Varispeed F7

INSTRUCTION MANUAL

GENERAL PURPOSE INVERTER (CURRENT VECTOR CONTROL)

MODEL: CIMR-F7A

200V CLASS 0.4 to 110kW (1.2 to 160kVA)

400V CLASS 0.4 to 300kW (1.4 to 510kVA)

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

YASKAWA

MANUAL NO. TOE-S616-55.1D

Preface

This manual is designed to ensure correct and suitable application of Varispeed F7-Series Inverters. Read this manual before attempting to install, operate, maintain, or inspect an Inverter and keep it in a safe, convenient location for future reference. Be sure you understand all precautions and safety information before attempting application.

General Precautions

- The diagrams in this manual may be indicated without covers or safety shields to show details. Be sure to restore covers or shields before operating the Units and run the Units according to the instructions described in this manual.
- Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.
- 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.
- When ordering a new copy of the manual due to damage or loss, contact your Yaskawa representatives or the nearest Yaskawa sales office and provide the manual number shown on the front cover.
- If nameplates become warn or damaged, order new ones from your Yaskawa representatives or the nearest Yaskawa sales office.

Safety Information

The following conventions are used to indicate precautions in this manual. Failure to heed precautions provided in this manual can result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

WARNING

Indicates precautions that, if not heeded, could possibly result in loss of life or serious injury.

CAUTION

Indicates precautions that, if not heeded, could result in relatively serious or minor injury, damage to the product, or faulty operation.

Failure to heed a precaution classified as a caution can result in serious consequences depending on the situation.

IMPORTANT

Indicates important information that should be memorized.

Safety Precautions

■ Confirmations upon Delivery

⚠ CAUTION

- Never install an Inverter that is damaged or missing components.
  Doing so can result in injury.

■ Installation

⚠ CAUTION

- Always hold the case when carrying the Inverter.
  If the Inverter is held by the front cover, the main body of the Inverter may fall, possibly resulting in injury.
- Attach the Inverter to a metal or other noncombustible material.
  Fire can result if the Inverter is attached to a combustible material.
- Install a cooling fan or other cooling device when installing more than one Inverter in the same enclosure so that the temperature of the air entering the Inverters is below 45°C.
  Overheating can result in fires or other accidents.

■ Wiring

⚠ WARNING

- Always turn OFF the input power supply before wiring terminals.
  Otherwise, an electric shock or fire can occur.
- Wiring must be performed by an authorized person qualified in electrical work.
  Otherwise, an electric shock or fire can occur.
- Be sure to ground the ground terminal. (200 V Class: Ground to 100 Ω or less, 400 V Class: Ground to 10 Ω or less)
  Otherwise, an electric shock or fire can occur.
- Always check the operation of any emergency stop circuits after they are wired.
  Otherwise, there is the possibility of injury. (Wiring is the responsibility of the user.)
- Never touch the output terminals directly with your hands or allow the output lines to come into contact with the Inverter case. Never short the output circuits.
  Otherwise, an electric shock or ground short can occur.
- If the power supply is turned ON during the FWD (or REV) Run Command is given, the motor will start automatically.
  Turn the power supply ON after verifying that the RUN signal is OFF.
  Failure to observe this warning may result in injury.
- When the 3-wire sequence is set, do not make the wiring for the control circuit unless the multi-function input terminal constant is set.
  Failure to observe this warning may result in injury.

⚠ CAUTION

- Check to be sure that the voltage of the main AC power supply satisfies the rated voltage of the Inverter.
  Injury or fire can occur if the voltage is not correct.
- Do not perform voltage withstand tests on the Inverter.
  Otherwise, semiconductor elements and other devices can be damaged.
- Connect braking resistors, Braking Resistor Units, and Braking Units as shown in the I/O wiring examples.
  Otherwise, a fire can occur and the Inverter, braking resistors, Braking Resistor Units, and Braking Units can be damaged.

⚠ CAUTION

- Tighten all terminal screws to the specified tightening torque.
  Otherwise, a fire may occur.
- Do not connect AC power to output terminals U, V, and W.
  The interior parts of the Inverter will be damaged if voltage is applied to the output terminals.
- Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits.
  The Inverter can be damaged or interior parts burnt if these devices are connected.
- Do not connect magnetic contactors to the output circuits.
  If a load is connected while the Inverter is operating, surge current will cause the overcurrent protection circuit inside the Inverter to operate.

■ Setting User Constants

⚠ CAUTION

- Disconnect the load (machine, device) from the motor before performing rotational autotuning.
  The motor may turn, possibly resulting in injury or damage to equipment. Also, motor constants cannot be correctly set with the motor attached to a load.
- Stay clear of the motor during rotational autotuning.
  The motor repeats running and stopping until autotuning has been completed, possibly resulting in injury.
- In stationary autotuning 1, when the motor is first operated in the drive mode after tuning, the remaining motor constants E2-02 (Motor rated slip) and E2-03 (Motor no-load current) are set automatically. To perform an operation immediately after stationary autotuning 1, use the following procedure under the recommended conditions.
  (1) Check the values of E2-02 and E2-03 in verify mode or advanced programming mode.
  (2) Run the motor once in drive mode under the following conditions.
    - The Inverter and the motor are connected.
    - The motor shaft is not locked with a mechanical brake or other stopping mechanism (or function).
    - A motor-load ratio of 30% or less is maintained.
    - A speed of 30% or more of the base frequency set at E1-06 (default = highest frequency) is maintained at a constant speed for one second or more.

  (3) After stopping the motor, check the values of E2-02 and E2-03 again in verify mode or advanced programming mode. If the values of E2-02 and E2-03 differ from the ones before the first operation was carried out, the settings have been successfully completed. Next, check if the values are suitable or not.

  If the values of E2-02 and E2-03 differed greatly from the reference data of the motor in the test report or the instruction manual (TOE-S616-55.1), hunting, motor vibrations, insufficient motor torque, or an overcurrent may occur because the motor is operated although the aforementioned conditions have not been fulfilled after stationary autotuning 1. For elevators, failure to observe this caution may result in the cage falling or injury. If so, perform stationary autotuning 1 again and run the motor using the aforementioned procedure under the recommended conditions or perform stationary autotuning 2 or rotational autotuning.
  Usually the standard setting for E2-02 is 1 Hz to 3 Hz, and that for E2-03 is 30% to 65% of the rated current for a general-purpose motor. Generally, the larger the motor capacity is, the smaller the rated slip and the ratio of the no-load current to the rated current become. Use the data given in *Factory Settings that Change with the Inverter Capacity (o2-04) of Chapter 5 User Constants* as a reference.

Trial Operation

⚠ WARNING

- Check to be sure that the front cover is attached before turning ON the power supply.
  An electric shock may occur.
- Do not come close to the machine when the fault reset function is used. If the alarmed is cleared, the machine may start moving suddenly.
  Also, design the machine so that human safety is ensured even when it is restarted.
  Injury may occur.
- Provide a separate emergency stop switch; the Digital Operator STOP Key is valid only when its function is set.
  Injury may occur.
- Reset alarms only after confirming that the RUN signal is OFF.
  Injury may occur.

⚠ CAUTION

- Don't touch the radiation fins (heatsink), braking resistor, or Braking Resistor Unit. These can become very hot.
  Otherwise, a burn injury may occur.
- Be sure that the motor and machine is within the applicable ranges before starting operation.
  Otherwise, an injury may occur.
- Provide a separate holding brake if necessary.
  Always construct the external sequence to confirm that the holding brake is activated in the event of an emergency, a power failure, or an abnormality in the Inverter.
  Failure to observe this caution can result in injury.
- If using an Inverter with an elevator, take safety measures on the elevator to prevent the elevator from dropping.
  Failure to observe this caution can result in injury.
- Don't check signals while the Inverter is running.
  Otherwise, the equipment may be damaged.
- Be careful when changing Inverter settings. The Inverter is factory set to suitable settings. For the Inverters in the 400 V class of 75 kW or more, however, select the correct connector according to the input voltage.
  Otherwise, the equipment may be damaged.

Maintenance and Inspection

⚠ WARNING

- Do not touch the Inverter terminals. Some of the terminals carry high voltages and are extremely dangerous.
  Doing so can result in electric shock.
- Always have the protective cover in place when power is being supplied to the Inverter. When attaching the cover, always turn OFF power to the Inverter through the MCCB.
  Doing so can result in electric shock.
- Turn OFF the main circuit power supply, wait for the time indicated on the front cover, and make sure the CHARGE indicator light has gone out, and then perform maintenance and inspection.
  The capacitor will remain charged and is dangerous.
- 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 grounded tools.
  Failure to heed these warning can result in electric shock.

⚠ WARNING

- Provide a separate holding brake if necessary.
  Always make any adjustments other than those involving the operation of the Inverter with the holding brake released. Failure to observe this caution may result in injury.
- If using an Inverter with an elevator, take safety measures on the elevator to prevent the elevator from dropping.
  Failure to observe this caution can result in injury.

⚠ CAUTION

- A CMOS IC is used in the control board. Handle the control board and CMOS IC carefully.
  The CMOS IC can be destroyed by static electricity if touched directly.
- Do not change the wiring, or remove connectors or the Digital Operator, during operation.
  Doing so can result in personal injury.

■ Other

⚠ WARNING

- Do not attempt to modify or alter the Inverter.
  Doing so can result in electrical shock or injury.

⚠ CAUTION

- Do not subject the Inverter to halogen gases, such as fluorine, chlorine, bromine, and iodine, at any time even during transportation or installation.
  Otherwise, the Inverter can be damaged or interior parts burnt.

Warning Information and Position

There is warning information on the Inverter in the position shown in the following illustration. Always heed the warnings.

Warning information position

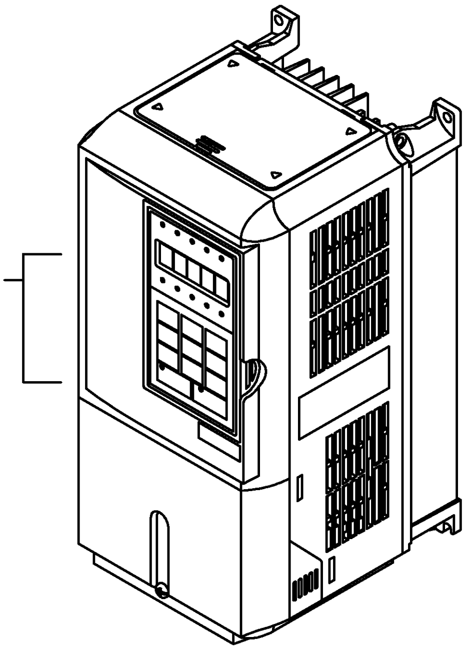


Illustration shows the CIMR-F7A20P4

Warning information position

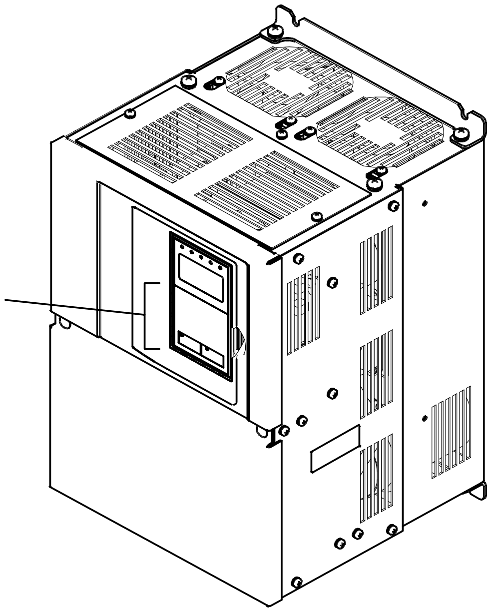


Illustration shows the CIMR-F7A2022

Warning Information

WARNING

Risk of electric shock.

- •Read manual before installing.
- •Wait 5 minutes for capacitor discharge after disconnecting power supply.

AVERTISSEMENT

Risque de décharge électrique.

- •Lire le manuel avant l' installation.
- •Attendre 5 minutes aprés la coupure de l' allmentation. Pour permettre la décharge des condensateurs.

危険

けが・感電のおそれがあります。

- •据え付け・運転の前には必ず取扱説明書をお読み下さい。
- •通電中及び電源遮断後5分以内はフロントカバーを外さないで下さい。

Warranty Information

■ Free Warranty Period and Scope

Warranty Period

This product is warranted for twelve months after being delivered to Yaskawa's customer 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 customer. 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 customer, 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 provide a replacement, repair the defective product, and provide shipping to and from the site free of charge.

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 customer 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 customer is determined to be responsible.
- Problems due to additions or modifications made to a Yaskawa product 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 customers outside of Japan for a reasonable fee. Contact your local Yaskawa representative for more information.

■ Exceptions

Any inconvenience to the customer 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

- The Varispeed F7 was not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.
- Customers 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.

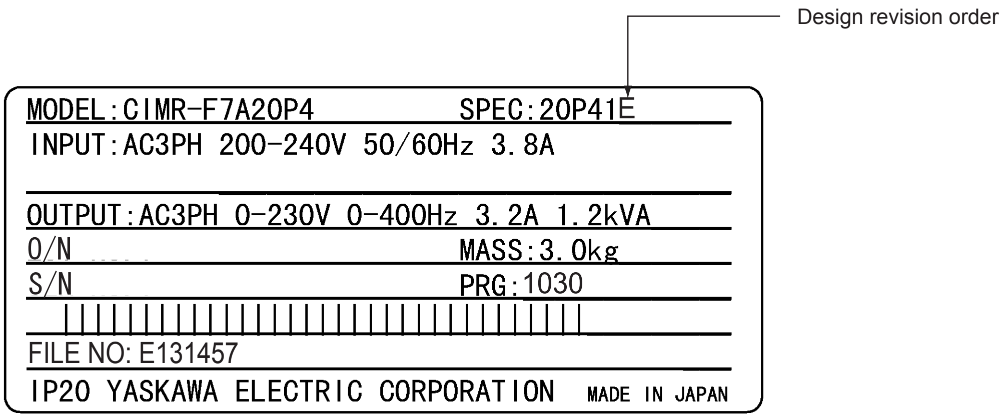
Registered Trademarks

The following registered trademarks are used in this manual.

- DeviceNet is a registered trademark of the ODVA (Open DeviceNet Vendors Association, Inc.).
- InterBus is a registered trademark of Phoenix Contact Co.
- ControlNet is a registered trademark of ControlNet International, Ltd.
- LONWORKS is a registered trademark of the Echelon.

Before Reading This Manual

This manual explains both the conventional Varispeed F7-Series Inverters and the F7-series Inverters with SPEC: E or later.
The shaded sections or those specified as being for SPEC: E or later apply only to F7-series Inverters with SPEC: E or later (Inverter with design revision order of E or later.)
Be certain to check the specification on the Inverter nameplate.
Example of Inverter Nameplate



■ Precautions when Using a F7-series Inverter with SPEC: C or Earlier

The design revision number and software version of the F7-series Inverters with SPEC: E or later have been modified as shown in the table below. The design revision order and software version can be found on the Inverter nameplate. When using a F7-series Inverter with SPEC: C or earlier, observe the following precautions.

Inverter	Design Revision Order	Software Version
Inverter with SPEC: C or earlier	A, B, or C	PRG:101□
Inverter with SPEC: E or later	E or later	PRG:103□

Precautions

- The factory settings of C6-01 (CT/VT selection) and the constants related to C6-01 of the F7-series Inverter with SPEC: C or earlier are different from those of the F7-series Inverter with SPEC: E or later.
  Refer to *Application and Overload Selections* of *Chapter 6 Constant Settings by Function*, and set the constants according to your application.
- The COPY function of the Digital Operator for the F7-series Inverter with SPEC: C or earlier is limited because of the software version different from that of the F7-series Inverter with SPEC: E or later.
  Set the related constants, referring to *Application and Overload Selections* of *Chapter 6 Constant Settings by Function*.

Contents

1

Handling Inverters

This chapter describes the checks required upon receiving or installing an Inverter.

Varispeed F7 Introduction

◆ Varispeed F7 Applications

The Varispeed F7 is ideal for the following applications.

- Fan, blower, and pump applications
- Conveyors, pushers, metal tooling machines, etc.

Settings must be adjusted to the application for optimum operation. Refer to *Chapter 4 Trial Operation.*

◆ Varispeed F7 Models

The Varispeed-F7 Series of Inverters included two Inverters in two voltage classes: 200 V and 400 V. Maximum motor capacities vary from 0.4 to 300 kW (41 models).

Table 1.1 Varispeed F7 Models

Voltage Class	Maximum Motor Capacity kW	Varispeed F7		Specifications (Always specify through the protective structure when ordering.)	
		Output Capacity kVA	Basic Model Number	Open Chassis (IEC IP00) CIMR-F7□□□□□□	Enclosed Wall-mounted [IEC IP20, NEMA 1 (Type 1)] CIMR-F7A□□□□□□
200 V Class	0.4	1.2	CIMR-F7A20P4	Remove the top and bottom covers from the Enclosed Wall-mounted model.	20P41□
	0.75	1.6	CIMR-F7A20P7		20P71□
	1.5	2.7	CIMR-F7A21P5		21P51□
	2.2	3.7	CIMR-F7A22P2		22P21□
	3.7	5.7	CIMR-F7A23P7		23P71□
	5.5	8.8	CIMR-F7A25P5		25P51□
	7.5	12	CIMR-F7A27P5		27P51□
	11	17	CIMR-F7A2011		20111□
	15	22	CIMR-F7A2015		20151□
	18.5	27	CIMR-F7A2018	20220□	20181□
	22	32	CIMR-F7A2022		20221□
	30	44	CIMR-F7A2030	20300□	20301□
	37	55	CIMR-F7A2037	20370□	20371□
	45	69	CIMR-F7A2045	20450□	20451□
	55	82	CIMR-F7A2055	20550□	20551□
	75	110	CIMR-F7A2075	20750□	20751□
	90	130	CIMR-F7A2090	20900□	20901□
	110	160	CIMR-F7A2110	21100□	-

Table 1.1 Varispeed F7 Models (Continued)

Voltage Class	Maximum Motor Capacity kW	Varispeed F7		Specifications (Always specify through the protective structure when ordering.)	
		Output Capacity kVA	Basic Model Number	Open Chassis (IEC IP00) CIMR-F7□□□□□□	Enclosed Wall-mounted [IEC IP20, NEMA 1 (Type 1)] CIMR-F7A□□□□□□
400 V Class	0.4	1.4	CIMR-F7A40P4	Remove the top and bottom covers from the Enclosed Wall-mount model.	40P41□
	0.75	1.6	CIMR-F7A40P7		40P71□
	1.5	2.8	CIMR-F7A41P5		41P51□
	2.2	4.0	CIMR-F7A42P2		42P21□
	3.7	5.8	CIMR-F7A43P7		43P71□
	5.5	9.5	CIMR-F7A45P5		45P51□
	7.5	13	CIMR-F7A47P5		47P51□
	11	18	CIMR-F7A4011		40111□
	15	24	CIMR-F7A4015		40151□
	18.5	30	CIMR-F7A4018	40220□	40181□
	22	34	CIMR-F7A4022		40221□
	30	46	CIMR-F7A4030	40300□	40301□
	37	57	CIMR-F7A4037	40370□	40371□
	45	69	CIMR-F7A4045	40450□	40451□
	55	85	CIMR-F7A4055	40550□	40551□
	75	110	CIMR-F7A4075	40750□	40751□
	90	140	CIMR-F7A4090	40900□	40901□
	110	160	CIMR-F7A4110	41100□	41101□
	132	200	CIMR-F7A4132	41320□	41321□
	160	230	CIMR-F7A4160	41600□	41601□
	185	280	CIMR-F7A4185	41850□	-
	220	390	CIMR-F7A4220	42200□	-
	300	510	CIMR-F7A4300	43000□	-

Confirmations upon Delivery

◆ Checks

Check the following items as soon as the Inverter is delivered.

Table 1.2 Checks

Item	Method
Has the correct model of Inverter been delivered?	Check the model number on the nameplate on the side of the Inverter.
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.
Are any screws or other components loose?	Use a screwdriver or other tools to check for tightness.

If you find any irregularities in the above items, contact the agency from which you purchased the Inverter or your Yaskawa representative immediately.

◆ Nameplate Information

There is a nameplate attached to the side of each Inverter. The nameplate shows the model number, specifications, lot number, serial number, and other information on the Inverter.

■ Example Nameplate

The following nameplate is an example for a standard domestic (Japan) Inverter: 3-phase, 200 VAC, 0.4 kW, IEC IP20 and NEMA 1 (Type 1) standards

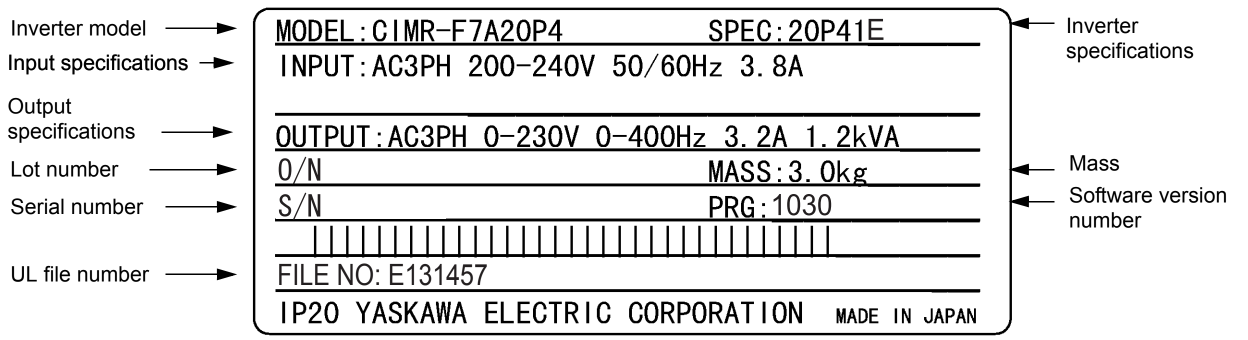


Fig 1.1 Nameplate

■Inverter Model Numbers

The model number of the Inverter on the nameplate indicates the specification, voltage class, and maximum motor capacity of the Inverter in alphanumeric codes.

CIMR - F7 A 2 0P4

Inverter (CIMR)

Varispeed F7 (F7)

No.	Specification
A	Standard domestic model

No.	Voltage Class
2	AC input, 3-phase, 200 V
4	AC input, 3-phase, 400 V

No.	Max. Motor Capacity
0P4	0.4 kW
0P7 to 300	0.75 kW to 300 kW

"P" indicates the decimal point.

Fig 1.2 Inverter Model Numbers

1

■Inverter Specifications

The Inverter specifications ("SPEC") on the nameplate indicate the voltage class, maximum motor capacity, the protective structure, and the revision of the Inverter in alphanumeric codes.

2 0P4 1 E

No.	Voltage Class
2	AC input, 3-phase, 200 V
4	AC input, 3-phase, 400 V

No.	Max. Motor Capacity
0P4	0.4 kW
0P7 to 300	0.75 kW to 300 kW

"P" indicates the decimal point.

No.	Protective Structure
0	Open chassis (IEC IP00)
1	Enclosed wall-mounted (IEC IP20, NEMA 1 (Type 1))

Design revision order (E)

Fig 1.3 Inverter Specifications

TERMS

Open Chassis Type (IEC IP00)

Protected so that parts of the human body cannot reach electrically charged parts from the front when the Inverter is mounted in a control panel.

Enclosed Wall-mounted Type (IEC IP20, NEMA 1 (Type 1))

The Inverter is structured so that the Inverter is shielded from the exterior, and can thus be mounted to the interior wall of a standard building (not necessarily enclosed in a control panel). The protective structure conforms to the standards of NEMA 1 (Type 1) in the USA. The protective covers (see *Fig. 1.4*) are required for an IEC IP20 or NEMA 1 (Type 1) protective structure.

◆ Component Names

The external appearance and component names of the Inverter are shown in *Fig 1.4*. The Inverter with the terminal cover removed is shown in *Fig 1.5*.

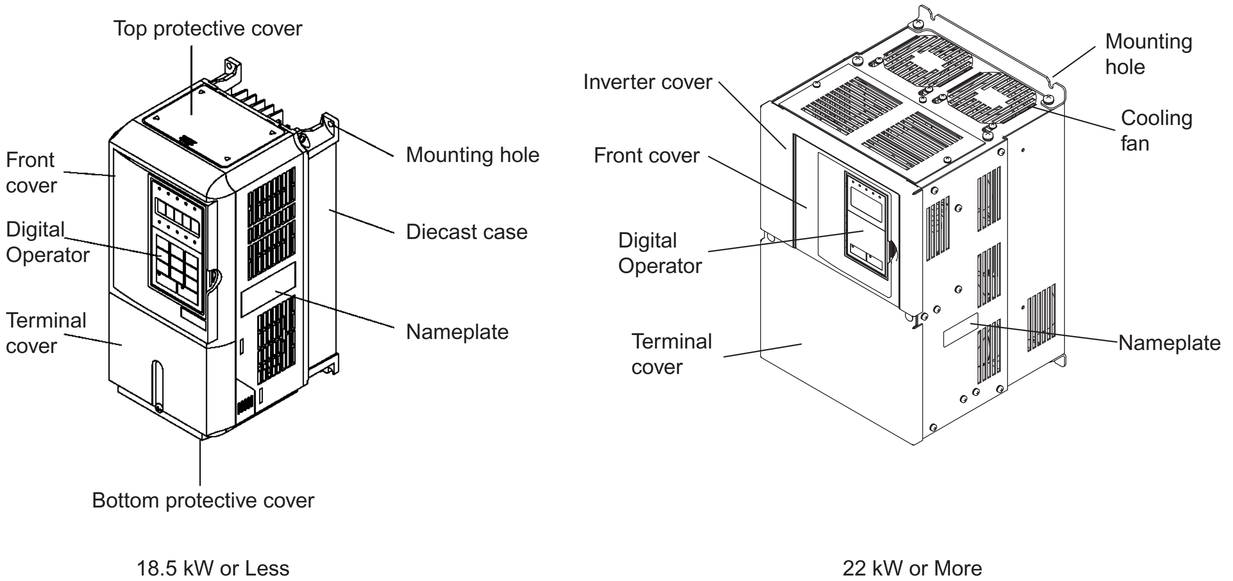


Fig 1.4 Inverter Appearance

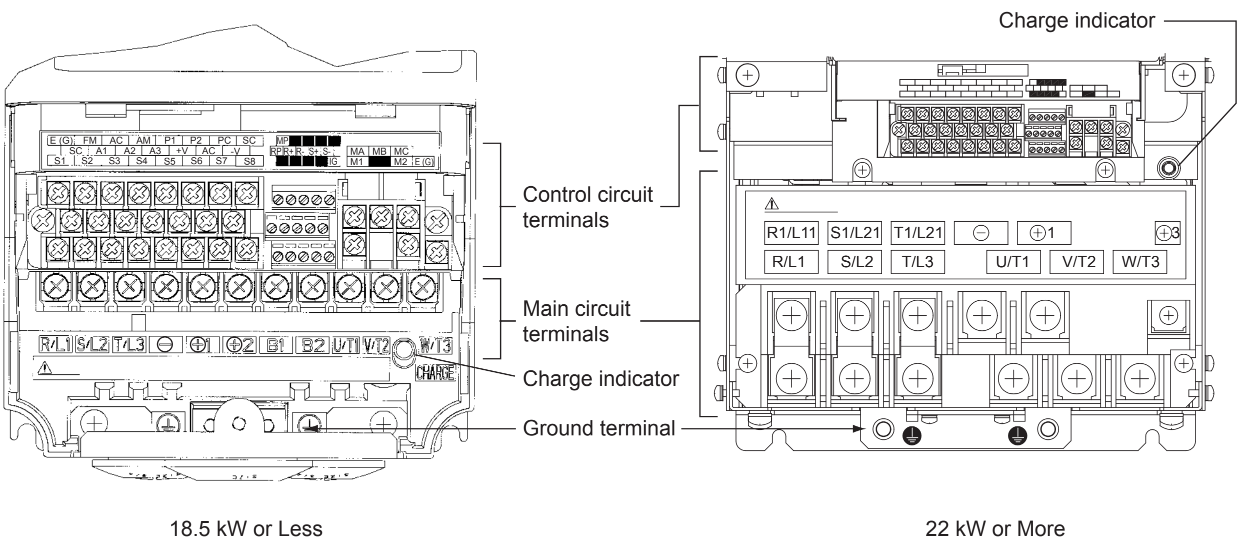
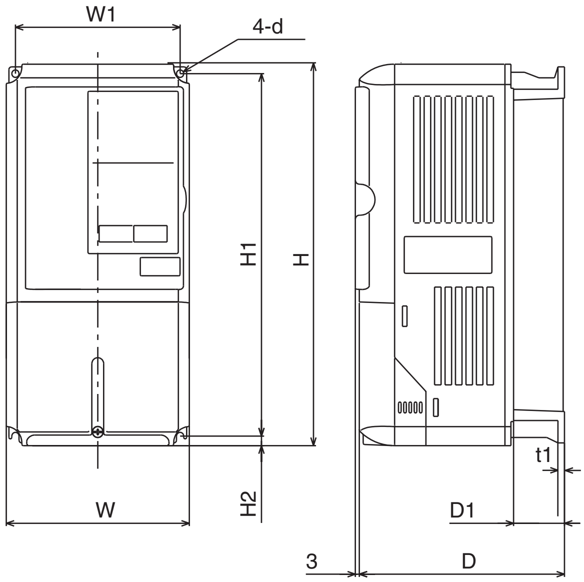


Fig 1.5 Terminal Arrangement (Examples of Inverters with SPEC: E or later)

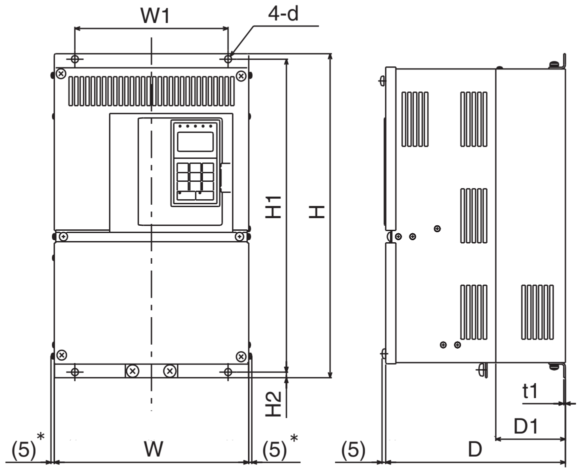
Exterior and Mounting Dimensions

◆ Open Chassis Inverters (IP00)

Exterior diagrams of the Open Chassis Inverters are shown below.

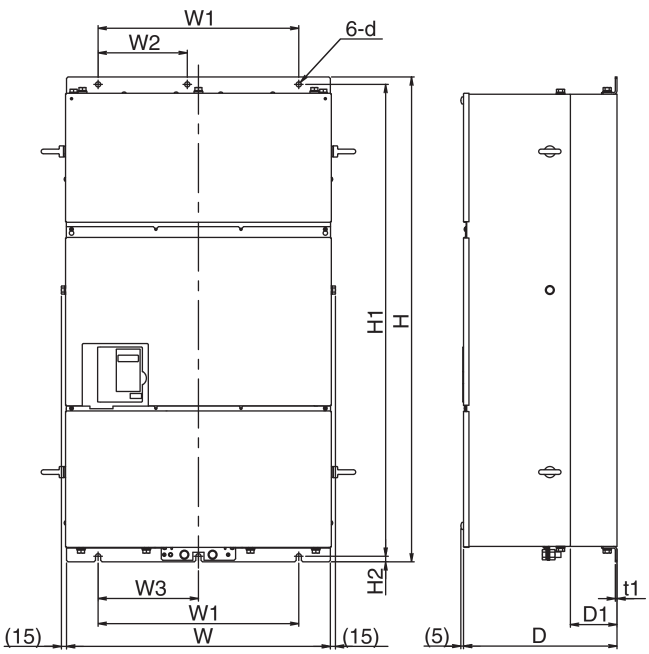


200 V/400 V Class Inverters of 0.4 to 18.5 kW



* (10) for 200 V Class Inverters of 37 to 110 kW or 400 V Class Inverters of 75 to 160 kW.

200 V Class Inverters of 22 or 110 kW
400 V Class Inverters of 22 to 160 kW

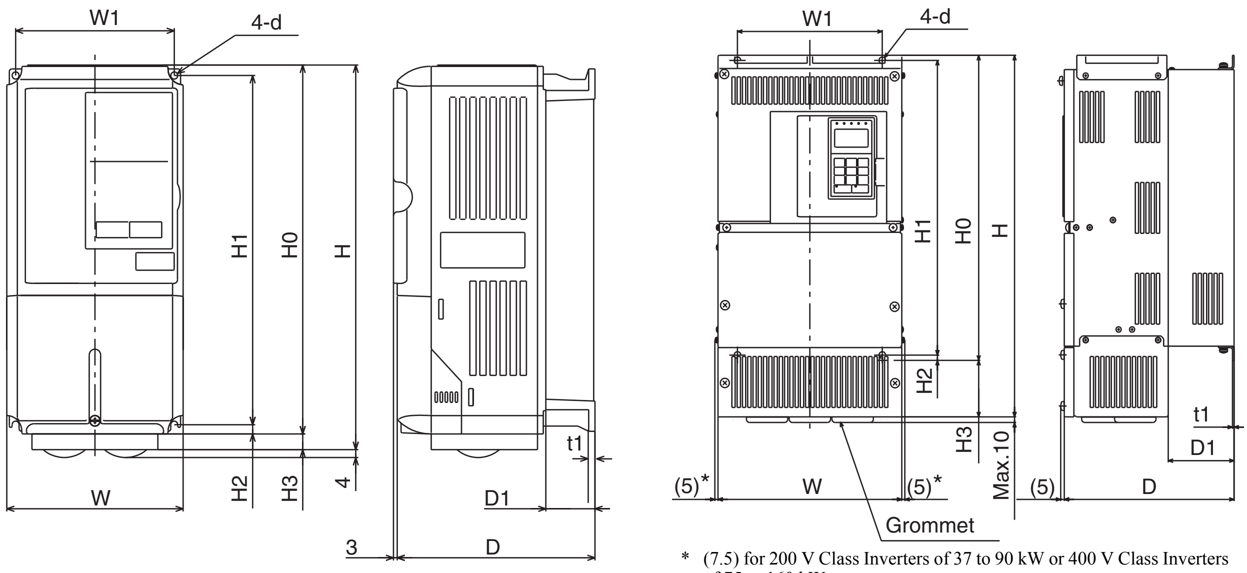


400 V Class Inverters of 185 to 300 kW

Fig 1.6 Exterior Diagrams of Open Chassis Inverters

◆ Enclosed Wall-mounted Inverters [NEMA1 (Type 1)]

Exterior diagrams of the Enclosed Wall-mounted Inverters [NEMA1 (Type 1)] are shown below.



* (7.5) for 200 V Class Inverters of 37 to 90 kW or 400 V Class Inverters of 75 to 160 kW.

200 V/400 V Class Inverters of 0.4 to 18.5 kW

200 V Class Inverters of 22 to 90 kW
400 V Class Inverters of 22 to 160 kW

Fig 1.7 Exterior Diagrams of Enclosed Wall-mounted Inverters

Table 1.3 Inverter Dimensions (mm) and Masses (kg)

Voltage Class	Max. Appli-cable Motor Output [kW]	Dimensions (mm)																					Caloric Value (W)			Cool-ing Method
		Open Chassis (IP00)									Enclosed Wall-mounted [NEMA1 (Type 1)]															
		W	H	D	W1	H1	H2	D1	t1	Ap-prox. Mass	W	H	D	W1	H0	H1	H2	H3	D1	t1	Ap-prox. Mass	Mount-ing Holes d*	Exter nal	Inter-nal	Total Heat Gen-era-tion	
200 V (3-phase)	0.4	140	280	157	126	266	7	39	5	3	140	280	157	126	280	266	7	0	39	5	3	M5	20	39	59	Natu-ral
	0.75																						27	42	69	
	1.5																						50	50	100	
	2.2																						70	59	129	
	3.7			177				59		4			177						59		4		112	74	186	Fan
	5.5																						164	84	248	
	7.5	200	300	197	186	285	8	65.5	2.3	6	200	300	197	186	300	285	8		65.5	2.3	6	M6	219	113	332	
	11									7		310						10			7		374	170	544	
	15	240	350	207	216	335	7.5	78		11	240	350	207	216	350	335	7.5	0	78		11		429	183	612	
	18.5											380						30					501	211	712	
	22	250	400	258	195	385		100		21	254	535	258	195	400	385		135	100		24		586	274	860	
	30	275	450		220	435				24	279	615		220	450	435		165			27		865	352	1217	
	37	375	600	298	250	575	12.5	100	3.2	57	380	809	298	250	600	575	12.5	209	100	3.2	62	M10	1015	411	1426	
	45			328				130		63			328						130		68		1266	505	1771	
	55	450	725	348	325	700				86	453	1027	348	325	725	700		302			94		1588	619	2207	
	75									87											95		2019	838	2857	
	90	500	850	358	370	820	15		4.5	108	504	1243	358	370	850	820	15	393		4.5	114	M12	2437	997	3434	
	110	575	885	378	445	855		140		150	---												2733	1242	3975	
400 V (3-phase)	0.4	140	280	157	126	266	7	39	5	3	140	280	157	126	280	266	7	0	39	5	3	M5	14	39	53	Natu-ral
	0.75																						17	41	58	
	1.5																						36	48	84	
	2.2			177				59		4			177						59		4		59	56	115	Fan
	3.7																						80	68	148	
	5.5																						127	82	209	
	7.5	200	300	197	186	285	8	65.5	2.3	6	200	300	197	186	300	285	8		65.5	2.3	6	M6	193	114	307	
	11																						252	158	410	
	15	240	350	207	216	335	7.5	78		10	240	350	207	216	350	335	7.5		78		10		326	172	498	
	18.5																						426	208	634	
	22	275	450	258	220	435		100		21	279	535	258	220	450	435		85	100		24		466	259	725	
	30																						678	317	995	
	37	325	550	283	260	535		105		36	329	635	283	260	550	535		165	105		40		784	360	1144	
	45											715											901	415	1316	
	55																						1203	495	1698	
	75	450	725	348	325	700	12.5	130	3.2	88	453	1027	348	325	725	700	12.5	302	130	3.2	96	M10	1399	575	1974	
	90									89											97		1614	671	2285	
	110	500	850	358	370	820	15		4.5	102	504	1243	358	370	850	820	15	393		4.5	122	M12	2097	853	2950	
	132									120											130		2388	1002	3390	
	160	575	910	378	445	855	46	140		160	579	1324	378	445	916	855	46	408	140		170		2791	1147	3938	

* Same for Open Chassis and Enclosed Wall-mounted Inverters.

Table 1.4 400 VAC (185 to 300 kW) Inverter Dimensions (mm) and Masses (kg)

Voltage Class	Max. Appli-cable Motor Output [kW]	Dimensions (mm)																						Heat Generation (W)			Cooling Method
		Open Chassis (IP00)											Enclosed Wall-mounted [NEMA1 (Type 1)]														
		W	H	D	W1	W2	W3	H1	H2	D1	t1	Ap-prox. Mass	W	H	D	W1	W2	W3	H1	H2	D1	t1	Ap-prox. Mass	Mount-ing Holes d*	Exter-nal	Inter-nal	Total Heat Gener-ation	
400 V (3-phase)	185	710	1305	413	540	240	270	1270	15	125.5	4.5	260	---											M12	3237	1372	4609	Natu-ral
	220											280													3740	1537	5277	
	300	916	1475	413	730	365	365	1440	15	125.5	4.5	405													5838	2320	8158	

1

Checking and Controlling the Installation Site

Install the Inverter in the installation site described below and maintain optimum conditions.

◆ Installation Site

Install the Inverter under the following conditions and a pollution level of 2 or less (UL standard).

Table 1.5 Installation Site

Type	Ambient Operating Temperature	Humidity
Enclosed wall-mounted	-10 to + 40 °C	95% RH or less (no condensation)
Open chassis	-10 to + 45 °C	95% RH or less (no condensation)

Protection covers are attached to the top and bottom of the Inverter. Be sure to remove the protection covers before installing a 200 or 400 V Class Inverter with an output of 18.5 kW or less in a panel. Refer to Page 1-17 on how to remove the protection covers.

Observe the following precautions when mounting the Inverter.

- Install the Inverter in a clean location free from oil mist and dust. It can be installed in a totally enclosed panel that is completely shielded from floating dust.
- When installing or operating the Inverter, always take special care so that metal powder, oil, water, or other foreign matter does not get into the Inverter.
- Do not install the Inverter on combustible material, such as wood.
- Install the Inverter in a location free from radioactive materials and combustible materials.
- Install the Inverter in a location free from harmful gasses and liquids.
- Install the Inverter in a location without excessive oscillation.
- Install the Inverter in a location free from chlorides.
- Install the Inverter in a location not in direct sunlight.

◆ Controlling the Ambient Temperature

To enhance the reliability of operation, the Inverter should be installed in an environment free from extreme temperature increases. If the Inverter is installed in an enclosed environment, such as a box, use a cooling fan or air conditioner to maintain the internal air temperature below 45°C.

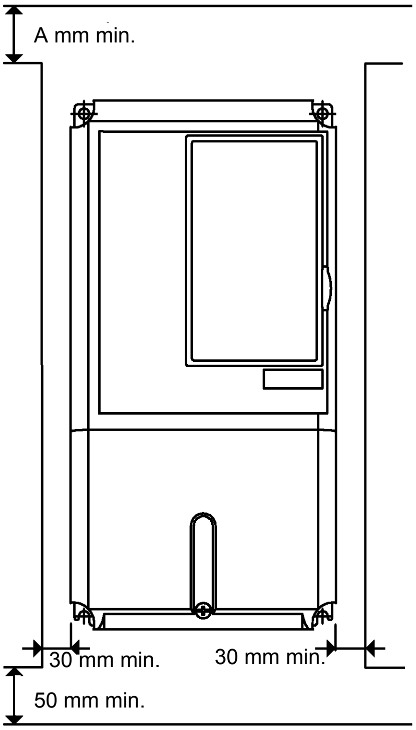
◆ Protecting the Inverter from Foreign Matter

Place a cover over the Inverter during installation to shield it from metal powder produced by drilling.

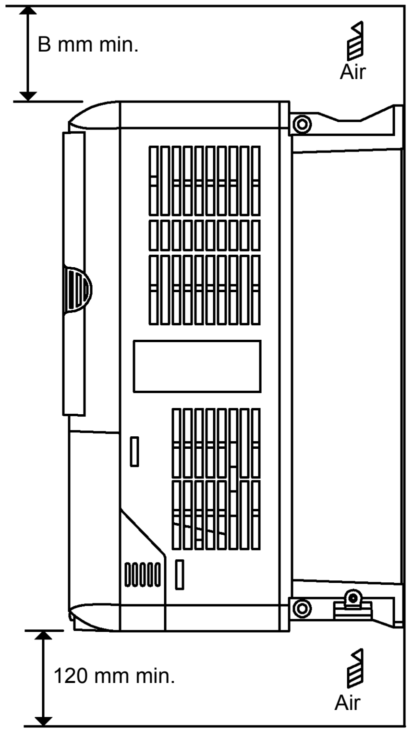
Always remove the cover from the Inverter after completing installation. Otherwise, ventilation will be reduced, causing the Inverter to overheat.

Installation Orientation and Space

Install the Inverter vertically so as not to reduce the cooling effect. When installing the Inverter, always provide the following installation space to allow normal heat dissipation.



Horizontal Space



Vertical Space

200 V Class Inverters of 110 kW or 400 V Class Inverters of 160 to 220 kW*: A = 120, B = 120
400 V Class Inverters of 300 kW*: A = 300, B = 300
All other Inverters*: A = 50, B = 120

*If, however, there is a fan in the top of the control panel with sufficient exhaust capacity, the following dimensions may be used: A = 50, B = 120.

Fig 1.8 Inverter Installation Orientation and Space

IMPORTANT

1. The same space is required horizontally and vertically for both Open Chassis (IP00) and Enclosed Wall-mounted [IP20, NEMA 1 (Type 1)] Inverters.
2. Always remove the protection covers before installing a 200 or 400 V Class Inverter with an output of 18.5 kW or less in a panel. Refer to Page 1-17 on how to remove the protection covers.
   Always provide enough space for suspension eye bolts and the main circuit lines when installing a 200 or 400 V Class Inverter with an output of 22 kW or more in a panel.

Removing and Attaching the Terminal Cover

Remove the terminal cover to wire cables to the control circuit and main circuit terminals.

◆ Removing the Terminal Cover

■ Inverters of 18.5 kW or Less

Loosen the screws at the bottom of the terminal cover, press in on the sides of the terminal cover in the direction indicated by arrow 1, and then lift the terminal cover up to an angle of about 30 degrees in the direction indicated by arrow 2.

Remove the terminal cover in the direction indicated by arrow 3.

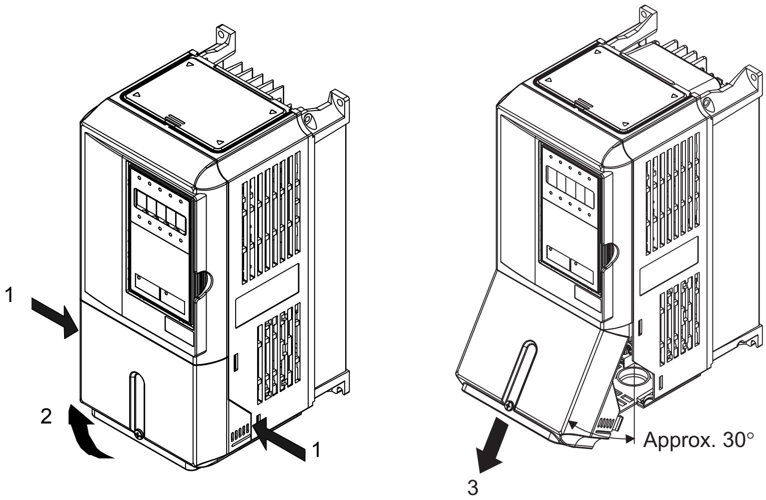


Fig 1.9 Removing the Terminal Cover (Model CIMR-F7A20P4 Shown Above)

■ Inverters of 22 kW or More

Loosen the screws on the left and right at the top of the terminal cover, pull out the terminal cover in the direction of arrow 1 and then lift up on the terminal in the direction of arrow 2.

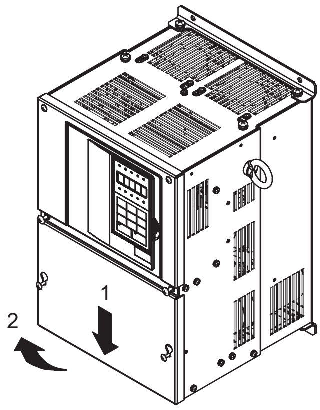


Fig 1.10 Removing the Terminal Cover (Model CIMR-F7A2022 Shown Above)

◆ Attaching the Terminal Cover

When wiring the terminal block has been completed, attach the terminal cover by reversing the removal procedure.

For Inverters with an output of 18.5 kW or less, insert the tab on the top of the terminal cover into the grove on the Inverter and press in on the bottom of the terminal cover until it clicks into place.

Removing/Attaching the Digital Operator and Front Cover

The methods of removing and attaching the Digital Operator and Front Cover are described in this section.

◆ Inverters of 18.5 kW or Less

To attach optional boards or change the terminal board connector, remove the Digital Operator and front cover in addition to the terminal cover. Always remove the Digital Operator from the front cover before removing the terminal cover.

The removal and attachment procedures are given below.

■Removing the Digital Operator

Press the lever on the side of the Digital Operator in the direction of arrow 1 to unlock the Digital Operator and lift the Digital Operator in the direction of arrow 2 to remove the Digital Operator as shown in the following illustration.

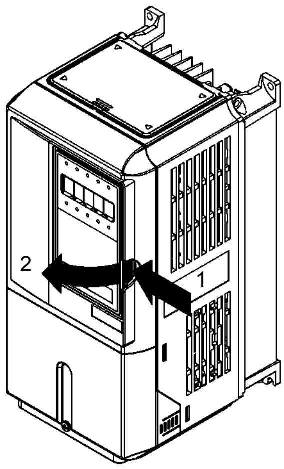


Fig 1.11 Removing the Digital Operator (Model CIMR-F7A40P4 Shown Above)

■Removing the Front Cover

Press the left and right sides of the front cover in the directions of arrows 1 and lift the bottom of the cover in the direction of arrow 2 to remove the front cover as shown in the following illustration.

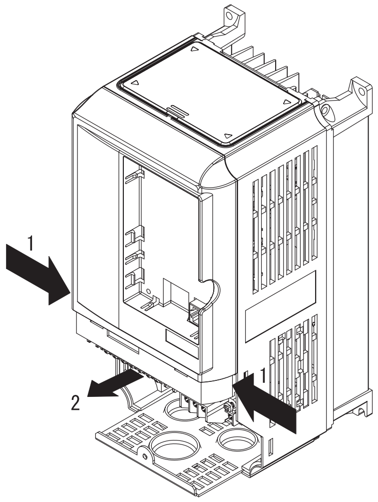


Fig 1.12 Removing the Front Cover (Model CIMR-F7A40P4 Shown Above)

■Mounting the Front Cover

After wiring the terminals, mount the front cover to the Inverter by performing in reverse order to the steps to remove the front cover.

1. Do not mount the front cover with the Digital Operator attached to the front cover; otherwise, Digital Operator may malfunction due to imperfect contact.
2. Insert the tab of the upper part of the front cover into the groove of the Inverter and press the lower part of the front cover onto the Inverter until the front cover snaps shut.

■Mounting the Digital Operator

After attaching the terminal cover, mount the Digital Operator onto the Inverting using the following procedure.

1. Hook the Digital Operator at A (two locations) on the front cover in the direction of arrow 1 as shown in the following illustration.
2. Press the Digital Operator in the direction of arrow 2 until it snaps in place at B (two locations).

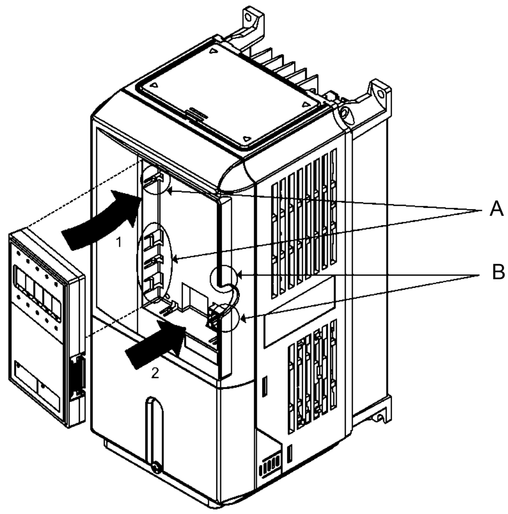


Fig 1.13 Mounting the Digital Operator

IMPORTANT

1. Do not remove or attach the Digital Operator or mount or remove the front cover using methods other than those described above, otherwise the Inverter may break or malfunction due to imperfect contact.
2. Never attach the front cover to the Inverter with the Digital Operator attached to the front cover. Imperfect contact can result.
   Always attach the front cover to the Inverter by itself first, and then attach the Digital Operator to the front cover.

◆ Inverters of 22 kW or More

For Inverter with an output of 22 kW or more, remove the terminal cover and then use the following procedures to remove the Digital Operator and front cover.

■Removing the Digital Operator

Use the same procedure as for Inverters with an output of 18.5 kW or less.

■Removing the Front Cover

Lift up at the location label 1 at the top of the control circuit terminal board in the direction of arrow 2.

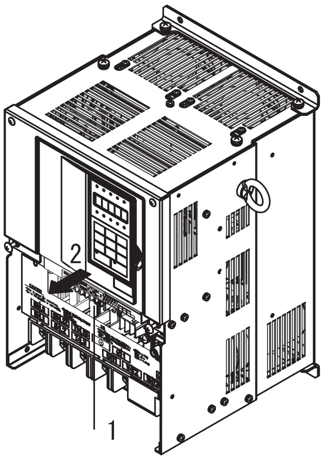


Fig 1.14 Removing the Front Cover (Model CIMR-F7A2022 Shown Above)

■ Attaching the Front Cover

After completing required work, such as mounting an optional board or setting the control circuit terminal board, attach the front cover by reversing the procedure to remove it.

1. Confirm that the Digital Operator is not mounted on the front cover. Contact faults can occur if the cover is attached while the Digital Operator is mounted to it.
2. Insert the tab on the top of the front cover into the slot on the Inverter and press in on the cover until it clicks into place on the Inverter.

■Attaching the Digital Operator

Use the same procedure as for Inverters with an output of 18.5 kW or less.

Removing and Attaching the Protection Cover

Inverters of 18.5 kW or less have protection covers on the top and bottom as shown in *Fig. 1.4.*Always remove the protection covers before installing an Inverter of 18.5 kW or less in a panel. Use the following procedure to remove and attach a protection cover.

◆ Removing the Protection Cover

■Top Protection Cover

Insert the tip of the straightedge screwdriver in the slot. Then, lift the cover up in the direction shown by the arrow to remove it.

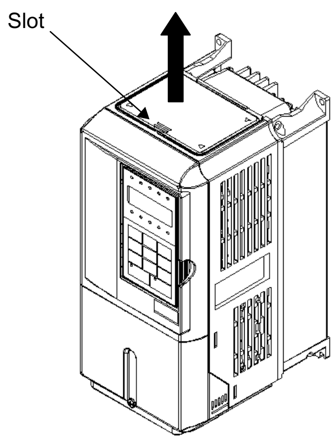


Fig 1.15 Removing the Top Protection Cover (Model CIMR-F7A45P5 Shown Above)

■Bottom Protection Cover

1. Remove the terminal cover as described on Page 1-12.
2. Loosen the two screws, and remove the protection cover.
3. Return the screws to their original position and tighten (them).
4. Reattach the terminal cover as described on Page 1-12.

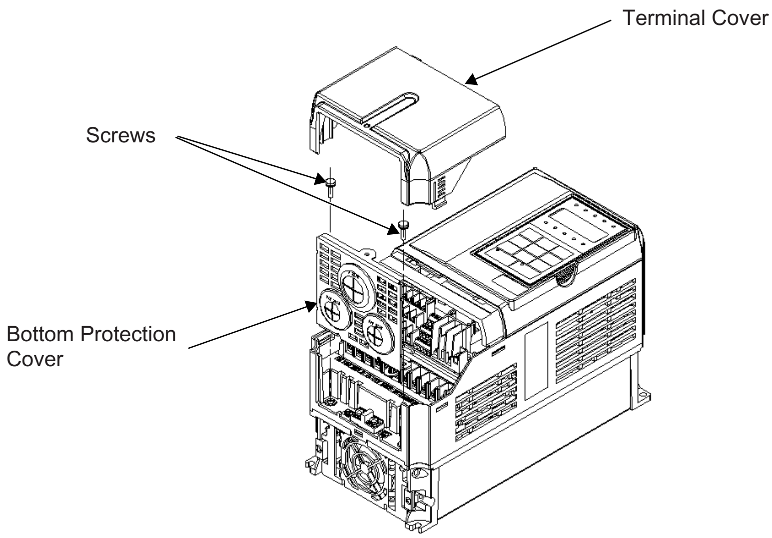


Fig 1.16 Removing the Bottom Protection Cover (Model CIMR-F7A45P5 Shown Above)

◆ Attaching the Protection Cover

■Top Protection Cover

The protection cover has four hooks: two hooks on the bottom and two on the sides. Fit the bottom hooks into the holes, bend the cover slightly, and press the cover down until the hooks on the side snap.

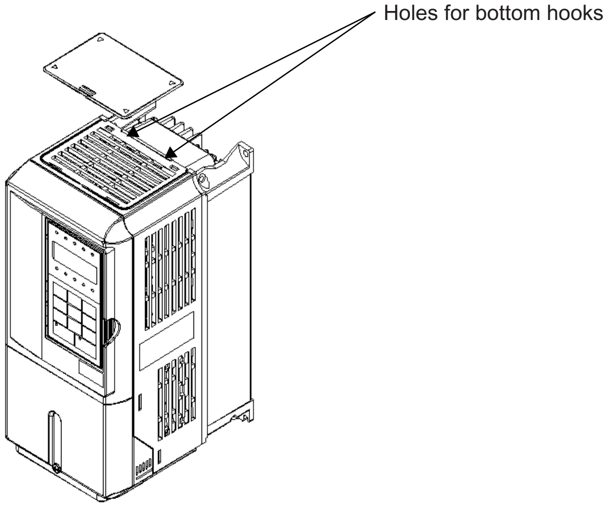


Fig 1.17 Attaching the Top Protection Cover (Model CIMR-F7A45P5 Shown Above)

■Bottom Protection Cover

To attach the bottom protection cover, reverse the procedure used to remove it.

2

Wiring

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

Connections to Peripheral Devices

Examples of connections between the Inverter and typical peripheral devices are shown in *Fig 2.1*.

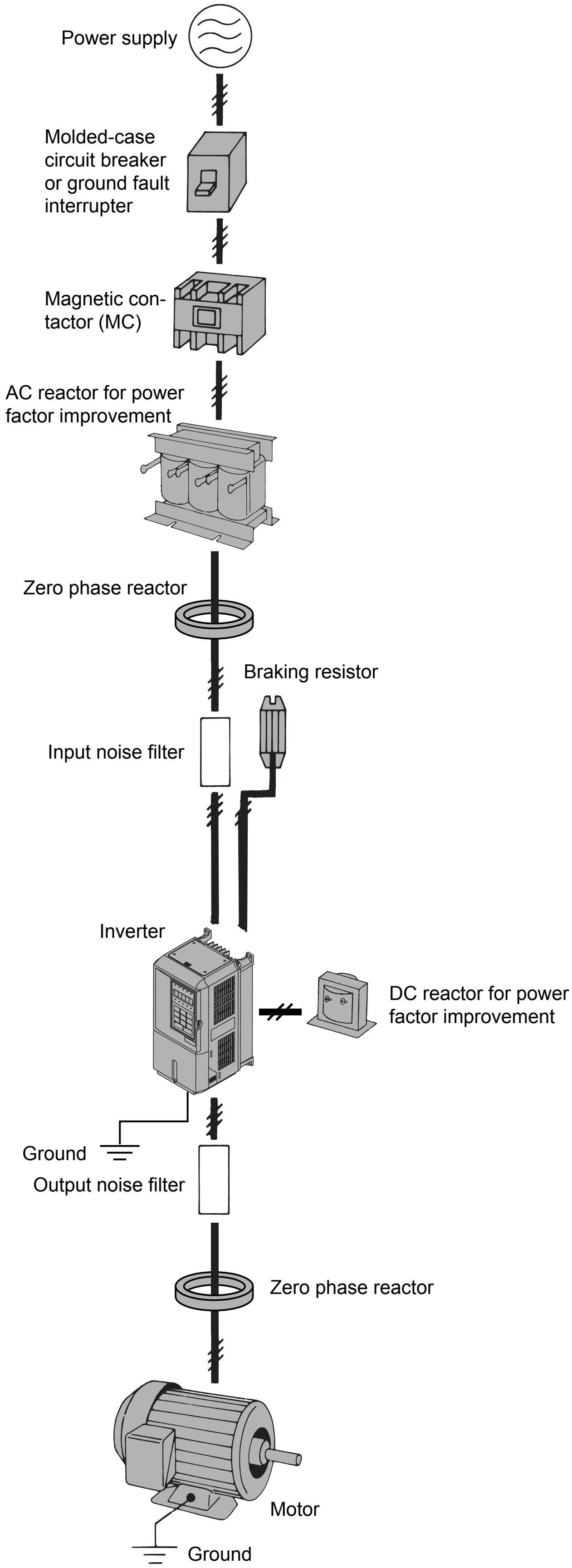


Fig 2.1 Example Connections to Peripheral Devices

Connection Diagram

The connection diagram of the Inverter is shown in *Fig 2.2*.

When using the Digital Operator, the motor can be operated by wiring only the main circuits.

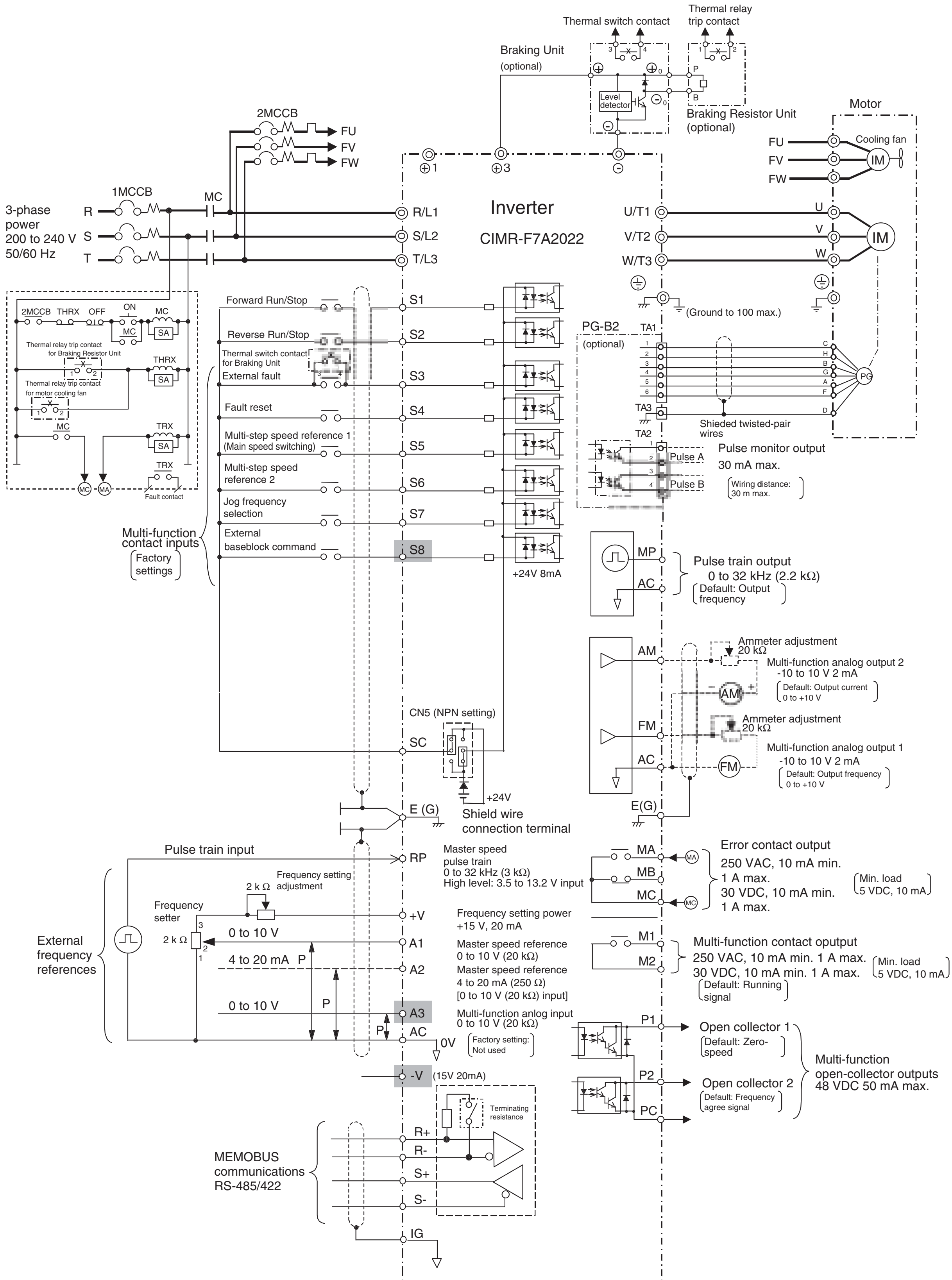


Fig 2.2 Connection Diagram (Model CIMR-F7A2022 Shown Above)

IMPORTANT

1. Control circuit terminals are arranged as shown below.

   Inverters with SPEC: C or earlier

E(G)	FM	AC	AM	P1	P2	PC	SC
SC	A1	A2		+V	AC		
S1	S2	S3	S4	S5	S6	S7	

MP				
RP	R+	R−	S+	S−
				IG

MA	MB	MC	
M1		M2	E(G)

   Inverters with SPEC: E or later

E(G)	FM	AC	AM	P1	P2	PC	SC
SC	A1	A2	A3	+V	AC	−V	
S1	S2	S3	S4	S5	S6	S7	S8

MP				
RP	R+	R−	S+	S−
				IG

MA	MB	MC	
M1		M2	E(G)

2. The output current capacity of the +V and −V terminals are 20 mA. Do not short-circuit between the +V, −V, and AC terminals. Doing so may result in a malfunction or a breakdown of the Inverter.
3. Disable the stall prevention during deceleration (set constant L3-04 to 0) when using a Braking Resistor Unit. If this user constant is not changed to disable stall prevention, the system may not stop during deceleration.
4. Main circuit terminals are indicated with double circles and control circuit terminals are indicated with single circles.
5. The wiring for a motor with a cooling fan is not required for self-cooling motors.
6. PG circuit wiring (i.e., wiring to the PG-B2 Board) is not required for control without a PG.
7. Sequence input signals S1 to S8 are labeled for sequence connections (0 V common and sinking mode) for no-voltage contacts or NPN transistors. These are the default settings.
   For PNP transistor sequence connections (+24V common and sourcing mode) or to provide a 24-V external power supply, refer to *Table 2.13*.
8. The master speed frequency reference can set to input either a voltage (terminal A1) or current (terminal A2) by changing the setting of parameter H3-13. The default setting is for a voltage reference input.
9. The multi-function analog output is a dedicated meter output for an analog frequency meter, ammeter, voltmeter, wattmeter, etc. Do not use this output for feedback control or for any other control purpose.
10. DC reactors to improve the input power factor are built into 200 V Class Inverters for 22 to 110 kW and 400 V Class Inverters for 22 to 300 kW. A DC reactor is thus an option only for Inverters for 18.5 kW or less.
11. Set parameter L8-01 to 1 when using a breaking resistor (ERF). When using a Braking Resistor Unit, a shutoff sequence for the power supply must be made using a thermal relay trip.
12. The permissible load of a multi-function contact output and an error contact output is 10 mA. Use a multi-function open-collector output for a load less than 10 mA.
13. Do not ground nor connect the AC terminal on the control circuit to the unit. Doing so may result in a malfunction or a breakdown of the Inverter.
14. If turning off the power only for the main circuit but leaving the power ON for the control circuit, use a separate power supply for the control circuit and a specially designed Inverter, which are sold as options.
15. indicates shield wire and P indicates twisted-pair shield wire.

Terminal Block Configuration

The terminal arrangement for 200 V Class Inverters are shown in *Fig 2.3* and *Fig 2.4*.

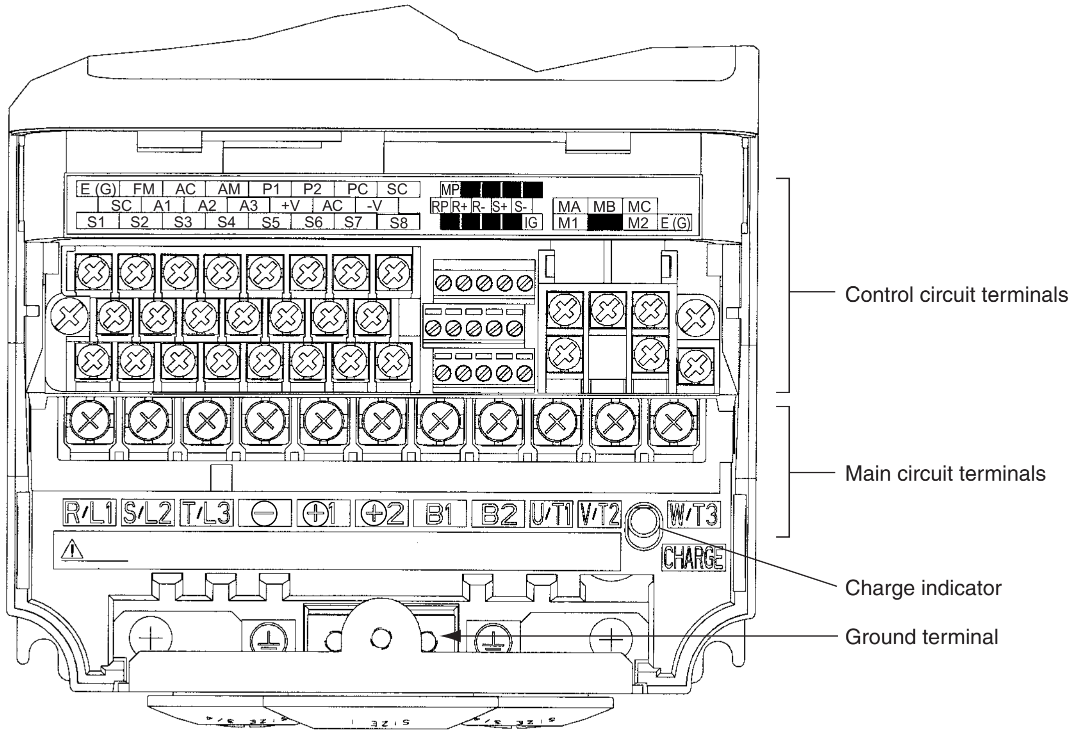


Fig 2.3 Terminal Arrangement (200 V Class Inverter with SPEC: E or later for 0.4 kW Shown Above)

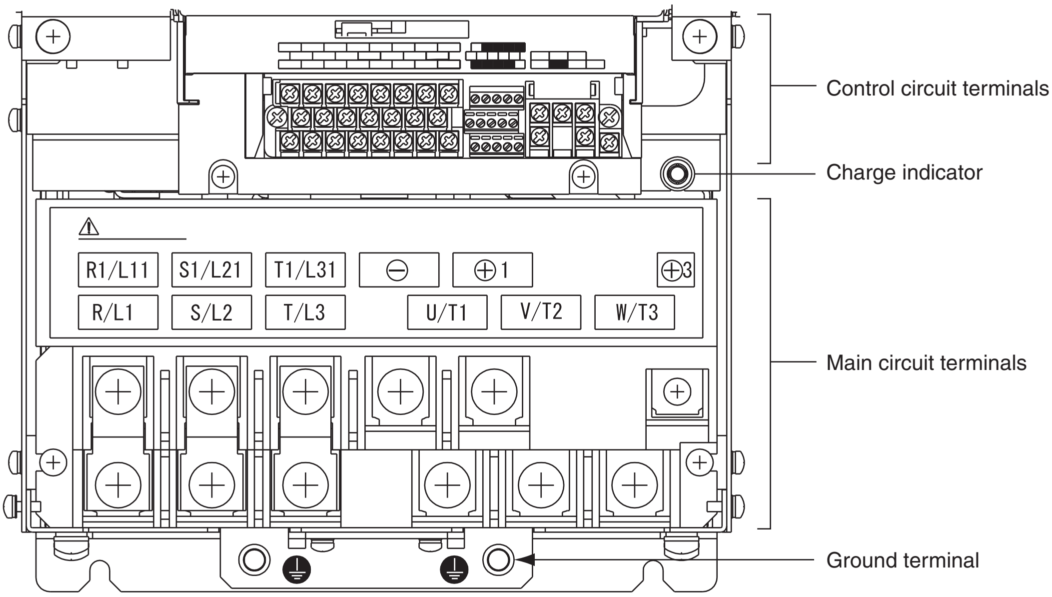


Fig 2.4 Terminal Arrangement (200 V Class Inverter with SPEC: E or later for 22 kW Shown Above)

Wiring Main Circuit Terminals

◆ Applicable Wire Sizes and Closed-loop Connectors

Select the appropriate wires and crimp terminals from *Table 2.1* to *Table 2.3*. Refer to instruction manual TOBPC72060000 for wire sizes for Braking Resistor Units and Braking Units.

