Super Energy-saving Medium-voltage Inverter FSDrive-MV1S

INSTRUCTIONS

3 kV Class, 6 kV Class

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

YASKAWA

MANUAL NO. TOEP C710687 00B

Preface

Thank you for purchasing the Yaskawa Inverter for system applications FSDrive-MV1S series.
This manual is designed to ensure correct and suitable application of the Yaskawa FSDrive-MV1S series Inverter (hereinafter referred to as FSDrive-MV1S). As soon as this product is delivered, read this manual before attempting to install, operate, maintain, or inspect an FSDrive-MV1S and handle the FSDrive-MV1S according to the instructions described in this manual. Be sure you understand all precautions and safety information before attempting to use the FSDrive-MV1S.
This manual is required for maintenance management of the FSDrive-MV1S including daily maintenance as well as checking and troubleshooting. Keep this manual in a safe place for further reference.

General Safety

◆ General Precautions

- All diagrams in this manual may show the product without covers or safety shields to show details. Replace covers and shields before operating the product and operate the product according to the instructions given in this manual.
- The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual. Such changes are implemented by updating the document number to indicate a revised edition.
- When ordering a new copy of the manual due to damage or loss, contact your Yaskawa representative or the nearest Yaskawa sales office and provide the manual number shown on the front cover.
- Modification of the product by the end user is not subject to Yaskawa's quality assurance, and we can therefore accept no responsibility for such modifications.
- This manual must be safely delivered into the hands of the end user of the product.
- This manual is also required for daily maintenance and inspection and other processes, so keep it in a safe place.

◆ Supplemental Safety Information

The conventions and signal words presented from here on are used for different types of safety information in this document. The following conventions are used to indicate safety messages in this manual. Failure to heed these messages could result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

DANGER	**Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.**
WARNING	**Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.**
CAUTION	**Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.**
NOTICE	**Indicates a property damage message.**

Indicates important information that should be memorized.

◆ Safety Messages

■General

⚠ WARNING

- For correct use, be sure to read this manual and other attached documents thoroughly before use (installation, operation, maintenance, inspection, etc.). Also, be sure to use the equipment after having acquired a thorough knowledge of the equipment, the safety information, and all of the precautions. Be sure to keep the documents in a place where they are readily available for anyone using the device.

■Storage and Transportation

NOTICE

- If disinfectants or insecticides must be used to treat packing materials such as wooden frames, pallets, or plywood, the packing materials must be treated before the product is packaged, and methods other than fumigation must be used.
  Example: Heat treatment, where materials are kiln-dried to a core temperature of 56°C for 30 minutes or more.
  If the electronic products, which include stand-alone products and products installed in machines, are packed with fumigated wooden materials, the electrical components may be greatly damaged by the gases or fumes resulting from the fumigation process. In particular, disinfectants containing halogens, which includes chlorine, fluorine, bromine and iodine, can contribute to the erosion of the capacitors.

■Confirmations upon Receipt

⚠ DANGER

- If there is any damage or any missing components, cease using the device immediately and contact Yaskawa representative.
  Failure to comply may result in injury while wiring the device, or electric shock or fire due to a fault while the unit is powered up.

■Wiring

⚠ DANGER

- Do not connect or disconnect wiring while the power is on.
  Failure to comply will result in death or serious injury by fire.
  Prior to wiring, make sure the input power supply is shut off.
- Do not allow unqualified personnel to perform work on the Inverter.
  Failure to comply could result in death or serious injury by fire.
  Installation, maintenance, inspection, and servicing must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of Inverters.
- Make sure ground terminals are properly grounded with a resistance of less than 10Ω. The recommended AWG cable size for grounding is one with a diameter of 2.66 mm or more.
  Improper grounding can result in electric shock or fire.
- Do not forget to include an emergency stop circuit in the application.
  Failure to comply could result in death or serious injury.
  A communication error between the digital operator keypad and the drive's internal control board may make it impossible to stop the drive with the digital operator.

⚠ DANGER

- Once an emergency stop circuit has been wired, check to make sure it is operating properly.
  Failure to comply could result in death or serious injury.
  The emergency stop circuit may fail to operate if left unchecked. The user is fully responsible for properly wiring the emergency circuit.
- Never touch the input and output terminals or allow the input and output lines to come into contact with the control panel or any other metallic device or materials.
- Never short the output terminals.
  Failure to comply will result in death or serious injury by fire because of electric shock or a grounding short, and is extremely dangerous.

⚠ CAUTION

- Connect the input and output terminals correctly.
  Incorrect wiring of input and output terminals will result in damage to the Inverter when the power supply is turned on, and may result in injury.
- Do not use an improper voltage source.
  Failure to comply could result in death or serious injury by fire.
  Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.
- Do not perform a voltage withstand test on the device.
  Failure to comply may damage semiconductor components.
- Never connect a power supply to output terminals U, V, and W.
  Applying voltage to the output terminals will damage power cells in the Inverters.
- Do not connect a phase-forward capacitor or an LC/RC noise filter to the output circuit.
  Connecting such devices can damage internal components or cause them to overheat.

■Setting User Constants

⚠ CAUTION

- During autotuning, the motor must be disconnected from any load (machine, equipment).
  The motor may operate in an unexpected manner, possibly resulting in injury or damage to equipment. Also, motor constants cannot be correctly set with the motor attached to a load.
- Protect both exposed ends of any coupling detached for autotuning with tape or cloth.
  Failure to comply could result in damage to the coupling or in grease being splashed.
- Do not touch the motor during autotuning.
  The motor may suddenly restart from the stopped state, leading to an injury,

■Test Run

⚠ DANGER

- Make sure that the panel door is properly closed before turning on the input power supply.
  Failure to comply could result in electric shock.
- Prepare a separate emergency stop switch.
  Only the stop button should be enabled when the emergency switch has been triggered.
  Incorrect use of the Inverter could result in death or serious injury.
- In the event of a fault, first clear the Run command and then reset the fault.
  If the Run command is present, the Inverter will disregard any attempts to reset the fault. The Run command must first be removed before a fault situation can be cleared.
  Incorrect use of the Inverter could result in death or serious injury.

⚠ CAUTION

- Do not touch the main circuit or the transformer shortly after the main circuit power supply has been turned off.
  Failure to comply could result in a burn injury because the main circuit remains very hot.
- Do not connect a measuring device to the control board for a signal check during operation.
  Failure to comply could result in electric shock or damage to the equipment.

NOTICE

- Refrain from making unnecessary parameter setting changes.
  Unnecessary parameter settings can lead to equipment damage and personal injury.
  Default settings are often the most appropriate values.

■Maintenance and Inspection

⚠ DANGER

- Do not attempt to modify or alter the Inverters.
  Failure to comply could damage Inverters components, or result in death or serious injury.
- Refrain from touching the terminals unnecessarily. The Inverters has high voltage terminals, which are extremely dangerous.
  Failure to comply could result in death or serious injury by electric shock.
- Make sure that the panel door is properly closed while the Inverters are powered up. When opening the door, make sure power to the main circuit has been shut off.
  Failure to comply could result in death or serious injury by electric shock.
- Perform maintenance and Inverters inspection after first shutting off power to the main circuit, then waiting for the CHARGE LED on the front face of the Power Cell to go out.
  Residual voltage in Inverters capacitors can cause electric shock.
  Failure to comply could result in death or serious injury.
- Maintenance, inspection, and component replacement should be performed only by a qualified electrical engineer or by personnel who have received proper training for this product.
  Failure to comply could result in death or serious injury by electric shock.
  Maintenance, inspection, and replacing components must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of Inverters.
- Remove any and all metal accessories (rings, wristwatch, etc.) prior to performing any work on the drive, and take proper steps to ensure insulation from electric shock.
  Failure to comply could result in electric shock.

NOTICE

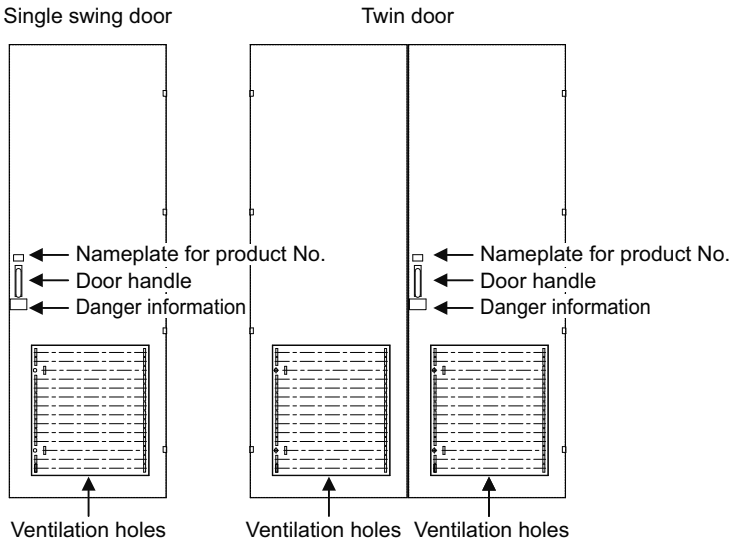
- The control board contains a CMOS IC, and must be handled with care.
  Touching the board directly may result in the transfer of static electricity, which can destroy the CMOS IC.
- Never remove any connectors or attempt to change any wiring on the control circuit while the drive is on.
  Failure to comply may damage electrical components.
- When carrying out measurement with an oscilloscope, use an insulated oscilloscope without grounding.
  Failure to comply could result in damage to the Inverter or the oscilloscope.
- Do not pull too strongly when pulling the Power Cell out.
  Failure to comply could result in the Power Cell being thrown out and your hands or fingers being caught in the machinery.
- After completing the work, make sure that no hand tools or screws are left inside the Inverter.

■Restrictions

- This product was not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.
  End users who intend to use the product described in this manual for devices or systems relating to transportation, health care, space aviation, nuclear power control applications, or underwater use must contact their Yaskawa representatives or the nearest Yaskawa sales office beforehand.
- This product has been manufactured under strict quality-control guidelines. However, if this product is to be installed in any location where its failure could involve or result in a life-and-death situation or loss of human life, or in a facility where failure may cause a serious accident or physical injury, safety devices must be installed to minimize the likelihood of any accident.

Danger Information and Position

There is danger information on the Inverter in the locations shown in the following illustration. Always heed the danger sign.



Danger Information

Warranty Information

■ Free Warranty Period and Scope

Warranty Period

This product is warranted for twelve months after being delivered to end user or if applicable eighteen months from the date of shipment from Yaskawa's factory whichever comes first.

Scope of Warranty

Inspections

Periodic inspections must be conducted by the end user. However, upon request, Yaskawa or one of Yaskawa's Service Centers can inspect the product for a fee. In this case, if after conferring with the end user, a Yaskawa product is found to be defective due to Yaskawa workmanship or materials and the defect occurs during the warranty period, then this fee will be waived and the problem remedied free of charge.

Repairs

If a Yaskawa product is found to be defective due to Yaskawa workmanship or materials and the defect occurs during the warranty period, Yaskawa will bear the cost of repairing the unit, replacing it, or dispatching a repair technician.

However, if the Yaskawa Authorized Service Center determines that the problem with a Yaskawa product is not due to defects in Yaskawa's workmanship or materials, then the end user will be responsible for the cost of any necessary repairs. Some problems that are outside the scope of this warranty are:

- Problems due to improper maintenance or handling, carelessness, or other reasons where the end user is determined to be responsible.
- Problems due to additions or modifications made to a Yaskawa product by the end user without Yaskawa's understanding.
- Problems due to the use of a Yaskawa product under conditions that do not meet the recommended specifications.
- Problems caused by natural disaster or fire.
- Or other problems not due to defects in Yaskawa workmanship or materials.

Warranty service is only applicable within Japan.

However, after-sales service is available for end users outside of Japan for a reasonable fee. Contact your local Yaskawa representative for more information.

■ Exceptions

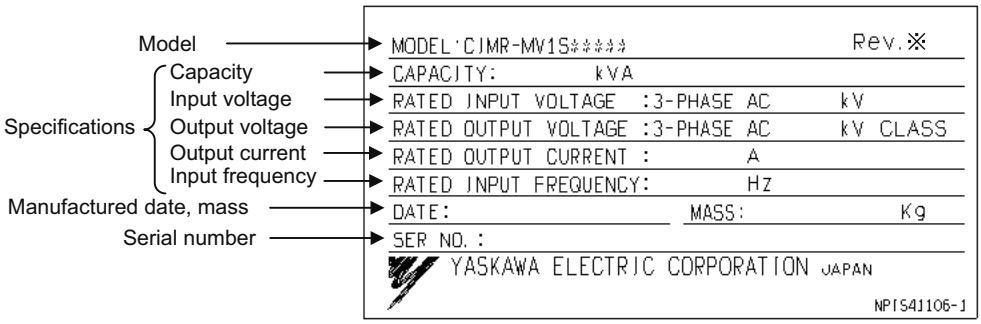
Any inconvenience to the end user or damage to non-Yaskawa products due to Yaskawa's defective products whether within or outside the warranty period are NOT covered by this warranty.

■ Restrictions

- This product was not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.
- End users who intend to use the product described in this manual for devices or systems relating to transportation, health care, space aviation, atomic or electric power, or underwater use must contact their Yaskawa representatives or the nearest Yaskawa sales office beforehand.
- This product has been manufactured under strict quality-control guidelines. However, if this product is to be installed in any location where failure of this product could involve or result in a life-and-death situation or loss of human life or in a facility where failure may cause a serious accident or physical injury, safety devices must be installed to minimize the likelihood of any accident.

Before Reading This Manual

There are places in this manual where the constants and explanations depend on the version and capacity of the Inverter. Be sure to confirm the version and capacity on the Inverter's nameplate.



Example of the Inverter's nameplate

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Handling Inverters

This chapter describes things that must be checked upon receiving or installing an FSDrive-MV1S.

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Checking the FSDrive-MV1S Model and Nameplate

Check the following points as soon as the Inverter has been delivered.

⚠ DANGER
• If you discover any damage or missing parts in the Inverter, stop using it and contact your Yaskawa representative. Electrical circuits may fail when current is applied, leading to electric shock or fire.

Table 1.1 Items to be Checked and Checking Methods upon Delivery

Item	Method
Has the correct Inverter model been delivered?	Check the model number on the nameplate on the inside of the Control section door.
Is the Inverter damaged in any way?	Inspect the entire exterior of the Inverter to see if there are any scratches or other damage resulting from shipping. Open the Inverter door, and inspect the interior of the Inverter to see if there is any damage or displacement, and to confirm that there are no missing parts.
Are any screws or other components loose?	Use a screwdriver or other tool to check for tightness. In particular, check the tightening torque of all terminal screws on the electrical connections.

If you find any irregularities in the above items, contact your Inverter supplier or Yaskawa representatives or the nearest Yaskawa sales office immediately.

◆ Nameplate

The nameplate is affixed on the inside of the Control section door of the Inverter.

An example of a nameplate with standard specifications is shown below.

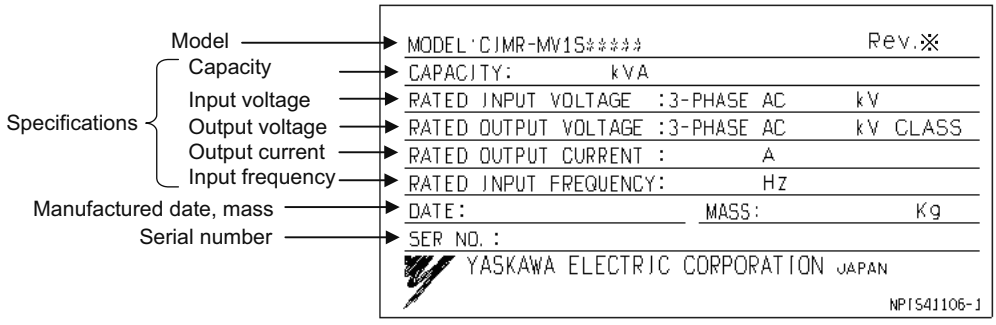


Fig 1.1 Nameplate

◆ Descriptions of Inverter Models

The Inverter model number on the nameplate indicates the specifications, voltage class, and maximum applicable motor capacity of the Inverter in alphanumeric code.

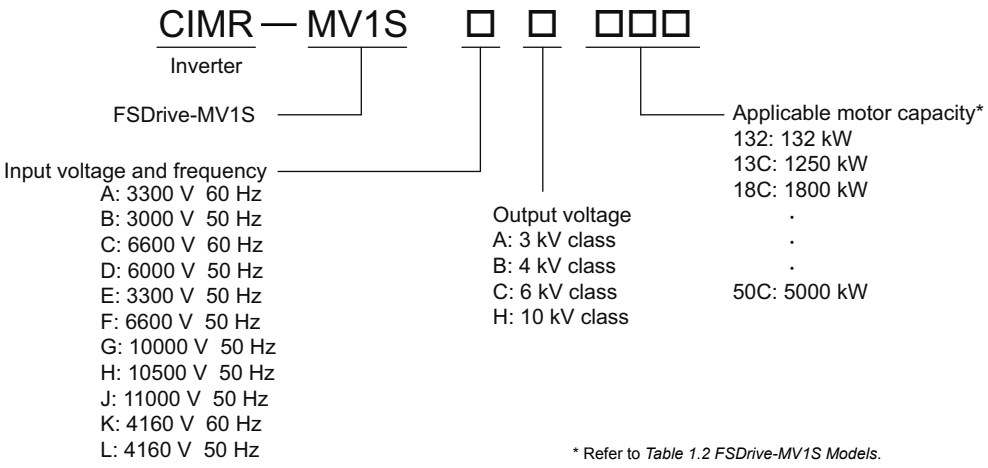


Fig 1.2 Inverter Model Descriptions

FSDrive-MV1S Models

Table 1.2 FSDrive-MV1S Models

Input Voltage V	Power Supply Frequency Hz	Output Voltage V	Nominal Capacity kVA	Rated Current A	Model Number	Product Code No.	Max. Applicable Motor Capacity* kW <Reference>
3000	50	3300	200	35	CIMR-MV1SBA132	71686-MV1SBA132-C	132
			285	50	CIMR-MV1SBA200	71686-MV1SBA200-C	200
			400	70	CIMR-MV1SBA315	71686-MV1SBA315-C	315
			570	100	CIMR-MV1SBA450	71686-MV1SBA450-C	450
			800	140	CIMR-MV1SBA630	71686-MV1SBA630-C	630
			1150	200	CIMR-MV1SBA900	71686-MV1SBA900-C	900
			1500	260	CIMR-MV1SBA13C	71686-MV1SBA13C-C	1250
			1900	330	CIMR-MV1SBA15C	71686-MV1SBA15C-C	1500
			2300	400	CIMR-MV1SBA18C	71686-MV1SBA18C-C	1800
			3000	520	CIMR-MV1SBA25C	71686-MV1SBA25C-C	2500
3300	50		200	35	CIMR-MV1SEA132	71686-MV1SEA132-C	132
			285	50	CIMR-MV1SEA200	71686-MV1SEA200-C	200
			400	70	CIMR-MV1SEA315	71686-MV1SEA315-C	315
			570	100	CIMR-MV1SEA450	71686-MV1SEA450-C	450
			800	140	CIMR-MV1SEA630	71686-MV1SEA630-C	630
			1150	200	CIMR-MV1SEA900	71686-MV1SEA900-C	900
			1500	260	CIMR-MV1SEA13C	71686-MV1SEA13C-C	1250
			1900	330	CIMR-MV1SEA15C	71686-MV1SEA15C-C	1500
			2300	400	CIMR-MV1SEA18C	71686-MV1SEA18C-C	1800
			3000	520	CIMR-MV1SEA25C	71686-MV1SEA25C-C	2500
3300	60		200	35	CIMR-MV1SAA132	71686-MV1SAA132-C	132
			285	50	CIMR-MV1SAA200	71686-MV1SAA200-C	200
			400	70	CIMR-MV1SAA315	71686-MV1SAA315-C	315
			570	100	CIMR-MV1SAA450	71686-MV1SAA450-C	450
			800	140	CIMR-MV1SAA630	71686-MV1SAA630-C	630
			1150	200	CIMR-MV1SAA900	71686-MV1SAA900-C	900
			1500	260	CIMR-MV1SAA13C	71686-MV1SAA13C-C	1250
			1900	330	CIMR-MV1SAA15C	71686-MV1SAA15C-C	1500
			2300	400	CIMR-MV1SAA18C	71686-MV1SAA18C-C	1800
			3000	520	CIMR-MV1SAA25C	71686-MV1SAA25C-C	2500

Table 1.2 FSDrive-MV1S Models (Continued)

Input Voltage V	Power Supply Frequency Hz	Output Voltage V	Nominal Capacity kVA	Rated Current A	Model Number	Product Code No.	Max. Applicable Motor Capacity* kW <Reference>
6000	50	6600	400	35	CIMR-MV1SDC250	71686-MV1SDC250-C	250
			570	50	CIMR-MV1SDC400	71686-MV1SDC400-C	400
			800	70	CIMR-MV1SDC630	71686-MV1SDC630-C	630
			1150	100	CIMR-MV1SDC900	71686-MV1SDC900-C	900
			1600	140	CIMR-MV1SDC13C	71686-MV1SDC13C-C	1250
			2300	200	CIMR-MV1SDC18C	71686-MV1SDC18C-C	1800
			3000	260	CIMR-MV1SDC25C	71686-MV1SDC25C-C	2500
			3800	330	CIMR-MV1SDC30C	71686-MV1SDC30C-C	3000
			4600	400	CIMR-MV1SDC36C	71686-MV1SDC36C-C	3600
			5300	460	CIMR-MV1SDC43C	71686-MV1SDC43C-C	4300
			6000	520	CIMR-MV1SDC50C	71686-MV1SDC50C-C	5000
6600	50		400	35	CIMR-MV1SFC250	71686-MV1SFC250-C	250
			570	50	CIMR-MV1SFC400	71686-MV1SFC400-C	400
			800	70	CIMR-MV1SFC630	71686-MV1SFC630-C	630
			1150	100	CIMR-MV1SFC900	71686-MV1SFC900-C	900
			1600	140	CIMR-MV1SFC13C	71686-MV1SFC13C-C	1250
			2300	200	CIMR-MV1SFC18C	71686-MV1SFC18C-C	1800
			3000	260	CIMR-MV1SFC25C	71686-MV1SFC25C-C	2500
			3800	330	CIMR-MV1SFC30C	71686-MV1SFC30C-C	3000
			4600	400	CIMR-MV1SFC36C	71686-MV1SFC36C-C	3600
			5300	460	CIMR-MV1SFC43C	71686-MV1SFC43C-C	4300
			6000	520	CIMR-MV1SFC50C	71686-MV1SFC50C-C	5000
6600	60		400	35	CIMR-MV1SCC250	71686-MV1SCC250-C	250
			570	50	CIMR-MV1SCC400	71686-MV1SCC400-C	400
			800	70	CIMR-MV1SCC630	71686-MV1SCC630-C	630
			1150	100	CIMR-MV1SCC900	71686-MV1SCC900-C	900
			1600	140	CIMR-MV1SCC13C	71686-MV1SCC13C-C	1250
			2300	200	CIMR-MV1SCC18C	71686-MV1SCC18C-C	1800
			3000	260	CIMR-MV1SCC25C	71686-MV1SCC25C-C	2500
			3800	330	CIMR-MV1SCC30C	71686-MV1SCC30C-C	3000
			4600	400	CIMR-MV1SCC36C	71686-MV1SCC36C-C	3600
			5300	460	CIMR-MV1SCC43C	71686-MV1SCC43C-C	4300
			6000	520	CIMR-MV1SCC50C	71686-MV1SCC50C-C	5000

* Indicates the capacities of Yaskawa's 4-pole motors.

FSDrive-MV1S Configuration

Fig. 1.3 shows the appearance and internal layout diagram of FSDrive-MV1S.

The FSDrive-MV1S is composed of the following three components:

- Transformer section
- Power Cell section
- Control section

■Transformer Section

The Transformer section houses a 3-phase transformer with multiple windings on the secondary side. The secondary winding of the transformer on the output side is composed of nine 3-phase windings for the 3-kV class or eighteen 3-phase windings for the 6 kV class. Each of the windings is connected to a 3-phase input terminal of the Power Cell.

Several cooling fans for the Transformer section are mounted in the upper part of the Inverter. Cooled air brought through the filters on the front face of the Transformer section passes the Transformer section and is expelled into the upper part of the Inverter. In some models the cooled air from the front of the Transformer section and Power Cell section passes the Transformer section and is expelled into the upper part of the Inverter.

■Power Cell Section

The Power Cell section on the output side contains a total of nine Power Cells with three steps for each phase in the 3 kV class, or a total of eighteen power cells with six steps each in the 6 kV class. Each Power Cell is a single-phase inverter with 3-phase 630 V input.

Multiple cooling fans for the Power Cell section are mounted in the upper part of the Inverter. Cooled air brought through the filters on the front of the Power Cell section passes the Power Cell fin, flows into the air duct at the rear of the Inverter, and is expelled into the upper part of the Inverter.

The power section and the cell control board (CCB) are incorporated into the Power Cell. Each CCB is connected to the controller in the Control section with an optical fiber cable. The CCB controls PWM output of the cell according to the references sent from the controller through the optical fiber cable. The CCB has protection functions against overvoltage, undervoltage, IGBT overheat and other problems, and sends an answerback to the controller through the optical fiber cable.

■Control Section

The Control section houses the following components.

- Controller and control power supply to control an FSDrive-MV1S
- MCCB (Molded Case Circuit Breaker)
- Sequence I/O relay
- Peripheral circuits such as an analog I/O isolation amplifier
- Control circuit terminal block

All external cables except the input and output cables of the main circuit are connected to the control circuit terminal block.

A 200/220-VAC power supply is required as the control source power for the cooling fan and control circuit. (380/400/440-VAC power supply is also applicable.)

The controller is composed of the following components.

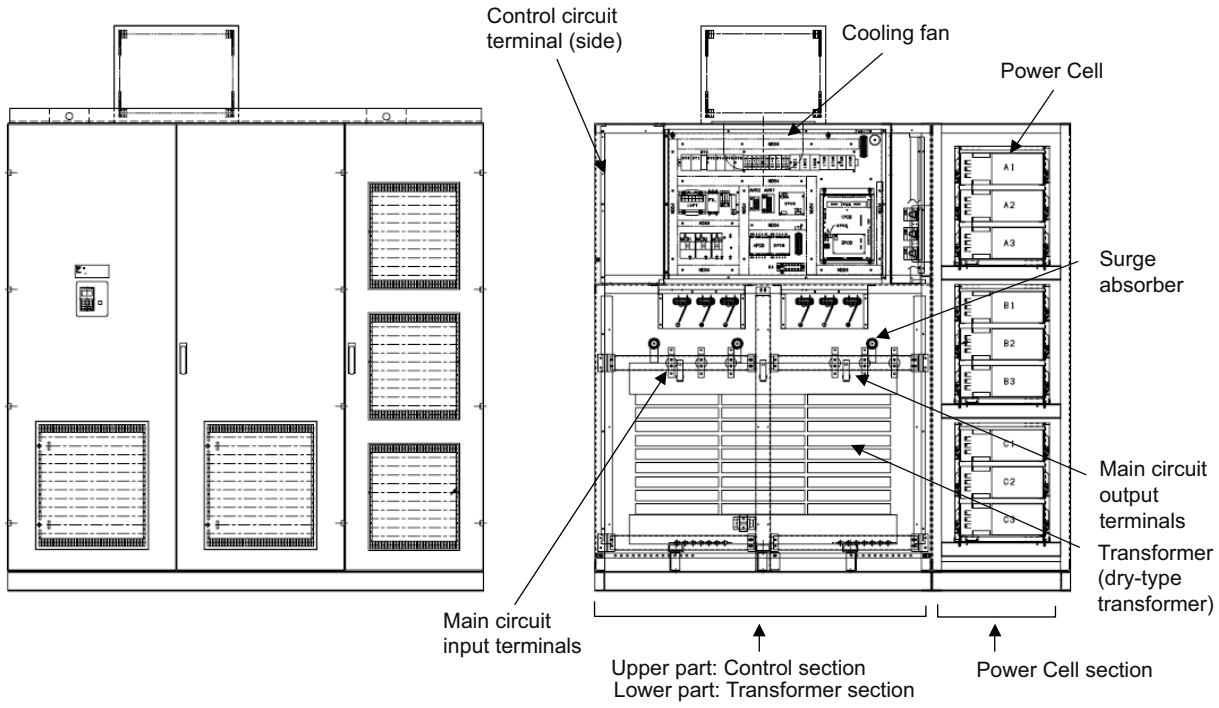
- CPU board
- Modulator board
- Current detection resistor board
- Optical fiber interface board (only for 6 kV class Inverters)

The current detection resistor boards differ depending on the Inverter capacity. Refer to *Table 8.5 Current Detection Resistor Boards* for more information.
There are the following three types of power supply to the controller.

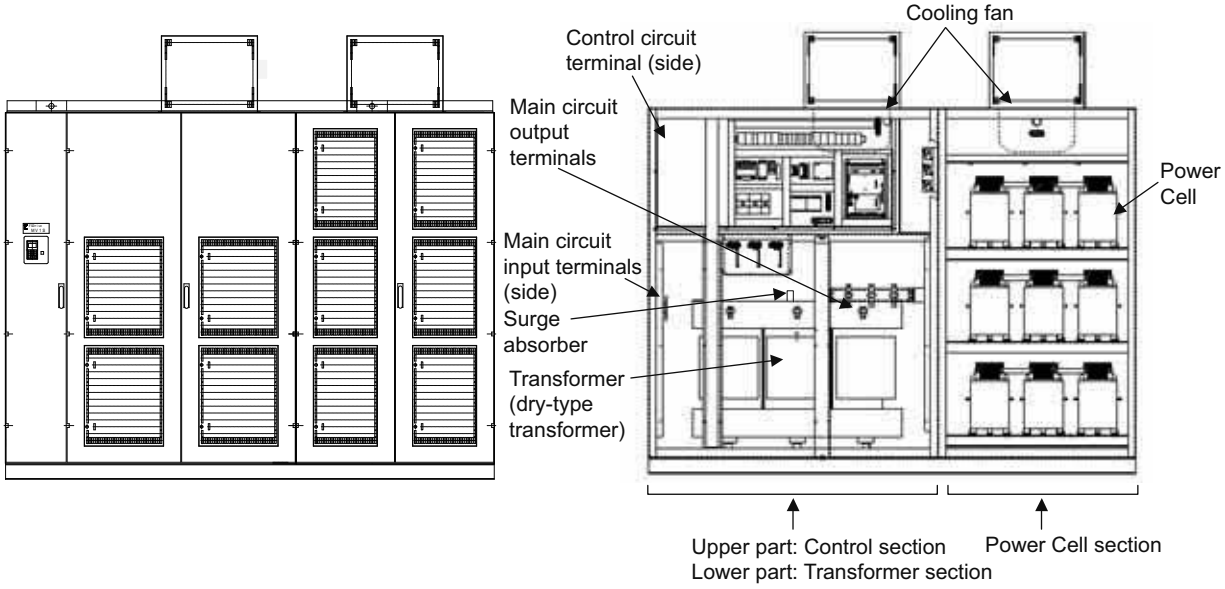
- 5V: Control circuit power supply
- ±15V: Analog I/O power supply
- 24V: Sequence I/O power supply

Refer to *Table 8.4 List of Recommended Spare Parts* for the power supply model.

A Digital Operator including the functions of parameter writing/reading and status/fault monitoring, and a modular jack for connecting to a personal computer are provided on the Control section door.



3 kV Class, 800 kVA FSDrive-MV1S



3 kV Class, 1150 kVA FSDrive-MV1S

Fig 1.3 FSDrive-MV1S Appearance and Internal Layout Diagram

Installation

◆ Installation Environment

Install the Inverter at a location that satisfies the following requirements and maintain the optimum operation conditions.

- Ambient temperature: -5°C to +40°C
- Relative humidity: 85%RH max. without condensation
  If air temperature around the Inverter largely varies, condensation may occur.
  When installing the Inverter in such environment, take a measure to prevent condensation, such as installing a space heater, inside the Inverter panel. If a space heater is required, consult Yaskawa in advance.
- Free from dripping water
- Free from corrosive liquid or gas
- Not subjected to excessive dust and iron powder
  Install the Inverter in a location that meets the following air quality standards (pollution).
  JIS C704 Level 2 or lower
- Not subjected to excessive vibration
  20 Hz maximum with 1G (9.8 m/s^2), 20 to 55 Hz with 0.2G
- Free from risk of salt damages (Not subjected to chlorides)
  Take a measure to prevent salt contained open air, rain, and dust from entering the electric room.
  A contact with such air, rain, or dust may degrade insulation and corrode metallic parts, resulting in Inverter failure.
- Altitude: 1000 m or lower above sea level
- The electric room must be protected against wind and rain.
- Fan cover
  If the installation space is so limited that the fan cover cannot be installed, consult Yaskawa in advance.
- Never install a duct on the air exhausting system.
- Modifications on the air exhausting system (cooling fan) on the top of the Inverter, such as installing air exhaust ducts, may lower the cooling effect, resulting in abnormal temperature rise and Inverter failure.
  If any additional ventilation system such as duct is required, consult Yaskawa in advance.
- Install an air conditioner or ventilation system with enough capacity for the total power loss of the Inverter and the devices in the electric room so that the temperature can be kept 40 °C or less and the humidity 85% or less in the electric room. (Yaskawa recommends installation of air conditioner.)
- Use a power supply with the voltage fluctuation ±10% and frequency fluctuation ±5%.
- Air temperature around the Inverter when leaving the Inverter without the power being supplied must be kept between -10°C to +50°C.
  For a long-term storage of the Inverter, refer to *Storage on page 1-20*.

Protecting the Inverter from Foreign Matter

Take measures to prevent foreign matter such as metal chips or powder from entering the Inverter during installation. Make sure that tools and unused parts are not left in or around the Inverter after installing it. Carefully check the power flow sections, their surroundings, the air filter section, and the ventilation louver on the top of the Inverter, and confirm that there are no foreign objects or obstacles.

If the Inverter must be installed in a location subject to excessive vibration caused by machines such as cranes, contact your Yaskawa representatives or the nearest Yaskawa sales office. The Inverter generates noise, including radio noise, to some extent. This should be considered when selecting the installation location.

◆ Checking the Installation Space

Secure the space described below around the Inverter to maintain sufficient cooling of the Inverter.

If the installation space is so limited that the described space cannot be reserved around the Inverter, contact your Yaskawa representatives.

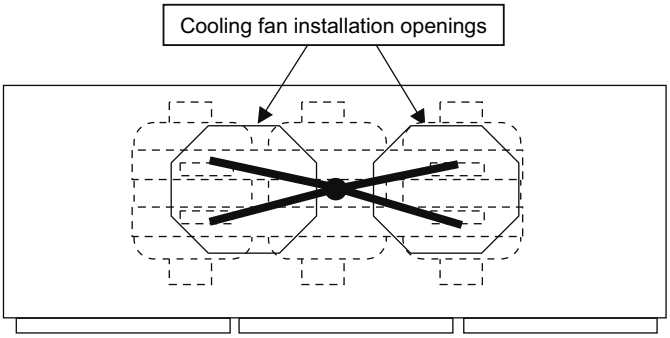
- Space Above the Inverter
  Secure a distance of at least one meter between the top of the Inverter (excluding the exhaust cover) and the room's ceiling.
  Air is expelled through the cooling fans on top of the Inverter. If the cooling fans are too close to the ceiling, expelled air may be returned to the Inverter and lower the cooling fan capacity.
  Additionally, sufficient space to remove the cooling fan from the top of the Inverter is required for replacement.
- Space in Front of the Inverter
  Secure a space of two meters or more in front of the Inverter to allow for maintenance.
  Space for a lifter to draw out the Power Cell is required.
- Space Behind the Inverter
  Secure a space of 60 cm or more behind the Inverter to allow for maintenance.
  This space is required when leading the cable into the Inverter and installing anchors on the back of the Inverter.
- Space on Either Side of the Inverter
  Secure a space of 3 cm or more on each side of the Inverter panel.

◆ Transporting

⚠ CAUTION

- Movement of the Inverter with a crane must be performed only by a qualified crane operator.
  Failure to observe this precaution may result in injury or in dropping the Inverter.

- To lift the small/middle capacity (3 kV class 200 kVA to 3000 kVA, 6 kV class 400 kVA to 3800 kVA) Inverters, use the angle bars for lifting on top of the Inverter.
- To lift the large capacity (6 kV class 4600 kVA to 6000 kVA) Inverters, use the support hooks or the hanging jig provided as an accessory to lift the Transformer section. (Refer to *Fig. 1.7*)
  Use the angle bars for lifting on top of the Inverter to lift the Power Cell and Control sections.
- The cooling fans on top of the Inverter are not fitted with the cooling exhaust cover (accessory), so be careful not to damage them during transportation.
- When using rollers to move the Inverter, make sure that the following conditions are met.
  - Place the Inverter on the rollers, so the rollers extend approximately 1 cm or more on each side of the Inverter.
  - Distribute the weight of the Inverter evenly on the rollers so stress is evenly distributed on the bottom of the panel.
  - Create a smooth, even surface for rolling by laying boards flat on the floor. Use boards with sufficient strength and durability, and make sure the boards do not have gaps between them.



View from above

The Inverter is shipped with the upper cooling fan and ventilation cover removed.
Pass the support wire through the openings on the top of the Inverter where the cooling fan is to be installed.
Connect the wire to the support hooks on the transformer, so the enclosure panel can hang as shown in the diagram.

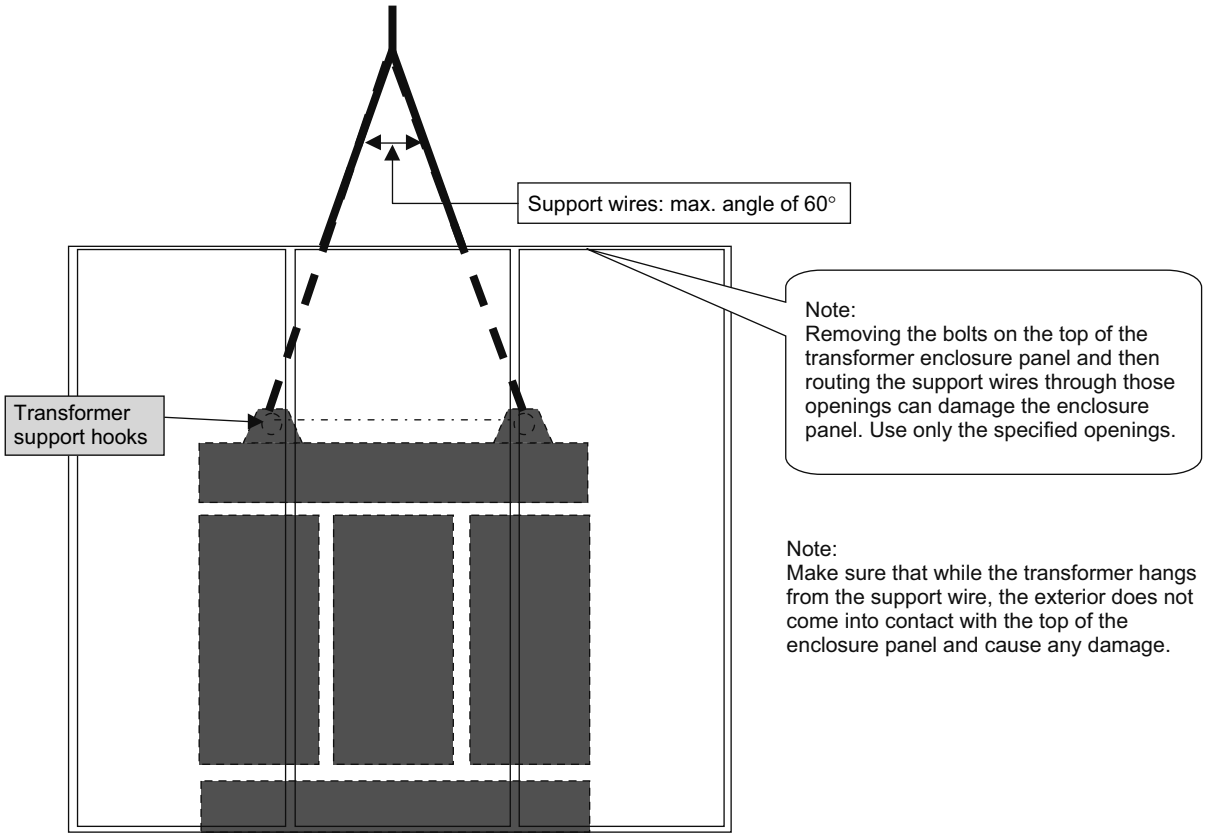
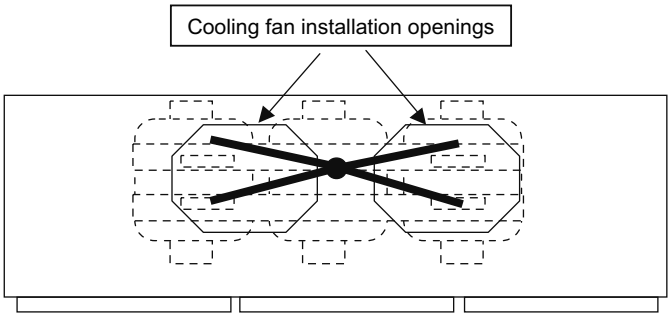
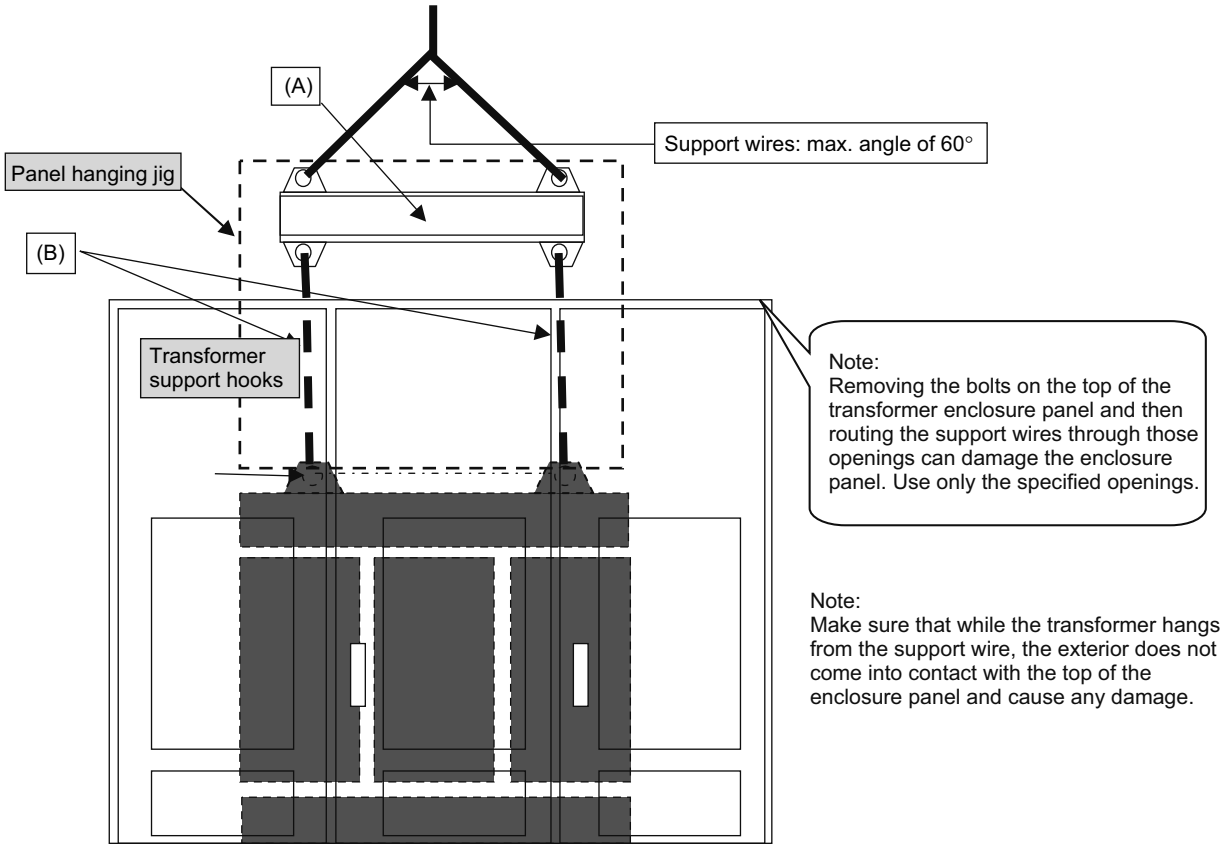


Fig 1.4 Hanging the Inverter, Part 1



View from above

The Inverter is shipped with the upper cooling fan and ventilation cover removed.
Pass the support wire (B) through the openings on the top of the Inverter where the cooling fan is to be installed. After connecting the wire to the transformer, pass the wire through the hanging jig (A) to hang the enclosure panel for each transformer. Both the support wire (B) and the hanging jig (A) are included with the panel when the Inverter is shipped from the factory.



Note:
Make sure that while the transformer hangs from the support wire, the exterior does not come into contact with the top of the enclosure panel and cause any damage.

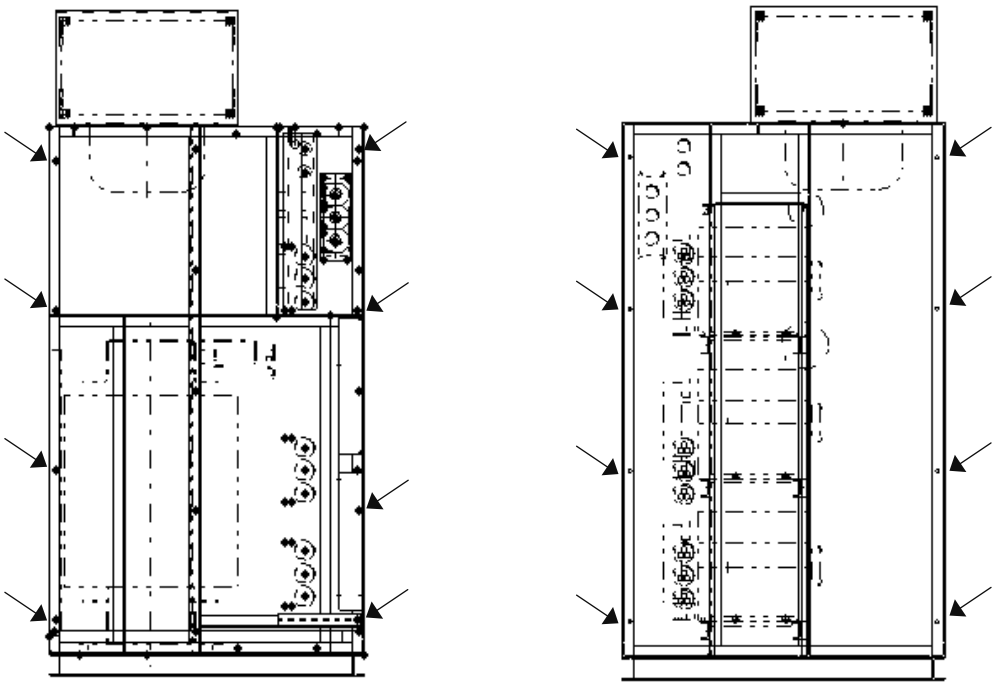
Fig 1.5 Hanging the Inverter, Part 2

◆ Side-by-Side Installation

Inverters of both 3 kV with a capacity of 1900 kVA or more and 6 kV classes with a capacity of 2300 kVA or more are designed as two panels that are installed side-by-side. (Refer to *Table 1.3*.)

On these models, eight holes are provided each on the Transformer section frame and Power Cell section frame as shown in *Fig. 1.6*.

Use M10 × 30L bolts, washers, S washers, and nuts to join the sections.



Transformer Section Frame　　Power Cell Section Frame

Fig 1.6 Mounting Holes for Side-by-Side Installation (Example of 3 kV, 2300 kVA Inverter)

■Bolts between Sections

Install the Transformer section frame against the Power Cell section frame without leaving any space between, and fix two frames using the M10 bolts provided as accessories.
M10 bolt tightening torque: 18 to 23 N·m
Any space between two frames may cause a leakage of cooling air, resulting in the Inverter failure.

■Wiring between Sections

Make the following wirings between sections.
Main circuit, grounding bus, cooling fan, and optical fiber cable

■Installation Accuracy

Use a measurement instrument such as theodolite to measure the horizontal precision on the installation base 1m by 1m. The allowable error is within ±2 mm.

◆ Installing an Inverter on a Floor

The table below shows the dimensions and the number of mounting holes when installing an Inverter on a floor.

Use mounting screws of M12 diameter to secure the Inverter.

Attach and fasten M12 screws in all the mounting holes to secure the Inverter under any installation conditions, whether there is vibration or not.

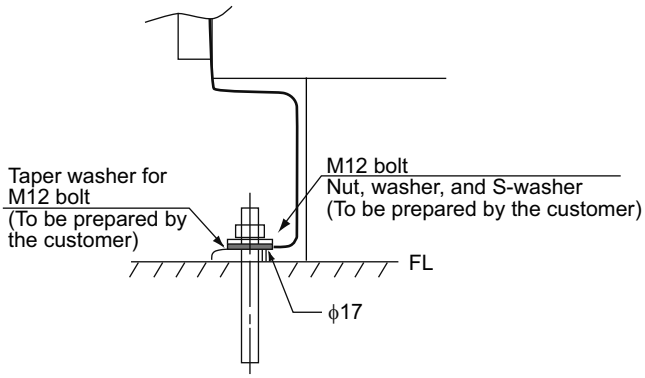
Table 1.3 Inverter Dimensions (mm), Sizes and Numbers of Mounting Holes

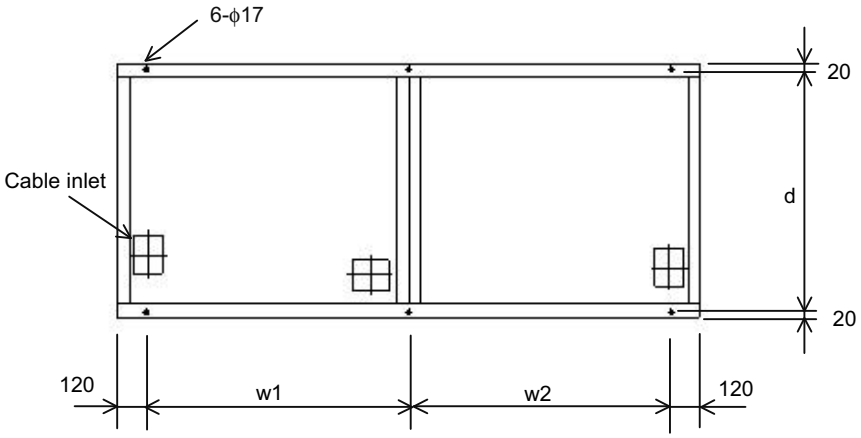
Voltage Class kV	Frequency Hz	FSDrive-MV1S Models CIMR-MV1S ■■□□□	Bottom Dimension Drawing	Installation Dimensions [mm]				Mounting Hole N – ϕ
				w1	w2	w3	d	
3	50/60	132	1	1030	1030	–	935	6 – ϕ17
		200	1	1030	1030	–	935	6 – ϕ17
		315	1	1080	1080	–	935	6 – ϕ17
		450	1	1080	1080	–	935	6 – ϕ17
		630	1	1080	1080	–	935	6 – ϕ17
		900	2	1780	1180	–	1135	6 – ϕ17
		13C	2	1780	1180	–	1135	6 – ϕ17
		15C*	3	1760	1360	–	1335	8 – ϕ17
		18C*	3	1760	1360	–	1335	8 – ϕ17
		25C*	4	1380	2360	–	1335	10 – ϕ17
6	50/60	250	2	1780	1380	–	935	6 – ϕ17
		400	2	1780	1380	–	935	6 – ϕ17
		630	2	1780	1380	–	1135	6 – ϕ17
		900	2	1780	1380	–	1135	6 – ϕ17
		13C	2	1780	1380	–	1135	6 – ϕ17
		18C*	3	1760	2360	–	1335	8 – ϕ17
		25C*	4	1080	1430	1430	1335	12 – ϕ17
		30C*	4	1280	1730	1730	1535	12 – ϕ17
		36C*	4	1280	1730	1730	1535	12 – ϕ17
		43C*	5	1280	2360	2360	1535	14 – ϕ17
		50C*	5	1280	2360	2360	1535	14 – ϕ17

* The Inverter has a modular construction.

■Installation Example

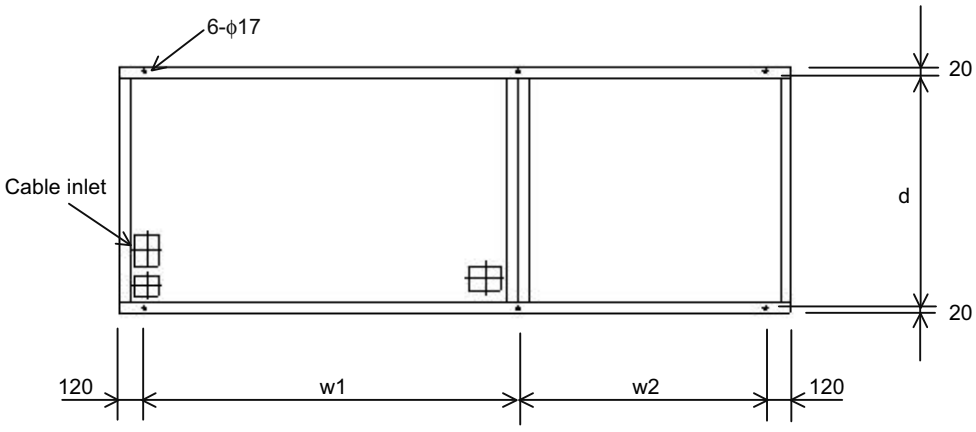
Use a taper washer for the channel contact surface.





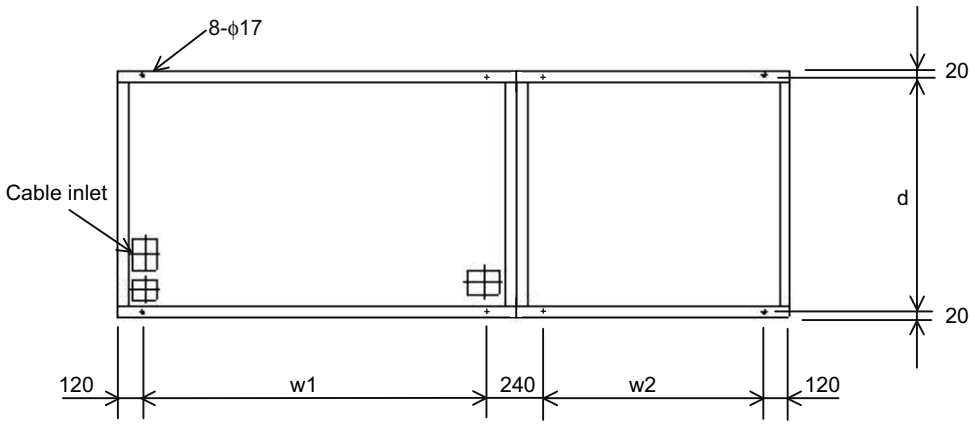
Front: with the door removed

Bottom Dimension Drawing 1



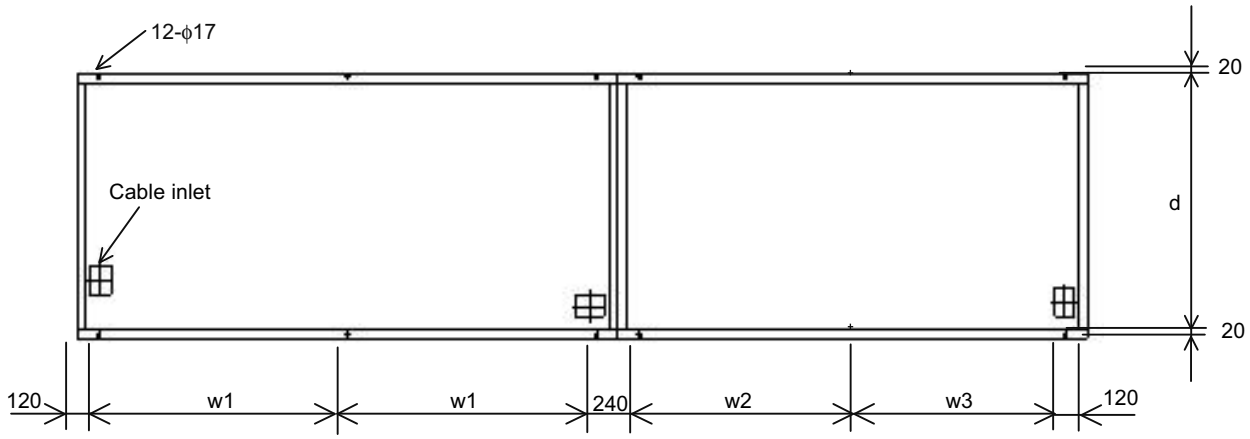
Front: with the door removed

Bottom Dimension Drawing 2



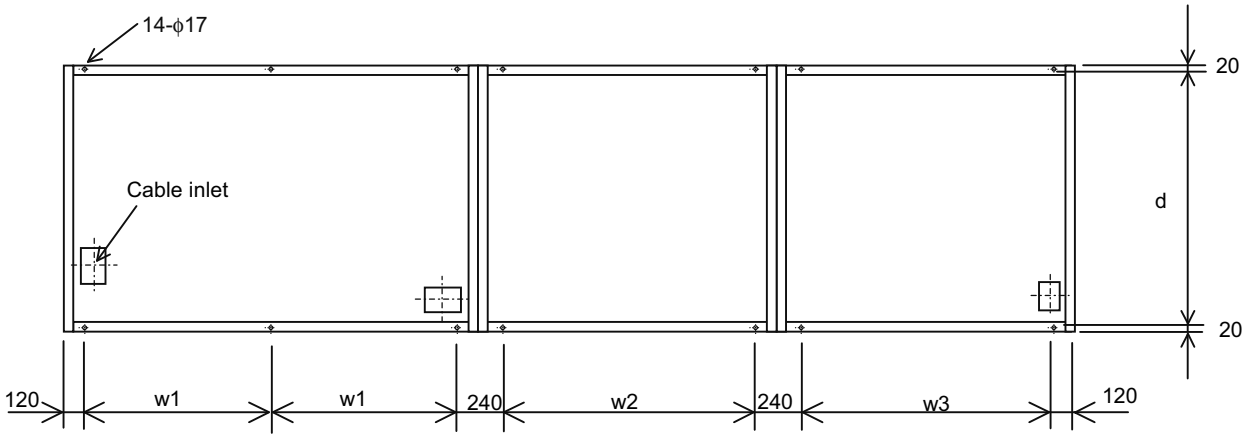
Front: with the door removed

Bottom Dimension Drawing 3



Front: with the door removed

Bottom Dimension Drawing 4



Front: with the door removed

Bottom Dimension Drawing 5

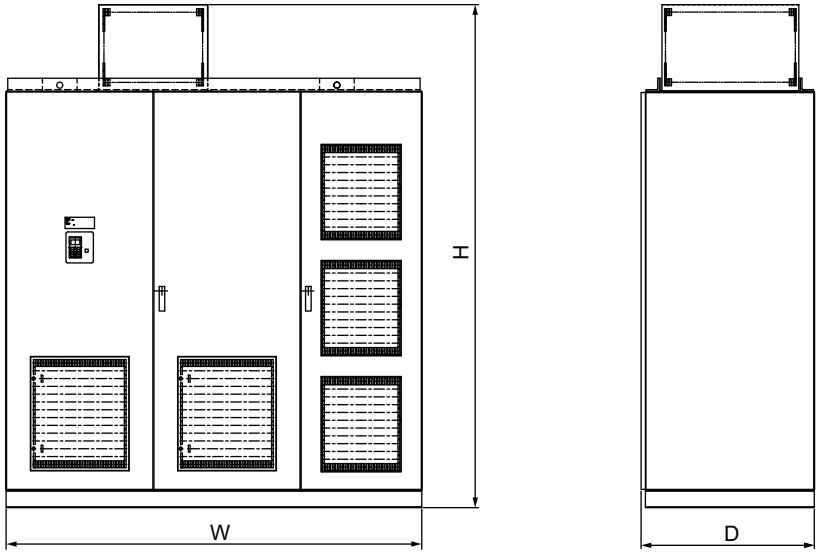
Dimensions

The FSDrive-MV1S dimensions, mass, and dimension drawings are shown below.

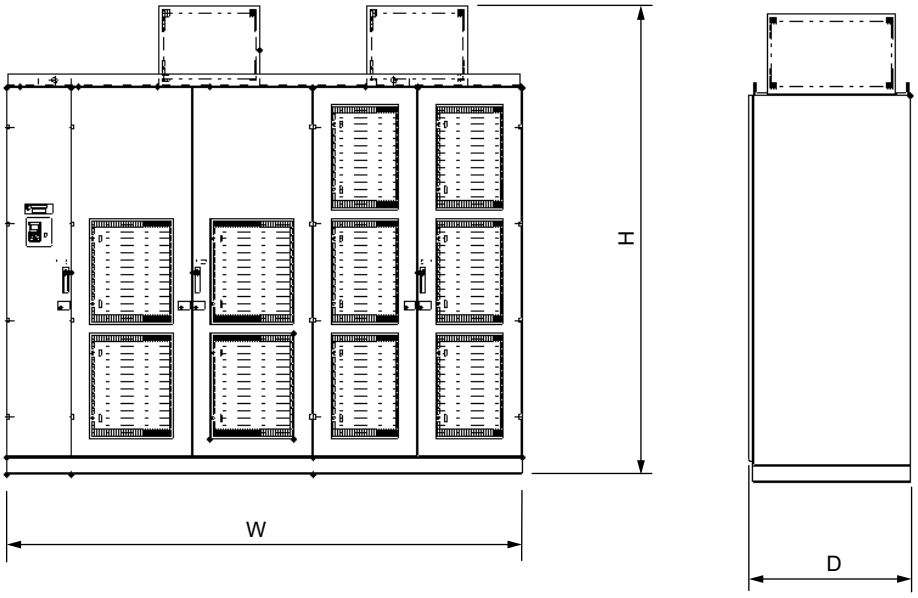
Table 1.4 Inverter Dimensions (mm) and Mass (kg)

Voltage Class kV	Frequency Hz	FSDrive-MV1S Models CIMR-MV1S ■■□□□	Dimension Drawing No.	Dimensions [mm]			Approx. Mass kg*
				Width W	Height H	Depth D	
3	50/60	132	1	2300	2900	1000	2500
		200	1	2300	2900	1000	2500
		315	1	2400	2900	1000	2800
		450	1	2400	2900	1000	3000
		630	1	2400	2900	1000	3200
		900	2	3200	2900	1200	4000
		13C	2	3200	2900	1200	4600
		15C	2	3600	2900	1400	5500
		18C	2	3600	2900	1400	6200
		25C	4	5600	2900	1400	8000
6	50/60	250	2	3400	2900	1000	3500
		400	2	3400	2900	1000	3500
		630	2	3400	2900	1200	3800
		900	2	3400	2900	1200	4400
		13C	2	3400	2900	1200	4800
		18C	3	4600	2900	1400	6500
		25C	4	5500	2900	1400	7900
		30C	4	6500	2900	1600	9200
		36C	4	6500	2900	1600	10000
		43C	5	8000	2900	1600	12400
		50C	5	8000	3150	1600	13500

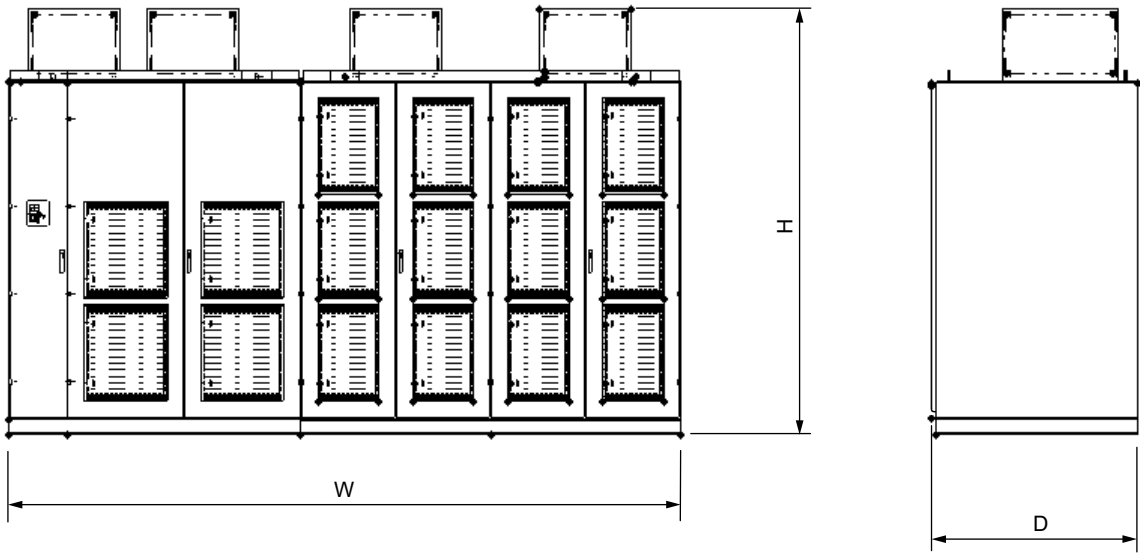
* Indicates the maximum value.



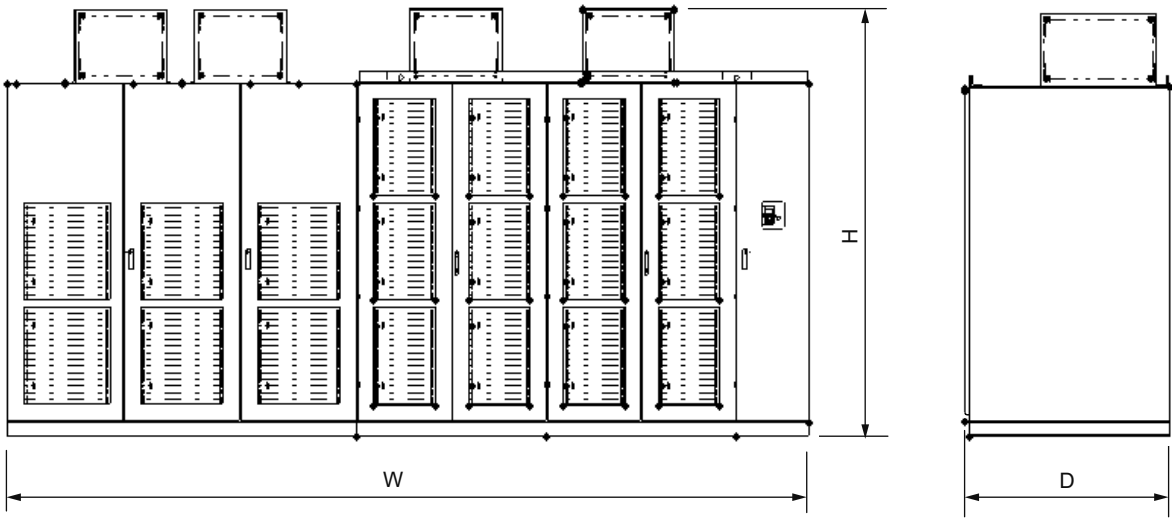
Dimension Drawing 1



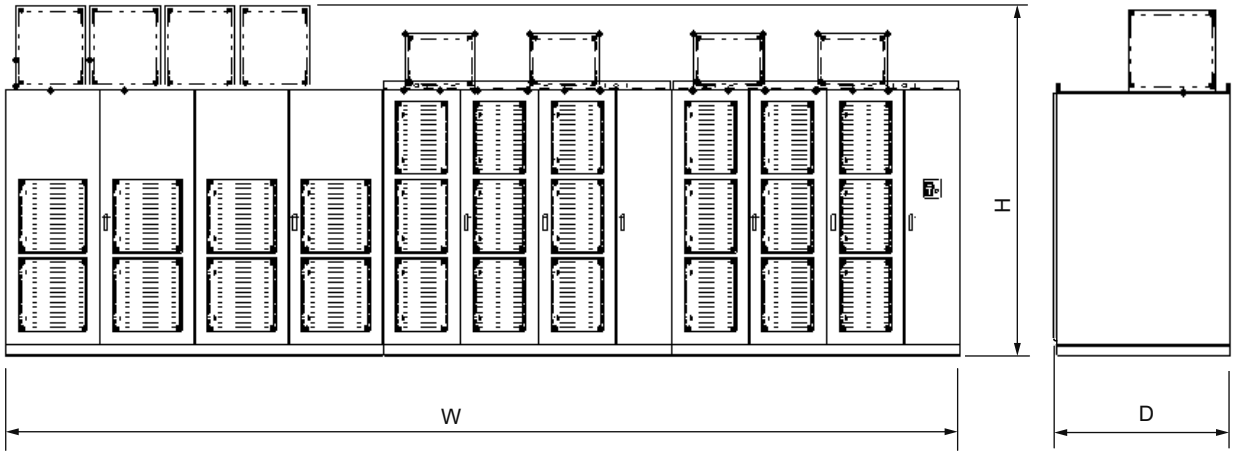
Dimension Drawing 2



Dimension Drawing 3



Dimension Drawing 4



Dimension Drawing 5

Storage

When storing the removed Inverter in a warehouse or keeping the installed Inverter without the power being supplied, observe the following precautions to secure the reliability.

