



2-Phase Stepping Motor Unit

CSK Series

OPERATING MANUAL

Thank you for purchasing an Oriental Motor product.

This operating 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.

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1 Introduction

■ Before use

Only qualified personnel should work with the product.

Use the product correctly after thoroughly reading the section “Safety precautions”.

The product described in this manual has been designed and manufactured for use in general industrial machinery, and must not be used 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

The **CSK** series 2-phase stepping motor is a unit product consisting of a driver of the open-chassis type, photocoupler I/O specification and a 2-phase stepping motor.

We offer the standard type with a base motor step angle of 1.8°, and the high resolution type with a 0.9° step angle. A geared type is also available.

■ Compliance with the EC Directives

• For Low Voltage Directive (73/23/EEC)

The **CSK** series motors and drivers are not subject to the Low Voltage Directive, since their input power supply voltage is 36 VDC or below. However, the product must satisfy the following conditions with regard to installation and connection:

- Use the product in a protected environment within an enclosure.
- As for the driver's and digital I/O signal's power supply, use a DC power supply with reinforced insulation on both the primary and secondary sides.

• For EMC Directive (89/336/EEC, 92/31/EEC)

This product has received EMC measures under the conditions specified in “Example of motor and driver installation and wiring” on p.17.



Be sure to conduct EMC measures with the product assembled in your equipment by referring to 5.6 “Installing and wiring in compliance with EMC Directive” on p.15.

■ Hazardous substances

RoHS (Directive 2002/95/EC 27Jan.2003) compliant

2 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.

 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 safe use of the product.

Warning

General

- 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.
- Assign qualified personnel the task of installing, wiring, operating/controlling, inspecting and troubleshooting the product. Failure to do so may result in fire or injury.
- Provide a means to hold the moving parts in place for applications involving vertical travel. The motor loses holding torque when the power is shut off, allowing the moving parts to fall and possibly cause injury or damage to equipment.

Installation

- Install the motor and driver in their enclosures in order to prevent injury.

Connection

- Keep the driver’s input power voltage within the specified range to avoid fire and electric shock.
- For the driver’s 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.
- The digital I/O part does not have reinforced insulation. For the digital I/O, use a DC power supply with reinforced insulation provided on the primary and secondary sides. Failure to do so may result in electric shock.
- Connect the cables securely according to the wiring diagram in order to prevent fire.
- Do not forcibly bend, pull or pinch the cable. Doing so may fire.

Operation

- Turn off the driver power in the event of a power failure, or the motor may suddenly start when the power is restored and may cause injury or damage to equipment.
- Do not turn the C.OFF input to ON while the motor is operating. The motor will stop and lose its holding ability, which may result in injury or damage to equipment.

Repair, disassembly and modification

- Do not disassemble or modify the motor or driver. This may cause fire, electric shock or injury.



General

- Do not use the motor and driver beyond their specifications, or injury or damage to equipment may result.
- Keep your fingers and objects out of the openings in the motor and driver, or fire or injury.
- Do not touch the motor or driver during operation or immediately after stopping. The surfaces are hot and may cause a skin burn(s).
- If the power supply cable or motor cable connected the driver are forcibly bent or pulled, the driver will receive stress and may suffer damage.

Transportation

- Do not hold the motor output shaft or motor cable. This may cause injury.

Installation

- Keep the area around the motor and driver free of combustible materials in order to prevent fire or a skin burn(s)..
- To prevent the risk of damage to equipment, leave nothing around the motor and driver that would obstruct ventilation.
- Provide a cover over the rotating parts (output shaft) of the motor to prevent injury.

Operation

- Use a motor and driver only in the specified combination. An incorrect combination may cause a 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 control inputs to the driver to OFF. Otherwise, the motor may start suddenly and cause injury or damage to equipment.
- Before moving the motor directly (as in the case of manual positioning), confirm that the driver C.OFF input is ON to prevent injury.
- To prevent bodily injury, do not touch the rotating parts (output shaft) of the motor during operation.
- Immediately when trouble has occurred, stop running and turn off the driver power. Failure to do so may result in fire, electric shock or injury.

Disposal

- To dispose of the motor or driver, disassemble it into parts and components as much as possible and dispose of individual parts/components as industrial waste.

3 Precautions for use

This section covers limitations and requirements the user should consider when using the **CSK** series.

- **Do not apply an overhung load and thrust load in excess of the specified permissible limit.**
Be sure to operate the motor within the specified permissible limit of overhung load and thrust load. Operating it under an excessive overhung load and thrust load may damage the motor bearings (ball bearings). See p.13 for details.
- **Motor case temperature**
When operating the motor, keep the motor's case temperature to 100 °C (212 °F) or below. If that temperature exceeds 100 °C (212 °F) due to operating conditions (ambient temperature, operating speed, duty, etc.), the motor coil may be burned or the life of the bearing shortened.
- **Driver's heatsink temperature**
When operating the motor, keep the driver's heatsink temperature to 80 °C (176 °F) or below. If the temperature exceeds 80 °C (176 °F), the driver may be damaged.
- **Conduct the insulation resistance measurement or withstand voltage test separately on the motor and the driver.**
Conducting the insulation resistance measurement or withstand voltage test with the motor and driver connected may result in injury or damage to equipment.
- **Preventing electrical noise**
See 5.6 "Installing and wiring in compliance with EMC Directive" on p.15 for measures with regard to noise.
- **Check the colors of motor leads and connect them correctly and securely.**
Wrong connection of leads or poor contact may damage the driver.
- **Regeneration**
When a large inertial load is operated at high speed, regenerative energy will generate and increase the power supply voltage, which can damage the driver. Review the operating condition and make sure regenerative voltage will not generate.
- **Maximum static torque at excitation**
The maximum static torque at excitation represents the torque when the motor is excited at the rated current. If the motor is combined with a dedicated driver, the automatic current cutback function reduces the maximum static torque at excitation to around 40%. (The specific value varies, depending on the motor standstill current that is set.) Once started, the motor can be accelerated or operated at the maximum static torque at excitation. However, the holding torque drops to around 40% while the motor is at a standstill. Therefore, when selecting a motor consider the reduced holding torque at motor standstill of around 40% of the maximum static torque at excitation.

3 Precautions for use

- **Geared type motors**

Allowable torque

Operate the motor by making sure the sum of the acceleration/deceleration torque at the starting/stopping of the motor and the load (friction) torque doesn't exceed the allowable torque. Operating the motor in excess of the allowable torque may result in a damaged gear.

Allowable speed range

Operate the motor at speeds within the allowable range.

Operating the motor at a speed outside the allowable range may result in a shorter gear life.

Backlash

The gear output shaft is subject to backlash of 1° to 2°. Backlash refers to the looseness at the gear output shaft, as generated when the input side of the gear is fixed. To reduce the effect of backlash, perform positioning operations from one direction only either from the CW direction or the CCW direction.

Rotating direction of the gear output shaft

The relationship between the rotating direction of the motor shaft and that of the gear output shaft changes as follows, depending on the gear type and gear ratio.

Gear ratio	Rotating direction
3.6:1, 7.2:1, 9:1, 10:1	Same direction
18:1, 36:1	Opposite direction

Grease of geared motor

On rare occasions, a small amount of grease may ooze out from the geared motor. If there is concern over possible environmental damage resulting from the leakage of grease, check for grease stains during regular inspections. Alternatively, install an oil pen or other device to prevent leakage from causing further damage. Oil leakage may lead to problems in the customer's equipment or products.

4 Preparation

This section covers the points to be checked along with the names and functions of respective parts.

4.1 Checking the product

Upon opening the package, verify that the items listed below are included.

Report any missing or damaged items to the branch or sales office from which you purchased the product. Verify the model number of the purchased unit against the number shown on the package label. Check the model number of the motor and driver against the number shown on the nameplate. The unit models and corresponding motor/driver combinations are listed on p.8.

- Motor 1 unit
 - Driver 1 unit
 - OPERATING MANUAL 1 copy
 - Motor mounting screws (geared type only) 4 pcs.
- CSK243A(B)T-SG:** M3 cross recessed screw
CSK243A(B)TA-SG: No.4-40 UNC Cross recessed screw
CSK264A(B)T-SG: M4 hexagonal socket head screw
CSK264A(B)TA-SG: No.8-32 UNC Hexagonal socket head screw

Note

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

4.2 Combinations of motors and drivers

□ in the model represents a number indicating the gear ratio.

