### Autonics

# 2-Phase Closed-Loop Stepper Motor Ai-M SERIES

# INSTRUCTION MANUA



Thank you for choosing our Autonics product Please read the following safety considerations before use.

## ■ Safety Considerations

\*\*Please observe all safety considerations for safe and proper product operation to avoid

 $imes \Delta$  symbol represents caution due to special circumstances in which hazards may occur.

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

1. 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, or product and ambient equipment

- Failure to follow this instruction may result in fire, personal injury, or economic loss. 2. Fix the unit on the metal plate.
- Failure to follow this instruction may result in personal injury, or product and ambient damage.

  3. Do not connect, repair, or inspect the unit while connected to a power source. Failure to follow this instruction may result in fire.

  4. Install the unit after considering counter plan against power failure. Failure to follow this instruction may result in personal injury, or economic loss.

  5. Check 'Connections' before wiring.
  Failure to follow this instruction may result in fire.

  Do not disassemble or modify the unit

- Do not disassemble or modify the unit.
   Failure to follow this instruction may result in fire.

- Failure to follow this instruction may result in fire.

  7. Install the motor in the housing or ground it.
  Failure to follow this instruction may result in fire, or personal injury.

  8. Make sure to install covers on motor rotating components.
  Failure to follow this instruction may result in personal injury.

  9. Do not touch the unit during or after operation for a while.
  Failure to follow this instruction may result in burn due to high temperature of the surface.

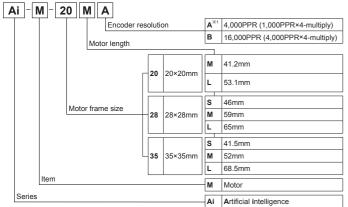
  10. Turn OFF the power directly when error occurs.
  Failure to follow this instruction may result in fire, or personal injury.

### **⚠** Caution

- I. Use the unit within the rated specifications.
  Failure to follow this instruction may result in fire or product damage.

  2. Use dry cloth to clean the unit, and do not use water or organic solvent.
  Failure to follow this instruction may result in fire.
- Do not use the unit in the place where flammable/explosive/corrosive gas direct sunlight, radiant heat, vibration, impact, or salinity may be present.
- Failure to follow this instruction may result in fire or explosion
- 4. The motor may overheat depending on the environment.

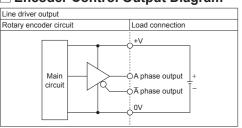
  Install the unit at the well-ventilated environment and forced cooling with a cooling fan. Failure to follow this instruction may result in product damage and degra
- Ordering Information



\*1: Microstep control for AiS driver, it controls up to 10.000PPR

AiS Ser	AiS Series				
Set	Driver	Motor			
AiS-20MA	AiS-D-20MA	Ai-M-20MA			
AiS-20LA	AiS-D-20LA	Ai-M-20LA			
AiS-28SB	AiS-D-28SB	Ai-M-28SB			
AiS-28MB	AiS-D-28MB	Ai-M-28MB			
AiS-28LB	AiS-D-28LB	Ai-M-28LB			
AiS-35SB	AiS-D-35SB	Ai-M-35SB			
AiS-35MB	AiS-D-35MB	Ai-M-35MB			
AiS-35LB	AiS-D-35LB	Ai-M-35LB			

## ■ Encoder Control Output Diagram



XAll output circuits of A, Ā, B, Ē, Z, Ā phase are the same.

The above specifi cations are subject to change and some models may be discor

- \*Be sure to follow cautions written in the instruction manual and the technical descriptions

### Specifications

Motor

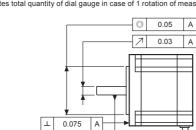
Frame Size Zumm				
Model	Ai-M-20MA	Ai-M-20LA		
Max. holding torque*1	0.183kgf·cm (0.018N·m)	0.357kgf·cm (0.035N·m)		
Rotor moment of inertia	2g·cm² (2×10 <sup>-7</sup> kg·m²)			
Rated current	0.6A/Phase			
Resistance	6.6Ω/Phase ±10%	10.5Ω/Phase ±10%		
Inductance	2.1mH/Phase ±20%	4.0mH/Phase ±20%		
Weight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

Frame size 28mm					
Model	Ai-M-28SB	Ai-M-28MB	Ai-M-28LB		
Max. holding 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 (9×10 <sup>-7</sup> kg·m²)	12g·cm² (12×10 <sup>-7</sup> kg·m²)	18g·cm <sup>2</sup> (18×10 <sup>-7</sup> kg·m <sup>2</sup> )		
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 <sup>**2</sup>	Approx. 0.260kg (approx. 0.162kg)	Approx. 0.318kg (approx. 0.222kg)	Approx. 0.342kg (approx. 0.248kg)		

Model	Ai-M-35SB	Ai-M-35MB	Ai-M-35LB
Max. holding torque <sup>*1</sup>	0.714kgf·cm (0.07N·m)	1.326kgf·cm (0.13N·m)	3.162kgf·cm (0.31N·m)
Rotor moment of inertia	8g·cm² (8×10 <sup>-7</sup> kg·m²)	14g·cm² (14×10 <sup>-7</sup> kg·m²)	22g·cm² (22×10 <sup>-7</sup> kg·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 <sup>**2</sup>	Approx. 0.278kg (approx. 0.180kg)	Approx. 0.347kg (approx. 0.250kg)	Approx. 0.456kg (approx. 0.366kg)

- X1: 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 o %2: The weight includes packaging. The weight in parenthesis is for unit only.

