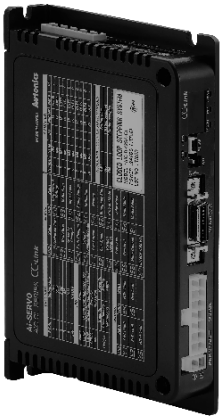
Controller Integrated 2-Phase Closed-Loop Stepper Motor Driver

▣ 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 20mm, 28mm, 35mm, 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	**C**C-**L**ink

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

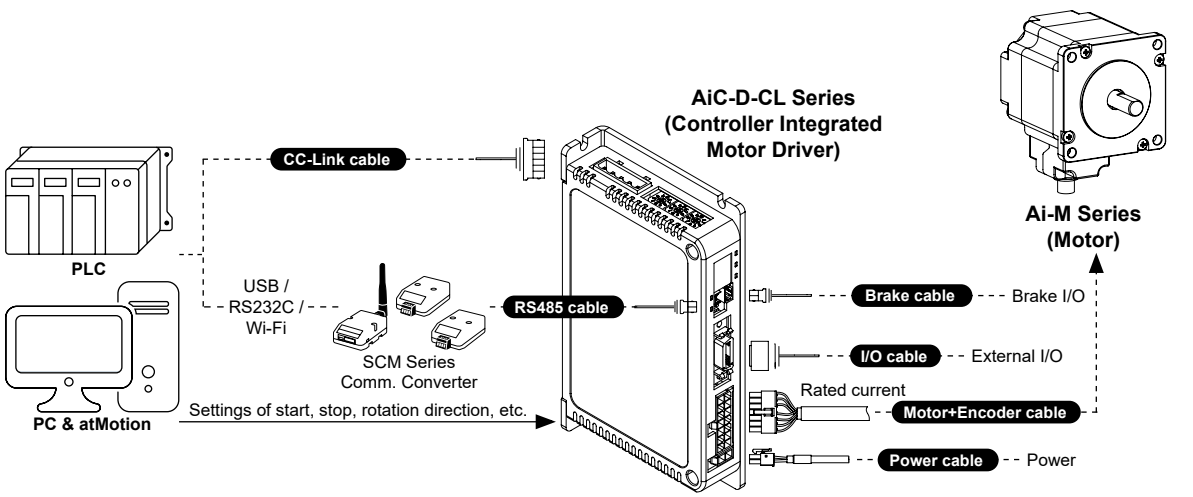
Category

C	Controller

Series

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

▣ Configuration Diagram



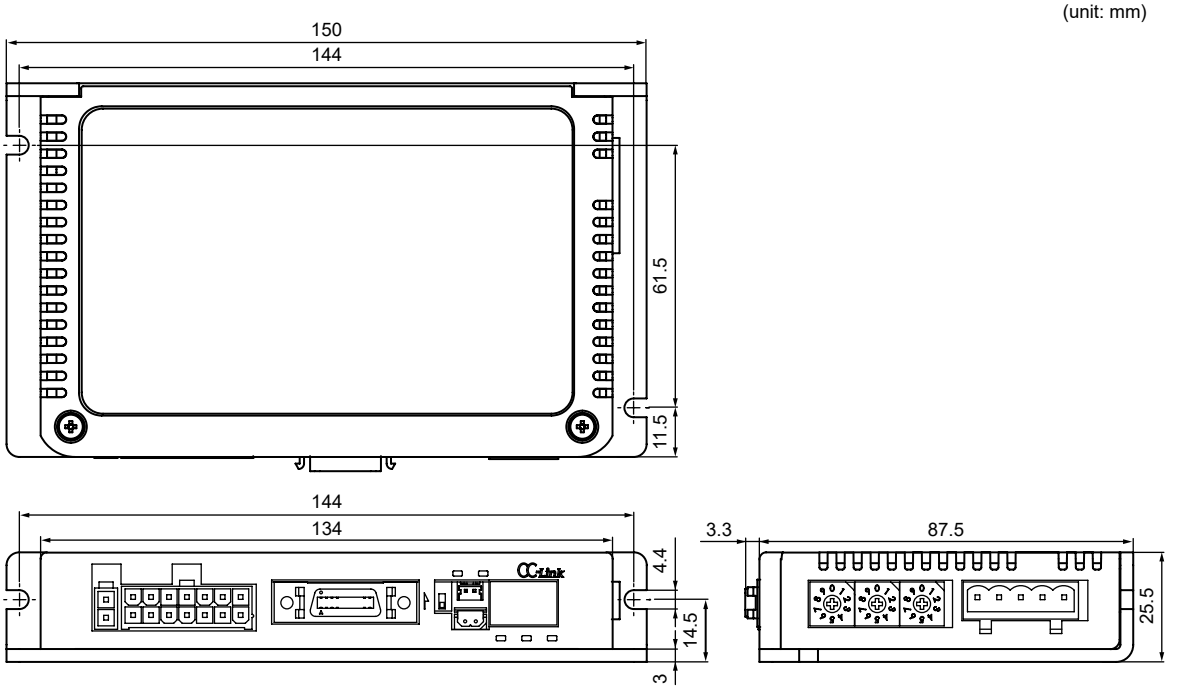
▣ Specifications

Model※1		-	AiC-D-28SB-CL	AiC-D-35SB-CL	AiC-D-42SA(-B)-CL	AiC-D-56SA(-B)-CL	AiC-D-60SA(-B)-CL
		AiC-D-20MA-CL	AiC-D-28MB-CL	AiC-D-35MB-CL	AiC-D-42MA(-B)-CL	AiC-D-56MA(-B)-CL	AiC-D-60MA(-B)-CL
		AiC-D-20LA-CL	AiC-D-28LB-CL	AiC-D-35LB-CL	AiC-D-42LA(-B)-CL	AiC-D-56LA(-B)-CL	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. 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, 10000 [Pulse/Rev]	500(factory default), 1000, 1600, 2000, 3600, 5000, 6400, 7200, 10000, 16000 [Pulse/Rev]		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 ● In-Position indicator: yellow LED ● Servo On/Off indicator: orange LED ● Alarm/Warning status display part: red LED 7 segment ● CC-Link status indicator: red, green LED					
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), 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)					
	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, regenerative voltage, motor misalignment, command speed, input voltage,in-position, memory, emergency stop, program mode, index mode, home search mode, comm. station setting, 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)					

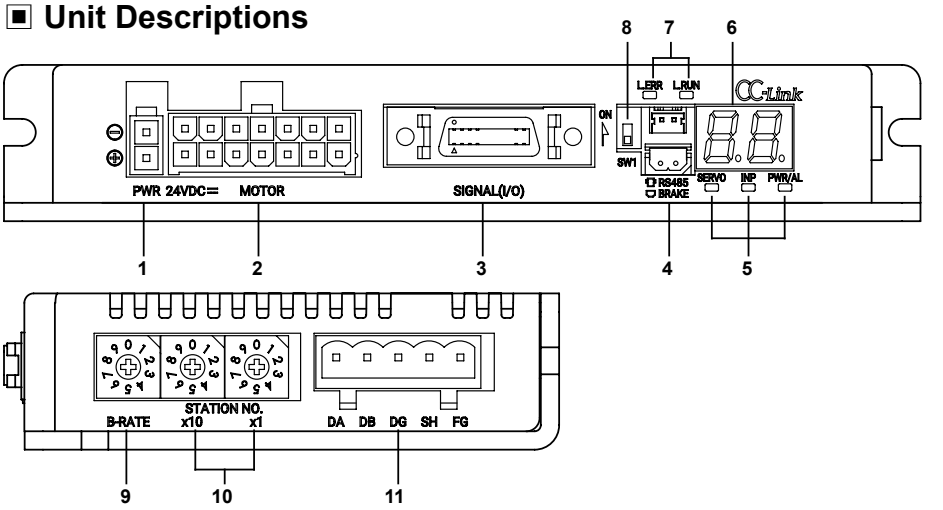
