

Standard / Built-in Brake Type 2-Phase Closed-loop Stepper Motor (□ 42 mm, □ 56 mm, □ 60 mm)



Ai-M Series PRODUCT MANUAL

For your safety, read and follow the considerations written in the instruction manual, other manuals and Autonics website.

The specifications, dimensions, etc. are subject to change without notice for product improvement. Some models may be discontinued without notice.

Features

- Supports □ 42 mm, □ 56 mm, □ 60 mm
- Non-excitation electromagnetic built-in brake type motor (Ai-M-B Series)

Safety Considerations

- Observe all 'Safety Considerations' for safe and proper operation to avoid hazards.
- ⚠ symbol indicates caution due to special circumstances in which hazards may occur.

⚠ Warning Failure to follow instructions may result in serious injury or death.

- 01. 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.
- 02. 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.
- 03. Do not use the brake for safety.**
Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
- 04. Fix the unit on the metal plate.**
Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
- 05. Do not connect, repair, or inspect the unit while connected to a power source.**
Failure to follow this instruction may result in fire.
- 06. Install the unit after considering counter plan against power failure.**
Failure to follow this instruction may result in personal injury, economic loss or fire.
- 07. Check 'Connections' before wiring.**
Failure to follow this instruction may result in fire.
- 08. Do not disassemble or modify the unit.**
Failure to follow this instruction may result in fire or electric shock.
- 09. Install the motor in the housing or ground it.**
Failure to follow this instruction may result in personal injury, fire or electronic shock.
- 10. Make sure to install covers on motor rotating components.**
Failure to follow this instruction may result in personal injury.
- 11. 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.
- 12. Upon occurrence of an error, disconnect the power source.**
Failure to follow this instruction may result in personal injury, fire or electronic shock.

⚠ Caution Failure to follow instructions may result in injury or product damage.

- 01. Use the unit within the rated specifications.**
Failure to follow this instruction may result in fire or product damage.
- 02. Brake is non-polar. When connecting the brake, use AWG 24 (0.2 mm²) cable or over.**
Failure to follow this instruction may result in malfunction due to contact failure.
- 03. Use a dry cloth to clean the unit, and do not use water or organic solvent.**
Failure to follow this instruction may result in fire.
- 04. 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 or degradation by heat.
- 05. Keep the product away from metal chip, dust, and wire residue which flow into the unit.**
Failure to follow this instruction may result in fire or product damage.

Cautions during Use

- Follow instructions in 'Cautions during Use'.
Otherwise, it may cause unexpected accidents.
- At low temperature, reducing the grease's consistency of ball-bearing and etc. causes the friction torque increment.
Start the motor gradually since motor's torque is in normal state.
- Encoder shield cable must be connected to F.G. terminal.
- When wiring encoder cable, separate it from high voltage cable, power cable, etc. to prevent surge and inductive noise and keep the cable length as short as possible.
Failure to follow this instruction may result in raised cable resistance, residual voltage and output waveform noise.
- Maintain and inspect regularly the following lists.
 - Unwinding bolts and connection parts for the unit installation and load connection
 - Abnormal sound from Ball-bearing of the unit
 - Damage and stress of lead cable of the unit
 - Connection error with driver
 - Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.