◆ Short-term Storage (Within one month after unpacked, or within three months after delivery to FOB destination)

■Environmental Conditions

Same as those described in Installation Environment (Refer to Page 1-9) except for the ambient temperature.
Allowable ambient temperature: −5°C to +50°C

◆ Long-term Storage (More than one month after unpacked, or more than three months after delivery to FOB destination)

■Environmental conditions

Same as those described in Installation Environment (Refer to Page 1-9) except for the ambient temperature.
Allowable ambient temperature: −5°C to + 50°C

■Others

- Take a measure to prevent the inside-panel wirings and cables from being damaged by rats, etc.
- Place the Inverter panel in the orientation described in the Dimension Drawings, and do not place its side on the bottom or one above the other.
- For the Inverter with UPS, charge the battery every three months. Connect a 100-VAC power supply to the UPS socket to charge the battery (Refer to the UPS instruction manual for details.).
- Take a measure to prevent the Inverter panel from being damaged by external shocks.

Storing an Inverter in a Device without Power

- Cover the whole Inverter panel double with a 0.1 mm or thicker sheet to prevent dusts and water drops from entering the panel.
- Completely seal the outer circumference surface of the bottom of the Inverter panel to prevent moisture and dust from entering the panel.
- Protect every corner of the Inverter panel with shock-absorbing materials so that the sheet will not be sheared.

Storing an Individual Inverter

- Cover the whole Inverter panel double with a 0.1 mm or thicker sheet to prevent dusts and water drops in the warehouse from entering the panel.
- Protect every corner of the Inverter panel with shock-absorbing materials so that the sheet will not be sheared.
- Roll in the sheet under the bottom of the Inverter panel so that the Inverter panel will not absorb moisture from the floor.
- For protection against humidity on the floor, place 50 to 100 mm square timbers between the Inverter panel and the floor to avoid direct contact.
- Place the square timbers in an even distance in the direction shown below so that the whole bottom of the panel is evenly loaded.
- Provide supports or take other preventative actions so that the Inverter panel does not fall down.

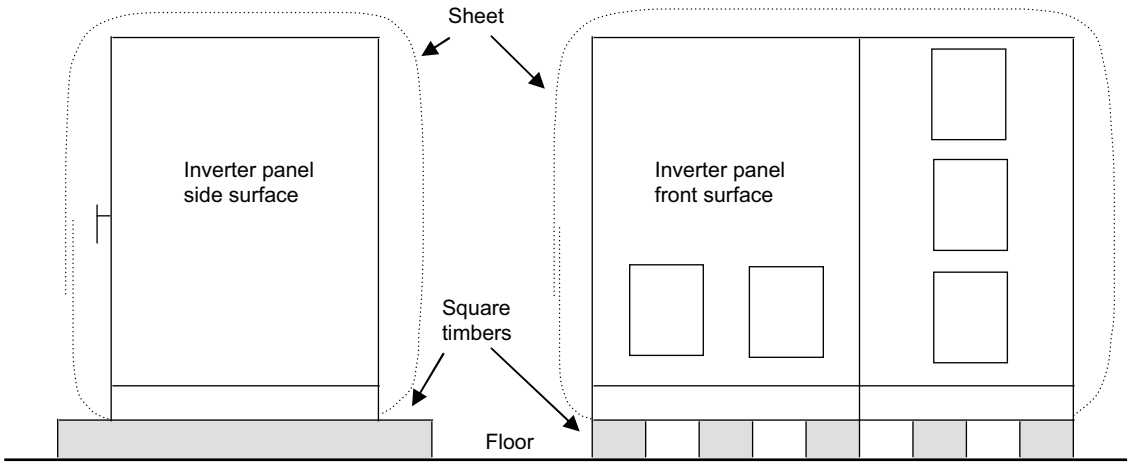


Fig 1.7 Direction of Square Timbers

■Moisture Absorbers

Place a 1 kg silica gel every 1 m^3.
Replace the silica gel every three months, but the period the silica gel remains effective differs depending on the ambient humidity.

■Periodic Inspection

Check and confirm the following items every month.

- Humidity absorbing level of silica gel (Check the level by color using the color type.).
- The Inverter is not wet due to humidity or roof leaks.
- The Inverter is neither corroded nor rusted (both the interior and exterior).

■Turning On the Power

Before turning on the power to the Inverter after an extended shutdown, carefully check the Inverter for moisture/humidity and dusts.

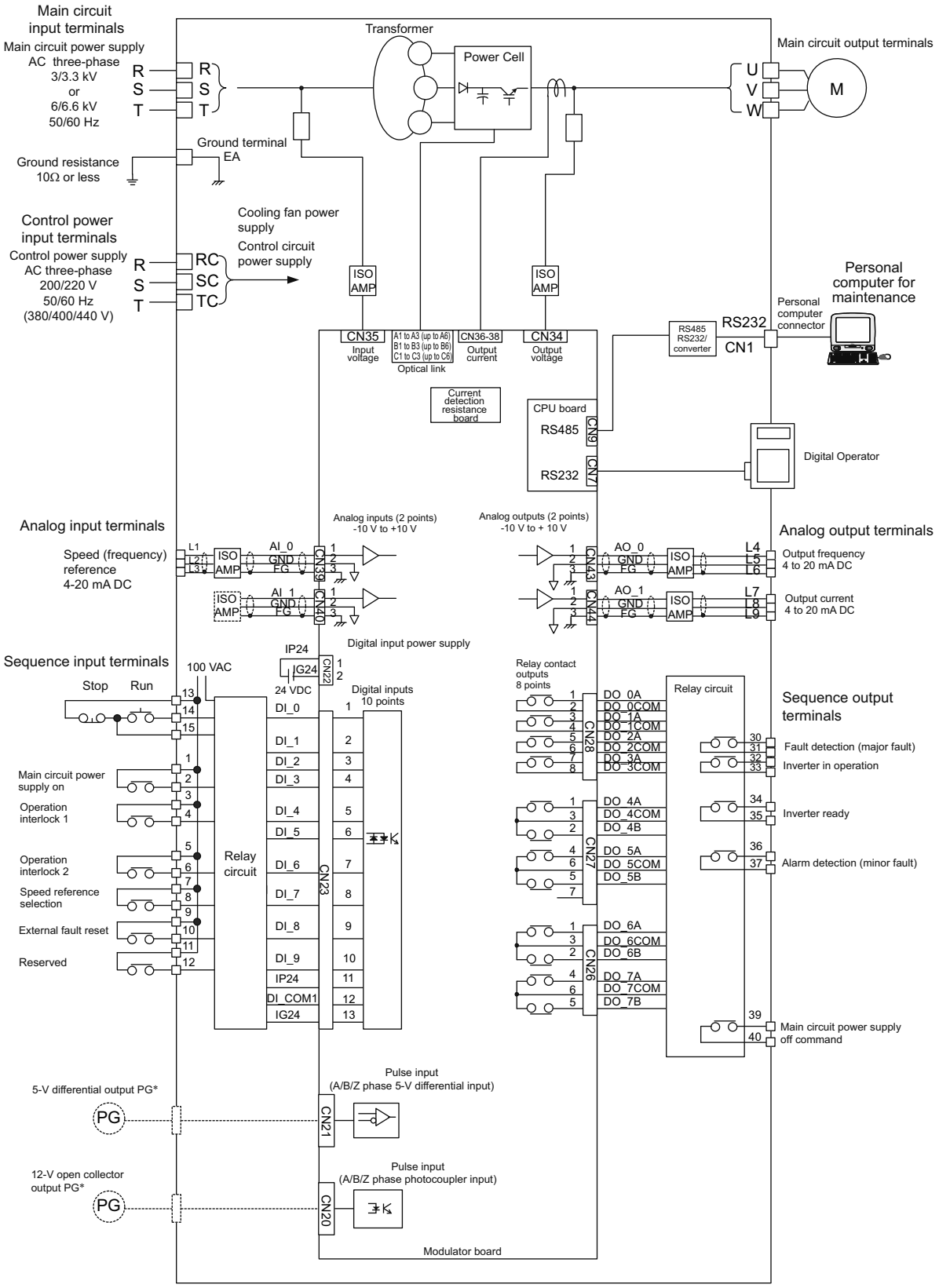
2 Wiring

This chapter describes terminal wirings, main circuit terminal connections and specifications, and control circuit terminal connections and specifications.

Standard Wiring 2-2
Terminals 2-4
Routing Cables 2-5
Wiring Main Circuit Terminals 2-9
Wiring Control Circuit Terminals 2-14
Connector for a Personal Computer 2-17
Wiring Check 2-18

Standard Wiring

Fig. 2.1 shows the standard connection diagram of the FSDrive-MV1S.



Note * Only one of the two can be selected.

Fig 2.1 Standard Wiring

IMPORTANT

1. The external connection terminals include main circuit input terminals (R, S, and T), main circuit output terminals (U, V, and W), a grounding terminal (EA), and control circuit terminals. The control circuit terminals include control power supply input terminals (RC, SC, and TC), analog input and output terminals (L1 to L9), and sequence input and output terminals (1 to 40).
2. The analog input and output terminals [speed (frequency) reference input] are for 4 mA to 20 mA of current input.
3. The analog output terminals are for monitoring output frequency and current. They are not used for controls such as feedback control. Be careful not to short a circuit between terminals. Doing so will cause the Inverter to malfunction or develop a fault.
4. The sequence input terminals 1 through 15 are labeled for sequence connections for no-voltage contacts. The sequence output terminals 30 through 40 are for relay output. Refer to *Table 2.5* for the sequence input and output terminal specifications.
5. Do not use terminals other than grounding terminals for grounding. Doing so will cause the Inverter to malfunction or develop a fault.
6. For flux vector control, PG circuit wiring is required in addition to the standard wiring. Contact your Yaskawa representatives if wirings other than the standard wiring are required.

Terminals

Fig. 2.2 and Fig. 2.3 show the terminals provided on the FSDrive-MV1S.

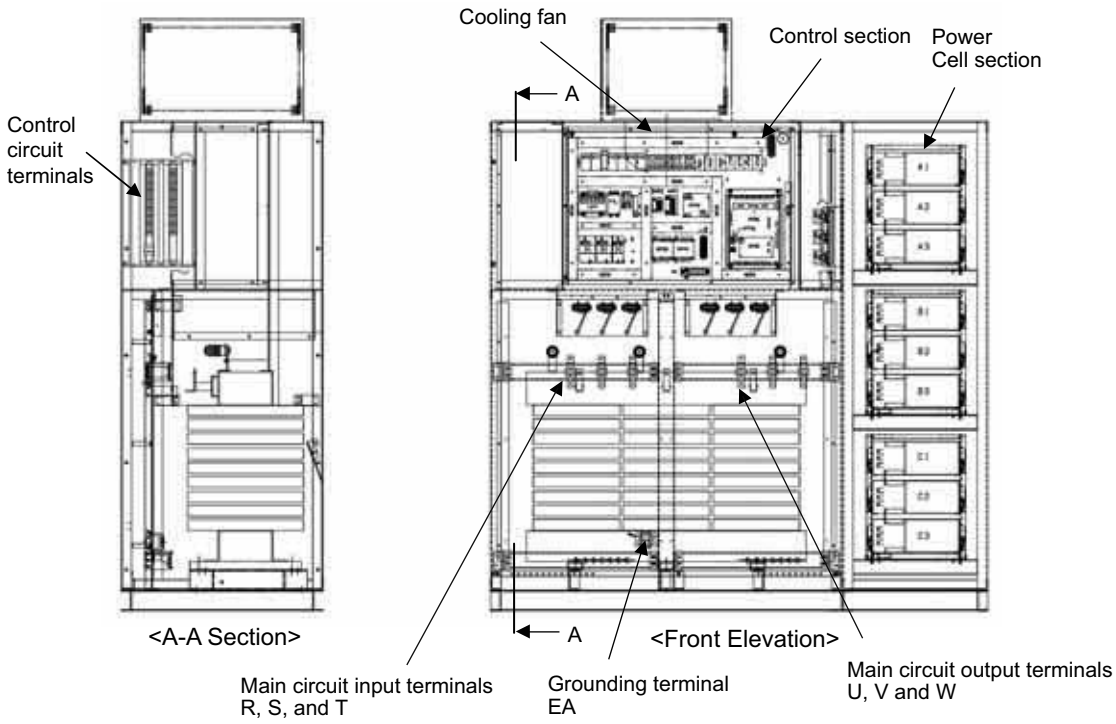


Fig 2.2 Terminal Locations (3 kV class, 800 kVA FSDrive-MV1S)

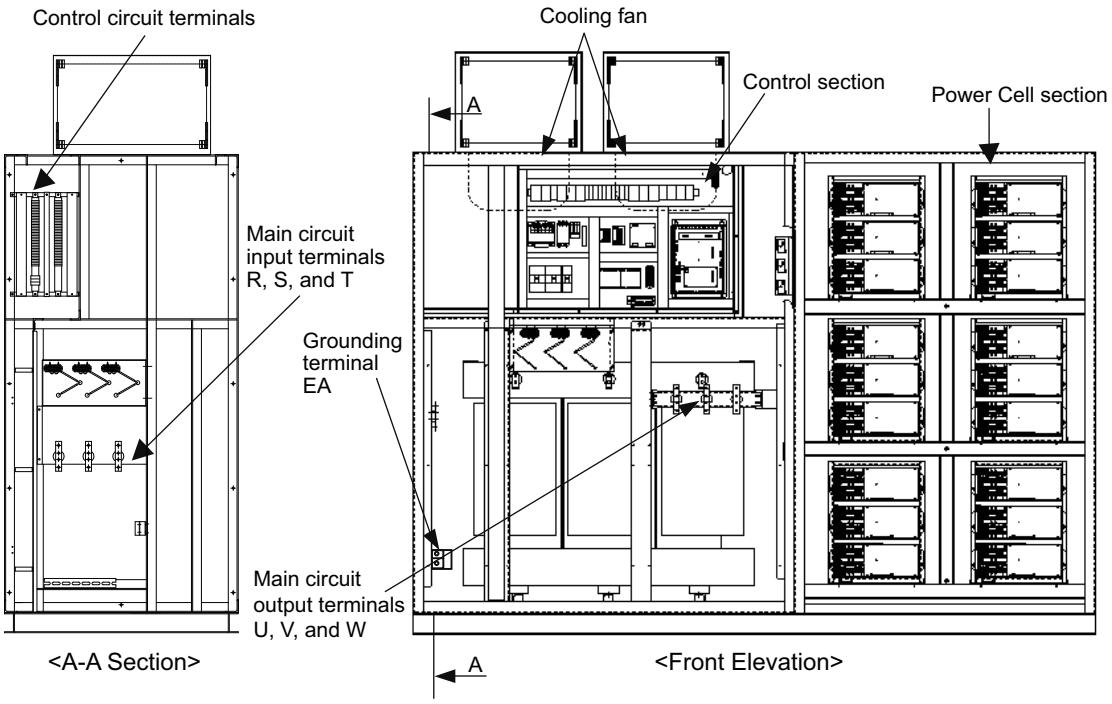


Fig 2.3 Terminal Locations (6 kV class, 1600 kVA FSDrive-MV1S)

Routing Cables

The structure of the terminals conforms to JCS standards stipulated by the Japanese Electric Wire & Cable Makers' Association. Route the cables according to the JCS standards appropriate for 3 kV class and 6 kV class Inverters.

Examples of cable routing are shown in *Fig. 2.4* and *Fig. 2.5*.

IMPORTANT

- Secure the cables using the cable bracket. Do not secure the cables at an intermediate point between the cable bracket and control circuit terminals.
- Prepare cable brackets suitable for the size of the cables used.

■Inverter Input Cable

Route the Inverter primary side input cable into the Inverter panel through the Inverter input cable inlet port on the bottom of the Transformer section.

■Inverter Output Cable

Route the Inverter secondary side output cable into the Inverter panel through the Inverter output cable inlet port on the bottom of the Transformer section.

■Cable Fixing

Install a cable bracket (to be prepared by the customer) on the cable bracket fitting near the cable inlet port to secure the cables.

■Cable Separation

The medium-voltage cable, low-voltage cable, and weak-current cable must be separated each other for the distance 15 cm minimum.
If a rigid heat-resistant partition such as steel separator is installed between cables, the distance 15 cm between cables is not necessary.

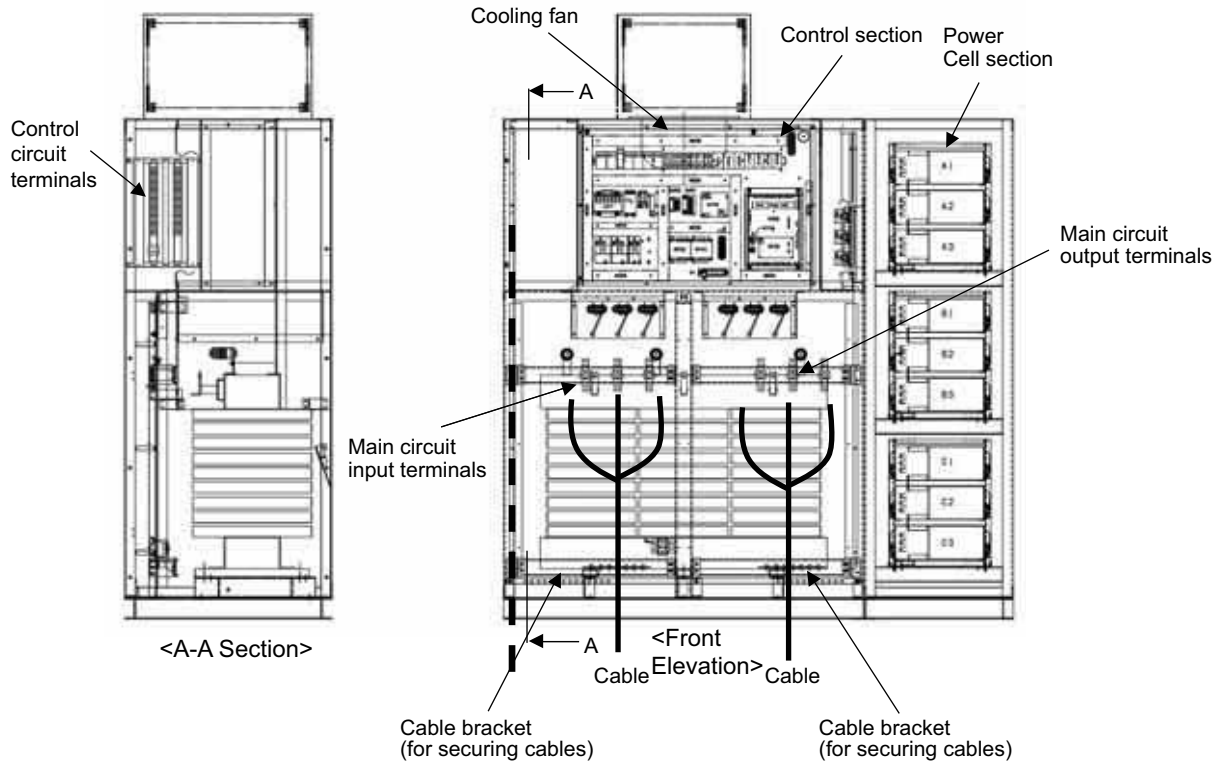


Fig 2.4 Cable Routing (3 kV class, 800 kVA FSDrive-MV1S)

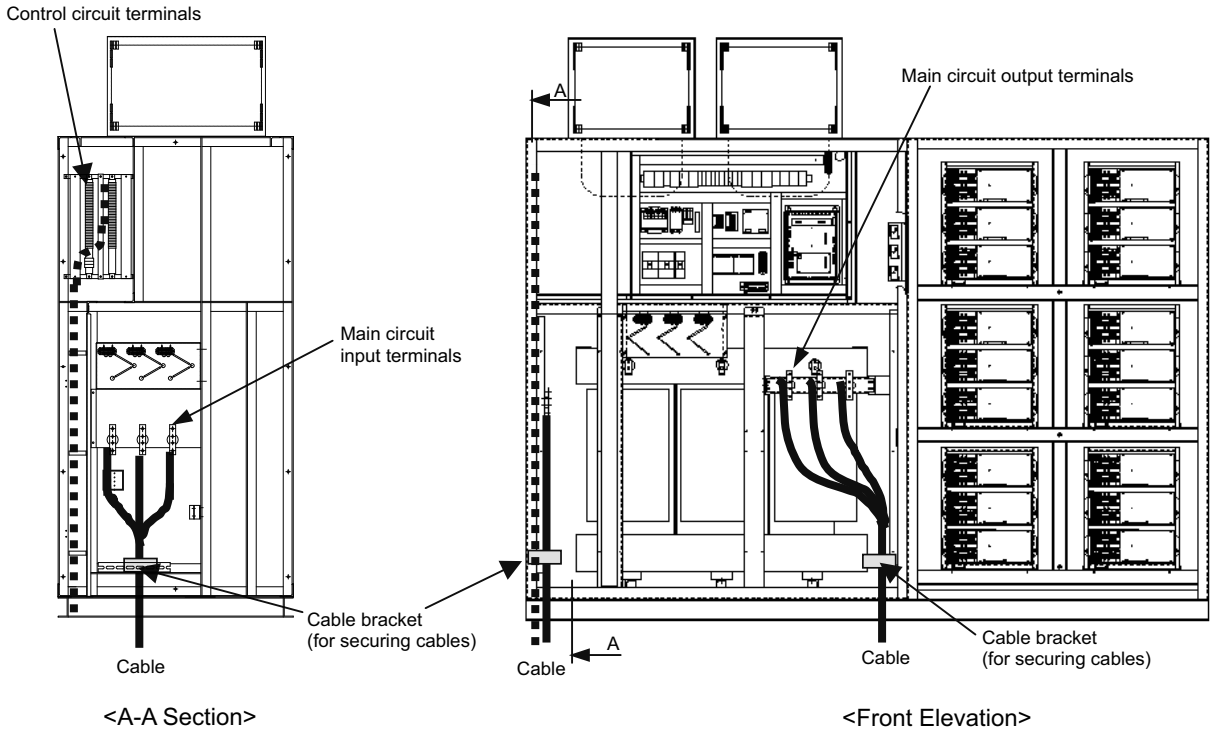
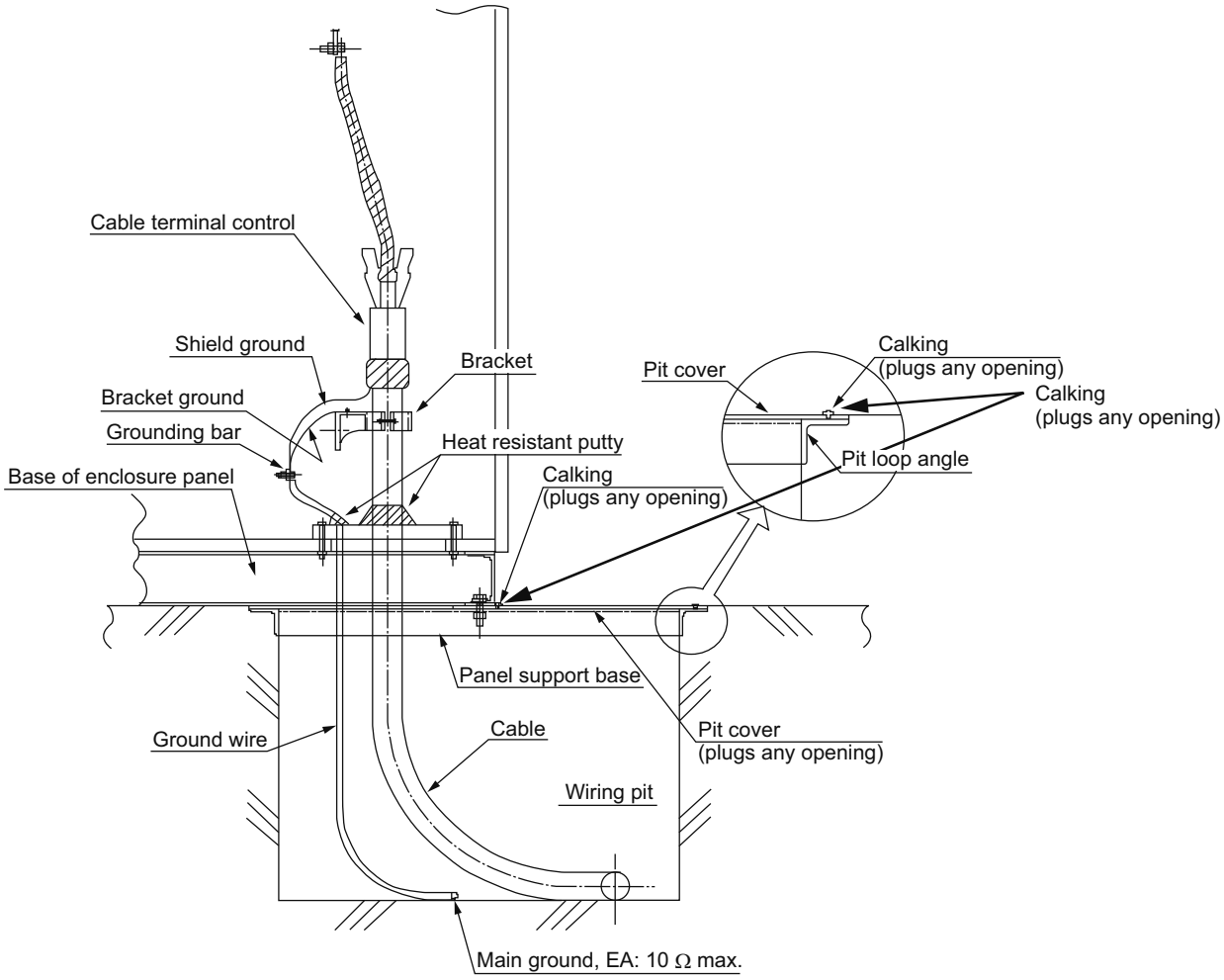


Fig 2.5 Cable Routing (6 kV class, 1600 kVA FSDrive-MV1S)

◆ Caution when Routing Cables

The area where the cables enter the bottom of the Inverter should be tightly sealed with putty so that no open space remains. A proper operating environment cannot be maintained if air or dust from the outside makes its way into the Inverter, and can result in the equipment failure.

Make sure the area around the channel base and the pit cover are tightly sealed so that no opening remains. Again, a proper operating environment cannot be maintained if air or dust from the outside makes its way into the Inverter, and can result in the equipment failure.



Wiring Main Circuit Terminals

◆ Main Circuit Terminals

■Input Terminals

Table 2.1 Main Circuit Input Terminals

Terminal Code	Signal	Specifications
R	Main circuit phase-R input	Main circuit AC three-phase inputs 3 kV/3.3 kV AC or 6 kV/6.6 kV AC 50 Hz/60 Hz
S	Main circuit phase-S input	
T	Main circuit phase-T input	

■Output Terminals

Table 2.2 Main Circuit Output Terminals

Terminal Code	Signal	Specifications
U	Main circuit phase-U output	Main circuit three-phase outputs
V	Main circuit phase-V output	
W	Main circuit phase-W output	

◆ Applicable Wire Sizes and Crimp Terminals

Refer to *Table 2.3* to select appropriate wires and crimp terminals for main circuit wiring and grounding.

Table 2.3 Terminal Screw Size and Applicable Wire Sizes

Voltage Class [kV]	Frequency [Hz]	Model CIMR-MV1S ■■□□□	Rated Current [A]	Terminal		Terminal Screw Size	Tightening Toque [N·m]	Applicable Wire Size [mm^2] (AWG)
				Function	Code			
3	50/60	132	35	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			60	Ground	EA	M5	2.0 to 2.5	5.5 to 14 (10 to 6)
		200	50	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			60	Ground	EA	M5	2.0 to 2.5	5.5 to 14 (10 to 6)
		315	70	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			80	Ground	EA	M6	4.0 to 4.9	5.5 to 22 (10 to 4)
		450	100	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			125	Ground	EA	M8	8.9 to 10.8	5.5 to 38 (10 to 2)
		630	140	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			150	Ground	EA	M8	8.9 to 10.8	22 to 60 (4 to 2/0)
		900	200	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			200	Ground	EA	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
		13C	260	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	60 to 100 (2/0 to 4/0)
			300	Ground	EA	M10	18.0 to 23.0	22 to 150 (4 to 300MCM)
		15C	330	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			400	Ground	EA	M12	31.5 to 39.5	60 to 200 (2/0 to 400MCM)
		18C	400	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			400	Ground	EA	M12	31.5 to 39.5	60 to 200 (2/0 to 400MCM)
		25C	520	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			600	Ground	EA	M16	78.5 to 98.0	150 to 325 (300MCM to 600MCM)

Table 2.3 Terminal Screw Size and Applicable Wire Sizes (Continued)

Voltage Class [kV]	Frequency [Hz]	Model CIMR-MV1S ■■□□□	Rated Current [A]	Terminal		Terminal Screw Size	Tightening Toque [N·m]	Applicable Wire Size [mm^2] (AWG)
				Function	Code			
6	50/60	250	35	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			60	Ground	EA	M5	2.0 to 2.5	5.5 to 14 (10 to 6)
		400	50	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			60	Ground	EA	M5	2.0 to 2.5	5.5 to 14 (10 to 6)
		630	70	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
			80	Ground	EA	M6	4.0 to 4.9	5.5 to 22 (10 to 4)
		900	100	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			125	Ground	EA	M8	8.9 to 10.8	5.5 to 38 (10 to 2)
		13C	140	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			150	Ground	EA	M8	8.9 to 10.8	22 to 60 (4 to 2/0)
		18C	200	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	38 to 100 (2 to 4/0)
			200	Ground	EA	M10	18.0 to 23.0	22 to 100 (4 to 4/0)
		25C	260	I/O	R, S, T, U, V, W	M10	18.0 to 23.0	60 to 100 (2/0 to 4/0)
			300	Ground	EA	M10	18.0 to 23.0	22 to 150 (4 to 300MCM)
		30C	330	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			400	Ground	EA	M12	31.5 to 39.5	60 to 200 (2/0 to 400MCM)
		36C	400	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			400	Ground	EA	M12	31.5 to 39.5	60 to 200 (2/0 to 400MCM)
		43C	460	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			600	Ground	EA	M16	78.5 to 98.0	150 to 325 (300MCM to 600MCM)
		50C	520	I/O	R, S, T, U, V, W	M12	31.5 to 39.5	150 to 325 (300MCM to 600MCM)
			600	Ground	EA	M16	78.5 to 98.0	150 to 325 (300MCM to 600MCM)

IMPORTANT

A line-to-line voltage drop must be taken into consideration when selecting wire size.
Determine the wire size for the main circuit so that the line-to-line voltage drop is within 2% of the rated voltage. In conditions where a voltage drop may arise, increase the wire size depending on the cable length. The line-to-line voltage drop is calculated as follows.

Line-to-line voltage drop (V) = $\sqrt{3}$ x Wire resistance (Ω/km) x Wire length (m) x Current (A) x 10^{-3}

◆ Wiring the Main Circuits

This section describes wiring for the main circuit inputs and outputs, and grounding.
For each terminal code, be sure to correctly connect the input terminals to the power supply and the output terminals to the load.

⚠ DANGER

- Do not touch the input and output terminals directly with your hands and do not bring the input and output wires into contact with the Inverter case or metal parts. In addition, do not short circuit the output wires.
  Otherwise, an electric shock or grounding fault may occur.

⚠ CAUTION

- Connect input and output wires correctly.
  Incorrect wiring of input and output terminals will damage the Inverter when the power supply is turned on, and may result in injury.

■Wiring the Main Circuit Input Terminals

The main circuit power supply can be connected to any of main circuit input terminals R, S, or T, as the phase sequence of the main circuit power supply is irrelevant to the phase sequence. However, we recommend that you connect in the same sequence as the input power supply to ensure product maintainability.

■Wiring the Main Circuit Output Terminals

⚠ CAUTION

- Do not connect the main circuit power supply to the output terminals U, V, and W.
  Applying voltage to the output terminals may damage the Inverter or burn its parts.

Observe the following points when wiring the main circuit output terminals.

Connecting a Motor to the Inverter

Connect the motor lead wires U, V, and W to the Inverter main circuit output terminals U, V, W respectively.

Confirm that the motor rotates in the forward direction under the forward run command during trial operation. If the motor rotates in reverse, check the output terminal codes and the motor lead wire codes, and switch over any two of the output terminals U, V, and W and reconnect.

Switch phases when using a motor encoder (pulse generator). Use the specified cable when connecting to the Inverter enclosure panel.

■Ground Wiring

Observe the following points when wiring grounding lines.

⚠ DANGER

- Always ground the ground terminals. (Ground resistance 10 Ω or less, wire size 2.6 mm^2 min.)
  Otherwise, an electric shock or fire may occur.

- Perform grounding work as follows.

  Grounding terminal EA: Ground resistance 10 Ω or less, wire size 2.6 mm min.

  Transformer contact preventive plate: Ground resistance of 150 / I (Ω) or less, where the one line to ground fault current (A) on the medium-voltage circuit of the transformer is taken as I

  Control circuit (400 V max.): Ground resistance 10 Ω or less, wire size 1.6 mm min.

- Do not share the ground wire with other devices, such as welding machines or power tools.
- Always use a ground wire that complies with the applicable electric code, and always minimize the length of the ground wire.
- When using more than one Inverter, ground to one point and be careful not to loop the ground wire.

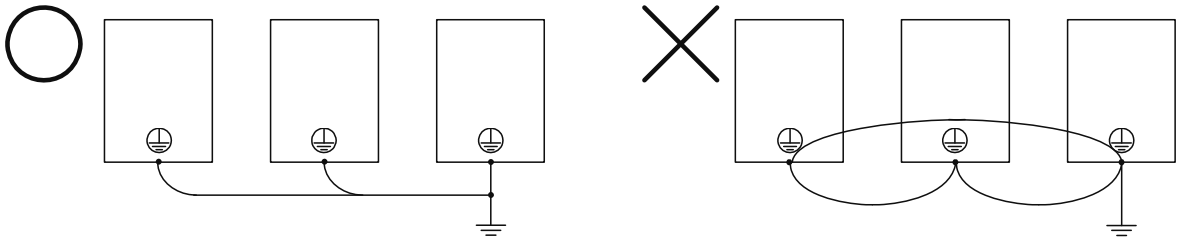
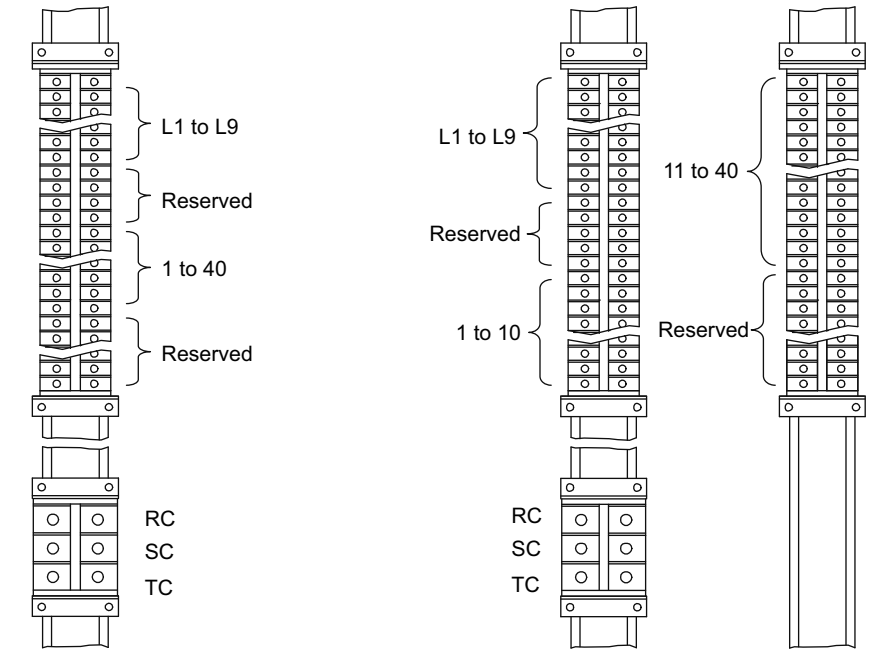


Fig 2.6 Ground Wiring

Wiring Control Circuit Terminals

◆ Control Circuit Terminal Layout and Specifications

Fig. 2.7 shows the control circuit terminal layout and *Table 2.4, Table 2.5*, and *Table 2.6* show each terminal function. Use appropriate terminals according to the application.



6 kV class, 3000 kVA
FSDrive-MV1S

3 kV class, 800 kVA and
6 kV class, 1600 kVA
FSDrive-MV1S

Fig 2.7 Control Circuit Terminal Layout

Table 2.4 Analog Input and Output Terminal Specifications

Type	Signal Name	Signal Level	Terminal Code	Terminal Function
Analog input terminals	Speed (frequency) reference	4 mA DC to 20 mA DC, 0 Hz to 60 Hz	L1	Speed (frequency) reference input signal
			L2	Ground
			L3	Shield ground
Analog output terminals	Output frequency	4 mA DC to 20 mA DC, 0 Hz to 60 Hz	L4	Output frequency output signal
			L5	Ground
			L6	Shield ground
	Output current	4 mA DC to 20 mA DC, 0% to 150%	L7	Output current output signal
			L8	Ground
			L9	Shield ground
Reserved	–	–	–	–

Table 2.5 Sequence Input and Output Terminal Specifications

Type	Signal Name	Signal Level	Terminal Code	Terminal Function
Sequence input terminals	Main circuit power on	Contact input 110 VAC, 15 mA	1 2	On: Power ON
	Operation interlock _1	Contact input 110 VAC, 15 mA	3 4	On: Interlock established
	Operation interlock_2	Contact input 110 VAC, 15 mA	5 6	On: Interlock established
	Speed reference selection	Contact input 110 VAC, 15 mA	7 8	On: Fixed speed selection Off: External input reference
	External fault reset	Contact input 110 VAC, 15 mA	9 10	On: Reset
	Reserved	–	11 to 29, and 38	–
	Stop/Run	Contact input 110 VAC/15 mA	13 14	On: Run
			15	Off: Stop
Sequence output terminals	Inverter fault detection (major fault)	NO contact relay output LY4N 110 VAC (manufactured by OMRON Corporation) 110 VAC/7.5 A, 24 VDC/5 A	30 31	Fault detection (major fault): Closed
	Inverter in operation	NO contact relay output LY4N 110 VAC (manufactured by OMRON Corporation) 110 VAC/7.5 A, 24 VDC/5 A	32 33	During operation: Closed
	Inverter ready	NO contact relay output LY4N 110 VAC (manufactured by OMRON Corporation) 110 VAC/7.5 A, 24 VDC/5 A	34 35	Ready: Closed
	Inverter alarm detection (minor fault)	NO contact relay output LY4N 110 VAC (manufactured by OMRON Corporation) 110 VAC/7.5 A, 24 VDC/5 A	36 37	Alarm detection (minor fault): Closed
	Main circuit power supply off command	NO contact relay output MM2XP 110 VAC (manufactured by OMRON Corporation) 220 VAC/7.5 A, 110 VDC/6 A	39 40	When power needs to be shut off: Closed
	Reserved	–	–	–

Table 2.6 Control Power Supply Input Terminal Specifications

Type	Signal Name	Terminal Code	Terminal Function
Control power supply input terminals	R	RC	200/220 VAC, 50/60 Hz
	S	SC	
	T	TC	

◆ Applicable Wire Sizes

Table 2.7 shows the wire size of each terminal. Select an appropriate wire size considering the current capacity.

Table 2.7 Wire Sizes

Terminal Type	Terminal Code	Terminal Screw	Tightening Torque N·m	Applicable Wire Size mm^2 (AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type (For reference)
Analog input and output terminals	L1 to L9	M3.5	0.8 to 1.0	0.5 to 2*2 (20 to 14)	1.25 (12)	• Shielded twisted-pair wire*1
Sequence input and output terminals	1 to 40	M3.5	0.8 to 1.0	0.5 to 2*2 (20 to 14)	1.25 (12)	• Insulated vinyl sheathed cable (CVV) for control circuit
Control power supply input terminals	RC, SC, TC	M5	2 to 2.5	8 to 14*2 (8 to 6)	8 (8)	• 600-V insulated vinyl sheathed cable (VV)

* 1. Use shielded twisted-pair wires to input an external speed (frequency) reference.
* 2. For more information on the size of round crimp terminals, refer to JIS C2805, Crimp-Type Terminal Lugs for Copper Conductors.

◆ Control Circuit Wiring Precautions

Observe the following precautions when wiring control circuits.

- Separate the analog I/O (Terminals L1 to L9) wiring from the sequence I/O (Terminals 1 to 40) wiring, other power lines and power supply lines.
- Use shielded twisted-pair wires for analog I/O (Terminals L1 to L9) wirings to prevent malfunctions caused by noise.
- Lay the shielded wires so that they will not have contact with other signal lines and devices.
- Tighten the screws with the specified tightening torque.
- Use round crimp terminals to connect cables to the terminal block.
- Use a Phillips screw driver to tighten terminal screws.

Connector for a Personal Computer

◆ Specifications

Table 2.8 Personal Computer Connector Specifications

Connector type	Modular jack
Number of poles	8

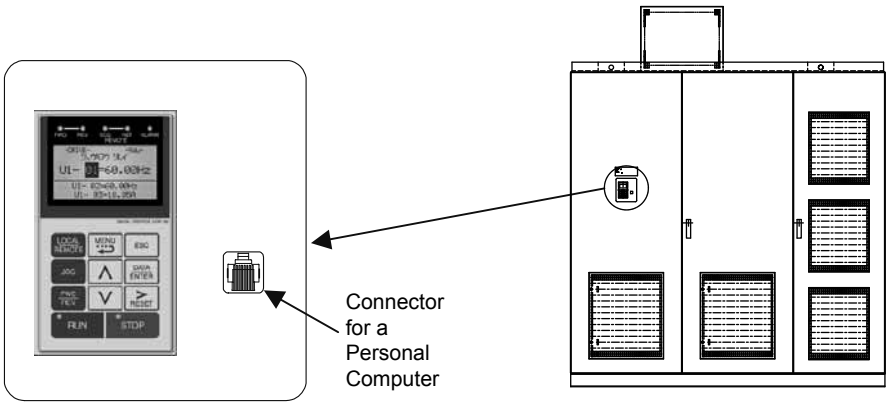


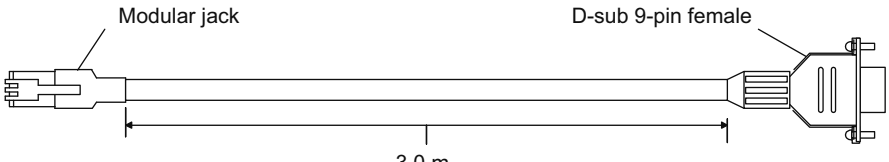
Fig 2.8 Location of Connector for a Personal Computer

◆ Connection Cable

Use the following cable for connection to a personal computer.

Table 2.9 Personal Computer Connection Cable Specifications

Model	JZCP-751904
Length	3 m
Manufacturer	Yaskawa Electric Corporation



Inverter		
No.	Signal Name	Description
1	–	
2	GND	Ground
3	GND	Ground
4	–	
5	–	
6	RS232RX	RS232 receive signal
7	RS232TX	RS232 send signal
8	–	

Personal Computer		
No.	Signal Name	Description
1	CD	
2	RD	RS232 receive signal
3	TD	RS232 send signal
4	DTR	
5	GND	Ground
6	DSR	
7	RTS	
8	CTS	
9	N.C.	

Fig 2.9 Personal Computer Connection Cable and Wiring

Wiring Check

◆ Checks

Check all wiring after wiring work has been completed. Do not perform a buzzer check on control circuits. Confirm the following items.

- All wiring is correct.
- No foreign matter such as wire chips or unnecessary screws remain.
- All screws are securely tightened.
- No wire ends have contact with terminals other than the ones they are connected to.

3

Digital Operator and Modes

This chapter describes Digital Operator displays and functions, and provides an overview of operating modes and switching between modes.

Digital Operator 3-2
Modes 3-4

Digital Operator

This section describes the displays and functions of the Digital Operator.

◆ Digital Operator Display

The key names and functions of the Digital Operator are described below.

Drive Mode Indicators (LED)

FWD: Lit when there is a Forward Run Command input.
REV: Lit when there is a Reverse Run Command input.
SEQ: Lit when the Run Command from a source other than the Digital Operator is enabled.
REF: Lit when the speed (frequency) reference from a source other than the Digital Operator is enabled.
ALARM: Lit when an fault (major fault) is activated. Flashes when an alarm (minor fault) is activated.

Data Display (LCD)

Mode Display (Displayed at upper left of data display.)
DRIVE: Lit in Drive Mode.
QUICK: Lit in Quick Programming Mode.
ADV: Lit in Advanced Programming Mode.
A. TUNE: Lit in Autotuning Mode.
– : Lit in Fault History Mode.

Keys

Execute operations such as setting user constants, monitoring, jogging, and autotuning.

Fig 3.1 Digital Operator Component Names and Functions

◆ Digital Operator Keys

The names and functions of the Digital Operator Keys are described in *Table 3.1*.

Table 3.1 Key Functions

Key	Name	Function
LOCAL REMOTE	LOCAL/REMOTE Key	Switches between operation using the Digital Operator (LOCAL) and operation from a device other than the Digital Operator (REMOTE). This key can be enabled or disabled by the setting of user constant o2-01.
MENU	MENU Key	Selects menu items (modes).
ESC	ESC Key	Returns to the status before the DATA/ENTER Key was pressed.

Table 3.1 Key Functions (Continued)

Key	Name	Function
JOG	JOG Key	Enables jog operation when the Inverter is being operated from the Digital Operator.
FWD / REV	FWD/REV Key	Selects the rotation direction of the motor when the Inverter is being operated from the Digital Operator.
RESET	Shift/RESET Key	Sets the number of digits for user constant settings. Also acts as the Reset Key when a fault has occurred.
∧	Increment Key	Selects menu items (modes), sets user constant numbers, and increments set values. Used to move to the next item or data.
∨	Decrement Key	Selects menu items (modes), sets user constant numbers, and decrements set values. Used to move to the previous item or data.
DATA / ENTER	DATA/ENTER Key	Pressed to enter menu items (modes), user constants, and set values. Also used to switch from one display to another.
RUN	RUN Key	Starts the Inverter operation when the Inverter is being controlled by the Digital Operator.
STOP	STOP Key	Stops Inverter operation when the Inverter is being controlled by the Digital Operator. This Key can be enabled or disabled when operating from the control circuit terminal by setting user constant o2-02.

There are indicators on the upper left of the RUN and STOP Keys on the Digital Operator. These indicators will light and flash to indicate operating status.

Modes

This section describes the Inverter's modes and switching between modes.

◆ Inverter Modes

The Inverter's user constants and monitoring functions are organized in groups called modes that make it easier to read and set user constants. The Inverter is equipped with 5 modes.

The 5 modes and their primary functions are shown in the *Table 3.2*.

Table 3.2 Modes

Mode	Primary function(s)
Drive mode	The Inverter can be run in this mode. Use this mode when monitoring values such as speed (frequency) references or output current, displaying fault information.
Quick programming mode	Use this mode to reference and set the minimum user constants to operate the Inverter (for example, the operating environment of the Inverter and Digital Operator).
Advanced programming mode	Use this mode to refer to and set all user constants.
Autotuning mode	Use this mode when running a motor with unknown motor constants. The motor constants are calculated and set automatically. This mode can also be used to measure only the motor line-to-line resistance. Autotuning must be performed during trial operation while the motor is disconnected from all machines and equipment.
Fault history mode	Use this mode to display the fault history of a maximum of 256 data.

◆ Switching Modes

The mode selection display will appear when the MENU Key is pressed from a monitor or data setting display.

Press the MENU Key from the mode selection display to switch between the modes.

Press the DATA/ENTER Key in the mode selection display to refer to user constants and monitor data and from a monitor display to access the setting display.

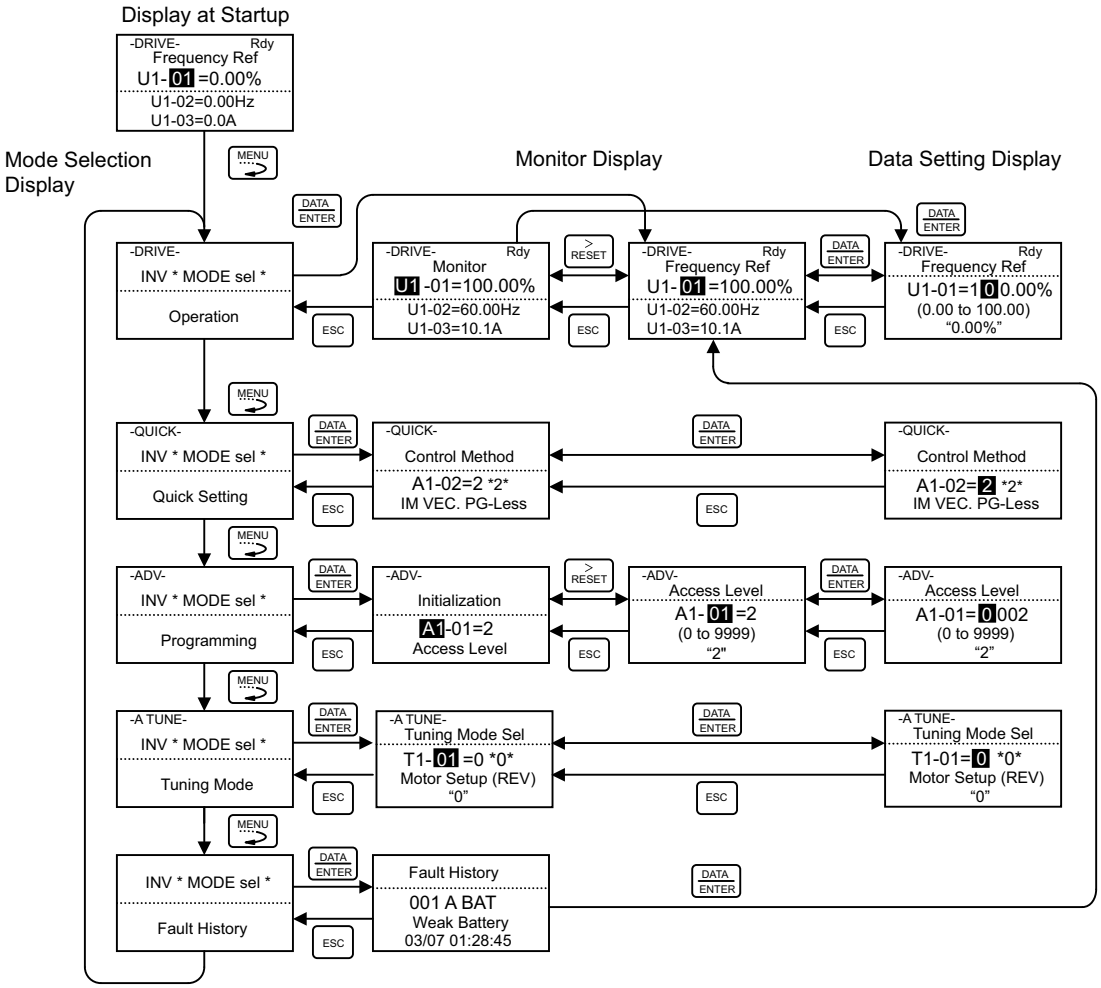


Fig 3.2 Mode Transitions

When running the Inverter after using Digital Operator, press the MENU Key to select the drive mode ("DRIVE" is displayed on the LCD screen) and then press the DATA/ENTER Key from the drive mode display to bring up the monitor display.

Run commands can not be received from any other display. Monitor display in the drive mode will appear when the power is turned on.

◆ Drive Mode

Drive mode is the mode in which the Inverter can be operated. The following monitor displays are possible in drive mode: The speed (frequency) reference, output frequency, output current, and output voltage, as well as fault information and the fault history.

When b1-01 [speed (reference) selection] is set to 0 (Digital Operator), the reference can be changed from the data setting display. Use the Increment, Decrement, and Shift/RESET Keys to change the reference. The user constant will be written and the monitor display will be returned to when the DATA/ENTER Key is pressed after changing the setting.

■Example Operations

Key operations in drive mode are shown in the following figure.

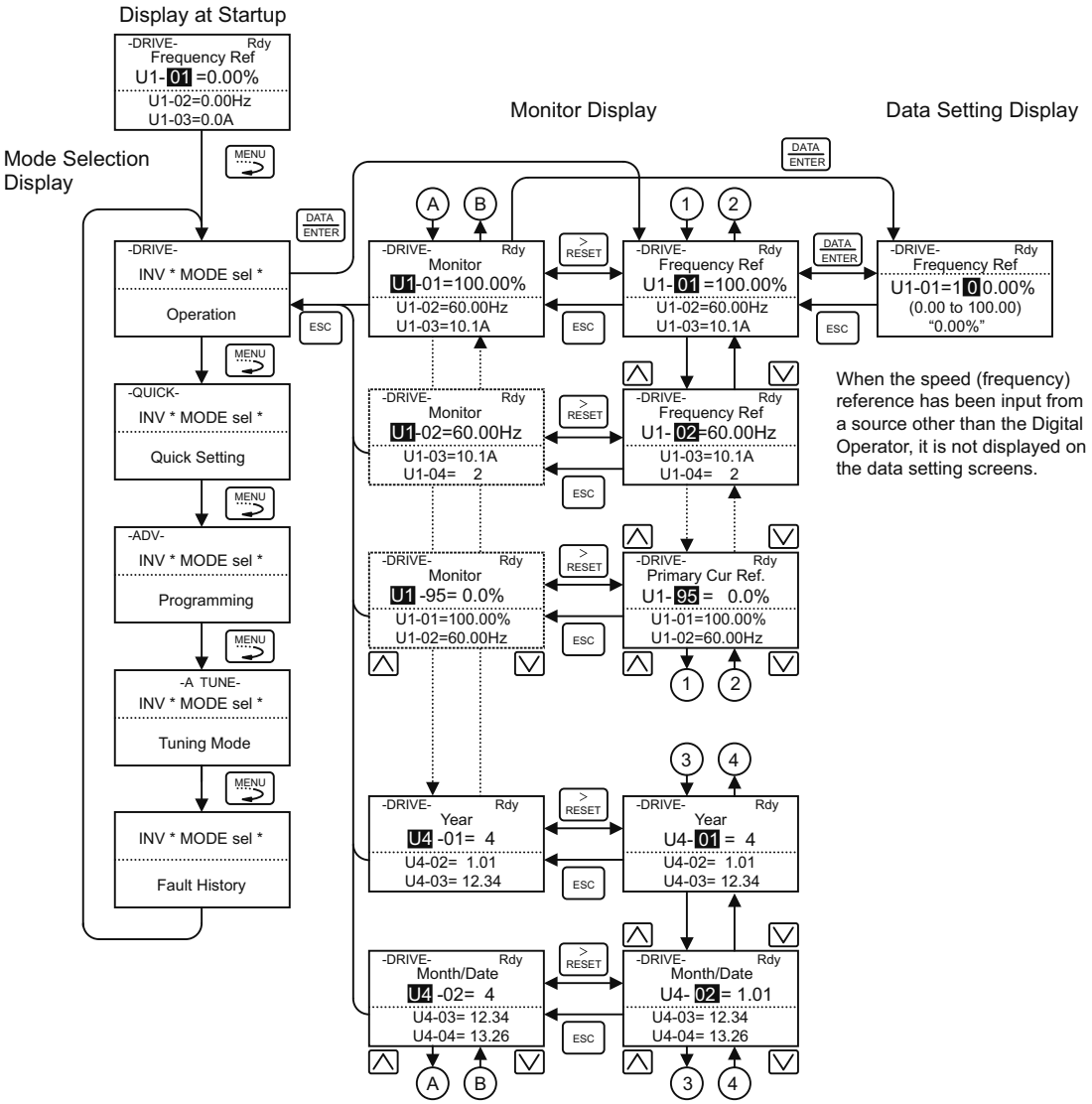


Fig 3.3 Operations in Drive Mode

Note When changing the display with the Increment and Decrement Keys, the next display after the one for the last parameter number will be the one for the first parameter number and vise versa. For example, the next display after the one for U1-01 will be U1-95. This is indicated in the figures by the letters A and B and the numbers 1 to 4. The display for the first monitor constant [speed (frequency) reference] will be displayed when power is turned on. Operation cannot be started from the mode selection display.

◆ Quick Programming Mode

In quick programming mode, the constants required for Inverter trial operation can be monitored and set.

Constants can be changed from the data setting displays. Use the Increment, Decrement, and Shift/RESET Keys to change the user constants. The user constant will be written and the monitor display will be returned to when the DATA/ENTER Key is pressed after changing the setting.

Refer to *Chapter 5 User Constants* for details on the constants displayed in quick programming mode.

■Example Operations

Key operations in quick programming mode are shown in the following figure.

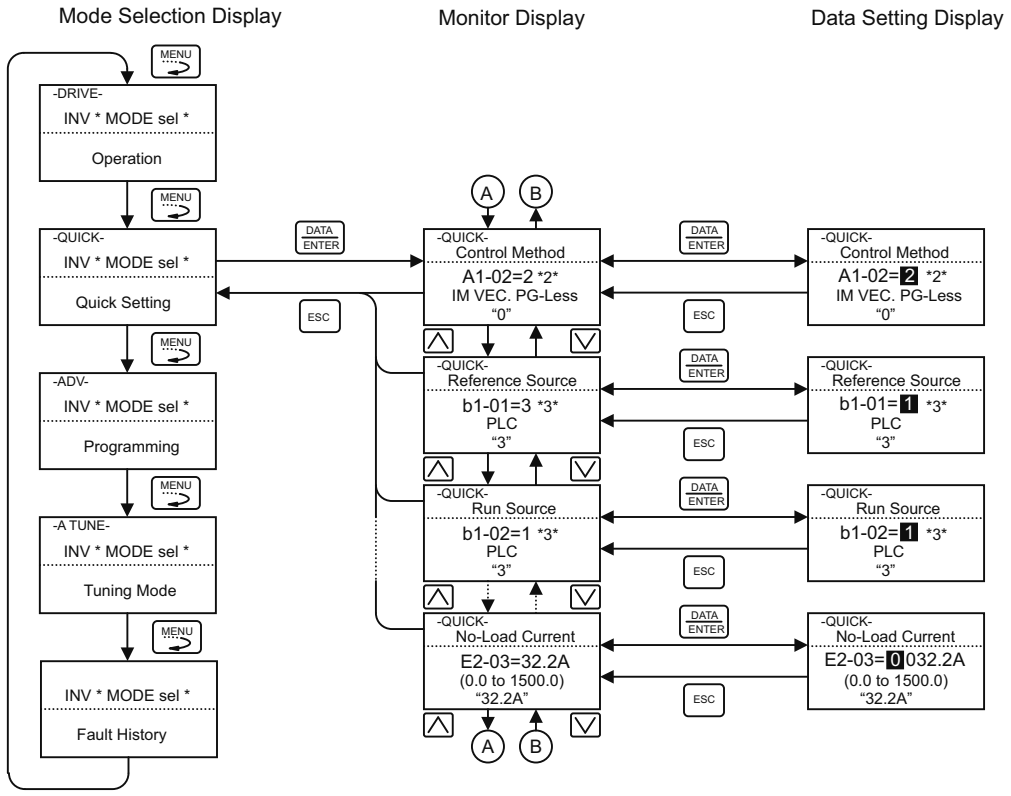


Fig 3.4 Operations in Quick Programming Mode

◆ Advanced Programming Mode

In advanced programming mode, all Inverter constants can be monitored and set.

User constants can be changed from the data setting displays. Use the Increment, Decrement, and Shift/RESET Keys to change the user constants. The user constant will be written and the monitor display will be returned to when the DATA/ENTER Key is pressed after changing the setting.

Refer to *Chapter 5 User Constants* for details on the constants.

■Example Operations

Key operations in advanced programming mode are shown in the following figure.

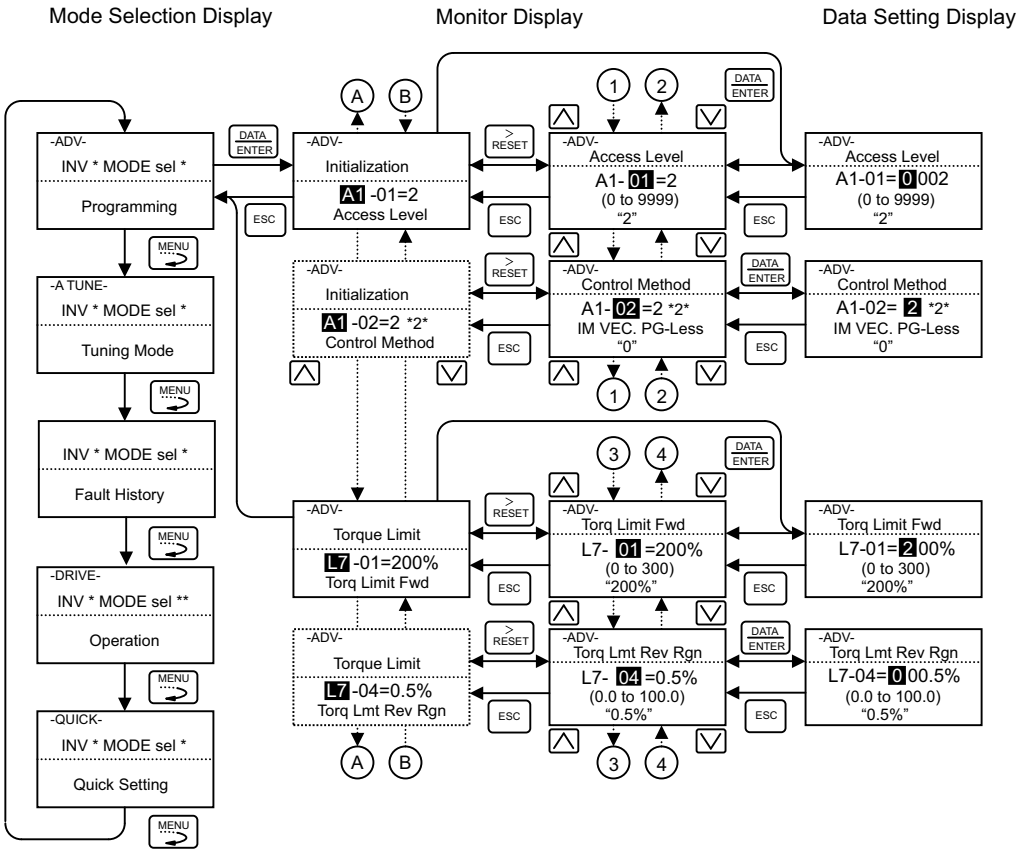


Fig 3.5 Operations in Advanced Programming Mode

■Setting User Constants

Here, the procedure is shown to change C1-01 (Acceleration time) from 60 s to 20 s.

Table 3.3 Setting User Constants in Advanced Programming Mode

Step No.	Digital Operator Display	Description
1	-DRIVE- Rdy Frequency Ref U1-01 =0.00% U1-02=0.00Hz U1-03=0.0A	Power supply turned on.
2	-DRIVE- INV * MODE sel * Operation	MENU key pressed to enter drive mode.
3	-QUICK- INV * MODE sel * Quick Setting	MENU key pressed to enter quick programming mode.
4	-ADV- INV * MODE sel * Programming	MENU key pressed to enter advanced programming mode.
5	-ADV- Initialization A1 -01=2 Access Level	DATA/ENTER Key pressed to access monitor display.
6	-ADV- Accel Time 1 C1 - 01 = 60.0sec (0.0 to 6000.0) “60.0sec”	Increment or Decrement Key pressed to display C1-01 (Acceleration time 1).
7	-ADV- Accel Time 1 C1-01=060.0sec (0.0 to 6000.0) “10.0sec”	DATA/ENTER Key pressed to access data setting display.
8	-ADV- Accel Time 1 C1-01=006.0sec (0.0 to 6000.0) “60.0sec”	Shift/RESET Key pressed to move the flashing digit to the right.
9	-ADV- Accel Time 1 C1-01=002.0sec (0.0 to 6000.0) “10.0sec”	Decrement Key pressed to change set value to 20.00 s.
10	-ADV- Entry Accepted	DATA/ENTER Key pressed to enter the set data. “Entry Accepted” is displayed for 1.0 s after the data setting has been confirmed with the DATA/ENTER Key.
11	-ADV- Accel Time 1 C1 - 01 = 20.0sec (0.0 to 6000.0) “60.0sec”	The monitor display for C1-01 returns.

◆ Autotuning Mode

In autotuning mode, the required motor constants for operation can be automatically tuned and set. Autotuning must be performed during trial operation.

Contact your Yaskawa representatives to set motor constants by calculation.

■Example of Operation

Set the rated voltage, rated current, rated frequency, rated speed, and number of poles specified on the name-plate on the motor and then press the RUN Key. The motor will automatically run and these set values and motor constant values measured by autotuning will be set.

Always set the above items. Autotuning cannot be started otherwise, for example, it cannot be started from the motor rated voltage display.

User constants can be changed from the data setting displays. Use the Increment, Decrement, and Shift/ RESET Keys to change the user constant. The user constant will be written and the monitor display will be returned to when the DATA/ENTER Key is pressed after changing the setting.

The following example shows autotuning for open-loop vector control while operating the motor.

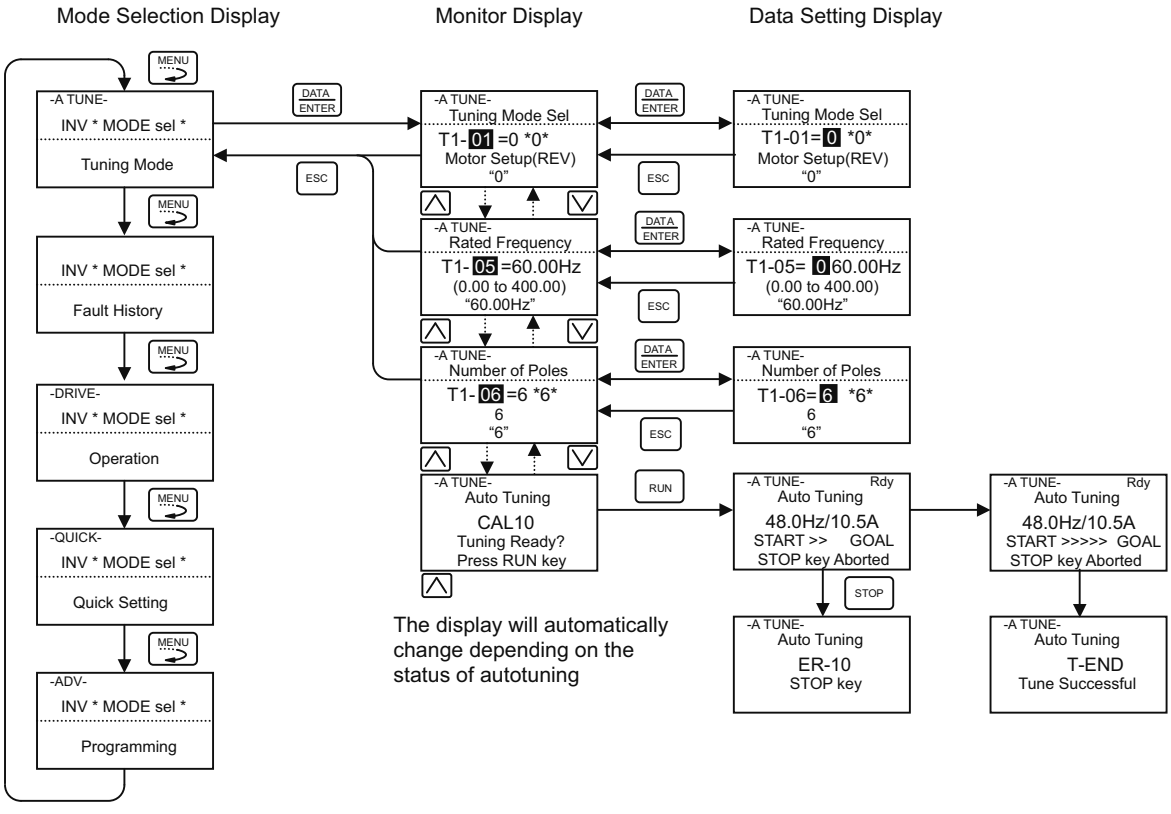


Fig 3.6 Operation in Autotuning Mode

◆ Fault History Mode

Fault history mode is used to display the fault history of a maximum of 256 data.

The record number of the fault history is attached, the latest data is 001 and the oldest data is 256. The display data can be changed by the Increment Key and the Decrement Key. When a fault has occurred, the Shift/ RESET Key acts as a fault reset key. If the DATA/ENTER key is pressed, it will return to the drive mode.

