Oriental motor

HM-60346-4

OPERATING MANUAL

Driver for 5-Phase Stepping Motor

CVD Series SC type

CE KC

Thank you for purchasing an Oriental Motor product.
This Manual describes product handling procedures and safety precautions.
• Please read it thoroughly to ensure safe operation.
• Always keep the manual where it is readily available.

| memo | The items under this heading contain related information and contents to gain a further understanding of the text in this manual. |

Table of contents

Description of graphic symbols

| 🚫	Indicates "prohibited" actions that must not be performed.
❗	Indicates "compulsory" actions that must be performed.

Introduction

■ Before use

Only qualified personnel of electrical and mechanical engineering should work with the product.
Use the product correctly after thoroughly reading the "Safety precautions."
In addition, be sure to observe the contents described in warning, caution, and note in this manual.
The product described in this manual is designed and manufactured to be incorporated in general industrial equipment. Do not use for any other purpose. Oriental Motor Co., Ltd. is not responsible for any damage caused through failure to observe this warning.

■ Overview of the product

This product is a driver for 5-phase stepping motors. Simply inputting operation signals from a programmable controller can easily drive the motor without using a pulse generator.
You can set two different operating speeds of high speed and low speed, and also switch the speed by the input signal even while operating.
The **CVD** Series SC type defines the operating speed of the high speed side as "Speed1" and the operating speed of the low speed side as "Speed2."
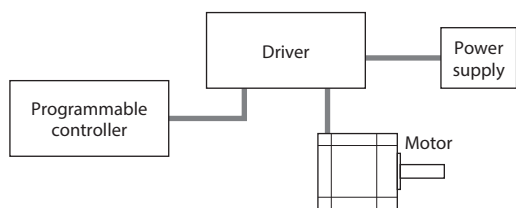
Safety precautions

The precautions described below are intended to prevent danger or injury to the user and other personnel through safe, correct use of the product. Use the product only after carefully reading and fully understanding these instructions.

Description of signs

⚠WARNING	Handling the product without observing the instructions that accompany a "WARNING" symbol may result in serious injury or death.
⚠CAUTION	Handling the product without observing the instructions that accompany a "CAUTION" symbol may result in injury or property damage.
Note	The items under this heading contain important handling instructions that the user should observe to ensure the safe use of the product.

⚠WARNING

🚫	• Do not use the product in explosive or corrosive environments, in the presence of flammable gases, locations subjected to splashing water, or near combustibles. Doing so may result in fire or injury. • Do not forcibly bend, pull or pinch the cable. Doing so may result in fire. • Do not remove the motor excitation during operation. Doing so may cause the motor to stop and lose the holding force, resulting in injury or damage to equipment. • Do not disassemble or modify the driver. Doing so may result in injury or damage to equipment.
❗	• Assign qualified personnel to the task of installing, wiring, operating/controlling, inspecting and troubleshooting the driver. Failure to do so may result in fire, injury, or damage to equipment. • When an alarm is generated in the driver (any of the driver's protective functions is triggered), remove the cause before clearing the alarm (protective function). Continuing the operation without removing the cause of the problem may cause malfunction of the motor and the driver, leading to injury or damage to equipment. • Install the driver inside an enclosure. Failure to do so may result in injury. • Always keep the power supply voltage of the driver within the specified range. Failure to do so may result in fire. • For the driver power supply use a DC power supply with reinforced insulation on its primary and secondary sides. Failure to do so may result in electric shock. • Connect the cables securely according to the wiring diagram. Failure to do so may result in fire. • Turn off the driver power supply in the event of a power failure. Failure to do so may result in injury or damage to equipment.

⚠CAUTION

🚫	• Do not use the driver beyond its specifications. Doing so may result in injury or damage to equipment. • Do not insert a finger or an object between the board and the heat sink. Failure to do so may result in fire or injury. • Do not touch the driver during operation or immediately after stopping. Doing so may result in a skin burn(s). • Do not forcibly bend or pull the cable that was connected to the driver. Doing so may result in damage to the product,. • Keep the area around the driver free of combustible materials. Failure to do so may result in fire or a skin burn(s). • Leave nothing around the product that would obstruct ventilation. Failure to do so may result in damage to equipment.

⚠CAUTION

- Use a motor and driver only in the specified combination. Failure to do so may result in fire.
- Provide an emergency stop device or emergency stop circuit external to the equipment so that the entire equipment will operate safely in the event of a system failure or malfunction. Failure to do so may result in injury.
- Before supplying power to the driver, turn all input signals to the driver to OFF. Failure to do so may result in injury or damage to equipment.
- When moving the moving part manually, put the motor into a non-excitation state. Continuing the work while the motor is in an excitation state may result in injury.
- Immediately when a problem occurred, stop operation and turn off the driver power. Failure to do so may result in fire or injury.

Precautions for use

- **When conducting the insulation resistance measurement or the dielectric strength test, be sure to separate the connection between the motor and the driver.**

Conducting the insulation resistance measurement or dielectric strength test with the motor and driver connected may result in damage to the product.

- **Regeneration**

When a large load inertia is operated at a high speed, the power supply voltage may increase by the regenerative energy generated, causing an alarm of overvoltage to generate. This may result in damage to the driver, so reconsider the operating condition so as not to generate the regenerative voltage.

Preparation

■ Checking the product

Verify that the items listed below are included. Report any missing or damaged items to the Oriental Motor sales office from which you purchased the product.

- Driver .... 1 unit
- Instructions and Precautions for Safe Use .... 1 copy
- Connector housing/contact .... 1 set
  (Packed in a bag; refer to the table below.)

Application	Housing *	Contact *
For power supply (CN1)	1 pc. 51103-0200 (2-poles)	19 pcs. 50351-8100
For motor (CN2)	1 pc. 51103-0500 (5-poles)	
For I/O signals (CN3)	1 pc. 51103-1200 (12-poles)	

* Manufacturer: Molex Incorporated

Note When removing the driver from the ESD protection bag, make sure your hands are not charged with static electricity. This is to prevent damage to the driver due to static electricity.

■ How to identify the product model

$$\underset{1}{\underline{CVD}}\ \underset{2}{\underline{5}}\ \underset{3}{\underline{18}}\ \underset{4}{\underline{B}}\ \underset{5}{\underline{R}}\ -\ \underset{6}{\underline{K}}\ \underset{7}{\underline{SC}}$$

1	Series	**CVD**: CVD Series
2	Number of phases of motor	**5**: 5-phase
3	Motor rated current	**12**: 1.2 A/phase **18**: 1.8 A/phase **24**: 2.4 A/phase
4	Driver shape	**B**: With mounting plate
5	Connector shape	**R**: Right angle Blank: Vertical
6	Power supply input	**K**: DC power supply
7	Driver type	**SC**: Speed control

■ Information about nameplate

The figure shows an example.

Driver model → **CVD518BR-KSC**
Serial number → UQ8 1234567
Manufacturing date → 2017/03
ORIENTAL MOTOR CO.,LTD
MADE IN JAPAN

■ Motor specifications for possible combinations

Use the driver in combination with the motors shown in the table.
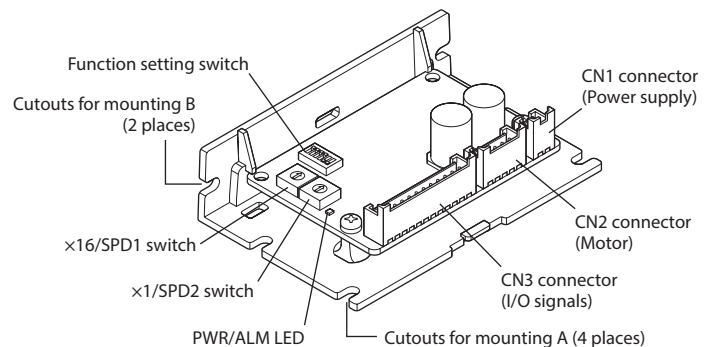Check the motor rated current on the Oriental Motor Website or the motor nameplate.

Model name *1	Motor rated current	Motor combination *2
CVD512B□-KSC	1.2 A/phase	**PKP523N12■** **PKP525N12■**
CVD518B□-KSC	1.8 A/phase	**PKP543N18■2** **PKP544N18■2** **PKP545N18■2** **PKP546N18■2**
CVD524B□-KSC	2.4 A/phase	**PKP564FN24■2** **PKP566FN24■2** **PKP569FN24■2**

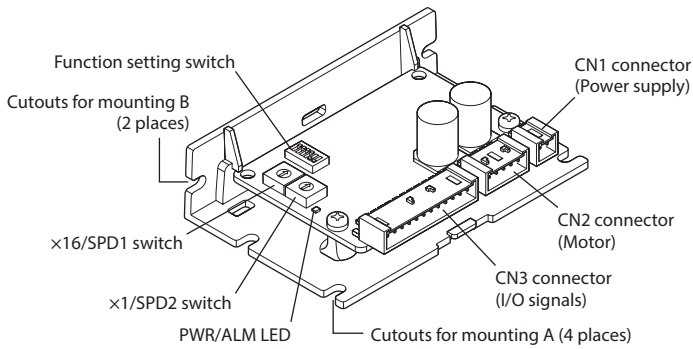*1 When the connector shape is of right angle, the box (□) in the model name indicates **R**.
*2 The box (■) in the model name indicates **A** (single shaft) or **B** (double shaft) representing the motor shape.