※1: The model name indicates driver type. (none: standard type, B: built-in brake type)
E.g.) AiC-D-42LA-B-CL: built-in brake type stepping motor driver.
※2: Based on the ambient temperature 25℃, ambient humidity 55%RH, and STOP current 50%.
※3: Max. power consumption during operation. When changing 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

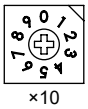
◎ CC-Link comm. speed setting rotary switch (B-RATE)

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	

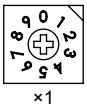
◎ CC-Link station setting rotary switch (STATION NO.)

※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

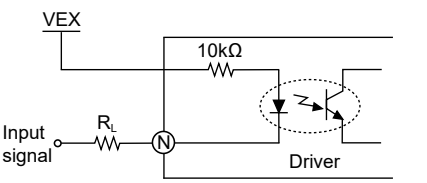
Functions can be assigned in general input IN0 to IN7.
Assignable functions are as below.

Function	Descriptions	Function	Descriptions
User Input0	User input	+Jog	+ jog drive
User Input1		-Jog	- jog drive
User Input2		Pause	Puase
User Input3		Servo On/Off	Servo ON/OFF
User Input4		Home	Home search
User Input5		Alarm Reset	Alarm reset
User Input6		SD	Slow Down
User Input7		Clear Pos.	Clear position, set current position as 0
Reset	Driver reset	Step0	Step number setting (the combination of 6 bit, 0 to 5, selectable 0 to 64)
Start	Program mode driver start	Step1	
Start Index	Index drive start	Step2	
Stop	Drive stop	Step3	
EMG	Driver emergency stop	Step4	
+RUN	+ continuous drive	Step5	
-RUN	- continuous drive	—	

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

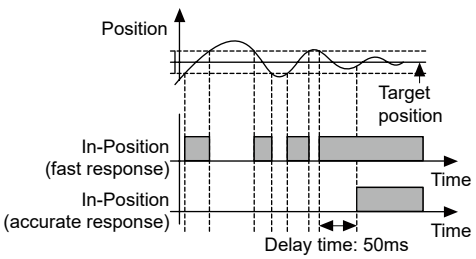
▣ Control Input/Output

◎ 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



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**'.