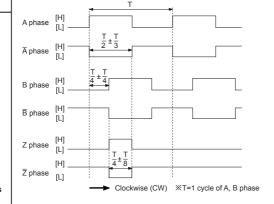
Commo	n specifications			
Standard ste	p angle	1.8° / 0.9° (Full/Half step)		
Motor phase		2 phase		
Run method		Bipolar		
Insulation cla	ass	B type (130°C)		
Insulation re	sistance	Over 100MΩ (at 500VDC megger) between motor coil-case		
Dielectric str	ength	0.5kVAC 50/60Hz for 1 min between motor coil-case		
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		
Environment	Ambient humidity	20 to 85%RH, storage: 15 to 90%RH		
Approval		C€		
Protection st	ructure	IP30 (IEC34-5 standard)		
Stop angle e	error <sup>**1</sup>	±0.09°		
Shaft vibration	on <sup>*2</sup>	0.03mm T.I.R.		
Radial Move	ment <sup>**3</sup>	Max. 0.025mm (load 450g)		
Axial Movem	nent <sup>**4</sup>	Max. 0.005mm (load 920g)		
Concentricity for shaft of setup in-low		0.05mm T.I.R.		
Perpendicularity of set-up plate shaft		0.075mm T.I.R.		
X1: Specific	ations are for full-step	angle, without load. (Values may vary by load size)		
※2: T.I.R. (T	otal Indicator Reading	g)		
- Indicates total quantity of dial gauge in case of 1 rotation of measuring part around the reference				
point.				
		O   O O   A		



X3: Amount of radial shaft displacement when adding a radial load (450g) to the tip of the motor shaft.
 X4: Amount of axial shaft displacement when adding a axial load (920g) to the shaft.
 Environment resistance is rated at no freezing or condensation.

O I	Encoder					
Item			Magnetic incremental rotary encoder			
	Frame size 20mm <sup>×1</sup>		4,000PPR (1,000PPR×4-multiply)			
Re	solution	Frame size 28mm	16,000PPR (4,000PPR×4-multiply)			
		Frame size 35mm				
	Output pha	ase	A, A, B, B, Z, Z phase			
	Output duty rate		$\frac{1}{2} \pm \frac{1}{3}$ (T=1 cycle of A phase)			
٦	Phase difference of output		Output between A and B phase: $\frac{T}{4} \pm \frac{T}{4}$ (T=1 cycle of A phase)			
specification	Control output	Line driver output	• [Low] - Load current: max. 20mA, Residual voltage: max. 0.5VDC== • [High] - Load current: max20mA, Output voltage: min. 2.5VDC==			
) e	Response	Frame size 20mm	Max. 1.5μs (cable length: 2m, I sink = 20mA)			
	time	Frame size 28mm	Max. 1μs (cable length: 2m, I sink = 20mA)			
Electrical	(rise, fall)	Frame size 35mm	IMax. τμs (cable length. 2m, r sink – 20mA)			
E E	Max. response frequency	Frame size 20mm	200kHz			
-		Frame size 28mm	1.000kHz			
		Frame size 35mm	1,000K12			
	Power supply		5VDC ±5% (ripple P-P: max. 5%)			
	Current consumption		Max. 50mA (disconnection of the load)			
Ж1	: Microstep	control for AiS driver,	it controls up to 10,000PPR.			

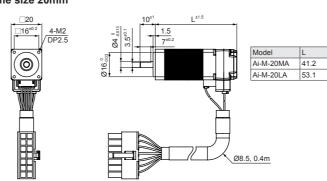
### **■** Encoder Output Waveforms



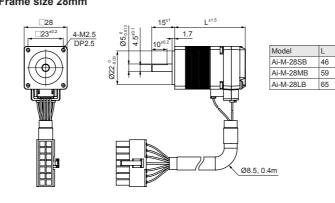


## Dimensions

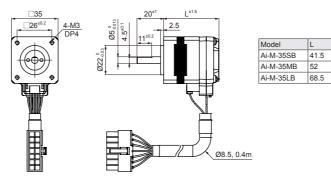
Frame size 20mm



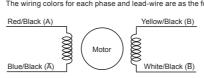
### ○ Frame size 28mm



#### ○ Frame size 35mm



#### ■ Connection Diagram



### ■ Connection Connectors of Motor

Pin arran	gement	Pin No.	Function	Pin No.	Function
8901734 1234567		1	GND	8	+5VDC
		2	ENCODER A	9	ENCODER Ā
		3	ENCODER B	10	ENCODER B
		4	ENCODER Z	11	ENCODER Z
		5	GND EARTH	12	N·C
	6	MOTOR A	13	MOTOR B	
		7	MOTOR Ā	14	MOTOR B
Туре		Specifications			
		Connector	Connector terminal	Housing	Manufacture
CN2	Motor+Encoder	5557-14R	5556T2	T_	Molex

## Cable (sold separately)

Туре	Model			
Motor+Encoder cable	Normal	Moving		
	C1D14M-□ <sup>X1</sup>	C1DF14M-⊡ <sup>ж1</sup>		
X1: ☐ indicates cable length (1, 2, 3, 5, 7, 10).				