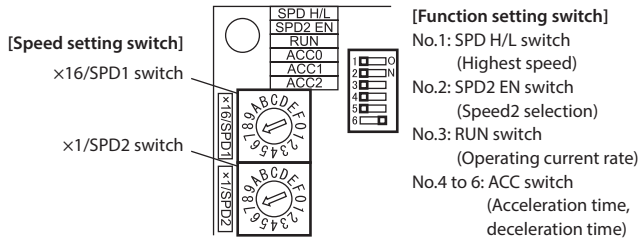## ■ Names of parts

● When the connector shape is of vertical

2

● **When the connector shape is of right angle**

Function setting switch
Cutouts for mounting B (2 places)
CN1 connector (Power supply)
×16/SPD1 switch
×1/SPD2 switch
PWR/ALM LED
CN2 connector (Motor)
CN3 connector (I/O signals)
Cutouts for mounting A (4 places)

● **Details of switches**

Refer to p.10 for the setting method. The figure shows the factory setting.

[Speed setting switch]
×16/SPD1 switch
×1/SPD2 switch

[Function setting switch]
No.1: SPD H/L switch (Highest speed)
No.2: SPD2 EN switch (Speed2 selection)
No.3: RUN switch (Operating current rate)
No.4 to 6: ACC switch (Acceleration time, deceleration time)

(memo) Switch the ACC switch (function setting switch No.4 to No.6) while the motor is stopped. Other switches can be changed even while the motor is operating.

● **Function setting switch**

No.	Indication	Function	Factory setting
1	SPD H/L	Selects the highest speed of the Speed1. OFF: 600 r/min ON: 200 r/min	OFF
2	SPD2 EN	Selects the setting method of the Speed2. OFF: Fixed to 10 % of the Speed1 ON: Set from 16 operating speeds	OFF
3	RUN	Sets the operating current rate. OFF: 100 % ON: 70 %	OFF
4	ACC0	Sets the acceleration time and deceleration time based on a combination of ON/OFF status of three switches. Factory setting: 0.50 s	No.4: OFF No.5: OFF No.6: ON
5	ACC1		
6	ACC2		

● **Speed setting switch**

Indication	Function	Factory setting
×16/SPD1	Sets the Speed1.	7
×1/SPD2	Sets the Speed1 or Speed2.	7

Installation

■ Location for installation

The driver is designed and manufactured to be incorporated in equipment. Install it in a well-ventilated location that provides easy access for inspection. The location must also satisfy the following conditions:

- Inside an enclosure that is installed indoors (provide vent holes)
- Operating ambient temperature 0 to +50 °C (+32 to +122 °F) (non-freezing)
- Operating ambient humidity 85 % or less (non-condensing)
- Area free of explosive atmosphere or toxic gas (such as sulfuric gas) or liquid
- Area not exposed to direct sun
- Area free of excessive amount of dust, iron particles or the like
- Area not subject to splashing water (rain, water droplets), oil (oil droplets) or other liquids
- Area free of excessive salt
- Area not subject to continuous vibration or excessive shocks
- Area free of excessive electromagnetic noise (from welders, power machinery, etc.)
- Area free of radioactive materials, magnetic fields or vacuum
- 1,000 m (3,300 ft.) or lower above sea level

■ Installation direction

Install the driver on a metal plate having excellent vibration resistance in vertically or horizontally. If the driver is installed under conditions other than vertical or horizontal position, its heat radiation effect will deteriorate.
The items shown below are necessary in order to install the driver. The items are not included and must be provided by the customer.
Torque the mounting screw to 0.5 N·m (71 oz-in).

- M3 Screw ....4 pieces (2 pieces) *1
- M3 Spring washer................................4 pieces (2 pieces) *1
- M3 Nut..4 pieces (2 pieces) *1 *2
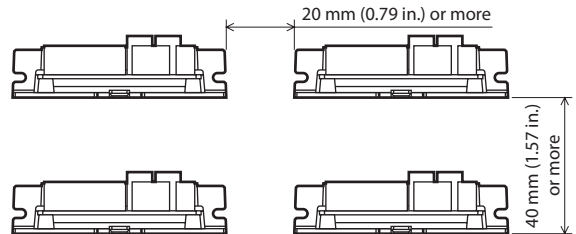
*1 ( ): When using the cutouts for mounting B.
*2 Not necessary if screw holes are provided in the mounting plate.

There must be clearances of at least 25 mm (0.98 in.) and 50 mm (1.97 in.) in the horizontal and vertical directions respectively, between the driver and enclosure or other equipment within the enclosure. When two or more drivers are to be installed side by side, provide clearances in the horizontal and vertical directions as shown in the figure.
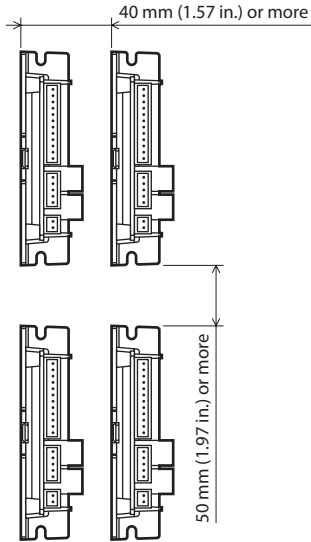
(memo)
- Install the driver inside an enclosure.
- Do not install any equipment that generates a large amount of heat or noise near the driver.
- If the ambient temperature of the driver exceeds 50 °C (122 °F), improve the ventilation condition.

● **Horizontal installation**

20 mm (0.79 in.) or more
40 mm (1.57 in.) or more

● Vertical installation

40 mm (1.57 in.) or more

50 mm (1.97 in.) or more

■ Installation method

Install the driver using either the "cutouts for mounting A" or "cutouts for mounting B."
The figure shows the driver which connector shape is of right angle.

Note If both cutouts A and B are used for installation, the heat sink is distorted, causing the board to apply stress.
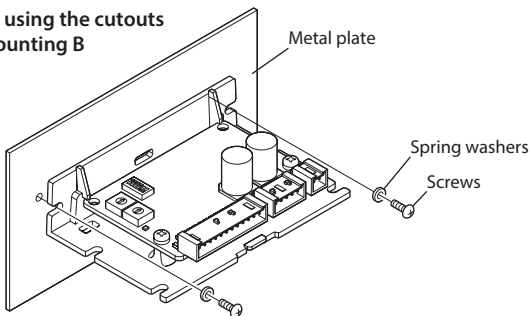
● Horizontal installation

Install the driver in a direction shown in the figure. Installing the driver upside down causes the heat radiation effect to deteriorate.
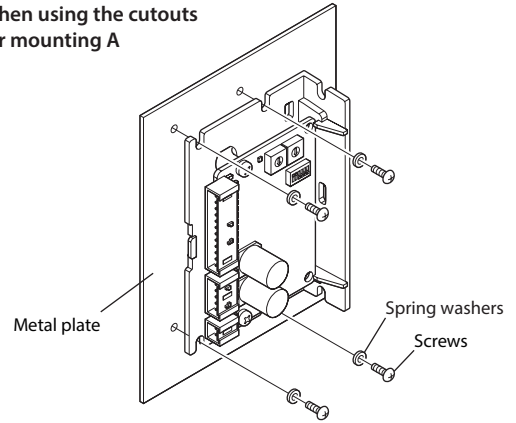
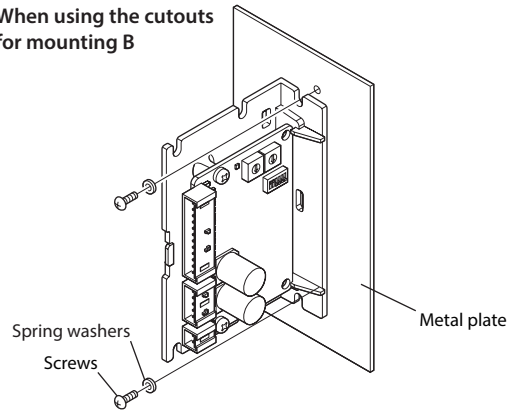**When using the cutouts for mounting A**

Screws
Spring washers
Metal plate

When using the cutouts for mounting B

Metal plate
Spring washers
Screws
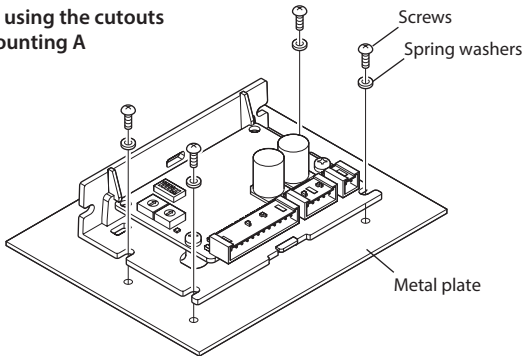
● Vertical installation

The driver can be installed in any direction.

When using the cutouts for mounting A

Metal plate
Spring washers
Screws

When using the cutouts for mounting B

Metal plate
Spring washers
Screws

■ Dimension [unit: mm (in.)]

