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**(B) Fiber Optic Sensors**
**(C) Displacement Sensors**
**(D) LiDAR**
**(E) Door/Area Sensors**
**(F) Vision Sensors**
**(G) Proximity Sensors**
**(H) Pressure Sensors**
**(I) Rotary Encoders**
**(J) Connectors / Connector Cables / Sensor Distribution Boxes / Sockets**

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**(C) Power Controllers**
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**(E) Timers**
**(F) Digital Panel Meters**
**(G) Indicators**
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**(I) Digital Display Units**
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# Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid hazards.
※⚠ 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.

## ▣ Closed Loop Stepper Motor

### ⚠ Warning

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, economic loss or fire.
2. **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.
3. **Do not use the brake for safety.**
   Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
4. **Fix the unit on the metal plate.**
   Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
5. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire.
6. **Install the unit after considering counter plan against power failure.**
   Failure to follow this instruction may result in personal injury, economic loss or fire.
7. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
8. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire or electric shock.
9. **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. **OFF the power directly when error occurs.**
    Failure to follow this instruction may result in personal injury, fire or electronic shock.

### ⚠ Caution

1. **Brake is non-polar. When connecting the brake, use AWG (0.2mm$^2$) cable or over.**
   Failure to follow this instruction may result in fire or malfunction due to contact failure.
2. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
3. **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.
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 or degradation by heat.

## ▣ Closed Loop Stepper Motor Driver

### ⚠ Warning

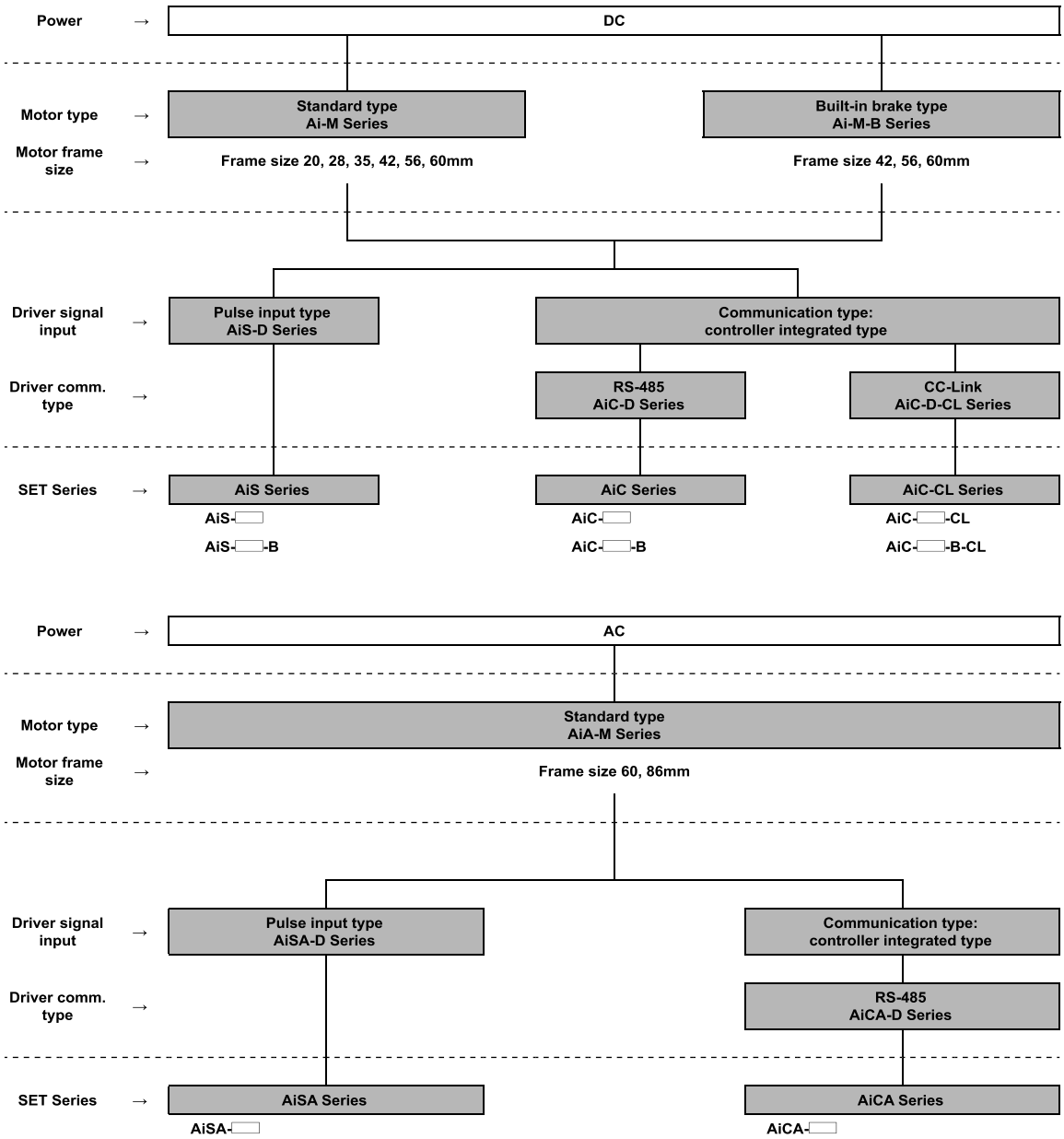
1. **Do not use the unit in the place where flammable/explosive/corrosive gas, high humidity, direct sunlight, radiant heat, vibration, impact, or salinity may be present.**
   Failure to follow this instruction may result in explosion or fire.
2. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire or electric shock.
3. **Install the unit after considering counter plan against power failure.**
   Failure to follow this instruction may result in personal injury, economic loss or fire.
4. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
5. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire or electric shock.
6. **Install the driver in the housing or ground it.**
   Failure to follow this instruction may result in personal injury, fire or electronic shock.
7. **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.
8. **Emergency stop directly when error occurs.**
   Failure to follow this instruction may result in personal injury or fire.

### ⚠ Caution

1. **When connecting the power input, use AWG 18(0.75mm$^2$) cable or over.**
   Failure to follow this instruction may result in fire.
2. **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.
3. **To use the motor safely, do not apply external force to the motor.**
4. **It is recommended to use STOPPER for the vertical load.**
5. **Install overcurrent prevention device (e.g. the current breaker, etc) to connect the driver with power.**
   Failure to follow this instruction may result in fire.
6. **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 driver movement.
7. **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 driver.
8. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
9. **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 or electric shock.
10. **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.
11. **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.
12. **Use the designated motor only.**
    Failure to follow this instruction may result in fire or product damage.

| | |
|---|---|
| | **General precaution**<br>Indicate general warning, caution or danger. |

# Closed Loop Stepper System Selection Guide




※For more detailed model name, refer to 'Closed loop Stepper System SET Scheme'.

# Closed Loop Stepper System SET Scheme

## ▣ Standard Type

| Power | Driver signal input | | Motor frame size | Motor | Driver | SET |
|---|---|---|---|---|---|---|
| DC | Pulse input type | | Frame size 20mm | Ai-M-20MA | AiS-D-20MA | AiS-20MA |
| | | | | Ai-M-20LA | AiS-D-20LA | AiS-20LA |
| | | | Frame size 28, 35mm | Ai-M-□SB | AiS-D-□SB | AiS-□SB |
| | | | | Ai-M-□MB | AiS-D-□MB | AiS-□MB |
| | | | | Ai-M-□LB | AiS-D-□LB | AiS-□LB |
| | | | Frame size 42, 56, 60mm | Ai-M-□SA | AiS-D-□SA | AiS-□SA |
| | | | | Ai-M-□MA | AiS-D-□MA | AiS-□MA |
| | | | | Ai-M-□LA | AiS-D-□LA | AiS-□LA |
| | Controller integrated type | RS-485 | Frame size 20mm | Ai-M-20MA | AiC-D-20MA | AiC-20MA |
| | | | | Ai-M-20LA | AiC-D-20LA | AiC-20LA |
| | | | Frame size 28, 35mm | Ai-M-□SB | AiC-D-□SB | AiC-□SB |
| | | | | Ai-M-□MB | AiC-D-□MB | AiC-□MB |
| | | | | Ai-M-□LB | AiC-D-□LB | AiC-□LB |
| | | | Frame size 42, 56, 60mm | Ai-M-□SA | AiC-D-□SA | AiC-□SA |
| | | | | Ai-M-□MA | AiC-D-□MA | AiC-□MA |
| | | | | Ai-M-□LA | AiC-D-□LA | AiC-□LA |
| | | CC-Link | Frame size 42, 56, 60mm | Ai-M-□SA | AiC-D-□SA-CL | AiC-□SA-CL |
| | | | | Ai-M-□MA | AiC-D-□MA-CL | AiC-□MA-CL |
| | | | | Ai-M-□LA | AiC-D-□LA-CL | AiC-□LA-CL |
| AC | Pulse input type | | Frame size 60, 86mm | AiA-M-□MA | AiSA-D-□MA | AiSA-□MA |
| | | | | AiA-M-□LA | AiSA-D-□LA | AiSA-□LA |
| | Controller integrated type | RS-485 | Frame size 60, 86mm | AiA-M-□MA | AiCA-D-□MA | AiCA-□MA |
| | | | | AiA-M-□LA | AiCA-D-□LA | AiCA-□LA |

## ▣ Built-in Brake Type

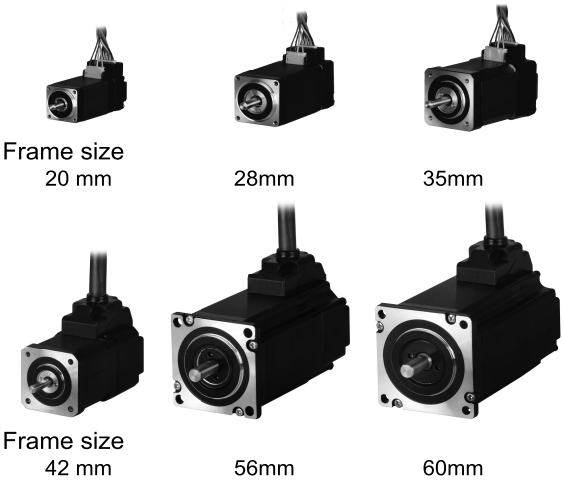
| Power | Driver signal input | | Motor frame size | Motor | Driver | SET |
|---|---|---|---|---|---|---|
| DC | Pulse input type | | Frame size 42, 56, 60mm | Ai-M-□SA-B | AiS-D-□SA-B | AiS-□SA-B |
| | | | | Ai-M-□MA-B | AiS-D-□MA-B | AiS-□MA-B |
| | | | | Ai-M-□LA-B | AiS-D-□LA-B | AiS-□LA-B |
| | Controller integrated type | RS-485 | Frame size 42, 56, 60mm | Ai-M-□SA-B | AiC-D-□SA-B | AiC-□SA-B |
| | | | | Ai-M-□MA-B | AiC-D-□MA-B | AiC-□MA-B |
| | | | | Ai-M-□LA-B | AiC-D-□LA-B | AiC-□LA-B |
| | | CC-Link | Frame size 42, 56, 60mm | Ai-M-□SA-B | AiC-D-□SA-B-CL | AiC-□SA-B-CL |
| | | | | Ai-M-□MA-B | AiC-D-□MA-B-CL | AiC-□MA-B-CL |
| | | | | Ai-M-□LA-B | AiC-D-□LA-B-CL | AiC-□LA-B-CL |

※□: motor frame size

# 2-Phase Closed-Loop Stepper Motor

## ▣ Features

- Minimal heat generating, high torque motor (control voltage 55V)
- Higher cost-efficiency compared to conventional servo motors
- Available in motor frame size 20mm, 28mm, 35mm, 42mm, 56mm, 60mm




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

CE

## ▣ Ordering Information

**Ai - M - 42 L A**

| | | | |
|---|---|---|---|
| Encoder resolution | A※1 | 4,000PPR(1,000PPR×4-multiply) |
| | B※2 | 16,000PPR(4,000PPR×4-multiply) |
| | A※3 | 10,000PPR(2,500PPR×4-multiply) |
| Motor length | | | |
| Motor frame size | 20 | 20×20mm | M 41.2mm |
| | | | L 53.1mm |
| | 28 | 28×28mm | S 46mm |
| | | | M 59mm |
| | | | L 65mm |
| | 35 | 35×35mm | S 41.5mm |
| | | | M 52mm |
| | | | L 68.5mm |
| | 42 | 42×42mm | S 67.5mm |
| | | | 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 |
| Item | | | M Motor |
| Series | | | Ai Artificial intelligence |

※1: Encoder resolution for frame size 20mm motors.
Microstep control for AiS driver, it controls up to 10,000PPR.
※2: Encoder resolution for frame size 28, 35mm motors.
※3: Encoder resolution for frame size 42, 56, 60mm motors.

## ▣ Specifications

### ◎ Motor

**• Frame size 20mm**

| 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·cm$^2$ (2×10$^{-7}$kg·m$^2$) | |
| 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) |

**• 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·cm$^2$ (9×10$^{-7}$kg·m$^2$) | 12g·cm$^2$ (12×10$^{-7}$kg·m$^2$) | 18g·cm$^2$ (18×10$^{-7}$kg·m$^2$) |
| 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) |

**• Frame size 35mm**

| Model | Ai-M-35SB | Ai-M-35MB | Ai-M-35LB |
|---|---|---|---|
| Max. holding 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·cm$^2$ (8×10$^{-7}$kg·m$^2$) | 14g·cm$^2$ (14×10$^{-7}$kg·m$^2$) | 22g·cm$^2$ (22×10$^{-7}$kg·m$^2$) |
| 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. 0.278g (approx. 0.180kg) | Approx. 0.347kg (approx. 0.250kg) | Approx. 0.456kg (approx. 0.366kg) |

**• 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.

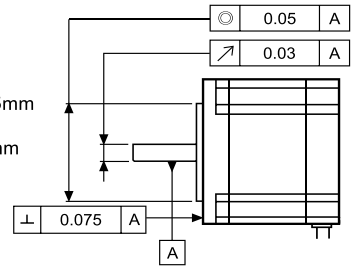
## ▣ Specifications

**• 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 | 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. 0.05mm (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)
- 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 (450g for frame size 20, 28, 35mm and 25N for frame size 42, 56, 60mm) to the tip of the motor shaft.
※4: Amount of axial shaft displacement when adding a axial load (920g for frame size 20, 28, 35mm and 50N for frame size 42, 56, 60mm) to the shaft.
※Environment resistance is rated at no freezing or condensation.




### ◎ Encoder

**• Frame size 20, 28, 35mm**

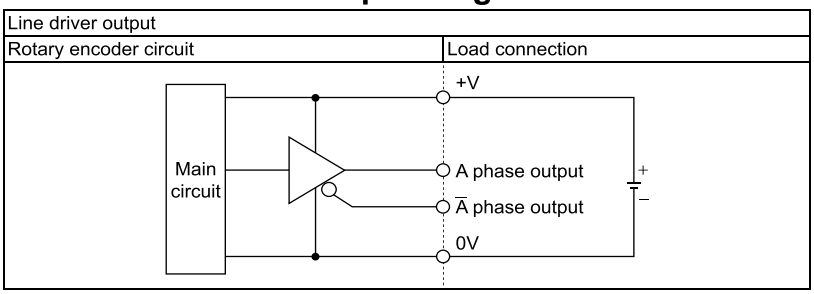
| Item | | | Magnetic incremental rotary encoder |
|---|---|---|---|
| Resolution | | Frame size 20mm※1 | 4,000PPR (1,000PPR×4-multiply) |
| | | Frame size 28, 35mm | 16,000PPR (4,000PPR×4-multiply) |
| Electrical specification | Output phase | | A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase |
| | Output duty rate | | $\frac{T}{2} \pm \frac{T}{3}$ (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⎓<br>• [High] - Load current: max. -20mA, output voltage: min. 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) |

※1: Microstep control for AiS driver, it controls up to 10,000PPR.

**• Frame size 42, 56, 60mm**

| 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⎓<br>• [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

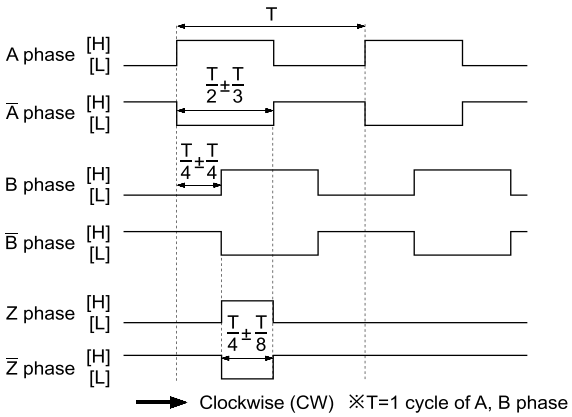


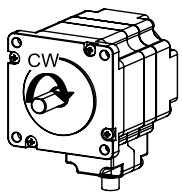

※All output circuits of A, Ā, B, B̄, Z, Z̄ phase are the same.



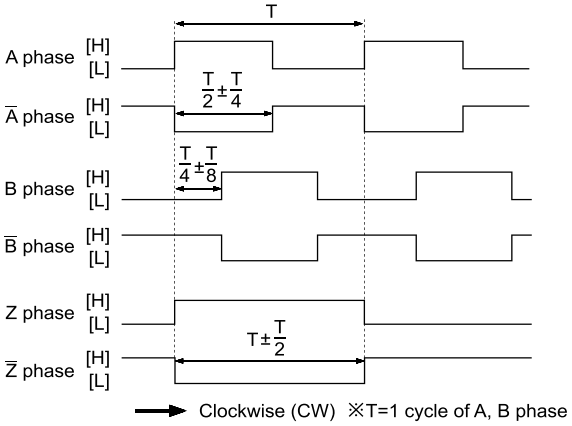
## ■ Encoder Output Waveforms

### ◎ Frame size 20, 28, 35mm



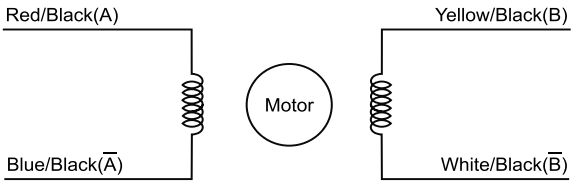

### ◎ Frame size 42, 56, 60mm





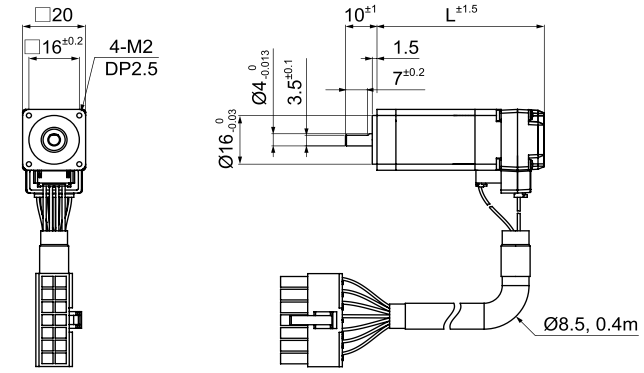

## ■ Connection Diagram

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



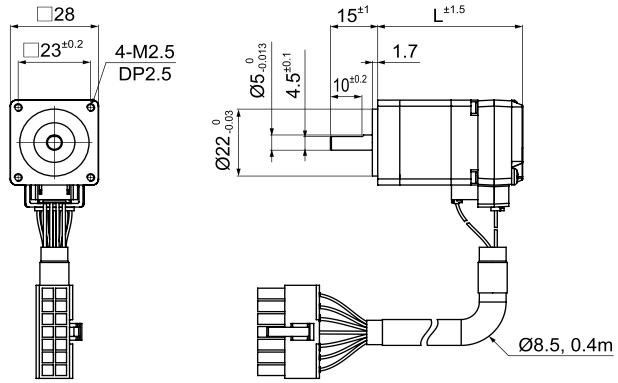
## ▣ Dimensions

### ◎ Frame size 20mm



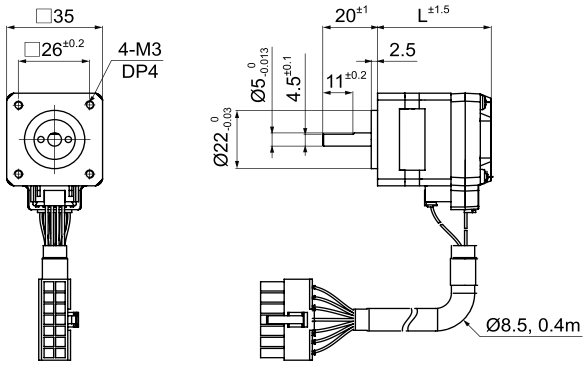

| Model | L |
|---|---|
| Ai-M-20MA | 41.2 |
| Ai-M-20LA | 53.1 |

### ◎ Frame size 28mm




| Model | L |
|---|---|
| Ai-M-28SB | 46 |
| Ai-M-28MB | 59 |
| Ai-M-28LB | 65 |

### ◎ Frame size 35mm



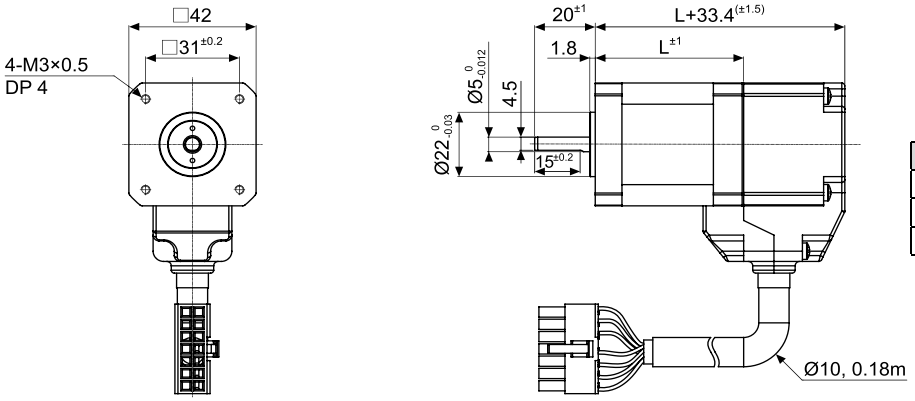

| Model | L |
|---|---|
| Ai-M-35SB | 41.5 |
| Ai-M-35MB | 52 |
| Ai-M-35LB | 68.5 |

## ▣ Dimensions

(unit: mm)

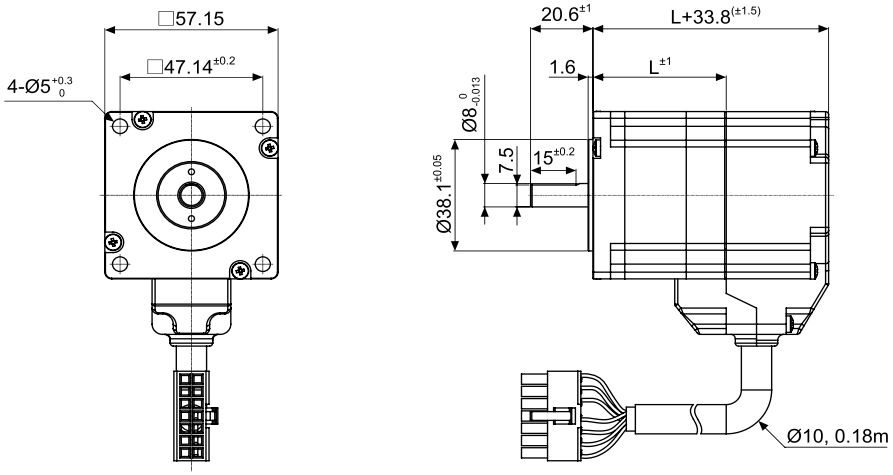


### ◎ Frame size 42mm



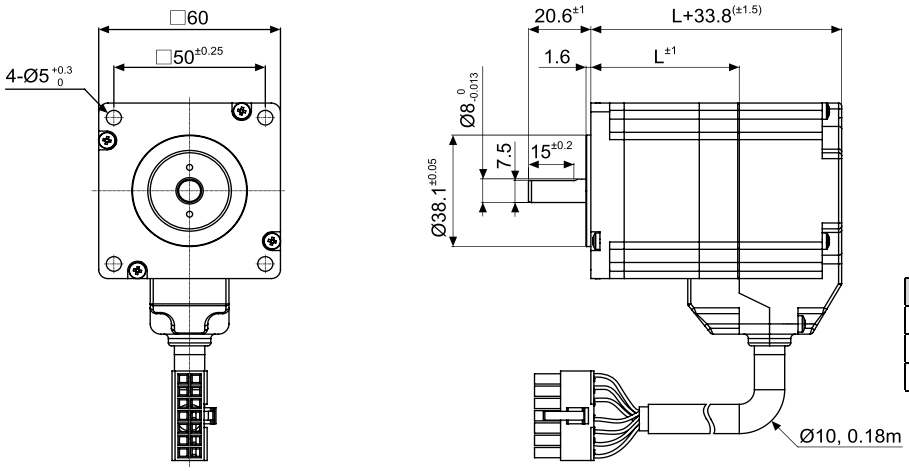

| Model | L |
|---|---|
| Ai-M-42SA | 34.1 |
| Ai-M-42MA | 40.1 |
| Ai-M-42LA | 48.1 |

### ◎ Frame size 56mm




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

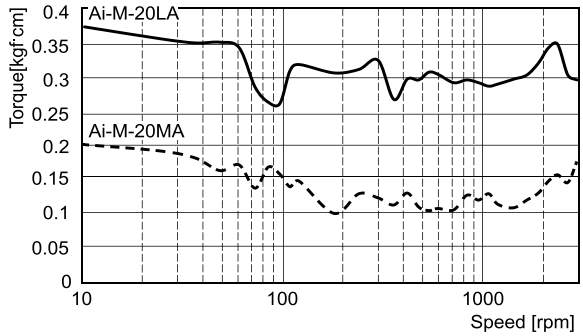
### ◎ Frame size 60mm



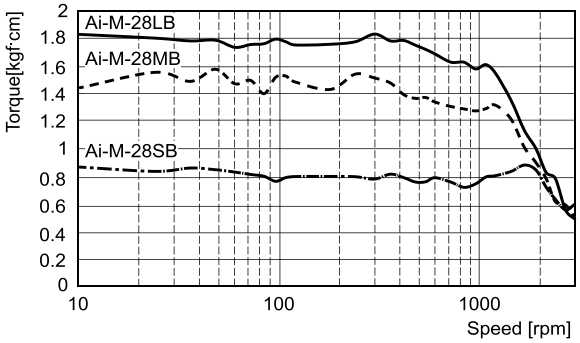

| Model | L |
|---|---|
| Ai-M-60SA | 48.1 |
| Ai-M-60MA | 69 |
| Ai-M-60LA | 86 |

## ▣ Motor Characteristics

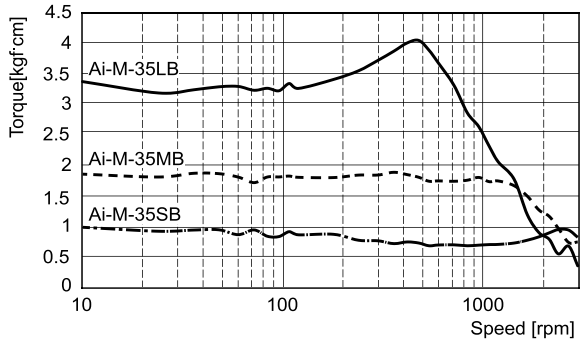
### ◎ Frame size 20mm



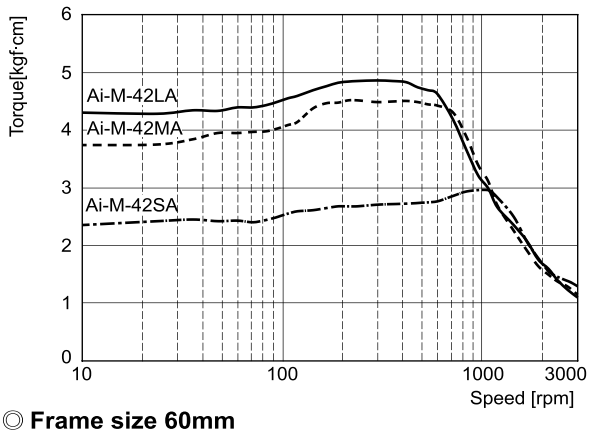

### ◎ Frame size 28mm



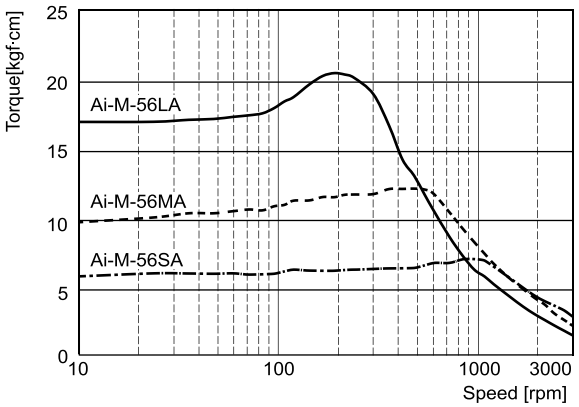

### ◎ Frame size 35mm



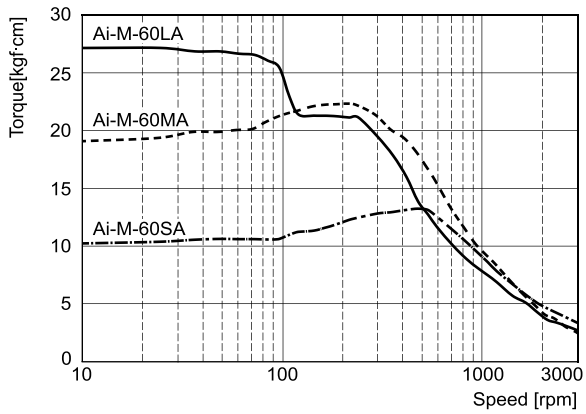

### ◎ Frame size 42mm




### ◎ Frame size 56mm

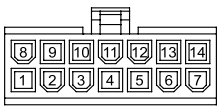



### ◎ Frame size 60mm



## ▣ Motor Connectors

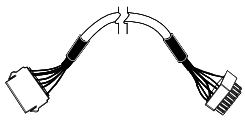
### ◎ CN2: Motor+Encoder Connector

| 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 | F.G. | 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 | Frame size 20, 28, 35mm | 5557-14R | 5556T2 | — | Molex |
| | | Frame size 42, 56, 60mm | | 5556T | | |

※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.

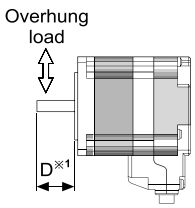


## ▣ Motor Installation

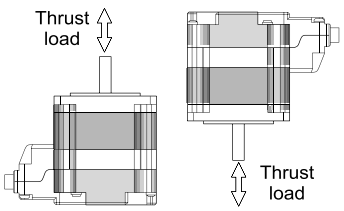
### 1. Mounting direction

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**



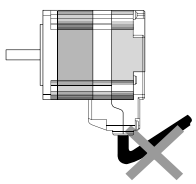

**Facing up, down**




※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 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) | |
| Frame size 42mm | 2 (20) | 2.6 (25) | 3.5 (34) | 5.3 (52) | |
| 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.

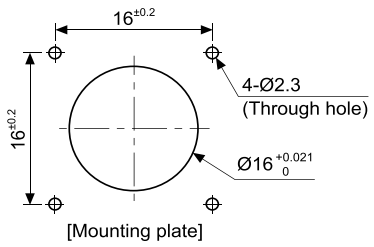


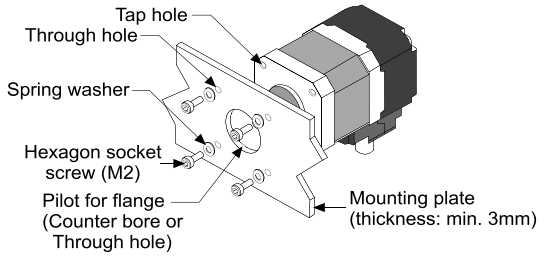
## ▣ Motor Installation

### 2. Mounting method

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.

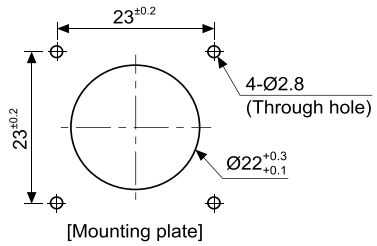
#### ◎ Frame size 20mm

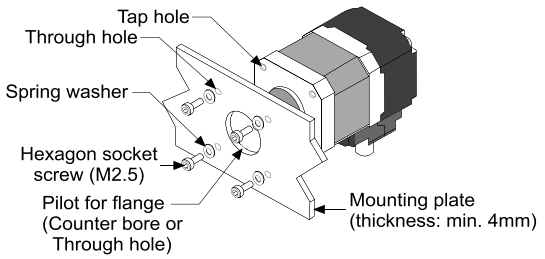



※Do not draw the wire with over strength 5N after wiring the encoder.

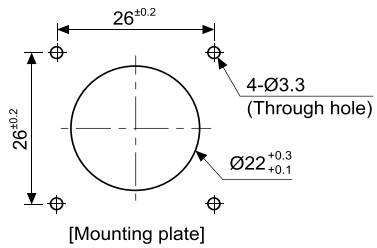
#### ◎ Frame size 28mm

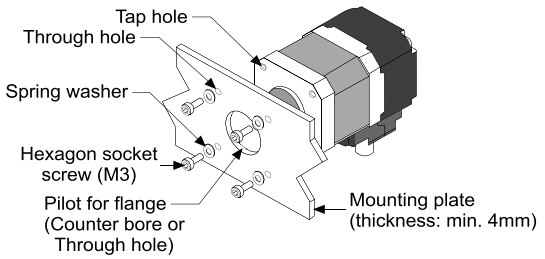



※Do not draw the wire with over strength 5N after wiring the encoder.

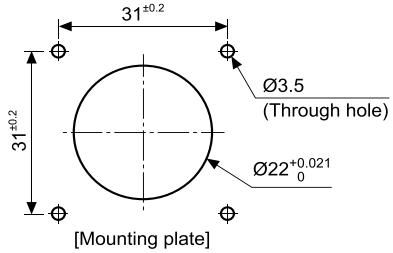
#### ◎ Frame size 35mm

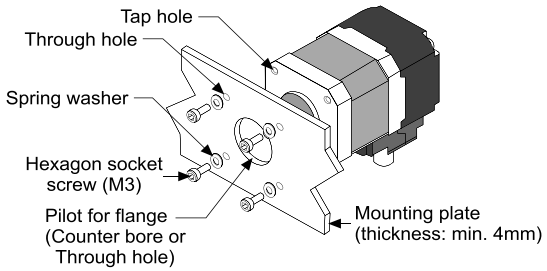



※Do not draw the wire with over strength 5N after wiring the encoder.

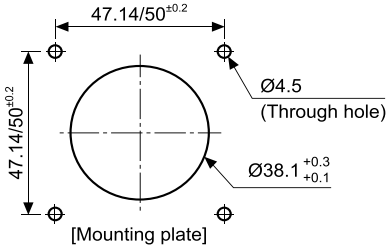
#### ◎ Frame size 42mm

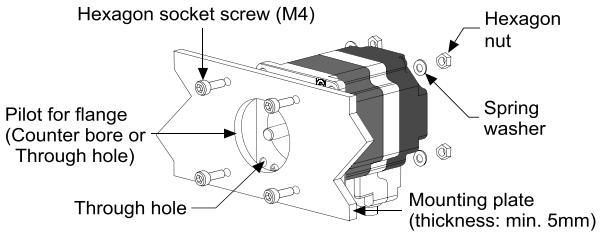


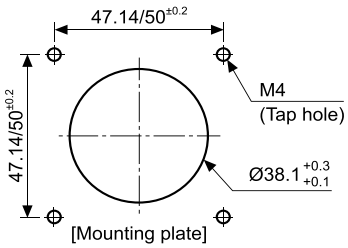



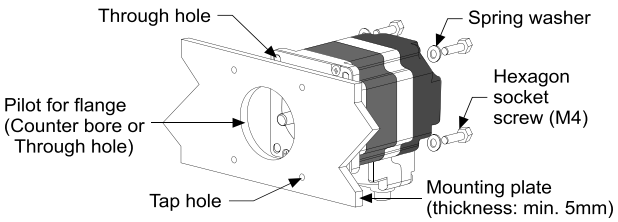

※Do not draw the wire with over strength 30N after wiring the encoder.

### ◎ Frame size 56mm/60mm



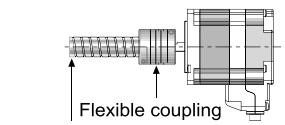
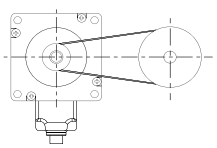
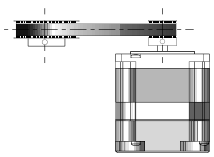




※Do not draw the wire with over strength 30N after wiring the encoder.

## 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 | Load connection with pulley, belt, and wire | Load connection with gear |
|---|---|---|
|   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.
① Inside of the housing which is installed indoors
(This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
② Within 0 to 50°C (at non-freezing status) of ambient temperature
③ Within 20 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 acidity
⑨ The place where easy heat dissipation could be made
⑩ The place without 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 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).

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  Otherwise, it may cause unexpected accidents.
- 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.
- 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
- Must connect the encoder shield cable to the F.G. terminal.
- 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.
- 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

# Built-in Brake Type 2-Phase Closed-Loop Stepper Motor

## Features

- Built-in electromagnetic brake type with non-excitation
- Minimal heat generating, high torque motor (control voltage 55V)
- Higher cost-efficiency compared to servo motors
- Frame size 42mm, 56mm, 60mm supported

Frame size 42mm | 56mm | 60mm

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

CE



## Ordering Information

**Ai - M - 42 L A - B**

| | | | |
|---|---|---|---|
| Brake | **B** | | Built-in brake type |
| Encoder resolution | **A** | | 10,000PPR (2,500PPR×4-multiply) |
| Motor length | | | |
| Motor frame size | **42** | 42×42mm | **S** 102.3mm |
| | | | **M** 108.3mm |
| | | | **L** 116.3mm |
| | **56** | 57.2×57.2mm | **S** 112.1mm |
| | | | **M** 125.1mm |
| | | | **L** 146.1mm |
| | **60** | 60×60mm | **S** 116.7mm |
| | | | **M** 137.6mm |
| | | | **L** 154.6mm |
| Item | **M** | | Motor |
| Series | **Ai** | | Artificial intelligence |

## ▣ Specifications

### ◎ Motor

**• Frame size 42mm**

| Model | Ai-M-42SA-B | Ai-M-42MA-B | Ai-M-42LA-B |
|---|---|---|---|
| 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. 0.77kg (approx. 0.67kg) | Approx. 0.83kg (approx. 0.73kg) | Approx. 0.90kg (approx. 0.80kg) |

**• Frame size 56mm**

| Model | Ai-M-56SA-B | Ai-M-56MA-B | Ai-M-56LA-B |
|---|---|---|---|
| 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. 1.30kg (approx. 1.15kg) | Approx. 1.52kg (approx. 1.38kg) | Approx. 1.90kg (approx. 1.75kg) |

**• Frame size 60mm**

| Model | Ai-M-60SA-B | Ai-M-60MA-B | Ai-M-60LA-B |
|---|---|---|---|
| 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. 1.53kg (approx. 1.36kg) | Approx. 1.90kg (approx. 1.74kg) | Approx. 2.23kg (approx. 2.07kg) |

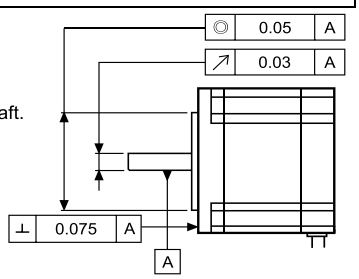
※1: Max. holding torque is maintenance torque of stopping the motor when supplying the rated current (2-phase excitation) and is the standard for comparing the performance of motors.
※2: The weight includes packaging. The weight in parenthesis is for unit only.

**• 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.



# Built-in Brake Type 2-Phase Closed-Loop Stepper Motor

## ▣ Specifications

### ◎ Brake

| | 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 | 6g·cm$^2$ | 19g·cm$^2$ | |
| Insulation class | B type (130℃) | | |
| 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.

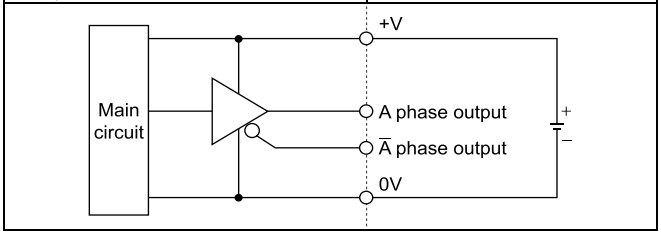
### ◎ Encoder

| 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⎓<br>• [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

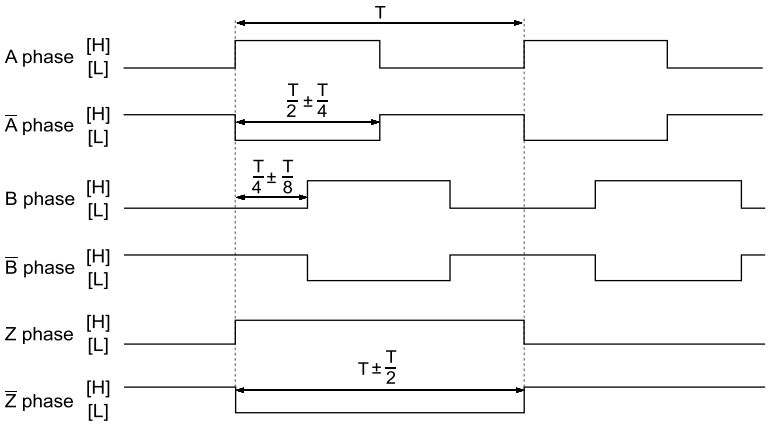
Line driver output

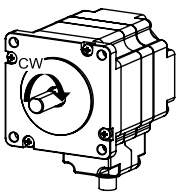
| Rotary encoder circuit | Load connection |
|---|---|




※All output circuits of A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase are the same.

## ▣ Encoder Output Waveforms



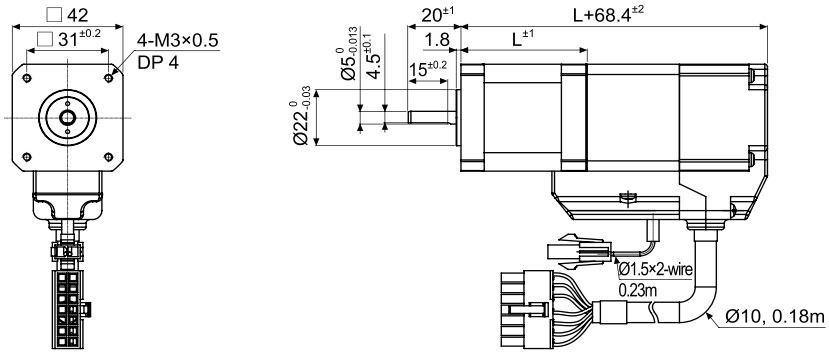




Clockwise (CW) ※T=1 cycle of A, B phase

## ▣ Dimensions

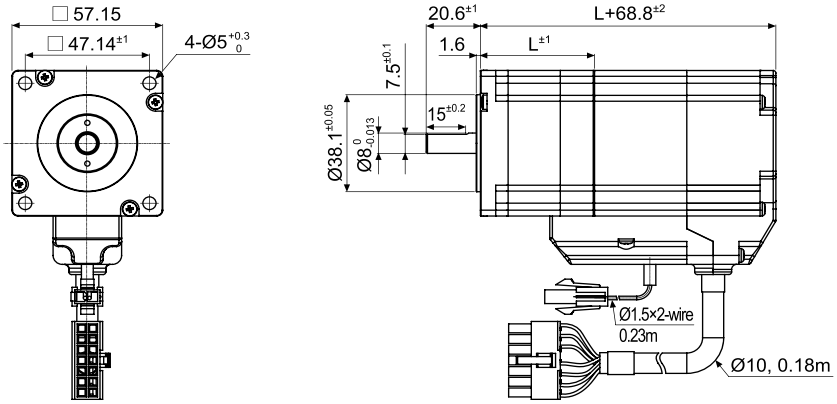
(unit: mm)

### ◎ Frame size 42mm



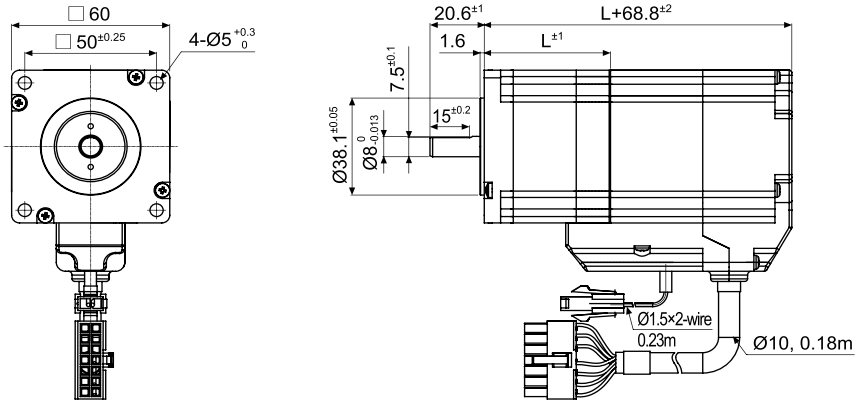

| Model | L |
|---|---|
| Ai-M-42SA-B | 33.9 |
| Ai-M-42MA-B | 39.9 |
| Ai-M-42LA-B | 47.9 |

### ◎ Frame size 56mm




| Model | L |
|---|---|
| Ai-M-56SA-B | 43.3 |
| Ai-M-56MA-B | 56.3 |
| Ai-M-56LA-B | 77.3 |

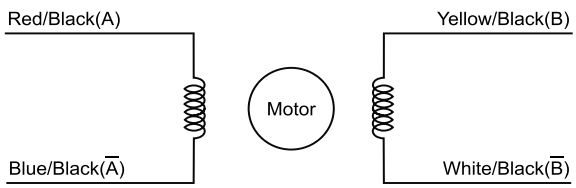
### ◎ Frame size 60mm




| Model | L |
|---|---|
| Ai-M-60SA-B | 47.9 |
| Ai-M-60MA-B | 68.8 |
| Ai-M-60LA-B | 85.8 |

## ▣ Connection Diagram

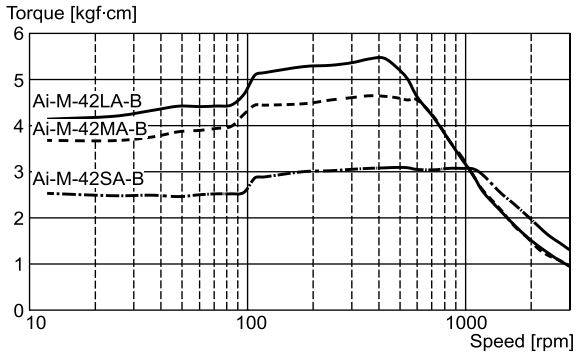
Autonics 2-phase closed-loop stepper motors take bipolar wiring methods.
The wiring colors for each phase and lead-wire are as the followings:



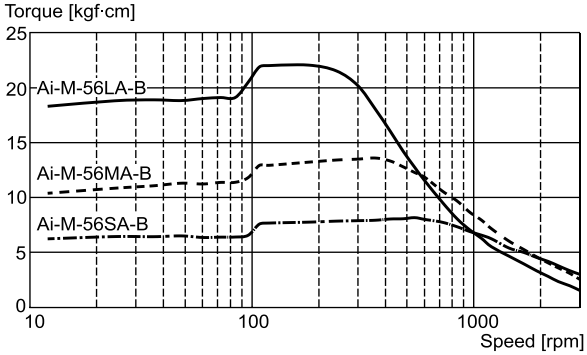
# Built-in Brake Type 2-Phase Closed-Loop Stepper Motor

## ▣ Motor Characteristics

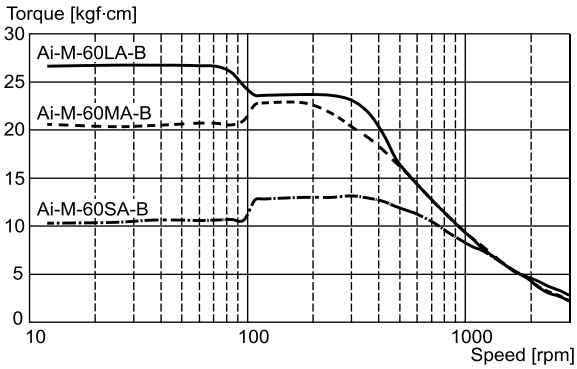
### ◎ Frame size 42mm




### ◎ Frame size 56mm




### ◎ Frame size 60mm

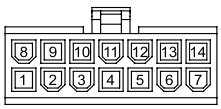



## ▣ Motor Connectors

### ◎ CN1: Power connector

| Pin arrangement | Pin No. | Function |
|---|---|---|
| | 1 | 24VDC⎓ |
| | 2 | GND |

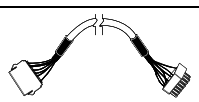
### ◎ CN2: Motor+Encoder connector

| 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 | F.G. | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

| Type | | Specifications | | | Manufacture |
|---|---|---|---|---|---|
| | | Connector | Connector terminal | Housing | |
| CN1 | Power | 5559-02P | 5558T | — | Molex |
| CN2 | Motor+Encoder | 5557-14R | 5556T | — | Molex |

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

### ◎ Cable (sold separately)

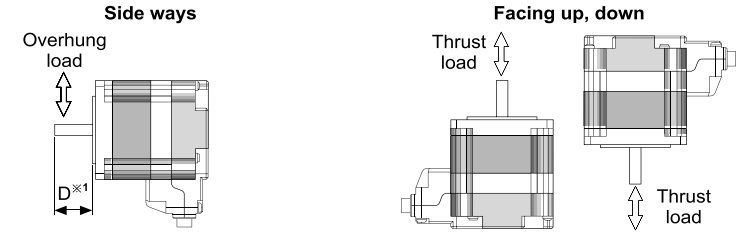
| Type | Model | |
|---|---|---|
| Motor+Encoder cable | Normal | Moving |
|  | C1D14MB-□※1 | C1DF14MB-□※1 |

※1: □ indicates cable length (1, 2, 3, 5, 7, 10).
E.g.) C1DF14MB-10: 10m moving type, built-in brake type motor+encoder cable.

## ▣ Motor Installation

### 1. Mounting direction

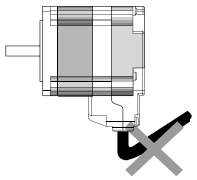
Motor can be mounted in any directions-facing up, facing down and side ways.
No matter which direction motors to be mounted, make sure not to apply overhung or thrust load on the shaft.
Refer to the table below for allowable shaft overhung load / thrust load.




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

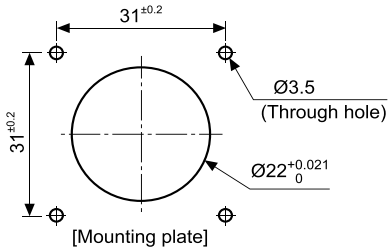
| Motor size | The distance from the shaft in front (mm), Allowable overhung load [kgf (N)] | | | | Allowable thrust load |
|---|---|---|---|---|---|
| | D=0 | D=5 | D=10 | D=15 | |
| Frame size 42mm | 2 (20) | 2.6 (25) | 3.5 (34) | 5.3 (52) | Under the load of motor |
| Frame size 56mm | 5.5 (54) |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

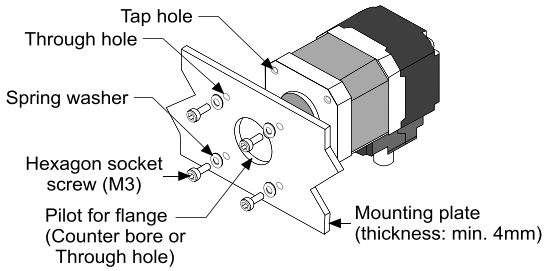
Do not apply excessive force to motor cable when mounting motors.
Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable by force.
In case of frequent cable movement required application, proper safety countermeasures must be ensured.



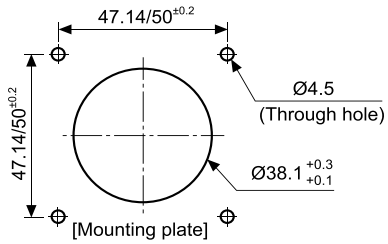
### 2. Mounting method

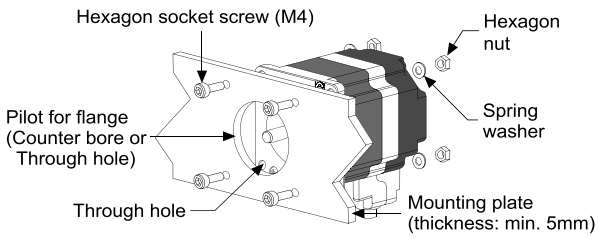
◎ **Frame size 42mm**

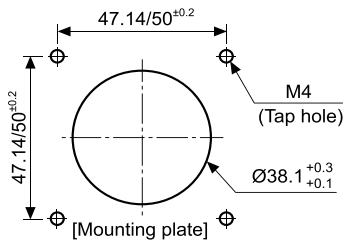


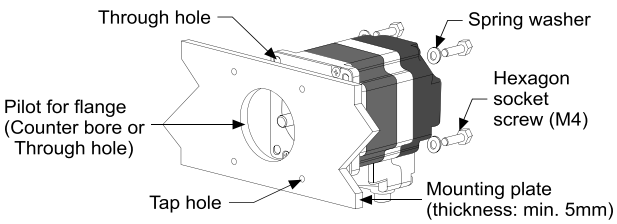




◎ **Frame size 56mm/60mm**



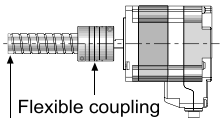
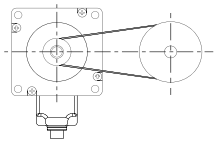
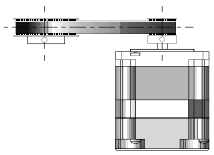




With considering heat radiation and vibration isolation, mount the motor as tight as possible against a metal panel having high thermal conductivity such as iron or aluminum.
When mounting motors, use hexagon socket screws, hexagon nuts, spring washers and flat washers.
Refer to the table below for allowable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

### 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 |
|---|---|---|
|  Ball screw or TM screw<br>※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.<br>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.<br>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.
① Inside of the housing which is installed indoors
(This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
② Within 0 to 50°C (at non-freezing status) of ambient temperature
③ Within 20 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 acidity
⑨ The place where easy heat dissipation could be made
⑩ The place without 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 no radioactive substances and magnetic fields exist. It shall be no vacuum status as well.

## ▣ Troubleshooting

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

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  Otherwise, it may cause unexpected accidents.
- 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.
- When power is supplied or not to the brake, the unit may occur clack sound.
- When drive the motor, supply power to electro-magnetic brake for releasing the brake.
  When the brake pad is worn out, the product life cycle is shorten, the rated static friction torque is reduced.
- 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.
- Must connect the encoder shield cable to the F.G. terminal.
- 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.
- 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

# 2-Phase Closed-Loop Stepper Motor Driver

## Features

- Brake operation for safe control of vertical load at power OFF and alarm occur. (built-in brake type)
- Realized the closed loop with higher cost-efficiency compared to servo motor system
- Rapid response which is advantageous for the short distance continuous operation
- Able to implement Low frequency operation in low speed area and high torque in high speed area
- Easy to use as much as unskilled people can use with tuning unnecessary method (Gain setting with the switch)
- Applicable to the precision equipment such as optical inspection equipment with the features of maintaining torque in stop and having no micro vibration (hunting)
- Various resolutions
- Various alarms out
  : overcurrent, overspeed, motor connection error, encoder connection error, and etc., overall 12 types
- Frame size 20mm, 28mm, 35mm, 42mm, 56mm, 60mm motors supported

**Please read "Safety Considerations" in the instruction manual before using.**

CE

## Applications

- Filed requiring preciseness such as semiconductor equipment, 3D printer, optical inspection equipment, chip mounter, cartesian robot, conveying equipment, and alignment stage.

## Ordering Information

**Ai S - D - 42 L A - □**

**Brake**

| | |
|---|---|
| **No mark** | Standard type |
| **B**※1 | Built-in brake type |

**Encoder resolution**

| | |
|---|---|
| **A**※2 | 4,000PPR(1,000PPR×4-multiply) |
| **B**※3 | 16,000PPR(4,000PPR×4-multiply) |
| **A**※4 | 10,000PPR (2,500PPR×4-multiply) |

**Motor length**

**Motor frame size**

| | | | Standard type | Built-in brake type |
|---|---|---|---|---|
| **20** | 20×20mm | **M** | 41.2mm | — |
| | | **L** | 53.1mm | — |
| **28** | 28×28mm | **S** | 46mm | — |
| | | **M** | 59mm | — |
| | | **L** | 65mm | — |
| **35** | 35×35mm | **S** | 41.5mm | — |
| | | **M** | 52mm | — |
| | | **L** | 68.5mm | — |
| **42** | 42×42mm | **S** | 67.5mm | 102.3mm |
| | | **M** | 73.5mm | 108.3mm |
| | | **L** | 81.5mm | 116.3mm |
| **56** | 57.2×57.2mm | **S** | 77.3mm | 112.1mm |
| | | **M** | 90.3mm | 125.1mm |
| | | **L** | 111.3mm | 146.1mm |
| **60** | 60×60mm | **S** | 81.9mm | 116.7mm |
| | | **M** | 102.8mm | 137.6mm |
| | | **L** | 119.8mm | 154.6mm |

**Item**

| | |
|---|---|
| **D** | Driver |

**Category**

| | |
|---|---|
| **S** | Standard |

**Series**

| | |
|---|---|
| **Ai** | **A**rtificial **i**ntelligence |

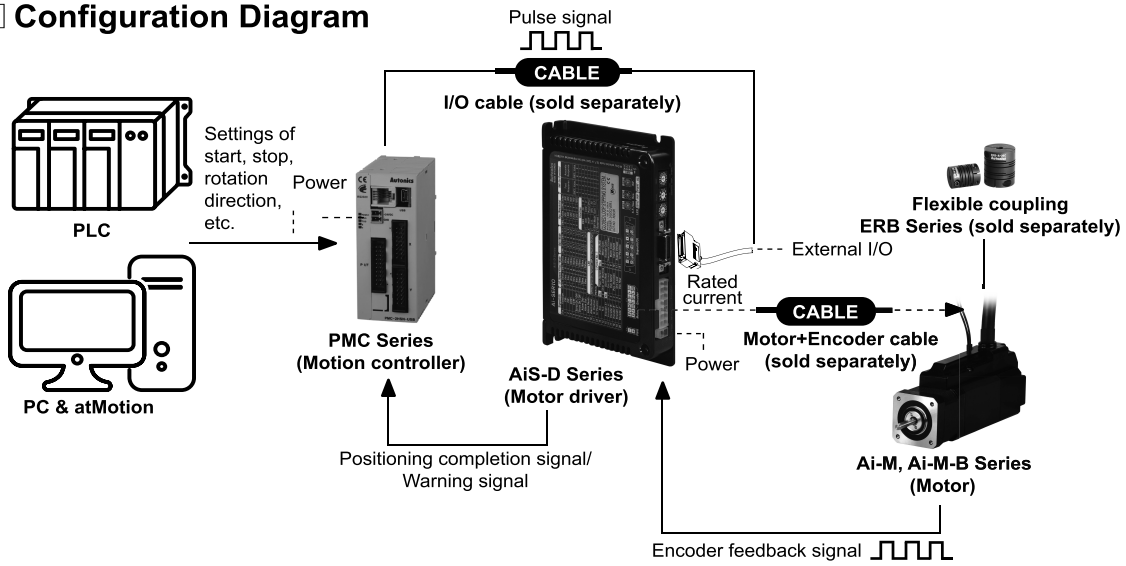
※1: Built-in brake type is only for frame size 42, 56, 60mm motors.
※2: Encoder resolution for frame size 20mm motors.
Microstep control for AiS driver, it controls up to 10,000PPR.
※3: Encoder resolution for frame size 28, 35mm motors.
※4: Encoder resolution for frame size 42, 56, 60mm motors.

## ▣ Specifications

| Model | | | AiS-D-20MA | AiS-D-20LA | AiS-D-28SB | AiS-D-28MB | AiS-D-28LB | AiS-D-35SB | AiS-D-35MB | AiS-D-35LB | AiS-D-42SA-□ | AiS-D-42MA-□ | AiS-D-42LA-□ | AiS-D-56SA-□ | AiS-D-56MA-□ | AiS-D-56LA-□ | AiS-D-60SA-□ | AiS-D-60MA-□ | AiS-D-60LA-□ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Power supply | | | 24VDC⎓ | | | | | | | | | | | | | | | | |
| Allowable voltage range | | | 90 to 110% of the rated voltage | | | | | | | | | | | | | | | | |
| Power consumption | STOP※1 | Standard type | Max. 10W | | | | | | | | Max. 7W | Max. 7.5W | Max. 8W | Max. 9.5W | Max. 10W | Max. 11W | Max. 12W | Max. 13W | Max. 14W |
| | | Built-in brake type | — | | | | | | | | Max. 16W | | Max. 17W | Max. 23W | | Max. 25W | | Max. 26W | |
| | Max. during operation※2 | Standard type | Max. 50W | | Max. 60W | | | | | | Max. 60W | | | Max. 120W | | | Max. 240W | | |
| | | Built-in brake type | — | | | | | | | | | | | | | | | | |
| Max. RUN current※3 | | | 0.6A/Phase | | 1.0A/Phase | | | 1.2A/Phase | | | 1.7A/Phase | | | 3.5A/Phase | | | | | |
| STOP current | | | 25% or 50% of max. RUN current (factory default: 50%) | | | | | | | | | | | | | | | | |
| Rotation speed | | | 0 to 3,000rpm | | | | | | | | | | | | | | | | |
| Resolution | | | 500 (factory default), 1000, 1600, 2000, 3600, 4000, 5000, 6400, 7200, 10000PPR | | 500 (factory default), 1000, 1600, 2000, 3600, 5000, 6400, 7200, 10000PPR | | | | | | 500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000PPR | | | | | | | | |
| Speed filter | | | 0 (disable), 2, 4, 6, 8, 10, 20, 40, 60 (factory default), 80, 100, 120, 140, 160, 180, 200ms | | | | | | | | | | | | | | | | |
| Position control gain | | | (P Gain, I Gain)=(1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (6, 1), (1, 2), (2, 2), (3, 2), (4, 2), (5, 2), (1, 3), (2, 3), (3, 3), (4, 3), (5, 3) | | | | | | | | | | | | | | | | |
| In-Position | | | Within the range of Fast response: 0 to 7 or Accurate response: 0 to 7 | | | | | | | | | | | | | | | | |
| Pulse input method | | | 1-pulse or 2-pulse input (factory default) method | | | | | | | | | | | | | | | | |
| Motor rotation direction | | | CW (factory default), CCW | | | | | | | | | | | | | | | | |
| Status indicator | | | ● Power/Warning indicator: green LED ● Alarm indicator: red LED<br>● In-position indicator: yellow LED ● Servo On/Off indicator: orange LED | | | | | | | | | | | | | | | | |
| Input signal | | | RUN pulse, servo On/Off, alarm reset (photocoupler input) | | | | | | | | | | | | | | | | |
| Output signal | | | ● In-position, alarm out (photocoupler output),<br>● Encoder signal (A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase, corresponding to 26C31) (line driver output), | | | | | | | | ● In-position, alarm out (photocoupler output),<br>● Encoder signal (A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase, corresponding to 26C31) (line driver output),<br>● Brake (built-in brake type) (at supplying moment: 24VDC⎓ for 0.2 sec, in normal status: 11.5VDC⎓ ±10%) | | | | | | | | |
| Input pulse specifications | Pulse width | | ● CW, CCW : input pulse frequency duty 50% (min. 2μs),<br>● Serve On/Off : min. 1ms,<br>● Alarm reset : min. 20ms | | ● CW, CCW : input pulse frequency duty 50% (min. 1.25μs),<br>● Serve On/Off: min. 1ms,<br>● Alarm reset: min. 20ms | | | | | | ● CW, CCW: input pulse frequency duty 50%,<br>● Serve On/Off: min. 1ms,<br>● Alarm reset: min. 20ms | | | | | | | | |
| | Rising/Falling time | | CW, CCW: max. 0.5μs | | | | | | | | | | | | | | | | |
| | Pulse input voltage | | ● CW, CCW - [H]: 4-8VDC⎓, [L]: 0-0.5VDC⎓ ● Servo On/Off, alarm reset - [H]: 24VDC⎓, [L]: 0-0.5VDC⎓ | | | | | | | | | | | | | | | | |
| | Max. input pulse freq.※4 | | CW, CCW: 500kHz | | | | | | | | | | | | | | | | |
| Input resistance | | | 220Ω (CW, CCW), 10kΩ (servo On/Off, alarm reset) | | | | | | | | | | | | | | | | |
| Insulation resistance | | | Over 100MΩ (at 500VDC⎓ megger) | | | | | | | | | | | | | | | | |
| Dielectric strength | | | 1,000VAC~ 60Hz for 1 min | | | | | | | | | | | | | | | | |
| Vibration | | | 1.5mm amplitude at frequency 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℃, storage: -20 to 70℃ | | | | | | | | 0 to 50℃, storage: -10 to 60℃ (standard type), -20 to 70℃ (built-in brake type) | | | | | | | | |
| | Ambient humi. | | 35 to 85%RH, storage: 10 to 90%RH | | | | | | | | | | | | | | | | |
| Approval | | | CE | | | | | | | | | | | | | | | | |
| Protection structure | | | IP20 (IEC standard) | | | | | | | | | | | | | | | | |
| Weight※5 | | | Approx. 400g (approx. 290g) | | | | | | | | | | | | | | | | |

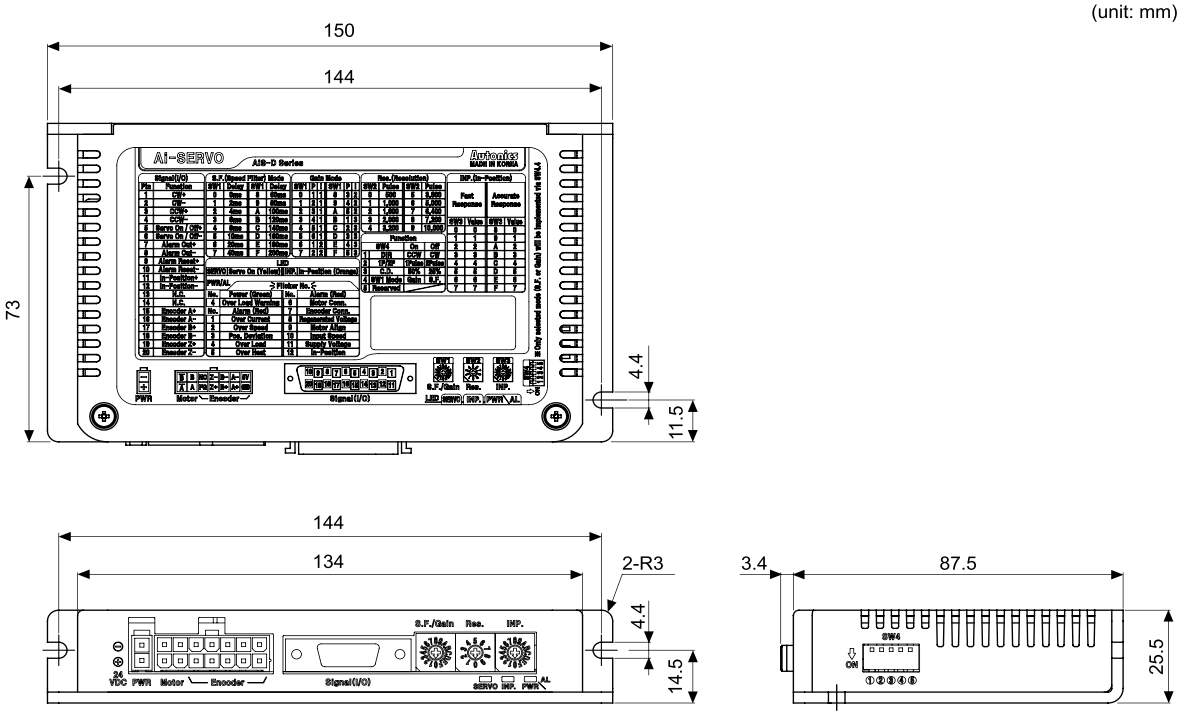
※1: Based on the ambient temperature 25℃, ambient humidity 55%RH, and STOP current 50%.
※2: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase.
The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※3: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※4: Max. input pulse frequency is max. frequency to be input and is not the same as max. pull-out frequency or max. slewing frequency.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Configuration Diagram




## ▣ Dimensions

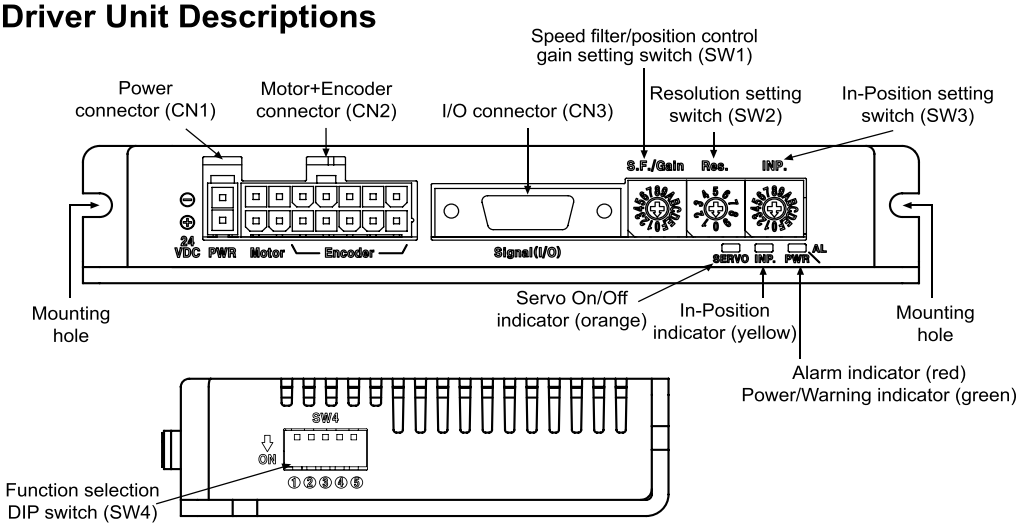
(unit: mm)




## ▣ Driver Status Indicators

| Status indicator | LED color | Function | Descriptions |
|---|---|---|---|
| PWR | Green | Power indicator | Turns ON when the unit operates normally after supplying power |
| | | Warning indicator | Flashes when over load status is maintained |
| AL | Red | Alarm indicator | When alarm occurs, it flashes in various ways depending on the situation.<br>Refer to '▣ **Control Input/Output** → ◎ **Output** → **2. Alarm/Warning**' |
| 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. |

## ▣ Driver Unit Descriptions




## ▣ Driver Setting

### ◎ SW1: Speed filter setting switch or position control gain setting switch

-SW1 shifts its mode between the speed filter setting or the position control gain setting, depending on 4th pin in SW4 as follows.
-Modified setting values are not applied in the running status, and the values will be applied after motor stopped.