Alarm status	Alarm type	Descriptions	Motor status	Torque status
E. 1	Comm. station setting error	CC-Link station setting error	Remain	Remain
E.2	Comm. speed setting error	CC-Link speed setting error		
E.3	Comm. station setting change	CC-Link station setting change		
E.4	Comm. speed setting change	CC-Link speed setting change		
E.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' When index command is not completed due to the stop command		
E.H.	Home search mode error	When failed to find home		

※When E.E. to E.H. alarm occurs, the motor stops, but the current flowing into the motor is not blocked.

▣ Control Input/Output

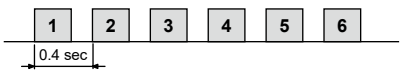
● **Warning**

-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.

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 (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

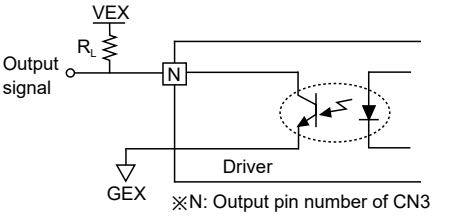
Functions can be assigned in general output OUT0 to OUT7.
Assignable functions are as right table.

Function	Descriptions
User Output0	User output
User Output1	
User Output2	
User Output3	
User Output4	
User Output5	
User Output6	
In-Position	In-Position output
Alarm	Alarm output
Warning	Warning 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.

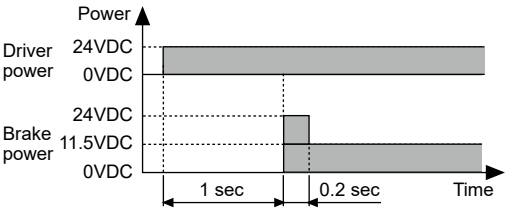
$$※R_L = \frac{VEX-0.7V}{0.01A}$$



※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.

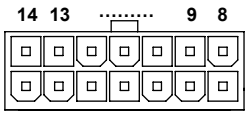
▣ Driver Connectors

◎ Connector function

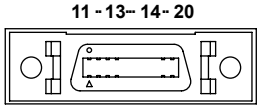
● CN1: Power connector

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

※Functions can be assigned in general input/output. For more information, refer to 'user manual'.

● RS 485 comm. connector (CN4: RS485)

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

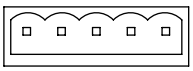
※RS485 comm. is for parameter setting and operation test instead of driver operation. When operating with CC-Link, disconnect the RS485 comm. from the device.

● Brake connector (CN5: BRAKE)

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

※Corresponding connector is built-in brake type only.

● 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.

▣ 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

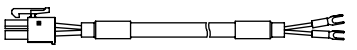
Comm. standard	CC-Link Ver.1.10	Max. transmit distance	Depend on comm. speed
Station type	Remote Device station	Remote I/O	● 1 station occupied: Ryn/RXn 32 points each ● 2 stations occupied: Ryn/RXn 64 points each
Connection cable	CC-Link dedicated cable	Remote register	● 1 station occupied: RWrn/RWwn 4 words each ● 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, 2 stations occupied	—	

▣ Sold Separately

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

◎ Power cable

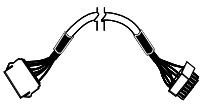
● **CJ-PW-□**



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

◎ Motor+Encoder cable

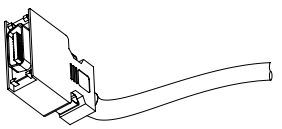
● **Normal: C1D14MB-□, Moving: C1DF14MB-□**



