AC Type 2-Phase Closed-Loop Stepper Motor Driver

▣ Features

NEW

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

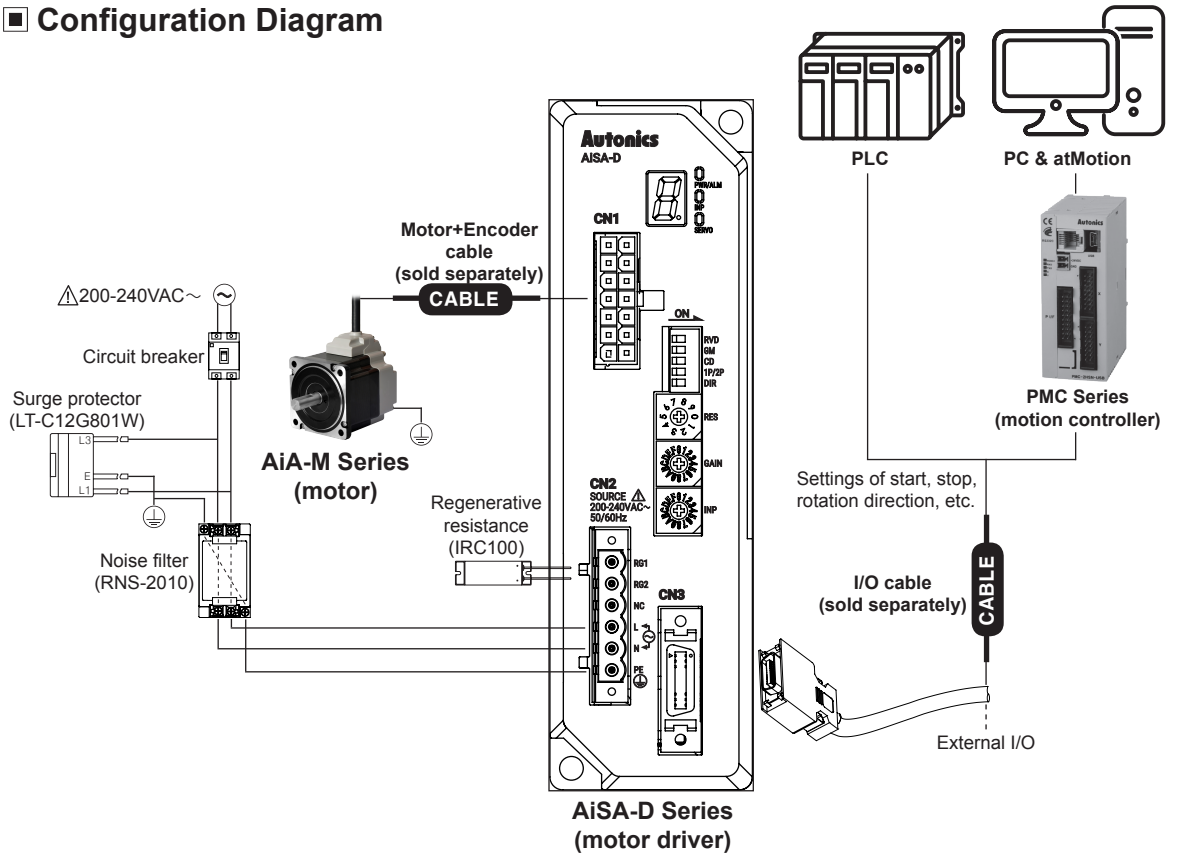
Please read "Safety Considerations" in operation manual before using.

CE

▣ Applications

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

▣ Configuration Diagram



AC Type 2-Phase Closed-Loop Stepper Motor Driver

■ Ordering Information

Ai S A - D - 60 M A

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

◎ AiSA Series

Set	Driver	Motor
AiSA-60MA	AiSA-D-60MA	AiA-M-60MA
AiSA-60LA	AiSA-D-60LA	AiA-M-60LA
AiSA-86MA	AiSA-D-86MA	AiA-M-86MA
AiSA-86LA	AiSA-D-86LA	AiA-M-86LA

