

Brushless DC Motor and Driver Package **BLU 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

The **BLU** series is designed and manufactured for use as an internal component of general industrial equipment. Do not use it for any other purpose.

Oriental Motor will not be liable for whatever damage arises from failure to observe this warning.

■ Product overview

The **BLU** series is a brushless DC motor unit adopting a thin, high-torque brushless DC motor and a compact driver. The **BLU** allows motor speed setting and start/stop operation to be controlled only by the driver. This series is well suited for the speed control of transfer equipment and agitators which do not frequently change speed. The **BLU** is available in three types; [1] single-phase 100-115 V, 50/60 Hz, [2] single-phase 200-230 V, 50/60 Hz, and [3] three-phase 200-230 V, 50/60 Hz. The **BLU** series consists of the combination type that comes with a dedicated gearhead ideal for high-torque operation through gear reduction, the pinion type compatible with optional dedicated gearheads, and the round shaft type perfect for applications that require high-speed rotational movement.

■ Standards and CE Marking

This product is recognized by UL and certified by CSA, and bears the CE Marking (Low Voltage Directive and EMC Directives) in compliance with the EN Standards.

● Applicable standards

	Applicable Standards	Certification Body	Standards File No.	CE Marking
Motor	UL 60950-1	UL	E208200	Low Voltage Directives EMC Directives
	CSA C22.2 No.60950-1			
	EN 60950-1 EN 60034-1 EN 60034-5 IEC 60664-1	Conform to EN/IEC Standards		
Driver	UL 508C* CSA C22.2 No.14	UL	E171462	
	EN 60950-1 EN 50178	Conform to EN Standards		

* For UL Standard (UL 508C), the product is recognized for the condition of Maximum Surrounding Air Temperature 40 °C (104 °F).

● Installation conditions

Overvoltage category III, Pollution degree 2, Class I (For EN Standard). When the machinery to which the driver is mounted requires pollution degree 3 specifications, install the driver in a cabinet that complies with IP54.

● Low Voltage Directive

The product is to be machinery incorporated, so it should be installed within an enclosure.

- Install the product within an enclosure to avoid contact with hands.
- Be sure to maintain a protective earth in case hands should make contact with the product. Securely ground the protective earth terminals of the motor and driver.

● EMC Directives

This product bears the CE Mark under the conditions specified in “Example of motor and driver installation and wiring” (→p.10). Be sure to conduct EMC measures with the product assembled in your equipment by referring to 5.9 “Installing and wiring in compliance with EMC Directive (89/336/EEC, 92/31/EEC)” (→p.10).

■ Hazardous substances

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

2 Safety precautions

Only qualified personnel should work with the product. Use the product correctly after thoroughly reading the section “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. Please read and understand these precautions thoroughly before using the product.

⚠ Warning

Handling the product without observing the instructions that accompany a “Warning” symbol may result in death or serious bodily injury.

⚠ Caution

Handling the product without observing the instructions that accompany a “Caution” symbol may result in bodily 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, electric shock 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, electric shock or injury.
- Do not transport, install the product, perform connections or inspections when the power is on. Always turn the power off before carrying out these operations. Failure to do so may result in electric shock.
- When the protection function is triggered, shut off the power immediately. Turn the power back on only after removing the cause. Continuing the operation without removing the cause of the problem may cause malfunction of the motor and driver, leading to injury or damage to equipment.
- To prevent the risk of electric shock, use the motor and driver for class I equipment only.
- When installing the motor and driver, ground them to prevent the risk of electric shock.
- Keep the driver's power supply input voltage within the specified range to avoid fire and electric shock.
- Connect the cables securely according to the wiring diagram in order to prevent fire and electric shock.
- Do not rework or modify the motor cable and extension cable (sold separately). Do not remove the sheath of the cable and then ground or touch the shielded wire. This may cause electric shock or trigger the ground fault interrupt circuit.
- Be sure to install the terminal cover of the power connection terminal and input/output signal connection terminal after making connections. Otherwise, fire and electric shock may occur.
- Do not forcibly bend, pull or pinch the cable. Doing so may result in fire and electric shock.
- 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 use it in a vertical application. When the driver protection function is activated, the motor will stop and movable portions may fall down to cause injury of the operator and damage of the equipment.
- Do not touch the terminals block of the driver immediately after the power is turned off (for a period of 30 seconds). Failure to do so may result in electric shock.
- Do not disassemble or modify the motor, gearhead or driver. This may cause electric shock or injury. Refer all such internal inspections and repairs to the branch or sales office from which you purchased the product.

⚠ Caution

- Do not use the motor and driver beyond their specifications, or electric shock, injury or damage to equipment may result.
- Keep objects out of the openings in the driver, or electric shock, injury or damage to equipment may result.
- Do not touch the motor and driver during operation or immediately after stopping. The surfaces are hot and may cause a burn.
- Do not hold the motor output shaft or motor cable. This may cause injury.
- Keep the area around the motor and driver free of combustible materials in order to prevent fire or a burn.
- Provide a cover over the rotating parts (output shaft) of the motor to prevent injury.
- Do not allow your finger to be caught between the motor and gearhead when the motor (pinion shaft) and gearhead are combined. This may cause injury.
- Do not allow your finger to be caught between the equipment and motor or gearhead when installing the motor or motor with gearhead on the equipment. This may cause injury.
- 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.
- 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.
- The motor's surface temperature may exceed 70 °C, even under normal operating conditions. If a motor is accessible during operation, post a warning label shown in the figure in a conspicuous position to prevent the risk of burns.
- Use an insulated Phillips screwdriver for adjusting the acceleration time and deceleration time setting potentiometer of the driver. Otherwise, electric shock may occur.
- When testing the insulation resistance or dielectric strength, do not touch the terminal. Otherwise, electric shock may occur.
- 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.



Warning label

3 Precautions for use

This chapter explains the restrictions and other items you should take heed of when using the **BLU** series.

■ Connect protective devices to the power line

Connect a circuit breaker or earth leakage breaker to the driver's power line to protect the primary circuit. If an earth leakage breaker is to be installed, use one incorporating high-frequency noise elimination measures. Refer to 9.2 "Recommended peripherals" (→p.15) for the selection of appropriate protective devices.

■ Do not perform gravitational operation

With the **BLU** series, any operation in which the motor output shaft is turned (gravitational operation) will disable the motor speed control. In addition, a gravitational operation will cause the driver's primary inverter voltage to exceed the allowable value, thereby triggering a protection function and causing the motor to stop spontaneously. When the motor stops, the load may drop.

■ Do not use a solid-state relay (SSR) to turn on/off the power

A circuit that turns on/off the power via a solid-state relay (SSR) may damage the motor and driver.

■ 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.

■ Grease measures

On rare occasions, a small amount of grease may ooze out from the gearhead. 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 pan or other device to prevent leakage from causing further damage. Oil leakage may lead to problems in the customer's equipment or products.

■ Apply grease on the output shaft of hollow shaft flat gearhead

If you are using a hollow shaft flat gearhead, apply grease (molybdenum disulfide grease, etc.) on the surface of the load shaft and inner walls of the hollow output shaft to prevent seizure.

■ Noise elimination measures

Provide the following noise elimination measures to prevent a motor or driver malfunction caused by external noise.

Wiring the motor

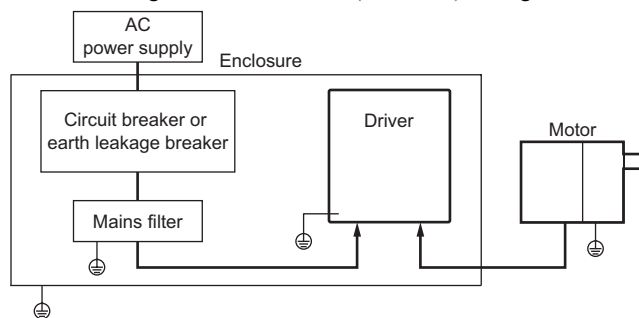
To extend the wiring between the driver and motor, use the optional extension cable (sold separately).

Wiring the I/O signal cable

- Minimize the wiring length of the I/O signal cable.
- Provide a minimum clearance of 100 mm (4 in.) between the I/O signal cable and any inductive load such as an electromagnetic relay or any power line (power cable, motor cable, etc.). Do not place the I/O signal cable and a power line in the same duct or pipe or bundle them together.
- For more effective elimination of noise, use a shielded I/O signal cable or attach ferrite cores if a non-shielded cable is used.

Connecting a mains filter for power line

- Connect a mains filter to the AC power input part of the driver to prevent external noise from reaching the driver via the power line.
- Provide a ground connection from the mains filter ground terminal using a cable of AWG18 (0.75 mm²) or larger.



4 Preparation

This chapter explains what you must do before using the **BLU** series, as well as the name and function of each part of the unit.

4.1 Confirming the product

Open the package and confirm that all of the following items (→p.4) are available.

If any of the items are missing or damaged, please contact the Oriental Motor branch or sales office from where you purchased the product.

Confirm the model of the unit against the model name shown on the package label.

Confirm the models of the motor and driver against the model names shown on their respective nameplates.

Refer to 4.2 "Combination tables" (→p.4) for the allowable motor and driver combinations for each unit model.