Table 2.1 200 V Class Wire Sizes

Inverter Model CIMR-□	Terminal Symbol	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm^2(AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type
F7A20P4	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	Power cables, e.g., 600 V vinyl power cables
	⏚					
F7A20P7	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A21P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A22P2	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A23P7	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	3.5 to 5.5 (12 to 10)	3.5 (12)	
	⏚					
F7A25P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	5.5 (10)	5.5 (10)	
	⏚					
F7A27P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M5	2.5	8 to 14 (8 to 6)	8 (8)	
	⏚					
F7A2011	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M5	2.5	14 to 22 (6 to 4)	14 (6)	
	⏚					
F7A2015	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3	M6	4.0 to 5.0	30 to 38 (4 to 2)	30 (4)	
	B1, B2	M5	2.5	8 to 14 (8 to 6)	-	
	⏚	M6	4.0 to 5.0	22 (4)	22 (4)	
F7A2018	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3	M8	9.0 to 10.0	30 to 38 (3 to 2)	30 (3)	
	B1, B2	M5	2.5	8 to 14 (8 to 6)	-	
	⏚	M6	4.0 to 5.0	22 (4)	22 (4)	
F7A2022	R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M8	9.0 to 10.0	30 to 60 (3 to 1)	30 (3)	
	⊕3	M6	4.0 to 5.0	8 to 22 (8 to 4)	-	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	
F7A2030	R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M8	9.0 to 10.0	50 to 60 (1 to 1/0)	50 (1)	
	⊕3	M6	4.0 to 5.0	8 to 22 (8 to 4)	-	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	

Table 2.1 200 V Class Wire Sizes (Continued)

Inverter Model CIMR-☐	Terminal Symbol	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm^2(AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type
F7A2037	R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	60 to 100 (2/0 to 4/0)	60 (2/0)	Power cables, e.g., 600 V vinyl power cables
	⊕3	M8	8.8 to 10.8	5.5 to 22 (10 to 4)	-	
	⏚	M10	17.6 to 22.5	30 to 60 (2 to 2/0)	30 (2)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A2045	R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	80 to 100 (3/0 to 4/0)	80 (3/0)	
	⊕3	M8	8.8 to 10.8	5.5 to 22 (10 to 4)	-	
	⏚	M10	17.6 to 22.5	38 to 60 (1 to 2/0)	38 (1)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A2055	R/L1, S/L2, T/L3, ⊖, ⊕1	M10	17.6 to 22.5	50 to 100 (1/0 to 4/0)	50 × 2P (1/0 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	100 (4/0)	100 (4/0)	
	⊕3	M8	8.8 to 10.8	5.5 to 60 (10 to 2/0)	-	
	⏚	M10	17.6 to 22.5	30 to 60 (3 to 4/0)	50 (1/0)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A2075	⊖, ⊕1	M12	31.4 to 39.2	80 to 125 (3/0 to 250)	80 × 2P (3/0 × 2P)	
	R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	80 to 100 (3/0 to 4/0)	80 × 2P (3/0 × 2P)	
	⊕3	M8	8.8 to 10.8	5.5 to 60 (10 to 2/0)	-	
	⏚	M12	31.4 to 39.2	100 to 200 (3/0 to 400)	100 (3/0)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A2090	R/L1, S/L2, T/L3, ⊖, ⊕1	M12	31.4 to 39.2	150 to 200 (250 to 400)	150 × 2P (250 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M12	31.4 to 39.2	100 to 150 (4/0 to 300)	100 × 2P (4/0 × 2P)	
	⊕3	M8	8.8 to 10.8	5.5 to 60 (10 to 2/0)	-	
	⏚	M12	31.4 to 39.2	60 to 150 (2/0 to 300)	60 × 2P (2/0 × 2P)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A2110	R/L1, S/L2, T/L3, ⊖, ⊕1	M12	31.4 to 39.2	200 to 325 (350 to 600)	200 × 2P, or 50 × 4P (350 × 2P, or 1/0 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M12	31.4 to 39.2	150 to 325 (300 to 600)	150 × 2P, or 50 × 4P (300 × 2P, or 1/0 × 4P)	
	⊕3	M8	8.8 to 10.8	5.5 to 60 (10 to 2/0)	-	
	⏚	M12	31.4 to 39.2	150 (300)	150 × 2P (300 × 2P)	
	r/ℓ1, ⊿/ℓ2	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	

* The wire thickness is set for copper wires at 75°C

Table 2.2 400 V Class Wire Sizes

Inverter Model CIMR-☐	Terminal Symbol	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm^2 (AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type
F7A40P4	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	Power cables, e.g., 600 V vinyl power cables
	⏚					
F7A40P7	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A41P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A42P2	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	2 (14)	
	⏚					
F7A43P7	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	2 to 5.5 (14 to 10)	3.5 (12)	
	⏚				2 (14)	
F7A45P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.2 to 1.5	3.5 to 5.5 (12 to 10)	3.5 (12)	
	⏚			2 to 5.5 (14 to 10)	2 (14)	
F7A47P5	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M4	1.8	5.5(10)	5.5 (10)	
	⏚			3.5 to 5.5 (12 to 10)	3.5 (12)	
F7A4011	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M5	2.5	5.5 to 14 (10 to 6)	8 (8)	
	⏚				5.5 (10)	
F7A4015	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3	M5	2.5	8 to 14 (8 to 6)	8 (8)	
	⏚	M5 (M6)	2.5 (4.0 to 5.0)	5.5 to 14 (10 to 6)	5.5 (10)	
F7A4018	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3	M6	4.0 to 5.0	8 to 38 (8 to 2)	8 (8)	
	B1, B2	M5	2.5	8 (8)	8 (8)	
	⏚	M6	4.0 to 5.0	8 to 22 (8 to 4)	8 (8)	
F7A4022	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕3, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M6	4.0 to 5.0	14 to 22 (6 to 4)	14 (6)	
	⏚	M8	9.0 to 10.0	14 to 38 (6 to 2)	14 (6)	
F7A4030	R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕3, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M6	4.0 to 5.0	22 (4)	22 (4)	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	
F7A4037	R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M8	9.0 to 10.0	22 to 60 (4 to 1/0)	38 (2)	
	⊕3	M6	4.0 to 5.0	8 to 22 (8 to 4)	-	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	
F7A4045	R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M8	9.0 to 10.0	38 to 60 (2 to 1/0)	38 (2)	
	⊕3	M6	4.0 to 5.0	8 to 22 (8 to 4)	-	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	

Table 2.2 400 V Class Wire Sizes (Continued)

Inverter Model CIMR-☐	Terminal Symbol	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm^2 (AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type
F7A4055	R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M8	9.0 to 10.0	50 to 60 (1 to 1/0)	50 (1)	
	⊕3	M6	4.0 to 5.0	8 to 22 (8 to 4)	-	
	⏚	M8	9.0 to 10.0	22 to 38 (4 to 2)	22 (4)	
F7A4075	R/L1, S/L2, T/L3, ⊖, ⊕1	M10	17.6 to 22.5	60 to 100 (2/0 to 4/0)	60 (2/0)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	50 to 100 (1/0 to 4/0)	50 (1/0)	
	⊕3	M8	8.8 to 10.8	5.5 to 22 (10 to 4)	-	
	⏚	M10	17.6 to 22.5	38 to 60 (2 to 2/0)	38 (2)	
	r/ℓ1, ℓ200/$\ell_2$200, ℓ400/$\ell_2$400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4090	R/L1, S/L2, T/L3, ⊖, ⊕1	M10	17.6 to 22.5	80 to 100 (3/0 to 4/0)	100 (4/0)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	80 to 100 (3/0 to 4/0)	100 (4/0)	
	⊕3	M8	8.8 to 10.8	8 to 22 (8 to 4)	-	
	⏚	M10	17.6 to 22.5	50 to 100 (1 to 4/0)	50 (1)	
	r/ℓ1, ℓ200/$\ell_2$200, ℓ400/$\ell_2$400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4110	R/L1, S/L2, T/L3, ⊖, ⊕1	M10	17.6 to 22.5	50 to 100 (1/0 to 4/0)	50 × 2P (1/0 × 2P)	Power cables, e.g., 600 V vinyl power cables
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	50 to 100 (1/0 to 4/0)	50 × 2P (1/0 × 2P)	
	⊕3	M8	8.8 to 10.8	8 to 60 (8 to 2/0)	-	
	⏚	M12	31.4 to 39.2	60 to 150 (2/0 to 300)	60 (2/0)	
	r/ℓ1, ℓ200/$\ell_2$200, ℓ400/$\ell_2$400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4132	R/L1, S/L2, T/L3, ⊖, ⊕1	M10	17.6 to 22.5	80 to 100 (3/0 to 4/0)	80 × 2P (3/0 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M10	17.6 to 22.5	60 to 100 (2/0 to 4/0)	60 × 2P (2/0 × 2P)	
	⊕3	M8	8.8 to 10.8	8 to 60 (8 to 2/0)	-	
	⏚	M12	31.4 to 39.2	100 to 150 (4/0 to 300)	100 (4/0)	
	r/ℓ1, ℓ200/$\ell_2$200, ℓ400/$\ell_2$400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4160	R/L1, S/L2, T/L3, ⊖, ⊕1	M12	31.4 to 39.2	100 to 200 (4/0 to 400)	100 × 2P (4/0 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M12	31.4 to 39.2	80 to 200 (3/0 to 400)	80 × 2P (3/0 × 2P)	
	⊕3	M8	8.8 to 10.8	8 to 60 (8 to 2/0)	-	
	⏚	M12	31.4 to 39.2	50 to 150 (1/0 to 300)	50 × 2P (1/0 × 2P)	
	r/ℓ1, ℓ200/$\ell_2$200, ℓ400/$\ell_2$400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	

Table 2.2 400 V Class Wire Sizes (Continued)

Inverter Model CIMR-☐	Terminal Symbol	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm^2 (AWG)	Recommended Wire Size mm^2 (AWG)	Wire Type
F7A4185	R/L1, S/L2, T/L3	M16	78.4 to 98	100 to 325 (4/0 to 600)	150 × 2P (300 × 2P)	Power cables, e.g., 600 V vinyl power cables
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 2P (250 × 2P)	
	⊖, ⊕1	M16	78.4 to 98	100 to 325 (4/0 to 600)	325 × 2P (600 × 2P)	
	⊕3	M16	78.4 to 98	100 to 325 (4/0 to 600)	-	
	⏚	M16	78.4 to 98	100 to 325 (4/0 to 600)	100 × 2P (3/0 × 2P)	
	r/ℓ1, Δ200/ℓ2200, Δ400/ℓ2400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4220	R/L1, S/L2, T/L3	M16	78.4 to 98	100 to 325 (4/0 to 600)	250 × 2P (500 × 2P)	
	U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31	M16	78.4 to 98	100 to 325 (4/0 to 600)	200 × 2P (400 × 2P)	
	⊖, ⊕1	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 4P (250 × 4P)	
	⊕3	M16	78.4 to 98	100 to 325 (4/0 to 600)	-	
	⏚	M16	78.4to 98	100 to 325 (4/0 to 600)	125 × 2P (250 × 2P)	
	r/ℓ1, Δ200/ℓ2200, Δ400/ℓ2400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	
F7A4300	R/L1, S/L2, T/L3	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 4P (250 × 4P)	
	R1/L11, S1/L21, T1/L31	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 2P (250 × 2P)	
	U/T1, V/T2, W/T3	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 4P (4/0 × 4P)	
	⊖, ⊕1	M16	78.4 to 98	100 to 325 (4/0 to 600)	200 × 4P (400 × 4P)	
	⊕3	M16	78.4 to 98	100 to 325 (4/0 to 600)	-	
	⏚	M16	78.4 to 98	100 to 325 (4/0 to 600)	125 × 2P (250 × 2P)	
	r/ℓ1, Δ200/ℓ2200, Δ400/ℓ2400	M4	1.3 to 1.4	0.5 to 5.5 (20 to 10)	1.25 (16)	

* The wire thickness is set for copper wires at 75°C.

Table 2.3 Closed-loop Connector Sizes (JIS C2805) (200 V Class and 400 V Class)

Wire Thickness (mm^2)	Terminal Screws	Size
0.5	M3.5	1.25 to 3.5
	M4	1.25 to 4
0.75	M3.5	1.25 to 3.5
	M4	1.25 to 4
1.25	M3.5	1.25 to 3.5
	M4	1.25 to 4
2	M3.5	2 to 3.5
	M4	2 to 4
	M5	2 to 5
	M6	2 to 6
	M8	2 to 8
3.5/5.5	M4	5.5 to 4
	M5	5.5 to 5
	M6	5.5 to 6
	M8	5.5 to 8
8	M5	8 to 5
	M6	8 to 6
	M8	8 to 8
14	M6	14 to 6
	M8	14 to 8
22	M6	22 to 6
	M8	22 to 8
30/38	M8	38 to 8
50/60	M8	60 to 8
	M10	60 to 10
80	M10	80 to 10
100		100 to 10
100	M12	100 to 12
150		150 to 12
200		200 to 12
325	M12 x 2	325 to 12
	M16	325 to 16

IMPORTANT

1. Determine the wire size for the main circuit so that line voltage drop is within 2% of the rated voltage. Line voltage drop is calculated as follows:

   Line voltage drop (V) = $\sqrt{3}$ x wire resistance (W/km) x wire length (m) x current (A) x 10^{-3}
2. Use a closed-loop connector (made by J.S.T. Mfg. Co., Ltd. or an equivalent) for the main circuit input and output terminals of Inverters of 200V 11 kW or more and those of 400V 22 kW or more.

◆ Main Circuit Terminal Functions

Main circuit terminal functions are summarized according to terminal symbols in *Table 2.4*. Wire the terminals correctly for the desired purposes.

Table 2.4 Main Circuit Terminal Functions (200 V Class and 400 V Class)

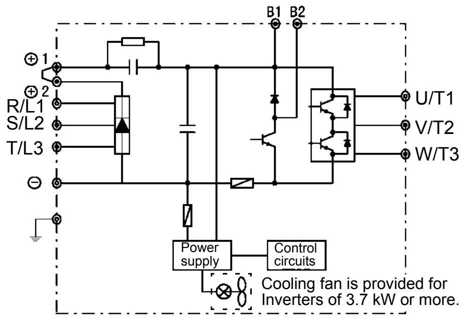
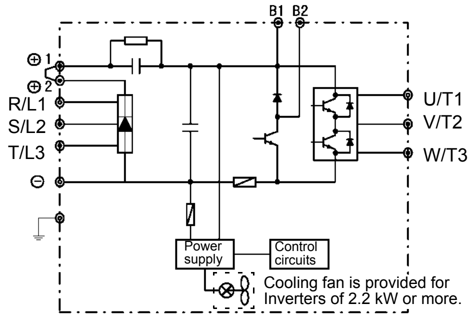
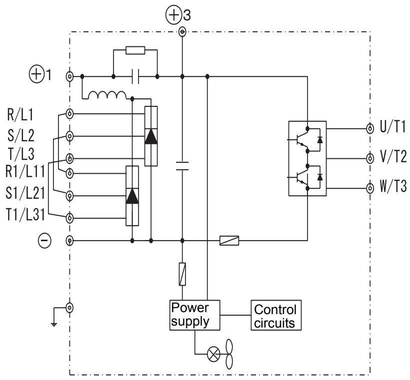
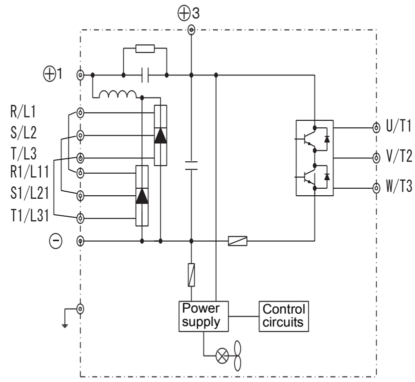
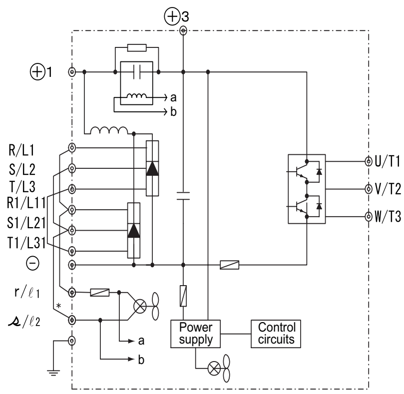
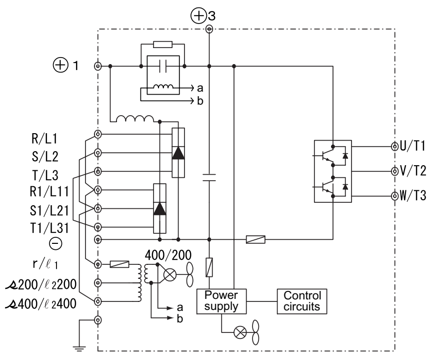
Purpose	Terminal Symbol	Model: CIMR-F7A □	
		200 V Class	400 V Class
Main circuit power input	R/L1, S/L2, T/L3	20P4 to 2110	40P4 to 4300
	R1/L11, S1/L21, T1/L31	2022 to 2110	4022 to 4300
Inverter outputs	U/T1, V/T2, W/T3	20P4 to 2110	40P4 to 4300
DC power input	⊕1, ⊖	20P4 to 2110	40P4 to 4300
Braking Resistor Unit connection	B1, B2	20P4 to 2018	40P4 to 4018
DC reactor connection	⊕1, ⊕2	20P4 to 2018	40P4 to 4018
Braking Unit connection	⊕3, ⊖	2022 to 2110	4022 to 4300
Ground	⏚	20P4 to 2110	40P4 to 4300

Note The ⊕1 and ⊖ input terminals for the DC power do not conform to UL/cUL standards.

◆ Main Circuit Configurations

The main circuit configurations of the Inverter are shown in *Fig 2.5*.

Table 2.5 Inverter Main Circuit Configurations

200 V Class	400 V Class
CIMR-F7A20P4 to 2018 	CIMR-F7A40P4 to 4018 
CIMR-F7A2022, 2030 	CIMR-F7A4022 to 4055 
CIMR-F7A2037 to 2110 	CIMR-F7A4075 to 4300 

Note Consult your Yaskawa representative before using 12-phase rectification.

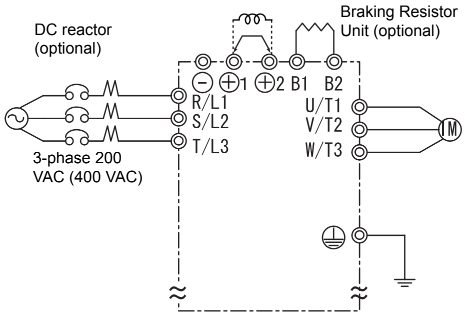
* These terminals are wired before shipment. When using DC power for the main circuit power supply, remove the wires between R-r/ℓ_1 and S-⊿/ℓ_2, then, for 200 V Class Inverters, input 200 VAC to r/ℓ_1- ⊿/ℓ_2, or, for 400 V Class Inverters, input either 200 VAC to r/ℓ_1- ⊿200/$\ell_2$200 or 400 VAC to r/ℓ_1- ⊿400/$\ell_2$400.

2

◆ Standard Connection Diagrams

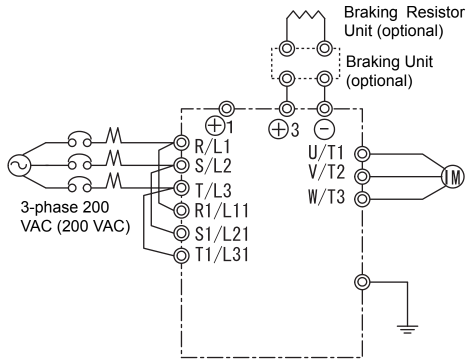
Standard Inverter connection diagrams are shown in *Fig 2.5.* The connections depend on the Inverter capacity.

■CIMR-F7A20P4 to 2018 and 40P4 to 4018



Be sure to remove the short-circuit bar before connecting the DC reactor.

■CIMR-F7A2022, 2030, and 4022 to 4055

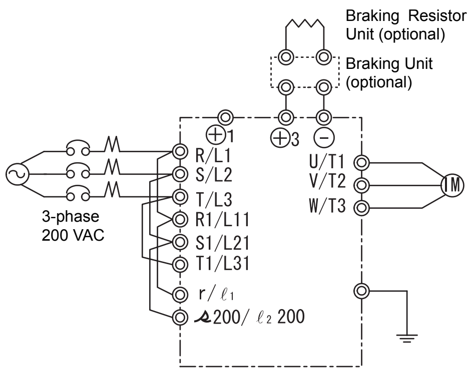


The DC reactor is built in.

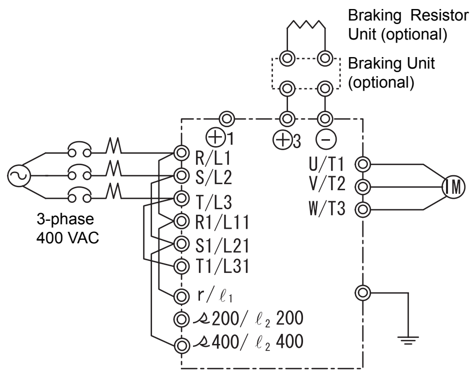
IMPORTANT

When connecting a separately-installed type Braking Unit (model CDBR), connect the B1 terminal of the Inverter to the + terminal of the Braking Unit and connect the – terminal of the Inverter to the – terminal of the Braking Unit. The B2 terminal is not used in this case.

■CIMR-FA2037 to 2110



■CIMR-F7A4075 to 4300



Control power is supplied internally from the main circuit DC power supply for all Inverter models.

IMPORTANT

If a Braking Unit or a Braking Resistor Unit is connected to a wrong terminal, the Inverter, Braking Unit, or Braking Resistor Unit can be damaged.
Refer to *FOR VARISPEED-600 SERIES INVERTER BRAKING UNIT BRAKING RESISTOR UNIT INSTRUCTIONS (TOBPC720600000)* for connecting the Inverter with a Braking Unit or a Braking Resistor Unit.

Fig 2.5 Main Circuit Terminal Connections

◆ Wiring the Main Circuits

This section describes wiring connections for the main circuit inputs and outputs.

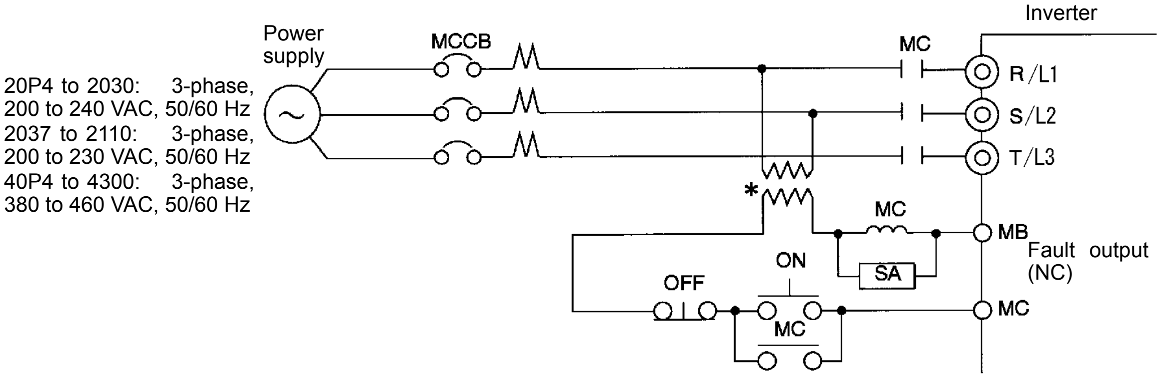
■Wiring Main Circuit Inputs

Observe the following precautions for wiring the main circuit power supply inputs.

Installing a Molded-case Circuit Breaker

Always connect the power input terminals (R, S, and T) and power supply via a molded-case circuit breaker (MCCB) suitable for the Inverter.

- Choose an MCCB with a capacity of 1.5 to 2 times the Inverter's rated current.
- For the MCCB's time characteristics, be sure to consider the Inverter's overload protection (one minute at 150% of the rated output current).
- If the same MCCB is to be used for more than one Inverter, or other devices, set up a sequence so that the power supply will be turned OFF by a fault output, as shown in *Fig 2.6*.



* For 400 V Class Inverters, connect a 400/200 V transformer.

Fig 2.6 MCCB Installation

Installing a Ground Fault Interrupter

Inverter outputs use high-speed switching, so high-frequency leakage current is generated. At the Inverter primary side, use a ground fault interrupter for Inverters with a countermeasure against high frequency to detect only the leakage current in the frequency range that is hazardous to humans and to ignore high-frequency leakage current. Use one or several ground fault interrupters with a total cumulative sensitivity amperage of at least 30 mA per Inverter.

Using a ground fault interrupter without a countermeasure against high frequency may result in a malfunction caused by high-frequency leakage current. If a ground fault interrupter without a countermeasure malfunctions, replace it with a ground fault interrupter with a countermeasure against high frequency or reduce the carrier frequency of the Inverter. Alternatively, use one or several ground fault interrupters with a total cumulative sensitivity amperage of at least 200 mA per Inverter.

Installing a Magnetic Contactor

If the power supply for the main circuit is to be shut off during a sequence, a magnetic contactor can be used.

When a magnetic contactor is installed on the primary side of the main circuit to forcibly stop the Inverter, however, the regenerative braking does not work and the Inverter will coast to a stop.

- The Inverter can be started and stopped by opening and closing the magnetic contactor on the primary side. Frequently opening and closing the magnetic contactor, however, may cause the Inverter to break down. Start and stop the Inverter at most once every 30 minutes.
- When the Inverter is operated with the Digital Operator, automatic operation cannot be performed after recovery from a power interruption.
- If the Braking Resistor Unit is used, program the sequence so that the magnetic contactor is turned OFF by the contact of the Unit's thermal overload relay.

Connecting Input Power Supply to the Terminal Block

Input power supply can be connected to any terminal R, S or T on the terminal block; the phase sequence of input power supply is irrelevant to the phase sequence.

Installing an AC Reactor or DC Reactor

If the Inverter is connected to a large-capacity power transformer (600 kW or more) or the phase advancing capacitor is switched, an excessive peak current may flow through the input power circuit, causing the converter unit to break down.

To prevent this, install an optional AC Reactor on the input side of the Inverter or a DC reactor to the DC reactor connection terminals.

This also improves the power factor on the power supply side.

Installing a Surge Absorber

Always use a surge absorber or diode for inductive loads near the Inverter. These inductive loads include magnetic contactors, electromagnetic relays, solenoid valves, solenoids, and magnetic brakes.

Installing a Noise Filter on Power Supply Side

Install a noise filter to eliminate noise transmitted between the power line and the Inverter.

- Correct Noise Filter Installation

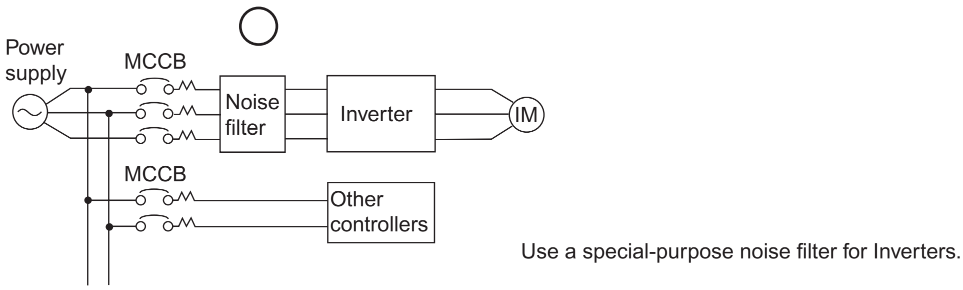


Fig 2.7 Correct Power supply Noise Filter Installation

- Incorrect Noise Filter Installation

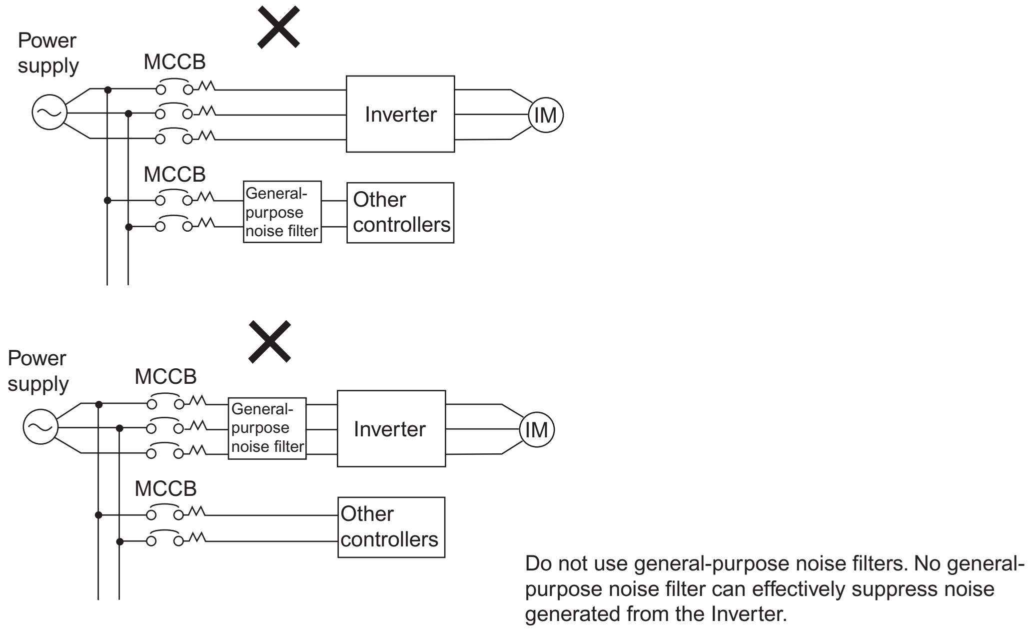


Fig 2.8 Incorrect Power supply Noise Filter Installation

■Wiring the Output Side of Main Circuit

Observe the following precautions when wiring the main output circuits.

Connecting the Inverter and Motor

Connect output terminals U, V, and W to motor lead wires U, V, and W, respectively.

Check that the motor rotates forward with the Forward Run Command. Switch over any two of the output terminals to each other and reconnect if the motor rotates in reverse with the Forward Run Command.

Never Connect a Power Supply to Output Terminals

Never connect a power supply to output terminals U, V, and W. If voltage is applied to the output terminals, the internal circuits of the Inverter will be damaged.

Never Short or Ground Output Terminals

If the output terminals are touched with bare hands or the output wires come into contact with the Inverter casing, an electric shock or grounding will occur. This is extremely hazardous. Do not short the output wires.

Do Not Use a Phase Advancing Capacitor or Noise Filter

Never connect a phase advancing capacitor or LC/RC noise filter to an output circuit. The high-frequency components of the Inverter output may result in overheating or damage to these part or may result in damage to the Inverter or cause other parts to burn.

Precautions When Using an Magnetic Contactor

Never connect an magnetic contactor between the Inverter and motor and turn it ON or OFF during operation. If the magnetic contactor is turned ON while the Inverter is operating, a large inrush current will be created and the overcurrent protection in the Inverter will operate.

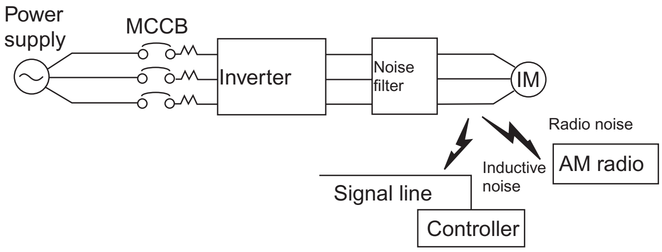
When using an magnetic contactor to switch to a commercial power supply, stop the Inverter and motor before operating the magnetic contactor. Use the speed search function if the magnetic contactor is operated during operation. If measures for momentary power interrupts are required, use a delayed release magnetic contactor.

Installing a Thermal Overload Relay

This Inverter has an electronic thermal protection function to protect the motor from overheating. If, however, more than one motor is operated with one Inverter or a multi-polar motor is used, always install a thermal relay (THR) between the Inverter and the motor and set L1-01 to 0 (no motor protection). The sequence should be designed so that the contacts of the thermal overload relay turn OFF the magnetic contactor on the main circuit inputs.

Installing a Noise Filter on Output Side

Connect a noise filter to the output side of the Inverter to reduce radio noise and inductive noise.



Inductive Noise: Electromagnetic induction generates noise on the signal line, causing the controller to malfunction.

Radio Noise: Electromagnetic waves from the Inverter and cables cause the broadcasting radio receiver to make noise.

Fig 2.9 Installing a Noise Filter on the Output Side

Countermeasures Against Inductive Noise

As described previously, a noise filter can be used to prevent inductive noise from being generated on the output side. Alternatively, cables can be routed through a grounded metal pipe to prevent inductive noise. Keeping the metal pipe at least 30 cm away from the signal line considerably reduces inductive noise.

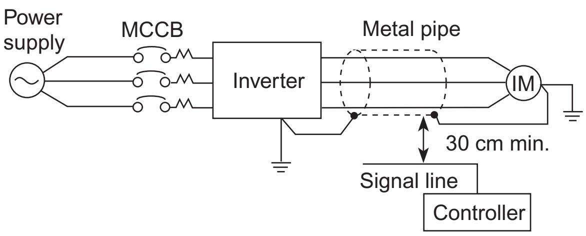


Fig 2.10 Countermeasures Against Inductive Noise

Countermeasures Against Radio Interference

Radio noise is generated from the Inverter as well as from the input and output lines. To reduce radio noise, install noise filters on both input and output sides, and also install the Inverter in a totally enclosed steel box.

The cable between the Inverter and the motor should be as short as possible.

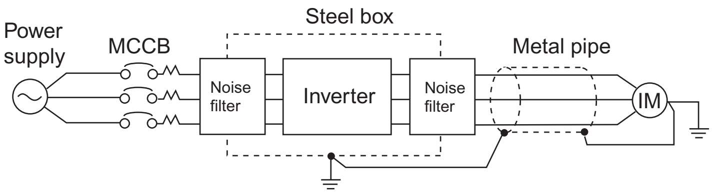


Fig 2.11 Countermeasures Against Radio Interference

Cable Length between Inverter and Motor

If the cable between the Inverter and the motor is long, the high-frequency leakage current will increase, causing the Inverter output current to increase as well. This may affect peripheral devices. To prevent this, adjust the carrier frequency (set in C6-01, C6-02) as shown in *Table 2.6*. (For details, refer to *Chapter 5 User Constants*.)

Table 2.6 Cable Length between Inverter and Motor

Cable length	50 m max.	100 m max.	More than 100 m
Carrier frequency	15 kHz max.	10 kHz max.	5 kHz max.

■Ground Wiring

Observe the following precautions when wiring the ground line.

- Always use the ground terminal of the 200 V Inverter with a ground resistance of less than 100 Ω and that of the 400 V Inverter with a ground resistance of less than 10 Ω.
- Do not share the ground wire with other devices, such as welding machines or power tools.
- Always minimize the length of the ground wire.
  Leakage current flows through the Inverter. Therefore, if the distance between the ground electrode and the ground terminal is too long, potential on the ground terminal of the Inverter will become unstable.
- When using more than one Inverter, be careful not to loop the ground wire.

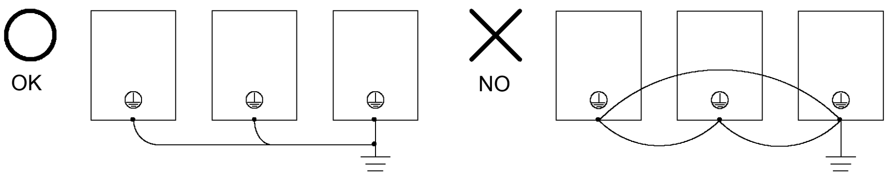


Fig 2.12 Ground Wiring

■Connecting the Braking Resistor (ERF)

A Braking Resistor that mounts to the Inverter can be used with 200 V and 400 V Class Inverters with outputs from 0.4 to 3.7 kW.

Connect the braking resistor as shown in *Fig 2.13*.

Table 2.7

L8-01 (Protect selection for internal DB resistor)	1 (Enables overheat protection)
L3-04 (Stall prevention selection during deceleration) (Select either one of them.)	0 (Disables stall prevention function)
	3 (Enables stall prevention function with braking resistor)

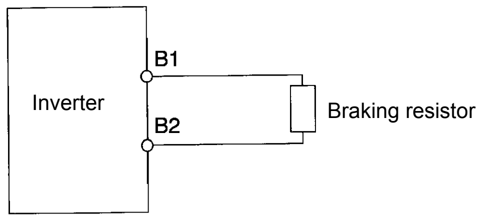


Fig 2.13 Connecting the Braking Resistor

IMPORTANT

The braking resistor connection terminals are B1 and B2. Do not connect to any other terminals. Connecting to any terminals other than B1 or B2 can cause the resistor to overheat, resulting in damage to the equipment.

■Connecting the Braking Resistor Unit (LKEB) and Braking Unit (CDBR)

Use the following settings if using a Braking Resistor Unit and Braking Unit.

A Braking Resistor that mounts to the Inverter can also be used with Inverters with outputs from 0.4 to 3.7 kW.

Table 2.8

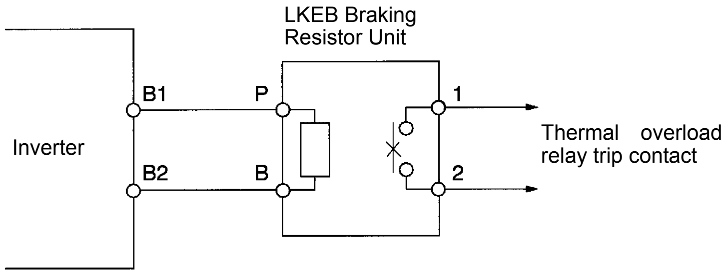
L8-01 (Protect selection for internal DB resistor)	0 (Disables overheat protection)
L3-04 (Stall prevention selection during deceleration) (Select either one of them.)	0 (Disables stall prevention function)
	3 (Enables stall prevention function with braking resistor)

L8-01 is used when a braking resistor without thermal overload relay trip contacts (ERF type mounted to Inverter) is connected.

The Braking Resistor Unit cannot be used and the deceleration time cannot be shortened by the Inverter if L3-04 is set to 1 (i.e., if stall prevention is enabled for deceleration).

To prevent the Unit from overheating, design the sequence to turn OFF the power supply for the thermal overload relay trip contacts of the Unit as shown in *Fig 2.14*.

200 V and 400 V Class Inverters with 0.4 to 18.5 kW Output



IMPORTANT

When connecting a separately-installed type Braking Unit (model CDBR), connect the B1 terminal of the Inverter to the + terminal of the Braking Unit and connect the – terminal of the Inverter to the – terminal of the Braking Unit. The B2 terminal is not used in this case.

200 V and 400 V Class Inverters with 22 kW or higher Output

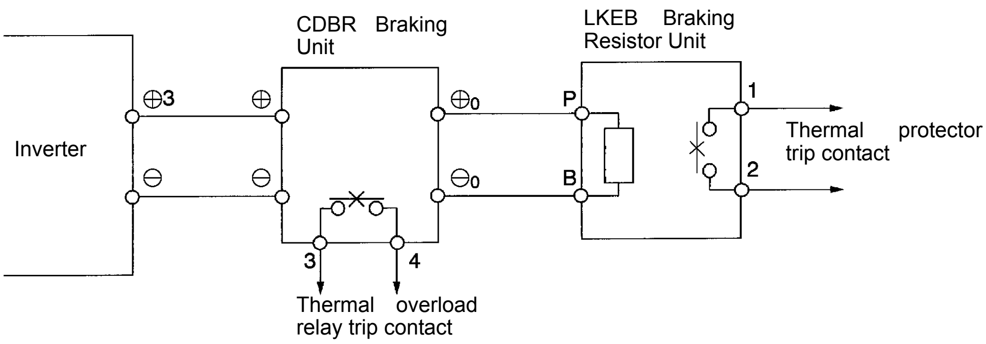


Fig 2.14 Connecting the Braking Resistor Unit and Braking Unit

Connecting Braking Units in Parallel

When connecting two or more Braking Units in parallel, use the wiring and connectors shown in *Fig 2.15*. There are connectors for selecting whether each Braking Unit is to be a Master or Slave. Select “Master” for the first Braking Unit only, and select “Slave” for all other Braking Units (i.e., from the second Unit onwards).

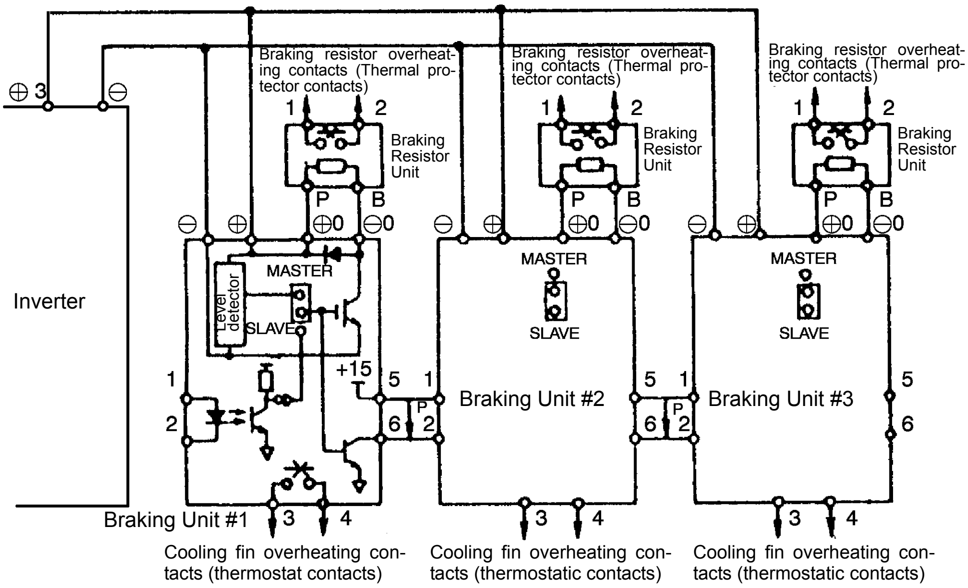
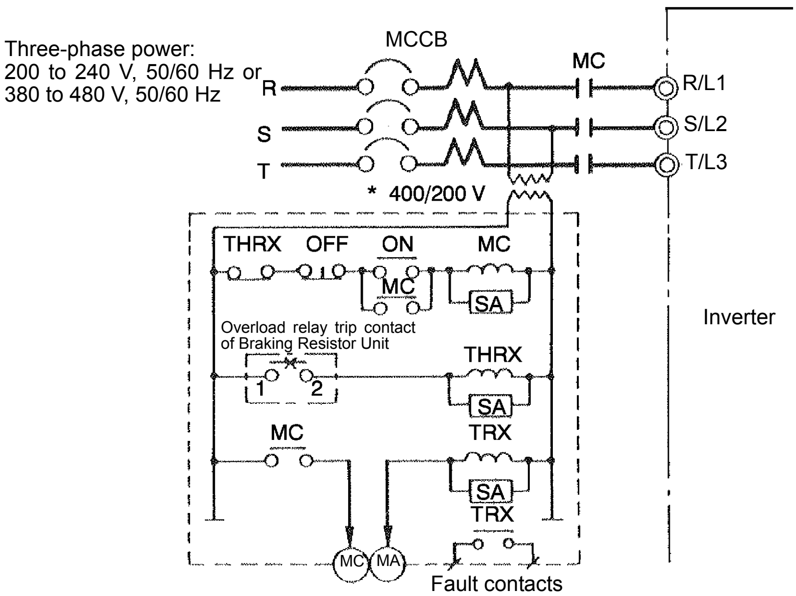


Fig 2.15 Connecting Braking Units in Parallel

Breaking Unit Application Precautions

When using a Braking Resistor Unit, create a sequence to detect overheating of the braking resistor and turn OFF the power supply to the Inverter.



* Use a transformer with 200 and 400 V outputs for the power 400 V Inverter.

Fig 2.16 Power Shutoff Sequence

Wiring Control Circuit Terminals

◆ Wire Sizes and Closed-loop Connectors

For remote operation using analog signals, keep the control line length between the Digital Operator or operation signals and the Inverter to 50 m or less, and separate the lines from high-power lines (main circuits or relay sequence circuits) to reduce induction from peripheral devices.

When setting frequencies from an external frequency setter (and not from a Digital Operator), use shielded twisted-pair wires and ground the shield to terminal E (G), as shown in the following diagram.

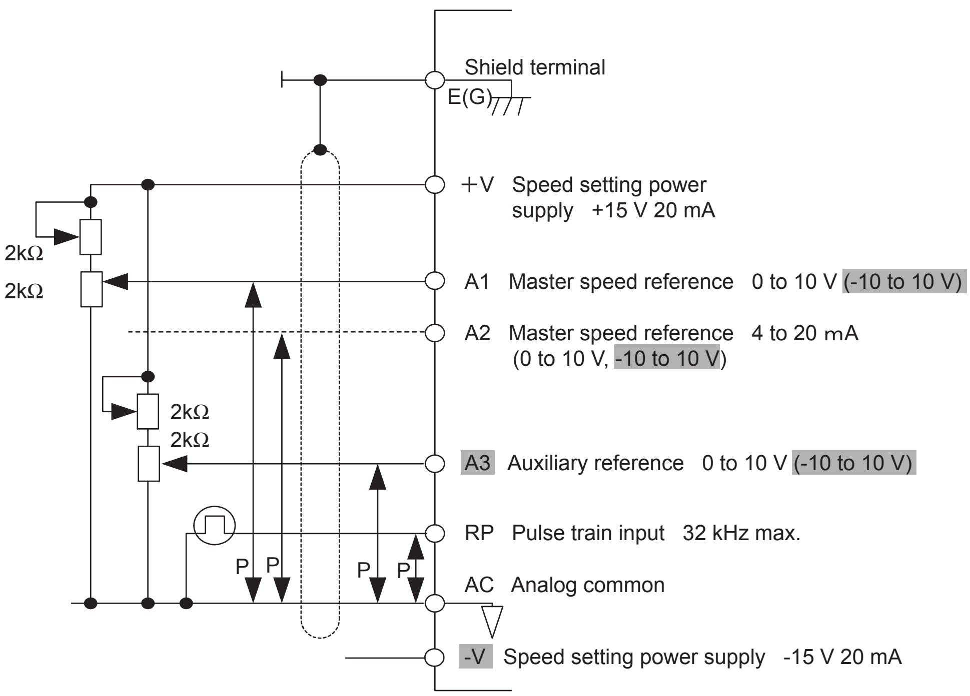


Fig 2.17

Terminal numbers and wire sizes are shown in *Table 2.9*.

Table 2.9 Terminal Numbers and Wire Sizes (Same for all Models)

Terminals	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm2(AWG)	Recommended Wire Size mm2(AWG)	Wire Type
FM, AC, AM, P1, P2, PC, SC, A1, A2, A3, +V, -V, S1, S2, S3, S4, S5, S6, S7, S8, MA, MB, MC, M1, M2	M3.5	0.8 to 1.0	0.5 to 2*2 (20 to 14)	0.75 (18)	• Shielded, twisted-pair wire*1 • Shielded, polyethylene-covered, vinyl sheath cable (KPEV-S by Hitachi Electrical Wire or equivalent)
MP, RP, R+, R-, S+, S-, IG	Phoenix type	0.5 to 0.6	Single wire*3: 0.14 to 2.5 Stranded wire: 0.14 to 1.5 (26 to 14)	0.75 (18)	
E (G)	M3.5	0.8 to 1.0	0.5 to 2*2 (20 to 14)	1.25 (12)	

* 1. Use shielded twisted-pair cables to input an external frequency reference.
* 2. Refer to *Table 2.3 Close-loop Connector Sizes* for suitable closed-loop crimp terminal sizes for the wires.
* 3. We recommend using straight solderless terminal on signal lines to simplify wiring and improve reliability.

■ Straight Solderless Terminals for Signal Lines

Models and sizes of straight solderless terminal are shown in the following table.

Table 2.10 Straight Solderless Terminal Sizes

Wire Size mm^2 (AWG)	Model	d1	d2	L	Manufacturer
0.25 (24)	AI 0.25 - 8YE	0.8	2	12.5	Phoenix Contact
0.5 (20)	AI 0.5 - 8WH	1.1	2.5	14	
0.75 (18)	AI 0.75 - 8GY	1.3	2.8	14	
1.25 (16)	AI 1.5 - 8BK	1.8	3.4	14	
2 (14)	AI 2.5 - 8BU	2.3	4.2	14	

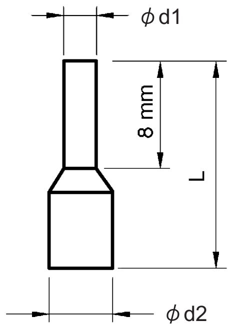


Fig 2.18 Straight Solderless Terminal Sizes

■Wiring Method

Use the following procedure to connect wires to the terminal block.

1. Loosen the terminal screws with a thin-slot screwdriver.
2. Insert the wires from underneath the terminal block.
3. Tighten the terminal screws firmly.

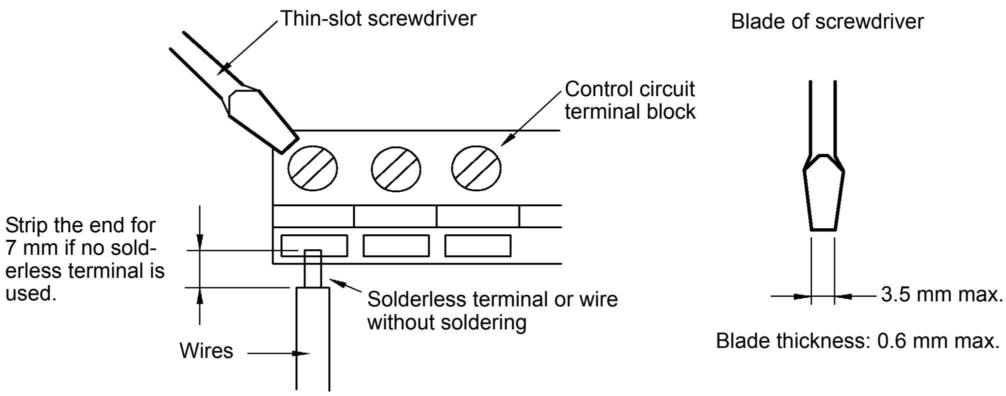


Fig 2.19 Connecting Wires to Terminal Block

◆ Control Circuit Terminal Functions

The functions of the control circuit terminals are shown in *Table 2.11*. Use the appropriate terminals for the correct purposes.

Table 2.11 Control Circuit Terminals

Type	No.	Signal Name	Function	Signal Level
Sequence input signals	S1	Forward Run/Stop Command	Forward run when ON; stopped when OFF.	24 VDC, 8 mA Photocoupler isolation
	S2	Reverse Run/Stop Command	Reverse run when ON; stopped when OFF.	
	S3	Multi-function input 1*1	Factory setting: External fault when ON.	
	S4	Multi-function input 2*1	Factory setting: Fault reset when ON.	
	S5	Multi-function input 3*1	Factory setting: Multi-speed reference 1 effective when ON.	
	S6	Multi-function input 4*1	Factory setting: Multi-speed reference 2 effective when ON.	
	S7	Multi-function input 5*1	Factory setting: Jog frequency selected when ON.	
	S8	Multi-function input 6*1	Factory setting: External baseblock when ON.	
	SC	Sequence input common	-	
Analog input signals	+V	+15 V power output	+15 V power supply for analog references	+15 V (Max. current: 20 mA)
	-V	-15 V power output	-15 V power supply for analog references	-15 V (Max. current: 20 mA)
	A1	Master speed frequency reference	-10 to +10 V/-100 to 100% 0 to +10 V/100%	-10 to +10 V, 0 to +10 V (Input impedance: 20 kΩ)
	A2	Multi-function analog input	4 to 20 mA/100%, -10 to +10 V/-100 to +100%, 0 to +10 V/100% Factory setting: Added to terminal A1 (H3-09 = 0)	4 to 20 mA (Input impedance: 250 Ω) -10 to +10 V, 0 to +10 V (Input impedance: 20 kΩ)
	A3	Multi-function analog input	-10 to +10 V/-100 to +100%, 0 to +10 V/100% Factory setting: Not used (H3-05 = 1F)	-10 to +10 V, 0 to +10 V (Input impedance: 20 kΩ)
	AC	Analog reference common	0 V	-
	E(G)	Shield wire, optional ground line connection point	-	-
Photocoupler outputs	P1	Multi-function PHC output 1	Factory setting: Zero-speed Zero-speed level (b2-01) or below when ON.	50 mA max. at 48 VDC*2
	P2	Multi-function PHC output 2	Factory setting: Frequency agreement detection Frequency within 2 Hz of set frequency when ON.	
	PC	Photocoupler output common for P1 and P2	-	

2

Table 2.11 Control Circuit Terminals (Continued)

Type	No.	Signal Name	Function	Signal Level
Relay outputs	MA	Fault output signal (NO contact)	Fault when CLOSED across MA and MC Fault when OPEN across MB and MC	Dry contacts Contact capacity: 10 mA min., 1 A max. at 250 VAC 10 mA min., 1 A max. at 30 VDC Minimum permissible load: 5 VDC, 10 mA*4
	MB	Fault output signal (NC contact)		
	MC	Relay contact output common	-	
	M1	Multi-function contact output (NO contact)	Factory setting: Operating Operating when CLOSED across M1 and M2.	
	M2			
Analog monitor outputs	FM	Multi-function analog monitor 1	Factory setting: Output frequency 0 to 10 V/100% frequency	-10 to +10 VDC ±5% 2 mA max.
	AM	Multi-function analog monitor 2	Factory setting: Current monitor 5 V/Inverter's rated current	
	AC	Analog common	-	
Pulse I/O	RP	Multi-function pulse input*3	Factory setting: Frequency reference input (H6-01 = 0)	0 to 32 kHz (3 kΩ)
	MP	Multi-function pulse monitor	Factory setting: Output frequency (H6-06 = 2)	0 to 32 kHz (2.2 kΩ)
RS-485/422	R+	MEMOBUS communications input	For 2-wire RS-485, short R+ and S+ as well as R- and S-.	Differential input, photocoupler isolation
	R-			
	S+	MEMOBUS communications output		Differential output, photocoupler isolation
	S-			
	IG	Communications shield wire	-	-

* 1. For a 3-wire sequence, the default settings are a 3-wire sequence for S5, multi-step speed setting 1 for S6, multi-step speed setting 2 for S7, and jog frequency command for S8.

* 2. When driving a reactive load, such as a relay coil, always insert a flywheel diode as shown in *Fig 2.20*.

* 3. Pulse input specifications are given in the following table.

* 4. Use the photocoupler outputs when the minimum permissible load is 5 VDC or less and 10 mA or less.

Low level voltage	0.0 to 0.8 V
High level voltage	3.5 to 13.2 V
H duty	30% to 70%
Pulse frequency	0 to 32 kHz

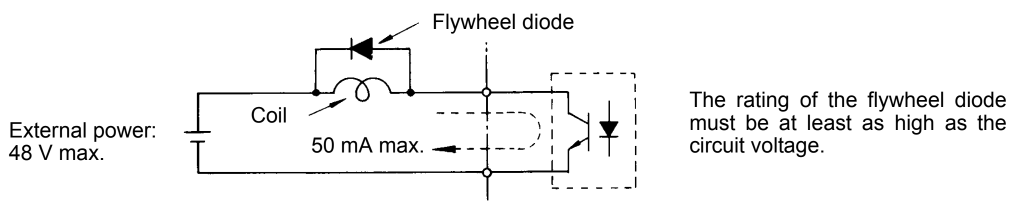


Fig 2.20 Flywheel Diode Connection

■Shunt Connector CN5 and DIP Switch S1

The shunt connector CN 5 and DIP switch S1 are described in this section.

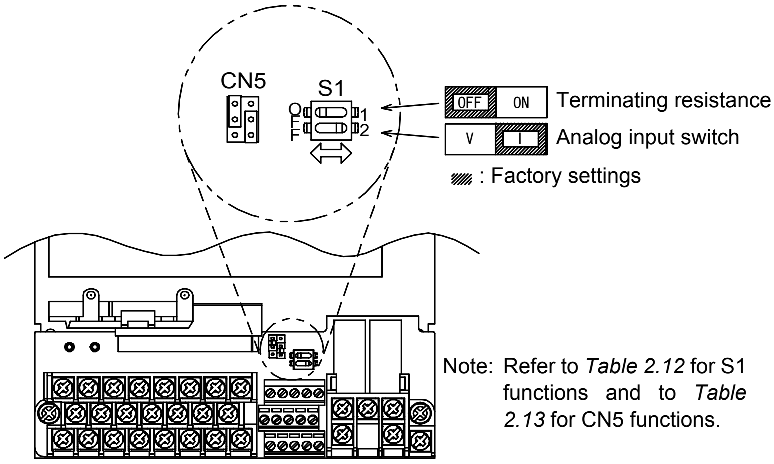


Fig 2.21 Shunt Connector CN5 and DIP Switch S1

The functions of DIP switch S1 are shown in the following table.

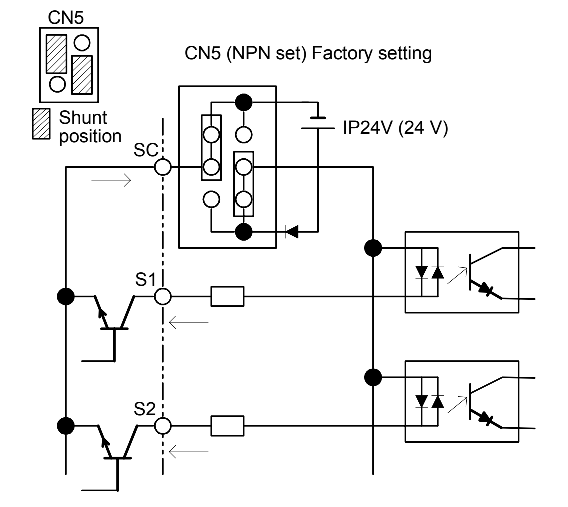
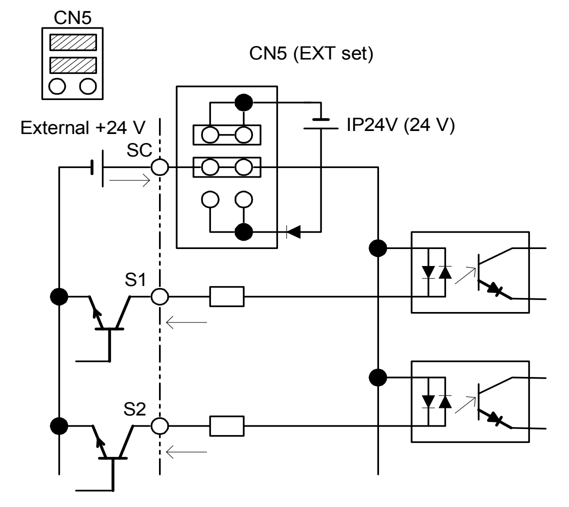
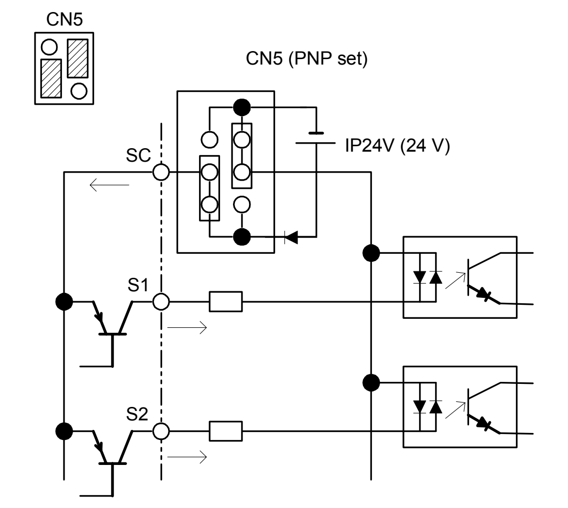
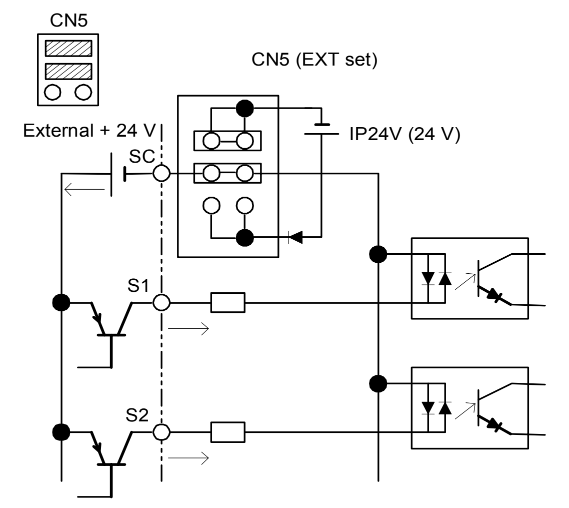
Table 2.12 DIP Switch S1

Name	Function	Setting
S1-1	RS-485 and RS-422 terminating resistance	OFF: No terminating resistance ON: Terminating resistance of 110 Ω
S1-2	Input method for analog input A2	OFF: 0 to 10 V, –10 to 10 V (internal resistance: 20 kΩ) ON: 4 to 20 mA (internal resistance: 250 Ω)

■ Sinking/Sourcing Mode

The input terminal logic can be switched between sinking mode (0-V common) and sourcing mode (+24-V common) if shunt connector CN5 is used. An external 24-V power supply is also supported, providing more freedom in signal input methods.

Table 2.13 Sinking/Sourcing Mode and Input Signals

	Internal Power Supply	External Power Supply
Sink-ing Mode		
Sourc-ing Mode		

◆ Control Circuit Terminal Connections

Connections to Inverter control circuit terminals are shown in *Fig 2.22*.

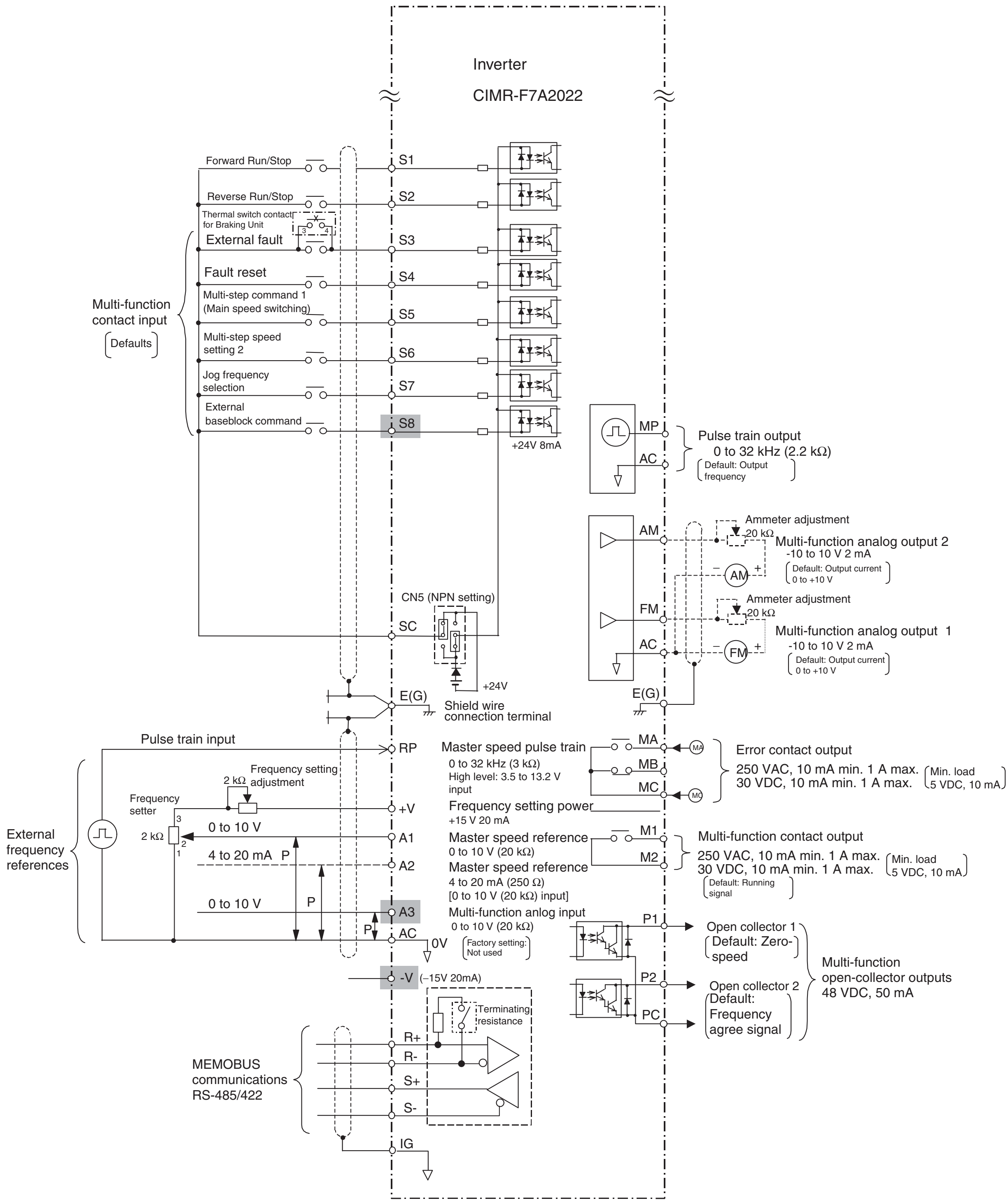


Fig 2.22 Control Circuit Terminal Connections

◆ Control Circuit Wiring Precautions

Observe the following precautions when wiring control circuits.

- Separate control circuit wiring from main circuit wiring (terminals R/L1, S/L2, T/L3, B1, B2, U/T1, V/T2, W/T3, ⊖, ⊕1, ⊕2, and ⊕3) and other high-power lines.
- Separate wiring for control circuit terminals MA, MB, MC, M1, and M2 (contact outputs) from wiring to other control circuit terminals.
- Use shielded twisted-pair cables for control circuits to prevent operating faults. Process cable ends as shown in *Fig 2.23*.
- Connect the shield wire to terminal E (G).
- Insulate the shield with tape to prevent contact with other signal lines and equipment.
- Use a class 2 power supply (UL standard) when connecting to the control terminals.

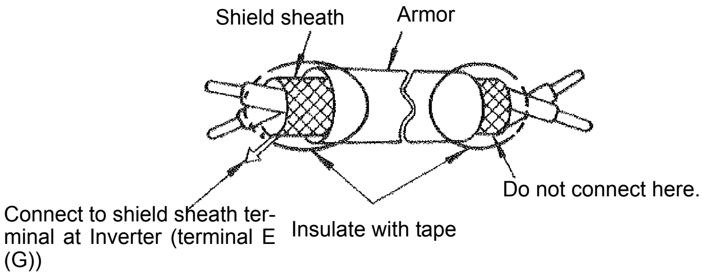


Fig 2.23 Processing the Ends of Shielded Twisted-pair Cables

Wiring Check

◆ Checks

Check all wiring after wiring has been completed. Do not perform a buzzer check on control circuits. Perform the following checks on the wiring.

- Is all wiring correct?
- Have any wire clippings, screws, or other foreign material been left?
- Are all screws tight?
- Are any wire ends contacting other terminals?

Installing and Wiring Option Boards

◆ Option Board Models and Specifications

Up to three option boards can be mounted in the Inverter. You can mount up one board into each of the three places on the control board (A, C, and D) shown in *Fig 2.24*.

Table 2.14 lists the type of option boards and their specifications.

Table 2.14 Option Board Specifications

Board	Model	Specifications	Mounting Location
PG Speed Control Boards	PG-A2	Serial open-collector/complimentary inputs	A
	PG-B2	Phase A/B complimentary inputs	A
	PG-D2	Single line-driver inputs	A
	PG-X2	Phase A/B line-driver inputs	A
Speed Reference Boards	AI-14U	Input signal levels 0 to 10 V DC (20 kΩ), 1 channel 4 to 20 mA (250 Ω), 1 channel Input resolution: 14-bit	C
	AI-14B	Input signal levels 0 to 10 V DC (20 kΩ) 4 to 20 mA (250 Ω), 3 channels Input resolution: 13-bit with sign bit	C
	DI-08	8-bit digital speed reference setting	C
	DI-16H2	16-bit digital speed reference setting	C
DeviceNet Communication Board	SI-N1	DeviceNet communications support	C
Profibus-DP Communication Board	SI-P1	Profibus-DP communications support	C
InterBus-S Communication Board *	SI-R	InterBus-S communications support	C
CANopen Communication Board *	SI-S1	CANopen communications support	C
CC-Link Communication Board	SI-C	CC-Link communications support	C
LONWORKS Communication Board	SI-J	LONWORKS communications support	C
	SI-W1		
MECHATROLINK Communication Board	SI-T	MECHATROLINK communications support	C
Analog Monitor Board	AO-08	8-bit analog outputs, 2 channels	D
	AO-12	12-bit analog outputs, 2 channels	D
Digital Output Board	DO-08	Six photocoupler outputs and 2 relay outputs	D
	DO-02C	2 relay outputs	D

* Under development

◆ Installation

Before mounting an option board, remove the terminal cover and be sure that the charge indicator inside the Inverter is not lit. After confirming that the charge indicator is not lit, remove the Digital Operator and front cover and then mount the option board.

The side of the front cover of the Inverter for 200/400 V Class 0.4 to 5.5 kW can be cut out as described in *Fig 2.25* to make wiring of the option board easy. If the side of the front cover is cut out, the protective structure will be open chassis (IEC IP00).

Refer to documentation provided with the option board for actual mounting instructions for option slots A, C, and D.

■ Preventing C and D option board Connectors from Rising

After installing an option board into slot C or D, insert an option clip to prevent the side with the connector from rising. The option clip can be easily removed by holding onto the protruding portion of the clip and pulling it out.

Remove the option clip before installing an option board into slot C or D. The option board cannot be installed completely and may not function property if it is installed with the option clip attached.

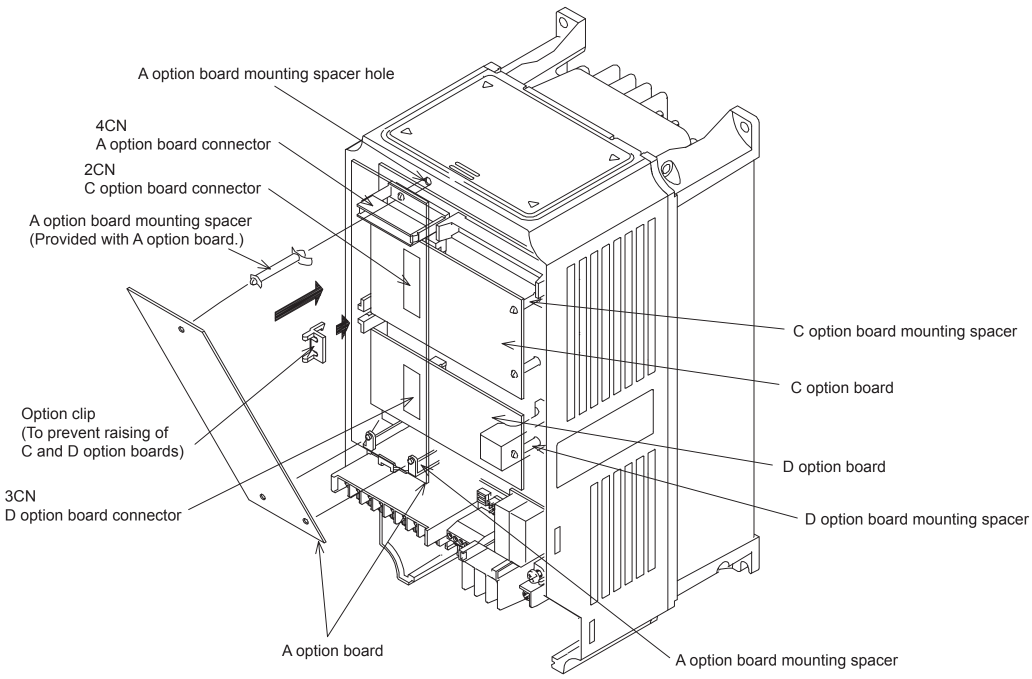


Fig 2.24 Mounting option boards

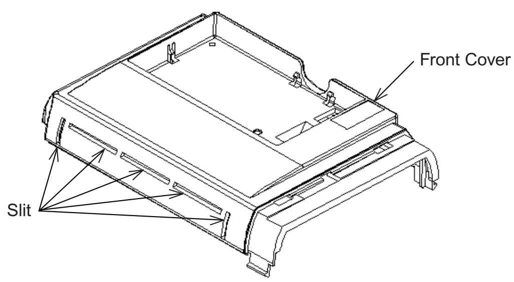


Fig 2.25 Cutting the Front Cover

Cut out the slits on the front cover with nippers. Be careful to avoid injury.

◆ PG Speed Control Board Terminals and Specifications

The terminal specifications for the PG Speed Control Boards are given in the following tables.

■PG-A2

The terminal specifications for the PG-A2 are given in the following table.

Table 2.15 PG-A2 Terminal Specifications

Terminal	No.	Contents	Specifications
TA1	1	Power supply for pulse generator	12 VDC (±5%), 200 mA max.
	2		0 VDC (GND for power supply)
	3	+12 V/open collector switching terminal	Terminal for switching between12 V voltage input and open collector input. For open collector input, short across 3 and 4.
	4		
	5	Pulse input terminal	H: +4 to 12 V; L: +1 V max. (Maximum response frequency: 30 kHz)
	6		Pulse input common
	7	Pulse monitor output terminal	12 VDC (±10%), 20 mA max.
	8		Pulse monitor output common
TA2	(E)	Shield connection terminal	-

■PG-B2

The terminal specifications for the PG-B2 are given in the following table.

Table 2.16 PG-B2 Terminal Specifications

Terminal	No.	Contents	Specifications
TA1	1	Power supply for pulse generator	12 VDC (±5%), 200 mA max.
	2		0 VDC (GND for power supply)
	3	A-phase pulse input terminal	H: +8 to 12 V L: +1 V max. (Maximum response frequency: 30 kHz)
	4		Pulse input common
	5	B-phase pulse input terminal	H: +8 to 12 V L: +1 V max. (Maximum response frequency: 30 kHz)
	6		Pulse input common
TA2	1	A-phase monitor output terminal	Open collector output, 24 VDC, 30 mA max.
	2		A-phase monitor output common
	3	B-phase monitor output terminal	Open collector output, 24 VDC, 30 mA max.
	4		B-phase monitor output common
TA3	(E)	Shield connection terminal	-

■PG-D2

The terminal specifications for the PG-D2 are given in the following table.

Table 2.17 PG-D2 Terminal Specifications

Terminal	No.	Contents	Specifications
TA1	1	Power supply for pulse generator	12 VDC (±5%), 200 mA max.*
	2		0 VDC (GND for power supply)
	3		5 VDC (±5%), 200 mA max.*
	4	Pulse input + terminal	Line driver input (RS-422 level input) Maximum response frequency: 300 kHz
	5	Pulse input - terminal	
	6	Common terminal	-
	7	Pulse monitor output + terminal	Line driver output (RS-422 level output)
	8	Pulse monitor output - terminal	
TA2	(E)	Shield connection terminal	-

* 5 VDC and 12 VDC cannot be used at the same time.

■PG-X2

The terminal specifications for the PG-X2 are given in the following table.

