Ai-M Series

2-Phase Closed-Loop Stepper Motor

◼ Features

NEW

- Minimal heat generating, high torque motor (control voltage 55V)
- Higher cost-efficiency compared to conventional servo motors
- Available in motor frame size 42mm, 56mm, 60mm

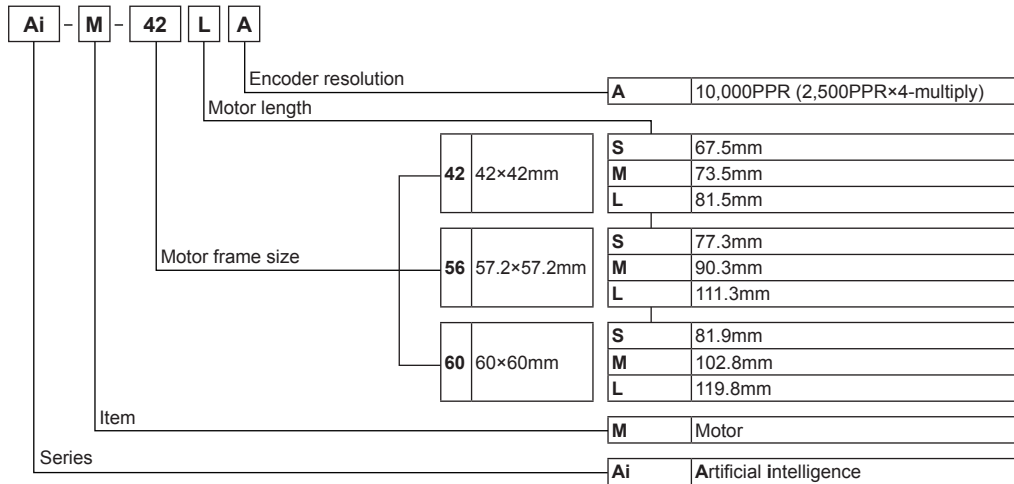⚠ **Please read "Safety Considerations" in operation manual before using.**

C E

[Frame size 56mm]
[Frame size 42mm]
[Frame size 60mm]

◼ Ordering Information

| Ai | – | M | – | 42 | L | A |

				Encoder resolution		**A**	10,000PPR (2,500PPR×4-multiply)

Motor length

			S	67.5mm
42	42×42mm		**M**	73.5mm
			L	81.5mm
56	57.2×57.2mm		**S**	77.3mm
			M	90.3mm
			L	111.3mm
60	60×60mm		**S**	81.9mm
			M	102.8mm
			L	119.8mm

Motor frame size

Item

M	Motor

Series

Ai	**A**rtificial **i**ntelligence

◎ AiS Series

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

◎ AiC Series

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

Autonics

2-Phase Closed-Loop Stepper Motor

◼ Specifications

◎ Motor

● Frame size 42mm

Model	Ai-M-42SA	Ai-M-42MA	Ai-M-42LA
Max. holding 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·cm^2 (35×10^{-7}kg·m^2)	54g·cm^2 (54×10^{-7}kg·m^2)	77g·cm^2 (77×10^{-7}kg·m^2)
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]	Approx. 0.45kg (approx. 0.34kg)	Approx. 0.52kg (approx. 0.41kg)	Approx. 0.59kg (approx. 0.48kg)

● Frame size 56mm

Model	Ai-M-56SA	Ai-M-56MA	Ai-M-56LA
Max. holding 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·cm^2 (140×10^{-7}kg·m^2)	280g·cm^2 (280×10^{-7}kg·m^2)	480g·cm^2 (480×10^{-7}kg·m^2)
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]	Approx. 0.76kg (approx. 0.62kg)	Approx. 0.99kg (approx. 0.85kg)	Approx. 1.36kg (approx. 1.22kg)