- Motor (with a gearhead, only for combination type)..... 1 unit
- Driver..... 1 unit
- Driver mounting screw set
(M3 screw, washer and nut, 4 pcs. each)..... 1 set
- Short circuit bar 1 pc.
- Power cable..... 1 pc.
- Operating manual (this manual)..... 1 copy

Accessories for combination type parallel shaft gearhead*

- Hexagonal socket head screw set
(Screw, flat washer, spring washer and nut, 4 pcs. each)..... 1 set
- Parallel key 1 pc.

Accessories for combination type hollow shaft flat gearhead*

- Hexagonal socket head screw set
(Screw, flat washer, spring washer and nut, 4 pcs. each)..... 1 set
- Safety cover 1 pc.
- Safety-cover mounting screw (M3)..... 2 pcs.
- Parallel key 1 pc.

* These parts are not supplied if the motor is of the round shaft or pinion shaft type.

4.2 Combination tables

■ Combination type parallel shaft gearhead

The motor comes preassembled with a parallel shaft gearhead.

Unit model	Components		
	Motor model	Gearhead model	Driver model
BLU220A-□	BLUM220-GFS	GFS2G□	BLUD20A
BLU220C-□			BLUD20C
BLU220S-□			BLUD20S
BLU440A-□	BLUM440-GFS	GFS4G□	BLUD40A
BLU440C-□			BLUD40C
BLU440S-□			BLUD40S
BLU590A-□	BLUM590-GFS	GFS5G□	BLUD90A
BLU590C-□			BLUD90C
BLU590S-□			BLUD90S

* □ in the model names indicates a number representing the gear ratio (5, 10, 15, 20, 30, 50, 100 or 200).

■ Combination type hollow shaft flat gearhead

The motor comes preassembled with a hollow shaft flat gearhead.

Unit model	Components		
	Motor model	Gearhead model	Driver model
BLU220A-□FR	BLUM220-GFS	GFS2G□FR	BLUD20A
BLU220C-□FR			BLUD20C
BLU220S-□FR			BLUD20S
BLU440A-□FR	BLUM440-GFS	GFS4G□FR	BLUD40A
BLU440C-□FR			BLUD40C
BLU440S-□FR			BLUD40S
BLU590A-□FR	BLUM590-GFS	GFS5G□FR	BLUD90A
BLU590C-□FR			BLUD90C
BLU590S-□FR			BLUD90S

* □ in the model names indicates a number representing the gear ratio (5, 10, 15, 20, 30, 50, 100 or 200).

■ Round shaft type

Unit model	Components	
	Motor model	Driver model
BLU220A-A	BLUM220-A	BLUD20A
BLU220C-A		BLUD20C
BLU220S-A		BLUD20S
BLU440A-A	BLUM440-A	BLUD40A
BLU440C-A		BLUD40C
BLU440S-A		BLUD40S
BLU590A-A	BLUM590-A	BLUD90A
BLU590C-A		BLUD90C
BLU590S-A		BLUD90S

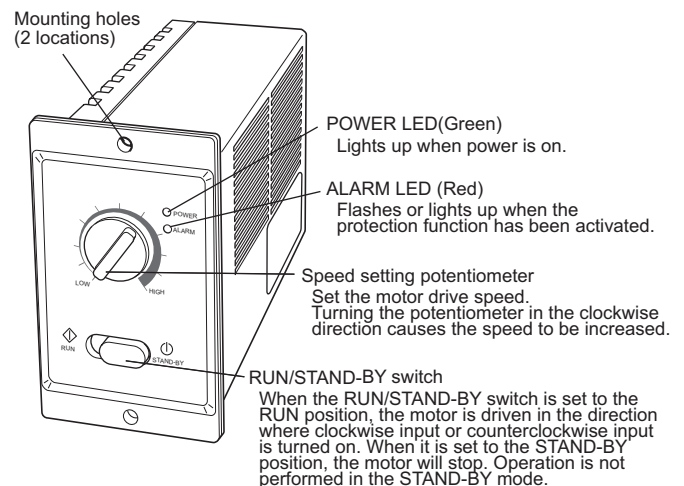
■ Pinion shaft type

Unit model	Components		Applicable gearhead (sold separately)
	Motor model	Driver model	
BLU220A-GFS	BLUM220-GFS	BLUD20A	GFS2G□ GFS2G□FR
BLU220C-GFS		BLUD20C	
BLU220S-GFS		BLUD20S	
BLU440A-GFS	BLUM440-GFS	BLUD40A	GFS4G□ GFS4G□FR
BLU440C-GFS		BLUD40C	
BLU440S-GFS		BLUD40S	
BLU590A-GFS	BLUM590-GFS	BLUD90A	GFS5G□ GFS5G□FR
BLU590C-GFS		BLUD90C	
BLU590S-GFS		BLUD90S	

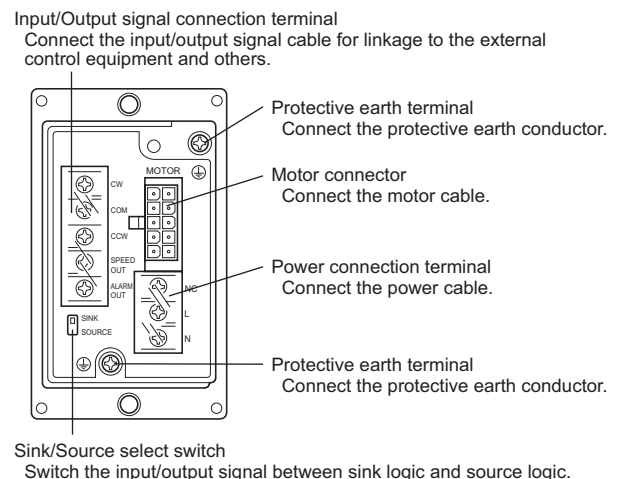
* □ in the model names indicates a number representing the gear ratio (5, 10, 15, 20, 30, 50, 100 or 200).

4.3 Names and functions of parts

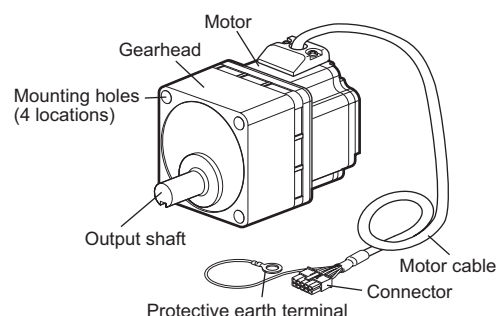
■ Front of driver



■ Back of driver



■ Motor



* Illustration shows combination type parallel shaft gearhead.

5 Installation

5.1 Installation location

The motor and driver are designed and manufactured for use as internal components of equipment.

Install the motor and driver in a well-ventilated place where they can be inspected easily and the following conditions are satisfied:

- Inside an enclosure installed indoors (provide a ventilation hole)
- Ambient temperature

Motor: 0 to +50 °C (+32 to +122 °F) (non-freezing)

Driver: 0 to +40 °C (+32 to +104 °F) (non-freezing)

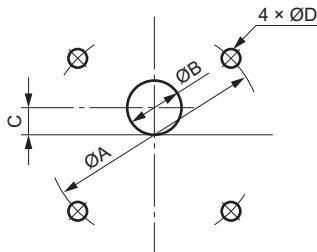
The product is recognized/certified by UL/CSA at 0 to +40 °C (+32 to +104 °F).

- 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 (rains, 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

Install the motor to a flat mounting plate offering excellent vibration resistance and high heat conductivity.

5.2 Installing the combination type parallel shaft gearhead

1. Open mounting holes in the mounting plate.



[Unit: mm (in.)]

Unit model	ØA	ØB	C	ØD
BLU220	70 (2.76)	24 (0.94)	10 (0.39)	4.5 (0.177)
BLU440	94 (3.70)	34 (1.34)	13 (0.51)	6.5 (0.256)
BLU590	104 (4.09)	40 (1.57)	18 (0.71)	8.5 (0.335)

* ØB indicates the external dimensions of the product.

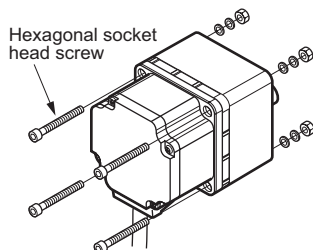
Open holes with a minimum diameter of ØB + 1 mm (0.04 in.).

Maximum applicable plate thickness

Unit model	Maximum applicable plate thickness
BLU220	5 mm (0.20 in.)
BLU440	8 mm (0.31 in.)
BLU590	12 mm (0.47 in.)

* The figures in the table apply when the supplied hexagonal socket head screw is used.

2. Install the supplied hexagonal socket head screw in the four mounting holes you just opened and tighten the nuts until no gaps remain between the motor and mounting plate.



Unit model	Nominal thread size	Tightening torque
BLU220	M4	1.8 N·m (15.9 lb-in)
BLU440	M6	6.4 N·m (56 lb-in)
BLU590	M8	15.5 N·m (137 lb-in)

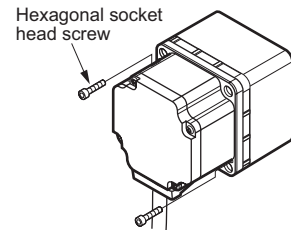
Note

Fit the boss on the gearhead mounting surface into a counterbore or through pilot-receiving hole

■ Changing direction of the cable outlet

The gearhead can be removed and the motor cable position changed to the desired 90° direction.