• Standard type

Unit model	Motor model	Driver model
CSK243-AT	PK243-01A	CSD2109-T
CSK243-BT	PK243-01B	
CSK243-ATA	PK243-01AA	
CSK243-BTA	PK243-01BA	
CSK244-AT	PK244-01A	CSD2112-T
CSK244-BT	PK244-01B	
CSK244-ATA	PK244-01AA	
CSK244-BTA	PK244-01BA	
CSK245-AT	PK245-01A	
CSK245-BT	PK245-01B	
CSK245-ATA	PK245-01AA	
CSK245-BTA	PK245-01BA	

Unit model	Motor model	Driver model
CSK264-AT	PK264-02A	CSD2120-T
CSK264-BT	PK264-02B	
CSK266-AT	PK266-02A	
CSK266-BT	PK266-02B	
CSK268-AT	PK268-02A	CSD2145T
CSK268-BT	PK268-02B	
CSK296-ATA	PK296-03AA	
CSK296-BTA	PK296-03BA	CSD2145T
CSK299-ATA	PK299-03AA	
CSK299-BTA	PK299-03BA	CSD2140T
CSK2913-ATA	PK2913-02AA	
CSK2913-BTA	PK2913-02BA	

• High resolution type

Unit model	Motor model	Driver model
CSK243MAT	PK243MA	CSD2109-T
CSK243MBT	PK243MB	
CSK243MATA	PK243MAA	
CSK243MBTA	PK243MBA	
CSK244MAT	PK244MA	CSD2112-T
CSK244MBT	PK244MB	
CSK244MATA	PK244MAA	
CSK244MBTA	PK244MBA	

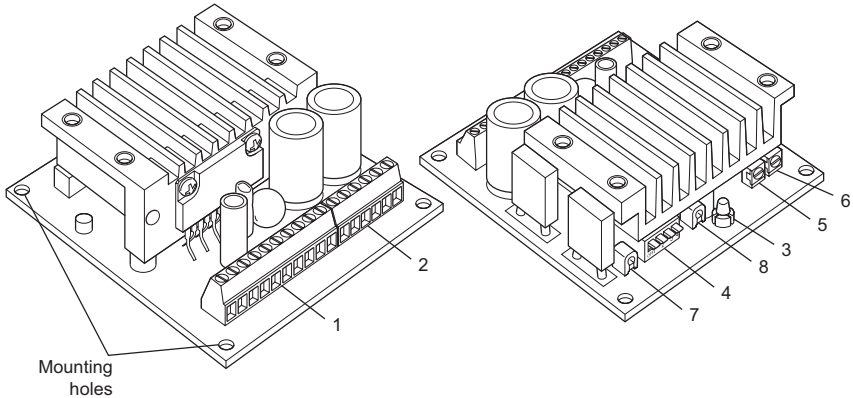
Unit model	Motor model	Driver model
CSK245MAT	PK245MA	CSD2112-T
CSK245MBT	PK245MB	
CSK245MATA	PK245MAA	
CSK245MBTA	PK245MBA	
CSK264MAT	PK264MA	CSD2120-T
CSK264MBT	PK264MB	
CSK266MAT	PK266MA	
CSK266MBT	PK266MB	
CSK268MAT	PK268MA	
CSK268MBT	PK268MB	

• Geared type

Unit model	Motor model	Driver model
CSK243AT-SG□	PK243A1-SG□	CSD2109-T
CSK243BT-SG□	PK243B1-SG□	
CSK243ATA-SG□	PK243A1A-SG□	CSD2109-T
CSK243BTA-SG□	PK243B1A-SG□	
CSK264AT-SG□	PK264A2-SG□	CSD2120-T
CSK264BT-SG□	PK264B2-SG□	
CSK264ATA-SG□	PK264A2A-SG□	CSD2120-T
CSK264BTA-SG□	PK264B2A-SG□	

4.3 Names and functions of driver

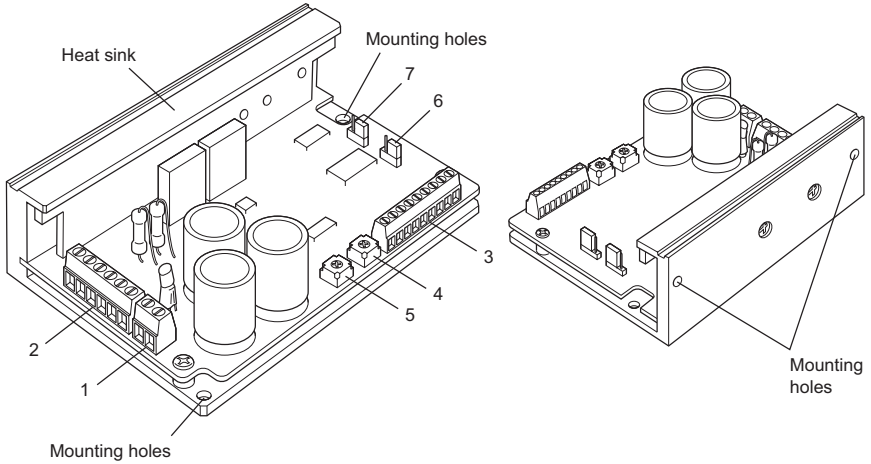
■ CSD2109-T, CSD2112-T, CSD2120-T



No.	Name	Description
1	I/O and power supply terminal blocks (TB1)	Connect the I/O signals and a 24 VDC or 36 VDC power supply.
2	Motor terminal blocks (TB2)	Connect the motor leads.
3	Power supply input indicator LED (POWER)	This LED is lit while current is supplied (green).
4	Automatic current cutback function switch (ACD)	Set whether to enable or disable the automatic current cutback function.
	Step angle switch (F/H)	Set the motor's step angle (full step/ half step).
	Pulse input mode switch (1P/2P)	Set to 1-pulse input mode or 2-pulse input mode according to the pulse output mode of the controller.
	Power supply voltage switch (24/36V)	Set to 24 V or 36 V according to the driver's power supply voltage.
5	Motor operating current potentiometer (RUN VR)	Set the motor operating current. If there is sufficient torque, the current setting can be reduced to suppress increases in motor/driver temperatures.
6	Motor standstill current potentiometer (STOP VR)	Set the motor standstill current (in the current cutback state).
7	Positive check terminal for motor operating current (C.C.+)	This terminal is used to check the motor operating current.
8	Negative check terminal for motor operating current (C.C.-)	

4 Preparation

■ CSD2140T, CSD2145T



No.	Name	Description
1	Power supply terminal blocks (TB1)	Connect 24 VDC power supply.
2	Motor terminal blocks (TB2)	Connect the motor leads.
3	I/O terminal blocks (TB3)	Connect the I/O signals.
4	Motor operating current potentiometer (RUN VR)	Set the motor operating current. If there is sufficient torque, the current setting can be reduced to suppress increases in motor/driver temperatures.
5	Motor standstill current potentiometer (STOP VR)	Set the motor standstill current (in the current cutback state).
6	Automatic current cutback function jumper socket (C.C./A.C.D.)	Set whether to enable or disable the automatic current cutback function.
7	Step angle jumper socket (FULL/HALF)	Set the motor's step angle (full step/half step).

5 Installation

This chapter explains the installation location, installation method and how to install a load. The installation and wiring methods in compliance with the EMC Directive are also explained.

5.1 Location for installation

The motor and driver are designed and manufactured for installation in equipment. Install them 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
 - Motor: -10 to $+50$ °C ($+14$ to $+122$ °F) (non-freezing)
 - Driver: 0 to $+40$ °C ($+32$ to $+104$ °F) (non-freezing)
- Operating ambient humidity 85% or less (non-condensing)
- Area that is 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

5.2 Installing the motor

■ Installation direction

The motor can be installed in any direction.

■ Installation method

Install the motor onto an appropriate flat metal plate having excellent vibration resistance and heat conductivity.

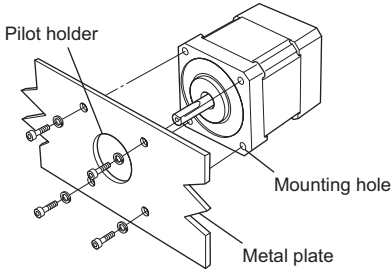
When installing the motor, secure it with four bolts (supplied for geared types only) through the four mounting holes provided. Do not leave a gap between the motor and metal plate.