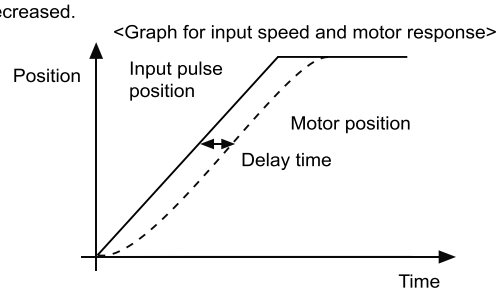
| 4th pin in SW4 | Setting |
|---|---|
| OFF | Speed filter |
| ON | Position control gain |

**• Speed filter setting**

-Speed filter decides operation responsiveness of the motor to input pulse.
-Set the delay time between the position of input pulse and the position of motor to prevent load changing or disturbance with soft operation function.
※If the setting value is too high, the synchronous response by command is decreased.

| Setting switch | Setting | Delay time | Setting | Delay time |
|---|---|---|---|---|
| S.F./Gain | 0 | Disable | 8※1 | 60ms |
| | 1 | 2ms | 9 | 80ms |
| | 2 | 4ms | A | 100ms |
| | 3 | 6ms | B | 120ms |
| | 4 | 8ms | C | 140ms |
| | 5 | 10ms | D | 160ms |
| | 6 | 20ms | E | 180ms |
| | 7 | 40ms | F | 200ms |

※1: Factory default



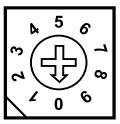

**• Position control gain setting**

-Position control gain decides responsiveness of the motor to position command.
-Gain setting in motor stationary state, depending on load of motor, realizes rapid positioning and stabilized performance.
-P_Gain: Adjust vibration in running drive.
-I_Gain: Adjust vibration in accelerating/decelerating drive.

| Setting switch | Setting | Gain | | Setting | Gain | |
|---|---|---|---|---|---|---|
| | | P | I | | P | I |
| S.F./Gain | 0 | 1 | 1 | 8 (factory default) | 3 | 2 |
| | 1 | 2 | 1 | 9 | 4 | 2 |
| | 2 | 3 | 1 | A | 5 | 2 |
| | 3 | 4 | 1 | B | 1 | 3 |
| | 4 | 5 | 1 | C | 2 | 3 |
| | 5 | 6 | 1 | D | 3 | 3 |
| | 6 | 1 | 2 | E | 4 | 3 |
| | 7 | 2 | 2 | F | 5 | 3 |

## ◎ SW2: Resolution setting switch

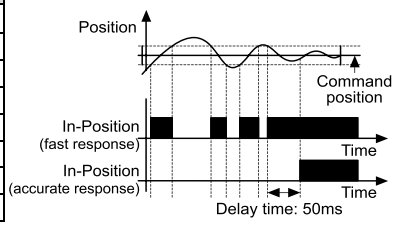
-Set the resolution of driver.
-Refer to the table below for the number of pulses per 1 rotation by resolution.
-Modified setting values are not applied in the running status, and the values will be applied after motor stopped.

| Setting switch | Setting | Frame size 20mm | | Frame size 28/35mm | | Frame size 42/56/60mm | |
|---|---|---|---|---|---|---|---|
| | | Pulse/Revolution | Resolution | Pulse/Revolution | Resolution | Pulse/Revolution | Resolution |
|  RES. | 0 (factory default) | 500 | 2.5 | 500 | 2.5 | 500 | 2.5 |
| | 1 | 1000 | 5 | 1000 | 5 | 1000 | 5 |
| | 2 | 1600 | 8 | 1600 | 8 | 1600 | 8 |
| | 3 | 2000 | 10 | 2000 | 10 | 2000 | 10 |
| | 4 | 3600 | 18 | 3600 | 18 | 3200 | 16 |
| | 5 | 4000 | 20 | 5000 | 25 | 3600 | 18 |
| | 6 | 5000 | 25 | 6400 | 32 | 5000 | 25 |
| | 7 | 6400 | 32 | 7200 | 36 | 6400 | 32 |
| | 8 | 7200 | 36 | 10000 | 50 | 7200 | 36 |
| | 9 | 10000 | 50 | 16000 | 80 | 10000 | 50 |

## ◎ SW3: In-Position setting swtich

-After position command pulse has finished, if the gap between target position and real position is under In-Position setting value, positioning completion pulse is output.
-Modified setting values are not applied in the running status, and the values will be applied after motor stopped.

| Setting switch | Fast response | | Accurate response | |
|---|---|---|---|---|
| | Setting | Value | Setting | Value |
| INP. | 0 (factory default) | 0 | 8 | 0 |
| | 1 | ±1 | 9 | ±1 |
| | 2 | ±2 | A | ±2 |
| | 3 | ±3 | B | ±3 |
| | 4 | ±4 | C | ±4 |
| | 5 | ±5 | D | ±5 |
| | 6 | ±6 | E | ±6 |
| | 7 | ±7 | F | ±7 |






## ◎ SW4: Function selection DIP switch

-Set rotation direction, pulse input method, STOP current, SW1 setting, and test mode.

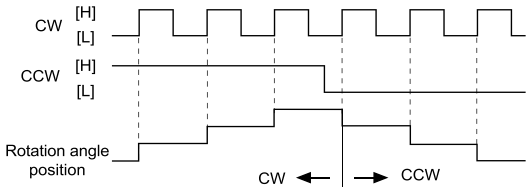
| Setting switch | No. | Name | Function | Switch position | |
|---|---|---|---|---|---|
| | | | | ON | OFF (factory default) |
| | 1※1 | DIR | Rotation direction | CCW | CW |
| | 2※1 | 1P/2P | Pulse input method | 1-pulse input method | 2-pulse input method |
| | 3※2 | C.D. | STOP current | 25% of max. RUN current | 50% of max. RUN current |
| | 4※2 | SW1 Mode | SW1 setting | Position control gain | Speed filter |
| | 5※3 | Reserved | Test mode | Test mode | Normal mode |

※1: When motor runs or stops, modified setting values will be applied immediately.
※2: Modified setting values are not applied in the running status, and the values will be applied after motor stopped.
※3: Set to OFF when using the device. It is only for the operation test in manufacturing process.

### • Pulse input method

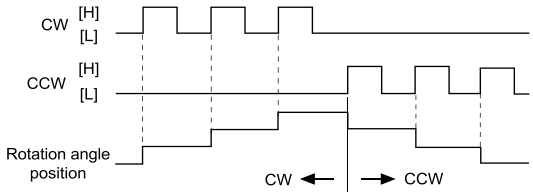
**A. 1-pulse input method**

CW: rotation operation signal input
CCW: rotation direction signal input
([H]: forward rotation, [L]: reverse rotation)




**B. 2-pulse input method**

CW: forward rotation signal input
CCW: reverse rotation signal input




※[H]: photocoupler ON (voltage of both ends 4-8VDC⎓) [L]: photocoupler OFF (voltage of both ends 0-0.5VDC⎓)

### • STOP current

-In order to decrease motor heat and current consumption at motor stopping moment (in case there is no input during the time of the double width of last input pulse), set the stop current supplied to the motor phase.

## ▣ Control Input/Output

Inner signal of all input/output consists of photocoupler.
ON, [H]: photocoupler power ON / OFF, [L]: photocoupler power OFF.
※Brake operation is only for built-in brake type.

### ◎ Input

#### 1. Position command pulse

- Pulse input is selectable from 1-pulse input method and 2-pulse input method. (Refer to '◎ **SW4: Function selection DIP switch**'.)
- When using extending cable, it is recommended to connect Common mode choke coil (2mH) to the CW, CCW terminal in series connection.

#### 2. Servo On/Off

-Servo On/Off signal maintains over 1ms as [H]: Regarded as Servo Off signal and phase current is cut to release torque.
The Servo On indicator, the In-Position output and indicator turns OFF. Brake operates.
-Servo On/Off signal maintains over 1ms as [L]: Regarded as Servo On signal and phase current is supplied to gain torque.
The Servo On indicator, the In-Position output and indicator turns ON. Brake is released.
※Use this function after stopping the motor.
※Refer to '**4. Example of input circuit connection**'.

#### 3. Alarm Reset

-This signal is for clearing the alarm.
-Alarm reset signal maintains over 20ms as [H]: Alarm is cleared, the alarm indicator and alarm output turns OFF,
and the driver returns to normal status. Brake is released.
※If the causes of the alarm are not removed, driver may not be returned to the normal status even with alarm reset.
※Refer to '**4. Example of input circuit connection**'.

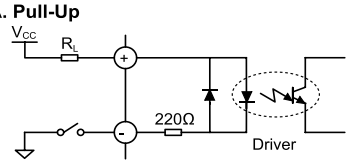
#### 4. Example of input circuit connection

**• Input pulse (CW, CCW)**

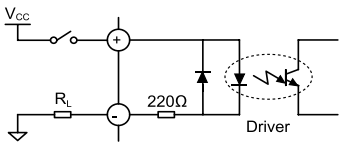
-It is recommended to use 5VDC⎓ at $V_{CC}$ and short the $R_L$.
-In case $V_{CC}$ is over 5VDC⎓, calculate $R_L$ value using following formula and use $V_{CC}$ below 30VDC⎓ $R_L = \frac{V_{CC}-2.17V}{0.011A} - 220\Omega$
-In case $V_{CC}$ is 12, 24VDC⎓, refer to the table below for $R_L$.

| $V_{CC}$ | $R_L$ |
|---|---|
| 12VDC⎓ | 680Ω (min. 0.25W) |
| 24VDC⎓ | 1.8kΩ (min. 0.5W) |

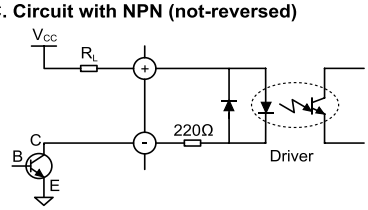
**A. Pull-Up**



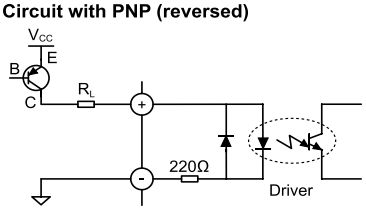

**B. Pull-Down**




**C. Circuit with NPN (not-reversed)**

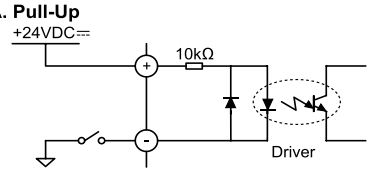



**D. Circuit with PNP (reversed)**

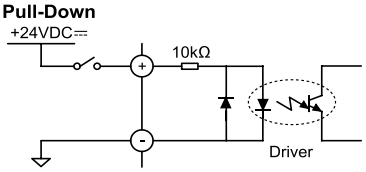



**• External input (Servo On/Off, Alarm Reset)**

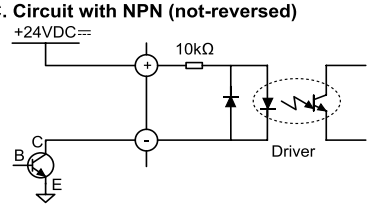
**A. Pull-Up**



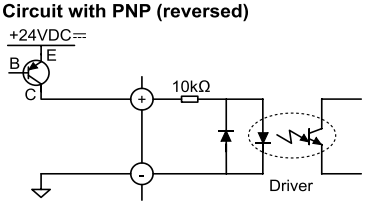

**B. Pull-Down**




**C. Circuit with NPN (not-reversed)**




**D. Circuit with PNP (reversed)**



## ◎ Output

### 1. In-Position

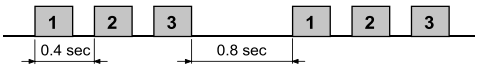
-In-Position output is output condition of positioning completion signal.
-If the gap between target position and real position is under In-Position setting value after position command pulse has finished, In-Position output turns to [H] and the In-Position indicator turns ON.
-In reverse, when the gap is over In-Position setting value, In-Position output turns to [L] and In-Position indicator turns OFF.
-For accurate drive, check the In-Position output again and execute the next drive.
※Refer to '**3. Example of output circuit connection**'.

### 2. Alarm/Warning

● 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 supplying alarm reset, driver returns to the normal status.
※Refer to '**3. Example of output circuit connection**'.
● Warning
- This function notices dangers with the alarm indicator prior to over load alarm.
- When turning out from the alarming condition, driver returns to the normal status automatically.

| Alarm indicator | No. of flashing | Alarm type | | Descriptions | Motor stop | Maintain torque |
|---|---|---|---|---|---|---|
| AL (red) | 1 | Overcurrent error | | When over current flows at motor RUN element | O | × |
| | 2 | Overspeed error | | When motor speed is over 4,000rpm | | |
| | 3 | Position tracking error | | When the gap between position command value and current position value is over 90° | | |
| | 4 | Overload error | | When applying load over the rated load for over 1 sec | | |
| | 5 | Overheat error | | When driver inner temperature is over 80°C | | |
| | 6 | Motor connection error | | When motor cable connection error occurs at driver | | |
| | 7 | Encoder connection error | | When encoder cable connection error occurs at driver | | |
| | 8 | Regenerative voltage error | | When regenerative voltage is over 78V | | |
| | 9 | Motor misalignment | | When motor is in misalignment | | |
| | 10 | Command pulse error | | When Input pulse is over 3,500rpm | | |
| | 11 | Input voltage error | Frame size 20, 28, 35mm | When Input voltage is out of 21-27VDC⎓ ±5% | | |
| | | | Frame size 42, 56, 60mm | When Input voltage is out of 24VDC⎓ ±10% | | |
| | 12 | In-Position error | | When position error (over 1) is kept over 3 sec, after motor stopped. | | |
| Warning indicator | No. of flashing | Warning type | | Descriptions | Motor stop | Maintain torque |
| PWR (green) | 4 | Overload warning | | When maximum load is kept connected over 10 sec. (motor or driver can be overheated) | × | O |

※Even though warning occurs, it drives as normal status and it may cause damage by fire.
It is recommend 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.
< E.g. case of alarm 3 >



### 3. Example of output circuit connection

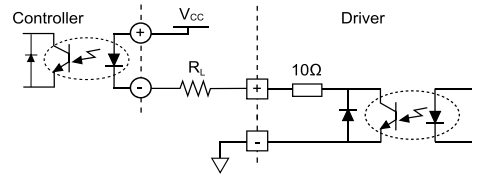
-It is recommend to use below 50VDC⎓ at $V_{CC}$.

Use the $R_L$ for $I_C$ (collector current of secondary detector) of photocoupler inside the driver to be within 25mA following the below formula.

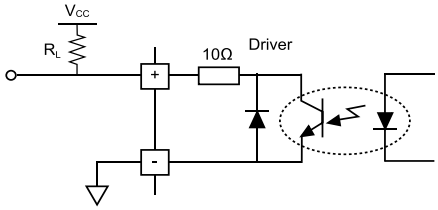
※A: $R_L = \frac{V_{CC}-0.3V-V_F}{0.025A} - 10\Omega$ ※B, C: $R_L = \frac{V_{CC}-0.3V}{0.025A} - 10\Omega$

($V_F$ is LED forward voltage of primary photocoupler.)

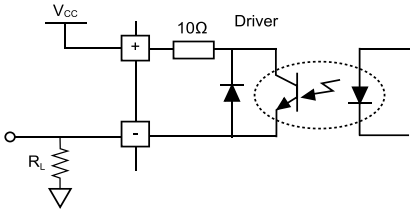
**A. Circuit with photocoupler**




**B. Circuit with pull up (reversed)**

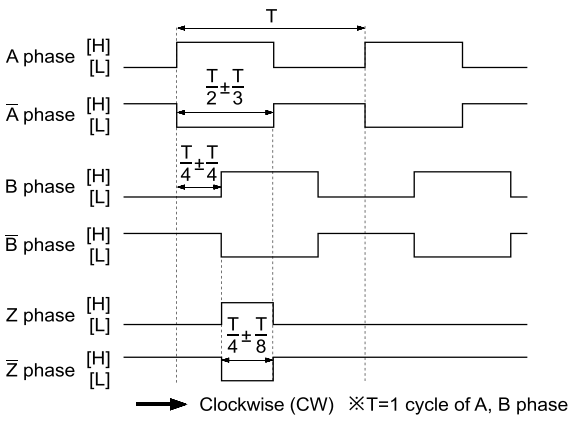


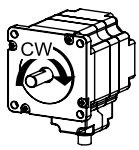

**C. Circuit with pull down (not-reversed)**



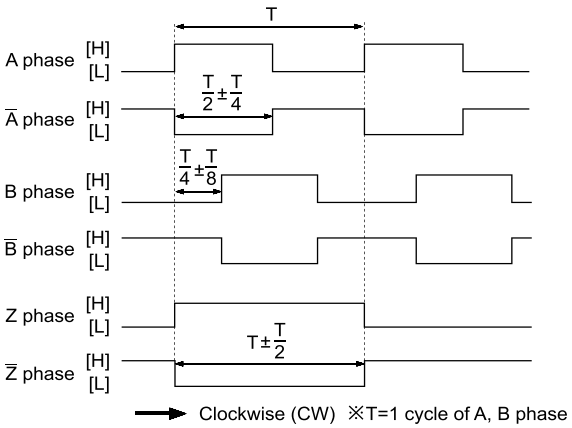

### 4. Encoder output waveforms

**◎ Frame size 20, 28, 35mm**



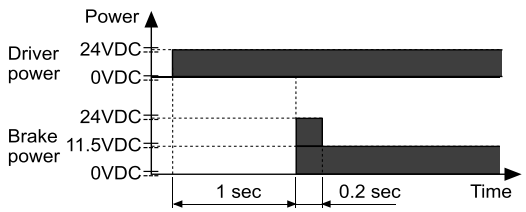

**◎ Frame size 42, 56, 60mm**




※It is recommended to use Line driver output (corresponding to 26C32) at RECEIVER end of encoder output and terminating resisters (100-150Ω) in parallel at both ends of each phase (A, Ā, B, B̄, Z, Z̄, corresponding to 26C31).

### 5. 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.

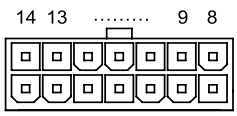
## ▣ Driver Connectors

### ◎ Connector function

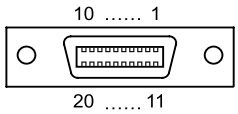
**● CN1: Power connector**

| Pin arrangement | Pin no. | Function |
|---|---|---|
| | 2 | GND |
| | 1 | 24VDC⎓ |

**● 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 | F.G. | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

**● CN3: I/O connector**

| Pin arrangement | Pin no. | Input/ Output | Function | Pin no. | Input/ Output | Function |
|---|---|---|---|---|---|---|
|  | 1 | Input | CW+ | 11 | Output | In-Position+ |
| | 2 | Input | CW- | 12 | Output | In-Position- |
| | 3 | Input | CCW+ | 13 | Output | Brake+ |
| | 4 | Input | CCW- | 14 | Output | Brake- |
| | 5 | Input | Servo On/Off+ | 15 | Output | Encoder A |
| | 6 | Input | Servo On/Off- | 16 | Output | Encoder $\overline{A}$ |
| | 7 | Output | Alarm Out+ | 17 | Output | Encoder B |
| | 8 | Output | Alarm Out- | 18 | Output | Encoder $\overline{B}$ |
| | 9 | Input | Alarm Reset+ | 19 | Output | Encoder Z |
| | 10 | Input | Alarm Reset- | 20 | Output | Encoder $\overline{Z}$ |

### ◎ Connector specifications

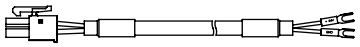
| Type | | | Specifications | | | Manufacture |
|---|---|---|---|---|---|---|
| | | | Connector | Connector terminal | Housing | |
| CN1 | Driver | | 0039301020 | — | — | Molex |
| | Power | | CHD1140-02 | CTD1140 | — | HANLIM |
| CN2 | Driver | | 35318-1420 | — | — | Molex |
| | Motor+ Encoder | Frame size 20, 28, 35mm | 5557-14R | 5556T2 | — | Molex |
| | | Frame size 42, 56, 60mm | | 5556T | | |
| CN3 | Driver | | 10220-52A2 PL | — | — | 3M |
| | I/O connector | | 10120-3000PE | — | 10320-52F0-008 | 3M |
| | | | CJ-MP20-HP□ (sold separately) | — | — | Autonics |

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

## ▣ Sold Separately

### ◎ Power cable

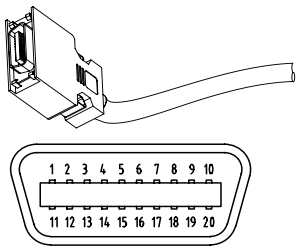
- **CJ-PW-□**



※□ of model name indicates cable length (010, 020)
E.g.) CJ-PW-010: 1m power cable.

### ◎ I/O cable

- **CO20-MP□-R (standard: AiS TAG)**

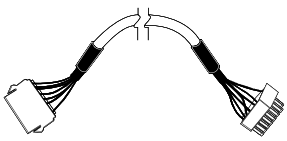



| Pin no. | Function (name tag) | Cable color | Dot line color-numbers | Pin no. | Function (name tag) | Cable color | Dot line color-numbers |
|---|---|---|---|---|---|---|---|
| 1 | CW+ | Yellow | Black-1 | 11 | In-Position+ | White | Black-1 |
| 2 | CW- | | Red-1 | 12 | In-Position- | | Red-1 |
| 3 | CCW+ | | Black-2 | 13 | Brake+ | | Black-2 |
| 4 | CCW- | | Red-2 | 14 | Brake- | | Red-2 |
| 5 | Servo On/Off+ | | Black-3 | 15 | Encoder A+ | | Black-3 |
| 6 | Servo On/Off- | | Red-3 | 16 | Encoder A- | | Red-3 |
| 7 | Alarm Out+ | | Black-4 | 17 | Encoder B+ | | Black-4 |
| 8 | Alarm Out- | | Red-4 | 18 | Encoder B- | | Red-4 |
| 9 | Alarm Reset+ | | Black-5 | 19 | Encoder Z+ | | Black-5 |
| 10 | Alarm Reset- | | Red-5 | 20 | Encoder Z- | | Red-5 |

※□ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200)
E.g.) CO20-MP070-R: 7m I/O cable.

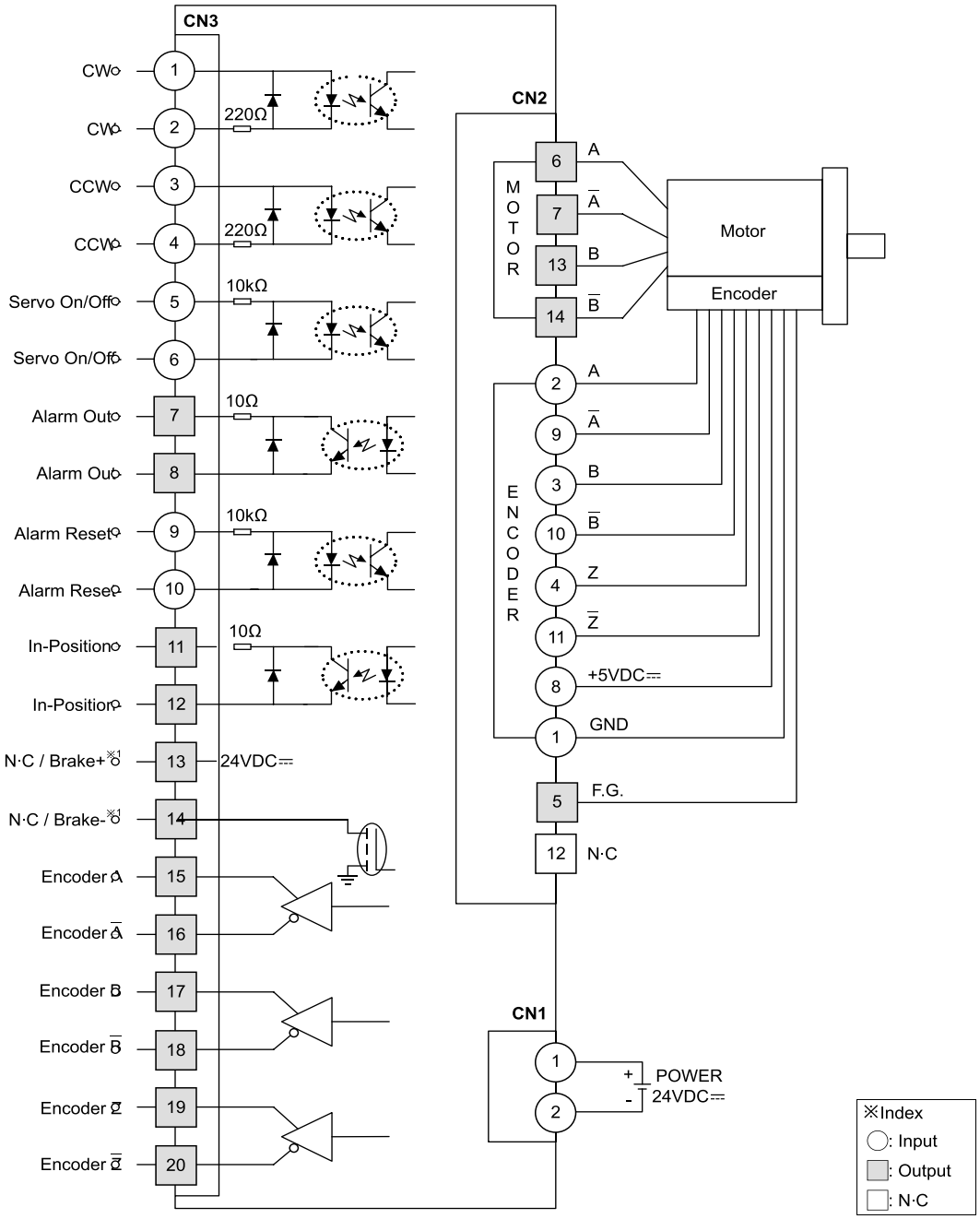
### ◎ Motor+Encoder cable

- **Normal: C1D14M(B)-□, Moving: C1DF14M(B)-□**



※□ of model name indicates cable length (1, 2, 3, 5, 7, 10)
E.g.) C1DF14MB-10: 10m moving type, built-in brake type motor+encoder cable.

## ▣ Connection for Motor and Driver




※1: Corresponding pins are only in built-in brake type.
※The Connection diagram is base on built-in brake type.

## ▣ 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).

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'. 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.
- Do not input CW, CCW signal at the same time in 2-pulse input method.
- When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.
- Use twisted pair (over 0.2mm$^2$) for the signal cable which should be shorter than 2m.
- The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
- Keep the distance between power cable and signal cable more than 10cm.
- Motor vibration and noise can occur in specific frequency period.
  ①Change motor installation method or attach the damper.
  ②Use 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.
  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 motor
  ⑤Inconsistency 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.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II

# Controller Integrated 2-Phase Closed-Loop Stepper Motor Driver



## ▣ Features

- 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, program mode
- 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 10-level resolutions (electric gear)
- Various alarms out
  : overcurrent, overspeed, overheat, motor connection error, encoder connection error, and etc., overall 17 types
- Frame size 20mm, 28mm, 35mm, 42mm, 56mm, 60mm motors supported

**Please read "Safety Considerations" in the instruction manual before using.**

## ▣ Applications

- Filed requiring preciseness such as semiconductor equipment, 3D printer, optical inspection equipment, chip mounter, cartesian robot, conveying equipment, and alignment stage.

## ▣ Manual

For the detail information and instructions, please refer to user manual, user manual for communication manual and library manual and be sure to follow cautions written in the technical descriptions (catalog, website).
Visit our website (www.autonics.com) to download manuals.

## ▣ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

< Computer specification for using software>

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

< atMotion screen >

## ▣ Ordering Information

| Ai | C | – | D | – | 42 | L | A | – | |
|---|---|---|---|---|---|---|---|---|---|

**Brake**

| | |
|---|---|
| **No mark** | Standard type |
| **B**※1 | Built-in brake type |

**Encoder resolution**

| | |
|---|---|
| **A**※2 | 4,000PPR(1,000PPR×4-multiply) |
| **B**※3 | 16,000PPR(4,000PPR×4-multiply) |
| **A**※4 | 10,000PPR(2,500PPR×4-multiply) |

**Motor length**

**Motor frame size**

| | | | Standard type | Built-in brake type |
|---|---|---|---|---|
| **20** | 20×20mm | **M** | 41.2mm | – |
| | | **L** | 53.1mm | – |
| **28** | 28×28mm | **S** | 46mm | – |
| | | **M** | 59mm | – |
| | | **L** | 65mm | – |
| **35** | 35×35mm | **S** | 41.5mm | – |
| | | **M** | 52mm | – |
| | | **L** | 68.5mm | – |
| **42** | 42×42mm | **S** | 67.5mm | 102.3mm |
| | | **M** | 73.5mm | 108.3mm |
| | | **L** | 81.5mm | 116.3mm |
| **56** | 57.2×57.2mm | **S** | 77.3mm | 112.1mm |
| | | **M** | 90.3mm | 125.1mm |
| | | **L** | 111.3mm | 146.1mm |
| **60** | 60×60mm | **S** | 81.9mm | 116.7mm |
| | | **M** | 102.8mm | 137.6mm |
| | | **L** | 119.8mm | 154.6mm |

**Item**

| | |
|---|---|
| **D** | Driver |

**Category**

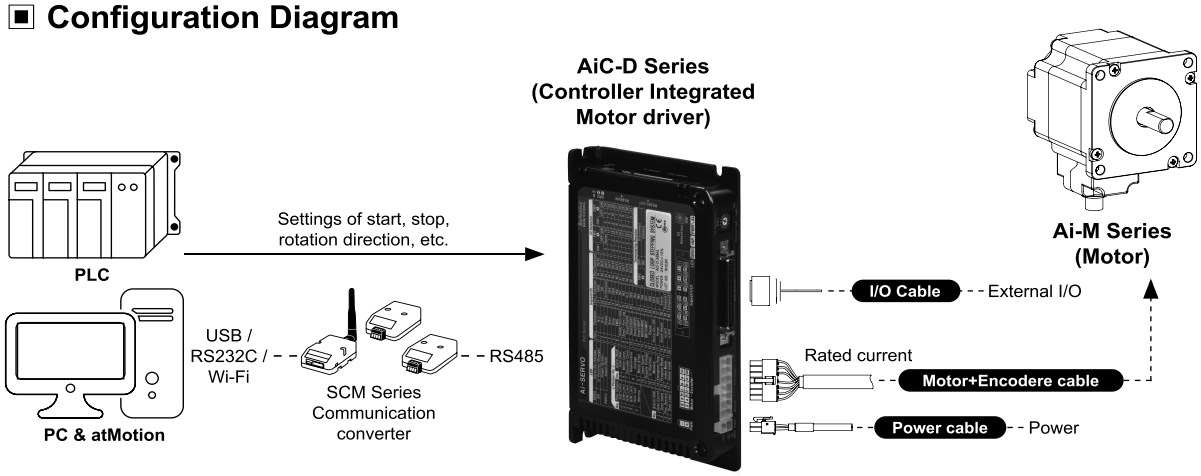
| | |
|---|---|
| **C** | Controller |

**Series**

| | |
|---|---|
| **Ai** | Artificial intelligence |

※1: Built-in brake type is only for frame size 42, 56, 60mm motors.
※2: Encoder resolution for frame size 20mm motors. Microstep control for AiC driver, it controls up to 10,000PPR.
※3: Encoder resolution for frame size 28, 35mm motors.
※4: Encoder resolution for frame size 42, 56, 60mm motors.

## ▣ Configuration Diagram



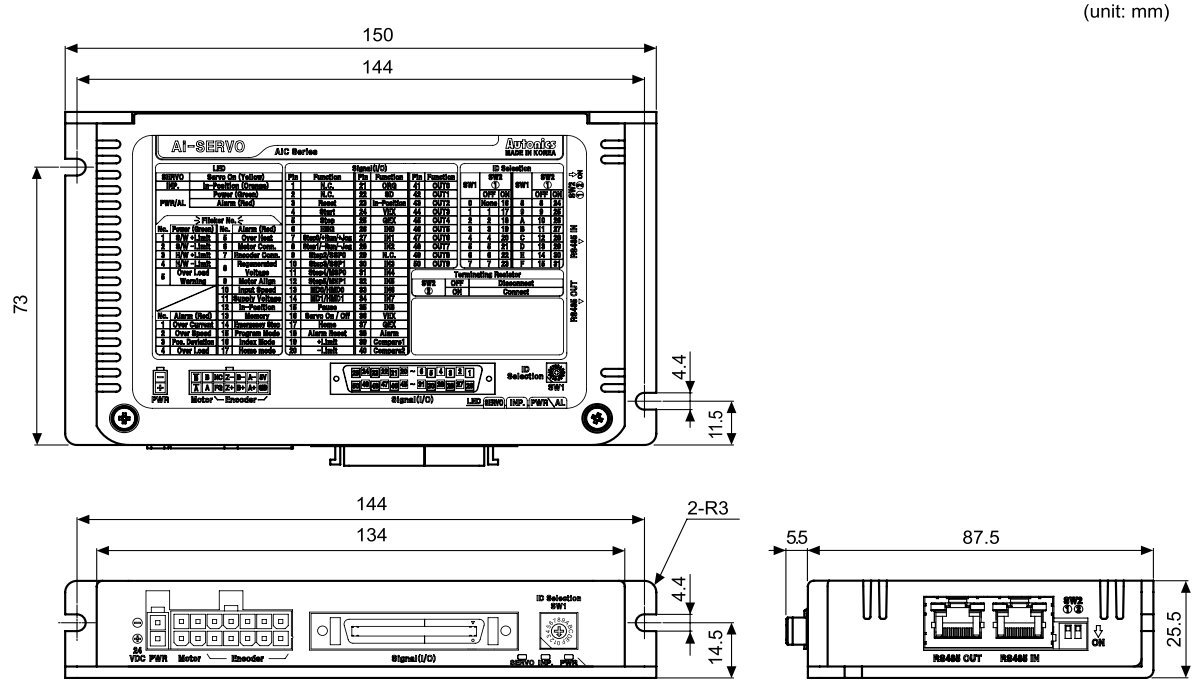
## ▣ Specifications

| Model※1 | | — | 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※2 | Max. 10W | | | Max. 10W | Max. 12W | Max. 15W |
| | Max. during operation※3 | Max. 60W | | | Max. 60W | Max. 120W | Max. 240W |
| Max. RUN current※4 | | 0.6A/Phase | 1.0A/Phase | 1.2A/Phase | 1.7A/Phase | 3.5A/Phase | |
| STOP current※5 | | 20 to 100% of max. RUN current (factory default: 50%) | | | | | |
| Rotation speed | | 0 to 3000rpm | | | | | |
| Resolution※5 | | 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, 10000PPR | | |
| Speed filter※5 | | 0 (disable), 2, 4, 6, 8, 10, 20, 40, 60 (factory default), 80, 100, 120, 140, 160, 180, 200ms | | | | | |
| Positioning Gain※5 | | (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(factory default) to 7, Accurate Response: 0 to 7 | | | | | |
| Motor rotation direction※5 | | CW, CCW | | | | | |
| Status indicator | | ● Power/Warning indicator: green LED ● Alarm indicator: red LED ● In-Position indicator: yellow LED<br>● Servo On/Off indicator: orange LED ● RS485 DATA IN/OUT indicator: green, yellow 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<br>● 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 stpes | | | | | |
| Program function | Step | 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 outuput port), JMP (jump), REP (start repetition), RPE (end repetition), END (end program), POS (position set), TIM (timer), CMP (compare output) | | | | | |
| | Start | Power On Program auto-start function | | | | | |
| | Home search | Power On Home Search auto-start function | | | | | |
| Home search mode | | Home, limit home, zero home, torque home | | | | | |
| RS485 comm. | Comm. speed※5 | 9600, 19200, 38400, 57600, 115200(factory default) bps | | | | | |
| Multiaxial control | | 31-axis | | | | | |
| ID setting switch | | 16-bit rotary switch (0 to F), 1-bit DIP switch (ON/OFF) | | | | | |
| Alarm output | | Overcurrent, overspeed, position tracking, overload, overheat, 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, overload | | | | | |
| Insulation resistance | | Over 100MΩ (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 | | | | | |
| Envoronment | Ambient temp. | 0 to 50℃, storage: -10 to 60℃ | | | | | |
| | Ambient humi. | 35 to 85%RH, storage: 10 to 90%RH | | | | | |
| Protection structure | | IP20(IEC standard) | | | | | |
| Approval | | CE | | | | | |
| Weight※6 | | Approx 460g (approx 300g) | | | | | |

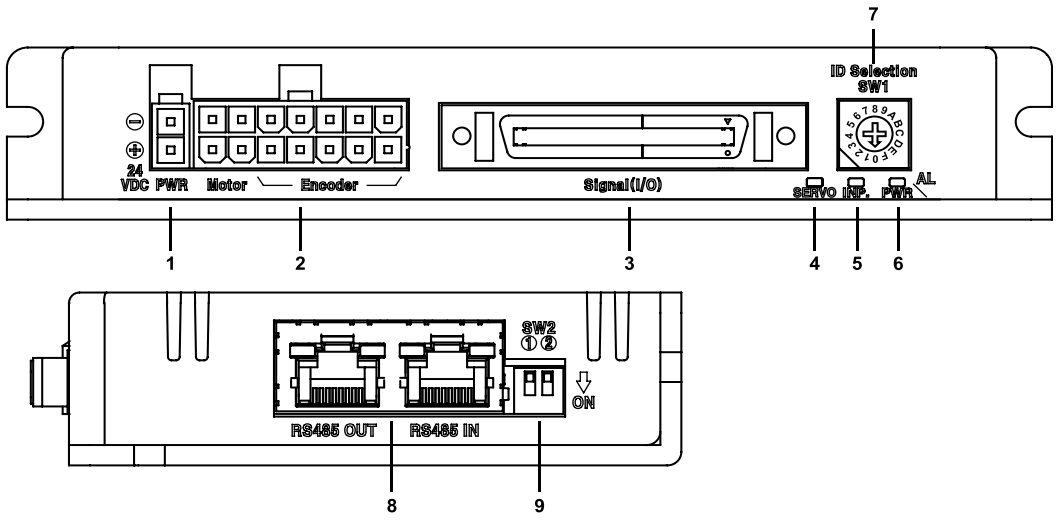
※1: The model name indicates driver type. (none: standard type, B: built-in brake type)
E.g.) AiC-D-42LA-B: built-in brake type stepping motor driver.
※2: Based on the ambient temperature 25℃, ambient humidity 55%RH, and STOP current 50%.
※3: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase.
The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※4: Run current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※5: Settable with the edicated program (atMotion).
※6: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Dimensions

(unit: mm)




## ▣ 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)

## ▣ Status Indicators

| 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 '▣ **Control Input/Output** → ◎ **Output** → **3. Alarm/Warning**'. |
| 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 receives data. |
| TXD OUT※1 | | Green | | Flashes when sending data. |

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



## ▣ Driver Setting

### ◎ SW1: ID setting switch

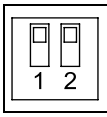
※Set Node ID of the driver.
※Depending on the 1 switch setting of the SW2, it is possible to connect max. 31-axis.

| 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 |



### ◎ SW2: ID setting/Terminating resistance DIP switch

※Set Node ID of the driver.
※Set to use terminating resistance.

| | 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 |

## ▣ Control Input/Output

Inner signal of all input/output consists of photocoupler.
ON, [H]: photocoupler power ON
OFF, [L]: photocoupler power OFF
※Brake operation is only for built-in brake type.

### ◎ Input

**1. Exclusive input (20)**

| Signal name | Descriptions | Pin no. | Signal name | Descriptions | Pin no. |
|---|---|---|---|---|---|
| Reset | Reset command | 3 | MD0/HMD0 | Operation mode designate 0 / Home search mode designate 0 | 13 |
| Start | Drive start command | 4 | MD1/HMD1 | Operation mode designate 1 / Home search mode designate 1 | 14 |
| Stop | Drive stop command | 5 | Pause | Pause | 15 |
| EMG | Drive emergency stop command | 6 | Servo On/Off | Servo On/Off | 16 |
| Step0/+Run/+Jog | Step designate 0 / +Run / +Jog | 7 | Home | Home search | 17 |
| Step1/-Run/-Jog | Step designate 1 / -Run / -Jog | 8 | Alarm Reset | Alarm reset command | 18 |
| Step2/SSP0 | Step designate 2 / Start speed designate 0 | 9 | +Limit | +direction limit sensor | 19 |
| Step3/SSP1 | Step designate 3 / Start speed designate 1 | 10 | -Limit | -direction limit sensor | 20 |
| Step4/MSP0 | Step designate 4 / Max. speed designate 0 | 11 | ORG | Home sensor | 21 |
| Step5/MSP1 | Step designate 5 / Max. speed designate 1 | 12 | SD | Deceleration (deceleration stop) signal | 22 |

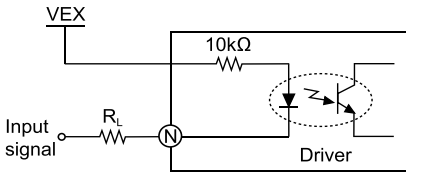
**2. General input (9)**

| 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 |

**3. Example of input circuit connection**

-All input circuits are insulated with photocoupler, and separate external power (recommended: 24VDC⎓) is necessary.
-Case of using external power 24VDC⎓ does not require $R_L$.
-In case using external power over 24VDC⎓, select $R_L$ value that $I_F$ (forward current of primary LED) of photocoupler to be around 2.5mA (max. 10mA).

※ $R_L = \frac{VEX-1.25V}{0.0025A} - 10\times10^3\,\Omega$




※N: Input pin number of CN3

### ◎ Output

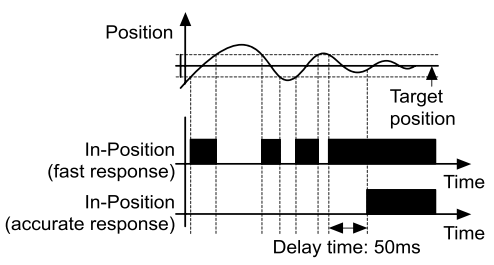
**1. Exclusive output (AiC-D: 4, AiC-D-B: 6)**

| Signal name | Descriptions | Pin no. | Signal name | Descriptions | Pin no. |
|---|---|---|---|---|---|
| Brake+ | Brake output (24VDC⎓) | 1 | Alarm | Alarm output | 38 |
| Brake- | Brake output (GND) | 2 | Compare1 (trigger) | Comparison output1 | 39 |
| In-Position | Drive ending pulse | 23 | Compare2 (trigger) | Comparison output2 | 40 |

**2. In-Position**

-In-Position output represents output is output 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 ON and In-Position indicator turns ON.
-In reverse, when the gap is over In-Position setting value, In-Position output turns OFF and the In-Position indicator turns OFF.
※For accurate drive, check the In-Position output again and execute the next drive.
※Refer to '**6. Example of output circuit connection**'.

| 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 |



## ▣ Control Input/Output

### 3. Alarm/Warning

● **Alarm**

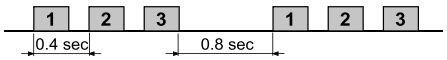
-This function stops motor to protect driver, depending on the error status such as overcurrent or overspeed.
-In case of normal status, output turns ON, and in case of alarming status, output turns OFF.
-When alarm occurs, brake operates.
-When supplying alarm reset, driver returns to the normal status.
※Refer to '**6. Example of output circuit connection**'.

● **Warning**

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

| Alarm indicator | No. of flashing | Alarm type | Descriptions | Motor status | Torque status |
|---|---|---|---|---|---|
| AL (red) | 1 | Overcurrent error | When overcurrent flows at motor RUN element | Stop | Release |
| | 2 | Overspeed error | When motor speed is over 4,000rpm | | |
| | 3 | Position tracking error | When the gap between position command value and current position value is over 90° | | |
| | 4 | Overload error | When applying load over the rated load for over 1 sec. | | |
| | 5 | Overheat error | When driver inner temperature is over 80℃ | | |
| | 6 | Motor connection error | When motor cable connection error occurs at driver | | |
| | 7 | Encoder connection error | When encoder cable connection error occurs at driver | | |
| | 8 | Regenerative voltage error | When regenerative voltage is over 78V | | |
| | 9 | Motor misalignment | When motor is in misalignment | | |
| | 10 | Command speed error | When command speed is over 3,500rpm | | |
| | 11 | Input voltage error | When input voltage is out of 24VDC⎓ ±10% | | |
| | 12 | In-Position error | When position error (over 1) is kept over 3 sec, after motor stopped | | |
| | 13 | Memory error | When memory error is detected as power supplied | | |
| | 14 | Emergency stop | When emergently stopped with emergency stop command | Stop | Remain |
| | 15 | Program mode error | When 'END' command is not exist at the last step | | |
| | 16 | Index mode error | When other instruction is used but 'INC', 'ABS'<br>When index command is not completed due to the stop command | | |
| | 17 | Home search mode error | When failed to find home | | |
| Warning indicator | No. of flashing | Warning type | Descriptions | Motor status | Torque status |
| PWR (green) | 1 | + software limit | When normal direction (CW) software limit is ON | Stop | Remain |
| | 2 | - software limit | When reverse direction (CCW) software limit is ON | | |
| | 3 | + hardware limit | When normal direction (CW) hardware limit is ON | | |
| | 4 | - hardware limit | When reverse direction (CCW) hardware limit is ON | | |
| | 5 | Overload warning | When maximum load is kept connected over 10 sec (motor or driver can be overheated) | Remain | Remain |

※Even though warning occurs, it drives as normal status and it may cause damage by fire.
It is recommend not to use the unit during warning status.
※Depending on alarm/warning type, it flashes 0.4 sec interval and it turns OFF for 0.8 sec repeatedly.
<In case of no. 3 alarm>




### 4. Comparison output (compare1, compare2)

Outputs trigger pulse on the certain interval that user has set.

| Mode | Descriptions |
|---|---|
| 0 | Not use comparison output. |
| 1 | Comparison output turns ON when the present absolute position value is same or bigger than the set position value. |
| 2 | Comparison output turns ON when the present absolute position value is same or smaller than the set position value. |
| 3 | Trigger pulses output with the set interval and width. |

※Please refer to the user manual to learn how to set.

### 5. General output (AiC-D: 10, AiC-D-B: 9)

● **Standard type**

| Signal name | Descriptions | Pin no. |
|---|---|---|
| OUT0 to OUT9 | General output 0 to 9 | 41 to 50 |

● **Built-in brake type**

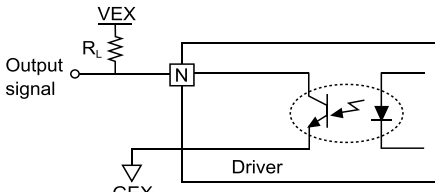
| Signal name | Descriptions | Pin no. |
|---|---|---|
| OUT0 to OUT8 | General output 0 to 8 | 41 to 49 |

## ▣ Control Input/Output

**6. 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.

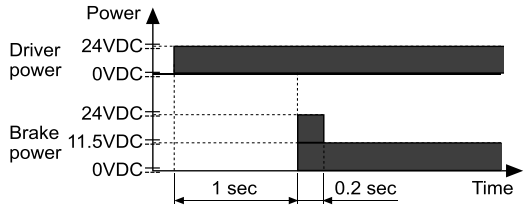
※ $R_L = \frac{VEX-0.7V}{0.01A}$



※N: Output pin number of CN3

**7. 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.

## ▣ Communication Output

It is for parameter setting and monitoring via external devices (PC, PLC, etc.).

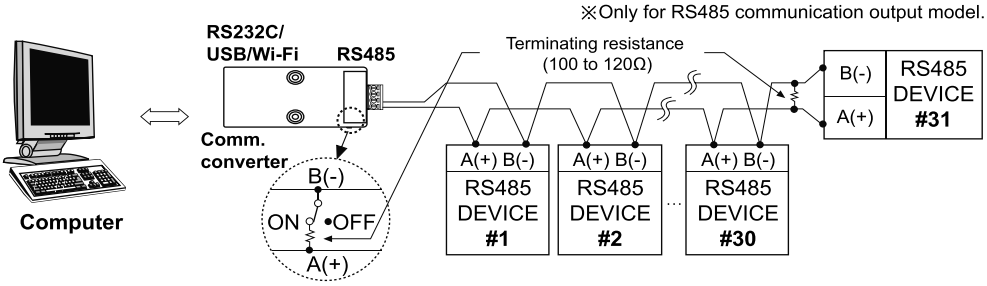
### ◎ Interface

| | | | |
|---|---|---|---|
| Comm. protocol | Modbus RTU | Comm. speed | 9600, 19200, 38400, 57600, 115200 bps |
| Connection type | RS485 | Comm. response wait time | 5 to 99ms |
| Application standard | Compliance with EIA RS485 | Start bit | 1-bit (fixed) |
| Max. connection | 31 units (address: 01 to 31) | Data bit | 8-bit (fixed) |
| Synchronous method | Asynchronous | Parity bit | None, Odd, Even |
| Comm. method | Two-wire half duplex | Stop bit | 1-bit, 2-bit |
| Comm. distance | Max. 800m | | |

※It is not allowed to set overlapping communication address at the same communication line.
Use twisted pair wire for RS485 communication.

### ◎ Application of system organization

※Only for RS485 communication output model.




※It is recommended to use Autonics communication converter;
SCM-WF48 (Wi-Fi to RS485·USB wireless communication converter, sold separately),
SCM-US48I (USB to RS485 converter, sold separately), SCM-38I (RS232C to RS485 converter, sold separately).
Please use twisted pair wire, which is suitable for RS485 communication, for SCM-WF48, SCM-US48I and SCM-38I.

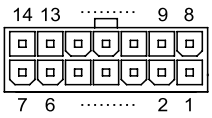
## ▣ Driver Connectors

### ◎ Connector function

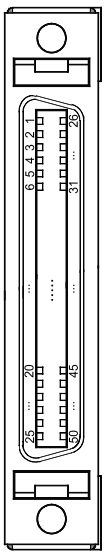
**● CN1: Power connector**

| Pin arrangement | Pin no. | Function |
|---|---|---|
| | 2 | GND |
| | 1 | 24VDC⎓ |

**● CN2: Motor+Encoder connector**

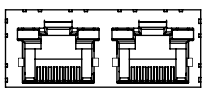
| Pin arrangement | Pin no. | Function | Pin no. | Function |
|---|---|---|---|---|
|  | 1 | GND | 8 | +5VDC⎓ |
| | 2 | Encoder A | 9 | Encoder $\overline{A}$ |
| | 3 | Encoder B | 10 | Encoder $\overline{B}$ |
| | 4 | Encoder Z | 11 | Encoder $\overline{Z}$ |
| | 5 | F.G. | 12 | N·C |
| | 6 | Motor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

**● CN3: I/O connector**

| Pin arrangement | Pin no. | I/O | Function | Pin no. | I/O | Function |
|---|---|---|---|---|---|---|
|  | 1※1 | Output | Brake+ | 26 | Input | IN0 |
| | 2※1 | Output | Brake- | 27 | Input | IN1 |
| | 3 | Input | Reset | 28 | Input | IN2 |
| | 4 | Input | Start | 29 | — | N·C |
| | 5 | Input | Stop | 30 | Input | IN3 |
| | 6 | Input | EMG | 31 | Input | IN4 |
| | 7 | Input | Step0/+Run/+Jog | 32 | Input | IN5 |
| | 8 | Input | Step1/-Run/-Jog | 33 | Input | IN6 |
| | 9 | Input | Step2/SSP0 | 34 | Input | IN7 |
| | 10 | Input | Step3/SSP1 | 35 | Input | IN8 |
| | 11 | Input | Step4/MSP0 | 36 | Input | VEX |
| | 12 | Input | Step5/MSP1 | 37 | Input | GEX |
| | 13 | Input | MD0/HMD0 | 38 | Output | Alarm |
| | 14 | Input | MD1/HMD1 | 39 | Output | Compare1 (Trigger) |
| | 15 | Input | Pause | 40 | Output | Compare2 (Trigger) |
| | 16 | Input | Servo On/Off | 41 | Output | OUT0 |
| | 17 | Input | Home | 42 | Output | OUT1 |
| | 18 | Input | Alarm Reset | 43 | Output | OUT2 |
| | 19 | Input | +Limit | 44 | Output | OUT3 |
| | 20 | Input | -Limit | 45 | Output | OUT4 |
| | 21 | Input | ORG | 46 | Output | OUT5 |
| | 22 | Input | SD | 47 | Output | OUT6 |
| | 23 | Output | In-Position | 48 | Output | OUT7 |
| | 24 | Input | VEX | 49 | Output | OUT8 |
| | 25 | Input | GEX | 50※2 | Output | OUT9 |

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

**● CN4: RS485 communication cable connector**

| Pin arrangement | Pin no. | I/O | Function | Pin no. | I/O | Function |
|---|---|---|---|---|---|---|
|  | 1 | — | N·C | 5 | — | N·C |
| | 2 | — | N·C | 6 | Input/Output | RS485 DATA- |
| | 3 | Input/Output | RS485 DATA+ | 7 | — | N·C |
| | 4 | — | N·C | 8 | — | N·C |

### ◎ 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 | Frame size 20, 28, 35mm | 5557-14R | 5556T2 | | |
| | | Frame size 42, 56, 60mm | | 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 |

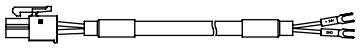
※Above connectors are suitable for AiC-D Series. You can use equivalent or substitute connectors.

## ▣ Sold Separately

※It is recommended to use ferrite core at power cable, I/O cable and Motor+Encoder cable.

### ◎ Power cable

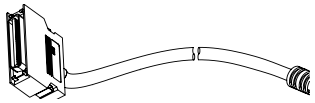
- **CJ-PW-□**



※□ of model name indicates cable length (010, 020)
E.g.) CJ-PW-010: 1m power cable.

### ◎ I/O cable

- **CO50-MP□-R**
  **(standard: AiC TAG)**

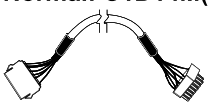


| Pin no. | Function (name tag) | Cable color | Dot line color-numbers | Pin no. | Function (name tag) | Cable color | Dot line color-numbers |
|---|---|---|---|---|---|---|---|
| 1 | Brake+ | Orange | Black-1 | 26 | IN0 | White | Red-3 |
| 2 | Brake- | | Red-1 | 27 | IN1 | | Black-4 |
| 3 | Reset | | 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 | OUT9 | | Red-5 |

※□ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200)
E.g.) CO50-MP070-R: 7m I/O cable.

### ◎ Motor+Encoder cable

- **Normal: C1D14M(B)-□, Moving: C1DF14M(B)-□**



※□ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20)
E.g.) C1DF14MB-10: 10m moving type, built-in brake type motor+encoder cable.

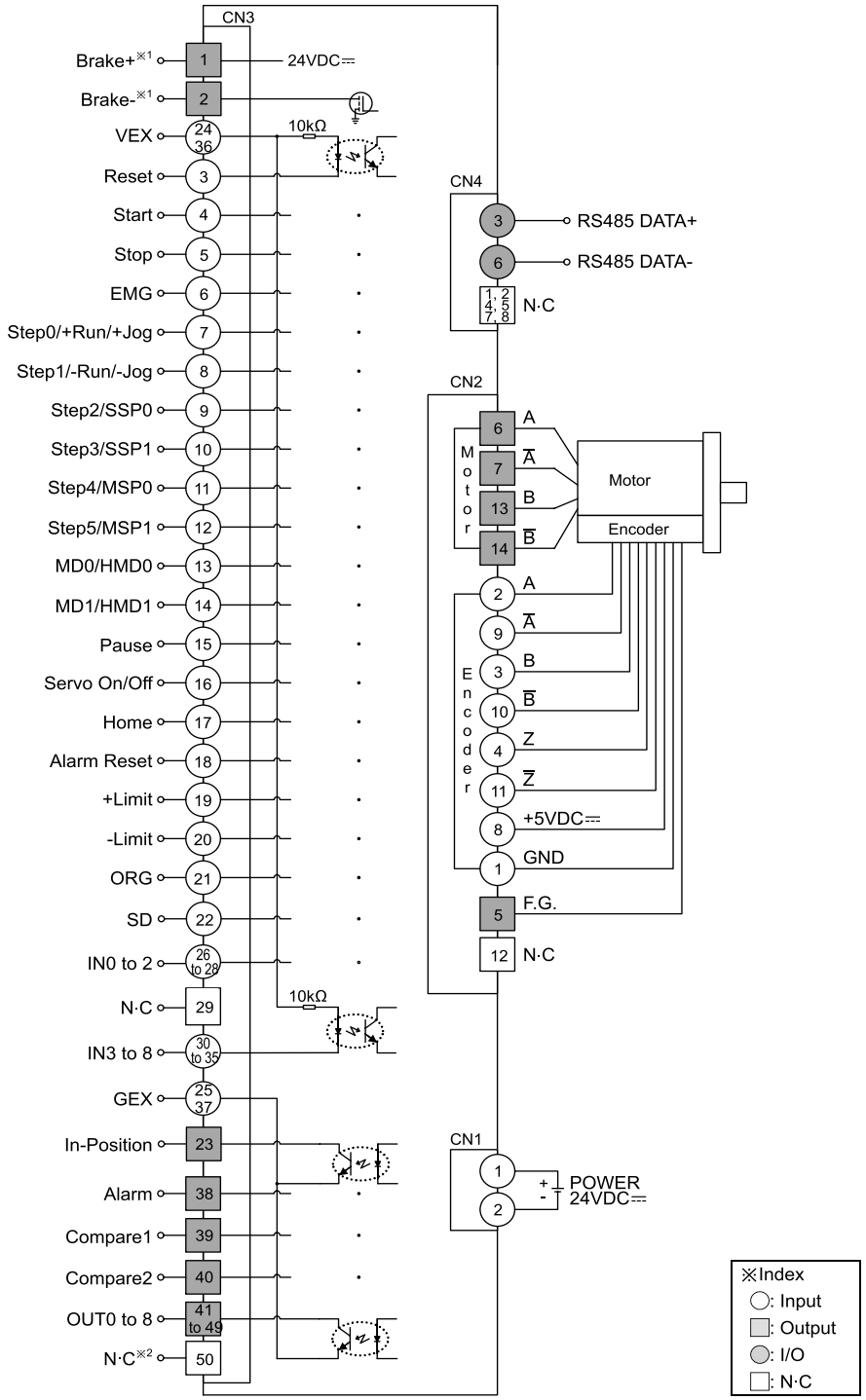
### ◎ Communication converter

- **SCM-WF48**
  **(Wi-Fi to RS485·USB wireless communication converter)**

- **SCM-US48I**
  **(USB to RS485 converter)**

- **SCM-38I**
  **(RS232C to RS485 converter)**

## ▣ Connection for Motor and Driver




※1: Corresponding pins are N.C in standard type.
※2: It corresponds to OUT9(output) in standard type.
※The Connection diagram is base on built-in brake type.

## ▣ Troubleshooting

**1. When driver communication is failed**

①Check whether the connection between driver and communication cable is correct.
②Check whether the port and communication speed is set correctly in the dedicated communication program.

**2. When operation of motor is unstable**

①Check that driver, motor, and brake are connected correctly.
②Check whether operation command is set correctly (e.g. speed, accel/deceleration speed).

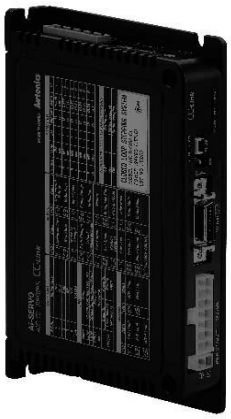
## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  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 Series recommended)
- The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
- 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

# Controller Integrated 2-Phase Closed-Loop Stepper Motor Driver



## ▣ Features



- CC-Link communication type Ai-SERVO
- Real-time position control with closed-loop system
- Controllable maximum 42 axis
- Able to check alarm and status with Alarm/Status display part (7 segment)
- Motor driver and controller integral type
- Faster response and performing low-speed/high torque for short-distance continuous drive to compare with the servo system.
- Applicable to the precision equipment such as optical inspection equipment with the features of having no micro vibration (hunting) in stop
- Dedicated Windows program (atMotion) provided for parameter setting and monitoring
- Easy and various gain setting supported through the program(GUI)
- Containing 10-level resolutions
- Frame size 42mm, 56mm, 60mm motors supported (applied motor: Ai-M Series)

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

CE

## ▣ Applications

- Filed requiring preciseness such as semiconductor equipment, 3D printer, optical inspection equipment, chip mounter, cartesian robot, conveying equipment, and alignment stage.

## ▣ Manual

For the detail information and instructions, please refer to user manual, user manual for communication manual and library manual and be sure to follow cautions written in the technical descriptions (catalog, website).
Visit our website (www.autonics.com) to download manuals.

## ▣ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

<Computer specification for using software>

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

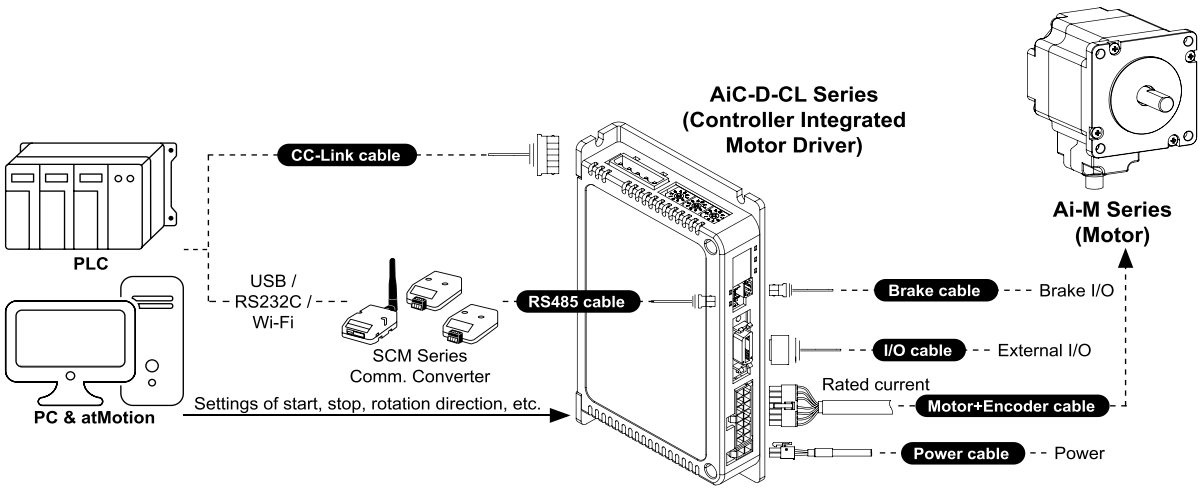
<atMotion screen>

## ▣ Ordering Information

Ai C - D - 42 L A - □ - CL

| | | | |
|---|---|---|---|
| Comm. Type | CL | CC-Link | |
| Brake | No mark | Standard type | |
| | B | Built-in brake type | |
| Encoder resolution | A | 10,000PPR(2,500PPR×4-multiply) | |
| Motor length | | Standard type | Built-in brake type |
| Motor frame size 42 (42×42mm) | S | 67.5mm | 102.3mm |
| | M | 73.5mm | 108.3mm |
| | L | 81.5mm | 116.3mm |
| Motor frame size 56 (57.2×57.2mm) | S | 77.3mm | 112.1mm |
| | M | 90.3mm | 125.1mm |
| | L | 111.3mm | 146.1mm |
| Motor frame size 60 (60×60mm) | S | 81.9mm | 116.7mm |
| | M | 102.8mm | 137.6mm |
| | L | 119.8mm | 154.6mm |
| Item | D | Driver | |
| Category | C | Controller | |
| Series | Ai | Artificial intelligence | |

## ▣ Configuration Diagram



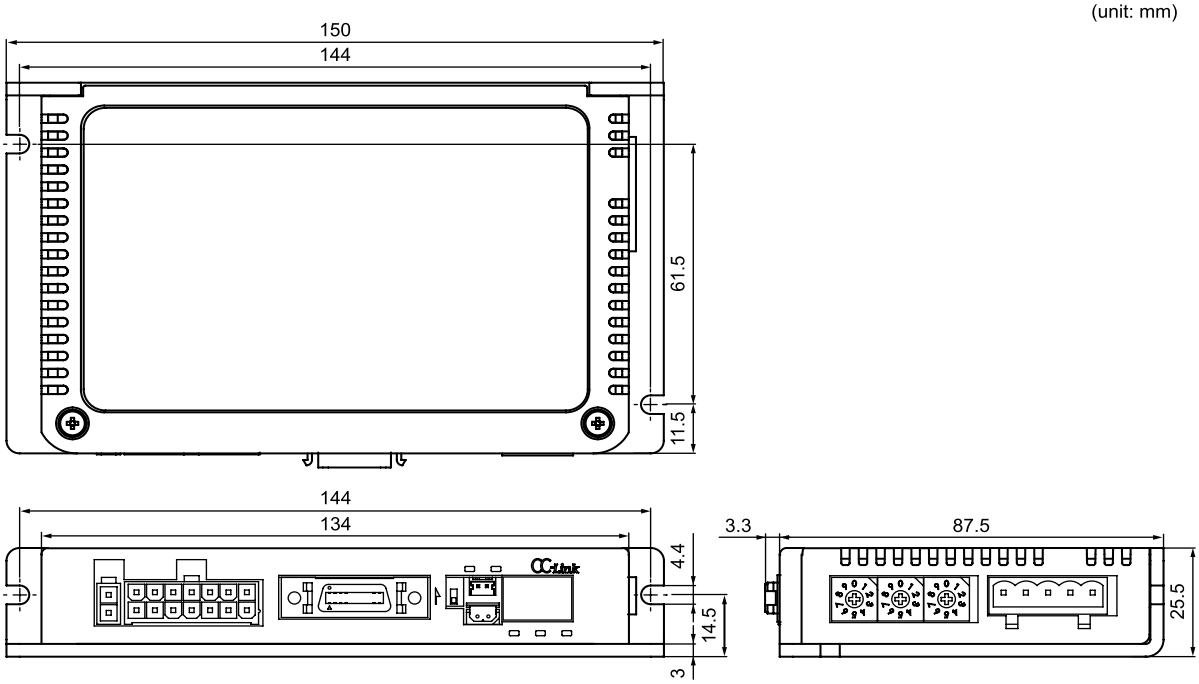
## ▣ Specifications

| Model※1 | | AiC-D-42SA(-B)-CL<br>AiC-D-42MA(-B)-CL<br>AiC-D-42LA(-B)-CL | AiC-D-56SA(-B)-CL<br>AiC-D-56MA(-B)-CL<br>AiC-D-56LA(-B)-CL | AiC-D-60SA(-B)-CL<br>AiC-D-60MA(-B)-CL<br>AiC-D-60LA(-B)-CL |
|---|---|---|---|---|
| Power supply | | 24VDC⎓ | | |
| Allowable voltage range | | 90 to 110% of the rated voltage | | |
| Power Consumption | STOP※2 | Max. 10W | Max. 12W | Max. 15W |
| | Max. during operation※3 | Max. 60W | Max. 120W | Max. 240W |
| Max. RUN current※4 | | 1.7A/Phase | 3.5A/Phase | |
| STOP current※5 | | 20 to 100% of max. RUN current (factory default: 50%) | | |
| Rotation speed | | 0 to 3000rpm | | |
| Resolution※5 | | 500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000PPR | | |
| Speed filter※5 | | 0 (disable), 2, 4, 6, 8, 10, 20, 40, 60 (factory default), 80, 100, 120, 140, 160, 180, 200ms | | |
| Positioning Gain※5 | | (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(factory default) to 7, Accurate Response: 0 to 7 | | |
| Motor rotation direction※5 | | CW, CCW | | |
| Status indicator | | ● Power/Alarm indicator: green/red LED<br>● Servo On/Off indicator: orange LED<br>● CC-Link status indicator: red, green LED<br>● In-Position indicator: yellow LED<br>● Alarm/Warning status display part: red LED 7 segment | | |
| I/O voltage level | | [H]: 5-30VDC⎓, [L]: 0-2VDC⎓ | | |
| I/O | Input | Exclusive input: 3, general input: 8 | | |
| | Output | General output: 7 | | |
| External power supply | | VEX(recommended: 24VDC⎓), GEX(GND) | | |
| Operation mode | | Jog, Continuous, Index, Program mode | | |
| Index step numbers | | 64 steps | | |
| Program function | Step | 256 steps | | |
| | Control command | ABS (move absolute position), INC (move incremental position), HOM (home search),<br>ICJ (jump input condition), IRD (waiting input), OPC (on/off of output port), OPT (on pulse from output port),<br>JMP (jump), REP (start repetition), RPE (end repetition), END (end program), POS (position set), TIM (timer) | | |
| | Start | Power On Program auto-start function | | |
| | Home search | Power On Home Search auto-start function | | |
| Home search mode | | Home, limit home, zero home, torque home | | |
| RS485 comm. | Comm. speed※5 | 9600, 19200, 38400, 57600, 115200(factory default) bps | | |
| Alarm output | | Overcurrent, overspeed, position tracking, overload, overheat, motor connection, encoder connection,<br>regenerative voltage, motor misalignment, command speed, input voltage,in-position, memory,<br>emergency stop, program mode, index mode, home search mode, comm. station setting,<br>comm. mode setting, comm. station setting change, comm. mode setting change, comm. failure | | |
| Warning output | | ±software limit, ±hardware limit, overload | | |
| Insulation resistance | | Over 100MΩ (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℃, storage: -10 to 60℃ | | |
| | Ambient humi. | 35 to 85%RH, storage: 10 to 90%RH | | |
| Protection structure | | IP20(IEC standard) | | |
| Approval | | CE | | |
| Weight※6 | | Approx 470g (approx 320g) | | |

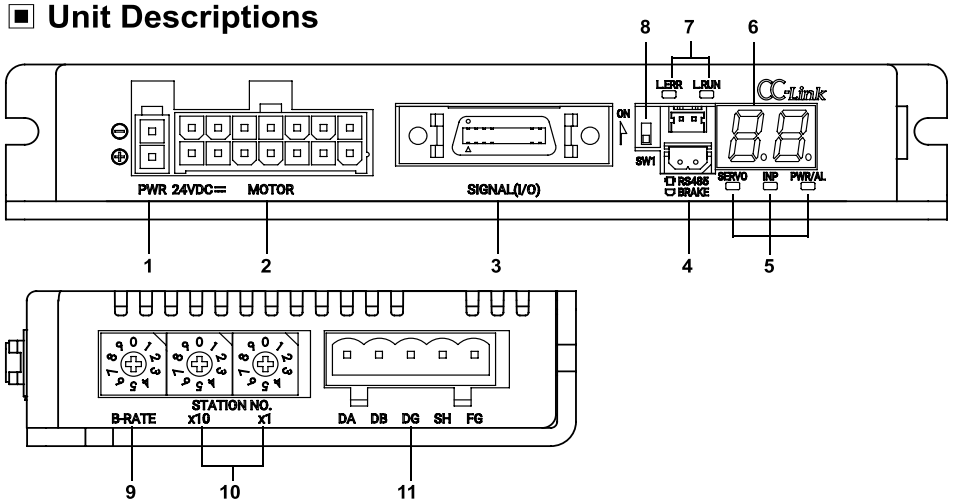
※1: The model name indicates driver type. (none: standard type, B: built-in brake type)
E.g.) AiC-D-42LA-B-CL: built-in brake type stepping motor driver.
※2: Based on the ambient temperature 25℃, ambient humidity 55%RH, and STOP current 50%.
※3: Max. power consumption during operation. When changing 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.
※4: Run current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※5: Settable with the dedicated program (atMotion).
※6: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Dimensions

(unit: mm)




## ▣ Unit Descriptions




1. Power connector (CN1: PWR)
2. Motor+Encoder connector (CN2: Motor / Encoder)
3. I/O connector (CN3: Signal I/O)
4-1. RS485 Communication connector (CN4: RS485)
4-2. Brake connector (CN5: BRAKE)
5-1. Servo On/Off indicator (Servo, Orange)
5-2. In-Position indicator (INP, Yellow)
5-3. Power/Alarm indicator (PWR/AL, Green/Red)
6. Alarm/Warning status display part (7 segment, Red)
7: CC-Link status indicator (L.ERR/L.RUN, Red/Green)
8: CC-Link station setting DIP switch (SW1)
9: CC-Link comm. speed setting rotary switch (B-RATE)
10: CC-Link station setting rotary switch (STATION NO.)
11: CC-Link connector (CN6: DA DB DG SH FG)

## ▣ Status Indicators

| Status indicator | LED color | Function | Descriptions |
|---|---|---|---|
| PWR | 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 '▣ **Control Input/Output** → ◎ **Output** → **3. Alarm/Warning**'. |
| 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. |
| L.RUN | Green | CC-Link comm. indicator | Turns ON when communication operates normally. |
| L.ERR | Red | | Turns ON when communication failure. |



## ▣ Driver Setting

### ◎ CC-Link station setting DIP switch (SW1)

| Setting | CC-Link station setting |
|---|---|
| ON | 2 stations occupied |
| OFF(factory default) | 1 station occupied |

### ◎ CC-Link comm. speed setting rotary switch (B-RATE)

B-RATE

| Setting | Comm. speed (bps) | Setting | Comm. speed (bps) |
|---|---|---|---|
| 0 | 156k | 5 | Disable |
| 1 | 625k | 6 | |
| 2 | 2.5M | 7 | |
| 3 | 5M | 8 | |
| 4 | 10M | 9 | |

### ◎ CC-Link station setting rotary switch (STATION NO.)

※Set the CC-Link comm. station.
※Available setting range is 01 to 64.