1. Remove the hexagonal socket head screws (2 pcs.) assembling the motor and gearhead and detach the motor from the gearhead.

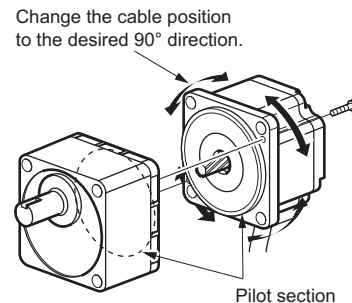


2. Using the pilot sections of the motor and gearhead as guides, install the gearhead to the motor and tighten the hexagonal socket head screws.

At this time, the motor cable position can be changed to the desired 90° direction.

When installing the gearhead, slowly rotate it clockwise/counterclockwise to prevent the pinion of the motor output shaft from contacting the side panel or gear of the gearhead.

Also confirm that no gaps remain between the motor flange surface and the end face of the gearhead's pilot section.



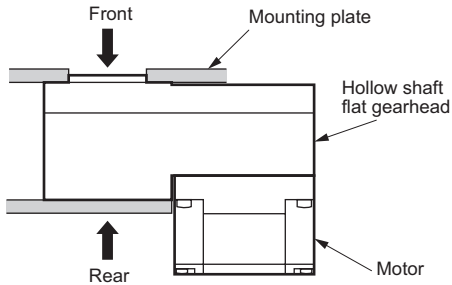
Unit model	Nominal thread size	Tightening torque
BLU220 BLU440	M2.6	0.4 N·m (3.5 lb-in)
BLU590	M3	0.6 N·m (5.3 lb-in)

Note

- Do not forcibly assemble the motor and gearhead. Also, do not let metal objects or other foreign matters enter the gearhead. The pinion or gear of the motor output shaft may be damaged, resulting in noise or shorter service life.
- Do not allow dust to attach to the pilot sections of the motor and gearhead. Also, assemble the motor and gearhead carefully by not pinching the O-ring at the motor's pilot section. If the O-ring is crushed or severed, grease may leak from the gearhead.
- The hexagonal socket head screws assembling the motor and gearhead are affixing the motor and gearhead only temporarily. When installing the gearhead, be sure to use the supplied four hexagonal socket head screws.

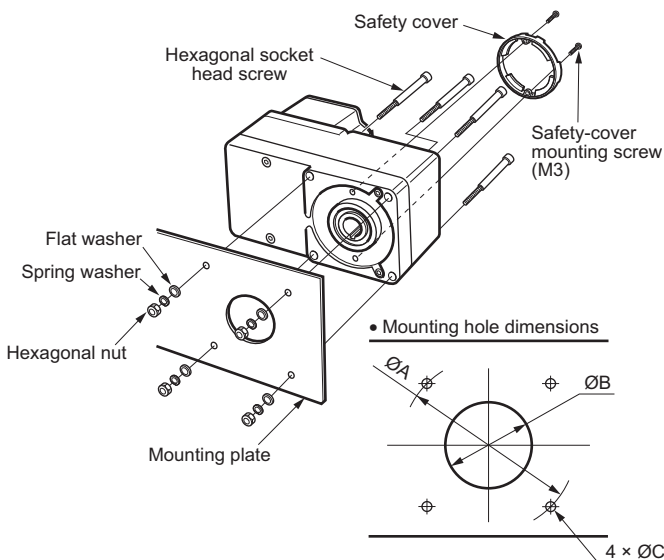
5.3 Installing the combination type hollow shaft flat gearhead

A combination type hollow shaft flat gearhead can be installed by using either its front or rear side as the mounting surface. Install the supplied hexagonal socket head screw in the four mounting holes you opened and tighten the nuts until no gaps remain between the motor and mounting plate. Also, attach the supplied safety cover to the hollow output shaft on the end opposite from the one where the load shaft is installed.

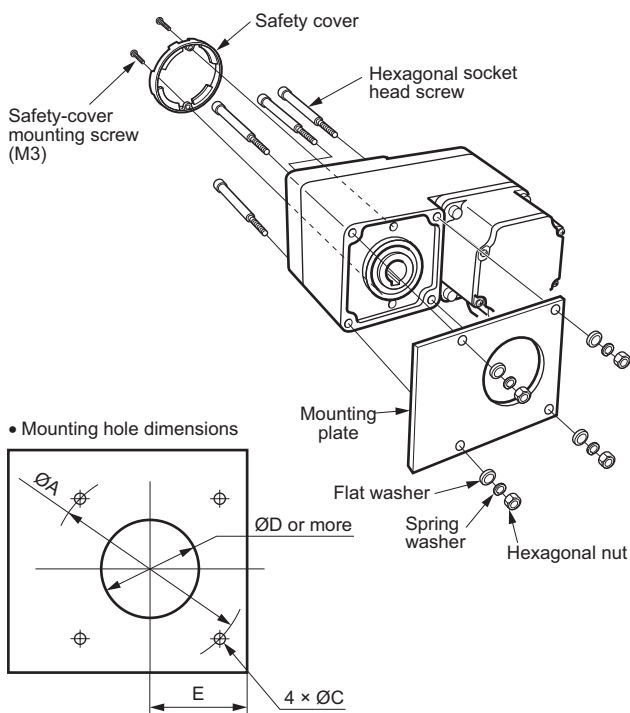


• Using the front side as the mounting surface

When the gearhead is installed by using its front side as the mounting surface, use the boss of the output shaft to align the center.



• Using the rear side as the mounting surface



[Unit: mm (in.)]

Unit model	Nominal thread size	Tightening torque	ØA	ØB	ØC	ØD	E
BLU220	M5	3.8 N·m (33 lb-in)	70 (2.76)	34 ^{+0.039} ₀ (1.34 ^{+0.0015})	5.5 (0.217)	25 (0.98)	29 (1.14)
BLU440	M6	6.4 N·m (56 lb-in)	94 (3.70)	38 ^{+0.039} ₀ (1.50 ^{+0.0015})	6.5 (0.256)	30 (1.18)	39 (1.54)
BLU590	M8	15.5 N·m (137 lb-in)	104 (4.09)	50 ^{+0.039} ₀ (1.97 ^{+0.0015})	8.5 (0.335)	35 (1.38)	44 (1.73)

Note

When installing the gearhead by using its rear side as the mounting surface, prevent contact between the mounting plate and motor by keeping dimension E below the specified value.

Maximum applicable plate thickness

Unit model	Maximum applicable plate thickness
BLU220	5 mm (0.20 in.)
BLU440	8 mm (0.31 in.)
BLU590	12 mm (0.47 in.)

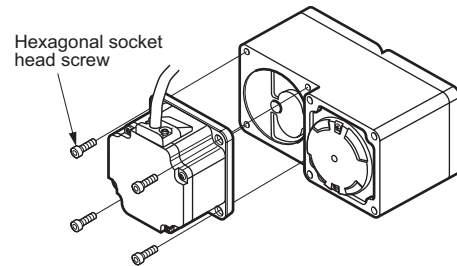
* The figures in the table apply when the supplied hexagonal socket head screw is used.

■ Changing direction of the cable outlet

The gearhead can be removed and the motor cable position changed to one of three 90° directions.

Note that the motor cable cannot be positioned in the direction where the cable faces the gearhead output shaft.

1. Remove the hexagonal socket head screws (4 pcs.) attaching the hollow shaft flat gearhead and detach the motor from the hollow shaft flat gearhead.

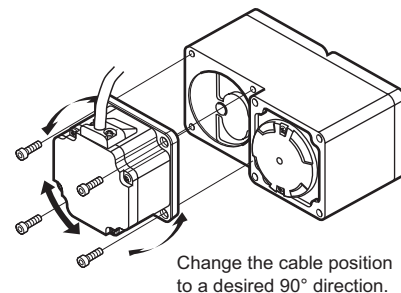


2. Using the pilot sections of the motor and hollow shaft flat gearhead as guides, install the motor to the hollow shaft flat gearhead and tighten the hexagonal socket head screws.

At this time, the motor cable position can be changed to one of three 90° directions.

Install the motor carefully to prevent the pinion of the motor output shaft from contacting the casing or gear of the hollow shaft flat gearhead.

Also confirm that no gaps remain between the motor flange surface and the end face of the hollow shaft flat gearhead's pilot section.



Unit model	Nominal thread size	Tightening torque
BLU220	M4	1.8 N·m (15.9 lb-in)
BLU440	M6	6.4 N·m (56 lb-in)
BLU590	M8	15.5 N·m (137 lb-in)

Note

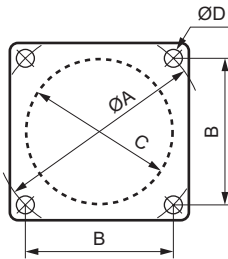
- Do not forcibly assemble the motor and hollow shaft flat gearhead. Also, do not let metal objects or other foreign matters enter the hollow shaft flat gearhead. The pinion of the motor output shaft or the hollow shaft flat gearhead itself may be damaged, resulting in noise or shorter service life.
- Do not allow dust to attach to the pilot sections of the motor and hollow shaft flat gearhead. Also, assemble the motor carefully by not pinching the O-ring at the motor's pilot section. If the O-ring is pinched, the coupling strength will drop and grease may leak from the hollow shaft flat gearhead.