Table 2.18 PG-X2 Terminal Specifications

Terminal	No.	Contents	Specifications
TA1	1	Power supply for pulse generator	12 VDC (±5%), 200 mA max.*
	2		0 VDC (GND for power supply)
	3		5 VDC (±5%), 200 mA max.*
	4	A-phase + input terminal	Line driver input (RS-422 level input) Maximum response frequency: 300 kHz
	5	A-phase - input terminal	
	6	B-phase + input terminal	
	7	B-phase - input terminal	
	8	Z-phase + input terminal	
	9	Z-phase - input terminal	
	10	Common terminal	0 VDC (GND for power supply)
TA2	1	A-phase + output terminal	Line driver output (RS-422 level output)
	2	A-phase - output terminal	
	3	B-phase + output terminal	
	4	B-phase - output terminal	
	5	Z-phase + output terminal	
	6	Z-phase - output terminal	
	7	Control circuit common	Control circuit GND
TA3	(E)	Shield connection terminal	-

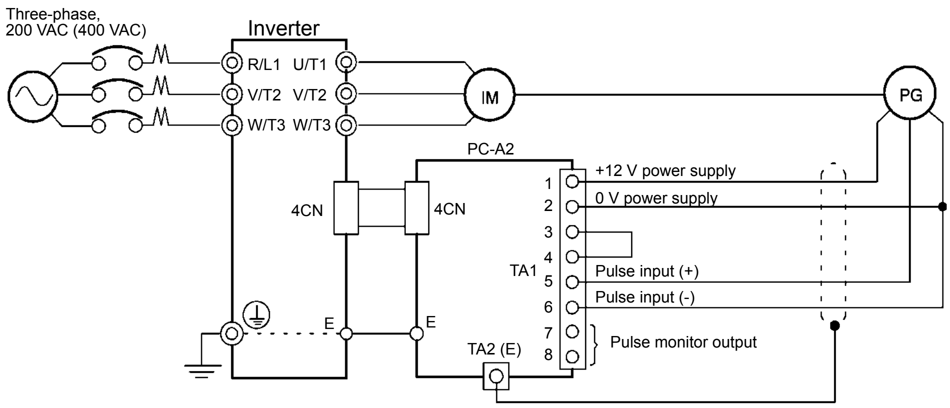
* 5 VDC and 12 VDC cannot be used at the same time.

◆ Wiring

Wiring examples are provided in the following illustrations for the option boards.

■ Wiring the PG-A2

Wiring examples are provided in the following illustrations for the PG-A2.



- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.
- For open collector input, short across 3 and 4.

Fig 2.26 PG-A2 Wiring

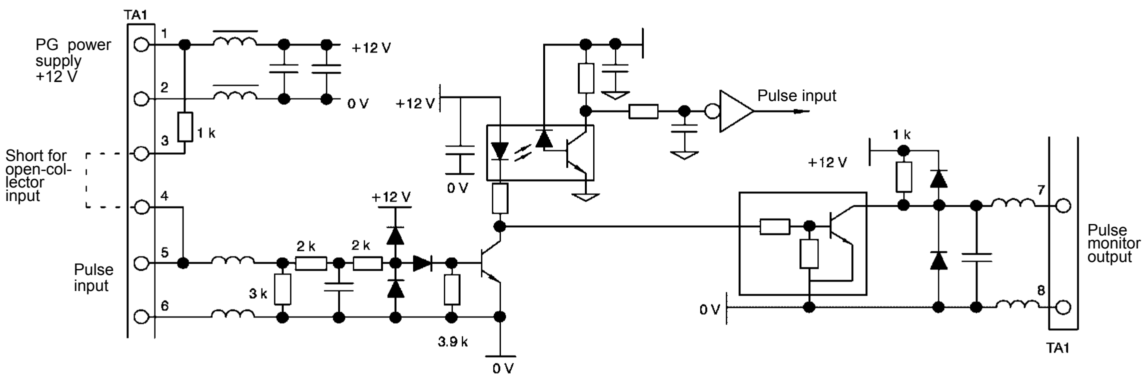
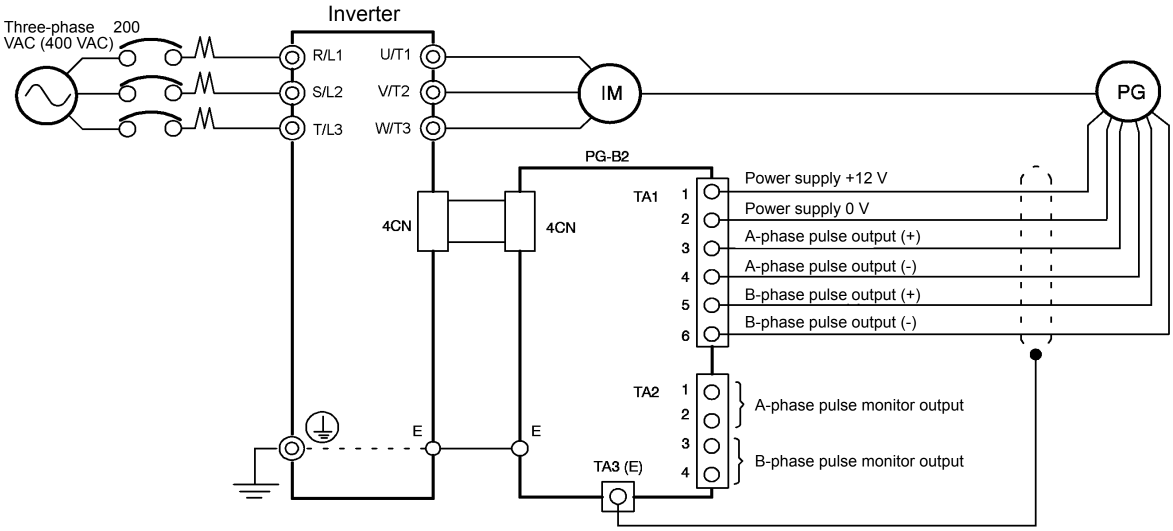


Fig 2.27 I/O Circuit Configuration of the PG-A2

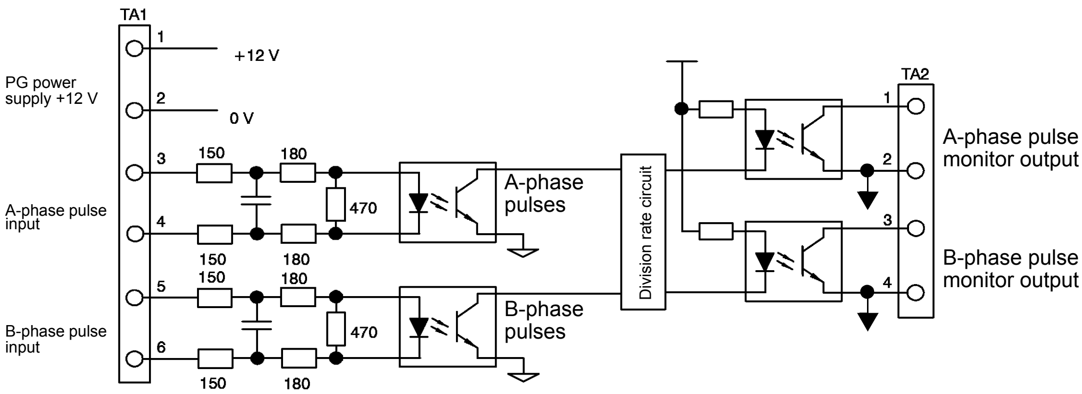
■ Wiring the PG-B2

Wiring examples are provided in the following illustrations for the PG-B2.

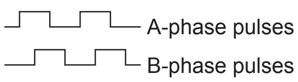


- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.
- The direction of rotation of the PG can be set in user constant F1-05. The factory preset if for forward rotation, A-phase advancement.

Fig 2.28 PG-B2 Wiring



- When connecting to a voltage-output-type PG (encoder), select a PG that has an output impedance with a current of at least 12 mA to the input circuit photocoupler (diode).
- The pulse monitor dividing ratio can be changed using constant F1-06 (PG division rate).

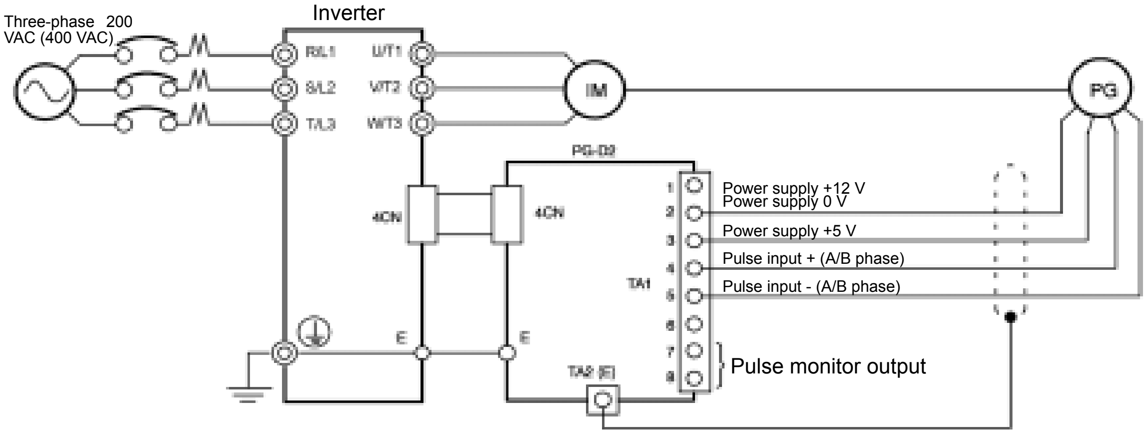


- The pulse monitor emitter is connected to common inside the PG-B2. The emitter common must be used for external circuits.

Fig 2.29 I/O Circuit Configuration of the PG-B2

■Wiring the PG-D2

Wiring examples are provided in the following illustrations for the PG-D2.

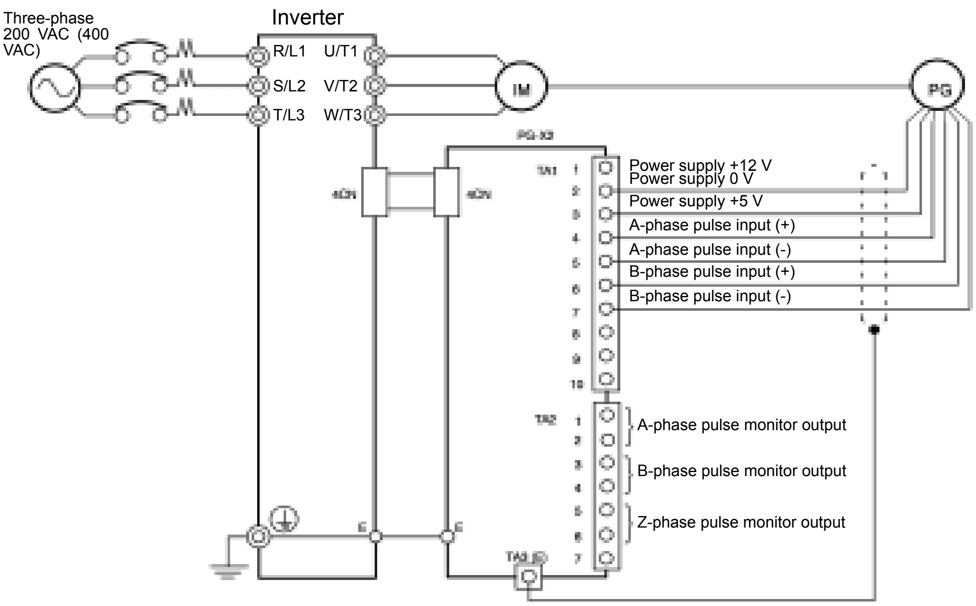


- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.

Fig 2.30 PG-D2 Wiring

■Wiring the PG-X2

Wiring examples are provided in the following illustrations for the PG-X2.



- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.
- The direction of rotation of the PG can be set in user constant F1-05 (PG Rotation). The factory preset if for motor forward rotation, A-phase advancement.

Fig 2.31 PG-X2 Wiring

◆ Wiring Terminal Blocks

Use no more than 100 meters of wiring for PG (encoder) signal lines, and keep them separate from power lines.

Use shielded, twisted-pair wires for pulse inputs and pulse output monitor wires, and connect the shield to the shield connection terminal.

■Wire Sizes (Same for All Models)

Terminal wire sizes are shown in *Table 2.19*.

Table 2.19 Wire Sizes

Terminal	Terminal Screws	Wire Thickness (mm^2)	Wire Type
Pulse generator power supply Pulse input terminal Pulse monitor output terminal	-	Stranded wire: 0.5 to 1.25 Single wire: 0.5 to 1.25	• Shielded, twisted-pair wire • Shielded, polyethylene-covered, vinyl sheath cable (KPEV-S by Hitachi Electric Wire or equivalent)
Shield connection terminal	M3.5	0.5 to 2	

■Straight Solderless Terminals for Control Circuit Terminals

We recommend using straight solderless terminal on signal lines to simplify wiring and improve reliability.

Refer to *Table 2.10 Straight Solderless Terminal Sizes* for specifications.

■Closed-loop Connector Sizes and Tightening Torque

The closed-loop connectors and tightening torques for various wire sizes are shown in *Table 2.20*.

Table 2.20 Closed-loop Connectors and Tightening Torques

Wire Thickness [mm^2]	Terminal Screws	Crimp Terminal Size	Tightening Torque (N • m)
0.5	M3.5	1.25 - 3.5	0.8
0.75		1.25 - 3.5	
1.25		1.25 - 3.5	
2		2 - 3.5	

■Wiring Method and Precautions

The wiring method is the same as the one used for straight solderless terminals. Refer to page 2-24. Observe the following precautions when wiring.

- Separate the control signal lines for the PG Speed Control Board from main circuit lines and power lines.
- Connect the shield when connecting to a PG. The shield must be connected to prevent operational errors caused by noise. Also, do not use any lines that are more than 100 m long. Refer to *Fig 2.23* for details on connecting the shield.
- Connect the shield to the shield terminal (E).
- Do not solder the ends of wires. Doing so may cause contact faults.
- When not using straight solderless terminals, strip the wires to a length of approximately 5.5 mm.

◆ Selecting the Number of PG (Encoder) Pulses

The setting for the number of PG pulses depends on the model of PG Speed Control Board being used. Set the correct number for your model.

■PG-A2/PG-B2

The maximum response frequency is 32,767 Hz.

Use a PG that outputs a maximum frequency of approximately 20 kHz for the rotational speed of the motor.

$$\frac{\text{Motor speed at maximum frequency output (min}^{-1})}{60} \times \text{PG rating (p/rev)} = 20{,}000\ \text{Hz}$$

Some examples of PG output frequency (number of pulses) for the maximum frequency output are shown in *Table 2.21*.

Table 2.21 PG Pulse Selection Examples

Motor's Maximum Speed (min^{-1})	PG Rating (p/rev)	PG Output Frequency for Maximum Frequency Output (Hz)
1800	600	18,000
1500	600	15,000
1200	900	18,000
900	1200	18,000

Note 1. The motor speed at maximum frequency output is expressed as the sync rotation speed.
2. The PG power supply is 12 V.
3. A separate power supply is required if the PG power supply capacity is greater than 200 mA. (If momentary power loss must be handled, use a backup capacitor or other method.)

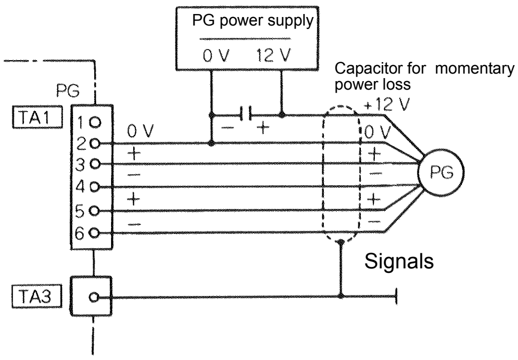


Fig 2.32 PG-B2 Connection Example

■PG-D2/PG-X2

There are 5 V and 12 V PG power supplies.
Check the PG power supply specifications before connecting.

The maximum response frequency is 300 kHz.

Use the following equation to computer the output frequency of the PG (f_{PG}).

$$f_{PG}(\mathrm{Hz}) = \frac{\text{Motor speed at maximum frequency output (min}^{-1}\text{)}}{60} \times \text{PG rating (p/rev)}$$

A separate power supply is required if the PG power supply capacity is greater than 200 mA. (If momentary power loss must be handled, use a backup capacitor or other method.)

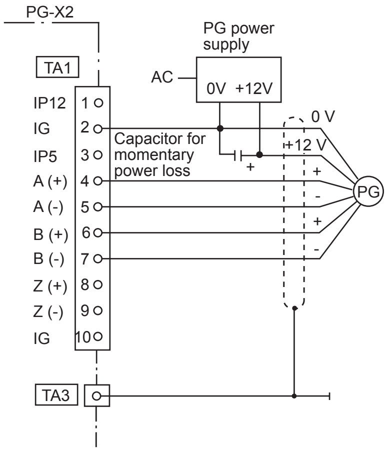


Fig 2.33 PG-X2 Connection Example (for 12 V PG power supply)

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

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.

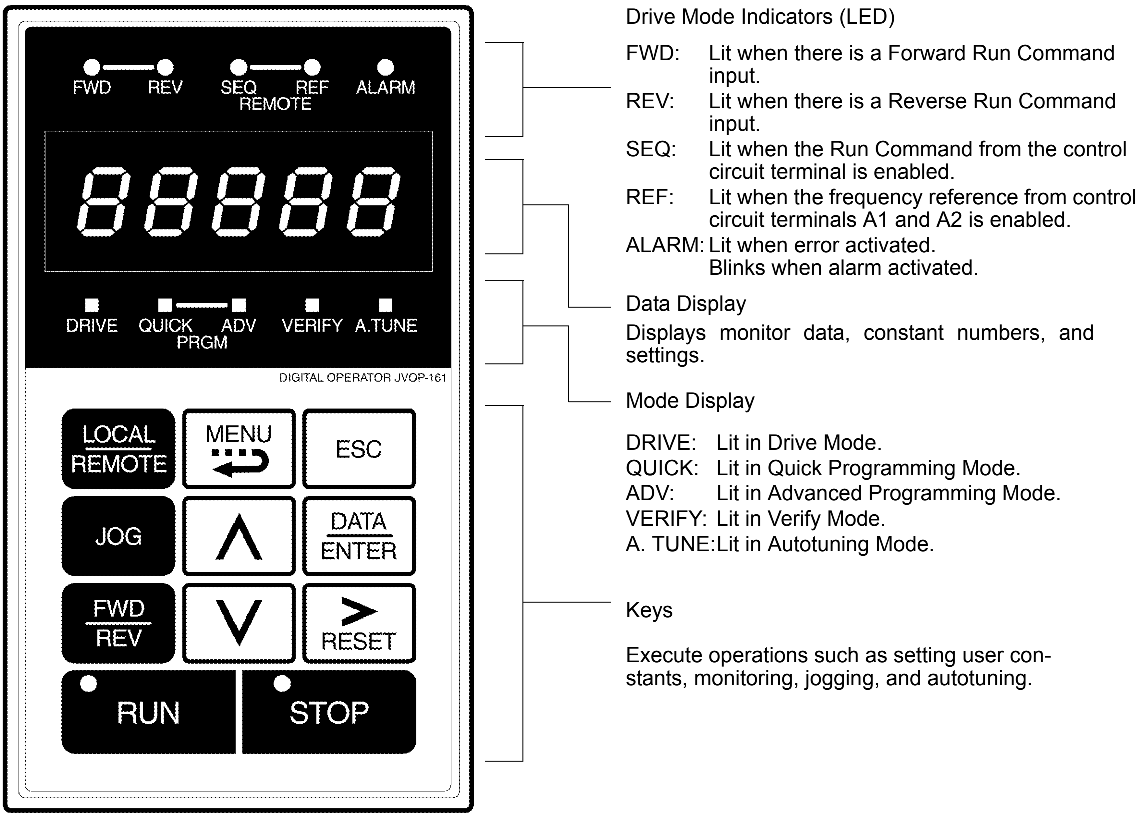


Fig 3.1 Digital Operator Component Names and Functions

◆ 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 via the Digital Operator (LOCAL) and control circuit terminal operation (REMOTE). This Key can be enabled or disabled by setting 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, sets user constant numbers, and increments set values. Used to move to the next item or data.
∨	Decrement Key	Selects menu items, 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, user constants, and set values. Also used to switch from one screen to another. Constants cannot be changed when Undervoltage (UV) is detected.
RUN	RUN Key	Starts the Inverter operation when the Inverter is being controlled by the Digital Operator.
STOP	STOP Key	Stops Inverter operation. This Key can be enabled or disabled when operating from the control circuit terminal by setting user constant o2-02.

Note Except in diagrams, Keys are referred to using the Key names listed in the above table.

3

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.

The RUN Key indicator will flash and the STOP Key indicator will light during initial excitation of the dynamic brake. The relationship between the indicators on the RUN and STOP Keys and the Inverter status is shown in the *Fig 3.2*.

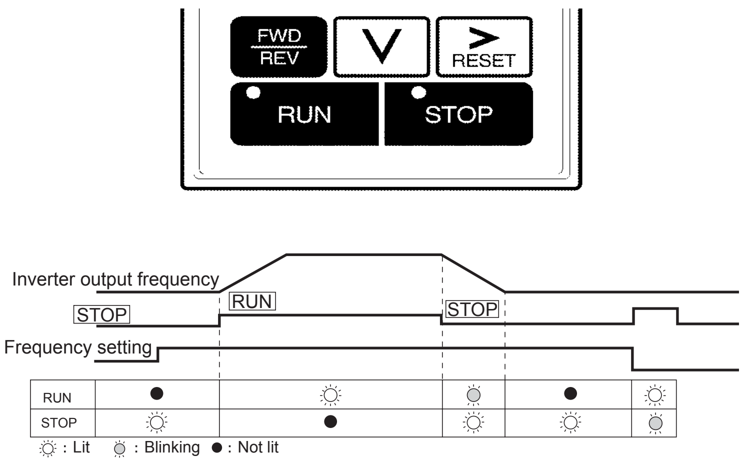


Fig 3.2 RUN and STOP Indicators

The following table shows the relationship between the indicators on the RUN and STOP Keys and the Inverter conditions.

The indicators are lit, unlit or blinking reflecting the order of priority.

Table 3.2 Relation of Inverter to RUN and STOP Indicators

Priority	RUN Indicator	STOP Indicator	Inverter Status	Conditions
1	●	●	Stopped	Power supply is shut down.
2	●	◎	Stopped*	Emergency stop • Stop Command is sent from the Digital Operator when the control circuit terminals were used to operate the Inverter. • Emergency Stop Command is sent from the control circuit terminal. Switched from LOCAL (operation using the Digital Operator) to REMOTE (operation using the control circuit terminals) when the Run Command is sent from the external terminal. Switched from the Quick or Advanced Quick programming mode to the Drive mode when the Run Command is sent from the external terminal.
3	☼	◎	Stopped	The Inverter is run at a frequency below the minimum output frequency. The Run Command is carried out when the External Baseblock Command using the multi-function contact input terminal is issued.
4	●	☼	Stopped	Stopped
5	◎	☼	Running	During deceleration to a stop During DC injection braking when using the multi-function contact input terminal. During initial excitation of DC injection braking while the Inverter is stopped.
6	◎	◎	Running	During emergency deceleration • Stop Command is sent from the Digital Operator when operating the Inverter using the control circuit terminals. • Emergency Stop Command is sent from the control circuit terminal.
7	☼	●	Running	Run Command is issued. During initial excitation of DC injection braking when starting the Inverter.

Note ☼: Lit ◎: Blinking ●: Not lit

* If planning to run the Inverter again, first turn OFF the Run Command and Emergency Stop Command from the control circuit terminal and send the Run Command.

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 3.3*.

Table 3.3 Modes

Mode	Primary function(s)
Drive mode	The Inverter can be run in this mode. Use this mode when monitoring values such as frequency references or output current, displaying fault information, or displaying the fault history.
Quick programming mode	Use this mode to reference and set the minimum user constants to operate the Inverter (e.g., the operating environment of the Inverter and Digital Operator).
Advanced programming mode	Use this mode to reference and set all user constants.
Verify mode	Use this mode to read/set user constants that have been changed from their factory-set values.
Autotuning mode*	Use this mode when running a motor with unknown motor constants in the vector control method. The motor constants are calculated and set automatically. This mode can also be used to measure only the motor line-to-line resistance.

* Always perform autotuning with the motor before operating using vector control. Autotuning mode will not be displayed during operation or when an error has occurred. The factory setting of the Inverter is A1-02 = 0 for V/f control.

◆ Switching Modes

The mode selection display will appear when the MENU Key is pressed from a monitor or setting display. Press the MENU Key from the mode selection display to switch between the modes.

Press the DATA/ENTER Key from the mode selection key to monitor data and from a monitor display to access the setting display.

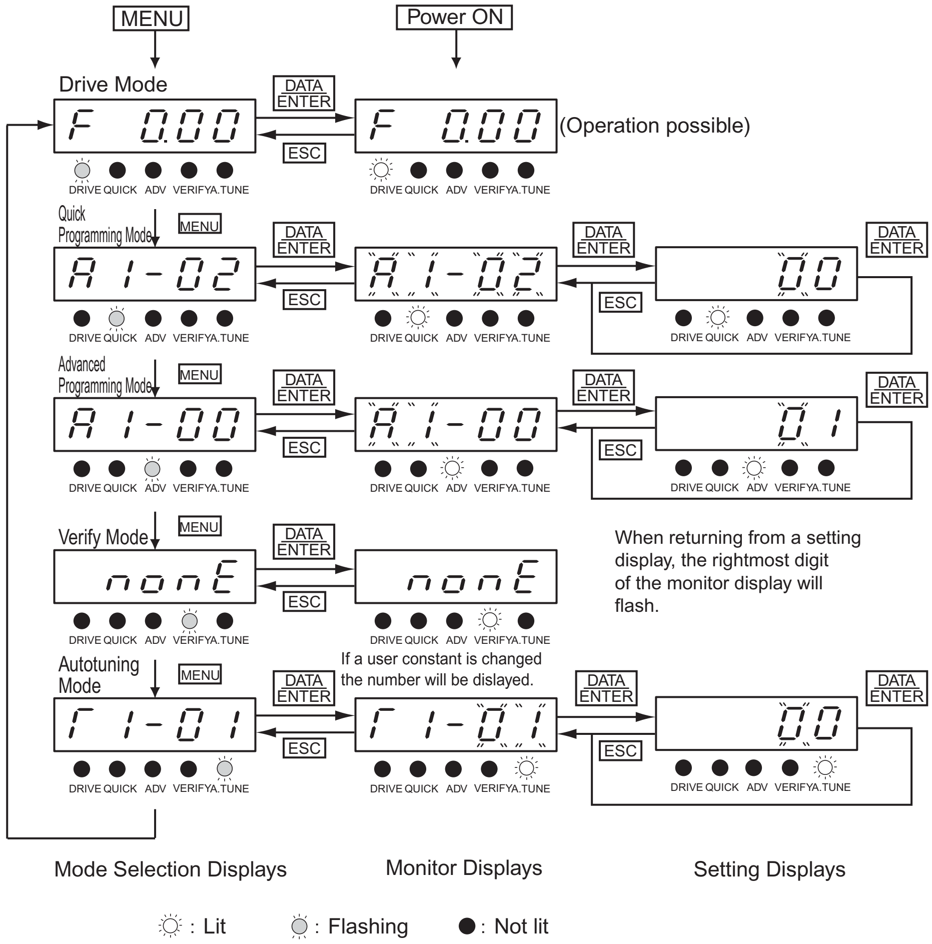


Fig 3.3 Mode Transitions

IMPORTANT

When running the Inverter after using Digital Operator, press the MENU Key to enter the drive mode (DRIVE indicator will flash) and then press the DATA/ENTER Key from the drive mode display to bring up the monitor display (DRIVE indicator will light). Run Commands can't 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 frequency reference, output frequency, output current, and output voltage, as well as fault information and the fault history.

When b1-01 (Reference selection) is set to 0, the frequency can be changed from the frequency setting display. Use the Increment, Decrement, and Shift/RESET Keys to change the frequency. 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.

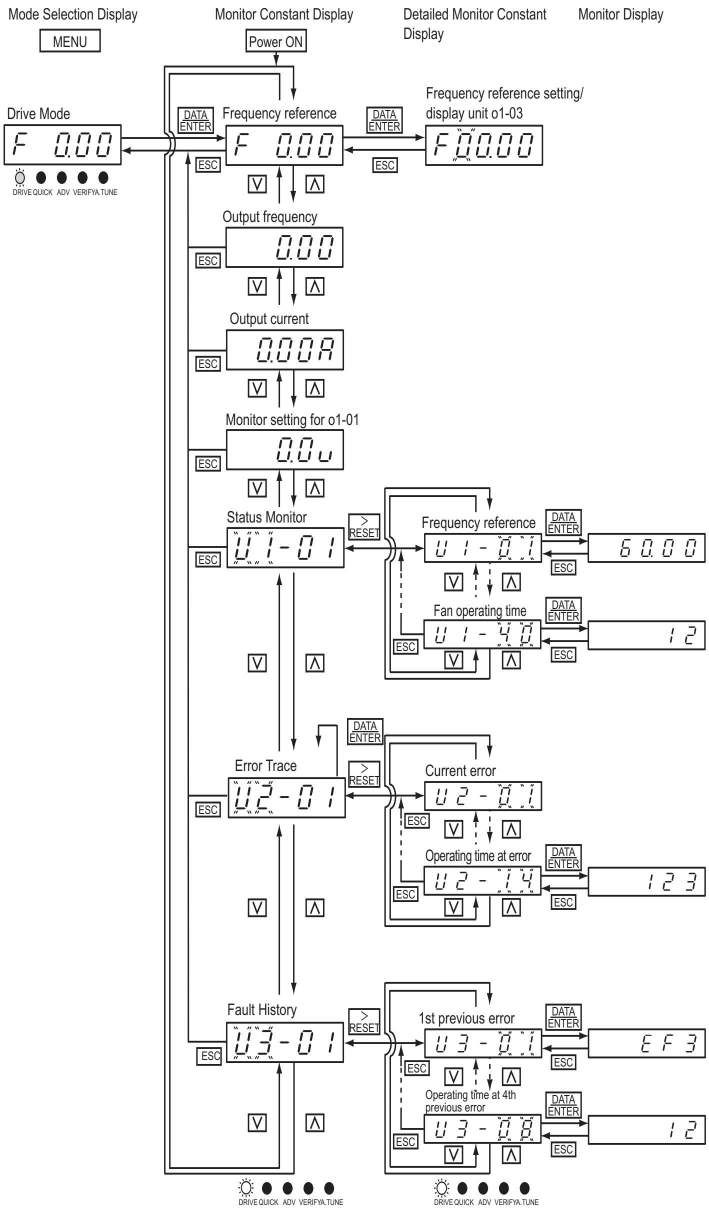


Fig 3.4 Operations in Drive Mode

IMPORTANT

The display for the first monitor constant (frequency reference) will be displayed when power is turned ON. The monitor item displayed at startup can be set in o1-02 (Monitor Selection after Power Up).
Operation cannot be started from the mode selection display.

3

◆ 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 setting displays. Use the Increment, Decrement, and Shift/RESET Keys to change the frequency. 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.

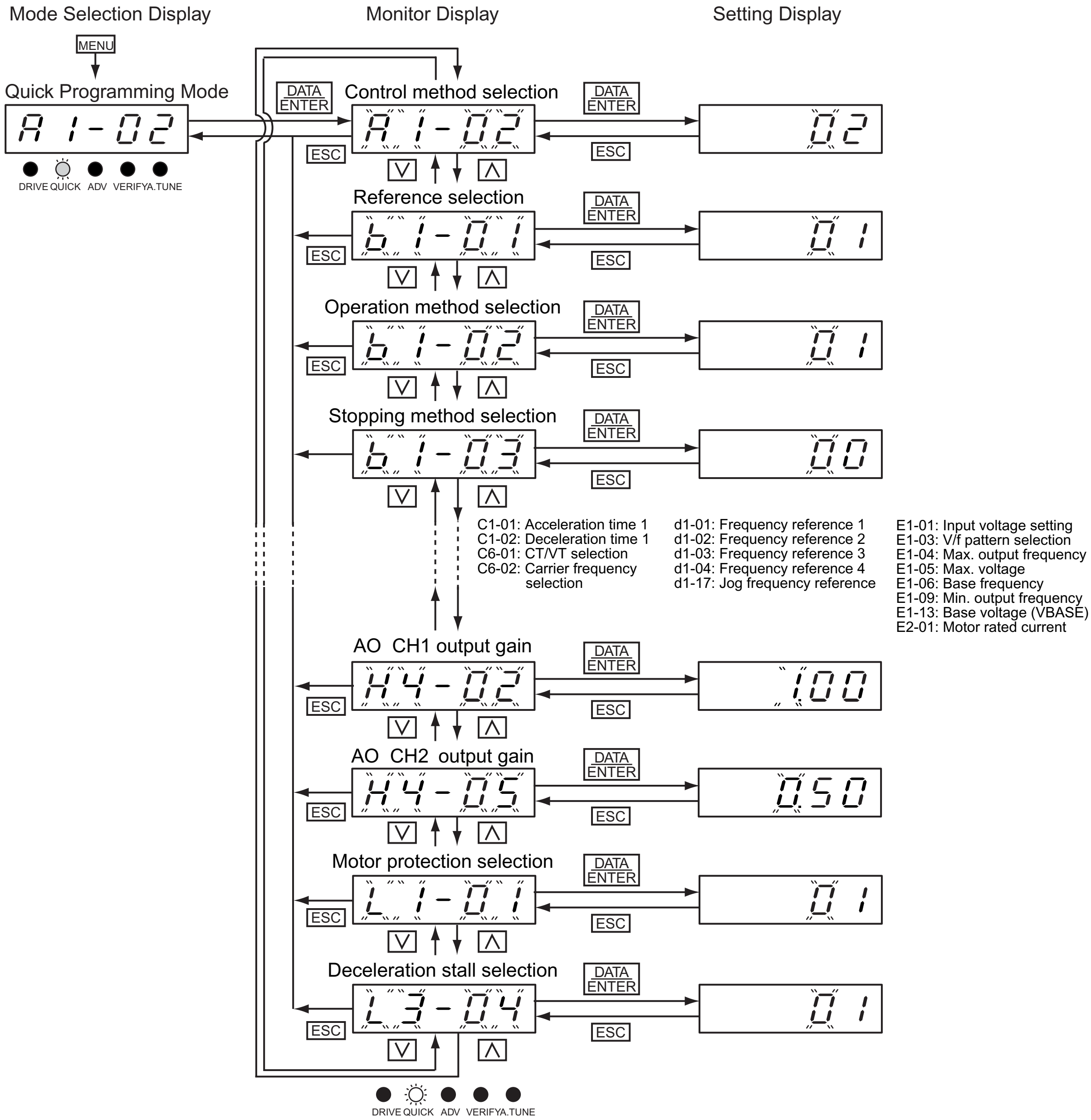


Fig 3.5 Operations in Quick Programming Mode

◆ Advanced Programming Mode

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

Constants can be changed from the setting displays. Use the Increment, Decrement, and Shift/RESET Keys to change the frequency. 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.

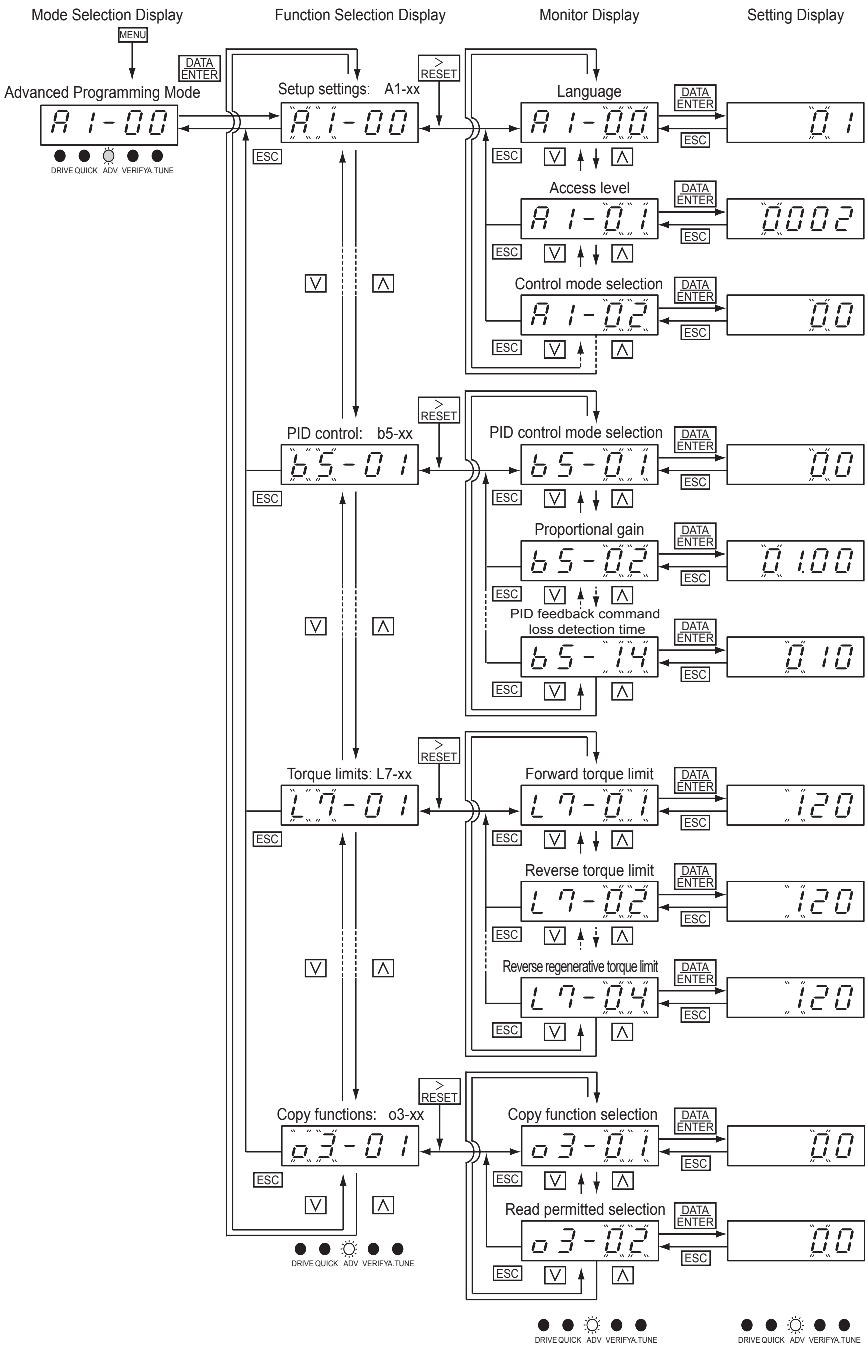
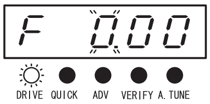
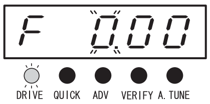
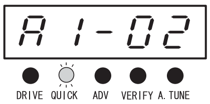
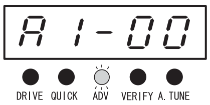
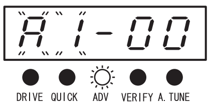
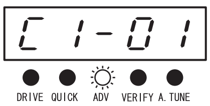
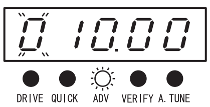
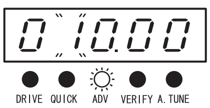
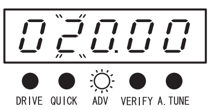
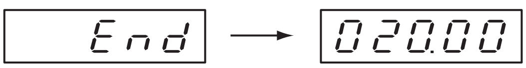
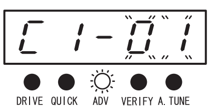


Fig 3.6 Operations in Advanced Programming Mode

■Setting User Constants

Here, the procedure is shown to change C1-01 (Acceleration Time 1) from 10 s to 20 s.

Table 3.4 Setting User Constants in Advanced Programming Mode

Step No.	Digital Operator Display	Description
1		Power supply turned ON.
2		MENU Key pressed to enter drive mode.
3		MENU Key pressed to enter quick programming mode.
4		MENU Key pressed to enter advanced programming mode.
5		DATA/ENTER pressed to access monitor display.
6		Increment or Decrement Key pressed to display C1-01 (Acceleration Time 1).
7		DATA/ENTER Key pressed to access setting display. The setting of C1-01 (10.00) is displayed.
8		Shift/RESET Key pressed to move the flashing digit to the right.
9		Increment Key pressed to change set value to 20.00 s.
10		DATA/ENTER Key pressed to enter the set data. “END” is displayed for 10 s and then the entered value is displayed for 0.5 s.
11		The monitor display for C1-01 returns.

◆ Verify Mode

Verify mode is used to display any constants that have been changed from their default settings in a programming mode or by autotuning. “None” will be displayed if no settings have been changed.

Of the environment mode settings, only A1-02 will be displayed if it has been changed. Other environment modes settings will not be displayed even if they have been changed from their default settings.

Even in verify mode, the same procedures can be used to change settings as are used in the programming modes. Use the Increment, Decrement, and Shift/RESET Keys to change the frequency. 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

An example of key operations is given below for when the following settings have been changed from their default settings: b1-01 (Reference Selection), C1-01 (Acceleration Time 1), E1-01 (Input Voltage Setting), and E2-01 (Motor Rated Current).

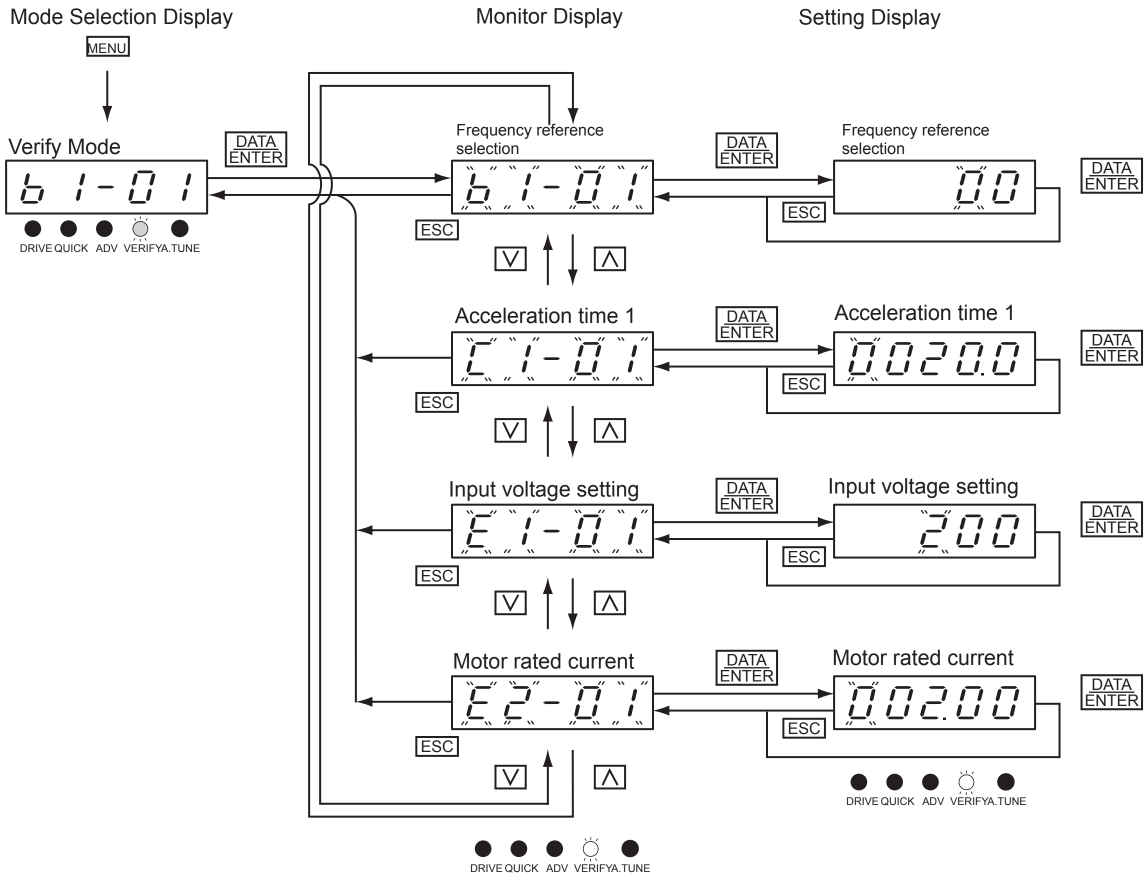


Fig 3.7 Operations in Verify Mode

◆ Autotuning Mode

Autotuning automatically tunes and sets the required motor constants when operating in the vector control method. Always perform autotuning before starting operation.

When V/f control has been selected, stationary autotuning for only line-to-line resistance can be selected.

When the motor cannot be disconnected from the load, perform stationary autotuning. Contact your Yaskawa representatives to set motor constants by calculation.

The Inverter's autotuning function automatically determines the motor constants, while a servo system's autotuning function determines the size of a load, so these autotuning functions are fundamentally different.

The factory setting of the Inverter is A1-02 = 0 for V/f control.

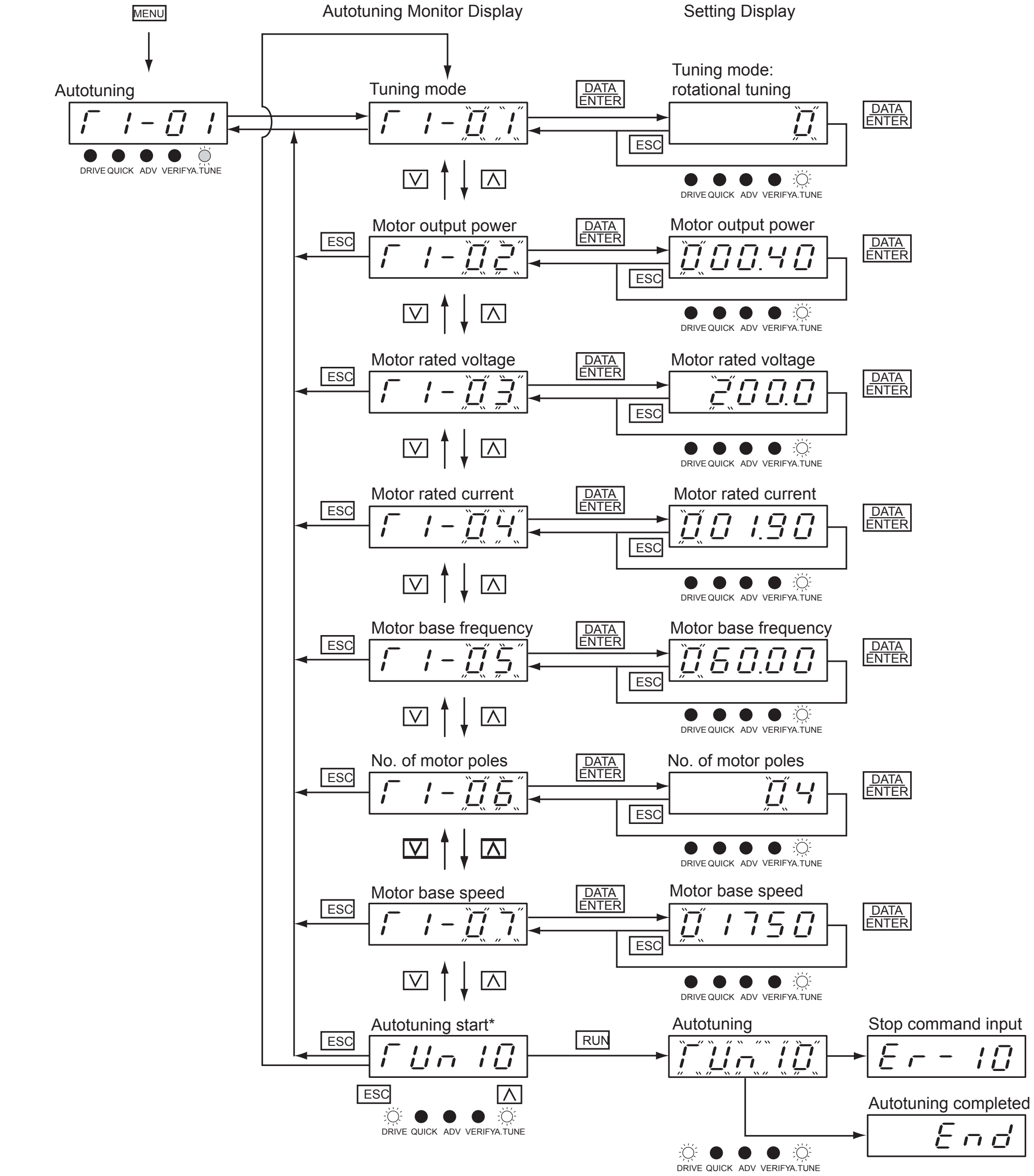
■Example of Operation

Set the motor output power (in kW), rated voltage, rated current, rated frequency, rated speed, and number of poles specified on the nameplate on the motor and then press the RUN Key. The motor is automatically run and the motor constants measured based on these settings and autotuning will be set.

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

Constants can be changed from the setting displays. Use the Increment, Decrement, and Shift/RESET Keys to change the frequency. 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 without switching to motor 2.



* TUn10 will be displayed during rotational autotuning and TUn11 will be displayed during stationary autotuning. The DRIVE indicator will light when autotuning starts.

Fig 3.8 Operation in Autotuning Mode

IMPORTANT

If a fault occurs during autotuning, refer to *Chapter 7 Troubleshooting*.

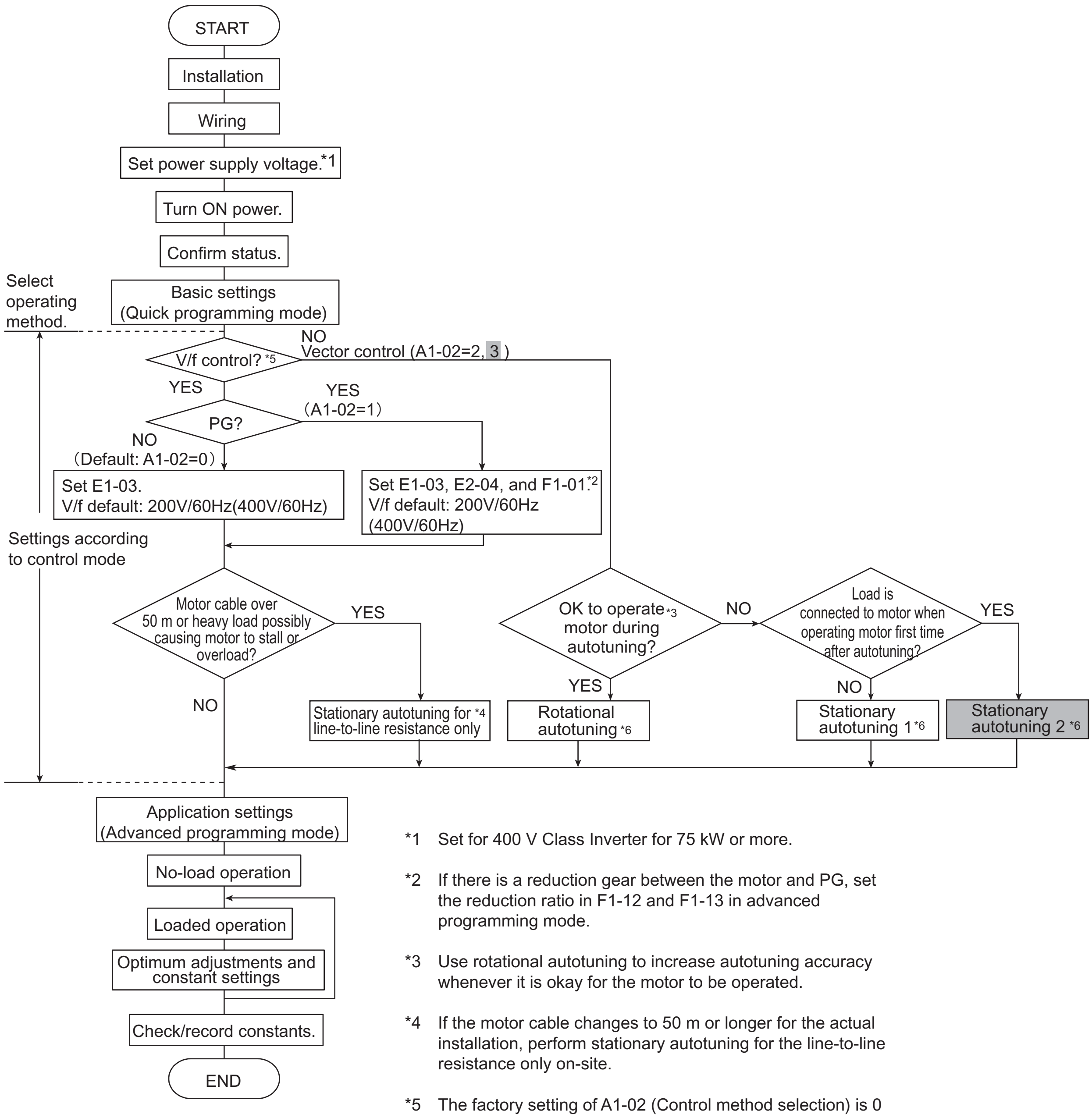
4

Trial Operation

This chapter describes the procedures for trial operation of the Inverter and provides an example of trial operation.

Overview of Trial Operation Procedure

Perform trial operation according to the following flowchart. When setting the basic user constants, always set C6-01 (CT/VT Selection) according to the application.



*1 Set for 400 V Class Inverter for 75 kW or more.

*2 If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13 in advanced programming mode.

*3 Use rotational autotuning to increase autotuning accuracy whenever it is okay for the motor to be operated.

*4 If the motor cable changes to 50 m or longer for the actual installation, perform stationary autotuning for the line-to-line resistance only on-site.

*5 The factory setting of A1-02 (Control method selection) is 0 (V/f control).

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

Fig 4.1 Trial Operation Flowchart

Trial Operation Procedures

The procedure for the trial operate is described in order in this section.

◆ Application Confirmation

First, confirm the application before using the Inverter.

- Fan, blower, pump
- Other equipment

For any Inverter application other than a fan, blower, or pump, set C6-01 (CT/VT Selection) to 0 (CT: low carrier, constant torque). The default setting is 1 (VT: high carrier, variable torque) for Inverters with SPEC: C or earlier and 0 (CT: low carrier, constant torque) for Inverters with SPEC: E or later.
However, only 1(VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters with any SPEC.

◆ Setting the Power Supply Voltage Jumper (400 V Class Inverters of 75 kW or Higher)

Set the power supply voltage jumper after setting E1-01 (Input Voltage Setting) for 400 V Class Inverters of 75 kW or higher. Insert the jumper into the power tap nearest to the actual power supply voltage. If the wrong connector is selected, the Inverter may be damaged.

The jumper is factory-set to 440 V when shipped. If the power supply voltage is not 440 V, use the following procedure to change the setting.

1. Turn OFF the power supply and wait for at least 5 minutes.
2. Confirm that the CHARGE indicator has gone out.
3. Remove the terminal cover.
4. Insert the jumper at the position for the voltage supplied to the Inverter (see *Fig 4.2*).
5. Return the terminal cover to its original position.

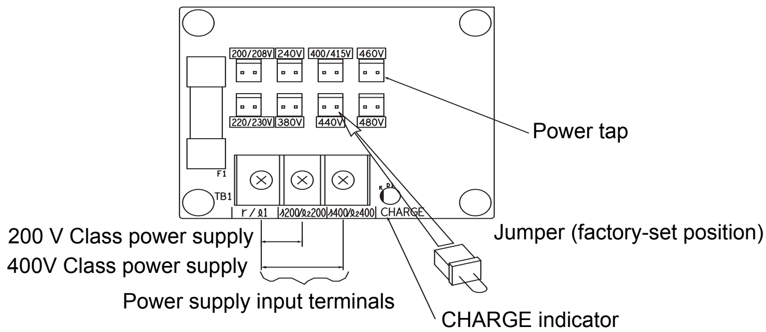


Fig 4.2 Power Supply Voltage Jumper

◆ Power ON

Confirm all of the following items and then turn ON the power supply.

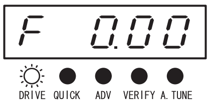
1. Check that the power supply is of the correct voltage.
   200V Class: 3-phase 200 to 240 VAC 50/60 Hz
   400V Class: 3-phase 380 to 480 VAC 50/60 Hz
   For an Inverter of 200 V, 37 kW or more, use one of the following power supplies for the cooling fan.
   3-phase 200/208/220 VAC 50 Hz or 3-phase 200/208/220/230 VAC 60 Hz

2. Make sure that the motor output terminals (U, V, W) and the motor are connected correctly.
3. Make sure that the Inverter control circuit terminal and the control device are wired correctly.
4. Set all Inverter control circuit terminals to turn OFF.
5. When using a PG speed control board, make sure that it is wired correctly.
6. Make sure that the motor is not connected to the mechanical system. (No-load condition)

◆ Checking the Display Status

If the Digital Operator's display at the time the power is connected is normal, it will read as follows:

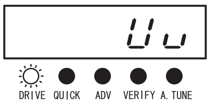
Display for normal operation



The frequency reference monitor is displayed in the data display section.

When an fault has occurred, the details of the fault will be displayed instead of the above display. In that case, refer to *Chapter 7 Troubleshooting*. The following display is an example of a display for faulty operation.

Display for fault operation



The display will differ depending on the type of fault.
A low voltage alarm is shown at left.

◆ Basic Settings

Switch to the quick programming mode (the QUICK indicator on the Digital Operation should be lit) 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 the user constants.

Constants that must be set are listed in *Table 4.1* and those that are set according to the application are listed in *Table 4.2*.

Table 4.1 Basic Settings of Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Page
A1-02	Control method selection	Set the control method for the Inverter. 0: V/f control 1: V/f control with PG 2: Open-loop vector control 3: Flux vector control	0 to 2 0 to 3	0	5-8
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	5-10 6-6 6-79 6-98
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	5-10 6-15 6-79 6-98
C1-01	Acceleration time 1	Set the acceleration time in seconds for the output frequency to climb from 0% to 100%.	0.0 to 6000.0 s *1	10.0 s	5-20 6-25
C1-02	Deceleration time 1	Set the deceleration time in seconds for the output frequency to fall from 100% to 0%.	0.0 to 6000.0 s *1	10.0 s	5-20 6-25
C6-01	CT/VT selection	Set to CT (not low noise, maximum current overload: 150%) or VT (low noise, maximum current overload:120%). 0: CT 1: VT	0 or 1	1*2 0*2	5-25 6-2
E1-01	Input voltage setting	Set the Inverter's nominal input voltage in volts. This setting is used as a reference value in protection functions.	155 to 255 V (200 V Class) 310 to 510 V (400 V Class)	200 V (200 V Class) 400 V (400 V Class)	5-32 6-122
E2-01	Motor rated current	Set the motor rated current.	10% to 200% of Inverter's rated current	Setting for general-purpose motor of same capacity as Inverter	5-34 6-60 6-120

Table 4.1 Basic Settings of Constants (Continued)

Constant Number	Name	Description	Setting Range	Factory Setting	Page
L1-01	Motor protection selection	Set to enable or disable the motor overload protection function using the electronic thermal relay. 0: Disabled 1: General motor protection 2: Inverter motor protection 3: Vector motor protection	0 to 3	1	5-55 6-60

* 1. The setting range for acceleration/deceleration times will depends on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times becomes 0.00 to 600.00 seconds.

* 2. Only 1(VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.

IMPORTANT

When C6-01 is set to 0 (CT), non-low noise will apply and the Inverter overload withstand ratio will be 150% of the Inverter rating per minute. When C6-01 is set to 1 (VT), low noise will apply and the Inverter overload withstand ratio will be 120% of the Inverter rating per minute. If C6-01 is set to 1 (VT) when overload withstand capability is required by the application, the life of the Inverter may be reduced.

Table 4.2 Constants That Are Set As Required

Constant Number	Name	Description	Setting Range	Factory Setting	Page
b1-03	Stopping method selection	Select stopping method when Stop Command is sent. 0: Deceleration to stop 1: Coast to stop 2: DC braking stop 3: Coast to stop with timer	0 to 3 *1	0	5-10 6-17
C6-02	Carrier frequency selection	The carrier frequency is set low if the motor cable is 50 m or longer or to reduce radio noise or leakage current. The factory setting and setting range depends on the setting of C6-01.	0, 1 (C6-01=0) 0 to F (C6-01=1)	0, 1 (C6-01=0) 6*2 (C6-01=1)	5-25 6-2
d1-01 to d1-04 and d1-17	Frequency references 1 to 4 and jog frequency reference	Set the required speed references for multi-step speed operation or jogging.	0.00 to 400.00 *3*4 0.00 to 300.00 *3*5	d1-01 to d1-04: 0.00 Hz d1-17: 6.00 Hz	5-26 6-10
H4-02 and H4-05	FM and AM terminal output gain	Set the voltage level gain for the multi-function analog output 1 (H4-02) and 2 (H4-05). Set the number of multiples of 10 V to be output as the 100% output for the monitor item.	0.00 to 2.50	H4-02: 1.00 H4-05: 0.50	5-52
L3-04	Stall prevention selection during deceleration	0: Disabled (Deceleration as set. If deceleration time is too short, a main circuit overvoltage may result.) 1: Enabled (Deceleration is stopped when the main circuit voltage exceeds the overvoltage level. Deceleration restarts when voltage is returned.) 2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that the Inverter can decelerate in the shortest possible time. Set deceleration time is disregarded.) 3: Enabled (with Braking Resistor Unit) When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3.	0 to 3 *6	1	5-59 6-32

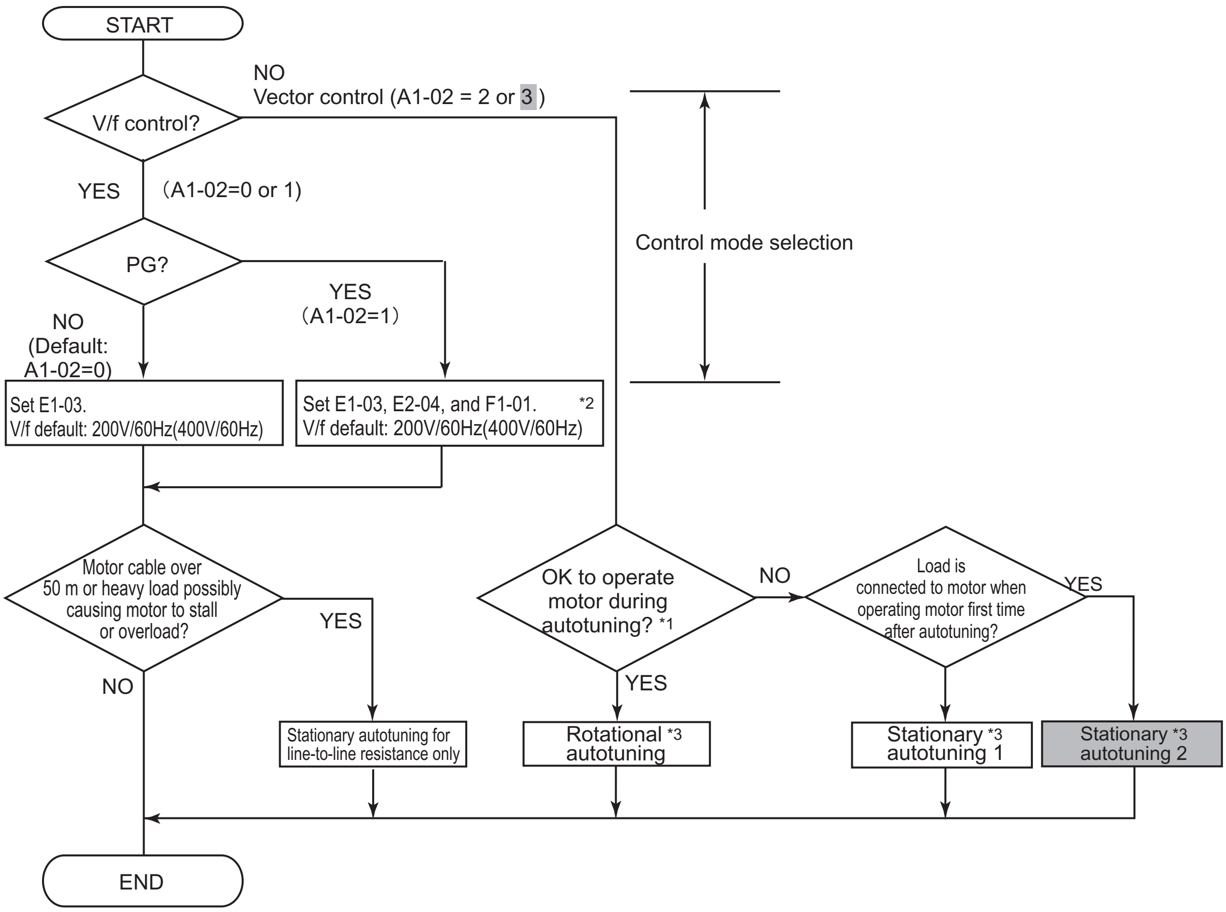
* 1. 0 or 1 for flux vector control.
* 2. The factory setting depends on the capacity of the Inverter.
* 3. The upper limit of the setting range depends on the upper limit set in E1-04.
* 4. When C6-01 = 0, the upper limit is 150.00.
* 5. When C6-01 = 1, the upper limit is 400.00.
* 6. When using flux vector control, 0 to 2.

◆ Settings for the Control Methods

Autotuning methods depend on the control method set for the Inverter. Make the settings required by the control method.

■Overview of Settings

Make the required settings in quick programming mode and autotuning mode according to the following flowchart.



Note If the motor cable changes to 50 m or longer for the actual installation, perform stationary autotuning for the line-to-line resistance only on-site.
* 1. Use rotational autotuning to increase autotuning accuracy whenever it is okay for the motor to be operated.
* 2. If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13.
* 3. If the maximum output frequency is different from the base frequency, set the maximum output frequency (E1-04) to the value of the base frequency after autotuning.

Fig 4.3 Settings According to the Control Method

4

■Setting the Control Method

Any of the following four control methods can be set.

Control Method	Constant Setting	Basic Control	Main Applications
V/f control	A1-02 = 0 (factory setting)	Voltage/frequency ratio fixed control	Variable speed control, particularly control of multiple motors with one Inverter and replacing existing Inverters
V/f control with PG	A1-02 = 1	Voltage/frequency ratio fixed control with speed compensation using a PG	Applications requiring high-precision speed control using a PG on the machine side
Open-loop vector control	A1-02 = 2	Current vector control without a PG	Variable speed control, applications requiring speed and torque accuracy using vector control without a PG
Flux vector control	A1-02 = 3	Flux vector control	Very high-performance control with a PG (simple servo drives, high-precision speed control, torque control, and torque limiting)

Note With vector control, the motor and Inverter must be connected 1:1. The motor capacity for which stable control is possible is 50% to 100% of the capacity of the Inverter.

V/f Control (A1-02 = 0)

- Set either one of the fixed patterns (0 to E) in E1-03 (V/f Pattern Selection) or set F in E1-03 to specify a user-set pattern as required for the motor and load characteristics in E1-04 to E1-13 in advanced programming mode.

Simple operation of a general-purpose motor at 50 Hz:	E1-03 = 0
Simple operation of a general-purpose motor at 60 Hz:	E1-03 = F (default) or 1 If E1-03 = F, the default setting in the user setting from E1-04 to E1-13 are for 60 Hz

- Perform stationary autotuning for the line-to-line resistance only if the motor cable is 50 m or longer for the actual installation or the load is heavy enough to produce stalling. Refer to the following section on *Autotuning* for details on stationary autotuning.

V/f Control with PG (A1-02=1)

- Set either one of the fixed patterns (0 to E) in E1-03 (V/f Pattern Selection) or set F in E1-03 to specify a user-set pattern as required for the motor and load characteristics in E1-04 to E1-13 in advanced programming mode.

Simple operation of a general-purpose motor at 50 Hz:	E1-03 = 0
Simple operation of a general-purpose motor at 60 Hz:	E1-03 = F (default) or 1 If E1-03 = F, the default setting in the user setting from E1-04 to E1-13 are for 60 Hz

- Set the number of motor poles in E2-04 (Number of Motor Poles)
- Set the number of rotations per pulse in F1-01 (PG Constant). If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13 in advanced programming mode.
- Perform stationary autotuning for the line-to-line resistance only if the motor cable is 50 m or longer for the actual installation or the load is heavy enough to produce stalling. Refer to the following section on *Autotuning* for details on stationary autotuning.

Open-loop Vector Control (A1-02 = 2)

Perform autotuning. If the motor can be operated, perform rotational autotuning. If the motor cannot be operated, perform stationary autotuning 1 or 2. Refer to the following section on *Autotuning* for details on autotuning.

Flux Vector Control (A1-02 = 3)

Perform autotuning. If the motor can be operated, perform rotational autotuning. If the motor cannot be operated, perform stationary autotuning 1 or 2. Refer to the following section on *Autotuning* for details on autotuning.

◆ Autotuning

Use the following procedure to perform autotuning if using the vector control method or the cable length is long, etc. Motor constants will be set automatically.

If the control method was changed after autotuning, be sure to perform autotuning again.

One of the following four autotuning modes can be set.

- Rotational autotuning
- Stationary autotuning 1
- Stationary autotuning for line-to-line resistance only
- Stationary autotuning 2

■ Precautions Before Using Autotuning

Read the following precautions before using autotuning.

- Autotuning the Inverter is fundamentally different from autotuning the servo system. Inverter autotuning automatically adjusts parameters according to detected motor constants, whereas servo system autotuning adjusts parameters according to the detected size of the load.
- When speed or torque precision is required at high speeds (i.e., 90% of the rated speed or higher), use a motor with a rated voltage that is 20 V less than the input power supply voltage of the Inverter for 200V-class Inverters and 40 V less for 400V-class Inverters. If the rated voltage of the motor is the same as the input power supply voltage, the voltage output from the Inverter will be unstable at high speeds and sufficient performance will not be possible.
- Use stationary autotuning 1 or 2 whenever performing autotuning for a motor that is connected to a load.
- Use rotational autotuning whenever performing autotuning for a motor that has fixed output characteristics, when high precision is required, or for a motor that is not connected to a load.
- If rotational autotuning is performed for a motor connected to a load, the motor constants will not be found accurately and the motor may exhibit abnormal operation. Never perform rotational autotuning for a motor connected to a load.
- If the wiring between the Inverter and motor changes by 50 m or more between autotuning and motor installation, perform stationary autotuning for line-to-line resistance only.
- If the motor cable is long (50 m or longer), perform stationary autotuning for line-to-line resistance only even when using V/f control.
- The status of the multi-function inputs and multi-function outputs will be as shown in the following table during autotuning. When performing autotuning with the motor connected to a load, be sure that the holding brake is not applied during autotuning, especially for conveyor systems or similar equipment.

Tuning Mode	Multi-function Inputs	Multi-function Outputs
Rotational autotuning	Do not function.	Same as during normal operation
Stationary autotuning 1	Do not function.	Maintain same status as when autotuning is started.
Stationary autotuning for line-to-line resistance only	Do not function.	Maintain same status as when autotuning is started.
Stationary autotuning 2	Do not function.	Maintain same status as when autotuning is started.

- To cancel autotuning, always use the STOP Key on the Digital Operator.
- Power will be supplied to the motor when stationary autotuning is performed even though the motor will not turn. Do not touch the motor until autotuning has been completed.

■Setting the Autotuning Mode

Rotational Autotuning (T1-01 = 0)

Rotational autotuning is used for open-loop vector control and flux vector control. Set T1-01 to 0, input the data from the nameplate, and then press the RUN Key on the Digital Operator. The Inverter will stop the motor for approximately 1 minute and then set the required motor constants automatically while operating the motor for approximately 1 minute.

IMPORTANT

1. Always disconnect the motor from the machine and confirm that it is safe to operate the motor before performing rotational autotuning.
2. If the motor cannot be operated by itself, perform stationary autotuning, but always use rotational autotuning whenever it is possible to operate the motor by itself to increase performance.

Stationary Autotuning 1 (T1-01 = 1)

Stationary autotuning1 is used for open-loop vector control and flux vector control. Set T1-01 to 1, input the data from the nameplate, and then press the RUN Key on the Digital Operator. The Inverter will supply power to the stationary motor for approximately 1 minute and some of the motor constants will be set automatically. The remaining motor constants E2-02 (motor rated slip) and E2-03 (motor no-load current) will be set automatically the first time operation is started in drive mode. To perform an operation immediately after stationary autotuning1, use the following procedure under the recommended conditions.

1. Check the values of E2-02 and E2-03 in verify mode or advanced programming mode.
2. Run the motor once in drive mode under the following conditions.
   - The Inverter and the motor are connected.
   - The motor shaft is not locked with a mechanical brake or other stopping mechanism (or function).
   - A motor-load ratio of 30% or less is maintained.
   - A speed of 30% or more of the base frequency set at E1-06 (default = highest frequency) is maintained at a constant speed for one second or more.
3. After stopping the motor, check the values of E2-02 and E2-03 again in verify mode or advanced programming mode. If the values of E2-02 and E2-03 differ from the ones before the first operation was carried out, the settings have been successfully completed. Next, check if the values are suitable or not.

If the values of E2-02 and E2-03 differed greatly from the reference data of the motor in the test report or the instruction manual, hunting, motor vibrations, insufficient motor torque, or an overcurrent may occur because the motor is operated although the aforementioned conditions have not been fulfilled after stationary autotuning1. For elevators, failure to observe this caution may result in the cage falling or injury. If so, perform stationary autotuning1 again and run the motor using the aforementioned procedure under the recommended conditions or perform stationary autotuning 2 or rotational autotuning.

Usually the standard setting for E2-02 is 1 Hz to 3 Hz, and that for E2-03 is 30% to 65% of the rated current for a general-purpose motor. Generally, the larger the motor capacity is, the smaller the rated slip and the ratio of the no-load current to the rated current become. Use the data given in *Factory Settings that Change with the Inverter Capacity (o2-04)* of *Chapter 5 User Constants* as a reference.

IMPORTANT

1. Power will be supplied to the motor when stationary autotuning 1 is performed even though the motor will not turn. Do not touch the motor until autotuning has been completed.
2. When performing stationary autotuning 1 connected to a conveyor or other machine, ensure that the holding brake is not activated during autotuning.