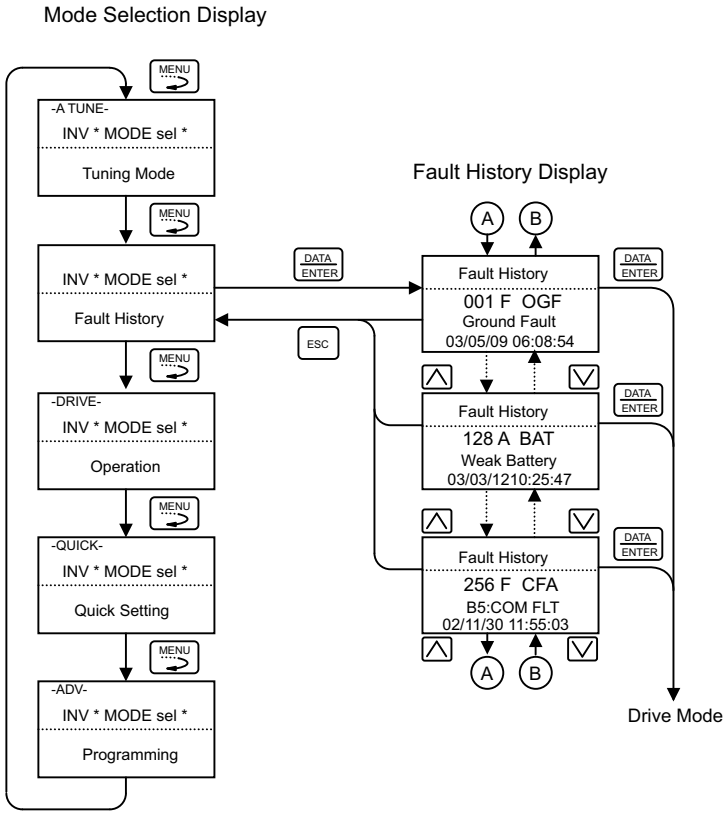


Fig 3.7 Operation in Fault History Mode

4

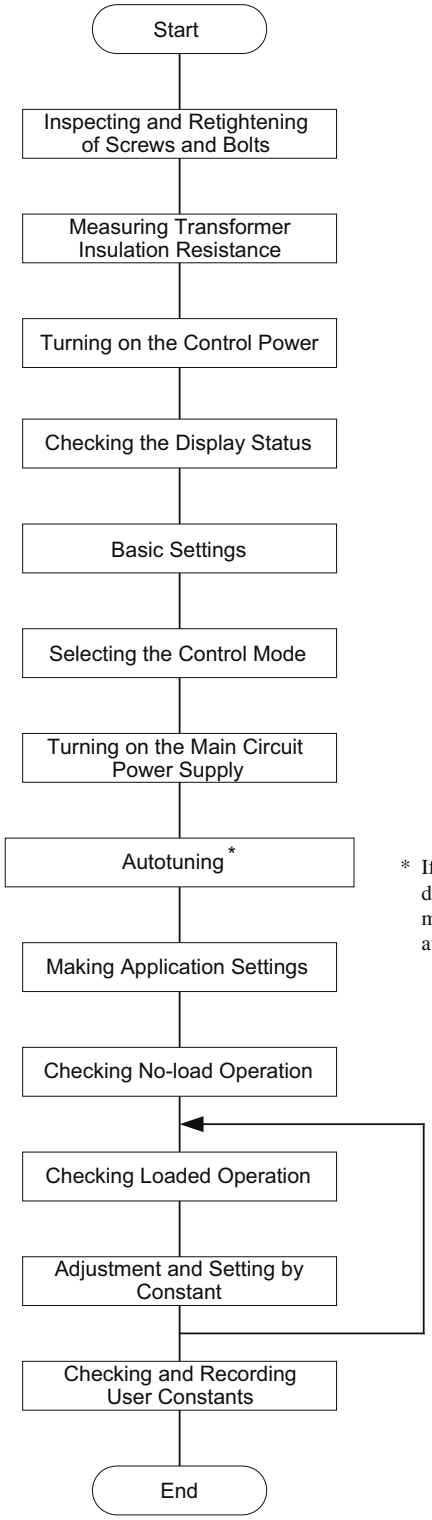
Trial Operation

This chapter describes the procedures for trial operation of the FSDrive-MV1S and provides an example of trial operation.

Trial Operation Flowchart.....4-2
Trial Operation Procedures.....4-3
Making Adjustments 4-13

Trial Operation Flowchart

Carry out a trial operation according to the flowchart below.



* If the maximum output frequency is different from the base frequency, set the maximum output frequency (E1-04) after autotuning.

Fig 4.1 Trial Operation Flowchart

Trial Operation Procedures

The procedures for trial operation are described in this section, and should be followed in the order presented.

◆ Inspecting and Retightening Screws and Bolts

After installing and wiring the Inverter, visually check the components on and in the control panels and confirm that nothing is damaged or missing.

Also check for loose screws or bolts, and retighten if necessary.

◆ Measuring Transformer Insulation Resistance

Disconnect the incoming primary line to the Inverter using the main circuit input terminal and measure the insulation resistance of the primary side of the transformer using a 1000 V Megger insulation resistance tester. Confirm that the measured value is 30 MΩ or more.

The transformer primary side has a high-resistance grounded voltage detection circuit. Make sure that this detection circuit is disconnected before measuring transformer insulation resistance.

◆ Turning on the Control Power

Items to be checked before turning on the control power supply:

- Confirm that the control power supply is the correct voltage.
- Confirm that the control circuit terminals and controller are correctly connected.
- When using a PG, be certain the PG is correctly wired.

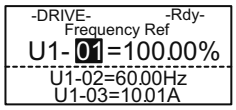
Items to be checked after turning on the control power supply:

- Measure the voltage input from the control power supply.
  If the input voltage is different from the value indicated on the elementary wiring diagram, switch the transformer tap setting for control, and measure the transformer secondary side voltage.
- Manually operate the cooling fan and check the following:
  - Is the direction of rotation correct?
  - Is there any oscillation?
  - Is there any air leakage?

◆ Checking the Display Status

When the power is turned on, the Digital Operator display in the normal status reads as follows.

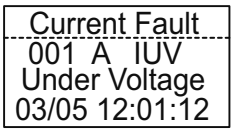
[Display in the normal status]



Monitor display of the speed (frequency) reference on the data display section

When the Inverter detects an alarm, the details of the alarm are displayed on the Digital Operator. Take appropriate measures by referring to *Chapter 7 Troubleshooting*. An example display with an alarm detected is shown below. When an alarm is detected, the ALARM lamp at the upper right of the Digital Operator lights or flashes.

[Display at alarm detection]



The display varies depending on the details of the alarm. The figure to the left shows an example when main circuit power supply voltage reduction (IUV) was detected.

◆ Basic Settings

Switch to the quick programming mode (QUICK will be displayed on the LCD screen), and then set the following user constants.

Refer to *Chapter 3 Digital Operator and Modes* for Digital Operator operating procedures and to *Chapter 5 User Constants* and *Chapter 6 Constant Settings by Function* for details on user constants.

Table 4.1 Basic Settings of User Constants

◎: Required constant settings, ○: Optional constant settings

Category	Constant No.	Name	Description	Setting Range	Factory Setting
◎	A1-02	Control method selection	Selects the control method of the Inverter 2: Open-loop vector control 3: Flux vector control	2 or 3	2
◎	b1-01	Speed (reference) selection	Selects the speed (frequency) reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: PLC	0 to 3	3
◎	b1-02	Operation method selection	Selects the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: PLC	0 to 3	3
○	b1-03	Stopping method selection	Selects the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop	0 or 1	1
◎	C1-01	Acceleration time 1	Sets the acceleration time to accelerate from 0% to 100%.	0.0 to 6000.0	60.0 s
◎	C1-02	Deceleration time 1	Sets the deceleration time to decelerate from 100% to 0%.	0.0 to 6000.0	120.0 s
○	d1-01	Speed (frequency) reference 1	Sets the speed (frequency) reference.	0.00 to 110.00	0.00%
◎	E1-01	Input voltage setting	Sets the input voltage for the Power Cell in 1-volt units. The set value becomes the reference value for protection functions, etc.	180 to 700	630 V
◎	E1-04 to E1-06 and E1-09	Max. output frequency, Max. voltage, Base frequency, Min. output frequency	Sets the voltages and frequencies (speeds) required for V/f characteristics	Voltage: 0 to 8000 V Frequency (speed): 0 to 8000 min^{-1}	(See Chapter 5.)

Table 4.1 Basic Settings of User Constants (Continued)

◎: Required constant settings, ○: Optional constant settings

Category	Constant No.	Name	Description	Setting Range	Factory Setting
◎	E2-01 to E2-04	Motor rated current, Motor rated slip, Motor no-load current, Number of motor poles	Sets the motor constants according to the specifications on the nameplate, test report, etc.	(See Chapter 5.)	(See Chapter 5.)
○	o2-04	kVA selection	Sets the Inverter capacity with a code number. Changing from factory setting is not necessary. Check the settings using the advanced programming mode.	60 to FF	Code corresponding to Inverter capacity

◆ Selecting the Control Method

Select either of the following two control methods.

Control Method	Constant Setting	Basic Control	Main Applications
Open-loop vector control	A1-02 = 2 (Factory setting)	Current vector control without a PG	Variable speed control that requires high performance without using a PG
Flux vector control	A1-02 = 3	Current vector control with a PG	Ultra high-performance control using a PG such as high-accuracy speed control, torque control, and torque limit

The autotuning mode varies depending on the control method of the Inverter.

◆ Turning on the Main Circuit Power Supply

⚠ DANGER

- Check to be sure that the Inverter door is closed before turning on the main circuit power supply. Do not open the Inverter door while power is being supplied.
  Electric shock may occur.

If the transformer primary side rated voltage and the Inverter rated output voltage are different, be sure to make the following constant settings. (Software version S0108 or later)

Constant No.	Name	Description	Setting Range	Factory Setting
Y1-26	Transformer primary side input voltage	Set the transformer primary side rated voltage.	2700 to 12100*1	3300 V*1
L9-01	Main circuit power supply setting voltage	Set the main circuit power supply voltage. (transformer primary side). Be sure to set the value corresponding to the Y1-26 setting.	2500 to 3800*2	3300 V*1

* 1. The factory settings and setting range depend on the Inverter capacity.
* 2. The setting range depends on the Y1-26 setting.

Items to be checked before turning on the main circuit power supply:

- Confirm that the main circuit power supply is the correct voltage.
- Confirm that the Inverter main circuit input and output terminals (input terminals R, S, and T and output terminals U, V, and W) are correctly connected.
- Confirm that the motor is not connected to a mechanical system (No-load status).

Items to be checked after turning on the main circuit power supply:

- Measure the input voltage of each Power Cell.
  If the measured value exceeds the Power Cell rated input voltage of 630 VAC, switch the transformer tap setting for the main circuit and recheck the input voltage of the Power Cell.

Confirm the following by using the Digital Operator.

- Confirm input power supply voltage U1-90.
- Is the Inverter in the normal status?

◆ Autotuning

⚠ CAUTION

- During autotuning, the motor must be disconnected from any load (machine, equipment).
  The motor may operate in an unexpected manner, possibly resulting in injury or damage to equipment. Also, motor constants cannot be correctly set with the motor attached to a load.
- Protect both exposed ends of any coupling detached for autotuning with tape or cloth.
  Otherwise, the coupling may be damaged or grease may splash.
- Do not touch the motor during autotuning.
  The motor may suddenly restart from the stopped state, leading to an injury.


IMPORTANT

When the operation mode enabling driving of multiple motors is selected (A1-02 = 2 and E1-02 = 3), autotuning cannot be performed.


INFO

Autotuning an inverter is fundamentally different from autotuning a servo system. Inverter autotuning automatically adjusts constants according to the detected motor constants, whereas servo system autotuning detects the size of the load.

Use the following procedure to perform autotuning to automatically set motor constants before running the motor.
If the control method is changed after autotuning, be sure to perform autotuning again.

Be sure to press the STOP Key on the Digital Operator to cancel autotuning.

■Setting the Autotuning Mode

Rotational autotuning (T1-01 = 0)

Set T1-01 to 0, input the data described on the nameplate, and then press the RUN Key on the Digital Operator. The Inverter will first stop the motor for approximately one minute and then set all the required motor constants automatically while operating the motor for approximately four minutes.

Stationary autotuning for line-to-line resistance only (T1-01 = 2)

This mode can be used to improve the control errors when the motor cable is long (50 m or longer), the length of the motor cable has been changed at installation after performing autotuning, or the capacities of the motor and Inverter differ.

By setting T1-01 to 2 and pressing the RUN Key on the Digital Operator, the Inverter will energize the motor while it is stopped for approximately one minute and automatically measure the line-to-line resistance of the motor (E2-05) and cable resistance.


IMPORTANT

1. When stationary autotuning for line-to-line resistance only is performed, the motor will be energized even though it will not turn. Do not carelessly touch the motor before autotuning completes.
2. When performing stationary autotuning for line-to-line resistance only with the motor left connected to the machine, for transfer equipment for example, take measures to prevent the holding brake from being released by accident during autotuning.

■Precautions before Performing Autotuning

For motors with a higher rated voltage than that of the main circuit power supply of the Inverter (refer to *Fig. 4.2*), decrease the motor base voltage to avoid saturation of the Inverter output voltage. Perform autotuning by following the procedure below.

1. Input main circuit power supply voltage for T1-03 (Motor rated voltage).
2. Input the value obtained by the calculation below for T1-05 (Motor base frequency).
   (Base frequency stated on the motor nameplate) × (T1-03 set value) / (Rated voltage stated on the motor nameplate)
3. Execute autotuning.

Input the base frequency stated on the nameplate of the motor for E1-04 (Maximum output frequency) after completion of autotuning.

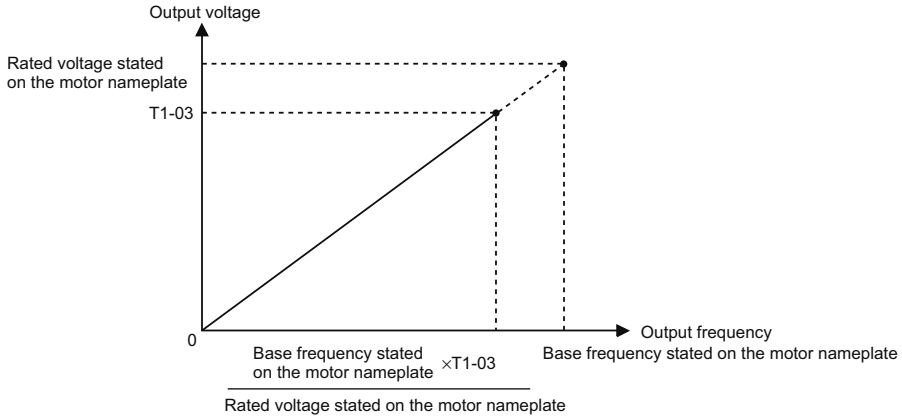


Fig 4.2 Motor Base Frequency and Inverter Main Circuit Voltage Settings

IMPORTANT

1. When speed accuracy is required in the high-speed range (90% or more of the rated speed), set "input power supply voltage × 0.9" for T1-03 (Motor rated voltage).
2. In the high-speed range (90% or more of the rated speed), the output current will increase in relation to the decrease of the main circuit power supply voltage. Confirm the current margin of the Inverter.

■Precautions after Performing Autotuning

When the maximum output frequency is different from the base frequency, set the maximum output frequency (E1-04) after completion of autotuning.

■Constant Settings for Autotuning

The following constants must be set before autotuning.

Table 4.2 Constants to be Set Before Autotuning

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Data Displays during Autotuning	
					Open-loop Vector	Flux Vector
T1-01	Autotuning mode / Tuning Mode Sel	Set the autotuning mode. 0: Rotational autotuning 2: Stationary autotuning for line-to-line resistance only	0 or 2	0	Yes	Yes
T1-03	Motor rated voltage / Rated Voltage	Set the voltage equivalent to the rated speed of no-load operation.	0 to 8000	Voltages set in E1-13	Yes	Yes
T1-04	Motor rated current / Rated Current	Set the motor rated current in amperes.*2 (Set the rated current indicated on the nameplate.)	0.1 to 1500.0 *1, *4	Amperes set in E2-01	Yes	Yes
T1-05	Motor base frequency / Rated frequency	Set the motor base frequency in hertz.*2, *3 (Set the base frequency indicated on the nameplate.)	0.00 to 400.00	Hertz set in E1-06	Yes	Yes
T1-06	Number of motor poles / Number of Poles	Set the number of motor poles. (Set the number of motor poles indicated on the nameplate.)	2 to 48	Number of poles set in E2-04	Yes	Yes
T1-07	Motor base speed / Rated speed	Set the motor base speed in min^{-1}.*2 (Set the speed indicated on the nameplate)	0 to 12000	Calculated value min^{-1}	Yes	Yes
T1-08	Number of PG pulses when tuning / PG Pulses/Rev	Sets the number of PG (pulse generator or encoder) pulses. Sets the number of pulses per motor revolution without multiplying.	0 to 8192	Number of pulses set in H7-01	No	Yes
T1-10	Motor insulation class / Insulating class	Set the insulation class described on the motor nameplate. 0: Insulation class A (100°C) 1: Insulation class E (120°C) 2: Insulation class B (130°C) 3: Insulation class F (155°C) 4: Insulation class H (180°C)	0 to 4	1	Yes	Yes

* 1. Setting range is between 10 and 200% of the Inverter rated output current.

* 2. For fixed output motors, set the base speed value.

* 3. For inverter motors or for specialized vector motors, the voltage or frequency may be lower than for general-purpose motors. Always confirm the information on the nameplate or in test reports. If the no-load values are known, input the no-load voltage in T1-03 and the no-load frequency in T1-05 to ensure accuracy.

* 4. The settings that ensure stable vector control are between 50 and 100% of the Inverter rated output current.

For the operation and the display of the Digital Operator during autotuning, refer to *Autotuning Mode* in *Chapter 3 Digital Operator and Modes*.

■Precautions When Setting Constants Using Precise Data

When performing autotuning by setting the constants to the values noted on the motor test report or design data, the contents of data to be set for autotuning differs as shown in the table below.

Digital Operator Display (Constant No.)	Normal Setting	Setting with Precise Data
T1-03	Motor rated voltage	No-load voltage at motor rated speed
T1-05	Motor base frequency	No-load frequency at motor rated speed

◆ Making Application Settings

Set the constants as required in advanced programming mode (ADV will be displayed on the LCD screen). All constants that can be set in quick programming mode can also be displayed and set in advanced programming mode.

Two setting examples for specific requirements are given below.

- To operate the machine in reverse, set b1-04 to 0 to enable reverse operation.
- To increase the speed of a 60 Hz motor by 10%, set E1-04 to 66.0 Hz.

◆ Checking No-load Operation

Disconnect the motor from the machine to establish the no-load status of the motor, and then press the LOCAL/REMOTE Key on the Digital Operator once to select LOCAL mode (the LED indicator lamps SEQ and REF on the Digital Operator will turn off).

After confirming safety conditions around the motor and the machine, operate the Inverter from the Digital Operator. Confirm that the motor rotates correctly and that no fault is displayed on the Digital Operator.

The motor will continue running at the JOG speed reference (d1-17, factory setting 10.00%) as long as the JOG Key on the Digital Operator is being pressed. If the external sequence prevents operation from the Digital Operator, confirm that the emergency stop circuits and machine safety mechanisms function correctly, and then start operation in REMOTE mode (with signals from the control circuit terminals). Safety precautions must always be taken before starting operation whether the motor is connected to a machine or not.

INFO

Both a Run command (forward/reverse) and speed (frequency) reference (or multi-step speed reference) must be input to start Inverter operation.
Input the command and reference whether the operation method is Local or Remote.

◆ Checking Loaded Operation

Connect the machine to the motor, and start operation from the Digital Operator or using signals from the control circuit terminals in the same way as described in No-load Operation.

■Connecting the Machine

- After confirming that the motor is completely stopped, connect the machine to the motor.
- Be sure to tighten all screws when securing the motor shaft to the machine.

■Operation Using the Digital Operator

- Use the Digital Operator to start operation in LOCAL mode in the same way as for no-load operation.
- Make sure that the STOP Key on the Digital Operator can be easily accessed in case of fault occurrence.
- Set the speed (frequency) reference to a low-speed value at the beginning, approximately one tenth of the actual operation speed.

■Checking Operation Status

- Confirm that the operating direction is correct and that the machine operates smoothly at a low-speed, and then increase the speed (frequency) reference.
- Change the speed (frequency) reference and rotation direction to confirm that there is no vibration or abnormal noise from the machine. Check the monitor display to ensure that U1-03 (Output current) is not too high.
- If there are problems such as hunting and oscillation caused by control performance, refer to *Making Adjustments* in *Chapter 4 Trial Operation* and adjust the settings.

◆ Checking and Recording User Constants

Check the constants for which the settings were changed during trial operation, and record them in the constants table.

INFO

- It is possible to disable setting of user constants other than A1-00, A1-01, A1-04, and A1-11 to A1-13 by setting the access level of the user constant (A1-01) to 0 (monitoring only).
- It is possible to disable monitoring of user constants unless the matching password is input by setting the access level of the user constant (A1-01) to 0 (monitoring only) and the password (A1-04 and A1-05).

Making Adjustments

If problems such as hunting and oscillation caused by control performance occur during trial operation, change the settings of the constants listed below according to the selected control method. The table below lists only the most commonly used constants.

Table 4.3 Constants to be Adjusted

Control Method	Name (Constant No.)	Functions	Factory Setting	Recommended Setting	Adjustment Method
Open-loop vector control (A1-02 = 2)	Speed feedback detection control (AFR) gain (n2-01)	• Improves torque and speed response. • Reduces hunting and oscillation at middle-speed (10 to 40 Hz).	2.00	0.50 to 2.00	• If torque or speed response is slow, decrease the setting. • If hunting or oscillation occurs, increase the setting.
	Torque compensation primary delay time constant (C4-02)	• Improves torque and speed response. • Reduces hunting and oscillation.	50 ms	20 to 100 ms	• If torque or speed response is slow, decrease the setting. • If hunting or oscillation occurs, increase the setting.
	Slip compensation primary delay time constant (C3-02)	• Improves speed response. • Increases speed stability.	3000 ms	100 to 5000 ms	• If speed response is slow, decrease the setting. • If speed is unstable, increase the setting.
	Slip compensation gain (C3-01)	• Improves speed accuracy.	1.0	0.5 to 1.5	• If speed is too low, increase the setting. • If speed is too high, decrease the setting.
Flux vector control (A1-02=3)	Speed control (ASR) proportional gain 1 (C5-01) Speed control (ASR) proportional gain 2 (C5-03)	• Improves torque and speed response. • Reduces hunting and oscillation.	5.00	2.00 to 15.00	• If torque or speed response is slow, increase the setting. • If hunting or oscillation occurs, decrease the setting.
	ASR integral (I) time 1 (High-speed) (C5-02) ASR integral (I) time 2 (Low-speed) (C5-04)	• Improves torque and speed response. • Reduces hunting and oscillation.	5.000 s	1.000 to 10.000 s	• If torque or speed response is slow, decrease the setting. • If hunting or oscillation occurs, increase the setting.
	ASR switching speed (C5-07)	Switches the ASR proportional gain and integral time according to the output frequency.	0.00%	0.00 to 100.00%	Set the speed (frequency) so that the ASR proportional gain and integral time can be secured at both low and high speeds.

The constant settings that indirectly change control performance are listed below.

Table 4.4 Constants that Indirectly Change Control Performance and their Functions

Name (Constant No.)	Functions
Acceleration/deceleration time (C1-01 to -11)	Adjusts the torque during acceleration and deceleration.
S-curve characteristics (C2-01 to -04)	Used to prevent shock at the start or completion of acceleration/deceleration.
Jump frequency (d3-01 to -04)	Used to avoid machine resonance points during operation.
Analog input filter time constant (H3-16)	Used to prevent fluctuation of analog input signals caused by noise.
Stall prevention (L3-01 to -03)	Used to prevent motor stall or overvoltage (OV) for heavy-load operation or rapid acceleration. Factory setting: Disabled
Torque limit (L7-01 to -04)	Sets the maximum torque for vector control. When increasing the setting, use an Inverter with higher capacity than the motor. Excessively decreasing the setting under heavy load will cause motor stall.

5

User Constants

This chapter describes all user constants that can be set in the FSDrive-MV1S.

User Constant Descriptions 5-2
User Constant Tables 5-3

User Constant Descriptions

This section describes the contents of the user constant tables.

◆ Description of User Constant Tables

User constant tables are structured as shown below. Here, b1-01 [speed (frequency) reference selection] is used as an example.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
b1-01	Speed (frequency) selection Reference Source	Set the speed (frequency) reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A0H	–

- Constant No.: The number of the user constant
- Name: The name of the user constant
- Description: Details on the function or settings of the user constant
- Setting Range: The setting range for the user constant
- Factory Setting: The factory setting (each control method has its own factory setting. Therefore the factory setting changes for some user constants when the control method is changed.)
- Change during Operation: Indicates whether or not the constant can be changed while the Inverter is in operation.
  - Yes: Changes possible during operation
  - No: Changes not possible during operation
- Control Methods: Indicates the control methods in which the user constant can be monitored or set. Refer to *Modes* on page 3-4 for details of Inverter modes.
  - Q: Items which can be monitored and set in either quick programming mode or advanced programming mode.
  - A: Items which can be monitored and set only in advanced programming mode.
  - No: Items which cannot be monitored or set for the control method.
- MEMOBUS Register: The register number used for MEMOBUS communications.
- Reference Page: Indicates the page number that describes the details of the user constant.

User Constant Tables

This section describes the contents of the user constant tables.
Refer to the parameter setting table included in the performance test record for the set values at the time of shipment and the completion of a test run.

Group Number	Group Name	Functional Number	Functional Name
A	Setup Settings	A1	Initialize Mode
		A3	Hi Speed Trace
		A4	Lo Speed Trace
B	Application Constants	b1	Operation Mode Selections
		b2	DC Injection Braking
		b3	Speed Search
		b8	Energy-saving Control
C	Autotuning Constants	C1	Acceleration/Deceleration Time
		C2	S-curve Characteristics
		C3	Motor Slip Compensation
		C4	Torque Compensation
		C5	Speed Control (ASR)
D	Reference Constants	d1	Speed (Frequency) Reference
		d2	Speed (Frequency) Reference Upper/Lower Limits
		d3	Jump Frequencies
		d5	Torque Control
E	Motor Constants	E1	V/f Characteristics
		E2	Motor Setup
F	PLC Constants	F8	PLC
H	Terminal Function Constants	H1	Multi-function Contact Inputs
		H2	Multi-function Contact Outputs
		H3	Multi-function Analog Inputs
		H4	Multi-function Analog Outputs
		H7	PG Setup
L	Protection Function Constants	L1	Motor Overload Protection
		L2	Power Loss Ridethrough
		L3	Stall Prevention
		L4	Frequency Detection
		L5	Auto Restart
		L6	Overtorque/Undertorque Detection
		L7	Torque Limits
		L8	Hardware Protection 1
		L9	Hardware Protection 2
N	Special Adjustments	n2	Speed Feedback Detection Control (AFR)
		n6	Synchronous Transfer with Commercial Power Supply
		n9	Factory Setting 1
O	Digital Operator Constants	o1	Monitor Select
		o2	Operation (Key Function)
Y	Factory Setting Constants	Y1	Factory Setting 2
T	Motor Autotuning Constants	T1	Autotuning
U	Monitor Constants	U1	Status Monitor
		U2	Fault Trace
		U4	Calendar

◆ Setup Settings: A

The following settings are made with the environment constants (A constants): Digital Operator display language, access level, control method, initialization of constants, calendar, and trace function.

■ Initialize Mode: A1

User constants for the environment modes are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
A1-00	Language selection for Digital Operator display / Select Language	Selects the language displayed on the Digital Operator (LCD). 0: English 1: Japanese 2: Chinese	0 to 2	1	Yes	A	A	100H	–
A1-01	Constant access level / Access Level	Sets the constant access level (set/monitor). 0: Monitoring only (Monitoring drive mode and setting A1-01, A1-04, A1-11 to A1-13.) 2: Advanced (Constants can be monitor and set in both quick programming (Q) mode and advanced programming (A) mode.)	0 or 2	2	No	A	A	101H	4-12 6-60
A1-02	Control method selection / Control Method	Sets the control method of the Inverter. 2: Open-loop vector control 3: Flux vector control This constant is not initialized by the initialize operation.	2 or 3	2	No	Q	Q	102H	4-5 4-6 4-13
A1-03	Initialize / Init Parameters	Initializes the constants using the specified method. 0: No initializing 2220: Initializes using a two-wire sequence. (Initializes to the factory setting.)	0 to 9999	0	No	A	A	103H	–
A1-04*	Password 1 (for inputting) / Enter Password	Inputs the password when a password has been set in A1-05. This function write-protects some constants of the initialize mode. If the password does not match, A1-01 to A1-03 constants can no longer be changed. (Programming mode constants can be changed.)	0 to 9999	0	No	A	A	104H	4-12 6-60

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
A1-05*	Password setting / Select Password	Sets a four digit number as the password. This constant is not usually displayed. When the Password (A1-04) is displayed, hold down the RESET Key and press the Menu Key and this constant will be displayed.	0 to 9999	0	No	A	A	105H	4-12 6-60
A1-11	Year setting / Year	Sets the calendar year. (Lower two digits of the year)	0 to 99	–	No	A	A	10BH	–
A1-12	Month and Date setting / Month/Date	Sets the calendar month and day.	1.01 to 12.31	–	No	A	A	10CH	–
A1-13	Hour and Minute setting / Hour/Minute	Sets the calendar hour and minute.	0.00 to 23.59	–	No	A	A	10DH	–

* This setting is applicable for FSDrive-MV1S with software version S0107 or later.

■Hi Speed Trace: A3

User constants for Hi speed trace are shown in the following table.

Constant No.	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods		MEMOBUS Register	Reference Page
	Digital Operator Display					Open-loop Vector	Flux Vector		
A3-01	Trace data 01 selection Trace Data01 Sel	Sets the trace data 01 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	40 (U1-01)	No	A	A	130H	–
A3-02	Trace data 02 selection Trace Data02 Sel	Sets the trace data 02 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	41 (U1-02)	No	A	A	131H	–
A3-03	Trace data 03 selection Trace Data03 Sel	Sets the trace data 03 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	42 (U1-03)	No	A	A	132H	–
A3-04	Trace data 04 selection Trace Data04 Sel	Sets the trace data 04 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	44 (U1-05)	No	A	A	133H	–
A3-05	Trace data 05 selection Trace Data05 Sel	Sets the trace data 05 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	45 (U1-06)	No	A	A	134H	–
A3-06	Trace data 06 selection Trace Data06 Sel	Sets the trace data 06 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	48 (U1-09)	No	A	A	135H	–
A3-07	Trace data 07 selection Trace Data07 Sel	Sets the trace data 07 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	49 (U1-10)	No	A	A	136H	–
A3-08	Trace data 08 selection Trace Data08 Sel	Sets the trace data 08 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	4A (U1-11)	No	A	A	137H	–
A3-09	Trace data 09 selection Trace Data09 Sel	Sets the trace data 09 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	4B (U1-12)	No	A	A	138H	–
A3-10	Trace data 10 selection Trace Data10 Sel	Sets the trace data 10 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	51 (U1-18)	No	A	A	139H	–
A3-11	Trace data 11 selection Trace Data11 Sel	Sets the trace data 11 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	52 (U1-19)	No	A	A	13AH	–
A3-12	Trace data 12 selection Trace Data12 Sel	Sets the trace data 12 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	59 (U1-26)	No	A	A	13BH	–
A3-13	Trace data 13 selection Trace Data13 Sel	Sets the trace data 13 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	5A (U1-27)	No	A	A	13CH	–

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
A3-14	Trace data 14 selection Trace Data14 Sel	Sets the trace data 14 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	70 (U1-49)	No	A	A	13DH	–
A3-15	Trace data 15 selection Trace Data15 Sel	Sets the trace data 15 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	8D (U1-78)	No	A	A	13EH	–
A3-16	Trace data 16 selection Trace Data16 Sel	Sets the trace data 16 of Hi speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	99 (U1-90)	No	A	A	13FH	–
A3-33	Hi speed trace interval setting HiTrace Interval	Sets the sampling interval in a Hi speed trace. Ex.) By setting 4, sampling is performed at an interval of 1 ms.	1 to 30000	4	No	A	A	150H	–

Note By setting the above user constant, the trace data can be checked on occurrence of an error using a PC.

■Lo Speed Trace: A4

User constants for Lo speed trace are shown in the following table.

Constant No.	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods		MEMOBUS Register	Reference Page
	Digital Operator Display					Open-loop Vector	Flux Vector		
A4-01	Trace data 01 selection Trace Data01 Sel	Sets the trace data 01 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	40 (U1-01)	No	A	A	160H	–
A4-02	Trace data 02 selection Trace Data02 Sel	Sets the trace data 02 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	41 (U1-02)	No	A	A	161H	–
A4-03	Trace data 03 selection Trace Data03 Sel	Sets the trace data 03 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	42 (U1-03)	No	A	A	162H	–
A4-04	Trace data 04 selection Trace Data04 Sel	Sets the trace data 04 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	44 (U1-05)	No	A	A	163H	–
A4-05	Trace data 05 selection Trace Data05 Sel	Sets the trace data 05 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	45 (U1-06)	No	A	A	164H	–
A4-06	Trace data 06 selection Trace Data06 Sel	Sets the trace data 06 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	48 (U1-09)	No	A	A	165H	–
A4-07	Trace data 07 selection Trace Data07 Sel	Sets the trace data 07 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	49 (U1-10)	No	A	A	166H	–
A4-08	Trace data 08 selection Trace Data08 Sel	Sets the trace data 08 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	4A (U1-11)	No	A	A	167H	–
A4-09	Trace data 09 selection Trace Data09 Sel	Sets the trace data 09 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	4B (U1-12)	No	A	A	168H	–
A4-10	Trace data 10 selection Trace Data10 Sel	Sets the trace data 10 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	51 (U1-18)	No	A	A	169H	–
A4-11	Trace data 11 selection Trace Data11 Sel	Sets the trace data 11 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	52 (U1-19)	No	A	A	16AH	–
A4-12	Trace data 12 selection Trace Data12 Sel	Sets the trace data 12 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	59 (U1-26)	No	A	A	16BH	–
A4-13	Trace data 13 selection Trace Data13 Sel	Sets the trace data 13 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	5A (U1-27)	No	A	A	16CH	–

Constant No.	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods		MEMOBUS Register	Reference Page
	Digital Operator Display					Open-loop Vector	Flux Vector		
A4-14	Trace data 14 selection Trace Data14 Sel	Sets the trace data 14 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	70 (U1-49)	No	A	A	16DH	–
A4-15	Trace data 15 selection Trace Data15 Sel	Sets the trace data 15 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	8D (U1-78)	No	A	A	16EH	–
A4-16	Trace data 16 selection Trace Data16 Sel	Sets the trace data 16 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	99 (U1-90)	No	A	A	16FH	–
A4-17	Trace data 17 selection Trace Data17 Sel	Sets the trace data 17 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	170H	–
A4-18	Trace data 18 selection Trace Data18 Sel	Sets the trace data 18 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	171H	–
A4-19	Trace data 19 selection Trace Data19 Sel	Sets the trace data 19 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	172H	–
A4-20	Trace data 20 selection Trace Data20 Sel	Sets the trace data 20 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	173H	–
A4-21	Trace data 21 selection Trace Data21Sel	Sets the trace data 21 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	174H	–
A4-22	Trace data 22 selection Trace Data22 Sel	Sets the trace data 22 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	175H	–
A4-23	Trace data 23 selection Trace Data23 Sel	Sets the trace data 23 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	176H	–
A4-24	Trace data 24 selection Trace Data24 Sel	Sets the trace data 24 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	177H	–
A4-25	Trace data 25 selection Trace Data25 Sel	Sets the trace data 25 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	178H	–
A4-26	Trace data 26 selection Trace Data26 Sel	Sets the trace data 26 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	179H	–
A4-27	Trace data 27 selection Trace Data27 Sel	Sets the trace data 27 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17AH	–

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
A4-28	Trace data 28 selection Trace Data28 Sel	Sets the trace data 28 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17BH	–
A4-29	Trace data 29 selection Trace Data29 Sel	Sets the trace data 29 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17CH	–
A4-30	Trace data 30 selection Trace Data30 Sel	Sets the trace data 30 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17DH	–
A4-31	Trace data 31 selection Trace Data31 Sel	Sets the trace data 31 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17EH	–
A4-32	Trace data 32 selection Trace Data32 Sel	Sets the trace data 32 of Lo speed trace. Set the MEMOBUS register address of U1 constants.	0 to A2	0	No	A	A	17FH	–
A4-33	Lo speed trace interval setting LoTrace interval	Sets the sampling interval in a Lo speed trace. Ex.) By setting 20, sampling is performed at an interval of 100 ms.	1 to 30000	20	No	A	A	180H	–

◆ Application Constants: B

The following settings are made with the application constants (B constants): operation mode selection, DC injection braking, speed searching and energy-saving control.

■Operation Mode Selections: b1

User constants for operation mode selection are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
b1-01	Speed (frequency) selection / Reference Source	Sets the speed (frequency) reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A0H	6-2 6-47
b1-02	Operation method selection / Run Source	Sets the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A1H	6-4 6-47
b1-03	Stopping method selection / Stopping Method	Sets the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop	0 or 1	1	No	Q	Q	1A2H	6-5
b1-04	Prohibition of reverse operation / Reverse Oper	Sets whether reverse rotation of the motor is prohibited or not. 0: Reverse enabled 1: Reverse disabled	0 or 1	1	No	A	A	1A3H	6-37
b1-05	Operation selection for setting E1-09 or less / Zero-Speed Oper	Sets the method of operation when the speed (frequency) reference input is less than the minimum output frequency (E1-09). 0: Run at speed (frequency) reference (E1-09 not effective). 1: Stop output [speeds (frequencies) below E1-09 in the coast to stop state.] 2: Run at min. frequency (E1-09). (Output frequency set in E1-09) 3: Run at zero-speed [Speeds (frequencies) below E1-09 are zero]	0 to 3	1*	No	No	A	1A4H	6-5

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
b1-06	Read sequence input twice Cntl Input Scans	Sets the responsiveness of the sequence inputs (forward/reverse and multi-function inputs.) 0: Two scans every 1 ms 1: Two scans every 5 ms	0 or 1	1	No	A	A	1A5H	–
b1-07	Operation selection after switching to remote mode LOC/REM RUN Sel	Sets the operation interlocking mode when the source of Run Commands is switched from LOCAL (Digital Operator) to REMOTE (control circuit terminals). 0: While switched to REMOTE, Run Commands are disregarded. (Turn the Run signal off once and input it again to operate the Inverter.) 1: While switched to REMOTE, the Inverter is operated according to Run Commands.	0 or 1	0	No	A	A	1A6H	–

* The factory setting will change when the control method is changed.

■DC Injection Braking: b2

User constants for injection braking are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
b2-01	Zero-speed level (DC injection braking starting frequency) / DCInj Start Freq	Sets the frequency which starts DC injection braking as a percentage when deceleration to stop is selected. When b2-01 is less than E1-09, E1-09 becomes the DC injection braking starting frequency. (In the flux vector control, zero-speed control starts from the value set in b2-01.)	0.00 to 10.00	0.50%*	No	A	A	1B0H	6-5
b2-02	DC injection braking current / DCInj Current	Sets the DC injection braking current as a percentage, taking the motor rated current as 100%. In the flux vector control, DC excitation current depends on the value set in E2-03.	0 to 100	50%	No	A	No	1B1H	6-5 6-8
b2-03	DC injection braking (pre-excitation) time at start / DCInj Time @ Start	Sets the time to perform DC injection braking on starting in seconds. Used to stop a coasting motor and restart it. When the set value is 0.00, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	1B2H	6-6 6-8
b2-04	DC injection braking (pre-excitation) time at stop / DCInj Time @ Stop	Sets the time to perform DC injection braking on stopping in seconds. Used to prevent coasting after the Stop Command is input. When the set value is 0.00, DC injection braking at stop is not performed.	0.00 to 10.00	0.50 s	No	A	A	1B3H	6-6

* The factory setting will change when the control method is changed.

■Speed Search: b3

User constants for the speed search are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
b3-01	Speed search selection at start (common) SpdSrch at Start	Enables/disables the speed search function when a Run Command is input, and sets the speed search method. 0: Disabled, speed estimation 1: Enabled, speed estimation 2: Disabled, current detection 3: Enabled, current detection Speed Estimation: When the search is started, the motor speed is estimated and acceleration/deceleration is performed from the estimated speed to the specified frequency. Current Detection: The speed search is started from the frequency when power was momentarily lost or the maximum frequency, and the speed is detected based on the search current level.	0 to 3	0*	No	A	A	1C0H	6-40
b3-02	Speed search operating current (common) SpdSrch Current	Sets the speed search operation current as a percentage, taking the Inverter rated current as 100%. Usually setting is not necessary. When restarting is not possible with the factory settings, adjust the value.	0 to 200	30%*	No	A	No	1C1H	6-40
b3-03	Speed search deceleration time (common) SpdSrch Dec Time	Sets the output frequency deceleration time during speed search in seconds. Set the time for deceleration from the maximum output frequency to the minimum output frequency.	0.1 to 10.0	4.0 s	No	A	No	1C2H	6-40
b3-05	Speed search wait time (common) Search Delay	Sets the magnetic contactor operating delay time when there is a medium-voltage magnetic contactor on the output side of the Inverter. When a speed search is performed after recovering from a momentary power loss, the search operation is delayed by the time set here.	0.0 to 20.0	0.2	No	A	A	1C4H	6-40

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
b3-06	Output current 1 during speed search (speed estimation) / Srch Im Lvl1	Sets the output current during the first half of speed search as a coefficient to the motor rated current (E2-01). Increase the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.0 to 1.0	0.5	No	A	A	1C5H	6-40
b3-07	Output current 2 during speed search (speed estimation) / Srch Im Lvl2	Sets the output current during the last half of speed search as a coefficient to the motor no-load current (E2-03). The multiplication of motor no-load current and set coefficient is limited to the motor rated current (E2-01). Increase the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.0 to 3.0	1.5	No	A	A	1C6H	6-41
b3-10	Speed search detection compensation gain (speed estimation) / Srch Detect Comp	Restarts operation at a speed obtained by multiplying the speed from the speed search by the compensation gain. Increase this setting if overvoltages of Power Cells occur when a speed search is performed after a long baseblock, for example, in searches at startup.	1.00 to 1.50	1.05	No	A	No	1C9H	6-41
b3-11	Speed estimation method switching level (speed estimation) / Srch Mthd Sw Lvl	Switches the speed estimation method automatically according to the motor residual voltage. Set the switching level.	0.5 to 100.0	5.0%	No	A	A	1CAH	6-41
b3-12	Current detection dead-zone width during speed search (speed estimation) / Srch I Deadband	On speed estimation, the motor speed is estimated from the detected current value. For current detection, the dead-zone must be set. Set the dead-zone width using the current detection resolution as reference amount. Decrease the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.5 to 10.0	4.0	No	A	A	1CBH	6-41

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
b3-13	Torque compensation time constant during speed search (common) / TComp T at SpdSr	Sets primary lag of the torque compensation function during a speed search in milliseconds.	0 to 10000	10 ms	No	A	A	1CCH	6-41
b3-14	Current control start level during voltage restoration (common) / Srch Lvl Red I	Sets the level to start prolongation of the voltage restoration time to control the current during a speed search. Set the level, taking no-load current as 1.0.	0.0 to 5.0	2.0	No	A	A	1CDH	6-41
b3-15	Time constant for current control during voltage restoration (common) / Srch T Red I	Sets the time constant for filtering for the operation to prolong voltage restoration time in order to control current during a speed search.	0 to 100	5 ms	No	A	A	1CEH	6-41
b3-16	Wait time after completion of speed search (common) / SpdSrch Ret Time	Sets the wait time for switching to normal control after completion of speed search. The speed (frequency) reference will be held during the set wait time.	0.00 to 5.00	0.01 s	No	A	No	1CFH	6-42
b3-17	Software CLA current limit 1 during speed search (common) / SpdSrch CLA Lvl1	Sets the software current limit value during a speed search as a percentage, taking the motor rated current as 100%.	0.0 to 300.0	100.0%	No	A	A	1D0H	6-42
b3-18	Software CLA current limit 2 during speed search (common) / SpdSrch CLA Lvl2	Sets the software current limit value at 0 Hz during a speed search as a percentage, taking the motor rated current as 100%	0.0 to 300.0	100.0%	No	A	A	1D1H	6-42

* The factory setting will change when the control method is changed.

■Energy-saving Control: b8

User constants for energy-saving control functions are shown in the following table.

(Software version: S0107 or later.)

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
b8-01	Energy-saving mode selection / Energy Save Sel	Sets whether to enable or disable energy-saving control. 0: Disable 1: Enable	0 or 1	0	No	A	A	220H	6-65
b8-02	Energy-saving control gain / Energy Save Gain	Sets the energy-saving control gain. The energy-saving effect is reduced when the setting value is decreased. Setting 0.00 disables this energy-saving control.	0.0 to 0.75	0.75	No	A	No	221H	6-65
b8-03	Energy-saving control filter time constant / Energy Save F.T	Sets the energy-saving control filter time constant.	0.00 to 10.00	2.00 s	No	A	No	222H	6-65

◆ Autotuning Constants: C

The following settings are made with the autotuning constants (C constants): acceleration/deceleration times, S-curve characteristics, slip compensation, torque compensation, and speed control (ASR).

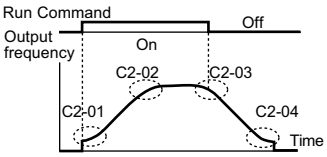
■Acceleration/Deceleration Time: C1

User constants for acceleration and deceleration times are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
C1-01	Acceleration time 1 / Accel Time 1	Sets the acceleration time to accelerate from 0% to 100%, in seconds.	0.0 to 6000.0	60.0 s	Yes	Q	Q	240H	6-10
C1-02	Deceleration time 1 / Decel Time 1	Sets the deceleration time to decelerate from 100% to 0%, in seconds.	0.0 to 6000.0	120.0 s	Yes	Q	Q	241H	6-10
C1-03	Acceleration time 2 / Accel Time 2	Sets the acceleration time when accel/decel time 1 is set to on for a multi-function input.	0.0 to 6000.0	60.0 s	Yes	A	A	242H	6-10
C1-04	Deceleration time 2 / Decel Time 2	Sets the deceleration time when accel/decel time 1 is set to on for a multi-function input.	0.0 to 6000.0	120.0 s	Yes	A	A	243H	6-10
C1-05	Acceleration time 3 / Accel Time 3	Sets the acceleration time when accel/decel time 2 is set to on for a multi-function input.	0.0 to 6000.0	60.0 s	No	A	A	244H	6-10
C1-06	Deceleration time 3 / Decel Time 3	Sets the deceleration time when accel/decel time 2 is set to on for a multi-function input.	0.0 to 6000.0	120.0 s	No	A	A	245H	6-10
C1-07	Acceleration time 4 / Accel Time 4	Sets the acceleration time when accel/decel time 1 and accel/decel time 2 are set to on for multi-function inputs.	0.0 to 6000.0	60.0 s	No	A	A	246H	6-10
C1-08	Deceleration time 4 / Decel Time 4	Sets the deceleration time when accel/decel time 1 and accel/decel time 2 are set to on for the multi-function inputs.	0.0 to 6000.0	120.0 s	No	A	A	247H	6-10
C1-09	Emergency stop time / Fast Stop Time	Sets the deceleration time when Emergency (fast) stop is set to on for a multi-function input.	0.0 to 6000.0	10.0 s	No	A	A	248H	–
C1-11	Accel/decel time switching frequency / Acc/Dec SW Freq	Sets the frequency for automatic acceleration/deceleration switching as a percentage. Below set frequency: Accel/decel time 4 Set frequency or above: Accel/decel time 1 Accel/decel time 1 and accel/decel time 2 set for multi-function inputs take priority.	0.00 to 100.00	0.00%	No	A	A	24AH	6-10

■S-curve Characteristics: C2

User constants for S-curve characteristics are shown in the following table.

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
C2-01	S-curve characteristic time at acceleration start SCrv Acc @ Start	Sets the S-curve characteristic time for all sections in seconds. When the S-curve characteristic time is set, the acceleration/deceleration times will increase by only half of the S-curve characteristic times at start and end. 	0.00 to 2.50	0.00 s	No	A	A	250H	6-11
C2-02	S-curve characteristic time at acceleration end SCrv Acc @ End		0.00 to 2.50	0.00 s	No	A	A	251H	6-11
C2-03	S-curve characteristic time at deceleration start SCrv Dec @ Start		0.00 to 2.50	0.00 s	No	A	A	252H	6-11
C2-04	S-curve characteristic time at deceleration end SCrv Dec @ End		0.00 to 2.50	0.00 s	No	A	A	253H	6-11

■Motor Slip Compensation: C3

User constants for slip compensation are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
C3-01	Slip compensation gain Slip Comp Gain	Used to improve speed accuracy when operating with a load. Usually setting is not necessary. Adjust this constant at the following cases. • When the actual speed is lower than the target speed, increase the set value. • When the actual speed is higher than the target speed, decrease the set value. Used as the applicable control gain when using flux vector control.	0.0 to 2.5	1.0*	Yes	A	A	260H	6-22
C3-02	Slip compensation primary delay time constant Slip Comp Time	Sets the slip compensation primary delay time in milliseconds. Usually setting is not necessary. Adjust this constant at the following cases. • Decrease the setting when slip compensation response is slow. • When speed is not stable, increase the setting.	0 to 10000	3000 ms *	No	A	A	261H	6-22
C3-03	Slip compensation limit Slip Comp Limit	Sets the upper limit of the slip compensation as a percentage, taking motor rated slip as 100%.	0 to 250	200%	No	A	No	262H	6-22
C3-04	Slip compensation selection during regeneration Slip Comp Regen	Enables or disables slip compensation during regeneration. 0: Disabled 1: Enabled	0 or 1	0	No	A	No	263H	–
C3-05	Output voltage limit operation selection Output V limit	Sets whether the motor flux will be lowered automatically when the output voltage become saturated. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	264H	6-22

* The factory setting will change when the control method is changed.

■Torque Compensation: C4

User constants for torque compensation are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
C4-01	Torque compensation gain / Torq Comp Gain	Sets torque compensation gain as a ratio. Usually setting is not necessary. Adjust in the following cases: • When the cable is long, increase the set value. • When the motor capacity is smaller than the Inverter capacity (Max. applicable motor capacity), increase the set value. • When the motor is vibrating, decrease the set value. Adjust the output current range at low speed rotation so that it does not exceed the Inverter rated output current.	0.00 to 2.50	1.00	Yes	A	No	270H	6-25
C4-02	Torque compensation primary delay time constant / Torq Comp Time	Sets the torque compensation primary delay time in milliseconds. Usually setting is not necessary. Adjust in the following cases: • When the motor is vibrating, increase the set value. • When the responsiveness of the motor is low, decrease the set value.	0 to 10000	50 ms	No	A	No	271H	6-25

■Speed Control (ASR): C5

User constants for speed control are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
C5-01	ASR proportional (P) gain 1 ASR P Gain 1	Sets the proportional gain of the speed control loop (ASR).	0.00 to 300.00 *2	5.00*1	Yes	No	A	280H	–
C5-02	ASR integral (I) time 1 ASR I Time 1	Sets the integral time of the speed control loop (ASR) in seconds.	0.000 to 10.000	5.000 s*1	Yes	No	A	281H	–
C5-03	ASR proportional (P) gain 2 ASR P Gain 2	Used to change gain in respect to the rotational speed. Usually setting is not necessary.	0.00 to 300.00	5.00*1	Yes	No	A	282H	–
C5-04	ASR integral (I) time 2 ASR I Time 2		0.000 to 10.000	0.5000 s *1	Yes	No	A	283H	–
C5-06	ASR primary delay time ASR Delay Time	Sets the filter time constant for outputting torque references from the speed control loop (ASR). It is set in seconds. Usually setting is not necessary.	0.000 to 0.500	0.012 s*1	Yes	No	A	285H	–
C5-07	ASR switching speed ASR Gain SW Freq	Sets the speed (frequency) for switching between proportion gain 1, 2 and integral time 1, 2 as a percentage. Speed control (ASR) proportion gain switching set for a multi-function input takes priority.	0.00 to 100.00	0.00%	No	No	A	286H	–
C5-08	ASR integral (I) limit ASR I Limit	Sets the upper limit of the speed control loop (ASR) integral quantity as a percentage, taking the rated load as 100%.	0 to 400	200%	No	No	A	287H	–

* 1. The factory setting will change when the control method is changed.

* 2. The setting range is 1.00 to 300.00 for flux vector control.

◆ Reference Constants: D

The following settings are made with the reference constants (D constants): Speed (frequency) references.

■Speed (Frequency) Reference: d1

User constants for speed (frequency) references are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
d1-01	Speed (frequency) reference 1 / Reference 1	Sets the speed (frequency) reference.	0.00 to 100.00	0.00%	Yes	Q	Q	2C0H	–
d1-02	Speed (frequency) reference 2 / Reference 2	Sets the speed (frequency) reference when multi-step speed reference 1 is on for a multi-function contact input.	0.00 to 110.00	0.00%	Yes	Q	Q	2C1H	–
d1-03	Speed (frequency) reference 3 / Reference 3	Sets the speed (frequency) reference when multi-step speed reference 2 is on for a multi-function contact input.	0.00 to 110.00	0.00%	Yes	Q	Q	2C2H	–
d1-04	Speed (frequency) reference 4 / Reference 4	Sets the speed (frequency) reference when multi-step speed references 1 and 2 are on for multi-function contact inputs.	0.00 to 110.00	0.00%	Yes	Q	Q	2C3H	–
d1-05	Speed (frequency) reference 5 / Reference 5	Sets the speed (frequency) reference when multi-step speed reference 3 is on for a multi-function contact input.	0.00 to 110.00	0.00%	Yes	Q	Q	2C4H	–
d1-06	Speed (frequency) reference 6 / Reference 6	Sets the speed (frequency) reference when multi-step speed references 1 and 3 are on for multi-function contact inputs.	0.00 to 110.00	0.00%	Yes	Q	Q	2C5H	–
d1-07	Speed (frequency) reference 7 / Reference 7	Sets the speed (frequency) reference when multi-step speed references 2 and 3 are on for multi-function contact inputs.	0.00 to 110.00	0.00%	Yes	Q	Q	2C6H	–
d1-08	Speed (frequency) reference 8 / Reference 8	Sets the speed (frequency) reference when multi-step speed references 1, 2, and 3 are on for multi-function contact inputs.	0.00 to 110.00	0.00%	Yes	Q	Q	2C7H	–
d1-17	Jog speed (frequency) reference / Jog Reference	Sets the speed (frequency) reference when the jog speed (frequency) reference selection, FJOG command, or RJOG command is on for multi-function contact inputs.	0.00 to 100.00	10.00%	Yes	Q	Q	2D0H	6-51

■Speed (Frequency) Reference Upper/Lower Limits: d2

User constants for speed (frequency) reference limits are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
d2-01	Speed (frequency) reference upper limit Ref Upper Limit	Sets the upper limit of the speed (frequency) reference as a percentage, taking the max. output frequency as 100%.	0.0 to 110.0	100.0%	No	A	A	2E0H	6-21 6-49
d2-02	Speed (frequency) reference lower limit Ref Lower Limit	Sets the lower limit of the speed (frequency) reference as a percent age, taking the max. output frequency as 100%.	0.0 to 109.0	0.0%	No	A	A	2E1H	6-21 6-49

■Jump Frequencies: d3

User constants for jump frequencies are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
d3-01	Jump frequency 1 Jump Freq 1	Sets the center values of the jump frequencies as a percentage. This function is disabled by setting the jump frequency to 0.0. Always ensure that the following applies: d3-01 ≥ d3-02 ≥ d3-03 Operation in the jump frequency range is prohibited but during acceleration and deceleration, speed changes smoothly without jump.	0.0 to 100.0	0.0%	No	A	A	2F0H	6-20
d3-02	Jump frequency 2 Jump Freq 2		0.0 to 100.0	0.0%	No	A	A	2F1H	6-20
d3-03	Jump frequency 3 Jump Freq 3		0.0 to 100.0	0.0%	No	A	A	2F2H	6-20
d3-04	Jump frequency width Jump Bandwidth	Sets the jump frequency bandwidth as a percentage. The jump frequency range will be the jump frequency ± d3-04.	0.0 to 100.0	1.0%	No	A	A	2F3H	6-20

■Torque Control: d5

User constants for the torque control are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
d5-01	Torque control selection / Torq Control Sel	0: Speed control 1: Torque control To use the function for switching between speed and torque control, set this constant to 0 and set the multi-function input to speed/torque control change.	0 or 1	0	No	No	A	310H	6-66
d5-02	Torque reference primary delay time constant / Torq Ref Filter	Sets the primary delay time constant of the torque reference filter in milliseconds. This function can be used to eliminate the noise of the torque reference signal or to adjust the responsiveness with the host controller. When oscillation occurs during torque control, increase the set value.	0 to 1000	0 ms	No	No	A	311H	6-66
d5-03	Speed limit selection / Speed Limit Sel	Sets the speed limit command method for the torque control. 1: Limited by a speed (frequency) reference (refer to b1-01) 2: Limited by d5-04 constant setting value.	1 or 2	1	No	No	A	312H	6-66
d5-04	Speed limit / Speed Lmt Value	Sets the speed limit during torque control as a percentage, taking the maximum output frequency as 100%. This function is enabled when d5-03 is set to 2. Directions are as follows. +: Run Command direction -: Opposite to Run Command direction	-120 to 120	0%	No	No	A	313H	6-66
d5-05	Speed limit bias / Speed Lmt Bias	Sets the speed limit bias as a percentage, taking the maximum output frequency as 100%. Bias is applied to the specified speed limit. It can be used to adjust the margin for the speed limit.	0 to 120	10%	No	No	A	314H	6-66

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
d5-06	Speed/torque control switching timer Ref Hold Time	Sets the delay time from inputting speed/torque control change set for a multi-function input (from off to on or on to off) until the control is actually changed, in milliseconds. This function is enabled when speed/torque control change is set for a multi-function input. For the time set for the speed/torque control switching timer, the analog inputs (torque reference, speed limit) hold the values at the time that the speed/torque control change took place. Complete external preparations for the change during this period.	0 to 1000	0 ms	No	No	A	315H	6-67

◆ Motor Constants: E

The following settings are made with the motor constants (E constants): V/f characteristics and motor constants.

■V/f Characteristics: E1

User constants for V/f characteristics are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
E1-01	Input voltage setting / Input Voltage	Sets the input voltage for the Power Cell in 1-volt units.	180 to 700	630 V	No	Q	Q	340H	–
E1-02*	Motor type selection / Motor Selection	Selects the type of the motor. 0: General-purpose motor 1: V/f motor 2: Vector motor 3: Multiple motors (when using two or more motors)	0 to 3	2	No	Q	Q	341H	6-75
E1-04	Max. output frequency (FMAX) / Max Frequency	To set V/f characteristics in a straight line, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded. Always ensure that the four frequencies (speeds) are set in the following manner: E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)	0 to 8000	1200 min^{-1}	No	Q	Q	344H	–
E1-05	Max. voltage (VMAX) / Max Voltage		0 to 8000	3300	No	Q	Q	347H	–
E1-06	Base frequency (FA) / Base Frequency		0 to 8000	1200 min^{-1}	No	Q	Q	349H	–
E1-07	Mid. output frequency (FB) / Mid Frequency A		0 to 8000	0 min^{-1}	No	A	No	34CH	–
E1-08	Mid. output frequency voltage (VC) / Mid Voltage A		0 to 8000	0 V	No	A	No	34EH	–
E1-09	Min. output frequency (FMIN) / Min Frequency		0 to 8000	0 min^{-1}	No	Q	A	350H	–
E1-10	Min. output frequency voltage (VMIN) / Min Voltage		0 to 8000	0 V	No	A	No	353H	–
E1-11	Mid. output frequency 2 / Mid Frequency B	Set only to fine-adjust V/f for the output range. Normally, this setting is not required.	0 to 8000	0 min^{-1}	No	A	A	355H	–
E1-12	Mid. output frequency voltage 2 / Mid Voltage B		0 to 8000	0 V	No	A	A	357H	–
E1-13	Base voltage (VBASE) / Base Voltage		0 to 8000	3300 V	No	Q	Q	358H	–

* This setting is applicable for FSDrive-MV1S with software version S0107 or later. This setting can be selected only for open-loop vector control.

■Motor Setup: E2

User constants for motor setting are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
E2-01	Motor rated current Motor Rated FLA	Sets the motor rated current in amperes. These set values will become the reference values for motor protection, torque limits, and torque control.	0.1 to 1500.0	86.6 A	No	Q	Q	360H	–
E2-02	Motor rated slip Motor Rated Slip	Sets the motor rated slip in hertz. These set values will become the reference values for slip compensation.	0.00 to 20.00	0.75 Hz	Yes	Q	Q	361H	–
E2-03	Motor no-load current No-Load Current	Sets the motor no-load current in amperes.	0.00 to 1500.0	32.2 A	Yes	Q	Q	362H	–
E2-04	Number of motor poles Number of Poles	Sets the number of motor poles.	2 to 48 (Only multiples of 2 can be set.)	6 poles	No	Q	Q	363H	–
E2-05	Motor line-to-line resistance Term Resistance	Sets the motor line-to-line resistance in ohms.	0.000 to 65.000	0.307 Ω	Yes	A	A	364H	–
E2-06	Motor leak inductance Leak Inductance	Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage.	0.0 to 40.0	27.2%	Yes	A	A	365H	–
E2-07	Motor iron core saturation coefficient 1 Saturation Comp1	Sets the motor iron core saturation coefficient at 50% of magnetic flux.	0.00 to 1.00	0.50	Yes	A	A	366H	–
E2-08	Motor iron core saturation coefficient 2 Saturation Comp2	Sets the motor iron core saturation coefficient at 75% of magnetic flux.	0.00 to 1.00	0.75	Yes	A	A	367H	–
E2-09	Motor mechanical loss Mechanical Loss	Sets motor mechanical loss as a percentage, taking the motor rated capacity as 100%. Usually setting is not necessary. Adjust in the following circumstances: • When torque loss is large due to motor bearing. • When the torque loss in the pump or fan is large. The set mechanical loss will compensate for torque.	0.0 to 10.0	0.0%	Yes	No	A	368H	–
E2-11	Motor rated capacity Mtr Rated Power	Sets the rated capacity of the motor in units of kilowatts.	0 to 10000	630 kW	No	Q	Q	36AH	–
E2-12	Motor wiring resistance Wiring Resistor	Sets the motor wiring resistance as a percentage.	0.00 to 1.00	0.00%	Yes	A	A	36BH	–

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
E2-13	Motor temperature OH level / Motor Temp OHLVL	Sets the motor temperature overheat level in °C units.	50 to 200	120°C	No	A	A	36CH	–
E2-14	Motor Thermistor selection / Motor Thermistor	Selects the presence/ absence of the motor thermistor. 0: Absent 1: Present	0 or 1	0	No	A	A	36DH	–

◆ PLC Constants: F

The following settings are made with the PLC constants (F constants): PLC functions.

■PLC: F8

User constants for PLC are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
F8-06	Control response 1 selection / ControlResponse 1	Selects the item to be set as control response 1 to the PLC from the relevant U1 constants.	1 to 99	9	No	A	A	405H	–
F8-07	Control response 2 selection / ControlResponse2	Selects the item to be set as control response 2 to the PLC from the relevant U1 constants.	1 to 99	90	No	A	A	406H	–
F8-08	Control response 3 selection / ControlResponse3	Selects the item to be set as control response 3 to the PLC from the relevant U1 constants.	1 to 99	43	No	A	A	407H	–
F8-09	Control response 4 selection / ControlResponse4	Selects the item to be set as control response 4 to the PLC from the relevant U1 constants.	1 to 99	54	No	A	A	408H	–
F8-10	Torque reference (torque limit) selection / Torq Ref/Lmt Sel	Enables or disables torque references (torque limits) from the PLC. 0: Disabled 1: Enabled	0 or 1	0	No	A	A	409H	–
F8-11	External-magnetic-flux reference selection / Ext-Mag-flux Sel	Enables or disables external magnetic flux reference from the PLC. 0: Disabled 1: Enabled	0 or 1	0	No	No	A	40AH	–
F8-12	ASR proportional gain selection / ASR P Gain Sel	Enables or disables ASR proportional gain from the PLC. 0: Disabled 1: Enabled	0 or 1	0	No	No	A	40BH	–
F8-13	Torque limit selection (FWD) / Torque limit Sel	Enables or disables power torque limits from the PLC. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	40CH	–
F8-14	Torque limit selection (REV) / Torque limit Sel	Enables or disables regeneration torque limits from the PLC. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	40DH	–
F8-15	Speed limit bias selection / Speed limit Sel	Enables or disables speed limit bias from the PLC. 0: Disabled 1: Enabled	0 or 1	1	No	No	A	40EH	–

◆ Terminal Function Constants: H

The following settings are made with the terminal function constants (H constants): Settings for external terminal functions.

Do not change the settings carelessly because the external terminal functions are processed by the internal PLC.

Confirm the actual external terminal numbers by checking the elementary wiring diagram. In some cases, the external terminal numbers are customized for each Inverter.

The name of the input-and-output terminal in the following constant tables corresponds as follows with the signal name of the control board (modulator board).

	Names in Constant Tables	Signal Names of Control Board*
Digital Input	S1 to S20	DI_0 to DI_19
Digital Output	DO1 to DO8	DO_0 to DO_7
Analog Input	AI1 to AI4	AI_0 to AI_3
Analog Output	AO1 to AO3	AO_0 to AO_3

* Refer to *Fig. 2.1 Standard Wiring*.

■Multi-function Contact Inputs: H1

User constants for multi-function contact inputs are shown in the following tables.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
H1-03	Terminal S3 function selection (multi-function input) Terminal S3 Sel	Multi-function contact input (S3)	0 to 8F	F	No	A	A	422H	–
H1-04	Terminal S4 function selection (multi-function input) Terminal S4 Sel	Multi-function contact input (S4)	0 to 8F	F	No	A	A	423H	–
H1-05	Terminal S5 function selection (multi-function input) Terminal S5 Sel	Multi-function contact input (S5)	0 to 8F	F	No	A	A	424H	–
H1-06	Terminal S6 function selection (multi-function input) Terminal S6 Sel	Multi-function contact input (S6)	0 to 8F	F	No	A	A	425H	–
H1-07	Terminal S7 function selection (multi-function input) Terminal S7 Sel	Multi-function contact input (S7)	0 to 8F	F	No	A	A	426H	–
H1-08	Terminal S8 function selection (multi-function input) Terminal S8 Sel	Multi-function contact input (S8)	0 to 8F	F	No	A	A	427H	–

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
H1-09	Terminal S9 function selection (multi-function input) Terminal S9 Sel	Multi-function contact input (S9)	0 to 8F	F	No	A	A	428H	–
H1-10	Terminal S10 function selection (multi-function input) Terminal S10 Sel	Multi-function contact input (S10)	0 to 8F	F	No	A	A	429H	–
H1-11	Terminal S11 function selection (multi-function input) Terminal S11 Sel	Multi-function contact input (S11)	0 to 8F	F	No	A	A	42AH	–
H1-12	Terminal S12 function selection (multi-function input) Terminal S12 Sel	Multi-function contact input (S12)	0 to 8F	F	No	A	A	42BH	–
H1-13	Terminal S13 function selection (multi-function input) Terminal S13 Sel	Multi-function contact input (S13)	0 to 8F	F	No	A	A	42CH	–
H1-14	Terminal S14 function selection (multi-function input) Terminal S14 Sel	Multi-function contact input (S14)	0 to 8F	F	No	A	A	42DH	–
H1-15	Terminal S15 function selection (multi-function input) Terminal S15 Sel	Multi-function contact input (S15)	0 to 8F	F	No	A	A	42EH	–
H1-16	Terminal S16 function selection (multi-function input) Terminal S16 Sel	Multi-function contact input (S16)	0 to 8F	F	No	A	A	42FH	–

Multi-function Contact Input Functions

Setting Value	Function	Control Methods		Reference Page
		Open-loop Vector	Flux Vector	
0	3-wire sequences (On: Reverse Run Command) (Note) Common for terminal S1 (Run) and terminal S2 (Stop)	Yes	Yes	–
1	Local/Remote selection (On: Digital Operator, Off: other than Digital Operator)	Yes	Yes	6-47
2	PLC/Inverter selection (On: PLC)	Yes	Yes	–
3	Multi-step speed reference 1 When the multi-function analog input function selection (H3-09) is set to the auxiliary speed (frequency) reference (0), this function is used in common with the master/auxiliary speed switch.	Yes	Yes	–
4	Multi-step speed reference 2	Yes	Yes	–
5	Multi-step speed reference 3	Yes	Yes	–
6	Jog speed (frequency) selection (higher priority than multi-step speed reference)	Yes	Yes	–
7	Acceleration/deceleration time selection 1	Yes	Yes	6-11
8	Baseblock command NO (NO contact) (On: Baseblock)	Yes	Yes	6-48
9	Baseblock command NC (NC contact) (Off: Baseblock)	Yes	Yes	6-48
A	Acceleration/deceleration on hold (On: Acceleration/deceleration stopped, speed (frequency) on hold)	Yes	Yes	–
B	Inverter overheat advance notice OH2 (On: OH2 displayed)	Yes	Yes	–
C	Multi-function analog input selection (On: Enabled)	Yes	Yes	–
E	Speed control integral reset (On: Integral control disabled)	No	Yes	–
F	Not used*1	Yes	Yes	–
10	Up command (On: Up command) (Always set with the down command.)	Yes	Yes	6-49
11	Down command (On: Down command) (Always set with the up command.)	Yes	Yes	6-49
12	FJOG command [On: Forward run at jog speed (frequency) d1-17]	Yes	Yes	6-51
13	RJOG command [On: Reverse run at jog speed (frequency) d1-17]	Yes	Yes	6-51
14	Fault reset (On: Fault reset)	Yes	Yes	–
1A	Acceleration/deceleration time 2	Yes	Yes	6-11
1B	Constants write enable (On: Constants write enabled, Off: Constants write disabled)	Yes	Yes	6-59
1E	Analog speed (frequency) reference sample/hold (Sampling at the leading edge of the on signal and holding the value)	Yes	Yes	–
1F	Speed (frequency) reference terminal AI1/AI2 selection (On: AI2)	Yes	Yes	–
20 to 2F	External fault (Desired settings possible) Input mode: NO contact/NC contact, Detection mode: Normal/during operation, Stopping method: Deceleration to stop/coast to stop/emergency stop/continues running	Yes	Yes	6-52
60	DC injection braking command (On: Performs DC injection braking)	Yes	Yes	6-9
61	External speed search command 1 (On: Speed search) (Search from maximum output frequency for current detection type)	Yes	No	6-42
62	External speed search command 2 (On: Speed search) (Search from speed (frequency) reference for current detection type)	Yes	No	6-42
6F	Emergency stop (NO contact) (On: Coast to a stop)	Yes	Yes	6-9
70	Emergency stop (NC contact) (Off: Coast to a stop)	Yes	Yes	6-9
71	Speed/torque control change (On: Torque control)	No	Yes	6-68
77	Speed control (ASR) proportional gain switch (On: C5-03, Off: Gain determined by C5-01 and C5-03)	No	Yes	6-68
80*2	Synchronous transfer command for synchronous transfer from the Inverter to a commercial power supply. (On: transfer command from Inverter to commercial power supply)	Yes	No	6-80
81*2	Synchronous transfer command for synchronous transfer from a commercial power supply to the Inverter. (On: transfer command from commercial power supply to Inverter)	Yes	No	6-80
82*2	Breaker closed signal of the commercial power supply [On: closed signal (answerback)]	Yes	No	6-80
83*2	Breaker closed signal of the Inverter secondary side [On: closed signal (answerback)]	Yes	No	6-80

* 1. Set to F when multi-function contact input is used for the built-in PLC or not used as multi-function contact input. The factory settings of all multi-function contact inputs are F. Input the signals shown in *Fig. 2.1* to each input terminal. The input signals are processed by the built-in PLC.