● When the connector shape is of vertical

Mass: 0.06 kg (2.1 oz.)

85 (3.35)
78 (3.07)
3.5 (0.14)
3.5 (0.14)
52.5 (2.07)
30 (1.18)
3.5 (0.14)
5 (0.20)
24.5 (0.96) max.
20 (0.79)
2.5 (0.10)
2 (0.08)
3.5 (0.14)
78 (3.07)
3.5 (0.14)
8 (0.31)

4
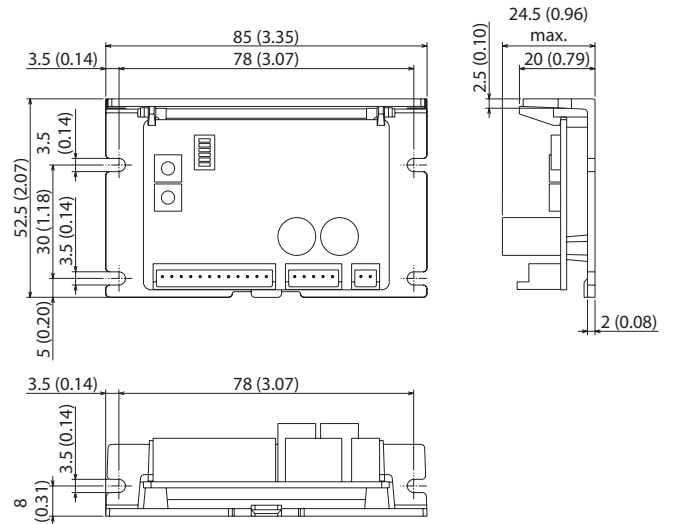
● **When the connector shape is of right angle**

Mass: 0.06 kg (2.1 oz.)
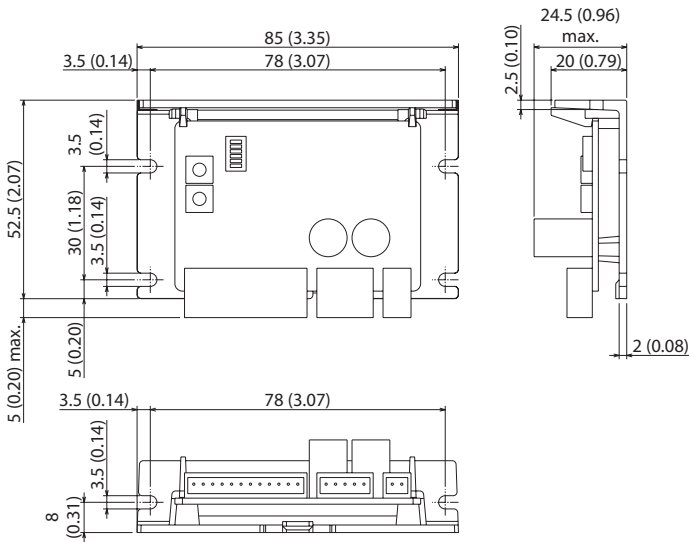
Connection

■ Applicable connector

Type	Application	Model *
Connector housing	For power supply (CN1)	51103-0200
	For motor (CN2)	51103-0500
	For I/O signals (CN3)	51103-1200
Contact	–	50351-8100
Designated crimping tool	–	63811-8100

Applicable lead wire	• For power supply (CN1)
	  - Stranded wire AWG22 (0.3 mm^2)
	  - Outer sheath diameter:
	    ø1.15 to 1.8 mm (ø0.045 to 0.071 in.)
	  - Strip length of wire insulation:
	    2.3 to 2.8 mm (0.091 to 0.11 in.)
	• For motor (CN2)
	  - Stranded wire AWG24 to 22 (0.2 to 0.3 mm^2) *
	  - Outer sheath diameter:
	    ø1.15 to 1.8 mm (ø0.045 to 0.071 in.)
	  - Strip length of wire insulation:
	    2.3 to 2.8 mm (0.091 to 0.11 in.)
	  * AWG22 (0.3 mm^2) for the **CVD524B□-KSC**
	• For I/O signals (CN3)
	  - Stranded wire AWG24 to 22 (0.2 to 0.3 mm^2)
	  - Outer sheath diameter:
	    ø1.15 to 1.8 mm (ø0.045 to 0.071 in.)
	  - Strip length of wire insulation:
	    2.3 to 2.8 mm (0.091 to 0.11 in.)		

* Manufacturer: Molex Incorporated

- For the I/O signal cable, use a twisted pair cable.
- Keep the wiring distance as short as possible [less than 2 m (6.6 ft.)] to suppress the effect of noise.
- A connection cable set is also available in our products. Lead wires with a connector allow for easy connection.

■ Connector pin assignment
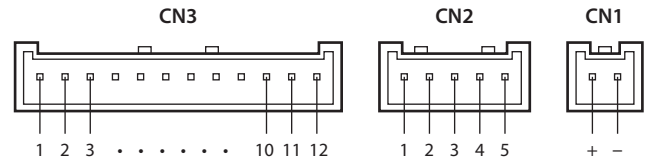
● **CN1 (Power supply)**

Pin No.	Direction	Signal name	Description
+	Input	POWER	+24 VDC
−			GND

● **CN2 (Motor)**

Pin No.	Direction	Signal name	Description
1	Output	MOTOR	Blue motor lead wire
2			Red motor lead wire
3			Orange motor lead wire
4			Green motor lead wire
5			Black motor lead wire

(memo) Connector pin assignments vary depending on the motor. For details, refer to "Connecting the motor" on p.6.

● **CN3 (I/O signals)**

Pin No.	Direction	Signal name		Description
1	Input	FWD	+	Forward input
2			−	
3		RVS	+	Reverse input
4			−	
5		AWO	+	All windings off input
6			−	
7		M0	+	Data selection input
8			−	
9	Output	ALM	+	Alarm output
10			−	
11		PLS-OUT	+	Pulse output
12			−	

■ Connecting the power supply

Use a power supply that can supply the following current capacity. When the power is turned on, the PWR/ALM LED will be lit in green.

Model name *	Input power supply voltage	Power supply current capacity
CVD512B□-KSC	+24 VDC±10 %	0.9 A or more
CVD518B□-KSC		2.5 A or more
CVD524B□-KSC		3.0 A or more

* When the connector shape is of right angle, the box (□) in the model name indicates **R**.

(Note)
- When connecting, pay attention to the polarity of the power supply. Reverse-polarity connection may cause damage to the driver.
- Connect the connector securely. Insecure connection may cause malfunction or damage to the motor and driver.

• When disconnecting the connector, pull out while pressing the latches on the connector.
• When turning on the power supply again or connecting/disconnecting the connector, turn off the power and wait for the PWR/ALM LED to turn off.
• Separate I/O signal cable at least 100 mm (3.94 in.) from electromagnetic relays and other than inductance loads. Additionally, route I/O signal cable perpendicular to power supply cable and motor cable, rather than in a parallel fashion.
• Do not route the power supply cable in the same conduits as other power supply lines and motor cable.
• If the motor cable or power supply cable generates an undesirable amount of noise depending on the wiring or configuration, shield the cable or install a ferrite core.

■ Connecting the motor

Connector pin assignments vary depending on the motor. Refer to the table. The pin number is shown in the figure.
"Color" in the table shows the lead wire colors of our connection cable.

(Note) The motors of the model A and model B are different in pin assignments. Wrong connection will not cause the motor to operate properly.

Model A Pin No. → 5 1   **Model B** Pin No. → 1 5
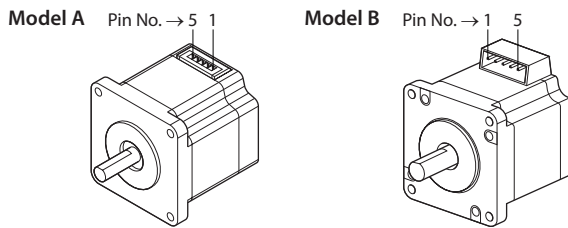
Driver CN2 Pin No.	Model A		Model B	
	Pin No.	Color	Pin No.	Color
1	5	Blue	1	Blue
2	4	Red	2	Red
3	3	Orange	3	Orange
4	2	Green	4	Green
5	1	Black	5	Black

■ Explanation of I/O signals

● Input signals

All input signals of the driver are photocoupler inputs.
The signal input state represents "ON: Carrying current" or "OFF: Not carrying current" state of the internal photocoupler rather than the voltage level of the signal.

● FWD (Forward) input, RVS (Reverse) input

Turning the FWD input or RVS input ON will start continuous operation.

FWD input	RVS input	Motor movement
ON	OFF	The motor rotates in the forward direction.
OFF	**ON**	The motor rotates in the reverse direction.
ON	**ON**	Immediate stop
OFF	OFF	Deceleration stop

(memo) If the driver power is turned ON while the FWD input or RVS input is being ON, the motor will operate.

● AWO (All windings off) input

When the AWO input is turned ON, the motor current will be cut off and the motor will lose its holding torque. The motor output shaft can be turned manually.
When the AWO input is turned OFF, current will be supplied and the holding torque will be restored.
Also, when the overheat alarm was generated, the alarm can be reset if the AWO input is turned from OFF to ON after the circuit temperature of the driver decreased 75 ℃ (167 ℉) or lower.