×10

| Setting | Station No. (×10) |
|---|---|
| 0 | 0×10 |
| 1 | 1×10 |
| 2 | 2×10 |
| 3 | 3×10 |
| 4 | 4×10 |
| 5 | 5×10 |
| 6 | 6×10 |
| 7 | Disable |
| 8 | |
| 9 | |

×1

| Setting | Station No. (×1) |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |

## ▣ Control Input/Output

Inner signal of all input/output consists of photocoupler.
ON, [H]: photocoupler power ON
OFF, [L]: photocoupler power OFF
※Brake operation is only for built-in brake type.

### ◎ Input

#### 1. Exclusive input (3)

| Signal name | Descriptions | Pin no. |
|---|---|---|
| ORG | Home sensor | 10 |
| +Limit | +direction limit sensor | 11 |
| -Limit | -direction limit sensor | 12 |

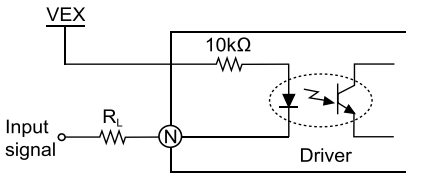
#### 2. General input (8)

| Signal name | Descriptions | Pin no. |
|---|---|---|
| IN0 | General input 0 | 2 |
| IN1 | General input 1 | 3 |
| IN2 | General input 2 | 4 |
| IN3 | General input 3 | 5 |
| IN4 | General input 4 | 6 |
| IN5 | General input 5 | 7 |
| IN6 | General input 6 | 8 |
| IN7 | General input 7 | 9 |

#### 3. Example of input circuit connection

-All input circuits are insulated with photocoupler, and separate external power (recommended: 24VDC) is necessary.
-Case of using external power 24VDC does not require $R_L$.
-In case using external power over 24VDC, select $R_L$ value that $I_F$ (forward current of primary LED) of photocoupler to be around 2.5mA (max. 10mA).

※$R_L = \frac{VEX-1.25V}{0.0025A} - 10\times10^3\,\Omega$



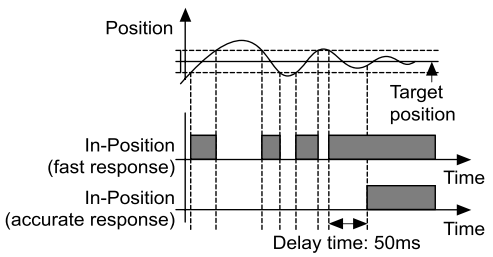

※N: Input pin number of CN3

### ◎ Output

#### 1. In-Position

-In-Position output represents output is output 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 ON and In-Position indicator turns ON.
-In reverse, when the gap is over In-Position setting value, In-Position output turns OFF and the In-Position indicator turns OFF.
※For accurate drive, check the In-Position output again and execute the next drive.
※Refer to '**6. Example of output circuit connection**'.

| 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 |



## ▣ Control Input/Output



### 2. Alarm/Warning

● **Alarm**

-This function stops motor to protect driver, depending on the error status such as overcurrent or overspeed.
-In case of normal status, output turns ON, and in case of alarming status, output turns OFF.
-When alarm occurs, brake operates.
-When supplying alarm reset, driver returns to the normal status.
※Refer to '**6. Example of output circuit connection**'.

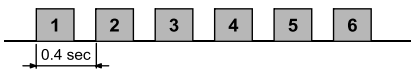
● **Warning**

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

| Alarm status | Alarm type | Descriptions | Motor status | Torque status |
|---|---|---|---|---|
| C.1 | Comm. station setting error | CC-Link station setting error | Remain | Remain |
| C.2 | Comm. speed setting error | CC-Link speed setting error | | |
| C.3 | Comm. station setting change | CC-Link station setting change | | |
| C.4 | Comm. speed setting change | CC-Link speed setting change | | |
| C.5 | Comm. failure | Communication with CC-Link master is disconnected | | |
| E.1 | Overcurrent error | When overcurrent flows at motor RUN element | Stop | Release |
| E.2 | Overspeed error | When motor speed is over 4,000rpm | | |
| E.3 | Position tracking error | When the gap between position command value and current position value is over 90˚ | | |
| E.4 | Overload error | When applying load over the rated load for over 1 sec. | | |
| E.5 | Overheat error | When driver inner temperature is over 80℃ | | |
| E.6 | Motor connection error | When motor cable connection error occurs at driver | | |
| E.7 | Encoder connection error | When encoder cable connection error occurs at driver | | |
| E.8 | Regenerative voltage error | When regenerative voltage is over 78V | | |
| E.9 | Motor misalignment | When motor is in misalignment | | |
| E.A | Command speed error | When command speed is over 3,500rpm | | |
| E.b | Input voltage error | When input voltage is out of 24VDC ±10% | | |
| E.C | In-Position error | When position error (over 1) is kept over 3 sec, after motor stopped | | |
| E.d | Memory error | When memory error is detected as power supplied | | |
| E.E | Emergency stop | When emergently stopped with emergency stop command | Stop | Remain |
| E.F | Program mode error | When 'END' command is not exist at the last step | | |
| E.G | Index mode error | When other instruction is used but 'INC', 'ABS'<br>When index command is not completed due to the stop command | | |
| E.H | Home search mode error | When failed to find home | | |
| Warning status | Warning type | Descriptions | Motor status | Torque status |
| W.1 | + software limit | When normal direction (CW) software limit is ON | Stop | Remain |
| W.2 | - software limit | When reverse direction (CCW) software limit is ON | | |
| W.3 | + hardware limit | When normal direction (CW) hardware limit is ON | | |
| W.4 | - hardware limit | When reverse direction (CCW) hardware limit is ON | | |
| W.5 | Overload warning | When maximum load is kept connected over 10 sec<br>(motor or driver can be overheated) | Remain | Remain |

※Even though warning occurs, it drives as normal status and it may cause damage by fire.
It is recommend not to use the unit during warning status.
※The alarm/warning flashes 0.4 sec repeatedly.

<In case of no. 3 alarm>




### 3. General output (7)

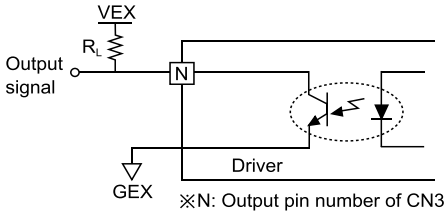
| Signal name | Descriptions | Pin no. |
|---|---|---|
| OUT0 | General output 0 | 13 |
| OUT1 | General output 1 | 14 |
| OUT2 | General output 2 | 15 |
| OUT3 | General output 3 | 16 |
| OUT4 | General output 4 | 17 |
| OUT5 | General output 5 | 18 |
| OUT6 | General output 6 | 19 |

## ▣ Control Input/Output

**4. 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.

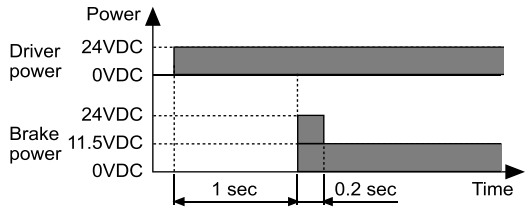
※$R_L = \frac{VEX-0.7V}{0.01A}$



※N: Output pin number of CN3

**5. 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.

## ▣ Communication Output

It is for parameter setting and monitoring via external devices (PC, PLC, etc.).
In CC-Link setting, the communication speed must be same between PLC and the driver.
The settable station number is 01 to 64, the station number must not be overlapped. (65 to 99 is not available)

### ◎ Interface

| | | | |
|---|---|---|---|
| Comm. standard | CC-Link Ver.1.10 | Max. transmit distance | Depend on comm. speed |
| Station type | Remote Device station | Remote I/O | ● 1 station occupied: Ryn/RXn 32 points each<br>● 2 stations occupied: Ryn/RXn 64 points each |
| Connection cable | CC-Link dedicated cable | Remote register | ● 1 station occupied: RWrn/RWwn 4 words each<br>● 2 stations occupied: RWrn/RWwn 8 words each |
| Comm. speed | 156k, 625k, 2.5M, 5M, 10M bps | Command | Point table read/write, parameter read/write, read only, special command monitor only, network connection, drive control, motion control, drive status |
| Station number | 01 to 64 | Comm. setting switch | 10 bit rotary switch (0 to 9): 3, 1 bit DIP switch (ON/OFF) |
| Number of occupied stations | 1 station occupied,<br>2 stations occupied | — | |

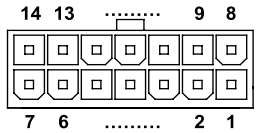
## ▣ Driver Connectors

### ◎ Connector function

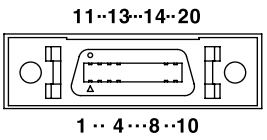
**● CN1: Power connector**

| Pin arrangement | Pin no. | Function |
|---|---|---|
| | 1 | 24VDC |
| | 2 | GND |

**● 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 | F.G. | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

**● CN3: I/O connector**

| Pin arrangement | Pin no. | I/O | Function | Pin no. | I/O | Function |
|---|---|---|---|---|---|---|
|  | 1 | — | VEX | 11 | Exclusive input | +Limit |
| | 2 | General input | IN0 | 12 | Exclusive input | -Limit |
| | 3 | General input | IN1 | 13 | General output | OUT0 |
| | 4 | General input | IN2 | 14 | General output | OUT1 |
| | 5 | General input | IN3 | 15 | General output | OUT2 |
| | 6 | General input | IN4 | 16 | General output | OUT3 |
| | 7 | General input | IN5 | 17 | General output | OUT4 |
| | 8 | General input | IN6 | 18 | General output | OUT5 |
| | 9 | General input | IN7 | 19 | General output | OUT6 |
| | 10 | Exclusive input | ORG | 20 | — | GEX |

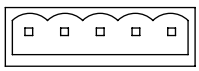
**● RS 485 comm. connector (CN4: RS485)**

| Pin arrangement | Pin no. | Function |
|---|---|---|
| | 1 | RS485 DATA- |
| | 2 | RS485 DATA+ |

**● Brake connector (CN5: BRAKE)**

| Pin arrangement | Pin no. | Function |
|---|---|---|
| | 1 | Brake- |
| | 2 | Brake+ |

**● CC-Link comm. connector (CN6: DA DB DG SH FG)**

| Pin arrangement | Pin no. | Function | Pin no. | Function |
|---|---|---|---|---|
|  | 1 | F.G. | 4 | DB |
| | 2 | SLD | 5 | DA |
| | 3 | DG | — | |

### ◎ Connector specifications

| Type | | Specifications | | | Manufacture |
|---|---|---|---|---|---|
| | | Connector | Connector terminal | Housing | |
| CN1 | Driver | LAD1140-02 | - | - | HANLIM |
| | Power | CHD1140-02 | CTD1140 | - | |
| CN2 | Driver | 35318-1420 | - | - | Molex |
| | Motor+Encoder | 5557-14R | 5556T | | |
| CN3 | Driver | 10220-52A2 PL | - | - | 3M |
| | I/O connector | 10150-3000PE | - | 10350-52F0-008 | |
| | | CO20-MP□-R (Sold separately) | - | - | Autonics |
| CN4 | Driver | 053254-0270 | - | - | Molex |
| | RS485 connector | 51065-0200 | 50212-8000 | - | |
| CN5 | Driver | 5268-02A | - | - | |
| | Brake | 5264-02 | 5263PBT | - | |
| CN6 | Driver | 2EHDRC-05P-OR※1 | - | - | Dinkle |
| | CC-Link connector | 2ESDV-05P-OR | - | - | |

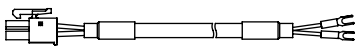
※1: CC-Link dedicated cable must be used and performance can not be guaranteed when using other cables.
※ Above connectors are suitable for AiC-D-CL Series. The connectors can be used with equivalent or substitute.

## ▣ Sold Separately

※It is recommended to use ferrite core at power cable, I/O cable and Motor+Encoder cable.

### ◎ Power cable

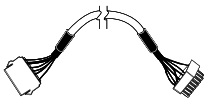
- **CJ-PW-□**



※□ of model name indicates cable length (010, 020)
E.g.) CJ-PW-010: 1m power cable.

### ◎ Motor+Encoder cable

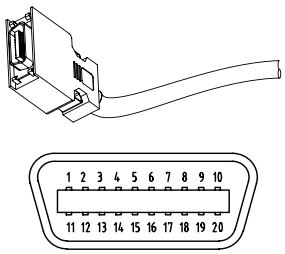
- **Normal: C1D14M(B)-□, Moving: C1DF14M(B)-□**



※□ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20)
(B) of model name indicates the built-in brake type, none indicates the standard type.
E.g.) C1DF14MB-10: 10m moving type, built-in brake type motor+encoder cable.

### ◎ I/O cable

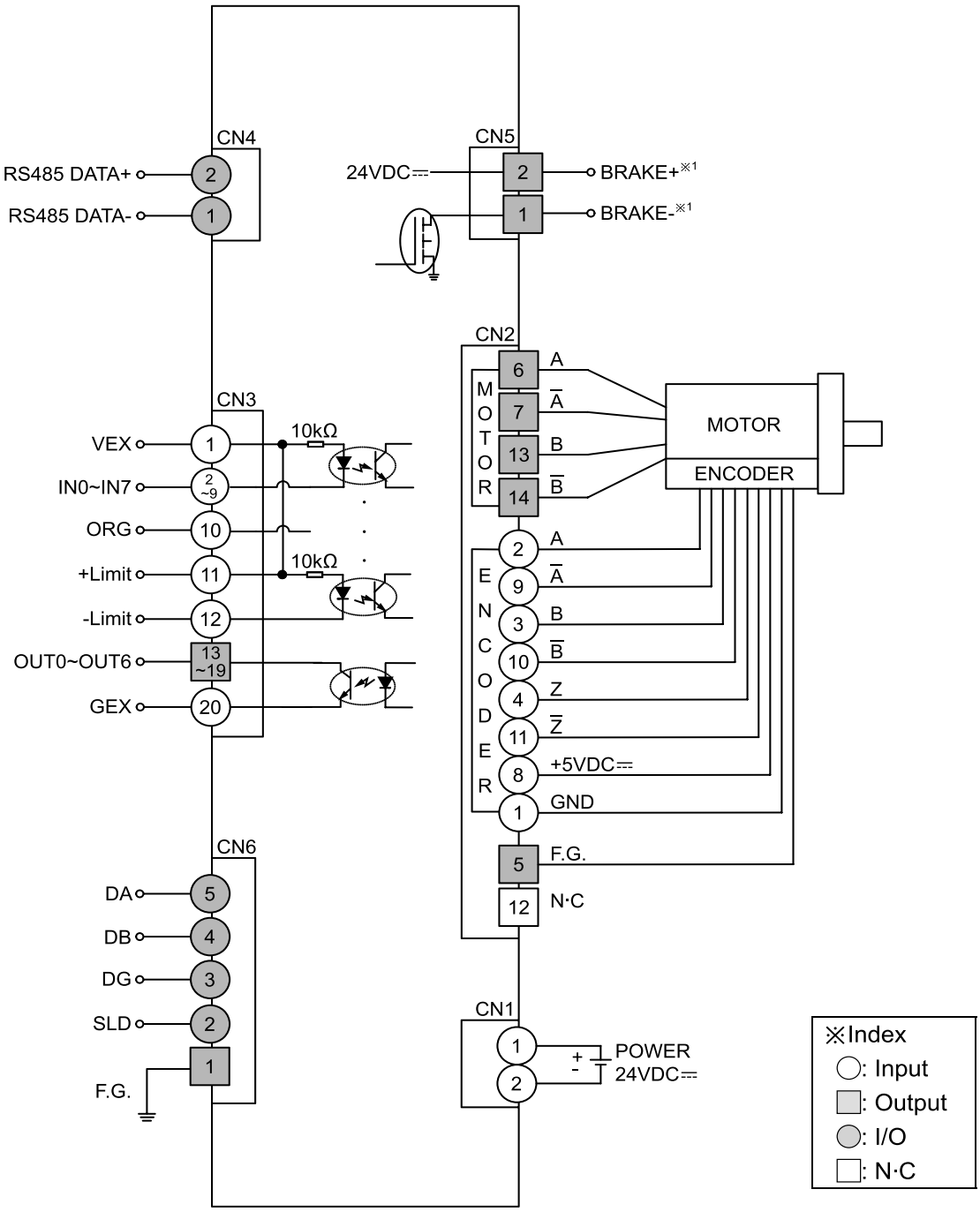
- **CO20-MP□-R**
  **(standard: AiC-CL TAG)**




| Pin no. | Function (Name TAG) | Cable color | Dot line color-numbers | Pin no. | Function (Name TAG) | Cable color | Dot line color-numbers |
|---|---|---|---|---|---|---|---|
| 1 | VEX | Yellow | Black-1 | 11 | +Limit | White | Black-1 |
| 2 | IN0 | | Red-1 | 12 | -Limit | | Red-1 |
| 3 | IN1 | | Black-2 | 13 | OUT0 | | Black-2 |
| 4 | IN2 | | Red-2 | 14 | OUT1 | | Red-2 |
| 5 | IN3 | | Black-3 | 15 | OUT2 | | Black-3 |
| 6 | IN4 | | Red-3 | 16 | OUT3 | | Red-3 |
| 7 | IN5 | | Black-4 | 17 | OUT4 | | Black-4 |
| 8 | IN6 | | Red-4 | 18 | OUT5 | | Red-4 |
| 9 | IN7 | | Black-5 | 19 | OUT6 | | Black-5 |
| 10 | ORG | | Red-5 | 20 | GEX | | Red-5 |

※□ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200)
E.g.) CO20-MP070-R: 7m I/O cable.

## ▣ Connection for Motor and Driver




※1: Corresponding pins are only in built-in brake type.
※The Connection diagram is base on built-in brake type.

## ▣ 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 Off.<br>In case of On, 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. |
| | Motor gain value is not correct. | Change the Motor Gain parameter as the certain value. |

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  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 Series recommended)
- The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
- 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

# 2-Phase Closed-Loop Stepper Motor (for AC driver)

## Features

- Minimal heat generating, high torque motor
- Higher cost-efficiency compared to servo motors
- Frame size 60mm, 86mm supported

Frame size 60mm

86mm

**Please read "Safety Considerations" in the instruction manual before using.**

## Ordering Information

**Ai** **A** - **M** - **60** **M** **A**

| | | | |
|---|---|---|---|
| Encoder resolution | | **A** | 10,000PPR (2,500PPR×4-multiply) |
| Motor length | | **M** | 82.8mm |
| | | **L** | 103.8mm |
| Motor frame size | **60** 60×60mm | **M** | 94.9mm |
| | | **L** | 109.4mm |
| | **86** 86×86mm | **M** | 94.9mm |
| | | **L** | 109.4mm |
| Item | | **M** | Motor |
| Voltage | | **A** | AC power |
| Series | | **Ai** | Artificial intelligence |

## ▣ Specifications

### ◎ Motor

| Model | AiA-M-60MA | AiA-M-60LA | AiA-M-86MA | AiA-M-86LA |
|---|---|---|---|---|
| Max. holding torque※1 | 11.22kgf·cm (1.1N·m) | 22.43kgf·cm (2.2N·m) | 28.56kgf·cm (2.8N·m) | 40.8kgf·cm (4.0N·m) |
| Rotor moment of inertia | 240g·cm$^2$ (240×10$^{-7}$kg·m$^2$) | 490g·cm$^2$ (490×10$^{-7}$kg·m$^2$) | 1,100g·cm$^2$ (1,100×10$^{-7}$kg·m$^2$) | 1,800g·cm$^2$ (1,800×10$^{-7}$kg·m$^2$) |
| Rated current | 2.0A/Phase | | | |
| Resistance ±10% | 1.5Ω/Phase | 2.4Ω/Phase | 2.3Ω/Phase | 1.9Ω/Phase |
| Inductance ±20% | 3.9mH/Phase | 8.5mH/Phase | 11.5mH/Phase | 16.2mH/Phase |
| Weight※2 | Approx. 0.95kg (approx. 0.75kg) | Approx. 1.35kg (approx. 1.15kg) | Approx. 2.00kg (approx. 1.70kg) | Approx. 2.60kg (approx. 2.30kg) |

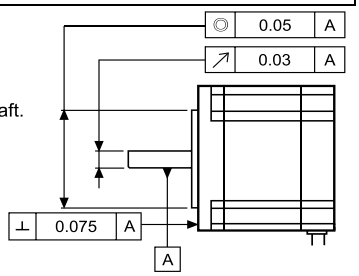
※1: Max. holding torque is maintenance torque of stopping the motor when supplying the rated current (2-phase excitation) and is the standard for comparing the performance of motors.
※2: The weight includes packaging. The weight in parenthesis is for unit only.

**• 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.

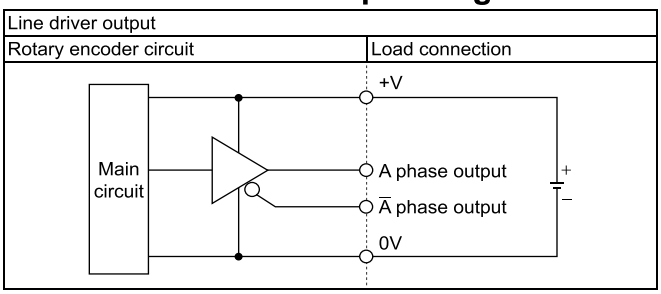
※3: Amount of radial shaft displacement when adding a radial load (25N) to the tip of the motor shaft.
※4: Amount of axial shaft displacement when adding a axial load (50N) to the shaft.
※Environment resistance is rated at no freezing or condensation.




### ◎ Encoder

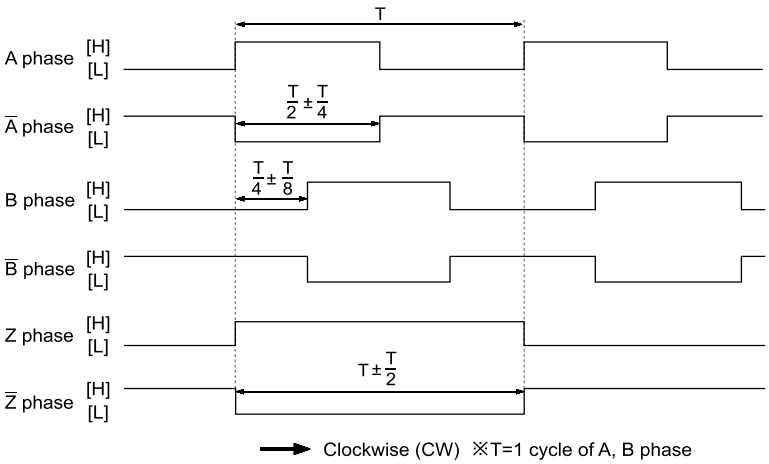
| Item | | | Incremental rotary encoder |
|---|---|---|---|
| Resolution | | | 10,000PPR (2,500PPR×4-multiply) |
| Electrical specification | Output phase | | A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase |
| | Output duty rate | | $\frac{T}{2} \pm \frac{T}{4}$ (T=1 cycle of A phase) |
| | 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⎓<br>• [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) |

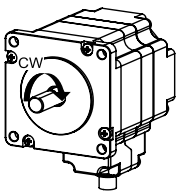
## ▣ Encoder Control Output Diagram




※All output circuits of A, Ā, B, B̄, Z, Z̄ phase are the same.

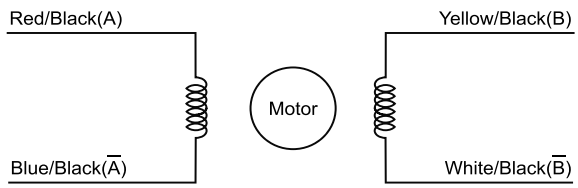
## ▣ Encoder Output Waveforms




## ▣ Connection Diagram

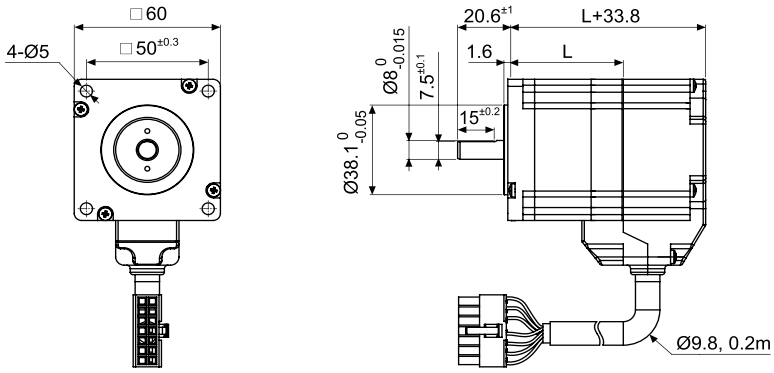
Autonics 2-phase closed-loop stepper motors take bipolar wiring methods.
The wiring colors for each phase and lead-wire are as the followings:



## ▣ Dimensions

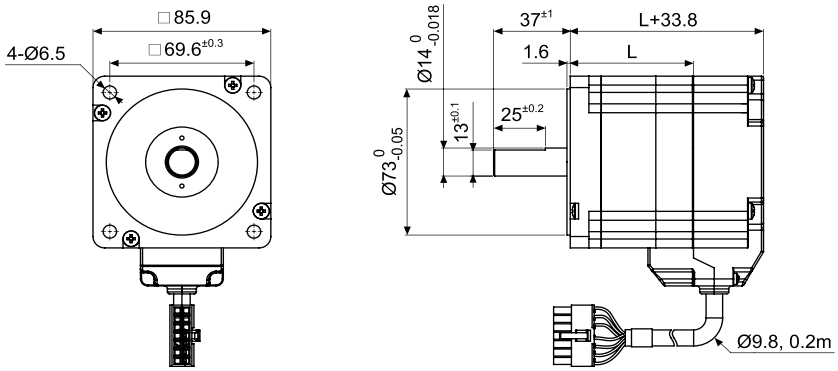
(unit: mm)

### ◎ Frame size 60mm




| Model | L |
|---|---|
| AiA-M-60MA | 47.4 |
| AiA-M-60LA | 68.3 |

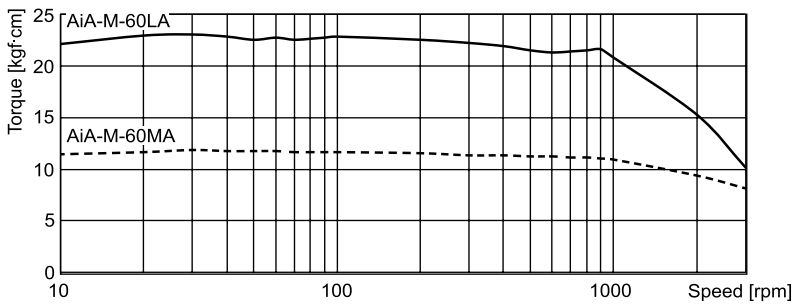
### ◎ Frame size 86mm



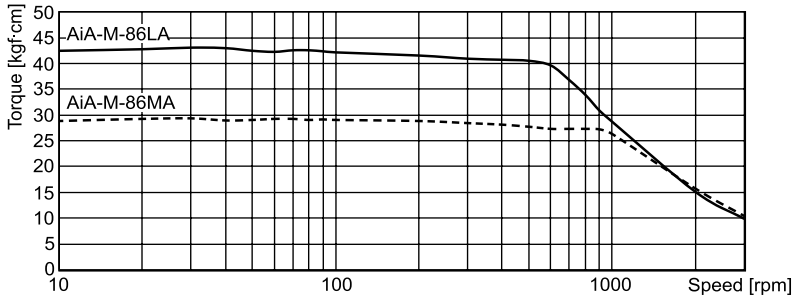

| Model | L |
|---|---|
| AiA-M-86MA | 59.5 |
| AiA-M-86LA | 74 |

## ▣ Motor Characteristics

### ◎ Frame size 60mm

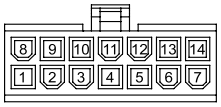



### ◎ Frame size 86mm



## ▣ Motor Connectors

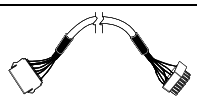
### ◎ CN1: Motor+Encoder connector

| 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 | PE | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

| Type | | Specifications | | | Manufacture |
|---|---|---|---|---|---|
| | | Connector | Connector terminal | Housing | |
| CN1 | Motor+Encoder | 5557-14R | 5556T | — | Molex |

※Above connector is suitable for AiA-M Series.

### ◎ Cable (sold separately)

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

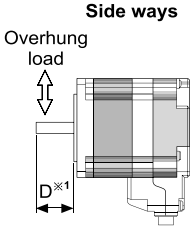
※1: □ indicates cable length (1, 2, 3, 5, 7, 10).
E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

## ▣ Motor Installation

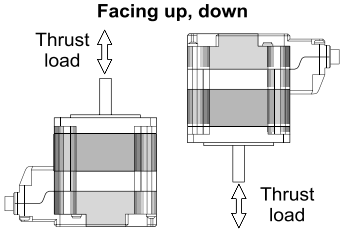
### 1. Mounting direction

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**



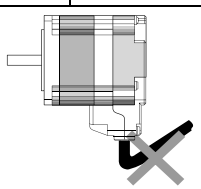

**Facing up, down**




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

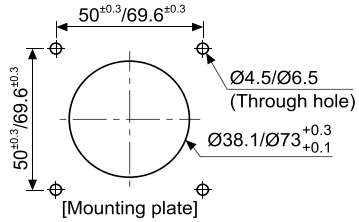
| Motor size | The distance from the shaft in front (mm), Allowable overhung load [kgf (N)] | | | | Allowable thrust load |
|---|---|---|---|---|---|
| | D=0 | D=5 | D=10 | D=15 | |
| Frame size 60mm | 5.5 (54) | 6.8 (67) | 9.1 (89) | 13.3 (130) | Under the load of motor |
| Frame size 86mm | 26.5 (260) | 29.5 (290) | 34.6 (340) | 39.7 (390) | |

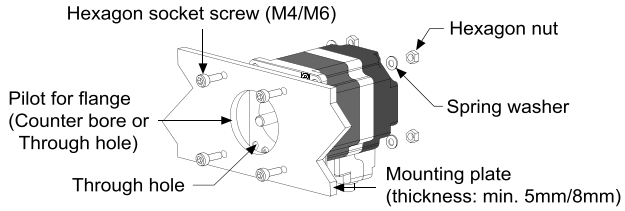
Do not apply excessive force to motor cable when mounting motors.
Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable by force.
In case of frequent cable movement required application, proper safety countermeasures must be ensured.

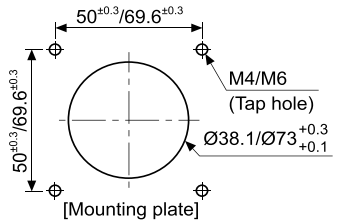


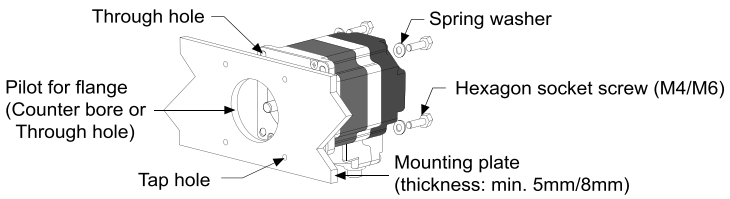
## 2. Mounting method

◎ **Frame size 60mm/86mm**



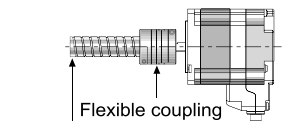
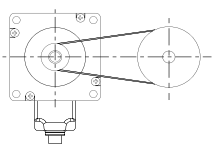
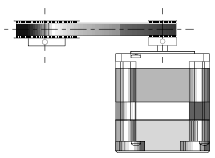




With considering heat radiation and vibration isolation, mount the motor as tight as possible against a metal panel having high thermal conductivity such as iron or aluminum.
When mounting motors, use hexagon socket screws, hexagon nuts, spring washers and flat washers.
Refer to the table below for allowable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

## 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 |
|---|---|---|
|  Ball screw or TM screw<br>※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.<br>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.<br>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.
① Inside of the housing which is installed indoors
(This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
② Within 0 to 50℃ (at non-freezing status) of ambient temperature
③ Within 20 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 acidity
⑨ The place where easy heat dissipation could be made
⑩ The place without 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 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).

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  Otherwise, it may cause unexpected accidents.
- 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.
- 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.
- Must connect the encoder shield cable to the F.G. terminal.
- 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.
- 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

# AC Type 2-Phase Closed-Loop Stepper Motor Driver

## ▣ Features

- Higher cost-efficiency compared to servo motor drivers
- Alarm/Status display part (7-segment)
- Rapid response which is advantageous for the short distance continuous operation
- Able to implement Low frequency operation and high torque in low speed area
- Low current drive at middle·high speed area
- Max. stop torque at current down mode (available vertical load attaching)
- Easy to use as much as unskilled people can use with tuning unnecessary method (Gain setting with the switch)
- Applicable to the precision equipment such as optical inspection equipment with the features of maintaining torque in stop and having no micro vibration (hunting)
- Various resolutions
  : 500, 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000 (10 steps)
- Various alarms output
  : overcurrent, overspeed, motor connection error, encoder connection error, and etc., overall 12 types
- Frame size 60mm, 86mm supported

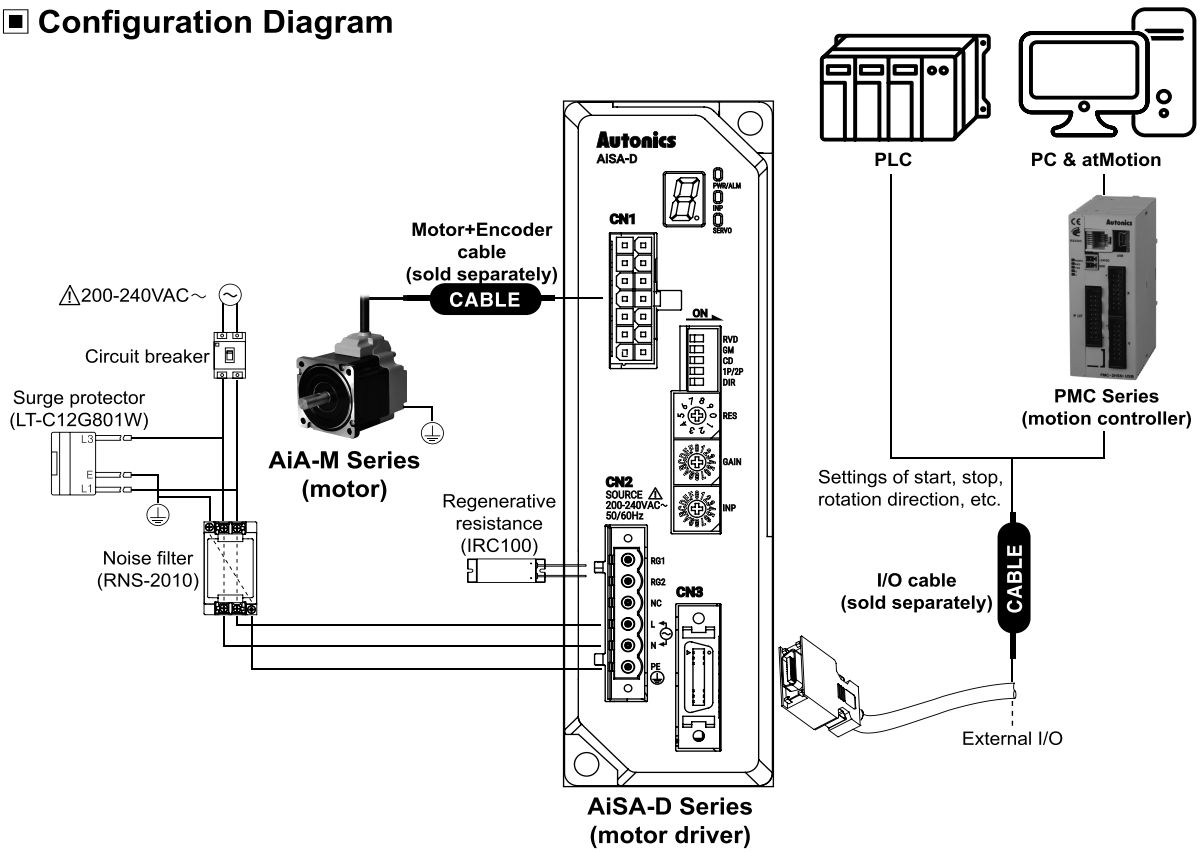
**⚠ Please read "Safety Considerations" in the instruction manual before using.**

CE

## ▣ Applications

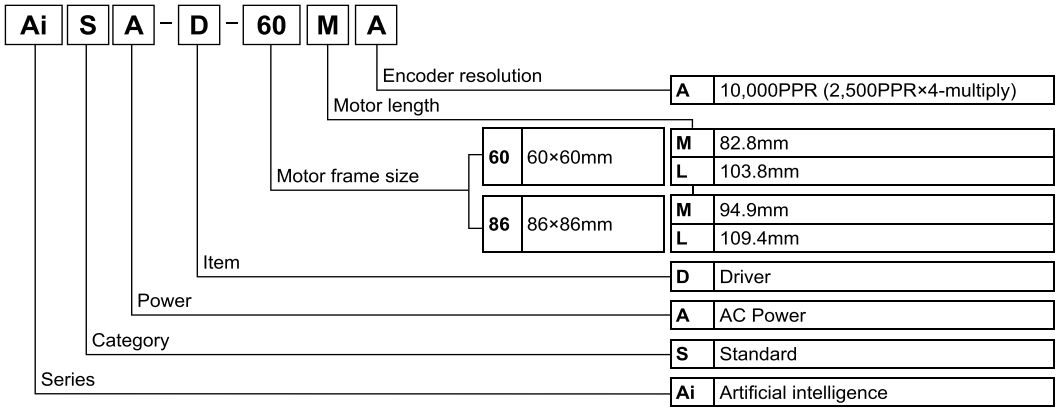
- Filed requiring preciseness such as semiconductor equipment, 3D printer, optical inspection equipment, chip mounter, cartesian robot, conveying equipment, and alignment stage.

## ▣ Configuration Diagram



# AC Type 2-Phase Closed-Loop Stepper Motor Driver

## ■ Ordering Information



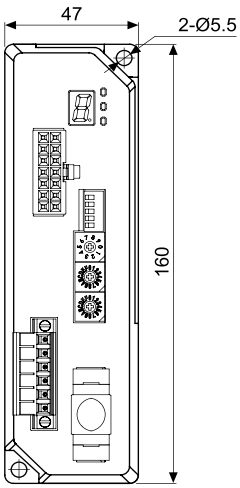

## ■ Specifications

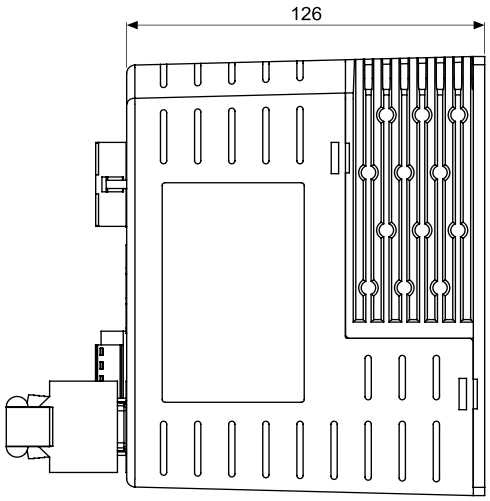
| Model | | AiSA-D-60MA | AiSA-D-60LA | AiSA-D-86MA | AiSA-D-86LA |
|---|---|---|---|---|---|
| Power supply | | 200-240VAC～ 50/60Hz | | | |
| Power consumption | STOP※1 | Max. 60W | | Max. 65W | Max. 70W |
| | Max. during operation※2 | Max. 160W | Max. 220W | Max. 250W | Max. 300W |
| Max. RUN current※3 | | 2.0A/Phase | | | |
| STOP current | | 20% or 30% of max. RUN current (factory default: 30%) | | | |
| Rotation speed | | 0 to 3000rpm | | | |
| Resolution | | 500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000PPR | | | |
| Motor GAIN | | Within the range of motor gain: 1 to 32 | | | |
| In-Position | | Within the range of Fast response: 0 to 7 or Accurate response: 0 to 7 | | | |
| Pulse input method | | 1-pulse or 2-pulse input (factory default) method | | | |
| Motor rotation direction | | CW (factory default), CCW | | | |
| Status display | | ● Power/Alarm indicator: green/red LED ● In-Position indicator: orange LED<br>● Servo On/Off indicator: blue LED ● Alarm/Status display part: red LED 7seg. | | | |
| Input signal | | RUN pulse, Servo On/Off, alarm reset (photocoupler input) | | | |
| Output signal | | In-Position, alarm out (photocoupler output),<br>Encoder signal (A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase, corresponding to 26C31) (line driver output) | | | |
| Input pulse specifications | Pulse width | CW, CCW: input pulse frequency duty 50%, Servo On/Off: min. 1ms, alarm reset: min. 20ms | | | |
| | Rising/Falling time | CW, CCW: max. 0.5μs | | | |
| | Pulse input voltage | CW, CCW - [H]: 4-8VDC⎓, [L]: 0-0.5VDC⎓<br>Servo On/Off, alarm reset - [H]: 24VDC⎓, [L]: 0-0.5VDC⎓ | | | |
| | Max. input pulse freq.※4 | CW, CCW: 500kHz | | | |
| Input resistance | | 220Ω (CW, CCW), 10kΩ (Servo On/Off, alarm reset) | | | |
| Insulation resistance | | Over 100MΩ (at 500VDC⎓ megger) | | | |
| Dielectric strength | | 1,500VAC～ 50/60Hz 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. 900g (approx. 780g) | | | |

※1: Based on the ambient temperature 25°C, ambient humidity 55%RH, and STOP current 30%.
※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: Max. input pulse frequency is max. frequency to be input and is not the same as max. pull-out frequency or max. slewing frequency.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

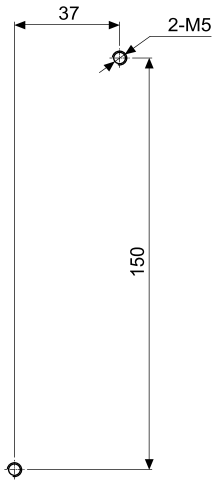
## ▣ Dimensions

(unit: mm)

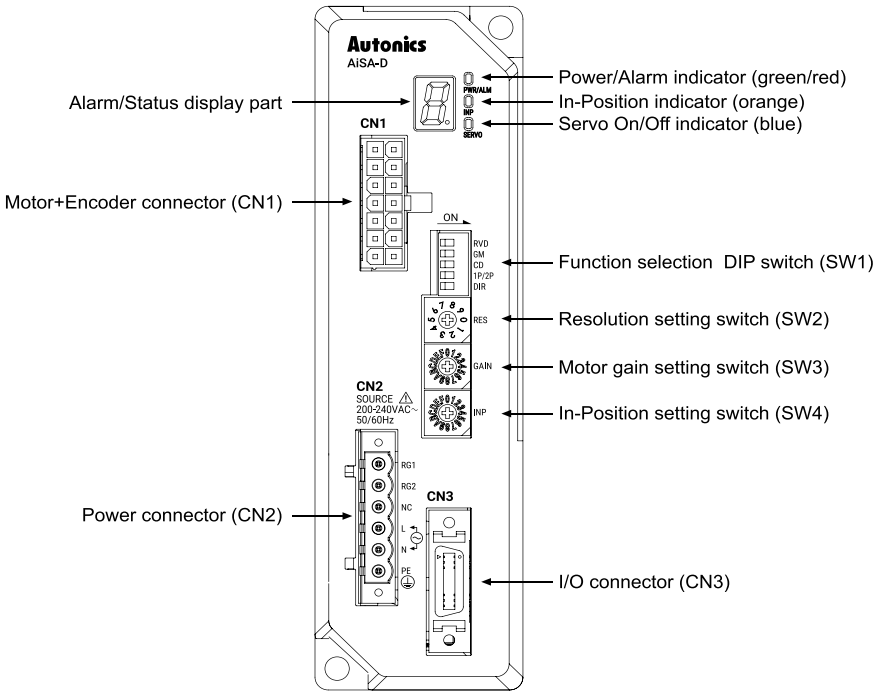



◎ **Panel cut-out**




## ▣ Driver Unit Descriptions



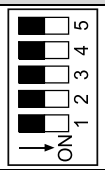
## ▣ Driver Status Indicators

| Indicator & Display part | LED color | Function | Descriptions |
|---|---|---|---|
| PWR/ALM | Green | Power indicator | Turns ON when the unit operates normally after supplying power |
| | Red | Alarm indicator | When alarm occurs, it flashes in various ways depending on the situation. Refer to '▣ **Control Input/Output** → ◎ **Output** → **2. Alarm**'. |
| INP | Orange | In-Position indicator | Turns ON when motor is placed at command position after positioning input. |
| SERVO | Blue | Servo On/Off indicator | Turns ON when Servo is operating, turns OFF when servo is not operating. |
| Alarm/Status display part | Red | Alarm, status indicator | When alarm occurs, it displays number of the corresponding alarm and the setting number of the rotary switches (RES/GAIN/INP) |

## ▣ Driver Setting

### ◎ SW1: Function selection DIP switch

-Set rotation direction, pulse input method, STOP current, gain setting, and test mode.

| Setting switch | No. | Name | Function | Switch position | |
|---|---|---|---|---|---|
| | | | | ON | OFF (factory default) |
|  | 1 | DIR | Rotation direction | CCW | CW |
| | 2 | 1P/2P | Pulse input method | 1-pulse input method | 2-pulse input method |
| | 3 | CD | STOP current | 20% of max. RUN current | 30% of max. RUN current |
| | 4 | GM | Gain setting | High gain | Low gain |
| | 5※1 | RVD | Test mode | Test mode | Normal mode |

※1: Set to OFF when using the device. It is only for the operation test in manufacturing process.



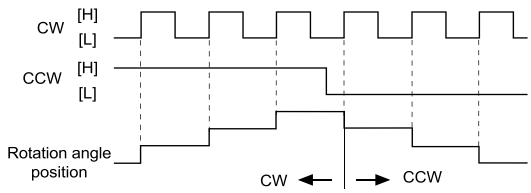
**• Pulse input method**

※1-pulse input method

CW: rotation operation signal input

CCW: rotation direction signal input

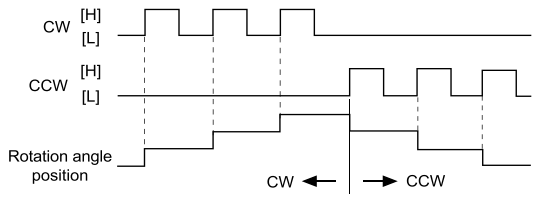
([H]: forward rotation, [L]: reverse rotation)




※2-pulse input method

CW: forward rotation signal input

CCW: reverse rotation signal input




※[H]: photocoupler ON (voltage of both ends 4-8VDC⎓) [L]: photocoupler OFF (voltage of both ends 0-0.5VDC⎓)

**• STOP current**

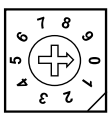
-In order to decrease motor heat and current consumption at motor stopping moment (in case there is no input during the time of the double width of last input pulse), set the stop current supplied to the motor phase.

### ◎ SW2: Resolution setting switch

-Set the resolution of driver.

-The number of pulses per 1 rotation by resolution is each 500, 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000.

-Modified setting values are not applied in the running status, and the values will be applied after motor stopped.

| Setting switch | Setting | Pulse/Revolution | Resolution |
|---|---|---|---|
|  RES | 0 (factory default) | 500 | 2.5 |
| | 1 | 1000 | 5 |
| | 2 | 1600 | 8 |
| | 3 | 2000 | 10 |
| | 4 | 3200 | 16 |
| | 5 | 3600 | 18 |
| | 6 | 5000 | 25 |
| | 7 | 6400 | 32 |
| | 8 | 7200 | 36 |
| | 9 | 10000 | 50 |

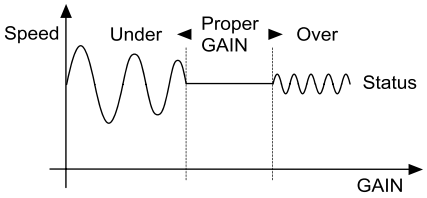
### ◎ SW3: Motor gain setting switch

-SW3 shifts motor gain between high and low, depending on 4th pin in SW1.

**• Motor gain**

-Motor gain is selectable from 32 gains.
-The larger gain is, the more improved transient response becomes and the less error occurs.
※At the lowest system load status, raise the gain value until motor vibrates and set to 1 to 2 level lower.

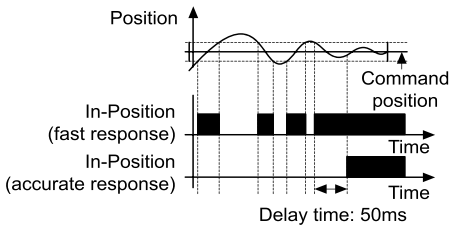
| Setting switch | 4th pin in SW1=OFF | | | | 4th pin in SW1=ON | | | |
|---|---|---|---|---|---|---|---|---|
| | Setting | GAIN | Setting | GAIN | Setting | GAIN | Setting | GAIN |
| GAIN | 0 | ×1 | 8 | ×9 | 0 | ×17 | 8 | ×25 |
| | 1 | ×2 | 9 | ×10 | 1 | ×18 | 9 | ×26 |
| | 2 | ×3 | A | ×11 | 2 | ×19 | A | ×27 |
| | 3 | ×4 | B | ×12 | 3 | ×20 | B | ×28 |
| | 4 | ×5 | C | ×13 | 4 | ×21 | C | ×29 |
| | 5 | ×6 | D | ×14 | 5 | ×22 | D | ×30 |
| | 6 | ×7 | E | ×15 | 6 | ×23 | E | ×31 |
| | 7 | ×8 | F | ×16 | 7 | ×24 | F | ×32 |




### ◎ SW4: In-Position setting swtich

-After position command pulse has finished, if the gap between target position and real position is under In-Position setting value, positioning completion pulse is output.
-Modified setting values are not applied in the running status, and the values will be applied after motor stopped.

| Setting switch | Fast response | | Accurate response | |
|---|---|---|---|---|
| | Setting | Value | Setting | Value |
| INP | 0 (factory default) | 0 | 8 | 0 |
| | 1 | ±1 | 9 | ±1 |
| | 2 | ±2 | A | ±2 |
| | 3 | ±3 | B | ±3 |
| | 4 | ±4 | C | ±4 |
| | 5 | ±5 | D | ±5 |
| | 6 | ±6 | E | ±6 |
| | 7 | ±7 | F | ±7 |




## ▣ Contol Input/Output

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

### ◎ Input

**1. Position command pulse**

-Pulse input is selectable from 1-pulse input method and 2-pulse input method.
(Refer to '◎ **SW1: Function selection DIP switch**'.)
-When using extending cable, it is recommended to connect Common mode choke coil (2mH) to the CW, CCW terminal in series connection.

**2. Servo On/Off**

-This signal is for rotating axis of motor using external force or used for manual positioning.
-Servo On/Off signal maintains over 1ms as [H]
: Regarded as Servo Off signal and phase current is cut to release torque.
The Servo ON indicator, the In-Position output and indicator turns OFF.
-Servo On/Off signal maintains over 1ms as [L]
: Regarded as Servo On signal and phase current is supplied to gain torque.
The Servo ON indicator, the In-Position output and indicator turns ON.
※Stop the motor for using the signal.
※Refer to '**4. Example of input circuit connection**'.

**3. Alarm Reset**

-This signal is for clearing the alarm.
-Alarm reset signal maintains over 20ms as [H]
: Alarm is cleared, the alarm indicator and alarm output turns OFF, and the driver returns to normal status.
※If the causes of the alarm are not removed, driver may not be returned to the normal status even with alarm reset.
※Refer to '**4. Example of input circuit connection**'.

### 4. Example of input circuit connection

**• Input pulse (CW, CCW)**

-It is recommended to use 5VDC⎓ at $V_{CC}$ and short the $R_L$.

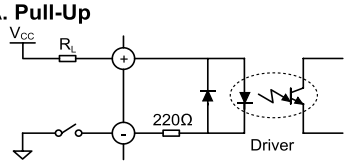
-In case $V_{CC}$ is over 5VDC⎓, calculate $R_L$ value using following formula and use $V_{CC}$ below 30VDC⎓.

※$R_L = \frac{V_{CC}-2.17V}{0.011A} - 220\Omega$

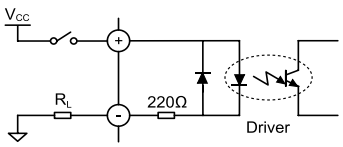
-In case $V_{CC}$ is 12, 24VDC⎓, refer to the table on the right for $R_L$.

| $V_{CC}$ | $R_L$ |
|---|---|
| 12VDC⎓ | 680Ω (min. 0.25W) |
| 24VDC⎓ | 1.8kΩ (min. 0.5W) |

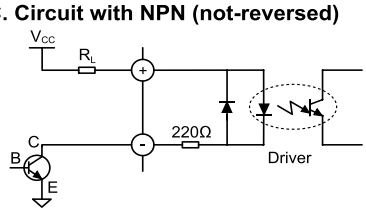
**A. Pull-Up**



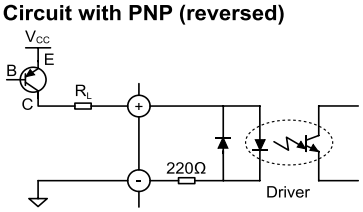

**B. Pull-Down**




**C. Circuit with NPN (not-reversed)**

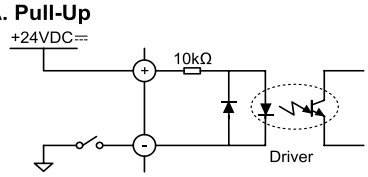



**D. Circuit with PNP (reversed)**

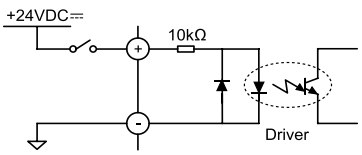



**• External input (Servo On/Off, Alarm Reset)**

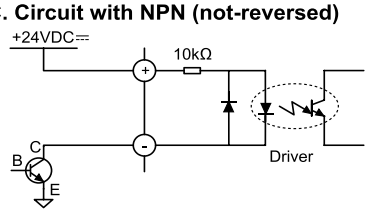
**A. Pull-Up**



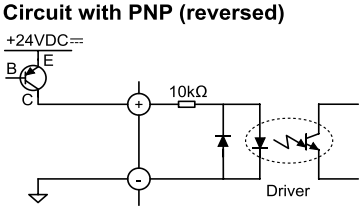

**B. Pull-Down**




**C. Circuit with NPN (not-reversed)**




**D. Circuit with PNP (reversed)**




## ◎ Output

### 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.

-For accurate drive, check the In-Position output again and execute the next drive.

※Refer to '**3. Example of output circuit connection**'.

## 2. Alarm

### ● Alarm

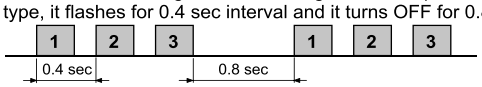
-This function stops motor to protect driver, depending on the error status such as overcurrent or overspeed.
-In case of normal status, output is [H], and in case of alarming status, output is [L].
-When supplying alarm reset, driver returns to the normal status.
※Refer to '**3. Example of output circuit connection**'.

### ● Alarm/Status display

-When alarm occurs, the alarm indicator (ALM, red) flashes as the times of corresponding alarm type.
-The alarm/status display part displays the number of the corresponding alarm type.

| ALM flashing times | Alarm/ Status | Alarm type | Descriptions | Motor stop | Maintain torque |
|---|---|---|---|---|---|
| 1 | 1 | Overcurrent error | When overcurrent flows at motor RUN element | O | × |
| 2 | 2 | Overspeed error | When motor speed is over 3,500rpm | | |
| 3 | 3 | Position tracking error | When the gap between position command value and current position value is over 90° | | |
| 4 | 4 | Overload error | When applying load over the rated load for over 1 sec | | |
| 5 | 5 | Overheat error | When heatsink temperature is over 90℃ | | |
| 6 | 6 | Motor connection error | When motor cable connection error occurs at driver | | |
| 7 | 7 | Encoder connection error | When encoder cable connection error occurs at driver | | |
| 8 | 8 | Overvoltage error | When input voltage is over 240VAC～ +10% | | |
| 9 | 9 | Undervoltage error※1 | When input voltage is under 200VAC～ -10% | | |
| 10 | A | Motor misalignment | When motor is in misalignment | | |
| 11 | b | Command pulse error | When input pulse is over 3,500rpm | | |
| | | | When pulse is input before initial alignment | | |
| 12 | C | In-Position error | When position error (over 1) is kept over 3 sec, after motor stopped. | | |

※1: When cutting off the power, the undervoltage error occurring is normal operation.
※Depending on the alarm type, it flashes for 0.4 sec interval and it turns OFF for 0.8 sec repeatedly.
<E.g. case of alarm 3>



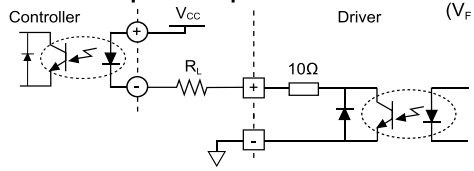

## 3. Example of output circuit connection

-It is recommended to use below 50VDC⎓ at $V_{CC}$.
Use the $R_L$ for $I_C$ (collector current of secondary detector) of photocoupler inside the driver to be within 25mA following the below formula.

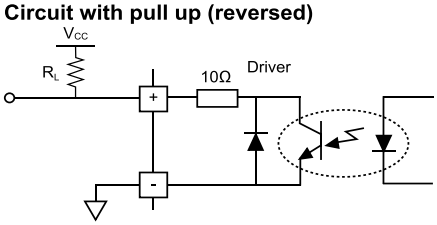
※A: $R_L = \frac{V_{CC}\text{-}0.3V\text{-}V_F}{0.025A} - 10\Omega$ ※B, C: $R_L = \frac{V_{CC}\text{-}0.3V}{0.025A} - 10\Omega$

($V_F$ is LED forward voltage of primary photocoupler.)

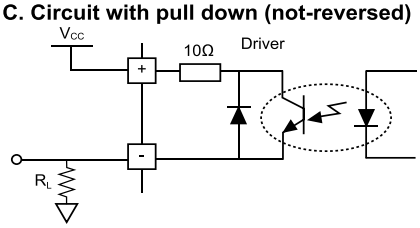
### A. Circuit with photocoupler



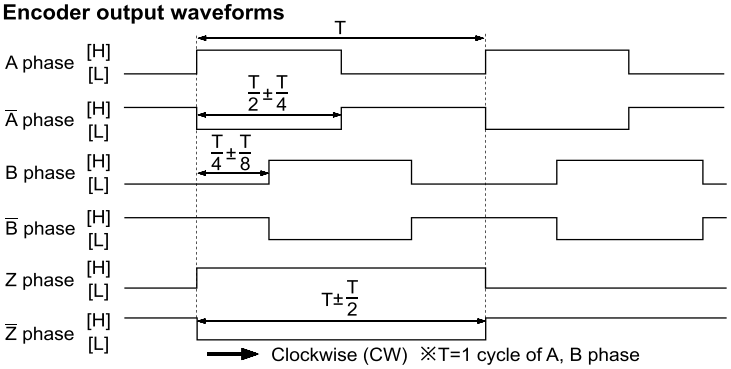

### B. Circuit with pull up (reversed)

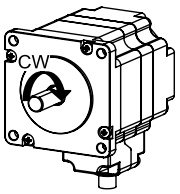



### C. Circuit with pull down (not-reversed)




## 4. Encoder output waveforms



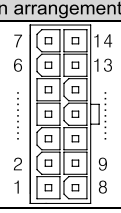

※It is recommended to use Line driver output (corresponding to 26C32) at RECEIVER end of encoder output and terminating resisters (100-150Ω) in parallel at both ends of each phase (A, Ā, B, B̄, Z, Z̄, corresponding to 26C31).

# AC Type 2-Phase Closed-Loop Stepper Motor Driver

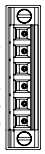
## ▣ Driver Connectors

### ◎ Connector function

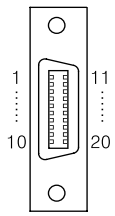
**● CN1: Motor+Encoder Connector**

| 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 | PE | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

**● CN2: Power connector**

| Pin arrangement | Pin no. | Function |
|---|---|---|
|  | 1 | Regenerative resistance |
| | 2 | |
| | 3 | N·C |
| | 4 | Power |
| | 5 | |
| | 6 | PE |

**● CN3: I/O connector**

| Pin arrangement | Pin no. | Input/Output | Function | Pin no. | Input/Output | Function |
|---|---|---|---|---|---|---|
|  | 1 | Input | CW+ | 11 | Output | In-Position+ |
| | 2 | Input | CW- | 12 | Output | In-Position- |
| | 3 | Input | CCW+ | 13 | — | N·C |
| | 4 | Input | CCW- | 14 | — | N·C |
| | 5 | Input | Servo On/Off+ | 15 | Output | Encoder A |
| | 6 | Input | Servo On/Off- | 16 | Output | Encoder $\overline{A}$ |
| | 7 | Output | Alarm Out+ | 17 | Output | Encoder B |
| | 8 | Output | Alarm Out- | 18 | Output | Encoder $\overline{B}$ |
| | 9 | Input | Alarm Reset+ | 19 | Output | Encoder Z |
| | 10 | Input | Alarm Reset- | 20 | Output | Encoder $\overline{Z}$ |

### ◎ Connector specifications

| Type | | Specifications | | | Manufacture |
|---|---|---|---|---|---|
| | | Connector | Connector terminal | Housing | |
| CN1 | Motor+Encoder | 5557-14R | 5556T | — | Molex |
| CN2 | Power | 5ESDVM-06P-OR | — | — | Dinkle |
| CN3 | I/O connector | 10120-3000PE | — | 10320-52F0-008 | 3M |
| | | CJ-MP20-HP□ (sold separately) | — | — | Autonics |

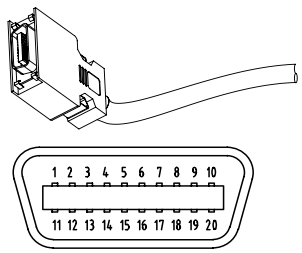
※Above connectors are suitable for AiSA-D Series.

## ▣ Sold Separately

※It is recommended to use ferrite core at I/O cable and Motor+Encoder cable.

### ◎ I/O cable

**● CO20-MP□-R**
**(standard: AiS TAG)**

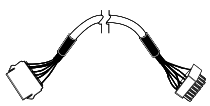



| Pin no. | Function (name tag) | Cable color | Dot line color-numbers | Pin no. | Function (name tag) | Cable color | Dot line color-numbers |
|---|---|---|---|---|---|---|---|
| 1 | CW+ | Yellow | Black-1 | 11 | In-Position+ | White | Black-1 |
| 2 | CW- | | Red-1 | 12 | In-Position- | | Red-1 |
| 3 | CCW+ | | Black-2 | 13 | — | | Black-2 |
| 4 | CCW- | | Red-2 | 14 | — | | Red-2 |
| 5 | Servo On/Off+ | | Black-3 | 15 | Encoder A+ | | Black-3 |
| 6 | Servo On/Off- | | Red-3 | 16 | Encoder A- | | Red-3 |
| 7 | Alarm Out+ | | Black-4 | 17 | Encoder B+ | | Black-4 |
| 8 | Alarm Out- | | Red-4 | 18 | Encoder B- | | Red-4 |
| 9 | Alarm Reset+ | | Black-5 | 19 | Encoder Z+ | | Black-5 |
| 10 | Alarm Reset- | | Red-5 | 20 | Encoder Z- | | Red-5 |

※□ of model name indicates cable length (010, 020).
For corresponding EMC standard, cable length should be below 2m.
E.g.) CO20-MP020-R: 2m I/O cable.