● Frame size 60mm

Model	Ai-M-60SA	Ai-M-60MA	Ai-M-60LA
Max. holding 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·cm^2 (240×10^{-7}kg·m^2)	490g·cm^2 (490×10^{-7}kg·m^2)	690g·cm^2 (690×10^{-7}kg·m^2)
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]	Approx. 0.89kg (approx. 0.75kg)	Approx. 1.27kg (approx. 1.13kg)	Approx. 1.58kg (approx. 1.44kg)

[1]: Max. holding torque is maintenance torque of stopping the motor when supplying the rated current (2-phase excitation) and is the standard for comparing the performance of motors.
[2]: The weight includes packaging. The weight in parenthesis is for unit only.

● Common specifications

Standard step angle		1.8°/0.9° (Full/Half step)
Motor phase		2-phase
Run method		Bipolar
Insulation class		B type (130℃)
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 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℃, storage: -20 to 70℃
	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]		Max. 0.025mm (load 25N)
Axial Movement[4]		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)
 - Indicates total quantity of dial gauge in case of 1 rotation of measuring part around the reference point.
[3]: Amount of radial shaft displacement when adding a radial load (25N) to the tip of the motor shaft.
[4]: Amount of axial shaft displacement when adding a axial load (50N) to the shaft.
※Environment resistance is rated at no freezing or condensation.
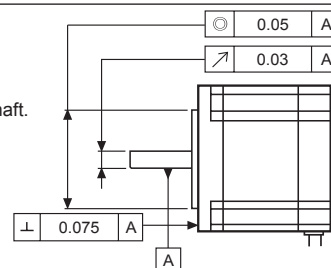
(A) Photoelectric Sensors

(B) Fiber Optic Sensors

(C) Door/Area Sensors

(D) Proximity Sensors

(E) Pressure Sensors

(F) Rotary Encoders

(G) Connectors/ Connector Cables/ Sensor Distribution Boxes/Sockets

(H) Temperature Controllers

(I) SSRs / Power Controllers

(J) Counters

(K) Timers

(L) Panel Meters

(M) Tacho / Speed / Pulse Meters

(N) Display Units

(O) Sensor Controllers

(P) Switching Mode Power Supplies

(Q) Stepper Motors & Drivers & Controllers

(R) Graphic/ Logic Panels

(S) Field Network Devices

(T) Software

Ai-M Series

▣ Specifications

◎ Encoder

Item		Incremental rotary encoder
Resolution		10,000PPR (2,500PPR×4-multiply)
Electrical specification	Output phase	A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase
	Output duty rate	$\frac{T}{2} \pm \frac{T}{4}$ (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: min. 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)

▣ Encoder Control Output Diagram

Line driver output	
Rotary encoder circuit	Load connection
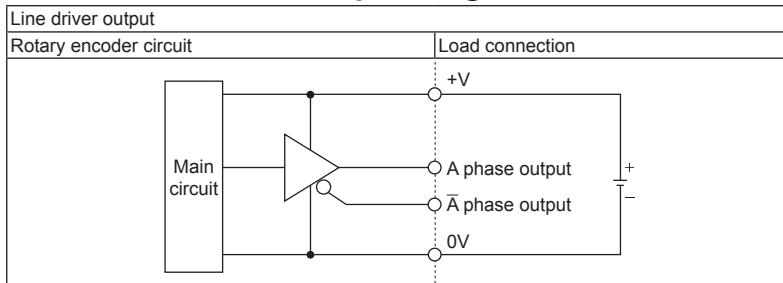
※All output circuits of A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase are the same.