Stationary Autotuning for Line-to-Line Resistance Only (T1-01 = 2)

Stationary autotuning for line-to-line resistance only can be used in any control method. This is the only autotuning possible for V/f control and V/f control with PG modes.

Autotuning can be used to prevent control errors when the motor cable is long (50 m or longer) or the cable length has changed since installation or when the motor and Inverter have different capacities.

Set T1-01 to 2, and then press the RUN Key on the Digital Operator. The Inverter will supply power to the stationary motor for approximately 20 seconds and the Motor Line-to-Line Resistance (E2-05) and cable resistance will be automatically measured.

IMPORTANT

1. Power will be supplied to the motor when stationary autotuning for line-to-line resistance is performed even though the motor will not turn. Do not touch the motor until autotuning has been completed.
2. When performing stationary autotuning connected to a conveyor or other machine, ensure that the holding brake is not activated during autotuning.

Stationary Autotuning 2 (T1-01 = 4)

If using Inverters for applications with constant loads such as for elevators, or with a motor load ratio exceeding 30% at startup, and rotational autotuning without loads cannot be performed, perform stationary autotuning 2 (T1-01=4).

Stationary autotuning 2 is used for open-loop vector control and flux vector control. Set T1-04 to 4, and Motor no-load current (T1-09) will be added as a setting item. Input the data from the nameplate. Be sure to input the value or motor no-load current (motor exciting current) from motor examination results to T1-09. After autotuning, the value of T1-09 will be written in E2-03. When not setting T1-09, the value of Yaskawa standard motor's no-load current will be written in E2-03.

IMPORTANT

1. Power will be supplied to the motor when stationary autotuning 2 is performed even though the motor will not turn. Do not touch the motor until autotuning has been completed.
2. When performing stationary autotuning 2 connected to a conveyor or other machine, ensure that the holding brake is not activated during autotuning.

■Precautions for Rotational and Stationary Autotuning

Lower the base voltage based on *Fig 4.4* to prevent saturation of the Inverter's output voltage when the rated voltage of the motor is higher than the voltage of the power supply to the Inverter. Use the following procedure to perform autotuning.

1. Input the voltage of the input power supply to T1-03 (Motor rated voltage).
2. Input the results of the following formula to T1-05 (Motor base frequency):
   (Base frequency from the motor's nameplate × setting of T1-03)/(Rated voltage from motor's nameplate)

3. Perform autotuning.

After having completed autotuning, set E1-04 (Max. output frequency) to the base frequency shown on the motor nameplate.

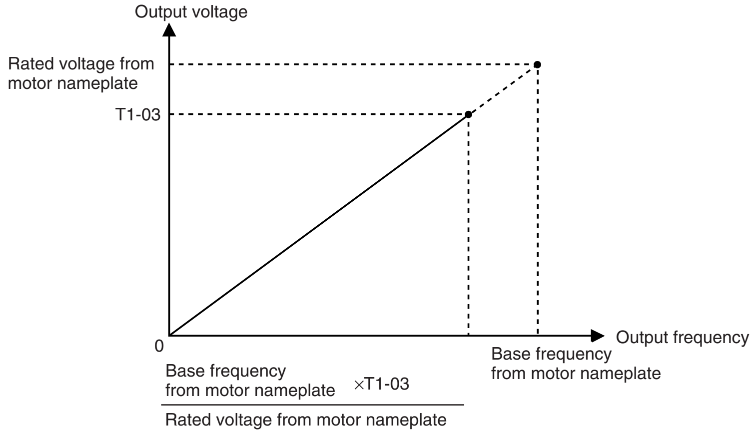


Fig 4.4 Motor Base Frequency and Inverter Input Voltage Setting

IMPORTANT

1. When speed precision is required at high speeds (i.e., 90% of the rated speed or higher), set T1-03 (Motor rated voltage) to the input power supply voltage × 0.9.
2. When operating at high speeds (i.e., 90% of the rated speed or higher), the output current will increase as the input power supply voltage is reduced. Be sure to provide sufficient margin in the Inverter current.

■Precautions after Using Rotational and Stationary Autotuning

After completing autotuning, set E1-04 (Max. output frequency) to the base frequency from the motor's nameplate.

In stationary autotuning1, when the motor is first operated in the drive mode after tuning, the remaining motor constants E2-02 (Motor rated slip) and E2-03 (Motor no-load current) are set automatically. To perform an operation immediately after stationary autotuning 1, use the following procedure under the recommended conditions.

1. Check the values of E2-02 and E2-03 in verify mode or advanced programming mode.
2. Run the motor once in drive mode under the following conditions.
   - The Inverter and the motor are connected.
   - The motor shaft is not locked with a mechanical brake or other stopping mechanism (or function).
   - A motor-load ratio of 30% or less is maintained.
   - A speed of 30% or more of the base frequency set at E1-06 (default = highest frequency) is maintained at a constant speed for one second or more.
3. After stopping the motor, check the values of E2-02 and E2-03 again in verify mode or advanced programming mode. If the values of E2-02 and E2-03 differ from the ones before the first operation was carried out, the settings have been successfully completed. Next, check if the values are suitable or not.

If the values of E2-02 and E2-03 differed greatly from the reference data of the motor in the test report or the instruction manual, hunting, motor vibrations, insufficient motor torque, or an overcurrent may occur because the motor is operated although the aforementioned conditions have not been fulfilled after stationary autotuning 1. For elevators, failure to observe this caution may result in the cage falling or injury. If so, perform stationary autotuning 1 again and run the motor using the aforementioned procedure under the recommended conditions or perform stationary autotuning 2 or rotational autotuning.

Usually the standard setting for E2-02 is 1Hz to 3Hz, and that for E2-03 is 30% to 65% of the rated current for a general-purpose motor. Generally, the larger the motor capacity is, the smaller the rated slip and the ratio of the no-load current to the rated current become. Use the data given in *Factory Settings that Change with the Inverter Capacity (o2-04)* of *Chapter 5 User Constants* as a reference.

■ Constant Settings for Autotuning

The following constants must be set before autotuning.

Table 4.3 Constant Settings before Autotuning

Constant Number	Name	Display	Setting Range	Factory Setting	Data Displays during Autotuning			
					V/f	V/f with PG	Open Loop Vector	Flux Vector
T1-00	Motor 1/2 selection*1	When switching to motor 2 is selected, set the motor for which autotuning is to be performed. (This constant is ignored if motor 2 is not selected.) 1: Motor 1 2: Motor 2	1 or 2	1	Yes	Yes	Yes	Yes
T1-01	Autotuning mode selection	Set the autotuning mode. 0: Rotational autotuning 1: Stationary autotuning 1 2: Stationary autotuning for line-to-line resistance only 4: Stationary autotuning 2	0 to 2 *9 0 to 2, 4 *9	2 *2	Yes (only for 2)	Yes (only for 2)	Yes	Yes
T1-02	Motor output power	Set the output power of the motor in kilowatts.*3 *5	0. 00 to 650.00 kW	0.40 kW *6	Yes	Yes	Yes	Yes
T1-03	Motor rated voltage	Set the rated voltage of the motor in volts.*3 *4	0.0 to 255.0 V (200 V Class) 0.0 to 510.0 V (400 V Class)	200.0 V (200 V Class) 400.0 V (400 V Class)	-	-	Yes	Yes
T1-04	Motor rated current	Set the rated current of the motor in amps.*3 *5	0.32 to 6.40 A *10	1.90 A *6	Yes	Yes	Yes	Yes
T1-05	Motor base frequency	Set the base frequency of the motor in hertz.*3 *4	0.0 to 400.0 Hz *7 0.0 to 300.0 Hz *11	60.0 Hz	-	-	Yes	Yes
T1-06	Number of motor poles	Set the number of motor poles.	2 to 48 poles	4 poles	-	-	Yes	Yes
T1-07	Motor base speed	Set the base speed of the motor in min^{-1}.*3	0 to 24000	1750 min^{-1}	-	-	Yes	Yes
T1-08	Number of PG pulses when turning	Set the number of pulses for the PG (pulse generator or encoder). Set the number of pulses per motor revolution without a multiplication factor.	0 to 60000	600	-	Yes	-	Yes
T1-09	Motor no-load current	Set the current value recorded in the motor's test results for a motor without a load. Displayed only when Stationary autotuning 2 is selected (T1-01 = 4).	0.00 to 1.89 *8	1.20A *6	No	No	No	Yes

* 1. Not normally displayed. Displayed only when a motor switch command is set for a multi-function digital input (one of H1-01 to H1-06 set to 16).
* 2. The factory setting will change when the control method is changed. The V/f control factory setting is given.
* 3. For a constant-output motor, set the value at the base speed.

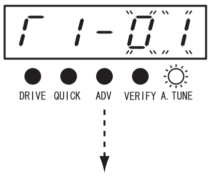
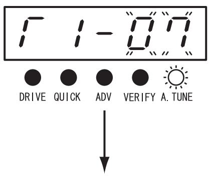
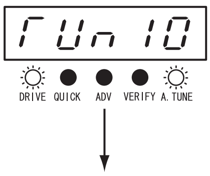
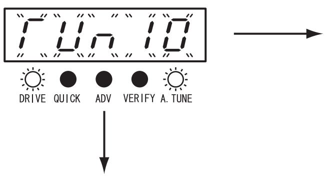
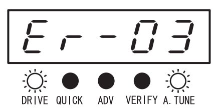
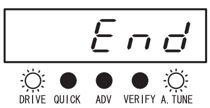
4

* 4. For an Inverter motor or vector motor, the voltage and frequency may be lower than for a general-purpose motor. Always confirm setting on the name-plate or in test reports. Also, if you know the no-load values, set the no-load voltage in T1-03 and the no-load frequency in T1-05 to obtain better accuracy.
* 5. Stable vector control will be possible when the setting is between 50% and 100% of Inverter rating.
* 6. The factory setting depends on the Inverter capacity. The values for a 200 V Class Inverter for 0.4 kW are given.
* 7. When C6-01=0, the upper limit is 150.00.
* 8. The setting range depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given. The upper limit depends on the setting of E2-01.
* 9. Set T1-02 and T1-04 when 2 is set for T1-01. Only set value 2 is possible for V/f control or V/f control with PG.
* 10.The setting range is from 10% to 200% of the Inverter rated output current. The value for a 200 V Class Inverter for 0.4 kW is given.
* 11.When C6-01=1, the upper limit is 400.00.

■Digital Operator Displays during Autotuning

The following displays will appear on the Digital Operator during autotuning.

Table 4.4 Digital Operator Displays during Autotuning

Digital Operator Display	Description
Autotuning mode selection: T1-01 	Using the same procedures as for the programming modes check and set the T1 constants according to information on the previous page. Be sure that T1-01 (Autotuning Mode Selection) is set correctly and check safety around the motor and machine.
Motor base speed: T1-07 (For rotational autotuning) 	The autotuning start display will appear when all settings through T1-07 have been completed. The A.TUNE and DRIVE indicators will be lit. If using stationary autotuning 2, all settings through T1-09 are to be set.
Autotuning started: TUn10 	Autotuning will start when the RUN Key is pressed from the autotuning start display. The digit second from the right in TUn□□ is the Motor 1/2 Selection (T1-00) and the right digit is the Autotuning Mode Selection (T1-01).
Autotuning Stop Command input 	If the STOP Key is pressed or a measurement error occurs during autotuning, and error message will be display and autotuning will be stopped. Refer to *Errors during Autotuning* on page 7-18.
Autotuning completed 	END will be displayed after approximately 1 to 2 minutes, indicating that autotuning has been completed.

■Precautions After Using Autotuning

For a fixed output region, the V/f pattern for the maximum point in the output region must be set after completing autotuning. To increase the motor's rated speed by 1 to 1.2 times or when using a fixed output motor, make the following changes after autotuning. Do not change E1-06 (Base frequency) or E1-13 (Base voltage).

Increasing the Motor's Rated Speed by 1 to 1.2 Times

To increase the motor's rated speed by 1 to 1.2 times, use the following formula to change the setting of E1-04 (Maximum output frequency):

E1-04 = (Motor's rated speed) × (No. of motor poles)/120 (Hz) × (1 to 1.2)

If the motor's speed is increased beyond the rated speed, fixed output characteristics will be used at high speeds and motor torque will be reduced.

Applications to Constant Output Motors Such as Motors for Machine Tools

Use the following formula to change the settings of E1-04 (Maximum output frequency) and E1-05 (Maximum frequency) when using a motor with a fixed output, e.g., a motor for a machine tool:

E1-04 = Frequency (Hz) at maximum speed under no-load conditions (load rate = 0)
E1-05 = Voltage (V) at maximum speed under no-load conditions (load rate = 0)

Do not change the E2 motor constants after performing autotuning.

■ Precautions for Precision Settings

Settings for autotuning are different when performing autotuning using motor test reports or design data. Use the following table as reference.

Operator Display	Simple Setting	Precision Setting
T1-03	Motor rated voltage	Voltage under no-load conditions at motor rated speed
T1-05	Motor base frequency	Frequency under no-load conditions at rated speed

◆ Application Settings

User constants are set as required in advanced programming mode (i.e., with the ADV indicator lit on the Digital Operator). All the constants that can be set in quick programming mode can also be displayed and set in advanced programming mode.

■Setting Examples

The following are examples of settings for applications.

- When using an Inverter-mounted braking resistor (ERF), set L8-01 to 1 to enable ERF braking resistor overheating protection.
- To prevent the machine from being operated in reverse, set b1-04 to 1 to disable reverse operation.
- To increase the speed of a 60 Hz motor by 10%, set E1-04 to 66.0 Hz.
- To use a 0 to 10-V analog signal for a 60 Hz motor for variable-speed operation between 0 and 54 Hz (0% to 90% speed deduction), set H3-02 to 90.0%.
- To control speed between 20% and 80% to ensure smooth gear operation and limit the maximum speed of the machine, set d2-01 to 80.0% and set d2-02 to 20.0%.

◆ No-load Operation

To being no-load operation (without connecting the machine and the motor), press the LOCAL/REMOTE Key on the Digital Operator to change to LOCAL mode (the SEQ and REF indicators on the Digital Operator should be OFF).

Always confirm safety around the motor and machine before starting Inverter operation from the Digital Operator. Confirm that the motor works normally and that no errors are displayed at the Inverter.

Jog Frequency Reference (d1-17, default: 6.00 Hz) can be started and stopped by pressing and releasing the JOG Key on the Digital Operator. If the external sequence prevent operation from the Digital Operator, confirm that emergency stop circuits and machine safety mechanisms are functioning, and then start operation in REMOTE mode (i.e., with a signal from the control signal terminals). The safety precautions must always be taken before starting the Inverter with the motor connected to the machine.

INFO

Both a Run Command (forward or reverse) and a frequency reference (or multi-step speed reference) must be provided to start Inverter operation.
Input these commands and reference regardless of the operation method (i.e., LOCAL of REMOTE).

◆ Loaded Operation

Connect the machine to the motor and then start operation as described for no-load operation (i.e., from the Digital Operator or by using control circuit terminal signals).

■Connecting the Load

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

■Operation using the Digital Operator

- Use the Digital Operator to start operation in LOCAL mode in the same way as in no-load operation.
- If fault occurs during operation, make sure the STOP Key on the Digital Operator is easily accessible.
- At first, set the frequency reference to a low speed of one tenth the normal operating speed.

■ Checking Operating Status

- Having checked that the operating direction is correct and that the machine is operating smoothly at slow speed, increase the frequency reference.
- After changing the frequency reference or the rotation direction, check that there is no oscillation or abnormal sound from the motor. Check the monitor display to ensure that U1-03 (Output Current) is not too high.
- Refer to *Adjustment Suggestions* on page 4-18 if hunting, vibration, or other problems originating in the control system occur.

◆ Check and Recording User Constants

Use verify mode (i.e., when the VERIFY indicator on the Digital Operator is lit) to check user constants that have been changed for trial operation and record them in a user constant table.

Any user constants that have been change by autotuning will also be displayed in verify mode.

If required, the copy function in constants o3-01 and o3-02 displayed in advanced programming mode can be used to copy the changed settings from the Inverter to a recording area in the Digital Operator. If changed settings are saved in the Digital Operator, they can be easily copied back to the Inverter to speed up system recovery if for any reason the Inverter has to be replaced.

The following functions can also be used to manage user constants.

- Recording user constants
- Setting access levels for user constants
- Setting a password

■ Recording User Constants (o2-03)

If o2-03 is set to 1 after completing trial operation, the settings of user constants will be saved in a separate memory area in the Inverter. Later, after Inverter settings have been changed, the user constants can be initialized to the settings saved in the separate memory area when o2-03 was set to 1 by setting A1-03 (Initialize) to 1110.

■User Constant Access Levels (A1-01)

A1-01 can be set to 0 (monitoring-only) to prevent user constants from being changed. A1-01 can also be set to 1 (User-specified Constants) and used along with A2 constants to display only constants required by the machine or application in a programming mode.

■Password (A1-04 and A1-05)

When the access level is set to monitoring-only (A1-01 = 0), a password can be set so that user constants will be displayed only when the correct password is input.

Adjustment Suggestions

If hunting, vibration, or other problems originating in the control system occur during trial operation, adjust the constants listed in the following table according to the control method. This table lists only the most commonly used user constants.

Table 4.5 Adjusted User Constants

Control Method	Name (Constant Number)	Performance	Factory Setting	Recom-mended Setting	Adjustment Method
V/f control (A1-02 = 0 or 1)	Hunting-prevention gain (N1-02)	Controlling hunting and vibration in mid-dle-range speeds (10 to 40 Hz)	1.00	0.50 to 2.00	• Reduce the setting if torque is insufficient for heavy loads. • Increase the setting if hunt-ing or vibration occurs for light loads.
	Carrier frequency selection (C6-02)	• Reducing motor magnetic noise • Controlling hunting and vibration at low speeds	1 (C6-01=0) Depends on capacity (C6-01=1)	0 to default	• Increase the setting if motor magnetic noise is high. • Reduce the setting if hunt-ing or vibration occurs at low to middle-range speeds.
	Torque compensation primary delay time constant (C4-02)	• Increasing torque and speed response • Controlling hunting and vibration	Depends on capacity	200 to 1000 ms	• Reduce the setting if torque or speed response is slow. • Increase the setting if hunt-ing or vibration occurs.
	Torque compensation gain (C4-01)	• Improving torque at low speeds (10 Hz or lower) • Controlling hunting and vibration	1.00	0.50 to 1.50	• Increase the setting if torque is insufficient at low speeds. • Reduce the setting if hunt-ing or vibration occurs for light loads.
	Middle output fre-quency voltage (E1-08) Minimum output fre-quency voltage (E1-10)	• Improving torque at low speeds • Controlling shock at startup	Depends on capac-ity and voltage	Default to Default + 3 to 5 V*	• Increase the setting if torque is insufficient at low speeds. • Reduce the setting if shock at startup is large.
Open-loop vector con-trol (A1-02 = 2)	Speed feedback detec-tion control (AFR) gain (N2-01)	• Increasing torque and speed response • Controlling hunting and vibration in mid-dle-range speeds (10 to 40 Hz)	1.00	0.50 to 2.00	• Reduce the setting if torque or speed response is slow. • Increase the setting if hunt-ing or vibration occurs.
	Torque compensation primary delay time constant (C4-02)	• Increasing torque and speed response • Controlling hunting and vibration	20 ms	20 to 100 ms	• Reduce the setting if torque or speed response is slow. • Increase the setting if hunt-ing or vibration occurs.
	Slip compensation pri-mary delay time (C3-02)	• Increasing speed response • Improving speed sta-bility	200 ms	100 to 500 ms	• Reduce the setting if speed response is slow. • Increase the setting if the speed is not stable.
	Slip compensation gain (C3-01)	• Improving speed accuracy	1.0	0.5 to 1.5	• Increase the setting if speed response is slow. • Reduce the setting if the speed is too fast.

Table 4.5 Adjusted User Constants (Continued)

Control Method	Name (Constant Number)	Performance	Factory Setting	Recom-mended Setting	Adjustment Method
Open-loop vector control (A1-02 = 2)	Carrier frequency selection (C6-02)	• Reducing motor magnetic noise • Controlling hunting and vibration at low speeds (10 Hz or less)	1 (C6-01=0) Depends on capacity (C6-01=1)	0 to default	• Increase the setting if motor magnetic noise is high. • Reduce the setting if hunting or vibration occurs at low speeds.
	Middle output frequency voltage (E1-08) Minimum output frequency voltage (E1-10)	• Improving torque at low speeds • Controlling shock at startup	Depends on capacity and voltage	Default to Default + 3 to 5 V *	• Increase the setting if torque or speed response is slow. • Reduce the setting if shock at startup is large.
Flux vector control (A1-02 = 3)	ASR proportional gain 1 (C5-01) and ASR proportional gain 2 (C5-03)	• Torque and speed response • Controlling hunting and vibration	20.00	10.00 to 50.00	• Increase the setting (by increments of 5) if torque or speed response is slow. • Reduce the setting if hunting or vibration occurs.
	ASR integral time 1 (high-speed) (C5-02) and ASR integral time 2 (low-speed) (C5-04)	• Torque and speed response • Controlling hunting and vibration	0.500 s	0.300 to 1.000 s	• Reduce the setting if torque or speed response is slow. • Increase the setting if hunting or vibration occurs.
	ASR switching frequency (C5-07)	Switching the ASR proportional gain and integral time according to the output frequency	0.0 Hz	0.0 to max. output frequency	Set the output frequency at which to change the ASR proportional gain and integral time when the same values cannot be used for both high-speed and low-speed operation.
	ASR primary delay time (C5-06)	• Controlling hunting and vibration	0.004 s	0.004 to 0.020 s	• Reduce the setting (by increments of 0.01) if torque or speed response is show. • Increase the setting if machine rigidity is low and the system vibrates easily.
	Carrier frequency selection (C6-02)	• Reducing motor magnetic noise • Controlling hunting and vibration at low speeds (3 Hz or less)	1 (C6-01=0) Depends on the capacity (C6-01=1)	2.0 kHz to default	• Increase the setting if motor magnetic noise is high. • Reduce the setting if hunting or vibration occurs at low to middle-range speeds.

* The setting is given for 200 V Class Inverters. Double the voltage for 400 V Class Inverters.

- Do not change the Torque Compensation Gain (C4-01) from its default setting of 1.00 when using open-loop vector control.
- If speeds are inaccurate during regeneration in open-loop vector control, enable Slip Compensation During Regeneration (C3-04 = 1).
- Use slip compensation to improve speed control during V/f control (A1-02 = 0).
  Set the Motor Rated Current (E2-01), Motor Rated Slip (E2-02), and Motor No-load Current (E2-03), and then adjust the Slip Compensation Gain (C3-01) to between 0.5 and 1.5. The default setting for V/f control is C3-01 = 0.0 (slip compensation disabled).

* To improve speed response and stability in V/f control with a PG (A1-02 = 1), set the ASR constants (C5-01 to C5-05) to between 0.5 and 1.5 times the default. (It is not normally necessary to adjust this setting.) ASR for V/f control with a PG will only control the output frequency; a high gain, such as is possible for open-loop vector control, cannot be set.

The following user constants will also indirectly affect the control system.

Table 4.6 Constants Indirectly Affecting Control and Applications

Name (Constant Number)	Application
CT/VT selection (C6-01)	Sets the maximum torque and overload capability to 120% or 150%.
DWELL function (b6-01 to b6-04)	Used for heavy loads or large machine backlashes.
Droop function (b7-01 to b7-02)	Used to soften the torque or to balance the load between two motors. Can be used when the control method (A1-02) is set to 3.
Acceleration/deceleration times (C1-01 to C1-11)	Adjust torque during acceleration and deceleration.
S-curve characteristics (C2-01 to C2-04)	Used to prevent shock when completing acceleration.
Jump frequencies (d3-01 to d3-04)	Used to avoid resonance points during operation.
Analog input filter time constant (H3-12)	Used to prevent fluctuations in analog input signals caused by noise.
Stall prevention (L3-01 to L3-06, L3-11, L3-12)	Used to prevent 0 V (overvoltage errors) and motor stalling for heavy loads or rapid acceleration/deceleration. Stall prevention is enabled by default and the setting does not normally need to be changed. When using a braking resistor, however, disable stall prevention during deceleration by setting L3-04 to 0.
Torque limits (L7-01 to L7-04, L7-06, L7-07)	Set the maximum torque during vector control. If a setting is increased, use a motor with higher capacity than the Inverter. If a setting is reduced, stalling can occur under heavy loads.
Feed forward control (N5-01 to N5-04)	Used to increase response for acceleration/deceleration or to reduce over-shooting when there is low machine rigidity and the gain of the speed controller (ASR) cannot be increased. The inertia ratio between the load and motor and the acceleration time of the motor running alone must be set.

5

User Constants

This chapter describes all user constants that can be set in the Inverter.

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 (Frequency Reference Selection) is used as an example.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H	6-6

- Constant Number: 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 when the control method is changed.)
  Refer to page 5-81 for factory settings by control method.
- 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.
  - 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.
- Page: Reference page for more detailed information on the constant.

Digital Operation Display Functions and Levels

The following figure shows the Digital Operator display hierarchy for the Inverter.

MENU

Drive Mode
Inverter can be operated and its status can be displayed.

Quick Programming Mode
Minimum constants required for operation can be monitored or set.

Advanced Programming Mode
All constants can be monitored or set.

Verify Mode
Constants changed from the default settings can be monitored or set.

Autotuning Mode
Automatically sets motor constants if autotuning data (from motor nameplate) is input for open-loop vector control or to measure the line-to-line resistance for V/f control.

No.	Function	Page
U1	Status Monitor Constants	5-74
U2	Fault Trace	5-79
U3	Fault History	5-80
A1	Initialize Mode	5-8
A2	User-specified Setting Mode	5-9
b1	Operation Mode Selections	5-10
b2	DC Injection Braking	5-12
b3	Speed Search	5-13
b4	Timer Function	5-15
b5	PID Control	5-15
b6	Dwell Functions	5-17
b7	Droop Control	5-18
b8	Energy Saving	5-18
b9	Zero-Servo	5-19
C1	Acceleration/Deceleration	5-20
C2	S-curve Acceleration/Deceleration	5-21
C3	Motor Slip Compensation	5-22
C4	Torque Compensation	5-23
C5	Speed Control (ASR)	5-24
C6	Carrier Frequency	5-25
d1	Preset Reference	5-26
d2	Reference Limits	5-27
d3	Jump Frequencies	5-28
d4	Reference Frequency Hold	5-28
d5	Torque Control	5-29
d6	Field Weakening	5-31
E1	V/f Pattern	5-32
E2	Motor Setup	5-34
E3	Motor 2 V/f Pattern	5-36
E4	Motor 2 Setup	5-37
F1	PG Option Setup	5-38
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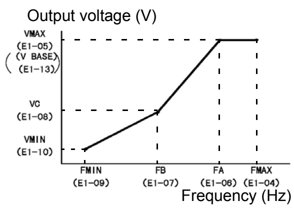
◆ User Constants Settable in Quick Programming Mode

The minimum user constants required for Inverter operation can be monitored and set in quick programming mode. The user constants displayed in quick programming mode are listed in the following table. These, and all other user constants, are also displayed in advanced programming mode.

Refer to the overview of modes on page 3-5 for an overview of quick programming mode.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
A1-02	Control method selection	Used to select the control method for the Inverter 0: V/f control 1: V/f with PG 2: Open loop vector 3: Flux vector This constant is not initialized by the initialize operation.	0 to 2 0 to 3	0	No	Q	Q	Q	Q	102H
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	No	Q	Q	Q	Q	181H
b1-03	Stopping method selection	Used to set the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop 2: DC injection braking stop (Stops faster than coast to stop, no regenerative operation.) 3: Coast to stop with timer (Run Commands are disregarded during deceleration.)	0 to 3 *1	0	No	Q	Q	Q	Q	182H
C1-01	Accelera-tion time 1	Sets the acceleration time to accelerate from 0 to the maximum output frequency, in 1-second units.	0.0 to 6000.0 *2	10.0 s	Yes	Q	Q	Q	Q	200H
C1-02	Decelera-tion time 1	Sets the deceleration time to decelerate from the maximum output frequency to 0, in 1-second units.			Yes	Q	Q	Q	Q	201H
C6-01	CT/VT selection	0: CT (low carrier, constant torque, 150% per minute) 1: VT (high carrier, variable torque, 120% per minute)	0 or 1	1 *3 0 *3	No	Q	Q	Q	Q	223H

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods: V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	MEMO BUS Regis-ter
C6-02	Carrier fre-quency selection	Select carrier wave fixed pattern. 0: Low-noise PWM 1: 2.0 kHz 2: 5.0 kHz 3: 8.0 kHz 4: 10.0 kHz 5: 12.5 kHz 6: 15.0 kHz F: Enables detailed settings using constants C6-03 to C6-05	0,1 (C6-01=0) 0 to F (C6-01=1)	1 (C6-01=0) 6 *4 (C6-01=1)	No	Q	Q	Q	Q	224H
d1-01	Frequency reference 1	Sets the frequency reference in the units used in o1-03.	0.00 to 400.00 *5 *13	0.00 Hz	Yes	Q	Q	Q	Q	280H
d1-02	Frequency reference 2	The frequency reference when multi-step speed reference 1 is ON for a multi-function input.		0.00 Hz	Yes	Q	Q	Q	Q	281H
d1-03	Frequency reference 3	The frequency reference when multi-step speed reference 2 is ON for a multi-function input.		0.00 Hz	Yes	Q	Q	Q	Q	282H
d1-04	Frequency reference 4	The frequency reference when multi-step speed references 1 and 2 are ON for multi-function inputs.	0.00 to 300.00 *5 *6	0.00 Hz	Yes	Q	Q	Q	Q	283H
d1-17	Jog frequency reference	The frequency reference when the jog frequency reference selection, FJOG command, or RJOG command is ON.		6.00 Hz	Yes	Q	Q	Q	Q	292H
E1-01	Input volt-age setting	Set the Inverter input voltage in 1 volt. This setting is used as a reference value in protection functions.	155 to 255 *7	200 V *7	No	Q	Q	Q	Q	300H
E1-03	V/f pattern selection	0 to E: Select from the 15 preset patterns. F: Custom user-set patterns (Applicable for settings E1-04 to E1-10.)	0 to F	F	No	Q	Q	No	No	302H
E1-04	Max. output frequency		40.0 to 400.0 *13 40.0 to 300.0 *6	60.0 Hz *8	No	Q	Q	Q	Q	303H
E1-05	Max. voltage		0.0 to 255.0*7	200.0 V *7*8	No	Q	Q	Q	Q	304H
E1-06	Base 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 frequen-cies are set in the following manner: E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)	0.0 to 400.0 *13 0.0 to 300.0 *6	60.0 Hz *8	No	Q	Q	Q	Q	305H
E1-09	Min. output frequency		0.0 to 400.0 *13 0.0 to 300.0 *6	1.5 Hz *8	No	Q	Q	Q	A	308H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
E1-13	Base voltage	Set only to fine-adjust V/f for the output range. Normally, this setting is not required.	0.0 to 255.0 *7	0.0 V *9	No	A	A	Q	Q	30CH
E2-01	Motor rated current	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque limits and torque control. This constant is automatically set during autotuning.	0.32 to 6.40 *10	1.90 A *4	No	Q	Q	Q	Q	30EH
E2-04	Number of motor poles	Sets the number of motor poles. This constant is automatically set during autotuning.	2 to 48	4 poles	No	No	Q	No	Q	311H
E2-11	Motor rated output	Set the rated output of the motor in units of 0.01 kW. This constant is automatically set during autotuning.	0.00 to 650.00	0.40 kW *4	No	Q	Q	Q	Q	318H
F1-01	PG constant	Sets the number of PG (pulse generator or encoder) pulses. Sets the number of pulses per motor revolution.	0 to 60000	600	No	No	Q	No	Q	380H
H4-02	Gain (terminal FM)	Sets the multi-function analog output 1 voltage level gain. Sets whether the monitor item output will be output in multiples of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available. *12	0.00 to 2.50	1.00	Yes	Q	Q	Q	Q	41EH
H4-05	Gain (terminal AM)	Set the voltage level gain for multi-function analog output 2. Set the number of multiples of 10 V to be output as the 100% output for the monitor items. The maximum output from the terminal is 10 V. A meter calibration function is available. *12	0.00 to 2.50	0.50	Yes	Q	Q	Q	Q	421H
L1-01	Motor protection selection	Sets whether the motor overload function is enabled or disabled at electric thermal overload relay. 0: Disabled 1: General-purpose motor protection 2: Inverter motor protection 3: Vector motor protection In some applications when the Inverter power supply is turned off, the thermal value is reset, so even if this constant is set to 1, protection may not be effective. When several motors are connected to one Inverter, set to 0 and ensure that each motor is installed with a protection device.	0 to 3	1	No	Q	Q	Q	Q	480H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
L3-04	Stall prevention selection during decel	0: Disabled (Deceleration as set. If deceleration time is too short, a main circuit overvoltage may result.) 1: Enabled (Deceleration is stopped when the main circuit voltage exceeds the overvoltage level. Deceleration restarts when voltage is returned.) 2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that in Inverter can decelerate in the shortest possible time. Set deceleration time is disregarded.) 3: Enabled (with Braking Resistor Unit) When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3.	0 to 3 *11	1	No	Q	Q	Q	Q	492H

* 1. 0 or 1 for flux vector control.

* 2. The setting range for acceleration/deceleration times will depends on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times becomes 0.00 to 600.00 seconds.

* 3. Only 1(VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.

* 4. The factory settings depend on the capacity of the Inverter. The values for a 200 V Class Inverter of 0.4 kW are given.

* 5. The upper limit of the setting range depends on the upper limit set in E1-04.

* 6. When C6-01 = 1, the upper limit is 400.00 (d1 constants)/400.0(E1 constants).

* 7. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.

* 8. The factory setting will change when the control method is changed. The V/f control factory settings are given.

* 9. E1-13 is set to the same value as E1-05 by autotuning.

* 10.The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V Class Inverter of 0.4 kW is given.
For the motor no-load current, set E2-03 to a value less than that of E2-01.

* 11.When using flux vector control, 0 to 2.

* 12.The CH1 output can be adjusted when the H4-02 or H4-03 setting is displayed in Quick, Advanced, or Verify mode while the motor is stopped.
The CH2 output can be adjusted when the H4-05 or H4-06 setting is displayed in quick, Advance, or Verify mode while the motor is stopped.
For analog output, the value equivalent to 100% of output value of monitored item is multiplied by the gain setting and the set bias is added.

* 13.When C6-01 = 0, the upper limit is 150.00 (d1 constants)/150.0(E1 constants).

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User Constant Tables

◆ A: Setup Settings

The following settings are made with the environment constants (A constants): Language displayed on the Digital Operator, access level, control method, initialization of constants.

■ Initialize Mode: A1

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
A1-00	Language selection for Digital Operator display	Used to select the language displayed on the Digital Operator (LED). 0: English 1: Japanese 2: German 3: French 4: Italian 5: Spanish 6: Portuguese This constant is not initialized by the initialize operation.	0 to 6	1	Yes	A	A	A	A	100H	-
A1-01	Constant access level	Used to set the constant access level (set/read.) 0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.) 1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.) 2: Advanced (Constants can be read and set in both quick programming mode and advanced programming (A) mode.)	0 to 2	2	Yes	A	A	A	A	101H	4-17 6-155
A1-02	Control method selection	Used to select the control method for the Inverter 0: V/f control 1: V/f with PG 2: Open loop vector 3: Flux vector This constant is not initialized by the initialize operation.	0 to 2 0 to 3	0	No	Q	Q	Q	Q	102H	4-5 4-7 4-18

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
A1-03	Initialize	Used to initialize the constants using the specified method. 0: No initializing 1110: Initializes using the User constants 2220: Initializes using a two-wire sequence. (Initializes to the factory setting.) 3330: Initializes using a three-wire sequence.	0 to 3330	0	No	A	A	A	A	103H	6-15 6-16 6-150
A1-04	Password	Password input when a password has been set in A1-05. This function write-protects some constants of the initialize mode. If the password is changed, A1-01 to A1-03 and A2-01 to A2-32 constants can no longer be changed. (Programming mode constants can be changed.)	0 to 9999	0	No	A	A	A	A	104H	4-17 6-156
A1-05	Password setting	Used to set 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 the password will be displayed.	0 to 9999	0	No	A	A	A	A	105H	4-17 6-156

■User-set Constants: A2

The constants set by the user are listed in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
A2-01 to A2-32	User setting constants	Used to set the constant numbers that can be set/read. Maximum 32. Effective when the Constant Access Level (A1-01) is set to User Program (1). Constants set in constants A2-01 to A2-32 can be set/read in programming mode.	b1-01 to o3-02	-	No	A	A	A	A	106H to 125H	6-156

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◆ Application Constants: b

The following settings are made with the application constants (B constants): Operation method selection, DC injection braking, speed searching, timer functions, dwell functions, droop control, energy saving control, and zero-servo control.

■Operation Mode Selections: b1

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H	4-5 6-6 6-79 6-98
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	No	Q	Q	Q	Q	181H	4-5 6-15 6-79 6-98
b1-03	Stopping method selection	Used to set the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop 2: DC injection braking stop (Stops faster than coast to stop, no regenerative operation.) 3: Coast to stop with timer (Run Commands are disregarded during deceleration.)	0 to 3 *	0	No	Q	Q	Q	Q	182H	4-6 6-17
b1-04	Prohibition of reverse operation	0: Reverse enabled 1: Reverse disabled	0 or 1	0	No	A	A	A	A	183H	6-65

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
b1-05	Operation selection for setting E1-09 or less	Used to set the method of operation when the frequency reference input is less than the minimum output frequency (E1-09). 0: Run at frequency reference (E1-09 not effective). 1: STOP (Frequencies below E1-09 in the coast to stop state.) 2: Run at min. frequency. (E1-09) 3: Run at zero-speed (Frequencies below E1-09 are zero)	0 to 3	0	No	No	No	No	A	184H	6-17
b1-06	Read sequence input twice	Used to set the responsiveness of the control inputs (forward/reverse and multi-function inputs.) 0: Two scans every 2 ms (Use for fast responses.) 1: Two scans every 5 ms (Use for possible malfunction due to noise.)	0 or 1	1	No	A	A	A	A	185H	-
b1-07	Operation selection after switching to remote mode	Used to set the operation mode by switching to the Remote mode using the Local/Remote Key. 0: Run signals that are input during mode switching are disregarded. (Input Run signals after switching the mode.) 1: Run signals become effective immediately after switching to the Remote mode.	0 or 1	0	No	A	A	A	A	186H	-
b1-08	Run Command selection in programming modes	Used to set an operation interlock in programming modes. 0: Cannot operate. 1: Can operate (Disabled when Digital Operator is set to select Run Command (when b1-02 = 0)). 2: Cannot operate. (Cannot be in programming mode during operation.)	0 to 1 0 to 2	0	No	A	A	A	A	187H	-

* 0 or 1 for flux vector control.

■DC Injection Braking: b2

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
b2-01	Zero-speed level (DC injection braking starting frequency)	Used to set the frequency which starts DC injection braking in units of Hz when deceleration to stop is selected. When b2-01 is less than E1-09, E1-09 is used to set the starting frequency for the DC injection braking. In flux vector control, b2-01 is used to set the starting frequency for the zero-speed control.	0.0 to 10.0	0.5 Hz	No	A	A	A	A	189H	6-17 6-145
b2-02	DC injection braking current	Sets the DC injection braking current as a percentage of the Inverter rated current. The DC injection braking current in flux control is affected by any change to the setting of E2-03.	0 to 100	50%	No	A	A	A	No	18AH	6-18 6-22
b2-03	DC injection braking time at start	Used to set the time to perform DC injection braking at start in units of 1 second. Used to stop coasting motor and restart it. When the set value is 0, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	A	A	18BH	6-18 6-22
b2-04	DC injection braking time at stop	Used to set the time to perform DC injection braking at stop (zero-speed control in flux vector control) in units of 1 second. 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	A	A	18CH	6-18
b2-08	Magnetic flux compensation volume	Sets the magnetic flux compensation as a percentage of the no-load current.	0 to 1000	0%	No	No	No	A	A	190H	-

■Speed Search: b3

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
b3-01	Speed search selection (current detection or speed calcu-lation)	Enables/disables the speed search function for the Run Command and sets the speed search method. 0:Disabled, speed calculation 1: Enabled, speed calculation 2: Disabled, current detection 3: Enabled, current detection Speed Calculation: When the search is started, the motor speed is calculated and acceleration/deceleration is performed from the calculated speed to the specified frequency (motor direction is also searched). Current Detection: The speed search is started from the frequency when power was momentarily lost and the maximum frequency, and the speed is detected at the search current level.	0 to 3	2*1	No	A	A	A	No	191H	6-68
b3-02	Speed search oper-ating cur-rent (current detection)	Sets the speed search opera-tion current as a percentage, taking the Inverter rated cur-rent as 100%. Not usually necessary to set. When restarting is not possi-ble with the factory settings, reduce the value.	0 to 200	120% *1 *2 150% *1 *2	No	A	No	A	No	192H	6-68
b3-03	Speed search decelera-tion time (current detection)	Sets the output frequency deceleration time during speed search in 1-second units. Set the time for deceleration from the maximum output frequency to the minimum output frequency.	0.1 to 10.0	2.0 s	No	A	No	A	No	193H	6-68

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
b3-05	Speed search wait time (current detection or speed calculation)	Sets the magnetic contactor operating delay time when there is a 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 s	No	A	A	A	A	195H	6-68
b3-10	Sets the magnetic flux compensation as a percentage of the no-load current.	Operation restarts at a speed obtained by multiplying the speed from the speed search by the compensation gain (excitation search only.) Increase this setting if overvoltages occur when a speed search is performed after a long baseblock, for example, in searches at startup.	1.00 to 1.20	1.10	No	A	No	A	No	19AH	6-68
b3-14	Rotation direction search selection	0: Disabled (operates with specified rotation direction) 1: Enabled (operates with rotation direction found by search)	0 or 1	1	No	A	A	A	No	19EH	6-69
b3-17	Speed search retrial current level	Sets the current level to retry a speed search as a percentage, taking the Inverter rated current as 100%.	0 to 200	150% *2	No	A	No	A	No	1F0H	6-69
b3-18	Speed search retrial detection time	Sets the time for detection in a speed search retrial in units of seconds.	0.00 to 1.00	0.10 s	No	A	No	A	No	1F1H	6-69
b3-19	Number of speed search retrials	Sets the number of times that a speed search can be retried.	0 to 10	0	No	A	No	A	No	1F2H	6-69

* 1. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 2. C6-01 = 1:120%, C6-01 = 0:150%

■Timer Function: b4

User constants for timer functions are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
b4-01	Timer function ON-delay time	Sets the timer function output ON-delay time (dead band) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-□□ or H2-□□.	0.0 to 300.0	0.0 s	No	A	A	A	A	1A3H	6-108
b4-02	Timer function OFF-delay time	Sets the timer function output OFF-delay time (dead band) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-□□ or H2-□□.	0.0 to 300.0	0.0 s	No	A	A	A	A	1A4H	6-108

■PID Control: b5

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
b5-01	PID control method selection	0: Disabled 1: Enabled (Deviation is D-controlled.) 2: Enabled (Feedback value is D-controlled.) 3: PID control enabled (frequency reference + PID output, D control of deviation) 4: PID control enabled (frequency reference + PID output, D control of feedback value).	0 to 4	0	No	A	A	A	A	1A5H	6-110
b5-02	Proportional gain (P)	Sets P-control proportional gain as a percentage. P-control is not performed when the setting is 0.00.	0.00 to 25.00	1.00	Yes	A	A	A	A	1A6H	6-110
b5-03	Integral (I) time	Sets I-control integral time in 1-second units. I-control is not performed when the setting is 0.0.	0.0 to 360.0	1.0 s	Yes	A	A	A	A	1A7H	6-110
b5-04	Integral (I) limit	Sets the I-control limit as a percentage of the maximum output frequency.	0.0 to 100.0	100.0%	Yes	A	A	A	A	1A8H	6-110
b5-05	Derivative (D) time	Sets D-control derivative time in 1-second units. D-control is not performed when the setting is 0.00.	0.00 to 10.00	0.00 s	Yes	A	A	A	A	1A9H	6-110

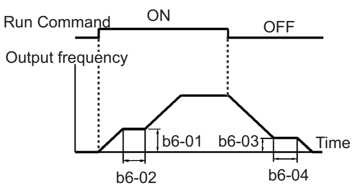
Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
b5-06	PID limit	Sets the limit after PID-control as a percentage of the maximum output frequency.	0.0 to 100.0	100.0%	Yes	A	A	A	A	1AAH	6-110
b5-07	PID offset adjustment	Sets the offset after PID-control as a percentage of the maximum output frequency.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	1ABH	6-110
b5-08	PID primary delay time constant	Sets the time constant for low pass filter for PID-control outputs in 1-second units. Not usually necessary to set.	0.00 to 10.00	0.00 s	Yes	A	A	A	A	1ACH	6-110
b5-09	PID output characteristics selection	Select forward/reverse for PID output. 0: PID output is forward. 1: PID output is reverse (highlights the output code)	0 or 1	0	No	A	A	A	A	1ADH	6-110
b5-10	PID output gain	Sets output gain.	0.0 to 25.0	1.0	No	A	A	A	A	1AEH	6-110
b5-11	PID reverse output selection	0: 0 limit when PID output is negative. 1: Reverses when PID output is negative. 0 limit when reverse prohibit is selected using b1-04.	0 or 1	0	No	A	A	A	A	1AFH	6-110
b5-12	Selection of PID feedback command loss detection	0: No detection of loss of PID feedback. 1: Detection of loss of PID feedback. Operation continues during detection, with the malfunctioning contact not operating. 2: Detection of loss of PID feedback. Coasts to stop during detection, and fault contact operates.	0 to 2	0	No	A	A	A	A	1B0H	6-111
b5-13	PID feedback command loss detection level	Sets the PID feedback loss detection level as a percent units, with the maximum output frequency at 100%.	0 to 100	0%	No	A	A	A	A	1B1H	6-111
b5-14	PID feedback command loss detection time	Sets the PID feedback loss detection level in s units.	0.0 to 25.5	1.0 s	No	A	A	A	A	1B2H	6-111
b5-15	PID sleep function operation level	Set the PID sleep function start level as a frequency.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B3H	6-111

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
b5-16	PID sleep operation delay time	Set the delay time until the PID sleep function starts in seconds.	0.0 to 25.5	0.0 s	No	A	A	A	A	1B4H	6-111
b5-17	Accel/decel time for PID reference	Set the accel/decel time for PID reference in seconds.	0.0 to 25.5 0.0 to 6000.0	0.0 s	No	A	A	A	A	1B5H	6-111

* 1. When C6-01 = 0, the upper limit is 150.0.
* 2. When C6-01 = 1, the upper limit is 400.0.

■Dwell Functions: b6

User constants for dwell functions are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
b6-01	Dwell frequency at start	The dwell function is used to output frequency temporarily when driving a motor with a heavy load.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B6H	4-20 6-29
b6-02	Dwell time at start		0.0 to 10.0	0.0 s	No	A	A	A	A	1B7H	4-20 6-29
b6-03	Dwell frequency at stop		0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B8H	4-20 6-29
b6-04	Dwell time at stop		0.0 to 10.0	0.0 s	No	A	A	A	A	1B9H	4-20 6-29

* 1. When C6-01 = 0, the upper limit is 150.0.
* 2. When C6-01 = 1, the upper limit is 400.0.

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■Droop Control: b7

User constants for droop functions are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
b7-01	Droop con-trol gain	Sets the slip as a percentage of maximum frequency when the maximum output frequency is specified and the rated torque occurs. Droop-control is not per-formed when the setting is 0.0.	0.0 to 100.0	0.0	Yes	No	No	No	A	1CAH	4-20 6-144
b7-02	Droop con-trol delay time	Droop control responsive-ness constant When hunting or oscillation occurs, increase the value.	0.03 to 2.00	0.05 s	Yes	No	No	No	A	1CBH	4-20 6-144

■Energy Saving: b8

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
b8-01	Energy-sav-ing mode selection	Select whether to enable or disable energy-saving con-trol. 0: Disable 1: Enable	0 or 1	0	No	A	A	A	A	1CCH	6-118
b8-02	Energy-sav-ing gain	Set the energy-saving gain with the vector control method.	0.0 to 10.0	0.7 *1	Yes	No	No	A	A	1CDH	6-118
b8-03	Energy-sav-ing filter time con-stant	Set the energy-saving filter time constant with the vector control method.	0.00 to 10.00	0.50 s *2	Yes	No	No	A	A	1CEH	6-118
b8-04	Energy-sav-ing coeffi-cient	Set the maximum motor effi-ciency value. Set the motor rated capacity in E2-11, and adjust the value by 5% at a time until output power reaches a mini-mum value.	0.00 to 655.00	288.20 *3 *4	No	A	A	No	No	1CFH	6-118
b8-05	Power detection filter time constant	Set the time constant for out-put power detection.	0 to 2000	20 ms	No	A	A	No	No	1D0H	6-118

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	MEMO BUS Regis-ter	Page
b8-06	Search operation voltage lim-iter	Set the limit value of the voltage control range during search operation. Perform search operation to optimize operations using minute variations in voltage using energy-saving control. Set to 0 to disable the search operation. 100% is the motor base voltage.	0 to 100	0%	No	A	A	No	No	1D1H	6-118

* 1. The factory setting is 1.0 when using flux vector control.
* 2. The factory setting is 2.00 s when Inverter capacity is 55 kW min.
The factory setting will change when the control method is changed. The open-loop vector factory setting is given.
* 3. By setting E2-11 (Motor rated output) the appropriate value will be set.
* 4. The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.

■Zero-Servo: b9

User constants for zero-servo functions are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	MEMO BUS Regis-ter	Page
b9-01	Zero-servo gain	Adjust the strength of the zero-servo lock. Enabled when the "zero-servo command" is set for the multi-function input. When the zero-servo com-mand has been input and the frequency reference drop below excitation level (b2-01), a position control loop is created and the motor stops. Increasing the zero-servo gain in turn increases the strength of the lock. Increasing it by too much will cause oscillation.	0 to 100	5	No	No	No	No	A	1DAH	6-145
b9-02	Zero-servo completion width	Sets the output width of the zero-servo completion sig-nal. Enabled when the "zero-servo completion (end)" is set for a multi-function input. The zero-servo com-pletion signal is ON when the current position is within the range (the zero-servo start position± zero-servo completion width.) Set the allowable position displacement from the zero-servo start position to 4 times the pulse rate of the PG (pulse generator, encoder) in use.	0 to 16383	10	No	No	No	No	A	1DBH	6-145

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◆ Autotuning Constants: C

The following settings are made with the autotuning constants (C constants): Acceleration/deceleration times, s-curve characteristics, slip compensation, torque compensation, speed control, and carrier frequency functions.

■Acceleration/Deceleration: C1

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C1-01	Acceleration time 1	Sets the acceleration time to accelerate from 0 to the maximum output frequency, in 1-second units.	0.0 to 6000.0 *1	10.0 s	Yes	Q	Q	Q	Q	200H	4-5 4-20 6-25
C1-02	Deceleration time 1	Sets the deceleration time to decelerate from the maximum output frequency to 0, in 1-second units.			Yes	Q	Q	Q	Q	201H	4-5 4-20 6-25
C1-03	Acceleration time 2	The acceleration time when the multi-function input “accel/decel time 1” is set to ON.			Yes	A	A	A	A	202H	4-20 6-25
C1-04	Deceleration time 2	The deceleration time when the multi-function input “accel/decel time 1” is set to ON.			Yes	A	A	A	A	203H	4-20 6-25
C1-05	Acceleration time 3	The acceleration time when the multi-function input “accel/decel time 2” is set to ON.			No	A	A	A	A	204H	4-20 6-25
C1-06	Deceleration time 3	The deceleration time when the multi-function input “accel/decel time 2” is set to ON.			No	A	A	A	A	205H	4-20 6-25
C1-07	Acceleration time 4	The acceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON.			No	A	A	A	A	206H	4-20 6-25
C1-08	Deceleration time 4	The deceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON.			No	A	A	A	A	207H	4-20 6-25
C1-09	Emergency stop time	The deceleration time when the multi-function input “Emergency (fast) stop” is set to ON. This function can be used as a stopping method when a fault has been detected.			No	A	A	A	A	208H	4-20 6-24

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C1-10	Accel/decel time setting unit	0: 0.01-second units 1: 0.1-second units	0 or 1	1	No	A	A	A	A	209H	4-20 6-25 6-26
C1-11	Accel/decel time switching frequency	Sets the frequency for automatic acceleration/deceleration switching. Below set frequency: Accel/decel time 4 Above set frequency: Accel/decel time 1 The multi-function input "accel/decel time 1" or "accel/decel time 2" take priority.	0.0 to 400.0 *2 0.0 to 300.0 *3	0.0 Hz	No	A	A	A	A	20AH	4-20 6-25

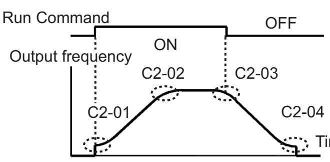
* 1. The setting range for acceleration/deceleration times will depend on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times become 0.00 to 600.00 seconds.

* 2. When C6-01=0, the upper limit is 150.0.

* 3. When C6-01=1, the upper limit is 400.0.

■S-curve Acceleration/Deceleration: C2

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C2-01	S-curve characteristic time at acceleration start	All sections of the S-curve characteristic time are set in seconds units. When the S-curve characteristic time is set, the accel/decel times will increase by only half of the S-curve characteristic times at start and end.	0.00 to 2.50	0.20 s	No	A	A	A	A	20BH	4-20 6-26
C2-02	S-curve characteristic time at acceleration end		0.00 to 2.50	0.20 s	No	A	A	A	A	20CH	4-20 6-26
C2-03	S-curve characteristic time at deceleration start		0.00 to 2.50	0.20 s	No	A	A	A	A	20DH	4-20 6-26
C2-04	S-curve characteristic time at deceleration end		0.00 to 2.50	0.00 s	No	A	A	A	A	20EH	4-20 6-26

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■Motor Slip Compensation: C3

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C3-01	Slip compensation gain	Used to improve speed accuracy when operating with a load. Usually setting is not necessary. Adjust this constant at the following times. • When actual speed is low, increase the set value. • When actual speed is high, decrease the set value. Used as the applicable control gain when using flux vector control.	0.0 to 2.5	0.0*	Yes	A	No	A	A	20FH	4-18 6-43
C3-02	Slip compensation primary delay time	Slip compensation primary delay time is set in ms units. Usually setting is not necessary. Adjust this constant at the following times. • Reduce the setting when slip compensation responsive is slow. • When speed is not stabilized, increase the setting.	0 to 10000	2000 ms *	No	A	No	A	No	210H	4-18 6-43
C3-03	Slip compensation limit	Sets the slip compensation limit as a percentage of motor rated slip.	0 to 250	200%	No	A	No	A	No	211H	6-43
C3-04	Slip compensation selection during regeneration	0: Disabled. 1: Enabled. When the slip compensation during regeneration function has been activated, as regeneration capacity increases momentarily, it may be necessary to use a braking option (braking resistor, Braking Resistor Unit or Braking Unit.)	0 or 1	0	No	A	No	A	No	212H	6-43
C3-05	Output voltage limit operation selection	0: Disabled. 1: Enabled. (The motor flux will be lowered automatically when the output voltage become saturated.)	0 or 1	0	No	No	No	A	A	213H	6-43

* The factory setting will change when the control method is changed. The V/f control factory settings are given.

■Torque Compensation: C4

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C4-01	Torque compensation gain	Sets torque compensation gain as a ratio. Usually setting is not necessary. Adjust in the following circumstances: • 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 values. • When the motor is oscillating, decrease the set values. Adjust the output current range at minimum speed rotation so that it does not exceed the Inverter rated output current. Do not alter the torque compensation gain from its default (1.00) when using the open loop vector control method.	0.00 to 2.50	1.00	Yes	A	A	A	No	215H	4-18 6-46
C4-02	Torque compensation primary delay time constant	The torque compensation delay time is set in ms units. Usually setting is not necessary. Adjust in the following circumstances: • When the motor is oscillating, increase the set values. • When the responsiveness of the motor is low, decrease the set values.	0 to 10000	200 ms *	No	A	A	A	No	216H	4-18 6-46
C4-03	Forward starting torque	Sets the forward starting torque as a percentage of the motor rated torque.	0.0 to 200.0	0.0%	No	No	No	A	No	217H	-
C4-04	Reverse starting torque	Sets the reverse starting torque as a percentage of the motor rated torque.	-200.0 to 0.0	0.0%	No	No	No	A	No	218H	-
C4-05	Starting torque time constant	Sets the delay time in ms for starting torque. The filter is disabled if the time is set to 0 to 4 ms.	0 to 200	10 ms	No	No	No	A	No	219H	-

* The factory setting will change when the control method is changed. The V/f control factory setting is given.

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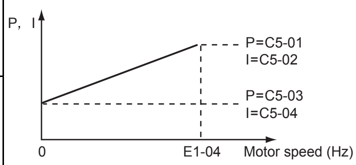
■Speed Control (ASR): C5

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
C5-01	ASR proportional (P) gain 1	Sets the proportional gain of the speed loop (ASR.)	1.00 to 300.00 *1	20.00 *2	Yes	No	A	No	A	21BH	4-19 6-136
C5-02	ASR integral (I) time 1	Sets the integral time of the speed loop (ASR) in 1-second units.	0.000 to 10.000	0.500 s *2	Yes	No	A	No	A	21CH	4-19 6-136
C5-03	ASR proportional (P) gain 2	Usually setting is not necessary. Set to change the rotational speed gain.	1.00 to 300.00 *1	20.00 *2	Yes	No	A	No	A	21DH	4-19 6-137
C5-04	ASR integral (I) time 2		0.000 to 10.000	0.500 s *2	Yes	No	A	No	A	21EH	4-19 6-137
C5-05	ASR limit	Sets the upper limit for the compensation frequency for the speed control loop (ASR) to a percentage of the maximum output frequency.	0.0 to 20.0	5.0%	No	No	A	No	No	21FH	6-137
C5-06	ASR primary delay time	Sets the filter time constant for outputting torque references from the speed control loop (ASR). It is set in 1-second units. Usually setting is not necessary.	0.000 to 0.500	0.004 s	No	No	No	No	A	220H	4-19 6-137
C5-07	ASR switching frequency	Sets the frequency for switching between Proportion Gain 1, 2 and Integral Time 1, 2 in Hz units. The multi-function input “ASR switching proportional gain” has the priority.	0.0 to 300.0 *3	0.0 Hz	No	No	No	No	A	221H	4-19 6-137
C5-08	ASR integral (I) limit	Sets the upper limit for the integral (I) amount for the speed control loop (ASR) to a percentage of the rated load.	0 to 400	400%	No	No	No	No	A	222H	6-137

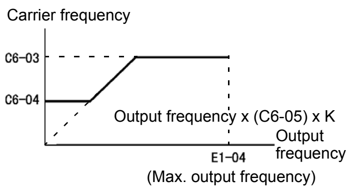
* 1. When using V/f with PG control, 0.00 to 300.00. The flux vector setting ranges are given.

* 2. When the control method changes, the factory setting is changed. The flux vector control factory settings are given. Refer to *Factory Settings that Change with the Control Method (A1-02)*.

* 3. When C6-01 = 1, the upper limit is 400.0.

■Carrier Frequency: C6

User constants for the carrier frequency are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
C6-01	CT/VT selection	0: CT (low carrier, constant torque, 150% per minute) 1: VT (high carrier, variable torque, 120% per minute)	0 or 1	1*1 0*1	No	Q	Q	Q	Q	223H	4-5 4-20 6-2
C6-02	Carrier frequency selection	Select carrier wave fixed pattern. 0: Low-noise PWM 1: 2.0 kHz 2: 5.0 kHz 3: 8.0 kHz 4: 10.0 kHz 5: 12.5 kHz 6: 15.0 kHz F: Enables detailed settings using constants C6-03 to C6-05	0,1 (C6-01=0) 0 to F (C6-01=1)	1 (C6-01=0) 6*2 (C6-01=1)	No	Q	Q	Q	Q	224H	4-6 4-18 4-19 6-2
C6-03 *4	Carrier frequency upper limit	Set the carrier frequency upper limit and lower limit in kHz units. The carrier frequency gain is set as follows: With the vector control method, the upper limit of the carrier frequency is fixed in C6-03.	2.0 to 15.0 *3 2.0 to 2.5	15.0 kHz *2 2.0 kHz	No	A	A	A	A	225H	6-2
C6-04 *4	Carrier frequency lower limit		0.4 to 15.0 *3 0.4 to 2.5	15.0 kHz *2 2.0 kHz	No	A	A	No	A	226H	6-2
C6-05 *4	Carrier frequency proportional gain	K is a coefficient that depends on the setting of C6-03. C6-03 ≥ 10.0 kHz: K = 3 10.0 kHz > C6-03 ≥ 5.0 kHz: K = 2 5.0 kHz > C6-03: K = 1	00 to 99	00	No	A	A	No	A	227H	6-2

* 1. Only 1(VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.
* 2. The factory settings depend on the capacity of the Inverter. The values for a 200 V Class Inverter of 0.4 kW are given.
* 3. The setting ranges depend on the capacity of the Inverter. The values for a 200 V Class Inverter of 0.4 kW are given.
* 4. This constant can be monitored or set only when F is set for C6-02.

◆ Reference Constants: d

The following settings are made with the reference constants (d constants): Frequency references.

■Preset Reference: d1

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
d1-01	Frequency reference 1	Sets the frequency reference in the units used in o1-03.	0.00 to 400.00 *1 *3	0.00 Hz	Yes	Q	Q	Q	Q	280H	4-6 6-10
d1-02	Frequency reference 2	The frequency reference when multi-step speed reference 1 is ON for a multi-function input.		0.00 Hz	Yes	Q	Q	Q	Q	281H	4-6 6-10
d1-03	Frequency reference 3	The frequency reference when multi-step speed reference 2 is ON for a multi-function input.		0.00 Hz	Yes	Q	Q	Q	Q	282H	4-6 6-10
d1-04	Frequency reference 4	The frequency reference when multi-step speed references 1 and 2 are ON for multi-function inputs.		0.00 Hz	Yes	Q	Q	Q	Q	283H	4-6 6-10
d1-05	Frequency reference 5	The frequency when multi-step speed reference 3 is ON for a multi-function input.		0.00 Hz	Yes	A	A	A	A	284H	6-10
d1-06	Frequency reference 6	The frequency reference when multi-step speed references 1 and 3 are ON for multi-function inputs.	0.00 to 300.00 *1 *2	0.00 Hz	Yes	A	A	A	A	285H	6-10
d1-07	Frequency reference 7	The frequency reference when multi-step speed references 2 and 3 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	286H	6-10
d1-08	Frequency reference 8	The frequency reference when multi-step speed references 1, 2, and 3 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	287H	6-10
d1-09	Frequency reference 9	The frequency reference when multi-step speed reference 4 is ON for a multi-function input.		0.00 Hz	Yes	A	A	A	A	288H	-
d1-10	Frequency reference 10	The frequency reference when multi-step speed references 1 and 4 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	28BH	-
d1-11	Frequency reference 11	The frequency reference when multi-step speed references 2 and 4 are ON for a multi-function inputs.		0.00 Hz	Yes	A	A	A	A	28CH	-

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
d1-12	Frequency reference 12	The frequency reference when multi-step speed references 1, 2, and 4 are ON for multi-function inputs.	0.00 to 400.00 *1 *3	0.00 Hz	Yes	A	A	A	A	28DH	-
d1-13	Frequency reference 13	The frequency reference when multi-step speed references 3 and 4 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	28EH	-
d1-14	Frequency reference 14	The frequency reference when multi-step speed references 1, 3, and 4 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	28FH	-
d1-15	Frequency reference 15	The frequency reference when multi-step speed references 2, 3, and 4 are ON for multi-function inputs.	0.00 to 300.00 *1 *2	0.00 Hz	Yes	A	A	A	A	290H	-
d1-16	Frequency reference 16	The frequency reference when multi-step speed references 1, 2, 3, and 4 are ON for multi-function inputs.		0.00 Hz	Yes	A	A	A	A	291H	-
d1-17	Jog frequency reference	The frequency reference when the jog frequency reference selection, FJOG command, or RJOG command is ON.		6.00 Hz	Yes	Q	Q	Q	Q	292H	4-6 6-10 6-87

Note The unit is set in o1-03 (frequency units of reference setting and monitor), default: 0.01 Hz.
* 1. The upper limit of the setting range depends on the upper limit set in E1-04.
* 2. When C6-01 = 1, the upper limit is 400.00.
* 3. When C6-01 = 0, the upper limit is 150.00.

■Reference Limits: d2

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
d2-01	Frequency reference upper limit	Set the output frequency upper limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	100.0%	No	A	A	A	A	289H	6-41 6-82
d2-02	Frequency reference lower limit	Sets the output frequency lower limit as a percentage of the maximum output frequency.	0.0 to 110.0	0.0%	No	A	A	A	A	28AH	6-41 6-82
d2-03	Master speed reference lower limit	Set the master speed reference lower limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	0.0%	No	A	A	A	A	293H	6-41 6-82

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■Jump Frequencies: d3

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
d3-01	Jump frequency 1	Set the center values of the jump frequencies in Hz. This function is disabled by setting the jump frequency to 0 Hz. 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 400.0 *1 / 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	294H	4-20 6-38
d3-02	Jump frequency 2			0.0 Hz	No	A	A	A	A	295H	4-20 6-38
d3-03	Jump frequency 3			0.0 Hz	No	A	A	A	A	296H	4-20 6-38
d3-04	Jump frequency width	Sets the jump frequency bandwidth in Hz. The jump frequency will be the jump frequency ± d3-04.	0.0 to 20.0	1.0 Hz	No	A	A	A	A	297H	4-20 6-38

* 1. When C6-01 = 1, the upper limit is 150.0.
* 2. When C6-01 = 0, the upper limit is 400.0.

■Reference Frequency Hold: d4

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
d4-01	Frequency reference hold function selection	Sets whether or not frequencies on hold will be recorded. 0: Disabled (when operation is stopped or the power is turned on again starts at 0.) 1: Enabled (when operation is stopped or the power is turned on again starts at the previous hold frequency.) This function is available when the multi-function inputs “accel/decel Ramp Hold” or “up/down” commands are set.	0 or 1	0	No	A	A	A	A	298H	6-81

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
d4-02	+ - Speed limits	Set the frequency to be add to or subtracted from the analog frequency reference as a percent, taking the maximum output frequency to be 100%. Enabled when the increase (+) speed command or decrease (-) speed command is set for a multi-function input.	0 to 100	10%	No	A	A	A	A	299H	6-85

■Torque Control: d5

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
d5-01	Torque control selection	0: Speed control (C5-01 to C5-07) 1: Torque control This function is only available in flux vector control method. To use the function for switching between speed and torque control, set to 0 and set the multi-function input to “speed/torque control change.”	0 or 1	0	No	No	No	No	A	29AH	6-129
d5-02	Torque reference delay time	Set the torque reference delay time in ms units. This function can be used to adjust the noise of the torque control signal or the responsiveness with the host controller. When oscillation occurs during torque control, increase the set value.	0 to 1000	0 ms	No	No	No	No	A	29BH	6-129
d5-03	Speed limit selection	Set the speed limit command method for the torque control method. 1: The analog input limit from a frequency reference (see b1-01) 2: Limited by d5-04 constant setting values.	1 or 2	1	No	No	No	No	A	29CH	6-129

5

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
d5-04	Speed limit	Set the speed limit during torque control as a percentage of the maximum output frequency. This function is enabled when d5-03 is set to 2. Directions are as follows. +: Run Command direction -: Run Command opposite direction	-120 to +120	0%	No	No	No	No	A	29DH	6-129
d5-05	Speed limit bias	Set the speed limit bias as a percentage of the maximum output frequency. Bias is given to the specified speed limit. It can be used to adjust the margin for the speed limit.	0 to 120	10%	No	No	No	No	A	29EH	6-129
d5-06	Speed/torque control switching timer	Set the delay time from inputting the multi-function input “speed/torque control change” (from On to OFF or OFF to ON) until the control is actually changed, in ms units. This function is enabled when the multi-function input “speed/torque control change” is set. In the speed/torque control switching timer, the analog inputs hold the values of when the “speed/torque control change” changes. Always be sure to allow time for this process to finish completely.	0 to 1000	0 ms	No	No	No	No	A	29FH	6-130

■Field Weakening: d6

User constants for the field weakening command are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
d6-01	Field weak-ening level	Set the Inverter output volt-age when the field weaken-ing command is input. It is enabled when the field weakening command is set for a multi-function input. Set the level as a percentage taking the voltage set in the V/f pattern as 100%.	0 to 100	80%	No	A	A	No	No	2A0H	-
d6-02	Field frequency	Set the lower limit in hertz of the frequency range where field control is valid. The field weakening com-mand is valid only at fre-quencies above this setting and only when the speed is in agreement with the cur-rent speed reference.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	No	No	2A1H	-
d6-03	Field forc-ing func-tion selection	Set the field forcing func-tion. 0: Disabled 1: Enabled	0 or 1	0	No	No	No	A	A	2A2H	-
d6-06	Field forc-ing limit	Set the excitation current ref-erence's upper limit for field forcing. Set the limit as a percentage, taking the motor's no-load current as 100%. Enabled for opera-tion other than DC excita-tion. Usually, there is no need to change this setting	100 to 400	400%	No	No	No	A	A	2A5H	-

* 1. When C6-01 = 0, the upper limit is 150.0.
* 2. When C6-01 = 1, the upper limit is 400.0.

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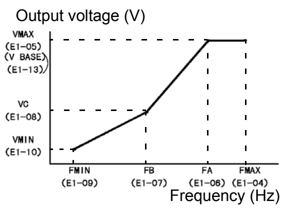
◆ Motor Constant Constants: E

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

■V/f Pattern: E1

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

<table>
<tr><th rowspan="2">Con-stant Num-ber</th><th rowspan="2">Name</th><th rowspan="2">Description</th><th rowspan="2">Setting Range</th><th rowspan="2">Factory Setting</th><th rowspan="2">Change during Opera-tion</th><th colspan="4">Control Methods</th><th rowspan="2">MEMO BUS Regis-ter</th><th rowspan="2">Page</th></tr>
<tr><th>V/f</th><th>V/f with PG</th><th>Open Loop Vec-tor</th><th>Flux Vec-tor</th></tr>
<tr><td>E1-01</td><td>Input volt-age setting</td><td>Set the Inverter input voltage in 1 volt.
This setting is used as a refer-ence value in protection func-tions.</td><td>155 to 255
*1</td><td>200 V
*1</td><td>No</td><td>Q</td><td>Q</td><td>Q</td><td>Q</td><td>300H</td><td>4-5
6-122</td></tr>
<tr><td>E1-03</td><td>V/f pattern selection</td><td>0 to E: Select from the 15 preset patterns.
F: Custom user-set patterns (Applicable for settings E1-04 to E1-10.)</td><td>0 to F</td><td>F</td><td>No</td><td>Q</td><td>Q</td><td>No</td><td>No</td><td>302H</td><td>6-122</td></tr>
<tr><td>E1-04</td><td>Max. output frequency</td><td rowspan="7">

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 fre-quencies are set in the following manner:
E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)</td><td>40.0 to 400.0
*6
40.0 to 300.0
*5</td><td>60.0 Hz
*2</td><td>No</td><td>Q</td><td>Q</td><td>Q</td><td>Q</td><td>303H</td><td>6-123</td></tr>
<tr><td>E1-05</td><td>Max. voltage</td><td>0.0 to 255.0
*1</td><td>200.0 V
*1*2</td><td>No</td><td>Q</td><td>Q</td><td>Q</td><td>Q</td><td>304H</td><td>6-123</td></tr>
<tr><td>E1-06</td><td>Base frequency</td><td>0.0 to 400.0
*6
0.0 to 300.0
*5</td><td>60.0 Hz
*2</td><td>No</td><td>Q</td><td>Q</td><td>Q</td><td>Q</td><td>305H</td><td>6-123</td></tr>
<tr><td>E1-07</td><td>Mid. output frequency</td><td>0.0 to 400.0
*6
0.0 to 300.0
*5</td><td>3.0 Hz
*2</td><td>No</td><td>A</td><td>A</td><td>A</td><td>No</td><td>306H</td><td>6-123</td></tr>
<tr><td>E1-08</td><td>Mid. output frequency voltage</td><td>0.0 to 255 *1</td><td>15.0 V
*1 *2</td><td>No</td><td>A</td><td>A</td><td>A</td><td>No</td><td>307H</td><td>4-18
4-19
6-123</td></tr>
<tr><td>E1-09</td><td>Min. output frequency</td><td>0.0 to 400.0
*6
0.0 to 300.0
*5</td><td>1.5 Hz
*2</td><td>No</td><td>Q</td><td>Q</td><td>Q</td><td>A</td><td>308H</td><td>6-123</td></tr>
<tr><td>E1-10</td><td>Min. output frequency voltage</td><td>0.0 to 255.0
*1</td><td>9.0 V
*1 *2</td><td>No</td><td>A</td><td>A</td><td>A</td><td>No</td><td>309H</td><td>4-18
4-19
6-123</td></tr>
</table>

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
E1-11	Mid. output frequency 2	Set only to fine-adjust V/f for the output range. Normally, this setting is not required.	0.0 to 400.0 *6 0.0 to 300.0 *5	0.0 Hz *3	No	A	A	A	A	30AH	6-123
E1-12	Mid. output frequency voltage 2		0.0 to 255.0 *1	0.0 V *3	No	A	A	A	A	30BH	6-123
E1-13	Base voltage		0.0 to 255.0 *1	0.0 V *4	No	A	A	Q	Q	30CH	6-123

* 1. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 2. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 3. E1-11 and E1-12 are disregarded when set to 0.0.
* 4. E1-13 is set to the same value as E1-05 by autotuning.
* 5. When C6-01 = 1, the upper limit is 400.0.
* 6. When C6-01 = 0, the upper limit is 150.0.