● M0 (Data selection) input

Turning the M0 input OFF will select the Speed1 (high speed).
Turning the M0 input ON will select the Speed2 (low speed).

● Output signals

The driver outputs signals are photocoupler/open-collector output.
The signal output state represents "ON: Carrying current" or "OFF: Not carrying current" state of the internal photocoupler rather than the voltage level of the signal.

● ALM (Alarm) output

The ALM output is normally closed. When an alarm generates, the ALM output will turn OFF and put the motor into a non-excitation state. At the same time, the PWR/ALM LED of the driver will blink in red.
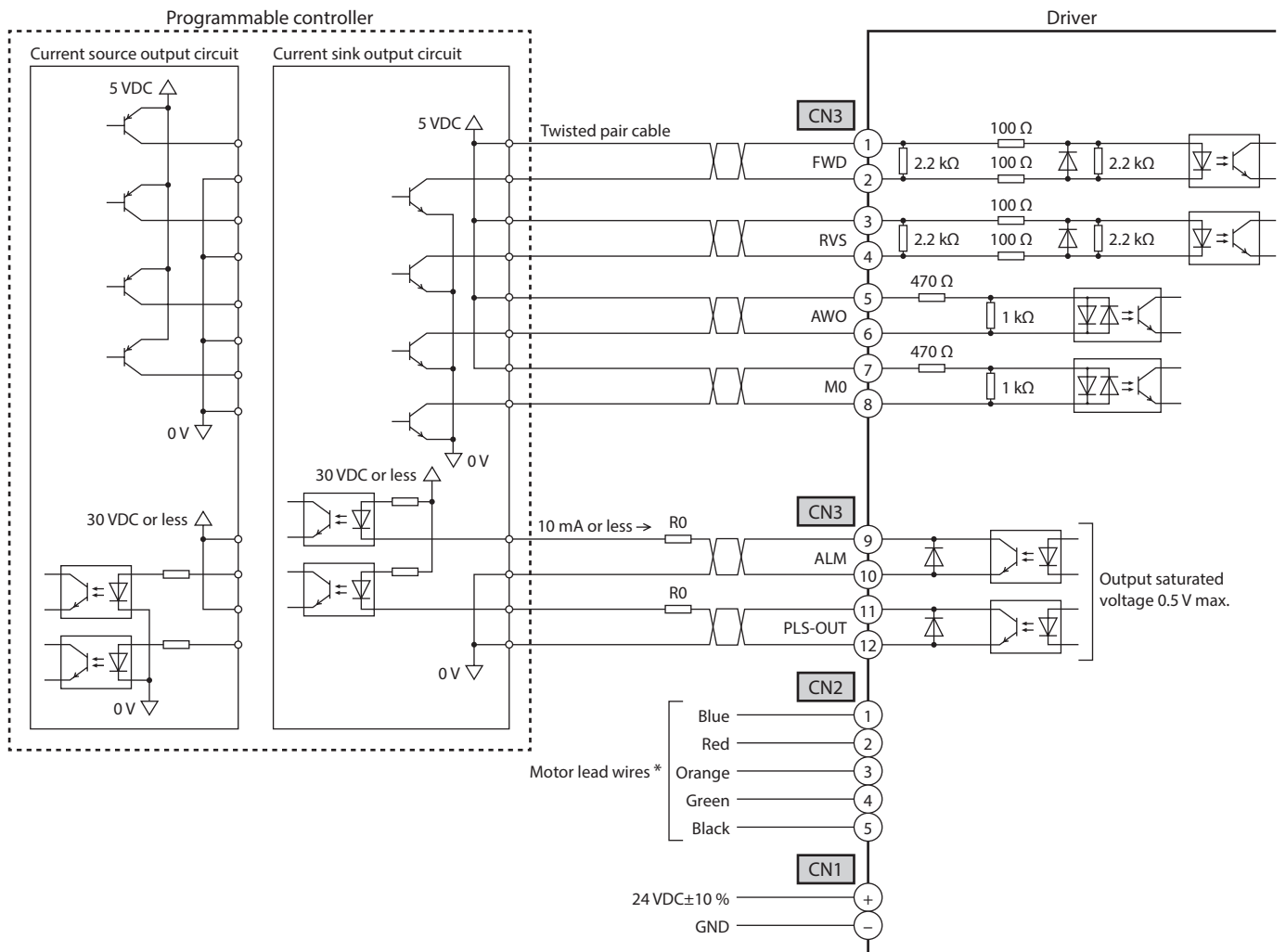
● PLS-OUT (Pulse) output

The PLS-OUT output are output 50 times with each revolution of the motor output shaft. ON-OFF ratio (duty ratio) for when the motor is operated at constant speed is 50 %.
The maximum output frequency is 500 Hz.

■ Connection example

● When using the voltage of input signals at 5 VDC (Refer to p.8 for when connecting 24 VDC.)

Programmable controller

Current source output circuit | Current sink output circuit

Driver

CN3

| 1 | FWD | 100 Ω |
| 2 | | 100 Ω |

2.2 kΩ, 2.2 kΩ

| 3 | RVS | 100 Ω |
| 4 | | 100 Ω |

2.2 kΩ, 2.2 kΩ

| 5 | AWO | 470 Ω |
| 6 | | 1 kΩ |

| 7 | M0 | 470 Ω |
| 8 | | 1 kΩ |

Twisted pair cable

5 VDC

5 VDC

0 V

0 V

30 VDC or less

30 VDC or less

10 mA or less → R0

R0

0 V

0 V

CN3

9	ALM
10	
11	PLS-OUT
12	

Output saturated voltage 0.5 V max.

CN2

Motor lead wires *

Blue	1
Red	2
Orange	3
Green	4
Black	5

CN1

| 24 VDC±10 % | + |
| GND | − |

* Connector pin assignments vary depending on the motor. For details, refer to "Connecting the motor" on p.6

(memo) • Use output signals at 30 VDC, 10 mA or less. If the current exceeds 10 mA, connect an external resistor R0 so that the current becomes 10 mA or less.
• Up to three our cables can be used for the connection between the motor and driver. Keep 10 m (32.8 ft.) or less for the wiring distance between the motor and driver.

● **When using the voltage of input signals at 24 VDC**

Programmable controller | Driver

Current source output circuit | Current sink output circuit

24 VDC

24 VDC | Twisted pair cable | CN3

| 1 | 100 Ω |
| FWD | 2.2 kΩ | 100 Ω | 2.2 kΩ |
R1 | 2 |
1.5 to 2.2 kΩ, 0.5 W or more

| 3 | 100 Ω |
| RVS | 2.2 kΩ | 100 Ω | 2.2 kΩ |
R1 | 4 |
1.5 to 2.2 kΩ, 0.5 W or more

| 5 | 470 Ω |
| AWO | 1 kΩ |
R2 | 6 |
1.5 to 2.2 kΩ, 0.5 W or more

| 7 | 470 Ω |
| M0 | 1 kΩ |
R2 | 8 |
1.5 to 2.2 kΩ, 0.5 W or more

0 V

0 V
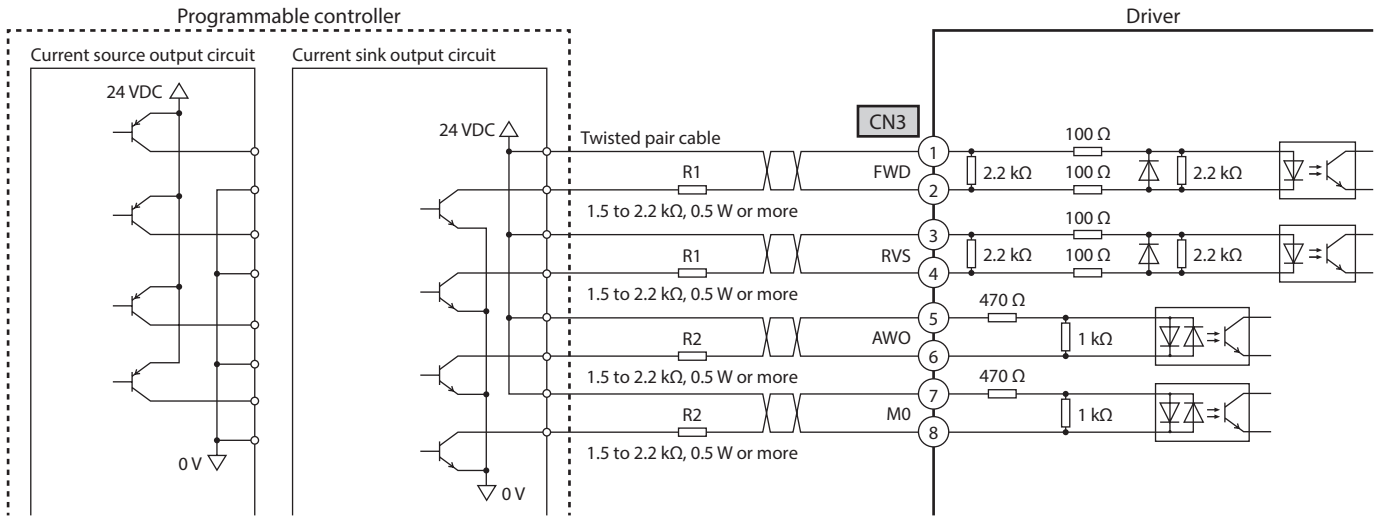
(memo)
- The input voltage specification for the FWD input and RVS input is 5 VDC. If the voltage exceeding 5 VDC is applied, connect an external resistor R1 so that the input current becomes 7 to 20 mA.
  Example) When the 24 VDC is connected: R1=1.5 to 2.2 kΩ, 0.5 W or more
- The input voltage specification for the AWO input and M0 input is 5 VDC. If the voltage exceeding 5 VDC is applied, connect an external resistor R2 so that the input current becomes 5 to 15 mA.
  Example) When the 24 VDC is connected: R2=1.5 to 2.2 kΩ, 0.5 W or more
- When our external resistor module **VCS01** is connected instead of the external resistor R1 and R2, use at 24 VDC ±5 %.
- Up to three our cables can be used for the connection between the motor and driver. Keep 10 m (32.8 ft.) or less for the wiring distance between the motor and driver.
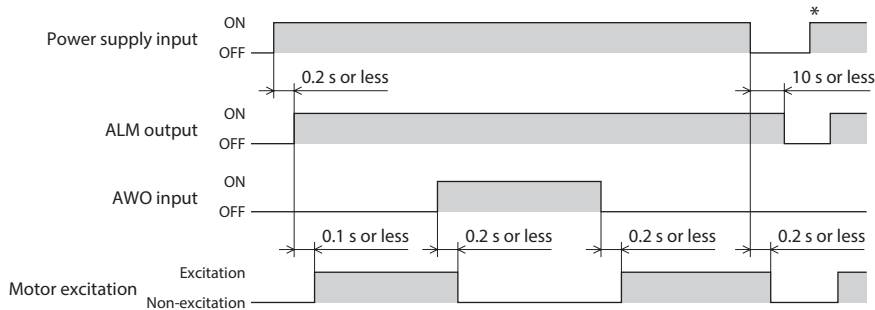
■ Timing chart