▣ Encoder Output Waveforms
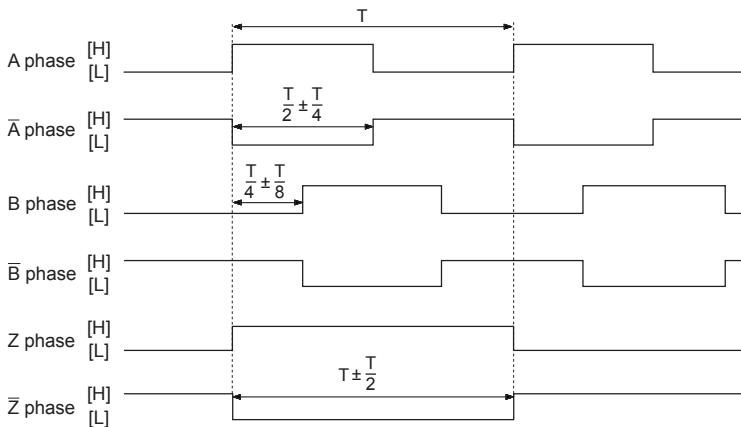
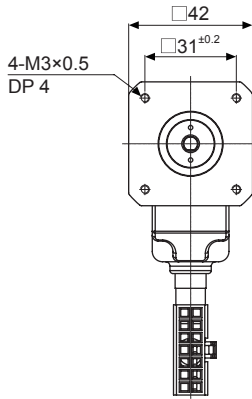Clockwise (CW) ※T=1 cycle of A, B phase
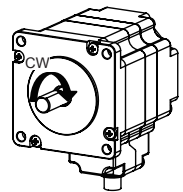
▣ Connection Diagram

Autonics 2 phase closed-loop stepper motors take bipolar wiring methods.
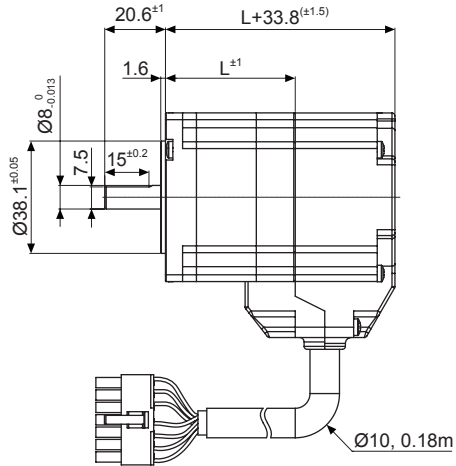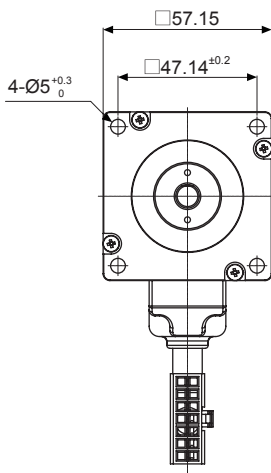The wiring colors for each phase and lead-wire are as the followings:

Red/Black(A)   Yellow/Black(B)

Motor

Blue/Black($\overline{A}$)   White/Black($\overline{B}$)

Autonics
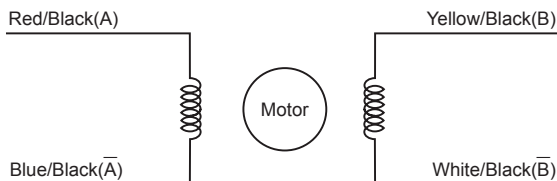
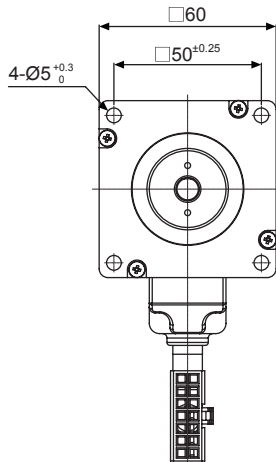# 2-Phase Closed-Loop Stepper Motor