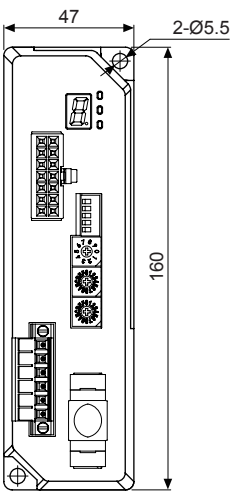
■ Specifications

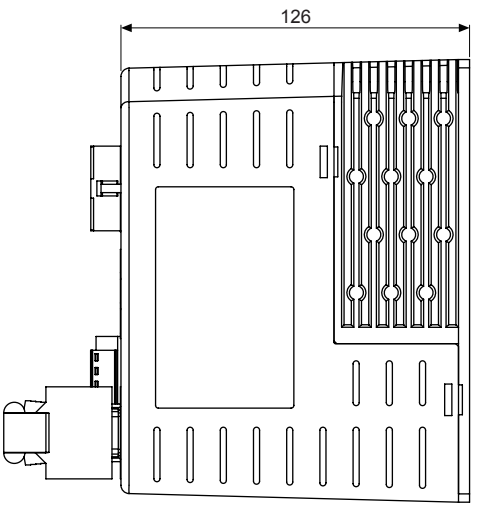
Model		AiSA-D-60MA	AiSA-D-60LA	AiSA-D-86MA	AiSA-D-86LA
Power supply		200-240VAC～ 50/60Hz			
Power consumption	STOP※1	Max. 60W		Max. 65W	Max. 70W
	Max. during operation※2	Max. 160W	Max. 220W	Max. 250W	Max. 300W
Max. RUN current※3		2.0A/Phase			
STOP current		20% or 30% of max. RUN current (factory default: 30%)			
Rotation speed		0 to 3000rpm			
Resolution		500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000PPR			
Motor GAIN		Within the range of motor gain: 1 to 32			
In-Position		Within the range of Fast response: 0 to 7 or Accurate response: 0 to 7			
Pulse input method		1-pulse or 2-pulse input (factory default) method			
Motor rotation direction		CW (factory default), CCW			
Status display		● Power/Alarm indicator: green/red LED ● In-Position indicator: orange LED ● Servo On/Off indicator: blue LED ● Alarm/Status display part: red LED 7seg.			
Input signal		RUN pulse, Servo On/Off, alarm reset (photocoupler input)			
Output signal		In-Position, alarm out (photocoupler output), 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 resistance		Over 100MΩ (at 500VDC megger)			
Dielectric strength		1,500VAC 50/60Hz for 1 min			
Vibration		1.5mm amplitude at frequency of 10 to 55Hz (for 1 min) in each X, Y, Z direction for 2 hours			
Shock		300m/s^2 (approx. 30G) in each X, Y, Z direction for 3 times			
Environment	Ambient temp.	0 to 50℃, storage: -10 to 60℃			
	Ambient humi.	35 to 85%RH, storage: 10 to 90%RH			
Approval		CE			
Protection structure		IP20 (IEC standard)			
Weight※5		Approx. 900g (approx. 780g)			

※1: Based on the ambient temperature 25℃, ambient humidity 55%RH, and STOP current 30%.
※2: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase. The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※3: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※4: Max. input pulse frequency is max. frequency to be input and is not the same as max. pull-out frequency or max. slewing frequency.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

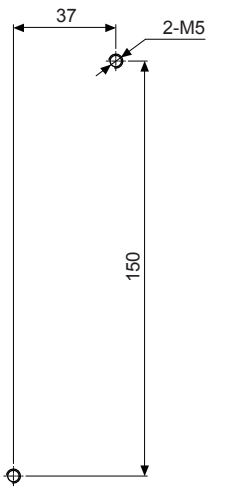
▣ Dimensions

(unit: mm)