Specifications			
Model	Ai-M-42SA-□	Ai-M-42MA-□	Ai-M-42LA-□
Max. stop torque	0.25 N m	0.4 N m	0.48 N m
Rotor inertia moment	$35 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$54 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$77 \times 10^{-7} \text{ kg} \cdot \text{m}^2$
Rated current	1.7 A / Phase		
Basic step angle	1.8° / 0.9° (Full / Half step)		
Resistance	1.7 Ω / Phase ±10%	1.85 Ω / Phase ±10%	2.1 Ω / Phase ±10%
Inductance	1.9 mH / Phase ±20%	3.5 mH / Phase ±20%	4.4 mH / Phase ±20%
Unit weight (packaged) ⁰¹⁾	≈ 0.34 kg (≈ 0.45 kg)	≈ 0.41 kg (≈ 0.52 kg)	≈ 0.48 kg (≈ 0.59 kg)
	≈ 0.67 kg (≈ 0.77 kg)	≈ 0.73 kg (≈ 0.83 kg)	≈ 0.80 kg (≈ 0.90 kg)
Model	Ai-M-56SA-□	Ai-M-56MA-□	Ai-M-56LA-□
Max. stop torque	0.6 N m	1.2 N m	2.0 N m
Rotor inertia moment	$140 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$280 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$480 \times 10^{-7} \text{ kg} \cdot \text{m}^2$
Rated current	3.5 A / Phase		
Basic step angle	1.8° / 0.9° (Full / Half step)		
Resistance	0.55 Ω / Phase ±10%	0.57 Ω / Phase ±10%	0.93 Ω / Phase ±10%
Inductance	1.05 mH / Phase ±20%	1.8 mH / Phase ±20%	3.7 mH / Phase ±20%
Unit weight (packaged) ⁰¹⁾	≈ 0.62 kg (≈ 0.76 kg)	≈ 0.85 kg (≈ 0.99 kg)	≈ 1.22 kg (≈ 1.36 kg)
	≈ 1.15 kg (≈ 1.30 kg)	≈ 1.38 kg (≈ 1.52 kg)	≈ 1.75 kg (≈ 1.90 kg)
Model	Ai-M-60SA-□	Ai-M-60MA-□	Ai-M-60LA-□
Max. stop torque	1.1 N m	2.2 N m	2.9 N m
Rotor inertia moment	$240 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$490 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$690 \times 10^{-7} \text{ kg} \cdot \text{m}^2$
Rated current	3.5 A / Phase		
Basic step angle	1.8° / 0.9° (Full / Half step)		
Resistance	1.0 Ω / Phase ±10%	1.23 Ω / Phase ±10%	1.3 Ω / Phase ±10%
Inductance	1.5 mH / Phase ±20%	2.6 mH / Phase ±20%	3.8 mH / Phase ±20%
Unit weight (packaged) ⁰¹⁾	≈ 0.75 kg (≈ 0.89 kg)	≈ 1.13 kg (≈ 1.27 kg)	≈ 1.44 kg (≈ 1.58 kg)
	≈ 1.36 kg (≈ 1.53 kg)	≈ 1.74 kg (≈ 1.90 kg)	≈ 2.07 kg (≈ 2.23 kg)

01) Listed in order of
Standard type
Built-in brake type

Motor phase	2-phase
RUN method	Bipolar
Insulation class	B type (130°C)
Insulation resistance	Between the motor coil and the case: ≥ 100 MΩ (500 VDC≐ megger)
Dielectric strength	Between the all charging part and the case: 500 VAC~ 50 / 60 Hz for 1 minute
Vibration	1.5 mm double amplitude at frequency 10 to 55 Hz in each X, Y, Z direction for 2 hours
Shock	≤ 50 G
Ambient temp.	0 to 50°C, storage: -20 to 70°C (no freezing or condensation)
Ambient humi.	20 to 85%RH, storage: 15 to 90%RH (no freezing or condensation)
Protection rating	IP30 (IEC34-5 standard)
Certification	CE UK ENEC
Stop angle error	± 0.09° (Full step, no load)
Shaft vibration	0.03 mm T.I.R.
Radial movement ⁰¹⁾	≤ 0.025 mm T.I.R.
Axial movement ⁰²⁾	≤ 0.01 mm T.I.R.
Shaft concentricity	0.05 mm T.I.R.
Shaft perpendicularity	0.075 mm T.I.R.

01) Amount of radial shaft displacement when applying radial load (25 N) to the end of the shaft.

02) Amount of axial shaft displacement when applying axial load (50 N) to the motor shaft.

Encoder type	Incremental rotary encoder
Power supply	5 VDC≐ ± 5% (ripple P-P: ≤ 5%)
Current consumption	≤ 50 mA (no load)
Resolution	10,000 PPR (2,500 PPR × 4)
Control output	Line driver output
Output phase	A, \bar{A} , B, \bar{B} , Z, \bar{Z}
Output waveform	Output duty rate: $\frac{T}{2} \pm \frac{T}{4}$, A-B phase difference: $\frac{T}{4} \pm \frac{T}{8}$ (T = 1 cycle of A)
Inflow current	≤ 20 mA
Residual voltage	≤ 0.5 VDC≐
Outflow current	≤ -20 mA
Output voltage	≥ 2.5 VDC≐
Response speed	≤ 0.5 μs (based on cable length: 2 m, I sink = 20 mA)
Max. response freq.	300 kHz

Built-in brake type frame size	□ 42 mm	□ 56 mm	□ 60 mm
Rated excitation voltage ⁰¹⁾	24 VDC≐ ±10%		
Rated excitation current	0.208 A	0.275 A	
Static friction torque	≥ 0.18 N m	≥ 0.8 N m	
Rotation part inertia moment	$6 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	$19 \times 10^{-7} \text{ kg} \cdot \text{m}^2$	
Insulation class	B type (130°C)		
B type brake	Brake is released when power ON, brake is locked when power OFF		
Operating time	≤ 25 ms	≤ 30 ms	
Releasing time	≤ 10 ms	≤ 20 ms	

01) In order to reduce the heat generation of the built-in brake, the voltage drops from 24 VDC≐ to 11.5 VDC≐ to control.