※□ 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

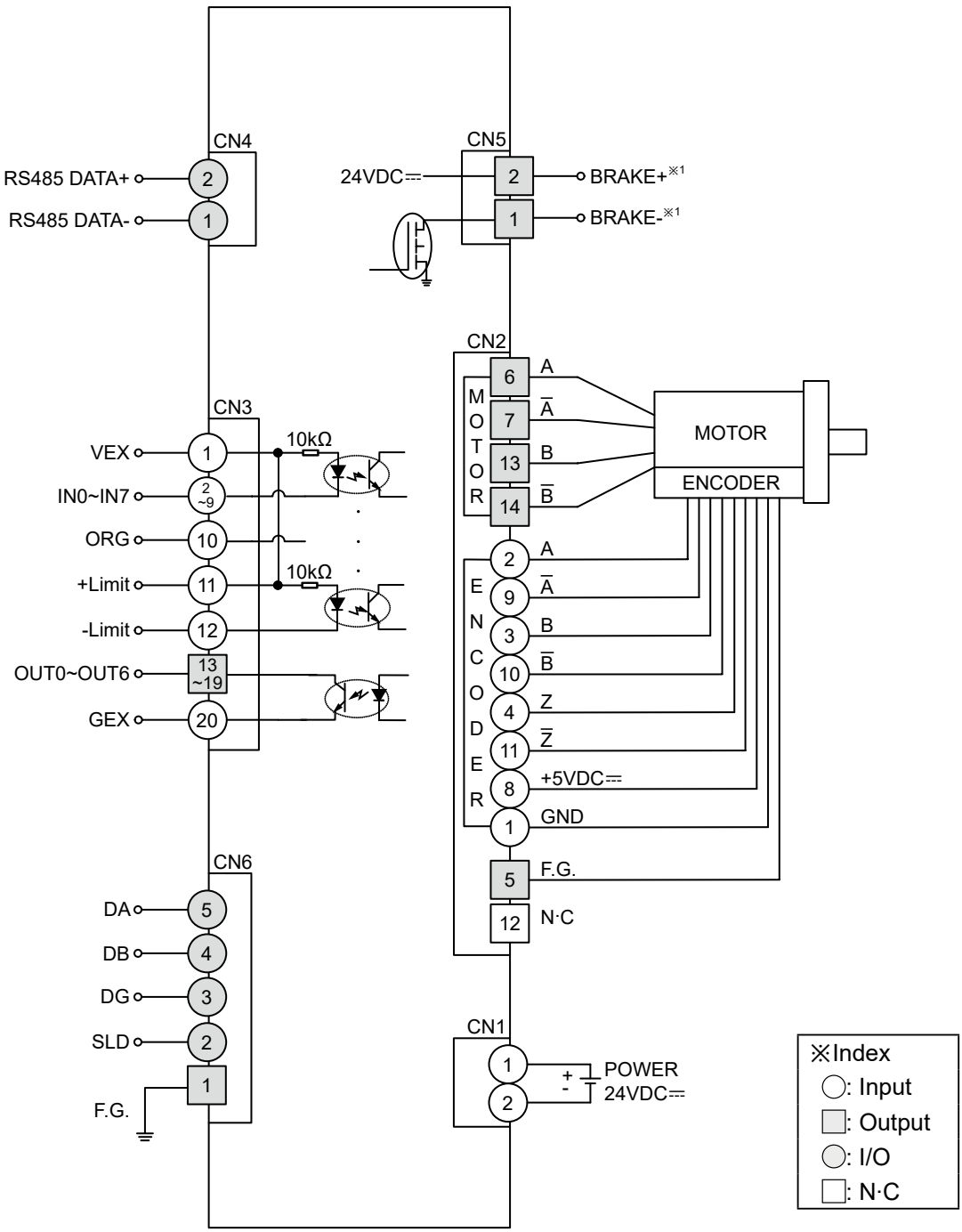
● **CO20-MP□-R**
(standard: AiC-CL TAG)



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. 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.

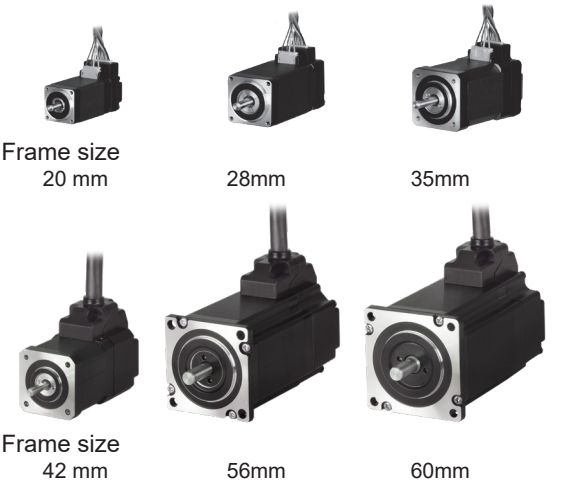
▣ Proper Usage

- 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

▣ 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



Frame size
20 mm | 28mm | 35mm | 42 mm | 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**	**A**rtificial **i**ntelligence	

※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.

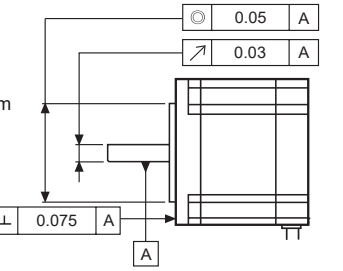
▣ Specifications

• 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

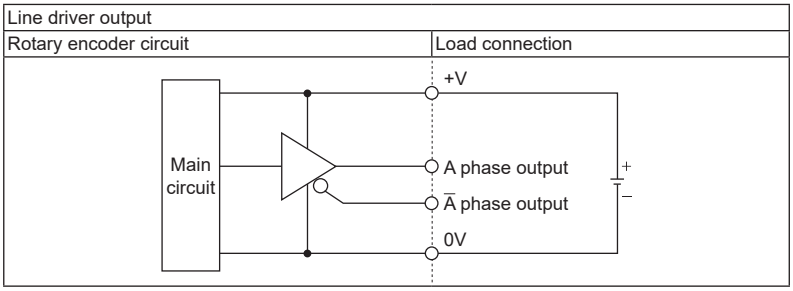
Item			Magnetic incremental rotary encoder
Resolution		Frame size 20mm※1	4,000PPR (1,000PPR×4-multiply)
		Frame size 28, 35mm	16,000PPR (4,000PPR×4-multiply)
Electrical specification	Output phase		A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase
	Output duty rate		$\frac{T}{2} \pm \frac{T}{3}$ (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⎓ • [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⎓ • [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)

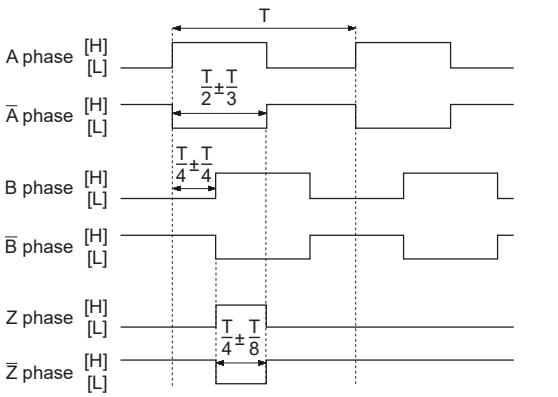
■ Encoder Control Output Diagram

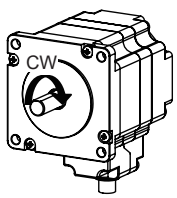


※All output circuits of A, Ā, B, B̄, Z, Z̄ phase are the same.