Note

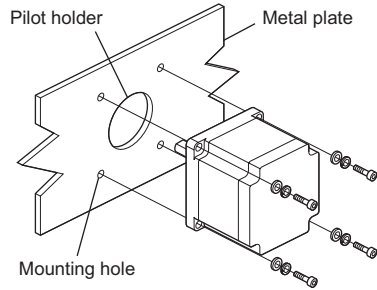
- Insert the pilot located on the motor's installation surface into the metal plate's.
- Do not loosen the gearhead attaching screws (4 pcs.).

5 Installation

- Installation method A



- Installation method B



Motor type		Nominal size	Tightening torque [N·m (oz-in)]	Effective depth of bolt [mm (in.)]	Installation method
Standard type	PK24□-01A(B)	M3	1 (142)	4.5 (0.18)	A
	PK24□-01A(B)/A	No.4-40UNC	1 (142)	4.5 (0.18)	A
	PK26	M4 No.8-32UNC	2 (280)	-	B
	PK29	No.10-24 UNC	3 (420)	-	B
High- resolution type	PK24□MA(B)	M3	1 (142)	4.5 (0.18)	A
	PK24□MA(B)/A	No.4-40UNC	1 (142)	4.5 (0.18)	A
	PK26□M	M4 No.8-32UNC	2 (280)	-	B
Geared type	PK243A(B)1-SG	M3	1 (142)	7 (0.28)	A
	PK243A(B)1A-SG	No.4-40 UNC	1 (142)	7 (0.28)	A
	PK264A(B)2-SG	M4	2 (280)	8 (0.31)	A
	PK264A(B)2A-SG	No.8-32 UNC	2 (280)	8 (0.31)	A

5.3 Installing a load

When connecting a load to the motor, align the centers of the motor's output shaft and load shaft. Also, keep the overhang load and thrust load to the permissible values or less.

Coupling	Align the centers of the motor's output shaft and load shaft in a straight line.
Belt drive	Align the motor's output shaft and load shaft in parallel with each other, and position both pulleys so that the line connecting their centers is at a right angle to the shafts.
Gear drive	Align the motor's output shaft and gear shaft in parallel with each other, and let the gears mesh at the center of the tooth widths.

Note

- When coupling the load to the motor, pay attention to the centering of the shafts, belt tension, parallelism of the pulleys, and so on. Securely tighten the coupling and pulley set screws.
- Be careful not to damage the output shaft or bearings when installing a coupling or pulley to the motor's output shaft.
- Do not modify or machine the motor's output shaft. Doing so may damage the bearings and destroy the motor.

5.4 Permissible overhung load and permissible thrust load

The overhung load on the motor's output shaft or gear output shaft must be kept within the permissible values listed below.

Note Failure due to fatigue may occur if the motor's bearings and output shaft are subject to repeated loading by an overhung or thrust load that is in excess of the permissible limit.

Motor type		Permissible overhung load [N (lb.)]					Permissible thrust load [N (lb.)]
		Distance from the tip of motor's output shaft [mm (in.)]					
		0 (0)	5 (0.20)	10 (0.39)	15 (0.59)	20 (0.79)	
Standard type	PK243						0.21 (0.46)*
	PK244	20 (4.5)	25 (5.6)	34 (7.6)	52 (11.7)	-	0.27 (0.59)*
	PK245						0.35 (0.77)*
	PK264						0.45 (0.99)*
	PK266	54 (12.1)	67 (15)	89 (20)	130 (29)	-	0.7 (1.54)*
	PK268						1 (2.2)*
	PK296						1.7 (3.7)
	PK299	260 (58)	290 (65)	340 (76)	390 (87)	480 (108)	2.8 (6.2)
PK2913						3.8 (8.4)	
High-resolution type	PK243M						0.24 (0.53)*
	PK244M	20 (4.5)	25 (5.6)	34 (7.6)	52 (11.7)	-	0.3 (0.66)*
	PK245M						0.37 (0.81)*
	PK264M						0.45 (0.99)*
	PK266M	54 (12.1)	67 (15)	89 (20)	130 (29)	-	0.7 (1.54)*
	PK268M						1 (2.2)*
Geared type	PK243SG	10 (2.2)	15 (3.3)	20 (4.5)	30 (6.7)	-	15 (3.3)
	PK264SG (gear ratio: 3.6 to 10)	30 (6.7)	40 (9)	50 (11.2)	60 (13.5)	70 (15.7)	30 (6.7)
	PK264SG (gear ratio: 18 to 36)	80 (18)	100 (22)	120 (27)	140 (31)	160 (36)	

* indicated the motor's mass [kg (lb.)]. The thrust load should not exceed the motor's mass.

5.5 Installing the driver

When installing the driver in an enclosure, be sure to follow the diagram illustrated. Provide a minimum clearance of 25 mm (1 in.) in the horizontal direction or 50 mm (2 in.) in the vertical direction between the driver and enclosure or other equipment within the enclosure. When installing two or more drivers side by side, provide a minimum clearance of 20 mm (0.79 in.) between drivers.

Note

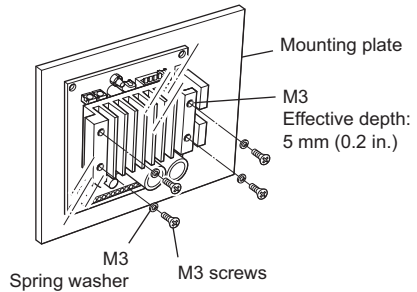
- Do not install any equipment that generates a large amount of heat near the driver.
- Check ventilation if the ambient temperature of the driver exceeds 40 °C (104 °F).

■ CSD2109-T, CSD2112-T, CSD2120-T

Mount the printed circuit board or heat sink to the mounting plate. (Screws and spacers are not supplied.)

• Mounting the heat sink

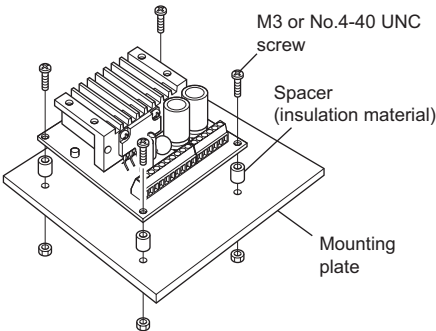
Mount the heat sink to the mounting plate using M3 screws.



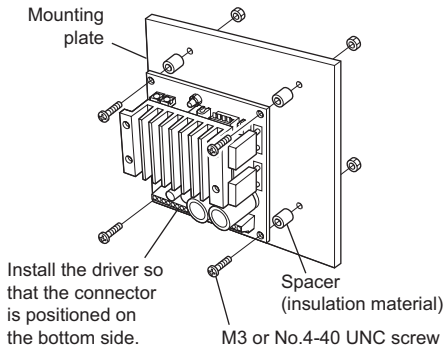
• Mounting the printed circuit board

Mount the printed circuit board to the mounting plate using M3 or No.4-40 UNC screws. Insert a spacer [5 mm (0.2 in.) or thicker] between the printed circuit board and the mounting plate.

• Horizontal installation



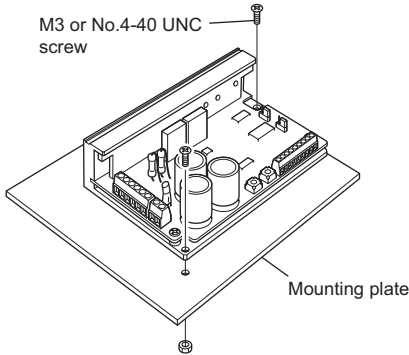
• Vertical installation



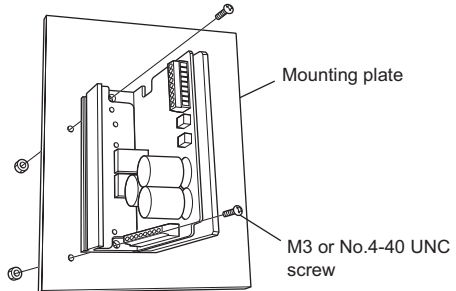
■ CSD2140T, CSD2145T

Mount the driver to the mounting plate using M3 or No.4-40 UNC screws.

• Horizontal installation



• Vertical installation



5.6 Installing and wiring in compliance with EMC Directive

Effective measures must be taken against the EMI that the **CSK** series may give to adjacent control-system equipment, as well as the EMS of the **CSK** series itself, in order to prevent a serious functional impediment in the machinery. The use of the following installation and wiring methods will enable the **CSK** series to be compliant with the EMC Directive (the aforementioned compliance standards).