5.4 Installing the round shaft type

Install the motor to a mounting plate of the following size or larger, so that the motor case temperature will not exceed 90 °C (194 °F).

Unit model	Size of radiation plate [mm (in.)]	Thickness [mm (in.)]	Material
BLU220	135×135 (5.31×5.31)	5 (0.20)	Aluminum
BLU440	165×165 (6.50×6.50)		
BLU590	200×200 (7.87×7.87)		

1. Open mounting holes in the mounting plate.



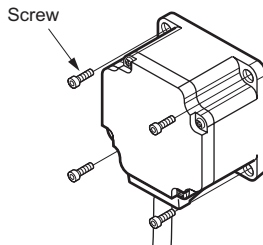
[Unit: mm (in.)]

Unit model	ØA	B
BLU220	70 (2.76)	49.5 (1.949)
BLU440	94 (3.70)	66.47 (2.616)
BLU590	104 (4.09)	73.54 (2.895)

Unit model	ØC	ØD
BLU220	54 ^{+0.030} ₀ (2.1260 ^{+0.0012} ₀)	4.5 (0.177)
BLU440	73 ^{+0.030} ₀ (2.8740 ^{+0.0012} ₀)	6.5 (0.256)
BLU590	83 ^{+0.035} ₀ (3.2677 ^{+0.0014} ₀)	8.5 (0.335)

* ØC indicates the pilot diameter on the flange.

2. Install four screws (not supplied) in the four mounting holes you just opened and tighten the nuts until no gaps remain between the motor and mounting plate.



Unit model	Nominal thread size	Tightening torque
BLU220	M4	1.8 N·m (15.9 lb-in)
BLU440	M6	6.4 N·m (56 lb-in)
BLU590	M8	15.5 N·m (137 lb-in)

Note

Fit the boss on the motor mounting surface into a counterbore or through pilot-receiving hole.

5.5 Installing the pinion shaft type

A pinion shaft motor is used with a parallel shaft gearhead or hollow shaft flat gearhead assembled to it.

Installing a parallel shaft gearhead: → p.5

Installing a hollow shaft flat gearhead: → p.6

5.6 Installing a load on the combination type parallel gearhead or round shaft type

When installing a load on the motor (gearhead), align the center of the motor output shaft (gearhead output shaft) with the center of the load shaft.

Note

- When coupling the motor (gearhead) with a load, pay attention to centering, belt tension, parallelism of pulleys, etc. Also, securely affix the tightening screws of the coupling or pulleys.
- When installing a load, do not damage the motor output shaft (gearhead output shaft) or bearing. Forcing in the load by driving it with a hammer, etc., may break the bearing. Do not apply any excessive force to the output shaft.
- Do not modify or machine the motor (gearhead) output shaft. The bearing may be damaged or motor (gearhead) may break.

■ Output shaft shape

Combination type parallel shaft gearhead

A key groove is provided on the output shaft of each combination type parallel shaft gearhead. Form a key groove on the load side and affix the load using the supplied parallel key.

Unit model	Parallel key dimension
BLU220	4 mm (0.1575 in.)
BLU440	5 mm (0.1969 in.)
BLU590	6 mm (0.2362 in.)

Round shaft type

A flat section is provided on the motor output shaft of each round shaft motor. Apply a double-point screw, etc., at the flat section to securely affix the load and prevent it from spinning.

■ How to install a load

● Using a coupling

Align the centerline of the motor (gearhead) output shaft with the centerline of the load shaft.

● Using a belt

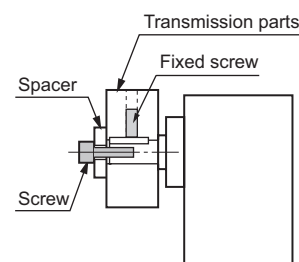
Adjust the motor (gearhead) output shaft to lie parallel with the load shaft and form right angles between the output shaft/load shaft and the line connecting the centers of both pulleys.

● Using a gear

Adjust the motor (gearhead) output shaft to lie parallel with the gear shaft and allow the output shaft to mesh correctly with the centers of the gear teeth.

● When using the output axis tip screw hole of a gearhead

Use a screw hole [M6, effective depth 12 mm (0.47 in.)] provided at the tip of the output shaft of GFS5G□ as an auxiliary means for preventing the transfer mechanism from disengaging.



The example of output axis tip screw hole use

■ Permissible overhung load and permissible thrust load

Make sure the overhung load and thrust load received by the gearhead output shaft will not exceed the allowable values shown in the table below.

Note

If the overhung load or thrust load exceeds the specified allowable value, repeated load applications may cause the bearing or output shaft of the gearhead to undergo a fatigue failure.

● Combination type parallel shaft gearhead

Unit model	Gear ratio	Distance from tip of gearhead output shaft and permissible overhung load [N (lb.)]		Permissible thrust load [N (lb.)]
		10 mm (0.39 in.)	20 mm (0.79 in.)	
BLU220	5	100 (22)	150 (33)	40 (9)
	10 to 20	150 (33)	200 (45)	
	30 to 200	200 (45)	300 (67)	
BLU440	5	200 (45)	250 (56)	100 (22)
	10 to 20	300 (67)	350 (78)	
	30 to 200	450 (101)	550 (123)	
BLU590	5	300 (67)	400 (90)	150 (33)
	10 to 20	400 (90)	500 (112)	
	30 to 200	500 (112)	650 (146)	

● Round shaft type

Unit model*1	Distance from tip of gearhead output shaft and permissible overhung load [N (lb.)]		Permissible thrust load [N (lb.)]
	10 mm (0.39 in.)	20 mm (0.79 in.)	
BLU220□-A	70 (15.7)	100 (22)	Not to exceed one-half the motor's dead weight*2
BLU440□-A	120 (27)	140 (31)	
BLU590□-A	160 (36)	170 (38)	

*1 □ in the model names indicates the power supply specification (A, C or S).

*2 Minimize the thrust load. If a thrust load must be applied, do not let it exceed one-half the motor's dead weight.

5.7 Installing a load on the combination type hollow shaft flat gearhead

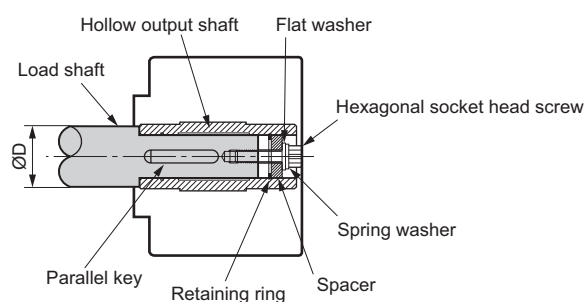
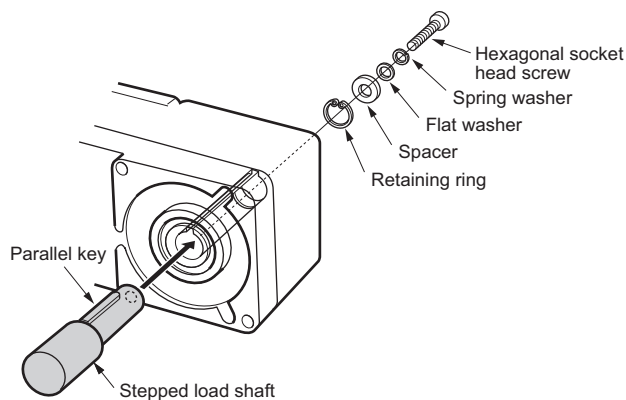
If the motor is subject to a strong impact upon instantaneous stop or receives a large overhung load, use a stepped load shaft.

Note

Apply grease (molybdenum disulfide grease, etc.) on the surface of the load shaft and inner walls of the hollow output shaft to prevent seizure.

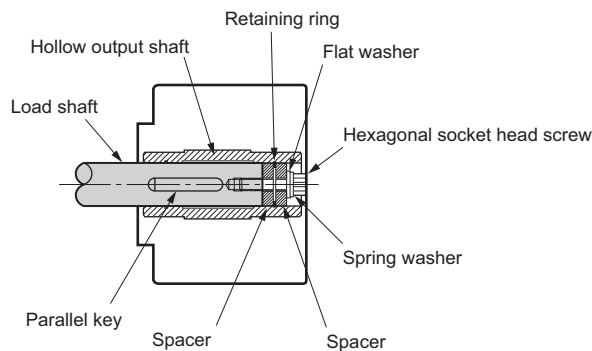
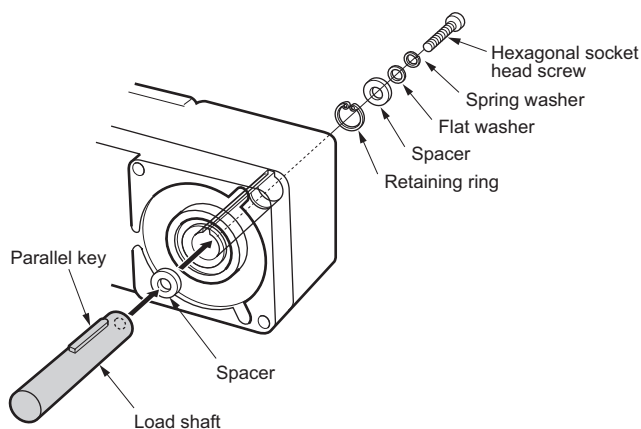
● Stepped load shaft

Install each hexagonal socket head screw over a retaining ring, spacer, flat washer and spring washer and securely affix the ring.