* 2. This setting is applicable for FSDrive-MV1S with software version S0108 or later.

■ Multi-function Contact Outputs: H2

User constants for multi-function outputs are shown in the following tables.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
H2-01	Terminal DO1 function selection DO1 Sel	Multi-function contact output 1 (DO1)	0 to FF	F	No	A	A	440H	–
H2-02	Terminal DO2 function selection DO2 Sel	Multi-function contact output 2 (DO2)	0 to FF	F	No	A	A	441H	–
H2-03	Terminal DO3 function selection DO3 Sel	Multi-function contact output 3 (DO3)	0 to FF	F	No	A	A	442H	–
H2-04	Terminal DO4 function selection DO4 Sel	Multi-function contact output 4 (DO4)	0 to FF	F	No	A	A	443H	–
H2-05	Terminal DO5 function selection DO5 Sel	Multi-function contact output 5 (DO5)	0 to FF	F	No	A	A	444H	–
H2-06	Terminal DO6 function selection DO6 Select	Multi-function contact output 6 (DO6)	0 to FF	F	No	A	A	445H	–
H2-07	Terminal DO7function selection DO7 Select	Multi-function contact output 7 (DO7)	0 to FF	F	No	A	A	446H	–
H2-08	Terminal DO8 function selection DO8 Select	Multi-function contact output 8 (DO8)	0 to FF	F	No	A	A	447H	–

Multi-function Contact Output Functions

Setting Value	Function	Control Methods		Reference Page
		Open-Loop Vector	Flux Vector	
0	During run (On: Run Command is on or voltage is being output)	Yes	Yes	6-53
1	Zero-speed (On: During zero-speed control)	Yes	Yes	6-53
2	Frequency (speed) agree 1 (detection width L4-02) [On: Output frequency (or motor speed) = Speed (frequency) reference (detection width L4-02)]	Yes	Yes	6-29
3	Desired frequency (speed) agree 1 [On: Output frequency (or motor speed) = ±L4-01 (detection width L4-02) and during frequency agree]	Yes	Yes	6-29
4	Frequency (FOUT) detection 1 [On: +L4-01 ≥ Output frequency (or motor speed) ≥ –L4-01 (detection width L4-02)]	Yes	Yes	6-29
5	Frequency (FOUT) detection 2 [On: Output frequency (or motor speed) ≥ +L4-01 or output frequency (or motor speed) ≤ –L4-01 (detection width L4-02)]	Yes	Yes	6-29
6	Inverter operation ready (READY) (On: Inverter ready) Ready: Normal status without error after initialization	Yes	Yes	–
7	During main circuit undervoltage (UV) detection [On: Main circuit power supply undervoltage (UV) being detected]	Yes	Yes	–
8	During baseblock (On: during baseblock)	Yes	Yes	–
9	Speed (frequency) reference selection (On: Digital Operator, Off: other than Digital Operator)	Yes	Yes	–
A	Run command selection status (On: Digital Operator, Off: other than Digital Operator)	Yes	Yes	–
B	Overtorque/undertorque detection 1 NO (NO contact) (On: Overtorque/undertorque detection)	Yes	Yes	6-33
C	Loss of speed (frequency) reference [Effective when L4-05 (operation selection when speed (frequency) reference is lost) is set to 1] [On: speed (frequency) reference lost]	Yes	Yes	–
E	Fault detection (major fault) (On: Error other than CPF00 and CPF01 has occurred)	Yes	Yes	–
F	Not used*1	Yes	Yes	–
10	Alarm detection (minor fault) (On: Alarm generated)	Yes	Yes	–
11	Fault reset command active (On: Fault reset command active)	Yes	Yes	–
13	Frequency (speed) agree 2 (detection width L4-04) [On: Output frequency (or motor speed) = Speed (frequency) reference (detection width L4-04)	Yes	Yes	6-29
14	Desired frequency (speed) agree 2 [On: Output frequency (or motor speed) = L4-03 (detection width L4-04), and frequency agree]	Yes	Yes	6-29
15	Frequency (FOUT) detection 3 [On: Output frequency (or motor speed) ≤ L4-03 (detection width L4-04)]	Yes	Yes	6-29
16	Frequency (FOUT) detection 4 [On: Output frequency (or motor speed) ≥ L4-03 (detection width L4-04)]	Yes	Yes	6-29
17	Overtorque/undertorque detection 1 NC (NC contact) (Off: Overtorque/undertorque detection)	Yes	Yes	6-33
18	Overtorque/undertorque detection 2 NO (NO contact) (On: Overtorque/undertorque detection)	Yes	Yes	6-33
19	Overtorque/undertorque detection 2 NC (NC contact) (Off: Overtorque/undertorque detection)	Yes	Yes	6-33
1A	During reverse run (On: During reverse run)	Yes	Yes	–
1B	During baseblock 2 (Off: During baseblock)	Yes	Yes	–
1D	During regeneration (On: During regeneration)	No	Yes	–
1E*3	During auto restart (On: During auto restart)	Yes	Yes	6-46
30	During torque limit (current control) (On: During torque limit)	Yes	Yes	–
31	During speed (frequency) limit (On: During speed (frequency) limit)	No	Yes	6-54
32*4	During speed limiter circuit operation (On: Speed limiter active) (except when stopped)	No	Yes	6-68
37	During run 2 (On: Frequency output, Off: Base block, DC injection braking, pre-excitation, operation stop)	Yes	Yes	6-53 6-68
40*2	Breaker close command for commercial power supply (On: Close command, Off: Open command)	Yes	No	6-80
41*2	Inverter secondary side breaker close command (On: Close command, Off: Open command)	Yes	No	6-80
42*2	Completion of synchronous transfer to commercial power supply (On: Synchronous transfer to commercial power supply completed)	Yes	No	6-80

* 1. Set to F when multi-function contact output is used for the built-in PLC or not used as multi-function contact output. The factory settings of all multi-function contact outputs are F and the signals shown in *Fig. 2.1* are output from the built-in PLC to each output terminal.

* 2. This setting is applicable for FSDrive-MV1S with software version S0108 or later.
* 3. This setting is applicable for FSDrive-MV1S with software version S0110 or later.
* 4. This setting is applicable for FSDrive-MV1S with software version S0112 or later.

■Multi-function Analog Inputs: H3

User constants for analog inputs are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
H3-01	Speed (frequency) reference signal level selection (terminal AI1) / Term AI1 Signal	Selects the input signal level of terminal AI1. 0: 0 to 10 V 1: -10V to 10 V	0 or 1	0	No	A	A	450H	6-16
H3-02	Speed (frequency) reference input gain (terminal AI1) / Term AI1 Gain	Sets the input gain of terminal AI1. Set the speed (frequency) when 10 V is input as a percentage, taking the maximum output frequency as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	451H	6-16
H3-03	Speed (frequency) reference input bias (terminal AI1) / Term AI1 Bias	Sets the input bias of terminal AI1. Set the speed (frequency) when 0 V is input as a percentage, taking the maximum output frequency as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	452H	6-16
H3-04	Signal level selection (terminal AI2) / Term AI2 Signal	Selects the input signal level of terminal AI2. 0: 0 to 10 V 1: -10 V to 10 V	0 or 1	0	No	A	A	453H	6-16 6-67
H3-05	AI2 function selection / Term AI2 Sel	Sets the multi-function analog input function for terminal AI2.	0 to 1F	F	No	A	A	454H	6-16 6-67
H3-06	Input gain (terminal AI2) / Term AI2 Gain	Sets the input gain of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	455H	6-16 6-67
H3-07	Input bias (terminal AI2) / Term AI2 Bias	Sets the input bias of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	456H	6-16 6-67
H3-08	Signal level selection (terminal AI3) / Term AI3 Signal	Selects the input signal level of terminal AI3. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	457H	6-16 6-67
H3-09	Function selection (terminal AI3) / Term AI3 Sel	Sets the multi-function analog input function for terminal AI3.	0 to 1F	F	No	A	A	458H	6-16 6-67
H3-10	Input gain (terminal AI3) / Term AI3 Gain	Sets the input gain of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	459H	6-17 6-67

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
H3-11	Input bias (terminal AI3) Term AI3 Bias	Sets the input bias of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45AH	6-17 6-67
H3-12	Signal level selection (terminal AI4) Term AI4 Signal	Selects the input signal level of terminal AI4. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	45BH	6-17 6-67
H3-13	Function selection (terminal AI4) Term AI4 Sel	Sets the multi-function analog input function for terminal AI4.	0 to 1F	F	No	A	A	45CH	6-17 6-68
H3-14	Input gain (terminal AI4) Term AI4 Gain	Sets the input gain of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	45DH	6-17 6-68
H3-15	Input bias (terminal AI4) Term AI4 Bias	Sets the input bias of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45EH	6-17 6-68
H3-16	Analog input filter time constant Filter Avg Time	Sets the primary delay filter time constant in seconds for the four analog input terminals. Effective for noise control etc.	0.00 to 2.00	0.00 s	No	A	A	45FH	6-17 6-68

Multi-function Analog Input Functions

Setting Value	Function	Contents (100%)	Control Methods		Reference Page
			Open-loop Vector	Flux Vector	
0	Auxiliary speed (frequency) reference (Can be set only for H3-09)	Maximum number of rotations	Yes	Yes	–
1	Frequency gain	Speed (frequency) reference terminal value	Yes	Yes	–
2	Frequency bias	Maximum number of rotations	Yes	Yes	–
5	Acceleration/deceleration time gain (reduction coefficient)	Set acceleration and deceleration times	Yes	Yes	–
6	DC injection braking current	Inverter rated output current	Yes	No	6-9
7	Overtorque detection level	Motor rated torque	Yes	Yes	–
9	Output frequency lower limit level	Maximum number of rotations	Yes	Yes	–
A	Jump frequency	Maximum number of rotations	Yes	Yes	–
E*1	Motor temperature input	450°C (note that 0% represents −50°C)	Yes	Yes	–
F	Not used*2	–	Yes	Yes	–
10	Positive torque limit	Motor rated torque	Yes	Yes	6-69
11	Negative torque limit	Motor rated torque	Yes	Yes	6-69
12	Regenerative torque limit	Motor rated torque	Yes	Yes	6-69
13	Torque reference at torque control/ Torque limit at speed control	Motor rated torque	No	Yes	6-69
14	Torque compensation	Motor rated torque	No	Yes	6-69
15	Positive/negative torque limit	Motor rated torque	Yes	Yes	6-69
1F	(For H3-09 and H3-13) Analog input not used	–	Yes	Yes	–
	(For H3-05) Speed (frequency) reference	Maximum number of rotations			–

* 1. This setting is applicable for FSDrive-MV1S with software version S0112 or later.

* 2. Set to F when the multi-function analog input is used for the built-in PLC or not used as multi-function analog input.

■Multi-function Analog Outputs: H4

User constants for multi-function analog outputs are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
H4-01	AO1 Monitor output selection (multi-function AO) Term AO1 Signal	Sets the number of monitor items (U1-□□) to be output from terminal AO1. Refer to *Monitor Constants: U* on page 5-64 to determine which constants are available for analog output.	0 to 99	2	Yes	A	A	470H	6-55
H4-02	Output gain (terminal AO1) Term AO1 Gain	Sets the voltage level gain of terminal AO1. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	471H	6-55
H4-03	Output bias (terminal AO1) Term AO1 Bias	Sets the voltage level bias of terminal AO1. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	472H	6-55
H4-04	AO2 Monitor output selection (multi-function AO) Term AO2 Signal	Sets the number of monitor items (U1-□□) to be output from terminal AO2. Refer to *Monitor Constants: U* on page 5-64 to determine which constants are available for analog output.	0 to 99	3	Yes	A	A	473H	6-55
H4-05	Output gain (terminal AO2) Term AO2 Gain	Sets the voltage level gain of terminal AO2. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	474H	6-55
H4-06	Output bias (terminal AO2) Term AO2 Bias	Sets the voltage level bias of terminal AO2. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	475H	6-55
H4-07	AO3 Monitor output selection (multi-function AO) Term AO3 Signal	Sets the number of monitor items (U1-□□) to be output from terminal AO3. Refer to *Monitor Constants: U* on page 5-64 to determine which constants are available for analog output.	0 or 99	5	Yes	A	A	476H	6-55
H4-08	Output gain (terminal AO3) Term AO3 Gain	Sets the voltage level gain of terminal AO3.Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	477H	6-55

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
H4-09	Output bias (terminal AO3) / Term AO3 Bias	Sets the voltage level bias of terminal AO3. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	478H	6-55
H4-10	AO4 Monitor output selection (multi-function AO) / Term AO4 Signal	Sets the number of monitor items (U1-□□) to be output from terminal AO4. Refer to *Monitor Constants: U* on page 5-64 to determine which constants are available for analog output.	0 to 99	9	Yes	A	A	479H	6-56
H4-11	Output gain (terminal AO4) / Term AO4 Gain	Sets the voltage level gain of terminal AO4. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	47AH	6-56
H4-12	Output bias (terminal AO4) / Term AO4 Bias	Sets the voltage level bias of terminal AO4. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	47BH	6-56
H4-13	Analog output signal level selection / Signal Select	Sets the signal level of four analog outputs. 0: 0 to +10 V 1: -10 to +10 V	0 or 1	1	No	A	A	47CH	6-56

■PG Setup: H7

User constants for PG setup are shown in the following table. (Used in the control mode using the PG)

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
H7-01	PG constant / PG Pulses/Rev	Sets the number of PG (pulse generator or encoder) pulses. Set the number of pulses per motor revolution without multiplying.	0 to 8192	600*1	No	No	Q	4A0H	6-62
H7-02	Operation selection at PG disconnection detection / PG Fdbk Loss Sel	Sets the stopping method when PG disconnection (PGO) is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation Do not select any value other than 1 (coast to stop) In the case of a differential input, this setting is disregarded. PG disconnection detection by the circuit operates and the motor coasts to stop.	0 to 3	1	No	No	A	4A1H	6-62
H7-04	Operation selection at excessive speed deviation / PG Deviation Sel	Sets the stopping method when an excessive speed deviation (DEV) is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation	0 to 3	3	No	No	A	4A3H	6-62
H7-05	PG rotation direction / PG Rotation Sel	Sets the rotation direction of the PG. 0: Phase A leads with forward run command. 1: Phase A leads with reverse Run Command.	0 or 1	1*1	No	No	A	4A4H	6-62
H7-08	Overspeed detection level / PG Overspd Level	Sets the overspeed detection method. When frequencies beyond the level set in H7-08 (set as a percentage, taking the maximum output frequency as 100%) continue for the time set in H7-09 (detection time: seconds), an overspeed is detected.	0 to 120	115%	No	No	A	4A7H	6-62
H7-09	Overspeed detection delay time / PG Overspd Time		0.0 to 2.0	0.0 s*1	No	No	A	4A8H	6-62

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
H7-10	Excessive speed deviation detection level / PG Deviate Level	Sets the speed deviation detection method. When speed deviations beyond the level set in H7-10 (set as a percentage, taking the maximum output frequency as 100%) continue for the time set in H7-11 (detection time: seconds), an excessive speed deviation is detected. Speed deviation is the difference between actual motor speed and the reference speed.	0 to 50	10%	No	No	A	4A9H	6-63
H7-11	Excessive speed deviation detection delay time / PG Deviate Time		0 to 10.0	0.5 s	No	No	A	4AAH	6-63
H7-14	PG disconnection detection delay time / PGO Detect Time	Sets the PG disconnection detection time in seconds. In the case of a differential input, this setting is disregarded. PG disconnection detection by the circuit operates and the motor coasts to stop.	0.0 to 10.0	3.0 s	No	No	A	4ADH	6-63
H7-26*2	PG channel selection / PG Channel Sel	Selects the input channel depending on the PG specifications. 0: CH1 (differential, A-/B-phase input) 1: CH2 (complementary, A-/B-phase input)	0 or 1	0	No	No	A	4B9H	–

* 1. The factory setting will change when the control method is changed.

* 2. This setting is applicable for FSDrive-MV1S with software version S0111 or later.

◆ Protection Function Constants: L

The following settings are made with the protection function constants (L constants): Motor overload protection function, power loss ridethrough function, stall prevention function, frequency detection, overtorque/undertorque detection, torque limits, and hardware protection.

■Motor Overload Protection: L1

User constants for motor protection functions are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L1-01	Motor protection selection / MOL Fault Select	Sets whether the motor overload protection function is enabled or disabled at electronic thermal relay. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	4E0H	6-35
L1-02	Motor protection time constant / MOL Time Const	Sets protection time when overload of the motor overload detection level (L1-07) is applied to the load status that was lower than the motor overload detection start level (L1-06). Set a value appropriate for the overload capacity of the motor.	1.0 to 300.0	60.0 s	No	A	A	4E1H	6-35
L1-04	Selection of operation when motor overload is detected / MOL Select	Sets the stopping method when motor overload is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation	0 to 3	1	No	A	A	4E3H	6-35
L1-06	Motor overload detection start level / OL1 Start Level	Sets the motor overload detection start level as a percentage, taking the motor rated current as 100%. The set value must be smaller than L1-07.	20 to 300	110%	No	A	A	4E5H	6-35
L1-07	Motor overload detection level / OL1 Level	Sets the motor overload detection level as a percentage, taking the motor rated current as 100%. The set value must be bigger than L1-06.	30 to 300	150%	No	A	A	4E6H	6-35

■Power Loss Ridethrough: L2

User constants for power loss ridethroughs are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L2-01	Selection of operation at momentary power loss detection / PwrL Selection	Selects the operation when a momentary power loss occurs. 0: Disabled [main circuit undervoltage (IUV) detection] 1: Enabled [Restarted when the main circuit power returns within the time set for L2-02. When L2-02 is exceeded, main circuit undervoltage (IUV) is detected.] A backup of the control power supply is necessary for momentary power loss compensation.	0 or 1	0	No	A	A	4F0H	6-38
L2-02	Momentary power loss ridethru time / PwrL Ridethru t	Sets the ridethrough time in seconds when L2-01 is set to 1.	0.0 to 10.0	2.0 s	No	A	A	4F1H	6-38
L2-03	Min. baseblock time / PwrL Baseblock t	Sets the minimum baseblock time in seconds at recovery after momentary power loss or Inverter stop. The Inverter will not accept Run Commands for the set period of time and maintains the baseblock state. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs at the start of DC injection braking, increase the set values.	0.1 to 5.0	2.0 s	No	A	A	4F2H	6-38 6-42
L2-04	Voltage recovery time / PwrL V/F Ramp t	Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search, in seconds. Sets the time required to recover from 0 V to the maximum voltage. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs during voltage recovery or after recovery, increase the set values.	0.0 to 10.0	3.0 s	No	A	A	4F3H	6-38 6-42
L2-06	KEB operation selection / KEB SEL	Enables or disables the KEB functions. 0: Disabled 1: Enabled	0 or 1	0	No	A	No	4F5H	–
L2-07	KEB operation time / KEB Time	Sets the compensation time in seconds when KEB operation selection (L2-06) is set to 1.	0.0 to 1.0	0.3 s	No	A	A	4F6H	–
L2-08	KEB torque limit integration time / KEB Tlmt Time	Sets the torque limit integration time for KEB operation in milliseconds.	5 to 1000	30 ms	No	A	No	4F7H	–

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
L2-09	KEB AFR gain KEB K AFR Gain	Sets the AFR gain for KEB operation.	0.00 to 10.00	2.00	No	A	No	4F8H	–

■Stall Prevention: L3

User constants for the stall prevention function are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L3-01	Stall prevention selection during acceleration / StallP Accel Sel	Sets whether the stall prevention during acceleration function is enabled or disabled. 0: Disabled (Acceleration as set. With a heavy load, the motor may stall.) 1: Enabled (Acceleration stopped when L3-02 level is exceeded. Acceleration starts again when the current level is recovered.) 2: Optimum adjustment (Using the L3-02 level as the reference, acceleration is automatically adjusted. Set acceleration time is disregarded.)	0 to 2	0	No	A	No	520H	6-13
L3-02	Stall prevention level during acceleration / StallP Accel Lvl	This setting is valid when L3-01 is set to 1 or 2. Set as a percentage, taking the Inverter rated output current as 100%. Usually setting is not necessary. Reduce the set value if the motor stalls when operated with the factory settings.	0 to 200	150%	No	A	No	521H	6-13
L3-03	Stall prevention limit during acceleration / StallP CHP Lvl	Sets the lower limit for stall prevention during acceleration, as a percentage taking the Inverter rated output current as 100%, when operation is in the frequency range above E1-06. Usually setting is not necessary.	0 to 100	100%*1	No	A	No	522H	6-13
L3-04*2	Excessive deceleration prevention selection / OverDecelP Sel	0: Disabled [Decelerates according to the settings. Power Cell DC bus bar overvoltage (OVR VOLT) may occur when deceleration time is short.] 1: Enabled (Stops deceleration when the DC bus bar voltage exceeds 1045 V. Restarts deceleration when the voltage is restored.)	0 or 1	1	No	A	A	523H	6-15

* 1. The factory setting will change when the control method is changed.

* 2. This setting is applicable for FSDrive-MV1S with software version S0112 or later.

■Frequency Detection: L4

User constants for the frequency detection function are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L4-01	Frequency detection level / Spd Agree Level	Valid when the following items are set for a multi-function contact output. "Desired frequency (speed) agree 1" "Frequency (FOUT) detection 1" "Frequency (FOUT) detection 2" Set the frequency to be detected as a percentage.	0.0 to 100.0	0.0%	No	A	A	530H	6-28
L4-02	Frequency detection width / Spd Agree Width	Valid when the following items are set for a multi-function contact output. "Frequency (speed) agree 1" "Desired frequency (speed) agree 1" "Frequency (FOUT) detection 1" "Frequency (FOUT) detection 2" Set the frequency detection width as a percentage.	0.0 to 100.0	2.0%	No	A	A	531H	6-28
L4-03	Frequency detection level (+/-) / Spd Agree Lvl+-	Valid when the following items are set for a multi-function contact output. "Desired frequency (speed) agree 2" "Frequency (FOUT) detection 3" "Frequency (FOUT) detection 4" Set the frequency detection width as a percentage.	-100.0 to 100.0	0.0%	No	A	A	532H	6-28
L4-04	Frequency detection width (+/-) / Spd Agree Width+-	Valid when the following items are set for a multi-function contact output. "Frequency (speed) agree 2" "Desired frequency (speed) agree 2" "Frequency (FOUT) detection 3" "Frequency (FOUT) detection 4" Set the frequency detection width as a percentage.	0.0 to 100.0	2.0%	No	A	A	533H	6-28

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
L4-05	Operation selection when speed (frequency) reference is lost Ref Loss Sel	Sets the operation when the speed (frequency) reference is lost. 0: Stop [Operation follows the speed (frequency) reference.] 1: Operation at 80% speed continues. (At 80% of the speed before the frequency reference was lost) Lost frequency reference: Reference voltage drops over 90% in 400 ms. This setting is valid when b1-01 is set to 1.	0 or 1	0	No	A	A	534H	–

■Auto Restart: L5

User constants for the auto restart function are shown in the following table.

(Applicable software versions: S0109 or later)

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
L5-01	Number of auto restart attempts Num of Restarts	Sets the number of auto restart attempts. Automatically restarts after a fault and conducts a speed search from the run frequency.	0 to 5	0	No	A	A	540H	6-46
L5-02	Auto restart operation selection Restart Sel	Sets whether a fault contact output is activated during auto restart. 0: Not output (Fault contact is not activated.) 1: Output (Fault contact is activated.)	0 or 1	0	No	A	A	541H	6-46
L5-03	Auto restart duration time Max Restart Time	Sets the maximum duration time for fault resetting operation during auto restart. Protective operation is activated if the fault is not cleared even when the set time has elapsed.	0.01 to 18.00	0.05	No	A	A	542H	6-46

■Overtorque/Undertorque Detection: L6

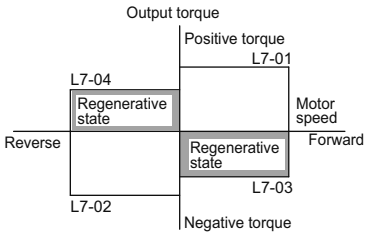
User constants for the overtorque/undertorque detection function are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
L6-01	Overtorque/ Undertorque detection operation selection 1 Torq Det 1 Sel	Sets the operation when overtorque or undertorque is detected. 0: Overtorque/undertorque detection disabled 1: Overtorque detection only with speed agreement, operation continues after detection (alarm). 2: Overtorque detected continuously during operation, operation continues after detection (alarm). 3: Overtorque detection only with speed agreement, output stopped upon detection (protected operation). 4: Overtorque detected continuously during operation, output stopped upon detection (protected operation). 5: Undertorque detection only with speed agreement, operation continues after detection (alarm). 6: Undertorque detected continuously during operation, operation continues after detection (alarm). 7: Undertorque detection only with speed agreement, output stopped upon detection (protected operation). 8: Undertorque detected continuously during operation, output stopped upon detection (protected operation). Output when Overtorque/ undertorque detection 1 NO or Overtorque/undertorque detection 1 NC is selected for the multi-function contact output.	0 to 8	0	No	A	A	550H	6-31
L6-02	Overtorque/ Undertorque detection level 1 Torq Det 1 Lvl	Sets the overtorque/undertorque detection level. Set the value as a percentage, taking the motor rated torque as 100%	0 to 300	150%	No	A	A	551H	6-32

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L6-03	Overtorque/ Undertorque detection time 1 Torq Det 1 Time	Sets the overtorque/undertorque detection time in seconds.	0.0 to 10.0	0.1 s	No	A	A	552H	6-32
L6-04	Overtorque/Undertorque detection operation selection 2 Torq Det 2 Sel	Sets the operation when overtorque or undertorque is detected. 0: Overtorque/undertorque detection disabled 1: Overtorque detection only with speed agreement, operation continues after detection (alarm). 2: Overtorque detected continuously during operation, operation continues after detection (alarm). 3: Overtorque detection only with speed agreement, output stopped upon detection (protected operation). 4: Overtorque detected continuously during operation, output stopped upon detection (protected operation). 5: Undertorque detection only with speed agreement, operation continues after detection (alarm). 6: Undertorque detected continuously during operation, operation continues after detection (alarm). 7: Undertorque detection only with speed agreement, output stopped upon detection (protected operation). 8: Undertorque detected continuously during operation, output stopped upon detection (protected operation). Output when Overtorque/ undertorque detection 2 NO or Overtorque/undertorque detection 2 NC is selected for the multi-function contact output.	0 to 8	0	No	A	A	553H	6-32
L6-05	Overtorque/Undertorque detection level 2 Torq Det 2 Lvl	Sets the overtorque/undertorque detection level. Set the value as a percentage, taking the motor rated torque as 100%.	0 to 300	150%	No	A	A	554H	6-32
L6-06	Overtorque/Undertorque detection time 2 Torq Det 2 Time	Sets the overtorque/undertorque detection time in seconds.	0.0 to 10.0	0.1 s	No	A	A	555H	6-32

■Torque Limits: L7

User constants for torque limits are shown in the following table.

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L7-01	Forward drive torque limit / Torq Limit Fwd	Sets the torque limit value as a percentage, taking the motor rated torque as 100%. Individual setting for four quadrants is possible. 	0 to 300	100%	No	A	A	560H	6-27
L7-02	Reverse drive torque limit / Torq Limit Rev		0 to 300	100%	No	A	A	561H	6-27
L7-03	Forward regenerative torque limit / Torq Lmt Fwd Rgn		0.0 to 100.0	0.5%	No	A	A	562H	6-27
L7-04	Reverse regenerative torque limit / Torq Lmt Rev Rgn		0.0 to 100.0	0.5%	No	A	A	563H	6-27

■Hardware Protection 1: L8

User constants for hardware protection1 functions are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L8-07	Output open-phase protection selection / Ph Loss Out Sel	Sets whether the output open-phase protection function is enabled or disabled. 0: Disabled 1: Enabled (Detect open phase in one phase only) 2: Enabled (Detect open phase in two or more phases) When applied motor capacity is small in relation to Inverter capacity, output open-phase may be detected inadvertently or open-phase may not be detected. In this case, set to 0.	0 to 2	2	No	A	A	576H	–
L8-08	Output open-phase detection level / Ph Loss Out Lvl	• When L8-07 = 1: Any of phases U, V and W, with output current > 5% and output frequency ≥1.0Hz • When L8-07 = 2: All phases U, V and W, with output frequency ≥ 1.0 Hz When the output current of the above mentioned phases is less than the value set in L8-08 for 500 ms or more, output open-phase is detected. An UP/DOWN counter is used to count 500 ms.	0.0 to 20.0	3.0%	No	A	A	577H	–
L8-14*	Inverter protection function selection / Inverter OL Sel	Enables or disables the Inverter protection function by using an electronic thermal relay. Do not change from the factory setting. 0: Disabled 1: Enabled	0 or 1	0	No	A	A	57DH	6-61
L8-19	Soft CLA selection / Soft CLA Sel	Sets whether the software CLA (software current limit) is enabled or disabled. 0: Disabled (Gain is set to 0) 1: Enabled	0 or 1	1	No	A	A	582H	–

* This setting is applicable for FSDrive-MV1S with software version S0107 or later.

■Hardware Protection 2: L9

User constants for hardware protection 2 functions are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L9-01[*1]	Main circuit power supply voltage setting / Main Input Volt	Sets the main circuit power supply voltage (transformer primary side). This setting is used as a reference value in protection functions.	2500 to 3800[*3]	3300 V[*4]	No	A	A	5A0H	4-7 7-3
L9-02[*2]	Selection of operation when input overvoltage is detected / IOV Select	Selects the operation when input overvoltage (IOV) is detected. 0: Detection disabled 1: Coast to stop [fault detection (major fault)] 2: Continue operation [alarm detection (minor fault)]	0 to 2	1	No	A	A	5A1H	–
L9-03[*2]	Input overvoltage detection time / IOV Time	Sets the time before detecting the input overvoltage (IOV) in 0.01-seconds units. The input overvoltage (IOV) is detected when the main circuit power supply voltage exceeds 120%, taking the main circuit input voltage (L9-01) as 100%, for the time set for L9-03.	0.00 to 2.00	0.05 s	No	A	A	5A2H	–
L9-06	Output overvoltage detection level / OUTPUT OV Lvl	Set the output overvoltage (OOV) detection level in 0.1% units, taking the maximum motor voltage (E1-05) as 100%.	110.0 to 200.0	120%	No	A	A	5A5H	–
L9-07	Output overvoltage detection time / OV Time	Sets the time before detecting the output overvoltage (OOV) in 0.01-seconds units. The output overvoltage (OOV) is detected when the output voltage exceeds the value set for L9-06 for the time set for L9-07.	0 to 10.00	1.00s	No	A	A	5A6H	–
L9-14	Control power supply fault detection (major fault) selection / CUV Det Sel	Sets whether the control power supply fault (CUV) detection is enabled or disabled. 0: Disabled 1: Enabled	0 or 1	0	No	A	A	5ADH	–
L9-20	Selection of operation when ground fault is detected on output side / OGF Select	Selects the operation when an output ground fault (OGF) is detected by the output zero-phase voltage detection function. 0: Detection disabled 1: Coast to stop [fault detection (major fault)] 2: Continue operation [alarm detection (minor fault)]	0 to 2	1	No	A	A	5B3H	–

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
L9-21	Output ground fault detection level / Output OGF Lvl	Sets the output ground fault (OGF) detection level in output zero-phase voltage detection in units of 0.1%, taking the voltage class as 100%. (Voltage class, 3-kV class: 3300V, 6-kV class: 6600V)	0.0 to 100.0	5.0%	No	A	A	5B4H	–
L9-22	Output ground fault detection time / OGF Time	Sets the output ground fault (OGF) detection time in output zero-phase voltage detection in units of 0.001 seconds. The output ground fault (OGF) is detected when the output zero-phase voltage detection value exceeds the level set in L9-21 for the time set in L9-22 or longer.	0.001 to 2.000	0.200 s	No	A	A	5B5H	–

* 1. This setting is applicable for FSDrive-MV1S with software version S0108 or later.

* 2. This setting is applicable for FSDrive-MV1S with software version S0104 or later.

* 3. The setting range depends on the transformer primary side input voltage (Y1-26) setting. (This setting is applicable for FSDrive-MV1S with software version S0108 or later.)

* 4. The factory setting depends on the Inverter capacity.

◆ Special Adjustments: N

The following settings are made with the special adjustments constants (N constants): Speed feedback detection, synchronous transfer with commercial power supply, and factory setting 1.

■Speed Feedback Detection Control (AFR): n2

User constants for speed feedback detection control functions are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
n2-01	Speed feedback detection control (AFR) gain AFR Gain	Sets the gain for internal speed feedback detection control as a multiplying factor. Usually, this setting is not necessary. Adjust this constant as follows: • If hunting occurs, increase the set value. • If response is low, decrease the set value. Adjust the setting by 0.05 at a time, while checking the response.	0.00 to 10.00	2.00	No	A	No	5D0H	6-26
n2-02	Speed feedback detection control (AFR) time constant AFR Time	Sets the time constant to decide the rate of change in the speed feedback detection control (AFR).	0 to 2000	250 ms	No	A	No	5D1H	6-26
n2-03	Speed feedback detection control (AFR) time constant 2 AFR Time 2	Sets the time constant to decide the rate of change in the speed feedback detection control (AFR). Increase the setting if an overvoltage (OV) fault occurs at the completion of acceleration or when the load changes radically.	0 to 2000	750 ms	No	A	No	5D2H	6-26
n2-05	Starting gain for speed feedback detection control (AFR) gain change AFR G of Start	Sets the gain to the AFR gain at 0 Hz. The hunting by AFR is controlled at the time of a low speed (0-12 Hz).	0.00 to 2.00	0.20	No	A	No	5D4H	6-26

■Synchronous Transfer with Commercial Power Supply: n6

User constants for synchronous transfer with commercial power supply are shown in the following table.
These constants are applicable for Inverters with software version S0108 or later.

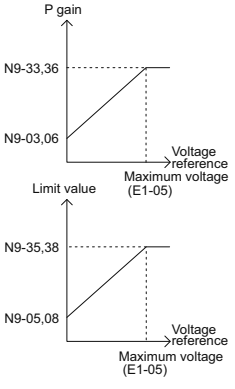
Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
n6-01	Synchronous transfer mode / SyncTransferMODE	Sets whether the synchronous transfer with commercial power supply is enabled or disabled. 0: Disabled 1: Enabled	0 or 1	0	No	A	No	630H	6-78
n6-02	Amplitude synchronous P gain / Vamp Sync P Gain	Sets the proportional gain used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage.	0.00 to 1.00	0.04	No	A	No	631H	6-78
n6-03	Amplitude synchronous I gain / Vamp Sync I Time	Sets the integral time used in the control to synchronize the amplitudes of commercial power supply voltage and Inverter output voltage in milliseconds.	0 to 1000	20 ms	No	A	No	632H	6-78
n6-04	Amplitude synchronous primary delay time constant / Vamp Sync Filter	Sets the primary delay filter time constant used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage in seconds.	0.000 to 1.000	0.200 s	No	A	No	633H	6-78
n6-05	Amplitude synchronous output limit / Vamp Sync Limit	Sets the output limit used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage as a percentage, taking the voltage class as 100%.	0 to 20	10%	No	A	No	634H	6-78
n6-06	Amplitude synchronous detection bias / Vamp bias	Sets the bias for the commercial power supply voltage amplitude detection value as a percentage, taking the voltage class as 100%.	-100.0 to 100.0	0.0%	No	A	No	635H	6-78
n6-07	Amplitude synchronous level / Vamp Sync Level	Sets the amplitude synchronous judgment level of the commercial power supply voltage and Inverter output voltage as a percentage, taking the voltage class as 100%	0.0 to 10.0	3.0%	No	A	No	636H	6-78
n6-09	Phase synchronous P gain / Phase Sync Pgain	Sets the proportional gain used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage.	0.0000 to 0.1000	0.0033	No	A	No	638H	6-78
n6-10	Phase synchronous I time / PhaseSync I Time	Sets the integral time used in the control to synchronize the phases of commercial power voltage and Inverter output voltage in microseconds.	0 to 9999	0 ms	No	A	No	639H	6-78

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
n6-11	Phase synchronous primary delay time constant / PhaseSyncFilter	Sets the primary delay filter time constant used in the control to synchronize the phases of commercial power voltage and Inverter output voltage in seconds.	0.000 to 1.000	0.100 s	No	A	No	63AH	6-79
n6-12	Phase synchronous output upper limit / Phase Sync U-Lim	Sets the upper output limit used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage as a percentage, taking the maximum frequency (E1-04) as 100%.	0 to 20	5%	No	A	No	63BH	6-79
n6-13	Phase synchronous output lower limit / Phase Sync L-Lim	Sets the lower output limit used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage as a percentage, taking the maximum frequency (E1-04) as 100%.	-20 to 0	-5%	No	A	No	63CH	6-79
n6-14	Power supply phase detection bias / Phase bias	Sets the bias for the commercial power supply voltage phase detection value in units of degrees.	-180.0 to 180.0	0.0 deg	No	A	No	63DH	6-79
n6-15	Phase synchronous level / Phase Sync Level	Sets the judgment level of the phase synchronization of the commercial power supply voltage and Inverter output voltage in units of degrees.	0.0 to 30.0	3.0 deg	No	A	No	63EH	6-79
n6-26	Power supply synchronous time limit / Sync limit Time	Sets the time limit for the synchronous processing for the commercial power supply in seconds. If the power supply is not synchronized within the set time limit, a fault will be detected and the operation will be stopped.	10.0 to 6000.0	15.0 s	No	A	No	649H	6-79

■Factory Setting 1: n9

User constants for factory setting 1 are shown in the following table.

(Software version: S0110 or later)

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Reference Page
n9-03	q axis current control (ACR) gain ACR q Gain	Sets the P gain for the ACR (PI control) of the q axis. If a value satisfying n9-33 > n9-03 is set, the P gain varies according to the voltage reference (refer to n9-33 to n9-38).	0.00 to 2.00	0.10*	No	A	A	692H	–
n9-04	q axis current control (ACR) integral time ACR q I Time	Sets the integral time for the ACR (PI control) of the q axis.	0.0 to 100.0	0.0*	No	A	A	693H	–
n9-05	q axis current control (ACR) limit ACR q Limit	Sets the limit value for the ACR (PI control) of the q axis. If a value satisfying n9-35 > n9-05 is set, the limit value varies according to the voltage reference (refer to n9-33 to n9-38).	0 to 150	5*	No	A	A	694H	–
n9-06	d axis current control (ACR) gain ACR d Gain	Sets the P gain for the ACR (PI control) of the d axis. If a value satisfying n9-36 > n9-06 is set, the P gain varies according to the voltage reference (refer to n9-33 to n9-38).	0.00 to 2.00	0.30*	No	A	A	695H	–
n9-07	d axis current control (ACR) integral time ACR d I Time	Sets the integral time for the ACR (PI control) of the d axis.	0.0 to 100.0	0.0*	No	A	A	696H	–
n9-08	d axis current control (ACR) limit ACR d Limit	Sets the limit value for the ACR (PI control) of the d axis. If a value satisfying n9-38 > n9-08 is set, the limit value varies according to the voltage reference (refer to n9-33 to n9-38).	0 to 150	5*	No	A	A	697H	–
n9-33	q axis current control (ACR) gain 2 ACR q Gain 2	Sets the P gain and limit value for the ACR (PI control) when the voltage reference equals the maximum voltage. The P gain and limit value vary according to the voltage reference as shown in the diagram. 	0.00 to 2.00	0.10*	No	A	A	6B0H	–
n9-35	q axis current control (ACR) limit 2 ACR q Limit 2		0 to 150	5*	No	A	A	6B2H	–
n9-36	d axis current control (ACR) gain 2 ACR d Gain 2		0.00 to 2.00	0.30*	No	A	A	6B3H	–
n9-38	d axis current control (ACR) limit 2 ACR d Limit 2		0 to 150	5*	No	A	A	6B5H	–

* The factory setting will change when the control method is changed

◆ Digital Operator Constants: O

The following settings are made with the Digital Operator constants (o constants): Monitor select and multi-function selections.

■Monitor Select: o1

User constants for Digital Operator display are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
o1-05	LCD brightness adjustment LCD Contrast	Set a smaller value to brighten the LCD and a larger value to darken the LCD (standard: 10). Adjusts the brightness of the LCD of the Digital Operator 20: (LCD color deepened.) 10: Standard 0: (LCD color becomes paler.)	0 to 20	10	No	A	A	6E4H	–

■Operation (Key Function): o2

User constants for Digital Operator key functions are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
o2-01	LOCAL/ REMOTE key function selection Local/Remote Key	Sets the Digital Operator LOCAL/ REMOTE Key functions. 0: Disabled 1: Enabled (Switches between the operation using the Digital Operator and the operation set in the constants.)	0 or 1	1	No	A	A	6F0H	6-58
o2-02	STOP key function selection Oper STOP Key	Sets the STOP Key functions. 0: Disabled (When Run Commands are issued from a device other than the Digital Operator, the STOP Key is disabled.) 1: Enabled (The STOP Key is always effective during run.)	0 or 1	0	No	A	A	6F1H	6-58

<table>
<tr><th rowspan="2">Constant No.</th><th>Name</th><th rowspan="2">Description</th><th rowspan="2">Setting Range</th><th rowspan="2">Factory Setting</th><th rowspan="2">Change during Operation</th><th colspan="2">Control Methods</th><th rowspan="2">MEMOBUS Register</th><th rowspan="2">Reference Page</th></tr>
<tr><th>Digital Operator Display</th><th>Open-loop Vector</th><th>Flux Vector</th></tr>
<tr><td>o2-04</td><td>kVA selection

kVA selection</td><td>Usually it is not necessary to change the factory setting.
This setting is not initialized in the initialization process.
<table>
<tr><th>Code</th><th>Rated Voltage V</th><th>Nominal Capacity kVA</th><th>Max. Applicable Motor Capacity kW</th><th>Rated Current A</th></tr>
<tr><td>60</td><td>3300</td><td>200</td><td>132</td><td>35</td></tr>
<tr><td>61</td><td>3300</td><td>285</td><td>200</td><td>50</td></tr>
<tr><td>62</td><td>3300</td><td>400</td><td>315</td><td>70</td></tr>
<tr><td>63</td><td>3300</td><td>570</td><td>450</td><td>100</td></tr>
<tr><td>64</td><td>3300</td><td>800</td><td>630</td><td>140</td></tr>
<tr><td>65</td><td>3300</td><td>1150</td><td>900</td><td>200</td></tr>
<tr><td>66</td><td>3300</td><td>1500</td><td>1250</td><td>260</td></tr>
<tr><td>67</td><td>3300</td><td>2300</td><td>1800</td><td>400</td></tr>
<tr><td>68</td><td>3300</td><td>3000</td><td>2500</td><td>520</td></tr>
<tr><td>69</td><td>3300</td><td>1900</td><td>1500</td><td>330</td></tr>
<tr><td>70</td><td>6600</td><td>400</td><td>250</td><td>35</td></tr>
<tr><td>71</td><td>6600</td><td>570</td><td>400</td><td>50</td></tr>
<tr><td>72</td><td>6600</td><td>800</td><td>630</td><td>70</td></tr>
<tr><td>72</td><td>6600</td><td>1150</td><td>900</td><td>100</td></tr>
<tr><td>74</td><td>6600</td><td>1600</td><td>1250</td><td>140</td></tr>
<tr><td>75</td><td>6600</td><td>2300</td><td>1800</td><td>200</td></tr>
<tr><td>76</td><td>6600</td><td>3000</td><td>2500</td><td>260</td></tr>
<tr><td>77</td><td>6600</td><td>4600</td><td>3550</td><td>400</td></tr>
<tr><td>78</td><td>6600</td><td>6000</td><td>5000</td><td>520</td></tr>
<tr><td>79</td><td>6600</td><td>3800</td><td>3000</td><td>330</td></tr>
<tr><td>7A</td><td>6600</td><td>5300</td><td>4300</td><td>460</td></tr>
</table></td><td>60 to FF</td><td>64</td><td>No</td><td>A</td><td>A</td><td>6F3H</td><td>–</td></tr>
<tr><td>o2-05</td><td>Speed (frequency) reference setting

Operator M.O.P.</td><td>Sets whether the Enter Key is necessary when the speed (frequency) reference is set on the Digital Operator speed (frequency) reference monitor.
0: Enter Key necessary
1: Enter Key not necessary
When set to 1, the Inverter accepts the speed (frequency) reference without pressing the Enter Key.</td><td>0 or 1</td><td>0</td><td>No</td><td>A</td><td>A</td><td>6F4H</td><td>6-58</td></tr>
<tr><td>o2-06</td><td>Selection of operation when Digital Operator is disconnected

Oper Detection</td><td>Sets the operation when the Digital Operator is disconnected.
0: Disabled (Operation continues even if the Digital Operator is disconnected.)
1: Enabled (OPR is detected at Digital Operator disconnection. Inverter output will be stopped, and fault contact will be operated.)</td><td>0 or 1</td><td>0</td><td>No</td><td>A</td><td>A</td><td>6F5H</td><td>–</td></tr>
<tr><td>o2-07</td><td>Cumulative operation time setting

Elapsed Time Set</td><td>Sets the initial value of the cumulative operation time (U1-13) in units of hours.
Operation time is accumulated starting from the set value.</td><td>0 to 65535</td><td>0 hr</td><td>No</td><td>A</td><td>A</td><td>6F6H</td><td>6-58</td></tr>
<tr><td>o2-08</td><td>Cumulative operation time selection

Elapsed Time Run</td><td>Sets the time to be counted for cumulative operation time (U1-13).
0: Cumulative power on time (The time from turning on the Inverter power till turning it off is accumulated.)
1: Cumulative run time (The time that the Inverter issues outputs is accumulated.)</td><td>0 or 1</td><td>0</td><td>No</td><td>A</td><td>A</td><td>6F7H</td><td>–</td></tr>
</table>

◆ Factory Setting Constants: Y

The following settings are made with the factory constants (Y constants): hardware adjustment.

■Factory Setting 2: Y1

User constants for factory setting 2 are shown in the following table.

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register	Reference Page
Y1-22	Input voltage detection gain Input V Gain	Sets the gain for adjustment of input voltage detection value (Operated in inverse proportion)	0 to 10.000	5.389	No	A	A	785H	–
Y1-23	Input current detection gain Input I Gain	Sets the gain for adjustment of input current detection value (Operated in inverse proportion)	0 to 15.000	6.600*1	No	A	A	786H	–
Y1-24	Output voltage detection gain Output V Gain	Sets the gain for adjustment of output voltage detection value (Operated in inverse proportion)	0 to 10.000	5.389	No	A	A	787H	–
Y1-25	Output current detection gain Output I Gain	Sets the gain for adjustment of output current detection value (Operated in inverse proportion)	0 to 10.000	8.712*1	No	A	A	788H	–
Y1-26*3	Transformer primary side input voltage Input V of Trans	Sets the transformer primary side rated voltage. Be sure to set this constant if the transformer primary side rated voltage and the Inverter rated output voltage are different.	2700 to 12100*2	3300 V*2	No	A	A	789H	4-7
Y1-27*4	Output voltage neutral point selection Neutral Select	Sets the Power Cell terminal that is connected to the neutral point of the output voltage. 0: T1 1: T2	0 or 1	1*1	No	A	A	78AH	–

* 1. The factory settings depend on the Inverter capacity.
* 2. The factory settings and setting range depend on the Inverter capacity.
* 3. This setting is applicable for FSDrive-MV1S with software version S0108 or later.
* 4. This setting is applicable for FSDrive-MV1S with software version S0110 or later.

◆ Motor Autotuning Constants: T

The following settings are made with the motor autotuning constants (T constants): Settings for autotuning of the motors.

■Autotuning: T1

User constants for autotuning are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Data Displays during Autotuning: Open-loop Vector	Data Displays during Autotuning: Flux Vector	MEMOBUS Register	Reference Page
T1-01	Autotuning mode / Tuning Mode Sel	Sets the autotuning mode. 0: Rotational autotuning 1: Stationary autotuning for line-to-line resistance only	0 or 2	0	No	Yes	Yes	720H	4-10
T1-03	Motor rated voltage / Rated Voltage	Sets the voltage equivalent to the rated speed of no-load operation. (The rated voltage on the nameplate may be set, however, sufficient characteristics cannot be obtained.)	0 to 8000	E1-13 V	No	Yes	Yes	722H	4-10
T1-04	Motor rated current / Rated Current	Set the rated current on the nameplate of the motor in amperes.	0.1 to 1500.0	E2-01 A	No	Yes	Yes	723H	4-10
T1-05	Motor base frequency / Rated Frequency	Set the base frequency on the nameplate of the motor in hertz. (Frequency without load)	0.00 to 400.00	E1-06 Hz	No	Yes	Yes	724H	4-10
T1-06	Number of motor poles / Number of Poles	Set the number of motor poles on the nameplate of the motor.	2 to 48	E2-04	No	Yes	Yes	725H	4-10
T1-07	Motor base speed / Rated Speed	Set the base speed on the nameplate of the motor in min^{-1}. (Rated speed with rated load)	0 to 12000	Calculated value min^{-1}	No	Yes	Yes	726H	4-10
T1-08	Number of PG pulses when autotuning / PG Pulses/Rev	Sets the number of PG (pulse generator or encoder) pulses. Sets the number of pulses per motor revolution without multiplying.	0 to 8192	H7-01	No	No	Yes	727H	4-10
T1-10	Motor insulation class / Insulation class	Set the motor insulation class on the nameplate. 0: Insulation class A (100°C) 1: Insulation class E (120°C) 2: Insulation class B (130°C) 3: Insulation class F (155°C) 4: Insulation class H (180°C)	0 to 4	1	No	Yes	Yes	729H	4-10

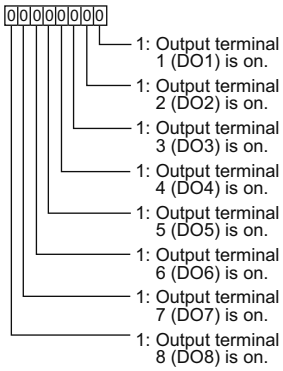
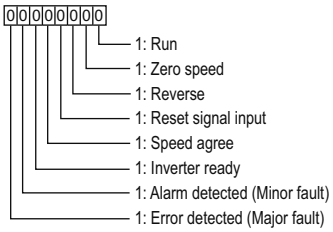
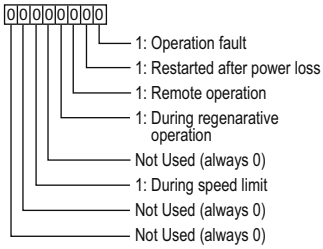
◆ Monitor Constants: U

The following settings are made with the monitor constants (U constants): Setting constants for monitoring in drive mode.

■ Status Monitor: U1

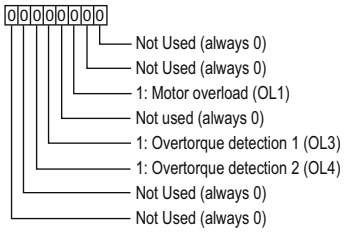
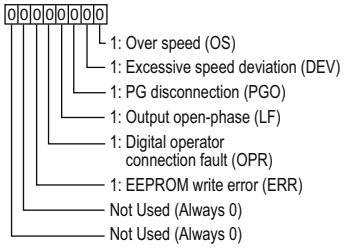
User constants for monitoring status are shown in the following table.

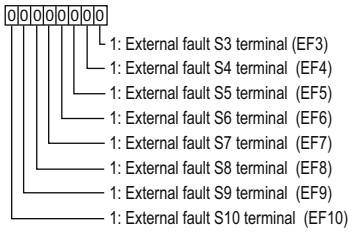
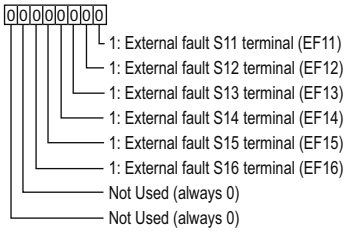
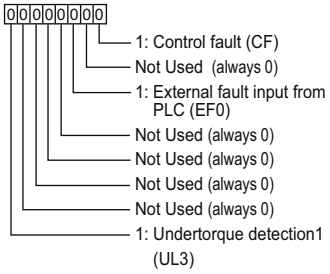
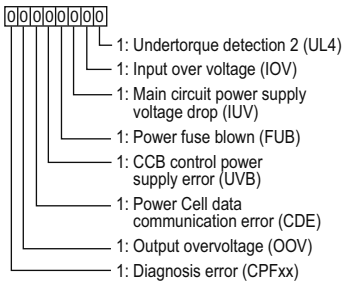
Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U1-01	Speed (frequency) reference / Frequency Ref	Monitors/sets the speed (frequency) reference value.	Max. frequency (E1-04)	0.01%	A	A	40H
U1-02	Output frequency / Output Freq	Monitors the output frequency.	Max. frequency	0.01 Hz	A	A	41H
U1-03	Output current / Output Current	Monitors the output current.	Inverter rated output current	0.1 A	A	A	42H
U1-04	Control method / Control Method	Monitors the current control method.	–	–	A	A	43H
U1-05	Motor speed / Motor Speed	Monitors the detected motor speed.	Max. frequency (E1-04)	0.01%	A	A	44H
U1-06	Output voltage reference / Output Voltage	Monitors the output voltage reference value in the Inverter.	Voltage class 3300 VAC (6600 VAC)	1 V	A	A	45H
U1-08	Output power / Output kWatts	Monitors the output power (internally detected value).	Inverter capacity (max. applicable motor capacity) kW	1 kW	A	A	47H
U1-09	Torque reference (internal) / Torque Reference	Monitors the internal torque reference value.	Motor rated torque	0.1%	A	A	48H
U1-10	Input terminal status (1-8) / Input Sts (1-8)	Monitors the on/off state of the input terminal (1-8). 0 0 0 0 0 0 0 0 1: Input terminal 1 is on. 1: Input terminal 2 is on. 1: Input terminal 3 is on. 1: Input terminal 4 is on. 1: Input terminal 5 is on. 1: Input terminal 6 is on. 1: Input terminal 7 is on. 1: Input terminal 8 is on.	–	–	A	A	49H

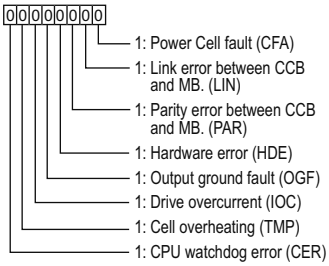
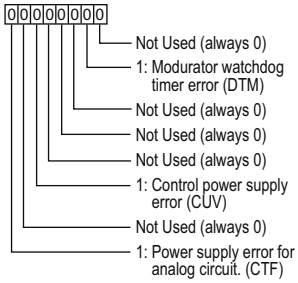
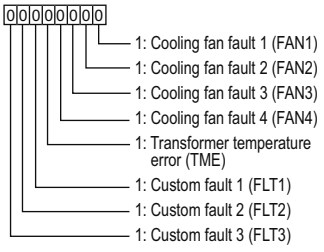
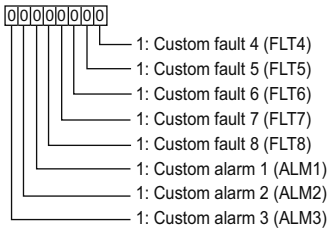
Constant No.	Name Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
U1-11	Output terminal status (1-8) Output Term Sts	Monitors the on/off state of the output terminal (1-8). 	–	–	A	A	4AH
U1-12	Inverter operating status Int Ctl Sts	Monitors the inverter operating status. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status 	–	–	A	A	4BH
U1-13	Cumulative operation time Elapsed Time	Monitors the total operating time of the Inverter.	–	1H	A	A	4CH
U1-14	Software No. (CPU) CPU Rev.	(For manufacturer's management purposes)	–	–	A	A	4DH
U1-15	Terminal AI1 input voltage AI1 Input	Monitors the input voltage of the multi-function analog input 1 [speed (frequency) reference].	10 V	0.01%	A	A	4EH
U1-16	Terminal AI2 input voltage AI2 Input	Monitors the input voltage of the multi-function analog input 2.	10 V	0.01%	A	A	4FH

Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U1-17	Terminal AI3 input voltage / AI3 Input	Monitors the input voltage of the multi-function analog input 3.	10 V	0.01%	A	A	50H
U1-18	Motor secondary current (Iq) / Mot SEC Current	Monitors the calculated value of the motor secondary current.	Motor rated secondary current	0.1%	A	A	51H
U1-19	Motor excitation current (Id) / Mot EXC Current	Monitors the calculated value of the motor excitation current.	Motor rated secondary current	0.1%	A	A	52H
U1-20	Output frequency after soft-start / SFS Output	Monitors the output frequency after a soft start. The frequency given does not include compensations, such as slip compensation.	Max. frequency	0.01%	A	A	53H
U1-21	ASR input (speed deviation) / ASR Input	Monitors the input to the speed control loop.	Max. frequency	0.01%	No	A	54H
U1-22	ASR output / ASR Output	Monitors the output from the speed control loop.	Motor rated secondary current	0.01%	No	A	55H
U1-23	ASR integral output / ASR Integral	Monitors the integral value from the speed control loop.	Motor rated secondary current	0.01%	No	A	56H
U1-25	Terminal AI4 input voltage / AI4 Input	Monitors the input voltage of the multi-function analog input 4.	10 V	0.01%	A	A	58H
U1-26	Output voltage reference (Vq) / Voltage Ref (Vq)	Monitors the Inverter internal voltage reference for motor secondary current control.	Voltage class 3300 VAC (6600 VAC)	1 V	A	A	59H
U1-27	Output voltage reference (Vd) / Voltage Ref (Vd)	Monitors the Inverter internal voltage reference for motor excitation current control.	Voltage class 3300 VAC (6600 VAC)	1 V	A	A	5AH
U1-28	Software No. (FPGA) / FPGA Rev.	(For manufacturer's management purposes)	–	–	A	A	5BH
U1-32	Current control output of q axis / ACR(q) Output	Monitors the current control output value for the motor secondary current.	Voltage class 3300 VAC (6600 VAC)	0.1%	A	A	5FH
U1-33	Current control output of d axis / ACR(d) Output	Monitors the current control output value for the motor excitation current.	Voltage class 3300 VAC (6600 VAC)	0.1%	A	A	60H
U1-34	OPE fault constant / OPE Detected	Monitors the first constant number where an operation (OPE) fault was detected.	–	–	A	A	61H

Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U1-41	Fin temperature / Actual Fin Temp	Monitors the temperature of the fin in the Inverter (Power Cell: A1). (Approximate temperature above 80°C is displayed)	–	1°C	A	A	68H
U1-42	Shows input terminal status. (9-16) / Input Sts (9-16)	Monitors on/off status of the input terminal (9-16). 0 0 0 0 0 0 0 0 1: Input terminal 9 is on. 1: Input terminal 10 is on. 1: Input terminal 11 is on. 1: Input terminal 12 is on. 1: Input terminal 13 is on. 1: Input terminal 14 is on. 1: Input terminal 15 is on. 1: Input terminal 16 is on.	–	–	A	A	69H
U1-43	Input terminal status (17-20) / Input Sts (17-20)	Monitors on/off status of the input terminal (17-20). 0 0 0 0 0 0 0 0 1: Input terminal 17 is on. 1: Input terminal 18 is on. 1: Input terminal 19 is on. 1: Input terminal 20 is on. Not Used (always 0) Not Used (always 0) Not Used (always 0) Not Used (always 0)	–	–	A	A	6AH
U1-46	Superior command 1 / Superior Cmd 1	Monitors the lower byte of the operation signal from the PLC.	–	–	A	A	6DH
U1-47	Superior command 2 / Superior Cmd 2	Monitors the upper byte of the operation signal from the PLC.	–	–	A	A	6EH
U1-48	External torque reference / Torque Reference	Monitors the external torque reference.	Motor rated torque	0.01%	A	A	6FH
U1-49	Output zero-phase voltage / Output Zero V	Monitors the detected output zero-phase voltage value on the output side.	Voltage class	1 V	A	A	70H
U1-51	Torque compensation / Input T-Cmp	Monitors the torque compensation.	Motor rated torque	0.01%	No	A	72H
U1-52	Slip frequency reference / Slip Reference	Monitors the slip frequency reference.	Motor rated slip	0.01%	A	A	73H
U1-53	Magnetic flux reference / Mag-flux Ref.	Monitors the magnetic flux reference.	Motor no-load current	0.01%	A	A	74H

Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U1-54	Voltage drop at momentary power loss / Power Descent	Not used.	–	0.01%	A	A	75H
U1-55	Motor temperature / Motor Temp.	Not used.	–	1°C	A	A	76H
U1-64	Current reference of q axis / Iq Reference	Monitors the Inverter internal voltage reference of q axis for motor secondary current control.	Motor rated current	0.1%	A	A	7FH
U1-65	Current reference of d axis / Id Reference	Monitors the Inverter internal voltage reference of d axis for motor excitation current control.	Motor rated current	0.1%	A	A	80H
U1-71	Speed detection PG counter value / PG Counter Value	Monitors the pulse counter from PG.	65536	Pulse	No	A	86H
U1-77	Output current average / Output I Average	Monitors the average of the output current integrated values. (Accumulation time: 40 minutes)	Inverter rated current	0.1 A	A	A	8CH
U1-78	Output voltage / Output Voltage	Monitors the detected output voltage.	Voltage class 3300 VAC (6600 VAC)	1 V	A	A	8DH
U1-80	Error status 1 / Error Sts 1	Monitors Inverter error status 1. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status 	–	–	A	A	8FH

Constant No.	Name Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
U1-81	Error status 2 Error Sts 2	Monitors Inverter error status 2. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status  	–	–	A	A	90H
U1-82	Error status 3 Error Sts 3	Monitors Inverter error status 3. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status  	–	–	A	A	91H

Constant No.	Name Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
U1-83	Error status 4 Error Sts 4	Monitors Inverter error status 4. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status  	–	–	A	A	92H
U1-84	Error status 5 Error Sts 5	Monitors Inverter error status 5. Low/High register is changed by the DATA/ENTER Key on the Digital Operator. Lower register (L) status  High register (H) status  	–	–	A	A	93H
U1-86	AO1 output value AO1 output value	Monitors the AO1 output value. -10 V to 10 V: -32768 to 32767	32767	–	A	A	95H

Constant No.	Name Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
U1-87	AO2 output value AO2 Output	Monitors the AO2 output value. -10 V to 10 V: -32768 to 32767	32767	–	A	A	96H
U1-88	AO3 output value AO3 Output	Monitors the AO3 output value. -10 V to 10 V: -32768 to 32767	32767	–	A	A	97H
U1-89	AO4 output value AO4 Output	Monitors the AO4 output value. -10 V to 10 V: -32768 to 32767	32767	–	A	A	98H
U1-90	Input voltage Power Voltage	Monitors the detected input voltage.	Main circuit input voltage	1 V	A	A	99H
U1-94	Input current Power Current	Not used.	–	0.1 A	A	A	9DH
U1-95	Primary current reference Primary Cur Ref.	Monitors the primary current reference.	Motor rated current	0.1 A	A	A	9EH

■Fault Trace: U2

User constants for fault tracing are shown in the following table.

Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U2-01	Current fault / Current Fault	Monitors the details of the current fault. It is cleared by fault resetting.	–	Error Code	A	A	–
U2-02	Previous fault / Last Fault	Monitors the details of the error that occurred just prior to the current fault. It is cleared by initialization.	–	Error Code	A	A	–
U2-03	Speed (frequency) reference at fault (U1-01) / Frequency Ref	Monitors the speed (frequency) reference at the occurrence of a fault. It is cleared by initialization.	Max. frequency	0.01%	A	A	–
U2-04	Output frequency at fault (U1-02) / Output Freq	Monitors the output frequency at the occurrence of a fault. It is cleared by initialization.	Max. frequency	0.01Hz	A	A	–
U2-05	Inverter output current at fault (U1-03) / Output Current	Monitors the Inverter output current at the occurrence of a fault. It is cleared by initialization.	Inverter rated output current	0.1 A	A	A	–
U2-06	Motor speed at fault (U1-05) / Motor Speed	Monitors the motor speed at the occurrence of a fault. It is cleared by initialization.	Max. frequency	0.01%	A	A	–
U2-07	Output voltage reference at fault (U1-06) / Output Voltage	Monitors the output voltage reference at the occurrence of a fault. It is cleared by initialization.	Voltage class 3300 VAC (6600 VAC)	1 V	A	A	–
U2-09	Output power at fault (U1-08) / Output kWatts	Monitors the output power supply at the occurrence of a fault. It is cleared by initialization.	Inverter capacity (max. applicable motor capacity) kW	0.1 kW	A	A	–
U2-10	Torque reference at fault (U1-09) / Torque Reference	Monitors the torque reference at the occurrence of a fault. It is cleared by initialization.	Motor rated torque	0.1%	A	A	–
U2-11	Input terminal status at fault (U1-10) / Input Term Sts	Monitors the state of the input terminals at the occurrence of a fault. It is cleared by initialization. The format is the same as for U1-10.	–	–	A	A	–
U2-12	Output terminal status at fault (U1-11) / Output Term Sts	Monitors the state of the output terminals at the occurrence of a fault. It is cleared by initialization. The format is the same as for U1-11.	–	–	A	A	–

Constant No.	Name: Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U2-13	Operation status at fault (U1-12_L) MxC Status	Monitors the operation status at the occurrence of a fault. It is cleared by initialization. The format is the same as for U1-12(L).	–	–	A	A	–
U2-14	Operation status 2 at fault (U1-12_H) MxC Status 2	Monitors the operation status 2 at the occurrence of a fault. It is cleared by initialization. The format is the same as for U1-12(H).	–	–	A	A	–
U2-15	Cumulative operation time at fault (U1-13) Elapsed time	Monitors the cumulative operation time at the occurrence of a fault. It is cleared by initialization.	–	1 hr	A	A	–
U2-18	Speed control (ASR) output at fault (U1-22) ASR Output	Monitors the speed controller (ASR) output at the occurrence of a fault. It is cleared by initialization.	Motor rated secondary current	0.01%	No	A	–
U2-19	External torque reference at fault (U1-48) Torque Reference	Monitors the external torque reference at the occurrence of a fault. It is cleared by initialization.	Motor rated torque	0.01%	A	A	–
U2-20	Torque compensation at fault (U1-51) Input T-Cmp	Monitors the torque compensation at the occurrence of a fault. It is cleared by initialization.	Motor rated torque	0.01%	No	A	–
U2-21	Magnetic flux reference at fault (U1-53) Mag-flux Ref	Monitors the magnetic flux reference at the occurrence of a fault. It is cleared by initialization.	Motor no-load current	0.01%	A	A	–

■Calendar: U4

User constants for monitoring calendar are shown in the following table.

Constant No.	Name: Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U4-01	Monitor Year Year	Monitors the calendar year. (Last two digits of the year)	–	–	A	A	–
U4-02	Monitor Month and Date Month/Date	Monitors the calendar month and day.	–	–	A	A	–

Constant No.	Name / Digital Operator Display	Description	100% Value	Digital Operator Display Unit	Control Methods		MEMOBUS Register
					Open-loop Vector	Flux Vector	
U4-03	Monitor Hour and Minute Hour/Minute	Monitors the calendar hour and minute.	–	–	A	A	–
U4-04	Monitor Minute and Second Minute/Second	Monitors the calendar minute and second.	–	–	A	A	–

6

Constant Settings by Function

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Speed (Frequency) Reference

This section describes how to input speed (frequency) references.

◆ Selecting the Speed (Frequency) Reference Source

Set constant b1-01 to select the speed (frequency) reference source.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b1-01	Speed (frequency) selection Reference Source	Sets the speed (frequency) reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A0H

■Inputting the Speed (Frequency) Reference from the Digital Operator

When b1-01 is set to 0, you can input the speed (frequency) reference from the Digital Operator.

Input the speed (frequency) reference from the speed (frequency) reference setting display on the Digital Operator.

For details on setting the speed (frequency) reference, refer to *Chapter 3 Digital Operator and Modes*.

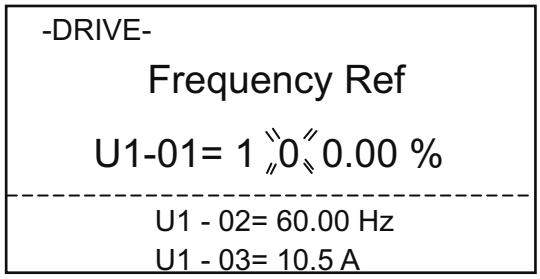


Fig 6.1 Speed (Frequency) Reference Setting Display

■Inputting the Speed (Frequency) Reference Using Control Circuit Terminal (Analog Setting)

When b1-01 is set to 1, you can input the speed (frequency) reference from control circuit terminal AI1.