● Excitation timing

Power supply input	ON / OFF
0.2 s or less	10 s or less
ALM output	ON / OFF
AWO input	ON / OFF
0.1 s or less	0.2 s or less	0.2 s or less	0.2 s or less
Motor excitation	Excitation / Non-excitation

* Turn on the power supply again after the PWR/ALM LED is turned off.

● Operation timing

FWD input	ON / OFF
RVS input	ON / OFF
M0 input	ON / OFF
Motor operation

* : 2 ms or less

8
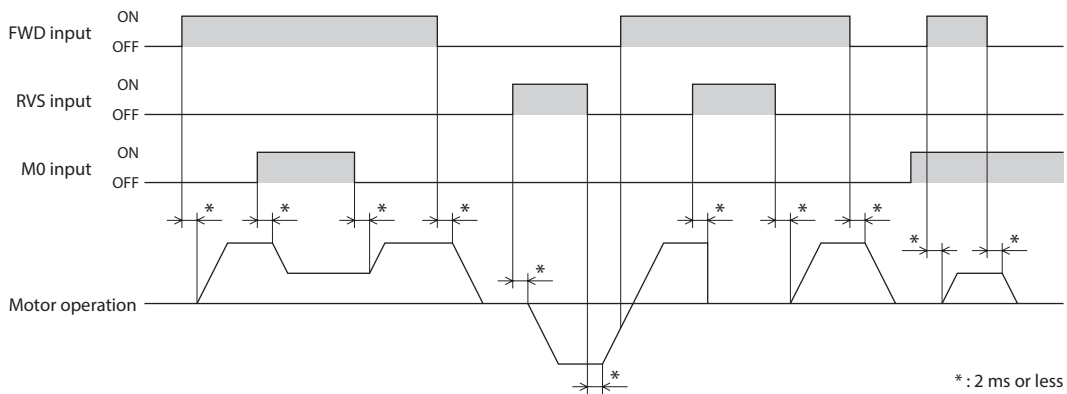
■ Noise measures

The electrical noise is of two types: One is a noise to invade into the driver from the outside and cause the driver malfunction, and the other is a noise to emit from the driver and cause peripheral equipment malfunction.
For the noise that is invaded from the outside, take measures to prevent the driver malfunction. It is needed to take adequate measures because signal lines are very likely to be affected by the noise.
For the noise that is emitted from the driver, take measures to suppress it.

### ● Measures against electrical noise

There are the following three methods mainly to take measures against the electrical noise.

● Noise suppression

• When relays or electromagnetic switches are used together with the system, use noise filters and CR circuits to suppress surges generated by them.
• Cover the driver by a metal plate such as aluminum. This is effective in shielding the electrical noise emitted from the driver.

● Prevention of noise propagation

• Place the power lines, such as the motor and power supply cables, keeping a distance of 100 mm (3.94 in.) or more from the signal lines, and also do not bundle them or wire them in parallel. If the power cables and signal cables have to cross, cross them at a right angle.
• Use shielded twisted pair cables of AWG22 (0.3 mm^2) for power lines and AWG24 to AWG22 (0.2 to 0.3 mm^2) for signal lines.
• Keep cables as short as possible without coiling and bundling extra lengths.
• To ground a shielded cable, use a metal cable clamp that will maintain contact with the entire circumference of the cable. Ground the cable clamp near the product.

Shielded cable   Cable clamp
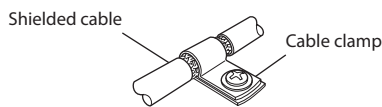
• Grounding multiple points will increase effect to block electrical noise because impedance on the grounding points is decreased. However, ground them so that a potential difference does not occur among the grounding points. I/O signal cables that include a ground wire are provided in our product line. Refer to p.12 for the model name.

● Suppression of effect by noise propagation

Loop the noise propagated cable around a ferrite core. Doing so will prevent the propagated noise invades into the driver or emits from the driver. The frequency band in which an effect by the ferrite core can be seen is generally 1 MHz or more. Check the frequency characteristics of the ferrite core used. To increase the effect of noise attenuation by the ferrite core, loop the cable a lot.

● Our noise suppression parts

Refer to p.12 for the model name.

● I/O signal cable

This cable is a shielded twisted pair cable for good noise immunity to connect the driver and programmable controller. The ground wires useful to grounding are provided at both ends of the cable. The EMC measures are conducted using our I/O signal cable.

● Surge suppressor

This product is effective to suppress the surge which occurs in a relay contact part. Connect it when using a relay or electromagnetic switch. CR circuit for surge suppression and CR circuit module are provided.

■ Conformity to the EMC Directive

Effective measures must be taken against the EMI that the motor and driver may give to adjacent control-system equipment, as well as the EMS of the motor and driver itself, in order to prevent a serious functional impediment in the machinery. The use of the following installation and wiring methods will enable the motor and driver to be compliant with the EMC Directive. Refer to p.12 for the Applicable Standards.
Oriental Motor conducts EMC measurements on its motors and drivers in accordance with the "Example of motor and driver installation and wiring" in the below.
The user is responsible for ensuring the machine's compliance with the EMC Directive, based on the installation and wiring explained below.

● Power supply

The driver is a product of DC power input. Use a DC power supply (switched-mode power supply etc.) that conforms to the EMC Directive.

● Connecting the signal cable

Refer to "Prevention of noise propagation."

● How to ground

• The cable used to ground the motor and driver must be as thick and short as possible so that no potential difference is generated.
• Choose a large, thick and uniformly conductive surface for the grounding point.
• Install the motor to the grounded metal plate.

● Example of motor and driver installation and wiring

---- is a shielded box.
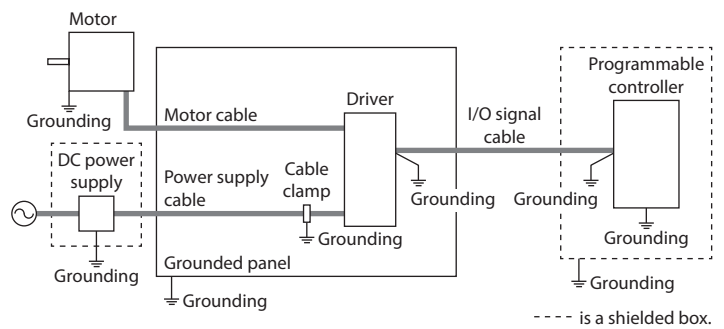
Note The driver uses parts that are sensitive to electrostatic charge. Take measures against static electricity since static electricity may cause the driver to malfunction or suffer damage.

9

Setting

The figure shows the factory setting.