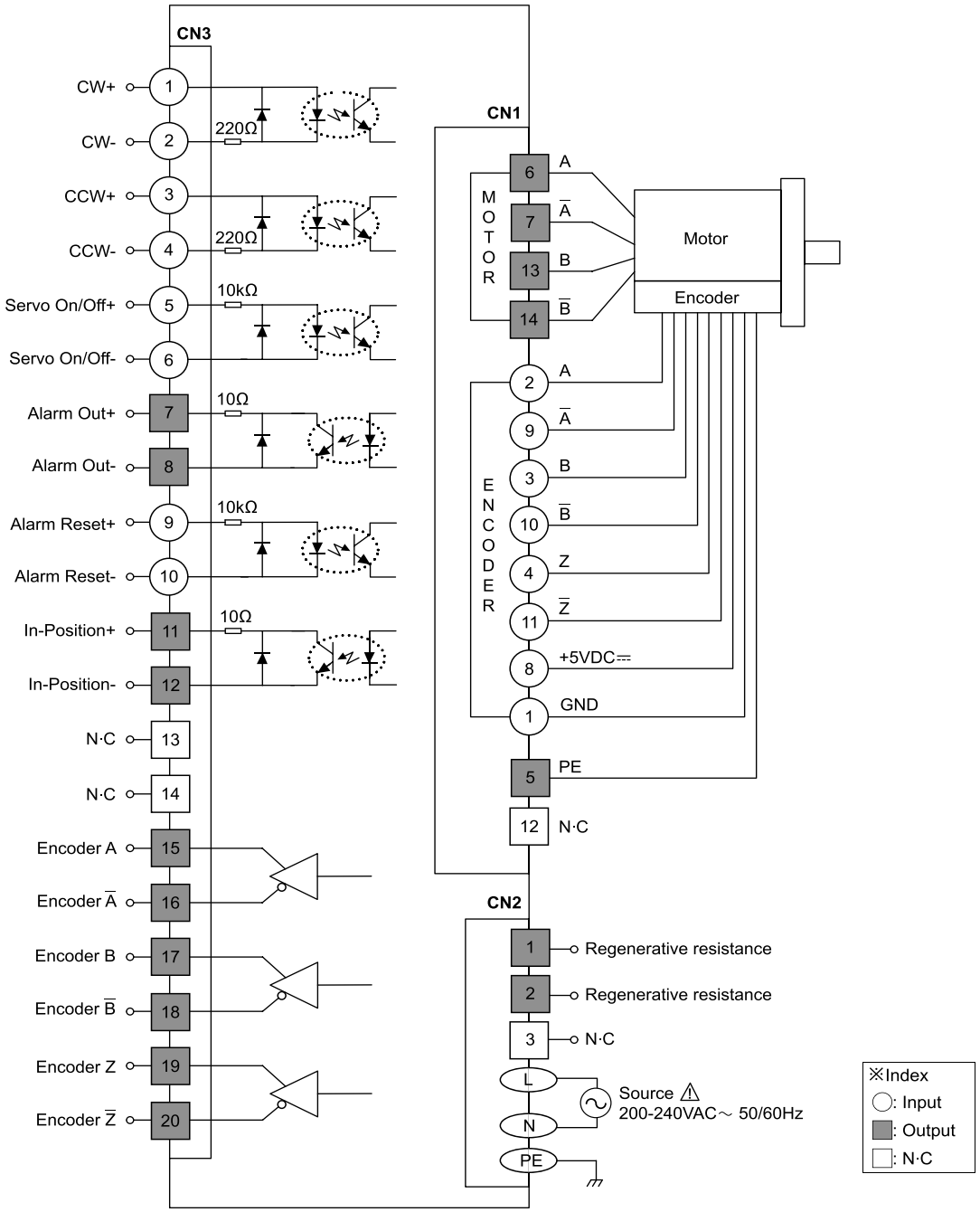
### ◎ Motor+Encoder cable

**● Normal: C1D14M-□, Moving: C1DF14M-□**



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

## ▣ Connection for Motor and Driver



## ▣ Options for Power Connector (CN2)

| Options | Model | Specifications | Manufacture |
|---|---|---|---|
| Regenerative resistance | IRC100 | • Resistance: 100Ω ±5%,<br>• Rated power: 60W (standby), 100W (with heatsink) | RARA Electronics Corp. |
| | Used when the load inertia is large or the deceleration time is short.<br>Forced cooling is required when the surface temperature of the regenerative resistor is high. | | |
| Noise filter | RNS-2010 | • Rated voltage: 250V<br>• Rated current: 10A<br>• Max. leakage current: 1mA | Orient Electronics |
| | Connect the unit to the power side to suppress external noise.<br>Keep wiring as short as possible, and must ground it when connecting power. | | |
| Surge protector | LT-C12G801W | — | OTOWA Electric CO. Ltd |
| | Connect the unit to the power side to protect the product from external noise and surge. | | |

※Use the unit which is commercially available.



## ▣ Troubleshooting

**1. When motor does not rotate**
①Check the connection status between controller, 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, motor are connected correctly.
②Check the driver pulse input specifications (voltage, width).



## ▣ Proper Usage

- Follow instructions in 'Proper Usage'. Otherwise, it may cause unexpected accidents.
- Do not input CW, CCW signal at the same time in 2-pulse input method.
- When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.
- To extend the motor+encoder cable, use the designated the cable.
- Keep the distance between power cable and signal cable more than 10cm.
- Install the unit vertically on the alarm/status display part upper side.
- For heat radiation of the driver, install a fan.
- Do not change any setting switches (function, resolution, motor gain, in-position switches) during the operation or after supplying power. Failure to follow this instruction may result in malfunction.
- Motor vibration and noise can occur in specific frequency period.
  ①Change motor installation method or attach the damper.
  ②Use and set the gain value.
- 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 motor
  ⑤Inconsistency 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.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II

# AC Type Controller Integrated 2-Phase Closed-Loop Stepper Motor Driver

## ▣ Features

- Real-time position controllable with closed-loop system
- Motor driver and controller integral type
- As AC power type, possible to omit SMPS and perform higher torque than DC power type
- Able to check alarm and status with Alarm/Status display part (7 segment)
- Controllable maximum 31 axis with RS485 communication
- Auto Current Down Mode available
- C language library provided (32-bit, 64-bit)
- Dedicated Windows program (atMotion) provided
- Easy to set various Gain with program (GUI)
- Applicable to the precision equipment such as optical inspection equipment with the features of maintaining torque in stop and having no micro vibration (hunting)
- 10 levels of resolutions available
- Frame size 42mm, 56mm, 60mm motor supported (Applied motor: AiA-M Series)

**Please read "Safety Considerations" in the instruction manual before using.**

CE

## ▣ Applications

- Filed requiring preciseness such as semiconductor equipment, 3D printer, optical inspection equipment, chip mounter, cartesian robot, conveying equipment, and alignment stage.

## ▣ Manual

For the detail information and instructions, please refer to user manual, user manual for communication manual and library manual and be sure to follow cautions written in the technical descriptions (catalog, website).
Visit our website (www.autonics.com) to download manuals.

## ▣ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

< Computer specification for using software>

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

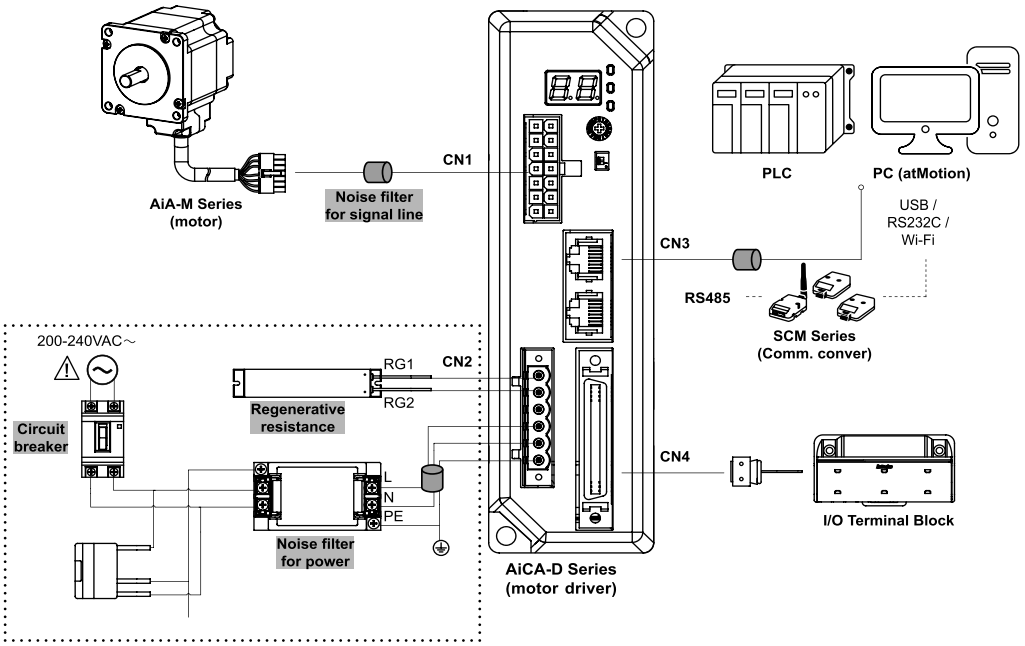
< atMotion screen >

## ▣ Ordering Information

**Ai C A – D – 60 M A**

| | | | |
|---|---|---|---|
| Encoder resolution | A | 10,000PPR(2,500PPR×4-multiply) | |
| Motor length | M | 82.8mm | |
| | L | 103.8mm | |
| Motor frame size | 60 | (60×60mm) | |
| | 86 | (86×86mm) | |
| | M | 94.9mm | |
| | L | 109.4mm | |
| Item | D | Driver | |
| Voltage | A | AC power | |
| Category | C | Controller | |
| Series | Ai | Artificial intelligence | |

## ▣ Configuration Diagram




※ The thickness of cable should be same or thicker than the below specifications when connecting the cable for connector.
① CN1(motor+encoder connector): AWG22, AWG24
② CN2(power connector): AWG18
③ CN3(communication connector): AWG28
④ CN4(I/O connector): AWG28
※ In case of unstable communication due to noise from peripherals and power, use ferrite core in the wiring.
※ [redacted] are sold separately.

### ◎ Noise filter for signal line

-Connect to wiring to suppress external noise.
-Depending on frequency, filtered noise may different.

| Model | Specification | Manufacture |
|---|---|---|
| Comm. line | 28A2025-0A2 | Lairdtech |
| Motor line | 28A5776-0A2 | |
| Power line | 28A5131-0A2 | |

### ◎ Regenerative resistance

-Connect Pin no. 1, 2 on power connector (CN2).
-Use in condition of the high inertia load or the short deceleration time.
-Forced cooling is required in condition of high surface temperature of regenerative resistance.

| Model | Specification | Manufacture |
|---|---|---|
| IRC100 | • Resistance: 100Ω ±5%,<br>• Rated Power: 60W(standby), 100W(heatsink attached) | Rara Electronics Corp. |

### ◎ Noise filter for power

-Connect the power to suppress external noise.
-The wires should be connected as short as possible and grounded.

| Model | Specification | Manufacture |
|---|---|---|
| RNS-2006 | • Rated voltage: 250V<br>• Rated current: 6A<br>• Max. leakage current: 1mA | Orient Electronics |

### ◎ Surge protector

Protect the product from external noise and surge by connecting power.
※ Be sure to disconnect the surge protector when testing internal pressure.
It may result in porduct damage.

| Model | Specification | Manufacture |
|---|---|---|
| LT-C12G801W | — | OTOWA Electric Co. Ltd |

## ▣ Specifications

| Model | | AiCA-D-60MA | AiCA-D-60LA | AiCA-D-86MA | AiCA-D-86LA |
|---|---|---|---|---|---|
| Power supply | | 200-240VAC～ 50/60Hz | | | |
| Power consumption | STOP※1 | Max. 60W | | Max. 65W | |
| | Max. during operation | Max. 160W | Max. 220W | Max. 250W | Max. 300W |
| Max. RUN current※2 | | 2.0A/Phase | | | |
| STOP current | | 20% of max. RUN current | | | |
| Rotation speed | | 0 to 3000rpm | | | |
| Resolution※3 | | 500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000 PPR | | | |
| Motor GAIN | | 0 to 30, Fine Gain | | | |
| Positioning range | | -2,147,483,648 to +2,147,483,647 | | | |
| In-Position | | Fast Response: 0 to 7<br>Accurate Response: 0 to 7 | | | |
| Motor rotation direction※2 | | CW, CCW | | | |
| Status display | | • Power/Alarm indicator: green/red LED • In-Position indicator: orange LED<br>• Servo On/Off indicator: blue LED • Alarm/Status display part: red LED 7seg. | | | |
| I/O voltage level | | [H]: 15-30VDC⎓, [L]: 0-2VDC⎓ | | | |
| I/O | Input | Exclusive input: 20, general input: 9 | | | |
| | Output | Exclusive output: 4, general output: 10 | | | |
| External power supply | | VEX(recommended: 24VDC⎓): 2, GEX(GND): 2 | | | |
| Operation mode | | Jog / Continuous / Index / Program / Position / Torque mode | | | |
| Index step numbers | | 64 steps | | | |
| Program Function | Step | 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), TOQ(torque control) | | | |
| | Start | Power ON program auto-start function | | | |
| | Home search | Power ON home search auto-start function | | | |
| RS485 Comm. | Comm. Speed※3 | 9600, 19200, 38400, 57900, 115200(factory default) [bps] | | | |
| Multiaxial control | | 31-axis | | | |
| ID setting switch | | 16bit rotary switch(0~F), 1bit DIP switch | | | |
| Alarm output | | Overcurrent, overspeed, position tracking, overload, overheat, motor connection, encoder connection, overvoltage, undervoltage, motor misalignment, command speed, In-Position, memory, emergency stop, program mode, index mode, home search mode | | | |
| Warning output | | ±Software limit, ±hardware limit, overload | | | |
| Input resistance | | 4.7kΩ(Anode Pull-up) | | | |
| Insulation resistance | | Over 200MΩ (at 500VDC⎓ megger) | | | |
| Dielectric strength | | 1,500VAC～ 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 himi. | 35 to 85%RH, storage: 10 to 90%RH | | | |
| Protection structure | | IP20(IEC standard) | | | |
| Sold separately | | • I/O cable: CO50-MP□-R※4(standard: AiC TAG)<br>• Motor+Encoder cable - normal: C1D14M-□※5 / moving: C1DF14M-□※5<br>• Communication converter: SCM-WF48, SCM-US48I, SCM-38I | | | |
| Approval | | CE | | | |
| Weight※6 | | Approx. 1,080g (approx. 800g) | | | |

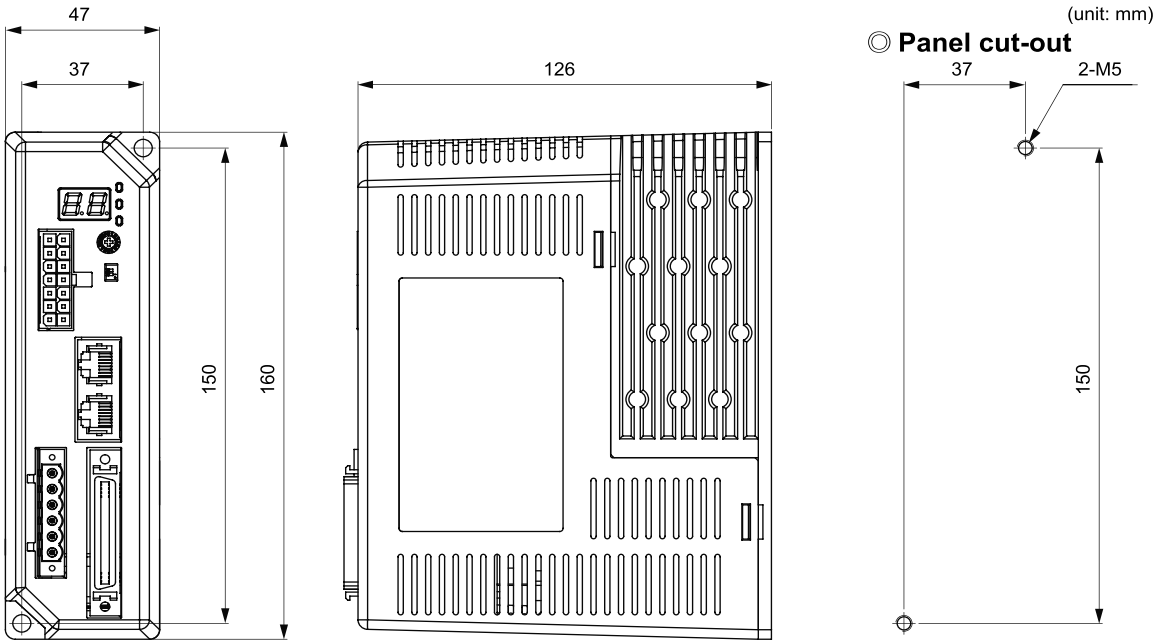
※1: Based on the ambient temperature 25°C, ambient humidity 55%RH and STOP current 20%.
※2: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※3: Settable with the dedicated program (atMotion).
※4: □ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200)
E.g.) CO50-MP070-R: 7m I/O cable.
For corresponding EMC standard, cable length should be below 2m.
※5: □ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20)
E.g.) C1DF14M-10: 10m moving type motor+encoder cable.
※6: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Factory Default

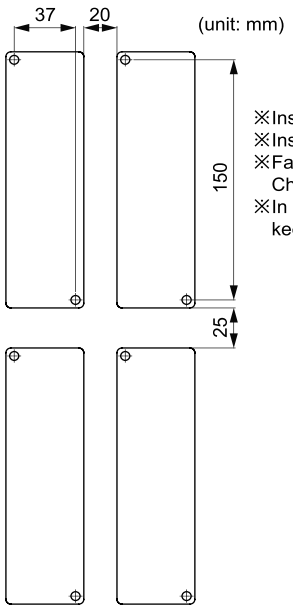
| Function | | Factory default |
|---|---|---|
| Resolution | | 500PPR |
| Motor GAIN | | 0 |
| In-Position | | 0 |
| Comm. speed | | 115,200bps |
| Communication ID setting switch (ID Sel) | | 1 |
| Communication ID setting/Terminating resistance setting DIP switch(ID, TERM) | Communication ID setting (ID) | OFF |
| | Terminating resistance setting (TERM) | OFF |

## ▣ Dimensions

(unit: mm)

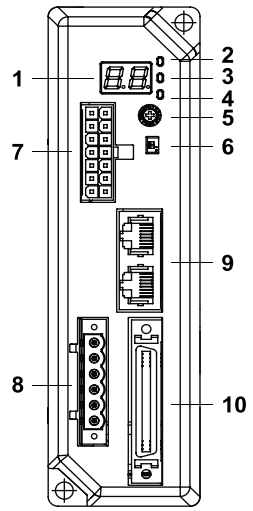



## ▣ Installation




※Install on the metal plate with high thermal conductivity for heat dissipation of the driver.
※Install in the well-ventilated area and install the cooling fan in the unventilated environment.
※Failure to heat dissipation may result in damage or malfunction due to the stress on the product.
Check the environment of use within the rated specifications and install on the well-heat dissipated area.
※In case of installing the drivers more than two,
keep distance at least 20mm in the horizontal direction and at least 25mm in the vertical direction.

## ▣ Unit Descriptions




**1. Alarm/Status display part (orange)**
: Displays the corresponding number, status, model, etc. when Alarm occurs.
**2. Power/Alarm indicator (PWR/ALM) (green/red)**
**3. In-Position indicator (INP) (orange)**
:Turns ON when motor is placed at command position after positioning input.
**4. Servo On/Off indicator (SERVO) (blue)**
: Turns ON when Servo is operating
Turns OFF when Servo is not operating
**5. Communication ID setting rotary switch (ID Sel setting: 0 to F)**
: [ID OFF] ID Sel setting 0 to F → Node ID 0(disable) to 15
[ID ON] ID Sel setting 0 to F → Node ID 16 to 31
**6. Communication ID setting/Terminating resistance DIP switch (ID, TERM)**
: ID - Communication ID setting,
TERM - Set to use terminating resistance
**7. Motor+Encoder connector (CN1)**
**8. Power connector (CN2)**
**9. Communication cable connector (CN3)**
**10. I/O connector (CN4)**

## ▣ Driver Status Indicators

| Indicator & Display part | LED color | Function | Descriptions |
|---|---|---|---|
| PWR/ALM | Green | Power indicator | Turns ON when the unit operates normally after supplying power. |
| | Red | Alarm indicator | When alarm occurs, it flashes in various ways depending on the situation. Refer to '▣ **Control Input/Output** → ◎ **Output** → **3. Alarm/Warning**'. |
| INP. | Orange | In-Position indicator | Turns ON when motor is placed at command position after positioning input. |
| SERVO | Blue | Servo On/Off indicator | Turns ON when Servo is operating, turns OFF when servo is not operating. |
| Alarm/Status display part | Red | Alarm, status indicator | Displays the corresponding number, status, model, etc. when Alarm occurs. |
| RxD IN※1 | Yellow | RS485 Data I/O display | Flashes when receiving data. |
| TxD OUT※1 | Green | | Flashes when sending data. |

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

## ▣ Driver Setting

### ◎ ID Sel: Communication ID setting switch

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

| Setting switch | Setting | ID | | Setting | ID | |
|---|---|---|---|---|---|---|
| | | ID OFF | ID ON | | ID OFF | ID ON |
| ID Sel | 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 |

### ◎ ID, TERM: Communication ID setting/Terminating resistance DIP switch

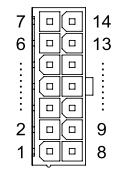
※Set Node ID of the driver.
※Set to use terminating resistance.

| | 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 |

## ▣ Driver Connectors

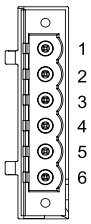
### ◎ Connector function

**● CN1: Motor+Encoder connector**

| Pin arrangement | Pin no. | Fuction | 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 | PE | 12 | N·C |
| | 6 | Motor A | 13 | Motor B |
| | 7 | Motor $\overline{A}$ | 14 | Motor $\overline{B}$ |

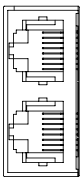


**● CN2: Power connector**

| Pin arrangement | Pin no. | Function |
|---|---|---|
|  | 1 | Connect regenerative resistance |
| | 2 | |
| | 3 | N·C |
| | 4 | AC power input |
| | 5 | |
| | 6 | PE |

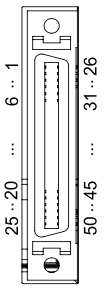


**● CN3: RS485 Communication cable connector**

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



**● CN4: I/O connector**

| Pin arrangement | Pin no. | Input/Output | Function | Pin no. | Input/Output | Function |
|---|---|---|---|---|---|---|
|  | 1 | — | N·C | 26 | Input | IN0 |
| | 2 | — | N·C | 27 | Input | IN1 |
| | 3 | Input | Reset | 28 | Input | IN2 |
| | 4 | Input | Start | 29 | — | N·C |
| | 5 | Input | Stop | 30 | Input | IN3 |
| | 6 | Input | EMG | 31 | Input | IN4 |
| | 7 | Input | Step0/+Run/+Jog | 32 | Input | IN5 |
| | 8 | Input | Step1/-Run/-Jog | 33 | Input | IN6 |
| | 9 | Input | Step2/SSP0 | 34 | Input | IN7 |
| | 10 | Input | Step3/SSP1 | 35 | Input | IN8 |
| | 11 | Input | Step4/MSP0 | 36 | Input | VEX |
| | 12 | Input | Step5/MSP1 | 37 | Input | GEX |
| | 13 | Input | MD0/HMD0 | 38 | Output | Alarm |
| | 14 | Input | MD1/HMD1 | 39 | Output | Compare1(Trigger) |
| | 15 | Input | Pause | 40 | Output | Compare2(Trigger) |
| | 16 | Input | Servo On/Off | 41 | Output | OUT0 |
| | 17 | Input | Home | 42 | Output | OUT1 |
| | 18 | Input | Alarm Reset | 43 | Output | OUT2 |
| | 19 | Input | +Limit | 44 | Output | OUT3 |
| | 20 | Input | -Limit | 45 | Output | OUT4 |
| | 21 | Input | ORG | 46 | Output | OUT5 |
| | 22 | Input | SD | 47 | Output | OUT6 |
| | 23 | Output | In-Position | 48 | Output | OUT7 |
| | 24 | Input | VEX | 49 | Output | OUT8 |
| | 25 | Input | GEX | 50 | Output | OUT9 |



### ◎ Connector Specifications

| Type | | Specifications | | | Manufacture |
|---|---|---|---|---|---|
| | | Connector | Connector terminal | Housing | |
| CN1 | Motor+Encoder | 5557-14R | 5556T | — | Molex |
| CN2 | Power | 5ESDVM-06P-OR | — | — | Dinkle |
| CN3 | Communication | LS-CV-J45BBKZ | — | — | EPN. |
| CN4 | I/O connector | 10150-3000PE | — | 10350-52F0-008 | 3M |

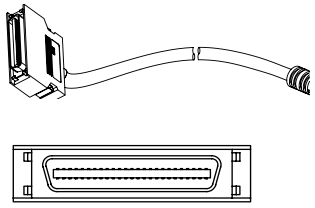
※Above connectors are suitable for AiCA-D Series

## ▣ Sold Separately

※Recommended to use ferrite core at both ends of the I/O cable and Motor+Encoder cable.

### ◎ I/O Cable

- **CO50-MP□-R**
  **(Standard: AiC TAG)**

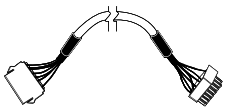


| Pin no. | Function (Name TAG) | Cable color | Dot line color-numbers | Pin no. | Function (Name TAG) | Cable color | Dot line color-numbers |
|---|---|---|---|---|---|---|---|
| 1 | Brake+ | Orange | Black-1 | 26 | IN0 | White | Red-3 |
| 2 | Brake- | | Red-1 | 27 | IN1 | | Black-4 |
| 3 | Reset | | 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 | OUT9 | | Red-5 |

※□ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200).
E.g.) CJ-MP50-HP070: 7m I/O cable

### ◎ Motor+Encoder cable

- **Normal: C1D14M-□, Moving: C1DF14M-□**



※□ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20).
E.g.) C1DF14M-10: 10m moving type motor+encoder cable

### ◎ Communication converter

- **SCM-WF48**
  **(Wi-Fi to RS485·USB wireless communication converter)**

- **SCM-US48I**
  **(USB to RS485 converter)**

- **SCM-38I**
  **(RS232C to RS485 converter)**

## ▣ Control Input/Output

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

### ◎ Input

#### 1. Exclusive input (20)

| Signal name | Descriptions | Pin no. | Signal name | Descriptions | Pin no. |
|---|---|---|---|---|---|
| Reset | Reset command | 3 | MD0/HMD0 | Operation mode designate 0 / Home search mode designate 0 | 13 |
| Start | Drive start command | 4 | MD1/HMD1 | Operation mode designate 1 / Home search mode designate 1 | 14 |
| Stop | Drive stop command | 5 | Pause | Pause | 15 |
| EMG | Drive emergency stop command | 6 | Servo On/Off | Servo On/Off | 16 |
| Step0/+Run/+Jog | Step designate 0 / +Run / +Jog | 7 | Home | Home search | 17 |
| Step1/-Run/-Jog | Step designate 1 / +Run / +Jog | 8 | Alarm Reset | Alarm reset command | 18 |
| Step2/SSP0 | Step designate 2 / Start speed designate 0 | 9 | +Limit | +direction limit sensor | 19 |
| Step3/SSP1 | Step designate 3 / Start speed designate 1 | 10 | -Limit | -direction limit sensor | 20 |
| Step4/MSP0 | Step designate 4 / Max. Speed designate 0 | 11 | ORG | Home sensor | 21 |
| Step5/MSP1 | Step designate 5 / Max. Speed designate 1 | 12 | SD | Dceleration (deceleration stop) signal | 22 |

#### 2. General input (9)

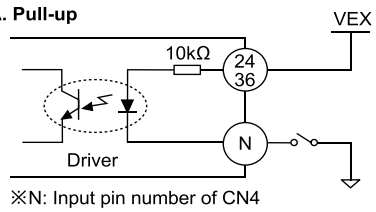
| Signal name | Descriptions | Pin no. |
|---|---|---|
| IN0~IN2 | General input 0 to 2 | 26 to 28 |
| IN3~IN8 | General input 3 to 8 | 30 to 35 |

#### 3. Example of input circuit connection

-All input circuits are insulated with photocoupler, and separate external power (recommended: 24VDC⎓) is necessary.
-Case of using external power 24VDC⎓ does not require $R_L$.
-In case using external power over 24VDC⎓, select RL value that $I_F$ (forward current of primary LED) of photocoupler to be around 2.5mA (max. 10mA).

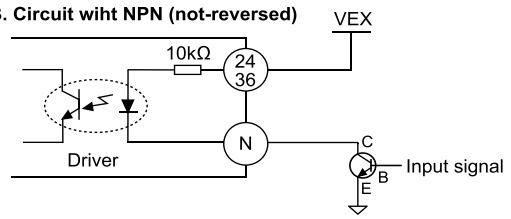
※$R_L = \frac{VEX-1.25V}{0.0025A} - 10\times10^3\Omega$

**A. Pull-up**




※N: Input pin number of CN4

**B. Circuit wiht NPN (not-reversed)**




### ◎ Output

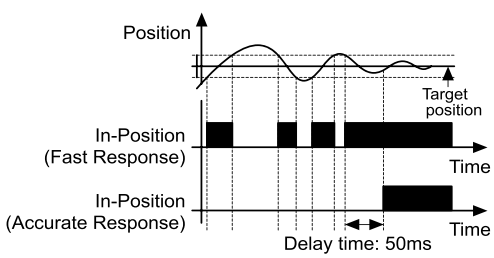
#### 1. Exclusive output (4)

| Signal name | Descriptions | Pin no. | Signal name | Descriptions | Pin no. |
|---|---|---|---|---|---|
| In-Position | Drive ending pulse | 23 | Compare1(Trigger) | Comparison output 1 | 39 |
| Alarm | Alarm output | 38 | Compare2(Trigger) | Comparison output 2 | 40 |

#### 2. In-Position

-In-Position output represents output is output 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 ON and In-Position indicator turns ON.
-In reverse, when the gap is over In-Position setting value, In-Position output turns OFF and the In-Position indicator turns OFF.
※For accurate drive, check the In-Position output again and execute the next drive.
※Refer to '**6. example of output circuit connection**'.

| 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 |



## ▣ Control Input/Output

### 3. Alarm/Warning

**・Alarm**

-This function stops motor to protect driver, depending on the error status such as overcurrent or overspeed.
-In case of normal status, output turns ON, and in case of alarming status, output turns OFF.
-When supplying alarm reset, driver returns to the normal status.
※Refer to '**6. example of output circuit connection**'.

**・Warning**

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

**・Alarm/Warning indicator**

-When alarm occurs, the alarm indicator (ALM, red) flashes as the times of corresponding alarm type.
-The alarm/status display part displays the number of the corresponding alarm type.

| Alarm/Status | Alarm type | Descriptions | Motor status | Torque status |
|---|---|---|---|---|
| 01 | Overcurrent error | When overcurrent flows at motor RUN element | Stop | Release |
| 02 | Overspeed error | When motor speed is over 4,000rpm | | |
| 03 | Position tracking error | When the gap between position command value and current position value is over 90° | | |
| 04 | Overload error | When applying load over the rated load for over 1 sec | | |
| 05 | Overheat error | When heatsink temperature is over 80℃ | | |
| 06 | Motor connection error | When motor cable connection error occurs at driver | | |
| 07 | Encoder connection error | When encoder cable connection error occurs at driver | | |
| 08 | Overvoltage error | When input voltage is over 240VAC～ +10% | | |
| 09 | Undervoltage error | When input voltage is under 200VAC～ -10% | | |
| 10 | Motor misalignment | When motor is in misalignment | | |
| 11 | Command pulse error | When input pulse is over 3,500rpm | | |
| | | When pulse is input before initial alignment | | |
| 12 | In-Position error | When position error (over 1) is kept over 3 sec, after motor stopped. | | |
| 13 | Memory error | When memory error is detected as power supplied | | |
| 14 | Emergency stop | When emergently stopped with emergency stop command | Stop | Remain |
| 15 | Program mode errer | When 'END' command is not exist at the last step | | |
| 16 | Index mode error | When other instruction is used but 'INC', 'ABS' | | |
| | | When index command is not completed du to the stop command | | |
| 17 | Home search mode error | When failed to find home | | |

※Depending on the alarm/warning type, it displays as a segment on the Alarm/Status display part.

| Warning/Stauts | Warning type | Descriptions | Motor status | Torque status |
|---|---|---|---|---|
| 91 | +Software limit | When normal direction (CW) software limit is ON. | Stop | Remain |
| 92 | -Software limit | When reverse direction (CCW) software limit is ON. | | |
| 93 | +Hardware limit | When normal direction (CW) hardware limit is ON. | | |
| 94 | -Hardware limit | When reverse direction (CCW) hardware limit is ON. | | |
| 95 | Overload warning | When maximum load is kept connected over 10 sec. (may cause overheat on motor and driver) | Remain | Remain |

※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.

## ▣ Control Input/Output

### 4. Comparison output (Compare1, Compare2)

It outputs trigger pulse at the designated cycle.

| Mode | Description |
|---|---|
| 0 | Not use comparison output. |
| 1 | Comparison output turns ON when the present absolute position value is same or bigger than the set position value. |
| 2 | Comparison output turns ON when the present absolute position value is same or smaller than the set position value. |
| 3 | Trigger pulses output with the set interval and width. |

※Please refer to the user manual to learn how to set.

### 5. General output (10)

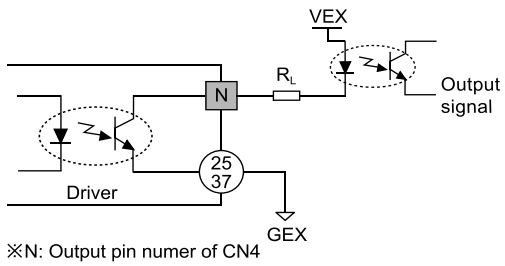
| Signal name | Descriptions | Pin no. |
|---|---|---|
| OUT0 to OUT9 | General output 0 to 9 | 41 to 50 |

### 6. Example of output circuit connection

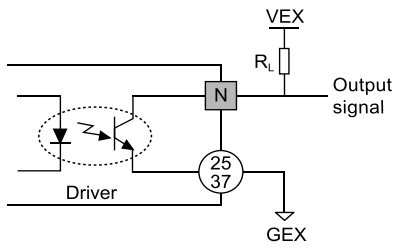
-All output circuits are insulate with photocoupler.
-External power input is available from 5VDC⎓ to 80VDC⎓ with the open collector method.
Select RL value that IC (collector current of secondary LED) of photocoupler to be around 10mA.

$※R_L = \frac{VEX-0.7V}{0.01A}$

**A. Circuit with photocoupler**




**B. Circuit with pull-up(reversed)**




※N: Output pin numer of CN4

## ▣ Communication Output

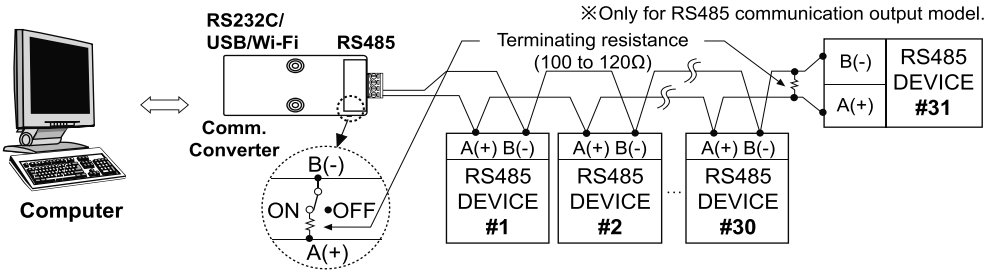
It is for parameter setting and monitoring via external devices (PC, PLC, etc.).

### ◎ Interface

| | | | |
|---|---|---|---|
| Comm. protocol | Modbus RTU | Comm. speed | 9600, 19200, 38400, 57600, 115200 bps |
| Connection type | RS485 | Comm. response wait time | 5 to 99ms |
| Application standard | Compliance with EIA RS485 | Start bit | 1bit (fixed) |
| Max. connections | 31 units (address: 01 to 31) | Data bit | 8bit (fixed) |
| Synchronous method | Asynchronous | Parity bit | None, Even, Odd |
| Comm. method | Two-wire half duplex | Stop bit | 1-bit, 2-bit |
| Comm. distance | Max. 800m | | |

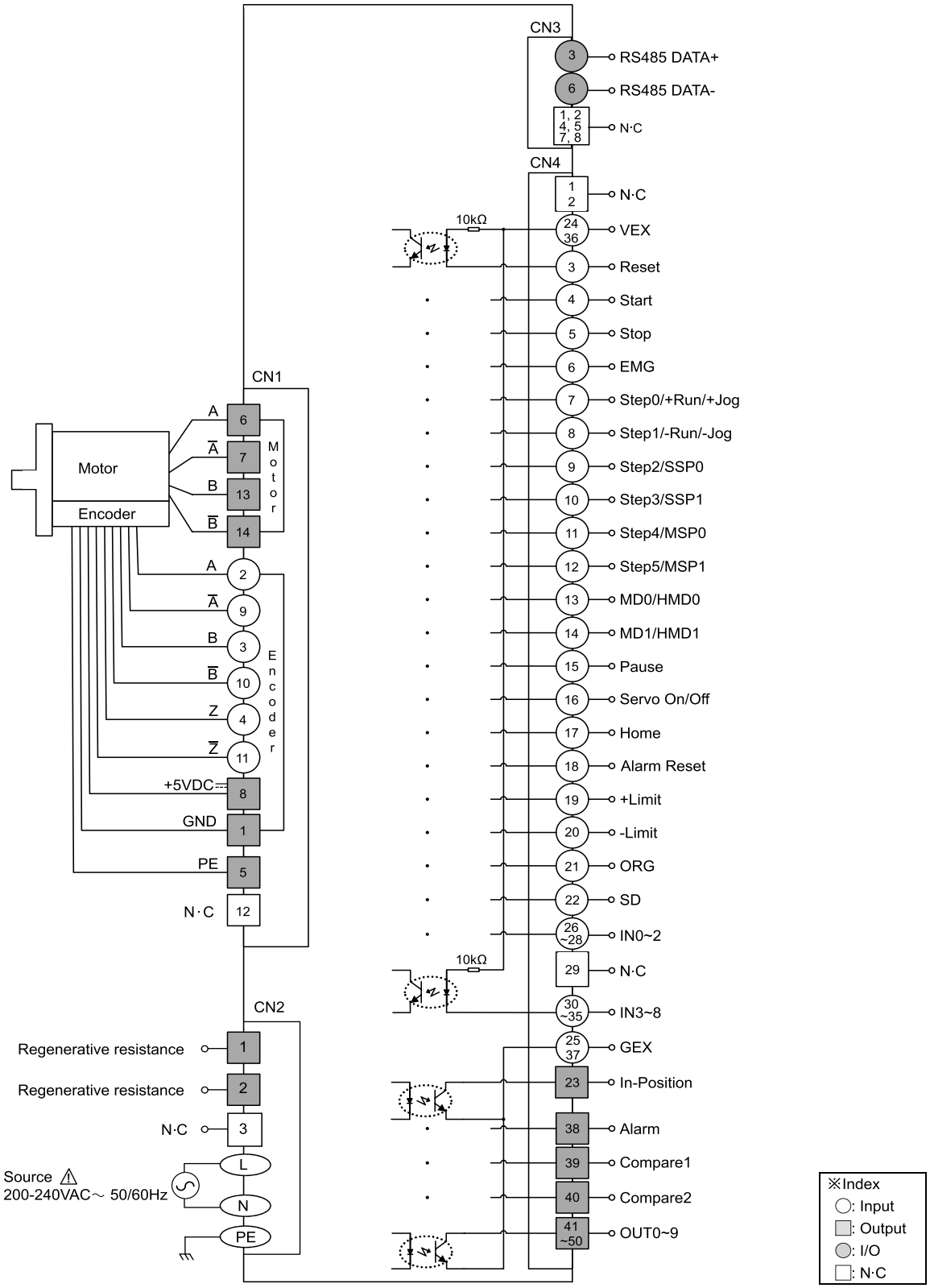
※It is not allowed to set overlapping communication address at the same communication line.
Use twisted pair wire for RS485 communication.

### ◎ Application of system organization




※It is recommended to use Autonics communication converter;
SCM-WF48 (Wi-Fi to RS485·USB wireless communication converter, sold separately),
SCM-US48I (USB to RS485 converter, sold separately), SCM-38I (RS232C to RS485 converter, sold separately).
Please use twisted pair wire, which is suitable for RS485 communication, for SCM-WF48, SCM-US48I and SCM-38I.

## ▣ Connection of Motor and Driver



## ▣ 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].<br>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. |
| | Motor gain value is not correct. | Change the Motor Gain parameter as the certain value. |

## ▣ Proper Usage

- Follow instructions in 'Proper Usage'.
  Otherwise, It may cause unexpected accidents.
- It is recommended to use 485 converter with the separate power.
  (Autonics product, SCM-38I, recommended)
- Keep the distance between power cable and signal cable more than 10cm.
- Motor vibration and noise can occur in specific frequency period
  ①Change motor installation method or attach the damper.
  ②Use 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.
  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 motor
  ⑤Inconsistency 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.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II

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# (B) Stepper Motors


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**5-Phase Stepper Motors** B-4

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AK-R Series (Rotary Actuator Type) ..... B-16

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Installation instruction of 5-Phase Stepper Motors..... B-20

# Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid hazards.
※⚠ 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.

## ■ 5-Phase Stepper Motor

### ⚠ Warning

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, economic loss or fire.
2. **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.
3. **Do not use the brake for safety.**
   **[AK-B Series, AK-GB Series, AK-RB Series]**
   Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
4. **Fix the unit on the metal plate.**
   Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
5. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire.
6. **Install the unit after considering counter plan against power failure.**
   Failure to follow this instruction may result in personal injury, economic loss or fire.
7. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
8. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire or electric shock.
9. **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. **OFF the power directly when error occurs.**
    Failure to follow this instruction may result in personal injury, fire or electronic shock.

### ⚠ Caution

1. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
2. **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.
3. **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.

**General precaution**
Indicate general warning, caution or danger.

# 5-Phase Stepper Motor and Driver Specifications

(○: **General specifications**, ◎: **High-speed, High-torque specifications**)

| Motor | | | | | Driver | | |
|---|---|---|---|---|---|---|---|
| Frame size | Type | Model | Torque (kgf·cm) | Rated current (A/Phase) | **MD5-HD14/MD5-ND14/ MD5-HD14-2X(3X)** | **MD5-HF14/ MD5-HF14-AO** | **MD5-HF28** |
| **24mm** | Shaft type | **02K-S523(W)** | 0.18 | 0.75 | ○ | ◎ | — |
| | | **04K-S525(W)** | 0.28 | 0.75 | ○ | ◎ | — |
| **42mm** | Shaft type / Shaft + Built-in brake type | **A1K-S543(W)-B** | 1.3 | 0.75 | ○ | ◎ | — |
| | | **A2K-S544(W)-B** | 1.8 | 0.75 | ○ | ◎ | — |
| | | **A2K-M544(W)** | 1.8 | 1.4 | ○ | ◎ | — |
| | | **A3K-S545(W)-B** | 2.4 | 0.75 | ○ | ◎ | — |
| | Hollow shaft type | **AH1K-S543** | 1.3 | 0.75 | ○ | ◎ | — |
| | | **AH2K-S544** | 1.8 | 0.75 | ○ | ◎ | — |
| | | **AH3K-S545** | 2.4 | 0.75 | ○ | ◎ | — |
| | Geared type/ Geared + Built-in brake type | **A10K-S545(W)-GB5** | 10 | 0.75 | ○ | ◎ | — |
| | | **A15K-S545(W)-GB7.2** | 15 | 0.75 | ○ | ◎ | — |
| | | **A15K-S545(W)-GB10** | 15 | 0.75 | ○ | ◎ | — |
| **60mm** | Shaft type / Shaft + Built-in brake type | **A4K-S564(W)-B** | 4.2 | 0.75 | ○ | ◎ | — |
| | | **A4K-M564(W)-B** | 4.2 | 1.4 | ○ | ◎ | — |
| | | **A4K-G564(W)** | 4.2 | 2.8 | — | — | ◎ |
| | | **A8K-S566(W)-B** | 8.3 | 0.75 | ○ | ◎ | — |
| | | **A8K-M566(W)-B** | 8.3 | 1.4 | ○ | ◎ | — |
| | | **A8K-G566(W)** | 8.3 | 2.8 | — | — | ◎ |
| | | **A16K-M569(W)-B** | 16.6 | 1.4 | ○ | ◎ | — |
| | | **A16K-G569(W)-B** | 16.6 | 2.8 | — | — | ◎ |
| | Hollow shaft type | **AH4K-S564(W)** | 4.2 | 0.75 | ○ | ◎ | — |
| | | **AH4K-M564(W)** | 4.2 | 1.4 | ○ | ◎ | — |
| | | **AH8K-S566(W)** | 8.3 | 0.75 | ○ | ◎ | — |
| | | **AH8K-M566(W)** | 8.3 | 1.4 | ○ | ◎ | — |
| | | **AH16K-M569(W)** | 16.6 | 1.4 | ○ | ◎ | — |
| | | **AH16K-G569(W)** | 16.6 | 2.8 | — | — | ◎ |
| | Geared type/ Geared + Built-in brake type | **A35K-M566(W)-GB5** | 35 | 1.4 | ○ | ◎ | — |
| | | **A40K-M566(W)-GB7.2** | 40 | 1.4 | ○ | ◎ | — |
| | | **A50K-M566(W)-GB10** | 50 | 1.4 | ○ | ◎ | — |
| | Rotary actuator type/ Rotary actuator + Built-in brake type | **A35K-M566(W)-RB5** | 35 | 1.4 | ○ | ◎ | — |
| | | **A40K-M566(W)-RB7.2** | 40 | 1.4 | ○ | ◎ | — |
| | | **A50K-M566(W)-RB10** | 50 | 1.4 | ○ | ◎ | — |
| **85mm** | Shaft type / Shaft + Built-in brake type | **A21K-M596(W)-B** | 21 | 1.4 | ○ | ◎ | — |
| | | **A21K-G596(W)-B** | 21 | 2.8 | — | — | ◎ |
| | | **A41K-M599(W)-B** | 41 | 1.4 | ○ | ◎ | — |
| | | **A41K-G599(W)-B** | 41 | 2.8 | — | — | ◎ |
| | | **A63K-M5913(W)-B** | 63 | 1.4 | ○ | ◎ | — |
| | | **A63K-G5913(W)-B** | 63 | 2.8 | — | — | ◎ |
| | Hollow shaft type | **AH21K-M596(W)** | 21 | 1.4 | ○ | ◎ | — |
| | | **AH21K-G596(W)** | 21 | 2.8 | — | — | ◎ |
| | | **AH41K-M599(W)** | 41 | 1.4 | ○ | ◎ | — |
| | | **AH41K-G599(W)** | 41 | 2.8 | — | — | ◎ |
| | | **AH63K-M5913(W)** | 63 | 1.4 | ○ | ◎ | — |
| | | **AH63K-G5913(W)** | 63 | 2.8 | — | — | ◎ |
| | Geared type/ Geared + Built-in brake type | **A140K-M599(W)-GB5** | 140 | 1.4 | ○ | ◎ | — |
| | | **A140K-G599(W)-GB5** | 140 | 2.8 | — | — | ◎ |
| | | **A200K-M599(W)-GB7.2** | 200 | 1.4 | ○ | ◎ | — |
| | | **A200K-G599(W)-GB7.2** | 200 | 2.8 | — | — | ◎ |
| | | **A200K-M599(W)-GB10** | 200 | 1.4 | ○ | ◎ | — |
| | | **A200K-G599(W)-GB10** | 200 | 2.8 | — | — | ◎ |

※**(W)** stands for dual shaft of motor. (The built-in brake type provides single shaft type only.)
※The motor torque has a big difference in torque by the characteristics of the driver.
Please refer to the graph in this catalogue that shows the characteristics of motors and drivers.
For MD5-HD14, MD5-HD14-2X(3X), MD5-ND14, the high-speed region torque characteristics are better at 35VDC than at 20VDC.
In addition, MD5-HF14 and MD5-HF28 have further improved torque characteristics in the high-speed area than using DC type driver.

# 5-Phase Stepper Motor

## ▣ Ordering Information

**• Application model: shaft type, hollow shaft type, built-in brake type**

**A □ 8K – M 5 6 6 □ – □ B**

| | | | |
|---|---|---|---|
| Motor type | **No mark** | Standard type | |
| | **B**※1 | Built-in brake type | |
| Wire connection | **No mark** | Pentagon | |
| | **S**※2 | Standard | |
| Shaft type | **No mark** | Single shaft | |
| | **W** | Dual shaft | |
| Motor length | **2** | 24×24mm | **3** 30.5mm |
| | | | **5** 46.5mm |
| | **4** | 42×42mm | **3** 33mm |
| | | | **4** 39mm |
| | | | **5** 47mm |
| | **6** | 60×60mm | **4** 48.5mm |
| | | | **6** 59.5mm |
| | | | **9** 89mm |
| | **9** | 85×85mm | **6** 68mm |
| | | | **9** 98mm |
| | | | **13** 128mm |
| Motor frame size | | | |
| Motor phase | **5** | 5 phase | |
| Rated current | **S** | 0.75A/Phase | |
| | **M** | 1.4A/Phase | |
| | **G** | 2.8A/Phase | |
| Max. holding torque | **Square** | kgf·cm (refer to motor specification) | |
| Motor type | **No mark** | Shaft type | |
| | **H** | Hollow shaft type | |
| Item | **A** | Autonics motor | |

※1: Built-in brake type provides single shaft type only.
※2: Standard wiring is optional. (except frame size 24mm motor, A4K-G564(W), A8K-G566(W))

## ▣ Ordering Information

**• Application model: geared type, geared+built-in brake type, rotary actuator type, rotary actuator+built-in brake type**

**A □ – M 5 □ □ □ – □ □**

| | | | | |
|---|---|---|---|---|
| Gear ratio | **5** | 1:5 | | |
| | **7.2** | 1:7.2 | | |
| | **10** | 1:10 | | |
| Motor type | **G** | Geared type | | |
| | **GB**※1 | Geared+built-in brake type | | |
| | **R** | Rotary actuator type | | |
| | **RB**※1 | Rotary actuator+built-in brake type | | |
| Shaft type | **No mark**※1 | Single shaft | | |
| | **W** | Dual shaft | | |
| Motor length | | | | |
| Motor frame size | **4** | 42×42mm | **5** | 47mm |
| | **6** | 60×60mm | **6** | 59.5mm |
| | **9** | 85×85mm | **9** | 98mm |
| Motor phase | **5** | 5 Phase | | |
| Rated current | **S** | 0.75A/Phase | | |
| | **M** | 1.4A/Phase | | |
| | **G** | 2.8A/Phase | | |
| Max. allowable torque | **10K** | 10kgf·cm | **50K** | 50kgf·cm |
| | **15K** | 15kgf·cm | **140K** | 140kgf·cm |
| | **35K** | 35kgf·cm | **200K** | 200kgf·cm |
| | **40K** | 40kgf·cm | | |
| Item | **A** | Autonics motor | | |

※1: Built-in brake type provides single shaft type only.

## ▣ Specifications of Motor

| Motor | | Model | Rated current (A/Phase) | Max. holding torque (kgf·cm) | Max. allowable torque (kgf·cm) | Rotor moment of inertia (gf·cm²) | Winding resistance (Ω) | Motor length (mm) |
|---|---|---|---|---|---|---|---|---|
| Frame size | Type | | | | | | | |
| **24mm** | Shaft type | **02K-S523(W)** | 0.75 | 0.18 | — | 4.2 | 1.1 | 30.5 |
| | | **04K-S525(W)** | 0.75 | 0.28 | — | 8.2 | 1.7 | 46.5 |
| **42mm** | Shaft type/ Built-in brake type | **A1K-S543(W)-B** | 0.75 | 1.3 | — | 35 | 1.7 | 33/56 |
| | | **A2K-S544(W)-B** | 0.75 | 1.8 | — | 54 | 2.2 | 39/62 |
| | | **A2K-M544(W)** | 1.4 | 1.8 | — | 54 | 2.2 | 39 |
| | | **A3K-S545(W)-B** | 0.75 | 2.4 | — | 68 | 2.2 | 47/70 |
| | Hollow shaft type | **AH1K-S543** | 0.75 | 1.3 | — | 35 | 1.7 | 33 |
| | | **AH2K-S544** | 0.75 | 1.8 | — | 54 | 2.2 | 39 |
| | | **AH3K-S545** | 0.75 | 2.4 | — | 68 | 2.2 | 47 |
| | Geared type | **A10K-S545(W)-G5** | 0.75 | — | 10 | 68 | 2.2 | 74.5 |
| | | **A15K-S545(W)-G7.2** | 0.75 | — | 15 | 68 | 2.2 | 74.5 |
| | | **A15K-S545(W)-G10** | 0.75 | — | 15 | 68 | 2.2 | 74.5 |
| | Geared+ built-in brake type | **A10K-S545-GB5** | 0.75 | — | 10 | 68 | 2.2 | 97.5 |
| | | **A15K-S545-GB7.2** | 0.75 | — | 15 | 68 | 2.2 | 97.5 |
| | | **A15K-S545-GB10** | 0.75 | — | 15 | 68 | 2.2 | 97.5 |
| **60mm** | Shaft type/ Built-in brake type | **A4K-S564(W)-B** | 0.75 | 4.2 | — | 175 | 2.6 | 48.5/75 |
| | | **A4K-M564(W)-B** | 1.4 | 4.2 | — | 175 | 0.8 | 48.5/75 |
| | | **A4K-G564(W)** | 2.8 | 4.2 | — | 175 | 0.26 | 48.5 |
| | | **A8K-S566(W)-B** | 0.75 | 8.3 | — | 280 | 4.0 | 59.5/86 |
| | | **A8K-M566(W)-B** | 1.4 | 8.3 | — | 280 | 1.1 | 59.5/86 |
| | | **A8K-G566(W)** | 2.8 | 8.3 | — | 280 | 0.35 | 59.5 |
| | | **A16K-M569(W)-B** | 1.4 | 16.6 | — | 560 | 1.8 | 89/115.5 |
| | | **A16K-G569(W)-B** | 2.8 | 16.6 | — | 560 | 0.56 | 89/115.5 |
| | Hollow shaft type | **AH4K-S564(W)** | 0.75 | 4.2 | — | 175 | 2.6 | 48.5 |
| | | **AH4K-M564(W)** | 1.4 | 4.2 | — | 175 | 0.8 | 48.5 |
| | | **AH8K-S566(W)** | 0.75 | 8.3 | — | 280 | 4.0 | 59.5 |
| | | **AH8K-M566(W)** | 1.4 | 8.3 | — | 280 | 1.1 | 59.5 |
| | | **AH16K-M569(W)** | 1.4 | 16.6 | — | 560 | 1.8 | 89 |
| | | **AH16K-G569(W)** | 2.8 | 16.6 | — | 560 | 0.56 | 89 |
| | Geared type | **A35K-M566(W)-G5** | 1.4 | — | 35 | 280 | 1.1 | 94.5 |
| | | **A40K-M566(W)-G7.2** | 1.4 | — | 40 | 280 | 1.1 | 94.5 |
| | | **A50K-M566(W)-G10** | 1.4 | — | 50 | 280 | 1.1 | 94.5 |
| | Geared+ built-in brake type | **A35K-M566-GB5** | 1.4 | — | 35 | 280 | 1.1 | 121 |
| | | **A40K-M566-GB7.2** | 1.4 | — | 40 | 280 | 1.1 | 121 |
| | | **A50K-M566-GB10** | 1.4 | — | 50 | 280 | 1.1 | 121 |
| | Rotary actuator type | **A35K-M566(W)-R5** | 1.4 | — | 35 | 280 | 1.1 | 93.5 |
| | | **A40K-M566(W)-R7.2** | 1.4 | — | 40 | 280 | 1.1 | 93.5 |
| | | **A50K-M566(W)-R10** | 1.4 | — | 50 | 280 | 1.1 | 93.5 |
| | Rotary actuator+ built-in brake type | **A35K-M566-RB5** | 1.4 | — | 35 | 280 | 1.1 | 120 |
| | | **A40K-M566-RB7.2** | 1.4 | — | 40 | 280 | 1.1 | 120 |
| | | **A50K-M566-RB10** | 1.4 | — | 50 | 280 | 1.1 | 120 |
| **85mm** | Shaft type/ Built-in brake type | **A21K-M596(W)-B** | 1.4 | 21 | — | 1400 | 1.76 | 68/103 |
| | | **A21K-G596(W)-B** | 2.8 | 21 | — | 1400 | 0.4 | 68/103 |
| | | **A41K-M599(W)-B** | 1.4 | 41 | — | 2700 | 2.6 | 98/133 |
| | | **A41K-G599(W)-B** | 2.8 | 41 | — | 2700 | 0.58 | 98/133 |
| | | **A63K-M5913(W)-B** | 1.4 | 63 | — | 4000 | 3.92 | 128/163 |
| | | **A63K-G5913(W)-B** | 2.8 | 63 | — | 4000 | 0.86 | 128/163 |
| | Hollow shaft type | **AH21K-M596(W)** | 1.4 | 21 | — | 1400 | 1.76 | 68 |
| | | **AH21K-G596(W)** | 2.8 | 21 | — | 1400 | 0.4 | 68 |
| | | **AH41K-M599(W)** | 1.4 | 41 | — | 2700 | 2.6 | 98 |
| | | **AH41K-G599(W)** | 2.8 | 41 | — | 2700 | 0.58 | 98 |
| | | **AH63K-M5913(W)** | 1.4 | 63 | — | 4000 | 3.92 | 128 |
| | | **AH63K-G5913(W)** | 2.8 | 63 | — | 4000 | 0.86 | 128 |
| | Geared type | **A140K-M599(W)-G5** | 1.4 | — | 140 | 2700 | 2.6 | 145 |
| | | **A140K-G599(W)-G5** | 2.8 | — | 140 | 2700 | 0.58 | 145 |
| | | **A200K-M599(W)-G7.2** | 1.4 | — | 200 | 2700 | 2.6 | 145 |
| | | **A200K-G599(W)-G7.2** | 2.8 | — | 200 | 2700 | 0.58 | 145 |
| | | **A200K-M599(W)-G10** | 1.4 | — | 200 | 2700 | 2.6 | 145 |
| | | **A200K-G599(W)-G10** | 2.8 | — | 200 | 2700 | 0.58 | 145 |
| | Geared+ built-in brake type | **A140K-M599-GB5** | 1.4 | — | 140 | 2700 | 2 6 | 180 |
| | | **A140K-G599-GB5** | 2.8 | — | 140 | 2700 | 0.58 | 180 |
| | | **A200K-M599-GB7.2** | 1.4 | — | 200 | 2700 | 2.6 | 180 |
| | | **A200K-G599-GB7.2** | 2.8 | — | 200 | 2700 | 0.58 | 180 |
| | | **A200K-M599-GB10** | 1.4 | — | 200 | 2700 | 2.6 | 180 |
| | | **A200K-G599-GB10** | 2.8 | — | 200 | 2700 | 0.58 | 180 |

※**(W)** stands for dual shaft of motor. (the built-in brake type provides single shaft type only.)
※Motor length is measured without shaft.
※Hollow shaft type with standard wiring is optional. (except frame size 24mm motor.)

# 5-Phase Stepper Motor

## ▣ Specifications

### ● Frame size 24mm

| Model | | 02K-S523(W) | 04K-S525(W) |
|---|---|---|---|
| Max. holding torque※1 | | 0.18kgf·cm (0.018N·m) | 0.28kgf·cm (0.027N·m) |
| Rotor moment of inertia | | 4.2gf·cm$^2$ (4.2×10$^{-7}$kgf·m$^2$) | 8.2gf·cm$^2$ (8.2×10$^{-7}$kgf·m$^2$) |
| Rated current | | 0.75A/Phase | |
| Standard step angle | | 0.72°/0.36° (Full/Half step) | |
| Insulation class | | B type (130℃) | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | |
| Dielectric strength | | 0.5kVAC 50/60Hz for 1 min between motor coil-case | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | |
| Protection structure | | IP30 (IEC34-5 standard) | |
| Weight※2 | | Approx. 0.10kg (approx. 0.08kg) | Approx. 0.16kg (approx. 0.12kg) |

※1: Max. holding torque is maintenance torque in stopping the motor when supply the rated current and is standard method for comparing the performance of motors.
※2: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

### ● Frame size 42mm

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | Shaft type | A1K-S543(W) | A2K-S544(W) | A2K-M544(W) | A3K-S545(W) | — | — | — |
| | Hollow shaft type | AH1K-S543 | AH2K-S544 | — | AH3K-S545 | — | — | — |
| | Built-in brake type | A1K-S543-B | A2K-S544-B | — | A3K-S545-B | — | — | — |
| | Geared type | — | — | — | — | A10K-S545(W)-G5 | A15K-S545(W)-G7.2 | A15K-S545(W)-G10 |
| | Geared + built-in brake type | — | — | — | — | A10K-S545-GB5 | A15K-S545-GB7.2 | A15K-S545-GB10 |
| Max. holding torque※1 | | 1.3kgf·cm (0.13N·m) | 1.8kgf·cm (0.18N·m) | | 2.4kgf·cm (0.24N·m) | — | — | — |
| Max. allowable torque※1 | | — | — | — | — | 10kgf·cm (1.0N·m) | 15kgf·cm (1.5N·m) | |
| Rotor moment of inertia | | 35gf·cm$^2$ (35×10$^{-7}$kgf·m$^2$) | 54gf·cm$^2$ (54×10$^{-7}$kgf·m$^2$) | | 68gf·cm$^2$ (68×10$^{-7}$kgf·m$^2$) | | | |
| Rated current | | 0.75A/Phase | | 1.4A/Phase | 0.75A/Phase | | | |
| Standard step angle | | 0.72°/ 0.36° (Full/Half step) | | | | 0.144°/ 0.072° (Full/Half step) | 0.1°/ 0.05° (Full/Half step) | 0.072°/ 0.036° (Full/Half step) |
| Gear ratio | | — | | | | 1:5 | 1:7.2 | 1:10 |
| Allowable speed range | | — | | | | 0 to 360rpm | 0 to 250rpm | 0 to 180rpm |
| Backlash [min] | | — | | | | ±35' (0.58°) | | |
| Electro-Magnetic Brake※ | Rated excitation voltage | 24VDC⎓ ±10% (no-polarity) | | | | | | |
| | Rated excitation current | 0.2A | | | | | | |
| | Static friction torque | 1.8kgf·cm | | | | | | |
| | Rotation part inertia | 3×10$^{-7}$kgf·cm$^2$ | | | | | | |
| | B type brake | Power on: brake is released, power off: brake is operating | | | | | | |
| | Operating time | Max. 25ms | | | | Max. 15ms | | |
| | Releasing time | Max. 15ms | | | | Max. 25ms | | |
| Insulation class | | B type (130℃) | | | | | | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | | | | | | |
| Dielectric strength | | 1kVAC (at 0.75A/Phase is 0.5kVAC) 50/60Hz for 1 min between motor coil-case | | | | | | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | | | | | | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | | | | | |
| Protection structure | | IP30 (IEC34-5 standard) | | | | | | |
| Weight※3 | | Shaft type : approx. 0.34kg (approx. 0.25kg), Hollow shaft type : approx. 0.35kg (approx. 0.25kg), Built-in brake type : approx. 0.44kg (approx. 0.39kg) | Shaft type : approx. 0.39kg (approx. 0.3kg), Hollow shaft type : approx. 0.4kg (approx. 0.3kg), Built-in brake type : approx. 0.49kg (approx. 0.44kg) | | Shaft type : approx. 0.49kg (approx. 0.4kg) Hollow shaft type : approx. 0.5kg (approx. 0.4kg), Built-in brake type : approx. 0.59kg (approx. 0.54kg) | Geared type : approx. 0.68kg (approx. 0.58kg), Geared+built-in brake type : approx. 0.78kg (approx. 0.72kg) | | |

※1: Max. holding torque/Max. allowable torque is maintenance torque in stopping the motor when supply the rated current and is standard method for comparing the performance of motors.
※2: It is only available for built-in brake type, geared+built-in brake type.
※3: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Specifications

### ● Frame size 60mm

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model | Shaft type | **A4K-S564(W)** | **A4K-M564(W)** | **A4K-G564(W)** | **A8K-S566(W)** | **A8K-M566(W)** | **A8K-G566(W)** | **A16K-M569(W)** | **A16K-G569(W)** | |
| | Hollow shaft type | **AH4K-S564(W)** | **AH4K-M564(W)** | — | **AH8K-S566(W)** | **AH8K-M566(W)** | — | **AH16K-M569(W)** | **AH16K-G569(W)** | |
| | Built-in brake type | **A4K-S564-B** | **A4K-M564-B** | — | **A8K-S566-B** | **A8K-M566-B** | — | **A16K-M569-B** | **A16K-G569-B** | |
| Max. holding torque※1 | | 4.2kgf·cm (0.41N·m) | | | 8.3kgf·cm (0.81N·m) | | | 16.6kgf·cm (1.63N·m) | | |
| Rotor moment of inertia | | 175gf·cm$^2$ (175×10$^{-7}$kgf·m$^2$) | | | 280gf·cm$^2$ (280×10$^{-7}$kgf·m$^2$) | | | 560gf·cm$^2$ (560×10$^{-7}$kgf·m$^2$) | | |
| Rated current | | 0.75A/Phase | 1.4A/Phase | 2.8A/Phase | 0.75A/Phase | 1.4A/Phase | 2.8A/Phase | 1.4A/Phase | 2.8A/Phase | |
| Standard step angle | | 0.72°/ 0.36° (Full/Half step) | | | | | | | | |
| Electro-Magnetic Brake※2 | Rated excitation voltage | 24VDC⎓ ±10% (no-polarity) | | | | | | | | |
| | Rated excitation current | 0.33A | | | | | | | | |
| | Static friction torque | 8kgf·cm | | | | | | | | |
| | Rotation part inertia | 29×10$^{-7}$kgf·cm$^2$ | | | | | | | | |
| | B type brake | Power on: brake is released, power off: brake is operating | | | | | | | | |
| | Operating time | Max. 25ms | | | | | | | | |
| | Releasing time | Max. 20ms | | | | | | | | |
| Insulation class | | B type (130℃) | | | | | | | | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | | | | | | | | |
| Dielectric strength | | 1kVAC (at 0.75A/Phase is 0.5kVAC) 50/60Hz for 1 min between motor coil-case | | | | | | | | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | | | | | | | | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | | | | | | | |
| Protection structure | | IP30 (IEC34-5 standard) | | | | | | | | |
| Weight※4 | | Standard type<br>: approx. 0.85kg (approx. 0.6kg),<br>Hollow shaft type<br>: approx. 0.87kg (approx. 0.6kg),<br>Built-in brake type<br>: approx. 1.03kg (approx. 0.95kg) | | | Standard type<br>: approx. 1.05kg (approx. 0.8kg),<br>Hollow shaft type<br>: approx. 1.07kg (approx. 0.8kg),<br>Built-in brake type<br>: approx. 1.33kg (approx. 1.25kg) | | | Standard type<br>: approx. 1.55kg (approx. 1.3kg),<br>Hollow shaft type<br>: approx. 1.57kg (approx. 1.3kg),<br>Built-in brake type<br>: approx. 1.73kg (approx. 1.65kg) | | |

※Environment resistance is rated at no freezing or condensation.

### ● Frame size 60mm

| | | | | |
|---|---|---|---|---|
| Model | Geared type | **A35K-M566(W)-G5** | **A40K-M566(W)-G7.2** | **A50K-M566(W)-G10** |
| | Geared type+ Built-in brake type | **A35K-M566-GB5** | **A40K-M566-GB7.2** | **A50K-M566-GB10** |
| | Rotary actuator type | **A35K-M566(W)-R5** | **A40K-M566(W)-R7.2** | **A50K-M566(W)-R10** |
| | Rotary actuator+ Built-in brake type | **A35K-M566-RB5** | **A40K-M566-RB7.2** | **A50K-M566-RB10** |
| Max. allowable torque※1 | | 35kgf·cm (3.4N·m) | 40kgf·cm (3.9N·m) | 50kgf·cm (4.9N·m) |
| Rotor moment of inertia | | 280gf·cm$^2$ (280×10$^{-7}$kgf·m$^2$) | | |
| Rated current | | 1.4A/Phase | | |
| Standard step angle | | 0.144°/ 0.072° (Full/Half step) | 0.1°/ 0.05° (Full/Half step) | 0.072°/ 0.036° (Full/Half step) |
| Gear ratio | | 1:5 | 1:7.2 | 1:10 |
| Allowable speed range | | 0 to 360rpm | 0 to 250rpm | 0 to 180rpm |
| Backlash [min] | | ±20' (0.33°) | | |
| Electro-Magnetic Brake※2 | Rated excitation voltage | 24VDC⎓ ±10% (no-polarity) | | |
| | Rated excitation current | 0.33A | | |
| | Static friction torque | Min. 8kgf·cm | | |
| | Rotation part inertia | 29×10$^{-7}$kgf·cm$^2$ | | |
| | B type brake | Power on: brake is released, power off: brake is operating | | |
| | Operating time | Max. 20ms | | |
| | Releasing time | Max. 25ms | | |
| Absolute position error※3 | | ±20' (0.33°) | | |
| Lost motion※3 | | ±20' (0.33°) | | |
| Insulation class | | B type (130℃) | | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | | |
| Dielectric strength | | 1kVAC 50/60Hz for 1 min between motor coil-case | | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | |
| Protection structure | | IP30 (IEC34-5 standard) | | |
| Weight※4 | | Geared type: approx. 1.57kg (approx. 1.3kg), geared+built-in brake type: approx. 1.65kg (approx. 1.57kg), rotary actuator type: approx. 1.4kg (approx. 1.3kg), rotary actuator+built-in brake type: approx. 1.7kg (approx.1.6kg) | | |

※1: Max. holding torque/Max. allowable torque is maintenance torque in stopping the motor when supply the rated current and is standard method for comparing the performance of motors.
※2: It is only available for built-in brake type, geared+built-in brake type.
※3: It is only available for Rotary actuator type, Rotary actuator+built-in brake type.
※4: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Specifications

### ● Frame size 85mm

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Model | Shaft type | **A21K-M596(W)** | **A21K-G596(W)** | **A41K-M599(W)** | **A41K-G599(W)** | **A63K-M5913(W)** | **A63K-G5913(W)** | | | | |
| | Hollow shaft type | **AH21K-M596(W)** | **AH21K-G596(W)** | **AH41K-M599(W)** | **AH41K-G599(W)** | **AH63K-M5913(W)** | **AH63K-G5913(W)** | | | | |
| | Built-in brake type | **A21K-M596-B** | **A21K-G596-B** | **A41K-M599-B** | **A41K-G599-B** | **A63K-M5913-B** | **A63K-G5913-B** | | | | |
| Max. holding torque※1 | | 21kgf·cm (2.1N·m) | | 41kgf·cm (4.0N·m) | | 63kgf·cm (6.2N·m) | | | | | |
| Rotor moment of inertia | | 1,400gf·cm$^2$ (1,400×10$^{-7}$kgf·m$^2$) | | 2,700gf·cm$^2$ (2,700×10$^{-7}$kgf·m$^2$) | | 4,000gf·cm$^2$ (4,000×10$^{-7}$kgf·m$^2$) | | | | | |
| Rated current | | 1.4A/Phase | 2.8A/Phase | 1.4A/Phase | 2.8A/Phase | 1.4A/Phase | 2.8A/Phase | | | | |
| Standard step angle | | 0.72°/ 0.36° (Full/Half step) | | | | | | | | | |
| Electro-Magnetic Brake※2 | Rated excitation voltage | 24VDC⎓ ±10% (no-polarity) | | | | | | | | | |
| | Rated excitation current | 0.62A | | | | | | | | | |
| | Static friction torque | 40kgf·cm | | | | | | | | | |
| | Rotation part inertia | 153×10$^{-7}$kgf·cm$^2$ | | | | | | | | | |
| | B type brake | Power on: brake is released, power off: brake is operating | | | | | | | | | |
| | Operating time | Max. 60ms | | | | | | | | | |
| | Releasing time | Max. 15ms | | | | | | | | | |
| Insulation class | | B type (130℃) | | | | | | | | | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | | | | | | | | | |
| Dielectric strength | | 1kVAC 50/60Hz for 1 min between motor coil-case | | | | | | | | | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | | | | | | | | | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | | | | | | | | |
| Protection structure | | IP30 (IEC34-5 standard) | | | | | | | | | |
| Weight※3 | | Shaft type<br>: approx. 2.15kg (approx. 1.7kg),<br>Hollow shaft type<br>: approx. 2.18kg (approx. 1.7kg),<br>Built-in brake type<br>: approx. 2.74kg (approx. 2.64kg) | | Shaft type<br>: approx. 3.25kg (approx. 2.8kg),<br>Hollow shaft type<br>: approx. 3.28kg (approx. 2.8kg),<br>Built-in brake type<br>: approx. 3.84kg (approx. 3.74kg) | | Shaft type<br>: approx. 4.25kg (approx. 3.8kg),<br>Hollow shaft type<br>: approx. 4.28kg (approx. 3.8kg),<br>Built-in brake type<br>: approx. 4.84kg (approx. 4.74kg) | | | | | |

※Environment resistance is rated at no freezing or condensation.