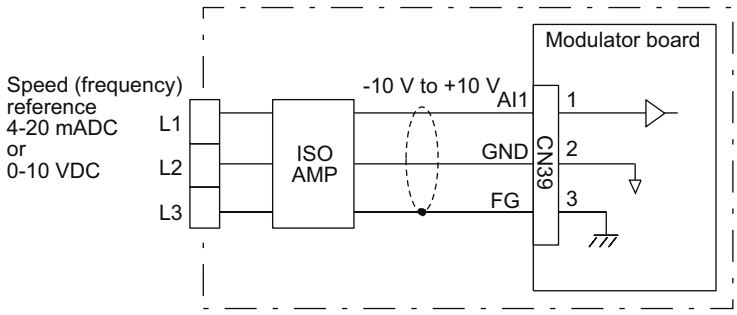


Fig 6.2 Input for Speed (Frequency) Reference

INFO

Isolation amplifier (ISO AMP) has two types of input, voltage input and current input. The standard Inverter is equipped with an ISO AMP accommodating current input (4-20 mADC). When changing the current input to voltage input, change the ISO AMP as well.

Run Command

This section describes input methods for Run Commands.

◆ Selecting the Run Command Source

Set constant b1-02 to select the source for Run Commands.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b1-02	Operation method selection Run Source	Sets the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A1H

■Performing Operations Using a Digital Operator

When b1-02 is set to 0, you can perform Inverter operations using the Digital Operator keys (RUN, STOP, JOG, and FWD/REV). For details on the Digital Operator, refer to *Chapter 3 Digital Operator and Modes*.

■Performing Operations Using Control Circuit Terminals

When b1-02 is set to 1, you can perform Inverter operations using the control circuit terminals.

Stopping Methods

This section describes methods of stopping the Inverter.

◆ Selecting the Stopping Method when a Stop Command is Sent

There are two methods of stopping the Inverter when a Stop Command is sent:

- Deceleration to stop
- Coast to stop

Set constant b1-03 to select the Inverter stopping method.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b1-03	Stopping method selection Stopping Method	Sets the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop	0 or 1	1	No	Q	Q	1A2H
b1-05	Operation selection for setting E1-09 or less Zero-Speed Oper	Sets the method of operation when the speed (frequency) reference input is less than the minimum output frequency (E1-09). 0: Run at speed (frequency) reference (E1-09 not effective). 1: Stop output [speeds (Frequencies) below E1-09 in the coast to stop state.] 2: Run at min. frequency (E1-09). (Output frequency set in E1-09) 3: Run at zero-speed [Speeds (frequencies) below E1-09 are zero]	0 to 3	1*	No	No	A	1A4H
b2-01	Zero-speed level (DC injection braking starting frequency) DCInj Start Freq	Sets the frequency which starts DC injection braking as a percentage when deceleration to stop is selected. When b2-01 is less than E1-09, E1-09 becomes the DC injection braking starting frequency. (In the flux vector control, zero-speed control starts from the value set in b2-01.)	0.00 to 10.00	0.50%*	No	A	A	1B0H
b2-02	DC injection braking current DCInj Current	Sets the DC injection braking current as a percentage, taking the motor rated current as 100%. In the flux vector control, DC excitation current depends on the value set in E2-03.	0 to 100	50%	No	A	No	1B1H

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b2-03	DC injection braking (pre-excitation) time at start DCInj Time @ Start	Sets the time to perform DC injection braking on starting in seconds. Used to stop a coasting motor and restart it. When the set value is 0.00, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	1B2H
b2-04	DC injection braking (pre-excitation) time at stop DCInj Time @ Stop	Sets the time to perform DC injection braking on stopping in seconds. Used to prevent coasting after the Stop Command is input. When the set value is 0.00, DC injection braking at stop is not performed.	0.00 to 10.00	0.50 s	No	A	A	1B3H

* The factory setting will change when the control method is changed.

■Deceleration to Stop

If b1-03 is set to 0, the motor decelerates to a stop according to the deceleration time set in C1-02 (Deceleration time 1). (Factory setting)

If the output frequency when decelerating to a stop falls below b2-01, the DC injection brake will be applied using the DC current set in b2-02 only for the time set in b2-04.

For deceleration time settings, refer to page 6-10 *Setting Acceleration and Deceleration Times*.

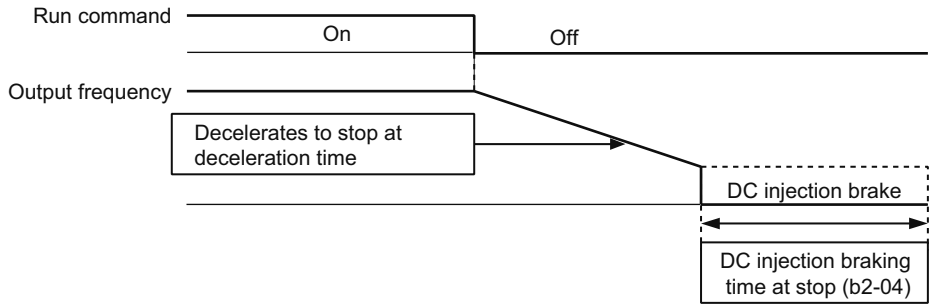


Fig 6.3 Deceleration to Stop

The operation after stopping depends on the setting of b1-05 when flux vector control is selected (A1-02 = 3).

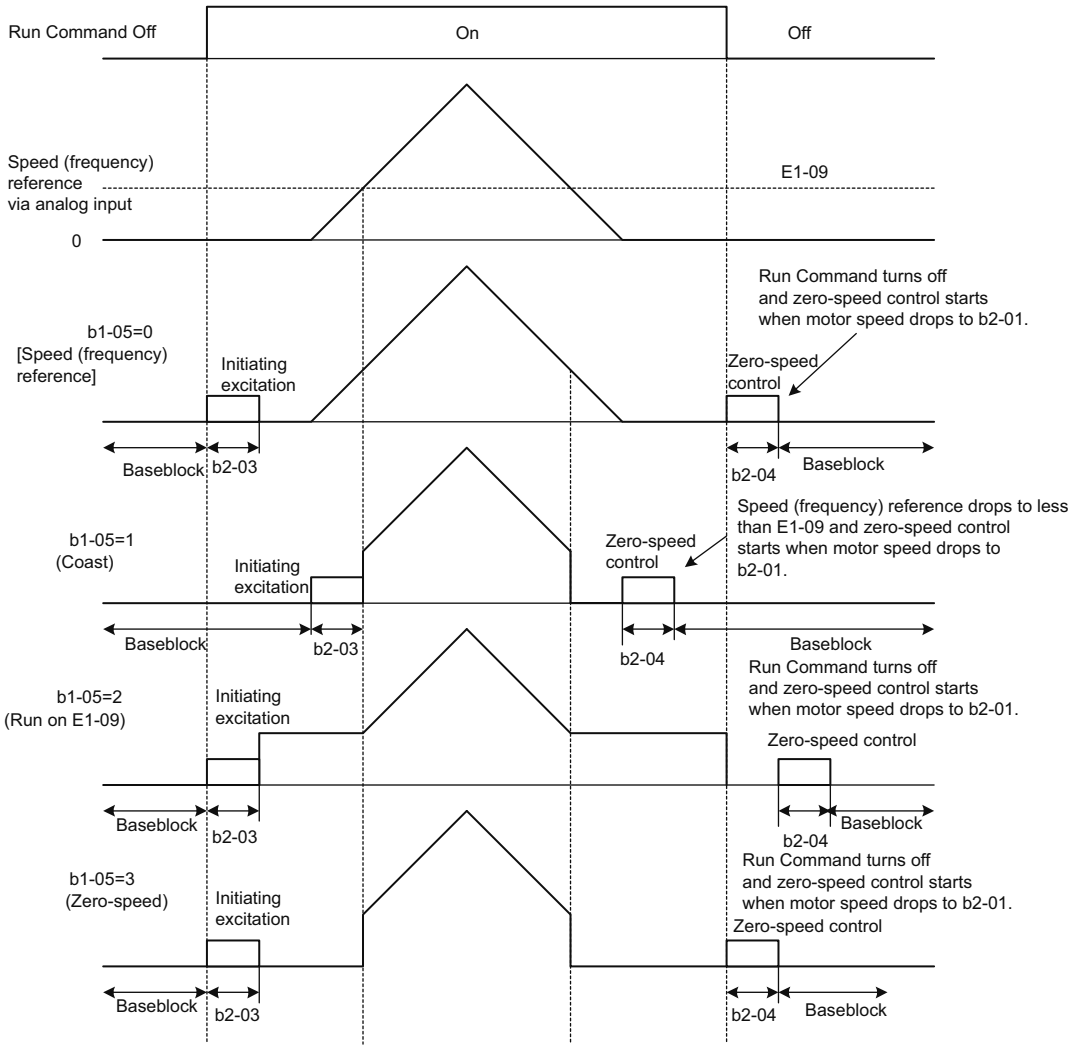


Fig 6.4 Deceleration to Stop (for Flux Vector Control)

Setting Precautions

- When using flux vector control, zero-speed control starts when the motor speed drops to b2-01 during deceleration. Also, the setting b2-01 < E1-09 is possible.
- When using flux vector control, the current level of the pre-excitation is the value set for E2-03 (Motor no-load current). Accordingly, b2-02 is invalid.

■Coast to Stop

If the Stop Command is input (the Run Command is turned off) when b1-03 is set to 1, the Inverter output voltage is stopped. The motor coasts to a stop at the deceleration rate corresponding to the inertia including the load and the mechanical loss.

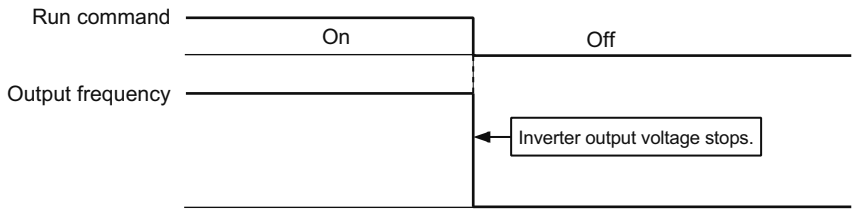


Fig 6.5 Coast to Stop

INFO

After the Stop Command is input, Run Commands are ignored until the min. baseblock time (L2-03) has elapsed.

◆ Using the DC Injection Brake at Start

Set constant b2-03 to apply the DC injection braking current to the motor while it is coasting to a stop, to stop the motor and then restart it.

Set b2-03 to 0 to disable the DC injection brake at start.

Set the DC injection brake current using b2-02. Pre-excitation is performed for flux vector control with the current set in E2-03 (Motor no-load current).

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b2-02	DC injection braking current / DCInj Current	Sets the DC injection braking current as a percentage, taking the motor rated current as 100%. In the flux vector control, DC excitation current depends on the value set in E2-03.	0 to 100	50%	No	A	No	1B1H
b2-03	DC injection braking (pre-excitation) time at start / DCInj Time@Start	Sets the time to perform DC injection braking on starting in seconds. Used to stop a coasting motor and restart it. When the set value is 0.00, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	1B2H

■Inputting the DC Injection Brake Command from Control Circuit Terminals

By setting H1-03 to H1-16 (Multi-function contact input terminals S3 to S16) to 60 (DC injection brake command), the DC injection brake can be applied to the motor by turning on the terminal for which the DC injection brake command has been set when the Inverter is being stopped. Pre-excitation is used for the flux vector control.

The timing chart for the DC injection brake is shown below.

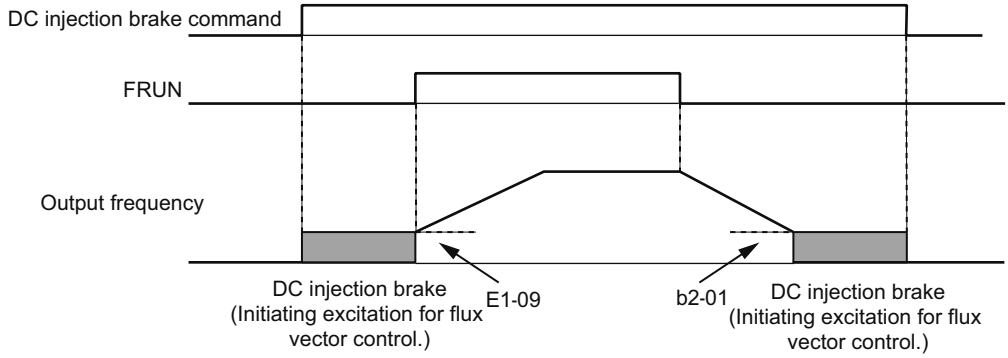


Fig 6.6 DC Injection Brake Timing Chart

If the Run Command or the jog command is input while the DC injection brake command is being input from an external terminal, the DC injection brake will be released, and operation will resume.

■Changing the DC Injection Brake Current Using an Analog Input

If you set H3-05 (Multi-function analog input terminal AI2 function selection), H3-09 (Multi-function analog input terminal AI3 function selection), or H3-13 (Multi-function analog input terminal AI4 function selection) to 6 (DC injection brake current), you can change the DC injection brake current level using the analog input.

At 10 V input (voltage), 100% of the Inverter rated output current will be applied.

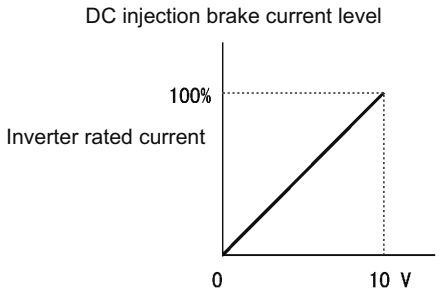


Fig 6.7 DC Injection Brake Current Using an Analog Input

◆ Using an Emergency Stop

By setting H1-03 to H1-16 (Multi-function contact input terminals S3 to S16) to 6F or 70 (Emergency stop), the motor is made to coast to a stop. If inputting the emergency stop with an NO contact, set any of H1-03 to H1-16 to 6F, and if inputting the emergency stop with an NC contact, set to 70.

Acceleration and Deceleration Characteristics

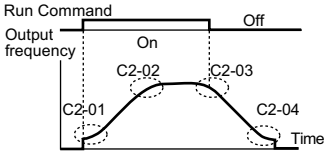
This section describes the acceleration and deceleration characteristics of the Inverter.

◆ Setting Acceleration and Deceleration Times

Acceleration time indicates the time taken for the output frequency to climb from 0% to 100%. Deceleration time indicates the time taken for the output frequency to reduce from 100% to 0%. The factory setting of the acceleration time is C1-01, and the factory setting of the deceleration time is C1-02.

■Related Parameters

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
C1-01	Acceleration time 1 Accel Time 1	Sets the acceleration time to accelerate from 0% to 100%, in seconds.	0.0 to 6000.0	60.0 s	Yes	Q	Q	240H
C1-02	Deceleration time 1 Decel Time 1	Sets the deceleration time to decelerate from 100% to 0%, in seconds.	0.0 to 6000.0	120.0 s	Yes	Q	Q	241H
C1-03	Acceleration time 2 Accel Time 2	Sets the acceleration time when accel/decel time 1 is set to on for a multi-function input.	0.0 to 6000.0	60.0 s	Yes	A	A	242H
C1-04	Deceleration time 2 Decel Time 2	Sets the deceleration time when accel/decel time 1 is set to on for a multi-function input.	0.0 to 6000.0	120.0 s	Yes	A	A	243H
C1-05	Acceleration time 3 Accel Time 3	Sets the acceleration time when accel/decel time 2 is set to on for a multi-function input.	0.0 to 6000.0	60.0 s	No	A	A	244H
C1-06	Deceleration time 3 Decel Time 3	Sets the deceleration time when accel/decel time 2 is set to on for a multi-function input.	0.0 to 6000.0	120.0 s	No	A	A	245H
C1-07	Acceleration time 4 Accel Time 4	Sets the acceleration time when accel/decel time 1 and accel/decel time 2 are set to on for multi-function inputs.	0.0 to 6000.0	60.0 s	No	A	A	246H
C1-08	Deceleration time 4 Decel Time 4	Sets the deceleration time when accel/decel time 1 and accel/decel time 2 are set to on for the multi-function inputs.	0.0 to 6000.0	120.0 s	No	A	A	247H
C1-11	Accel/decel time switching frequency Acc/Dec SW Freq	Sets the frequency for automatic acceleration/deceleration switching as a percentage. Below set frequency: Accel/decel time 4 Set frequency or above: Accel/decel time 1 Accel/decel time 1 and accel/decel time 2 set for multi-function inputs take priority.	0.00 to 100.00	0.00%	No	A	A	24AH

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
C2-01	S-curve characteristic time at acceleration start SCrv Acc @ Start	Sets the S-curve characteristic time for all sections in seconds. When the S-curve characteristic time is set, the acceleration/deceleration times will increase by only half of the S-curve characteristic times at start and end. 	0.00 to 2.50	0.00 s	No	A	A	250H
C2-02	S-curve characteristic time at acceleration end SCrv Acc @ End		0.00 to 2.50	0.00 s	No	A	A	251H
C2-03	S-curve characteristic time at deceleration start SCrv Dec @ Start		0.00 to 2.50	0.00 s	No	A	A	252H
C2-04	S-curve characteristic time at deceleration end SCrv Dec @ End		0.00 to 2.50	0.00 s	No	A	A	253H

■Switching Acceleration and Deceleration Time Using Multi-Function Input Terminal Commands

Using the Inverter, you can set four acceleration times and four deceleration times. By setting constants H1-03 to H1-16 (Multi-function contact input terminals S3 to S16) to 7 (Acceleration/deceleration time selection 1) or 1A (Acceleration/deceleration time selection 2), you can switch the acceleration/deceleration time even during operation by combining the on/off status of the terminals.

The following table shows the acceleration/deceleration time switching combinations.

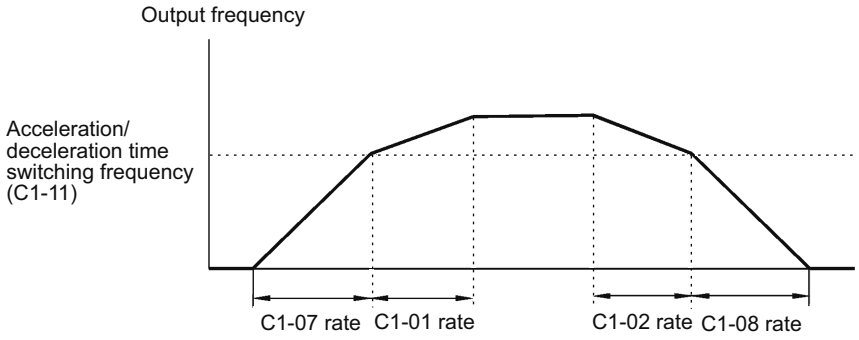
Acceleration/Deceleration Time Selection 1 Terminal	Acceleration/Deceleration Time Selection 2 Terminal	Acceleration Time	Deceleration Time
Off	Off	C1-01	C1-02
On	Off	C1-03	C1-04
Off	On	C1-05	C1-06
On	On	C1-07	C1-08

■Switching Acceleration and Deceleration Time Automatically

Use this setting when you want to switch acceleration/deceleration time automatically using the set frequency.

When the output frequency reaches the set value in C1-11, the Inverter switches the acceleration/deceleration time automatically as shown in the following diagram.

Set C1-11 to a value other than 0.00 %. If C1-11 is set to 0.00 %, the function will be disabled.



When output frequency ≥ C1-11, acceleration and deceleration are performed using acceleration/deceleration time 1 (C1-01, C1-02).
When output frequency < C1-11, acceleration and deceleration are performed using acceleration/deceleration time 4 (C1-07, C1-08).

Fig 6.8 Acceleration/Deceleration Time Switching Frequency

■Entering S-curve Characteristics in the Acceleration and Deceleration Time

By accelerating and decelerating using an S-curve pattern, you can reduce shock when starting and stopping the machine.

Using the Inverter, you can set an S-curve characteristic time for each of the following: Acceleration start time, deceleration start time, acceleration end time, and deceleration end time.

INFO

By setting the S-curve characteristic time, acceleration/deceleration time can be made longer as follows:
Acceleration time = Selected acceleration time + (S-curve characteristic time for acceleration start + S-curve characteristic time for acceleration end) / 2
Deceleration time = Selected deceleration time + (S-curve characteristic time for deceleration start + S-curve characteristic time for deceleration end) / 2

Setting Example

The S-curve characteristic when switching operation (forward/reverse) is shown in the following diagram.

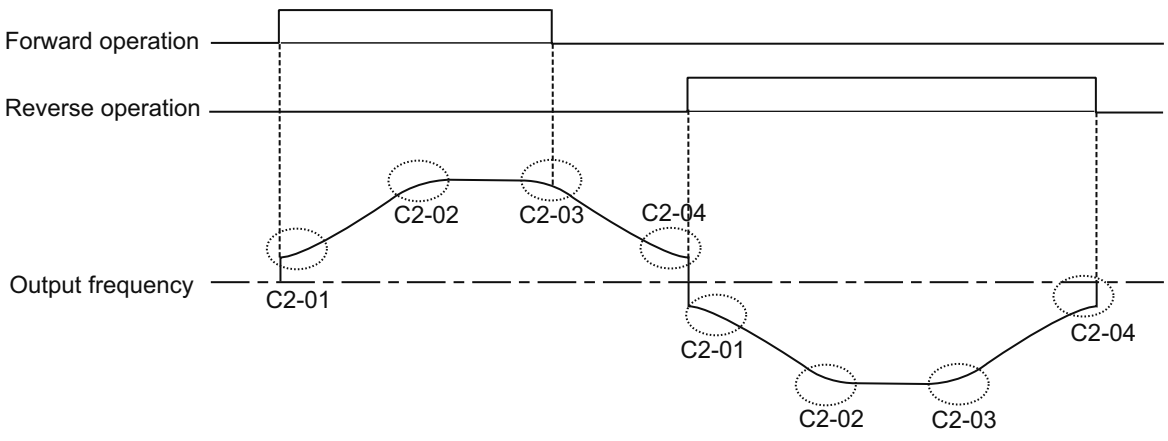


Fig 6.9 S-curve Characteristic during Operation Switching

◆ Preventing the Motor from Stalling During Acceleration (Stall Prevention During Acceleration Function)

The stall prevention during acceleration function prevents the motor from stalling if a heavy load is placed upon it, or if sudden rapid acceleration is performed.

If you set L3-01 to 1 (Enabled) and the Inverter output current exceeds the -15% level of the set value in L3-02, the acceleration rate will begin to slow down. When L3-02 is exceeded, acceleration will stop.

By setting L3-01 to 2 (Optimum adjustment), the motor current is made to increase at an acceleration rate that takes the setting of L3-02 as the reference value. When this setting is made, the acceleration time setting is ignored.

■Related Parameters

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L3-01	Stall prevention selection during acceleration / StallP Accel Sel	Sets whether the stall prevention during acceleration function is enabled or disabled. 0: Disabled (Acceleration as set. With a heavy load, the motor may stall.) 1: Enabled (Acceleration stopped when L3-02 level is exceeded. Acceleration starts again when the current level is recovered.) 2: Optimum adjustment (Using the L3-02 level as the reference, acceleration is automatically adjusted. Set acceleration time is disregarded.)	0 to 2	0	No	A	No	520H
L3-02	Stall prevention level during acceleration / StallP Accel Lvl	This setting is valid when L3-01 is set to 1 or 2. Set as a percentage, taking the Inverter rated output current as 100%. Usually setting is not necessary. Reduce the set value if the motor stalls when operated with the factory settings.	0 to 200	150%	No	A	No	521H
L3-03	Stall prevention limit during acceleration / StallP CHP Lvl	Sets the lower limit for stall prevention during acceleration, as a percentage taking the Inverter rated output current as 100%, when operation is in the frequency range above E1-06. Usually setting is not necessary.	0 to 100	100%*	No	A	No	522H

* The factory setting will change when the control method is changed.

■Timing Chart

The following figure shows the frequency characteristics when L3-01 is set to 1.

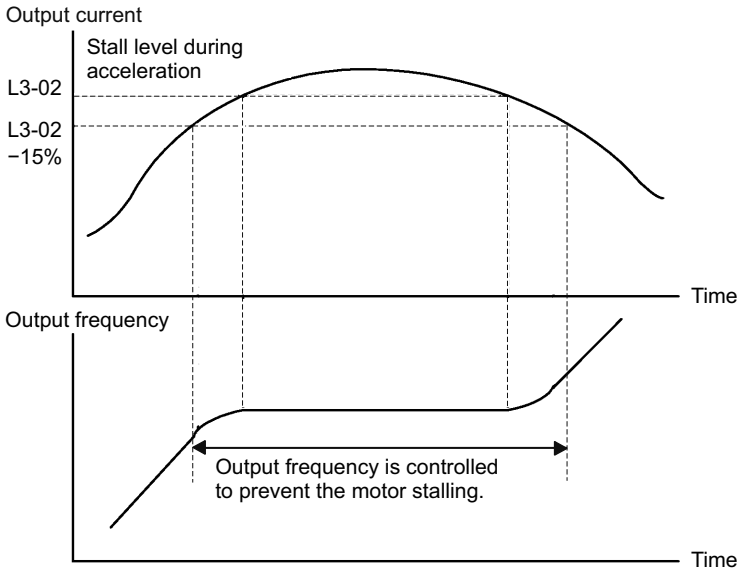


Fig 6.10 Timing Chart for Stall Prevention During Acceleration

■Setting Precautions

- If the motor capacity is small compared to the Inverter capacity, or if the motor stalls when operated with the factory settings, decrease the setting of L3-02. Set the constants as a percentage, taking the Inverter rated voltage as 100%.
- If using the motor in the constant output range, L3-02 will be automatically lowered to prevent stalling in the constant output range. L3-03 is the limit value to prevent the stall prevention level in the constant output range from being reduced more than necessary.

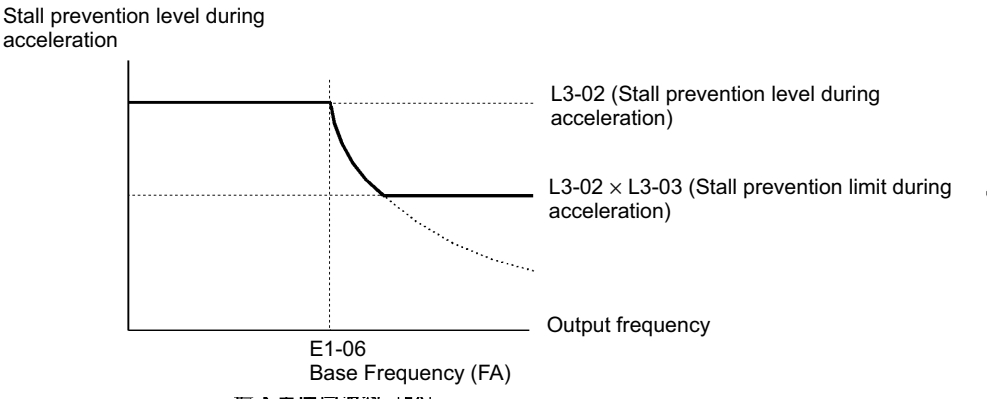


Fig 6.11 Stall Prevention Level and Limit During Acceleration

◆ Preventing Excessive Deceleration of the Motor (Excessive Deceleration Prevention Function, Software Version: S0112 or Later)

The excessive deceleration prevention function stops deceleration to suppress increase of the DC bus bar voltage when the DC bus bar voltage of the Power Cell has exceeded the excessive voltage prevention level. This prevents occurrences of DC bus bar overvoltage (OVR VOLT) of the Power Cell. Even when the deceleration is set somewhat shorter, the deceleration time is prolonged according to the DC bus bar voltage.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L3-04	Excessive deceleration prevention selection OverDecelP Sel	0: Disabled [Decelerates according to the settings. Power Cell DC bus bar overvoltage (OVR VOLT) may occur when deceleration time is short.] 1: Enabled (Stops deceleration when the DC bus bar voltage exceeds 1045 V. Restarts deceleration when the voltage is recovered.)	0 or 1	1	No	A	A	523H

■Setting Example

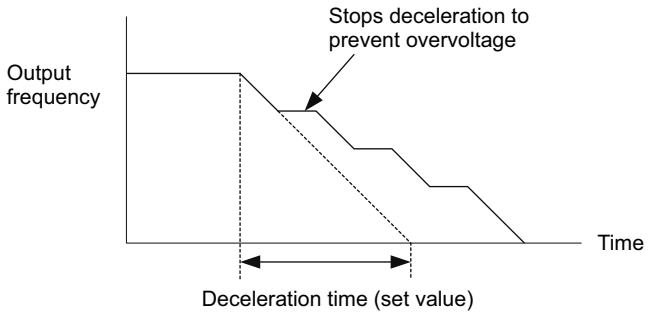


Fig 6.12 Operation of Excessive Deceleration Prevention Function

Adjusting Speed (Frequency) References

This section describes methods of adjusting speed (frequency) references.

◆ Adjusting Analog Input

Gain and bias are among the constants used to adjust analog inputs.

The speed (frequency) reference of analog inputs can be adjusted when b1-01 [speed (frequency) reference selection] is set to 1 [control circuit terminal (analog input)].

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
H3-01	Speed (frequency) reference signal level selection (terminal AI1) Term AI1 Signal	Selects the input signal level of terminal AI1. 0: 0 to 10 V 1: -10V to 10 V	0 or 1	0	No	A	A	450H
H3-02	Speed (frequency) reference input gain (terminal AI1) Term AI1 Gain	Sets the input gain of terminal AI1. Set the speed (frequency) when 10 V is input as a percentage, taking the maximum output frequency as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	451H
H3-03	Speed (frequency) reference input bias (terminal AI1) Term AI1 Bias	Sets the input bias of terminal AI1. Set the speed (frequency) when 0 V is input as a percentage, taking the maximum output frequency as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	452H
H3-04	Signal level selection (terminal AI2) Term AI2 Signal	Selects the input signal level of terminal AI2. 0: 0 to 10 V 1: -10 V to 10 V	0 or 1	0	No	A	A	453H
H3-05	AI2 function selection Term AI2 Sel	Sets the multi-function analog input function for terminal AI2.	0 to 1F	F	No	A	A	454H
H3-06	Input gain (terminal AI2) Term AI2 Gain	Sets the input gain of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	455H
H3-07	Input bias (terminal AI2) Term AI2 Bias	Sets the input bias of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	456H
H3-08	Signal level selection (terminal AI3) Term AI3 Signal	Selects the input signal level of terminal AI3. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	457H
H3-09	Function selection (terminal AI3) Term AI3 Sel	Sets the multi-function analog input function for terminal AI3.	0 to 1F	F	No	A	A	458H

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
H3-10	Input gain (terminal AI3) / Term AI3 Gain	Sets the input gain of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	459H
H3-11	Input bias (terminal AI3) / Term AI3 Bias	Sets the input bias of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45AH
H3-12	Signal level selection (terminal AI4) / Term AI4 Signal	Selects the input signal level of terminal AI4. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	45BH
H3-13	Function selection (terminal AI4) / Term AI4 Sel	Sets the multi-function analog input function for terminal AI4.	0 to 1F	F	No	A	A	45CH
H3-14	Input gain (terminal AI4) / Term AI4 Gain	Sets the input gain of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	45DH
H3-15	Input bias (terminal AI4) / Term AI4 Bias	Sets the input bias of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45EH
H3-16	Analog input filter time constant / Filter Avg Time	Sets the primary delay filter time constant in seconds for the four analog input terminals. Effective for noise control etc.	0.00 to 2.00	0.00 s	No	A	A	45FH

■Adjusting the Analog Speed (Frequency) Reference Using Constants

Speed (frequency) references are input as analog voltages from the control circuit terminals.

When using speed (frequency) reference terminal AI1 as the input terminal, make adjustments using H3-02 and H3-03.

When using multi-function analog input terminal AI2 as the speed (frequency) reference terminal, make adjustments using H3-06 and H3-07.
When using multi-function analog input terminal AI3 as the auxiliary speed (frequency) reference terminal, make adjustments using H3-10 and H3-11.

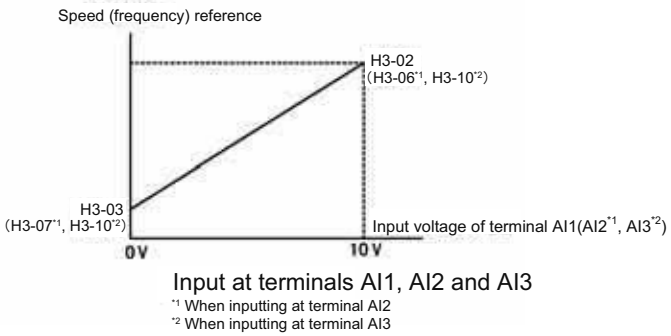


Fig 6.13 Input from Terminal AI1, AI2 or AI3

■Adjusting Frequency Gain Using Analog Inputs

When constant H3-05, H3-09 or H3-13 is set to 1 (frequency gain), the gain applying to the speed (frequency) reference is adjusted by inputs from analog input terminal AI2, AI3 or AI4.

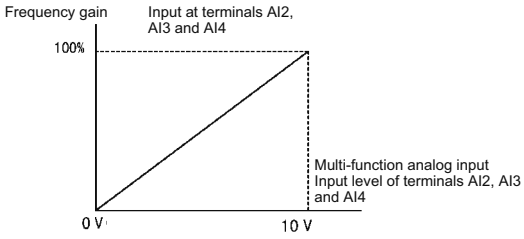
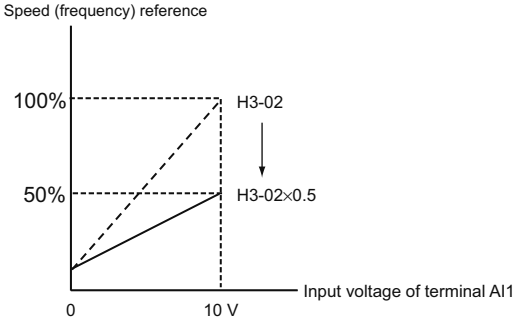


Fig 6.14 Input from Frequency Gain Adjustment Terminal AI2, AI3 or AI4

The frequency gain that applies to terminal AI1 is the product of the value set in H3-02 and the gain for terminal AI2, AI3 or AI4. For example, when H3-02 is set to 100% and terminal AI2 is set to 5 V, the speed (frequency) reference of terminal AI1 becomes 50%.



■Adjusting Frequency Bias Using Analog Inputs

When constant H3-05, H3-09 or H3-13 is set to 2 (frequency bias), the speed (frequency) equivalent of the input voltage of terminal AI2, AI3 or AI4 is added to the speed (frequency) reference as the bias.

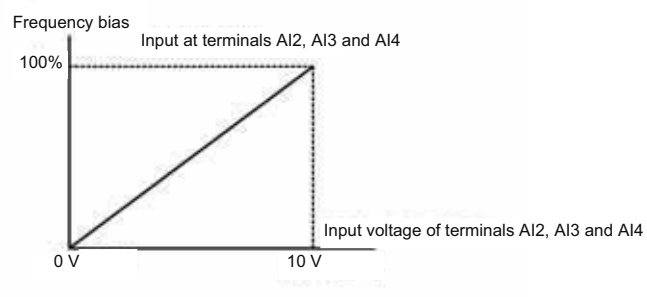
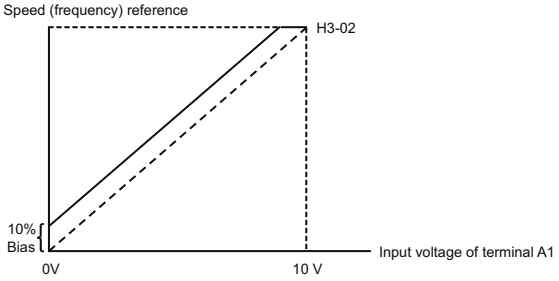


Fig 6.15 Frequency Bias Adjustment (Input from Terminal AI2, AI3 or AI4)

For example, with H3-02 set to 100%, H3-03 to 0% and terminal AI2 to 1 V, the speed (frequency) reference becomes 10% when 0 V is input to terminal AI1.



◆ Operation Avoiding Resonance (Jump Frequency Function)

The jump frequency function operates the motor while avoiding resonance caused by characteristic frequencies in the machinery.

This function is effective in creating a speed (frequency) reference dead band.

During constant-speed operation, operation within the jump frequency range is prohibited. Smooth operation is still used during acceleration and deceleration, that is, jumps are not performed.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
d3-01	Jump frequency 1 Jump Freq 1	Sets the center values of the jump frequencies as a percentage. This function is disabled by setting the jump frequency to 0.0. Always ensure that the following applies: d3-01 ≥ d3-02 ≥ d3-03 Operation in the jump frequency range is prohibited but during acceleration and deceleration, speed changes smoothly without jump.	0.0 to 100.0	0.0%	No	A	A	2F0H
d3-02	Jump frequency 2 Jump Freq 2		0.0 to 100.0	0.0%	No	A	A	2F1H
d3-03	Jump frequency 3 Jump Freq 3		0.0 to 100.0	0.0%	No	A	A	2F2H
d3-04	Jump frequency width Jump Bandwidth	Sets the jump frequency bandwidth as a percentage. The jump frequency range will be the jump frequency ± d3-04.	0.0 to 100.0	1.0%	No	A	A	2F3H

The relationship between the speed (frequency) reference and the output frequency with the jump frequency set is shown in the diagram below.

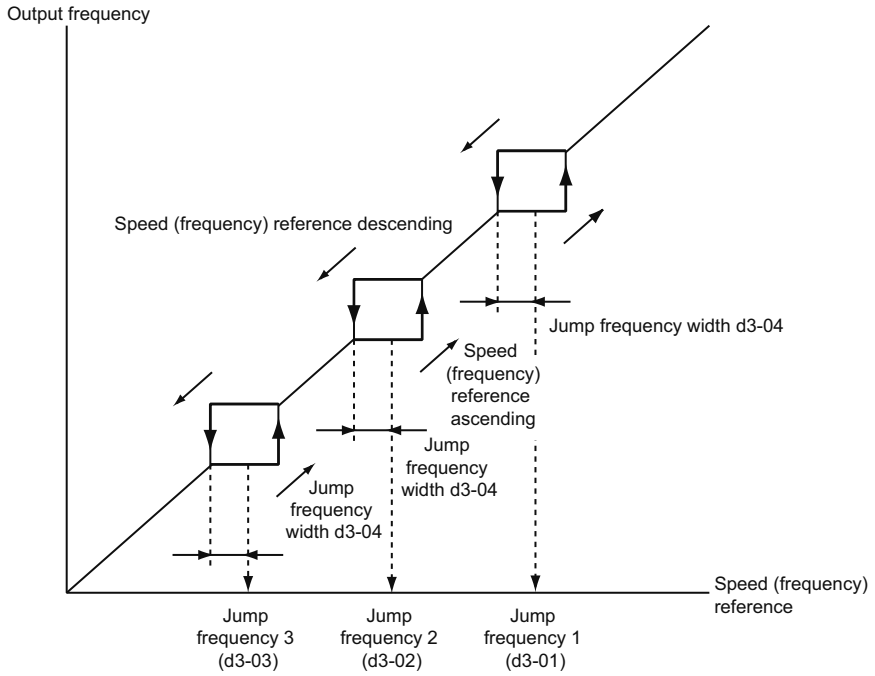


Fig 6.16 Jump Frequency

■Setting Precautions

- Set the jump frequency to fulfill the following conditions: d3-01 ≥ d3-02 ≥ d3-03.
- When constants d3-01 to d3-03 are set to 0%, the jump frequency function is disabled.

Speed Limit [Speed (Frequency) Reference Limit Function]

This section describes how to limit the motor speed.

◆ Limiting Maximum Frequency

If you do not want the motor to run below a given speed (frequency), use constant d2-01.

Set the upper limit value of the Inverter speed (frequency) reference as a percentage, taking E1-04 (maximum output frequency) as 100%.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
d2-01	Speed (frequency) reference upper limit Ref Upper Limit	Sets the upper limit of the speed (frequency) reference as a percentage, taking the max. output frequency as 100%.	0.0 to 110.0	100.0%	No	A	A	2E0H

◆ Limiting Minimum Frequency

If you do not want the motor to run below a given speed (frequency), use constant d2-02.

Set the lower limit value of the Inverter speed (frequency) reference as a percentage, taking E1-04 (maximum output frequency) as 100%.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
d2-02	Speed (frequency) reference lower limit Ref Lower Limit	Sets the lower limit of the speed (frequency) reference as a percent age, taking the max. output frequency as 100%.	0.0 to 109.0	0.0%	No	A	A	2E1H

Improved Operating Efficiency

This section describes functions for improving motor operating efficiency.

◆ Reducing Motor Speed Fluctuation (Slip Compensation Function)

When a load is large, the amount of motor slip increases and the motor speed decreases. The slip compensation function controls the motor at a constant speed, regardless of changes in load. When the motor is operating at the rated load, E2-02 (Motor rated slip) × C3-01 (Slip compensation gain) is added to the output frequency by the slip compensation function.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
C3-01	Slip compensation gain / Slip Comp Gain	Used to improve speed accuracy when operating with a load. Usually setting is not necessary. Adjust this constant at the following cases. • When the actual speed is lower than the target speed, increase the set value. • When the actual speed is higher than the target speed, decrease the set value. Used as the applicable control gain when using flux vector control.	0.0 to 2.5	1.0*	Yes	A	A	260H
C3-02	Slip compensation primary delay time constant / Slip Comp Time	Sets the slip compensation primary delay time in milliseconds. Usually setting is not necessary. Adjust this constant at the following cases. • Decrease the setting when slip compensation response is slow. • When speed is not stable, increase the setting.	0 to 10000	3000 ms *	No	A	A	261H
C3-03	Slip compensation limit / Slip Comp Limit	Sets the upper limit of the slip compensation as a percentage, taking motor rated slip as 100%.	0 to 250	200%	No	A	No	262H
C3-05	Output voltage limit operation selection / Output V limit	Sets whether the motor flux will be lowered automatically when the output voltage become saturated. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	264H

* The factory setting will change when the control method is changed.

■Adjusting Slip Compensation Gain

Set C3-01 to 1.0 to compensate for the rated slip set using the rated torque output status.

Adjust the slip compensation gain using the following procedure.

1. Set E2-02 (Motor rated slip) and E2-03 (Motor no-load current) correctly.
   - You can calculate the motor rated slip from the values on the motor nameplate using the following formula.

     Amount of motor rated slip (Hz) = Motor rated frequency (Hz) - Rated speed (min^{-1}) × No. of motor poles / 120
   - Set the value for motor no-load current at the rated voltage, the rated frequency and with no load. The motor rated slip is automatically set in the vector control using autotuning.
2. Apply a load, and measure the speed to adjust the slip compensation gain. Adjust the slip compensation gain by 0.1 at a time. If the speed is less than the target value, increase the slip compensation gain, and if the speed is greater than the target value, reduce the slip compensation gain.

For flux vector control, the slip compensation gain is used as the motor temperature compensation gain. When the motor temperate increases, the motor's internal constant increases, resulting in an increase in slip. If C3-01 is set, the amount of slip is adjusted as the temperature rises. Set C3-01 if the amount of torque varies with the temperature when using torque control or a torque limit. The larger the value of C3-01, the larger the compensation.

■Adjusting Slip Compensation Primary Delay Time Constant

Set the slip compensation primary delay time constant in milliseconds.

Normally, there is no need to make these settings. When the slip compensation response is low, lower the set value. When the speed is unstable, increase the set value.

■Adjusting Slip Compensation Limit

Set the upper limit for the slip compensation amount as a percentage, taking the motor rated slip amount as 100%.

If the speed is lower than the target value but does not change even when you adjust the slip compensation gain, the motor may have reached the slip compensation limit. Increase the limit, and check the speed again. Make the settings, however, to make sure that the sum of the slip compensation limit and reference frequency does not exceed the tolerance of the machine.

The following diagram shows the slip compensation limit for the constant torque range and constant output range.

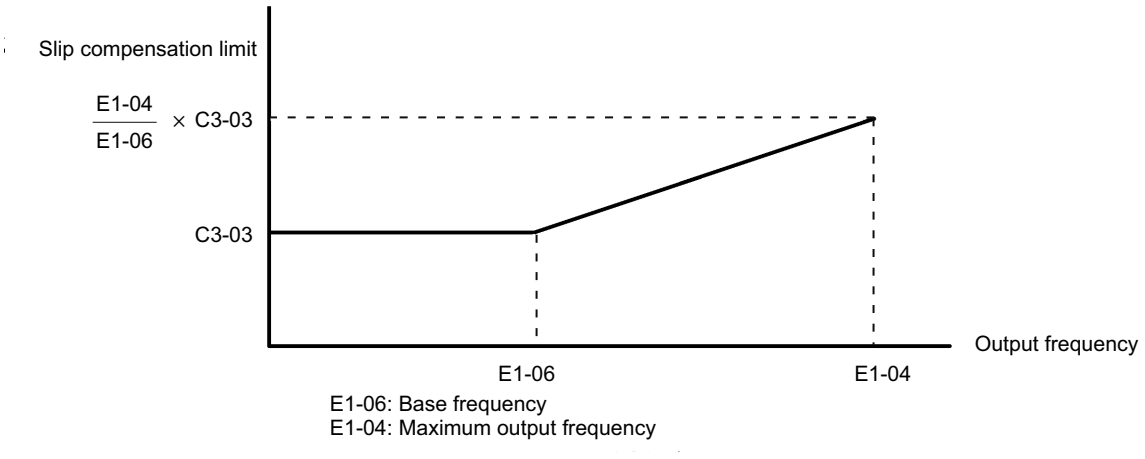


Fig 6.17 Slip Compensation Limit

■Selecting Output Voltage Limit Operation

If output voltage saturation occurs while the output voltage limit operation is disabled, the output current will not change, but torque control accuracy will be lost. If torque control accuracy is required, change the settings to enable the output voltage limit operation.

If the output voltage limit operation is enabled, motor magnetic flux current is controlled automatically, and torque control accuracy is maintained by limiting the output voltage references. Consequently, the output current will increase by approximately 10% maximum (with rated load) compared with when the output voltage limit operation is disabled, so check the Inverter current margin.

Setting Precautions

- If using the device at medium to low speed only, if the power supply voltage is 10% or more higher than the motor rated voltage, or if the torque control accuracy at high speeds is not required, it is not necessary to change the output voltage limit operation.
- If the power supply voltage is too low compared with the motor rated voltage, torque control accuracy may be lost even if the output voltage limit operation is enabled.

◆ Compensating for Insufficient Torque at Startup and Low-speed Operation (Torque Compensation Function)

The torque compensation function detects that the motor load has increased, and increases the output torque.

In the vector control, the motor primary current is separated into the motor excitation current component and the torque current (motor secondary current) component by calculation, and each component is controlled individually.

The torque current component is calculated as follows: Calculated torque reference × C4-01.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
C4-01	Torque compensation gain / Torq Comp Gain	Sets torque compensation gain as a ratio. Usually setting is not necessary. Adjust in the following cases: • When the cable is long, increase the set value. • When the motor capacity is smaller than the Inverter capacity (Max. applicable motor capacity), increase the set value. • When the motor is vibrating, decrease the set value. Adjust the output current range at low speed rotation so that it does not exceed the Inverter rated output current.	0.00 to 2.50	1.00	Yes	A	No	270H
C4-02	Torque compensation primary delay time constant / Torq Comp Time	Sets the torque compensation primary delay time in milliseconds. Usually setting is not necessary. Adjust in the following cases: • When the motor is vibrating, increase the set value. • When the responsiveness of the motor is low, decrease the set value.	0 to 10000	50 ms	No	A	No	271H

■Adjusting Torque Compensation Gain

Normally, there is no need to make this adjustment. Do not adjust the torque compensation gain when using open-loop vector control.

Adjust the torque compensation gain within the range that the output current during low-speed rotation does not exceed the Inverter rated output current.

■Adjusting the Torque Compensation Primary Delay Time Constant

Set the torque compensation primary delay time constant in milliseconds.

Normally, there is no need to make this adjustment. Adjust in the following circumstances.

- If the motor is vibrating, increase the set value.
- If the motor responsiveness is low, decrease the set value.

◆ Stabilizing Speed [Speed Feedback Detection Control (AFR) Function]

The speed feedback detection control (AFR) function measures the stability of the speed when a load is suddenly applied, by calculating the excessive fluctuation of the torque current feedback value, and by using the output frequency to compensate for the amount of fluctuation.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
n2-01	Speed feedback detection control (AFR) gain AFR Gain	Sets the gain for internal speed feedback detection control as a multiplying factor. Usually, this setting is not necessary. Adjust this constant as follows: • If hunting occurs, increase the set value. • If response is low, decrease the set value. Adjust the setting by 0.05 at a time, while checking the response.	0.00 to 10.00	2.00	No	A	No	5D0H
n2-02	Speed feedback detection control (AFR) time constant AFR Time	Sets the time constant to decide the rate of change in the speed feedback detection control (AFR).	0 to 2000	250 ms	No	A	No	5D1H
n2-03	Speed feedback detection control (AFR) time constant 2 AFR Time 2	Sets the time constant to decide the rate of change in the speed feedback detection control (AFR). Increase the setting if an overvoltage (OV) fault occurs at the completion of acceleration or when the load changes radically.	0 to 2000	750 ms	No	A	No	5D2H
n2-05	Starting gain for speed feedback detection control (AFR) gain change AFR G of Start	Sets the gain to the AFR gain at 0 Hz. The hunting by AFR is controlled at the time of a low speed (0-12 Hz).	0.00 to 2.00	0.20	No	A	No	5D4H

Machine Protection

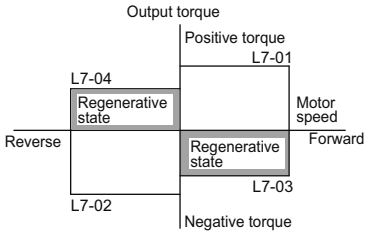
This section describes functions for protecting the machine.

◆ Limiting Motor Torque (Torque Limit Function)

Since the output torque of the motor is calculated internally, a torque limit of any value can be applied. Enable this function if you do not want a torque above a specified amount to be applied to the load, or if you do not want a regeneration value above a specified amount to occur.

Individual torque limits can be set for the four quadrants of forward drive, reverse drive, forward regenerative, and reverse regenerative.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L7-01	Forward drive torque limit Torq Limit Fwd	Sets the torque limit value as a percentage, taking the motor rated torque as 100%. Individual setting for four quadrants is possible. 	0 to 300	100%	No	A	A	560H
L7-02	Reverse drive torque limit Torq Limit Rev		0 to 300	100%	No	A	A	561H
L7-03	Forward regenerative torque limit Torq Lmt Fwd Rgn		0.0 to 100.0	0.5%	No	A	A	562H
L7-04	Reverse regenerative torque limit Torq Lmt Rev Rgn		0.0 to 100.0	0.5%	No	A	A	563H

■Setting Precautions

- When the torque limit function is operating, control and compensation of the motor speed is disabled because torque control is given priority. Therefore, the acceleration and deceleration time may increase or the motor speed may decrease.
- The torque limit accuracy is ±5% at an output frequency of 10 Hz or above. When the output frequency is less than 10 Hz, accuracy is reduced.

◆ Detecting Frequency

Set these constants when signals for the frequency agree, desired frequency agree, or frequency detection from a multi-function contact is output. When using flux vector control, the motor speed is detected.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
L4-01	Frequency detection level Spd Agree Level	Valid when the following items are set for a multi-function contact output. "Desired frequency (speed) agree 1" "Frequency (FOUT) detection 1" "Frequency (FOUT) detection 2" Set the frequency to be detected as a percentage.	0.0 to 100.0	0.0%	No	A	A	530H
L4-02	Frequency detection width Spd Agree Width	Valid when the following items are set for a multi-function contact output. "Frequency (speed) agree 1" "Desired frequency (speed) agree 1" "Frequency (FOUT) detection 1" "Frequency (FOUT) detection 2" Set the frequency detection width as a percentage.	0.0 to 100.0	2.0%	No	A	A	531H
L4-03	Frequency detection level (+/-) Spd Agree Lvl+-	Valid when the following items are set for a multi-function contact output. "Desired frequency (speed) agree 2" "Frequency (FOUT) detection 3" "Frequency (FOUT) detection 4" Set the frequency detection width as a percentage.	-100.0 to 100.0	0.0%	No	A	A	532H
L4-04	Frequency detection width (+/-) Spd Agree Width+-	Valid when the following items are set for a multi-function contact output. "Frequency (speed) agree 2" "Desired frequency (speed) agree 2" "Frequency (FOUT) detection 3" "Frequency (FOUT) detection 4" Set the frequency detection width as a percentage.	0.0 to 100.0	2.0%	No	A	A	533H

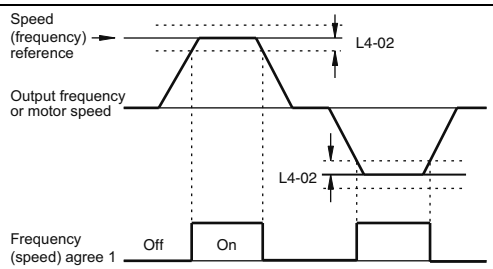
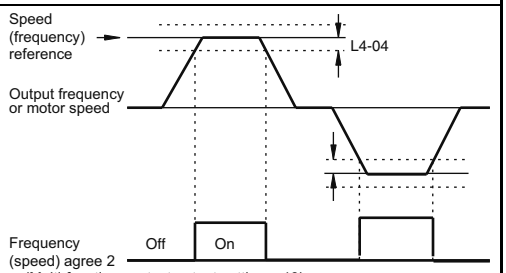
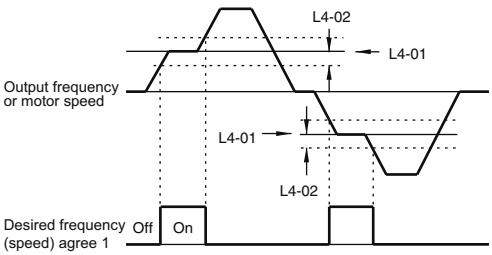
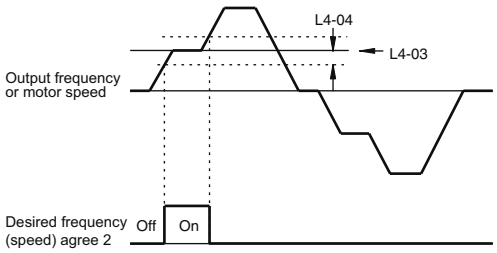
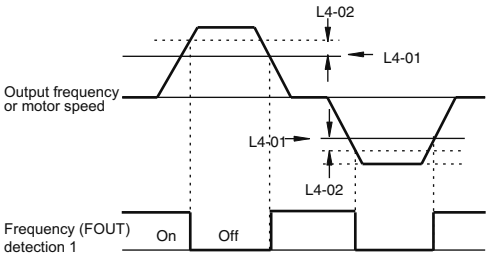
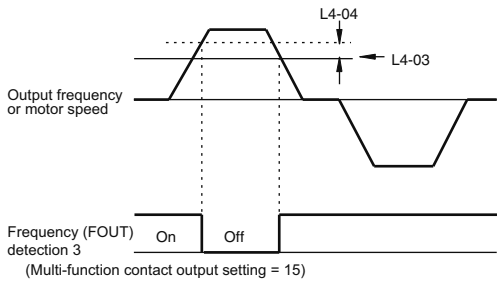
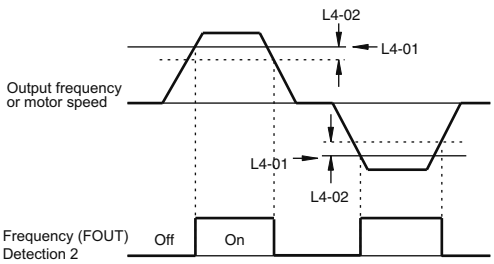
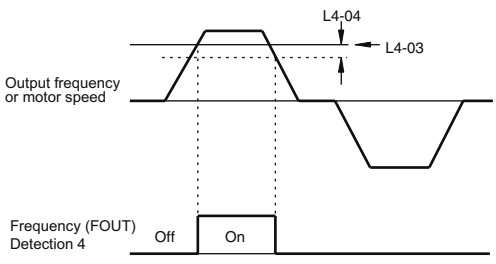
■Constants and Output Signals

User Constant No.	Name	Function
L4-01	Frequency detection level	Desired frequency (speed) agree 1 Frequency (FOUT) detection 1 Frequency (FOUT) detection 2
L4-02	Frequency detection width	Frequency (speed) agree 1 Desired frequency (speed) agree 1 Frequency (FOUT) detection 1 Frequency (FOUT) detection 2
L4-03	Frequency detection level (+/-)	Desired frequency (speed) agree 2 Frequency (FOUT) detection 3 Frequency (FOUT) detection 4
L4-04	Frequency detection width (+/-)	Frequency (speed) agree 2 Desired frequency (speed) agree 2 Frequency (FOUT) detection 3 Frequency (FOUT) detection 4

Set the corresponding setting in the multi-function contact outputs (H2-01 to H2-08) to output the frequency agree signal, desired frequency agree signal, or frequency detection signal.

Function	Setting
Frequency (speed) agree 1	2
Desired frequency (speed) agree 1	3
Frequency (FOUT) detection 1	4
Frequency (FOUT) detection 2	5
Frequency (speed) agree 2	13
Desired frequency (speed) agree 2	14
Frequency (FOUT) detection 3	15
Frequency (FOUT) detection 4	16

Timing Chart for Frequency Detection Operation

<table>
<tr><th>Related constant</th><th>L4-01: Frequency detection level
L4-02: Frequency detection width</th><th>L4-03: Frequency detection level
(+/– single sided detection)
L4-04: Frequency detection width
(+/– single sided detection)</th></tr>
<tr><td rowspan="2">Frequency (speed) agree 1</td><td>Frequency (speed) agree 1</td><td>Frequency (speed) agree 2</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td rowspan="2">Desired frequency (speed) agree 1</td><td>Desired frequency (speed) agree 1
(on at the following conditions during frequency agree)</td><td>Desired frequency (speed) agree 2
(signal side detection)
(on at the following conditions during frequency agree)</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td rowspan="4">Frequency (FOUT) detection</td><td>Frequency (FOUT) detection 1
(L4-01 > | Output frequency |)</td><td>Frequency (FOUT) detection 3
(L4-03 > Output frequency)</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Frequency (FOUT) detection 2
(L4-01 < | Output frequency |)</td><td>Frequency (FOUT) detection 4
(L4-03 < Output frequency)</td></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>

◆ Detecting Motor Torque

If an excessive load is placed on the machinery (overtorque) or the load is suddenly lightened (undertorque), an alarm signal can be output to multi-function contact output terminals DO1 to DO8. Two types of torque detection can be performed independently.

To use the overtorque/undertorque detection function, set B, 17, 18, 19 (Overtorque/undertorque detection NO/NC) in one of the following constants: H2-01 to H2-08 (Multi-function contact output terminals DO1 to DO8 function selection). Overtorque and undertorque are detected based on the values set for L6-01 and L6-04.

The overtorque/undertorque detection level is the motor torque (motor rated torque 100%).

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
L6-01	Overtorque/ Undertorque detection operation selection 1 Torq Det 1 Sel	Sets the operation when overtorque or undertorque is detected. 0: Overtorque/undertorque detection disabled 1: Overtorque detection only with speed agreement, operation continues after detection (alarm). 2: Overtorque detected continuously during operation, operation continues after detection (alarm). 3: Overtorque detection only with speed agreement, output stopped upon detection (protected operation). 4: Overtorque detected continuously during operation, output stopped upon detection (protected operation). 5: Undertorque detection only with speed agreement, operation continues after detection (alarm). 6: Undertorque detected continuously during operation, operation continues after detection (alarm). 7: Undertorque detection only with speed agreement, output stopped upon detection (protected operation). 8: Undertorque detected continuously during operation, output stopped upon detection (protected operation). Output when Overtorque/undertorque detection 1 NO or Overtorque/undertorque detection 1 NC is selected for the multi-function contact output.	0 to 8	0	No	A	A	550H

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L6-02	Overtorque/ Undertorque detection level 1 / Torq Det 1 Lvl	Sets the overtorque/undertorque Set the value as a percentage, taking the motor rated torque as 100%	0 to 300	150%	No	A	A	551H
L6-03	Overtorque/ Undertorque detection time 1 / Torq Det 1 Time	Sets the overtorque/undertorque detection time in seconds.	0.0 to 10.0	0.1 s	No	A	A	552H
L6-04	Overtorque/Undertorque detection operation selection 2 / Torq Det 2 Sel	Sets the operation when overtorque or undertorque is detected. 0: Overtorque/undertorque detection disabled 1: Overtorque detection only with speed agreement, operation continues after detection (alarm). 2: Overtorque detected continuously during operation, operation continues after detection (alarm). 3: Overtorque detection only with speed agreement, output stopped upon detection (protected operation). 4: Overtorque detected continuously during operation, output stopped upon detection (protected operation). 5: Undertorque detection only with speed agreement, operation continues after detection (alarm). 6: Undertorque detected continuously during operation, operation continues after detection (alarm). 7: Undertorque detection only with speed agreement, output stopped upon detection (protected operation). 8: Undertorque detected continuously during operation, output stopped upon detection (protected operation). Output when Overtorque/undertorque detection 2 NO or Overtorque/undertorque detection 2 NC is selected for the multi-function contact output.	0 to 8	0	No	A	A	553H
L6-05	Overtorque/Undertorque detection level 2 / Torq Det 2 Lvl	Sets the overtorque/undertorque detection level. Set the value as a percentage, taking the motor rated torque as 100%.	0 to 300	150%	No	A	A	554H
L6-06	Overtorque/Undertorque detection time 2 / Torq Det 2 Time	Sets the overtorque/undertorque detection time in seconds.	0.0 to 10.0	0.1 s	No	A	A	555H

Multi-function Contact Output (H2-01 to H2-08)

Setting Value	Function	Control Methods	
		Open-loop Vector	Flux Vector
B	Overtorque/undertorque detection 1 NO (NO contact) (On: Overtorque/undertorque detection)	Yes	Yes
17	Overtorque/undertorque detection 1 NC (NC contact) (Off: Overtorque/undertorque detection)	Yes	Yes
18	Overtorque/undertorque detection 2 NO (NO contact) (On: Overtorque/undertorque detection)	Yes	Yes
19	Overtorque/undertorque detection 2 NC (NC contact) (Off: Overtorque/undertorque detection)	Yes	Yes

■L6-01 and L6-04 Set Values and LCD Indications

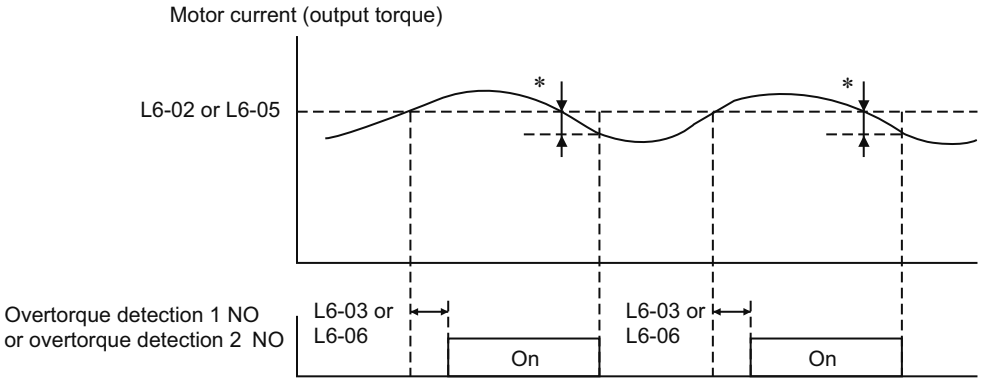
The relationship between alarms displayed on the Digital Operator when overtorque or undertorque is detected, and the set values in L6-01 and L6-04, is shown in the following table.

Set Value	Function	LCD Indications	
		Overtorque/ Undertorque Detection 1	Overtorque/ Undertorque Detection 2
0	Overtorque/undertorque detection disabled.	–	–
1	Overtorque detection only with speed matching, operation continues after detection (alarm).	OL3 flashes	OL4 flashes
2	Overtorque detected continuously during operation, operation continues after detection (alarm).	OL3 flashes	OL4 flashes
3	Overtorque detection only with speed matching, output stopped upon detection (protected operation).	OL3 lit	OL4 lit
4	Overtorque detected continuously during operation, output stopped upon detection (protected operation).	OL3 lit	OL4 lit
5	Undertorque detection only with speed matching, operation continues after detection (alarm).	UL3 flashes	UL4 flashes
6	Undertorque detected continuously during operation, operation continues after detection (alarm).	UL3 flashes	UL4 flashes
7	Undertorque detection only with speed matching, output stopped upon detection (protected operation).	UL3 lit	UL4 lit
8	Undertorque detected continuously during operation, output stopped upon detection (protected operation).	UL3 lit	UL4 lit

■Setting Example

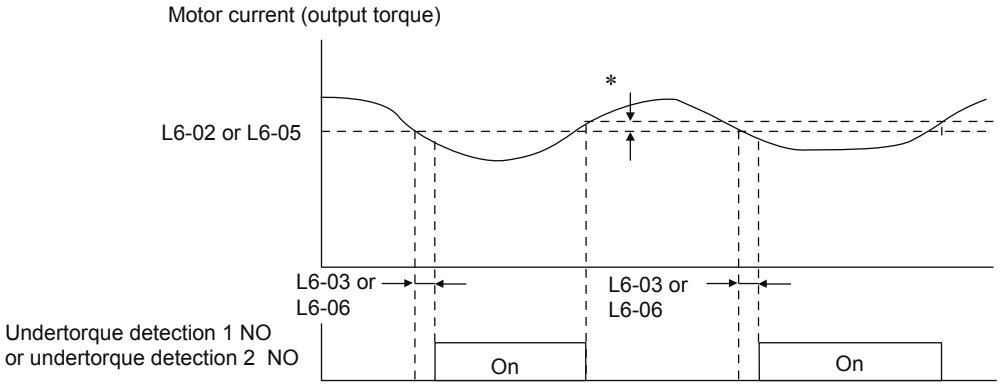
The following diagram shows the timing chart for overtorque and undertorque detection.

- Overtorque Detection



* The overtorque detection disabled band is approximately 10% of the motor rated torque.

- Undertorque Detection



* The undertorque detection disabled band is approximately 10% of the motor rated torque.

◆ Motor Overload Protection

You can protect the motor from overload using the Inverter's built-in electronic thermal relay.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
E2-01	Motor rated current / Motor Rated FLA	Sets the motor rated current in amperes. These set values will become the reference values for motor protection, torque limits and torque control.	0.1 to 1500.0	86.6 A	No	Q	Q	360H
L1-01	Motor protection selection / MOL Fault Select	Sets whether the motor overload protection function is enabled or disabled at electronic thermal relay. 0: Disabled 1: Enabled	0 or 1	1	No	A	A	4E0H
L1-02	Motor protection time constant / MOL Time Const	Sets protection time when overload of the motor overload detection level (L1-07) is applied to the load status that was lower than the motor overload detection start level (L1-06). Set a value appropriate for the overload capacity of the motor.	1.0 to 300.0	60.0 s	No	A	A	4E1H
L1-04	Selection of operation when motor overload is detected / MOL Select	Sets the stopping method when motor overload is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation	0 to 3	1	No	A	A	4E3H
L1-06	Motor overload detection start level / OL1 Start Level	Sets the motor overload detection start level as a percentage, taking the motor rated current as 100%. The set value must be smaller than L1-07.	20 to 300	110%	No	A	A	4E5H
L1-07	Motor overload detection level / OL1 Level	Sets the motor overload detection level as a percentage, taking the motor rated current as 100%. The set value must be bigger than L1-06.	30 to 300	150%	No	A	A	4E6H

■Setting Example

Set the motor overload detection start level for L1-06, the motor overload detection level for L1-07, and the motor protection operation time at the motor overload detection level for L1-02, taking the motor rated current as 100%.

The factory setting capacity is 150% for 60 seconds.

If the output current exceeds the motor overload detection start level, the electronic thermal relay will be activated.

The following diagram shows an example of the characteristics of the electronic thermal protection operation time (L1-02=60 seconds, L1-06=110%, L1-07=150%).

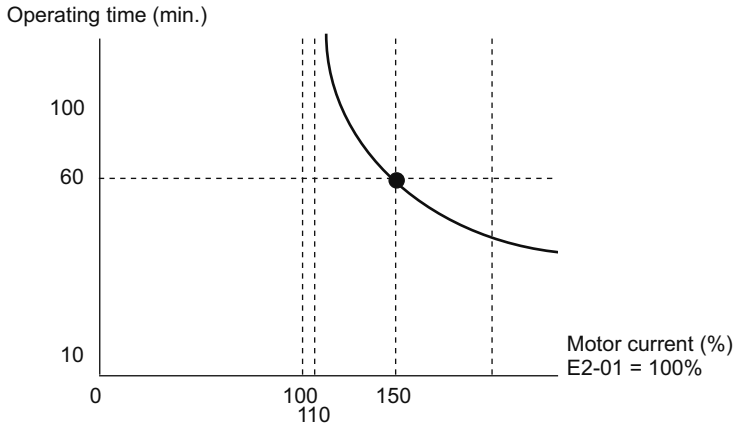


Fig 6.18 Motor Protection Operation Time

Setting Precautions

- To detect overloads at an earlier timing, set smaller values for L1-02 and L1-07.
- If L1-06 (Motor overload detection start level) is set as equal to or higher than L1-07 (Motor overload detection level), an OPE11 (Constant setting error) operation error will occur. Set L1-06 to a value of lower than L1-07.
- If multiple motors are connected to one Inverter, set constant L1-01 to 0 (disabled). To protect the motor, install a thermal relay in the motor power line, and implement protective measures against overload on each motor.

◆ Limiting the Motor Rotation Direction

If you set motor reverse rotation prohibited, a Reverse Run Command will not be accepted even if it is input. Use this setting for applications in which reverse motor rotation can cause problems (for example, fans, pumps, etc.)

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b1-04	Prohibition of reverse operation / Reverse Oper	Sets whether reverse rotation of the motor is prohibited or not. 0: Reverse enabled 1: Reverse disabled	0 or 1	1	No	A	A	1A3H

Continuing Operation

This section describes functions for continuing or automatically restarting Inverter operation even if an error occurs.

◆ Restarting Automatically after Power Is Restored

Even if a temporary power loss occurs, you can restart the Inverter automatically after power is restored to continue motor operation. To restart the Inverter after power has been restored, set L2-01 to 1.

