Autonics

2-Phase Closed-Loop Stepper Motor Driver
AiS-D SERIES
INSTRUCTION MANUAL

CE

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

▣ Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid 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 fire, personal injury, or economic loss.
2. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire.
3. **Install the unit after considering counter plan against power failure.**
   Failure to follow this instruction may result in personal injury, or economic loss.
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.
6. **Install the driver in the housing or ground it.**
   Failure to follow this instruction may result in electronic shock, personal injury.
7. **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.
8. **Emergency stop directly when error occurs.**
   Failure to follow this instruction may result in fire, or personal injury.

⚠ Caution

1. **When connecting the power input, use AWG 18(0.75mm²) 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 signal.
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 dry cloth to clean the unit, and do not use water or organic solvent.**
   Failure to follow this instruction may result in fire.
7. **Do not use the unit in the place where flammable/explosive/corrosive gas, humidity, direct sunlight, radiant heat, vibration, impact, or salinity may be present.**
   Failure to follow this instruction may result in fire or explosion.
8. **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 and degradation.
9. **Keep metal chip, dust, and wire residue from flowing into the unit.**
   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.

▣ Ordering Information

Ai S - D - 42 L A

- Series: **Ai** Artificial Intelligence
- Category: **S** Standard
- Item: **D** Driver
- Motor frame size:
  - **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
- Motor length
- Encoder resolution: **A** 10,000PPR (2,500PPR×4-multiply)

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

※**The above specifications are subject to change and some models may be discontinued without notice.**
※**Be sure to follow cautions written in the instruction manual and the technical descriptions (catalog, homepage).**

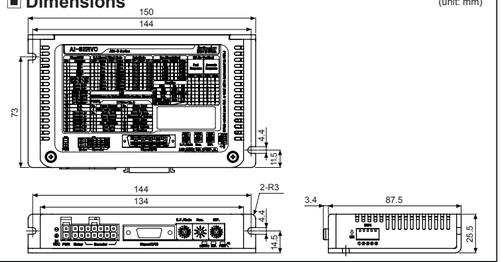
▣ Specifications

Model		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	Max. 7W	Max. 7.5W	Max. 8W	Max. 9.5W	Max. 10W	Max. 11W	Max. 12W	Max. 13W	Max. 14W
	Max. during operation※2	Max. 60W			Max. 120W			Max. 240W		
Max. RUN current※3		1.7A/Phase			3.5A/Phase					
STOP current		25% or 50% of max. RUN current (set by SW4 switch)								
Rotation speed		0 to 3000rpm								
Resolution		500, 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000PPR (set by SW2 switch)								
Motor drive response		0 to F (set by SW1 switch)								
Position control gain										
In-Position		0 to F (set by SW3 switch)								
Pulse input method		1-pulse or 2-pulse input method (set by SW4 switch)								
Motor rotation direction		CW, CCW (set by SW4 switch)								
Status indicator		● Power/Warning indicator: green LED ● Alarm indicator: red LED, ● 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), 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 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 voltage		Over 100MΩ (at 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/s² (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. 400g (approx. 290g)								

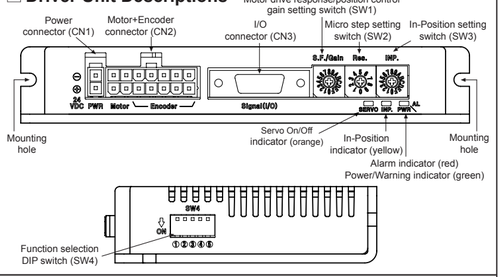
※1: Based on the ambient temperature 25°C, ambient humidity 55%RH, and STOP current 50%.
※2: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase. The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※3: RUN 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 does 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.

▣ Dimensions

(unit: mm)



▣ Driver Unit Descriptions



▣ 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. Refer to '▣ Control Input/Output > ○ Output > **2. Alarm/Warning Out**'.
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.

▣ Connection Connectors of Driver

○ **Connector function**

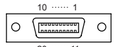
● **Power connector (CN1)**

Pin arrangement	Pin No.	Function
	2	GND
	1	24VDC

● **Motor+Encoder connector (CN2)**

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 $\overline{B}$
	7	Motor $\overline{A}$	14	Motor B

● **I/O connector (CN3)**

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 $\overline{Z}$

▣ Driver Setting

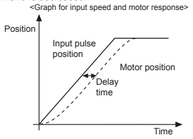
○ **SW1: Motor drive response setting switch (speed filter) or position control gain setting switch**
-SW1 shifts its mode between motor drive response setting or position control gain setting, depending on 4th pin in SW4 as follows.
-Modified setting values are not applied in the running status, and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

4th pin in SW4	Setting
OFF	Motor drive response
ON	Position control gain

● **Motor drive response setting**
-Set motor drive response for 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	Not used	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

<Graph for input speed and motor response>



※1: Factory default

● **Position control gain setting**
-Position control gain decides responsiveness of 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 status.
-I_Gain: Adjust vibration in accelerating/decelerating status.

