MITSUBISHI ELECTRIC

MAGNETIC MOTOR DRIVE UNIT

MELIPM SERIES

INSTRUCTION MANUAL

High Performance & Compact

MD-CX520-0.5K to 3.5K

Please read here first

Thank you for choosing the Mitsubishi Magnetic Motor Drive Unit. This instruction manual gives handling information and precautions for use of the drive unit. Incorrect handling of the equipment may cause an unexpected fault. To optimize the unit capability, please read this manual carefully before using the equipment.

General precautions

- Please forward this instruction manual to the end user.
- Many of the diagrams and drawings in this instruction manual show the drive unit without a cover, or partially open for explanation. Never operate the drive unit in this manner. The cover must be installed and the instruction in this manual must be followed when operating the drive unit.
- After reading this manual, the manual must be stored in a place where it is easily accessible for the operator.
- This instruction manual is subject to modifications for specification changes and manual improvements. After such modifications have been made, the instruction manual will be published as a revised version with a new number located on the bottom left of the back cover.

For safe operation of this product

- This product has not been designed or manufactured for use in or with a device or system which will be used under circumstances where life may be endangered.
- Consult with Mitsubishi if you are planning to use this product for special purposes, e.g. equipment or systems designed for manned transport vehicles, medical purposes, aerospace, nuclear power, electric power or undersea junctions.
- This product has been manufactured under strict quality control. However, when installing the product where serious accidents or losses could occur if the product fails, install appropriate safety devices in the system.
- This product must be used with the instructed motor.
- A single drive unit must be used with a single motor.

Safety Instructions

This section is specifically about safety matters

Do not attempt to install, operate, maintain or inspect the drive unit until you have read through this instruction manual and appended documents carefully and can use the equipment correctly. Do not use the drive unit until you have a full knowledge of the equipment, safety information and instructions.
In this instruction manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

⚠**WARNING**	Incorrect handling may cause hazardous conditions, resulting in death or severe injury.

⚠**CAUTION**	Incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause only material damage.

The CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personal safety.

NOTICE denotes the items which do not correspond to "WARNING" or "CAUTION" but should be observed by the customer.
MEMO denotes the items which the user should know for operation.

1. Usage

⚠WARNING
● The MELIPM series motor is a synchronous motor with high-performance magnets built in its rotor. Therefore, after the drive unit is powered off, there are high voltages at the motor terminals while the motor is running. Before wiring or inspection, the motor must be confirmed to be stopped. In any application where the motor is rotated by a load such as a fan or blower, connect a low-voltage manual switch on the drive unit's output side, open the switch, and start wiring or maintenance and inspection. Not doing so can cause an electric shock. ● Never disassemble or modify the unit. Doing so can cause an electric shock, fire or injury. ● Do not use the unit with any load other than the specified motor. Doing so can cause a fire or injury. ● Safety devices must be provided for the whole system, e.g. emergency brakes, to ensure that the machine or device is not placed in hazardous conditions if the drive unit fails.

⚠CAUTION
● If a holding brake is required, it must be prepared separately. Stop status cannot be held by the inverter's brake function. This may result in injury. ● Before operating the drive unit which had been stored for an extended period of time, inspection and test operations must be performed on the unit before using. Not doing so can cause accidents.

2. Transportation

⚠CAUTION
● Do not stack the drive unit boxes higher than the number indicated on the package. Injury may result. ● The weight must be confirmed before carrying the drive unit. Not doing so can cause injury. ● When carrying the drive unit, do not exert a force partially, i.e. do not hold the front cover or operation panel. Doing so can cause the unit to drop, leading to injury. ● The drive unit is precision piece of equipment. Do not drop the unit, or subject it to impact. Doing so can damage the drive unit.

3. Installation

⚠CAUTION
● Do not install or operate the drive unit if it is damaged or has parts missing. Such installation or operation can cause accidents. ● The drive unit must be always installed in the specified orientation and environment. Otherwise, they can cause a fire or accidents. ● The drive unit must be installed on an inflammable material such as metal. Not doing so can cause a fire. ● Do not place combustible materials nearby. Doing so can cause a fire. ● The drive unit must be installed to the position where it can withstand the weight of the drive unit. Failure to do so can cause accidents. ● Foreign conductive objects must be prevented from entering the drive unit. That includes screws and metal fragments or other flammable substance such as oil. They can cause a fire or accidents.

4. Wiring

⚠WARNING
● Any person who is involved in the wiring of this equipment should be fully competent to do the work. Otherwise electric shock or fire may occur. ● A moulded case circuit breaker or earth leakage circuit breaker must be installed. Otherwise, a drive unit failure can cause large currents to flow, resulting in a fire. ● The unit must be installed before wiring. Not doing so can cause an electric shock or fire. ● Before restarting wiring after power-on, the motor must be confirmed to be stopped, and 10 minutes or longer time must be elapsed after switching power off. Wiring must be performed after confirming that the DC voltage across the DC terminals P/+ and N/- is low enough to do the work. Immediately after power-off, the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). It may cause an electric shock. ● Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. The work must be started after confirming that the motor has stopped. Not doing so can cause an electric shock. ● This drive unit must be earthed (grounded). Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 536 class 1 and other applicable standards). Not doing so can cause an electric shock or fire.

⚠CAUTION
● The input power supply voltage must match the rated voltage specifications. Mismatch can cause a fire or accidents. ● The terminal layout and terminal symbols must be checked to ensure that connections are correct. Wrong connections can cause a fire or accidents. ● Do not connect a power supply to the motor connection terminals U, V, W. Doing so can cause a fire or accidents. ● The motor connection terminals U, V, W must match the motor phase sequence. Wrong connections can cause accidents due to reverse rotation of the motor. ● Do not connect a resistor across the DC terminals P/+-N/-. Doing so can cause a fire or accidents. ● Take measures to prevent peripheral sensors and equipment from malfunctioning due to electromagnetic noises. Not doing so can cause accidents. ● Measures must be taken to prevent peripheral power capacitors and generators from overheating or being damaged due to power harmonics. Not doing so can cause a fire. ● The power factor correction capacitor, surge suppressor, and radio noise filter (FR-BIF option) must be connected on the power supply side. Connection on the output side can cause a fire.

5. Operation

⚠WARNING
● The front cover must be reinstalled before switching input power on. While power is on, do not remove the front cover. Doing so can cause an electric shock. ● Do not touch the switches with wet hands. Doing so can cause an electric shock. ● A separate switch that makes an emergency stop must be provided. The "STOP/RESET" key of the operation panel or parameter unit is valid for stopping only when the function setting has been made. Not providing a separate emergency switch may cause accidents. ● When the stall prevention function is activated, operation will be performed independently of the preset acceleration/deceleration time and preset speed. The machine must be designed to ensure safety if the stall prevention function is activated. Not doing so can cause accidents. ● At the occurrence of an alarm, the run signal must be turned off before resetting the alarm. The drive unit will restart abruptly if you reset the alarm with the run signal on. This may result in injury. ● At occurrence of an alarm, the run signal must be turned off. If you do not turn off the run signal, the alarm may be reset due to power OFF-ON at the occurrence of an instantaneous power failure or like, restarting the drive unit suddenly. This may result in injury.

⚠CAUTION
● You can set the motor speed easily between low speed and high speed. The speed command must be set so that the machine speed will not exceed the permissible range of the machine design. Failure to do so can cause accidents. ● If the motor is rotated by the load, the motor must be ensured not to exceed its maximum speed. Otherwise the drive unit may break. ● While power is on or some time after power-off, do not touch the heatsink and brake resistor as they are hot. You may get burned. ● The electronic overcurrent protection function for motor overheat protection is initialized when the drive unit is reset. Frequent resetting of the drive unit will disable motor overheat protection. The motor may be burned if it is operated under overload.

6. Maintenance, Inspection and Part (Cooling Fan) Replacement

⚠WARNING
● Any person who is involved in maintenance, inspection or part replacement should be fully competent to do the work. Otherwise, an electric shock or injury can occur. ● The motor must be confirmed to be stopped and 10 minutes or longer time must be elapsed after switching power off. Replacement must be performed after confirming that the DC voltage across the DC terminals P/+ and N/- is low enough to do the work. Immediately after power-off, the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). Not doing so can cause an electric shock. ● Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. Always start replacement after confirming that the motor has stopped. Not doing so can cause an electric shock. ● Do not conduct a pressure test. A pressure test can damage the drive unit. ● Do not perform an insulation resistance test on the control circuit using a megger. A pressure test can damage the drive unit. ● While power is on, do not replace the cooling fan. Replacing the cooling fan during power-on can be hazardous.

7. Disposal

⚠CAUTION
● Dispose of the drive unit as general industrial waste. Its solder (lead) can cause environmental contamination.

——— CONTENTS ———

1. PRE-OPERATION INFORMATION

This section provides basic information required to use a drive unit.

Contents of This Section

<Abbreviations>
- PU
  Operation panel and parameter unit (FR-PU04)
- Drive unit
  Mitsubishi magnet motor drive
- Pr.
  Parameter number
- PU operation
  Operation using PU
- External operation
  Operation using the control circuit signals
- Combined operation
  Combined operation using PU and External operations

1.1 Checking the Product

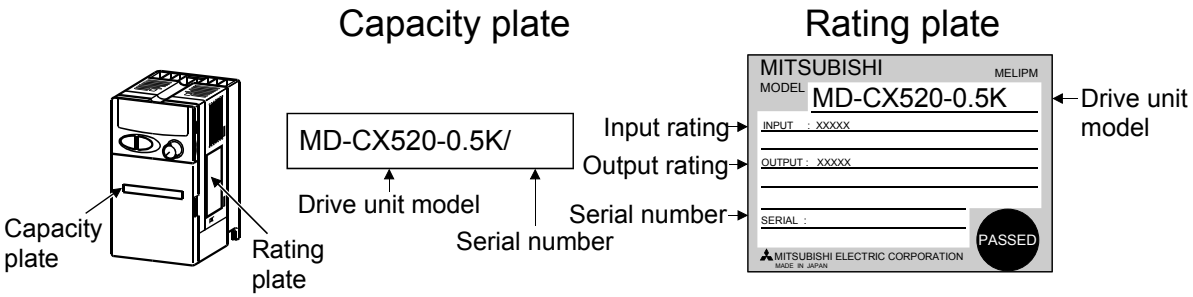
Unpack the drive unit, inspect the contents, and check the rating plate to ensure that the product agrees with your order.

1.1.1 Contents

Contents	Quantity
Drive unit	1
Instruction manual	1

1.1.2 Model

● Locations of the capacity plate and rating plate and definitions of their descriptions



● Model

M D - C X 5 2 0 - □ □ K

Series | Capacity

Power supply: 3-phase 200V

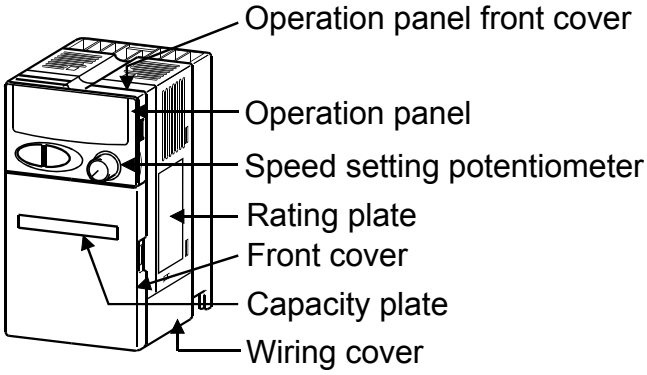
1.1.3 Drive units to be used with motors

Use a drive unit and motor in the following combinations.
(Combine same capacities.)

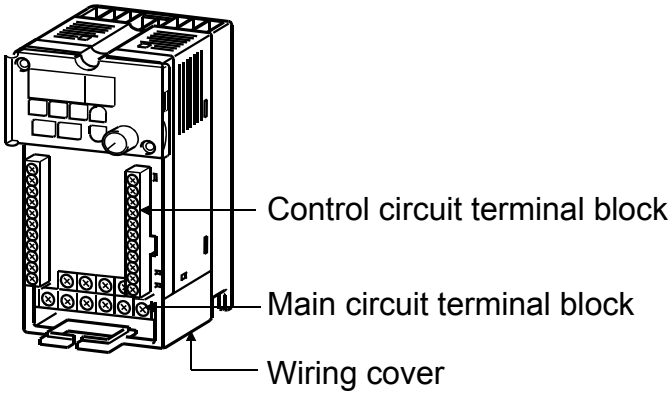
Drive unit	Motor
MD-CX520-0.5K	MM-CF52
MD-CX520-1.0K	MM-CF102
MD-CX520-1.5K	MM-CF152
MD-CX520-2.0K	MM-CF202
MD-CX520-3.5K	MM-CF352

1.2 Parts Identification

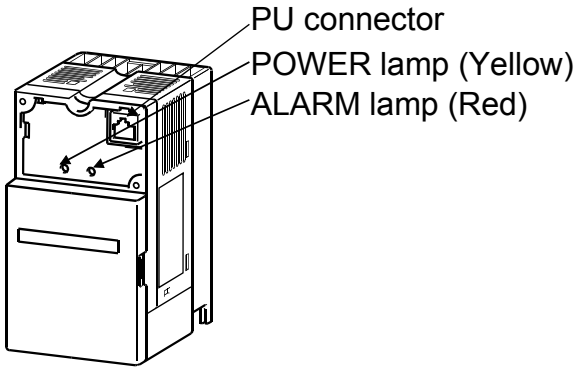
● Appearance of drive unit



● Without the front cover and the operation panel front cover



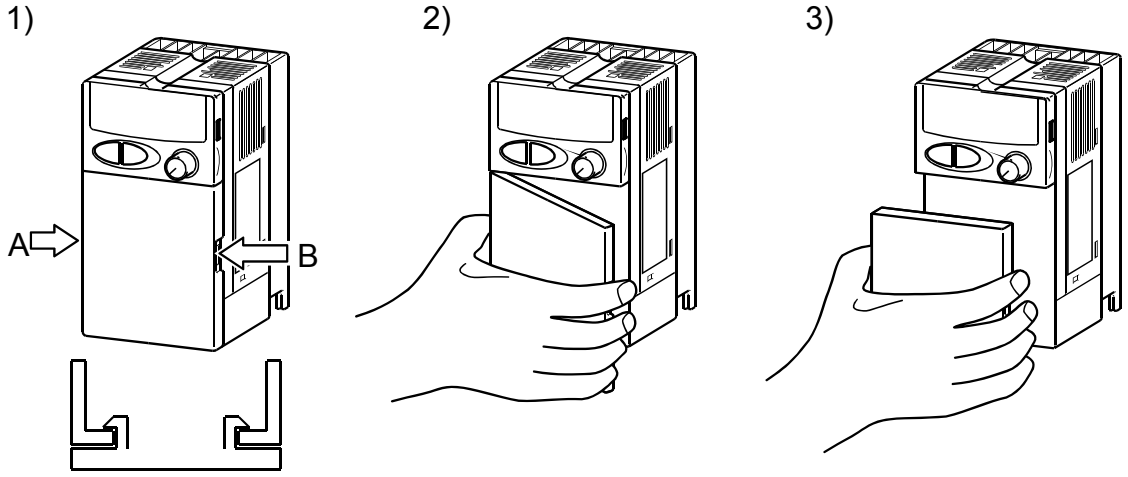
● Without the operation panel



1.3 Handling of Covers and Operation Panel

1.3.1 Removal and reinstallation of the front cover

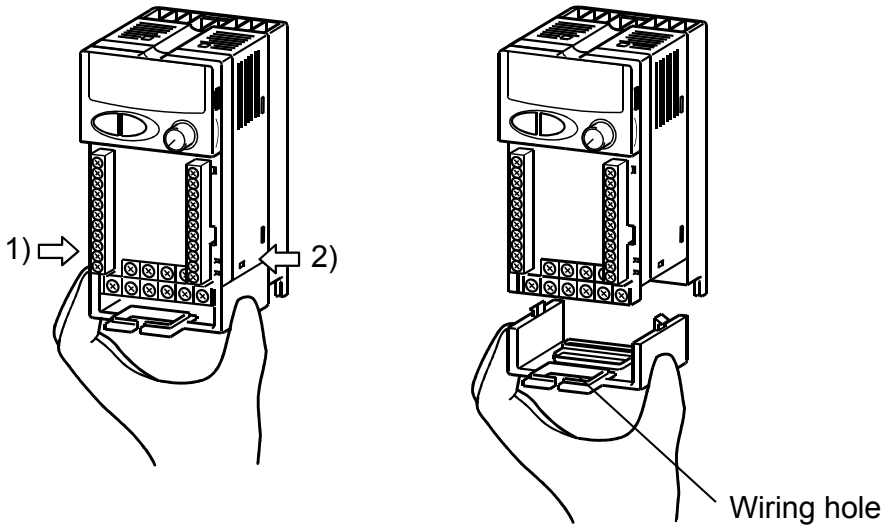
The front cover is fastened by the latches in positions A and B.
Push either A or B in the direction of arrow, and using the other end as a support, pull the front cover toward you to remove.



To reinstall the front cover, fasten it with the latches securely.

1.3.2 Removal and reinstallation of the wiring cover

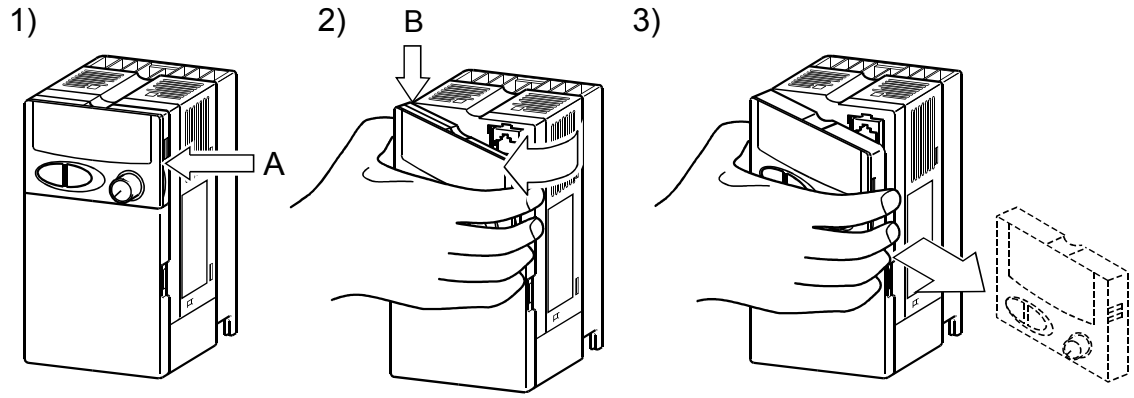
The wiring cover is fastened by the latches in positions 1 and 2.
Push either 1 or 2 in the direction of arrow, and pull the wiring cover downward to remove.



Run the cables through the wiring hole and reinstall the cover securely in the original position.

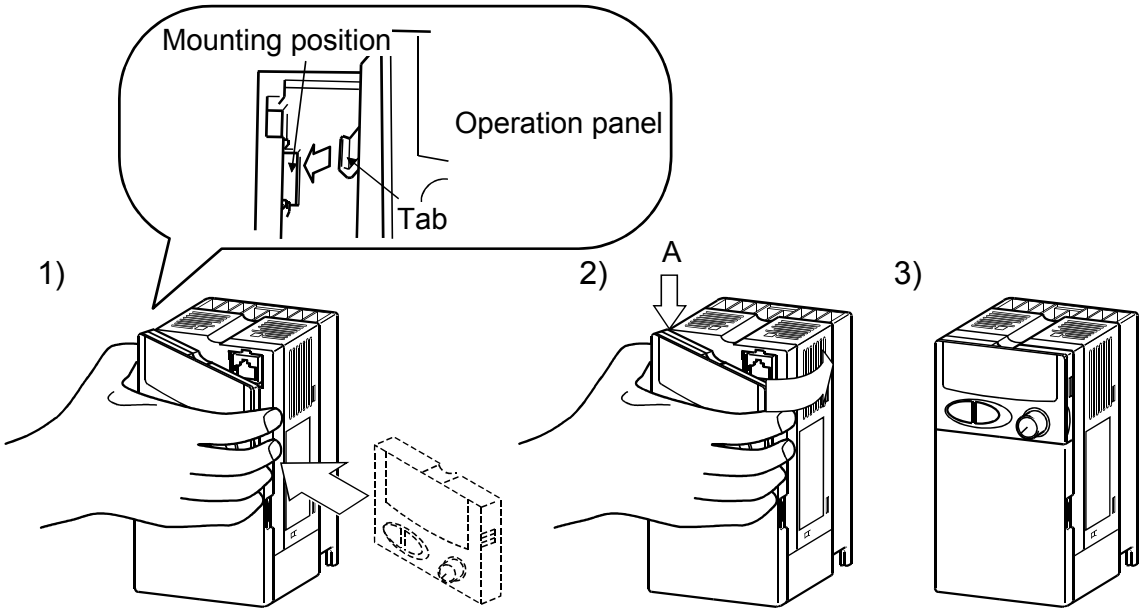
1.3.3 Removal and reinstallation of the operation panel

Hold down the arrow part A, and using the arrow part B as a support, pull the right hand side of the operation panel toward you and remove the panel rightward.



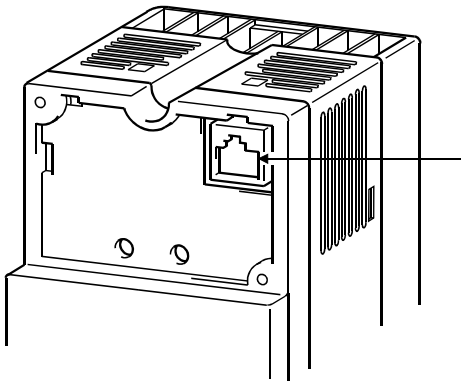
If the operation panel is removed in any other method, force will be applied to the internal connector, damaging the panel.

To reinstall, insert the tab (left side) of the operation panel into the mounting position of the drive unit and push in the right hand side tab.



● To use a connection cable

1) Remove the operation panel.
2) Mount the back cover of the option (FR-E5P) to the back of the operation panel.
3) Connect one side of the connection cable to the PU connector on the drive unit, and the other side to the connection adaptor of the option FR-E5P. Make sure that the operation panel is securely installed.

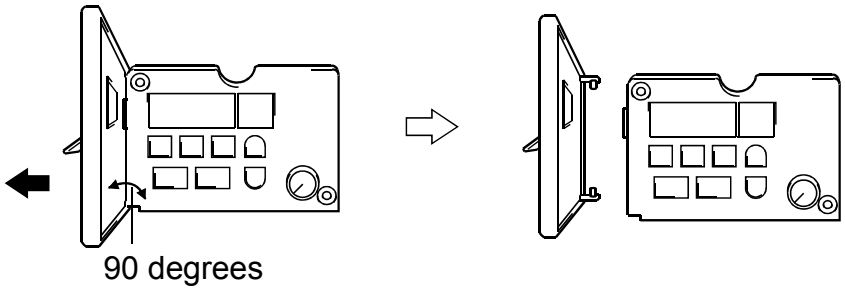


● To mount the operation panel on the enclosure

Open the front cover of the operation panel and find the mounting screw guides on the top left and the bottom right corners. These guides are used to securely mount an operation panel to the enclosure. Remove the operation panel, then mount the back cover of the option (FR-E5P) to the operation panel. Make holes on the mounting guides, and securely mount the operation panel to the enclosure with screws.

● Removal of the operation panel front cover

1) Open the operation panel front cover at 90 degrees.
2) Move the cover to the left to remove the operation panel front cover.



1.4 Transportation

When carrying, always support the whole drive unit.

1.5 Storage

Store the drive unit in the following environment.

Atmosphere	No corrosive gas, flammable gas, oil mist, dust and dirt. No exposure to direct sunlight. No salt.
Surrounding air temperature	-10°C to +50°C (non-freezing)
Storage temperature	-20°C to +65°C (applies to short-time transit)
Ambient humidity	90%RH or less (non-condensing)
Vibration	5.9m/s^2 or less at 10 to 55Hz (directions of X, Y, Z axes)

NOTICE	● Even if the specification value of humidity is satisfied, condensation and/or freezing will occur in places where temperatures vary greatly. Avoid storing the equipment in such places. ● Avoid placing the unit directly on the floor. Place it on a stand or shelf.

MEMO

2. INSTALLATION

This section gives preparatory information on installation and wiring of the drive unit.

NOTICE	● The Japanese harmonic suppression guidelines for suppression of harmonics were established by the Ministry of Economy, Trade and Industry (formerly Ministry of International Trade and Industry) in September 1994. To comply with the regulation levels determined by the Japan Electrical Manufacturers' Association in accordance with the "harmonic suppression guideline for household appliances and general-purpose products", connect the optional power factor improving reactor (FR-BEL or FR-BAL).

Contents of This Section

2.1 Checking the Installation Environment

2.1.1 Operating environment

● General operating environment
Install the unit in the following environment.

Atmosphere	Indoors (No corrosive gas, flammable gas, oil mist, dust and dirt. No exposure to direct sunlight. No salt.)
Surrounding air temperature	-10°C to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Altitude	Maximum 1000m above sea level
Vibration	5.9m/s^2 or less at 10 to 55Hz (directions of X, Y, Z axes)

⚠CAUTION
● Install the equipment on a non-flammable material. Failure to do so can cause a fire. ● Do not place flammable materials nearby. Doing so can cause a fire. ● Install the unit in a load-bearing place. Failure to do so can cause accidents.

● Noise environment

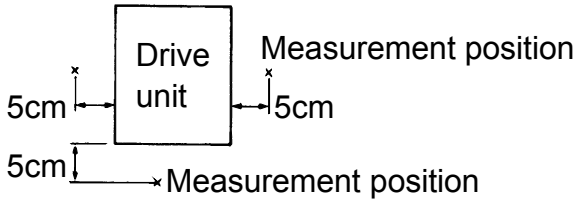
Since drive unit is an electronic piece of equipment, the drive unit may malfunction if there are machines which generate large noises (e.g. welder, power equipment) in the periphery. Fit surge suppressors, noise filters and/or like to the noise sources, install the drive unit as far away as possible from noise sources, or place shielding plates and the like to fully suppress noises.

⚠CAUTION
● The drive unit itself can be the source of noises. Take noise suppression measures to prevent peripheral equipment from malfunctioning due to noises. Refer to: Section 3.1.2 Electromagnetic noise Section 6.3 Malfunction due to Electromagnetic Noise and Countermeasures

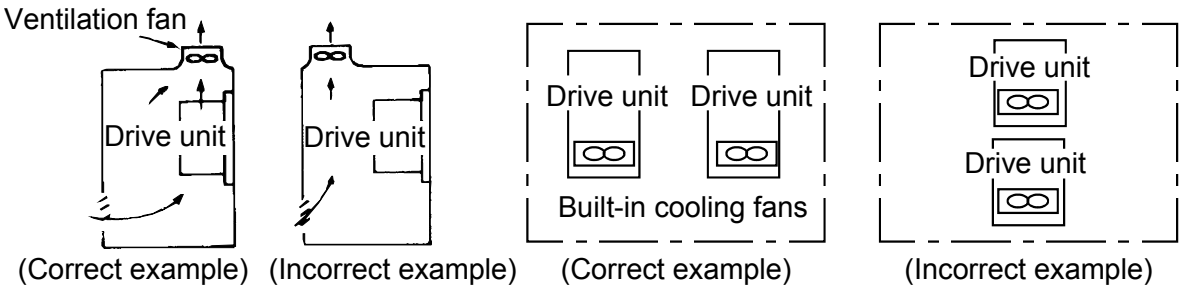
2.1.2 Installation in enclosure

A drive unit heats up by itself or by peripheral devices when it is used in an enclosure. Make sure that the internal temperature inside the enclosure is within the permissible value.

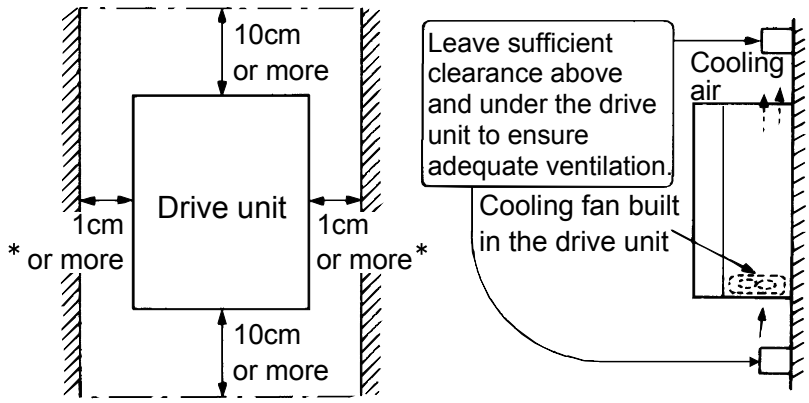
● Measurement positions of surrounding air temperatures



● Layout of drive units within enclosure



NOTICE	● Leave the specified clearances between the drive unit and enclosure walls or other equipment. Not doing so can cause a failure. In addition, improper convection of air in the enclosure will reduce the heat dissipation effect. Fully consider the equipment layout in the enclosure and the use of a cooling fan for ventilation, for example.



* These clearances are also required for replacement of the cooling fan.

● Installation in totally-enclosed enclosure

The following formula shows the relation between the internal temperature rise and the dissipation area in the totally-closed enclosure (hereinafter referred to as enclosure), which encloses a drive unit.

$$A = \frac{P}{K \cdot \Delta T}$$

A: Dissipation area (m^2)
P: Total loss of the enclosure (W)
ΔT: Difference between the temperatures inside and outside of the enclosure (°C)
K: Dissipation coefficient

The dissipation area A excludes the areas that touch dissipation-interfering structures, such as walls and floors.
The dissipation coefficient K is usually 5 or 6. However, it differs depending on factors such as enclosure structure, internal component layout, and outside temperature.