Connectors

■ Motor + Encoder connector

Pin	Function	Pin	Function
1	GND	8	+5 VDC≐
2	Encoder A	9	Encoder \bar{A}
3	Encoder B	10	Encoder \bar{B}
4	Encoder Z	11	Encoder \bar{Z}
5	PE	12	N·C
6	Motor A	13	Motor B
7	Motor \bar{A}	14	Motor \bar{B}

■ Brake connector

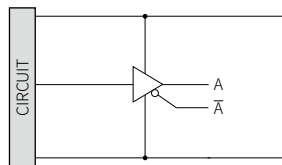
Pin	Function
1	24 VDC≐
2	GND

■ Suitable specifications

Type	Connector specifications	Manufacture
Motor + Encoder connector	5557-14R (connector terminal: 5556T)	Molex
Brake connector	5559-02P (connector terminal: 5558T)	Molex

Encoder Control Output Diagram

■ Line driver output

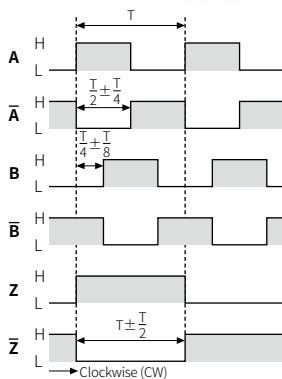


Encoder Output Waveforms

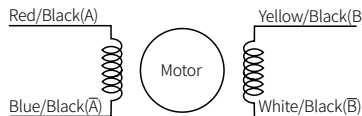
• The rotation direction is based on facing the shaft, and it is clockwise (CW) when rotating to the right.

• Output Duty rate: $\frac{T}{2} \pm \frac{T}{4}$ (T = 1 cycle of A)

• A-B phase difference: $\frac{T}{4} \pm \frac{T}{8}$ (T = 1 cycle of A)

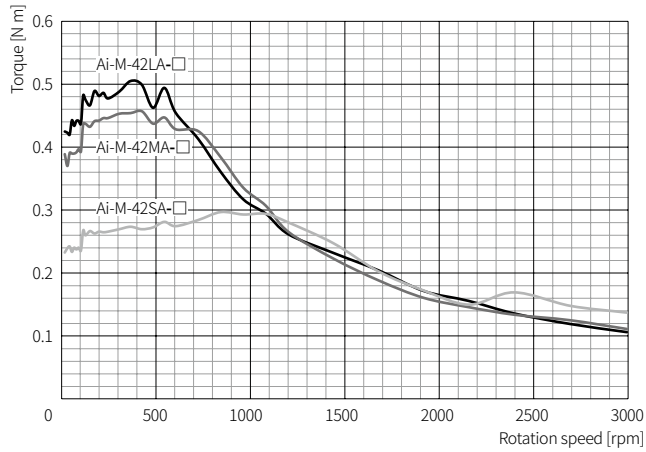


Connection Diagram

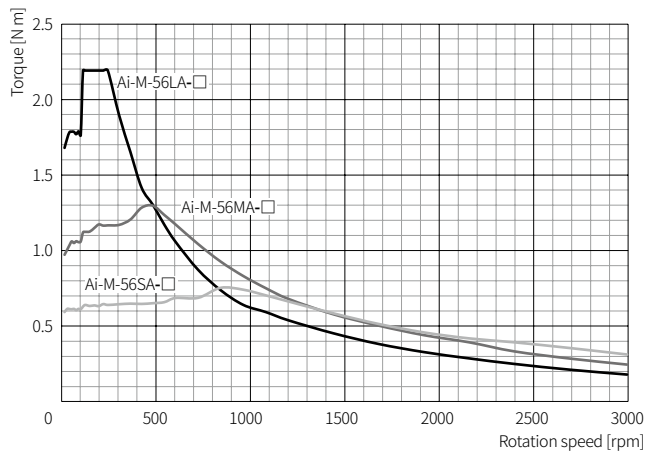


Motor Characteristics

■ □ 42 mm



■ □ 56 mm



■ □ 60 mm