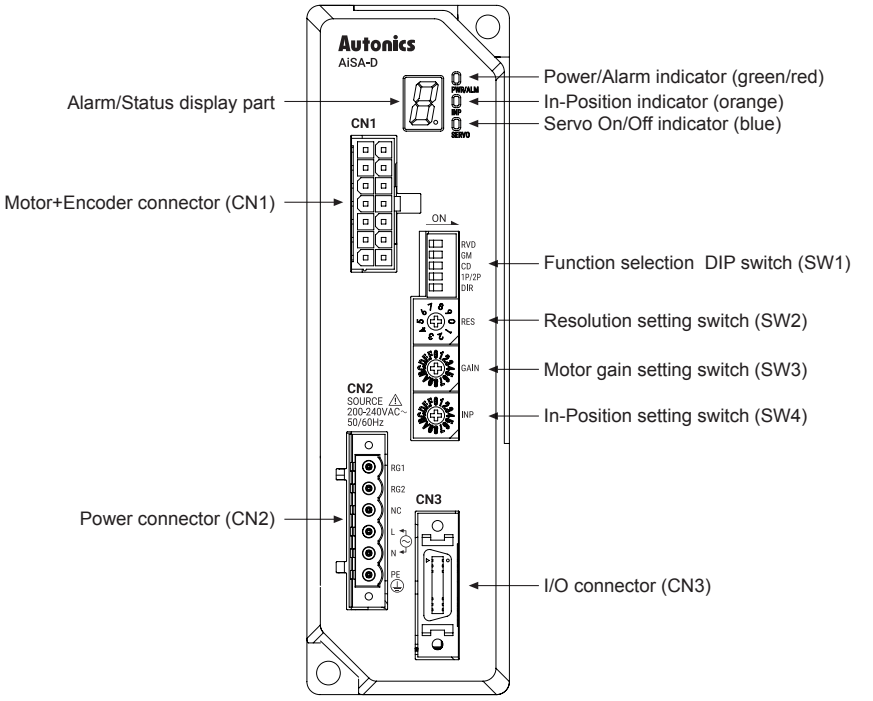




◎ Panel cut-out



▣ Driver Unit Descriptions



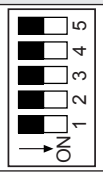
▣ Driver Status Indicators

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

▣ Driver Setting

◎ SW1: Function selection DIP switch

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

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

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

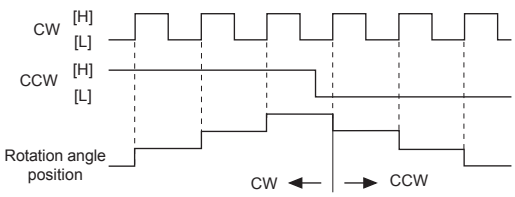
• Pulse input method

※1-pulse input method

CW: rotation operation signal input

CCW: rotation direction signal input

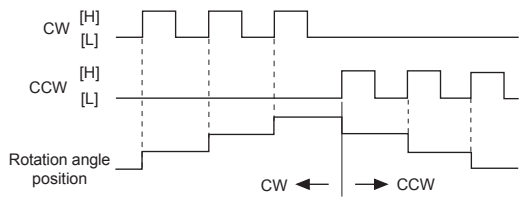
([H]: forward rotation, [L]: reverse rotation)



※2-pulse input method

CW: forward rotation signal input

CCW: reverse rotation signal input



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

• STOP current

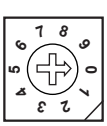
-In order to decrease motor heat and current consumption at motor stopping moment (in case there is no input during the time of the double width of last input pulse), set the stop current supplied to the motor phase.

◎ SW2: Resolution setting switch

-Set the resolution of driver.

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

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

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

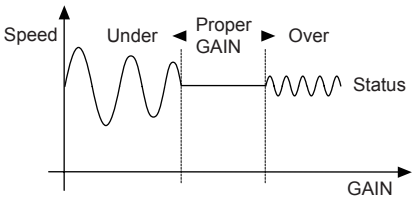
◎ SW3: Motor gain setting switch

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

• Motor gain

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

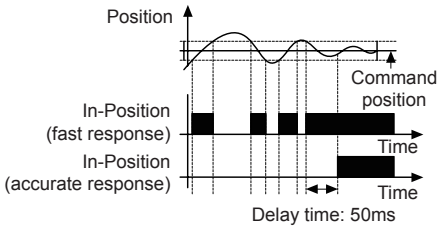
Setting switch	4th pin in SW1=OFF				4th pin in SW1=ON			
	Setting	GAIN	Setting	GAIN	Setting	GAIN	Setting	GAIN
 GAIN	0	×1	8	×9	0	×17	8	×25
	1	×2	9	×10	1	×18	9	×26
	2	×3	A	×11	2	×19	A	×27
	3	×4	B	×12	3	×20	B	×28
	4	×5	C	×13	4	×21	C	×29
	5	×6	D	×14	5	×22	D	×30
	6	×7	E	×15	6	×23	E	×31
	7	×8	F	×16	7	×24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



◎ SW4: In-Position setting swtich

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

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



▣ Contol Input/Output

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

◎ Input

1. Position command pulse

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

2. Servo On/Off

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

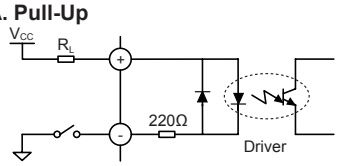
-In case V_{CC} is over 5VDC, calculate R_L value using following formula and use V_{CC} below 30VDC.