● Non-stepped load shaft

Install each hexagonal socket head screw over a retaining ring, spacer, flat washer and spring washer and securely affix the ring. Also insert a spacer on the load shaft side.



Recommended load shaft installation dimensions

[Unit: mm (in.)]

Unit model	Inner diameter of hollow shaft	Recommended tolerance of load shaft	Nominal diameter of retaining ring	Applicable screw	Spacer thickness	Outer diameter of stepped shaft (ØD)
BLU220	$\varnothing 12^{+0.027}_0$ ($\varnothing 0.4724^{+0.0011}_0$)	$\varnothing 12^{+0.018}_0$ ($\varnothing 0.4724^{+0.0007}_0$)	$\varnothing 12$ ($\varnothing 0.47$)	M4	3 (0.12)	20 (0.79)
BLU440	$\varnothing 15^{+0.027}_0$ ($\varnothing 0.5906^{+0.0011}_0$)	$\varnothing 15^{+0.018}_0$ ($\varnothing 0.5906^{+0.0007}_0$)	$\varnothing 15$ ($\varnothing 0.59$)	M5	4 (0.16)	25 (0.98)
BLU590	$\varnothing 20^{+0.033}_0$ ($\varnothing 0.7874^{+0.0013}_0$)	$\varnothing 20^{+0.021}_0$ ($\varnothing 0.7874^{+0.0008}_0$)	$\varnothing 20$ ($\varnothing 0.79$)	M6	5 (0.20)	30 (1.18)

■ Permissible overhung load and permissible thrust load

Make sure the overhung load and thrust load received by the gearhead output shaft will not exceed the allowable values shown in the table below.

Note

If the overhung load or thrust load exceeds the specified allowable value, repeated load applications may cause the bearing or output shaft of the gearhead to undergo fatigue failure.

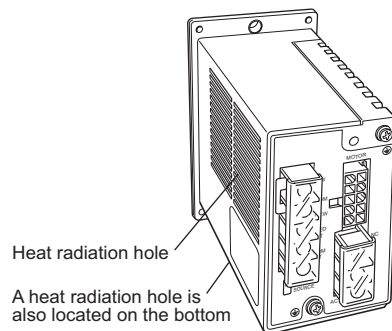
● Combination type hollow shaft flat gearhead

Unit model	Gear ratio	Distance from hollow shaft flat gearhead mounting surface and overhung load [N (lb.)]		Permissible thrust Load [N (lb.)]
		10 mm (0.39 in.)	20 mm (0.79 in.)	
BLU220	5, 10	450 (101)	370 (83)	200 (45)
	15 to 200	500 (112)	400 (90)	
BLU440	5, 10	800 (180)	660 (148)	400 (90)
	15 to 200	1200 (270)	1000 (220)	
BLU590	5, 10	900 (200)	770 (173)	500 (112)
	15, 20	1300 (290)	1110 (240)	
	30 to 200	1500 (330)	1280 (280)	

5.8 Installing the driver

■ Installation direction

The driver is designed based on the assumption of heat radiation due to air convection. When you want to install the driver inside the housing, install it to ensure that one of two heat radiation holes of the driver faces downward.



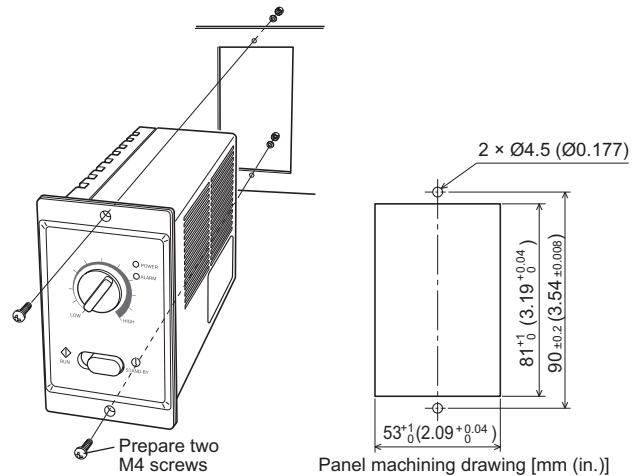
Note

- Install the driver 25 mm (1 in.) or more away from the housing and other equipment inside the housing in the horizontal direction, and 50 mm (2 in.) or more away in the vertical direction.
- Around the driver, do not install the equipment which generates a great deal of heat or noise.
- If the ambient temperature of the driver exceeds 40 °C (104 °F), review the ventilation conditions or forcibly cool driver with a fan.

■ Installation method

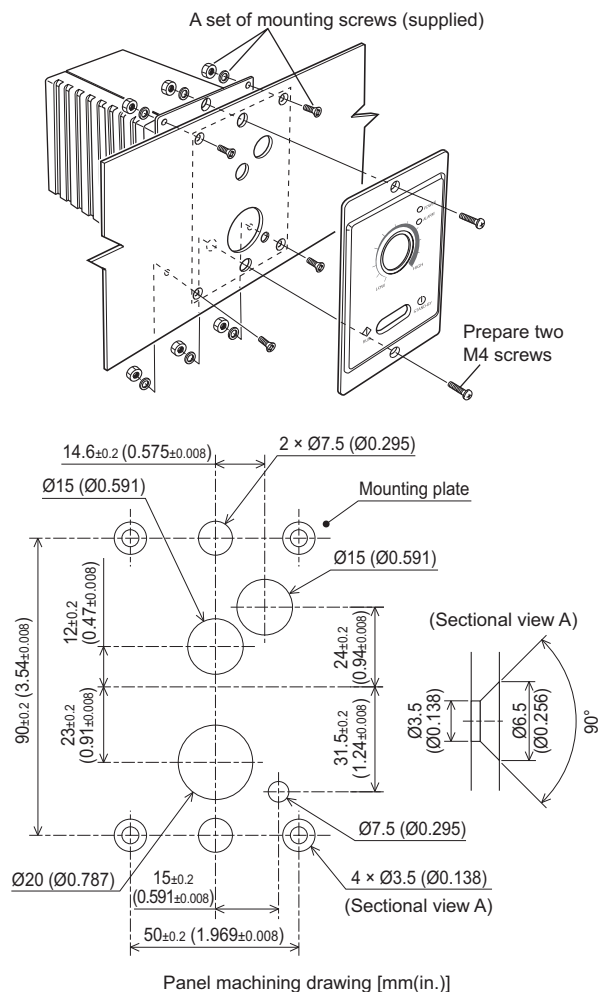
Install the driver on the metallic plate having an excellent resistance to vibration.

- When mounting the unit by drilling a rectangular hole
Use the driver mounting hole and mount the unit with two M4 screws and nuts.



- When using the included set of the mounting screws to mount the driver

Remove the front panel according to the steps shown in “How to remove front panel” (→ p.14), and mount the driver.
Use a plate 2 mm (0.08 in.) or less in thickness.



Note

Use a tightening torque of 0.7 N·m (6.1 lb-in) or less for the screws. Tightening them at a torque above 0.7 N·m (6.1 lb-in) could damage the driver.

5.9 Installing and wiring in compliance with EMC Directive (89/336/EEC, 92/31/EEC)

The **BLU** series is designed and manufactured for use as an internal component of equipment. The EMC Directives require that your mechanical equipment in which the **BLU** series is installed satisfy the applicable requirements.

The installation/wiring methods of the motor and driver explained here represent the basic methods that are effective in helping your mechanical equipment conform to the EMC Directives.

The final level of conformance of your mechanical equipment to the EMC Directives will vary depending on the control system equipment used with the motor/driver, configuration of electrical parts, wiring, layout, hazard level, and the like. Therefore, you must conduct the EMC tests on your mechanical equipment to confirm compliance.

■ Applicable standards

EMI

Emission Tests	EN 61000-6-4
Radiated Emission Test	EN 55011
Conducted Emission Test	EN 55011

EMS

Immunity Tests	EN 61000-6-2
Electrostatic Discharge Immunity Test	IEC 61000-4-2
Radiation Field Immunity Test	IEC 61000-4-3
Fast Transient/Burst Immunity Test	IEC 61000-4-4
Surge Immunity Test	IEC 61000-4-5
Conductive Noise Immunity Test	IEC 61000-4-6
Power Frequency Magnetic Field Immunity Test	IEC 61000-4-8
Voltage Dip Immunity Test	IEC 61000-4-11
Voltage Interruption Immunity Test	IEC 61000-4-11

Without effective measures to suppress the electromagnetic interference (EMI) caused by the **BLU** series in the surrounding control system equipment or the electromagnetic spectrum (EMS) generated by the **BLU** series, the function of your mechanical equipment may be seriously affected.