E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

## ■ Troubleshooting

- ①Check the connection status between controller and driver, and pulse input specifications (voltage, width)
- ©Check 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. When RUN mode is 2-pulse input method, check CW and CCW pulse input are changed or not.
- When motor drive is unstable
- ①Check that driver and motor are connected correctly. ②Check the driver pulse input specifications (voltage, width).

#### ■ 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

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



X1: The distance from the shaft in front (mm)

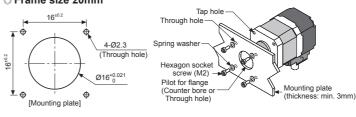
Motor size	The distance from the shaft in front (mm), Allowable overhung load [kgf (N)]				Allowable
IVIOLOI SIZE	D=0	D=5	D=10	D=15	thrust load
Frame size 20mm	1.22 (12)	1.53 (15)	_	_	Under the load of motor
Frame size 28mm	2.55 (25)	3.46 (34)	5.3 (52)		
Frame size 35mm	2 (20)	2.55 (25)	3.46 (34)	5.3 (52)	load of filotor

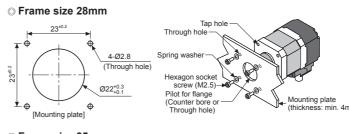
Do not apply excessive force to motor cable when mounting motors Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable by force

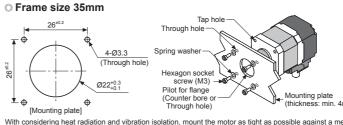


### 2. Mounting method

○ Frame size 20mm







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 5N after wiring the encoder.

#### 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		
Flexible coupling Ball screw or TM screw  **Use Autonics flexible coupling (ERB Series).		

#### 4. Installation condition

When connecting the load directly

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.)

@Within 0 to 50°C (at non-freezing status) of ambient temperature

When connecting the load directly (ball 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.

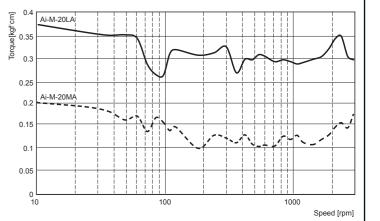
The motor shaft and the load shaft should be parallel. Connect the motor shaft and the line which connects the center of two pulleys to a right angle.

The motor shaft and the load shaft The motor shaft and the load shaft

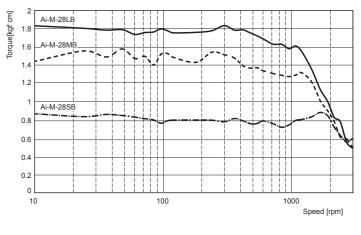
- ③Within 20 to 85%RH (at non-dew status) of ambient humidity
- The place without explosive, flammable and corrosive gas
   The place without direct ray of light
   The place where dust or metal scrap does not enter into the unit
- The place without contact with water, oil, or other liquid The place without contact with strong alkali or acidity The place where easy heat dissipation could be made
- The place without continuous vibration or severe shock
- @The place with less electronic noise occurs by welding machine, motor, etc
- ®The place where no radioactive substances and magnetic fields exist. It shall be no vacuum

#### ■ Motor Characteristics

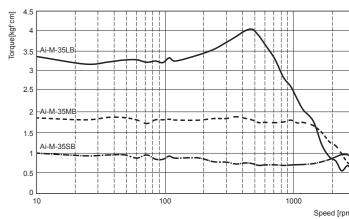
○ Frame size 20mm



#### Frame size 28mm



#### ○ Frame size 35mm



### Cautions during Use

- 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.  $\ensuremath{\textcircled{\upomega}}$  Unwinding 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 4 Connection error with driver
- ⑤Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.
- . This unit may be used in the following environments.
- ①Indoors (in the environment condition rated in 'Specifications') ②Altitude max 2 000m
- ③Pollution degree 2 @Installation category II

### Major Products

- Photoelectric Sensors Temperature Controlle
- Door Side Sensors Counters
- Area Sensors Timers
   Proximity Sensors Panel Meters
   Pressure Sensors Tachometer/Pulse (Rate) Meters
- Rotary Encoders Display Units
- Connector/Sockets Sensor Controllers
- Switching Mode Power Supplies
  Control Switches/Lamps/Buzzers
- I/O Terminal Blocks & Cables ■ Stepper Motors/Drivers/Motion Control
- Graphic/Logic Panels
- Field Network Devices ■ Laser Marking System (Fiber, CO₂, Nd: YAG)
  ■ Laser Welding/Cutting System

**Autonics** Corporation

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