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

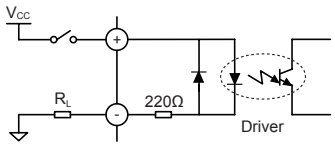
-In case V_{cc} is 12, 24VDC, refer to table on the right for R_L.

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

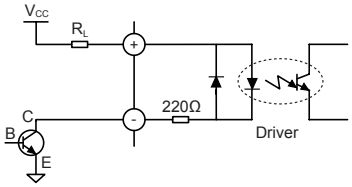
A. Pull-Up



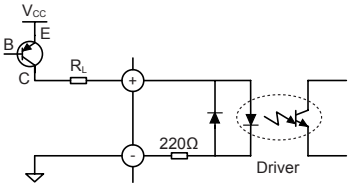
B. Pull-Down



C. Circuit with NPN (not-reversed)

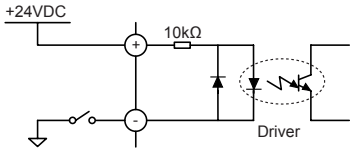


D. Circuit with PNP (reversed)

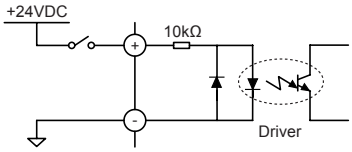


● External input (Servo On/Off, Alarm Reset)

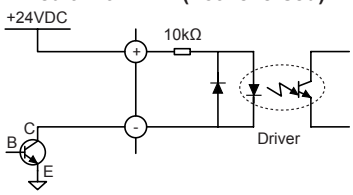
A. Pull-Up



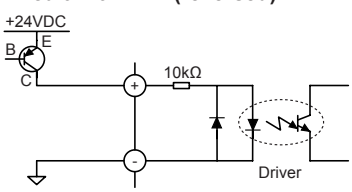
B. Pull-Down



C. Circuit with NPN (not-reversed)



D. Circuit with PNP (reversed)



◎ Output

1. In-Position

-In-Position output is output condition of positioning completion signal.

-If the gap between target position and real position is under In-Position setting value after position command pulse has finished, In-Position output turns to [H] and the In-Position indicator turns ON.

-In reverse, when the gap is over In-Position setting value, In-Position output turns to [L] and the In-Position indicator turns OFF.

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

※Refer to example of output circuit connection.

2. Alarm

● Alarm

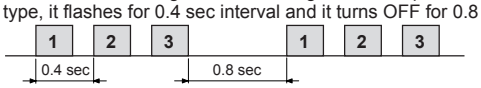
-This function stops motor to protect driver, depending on the error status such as over current or over speed.
-In case of normal status, output is [H], and in case of alarming status, output is [L].
-When supplying alarm reset, driver returns to the normal status.
※Refer to example of output circuit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

● Alarm/Status display

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

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

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



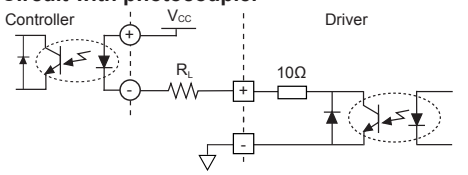
3. Example of output circuit connection

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

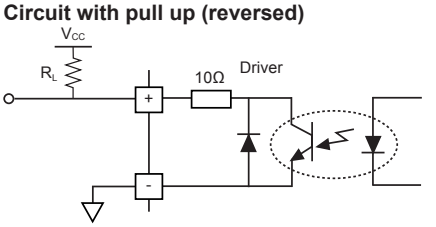
※A: $R_L = \frac{V_{CC}-0.3V-V_F}{0.025A} - 10\Omega$ ※B, C: $R_L = \frac{V_{CC}-0.3V}{0.025A} - 10\Omega$

(V_F is LED forward voltage of primary photocoupler.)