The **BLU** series will conform to the EMC Directives if installed/wired using the methods specified below.

■ Connecting a mains filter

Install a mains filter in the power line in order to prevent the noise generated within the driver from propagating outside via the AC input line.

For mains filters, use the products as shown in the chart, or an equivalent.

Manufacturer	Single-phase 100-115 V	Single-phase 200-230 V	Three-phase 200-230 V
DENSEI-LAMBDA K.K.	MC1210	MC1210	MC1310
OKAYA ELECTRIC INDUSTRIES CO., LTD.	SUP-EL10-ER-6	SUP-EL10-ER-6	3SUP-HQ10-ER-6
TDK Corporation	—	ZAG2210-11S	—
Schaffner EMC	—	FN2310X-10-06 FN2330Y-10-06 FN2070-10-06	FN251-8-07

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 (AWG22: 0.3 mm² or more) parallel with the mains-filter output cable (AWG22: 0.3 mm² or more). 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.

■ Grounding procedure

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

● Grounding the driver

Ground the protective earth terminal at the rear of the driver. Refer to the 6.2 "Connecting the power supply" (→p.11) for the way to ground the driver.

● Grounding the motor

Ground the motor by using the protective earth terminal of the motor cable.

Refer to the 6.1 "Connecting the motor" (→p.11) for the way to ground the driver.

■ Connecting the motor cable

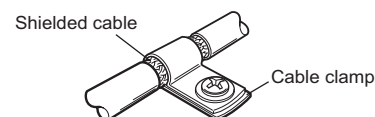
To expand connection between the motor and driver, use the optional extension cable.

Connection can be extended to a maximum of 10.5 m (34.4 ft.).

■ Wiring the signal cable

For the signal cable for the driver, use a shielded cable of AWG28 (0.08 mm²) or more in diameter, and keep it as short as possible.

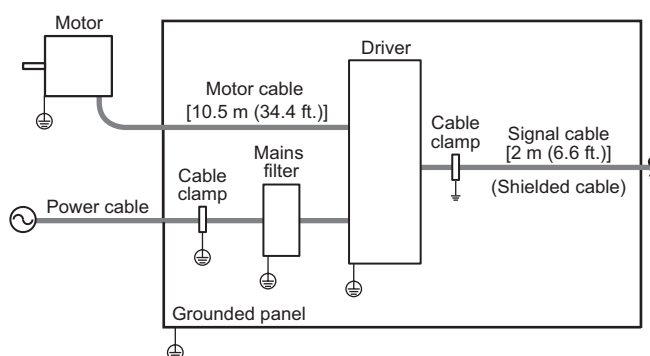
To ground a shielded cable, use a metal cable clamp or similar device that will maintain contact with the entire circumference of the shielded cable. Attach a cable clamp as close to the end of the cable as possible, and connect it to an appropriate grounding point as shown in the figure.



■ Notes about installation and wiring

- Connect the motor/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 (4 to 8 in.)] as possible from the signal cables. If they must cross, do so at a right angle. Place the AC input cable and output cable of a mains filter separately from each other.

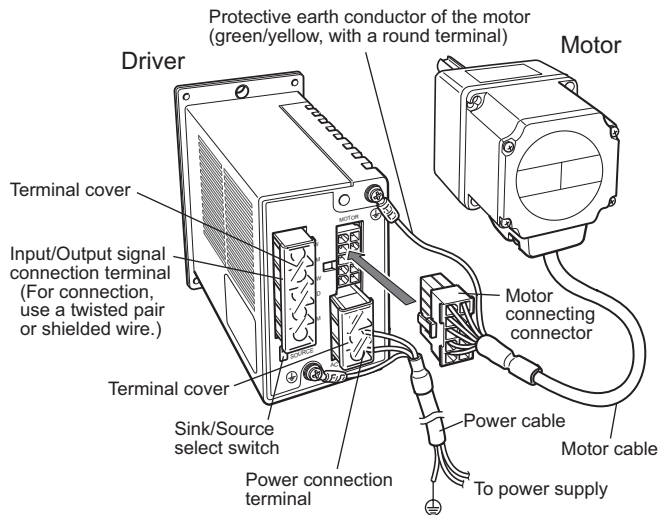
■ Example of motor and driver installation and wiring



■ Precautions about static electricity

Static electricity may cause the driver to malfunction or become damaged. Do not come close to or touch the driver while the power is on except when operating the speed setting potentiometer or switch of the front of driver.

6 Connection



Note

After shutting down the power, wait at least 30 seconds before turning it back on, unplugging, or plugging in the motor's cable connector.

6.1 Connecting the motor

Insert the motor cable connector into the motor connector (MOTOR) of the driver.

To expand connection between the motor and driver, use the optional extension cable. Connection can be extended to a maximum of 10.5 m (34.4 ft.).

Connect the protective earth conductor of the motor (green/yellow) to the driver as shown.

When an extension cable is used or direct contact between the hands and motor is anticipated, connect the protective earth conductor of the motor directly to the ground. If the protective earth conductor is not sufficiently long, use a lead wire with a diameter equivalent to AWG18 (0.75 mm²) or more to extend the protective earth conductor and then connect it to the ground over the shortest possible distance. An extension cable must be provided separately by the customer. Additionally, the dedicated extension cable (sold separately) is not provided with a protective earth conductor. Be sure to provide grounding at a relay point or extend the cable for grounding.

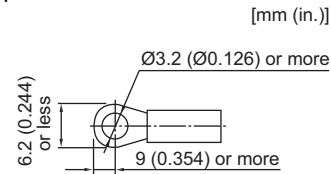
Note

Have the connector plugged in securely. Insecure connection may cause malfunction or damage to the motor or driver.

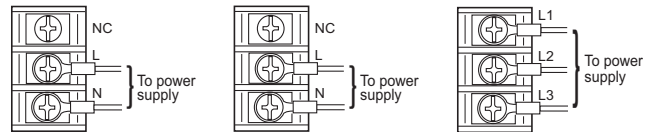
6.2 Connecting the power supply

Connect the power cable to the driver. Connect the red lead wire and black lead wire to the power connection terminal, and the green/yellow lead wire to the protective earth terminal. For the power cable, use the attached power cable or a cable with a diameter equivalent to AWG22 (0.3 mm²) or more. For the protective earth conductor, use a cable with a diameter equivalent to AWG18 (0.75 mm²) or more. For connection, use the insulated round crimp terminal.

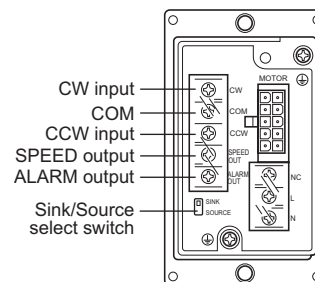
Applicable crimp terminal



- Single-phase 100-115 V
Single-phase
100-115 V ±10% 50/60 Hz
- Single-phase 200-230 V
Single-phase
200-230 V ±10% 50/60 Hz
- Three-phase 200-230 V
Single-phase
200-230 V ±10% 50/60 Hz



6.3 Input/Output signals



■ Signal input circuit

The signal input circuit is initially set to sink logic. Switch the circuit mode between sink logic and source logic according to the external control equipment used.

Input signals of the driver are provided as photocoupler inputs. The signal state indicates the "ON: current supplied" or "OFF: current not supplied" status of the internal photocoupler rather than the voltage level of the signal.

■ Signal output circuit

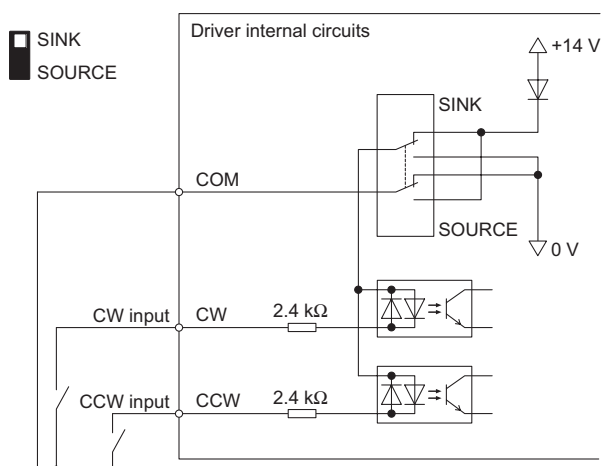
The signal input circuit is initially set to sink logic. Switch the circuit mode between sink logic and source logic according to the external control equipment used.

Output signals of the driver are provided as transistor open-collector outputs. The signal state indicates the "ON: current supplied" or "OFF: current not supplied" status of the internal photocoupler rather than the voltage level of the signal.

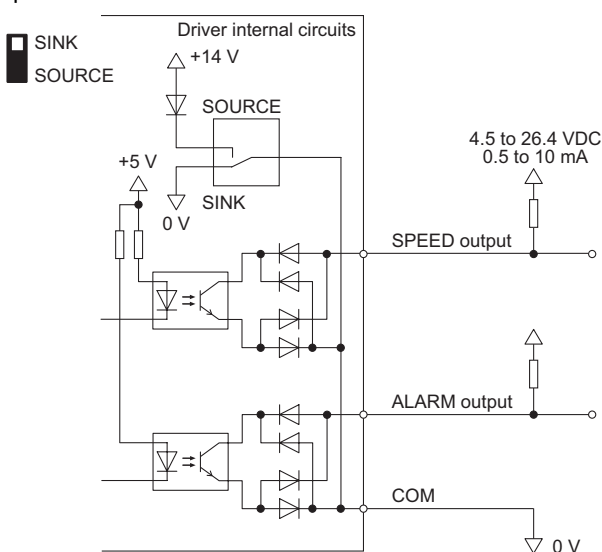
The ON voltage of the output circuit is approx. 1.5 V. Exercise caution when driving other elements using the output circuit.