[Speed setting switch]
×16/SPD1 switch
×1/SPD2 switch

[Function setting switch]
No.1: SPD H/L switch
(Highest speed)
No.2: SPD2 EN switch
(Speed2 selection)
No.3: RUN switch
(Operating current rate)
No.4 to 6: ACC switch
(Acceleration time,
deceleration time)
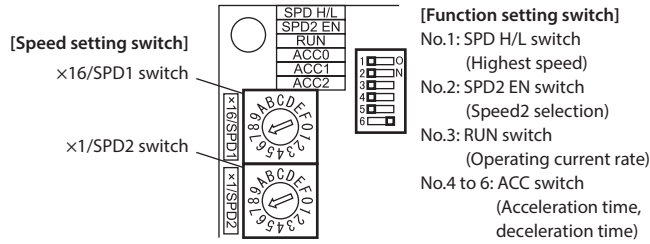
Two different operating speeds of high speed and low speed can be set in the driver.
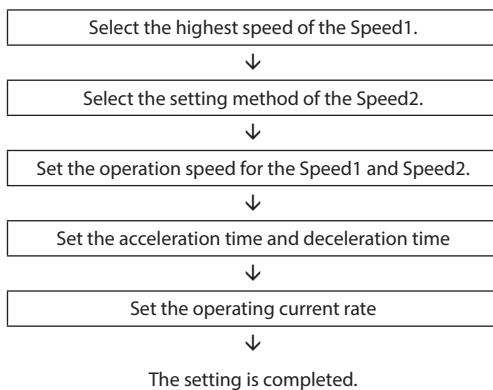It defines the high speed side as "Speed1" and the low speed side as "Speed2" to be as follows.
- Speed1...........Operating speed at the high speed side for when the M0 input is turned OFF.
- Speed2...........Operating speed at the low speed side for when the M0 input is turned ON.

Speed1
Speed2
FWD input
RVS input
M0 input
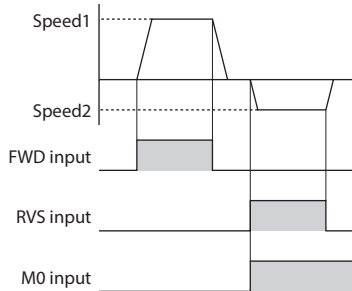
Two setting patterns are available for the Speed1 and Speed2, and they vary depending on the setting of the SPD2 EN switch (function setting switch No.2).

Setting pattern	SPD2 EN switch	Speed setting method	Switch used
Pattern 1	OFF	Speed1: Selected one from 256 different speeds	Use in a combination of ×16/SPD1 and ×1/SPD2
		Speed2: Fixed to a 10 % speed of the Speed1	No use
Pattern 2	ON	Speed1: Selected one from 16 different speeds	×16/SPD1
		Speed2: Selected one from 16 different speeds in a range of 0.5 to 50 % of the Speed1	×1/SPD2

■ Setting procedure

Select the highest speed of the Speed1.
↓
Select the setting method of the Speed2.
↓
Set the operation speed for the Speed1 and Speed2.
↓
Set the acceleration time and deceleration time
↓
Set the operating current rate
↓
The setting is completed.

■ Setting item

● Highest speed

The highest speed of the Speed1 is selected with the SPD H/L switch (function setting switch No.1). Select either 200 r/min or 600 r/min for the highest speed. The speed, which can be set with the speed setting switch, differs in 200 r/min and 600 r/min. Check a desired speed with the tables on p.14 to p.15.
OFF: 600 r/min
ON: 200 r/min

Factory setting: OFF (600 r/min)

● Setting method for the Speed2

The setting method for the Speed2 is selected with the SPD2 EN (function setting switch No.2).
OFF: Fixed to a 10 % speed of the Speed1
ON: Selected one from 16 different speeds in a range of 0.5 to 50 % of the Speed1

Factory setting: OFF (Fixed to a 10 % speed of the Speed1)

● Operating speed

The operating speed varies depending on the setting pattern.

● Pattern 1
- Speed1...........Check a desired speed from 256 different speeds in the tables on p.14, and set using a combination of the ×16/SPD1 switch and the ×1/SPD2 switch.
- Speed2...........This is fixed to a 10 % speed of the Speed1.

● Pattern 2
- Speed1...........Check a desired speed from 16 different speeds in the tables on p.15, and set with the ×16/SPD1 switch.
- Speed2...........Check a desired speed from 16 different speeds in the tables on p.15, and set with the ×1/SPD2 switch.

● Acceleration time and deceleration time

The acceleration time refers to the time needed for the operating speed to reach 600 r/min from 0 r/min. The deceleration time refers to the time needed for the operating speed to reach 0 r/min from 600 r/min. The same time is applied to all of the acceleration, deceleration, and changing speed.
Set using the ACC0 to ACC2 switches (function setting switch No.4 to No.6).

Factory setting: 0.50 s

Speed [r/min]
600
Setting speed
Time [s]
Acceleration time
Deceleration time
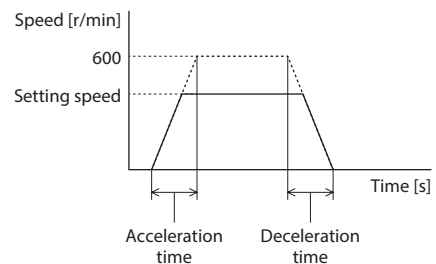
ACC0 (No.4)	ACC1 (No.5)	ACC2 (No.6)	Acceleration time Deceleration time
OFF	OFF	OFF	0.00 s
ON	OFF	OFF	0.05 s
OFF	ON	OFF	0.10 s
ON	ON	OFF	0.20 s
OFF	OFF	ON	0.50 s
ON	OFF	ON	1.00 s
OFF	ON	ON	2.00 s
ON	ON	ON	3.00 s

● Operating current rate and standstill current rate

● Operating current rate

If the load is small and there is an ample allowance for torque, the motor temperature rise can be suppressed by setting a lower operating current rate. The actual operating current is a value that the rated operating current of the driver is multiplied by the operating current rate.

Operating current = Driver rated current × Operating current rate

Select the operating current rate using the RUN switch (function setting switch No.3).
OFF: Operating current rate 100 %
ON: Operating current rate 70 %

Factory setting: OFF (100 %)

(memo) Set the operating current rate to 70 % when using the **CVD524BR-KSC** with our circuit protection cover.

● Standstill current rate

When the motor stops, the current cutback function will be actuated to lower the motor current to the standstill current. The standstill current rate is 50 % of the operating current.
Standstill current = Operating current × 50 %

Alarm

When the driver's protective function triggers and an alarm generates, the ALM output is turned OFF and put the motor into a non-excitation state. At the same time, the PWR/ALM LED will blink in red. The cause of the alarm can be checked by counting the number of times the PWR/ALM LED blinks.

■ Alarm list

Number of times LED blinks	Alarm type	Cause and remedial action
2	Overheat	**[Cause]** The temperature of the driver circuit board reached 85 °C (185 °F). **[Remedial action]** Review the ventilation condition.
3	Overvoltage	**[Cause]** The power supply voltage exceeded 43.1 V. **[Remedial action]** Check the input voltage of the power supply.
3	Overvoltage	**[Cause]** A large inertial load was stopped abruptly or vertical operation was performed. **[Remedial action]** If this alarm generates during operation, reduce the load or increase the acceleration/deceleration time.
5	Overcurrent	**[Cause]** An excessive current was flowed through the driver output circuit for motor. **[Remedial action]** Turn off the power and check that the motor, cable and driver are not damaged.
5	Overcurrent	**[Cause]** The motor was made a quick stop or a rapid deceleration. **[Remedial action]** Review the operating conditions.
9	EEPROM error	**[Cause]** The stored data in the driver was damaged. **[Remedial action]** Contact your nearest Oriental Motor sales office.
Lit	CPU error	**[Cause]** CPU malfunctioned. **[Remedial action]** Turn on the power supply again.

■ Alarm reset

When the power supply is turned on again, the alarm will be reset. Before resetting an alarm, always remove the cause of the alarm and ensure safety. The overheat alarm can be reset by the AWO input if the circuit temperature of the driver goes down 75 °C (167 °F) and under. Be sure to check the circuit temperature went down 75 °C (167 °F) and under before resetting the alarm by turning the AWO input from OFF to ON.

*1 85 °C (185 °F) or more
*2 75 °C (167 °F) or more
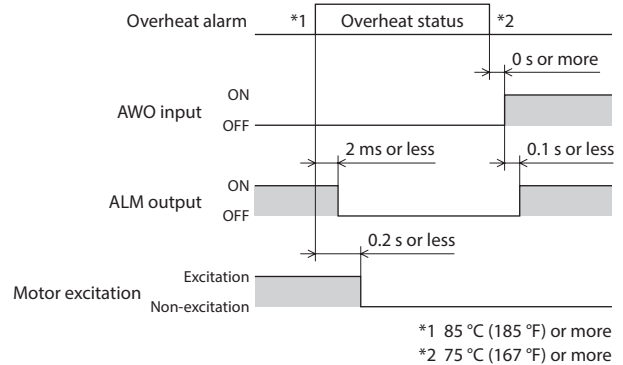
Maintenance/inspection

■ Inspection

It is recommended that periodic inspections are conducted for the items listed below after each operation of the motor. If an abnormal condition is noted, discontinue any use and contact your nearest Oriental Motor sales office.

Inspection item

• Check if the installation place of the driver is loose.
• Check if any of the connection parts of the connector is loose.
• Check if dust and others attach on the driver.
• Check if the driver has unusual smells or appearance defects.

(Note) The driver uses semiconductor elements, so be extremely careful when handling them. Static electricity may damage the driver.

■ Warranty

Check on the Oriental Motor Website for the product warranty.