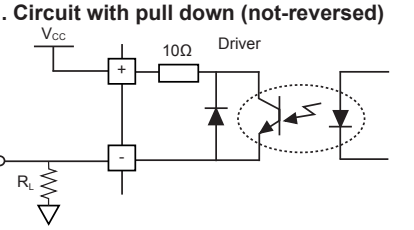
A. Circuit with photocoupler



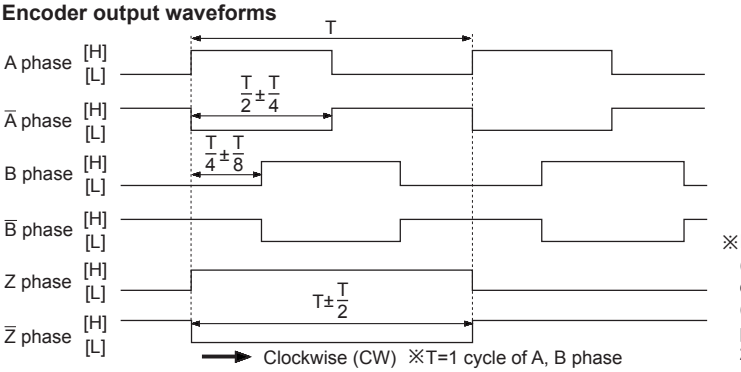
B. Circuit with pull up (reversed)

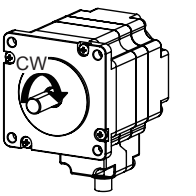


C. Circuit with pull down (not-reversed)



4. Encoder output waveforms



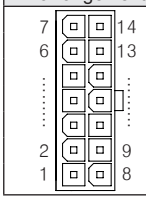


※It is recommended to use Line driver output (corresponding to 26C32) at RECEIVER end of encoder output and terminating resisters (100-150Ω) in parallel at both ends of each phase (A, Ā, B, B̄, Z, Z̄, corresponding to 26C31).

▣ Connection Connectors of Driver

◎ Connector function

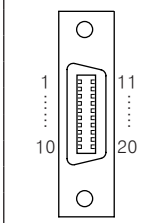
● CN1: Motor+Encoder Connector

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

● CN2: Power connector

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

● CN3: I/O connector

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

◎ Connector specifications

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

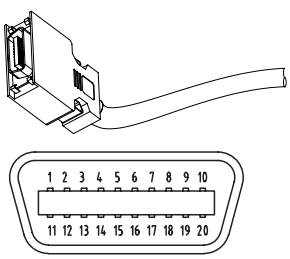
※Above connectors are suitable for AiSA-D Series.

▣ Sold Separately

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

◎ I/O cable

● CJ-MP20-HP□
(standard: AiS TAG)

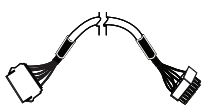


Pin no.	Function (name tag)	Cable color	Dot line color-numbers	Pin no.	Function (name tag)	Cable color	Dot line color-numbers
1	CW+	Yellow	Black-1	11	IN POSITION+	White	Black-1
2	CW-		Red-1	12	IN POSITION-		Red-1
3	CCW+		Black-2	13	—		Black-2
4	CCW-		Red-2	14	—		Red-2
5	SERVO ON/OFF+		Black-3	15	ENCODER A+		Black-3
6	SERVO ON/OFF-		Red-3	16	ENCODER A-		Red-3
7	ALARM OUT+		Black-4	17	ENCODER B+		Black-4
8	ALARM OUT-		Red-4	18	ENCODER B-		Red-4
9	ALARM RESET+		Black-5	19	ENCODER Z+		Black-5
10	ALARM RESET-		Red-5	20	ENCODER Z-		Red-5

※□ of model name indicates cable length (010, 020).
For corresponding EMC standard, cable length should be below 2m.
E.g.) CJ-MP20-HP020: 2m I/O cable.