The compliance of the final machinery with the EMC Directive will depend on such factors as the configuration, wiring, layout and risk involved in the control-system equipment and electrical parts. It therefore must be verified through EMC measures by the customer of the machinery.

Applicable standards

EMI	Emission Tests	EN 61000-6-4
	Radiated Emission Test	EN 55011
EMS	Immunity Tests	EN 61000-6-2
	Radiation Field Immunity Test	IEC 61000-4-3
	Fast Transient / Burst Immunity Test	IEC 61000-4-4
	Conductive Noise Immunity Test	IEC 61000-4-6

• Power supply

The **CSK** series products are of the DC power supply input specification. Use a DC power supply that is optimally compliant with the EMC Directive.

• **Connecting mains filter for power supply line**

Connect a mains filter in the AC input line to prevent the noise generated in the driver from propagating externally through the power supply line. Use a mains filter or equivalent as below table.

Manufacture	Product number
Tyco Electronics CORCOM	10ESK1
TDK Corporation	ZAG2210-11S

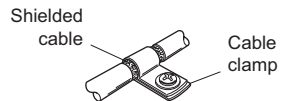
- Install the mains filter as close to the driver as possible, and use cable clamps and other means to secure the input and output cables firmly to the surface of the enclosure.
 - Connect the ground terminal of the mains filter to the grounding point, using as thick and short a wire as possible.
 - Do not place the AC input cable (AWG18) parallel with the mains filter output cable (AWG18). Parallel placement will reduce mains filter effectiveness if the enclosure's internal noise is directly coupled to the power supply cable by means of stray capacitance.
- **How to ground**

The cable used to ground the driver and mains filter 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.

• **Wiring the power supply cable and signal cable**

Use a shielded cable of AWG18 or more in diameter for the driver power supply cable, and keep it as short as possible. Use a shielded cable of AWG24 to AWG22 in diameter for the driver signal cable, and keep it as short as possible.

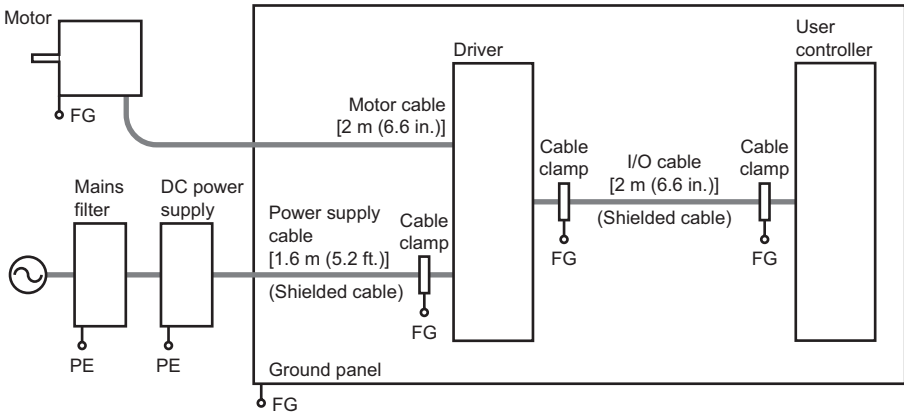
To ground a shielded cable, use a metal clamp or similar device that will maintain contact with the entire circumference of the shielded cable. Attach a cable clamp as close to the end of the cable as possible, and connect it as shown in the figure.



• **Notes about installation and wiring**

- Connect the driver and other peripheral control equipment directly to the grounding point so as to prevent a potential difference from developing between grounds.
- When relays or electromagnetic switches are used together with the system, use mains filters and CR circuits to suppress surges generated by them.
- Keep cables as short as possible without coiling and bundling extra lengths.
- Place the power cables such as the motor and power supply cables as far apart [100 to 200 mm (3.93 to 7.87 in.)] as possible from the signal cables. If they have to cross, cross them at a right angle. Place the AC input cable and output cable of a mains filter separately from each other.

• Example of motor and driver installation and wiring



■ **Precautions about static electricity**

Static electricity may cause the driver to malfunction or suffer damage. Be careful when handling the driver with the power on.

Always use an insulated screwdriver when adjusting the motor current using the control on the driver.

Note

Do not come close to or touch the driver while the power is on.

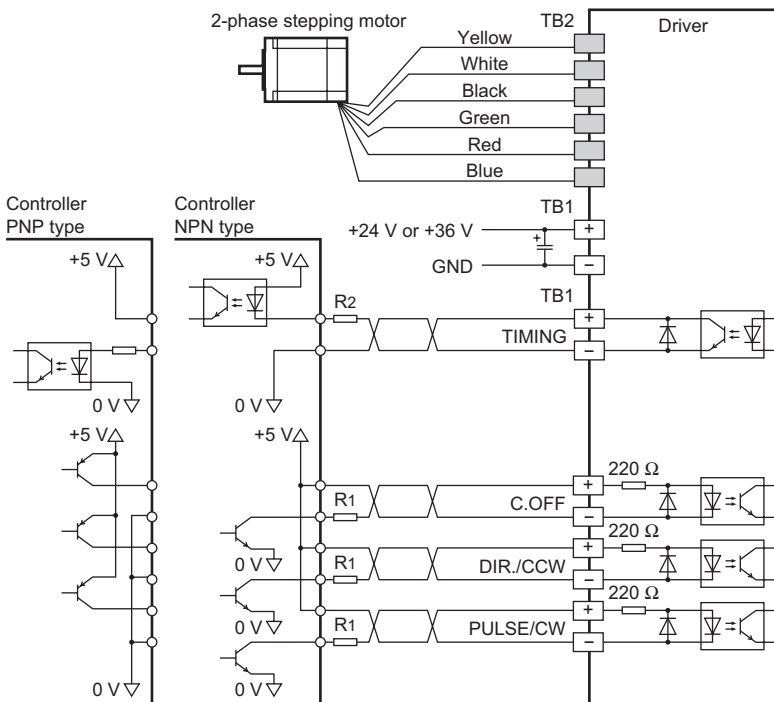
6 Connection

This section covers the methods and examples of connecting and grounding the driver, motor, power and controller, as well as the control input/output signals.

6.1 Connection of CSD2109-T, CSD2112-T, CSD2120-T

■ Connection example

Either 24 VDC or 36 VDC is selected as a driver's power supply.
Be sure to check the setting of the power supply voltage switch. Refer to p.30.



Note

- Be certain the control input/output cable that connects the driver and controller is as short as possible. The maximum input frequency will decrease as the cable length increases.
- When a large inertial load is operated at high speed, regenerative energy will generate and increase the power supply voltage, which can damage the driver. When performing the operation described above, change the operating conditions so that any temporary rise in supply voltage due to regenerative energy will not exceed 6 V.

■ Connecting the I/O and power supply

Connecting the I/O power supply wires into the driver's I/O and power supply terminal blocks (TB1).

Screw terminals are used. Remove the insulation from the core, then insert the core into the terminal and tighten with terminal screws. Strip 5 mm (0.2 in.) of insulation. Tighten the terminal screw to the specified tightening torque.

- Use a cable of AWG 22 to 18 for the power supply line.
- Use a cable of AWG 24 to 20 for the I/O line.
- Tightening torque: 0.22 to 0.25 N·m (1.95 to 2.2 lb-in)

• Power supply voltage

Use a power supply that can supply the following current capacity.

Driver model	CSD2109-T	CSD2112-T	CSD2120-T
Power supply			
Input voltage	24 VDC \pm 10% or 36 VDC \pm 10%		
Current capacity	1.4 A or more	1.6 A or more	2.8 A or more

Note

- Pay attention to polarity when connecting the power supply. Connecting the power supply in reverse polarity may damage the driver.
- Do not wire the driver's power supply cable in the same conduit in which another power line or the motor cable is wired.
- To cycle the power, turn off the power and then wait for at least 5 seconds.

• Terminal blocks pin assignments (TB1)

Signal name	Description
POWER+	DC power supply input
POWER-	GND
TIMING+ output	Excitation timing output
TIMING- output	
C.OFF+ input	All windings off input
C.OFF- input	
DIR./CCW+ input	Rotation direction (CCW pulse) input*
DIR./CCW- input	
PULSE/CW+ input	Pulse (CW pulse) input*
PULSE/CW- input	

- * When 1-pulse input mode, the inputs are the pulse and the rotation direction.
When 2-pulse input mode, the inputs are CW pulse and CCW pulse.