■ Disposal

Dispose the product correctly in accordance with laws and regulations, or instructions of local governments.

General specifications

Operation environment	Ambient temperature	0 to +50 °C (+32 to +122 °F) (non-freezing)
	Humidity	85 % or less (non-condensing)
	Altitude	Up to 1,000 m (3,300 ft.) above sea level
	Surrounding atmosphere	No corrosive gas, dust, water or oil
Storage environment, Shipping environment	Ambient temperature	−25 to +70 °C (−13 to +158 °F) (non-freezing)
	Humidity	85 % or less (non-condensing)
	Altitude	Up to 3,000 m (10,000 ft.) above sea level
	Surrounding atmosphere	No corrosive gas, dust, water or oil

Regulations and standards

■ CE Marking

● Low Voltage Directive

The input power supply voltage of this product is 24 VDC. Therefore this product is not subject to the Low Voltage Directive, but install and connect it as follows.
• This product is designed and manufactured to be incorporated in equipment. Be sure to install the product inside an enclosure.
• For the driver power supply, use a DC power supply with reinforced insulation on its primary and secondary sides.

● EMC Directive

This product is conducted EMC testing under the conditions specified in "Example of motor and driver installation and wiring" on p.9. The conformance of your mechanical equipment with the EMC Directive will vary depending on such factors as the configuration, wiring, and layout for other control system devices and electrical parts used with this product. It therefore must be verified through conducting EMC measures in a state where all parts including this product have been installed in the equipment.

⚠CAUTION This equipment is not intended for use in residential environments nor for use on a low-voltage public network supplied in residential premises, and it may not provide adequate protection to radio reception interference in such environments.

■ Republic of Korea, Radio Waves Act

This product is affixed the KC Mark under the Republic of Korea, Radio Waves Act.

■ RoHS Directive

This product does not contain the substances exceeding the restriction values.

Cables

■ Connection cable set

For the connection cable set, a set of three cables for the power supply, motor, and input/output signals is provided.

Model name	Length [m (ft.)]	Conductor
LCS04SD5	0.6 (2)	AWG22 (0.3 mm^2)

■ I/O signal cables

This is a shielded twisted pair cable for the driver control I/O signals (12 pins) that has good noise immunity. The ground wires useful to grounding are provided at both ends of the cable.

Model name	Length [m (ft.)]	Conductor
CC12D005-2	0.5 (1.6)	AWG24 (0.2 mm^2)
CC12D010-2	1 (3.3)	
CC12D015-2	1.5 (4.9)	
CC12D020-2	2 (6.6)	

Accessories

■ CR circuit for surge suppression

This product is effective to suppress the surge which occurs in a relay contact part. Use it to protect the contacts of the relay or switch.
Model name: **EPCR1201-2**

■ External resistor module

Five current-limiting resistors, which are required when the 24 VDC output controller is connected to the driver, are mounted. LEDs are also mounted in order to check the signal input.
Model name: **VCS01**

■ CR circuit module

This product is effective to suppress the surge which occurs in a relay contact part. Use this product to protect the contacts of the relay or switch.
Four pieces of CR circuit for surge suppression are mounted on the compact circuit, and this product can be installed to the DIN rail. This product can make the wiring easily and securely since it also supports terminal block connection.
Model name: **VCS02**

■ Circuit protection cover

This is a cover to protect the circuit board as well as to prevent from contacting to the live connections.
It can be used for the driver which connector shape is of right angle.
Model name: **PADC-CVD**

Specifications

- When the connector shape of the driver is of right angle, the box (□) in the model name indicate **R**.
- The box (■) in the motor model indicates **A** (single shaft) or **B** (double shaft) representing the motor type.

● CVD512B□-KSC

Motor model	**PKP523N12■**	**PKP525N12■**
Maximum static torque at excitation [N·m (oz-in)]	0.052 (7.3)	0.091 (12.9)
Holding torque at motor standstill [N·m (oz-in)]	0.026 (3.6)	0.045 (6.3)
Rotor inertia [J: kg·m^2 (oz-in^2)]	$9×10^{-7}$ (0.049)	$18×10^{-7}$ (0.099)
Rated current [A/phase]	1.2	
Setting speed range [r/min]	0.02 to 600	
Speed accuracy *	±0.8 %	
Power supply input	24 VDC±10 %, 0.9 A	
Excitation mode	Microstepping	

* The actual operating speed is accurate within ±0.8 % against the set speed.

● CVD518B□-KSC

Motor model	**PKP543N18■2**	**PKP544N18■2**	**PKP545N18■2**	**PKP546N18■2**
Maximum static torque at excitation [N·m (oz-in)]	0.22 (31)	0.3 (42)	0.37 (52)	0.5 (71)
Holding torque at motor standstill [N·m (oz-in)]	0.11 (15.6)	0.15 (21)	0.19 (26)	0.25 (35)
Rotor inertia [J: kg·m^2 (oz-in^2)]	$35×10^{-7}$ (0.192)	$55×10^{-7}$ (0.3)	$71×10^{-7}$ (0.39)	$110×10^{-7}$ (0.6)
Rated current [A/phase]	1.8			
Setting speed range [r/min]	0.02 to 600			
Speed accuracy *	±0.8 %			
Power supply input	24 VDC±10 %, 2.5 A			
Excitation mode	Microstepping			

* The actual operating speed is accurate within ±0.8 % against the set speed.

● CVD524B□-KSC

Motor model	**PKP564FN24■2**	**PKP566FN24■2**	**PKP569FN24■2**
Maximum static torque at excitation [N·m (oz-in)]	0.66 (93)	1.15 (163)	2.1 (290)
Holding torque at motor standstill [N·m (oz-in)]	0.33 (46)	0.58 (82)	1.1 (156)
Rotor inertia [J: kg·m^2 (oz-in^2)]	$160×10^{-7}$ (0.88)	$290×10^{-7}$ (1.59)	$540×10^{-7}$ (3)
Rated current [A/phase]	2.4		
Setting speed range [r/min]	0.02 to 600		
Speed accuracy *	±0.8 %		
Power supply input	24 VDC±10 %, 3.0 A		
Excitation mode	Microstepping		

* The actual operating speed is accurate within ±0.8 % against the set speed.

Operating speed Setting value list

Pattern 1	Speed1: Selected one from 256 different speeds
	Speed2: Fixed to a 10 % speed of the Speed1
Pattern 2	Speed1: Selected one from 16 different speeds
	Speed2: Selected one from 16 different speeds in a range of 0.5 to 50 % of the Speed1

The actual operating speed is accurate within ±0.8 % against the set speed.

■ Pattern 1

● List of Speed1 for when the highest speed is 600 r/min (r/min)

×16/SPD1 switch \ ×1/SPD2 switch	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20	2.30	2.40
1	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00
2	42.50	45.00	47.50	50.00	52.50	55.00	57.50	60.00	62.50	65.00	67.50	70.00	72.50	75.00	77.50	80.00
3	82.50	85.00	87.50	90.00	92.50	95.00	97.50	100.00	102.50	105.00	107.50	110.00	112.50	115.00	117.50	120.00
4	122.50	125.00	127.50	130.00	132.50	135.00	137.50	140.00	142.50	145.00	147.50	150.00	152.50	155.00	157.50	160.00
5	162.50	165.00	167.50	170.00	172.50	175.00	177.50	180.00	182.50	185.00	187.50	190.00	192.50	195.00	197.50	200.00
6	202.50	205.00	207.50	210.00	212.50	215.00	217.50	220.00	222.50	225.00	227.50	230.00	232.50	235.00	237.50	240.00
7	242.50	245.00	247.50	250.00	252.50	255.00	257.50	260.00	262.50	265.00	267.50	270.00	272.50	275.00	277.50	280.00
8	282.50	285.00	287.50	290.00	292.50	295.00	297.50	300.00	302.50	305.00	307.50	310.00	312.50	315.00	317.50	320.00
9	322.50	325.00	327.50	330.00	332.50	335.00	337.50	340.00	342.50	345.00	347.50	350.00	352.50	355.00	357.50	360.00
A	362.50	365.00	367.50	370.00	372.50	375.00	377.50	380.00	382.50	385.00	387.50	390.00	392.50	395.00	397.50	400.00
B	402.50	405.00	407.50	410.00	412.50	415.00	417.50	420.00	422.50	425.00	427.50	430.00	432.50	435.00	437.50	440.00
C	442.50	445.00	447.50	450.00	452.50	455.00	457.50	460.00	462.50	465.00	467.50	470.00	472.50	475.00	477.50	480.00
D	482.50	485.00	487.50	490.00	492.50	495.00	497.50	500.00	502.50	505.00	507.50	510.00	512.50	515.00	517.50	520.00
E	522.50	525.00	527.50	530.00	532.50	535.00	537.50	540.00	542.50	545.00	547.50	550.00	552.50	555.00	557.50	560.00
F	562.50	565.00	567.50	570.00	572.50	575.00	577.50	580.00	582.50	585.00	587.50	590.00	592.50	595.00	597.50	600.00

● List of Speed1 for when the highest speed is 200 r/min (r/min)