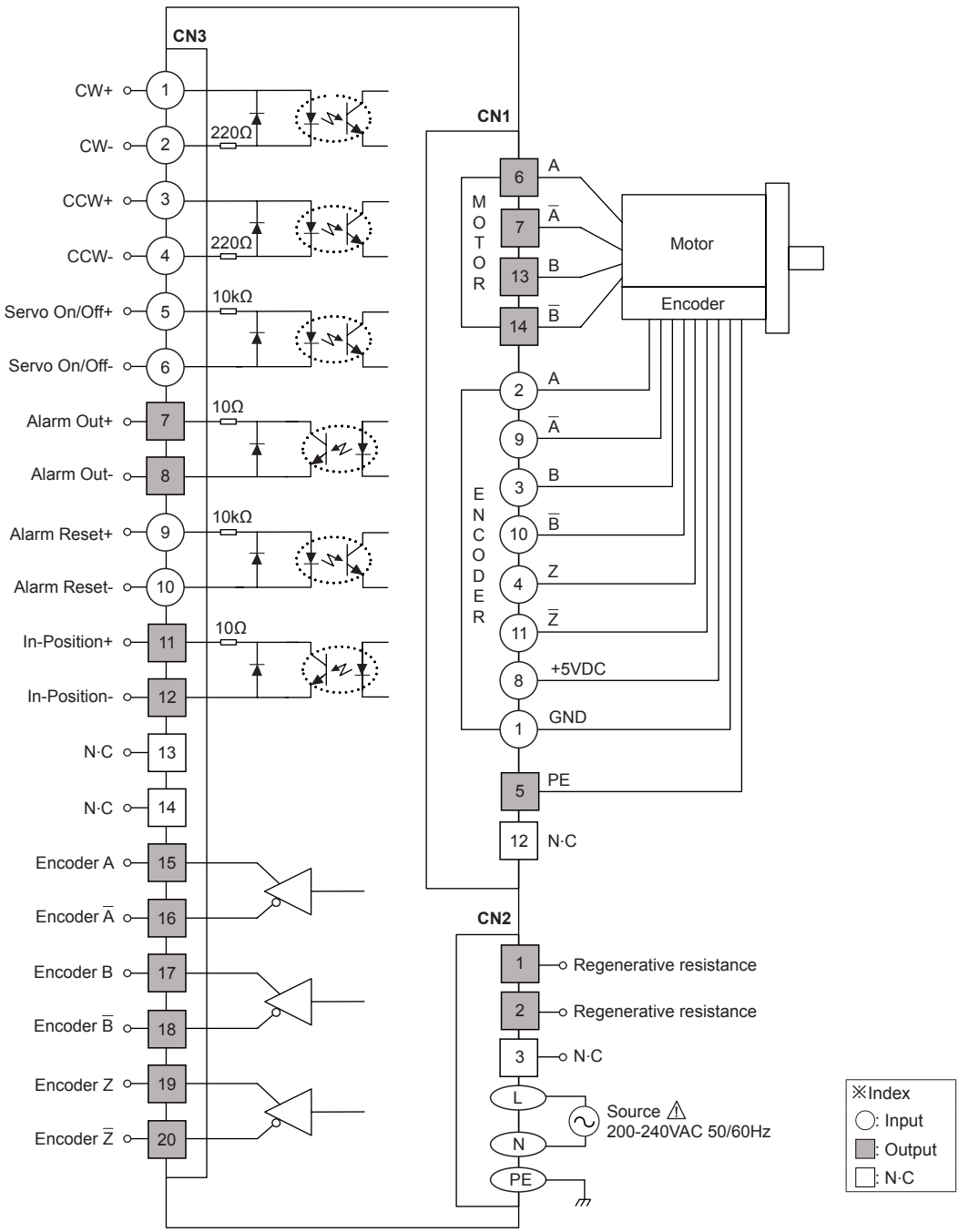
◎ Motor+Encoder cable

● Normal: CID14M-□, Moving: CIDF14M-□



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

▣ Connection for Motor and Driver



■ Options for Power Connector (CN2)

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

※Use the unit which is commercially available.

■ Troubleshooting

1. When motor does not rotate

①Check the connection status between controller, driver, and pulse input specifications (voltage, width).
②Check the pulse and direction signal are connected correctly.

2. When motor rotates to the opposite direction of the designated direction

①When RUN mode is 1-pulse input method, CCW input [H] is for forward, [L] is for backward.
②When RUN mode is 2-pulse input method, check CW and CCW pulse input are changed or not.

3. When motor drive is unstable

①Check that driver, motor are connected correctly.
②Check the driver pulse input specifications (voltage, width).

■ Proper Usage

- Follow instructions in 'Proper Usage'. Otherwise, it may cause unexpected accidents.
- Do not input CW, CCW signal at the same time in 2-pulse input method.
- When the signal input voltage is exceeded the rated voltage, connect additional resistance at the outside.
- To extend the motor+encoder cable, use the designated the cable.
- Keep the distance between power cable and signal cable more than 10cm.
- Install the unit vertically on the alarm/status display part upper side.
- For heat radiation of the driver, install a fan.
- Do not change any setting switches (function, resolution, motor gain, in-position switches) during the operation or after supplying power. Failure to follow this instruction may result in malfunction.
- Motor vibration and noise can occur in specific frequency period.
  ①Change motor installation method or attach the damper.
  ②Use and set the gain value.
- For using motor, it is recommended to maintenance and inspection regularly.
  ①Unwinding bolts and connection parts for the unit installation and load connection
  ②Strange sound from ball bearing of the unit
  ③Damage and stress of lead cable of the unit
  ④Connection error with motor
  ⑤Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.
- This product does not prepare protection function for a motor.
- This unit may be used in the following environments.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II