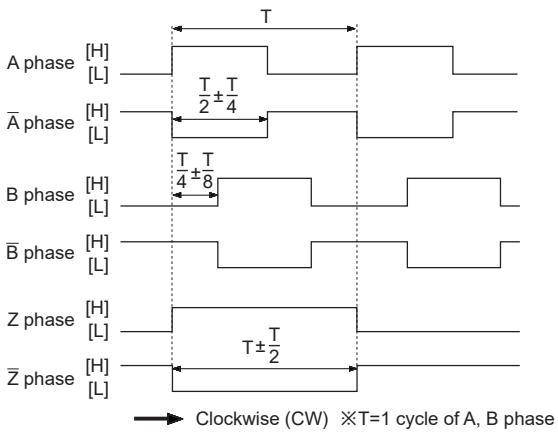
■ Encoder Output Waveforms

◎ **Frame size 20, 28, 35mm**



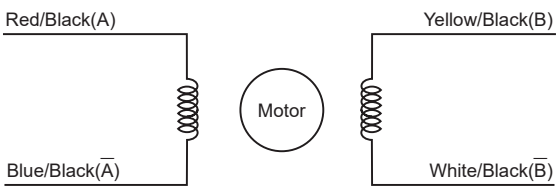


◎ **Frame size 42, 56, 60mm**



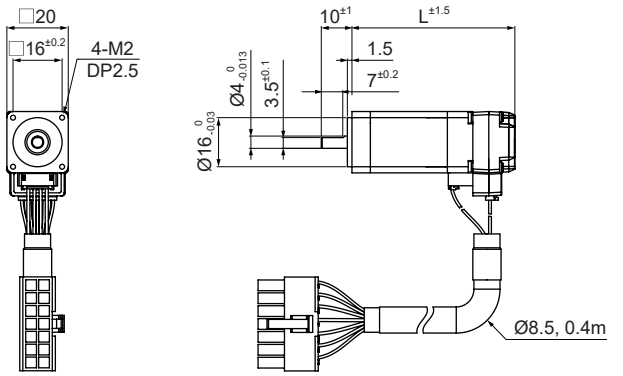
■ Connection Diagram

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



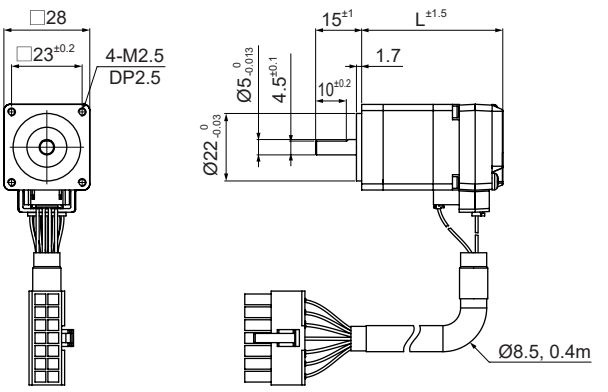
▣ Dimensions

◎ Frame size 20mm



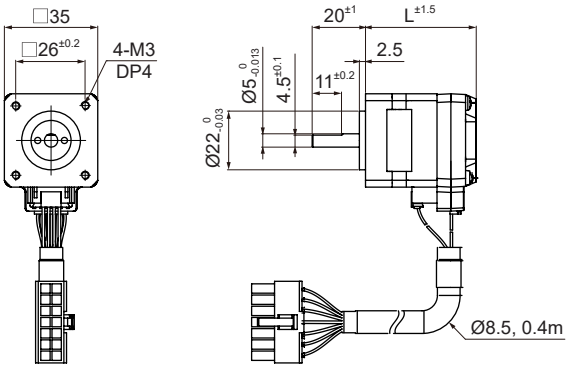
Model	L
Ai-M-20MA	41.2
Ai-M-20LA	53.1

◎ Frame size 28mm



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