×16/SPD1 switch \ ×1/SPD2 switch	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
1	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50
2	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	15.50	16.00	16.50
3	17.00	17.50	18.00	18.50	19.00	19.50	20.00	20.50	21.00	21.50	22.00	22.50	23.00	23.50	24.00	24.50
4	25.00	25.50	26.00	26.50	27.00	27.50	28.00	28.50	29.00	29.50	30.00	30.50	31.00	31.50	32.00	32.50
5	33.00	33.50	34.00	34.50	35.00	35.50	36.00	36.50	37.00	37.50	38.00	38.50	39.00	39.50	40.00	40.50
6	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00	51.00	52.00	53.00	54.00	55.00	56.00
7	57.00	58.00	59.00	60.00	61.00	62.00	63.00	64.00	65.00	66.00	67.00	68.00	69.00	70.00	71.00	72.00
8	73.00	74.00	75.00	76.00	77.00	78.00	79.00	80.00	81.00	82.00	83.00	84.00	85.00	86.00	87.00	88.00
9	89.00	90.00	91.00	92.00	93.00	94.00	95.00	96.00	97.00	98.00	99.00	100.00	101.00	102.00	103.00	104.00
A	105.00	106.00	107.00	108.00	109.00	110.00	111.00	112.00	113.00	114.00	115.00	116.00	117.00	118.00	119.00	120.00
B	121.00	122.00	123.00	124.00	125.00	126.00	127.00	128.00	129.00	130.00	131.00	132.00	133.00	134.00	135.00	136.00
C	137.00	138.00	139.00	140.00	141.00	142.00	143.00	144.00	145.00	146.00	147.00	148.00	149.00	150.00	151.00	152.00
D	153.00	154.00	155.00	156.00	157.00	158.00	159.00	160.00	161.00	162.00	163.00	164.00	165.00	166.00	167.00	168.00
E	169.00	170.00	171.00	172.00	173.00	174.00	175.00	176.00	177.00	178.00	179.00	180.00	181.00	182.00	183.00	184.00
F	185.00	186.00	187.00	188.00	189.00	190.00	191.00	192.00	193.00	194.00	195.00	196.00	197.00	198.00	199.00	200.00

■ Pattern 2

● List of Speed1 and Speed2 for when the highest speed is 600 r/min (r/min)

×16/SPD1 switch (Speed1)	×1/SPD2 switch (Speed2)															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 — 225	1.1250	2.2500	4.5000	6.7500	9.0000	11.2500	16.8750	22.5000	33.7500	45.0000	56.2500	67.5000	78.7500	90.0000	101.2500	112.5000
1 — 250	1.2500	2.5000	5.0000	7.5000	10.0000	12.5000	18.7500	25.0000	37.5000	50.0000	62.5000	75.0000	87.5000	100.0000	112.5000	125.0000
2 — 275	1.3750	2.7500	5.5000	8.2500	11.0000	13.7500	20.6250	27.5000	41.2500	55.0000	68.7500	82.5000	96.2500	110.0000	123.7500	137.5000
3 — 300	1.5000	3.0000	6.0000	9.0000	12.0000	15.0000	22.5000	30.0000	45.0000	60.0000	75.0000	90.0000	105.0000	120.0000	135.0000	150.0000
4 — 325	1.6250	3.2500	6.5000	9.7500	13.0000	16.2500	24.3750	32.5000	48.7500	65.0000	81.2500	97.5000	113.7500	130.0000	146.2500	162.5000
5 — 350	1.7500	3.5000	7.0000	10.5000	14.0000	17.5000	26.2500	35.0000	52.5000	70.0000	87.5000	105.0000	122.5000	140.0000	157.5000	175.0000
6 — 375	1.8750	3.7500	7.5000	11.2500	15.0000	18.7500	28.1250	37.5000	56.2500	75.0000	93.7500	112.5000	131.2500	150.0000	168.7500	187.5000
7 — 400	2.0000	4.0000	8.0000	12.0000	16.0000	20.0000	30.0000	40.0000	60.0000	80.0000	100.0000	120.0000	140.0000	160.0000	180.0000	200.0000
8 — 425	2.1250	4.2500	8.5000	12.7500	17.0000	21.2500	31.8750	42.5000	63.7500	85.0000	106.2500	127.5000	148.7500	170.0000	191.2500	212.5000
9 — 450	2.2500	4.5000	9.0000	13.5000	18.0000	22.5000	33.7500	45.0000	67.5000	90.0000	112.5000	135.0000	157.5000	180.0000	202.5000	225.0000
A — 475	2.3750	4.7500	9.5000	14.2500	19.0000	23.7500	35.6250	47.5000	71.2500	95.0000	118.7500	142.5000	166.2500	190.0000	213.7500	237.5000
B — 500	2.5000	5.0000	10.0000	15.0000	20.0000	25.0000	37.5000	50.0000	75.0000	100.0000	125.0000	150.0000	175.0000	200.0000	225.0000	250.0000
C — 525	2.6250	5.2500	10.5000	15.7500	21.0000	26.2500	39.3750	52.5000	78.7500	105.0000	131.2500	157.5000	183.7500	210.0000	236.2500	262.5000
D — 550	2.7500	5.5000	11.0000	16.5000	22.0000	27.5000	41.2500	55.0000	82.5000	110.0000	137.5000	165.0000	192.5000	220.0000	247.5000	275.0000
E — 575	2.8750	5.7500	11.5000	17.2500	23.0000	28.7500	43.1250	57.5000	86.2500	115.0000	143.7500	172.5000	201.2500	230.0000	258.7500	287.5000
F — 600	3.0000	6.0000	12.0000	18.0000	24.0000	30.0000	45.0000	60.0000	90.0000	120.0000	150.0000	180.0000	210.0000	240.0000	270.0000	300.0000

● List of Speed1 and Speed2 for when the highest speed is 200 r/min (r/min)

×16/SPD1 switch (Speed1)	×1/SPD2 switch (Speed2)															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 — 12.5	0.0625	0.1250	0.2500	0.3750	0.5000	0.6250	0.9375	1.2500	1.8750	2.5000	3.1250	3.7500	4.3750	5.0000	5.6250	6.2500
1 — 25.0	0.1250	0.2500	0.5000	0.7500	1.0000	1.2500	1.8750	2.5000	3.7500	5.0000	6.2500	7.5000	8.7500	10.0000	11.2500	12.5000
2 — 37.5	0.1875	0.3750	0.7500	1.1250	1.5000	1.8750	2.8125	3.7500	5.6250	7.5000	9.3750	11.2500	13.1250	15.0000	16.8750	18.7500
3 — 50.0	0.2500	0.5000	1.0000	1.5000	2.0000	2.5000	3.7500	5.0000	7.5000	10.0000	12.5000	15.0000	17.5000	20.0000	22.5000	25.0000
4 — 62.5	0.3125	0.6250	1.2500	1.8750	2.5000	3.1250	4.6875	6.2500	9.3750	12.5000	15.6250	18.7500	21.8750	25.0000	28.1250	31.2500
5 — 75.0	0.3750	0.7500	1.5000	2.2500	3.0000	3.7500	5.6250	7.5000	11.2500	15.0000	18.7500	22.5000	26.2500	30.0000	33.7500	37.5000
6 — 87.5	0.4375	0.8750	1.7500	2.6250	3.5000	4.3750	6.5625	8.7500	13.1250	17.5000	21.8750	26.2500	30.6250	35.0000	39.3750	43.7500
7 — 100.0	0.5000	1.0000	2.0000	3.0000	4.0000	5.0000	7.5000	10.0000	15.0000	20.0000	25.0000	30.0000	35.0000	40.0000	45.0000	50.0000
8 — 112.5	0.5625	1.1250	2.2500	3.3750	4.5000	5.6250	8.4375	11.2500	16.8750	22.5000	28.1250	33.7500	39.3750	45.0000	50.6250	56.2500
9 — 125.0	0.6250	1.2500	2.5000	3.7500	5.0000	6.2500	9.3750	12.5000	18.7500	25.0000	31.2500	37.5000	43.7500	50.0000	56.2500	62.5000
A — 137.5	0.6875	1.3750	2.7500	4.1250	5.5000	6.8750	10.3125	13.7500	20.6250	27.5000	34.3750	41.2500	48.1250	55.0000	61.8750	68.7500
B — 150.0	0.7500	1.5000	3.0000	4.5000	6.0000	7.5000	11.2500	15.0000	22.5000	30.0000	37.5000	45.0000	52.5000	60.0000	67.5000	75.0000
C — 162.5	0.8125	1.6250	3.2500	4.8750	6.5000	8.1250	12.1875	16.2500	24.3750	32.5000	40.6250	48.7500	56.8750	65.0000	73.1250	81.2500
D — 175.0	0.8750	1.7500	3.5000	5.2500	7.0000	8.7500	13.1250	17.5000	26.2500	35.0000	43.7500	52.5000	61.2500	70.0000	78.7500	87.5000
E — 187.5	0.9375	1.8750	3.7500	5.6250	7.5000	9.3750	14.0625	18.7500	28.1250	37.5000	46.8750	56.2500	65.6250	75.0000	84.3750	93.7500
F — 200.0	1.0000	2.0000	4.0000	6.0000	8.0000	10.0000	15.0000	20.0000	30.0000	40.0000	50.0000	60.0000	70.0000	80.0000	90.0000	100.0000