■ Connecting the motor

Connecting the motor leads into the driver's motor terminal blocks (TB2).

- Terminal blocks pin assignments (TB2)

Signal name	Description
YELLOW	Connect the yellow motor lead.
WHITE	Connect the white motor lead.
BLACK	Connect the black motor lead.
GREEN	Connect the green motor lead.
RED	Connect the red motor lead.
BLUE	Connect the blue motor lead.

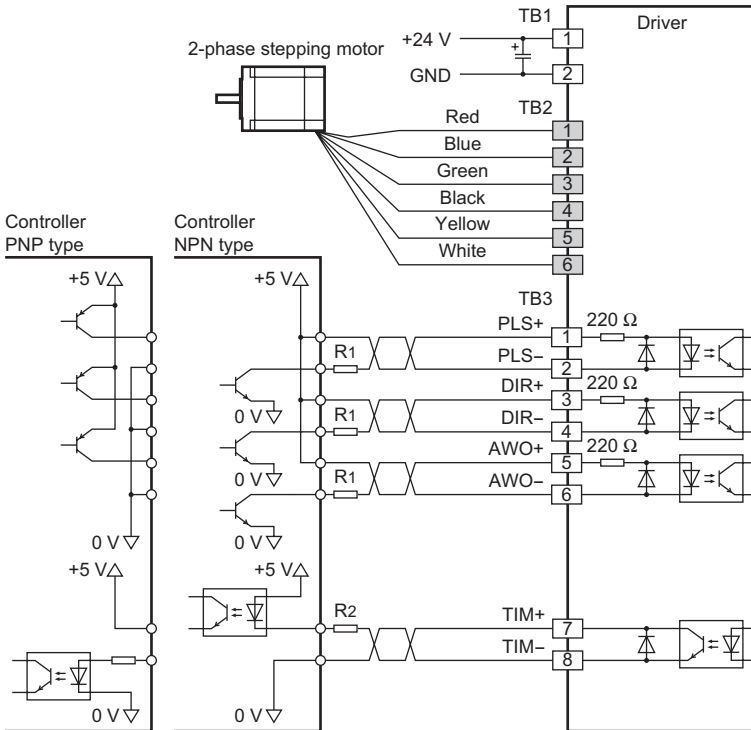
Note

Check the colors of motor leads and connect them correctly and securely. Wrong connection of leads or poor contact may damage the driver.

6.2 Connection of CSD2140T, CSD2145T

■ Connection example

The driver's power supply voltage should be 24 VDC.



Note

- Be certain the control input/output cable that connects the driver and controller is as short as possible. The maximum input frequency will decrease as the cable length increases.
- When a large inertial load is operated at high speed, regenerative energy will generate and increase the power supply voltage, which can damage the driver. When performing the operation described above, change the operating conditions so that any temporary rise in supply voltage due to regenerative energy will not exceed 6 V.

■ Connecting the power supply

Connecting the power supply wires into the driver's power supply terminal blocks (TB1). Screw terminals are used. Remove the insulation from the core, then insert the core into the terminal and tighten with terminal screws. Strip 5 mm (0.2 in.) of insulation. Tighten the terminal screw to the specified tightening torque.

Use a cable of AWG 22 to 18 for the power supply line.

Tightening torque: 0.22 to 0.25 N·m (1.95 to 2.2 lb-in)

• Power supply voltage

Use a power supply that can supply the following current capacity.

Driver model	CSD2140T	CSD2145T
Power supply input voltage	24 VDC±10%	
Power supply current capacity	5 A or more	5.5 A or more

• Terminal blocks pin assignments (TB1)

No.	Signal name	Description
1	POWER+	DC power supply input
2	POWER-	GND

Note

- Pay attention to polarity when connecting the power supply. Connecting the power supply in reverse polarity may damage the driver.
- Do not wire the driver's power supply cable in the same conduit in which another power line or the motor cable is wired.
- After turning off the power supply, wait at least 5 seconds before turning it on again.

■ Connecting the I/O

Connecting the I/O signal wires into the driver's I/O terminal blocks (TB3). Screw terminals are used. Remove the insulation from the core, then insert the core into the terminal and tighten with terminal screws. Strip 5 mm (0.2 in.) of insulation. Tighten the terminal screw to the specified tightening torque.

Use a cable of AWG 24 to 20 for the I/O line.

Tightening torque: 0.22 to 0.25 N·m (1.95 to 2.2 lb-in)

• Terminal blocks pin assignments (TB3)

No.	Signal name	Description
1	PLS+ input	CW pulse input
2	PLS- input	
3	DIR+ input	Rotation direction input
4	DIR- input	
5	AWO+ input	All windings off input
6	AWO- input	
7	TIM+ input	Timing output
8	TIM- input	
9	NC	Not used

■ Connecting the motor

Connecting the motor leads into the driver's motor terminal blocks (TB2).

- Terminal blocks pin assignments (TB2)

No.	Signal name	Description
1	RED	Connect the red motor lead.
2	BLUE	Connect the blue motor lead.
3	GREEN	Connect the green motor lead.
4	BLACK	Connect the black motor lead.
5	YELLOW	Connect the yellow motor lead.
6	WHITE	Connect the white motor lead.

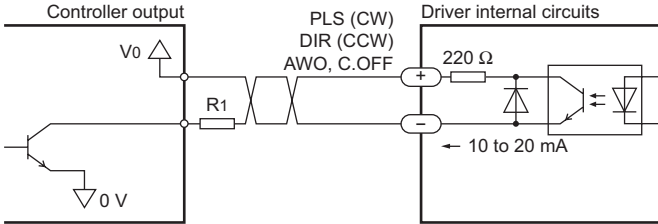
Note

Check the colors of motor leads and connect them correctly and securely. Wrong connection of leads or poor contact may damage the driver.

6.3 About input/output

■ Input signals

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



Use 5 VDC as the input signal voltage.

When the input signal voltage V_0 is equal to 5 VDC, the external resistances R_1 is not necessary. When V_0 is above 5 VDC, connect R_1 to keep the input current 10 to 20 mA.

$$R_1 = \frac{V_0}{20 \text{ mA}} - 220 [\Omega]$$

- PLS (CW pulse) input and DIR (CCW pulse) input

CSD2109-T, CSD2112-T and CSD2120-T can select either 1-pulse input mode or 2-pulse input mode as the pulse input mode to match the controller used. For details on how to set the pulse input mode, see p.29.

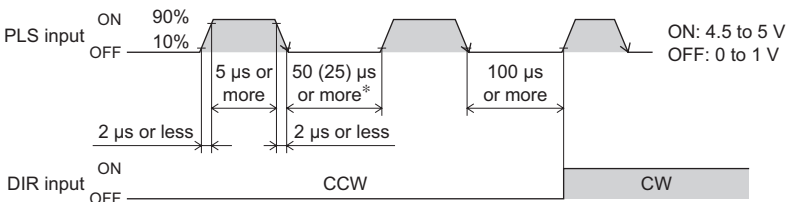
The direction of rotation indicates the direction in which the motor’s output shaft rotates, as viewed from the motor mounting surface. The output shaft of the geared type rotates in the direction opposite the motor’s rotation when the gear ratio is 18:1 or 36:1.

1-pulse input mode

The controller pulses are connected to the PLS+ input or the PLS- input, and the rotation direction is connected to the DIR+ input or DIR- input.

- When the DIR input is ON, a fall of the PLS input from ON to OFF will rotate the motor one step in the CW direction.
- When the DIR input is OFF, a fall of the PLS input from ON to OFF will rotate the motor one step in the CCW direction.

Use an input pulse signal with a waveform having a sharp rise and fall, as shown in the figure:



* () indicates the CSD2140T and CSD2145T.

Note

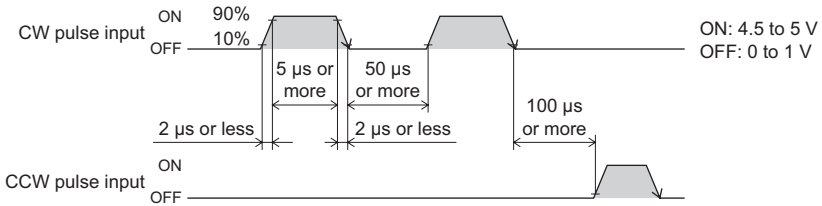
The interval for switching the motor direction represents the response time of the circuit. Set this interval to an appropriate time after which the motor will respond.

