DRW180664AB

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 grounded housing or ground it directly.**
   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(0.75mm^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 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 - 20 M A

- Encoder resolution: **A**※1 4,000PPR(1,000PPR×4-multiply), **B** 16,000PPR(4,000PPR×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
- Item: **D** Driver
- Category: **S** Standard
- Series: **Ai** Artificial Intelligence

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

○ AiS Series

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

※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).

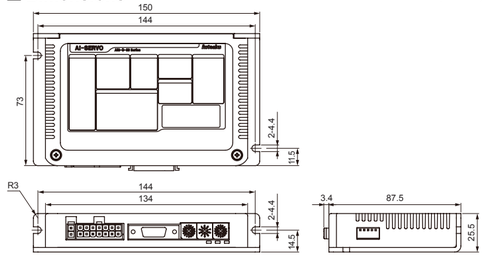
▣ Specifications

Model		AiS-D-20MA	AiS-D-20LA	AiS-D-28SB	AiS-D-28MB	AiS-D-28LB	AiS-D-35SB	AiS-D-35MB	AiS-D-35LB
Power supply		24VDC⎓							
Allowable voltage range		90 to 110% of the rated voltage							
Power consumption	STOP※1	Max. 10W							
	Max. during operation※2	Max. 50W		Max. 60W					
Max. run current※3		0.6A/Phase		1.0A/Phase			1.2A/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, 10000, 16000PPR					
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, ● 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, Ā, B, B̄, Z, Z̄ phase, corresponding to 26C31) (line driver output)							
Input pulse specifications	Pulse width	● CW, CCW : input pulse frequency duty 50% (min. 2μs). ● Servo On/Off: min. 1ms, ● Alarm reset: min. 20ms		● CW, CCW: input pulse frequency duty 50% (min. 1.25μs), ● 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: 800kHz							
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/s^2 (approx. 30G) in each X, Y, Z direction for 3 times							
Environment	Ambient temp.	0 to 50°C, storage: -20 to 70°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)							

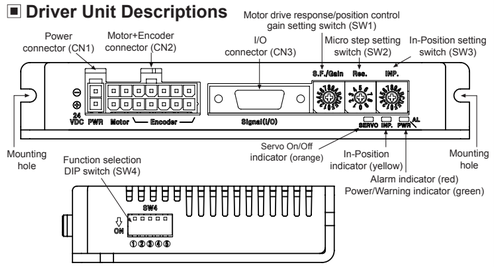
※1: Based on the ambient temperature 25°C, ambient humidity 55%RH, and STOP current 50%.
※2: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase. The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※3: Max.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

● **CN1: Power connector**

Pin arrangement	Pin No.	Function
2 1	2	GND
	1	24VDC

● **CN2: Motor+Encoder connector**

Pin No.	Function	Pin No.	Function
1	GND	8	+5VDC
2	Encoder A	9	Encoder Ā
3	Encoder B	10	Encoder B̄
4	Encoder Z	11	Encoder Z̄
5	GND EARTH	12	N·C
6	Motor A	13	Motor B
7	Motor Ā	14	Motor B̄

● **CN3: I/O connector**

Pin arrangement	Pin No.	Input/ Output	Function	Pin No.	Input/ Output	Function
10 ····· 1 20 ····· 11	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 Ā
	7	Output	Alarm Out+	17	Output	Encoder B
	8	Output	Alarm Out-	18	Output	Encoder B̄
	9	Input	Alarm Reset+	19	Output	Encoder Z
	10	Input	Alarm Reset-	20	Output	Encoder Z̄

▣ Driver Setting

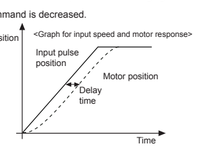
○ **SW1: Speed filter setting switch or position control gain setting switch**
-SW1 shifts its mode between the speed filter setting or position control gain setting, depending on 4th pin in SW4 as follows.
-Modified setting values are not applied in the running status, and the values will be applied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

4th pin in SW4	Setting
OFF	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 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 zone.

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: Resolution setting switch**
-Set the resolution of driver.
-Refer to the below table 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.