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■Motor Setup: E2

User constants for motor 1 are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
E2-01	Motor rated current	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque limits and torque control. This constant is automatically set during autotuning.	0.32 to 6.40 *2	1.90 A *1	No	Q	Q	Q	Q	30EH	4-5 6-60 6-120
E2-02	Motor rated slip	Sets the motor rated slip in Hz units. These set values will become the reference values for slip compensation. This constant is automatically set during autotuning.	0.00 to 20.00	2.90 Hz *1	No	A	A	A	A	30FH	6-118 6-120
E2-03	Motor no-load current	Sets the motor no-load current in 1 A units. This constant is automatically set during autotuning.	0.00 to 1.89 *3	1.20 A *1	No	A	A	A	A	310H	6-120
E2-04	Number of motor poles	Sets the number of motor poles. This constant is automatically set during autotuning.	2 to 48	4 poles	No	No	Q	No	Q	311H	6-120
E2-05	Motor line-to-line resistance	Sets the motor phase-to-phase resistance in Ω units. This constant is automatically set during autotuning.	0.000 to 65.000	9.842 Ω *1	No	A	A	A	A	312H	6-120
E2-06	Motor leak inductance	Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage. This constant is automatically set during autotuning.	0.0 to 40.0	18.2% *1	No	No	No	A	A	313H	6-120
E2-07	Motor iron saturation coefficient 1	Sets the motor iron saturation coefficient at 50% of magnetic flux. This constant is automatically set during autotuning.	0.00 to 0.50	0.50	No	No	No	A	A	314H	6-120
E2-08	Motor iron saturation coefficient 2	Sets the motor iron saturation coefficient at 75% of magnetic flux. This constant is automatically set during autotuning.	0.50 to 0.75 *4	0.75	No	No	No	A	A	315H	6-120

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
E2-09	Motor mechanical loss	Sets motor mechanical loss as a percentage of motor rated output (W). 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	No	No	No	No	A	316H	6-121
E2-10	Motor iron loss for torque compensation	Sets motor iron loss in W units.	0 to 65535	14 W *1	No	A	A	No	No	317H	6-121
E2-11	Motor rated output	Set the rated output of the motor in units of 0.01 kW. This constant is automatically set during autotuning.	0.00 to 650.00	0.40 kW *1	No	Q	Q	Q	Q	318H	6-118

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.

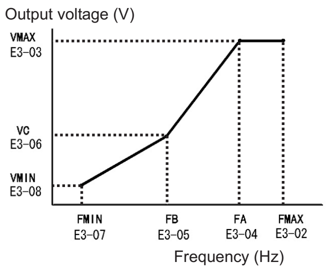
* 2. The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V Class Inverter of 0.4 kW is given.
For the motor no-load current, set E2-03 to a value less than that of E2-01.

* 3. The setting range depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given. The upper limit depends on the setting of E2-01.

* 4. The lower limit of E2-08 is the setting value of E2-07.

■ Motor 2 V/f Pattern: E3

User constants for motor 2 V/f characteristics are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Page
E3-01	Motor 2 control method selection	0: V/f control 1: V/f control with PG 2: Open-loop vector control 3: Flux vector control	0 to 2 0 to 3	0	No	A	A	A	A	319H	-
E3-02	Motor 2 max. output frequency (FMAX)	 To set V/f characteristics in a straight line, set the same values for E3-05 and E3-07. In this case, the setting for E3-06 will be disregarded. Always ensure that the four frequencies are set in the following manner: E3-02 (FMAX) ≥ E3-04 (FA) > E3-05 (FB) > E3-07 (FMIN)	40.0 to 400.0 *4 40.0 to 300.0 *3	60.0 Hz	No	A	A	A	A	31AH	-
E3-03	Motor 2 max. voltage (VMAX)		0.0 to 255.0 *1	200.0 V *2	No	A	A	A	A	31BH	-
E3-04	Motor 2 max. voltage frequency (FA)		0.0 to 400.0 *4 0.0 to 300.0 *3	60.0 Hz	No	A	A	A	A	31CH	-
E3-05	Motor 2 mid. output frequency 1 (FB)		0.0 to 400.0 *4 0.0 to 300.0 *3	3.0 Hz *2	No	A	A	A	No	31DH	-
E3-06	Motor 2 mid. output frequency voltage 1 (VC)		0.0 to 255.0 *1	15.0 V *1	No	A	A	A	No	31EH	-
E3-07	Motor 2 min. output frequency (FMIN)		0.0 to 400.0 *4 0.0 to 300.0 *3	1.5 Hz *2	No	A	A	A	A	31FH	-
E3-08	Motor 2 min. output frequency voltage (VMIN)		0.0 to 255.0 *1	9.0 V *1	No	A	A	A	No	320H	-

* 1. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 2. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 3. When C6-01 = 1, the upper limit is 400.0.
* 4. When C6-01 = 0, the upper limit is 150.0.

■Motor 2 Setup: E4

User constants for motor 2 are shown in the following table.

Con- stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera- tion	Control Methods				MEMO BUS Regis- ter	Page
						V/f	V/f with PG	Open Loop Vec- tor	Flux Vec- tor		
E4-01	Motor 2 rated cur- rent	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque lim- its and torque control. This constant is automati- cally set during autotuning.	0.32 to 6.40 *2	1.90 A *1	No	A	A	A	A	321H	6-60
E4-02	Motor 2 rated slip	Sets the motor rated slip in Hz units. These set values will become the reference values for slip compensation. This constant is automati- cally set during autotuning.	0.00 to 20.00	2.90 Hz *1	No	A	A	A	A	322H	-
E4-03	Motor 2 no- load current	Sets the motor no-load cur- rent in 1 A units. This constant is automati- cally set during autotuning.	0.00 to 1.89 *3	1.20 A *1	No	A	A	A	A	323H	-
E4-04	Motor 2 number of poles (num- ber of poles)	Sets the number of motor poles. This constant is automati- cally set during autotuning.	2 to 48	4 poles	No	No	A	No	A	324H	-
E4-05	Motor 2 line-to-line resistance	Sets the motor phase-to- phase resistance in Ω units. This constant is automati- cally set during autotuning.	0.000 to 65.000	9.842 Ω *1	No	A	A	A	A	325H	-
E4-06	Motor 2 leak induc- tance	Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage. This constant is automati- cally set during autotuning.	0.0 to 40.0	18.2% *1	No	No	No	A	A	326H	-
E4-07	Motor 2 rated capac- ity	Set the rated output of the motor in units of 0.01 kW. This constant is automati- cally set during autotuning.	0.00 to 650.00	0.40 kW *1	No	A	A	A	A	327H	-

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.
* 2. The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V Class Inverter of 0.4 kW is given.
* 3. If a multi-function input is set for motor 2 (H1-☐☐ = 16), the setting range will depend upon the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given. The upper limit depends on the setting of E4-01.

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◆ Option Constants: F

The following settings are made with the option constants (F constants): Settings for option boards

■PG Option Setup: F1

User constants for the PG Speed Control Board are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
F1-01	PG constant	Sets the number of PG (pulse generator or encoder) pulses. Sets the number of pulses per motor revolution.	0 to 60000	600	No	No	Q	No	Q	380H	6-157
F1-02	Operation selection at PG open circuit (PGO)	Sets the PG disconnection stopping method. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (To protect the motor or machinery, do not normally make this setting.)	0 to 3	1	No	No	A	No	A	381H	6-157
F1-03	Operation selection at overspeed (OS)	Sets the stopping method when an overspeed (OS) fault occurs. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (To protect the motor or machinery, do not normally make this setting.)	0 to 3	1	No	No	A	No	A	382H	6-157

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Page
F1-04	Operation selection at deviation	Sets the stopping method when a speed deviation (DEV) fault occurs. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (DEV is displayed and operation continued.)	0 to 3	3	No	No	A	No	A	383H	6-157
F1-05	PG rotation	0: Phase A leads with Forward Run Command. (Phase B leads with Reverse Run Command.) 1: Phase B leads with Forward Run Command. (Phase A leads with Reverse Run Command.)	0 or 1	0	No	No	A	No	A	384H	6-158
F1-06	PG division rate (PG pulse monitor)	Sets the division ratio for the PG speed control board pulse output. Division ratio = (1+ n) /m (n=0 or 1 m=1 to 32) F1-06 = □ □□ n m This constant is only effective when a PG-B2 is used. The possible division ratio settings are: 1/32 ≤ F1-06 ≤ 1.	1 to 132	1	No	No	A	No	A	385H	6-158
F1-07	Integral value during accel/decel enable/disable	Sets integral control during acceleration/deceleration to either enabled or disabled. 0: Disabled (The integral function isn't used while accelerating or decelerating; it is used at constant speeds.) 1: Enabled (The integral function is used at all times.)	0 or 1	0	No	No	A	No	No	386H	6-158
F1-08	Overspeed detection level	Sets the overspeed detection method. Frequencies above that set for F1-08 (set as a percentage of the maximum output frequency) that continue to exceed this frequency for the time set in F1-09 are detected as overspeed faults.	0 to 120	115%	No	No	A	No	A	387H	6-158
F1-09	Overspeed detection delay time		0.0 to 2.0	0.0 s *	No	No	A	No	A	388H	6-158

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
F1-10	Excessive speed deviation detection level	Sets the speed deviation detection method. Any speed deviation above the F1-10 set level (set as a percentage of the maximum output frequency) that continues for the time set in F1-11 is detected as a speed deviation. Speed deviation is the difference between actual motor speed and the reference command speed.	0 to 50	10%	No	No	A	No	A	389H	6-158
F1-11	Excessive speed deviation detection delay time		0.0 to 10.0	0.5 s	No	No	A	No	A	38AH	6-158
F1-12	Number of PG gear teeth 1	Sets the number of teeth on the gears if there are gears between the PG and the motor.	0 to 1000	0	No	No	A	No	No	38BH	6-158
F1-13	Number of PG gear teeth 2	$\frac{\text{Input pulses from PG} \times 60}{\text{F1-01}} \times \frac{\text{F1-13}}{\text{F1-12}}$ A gear ratio of 1 will be used if either of these constants is set to 0.		0	No	No	A	No	No	38CH	6-158
F1-14	PG open-circuit detection time	Used to set the PG disconnection detection time. PGO will be detected if the detection time continues beyond the set time.	0.0 to 10.0	2.0 s	No	No	A	No	A	38DH	6-158

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

■Analog Reference Board: F2

User constants for the Analog Reference Board are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
F2-01	Bi-polar or uni-polar input selection	Sets the functions for channel 1 to 3 which are effective when the AI-14B Analog Reference Board is used. 0: 3-channel individual (Channel 1: terminal A1, Channel 2: terminal A2, Channel 3: terminal A3) 1: 3-channel addition (Addition values are the frequency reference) When set to 0, select 1 for b1-01. In this case the multi-function input “Option/ Inverter selection” cannot be used.	0 or 1	0	No	A	A	A	A	38FH	6-164

■Digital Reference Board: F3

User constants for the Digital Reference Board are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
F3-01	Digital input option	Sets the Digital Reference Board input method. 0: BCD 1% unit 1: BCD 0.1% unit 2: BCD 0.01% unit 3: BCD 1 Hz unit 4: BCD 0.1 Hz unit 5: BCD 0.01 Hz unit 6: BCD special setting (5-digit input) 7: Binary input 6 is only effective when the DI-16H2 is used. When o1-03 is set to 2 or higher, the input will be BCD, and the units will change to the o1-03 setting.	0 to 7	0	No	A	A	A	A	390H	6-164

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■Analog Monitor Boards: F4

User constants for the Analog Monitor Board are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register	Page
F4-01	Channel 1 monitor selection	Effective when the Analog Monitor Board is used. Monitor selection: Set the number of the monitor item to be output. (U1-□□) The monitor items that can be set depends on the control method. Gain: Set the multiple of 10 V for outputting monitor items. 4, 10 to 14, 25, 28, 31, 34, 35, 39, 40, 42 cannot be set. 29 to 31 are not used. When the AO-12 Analog Monitor Board is used, outputs of ± 10 V are possible. To output ± 10 V, set F4-07 or F4-08 to 1. When the AO-08 Analog Monitor Board is used, only outputs of 0 to +10 V are possible. A meter calibration function is available.*	1 to 99	2	No	A	A	A	A	391H	6-92
F4-02	Channel 1 gain		0.00 to 2.50	1.00	Yes	A	A	A	A	392H	6-92
F4-03	Channel 2 monitor selection		1 to 99	3	No	A	A	A	A	393H	6-92
F4-04	Channel 2 gain		0.00 to 2.50	0.50	Yes	A	A	A	A	394H	6-92
F4-05	Channel 1 output monitor bias	Sets the channel 1 item bias to 100%/10 V when the Analog Monitor Board is used.	-10.0 to 10.0	0.0%	Yes	A	A	A	A	395H	6-92
F4-06	Channel 2 output monitor bias	Sets the channel 2 item bias to 100%/10 V when the Analog Monitor Board is used.	-10.0 to 10.0	0.0%	Yes	A	A	A	A	396H	6-92
F4-07	Analog output signal level for channel 1	0: 0 to 10 V 1: -10 to +10 V	0 or 1	0	No	A	A	A	A	397H	6-92
F4-08	Analog output signal level for channel 2	0: 0 to 10 V 1: -10 to +10 V	0 or 1	0	No	A	A	A	A	398H	6-92

* The CH1 output can be adjusted when the F4-02 or F4-05 setting is displayed in Quick, Advanced, or Verify mode while the motor is stopped.
The CH2 output can be adjusted when the F4-04 or F4-06 setting is displayed in Quick, Advanced, or Verify mode while the motor is stopped.
For analog output, the value equivalent to 100% of output value of monitored item is multiplied by the gain setting and the set bias is added.

■Digital Output Boards (DO-02C and DO-08): F5

User constants for the Digital Output Board are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
F5-01	Channel 1 output selection	Effective when a Digital Output Board (DO-02C or DO-08) is used. Set the number of the multi-function output to be output.	0 to 37	0	No	A	A	A	A	399H	6-161
F5-02	Channel 2 output selection	Effective when a Digital Output Board (DO-02C or DO-08) is used. Set the number of the multi-function output to be output.	0 to 37	1	No	A	A	A	A	39AH	6-161
F5-03	Channel 3 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	2	No	A	A	A	A	39BH	6-161
F5-04	Channel 4 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	4	No	A	A	A	A	39CH	6-161
F5-05	Channel 5 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	6	No	A	A	A	A	39DH	6-161
F5-06	Channel 6 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	37	No	A	A	A	A	39EH	6-161
F5-07	Channel 7 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	0F	No	A	A	A	A	39FH	6-162
F5-08	Channel 8 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	0F	No	A	A	A	A	3A0H	6-162
F5-09	DO-08 output mode selection	Effective when a DO-08 Digital Output Board is used. Set the output mode. 0: 8-channel individual outputs 1: Binary code output 2: Output according to F5-01 to F5-08 settings.	0 to 2	0	No	A	A	A	A	3A1H	6-162

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■Communications Option Boards: F6

User constants for a Communications Option Board are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
F6-01	Operation selection after com-munica-tions error	Set the stopping method for communications errors. 0: Deceleration stop using deceleration time in C1-02 1: Coast to stop 2: Emergency stop using deceleration time in C1-09 3: Continue operation	0 to 3	1	No	A	A	A	A	3A2H	-
F6-02	Input level of external fault from Communi-cations Option Board	0: Always detect 1: Detect during operation	0 or 1	0	No	A	A	A	A	3A3H	-
F6-03	Stopping method for external fault from Communi-cations Option Board	0: Deceleration stop using deceleration time in C1-02 1: Coast to stop 2: Emergency stop using deceleration time in C1-09 3: Continue operation	0 to 3	1	No	A	A	A	A	3A4H	-
F6-04	Trace sam-pling from Communi-cations Option Board	-	0 to 60000	0	No	A	A	A	A	3A5H	-
F6-06	Torque ref-erence/ torque limit selection from opti-cal option	0: Torque reference/torque limit from transmission disabled. 1: Torque reference/torque limit from transmission enabled.	0 or 1	0	No	No	No	No	A	3A7H	-
F6-08 *	Operation selection after SI-T WDT error	Set the stopping method for SI-T WDT errors (E5). 0: Deceleration stop using deceleration time in C1-02 1: Coast to stop 2: Emergency stop using deceleration time in C1-09 3: Continue operation	0 to 3	1	No	A	A	A	A	3B6H	-
F6-09 *	Number of SI-T BUS error detec-tion	Set the number which SI-T detects BUS errors.	2 to 10	2	No	A	A	A	A	3B7H	-

* Refer to *MECHATROLINK COMMUNICATIONS INTERFACE CARD INSTRUCTIONS (TOBPC73060008)* for details.

◆ Terminal Function Constants: H

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

■Multi-function Contact Inputs: H1

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
H1-01	Terminal S3 function selection	Multi-function contact input 1	0 to 78	24	No	A	A	A	A	400H	-
H1-02	Terminal S4 function selection	Multi-function contact input 2	0 to 768	14	No	A	A	A	A	401H	-
H1-03	Terminal S5 function selection	Multi-function contact input 3	0 to 78	3 (0)*	No	A	A	A	A	402H	-
H1-04	Terminal S6 function selection	Multi-function contact input 4	0 to 78	4 (3)*	No	A	A	A	A	403H	-
H1-05	Terminal S7 function selection	Multi-function contact input 5	0 to 78	6 (4)*	No	A	A	A	A	404H	-
H1-06	Terminal S8 function selection	Multi-function contact input 6	0 to 78	8 (6) *	No	A	A	A	A	4-5H	-

* The values in parentheses indicate factory settings when initialized in 3-wire sequence.

Multi-function Contact Input Functions

Setting Value	Function	Control Methods				Page
		V/f	V/f with PG	Open Loop Vector	Flux Vector	
0	3-wire sequence (Forward/Reverse Run Command)	Yes	Yes	Yes	Yes	6-16
1	Local/Remote selection (ON: Local, OFF: Remote)	Yes	Yes	Yes	Yes	6-79
2	Option/Inverter selection (ON: Option board)	Yes	Yes	Yes	Yes	6-86 6-164
3	Multi-step speed reference 1 When H3-09 is set to 2, this function is combined with the master/auxiliary speed switch.	Yes	Yes	Yes	Yes	6-10
4	Multi-step speed reference 2	Yes	Yes	Yes	Yes	6-10
5	Multi-step speed reference 3	Yes	Yes	Yes	Yes	6-10
6	Jog frequency command (higher priority than multi-step speed reference)	Yes	Yes	Yes	Yes	6-10
7	Accel/decel time 1	Yes	Yes	Yes	Yes	6-26
8	External baseblock NO (NO contact: Baseblock at ON)	Yes	Yes	Yes	Yes	6-80
9	External baseblock NC (NC contact: Baseblock at OFF)	Yes	Yes	Yes	Yes	6-80

Setting Value	Function	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	Page
A	Acceleration/deceleration ramp hold (ON: Acceleration/deceleration stopped, frequency on hold)	Yes	Yes	Yes	Yes	6-81
B	OH2 alarm signal input (ON: OH2 will be displayed)	Yes	Yes	Yes	Yes	-
C	Multi-function analog input selection (ON: Enable)	Yes	Yes	Yes	Yes	-
D	No V/f control with PG (ON: Speed feedback control disabled,) (normal V/f control)	No	Yes	No	No	6-137
E	Speed control integral reset (ON: Integral control disabled)	No	Yes	No	Yes	6-137
F	Not used (Set when a terminal is not used)	-	-	-	-	-
10	Up command (Always set with the down command)	Yes	Yes	Yes	Yes	6-82
11	Down command (Always set with the up command)	Yes	Yes	Yes	Yes	6-82
12	FJOG command (ON: Forward run at jog frequency d1-17)	Yes	Yes	Yes	Yes	6-87
13	RJOG command (ON: Reverse run at jog frequency d1-17)	Yes	Yes	Yes	Yes	6-87
14	Fault reset (Reset when turned ON)	Yes	Yes	Yes	Yes	7-2
15	Emergency stop. (Normally open condition: Deceleration to stop in deceleration time set in C1-09 when ON.)	Yes	Yes	Yes	Yes	6-24
16	Motor switch command (Motor 2 selection)	Yes	Yes	Yes	Yes	-
17	Emergency stop (Normally closed condition: Deceleration to stop in deceleration time set in C1-09 when OFF)	Yes	Yes	Yes	Yes	6-24
18	Timer function input (Functions are set in b4-01 and b4-02 and the timer function outputs are set in H1-☐☐ and H2-☐☐.)	Yes	Yes	Yes	Yes	6-108 7-21
19	PID control disable (ON: PID control disabled)	Yes	Yes	Yes	Yes	6-112
1A	Accel/Decel time 2	Yes	Yes	Yes	Yes	6-26
1B	Constants write enable (ON: All constants can be written-in. OFF: All constants other than frequency monitor are write protected.)	Yes	Yes	Yes	Yes	6-155
1C	Trim control increase (ON: d4-02 frequency is added to analog frequency reference.)	Yes	Yes	Yes	Yes	6-85
1D	Trim control decrease (ON: d4-02 frequency is subtracted from analog frequency reference.)	Yes	Yes	Yes	Yes	6-85
1E	Analog frequency reference sample/hold	Yes	Yes	Yes	Yes	6-86
20 to 2F	External fault (Desired settings possible) Input mode: NO contact/NC contact, Detection mode: Normal/during operation	Yes	Yes	Yes	Yes	6-88
30	PID control integral reset (reset when reset command is input or when stopped during PID control)	Yes	Yes	Yes	Yes	6-112
31	PID control integral hold (ON: Hold)	Yes	Yes	Yes	Yes	6-112
32	Multi-step speed reference 4	Yes	Yes	Yes	Yes	-
34	PID soft starter ON/OFF	Yes	Yes	Yes	Yes	6-112
35	PID input characteristics switch	Yes	Yes	Yes	Yes	6-112
60	DC injection braking command (ON: Performs DC injection braking)	Yes	Yes	Yes	Yes	6-23
61	External search command 1 (ON: Speed search from maximum output frequency)	Yes	No	Yes	No	6-69
62	External search command 2 (ON: Speed search from set frequency)	Yes	No	Yes	No	6-69

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	Page
63	Field weakening command (ON: Field weakening control set for d6-01 and d6-02)	Yes	Yes	No	No	-
64	External speed search command 3 (NC contact)	Yes	Yes	Yes	Yes	-
65	KEB (deceleration at momentary power loss) command (NC contact)	Yes	Yes	Yes	Yes	-
66	KEB (deceleration at momentary power loss) command (NO contact)	Yes	Yes	Yes	Yes	-
67	Communications test mode (“Pass” is displayed when the communication test is passed.)	Yes	Yes	Yes	Yes	6-107
68	High-slip braking (HSB)	Yes	Yes	No	No	-
71	Speed/torque control change (ON: Torque control)	No	No	No	Yes	6-131 6-135
72	Zero-servo command (ON: Zero-servo)	No	No	No	Yes	6-145
77	Speed control (ASR) proportional gain switch (ON: C5-03)	No	No	No	Yes	6-137
78	Polarity reversing command for external torque reference	No	No	No	Yes	6-131

■ Multi-function Contact Outputs: H2

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H2-01	Terminal M1-M2 function selection (contact)	Multi-function contact output	0 to 3D	0	No	A	A	A	A	40BH	-
H2-02	Terminal P1 function selection (open collector)	Multi-function contact output 1	0 to 3D	1	No	A	A	A	A	40CH	-
H2-03	Terminal P2 function selection (open collector)	Multi-function contact output 2	0 to 3D	2	No	A	A	A	A	40DH	-

Multi-function Contact Output Functions

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	Page
0	During run (ON: Run Command is ON or voltage is being output)	Yes	Yes	Yes	Yes	6-89
1	Zero-speed	Yes	Yes	Yes	Yes	6-89
2	Frequency agree 1 (L4-02 used.)	Yes	Yes	Yes	Yes	6-54
3	Desired frequency agree 1 (ON: Output frequency = ±L4-01, L4-02 used and during frequency agree)	Yes	Yes	Yes	Yes	6-54

Setting Value	Function	Control Methods				Page
		V/f	V/f with PG	Open Loop Vector	Flux Vector	
4	Frequency (FOUT) detection 1 (ON: +L4-01 ≥ output frequency ≥ -L4-01, L4-02 used)	Yes	Yes	Yes	Yes	6-54
5	Frequency (FOUT) detection 2 (ON: Output frequency ≥ +L4-01 or output frequency ≤ -L4-01, L4-02 used)	Yes	Yes	Yes	Yes	6-54
6	Inverter operation ready READY: After initialization, no faults	Yes	Yes	Yes	Yes	-
7	During DC bus undervoltage (UV) detection	Yes	Yes	Yes	Yes	-
8	During baseblock (ON: during baseblock)	Yes	Yes	Yes	Yes	-
9	Frequency reference selection (ON: Frequency reference from Operator)	Yes	Yes	Yes	Yes	-
A	Run Command selection status (ON: Run Command from Operator)	Yes	Yes	Yes	Yes	-
B	Overtorque/undertorque detection 1 NO (NO contact: Overtorque/undertorque detection at ON)	Yes	Yes	Yes	Yes	6-57
C	Loss of frequency reference (Effective when 1 is set for L4-05)	Yes	Yes	Yes	Yes	6-74
D	Braking resistor fault (ON: Resistor overheat or braking transistor fault)	Yes	Yes	Yes	Yes	6-77
E	Fault (ON: Digital Operator communications error or fault other than CPF00 and CPF01 has occurred.)	Yes	Yes	Yes	Yes	-
F	Not used. (Set when the terminals are not used.)	-	-	-	-	-
10	Minor fault (ON: Alarm displayed)	Yes	Yes	Yes	Yes	-
11	Fault reset command active	Yes	Yes	Yes	Yes	-
12	Timer function output	Yes	Yes	Yes	Yes	6-108
13	Frequency agree 2 (L4-04 used)	Yes	Yes	Yes	Yes	6-54
14	Desired frequency agree 2 (ON: Output frequency = L4-03, L4-04 used, and during frequency agree)	Yes	Yes	Yes	Yes	6-54
15	Frequency detection 3 (ON: Output frequency ≤ L4-03, L4-04 used)	Yes	Yes	Yes	Yes	6-54
16	Frequency detection 4 (ON: Output frequency ≥ L4-03, L4-04 used)	Yes	Yes	Yes	Yes	6-54
17	Overtorque/undertorque detection 1 NC (NC Contact: Torque detection at OFF)	Yes	Yes	Yes	Yes	6-57
18	Overtorque/undertorque detection 2 NO (NO Contact: Torque detection at ON)	Yes	Yes	Yes	Yes	6-57
19	Overtorque/undertorque detection 2 NC (NC Contact: Torque detection at OFF)	Yes	Yes	Yes	Yes	6-57
1A	During reverse run (ON: During reverse run)	Yes	Yes	Yes	Yes	-
1B	During baseblock 2 (OFF: During baseblock)	Yes	Yes	Yes	Yes	-
1C	Motor selection (Motor 2 selected)	Yes	Yes	Yes	Yes	-
1D	During regeneration (ON: During regeneration)	No	No	No	Yes	-
1E	Restart enabled (ON: Restart enabled)	Yes	Yes	Yes	Yes	6-75
1F	Motor overload (OL1, including OH3) pre-alarm (ON: 90% or more of the detection level)	Yes	Yes	Yes	Yes	6-61 6-90
20	Inverter overheat (OH) pre-alarm (ON: Temperature exceeds L8-02 setting)	Yes	Yes	Yes	Yes	6-90
30	During torque limit (current limit) (ON: During torque limit)	No	No	Yes	Yes	-
31	During speed limit (ON: During speed limit)	No	No	No	Yes	6-90

Setting Value	Function	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	Page
32	Speed control circuit operating for torque control (except when stopped). The external torque reference will be limited if torque control is selected (internal torque reference < external torque reference). Output when the motor is rotating at the speed limit.	No	No	No	Yes	6-131
33	Zero-servo end (ON: Zero-servo function completed)	No	No	No	Yes	6-90 6-146
36*1	Frequency (FOUT) detection 5	Yes	Yes	Yes	Yes	6-53
37	During run 2 (ON: Frequency output, OFF: Base block, DC injection braking, initial excitation, operation stop)	Yes	Yes	Yes	Yes	6-90
3D*2	Inverter's Cooling Fan Fault detected	Yes	Yes	Yes	Yes	6-76

* 1. Applicable for F7-series Inverters with software versions PRG:1032 or later.
* 2. Applicable for F7-series Inverters with software versions PRG:1031 or later.

■Analog Inputs: H3

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H3-01	Signal level selection (terminal A1)	0: 0 to 10 V 1: –10 to 10 V	0 or 1	0	No	A	A	A	A	410H	6-35
H3-02	Gain (terminal A1)	Sets the frequency when 10 V is input, as a percentage of the maximum output frequency.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	411H	6-35
H3-03	Bias (terminal A1)	Sets the frequency when 0 V is input, as a percentage of the maximum frequency.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	412H	6-35
H3-04	Signal level selection (terminal A3)	0: 0 to 10 V 1:–10 to 10 V	0 or 1	0	No	A	A	A	A	413H	6-35 6-130
H3-05	Multi-function analog input (terminal A3) function selection	Select from the functions listed in the following table. Refer to the next page.	0 to 1F	1F	No	A	A	A	A	414H	6-35 6-130
H3-06	Gain (terminal A3)	Sets the input gain (level) when 10V is input. Set according to the 100% value selected from H3-05.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	415H	6-35 6-130
H3-07	Bias (terminal A3)	Sets the input gain (level) when 0V is input. Set according to the 100% value selected from H3-05.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	416H	6-35 6-130

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H3-08	Signal level selection (terminal A2)	0: 0 to +10V, with lower limit 1: –10 to 10 V, without lower limit 2: 4 to 20 mA. Switch current and voltage input using the switch on the control panel.	0 to 2	2	No	A	A	A	A	417H	6-35 6-130
H3-09	Multi-function analog input (terminal A2) function selection	Select multi-function analog input function for terminal A2. Refer to the next table.	0 to 1F	0	No	A	A	A	A	418H	6-35 6-130
H3-10	Gain (terminal A2)	Sets the input gain (level) when 10 V (20 mA) is input. Set according to the 100% value for the function set for H3-09.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	419H	6-35 6-130
H3-11	Bias (terminal A2)	Sets the input gain (level) when 0 V (4 mA) is input. Set according to the 100% value for the function set for H3-09.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	41AH	6-35 6-130
H3-12	Analog input filter time constant	Sets primary delay filter time constant in seconds for the analog input terminal. Effective for noise control etc.	0.00 to 2.00	0.00 s 0.03 s	No	A	A	A	A	41BH	4-20 6-36
H3-13	Terminal A1/A2 switching	0: Use terminal A1 analog input as main speed frequency reference. 1: Use terminal A2 analog input as main speed frequency reference. Effective when H3-09 is set to 2 and H3-05 is not set to 0 or 2.	0 or 1	0	No	A	A	A	A	41CH	-

H3-05 and H3-09 Settings

Setting Value	Function	Contents (100%)	Control Methods				Page
			V/f	V/f with PG	Open Loop Vector	Flux Vector	
0	Add to terminal A1	Maximum output frequency	Yes	Yes	Yes	Yes	6-37 6-131
1	Frequency gain	Frequency reference (voltage) command value	Yes	Yes	Yes	Yes	6-36
2	Auxiliary frequency reference 1 (2nd step analog)	Maximum output frequency	Yes	Yes	Yes	Yes	6-11
3	Auxiliary frequency reference 2 (3rd step analog)	Maximum output frequency	Yes	Yes	Yes	Yes	6-11
4	Voltage bias	200V (200V-class), 400V (400V-class)	Yes	Yes	No	No	-
5	Accel/decel change (reduction coefficient)	Set acceleration and deceleration times (C1-01 to C1-08)	Yes	Yes	Yes	Yes	6-27
6	DC injection braking current	Inverter rated output current	Yes	Yes	Yes	No	6-23
7	Overtorque/undertorque detection level	Motor rated torque for vector control Inverter rated output current for V/f control	Yes	Yes	Yes	Yes	6-59
8	Stall prevention level during run	Inverter rated output current	Yes	Yes	No	No	6-53
9	Frequency reference lower limit level	Maximum output frequency	Yes	Yes	Yes	Yes	6-42
A	Jump frequency	Maximum output frequency	Yes	Yes	Yes	Yes	6-39
B	PID feedback	Maximum output frequency	Yes	Yes	Yes	Yes	6-112
C	PID target value	Maximum output frequency	Yes	Yes	Yes	Yes	6-112
D	Frequency bias 2	Maximum output frequency	Yes	Yes	Yes	Yes	6-37
E	Motor temperature input	10 V = 100%	Yes	Yes	Yes	Yes	6-64
10	Positive torque limit	Motor's rated torque	No	No	Yes	Yes	6-50
11	Negative torque limit	Motor's rated torque	No	No	Yes	Yes	6-50
12	Regenerative torque limit	Motor's rated torque	No	No	Yes	Yes	6-50
13	Torque reference/torque limit at speed control	Motor’s rated torque	No	No	No	Yes	6-131
14	Torque compensation	Motor’s rated torque	No	No	Yes	Yes	6-131
15	Positive/negative torque limit	Motor's rated torque	No	No	Yes	Yes	6-50
1F	Analog input not used.	-	Yes	Yes	Yes	Yes	6-11
16 to 1E	Not used	-	-	-	-	-	-

■Multi-function Analog Outputs: H4

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
H4-01	Monitor selection (terminal FM)	Sets the number of the monitor item to be output (U1-□□) from terminal FM. The monitor items that can be set depends on the control method. 4, 10 to 14, 25, 28 to 31, 34, 35, 39 to 43 cannot be set.	1 to 99	2	No	A	A	A	A	41DH	6-91
H4-02	Gain (terminal FM)	Sets the multi-function analog output 1 voltage level gain. Sets whether the monitor item output will be output in multiples of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available. *	0.00 to 2.50	1.00	Yes	Q	Q	Q	Q	41EH	4-6 6-91
H4-03	Bias (terminal FM)	Sets the multi-function analog output 1 voltage level bias. Sets output characteristic up/down parallel movement as a percentage of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available. *	-10.0 to +10.0	0.0%	Yes	A	A	A	A	41FH	6-91
H4-04	Monitor selection (terminal AM)	Sets the number of the monitor item to be output (U1-□□) from terminal AM. The monitor items that can be set depends on the control method. 4, 10 to 14, 25, 28 to 31, 34, 35, 39 to 43 cannot be set.	1 to 99	3	No	A	A	A	A	420H	6-91
H4-05	Gain (terminal AM)	Set the voltage level gain for multi-function analog output 2. Set the number of multiples of 10 V to be output as the 100% output for the monitor items. The maximum output from the terminal is 10 V. A meter calibration function is available.*	0.00 to 2.50	0.50	Yes	Q	Q	Q	Q	421H	4-6 6-91
H4-06	Bias (terminal AM)	Sets the multi-function analog output 2 voltage level bias. Sets output characteristic up/down parallel movement as a percentage of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available.*	-10.0 to +10.0	0.0%	Yes	A	A	A	A	422H	6-92

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H4-07	Analog output 1 signal level selection	Sets the signal output level for multi-function output 1 (terminal FM) 0: 0 to +10 V output 1: −10 to 10 V output	0 or 1	0	No	A	A	A	A	423H	6-92
H4-08	Analog output 2 signal level selection	Sets the signal output level for multi-function output 2 (terminal AM) 0: 0 to +10 V output 1: −10 to 10 V output	0 or 1	0	No	A	A	A	A	424H	-

* The CH1 output can be adjusted when the H4-02 or H4-03 setting is displayed in Quick, Advanced, or Verify mode while the motor is stopped.
The CH2 output can be adjusted when the H4-05 or H4-06 setting is displayed in Quick, Advanced, or Verify mode while the motor is stopped.
For analog output, the value equivalent to 100% of output value of monitored item is multiplied by the gain setting and the set bias is added.

■MEMOBUS Communications: H5

User constants for MEMOBUS communications are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H5-01	Slave address	Set the Inverter's slave address.	0 to 20 *1	1FH	No	A	A	A	A	425H	6-98
H5-02	Communication speed selection	Set the baud rate for MEMOBUS communications of communications connection terminals. 0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps	0 to 4	3	No	A	A	A	A	426H	6-98
H5-03	Communication parity selection	Set the parity for MEMOBUS communications of communications connection terminals. 0: No parity 1: Even parity 2: Odd parity	0 to 2	0	No	A	A	A	A	427H	6-98
H5-04	Stopping method after communication error	Set the stopping method for communications errors. 0: Deceleration to stop using deceleration time in C1-02 1: Coast to stop 2: Emergency stop using deceleration time in C1-09 3: Continue operation	0 to 3	3	No	A	A	A	A	428H	6-98

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
H5-05	Communication error detection selection	Set whether or not a communications timeout is to be detected as a communications error. 0: Do not detect. 1: Detect	0 or 1	1	No	A	A	A	A	429H	6-98
H5-06	Send wait time	Set the time from the Inverter receiving data to when the Inverter starts to send.	5 to 65	5 ms	No	A	A	A	A	42AH	6-98
H5-07	RTS control ON/ OFF	Select to enable or disable RTS control. 0: Disabled (RTS is always ON) 1: Enabled (RTS turns ON only when sending)	0 or 1	1	No	A	A	A	A	42BH	6-98
H5-10 *2	Unit Selection for MEMOBUS Register 0025H	Selects the units used for MEMOBUS registry 0025H (monitors the output voltage reference). 0: 0.1 V units 1: 1 V units	0, 1	0	No	A	A	A	A	436H	6-98

* 1. Set H5-01 to 0 to disable Inverter responses to MEMOBUS communications.
* 2. Applicable for F7-series Inverters with software versions PRG: 1032 or later.

■Pulse Train I/O: H6

User constants for pulse I/O are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
H6-01	Pulse train input function selection	0: Frequency reference 1: PID feedback value 2: PID target value	0 to 2	0	No	A	A	A	A	42CH	6-6 6-40 6-111
H6-02	Pulse train input scaling	Set the number of pulses in hertz, taking the reference to be 100%.	1000 to 32000	1440 Hz	Yes	A	A	A	A	42DH	6-6 6-40
H6-03	Pulse train input gain	Set the input gain level as a percent when the pulse train set in H6-02 is input.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	42EH	6-40
H6-04	Pulse train input bias	Set the input bias when the pulse train is 0.	-100.0 to 100.0	0.0%	Yes	A	A	A	A	42FH	6-40
H6-05	Pulse train input filter time	Set the pulse train input primary delay filter time constant in seconds.	0.00 to 2.00	0.10 s	Yes	A	A	A	A	430H	6-40

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
H6-06	Pulse train monitor selection	Select the pulse train monitor output items (value of the □□ part of U1-□□). There are two types of monitor items: Speed-related items and PID-related items.	1, 2, 5, 20, 24, 36	2	Yes	A	A	A	A	431H	6-94
H6-07	Pulse train monitor scaling	Set the number of pulses output when speed is 100% in hertz. Set H6-06 to 2, and H6-07 to 0, to make the pulse train monitor output synchronously to the output frequency.	0 to 32000	1440 Hz	Yes	A	A	A	A	432H	6-94

◆ Protection Function Constants: L

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

■Motor Overload: L1

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L1-01	Motor protection selection	Sets whether the motor overload function is enabled or disabled at electric thermal overload relay. 0: Disabled 1: General-purpose motor protection 2: Inverter motor protection 3: Vector motor protection In some applications when the Inverter power supply is turned off, the thermal value is reset, so even if this constant is set to 1, protection may not be effective. When several motors are connected to one Inverter, set to 0 and ensure that each motor is installed with a protection device.	0 to 3	1	No	Q	Q	Q	Q	480H	4-6 6-60

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L1-02	Motor protection time constant	Sets the electric thermal detection time in seconds units. Usually setting is not necessary. The factory setting is 150% overload for one minute. When the motor's overload resistance is known, also set the overload resistance protection time for when the motor is hot started.	0.1 to 5.0	1.0 min	No	A	A	A	A	481H	6-60
L1-03	Alarm operation selection during motor overheating	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and select the operation when the input motor temperature (thermistor) input exceeds the alarm detection level [1.17 V (±5%)]. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop using the deceleration time in C1-09. 3: Continue operation (H3 on the Operator flashes).	0 to 3	3	No	A	A	A	A	482H	6-63
L1-04	Motor overheating operation selection	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and select the operation when the motor temperature (thermistor) input exceeds the operation detection level [2.34V (±5%)]. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop using the deceleration time in C1-09.	0 to 2	1	No	A	A	A	A	483H	6-63
L1-05	Motor temperature input filter time constant	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and set the primary delay time constant for motor temperature (thermistor) inputs in seconds.	0.00 to 10.00	0.20 s	No	A	A	A	A	484H	6-63

■Power Loss Ridethrough: L2

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L2-01	Momentary power loss detection	0: Disabled [main circuit undervoltage (UV1) detection] 1: Enabled [Restarted when the power returns within the time for L2-02. When L2-02 is exceeded, main circuit undervoltage (UV1) is detected.] 2: Enabled while CPU is operating. [Restarts when power returns during control operations. Does not detect main circuit undervoltage. (UV1)]	0 to 2	0	No	A	A	A	A	485H	6-66
L2-02	Momentary power loss ridethru time	Ridethrough time, when Momentary Power Loss Selection (L2-01) is set to 1, in units of seconds.	0 to 25.5	0.1 s *1	No	A	A	A	A	486H	6-66
L2-03	Min. baseblock time	Sets the Inverter's minimum baseblock time in units of one second, when the Inverter is restarted after power loss ridethrough. Sets the time to approximately 0.7 times the motor secondary circuit time constant. When an overcurrent or overvoltage occurs when starting a speed search or DC injection braking, increase the set values.	0.1 to 5.0	0.2 s *1	No	A	A	A	A	487H	6-66 6-69
L2-04	Voltage recovery time	Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search, in units of one second. Sets the time required to recover from 0 V to the maximum voltage.	0.0 to 5.0	0.3 s *1	No	A	A	A	A	488H	6-67 6-69
L2-05	Undervoltage detection level	Sets the main circuit undervoltage (UV) detection level (main circuit DC voltage) in V units. Usually setting is not necessary. Insert an AC reactor in the Inverter input side to lower the main circuit undervoltage detection level.	150 to 210 *2	190 V *2	No	A	A	A	A	489H	6-67

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Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
L2-06	KEB decel-eration time	Sets in seconds the time required to decelerate from the speed where the deceler-ation at momentary power loss command (KEB) is input to zero-speed.	0.0 to 200.0	0.0 s	No	A	A	A	A	48AH	-
L2-07	Momentary recovery time	Set in seconds the time to accelerate to the set speed after recovery from a momentary power loss.	0.0 to 25.5	0.0 s *3	No	A	A	A	A	48BH	-
L2-08	Frequency reduction gain at KEB start	Sets as a percent the about to reduce the output frequency at the beginning of decelera-tion at momentary power loss (KEB). Reduction = slip frequency before KEB operation × L2-08 × 2	0 to 300	100%	No	A	A	A	A	48CH	-

Note Attach a Backup Capacitor Unit for Momentary Power Loss if compensation for power interruptions of up to 2.0 seconds is required for 200 V/400 V Class Inverters with outputs of 0.4 to 11 kW.

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.
* 2. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 3. If the setting is 0, the axis will accelerate to the specified speed over the specified acceleration time (C1-01 to C1-08).

■Stall Prevention: L3

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
L3-01	Stall pre-vention selection during accel	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 is returned.) 2: Intelligent acceleration mode (Using the L3-02 level as a basis, acceleration is automatically adjusted. Set acceleration time is disregarded.)	0 to 2	1	No	A	A	A	No	48FH	4-20 6-30
L3-02	Stall pre-vention level during accel	Effective when L3-01 is set to 1 or 2. Set as a percentage of Inverter rated current. Usually setting is not neces-sary. The factory setting reduces the set values when the motor stalls.	0 to 200	120% *1 150% *1	No	A	A	A	No	490H	4-20 6-30

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L3-03	Stall prevention limit during accel	Sets the lower limit for stall prevention during acceleration, as a percentage of the Inverter rated current, when operation is in the frequency range above E1-06. Usually setting is not necessary.	0 to 100	50%	No	A	A	A	No	491H	4-20 6-30
L3-04	Stall prevention selection during decel	0: Disabled (Deceleration as set. If deceleration time is too short, a main circuit overvoltage may result.) 1: Enabled (Deceleration is stopped when the main circuit voltage exceeds the overvoltage level. Deceleration restarts when voltage is returned.) 2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that in Inverter can decelerate in the shortest possible time. Set deceleration time is disregarded.) 3: Enabled (with Braking Resistor Unit) When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3.	0 to 3 *2	1	No	Q	Q	Q	Q	492H	4-6 4-20 6-32
L3-05	Stall prevention selection during running	0: Disabled (Runs as set. With a heavy load, the motor may stall.) 1: Deceleration time 1 (the deceleration time for the stall prevention function is C1-02.) 2: Deceleration time 2 (the deceleration time for the stall prevention function is C1-04.)	0 to 2	1	No	A	A	No	No	493H	4-20 6-52
L3-06	Stall prevention level during running	Effective when L3-05 is 1 or 2. Set as a percentage of the Inverter rated output current. Usually setting is not necessary. The factory setting reduces the set values when the motor stalls.	30 to 200	120% *1 150% *1	No	A	A	No	No	494H	4-20 6-52

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L3-11	Overvoltage inhibit selection	0: Disabled 1: Enabled Used to enable or disable the function for inhibiting main circuit overvoltages by reducing the regenerative torque limit according to the main circuit overvoltage level. If this function is enabled, when the main circuit voltage rises, operation will be performed with the regenerative torque less than the set value.	0 or 1	0	No	No	No	A	A	4C7H	4-20 6-34 7-2
L3-12	Overvoltage inhibit voltage level	Sets the main circuit voltage level for which the regenerative torque limit is restricted to 0. Usually, there is no need to change this setting. If main circuit overvoltages occur even with the overvoltage inhibit function enabled, reduce this setting.	350 to 390 *3	380V *3	No	No	No	A	A	4C8H	4-20 6-34

* 1. C6-01 = 1:120%, C6-01 = 0:150%
* 2. When using flux vector control, 0 to 2.
* 3. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.

■Reference Detection: L4

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L4-01	Speed agreement detection level	Effective when “Desired frequency (ref/setting) agree 1,” “Frequency detection 1,” or “Frequency detection 2" is set for a multi-function output. Frequencies to be detected are set in Hz units.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	499H	6-53
L4-02	Speed agreement detection width	Effective when “Frequency (speed) agree 1,” “Desired frequency (speed) agree 1,” or “Frequency (FOUT) detection 1,” Frequency (FOUT) detection 2 is set for a multi-function output. Sets the frequency detection width in Hz units.	0.0 to 20.0	2.0 Hz	No	A	A	A	A	49AH	6-53

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L4-03	Speed agreement detection level (+/-)	Effective when "Desired frequency (speed) agree 2," "Frequency (FOUT) detection 3," or "Frequency (FOUT) detection 4" is set for a multi-function output. Frequency that should be detected is set in Hz units.	-400.0 to +400.0 *3 -300.0 to +300.0 *4	0.0 Hz	No	A	A	A	A	49BH	6-54
L4-04	Speed agreement detection width (+/-)	Effective when "Frequency (speed) agree 2," "Desired frequency (speed) agree 2," Frequency (FOUT) detection 3 or "Frequency detection 4" is set for a multi-function output. Frequency detection width is set in Hz units.	0.0 to 20.0	2.0 Hz	No	A	A	A	A	49CH	6-54
L4-05	Operation when frequency reference is missing	0: Stop (Operation follows the frequency reference.) 1: Operation at 80% speed continues. (At 80% of speed before the frequency reference was lost) Frequency reference is lost: Frequency reference dropped over 90% in 400 ms.	0 or 1	0	No	A	A	A	A	49DH	6-74

* 1. When C6-01 = 0, the upper limit is 150.0.
* 2. When C6-01 = 1, the upper limit is 400.0.
* 3. When C6-01 = 0, -150.0 to +150.0.
* 4. When C6-01 = 1, -400.0 to +400.0.

■Fault Restart: L5

User constants for restarting faults are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L5-01	Number of auto restart attempts	Sets the number of auto restart attempts. Automatically restarts after a fault and conducts a speed search from the run frequency.	0 to 10	0	No	A	A	A	A	49EH	6-75
L5-02	Auto restart operation selection	Sets whether a fault contact output is activated during fault restart. 0: Not output (Fault contact is not activated.) 1: Output (Fault contact is activated.)	0 or 1	0	No	A	A	A	A	49FH	6-75

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■Torque Detection: L6

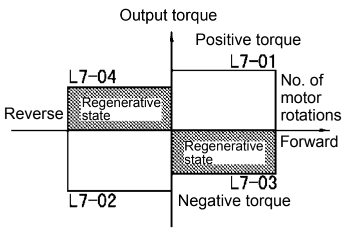
User constants for the torque detection function are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L6-01	Torque detection selection 1	0: Overtorque/undertorque detection disabled. 1: Overtorque detection only with speed agreement; operation continues after overtorque (warning). 2: Overtorque detected continuously during operation; operation continues after overtorque (warning). 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 overtorque (warning). 6: Undertorque detected continuously during operation; operation continues after overtorque (warning). 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).	0 to 8	0	No	A	A	A	A	4A1H	6-56
L6-02	Torque detection level 1	Open loop vector control: Motor rated torque is set as 100%. V/f control: Inverter rated current is set as 100%.	0 to 300	150%	No	A	A	A	A	4A2H	6-56
L6-03	Torque detection time 1	Sets the overtorque/undertorque detection time in 1-second units.	0.0 to 10.0	0.1 s	No	A	A	A	A	4A3H	6-57

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L6-04	Torque detection selection 2	Output of torque detection 1 is enabled by setting B or 17 for H2-□□ and output of torque detection 1 is enabled by setting 18 or 18 for H2-□□.	0 to 8	0	No	A	A	A	A	4A4H	6-57
L6-05	Torque detection level 2		0 to 300	150%	No	A	A	A	A	4A5H	6-57
L6-06	Torque detection time 2		0.0 to 10.0	0.1 s	No	A	A	A	A	4A6H	6-57

■Torque Limits: L7

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
L7-01	Forward drive torque limit	Sets the torque limit value as a percentage of the motor rated torque. Four individual regions can be set. 	0 to 300	200%	No	No	No	A	A	4A7H	4-20 6-49
L7-02	Reverse drive torque limit		0 to 300	200%	No	No	No	A	A	4A8H	4-20 6-49
L7-03	Forward regenerative torque limit		0 to 300	200%	No	No	No	A	A	4A9H	4-20 6-49
L7-04	Reverse regenerative torque limit		0 to 300	200%	No	No	No	A	A	4AAH	4-20 6-49
L7-06	Integral time setting for torque limit	Set the integral time for the torque limit. When integral control is set for the torque limit, reduce this setting to increase the change in frequency for the torque limit.	5 to 10000	200 ms	No	No	No	A	No	4ACH	4-20 6-49

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L7-07	Control method selection for torque limit during acceleration and deceleration	Select the control method for the torque limit during acceleration and deceleration. 0: Proportional control (integral control during constant speed) 1: Integral control Usually, this constant does not need to be set. For applications in which the torque limit will be reached during acceleration and deceleration, torque control can be given priority by selecting integral control. When the torque is limited, the acceleration and deceleration times may increase or the motor speed may not agree with the speed reference value.	0 or 1	0	No	No	No	A	No	4C9H	4-20 6-49

■Hardware Protection: L8

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L8-01	Protect selection for internal DB resistor (Type ERF)	0: Disabled (no overheating protection) 1: Enabled (overheating protection)	0 or 1	0	No	A	A	A	A	4ADH	6-77
L8-02	Overheat pre-alarm level	Sets the detection temperature for the Inverter overheat detection pre-alarm in °C. The pre-alarm detects when the cooling fin temperature reaches the set value.	50 to 130	95 °C *1	No	A	A	A	A	4AEH	6-78
L8-03	Operation selection after overheat pre-alarm	Sets the operation for when the Inverter overheat pre-alarm goes ON. 0: Decelerate to stop in deceleration time C1-02. 1: Coast to stop 2: Fast stop in fast-stop time C1-09. 3: Continue operation (Monitor display only.) A fault will be given in setting 0 to 2 and a minor fault will be given in setting 3.	0 to 3	3	No	A	A	A	A	4AFH	6-78

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
L8-05	Input open-phase protection selection	0: Disabled 1: Enabled (Detects if input current open-phase, power supply voltage imbalance or main circuit electrostatic capacitor deterioration occurs.) This fault is detected if a load is greater than approximately 80% of the maximum motor capacity.	0 or 1	0	No	A	A	A	A	4B1H	-
L8-07	Output open-phase protection selection	0: Disabled 1: Enabled (Detects one output open-phase.) 2: Enabled (Detects more than one output open-phases) Output open-phase is detected at less than 5% of Inverter rated current. When applied motor capacity is small for Inverter capacity, output open-phase may be detected inadvertently or open-phase may not be detected. In this case, set to 0.	0 to 1 0 to 2	0	No	A	A	A	A	4B3H	-
L8-09	Ground protection selection	0: Disabled 1: Enabled	0 or 1	1	No	A	A	A	A	4B5H	-
L8-10	Cooling fan control selection	Set the ON/OFF control for the cooling fan. 0: ON only when Inverter is ON 1: ON whenever power is ON	0 or 1	0	No	A	A	A	A	4B6H	-
L8-11	Cooling fan control delay time	Set the time in seconds to delay turning OFF the cooling fan after the cooling fan OFF command is received.	0 to 300	60 s	No	A	A	A	A	4B7H	-
L8-12	Ambient temperature	Set the ambient temperature. If set to 60 °C, the Inverter overload protection function (OL2) will start 20% earlier.	45 to 60	45 °C	No	A	A	A	A	4B8H	-
L8-15	OL2 characteristics selection at low speeds	0: OL2 characteristics at low speeds disabled. 1: OL2 characteristics at low speeds enabled.	0 or 1	1	No	A	A	A	A	4BBH	-
L8-18	Soft CLA selection	0: Disable 1: Enable	0 or 1	1 *2	No	A	A	A	A	4BEH	-
L8-32 *3	OH1 detection of Inverter' s cooling fan	0: Disabled (FAN minor fault detection) 1: Enabled (OH1 major fault detection)	0 or 1	1	No	A	A	A	A	4E2H	6-76

* 1. The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.
* 2. When the control method is changed, the factory setting will change. The V/f control factory setting is given.
* 3. Applicable for F7-Series Inverters with software versions PRG:1031 or later.

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◆ N: Special Adjustments

The following settings are made with the special adjustments constants (N constants): Hunting prevention, speed feedback detection control, high-slip braking, and feed forward control.

■Hunting Prevention Function: N1

User constants for hunting prevention are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
N1-01	Hunting-prevention function selection	0: Hunting-prevention function disabled 1: Hunting-prevention function enabled The hunting-prevention function suppresses hunting when the motor is operating with a light load. This function is enabled in V/f control method only. If high response is to be given priority over vibration suppression, disable the hunting-prevention function.	0 or 1	1	No	A	A	No	No	580H	6-47
N1-02	Hunting-prevention gain	Set the hunting-prevention gain multiplication factor. Normally, there is no need to make this setting. Make the adjustments as follows: • If vibration occurs with light load, increase the setting. • If the motor stalls, reduce the setting. If the setting is too large, the voltage will be too suppressed and the motor may stall.	0.00 to 2.50	1.00	No	A	A	No	No	581H	4-18 6-47

■Speed Feedback Protection Control Functions: N2

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
N2-01	Speed feed-back detec-tion control (AFR) gain	Set the internal speed feed-back detection control gain using the multiplication function. Normally, there is no need to make this setting. Adjust this constant as fol-lows: • 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	1.00	No	No	No	A	No	584H	4-18 6-48
N2-02	Speed feed-back detec-tion control (AFR) time constant	Set the time constant to decide the rate of change in the speed feedback detec-tion control.	0 to 2000	50 ms	No	No	No	A	No	585H	6-48
N2-03	Speed feed-back detec-tion control (AFR) time constant 2	Set the time constant to decide the amount of change in the speed.	0 to 2000	750 ms	No	No	No	A	No	586H	6-48

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■High-slip Braking: N3

User constants for high-slip braking are shown in the following table.

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
N3-01	High-slip braking decelera-tion fre-quency width	Sets the frequency width for deceleration during high-slip braking as a percent, taking the Maximum Frequency (E1-04) as 100%.	1 to 20	5%	No	A	A	No	No	588H	-
N3-02	High-slip braking cur-rent limit	Sets the current limit for deceleration during high-slip braking as a percent, taking the motor rated current as 100%. The resulting limit must be 150% of the Inverter rated current or less.	100 to 200	150%	No	A	A	No	No	589H	-

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
N3-03	High-slip braking stop dwell time	Set in seconds the dwell time for the output frequency for FMIN (1.5 Hz) during V/f control. Effective only during deceleration for high-slip braking.	0.0 to 10.0	1.0 s	No	A	A	No	No	58AH	-
N3-04	High-slip braking OL time	Set the OL time when the output frequency does not change for some reason during deceleration for high-slip braking.	30 to 1200	40 s	No	A	A	No	No	58BH	-

■Feed Forward: N5

User constants for the feed forward control are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register	Page
						V/f	V/f with PG	Open Loop Vector	Flux Vector		
N5-01	Feed forward control selection	Select the feed forward control. 0: Disabled 1: Enabled	0 or 1	0	No	No	No	No	A	5B0H	4-20 6-142
N5-02	Motor acceleration time	Set the time required to accelerate the motor at the rated torque (T_{100}) to the rated speed (Nr). J: $GD^2/4$, P: Motor rated output $ta = \frac{2\pi \cdot J\,[kgm^2] \cdot Nr\,[min^{-1}]}{60 \cdot T_{100}\,[N \cdot m]}\,[s]$ However, $T_{100} = \frac{60}{2\pi} \cdot \frac{P\,[kW]}{Nr\,[min^{-1}]} \times 10^3\,[N \cdot m]$	0.001 to 10.000	0.178 s *	No	No	No	No	A	5B1H	4-20 6-142
N5-03	Feed forward proportional gain	Set the proportional gain for feed forward control. Speed reference response will increase as the setting of N5-03 is increased.	0.00 to 100.00	1.0	No	No	No	No	A	5B2H	4-20 6-142
N5-04	Response frequency for speed command	Sets the response frequency to a speed command in units of 0.01 Hz. Used when the machine rigidity is high and the N5-03 is correctly adjusted. Usually, setting is not required.	0.00 to 50.00	40.00 Hz	No	No	No	No	A	5B3H	4-20 6-142

* The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter for 0.4 kW is given.

◆ Digital Operator Constants: o

The following settings are made with the Digital Operator constants (o constants): Multi-function selections and the copy function.

■Monitor Select: o1

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
o1-01	Monitor selection	Set the number of the monitor item to be displayed in the earliest 4 monitor items. (U1-□□) The output monitor voltage (factory setting) can be changed.	4 to 99	6	Yes	A	A	A	A	500H	-
o1-02	Monitor selection after power up	Sets the monitor item to be displayed when the power is turned on. 1: Frequency reference 2: Output frequency 3: Output current 4: The monitor item set for o1-01	1 to 4	1	Yes	A	A	A	A	501H	6-148
o1-03	Frequency units of reference setting and monitor	Sets the units that will be set and displayed for the frequency reference and frequency monitor. 0: 0.01 Hz units 1: 0.01% units (Maximum output frequency is 100%) 2 to 39: min^{-1} units (Sets the motor poles.) 40 to 39999: User desired display Set the desired values for setting and display for the max. output frequency. □□□□□ Set 4-digit number excluding the decimal point. Set the number of digits below the decimal point to display. Example: When the max. output frequency value is 200.0, set 12000	0 to 39999	0	No	A	A	A	A	502H	6-148 6-165

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
o1-04	Setting unit for fre-quency con-stants related to V/f character-istics	Set the setting unit for frequency reference-related constants. 0: Hz 1: min^{-1}	0 or 1	0	No	No	No	No	A	503H	6-148
o1-05	LCD bright-ness adjust-ment LCD Con-trast	Set a smaller value to lighten the LCD and a larger value to darken the LCD (standard: 3).	0 to 5	3	Yes	A	A	A	A	504H	-

■Multi-function Selections: o2

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

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter	Page
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor		
o2-01	LOCAL/REMOTE key enable/disable	Sets the Digital Operator Local/Remote Key 0: Disabled 1: Enabled (Switches between the Digital Operator and the constant settings.)	0 or 1	1	No	A	A	A	A	505H	6-148
o2-02	STOP key during con-trol circuit terminal operation	Sets the Stop Key in the run mode. 0: Disabled (When the Run Command is issued from and external terminal, the Stop Key is disabled.) 1: Enabled (Effective even during run.)	0 or 1	1	No	A	A	A	A	506H	6-149
o2-03	User con-stant initial value	Clears or stores user initial values. 0: Stores/not set 1: Begins storing (Records the set constants as user initial values.) 2: All clear (Clears all recorded user initial values) When the set constants are recorded as user initial val-ues, 1110 will be set in A1-03.	0 to 2	0	No	A	A	A	A	507H	4-17 6-149
o2-04	kVA selec-tion	Do not set unless using a control board from an Inverter with a different capacity.	0 to FF	0*1	No	A	A	A	A	508H	-

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
o2-05	Frequency reference setting method selection	When the frequency reference is set on the Digital Operator frequency reference monitor, sets whether the Enter Key is necessary. 0: Enter Key needed 1: Enter Key not needed When set to 1, the Inverter accepts the frequency reference without Enter Key operation.	0 or 1	0	No	A	A	A	A	509H	6-149
o2-06	Operation selection when digital operator is disconnected	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 is cut off, and fault contact is operated.)	0 or 1	0	No	A	A	A	A	50AH	-
o2-07	Cumulative operation time setting	Sets the cumulative operation time in hour units. Operation time is calculated from the set values.	0 to 65535	0 hr	No	A	A	A	A	50BH	6-149
o2-08	Cumulative operation time selection	0: Cumulative time when the Inverter power is on. (All time while the Inverter power is on is accumulated.) 1: Cumulative Inverter run time. (Only Inverter output time is accumulated.)	0 or 1	0	No	A	A	A	A	50CH	-
o2-09 *2	For factory adjustment	For adjustment at factory Do not set this constant.	0, 3	0	No	A	A	A	A	50DH	-
o2-10	Fan operation time setting	Set the initial value of the fan operation time using time units. The operation time accumulates from the set value.	0 to 65535	0 hr	No	A	A	A	A	50EH	6-149
o2-12	Fault trace/fault history clear function	0: Disabled (U2 and U3 constants are on hold.) 1: Enabled (Initializes U2 and U3 constants.)	0 or 1	0	No	A	A	A	A	510H	-
o2-14	Output power monitor clear selection	0: Holds output power monitor. 1: Initializes output power monitor. (Returns to 0.)	0 or 1	0	No	A	A	A	A	512H	5-77

* 1. The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.
* 2. Applicable for F7-series Inverters with software versions PRG: 1033 or later.

■ Copy Function: o3

User constants for the copy function are shown in the following table.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
o3-01	Copy function selection	0: Normal operation 1: READ (Inverter to Operator) 2: COPY (Operator to Inverter) 3: Verify (compare)	0 to 3	0	No	A	A	A	A	515H	6-151
o3-02	Read permitted selection	0: Read prohibited 1: Read permitted	0 or 1	0	No	A	A	A	A	516H	6-151

◆ T: Motor Autotuning

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register	Page
T1-00	Motor 1/2 selection	Set the location where the autotuned motor constants are to be stored. 1: E1 to E2 (motor 1) 2: E3 to E4 (motor 2)	1 or 2	1	No	Yes	Yes	Yes	Yes	700H	4-13
T1-01	Autotuning mode selection	Set the autotuning mode. 0: Rotational autotuning 1: Stationary autotuning 1 2: Stationary autotuning for line-to-line resistance only 4: Stationary autotuning 2	0 to 2 *1 0 to 2, 4 *1	2 *8	No	Yes	Yes	Yes	Yes	701H	4-10 4-13
T1-02	Motor output power	Set the output power of the motor in kilowatts.	0.00 to 650.00	0.40 kW *4	No	Yes	Yes	Yes	Yes	702H	4-13
T1-03	Motor rated voltage	Set the rated voltage of the motor in volts.	0.0 to 255.0*2	200.0 V *2	No	No	No	Yes	Yes	703H	4-13
T1-04	Motor rated current	Set the rated current of the motor in amps.	0.32 to 6.40 *3	1.90 A *4	No	Yes	Yes	Yes	Yes	704H	4-13
T1-05	Motor base frequency	Set the base frequency of the motor in hertz.	0.0 to 400.0*7 0.0 to 300.0*5	60.0 Hz	No	No	No	Yes	Yes	705H	4-13
T1-06	Number of motor poles	Set the number of motor poles.	2 to 48 poles	4 poles	No	No	No	Yes	Yes	706H	4-13
T1-07	Motor base speed	Set the base speed of the motor in min^{-1}.	0 to 24000	1750 min^{-1}	No	No	No	Yes	Yes	707H	4-13
T1-08	Number of PG pulses when turning	Set the number of pulses per revolution for the PG being used (pulse generator or encoder) without any multiplication factor.	0 to 60000	600	No	No	No	No	Yes	708H	4-13
T1-09	Motor no-load current	Set the current value recorded in the motor's test results for a motor without a load. Displayed only when Stationary autotuning 2 is selected (T1-01 = 4).	0.00 to 1.89 *6	1.20A *4	No	No	No	Yes	Yes	709H	4-13

* 1. Set T1-02 and T1-04 when 2 is set for T1-01. Only set value 2 is possible for V/f control or V/f control with PG.
* 2. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 3. The setting range is from 10% to 200% of the Inverter rated output current. The value for a 200 V Class Inverter for 0.4 kW is given.
* 4. The factory setting depends on the Inverter capacity. The values for a 200 V Class Inverter for 0.4 kW are given.
* 5. When C6-01 = 1, the upper limit is 400.00.
* 6. The setting range depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given. The upper limit depends on the setting of E2-01.
* 7. When C6-01 = 0, the upper limit is 150.0.
* 8. When the control method is changed, the factory setting will change. The V/f control factory setting is given.

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◆ U: Monitor Constants

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

■ Status Monitor Constants: U1

The constants used for monitoring status are listed in the following table.

Con-stant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMO BUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U1-01	Frequency reference	Monitors/sets the frequency reference value.*	10 V: Max. frequency (−10 to 10 V possible)	0.01 Hz	A	A	A	A	40H
U1-02	Output frequency	Monitors the output frequency.*	10 V: Max. frequency (−10 to 10 V possible)	0.01 Hz	A	A	A	A	41H
U1-03	Output current	Monitors the output current.	10 V: Inverter rated output current (0 to +10 V, absolute value output)	0.01 A	A	A	A	A	42H
U1-04	Control method	Checks the current control method.	(Cannot be output.)	-	A	A	A	A	43H
U1-05	Motor speed	Monitors the detected motor speed.*	10 V: Max. frequency (−10 to 10 V possible)	0.01 Hz	No	A	A	A	44H
U1-06	Output voltage	Monitors the output voltage reference value in the Inverter.	10 V: 200 VAC (400 VAC) (0 to +10 V output)	0.1 V	A	A	A	A	45H
U1-07	DC bus voltage	Monitors the main DC voltage in the Inverter.	10 V: 400 VDC (800 VDC) (0 to +10 V output)	1 V	A	A	A	A	46H
U1-08	Output power	Monitors the output power (internally detected value).	10 V: Inverter capacity (max. applicable motor capacity) (−10 to 10 V possible)	0.1 kW	A	A	A	A	47H
U1-09	Torque reference	Monitor in internal torque reference value for vector control.	10 V: Motor rated torque (−10 to 10 V possible)	0.1%	No	No	A	A	48H

* The unit is set in o1-03 (frequency units of reference setting and monitor).

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMOBUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U1-10	Input terminal status	Shows input ON/OFF status U1-10= 1: FWD command (S1) is ON. 1: REV command (S2) is ON. 1: Multi input 1 (S3) is ON. 1: Multi input 2 (S4) is ON. 1: Multi input 3 (S5) is ON. 1: Multi input 4 (S6) is ON. 1: Multi input 5 (S7) is ON. 1: Multi input 6 (S8) is ON.	(Cannot be output.)	-	A	A	A	A	49H
U1-11	Output terminal status	Shows output ON/OFF status. U1-11= 1: Multi-function contact output (M1-M2) is ON. 1: Multi-funtion contact output 1 (P1) is ON. 1: Multi-funtion contact output 2 (P2) is ON. Not used (always 0). 1: Error output (MA/AB-MC) is ON.	(Cannot be output.)	-	A	A	A	A	4AH
U1-12	Operation status	Inverter operating status. U1-12= 1: Run 1: Zero speed 1: Reverse 1: Reset signal input 1: Speed agree 1: Inverter ready 1: Minor fault 1: Major fault	(Cannot be output.)	-	A	A	A	A	4BH
U1-13	Cumulative operation time	Monitors the total operating time of the Inverter. The initial value and the operating time/power ON time selection can be set in o2-07 and o2-08.	(Cannot be output.)	1 hr	A	A	A	A	4CH
U1-14	Software No. (flash memory)	(Manufacturer's ID number)	(Cannot be output.)	-	A	A	A	A	4DH
U1-15	Terminal A1 input voltage	Monitors the input voltage of the voltage frequency reference. An input of 10 V corresponds to 100%.	10 V: 100% (10 V) (−10 to 10 V possible)	0.1%	A	A	A	A	4EH
U1-16	Terminal A2 input current (voltage)	Monitors the input current of the multi-function analog input. An input of 20 mA corresponds to 100%.	20 mA: 100% (4 to 20 mA) (0 to 10 V, −10 to 10 V possible)	0.1%	A	A	A	A	4FH

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMO BUS Register
U1-17	Terminal A3 input voltage	Monitors the input voltage of the multi-function analog input. An input of 10 V corresponds to 100%.	10 V: 100% (10 V) (−10 to 10 V possible)	0.1%	A	A	A	A	050H
U1-18	Motor secondary current (Iq)	Monitors the calculated value of the motor secondary current. The motor rated secondary current corresponds to 100%.	10 V:Motor rated secondary current) (−10 to 10 V output)	0.1%	A	A	A	A	51H
U1-19	Motor exciting current (Id)	Monitors the calculated value of the motor excitation current. The motor rated secondary current corresponds to 100%.	10 V:Motor rated secondary current) (−10 to 10 V output)	0.1%	No	No	A	A	52H
U1-20	Output frequency after soft-start	Monitors the output frequency after a soft start. The frequency given does not include compensations, such as slip compensation. The unit is set in o1-03.	10 V: Max. frequency (−10 to 10 V possible)	0.01 Hz	A	A	A	A	53H
U1-21	ASR input	Monitors the input to the speed control loop. The maximum frequency corresponds to 100%.	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	No	A	No	A	54H
U1-22	ASR output	Monitors the output from the speed control loop. The motor rated secondary current corresponds to 100%.	10 V:Motor rated secondary current) (−10 to 10 V possible)	0.01 %	No	A	No	A	55H
U1-24	PID feedback value	Monitors the feedback value when PID control is used. The input for the max. frequency corresponds to 100%.	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	57H
U1-26	Output voltage reference (Vq)	Monitors the Inverter internal voltage reference for motor secondary current control.	10 V: 200 VAC (400 VAC) (−10 to 10 V possible)	0.1 V	No	No	A	A	59H
U1-27	Output voltage reference (Vd)	Monitors the Inverter internal voltage reference for motor excitation current control.	10 V: 200 VAC (400 VAC) (−10 to 10 V possible)	0.1 V	No	No	A	A	5AH
U1-28	Software No. (CPU)	(Manufacturer’s CPU software No.)	(Cannot be output.)	-	A	A	A	A	5BH

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register
U1-29	Output power lower 4 digits	Monitors the Inverter's output power. The display is split into upper digits and lower digits in the following way. □□□□□ □□□.□ kWH U1-30 U1-29 Example: If the output power is 12345678.9 kWh, the display will be as follows: U1-29: 678.9 kWH U1-30: 12345 MWH Range: 0.0 to 32767999.9	(Cannot be output.)	kWH	A	A	A	A	05CH
U1-30	Output power upper 5 digits			MWH	A	A	A	A	05DH
U1-31	LED check	Lights all LEDs on the Digital Operator JVOP-161.	(Cannot be output.)	-	A	A	A	A	3CH
U1-32	ACR output of q axis	Monitors the current control output value for the motor secondary current.	10 V: 100% (−10 to 10 V possible)	0.1 %	No	No	A	A	5FH
U1-33	ACR output of d axis	Monitors the current control output value for the motor excitation current.	10 V: 100% (−10 to 10 V possible)	0.1 %	No	No	A	A	60H
U1-34	OPE fault constant	Shows the first constant number where an OPE fault was detected.	(Cannot be output.)	-	A	A	A	A	61H
U1-35	Zero-servo movement pulses	Shows the number of PG pulses times 4 for the movement range when stopped at zero.	(Cannot be output.)	1	No	No	No	A	62H
U1-36	PID input volume	PID feedback volume Given as maximum frequency/100%	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	63H
U1-37	PID output volume	PID control output Given as maximum frequency/100%	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	64H
U1-38	PID target value	PID target value Given as maximum frequency/100%	10 V: Max. frequency	0.01 %	A	A	A	A	65H
U1-39	MEMOBUS communications error code	Shows MEMOBUS errors. U1-39= 1: CRC error 1: Data length error Not used (always 0). 1: Parity error 1: Overrun error 1: Framing error 1: Timeout Not used (always 0).	(Cannot be output.)	-	A	A	A	A	66H

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Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMO BUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U1-40	Cooling fan operating time	Monitors the total operating time of the cooling fan. The time can be set in 02-10.	(Cannot be output.)	1 hr	A	A	A	A	68H
U1-44	ASR output without filter	Monitors the output from the speed control loop (i.e., the primary filter input value). 100% is displayed for rated secondary current of the motor.	10 V: Rated secondary current of motor (-10 V to 10 V)	0.01 %	No	No	No	A	6BH
U1-45	Feed forward control output	Monitors the output from feed forward control. 100% is displayed for rated secondary current of the motor.	10 V: Rated secondary current of motor (-10 V to 10 V)	0.01 %	No	No	No	A	6CH

■ Fault Trace: U2

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

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMOBUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U2-01	Current fault	The contents of the current fault.	(Cannot be output.)	-	A	A	A	A	80H
U2-02	Previous fault	The contents of the error that occurred just prior to the current fault.		-	A	A	A	A	81H
U2-03	Reference frequency at fault	The reference frequency when the previous fault occurred.		0.01 Hz	A	A	A	A	82H
U2-04	Output frequency at fault	The output frequency when the previous fault occurred.		0.01 Hz	A	A	A	A	83H
U2-05	Output current at fault	The output current when the previous fault occurred.		0.1 A	A	A	A	A	84H
U2-06	Motor speed at fault	The motor speed when the previous fault occurred.		0.01 Hz	No	A	A	A	85H
U2-07	Output voltage reference at fault	The output reference voltage when the previous fault occurred.		0.1 V	A	A	A	A	86H
U2-08	DC bus voltage at fault	The main current DC voltage when the previous fault occurred.		1 V	A	A	A	A	87H
U2-09	Output power at fault	The output power when the previous fault occurred.		0.1 kW	A	A	A	A	88H
U2-10	Torque reference at fault	The reference torque when the previous fault occurred. The motor rated torque corresponds to 100%.		0.1%	No	No	A	A	89H
U2-11	Input terminal status at fault	The input terminal status when the previous fault occurred. The format is the same as for U1-10.		-	A	A	A	A	8AH
U2-12	Output terminal status at fault	The output terminal status when the previous fault occurred. The format is the same as for U1-11.		-	A	A	A	A	8BH
U2-13	Operation status at fault	The operating status when the previous fault occurred. The format is the same as for U1-12.		-	A	A	A	A	8CH
U2-14	Cumulative operation time at fault	The operating time when the previous fault occurred.		1 hr	A	A	A	A	8DH

Note 1. The following faults are not included in the fault trace: CPF00, 01, 02, 03, UV1, and UV2.
2. If the PUF fault is already indicated in U2-xx or U3-xx, even if the PUF fault is detected again, the fault trace is not updated. (SPEC: E or later only)

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■Fault History: U3

User constants for the error log are shown in the following table.