◎ Frame size 35mm

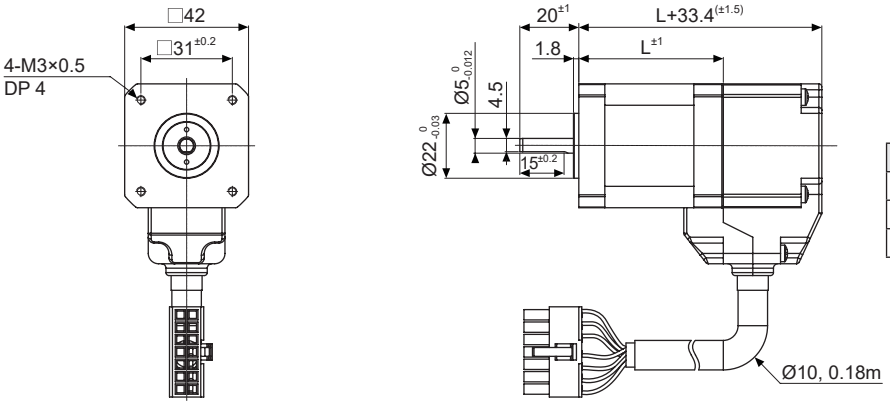


Model	L
Ai-M-35SB	41.5
Ai-M-35MB	52
Ai-M-35LB	68.5

▣ Dimensions

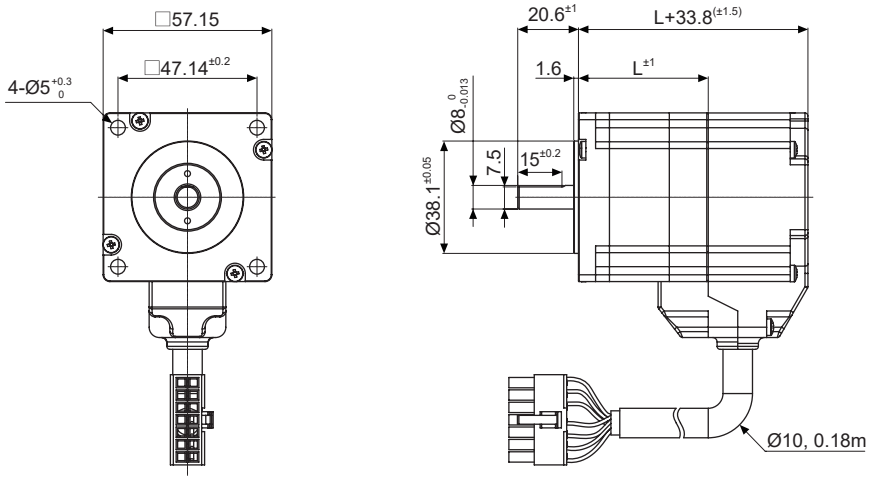
(unit: mm)

◎ Frame size 42mm



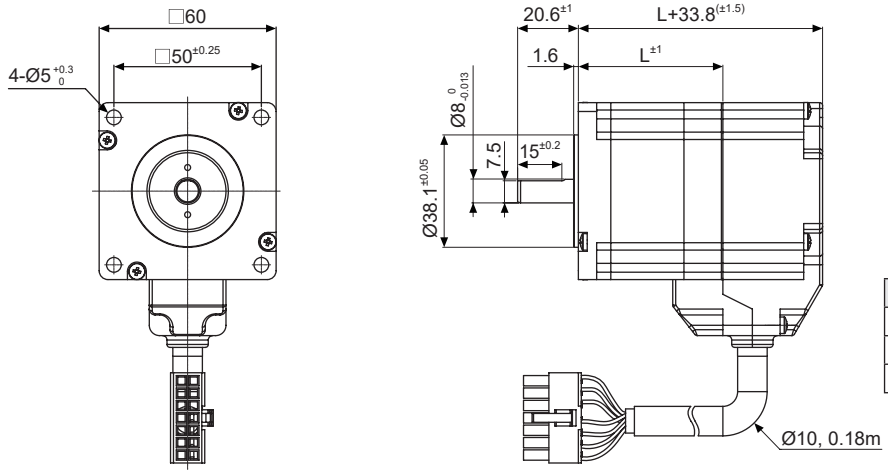
Model	L
Ai-M-42SA	34.1
Ai-M-42MA	40.1
Ai-M-42LA	48.1

◎ Frame size 56mm



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

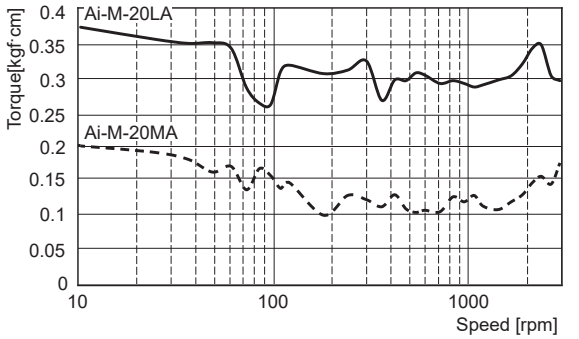
◎ Frame size 60mm



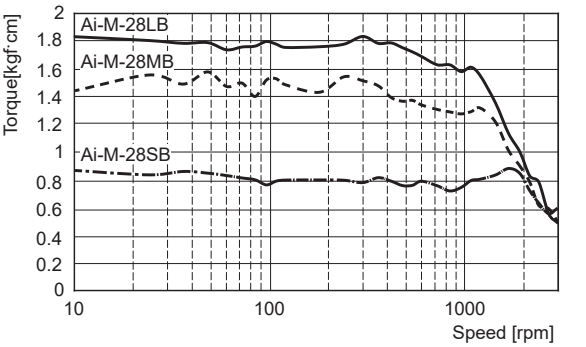
Model	L
Ai-M-60SA	48.1
Ai-M-60MA	69
Ai-M-60LA	86