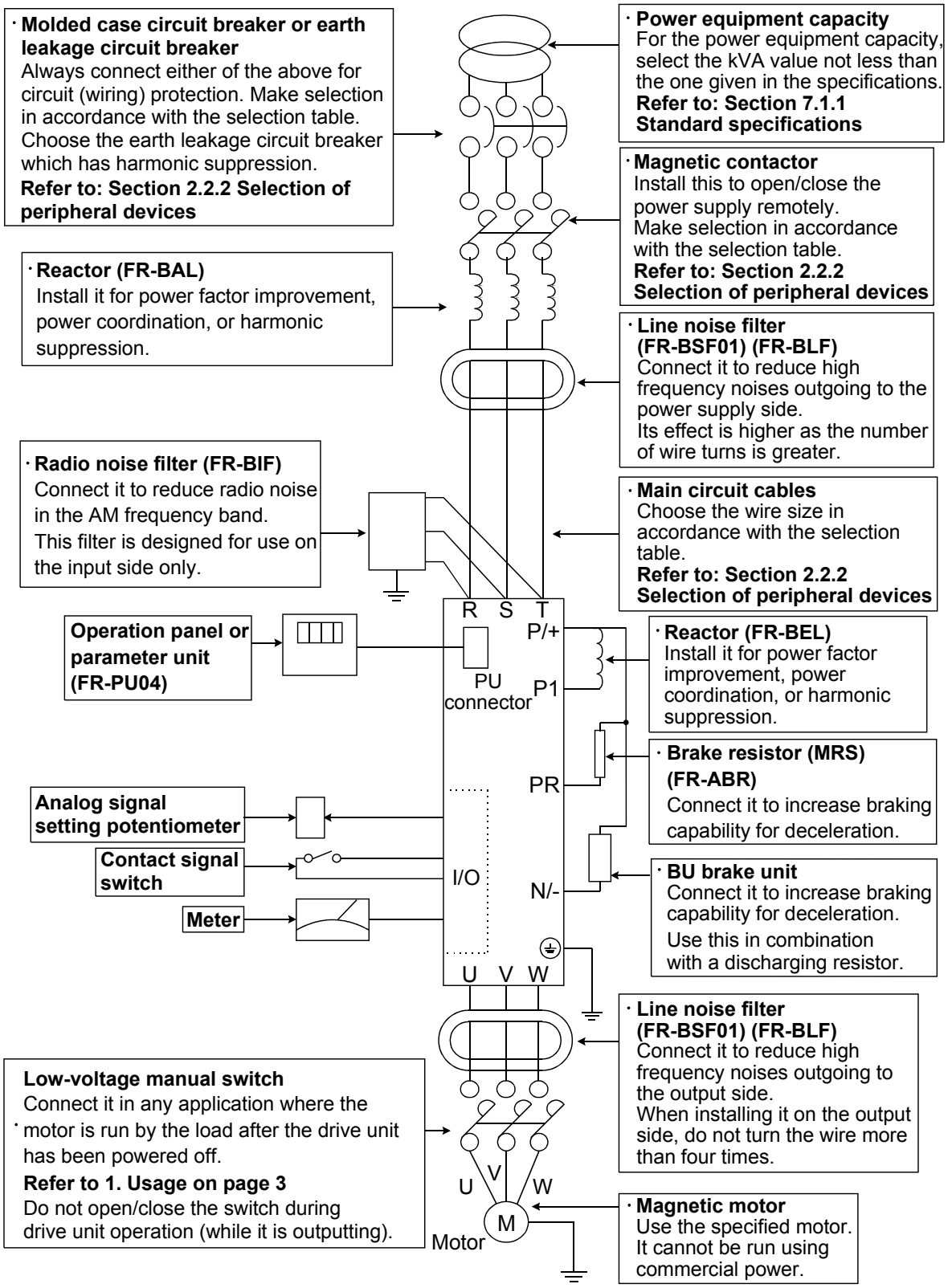
● Incurred loss

The following table lists incurred losses in a rated-load operation with a drive unit.

Capacity	Incurred loss (W) of the drive unit while in continuous operation under rated load
0.5K	45
1.0K	50
1.5K	85
2.0K	100
3.5K	160

2.2 Preparation of Peripheral Devices

2.2.1 Basic configuration



2.2.2 Selection of peripheral devices

(1) Wire size

● AC power input terminals R, S, T, motor connection terminals U, V, W, DC reactor connection terminals P/+, P1, DC terminals P/+, N/-, earth (ground) terminals

Capacity (K)	Terminal Screw Size	Wire Size, Unit: mm^2				Wire Type
		R, S, T	U, V, W	P/+, P1, N/-	Earth (ground) cable	
0.5	M3.5	2	2	2	2	Power cable 600V vinyl wire or equivalent
1.0						
1.5	M4	2 to 5.5	2 to 5.5	2 to 5.5	2 to 5.5	
2.0						
3.5						

● Control circuit terminals (all terminals)

Capacity	Terminal Screw Size	Wire Size, Unit: mm^2	Wire Type
All capacities	M2.5	0.3 to 0.75	Twisted shielded wire, polyethylene insulated vinyl wire for instrumentation or equivalent

MEMO	● Refer to the corresponding instruction manual for wire connection of a stand-alone option connected to the DC terminals P/+, N/-.

NOTICE	● Choose the size of the wires connected to the motor connection terminals so that a voltage drop due to the wires is less than 4V. The minimum wire size in the above selection table assumes that the wiring length is less than 20m. A voltage drop can be found by the following expression: Line voltage drop (mV) = $\sqrt{3} \times$ wire resistance (Ω/km) $\times$ wiring length (m) $\times$ current (A) ● Use the earth (ground) cable which is as thick as possible.

(2) Crimping terminals

Wire Size, Unit: mm^2	Terminal Screw Size	Crimping Terminal Size
2	M3.5	2-3.5
	M4	2-4
3.5/5.5	M4	5.5-4

(3) Moulded case circuit breaker, magnetic contactors

Capacity (K)	Moulded Case Circuit Breaker		Magnetic Contactor
	With power factor improving reactor	Without power factor improving reactor	With power factor improving reactor
0.5	30AF/5A		S-N10
1.0	30AF/10A		
1.5	30AF/15A		
2.0	30AF/15A	30AF/20A	S-N11, S-N12
3.5	30AF/30A		S-N20

If the magnetic contactor does not have power factor improving reactor, select the magnetic contactor as indicated in the following table depending on the power equipment capacity and the wiring length from the power equipment to the drive unit.

Power Supply Capacity		Less than 50kVA	50kVA or More		
Wiring length		—	20m or more	10m to 20m	Less than 10m
Capacity (K)	0.5	S-N18		S-N21	S-N21
	1.0				
	1.5	S-N21		S-N25	S-N50
	2.0	S-N11, S-N12			
	3.5	S-N20			

(4) Earth leakage circuit breakers

● Selection method

Use the earth leakage circuit breaker which has harmonic/surge suppression.
Mitsubishi product: Progressive Super Series NV-SF, NV-CF

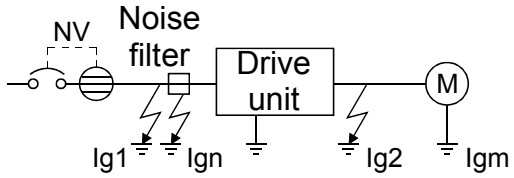
Capacity (K)	Earth Leakage Circuit Breaker	
	With power factor improving reactor	Without power factor improving reactor
0.5	30AF/5A	
1.0	30AF/10A	
1.5	30AF/15A	
2.0	30AF/15A	30AF/20A
3.5	30AF/30A	

MEMO	● Leakage currents from the wiring and motor include frequency components of a higher degree than those from the commercial power supply. Therefore, the earth leakage circuit breaker which is not a harmonic/surge suppression product can cause unnecessary operations. <Measures against unnecessary operations> • Minimize the wiring distance of I/O cables. • Run I/O cables away (more than 30cm) from the earth. • Set a lower value in Pr.72 "motor sound selection setting." [Section 8.5.6].

● Setting the rated detection current

Rated detection current ≥10{Ig1+Ign+K(Ig2+Igm)}

K: Constant set in consideration of harmonic components

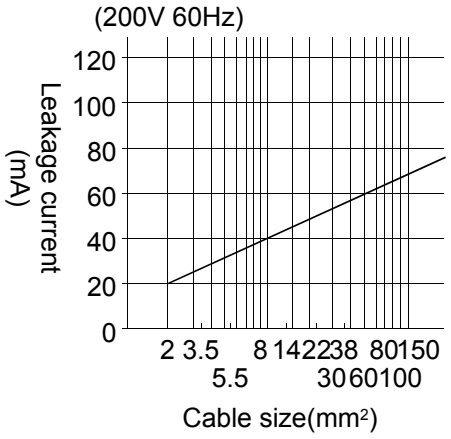


Earth Leakage Circuit Breaker		K
Type	Mitsubishi product	
Harmonic/surge suppression type	NV-SF NV-CF	1
Standard type	NV-CA NV-CS NV-SS	3

Ig1: Leakage current on the line between the leakage circuit breaker and the drive unit. (Refer to Fig. 2-2.)

Ig2: Leakage current on the line between the drive unit and the motor. (Refer to Fig. 2-2.)

Fig. 2-2 Graph showing the leakage current per 1km when the CV cable is routed in metal conduit



Ign: Leakage current from the filter installed at the input side.
Refer to Section 7.1.3 Option list for dedicated filters by Mitsubishi.

Igm: Leakage current from the motor

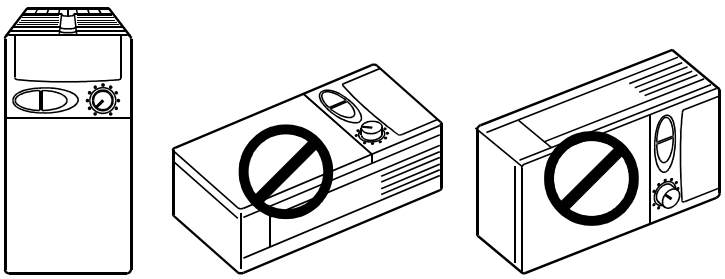
Capacity (K)	Leakage current (mA)
0.5, 1.0	0.1
1.5, 2.0	0.2
3.5	0.3

NOTICE	● Install a leakage current breaker at the input side (power supply side) of the drive unit. Installing it at the output side will cause the leakage current breaker to overheat and malfunction.

MEMO	● Leakage current may flow into another system via earth (ground) cable, etc.

2.3 Installation Method

1) Remove the front cover.
2) Open the operation panel front cover (for 1.0K or lower).
3) Remove the wiring cover (for 2.0K or lower).
4) Pass screws or bolts into the four mounting holes and secure the drive unit. (Three mounting holes for 1.0K or lower)

⚠CAUTION
● Prevent screws, metal pieces and other conductive foreign matter and oil and other flammable foreign matter from entering the drive unit. ● Securely screw or bolt the unit to the mounting surface vertically without looseness. Always install the unit in the specified mounting orientation. Not doing so can cause a failure.  ● Do not drop the unit, or subject it to impact.

5) Reattach the removed cover to the original position. Leave the cover removed when continuing the wiring work.

NOTICE	● Carefully check that the front cover has been mounted securely. Insecure mounting can cause a drop due to vibration or faulty display on the operation panel. ● The front cover is fitted with the capacity plate and the drive unit with the rating plate. The same serial number is printed on these plates. Always reinstall the cover to the drive unit from where it had been removed.

3. WIRING

This section describes the wiring of the drive unit.

⚠WARNING
● Any person who is involved in the wiring of this equipment should be fully competent to do the work. Not doing so can cause an electric shock or fire. ● Always install the unit before wiring. Not doing so can cause an electric shock or fire. ● Before restarting wiring after switching power "ON", make sure that the motor is at a stop, wait for more than 10 minutes after switching power "OFF", and confirm that the DC voltage across the DC terminals P/+ and N/- is low enough to do wiring. Immediately after power "OFF", the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). Therefore, an electric shock may occur. ● Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. Always start the work after confirming that the motor has stopped. Not doing so can cause an electric shock.

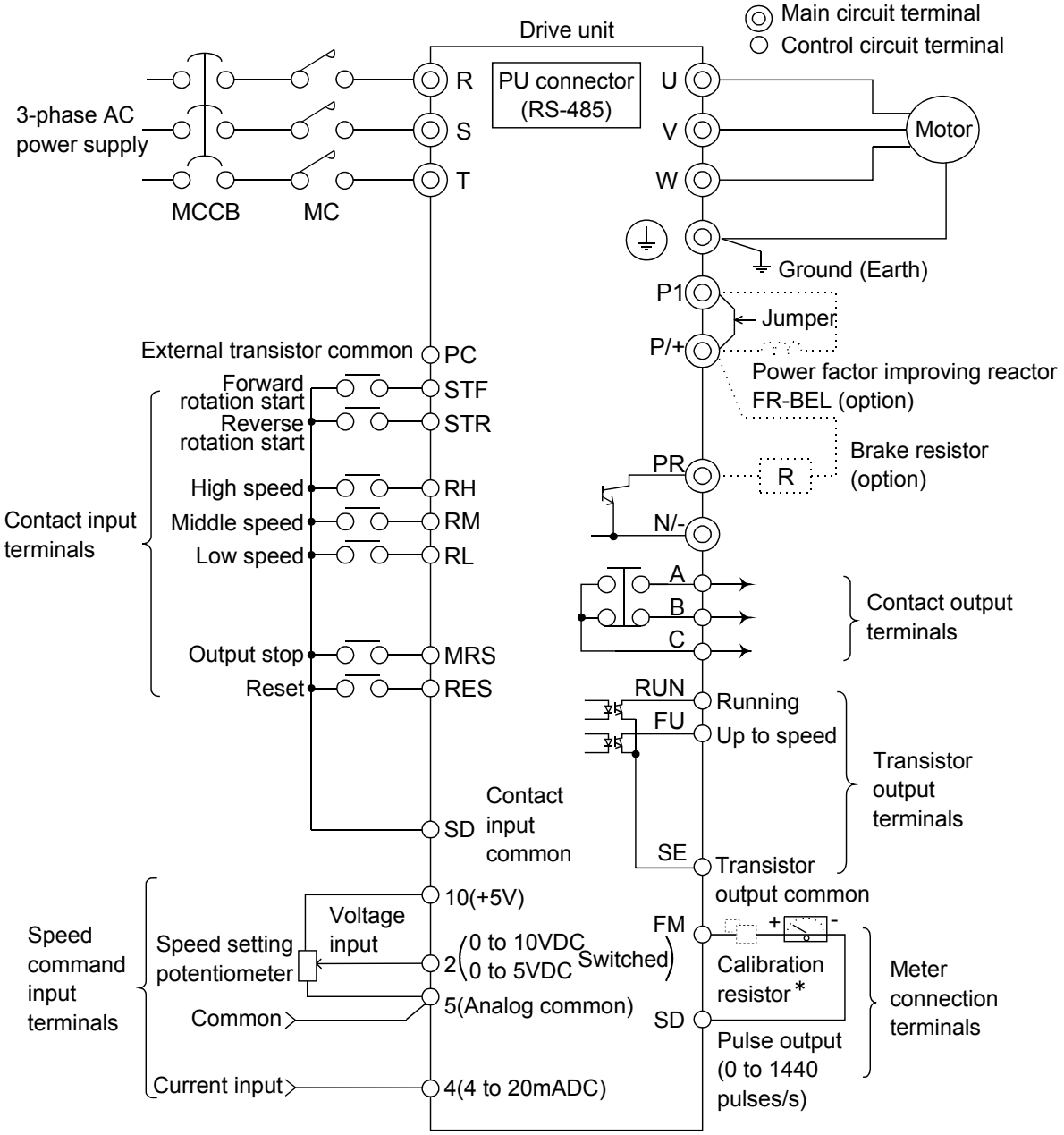
⚠CAUTION
● Take measures to prevent peripheral sensors and equipment from malfunctioning due to electromagnetic noises. Not doing so can cause accidents. ● Take measures to prevent peripheral power factor improving capacitors and generators from overheating or being damaged due to power harmonics. Not doing so can cause a fire. ● Do not leave wire offcuts in the drive unit. Doing so can cause a fault, failure or malfunction. ● If the machine must not be restarted when power is restored after a power failure, provide a magnetic contactor on the power supply side and also make up a sequence which will not turn "ON" the start signal automatically when power is restored. ● Tighten the terminal screws to the specified torque. Undertightening can cause an inter-terminal short circuit or malfunction. Overtightening can cause the screws and unit to be damaged, resulting in a short circuit, malfunction or the like.

Contents of This Section

3.1 Pre-Wiring Instructions

3.1.1 Terminal connection diagram

The following shows the wiring of all terminals. After confirming the function of each terminal, wire necessary terminals according to your application. When an operation panel is used to perform operation, merely doing the main circuit wiring enables the motor to run.



* This resistor is not needed when you use an operation panel or parameter unit (FR-PU04) to make calibration. Use a calibration resistor when the meter needs to be calibrated by a neighboring device because the meter is located far from the drive unit. Note that when you connect the calibration resistor, the meter may not deflect to the full scale. In this case, use the operation panel or parameter unit with the resistor to make calibration.

3.1.2 Electromagnetic noise

Perform the following measures to suppress electromagnetic noise that affects the drive unit, or to use weak-signal-handling devices (meter, receiver, telephone line, various sensors, etc.).

(1) When propagation of electromagnetic noise is expected via the signal line of the drive unit

- Install a data line filter to the signal line.

(2) When a nearby device is connected to a power supply different from the one for the drive unit

- Lay the signal lines of devices as far as possible away from the drive unit and its power cable.
- Do not lay the signal lines of devices and the power line of the drive unit in parallel. Do not bundle them either.
- Install a line noise filter to the power line of the drive unit. Install it either to the input or output side.
- Install a radio noise filter to the power line of the drive unit. Install it to the input side.
- Use shielded cables for signal lines and power lines.
- Put a signal line and a power line to individual metal ducts.

(3) When a device is sharing the same power source with the drive unit

- Install a line noise filter to the power line of the drive unit. Install it to the input side.
- Install a radio noise filter to the power line of the drive unit. Install it to the input side.

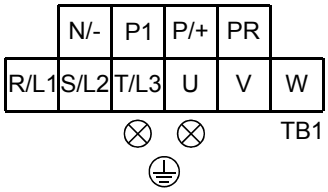
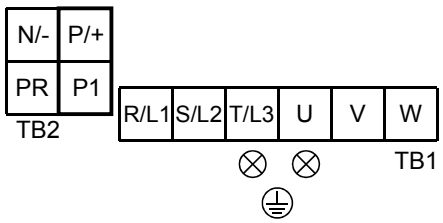
NOTICE	● The noise propagation pass and noise tolerances of devices have an influence on the effect of the noise reduction measures. Refer to: Section 6.3 Malfunction due to Electromagnetic Noise and Countermeasures

3.2 Wiring of the Main Circuit Terminals

3.2.1 Terminals

Symbol	Name	Description
R, S, T	AC power input terminals	Connect to the commercial power supply.
U, V, W	Motor connection terminals	Connect to a dedicated variable-speed synchronous motor.
P/+, PR	Brake resistor connection terminals	Connect the brake resistor (option).
P/+, P1	DC reactor connection terminals	Disconnect the jumper from terminals P/+ and P1, and connect the FR-BEL power factor improving DC reactor (option).
P/+, N/-	DC terminals	Connect to the BU brake unit (option).
⏚	Earth (ground) terminals	Terminals for connection of the earth (ground) cables. (There are two terminals.)

3.2.2 Terminal layout and connection specifications

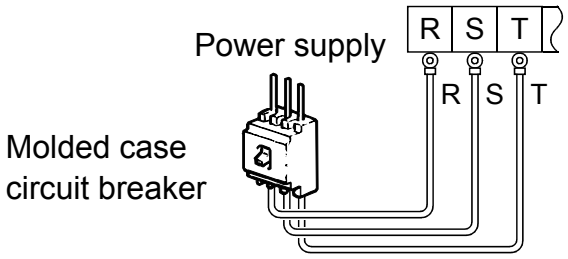
CX520-0.5,1.0K		CX520-1.5K to 3.5K	
Layout  		Layout  	
Screw size M3.5	Tightening torque 1.2N•m	Screw size M4	Tightening torque 1.5N•m

⚠CAUTION

- Tighten the terminal screws to the specified torque. Undertightening can cause an inter-terminal short circuit or malfunction. Overtightening can cause the screws and unit to be damaged, resulting in a short circuit, malfunction or the like.

3.2.3 Wiring of the AC power input terminals R, S, T

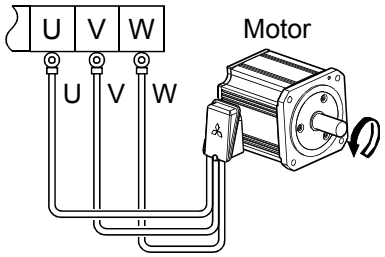
Connect these terminals to the AC power supply. You need not match the phase sequence.



⚠CAUTION
● Always apply power to only the AC power input terminals R, S, T. Applying power to the other terminals will damage the unit.

3.2.4 Wiring of the motor connection terminals U, V, W

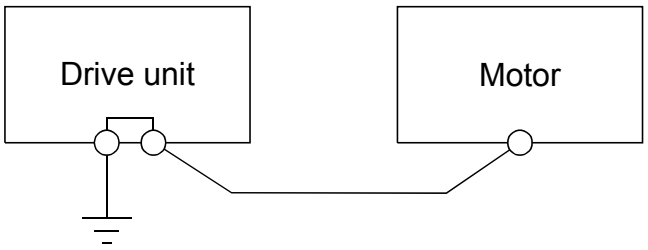
Connect these terminals to the motor. Match the phase sequence of the motor connection terminals U, V, W with that of the motor cables. Incorrect phase sequence will run the motor in reverse.



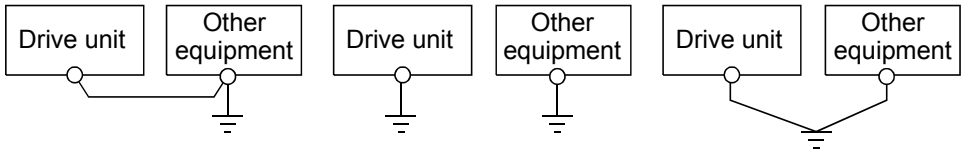
⚠CAUTION
● The wiring length between the drive unit and motor should be 100m maximum. Long wiring may cause torque to be insufficient or the overcurrent protection function to be activated. ● Between the drive unit and motor, do not fit a power factor improving capacitor, surge suppressor or FR-BIF radio noise filter (option).

3.2.5 Wiring of the earth (ground) terminals ⏚

There are two earth (ground) terminals. Connect one earth (ground) terminal to the motor's earth (ground) terminal and perform shared earthing (grounding) on the drive unit.



NOTICE	● Avoid shared earthing (grounding) with the other equipment susceptible to noise, and perform exclusive or single-point earthing (grounding).



Shared earthing (grounding) ··· Not allowed

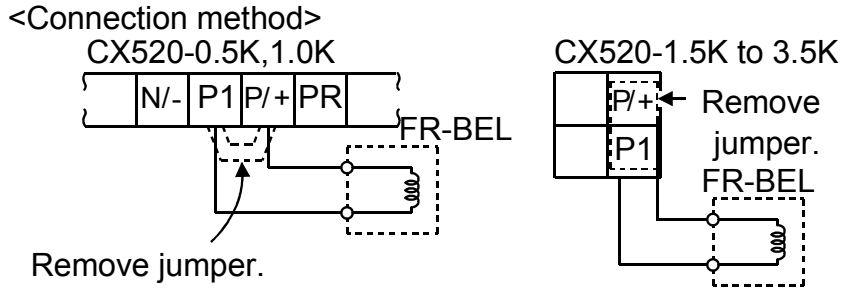
Exclusive earthing (grounding) ··· Allowed

1-point earthing (grounding) ···Allowed

⚠WARNING
● Earth (ground) the drive unit and motor securely to prevent an electric shock due to leakage currents. Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 536 class 1 and other applicable standards). ● For earthing (grounding), connect the cable to the exclusive earth (ground) terminal. (Do not use the screw of the casing, chassis or the like.)

3.2.6 Wiring of the DC reactor connection terminals P/+, P1

These terminals are designed for connection of the power factor improving reactor (FR-BEL).
Remove the jumper across the terminals P/+-P1 and connect the DC reactor.



NOTICE	● The wiring distance (overall length) should be within 5m.

MEMO	● Without removal of the jumper, the reactor will not be active.

3.2.7 Wiring of the brake resistor connection terminals P/+, PR

These terminals are designed for connection to the brake resistor (heavy-duty brake resistor).
Change Pr. 30 and Pr. 70 settings before use.

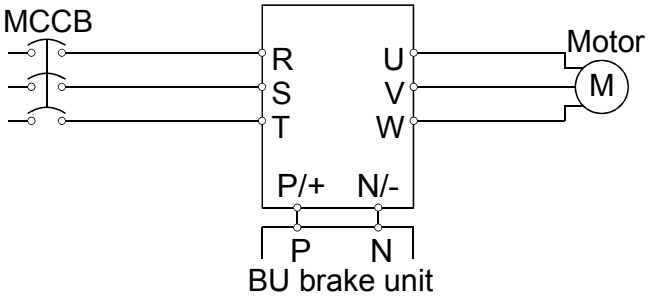
NOTICE	● Connect only the specified brake resistor.

3.2.8 Wiring of the DC terminals P/+, N/-

These terminals are designed for connection of the BU brake unit.

● Connection of the BU brake unit.

1) Connect the BU brake unit. For full information, read the BU brake unit instruction manual.
2) Change the Pr. 30 setting.



⚠CAUTION
● Do not connect the brake resistor or the like to the DC terminals P/+, N/- directly. Doing so can cause a fire. ● Incorrect (opposite) connection to the DC terminals P/+, N/- will damage the drive unit.

3.3 Wiring of the Control Circuit Terminals

⚠CAUTION
● Use shielded or twisted cables for wiring the control circuit input terminals. Also run them away from the main circuit wiring and other power cables. Not doing so can cause a malfunction due to noise.

3.3.1 Terminals

After confirming the function of each terminal, use necessary terminals according to your application.

(1) Contact input terminals

● Turning "ON" (closing) between any terminal and the common terminal, or turning "OFF" (opening) between any terminal and the common terminal provides the corresponding function as described below.

● The shaded terminal symbols indicate that their functions can be changed.

Refer to: Section 8.8.4 Selection of the control circuit contact input terminal functions

Symbol	Name	Description	
STF	Forward rotation start	Turn on this signal to start forward rotation or turn it off to stop.	Simultaneously turning on these signals gives a stop command.
STR	Reverse rotation start	Turn on this signal to start reverse rotation or turn it off to stop.	
RES	Reset	Turn on this signal (for more than 0.1s) to reset the protective circuit activated. Turn it off after the protective circuit is reset.	
MRS	Output stop	Turn on this signal (for more than 0.1s) to stop the output and disconnect the motor electrically, causing it to coast. Turing it off with the start signal input will restart the motor at the starting speed.	
RH	High speed	Combine on/off of these signals as appropriate to select multiple speeds. Refer to: Section 8.3.2 Variable-speed operation using contact input signals	
RM	Middle speed		
RL	Low speed		
SD	Contact input common	Common to the contact input terminals. (Not isolated from terminal 5.)	
PC	External transistor common	Common terminal used when the contact input terminal is connected to the transistor output (open collector output) of the external controller. This terminal can prevent a malfunction caused by a sneak current.	

MEMO	● Ratings of the contact input terminals Input resistance: 4.7kΩ, open-time voltage: 24±3VDC, short circuit-time current: 4 to 6mADC ● Use the terminal PC as a power supply terminal. Can be used as a power supply for a sensor or equivalent. The common terminal is terminal SD. Power supply voltage range: 24±2VDC, max. permissible current: 100mA When the terminal is used as a power supply, it cannot be used as an external transistor common terminal to prevent a sneak current. ● The response time of the contact input terminal is 20ms±15ms. (When the stall prevention function is activated, response may be slower.)

NOTICE	● When a transistor is used to input the signal of the contact input terminal, make sure that the electrical characteristics of the transistor used satisfy the following: I_C: Collector current, 10mA or more V_{CEX}: Open-time collector-emitter permissible voltage, 30V or more V_{CE}(sat): Conduction-time collector-emitter saturation voltage, 3V or less I_{CEX}: Collector shutoff current (leakage current), 100uA or less ● When a relay contact is used to input the signal of the contact input terminal, use two faint signal contacts in parallel or use a twin contact to prevent a contact fault.

(2) Speed command input terminals

- Terminals used to vary the motor speed with analog signals.
- The parameter function allows you to choose the analog speed command specifications.

Refer to: Section 8.3.1 Selection of the analog speed command specifications

Symbol	Name	Rating	Description
2	Voltage input	Input resistance: 10±1kΩ Max. permissible voltage: 20VDC	You can perform operation at the speed proportional to a 0 to 10VDC (or 0 to 5VDC) voltage signal.
4	Current input	Input resistance: 250Ω±2% Max. permissible current: 30mA DC	You can perform operation at the speed proportional to a 4 to 20mADC current signal.
5	Analog common	-	Common to the speed command input terminals. Do not earth (ground).
10	Power supply 5V	5V±0.2VDC Permissible load current: 10mA	Can be used as a power supply for the analog input signal, e.g. speed setting potentiometer. The common terminal is terminal 5.

(3) Transistor output terminals

- When the function of any terminal is activated, the internal transistor (open collector output) connected across that terminal and common terminal turns ON (conducts).
- You can set the parameter function to change the function of each terminal.

Refer to: Section 8.7.2 Selection of the control circuit output terminal functions
Section 8.7.3 Detection of running speed

Symbol	Name	Description
RUN	Running	ON (conducts) while the drive unit is outputting a speed command to the motor. OFF (does not conduct) during stop or coasting.
FU	Speed detection	Turns ON (conducts) when the speed output by the drive unit reaches or exceeds the preset value. OFF (does not conduct) when the speed is less than that.
SE	Transistor output common	Common to the transistor output terminals. Isolated from the terminals SD, 5.

MEMO	● Ratings of transistor output terminals Max. permissible voltage: 27VDC, max. permissible current: 0.1ADC

NOTICE	● When driving a coil load, connect a diode. Refer to: 3.3.5 Wiring of the transistor output terminals

(4) Contact output terminals

- When the protective function is activated, the relay contact connected to the terminal opens/closes.

  Refer to: Section 6.1.1 Protective function activated

- You can set the parameter function to change the function of each terminal.

  Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

Symbol	Contact Capacity	Description
A, B, C	200VAC 0.3A or 30VDC 0.3A	Normal: Terminals B-C closed (Terminals A-C open) Protective function activated: Terminals B-C open (Terminals A-C closed)

MEMO	● The response time of the contact output terminals is less than 100ms. (After drive unit output shutoff) ● When the drive unit is powered off, the contact output is placed in a normal status. Therefore, the contact output signal is not held when power is switched off after the protective function has been activated. When the signal must be held, provide an external holding circuit.

(5) Instrument connection terminals

- Used to display the motor speed externally.
- You can use the parameter function to choose the item other than the motor speed.

  Refer to: Section 8.7.5 Selection of the instrument connection terminal functions

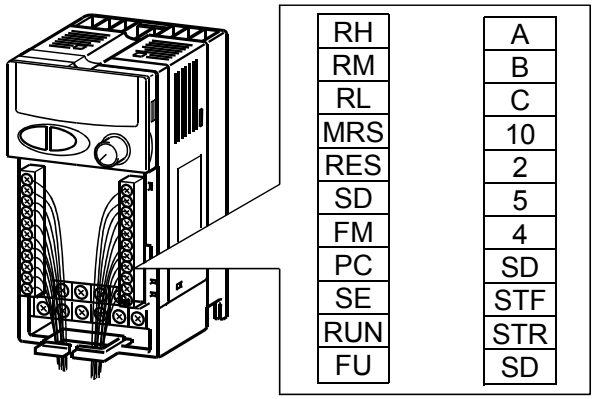
Symbol	Name	Description
FM	Meter connection	The output voltage has an 8VDC pulse waveform. The output varies in proportion to the motor speed and the average voltage is preset to approx. 4.7V at the rated speed and 1440 pulses/s. As a meter, use a 1mA moving-coil type DC ammeter or digital counter. As the common terminal, use terminal SD.

MEMO	● The output signal from the FM terminal is updated at intervals of several 10ms.

3.3.2 Terminal layout and connection specifications

Layout

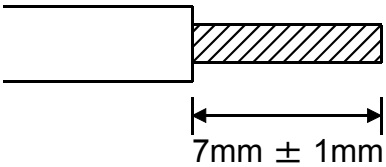
Terminal layout of control circuit



Screw size	Tightening torque
M2.5	0.25N•m to 0.49 N•m

Wiring method

1) For wiring the control circuit, use cables after stripping their sheaths.
   Refer to the gauge printed on the drive unit and strip the sheaths to the following dimensions. If the sheath is stripped too much, its cable may be shorted with the adjoining cable. If the sheath is stripped too little, the cable may come off.