2-pulse input mode

The controller's CW pulses are connected to the CW+ or the CW-, while the CCW pulses are connected to the CCW+ or the CCW-.

- When the CW pulse input changes from the ON to OFF, the motor will rotate one step in the CW direction.
- When the CCW pulse input changes from the ON to OFF, the motor will rotate one step in the CCW direction.

Use an input pulse signal with a waveform having a sharp rise and fall, as shown in the figure:

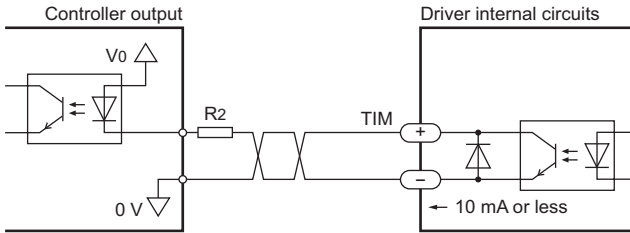


Note

- The interval for switching the motor direction represents the response time of the circuit. Set this interval to an appropriate time after which the motor will respond.
 - Always set the photocoupler to OFF when not inputting pulse signals.
 - Do not input CW pulse input and CCW pulse input at the same time. If one of these pulses is input when the other is ON the motor will not run properly.
- AWO (All windings off) input
 - C.OFF (All windings off) input
- Use the signal only when the motor's output shaft must be rotated manually for position adjustment (ON: 4.5 to 5 V, OFF: 0 to 1 V.)
- When the AWO (C.OFF) input is turned ON, the driver stops supplying current to the motor and the motor's holding torque is lost. You to adjust the load position manually.
 - When the AWO (C.OFF) input is turned OFF, the current supply to the motor resumes, thereby restoring the motor's holding torque.

■ Output signals

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



Use an output signal voltage of 5 VDC min. and 24 VDC max., and use output signal current of 10 mA max. If the output signal current is greater than 10 mA, connect external resistor R2.

$$R2 = \frac{V_0}{10 \text{ mA}} [\Omega]$$

• TIM (Excitation timing) output

When the motor-excitation state (combined phases of current flowing) is the excitation home position (step 0), the driver switches on the timing output. The motor excitation state is reset to the excitation home position when the power supply is switched on.

When the motor has a base step angle of 1.8°/step, the TIM output turns ON with a rotation of every 7.2° from the excitation home position in synchronization with a pulse input. The TIM output behaves differently depending on the combined motor and number of divisions.

Example of TIM output

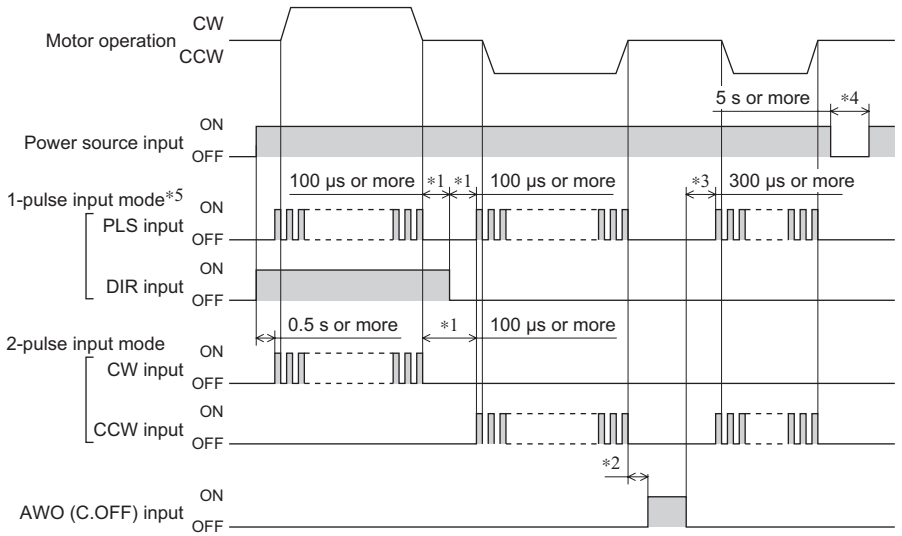
Motor type	Step angle		TIM output
	Full step	Half step	
Motor with 1.8°/step base step angle	1.8°	0.9°	Every 7.2°
Motor with 0.9°/step base step angle	0.9°	0.45°	Every 3.6°
Geared motor with 18 : 1 gear ratio	0.1°	0.05°	Every 0.4°

Also, when detecting the mechanical home position for a mechanical device, by making an AND circuit for the mechanical home position sensor and the TIM output, the variation in the motor stop position within the mechanical home position sensor can be reduced and the mechanical home position made more precise.

Note

- When using the TIM output, stop the motor's output shaft at an integer multiple of 7.2°.
- When switching the step angle, do this with the motor stopped and the TIM output ON.

6.4 Timing chart



The shaded section indicates that the photocoupler diode is emitting light.

*1 “100 μ s or more” indicated in connection with the direction-signal select time (1-pulse input mode) or CW/CCW pulse select time (2-pulse input mode) indicates a circuit response time. Set it to the time required for the motor to respond to the applicable pulse input.

*2 The specific duration varies depending on the load inertial moment, load torque, self-starting frequency, etc.

*3 Do not input pulse signals immediately after switching the AWO (C.OFF) input to OFF, given that it will affect the motor’s starting characteristics.

*4 After turning off the power supply, wait at least 5 seconds before turning the power supply back on.

*5 The CSD2140T, CSD2145T supports a 1-pulse input mode only.

Note

The CSD2109-T, CSD2112-T, and CSD2120-T respond up to 10 kHz with a pulse duty of 50%. When using it at higher speeds, narrow the pulse width (shorten the photocoupler’s ON time).

7 Setting

This section covers the selection and settings of driver functions.

Note

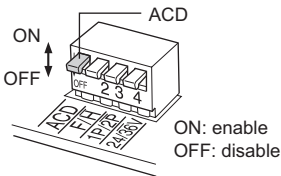
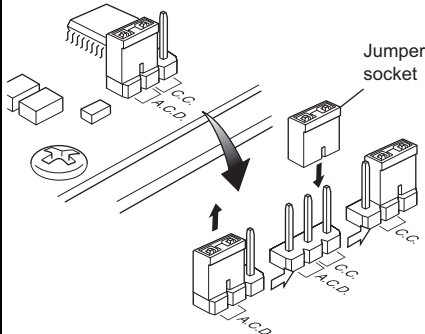
- Be sure to shut off the power before using the resolution select switch. The new resolution takes effect when the power is turned on again.
- The driver may malfunction or become damaged due to the effects of static electricity. While the driver is receiving current, handle the driver carefully and do not come near or touch the driver.
- When operating a function switch, jumper socket or current adjustment potentiometer, be sure to use an insulated screwdriver.

7.1 Automatic current cutback function

Set the automatic current cutback function using the automatic current cutback function switch (jumper socket).

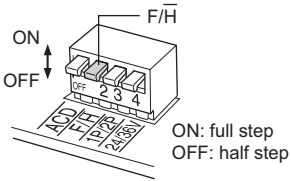
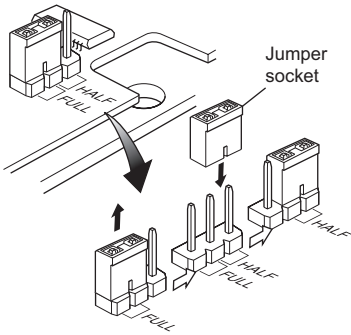
When the automatic current cutback function is ON, the motor current will automatically drop to the standstill current in approx. 0.1 second after the stopping of pulse output. This mechanism suppresses heat generation from the motor or driver while the motor is at standstill.

Keep the automatic current cutback function ON in normal conditions of use.

CSD2109-T, CSD2112-T, CSD2120-T	CSD2140T, CSD2145T
Automatic current cutback function switch (ACD) Factory setting: ON (enable)	Automatic current cutback function jumper socket (C.C./A.C.D.) Factory setting: A.C.D. (enable)
<ul style="list-style-type: none"> • Set this switch to ON to enable the automatic current cutback function. • Set this switch to OFF to disable the automatic current cutback function. 	Change the jumper sockets. <ul style="list-style-type: none"> • Set the jumper socket to A.C.D. to enable the automatic current cutback function. • Set the jumper socket to C.C. to disable the automatic current cutback function.
	