If L2-01 is set to 1, when power is restored within the time set in L2-02, the Inverter will restart. If the time set in L2-02 is exceeded, an alarm IUV (Main circuit voltage drop) will be detected.

Set constants L2-02 to L2-04 for operations related to restarting of Inverter operation.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L2-01	Selection of operation at momentary power loss detection / PwrL Selection	Selects the operation when a momentary power loss occurs. 0: Disabled [main circuit undervoltage (IUV) detection] 1: Enabled [Restarted when the main circuit power returns within the time set for L2-02. When L2-02 is exceeded, main circuit undervoltage (IUV) is detected.] A backup of the control power supply is necessary for momentary power loss compensation.	0 or 1	0	No	A	A	4F0H
L2-02	Momentary power loss ridethru time / PwrL Ridethru t	Sets the ridethrough time in seconds when L2-01 is set to 1.	0.0 to 10.0	2.0 s	No	A	A	4F1H
L2-03	Min. baseblock time / PwrL Baseblock t	Sets the minimum baseblock time in seconds at recovery after momentary power loss or Inverter stop. The Inverter will not accept Run Commands for the set period of time and maintains the baseblock state. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs at the start of DC injection braking, increase the set values.	0.1 to 5.0	2.0 s	No	A	A	4F2H
L2-04	Voltage recovery time / PwrL V/F Ramp t	Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search, in seconds. Sets the time required to recover from 0 V to the maximum voltage. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs during voltage recovery or after recovery, increase the set values.	0.0 to 10.0	3.0 s	No	A	A	4F3H

■Setting Precautions

- Error output signals are not output during momentary power loss recovery.
- To continue Inverter operation after the power has been restored, adjust settings so that Run Commands from the control circuit terminals are retained even during the power loss.
- To continue Inverter operation after power has been restored, it is necessary to back up the control power supply with a UPS or other device.
- Adjustment of the speed search (b3 constants) is necessary for operation start conditions when restarting Inverter operation.

◆ Speed Search

The speed search function finds the actual speed of the motor that is rotating due to inertia, and then starts smoothly from that speed. The speed search function is effective when restoring power after a momentary power loss, transferring from a commercial power supply to the Inverter, and restarting the fan running due to the moment of inertia.

Set whether to enable or disable speed search at startup, and set the type of speed search (speed estimation or current detection) using b3-01. To perform speed search every time a Run Command of the Inverter is input, set b3-01 to 1 or 3.

The difference between the types of speed search is explained below.

Search Method	Speed Estimation	Current Detection
Overview of Search Method	Estimates the motor speed when the search starts, and accelerates and decelerates from the estimated speed to the set frequency.	The speed search is started from the speed (frequency) reference at the time that the momentary power loss was detected, or from the maximum output frequency, and speed detection is performed based on the current level being searched for.
External Speed Search Command	External search command 1 and external search command 2 become the same operation, estimating the motor speed and starting the search from the estimated speed.	External speed search command 1: Starts speed search from the maximum output frequency. External speed search command 2: Starts speed search from the speed (frequency) reference set before the search command.
Application Precautions	Cannot be used with multiple motors and motors two or more frames smaller than the Inverter capacity.	Cannot be used with multiple motors. In open loop control, the motor may accelerate suddenly with light loads.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b3-01	Speed search selection at start (common) / SpdSrch at Start	Enables/disables the speed search function when a Run Command is input, and sets the speed search method. 0: Disabled, speed estimation 1: Enabled, speed estimation 2: Disabled, current detection 3: Enabled, current detection Speed Estimation: When the search is started, the motor speed is estimated and acceleration/deceleration is performed from the estimated speed to the specified frequency. Current Detection: The speed search is started from the frequency when power was momentarily lost or the maximum frequency, and the speed is detected based on the search current level.	0 to 3	0*	No	A	A	1C0H
b3-02	Speed search operating current (common) / SpdSrch Current	Sets the speed search operation current as a percentage, taking the Inverter rated current as 100%. Usually setting is not necessary. When restarting is not possible with the factory settings, adjust the value.	0 to 200	30%*	No	A	No	1C1H
b3-03	Speed search deceleration time (common) / SpdSrch Dec Time	Sets the output frequency deceleration time during speed search in seconds. Set the time for deceleration from the maximum output frequency to the minimum output frequency.	0.1 to 10.0	4.0 s	No	A	No	1C2H
b3-05	Speed search wait time (common) / Search Delay	Sets the magnetic contactor operating delay time when there is a medium-voltage magnetic contactor on the output side of the Inverter. When a speed search is performed after recovering from a momentary power loss, the search operation is delayed by the time set here.	0.0 to 20.0	0.2	No	A	A	1C4H
b3-06	Output current 1 during speed search (speed estimation) / Srch Im Lvl1	Sets the output current during the first half of speed search as a coefficient to the motor rated current (E2-01). Increase the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.0 to 1.0	0.5	No	A	A	1C5H

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b3-07	Output current 2 during speed search (speed estimation) Srch Im Lvl2	Sets the output current during the last half of speed search as a coefficient to the motor no-load current (E2-03). The multiplication of motor no-load current and set coefficient is limited to the motor rated current (E2-01). Increase the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.0 to 3.0	1.5	No	A	A	1C6H
b3-10	Speed search detection compensation gain (speed estimation) Srch Detect Comp	Restarts operation at a speed obtained by multiplying the speed from the speed search by the compensation gain. Increase this setting if overvoltages of Power Cells occur when a speed search is performed after a long baseblock, for example, in searches at startup.	1.00 to 1.50	1.05	No	A	No	1C9H
b3-11	Speed estimation method switching level (speed estimation) Srch Mthd Sw Lvl	Switches the speed estimation method automatically according to the motor residual voltage. Set the switching level.	0.5 to 100.0	5.0%	No	A	A	1CAH
b3-12	Current detection dead-zone width during speed search (speed estimation) Srch I Deadband	On speed estimation, the motor speed is estimated from the detected current value. For current detection, the dead-zone must be set. Set the dead-zone width using the current detection resolution as reference amount. Decrease the set value if the search speed becomes extremely slow when a speed search is performed after a long baseblock, for example, in searches at startup.	0.5 to 10.0	4.0	No	A	A	1CBH
b3-13	Torque compensation time constant during speed search (common) TComp T at SpdSr	Sets primary lag of the torque compensation function during a speed search in milliseconds.	0 to 10000	10 ms	No	A	A	1CCH
b3-14	Current control start level during voltage restoration (common) Srch Lvl Red I	Sets the level to start prolongation of the voltage restoration time to control the current during a speed search. Set the level, taking no-load current as 1.0.	0.0 to 5.0	2.0	No	A	A	1CDH
b3-15	Time constant for current control during voltage restoration (common) Srch T Red I	Sets the time constant for filtering for the operation to prolong voltage restoration time in order to control current during a speed search.	0 to 100	5 ms	No	A	A	1CEH

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b3-16	Wait time after completion of speed search (common) SpdSrch Ret Time	Sets the wait time for switching to normal control after completion of speed search. The speed (frequency) reference will be held during the set wait time.	0.00 to 5.00	0.01 s	No	A	No	1CFH
b3-17	Software CLA current limit 1 during speed search (common) SpdSrch CLA Lvl1	Sets the software current limit value during a speed search as a percentage, taking the motor rated current as 100%.	0.0 to 300.0	100.0%	No	A	A	1D0H
b3-18	Software CLA current limit 2 during speed search (common) SpdSrch CLA Lvl2	Sets the software current limit value at 0 Hz during a speed search as a percentage, taking the motor rated current as 100%	0.0 to 300.0	100.0%	No	A	A	1D1H
L2-03	Min. baseblock time PwrL Baseblock t	Sets the minimum baseblock time in seconds at recovery after momentary power loss or Inverter stop. The Inverter will not accept Run Commands for the set period of time and maintains the baseblock state. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs at the start of DC injection braking, increase the set values.	0.1 to 5.0	2.0 s	No	A	A	4F2H
L2-04	Voltage recovery time PwrL V/F Ramp t	Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search, in seconds. Sets the time required to recover from 0 V to the maximum voltage. When a drive overcurrent (IOC) or Power Cell fault (CFA) occurs during voltage recovery or after recovery, increase the set values.	0.0 to 10.0	3.0 s	No	A	A	4F3H

* The factory setting will change when the control method is changed.

Multi-function Contact Inputs (H1-03 to H1-16)

Setting Value	Function	Control Methods Open-loop Vector	Control Methods Flux Vector
61	External search command 1 Off: Speed search disabled (Start from the minimum output frequency) On: Speed estimation type (Motor speed estimated, speed search from the estimated speed) Current detection type (Speed search from maximum output frequency)	Yes	No
62	External search command 2 Off: Speed search disabled (Start from the minimum output frequency) On: Speed estimation type [Motor speed estimated, speed search from the estimated speed (same operation as for external search command 1)] Current detection type [Speed search from set frequency (speed (frequency) at the time the search command was input)]	Yes	No

■Setting Precautions

- When both external search commands 1 and 2 are set for the multi-function contact input terminals, an OPE03 (invalid multi-function input selection) operation error will occur. Set either external search command 1 or external search command 2.
- For flux vector control, set the speed search selection at start (b3-01) to 1. The speed search will start from the speed (frequency) detected by the PG.
- When executing a speed search using an external search command, program an external sequence so that both the Run Command and the external search command are on for at least the minimum baseblock time (L2-03).
- If the Inverter output is equipped with a medium-voltage magnetic contactor, set the operation delay time of the contactor in b3-05 (Speed search wait time). The factory setting is 0.2 s. When not using the medium-voltage magnetic contactor, you can reduce the search time by setting b3-05 to 0.0 s. After waiting for the speed search wait time, the Inverter will start the speed search.
- Constant b3-02 (Speed search operation current) is the setting (current detection level for search completion) for speed search at start for both a current detection type speed search and speed estimation type speed search. When the current falls below the detection level, the speed search is considered completed, and the motor accelerates or decelerates to the speed (frequency) reference. If the motor cannot restart, lower the set value.
- Constant b3-12 (current detection dead-zone width during speed search) is the setting for speed search at start (for estimating speed from detected current) for a speed estimation type speed search. Decrease the set value if the search speed is low compared to the actual motor speed and increase the set value if the search speed is high.

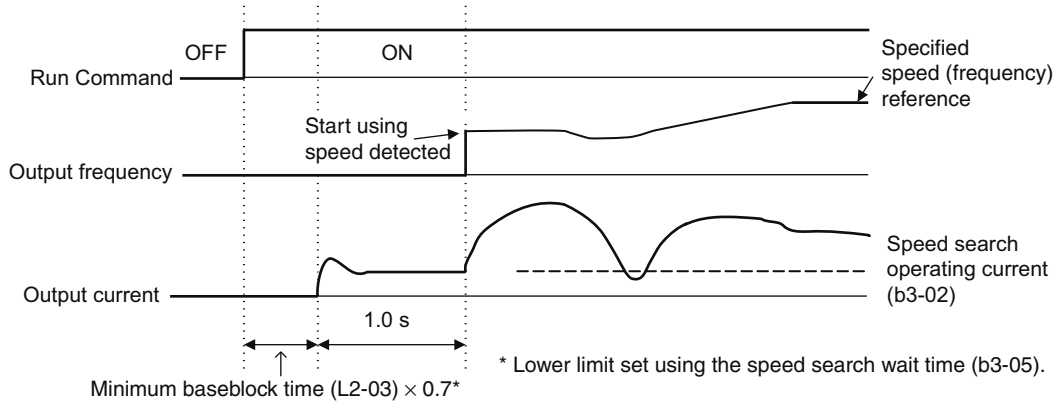
■Speed Estimation Type Speed Search

Execute autotuning before using the speed estimation type speed search. If the cable length between the motor and Inverter is changed after autotuning has been performed, perform only stationary autotuning for line-to-line resistance again.

The timing charts for speed estimation type speed search are shown below.

Speed Search at Startup

The timing chart when an external speed search command is input, or when a speed search is performed at the same time as a Run Command is input after the power has been shut down for a long period of time, is shown below.



Note: If the stopping method is set to coast to stop, and the Run Command turns on in a short time, the operation may be the same as for speed search after short baseblock explained later.

Fig 6.19 Speed Search at Startup (Speed Estimation)

Speed Search after Short Baseblock

The timing chart for a short baseblock (when Inverter operation is restarted after power has been restored from a momentary power loss) is shown below.

- Loss Time Shorter than the Minimum Baseblock Time (L2-03)

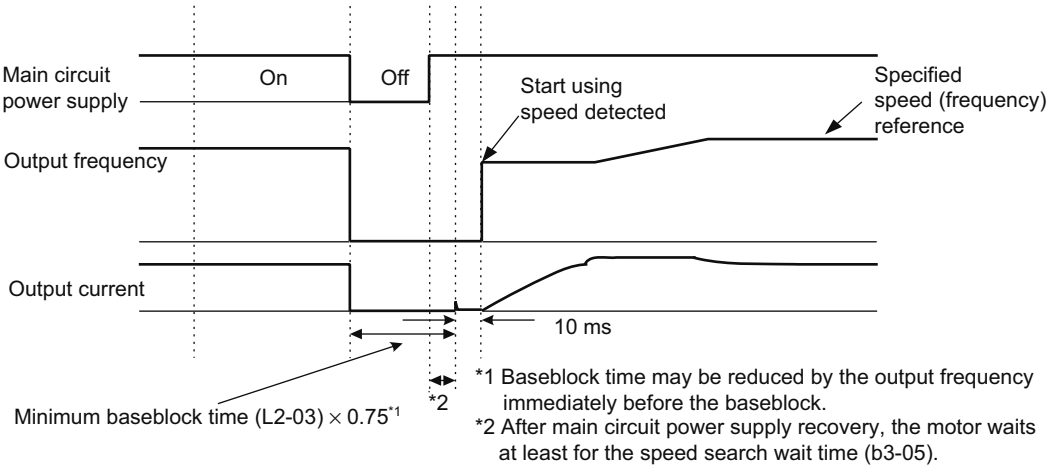
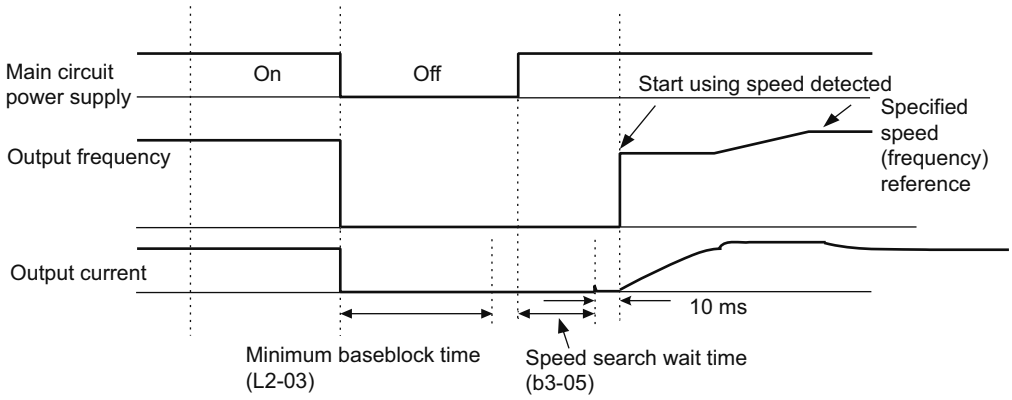


Fig 6.20 Speed Search after Baseblock (Speed Estimation: Loss Time < L2-03)

- Loss Time Longer than the Minimum Baseblock Time (L2-03)



Note: If the frequency immediately before the baseblock is low or the main circuit power supply is shut down for a long time, the operation may be the same as for speed search at startup, explained earlier.

Fig 6.21 Speed Search After Baseblock (Speed Estimation: Loss Time > L2-03)

■Current Detection Type Speed Search

The timing charts for current detection type speed search are shown below.

Speed Search at Startup

The timing chart when an external speed search command is input, or when a speed search is performed at the same time as a Run Command is input after the power has been shut down for a long period of time, is shown below.

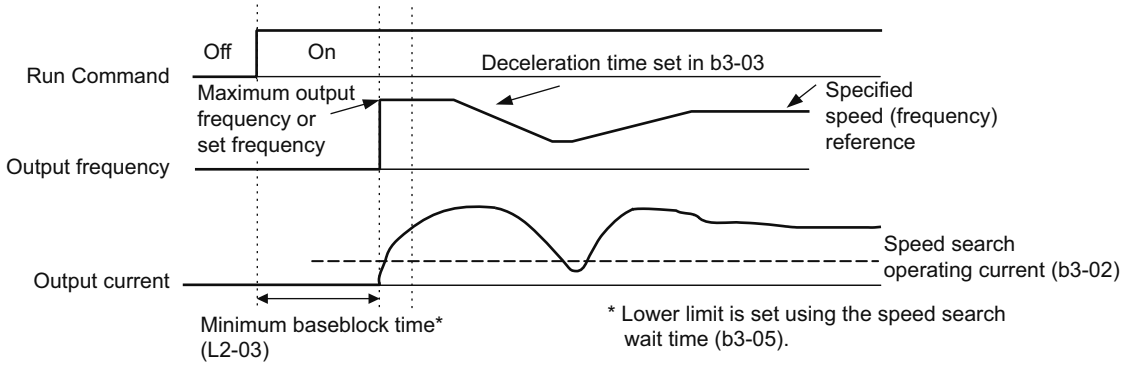


Fig 6.22 Speed Search at Startup (Current Detection)

Speed Search after Short Baseblock

The timing chart for a short baseblock (when Inverter operation is restarted after power has been restored from a momentary power loss) is shown below.

- Loss Time Shorter than Minimum Baseblock Time (L2-03)

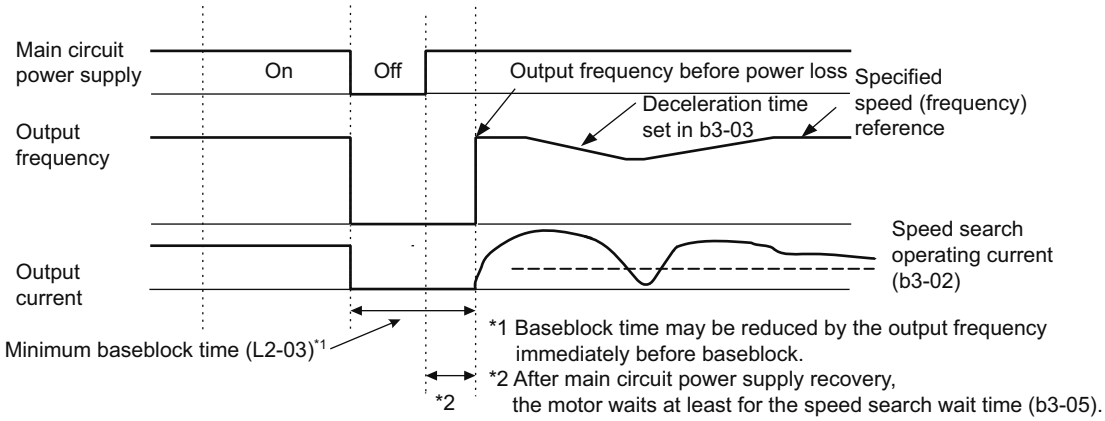


Fig 6.23 Speed Search after Baseblock (Current Detection: Loss Time < L2-03)

- Loss Time Longer than Minimum Baseblock Time (L2-03)

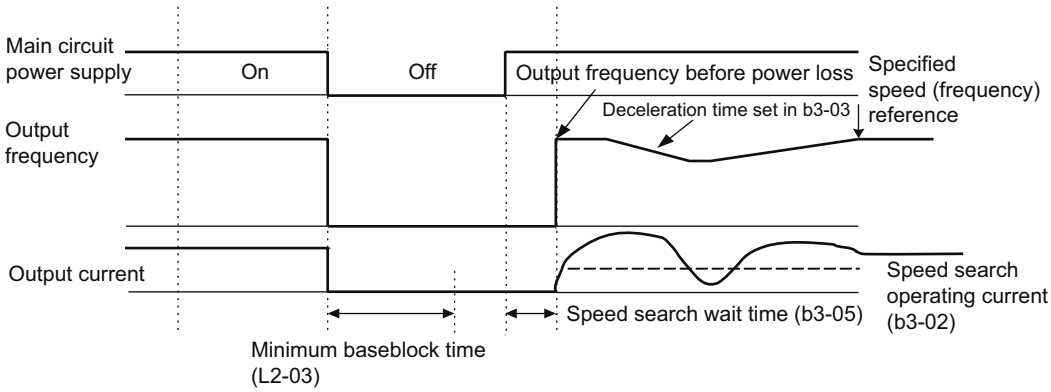


Fig 6.24 Speed Search after Baseblock (Current Detection: Loss Time > L2-03)

◆ Restarting Operation After Transient Fault (Auto Restart Function)

If an Inverter fault occurs during operation, the Inverter will perform a self-diagnosis. If no fault is detected, the Inverter will automatically restart using the speed search function (b3-01). This is called the auto restart function.

Set the number of auto restarts in L5-01. A fault reset will be attempted every 5 ms after a fault occurs and minimum baseblock time has passed. The number of auto restarts is counted when the Inverter attempts a fault reset and restarts operation. The protection function will activate if a fault continues to occur after auto restarting the number of times set in L5-01.

The auto restart function can be applied to the following faults. If a fault not listed below occurs, the protection function will activate (and the auto restart function will not).

- IOC (drive overcurrent)
- OGF (output side ground fault)
- OL2 (inverter overload)

■Auto Restart External Outputs

To output auto restart signals externally, set H2-□□ [multi-function contact output 1 (DO1) to 8 (DO8) function selection] to 1E (During auto restart).

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods		MEMOBUS Register
						Open-loop Vector	Flux Vector	
L5-01	Number of auto restart attempts Num of Restarts	Sets the number of auto restart attempts. Automatically restarts after a fault and conducts a speed search from the run frequency.	0 to 5	0	No	A	A	540H
L5-02	Auto restart operation selection Restart Sel	Sets whether a fault contact output is activated during auto restart. 0: Not output (Fault contact is not activated.) 1: Output (Fault contact is activated.)	0 or 1	0	No	A	A	541H
L5-03	Auto restart duration time Max Restart Time	Sets the maximum duration time for fault resetting operation during auto restart. Protective operation is activated if the fault is not cleared even when the set time has elapsed.	0.01 to 18.00	0.05	No	A	A	542H

■Application Precautions

- The counted number of auto restarts is reset under the following conditions:
  - After auto restart, normal operation has continued for 10 minutes.
  - After the protection operation has been performed, the fault has been verified, and a fault reset has been input.
  - After the power supply has been turned off, and then on again.
- Do not use the auto restart function when driving hoisting machines, such as elevators or cranes.

Input Terminal Functions

This section describes the input terminal functions, which set operating methods by switching the functions of the multi-function contact input terminals (S3 to S16).

◆ Temporarily Switching Operation between Digital Operator and Control Circuit Terminals

You can switch the Inverter Run Command inputs and speed (frequency) reference inputs between local (Digital Operator) and remote (input method selected using b1-01 and b1-02).

You can switch between local and remote by turning on and off the terminals if user constants H1-03 to H1-16 (multi-function contact input terminal S3 to S16 function selection) have been set to 1 (local/remote selection).

To input the Run Command or speed (frequency) reference from the control circuit terminals, set b1-01 or b1-02 to 1 (control circuit terminals).

The Run Command and speed (frequency) reference input from control circuit terminals are normally used via the PLC, so set b1-01 and b1-02 to 3 (PLC) and do not change this setting.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
b1-01	Speed (frequency) selection Reference Source	Sets the speed (frequency) reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A0H
b1-02	Operation method selection Run Source	Sets the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: PLC	0 to 3	3	No	Q	Q	1A1H

INFO

You can also perform local/remote switching using the LOCAL/REMOTE Key on the Digital Operator. When the local/remote function has been set in the multi-function contact input terminals, the LOCAL/REMOTE Key function on the Digital Operator will be disabled.

◆ Blocking Inverter Outputs (Baseblock Commands)

Set 8 or 9 (Baseblock command NO/NC) in one of the constants H1-03 to H1-16 (multi-function contact input terminal S3 to S16 function selection) to perform baseblock commands using the terminal's on/off operation, and stop Inverter output using the baseblock commands. At this time, the motor will be coasting and “BB” will blink on the Digital Operator.

When the baseblock command is cleared, operation is restarted by executing a speed search.

Multi-function Contact Inputs (H1-01 to H1-16)

Setting Value	Function	Control Methods	
		Open-loop Vector	Flux Vector
8	Baseblock command NO (NO contact) (On: Baseblock)	Yes	Yes
9	Baseblock command NC (NC contact) (Off: Baseblock)	Yes	Yes

■Timing Chart

The timing chart when using baseblock commands is shown below.

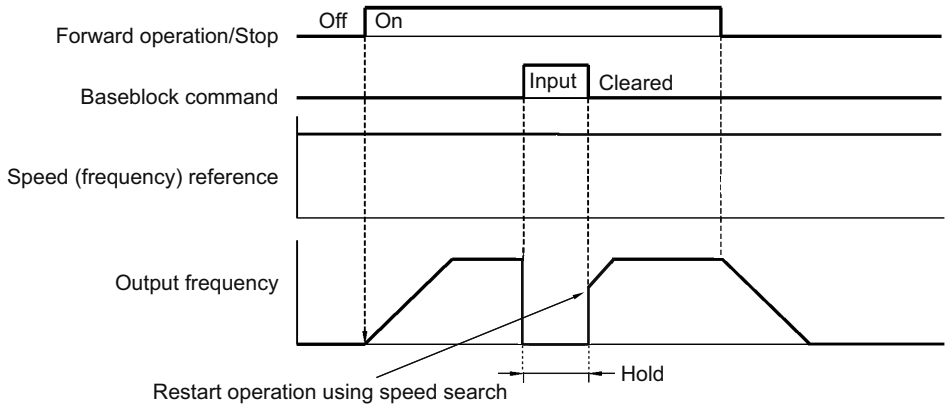


Fig 6.25 Baseblock Commands

◆ Raising and Lowering Speed (Frequency) References Using Contact Signals (UP/DOWN Command)

The UP and DOWN commands raise and lower Inverter speed (frequency) references by turning on and off a multi-function contact input terminal S3 to S16.

To use this function, set one of the constants H1-03 to H1-16 (Multi-function contact input terminal S3 to S16 function selection) to 10 (UP command) or 11 (DOWN command). Be sure to allocate two terminals so that the UP and DOWN commands can be used as a pair.

The output frequency depends on the acceleration and deceleration time. Be sure to set b1-02 (Operation method selection) to 1 (Control circuit terminal).

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
d2-01	Speed (frequency) reference upper limit Ref Upper Limit	Sets the upper limit of the speed (frequency) reference as a percentage, taking the max. output frequency as 100%.	0.0 to 110.0	100.0%	No	A	A	2E0H
d2-02	Speed (frequency) reference lower limit Ref Lower Limit	Sets the lower limit of the speed (frequency) reference as a percent age, taking the max. output frequency as 100%.	0.0 to 109.0	0.0%	No	A	A	2E1H

■Precautions

When setting and using UP and DOWN commands, observe the following precautions.

Setting Precautions

If multi-function contact input terminals S3 to S16 are set as follows, an operation error OPE03 (Invalid multi-function input selection) will occur:

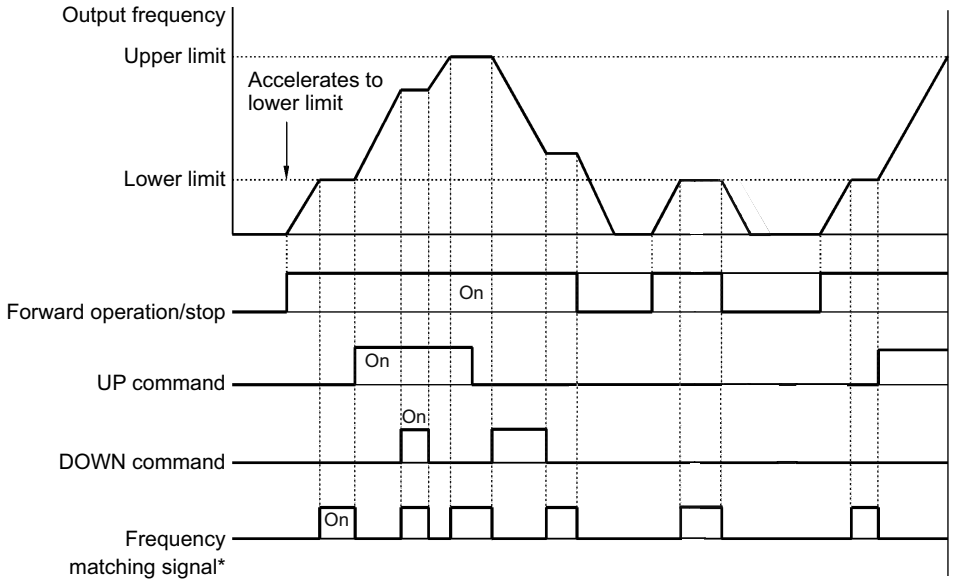
- Either the UP command or DOWN command has been set.
- UP/DOWN commands and an Acceleration/deceleration on hold command have been allocated at the same time.

Application Precautions

- Speed (frequency) reference outputs using UP/DOWN commands are limited by the speed (frequency) reference upper and lower limits set in constants d2-01 to d2-02. Here, the speed (frequency) reference from analog speed (frequency) reference terminal AI1 becomes the speed (frequency) reference lower limit. If using a combination of the speed (frequency) reference from terminal AI1 and the speed (frequency) reference lower limit set in d2-02, the larger lower limit will become the speed (frequency) reference lower limit.
- If inputting the Run Command when using UP/DOWN commands, the output frequency accelerates to the speed (frequency) reference lower limit.
- When using UP/DOWN commands, multi-step operations are disabled.

■Timing Chart

The timing chart when using the UP/DOWN command is shown below.



* The frequency matching signal turns on when the motor is not accelerating/decelerating while the Run Command is on.

Fig 6.26 UP/DOWN Commands Timing Chart

◆ Jog Speed (Frequency) Operation without Forward and Reverse Commands (FJOG/RJOG Command)

The FJOG/RJOG command functions operate the Inverter using jog speed (frequency) by using on/off operation of multi-function contact input terminals S3 to S16. When using the FJOG/RJOG commands, there is no need to input the Run Command.

To use this function, set one of the constants H1-03 to H1-16 (multi-function contact input terminal S3 to S16 function selection) to 12 (FJOG command) or 13 (RJOG command).

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
d1-17	Jog speed (frequency) reference Jog Reference	Sets the speed (frequency) reference when the jog speed (frequency) reference selection, FJOG command, or RJOG command is on for multi-function contact inputs.	0.00 to 100.00	10.00%	Yes	Q	Q	2D0H

Multi-function Contact Inputs (H1-03 to H1-16)

Setting Value	Function	Control Methods: Open-loop Vector	Control Methods: Flux Vector
12	FJOG command [On: Forward operation at jog speed (frequency) d1-17]	Yes	Yes
13	RJOG command [On: Reverse operation at jog speed (frequency) d1-17]	Yes	Yes

■Application Precautions

- Jog speed (frequency) references using FJOG and RJOG commands are given priority over other speed (frequency) references.
- When both the FJOG command and the RJOG command are on for 500 ms or longer at the same time, the Inverter stops according to the setting in b1-03 (stopping method selection).

◆ Stopping the Inverter by Notifying Peripheral Device Errors to the Inverter (External Fault Function)

The external fault function operates the error contact output, and stops the Inverter operation if the Inverter peripheral devices break down or an error occurs. The Digital Operator will display EFx [External fault (input terminal Sx)]. The x in EFx shows the terminal number of the terminal that inputs the external fault signal. For example, if an external fault signal is input to terminal S3, EF3 will be displayed.

To use the external fault function, set one of the values 20 to 2F in one of the constants H1-03 to H1-16 (multi-function contact input terminal S3 to S16 function selection).

Select the value to be set in H1-03 to H1-16 based on the combination of the following three conditions.

- Signal input level from peripheral devices
- External fault detection method
- Operation during external fault detection (major fault)

The following table shows the relationship between the combinations of conditions and the set values in H1-□□.

Set Value	Signal Input Level*1		Fault Detection Method*2		Operation During Fault Detection			
	NO Contact	NC Contact	Constant Detection	Detection during Operation	Deceler-ate to Stop (Error)	Coast to Stop (Error)	Emer-gency Stop (Error)	Continue Operation (Alarm)
20	Yes		Yes		Yes			
21		Yes	Yes		Yes			
22	Yes			Yes	Yes			
23		Yes		Yes	Yes			
24	Yes		Yes			Yes		
25		Yes	Yes			Yes		
26	Yes			Yes		Yes		
27		Yes		Yes		Yes		
28	Yes		Yes				Yes	
29		Yes	Yes				Yes	
2A	Yes			Yes			Yes	
2B		Yes		Yes			Yes	
2C	Yes		Yes					Yes
2D		Yes	Yes					Yes
2E	Yes			Yes				Yes
2F		Yes		Yes				Yes

* 1. Set the input level to detect errors, using either signal on or signal off. (NO contact: External fault when on; NC contact: External fault when off).

* 2. Set the detection method to detect errors, using either constant detection or detection during operation.
Constant detection: Detects while power is supplied to the Inverter.
Detection during operation: Detects only during Inverter operation.

Output Terminal Functions

The output terminal function, which sets the output methods by switching the functions of the multi-function output terminals (DO1 to DO8), is described here.

■During Run (Setting: 0)

Outputting turns on when the Run Command is input or the Inverter is outputting a voltage.

Off	The Run Command is off.
On	The Run Command is on or a voltage is being output.

■During Run 2 (Setting: 37)

Outputting turns on when the Inverter is outputting a frequency.

Off	Baseblock, DC injection braking, pre-excitation, or stopped
On	The Inverter is outputting a frequency.

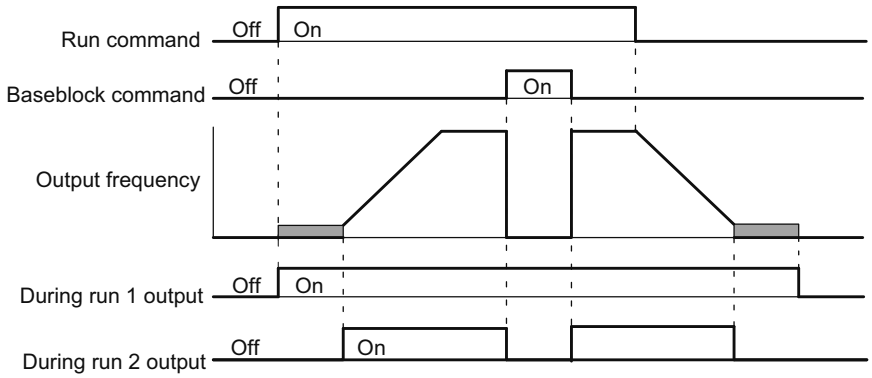


Fig 6.27 Timing Chart for During Run Output

■Zero-speed (Setting: 1)

The output turns on when the output frequency falls to or below the minimum output frequency (E1-09).

Off	The output frequency is the minimum output frequency (E1-09) or greater. [With flux vector control, the motor speed is the zero-speed level (b2-01) or greater.]
On	The output frequency is less than the minimum output frequency (E1-09). [With flux vector control, the motor speed is less than the zero-speed level (b2-01).]

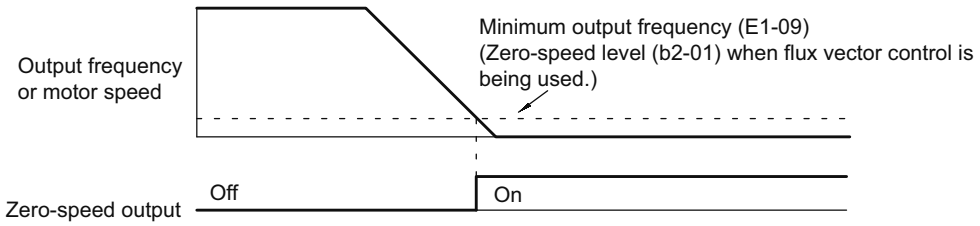


Fig 6.28 Timing Chart for Zero-speed Output

■Speed (frequency) reference limit (Setting: 31)

The output turns on when a limit is imposed on the speed (frequency) reference.

Off	Other than on condition
On	Enables the speed (frequency) reference limit in the following conditions (in the flux vector control method): • Speed (frequency) reference ≥ Speed (frequency) reference upper limit (d2-01) or Speed (frequency) reference ≤ Speed (frequency) reference lower limit (d2-02) or Speed (frequency) reference ≤ Output frequency lower limit of the multi-function analog input (Setting: 9) • The speed (frequency) reference is the Min. output frequency (E1-09) or less, and b1-05 is set to 1, 2, or 3.

Monitor Constants

This section describes the analog monitor constants.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
H4-01	AO1 Monitor output selection (multi-function AO) / Term AO1 Signal	Sets a multi-function analog output function for terminal AO1.	0 to 99	2	Yes	A	A	470H
H4-02	Output gain (terminal AO1) / Term AO1 Gain	Sets the voltage level gain of terminal AO1. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	471H
H4-03	Output bias (terminal AO1) / Term AO1 Bias	Sets the voltage level bias of terminal AO1. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	472H
H4-04	AO2 Monitor output selection (multi-function AO) / Term AO2 Signal	Sets a multi-function analog output function for terminal AO2.	0 to 99	3	Yes	A	A	473H
H4-05	Output gain (terminal AO2) / Term AO2 Gain	Sets the voltage level gain of terminal AO2. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	474H
H4-06	Output bias (terminal AO2) / Term AO2 Bias	Sets the voltage level bias of terminal AO2. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	475H
H4-07	AO3 Monitor output selection (multi-function AO) / Term AO3 Signal	Sets a multi-function analog output function for terminal AO3.	0 or 99	5	Yes	A	A	476H
H4-08	Output gain (terminal AO3) / Term AO3 Gain	Sets the voltage level gain of terminal AO3.Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	477H
H4-09	Output bias (terminal AO3) / Term AO3 Bias	Sets the voltage level bias of terminal AO3. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	478H

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
H4-10	AO4 Monitor output selection (multi-function AO) Term AO4 Signal	Sets a multi-function analog output function for terminal AO4.	0 to 99	9	Yes	A	A	479H
H4-11	Output gain (terminal AO4) Term AO4 Gain	Sets the voltage level gain of terminal AO4. Set the multiplying factor of 10 V for outputting 100% output of the monitor item. The maximum output from the terminal is 10 V.	0.00 to 30.00	1.00	Yes	A	A	47AH
H4-12	Output bias (terminal AO4) Term AO4 Bias	Sets the voltage level bias of terminal AO4. Set the value as a percentage, taking 10 V as 100%. The maximum output from the terminal is 10 V.	-100.0 to 100.0	0.0%	Yes	A	A	47BH
H4-13	Analog output signal level selection Signal Select	Sets the signal level of four analog outputs. 0: 0 to +10 V 1: -10 to +10 V	0 or 1	1	No	A	A	47CH

■Selecting Analog Monitor Items

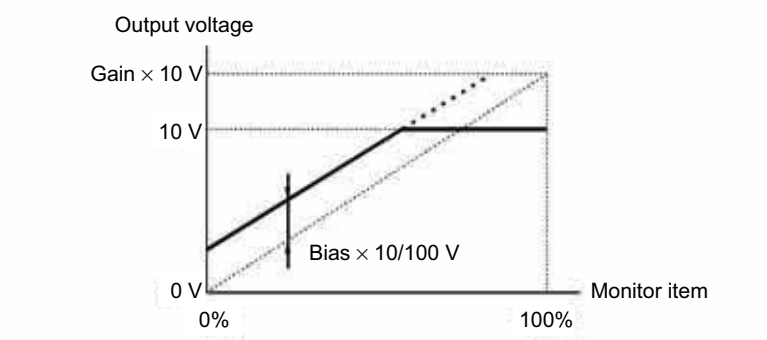
The Digital Operator monitor items U1-□□ (status monitor) are output from multi-function analog output terminals AO1 to AO4. Refer to *Chapter 5 User Constants*, and set the values for the □□ part of U1-□□ (status monitor).

■Adjusting the Analog Monitor

The output voltage for multi-function analog output terminals AO1 to AO4 can be adjusted using the gain/bias set for H4-02/H4-03, H4-05/H4-06, H4-08/H4-09, and H4-11/H4-12.

For example, for terminal AO1, press the ENTER Key with H4-02 or H4-03 displayed to display the data setting screen. Change the settings on the data setting screen. The voltage shown below will be output to terminal AO1.

10 V/100% monitor output × output gain (H4-02) + output bias (H4-03)



■Switching Analog Monitor Signal Levels

By setting H4-13 to 1, monitor items covering the range of −10 V to 10 V output 0 V to 10 V when the monitor value is positive (+), and 0 V to −10 V when the monitor value is negative (−). To output signals at 0 V to −10 V, use an extra isolation amplifier (ISOAMP) compatible with 0 V to −10 V in the control circuit. For monitor items, refer to *Chapter 5 User Constants*.

Digital Operator Functions

This section describes the Digital Operator functions.

◆ Setting Digital Operator Functions

You can set Digital Operator-related constants such as selecting the Digital Operator display and multi-function selections.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
o2-01	LOCAL/REMOTE key function selection Local/Remote Key	Sets the Digital Operator LOCAL/REMOTE Key functions. 0: Disabled 1: Enabled (Switches between the operation using the Digital Operator and the operation set in the constants.)	0 or 1	1	No	A	A	6F0H
o2-02	STOP key function selection Oper STOP Key	Sets the STOP Key functions. 0: Disabled (When Run Commands are issued from a device other than the Digital Operator, the STOP Key is disabled.) 1: Enabled (The STOP Key is always effective during run.)	0 or 1	0	No	A	A	6F1H
o2-05	Speed (frequency) reference setting Operator M.O.P.	Sets whether the Enter Key is necessary when the speed (frequency) reference is set on the Digital Operator speed (frequency) reference monitor. 0: Enter Key necessary 1: Enter Key not necessary When set to 1, the Inverter accepts the speed (frequency) reference without pressing the Enter Key.	0 or 1	0	No	A	A	6F4H
o2-07	Cumulative operation time setting Elapsed Time Set	Sets the initial value of the cumulative operation time (U1-13) in units of hours. Operation time is accumulated starting from the set value.	0 to 65535	0 hr	No	A	A	6F6H

■Disabling the LOCAL/REMOTE Key

By setting o2-01 to 0, the LOCAL/REMOTE Key on the Digital Operator is disabled. Inputting of commands from the Digital Operator, switching of the source of Run Commands set by b1-01 [speed (frequency) reference selection) and b1-02 (Run Command selection) cannot be performed.

■Disabling the STOP Key

If b1-02 (Operation method selection) is set to 1, 2, or 3, the Stop Command from the STOP Key on the Digital Operator is disabled.

Set o2-02 to 1 to enable Emergency Stop Commands from the STOP Key on the Digital Operator.

■Setting the Speed (Frequency) Reference using the UP and DOWN Keys without Using the Enter Key

Use this function when inputting speed (frequency) references from the Digital Operator. When o2-05 is set to 1, you can increment and decrement the speed (frequency) reference using the UP and DOWN Keys without using the ENTER Key.

For example, enter the Run Command using a 0% reference, and then continuously press the UP Key to increment the speed (frequency) reference by 0.01% only for the first 0.5 s, and then by 0.01% every 80 ms for 3 s thereafter. If the UP Key is pressed and held down for 3 s or more, the speed (frequency) reference will reach the maximum output frequency in 10 seconds. The speed (frequency) reference that has been set will be stored in memory 5 s after the UP or DOWN Key is released.

■Clearing Cumulative Operation Time

Set the cumulative operation time initial value in units of hours in constant o2-07. Set o2-07 to 0 to clear U1-13 (Cumulative operation time).

◆ Prohibiting Writing Constants from the Digital Operator

By setting A1-01 to 0, you can refer to and set a group of constants, A1-01, A1-04, and A1-11 to A1-13, and refer to the drive mode, using the Digital Operator.

If one of the constants H1-03 to H1-16 (Multi-function contact input terminal S3 to S16 function selection) is set to 1B (Write constants permitted), constants cannot be written even if A1-01 is set to 2 unless the set terminal is on. It is possible, however, to refer to constants.

■Related Constants

Constant No.	Name: Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
A1-01	Constant access level Access Level	Sets the constant access level (set/monitor). 0: Monitoring only (Monitoring drive mode and setting A1-01, A1-04, A1-11 and A1-13.) 2: Advanced (Constants can be monitor and set in both quick programming (Q) mode and advanced programming (A) mode.)	0 or 2	2	No	A	A	101H

◆ Setting Passwords

If a password is set for A1-05, the setting of constants A1-01 to A1-03 cannot be changed unless the set values in A1-04 and A1-05 match.

By setting A1-01 to 0 (Monitoring only) and using the password function, setting and referencing of all constants excluding A1-00, A1-01, A1-04, and A1-11 to A1-13, can be prohibited.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
A1-01	Constant access level Access Level	Sets the constant access level (set/monitor). 0: Monitoring only (Monitoring drive mode and setting A1-01, A1-04, A1-11 to A1-13.) 2: Advanced (Constants can be monitor and set in both quick programming (Q) mode and advanced programming (A) mode.)	0 or 2	2	No	A	A	101H
A1-04*	Password 1 (for inputting) Enter Password	Inputs the password when a password has been set in A1-05. This function write-protects some constants of the initialize mode. If the password does not match, A1-01 to A1-03 constants can no longer be changed. (Programming mode constants can be changed.)	0 to 9999	0	No	A	A	104H
A1-05*	Password setting Select Password	Sets a four digit number as the password. This constant is not usually displayed. When the Password (A1-04) is displayed, hold down the RESET Key and press the Menu Key and this constant will be displayed.	0 to 9999	0	No	A	A	105H

* This setting is applicable for FSDrive-MV1S with software version S0107 or later.

■Setting Precautions

Constant A1-05 is not displayed in normal key operations. To display the constant, press the MENU Key while holding down the RESET Key with A1-04 displayed.

Inverter Protection

This section describes the functions for protecting the Inverter.

◆ Performing Overload Protection (Applicable software versions: S0107 or later)

Overload protection of the Inverter is implemented using the Inverter-mounted electronic thermal relays.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
L8-14*	Inverter protection function selection Inverter OL Sel	Enables or disables the Inverter protection function by using an electronic thermal relay. Do not change from the factory setting. 0: Disabled 1: Enabled	0 or 1	0	No	A	A	57DH

* This setting is applicable for FSDrive-MV1S with software version S0107 or later.

The factory setting is 0 (disabled). Before using the Inverter in the overloaded range, be sure to change the setting to 1 (enabled).

■Overload Protection Characteristics

The following figure shows the overload protection characteristics of an inverter when electronic thermal relays are used.

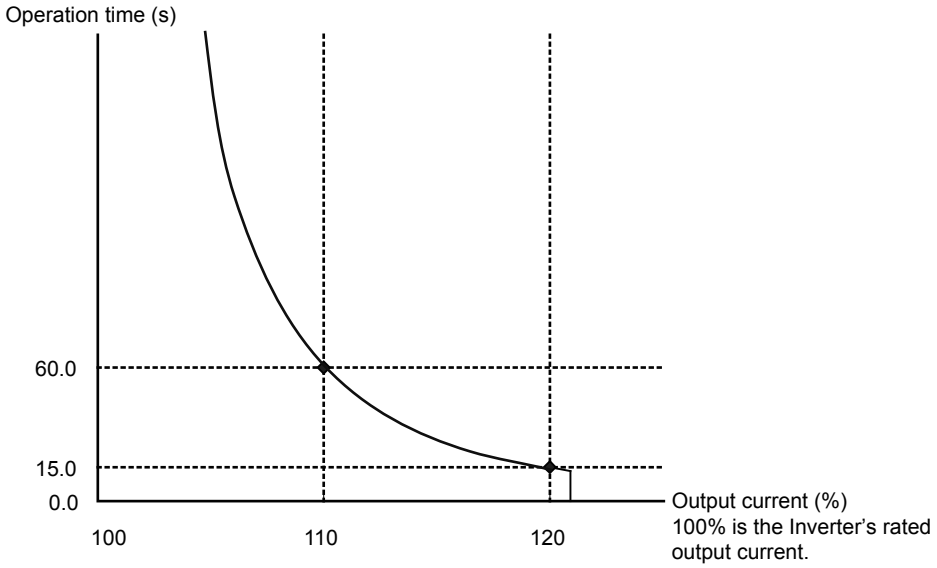


Fig 6.29 Overload Protection Characteristics

Individual Functions

This section describes the individual functions used in special applications.

◆ Performing Speed Control with PG

This section describes functions with Flux vector control.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
H7-01	PG constant PG Pulses/Rev	Sets the number of PG (pulse generator or encoder) pulses. Set the number of pulses per motor revolution without multiplying.	0 to 8192	600*	No	No	Q	4A0H
H7-02	Operation selection at PG disconnection detection PG Fdbk Loss Sel	Sets the stopping method when PG disconnection (PGO) is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation Do not select any value other than 1 (coast to stop) In the case of a differential input, this setting is disregarded. PG disconnection detection by the circuit operates and the motor coasts to stop.	0 to 3	1	No	No	A	4A1H
H7-04	Operation selection at excessive speed deviation PG Deviation Sel	Sets the stopping method when an excessive speed deviation (DEV) is detected. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop 3: Continue operation	0 to 3	3	No	No	A	4A3H
H7-05	PG rotation direction PG Rotation Sel	Sets the rotation direction of the PG. 0: Phase A leads with forward run command. 1: Phase A leads with reverse Run Command.	0 or 1	1*	No	No	A	4A4H
H7-08	Overspeed detection level PG Overspd Level	Sets the overspeed detection method. When frequencies beyond the level set in H7-08 (set as a percentage, taking the maximum output frequency as 100%) continue for the time set in H7-09 (detection time: seconds), an overspeed is detected.	0 to 120	115%	No	No	A	4A7H
H7-09	Overspeed detection delay time PG Overspd Time		0.0 to 2.0	0.0 s*	No	No	A	4A8H

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
H7-10	Excessive speed deviation detection level PG Deviate Level	Sets the speed deviation detection method. When speed deviations beyond the level set in H7-10 (set as a percentage, taking the maximum output frequency as 100%) continue for the time set in H7-11 (detection time: seconds), an excessive speed deviation is detected. Speed deviation is the difference between actual motor speed and the reference speed.	0 to 50	10%	No	No	A	4A9H
H7-11	Excessive speed deviation detection delay time PG Deviate Time		0 to 10.0	0.5 s	No	No	A	4AAH
H7-14	PG disconnection detection delay time PGO Detect Time	Sets the PG disconnection detection time in seconds. In the case of a differential input, this setting is disregarded. PG disconnection detection by the circuit operates and the motor coasts to stop.	0.0 to 10.0	3.0 s	No	No	A	4ADH

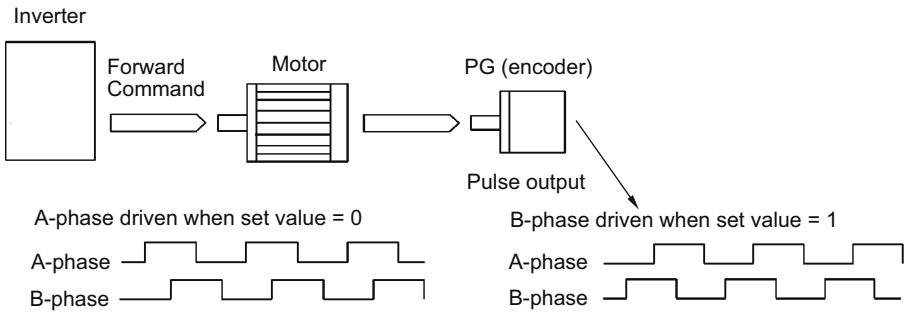
* The factory setting will change when the control method is changed.

■Setting the Number of PG Pulses

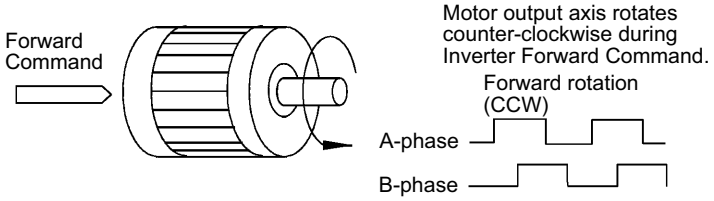
Set the number of PG (Pulse Generator/Encoder) pulses as a pulses/rotation value. Set the number of A-phase or B-phase pulses per 1 motor rotation in H7-01.

■Matching PG Rotation Direction and Motor Rotation Direction

Constant H7-05 matches the PG rotation direction and the motor rotation direction. If the motor is rotating forwards, set whether it is A-phase driven or B-phase driven.



Example: Forward rotation of standard Yaskawa motor [PG used: Samtack (KK)]



Yaskawa standard PG used is B-phase driven (CCW) when motor rotation is forward.

Fig 6.30 PG Rotation Direction Setting

Generally, PG is A-phase driven when rotation is clockwise (CW) seen from the input axis. Also, motor rotation is counter-clockwise (CCW) seen from the output side when Forward Commands are output. Consequently, when a general PG is mounted on the load side with forward motor rotation, the PG is A-phase driven, and it is B-phase driven when mounted opposing the load.

■Detecting PG Disconnection

When PG cable disconnection (PGO) is detected, the motor coasts to a stop.

Do not change the setting of constant H7-02 from 1 (Coast to stop).

■Detecting Motor Overspeed

An error (major fault) is detected when the motor speed exceeds the regulated limit. An overspeed (OS) is detected when a frequency that exceeds the set value in H7-08 continues for the time set in H7-09 or longer. When an overspeed (OS) is detected, the motor coasts to a stop.

■Detecting Speed Difference between the Motor and Speed (Frequency) Reference

An error (major fault) is detected when the speed deviation (the difference between the designated speed and the actual motor speed) is excessive. Excessive speed deviation (DEV) is detected when a condition where the speed (frequency) reference and the actual motor speed are within the value set for L4-02 and the speed deviation is equal to or larger than the value set for H7-10, and continues for the time set for H7-11 or longer after a speed agreement is detected. After the detection of the excessive speed deviation (DEV), the Inverter stops in accordance with the setting of H7-04.

◆ Energy-saving Control (Applicable software versions: S0107 or later)

To perform energy saving control, set b8-01 (Energy-saving mode selection) to 1.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b8-01	Energy-saving mode selection / Energy Save Sel	Sets whether to enable or disable energy-saving control. 0: Disable 1: Enable	0 or 1	0	No	A	A	220H
b8-02	Energy-saving control gain / Energy Save Gain	Sets the energy-saving control gain. The energy-saving effect is reduced when the setting value is decreased. Setting 0.00 disables this energy-saving control.	0.0 to 0.75	0.75	No	A	No	221H
b8-03	Energy-saving control filter time constant / Energy Save F.T	Sets the energy-saving control filter time constant.	0.00 to 10.00	2.00 s	No	A	No	222H

■Adjusting Energy-saving Control

The current references are calculated so that the output current is minimized. If the motor shows hunting, reduce the value set for b8-02 (Energy-saving control gain), or increase the value set for b8-03 (Energy-saving filter time constant).

◆ Torque Control

With flux vector control, the motor's output torque can be controlled by a torque reference from an analog input. To control torque, set d5-01 to 1 or set H1-□□ (multi-function contact input function selection S3 to S16) to 71 (Speed/torque control change) and turn ON the contact.

■Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
d5-01	Torque control selection Torq Control Sel	0: Speed control 1: Torque control To use the function for switching between speed and torque control, set this constant to 0 and set the multi-function input to speed/torque control change.	0 or 1	0	No	No	A	310H
d5-02	Torque reference primary delay time constant Torq Ref Filter	Sets the primary delay time constant of the torque reference filter in milliseconds. This function can be used to eliminate the noise of the torque reference signal or to adjust the responsiveness with the host controller. When oscillation occurs during torque control, increase the set value.	0 to 1000	0 ms	No	No	A	311H
d5-03	Speed limit selection Speed Limit Sel	Sets the speed limit command method for the torque control. 1: Limited by a speed (frequency) reference (refer to b1-01) 2: Limited by d5-04 constant setting value.	1 or 2	1	No	No	A	312H
d5-04	Speed limit Speed Lmt Value	Sets the speed limit during torque control as a percentage, taking the maximum output frequency as 100%. This function is enabled when d5-03 is set to 2. Directions are as follows. +: Run Command direction -: Opposite to Run Command direction	-120 to 120	0%	No	No	A	313H
d5-05	Speed limit bias Speed Lmt Bias	Sets the speed limit bias as a percentage, taking the maximum output frequency as 100%. Bias is applied to the specified speed limit. It can be used to adjust the margin for the speed limit.	0 to 120	10%	No	No	A	314H

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
d5-06	Speed/torque control switching timer Ref Hold Time	Sets the delay time from inputting speed/torque control change set for a multi-function input (from off to on or on to off) until the control is actually changed, in milliseconds. This function is enabled when speed/torque control change is set for a multi-function input. For the time set for the speed/torque control switching timer, the analog inputs (torque reference, speed limit) hold the values at the time that the speed/torque control change took place. Complete external preparations for the change during this period.	0 to 1000	0 ms	No	No	A	315H
H3-04	Signal level selection (terminal AI2) Term AI2 Signal	Selects the input signal level of terminal AI2. 0: 0 to 10 V 1: -10 V to 10 V	0 or 1	0	No	A	A	453H
H3-05	AI2 function selection Term AI2 Sel	Sets the multi-function analog input function for terminal AI2.	0 to 1F	F	No	A	A	454H
H3-06	Input gain (terminal AI2) Term AI2 Gain	Sets the input gain of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	455H
H3-07	Input bias (terminal AI2) Term AI2 Bias	Sets the input bias of terminal AI2. Set the reference value of the function selected in H3-05 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	456H
H3-08	Signal level selection (terminal AI3) Term AI3 Signal	Selects the input signal level of terminal AI3. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	457H
H3-09	Function selection (terminal AI3) Term AI3 Sel	Sets the multi-function analog input function for terminal AI3.	0 to 1F	F	No	A	A	458H
H3-10	Input gain (terminal AI3) Term AI3 Gain	Sets the input gain of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	459H
H3-11	Input bias (terminal AI3) Term AI3 Bias	Sets the input bias of terminal AI3. Set the reference value of the function selected in H3-09 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45AH
H3-12	Signal level selection (terminal AI4) Term AI4 Signal	Selects the input signal level of terminal AI4. 0: 0 to 10V 1: -10V to 10V	0 or 1	0	No	A	A	45BH

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
H3-13	Function selection (terminal AI4) Term AI4 Sel	Sets the multi-function analog input function for terminal AI4.	0 to 1F	F	No	A	A	45CH
H3-14	Input gain (terminal AI4) Term AI4 Gain	Sets the input gain of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 10 V input as 100%.	0.0 to 1000.0	100.0%	Yes	A	A	45DH
H3-15	Input bias (terminal AI4) Term AI4 Bias	Sets the input bias of terminal AI4. Set the reference value of the function selected in H3-13 as a percentage, taking the 0 V input as 100%.	-100.0 to 100.0	0.0%	Yes	A	A	45EH
H3-16	Analog input filter time constant Filter Avg Time	Sets the primary delay filter time constant in seconds for the four analog input terminals. Effective for noise control etc.	0.00 to 2.00	0.00 s	No	A	A	45FH

Multi-function Contact Inputs (H1-03 to H1-16)

Setting Value	Function	Control Methods Open-loop Vector	Control Methods Flux Vector
71	Speed/torque control change (ON: Torque control)	No	Yes
77	Speed control (ASR) proportional gain switch (On: C5-03, Off: Gain determined by C5-01 and C5-03)	No	Yes

Multi-function Contact Outputs (H2-01 to H2-08)

Setting Value	Function	Control Methods Open-loop Vector	Control Methods Flux Vector
32*	During speed limiter circuit operation (On: Speed control active) (except when stopped)	No	Yes
37	During run 2 (On: Frequency output, Off: Base block, DC injection braking, pre-excitation, operation stop)	Yes	Yes

* This setting is applicable for FSDrive-MV1S with software version S0112 or later.

Multi-function Analog Inputs (H3-05, H3-09, H3-13)

Setting Value	Function	Contents (100%)	Control Methods	
			Open-loop Vector	Flux Vector
10	Positive torque limit	Motor rated torque	Yes	Yes
11	Negative torque limit	Motor rated torque	Yes	Yes
12	Regenerative torque limit	Motor rated torque	Yes	Yes
13	Torque reference at torque control/Torque limit at speed control	Motor rated torque	No	Yes
14	Torque compensation	Motor rated torque	No	Yes
15	Positive/negative torque limit	Motor rated torque	Yes	Yes

Monitor Function

Constant No.	Name	Description	100% Value	Digital Operator Display Unit	Control Methods		MEMOBUS Register
	Digital Operator Display				Open-loop Vector	Flux Vector	
U1-09	Torque reference (internal) Torque Reference	Monitors the internal torque reference value.	Motor rated torque	0.1%	A	A	48H

■Inputting Torque References and Torque Reference Directions

The torque reference can be changed according to an analog input by setting H3-05 (Multi-function analog input terminal AI2 selection), H3-09 (Multi-function analog input terminal AI3 selection), or H3-13 (Multi-function analog input terminal AI4 selection) to 13 [Torque reference at torque control/Torque limit at speed control] or 14 (Torque compensation). The torque reference input methods are listed in the following table.

Torque Reference Input Method	Reference Location	Selection Method	Remarks
Voltage input (–10 V to 10 V)	Connector CN40-1, 2 (AI2)	H3-04 = 1 H3-05 = 13	Set H3-04 = 0 to command a torque reference within the range of 0 V to 10 V.
	Connector CN41-1, 2 (AI3)	H3-08 = 1 H3-09 = 13	Set H3-08 = 0 to command a torque reference within the range of 0 V to 10 V. By setting H3-09 = 14, the input can be used for torque compensation.
	Connector CN42-1, 2 (AI4)	H3-12 = 1 H3-13 = 13	Set H3-12 = 0 to command a torque reference within the range of 0 V to 10 V. By setting H3-13 = 14, the input can be used for torque compensation.

The direction of the torque output from the motor will be determined by the sign of the analog signal input. It does not depend on the direction of the Run Command. The direction of torque will be as follows:

- Positive analog reference: Torque reference for forward motor rotation (counterclockwise as viewed from the motor output axis).
- Negative analog reference: Torque reference for reverse motor rotation (clockwise as viewed from the motor output axis).

Application Precautions

If the analog signal input level is 0 V to 10 V, only the forward torque reference will be applied. To apply reverse torque, use an input level of -10 V to 10 V.

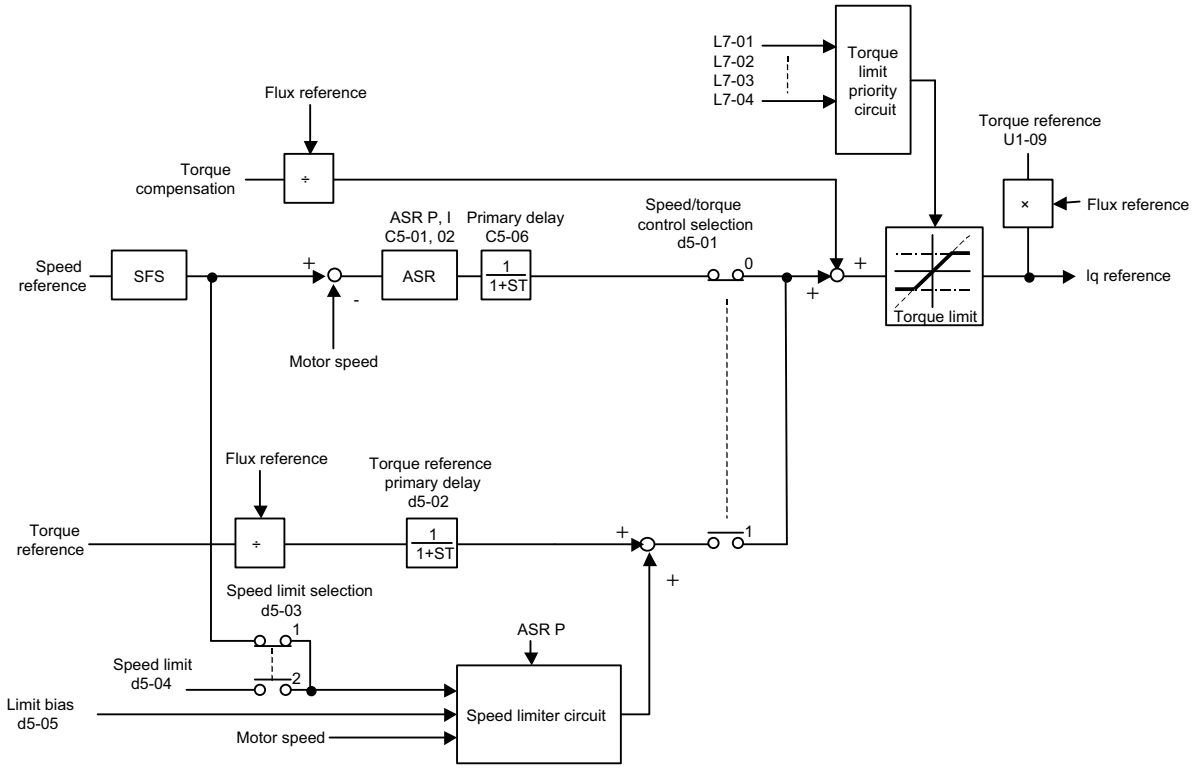


Fig 6.31 Torque Control Block Diagram

■Speed limiter circuit

If the external torque reference and load are not balanced during torque control, the motor will accelerate in either the forward or reverse direction. The speed limiter circuit is used to limit the speed within the specified value.

When the motor speed exceeds the speed limit value during torque control, the speed limiter circuit generates the suppression torque proportional to the speed above the limit value and adds to the torque reference.

Application Precautions

There are two ways to set a speed limit: using an input from an analog input terminal and setting a speed limit in d5-04. The inputs methods for a speed limit are listed in the following table.

Speed Limit Input Method	Reference Location	Selection Method	Remarks
Parameter setting	Set in d5-04	d5-03 = 2	–
Voltage input (−10 V to 10 V)	Connector CN39-1, 2 (AI1)	b1-01 = 1 H3-01 = 1	Set H3-01 to 0 if the speed limit is always to be positive.
	Connector CN40-1, 2 (AI2)	b1-01 = 0 H3-04 = 1 H3-05 = 1	Sum with the input at terminal AI1 becomes the speed limit. Set H3-04 to 0 if the reference at AI2 is always to be positive.
	Connector CN41-1, 2 (AI3)	b1-01 = 0 H3-08 = 1 H3-09 = 1	Sum with the input at terminal AI1 becomes the speed limit. Set H3-08 to 0 if the reference at AI3 is always to be positive.
	Connector CN42-1, 2 (AI4)	b1-01 = 0 H3-12 = 1 H3-13 = 1	Sum with the input at terminal AI1 becomes the speed limit. Set H3-12 to 0 if the reference at AI4 is always to be positive.

IMPORTANT

The direction in which speed is controlled is determined by the sign of the speed limit signal and the direction of the Run Command.
Positive voltage applied: The speed in the forward direction will be limited for forward operation.
Negative voltage applied: The speed in the reverse direction will be limited for reverse operation.
If the direction of motor rotation and the command direction are not the same, speed will be limited to 0 as long as b5-05 is set to 0.

■Setting Speed Limit Bias

The same speed limit bias can be set for the forward and reverse sides, and is different from the speed limit. Set d5-04 to 0, and set the speed limit bias (d5-05) as a percentage of the maximum output frequency.
When setting both forward and reverse speed limit biases to 50%, set the speed limit to 0 (d5-03 = 2, d5-04 = 0, d5-05 = 50). The torque control range with these settings is between −50% and +50% of the speed.
When using the speed limit together with the speed limit bias, the torque control range will be limited by the speed limit + the speed limit biases on the forward and reverse sides of the speed limit range.

When the forward speed limit is set to 50% and the speed limit bias is 10%, the torque control range will be as shown in the figure below.

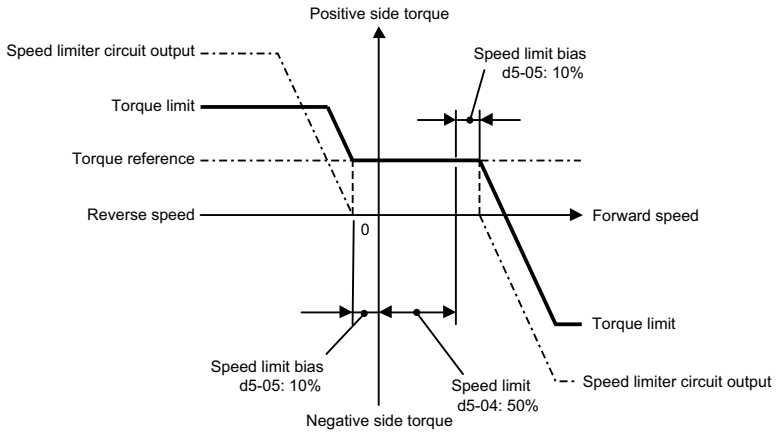


Fig 6.32 Speed Limit Bias Setting

■Torque Control Operation Examples

Operation examples will be described separately for the winding operation, in which the speed and motor torque are in the same directions, and the unwinding operation, in which the speed and motor torque are in opposite directions.

Winding Operation

In a winding operation, the line (speed) and torque generated by the motor are in the same direction, and both the speed limit and the torque reference input are positive. The motor will accelerate when the torque reference input is larger than the load and decelerate when it is smaller than the load. If the motor rotation exceeds the speed limit, a negative compensation value is output from the speed limiter circuit. When the rotation speed then drops below the speed limit, a positive compensation value is output. The torque compensation is value proportional to the ASR proportional gain. When the sum of the torque reference value and the torque compensation value output by the speed limiter circuit is the same as the actual load, the motor will stop accelerating and run at a constant speed.