2) When using blade terminals and solid wires for wiring, their diameters should be 0.9mm maximum. If they are larger, the threads may be damaged during tightening.
3) Loosen the terminal screw and insert the cable into the terminal.
4) Tighten the screw to the specified torque.
   Undertightening can cause cable disconnection or misoperation. Overtightening can cause damage to the screw or unit, leading to short circuit or misoperation.
   Tightening torque: 0.25N•m to 0.49N•m
   * Use a screwdriver No. 0 to tighten.

Note: When routing the stripped cables, twist them so that they do not become loose. In addition, do not solder it. Soldering can cause poor contact.

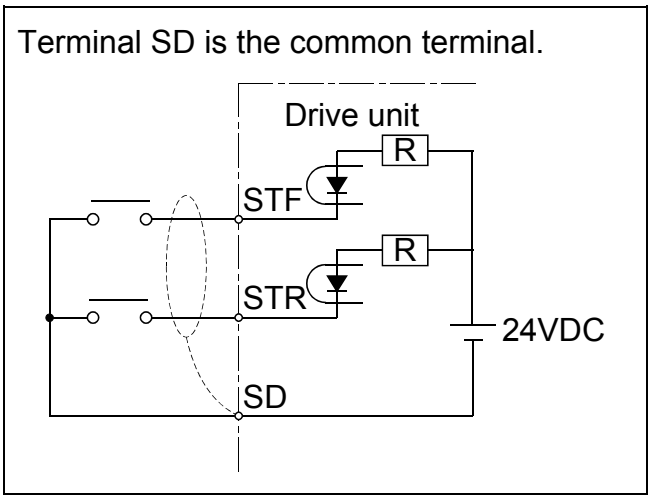
NOTICE	● When using a blade terminal or a solid wire for wiring, use one of 0.9mm or less diameter. Using one of larger diameter may damage the threads during tightening. ● Connect stripped cable so that its core does not become loose. Not doing so can cause shorting of adjacent cables.

3.3.3 Wiring of the contact input terminals

Use shielded or twisted shielded cables for wiring. Connect one shield sheath to the common terminal. Leave the other shield sheath open.

● When using contact signals

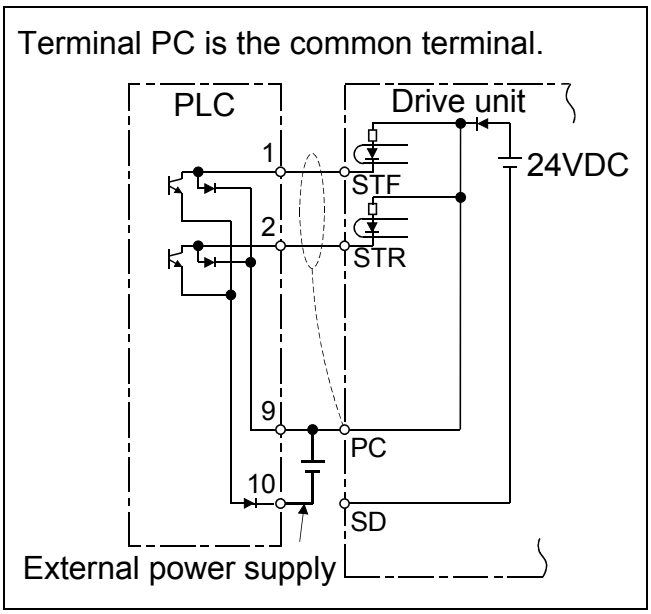
The following shows the wiring of the terminals STF, STR. The same wiring also applies to the other terminals.



● When using non-contact switches

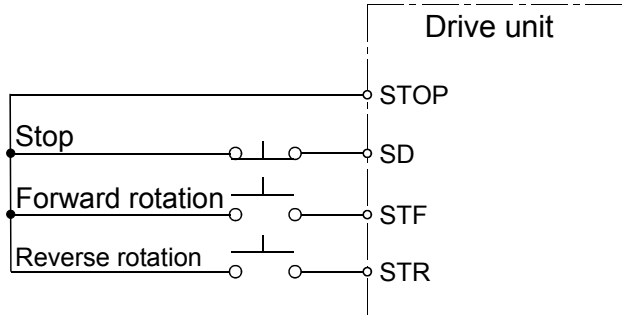
When using transistor outputs having an external power supply, such as a programmable controller (PLC), to input signals, perform the following wiring to prevent a malfunction caused by a sneak current from the external power supply.

The following shows the wiring of the terminals STF, STR. The same wiring also applies to the other terminals.



● When using push buttons
Assign the STOP signal to self-hold a start signal (forward/reverse rotation). Once a start signal is input, the start signal is held in the drive unit until a stop signal input. This button can be used only as a start signal.

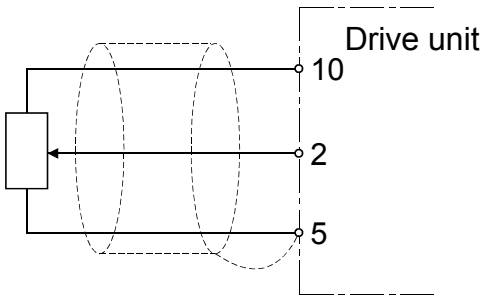
Terminal SD is the common terminal.



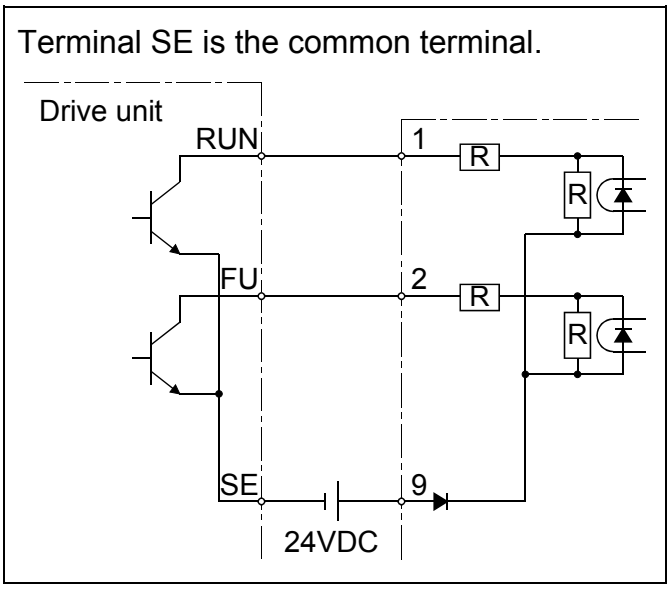
NOTICE	● Do not apply voltages to the contact input terminals. ● Do not short the terminals PC and SD. Doing so will damage the unit. ● When the terminal PC is used as a power supply terminal, the wiring length should be within 30m.

3.3.4 Wiring of the speed command input terminals

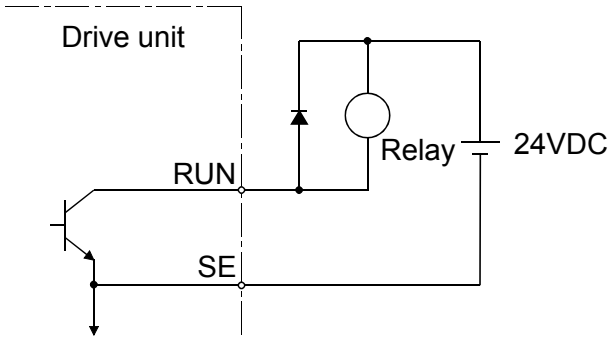
Use shielded or twisted shielded cables for wiring. Connect one shield sheath to the terminal 5. Leave the other shield sheath open.
The following diagram shows the wiring of the terminal 2. The same wiring also applies to the other terminals.



3.3.5 Wiring of the transistor output terminals



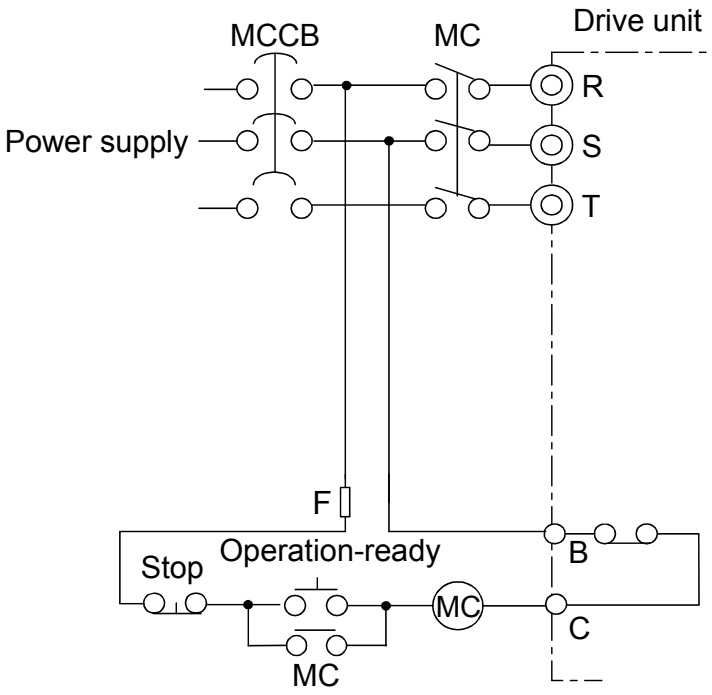
When driving a coil load such as a relay coil, always connect the following diode. Connect the diode with correct polarity. Opposite polarity will cause the drive unit to fail.



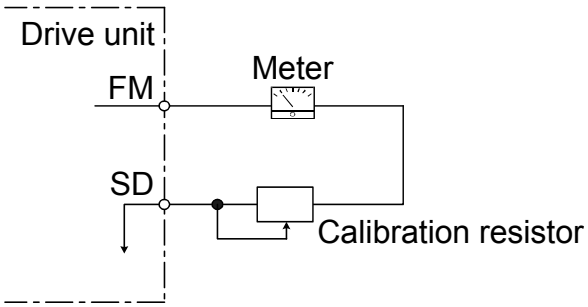
NOTICE	● Terminal SE is isolated from terminals SD and 5. Do not connect them each other.

3.3.6 Wiring of the contact output terminals

The following wiring example assumes that when the protective circuit is activated, the magnetic contactor (MC) on the power supply side is opened to switch off the main circuit power.



3.3.7 Wiring of the instrument connection terminals

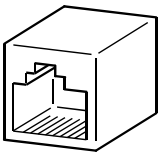


MEMO	● The calibration resistor is not needed when the operation panel or parameter unit is used to make calibration. Refer to: Pr. 900 [Section 8.7.5] ● The wiring distance between the drive unit and an indicator should be: 200m or less (analog indicator) 50m or less (digital indicator) ● Up to two analog indicators can be connected in parallel. ● Refer to Section 6.4.4 Power measurement at circuits for output signal waveforms.

3.4 Wiring of the PU Connector

3.4.1 Pin layout

As seen from the drive unit (receptacle side) front



8) to 1)

1)SG 5)SDA
2)P5S 6) RDB
3)RDA 7) SG
4)SDB 8) P5S

NOTICE	● Pins No. 2 and 8 (P5S) provide power to the operation panel. Do not use them when making RS-485 communication.

3.4.2 Using the cable to connect the operation panel

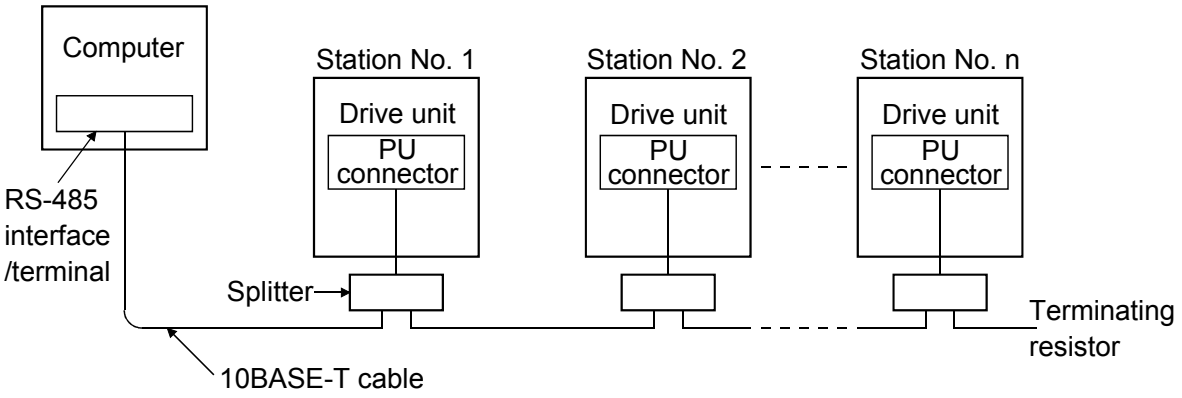
Use the optional "FR-CB2 parameter unit connection cable" or commercially available connector and cable for wiring.

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cat.5e cable that is compatible with TIA/EIA standards. (10BASE-T/100BASE-T/1000BASE-T) Example: SGLPEV-T (Cat5e/300m) 24AWG × 4 Mitsubishi Cable Industries, Ltd.

NOTICE	● The maximum wiring length is 20m.

3.4.3 System configuration examples for communication operation

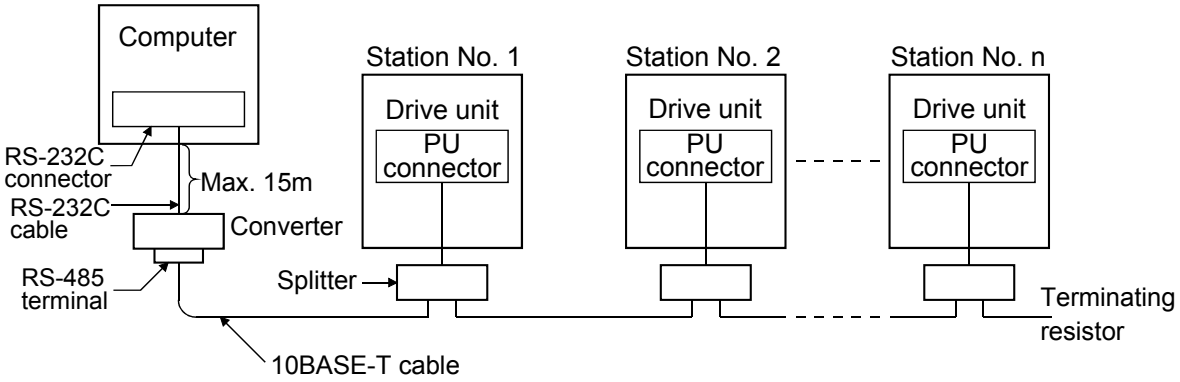
1) For RS-485 communication operation



● Parts used (Use commercially available parts for wiring)

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cat.5e cable that is compatible with TIA/EIA standards. (10BASE-T/100BASE-T/1000BASE-T) Example: SGLPEV-T (Cat5e/300m) 24AWG × 4 Mitsubishi Cable Industries, Ltd.

2) For RS-232C communication operation



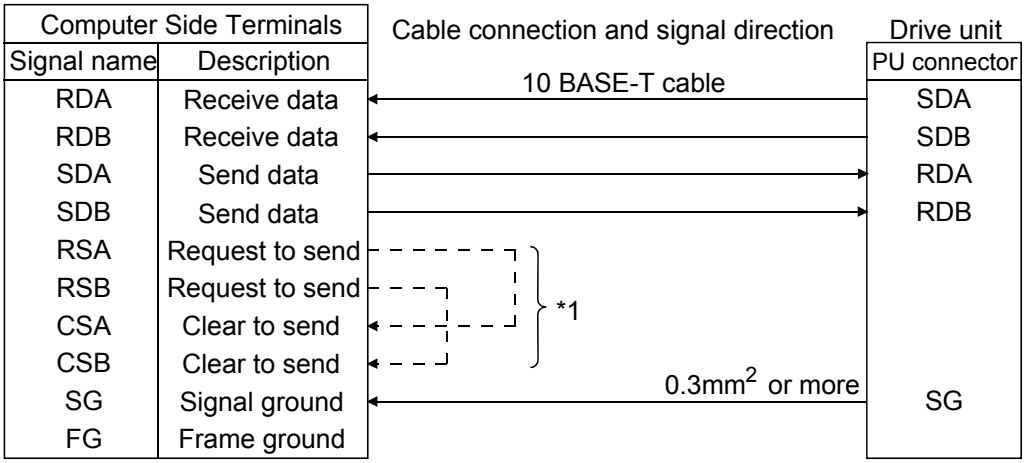
● Parts used (Use commercially available parts for wiring)

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cat.5e cable that is compatible with TIA/EIA standards. (10BASE-T/100BASE-T/1000BASE-T) Example: SGLPEV-T (Cat5e/300m) 24AWG × 4 Mitsubishi Cable Industries, Ltd.

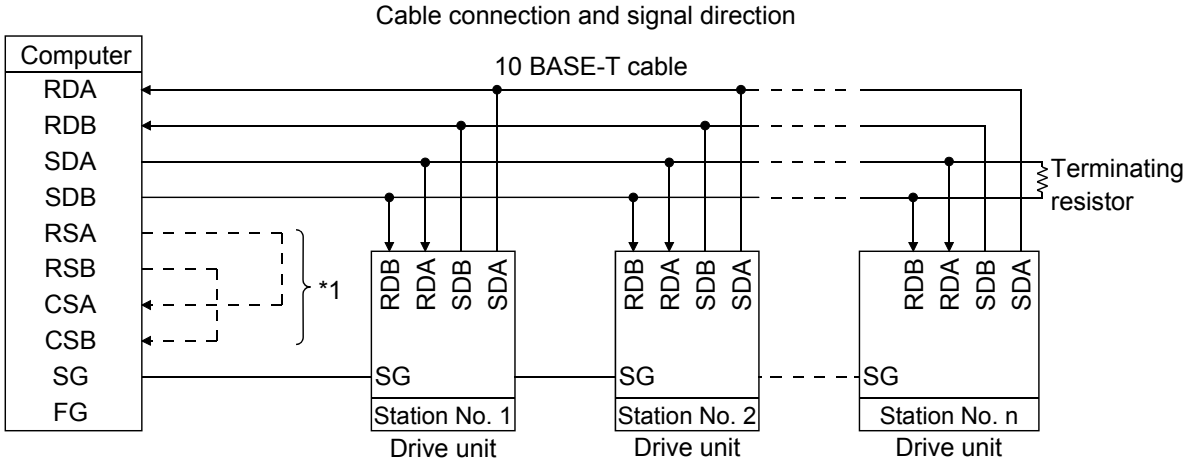
NOTICE	● Do not connect the PU connector to the computer's LAN board, FAX modem socket or telephone modular connector. Doing so may damage the drive unit due to electrical incompatibilities.

3.4.4 Wiring methods for communication operation

1) Wiring of one computer and one drive unit for RS-485



2) Wiring of one computer and "n" drive units for RS-485



NOTICE	● Communication may be affected by reflection depending on the transmission speed and/or transmission distance. Connect a terminating resistor if reflection interferes with communication. For connection using the PU connector, use a splitter since the termination resistor cannot be fitted. Connect the terminating resistor to only the remotest drive unit from the computer. (Terminating resistor: 100Ω) ● Connect the terminals marked *1 in accordance with the instruction manual of the computer used. Fully check the terminal numbers of the computer as they differ between models.

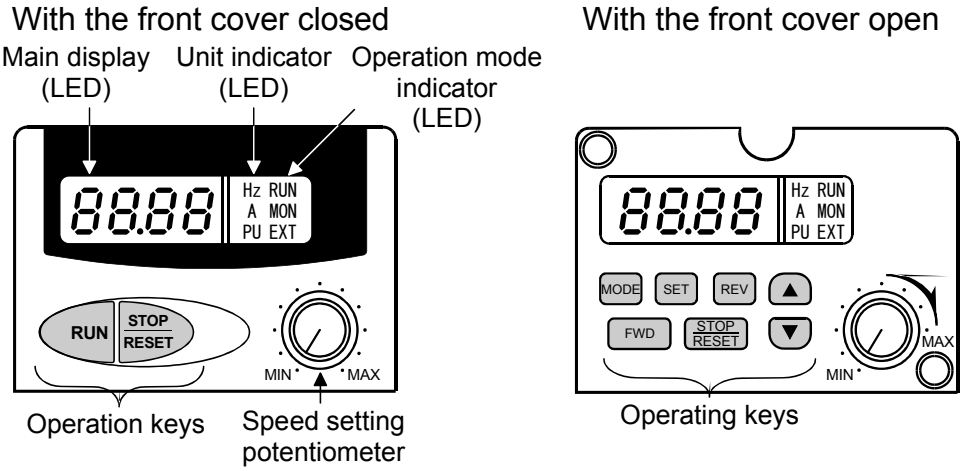
4. HANDLING OF OPERATION PANEL

This section describes how to use the operation panel on the drive unit.

MEMO	● For the way to use the FR-PU04 parameter unit, refer to the instruction manual of the FR-PU04 parameter unit. When the FR-PU04 is used, some of the FR-PU04 functions are restricted. Refer to: 4.4 Restrictions with FR-PU04

Contents of This Section

4.1 Parts Identification and Function



Name			Function
Main display (4-digit LED)			Displays the monitored value of speed, output current, etc. Also displays the setting values for different functions.
Unit indicator (LED) ○ :lit ● :unlit	Hz	A	
	●	●	Indicates that speed (r/min), machine speed, or voltage is monitored.
	○	●	Indicates that frequency is monitored.
	●	○	Indicates that current is monitored.
Operation mode indicator (LED) ○ : lit △ : flicker ● : unlit	MON		Lit during monitoring mode.
	EXT	PU	
	○	●	Indicates that External operation mode is selected.
	●	○	Indicates that PU operation mode is selected. Also indicates that speed setting or parameter setting mode is being made.
	○	○	Indicates that External/PU combined operation mode 1 or 2 is selected.
	●	●	Indicates that the help function is being used.
	RUN		○: During forward rotation △: During reverse rotation ●: In a stop status

Operation keys	MODE	Use this key during monitoring, speed setting, parameter setting, operation mode setting, and when using the help function.
	▲▼ (UP/DOWN)	Use this key to change a speed setting value, parameter number, parameter setting value, and help item. Press ▲ to increase the value, and ▼ to decrease the value.
	SET	Use this key to enter an operation such as a speed setting and parameter setting.
	REV	Use this key to operate in the reverse direction.
	FWD (RUN)	Use this key to operate in the forward direction.
	STOP/ RESET	Use this key to decelerate to stop. This key also resets a fault at a fault occurrence.
Speed setting potentiometer		Use this potentiometer to set a speed. Turn right to increase the speed.

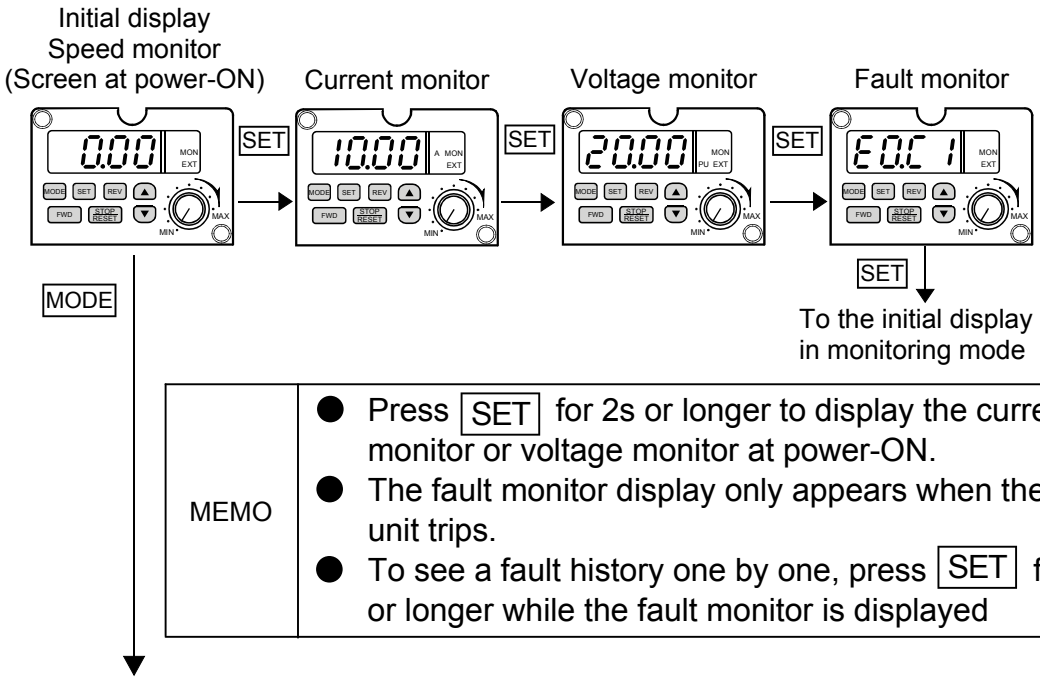
4.2 Operation Detail

Use the operation panel to start/stop an operation, to set a speed, to monitor commanded operation and status, and to display faults.
Use MODE key to display different setting modes in sequence.

Mode	Description	
Monitoring Mode	Select this mode to display a speed, motor current, and output voltage. Set a parameter to display other items. Refer to: Section 8.7.1 Selection of operation panel display data.	
Speed Setting Mode	Use this mode to input a speed command with the operation panel. This mode is only available under PU operation mode or PU/External combined operation 1 and 2. Refer to: Section 5. OPERATION	
Parameter Setting Mode	Use this mode to set a parameter.	
Operation Mode	Select External operation mode or PU operation mode. Set a parameter to keep the selected operation mode. Refer to: Pr. 79 [Section 8.2]	
Help Mode	The following functions are available in this mode.	
	Faults history reading	Reads the past four faults. The latest fault history has "." after the alphabet E. "E._ _0" indicates that there is no fault history.
	Faults history clear	Clears all the faults history.
	Parameter clear	Initializes all parameter settings to the factory settings. This command does not initialize Pr. 75, Pr. 146, Pr. 180 to Pr. 195, Pr. 900 to Pr. 905, Pr. 922, Pr. 923 and control parameters. Set a parameter to disable parameter clear. Refer to: Pr. 77 [Section 8.1]
	All parameter clear	Initializes all parameter settings and calibrated values to the factory settings. This command does not initialize Pr. 71, Pr. 75, Pr. 80, and Pr. 188.

4.3 Operation Method

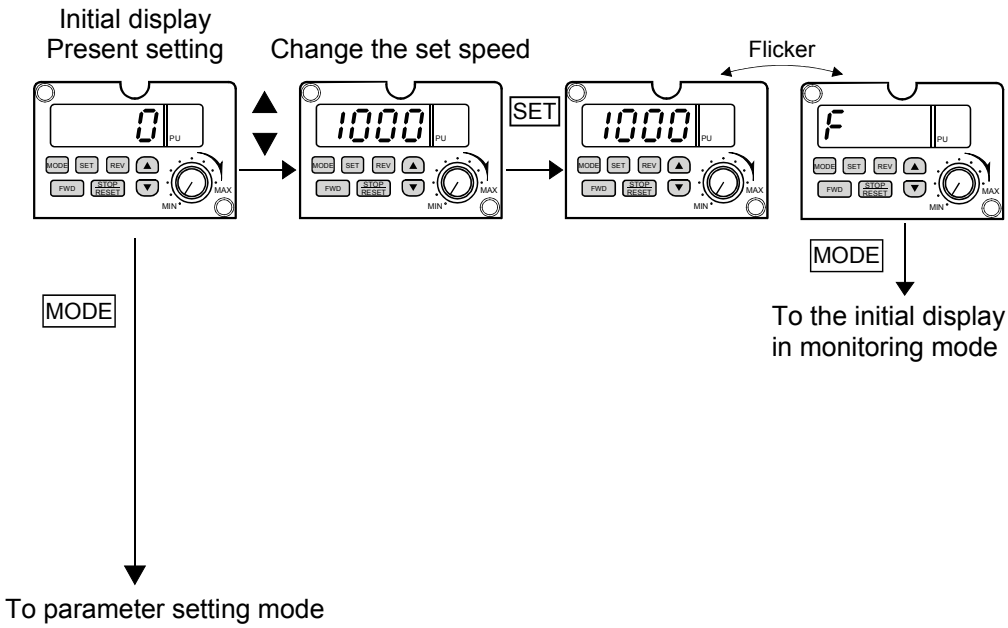
(1) Monitoring mode



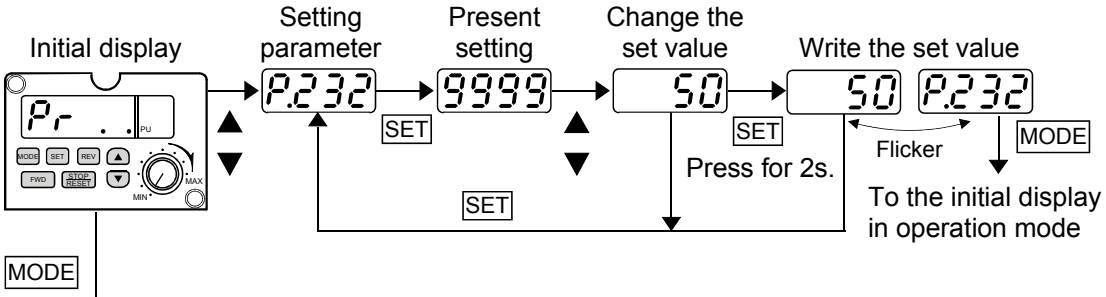
MEMO	● Press SET for 2s or longer to display the current monitor or voltage monitor at power-ON. ● The fault monitor display only appears when the drive unit trips. ● To see a fault history one by one, press SET for 2s or longer while the fault monitor is displayed

(2) Speed setting mode

Setting example: Set the speed to 1000r/min.



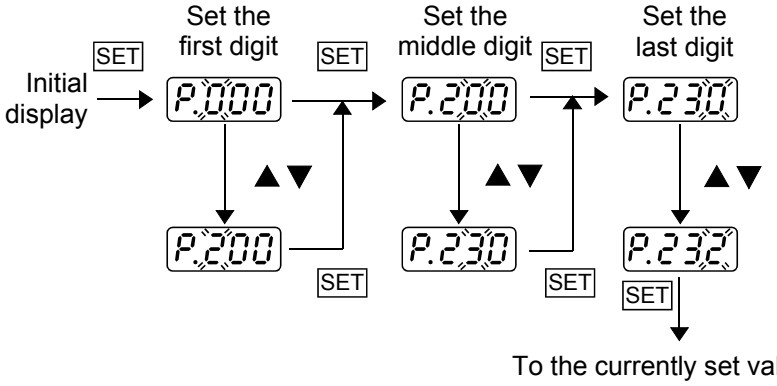
(3) Parameter setting mode
Setting example: Set "50" in Pr.232.