Con-stant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMO BUS Regis-ter
					V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
U3-01	Most recent fault	The error contents of 1st previous fault.	(Cannot be output.)	-	A	A	A	A	90H
U3-02	Second most recent fault	The error contents of 2nd previous fault.		-	A	A	A	A	91H
U3-03	Third most recent fault	The error contents of 3rd previous fault.		-	A	A	A	A	92H
U3-04	Fourth most recent fault	The error contents of 4th previous fault.		-	A	A	A	A	93H
U3-05	Cumulative operation time at fault	The total operating time when the 1st previous fault occurred.		1 hr	A	A	A	A	94H
U3-06	Accumu-lated time of second fault	The total operating time when the 2nd previous fault occurred.		1 hr	A	A	A	A	95H
U3-07	Accumu-lated time of third fault	The total operating time when the 3rd previous fault occurred.		1 hr	A	A	A	A	96H
U3-08	Accumu-lated time of fourth fault	The total operating time when the 4th previous fault occurred.		1 hr	A	A	A	A	97H

Note 1. The following errors are not recorded in the error log: CPF00, 01, 02, 03, UV1, and UV2.
2. If the PUF fault is already indicated in U2-xx or U3-xx, even if the PUF fault is detected again, the fault trace is not updated. (SPEC: E or later only)

◆ Factory Settings that Change with the Control Method (A1-02)

The factory settings of the following user constants will change if the control method (A1-02) is changed.

Con-stant Number	Name	Setting Range	Unit	Factory Setting: V/f Con-trol A1-02=0	Factory Setting: V/F with PG A1-02=1	Factory Setting: Open Loop Vector A1-02=2	Factory Setting: Flux Vector A1-02=3
b3-01	Speed search selection	0 to 3	1	2	3	2	-
b3-02	Speed search operating current	0 to 200	1%	120*6 150*6	-	100	-
b8-02	Energy-saving gain	0.0 to 10.0	0.1	-	-	0.7	1.0
b8-03	Energy-saving filter time constant	0.00 to 10.00	0.01 s	-	-	0.50*1	0.01*1
C3-01	Slip compensation gain	0.0 to 2.5	0.1	0.0	-	1.0	1.0
C3-02	Slip compensation primary delay time constant	0 to 10000	1 ms	2000	-	200	-
C4-02	Torque compensation primary delay time constant	0 to 10000	1 ms	200*7	200*7	20	-
C5-01	ASR proportional (P) gain 1	0 to 300.00	0.01	-	0.20	-	20.00
C5-02	ASR integral (I) time 1	0.000 to 10.000	0.001 s	-	0.200	-	0.500
C5-03	ASR proportional (P) gain 2	0.00 to 300.00	0.01	-	0.02	-	20.00
C5-04	ASR integral (I) time 2	0.000 to 10.000	0.001 s	-	0.050	-	0.500
E1-04 E3-02	Max. output frequency (FMAX)	40.0 to 400.0 *2 40.0 to 300.0 *5	0.1 Hz	60.0 *3	60.0 *3	60.0	60.0
E1-05 E3-03	Max. voltage (VMAX) *4	0.0 to 255.0 (0.0 to 510.0)	0.1 V	200.0 *3	200.0 *3	200.0	200.0
E1-06 E3-04	Base frequency (FA)	0.0 to 400.0*2 0.0 to 300.0*5	0.1 Hz	60.0 *3	60.0 *3	60.0	60.0
E1-07 E3-05	Mid. output frequency (FB)	0.0 to 400.0*2 0.0 to 300.0*5	0.1 Hz	3.0 *3	3.0 *3	3.0	0.0
E1-08 E3-06	Mid. output frequency voltage (VC)*4	0.0 to 255.0 (0.0 to 510.0)	0.1 V	15.0 *3	15.0 *3	11.0	0.0
E1-09 E3-07	Min. output frequency (FMIN)	0.0 to 400.0*2 0.0 to 300.0*5	0.1 Hz	1.5 *3	1.5 *3	0.5	0.0
E1-10 E3-08	Min. output frequency voltage (VMIN)*4	0.0 to 255.0 (0.0 to 510.0)	0.1 V	9.0 *3	9.0 *3	2.0	0.0
F1-09	Overspeed detection delay time	0.0 to 2.0	0.1 s	-	1.0	-	0.0
L8-18	Soft CLA selection	0, 1	1	1	1	1	0

* 1. For Inverters with a capacity of 55 kW or more, the factory setting is 2.00 for open-loop vector control and 0.05 for flux vector control.
* 2. When C6-01 = 0, the upper limit is 150.0.
* 3. Settings vary as shown in the following tables depending on the Inverter capacity and E1-03.
* 4. The settings shown are for 200 V Class Inverters. The values will double for 400 V Class Inverters.
* 5. When C6-01 = 1, the upper limit is 400.0.
* 6. C6-01 = 1:120%, C6-01 = 0:150%
* 7. 1000 ms for Inverters of 200 V Class 30 to 110 kW and 400 V Class 55 to 300 kW.

■200 V and 400 V Class Inverters of 0.4 to 1.5 kW

Constant Number	Unit	Factory Setting																Open Loop Vector Control	Flux Vector Control
E1-03	-	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
E1-04	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0	60.0	60.0
E1-05 *	V	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
E1-06	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07	Hz	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0
E1-08 *	V	15.0	15.0	15.0	15.0	35.0	50.0	35.0	50.0	19.0	24.0	19.0	24.0	15.0	15.0	15.0	15.0	11.0	0.0
E1-09	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	0.5	0.0
E1-10 *	V	9.0	9.0	9.0	9.0	8.0	9.0	8.0	9.0	11.0	13.0	11.0	15.0	9.0	9.0	9.0	9.0	2.0	0.0

* The settings shown are for 200 V Class Inverters. The values will double for 400 V Class Inverters.

■200 V and 400 V Class Inverters of 2.2 to 45 kW

Constant Number	Unit	Factory Setting																Open Loop Vector Control	Flux vector control
E1-03	-	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
E1-04	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0	60.0	60.0
E1-05 *	V	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
E1-06	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07 *	Hz	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0
E1-08 *	V	14.0	14.0	14.0	14.0	35.0	50.0	35.0	50.0	18.0	23.0	18.0	23.0	14.0	14.0	14.0	14.0	11.0	0.0
E1-09	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	0.5	0.0
E1-10 *	V	7.0	7.0	7.0	7.0	6.0	7.0	6.0	7.0	9.0	11.0	9.0	13.0	7.0	7.0	7.0	7.0	2.0	0.0

* The settings shown are for 200 V Class Inverters. The values will double for 400 V Class Inverters.

■200 V Class Inverters of 55 to 110 kW and 400 V Class Inverters of 55 to 300 kW

Constant Number	Unit	Factory Setting																Open Loop Vector Control	Flux vector control
E1-03	-	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
E1-04	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0	60.0	60.0
E1-05 *	V	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
E1-06	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07	Hz	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0
E1-08 *	V	12.0	12.0	12.0	12.0	35.0	50.0	35.0	50.0	15.0	20.0	15.0	20.0	12.0	12.0	12.0	12.0	11.0	0.0
E1-09	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	0.5	0.0
E1-10 *	V	6.0	6.0	6.0	6.0	5.0	6.0	5.0	6.0	7.0	9.0	7.0	11.0	6.0	6.0	6.0	6.0	2.0	0.0

* The settings shown are for 200 V Class Inverters. The values will double for 400 V Class Inverters.

◆ Factory Settings that Change with the Inverter Capacity (o2-04)

The factory settings of the following user constants will change if the Inverter capacity (o2-04) is changed.

■200 V Class Inverters

Constant Number	Name	Unit	Factory Setting								
-	Inverter Capacity	kW	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15
o2-04	kVA selection	-	0	1	2	3	4	5	6	7	8
b8-03	Energy-saving filter time constant	s	0.50 (Open loop vector control)								
b8-04	Energy-saving coefficient	-	288.20	223.70	169.40	156.80	122.90	94.75	72.69	70.44	63.13
C6-01	CT/VT selection	-	1	1	1	1	1	1	1	1	1
			0	0	0	0	0	0	0	0	0
C6-02	Carrier frequency selection (when VT is selected) *1 *4	-	6 *2	6 *2	6 *2	6*2	6*2	6 *2	6 *2	6 *2	6 *2
-	Carrier frequency selection upper limit (when VT is selected)*1	-	6	6	6	6	6	6	6	6	6
E2-01 (E4-01)	Motor rated current	A	1.90	3.30	6.20	8.50	14.00	19.60	26.60	39.7	53.0
E2-02 (E4-02)	Motor rated slip	Hz	2.90	2.50	2.60	2.90	2.73	1.50	1.30	1.70	1.60
E2-03 (E4-03)	Motor no-load current	A	1.20	1.80	2.80	3.00	4.50	5.10	8.00	11.2	15.2
E2-05 (E4-05)	Motor line-to-line resistance	Ω	9.842	5.156	1.997	1.601	0.771	0.399	0.288	0.230	0.138
E2-06 (E4-06)	Motor leak inductance	%	18.2	13.8	18.5	18.4	19.6	18.2	15.5	19.5	17.2
E2-10	Motor iron loss for torque compensation	W	14	26	53	77	112	172	262	245	272
L2-02	Momentary power loss ridethru time	s	0.1	0.1	0.2	0.3	0.5	1.0	1.0	1.0	2.0
L2-03	Min. baseblock (BB) time	s	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L2-04	Voltage recovery time	s	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
L2-08	Frequency reduction gain at KEB start	°C	95	95	95	95	95	95	95	95	95
L8-02	Overheat pre-alarm level	°C	95	95	95	100	95	95	95	95	90
N5-02	Motor acceleration time	s	0.178	0.142	0.166	0.145	0.154	0.168	0.175	0.265	0.244

Constant Number	Name	Unit	Factory Setting								
-	Inverter Capacity	kW	18.5	22	30	37	45	55	75	90	110
o2-04	kVA selection	-	9	A	B	C	D	E	F	10	11
b8-03	Energy-saving filter time constant	s	0.50 (Open loop vector control)					2.00 (Open loop vector control)			
b8-04	Energy-saving coefficient	-	57.87	51.79	46.27	38.16	35.78	31.35	23.10	20.65	18.12
C6-01	CT/VT selection	-	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1
C6-02	Carrier frequency selection (when VT is selected) [*1 *4]	-	6 [*2]	6[*2]	4 [*2]	3 [*2]	3 [*2]	3 [*2]	2 [*2]	2 [*2]	1 [*2]
-	Carrier frequency selection upper limit (when VT is selected)[*1]	-	6	6	6	4	4	4	4	4	1
E2-01 (E4-01)	Motor rated current	A	65.8	77.2	105.0	131.0	160.0	190.0	260.0	260.0	260.0
E2-02 (E4-02)	Motor rated slip	Hz	1.67	1.70	1.80	1.33	1.60	1.43	1.39	1.39	1.39
E2-03 (E4-03)	Motor no-load current	A	15.7	18.5	21.9	38.2	44.0	45.6	72.0	72.0	72.0
E2-05 (E4-05)	Motor line-to-line resistance	Ω	0.101	0.079	0.064	0.039	0.030	0.022	0.023	0.023	0.023
E2-06 (E4-06)	Motor leak inductance	%	20.1	19.5	20.8	18.8	20.2	20.5	20.0	20.0	20.0
E2-10	Motor iron loss for torque compensation	W	505	538	699	823	852	960	1200	1200	1200
L2-02	Momentary power loss ridethru time	s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
L2-03	Min. baseblock (BB) time	s	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.5	1.7
L2-04	Voltage recovery time	s	0.6	0.6	0.6	0.6	1.0	1.0	1.0	1.0	1.0
L2-08	Frequency reduction gain at KEB start	°C	95	95	95	95	95	95	95	95	95
L8-02	Overheat pre-alarm level	°C	100	90	90	95	100	105	110	100	110[*3]
N5-02	Motor acceleration time	s	0.317	0.355	0.323	0.320	0.387	0.317	0.533	0.592	0.646

Note Attach a Backup Capacitor Unit for Momentary Power Loss if compensation for power interruptions of up to 2.0 seconds is required for 200 V Class Inverters with outputs of 0.4 to 11 kW.

* 1. The factory settings when VT is selected are given.
When CT is selected, the factory settings are as follows for Inverters of any capacity:
Carrier frequency selection: 1 (2.0 kHz)
Carrier frequency selection upper limit: 2.5 kHz

* 2. The setting of C6-02 changes the carrier frequency selection as follows:
0: Low-noise PWM, 1: 2.0 kHz, 2: 5.0 kHz, 3: 8.0 kHz, 4: 10.0 kHz, 5: 12.5 kHz, 6: 15.0 kHz

* 3. 95 for Inverter SPEC Type A.

* 4. When setting the carrier frequency of 200 V Class Inverters of 30 kW or more to a value larger than the factory setting, reduce the value of the Inverter rated output current.

■400 V Class Inverters

Constant Number	Name	Unit	Factory Setting									
-	Inverter Capacity	kW	0.4	0.75	1.5	2.2	3.7	4.0	5.5	7.5	11	15
o2-04	kVA selection	-	20	21	22	23	24	25	26	27	28	29
b8-03	Energy-saving filter time constant	s	0.50 (Open loop vector control)									
b8-04	Energy-saving coefficient	-	576.40	447.40	338.80	313.60	245.80	236.44	189.50	145.38	140.88	126.26
C6-01	CT/VT selection	-	1	1	1	1	1	1	11	1	1	1
			0	0	0	0	0	0	0	0	0	0
C6-02	Carrier frequency selection (when VT is selected)*1 *3	-	6 *2	6*2	6 *2	6 *2	6 *2	6*2	6 *2	6 *2	6 *2	6 *2
-	Carrier frequency selection upper limit (when VT is selected)*1	-	6	6	6	6	6	6	6	6	6	6
E2-01 (E4-01)	Motor rated current	A	1.00	1.60	3.10	4.20	7.00	7.00	9.80	13.30	19.9	26.5
E2-02 (E4-02)	Motor rated slip	Hz	2.90	2.60	2.50	3.00	2.70	2.70	1.50	1.30	1.70	1.60
E2-03 (E4-03)	Motor no-load current	A	0.60	0.80	1.40	1.50	2.30	2.30	2.60	4.00	5.6	7.6
E2-05 (E4-05)	Motor line-to-line resistance	W	38.198	22.459	10.100	6.495	3.333	3.333	1.595	1.152	0.922	0.550
E2-06 (E4-06)	Motor leak inductance	%	18.2	14.3	18.3	18.7	19.3	19.3	18.2	15.5	19.6	17.2
E2-10	Motor iron loss for torque compensation	W	14	26	53	77	130	130	193	263	385	440
L2-02	Momentary power loss ridethru time	s	0.1	0.1	0.2	0.3	0.5	0.5	0.8	0.8	1.0	2.0
L2-03	Min. baseblock (BB) time	s	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9
L2-04	Voltage recovery time	s	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
L8-02	Overheat pre-alarm level	°C	95	95	95	90	95	95	95	90	95	95
N5-02	Motor acceleration time	s	0.178	0.142	0.166	0.145	0.154	0.154	0.168	0.175	0.265	0.244

Constant Number	Name	Unit	Factory Setting									
-	Inverter Capacity	kW	18.5	22	30	37	45	55	75	90	110	132
o2-04	kVA selection	-	2A	2B	2C	2D	2E	2F	30	31	32	33
b8-03	Energy-saving filter time constant	s	0.50 (Open loop vector control)					2.00 (Open loop vector control)				
b8-04	Energy-saving coefficient	-	115.74	103.58	92.54	76.32	71.56	67.20	46.20	38.91	36.23	32.79
C6-01	CT/VT selection	-	1	1	1	1	1	1	1	1	1	1
			0	0	0	0	0	0	0	0	0	0
C6-02	Carrier frequency selection (when VT is selected)*1 *3	-	6 *2	6 *2	4 *2	4 *2	4 *2	4 *2	3 *2	3 *2	3 *2	2 *2
-	Carrier frequency selection upper limit (when VT is selected)*1	-	6	6	6	6	6	6	4	4	4	4
E2-01 (E4-01)	Motor rated current	A	32.9	38.6	52.3	65.6	79.7	95.0	130.0	156.0	190.0	223.0
E2-02 (E4-02)	Motor rated slip	Hz	1.67	1.70	1.80	1.33	1.60	1.46	1.39	1.40	1.40	1.38
E2-03 (E4-03)	Motor no-load current	A	7.8	9.2	10.9	19.1	22.0	24.0	36.0	40.0	49.0	58.0
E2-05 (E4-05)	Motor line-to-line resistance	Ω	0.403	0.316	0.269	0.155	0.122	0.088	0.092	0.056	0.046	0.035
E2-06 (E4-06)	Motor leak inductance	%	20.1	23.5	20.7	18.8	19.9	20.0	20.0	20.0	20.0	20.0
E2-10	Motor iron loss for torque compensation	W	508	586	750	925	1125	1260	1600	1760	2150	2350
L2-02	Momentary power loss ridethru time	s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
L2-03	Min. baseblock (BB) time	s	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.5	1.7	1.7
L2-04	Voltage recovery time	s	0.6	0.6	0.6	0.6	0.6	1.0	1.0	1.0	1.0	1.0
L8-02	Overheat pre-alarm level	°C	98	78	85	85	90	90	98	108	100	110
N5-02	Motor acceleration time	s	0.317	0.355	0.323	0.320	0.387	0.317	0.533	0.592	0.646	0.673

Constant Number	Name	Unit	Factory Setting			
-	Inverter Capacity	kW	160	185	220	300
o2-04	kVA selection	-	34	35	36	37
b8-03	Energy-saving filter time constant	s	2.00 (Open loop vector control)			
b8-04	Energy-saving coefficient	-	30.13	30.57	27.13	21.76
C6-01	CT/VT selection	-	1 0	1 0	1	1
C6-02	Carrier frequency selection (when VT is selected)*1 *3	-	2 *2	2 *2	1 *2	1 *2
-	Carrier frequency selection upper limit (when VT is selected)*1	-	4	2	1	1
E2-01 (E4-01)	Motor rated current	A	270.0	310.0	370.0	500.0
E2-02 (E4-02)	Motor rated slip	Hz	1.35	1.30	1.30	1.25
E2-03 (E4-03)	Motor no-load current	A	70.0	81.0	96.0	130.0
E2-05 (E4-05)	Motor line-to-line resistance	Ω	0.029	0.025	0.020	0.014
E2-06 (E4-06)	Motor leak inductance	%	20.0	20.0	20.0	20.0
E2-10	Motor iron loss for torque compensation	W	2850	3200	3700	4700
L2-02	Momentary power loss ridethru time	s	2.0	2.0	2.0	2.0
L2-03	Min. baseblock (BB) time	s	1.8	1.9	2.0	2.1
L2-04	Voltage recovery time	s	1.0	1.0	1.0	1.0
L8-02	Overheat pre-alarm level	°C	108	95	100	108
N5-02	Motor acceleration time	s	0.777	0.864	0.910	1.392

Note Attach a Backup Capacitor Unit for Momentary Power Loss if compensation for power interruptions of up to 2.0 seconds is required for 200 V Class Inverters with outputs of 0.4 to 11 kW.

* 1. The factory settings when VT is selected are given.
When CT is selected, the factory settings are as follows for Inverters of any capacity:
Carrier frequency selection: 1 (2.0 kHz)
Carrier frequency selection upper limit: 2.5 kHz

* 2. The setting of C6-02 changes the carrier frequency selection as follows:
0: Low-noise PWM, 1: 2.0 kHz, 2: 5.0 kHz, 3: 8.0 kHz, 4: 10.0 kHz, 5: 12.5 kHz, 6: 15.0 kHz

* 3. When setting the carrier frequency of 400 V Class Inverters of 30 kW or more to a value larger than the factory setting, reduce the value of the Inverter rated output current.

5

6

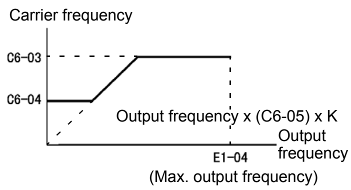
Constant Settings by Function

Application and Overload Selections

◆ Select the Overload to Suit the Application

Set C6-01 (CT: Low carrier constant torque, VT: High carrier variable torque) depending on the application for which the Inverter is used. The setting ranges for the Inverter carrier frequency, overload tolerance, and maximum output frequency depend on the setting in C6-01.

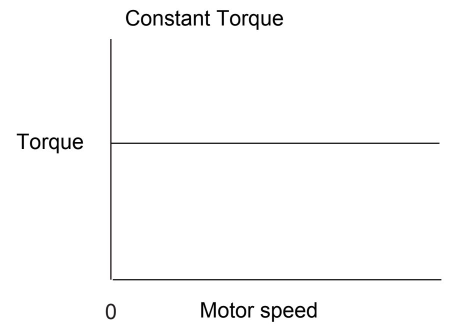
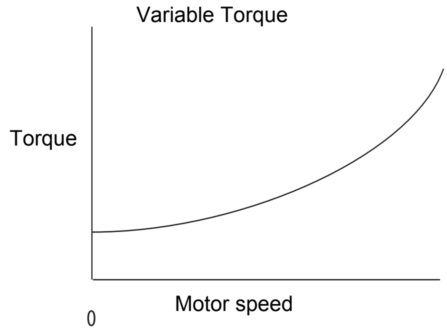
■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
C6-01	CT/VT selection	0: CT (low carrier, constant torque, 150% per minute) 1: VT (high carrier, variable torque, 120% per minute)	0 or 1	1*1 0*1	No	Q	Q	Q	Q	223H
C6-02	Carrier frequency selection	Select carrier wave fixed pattern. 0: Low-noise PWM 1: 2.0 kHz 2: 5.0 kHz 3: 8.0 kHz 4: 10.0 kHz 5: 12.5 kHz 6: 15.0 kHz F: Enables detailed settings using constants C6-03 to C6-05	0, 1 (C6-01=0) 0 to F (C6-01=1)	1 (C6-01=0) 6*2 (C6-01=1)	No	Q	Q	Q	Q	224H
C6-03 *4	Carrier frequency upper limit	Set the carrier frequency upper limit and lower limit in kHz units. The carrier frequency gain is set as follows: With the vector control method, the upper limit of the carrier frequency is fixed in C6-03.	2.0 to 15.0 *3 2.0 to 2.5	15.0 kHz *2 2.0 kHz	No	A	A	A	A	225H
C6-04 *4	Carrier frequency lower limit		0.4 to 15.0 *3 0.4 to 2.5	15.0 kHz *2 2.0 kHz	No	A	A	No	A	226H
C6-05 *4	Carrier frequency proportional gain	K is a coefficient that depends on the setting of C6-03. C6-03 ≥ 10.0 kHz: K = 3 10.0 kHz > C6-03 ≥ 5.0 kHz: K = 2 5.0 kHz > C6-03: K = 1	00 to 99	00	No	A	A	No	A	227H

* 1. Only 1(VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.
* 2. The factory settings depend on the capacity of the Inverter. The values for a 200 V Class Inverter of 0.4 kW are given.
* 3. The setting ranges depend on the capacity of the Inverter. The values for a 200 V Class Inverter of 0.4 kW are given.
* 4. This constant can be monitored or set only when F is set for C6-02.

■Difference Between CT and VT

The characteristics of CT (low carrier, constant torque) and VT (high carrier, variable torque) are shown below.

CT: Low Carrier, Constant Torque	VT: High Carrier, Variable Torque
	
Constant torque means a constant load torque for all motor speed, and it requires overload resistance capability. Applications include pushers, conveyors, cranes, and other friction or heavy loads.	Variable torque means that the load torque will decrease as the speed decreases. Normally, overload resistance capability is not required. Applications include fans and pumps.
Low carrier: Electromagnetic noise is present.	High carrier: Electromagnetic noise is not present.

■Setting Precautions

C6-01 (CT/VT Selection)

When setting C6-01, observe the following precautions.

- Depending on the set value in C6-01, the setting range of the related constants is limited as follows:

C6-01 Set Value	0 (Low Carrier, Constant Torque)	1 (High Carrier, Variable Torque)
Inverter Overload Protection Level	150% Inverter rated current/1 min.	120% Inverter rated current/1 min.
C6-02 (Carrier Frequency Selection)	0: Low carrier, low noise 1: Carrier 2.0 kHz	0: Low carrier low noise 1: Carrier 2.0 kHz 2: Carrier 5.0 kHz 3: Carrier 8.0 kHz 4: Carrier 10.0 kHz 5: Carrier 12.5 kHz 6: Carrier 15.0 kHz F: User-set*
E1-04 and E3-02 (Max. Output Frequency)	150Hz, 300 Hz	400 Hz
L3-02 (Stall Prevention Level During Acceleration)	150%	120%
L3-06 (Stall Prevention Level During Operation)	150%	120%

* Factory settings depend on Inverter capacity.
200 V and 400 V Class Inverters for 0.4 to 22 kW: 6 (15 kHz)
200 V Class Inverters for 30 kW, or 400 V Class Inverters for 30 to 55 kW: 4 (10 kHz)
200 V Class Inverters for 37 to 55 kW, or 400 V Class Inverters for 75 to 110 kW: 3 (8 kHz)
200 V Class Inverters for 75 to 90 kW, or 400 V Class Inverters for 132 to 185 kW: 2 (5 kHz)
200 V Class Inverter for 110 kW, or 400 V Class Inverters for 220 to 300 kW: 1 (2 kHz)

- When the setting in E1-04 or E3-02 is greater than 150 Hz (SPEC: C or earlier), 300 Hz (SPEC: E or later), if C6-01 is set to 0, an OPE02 (Invalid constant setting range) error will occur.

Carrier Frequency

When selecting the carrier frequency, observe the following precautions items.

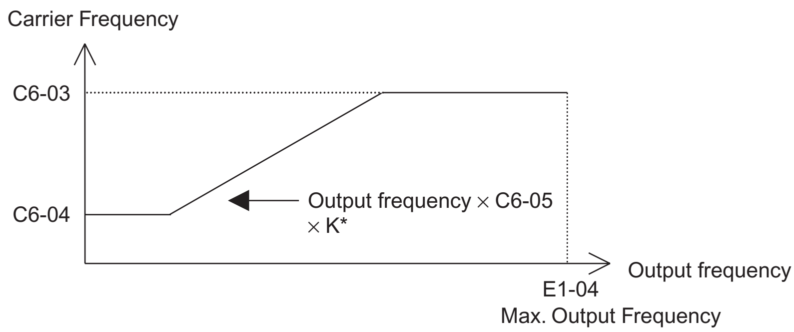
- When using a device with C6-01 set to 1 (VT), adjust the carrier frequency according to the cases shown below.
  If the wiring distance between Inverter and motor is long: Set the carrier frequency low. (Use the following values as guidelines.

Wiring Length	50 m or less	100 m or less	Over 100 m
C6-02 (carrier frequency) setting	0 to 6 (15 kHz)	0 to 4 (10 kHz)	0 to 2 (5 kHz)

  If speed and torque are inconsistent at low speeds: Set the carrier frequency low.
  If Inverter noise is affecting peripheral devices: Set the carrier frequency low.
  If leakage current from the Inverter is large: Set the carrier frequency low.
  If metallic noise from the motor is large: Set the carrier frequency high.

Carrier frequency upper limit depends on the Inverter capacity. Refer to *Factory Settings that Change with the Inverter Capacity (o2-04)* on page 5-83.

- When using V/f control or V/f control with PG, you can vary the carrier frequency to match the output frequency, as shown in the following diagram, by setting C6-03 (Carrier Frequency Upper Limit), C6-04 (Carrier Frequency Lower Limit), and C6-05 (Carrier Frequency Proportional Gain).



*K is the coefficient determined by the set value in C6-03.
C6-03 ≥ 10.0 kHz: K=3
10.0 kHz > C6-03 ≥ 5.0 kHz: K=2
5.0 kHz > C6-03: K=1

Fig 6.1

- With vector control, the carrier frequency is fixed by the Carrier Frequency Upper Limit in C6-03 if user-set, or by the carrier frequency set in C6-02.
- To fix the carrier frequency, set C6-03 and C6-04 to the same value, or set C6-05 to 0.
- If the settings are as shown below, OPE11 (Data setting error) will occur.

If Carrier Frequency Proportional Gain (C6-05) > 6 and C6-03 < C6-04.

If C6-01 = 0 and Carrier Frequency Selection C6-02 is set from 2 to E.

If C6-01 = 1 and Carrier Frequency Selection C6-02 is set from 7 to E.

■Carrier Frequency and Inverter Overload Current Level

When C6-01 is set to 1, the Inverter overload level will be reduced. Even when the overload current falls to below 120% constant 1 min, OL2 (Inverter overload) will be detected. The Inverter overload current reduction level is shown below.

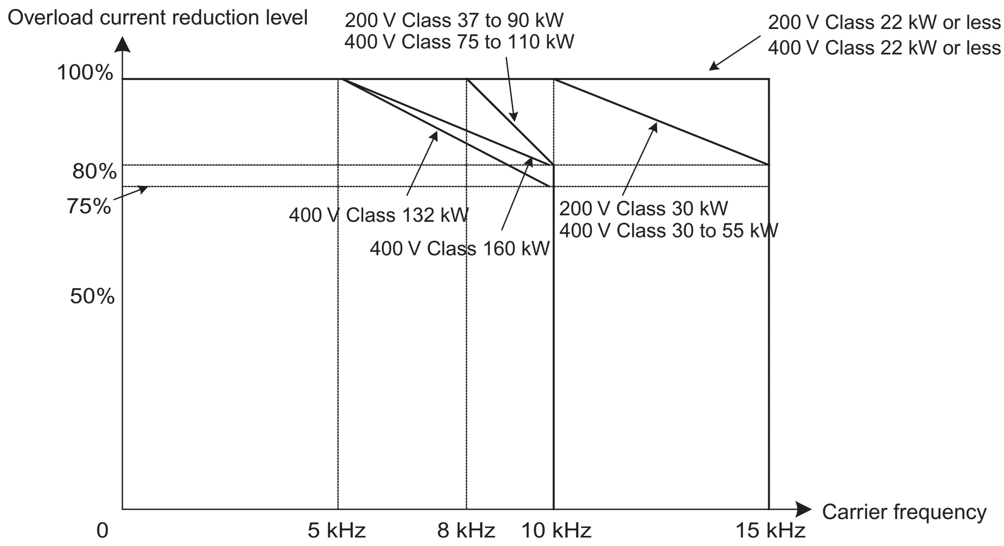


Fig 6.2 Overload Current Reduction Level

Frequency Reference

This section explains how to input the frequency reference.

◆ Selecting the Frequency Reference Source

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H
H6-01	Pulse train input function selection	0: Frequency reference 1: PID feedback value 2: PID target value	0 to 2	0	No	A	A	A	A	42CH
H6-02	Pulse train input scaling	Set the number of pulses in hertz, taking the reference to be 100%.	1000 to 32000	1440 Hz	Yes	A	A	A	A	42DH

■Input the Reference Frequency from the Digital Operator

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

Input the reference frequency from the Digital Operator's reference frequency setting display.

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

Fig 6.3 Frequency Setting Display

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

When b1-01 is set to 1, you can input the frequency reference from control circuit terminal A1 (voltage input), control circuit terminal A2 (voltage or current input) or control circuit terminal A3 (voltage input).

Inputting Master Speed Frequency Reference Only (Voltage Input)

When inputting a voltage for the master speed frequency reference, input the voltage to control circuit terminal A1.

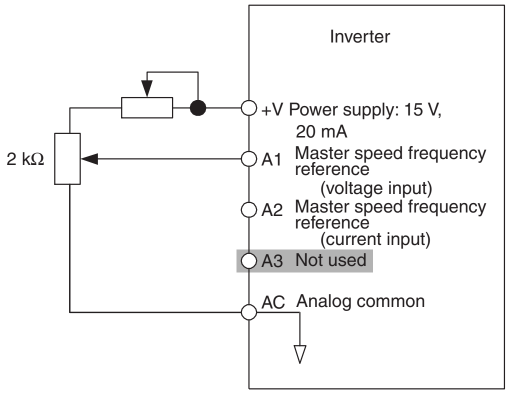


Fig 6.4 Voltage Input for Master Speed Frequency Reference

Inputting Master Speed Frequency Reference Only (Current Input)

When inputting a current for the master speed frequency reference, input the current to control circuit terminal A2, input 0 V to terminal A1, and make either of the following settings.

- Set H3-08 (Multi-function analog input terminal A2 signal level selection) to 2 (current input), and set H3-09 (Multi-function analog input terminal A2 function selection) to 0 (Add to terminal A1).
- Set H3-09 (Multi-function analog input terminal A2 function selection) to 2 (Auxiliary frequency reference 1), and set H3-13 (Terminal A1/A2 switching) to 1 (Use terminal A2 analog input as the main speed frequency reference).

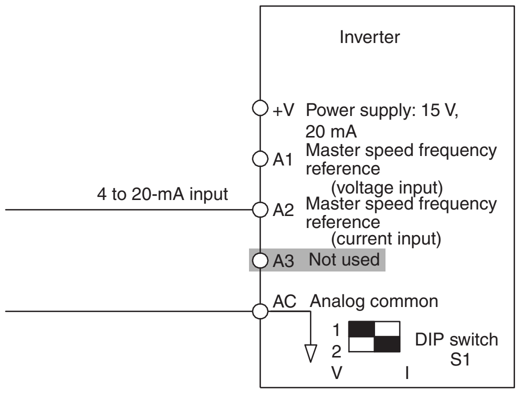


Fig 6.5 Current Input for Master Speed Frequency Reference

IMPORTANT

Turn ON pin 2 of DIP switch S1 (toward I), the voltage/current switch, when inputting a current to terminal A2. Turn OFF pin 2 of DIP switch S1 (toward V), the voltage/current switch, when inputting a voltage to terminal A2. Set H3-08 to the correct setting for the type of input signal being used.

6

Switch between 2 Step Speeds: Master/Auxiliary Speeds

When switching between the master and auxiliary speeds, input the master speed frequency reference to control circuit terminal A1 and the auxiliary speed frequency reference to control circuit terminal A2 or A3. The master speed frequency reference input to terminal A1 will be used for the Inverter frequency reference when the master speed reference 1 allocated to multi-function input terminal (factory setting: S5) is OFF, and the auxiliary speed frequency reference input to terminal A2 or A3 will be used for the Inverter frequency reference when the multi-speed reference 1 allocated to multi-function input terminal is ON.

When using terminal A2 as the input terminal of auxiliary speed frequency reference, set H3-09 (Multi-function analog input terminal A2 function selection) to 2 [Auxiliary speed reference frequency 1 (2nd speed analog)].

When using terminal A3 as the input terminal of auxiliary speed frequency reference, set H3-05 (Multi-function analog input terminal A3 function selection) to 2 [Auxiliary speed frequency reference 1 (2ndspeed analog)].

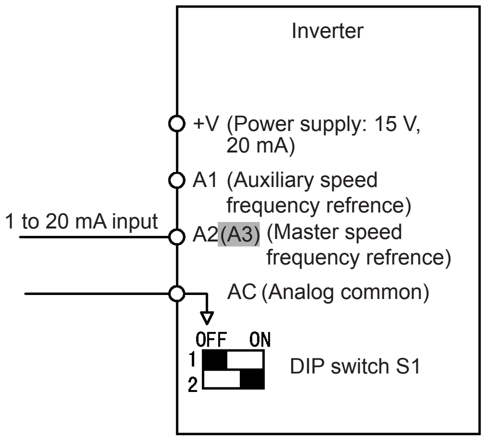


Fig 6.6 Switching between Master and Auxiliary Frequencies

Precautions on Setting DIP Switches and Constants

- When inputting voltage signals to terminal A2, set the pin 2 of the current/voltage switching DIP switch S1-2 to OFF side (factory setting: ON).
- When inputting current signals to terminal A2, set the pin 2 of the current/voltage switching DIP switch S1-2 to ON side (factory setting: ON).
- When setting terminal A2 as the master speed frequency input terminal and terminal A1 as the auxiliary speed frequency input terminal, set the H3-09 (Multi-function analog input terminal A2 function selection) to 2 and H3-05 (Multi-function analog input terminal A3 function selection) to a number other than 0 and H3-05 (Multi-function analog input terminal A3 function selection) to a number other than 0 and 2. And then, set H3-13 (Terminal A1/A2 switching) to 1.
- H3-09 and H3-05 cannot be set to 2 at the same time.

■Setting Frequency Reference Using Pulse Train Signals

When b1-01 is set to 4, the pulse train input to control circuit terminal RP is used as the frequency reference.

Set H6-01 (Pulse Train Input Function Selection) to 0 (frequency reference), and then set the 100% reference pulse frequency to H6-02 (Pulse Train Input Scaling).

Pulse Input Specifications	
Low level voltage	0.0 to 0.8 V
High level voltage	3.5 to 13.2 V
Heavy duty	30 to 70%
Pulse frequency	0 to 32 kHz

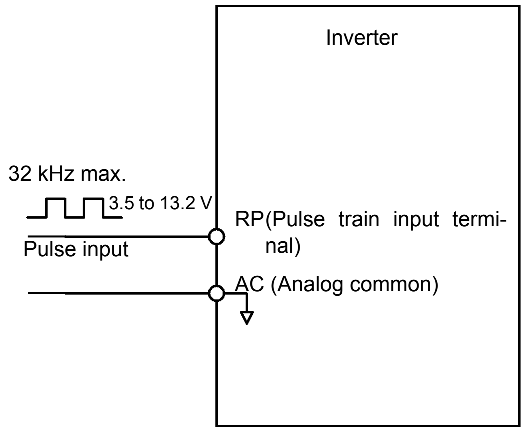


Fig 6.7 Frequency Reference Using Pulse Train Input

6

◆ Using Multi-Step Speed Operation

With Varispeed-F7 series Inverters, you can change the speed to a maximum of 17 steps, using 16 frequency references, and one jog frequency reference.

The following example of a multi-function input terminal function shows a 9-step operation using multi-step references 1 to 3 and jog frequency selection functions.

■Related Constants

To switch frequency references, set multi-step speed references 1 to 3 and the jog reference selection in the multi-function contact inputs (any of the terminals S3 to S8). Setting examples are shown below. The unused terminals need not be set.

Multi-function Contact Inputs (H1-01 to H1-06)

Terminal	Constant Number	Set Value	Details
S5	H1-03	3	Multi-step speed reference 1 [Also used for master speed/auxiliary speed switching when multi-function analog input H3-09 or H3-05 is set to 2 (auxiliary frequency reference).]
S6	H1-04	4	Multi-step speed reference 2 [Also used for auxiliary frequency reference 2 when multi-function analog input H3-09 or H3-05 is set to 3 (auxiliary frequency reference 2).]
S7	H1-05	5	Multi-step speed reference 3
S8	H1-06	6	Jog frequency selection (given priority over multi-step speed reference)

Combination of Multi-Function References and Multi-Function Contact Inputs. In the Above Setting Example

You can change the selected frequency reference by combining the ON/OFF status of S5 to S8 (multi-function contact input terminals) to set multi-step speed references 1 to 3 and the jog frequency selection. The following table shows the possible combinations.

Speed	TerminalS5	TerminalS6	TerminalS7	TerminalS8	Selected Frequency
	Multi-step Speed Reference 1	Multi-step Speed Reference 2	Multi-step Speed Reference 3	Jog Frequency Selection	
1	OFF	OFF	OFF	OFF	Frequency reference 1 d1-01, master speed frequency
2	ON	OFF	OFF	OFF	Frequency reference 2 d1-02, auxiliary frequency 1
3	OFF	ON	OFF	OFF	Frequency reference 3 d1-03, auxiliary frequency 2
4	ON	ON	OFF	OFF	Frequency reference 4 d1-04
5	OFF	OFF	ON	OFF	Frequency reference 5 d1-05
6	ON	OFF	ON	OFF	Frequency reference 6 d1-06
7	OFF	ON	ON	OFF	Frequency reference 7 d1-07
8	ON	ON	ON	OFF	Frequency reference 8 d1-08
9	-	-	-	ON*	Jog frequency d1-17

* Terminal S8's jog frequency selection is given priority over multi-step speed references.

Setting Precautions

Refer to the following to set step 1 to step 3 to analog inputs.

- **Step 1**
  When setting terminal A1's analog input to step 1, set b1-01 to 1, and when setting d1-01 (Frequency Reference 1) to step 1, set b1-01 to 0.
- **Step 2**
  When setting terminal A2's (or A3's) analog input to step 2, set H3-09 (H3-05 when A3 is used) to 2 (auxiliary frequency reference 1). When setting d1-02 (Frequency Reference 2) to step 2, do not set H3-09 (H3-05 when A3 is used) to 2.
- **Step 3**
  When setting terminal A3's (or A2's) analog input to step 3, set H3-05 (H3-09 when A2 is used) to 3 (auxiliary frequency reference 2). When setting d1-03(Frequency Reference 3) to step 3, do not set H3-05 (H3-09 when A2 is used) to 3.

■Connection Example and Time Chart

The following diagram shows a time chart and control circuit terminal connection example during a 9-step operation.

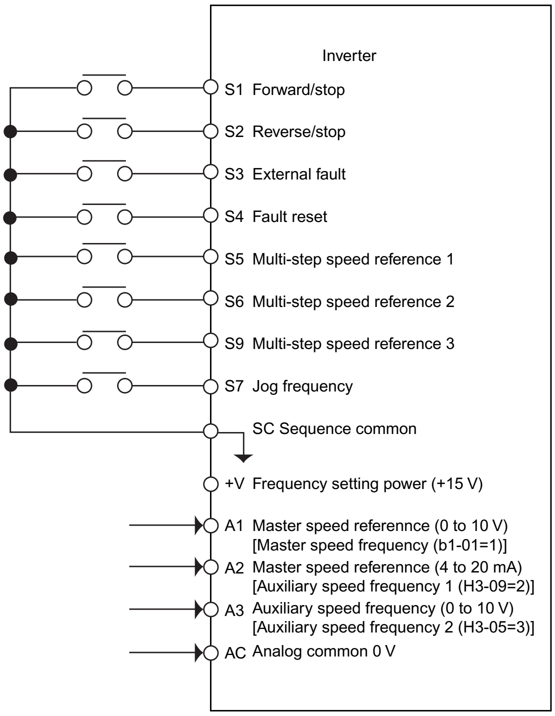


Fig 6.8 Control Circuit Terminal During 9-step Operation

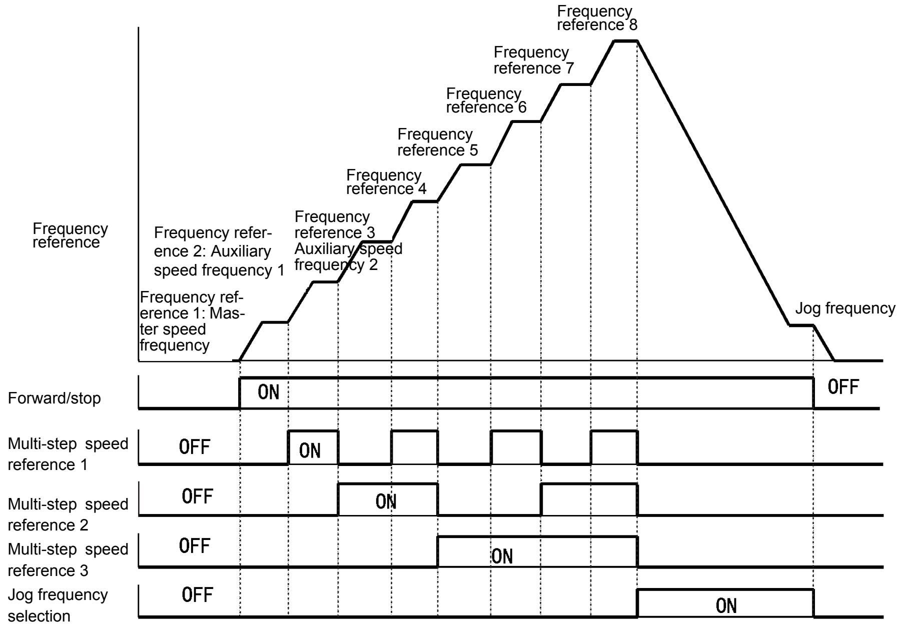
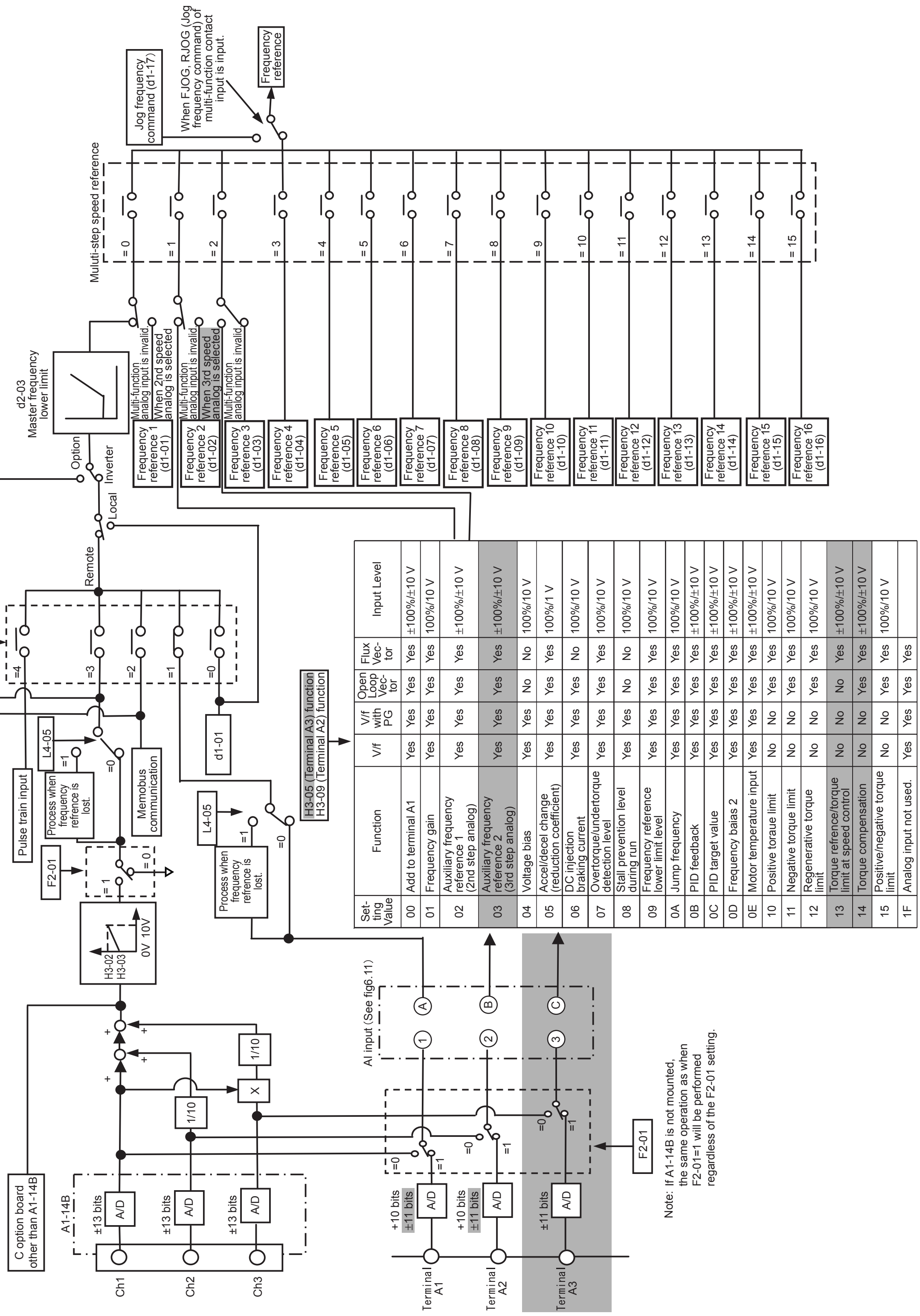


Fig 6.9 Multi-step speed reference/Jog Frequency Selection Time Chart

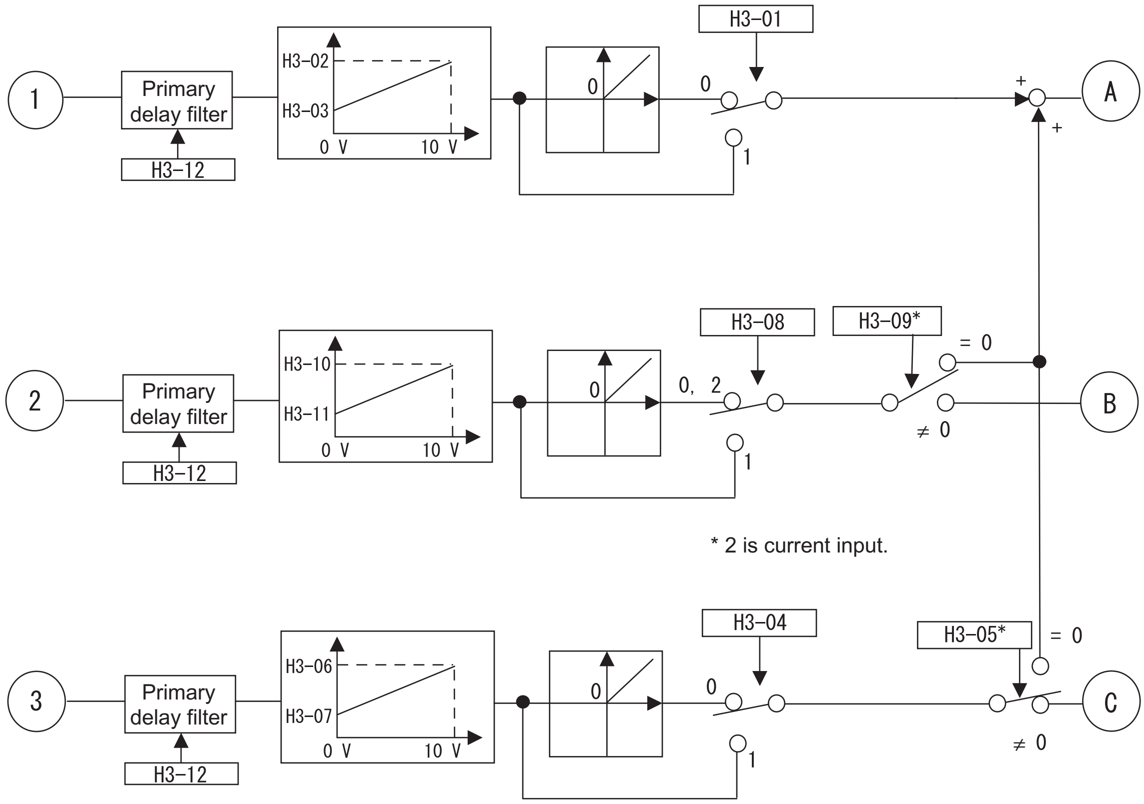
◆ Varispeed F7 Function Block

The following diagram shows the function block diagram of Varispeed F7. The shaded sections apply only to Inverters with SPEC: E or later.



Setting Value	Function	V/f	V/f with PG	Open Loop Vector	Flux Vector	Input Level
00	Add to terminal A1	Yes	Yes	Yes	Yes	±100%/±10 V
01	Frequency gain	Yes	Yes	Yes	Yes	100%/10 V
02	Auxiliary frequency reference 1 (2nd step analog)	Yes	Yes	Yes	Yes	±100%/±10 V
03	Auxiliary frequency reference 2 (3rd step analog)	Yes	Yes	Yes	Yes	±100%/±10 V
04	Voltage bias	Yes	Yes	No	No	100%/10 V
05	Accel/decel change (reduction coefficient)	Yes	Yes	Yes	Yes	100%/1 V
06	DC injection braking current	Yes	Yes	Yes	No	100%/10 V
07	Overtorque/undertorque detection level	Yes	Yes	Yes	Yes	100%/10 V
08	Stall prevention level during run	Yes	Yes	No	No	100%/10 V
09	Frequency reference lower limit level	Yes	Yes	Yes	Yes	100%/10 V
0A	Jump frequency	Yes	Yes	Yes	Yes	100%/10 V
0B	PID feedback	Yes	Yes	Yes	Yes	±100%/±10 V
0C	PID target value	Yes	Yes	Yes	Yes	±100%/±10 V
0D	Frequency baias 2	Yes	Yes	Yes	Yes	±100%/±10 V
0E	Motor temperature input	Yes	Yes	Yes	Yes	±100%/±10 V
10	Positive toraue limit	No	No	Yes	Yes	100%/10 V
11	Negative torque limit	No	No	Yes	Yes	100%/10 V
12	Regenerative torque limit	No	No	Yes	Yes	100%/10 V
13	Torque refrence/torque limit at speed control	No	No	No	Yes	±100%/±10 V
14	Torque compensation	No	No	Yes	Yes	±100%/±10 V
15	Positive/negative torque limit	No	No	Yes	Yes	100%/10 V
1F	Analog input not used.	Yes	Yes	Yes	Yes	

Fig 6.10 Varispeed F7 Function Block



* The same value can not be set in H3-05 and H3-09.

Fig 6.11 AI Input Detailed Diagram

Run Command

This section explains input methods for the Run Command.

◆ Selecting the Run Command Source

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	No	Q	Q	Q	Q	181H

■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.

Performing Operations Using a 2-wire Sequence

The factory setting is set to a 2-wire sequence. When control circuit terminal S1 is set to ON, forward operation will be performed, and when S1 is turned OFF, the Inverter will stop. In the same way, when control circuit terminal S2 is set to ON, reverse operation will be performed, and when S2 is turned OFF, the Inverter will stop.

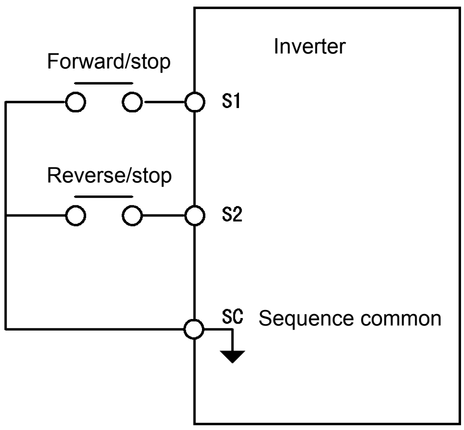


Fig 6.12 2-wire Sequence Wiring Example

Performing Operations Using a 3-wire Sequence

When any constant from H1-01 to H1-6 (multi-function contact input terminals S3 to S8) is set to 0, terminals S1 and S2 are used for a 3-wire sequence, and the multi-function input terminal that has been set functions as a Forward/Reverse Run Command terminal.

When the Inverter is initialized for 3-wire sequence control with A1-03, multi-function input 3 (terminal S5) becomes the input terminal for the Forward/Reverse Run Command.

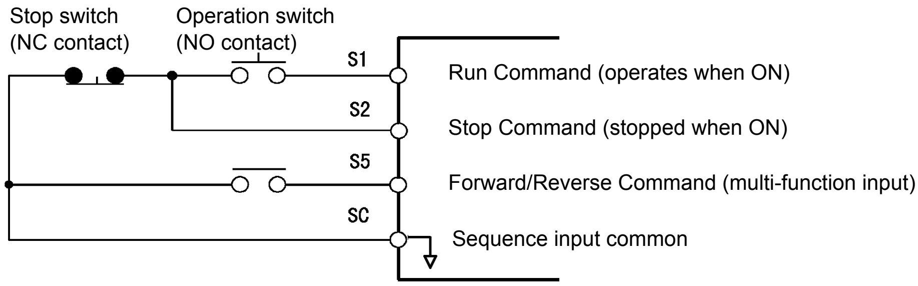


Fig 6.13 3-wire Sequence Wiring Example

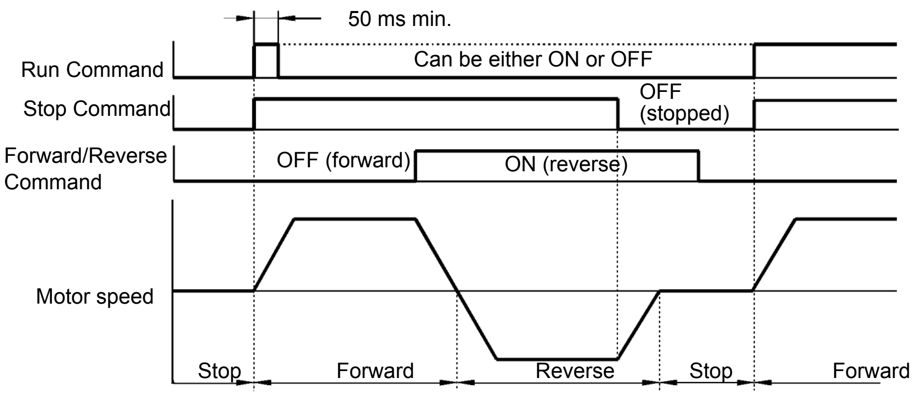


Fig 6.14 Three-wire Sequence Time Chart

INFO

1. Use a sequence that turns ON terminal S1 for 50 ms or longer for the Run Command. This will make the Run Command self-holding in the Inverter.
2. When the 3-wire sequence is set, do not make the wiring for the control circuit unless the multi-function input terminal constant is set. Failure to observe this warning may result in injury.

Stopping Methods

This section explains methods of stopping the Inverter.

◆ Selecting the Stopping Method when a Stop Command is Sent

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

- Deceleration to stop
- Coast to stop
- DC braking stop
- Coast to stop with timer

Set constant b1-03 to select the Inverter stopping method. A DC braking stop and coasting to a stop with a timer cannot be set for flux vector control.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMO BUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b1-03	Stopping method selection	Used to set the stopping method used when a Stop Command is input. 0: Deceleration to stop 1: Coast to stop 2: DC injection braking stop (Stops faster than coast to stop, no regenerative operation.) 3: Coast to stop with timer (Run Commands are disregarded during deceleration.)	0 to 3 *	0	No	Q	Q	Q	Q	182H
b1-05	Operation selection for setting E1-09 or less	Used to set the method of operation when the frequency reference input is less than the minimum output frequency (E1-09). 0: Run at frequency reference (E1-09 not effective). 1: STOP (Frequencies below E1-09 in the coast to stop state.) 2: Run at min. frequency. (E1-09) 3: Run at zero-speed (Frequencies below E1-09 are zero)	0 to 3	0	No	No	No	No	A	184H
b2-01	Zero-speed level (DC injection braking starting frequency)	Used to set the frequency which starts DC injection braking in units of Hz when deceleration to stop is selected. When b2-01 is less than E1-09, E1-09 is used to set the starting frequency for the DC injection braking. In flux vector control, b2-01 is used to set the starting frequency for the zero-speed control.	0.0 to 10.0	0.5 Hz	No	A	A	A	A	189H

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Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
b2-02	DC injection braking cur-rent	Sets the DC injection braking current as a percentage of the Inverter rated current. The DC injection braking cur-rent in flux control is affected by any change to the setting of E2-03.	0 to 100	50%	No	A	A	A	No	18AH
b2-03	DC injection braking time at start	Used to set the time to perform DC injection braking at start in units of 1 second. Used to stop coasting motor and restart it. When the set value is 0, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	A	A	18BH
b2-04	DC injection braking time at stop	Used to set the time to perform DC injection braking at stop (zero-speed control in flux vec-tor control) in units of 1 second. 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	A	A	18CH

* 0 or 1 for flux vector control.

■Deceleration to Stop

If the Stop Command is input (i.e., the Run Command is turned OFF) when b1-03 is set to 0, the motor decelerates to a stop according to the deceleration time that has been set. (Factory setting: C1-02 (Deceleration Time 1))

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 6-25 *Setting Acceleration and Deceleration Times*.

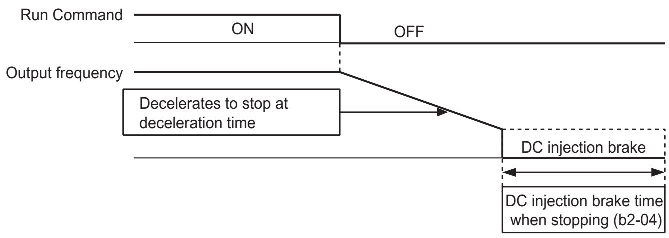


Fig 6.15 Deceleration to Stop

The following only applies to Inverters with SPEC: E or later.

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

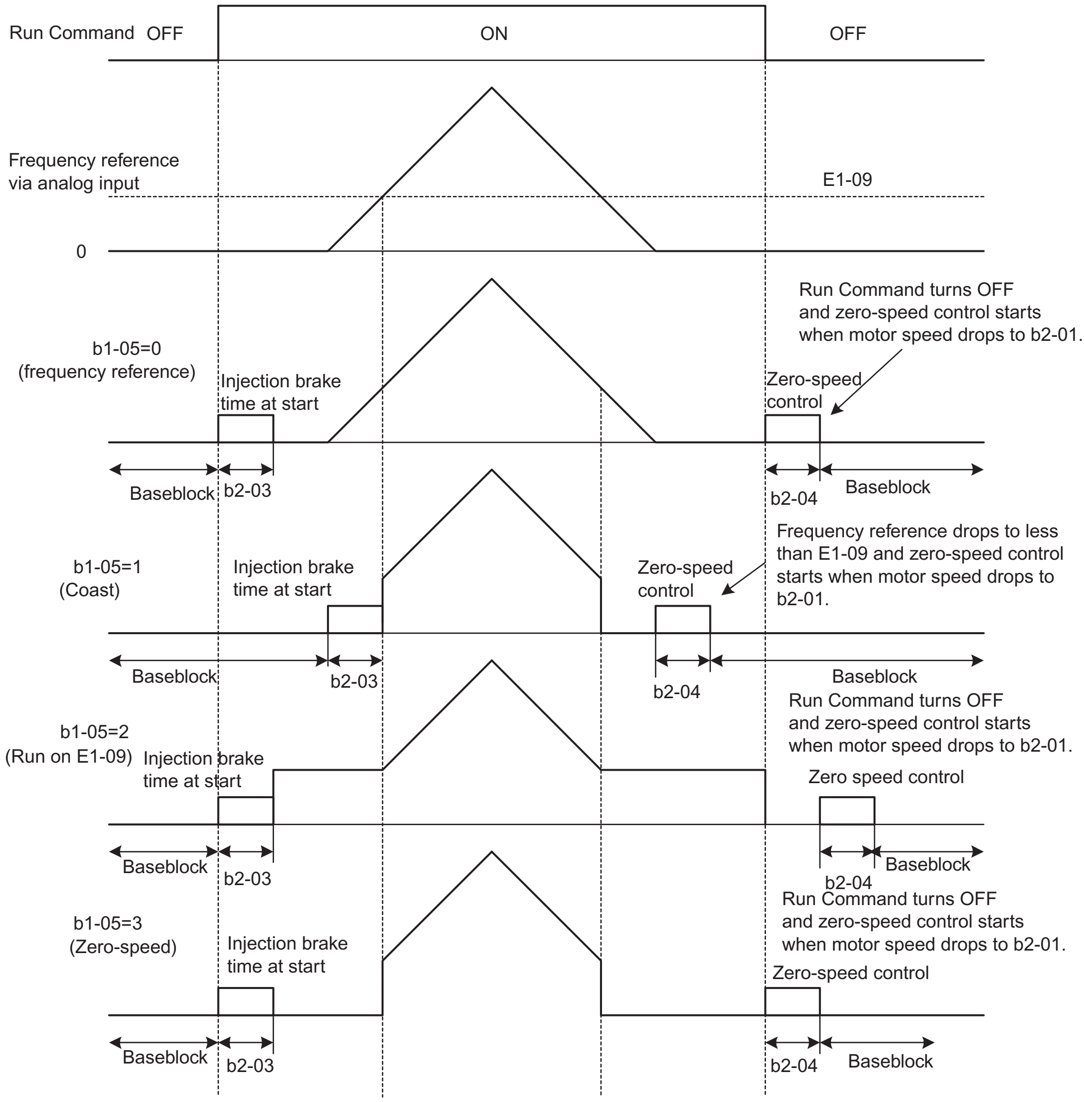


Fig 6.16 Deceleration to Stop (for Flux Vector Control)

Setting Precautions

- When using flux vector control, the zero-speed control starts when motor speed drops to b2-01 during deceleration. Also, the setting b2-01 < E1-09 is possible.
- The current level during injection brake time at start is the value of E2-03 (motor no-load current). Accordingly, b2-02 is invalid in flux vector control.

■Coast to Stop

If the Stop Command is input (i.e., the Run Command is turned OFF) when b1-03 is set to 1, the Inverter output voltage is interrupted. The motor coasts to a stop at the deceleration rate that counterbalances damage to the machine and inertia including the load.

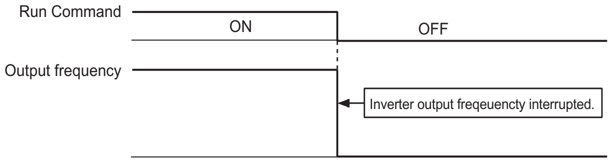


Fig 6.17 Coast to Stop

INFO

After the Stop Command is input, Run Commands are ignored until the Minimum Baseblock Time (L2-03) has elapsed.

■DC Braking Stop

If the Stop Command is input (i.e., the Run Command is turned OFF) when b1-03 is set to 2, a wait is made for the time set in L2-03 (Minimum Baseblock (BB) Time) and then the DC injection brake current set in b2-02 is sent to the motor to apply a DC injection brake to stop the motor. The DC injection brake time is determined by the set value in b2-04 and the output frequency when the Stop Command is input.

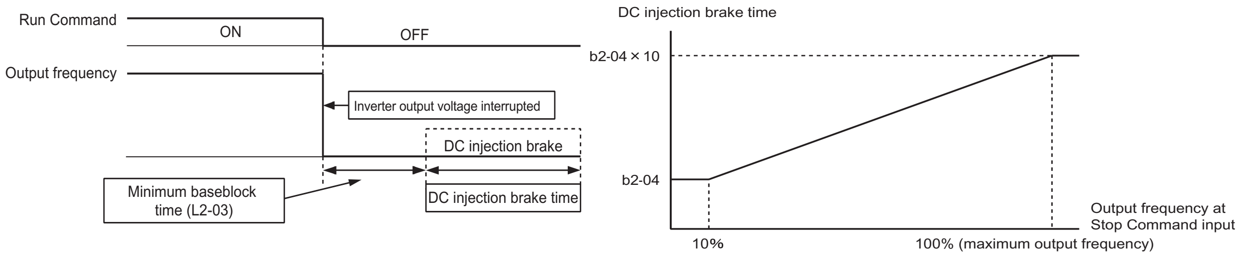


Fig 6.18 DC Injection Braking (DB) Stop

INFO

Lengthen the Minimum Baseblock Time (L2-03) when an overcurrent (OC) occurs during stopping.

6

■Coast to Stop with Timer

If the Stop Command is input (i.e., the Run Command is turned OFF) when b1-03 is set to 3, the Inverter output is interrupted to coast the motor to a stop. After the Stop Command is input, Run Commands are ignored until the time T has elapsed. The time T depends upon the output frequency when the Stop Command is input and the deceleration time.

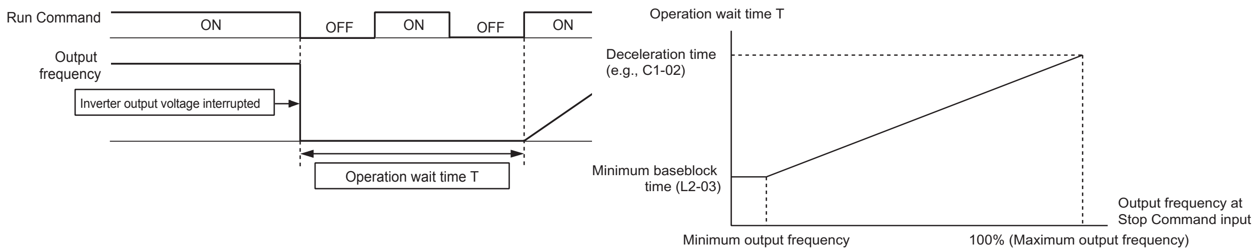


Fig 6.19 Coast to Stop with Timer

◆ Using the DC Injection Brake

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. DC injection braking is used at startup for flux vector control with the current set in E2-03 (Motor no-load current).

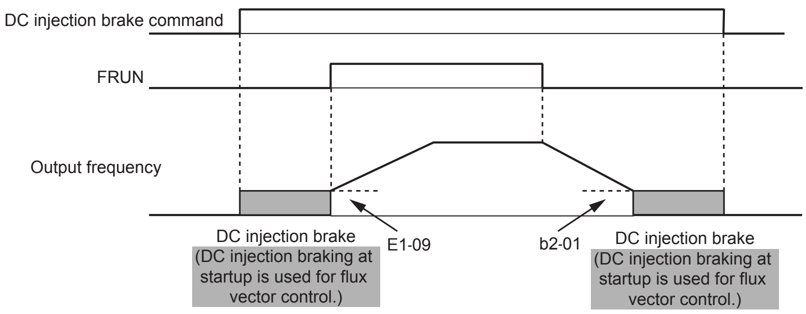
■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b2-02	DC injection braking current	Sets the DC injection braking current as a percentage of the Inverter rated current. The DC injection braking current in flux control is affected by any change to the setting of E2-03.	0 to 100	50%	No	A	A	A	No	18AH
b2-03	DC injection braking time at start	Used to set the time to perform DC injection braking at start in units of 1 second. Used to stop coasting motor and restart it. When the set value is 0, DC injection braking at start is not performed.	0.00 to 10.00	0.00 s	No	A	A	A	A	18BH

■Inputting the DC Injection Brake Command from Control Circuit Terminals

If you set a multi-function contact input terminal (H1-□□) to 60 (DC injection brake command), you can apply the DC injection brake to the motor by turning ON the terminal for which the DC injection brake command has been set when the Inverter is being stopped. DC injection braking is used at startup for flux vector control.

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



If you input the DC injection brake command from an external terminal, or if the Run Command and jog command are input, the DC injection brake will be disabled, and operation will resume.

Fig 6.20 DC Injection Brake Time Chart

■Changing the DC Injection Brake Current Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05(Multi-function Analog Input Terminal A3 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) or 20 mA input (current), 100% of the Inverter rated current will be applied.

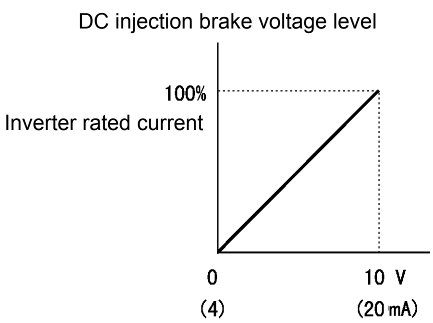


Fig 6.21 DC Injection Brake Current Using an Analog Input

◆ Using an Emergency Stop

Set a multi-function input terminal (H1-☐☐) to 15 or 17 (emergency stop) to decelerate to a stop at the deceleration time set in C1-09. If inputting the emergency stop with an NO contact, set the multi-function input terminal (H1-☐☐) to 15, and if inputting the emergency stop with an NC contact, set the multi-function input terminal (H1-☐☐) to 17.

After the emergency Stop Command has been input, operation cannot be restarted until the Inverter has stopped. To cancel the emergency stop, turn OFF the Run Command and emergency Stop Command.

■Related Parameters

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
C1-09	Emergency stop time	The deceleration time when the multi-function input "Emergency (fast) stop" is set to ON. This function can be used as a stopping method when a fault has been detected.	0.0 to 6000.0*	10.0 s	No	A	A	A	A	208H

* The setting range for acceleration/deceleration times will depends on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times becomes 0.00 to 600.00 seconds.