■ Dimensions

◎ Frame size 42mm

□42
□31$^{±0.2}$
4-M3×0.5
DP 4

20$^{±1}$ L+33.4$^{(±1.5)}$
1.8   L$^{±1}$
Ø5$_{-0.012}^{0}$
4.5
Ø22$_{-0.03}^{0}$
15$^{±0.2}$
Ø10, 0.18m
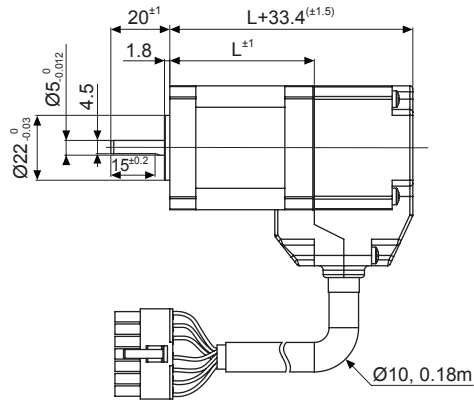
Model	L
Ai-M-42SA	34.1
Ai-M-42MA	40.1
Ai-M-42LA	48.1

◎ Frame size 56mm

□57.15
□47.14$^{±0.2}$
4-Ø5$_{0}^{+0.3}$

20.6$^{±1}$ L+33.8$^{(±1.5)}$
1.6   L$^{±1}$
Ø8$_{-0.013}^{0}$
7.5
Ø38.1$^{±0.05}$
15$^{±0.2}$
Ø10, 0.18m

Model	L
Ai-M-56SA	43.5
Ai-M-56MA	56.5
Ai-M-56LA	77.5

◎ Frame size 60mm

□60
□50$^{±0.25}$
4-Ø5$_{0}^{+0.3}$

20.6$^{±1}$ L+33.8$^{(±1.5)}$
1.6   L$^{±1}$
Ø8$_{-0.013}^{0}$
7.5
Ø38.1$^{±0.05}$
15$^{±0.2}$
Ø10, 0.18m
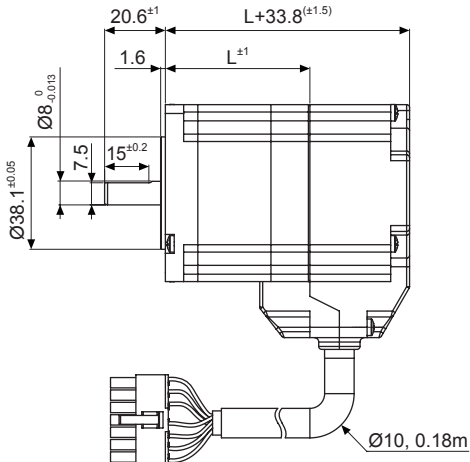
Model	L
Ai-M-60SA	48.1
Ai-M-60MA	69
Ai-M-60LA	86