● Sink logic

Input circuit

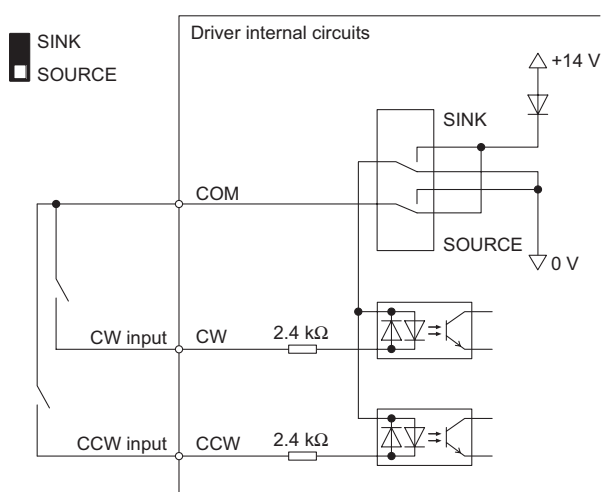


Output circuit

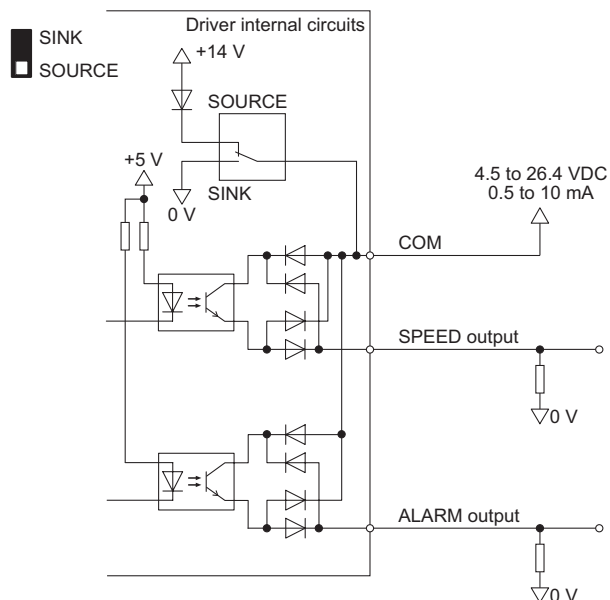


● Source logic

Input circuit



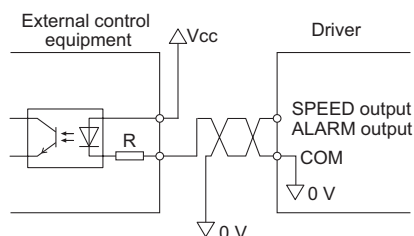
Output circuit



Note

- When you want to extend the input/output signal cable, the length must not exceed 2 m (6.6 ft.). The cable should be as short as possible in order to minimize noise.
- The input/output signal cable should be connected to run perpendicular to the power cable and motor cable, not in parallel with the power cable and motor cable.
- Signal output is an open collector output. Use a power supply of 26.4 VDC or less to connect the limit resistance (R) to limit output current to 0.5 to 10 mA.

Connection example of signal output (sink logic)



■ SPEED output

Concurrently with motor drive, the system outputs pulse signals (with a width of about 0.5 ms) at 30 pulses per rotation of the motor output shaft.

You can measure the SPEED output frequency and calculate motor speed.

$$\text{Motor speed (r/min)} = \frac{\text{SPEED output frequency (Hz)}}{30} \times 60$$

$$\frac{1}{T} = \text{SPEED output frequency}$$

If you want to indicate or monitor the motor output shaft speed and determine the speed of the gear head output shaft, use an optional digital speed indicator **SDM496**.

Note

- The digital speed indicator **SDM496** is not certified by the recognized safety standards. When the digital speed indicator is used with the **BLU** series, which is certified by the recognized safety standards and/or the conformed safety standards, the **BLU** series itself is not in conformance with the safety standards.
- The **SDM496** cannot be used with source logic circuits.

■ ALARM output

In the following cases, the protection function of the driver is enabled to turn off the ALARM output and to stop the motor. In this case, the LED flashes or lights up to allow the protection function to be checked.

* It is normal that the LED lamp will turn on at the moment of the connection with power supply.

● LED lamp flashes when the following protection function

Overload protection function

The LED lamp flashes when a load in excess of the rated torque is applied to the motor for about 5 seconds or more, or when the motor is instantly stopped or when the direction of rotation is switched repeatedly in a short period of time.

● LED lamp ON when the following protection function

Motor sensor error

Prevents motor malfunction when the sensor cable within the motor cable is disconnected during motor operation. (An alarm signal will not be output while the motor is at a standstill.)

Overvoltage protection function

When the motor is used in an elevating/lowering application or with a load in excess of the permissible load inertia, or when voltage applied to the driver has exceeded the voltage setting (115 VAC or 230 VAC) by 20% or greater.

Insufficient voltage protection function

When voltage applied to the driver is less than the voltage setting (100 VAC or 200 VAC) by 30% or greater.

Overspeed protection function

When motor speed has reached an excess of 2500 r/min.

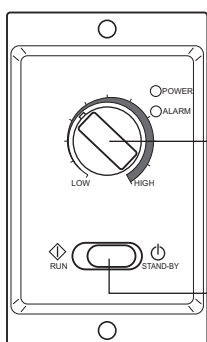
When an electrical connection is made as shown in the example, the ALARM output is turned on if the driver is normal but is turned off in the event of alarm.

When the ALARM output is turned off, turn off the power to the driver once the motor stops.

If the motor cable is free of any trouble, check the operating conditions (load torque, running pattern and power supply voltage). After removing the cause for activating the protection function, turn on power again and reset the alarm.

Once power has been turned off, wait at least 30 seconds before turning it on again.

7 Operation

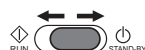


Speed setting potentiometer
Turning the potentiometer in the clockwise direction causes the speed to be increased. The speed can be set in the range from 100 to 2000 r/min. It is set to 0 r/min at the time of shipment.

RUN/STAND-BY switch

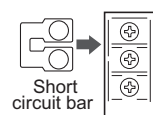
■ Running by the RUN/STAND-BY switch of the driver (Use the short circuit bar.)

When the RUN/STAND-BY switch is set to the RUN position, and the motor is driven. When it is set to the STAND-BY position, the motor will stop. Operation is not performed in the STAND-BY mode.

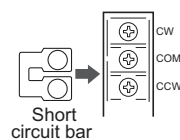


Drive direction depends on how the short circuit bar is connected.

Clockwise direction



Counterclockwise direction



Connect the attached short circuit piece between the CW and COM or CCW and COM.

Do not use the short circuit bar for other purposes.

Note

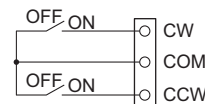
The RUN/STAND-BY switch is not a power ON/OFF switch. When you want to stop the motor for a long time, turn off the driver power.

■ Running by external signals

Set the RUN/STAND-BY switch to the RUN position.



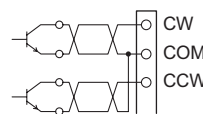
● Small-capacity switch and relay



Use a small-capacity contact type relay capable of opening and closing 14 VDC, 10 mA.

● Transistor output type external control equipment

Sink logic



Source logic

If the source logic is used, the CW input and CCW input cannot connect to external control equipment of transistor output type.

Note

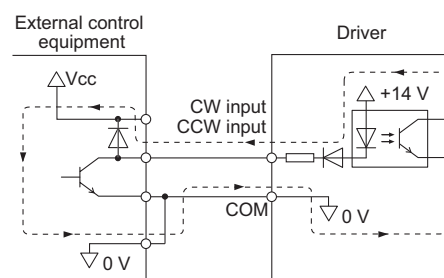
When you want to use the external control equipment with a built-in clamp diode, pay attention to the sequence of turning on or off the power.

Power ON: External control equipment ON → Driver ON

Power OFF: Driver OFF → External control equipment OFF

If the driver power is turned on first when connected as shown, or the external control equipment power is turned off with the driver power turned on, current will be applied, as indicated by arrow mark of the diagram, and this may cause the motor to be driven. When the power is turned on or off simultaneously, the motor may be driven temporarily due to differences in power capacity. The external control equipment power must be turned on first, and driver power must be turned off first.

Connection example



7.1 Rotating direction of the motor output shaft

The rotating direction of the motor output shaft is defined as clockwise (CW) or counterclockwise (CCW) as viewed from the motor output shaft.



■ Rotating direction of the gearhead output shaft

The rotating direction of the gearhead output shaft may be opposite that of the motor shaft, depending on the gear ratio. For the rotating direction of the output shaft of a specific gearhead used, refer to the operating manual for the gearhead.