▣ Motor Characteristics

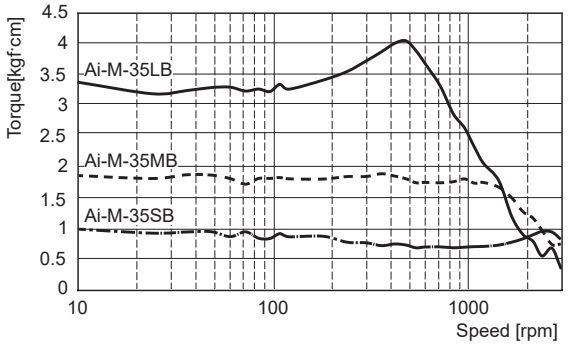
◎ Frame size 20mm



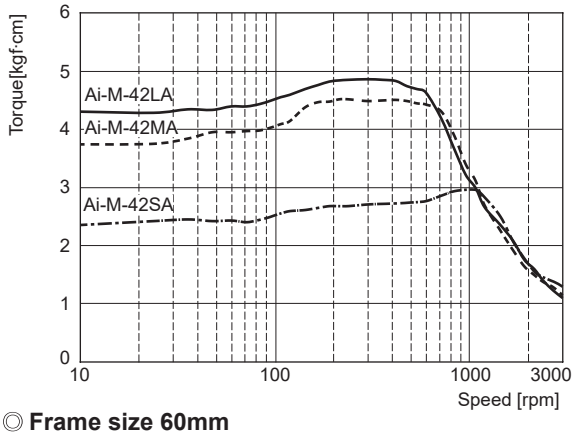
◎ Frame size 28mm



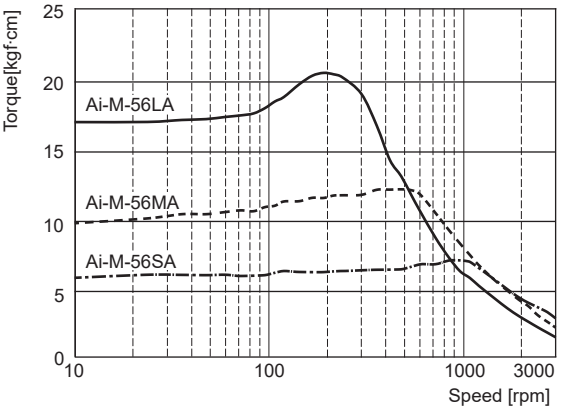
◎ Frame size 35mm



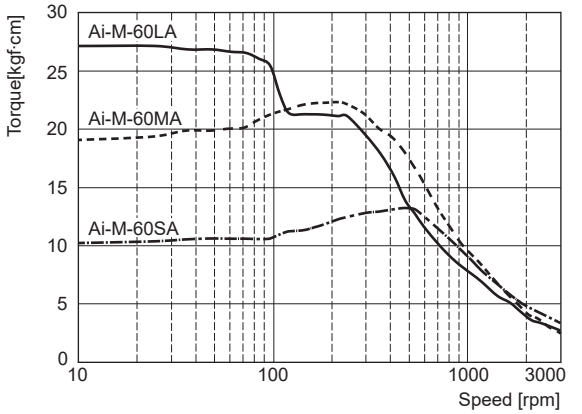
◎ Frame size 42mm



◎ Frame size 56mm

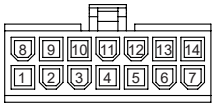


◎ Frame size 60mm



▣ Motor Connectors

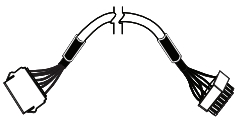
◎ CN2: Motor+Encoder Connector

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

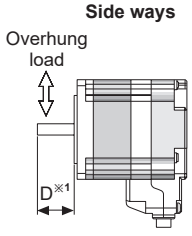
※1: □ indicates cable length (1, 2, 3, 5, 7, 10).
E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

▣ Motor Installation

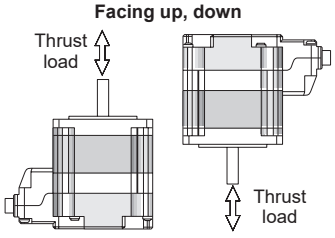
1. Mounting direction

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



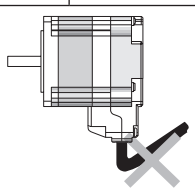
Facing up, down



※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.

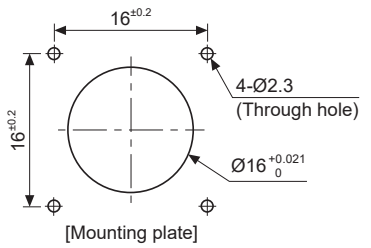


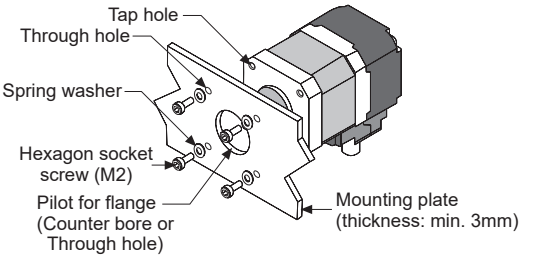
▣ Motor Installation

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.