Acceleration and Deceleration Characteristics

This section explains 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 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 Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
C1-01	Acceleration time 1	Sets the acceleration time to accelerate from 0 to the maximum output frequency, in 1-second units.	0.0 to 6000.0 *1	10.0 s	Yes	Q	Q	Q	Q	200H
C1-02	Deceleration time 1	Sets the deceleration time to decelerate from the maximum output frequency to 0, in 1-second units.			Yes	Q	Q	Q	Q	201H
C1-03	Acceleration time 2	The acceleration time when the multi-function input “accel/decel time 1” is set to ON.			Yes	A	A	A	A	202H
C1-04	Deceleration time 2	The deceleration time when the multi-function input “accel/decel time 1” is set to ON.			Yes	A	A	A	A	203H
C1-05	Acceleration time 3	The acceleration time when the multi-function input “accel/decel time 2” is set to ON.			No	A	A	A	A	204H
C1-06	Deceleration time 3	The deceleration time when the multi-function input “accel/decel time 2” is set to ON.			No	A	A	A	A	205H
C1-07	Acceleration time 4	The acceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON.			No	A	A	A	A	206H
C1-08	Deceleration time 4	The deceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON.			No	A	A	A	A	207H
C1-10	Accel/decel time setting unit	0: 0.01-second units 1: 0.1-second units	0 or 1	1	No	A	A	A	A	209H
C1-11	Accel/decel time switching frequency	Sets the frequency for automatic acceleration/deceleration switching. Below set frequency: Accel/decel time 4 Above set frequency: Accel/decel time 1 The multi-function input “accel/decel time 1” or “accel/decel time 2” take priority.	0.0 to 400.0 *2 0.0 to 300.0 *3	0.0 Hz	No	A	A	A	A	20AH

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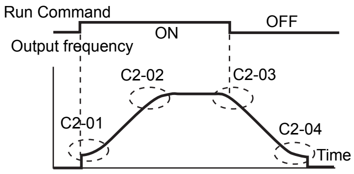
Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
C2-01	S-curve character-istic time at accelera-tion start	All sections of the S-curve characteristic time are set in seconds units. When the S-curve characteristic time is set, the accel/decel times will increase by only half of the S-curve characteristic times at start and end. 	0.00 to 2.50	0.20 s	No	A	A	A	A	20BH
C2-02	S-curve character-istic time at accelera-tion end		0.00 to 2.50	0.20 s	No	A	A	A	A	20CH
C2-03	S-curve character-istic time at deceler-ation start		0.00 to 2.50	0.20 s	No	A	A	A	A	20DH
C2-04	S-curve character-istic time at deceler-ation end		0.00 to 2.50	0.00 s	No	A	A	A	A	20EH

* 1. The setting range for acceleration/deceleration times will depend on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times become 0.00 to 600.00 seconds.
* 2. When C6-01=0, the upper limit is 150.0.
* 3. When C6-01=1, the upper limit is 400.0.

■Setting Acceleration and Deceleration Time Units

Set the acceleration/deceleration time units using C1-10. Constant C1-10 is set to 1 at the factory.

Set value	Details
0	The acceleration/deceleration time settings range is 0.00 to 600.00 in units of 0.01 s.
1	The acceleration/deceleration time settings range is 0.00 to 6000.0 in units of 0.1 s.

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

Using the Inverter, you can set four acceleration times and four deceleration times. When the multi-function input terminals (H1-□□) are set to 7 (acceleration/deceleration time selection 1) and 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.

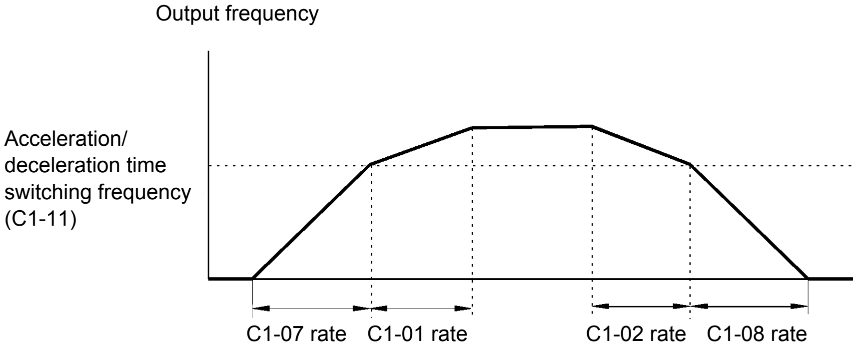
Acceleration/Deceleration Time Selection 1 Terminal	Acceleration/Deceleration Time Selection 2 Terminal	Acceleration Time	Deceleration Time
OFF	OFF	C1-01	C1-02
ON	OFF	C1-03	C1-04
OFF	ON	C1-05	C1-06
ON	ON	C1-07	C1-08

■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 0.0 Hz. If C1-11 is set to 0.0 Hz, 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 6.22 Acceleration/deceleration Time Switching Frequency

■Adjusting Acceleration and Deceleration Time Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to 5 (acceleration/deceleration time gain), you can adjust the acceleration/deceleration time using terminal A2's or A3's input voltage.

The Inverter's acceleration time when the acceleration time has been set in C1-01 is as follows:

Acceleration time = C1-01 set value x acceleration/deceleration time gain

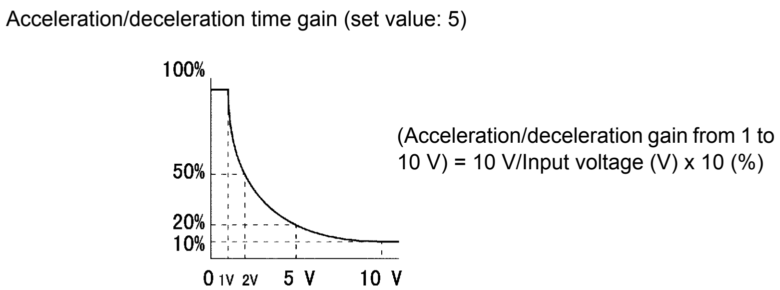


Fig 6.23 Acceleration/Deceleration Time Gain Using an Analog Input

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

By performing acceleration and deceleration 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

Set the S-curve characteristic time to lengthen acceleration/deceleration time as follows:

Acceleration time = Selected acceleration time + (Acceleration start time S-curve characteristic time + Acceleration end time S-curve characteristic time) / 2

Deceleration time = Selected deceleration time + (Deceleration start time S-curve characteristic time + Deceleration end time S-curve characteristic time) / 2

Setting Example

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

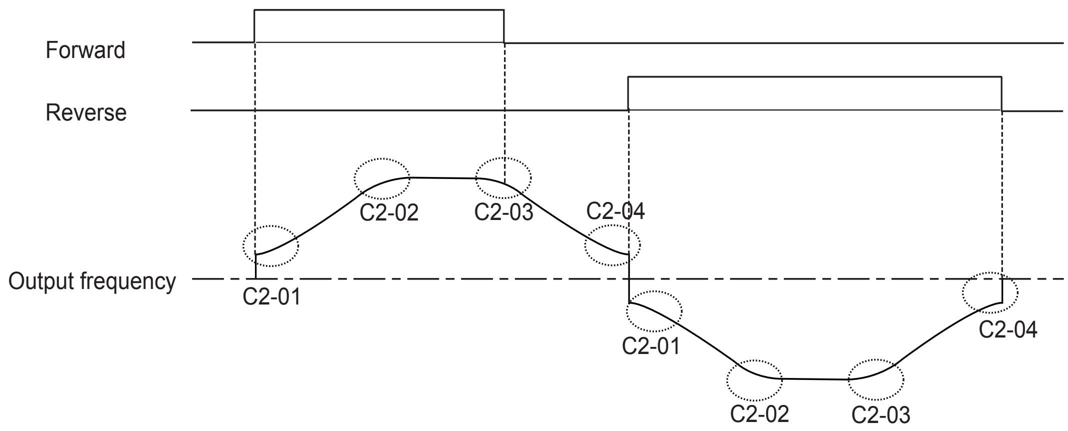
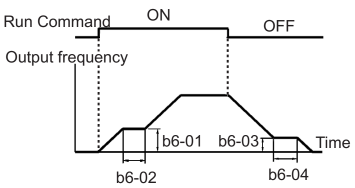


Fig 6.24 S-curve Characteristic during Operation Switching

◆ Accelerating and Decelerating Heavy Loads (Dwell Function)

The dwell function stores the output frequency when starting or stopping heavy loads. By temporarily storing the output frequency, you can prevent the motor from stalling. When using the dwell function, you must select a deceleration stop. Set b1-03 (Stopping Method Selection) to 0.

■Related Parameters

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
b6-01	Dwell frequency at start	 The dwell function is used to output frequency temporarily when driving a motor with a heavy load.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B6H
b6-02	Dwell time at start		0.0 to 10.0	0.0 s	No	A	A	A	A	1B7H
b6-03	Dwell frequency at stop		0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B8H
b6-04	Dwell time at stop		0.0 to 10.0	0.0 s	No	A	A	A	A	1B9H

* 1. When C6-01=0, the upper limit is 150.0.
* 2. When C6-01=1, the upper limit is 400.0.

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◆ 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 on the motor, or 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.

If you set L3-01 to 2 (optimum adjustment), the motor current accelerates to the value set in L3-02. With this setting, the acceleration time setting is ignored.

■Related Parameters

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L3-01	Stall prevention selection during accel	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 is returned.) 2: Intelligent acceleration mode (Using the L3-02 level as a basis, acceleration is automatically adjusted. Set acceleration time is disregarded.)	0 to 2	1	No	A	A	A	No	48FH
L3-02	Stall prevention level during accel	Effective when L3-01 is set to 1 or 2. Set as a percentage of Inverter rated current. Usually setting is not necessary. The factory setting reduces the set values when the motor stalls.	0 to 200	120% * 150% *	No	A	A	A	No	490H
L3-03	Stall prevention limit during accel	Sets the lower limit for stall prevention during acceleration, as a percentage of the Inverter rated current, when operation is in the frequency range above E1-06. Usually setting is not necessary.	0 to 100	50%	No	A	A	A	No	491H

* C6-01=1: 120%, C6-01=0: 150%

■Time Chart

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

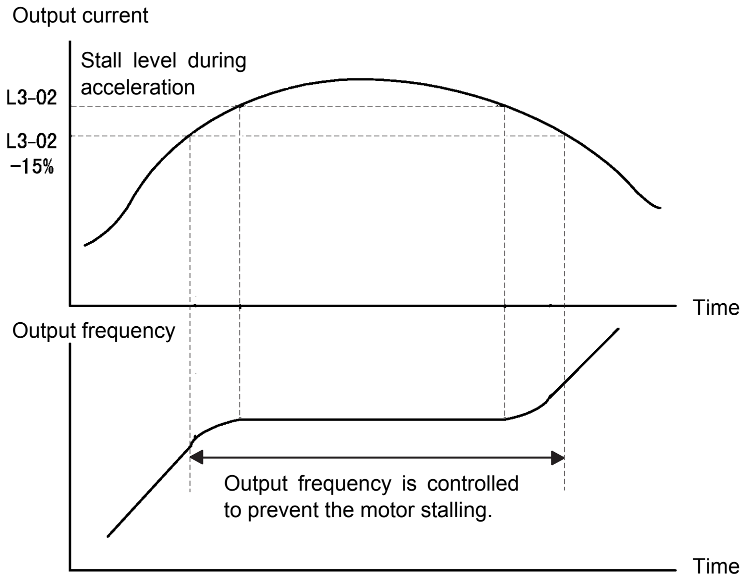

Fig 6.25 Time Chart for Stall Prevention During Acceleration

■Setting Precautions

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

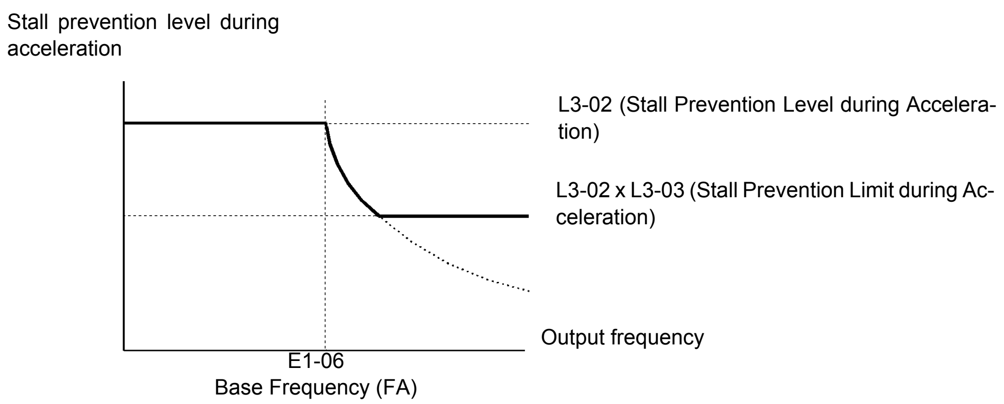

Fig 6.26 Stall Prevention Level and Limit During Acceleration

◆ Preventing Overvoltage During Deceleration (Stall Prevention During Deceleration Function)

The Stall Prevention During Deceleration function makes the rate of deceleration more gentle to suppress increases in DC bus voltage when the DC bus voltage exceeds the set value during motor deceleration.

This function automatically lengthens the deceleration time with respect to the bus voltage, even if the deceleration time has been set to a considerably small value.

If L3-04 is set to 1 or 2, when the main circuit DC voltage approaches the stall prevention level during deceleration, deceleration stops, and when deceleration falls below the level, is restarted. Using this operation, deceleration time is automatically lengthened. If L3-04 is set to 1, deceleration time returns to the set value, and if L3-04 is set to 2, deceleration is automatically adjusted to a faster deceleration time within the range of the stall prevention level during deceleration.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L3-04	Stall prevention selection during decel	0: Disabled (Deceleration as set. If deceleration time is too short, a main circuit overvoltage may result.) 1: Enabled (Deceleration is stopped when the main circuit voltage exceeds the overvoltage level. Deceleration restarts when voltage is returned.) 2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that in Inverter can decelerate in the shortest possible time. Set deceleration time is disregarded.) 3: Enabled (with Braking Resistor Unit) When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3.	0 to 3 *	1	No	Q	Q	Q	Q	492H

* When using flux vector control, 0 to 2.

■Setting Example

An example of stall prevention during deceleration when L3-04 is set to 1 as shown below.

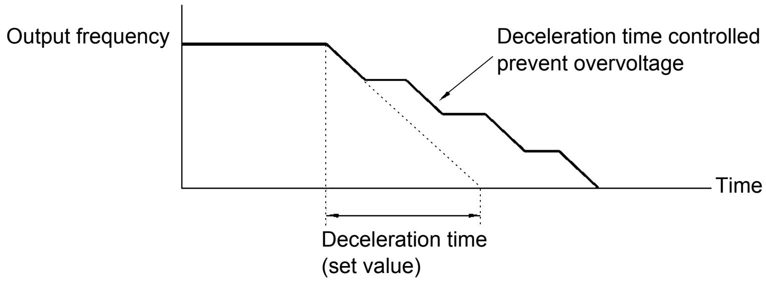

Fig 6.27 Stall Prevention During Deceleration Operation

■Setting Precautions

- The stall prevention level during deceleration differs depending on the Inverter capacity. Refer to the following table for details.

Inverter Capacity		Stall Prevention Level during Deceleration (V)
200 V Class		380
400 V Class	E1-01 ≥ 400 V	760
	E1-01 < 400 V	660

- When using the braking option (braking resistor, Braking Resistor Units, and Braking Units), be sure to set constant L3-04 to 0 or 3.
- To decelerate at a shorter time than the deceleration time set when L3-04 is set to 0 with the braking option enabled, set L3-04 to 3.
- The setting of L3-04 is ignored for flux vector control.

◆ Preventing Overvoltage by Automatically Reducing the Regenerative Torque Limit (Overvoltage Inhibit Function, SPEC: E or later only)

The overvoltage inhibit function is a function that, by reducing the regenerative torque limit to a value less than its set value according to the main circuit voltage level, suppresses voltage rises with regenerative torque. Using this function means that if, for example, the main circuit voltage rises during deceleration, the regenerative torque limit will be reduced and so the deceleration rate will be reduced automatically, suppressing rises in the main circuit voltage.

This function is effective for suppressing overvoltages that occur during stabilization after an overshoot following sudden acceleration. This function differs from the stall prevention during deceleration function in this respect.

This function is enabled during vector control.

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■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
L3-11	Overvoltage inhibit selec-tion	0: Disabled 1: Enabled Used to enable or disable the function for inhibiting main cir-cuit overvoltages by reducing the regenerative torque limit according to the main circuit overvoltage level. If this function is enabled, when the main circuit voltage rises, operation will be performed with the regenerative torque less than the set value.	0 or 1	0	No	No	No	A	A	4C7H
L3-12	Overvoltage inhibit volt-age level	Sets the main circuit voltage level for which the regenerative torque limit is restricted to 0. Usually, there is no need to change this setting. If main circuit overvoltages occur even with the overvoltage inhibit function enabled, reduce this setting.	350 to 390*	380V*	No	No	No	A	A	4C8H

* These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.

■Setting Precautions

When this function is enabled, if the main circuit voltage rises, the regenerative torque limit will decrease to a value less than its set value and so the motor will not rotate at the speed specified by the speed reference. Therefore, in applications where it is necessary to rotate the motor at the speed specified by the speed reference, disable this function and use a converter, a dynamic braking resistor, or a power regenerative unit to suppress rises in the main circuit voltage.

Adjusting Frequency References

This section explains methods of adjusting frequency references.

◆ Adjusting Analog Frequency References

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
H3-01	Signal level selection (terminal A1)	0: 0 to 10 V 1: −10 to 10 V	0 or 1	0	No	A	A	A	A	410H
H3-02	Gain (terminal A1)	Sets the frequency when 10 V is input. as a percentage of the maximum output frequency.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	411H
H3-03	Bias (terminal A1)	Sets the frequency when 0 V is input, as a percentage of the maximum frequency.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	412H
H3-04	Signal level selection (terminal A3)	0: 0 to 10 V 1: −10 to 10 V	0 or 1	0	No	A	A	A	A	413H
H3-05	Multi-function analog input (terminal A3) function selection	Select from the functions listed in the following table. Refer to the next page.	0 to 1F	1F	No	A	A	A	A	414H
H3-06	Gain (terminal A3)	Sets the input gain (level) when 10V is input. Set according to the 100% value selected from H3-05.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	415H
H3-07	Bias (terminal A3)	Sets the input gain (level) when 0 V is input. Set according to the 100% value selected from H3-05.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	416H
H3-08	Signal level selection (terminal A2)	0: 0 to +10V, with lower limit 1: −10 to 10 V without lower limit 2: 4 to 20 mA Switch current and voltage input using the switch on the control panel.	0 to 2	2	No	A	A	A	A	417H
H3-09	Multi-function analog input (terminal A2) function selection	Select multi-function analog input function for terminal A2. Refer to the next table.	0 to 1F	0	No	A	A	A	A	418H
H3-10	Gain (terminal A2)	Sets the input gain (level) when 10 V (20 mA) is input. Set according to the 100% value for the function set for H3-09.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	419H
H3-11	Bias (terminal A2)	Sets the input gain (level) when 0 V (4 mA) is input. Set according to the 100% value for the function set for H3-09.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	41AH

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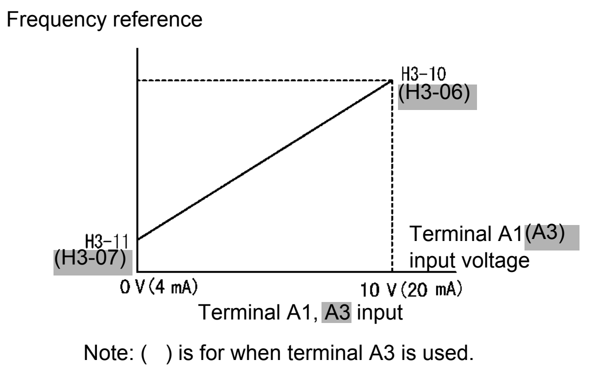
Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
H3-12	Analog input filter time constant	Sets primary delay filter time constant in seconds for the analog input terminal. Effective for noise control etc.	0.00 to 2.00	0.00 s 0.03 s	No	A	A	A	A	41BH

■Adjusting Analog Frequency Reference Using Constants

The frequency reference is input from the control circuit terminals using analog voltage and current.

If using frequency reference terminal A1 as an input terminal, perform adjustments using constants H3-02 and H3-03. If using multi-function analog input terminal A2 as a frequency reference terminal, perform adjustments using H3-10 and H3-11.

Adjustment can be made using H3-06 and H3-07 when multi-function analog input terminal A3 is used as a frequency reference terminal.



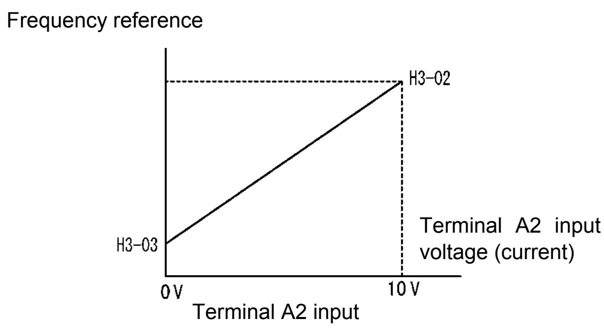


Fig 6.28 Terminals A1 and A2 Inputs

■Adjusting Frequency Gain Using an Analog Input

When H3-09 or H3-05 is set to 1 (frequency gain), you can adjust the frequency gain using the analog input terminal A2 or A3.

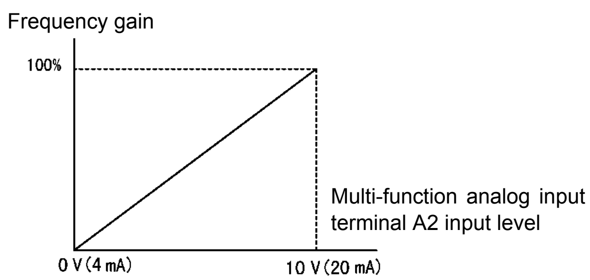
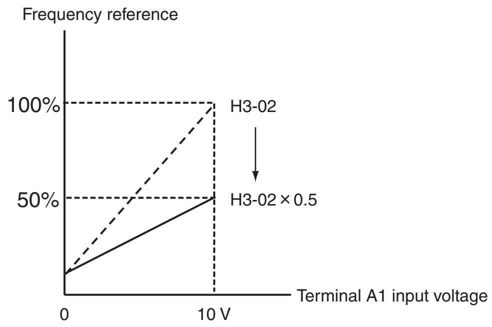


Fig 6.29 Frequency Gain Adjustment (Terminal A2 Input)

The frequency gain for terminal A1 is the product of H3-02 and terminal A2 gain. For example, when H3-02 is set to 100% and terminal A2 is set to 5 V, the terminal A1 frequency reference will be 50%.



■Adjusting Frequency Bias Using an Analog Input

When constant H3-09 or H3-05 is set to 0 (add to terminal A1), the frequency equivalent to the terminal A2 or A3 input voltage is added to A1 as a bias.

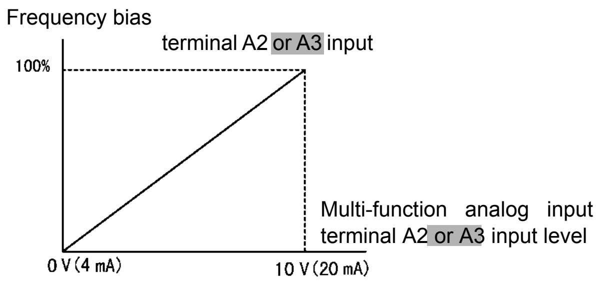
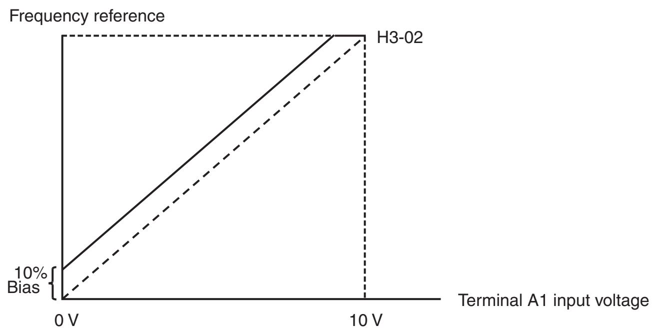


Fig 6.30 Frequency Bias Adjustment (Terminal A2 or A3 or A3 Input)

For example, if H3-02 is 100%, H3-03 is 0%, and terminal A2 is set to 1 V, the frequency reference from terminal A1 when 0 V is input to A1 will be 10%.



When constant H3-09 or H3-05 is set to D (frequency bias 2), the frequency equivalent to the terminal A2 or A3 input voltage is added to A1 as a bias.

6

◆ 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 frequency reference dead band.

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d3-01	Jump frequency 1	Set the center values of the jump frequencies in Hz. This function is disabled by setting the jump frequency to 0 Hz. 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 400.0*1	0.0 Hz	No	A	A	A	A	294H
d3-02	Jump frequency 2			0.0 Hz	No	A	A	A	A	295H
d3-03	Jump frequency 3		0.0 to 300.0*2	0.0 Hz	No	A	A	A	A	296H
d3-04	Jump frequency width	Sets the jump frequency bandwidth in Hz. The jump frequency will be the jump frequency ± d3-04.	0.0 to 20.0	1.0 Hz	No	A	A	A	A	297H

* 1. When C6-01=0, the upper limit is 150.0.

* 2. When C6-01=1, the upper limit is 400.0.

The relationship between the output frequency and the jump frequency reference is as follows:

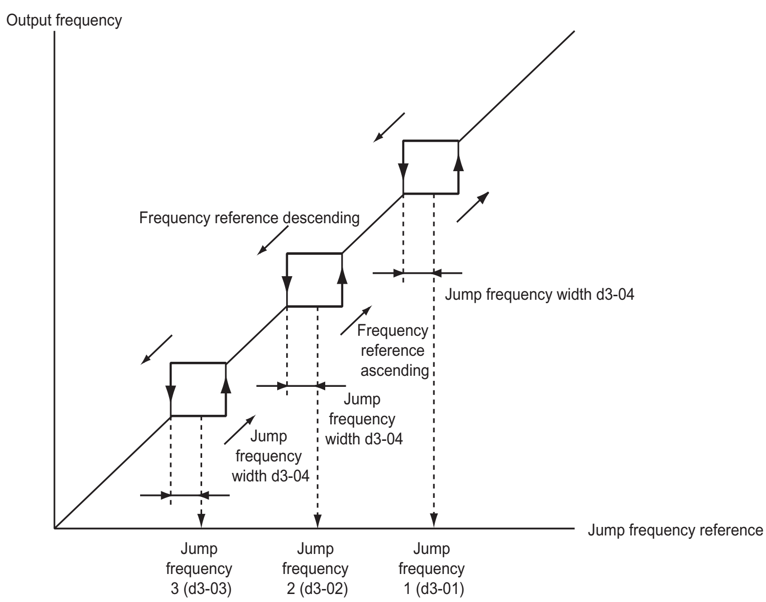


Fig 6.31 Jump Frequency

■Setting Jump Frequency Reference Using an Analog Input

When constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) is set to A (jump frequency), you can change the jump frequency using the terminal A2 or A3 input level.

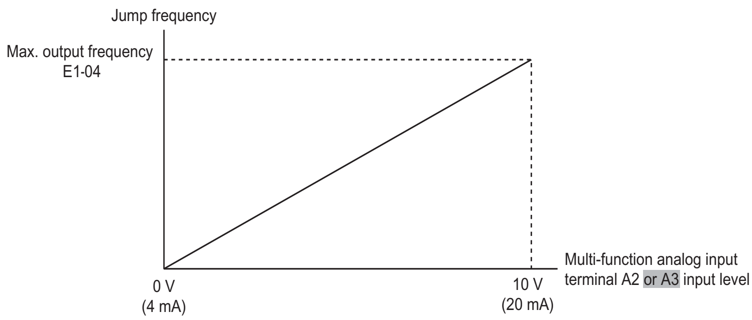


Fig 6.32   Jump Frequency Setting Using an Analog Input

■Setting Precautions

- Set the jump frequency according to the following formula: d3-01 ≥ d3-02 ≥ d3-03 > Analog input.
- When constants d3-01 to d3-03 are set to 0 Hz, the jump frequency function is disabled.

6

◆ Adjusting Frequency Reference Using Pulse Train Inputs

The frequency reference can be adjusted when b1-01 (Reference Selection) is set to 4 (Pulse Train Input). Set the pulse frequency in constant H6-02 to 100% reference, and then adjust the gain and bias accordingly using H6-03 and H6-04.

■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
H6-01	Pulse train input function selection	0: Frequency reference 1: PID feedback value 2: PID target value	0 to 2	0	No	A	A	A	A	42CH
H6-02	Pulse train input scaling	Set the number of pulses in hertz, taking the reference to be 100%.	1000 to 32000	1440 Hz	Yes	A	A	A	A	42DH
H6-03	Pulse train input gain	Set the input gain level as a per-cent when the pulse train set in H6-02 is input.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	42EH
H6-04	Pulse train input bias	Set the input bias when the pulse train is 0.	-100.0 to 100.0	0.0%	Yes	A	A	A	A	42FH
H6-05	Pulse train input filter time	Set the pulse train input primary delay filter time constant in sec-onds.	0.00 to 2.00	0.10 s	Yes	A	A	A	A	430H

The following diagram shows the method for adjusting the frequency reference using pulse inputs.

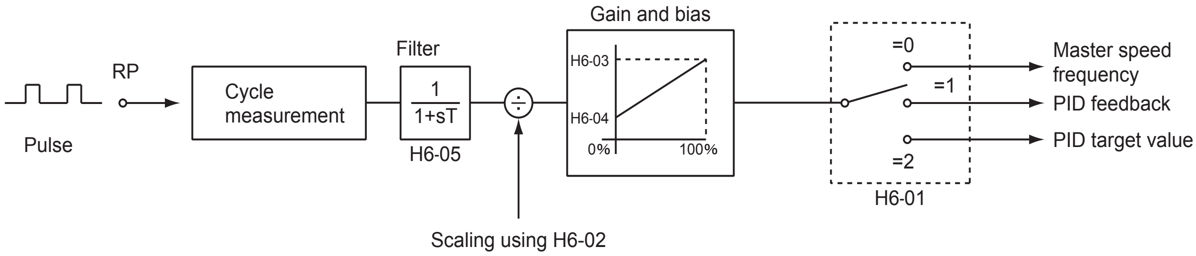


Fig 6.33 Frequency Reference Adjustments Using Pulse Train Inputs

Speed Limit (Frequency Reference Limit Function)

This section explains how to limit the motor speed.

◆ Limiting Maximum Output Frequency

If you do not want the motor to rotate above a given frequency, use constant d2-01.

Set the upper limit value of the Inverter output frequency as a percent, taking E1-04 (Maximum Output Frequency) to be 100%.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d2-01	Frequency reference upper limit	Set the output frequency upper limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	100.0%	No	A	A	A	A	289H

◆ Limiting Minimum Frequency

If you do not want the motor to rotate at below a given frequency, use constants d2-02 or d2-03.

There are two methods of limiting the minimum frequency, as follows:

- Adjust the minimum level for all frequencies.
- Adjust the minimum level for the master speed frequency (i.e., the lower levels of the jog frequency, multi-step speed frequency, and auxiliary frequency will not be adjusted).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d2-02	Frequency reference lower limit	Sets the output frequency lower limit as a percentage of the maximum output frequency.	0.0 to 110.0	0.0%	No	A	A	A	A	28AH
d2-03	Master speed reference lower limit	Set the master speed reference lower limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	0.0%	No	A	A	A	A	293H

■Adjusting Frequency Lower Limit Using an Analog Input

If you set constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to 9 (output frequency lower level), you can adjust the frequency lower level using the terminal A2 or A3 input level.

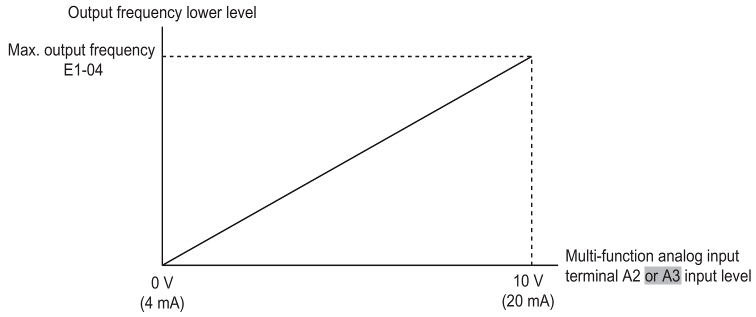


Fig 6.34 Output Frequency Lower Level for Multi-function Analog Input

INFO

If constant d2-02 and terminal A2 output frequency lower level have been set at the same time, the larger set value will become the frequency lower limit.

Improved Operating Efficiency

This section explains functions for improving motor operating efficiency.

◆ Reducing Motor Speed Fluctuation (Slip Compensation Function)

When the load is large, the amount of motor slip also grows large 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, constant E2-02 (Motor Rated Slip) × the frequency in constant C3-01 is added to the output frequency.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
C3-01	Slip compensation gain	Used to improve speed accuracy when operating with a load. Usually setting is not necessary. Adjust this constant at the following times. • When actual speed is low, increase the set value. • When actual speed is high, decrease the set value. Used as the applicable control gain when using flux vector control.	0.0 to 2.5	0.0*	Yes	A	No	A	A	20FH
C3-02	Slip compensation primary delay time	Slip compensation primary delay time is set in ms units. Usually setting is not necessary. Adjust this constant at the following times. • Reduce the setting when slip compensation responsive is slow. • When speed is not stabilized, increase the setting.	0 to 10000	2000 ms *	No	A	No	A	No	210H
C3-03	Slip compensation limit	Sets the slip compensation limit as a percentage of motor rated slip.	0 to 250	200%	No	A	No	A	No	211H
C3-04	Slip compensation selection during regeneration	0: Disabled. 1: Enabled. When the slip compensation during regeneration function has been activated, as regeneration capacity increases momentarily, it may be necessary to use a braking option (braking resistor, Braking Resistor Unit or Braking Unit.)	0 or 1	0	No	A	No	A	No	212H
C3-05	Output voltage limit operation selection	0: Disabled. 1: Enabled. (The motor flux will be lowered automatically when the output voltage become saturated.)	0 or 1	0	No	No	No	A	A	213H

* The factory setting will change when the control method is changed. The V/f control factory settings are given.

6

■Adjusting Slip Compensation Gain

You can switch the C3-01 constant settings as shown below by changing the control method.

- V/f control: 0.0
- Open-loop vector control: 1.0
- Flux vector control: 1.0

Set C3-01 to 1.0 to compensate 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) - No. of rated rotations (min^{-1}.) × No. of motor poles / 120
   Set the values for rated voltage, rated frequency, and no-load current in the motor unladen current. The motor rated slip is set automatically in the vector control using autotuning.
2. In V/f control, set C3-01 to 1.0. Setting this constant to 0.0 disables slip compensation.
3. 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 ms.

You can switch the factory settings as follows by changing the control method.

- V/f control: 2000 ms
- Open-loop vector control: 200 ms

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

The upper limit for the slip compensation amount can be set in C3-03 as a percent, 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 value 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 fixed output range.

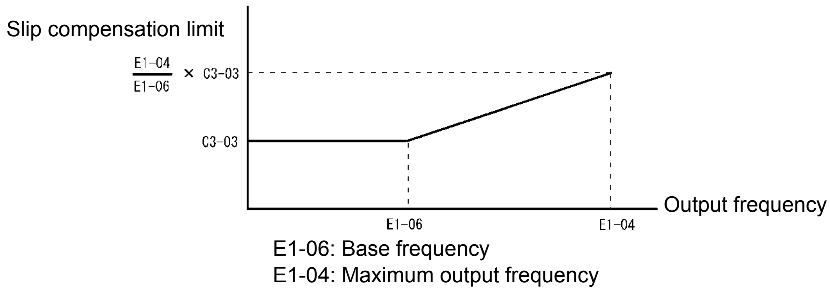


Fig 6.35 Slip Compensation Limit

■Selecting Slip Compensation Function During Regeneration

Whether to enable or disable the slip compensation function during regeneration can be set in C3-04.

If the slip compensation function operates during regeneration, you might have to use the braking option (braking resistor, Braking Resistor Unit, and Braking Unit) to momentarily increase the regenerative amount.

■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, set C3-05 to 1 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 to limit 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 insufficient, 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)

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

V/f control calculates and adjusts the motor primary loss voltage according to the output voltage (V), and compensates for insufficient torque at startup and during low-speed operation. Calculate the compensation voltage as follows: Motor primary voltage loss × constant C4-01.

Vector control separates the motor excitation current and the torque current by calculating the motor primary current, and controlling each of the two separately.

Calculate the torque current as follows: Calculated torque reference × C4-01

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
C4-01	Torque compensation gain	Sets torque compensation gain as a ratio. Usually setting is not necessary. Adjust in the following circumstances: • 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 values. • When the motor is oscillating, decrease the set values. Adjust the output current range at minimum speed rotation so that it does not exceed the Inverter rated output current. Do not alter the torque compensation gain from its default (1.00) when using the open loop vector control method.	0.00 to 2.50	1.00	Yes	A	A	A	No	215H
C4-02	Torque compensation primary delay time constant	The torque compensation delay time is set in ms units. Usually setting is not necessary. Adjust in the following circumstances: • When the motor is oscillating, increase the set values. • When the responsiveness of the motor is low, decrease the set values.	0 to 10000	200 ms *	No	A	A	A	No	216H

* The factory setting will change when the control method is changed. The V/f control factory setting is given.

■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 using V/f control in the following circumstances.

- If the cable is very long, increase the set value.
- If the (maximum applicable) motor capacity is smaller than the Inverter capacity, increase the set value.
- If the motor is vibrating, reduce the set value.

Adjust this constant so that the output current during low-speed rotation does not exceed the Inverter rated output current range.

■Adjusting the Torque Compensation Primary Delay Time Constant

Set the torque compensation function primary delay in ms.

You can switch the factory settings as follows by changing the control method settings:

- V/f control: 200 ms
- V/f control with PG: 200 ms
- Open-loop vector control: 20 ms

Normally, there is no need to make this setting. Adjust the constant as shown below.

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

◆ Hunting-prevention Function

The hunting-prevention function suppresses hunting when the motor is operating with a light load. This function can be used in V/f and V/f with PG.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMO BUS Register
N1-01	Hunting-prevention function selection	0: Hunting-prevention function disabled 1: Hunting-prevention function enabled The hunting-prevention function suppresses hunting when the motor is operating with a light load. This function is enabled in V/f control method only. If high response is to be given priority over vibration suppression, disable the hunting-prevention function.	0 or 1	1	No	A	A	No	No	580H
N1-02	Hunting-prevention gain	Set the hunting-prevention gain multiplication factor. Normally, there is no need to make this setting. Make the adjustments as follows: • If vibration occurs with light load, increase the setting. • If the motor stalls, reduce the setting. If the setting is too large, the voltage will be too suppressed and the motor may stall.	0.00 to 2.50	1.00	No	A	A	No	No	581H

6

◆ Stabilizing Speed (Speed Feedback Detection Function)

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
N2-01	Speed feedback detection control (AFR) gain	Set the internal speed feedback detection control gain using the multiplication function. Normally, there is no need to make this setting. 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	1.00	No	No	No	A	No	584H
N2-02	Speed feedback detection control (AFR) time constant	Set the time constant to decide the rate of change in the speed feedback detection control.	0 to 2000	50 ms	No	No	No	A	No	585H
N2-03	Speed feedback detection control (AFR) time constant 2	Set the time constant to decide the amount of change in the speed.	0 to 2000	750 ms	No	No	No	A	No	586H

Machine Protection

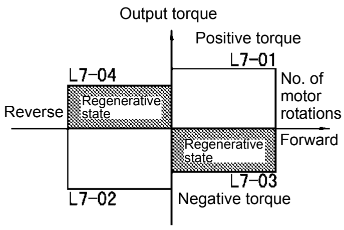
This section explains functions for protecting the machine.

◆ Limiting Motor Torque (Torque Limit Function)

The motor torque limit function is enabled with flux vector control and open-loop vector control.

In the open-loop vector control and flux vector control, the user-set value is applied to the torque limit by calculating internally the torque output by the motor. 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.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register
L7-01	Forward drive torque limit	Sets the torque limit value as a percentage of the motor rated torque. Four individual regions can be set.  	0 to 300	200%	No	No	No	A	A	4A7H
L7-02	Reverse drive torque limit		0 to 300	200%	No	No	No	A	A	4A8H
L7-03	Forward regenerative torque limit		0 to 300	200%	No	No	No	A	A	4A9H
L7-04	Reverse regenerative torque limit		0 to 300	200%	No	No	No	A	A	4AAH
L7-06	Integral time setting for torque limit	Set the integral time for the torque limit. When integral control is set for the torque limit, reduce this setting to increase the change in frequency for the torque limit.	5 to 10000	200 ms	No	No	No	A	No	4ACH
L7-07	Control method selection for torque limit during acceleration and deceleration	Select the control method for the torque limit during acceleration and deceleration. 0: Proportional control (integral control during constant speed) 1: Integral control Usually, this constant does not need to be set. For applications in which the torque limit will be reached during acceleration and deceleration, torque control can be given priority by selecting integral control. When the torque is limited, the acceleration and deceleration times may increase or the motor speed may not agree with the speed reference value.	0 or 1	0	No	No	No	A	No	4C9H

6

Multi-function Analog Input (H3-05,H3-09)

Setting Value	Function	Contents (100%)	Control Methods			
			V/f	V/f with PG	Open Loop Vector	Flux Vector
10	Positive torque limit	Motor's rated torque	No	No	Yes	Yes
11	Negative torque limit	Motor's rated torque	No	No	Yes	Yes
12	Regenerative torque limit	Motor's rated torque	No	No	Yes	Yes
15	Positive/negative torque limit	Motor's rated torque	No	No	Yes	Yes

Note The forward torque limit is the limit value when the analog input signal generates forward torque. This torque limit setting is enabled even when the analog input signal generates forward torque while the motor is operating (regeneration).

■Setting the Torque Limit in Constants

Using L7-01 to L7-04, you can set individually four torque limits in the following directions: Forward drive, reverse drive, forward regeneration, and reverse regeneration.

■Set the Torque Limit Value Using an Analog Input

You can change the analog input level torque limit value by setting the torque limit in multi-function analog input terminals A2 and A3.

The analog input terminal signal level is factory-set as follows:

Multi-function analog input terminal A2: 4 to 20 mA

Multi-function analog input terminal A3: 0 to 10

The following diagram shows the relationship between the torque limits.

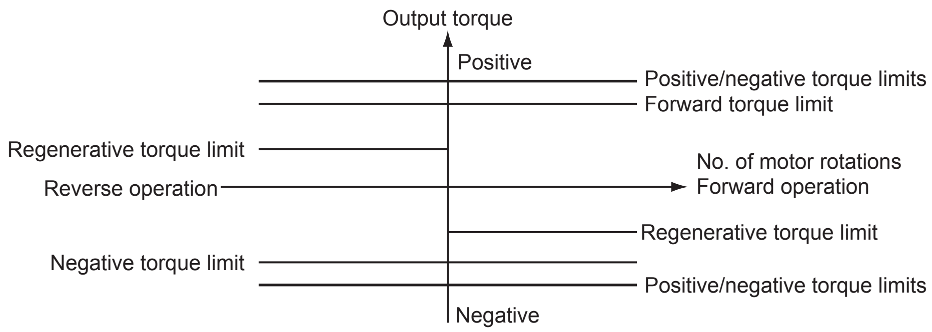


Fig 6.36 Torque Limit by Analog Input

■Setting Torque Limits Using Constants and an Analog Input

The following block diagram shows the relationship between torque limit using constants and torque limit using an analog input.

The lowest torque limit set from among the following is enabled: Torque limit using constants, torque limit using an analog input, 150% of Inverter rating (when set to CT), or 120% of Inverter rating (when set to VT) set in C6-01.

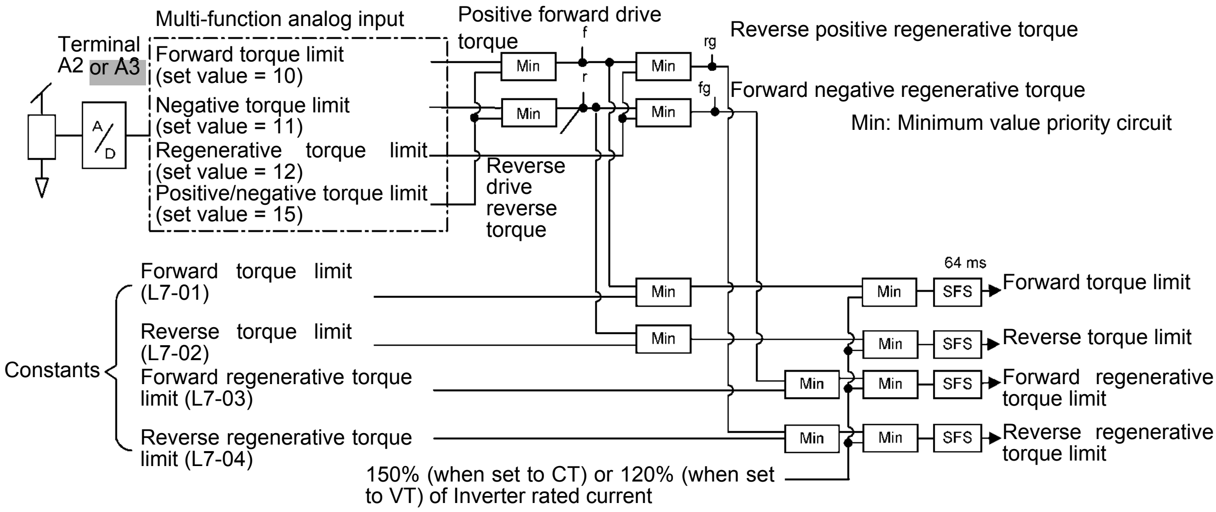


Fig 6.37 Torque Limit Using Constants and an Analog Input

■Selecting the Control Method for Torque Limit during Acceleration and Deceleration (SPEC: E or later only)

L7-07 is used to select the control method for the torque limit during acceleration and deceleration. The selections are proportional control and integral control. For applications, in which the torque limit will be reached during acceleration and deceleration, torque control can be given priority by selecting integral control. To increase the change in frequency for the torque limit when integral control is selected, decrease the value set for L7-06 (Integral Time Setting for Torque Limit).

■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 times may increase or the number of motor rotations may decrease.
- When using the torque limit to raise and lower loads, do not carelessly lower the torque limit value, as this may result in the motor falling or slipping.
- Torque limits using an analog input are the upper limit value (during 10 V or 20 mA input) of 100% of the motor rated torque. To make the torque limit value during 10 V or 20 mA input 150% of the rated torque, set the input terminal gain to 150.0 (%). Adjust the gain for multi-function analog input terminal A2 using H3-10 and for multi-function analog input terminal A3 using H3-06.
- The torque limit accuracy is ±5% at the output frequency of 10 Hz or above. When output frequency is less than 10 Hz, accuracy is lowered.
- When the torque is limited while L7-07 is set to 1 (integral control), the acceleration and deceleration times may increase or the motor speed may not agree with the speed reference value.

6

◆ Preventing Motor Stalling During Operation

Stall prevention during operation prevents the motor from stalling by automatically lowering the Inverter's output frequency when a transient overload occurs while the motor is operating at a constant speed.

Stall prevention during operation is enabled only during V/f control. If the Inverter output current continues to exceed the setting in constant L3-06 for 100 ms or longer, the motor speed is reduced. Set whether to enable or disable deceleration time using constant L3-05. Set the deceleration time using C1-02 (Acceleration time 1) or C1-04 (Acceleration Time 2).

If the Inverter output current reaches the set value in L3-06 - 2% (Inverter Rated Output Current), the motor will accelerate again at the frequency set or the acceleration time set.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMO BUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L3-05	Stall prevention selection during running	0: Disabled (Runs as set. With a heavy load, the motor may stall.) 1: Deceleration time 1 (the deceleration time for the stall prevention function is C1-02.) 2: Deceleration time 2 (the deceleration time for the stall prevention function is C1-04.)	0 to 2	1	No	A	A	No	No	493H
L3-06	Stall prevention level during running	Effective when L3-05 is 1 or 2. Set as a percentage of the Inverter rated output current. Usually setting is not necessary. The factory setting reduces the set values when the motor stalls.	30 to 200	120% * 150% *	No	A	A	No	No	494H

* C6-01= 1: 120%, C6-01= 0: 150%

◆ Changing Stall Prevention Level during Operation Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to 8 (stall prevention level during run), you can change the stall level during operation by setting H3-10 [Gain (Terminal A2)] and H3-11 [Bias (Terminal A2)] or H3-06 [Gain (Terminal A3)] and H3-07 [Bias (Terminal A3)].

The stall prevention level during operation enabled is the multi-function analog input terminal A2 or A3 input level or the set value in constant L3-06, whichever is the smaller.

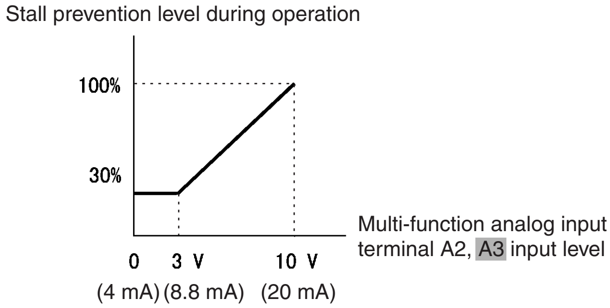


Fig 6.38 Stall Prevention Level during Operation Using an Analog Input

INFO

If the motor capacity is smaller than the Inverter capacity or the motor stalls when operating at the factory settings, lower the stall prevention level during operation.

◆ Using Frequency Detection

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

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMO BUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L4-01	Speed agreement detection level	Effective when “Desired frequency (ref/setting) agree 1,” “Frequency detection 1,” or “Frequency detection 2" is set for a multi-function output. Frequencies to be detected are set in Hz units.	0.0 to 400.0*1 0.0 to 300.0*2	0.0 Hz	No	A	A	A	A	499H
L4-02	Speed agreement detection width	Effective when “Frequency (speed) agree 1,” “Desired frequency (speed) agree 1,” or “Frequency (FOUT) detection 1,” Frequency (FOUT) detection 2 is set for a multi-function output. Sets the frequency detection width in Hz units.	0.0 to 20.0	2.0 Hz	No	A	A	A	A	49AH

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
L4-03	Speed agree-ment detec-tion level (+/-)	Effective when "Desired fre-quency (speed) agree 2," "Fre-quency (FOUT) detection 3," or "Frequency (FOUT) detection 4" is set for a multi-function out-put. Frequency that should be detected is set in Hz units.	-400.0 to +400.0 *3 -300.0 to +300.0 *4	0.0 Hz	No	A	A	A	A	49BH
L4-04	Speed agree-ment detec-tion width (+/-)	Effective when "Frequency (speed) agree 2," "Desired fre-quency (speed) agree 2," Fre-quency (FOUT) detection 3 or "Frequency detection 4" is set for a multi-function output. Frequency detection width is set in Hz units.	0.0 to 20.0	2.0 Hz	No	A	A	A	A	49CH

* 1. When C6-01 = 0, the upper limit is 150.0.
* 2. When C6-01 = 1, the upper limit is 400.0.
* 3. When C6-01 = 0, -150.0 to +150.0.
* 4. When C6-01 = 1, -400.0 to +400.0

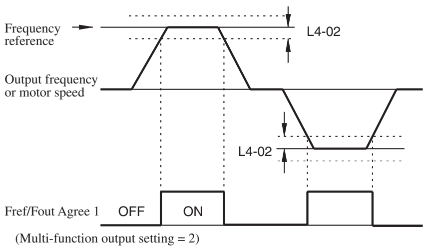
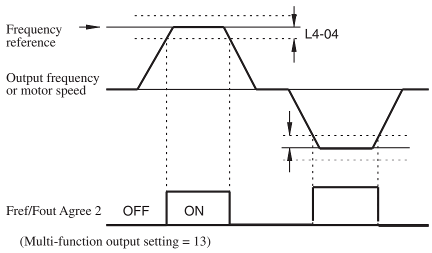
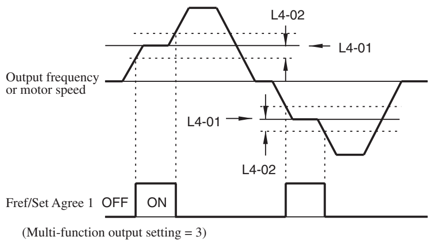
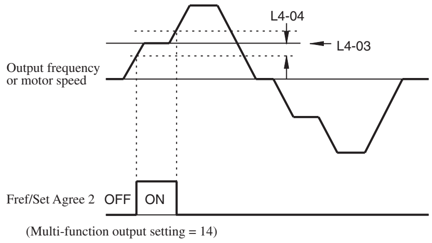
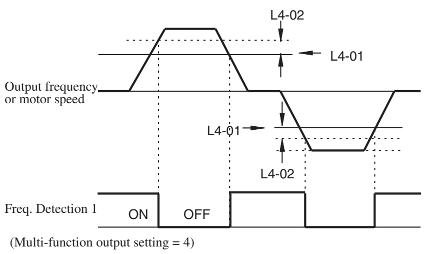
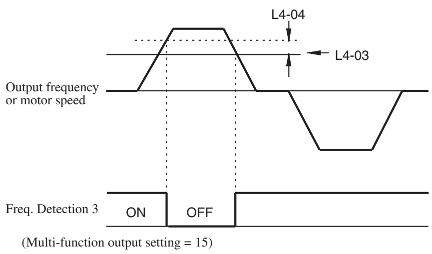
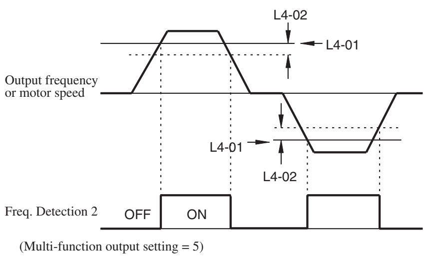
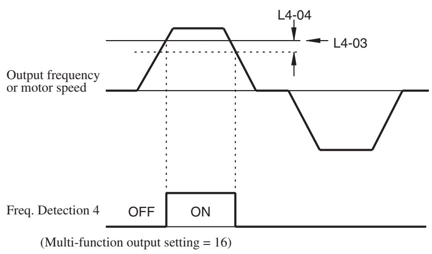
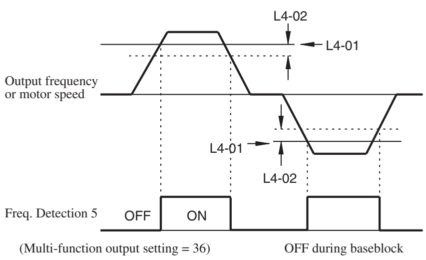
■Constants and Output Signals

User Constant Number	Name	Function
L4-01	Speed agree detection level	Fref/Set Agree 1 Frequency Detection 1 Frequency Detection 2 Frequency Detection 5
L4-02	Speed agree detection width	Fref/Fout Agree 1 Fref/Set Agree 1 Frequency Detection 1 Frequency Detection 2 Frequency Detection 5
L4-03	Speed agree detection level (+/-)	Fref/Set Agree 2 Frequency Detection 3 Frequency Detection 4
L4-04	Speed agree detection width (+/-)	Fref/Fout Agree 2 Fref/Set Agree 2 Frequency Detection 3 Frequency Detection 4

Set the corresponding setting in the multi-function output (H2-01 to H2-03) to output the desired Fref/Fout Agree signal, Fref/Set Agree signal, or Frequency Detection signal.

Function	Setting
Fref/Fout Agree 1	2
Fref/Set Agree 1	3
Frequency Detection 1	4
Frequency Detection 2	5
Fref/Fout Agree 2	13
Fref/Set Agree 2	14
Frequency Detection 3	15
Frequency Detection 4	16
Frequency Detection 5	36

Timing Chart for Frequency Detection Operation

<table>
<tr><th>Related constant</th><th>L4-01: Speed Agree Level
L4-02: Speed Agree Width</th><th>L4-03: Speed Agree Level +/–
L4-04: Speed Agree Width +/–</th></tr>
<tr><td rowspan="2">Fref/Fout Agree</td><td>Fref/Fout Agree 1</td><td>Fref/Fout Agree 2</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td rowspan="2">Fref/Set Agree</td><td>Fref/Set Agree 1
(ON at the following conditions during frequency agree)</td><td>Fref/Set Agree 2
(ON at the following conditions during frequency agree)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td rowspan="6">Fre-quency 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
(L4-01 < Output frequency)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Frequency (FOUT) Detection 5
(L4-01 < | Output frequency |)</td><td></td></tr>
<tr><td>
</td><td></td></tr>
</table>

6

◆ Detecting Motor Torque

If an excessive load is placed on the machinery (overtorque) or the load is suddenly lightened (undertorque), you can output an alarm signal to multi-function output terminal M1-M2, P1-PC, or P2-PC.

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 H2-03 (multi-function output terminals M1-M2, P1-PC, and P2-PC function selection).

The overtorque/undertorque detection level is the current level (Inverter rated output current 100%) in V/f control, and the motor torque (motor rated torque 100%) in vector control.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L6-01	Torque detection selection 1	0: Overtorque/undertorque detection disabled. 1: Overtorque detection only with speed agreement; operation continues after overtorque (warning). 2: Overtorque detected continuously during operation; operation continues after overtorque (warning). 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 overtorque (warning). 6: Undertorque detected continuously during operation; operation continues after overtorque (warning). 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).	0 to 8	0	No	A	A	A	A	4A1H
L6-02	Torque detection level 1	Open loop vector control: Motor rated torque is set as 100%. V/f control: Inverter rated current is set as 100%.	0 to 300	150%	No	A	A	A	A	4A2H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L6-03	Torque detection time 1	Sets the overtorque/undertorque detection time in 1-second units.	0.0 to 10.0	0.1 s	No	A	A	A	A	4A3H
L6-04	Torque detection selection 2	Output of torque detection 1 is enabled by setting B or 17 for H2-☐☐ and output of torque detection 1 is enabled by setting 18 or 18 for H2-☐☐.	0 to 8	0	No	A	A	A	A	4A4H
L6-05	Torque detection level 2		0 to 300	150%	No	A	A	A	A	4A5H
L6-06	Torque detection time 2		0.0 to 10.0	0.1 s	No	A	A	A	A	4A6H

Multi-function Output (H2-01 to H2-03)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
B	Overtorque/undertorque detection 1 NO (NO contact: Overtorque/undertorque detection at ON)	Yes	Yes	Yes	Yes
17	Overtorque/undertorque detection 1 NC (NC Contact: Overtorque/undertorque detection at OFF)	Yes	Yes	Yes	Yes
18	Overtorque/undertorque detection 2 NO (NO Contact: Overtorque/undertorque detection at ON)	Yes	Yes	Yes	Yes
19	Overtorque/undertorque detection 2 NC (NC Contact: Overtorque/undertorque detection at OFF)	Yes	Yes	Yes	Yes

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

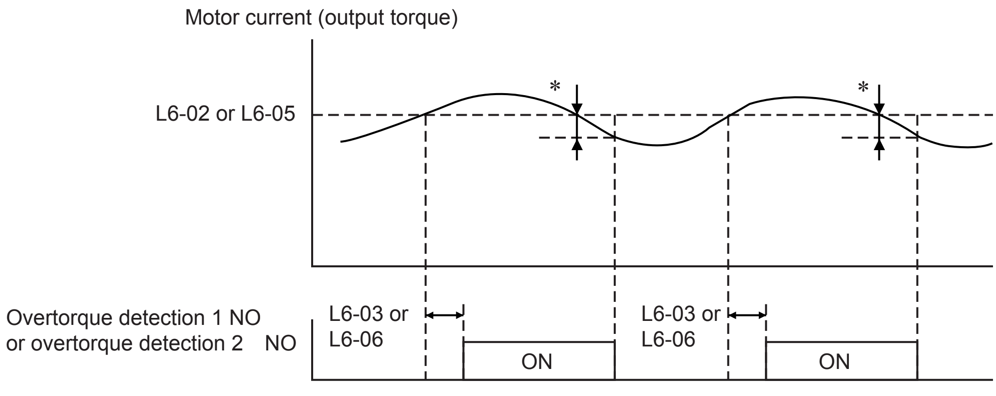
The relationship between alarms displayed by the Digital Operator when overtorque or undertorque is detected, and the set values in L6-01 and L6-04, is shown in the following table.

Set Value	Function	LED Indications	
		Overtorque/ Undertorque Detection 1	Overtorque/ Undertorque Detection 2
0	Overtorque/undertorque detection disabled.	-	-
1	Overtorque detection only with speed matching; operation continues after overtorque (warning).	OL3 flashes	OL4 flashes
2	Overtorque detected continuously during operation; operation continues after overtorque (warning).	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 overtorque (warning).	UL3 flashes	UL4 flashes
6	Undertorque detected continuously during operation; operation continues after overtorque (warning).	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

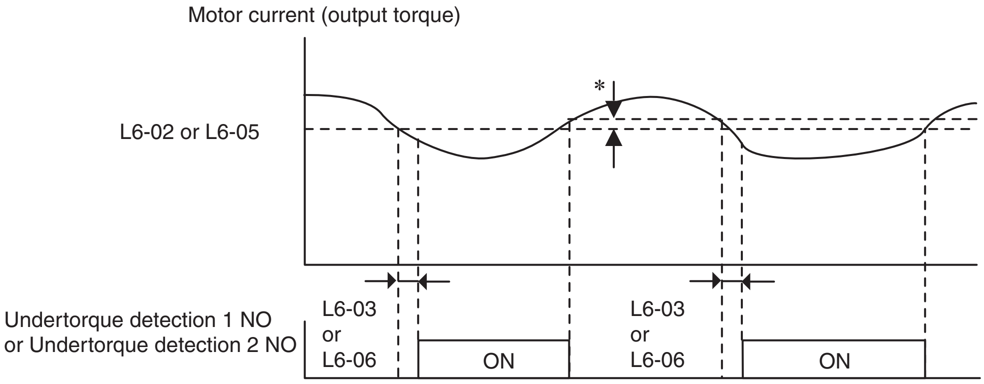
The following diagram shows the time chart for overtorque and undertorque detection.

- Overtorque Detection



* Overtorque detection disabled band is approximately 10% of the Inverter rated output current (or motor rated torque).

- Undertorque Detection



* The undertorque detection disabled margin is approximately 10% of the Inverter rated output current (or motor rated torque)

◆ Changing Overtorque and Undertorque Detection Levels Using an Analog Input

If you set constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to 7 (overtorque/undertorque detection level), you can change the overtorque/undertorque detection level.

If you change the overtorque/undertorque detection level using the multi-function analog input, only overtorque/undertorque detection level 1 will be enabled.

The following diagram shows the overtorque/undertorque detection level using an analog input.

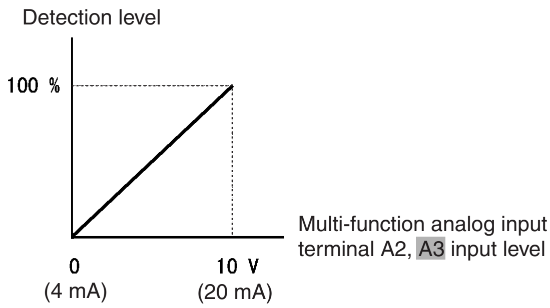


Fig 6.39 Overtorque/Undertorque Detection Level Using an Analog Input

Multi-Function Analog Input (H3-05, H3-09)

Setting Value	Function	Contents (100%)	Control Methods			
			V/f	V/f with PG	Open Loop Vector	Flux Vector
7	Overtorque/undertorque detection level	Motor rated torque for vector control Inverter rated output current for V/f control	Yes	Yes	Yes	Yes

◆ Motor Overload Protection

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
E2-01	Motor rated current	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque limits and torque control. This constant is automatically set during autotuning.	0.32 to 6.40 *2	1.90 A *1	No	Q	Q	Q	Q	30EH
E4-01	Motor 2 rated current	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque limits and torque control. This constant is automatically set during autotuning.	0.32 to 6.40 *2	1.90 A *1	No	A	A	A	A	321H
L1-01	Motor protection selection	Sets whether the motor overload function is enabled or disabled at electric thermal overload relay. 0: Disabled 1: General-purpose motor protection 2: Inverter motor protection 3: Vector motor protection In some applications when the Inverter power supply is turned off, the thermal value is reset, so even if this constant is set to 1, protection may not be effective. When several motors are connected to one Inverter, set to 0 and ensure that each motor is installed with a protection device.	0 to 3	1	No	Q	Q	Q	Q	480H
L1-02	Motor protection time constant	Sets the electric thermal detection time in seconds units. Usually setting is not necessary. The factory setting is 150% overload for one minute. When the motor's overload resistance is known, also set the overload resistance protection time for when the motor is hot started.	0.1 to 5.0	1.0 min	No	A	A	A	A	481H

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.

* 2. The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V Class Inverter of 0.4 kW is given.
For the motor no-load current, set E2-03 to a value less than that of E2-01.

Multi-Function Outputs (H2-01 to H2-03)

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector
1F	Motor overload (OL1, including OH3) pre-alarm (ON: 90% or more of the detection level)	Yes	Yes	Yes	Yes

■Setting Motor Rated Current

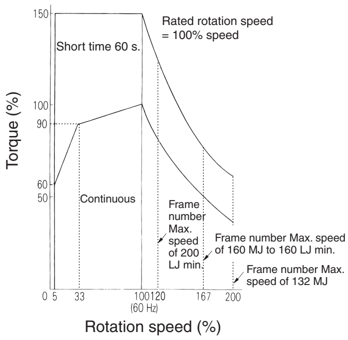
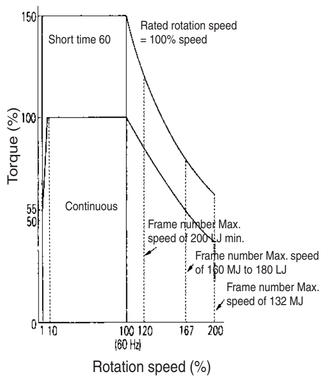
Set the rated current value on the motor nameplate in constants E2-01 (for motor 1) and E4-01 (for motor 2). This set value is the electronic thermal base current.

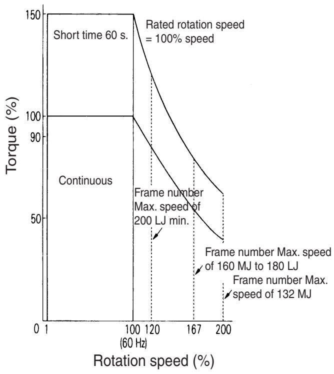
■Setting Motor Overload Protection Characteristics

Set the overload protection function in L1-01 according to the applicable motor.

The induction motor's cooling abilities differ according to the speed control range. Consequently, you must select the electronic thermal protection characteristics to match the applicable motor's tolerance load characteristics.

The following table shows the motor type and tolerance load characteristics.

L1-01 Set Value	Motor Type	Tolerance Load Characteristics	Cooling Ability	Electronic Thermal Operation (at 100% Motor Load)
1	General-purpose motor (standard motor)		Use this motor for operations using a commercial power supply. This motor construction yields best cooling effect when operating at 50/60 Hz.	When operating continuously at 50/60 Hz or less, motor overload detection (OL1) is detected. The Inverter outputs the error contact, and the motor coasts to a stop.
2	Inverter motor (constant torque) (1:10)		This motor yields a cooling effect even when operating at low speeds (approx. 6 Hz).	Operates continuously at 6 to 50/60 Hz.

L1-01 Set Value	Motor Type	Tolerance Load Characteristics	Cooling Ability	Electronic Thermal Operation (at 100% Motor Load)
3	Vector motor (1:100)		This motor yields a cooling effect even when operating at extremely low speeds (approx. 0.6 Hz).	Operates continuously at 0.6 to 60 Hz.

◆ Setting Motor Protection Operation Time

Set the motor protection operation time in L1-02.

If, after operating the motor continuously at the rated current, a 150% overload is experienced, set the (hot start) electronic thermal protection operation time. The factory setting is resistance to 150% for 60 seconds.

The following diagram shows an example of the characteristics of the electronic thermal protection operation time (L1-02 = 1.0 min., operation at 60 Hz, general-purpose motor characteristics, when L1-01 is set to 1)

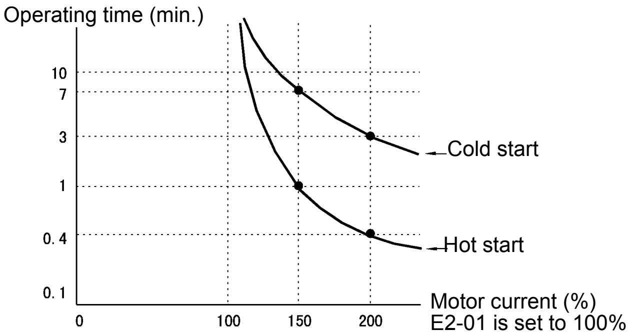


Fig 6.40 Motor Protection Operation Time

■Setting Precautions

- 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 cable, and perform overload protection on each motor.
- With applications where the power supply is often turned ON and OFF, there is a risk that the circuit cannot be protected even if this constant has been set to 1 (enabled), because the thermal value will be reset.
- To detect overloads in good time, set the set value in constant L1-02 to a low setting.
- When using a general-purpose motor (standard motor), the cooling ability will be lowered by $f^{1/4}$ (frequency). Consequently, the frequency may cause motor overload protection (OL1) to occur, even below the rated current. If operating using the rated current at a low frequency, use a special motor.

■Setting the Motor Overload Pre-Alarm

If the motor overload protection function is enabled (i.e., L1-01 is set to other than 0) and you set H2-01 to H2-03 (multi-function output terminals M1-M2, P1-PC, and P2-PC function selection) to 1F (motor overload OL1 pre-alarm), the motor overload pre-alarm will be enabled. If the electronic thermal value reaches minimum 90% of the overload detection level, the output terminal that has been set will be turned ON.

◆ Motor Overheating Protection Using PTC Thermistor Inputs

Perform motor overheating protection using the thermistor temperature resistance characteristics of the PTC (Positive Temperature Coefficient) built into the windings of each motor phase.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L1-03	Alarm operation selection during motor overheating	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and select the operation when the input motor temperature (thermistor) input exceeds the alarm detection level [1.17 V (±5%)]. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop using the deceleration time in C1-09. 3: Continue operation (H3 on the Operator flashes).	0 to 3	3	No	A	A	A	A	482H
L1-04	Motor overheating operation selection	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and select the operation when the motor temperature (thermistor) input exceeds the operation detection level [2.34V (±5%)]. 0: Decelerate to stop 1: Coast to stop 2: Emergency stop using the deceleration time in C1-09.	0 to 2	1	No	A	A	A	A	483H
L1-05	Motor temperature input filter time constant	Set Multi-function input terminal A3 (H3-05) or A2 (H3-09) to E and set the primary delay time constant for motor temperature (thermistor) inputs in seconds.	0.00 to 10.00	0.20 s	No	A	A	A	A	484H

6

■PTC Thermistor Characteristics

The following diagram shows the characteristics of the PTC thermistor temperature to the resistance value.

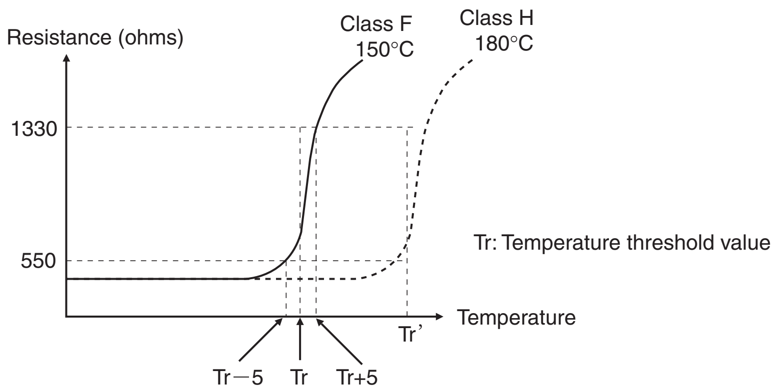


Fig 6.41 PTC Thermistor Temperature-Resistance Value Characteristics

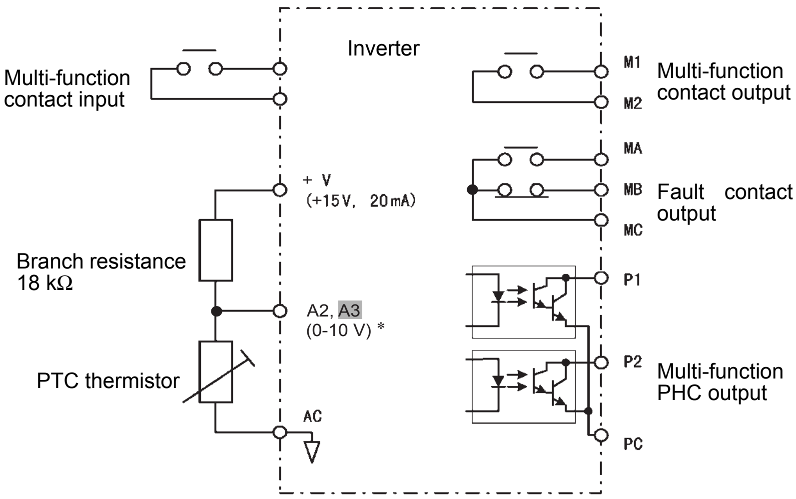
■Operation during Motor Overheating

Set the operation if the motor overheats in constants L1-03 and L1-04. Set the motor temperature input filter time constant in L1-05. If the motor overheats, the OH3 and OH4 error codes will be displayed on the Digital Operator.