7.2 Step angle

Set the step angle of the motor using the step angle switch (jumper socket).

CSD2109-T, CSD2112-T, CSD2120-T	CSD2140T, CSD2145T
Step angle switch (F/H) Factory setting: ON (full step)	Step angle jumper socket (FULL/HALF) Factory setting: FULL (full step)
<ul style="list-style-type: none"> Set this switch to ON to use the full step setting. Set this switch to OFF to use the half step setting. 	Change the jumper sockets. <ul style="list-style-type: none"> Set the jumper socket to FULL to use the full step setting. Set the jumper socket to HALF to use the half step setting.
	

■ Setting the step angle

Motor type	Full step (base step angle)	Half step
Standard type	1.8°/step	0.9°/step
High resolution type	0.9°/step	0.45°/step

The step angle of the geared type varies, depending on the gear ratio.

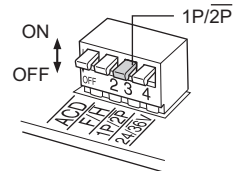
7.3 Pulse input mode

(Only for CSD2109-T, CSD2112-T, CSD2120-T)

Set the pulse input mode using the pulse input mode switch (1P/2P).

Factory setting: ON (1-pulse input mode)

- Set the switch to ON to control the motor using the pulse input and the rotation direction input indicating the direction of motor rotation.
- Set the switch to OFF to control the motor using two pulse inputs of CW and CCW.



ON: 1-pulse input mode
OFF: 2-pulse input mode

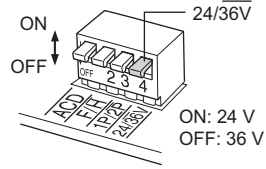
7.4 Power supply voltage

(Only for CSD2109-T, CSD2112-T, CSD2120-T)

Be sure to set the power supply voltage switch (24/36V) according to the driver's power supply input voltage.

Factory setting: ON (24 VDC)

- Set the switch to ON when the power supply voltage is 24 VDC.
- Set the switch to OFF when the power supply voltage is 36 VDC.



7.5 Motor currents

Set the motor currents during operation and in the current cutback state.

Motor operation current

Factory setting: Motor's rated current

When the load is light and there is a margin for motor torque, the motor's operating vibration and the temperature increase of the motor and driver can be held down by lowering the motor's operating current and standstill current.

Motor standstill current

Factory setting: 40% of motor operating current

Note

- Setting the motor operating current too low may affect the motor's starting characteristics and position retention performance.
- Be sure to adjust the current within the rated current of the motor/driver. Failure to do so may damage the motor/driver.
- When setting the current at motor standstill, be sure to do so after setting the motor's operating current and turning off the power supply to the driver.

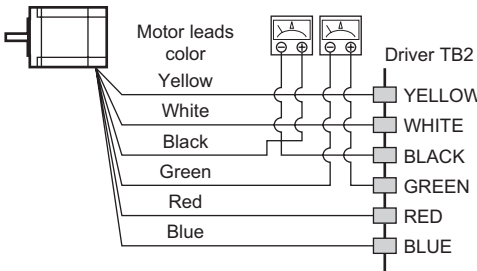
■ Setting method for CSD2109-T, CSD2112-T, CSD2120-T

An ammeter or tester is needed to set the motor current. Note that a tester is required only for the CSD2109-T, CSD2112-T and CSD2120-T.

- Connecting an ammeter or tester

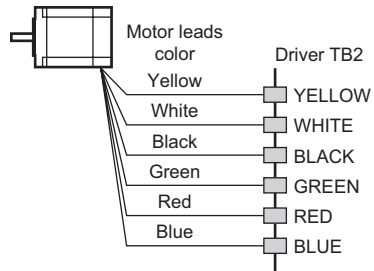
Connecting an ammeter:

Connect the driver, motor and DC ammeter.

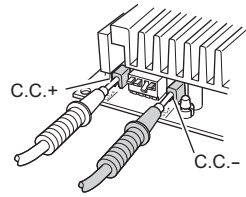


Connecting a tester:

Connect the driver and motor.

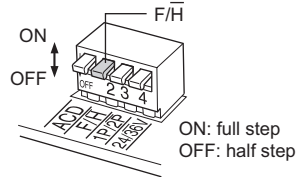


Insert the tester probes [approx. 2.1 mm (0.08 in.) in diameter] into the motor current check terminals (C.C.+ , C.C.-). Set the tester to the voltage measuring range.

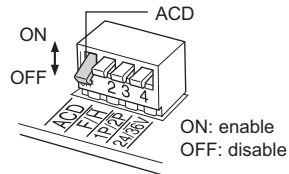


• Adjusting the motor operating current

1. Set the step angle switch (F/H) to ON.

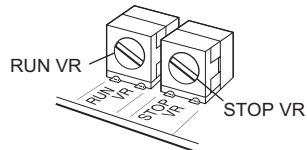


2. Set the automatic current cutback function switch (ACD) to OFF.



3. Turn on the power supply.
Wait until the motor reaches its operating current.

4. Using an insulated screwdriver, adjust the motor operating current potentiometer (RUN VR).
Be sure to adjust the current to the motor's rated current or below.



The sum of two DC ammeter readings indicates the current per motor phase.

When a tester is used, the voltage shown on the tester corresponds to the current per motor phase.

Example)

DC ammeter reading: 0.5 A, 0.45 A
Output current: 0.95 A/phase

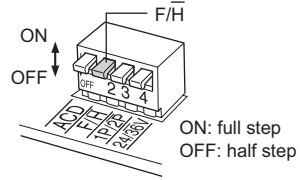
Example)

Tester reading: 0.95 V
Output current: 0.95 A/phase

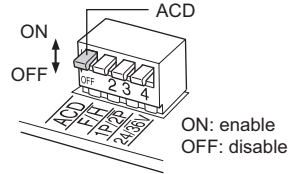
5. Turn off the power supply.
6. Set the automatic current cutback function switch (ACD) to ON again.
This completes the adjustment of the motor operating current.

• Adjusting the motor standstill current

1. Set the step angle switch (F/H) to ON.



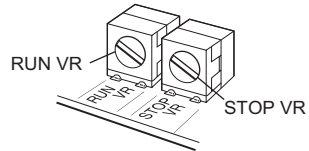
2. Set the automatic current cutback function switch (ACD) to ON.



3. Turn on the power supply.
Wait until the motor reaches its standstill current.

4. Using an insulated screwdriver, adjust the motor standstill current potentiometer (STOP VR).

Be sure to adjust the current to 40% of the motor's rated current or below.
The sum of two DC ammeter readings indicates the current per motor phase.
When a tester is used, the voltage shown on the tester corresponds to the current per motor phase.



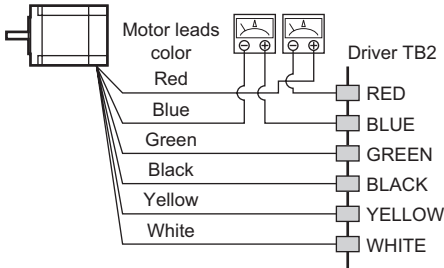
5. Turn off the power supply.

This completes the adjustment of the motor standstill current.
After about 0.1 second has passed since the pulse was stopped, the motor's operating current automatically decreases to the set value of current at motor standstill.

■ Setting method for CSD2140T, CSD2145T

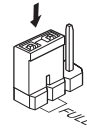
• Connecting an ammeter

Connect the driver, motor and DC ammeter.

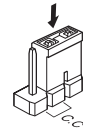


• Adjusting the motor operating current

1. Set the jumper socket for the step angle switch (FULL/HALF) to FULL.

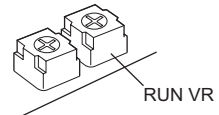


2. Set the jumper socket for automatic current cutback function (C.C./A.C.D.) to C.C.

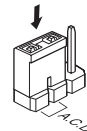


3. Turn on the power supply.
Wait until the motor reaches its operating current.

4. Using an insulated screwdriver, adjust the motor operating current potentiometer (RUN VR).
Be sure to adjust the current to the motor's rated current or below. The sum of two DC ammeter readings indicates the current per motor phase.

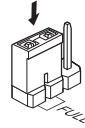


5. Turn off the power supply.
6. Set the jumper socket for automatic current cutback function (C.C./A.C.D.) to A.C.D. again.
This completes the adjustment of the motor operating current.