MODE

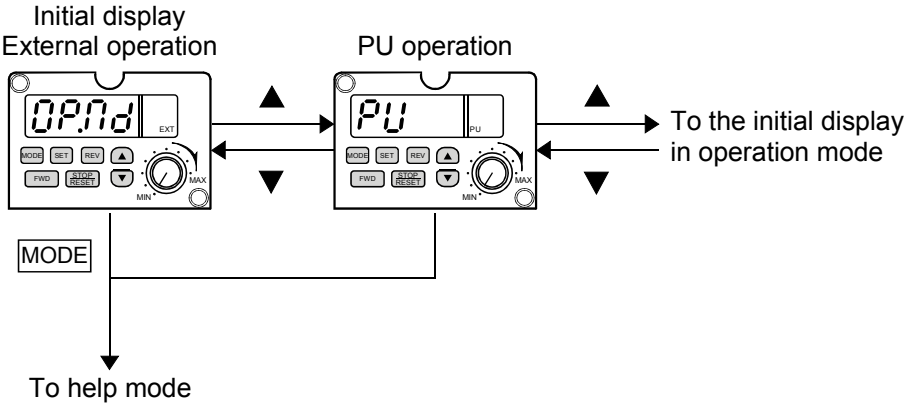
MEMO

● Each digit can be set for parameter numbers.
It cannot be done for setting values.

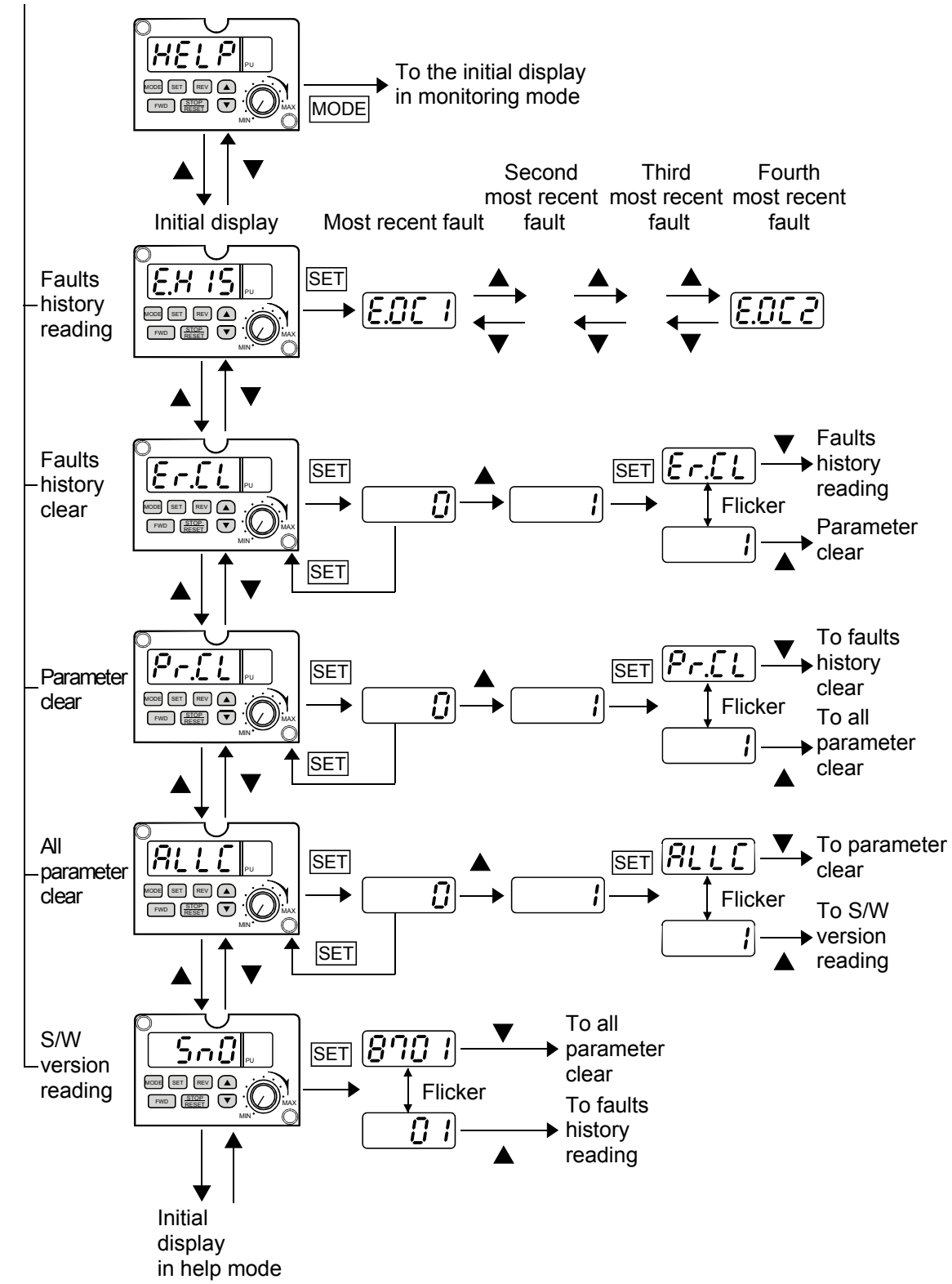


● When▲▼keys are selected to be used for the parameter number selection, "ron" appears at power-ON.
Press▲▼keys to display a parameter number.

(4) Operation mode



(5) Help mode



MEMO	● Press SET while a fault history is displayed to display the output frequency of the drive unit at the fault occurrence. ● Parameter clear and all parameter clear are available under PU operation mode and PU/External combined operation 1 and 2. "Err" flickers under External operation mode.

4.4 Restrictions with FR-PU04

When the FR-PU04 parameter unit (option) is used, some of the FR-PU04 functions are unavailable.

(1) Display language on parameter unit

- Only Japanese is available. It cannot be changed to any other language.

(2) Parameter name and setting range

- Parameter names (katakana characters) do not appear. (Except Pr.900, Pr.902 to Pr.905, Pr.922, and Pr.923.)
- Parameter setting ranges do not appear.

(3) Function-by-function parameter setting

- Not available.

(4) Help function

- The parameter list does not appear.
- The parameter change list does not appear.
- The troubleshooting function is unavailable. The remedy screen for "デンリュウガオオキイ" appears but the corresponding parameter function does not exist.
- The terminal assignment function is not displayed.

MEMO	● Copy mode Copying is not allowed between drive units of different capacities. If you have copied accidentally, perform all clear of the copy destination drive unit. In addition, copying is not allowed to drive units other than the MD-CX520 series.

5. OPERATION

This section descries the basic operation method of drive units.

⚠CAUTION
● If the machine should become out of control, perform test operation after ensuring safety. ● Start operation after performing test operation under light load at low speed to ensure that operation is performed safely. ● Check that the machine has no damage. ● Securely set the parameter values to match the operating machine system environment.

Contents of This Section

5.1 Power On

Switch power on after making sure that the unit has been installed and wired properly and that the start signal is OFF.
An LED on the operation panel and the POWER lamp are lit.

NOTICE	● If an LED is not lit, check the following points: ● Contact faults do not exist between the drive unit and the operation panel. ● The jumper across the DC reactor connection terminals P/+-P1 is fitted properly.

5.2 Parameter Setting

5.2.1 Selecting the operation mode parameters

Set appropriate parameters depending on how you input a start signal (forward rotation, reverse rotation, stop) and a speed signal.
Use Pr. 79 and Pr. 146 [Section 8.2] to select an operation mode.

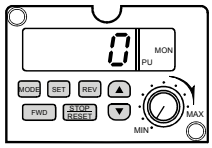
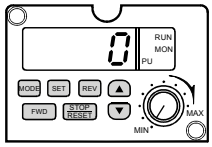
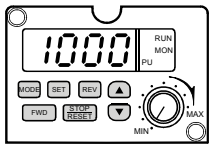
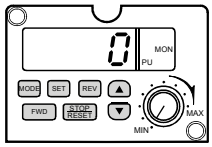
5.2.2 Checking the basic parameters

Drive units have various parameters to support different applications. Simple variable-speed operation can be performed with the initial setting. Enhanced operation can be performed for some load (machine) specifications with adjusted parameter settings. Before changing parameter settings, check the setting values.
The parameters, which we recommend to be pre-checked before operation, are indicated with B in the index of Section 8 PARAMETER FUNCTIONS. Set a value which is suitable for the load specification.

5.3 Operation Example

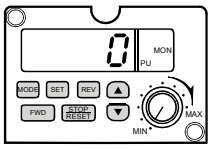
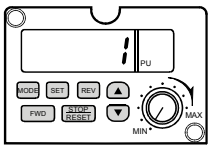
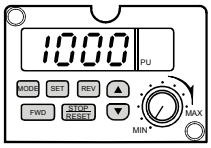
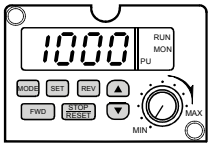
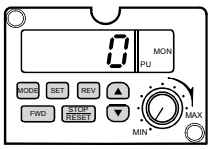
5.3.1 PU operation mode

(1) Setting the speed to 1000r/min with the speed setting potentiometer

Step	Operation procedure	Display (upon completion)
1. Checking the operation mode	1) The operation mode indicators "MON" and "PU" LEDs are lit, and the monitoring mode display appears at turn ON of the power supply. If the operation mode indicator "EXT" LED is lit, check if "1" is set in Pr. 79 [Section 8.2].	
2. Inputting a start signal	1) Press RUN(FWD) key for the operation mode indicator "RUN" LED to be lit and get ready for the forward rotation . Press REV key for the operation mode indicator "RUN" LED to flicker and get ready for the reverse rotation.	Forward rotation 
3. Inputting a speed	2) Turn the speed setting potentiometer clockwise to rotate a motor. Turn it further clockwise to increase its speed. Turn it counterclockwise to decrease the motor speed. If the value on the main display does not change even though the speed setting potentiometer is turned, check that "0" is set in Pr. 146 [Section 8.2].	
4. Inputting a stop signal	1) Press the STOP/RESET key to decelerate the motor to stop according to the set deceleration time. After the motor stops, operating mode indicator "RUN" LED turns OFF.	

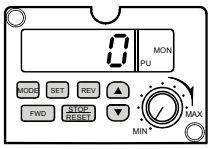
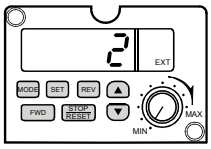
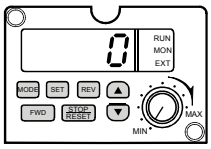
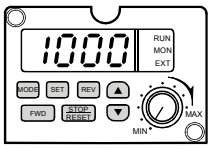
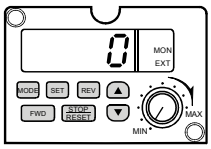
MEMO	● The motor accelerates (decelerates) according to the commanded speed changes or the acceleration (deceleration) time setting, whichever is slower. ● An operation speed can be set prior to the input of a start signal. In this case, the motor accelerates/decelerates according to the set acceleration/deceleration time. ● Use Pr. 922 and Pr. 923 [Section 8.2] to change the degree of motor speed allocated to a turn of the speed setting potentiometer.

(2) Setting the speed to 1000r/min with ▲▼ (UP/DOWN) keys

Step	Operation procedure (initial setting)	Display (upon completion)
1. Checking the operation mode	1) Operation mode indicators "MON" and "PU" LEDs are lit, and the monitor mode display appears when the power supply turns ON.	
	2) Set Pr. 146 = 1 in the parameter setting mode [Section 8.2].	
2. Inputting a speed	1) Use ▲▼ keys to set a speed in the speed setting mode.	
3. Inputting a start signal	1) Press RUN(FWD) key to start the forward rotation and REV key to start the reverse rotation. The speed increases according to the set acceleration time.	
	2) The display automatically changes from the speed setting mode to the monitoring mode. The operation mode indicator "RUN" LED is lit during the forward rotation and flickers during the reverse rotation.	
	3) Acceleration is completed when the set speed is displayed on the main display.	
4. Inputting a stop signal	1) Press the STOP/RESET key to decelerate the motor to stop according to the set deceleration time. After the motor stops, operation status indicator "RUN" LED turns OFF.	

5.3.2 External operation mode

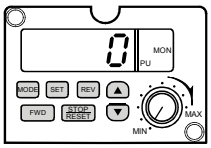
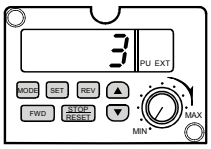
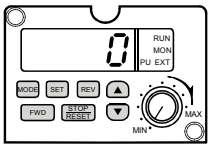
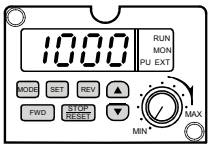
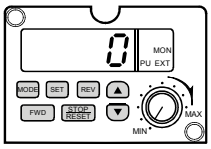
(1) Operation with the analog speed command (voltage input)

Step	Operation procedure (initial setting)	Display (upon completion)
1. Checking the operation mode	1) Operation mode indicator "MON" LED is lit, and the monitor mode display appears at turn ON of the power supply.	
	2) Set Pr. 79 = "0 or 2" in the parameter setting mode [Section 8.2]. The operation mode indicator "EXT" LED is lit while the External operation mode is selected.	
2. Inputting a start signal	1) Turn ON the start signal connected to the terminal STF (or STR). The operation status indicator "RUN" LED is lit (or flickers).	
3. Inputting a speed	1) Input a speed setting signal to the terminal 2 to run the motor. The speed increases in proportion to the increased ratio of the speed setting signal.	
4. Inputting a stop signal	2) Give a lower speed setting signal to the terminal 2 to reduce the speed. Turn the start signal off after the rotation speed becomes "0." Operation status indicator "RUN" LED turns off.	

MEMO	● The motor speed changes according to the change ratio (slope) of the input signal when using an analog command. The set acceleration/deceleration speed is the fastest speed change possible. To set the operation speed to correspond with the change ratio of the input signal, set "0" in the acceleration/deceleration time setting. ● The start signal can be turned ON/OFF after the speed setting signal has been input. In this case, the motor accelerates/decelerates according to the set acceleration/deceleration time. ● Use Pr. 902 to Pr. 905 [Section 8.3.1] to change the degree of motor speed allocated to an analog speed command.

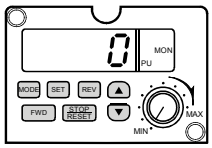
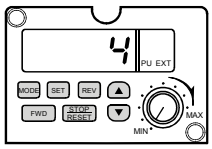
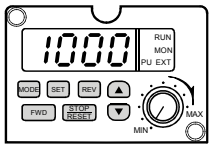
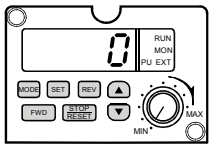
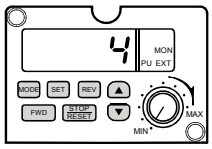
5.3.3 External/PU combined operation mode 1

Setting the speed to 1000r/min

Step	Operation procedure (initial setting)	Display (upon completion)
1. Checking the operation mode	1) Operation mode indicators "MON" and "PU" LEDs are lit, and the monitoring mode display appears when the power supply turns ON.	
	2) Set Pr. 79 = 3 in the parameter setting mode [Section 8.2]. The operation mode indicators "EXT" and "PU" LEDs are lit while External/PU operation mode is selected. Set "1" in Pr. 146 [Section 8.2] to use ▲▼ keys for speed setting.	
2. Inputting a start signal	1) Turn ON the start signal assigned to the terminal STF (or STR). The operation status indicator "RUN" LED is lit (or flickers).	
3. Inputting a speed	1) Set a speed in the speed setting mode. Turn the speed setting potentiometer or press ▲▼ keys to rotate the motor. The display automatically changes from the speed setting mode to the monitoring mode.	
4. Inputting a stop signal	1) Turn OFF the start signal. The motor decelerates to stop according to the set deceleration time. After the speed becomes "0," operation status indicator "RUN" LED turns OFF.	

5.3.4 External/PU combined operation mode 2

Operation with the analog speed command (voltage input)

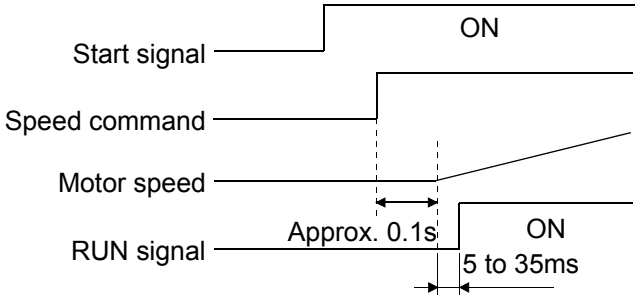
Step	Operation procedure (initial setting)	Display (upon completion)
1. Checking the operation mode	1) Operation mode indicators "MON" and "PU" LEDs are lit, and the monitor mode display appears when the power supply turns ON.	
	2) Set Pr. 79 = 4 in the parameter setting mode [Section 8.2]. The operation mode indicators "PU" and "EXT" LEDs are lit while External/PU operation mode is selected.	
2. Inputting a start signal	1) Press RUN(FWD) key to lit the operation mode indicator "RUN" LED. Press REV key to lit the operation mode indicator "RUN" LED.	
3. Inputting a speed	1) Input a speed setting signal to the terminal 2 to rotate the motor. The speed increases in proportion to the increased degree of the speed setting signal.	
4. Inputting a stop signal	1) Press the STOP/RESET key to decelerate the motor to stop according to the set deceleration time. After the motor stops, operation status indicator "RUN" LED turns OFF.	

MEMO	● The motor rotation speed changes according to the change ratio (slope) of the input signal when using an analog command. The set acceleration/deceleration speed becomes the fastest speed change possible. To set the operation speed to correspond with the change ratio of the input signal, set "0" to the acceleration/deceleration time setting. ● The start signal can be turned ON/OFF after the speed setting signal has been input. In this case, the motor accelerates/decelerates according to the set acceleration/deceleration time. ● Use Pr. 902 to Pr. 905 [Section 8.3.1] to change the degree of motor speed allocated to an analog speed command.

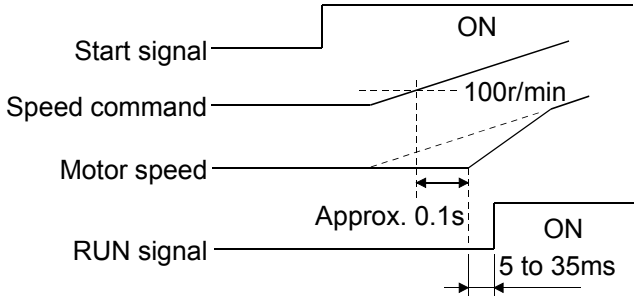
5.3.5 Operation at start

The drive unit detects the magnetic pole of the motor at every start. The magnetic pole detection time is approx. 0.1s (85ms±15ms) after the start signal and speed signal are input. During this period, the motor remains stopped and starts running after magnetic pole detection is finished.

● When inputting a speed command with the operation panel or with contact signals



● When inputting the speed command with an analog signal



MEMO	● When the start signal is entered after the input of the speed command, the motor starts running approx. 0.1s after the input of the start signal. ● When the analog signal is used to give the speed command, the motor starts running approx. 0.1s after the speed command has reached the value equivalent to 100r/min (setting of Pr. 13). ● When the operation is switched from forward to reverse, the motor stops approx. 0.1s to 0.3s according to the operating condition.

NOTICE	● When restarting the motor after decelerating it to a stop, start the motor after ensuring that it has stopped. If you start the motor that has not yet come to a complete stop, sufficient starting torque may not be provided. Especially with small load torque (friction torque) and large load moment of inertia, the motor rotates slightly even after the voltage brake operation is completed. Make sure the motor is completely stopped before restarting the operation. Refer to: Section 8.5.3 Stop operation ● Do not switch off the AC input power while the motor is running at a high speed. Doing so may activate the undervoltage protective circuit instantaneously under the influence of a motor-generated voltage. Refer to: Section 6.1.1 Protective function activated

MEMO

6. TROUBLESHOOTING

This section describes how to remedy a fault which occurred in your drive unit or motor and the maintenance and inspection of the drive unit.

NOTICE	● If you have found any fault, immediately perform inspection and take action to remove its cause. If you cannot identify the cause and resolve the malfunction, contact your sales representative.

⚠WARNING
● At occurrence of an alarm, turn off the operation signal before resetting the alarm. Resetting the alarm with the operation signal on will restart the motor suddenly. Injury may result. ● At occurrence of an alarm, immediately turn off the operation signal. Not doing so may reset the alarm due to power OFF-ON, e.g. instantaneous power failure, restarting the motor suddenly. Injury may result.

Contents of This Section

6.1 Message Displayed on the Operation Panel

6.1.1 Protective function activated

When the protective function is activated, one of the following messages appears on the operation panel. At this time, the ALARM lamp is lit, the drive unit output is shut off, and the motor, if running, coasts.

MEMO	● The protective function that has been activated can be exported from the control circuit output terminal. Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

When the protective function is activated, perform inspection and take action in accordance with Table 6-1 to remove its cause.

● To restart, reset the drive unit in any of the following methods.
- ● Switch the power OFF once, then ON
- ● Short the terminals RES-SD for more than 0.1s.
- ● Press the STOP/RESET key on the operation pane or parameter unit.

Table 6-1

Display detail		Protective function name Detection level	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
E.OC 1 (E.OC1)	カソクジカデンリュウ	Acceleration-time overcurrent Output current is more than 200% of the motor rating.	● The acceleration torque is beyond the drive unit capability. ● Increase the acceleration time. ● Change to the S-pattern acceleration/deceleration. ● Outputs U, V and W are in a short circuit or ground fault. ● Check the motor winding resistance. ● Check the connection cables for damage. ● The motor restarted during coasting. ● Drive unit capacity does not match with the motor capacity.
E.OC2 (E.OC2)	テイソクジカデンリュウ	Constant speed-time overcurrent Output current is more than 200% of the motor rating.	● Excessive load was applied instantaneously. ● Outputs U, V and W resulted in a short circuit or ground fault during constant-speed operation. ● Check the motor winding resistance. ● Check the connection cables for damage. ● Drive unit capacity does not match with the motor capacity.

Table 6-1 (Continued)

Display detail		Protective function name Detection level	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
E.OC3 (E.OC3)	ゲンソクジカデンリュウ	Deceleration-time overcurrent Output current is more than 200% of motor rating.	● The deceleration torque is beyond the drive unit capability. ● Increase the deceleration time. ● Change to the S-pattern acceleration/deceleration ● Outputs U, V and W resulted in a short circuit or ground fault during deceleration operation. ● Check the motor winding resistance. ● Check the connection cables for damage. ● The mechanical brake of the motor operates too early. ● Delay the operation timing. ● Drive unit capacity does not match with the motor capacity.
E.Ov1 (E.OV1)	カソクジカデンアツ	Acceleration-time overvoltage Main circuit DC voltage is more than 400V.	● Surge compounded with power during acceleration operation. ● Install a reactor. ● Fit a surge suppressor or like to the surge source. ● The regenerative energy handling capability is insufficient. ● Fit the regenerative brake option.
E.Ov2 (E.OV2)	テイソクジカデンアツ	Constant speed-time overvoltage Main circuit DC voltage is more than 400V.	● Surge compounded with power during constant speed operation. ● Install a reactor. ● Fit a surge suppressor or like to the surge source. ● Load increased suddenly, activating the stall prevention function. ● The regenerative energy handling capability is insufficient. ● Fit the regenerative brake option.
E.Ov3 (E.OV3)	ゲンソクジカデンアツ	Deceleration-time overvoltage Main circuit DC voltage is more than 400V.	● The deceleration torque is beyond the drive unit capability. ● Increase the deceleration time. ● Change to the S-pattern acceleration/deceleration ● The regenerative energy handling capability is insufficient. ● Fit the regenerative brake option. ● Surge compounded with power during deceleration operation or stop. ● Install a reactor. ● Fit a surge suppressor or like to the surge source.

Table 6-1 (Continued)

Display detail		Protective function name Detection level	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
E.THT (E.THT)	トランジスタホゴサーマル	Electronic thermal O/L relay Refer to Pr. 9 [Section 8.5.7]	● The motor and drive unit are operated under overload. ● Reduce the load. ● Increase the capacities of the motor and drive unit.
E.THM (E.THM)	デンシサーマル		
E.UVT (E.UVT)	フソクデンアツ	Undervoltage AC input power supply voltage is less than about 150V.	● An instantaneous voltage drop in the AC input power supply from the starting of a large capacity equipment, for example. NOTICE Do not switch the AC input power off while the motor is running at high speed. Doing so may activate the undervoltage protective circuit instantaneously under the influence of a motor-generated voltage. ● The AC input power supply voltage is insufficient. MEMO An alarm signal is not output if this protective circuit is activated with the AC input power insufficient. It is also not recorded in the faults history. To export as an external signal the fact that this protective circuit has been activated, assign the UVT signal to the control circuit output terminal using Pr. 190, Pr. 194, or Pr. 195 [Section 8.7.2]
E.FIN (E.FIN)	フィンカネツ	Fin overheat Heatsink temperature is higher than the permissible value of the components.	● The surrounding air temperate exceeded the permissible temperature. ● The cooling fan failed. MEMO An alarm signal can be provided by making control circuit output terminal assignment.

Table 6-1 (Continued)

Display detail		Protective function name Detection level	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
E.OHT (E.OHT)	ガイブホゴ	External failure —	● An external relay or another relay, which is connected to the terminal where the OH signal is assigned, turned ON. Refer to: Section 8.4 Selection of the Control Circuit Contact Input Terminal Functions
E.PUE (E.PUE)	PUヌケ ハッセイ	PU disconnection —	● A connection fault of the operation panel or the parameter unit occurred. Refer to: Pr. 75 [Section 8.2] ● RS-485 communication was interrupted. ● The number of communication retries exceeded the Pr. 121 setting. Refer to: Pr. 121 [Section 8.6]
E.OLT (E.OLT)	ストール ボウシ ニヨリ テイシ	Stall prevention stop Refer to Pr. 22 [Section 8.5.5]	● Motor overload activated the stall prevention function consecutively, stopping the motor. ● Reduce the load. ● Increase the capacities of the motor and drive unit.
E.LF (E.LF)	シュツリョク ケッソウ	Open loss	● One of the output phases U, V, or W was lost . MEMO Phase loss during motor driving may activate the overcurrent protective function.

If any of the messages in Table 6-2 appear, the drive unit is assumed to have failed. If the same message reappears after a fault reset, immediately replace the drive unit.

Table 6-2

Display detail		Protective function name	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
E.CPU (E.CPU)	CPUエラー	CPU fault	● Malfunction of CPU. ● CPU became faulty.
E. PE (E.PE)	パラメータ エラー	Storage device fault	● The storage device failed.
E. bE (E.BE)	ブレーキ カイロ イジョウ	Brake circuit fault	● The regenerative brake circuit failed. ● If E. BE reappears after a reset, immediately switch power off. Leaving power on will overheat the brake resistor.

6.1.2 Alarm function activated

If the alarm function is activated during motor operation, one of the displays in Table 6-3 is provided on the operation panel or the parameter unit.
If you ignore the alarm message and continue operation, the fault detection function may be activated, leading to an operation stop. When you noticed that the alarm function had been activated, immediately remove its cause.

MEMO	● The alarm function that has been activated can be exported as an alarm signal. Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

Table 6-3

Display detail		Alarm name Detection level	Related protective function
Operation panel (actual character)	Parameter unit		
OL (OL)	OL	Overload 1 Pr. 22 setting [Section 8.5.5]	Acceleration-time overcurrent, constant speed-time overcurrent, deceleration-time overcurrent, stall stop

oL (oL)	oL	Overload 2 Main circuit DC voltage more than 390V	Deceleration-time overvoltage
Fn (FN)	FN	Fan failure Cooling fan fault Refer to Pr. 244 [Section 8.5.7]	Fin overheat

6.1.3 Others

Table 6-4

Display detail		Name	Possible cause (●) and corrective action (●)
Operation panel (actual character)	Parameter unit		
Err (Err)	⟨A sentence will appear according to the fault.⟩	Operation error	● Parameter changing operation was performed during External operation. ● The value that was set is outside the parameter setting range. ● The RES signal remains ON. ● The operation panel is in a connection fault. ● Check the fitting status. MEMO An operation error does not activate the relay contact output.
PS (PS)	PS	Emergency stop operation	● The STOP/RESET key on the operation panel or parameter unit was pressed to make a stop during External operation. MEMO A reset cannot be made in the normal method. Refer to Pr. 75 [Section 8.2]

6.1.4 Correspondences between digital and actual characters

There are the following correspondences between the actual alphanumeric characters and the digital characters displayed on the operation panel.

Actual	Digital
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

Actual	Digital
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
L	

Actual	Digital
M	
N	
O	
o	
P	
S	
T	
U	
V	
r	
-	

6.2 Abnormal Motor Operation

If any of the following faults has occurred in the motor, identify the cause and take adequate measures.

Event	Area of inspection	Possible cause (●) and corrective action (•)
Motor remains stopped.	Check the main circuit.	● A normal power supply voltage is not applied. ● The jumper across terminals P/+-P1 has been disconnected. ● The motor is not wired properly. ● The switch connected between the motor and drive unit is open.
	Check the control signals.	● The start signal has not been initiated. ● Both the forward and reverse rotation signals are input. ● The speed setting signal is not input. ● AU signal is not ON while 4 to 20mA speed setting signal is given. ● The MRS signal remains ON.
	Check the parameter settings.	● The reverse rotation prevention, Pr. 78 [Section 8.5.1], has been set. ● Operation mode setting, Pr.79 [Section 8.2], is incorrect. ● "0" was set as the maximum speed, Pr. 1 [Section 8.5.1].
	Check the load.	● The load is too heavy. (The alarm message OL appears.) ● The motor shaft is locked.
	Others	● The alarm lamp is lit. ● The POWER lamp is off. ● Terminals PC and SD are shorted. ● Drive unit capacity does not match with the motor capacity.
Motor rotates in opposite direction.	Check the main circuit.	● The wiring of the motor connection terminals U, V, W does not match the motor phase sequence.
	Check the control signals.	● The wiring of the forward rotation signal (terminal STF) and that of the reverse rotation signal (terminal STR) was exchanged.

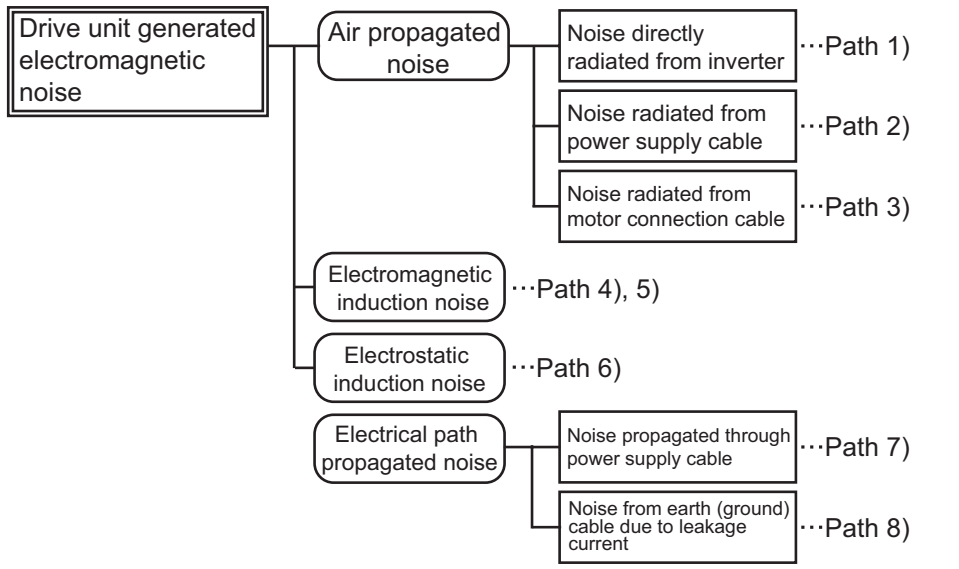
Speed differs from the setting.	Check the control signals.	● The speed setting signal differs from the setting. ● The speed setting signal is compounded with noise.
	Check the parameter settings.	● The speed signal bias/gain, Pr. 902 to Pr. 905 [Section 8.3.1], have been set. ● The maximum speed, Pr. 1 [Section 8.5.1], or minimum speed, Pr. 2 [Section 8.5.1], has been set. ● The stall prevention function, Pr. 22 [Section 8.5.5], has been activated. ● Increase the acceleration or deceleration time setting. ● Reduce the load.
Acceleration/ deceleration is not smooth.	Check the parameter settings.	● The stall prevention function, Pr. 22 [Section 8.5.5], has been activated. ● Increase the acceleration or deceleration time setting. ● Reduce the load.
Speed varies.	Check the control signals.	● The speed setting signal varies.
	Check the load.	● The load varies.
At start, motor shaft runs in opposite direction instantaneously.	Check the parameter settings.	● The acceleration time setting is more than that for the maximum permissible starting torque. ● Increase the acceleration time setting.