● Combination type parallel gearhead

Gear ratio: 5, 10, 15, 20 or 200

.....Same as the rotating direction of motor output shaft

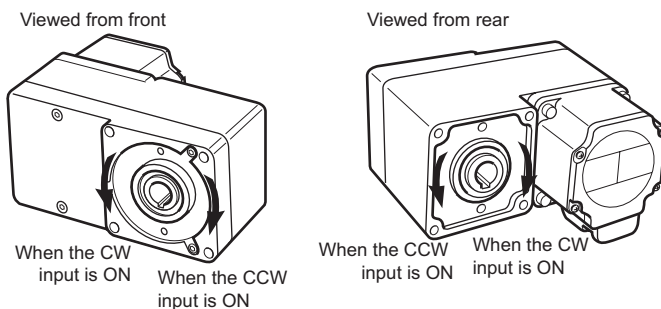
Gear ratio: 30, 50 or 100

.....Opposite the rotating direction of motor output shaft

● Combination type hollow shaft flat gearhead

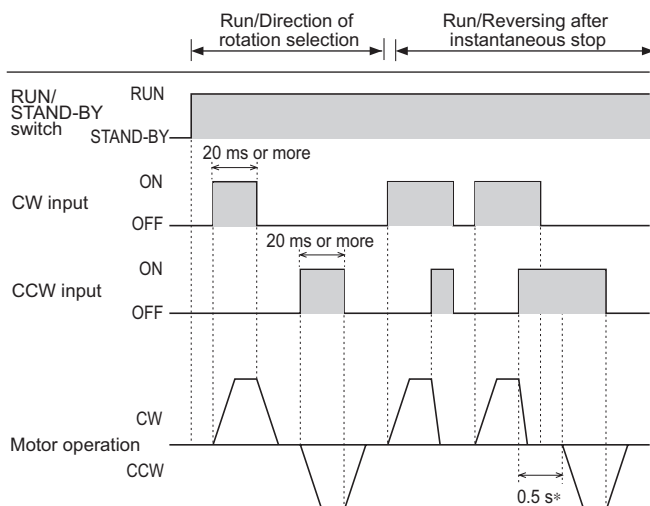
The rotating direction is opposite to the motor direction, when viewed from the front side, at all gear ratios.

With a combination type hollow shaft flat gearhead, the rotating direction will vary depending on whether the motor unit is viewed from the front or rear of the gearhead.



■ Timing chart

● Running by external signal



When both the CW and CCW inputs are turned on, the motor is stopped instantaneously.

* Motor does not run for 0.5 s after instantaneous stop, if a reversing run signal is input.

Note

- The CW and CCW input signals must be ON for at least 20 ms.
- Once the motor stops, the output shaft will become free.

7.2 Setting the acceleration time and deceleration time

The motor starts over the specified acceleration time and stops over the specified deceleration time.

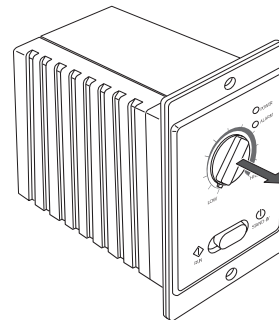
These acceleration time and deceleration time can be set in the range of 0.5 to 10 seconds (in a no-load state at 2000 r/min). The actual acceleration and deceleration times may vary depending on the conditions of use, load inertia, load torque and other conditions of your specific application.

■ How to remove front panel

In order to set the acceleration time and deceleration time, remove the front panel.

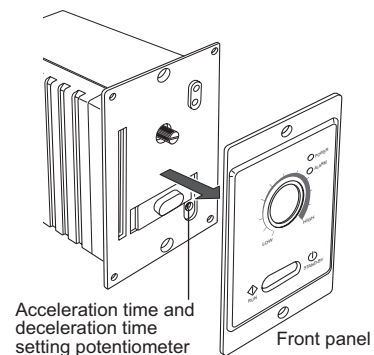
1. Remove the control knob of the speed setting potentiometer.

Put a flat tip screwdriver or the like between the front panel and the control knob. Then, pull the control knob toward you, and it will be removed. (Keep the knob completely at the LOW position.)



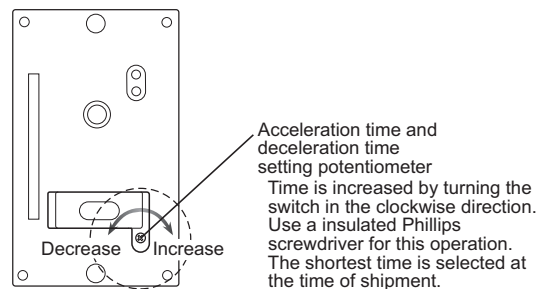
2. Remove front panel

Hold only the front panel, and pull it toward you. Then the front panel can be removed. In this case, the RUN/STAND-BY switch is also removed together. Care should be taken not to lose it. Reverse the above steps if you want to install the front panel.



■ Setting the acceleration time and deceleration time

The figure shows a view with the front panel removed.



8 Troubleshooting and remedial actions

An erroneous speed setting or connection may prevent the motor/driver from operating properly. If proper motor operation cannot be achieved, take an appropriate action by referring to this chapter. If the information provided here does not help, please call our Tech Support Line.

Problem	Likely cause	Corrective action
The motor fails to rotate.	The RUN/STAND-BY switch is set to the STANDBY position.	Set the RUN/STAND-BY switch to the RUN position. Turn on either CW or CCW input.
	Both CW and CCW inputs are turned on.	Turn off either CW or CCW input.
	The speed setting potentiometer is not adjusted.	Turn the speed setting potentiometer slightly in the clockwise direction.
	The protection function has been activated. (ALARM LED lamp flashes or lights up.)	Check for the cause of the protection function activation and take the appropriate measures.
The motor turns in the direction opposite to the specified one.	The CW input and CCW input are incorrect or electrical connection is wrong.	Supply correct input signals. When CW input is ON, the motor shaft rotates in the CW direction. When CCW input is ON, it rotates in the CCW direction.
	The combination type parallel shaft gearhead is using a gear with a gear ratio of 30, 50 or 100.	If the gear ratio is 30, 50 or 100, the gearhead output shaft will turn in the opposite direction to the motor output shaft. Reverse the CW and CCW input operations.
	A combination type hollow shaft flat gearhead is used.	With a combination type hollow shaft flat gearhead, the rotating direction is different depending on whether the gearhead is viewed from the front or rear (→ p.14).
Unstable motor operation	The center of the motor (gearhead) output shaft is not aligned with the center of the load shaft.	Check the coupling condition of the motor (gearhead) output shaft and load shaft.
Large vibration or speed fluctuation	Effect of noise.	Implement noise elimination measures by referring to chapter 3 "Precautions for use" (→ p.3). Provide ample clearances between the cables.
The motor doesn't stop instantaneously.	The load exceeds the allowable inertia.	Check the allowable inertia of the motor and change the load inertia.
	The deceleration time is too long.	Check the setting of the acceleration time and deceleration time setting potentiometer.
The motor speed doesn't rise quickly at start.	The load exceeds the allowable inertia.	Check the allowable inertia of the motor and change the load inertia.

9 Appendix

9.1 Optional parts and accessories

The optional parts and accessories for the **BLU** series are explained. All options are sold separately.

■ Extension cable

Use this dedicated extension cable to extend the wiring distance between the motor and driver.

Length [m (ft.)]	Model
1 (3.3)	CC01AXU
2 (6.6)	CC02AXU
3 (9.8)	CC03AXU
5 (16.4)	CC05AXU
10 (32.8)	CC10AXU

■ Digital speed indicator (**SDM496**)

Used to display/monitor the speed of the motor output shaft and the decelerated speed of the gearhead output shaft.

Note

- The digital speed indicator **SDM496** is not certified by the recognized safety standards. When the digital speed indicator is used with the **BLU** series, which is certified by the recognized safety standards and/or the conformed safety standards, the **BLU** series itself is not in conformance with the safety standards.
- The **SDM496** cannot be used with source logic circuits.

9.2 Recommended peripherals

■ Circuit breaker or earth leakage breaker

Be sure to connect a circuit breaker or earth leakage breaker to the power line of the driver to protect the primary circuit.

Rated current of protective device	5 A		
Circuit breaker	Mitsubishi Electric Corporation NF30		
Earth leakage breaker	To prevent malfunction, use an earth leakage breaker with a current sensitivity of 200 mA or more and operating time of 0.1 second or more, or use one incorporating high-frequency noise elimination measures. Mitsubishi Electric Corporation NV series Fuji Electric FA Components & Systems Co., Ltd. EG series, SG series		

■ Mains filter for power line

Manufacturer	Single-phase 100-115 V	Single-phase 200-230 V	Three-phase 200-230 V
DENSEI-LAMBDA K.K.	MC1210	MC1210	MC1310
OKAYA ELECTRIC INDUSTRIES CO., LTD.	SUP-EL10-ER-6	SUP-EL10-ER-6	3SUP-HQ10-ER-6
TDK Corporation	—	ZAG2210-11S	—
Schaffner EMC	—	FN2310X-10-06 FN2330Y-10-06 FN2070-10-06	FN251-8-07

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