Unwinding Operation

In a unwinding operation, the line (speed) and torque generated by the motor are in the opposite directions. (In this example, we'll assume that the line speed is positive and the torque reference input is negative.) For this unwinding operation, the speed limit is positive and the torque reference input is negative. If the motor rotation exceeds the speed limit, a negative compensation value is output from the speed limiter circuit. If the motor is rotating in reverse, a positive compensation value is output. If the speed is 0 or is below the speed limit, a 0 compensation value is output. In this way, the output from the speed limiter circuit is used to maintain the motor speed between 0 and the speed limit. When the sum of the torque reference value and the torque compensation value output by the speed limiter circuit is the same as the actual load, the motor will stop accelerating and run at a constant speed.

<table>
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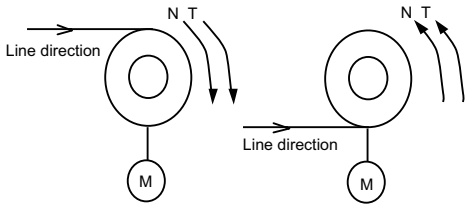
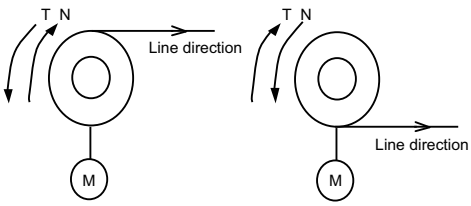
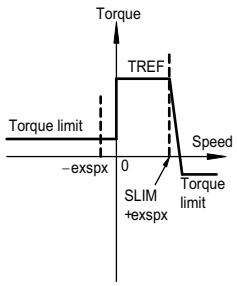
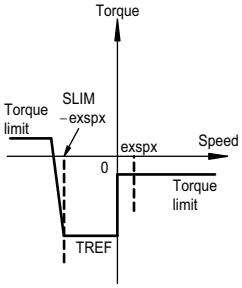
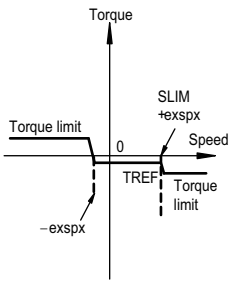
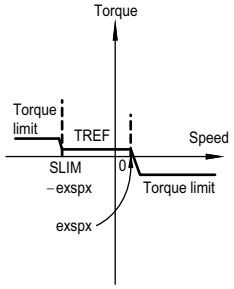
<tr><td colspan="2">Configuration</td><td colspan="2"> 
</td><td colspan="2"> 
</td></tr>
<tr><td colspan="2">Normal Rotation Direction</td><td>Forward</td><td>Reverse</td><td>Forward</td><td>Reverse</td></tr>
<tr><td rowspan="2">Reference Polarity</td><td>Torque Reference Polarity (TREF)</td><td>–</td><td>–</td><td>–</td><td>+</td></tr>
<tr><td>Speed Limit Polarity (SLIM)</td><td>+</td><td>–</td><td>+</td><td>–</td></tr>
<tr><td colspan="2">Generated Torque</td><td> 

exspx: Speed limit bias</td><td> 
</td><td> 
</td><td> 
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■Torque Reference Adjustment

Consider the following information when adjusting the torque.

Torque Reference Primary Delay Time Constant: d5-02

The time constant of the primary filter in the torque reference section can be adjusted. This constant is used to eliminate noise in the torque reference signal and adjust the responsiveness to the host controller. Increase the setting if oscillation occurs during torque control.

Setting the Torque Compensation

Set multi-function analog input terminal AI2, AI3 or AI4 to 14 (Torque compensation). When the amount of torque loss due to mechanical loss or other factors at the load is input to one of these terminals, it is added to the torque reference to compensate for the loss. The direction of torque will be as follows:

- Positive voltage: Torque compensation reference for forward motor rotation (counterclockwise as viewed from the motor output axis).
- Negative voltage: Torque compensation reference for reverse motor rotation (clockwise as viewed from the motor output axis).

Since the polarity of the voltage input determines the direction, only forward torque compensation can be input when the 0 V to 10 V analog input signal level has been selected. If you want to input reverse torque compensation, be sure to select the -10 V to 10 V signal level.

■Speed/Torque Control Switching Function

It is possible to switch between speed control and torque control when one of the multi-function contact inputs (H1-03 to H1-16) is set to 71 (Speed/torque control change). Speed control is performed when the input is off and torque control is performed when the input is on. Set d5-01 to 0 to enable speed/torque control switching function.

■Setting the Speed/Torque Control Switching Timer

The delay between a change in the speed/control switching function input (from on to off or from off to on) and the corresponding change in the control method can be set in d5-06. During the timer delay, the 3 analog inputs will retain the values they had when the on/off status of speed/torque control switching signal was changed. Use this delay to complete any changes required in external signals.

Application Precautions

- The speed (frequency) reference during speed control is determined according to the setting of b1-01 [Speed (frequency) selection]. The speed limit during torque control is determined according to the setting of d5-03 (Speed limit selection).
- If the torque reference has been assigned to a multi-function analog input, terminal AI2, AI3 or AI4, the input function changes when the control method is switched between torque control and speed control.
  During speed control: The multi-function analog input terminal is used as the torque limit input.
  During torque control: The multi-function analog input terminal is used as the torque reference input.
- When the Run Command turns off, the control method when stopped will be for speed control. Even from the torque control method, the system will automatically change to speed control and stop when the Run Command turns off.

- When A1-02 (Control method selection) is set to 3 (Flux vector control), speed and torque control can be switched during operation by setting one of the multi-function contact inputs (H1-03 to H1-16) to 71 (Speed/torque control change).

Reference Location	Constant No.	Factory Setting	Setting Value	Function
Connector CN24-1, 13 (S10)	H1-09	F	71	Speed/torque control change
Connector CN39-1, 2 (AI1)	b1-01	3	1	Speed (frequency) reference selection
	d5-03	1	1	Speed limit selection
Connector CN40-1, 2 (AI2)	H3-05	F	13	Torque reference/torque limit

A timing chart for switching between speed and torque control is shown in the following figure.

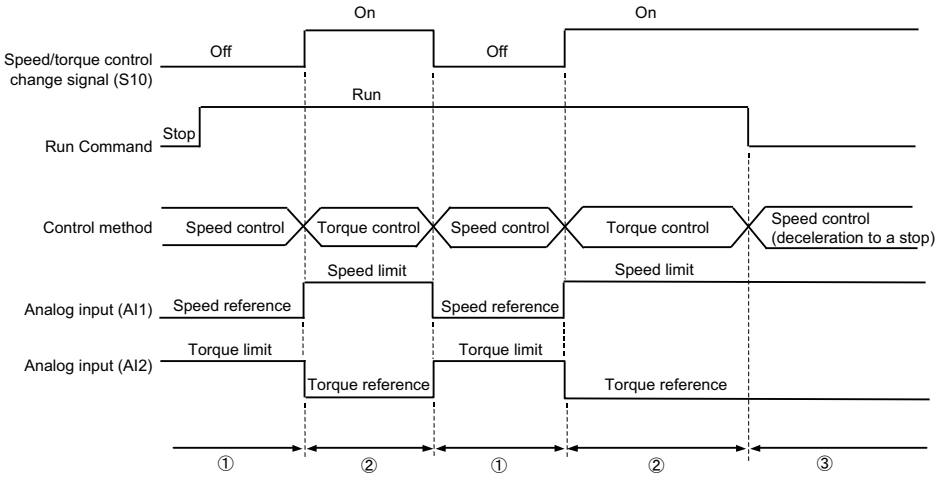


Fig 6.33 Speed/Torque Control Switching Timing Chart

◆ Driving Multiple Motors with a Single Inverter (Applicable software versions: S0107 or later)

Before driving multiple motors with a single inverter, select open-loop vector control and set E1-02 (Motor type selection) to 3. The Inverter acts as the power supply for the motors.

■ Related Constants

Constant No.	Name Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods Open-loop Vector	Control Methods Flux Vector	MEMOBUS Register
A1-02	Control method selection Control Method	Sets the control method of the Inverter. 2: Open-loop vector control 3: Flux vector control This constant is not initialized by the initialize operation.	2 or 3	2	No	Q	Q	102H
E1-01	Input voltage setting Input Voltage	Sets the input voltage for the Power Cell in 1 volt units.	180 to 700	630 V	No	Q	Q	340H
E1-02*	Motor type selection Motor Selection	Selects the type of the motor. 0: General-purpose motor 1: V/f motor 2: Vector motor 3: Multiple motors (when using two or more motors)	0 to 3	2	No	Q	Q	341H
E1-04	Max. output frequency (FMAX) Max Frequency	To set V/f characteristics in a straight line, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded. Always ensure that the four frequencies (speeds) are set in the following manner: E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)	0 to 8000	1200 min^{-1}	No	Q	Q	344H
E1-05	Max. voltage (VMAX) Max Voltage		0 to 8000	3300	No	Q	Q	347H
E1-06	Base frequency (FA) Base Frequency		0 to 8000	1200 min^{-1}	No	Q	Q	349H
E1-07	Mid. output frequency (FB) Mid Frequency A		0 to 8000	0 min^{-1}	No	A	No	34CH
E1-08	Mid. output frequency voltage (VC) Mid Voltage A		0 to 8000	0 V	No	A	No	34EH
E1-09	Min. output frequency (FMIN) Min Frequency		0 to 8000	0 min^{-1}	No	Q	A	350H
E1-10	Min. output frequency voltage (VMIN) Min Voltage		0 to 8000	0 V	No	A	No	353H

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
E1-11	Mid. output frequency 2 / Mid Frequency B	Set only to fine-adjust V/f for the output range. Normally, this setting is not required.	0 to 8000	0 min^{-1}	No	A	A	355H
E1-12	Mid. output frequency voltage 2 / Mid Voltage B		0 to 8000	0 V	No	A	A	357H
E1-13	Base voltage (VBASE) / Base Voltage		0 to 8000	3300 V	No	Q	Q	358H
E2-01	Motor rated current / Motor Rated FLA	Sets the motor rated current in amperes. These set values will become the reference values for motor protection, torque limits and torque control.	0.1 to 1500.0	86.6 A	No	Q	Q	360H
E2-03	Motor no-load current / No-Load Current	Sets the motor no-load current in amperes.	0.00 to 1500.0	32.2 A	Yes	Q	Q	362H
E2-04	Number of motor poles / Number of Poles	Sets the number of motor poles.	2 to 48 (Only multiples of 2 can be set.)	6 poles	No	Q	Q	363H
E2-05	Motor line-to-line resistance / Term Resistance	Sets the motor line-to-line resistance in ohms.	0.000 to 65.000	0.307 Ω	Yes	A	A	364H
E2-11	Motor rated capacity / Mtr Rated Power	Sets the rated capacity of the motor in units of kilowatts. This constant is automatically set during autotuning.	0 to 10000	630 kW	No	Q	Q	36AH
E2-12	Motor wiring resistance / Wiring Resistor	Sets the motor wiring resistance as a percentage.	0.00 to 1.00	0.00%	Yes	A	A	36BH

* This setting is applicable for FSDrive-MV1S with software version S0107 or later. This setting can be selected only for open-loop vector control.

■Setting Precautions

- Variation in the motors' capacities must be 30% or less of the maximum motor capacity.
- Select the Inverter capacity so that the rated output current of the Inverter satisfies the following condition and the maximum load will fall within the overload capacity of the Inverter:
  Total of motor rated current × 1.05 ≤ Inverter rated output current
- The load ratio must be the same for all motors. Allowable variation in the load ratio must be within ±10% of the average load ratio.
- If motors are to be added while the Inverter is running, the output current when adding the motors must be within the allowable range of the rated output current for the Inverter. Because of this, it is necessary to take measures to minimize the starting current. For example, add the motors when the output voltage of the Inverter is less than 30%. Also, the number of motors that can be added at one time is one or less than 10% of the total number of motors.
- The rotational speed of the motor varies in accordance with the characteristics and load ratio of each motor even if the frequency is the same.
- The minimum speed of the motor is about 5%. The speed varies in accordance with the motor characteristics and the load ratio.
- Electronic thermal relay protection is not applicable when driving multiple motors, so set L1-01 to 0 (Disabled). To protect the motors, implement protective measures against overload for each motor, by installing a thermal relay on the power lines of each motor for example.
- When setting E2-05 (Motor line-to-line resistance), be careful that the setting will not result in over excitation because of the variation in motor capacities and the load ratio. This may result in overheating of the motor.
- The speed search function cannot be used. Set b3-01 (Speed search selection at startup) to 0 and L2-01 (Selection of operation at momentary power loss) to 0.
- When multiple motors are operated in parallel, the following items are disabled: the torque limit function (L7-01 to L7-04) and the monitor values (U1-08, U1-09, U1-18, U1-19, U1-53, U1-64, U1-65, and U1-95).
- When selecting multiple motor operation (A1-02=2 and E1-02=3), the autotuning function cannot be used.

◆ Implementing Synchronous Transfers with a Commercial Power Supply (Applicable software versions: S0108 or later)

The Inverter output is synchronized with the commercial power supply to enable transfers back and forth between them without applying shock to the motor.

■Related Constants

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
n6-01	Synchronous transfer mode / SyncTransferMODE	Sets whether the synchronous transfer with commercial power supply is enabled or disabled. 0: Disabled 1: Enabled	0 or 1	0	No	A	No	630H
n6-02	Amplitude synchronous P gain / Vamp Sync P Gain	Sets the proportional gain used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage.	0.00 to 1.00	0.04	No	A	No	631H
n6-03	Amplitude synchronous I gain / Vamp Sync I Time	Sets the integral time used in the control to synchronize the amplitudes of commercial power supply voltage and Inverter output voltage in milliseconds.	0 to 1000	20 ms	No	A	No	632H
n6-04	Amplitude synchronous primary delay time constant / Vamp Sync Filter	Sets the primary delay filter time constant used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage in seconds.	0.000 to 1.000	0.200 s	No	A	No	633H
n6-05	Amplitude synchronous output limit / Vamp Sync Limit	Sets the output limit used in the control to synchronize the amplitudes of the commercial power supply voltage and Inverter output voltage as a percentage, taking the voltage class as 100%.	0 to 20	10%	No	A	No	634H
n6-06	Amplitude synchronous detection bias / Vamp bias	Sets the bias for the commercial power supply voltage amplitude detection value as a percentage, taking the voltage class as 100%.	-100.0 to 100.0	0.0%	No	A	No	635H
n6-07	Amplitude synchronous level / Vamp Sync Level	Sets the amplitude synchronous judgment level of the commercial power supply voltage and Inverter output voltage as a percentage, taking the voltage class as 100%.	0.0 to 10.0	3.0%	No	A	No	636H
n6-09	Phase synchronous P gain / Phase Sync Pgain	Sets the proportional gain used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage.	0.0000 to 0.1000	0.0033	No	A	No	638H
n6-10	Phase synchronous I time / PhaseSync I Time	Sets the integral time used in the control to synchronize the phases of commercial power voltage and Inverter output voltage in microseconds.	0 to 9999	0 ms	No	A	No	639H

Constant No.	Name / Digital Operator Display	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: Open-loop Vector	Control Methods: Flux Vector	MEMOBUS Register
n6-11	Phase synchronous primary delay time constant / PhaseSyncFilter	Sets the primary delay filter time constant used in the control to synchronize the phases of commercial power voltage and Inverter output voltage in seconds.	0.000 to 1.000	0.100 s	No	A	No	63AH
n6-12	Phase synchronous output upper limit / Phase Sync U-Lim	Sets the upper output limit used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage as a percentage, taking the maximum frequency (E1-04) as 100%.	0 to 20	5%	No	A	No	63BH
n6-13	Phase synchronous output lower limit / Phase Sync L-Lim	Sets the lower output limit used in the control to synchronize the phases of the commercial power supply voltage and Inverter output voltage as a percentage, taking the maximum frequency (E1-04) as 100%.	-20 to 0	-5%	No	A	No	63CH
n6-14	Power supply phase detection bias / Phase bias	Sets the bias for the commercial power supply voltage phase detection value in units of degrees.	-180.0 to 180.0	0.0 deg	No	A	No	63DH
n6-15	Phase synchronous level / Phase Sync Level	Sets the judgment level of the phase synchronization of the commercial power supply voltage and Inverter output voltage in units of degrees.	0.0 to 30.0	3.0 deg	No	A	No	63EH
n6-26	Power supply synchronous time limit / Sync limit Time	Sets the time limit for the synchronous processing for the commercial power supply in seconds. If the power supply is not synchronized within the set time limit, a fault will be detected and the operation will be stopped.	10.0 to 6000.0	15.0 s	No	A	No	649H

■Multi-function Contact Input (DI) (H1-03 to H1-16)

Setting Value	Function	Control Methods	
		Open-loop Vector	Flux Vector
80*	Synchronous transfer command for synchronous transfer from the Inverter to a commercial power supply. (On: transfer command from Inverter to commercial power supply)	Yes	No
81*	Synchronous transfer command for synchronous transfer from a commercial power supply to the Inverter. (On: transfer command from commercial power supply to Inverter)	Yes	No
82*	Breaker closed signal of the commercial power supply. [On: closed signal (answerback)]	Yes	No
83*	Breaker closed signal of the Inverter secondary side. [On: closed signal (answerback)]	Yes	No

* This setting is applicable for FSDrive-MV1S with software version S0108 or later.

■Multi-function Contact Output (DO) (H2-01 to H2-08)

Setting Value	Function	Control Methods	
		Open-loop Vector	Flux Vector
40*	Breaker close command for commercial power supply (On: Close command, Off: Open command)	Yes	No
41*	Inverter secondary side breaker close command (On: Close command, Off: Open command)	Yes	No
42*	Completion of synchronous transfer to commercial power supply (On: Synchronous transfer to commercial power supply completed)	Yes	No

* This setting is applicable for FSDrive-MV1S with software version S0108 or later.

■System Configuration for Synchronous Transfer with a Commercial Power Supply

The outline of a system for synchronous transfer with a commercial power supply is shown below.

When conducting a synchronous transfer with a commercial power supply, be sure to add the reactor, enable input of the breaker closed signal, and add the commercial power supply current detection unit.

Transferring from the Inverter to the commercial power supply and vice-versa is possible with the same system.

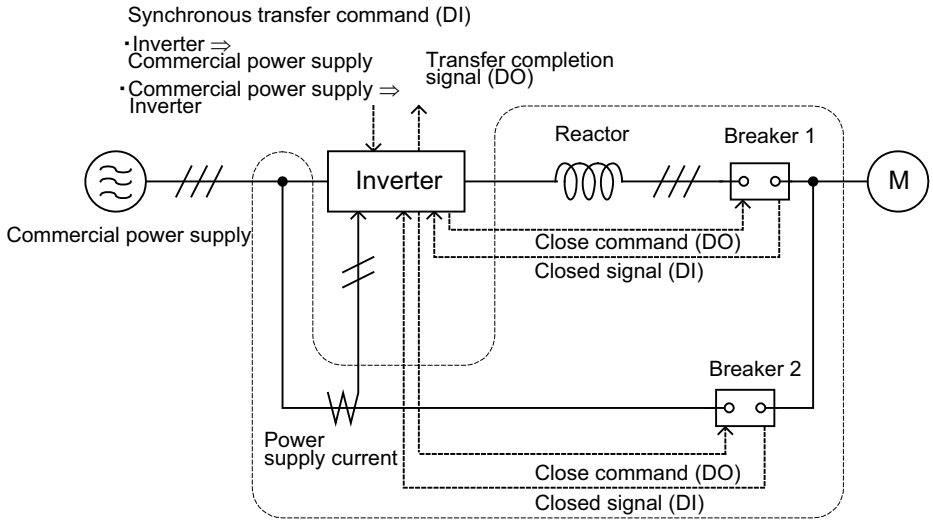


Fig 6.34 System Configuration for Synchronous Transfer with a Commercial Power Supply

■Transferring from the Inverter to a Commercial Power Supply

If the Run Command is input while the synchronous transfer command is being input, or if the synchronous transfer command is input while the Inverter is operating, the speed (frequency) reference will change automatically and the Inverter will start acceleration or deceleration toward the commercial power supply frequency. On completion of acceleration or deceleration, the amplitude and phase of the Inverter output will be synchronized with the commercial power supply. When the synchronization with the commercial power supply is established, breaker 2 on the commercial power supply side is closed and the Inverter and commercial power supply are operated in parallel. The transfer operation will be completed by opening breaker 1 on the Inverter secondary side.

A timing chart for the above is shown below.

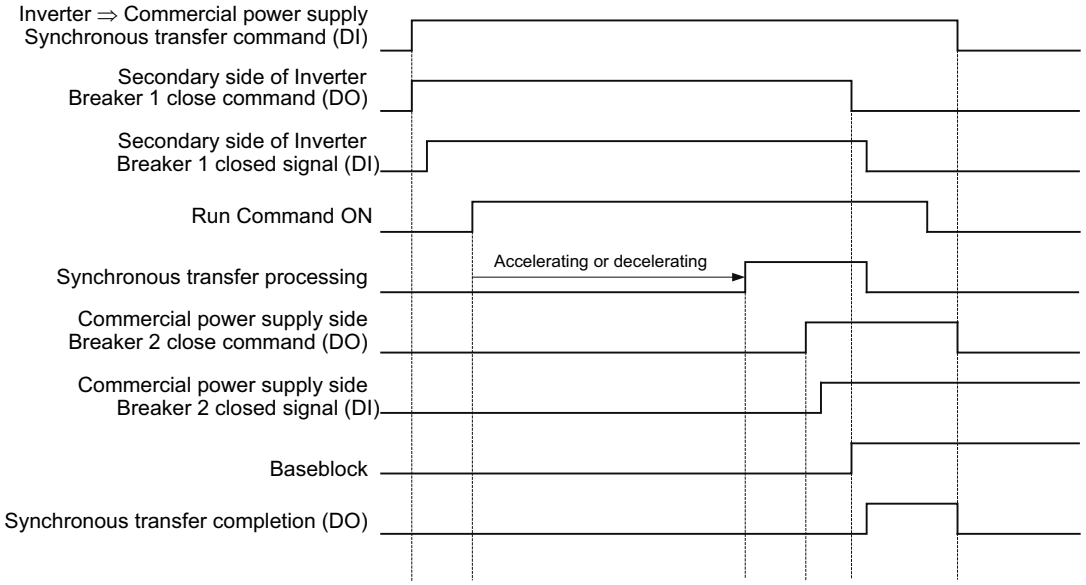


Fig 6.35 Timing Chart

■Transferring from a Commercial Power Supply to the Inverter

If the synchronous transfer command and Run Command are input while the motor is being driven with a commercial power supply, the Inverter's internal speed (frequency) reference will be changed automatically and the output frequency of the Inverter will accelerate to the commercial power supply frequency. On completion of acceleration of the Inverter, the amplitude and phase of the Inverter output will be synchronized with the commercial power supply. When synchronization with the commercial power supply is established, breaker 1 on the Inverter secondary side is closed and the Inverter and commercial power supply are operated in parallel. The transfer operation will be completed by opening breaker 2 on the commercial power supply side.

A timing chart for the above is shown below.

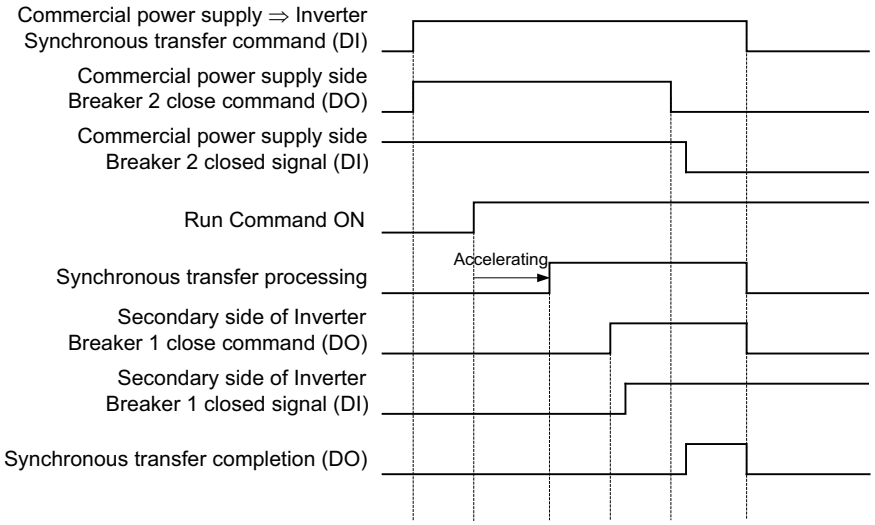


Fig 6.36 Timing Chart

■Application Precautions

- Select a reactor with an impedance of approximately 3% to 7%.
- Be sure to make the normal phase connection of the main circuit power supply to the Inverter. A fault will occur if a transfer command is given with a reversed phase connection.
- Be sure to input the closed signal of the breaker into the multi-function contact inputs of the Inverter.
- Be sure to allocate the necessary functions to the multi-function contacts. Otherwise, a fault will occur if an attempt is made to transfer. (H1-03 to H1-16: 82H and 83H, H2-01 to H2-08: 40H and 41H)
- While the synchronous transfer command is input, operate the breakers according to the commands from the Inverter. A fault will occur if the breakers operate against the commands. It is very dangerous if both breakers close without first achieving Inverter output synchronization.
- To interrupt synchronous transfer processing, turn off the Run Command.
- Do not turn off the synchronous transfer command until the transfer completion signal (DO) is output or the motor comes to a stop.
- The breaker close command (DO) for the commercial power supply, breaker close command (DO) for the Inverter secondary side, and synchronous transfer completion signal (DO) will all be turned off when the synchronous transfer command is turned off after the synchronous transfer completion signal is output. Therefore, program a sequential circuit to hold the close command for the target breaker if needed.
- The momentary power loss operations will be disabled while the synchronous transfer command is being input.
- The synchronous transfer function cannot be applied if multiple motors are being driven (E1-02 = 3).

7

Troubleshooting

This chapter describes the fault displays and countermeasures for the FSDrive-MV1S and motor problems and countermeasures.

Protective and Diagnostic Functions 7-2
Troubleshooting 7-14

Protective and Diagnostic Functions

This section describes the alarm functions of the Inverter. The alarm functions include fault detection (major faults), alarm detection (minor faults), operation error detection, and autotuning error detection.

⚠ DANGER

- Ensure that the main circuit power supply has been turned off before opening the cover of the Transformer section or Power Cell section.
  Otherwise, electric shock may occur.
- Wait at least ten minutes after the main circuit power supply has been turned off before opening the cover of the Power Cell section, and confirm that the CHARGE indicator on the front face of the Power Cell has been completely turned off before touching anything inside the Power Cell.
  Otherwise, electric shock may occur.

◆ Fault Detection and Alarm Detection

When an alarm is detected in the Inverter, the ALARM indicator on the Digital Operator on the Control section door lights (fault detection) or flashes (alarm detection), and the fault details are displayed on the monitor. Even after the fault is reset, the fault history can be displayed from the menu.

Fault detection (F) and alarm detection (A) are classified into Drive Faults and Power Cell Faults.

■Fault Detection (F)

When the Inverter detects a fault (major fault), the fault contact output operates, and the Inverter output is stopped causing the motor to coast to a stop. (The stopping method can be selected for some faults, and the selected stopping method will be used with these faults.)

When a fault has occurred, refer to the following table to identify the cause of the fault and take appropriate corrective action.

Use one of the following methods to reset the fault before restarting the Inverter:

- Set the multi-function contact inputs (H1-03 to H1-16) to 14 (Fault reset) and turn on the fault reset signal.
- Press the RESET Key on the Digital Operator.
- Turn the main circuit power supply and the control power supply off and then turn on the control power supply and the main circuit power supply again in this order.

■Alarm Detection (A)

When the Inverter detects an alarm (minor fault), the fault contact output does not operate. The system will automatically return to its original status once the cause of the alarm has been eliminated.

The Digital Operator display flashes and an alarm is sent from the multi-function contact outputs when the multi-function contact outputs (H2-01 to H2-08) are set to 10 (Alarm detection).

When an alarm has occurred, refer to the following table to identify the cause of the fault and take appropriate corrective action.

◆ Drive Faults

Drive faults are detected by the Control section. If any of these faults occurs, it is displayed on the Digital Operator, and its details are recorded in the memory.

Table 7.1 List of Drive Faults

Display	Rank*1	Name Probable Causes	Corrective Actions
IOV Overvoltage	F	Input Overvoltage The main circuit power supply voltage exceeded 120% of the set value (L9-01).	• Change the main circuit power supply voltage to an appropriate value. • Take measures to adjust the power supply voltage of the main circuit (for example, changing the taps of the transformer). • Change the detected value of the main circuit power supply voltage (U1-90) and the main circuit power supply voltage setting (L9-01) to appropriate values. • If detection is faulty, replace the isolation board, which detects the main circuit power supply voltage, or the modulator board.
UVL Under Voltage2	A	Main Circuit Power Supply Voltage Reduction 2 The main circuit power supply voltage went below 70% of the set value (L9-01).	
IUV Under Voltage	F (A)*2	Main Circuit Power Supply Voltage Reduction The main circuit power supply voltage went below 55% of the set value (L9-01).	
CUV CTL PS UnderVolt	F	Control Power Supply Fault • The control power supply voltage dropped. • An error occurred on the 5-V power supply board. (Detected when L9-14 is set to 1)	• Change the control power supply voltage to an appropriate value. • Replace the 5-V power supply board.
IOC Over Current	F	Drive Overcurrent The Inverter output current detection value exceeded the overcurrent detection level (132% of the Inverter rated output current).	• Reduce the load if it is too large. • Measure the insulation resistance of the motor and cables, and replace the motor or cables if continuity is detected. • Check the cables on the output side for disconnection or incorrect connection, and correct if necessary. • Change the acceleration/deceleration time setting to an appropriate value. • Check if the PG is installed properly, check the PG cables for disconnection or incorrect connection, and check if the PG settings (H7-01 and H7-05) are correct.
OOV Output OV Fault	F	Output Overvoltage The Inverter output voltage exceeded the output overvoltage detection level (L9-06) over the detection time (L9-07).	• Change the motor constants to appropriate values. Constants: E1-□□, E2-□□ • Change the settings of L9-06 and L9-07 to appropriate values. • Check the cables on the output side for disconnection or incorrect connection, and correct if necessary.

Table 7.1 List of Drive Faults (Continued)

Display	Rank*1	Name Probable Causes	Corrective Actions

TME
Tr Overtemp
	F	Transformer Temperature Fault (Input Terminal DI_1)
		A fault was detected from a contact input terminal (transformer overheat) on the control board.
		Note Check the actual input terminal number with the elementary diagram. The input terminal number varies for each Inverter.
			• Check to see if the transformer is overheated.
			• Check if the contact input terminals have been closed mistakenly.
			• Check the mechanical system and correct the cause of the fault.
			• Inspect the following points relating to the cooling fan of the Inverter.
			  • If the volume of cooling air is not sufficient, replace the cooling fan.
			  • If the intake filter is soiled, clean the filter.

FAN1 Fan Fault 1	F	Cooling Fan Fault 1 (Input Terminal DI_2) A fault was detected from a contact input terminal (cooling fan fault) on the control board. Note Check the actual input terminal number with the elementary diagram. The input terminal number varies for each Inverter. When using more than one cooling fan, faults may be found in multiple contact input terminals (FAN2 to 4).	Check the operation of the cooling fan and thermal relays. If the operation is not appropriate, replace the cooling fan or the drive circuit.
OL1 Motor Overloaded	F/A (Select with L1-04)	Motor Overloaded Inverter overload protection by the electronic thermal relay was activated.	• Change the setting of the motor rated current (E2-01) to an appropriate value. • Change the detection settings (L1-02, L1-06, and L1-07) to appropriate values. • Reduce the load if it is too large.
OL2 Inv Overloaded	F	Inverter overloaded Inverter overload protection by the electronic thermal relay was activated.	• Reexamine the load, acceleration/deceleration time, and cycle time. • Reexamine the V/f characteristics.
OL3 Overtorque Det 1	F/A (Select with L6-01)	Overtorque Detected 1 The current has reached or exceeded the setting of the overtorque detection level 1 (L6-02) for at least the period of time set for the detection time (L6-03).	• Change the settings in L6-02 and L6-03 to appropriate values. • Check the mechanical system and correct the cause of the overtorque.
OL4 Overtorque Det 2	F/A (Select with L6-04)	Overtorque Detected 2 The current has reached or exceeded the setting of the overtorque detection level 2 (L6-05) for at least the period of time set for the detection time (L6-06).	• Change the settings in L6-05 and L6-06 to appropriate values. • Check the mechanical system and correct the cause of the overtorque.
UL3 Undertorque Det 1	F/A (Select with L6-01)	Undertorque Detected 1 The current has dropped below the setting of the undertorque detection level 1 (L6-02) for at least the period of time set for the detection time (L6-03).	• Change the settings in L6-02 and L6-03 to appropriate values. • Check the mechanical system and correct the cause of the undertorque.
UL4 Undertorque Det 2	F/A (Select with L6-04)	Undertorque Detected 2 There has been a current less than the setting of undertorque detection level 2 (L6-05) for longer than the detection time (L6-06).	• Change the settings in L6-05 and L6-06 to appropriate values. • Check the mechanical system and correct the cause of the undertorque.

Table 7.1 List of Drive Faults (Continued)

Display	Rank*1	Name Probable Causes	Corrective Actions
PGO PG Open	F/A (Select with H7-02)	PG Disconnection Detected No PG pulses are input. Note During differential input, this is detected as a fault (F) by the circuit.	• Check the PG cables for disconnection or incorrect connection, and correct if necessary. • Check that power is supplied to the PG properly. • Check the output status of the PG.
DEV Speed Deviation	F/A (Select with H7-04)	Excessive Speed Deviation The speed deviation has reached or exceeded the setting of the excessive speed deviation detection level (H7-10) for at least the period of time set for the preset time (H7-11).	• Reduce the load. • Lengthen the acceleration time and deceleration time. Constant: C1-□□ • Change the settings in H7-10 and H7-11 to appropriate values.
OS Overspeed Det	F	Overspeed The speed has reached or exceeded the setting of the overspeed detection level (H7-08) for at least the period of time set for the preset time (H7-09).	• Change the settings in H7-08 and H7-09 to appropriate values. • Change the motor constants to appropriate values. Constant: E-□□, E2-□□ • Check the mechanical system and correct the cause of the overspeed.
OGF Ground Fault	F/A (Select with L9-20)	Output Ground Fault • A ground fault occurred at the Inverter output and the Inverter output current exceeded approximately 25% of the Inverter rated output current. [F: Selection with L9-20 is not possible.] • The zero-phase voltage at the Inverter output has exceeded the setting of the ground fault detection level (L9-21) for at least the period of time set for the detection time (L9-22). [F/A: Selection with L9-20 is possible.]	• Measure the insulation resistance of the motor and cables, and replace the motor or cables if continuity is detected. • Check the cables on the output side for disconnection or incorrect connection, and correct if necessary.
LF Output Pha Loss	F	Output Open-phase An open-phase occurred at the Inverter output. (This fault is detected when L8-07 is set to 1 or 2.)	Check the cables on the output side for disconnection or incorrect connection, and correct if necessary.
EF External Fault	A	Forward/Reverse Run Simultaneous Input The Forward and Reverse Run Commands were input at the same time for 0.5 seconds or longer.	• Reexamine the input sequence. Note When this alarm is occurred, the motor decelerates to a stop.
CF Out of Control	F	Control Fault The torque limit was reached continuously for 3 seconds or longer during deceleration to stop operation in open-loop vector control.	• Change the motor constant settings to appropriate values. Constant: E1-□□, E2-□□ • Lengthen the deceleration time. Constant: C1-□□

Table 7.1 List of Drive Faults (Continued)

Display	Rank*1	Name Probable Causes	Corrective Actions
OPR Opr Disconnect	F	Digital Operator Connection Fault The connection to the Digital Operator was broken during operation with a RUN Command from the Digital Operator. (Detected when 02-06 is set to 1.)	• Check the cables for disconnection, and replace them if necessary. • Turn the control power supply off and remove the Digital Operator from the Inverter. Reconnect the Digital Operator and turn the control power supply on. If the fault persists, replace the Digital Operator.
CPF00 COM-ERR (OP &INV)	–	Digital Operator Communications Error 1 Communications with the Digital Operator were not established within 5 seconds after the power was turned on. Note Since this fault is detected on the Digital Operator, the operation continues if there is no problem on the Inverter side.	Turn the control power supply off and remove the Digital Operator from the Inverter. Reconnect the Digital Operator and turn the control power supply on. If the fault persists, replace the Digital Operator, CPU board, or modulator board.
CPF01 COM-ERR (OP &INV)	–	Digital Operator Communications Error 2 After communications were established, there was a communications error with the Digital Operator for 2 seconds or longer. Note Since this fault is detected on the Digital Operator, the operation continues if there is no problem on the Inverter side.	Turn the control power supply off and remove the Digital Operator from the Inverter. Reconnect the Digital Operator and turn the control power supply on. If the fault persists, replace the Digital Operator, CPU board, or modulator board.
CPF03 EEPROM Error	F	EEPROM Error The control circuit is damaged.	Turn the control power supply off and back on. If the fault persists, replace the modulator board.
CPF05 External A/D Err	F	A/D Converter Error The control circuit is damaged.	Turn the control power supply off and back on. If the fault persists, replace the modulator board.
HDE HARD Fault	F	Hardware Fault The modulator board is damaged.	Turn the control power supply off and back on. If the fault persists, replace the modulator board.
DTM MB Watchdog Flt	F	Modulator Watchdog Fault The communication error between the modulator board and the CPU board occurred.	Turn the control power supply off and back on. If the fault persists, replace the CPU board or modulator board.
CTF Analog Pwr Fault	F	Analog Power Supply Fault The power supply (±15V) for the analog detection circuit was reduced.	Turn the control power supply off and back on. If the fault persists, replace the ±15 V power supply or modulator board.
CER CTL CPU Fault	F	CPU Watchdog Fault CPU error occurred.	Turn the control power supply off and back on. If the fault persists, replace the CPU board.
BAT Weak Battery	A	Battery Voltage Lowered Battery voltage (3 V) was lowered.	Replace the battery on the CPU board.

Table 7.1 List of Drive Faults (Continued)

Display	Rank*1	Name Probable Causes	Corrective Actions
EF0 Opt External FLT	F	External Fault (Option) An external fault defined by the system program was detected. Note Check the details of the fault by referring to the elementary diagram, etc.	Check the details of the fault and eliminate the cause.
EF3 to EF16 Ext Fault Sx (Terminals S3 to S16)	F/A (Select with H1-03 to H1-16)	External Fault (Input Terminal S3 to S16) An external fault was input from an external input terminal of the control board. Note Check the actual external terminal number with the elementary diagram. The external terminal number varies for each Inverter.	Eliminate the cause of the external fault and reset the external fault input of each multi-function contact input.
FLT x [Detail]	F	User Defined Faults (x: 1 to 7) A fault defined by the system program was detected. Note The detailed display shows the information defined by the system program. Check the details of the fault by referring to the elementary diagram, etc.	Check the details of the fault and eliminate the cause.
ALM x [Detail]	A	User Defined Alarms (x: 1 to 3) An alarm defined by the system program was detected. Note The detailed display shows the information defined by the system program. Check the details of the alarm by referring to the elementary diagram, etc.	Check the details of the alarm and eliminate the cause.
SYNC Sync Fault	F	Fault in Commercial Power Synchronous Transfer • Functions required for multi-function contacts are not set. • The phases of the power supply wiring to the Inverter are reversed. • The transfer was not completed within the time limit (n6-26). • The breaker operated against the command (DO).	• Set 82 H and 83 H for multi-function contact inputs (H1-03 to H1-16). • Set 40H and 41H for multi-function contact outputs (H2-01 to H2-08). • Correct the phase connection for the power supply wiring to the main circuit. • Transfer while the power supply fluctuation is minimal. • Reexamine the operating conditions so that the load fluctuation can be minimized. • Readjust the settings for the synchronous transfer function. [Refer to Page 6-78 *Implementing Synchronous Transfers with a Commercial Power Supply (Applicable software versions: S0108 or later)*.] • Reexamine the command sequence to the breakers.

* 1. F: Fault
A: Alarm
F/A: Fault or alarm depends on the constant setting

* 2. Detected as an alarm while the operation is stopped.

◆ Power Cell Faults

Power cell faults are detected by the control circuit of each Power Cell, and transmitted to the Control section. If any of these faults occur, they will be displayed on the Digital Operator, and the details will be recorded in the memory.

Table 7.2 List of Power Cell Faults

Display*1	Rank*2	Name Probable Causes	Corrective Actions

TMP	F	Excessive Power Cell Temperature	• Check the following points in relation to the cooling fan.
			  • If the volume of cooling air is not sufficient, replace the cooling fan.
			  • If the intake filter is soiled, clean the filter.
			• Clean the Power Cell unit if it is soiled.
			• Replace the CCB.
			• Replace the thermistor or Power Cell unit.

nn TEMP		The thermistor attached to the fin detected 90 °C or more.	
UVB	F	CCB Control Power Supply Fault	• Change the input voltage of the Power Cell to an appropriate value. • Check the Power Cell input power fuse. • Replace the CCB.
nn PWR FLT		DC bus bar voltage (P-N) dropped to less than 300 V.	
LIN	F	CCB-MB Communications Error (Link fault)	• Check the optical cable for disconnection, and replace if necessary. • Replace the CCB. • Replace the modulator board.
nn LINK FLT		A communications error in the CCB was detected.	
CFA	F	Power Cell Fault One of the following Power Cell faults was detected.	Take corrective measures for each faulty Power Cell.
nn OVR VOLT		DC Bus Bar Overvoltage DC bus bar voltage was increased to 1075 V or more.	• Change the input voltage of the Power Cell to an appropriate value. • Check the Power Cell input power fuse. • Replace the CCB.
nn UDR VOLT		DC Bus Bar Undervoltage DC bus bar voltage dropped to 475 V or less.	• Change the input voltage of the Power Cell to an appropriate value. • Check the Power Cell input power fuse. • Replace the CCB.
nn CAP FLT		DC Capacitor Overvoltage DC bus bar electrolytic capacitor voltage exceeded 400 V.	• Check the deterioration of the electrolytic capacitor, and replace if necessary. • Check the balance resistance. • Replace the CCB.
nn COM FLT		CCB-MB Communications Error (Parity Error) Parity check error between the CCB and the modulator board was detected.	• Check the optical cable for disconnection, and replace if necessary. • Replace the CCB. • Replace the modulator board.
nn Qx FLT		IGBT Qx Fault Shortcircuit occurred between the emitter and collector of IGBT elements Q1 to Q4.	Replace the Power Cell unit.
nn FUSE FLT		Power Fuse Blown Power Cell input power fuse has blown.	• Check the Power Cell input power fuse. • Replace the CCB.

* 1. "nn" shows the cell number.

* 2. F: Fault

◆ Operation Errors

An operation error will occur if there is an invalid setting or a contradiction between two constant settings. The details of the error are displayed on the Digital Operator, and the ALARM indicator flashes. Fault detection (major faults) or alarm detection (minor faults) operations will not be performed but the Inverter operation cannot be started until constants are set appropriately. Fault detection and alarm detection on multi-function contact outputs are not activated either.

When an operation error has occurred, refer to the following table to identify and correct the cause of the error.

Table 7.3 Operation Error Displays and Incorrect Settings

Display	Name	Probable Causes
OPE02 Limit	Constant Setting Range Error	The constant setting is outside the valid setting range. (OPE error constant No. will be shown on the display)
OPE03 Terminal	Multi-function Input Selection Error	One of the following errors has been made in the multi-function input (H1-01 to H1-16) settings: • The same setting has been selected for two or more multi-function inputs. • An up or down command was selected independently. (They must be selected together.) • External search command 1 (maximum output frequency) and external search command 2 (set frequency) have been set at the same time. • The Emergency Stop Command NO and NC have been set at the same time.
OPE07 Analog Selection	Multi-function Analog Input Selection Error	The same setting has been selected for two or more multi-function analog inputs.
OPE08 Ctrl Func Error	Constant Selection Error	A setting has been made that is not required in the current control method. Ex.: A function used only with open-loop vector control was selected for flux vector control. (OPE error constant No. will be displayed on the display.)
OPE10 V/f Ptrn Setting	V/f Data Setting Error	Constants E1-04, E1-06, E1-07, and E1-09 do not satisfy the following conditions: • E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)
OPE11 Carr Freq/ On-Delay	Constant Setting Error	The motor overload detection start level (L1-06) has been set to a value above the motor overload detection level (L1-07).
ERR EEPROM R/W Err	EEPROM Write Error	A verification error occurred when writing to the EEPROM. [Corrective Action] Turn the control power supply off and then back on. If the fault persists, set the constants again.

◆ Errors During Autotuning

Errors that may occur during autotuning are shown in the following table. If an error is detected during autotuning, the motor coasts to a stop. The details of the error are displayed on the Digital Operator. Fault detection and alarm detection on multi-function contact outputs are not activated.

Table 7.4 Errors During Autotuning

Display	Name Probable Causes	Corrective Actions
ER-01 Data Invalid	Motor Data Error The motor data input for autotuning are not appropriate.	Correct the data as follows: rated motor speed < 120 × rated frequency/number of motor poles.
ER-02 Accelerate	Motor Acceleration Error The motor did not accelerate with the specified acceleration.	• When the torque limit function is operating, change the setting values of L7-01 to L7-04 (Torque limits) to appropriate values. • If the acceleration time is too long, increase the setting value of C1-01 (Acceleration time). • If the load is connected to the motor, disconnect it from the motor.
ER-03 PG Direction	Motor Direction Error The indications of speed (frequency) reference and feedback speed are different, with the torque reference exceeding 100%.	• Check the PG cables for disconnection or incorrect connection, and correct if necessary. • Check the motor wiring for disconnection or incorrect connection, and correct if necessary • Change the rotation direction of the PG or the setting value of H7-05 (PG rotation direction) to appropriate values.
ER-04 Motor Speed Error	Motor Speed Error The torque reference value has exceeded 100% for 3 seconds during autotuning.	• Check the motor power cable for disconnection or incorrect connection, and correct if necessary • If the load is connected to the motor, disconnect it from the motor.
ER-05 Line-to-line Resistance Error	Line-to-line Resistance Error • Autotuning was not completed in the specified time. • The result of autotuning fell outside the set range of the constants.	• Change the setting for motor rated current to an appropriate value. • Check the motor power cable for disconnection or incorrect connection, and correct if necessary
ER-06 No-Load Current	No-load Current Error • Autotuning was not completed in the specified time. • The result of autotuning fell outside the set range of the constants.	
ER-07 Motor core saturation 1	Motor Iron Core Saturation Coefficient 1 Error • Autotuning was not completed in the specified time. • The result of autotuning fell outside the set range of the constants.	

Table 7.4 Errors During Autotuning (Continued)

Display	Name Probable Causes	Corrective Actions
ER-08 Motor core saturation 2	Motor Iron Core Saturation Coefficient 2 Error • Autotuning was not completed in the specified time. • The result of autotuning fell outside the set range of the constants.	• Change the setting for motor rated current to an appropriate value. • Check the motor power cable for disconnection or incorrect connection, and correct if necessary
ER-09 Rated FLA Alm	Rated Slip Error • Autotuning was not completed in the specified time. • The result of autotuning fell outside the set range of the constants.	If the load is connected to the motor, disconnect it from the motor.
ER-10 STOP key	STOP Key Input The STOP Key was pressed during autotuning, and autotuning was cancelled.	Autotuning has not been completed. Execute autotuning again from the beginning.
ER-11 I-det. Circuit	Current Detection Error The current flow exceeded the motor rated current.	• Change the setting for motor rated current to an appropriate value. • If the indication for the detected current value is reversed, replace the current detection unit. • Check the current detection circuit, motor cables, and DCCT cables for disconnection or incorrect connection, and correct if necessary
ER-12 Base Block	Base Block Stop The base block command was input from the PLC during autotuning, and autotuning was cancelled.	Clear the base block command from the PLC.

◆ LED Indicators on the Controller and CCB (Cell Control Board)

The following describes the LED indicators on the controller in the Control section and on the CCB in the Power Cell section. These indicators display operation statuses and faults.

⚠ DANGER

- Do not open the Inverter door to check the LED indicators while power is being supplied to the main circuit power supply.
  Doing so may result in electric shock.

■LED Indicators on the Controller

The controller has two types of LED indicators: An LED indicator that displays the controller status, and an LED indicator that displays the Power Cell status detected by the controller.

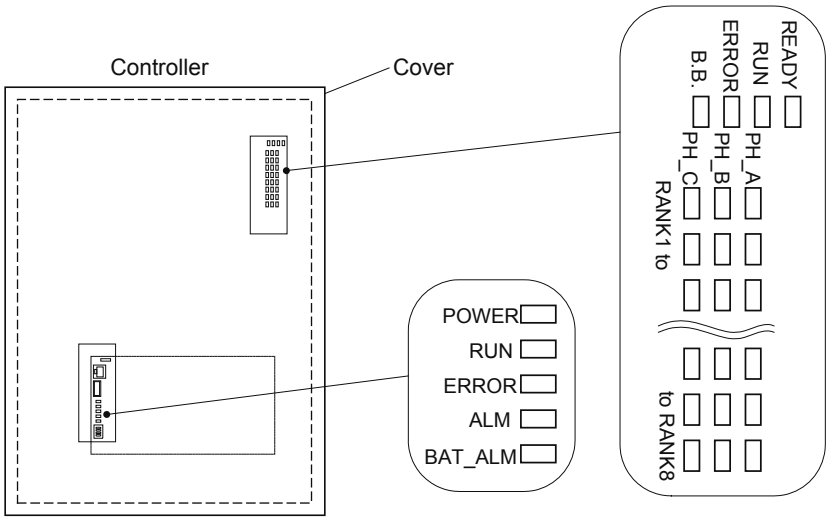


Fig 7.1 LED on Controller

Controller Status LED

POWER (Green)	:	Lit when control power is on.
RUN (Green)	:	Lit when the PLC is operating.
ERROR (Red)	:	Lit when a fault occurs in the controller.
ALM (Red)	:	Lit when an alarm occurs in the controller.
BAT ALM (Red)	:	Lit when the battery voltage has dropped.

Power Cell Status LED

READY (Green)	:	Lit when the control power is on.
RUN (Green)	:	Lit when the interface circuit of the Power Cell is operating.
ERROR (Red)	:	Lit when a fault occurs in the interface circuit of the Power Cell.
BB (Red)	:	Lit during baseblock.
PH_A RANK1 to 8 (Red)	:	Lit when a U-phase rank 1 to 8 Power Cell fault occurs.
PH_B RANK1 to 8 (Red)	:	Lit when a V-phase rank 1 to 8 Power Cell fault occurs.
PH_C RANK1 to 8 (Red)	:	Lit when a W-phase rank 1 to 8 Power Cell fault occurs.

■LED Indicators on the CCB (Cell Control Board)

The LED indicators on the CCB indicate the power supply status of the CCB, and operation or fault status of the IGBT.

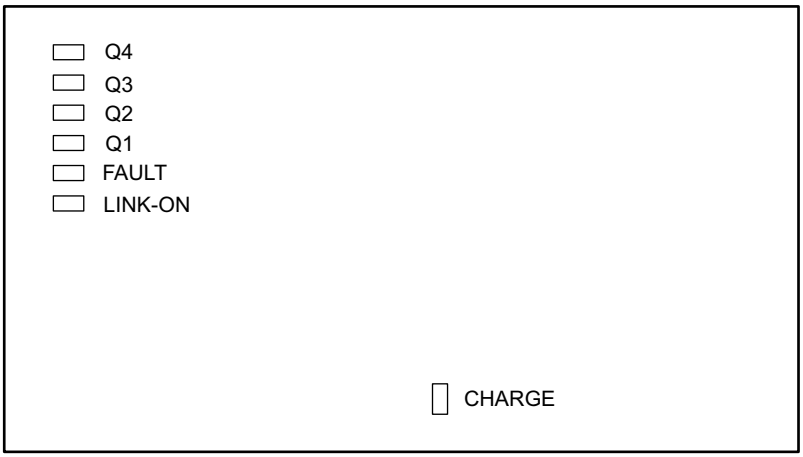


Fig 7.2 LED indicators on the CCB

Q4 : Lit when IGBT Q4 is operating.
Q3 : Lit when IGBT Q3 is operating.
Q2 : Lit when IGBT Q2 is operating.
Q1 : Lit when IGBT Q1 is operating.
FAULT : Lit when a Power Cell fault occurs.
LINK-ON : Lit when the control power supply is normal.
CHARGE : Lit when the DC bus bar voltage is at or above 50 V.

Never touch the Power Cell while any of these LED indicators are lit.

The LED indications for the Power Cell ready status, normal operation status, and fault status are shown in the following table.

7

LED indication ○: Off, ●: On

LED	Power Cell Ready Status	Normal Operation	Fault
Q4 (Green)	○	●	○
Q3 (Green)	○	●	○
Q2 (Green)	○	●	○
Q1 (Green)	○	●	○
FAULT (Red)	○	○	●
LINK-ON (Green)	●	●	–
CHARGE (Red)	●	●	●

Troubleshooting

If errors are made when setting the constants, wiring, or elsewhere, the Inverter and motor may not operate as expected when the system is started. If this should occur, use this section as a reference and apply the appropriate measures.

If the details of the alarm are displayed on the Digital Operator, refer to *Protective and Diagnostic Functions* in Chapter 7 Troubleshooting.

◆ If Constants Cannot Be Set

Use the following information if an Inverter constant cannot be set.

■The display does not change when the Increment and Decrement Keys are pressed.

The following causes are possible.

The Inverter is operating (drive mode).

There are some constants that cannot be set during operation. Turn the Inverter off and then make the settings.

Constant write enable has been set.

This occurs when one of H1-03 to H1-16 (multi-function contact input terminal S3 to S16 function selection) is set to 1B (constant write enable). If the constant write enable input is off, the constants cannot be changed. Turn it on and then set the constants.

◆ If the Motor Does Not Run

Use the following information if the motor does not run.

■The motor does not run when the RUN Key on the Digital Operator is pressed.

The following causes are possible.

The Inverter is not in drive mode.

If the Inverter is not in drive mode (DRIVE -Rdy- is not displayed on the Digital Operator), it is in the preparation status and cannot start.

Press the MENU Key to display the drive mode (DRIVE is displayed on the Digital Operator), and enter the drive mode by pressing the DATA/ENTER Key. -Rdy- will be displayed when drive mode is entered.

The operation method setting is wrong.

If b1-02 (Operation method selection) is set to any number other than 0 (Digital Operator), the motor will not run when the RUN Key is pressed. Either press the LOCAL/REMOTE Key to switch to Digital Operator operation or set b1-02 to 0 (Digital Operator).

INFO

The LOCAL/REMOTE Key is enabled by setting o2-01 (LOCAL/REMOTE key function selection) to 1 and disabled by setting o2-01 to 0. The LOCAL/REMOTE Key is enabled when the drive mode is entered.

The speed (frequency) reference is too low.

If the speed (frequency) reference is set below the frequency set in E1-09 (Minimum output frequency), the Inverter will not operate.

Raise the speed (frequency) reference to at least the minimum output frequency.

There is a multi-function analog input setting error.

If one of H3-05, H3-09 or H3-13 (Multi-function analog input terminal function selection) is set to 1 (Frequency gain), and if no voltage (current) is input, then the speed (frequency) reference will be zero. Check to be sure that the set value and analog input value are correct.

■The motor does not run when an external operation signal is input.

The following causes are possible.

The Inverter is not in drive mode.

If the Inverter is not in drive mode (DRIVE -Rdy- is not displayed on the Digital Operator), it is in the preparation status and cannot start.

Press the MENU Key to display the drive mode (DRIVE is displayed on the Digital Operator), and enter the drive mode by pressing the DATA/ENTER Key. -Rdy- will be displayed when drive mode is entered.

The operation method selection is wrong.

If b1-02 (Operation method selection) is set to 0 (Digital Operator), the motor will not run when an external operation signal is input. Set b1-02 to 3 (PLC) and try again.

Similarly, the motor will also not run if the LOCAL/REMOTE Key has been pressed to switch to Digital Operator operation. In that case, press the LOCAL/REMOTE Key again to return to the original setting.

INFO

The LOCAL/REMOTE Key is enabled by setting o2-01(LOCAL/REMOTE key function selection) to 1 and disabled by setting o2-01 to 0. The LOCAL/REMOTE Key is enabled when the drive mode is entered.

The speed (frequency) reference is too low.

If the speed (frequency) reference is set below the frequency set in E1-09 (Minimum output frequency), the Inverter will not operate.

Raise the speed (frequency) reference to at least the minimum output frequency.

There is a multi-function analog input setting error.

If one of H3-05, H3-09 or H3-13 (Multi-function analog input terminal function selection) is set to 1 (Frequency gain), and if no voltage (current) is input, then the speed (frequency) reference will be zero. Check to be sure that the set value and analog input value are correct.

■The motor stops during acceleration or when a load is connected.

The load may be too heavy. The Inverter has a stall prevention function, but the motor responsiveness limit may be exceeded if acceleration is too rapid or if the load is too heavy. Lengthen the acceleration time or reduce the load. Also consider increasing the motor capacity.

■The motor does not accelerate.

When the setting values of L7-01 to L7-04 (Torque limits) are too small or H3-05, H3-09, and H3-13 (Multi-function analog input terminal function selection) is set to 10 to 12 (Torque limits), the motor may not accelerate if the analog input values are too small. Check the setting values and analog input values.

■The motor only rotates in one direction.

Reverse run prohibited is selected. If b1-04 (Prohibition of reverse operation) is set to 1 (Reverse disabled), the Inverter will not receive Reverse Run Commands. To use both forward and reverse operation, set b1-04 to 0 (Reverse enabled).

◆ If the Direction of the Motor Rotation is Reversed

If the motor operates in the wrong direction, the motor output wiring is faulty. When Inverter terminals U, V, and W are properly connected to motor terminals U, V and W, the motor will operate in a forward direction when a Forward Run Command is executed. The forward direction depends on the manufacturer and the motor type, so be sure to check the specifications.

The direction of rotation can be reversed by switching two wires from among U, V and W.

◆ If the Motor Does Not Output Torque or If Acceleration is Slow

Use the following information if the motor does not output torque or if the acceleration time is too long.

■The torque limit has been reached.

When a torque limit has been set in L7-01 to L7-04 (Torque limits), no torque will be output beyond that limit. This can cause the torque to be insufficient, or the acceleration time to be too long. Check to be sure that the value set for the torque limit is appropriate.

If one of H3-05, H3-09 and H3-13 (Multi-function analog input terminal function selection) is set to 10 to 12 (Torque limits), also check to be sure that the analog input value is appropriate.

■The stall prevention level during acceleration is too low.

If the value set for L3-02 (Stall prevention level during acceleration) is too low, the acceleration time will be too long. Check to be sure that the set value is appropriate.

■Autotuning has not been performed for vector control

Vector control will not perform properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

◆ If the Motor Runs at A Higher Speed Than the Reference

Use the following information if the motor runs at a higher speed than the reference.

■The analog speed (frequency) reference bias or gain setting is wrong.

The values set in constants H3-03 [Speed (frequency) reference (AI1) input bias] and H3-02 [Speed (frequency) reference (AI1) input gain] are added to the speed (frequency) reference. Check if appropriate values are set.

◆ If the Slip Compensation Function Has Low Speed Precision

If speed control accuracy is low for the slip compensation function, the slip compensation limit has been reached. With the slip compensation function, compensation cannot be carried out beyond the value set for C3-03 (Slip compensation limit). Check if appropriate values are set.

◆ Speed Control Accuracy Is Low at High-speed Rotation (In Open-loop Vector Control)

The motor rated voltage is high.

The Inverter maximum output voltage is determined by its input voltage. (For example, if 3300 VAC is input, then the maximum output voltage will be 3300 VAC.) If, as a result of vector control, the output voltage reference value exceeds the maximum Inverter output voltage, the speed control accuracy will decrease. Use a motor with a low rated voltage (a special motor for use with vector control).

◆ If the Motor Overheats

Use the following information if the motor overheats.

■The load is too heavy.

If the motor load is too heavy and the motor is used with the effective torque exceeding the motor rated torque for a long time, the motor will overheat. Some motor rating are for short-period performance and are not continuous ratings. Reduce the load amount by either lightening the load or lengthening the acceleration/deceleration time. Also consider increasing the motor capacity.

■The ambient temperature is too high.

The motor rating is determined within a particular ambient operating temperature range. The motor will burn out if it is run continuously at the rated torque in an environment in which the maximum ambient operating temperature is exceeded. Lower the motor's ambient temperature to within the acceptable ambient operating temperature range.

■Autotuning has not been performed for vector control

Vector control will not perform properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

◆ If There is Mechanical Oscillation

Use the following information when there is mechanical oscillation.

■The machinery is making unusual sounds.

There is resonance between the machine's characteristic frequency and the output frequency of the Inverter.

To prevent this from occurring, either use the jump frequency functions in d3-01 to d3-04 or install rubber padding on the motor base to reduce oscillation.

■Oscillation or hunting occurs. (in open-loop vector control)

The gain adjustment is insufficient. Reset the gain to a more effective level by adjusting C4-02 (Torque compensation primary delay time constant), n2-01 [Speed feedback detection control (AFR) gain], and C3-02 (Slip compensation primary delay time constant) in this order. Lower the gain setting and raise the primary delay time constant setting.

Vector control will not perform properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

■Oscillation or hunting occurs. (in flux vector control)

The gain adjustment is insufficient. Adjust the various gains for speed control (ASR). If the oscillation points overlap with those of the machine and cannot be eliminated, increase the value set for C5-06 [primary delay time constant for speed control (ASR)] and then readjust the gains.

Vector control will not perform properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

■Autotuning has not been performed for vector control

Vector control will not perform properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

◆ If the Torque Generated from the Motor is Insufficient (Insufficient Power)

If autotuning has not been performed, or the control method has been changed since last performing autotuning, perform autotuning.

◆ If the Motor Keeps Running Even When Inverter Output is Stopped

If the motor keeps running even when the Inverter output is stopped, the DC injection braking is insufficient. If the motor continues running at low speed, without completely stopping even after a deceleration stop has been executed, it means that the DC injection braking is not operating enough when the frequency becomes less than the setting of b2-01 (DC injection braking starting frequency). Adjust the DC injection braking as follows:

- Increase the b2-02 (DC injection braking current) setting.
- Increase the b2-04 [DC injection braking (pre-excitation) time at stop] setting.

◆ If OV is Detected When the Fan is Started, or the Fan Stalls

A DC bus bar overvoltage and stalling can occur if the fan is already turning when it is started. The DC injection braking at start is insufficient.

By starting the fan only after completely stopping it by applying DC injection braking, DC bus bar overvoltage of Power Cell faults (CFA), and stalling of the fan can be avoided. Increase the value set for b2-03 [DC injection braking time (pre-excitation) at start].

◆ If Output Frequency Does Not Rise to Frequency Reference

Use the following information if the output frequency does not rise to the frequency reference.

■The frequency reference is within the jump frequency range.

When the jump frequency function is used, the output frequency does not change within the jump frequency range. Check to be sure that the values set for d3-01 to d3-03 (Jump frequency 1 to 3) and d3-04 (Jump frequency width) are appropriate.

■The frequency reference upper limit has been reached.

The output frequency upper limit is determined by the following formula:
E1-04 (Maximum output frequency) × d2-01 [Maximum speed (frequency) reference] / 100
Check to be sure that the constant E1-04 and d2-01 settings are appropriate.

8

Maintenance and Inspection

This chapter describes basic maintenance and inspection for the FSDrive-MV1S.

Periodic Inspection 8-3
Maintenance 8-9
Part Replacement Procedure 8-12
Spare Parts 8-24

The FSDrive-MV1S series Inverter is configured with many parts, and these parts must be operating properly in order to make full use of the Inverter functions. For this reason, it is essential to catch early signs of any malfunction and take prompt corrective action by periodically inspecting the Inverter. The service life of Inverter parts is limited even under normal operating conditions. Using them beyond this limitation can easily cause changes in their characteristics, and malfunctions. Replace them within their service life cycle, or the Inverter cannot be expected to operate properly with its original characteristics and performance.

⚠ DANGER

- Do not touch the Inverter terminals. Some of the terminals carry high voltages and are extremely dangerous.
  Doing so may result in electric shock.
- Always close the Inverter door while power is being supplied to the main circuit. Before opening the Inverter door, always turn off the power to the main circuit and wait for approximately 10 minutes.
  Doing so may result in electric shock.
- After turning off the main circuit power supply, wait until the CHARGE indicator on the front face of the Power Cell goes out before performing maintenance or inspections.
  Otherwise electric shock may occur because the capacitor will remain charged.
- Maintenance, inspection, and replacement of parts must be performed only by authorized personnel.
  Remove all metal objects, such as watches and rings, before starting work. Always use insulated tools.
  Failure to observe these warning may result in electric shock.

⚠ CAUTION

- A CMOS IC is used in the control board. Use antistatic envelopes when maintaining or carrying the control board.
  The CMOS IC may be destroyed by static electricity if touched directly.
- While power is being supplied, do not change wiring for the control circuit and do not insert or remove connectors.
  Doing so may damage the electric components.
- When carrying out measurement with an oscilloscope, use an insulated oscilloscope without grounding.
  Otherwise, the Inverter or the oscilloscope may be damaged.
- After completing the work, make sure that no hand tools or screws are left inside the Inverter.

Periodic Inspection

◆ Daily Inspection

Check the following items while the system is operating.

Table 8.1 Daily Inspections

Inspection Item	Details of Inspection
Ambient environment	• Check the ambient temperature. • Check the humidity. • Check for toxic gas. • Check for adhesion of dust, oil mist, etc.
Equipment in general	Check for abnormal vibration and noise.
Power supply voltage	Check the voltage of the main circuit power supply and the control power supply. (Check the indication on the gage of the power supply unit.)
Transformer	Check for odor and abnormal noise.
Cooling fan	Check for abnormal vibration and noise.
	Check the air filter for soiling.
Lamps	Check if any lamp is blown.
Meters	Check if the meter indication is normal.

◆ Periodic Inspection

Check the following items during periodic inspections. Perform periodic inspections once a year.

Table 8.2 Periodic Inspections

Location	Inspection Item	Details of Inspection
Transformer section, Power Cell section	Entire Transformer and Power Cell sections	Megger check between the main circuit terminals and ground terminal
		Check for loose screws, bolts, or connectors.
		Check for trace of overheat on each part.
		Check for soiling or adhesion of dust, etc.
	Wires	Check for damage or deterioration of the cable sheath.
	Transformer	Confirm that primary/secondary voltages are normal.
		Check the windings for damage, and check for breakage in the insulation sheets.
		Check the windings for accumulation of dust, and for adhesion of foreign matter.
	Power Cells	Check for leakage from the smoothing capacitor.
		Confirm that the safety valve of the smoothing capacitor is not protruding.
		Confirm that the smoothing capacitor has not expanded.
		Measure the capacitance of the smoothing capacitor. (Check the indication on the gage.)
		Check for loose screws or bolts.
		Confirm that the main circuit and control circuit fuses are normal.
		Check for accumulated dust and dirt on the heat sink.
	Surge absorber	Make sure the wall tube insulator is clean, the terminals are tight, and the installation bolts are securely fastened.
Control section	Circuits	Confirm no abnormalities in protective and indication circuits
	Relays	Confirm that there is no chattering noise during operation
		Confirm timer operation.
		Check for damaged contacts.
	Board	Check for abnormal smells and discoloration.
		Confirm the power supply voltage.
Cooling system	Air filter	Check for soiling or clogging.
	Cooling fan	Check for abnormal vibration and noise.
		Confirm the bearing operation.

The details of periodic inspections are described below.

■Megger Check (Measurement of Insulation Resistance)

1. Measure insulation resistance of the Inverter primary circuit.
   Use a 1000 V Megger insulation resistance tester.
   As the primary circuit is grounded at high-resistance for input voltage detection, isolate both the grounding line and the detection signal lines that are connected to the control board before measuring insulation resistance.
   The measured insulation resistance must be 30 MΩ or more.
2. Measure insulation resistance of the Inverter secondary circuit (motor side)
   Use a 1000 V Megger insulation resistance tester.
   As the secondary circuit is grounded at high-resistance for output voltage detection and ground-fault detection, isolate the high-resistance resistor and Power Cell output cables connected to the output terminals before measuring insulation resistance.
   If a secondary switchgear is provided, it is easier to open the contactor at the secondary switchgear output terminals and measure the insulation resistance at the secondary switchgear output terminals.
   The measured insulation resistance must be 2 MΩ or more.
3. Measure the surge absorber insulation resistance.
   User a 1000 V Megger insulation resistance tester.
   Take measurements after removing terminal wires.
   Resistance should be at least 1000 MΩ.

   Note: When performing a withstand voltage test, make sure the components being tested have been removed from the circuit.

■Screws, Bolts, and Connectors

Loose input and output terminal bolts and/or loose board connectors can cause failure or malfunction of the Inverter. During periodic inspection, be sure to retighten the screws and bolts and re-insert the connector securely.

Inspect the following terminals and connectors.

- Medium-voltage input and output terminals
  Tightening torque: 1800 to 2300 N·cm for M10 bolts, 3150 to 3950 N·cm for M12 bolts.
- Input and output voltage detection circuits (high-resistance section)
- Transformer input and output terminals and primary voltage tap terminals
- Transformer output terminal block
- Power Cell input and output terminals and optical fiber cable connector
- Power Cell screws, bolts, and connectors
- Control power supply input terminals
- Control transformer input and output terminals
- Cooling fan contactor input and output terminals
- Control fuse input and output terminals
- Screws, bolts, and connectors of each control board
- External input and output terminals

■Transformer

Inspect the transformer as described below.