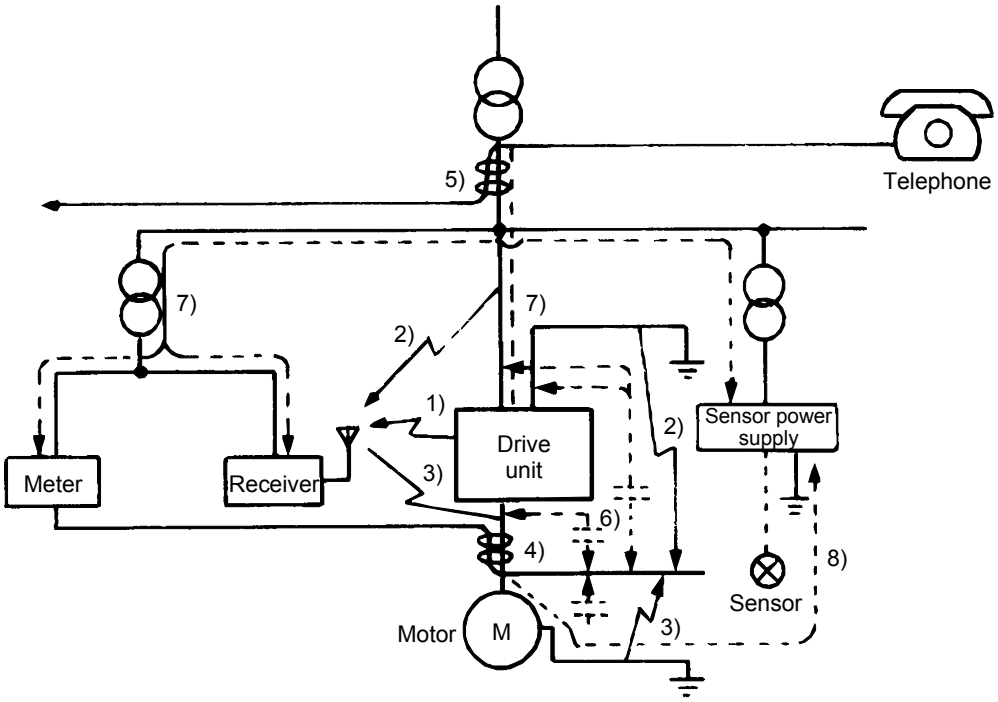
6.3 Malfunction Due to Electromagnetic Noise and the Corresponding Countermeasures

Electromagnetic noises from the drive unit are roughly categorized into the following:

- Noise that is radiated from the drive unit and the cable connected to its main circuit (I/O).
- Electromagnetically or electro-statically induced noise to the signal cable positioned near main circuit cables.
- The noise that propagates power supply lines
  External noises also take such propagation paths to make the drive unit malfunction.

(1) Electromagnetic noise types and propagation paths





(2) Countermeasures

Take the following countermeasures according to the expected noise propagation path. Refer to the expected effect (estimated level) in each section to determine whether to perform the countermeasure.

◎ (Significantly effective), ○(Effective), △(Slightly effective), – (Not effective)

Location	Countermeasure	Noise propagation path						
		Air propagated			Electro-magnetically induced	Electro-statically induced	Cable propagated	
		Radiated from drive unit	Radiated from power cable	Radiated from motor cable			Through power cable	Through earth (ground) cable
Drive unit	Set a lower value in Pr.72 "motor sound selection."	◎	◎	◎	◎	◎	◎	◎
AC power supply side	Install FR-BIF radio noise filter.	–	◎	–	–	–	◎	–
	Install FR-BSF01 or FR-BLF line noise filter.	–	◎	–	–	–	◎	△
	Put the power cable in a metal conduit or use shielded cable.	–	◎	–	–	–	◎	–
	Install insulation transformer or noise suppression transformer	–	△	–	–	–	◎	–
	Separate the power supply line.	–	–	–	–	–	◎	◎

Motor side	Install FR-BSF01 or FR-BLF line noise filter.	–	–	◎	△	△	–	◎
	Put the motor cable to metal conduit or use shielded cable.	–	–	◎	○	○	–	–
	Use 4-wire cable for the motor power cable. Earth (ground) one wire of the cable.	–	–	△	△	△	–	◎
Control circuit side	Use shielded cable for signal input cable.	△	△	△	○	◎	–	△
	Use twisted shield cable for speed input cable.	○	○	○	◎	◎	–	△
	Insert commercially available ferrite cores to speed input cable.	△	△	△	○	–	–	–

Location	Countermeasure	Noise propagation path						
		Air propagated			Electro-magnetically induced	Electro-statically induced	Cable propagation	
		Radiated from drive unit	Radiated from power cable	Radiated from motor cable			Through power cable	Through earth (ground) cable
Connected device side	Use twisted shield cable for speed input cable. Connect shield sheath to the common terminal of target unit.	○	○	○	◎	◎	–	◎
	Stop using parallel wiring with the power cable of the drive unit.	△	△	△	◎	◎	–	–
	Place the unit as far as possible from the drive unit and power cable.	◎	◎	◎	◎	◎	–	–
	Install a shielding plate between drive unit and power cable.	○	△	△	△	△	–	–
	Insert commercially available ferrite cores to signal input cable, etc.	–	–	–	–	–	○	△
	Lower the output impedance from the speed signal output circuit.	△	△	△	○	–	–	–

6.4 Maintenance and Inspection

⚠WARNING
● When performing inspection by removing the front cover or the like, switch power off, wait 10 or more minutes, then check that the voltage across the DC terminals P/+-N/- is less than 30VDC with a tester or like before starting inspection. Otherwise, an electric shock can occur. ● Any person who is involved in inspection should be fully competent to do the work. Otherwise, an electric shock can occur. Do not disassemble or repair the unit.

6.4.1 Inspection

(1) Daily inspection

During operation and power-on, visually check for the following faults without removing the cover and like.

1) Faulty motor operation
2) Improper installation environment (surrounding air temperature, humidity, dust, dirt, etc.)
3) Unusual noise, unusual vibration, foul odor, etc.
4) Overheat trace, discoloration, etc.
5) Improper cooling fan rotation
6) Improper on/off of lamps, LEDs and others
7) Improper meter indications

NOTICE	● Always use the drive unit in a clean status. ● When cleaning, always switch power off and gently wipe dirty areas with a soft cloth immersed in neutral detergent or ethanol. Do not use detergent or the like to clean the display section of the operation panel and parameter unit. ● When cleaning, do not use solvent, e.g. acetone, benzene, toluene or alcohol, as they will cause the drive unit surface paint to peel off.

(2) Periodic inspection

After operation has stopped, switch power off, remove the front cover, and perform periodic inspection referring to Table 6-5 Periodic Inspection List.

Table 6-5 Periodic Inspection List

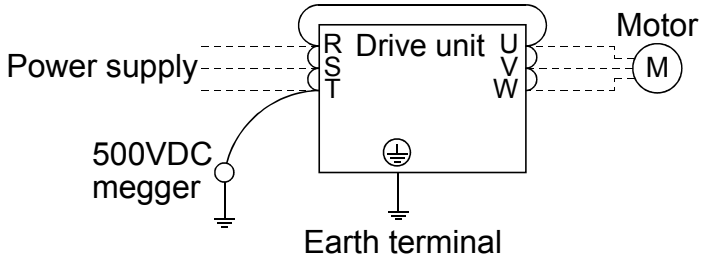
Area of inspection		Inspection items	Methods	Criteria
Surrounding environment		1) Check surrounding air temperature, humidity, vibration, atmosphere (for dust, dirt, gas, oil mist, water drops, etc.) 2) Check for tools, foreign matter and dangerous articles in the periphery.	1) Measure visually or with instruments. ● Thermometer ● Hygrometer ● Recorder 2) Visual check	1) Standard specification values must be satisfied. 2) Must not be left unremoved.
Overall unit		Check for unusual vibration and unusual noise.	Visual and auditory checks.	No fault.
Main circuit	General	1) Check for loose screws and bolts. 2) Check parts and members for deformation, crack, damage, and discoloration caused by overheat or deterioration. 3) Check for contamination and sticking dust and dirt.	1) Retighten. 2), 3) Visual check.	1), 2), 3) No fault.
	Conductors, cables	1) Check conductors for discoloration and distortion caused by overheat. 2) Check cable sheaths for breakage and discoloration.	1), 2) Visual check.	1), 2) No fault.
	Terminal block	Check for damage.	Visual check.	No fault.
	Smoothing capacitor	1) Check for liquid leakage, discoloration, crack and casing expansion. 2) Check for projected safety valve. 3) Measure capacitance.	1), 2) Visual check. 3) Use capacitance meter for measurement.	1), 2) No fault. 3) 85% or more of rated capacitance.
	Resistor	Check for foul odor and insulation crack due to overheat.	Olfactory, visual checks.	No fault.

Control circuit	Control printed circuits, connectors	1) Check for loose screws, bolts and connectors. 2) Check for unusual odor and discoloration. 3) Check for crack, damage, deformation, and rust. 4) Check capacitor for liquid leakage and traces of deformation.	1) Retighten. 2) Olfactory, visual checks. 3), 4) Visual check.	1), 2), 3), 4) No fault.
Cooling system	Cooling fan	1) Check for sticking foreign matter. 2) Check for loose connection.	1) Hand turn. 2) Visual check.	1) Smooth turn. 2) No fault.
	Ventilation path	Check for clogged heat sink, suction/exhaust ports, and sticking foreign matter.	Visual check.	No fault.

NOTICE

● Insulation resistance test using megger

Where possible, do not conduct an insulation resistance test using a megger since an insulation test has been done before shipment from the factory. When it is inevitable to make an insulation resistance test using a megger, disconnect all cables from the control circuit to prevent a test voltage from leaking into the control circuit. The drive unit will fail if the test voltage is applied to the control circuit.



● Pressure test

Do not conduct a pressure test. A pressure test can deteriorate the semiconductor parts in the drive unit.

6.4.2 Wear parts

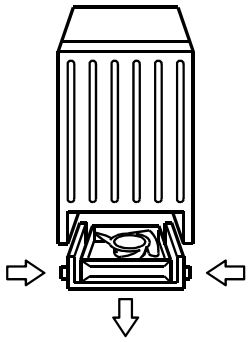
The replacement lives of the parts are as indicated below. Since the lives vary with the operating environment and/or usage, you must replace the parts if you have found any fault during periodic inspection or the like.

Part name	Standard replacement intervals	Method	Remarks
Cooling fan	2 to 3 years	Change (as required)	The bearing life of the cooling fan is 10,000 to 35,000 hours. For continuous operation, therefore, normally replace the fan every 2 to 3 years as a guideline.
Main circuit smoothing capacitor	5 years	Change (as required)	The life greatly depends on the surrounding air temperature and operation specifications of the drive unit. When continuous operation is performed in normal air-conditioned environment, the life is approximately 5 years. The life halves for each 10°C rise in surrounding air temperature. The capacitor deteriorates rapidly after the given period has elapsed, causing the motor to run unstably or activating the overcurrent protective function.
On-board smoothing capacitor	5 years	Change (as required)	

6.4.3 Cooling fan replacement method

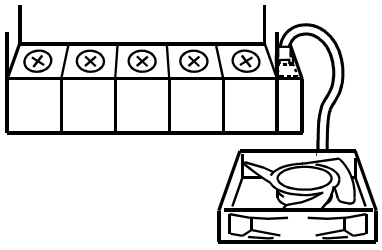
Removal

1) Remove the wiring cover.
2) Unplug the fan connector.
   The cooling fan is connected with the cooling fan connector on the drive unit terminal block side.
   Unplug the connector and remove the drive unit and cooling fan.
3) Remove the cooling fan cover.
   Push the cover in the direction of arrows and pull it down.
4) Remove the cooling fan and cooling fan cover.
   The cooling fan is secured by latches.
   The cooling fan and cooling fan cover can be removed by disengaging the latches.



Reinstallation

1) After confirming the orientation of the fan, reinstall the fan to the cover so that the arrow on the left of "AIR FLOW" faces in the opposite direction of the fan cover.
   Note: The wrong direction of air flow can shorten the drive unit life.
2) Reinstall the fan cover to the drive unit. Pass the wiring through the wiring groove to avoid it from being caught between the chassis and cover.
3) Connect the wiring to the connector.
4) Reinstall the wiring cover.

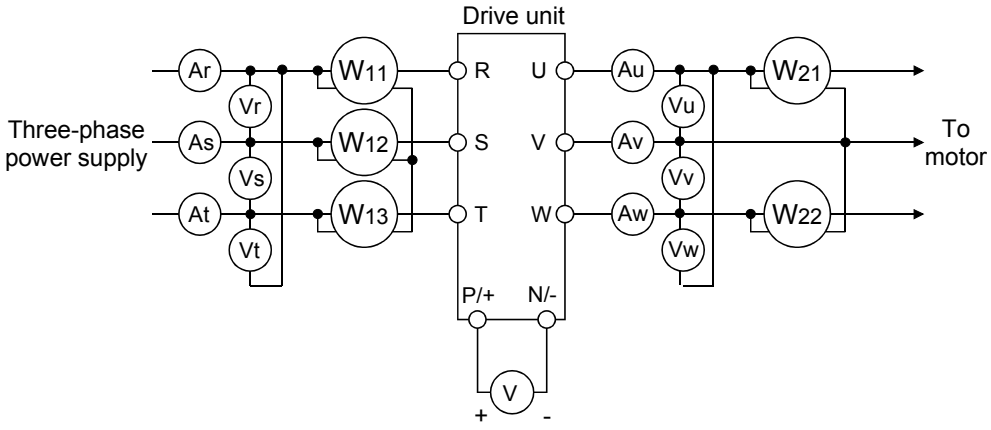


6.4.4 Power measurement at circuits

(1) Measurement of the main circuit voltage and current

The voltage/current at the power supply side and the output side of the drive unit contain harmonic components. Its measured value may differ according to the measuring tool.
Follow the following procedure to measure with a commercially available frequency meter.

● Measurement circuit



Input power = $W_{11}+W_{12}+W_{13}$
Output power = $W_{21}+W_{22}$

● Measurement tool

Item	Input (power supply) side			Output (motor) side			DC circuit terminals P/+, N/-
	Voltage waveform / Current waveform			Voltage waveform / Current waveform			
Meter name	Ammeter Ar,s,t	Voltmeter Vr,s,t	Wattmeter $W_{11,12,13}$	Ammeter Au,v,w	Voltmeter Vu,v,w	Wattmeter $W_{21,22}$	DC voltmeter V
Meter type	Movable core type	Rectifier type or movable core type	Electro dynamometer	Movable core type (NOTE 1)	Rectifier type (NOTE 2)	Electro dynamometer	Movable coil type
Meter signal							

NOTE 1. Eddy current loss incurred to the metal portion inside the meter becomes large with a carrier frequency larger than 5kHz (Pr. 72=3 or higher [Section 8.5.7]). The drive unit may even burn in such a condition. Do not perform such a setting.
In such case, use the approximate effective value.

2. Use FFT to correctly measure the output voltage.
Correct measurement cannot be executed with a tester or a commercially available meter.

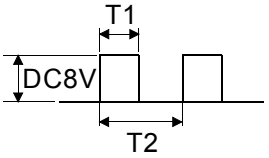
(2) Measurement of power factor

Power factor cannot be measured with a commercially available power-factor meter, which measures phase difference between the voltage and current. Measure the voltage/current and power at the power supply side, and perform the following calculation. To obtain the power factor of the motor alone, calculate it with voltage/current/power at the power supply side.

● Formula

$$\text{Power factor (\%)} = \frac{\text{Power(W)}}{\sqrt{3} \times \text{Voltage(V)} \times \text{Current(A)}} \times 100$$

(3) Measurement of control circuit power supply signal

Signal name	Location of measured terminal	Measurement tool	Measured value	
Speed setting signal	Across 2(+) and 5	Moving-coil type (tester can be used) (50kΩ or more internal resistance)	0 to 10VDC /0 to 5VDC	"5" is the common
	Across 4(+) and 5		4 to 20mADC	
Power supply for speed setting	Across 10(+) and 5		5VDC	
Indicator signal	Across FM(+) and SD		Approx. 5VDC of maximum speed (without a meter)  Pulse width T1: adjust with Pr. 900 Pulse cycle T2: adjust with Pr.55 (only valid for speed monitor)	SD is the common.
Selected start signal	Across SD and the following: STF, STR, RH, RM, RL		20 to 30VDC when terminals are open 1V or less during ON	
Reset	Across RES(+) and SD			
Output stop	Across MRS(+) and SD			

Fault signal	Across A and C Across B and C	Moving-coil type (such as tester)	Conduction measurement Across A and C <at OFF> no conduction <at ON> conduction Across B and C <at OFF> conduction <at ON> no conduction

7. SPECIFICATIONS

Contents of This Section

7.1 Drive Unit Specifications

7.1.1 Standard specifications

(1) Rated specifications

MD-CX520-□□		0.5K	1.0K	1.5K	2.0K	3.5K
Applicable motor capacity (kW)		0.5	1.0	1.5	2.0	3.5
Output	Overload capacity	150% 60s (inverse-time characteristics)				
	Regenerative braking torque (Note 1)	10% or more			5% or more	
Power supply	Rated input AC voltage	Three phase, 200V to 220V 50Hz, 200 to 230V 60Hz				
	Permissible AC voltage fluctuation	170 to 242V 50Hz, 170 to 253V 60Hz				
	Permissible frequency fluctuation	±5%				
	Power supply system capacity (kVA)	1.1	2.2	3.1	4.3	7.3
Protective structure		Enclosed type (IP20)				
Cooling system		Self-cooling	Air cooling			
Approx. mass (kg)		0.8	1.0	1.7	1.7	2.2

Note 1: Regenerative control torque indicates the short-time average torque (which varies with motor loss) provided when a motor alone is decelerated from the rated speed at the shortest time, and does not indicate continuous regenerative torque. The average deceleration torque becomes lower when the motor decelerates from a speed higher than the rated speed. Since the drive unit does not have a built-in brake resistor, use an optional brake resistor when regenerative energy is large. You can also use the brake unit (model BU).

MEMO	● The rated output capacity and rated speed of the motor used with the drive unit assume the rated input AC voltage indicated above. They cannot be guaranteed when the power supply voltage drops. ● The overload capacity indicated in % is the ratio of the overload current to the motor's rated output. ● The power supply system capacity varies with the values of the power supply side impedances (including those of the input reactor and cables). ● The drive unit cannot run multiple motors.

(2) Control specifications

Control system		Sensor-less PWM control
Carrier frequency		The following four carrier frequencies are available: 2kHz, 6kHz, 10kHz, and 14kHz
Max. output speed		3000r/min (output frequency 200Hz)
Speed resolution	Analog input	1/1000 of the max. preset speed (must be 0.15r/min or higher) 1/500 when 5VDC is selected
	Digital input	1r/min
Speed output resolution		0.15r/min
Speed accuracy	Analog input (25°C ±10°C)	Within ±0.5% of maximum output speed
	Digital input	Within ±0.05% of maximum output speed
Starting torque		150% or more
Speed control range		1:20
Initial magnetic pole detection time		Approx. 0.1s (85ms±15ms)
Acceleration/deceleration time setting range		0.08 to 3600.0s (acceleration and deceleration can be set individually)
Acceleration/deceleration pattern		Linear
Voltage braking		Operating speed, period of operation
Stall prevention operation level		Operation level (150%), presence or absence can be selected.

(3) Operational specifications

Operation method	PU operation		Operation panel (standard equipment) operation Parameter unit (option) operation
	External operation		Operation using external analog/contact signals
	Communication operation		Communication operation using RS-485 8-pole, 8-core modular connector, 1 channel
Terminal functions	Speed command		Analog input, 2 channels
		Voltage input	DC0 to 10V/DC0 to 5V
		Current input	DC4 to 20mA
	Start/stop		Contact input, 2 channels (Forward rotation/stop, reverse rotation/stop)
	Reset		Contact input, 1 channel
	Operation function input signal selection		Contact input, 4 channels
		Selection signals	Multi-speed operation (up to 15 speeds), current input selection, external signal input selection, PU/External operation switchover, output stop, start self-holding selection
	Operation status output signal selection		Relay changeover contact output, 1 channel
			Open collector output, 2 channels
		Selection signals	Running, up-to-frequency, overload alarm, speed detection (1 point), operation ready, output current detection, fault detection
	Meter output signal selection		Pulse train output, 1 channel
		Selection signals	Motor speed, motor current, preset speed
Protective functions			Overcurrent (acceleration/deceleration/constant speed), regenerative overvoltage (acceleration/deceleration/constant speed), undervoltage, instantaneous power failure (NOTE 2), overload (electronic thermal O/L relay), brake transistor alarm, output short circuit, brake resistor overheat, heatsink overheat, parameter error, PU disconnection, output phase loss, CPU fault
Alarm functions			Overload, fan failure, undervoltage
Operation panel	Operation commands		Start (forward rotation/reverse rotation) and stop commanded by operation of individual keys
			Speed command with ▲▼ keys or potentiometer
	Monitor items		Motor speed, motor current, output voltage, alarm display, preset speed, actual operation time
	Others		Faults history storage (4 faults), reading the number of motor rotations, motor current, and output voltage immediately before the protective function activation.

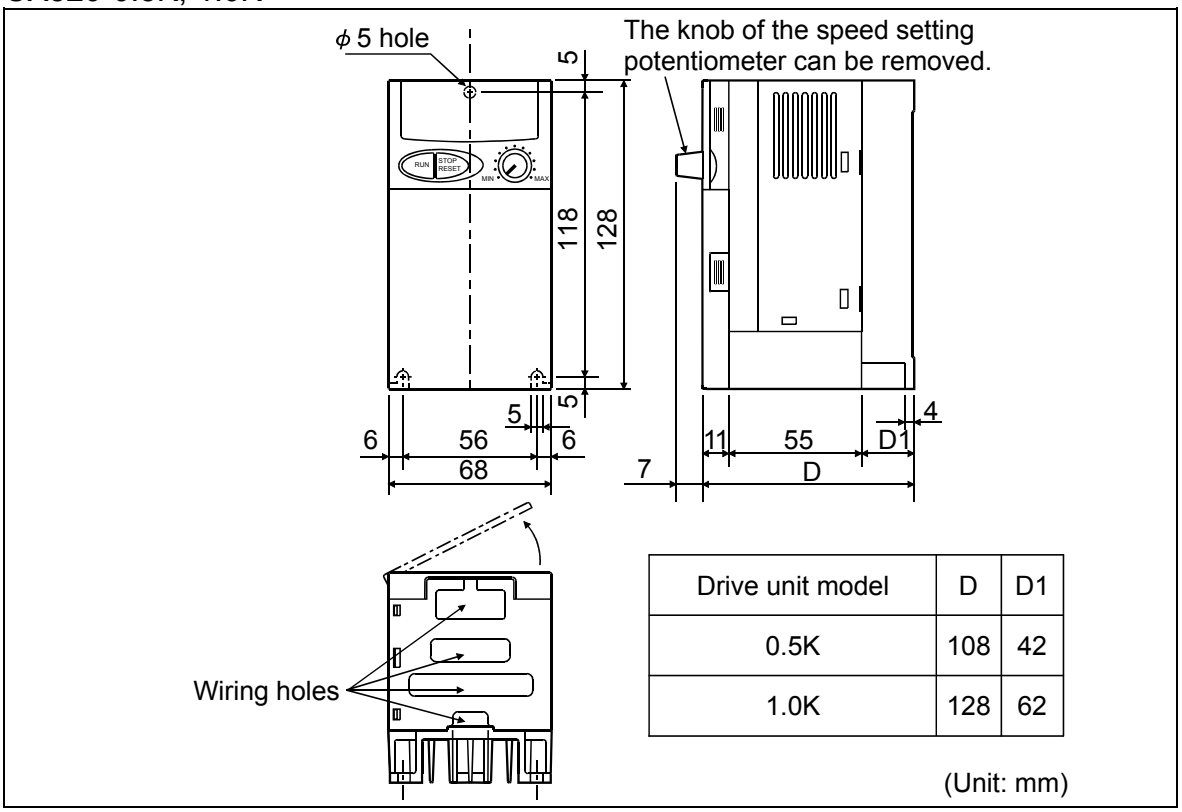
NOTE 2. Fault display and fault output are not available.

(4) Environmental specifications

Surrounding air temperature	-10°C to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Storage temperature	-20°C to +65°C (applies to short-time transit, etc.)
Atmosphere	Indoors. (No corrosive and flammable gases, oil mist, dust and dirt.)
Altitude, vibration	Max. 1000m above sea level, 5.9m/s^2 or less at 10 to 55Hz (directions of X, Y, Z axes)

7.1.2 Outline drawings

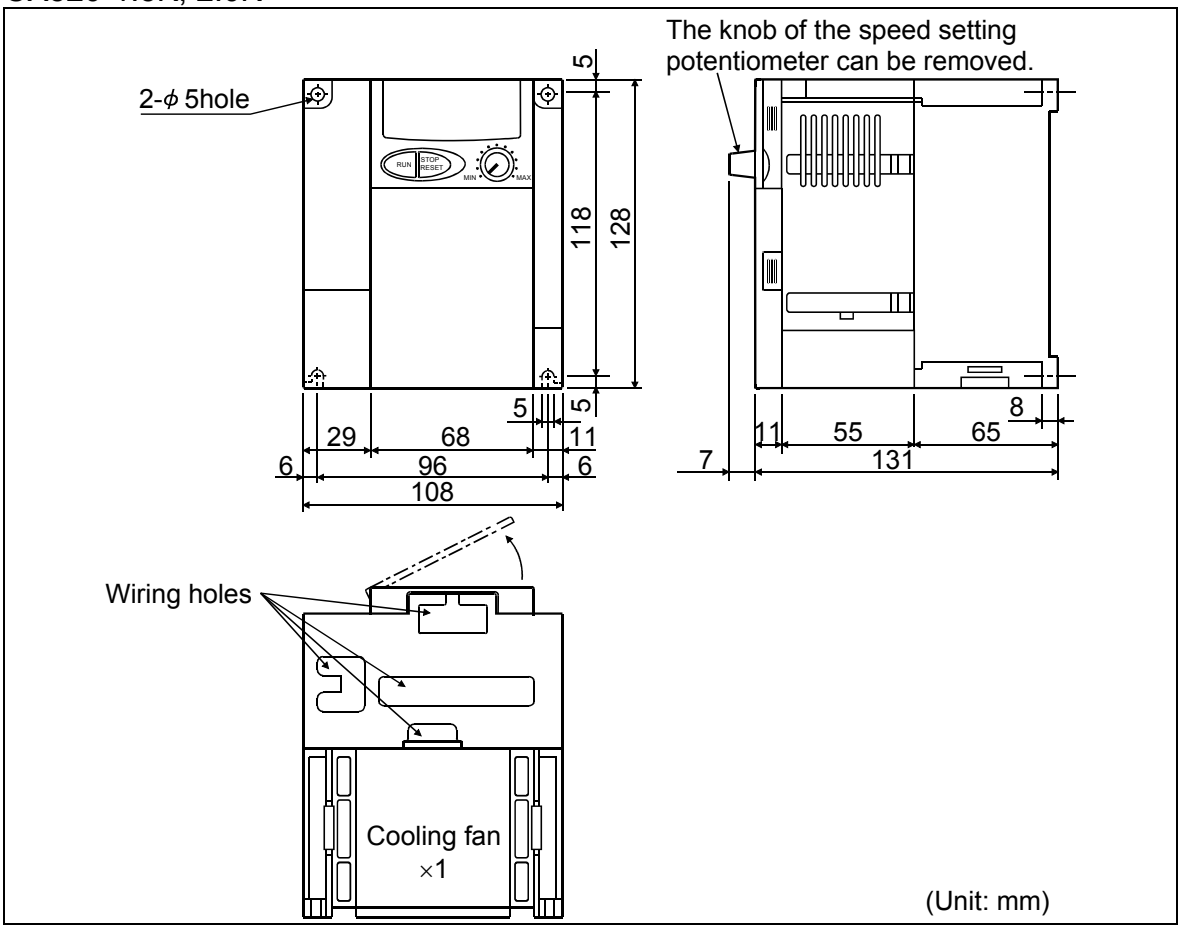
CX520-0.5K, 1.0K



Drive unit model	D	D1
0.5K	108	42
1.0K	128	62

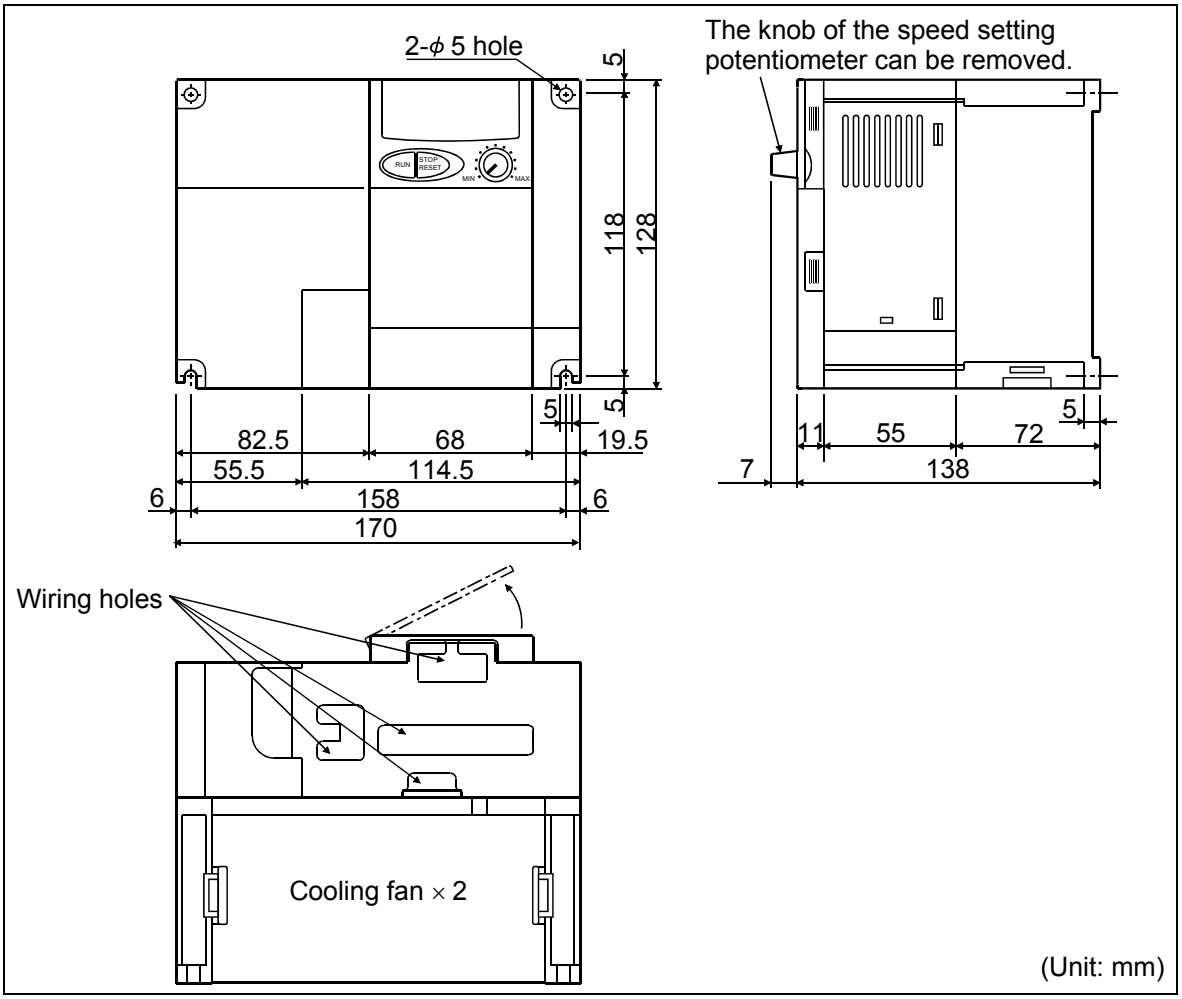
(Unit: mm)

CX520-1.5K, 2.0K



(Unit: mm)

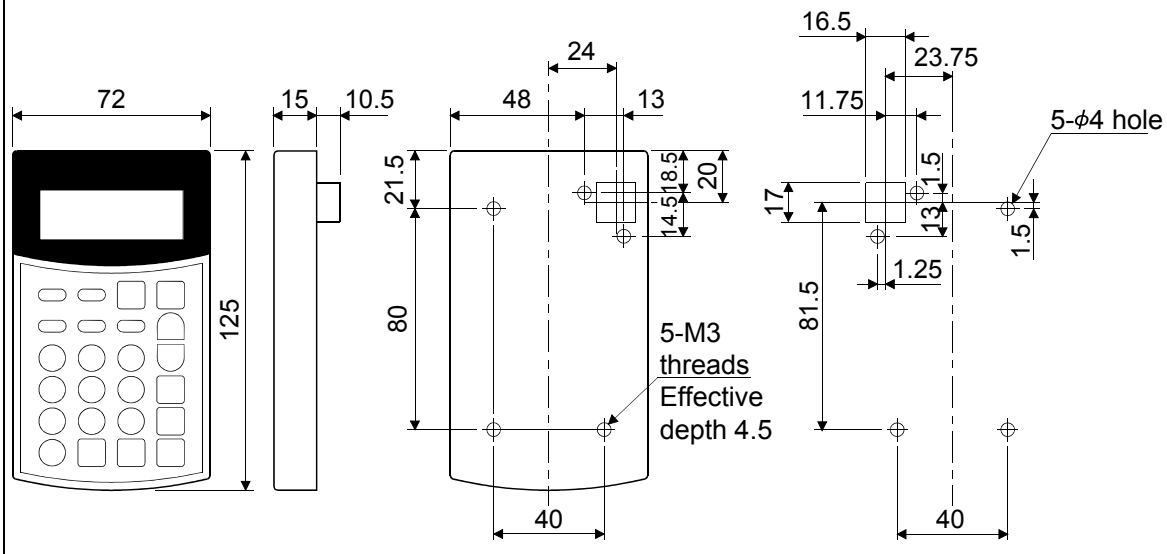
CX520-3.5K



(Unit: mm)

Parameter unit (FR-PU04)

<Outline drawing> <Panel cutting dimension drawing>



(Unit: mm)

Select the mounting screws so that their length will not exceed the mounting threads' effective depth.