Ai-M Series

■ Motor Characteristics

◎ Frame size 42mm

Torque[kgf·cm] vs Speed [rpm]
Ai-M-42LA
Ai-M-42MA
Ai-M-42SA

◎ Frame size 56mm

Torque[kgf·cm] vs Speed [rpm]
Ai-M-56LA
Ai-M-56MA
Ai-M-56SA

◎ Frame size 60mm

Torque[kgf·cm] vs Speed [rpm]
Ai-M-60LA
Ai-M-60MA
Ai-M-60SA
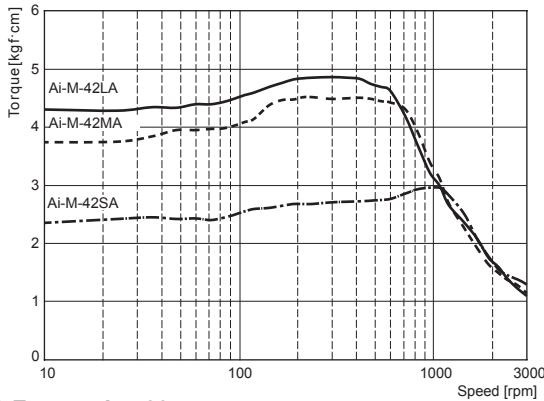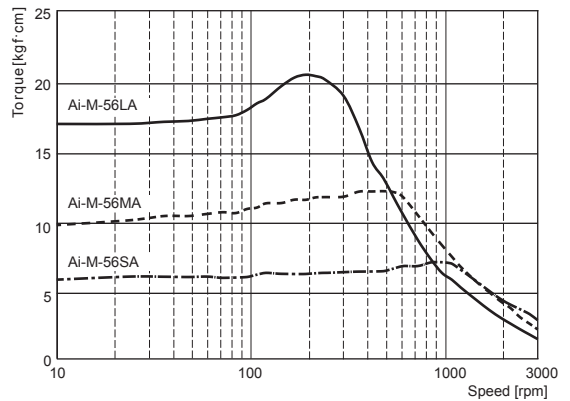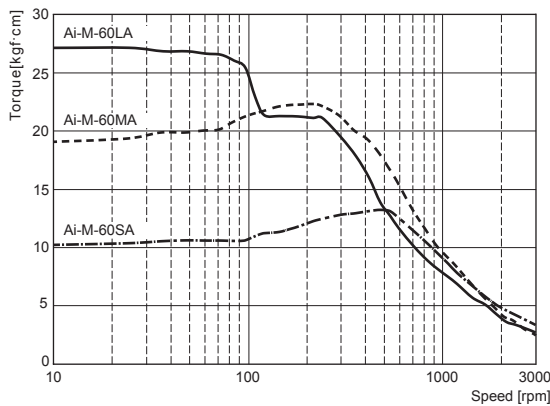
■ Connection Connectors of Motor

◎ CN2: Motor+Encoder Connector

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	GND EARTH	12	N·C
	6	MOTOR A	13	MOTOR B
	7	MOTOR $\overline{A}$	14	MOTOR $\overline{B}$

Type		Specifications			Manufacture
		Connector	Connector terminal	Housing	
CN2	Motor+Encoder	5557-14R	5556T	——	Molex

※Above connectors are suitable for Ai-M Series. You can use equivalent or substitute connectors.

◎ Cable (sold separately)

Type	Model	
Motor+Encoder cable	Normal	Moving
	C1D14M-□[※1]	C1DF14M-□[※1]

※1: □ indicates cable length (1, 2, 3, 5, 7, 10).
 E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

■ Motor Installation

1. Mounting direction

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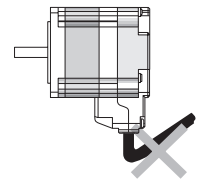Refer to the table below for allowable shaft overhung load / thrust load.