### ● Frame size 85mm

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | Geared type | **A140K-M599(W)-G5** | **A140K-G599(W)-G5** | **A200K-M599(W)-G7.2** | **A200K-G599(W)-G7.2** | **A200K-M599(W)-G10** | **A200K-G599(W)-G10** |
| | Geared+ Built-in brake type | **A140K-M599-GB5** | **A140K-G599-GB5** | **A200K-M599-GB7.2** | **A200K-G599-GB7.2** | **A200K-M599-GB10** | **A200K-G599-GB10** |
| Max. allowable torque※1 | | 140kgf·cm (13.7N·m) | | 200kgf·cm (19.6N·m) | | | |
| Rotor moment of inertia | | 2,700gf·cm$^2$ (2,700×10$^{-7}$kgf·m$^2$) | | | | | |
| Rated current | | 1.4A/Phase | 2.8A/Phase | 1.4A/Phase | 2.8A/Phase | 1.4A/Phase | 2.8A/Phase |
| Standard step angle | | 0.144°/ 0.072° (Full/Half step) | | 0.1°/ 0.05° (Full/Half step) | | 0.072°/ 0.036° (Full/Half step) | |
| Gear ratio | | 1:5 | | 1:7.2 | | 1:10 | |
| Allowable speed range | | 0 to 360rpm | | 0 to 250rpm | | 0 to 180rpm | |
| Backlash [min] | | ±15' (0.25°) | | | | | |
| Electro-Magnetic Brake※2 | Rated excitation voltage | 24VDC⎓ ±10% (no-polarity) | | | | | |
| | Rated excitation current | 0.62A | | | | | |
| | Static friction torque | 40kgf·cm | | | | | |
| | Rotation part inertia | 153×10$^{-7}$kgf·cm$^2$ | | | | | |
| | B type brake | Power on: brake is released, power off: brake is operating | | | | | |
| | Operating time | Max. 15ms | | | | | |
| | Releasing time | Max. 60ms | | | | | |
| Insulation class | | B type (130℃) | | | | | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger) between motor coil-case | | | | | |
| Dielectric strength | | 1kVAC 50/60Hz for 1 min between motor coil-case | | | | | |
| Environment | Ambient temp. | -10 to 50℃, storage: -25 to 85℃ | | | | | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | | | | |
| Protection structure | | IP30 (IEC34-5 standard) | | | | | |
| Weight※3 | | Geared type: approx. 4.88kg (approx. 4.4kg), geared+built-in brake type: approx. 5.5kg (approx. 5.2kg) | | | | | |

※1: Max. holding torque/Max. allowable torque is maintenance torque in stopping the motor when supply the rated current and is standard method for comparing the performance of motors.
※2: It is only available for built-in brake type, geared+built-in brake type.
※3: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

# Frame Size 24mm/42mm/60mm/85mm Shaft Type Motor
# Frame Size 42mm/60mm/85mm Built-in Brake Type Motor

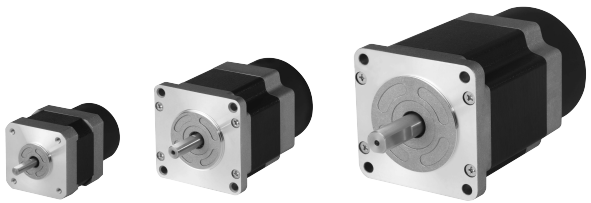


## ▣ Features

- Compact design and light weight with high accuracy, speed and torque
- Suitable for small-sized equipment applications
- Frame size 42mm/60mm/85mm built-in brake of shaft type for compact equipment (AK-B Series)
- Brake force is released (AK-B Series) when applying power on brake wire
- Cost-effective

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

Frame size
24mm 42mm 60mm 85mm



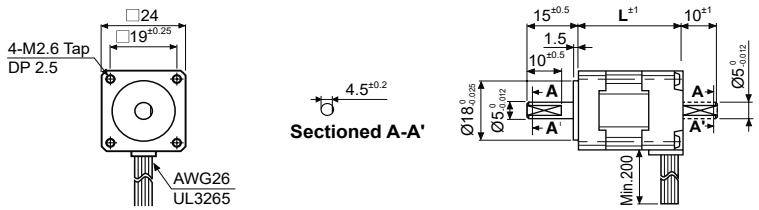
Frame size
42mm Brake built-in type
60mm Brake built-in type
85mm Brake built-in type

## ▣ Dimensions

※These dimensions are for dual shaft models. Single shaft models do not include shafts indicated in the dotted lines.
※For flexible coupling (ERB series) information, refer to '**ERB Series**' in '**Rotary encoder**'. (frame size 24mm, 48mm, 60mm (shaft type))
※Brake is non-polar and be sure to observe rated excitation voltage (24VDC). (except frame size 24mm)
SW1 ON: brake release / SW1 OFF: brake execute

### ◎ Frame size 24mm

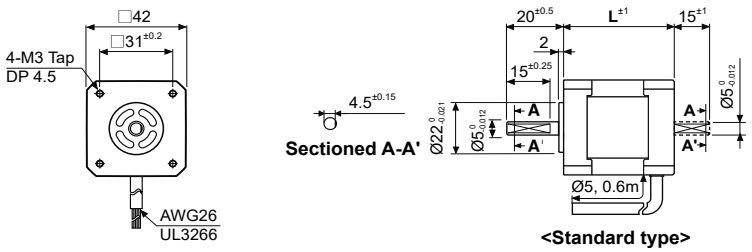
(unit: mm)




(unit: mm)

| Model | L |
|---|---|
| **02K-S523(W)** | 30.5 |
| **04K-S525(W)** | 46.5 |

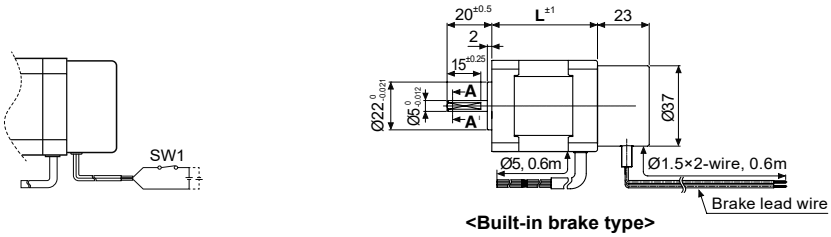
### ◎ Frame size 42mm




<Standard type>

(unit: mm)

| Model | L |
|---|---|
| **A1K-S543(W)-B** | 33 |
| **A2K-□544(W)-B** | 39 |
| **A3K-S545(W)-B** | 47 |

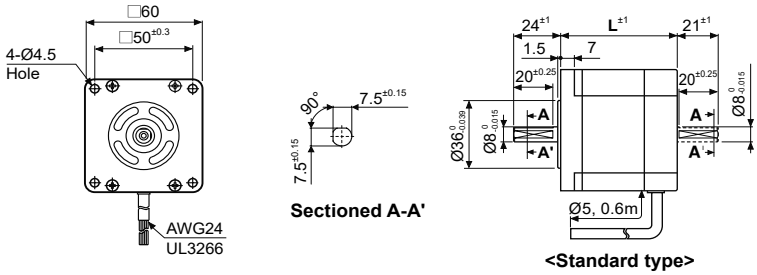



<Built-in brake type>

## ▣ Dimensions

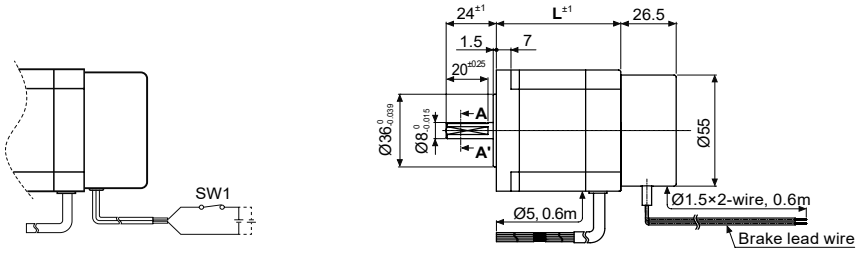
### ◎ Frame size 60mm

(unit: mm)

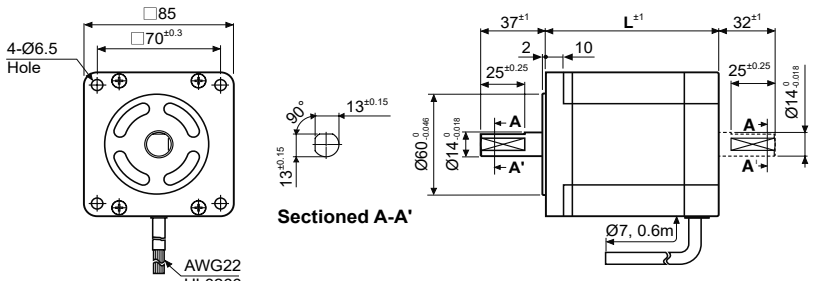



(unit: mm)

| Model | L |
|---|---|
| **A4K-□564(W)-B** | 48.5 |
| **A8K-□566(W)-B** | 59.5 |
| **A16K-□569(W)-B** | 89 |

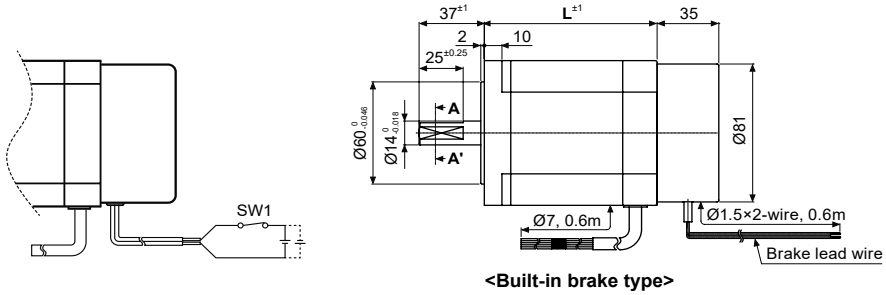



### ◎ Frame size 85mm



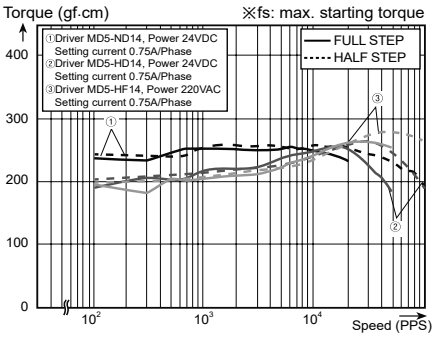

(unit: mm)

| Model | L |
|---|---|
| **A21K-□596(W)-B** | 68 |
| **A41K-□599(W)-B** | 98 |
| **A63K-□5913(W)-B** | 128 |



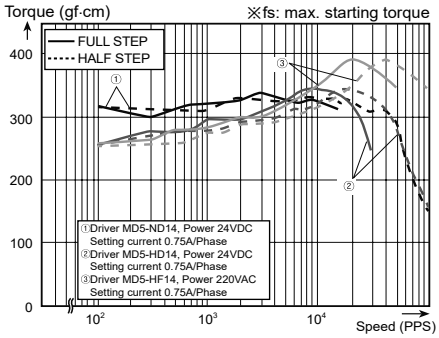
## ▣ Characteristic

### ● 02K-S523



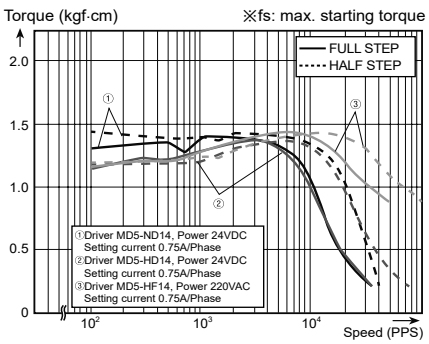

① fs Full Step: 3.6kpps, Half Step: 7.1kpps
② fs Full Step: 3.7kpps, Half Step: 7.2kpps
③ fs Full Step: 3.8kpps, Half Step: 7.5kpps

### ● 04K-S525



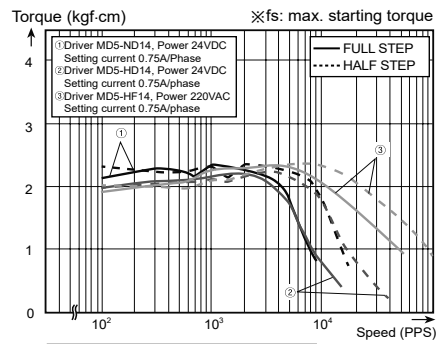

①fs Full Step: 3.1kpps, Half Step: 6.1kpps
②fs Full Step: 3.2kpps, Half Step: 6.3kpps
③fs Full Step: 3.3kpps, Half Step: 6.5kpps

### ● A1K-S543 / A1K-S543-B



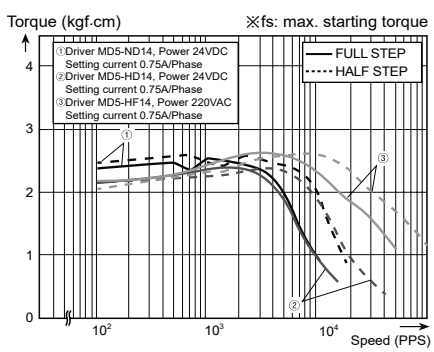

①fs Full Step: 3.3kpps, Half Step: 6.6kpps
②fs Full Step: 3.4kpps, Half Step: 6.7kpps
③fs Full Step: 3.5kpps, Half Step: 6.8kpps

### ● A2K-□544 / A2K-□544-B



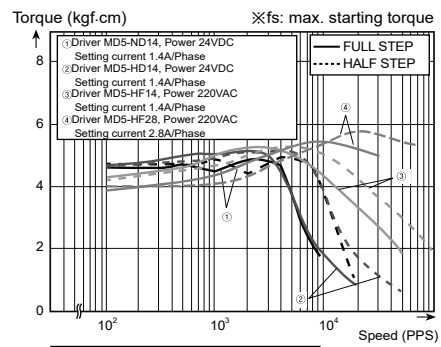

①fs Full Step: 3.2kpps, Half Step: 6.3kpps
②fs Full Step: 3.3kpps, Half Step: 6.5kpps
③fs Full Step: 3.4kpps, Half Step: 6.7kpps

### ● A3K-S545 / A3K-S545-B




①fs Full Step: 3kpps, Half Step: 5.9kpps
②fs Full Step: 3.1kpps, Half Step: 6.1kpps
③fs Full Step: 3.2kpps, Half Step: 6.4kpps

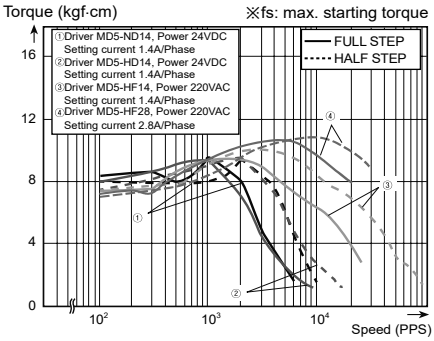
### ● A4K-□564 / A4K-M564-B




①fs Full Step: 2.7kpps, Half Step: 5.3kpps
②fs Full Step: 2.7kpps, Half Step: 5.8kpps
③fs Full Step: 3.7kpps, Half Step: 7.2kpps
④fs Full Step: 3.4kpps, Half Step: 6.8kpps

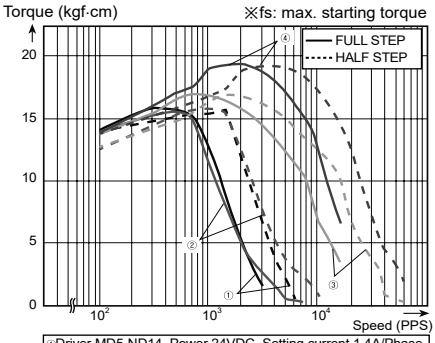
## ▣ Characteristic

### ● A8K-□566 / A8K-M566-B




①fs Full Step: 2.1kpps, Half Step: 4.1kpps
②fs Full Step: 2.1kpps, Half Step: 4.2kpps
③fs Full Step: 3.2kpps, Half Step: 6.3kpps
④fs Full Step: 3.3kpps, Half Step: 6.6kpps

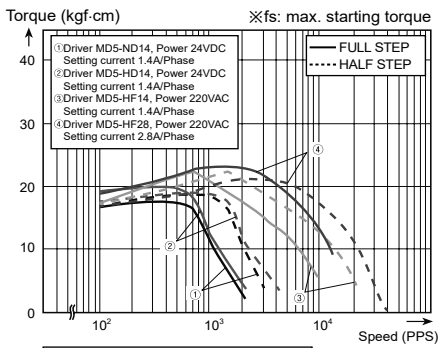
### ● A16K-□569 / A16K-□569-B




①Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
②Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
④Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

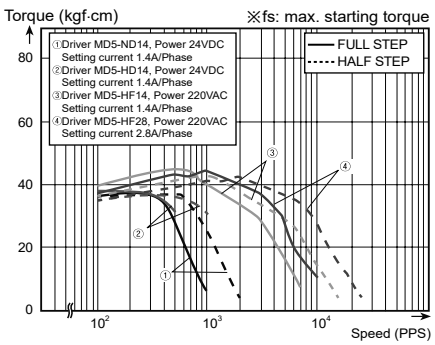
①fs Full Step: 1.8kpps, Half Step: 3.5kpps
②fs Full Step: 1.9kpps, Half Step: 3.5kpps
③fs Full Step: 2.6kpps, Half Step: 5.2kpps
④fs Full Step: 3.4kpps, Half Step: 6.8kpps

### ● A21K-□596 / A21K-□596-B



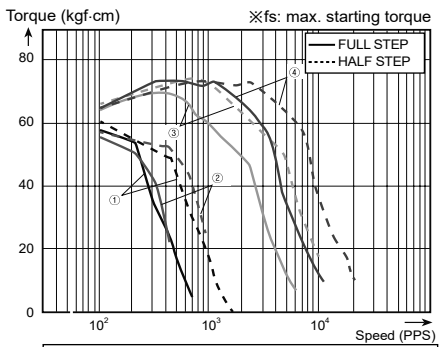

①fs Full Step: 1.5kpps, Half Step: 2.9kpps
②fs Full Step: 1.6kpps, Half Step: 3.1kpps
③fs Full Step: 2.2kpps, Half Step: 4.4kpps
④fs Full Step: 2.3kpps, Half Step: 4.6kpps

### ● A41K-□599 / A41K-□599-B




①fs Full Step: 1.4kpps, Half Step: 2.7kpps
②fs Full Step: 1.5kpps, Half Step: 2.9kpps
③fs Full Step: 1.8kpps, Half Step: 3.6kpps
④fs Full Step: 2.1kpps, Half Step: 4.3kpps

### ● A63K-□5913 / A63K-□5913-B




①Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
②Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
④Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

①fs Full Step: 1kpps, Half Step: 2.1kpps
②fs Full Step: 1.1kpps, Half Step: 2.2kpps
③fs Full Step: 1.8kpps, Half Step: 3.6kpps
④fs Full Step: 1.9kpps, Half Step: 3.8kpps

# Frame Size 42mm/60mm/85mm Hollow Shaft Type Motor



## ▣ Features

- Removable coupling connecting Ball-screw, TM-screw directly
- Remove resonance (vibration, noise) without coupling
- Compact design and light weight with high accuracy, speed and torque
- Suitable for small-sized equipment applications
- Cost-effective

Frame size
42mm 60mm 85mm

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

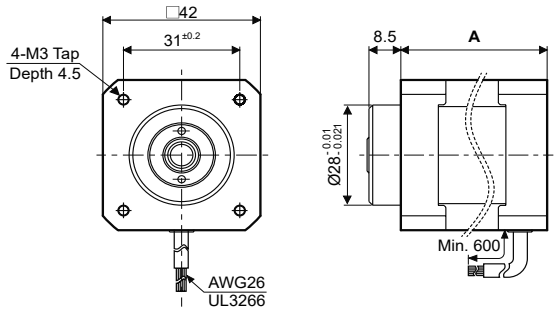
CE

## ▣ Dimensions

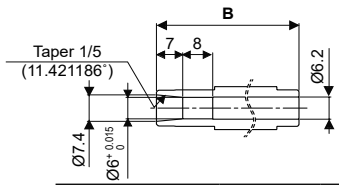
※Depending on processing of shaft to be assembled, hollow shaft type can be used both single and dual shaft.

(unit: mm)

### ◎ Frame size 42mm



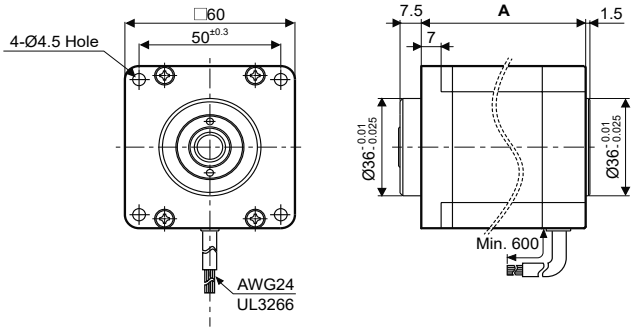

● **Hole dimensions**



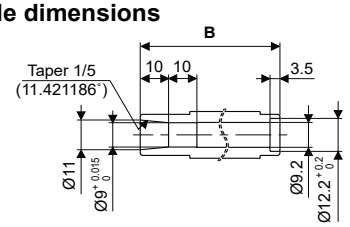

| Model | A | B |
|---|---|---|
| **AH1K-S543-□** | 33 | 38 |
| **AH2K-S544-□** | 39 | 44 |
| **AH3K-S545-□** | 47 | 52 |

### ◎ Frame size 60mm

(unit: mm)



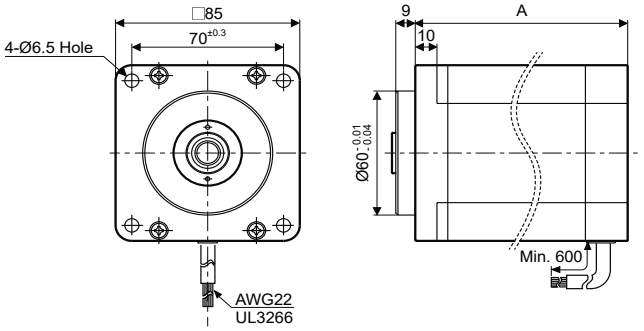

● **Hole dimensions**



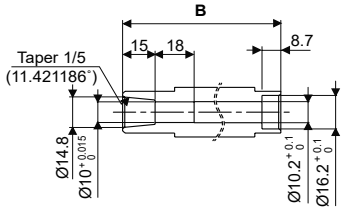

| Model | A | B |
|---|---|---|
| **AH4K-□564(W)-□** | 48.5 | 49.3 |
| **AH8K-□566(W)-□** | 59.5 | 60.3 |
| **AH16K-□569(W)-□** | 89 | 89.8 |

### ◎ Frame size 85mm

(unit: mm)



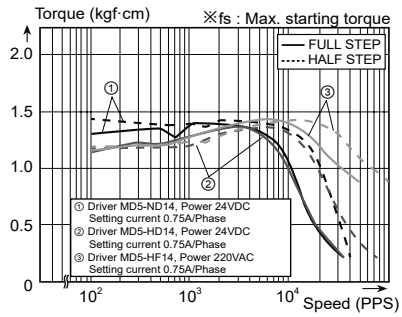

● **Hole dimensions**




| Model | A | B |
|---|---|---|
| **AH21K-□596(W)-□** | 68 | 73 |
| **AH41K-□599(W)-□** | 98 | 102.5 |
| **AH63K-□5913(W)-□** | 128 | 133 |

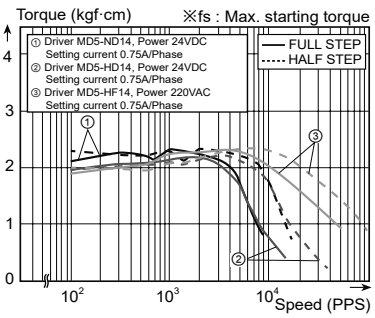
## ▣ Characteristic

### ● AH1K-S543-□



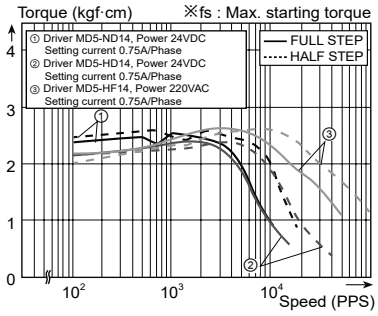

① fs Full Step: 3.3kpps, Half Step: 6.6kpps
② fs Full Step: 3.4kpps, Half Step: 6.7kpps
③ fs Full Step: 3.5kpps, Half Step: 6.8kpps

### ● AH2K-S544-□



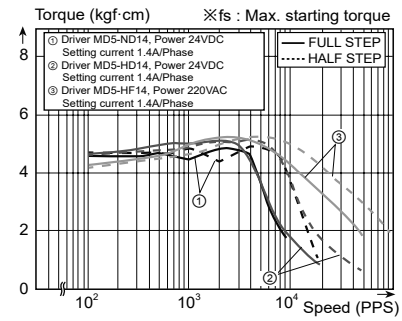

① fs Full Step: 3.2kpps, Half Step: 6.3kpps
② fs Full Step: 3.3kpps, Half Step: 6.5kpps
③ fs Full Step: 3.4kpps, Half Step: 6.7kpps

### ● AH3K-S545-□



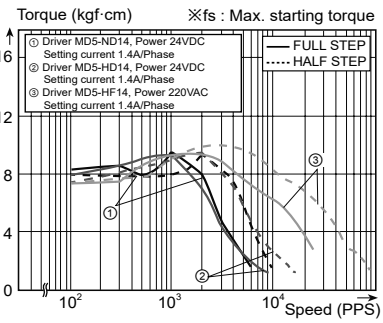

① fs Full Step: 3kpps, Half Step: 5.9kpps
② fs Full Step: 3.1kpps, Half Step: 6.1kpps
③ fs Full Step: 3.2kpps, Half Step: 6.4kpps

### ● AH4K-S(M)□564(W)-□



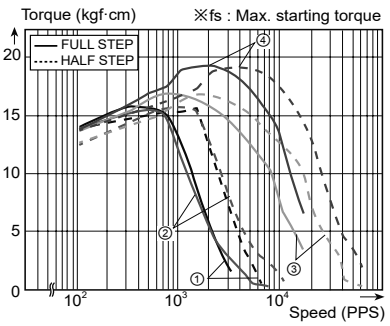

① fs Full Step: 2.7kpps, Half Step: 5.3kpps
② fs Full Step: 2.7kpps, Half Step: 5.8kpps
③ fs Full Step: 3.7kpps, Half Step: 7.2kpps

### ● AH8K-S(M)□566(W)-□




① fs Full Step: 2.1kpps, Half Step: 4.1kpps
② fs Full Step: 2.1kpps, Half Step: 4.2kpps
③ fs Full Step: 3.2kpps, Half Step: 6.3kpps

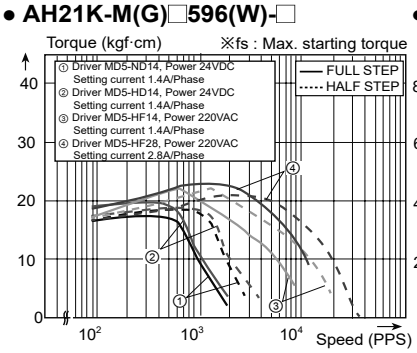
### ● AH16K-M(G)□569(W)-□




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
④ Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

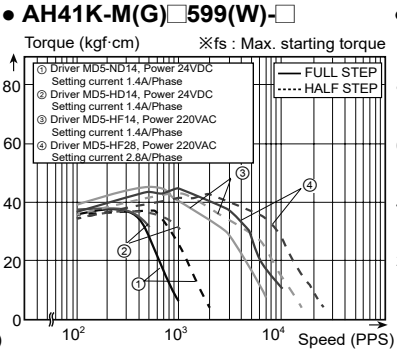
① fs Full Step: 1.8kpps, Half Step: 3.5kpps
② fs Full Step: 1.9kpps, Half Step: 3.5kpps
③ fs Full Step: 2.6kpps, Half Step: 5.2kpps
④ fs Full Step: 3.4kpps, Half Step: 6.8kpps

### ● AH21K-M(G)□596(W)-□



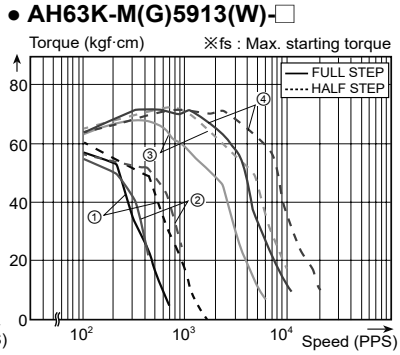

① fs Full Step: 1.5kpps, Half Step: 2.9kpps
② fs Full Step: 1.6kpps, Half Step: 3.1kpps
③ fs Full Step: 2.2kpps, Half Step: 4.4kpps
④ fs Full Step: 2.3kpps, Half Step: 4.6kpps

### ● AH41K-M(G)□599(W)-□




① fs Full Step: 1.4kpps, Half Step: 2.7kpps
② fs Full Step: 1.5kpps, Half Step: 2.9kpps
③ fs Full Step: 1.8kpps, Half Step: 3.6kpps
④ fs Full Step: 2.1kpps, Half Step: 4.3kpps

### ● AH63K-M(G)5913(W)-□




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
④ Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

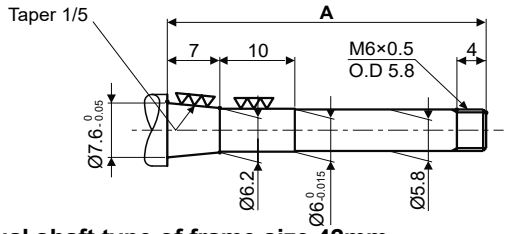
① fs Full Step: 1kpps, Half Step: 2.1kpps
② fs Full Step: 1.1kpps, Half Step: 2.2kpps
③ fs Full Step: 1.8kpps, Half Step: 3.6kpps
④ fs Full Step: 1.9kpps, Half Step: 3.8kpps

## ▣ Processing Example for Shaft Assembly

In order to assemble external shafts into Autonics motors, the shafts must be processed as shown in the figures below.



### ● Single shaft type of frame size 42mm

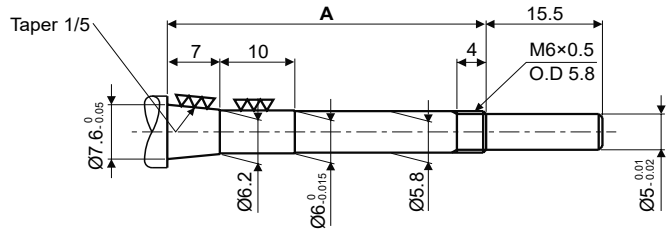



(unit: mm)

| Model | A |
|---|---|
| **AH1K-S543-□** | 42.5 |
| **AH2K-S544-□** | 48.5 |
| **AH3K-S545-□** | 56.5 |

※Lock nut is included.

### ● Dual shaft type of frame size 42mm

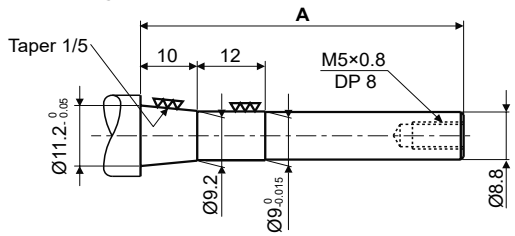



(unit: mm)

| Model | A |
|---|---|
| **AH1K-□543W-□** | 42.5 |
| **AH2K-□544W-□** | 48.5 |
| **AH3K-□545W-□** | 56.5 |

※Lock nut is included.

### ● Single shaft type of frame size 60mm

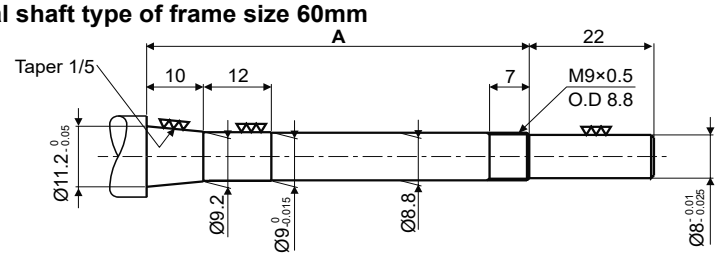



(unit: mm)

| Model | A |
|---|---|
| **AH4K-□564-□** | 46 |
| **AH8K-□566-□** | 57 |
| **AH16K-□569-□** | 86.5 |

※Hexagon wrench bolt, flat washer, spring washer and lock washer are included.

### ● Dual shaft type of frame size 60mm

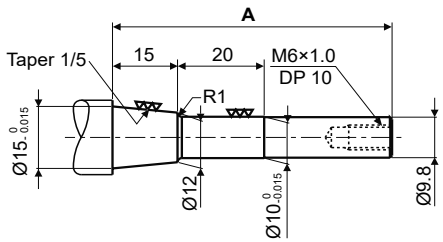



(unit: mm)

| Model | A |
|---|---|
| **AH4K-□564W-□** | 56.5 |
| **AH8K-□566W-□** | 67.5 |
| **AH16K-□569W-□** | 97 |

※Lock nut is included.

### ● Single shaft type of frame size 85mm

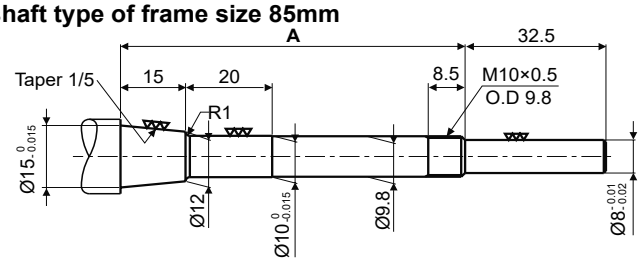



(unit: mm)

| Model | A |
|---|---|
| **AH21K-□596-□** | 64.5 |
| **AH41K-□599-□** | 94 |
| **AH63K-□5913-□** | 124.5 |

※Hexagon wrench bolt, flat washer, spring washer and lock washer are included.

### ● Dual shaft type of frame size 85mm




(unit: mm)

| Model | A |
|---|---|
| **AH21K-□596W-□** | 79.5 |
| **AH41K-□599W-□** | 109.5 |
| **AH63K-□5913W-□** | 139.5 |

※Lock nut is included.

# Frame Size 42mm/60mm/85mm Geared Type /Geared+Built-in Brake Type Motor Frame Size 60mm Rotary Actuator Type /Rotary Actuator+Built-in Brake Type Motor

## ▣ Features

- Compact design and light weight with high accuracy, speed and torque
- Cost-effective
- Backlash
  Frame size 42mm: ±35' (0.58°),
  60mm: ±20' (0.33°), 85mm: ±15' (0.25°)
- Brake force is released when applying 24VDC on brake wire
- Basic step angle
  1:5→ 0.144°, 1:7.2→ 0.1°, 1:10→ 0.072°
- Allowable speed
  1:5→ 0 to 360rpm, 1:7.2→ 0 to 250rpm
  1:10→ 0 to 180rpm

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

Frame size 42mm Geared type

60mm Geared type

85mm Geared type

Frame size 42mm Geared+ Built-in brake type

60mm Geared+ Built-in brake type

85mm Geared+ Built-in brake type

Frame size 60mm Rotary Actuator type

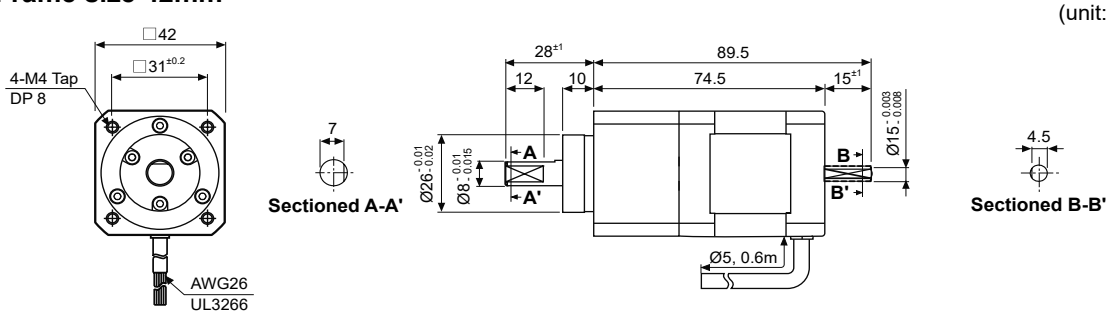
60mm Rotary Actuator+ Built-in brake type

## ▣ Dimensions

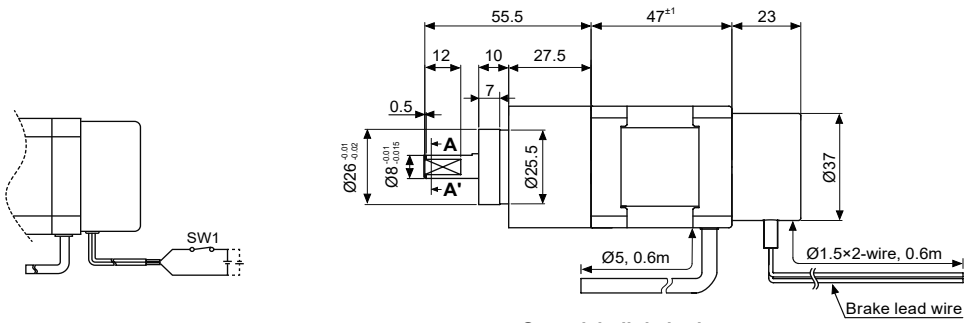
※These dimensions are for dual shaft models. Single shaft models do not include shafts indicated in the dotted lines.
※For flexible coupling (ERB series) information, refer to '**ERB Series**' in '**Rotary encoder**'.
(frame size 60mm, 85mm: geared type, geared+built-in brake type)
※Brake is non-polar and be sure to observe rated excitation voltage (24VDC).
※SW1 ON: brake release / SW1 OFF: brake execute

### ◎ Frame size 42mm

(unit: mm)




**<Geared type>**

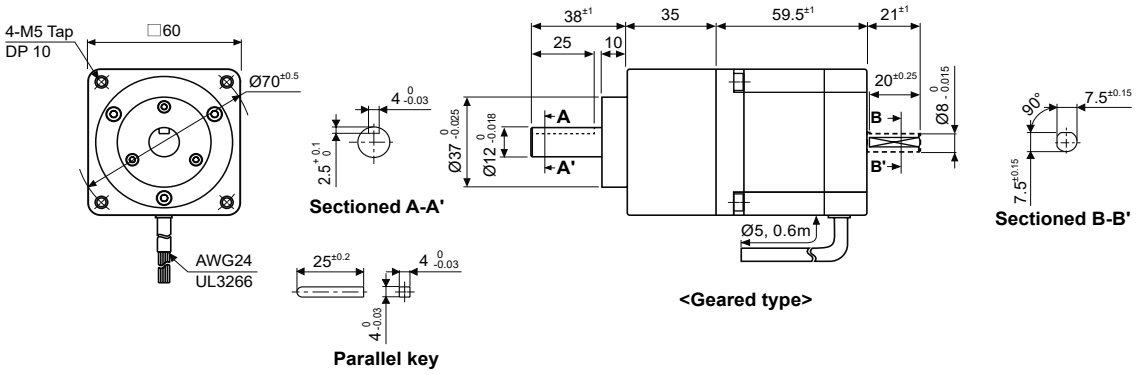


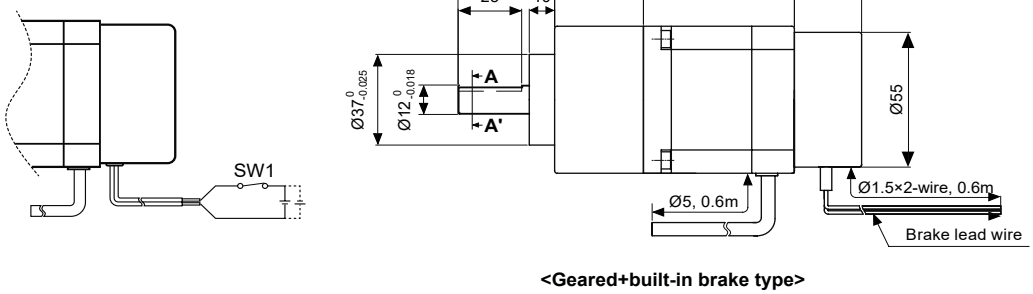

**<Geared+built-in brake type>**

## ▣ Dimensions

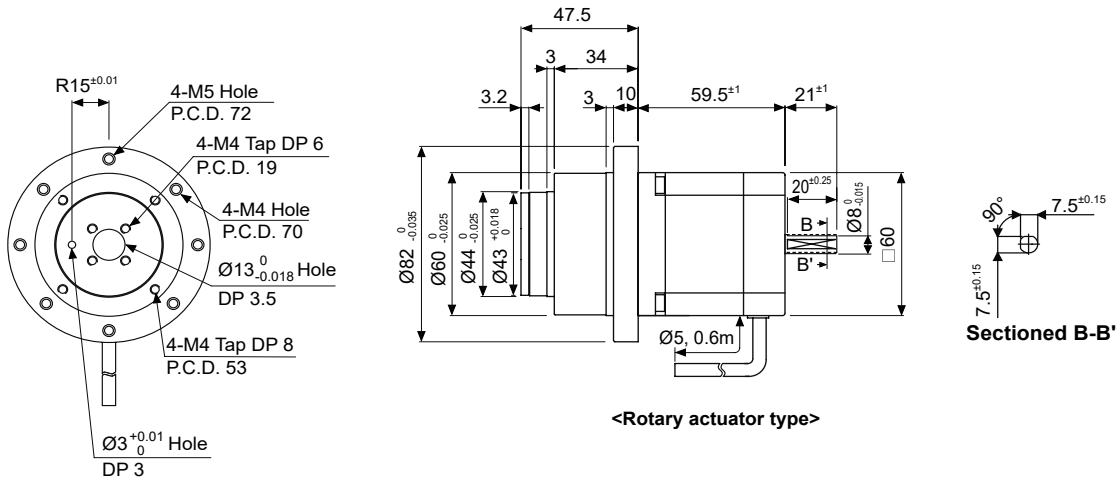
### ◎ Frame size 60mm

(unit: mm)

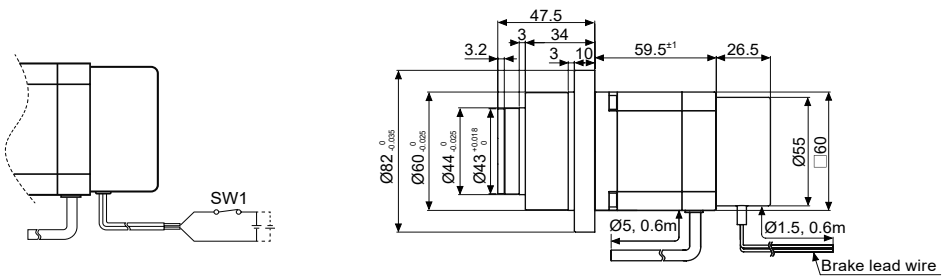



<Geared+built-in brake type>




<Rotary actuator type>

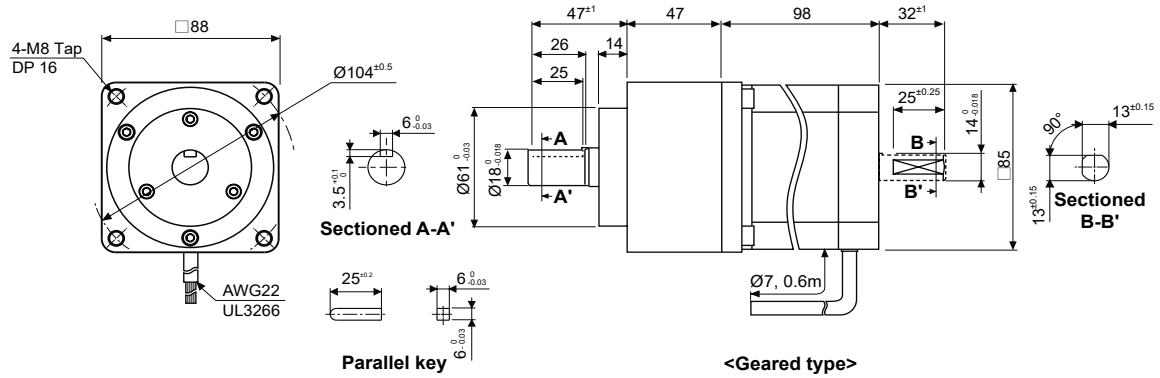


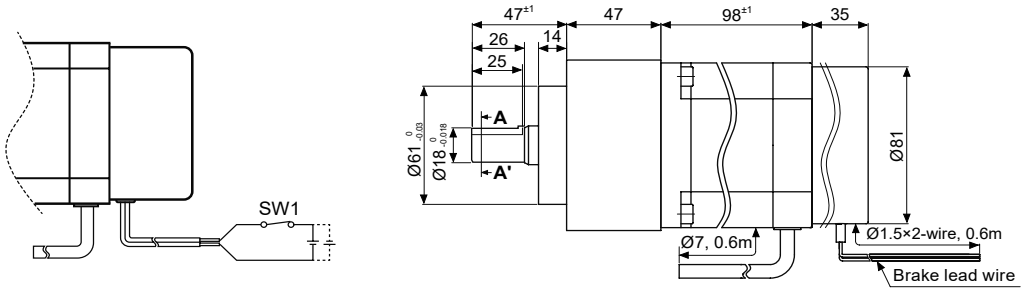

<Rotary actuator+built-in brake type>

## ▣ Dimensions

### ◎ Frame size 85mm

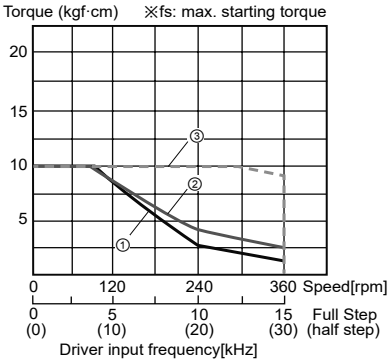
(unit: mm)



## ▣ Characteristic

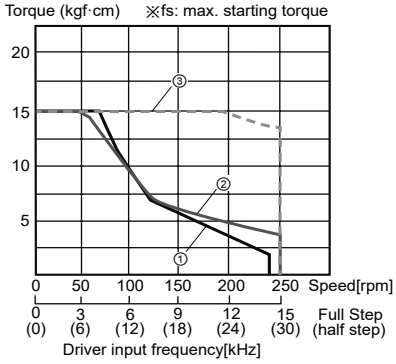
### ● A10K-S545(W)-G5
### A10K-S545-GB5




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 3.1kpps
② fs: 3.2kpps
③ fs: 3.2kpps

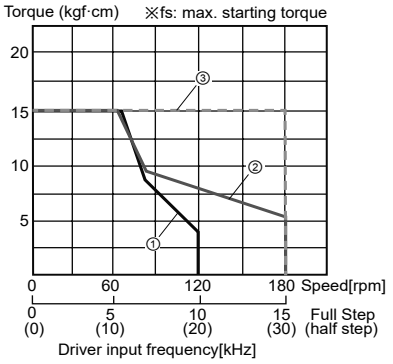
### ● A15K-S545(W)-G7.2
### A15K-S545-GB7.2




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 3.2kpps
② fs: 3.3kpps
③ fs: 3.4kpps

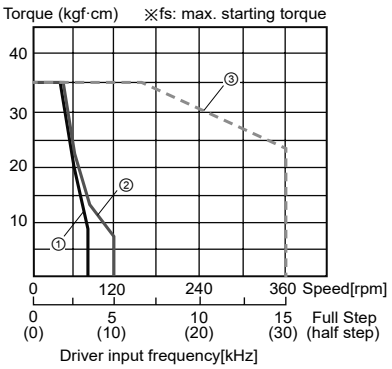
### ● A15K-S545(W)-G10
### A15K-S545-GB10




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 3.3kpps
② fs: 3.3kpps
③ fs: 3.4kpps

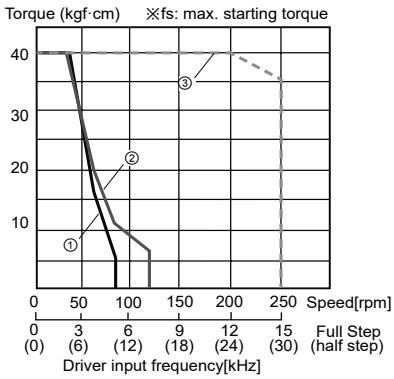
### ● A35K-M566(W)-□5
### A35K-M566-□B5




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 2.3kpps
② fs: 2.3kpps
③ fs: 2.6kpps

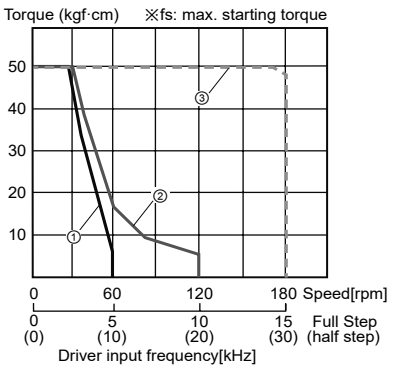
### ● A40K-M566(W)-□7.2
### A40K-M566-□B7.2




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 2.2kpps
② fs: 2.3kpps
③ fs: 2.6kpps

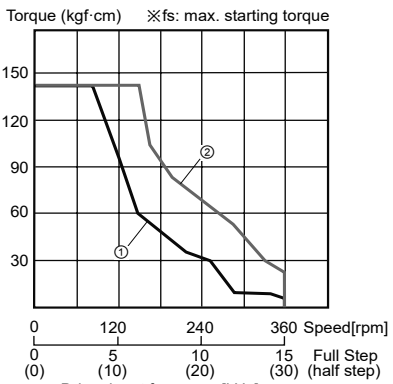
### ● A50K-M566(W)-□10
### A50K-M566-□B10




① Driver MD5-ND14, Power 24VDC, Setting current 1.4A/Phase
② Driver MD5-HD14, Power 24VDC, Setting current 1.4A/Phase
③ Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase

① fs: 2.3kpps
② fs: 2.3kpps
③ fs: 2.8kpps

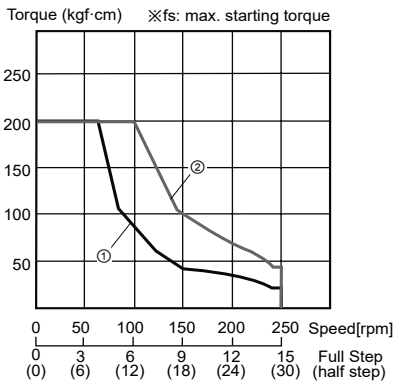
### ● A140K-□599(W)-G5
### A140K-□599-GB5




① Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
② Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

① fs: 1.8kpps
② fs: 2.1kpps

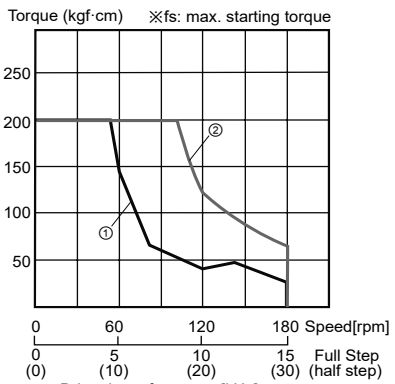
### ● A200K-□599(W)-G7.2
### A200K-□599-GB7.2




① Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
② Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

① fs: 1.8kpps
② fs: 2.1kpps

### ● A200K-□599(W)-G10
### A200K-□599-GB10




① Driver MD5-HF14, Power 220VAC, Setting current 1.4A/Phase
② Driver MD5-HF28, Power 220VAC, Setting current 2.8A/Phase

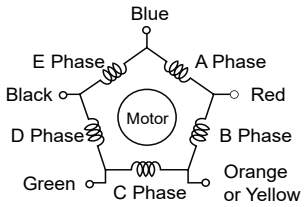
① fs: 1.9kpps
② fs: 2.1kpps

# Installation of Instruction of 5-Phase Stepper Motor

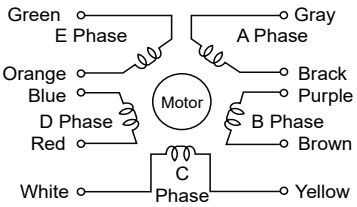
## ▣ Connection Diagram

5-phase stepper motor from Autonics is equipped with pentagon wiring method.
Therefore, 5-phase stepper motor is suitable for a driver with bipolar constant pentagon drive method.
The relations between each phase (coil) in the stepper motor and the color of the Lead-wire are followings.

**● Pentagon wiring (standard)**




**● Standard wiring (option)**




| Lead wire color for standard connection type | Lead wire color for pentagon connection type |
|---|---|
| Gray+Red | Blue |
| Yellow+Black | Red |
| Orange+White | Orange |
| Brown+Green | Green |
| Blue+Purple | Black |

In case of connecting standard connection type models to 5-phase motor drivers, make sure that lead wire of the motor must be connected as specified in the above table.

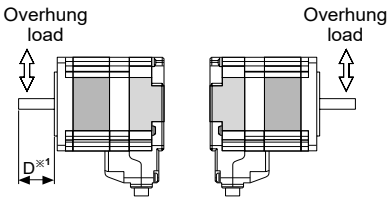
## ▣ Motor Installation

### ◎ Shaft type, hollow shaft type, geared type, geared built-in brake type stepper motor

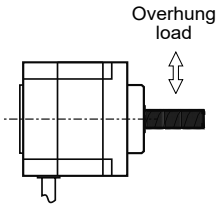
**● Mounting direction**

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.

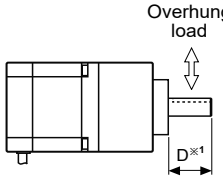
**● Side way**




**< Shaft type >**



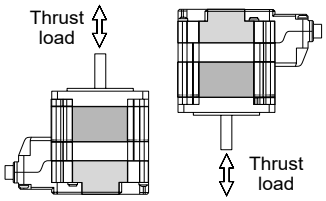

**< Hollow shaft type >**



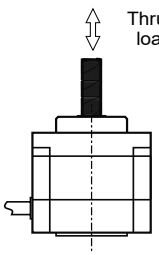

**< Geared, Geared built-in brake type >**

※1: The distance from the shaft tip (mm)

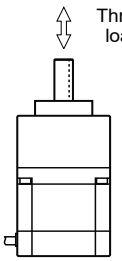
**● Facing up, down**




**< Shaft type >**




**< Hollow shaft type >**




**< Geared, Geared built-in brake type >**

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

| Motor frame size | The distance from the shaft in front (mm), Allowable overhung load [kgf (N)] | | | | | Allowable thrust load [kgf (N)] |
|---|---|---|---|---|---|---|
| | D=0 | D=5 | D=10 | D=15 | D=20 | |
| 24mm | 2(20) | 2.5(25) | 3.4(33) | — | — | Under the load of motor |
| 42mm | 2(20) | 2.5(25) | 3.4(33) | 5.2(51) | — | |
| 60mm | 6.3(62) | 7.5(74) | 9.5(93) | 13(127) | 19(186) | |
| 85mm | 26(255) | 29(284) | 34(333) | 39(382) | 48(470) | |

Refer to the table below for allowable overhung load / thrust load for geared type stepper motor.

| Motor frame size | The distance from the shaft in front (mm), Allowable overhung load [kgf (N)] | | | | | Allowable thrust load [kgf (N)] |
|---|---|---|---|---|---|---|
| | D=0 | D=5 | D=10 | D=15 | D=20 | |
| 42mm | 7.3(72) | 8.4(82) | 10(98) | 12.3(121) | — | 5(49) |
| 60mm | 25(245) | 27(265) | 30(294) | 34(333) | 39(382) | 10(98) |
| 85mm | 48(471) | 54(530) | 60(588) | 68(667) | 79(775) | 30(294) |

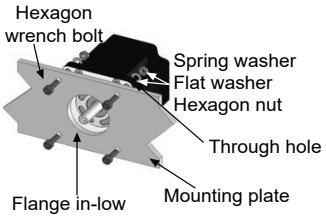
# Installation of Instruction of 5-Phase Stepper Motor



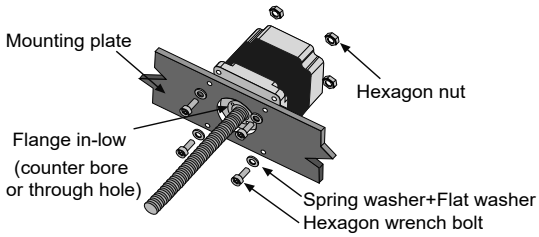
## ● Motor installation method

When installing the motor, carefully consider heat radiation and vibration resistance. Mount the unit tightly on the surface of a metal with high thermal conductivity. (steel, aluminum, etc.) Use hexagon bolts, spring washers and flat washers when installing the motor. Please refer to the table below for mounting plate thickness and bolt types.

### ● Through hole type

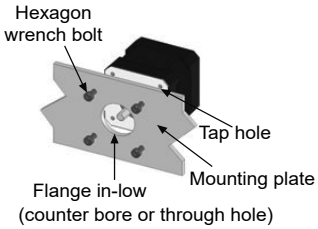



**< Shaft type >**



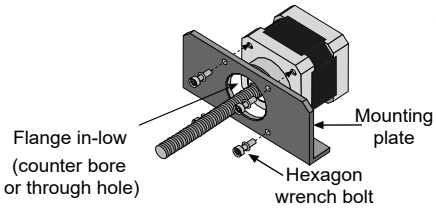

**< Hollow shaft type >**

### ● Tap hole type



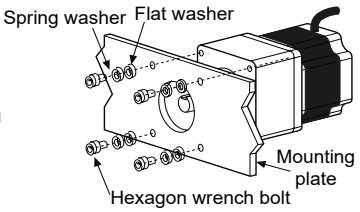

**< Shaft type >**

| Motor frame size | Mounting plate thickness | Applied bolt |
|---|---|---|
| 24mm | Min. 3mm | M2.6 |
| 42mm | Min. 4mm | M3 |
| 60mm | Min. 5mm | M4 |
| 85mm | Min. 8mm | M6 |




**< Hollow shaft type >**

| Motor frame size | Mounting plate thickness | Applied bolt |
|---|---|---|
| 42mm | Min. 4mm | M3 |
| 60mm | Min. 5mm | M4 |
| 85mm | Min. 8mm | M6 |

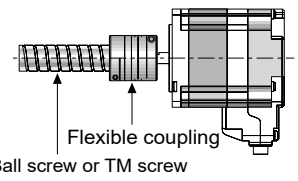
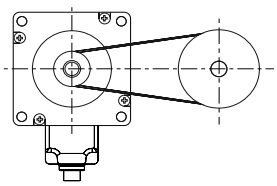
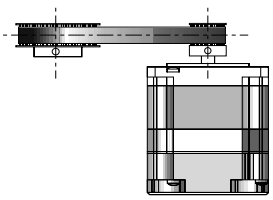



**< Geared, Geared built-in brake type >**

| Motor frame size | Mounting plate thickness | Applied bolt |
|---|---|---|
| 42mm | Min. 5mm | M4 |
| 60mm | Min. 8mm | M5 |
| 85mm | Min. 12mm | M8 |

## ● Connection with load (shaft type, geared type, geared built-in brake type stepper motor)

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 |
|---|---|---|
|  ※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 matched to that of shaft, it may cause severe vibration, shaft damage or shortened 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. |

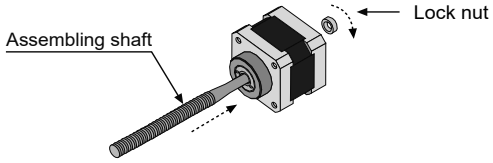
# Installation of Instruction of 5-Phase Stepper Motor

### ● Shaft assembly for hollow shaft type motor

Make sure that external shaft assembly into motors must be made as sturdy as possible. If not, motor's torque might not be thoroughly transmitted to the shaft. In case no additional shaft assembly changes would be made, it is recommended to apply adhesives on bolt fixing part.

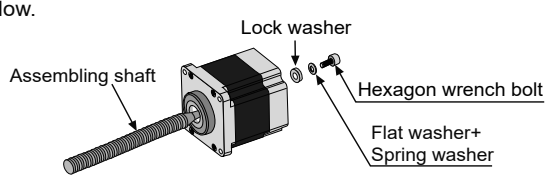
**1. Tap hollow shaft type motor**

Use pliers to fasten lock nut tightly as shown in the figure below.



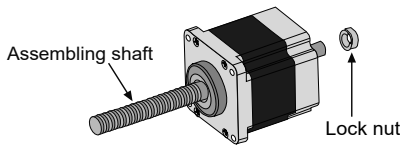

**2. Through hole type motor with single shaft**

Use hexagon wrench bolt, spring washer, flat washer and lock washer to fasten the shaft tightly as shown in the figure below.




**3. Through hole type motor with dual shaft**

Use a lock nut to fasten the shaft tightly as shown in the figure below.



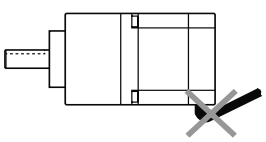

### ● Caution during install the motor

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.

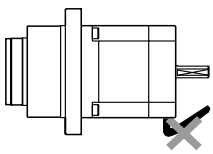
**< Shaft type >**



**< Hollow shaft type >**



**< Geared, Geared built-in brake type >**



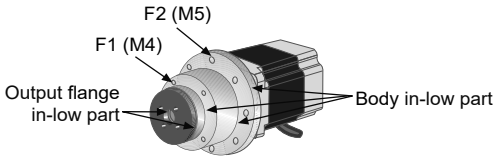
**< Rotary actuator, Rotary actuator built-in brake type >**

## ◎ Rotary actuator type stepper motor

### ● Motor installation method

①With considering heat radiation and vibration isolation, make sure the motor's in-low to be kept as close as possible against a metal panel having high thermal conductivity such as iron or aluminum. Make sure to use mounting plates with thickness more than 8mm.

②As shown in the figure below, total 4 mounting TAP holes on F1 and F2 are used to fix rotary actuator. In case of using M4, screw tightening torque needs to be 2N·m, and in case of M5, 4.4N·m.




③Do not apply excessive force on motor cable when installing rotary actuators. Do not forcibly pull or insert the cable. Do not move the motor cable repeatedly with excessive force, or It may cause poor connection or disconnection of the cable.
In case when frequent cable movement or excessive force is required, proper safety countermeasures must be ensured.

### ● Motor operation

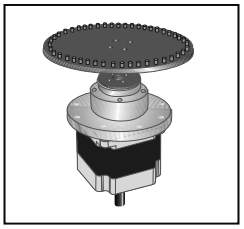
Observe the rated product specification.
① Do not apply rotational load on the motor while it stops.
② Do not apply excessive load on the motor while driving. It may cause motors to miss a step.
③ Use a sensor for home searching or division completed position detecting.

### ● Installation of accessories (index table, arm, etc.)

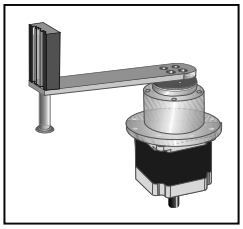
① Mount the accessory (index table or arm) on output axis flange using M4 screw. Note that Ø13 in-low part is processed with C0.3. It is necessary to process the accessory under C0.2 to mount. Place a positioning pin on flange's positioning hole and push it in. Make sure not to place the pin on output flange.
② Do not use a hammer to mount the accessory (table or arm). It may cause product damage. Mount the accessory with hands in a gentle manner.
③ Make sure that accessory mounted on output axis to be fixed as tight as possible. It may cause an accident if an actuator is detached from the motor while driving.

### ● Application example

<Index table>

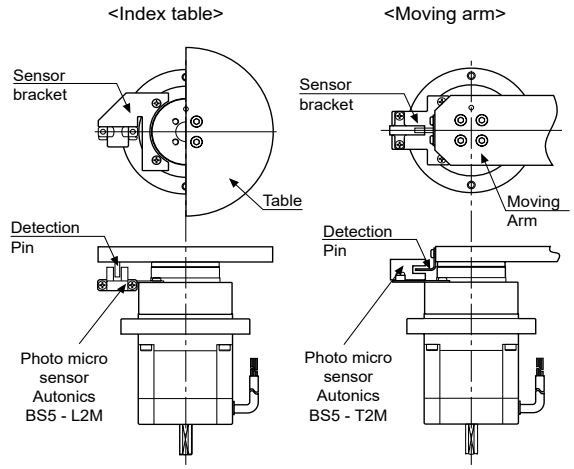


<Moving arm>



# Installation of Instruction of 5-Phase Stepper Motor

● **Sensor attachment**




## ▣ 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 -10 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

## ▣ Cautions during Use

● **Do not disassemble or modify the product.**
It may cause malfunction due to small dregs.
Once disassembling the motor, its performance would significantly decline.

● **Do not impact the motor.**
The air-gap, the distance between rotator and stator is processed as 0.05mm, but if it is impacted, the balance of air-gap can be broken and it may cause a malfunction.

● **Using at low temperature.**
Using motors at low temperature may cause reducing maximum starting / driving characteristics of the motor with rise of the friction torque, because grease consistency of the ball bearing and Gear Head becomes heavy. Since it is not error of the torque, start the motor in a steady manner.

● **Temperature rise**
The surface temperature of motor shall be under 100℃. It can be significantly increased by operation conditions (ambient temperature, drive speed, drive duty ratio, etc). In this case, use the cooling fan to lower the temperature forcedly. Or, it may cause damage on motor power cable by fire, shortening the life cycle of the inner ball-bearing, or malfunction of the unit.

● **Use the motor within the allowable torque range.**
The allowable torque range indicates the maximum value of mechanical strength of gear part and the total of ac/deceleration torque of start/stop and friction torque shall not be exceed the allowable torque range, or it may cause the breakdown of gear.

● **Use the motor within the allowable speed range.**
The allowable speed range includes the revolution number of gear and pulse speed of motor. Use the motor within the allowable speed range, or it may shorten the life cycle of gear part. (backlash is increased.)

● **Be careful of backlash when positioning the motors in both CW/CCW directions.**
Backlash refers to the displacement occurred on motor's output shaft while gear's input axis is fixed.
Geared type stepping motors are to realize high accuracy and low backlash. When positioning the motors in both CW/CCW directions, however, backlash may possibly occur. Therefore, make sure that motor positioning will be made in one single direction in case of geared type motors.

● **Clack sound of electro-magnetic brake**
When operating or releasing electro-magnetic brake, this machine may occur clack sound.
Be assured that it is not the cause of malfunction, and do not hit or disassemble the motor.

● **Using of electro-magnetic brake**
When drive the motor, supply power to electro-magnetic brake for releasing the brake. If not supply power, it may cause abnormal motor operation, and the brake pad of electro-magnetic brake is worn. It may also cause shorten product life cycle, reducing the rated static friction torque.

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# (C) Stepper Motor Drivers


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**5-Phase Stepper Motor Drivers**

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# Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid hazards.
※⚠ 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.

## ■ Stepper Motor Driver

### ⚠ Warning

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, economic loss or fire.
2. **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.
3. **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.
4. **Install the unit after considering counter plan against power failure.**
   Failure to follow this instruction may result in personal injury, economic loss or fire.
5. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
6. **For installing the unit, ground it exclusively and use over AWG 18(0.75mm$^2$) ground cable.**
   **[MD5-HF14, MD5-HF14-AO, MD5-HF28]**
   Failure to follow this instruction may result in electric shock.
7. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire or electric shock.
8. **Insulate the connector not to be exposed. [MD5-HF14, MD5-HF14-AO, MD5-HF28]**
   Failure to follow this instruction may result in electric shock.
9. **Install the driver in the housing or ground it.**
   Failure to follow this instruction may result in personal injury, fire or electronic shock.
10. **For rotating the motor manually when turning off the power, separate the motor and the driver.**
    Failure to follow this instruction may result in malfuction due to power applied to the driver.
11. **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.
12. **Emergency stop directly when error occurs.**
    Failure to follow this instruction may result in personal injury or fire.