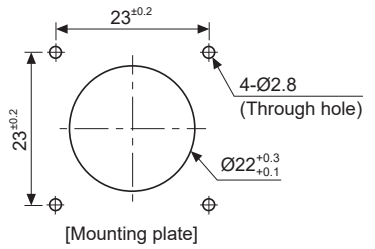
◎ Frame size 20mm

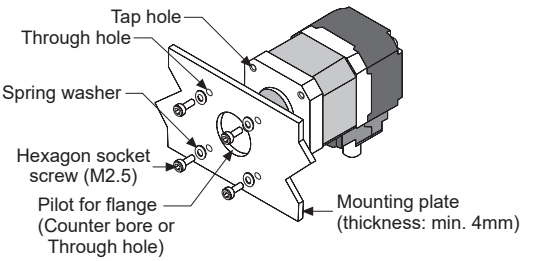




※Do not draw the wire with over strength 5N after wiring the encoder.

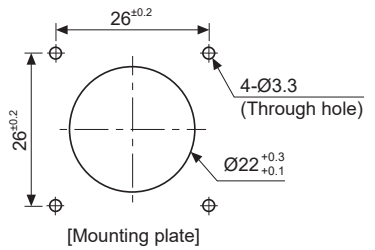
◎ Frame size 28mm

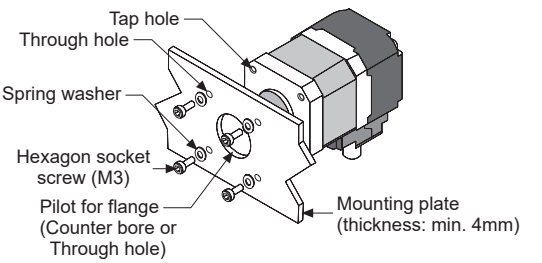




※Do not draw the wire with over strength 5N after wiring the encoder.

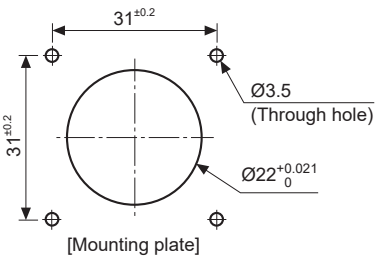
◎ Frame size 35mm

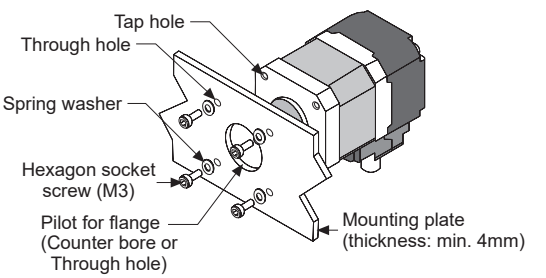




※Do not draw the wire with over strength 5N after wiring the encoder.

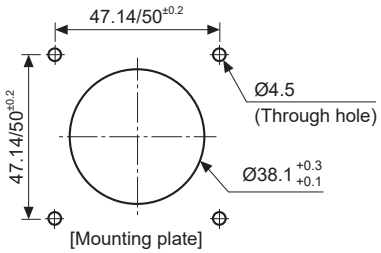
◎ Frame size 42mm

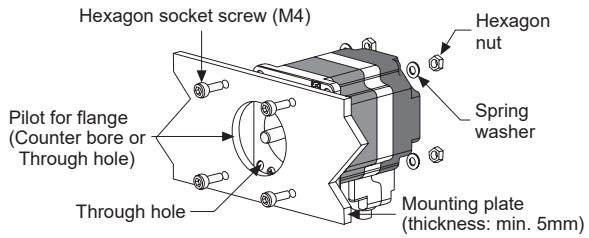


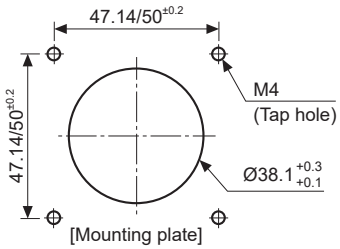


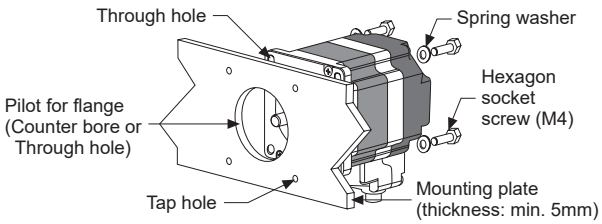
※Do not draw the wire with over strength 30N after wiring the encoder.

◎ Frame size 56mm/60mm





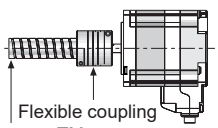
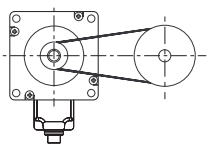
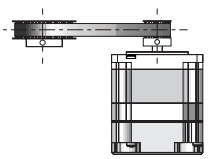




※Do not draw the wire with over strength 30N after wiring the encoder.

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℃ (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