Side ways

Overhung load

D※1

Facing up, down

Thrust load
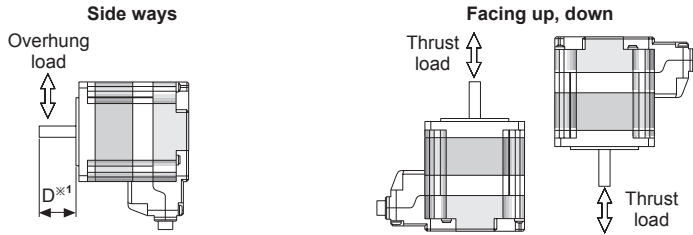
Thrust load

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

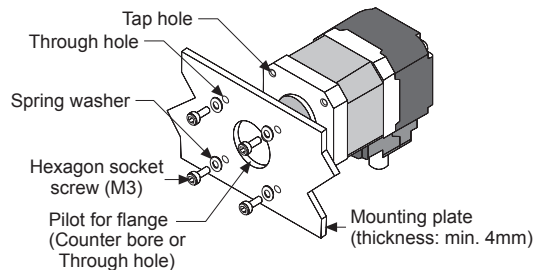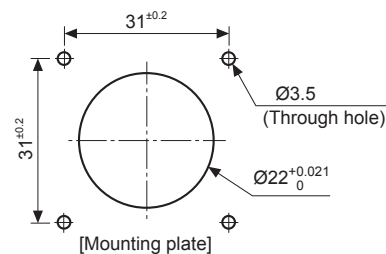| Motor size	The distance from the shaft in front (mm), Allowable overhung load [kgf (N)]				Allowable thrust load
	D=0	D=5	D=10	D=15	
Frame size 42mm	2 (20)	2.6 (25)	3.5 (34)	5.3 (52)	Under the load of motor
Frame size 56mm	5.5 (54)	6.8 (67)	9.1 (89)	13.3 (130)	
Frame size 60mm					

Do not apply excessive force to motor cable when mounting motors.
Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable by force.
In case of frequent cable movement required application, proper safety countermeasures must be ensured.
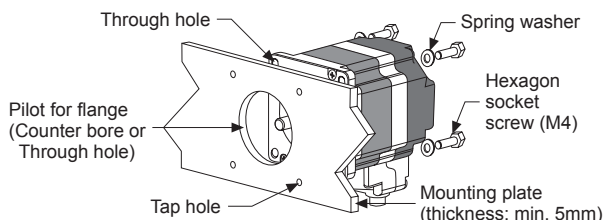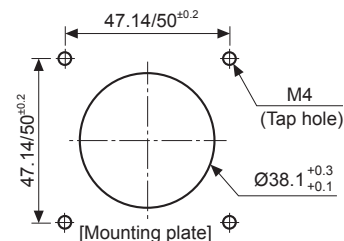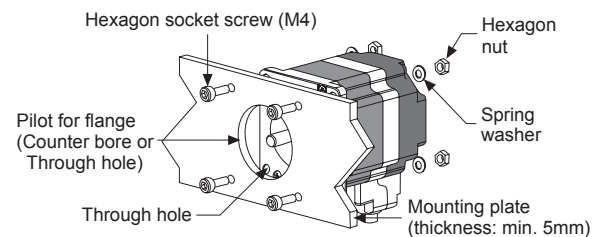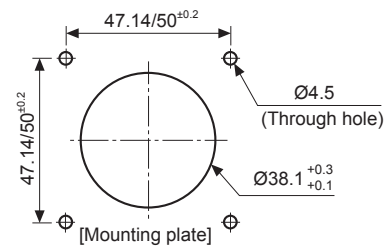
2. Mounting method

◎ **Frame size 42mm**

31±0.2

31±0.2

Ø3.5 (Through hole)

Ø22 +0.021 / 0

[Mounting plate]

Tap hole
Through hole
Spring washer
Hexagon socket screw (M3)
Pilot for flange (Counter bore or Through hole)
Mounting plate (thickness: min. 4mm)

◎ **Frame size 56mm/60mm**

47.14/50±0.2

47.14/50±0.2

Ø4.5 (Through hole)

Ø38.1 +0.3 / +0.1

[Mounting plate]

Hexagon socket screw (M4)
Hexagon nut
Spring washer
Pilot for flange (Counter bore or Through hole)
Through hole
Mounting plate (thickness: min. 5mm)

47.14/50±0.2

47.14/50±0.2

M4 (Tap hole)

Ø38.1 +0.3 / +0.1

[Mounting plate]

Through hole
Spring washer
Pilot for flange (Counter bore or Through hole)
Hexagon socket screw (M4)
Tap hole
Mounting plate (thickness: min. 5mm)

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, hexagon nuts, spring washers and flat washers.
Refer to the table below for allowable thickness of mounting plate and using bolt.
Do not draw the wire with over strength 30N after wiring the encoder.