Setting switch	Setting	Gain		Setting	Gain	
		P	I		P	I
 S.F./Gain	0	1	1	8※1	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

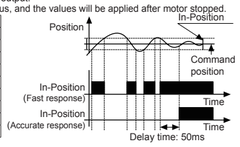
※1: Factory default

○ **SW2: Micro step setting switch (resolution)**
-Set the micro step 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: In-Position setting switch**
-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	Setting	Value	Setting	Value
	Fast Response		Accurate Response	
INP.	0※1	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



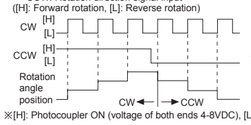
※1: Factory default

○ **SW4: Function selection DIP switch**
-Set rotation direction, pulse input method, STOP current, SW1 setting, and test mode.

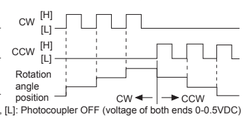
Setting switch	No.	Name	Function	Switch position	
				ON	OFF (factory default)
 ON 1 2 3 4 5	1※1	DIR	Rotation direction	CCW	CW
	2※1	1P/2P	Pulse input method	1-pulse input method	2-pulse input method
	3※2	C.D.	STOP current	25% of max. RUN current	50% of max. RUN current
	4※2	SW1 Mode	SW1 setting	Position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

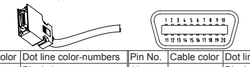
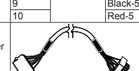
● STOP current
-When it stops (if there is no input during twice of the last input pulse width), set the stop current supplied at the motor phase to decrease motor heat and current consumption.

○ **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	5557-14R	5556T	—	Molex
CN3	Driver	10220-52A2 PL	—	—	3M
	I/O connector	10120-3000PE	—	10320-52F0-008	3M
		CJ-MP20-HP□ (sold separatly)	—	—	Autonics

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

○ **Cable (sold separately)**

Type	Model					
I/O cable	CJ-MP20-HP□ (sold separately)※1 					
	Pin No.	Cable color	Dot line color-numbers	Pin No.	Cable color	Dot line color-numbers
	1	Yellow	Black-1	11	White	Black-1
	2		Red-1	12		Red-1
	3		Black-2	13		Black-2
	4		Red-2	14		Red-2
	5		Black-3	15		Black-3
	6		Red-3	16		Red-3
	7		Black-4	17		Black-4
	8		Red-4	18		Red-4
	9		Black-5	19		Black-5
	10		Red-5	20		Red-5
Motor+Encoder cable						
	Normal	C1D14M-□※2				
	Moving	C1DF14M-□※2				

※1: □ indicates cable length (010, 020, 030, 050, 070, 100) E.g.) CJ-MP20-HP070: 7m I/O cable
※2: □ indicates cable length (1, 2, 3, 5, 7, 10) E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

▣ Control 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 '○ 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
-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. 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. Phase current is supplied to gain torque.
The Servo ON indicator, the In-Position output and indicator turns ON.
※Stop the motor for using this signal.
※Refer to example of input circuit connection.

3. Alarm Reset
-This signal is for clearing the alarm.
-When 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 alarm causes are not removed clearly and using alarm reset, driver may not be returned at the normal status.
※Refer to 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.

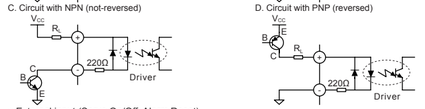
※$R_L = \frac{V_{CC}-2.17V}{0.011A} - 220\Omega$

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

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

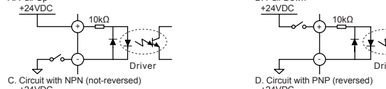
A. Pull-Up / B. Pull-Down

C. Circuit with NPN (not-reversed) / D. Circuit with PNP (reversed)

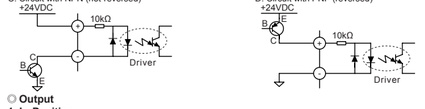


● External input (Servo On/Off, Alarm Reset)