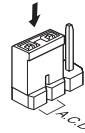


• Adjusting the motor standstill current

1. Set the jumper socket for the step angle switch (FULL/HALF) to FULL.

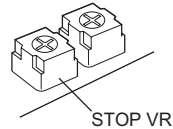


2. Set the jumper socket for automatic current cutback function (C.C./A.C.D.) to A.C.D.



3. Turn on the power supply.
Wait until the motor reaches its standstill current.

4. Using an insulated screwdriver, adjust the motor standstill current potentiometer (STOP VR).
Be sure to adjust the current to 40% of the motor's rated current or below.
The sum of two DC ammeter readings indicates the current per motor phase.



5. Turn off the power supply.
This completes the adjustment of the motor standstill current.
After about 0.1 second has passed since the pulse was stopped, the motor's operating current automatically decreases to the set value of current at motor standstill.

■ Current potentiometer and current values

- The characteristic of motor operating current indicates the output current corresponding to the setting of the motor operating current potentiometer.
- The characteristic of motor standstill current indicates the current cutback ratio corresponding to the setting of the motor standstill current potentiometer. The current cutback ratio changes according to the set motor operating current.

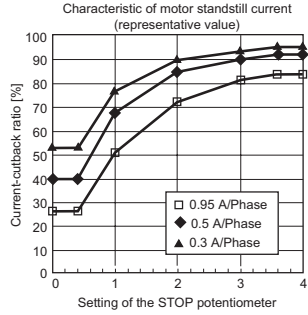
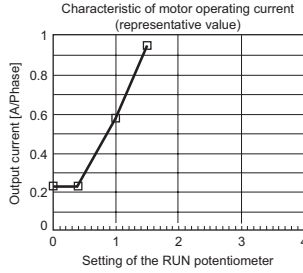
$$\text{Current-cutback ratio (\%)} = \frac{\text{Motor standstill current (A/ phase)}}{\text{Motor operating current (A/ phase)}} \times 100$$

Note Be sure to adjust the current within the rated current of the motor/driver.
Failure to do so may damage the motor/driver.

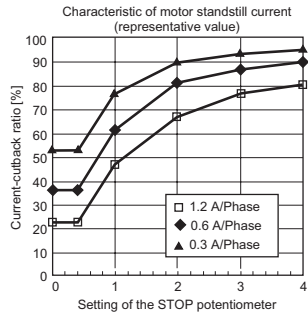
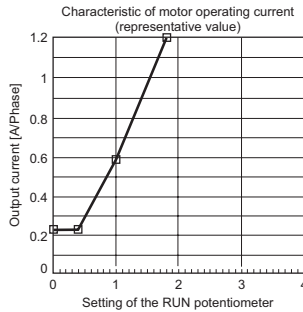
- Current potentiometer
The scale values are not displayed on the control.

CSD2109-T, CSD2112-T, CSD2120-T	CSD2140T, CSD2145T

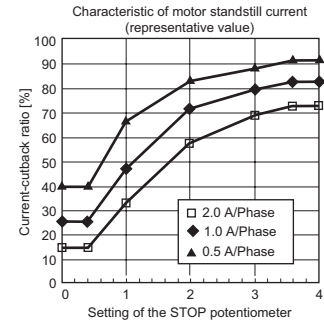
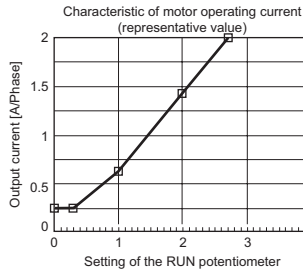
CSK243
CSK243M
CSK243SG



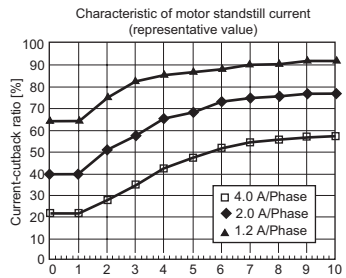
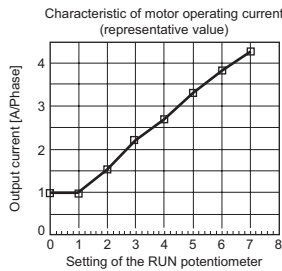
CSK244
CSK245
CSK244M
CSK245M



CSK264
CSK266
CSK268
CSK264M
CSK266M
CSK268M
CSK264SG



CSK296
CSK299
CSK2913



8 Inspection

It is recommended that periodic inspections be conducted for the items listed below after each operation of the motor.

If an abnormal condition is noted, stop the use and contact your nearest office.

Inspection items

- Are the motor installation screws loose?
- Are there any abnormal sounds from the motor's bearing section (ball bearings) or elsewhere?
- Do any of the motor lead wires have damage or stress, or is there any play at the section for connection with the driver?
- Is there any deviation between the centers of the motor's output shaft and load shaft?
- Are the driver installation screws or connector sections loose?
- Is there any dust or dirt on the driver?
- Are there any strange smells or other abnormalities at the driver?

Note

The driver uses semiconductor elements. Handle the driver carefully. There is a danger of the driver being damaged by static electricity, etc.

9 Troubleshooting and remedial actions

During motor operation, the motor or driver may fail to function properly due to an improper speed setting or wiring. When the motor cannot be operated correctly, refer to the contents provided in this section and take appropriate action. If the problem persists, contact your nearest office.

Phenomenon	Possible cause	Remedial action
<ul style="list-style-type: none"> The motor is not energized. The motor's output shaft can be turned easily by hand. 	Connection error in the motor or power supply.	Check that the connections between the driver, motor and power supply are correct.
	Current potentiometer incorrectly set. If the setting is too low, the motor torque will also be too low and operation will be unstable.	Return the current potentiometer to its factory setting and check.
	The all windings off input is set to ON.	Switch the all windings off input to OFF and confirm that the motor is excited.
The motor does not run.	Pulse input line connection error.	<ul style="list-style-type: none"> Check the controller and driver connections. Check the pulse input specifications (voltage and width).
	The CW input and the CCW input came ON at the same time.	Input either the CW input or the CCW input, and always switch the other terminal to OFF.
The motor rotates in the direction opposite that which is specified.	The CW input and the CCW input are connected in reverse.	Connect the CW pulses to the CW pulse input, and connect the CCW pulses to the CCW pulse input.
Motor operation is unstable.	Motor connection error.	Check that the driver and motor connections are correct.
	Current potentiometer incorrectly set. If the setting is too low, the motor torque will also be too low and operation will be unstable.	Return the current potentiometer to its factory setting and check.
Motor does not move the set amount.	Wrong step angle settings.	Check the settings of the step angle setting switches.
	Pulse output count is too low or too high.	Check whether or not the number of pulses required for operation at the set step angle are being output.
Loss of synchronization during acceleration or running.	The centers of the motor' output shaft and load shaft are not aligned.	Check the connection condition of the motor output shaft and load shaft.

9 Troubleshooting and remedial actions

Phenomenon	Possible cause	Remedial action
	The load or load fluctuation is too high.	Check for large load fluctuations during motor operation. If adjusting the motor's operating speed to low and high torque eliminates the problem, it is necessary to review the load conditions.
	The starting pulse speed is too high.	Lower the speed of the starting pulse.
	Acceleration (deceleration) time is too short.	Lengthen the acceleration (deceleration) time.
	Electrical noise	Check running with only the motor, driver and required controller. If the impact of noise is recognized, take countermeasures, such as rewiring for greater distance from the noise source, changing the signal cables to shielded wire, or mounting a ferrite core.
Current does not drop when the motor stops.	The all windings off input is set to ON.	Switch all windings off input to OFF.
Motor vibration too great.	The centers of the motor's output shaft and load shaft are not aligned.	Check the connection condition of the motor output shaft and load shaft.
	Motor resonating	If the vibration decreases when the operating pulse speed is changed, it means the motor is resonating. Change the operating pulse speed setting or install a clean damper (sold separately) to suppress vibration.
	Load too small.	Turn the motor operating current setting switch slightly in the counterclockwise direction in order to lower the current. Vibration will increase if the motor's output torque is too large for the load.
Motor too hot.	Long continuous operation time of the motor.	Decrease the operation time of the motor per session or increase the standstill time. Make sure that the motor case temperature will not exceed 100 °C (212 °F).
	The all windings off input is set to ON.	Switch all windings off input to OFF.
	Motor standstill current adjustment too high.	Lower the motor standstill current.

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