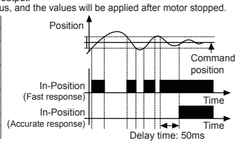
Setting switch	Setting	Frame size 20mm		Frame size 28/35mm	
		Pulse/Revolution	Resolution	Pulse/Revolution	Resolution
RES.	0※1	500	2.5	500	2.5
	1	1000	5	1000	5
	2	1600	8	1600	8
	3	2000	10	2000	10
	4	3600	18	3600	18
	5	4000	20	5000	25
	6	5000	25	6400	32
	7	6400	32	7200	36
	8	7200	36	10000	50
	9	10000	50	16000	80

※1: Factory default

○ **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	Fast Response		Accurate Response	
	Setting	Value	Setting	Value
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

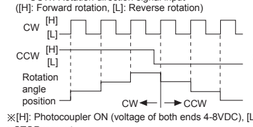


○ **SW4: Function selection DIP switch**
-Set rotation direction, pulse input method, STOP current, SW1 setting, and test mode.

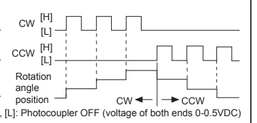
Setting switch	No.	Name	Function	Switch position	
				ON	OFF (factory default)
ON 1 2 3 4 5	1※1	DIR	Rotation direction	CCW	CW
	2※1	1P/2P	Pulse input method	1-pulse input method	2-pulse input method
	3※2	C.D.	STOP current	25% of max. RUN current	50% of max. RUN current
	4※2	SW1 Mode	SW1 setting	Position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

○ **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	5556T2	—	Molex
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.

○ **Cable (sold separately)**

Type	Model
Power cable	CJ-PW-□※1
I/O cable	CJ-MP20-HP□※2 (sold separately, 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

Motor+ Encoder cable	
Normal	C1D14M-□※3
Moving	C1DF14M-□※3

※1: □ indicates cable length (010, 020) E.g.) CJ-PW-010: 1m power cable
※2: □ indicates cable length (010, 020, 030, 050, 070, 100, 150, 200) E.g.) CJ-MP20-HP070: 7m I/O cable
※3: □ 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

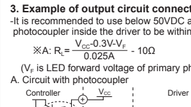
○ **Input**
1. Position command pulse
-Pulse input is selectable from 1-pulse input method and 2-pulse input method.
(Refer to '○ SW4: Function selection DIP switch'.)
-When using extending cable, it is recommended to connect Common mode choke coil (2mH) to the CW, CCW terminal in series connection.
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 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.
※Use this function after stopping the motor.
※Refer to 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 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.

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

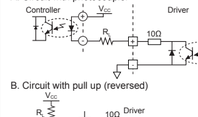
V_{CC}	R_L
12VDC	680Ω (min. 0.25W)
24VDC	1.8kΩ (min. 0.5W)

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

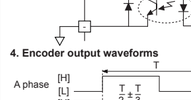
A. Pull-Up / B. Pull-Down



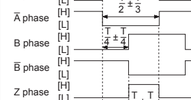
C. Circuit with NPN (not-reversed) / D. Circuit with PNP (reversed)



● 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 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 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 21-27VDC ±5%		
	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 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>

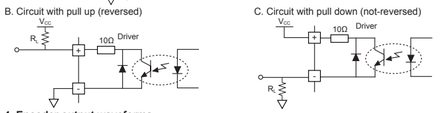
3. Example of output circuit connection
-It is recommended to use below 50VDC at V_{CC}. Use the R_L for I_C (collector current of secondary detector) of photocoupler inside the driver to be within 25mA following the below formula.

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

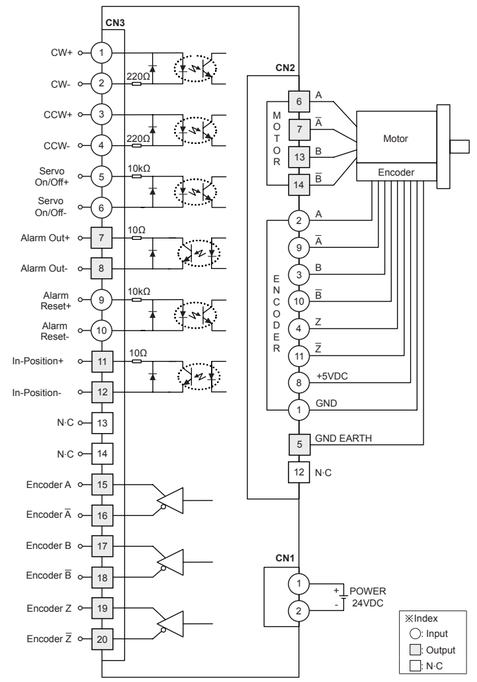
B. Circuit with pull up (reversed) / C. Circuit with pull down (not-reversed)



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). ※T=1 cycle of A, B phase

▣ 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 frequency 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, CO₂, 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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