A. Pull-Up / B. Pull-Down



C. Circuit with NPN (not-reversed) / D. Circuit with PNP (reversed)



○ **Output**

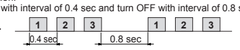
1. In-Position
-In-Position output represents output condition of positioning completion signal.
-If the gap between target position and real position is under In-Position setting value after pulse has finished, In-Position output turns to [H] and In-Position indicator turns ON.
-In reverse, when the 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 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 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	Over current error	When over current flows at motor RUN element	O	×
	2	Over speed 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	Over load error	When applying load over the rated load for over 1 sec		
	5	Over heat 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	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	Over load warning	When maximum load is kept connected over 10 sec. (motor or driver can be overheated)	×	O

※Although the driver normally operates in alarming status, the driver can be damaged.
Please operate the driver, avoiding alarming situation.
※Depending on alarm/warning type, indicators flash with interval of 0.4 sec and turn OFF with interval of 0.8 sec.

<E.g. case of alarm 3>

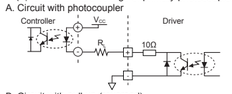


3. Example of output circuit connection
-It is recommended to use below 50VDC at V_{CC}. Use the R_L for I_C (collector current of secondary detector) of photo coupler inside the driver to be within 25mA following the below formula.

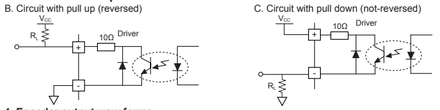
※A: $R_L = \frac{V_{CC}-0.3V-V_F}{0.025A} - 10\Omega$ ※B, C: $R_L = \frac{V_{CC}-0.3V}{0.025A} - 10\Omega$

(V_F is LED forward voltage of primary photocoupler.)

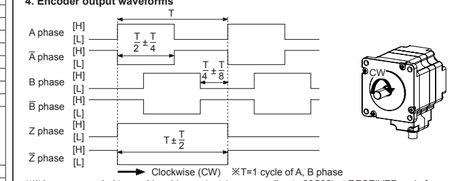
A. Circuit with photocoupler



B. Circuit with pull up (reversed) / C. Circuit with pull down (not-reversed)

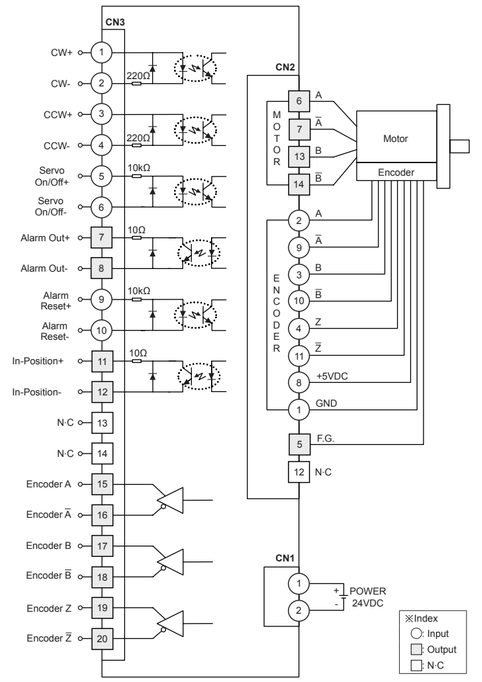


4. Encoder output waveforms



※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).

▣ Connection for Motor and Driver



▣ 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).

▣ Cautions during Use

1. Follow instructions in 'Cautions during Use'.
   Otherwise, It may cause unexpected accidents.
2. 24VDC power supply should be insulated and limited voltage/current or Class 2, SELV power supply device.
3. Re-supply power after min. 1 sec from disconnected power.
4. Do not input CW, CCW signal at the same time in 2-pulse input method.
5. When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.
6. The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
7. Keep the distance between power cable and signal cable more than 10cm.
8. 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.
9. 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.
10. This product does not prepare protection function for a motor.
11. 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

▣ Major Products

- Photoelectric Sensors
- Fiber Optic Sensors
- Door Sensors
- Door Side Sensors
- Area Sensors
- Proximity Sensors
- Pressure Sensors
- Rotary Encoders
- Connector/Sockets
- Switching Mode Power Supplies
- Control Switches/Lamps/Buzzers
- I/O Terminal Blocks & Cables
- Stepper Motors/Drivers/Motion Controllers
- Graphic/Logic Panels
- Field Network Devices
- Laser Marking System (Fiber, CO_2, Nd: YAG)
- Laser Welding/Cutting System
- Temperature Controllers
- Temperature/Humidity Transducers
- SSRs/Power Controllers
- Counters
- Timers
- Panel Meters
- Tachometer/Pulse (Rate) Meters
- Display Units
- Sensor Controllers

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