### ⚠ Caution

1. **When connecting the power input, use AWG 18(0.75mm$^2$) cable or over.**
2. **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.
3. **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 driver movement.
4. **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.
5. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
6. **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 or electric shock.
7. **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.
8. **Keep the product away from metal chip, dust, and wire residue which flow into the unit.**
   **[Except MD5-HD14-2X, 3X]**
   Failure to follow this instruction may result in fire or product damage.
9. **Keep metal chip, dust, and wire residue from flowing into the unit. [MD5-HD14-2X, 3X]**
   Failure to follow this instruction may result in fire or product damage.
10. **Use the designated motor only.**
    Failure to follow this instruction may result in fire or product damage.

**General precaution**
Indicate general warning, caution or danger.

# 5-Phase Stepper Motor and Driver Specifications

(○: **General specifications**, ◎: **High-speed, High-torque specifications**)

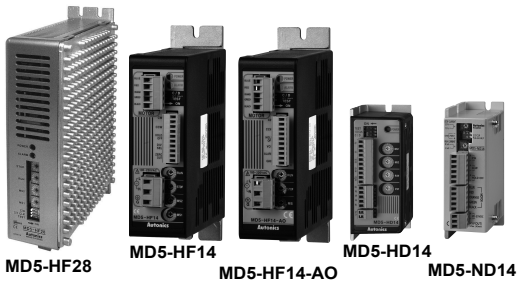
| Motor | | | | | Driver | | |
|---|---|---|---|---|---|---|---|
| Frame size | Type | Model | Torque (kgf·cm) | Rated current (A/Phase) | **MD5-HD14/MD5-ND14/ MD5-HD14-2X(3X)** | **MD5-HF14/ MD5-HF14-AO** | **MD5-HF28** |
| **24mm** | Shaft type | **02K-S523(W)** | 0.18 | 0.75 | ○ | ◎ | — |
| | | **04K-S525(W)** | 0.28 | 0.75 | ○ | ◎ | — |
| **42mm** | Shaft type / Shaft + Built-in brake type | **A1K-S543(W)-B** | 1.3 | 0.75 | ○ | ◎ | — |
| | | **A2K-S544(W)-B** | 1.8 | 0.75 | ○ | ◎ | — |
| | | **A2K-M544(W)** | 1.8 | 1.4 | ○ | ◎ | — |
| | | **A3K-S545(W)-B** | 2.4 | 0.75 | ○ | ◎ | — |
| | Hollow shaft type | **AH1K-S543** | 1.3 | 0.75 | ○ | ◎ | — |
| | | **AH2K-S544** | 1.8 | 0.75 | ○ | ◎ | — |
| | | **AH3K-S545** | 2.4 | 0.75 | ○ | ◎ | — |
| | Geared type/ Geared + Built-in brake type | **A10K-S545(W)-GB5** | 10 | 0.75 | ○ | ◎ | — |
| | | **A15K-S545(W)-GB7.2** | 15 | 0.75 | ○ | ◎ | — |
| | | **A15K-S545(W)-GB10** | 15 | 0.75 | ○ | ◎ | — |
| **60mm** | Shaft type / Shaft + Built-in brake type | **A4K-S564(W)-B** | 4.2 | 0.75 | ○ | ◎ | — |
| | | **A4K-M564(W)-B** | 4.2 | 1.4 | ○ | ◎ | — |
| | | **A4K-G564(W)** | 4.2 | 2.8 | — | — | ◎ |
| | | **A8K-S566(W)-B** | 8.3 | 0.75 | ○ | ◎ | — |
| | | **A8K-M566(W)-B** | 8.3 | 1.4 | ○ | ◎ | — |
| | | **A8K-G566(W)** | 8.3 | 2.8 | — | — | ◎ |
| | | **A16K-M569(W)-B** | 16.6 | 1.4 | ○ | ◎ | — |
| | | **A16K-G569(W)-B** | 16.6 | 2.8 | — | — | ◎ |
| | Hollow shaft type | **AH4K-S564(W)** | 4.2 | 0.75 | ○ | ◎ | — |
| | | **AH4K-M564(W)** | 4.2 | 1.4 | ○ | ◎ | — |
| | | **AH8K-S566(W)** | 8.3 | 0.75 | ○ | ◎ | — |
| | | **AH8K-M566(W)** | 8.3 | 1.4 | ○ | ◎ | — |
| | | **AH16K-M569(W)** | 16.6 | 1.4 | ○ | ◎ | — |
| | | **AH16K-G569(W)** | 16.6 | 2.8 | — | — | ◎ |
| | Geared type/ Geared + Built-in brake type | **A35K-M566(W)-GB5** | 35 | 1.4 | ○ | ◎ | — |
| | | **A40K-M566(W)-GB7.2** | 40 | 1.4 | ○ | ◎ | — |
| | | **A50K-M566(W)-GB10** | 50 | 1.4 | ○ | ◎ | — |
| | Rotary actuator type/ Rotary actuator + Built-in brake type | **A35K-M566(W)-RB5** | 35 | 1.4 | ○ | ◎ | — |
| | | **A40K-M566(W)-RB7.2** | 40 | 1.4 | ○ | ◎ | — |
| | | **A50K-M566(W)-RB10** | 50 | 1.4 | ○ | ◎ | — |
| **85mm** | Shaft type / Shaft + Built-in brake type | **A21K-M596(W)-B** | 21 | 1.4 | ○ | ◎ | — |
| | | **A21K-G596(W)-B** | 21 | 2.8 | — | — | ◎ |
| | | **A41K-M599(W)-B** | 41 | 1.4 | ○ | ◎ | — |
| | | **A41K-G599(W)-B** | 41 | 2.8 | — | — | ◎ |
| | | **A63K-M5913(W)-B** | 63 | 1.4 | ○ | ◎ | — |
| | | **A63K-G5913(W)-B** | 63 | 2.8 | — | — | ◎ |
| | Hollow shaft type | **AH21K-M596(W)** | 21 | 1.4 | ○ | ◎ | — |
| | | **AH21K-G596(W)** | 21 | 2.8 | — | — | ◎ |
| | | **AH41K-M599(W)** | 41 | 1.4 | ○ | ◎ | — |
| | | **AH41K-G599(W)** | 41 | 2.8 | — | — | ◎ |
| | | **AH63K-M5913(W)** | 63 | 1.4 | ○ | ◎ | — |
| | | **AH63K-G5913(W)** | 63 | 2.8 | — | — | ◎ |
| | Geared type/ Geared + Built-in brake type | **A140K-M599(W)-GB5** | 140 | 1.4 | ○ | ◎ | — |
| | | **A140K-G599(W)-GB5** | 140 | 2.8 | — | — | ◎ |
| | | **A200K-M599(W)-GB7.2** | 200 | 1.4 | ○ | ◎ | — |
| | | **A200K-G599(W)-GB7.2** | 200 | 2.8 | — | — | ◎ |
| | | **A200K-M599(W)-GB10** | 200 | 1.4 | ○ | ◎ | — |
| | | **A200K-G599(W)-GB10** | 200 | 2.8 | — | — | ◎ |

※**(W)** stands for dual shaft of motor. (The built-in brake type provides single shaft type only.)
※The motor torque has a big difference in torque by the characteristics of the driver.
Please refer to the graph in this catalogue that shows the characteristics of motors and drivers.
For MD5-HD14, MD5-HD14-2X(3X), MD5-ND14, the high-speed region torque characteristics are better at 35VDC than at 20VDC.
In addition, MD5-HF14 and MD5-HF28 have further improved torque characteristics in the high-speed area than using DC type driver.

# Small, Light, High Speed & Torque 5-Phase Stepper Motor Driver

## ▣ Features

- Bipolar constant pentagon drive method
- Includes auto current down and self-diagnosis function
- Low speed rotation and high accuracy controlling with microstep-driving (MD5-HD14, MD5-HF14, MD5-HF14-AO, MD5-HF28)
  [Max. resolution 250 division: In case of 5-phase stepper motor of which basic step angle is 0.72°, it enables to control up to 0.00288° per pulse and it requires 125,000 pulses per rotation.]
- Photocoupler input insulation method to minimize the effects from external noise




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

(only for MD5-HF14(-AO), MD5-HF28 model)

## ▣ Ordering Information

**MD 5 – H F 14 – □**

| | | |
|---|---|---|
| Output | No mark | Zero point excitation output※1 |
| | AO | Alarm output |
| RUN current | 14 | 1.4A/Phase |
| | 28 | 2.8A/Phase |
| Power supply | D | 20-35VDC |
| | F | 100-220VAC |
| Step type (resolution) | H | Micro step (250-division) |
| | N | Normal Step |
| Motor phase | 5 | 5-phase |
| Item | MD | Motor Driver |

※1: Except MD5-ND14

**※KR-55MC can be replaced with MD5-HD14.**
**※KR-5MC can be replaced with MD5-ND14.**
**※MD5-MF14 can be replaced with MD5-HF14.**
**※KR-505G can be replaced with MD5-HF28.**

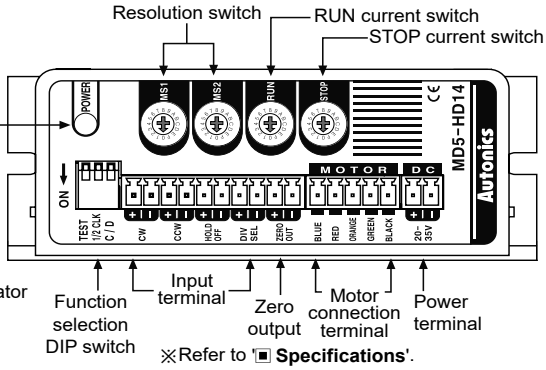
## ▣ Specifications

| Model | | MD5-HD14 | MD5-HF14 | MD5-HF14-AO | MD5-HF28 | MD5-ND14 |
|---|---|---|---|---|---|---|
| Power supply | | 20-35VDC⎓ ※1 | 100-220VAC～ 50/60Hz | | | 20-35VDC⎓ ※1 |
| Allowable voltage range | | 90 to 110% of the rated voltage | | | | |
| Max. current consumption※2 | | 3A | | | 5A | 3A |
| RUN current※3 | | 0.4-1.4A/Phase | | | 1.0-2.8A/Phase | 0.5-1.5A/Phase |
| STOP current | | 27 to 90% of RUN current (set by STOP current switch) | | | | 25 to 75% of RUN current (set by STOP current volume) |
| Drive method | | Bipolar constant current pentagon drive | | | | |
| Basic step angle | | 0.72°/step | | | | |
| Resolution | | 1, 2, 4, 5, 8, 10, 16, 20, 25, 40, 50, 80, 100, 125, 200, 250-division (0.72° to 0.00288°/Step) | | | | 1, 2-division (0.72°, 0.36°/step) |
| Input pulse characteristic | Pulse width | Min. 1μs (CW, CCW), Min. 1ms (HOLD OFF) | | | | Min. 10μs (CW, CCW), Min. 1ms (HOLD OFF) |
| | Duty rate | 50% (CW, CCW) | | | | |
| | Rising/Falling time | Below 130ns (CW, CCW) | | | | |
| | Pulse input voltage | [H]: 4-8VDC⎓, [L]: 0-0.5VDC | | | | |
| | Pulse input current | 7.5-14mA (CW, CCW), 10-16mA (HOLD OFF, DIVISION SELECTION, ZERO OUT)※4 | | | | |
| | Max. input pulse frequency※5 | Max. 500kHz (CW, CCW) | | | | Max. 50kHz (CW, CCW) |
| Input resistance | | 270Ω (CW, CCW), 390Ω (HOLD OFF, DIVISION SELECTION), 10Ω (ZERO OUT) | | 270Ω (CW, CCW), 390Ω (HOLD OFF), 10Ω (ALARM) | 270Ω (CW, CCW), 390Ω (HOLD OFF, DIVISION SELECTION), 10Ω (ZERO OUT) | 390Ω (CW, CCW, HOLD OFF) |
| Insulation resistance | | Over 100MΩ (at 500VDC megger, between all terminals and case) | | | | |
| Dielectric strength | | 1000VAC 50/60Hz for 1min (between all terminals and case) | | | | |
| Noise immunity | | ±500V the square wave noise (pulse width: 1μs) by the noise simulator | ±2kV the square wave noise (pulse width: 1μs) by the noise simulator | | | ±500V the square wave noise (pulse width: 1μs) by the noise simulator |
| Vibration | Mechanical | 1.5mm amplitude at frequency 5 to 60Hz (for 1 min) in each X, Y, Z direction for 2 hours | | | | |
| | Malfunction | 1.5mm amplitude at frequency 5 to 60Hz (for 1 min) in each X, Y, Z direction for 10 min | | | | |
| Environment | Ambient temp. | 0 to 40℃, storage: -10 to 60℃ | 0 to 50℃, storage: -10 to 60℃ | | | 0 to 40℃, storage: -10 to 60℃ |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | | | | |
| Approval | | CE | CE cULus | CE cULus | CE cULus | CE |
| Weight※6 | | Approx. 327.5g (approx. 220g) | Approx. 840g (approx. 680g) | Approx. 820g (approx. 660g) | Approx. 1.35kg (approx. 1.2kg) | Approx. 183g (approx. 130g) |

※1: When using over 30VDC power supply, torque characteristics are improved but the driver temperature raise. The unit should be installed at the well ventilation environment.
※2: Based on ambient temperature 25℃, ambient humidity 55%RH.
※3: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also varies depending on the load.
※4: In case of MD5-HF14-AO, MD5-ND14, there are no DIVISION SELECTION, ZERO OUT function.
※5: Max. input pulse frequency is max. frequency to be input and is not same as max. pull-out frequency or max. slewing frequency.
※6: The weight includes packaging. The weight in parenthesis is for unit only. ※Environment resistance is rated at no freezing or condensation.

# 5-Phase Micro Stepper Motor Driver [MD5-HD14]

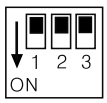
## ▣ Unit Description




※Refer to '▣ **Specifications**'.

## ▣ Functions

### ◎ Function selection DIP switch




| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | TEST | Self diagnosis function | 30rpm rotation | Not use |
| 2 | 1/2 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 3 | C/D | Auto current down | Not use | Use |

#### ● TEST

- Self diagnosis function is for motor and driver test.
- This function makes the motor rotate with 30rpm in full step. Rotation speed varies with resolution settings.
- Rotation speed = 30rpm/resolution
- In 1-pulse input method, it rotates to CCW, and in 2-pulse input method, it rotates to CW.

※Be sure that the TEST switch is OFF before supplying the power.
If the TEST switch is ON, the motor operates immediately and it may be dangerous.

#### ● 1/2 CLK

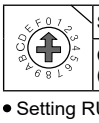
- 1/2 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

#### ● C/D (auto current down)

- This function is to reduce the current provided for motor automatically for preventing severe motor's heat when motor stops.
- If motor RUN pulse is not applied, the current provided for motor reduces as the set STOP current.

※Be sure that when motor RUN current is reduced, the stop torque of motor also reduced.
※Set the STOP current by the STOP current switch.

### ◎ Setting RUN current

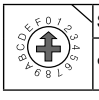



| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current (A/Phase) | 0.4 | 0.5 | 0.57 | 0.63 | 0.71 | 0.77 | 0.84 | 0.9 | 0.96 | 1.02 | 1.09 | 1.15 | 1.22 | 1.27 | 1.33 | 1.4 |

- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

### ◎ Setting STOP current

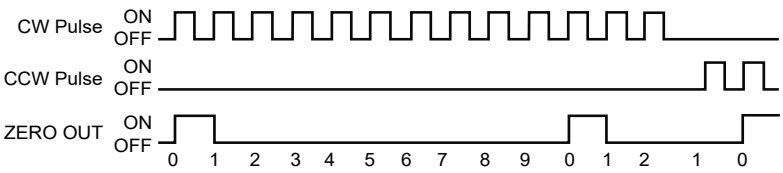



| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 90 |

- Setting STOP current is for the current provided for motor when the motor stops for preventing severe motor's heat.
- This setting is applied when using C/D (current down) function.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.
  E.g.) Set RUN current as 1.4A and STOP current as 40%.
  STOP current is set as 1.4A×0.4=0.56A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

### ◎ Zero point excitation output signal (ZERO OUT)




- This output indicates the initial step of excitation order of stepper motor and rotation position of motor axis.
- This signal outputs every 7.2° of rotation of the motor axis regardless of resolution.
  (50 outputs per 1 rotation of the motor.)
  E.g.) Full step: outputs one time by 10 pulses input, 20-division: outputs one time by 200 pulses input.

### ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

### ◎ Setting Microstep (microstep: resolution)

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resolution | 1 | 2 | 4 | 5 | 8 | 10 | 16 | 20 | 25 | 40 | 50 | 80 | 100 | 125 | 200 | 250 |
| Step angle | 0.72° | 0.36° | 0.18° | 0.144° | 0.09° | 0.072° | 0.045° | 0.036° | 0.0288° | 0.018° | 0.0144° | 0.009° | 0.0072° | 0.00576° | 0.0036° | 0.00288° |

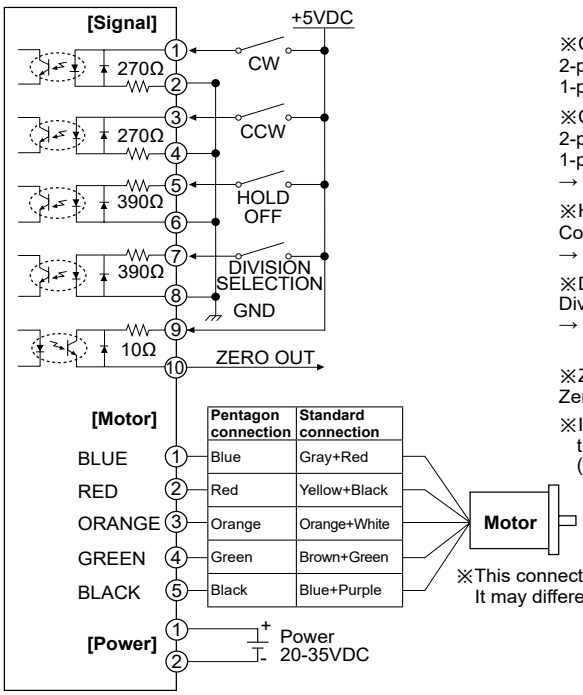
- **Setting Resolution (same as MS1, MS2)**
- The MS1, MS2 switches is for resolution setting.
- Select MS2 or MS2 by DIVISION SELECTION signal ([L]: MS1, [H]: MS2)
- Select the step angle (motor rotation angle per 1 pulse).
- The set step angle is dividing basic step angle (0.72°) of 5-phase stepper motor by setting value.
- The calculation formula of divided step angle is as below.

$$\text{Set step angle} = \frac{\text{Basic step angle (0.72°)}}{\text{Resolution}}$$

- When using geared type motor, the angle is step angle divided by gear ratio.
  Step angle / gear ratio = Step angle applied gear
  E.g) 0.72° / 10 (1:10) = 0.072°

※Must stop the motor before changing the resolution.

## ▣ I/O Circuit and Connections




※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)

※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→ [H]: CW, [L]: CCW

※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF

※DIVISION SELECTION
Division selection signal
→ [L]: Operated by MS1 setting resolution
[H]: Operated by MS2 setting resolution

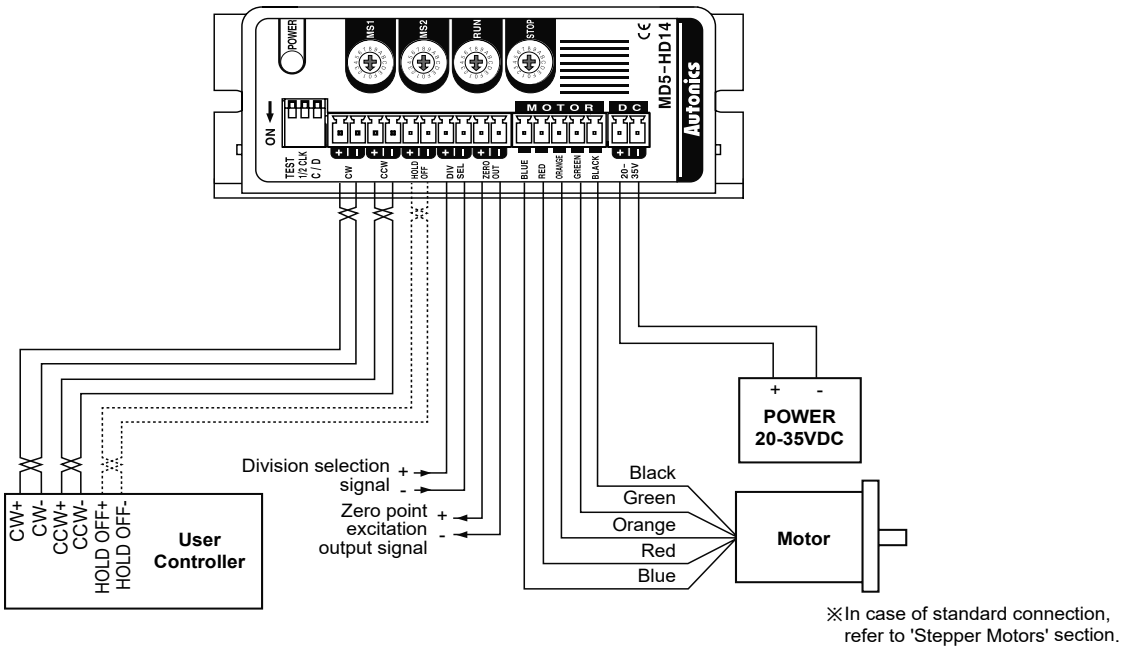
※ZERO OUT
Zero point excitation output signal → Zero point status ON

※If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside. (input power max. 24VDC, input current 10-20mA)

※This connection cable color is only for Autonics motors.
It may different cable color when using other motors.

# 5-Phase Stepper Motor Driver (1.4A/Phase, DC Power)

## ▣ Connections

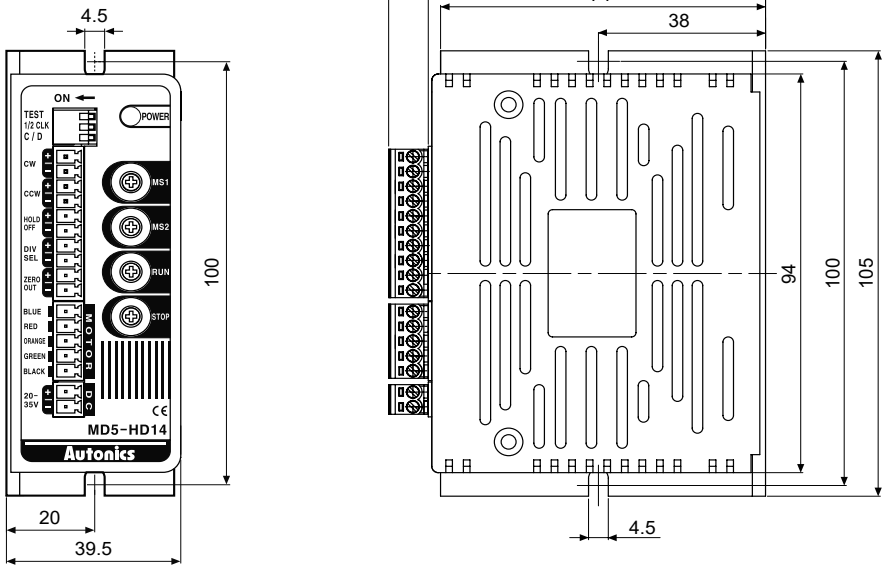



※In case of standard connection, refer to 'Stepper Motors' section.



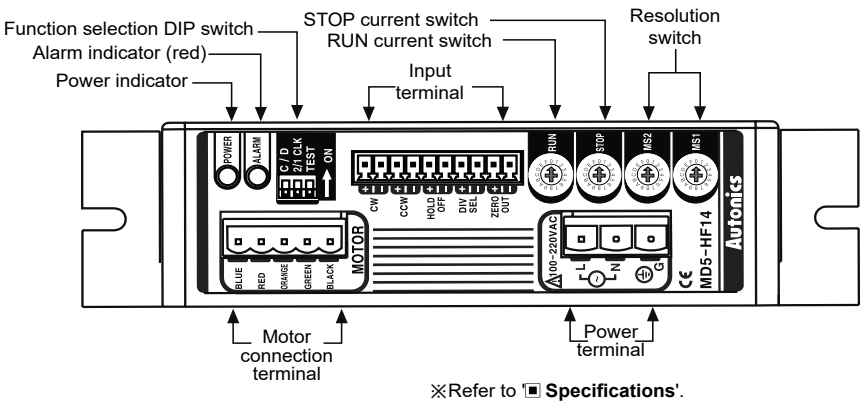
## ▣ Dimensions

(unit: mm)



# 5-Phase Micro Stepper Motor Driver [MD5-HF14]

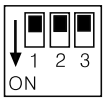
## ▣ Unit Description




※Refer to '▣ **Specifications**'.

## ▣ Functions

### ◎ Function selection DIP switch




| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | TEST | Self diagnosis function | 30rpm rotation | Not use |
| 2 | 2/1 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 3 | C/D | Auto current down | Not use | Use |

**● TEST**

- Self diagnosis function is for motor and driver test.
- This function makes the motor rotate with 30rpm in full step. Rotation speed varies with resolution settings.
- Rotation speed = 30rpm/resolution
- In 1-pulse input method, it rotates to CCW, and in 2-pulse input method, it rotates to CW.

※Be sure that the TEST switch is OFF before supplying the power.
If the TEST switch is ON, the motor operates immediately and it may be dangerous.

**● 2/1 CLK**

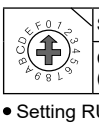
- 2/1 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

**● C/D (auto current down)**

- This function is to reduce the current provided for motor automatically for preventing severe motor's heat when motor stops.
- If motor RUN pulse is not applied, the current provided for motor reduces as the set STOP current.

※Be sure that when motor RUN current is reduced, the stop torque of motor also reduced.
※Set the STOP current by the STOP current switch.

### ◎ Setting RUN current

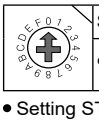


| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current (A/Phase) | 0.4 | 0.5 | 0.57 | 0.63 | 0.71 | 0.77 | 0.84 | 0.9 | 0.96 | 1.02 | 1.09 | 1.15 | 1.22 | 1.27 | 1.33 | 1.4 |

- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

### ◎ Setting STOP current

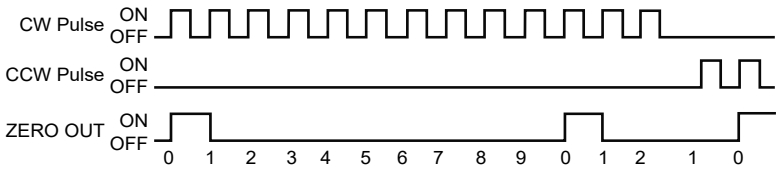


| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 90 |

- Setting STOP current is for the current provided for motor when the motor stops for preventing severe motor's heat.
- This setting is applied when using C/D (current down) function.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.
  E.g.) Set RUN current as 1.4A and STOP current as 40%.
  STOP current is set as 1.4A×0.4=0.56A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

## ◎ Zero point excitation output signal (ZERO OUT)




- This output indicates the initial step of excitation order of stepper motor and rotation position of motor axis .
- This signal outputs every 7.2° of rotation of the motor axis regardless of resolution.
  (50 outputs per 1 rotation of the motor.)
  E.g.) Full step: outputs one time by 10 pulses input, 20-division: outputs one time by 200 pulses input.

## ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

## ◎ Setting Microstep (microstep: resolution)

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resolution | 1 | 2 | 4 | 5 | 8 | 10 | 16 | 20 | 25 | 40 | 50 | 80 | 100 | 125 | 200 | 250 |
| Step angle | 0.72° | 0.36° | 0.18° | 0.144° | 0.09° | 0.072° | 0.045° | 0.036° | 0.0288° | 0.018° | 0.0144° | 0.009° | 0.0072° | 0.00576° | 0.0036° | 0.00288° |

- **Setting Resolution (same as MS1, MS2)**
- The MS1, MS2 switches is for resolution setting.
- Select MS2 or MS2 by DIVISION SELECTION signal ([L]: MS1, [H]: MS2)
- Select the step angle (motor rotation angle per 1 pulse).
- The set step angle is dividing basic step angle (0.72°) of 5-phase stepper motor by setting value.
- The calculation formula of divided step angle is as follow.

$$\text{Set step angle} = \frac{\text{Basic step angle (0.72°)}}{\text{Resolution}}$$

- When using geared type motor, the angle is step angle divided by gear ratio.
  Step angle / gear ratio = Step angle applied gear
  E.g) 0.72° / 10 (1:10) = 0.072°

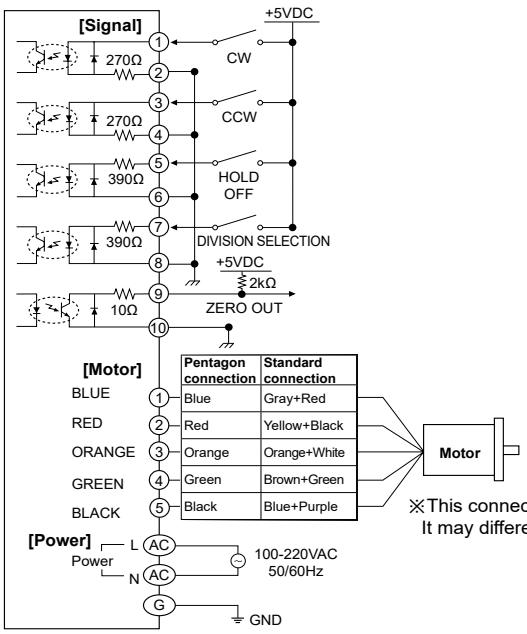
※Must stop the motor before changing the resolution.

## ◎ Alarm indication

- Overheat: When the temperature of driver base is over 80℃, the alarm indicator (red) turns ON and motor stops with holding the excision.
- Overcurrent: When overcurrent occurs due to motor damage by burn, driver damage, or error, the alarm indicator (red) turns ON and the motor becomes HOLD OFF.

※Turn OFF the power and remove the causes of alarm. Re-supply the power and the alarm indicator turns OFF and the driver is normal operation.

## ▣ I/O Circuit and Connections

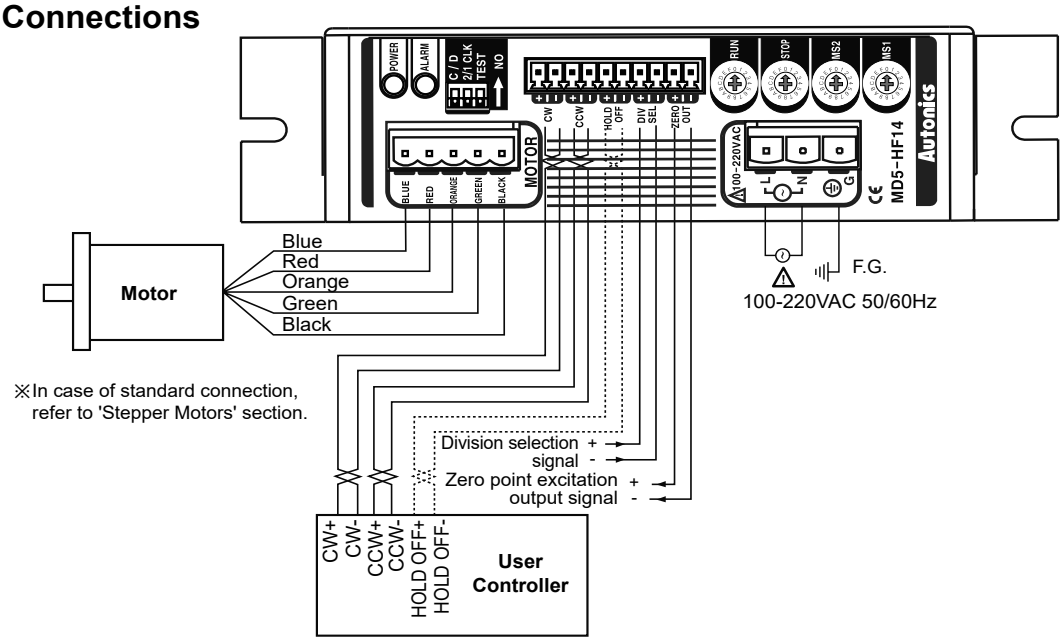



※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)
※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→ [H]: CW, [L]: CCW
※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF
※DIVISION SELECTION
Division selection signal
→ [L]: Operated by switch MS1
[H]: Operated by switch MS2
※ZERO OUT
Zero point excitation output signal → Zero point status ON

※If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside. (input power max. 24VDC, input current 10-20mA)

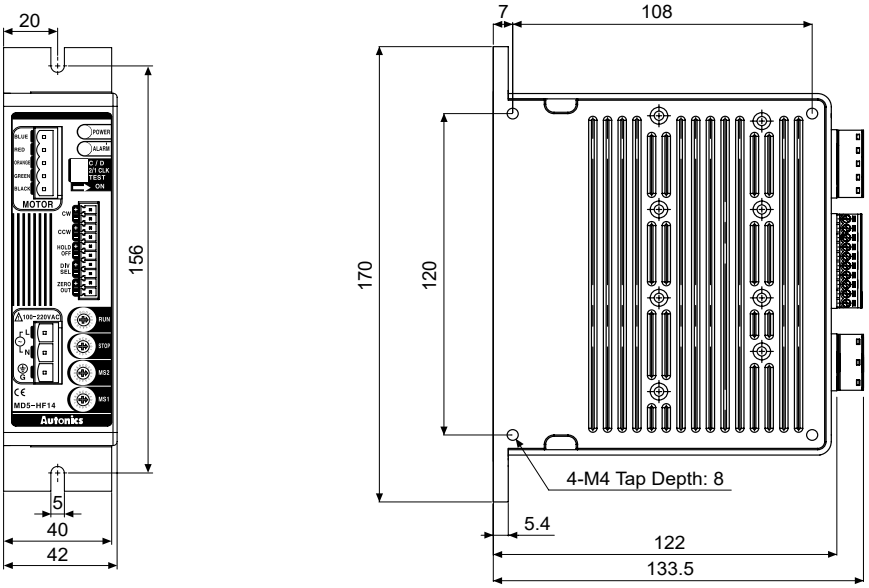
※This connection cable color is only for Autonics motors. It may different cable color when using other motors.

## ▣ Connections



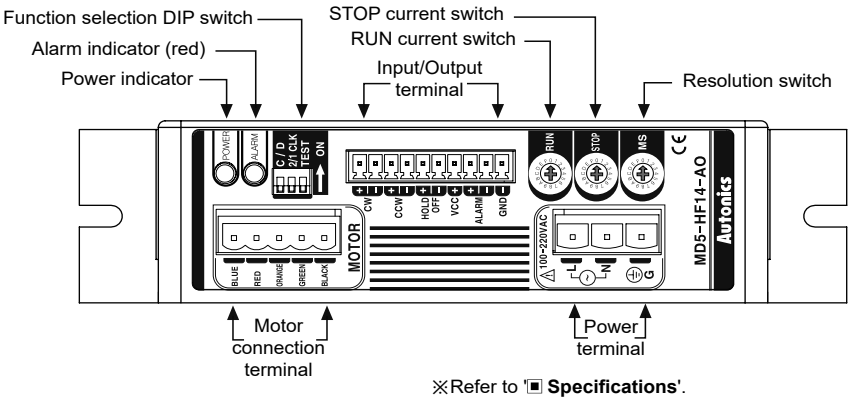

## ▣ Dimensions

(unit: mm)



# 5-Phase Micro Stepper Motor Driver [MD5-HF14-AO]

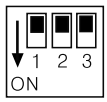
## ▣ Unit Description




※Refer to '▣ **Specifications**'.

## ▣ Functions

### ◎ Function selection DIP switch




| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | TEST | Self diagnosis function | 30rpm rotation | Not use |
| 2 | 2/1 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 3 | C/D | Auto current down | Not use | Use |

#### ● TEST

- Self diagnosis function is for motor and driver test.
- This function makes the motor rotate with 30rpm in full step. Rotation speed varies with resolution settings.
- Rotation speed = 30rpm/resolution
- In 1-pulse input method, it rotates to CCW, and in 2-pulse input method, it rotates to CW.

※Be sure that the TEST switch is OFF before supplying the power.
If the TEST switch is ON, the motor operates immediately and it may be dangerous.

#### ● 2/1 CLK

- 2/1 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

#### ● C/D (auto current down)

- This function is to reduce the current provided for motor automatically for preventing severe motor's heat when motor stops.
- If motor RUN pulse is not applied, the current provided for motor reduces as the set STOP current.

※Be sure that when motor RUN current is reduced, the stop torque of motor also reduced.
※Set the STOP current by the STOP current switch.

### ◎ Setting RUN current

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current (A/Phase) | 0.4 | 0.5 | 0.57 | 0.63 | 0.71 | 0.77 | 0.84 | 0.9 | 0.96 | 1.02 | 1.09 | 1.15 | 1.22 | 1.27 | 1.33 | 1.4 |

- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

### ◎ Setting STOP current

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 90 |

- Setting STOP current is for the current provided for motor when the motor stops for preventing severe motor's heat.
- This setting is applied when using C/D (current down) function.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.
  E.g.) Set RUN current as 1.4A and STOP current as 40%.
  STOP current is set as 1.4A×0.4=0.56A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

## ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

## ◎ Setting Microstep (microstep: resolution)

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resolution | 1 | 2 | 4 | 5 | 8 | 10 | 16 | 20 | 25 | 40 | 50 | 80 | 100 | 125 | 200 | 250 |
| Step angle | 0.72° | 0.36° | 0.18° | 0.144° | 0.09° | 0.072° | 0.045° | 0.036° | 0.0288° | 0.018° | 0.0144° | 0.009° | 0.0072° | 0.00576° | 0.0036° | 0.00288° |

### ● Setting Resolution (MS1)

- The set step angle is dividing basic step angle (0.72°) of 5-phase stepper motor by setting value.
- The calculation formula of divided step angle is as below.

$$\text{Set step angle} = \frac{\text{Basic step angle (0.72°)}}{\text{Resolution}}$$

- When using geared type motor, the angle is step angle divided by gear ratio.
  Step angle / gear ratio = Step angle applied gear
  E.g) 0.72° / 10 (1:10) = 0.072°

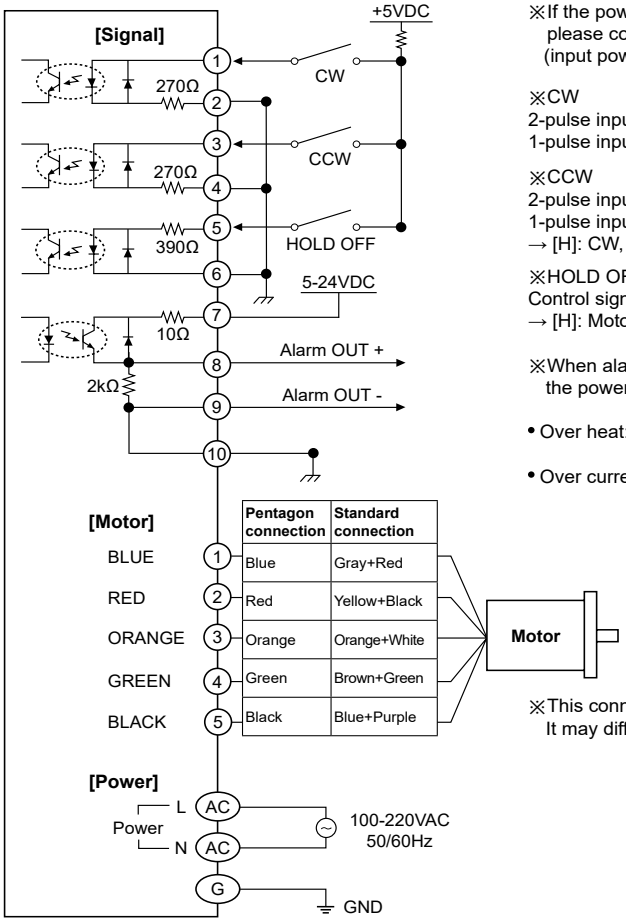
※Must stop the motor before changing the resolution.

## ◎ Alarm indication/output

- Overheat: When the temperature of driver base is over 80℃, the alarm indicator (red) turns ON and motor stops and alarm output turns ON with holding the excision.
- Overcurrent: When overcurrent occurs due to motor damage by burn, driver damage, or error, the alarm indicator (red) turns ON and alarm output turns ON. The motor becomes HOLD OFF.

※Turn OFF the power and remove the causes of alarm. Re-supply the power and the alarm indicator turns OFF and alarm output turns OFF. The driver is normal operation.

## ▣ I/O Circuit and Connections




※If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside.
(input power max. 24VDC, input current 10-24mA)

※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)

※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→ [H]: CW, [L]: CCW

※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF

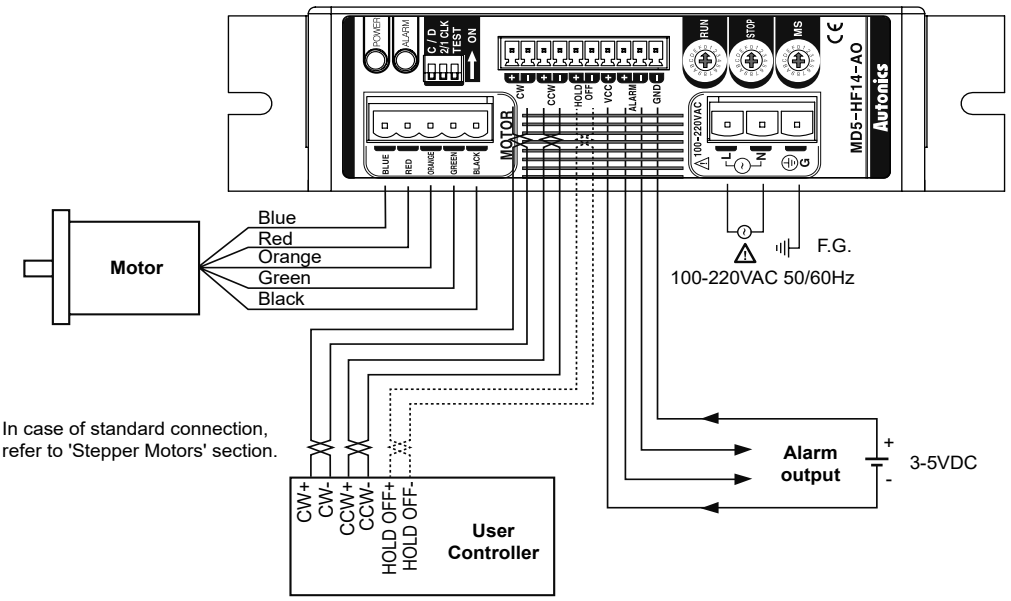
※When alarm occurs, the motor becomes HOLD OFF. Turn OFF the power and remove the causes to normal operation.

- Over heat:
- Over current:

※This connection cable color is only for Autonics motors.
It may different cable color when using other motors.

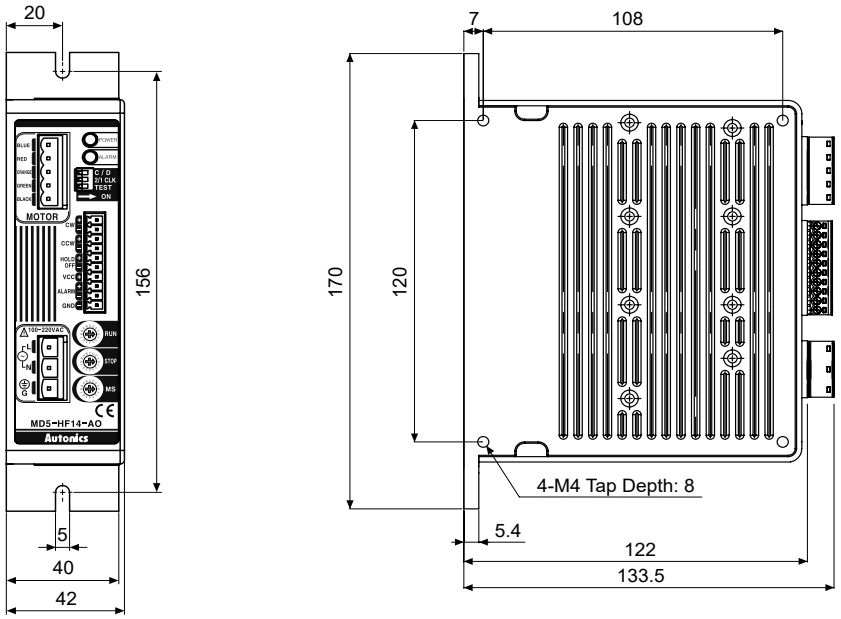
# 5-Phase Stepper Motor Driver (1.4A/Phase, AC Power, Alarm Output)

## ▣ Connections



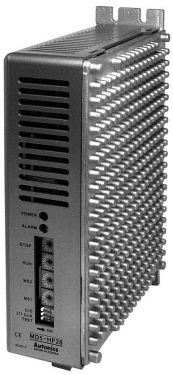

## ▣ Dimensions

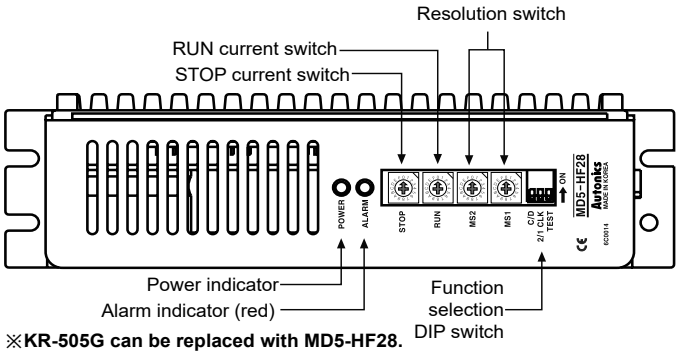
(unit: mm)



# 5-Phase Microstep Motor Driver [MD5-HF28]

## ▣ Unit Description



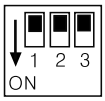



※**KR-505G can be replaced with MD5-HF28.**
※**Power supply 100-220VAC and socket type wire terminal blocks are upgraded comparing to KR Series.**

※Refer to '▣ **Specifications**'.

## ▣ Functions

### ◎ Function selection DIP switch




| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | TEST | Self diagnosis function | 30rpm rotation | Not use |
| 2 | 2/1 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 3 | C/D | Auto Current Down | Not use | Use |

**● TEST**

- Self diagnosis function is for motor and driver test.
- This function makes the motor rotate with 30rpm in full step. Rotation speed varies with resolution settings.
- Rotation speed = 30rpm/resolution
- In 1-pulse input method, it rotates to CCW, and in 2-pulse input method, it rotates to CW.

※Be sure that the TEST switch is OFF before supplying the power.
If the TEST switch is ON, the motor operates immediately and it may be dangerous.

**● 2/1 CLK**

- 2/1 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

**● C/D (auto current down)**

- This function is to reduce the current provided for motor automatically for preventing severe motor's heat when motor stops.
- If motor RUN pulse is not applied, the current provided for motor reduces as the set STOP current.

※Be sure that when motor RUN current is reduced, the stop torque of motor also reduced.
※Set the STOP current by the STOP current switch.

### ◎ Setting RUN current

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current (A/Phase) | 1.14 | 1.25 | 1.36 | 1.50 | 1.63 | 1.74 | 1.86 | 1.97 | 2.10 | 2.20 | 2.30 | 2.40 | 2.50 | 2.60 | 2.78 | 2.88 |

- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

### ◎ Setting STOP current

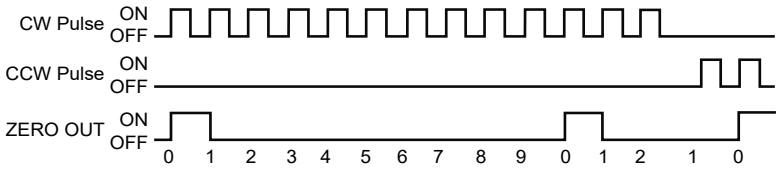
| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 90 |

- Setting STOP current is for the current provided for motor when the motor stops for preventing severe motor's heat.
- This setting is applied when using C/D (current down) function.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.

E.g.) Set RUN current as 2.5A and STOP current as 40%.
STOP current is set as 2.5A×0.4=1A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

## ◎ Zero point excitation output signal (ZERO OUT)




- This output indicates the initial step of excitation order of stepper motor and rotation position of motor axis.
- This signal outputs every 7.2° of rotation of the motor axis regardless of resolution.
  (50 outputs per 1 rotation of the motor.)
  E.g.) Full step: outputs one time by 10 pulses input, 20-division: outputs one time by 200 pulses input.

## ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

## ◎ Setting Microstep (microstep: resolution)

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resolution | 1 | 2 | 4 | 5 | 8 | 10 | 16 | 20 | 25 | 40 | 50 | 80 | 100 | 125 | 200 | 250 |
| Step angle | 0.72° | 0.36° | 0.18° | 0.144° | 0.09° | 0.072° | 0.045° | 0.036° | 0.0288° | 0.018° | 0.0144° | 0.009° | 0.0072° | 0.00576° | 0.0036° | 0.00288° |

- **Setting Resolution (same as MS1, MS2)**
- The MS1, MS2 switches is for resolution setting.
- Select MS2 or MS2 by DIVISION SELECTION signal ([L]: MS1, [H]: MS2)
- Select the step angle (motor rotation angle per 1 pulse).
- The set step angle is dividing basic step angle (0.72°) of 5-phase stepper motor by setting value.
- The calculation formula of divided step angle is as follow.

$$\text{Set step angle} = \frac{\text{Basic step angle (0.72°)}}{\text{Resolution}}$$

- When using geared type motor, the angle is step angle divided by gear ratio.
  Step angle / gear ratio = Step angle applied gear  E.g) 0.72° / 10 (1:10) = 0.072°

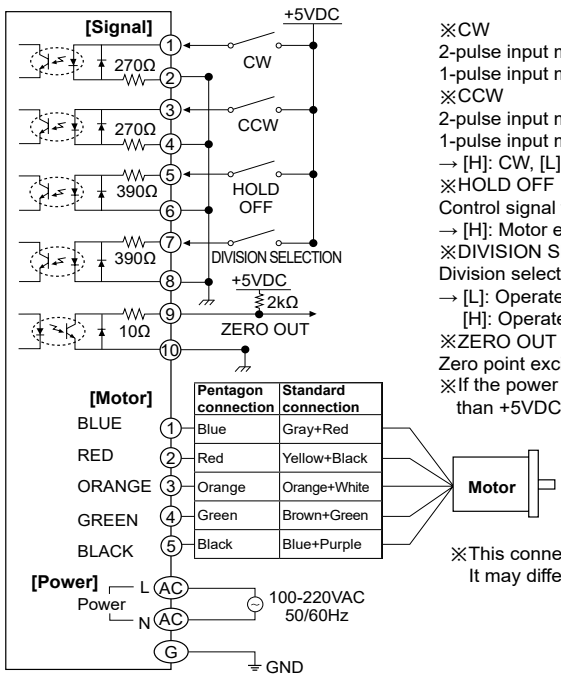
※Must stop the motor before changing the resolution.

## ◎ Alarm indication

- Overheat: When the temperature of driver base is over 80℃, the alarm indicator (red) turns ON and motor stops with holding the excision.
- Overcurrent: When overcurrent occurs due to motor damage by burn, driver damage, or error, the alarm indicator (red) turns ON and the motor becomes HOLD OFF.

※Turn OFF the power and remove the causes of alarm. Re-supply the power and the alarm indicator turns OFF and the driver is normal operation.

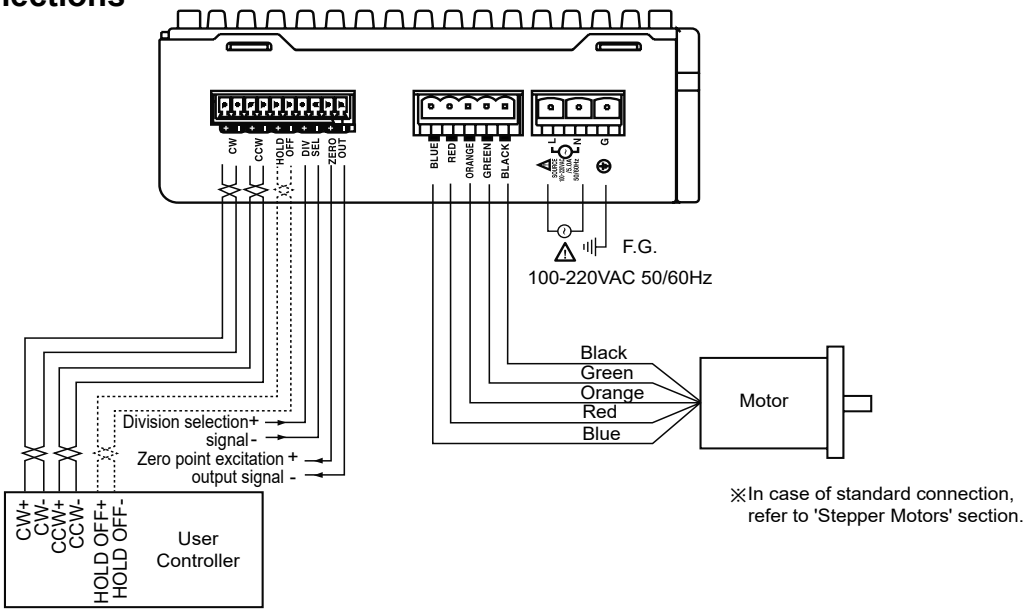
## ▣ I/O Circuit and Connections




※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)
※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→ [H]: CW, [L]: CCW
※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF
※DIVISION SELECTION
Division selection signal
→ [L]: Operated by switch MS1
[H]: Operated by switch MS2
※ZERO OUT
Zero point excitation output signal → Zero point status ON
※If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside.

※This connection cable color is only for Autonics motors.
It may different cable color when using other motors.

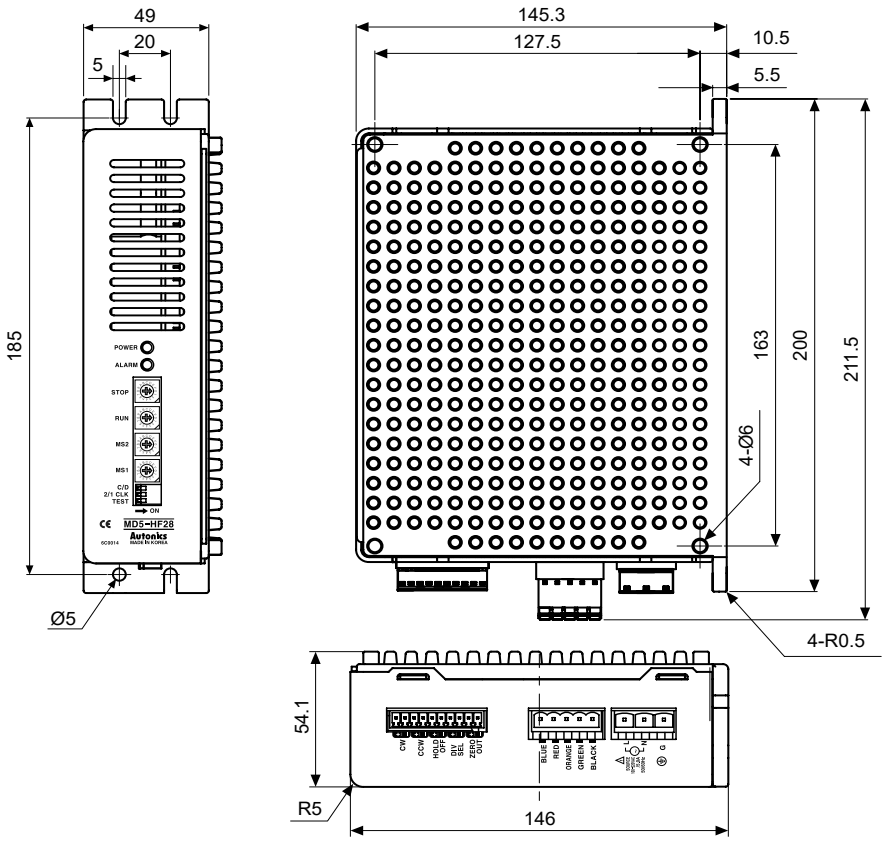
## ▣ Connections




※In case of standard connection, refer to 'Stepper Motors' section.

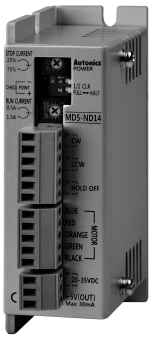
## ▣ Dimensions

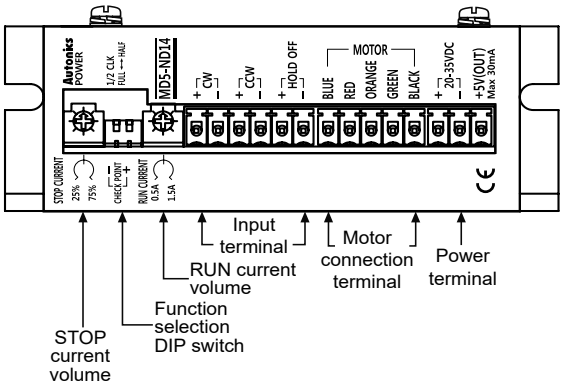
(unit: mm)



## 5-Phase Stepper Motor Driver [MD5-ND14]

### ▣ Unit Description






※Refer to '▣ **Specifications**'.

### ▣ Functions

#### ◎ Function selection DIP switch

| No. | Nameplate | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | 1/2 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 2 | FULL↔HALF | Select resolution | 1-division (0.72°) | 2-division (0.36°) |

※Changing pulse input method or resolution is available only when stepper motor stops.
If changing the resolution during operation, the motor may be out of phase.

**● 1/2 CLK**

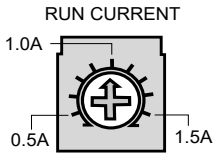
- 1/2 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

**● FULL ↔ HALF**

- FULL ↔ HALF switch is to set basic step angle for 5-phase stepper motor.

※Change resolution only when the motor stops.

#### ◎ Setting RUN current




- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

#### ◎ Setting STOP current

- Setting STOP current is for the current provided for motor when the motor stops.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.
  E.g.) Set RUN current as 1.4A and STOP current as 40%.
  STOP current is set as 1.4A×0.4=0.56A.

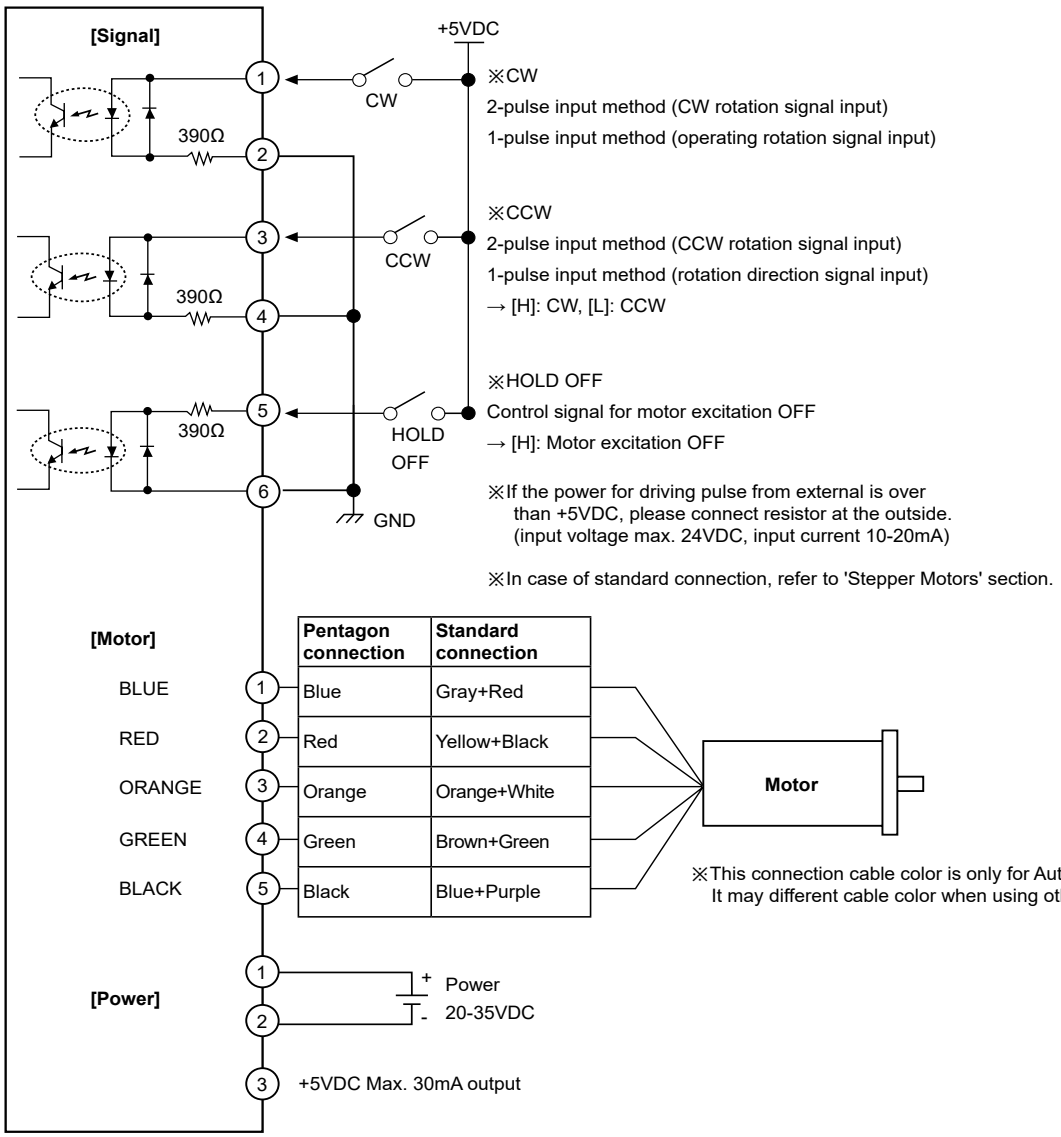
※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

#### ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

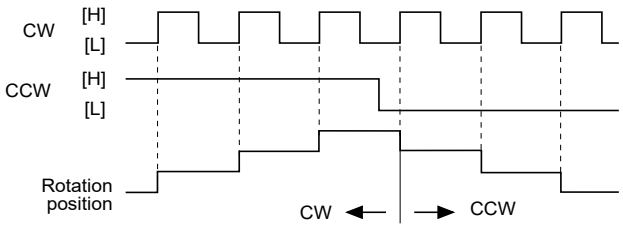
## ▣ I/O Circuit and Connections

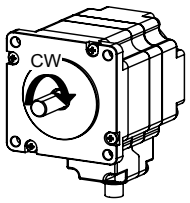


# 5-Phase Stepper Motor Driver (1.5A/Phase, DC Power)

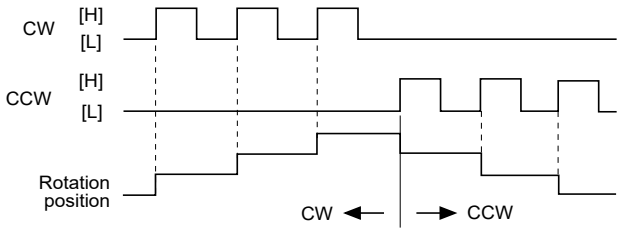
## ▣ Time Chart

### ◎ 1-pulse input method



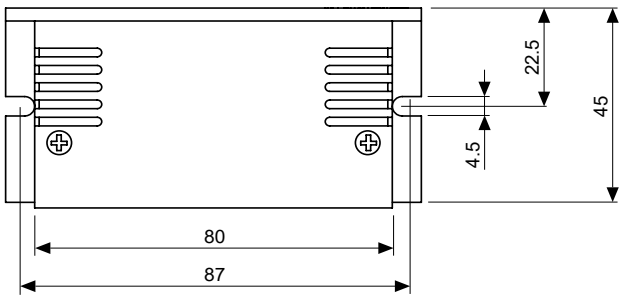

### ◎ 2-pulse input method

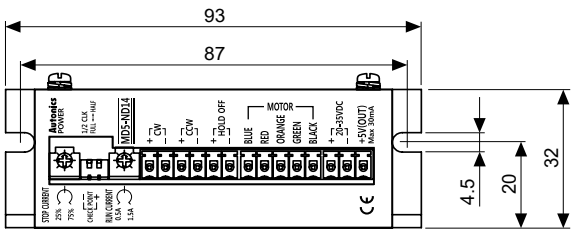


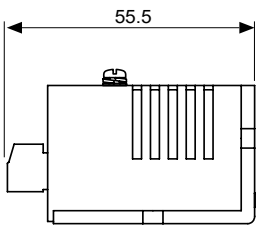

※Do not input CW, CCW signals at the same time in 2-pulse input method.
It may not operate properly if another direction signal is inputted when one of CW or CCW is [H].

## ▣ Dimensions

(unit: mm)



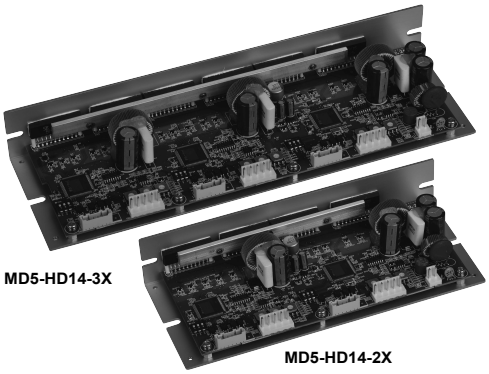



# Low Noise, Low Vibration Multi-Axis 5-Phase Stepper Motor Driver

## ■ Features

- **Simultaneous operation of 2, 3-axis by single power supply 20-35VDC**
- Small, light weight and advanced quality by custom IC and surface mounted circuit
- Realizing low noise, low vibration rotation with microstep-driving
- Low speed rotation and high accuracy controlling with microstep-driving
- Max. resolution 250 division: In case of 5-phase stepper motor of which basic step angle is 0.72°, it enables to control up to 0.00288° per pulse
- Includes auto current down and self-diagnosis function
- Photocoupler input insulation method to minimize the effects from external noise




**Please read "Safety Considerations" in the instruction manual before using.**

## ■ Ordering Information

**MD 5 – H D 14 – 2X**

| | | |
|---|---|---|
| Axis | 2X | 2-axis |
| | 3X | 3-axis※1 |
| RUN current | 14 | 1.4A/Phase |
| Power supply | D | 20-35VDC |
| Step type (resolution) | H | Micro step (250-division) |
| Motor phase | 5 | 5-phase |
| Item | MD | Motor Driver |

※1: Built-in zero point excitation output signal is optional.

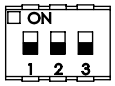
## ■ Specifications

| Model | | MD5-HD14-2X | MD5-HD14-3X |
|---|---|---|---|
| Power supply※1 | | 20-35VDC⎓ | |
| Allowable voltage fluctuation range | | 90 to 110% of the rated voltage | |
| Max. current consumption※2 | | 5A | 7A |
| RUN current※3 | | 0.4-1.4A/Phase | |
| STOP current | | 27 to 90% of RUN current (set by STOP current switch) | |
| Drive method | | Bipolar constant current pentagon drive | |
| Basic step angle | | 0.72°/Step | |
| Resolution | | 1, 2, 4, 5, 8, 10, 16, 20, 25, 40, 50, 80, 100, 125, 200, 250-division (0.72° to 0.00288°/Step) | |
| Input pulse characteristic | Pulse width | Min. 1μs (CW, CCW), Min. 1ms (HOLD OFF) | |
| | Duty rate | 50% (CW, CCW) | |
| | Rising/Falling time | Below 130ns (CW, CCW) | |
| | Pulse input voltage | [H]: 4-8VDC⎓, [L]: 0-0.5VDC | |
| | Pulse input current | 7.5-14mA (CW, CCW), 10-16mA (HOLD OFF, ZERO OUT) | |
| | Max. input pulse frequency※4 | Max. 500kHz (CW, CCW) | |
| Input resistance | | 270Ω (CW, CCW), 390Ω (HOLD OFF), 10Ω (ZERO OUT) | |
| Insulation resistance | | Over 100MΩ (at 500VDC megger, between all terminals and base) | |
| Dielectric strength | | 1,000VAC 50/60Hz for 1 min (between all terminals and base) | |
| Noise immunity | | ±500V the square wave noise (pulse width: 1μs) by the noise simulator | |
| Vibration | Mechanical | 1.5mm amplitude at frequency 5 to 60Hz (for 1 min) in each X, Y, Z direction for 2 hours | |
| | Malfunction | 1.5mm amplitude at frequency 5 to 60Hz (for 1 min) in each X, Y, Z direction for 10 min | |
| Envi-ron-ment | Ambient temp. | 0 to 40℃, storage: -10 to 60℃ | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | |
| Approval | | CE | |
| Weight※5 | | Approx. 446g (approx. 292g) | Approx. 597g (approx. 411g) |

※1: When using over 30VDC power supply, torque characteristics are improved but the driver temperature raise. The unit should be installed at the well ventilation environment.
※2: Based on ambient temperature 25℃, ambient humidity 55%RH.
※3: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also varies depending on the load.
※4: Max. input pulse frequency is max. frequency to be input and is not same as max. pull-out frequency or max. slewing frequency.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

## ▣ Functions

### ◎ Function selection DIP switch




| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF (default) |
| 1 | TEST | Self diagnosis function | 30rpm rotation | Not use |
| 2 | 1/2 CLK | Pulse input method | 1-pulse input method | 2-pulse input method |
| 3 | C/D | Auto Current Down | Not use | Use |

**● TEST**

- Self diagnosis function is for motor and driver test.
- This function makes the motor rotate with 30rpm in full step. Rotation speed varies with resolution settings.
- Rotation speed = 30rpm/resolution
- In 1-pulse input method, it rotates to CCW, and in 2-pulse input method, it rotates to CW.