1. Check the external appearance and clean the exterior of the transformer.
2. Retighten the bolts of transformer input and output terminals and transformer tap terminals
3. Measure the transformer secondary voltage.
   Turn on the control power supply and main circuit power supply, and measure the input voltages to the Power Cells. (Refer to *Fig. 8.1*.)
   Measure the input voltage to each Power Cell by using a digital multimeter AC range. (Measure the input voltage to each Power Cell across L1, L2, L3.) The measured input voltage must be the rated voltage (630 VAC) ±10 V. If the majority of measured values exceed the allowable range, adjust the transformer tap (+10, +5, or 0% can be selected).

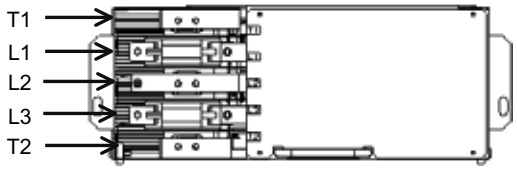


Fig 8.1 Power Cell Input Voltage Measurement

■Power Cells

Inspect all the Power Cells as described below.

- Check the external appearance.
  Check for discoloration indicating burn marks, for leakage from the smoothing capacitor, and for protruding safety valves and expansion of the smoothing capacitor.
- Retighten the bolts of input terminals L1, L2, and L3.
- Retighten the bolts of output terminals T1 and T2.
- Re-insert the optical fiber cable connector.
- Retighten the screws and bolts inside the Power Cell.
- Check the main circuit fuse and control circuit fuse.
  Check for discoloration and looseness.
- Clean the heat sink.
  If dirt and dust have accumulated on the heat sink, use dry air of 39.2×10^4 to 58.8×10^4 Pa (4 to 6 kg·cm^2) to clean it.

■Air Filter

If the air filter is soiled or clogged with dirt and dust, the cooling capacity of the Inverter will be degraded, resulting in abnormal temperature rise. Check the air filter for dirt and dust at each daily inspection, and periodically clean it with neutral detergent.

■Control Board

Visually check the control board for the following.

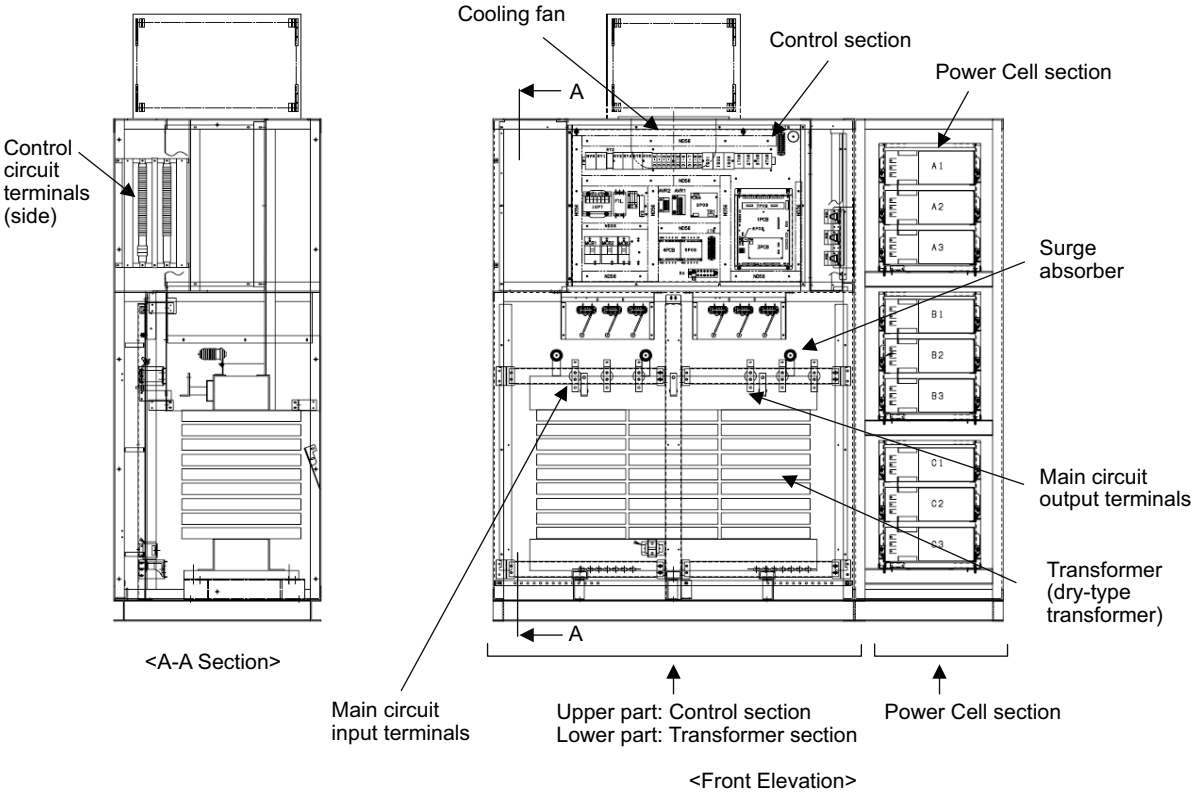
- Abnormal smell or discoloration of the board
- Loose screws or connectors

■Cooling Fan

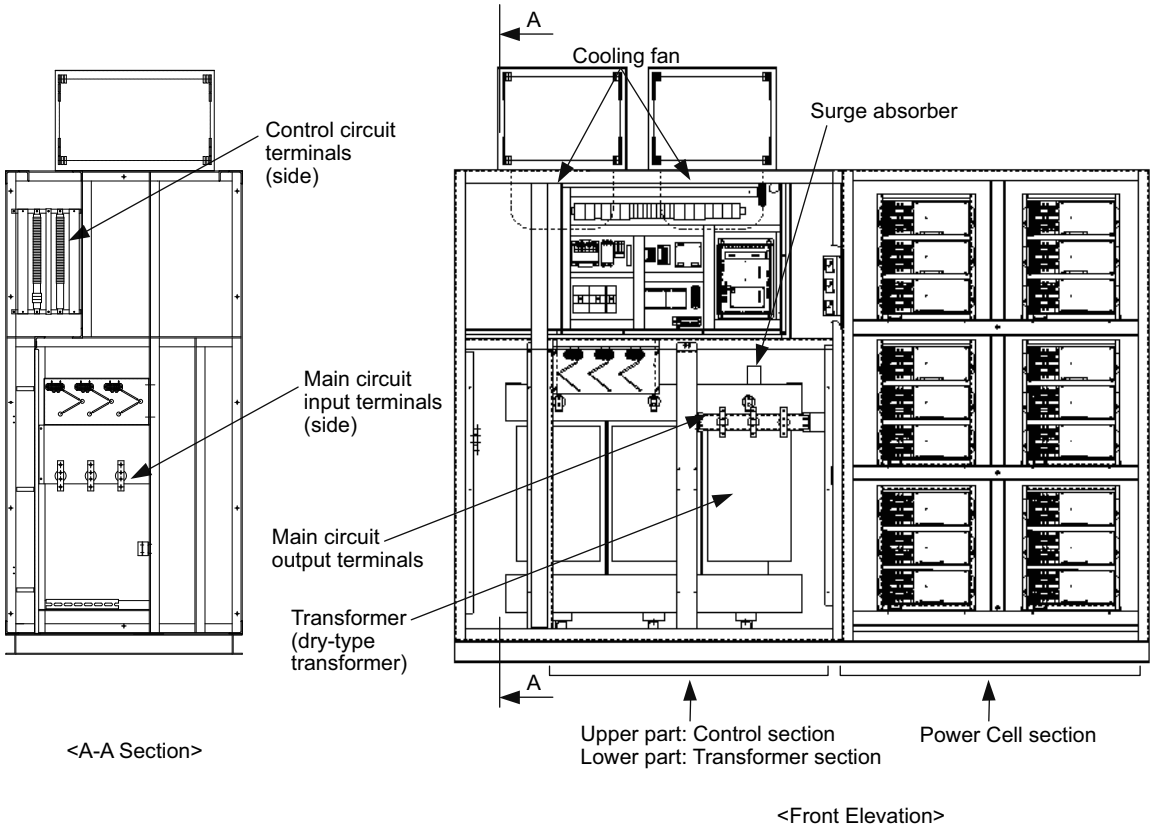
Inspect the cooling fan as described below.

- Check for abnormal vibration or noise
- Retighten the mounting bolts.
- Measure the motor insulation resistance.
  Use a 500 V Megger insulation resistance tester. The measured insulation resistance must be 10 MΩ or more.
- Motor bearing
  The service life of a bearing is approx. 15,000 hours.

◆ Location of Parts



3 kV Class, 800 kVA



6 kV Class, 1600 kVA

Fig 8.2 Internal Configuration Examples

Maintenance

◆ Periodic Maintenance of Parts

In order to keep the FSDrive-MV1S series Inverter operating normally over a long period of time, we recommend replacing parts in accordance with their service life.

The Inverter is configured with many parts, and each of these parts must be operating properly in order to make full use of the Inverter functions. Among the electronic components, there are some that require maintenance depending on their usage conditions.

To keep the Inverter operating normally over a long period of time, it is necessary to carry out periodical inspections and to replace the parts in accordance with their service lives. Periodic inspection standards vary, depending on the Inverter installation environment and usage conditions. Inverter maintenance periods are noted below for your reference.

Refer to Page 8-14 for replacement procedures for the cooling fan.

For the replacement of other parts, contact your Yaskawa representatives. These replacements require trained professionals.

Table 8.3 Part Replacement Guidelines

Part Name	Standard Replacement Period*	Replacement Method and Remarks
Cooling fan	1 to 2 years (15,000 service hours)	Replace the bearings. (Bearings on motor and fan) For flapper-type designs, the flapper should also be replaced when replacing motor and fan bearings.
Power Cell smoothing capacitor	5 years	Replace with a new capacitor. (Determine replacement need after inspection.)
Fuses	10 years	Replace with new fuses.
Aluminum capacitor on the printed circuit board	5 years	Replace with a new board. (Determine replacement need after inspection.)
Lithium battery	5 years	Replace with a new battery (Connect a battery to the CPU board with connector.) Product name: CR6L-CN014S manufactured by FDK Corporation Specifications: 3 V/2000 mAh
Breaker and power fuses	–	Determine replacement need after inspection.

* The standard replacement period is based on the following usage conditions.
- •Ambient temperature: Yearly average of 30°C.
- •Load factor: 80% max.
- •Operating rate: 12 hours max./day

◆ Spare Parts

Considering the importance of the system in which the FSDrive-MV1S is used, it is recommended that spare parts be prepared in advance for all possible measures for maintenance management. *Table 8.4* lists the recommended spare parts. Confirm the following items and contact your Yaskawa representatives when ordering the spare parts.

Inverter: Model, capacity, and Yaskawa order number

Spare parts: Part name, model, and quantity

Table 8.4 List of Recommended Spare Parts

Related to Boards

Part Name		Model	Remarks
Cell control board (CCB)		Varies depending on the Inverter capacity. (Refer to *Table 8.6*.)	
Controller	CPU board	JEBC-61301-INV	Control board to be mounted on the modulator board
	Modulator board	JEBC-61302-INV	Medium-voltage Inverter control module
	Current detection resistance board	JEBC-61902-x	x depends on the Inverter capacity. (Refer to *Table 8.5*.)
	Optical fiber interface board	JEBC-61601	Used only for 6 kV class Inverter
Isolation board		JEBC-61701	Input/Output voltage detection analog insulation board.
RS232/RS485 converter board		JEBC-61602	RS485/RS232 converter board mounted on the Digital Operator panel
5-V power supply board		JEBC-61901	5-V three-phase outputs
±15-V power supply		Marketed product	MMB50A-6-CN (manufactured by COSEL)
24-V power supply		Marketed product	R10A-24-CN (manufactured by COSEL)

Main Circuit

Part Name	Model	Model
Power Cell	Varies depending on the Inverter capacity. (Refer to *Table 8.6*.)	

Operation Circuit

Part Name	Model	Model
Molded-case circuit breaker	Marketed product	–
Contactor	Marketed product	–
Thermal relay	Marketed product	–

Others

Part Name	Model	Model
Digital Operator	JVOP-160	–
Optical fiber cable	WRMZ-1295	–
Cooling fan for Inverter	Marketed product	EF-35DTB1, EF-40DTB1, EF-40ETB, EF-45ETB, or EF-50FTB (manufactured by Mitsubishi Electric Corporation)
EWS cable (3 m)	JZCP-751904	–

Table 8.5 Current Detection Resistor Boards

Model	Resistance	Applicable Inverter Capacity
JEBC-61902-1	47 Ω	3 kV class-285 kVA 6 kV class-570 kVA
JEBC-61902-2	30 Ω	3 kV class-400 kVA 6 kV class-800 kVA
JEBC-61902-4	22 Ω	3 kV class-570 kVA, 1500 kVA 6 kV class-1150 kVA, 3000 kVA
JEBC-61902-5	15 Ω	3 kV class-800 kVA, 1900 kVA, 2300 kVA 6 kV class-1600 kVA, 3800 kVA, 4600 kVA
JEBC-61902-7	68 Ω	3 kV class-200 kVA 6 kV class-400 kVA
JEBC-61902-8	10 Ω	3 kV class-1150 kVA, 3000 kVA 6 kV class-2300 kVA, 5300 kVA, 6000 kVA

Table 8.6 Power Cells

Power Cell Rating	Power Cell Model	Cell Control Board (CCB) Model	Applicable Inverter Capacity
35A	7910250-1001X	7910161-4020X	3 kV class-200 kVA, 6 kV class-400 kVA
50A	7910250-1001X	7910161-4020X	3 kV class-285 kVA, 6 kV class-570 kVA
70A	7910250-1002X	7910161-4020X	3 kV class-400 kVA, 6 kV class-800 kVA
100A	7910250-1003X	7910161-4020X	3 kV class-570 kVA, 6 kV class-1150 kVA
140A	7910250-1004X	7910161-4020X	3 kV class-800 kVA, 6 kV class-1600 kVA
200A	7910250-1015X	7910161-4021X	3 kV class-1150 kVA, 6 kV class-2300 kVA
260A	7910250-1016X	7910161-4021X	3 kV class-1500 kVA, 6 kV class-3000 kVA
400A	7910250-1017X	7910161-4021X	3 kV class-1900 kVA, 2300 kVA 6 kV class-3800 kVA, 4600 kVA
520A	7910250-1018X	7910161-4021X	3 kV class-3000 kVA 6 kV class-5300 kVA, 6000 kVA

Table 8.7 Power Cells Compatible with Previous Panels*

Power Cell Rating	Power Cell Unit Model*	Applicable Inverter Capacity
35A	7910250-1021X	3 kV class-200 kVA, 6 kV class-400 kVA
50A	7910250-1021X	3 kV class-285 kVA, 6 kV class-570 kVA
70A	7910250-1022X	3 kV class-400 kVA, 6 kV class-800 kVA
100A	7910250-1023X	3 kV class-570 kVA, 6 kV class-1150 kVA
140A	7910250-1024X	3 kV class-800 kVA, 6 kV class-1600 kVA

* Previous panels for the FSDrive-MV1S were constructed with three Power Cells in one integral frame.

Part Replacement Procedure

◆ Cooling Fan

■Models and Number of Cooling Fans Used

Table 8.8 shows the cooling fan models, specifications, and number of cooling fans.

When replacing the cooling fans, use the models specified in *Table 8.8*. These cooling fans are manufactured by Mitsubishi Electric Corporation.

If cooling fans other than those specified in *Table 8.8* are used, Inverter performance cannot be guaranteed.

Table 8.8 Models and Number of Cooling Fans Used

Control Power Supply Voltage Class [V]	Voltage Class [kV]	Frequency [Hz]	Model CIMR-MV1S ■■□□□	Cooling Fans in Transformer Section		Cooling Fans in Power Cell Section	
				Model/Specifications	Qty	Model/ Specifications	Qty
200	3	50/60	132	EF35DTB3 150W	1	–	–
			200	EF40DTB3 200W	1	–	–
			315	EF40ETB3 400W	1	–	–
			450	EF50FTB3 750W	1	–	–
			630	EF50FTB3 750W	1	–	–
			900	EF50FTB3 750W	1	EF45ETB3 400W	1
			13C	EF40ETB3 400W	2	EF50FTB3 750W	1
			15C	EF50FTB3 750W	2	EF50FTB3 750W	2
			18C	EF50FTB3 750W	2	EF50FTB3 750W	2
			25C	EF45ETB3 400W	3	EF50FTB3 750W	2
	6	50/60	250	EF40ETB3 400W	1	–	–
			400	EF40DTB3 200W	2	–	–
			630	EF40ETB3 400W	2	–	–
			900	EF50FTB3 750W	2	–	–
			13C	EF50FTB3 750W	2	–	–
			18C	EF50FTB3 750W	2	EF50FTB3 750W	2
			25C	EF50FTB3 750W	3	EF50FTB3 750W	2
			30C	EF50FTB3 750W	3	EF50FTB3 750W	3
			36C	EF50FTB3 750W	4	EF50FTB3 750W	4
			43C	EF50FTB3 750W	4	EF50FTB3 750W	4
			50C	EF50FTB3 750W	4	EF50FTB3 750W	4

Table 8.8 Models and Number of Cooling Fans Used (Continued)

Control Power Supply Voltage Class [V]	Voltage Class [kV]	Frequency [Hz]	Model CIMR-MV1S ■■□□□	Cooling Fans in Transformer Section		Cooling Fans in Power Cell Section	
				Model/Specifications	Qty	Model/ Specifications	Qty
400	3	50/60	132	EF35DTB40A5 150W	1	–	–
			200	EF40DTB40A5 200W	1	–	–
			315	EF40ETB40A5 400W	1	–	–
			450	EF50FTB40A5 750W	1	–	–
			630	EF50FTB40A5 750W	1	–	–
			900	EF50FTB40A5 750W	1	EF50FTB40A5 750W	1
			13C	EF40ETB40A5 400W	2	EF50FTB40A5 750W	1
			15C	EF50FTB40A5 750W	2	EF50FTB40A5 750W	2
			18C	EF50FTB40A5 750W	2	EF50FTB40A5 750W	2
			25C	EF50FTB40A5 750W	3	EF50FTB40A5 750W	2
	6	50/60	250	EF40ETB40A5 400W	1	–	–
			400	EF40DTB40A5 200W	2	–	–
			630	EF40ETB40A5 400W	2	–	–
			900	EF50FTB40A5 750W	2	–	–
			13C	EF50FTB40A5 750W	2	–	–
			18C	EF50FTB40A5 750W	2	EF50FTB40A5 750W	2
			25C	EF50FTB40A5 750W	3	EF50FTB40A5 750W	2
			30C	EF50FTB40A5 750W	3	EF50FTB40A5 750W	3
			36C	EF50FTB40A5 750W	4	EF50FTB40A5 750W	4
			43C	EF50FTB40A5 750W	4	EF50FTB40A5 750W	4
			50C	EF50FTB40A5 750W	4	EF50FTB40A5 750W	4

Note Use the cooling fans with voltage ratings corresponding to the control power supply voltage (200-V class or 400-V class).

■Replacement Procedure

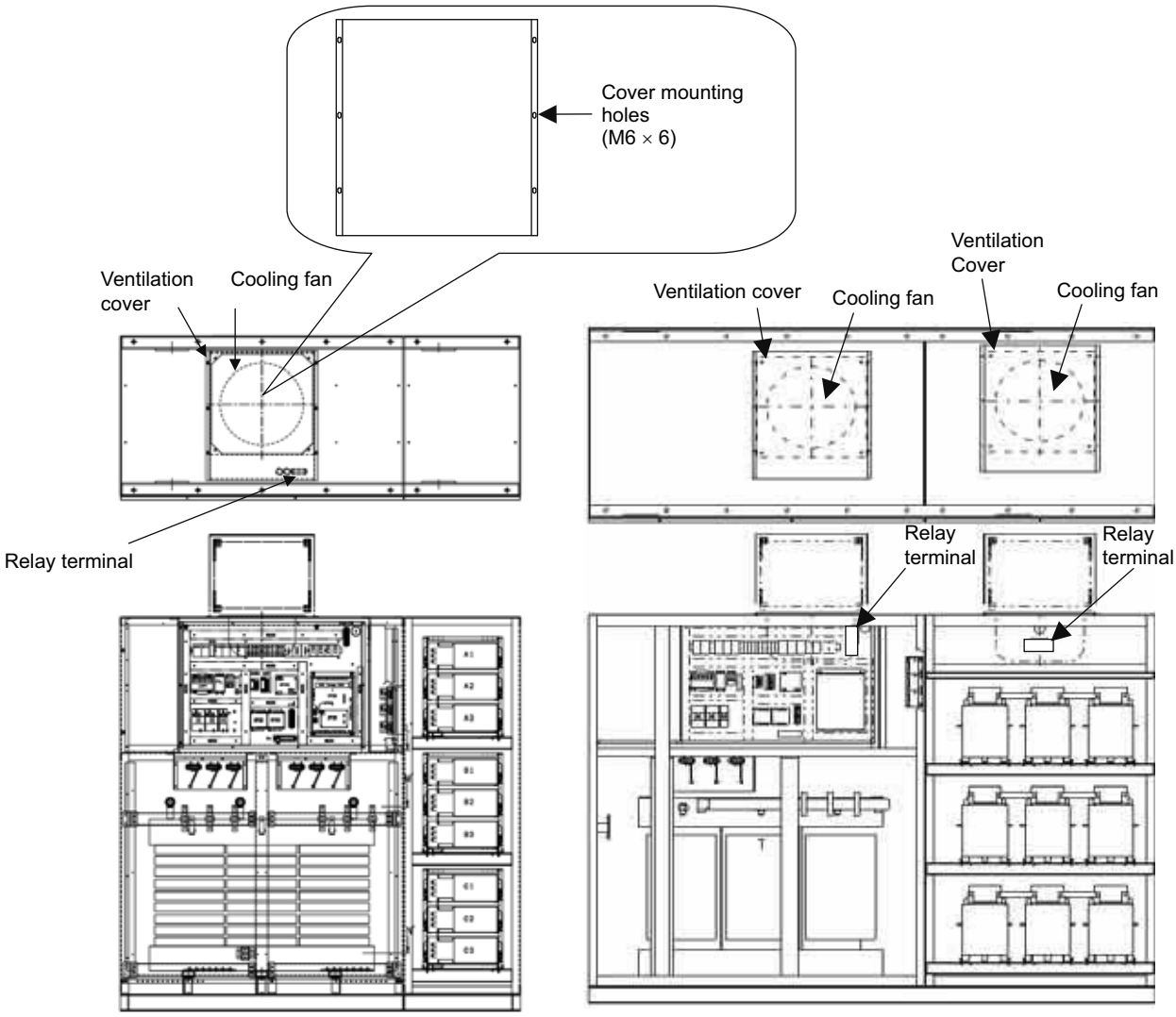
Refer to the *Fig. 8.3* and use the following procedure to replace the cooling fan.

Removing the Cooling Fan

1. Remove the ventilation cover on the top of the Inverter.
2. Disconnect the cooling fan cables from the panel top or from relay terminals inside the Inverter.
3. Remove the cooling fan mounting screws.
4. Pull the cooling fan upward to remove.

Mounting a New Cooling Fan

1. Mount the new cooling fan on the panel top and tighten the mounting screws.
2. Reinstall the components in the reverse order of removal. Make sure that the cables are fixed so that they will not have contact with or be caught in the cooling fan blades.



3 kV Class, 800 kVA　　3 kV Class, 1150 kVA

Fig 8.3 Cooling Fan Replacement

◆ Power Cell

Refer to *Fig. 8.4, Fig. 8.5*, and *Fig. 8.6* and use the following procedure to replace a Power Cell.

1. Disconnect the three-phase input wires (copper bar or wires) from the input terminals L1, L2, and L3. (*Fig. 8.4* ①*)*
2. Disconnect the wires (copper bar or wires) from the output terminals T1 and T2. (*Fig. 8.4* ②*)*
3. Disconnect the optical fiber cable from the cell control board (CCB). (*Fig. 8.4* ③*)*
   (Take special care not to damage the optical fiber cable when pulling out the Power Cell.)
4. Remove the Power Cell fixing screws on the left and right or the bottom of the front of the Power Cell. (*Fig. 8.4* ④)
5. Fit the lifter platform at that position to place it under the Power Cell.
   (*Fig. 8.5* ⑤ *and Fig. 8.6* ⑤*)*
6. Use the attachment bracket affixed to the lifter platform when installing or removing two of the upper groups of Power Cells of 140 A or lower (*Fig. 8.6* ⑨). Refer to instructions on attachment bracket installation on page 8-18.
7. Pull the Power Cell and place the whole Power Cell onto the lifter platform. (*Fig. 8.5* ⑥ *and Fig. 8.6* ⑥*)*
   The casters of the Power Cell are set slightly lower than the mounting face of the Power Cell. Pull the Power Cell with some force.

> **⚠ CAUTION**
>
> • Do not pull too strongly when pulling the Power Cell out.
> Otherwise, the Power Cell may fly out and your hands or fingers could get caught.

8. Fix the Power Cell on the platform using a belt or stopper, etc. to prevent the Power Cell from falling off. (*Fig. 8.5* ⑦ and *Fig. 8.6* ⑦)
9. Lower the Power Cell to a stable position. (*Fig. 8.5* ⑧ and *Fig. 8.6* ⑧)

Remount the Power Cell in the reverse order of removal after inspection and replacement.

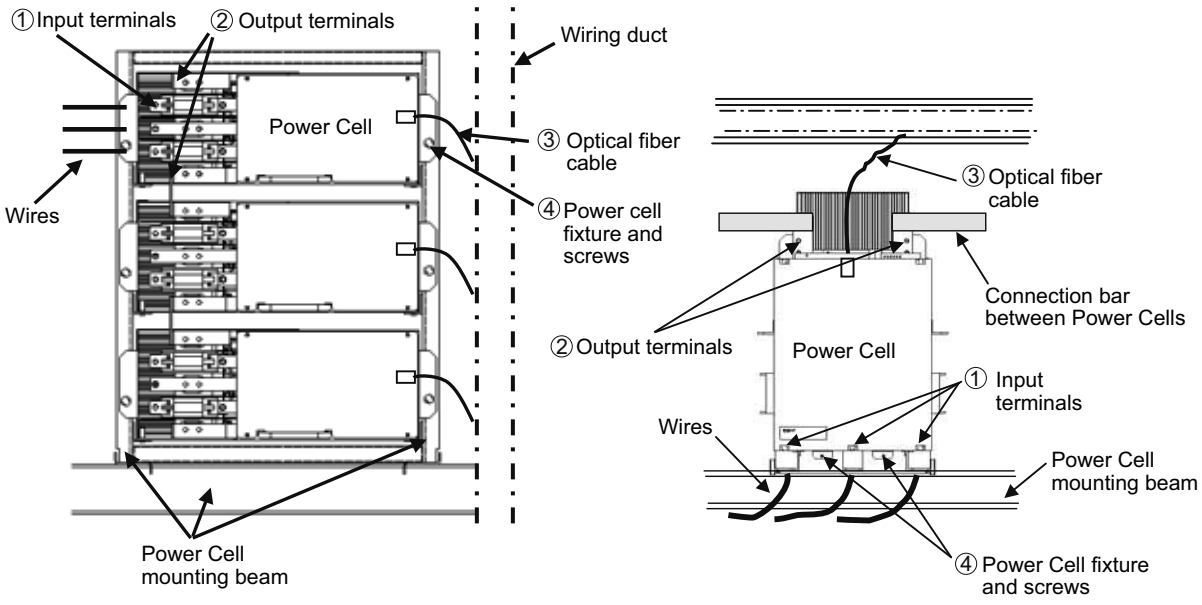
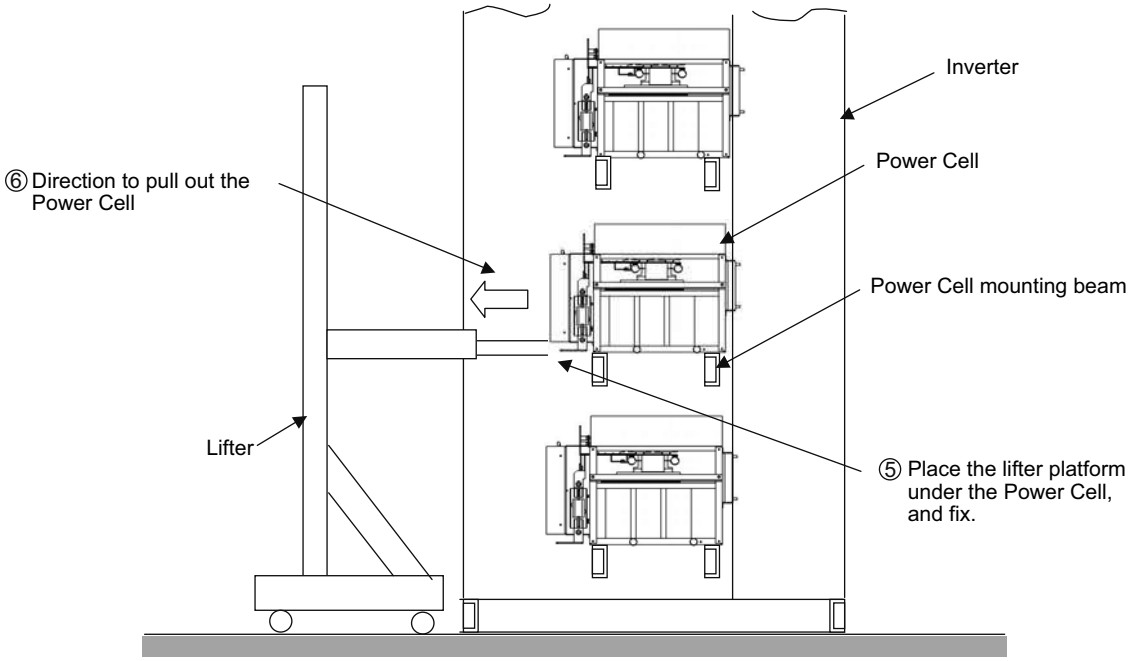
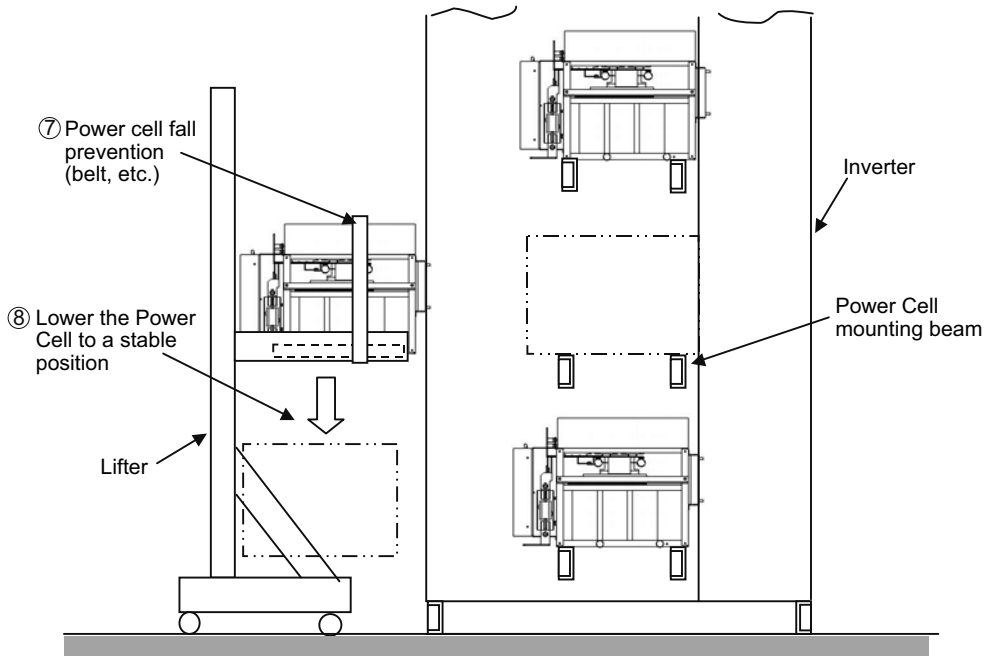


Fig 8.4 Power Cell Locations



<Power Cell: 200 A or More>

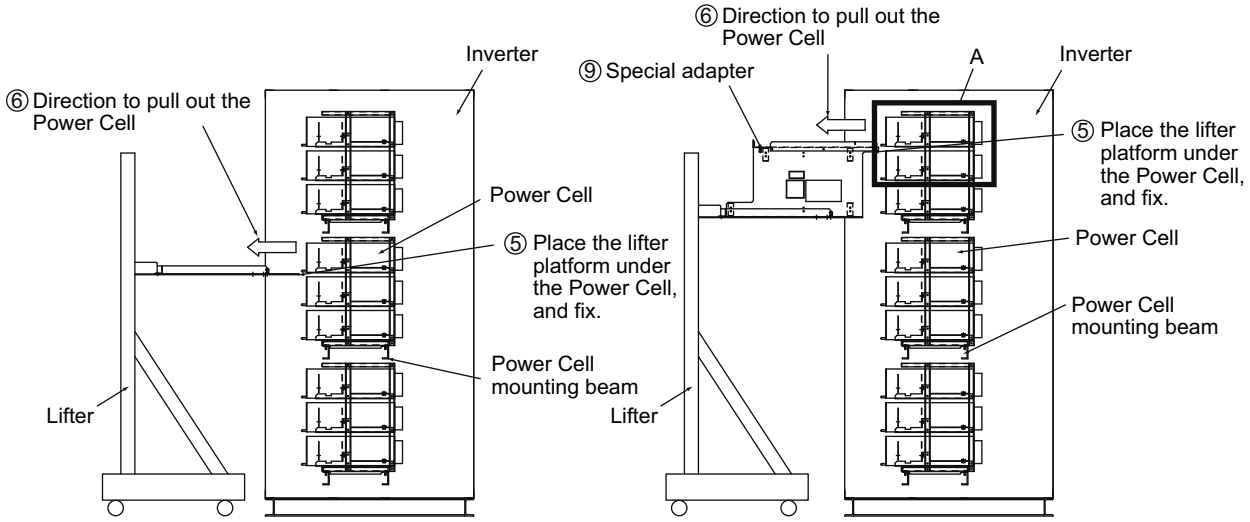
<Positioning the lifter platform and pulling out the Power Cell>



<Power Cell: 200 A or More>

<Fixing the Power Cell>

Fig 8.5 Pulling Out the Power Cell and Fixing it to Lifter <Power Cell: 200 A or More>



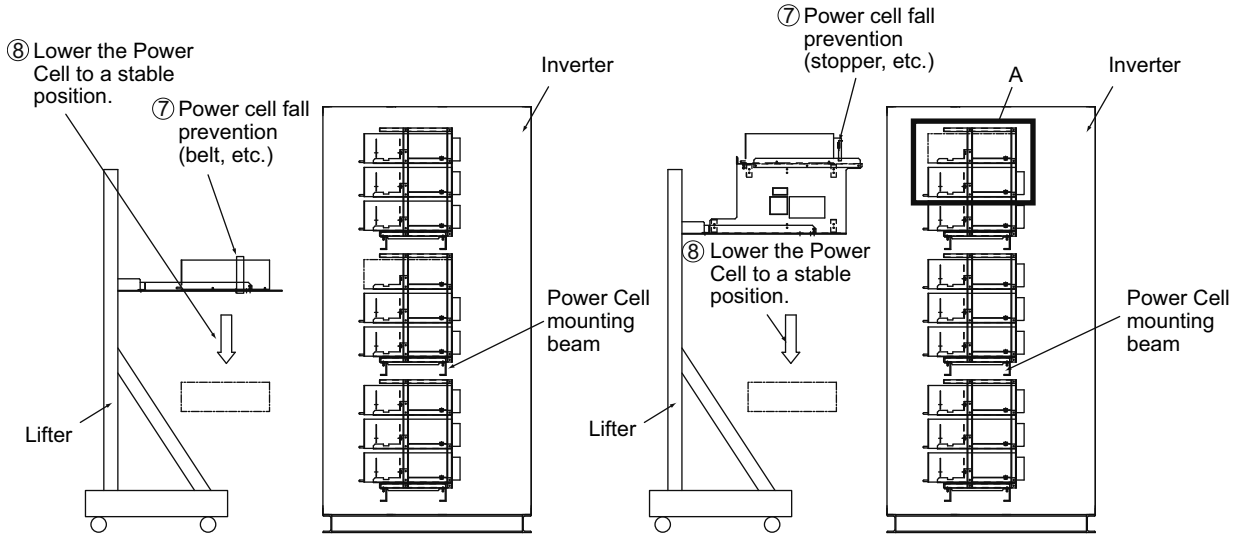
<Power Cell: 140 A or Lower>

<Positioning the lifter platform and pulling out the Power Cell>

<Power Cell: 140 A or Lower>

<Positioning the lifter platform and pulling out the Power Cell>

<Only Power Cells for A>



<Power Cell: 140 A or Lower>

<Fixing the Power Cell>

<Power Cell: 140 A or Lower>

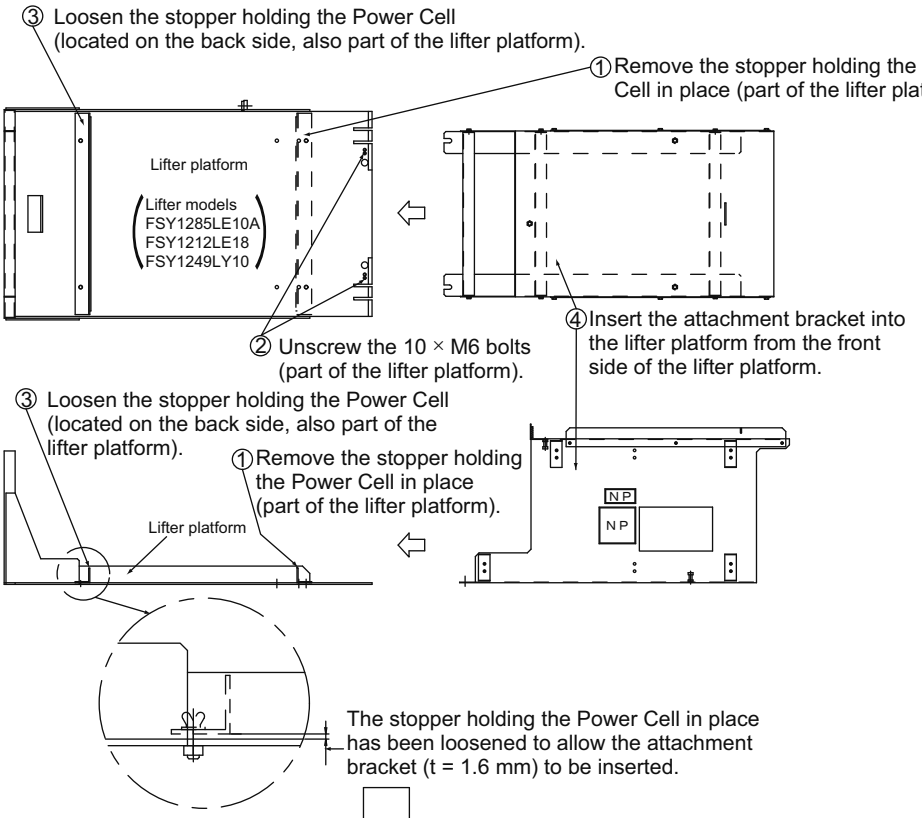
<Fixing the Power Cell>

<Only Power Cells for A>

Fig 8.6 Pulling Out the Power Cell and Fixing it to Lifter (Power cell: 140 A or Lower)

Attachment Bracket Installation Diagram

Preparation for Installing Attachment Bracket to Lifter Platform



Attachment Bracket Installed to Lifter Platform with Power Cell Removed

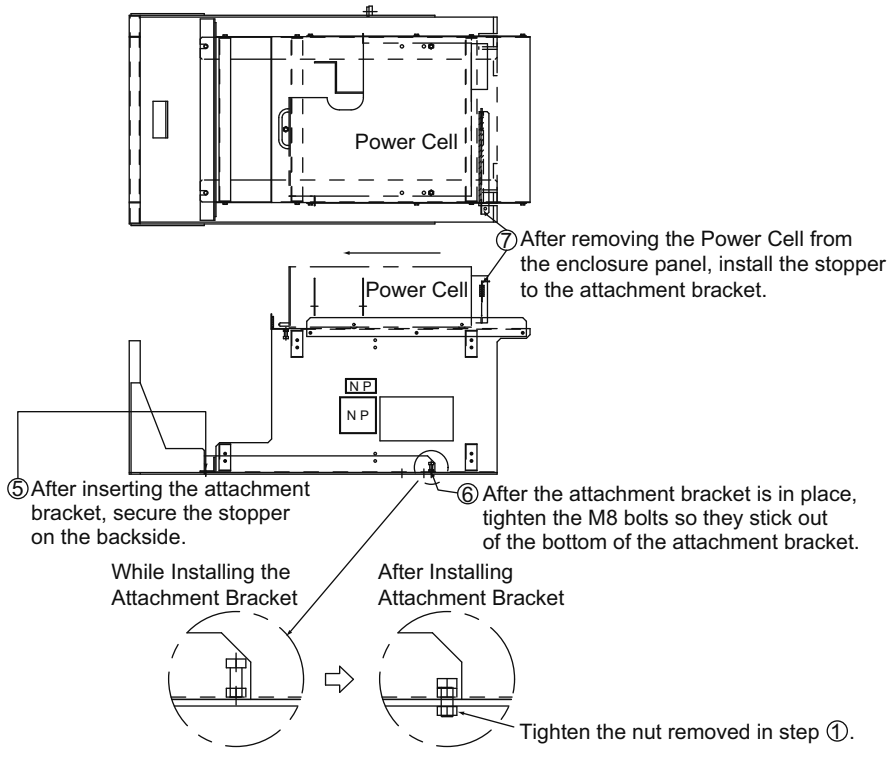


Fig 8.7 Installing and Removing the Attachment Bracket

■Removing an Old Power Cell from an Previous Panels and Installing a New Power Cell

* 1. Previous panels for the FSDrive-MV1S were constructed with three Power Cells in one integral frame.
* 2. The old Power Cell was designed in a three-cell integral construction.
* 3. A "Power Cell unit" refers to a single cell inside a frame designed for three cells.
* 4. Old Cells and Power Cell units are compatible. Other cells that can supply over 200 A or more can also be used.

Refer to *Fig. 8.5*, *Fig. 8.8* and *Fig. 8.9* and use the following procedure to replace the old Power Cell of previous panels.

1. Disconnect the three-phase input wires (copper bar or wires) from the input terminals L1, L2, and L3. (*Fig. 8.8 ①)*
2. Disconnect the wires (copper bar or wires) from the output terminals T1 and T2. (*Fig. 8.8 ②)*
3. Disconnect the optical fiber cable from the cell control board (CCB). (*Fig. 8.8 ③)*
   (Take special care not to damage the optical fiber cable when pulling out the old Power Cell.)
4. Remove the fixing screws on the bottom of the front of the old Power Cell. (*Fig. 8.8 ④)*
5. Extend the lifter platform to place it under the old Power Cell and fix it at that position. (*Fig. 8.5 ⑤)*
6. Pull the old Power Cell and place the whole Power Cell onto the lifter platform. (*Fig. 8.5 ⑥)*
   The casters of the old Power Cell are set slightly lower than the mounting face. Pull the old Power Cell with some force.

> **⚠ CAUTION**
>
> • Do not pull too strongly when pulling the Power Cell out.
> Otherwise, the Power Cell may fly out and your hands or fingers could get caught.

7. Fix the old Power Cell on the platform using a belt, etc. to prevent the old Power Cell from falling off. (*Fig. 8.5 ⑦)*
8. Pull the platform from panels, lower the platform together with the Power Cell. (*Fig. 8.5 ⑧)*

Remount the Power Cell unit by following the removal procedure in reverse after inspection and replacement. (*Fig. 8.9 ④)*

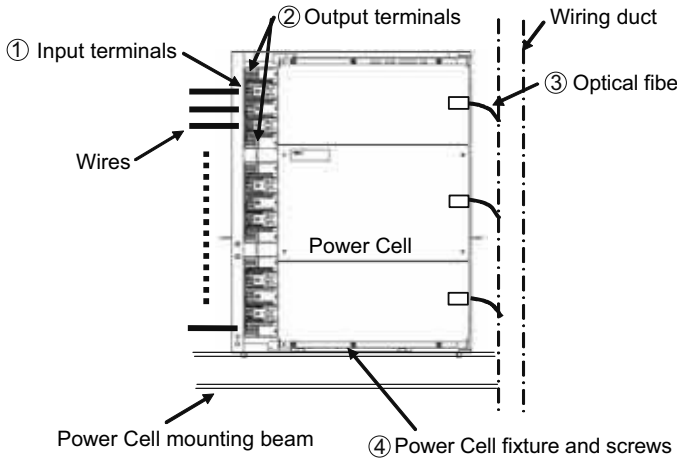


Fig 8.8 Old Power Cell Locations on Previous Panels

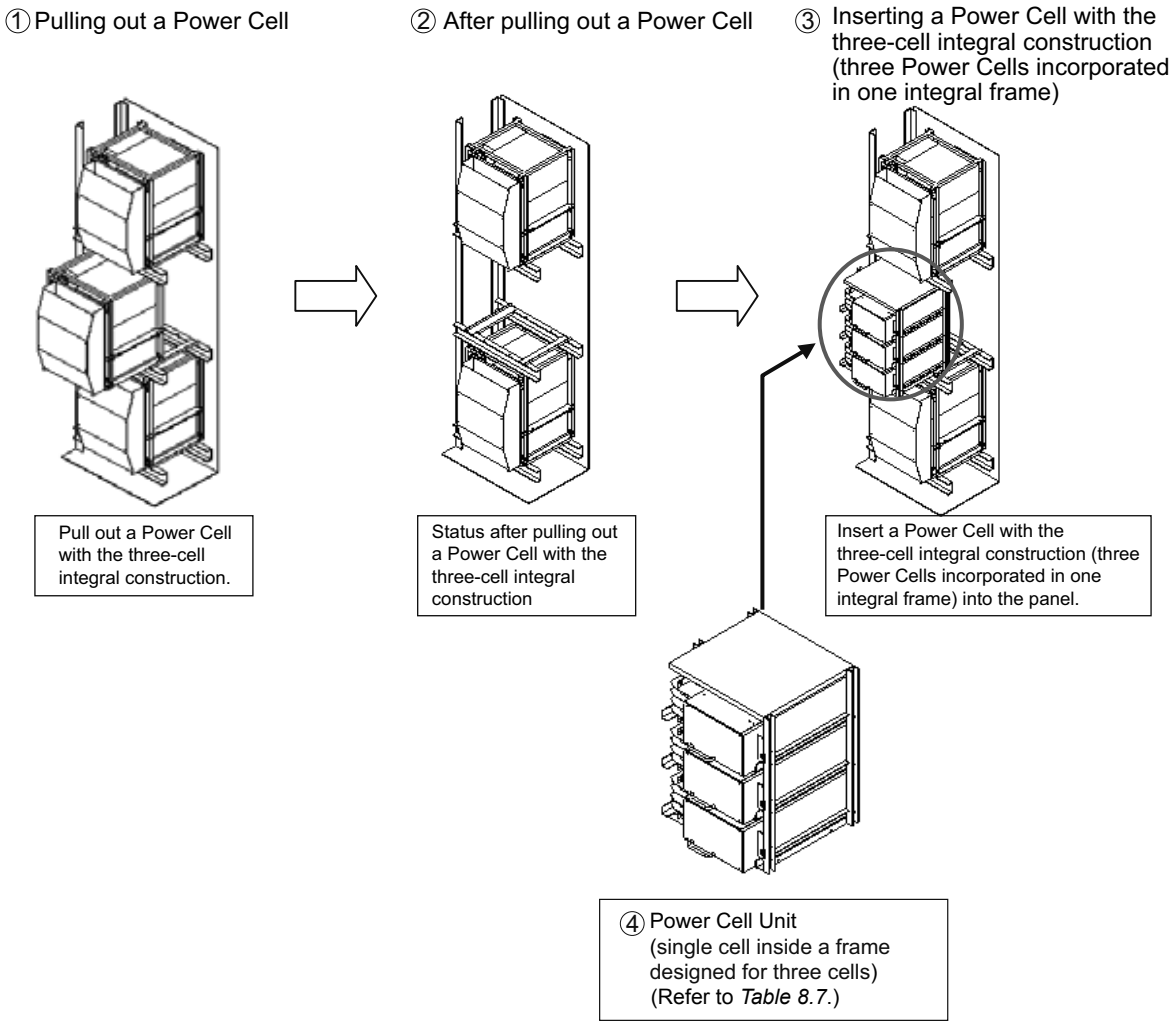


Fig 8.9 Procedure for Removing Old Power Cells of Previous Panels and Mounting Power Cell Unit (Power Cell: 140A or Lower)

IMPORTANT

The excessive deceleration prevention function cannot be used with the previous panels.

■Installation Procedure of Spare or Old Power Cells

When installing an old Power Cell, replace the Power Cell by following the procedure below while referring to *Fig. 8.10*.

1. Remove three Power Cells at the location where an old Power Cell is to be installed by following steps *1.* to *8.* in Page 8-15.
2. Remove the Power Cell mounting frame.

Mount the old Power Cell by reversing steps *1.* to *8.* in page 8-19 after inspection and replacement.

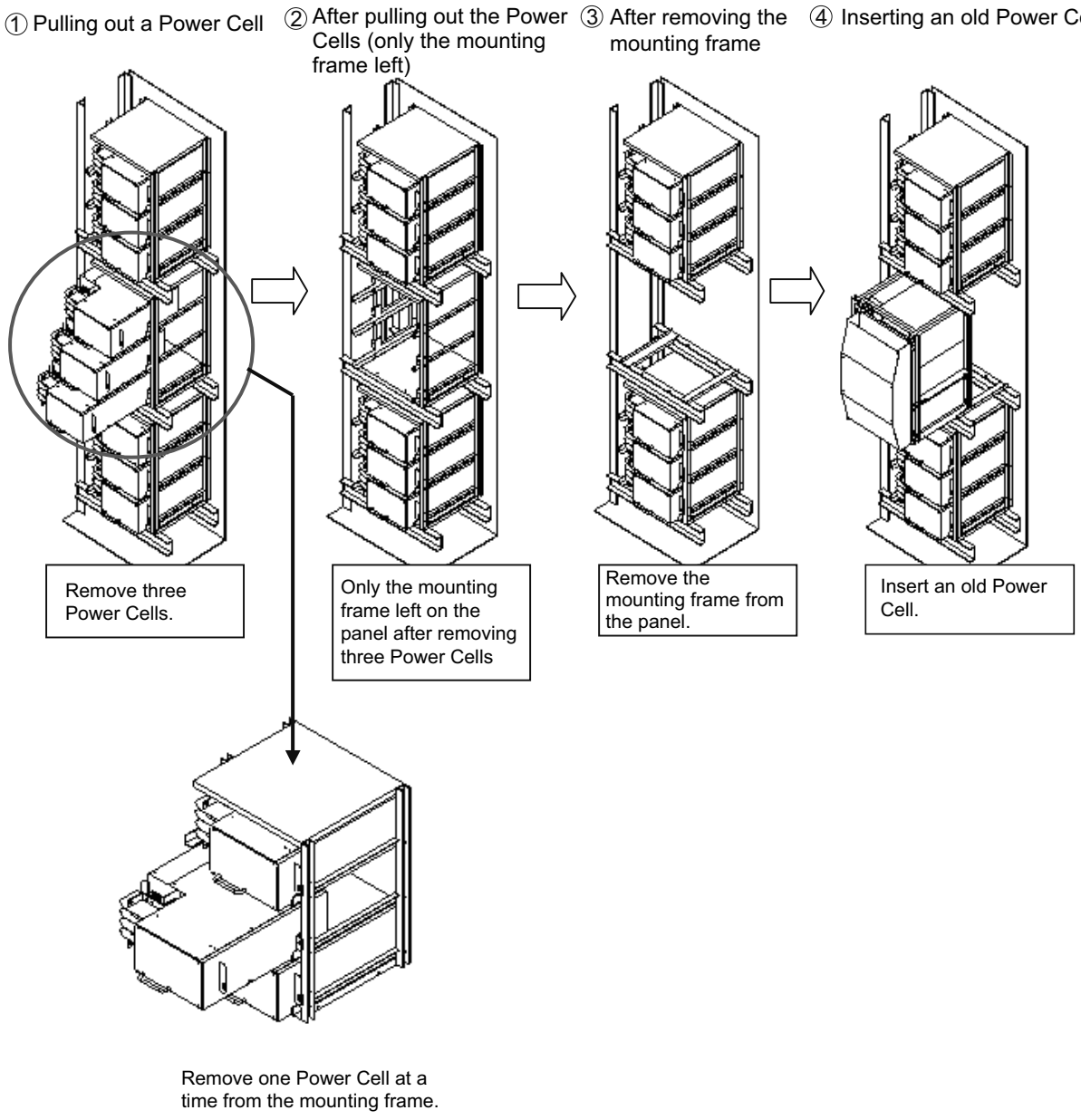


Fig 8.10 Installation Procedure of Spare or Old Power Cells

IMPORTANT

When the excessive deceleration prevention function is enabled after installing an old Power Cell, the faults due to overvoltage are not suppressed.

◆ Memory Backup Battery

■Replacement Period

A battery for memory backup is provided in the controller.

When the battery voltage drops below 2.5 V, an alarm will occur and BAT will be displayed on the Digital Operator. The LED indicator BAT_ALM on the controller also will light up. Replace the battery.

We recommend replacing the battery every 5 years even if no alarm is detected. (Indicated on the battery replacement interval nameplate on the controller.)

Use battery model CR6L-CN014S (see *Table 8.3*).

IMPORTANT

- Do not turn off the power with an alarm detected. Otherwise, the data and calendar settings stored in the backup memory may be lost.
- If the power is turned on when the battery voltage is less than 2.5 V, the backup data will be automatically cleared.

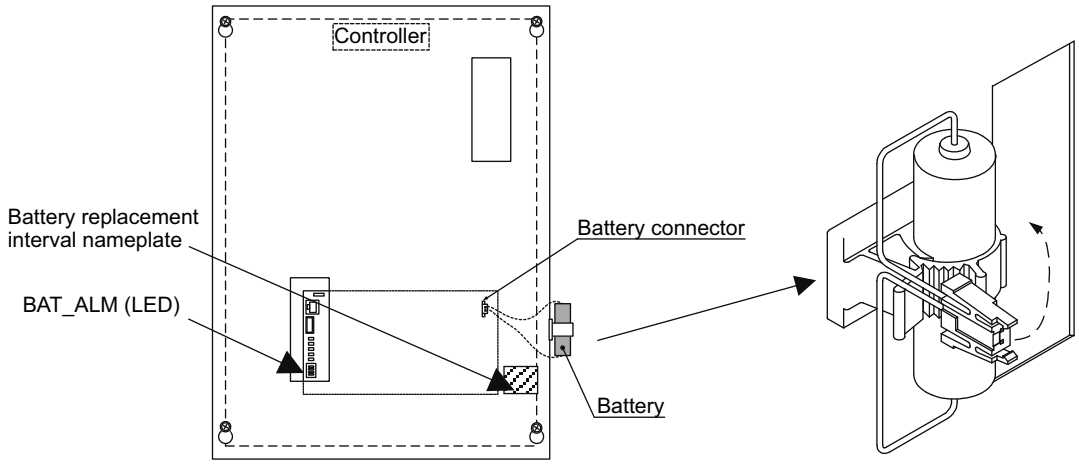
■Replacement Procedure

IMPORTANT

- Replace the battery while the control power is supplied.
- If the power is turned off, replace the battery within one hour after turning off the power. Within this period, the internal capacitor will back up the data.
- If the power is off for more than one hour, the backup data may be corrupted. In that case, turn on the power with the battery removed to clear the backup data and then set the battery.

Replace the battery by using the following procedure.

1. Touch the controller cover to remove static electricity before starting replacement work.
2. Remove the cover from the controller.
3. Disconnect the cable from the battery connector.
4. Remove the battery from the battery holder.
5. Clean the battery connector with alcohol or equivalent if there is dust or oil on the connector.
6. Mount a new battery in the battery holder.
7. Confirm the polarities and connect the battery holder to the connector.
8. Write the date when the battery should be replaced next.



- Be careful not to short-circuit the battery connector when removing or mounting the battery or cleaning the connector. If the connector is short-circuited, backup data may be lost.
- Check the backup data to confirm it has not been lost before restarting operation.

Spare Parts

When keeping power cells, boards, or cooling fans in reserve, observe the following precautions to secure the life and reliability.

◆ Storage Location

■Temperature and Humidity

Store the products in the following environmental condition.

Air temperature: –5°C to + 40°C, Relative humidity: 85 %RH without condensation, Away from direct sunlight

For a short-term (approximately one month) storage such as during transportation, the air temperature between –20°C and + 60°C is acceptable.

Carefully pack and store the products not to be affected by vibration and shock during transportation.

■Dust and Oil Mist

Avoid storing the products in a location subjected to dusts and oil mist, such as cement factory and spinning mill.

■Corrosive Gas

Avoid storing the products in a location subjected to corrosive gas, such as chemical factory, refinery, and sewage plant.

■Salt Damage

Avoid storing the products in a location where there is a risk of salt damage, such as a location near the beach, and in salt damaged areas.

■Others

Avoid storing the products in a location subjected to unfavorable conditions. The products should be stored safely in a ware a warehouse, office, or similar location.

■How to Store

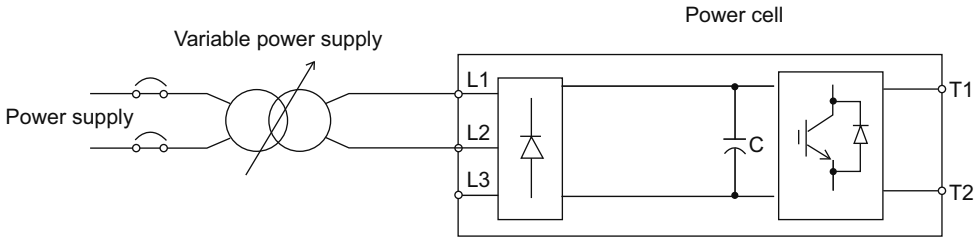
- Do not unpack the product to store.
- When storing the board after having unpacked, enclose the board in a conductive sheet bag.
- Protect the product not to be directly loaded during storage.

◆ Periodically Induct Current into the Main Circuit Capacitor

To avoid degradation of the capacitor, induct current into the capacitor every six months by applying the rated voltage (single- or three-phase) for aging the main circuit capacitor (inducting current into the capacitor without load (disconnected from the circuit) for one hour or longer.)

If no current had been inducted into the capacitor more two years or longer, use a variable power supply to gradually increase the voltage to the rated voltage for 2 to 3 minutes before starting aging the main circuit electrolytic capacitor.

Then, connect the capacitor to the regular circuit and operate the Inverter to confirm that no abnormality, such as Inverter fault and overcurrent and motor vibration and speed variation, occurs.



Note: A variable power supply to be prepared by the customer.

■When Using an AC Variable Power Supply (Single-phase/Three-phase)

- Single-phase AC variable power supply: Connect to the terminals L1 and L2 (or L3).
  Three-phase AC variable power supply: Connect to the terminals LA, L2, and L3.
- Gradually increase the voltage from 0 (zero) volt to 630 VAC.

■When Using a DC Variable Power Supply

- Connect the power supply to the terminals L1 and L2 (or L3).
- Gradually increase the voltage from 0 (zero) volt to 850 VDC.

9

Specifications

This chapter describes the FSDrive-MV1S series Inverter standard specifications.

FSDrive-MV1S Standard Specifications 9-2

FSDrive-MV1S Standard Specifications

The specifications for each model and capacity are listed below.

All models from 3 kV class 200 kVA to 6 kV class 6000 kVA have the same electric specifications such as control specifications.

■3 kV Class Models

Table 9.1 3 kV Class FSDrive-MV1S Standard Specifications

Model CIMR-MV1S□A□□□		132	200	315	450	630	900	13C	15C	18C	25C
Max. Applicable Motor Capacity (kW)*1		132	200	315	450	630	900	1250	1500	1800	2500
Nominal Capacity (KVA)		200	285	400	570	800	1150	1500	1900	2300	3000
Output Rating	Rated Output Current (A)	35 (30)	50 (45)	70 (60)	100 (85)	140 (120)	200 (170)	260 (230)	330 (290)	400 (350)	520 (440)
	Rated Output Voltage	Three-phase 3300 V (sine wave)									
Power Supply	Main Circuit (Input Voltage)	Three-phase 3000/3300 V ±10% 50/60 Hz ±5%									
	Control Circuit	Three-phase 200/220 V, 380 V, 400/440 V ±10% 50/60 Hz ±5%									
Inverter Efficiency		Approx. 97% (at motor rated speed and 100% load)									
Inverter Power Factor		0.95 min. (at motor rated speed and 100% load)									
Overload Capacity		110%/60 s, 120%/15 s									
Cooling Method		Forced air-cooling method									
Control Specifications	Control Method	Open-loop vector control, flux vector control, V/f control (for multiple motors)									
	Main Circuit	Voltage type series multiplex									
	Frequency Control Range	0.01 to 120 Hz									
	Frequency Control Accuracy	±0.5%									
	Analog Input Resolution	0.03 Hz									
	Acceleration/Deceleration Time	0.1 to 6,000 seconds									
	Main Control Functions	Restart after momentary power loss*2, torque limit, coasting to stop, jump frequencies, S-curve acceleration/deceleration, multi-step speed control, KEB function, energy-saving control, excessive deceleration prevention									
Protection Functions		Overcurrent, overvoltage, undervoltage, output ground fault, output open-phase, overload, motor overheat, cooling fan fault etc.									
Communications Functions		MEMOBUS [CP-215 and CP-218 (Ethernet) are optional.]									
Maintainability	Digital Operator	Status display, fault display, commands, setting/reading of constants									
	Main Circuit	Module configuration									
Environmental Specifications	Enclosure	IP 40 (simple dust-proof type)									
	Ambient Temperature and Humidity	-5°C to +40°C, 85%RH max. (with no condensation)									
	Storage Temperature	0°C to +50°C									
	Atmosphere	General environmental conditions (free from dust or corrosive gas), altitude: 1,000 m max.									
General Specifications	Paint Color	Internal and external surfaces painted in Munsell 5Y7/1 semiglossy									
	Applicable Standards	JIS, JEC, JEM, Electric Facility Technical Reference									

* 1. Maximum applicable capacity of Yaskawa's 4-pole standard motors

* 2. An uninterruptible input power supply unit (optional) for the control power supply is required to use the restart function for momentary power loss.

Note FSDrive-MV1S does not have the regenerative braking function.

■6 kV Class Models

Table 9.2 6 kV Class FSDrive-MV1S Standard Specifications

Model CIMR-MV1S□C□□□		250	400	630	900	13C	18C	25C	30C	36C	43C	50C
Max. Applicable Motor Capacity (kW)*1		250	400	630	900	1250	1800	2500	3000	3600	4300	5000
Nominal Capacity (kVA)		400	560	800	1200	1600	2300	3000	3800	4600	5300	6000
Output Rating	Rated Output Current (A)	35 (30)	50 (45)	70 (60)	100 (85)	140 (120)	200 (170)	260 (230)	330 (290)	400 (350)	460 (395)	520 (440)
	Rated Output Voltage	Three-phase 6600 V (sine wave)										
Power Supply	Main Circuit (Input Voltage)	Three-phase 6000/6600 V ±10% 50/60 Hz ±5%										
	Control Circuit	Three-phase 200/220 V, 380 V, 400/440 V ±10% 50/60 Hz ±5%										
Inverter Efficiency		Approx. 97% (at motor rated speed and 100% load)										
Inverter Power Factor		0.95 min. (at motor rated speed and 100% load)										
Overload Capacity		110%/60 s, 120%/15 s										
Cooling Method		Forced air-cooling method										
Control Specifications	Control Method	Open-loop vector control, flux vector control, V/f control (for multiple motors)										
	Main Circuit	Voltage type series multiplex										
	Frequency Control Range	0.01 to 120 Hz										
	Frequency Control Accuracy	±0.5%										
	Analog Input Resolution	0.03 Hz										
	Acceleration/Deceleration Time	0.1 to 6,000 seconds										
	Main Control Functions	Restart after momentary power loss*2, torque limit, coasting to stop, jump frequencies, S-curve acceleration/deceleration, multi-step speed control, KEB function, energy-saving control, excessive deceleration prevention										
Protection Functions		Overcurrent, overvoltage, undervoltage, output ground fault, output open-phase, overload, motor overheat, cooling fan fault, etc.										
Communications Functions		MEMOBUS [CP-215 and CP-218 (Ethernet) are optional.]										
Maintainability	Digital Operator	Status display, fault display, commands, setting/reading of constants										
	Main Circuit	Module configuration										
Environmental Specifications	Enclosure	IP 40 (simple dust-proof type)										
	Ambient Temperature and Humidity	-5°C to +40°C, 85%RH max. (with no condensation)										
	Storage Temperature	0°C to +50°C										
	Atmosphere	General environmental conditions (free from dust or corrosive gas), altitude: 1,000 m max.										
General Specifications	Paint Color	Internal and external surface painted in Munsell 5Y7/1 semiglossy										
	Applicable Standards	JIS, JEC, JEM, Electric Facility Technical Reference										

* 1. Maximum applicable capacity of Yaskawa's 4-pole standard motors

* 2. An uninterruptible input power supply unit (optional) for the control power supply is required to use the restart function for momentary power loss.

Note FSDrive-MV1S does not have the regenerative braking function.

10

Appendix

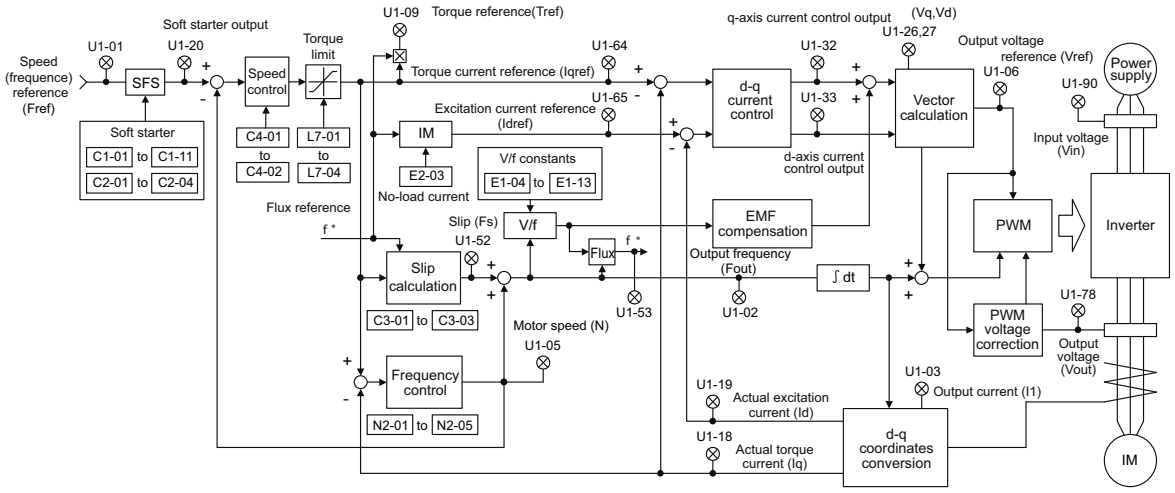
This chapter describes the FSDrive-MV1S functional block diagrams.

Functional Block Diagrams 10-2

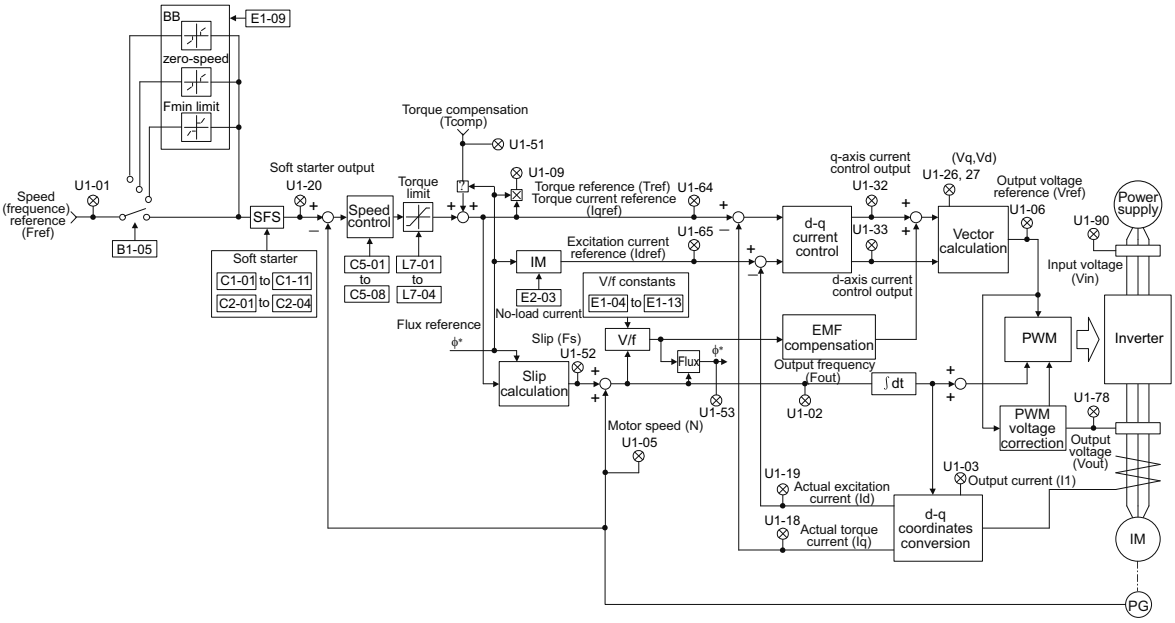
Functional Block Diagrams

The Inverter functional block diagrams for open-loop vector control and flux vector control are shown below.

◆ Open-loop Vector Control



◆ Flux Vector Control



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