7.1.3 Option list

Name		Model	Applicable capacity	Application, specification, etc.
Stand alone	Parameter unit (Japanese only)	FR-PU04	All capacities	LCD display and direct input with keys are available. Refer to: Section 4.4 Restrictions with FR-PU04
	Parameter unit connection cable	FR-CB201 FR-CB203 FR-CB205	All capacities	Connection cable for operation panel and parameter unit. Cable lengths are 1m, 3m, and 5m.
	Control panel rear cover and adapter set	FR-E5P	All capacities	Use this rear cover/junction adapter set to use the operation panel with the connection cable.
	Power factor improving DC reactor	FR-BEL-0.4K FR-BEL-0.75K FR-BEL-1.5K FR-BEL-2.2K FR-BEL-3.7K	0.5K 1.0K 1.5K 2.0K 3.5K	Use this to improve the input power factor (approx. 95% of total power factor) and to coordinate the power supply.
	Power factor improving AC reactor	FR-BAL-0.4K FR-BAL-0.75K FR-BAL-1.5K FR-BAL-2.2K FR-BAL-3.7K	0.5K 1.0K 1.5K 2.0K 3.5K	Use this to improve the input power factor (approx. 90% of total power factor) and to coordinate the power supply.
	Radio noise filter	FR-BIF	All capacities	Use this to reduce radio noise. (Leakage current = approx. 4mA)
	Line noise filter	FR-BSF01 FR-BLF	All capacities	Use this to reduce line noise. (Leakage current can be ignored.)
	Brake resistor	MRS120W200 MRS120W100 MRS120W60 MRS120W40	0.5K 1.0K 1.5K,2.0K 3.5K	Use this to improve the braking capability of the drive unit. (Permissible duty: 3%ED)
	High-duty brake resistor	FR-ABR-0.4K FR-ABR-0.75K FR-ABR-2.2K FR-ABR-3.7K	0.5K 1.0K 1.5K,2.0K 3.5K	Use this to improve the braking capability of the drive unit. (Permissible duty: 10%ED)
	BU type brake unit	BU-1500 BU-3700 BU-7.5K	0.5K,1.0K, 1.5K 2.0K 3.5K	Use this to improve the braking capability of the drive unit. Use this in combination with a discharging resistor.
	Discharging resistor	GZG, GRZG type	-	This is a resistor for BU-type brake unit resistor.

Operation and setting box	Three speed selector	FR-AT	All capacities	Use this to switch among three speeds of high, medium, and low.
	Deviation detector	FR-FD		Use this to perform differential-speed operation. Use this in combination with a deviation sensor and synchronizer.
	Master controller	FR-FG		Up to 35 drive units can be controlled in parallel.
	Ratio setter	FR-FH		Use this to perform ratio operation. Operation ratio to five drive units can be set.
	Motorized speed setter	FR-FK		Use this to perform a remote operation. Operation can be enabled from several locations.
	Speed detector	FR-FP		Use this to perform tracking operation for pilot generator (PG) signals.
Others	Pilot generator	QVAH-10	All capacities	Use this to perform tracking operation.
	Deviation detector	YVGC-500W-NS		Use this to perform differential speed operation. (mechanical deviation detection)
	Frequency setting potentiometer	WA2W1kΩ		Use this to set a speed. Wire wound 2W 1kΩ B characteristic

7.2. Motor Specifications

7.2.1 Standard specifications

Item \ Motor			2000r/min series				
			MM-CF52	MM-CF102	MM-CF152	MM-CF202	MM-CF352
Applicable drive unit		MD-CX520-□□	0.5K	1.0K	1.5K	2.0K	3.5K
Continuous characteristic (NOTE 1)		Rated output [kW]	0.5	1.0	1.5	2.0	3.5
		Rated torque[N•m]	2.39	4.78	7.16	9.55	16.70
Rated speed (NOTE 1) [r/min]			2000				
Maximum speed [r/min]			3000				
Short-time permissible speed [r/min]			3450				
Maximum torque [N•m]			4.78	9.56	14.32	19.09	33.41
Moment of inertia J [$\times 10^{-4}$kg•m^2]			6.6	13.7	20.0	45.5	85.6
Permissible load inertia moment ratio to the motor shaft (NOTE 2)			100 times or less			50 times or less	
Rated current [A]			1.81	3.70	5.22	7.70	12.50
Insulation level			F class				
Structure			Totally enclosed self-cooling type (protective structure: IP 44 (NOTE 3))				
Environment condition (NOTE 4)		Surrounding air temperature	-10°C to +40°C (non-freezing)				
		Ambient humidity	90%RH or less (non-condensing)				
		Storage temperature	-20°C to +70°C (non-freezing)				
		Storage humidity	90%RH or less (non-condensing)				
		Atmosphere	Indoors (avoid direct sunlight) without corrosive gas, flammable gas, oil mist, dust and dirt				
		Altitude	Maximum 1000m				
		Vibration	X: 9.8m/s^2 Y: 24.5m/s^2				
Mass [kg]			5.1	7.2	9.3	13.0	19.0

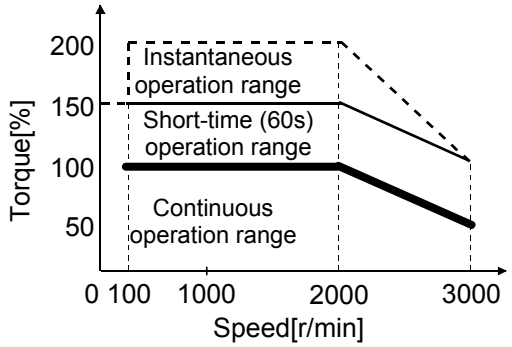
NOTE 1. The output and rated speeds cannot be guaranteed when the power supply voltage drops.

2. Under the load torque that is 20% of the rated motor torque.
When the load torque is larger, the permissible load inertia moment ratio becomes smaller. Contact us if the load moment inertia ratio exceeds the written value.

3. It excludes the area where the shaft passes through.

4. Special specification is required to use in a condition where oil and water splashes, etc., such as a factory with machines.

Torque characteristics



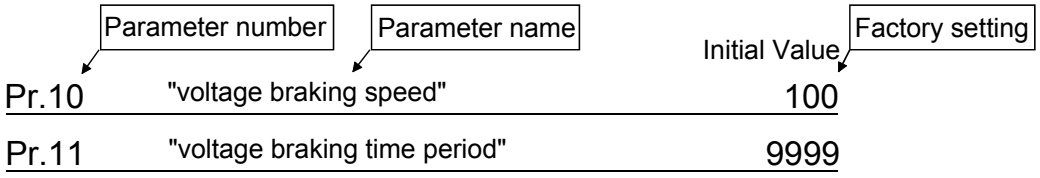
MEMO

8. PARAMETER FUNCTIONS

Refer to Appendix 1 for the parameter list.

This section describes parameter functions of drive units.
The following figure shows basic items given in the description and how to read them.

Example: Description of Pr.10 and Pr.11



Pr.	Setting Range	Unit	Operation
10	0 to 200	r/min	Voltage braking is applied to stop the motor when the speed drops to the set speed or lower.
11	0.0 to 60.0	s	Set the voltage braking time. While "0" is set, the motor coasts to stop when the speed drops to the Pr.10 setting or lower.
	9999	—	Voltage braking time (0 to 3s) is automatically adjusted.

- The minimum increment of the setting is 0.1 in the setting range 0.0 to 60.0, or 1 in the range 0 to 60.
- The value having a 0 on the right of the decimal point can be entered as an integer. (Example: 10.0 → 10)

MEMO	● If any parameter cannot be set, check that: ● The start signal (STF or STR) is not "ON". ● The parameter write disable selection (Pr. 77) setting has not been made. ● The PU operation mode has not been selected. ● When the PU operation mode cannot be selected, check that: ● The start signal (STF or STR) is not "ON". ● The operation mode (Pr.79) is set to a value other than "0."

Contents of This Section

The parameters with the B mark are the basic parameters.
Refer to: 5.2.2 Basic parameters for operation.

8.1 Protection and Editing of the Parameters

		Initial Value
Pr. 77	"parameter write disable selection"	0

You can select between write-enable and disable for parameter setting.

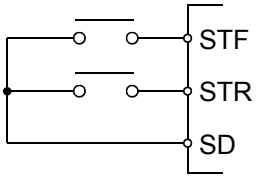
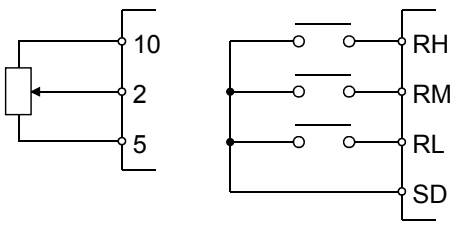
Setting range	Function	Exempt parameters
0	You can change the setting only during a stop in the PU operation mode.	Even during operation, you can change the values of the parameters whose numbers are shaded in the parameter list in Appendix 1. However, Pr.72 [Section 8.5.6] can be changed only in PU operation mode.
1	Whether the motor is running or at a stop, you cannot change the settings in any operation mode. Parameter clear, all parameter clear operations are also disabled.	Pr.22 [Section 8.5.5], Pr.75 [Section 8.2], and Pr.77, Pr.79 [Section 8.2], and Pr. 188 [Section 8.4] allow their values to be changed in any operation mode.
2	Whether the motor is running or at a stop, you can change the values in any operation mode.	Pr.79 [Section 8.2], Pr.180 to Pr.182, Pr.187, Pr. 189 [Section 8.4], 190, Pr.194, and Pr.195 [Section 8.7.2] allow their values to be changed during a stop only.

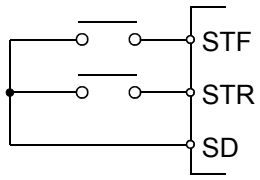
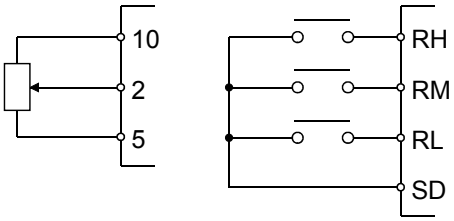
8.2 Selection of Operation Mode

		Initial Value
Pr. 79	"operation mode selection"	1

● To keep the selected operation mode

Setting Range	Mode	Function (Refer to: Section 5.3 Operation Example)
0	PU/External operation switchover	Switchover between PU operation mode and External operation mode is available with the operation panel or parameter unit (FR-PU04). At power-on, the drive unit is placed in External operation mode.
1	PU operation	PU operation mode is enabled.
2	External operation	External operation mode is enabled.
3	External/PU combined operation 1	External/PU combined operation mode 1 is enabled.
4	External/PU combined operation 2	External/PU combined operation mode 2 is enabled.

Operation Mode	Start signal input	Speed signal input
PU operation mode (operation panel)	Input with keys on the operation panel. RUN(FWD) REV STOP/RESET	Input with the speed setting potentiometer on the operation panel. (Pr. 146=0) Input with keys on the operation panel. (Pr. 146=1) ▲ ▼
External operation mode	Input via control circuit terminals. 	Input via control circuit terminals. 

<table>
<tr><td rowspan="2">External/PU combined operation mode 1 (operation panel)</td><td rowspan="2">Input via control circuit terminals.
 
</td><td>Input with the speed setting potentiometer on the operation panel. (Pr. 146=0)</td></tr>
<tr><td>Input with keys on the operation panel. (Pr. 146=1)
▲ ▼
Multi-speed input can be also made via control circuit terminals.</td></tr>
<tr><td>External/PU combined operation mode 2 (operation panel)</td><td>Input with keys on the operation panel.
RUN(FWD) REV
STOP/RESET</td><td>Input via control circuit terminals.
 
</td></tr>
</table>

Initial Value

Pr. 146 "speed command source selection" 0

Select whether to input a speed command with the speed setting potentiometer or with the ▲▼ keys on the operation panel.

Setting Range	Speed setting signal
0	The speed setting potentiometer is enabled.
1	▲▼ keys are enabled.

Initial Value

Pr. 75 "disconnected PU detection/PU stop selection" 0

● Disconnected PU detection function
You can make selection between continuous operation or a trip ("E.PUE" indication) when the operation panel or FR-PU04 parameter unit has been removed from the drive unit during operation.

MEMO	● This function is invalid if power is switched on with the operation panel or FR-PU04 parameter unit removed.

● PU stop selection

Select the operation mode in which an operation stop is made valid by the STOP/RESET key of the operation panel or FR-PU04 parameter unit.

Setting Range	PU Disconnection Detection Function	PU Stop Selection Operation Mode
0	Operation continued.	Any operation mode. When operation is stopped in External operation mode or PU/External combined operation mode 1, "PS" appears on the main display LED. No alarm signal is output.
1	Trip.	
2	Operation continued.	PU operation mode, PU/External combined operation mode 2
3	Trip.	

Restarting method when "PS" appears in the main indicator LED

To restart operation, turn "OFF" the operation command (STF or STR) signal, perform the following operation, and then turn "ON" the operation command.

(1) Operation panel

1) Press MODE key on the operation panel for 3 times. External operation mode display "OP.nd" appears.

   Press MODE key 3 times, then press ▲▼key while Pr. 79=3.

2) Press SET key.

(2) Parameter unit (FR-PU04)

1) Press EXT key.

MEMO	● The PU disconnection detection function is not available in the communication operation mode. ● Parameter settings do not return to their initial values even if parameter clear or all clear [Section 4.3] is performed.

Pr. 922 "operation panel potentiometer bias" Approx. 0/0

Pr. 923 "operation panel potentiometer gain" 100/2000

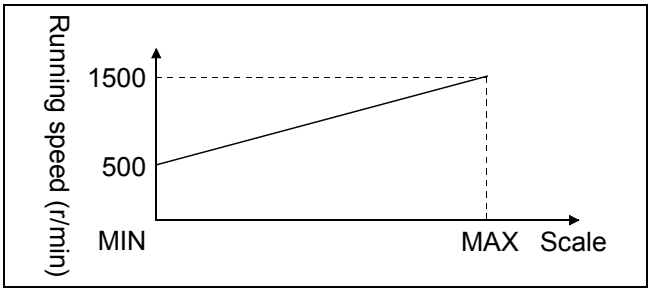
Set the relationship between the motor speed and the scale of the speed setting potentiometer on the operation panel.

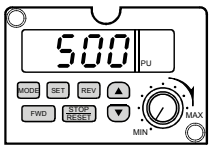
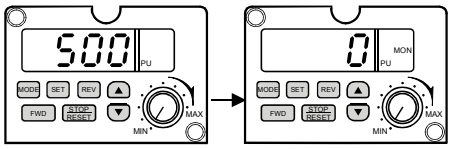
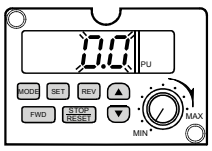
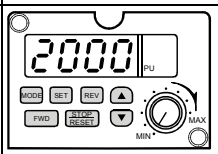
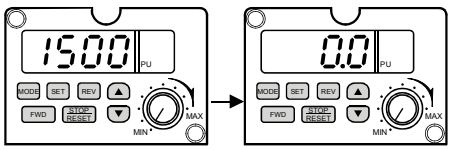
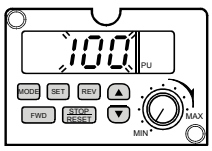
When the potentiometer is turned all the way to the left (MIN), it is approx. 0%. When it is turned all the way to the right (MAX), it is 100%.

Pr.	Setting Range			
	Motor speed	Unit	Scale value	Unit
922	0 to 2000	r/min	0.0 to 300.0	%
923	1 to 3000		0.0 to 300.0	

<Setting example 1>

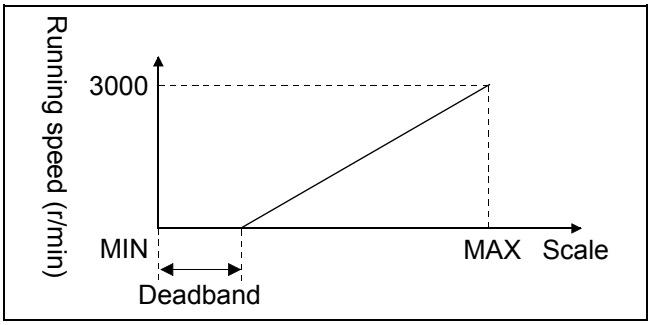
Set the speed to be 500r/min at MIN scale and 1500r/min at MAX scale.

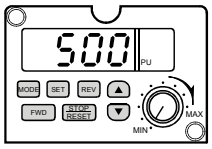
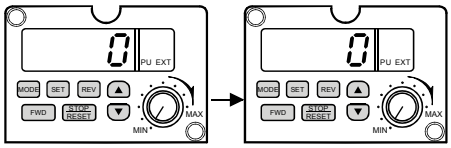
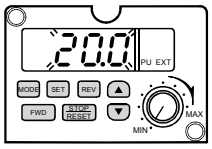
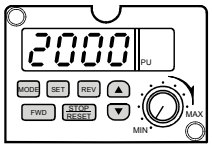
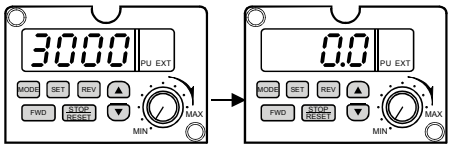
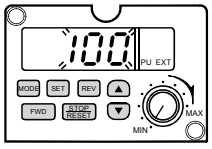


Item	Operation detail	Operation panel display (upon completion)
Bias setting	1) Set Pr. 79="1" and Pr. 146="0" to select PU operation mode. The Pr. 922 setting is displayed.	
	2) Set "500" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the potentiometer's position.
	3) Set the potentiometer to MIN. Press SET key until the set value starts flickering (approx. 2s).	 Flicker
Gain setting	4) Pr. 923 setting is displayed.	
	5) Set "1500" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the potentiometer's position.
	6) Turn the potentiometer to MAX. Press SET key until the set value starts flickering (approx. 2s).	 Flicker

<Setting example 2>

Allocate a deadband. Set the speed to be 3000r/min at the MAX scale.



Item	Operation detail	Operation panel display (upon completion)
Bias setting	1) Set Pr. 79="3" and Pr. 146="0" to select PU operation mode. The Pr. 922 setting is displayed.	
	2) Set "0" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the potentiometer's position.
	3) Set the potentiometer to 20%. Press SET key until the set value starts flickering (approx. 2s).	 Flicker
Gain setting	4) Pr. 923 setting is displayed.	
	5) Set "3000" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the potentiometer's position.
	6) Turn the potentiometer to MAX. Press SET key until the set value starts flickering (approx. 2s).	 Flicker

8.3 Selection of the Speed Command

8.3.1 Selection of the analog speed command specifications

Initial Value

Pr. 73 "speed command range selection" 0

Setting Range	Terminal 2 Input Voltage
0	0 to 10V
1	0 to 5V

Initial Value

Pr. 74 "filter time constant" 1

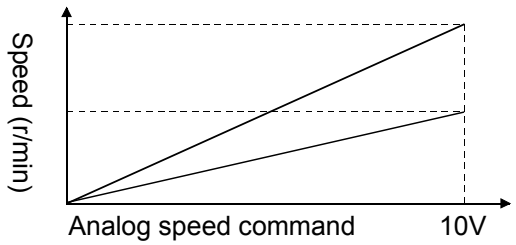
You can set the filter time constants of the speed command input terminals (terminals 2 and 4). Increase the value if stable operation cannot be performed due to the influence of noise on the speed command signal. Decreasing the value makes the speed command signal more susceptible to noise but the response of the speed command faster. Conversely, increasing the value makes the speed command signal less susceptible to noise but the response of the speed command slower.

Setting Range
0 to 8

Initial Value

Pr. 38 "speed at 10V(5V) input" 2000

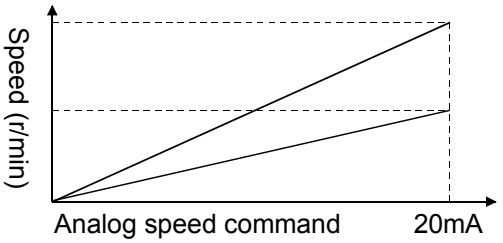
Set the speed at 10VDC (5VDC) of analog speed command. Analog speed command is input from the potentiometer (speed setter) connected across terminals 2 and 5.



Setting Range	Unit
1 to 3000	r/min

		Initial Value
Pr. 39	"speed at 20mA input"	2000

Set the speed at 20mA analog speed command. Analog speed command is input from the potentiometer (speed setter) connected across terminals 4 and 5.

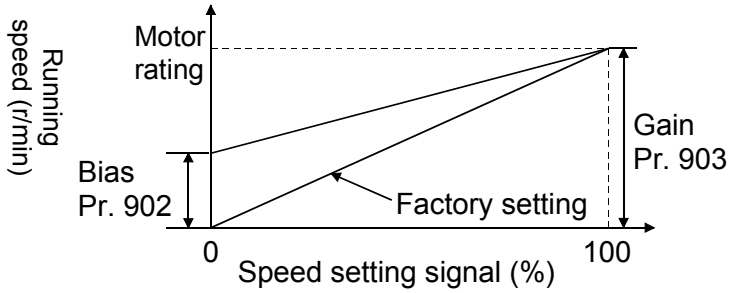


Setting Range	Unit
1 to 3000	r/min

		Initial Value
Pr. 902	"speed setting voltage bias"	approx. 0/0
Pr. 903	"speed setting voltage gain"	100/2000

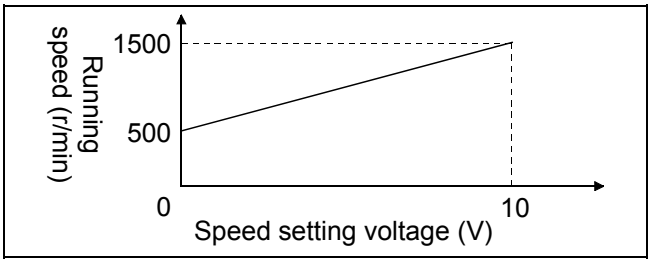
You can set the relationship between the magnitude of the speed setting analog voltage signal input to the terminal 2 and the motor speed. 0V of the speed setting signal corresponds to approx. 0%, and 5V or 10V (depending on Pr. 73 setting) to approx. 100%.

Pr.	Setting Range			
	Motor speed	Unit	Speed setting signal	Unit
902	0 to 2000	r/min	0.0 to 300.0	%
903	1 to 3000		0.0 to 300.0	

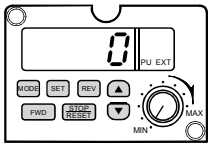
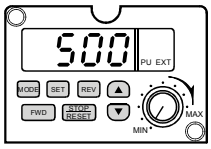
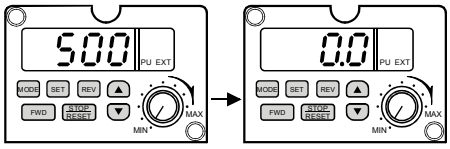
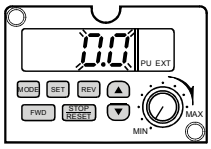
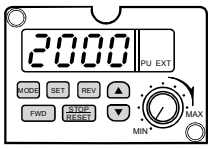
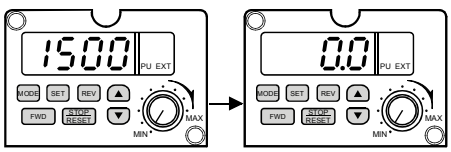
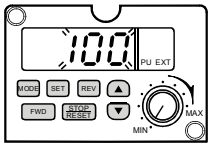


<Setting example 1>

Set the speed to be 500r/min at 0V speed setting signal and 1500r/min at 10V peed setting signal.

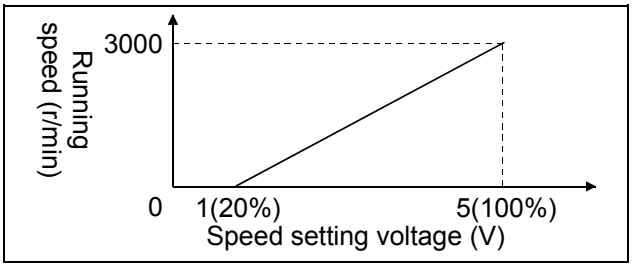


Confirm that a 0 to 10V voltage is selected to be input to the terminal 2. (Pr. 73=0)

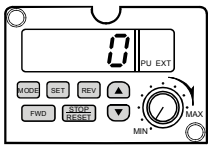
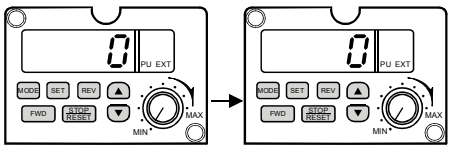
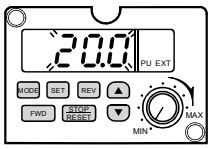
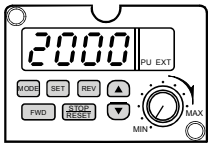
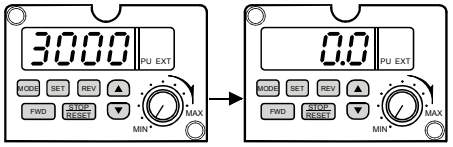
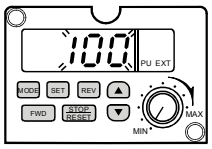
Item	Operation detail	Operation panel display (upon completion)
Bias setting	1) Select PU/External combined operation mode 2 (Pr. 79=4 [Section 8.2]). The Pr. 902 setting is displayed.	 Initial value "0" appears.
	2) Set "500" as the operation speed with ▲▼ keys.	
	3) Press SET until the "0.0" is displayed (approx. 2s).	 Value changes according to the potentiometer's position.
	4) Set "0" (speed setting signal) with ▲▼ keys. Press SET key until the set value starts flickering (approx. 2s).	 Flicker
Gain setting	1) Pr. 903 setting is displayed.	 Initial value "2000" appears.
	2) Set "1500" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the potentiometer's position.
	3) Set "100" with ▲▼ keys, or input 10V across terminals 2 and 5. Press SET key until the set value starts flickering (approx. 2s).	 Flicker

<Setting example 2>

Set the speed to be 0r/min at 1V speed setting signal and 3000r/min at 5V speed setting signal.



Confirm that a 0 to 5V voltage is selected to be input to the terminal 2. (Pr. 73=1)

Item	Operation detail	Operation panel display (upon completion)
Bias setting	1) Select PU/External combined operation mode 2 (Pr. 79=4 [Section 8.2]). The Pr. 902 setting is displayed.	 Initial value "0" appears.
	2) Set "0" as the operation speed with ▲▼ keys. Press SET key until the "0" is displayed. (approx. 2s).	 Value changes according to the voltage across terminals 2 and 5
	3) Set "20" with ▲▼ keys, or input 1V across terminals 2 and 5. Press SET key until the set value starts flickering (approx. 2s).	 Flicker
Gain setting	1) Pr. 903 setting is displayed.	 Initial value "2000" appears.
	2) Set "3000" as the operation speed with ▲▼ keys. Press SET key until the display changes (approx. 2s).	 Value changes according to the voltage across terminals 2 and 5
	3) Set "100" with ▲▼ keys, or input 5V across terminals 2 and 5. Press SET key until the set value starts flickering (approx. 2s).	 Flicker

		Initial Value
Pr. 904	"speed setting voltage bias"	approx. 20/0
Pr. 905	"speed setting voltage gain"	100/2000

You can set the relationship between the magnitude of the speed setting analog current signal input to the terminal 4 and the motor speed. When the speed setting signal is 0mA, it is approx. 0%. When it is 20mA, it is 100%.