※Be sure that the TEST switch is OFF before supplying the power.
If the TEST switch is ON, the motor operates immediately and it may be dangerous.

**● 1/2 CLK**

- 1/2 CLK switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

**● C/D (auto current down)**

- This function is to reduce the current provided for motor automatically for preventing severe motor's heat when motor stops.
- If motor RUN pulse is not applied, the current provided for motor reduces as the set STOP current.

※Be sure that when motor RUN current is reduced, the stop torque of motor also reduced.
※Set the STOP current by the Setting STOP current switch.

### ◎ Setting RUN current

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current (A/Phase) | 0.4 | 0.5 | 0.57 | 0.63 | 0.71 | 0.77 | 0.84 | 0.9 | 0.96 | 1.02 | 1.09 | 1.15 | 1.22 | 1.27 | 1.33 | 1.4 |

- Setting RUN current is for the current provided for motor when the motor runs.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat is severe.
※Set RUN current within the range of motor's rated current according to its load.
※Change RUN current only when the motor stops.

### ◎ Setting STOP current

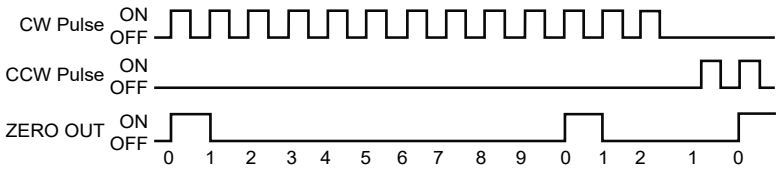
| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 27 | 31 | 36 | 40 | 45 | 50 | 54 | 58 | 62 | 66 | 70 | 74 | 78 | 82 | 86 | 90 |

- Setting STOP current is for the current provided for motor when the motor stops.
- This setting is applied when using C/D (current down) function.
- Setting value of STOP current is percentage (%) ratio of the set RUN current.

E.g.) Set RUN current as 1.4A and STOP current as 40%.
STOP current is set as 1.4A×0.4=0.56A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set too low, the heat is lower.
※Change STOP current only when the motor stops.

### ◎ Zero point excitation output signal (ZERO OUT) [Option]




- This output indicates the initial step of excitation order of stepper motor and rotation position of motor axis.
- This signal outputs every 7.2° of rotation of the motor axis regardless of resolution.
  (50 outputs per 1 rotation of the motor.)

E.g.) Full step: outputs one time by 10 pulses input,
20-division: outputs one time by 200 pulses input.

### ◎ HOLD OFF function

- This signal is for rotating motor's axis using external force or used for manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Must stop the motor for using this function.
※Refer to '▣ **I/O Circuit and Connections**'.

### ◎ Setting Microstep (microstep: resolution)

| Switch No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resolution | 1 | 2 | 4 | 5 | 8 | 10 | 16 | 20 | 25 | 40 | 50 | 80 | 100 | 125 | 200 | 250 |
| Step angle | 0.72° | 0.36° | 0.18° | 0.144° | 0.09° | 0.072° | 0.045° | 0.036° | 0.0288° | 0.018° | 0.0144° | 0.009° | 0.0072° | 0.00576° | 0.0036° | 0.00288° |

**● Resolution (MS1)**

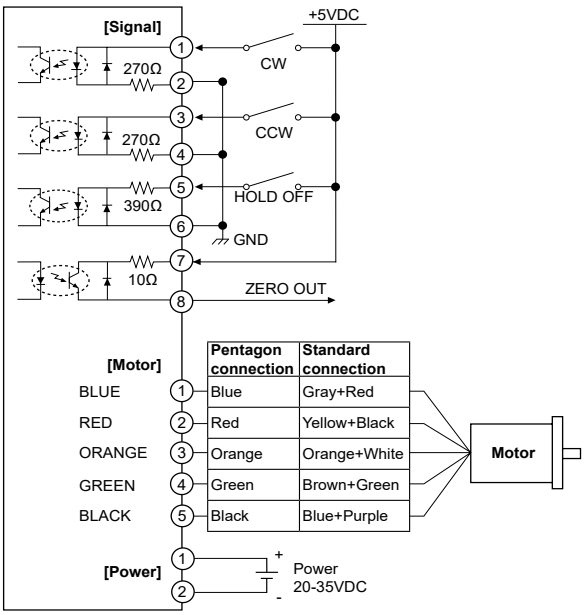
- The set step angle is dividing basic step angle (0.72°) of 5-phase stepper motor by setting value.
- The calculation formula of divided step angle is as below.

$$\text{Set step angle} = \frac{\text{Basic step angle (0.72°)}}{\text{Resolution}}$$

- When using geared type motor, the angle is step angle divided by gear ratio.
  Step angle/gear ratio = Step angle applied gear
  E.g) 0.72°/10 (1:10) = 0.072°

※Must stop the motor before changing the resolution.

## ▣ I/O Circuit and Connections




※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)

※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→ [H]: CW, [L]: CCW

※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF

※ZERO OUT (option)
Zero point excitation output signal → Zero point status ON

※If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside.
(input voltage max. 24VDC, input current 10-20mA)

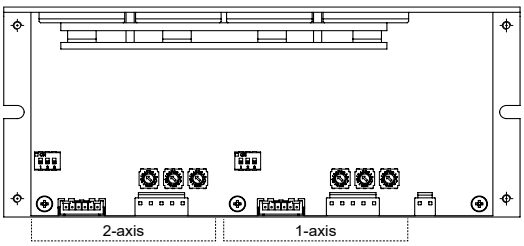
※In case of standard connection, refer to 'Stepper Motors' section

※This connection cable color is only for Autonics motors.
It may different cable color when using other motors.

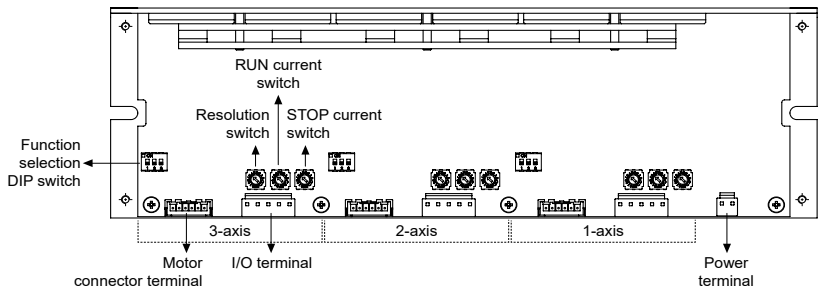
※Power input of 2/3-axis are used as same and I/O terminals are proportional to the number of axes.

## ▣ Unit Description

### ◎ MD5-HD14-2X




### ◎ MD5-HD14-3X



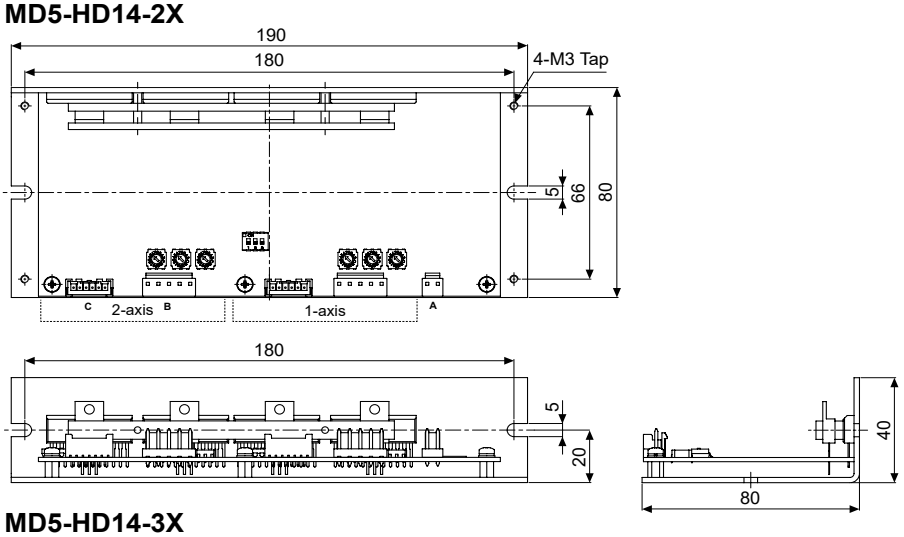

※Each axis structure is same.

# 5-Phase Stepper Motor Driver (1.4A/Phase, DC Power, Multi-Axis)

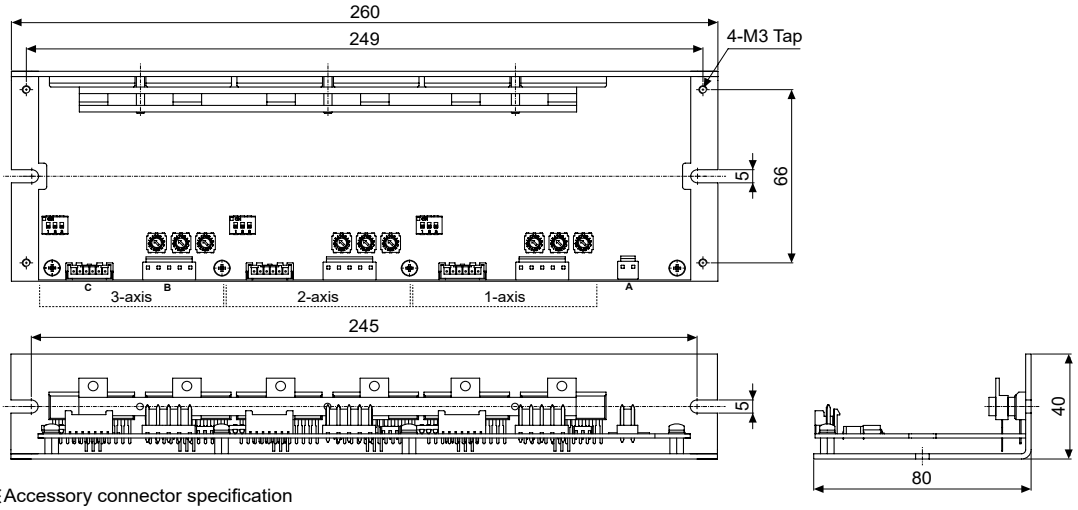
## ▣ Dimensions

### ◎ MD5-HD14-2X

(unit: mm)




### ◎ MD5-HD14-3X

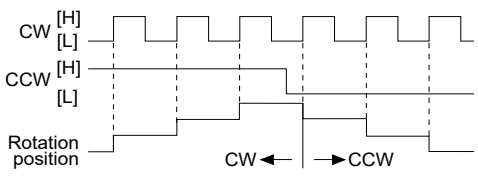



※Accessory connector specification

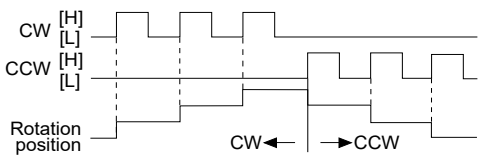
| Accessory | | Connector | | Qty. | |
|---|---|---|---|---|---|
| | | Manufacturer | Model No. | MD5-HD14-2X | MD5-HD14-3X |
| A | Power 2-wire housing | JST | VHR-2N | 1 | 1 |
| B | Motor 5-wire housing | | VHR-5N | 2 | 3 |
| C | Signal 6-wire housing | | XAP-06V-1 | 2 | 3 |
| — | Power/Motor terminal pin | | SVH-21T-P1.1 | 12 | 17 |
| — | Signal terminal pin | | SXA -001T-P0.6 | 12 | 18 |

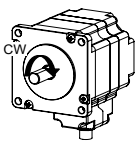
## ▣ Time Chart

### ◎ 1-pulse input method




### ◎ 2-pulse input method




※Do not input CW, CCW signals at the same time in 2-pulse input method.
It may not operate properly if another direction signal is inputted when one of CW or CCW is [H].

## ▣ Cautions during Use (Common Specifications of 5-Phase Stepper Motor Driver)

### 1. For signal input

①Do not input CW, CCW signal at the same time in 2-pulse input method. Failure to follow this instruction may result in malfunction. It may not operate properly if another direction signal is inputted when one of CW or CCW is [H].
②When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.

### 2. For RUN current, STOP current setting

①Set RUN current within the range of motor's rated current. Failure to follow this instruction may result in severe heat of motor or motor damage.
②If motor stops, switching for STOP current executed by the current down function. When hold off signal is [H] or current down function is OFF, the switching does not execute. (except MD5-ND14)
③Use the power for supplying sufficient current to the motor.
④Check the polarity of power before operating the unit. (only for MD5-HD14, HD14-2X/3X, ND14)

### 3. For rotating motor

(only for MD5-HD14, HD14-2X/3X, ND14)

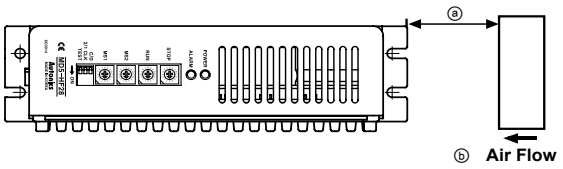
①For rotating the motor when driver power turns OFF, separate the motor from the driver.
(if not, the driver power turns ON)
②For rotating the motor when driver power turns ON, use Hold OFF function.

### 4. For cable connection

①Use twisted pair (over 0.2mm$^2$) for the signal cable which should be shorter than 2m.
②The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
③Must separate between the signal cable and the power cable over 10cm.

### 5. For installation

**①The unit must be installed with heat protection. The conditions of ②, ③ should be satisfied. (※MD5-ND14)**
②In order to increase heat protection efficiency of the driver, must install the heat sink close to metal panel and keep it well-ventilated.
③Excessive heat generation may occur on driver. Keep the heat sink under 80℃ when installing the unit.
(at over 80℃, forcible cooling shall be required.)
④If the unit is installed in distribution panel, enclosed space or place with heat, it may cause product damage by heat. Install a ventilation. (only for MD5-HF28)
⑤For heat radiation of driver, install a fan as below figure. (distance between the ⓐ fan and the unit: approx. within 70mm, ⓑ min. airflow: 0.71m$^3$/min at least)
(only for MD5-HF28)




### 6. For using setting switches

①Be sure that the TEST switch is OFF before supplying the power. If the TEST switch is ON, the motor operates immediately and it may be dangerous.
(except MD5-ND14)
②Do not change any setting switch during the operation or after supplying power. It may cause malfunction.

### 7. Autonics motor driver does not prepare protection function for a motor.

### 8. This product may be used in the following environments.

① Indoors
② Altitude max. 2,000m
③ Pollution degree 2
④ Installation category II

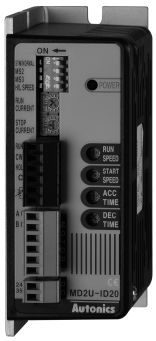
# Compact and High-Performance of 2-Phase Stepper Motor Driver

## ■ Features

- Unipolar constant current drive type
- Enable to brake when it stops by STOP current adjustment
- Low speed and precise control with microstep (MD2U-MD20)
- Insulate using photocoupler to minimize the influence by external noise
- Power supply: 24-35VDC

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

MD2U-MD20




MD2U-ID20

## ■ Ordering Information

| MD | 2 | U | – | M | D | 20 |
|---|---|---|---|---|---|---|

| | | |
|---|---|---|
| RUN current | 20 | 2A/Phase |
| Power supply | D | 24-35VDC |
| Step method (resolution) | M | Micro Step (20-division) |
| | I | Intelligent type |
| Drive method | U | Unipolar drive |
| Motor phase | 2 | 2-phase |
| Item | MD | Motor Driver |

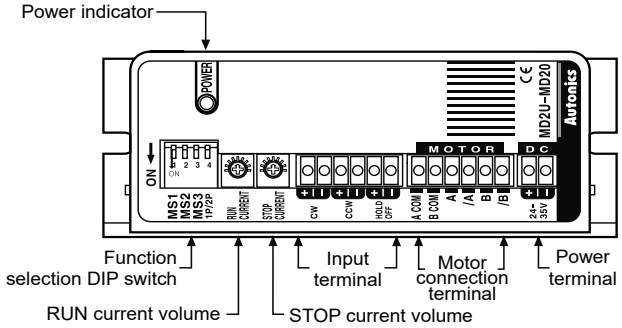
## ■ Specifications

| Model | | MD2U-MD20 | MD2U-ID20 |
|---|---|---|---|
| Power supply※1 | | 24-35VDC⎓ | |
| Allowable voltage range | | 90 to 110% of the rated voltage | |
| Max. current consumption※2 | | 3A | |
| RUN current※3 | | 0.5-2A/Phase | |
| STOP current | | 20 to 70% of RUN current (set by STOP current volume) | |
| Drive method | | Unipolar constant current drive type | |
| Basic step angle | | 1.8˚/Step | |
| Max. drive speed | | — | 1500rpm |
| Resolution | | 1, 2, 4, 5, 8, 10, 16, 20-division (1.8˚ to 0.09˚/Step) | — |
| Input pulse characteristic | Input pulse width | Min. 10μs (CW, CCW), min. 1ms (HOLD OFF) | |
| | Duty rate | 50% (CW, CCW) | |
| | Rising/Falling time | Max. 0.5μs (CW, CCW) | |
| | Pulse input voltage | [H]: 4-8VDC⎓, [L]: 0-0.5VDC⎓ | |
| | Max. input current | 4mA (CW, CCW), 10mA (HOLD OFF) | |
| | Max. input pulse freq.※4 | Max. 50kHz (CW, CCW) | |
| Input resistance | | 300Ω (CW, CCW), 390Ω (HOLD OFF) | 3.3kΩ (CW/CCW, RUN/STOP, HOLD OFF) |
| Insulation resistance | | Over 200MΩ (at 500VDC megger, between all terminals and case) | |
| Dielectric strength | | 1000VAC 50/60Hz for 1 min (between all terminals and case) | |
| Noise immunity | | ±500V the square wave noise (pulse width: 1μs) by the noise simulator | |
| Vibration | | 1.5mm amplitude at frequency of 10 to 55Hz (for 1 min) in each X, Y, Z direction for 2 hours | |
| Shock | Vibration | 300m/s² (approx. 30G) in each X, Y, Z direction for 3 times | |
| Environment | Ambient temp. | 0 to 50℃, storage: -10 to 60℃ | |
| | Ambient humi. | 35 to 85%RH, storage: 35 to 85%RH | |
| Approval | | CE | |
| Weight※5 | | Approx. 295g (approx. 180g) | Approx. 303g (approx. 190g) |

※1: Since torque characteristics are improved but the driver temperature rises with the 30VDC power supply, the driver should be installed at the well ventilated environment. Torque is variable by power supply.
※2: Based on the ambient temperature 25℃, ambient humidity 55%RH.
※3: RUN current varies depending on the input RUN frequency, and the max. instantaneous RUN current varies also.
※4: Max. input pulse frequency is max. frequency to be input and is not same as max. pull-out frequency or max. slewing frequency.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

# 2-Phase Micro Stepper Driver [MD2U-MD20]

## ▣ Unit Descriptions

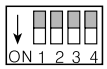



※Refer to '▣ **Secifications**'.

## ▣ Functions

### ◎ Function selection DIP switch

**● Microstep, pulse input method setting**

| | No. | Name | Function | Switch position | |
|---|---|---|---|---|---|
| | | | | ON | OFF |
|  | 1 | MS1 | Microstep setting | See table below | |
| | 2 | MS2 | | | |
| | 3 | MS3 | | | |
| | 4 | 1P/2P | Pulse input method | 1-pulse input method | 2-pulse input method |



| MS1 | MS2 | MS3 | Resolution |
|---|---|---|---|
| ON | ON | ON | 1 (Full-step) |
| ON | ON | OFF | 2-division |
| ON | OFF | ON | 4-division |
| ON | OFF | OFF | 5-division |
| OFF | ON | ON | 8-division |
| OFF | ON | OFF | 10-division |
| OFF | OFF | ON | 16-division |
| OFF | OFF | OFF | 20-division |

**● Resolution setting (MS1/MS2/MS3)**

- Select the step angle (motor rotation angle per 1 pulse).
- The set step angle is dividing basic step angle(1.8°) of 2-phase stepping motor by set resolution value.

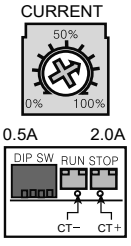
$$\text{E.g.) Set step angle} = \frac{\text{Basic angle (1.8°)}}{\text{Resolution}}$$

※Change resolution setting value only when the motor stops.

**● 1P/2P**

- The switch is to select pulse input method.
- 1-pulse input method: CW → operating rotation signal input, CCW → rotation direction signal input ([H]: CW, [L]: CCW)
- 2-pulse input method: CW → CW rotation signal input, CCW → CCW rotation signal input.

### ◎ Setting RUN current



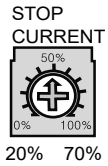

- RUN current setting is for the current provided to the motor in running status.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat of the motor is increased.
※Set RUN current properly for the load within the rated current range of the motor.
※RUN current setting range: 0.5 to 2.0A
※RUN current setting method: Measure the voltage by connecting a DC voltage meter to both CT+ and CT- terminals while the motor is running (max. 150rpm)

$$\text{E.g.) Input voltage (3V)} \times \frac{2}{3} = \text{2A (motor excitation current)}$$

※Change RUN current only when the motor stops.

### ◎ Setting STOP current




- STOP current setting is for the current provided to the motor in stopped status, preventing severe heat of the motor.
- This function is for reducing the heat by variable resistance ratio setting within 0 to 100% of RUN current setting range (actual setting range: 20 to 70%).
  E.g.) In case of RUN current setting value is 2A and
  STOP current setting value is 0% (actual setting range: 20%),
  STOP current 2A × 0.2 = 0.4A

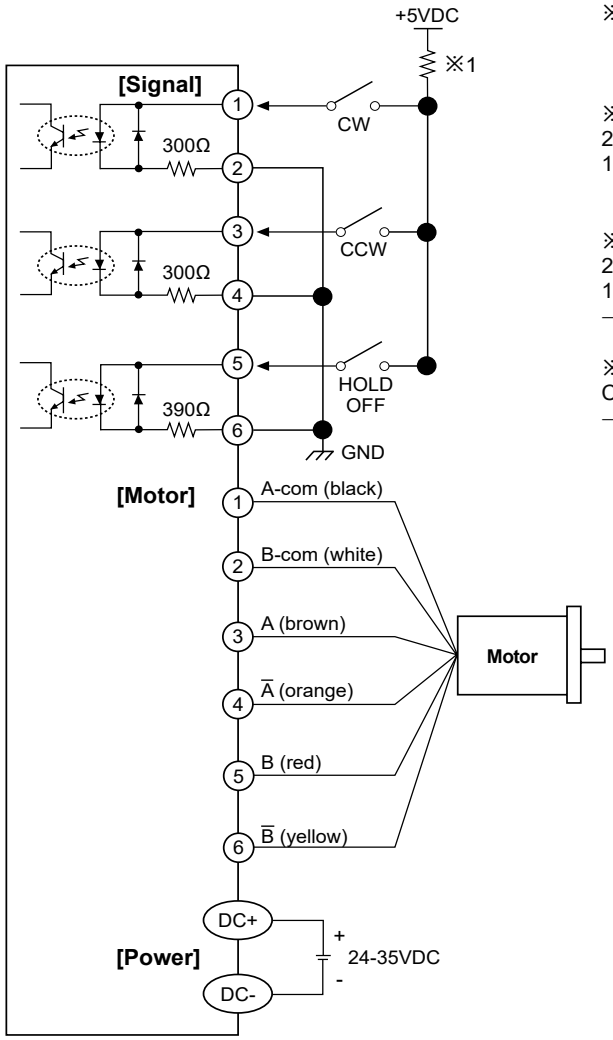
※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set low, the heat of the motor is also low.
※Change STOP current only when the motor stops.

### ◎ HOLD OFF function

- This signal is for rotating axis of the motor with external force or manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Use this function only when the motor stops.
※Refer to '▣ **I/O Circuit and Connections**'.

## ▣ I/O Circuit and Connections




※1: If the power for driving pulse from external is over than +5VDC, please connect resistor at the outside.
(input power max. 24VDC, input current 10-20mA)

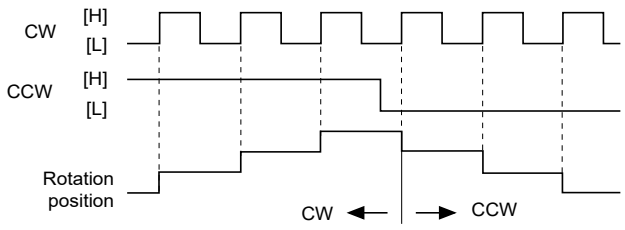
※CW
2-pulse input method (CW rotation signal input)
1-pulse input method (operating rotation signal input)

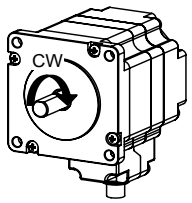
※CCW
2-pulse input method (CCW rotation signal input)
1-pulse input method (rotation direction signal input)
→[H]: CW, [L]: CCW

※HOLD OFF
Control signal for motor excitation OFF
→ [H]: Motor excitation OFF

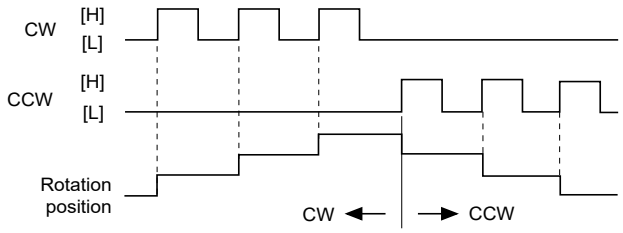
## ▣ Time Chart

**● 1 pulse input method**



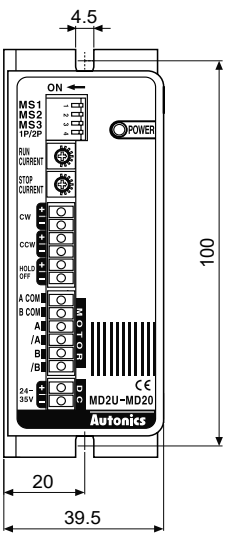

**● 2 pulse input method**

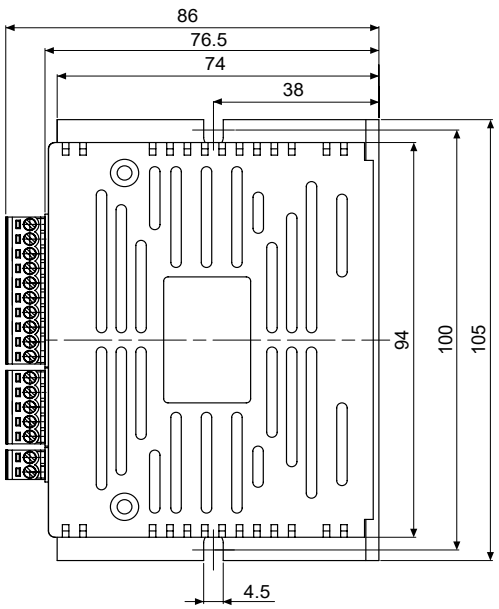



※Do not input CW, CCW signals at the same time in 2-pulse input method.
It may not operate properly if another direction signal is inputted when one of CW or CCW is [H].

## ▣ Dimensions

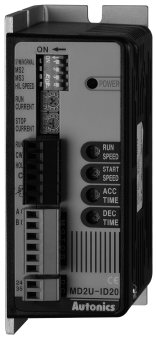
(unit: mm)



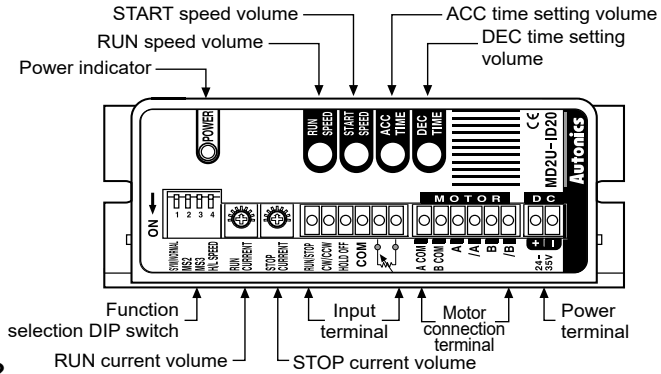



# 2-Phase Intelligent Stepper Motor Driver [MD2U-ID20]

## ▣ Unit Descriptions



※Refer to '▣ **Specifications**'.




### ◎ Intelligent type stepper motor driver?

MD2U-ID20 is an intelligent type stepper motor driver including all features to control 2-phase stepper motors so that no controllers are required.

- Realizing AC motor's driving features to stepper motors
- Controlling START speed, RUN speed and ACC/DEC speed
- User-friendly design to realize various functions (front switch and volume)

## ▣ Functions

### ◎ Function selection DIP switch

| No. | Name | Function | Switch position | |
|---|---|---|---|---|
| | | | ON | OFF |
| 1 | SYM/ NORMAL | SYM/NORMAL | Symmetry | Asymmetry |
| 2 | MS2 | Max. speed | | |
| 3 | MS3 | | | |
| 4 | H/L SPEED | High/Low speed | | |

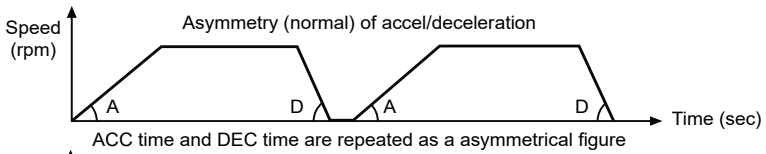
| MS2 | MS3 | H/L SPEED | Max. speed (rpm) |
|---|---|---|---|
| ON | ON | ON: High speed | 1500 |
| ON | OFF | | 1350 |
| OFF | ON | | 1000 |
| OFF | OFF | | 500 |
| D※1 | D※1 | OFF: Low speed | 150 |

※1: D=Don't care

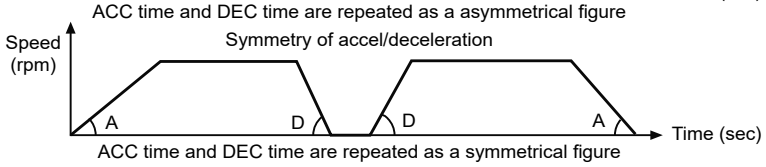
※Reboot the driver after changing function selection switch.

### ◎ Selection of Symmetry/Asymmetry

※The function to make the ACC/DEC time of run-speed as asymmetry or symmetry using DIP switch No. 1.




ACC time and DEC time are repeated as a asymmetrical figure




ACC time and DEC time are repeated as a symmetrical figure

※It is able to set the gradient (acceleration and deceleration time) as ACC/DEC time.

### ◎ Selection of max. speed (MS2, MS3)

※The function to select the max. speed of motors.

※The max. speed of stepper motor is changed by MS2/MS3 and Hi/Low speed.

※The features of run and vibration are able to change depending on MS2, MS3.

※Lower the max. speed to run a motor smoothly.

### ◎ Selection of H/L SPEED

※H/L SPEED mode selection switch

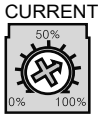
: Accel/deceleration control is not available in Low speed mode since all sections are included in Pull-in range.

※Low speed mode: It is able to drive a motor up to 150rpm of max. drive speed.

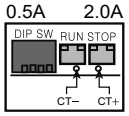
※High speed mode: It is able to drive a motor up to 1500rpm of max. drive speed.

### ◎ Setting RUN current

RUN CURRENT




0.5A 2.0A




- RUN current setting is for the current provided to the motor in running status.

※When RUN current is increased, RUN torque of the motor is also increased.
※When RUN current is set too high, the heat of the motor is increased.
※Set RUN current properly for the load within the rated current range of the motor.
※RUN current setting range: 0.5 to 2.0A
※RUN current setting method: Measure the voltage by connecting a DC voltage meter to both CT+ and CT- terminals while the motor is running (max. 150rpm)

E.g.) Input voltage (3V) × $\frac{2}{3}$ = 2A (motor excitation current)

※Change RUN current only when the motor stops.

### ◎ Setting STOP current

STOP CURRENT

20% 70%

- STOP current setting is for the current provided to the motor in stopped status, preventing severe heat of the motor.
- This function is for reducing the heat by variable resistance ratio setting within 0 to 100% of RUN current setting range (actual setting range: 20 to 70%).

E.g.) In case of RUN current setting value is 2A and
STOP current setting value is 0%(actual setting range: 20%),
STOP current 2A × 0.2 = 0.4A

※When STOP current is decreased, STOP torque of the motor is also decreased.
※When STOP current is set low, the heat of the motor is also low.
※Change STOP current only when the motor stops.

### ◎ Setting RUN speed

RUN SPEED

0% 100%

※It sets max. RUN speed.
※Max. RUN speed can be different depending on max. speed setting (MS2, MS3) and driving mode setting (Hi/Low speed).
※Since missing step can occur due to max. input pulse frequency of motors, consider motor type and its RUN current when setting max. RUN speed.
※Set the value only when the motor stops.

### ◎ Setting START speed

START SPEED

0% 100%

※It sets START speed.
※Max. START speed value is same with RUN speed value.
※Although START speed must be set within max. starting frequency, it is recommended to set up START speed within 0 to 50% for stable driving.
※Set the value only when the motor stops.

### ◎ Setting ACC time

ACC TIME

0% 100%

※It sets the acceleration time from START speed to max. RUN speed.
※Operates in AT_1 operation mode when ACC time is under 33.3%, AT_2 operation mode when ACC time is under 66.6%, and AT_3 operation mode when ACC time is over 66.6%.
※AT_1 is 0.5 sec when RUN speed=100%, START speed=0%.
※AT_2 is 1 sec when RUN speed=100%, START speed=0%.
※AT_3 is 2 sec when RUN speed=100%, START speed=0%.
※Set the value only when the motor stops.

### ◎ Setting DEC time

DEC TIME

0% 100%

※It sets the deceleration time from max. RUN speed to STOP.
※Operates in DT_1 operation mode when DEC time is under 33.3%, DT_2 operation mode when DEC time is under 66.6%, and DT_3 operation mode when DEC time is over 66.6%.
※DT_1 is 0.5 sec when RUN speed=100%, START speed=0%.
※DT_2 is 1 sec when RUN speed=100%, START speed=0%.
※DT_3 is 2 sec when RUN speed=100%, START speed=0%.
※Set the value only when the motor stops.

※ACC Time and DEC Time are declined in proportion to the setting value of START speed.
※The figures above indicate the factory default for each value.

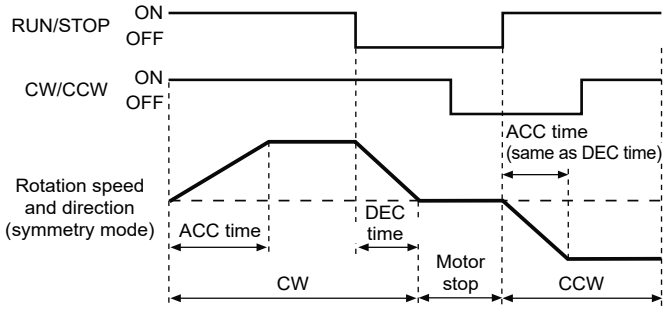
### ◎ HOLD OFF function

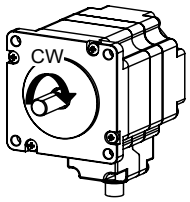
- This signal is for rotating axis of the motor with external force or manual positioning.
- When hold off signal maintains over 1ms as [H], motor excitation is released.
- When hold off signal maintains over 1ms as [L], motor excitation is in a normal status.

※Use this function only when the motor stops.
※Refer to '▣ **I/O Circuit and Connections**'.

## ▣ Time Chart

### ◎ High speed mode



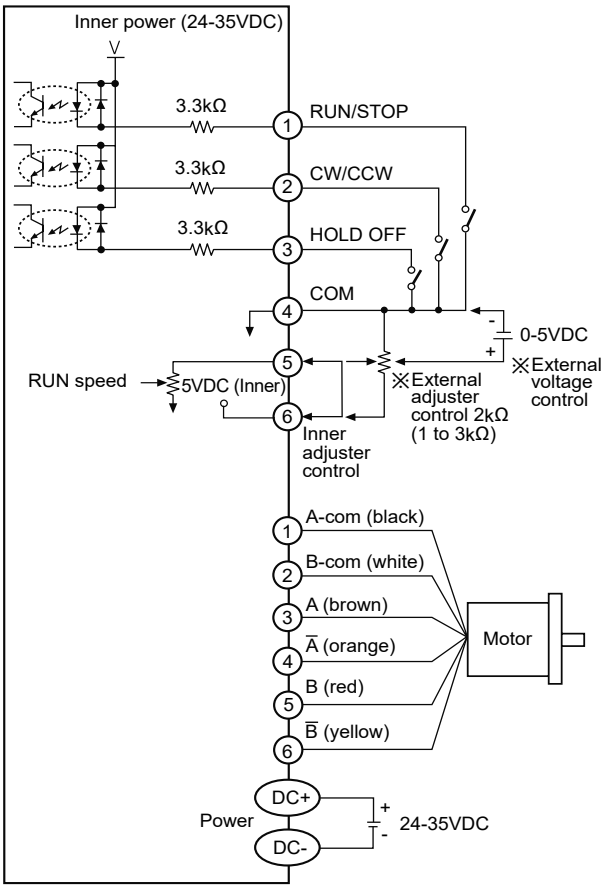

※It accelerates up to RUN speed during ACC time after RUN signal is ON and decelerates during DEC time after it is OFF.
※It is disable to change the direction during the signal is ON.
※It takes 0.5sec for deceleration when DEC time is "0%".

### ◎ Low speed mode

Max. RUN speed is 150rpm and ACC and DEC time are not available.
It is same with High speed to change RUN/STOP and direction.



## ▣ I/O Circuit and Connections




※Inner adjuster is correlated to external adjuster control and external voltage control. Make sure that inner adjuster must be set to maximum in order to set maximum RUN speed using external adjuster and external voltage.

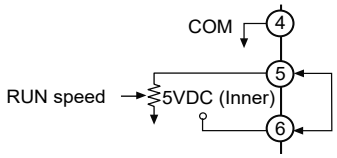
※RUN/STOP signal input
→ [ON]: RUN, [OFF]: STOP

※Direction signal input
→ [ON]: CW, [OFF]: CCW

※HOLD OFF signal iuput
→ [ON]: HOLD OFF, [OFF]: HOLD ON

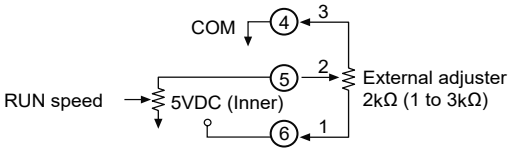
**● Inner adjuster control (Adjusting RUN speed with front VR)**

Make the connection between terminal No.5 and No.6.



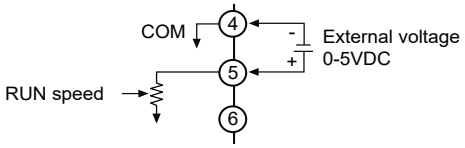

**● External adjuster control (Adjusting RUN speed with connecting external variable resistance)**

Connect variable resistance 2kΩ (1 to 3kΩ) for external adjuster control. If variable resistance is too low, full range setting might not be possible. Make sure to adjust RUN speed VR to maximum for external adjuster control.



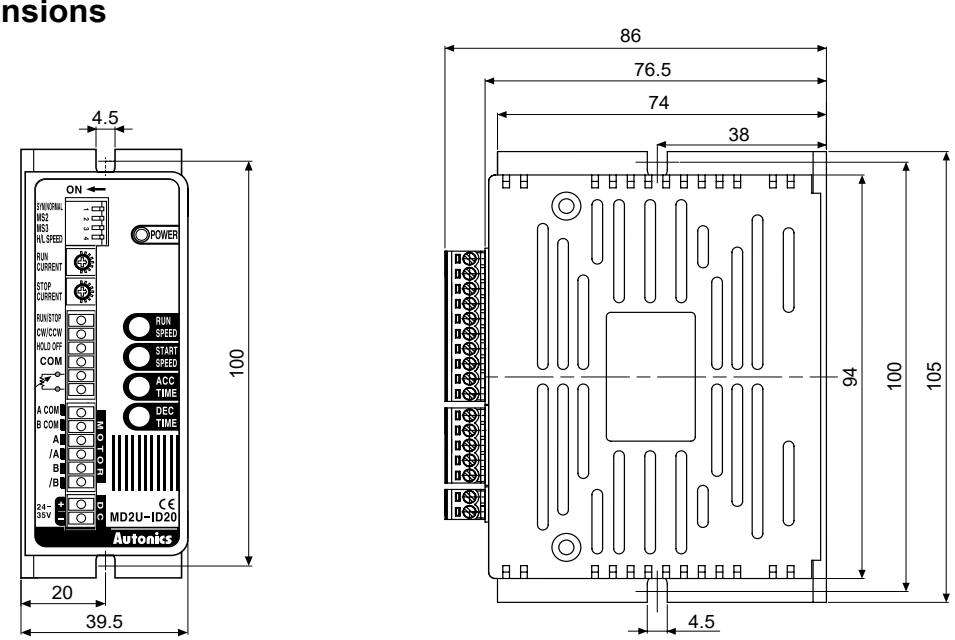

**● External voltage control (Adjusting RUN speed with external voltage input)**

Make sure to adjust RUN speed VR to maximum external voltage control.



## ▣ Dimensions

(unit: mm)




## ▣ Proper Usage

- Follow instructions in 'Proper Usage'. Otherwise, it may cause unexpected accidents.
- 24-35VDC 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.
- When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.
- Set RUN current within the range of motor's rated current depending on the load.
  When the rated motor current is over, the heat may be increased and motor may be damaged.
- If motor stops, switching for STOP current executed by the current down function.
  When hold off signal is [H] or current down function is off, the switching does not execute.
- Use twisted pair (over 0.2mm$^2$) for the signal cable which should be shorter than 2m.
- The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
- Keep the distance between power cable and signal cable more than 10cm.
- If the TEST switch is ON, the motor operates immediately and it may be dangerous.
- Do not change any setting switches (function, run/stop current, resolution switches) during the operation or after supplying power.
  Failure to follow this instruction may result in malfunction.
- Motor vibration and noise can occur in specific frequency period
  ①Change motor installation method or attach the damper.
  ②Use the unit out of the dedicated frequence range when vibration and noise occurs due to changing motor RUN speed.
- 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 motor
  ⑤Inconsistency 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.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II

# (D) Motion Controllers

Safety Considerations ..... D-2
PMC-1HS/2HS (1/2-Axis High Speed) ..... D-3
PMC-2HSP/2HSN (2-Axis Interpolation/Normal) ..... D-10
PMC-4B-PCI (4-Axis Board Type) ..... D-16
Applications ..... D-22
Technical Description ..... D-23

# Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid hazards.
※⚠ 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.

## ⚠ Warning

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, economic loss or fire.
2. **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.
3. **Install on a device panel or DIN rail to use.**
   **[Except PMC-4B-PCI]**
   Failure to follow this instruction may result in fire.
4. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire.
5. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
6. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire.
7. **Do not cut off power or disconnect connectors while operating the unit.**
   Failure to follow this instruction may result in personal injury or economic loss.
8. **Install the safety device at the out of the controller for stable system operation against external power error, controller malfunction, etc.**
   Failure to follow this instruction may result in personal injury or economic loss.
9. **Mount this unit on the PCI bus connector.**
   **[PMC-4B-PCI]**
   Failure to follow this instruction may result in personal injury, fire or product damage.

## ⚠ Caution

1. **When connecting the power input, use AWG 28-16(0.081 to 1.31mm$^2$) cable or over.**
   **[Except PMC-4B-PCI]**
2. **Must use the insulated trans at the power input.**
   **[Except PMC-4B-PCI]**
   Failure to follow this instruction may result in personal injury or fire.
3. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
4. **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.
5. **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.
6. **If a ribbon cable is used as the I/O line, connect the cable correctly and prevent from poor contact.**
   Failure to follow this instruction may result in malfunction.
7. **Note that this device is KCC certified for commercial use.**
   Make proper applications for the product.

**General precaution**
Indicate general warning, caution or danger.

# 1·2-Axis High Speed Programmable Motion Controller

## ▣ Features

- Max. 4Mpps high-speed operation
- 4 operation modes: Jog, Continuous, Index, Program mode
- 12 control command and 64 steps of operations
- Parallel I/O terminal built in which is connectable on PLC
- Create and edit operating programs, parameters by dedicated software
- Easy to operation of X, Y stage with joy stick
- RS232C port for all types
- Teaching and monitoring function by using teaching unit (PMC-2TU-232, sold separately)

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

**PMC-1HS (USB)** **PMC-1HS (232)** **PMC-2HS (USB)** **PMC-2HS (232)**

**PMC-2TU-232, sold separately**

## ▣ Manual

For the detail information and instructions, please refer to user manual and be sure to follow cautions written in the technical descriptions (catalog, website). Visit our website (www.autonics.com) to download manuals.

## ▣ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

< Computer specification for using software>

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

< atMotion screen >

## ▣ Standard Operation Method

There are four methods to operate PMC-1HS/PMC-2HS.

- Start with PC
  Connect a PC and the motion controller body via a communication cable, starts the operation program.
- Start with Parallel I/F
  Connect a sequence controller or switch to the Parallel I/F.
- Start with teaching unit (PMC-2TU-232, sold separately)
  Connect a communication cable annexed to a teaching unit (PMC-2TU-232).
  It is available to execute Jog output, home output and programs by drive operation of teaching unit.
- Control by serial communication
  The PMC-1HS/2HS Series provides serial communication commands.
  The PMC-1HS/2HS is connected to a PC or a sequence controller via an USB cable or RS-232C communication cable and it can control axes by means of user's independent program.

## ▣ Ordering Information

**PMC** − **2HS** − **USB**

| | | |
|---|---|---|
| Communication type | 232 | RS232C |
| | USB | USB, RS232C multiple use |
| Axis/Type | 1HS | 1-axis high speed stand-alone |
| | 2HS | 2-axis high speed stand-alone |
| Item | PMC | Programmable Motion Controller |

## ▣ Specifications

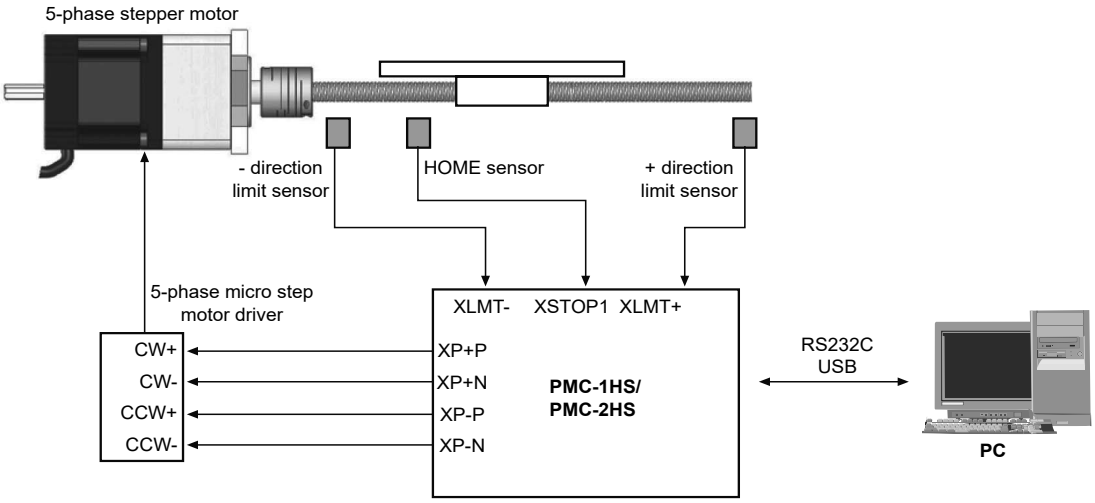
| Model | | PMC-1HS-232 | PMC-1HS-USB | PMC-2HS-232 | PMC-2HS-USB |
|---|---|---|---|---|---|
| Control axes | | 1-axis | | 2-axis<br>(Each axis can be independently programmed) | |
| Motor for control | | Pulse train input stepper motor or servo motor | | | |
| Power supply | | 24VDC⎓ ±10% | | | |
| Power consumption | | Max. 6W | | | |
| Operation mode | | Jog / Continuous / Index / Program mode | | | |
| In-Position setting | | ABSOLUTE / INCREMENTAL method | | | |
| Number of index steps | | 64 indexes per axis | | | |
| In-Position range | | -8,388,608 to +8,388,607 (supports pulse scaling function) | | | |
| Number of drive speed | | 4 | | | |
| Drive Speed | | 1pps to 4Mpps (1 to 8,000×magnification 1 to 500) | | | |
| Pulse output method | | 2-pulse output method (line driver output) | | | |
| Home search mode | | High speed near home search (Step 1) → Low speed near home search (Step 2)<br>→ Encoder Z-phase search (Step 3) → Offset movement (Step 4).<br>Configuring the detection direction and Enable/Disable in each step. | | | |
| Program function | Save | EEPROM | | | |
| | Steps | 64-step | | | |
| | Control command | ABS, INC, HOM, IJP, OUT, OTP, JMP, REP, RPE, END, TIM, NOP (12 types) | | | |
| | Start | Available power ON program auto start setting | | | |
| | Home search | Available power ON home search setting | | | |
| General output | | 1-point | | 2-point | |
| Control interface | | Parallel I/F | | | |
| Environ-ment | Ambient temp. | 0 to 45℃ | | | |
| | Ambient humidity | 35 to 85%RH | | | |
| Accessory | Common | User manual, CD | | | |
| | Power connector | [CN1] MC1, 5/2-ST-3.5 (PHOENIX): 1 | | | |
| | RS-232C connector | [CN2] RS-232C communication cable (1.5m): 1 | | | |
| | P I/F connector | [CN3] 20P MIL standard, 2.54mm connector: 1 | | | |
| | X-axis I/O connector | [CN4] 16P MIL standard, 2.54mm connector: 1 (In case of 2HS, using 2) | | | |
| | Y-axis I/O connector | — | | [CN5] 16P MIL standard, 2.54mm connector: 1 | |
| | USB connector | — | USB communication cable (1m): 1 | — | USB communication cable (1m): 1 |
| Approval | | CE | | | |
| Weight※1 | | Approx. 386g<br>(approx. 96.8g) | Approx. 421.6g<br>(approx. 96.9g) | Approx. 393.6g<br>(approx. 100.2g) | Approx. 432.2g<br>(approx. 100.4g) |

※1: The weight includes packing. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing of condensation.

## ▣ Program Commands

| Command type | Code | Description |
|---|---|---|
| Drive commands | ABS | Move absolute position |
| | INC | Move relative position |
| | HOM | Home search |
| I/O commands | IJP | Jump input condition |
| | OUT | ON/OFF of output port |
| | OTP | ON pulse from output port (certain time) |
| Program control commands | JMP | Jump |
| | REP | Start repetition |
| | RPE | End repetition |
| | END | End program |
| Others | TIM | Timer |
| | NOP | No operation |

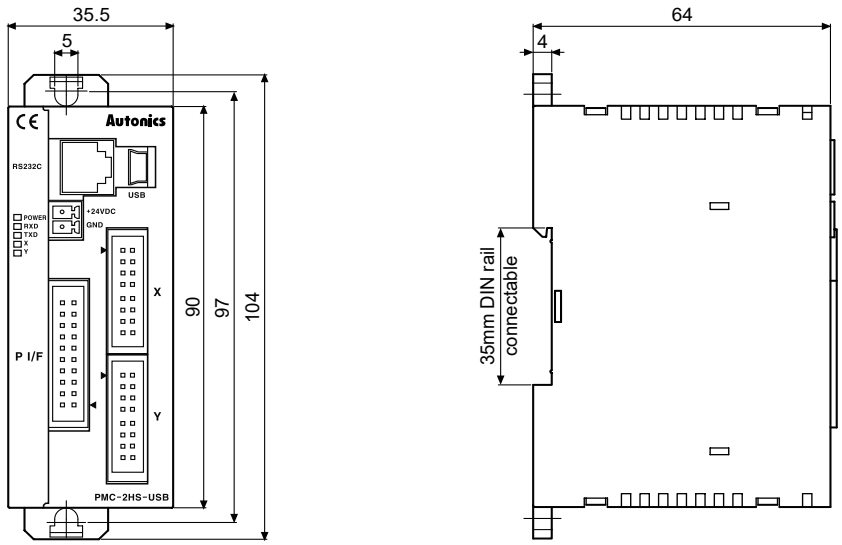
## ▣ Connections



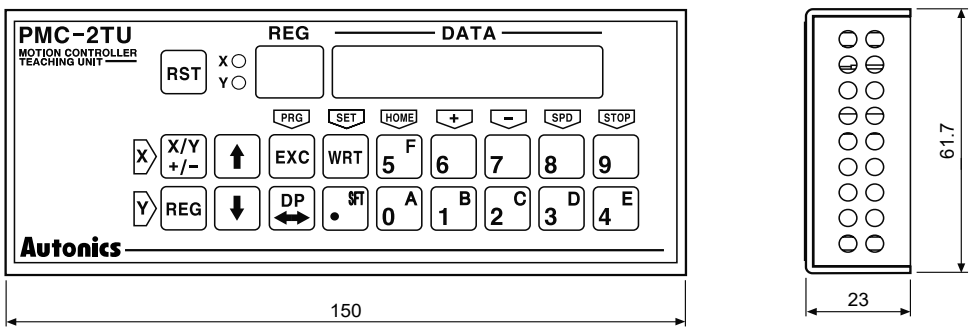

< Basic configuration of the motion controller (configuration only for X-axis) >

## ▣ Dimensions

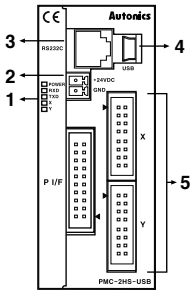
(unit: mm)




### ◎ Sold separately (teaching unit, PMC-2TU-232)

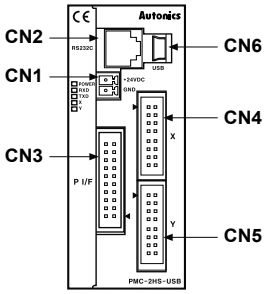


## ▣ Unit Descriptions




1. **Power / Status indicator**
   Used to indicate power, communication status of the controller, and operation status of each axis.
2. **Power connector terminal**
   Used to connect power for controller
3. **RS232C connector terminal**
   Used to connect RS232 serial (RJ12-DSUB9) connection cable
4. **USB/RS485 connector terminal**
   Used to connect USB and RS485 connection cable
5. **External I/O connector terminal**
   Used to operate various drives through input and output of Parallel I/F, X, Y

## ▣ External I/O Terminal Connection




| Connector No. | Description |
|---|---|
| CN1 | Power connector |
| CN2 | RS232C connector (connect with PMC-2TU-232) |
| CN3 | Parallel I/F connector |
| CN4 | X-axis I/O connector |
| CN5 | Y-axis I/O connector |
| CN6 | USB connector |

※PMC-1HS-232 does not have CN5 and CN6,
PMC-1HS-USB does not have CN5, and
PMC-2HS-232 does not have CN6.

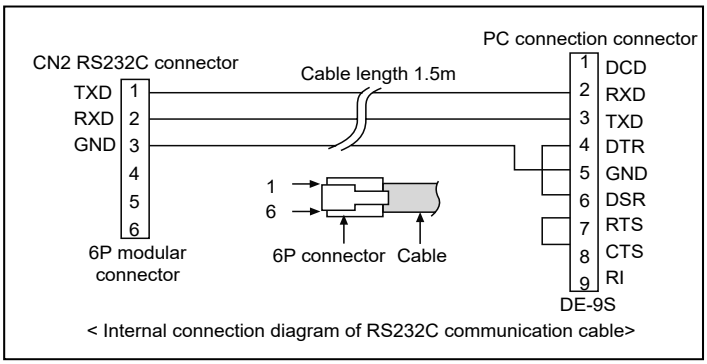
## ▣ CN1: Power Connector

| Pin No. | Signal name |
|---|---|
| 1 | 24VDC |
| 2 | GND (0V) |

## ▣ CN2: RS232C Connector

| Pin No. | Signal name | Input/Output | Description |
|---|---|---|---|
| 1 | TXD | Output | Transmitting data |
| 2 | RXD | Input | Receiving data |
| 3 | GND | — | Ground |
| 4 | — | — | N·C |
| 5 | — | — | |
| 6 | — | — | |

※The internal connection diagram of RS232C communication cable is as shown below.



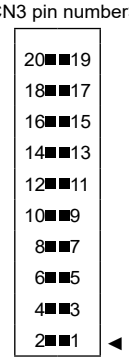

< Internal connection diagram of RS232C communication cable>

## ▣ CN3: Parallel I/F Connector

Motion controller is controlled via Parallel I/F connected with a sequencer or mechanical junction as the dedicated program.
'The input signal is in the ON state' means that the input signal and GEX terminal is connected via a mechanical junction or an open collector.
'The output is in the ON state' means that an open collector output transistor becomes high.

| Pin No. | Signal name | Input/Output | Description |
|---|---|---|---|
| 1 | RESET | Input | Reset |
| 2 | HOME | Input | Home search start |
| 3 | STROBE | Input | Drive start |
| 4 | X/JOG Y+ | Input | X-axis setting/Jog 2 mode Y+ |
| 5 | Y/JOG Y- | Input | Y-axis setting/Jog 2 mode Y- |
| 6 | REGSL0/RUN+/JOG X+ | Input | Register setting 0/Run+/Jog 2 mode X+ |
| 7 | REGSL1/RUN-/JOG X- | Input | Register setting 1/Run-/Jog 2 mode X- |
| 8 | REGSL2/SPD0 | Input | Register setting 2/Drive speed setting 0 |
| 9 | REGSL3/SPD1 | Input | Register setting 3/Drive speed setting 1 |
| 10 | REGSL4/JOG | Input | Register setting 4/Jog setting |
| 11 | REGSL5/STOP | Input | Register setting 5/Drive stop |
| 12 | MODE0 | Input | Operation mode setting 0 |
| 13 | MODE1 | Input | Operation mode setting 1 |
| 14 | X DRIVE/END | Output | X-axis drive/Drive end pulse |
| 15 | Y DRIVE/END | Output | Y-axis drive/Drive end pulse |
| 16 | X ERROR | Output | X-axis error |
| 17 | Y ERROR | Output | Y-axis error |
| 18 | GEX | 0V | GND |
| 19 | GEX | 0V | GND |
| 20 | VEX | +24V | Power output for sensor (less than 24VDC, 100mA) |

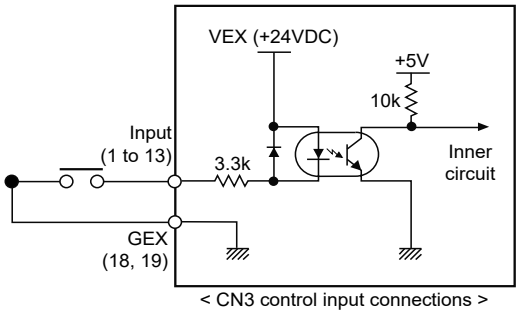
<CN3 pin number>



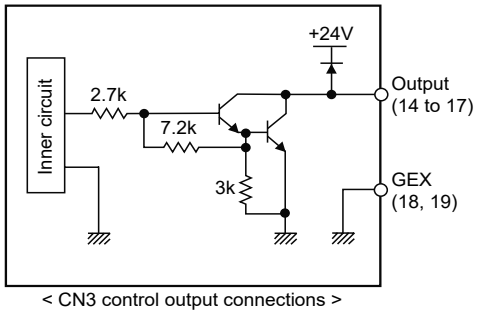

[Hirose connector]: HIF3BA-20PA-2.54DS
[Connector socket specification]: Contact the manufacture for the socket and cable.

| | Specifications | Manufacture |
|---|---|---|
| Connector socket | HIF3BA-20D-2.54R | Hirose Electric |
| I/O cable (sold separately) | CO20-HP□-L, CO20-HP□-R | Autonics |

## ▣ Input/Output Connections of CN3




< CN3 control input connections >




< CN3 control output connections >

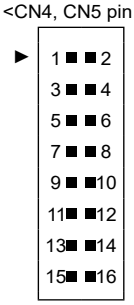
## ▣ CN4, CN5: X, Y-Axis Input/Output Connector

CN4 and CN5 are the I/O signal connector for X-axis and Y-axis respectively.
The pin arrangement of CN4 and CN5 are equal. PMC-1HS does not have CN5.
'n' in the below table means X for CN4 and Y for CN5.

| Pin No. | Signal name | Input/Output | Description |
|---|---|---|---|
| 1 | nP+P | Output | CW +direction drive pulse |
| 2 | nP+N | Output | CW -direction drive pulse |
| 3 | nP-P | Output | CCW +direction drive pulse |
| 4 | nP-N | Output | CCW -direction drive pulse |
| 5 | n OUT0 | Output | General output 0/DCC |
| 6 | n INPOS | Input | Servo In-Position complete |
| 7 | n ALARM | Input | Servo alarm |
| 8 | GEX | 0V | GND |
| 9 | n STOP2 | Input | Encoder Z-phase |
| 10 | n STOP1 | Input | Home |
| 11 | n STOP0 | Input | Near Home |
| 12 | n LMT+ | Input | LMT+ |
| 13 | n LMT- | Input | LMT- |
| 14 | EMG | Input | Emergency stop |
| 15 | GEX | 0V | GND |
| 16 | VEX | +24V | Power output for sensor (less than 24VDC, 100mA) |

※CN4, 5 input/output circuit except drive pulse is same as CN3 input/output circuit.
Drive pulse output of motion controller which input by motor driver is line driver output.

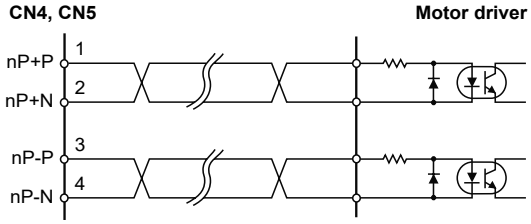
<CN4, CN5 pin number>



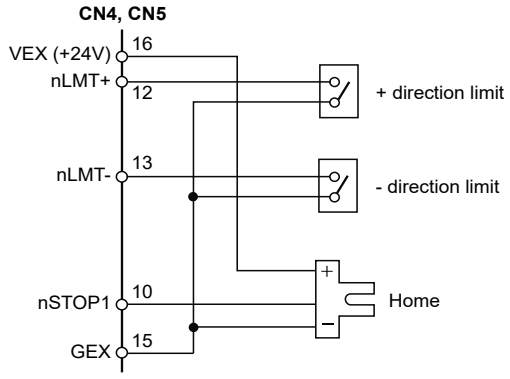

[Hirose connector]: HIF3BA-16PA-2.54DS
[Connector socket specification]: Contact the manufacture for the socket and cable.

| | Specifications | Manufacture |
|---|---|---|
| Connector socket | HIF3BA-16D-2.54R | Hirose Electric |

### E.g. Connection with a motor driver

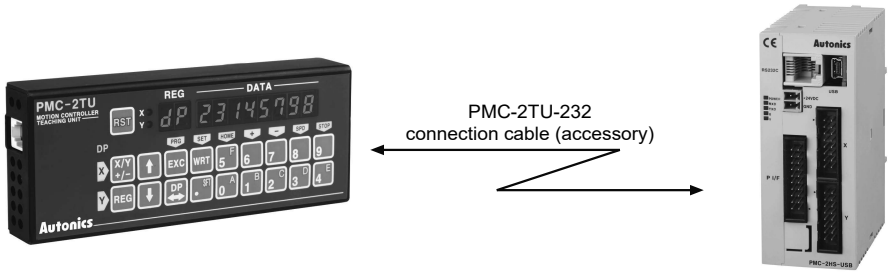



### E.g. Connect of Limit and Home signal



## ▣ Teaching Unit PMC-2TU-232 (sold separately)

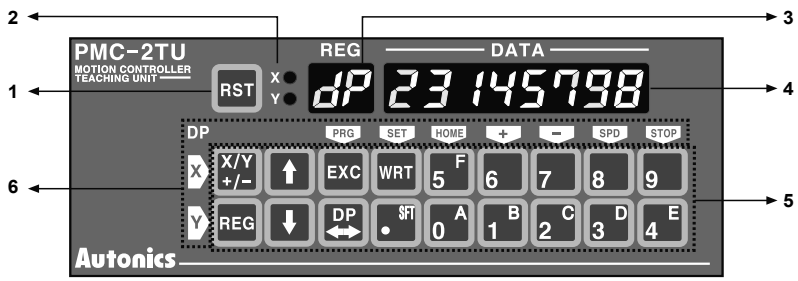
The teaching unit (PMC-2TU-232) is a device that builds the operation mode parameter and operation program for the main body without a PC. In addition, it can carry out the start of the operation program, the home search and Jog operation. The teaching unit is used by connection the private cable (1.5m) to the RS-232C connector (CN2) of the main body.




Teaching unit consists of data edit mode and drive operation mode.
The data edit mode displays a register number to the REG of the display part, and the drive handling mode displays dp (drive operation).
When turned on, it starts as the drive handling mode (dp display).
The [DP] button is used to convert the status of the data edit mode and the drive operation mode.

| Mode | Operation | REG display |
|---|---|---|
| Data edit | • Adding operation mode parameter and operation program<br>• Index drive operation | Register number |
| Drive handling | • Displaying the current position<br>• Jog operation<br>• Home search<br>• Program execution | dP<br>(drive operation) |

The front panel of the teaching unit is as shown below;




**1. Reset:** Reset the controller and teaching unit.
**2. X/Y display:** Display the currently selected axis.
**3. Register number display/dp**
: Displays the currently selected register number when data is editing and dp when operating drive.
**4. Data display**
: Displays the data of each register when data is editing and the current position of the selected axis when operating drive.
**5. Input button**
- X/Y: Converts the selecting axis. It is used to convert the sign of an input value when the value is entered and a mode data that the mode data is entered.
- REG: It is used to input the register number to display.
  If this button is pressed on the data input, the data input is canceled and returns to the state before the data input.
- ↑↓: Increases / decreases the displayed register number.
- EXC: Runs the displayed command. However, this command is only valid for ABS, INC, OUT, OTP and HOM 1 to 4 commands.
- DP: Converts the drive handling status and the data edit status.
- WRT: Adds a value when data is editing.

**6. Button display for drive operation**
: Displays button function as yellow letters to the left or the top of the input button in drive handling status.
The top end and the bottom end of the button handle X-axis and Y-axis respectively.

# PMC-2HSP/PMC-2HSN Series

## 2-axis High Speed Interpolation/Normal Motion Controller

### ▣ Features

- Independent 2-axis controlling with high operating speed of max. 4Mpps
- Linear/Circular interpolation control (PMC-2HSP)
- Realizing a wide variety of operation up to 200 steps using 17 control commands combination (13 commands except arc/linear interpolation command for PMC-2HSN series)
- Various control interface available (USB, RS232C, RS485, Parallel I/F)
- Controlling up to 32 axes (16-unit) via RS485 serial communication (Modbus RTU)
- 4 operation modes: Jog, Continuous, Index, Program mode
- Symmetrical/asymmetrical trapezoid, S-shaped de/acceleration driving function

PMC-2HS□-USB

PMC-2HS□-485

**Please read "Safety Considerations" in the instruction manual before using.**

(except for PMC-2HS□-485)

### ▣ User Manual

Please refer to user manual for detailed instructions and specifications.
Visit our website (www.autonics.com) to download user manual and software [atMotion].
User manual describes installing software, setting parameter and program, operation mode, and multi-axis operation, etc. to operate motion controller.

### ▣ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

< Computer specification for using software>

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

< atMotion screen >

### ▣ Standard Operation Method

There are three methods to operate the motion controller.

- Operation by PC
  Connect a PC and the controller with communication cable and run dedicated program (atMotion).
- Operation by Parallel I/F
  Connect a sequence controller or switch to Parallel I/F.
- Operation by serial communication (dedicated communication protocol)
  Using serial communication protocol, operate according to program writing by user.