(A) Photoelectric Sensors

(B) Fiber Optic Sensors

(C) Door/Area Sensors

(D) Proximity Sensors

(E) Pressure Sensors

(F) Rotary Encoders

(G) Connectors/ Connector Cables/ Sensor Distribution Boxes/Sockets

(H) Temperature Controllers

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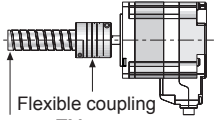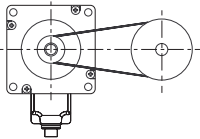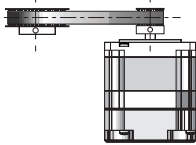
Ai-M Series

3. Connection with load

When connecting the load, be sure of the center, tension of the belt, and parallel of the pulley.
When connecting the load such as a pulley, a belt, be sure of the allowable thrust load, radial load, and shock.
Tighten the screw for a coupling or a pulley not to be unscrewed.
When connecting a coupling or a pulley on the motor shaft, be sure of damage of the motor shaft and the motor shaft bearing.
Do not disassemble or modify the motor shaft to connect with the load.

Direct load connection with coupling	Load connection with pulley, belt, and wire	Load connection with gear
 Flexible coupling Ball screw or TM screw ※Use Autonics flexible coupling (ERB Series).		
When connecting the load directly (ball screw, TM screw, etc) to the motor shaft, use a flexible coupling as shown in the above figure. If the center of the load is not aligned with that of shaft, it may cause severe vibration, shaft damage or shorten life cycle of the shaft bearing.	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.	The motor shaft and the load shaft should be parallel. Connect the motor shaft to the center of gear teeth side to be interlocked.

4. Installation condition

Install the motor in a place that meets certain conditions specified below.
It may cause product damage if it is used out of following conditions.
①Inside of the housing which is installed indoors
    (This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
②Within 0 to 50℃ (at non-freezing status) of ambient temperature
③Within 20 to 85%RH (at non-dew status) of ambient humidity
④The place without explosive, flammable and corrosive gas
⑤The place without direct ray of light
⑥The place where dust or metal scrap does not enter into the unit
⑦The place without contact with water, oil, or other liquid
⑧The place without contact with strong alkali or acidity
⑨The place where easy heat dissipation could be made
⑩The place without continuous vibration or severe shock
⑪The place with less salt content
⑫The place with less electronic noise occurs by welding machine, motor, etc.
⑬The place where no radioactive substances and magnetic fields exist. It shall be no vacuum status as well.

▣ Troubleshooting

1. When motor does not rotate
    ①Check the connection status between controller and driver, and pulse input specifications (voltage, width).
    ②Check the pulse and direction signal are connected correctly.
2. When motor rotates to the opposite direction of the designated direction
    ①When RUN mode is 1-pulse input method, CCW input [H] is for forward, [L] is for backward.
    ②When RUN mode is 2-pulse input method, check CW and CCW pulse input are changed or not.
3. When motor drive is unstable
    ①Check that driver and motor are connected correctly.
    ②Check the driver pulse input specifications (voltage, width).

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◧ Proper Usage

1. Follow instructions in 'Cautions during Use'.
   Otherwise, it may cause unexpected accidents.
2. Using motors at low temperature may cause reducing ball bearing's grease consistency and friction torque is increased.
   Start the motor in a steady manner since motor's torque is not to be influenced.
3. If wiring encoder cable, separate it from high voltage line or power cable for preventing surge and inductive noise.
   The cable length should be as short as possible.
   Failure to follow this instruction may result in raised cable resistance, residual voltage, and output waveform noise
4. Must connect the encoder shield cable to the F.G. terminal.
5. For using motor, it is recommended to maintenance and inspection regularly.
   ①Unwinding bolts and connection parts for the unit installation and load connection
   ②Strange sound from ball bearing of the unit
   ③Damage and stress of lead cable of the unit
   ④Connection error with driver
   ⑤Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.
6. This unit may be used in the following environments.
   ①Indoors (in the environment condition rated in 'Specifications')
   ②Altitude max. 2,000m
   ③Pollution degree 2
   ④Installation category II