Pr.	Setting Range			
	Motor speed	Unit	Speed setting signal	Unit
904	0 to 2000	r/min	0.0 to 300.0	%
905	1 to 3000		0.0 to 300.0	

Setting can be made in the same way as for the speed setting voltage bias/gain (Pr. 902 and 903).

8.3.2 Variable-speed operation using contact input signals

		Initial Value
Pr. 4	"three-speed setting (high speed)"	2000
Pr. 5	"three-speed setting (middle speed)"	1000
Pr. 6	"three-speed setting (low speed)"	500
Pr. 24 to 27	"multi-speed setting (speed 4 to 7)"	9999
Pr. 232 to 239	"multi-speed setting (speed 8 to 15)"	9999

Pr.	Setting Range	Unit
4 to 6	0 to 3000	r/min
24 to 27	0 to 3000	
232 to 239	9999	—

Combining "ON"/"OFF" of the contact signals allows you to choose the preset running speed (any of up to fifteen different speeds).
To use another terminal, select the control circuit contact input terminal function.
Refer to: 8.4 Selection of the Control Circuit Contact Input Terminal Functions

The following table lists the relationships between the contact signal input combinations and running speeds.

Speed	Contact Signal Input				Running Speed Setting Parameter	Remarks
	REX	RH	RM	RL		
Speed 1	OFF	ON	OFF	OFF	Pr. 4	When two or more contact signals are "ON", priority is given to the signals in order of terminals RL, RM and RL.
Speed 2	OFF	OFF	ON	OFF	Pr. 5	
Speed 3	OFF	OFF	OFF	ON	Pr. 6	
Speed 4	OFF	OFF	ON	ON	Pr. 24	When performing multi-speed operation at speed 4 and higher, set the running speed in the corresponding parameter. When "9999" is set in the parameter, input of the corresponding signal performs operation at the lower preset speed.
Speed 5	OFF	ON	OFF	ON	Pr. 25	
Speed 6	OFF	ON	ON	OFF	Pr. 26	
Speed 7	OFF	ON	ON	ON	Pr. 27	
Speed 8	ON	OFF	OFF	OFF	Pr.232	
Speed 9	ON	OFF	OFF	ON	Pr.233	
Speed 10	ON	OFF	ON	OFF	Pr.234	
Speed 11	ON	OFF	ON	ON	Pr.235	
Speed 12	ON	ON	OFF	OFF	Pr.236	
Speed 13	ON	ON	OFF	ON	Pr.237	
Speed 14	ON	ON	ON	OFF	Pr.238	
Speed 15	ON	ON	ON	ON	Pr.239	

MEMO

- Simultaneous input of the multi-speed operation signal and analog speed signal gives priority to the multi-speed operation signal.
- Any setting less than the Pr.13 setting will be a stop (0r/min) setting.

Refer to: 8.5.1 Running speed region

8.4 Selection of the Control Circuit Contact Input Terminal Functions

		Initial Value
Pr. 180	"RL terminal function selection"	0
Pr. 181	"RM terminal function selection"	1
Pr. 182	"RH terminal function selection"	2
Pr. 187	"MRS terminal function selection"	24

You can select/change the functions of the control circuit contact input terminals with parameter setting.
The following table shows the setting values and function of each parameter.

Setting Range	Signal Name	Function
0	RL	For multi-speed setting (speed 1 to 7) operation Refer to: 8.3.2 Variable-speed operation using contact input signals
1	RM	
2	RH	
4	AU	For a current input speed command. Refer to: 8.3.1 Selection of the analog speed command specifications
7	OH	When the external contact connected across terminals OH and SD is "OPEN", "external failure" activates. Refer to: Section 6.1.1 Protective function activated
8	REX	For multi-speed setting (speed 8 to 15) operation Refer to: Section 8.3.2 Variable-speed operation using contact input signals
24	MRS	Same function as the contact input terminal MRS. Refer to: Section 3.3.1 Terminals
25	STOP	Start self-holding selection
9999	-	No function

MEMO	● One function can be assigned to two or more terminals. In this case, the logic of terminal input is OR. ● The speed command is given in the order of multi-speed, current input (AU), and voltage input.

Initial Value

Pr. 188 "RES terminal operation selection" 0

Select the reset operation of the RES terminal. Reset operation is performed when RES-SD are shorted more than 0.1s.

Setting Range	Name	Function
0	CPU reset	The cumulative thermal value of the electronic overcurrent protection stored during operation is initialized. The alarm status is canceled. Performing reset operation during operation coasts the motor, and canceling the reset restarts the motor.
1	Alarm / CPU reset	The alarm status is canceled. At this time, the cumulative thermal value of the electronic overcurrent protection is also initialized. A reset input is not accepted during normal operation.

MEMO	● The reset operation performed using the STOP/RESET key on the operation panel or the parameter unit FR-PU04 will result in an alarm reset regardless of the Pr. 188 setting. ● The Pr. 188 setting does not return to the initial value if parameter clear or all clear [Section 4.2] is performed.

Initial Value

Pr. 189 "STF, STR terminal operation selection" 0

You can turn the terminal STF into a start/stop function and the terminal STR into a direction of rotation direction switching function.

Setting Range	Forward Rotation Operation		Reverse Rotation Operation		Stop	
	STF	STR	STF	STR	STF	STR
0	ON	OFF	OFF	ON	OFF	OFF
					ON	ON
1	ON	OFF	ON	ON	OFF	OFF
					OFF	ON

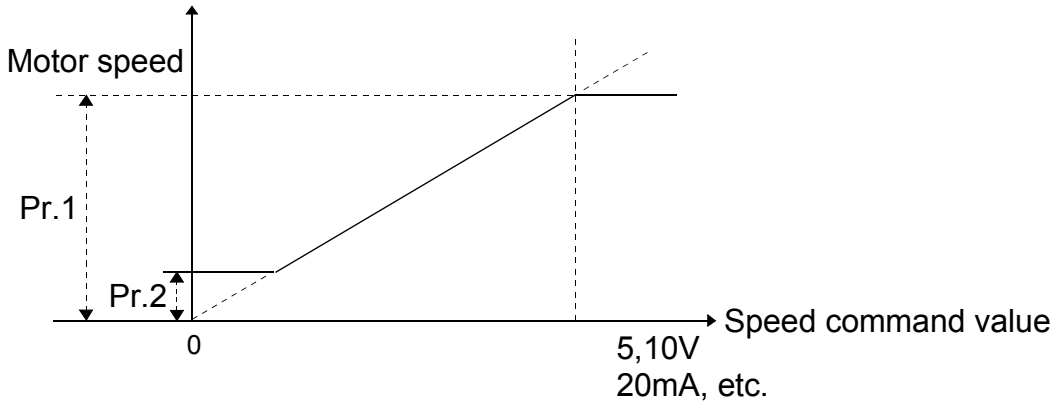
8.5 Setting of the Operation Pattern

8.5.1 Running speed region

		Initial Value
Pr. 1	"maximum speed"	3000
Pr. 2	"minimum speed"	0

Pr.	Setting Range	Unit
1	0 to 3000	r/min
2	0 to 3000	r/min

Set the maximum and minimum motor speed.
If the speed command entered is more than the maximum speed set in Pr. 1, the running speed is clamped at the maximum speed.
If the speed command entered is less than the minimum speed set in Pr. 2, the running speed will not fall below the minimum speed.
If the speed command is not input, turning "ON" the start signal will start operation at the minimum speed.



		Initial Value
Pr. 13	"minimum motor speed"	100

Setting Range	Unit
40 to 100	r/min

Motor stops at a speed command less than the Pr. 13 setting. When the speed command rises to the set value or higher, the motor accelerates according to the acceleration time set in Pr. 7 [Section 8.5.2].

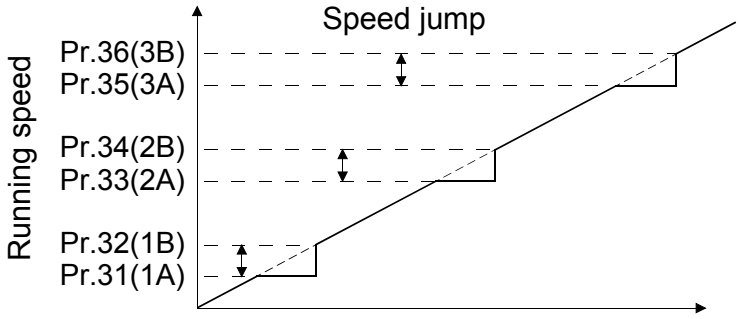
NOTICE	● Set 100r/min in Pr. 13. Setting a value lower than 100r/min under some load types may cause a large current to flow and trip the drive unit.

Initial Value

Pr. 31 to 36 "speed command jumps 1A to 3B" 9999

Pr.		Setting Range	Unit
At A side	At B side		
31	32	0 to 3000, 9999	r/min
33	34	0 to 3000, 9999	r/min
35	36	0 to 3000, 9999	r/min

You can set up to three speed areas where continuous operation will be disabled. You can avoid continuous operation at the speed at which resonance will occur due to the natural frequency of a mechanical system. When the speed command within the setting range is input, continuous operation is performed at the preset speed of value A.
Setting "9999" in the parameter makes this function invalid.



<Setting example 1>

Set Pr. 31 to "500(r/min)", Pr. 32 to "700(r/min)." The operation speed is 500(r/min) while the speed command is between 500 and 700(r/min).

<Setting example 2>

Set Pr. 31 to "700(r/min)", Pr. 32 to "500(r/min)." The operation speed is 700(r/min) while the speed command is between 500 and 700(r/min).

MEMO	● The "speed command jump" function is designed to disable continuous operation between the preset A and B points. When the running speed command is outside A-B, the speed varies between A and B in accordance with the preset acceleration/deceleration time. ● Any setting less than the Pr. 13 setting will be a stop (0r/min) setting.

Initial Value

Pr. 78 "reverse rotation prevention selection" 0

You can fix the direction of rotation.

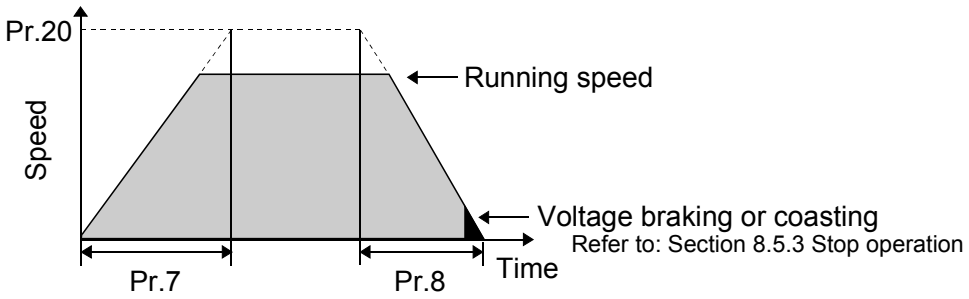
Setting Range	Function
0	Forward or reverse rotation operation is performed in accordance with the forward or reverse rotation command.
1	Forward rotation operation is performed in accordance with the forward rotation command. Operation is stopped in response to the reverse rotation command.
2	Reverse rotation operation is performed in accordance with the reverse rotation command. Operation is stopped in response to the forward rotation command.

8.5.2 Acceleration time and deceleration time

		Initial Value
Pr. 7	"acceleration time"	5
Pr. 8	"deceleration time"	5
Pr. 20	"acceleration/deceleration reference speed"	2000
Pr. 21	"acceleration/deceleration time unit"	0

Pr.	Pr.21	Setting Range	Unit
7, 8	0	0.0 to 3600	s
	1	0.00 to 360.0	
20	1 to 3000		r/min

In Pr. 7, set the time required to increase the speed from a start to the speed set in Pr. 20
In Pr. 8, set the time required to decrease the speed from the speed set in Pr. 20 to a stop.
Use Pr. 21 to change the setting increments.



The minimum acceleration/deceleration setting increment differs according to the acceleration/deceleration time setting while using the operation panel.

Pr.21	Minimum setting increment			Unit
	Setting value is less than 100	Setting value is 100 or more and less than 1000	Setting value is 1000 or more	
0	0.1	0.1	1	s
1	0.01		-	

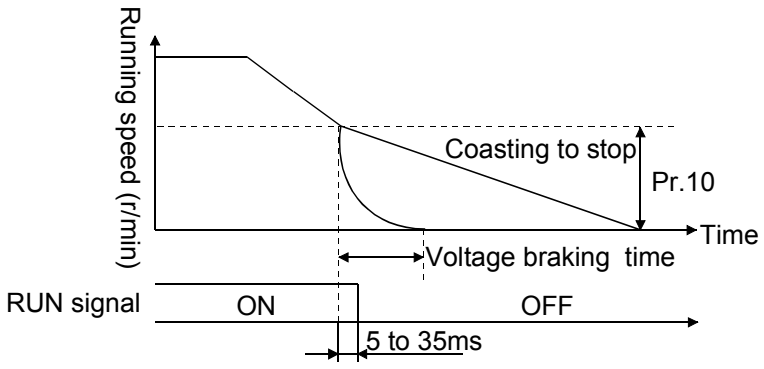
MEMO

- The minimum value of acceleration/deceleration time is 0.08s. Any acceleration/deceleration time setting of less than 0.08 is handled as 0.08s.
- The upper limit of acceleration time at up to 100r/min is 5s (converted with 2000r/min as the reference speed). When the acceleration time setting is greater than 5s, therefore, the acceleration time required to reach the acceleration/deceleration reference speed is represented by the following expression and is shorter than the preset acceleration time:
  Required acceleration time = 0.25 + T1
  T1 = (preset speed command - 100) × Pr. 7 setting /Pr. 20 setting
- The motor stops by voltage braking or by coasting when the speed falls to a speed lower than the Pr.10 setting. The required deceleration time from the speed set in Pr.20 to the speed set in Pr.10 can be calculated with:
  Required deceleration time = Pr. 8 setting ×
  (Pr. 20 setting -Pr. 10 setting)/Pr. 20 setting.
- Too short of an acceleration/deceleration time setting can cause an abnormal stop due to overload, overcurrent or overvoltage. Make a setting which will not display overload on the operation panel.
- Sudden acceleration in a time period less than 0.2s may cause starting torque shortage.

8.5.3 Stop operation

		Initial Value
Pr. 10	"voltage braking speed"	100
Pr. 11	"voltage braking time period"	9999

Pr.	Setting Range	Unit	Operation
10	40 to 200	r/min	Voltage braking is applied to stop the motor when the speed falls to the set speed or lower.
11	0.0 to 60.0	s	The value set here is always applied as the voltage braking time regardless of the time a motor requires to stop. When "0" is set, the motor coasts to stop at the Pr.10 setting or lower speed.
	9999	-	Detects the voltage at the motor terminal and automatically adjusts the voltage braking time (0 to 3s).



Voltage braking time changes according to the load moment of inertia.
The following table shows the voltage braking time references at different motor shaft load moment of inertia ratios.

Moment ratio	5 times	38 times	77 times
Voltage braking time	50ms	250ms	600ms

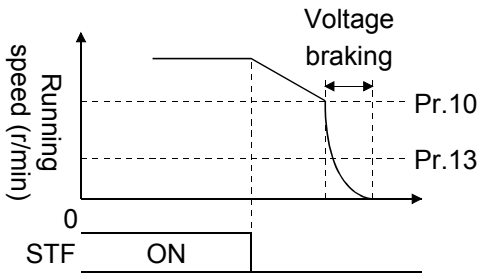
The voltage braking is applied as follows depending on the Pr. 13 "minimum motor speed" setting [Section 8.5.1] and its greater/smaller relationship.

(1) Pr.13 setting > Pr.10 setting

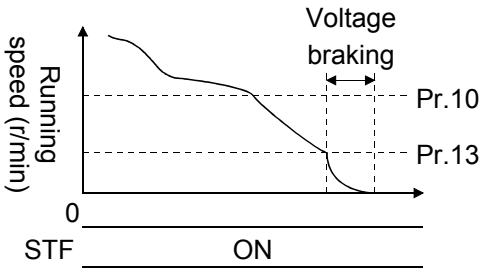
- Voltage braking is applied when the speed drops to a speed lower than Pr. 13.

(2) Pr. 13 setting < Pr.10 setting

1) Deceleration by turning OFF the start signal
   - Voltage braking applies when the speed drops to a speed lower than the Pr. 10 setting.
   - Voltage braking applies at turn OFF of the start signal while the speed is between Pr. 10 and Pr. 13 settings.



2) Deceleration by lowering the operation command
   - Voltage braking applies when the speed drops to a speed lower than the Pr. 13 setting.



MEMO	● Voltage braking is a type of dynamic braking, and it uses the power generated at motor terminals. Braking power is not generated in the low-speed operation (approx. 20r/min or less) where the motor terminal voltage is low, and the motor coasts to stop.

NOTICE	● Set Pr. 10 to 100r/min or higher. Setting a value lower than 100r/min under some load types may cause a large current to flow and trip the drive unit

8.5.4 Selection of regenerative brake unit

		Initial Value
Pr. 30	"regenerative brake option selection"	0
Pr. 70	"regenerative brake duty"	3

Pr.	Setting Range	Unit
30	0, 1	-
70	0.0 to 15.0	%

Set Pr. 30 and Pr. 70 according to the regenerative brake unit used. At the setting of Pr. 30 = 0, the Pr. 70 "regenerative brake duty" value is fixed at 3% and Pr. 70 cannot be read.
When Pr. 30 = "1", set the value given in the following table since Pr. 70 setting is enabled.

Regenerative brake option	Pr. 30	Pr. 70
MRS brake resistor (option)	0	-
BU- ☐☐ brake unit (option)	0	-
FR-ABR- ☐☐ high-duty brake resistor (option)	1	10

⚠CAUTION
● Do not set the Pr. 70 value which exceeds the setting of the brake resistor used. Doing so will overheat the brake resistor.

8.5.5 Stall prevention operation level

		Initial Value
Pr. 22	"stall prevention operation level"	150

Setting Range	Unit	Remarks
0,150	%	When 0 is set, the stall prevention function is not activated.

When the output current reaches the Pr. 22 setting, the speed is varied with the running status to suppress the torque. The setting is based on the rated motor current.
When the stall prevention function is activated, OL appears on the screen of the operation panel or FR-PU04 parameter unit. That the stall prevention function has been activated can be exported as OL signal from the terminal.

Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

MEMO	● If the stall prevention function is activated during acceleration or deceleration, the acceleration or deceleration time [Section 8.5.2] will be longer than the setting. When the travel of a machine or the like is determined by the acceleration or deceleration time, the travel will increase due to the operation of the stall prevention function. ● If the stall prevention function is activated during constant speed operation, the running speed may vary abruptly.

8.5.6 Motor sound selection

		Initial Value
Pr. 72	"motor sound selection"	1

Setting Range	Unit
1 to 4	-

Decreasing the setting value reduces the acoustic noise (metallic sound) from the motor, but increases electromagnetic noise from the drive unit.

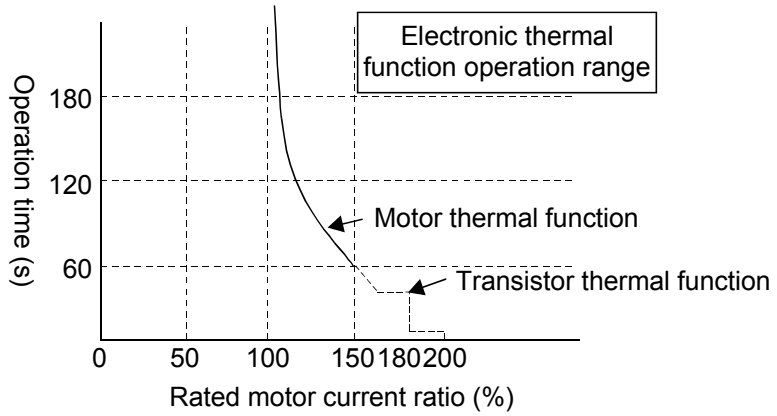
8.5.7 Other settings

		Initial Value
Pr. 9	"electronic thermal relay function selection."	1

The motor electronic thermal function protects the motor from overheating.
The transistor thermal function protects the drive unit from overheating.
Set "1" for normal operation.

Setting Range	Motor thermal function operation	Transistor thermal function operation
0	Disabled	Enabled
1	Enabled	Enabled

<Protection curve with electronic thermal function>



⚠CAUTION
● Electric thermal function is initialized at a reset of the drive unit (including power supply OFF, and reset with RES terminal and key operation). Frequent resets of the drive unit may disable the overheat protection of the motor and may cause the motor to be burnt at an overloaded condition.

Pr. 84	"rated motor speed"	Read-only

The rated speed of the motor used with the drive unit is displayed. This parameter is for read-only and its value cannot be changed.

Initial Value

Pr. 244 "cooling fan operation selection" 0

When the drive unit has a built-in cooling fan, you can select the operation of the cooling fan.

Setting Range	Operation
0	While the drive unit power is on, the cooling fan keeps running.
1	While the motor is operating, the cooling fan keeps running. While the motor is at a stop, the cooling fan is stopped according to the temperature of the drive unit.

MEMO	● If the cooling fan stops due to a failure, the "FN" alarm indication appears on the operation panel. Refer to: Section 6.1.2 Alarm function activated ● That the cooling fan has stopped due to a failure can be exported as an alarm signal. Refer to: Section 8.7.2 Selection of the control circuit output terminal functions ● When Pr. 244 = 1, the alarm function is activated if the fan starts running during the fan "OFF" command.

8.6 Communication operation from the PU connector

		Initial Value
Pr. 117	"station number"	0
Pr. 118	"communication speed"	192
Pr. 119	"stop bit length/data length"	1
Pr. 120	"parity check presence/absence"	2
Pr. 121	"number of communication retries"	1
Pr. 122	"communication check time interval"	0
Pr. 123	"waiting time setting"	9999
Pr. 124	"CR-LF presence/absence selection"	1

Make settings necessary for performing RS-485 communication operation from the PU connector using a personal computer or similar equipment.
After you have made parameter settings, reset the CPU or switch power "OFF" once. Switching power on again makes the parameter values valid.

Pr.	Setting Range	Unit	Description
117	0 to 31	Station	Set the station number of the drive unit.
118	48	—	4800bps
	96	—	9600bps
	192	—	19200bps
119	0	—	Stop bit length 1 bits/data length 8 bits
	1	—	Stop bit length 2 bits/data length 8 bits
	10	—	Stop bit length 1 bits/data length 7 bits
	11	—	Stop bit length 2 bits/data length 7 bits
120	0	—	None
	1	—	Odd parity present
	2	—	Even parity present
121	0 to 10	Times	Set the number of retries to be made at occurrence of a data receive error. If errors in excess of the setting occur consecutively, E. PUE appears, resulting in a trip.
	9999	—	Assigning the LF signal to the control circuit output terminal allows a communication error occurrence signal to be output. Occurrence of a communication error will not cause a trip. [Section 8.7.2]
122	0	—	No communication. (Communication operation not performed)
	0.1 to 999.8	s	When a no-communication status time reaches the setting, E. PUE appears and an alarm stop occurs.
	9999		No-communication status time check is not made.
123	0 to 150	—	Set the waiting time from when the drive unit has received data until it gives a reply. The actual waiting time is (setting × 10 + 12)ms (processing time).
	9999	—	Set the waiting time using communication data.

124	0	—	Without CR (carriage return), LF (line feed)
	1	—	With CR (carriage return)
	2	—	With CR (carriage return)/LF (line feed)

● Set Pr.146 "speed command source selection" = "1."

Refer to: Section 6.1.1 Protective function activated

(1) Communication specifications

Conforming standard		RS-485 Standard conformance
Number of units connected		1:N (max. 32 units)
Communication speed		Selected between 19200, 9600 and 4800bps
Control protocol		Asynchronous
Communication method		Half-duplex
Communication Data	Character system	ASCII (7 bits/8 bits) selectable
	Stop bit length	Selectable between 1 bit and 2 bits.
	Terminator	CR/LF presence/absence selectable
	Parity check	Selectable between presence (even/odd) and absence
	Sum check	Presence
	Waiting time setting	Selectable between presence and absence

(2) Communication operation functions

Setting a value other than 0 in Pr. 122 enables RS-485 communication with the computer connected to the PU connector, allowing you to make operation and parameter settings.

Setting Item		Description
Operation	Start	Give a forward rotation operation, reverse rotation operation or stop command.
	Speed setting	Set the running speed.
	Monitor	You can read the motor speed, motor current, output voltage, drive unit fault, or control circuit output terminal assignment function activated.
	Reset	Used to reset the drive unit. A reset from the terminal RES is also valid. Reset operation is performed as set in Pr. 188 [Section 8.4].
Parameter write and read		You can change or read each parameter value. Parameter write is performed as set in Pr. 77 [Section 8.1].

Select the operation mode through communication.

Operation Mode	Description
Communication operation mode	Start, speed setting and other operation settings are made through serial communication.
External operation mode	Start and speed setting are made using the input signals from the control circuit terminals. Speed setting via communication can be also enabled by selecting External/PU combined operation mode 1 (Pr. 79 [Section 8.2]).

The following operation is performed when a communication operation fault occurs.

Location of Fault Occurrence	Operation	
	Communication operation mode	External operation mode
Drive unit	Motor operation stopped	Motor operation stopped
	Communication continued	Communication continued
Communication (Computer or communication cable)	Whether motor operation is stopped or continued depends on the Pr. 75 [Section 8.2] setting.	Motor operation continued
	Communication stopped	Communication stopped

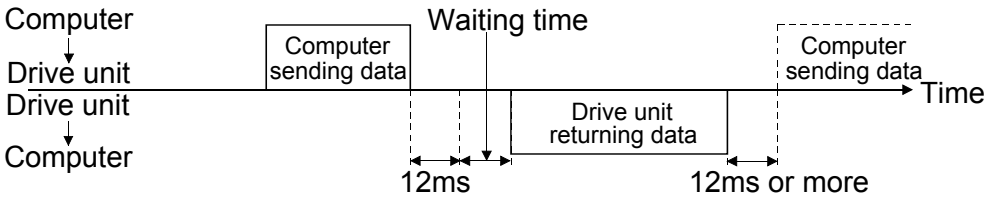
NOTICE	● Communication operation is performed in response to the communication request from the personal computer. Therefore, if communication is suspended due to a communication cable break or computer failure during operation, the drive unit cannot detect a fault and stop operation. However, operation trips (E. PUE) if the time set as the communication check time interval has elapsed. To stop operation before the time set as the communication check time interval is reached, reset the CPU using the RES terminal or switch power off. The motor will then coast to a stop.

(3) Communication data and communication protocol

The following table provides the communication data and communication protocol between the computer and drive unit.

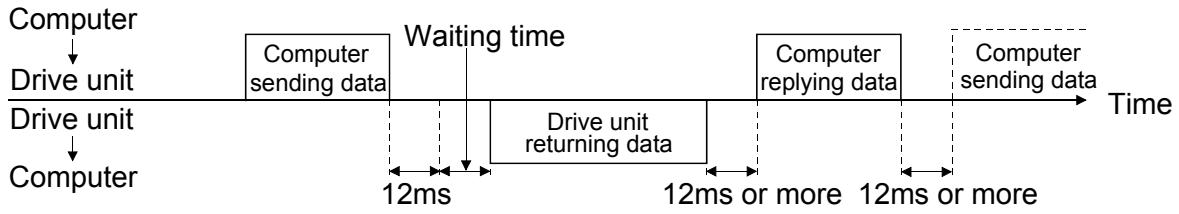
Communication Data	Description
Computer sending data	The computer gives a communication request to the drive unit in accordance with the user program.
Drive unit returning data	In response to the communication request from the computer, the drive unit returns data to the computer.
Computer replying data	The computer replies to the drive unit whether it could receive the drive unit returning data properly or not.

● Communication protocol in write mode (when drive unit writes data)



MEMO	● On detection of an error at the receipt of the data sent by the computer, the drive unit returns an error code, making the sent data invalid. Data is retransmitted (resending of data by the computer) when an error occurs. Setting of Pr. 121 allows the drive unit to trip if consecutive errors occur in the computer sending data.

● Communication protocol in read mode (when data is read from drive unit)



MEMO	● On detection of an error at the receipt of the drive unit returning data, an error occurrence is sent using the computer replying data. In this case, the drive unit makes retry transmission (resending of drive unit returning data). Setting of Pr. 121 allows the drive unit to trip if consecutive errors occur in the computer replying data.

Approximately 12ms plus waiting time after the drive unit has completed receiving the data sent by the computer, the drive unit sends the drive unit returning data to the computer.
Set the waiting time in Pr. 123 to match the answerable time of the computer.

MEMO	● The waiting time may also be set using the computer sending data. In this case, set 9999 in Pr. 123

(4) Communication data structure

Mode	Communication Data		Number of Characters 1	2	3	4	5	6	7	8	9	10
Write	Computer sending data		ENQ	Station number		Instruction code		Data code		Sum check		CR LF
	Drive unit returning data	Without error	ACK	Station number		CR LF						
		With error	NAX	Station number		Error Code	CR LF					
Read	Computer sending data		ENQ	Station number		Instruction Code		Sum check		CR LF		
	Drive unit sending data	Without error	STX	Station number		Data code		ETX	Sum check		CR LF	
		With error	NAX	Station number		Error Code	CR LF					
	Computer replying data	Without error	ACK	Station number		CR LF						
		With error	NAX	Station number		CR LF						

MEMO	● The above format assumes that the data code has two characters. The number of characters in the data code changes with the communication data. ● When using the computer sending data to set the "waiting time", insert the "waiting time" data (one character) in the position next to the instruction code. In this case, set 9999 in Pr. 123. (Example)

ENQ	Station number	Instruction code	Waiting time	Data code	Sum check	CR LF

MEMO	● The CR (carriage return) and LF (line feed) codes at the format end are automatically set by the computer when data is sent from the computer to the drive unit. In this case, the sending data from the drive unit must also be set to match the computer data. Select whether the CR and LF are used or not by setting the Pr. 124 value. ● Expression for calculating the communication data sending time Data send time (s) = total number of bits in one character × total number of characters / communication speed (bps) The total number of bits in one character is equal to the total number of following bits. Start bit: 1 bit Data: 7 or 8 bits (selected using Pr. 119) Stop bit: 1 or 2 bits (selected using Pr. 119) Parity check: 0 or 1 bit (selected using Pr. 120)

(5) Explanation of communication data structure

1) Control codes

The following table lists the ASCII codes and their definitions of the control code names which are set at the beginning, end and like of the format.

Signal Name	ASCII Code	Description
STX	H02	Start of Text (Start of data)
ETX	H03	End of Text (End of data)
ENQ	H05	Enquiry (Communication request)
ACK	H06	Acknowledge (No data error detected)
LF	H0A	Line Feed
CR	H0D	Carriage Return
NAX	H15	Negative Acknowledge (Data error detected)

2) Station number

Specify the station number of the drive unit used for communication with the computer.

Specify the drive unit station number within the range H00 to H1F (stations 0 to 31) in hexadecimal.

The communication data is converted into ASCII automatically.