### ▣ Ordering Information

**PMC** – **2HSP** – **USB**

| | | |
|---|---|---|
| Communication type | USB | USB / RS232C |
| | 485 | RS485 / RS232C |
| Axis/Type | 2HSP | 2-axis high speed interpolation |
| | 2HSN | 2-axis high speed normal |
| Item | PMC | Programmable Motion Controller |

# 2-axis High Speed Interpolation/Normal Motion Controller

## ▣ Specifications

| Model | | PMC-2HSP-USB | PMC-2HSP-485 | PMC-2HSN-USB | PMC-2HSN-485 |
|---|---|---|---|---|---|
| Control axes | | 2-axis | | | |
| Motor for control | | Pulse train input stepper motor or servo motor | | | |
| Power supply | | 24VDC⎓ | | | |
| Allowable voltage range | | 90 to 110% of rated voltage | | | |
| Power consumption | | Max. 6W | | | |
| In-Position range | | -8,388,608 to 8,388,607 (selectable absolute/relative value, available pulse-scaling function) | | | |
| Drive speed | | 1pps to 4Mpps (1 to 8,000pps×magnification 1 to 500) | | | |
| Pulse output method | | 1-Pulse/2-Pulse output method (line driver output) | | | |
| Operation mode | | Jog / Continuous / Index / Program mode | | | |
| Number of index steps | | 64 indexes per axis | | | |
| Program function | Steps | 200-step | | | |
| | Control command | ABS, INC, HOM, LID※1, CID※1, FID※1, RID※1, TIM, JMP, REP, RPE, ICJ, IRD, OPC, OPT, NOP, END | | | |
| | Start | Available power On program auto start setting | | | |
| | Home search | Available power On home search setting | | | |
| Home search mode | | High speed near home search (Step 1) → Low speed near home search (Step 2) → Encoder Z phase search (Step 3) → Offset movement (Step 4) | | | |
| I/O | | • Parallel I/F (CN3): 13 inputs, 4 outputs<br>• X-axis (CN4) / Y-axis (CN5): 8 inputs, 6 outputs (general-purpose I/O, two of each) | | | |
| Environ-ment | Ambient temperature | 0 to 45℃, storage: -15 to 70℃ | | | |
| | Ambient humidity | 20 to 90%RH, storage: 20 to 90%RH | | | |
| Accessory | | • [Common] Power connector, I/O connector: 3 (PI/F, X-axis, Y-axis), RS232C communication cable (1.5m): 1<br>• [USB type] USB communication cable 1m: 1 •[RS485 type] RS485 connector: 1 | | | |
| Approval | | CE K | CE | CE K | CE |
| Weight※2 | | Approx. 344g (approx. 101.5g) | Approx. 308.7g (approx. 101.6g) | Approx. 344g (approx. 101.5g) | Approx. 308.7g (approx. 101.6g) |

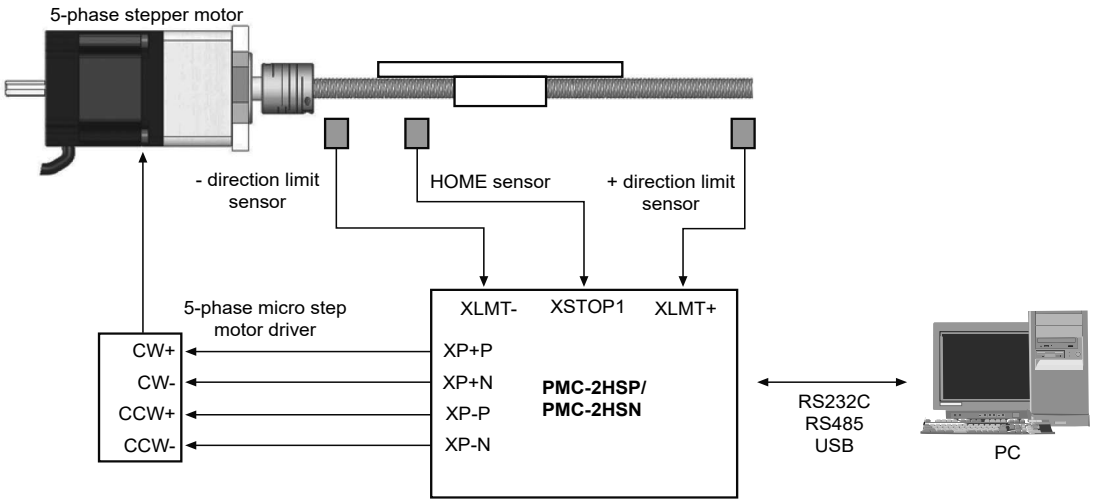
※1: These commands are only for PMC-2HSP series.
※2: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing of condensation.

## ▣ Program Commands

| Command type | Code | Description |
|---|---|---|
| Drive commands | ABS | Move absolute position |
| | INC | Move relative position |
| | HOM | Home search |
| | LID※1 | 2-axis linear interpolation |
| | CID※1 | 2-axis CW circular interpolation |
| | FID※1 | 2-axis CW arc interpolation |
| | RID※1 | 2-axis CCW arc interpolation |
| I/O commands | ICJ | Jump input condition |
| | IRD | Stand-by external input |
| | OPC | ON/OFF output port |
| | OPT | ON pulse from output port |
| Program control commands | JMP | Jump |
| | REP | Start repetition |
| | RPE | End repetition |
| | END | End program |
| Others | TIM | Timer |
| | NOP | No operation |

※1: These commands are only for PMC-2HSP series.

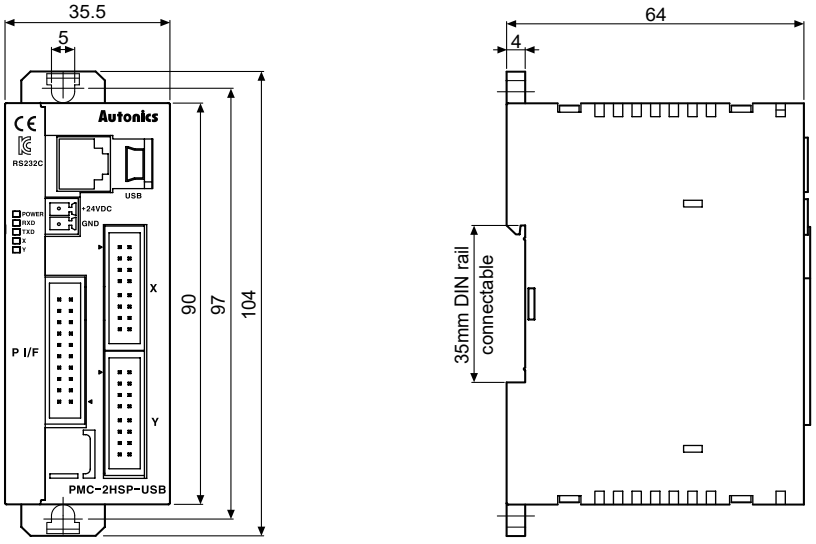
## ▣ Connections




< Basic configuration of the motion controller (configuration only for X-axis) >

## ▣ Dimensions

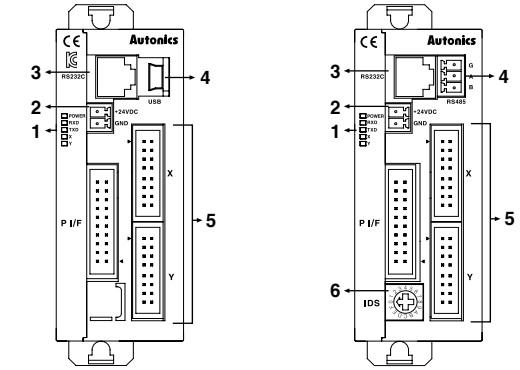
(unit: mm)



# 2-axis High Speed Interpolation/Normal Motion Controller

## ▣ Unit Descriptions

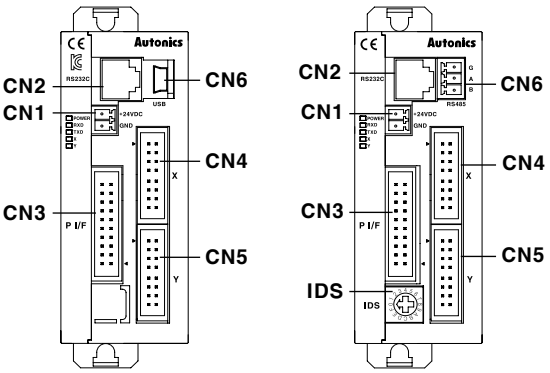
◎ PMC-2HS□-USB ◎ PMC-2HS□-485




1. **Power / Status indicator**
   Used to indicate power, communication status of the controller, and operation status of each axis.
2. **Power connector terminal**
   Used to connect power for controller
3. **RS232C connector terminal**
   Used to connect RS232 serial (RJ12-DSUB9) connection cable
4. **USB/RS485 connector terminal**
   Used to connect USB and RS485 connection cable
5. **External I/O connector terminal**
   Used to operate various drives through input and output of Parallel I/F, X, Y
6. **ID select switch**
   Used to set unique ID for each node in case of RS485 communication

## ▣ External I/O Terminal Connection

◎ PMC-2HS□-USB ◎ PMC-2HS□-485




● **Connector**

| Connector no. | Description |
|---|---|
| CN1 | Power connector |
| CN2 | RS232C connector |
| CN3 | Parallel I/F connector |
| CN4 | X-axis I/O connector |
| CN5 | Y-axis I/O connector |
| CN6 | PMC-2HSP/2HSN-USB: USB connector |
| | PMC-2HSP/2HSN-485: RS485 connector |
| IDS | ID selection switch |



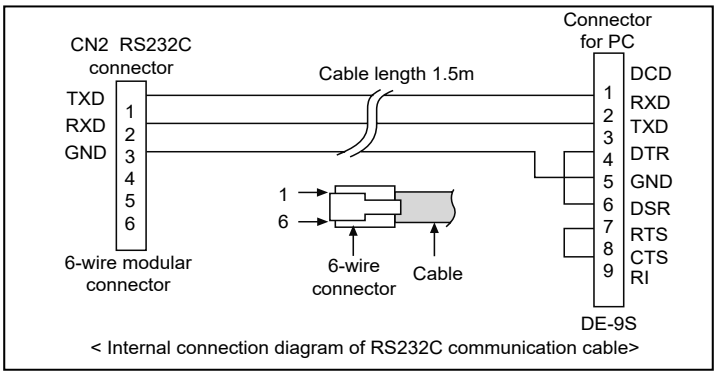
## ▣ CN1: Power Connector

| Pin no. | Signal name |
|---|---|
| 1 | 24VDC |
| 2 | GND (0V) |

## ▣ CN2: RS232C Connector

| Pin no. | Signal name | I/O | Description |
|---|---|---|---|
| 1 | TXD | Output | Receiving data |
| 2 | RXD | Input | Transmitting data |
| 3 | GND | — | Ground |
| 4 | — | — | N·C |
| 5 | — | — | |
| 6 | — | — | |

※The internal connection diagram of RS232C communication cable is shown on the right.



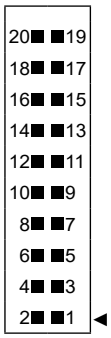

< Internal connection diagram of RS232C communication cable>

## ▣ CN3: Parallel I/F Connector

The Parallel I/F connector which is connected with a sequencer or mechanical contacts operates motion controller same as PC program. When input signal is ON, the input signal terminal and GEX terminal are connected by mechanical contacts or open collector output and open collector output transistor is ON when the output signal is ON.

| Pin no. | Signal name | I/O | Description |
|---|---|---|---|
| 1 | RESET | Input | Reset |
| 2 | HOME | Input | Home search start command |
| 3 | STROBE | Input | Drive start command |
| 4 | X/JOG Y+ | Input | X-axis designate/Jog Y+ |
| 5 | Y/JOG Y- | Input | Y-axis designate/Jog Y- |
| 6 | STEPSL0/RUN+/JOG X+ | Input | Register designate 0/Run+/Jog X+ |
| 7 | STEPSL1/RUN-/JOG X- | Input | Register designate 1/Run-/Jog X- |
| 8 | STEPSL2/SPD0 | Input | Register designate 2/Drive speed designate 0 |
| 9 | STEPSL3/SPD1 | Input | Register designate 3/Drive speed designate 1 |
| 10 | STEPSL4/JOG | Input | Register designate 4/Jog designate |
| 11 | STEPSL5/STOP | Input | Register designate 5/Drive stop |
| 12 | MODE0 | Input | Operation mode designate 0 |
| 13 | MODE1 | Input | Operation mode designate 1 |
| 14 | X DRIVE/END | Output | X-axis drive/Drive end pulse |
| 15 | Y DRIVE/END | Output | Y-axis drive/Drive end pulse |
| 16 | X ERROR | Output | X-axis error |
| 17 | Y ERROR | Output | Y-axis error |
| 18 | GEX | — | Ground |
| 19 | GEX | — | Ground |
| 20 | VEX | — | Power supply for sensor (24VDC, max. 100mA) |

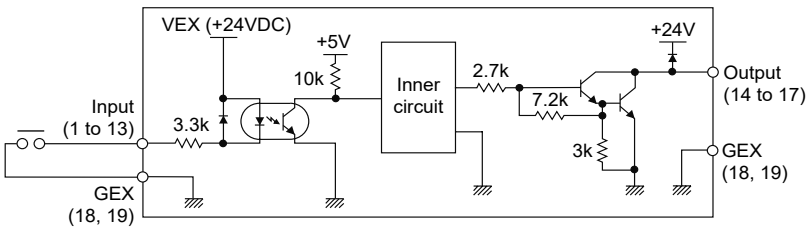
<CN3 pin number>




[Hirose connector]: HIF3BA-20PA-2.54DS
[Connector socket specification]: Contact the manufacture for the socket and cable.

| | Specifications | Manufacture |
|---|---|---|
| Connector socket | HIF3BA-20D-2.54R | Hirose Electric |
| I/O cable (sold separately) | CO20-HP□-L, CO20-HP□-R | Autonics |

## ▣ Input/Output Connections of CN3

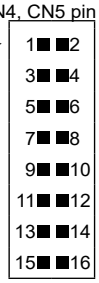


## ▣ CN4, CN5: X, Y-Axis Input/Output Connector

CN4 and CN5 are I/O signals for X-axis and Y-axis respectively.
The pin arrangement of CN4 and CN5 are equal. 'n' in the table means X for CN4 and Y for CN5.

| Pin no. | Signal name | I/O | Description |
|---|---|---|---|
| 1 | n P+P | Output | Drive pulse in the CW + direction |
| 2 | n P+N | Output | Drive pulse in the CW - direction |
| 3 | n P-P | Output | Drive pulse in the CCW + direction |
| 4 | n P-N | Output | Drive pulse in the CCW - direction |
| 5 | n OUT0 | Output | General output 0 |
| 6 | n OUT1 | Output | General output 1 |
| 7 | n IN0 | Input | General input 0 |
| 8 | n IN1 | Input | General input 1 |
| 9 | n STOP2 | Input | Encoder Z-phase |
| 10 | n STOP1 | Input | Home |
| 11 | n STOP0 | Input | Near Home |
| 12 | n LMT+ | Input | + direction limit |
| 13 | n LMT- | Input | - direction limit |
| 14 | EMG | Input | Emergency stop |
| 15 | GEX | — | Ground |
| 16 | VEX | — | Power supply for sensor (24VDC, max. 100mA) |

<CN4, CN5 pin no.>

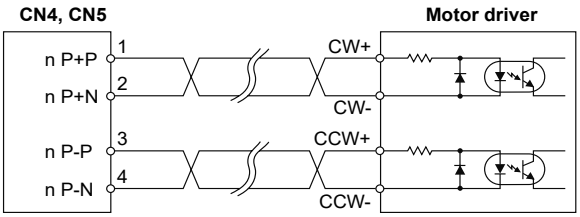



[Hirose connector]: HIF3BA-16PA-2.54DS
[Connector socket specification]: Contact the manufacture for the socket and cable.

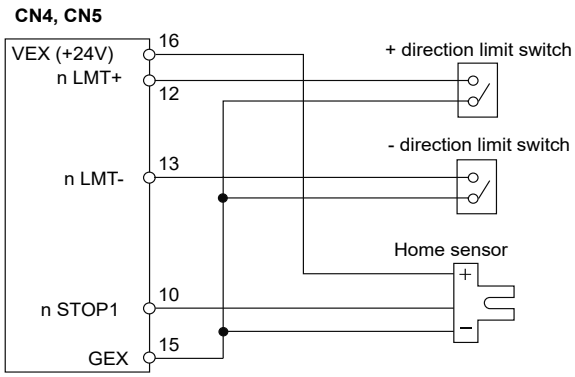
| | Specifications | Manufacture |
|---|---|---|
| Connector socket | HIF3BA-16D-2.54R | Hirose Electric |

※CN4, 5 input/output is same as CN3 input/output connections.
Drive pulse output of motion controller which is inputted to motor driver is line driver output.

### E.g. Connection with a motor driver

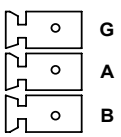



### E.g. Connect of Limit and Home signal




## ▣ CN6: RS485 Connector

| Pin no. | Signal name | I/O | Description |
|---|---|---|---|
| 1 | B (-) | I/O | Transmitting / Receiving data |
| 2 | A (+) | I/O | Transmitting / Receiving data |
| 3 | G | — | ※**1** |



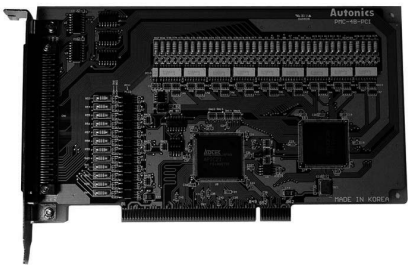

※1: Connect the ground when it is required depending on communication environments.

# PMC-4B-PCI

## 4-axis Board Type Programmable Motion Controller

### ■ Features

- Available to control 4-axis independent AC servo motor and stepper motor
- PC-PCI card
- Auto home search and synchronous operation
- Interpolation on circular/linear, bit pattern/continuous/ accel/deceleration drive
- 2/3-axis constant linear velocity.
- Supports Labview library and help, C language library and examples (download at Autonics website)



**Please read "Safety Considerations" in the instruction manual before using.**

**※Visit our website (www.autonics.com) to download manual and software.**

### ■ Software (atMotion)

- atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
- atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.
- Visit our website (www.autonics.com) to download the user manual and software.

### ■ Ordering Information

**PMC** – **4B** – **PCI**

| | | |
|---|---|---|
| Connection type | PCI | PCI |
| Axis/Type | 4B | 4-axis board type |
| Item | PMC | Programmable motion controller |

### ■ Specifications

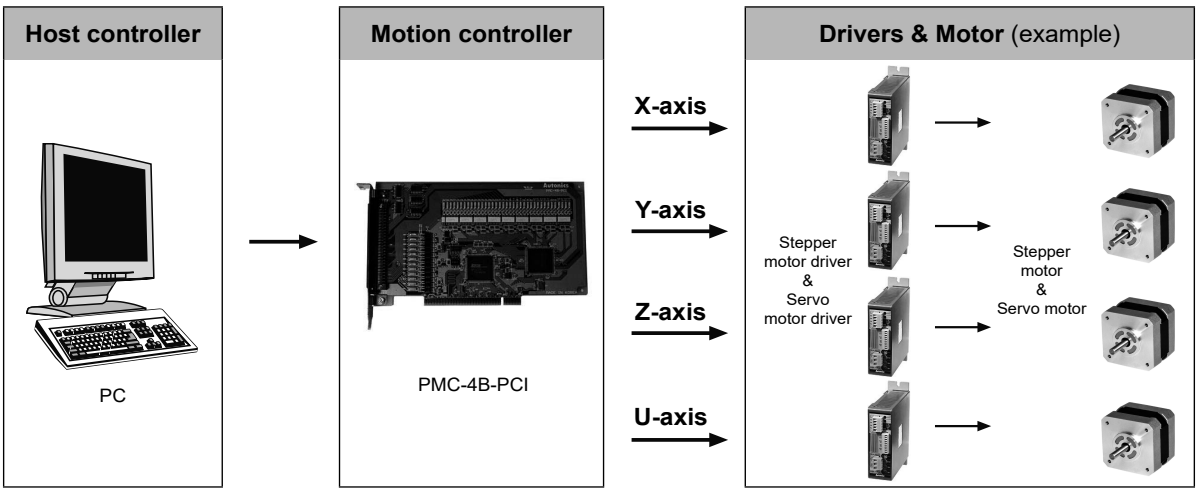
| Model | | **PMC-4B-PCI** |
|---|---|---|
| Control axes | | 4-axis |
| Power supply | | 5VDC⎓ (uses PC inner power) |
| External power supply | | 12-24VDC⎓ |
| Allowable voltage range | | 90 to 110% of rated voltage |
| CPU data bus | | 8/16-bit selectable |
| 2/3-axis linear interpolation | Range | -2,147,483,648 to 2,147,483,647 for each axis |
| | Speed | 1pps to 4Mpps |
| | Position accuracy | Max. ±0.5LSB (within all interpolation range) |
| Circular interpolation | Range | -2,147,483,648 to 2,147,483,647 for each axis |
| | Speed | 1pps to 4Mpps |
| | Position accuracy | Max. ±1 LSB (within all interpolation range) |
| 2/3-axis bit pattern interpolation speed | | 1 to 4Mpps (depends on CPU data setup time) |
| Other interpolations | | Selectable the axis, constant linear velocity, consecutive interpolation, interpolation step transmission (command, external signal) |
| Driver pulse output (X, Y-axis common specifications) | | Output speed range: 1pps to 4Mpps |
| | | Output speed accuracy: max ±0.1% (for setting value) |
| | | Speed magnification: 1 to 500 |
| | | S jerk speed: 954 to $62.5\times10^6$pps/sec (mag.=1) (accel/decel increase rate) $477\times10^3$ to $31.25\times10^9$pps/sec (mag.=500) |
| | | Accel/Decel: 125 to $1\times10^6$pps/sec (mag.=1) $62.5\times10^3$ to $500\times10^6$pps/sec (mag.=500) |
| | | Initial velocity: 1 to 8,000pps (mag.=1) / 500 to $4\times10^6$pps (mag.=500) |
| | | Drive speed: 1 to 8,000pps (mag.=1) / 500 to $4\times10^6$pps (mag.=500) |
| | | Number of output pulses: 0 to 4,294,967,295 (fixed pulse drive) |
| | | Speed curve: constant speed, symmetric/asymmetric linear accel/decel, parabola S curve drive |
| | | Fixed pulse drive deceleration mode auto deceleration (asymmetric linear accel/decel function)/ Manual deceleration |
| | | Changeable output pulse for driving, drive speed |
| | | Selectable individual 2-pulse/1-pulse direction method |
| | | Selectable drive pulse logic level, changeable output terminal |
| Encoder input pulse | | Inputtable 2-phase pulse/Up-Down pulse, selectable 2-phase pulse 1/2/4 multiply |

## ▣ Specifications

| | | |
|---|---|---|
| Position counter | | Logic position counter (for output pulse) count range: -2,147,483,648 to +2,147,483,647<br>Actual position counter (for input pulse) count range: -2,147,483,648 to 2,147,483,647 |
| Compare register | | Comp. +register position comparison range: -2,147,483,648 to +2,147,483,647 |
| | | Comp. -register position comparison range: -2,147,483,648 to +2,147,483,647 |
| | | Output/Signal output when the present value of the counter and the user position counter are same by comparing |
| | | Enables to operate as software limit |
| Auto home search | | High speed near home search (Step1) → Low speed near home search (Step2) |
| Interrupt function (except interpolation) | | 1 drive pulse output<br>when changing position counter ≥ Comp.-, when changing position counter ≥ Comp.+,<br>when changing position counter < Comp.-, when changing position counter < Comp.+,<br>when starting constant speed in accel/decel drive, when ending constant speed in accel/decel drive when ending drive, when ending auto home search, when running synchronous operation |
| Drive adjustment by external signal | | Enable to fixed/continuous pulse drive of +/- direction by EXP+/EXP- signal |
| | | Enable to drive 2-phase encoder signal mode (encoder input) |
| External deceleration stop/ immediate stop signal | | IN 0 to 3 each axis 4-point |
| | | Selectable signal valid/invalid and logical level, usable as general input |
| Input signal for servo motor | | Selectable alarm, INPOS signal valid/invalid and logic level |
| General output signal | | OUT 4 to 7 each axis 4-point (uses same terminal with drive status output signal) |
| Drive status signal output | | ASND (accelerating), DSND (decelerating) |
| Overrun limit signal input | | Selectable + direction, - direction each 1-point and logic level |
| | | At active, selectable immediate stop/decelerate stop |
| Emergency stop signal input | | EMG 1-point, stops drive pulse of all axes by low level |
| Integral filter | | Built-in integral filter at each input signal input terminal, selectable pass time (8 types) |
| Others | | Selectable the axis, constant linear velocity, consecutive interpolation, interpolation step transmission (command, external signal) |
| Environment | Ambient temperature | 0 to 45℃, storage: -10 to 55℃ |
| | Ambient humidity | 35 to 85%RH, storage: 35 to 85%RH |
| Approval | | CE |
| Weight※1 | | Approx. 654.4g (approx. 100.4g) |

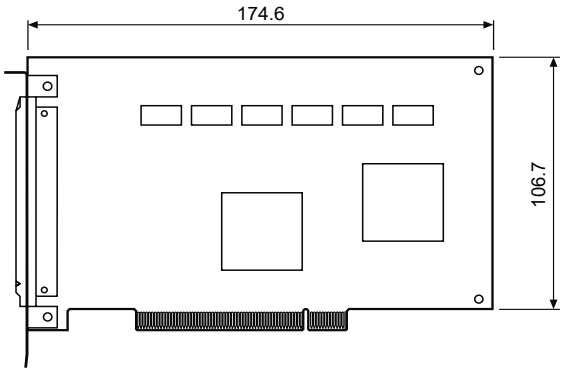
※1: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing of condensation.

## ▣ System



## ▣ Dimensions

(unit: mm)

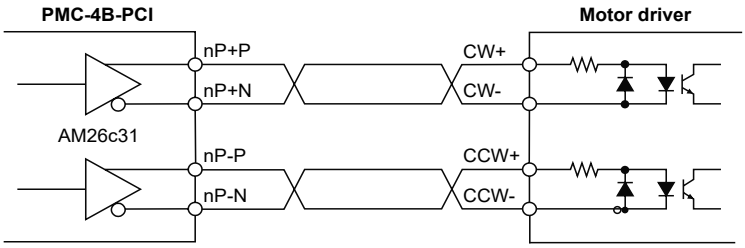



## ▣ Connections

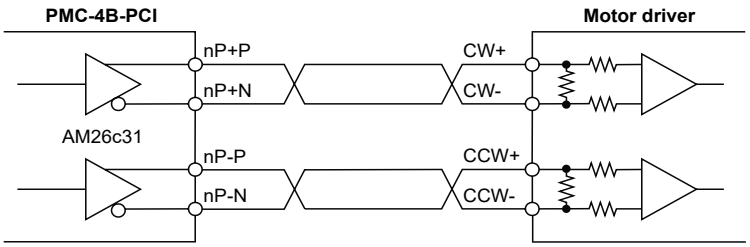
### ◎ Connection of pulse output signal (nP+P/N, nP-P/N)

Drive pulse output generates drive pulse signal of +/- direction using line driver (AM26c31) of differential output.
Followings are examples of connection with motor drivers with photocoupler or line driver input.

**● Example for the connection with a motor driver of photocoupler input**



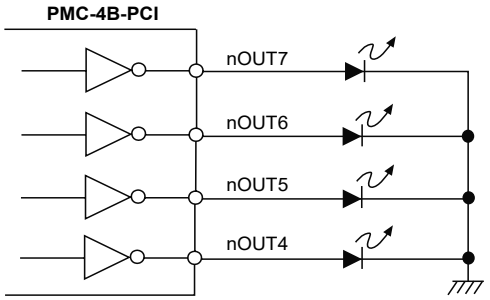

**● Example for the connection with a motor driver of line driver**




※It is recommended to use twisted pair shield wire for pulse output signal of driver operation regarding EMC.

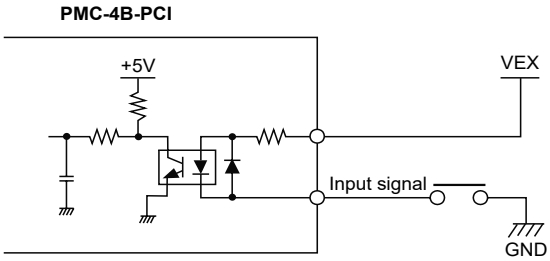
### ◎ Connection of common output signal (nOUT4 to 7)

Output signal is outputted by buffer (74LS06), and all outputs are OFF after reset.



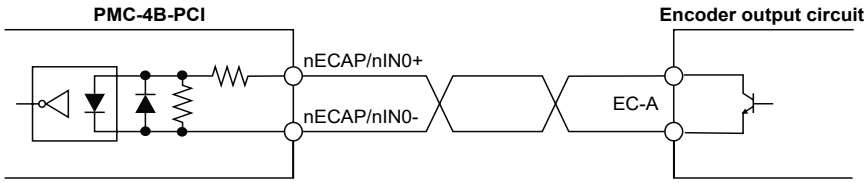
## ▣ Connections

### ◎ Connection of input signal (nIN1 to 3, nINPOS, nALRAM, nEXP+/-, EMG)

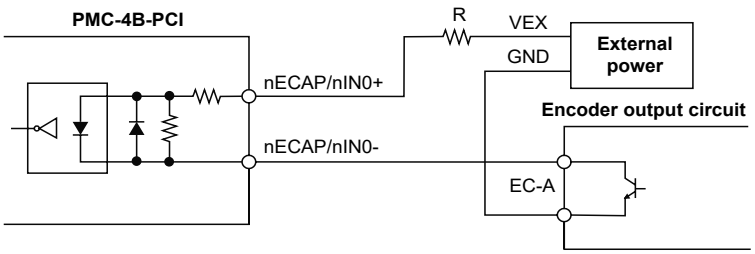



### ◎ Connection of encoder input signal (nECAP/N, nECBP/N) and nINO+/- signal

● **Example for the connection with line driver of differential output**




● **Example for the connection with encoder of NPN open collector output**

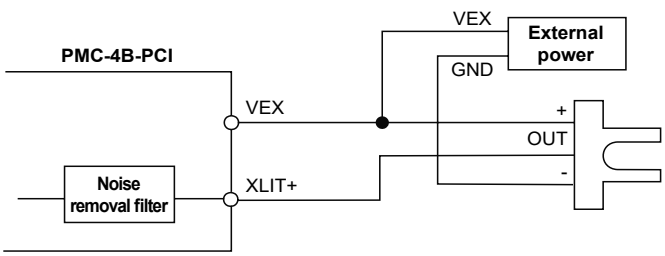



| External voltage | Resistance (R) |
|---|---|
| 5V | 0 |
| 12V | 820Ω 1/4W |
| 24V | 2kΩ 1W |

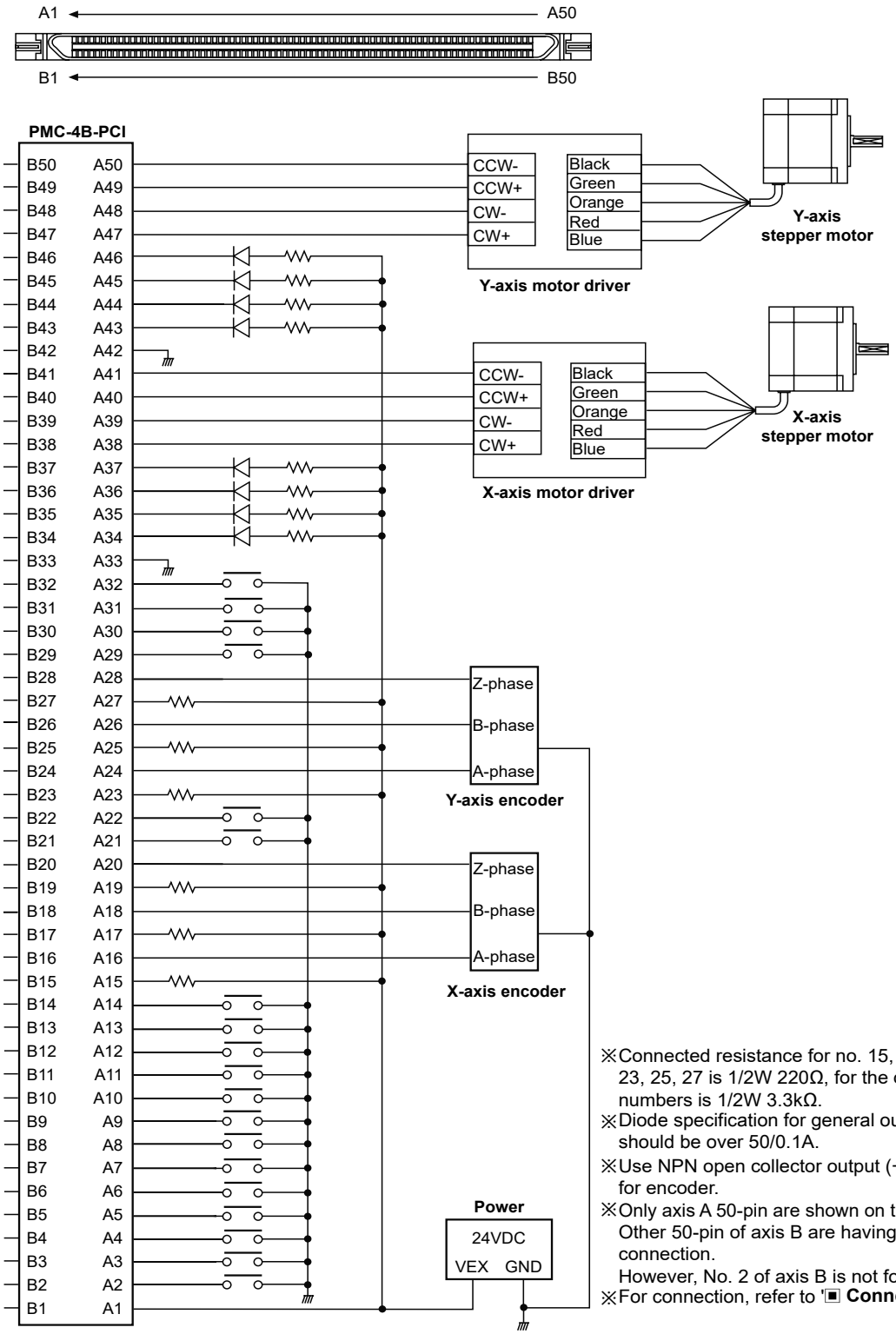
※Encoder A, B, Z phase are same connection.

### ◎ Connection of limit input signal (nLMIT+/-)

The outgoing cable of limit signal can be affected by noise. Since it can not be removed only with photocoupler, the filter circuit is built in PMC-4B-PCI. Please set enough passing time (FL=2, 3).



## ▣ Input/Output Connections



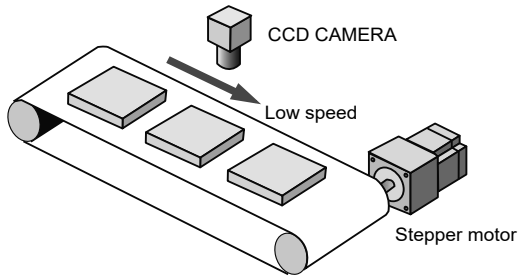
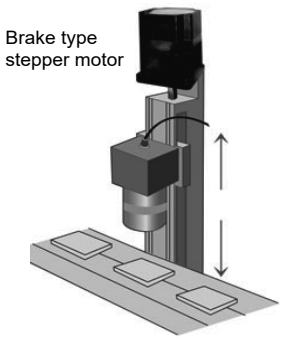
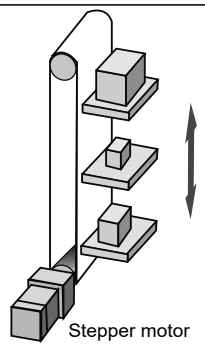
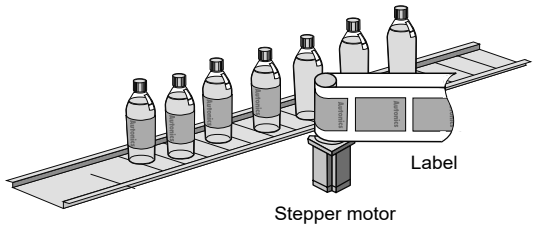
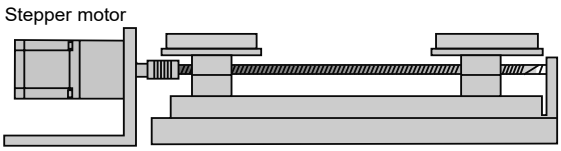
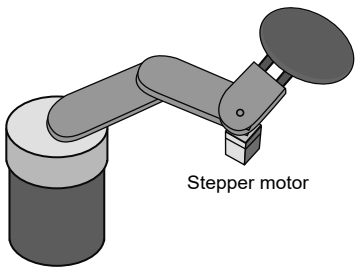
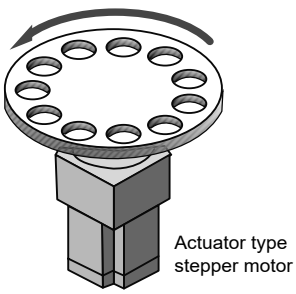
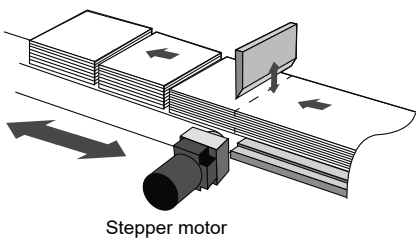

※Connected resistance for no. 15, 17, 19, 23, 25, 27 is 1/2W 220Ω, for the other numbers is 1/2W 3.3kΩ.
※Diode specification for general output pin should be over 50/0.1A.
※Use NPN open collector output (+12VDC) for encoder.
※Only axis A 50-pin are shown on the figure. Other 50-pin of axis B are having same connection.
However, No. 2 of axis B is not for use.
※For connection, refer to '▣ **Connections**'.

## ▣ Input/Output Specifications

| Pin no. | Signal | Description | Pin no. | Signal | Pin description |
|---|---|---|---|---|---|
| A1 | VEX | 12-24VDC | B1 | VEX | 12-24VDC |
| A2 | EMG | Emergency stop (4-axis stop) | B2 | - | N·C |
| A3 | XLMIT+ | X-axis + direction limit | B3 | ZLMIT+ | Z-axis + direction limit |
| A4 | XLMIT- | X-axis - direction limit | B4 | ZLMIT- | Z-axis – direction limit |
| A5 | XIN1 | X-axis input signal (home signal) | B5 | ZIN1 | Z-axis input signal (home signal) |
| A6 | XIN0 | X-axis input signal (near home signal) | B6 | ZIN0 | Z-axis input signal (near home signal) |
| A7 | XIN3 | X-axis input signal (encoder Z phase signal) | B7 | ZIN3 | Z-axis input signal (encoder Z phase signal) |
| A8 | YLMIT+ | Y-axis + direction limit | B8 | ULMIT+ | U-axis +direction limit |
| A9 | YLMIT- | Y-axis - direction limit | B9 | ULMIT- | U-axis -direction limit |
| A10 | YIN1 | Y-axis input signal (home signal) | B10 | UIN1 | U-axis input signal (home signal) |
| A11 | YIN0 | Y-axis input signal (near home signal) | B11 | UIN0 | U-axis input signal (near home signal) |
| A12 | YIN3 | Y-axis input signal (encoder Z phase signal) | B12 | UIN3 | U-axis input signal (encoder Z phase signal) |
| A13 | XINPOS | X-axis In-Position input | B13 | ZINPOS | Z-axis In-Position input |
| A14 | XALRAM | X-axis alarm input | B14 | ZALRAM | Z-axis alarm input |
| A15 | XECAP | X-axis Encoder A phase+ | B15 | ZECAP | Z-axis Encoder A phase+ |
| A16 | XECAN | X-axis Encoder A phase- | B16 | ZECAN | Z-axis Encoder A phase- |
| A17 | XECBP | X-axis Encoder B phase+ | B17 | ZECBP | Z-axis Encoder B phase+ |
| A18 | XECBN | X-axis Encoder B phase- | B18 | ZECBN | Z-axis Encoder B phase- |
| A19 | XECZP | X-axis Encoder Z phase+ | B19 | ZECZP | Z-axis Encoder Z phase+ |
| A20 | XECZN | X-axis Encoder Z phase- | B20 | ZECZN | Z-axis Encoder Z phase- |
| A21 | YINPOS | Y-axis In-Position input | B21 | UINPOS | U-axis In-Position input |
| A22 | YALARM | Y-axis alarm input | B22 | UALARM | U-axis alarm input |
| A23 | YECAP | Y-axis Encoder A phase+ | B23 | UECAP | U-axis Encoder A phase+ |
| A24 | YECAN | Y-axis Encoder A phase- | B24 | UECAN | U-axis Encoder A phase- |
| A25 | YECBP | Y-axis Encoder B phase+ | B25 | UECBP | U-axis Encoder B phase+ |
| A26 | YECBN | Y-axis Encoder B phase- | B26 | UECBN | U-axis Encoder B phase- |
| A27 | YECZP | Y-axis Encoder Z phase+ | B27 | UECZP | U-axis Encoder Z phase+ |
| A28 | YECZN | Y-axis Encoder Z phase- | B28 | UECZN | U-axis Encoder Z phase- |
| A29 | XEXP+ | X-axis manual + drive | B29 | ZEXP+ | Z-axis manual + drive |
| A30 | XEXP- | X-axis manual - drive | B30 | ZEXP- | Z-axis manual - drive |
| A31 | YEXP+ | Y-axis manual + drive | B31 | UEXP+ | U-axis manual + drive |
| A32 | YEXP- | Y-axis manual - drive | B32 | UEXP- | U-axis manual - drive |
| A33 | GND | GND | B33 | GND | GND |
| A34 | XOUT4/CMPP | X-axis general output | B34 | ZOUT4/CMPP | Z-axis general output |
| A35 | XOUT5/CMPM | X-axis general output | B35 | ZOUT5/CMPM | Z-axis general output |
| A36 | XOUT6/ASND | X-axis general output | B36 | ZOUT6/ASND | Z-axis general output |
| A37 | XOUT7/DSND | X-axis general output | B37 | ZOUT7/ DSND | Z-axis general output |
| A38 | XP+P | X-axis +direction +drive signal output | B38 | ZP+P | Z-axis +direction +drive signal output |
| A39 | XP+N | X-axis +direction -drive signal output | B39 | ZP+N | Z-axis +direction -drive signal output |
| A40 | XP-P | X-axis -direction +drive signal output | B40 | ZP-P | Z-axis -direction +drive signal output |
| A41 | XP-N | X-axis -direction -drive signal output | B41 | ZP-N | Z-axis -direction -drive signal output |
| A42 | GND | GND | B42 | GND | GND |
| A43 | YOUT4/CMPP | Y-axis general output | B43 | UOUT4/CMPP | U-axis general output |
| A44 | YOUT5/CMPM | Y-axis general output | B44 | UOUT5/CMPM | U-axis general output |
| A45 | YOUT6/ASND | Y-axis general output | B45 | UOUT6/ASND | U-axis general output |
| A46 | YOUT7/DSND | Y-axis general output | B46 | UOUT7/DSND | U-axis general output |
| A47 | YP+P | Y-axis +direction +drive signal output | B47 | UP+P | U-axis +direction +drive signal output |
| A48 | YP+N | Y-axis +direction -drive signal output | B48 | UP+N | U-axis +direction -drive signal output |
| A49 | YP-P | Y-axis -direction +drive signal output | B49 | UP-P | U-axis -direction +drive signal output |
| A50 | YP-N | Y-axis -direction -drive signal output | B50 | UP-N | U-axis -direction -drive signal output |

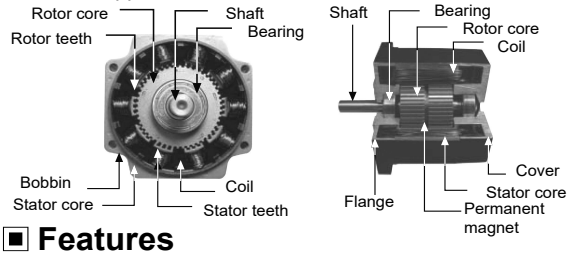
# Applications

## ▣ Applications

| Inspection facilities | Inspection facilities |
|---|---|
|  |  |
| Belt drive | Label position control in packaging machine |
|  |  |
| Ball screw drive | Wafer transfer robot control |
|  |  |
| Index Table | Cutting position control |
|  |  |

## ▣ Overview

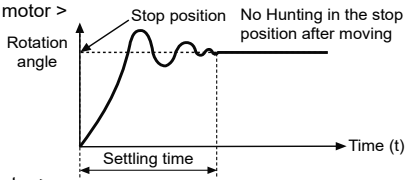
Stepper motor is a high accuracy position control motor which digital control rotating by a set mechanical angle decided by input pulses is available. It is available to control a rotation angle and speed accurately and it has lots of proper applications to be used. We have hybrid stepper motor with high characteristic such as a high accuracy and torque, which is used in a wide range of FA to OA field. Also, we have the driver (MD5/MD2U Series) and controllers (PMC Series) in order to get a high efficiency with our stepper motor.



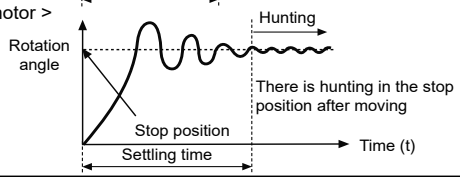

## ▣ Features

- **It is available to control a rotation angle and speed easily.**
  5-phase stepper motor is available to control the rotation angle and speed easily by electrical pulse (digital) signal as it is the motor rotating by a set mechanical angle decided by input pulse (digital) signal.
- **It is a high torque and response motor.**
  Stepper motor is small & light and can get a high torque. Also, rapid starting/stopping and reversing are available due to rapid acceleration as it has a stopping and starting torque.
- **It is available to control a position in a high resolution and accuracy.**
  Our 5-phase hybrid stepper motor rotates by 0.72°/ pulse and it is a high-resolution motor, which is available to rotate by 0.00288°/pulse when using micro step driver with 250 division. And, it stops in a high accuracy of ±3min (0.05° at non-load) when driving by 0.72°/pulse.
- **It has a self-holding torque.**
  5-phase stepper motor has a high holding torque when stopped in power on.
  Therefore, it is available to hold a stop position without mechanical break or control signal.
- **Settling time is short and there is no hunting status when stopped.**
  Settling time which motor axis is stopped after normal and reverse rotation by load inertia is short when motor is stopped at a stop position. There is no hunting which motor axis is stopped with delicate normal and reverse rotation when holding a stop position after settling time.

< Stepper motor >




< Servo motor >

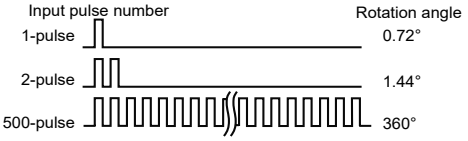



## ▣ Usage of Stepper Motor

Stepper motor can control a rotation angle and speed easily by number and speed of input pulse as follows.

● Rotation angle control

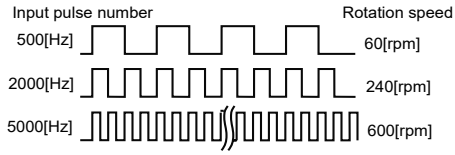
Rotation angle[ ° ]=Step angle[ ° ]×Pulse number




< Full step operation of 5-phase stepper motor (0.72°) >

● Rotation speed control

$$\text{Rotation speed[rpm]} = \frac{\text{Pulse speed[Hz]}}{\text{360°/Stop angle[°]}} \times 60\text{[Sec]}$$




< Full step operation of 5-phase stepper motor (0.72°) >

A driver only for the stepper motor and the controller only for controlling the driver are necessary in order to drive the stepper motor.

### ● Stepper motor

Autonics has various stepper motor to meet customer's needs.

### ● 5-phase stepper motor

### ● Driver

It is an exclusive driving circuit to drive the stepper motor and provides power to the motor in the order of the motor phase. We have the dedicated drivers for stepper motor.

### ● 5-phase stepper motor driver

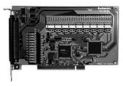
### ● 2-phase stepper motor driver

● **Controller**

It controls a rotation angle and speed etc. of the stepper motor. We have the dedicated controllers.

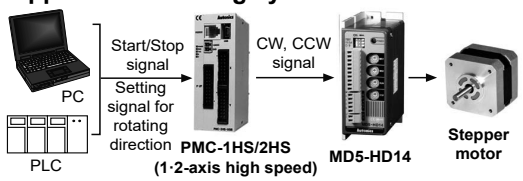
**PMC-1HS/2HS**
**(1/2-axis high speed)**

**PMC-2HSP/2HSN**
**(2-axis high speed Interpolation Normal)**



**PMC-4B-PCI**
**(4-axis board type)**

● **Stepper motor driving system**




## ▣ Micro Step?

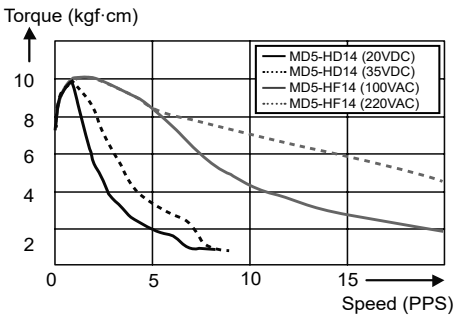
Micro step is a way to divide the basic step angle of the motor into smaller steps by decreasing the current to one phase. Micro step has the better resonance and vibration characteristics. It realizes high-accuracy controlling with smaller step angles divided by controlling coil current.

- ●Realizing low-speed / low-vibration and low noise driving
- ●Dividing motor's basic step angle into 250 divisions (0.72° to 0.00288°)

## ▣ DC Power Driver Vs AC Power Driver

### ◎ Characteristics

- In case of AC power supply, the higher speed, the better torque characteristics than DC power.
- Under the same driver conditions, the higher the power supply, the better torque characteristics motors can have. Proper safety countermeasures must be ensured when supplying high power supply. It may cause high heat generation.




| DC Power Driver | | AC Power Driver |
|---|---|---|
| ● 20 to 35VDC<br>● Relatively low torque characteristics<br>● Simple circuit structure<br>● Cost effective | **vs** | ● 100 to 220VAC<br>● High torque characteristics<br>● Relatively complex circuit structure due to AC to DC conversion circuit<br>● Expensive |

## ▣ Failure Diagnosis and Countermeasures

### ◎ Resonance

The motor may cause resonance within the specific frequency area. Take the measurement before driving the motor.

- 5-phase stepper motor driver resonance area: Approx. 300 to 500pps
- 2-phase stepper motor driver resonance area: Approx. 200pps

**● How to improve vibration characteristics**

- Adjusting RUN current
- Changing input pulse frequency
- Applying micro step function
- Selecting geared type motors
- Using DAMPER
- Using anti-vibration rubber
- Using elastic couplings

### ◎ Heat generation

Possible causes for heat generation include applying higher power supply, driving with higher RUN current than rated current and long time & continuous driving without stops.

**● How to improve heat generation characteristics**

- Adjusting RUN current
- Adjusting RUN DUTY ratio (Setting STOP time longer than RUN time.)
- Mounting heat prevention panels
- Applying Auto current down, HOLD OFF functions
- Using a fan

### ◎ Missing step

A phenomenon that a stepper motor is incapable of rotating as the frequency of input pulse.

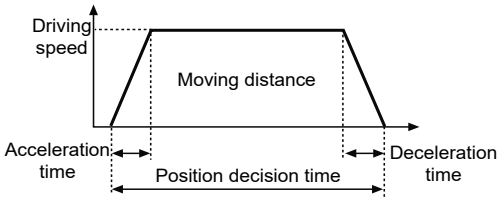
| Major Causes | Troubleshooting |
|---|---|
| Motor failure | Change a motor |
| Rapid De/Acceleration of Motor | Reduce driving speed / Make motor's acceleration time longer |
| Improper motor torque selecting for load | Change a motor having high torque. Select a geared type motor |
| Wrong driving speed setting (lower than max. starting frequency) | Drive a motor within starting frequency band. (Refer to motor's characteristics.) |
| Low input current | Increase input current |

## ▣ Calculation Method for Selecting Stepper Motor

It shows calculation method required in the selecting order. In real calculation it is impossible to get mechanical constant in many cases. Therefore, simple calculations are shown herewith.

### ◎ Decision of driving pattern

It is shown as the drawing converting the operation of the driving equipment to the rotating operation of the motor in the equipment using stepper motor. The below chart by starting speed acceleration /deceleration time, driving speed and position decision time of motor. The stepper motor is selected based on driving pattern chart.




< Driving Pattern >

#### ● Calculation of Necessary pulse number

It is the number of the pulse that should be input to stepper motor in order to transfer an object from starting position to target position by the carrying equipment. It is calculated as follows.

$$\text{Necessary pulse number} = \frac{\text{Moving distance of object}}{\text{Moving distance for 1 revolution}} \times \frac{360°}{\text{Step angle}}$$

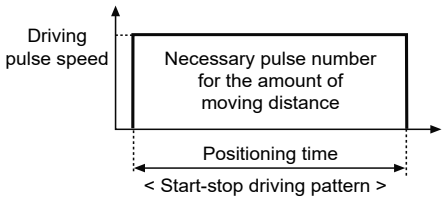
#### ● Calculation of the Driving pulse speed

It is the necessary pulse speed in order to rotate as much as the necessary pulse number in the set position decision time.
The necessary pulse number, the position decision time and the acceleration/deceleration time calculate the driving pulse speed.

**1) For start-stop driving**

Start-stop driving is what the stepper motor stops after revolving as much as the necessary pulse number for the position decision time operating in the driving pulse speed without acceleration/ deceleration on the motor driving. Start-stop driving is used when driving a motor in low speed. Also, it needs high acceleration/deceleration torque as it needs a rapid speed change. The driving pulse speed of start-stop driving is calculated as follows:

$$\text{Driving pulse speed[Hz]} = \frac{\text{Necessary pulse number[Pulse]}}{\text{Positioning time[sec]}}$$

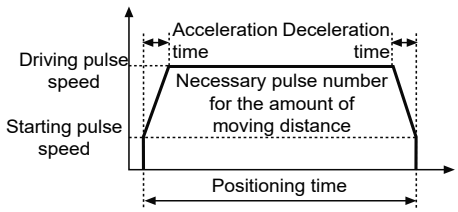



< Start-stop driving pattern >

**2) For acceleration/deceleration driving**

Acceleration/deceleration driving is what stepper motor stops decelerating the speed into the starting region after driving at the pulse speed for certain time when driving in accelerating the rotation speed of the motor by changing slowly the driving pulse speed in the starting region for the positioning time. Acceleration/deceleration time should be set properly depending on the carrying distance/speed and positioning time. In case of acceleration/deceleration driving it needs lower acceleration/deceleration torque than self-start driving as its speed changes gently. The driving pulse speed of acceleration/deceleration is calculated as below.

$$\text{Driving pulse speed[Hz]} = \frac{\text{Necessary pulse number-Starting pulse speed[Hz]} \times \text{Acceleration·Deceleration time[sec]}}{\text{Positioning time[sec]} - \text{Acceleration·Deceleration time[sec]}}$$




< Acceleration·Deceleration driving pattern >

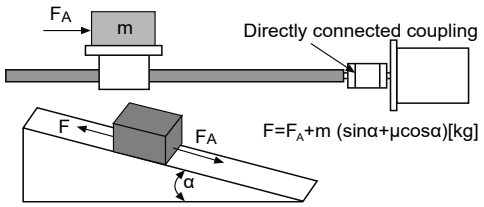
### ◎ Simple calculation of the necessary motor torque

The necessary motor torque=
(Load torque + Acceleration·Deceleration torque)
× Safety rate

#### ● Calculation of load torque ($T_L$)

Load torque indicates the friction power of a contacting part of the carrying equipment and this torque is always needed when the motor is driving.
Load torque is changed by the kinds of carrying equipment and the weight of an object. The calculation of load torque according to the kinds of carrying equipment is as below. Simple calculations without considering the constant are shown as below because it is impossible to get mechanical constant in many cases. Load torque can be calculated referring to below figures and numerical formulas.

**1) Ball-Screw driving**




※Calculation of load torque

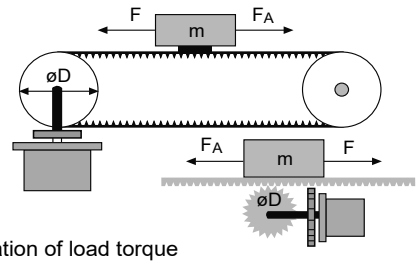
$$T_L = \left( \frac{F \cdot P_B}{2\pi\eta} + \frac{\mu_0 F_0 P_B}{2\pi} \right) \times \frac{1}{i} \text{ [kgf·cm]}$$

※Simple calculation of load torque

$$T_L = \frac{m \cdot P_B}{2\pi\eta} \times \frac{1}{i} \text{ [kgf·cm] (horizontal load)}$$

$$T_L = \frac{m \cdot P_B}{2\pi\eta} \times \frac{1}{i} \times 2 \text{ [kgf·cm] (vertical load)}$$

**2) Wire-Belt/Rack-Pinion driving**




※Calculation of load torque

$$T_L = \frac{F}{2\pi\eta} \times \frac{\pi D}{i} = \frac{FD}{2\eta i} \text{ [kgf·cm]}$$

$$F = F_A + m(\sin + \mu\cos\alpha) \text{ [kg]}$$

※Simple calculation of load torque

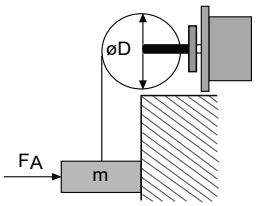
$$T_L = \frac{D}{2} \times m \times \frac{1}{\eta} \times \frac{1}{i} \text{ [kgf·cm] (horizontal load)}$$

$$T_L = \frac{D}{2} \times m \times \frac{1}{\eta} \times \frac{1}{i} \times 2 \text{ [kgf·cm] (vertical load)}$$

**3) Pulley driving**

※Calculation of load torque

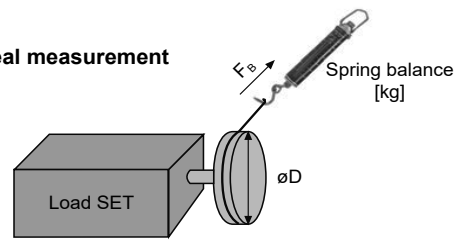
$$T_L = \frac{\mu F_A + m}{2\pi} \times \frac{\pi D}{i} = \frac{(\mu F_A + m)D}{2i} \text{ [kgf·cm]}$$




※Simple calculation of load torque

$$T_L = \frac{D}{2} \times m \times \frac{1}{i} \text{ [kgf·cm]}$$

**4) By real measurement**




It is the calculation method by reading the scale mark of the spring balance at the time when the pulley is rotated when drawing the spring balance slowly. It is available to get more accuracy load torque than by the calculation.
It is available to calculate the load torque as follows with the value ($F_B$) calculated by the spring balance.

$$T_L = \frac{F_B D}{2\pi} \text{ [kgf·cm]}$$

[Index]

| | | | |
|---|---|---|---|
| F | : Load of axis direction[kg] | $F_0$ | : Pre-pressure load [kg] (≅ 1/3 F) |
| η | : Efficiency ratio (0.85 to 0.95) | i | : Deceleration rate |
| $F_A$ | : External force[kg] | m | : The total weight of work and table[kg] |
| μ | : Friction coefficient | α | : Slop angle[°] |
| $\mu_0$ | : Internal friction coefficient of pre-pressure NUT (0.1 to 0.3) | | |
| $P_B$ | : Ball-screw pitch[cm/rev] | | |
| $F_B$ | : The force when starting the revolution of main shaft[kg] | | |
| D | : Outside diameter of pulley | | |

**● Calculation of Acceleration/Deceleration torque (Ta)**

Acceleration·Deceleration torque is for accelerating or decelerating the carrying equipment connected to the motor. It changes largely depending on the time of acceleration·deceleration and the value of load inertia moment of the carrying equipment. Therefore, the torque between self-start driving and acceleration·deceleration driving will show a big difference. Acceleration·Deceleration Torque is calculated as follows:

※For start-stop driving (high acceleration·deceleration torque is required)

$$\text{Acceleration·Deceleration Torque[kg·cm]} = \frac{\text{Rotator inertia moment[kgf·m²] + Load inertia moment[kg·m²]}}{\text{Gravitational acceleration[cm/sec²]}} \times \frac{\pi \times \text{Step angle[°]} \times \text{Driving frequency}^2\text{[Hz]}}{180 \times 3.6° / \text{Step angle[°]}}$$

※Acceleration/Deceleration driving

$$\text{Acceleration·Deceleration Torque[kgf·cm]} = \frac{\text{Rotator inertia moment[kg·m²] + Load inertia moment[kg·m²]}}{\text{Gravitational acceleration[cm/sec²]}} \times \frac{\pi \times \text{Step angle[°]}}{180°} \times \frac{\text{Driving frequency[Hz]-Starting frequency[Hz]}}{\text{Acceleration·Deceleration time[sec]}}$$

## ▣ Calculation Example for Motor Selection

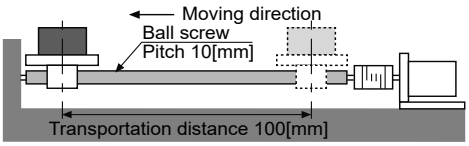
### ◎ Calculation of the number of the necessary pulse and the speed of the driving pulse.

These are practical examples for the number of the necessary pulse and the speed of the driving pulse with 5-phase stepper motor as below.

**● When driving ball-screw**

When carrying an object as follow figure for 1 sec. by using 5-phase stepper motor (0.72°/step), the number of the necessary pulse and the speed of the driving pulse are calculated as follows:

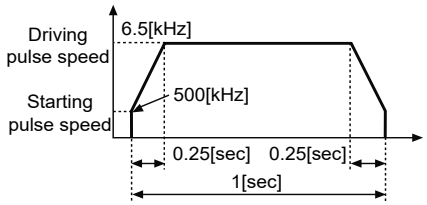
$$\text{Necessary pulse number} = \frac{100}{10} \times \frac{360°}{0.72°} = 5{,}000\text{[Pulse]}$$




If it executes start-stop driving for a second the speed of the driving pulse is calculated as 5,000[Pulse]/1[sec]=5[kHz] but, the start-stop driving is impossible at 5[kHz] and it should be driven with acceleration·deceleration driving. If calculating with setting the acceleration ·deceleration time as 25% of the position decision time and 500[Hz] of the starting pulse speed, it will be calculated as follows:

$$\text{Driving pulse speed[Hz]} = \frac{500\text{[Pulse]} - 500\text{[Hz]} \times 0.25\text{[sec]}}{1\text{[sec]} - 0.25\text{[sec]}} = 6.5\text{[kHz]}$$

It will be figured as follows:

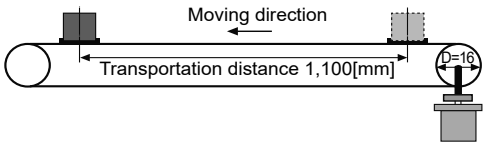


<Acceleration·Deceleration driving pattern >

**● When driving the timing belt**

When carrying an object as following figure for 1 sec. by using 5-phase stepper motor (0.72°/step), the moving distance/revolution is approx. 50[mm] by 2πr as the circumference of the pulley. As the moving distance/ revolution is 50[mm] the number of the necessary pulse is calculated as follows:

$$\text{Necessary pulse number} = \frac{1{,}100}{50} \times \frac{360°}{0.72°} = 11{,}000[\text{Pulse}]$$

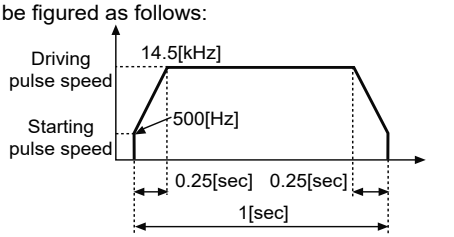



If driving with acceleration·deceleration like the example of a ball-screw the driving pulse speed is calculated as follows:

$$\text{Driving pulse speed[Hz]} = \frac{11{,}000[\text{Pulse}] - 500[\text{Hz}] \times 0.25[\text{sec}]}{1[\text{sec}] - 0.25[\text{sec}]}$$

$$= 14.5[\text{kHz}]$$

It will be figured as follows:



<Acceleration·Deceleration driving pattern >

## ◎ Calculation example of load torque ($T_L$)

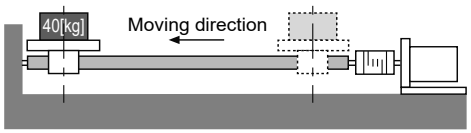
It is a real calculation example of load torque by using 5-phase stepper motor by simple numerical formulas.

**● When using ball-screw for driving horizontal load**

When carrying an object by using a ball-screw with 90[%] of efficiency and 40[kg] of the load weight as following figure, the load torque is calculated as follows;

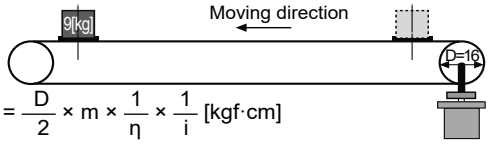
$$T_L = \frac{m \cdot P_B}{2\pi\eta} \times \frac{1}{i} [\text{kgf·cm}]$$

$$T_L = \frac{40[\text{kg}] \times 1[\text{cm}]}{2\pi \times 0.9} \times \frac{1}{1} \fallingdotseq 7.07[\text{kgf·cm}]$$




**● When using timing belt for driving horizontal load**

When carrying an object by using a timing belt with 90[%] of efficiency, 16[mm] diameter of pulley and 9[kg] of the load weight as following figure, the load torque is calculated as follows;

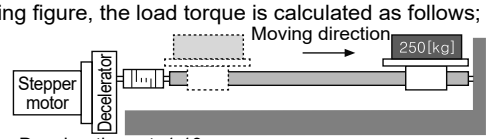



$$T_L = \frac{D}{2} \times m \times \frac{1}{\eta} \times \frac{1}{i} [\text{kgf·cm}]$$

$$T_L = \frac{1.6[\text{cm}]}{2} \times 9[\text{kg}] \frac{1}{0.9} \times \frac{1}{1} = 8[\text{kgf·cm}]$$

**● When using ball-screw and decelerator for driving horizontal load**

When carrying an object by using a ball screw with 5[mm] pitch, 90[%] of efficiency and 250[kg] of the load weight as following figure, the load torque is calculated as follows;



Deceleration rate1:10

$$T_L = \frac{m \cdot P_B}{2\pi\eta} \times \frac{1}{i} [\text{kgf·cm}]$$

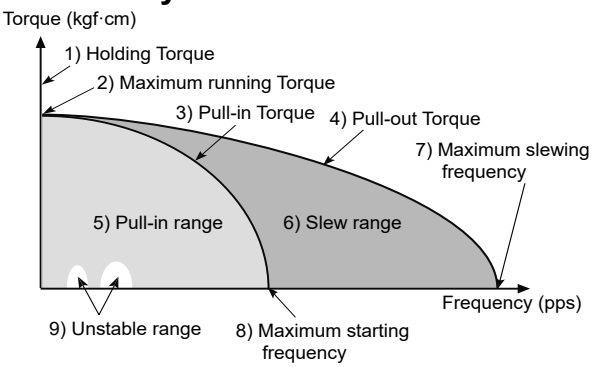
$$T_L = \frac{250[\text{kg}] \times 0.5[\text{cm}]}{2\pi \times 0.9} \times \frac{1}{10} = 2.21[\text{kgf·cm}]$$

The calculation result is for a horizontal load. Vertical load torque is 2 times of the horizontal load torque. Its result is only for load torque.

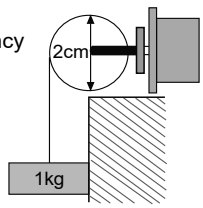
Acceleration·Deceleration torque should be added for real necessary torque of the motor. But, it is very difficult to get the moment of load inertia in the calculation.

In order to solve the difficulty it will be easy to calculate applying the start-stop driving or a large safety rate when acceleration·deceleration is rapid at the calculated load torque.

## ▣ Glossary




● Torque
Torque, moment of force, is the tendency of a force to rotate an object.
※Torque unit: N·m or kgf·cm
(1N·m = 10.1972kgf·cm)
※Required torque to rotate a rotator of which radius is 1cm in case of 1kg weight is applied.




● Refer to torque-frequency reference below. 1) to 6) have direct effect on driver's performance.

**1) Holding torque**
The amount of torque the motors produce at standstill while rated current is applied to the motors. In general, it is referred to as stepper motor's driving capacity.
**2) Maximum running torque**
Max. torque when running stepper motor with low speed (10pps)
**3) Pull-in torque**
Max. torque to drive a load within starting frequency range.
**4) Pull-out torque**
Max. torque required for a stepper motor to drive without pull-out within maximum starting frequency.
**5) Pull-in range (Max. starting range)**
Max. torque range that a stepper motor can drive a load with a certain frequency lower than max. starting frequency. It is allowed for the load to start & stop and forward & reverse rotation without de/acceleration within pull-in range. In case of driving a motor out of pull-in range, start a motor within pull-in range and do de/acceleration driving.
**6) Slew range (Pull-out range)**
Max. torque range required for a stepper motor to drive without pull-out within maximum starting frequency
**7) Maximum slewing frequency**
Max. frequency at which a stepper motor can rotate without fail to synchronize when driving a motor within max. starting frequency range in order to increase input frequency.
**8) Maximum starting frequency**
Maximum frequency is required for stepper motors to start & stop and forward & reverse rotation without de/acceleration in the state of no load. If it is required to drive a motor with higher frequency than max. starting frequency, drive a motor from max. starting frequency and do de/acceleration driving.
**9) Unstable range**
Within low speed area, resonance may occur.
Drive the motor after taking the measurement for resonance area.

# Software

atMotion
(Comprehensive Motion Device Management Program) ..... SW-2

# atMotion (Comprehensive Motion Device Management Program)

## ▣ atMotion Overview

atMotion is a comprehensive motion device management program that can be used with Autonics motion controllers.
atMotion provides GUI control for easy and convenient parameter setting and monitoring data management of multiple devices.

※Visit our website (www.autonics.com) to download the user manual and software.

## ▣ Features

- **Multiple Device Support**
  - Simultaneously monitor multiple devices and set parameters.
  - Simultaneously connect units of a single device with different addresses.
  - When using ModBus RTU for communication, multiple RS-232 ports are accessible.
- **Device Scan**
  : When multiple units are connected with different addresses, the unit scan function automatically searches for units.
- **Convenient User Interface**
  : User can freely arrange windows such as data monitoring, properties, and projects.
  Saving a project saves the screen layout also.
- **Project Management**
  : Saving data as a project file includes added device information, data monitoring screen layouts, and I/O source selection.
  When you open the project file, the last state of the saving moment will be loaded.
  Organizing project list makes managing project files easier.
- **Print Modbus Map Table Report**
  : Print address map reports of registered Modbus devices.
  Modbus map table reports can be saved in html (*.html) and pdf (*.pdf) formats.
- **Multilingual Support**
  : Default supporting language is Korean and English.
  User can add a different language, by modifying, renaming and saving the files in the 'Lang' folder.
- **Script Support**
  : Using Lua Script language allows applying different I/O processes for each devices.

## ▣ System Requirement

| Item | Minimum requirements |
|---|---|
| System | IBM PC compatible computer with Intel Pentium III or above |
| Operations | Microsoft Windows 98/NT/XP/Vista/7/8/10 |
| Memory | 256MB+ |
| Hard disk | 1GB+ of available hard disk space |
| VGA | Resolution: 1024×768 or higher |
| Others | RS-232 serial port (9-pin), USB port |

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