Example: H00 (binary) → H3030 (ASCII)

3) Instruction codes and data codes

The instruction code and data code have been set in correspondence with the operation mode, operation or parameter write or read. The communication data is converted into ASCII automatically.

i) Setting the operation mode

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Operation mode	Write	HFB	H0001: External operation mode H0002: Communication operation mode	4
	Read	H7B	H0001: External operation mode H0002: Communication operation mode	4

ii) Setting the operation items

Setting Item		Mode	Instruction Code	Data Codes and Definitions			Character count
Start		Write	HFA	H00: Stop H02: Forward rotation H04: Reverse rotation b7 b0 0 0 0 0 0 0 1 0 For forward rotation			2
Speed setting (RAM)		Write	HED	H0000 to H0BB8: 1r/min increments (hexadecimal) To change the running speed consecutively, write to the drive unit RAM.			4
		Read	H6D				
Speed setting (E^2PROM)		Write	HEE	H0000 to H0BB8: 1r/min increments (hexadecimal)			4
		Read	H6E				
Monitor	Speed	Read	H6F	H0000 to H0BB8: 0 to 3000r/min			4
	Motor current	Read	H70	H0000 to HC350: 0 to 500.00A			4
	Output voltage	Read	H71	H0000 to H0FA0: 0 to 400.0V			4
	Fault definition	Read	H74	H** **: Most recent fault / Second most recent fault	H00: No alarm H10: 0C1 H11: 0C2 H12: 0C3 H20: 0V1 H21: 0V2 H22: 0V3 H30: THT	H31: THM H40: FIN H60: OLT H70: BE H81:LF H90:OHT HB0: PE HB1: PUE	4
			H75	H** **: Third most recent fault / Fourth most recent fault			4
			H76	H** **: Fifth most recent fault / Sixth most recent fault			4
			H77	H** **: Seventh most recent fault / Eighth most recent fault			4

Monitor	Drive unit status	Read	H7A	H01: Function assigned to RUN terminal is activated H02: During forward rotation (STF terminal signal ON) H04: During reverse rotation (STR terminal signal ON) H40: Function assigned to FU terminal is activated H80: Function assigned to ABC terminal is activated	2
Reset		Write	HFD	H9696: The drive unit is reset. In this case, the drive unit returning data is not returned. After a reset, wait for more than 100ms and send the computer sending data.	4
Fault definition batch-clear		Write	HF4	H9696: Eight alarms stored as a history are all cleared.	4

iii) Parameter write and read

Parameter write and read require the setting of the extension codes given in Appendix 1 Parameter List (Numerical Order). After setting the extension code, set the instruction code given in Appendix 1 Parameter List (Numerical Order) and perform write or read.

This function is performed as set in Pr. 77 [Section 8.1].

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Extension code setting	Write	HFF	H00: Parameter of extension code 0 can be accessed for read/write. H01: Parameter of extension code 1 can be accessed for read/write. H02: Parameter of extension code 2 can be accessed for read/write. H09: Parameter of extension code 9 can be accessed for read/write.	2
	Read	H7F		
Parameter	Write	Refer to: Appendix 1 Parameter List.	H0000 to HFFFF: Parameter settings (hexadecimal)	4
	Read			

When converting a value having a decimal place, e.g. parameter setting range, into a data code, make conversion in the setting range whose decimal place has been carried. Use "HFFFF" with the value "9999" which means no function.

(Example)

Parameter	Setting Range (Parameter list)	Setting Range (Communication)	Data Code
Pr. 7	0.0 to 3600	0 to 36000	H0000 to H8CA0
Pr. 24	0 to 3000 9999	0 to 3000 9999	H0000 to H0BB8 HFFFF
Pr.44	0.0 to 3600 9999	0 to 36000 9999	H0000 to H8CA0 HFFFF
Pr. 122	0 0.1 to 999.8 9999	0 1 to 9998 9999	H0000 H0001 to H270E HFFFF
Pr. 124	0 1 2	0 1 2	H0001 H0002 H0003

Set the bias and gains in Pr. 902 to 905 [Section 8.3.1].

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Bias/gain	Write	HEC	H00: Bias/gain H01: Any analog A/D value H02: Analog A/D value of terminal	2
	Read	H6C		

Clear the parameters.

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Parameter clear	Write	HFC	H5A5A: The parameter settings other than the following are initialized to the factory settings. ● Communication parameters (Pr. 117 to 124) ● Calibration parameter (Pr. 900 [Section 8.7.5], Pr. 902 to Pr. 905 [Section 8.3.1]) ● Control parameters (Refer to: Section 8.8 Control Parameters) ● Pr. 75 [Section 8.2], Pr. 188 [Section 8.4] Also use the data code H9696 to initialize the communication parameters.	4

All clear	Write	HFC	H55AA: The parameter settings other than the following are initialized to the factory settings. ● Communication parameters (Pr. 117 to 124) ● Pr. 75, Pr. 188 Also use the data code H9966 to initialize the communication parameters.	4

4) Sum check

As a sum check value, set the lower 1 byte (8 bits) of the sum derived from ASCII data (station number, instruction code, waiting time, data code) except the control code. The communication data is converted into ASCII automatically.

Data →	ENQ	Station Number	Instruction Code	Waiting Time	Data Code	Sum Check
Binary code →	—	0 1	E 1	1	0 7 A D	F 4
ASCII code →	(H05)	H30 H31	H45 H31	H31	H30 H37 H41 H44	(H46 H34)

Sum check value calculation: H30+31+45+31+31+30+37+41+44=H1F4

5) Error codes

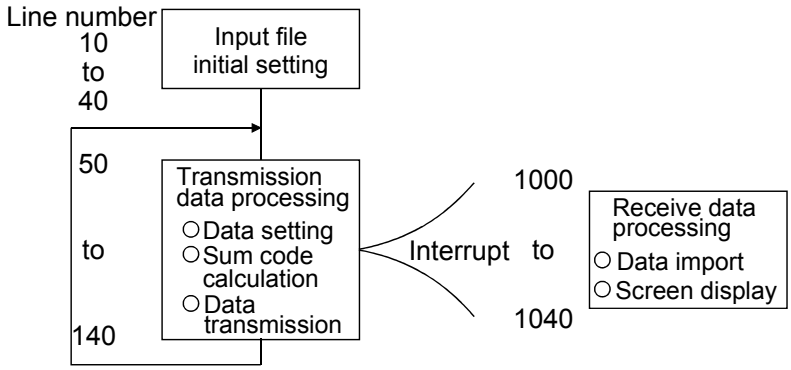
When the data received by the drive unit is in error, the error code is returned to the computer. The definitions of the error codes are as follows.

Error Code	Error Item	Error Definition	Drive Unit Operation
H0	Computer NAK error	The number of errors consecutively detected in communication request data from the computer is greater than the permissible number of retries.	If errors occur consecutively more than the permissible number of communication retries (Pr. 121 setting), the drive unit displays E. PUE and trips. Refer to: Section 6.1.1 Protective function activated
H1	Parity error	The parity check result does not match the specified parity.	
H2	Sum check error	The sum check value in the computer does not match that of the data received by the drive unit.	
H3	Protocol error	Data received by the drive unit is in the wrong protocol, data receive is not completed within the given time, or CR and LF are not as set in the parameter.	
H4	Framing error	The stop bit length differs from the initial setting.	
H5	Overrun	New data has been sent by the computer before the drive unit completes receiving the preceding data.	
H7	Character error	The character received is invalid (other than 0 to 9, A to F, control code).	The receive data is made invalid and the drive unit continues operation.
HA	Mode error	Parameter write was attempted in other than the computer link operation mode or during drive unit operation, for example.	
HB	Instruction code error	The specified command does not exist.	
HC	Data range error	Invalid data has been specified for parameter write, running speed write, etc.	

(6) Program example (Switching the operation mode to communication operation)

```
                                        Initial setting of input file
10 OPEN "COM1 : 9600,E,8,2,HD" AS #1    : Communication file opening
20 COMST1,1,1:COMST1,2,1                : Circuit control signal (RS (ON in data-receivable
                                          status), ER (unit ready signal)) ON/OFF setting
30 ON COM(1)GOSUB＊REC                  : Interrupt definition at data receive
40 COM(1)ON                             : Interrupt enable
50 D$= "01FB10002"                      Transmission data setting
60 S=0
70 FOR I=1 TO LEN(D$)
80 A$=MID$(D$,I,1)
90 A=ASC(A$)                            Sum code calculation
100 S=S+A
110 NEXTI
120 D$=CHR$(&H5)+D$+RIGHT$(HEX$(S),2): Addition of control and sum codes
130 PRINT#1,D$                          Data transmission
140 GOTO 50
1000 ＊REC                              Interrupt data receive
1010 IF LOC(1)=0 THEN RETURN            : Interrupt occurrence at data receive
1020 PRINT "RECEIVE DATA"
1030 PRINT INPUT$(LOC(1),#1)
1040 RETURN
```

General flowchart



NOTICE	● The drive unit does not accept data from the computer if it is in error. Hence, always insert a data error retry program in the user program. ● Since the communication of any data, e.g. run command, monitor, is started from the computer, the drive unit will not return data without the computer's command. For monitoring, therefore, design the program to cause the computer to provide a data read request as required.

8.7 Monitoring of Operation Status

8.7.1 Selection of operation panel display data

		Initial Value
Pr. 37	"speed unit switch-over 1"	0

Change the display unit of the operation panel or FR-PU04 parameter unit (option).

Setting Range	Function
0	The motor speed is displayed. The unit is r/min.
1 to 9998	By setting a value corresponding to the rated speed, a machine operation amount equivalent can be displayed. At the setting of "10", 10 appears when the motor reaches the rated speed and "3" appears when the motor reaches 1/3 of the rated speed.

MEMO	● Display on the operation panel is 4 digits. When the monitored value is "10000" or higher, it is displayed as "————." Use the option parameter unit, FR-PU04, in order to display "10000" or higher. ● Changing the speed unit switch-over setting also changes the units of the other speed-related parameter settings.

		Initial Value
Pr. 144	"speed unit switch-over 2"	0

Set this parameter to show the display unit of the operation panel or the FR-PU04 parameter unit (option) as an output frequency.

Setting Range	Function
0	The Pr. 37 setting is enabled.
1	The Pr. 37 setting is disabled and the output frequency is displayed. The unit is Hz.

Initial Value

Pr. 52 "main display screen data selection" 0

You can select the display data of the main display on the operation panel or the FR-PU04 parameter unit (option).

Setting Range	Display Data	Unit	Display
0	Motor speed	r/min	Use SET key on the operation panel or SHIFT key on the parameter unit (FR-PU04) to shift the displayed item sequentially.
	Motor current	A	
	Output voltage	V	
	Alarm indication	—	
100	Motor speed (during operation) Preset speed (during stop)	r/min	
	Motor current	A	
	Output voltage	V	
	Alarm indication	—	
5	Preset speed	r/min	Values are displayed on the voltage monitor display. Use SET key on the operation panel or SHIFT key on the parameter unit (FR-PU04) twice to shift to the voltage monitor display. Refer to: Section 4.3. Operation Method.
6	Motor speed	r/min	
23	Actual operation time	h	

MEMO	● When "23" is set, the actual operation time indicates the cumulative operation time period of the motor excluding the stopped time period. Actual operation time is added every hour and displayed. If the power supply of the drive unit is turned OFF within an hour, that operation time period less than hour is not recorded. ● When "23" is set, the maximum actual operation time is 65535h. Once the value is reached, the count goes back to 0 and accumulates from 0 again. On the operation panel, 9999h or higher value is displayed as "————." Use FR-PU04 to check 9999h or higher value. ● The units of A, V, and Hz are used for the displayed data on the operation panel. Other units are not displayed. ● For the way to use FR-PU04 , refer to the instruction manual of FR-PU04.

8.7.2 Selection of the control circuit output terminal functions

		Initial Value
Pr. 190	"RUN terminal function selection"	0
Pr. 194	"FU terminal function selection"	4
Pr. 195	"A, B, C terminal function selection"	99

You can select/change the functions of the control circuit output terminals. At the initial values, the terminal names and signal names match.

<Setting example>
Set Pr. 190=99 to assign the ABC signal to the RUN terminal. The same function as the ABC terminal is assigned to the RUN terminal when Pr. 195 = "99." It is possible to obtain the same signal from two terminals.

Setting Range	Signal Name	Operation
0	RUN	"ON" during motor operation, "OFF" during voltage braking operation or stop.
1	SU	"ON" upon reaching the set speed. Refer to: Section 8.7.3 Detection of running speed
3	OL	"ON" when the stall prevention function activates. Refer to: Section 8.5.5 Stall prevention operation level
4	FU	"ON" at the preset speed or more. Refer to: Section 8.7.3 Detection of running speed
11	RY	"ON" while the running is enabled with the start signal input.
12	Y12	"ON" at the set output current or higher. Refer to: Section 8.7.4 Detection of output current
21	UVT	"ON" when AC input power supply voltage is insufficient. Refer to: Section 6.1.1 Protective function activated (undervoltage)
25	FAN	"ON" only when the cooling fan fails.
98	LF	"ON" at a communication error Refer to: Pr. 121 "number of communication retries" [Section 8.6]
99	ABC	"ON" when the protective function activates and the output is stopped Refer to: Section 6 TROUBLESHOOTING
9999	—	No function

8.7.3 Detection of running speed

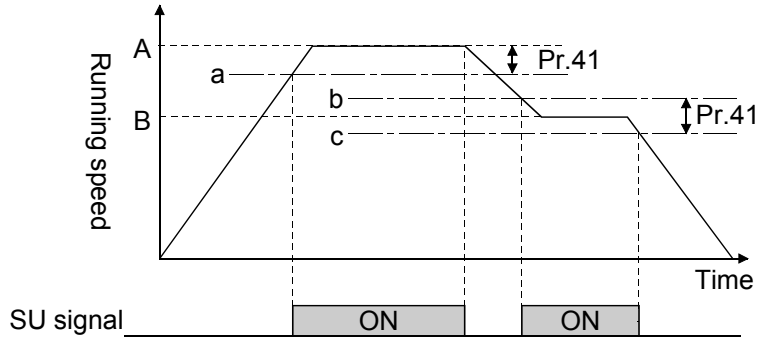
		Initial Value
Pr. 41	"detected speed range"	10

Setting Range	Unit
0.0 to 100.0	%

Assign the SU signal to an output terminal of the control circuit, and use that terminal to know when the motor speed reaches the setting range set with Pr. 41. Pr. 41 sets a range of a commanded speed.

Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

This signal is output when the motor speed reaches the commanded speed. This signal can be used to give a start signal for related devices.



<Setting example>
With Pr.41 = "10" setting
a = 0.9 × A, b = 1.1 × B, c = 0.9 × C

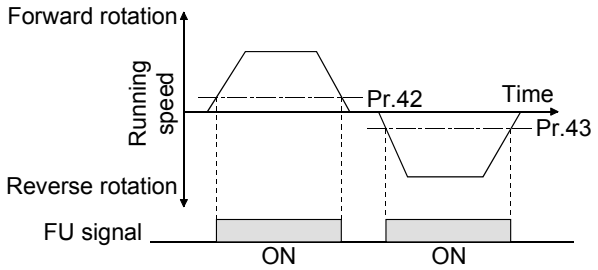
MEMO	● The SU signal may repeat "ON" and "OFF" if the speed is changed with analog signals and ▲▼ keys on the operation panel. In that case, set "0" in the acceleration/deceleration time. [Section 8.5.2]

		Initial Value
Pr. 42	"speed detection"	180
Pr. 43	"speed detection for reverse rotation"	9999

Pr.	Setting Range	Unit	Signal
42	0 to 3000	r/min	FU
43	0 to 3000	r/min	FU
	9999	—	—

Once the motor speed has reached or exceeded the speed set in the corresponding parameter, it is exported from the control circuit output terminals where the FU signal has been assigned.
Pr. 43 is valid for only the operation performed using the reverse rotation signal (terminal STR or REV key).
Setting the Pr. 43 value makes the Pr. 42 setting invalid for reverse rotation signal operation so that you can separate detection between forward rotation operation and reverse rotation operation.
Setting "9999" in Pr. 43 provides the same function as set in Pr. 42

Refer to: Section 8.7.2 Selection of the control circuit output terminal functions

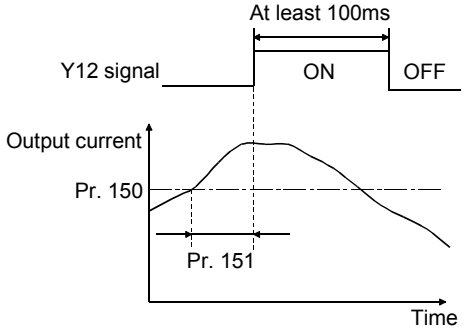


8.7.4 Detection of output current

		Initial Value
Pr. 150	"output current detection level"	150
Pr. 151	"output current detection time"	0

Pr.	Setting Range	Unit
150	0.0 to 200.0	%
151	0.0 to 10.0	s

If the motor current remains higher than the Pr. 150 setting for longer than the time set in Pr. 151, the terminal where the assigned Y12 signal turns "ON". The Pr. 150 value is based on the rated motor current.
Use any of Pr. 190, Pr. 194, and Pr. 195 [Section 8.7.2] to assign the terminal used for Y12 signal output.
Once turned on, the Y12 signal remains on for at least 100ms.



8.7.5 Selection of the instrument connection terminal functions

Initial Value

Pr. 54 "FM terminal function selection" 1

You can select the signals output to the FM terminal designed for instrument connection.

Setting Range	Display Data	Unit	Full-Scale
1	Motor speed	r/min	Value set in Pr. 55
2	Motor current	A	Value set in Pr. 56
5	Preset speed	r/min	Value set in Pr. 55

MEMO	● The maximum number of pulses of the terminal FM is 2400 pulses/s. ● The output signals from the terminal FM is updated at intervals of several 10ms.

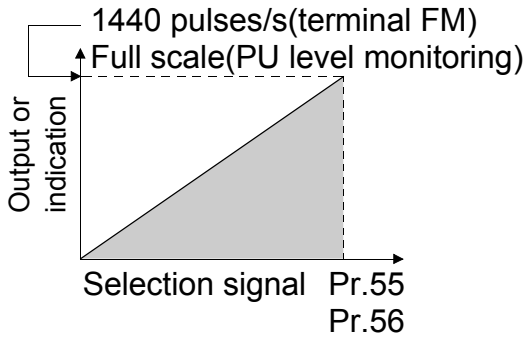
Initial Value

Pr. 55 "speed monitoring reference" 2000

Pr. 56 "current monitoring reference" rated motor current

The terminal FM outputs a 1440 pulse/s signal at the value set in Pr. 55 or 56.

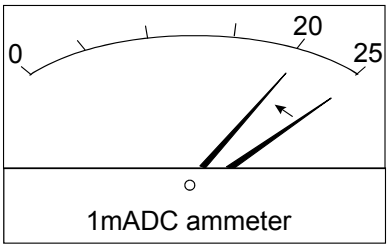
Pr.	Setting Range	Unit
55	0 to 3000	r/min
56	0.00 to 500.00	A



Pr. 900 "FM terminal calibration"

Using the operation panel or parameter unit, you can calibrate the full scale of a meter connected to the FM instrument connection terminal.
The terminal FM outputs a 1mADC current at the value set in Pr. 55 or 56. When the full scale of the meter used must be calibrated, it can be adjusted using Pr. 900.

<Calibration example>
Connect a 1mADC ammeter, which has "25" at the full scale. Calibrate it to indicate "20" at the running speed of 2000r/min.



<Calibration procedure with the operation panel>

1) Confirm that Pr. 55 is set to "2000."
2) Confirm that the + terminal of the ammeter is connected to the terminal FM, and the – terminal to the terminal SD.
3) If the ammeter is equipped with a calibration resistor, adjust the resistance to be "0," or remove the resistor.
4) Select PU operation mode.
5) Set the running speed to 2000r/min.
6) Press SET key.
7) Pr. 900 setting is displayed.
8) Press FWD key or REV key to start the operation. It does not require a motor to be connected.
9) Use ▲▼ keys to make the needle to point "20." Hold ▼ key to decrease the current flowing to the ammeter.) Press ▲ to increase.
10) Press SET key until Pr. 900 starts flickering (approx. 2s).
11) Press STOP/RESET to stop the operation.

MEMO	● Holding the ▲ key increases the current to approx. 2mA. Confirm the maximum rating of the ammeter and make adjustments. ● Calibration can be also performed for external operation. Set a frequency in External operation mode, and calibrate the meter in the procedure of 7) to 11). ● Calibration can be also performed during operation.

8.8 Control Parameters

These parameters are already set to optimal values when shipped from the factory. Do not change the settings.
Pr. 77 needs to be set to "801" for a setting to be changed.

<Control parameters>

Initial Value

Pr. 733 "electronic thermal O/L relay setting for motor protection" 100

Pr.	Setting Range	Unit	Operation
733	0.0 to 200.0	%	Set the reference torque to activate the motor overheating protection.

⚠CAUTION
Do not set a value higher than the initial value "100" in Pr. 733. If you are using your own forced-cooling system for the motor, please contact us.

Initial Value

Pr. 728 "acceleration time in low-speed range" 5

Pr.	Setting Range	Unit	Operation
728	0.00 to 15.00	s	Specify the maximum acceleration time at a speed less than the speed control range (lower than 100r/min). The reference speed during acceleration is the rated speed 2000r/min.

⚠CAUTION
Do not set a value higher than the initial value, "5," in Pr. 728. Doing so disable the output of 150% starting torque.

Initial Value

Pr. 713 "response speed time" 10

Pr. 714 "response speed adjustment" 100

Pr.	Setting Range	Unit	Operation
713	2 to 30	—	Setting a higher value in the parameters improves the response speed.
714	20.0 to 300.0	%	

⚠CAUTION
Setting a higher value to Pr. 713 and Pr. 714 improves the response speed. However, vibration may occur under some load conditions. Use the initial settings. If vibration occurs, set a lower value in Pr. 714.

Initial Value

Pr. 71 "applied motor" 1

Pr.	Setting Range	Unit	Operation
71	1	—	Set the motor to be used.

Pr. 80 "motor capacity"

Pr.	Setting Range	Unit	Operation
80	0.5,1.0, 1.5,2.0,3.5	kW	Set the motor capacity. The same capacity as the drive unit should be used.

NOTE: Changing Pr. 71 and Pr. 80 changes the motor-dedicated control constant inside the drive unit. It should be reset after the change.

Initial Value

Pr. 736 "overspeed adjustment coefficient" 100

Pr.	Setting Range	Unit	Operation
736	0 to 100	—	Adjust overspeed (overshoot, undershoot).

Over-speed amount depends on the load moment of inertia, acceleration/deceleration time, and load torque (friction torque).
Adjust the overspeed adjustment coefficient with the acceleration torque (proportional to "load moment of inertia"/"acceleration/deceleration time") and the load torque (friction) as shown in the figure below. Doing so can effectively suppress the overspeed amount.

Overspeed adjustment coefficient	0 to 100
Load torque	Large → Small
Acceleration torque	Small → Large

Initial Value

Pr. 737 "maximum voltage braking time period (s)"3

Pr.	Setting Range	Unit	Operation
737	0.0 to 60.0	s	Set the maximum voltage braking time when Pr. 11 "voltage braking time period" [Section 8.5.4.] is set to 9999. The motor usually stops within 3s. However, when it is rotated by an external force, it is forcibly stopped with voltage braking according to this parameter setting.

Initial Value

Pr. 738 "stop time during forward/reverse rotation switching (s)" 0

Pr.	Setting Range	Unit	Operation
738	0.0 to 60.0	s	Set the stop time period when switching from the forward to reverse rotation, or vice versa. At least approx. 100ms of stop time is required even if "0" is set.

APPENDIX

APPENDIX 1 Parameter List (Numerical Order)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction code		Data	Refer to page
					Read	Write	Extension	
1	Maximum speed	0 to 3000r/min	3000		01	81	0	8-19
2	Minimum speed	0 to 3000r/min	0		02	82	0	
4	Three-speed setting (high speed)	0 to 3000r/min	2000		04	84	0	8-16
5	Three-speed setting (middle speed)	0 to 3000r/min	1000		05	85	0	
6	Three-speed setting (low speed)	0 to 3000r/min	500		06	86	0	
7	Acceleration time	0.0 to 3600s/ 0.00 to 360.0s	5		07	87	0	8-22
8	Deceleration time	0.0 to 3600s/ 0.00 to 360.0s	5		08	88	0	
9	Electronic thermal O/L relay selection	0,1	1		09	89	0	8-26
10	Voltage braking speed	40 to 200r/min	100		0A	8A	0	8-23
11	Voltage braking time period	0.0 to 60.0s, 9999	9999		0B	8B	0	
13	Minimum motor speed	40 to 100r/min	100		0D	8D	0	8-19
20	Acceleration/ deceleration reference speed	1 to 3000r/min	2000		14	94	0	8-22
21	Acceleration/ deceleration time unit	0,1	0		15	95	0	
22	Stall prevention operation level	0,150%	150		16	96	0	8-25
24	Multi-speed setting (speed 4)	0 to 3000r/min, 9999	9999		18	98	0	8-16
25	Multi-speed setting (speed 5)	0 to 3000r/min, 9999	9999		19	99	0	
26	Multi-speed setting (speed 6)	0 to 3000r/min, 9999	9999		1A	9A	0	
27	Multi-speed setting (speed 7)	0 to 3000r/min, 9999	9999		1B	9B	0	
30	Regenerative brake option selection	0,1	0		1E	9E	0	8-25

APPENDIX 1 Parameter List (Numerical Order)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction code		Data	Refer to page
					Read	Write	Extension	
31	Speed command jump 1A	0 to 3000r/min, 9999	9999		1F	9F	0	8-20
32	Speed command jump 1B	0 to 3000r/min, 9999	9999		20	A0	0	
33	Speed command jump 2A	0 to 3000r/min, 9999	9999		21	A1	0	
34	Speed command jump 2B	0 to 3000r/min, 9999	9999		22	A2	0	
35	Speed command jump 3A	0 to 3000r/min, 9999	9999		23	A3	0	
36	Speed command jump 3B	0 to 3000r/min, 9999	9999		24	A4	0	
37	Speed unit switch-over 1	0 to 9998	0		25	A5	0	8-39
38	Speed at 10V(5V) input	1 to 3000r/min	2000		26	A6	0	8-11
39	Speed at 20mA input	1 to 3000r/min	2000		27	A7	0	8-12
41	Detected speed range	0.0 to 100.0%	10		29	A9	0	8-42
42	Speed detection	0 to 3000r/min	180		2A	AA	0	8-43
43	Speed detection for reverse rotation	0 to 3000r/min, 9999	9999		2B	AB	0	
52	Main display screen data selection	Refer to manual description.	0		34	B4	0	8-40
54	FM terminal function selection	Refer to manual description.	1		36	B6	0	8-44
55	Speed monitoring reference	0 to 3000r/min	2000		37	B7	0	
56	Current monitoring reference	0.00 to 500.00A	Rated motor current		38	B8	0	
70	Regenerative brake duty	0.0 to 15.0%	3		46	C6	0	8-25
72	Motor sound selection	1 to 4	1		48	C8	0	8-26
73	Speed command range selection	0,1	0		49	C9	0	8-11
74	Filter time constant	0 to 8	1		4A	CA	0	

APPENDIX 1 Parameter List (Numerical Order)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction code		Data	Refer to page
					Read	Write	Extension	
75	Disconnected PU detection/PU stop selection	0 to 3	0		4B	CB	0	8-7
77	Parameter write disable selection	0,1,2	0		4D	CD	0	8-5
78	Reverse rotation prevention selection	0,1,2	0		4E	CE	0	8-21
79	Operation mode selection	0 to 4	1		4F	CF	0	8-6
84	Rated motor speed	Read-only			54	—	0	8-26
117	Station number	0 to 31	0		11	91	1	8-28
118	Communication speed	48,96,192	192		12	92	1	
119	Stop bit length/data length	0,1,10,11	1		13	93	1	
120	Parity check presence /absence	0,1,2	2		14	94	1	
121	Number of communication retries	0 to 10,9999	1		15	95	1	
122	Communication check time interval	0,0.1 to 999.8, 9999	0		16	96	1	
123	Waiting time setting	0 to 150, 9999	9999		17	97	1	
124	CR-LF presence/absence selection	0,1,2	1		18	98	1	
144	Speed unit switch-over 2	0,1	0		2C	AC	1	8-39
146	Speed command source selection	0,1	0		2E	AE	1	8-7
150	Output current detection level	0.0 to 200.0%	150		32	B2	1	8-43
151	Output current detection time	0.0 to 10.0s	0		33	B3	1	

APPENDIX 1 Parameter List (Numerical Order)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction code		Data	Refer to page
					Read	Write	Extension	
180	RL terminal function selection	Refer to manual description.	0		14	94	2	8-17
181	RM terminal function selection	Refer to manual description.	1		15	95	2	
182	RH terminal function selection	Refer to manual description.	2		16	96	2	
187	MRS terminal function selection	Refer to manual description.	24		1B	9B	2	
188	RES terminal operation selection	0,1	0		1C	9C	2	8-18
189	STF, STR terminal operation selection	0,1	0		1D	9D	2	
190	RUN terminal function selection	Refer to manual description.	0		1E	9E	2	8-41
194	FU terminal function selection	Refer to manual description.	4		22	A2	2	
195	A, B, C terminal function selection	Refer to manual description.	99		23	A3	2	
232	Multi-speed setting (speed 8)	0 to 3000r/min, 9999	9999		28	A8	2	8-16
233	Multi-speed setting (speed 9)	0 to 3000r/min, 9999	9999		29	A9	2	
234	Multi-speed setting (speed 10)	0 to 3000r/min, 9999	9999		2A	AA	2	
235	Multi-speed setting (speed 11)	0 to 3000r/min, 9999	9999		2B	AB	2	
236	Multi-speed setting (speed 12)	0 to 3000r/min, 9999	9999		2C	AC	2	
237	Multi-speed setting (speed 13)	0 to 3000r/min, 9999	9999		2D	AD	2	
238	Multi-speed setting (speed 14)	0 to 3000r/min, 9999	9999		2E	AE	2	
239	Multi-speed setting (speed 15)	0 to 3000r/min, 9999	9999		2F	AF	2	
244	Cooling fan operation selection	0,1	0		34	B4	2	8-27

APPENDIX 1 Parameter List (Numerical Order)

No.	Name		Setting Range	Initial Value	Customer Setting	Instruction code		Data	Refer to page
						Read	Write	Extension	
900	Calibration parameters	FM terminal calibration	-	-		5C	DC	1	8-45
902		Speed setting voltage bias	0.0 to 300.0% 0 to 2000r/min	Approx. 0 0		5E	DE	1	8-12
903		Speed setting voltage gain	0.0 to 300.0% 1 to 3000r/min	100 2000		5F	DF	1	
904		Speed setting current bias	0.0 to 300.0% 0 to 2000r/min	Approx. 20 0		60	E0	1	8-15
905		Speed setting current gain	0.0 to 300.0% 1 to 3000r/min	100 2000		61	E1	1	
922		Operation panel potentiometer bias	0.0 to 300.0% 0 to 2000r/min	Approx. 0 0		16	96	9	8-8
923		Operation panel potentiometer gain	0.0 to 300.0% 1 to 3000r/min	100 2000		17	97	9	
991	LCD contrast		Available for option (FR-PU04).			5B	DB	9	—

REVISIONS

* The manual number is given on the bottom left of the back cover.

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