Error Codes If the Motor Overheats

Error Code	Details
OH3	Inverter stops or continues to operate, according to the setting in L1-03.
OH4	Inverter stops according to the setting in L1-04.

By setting H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to E (Motor temperature input), you can detect alarm OH3 or OH4 using the PTC temperature-resistance characteristics, and protect the motor. The terminal connections are shown in the following diagram. Set H3-08〔Signal level selection (terminal A2)〕(H3-04 when A3 is used) to 0 (0 to + 10 V).



* When using terminal A2, set DIP switch S1-2 to OFF (0 to 10 V).

Fig 6.42 Mutual Connections During Motor Overheating Protection

◆ Limiting 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 (e.g., fans, pumps, etc.)

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b1-04	Prohibition of reverse operation	0: Reverse enabled 1: Reverse disabled	0 or 1	0	No	A	A	A	A	183H

Continuing Operation

This section explains functions for continuing or automatically restarting Inverter operation using speed search even if an error occurs.

◆ Restarting Automatically After Power Is Restored

Even if a temporary power loss occurs, you can perform estimated/current detection speed search using the speed search function (b3-01) and 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 or 2. Make settings of L2-01 to L2-05 and b3-01 for related details of restarting.

- 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, alarm UV1 (main circuit undervoltage) will be detected.
- If L2-01 is set to 2:
  when the main power supply is restored while the control power supply (i.e., power supply to the control panel) is backed up, the Inverter will restart. Consequently, alarm UV1 (main circuit undervoltage) will not be detected.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L2-01	Momentary power loss detection	0: Disabled [main circuit undervoltage (UV1) detection] 1: Enabled [Restarted when the power returns within the time for L2-02. When L2-02 is exceeded, main circuit undervoltage (UV1) detection.] 2: Enabled while CPU is operating. [Restarts when power returns during control operations. Does not detect main circuit undervoltage (UV1).]	0 to 2	0	No	A	A	A	A	485H
L2-02	Momentary power loss ridethru time	Ridethrough time, when Momentary Power Loss Selection (L2-01) is set to 1, in units of seconds.	0 to 25.5	0.1 s *1	No	A	A	A	A	486H
L2-03	Min. baseblock time	Sets the Inverter's minimum baseblock time in units of one second, when the Inverter is restarted after power loss ridethrough. Sets the time to approximately 0.7 times the motor secondary circuit time constant. When an overcurrent or overvoltage occurs when starting a speed search or DC injection braking, increase the set values.	0.1 to 5.0	0.2 s *1	No	A	A	A	A	487H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L2-04	Voltage recovery time	Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search, in units of one second. Sets the time required to recover from 0 V to the maximum voltage.	0.0 to 5.0	0.3 s *1	No	A	A	A	A	488H
L2-05	Undervoltage detection level	Sets the main circuit undervoltage (UV) detection level (main circuit DC voltage) in V units. Usually setting is not necessary. Insert an AC reactor in the Inverter input side to lower the main circuit undervoltage detection level.	150 to 210 *2	190 V *2	No	A	A	A	A	489H

Note Attach a Backup Capacitor Unit for Momentary Power Loss if compensation for power interruptions of up to 2.0 seconds is required for 200 V/400 V Class Inverters with outputs of 0.4 to 11 kW.

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.

* 2. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.

■Setting Precautions

- Error output signals are not output during momentary power loss recovery.
- To continue Inverter operation after power has been restored, make settings so that Run Commands from the control main circuit terminal are stored even while power is suspended.
- If the momentary power loss operation selection is set to 0 (Disabled), when the momentary power loss exceeds 15 ms during operation, alarm UV1 (main circuit undervoltage) will be detected.

6

◆ Speed Search

The speed search function finds the actual speed of the motor that is rotating on inertia, and then starts smoothly from that speed. When restoring power after a temporary power loss, the speed search function switches the connection from the commercial power supply, and then restarts the fan that is rotating on inertia.

IMPORTANT

Speed search will be performed in the following cases.

- When Momentary power loss detection (L2-01) is set to 1 or 2 (Enabled) and power is restored after a momentary power loss.
- When Number of auto restart attempts (L5-01) is set from 1 to 10 and the auto restart is performed after a fault.
- Multi-function contact inputs (H1-□□) are set to External search command (61, 62, or 64) and the command is sent.
- Multi-function contact inputs (H1-□□) are set to External baseblock (8 or 9) and the release command is sent.

The selected speed search type in b1-01, speed calculation or current detection, will be performed.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
b3-01	Speed search selection (current detection or speed calculation)	Enables/disables the speed search function for the Run Command and sets the speed search method. 0: Disabled, speed calculation 1: Enabled, speed calculation 2: Disabled, current detection 3: Enabled, current detection Speed Calculation: When the search is started, the motor speed is calculated and acceleration/deceleration is performed from the calculated speed to the specified frequency (motor direction is also searched). Current Detection: The speed search is started from the frequency when power was momentarily lost and the maximum frequency, and the speed is detected at the search current level.	0 to 3	2 *1	No	A	A	A	No	191H
b3-02	Speed search operating current (current detection)	Sets the speed search operation current as a percentage, taking the Inverter rated current as 100%. Not usually necessary to set. When restarting is not possible with the factory settings, reduce the value.	0 to 200	120% *1 *3 150% *1 *3	No	A	No	A	No	192H
b3-03	Speed search deceleration time (current detection)	Sets the output frequency deceleration time during speed search in 1-second units. Set the time for deceleration from the maximum output frequency to the minimum output frequency.	0.1 to 10.0	2.0 s	No	A	No	A	No	193H
b3-05	Speed search wait time (current detection or speed calculation)	Sets the magnetic contactor operating delay time when there is a 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 s	No	A	A	A	A	195H
b3-10	Sets the magnetic flux compensation as a percentage of the no-load current.	Operation restarts at a speed obtained by multiplying the speed from the speed search by the compensation gain (excitation search only.) Increase this setting if overvoltages occur when a speed search is performed after a long baseblock, for example, in searches at startup.	1.00 to 1.20	1.10	No	A	No	A	No	19AH

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	MEMO BUS Regis-ter
b3-14	Rotation direction search selec-tion	0: Disabled (operates with specified rotation direction) 1: Enabled (operates with rota-tion direction found by search)	0 or 1	1	No	A	A	A	No	19EH
b3-17	Speed search retrial cur-rent level	Sets the current level to retry a speed search as a percentage, taking the Inverter rated current as 100%.	0 to 200	150% *3	No	A	No	A	No	1F0H
b3-18	Speed search retrial detec-tion time	Sets the time for detection in a speed search retrial in units of seconds.	0.00 to 1.00	0.10 s	No	A	No	A	No	1F1H
b3-19	Number of speed search retrials	Sets the number of times that a speed search can be retried.	0 to 10	0	No	A	No	A	No	1F2H
L2-03	Min. base-block time	Sets the Inverter's minimum baseblock time in units of one second, when the Inverter is restarted after power loss ride-through. Sets the time to approximately 0.7 times the motor secondary circuit time constant. When an overcurrent or over-voltage occurs when starting a speed search or DC injection braking, increase the set values.	0.1 to 5.0	0.2 s *2	No	A	A	A	A	487H
L2-04	Voltage recovery time	Sets the time required to return the Inverter output voltage to normal voltage at the comple-tion of a speed search, in units of one second. Sets the time required to recover from 0 V to the maximum volt-age.	0.0 to 5.0	0.3 s *2	No	A	A	A	A	488H

* 1. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 2. The factory settings depend upon the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.
* 3. C6-01 = 1:120%, C6-01 = 0:150%

Multi-function Contact Inputs (H1-01 to H1-06)

Set-ting Value	Function	Control Methods V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor
61	External search command 1 OFF: Speed search disabled (Start from lowest output frequency) ON: Speed estimation (Estimate the motor speed, and start search from estimated speed) Current detection (Start speed search from maximum output frequency)	Yes	No	Yes	No
62	External search command 2 OFF: Speed search disabled (Start from lowest output frequency) ON: Speed estimation (Estimate the motor speed, and start search from estimated speed) (Same operation as external search command 1) Current detection: Start speed search from set frequency (reference frequency when search command was input).	Yes	No	Yes	No

6

■Setting Precautions

- When both external search commands 1 and 2 are set for the multi-function contact terminals, an OPE03 (invalid multi-function input selection) operation error may occur. Set either external search command 1 or external search command 2.
- If speed search during startup is selected when using V/f control with PG, the Unit will start from the frequency detected by PG.
- If performing speed search using external search commands, add an external sequence so that the period when the Run Command and external search command are both ON is at the very least the Minimum Baseblock Time (L2-03).
- If the Inverter output is equipped with a contact, set the contact operation delay time in the Speed Search Wait Time (b3-05). The factory setting is 0.2 s. When not using the contact, you can reduce the search time by making the setting 0.0 s. After waiting for the speed search wait time, the Inverter starts the speed search.
- Constant b3-02 is a current detection speed search (current detection level for search completion). When the current falls below the detection level, the speed search is viewed as completed, and the motor accelerates or decelerates to the set frequency. If a motor overload (OL1) or an Inverter overload (OL2) occurs and the motor cannot restart, lower the set value.
- If an overcurrent (OC) is detected when using speed search after recovery following a power loss, lengthen the Minimum Baseblock Time (L2-03).
- If a main circuit over voltage (OV) is detected when using a current detection speed search after a momentary power loss, lengthen the Speed Search Detection Time (b3-03).

■Application Precautions for Speed Searches Using Estimated Speed

- When using V/f control with or without a PG, always perform stationary autotuning for only line-to-line resistance before using speed searches based on estimated speeds.
- When using vector control, always perform rotational or stationary autotuning (not stationary autotuning for line-to-line resistance only) before using speed searches based on estimated speeds.
- If the cable length between the motor and Inverter is changed after autotuning has been performed, perform stationary autotuning for line-to-line resistance only again.

IMPORTANT

The motor will not operate when stationary autotuning or stationary autotuning for line-to-line resistance only is performed.

■Speed Search Selection

Set whether to enable or disable speed search at startup, and set the type of speed search (estimated speed or current detection) using setting b3-01. To perform speed search when inputting the Run Command, set b3-01 to 1 or 3.

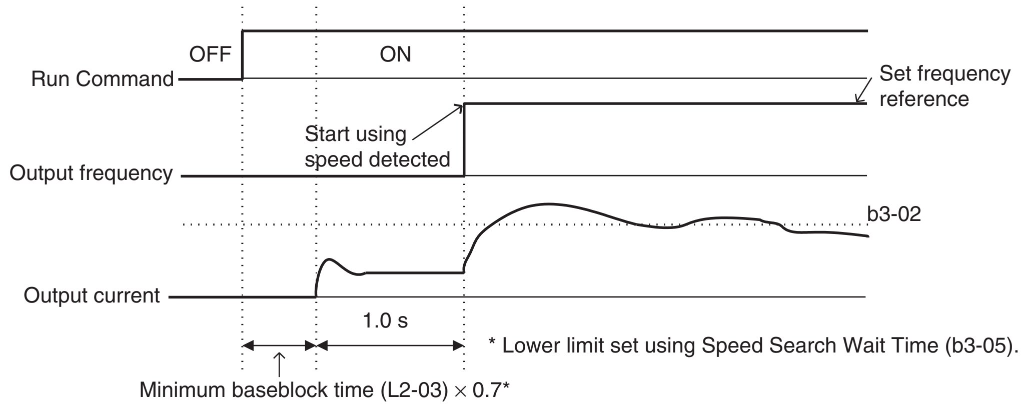
Search Name	Estimated Speed (b3-01 = 0 or 1)	Current Detection (b3-01 = 2 or 3)
Search Method	Estimates the motor speed when the search starts, and accelerates and decelerates from the estimated speed to the set frequency. You can also search including direction of motor rotation.	Starts speed search from the frequency when the temporary power loss was detected, or from the highest frequency, and performs speed detection at the current level during the search.
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 frequency reference set before the search command.
Application Precautions	Cannot be used multi-motor drives, motors two or more frames smaller than the Inverter capacity, and high-speed motors (130 Hz min.)	In control method without PG, the motor may accelerate suddenly with light loads.

■Estimated Speed Search (b3-01=0 or 1)

The time chart for estimated speed searches is shown below.

Search at Startup (b3-01=1)

The time chart when speed search at startup or external speed search command of multi-function inputs has been selected 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 the search in case 2.

Fig 6.43 Speed Search at Startup (Estimated Speed)

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■Speed Search after Short Baseblock (during Power Loss Recovery, etc.) (b3-01=0)

The time chart when the Inverter operation is restarted after power has been restored is shown below.

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

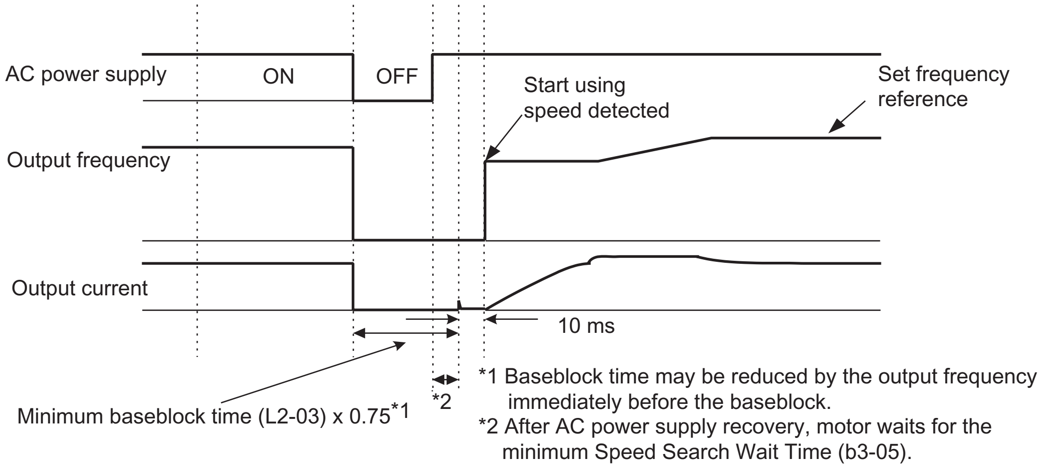
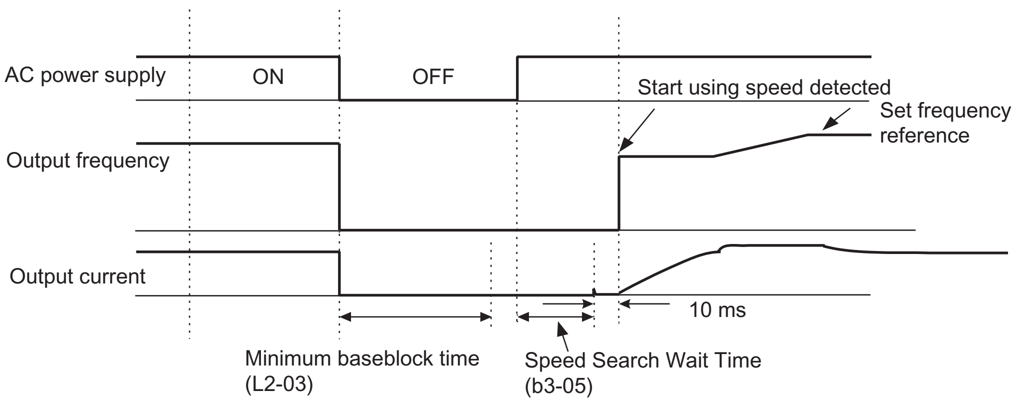


Fig 6.44 Speed Search after Baseblock (When Estimated Speed: Loss Time Is Set in L2-03)

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



Note: If the frequency immediately before the baseblock is low or the power supply break time is long, operation may be the same as the search in case 1.

Fig 6.45 Speed Search After Baseblock (Estimated Speed: Loss Time > L2-03)

■Current Detection Speed Search (b3-01=2 or 3)

The time charts for current detection speed search is shown below.

Speed Search at Startup (b3-01=3)

The time chart when speed search at startup or external speed search command of multi-function inputs has been selected is shown below.

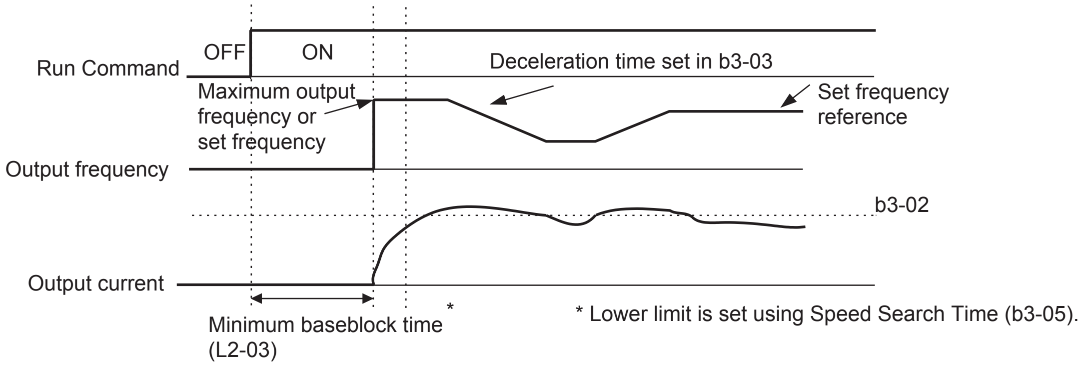


Fig 6.46 Speed Search at Startup (Using Current Detection)

Speed Search after Short Baseblock (during Power Loss Recovery, etc.) (b3-01=2)

The time chart when the Inverter operation is restarted after power has been restored is shown below.

- Loss Time Shorter Than Minimum Baseblock Time

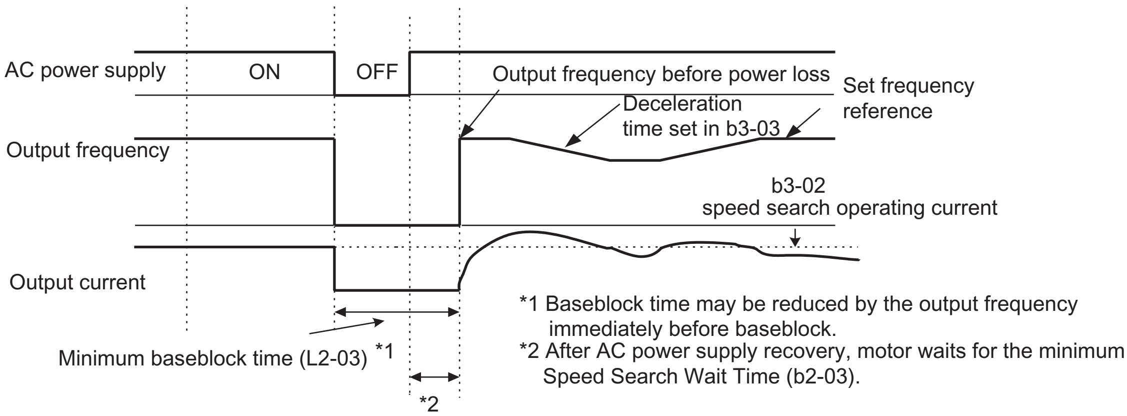


Fig 6.47 Speed Search After Baseblock (Current Detection: Loss Time < L2-03)

- Loss Time Longer Than Minimum Baseblock Time

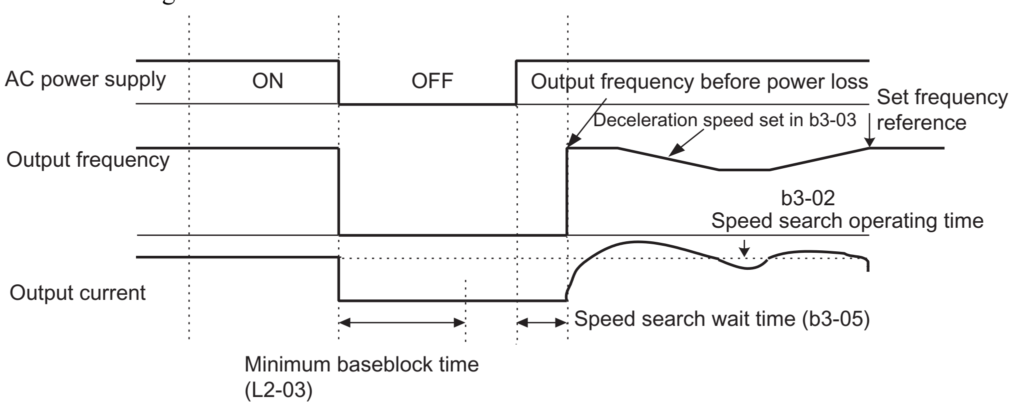


Fig 6.48 Speed Search After Baseblock (Current Detection: Loss Time > L2-03)

6

◆ Continuing Operation at Constant Speed When Frequency Reference Is Lost

The frequency reference loss detection function continues operation using 80% speed of the frequency reference before loss when the frequency reference using an master speed analog input* is reduced 90% or more in 400 ms.

When the error signal during frequency reference loss is output externally, set H2-01 to H2-03 (multi-function contact output terminal M1-M2, P1-PC, and P2-PC function selection) to C (frequency reference lost).

* Frequency references using the following master speed analog inputs are used to detect a frequency loss.

- Analog input using terminal A1
- Analog input using terminal A2 when H3-09 (Multi-function analog input terminal A2 function selection) is set to 0 (Add to terminal A1).
- Analog input using terminal A2 when H3-09 (Multi-function analog input terminal A2 function selection) is set to 2 (Auxiliary frequency reference 1) and H3-13 (Terminal A1/A2 switching) is set to 1 (Use terminal A2 analog input as the main speed frequency reference).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L4-05	Operation when frequency reference is missing	0: Stop (Operation follows the frequency reference.) 1: Operation at 80% speed continues. (At 80% of speed before the frequency reference was lost) Frequency reference is lost: Frequency reference dropped over 90% in 400 ms.	0 or 1	0	No	A	A	A	A	49DH

◆ Restarting Operation After Transient Fault (Auto Restart Function)

If an Inverter fault occurs during operation, the Inverter will perform 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 constant L5-01. A fault reset is 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 operate 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 operate and the auto restart function will not.

- OC (Overcurrent)
- GF (Ground fault)
- PUF (Fuse blown)
- OV (Main circuit overvoltage)
- UV1 (Main Circuit Undervoltage, Main Circuit Magnetic Contactor Operation Failure)*
- PF (Main circuit voltage fault)
- LF (Output phase failure)
- RH (Braking resistor overheated)
- RR (Braking transistor error)
- OL1 (Motor overload)
- OL2 (Inverter overload)
- OH1 (Motor overheat)
- OL3 (Overtorque)
- OL4 (Overtorque)

* When L2-01 is set to 1 or 2 (continue operation during momentary power loss)

■Auto Restart External Outputs

To output auto restart signals externally, set H2-01 to H2-03 (multi-function contact output terminals M1-M2, P1-PC, and P2-PC function selection) to 1E (auto restart).

6

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L5-01	Number of auto restart attempts	Sets the number of auto restart attempts. Automatically restarts after a fault and conducts a speed search from the run frequency.	0 to 10	0	No	A	A	A	A	49EH
L5-02	Auto restart operation selection	Sets whether a fault contact output is activated during fault restart. 0: Not output (Fault contact is not activated.) 1: Output (Fault contact is activated.)	0 or 1	0	No	A	A	A	A	49FH

■ Application Precautions

- The number of auto restarts count is reset under the following conditions:

  After auto restart, normal operation has continued for 10 minutes.

  After the protection operation has been performed, and the fault has been verified, and an fault reset has been input.

  After the power supply is turned OFF, and then ON again.

- Do not use the auto restart function with variable loads.

◆ Operation Selection After Cooling Fan Fault (SPEC: E or Later Only)

Use the constant setting to select the operation of the motor after a cooling fan fault occurs. This function can be used for times when a motor should not be stopped quickly (with an emergency stop.)

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L8-32*	OH1 detection of Inverter' s cooling fan	0: Disabled (FAN minor fault detection) 1: Enabled (OH1 major fault detection)	0 or 1	1	No	A	A	A	A	4E2H

* Applicable for F7-Series Inverters with software versions PRG:1031 or later.

The following table describes the operation of the motor and the display of the Digital Operator in accordance with the settings of the L8-32 if a cooling fan fault occurred.

Setting Value	Fault	Digital Operator	Motor Operation	Multi-function Contact Output
0	Cooling Fin Overheating	OH1 (lit)	Coast to a stop	Fault
	Inverter's Cooling Fan Fault	FAN (blink)	Continue operation*	Minor fault
1	Cooling Fin Overheating	OH (lit)	Coast to a stop	Fault
	Inverter's Cooling Fan Fault	OH1 (lit)	Coast to a stop	Fault

* If L8-32 is set to 0, the motor will continue running even if a cooling fan fault occurred. However, the Inverter rated output current and the overload capacity will be reduced. The rated output current will be reduced to 80% if the normal rated output current is 100%, and the overload capacity will be reduced to the values as follows.
When CT is selected: 100% per every 3 minutes, 150% per every 15 seconds
When VT is selected: 100% per every 30 seconds, 120% per every 10 seconds

IMPORTANT

If L8-32 is set to 0, be sure to set H2-01 to H2-03 multi-function contact outputs to 10 (minor fault) or to 3D (Inverter's cooling fan fault.) If a cooling fan fault occurs, stop the Inverter immediately and replace the cooling fan. If the Inverter continues to run while a cooling fan fault occurs, the Inverter's cooling ability will be affected and the Inverter's internal temperature will increase and shorten the Inverter's life.
During a cooling fan fault, the cooling fan stops for about 3 seconds every minute (interval operation.)

Inverter Protection

This section explains the functions for protecting the Inverter and the braking resistor.

◆ Performing Overheating Protection on Mounted Braking Resistors

Perform overheating protection on Inverter-mounted braking resistors (Model: ERF-150WJ □□).

When overheating in a mounted braking resistor is detected, an alarm RH (Mounted braking resistor overheating) is displayed on the Digital Operator, and the motor coasts to a stop.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
L8-01	Protect selection for internal DB resistor (Type ERF)	0: Disabled (no overheating protection) 1: Enabled (overheating protection)	0 or 1	0	No	A	A	A	A	4ADH

Multi-function Contact Outputs (H2-01 to H2-03)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
D	Braking resistor fault (ON: Resistor overheat or braking transistor fault)	Yes	Yes	Yes	Yes

6

INFO

The most likely causes of RH (Mounted braking resistor overheating) being detected are that the deceleration time is too short or that the motor regeneration energy is too large. In these cases, lengthen the deceleration time or replace the Braking Resistor Unit with one with a higher breaking capacity.

◆ Reducing Inverter Overheating Pre-Alarm Warning Levels

The Inverter detects the temperature of the cooling fins using the thermistor, and protects the Inverter from overheating. You can receive Inverter overheating pre-alarms in units of 1°C.

The following overheating pre-alarm warnings are available: Stopping the Inverter as error protection, and continuing operation, with the alarm OH (Radiation fins overheating) on the Digital Operator flashing.

■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
L8-02	Overheat pre-alarm level	Sets the detection temperature for the Inverter overheat detection pre-alarm in °C. The pre-alarm detects when the cooling fin temperature reaches the set value.	50 to 130	95 °C*	No	A	A	A	A	4AEH
L8-03	Operation selection after overheat pre-alarm	Sets the operation for when the Inverter overheat pre-alarm goes ON. 0: Decelerate to stop in deceleration time C1-02. 1: Coast to stop 2: Fast stop in fast-stop time C1-09. 3: Continue operation (Monitor display only.) A fault will be given in setting 0 to 2 and a minor fault will be given in setting 3.	0 to 3	3	No	A	A	A	A	4AFH

* The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.

Input Terminal Functions

This section explains input terminal functions, which set operating methods by switching functions for the multi-function contact input terminals (S3 to S8).

◆ Temporarily Switching Operation between Digital Operator and Control Circuit Terminals

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

You can switch between local and remote by turning ON and OFF the terminals if an output from H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) has been set to 1 (local/remote selection).

To set the control circuit terminals to remote, set b1-01 and b1-02 to 1 (Control circuit terminals).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	No	Q	Q	Q	Q	181H

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 external 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 H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to perform baseblock commands using the terminal's ON/OFF operation, and prohibit Inverter output using the baseblock commands. At this time, the motor will be coasting and “BB” will blink on the Digital Operator.

Clear the baseblock command to restart the operating using speed search from frequency references from the previous baseblock command input.

Multi-function Contact Inputs (H1-01 to H1-06)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
8	External baseblock NO (NO contact: Baseblock at ON)	Yes	Yes	Yes	Yes
9	External baseblock NC (NC contact: Baseblock at OFF)	Yes	Yes	Yes	Yes

■Time Chart

The time chart when using baseblock commands is shown below.

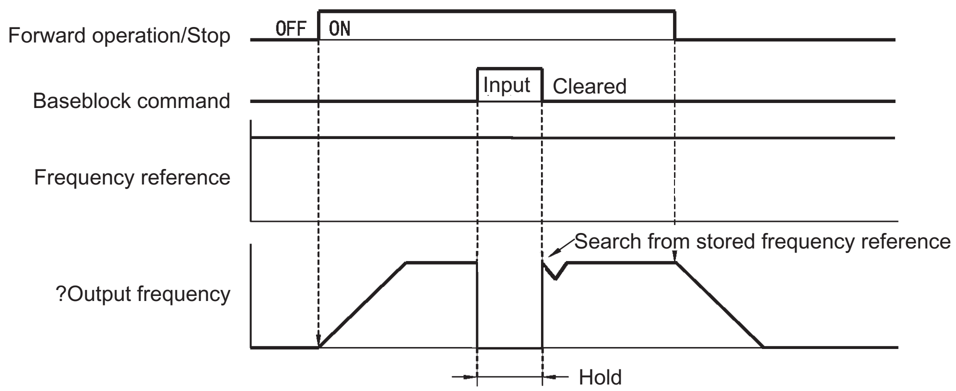


Fig 6.49 Baseblock Commands

IMPORTANT

If using baseblock commands with a variable load, do not frequently input baseblock commands during operation, as this may cause the motor to suddenly start coasting, and may result in the motor falling or slipping.

◆ Stopping Acceleration and Deceleration (Acceleration/Deceleration Ramp Hold)

The acceleration/deceleration ramp hold function stops acceleration and deceleration, stores the output frequency at that point in time, and then continues operation.

Set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to A (acceleration/deceleration ramp hold) to stop acceleration and deceleration when the terminal is turned ON and to store the output frequency at that point in time. Acceleration and deceleration will restart when the terminal is turned OFF.

If d4-01 is set to 1 and the Acceleration/Deceleration Ramp Hold command is input, the output frequency is still stored even after the power supply is turned OFF.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d4-01	Frequency reference hold function selection	Sets whether or not frequencies on hold will be recorded. 0: Disabled (when operation is stopped or the power is turned on again starts at 0.) 1: Enabled (when operation is stopped or the power is turned on again starts at the previous hold frequency.) This function is available when the multi-function inputs “accel/decel Ramp Hold” or “up/down” commands are set.	0 or 1	0	No	A	A	A	A	298H

■Time Chart

The time chart when using Acceleration/Deceleration Ramp Hold commands is given below.

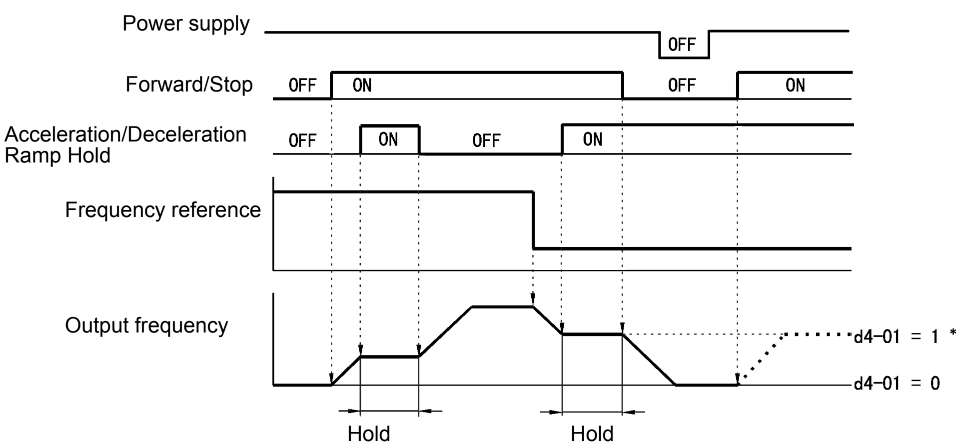


Fig 6.50 Acceleration/Deceleration Ramp Hold

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■Application Precautions

- When d4-01 is set to 1, the output frequency on hold is stored even after the power supply is turned OFF. If performing operations using this frequency after the Inverter has also been turned OFF, input the Run Command with the Acceleration/Deceleration Ramp Hold turned ON.
- When d4-01 is set to 0 and a Run Command is input while the Acceleration/Deceleration Ramp Hold is turned ON, the output frequency will be set to zero.
- If you input an Acceleration/Deceleration Ramp Hold command by error when decelerating during positioning, deceleration may be canceled.

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

The UP and DOWN commands raise and lower Inverter frequency references by turning ON and OFF a multi-function contact input terminal S3 to S8.

To use this function, set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to 10 (UP command) and 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 (Run Command selection) to 1 (Control circuit terminal).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d2-01	Frequency reference upper limit	Set the output frequency upper limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	100.0%	No	A	A	A	A	289H
d2-02	Frequency reference lower limit	Sets the output frequency lower limit as a percentage of the maximum output frequency.	0.0 to 110.0	0.0%	No	A	A	A	A	28AH
d2-03	Master speed reference lower limit	Set the master speed reference lower limit as a percent, taking the max. output frequency to be 100%.	0.0 to 110.0	0.0%	No	A	A	A	A	293H

■Precautions

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

Setting Precautions

If multi-function input terminals S3 to S8 are set as follows, operation error OPE03 (Invalid multi-function input selection) will occur:

- Only either the UP command or DOWN command has been set.
- UP/DOWN commands and Acceleration/Deceleration Ramp Hold have been allocated at the same time.

Application Precautions

- Frequency outputs using UP/DOWN commands are limited by the frequency reference upper and lower limits set in constants d2-01 to d2-03. Here, frequency references from analog frequency reference terminal A1 becomes the frequency reference lower limit. If using a combination of the frequency reference from terminal A1 and the frequency reference lower limit set in either constant d2-02 or d2-03, the larger lower limit will become the frequency reference lower limit.
- If inputting the Run Command when using UP/DOWN commands, the output frequency accelerates to the frequency reference lower limit.
- When using UP/DOWN commands, multi-step operations are disabled.
- When d4-01 (Frequency Reference Hold Function Selection) is set to 1, the frequency reference held using the UP/DOWN functions is stored even after the power supply is turned OFF. When the power supply is turned ON and the Run Command is input, the motor accelerates to the frequency reference that has been stored. To reset (i.e., to 0 Hz) the stored frequency reference, turn ON the UP or DOWN command while the Run Command is OFF.

■Connection Example and Time Chart

The time chart and settings example when the UP command is allocated to the multi-function contact input terminal S3, and the DOWN command is allocated to terminal S4, are shown below.

Constant	Name	Set Value
H1-01	Multi-function input (terminal S3)	10
H1-02	Multi-function input (terminal S4)	11

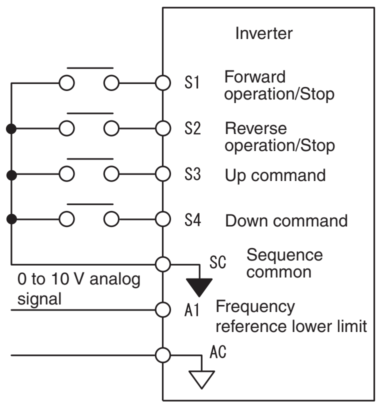
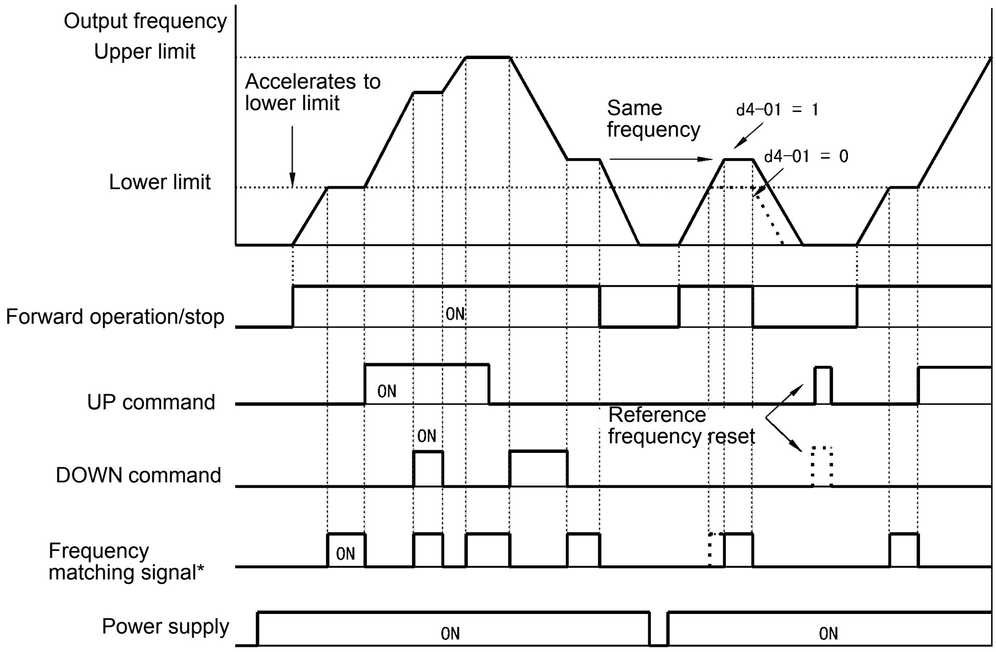


Fig 6.51 Connection Example when UP/DOWN Commands Are Allocated



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

Fig 6.52 UP/DOWN Commands Time Chart

◆ Accelerating and Decelerating Constant Frequencies in the Analog References (+/- Speed)

The +/- speed function increments or decrements the frequency set in analog frequency reference d4-02 (+/- Speed Limit) using two contact signal inputs.

To use this function, set One of the constants H1-01 to H1-06 (multi-function contact terminal inputs S3 to S8 function selection) to 1C (Trim Control Increase command) and 1D (Trim Control Decrease command). Be sure to allocate two terminals so that the Trim Control Increase command and Trim Control Decrease command can be used as a pair.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d4-02	+ - Speed limits	Set the frequency to be add to or subtracted from the analog frequency reference as a percent, taking the maximum output frequency to be 100%. Enabled when the increase (+) speed command or decrease (-) speed command is set for a multi-function input.	0 to 100	10%	No	A	A	A	A	299H

■Trim Control Increase/Decrease Command and Frequency Reference

The frequency references using Trim Control Increase/Decrease command ON/OFF operations are shown below.

Frequency Reference	Set Frequency Reference + d4-02	Set Frequency Reference - d4-02	Set Frequency Command	
Trim Control Increase Command Terminal	ON	OFF	ON	OFF
Trim Control Decrease Command Terminal	OFF	ON	ON	OFF

■Application Precautions

- Trim Control Increase/Decrease command is enabled when speed reference > 0 and the speed reference is from an analog input.
- When the analog frequency reference value - d4-02 < 0, the frequency reference is set to 0.
- If only the Trim Control Increase command or Trim Control Decrease command has been set for a multi-function contact input terminal S3 to S8, operation error OPE03 (invalid multi-function input selected) will occur.

◆ Hold Analog Frequency Using User-set Timing

When one of H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) is set to 1E (sample/hold analog frequency command), the analog frequency reference will be held from 100 ms after the terminal is turned ON, and operation will continue thereafter at that frequency.

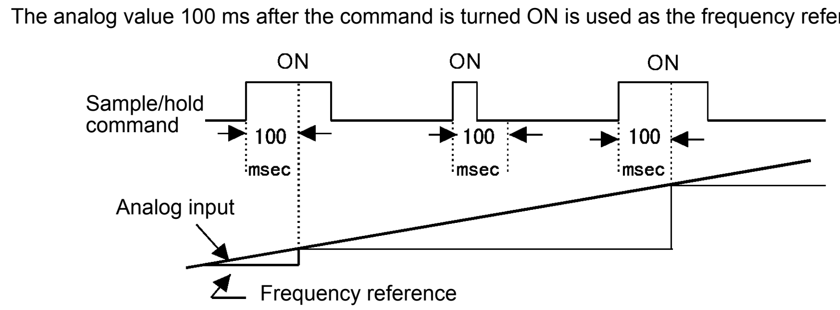


Fig 6.53 Sample/Hold Analog Frequency

■Precautions

When setting and executing sample and hold for analog frequency references, observe the following precautions.

Setting Precautions

When using sample/hold of analog frequency reference, you cannot use the following commands at the same time. If these commands are used at the same time, operation error OPE03 (invalid multi-function input selection) will occur.

- Acceleration/Deceleration Ramp Hold command
- UP/DOWN command
- Trim Control Increase/Decrease command

Application Precautions

- When performing sample/hold of analog frequency references, be sure to store references of 100 ms minimum. If the reference time is less than 100 ms, the frequency reference will not be held.
- The analog frequency reference that is held will be deleted when the power supply is turned OFF.

◆ Switching Operations between a Communications Option Board and Control Circuit Terminals

You can switch reference input between the Communications Option Board and the control circuit terminals. Set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to 2 (Option/Inverter selection) to enable switching reference input using the terminal ON/OFF status when the Inverter is stopped.

■Setting Precautions

To switch command inputs between the Communications Option Board and the control circuit terminals, set the following constants.

- Set b1-01 (Reference Selection) to 1 (Control circuit terminal [analog input])
- Set b1-02 (Operation Method Selection to 1 (Control circuit terminal (sequence inputs])
- Set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to 2 (Option/Inverter selection).

Terminal Status	Frequency Reference and Run Command Selection
OFF	Inverter (Can be operated from frequency reference or control circuit terminal from analog input terminal.)
ON	Communications Option Board (Frequency reference and Run Command are enabled from Communications Option Board.)

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

The FJOG/RJOG command functions operate the Inverter using jog frequencies by using the terminal ON/OFF operation. When using the FJOG/RJOG commands, there is no need to input the Run Command.

To use this function, set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to 12 (FJOG command) or 13 (RJOG command).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d1-17	Jog frequency reference	The frequency reference when the jog frequency reference selection, FJOG command, or RJOG command is ON.	0.00 to 400.00 *1 *3 0.00 to 300.00 *1 *2	6.00 Hz	Yes	Q	Q	Q	Q	292H

* 1. The upper limit of the setting range depends on the upper limit set in E1-04.
* 2. When C6-01 = 1, the upper limit is 400.00.
* 3. When C6-01 = 0, the upper limit is 150.00.

Multi-Function Contact Inputs (H1-01 to H1-06)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
12	FJOG command (ON: Forward run at jog frequency d1-17)	Yes	Yes	Yes	Yes
13	RJOG command (ON: Reverse run at jog frequency d1-17)	Yes	Yes	Yes	Yes

■Application Precautions

- Jog frequencies using FJOG and RJOG commands are given priority over other frequency references.
- When both FJOG command and RJOG commands 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 Programming Device Errors to the Inverter (External Fault Function)

The external fault function performs 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 input 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 H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection).

Select the value to be set in H1-01 to H1-06 from a combination of any of the following three conditions.

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

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

Set Value	Input Level (See Note 1.)		Error Detection Method (See Note 2.)		Operation During Error Detection			
	NO Contact	NC Contact	Constant Detection	Detection During Operation	Decelerate to Stop (Error)	Coast to Stop (Error)	Emergency Stop (Error)	Continue Operation (Warning)
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

Note 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 settings of H2-01 to H2-03 (Multi-function contact output terminals M1-M2, P1-PC, and P2-PC), is described here.

During Run (Setting: 0)

OFF	The Run Command is OFF and there is not output voltage.
ON	The Run Command is ON or a voltage is being output.

During Run 2 (Setting: 37)

OFF	The Inverter is not outputting a frequency. (Baseblock, DC injection braking, initial excitation, or stopped)
ON	The Inverter is outputting a frequency.

- These outputs can be used to indicate the Inverter's operating status.

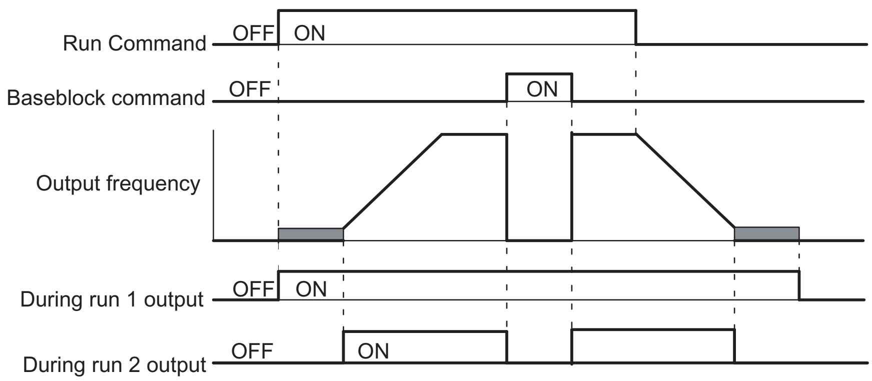


Fig 6.54 Timing Chart for “During RUN” Output

Zero-speed (Setting: 1)

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

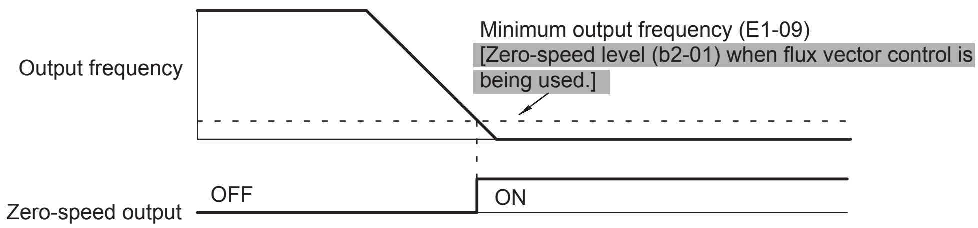


Fig 6.55 Timing Chart for Zero-speed

Motor Overload (OL1) Pre-alarm (Setting: 1F)

OFF	The motor protection function's electronic thermal value is less than 90% of the detection level.
ON	The motor protection function's electronic thermal value is greater than 90% of the detection level.

- This output function is valid when the motor overload protection function is enabled (L1-01 =1).
- This output can be used to warn of overheating before the protection function itself operates.

Inverter Overheat (OH) Pre-alarm (Setting: 20)

OFF	The cooling fin temperature is less than the "OH Pre-Alarm Level" set in L8-02.
ON	The cooling fin temperature exceeds the "OH Pre-Alarm Level" set in L8-02.

- This output function indicates that the temperature of the cooling fins reaches the temperature set in L8-02 (the Inverter overheating alarm detection level).

Speed reference limit (Setting: 31) (SPEC: E or later only)

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

Zero-servo End (Setting: 33) (SPEC: E or later only)

OFF	The zero-servo command isn't being input or zero-servo position control hasn't been completed.
ON	The position has been brought within the zero-servo completion width (b9-02) after the zero-servo command was input.

- This output function indicates that zero-servo position control has been completed.
- The output is turned ON after the zero-servo command is input and the difference between the zero-servo operation starting position and the current position is within the zero-servo completion width (b9-02).

Monitor Constants

This section explains the analog monitor and pulse monitor constants.

◆ Using the Analog Monitor Constants

This section explains the analog monitor constants.

■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
H4-01	Monitor selection (ter-minal FM)	Sets the number of the monitor item to be output (U1-□□) from terminal FM. The monitor items that can be set depends on the control method. 4, 10 to 14, 25, 28 to 31, 34, 35, 39 to 43 cannot be set.	1 to 99	2	No	A	A	A	A	41DH
H4-02	Gain (termi-nal FM)	Sets the multi-function analog output 1 voltage level gain. Sets whether the monitor item output will be output in multi-ples of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available.	0.00 to 2.50	1.00	Yes	Q	Q	Q	Q	41EH
H4-03	Bias (termi-nal FM)	Sets the multi-function analog output 1 voltage level bias. Sets output characteristic up/down parallel movement as a percentage of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available.	-10.0 to +10.0	0.0%	Yes	A	A	A	A	41FH
H4-04	Monitor selection (ter-minal AM)	Sets the number of the monitor item to be output (U1-□□) from terminal AM. The monitor items that can be set depends on the control method. 4, 10 to 14, 25, 28 to 31, 34, 35, 39 to 43 cannot be set.	1 to 99	3	No	A	A	A	A	420H
H4-05	Gain (termi-nal AM)	Set the voltage level gain for multi-function analog output 2. Set the number of multiples of 10 V to be output as the 100% output for the monitor items. The maximum output from the terminal is 10 V. A meter calibration function is available.	0.00 to 2.50	0.50	Yes	Q	Q	Q	Q	421H

6

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
H4-06	Bias (termi-nal AM)	Sets the multi-function analog output 2 voltage level bias. Sets output characteristic up/ down parallel movement as a percentage of 10 V. The maximum output from the terminal is 10 V. A meter calibration function is available.	-10.0 to +10.0	0.0%	Yes	A	A	A	A	422H
H4-07	Analog out-put 1 signal level selec-tion	Sets the signal output level for multi-function output 1 (termi-nal FM) 0: 0 to +10 V output 1: −10 to 10 V output	0 or 1	0	No	A	A	A	A	423H
F4-01	Channel 1 monitor selection	Effective when the Analog Monitor Board is used. Monitor selection: Set the number of the monitor item to be output. (U1-□□) The monitor items that can be set depends on the control method. Gain: Set the multiple of 10 V for out-putting monitor items. 4, 10 to 14, 25, 28, 31, 34, 35, 39, 40, 42 cannot be set. 29 to 31 are not used. When the AO-12 Analog Monitor Board is used, outputs of ± 10 V are possible. To output ± 10 V, set F4-07 or F4-08 to 1. When the AO-08 Analog Monitor Board is used, only outputs of 0 to +10 V are possible. A meter calibration function is available.	1 to 99	2	No	A	A	A	A	391H
F4-02	Channel 1 gain		0.00 to 2.50	1.00	Yes	A	A	A	A	392H
F4-03	Channel 2 monitor selection		1 to 99	3	No	A	A	A	A	393H
F4-04	Channel 2 gain		0.00 to 2.50	0.50	Yes	A	A	A	A	394H
F4-05	Channel 1 output moni-tor bias	Sets the channel 1 item bias to 100%/10 V when the Analog Monitor Board is used.	-10.0 to 10.0	0.0%	Yes	A	A	A	A	395H
F4-06	Channel 2 output moni-tor bias	Sets the channel 2 item bias to 100%/10 V when the Analog Monitor Board is used.	-10.0 to 10.0	0.0%	Yes	A	A	A	A	396H
F4-07	Analog out-put signal level for channel 1	0: 0 to 10 V 1: -10 to +10 V	0 or 1	0	No	A	A	A	A	397H
F4-08	Analog out-put signal level for channel 2	0: 0 to 10 V 1: -10 to +10 V	0 or 1	0	No	A	A	A	A	398H

■Selecting Analog Monitor Items

The digital operator monitor items (U1-□□ [status monitor]) are output from multi-function analog output terminals FM-AC and AM-AC. Refer to *Chapter 5 User Constants*, and set the values for the □□ part of U1-□□ (status monitor).

Alternatively, you can output monitor items (U1-□□ [status monitor]) from analog output option terminal channels 1 and 2 on analog monitor boards AO-08 and AO-12. Refer to the table of constants, and set the values.

■Adjusting the Analog Monitor Items

Adjust the output voltage for multi-function analog output terminals FM-AC and AM-AC using the gain and bias in H4-02, H4-03, H4-05, and H4-06. Also, adjust the output voltage for output channels 1 and 2 of Analog Output option boards AO-08 and AO-12 using the gain and bias in F4-02, F4-04, F4-05, and F4-06.

Adjusting the Meter

The output voltage for terminals FM-AC and AM-AC and output channels 1 and 2 of the AO option board can be adjusted while the Inverter is stopped. For example, just pressing the Enter Key and displaying the data setting display for H4-02 or H4-03 will cause the following voltage to be output by the FM-AC terminals.

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

Just pressing the Enter Key and displaying the data setting display for F4-02 or F4-05 will cause the following voltage to be output to channel 1 of the AO option board.

10 V/100% monitor output × output gain (F4-02) + output bias (F4-05)

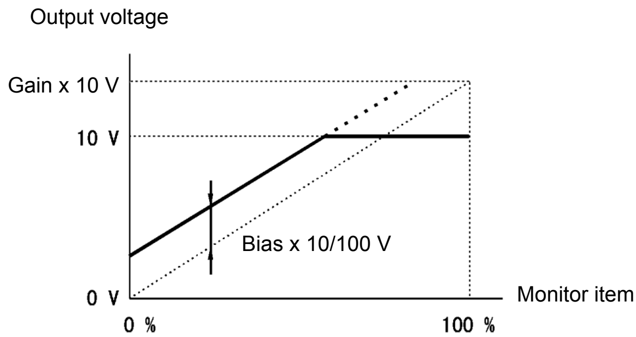


Fig 6.56 Monitor Output Adjustment

■Switching Analog Monitor Signal Levels

Monitor items corresponding to –10 to 10 V output 0 to 10 V signals when the monitor value is positive (+), and 0 to -10 V signals when the monitor value is negative (-). For monitor items corresponding to –10 to 10 V, refer to *Chapter 5 User Constants*.

INFO

You can select the signal levels separately for multi-function analog output terminals and analog output option terminals.

◆ Using Pulse Train Monitor Contents

This section explains pulse monitor constants.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
H6-06	Pulse train monitor selection	Select the pulse train monitor output items (value of the □□ part of U1-□□). There are two types of monitor items: Speed-related items and PID-related items.	1, 2, 5, 20, 24, 36	2	Yes	A	A	A	A	431H
H6-07	Pulse train monitor scaling	Set the number of pulses output when speed is 100% in hertz. Set H6-06 to 2, and H6-07 to 0, to make the pulse train monitor output synchronously to the output frequency.	0 to 32000	1440 Hz	Yes	A	A	A	A	432H

■Selecting Pulse Monitor Items

Output digital operator monitor items (U1-□□ [status monitor]) from pulse monitor terminal MP-AC. Refer to *Chapter 5 User Constants*, and set the □□ part of U1-□□ (Status monitor). The possible monitor selections are limited as follows: U1-01, 02, 05, 20, 24, 36.

■Adjusting the Pulse Monitor Items

Adjust the pulse frequency output from pulse monitor terminal MP-AC. Set the pulse frequency output when 100% frequency is output to H6-07.

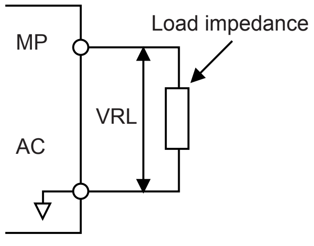
Set H6-06 to 2, and H6-07 to 0, to output the frequency synchronous with the Inverter's U-phase output.

■Application Precautions

When using a pulse monitor constant, connect a peripheral device according to the following load conditions. If the load conditions are different, there is a risk of characteristic insufficiency or damage to the machinery.

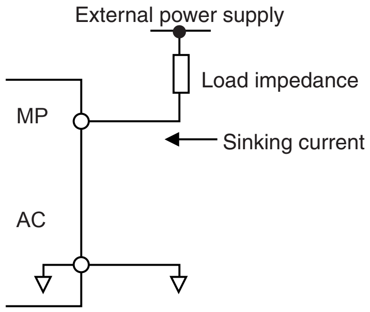
Using a Sourcing Output

Output Voltage (Isolated) VRL (V)	Load Impedance (kΩ)
+5 V min.	1.5 kΩ min.
+8 V min.	3.5 kΩ min.
+10 V min.	10 kΩ min.



Using a Sinking Input

External Power Supply (V)	12 VDC±10%, 15 VDC±10%
Sink Current (mA)	16 mA Max



6

Individual Functions

This section explains the individual functions used in special applications.

◆ Using MEMOBUS Communications

You can perform serial communications with MEMOCON-series Programmable Controllers (PLCs) or similar devices using the MEMOBUS protocol.

■MEMOBUS Communications Configuration

MEMOBUS communications are configured using 1 master (PLC) and a maximum of 31 slaves. Serial communications between master and slave are normally started by the master, and the slave responds.

The master performs signal communications with one slave at a time. Consequently, you must set the address of each slave beforehand, so the master can perform signal communications using that address. Slaves receiving commands from the master perform the specified function, and send a response to the master.

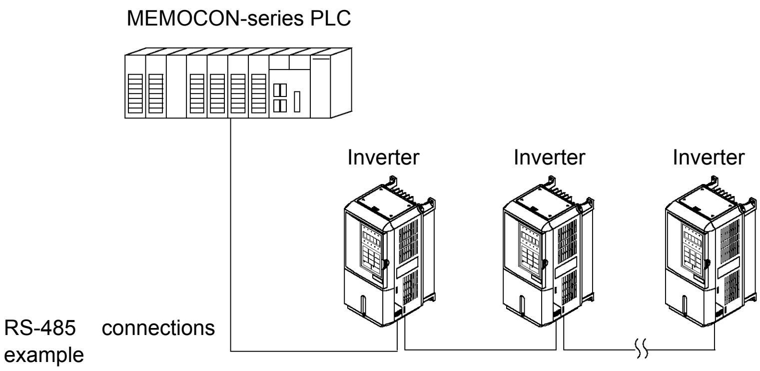


Fig 6.57 Example of Connections between PLC and Inverter

■Communications Specifications

The MEMOBUS communications specifications are shown in the following table.

Item	Specifications
Interface	RS-422, RS-485
Communications Cycle	Asynchronous (Start-stop synchronization)
Communications Parameters	Baud rate: Select from 1,200, 2,400, 4,800, 9,600, and 19,200 bps. Data length: 8 bits fixed Parity: Select from even, odd, or none. Stop bits: 1 bit fixed
Communications Protocol	MEMOBUS (RTU mode only)
Number of Connectable Units	31 units max. (when using RS-485)

■Communications Connection Terminal

MEMOBUS communications use the following terminals: S+, S-, R+, and R-. Set the terminating resistance by turning ON pin 1 of switch S1 for the last Inverter only, as seen from the PLC.

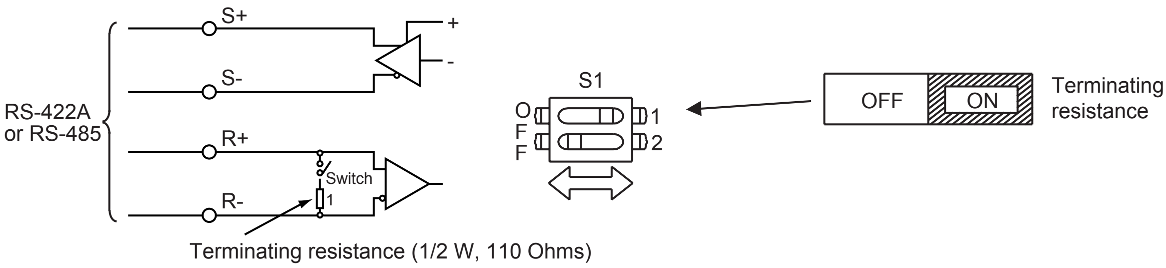
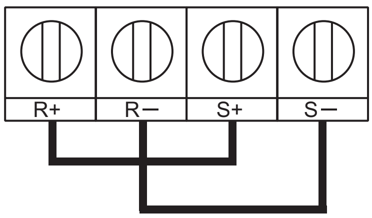


Fig 6.58 Communications Connection Terminal

IMPORTANT

1. Separate the communication cables from the main circuit cables and other wiring and power cables.
2. Use shielded cables for the communication cables, connect the shield cover to the Inverter earth terminal, and arrange the terminals so that the other end is not connected to prevent operating errors due to noise.
3. When using RS-485 communications, connect S+ to R+, and S- to R-, on the Inverter exterior.



■Procedure for Communicating with the PLC

Use the following procedure to perform communications with the PLC.

1. Turn OFF the power supply turned and connect the communication cable between the PLC and the Inverter.
2. Turn ON the power supply.
3. Set the required communications constants (H5-01 to H5-07) using the Digital Operator.
4. Turn OFF the power supply, and check that the Digital Operator display has completely disappeared.
5. Turn ON the power supply once again.
6. Perform communications with the PLC.

INFO

Set the timer on the master to monitor response time from the slave. Set the master so that if the slave does not respond to the master within the set time, the same command message will be sent from the master again.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register
b1-01	Reference selection	Set the frequency reference input method. 0: Digital Operator 1: Control circuit terminal (analog input) 2: MEMOBUS communications 3: Option board 4: Pulse train input	0 to 4	1	No	Q	Q	Q	Q	180H
b1-02	Operation method selection	Set the Run Command input method. 0: Digital Operator 1: Control circuit terminal (sequence input) 2: MEMOBUS communications 3: Option board	0 to 3	1	No	Q	Q	Q	Q	181H
H5-01	Slave address	Set the Inverter's slave address.	0 to 20*1	1FH	No	A	A	A	A	425H
H5-02	Communication speed selection	Set the baud rate for MEMOBUS communications of communications connection terminals. 0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps	0 to 4	3	No	A	A	A	A	426H
H5-03	Communication parity selection	Set the parity for MEMOBUS communications of communications connection terminals. 0: No parity 1: Even parity 2: Odd parity	0 to 2	0	No	A	A	A	A	427H
H5-04	Stopping method after communication error	Set the stopping method for communications errors. 0: Deceleration to stop using deceleration time in C1-02 1: Coast to stop 2: Emergency stop using deceleration time in C1-09 3: Continue operation	0 to 3	3	No	A	A	A	A	428H
H5-05	Communication error detection selection	Set whether or not a communications timeout is to be detected as a communications error. 0: Do not detect. 1: Detect	0 or 1	1	No	A	A	A	A	429H
H5-06	Send wait time	Set the time from the Inverter receiving data to when the Inverter starts to send.	5 to 65	5 ms	No	A	A	A	A	42AH
H5-07	RTS control ON/OFF	Select to enable or disable RTS control. 0: Disabled (RTS is always ON) 1: Enabled (RTS turns ON only when sending)	0 or 1	1	No	A	A	A	A	42BH
H5-10 *2	Unit Selection for MEMOBUS Register 0025H	Selects the units used for MEMOBUS registry 0025H (monitors the output voltage reference). 0: 0.1 V units 1: 1 V units	0, 1	0	No	A	A	A	A	436H

* 1. Set H5-01 to 0 to disable Inverter responses to MEMOBUS communications.

* 2. Applicable for F7-series Inverters with software versions PRG: 1032 or later.

MEMOBUS communications can perform the following operations regardless of the settings in b1-01 and b1-02.

- Monitoring operation status from the PLC
- Setting and reading constants
- Resetting errors
- Inputting multi-function commands

An OR operation is performed between the multi-function commands input from the PLC and commands input from multi-function contact input terminals S3 to S8.

■Message Format

In MEMOBUS communications, the master sends commands to the slave, and the slave responds. The message format is configured for both sending and receiving as shown below, and the length of data packets is changed by the command (function) contents.

Slave address
Function code
Data
Error check

The space between messages must support the following.

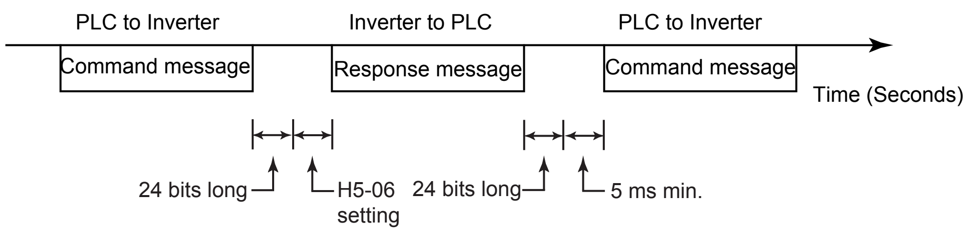


Fig 6.59 Message Spacing

Slave Address

Set the Inverter address from 0 to 20 Hex. If you set 0, commands from the master will be broadcast (i.e., the Inverter will not return responses).

Function Code

The function code specifies commands. There are three function codes, as shown below.

Function Code (Hexadecimal)	Function	Command Message		Response Message	
		Min. (Bytes)	Max. (Bytes)	Min. (Bytes)	Max. (Bytes)
03H	Read storage register contents	8	8	7	37
08H	Loopback test	8	8	8	8
10H	Write multiple storage registers	11	41	8	8

Data

Configure consecutive data by combining the storage register address (test code for a loopback address) and the data the register contains. The data length changes depending on the command details.

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Error Check

Errors are detected during communications using CRC-16. Perform calculations using the following method.

1. The factory setting for CRC-16 communications is usually 0, but when using the MEMOBUS system, set the factory setting to 1 (i.e., set all 16 bits to 1).
2. Calculate CRC-16 using MSB as slave address LSB, and LSB as the MSB of the final data.
3. Also calculate CRC-16 for response messages from the slaves, and compare them to the CRC-16 in the response messages.

■MEMOBUS Message Example

An example of MEMOBUS command/response messages is given below.

Reading Storage Register Contents

Read the contents of the storage register only for specified quantities whose addresses are consecutive, starting from a specified address. The contents of the storage register are separated into higher place 8 bits and lower place 8 bits, and comprise the data within response messages in address order.

The following table shows message examples when reading status signals, error details, data link status, and frequency references from the slave 2 Inverter.

Command Message

Slave Address		02H
Function Code		03H
Start Address	Higher place	00H
	Lower place	20H
Quantity	Higher place	00H
	Lower place	04H
CRC-16	Higher place	45H
	Lower place	F0H

Response Message (During Normal Operation)

Slave Address		02H
Function Code		03H
Data quantity		08H
Lead storage register	Higher place	00H
	Lower place	65H
Next storage register	Higher place	00H
	Lower place	00H
Next storage register	Higher place	00H
	Lower place	00H
Next storage register	Higher place	01H
	Lower place	F4H
CRC-16	Higher place	AFH
	Lower place	82H

Response Message (During Error)

Slave Address		02H
Function Code		83H
Error code		03H
CRC-16	Higher place	F1H
	Lower place	31H

Loopback Test

The loopback test returns command messages directly as response messages without changing the contents to check the communications between the master and slave. You can set user-defined test code and data values.

The following table shows a message example when performing a loopback test with the slave 1 Inverter.

Command Message

Slave address		01H
Function code		08H
Test Code	Higher place	00H
	Lower place	00H
Data	Higher place	A5H
	Lower place	37H
CRC-16	Higher place	DAH
	Lower place	8DH

Response Message (During Normal Operation)

Slave address		01H
Function code		08H
Test Code	Higher place	00H
	Lower place	00H
Data	Higher place	A5H
	Lower place	37H
CRC-16	Higher place	DAH
	Lower place	8DH

Response Message (During Error)

Slave address		01H
Function code		89H
Error Code		01H
CRC-16	Higher place	86H
	Lower place	50H

Writing to Multiple Storage Registers

Write the specified data to each specified storage register from the specified addresses. The written data must be in the following order in the command message: Higher place 8 bits, then lower place 8 bits, in storage register address order.

The following table shows an example of a message when forward operation has been set at a frequency reference of 60.0 Hz in the slave 1 Inverter by the PLC.

Command Message

Slave Address		01H
Function Code		10H
Start Address	Higher place	00H
	Lower place	01H
Quantity	Higher place	00H
	Lower place	02H
No. of data		04H
Lead data	Higher place	00H
	Lower place	01H
Next data	Higher place	02H
	Lower place	58H
CRC-16	Higher place	63H
	Lower place	39H

Response Message (During Normal Operation)

Slave Address		01H
Function Code		10H
Start Address	Higher place	00H
	Lower place	01H
Quantity	Higher place	00H
	Lower place	02H
CRC-16	Higher place	10H
	Lower place	08H

Response Message (During Error)

Slave Address		01H
Function Code		90H
Error code		02H
CRC-16	Higher place	CDH
	Lower place	C1H

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Set the number of data specified using command messages as quantity of specified messages x 2. Handle response messages in the same way.

INFO

■Data Tables

The data tables are shown below. The types of data are as follows: Reference data, monitor data, and broadcast data.

Reference Data

The reference data table is shown below. You can both read and write reference data.

Register No.	Contents	
0000H	Not used	
0001H	Frequency reference	
	Bit 0	Forward Run/Stop Command 1: Forward run 0: Stop
	Bit 1	Reverse Run/Stop Command 1: Reverse run 0: Stop
	Bit 2	External fault 1: Error (EFO)
	Bit 3	Fault reset 1: Reset command
	Bit 4	ComNet
	Bit 5	ComCtrl
	Bit 6	Multi-function input command 3
	Bit 7	Multi-function input command 4
	Bit 8	Multi-function input command 5
	Bit 9	Multi-function input command 6
	Bit A	Multi-function input command 7
	Bit B	Multi-function input command 8
	Bit C to F	Not used
0002H	Frequency reference (Set units using constant o1-03)	
0003H	Not used	
0004H	Not used	
0005H	Not used	
0006H	PID target value	
0007H	Analog output 1 setting (-11 V/-1540 to 11 V/1540)	
0008H	Analog output 2 setting (-11 V/-1540 to 11 V/1540)	
0009H	Multi-function contact output setting	
	Bit 0	Contact output (Terminal M1-M2) 1: ON 0: OFF
	Bit 1	PHC1(Contact P1-PC) 1: ON 0: OFF
	Bit 2	PHC2(Contact P2-PC) 1: ON 0: OFF
	Bit 3 to 5	Not used
	Bit 6	Set error contact (terminal MA-MC) output using bit 7. 1: ON 0: OFF
	Bit 7	Error contact (terminal MA-MC) 1: ON 0: OFF
	Bits 8 to F	Not used
000AH to 000EH	Not used	
000FH	Reference selection settings	
	Bit 0	Not used
	Bit 1	Use MEMOBUS 0006H PID target value 1: Enabled 0: Disabled
	Bits 2 to B	Not used
	C	Broadcast data terminal S5 input 1: Enabled 0: Disabled
	D	Broadcast data terminal S6 input 1: Enabled 0: Disabled
	E	Broadcast data terminal S7 input 1: Enabled 0: Disabled
	F	Broadcast data terminal S8 input 1: Enabled 0: Disabled

Note Write 0 to all unused bits. Also, do not write data to reserved registers.

Monitor Data

The following table shows the monitor data. Monitor data can only be read.

Register No.	Contents	
0020H	Inverter status	
	Bit 0	Operation 1: Operating 0: Stopped
	Bit 1	Reverse operation 1: Reverse operation 0: Forward operation
	Bit 2	Inverter startup complete 1: Completed 2: Not completed
	Bit 3	Error 1: Error
	Bit 4	Data setting error 1: Error
	Bit 5	Multi-function contact output (terminal M1 - M2) 1: ON 0: OFF
	Bit 6	Multi-function PHC output 1 (terminal P1 - PC) 1: ON 0: OFF
	Bit 7	Multi-function PHC output 2 (terminal P2 - PC) 1: ON 0: OFF
	Bits 8 to B	Not used
0021H	Error details	
	Bit 0	Overcurrent (OC) Ground fault (GF)
	Bit 1	Main circuit overvoltage (OV)
	Bit 2	Inverter overload (OL2)
	Bit 3	Inverter overheat (OH1, OH2)
	Bit 4	Injection brake transistor resistance overheat (rr, rH)
	Bit 5	Fuse blown (PUF)
	Bit 6	PID feedback reference lost (FbL)
	Bit 7	External fault (EF, EFO)
	Bit 8	Hardware error (CPF)
	Bit 9	Motor overload (OL1), overtorque 1 (OL3) detected, or overtorque 2 (OL4) detected
	Bit A	PG broken wire detected (PGO), Overspeed (OS), Speed deviation (DEV)
	Bit B	Main circuit undervoltage (UV) detected
	Bit C	Main circuit undervoltage (UV1), control power supply error (UV2), inrush prevention circuit error (UV3), power loss
	Bit D	Main Circuit Voltage Fault (PF), Output Open-phase (LF)
	Bit E	MEMOBUS communications error (CE)
	Bit F	Operator disconnected (OPR)
0022H	Data link status	
	Bit 0	Writing data
	Bit 1	Not used
	Bit 2	Not used
	Bit 3	Upper and lower limit errors
	Bit 4	Data integrity error
	Bits 5 to F	Not used
0023H	Frequency reference (U1-01)	
0024H	Output frequency (U1-02)	
0025H	Output voltage reference (U1-06)	
0026H	Output current (U1-03) (Unit: 1/0.1A)	
0027H	Output power (U1-08)	
0028H	Torque reference (U1-09)	
0029H	Not used	
002AH	Not used	
002BH	Sequence input status	
	Bit 0	Multi-function contact input terminal S1 1: ON, 0: OFF
	Bit 1	Multi-function contact input terminal S2 1: ON, 0: OFF
	Bit 2	Multi-function contact input terminal S3 1: ON, 0: OFF
	Bit 3	Multi-function contact input terminal S4 1: ON, 0: OFF
	Bit 4	Multi-function contact input terminal S5 1: ON, 0: OFF
	Bit 5	Multi-function contact input terminal S6 1: ON, 0: OFF
	Bit 6	Multi-function contact input terminal S7 1: ON, 0: OFF
	Bit 7	Multi-function contact input terminal S8 1: ON, 0: OFF
	Bits 8 to F	Not used

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Register No.	Contents		
002CH	Inverter status		
	Bit 0	Operation	1: Operating
	Bit 1	Zero-speed	1: Zero-speed
	Bit 2	Frequency matching	1: Matched
	Bit 3	User-defined speed matching	1: Matched
	Bit 4	Frequency detection 1	1: Output frequency ≤ L4-01
	Bit 5	Frequency detection 2	1: Output frequency ≥ L4-01
	Bit 6	Inverter startup completed	1: Startup completed
	Bit 7	Low voltage detection	1: Detected
	Bit 8	Baseblock	1: Inverter output baseblock
	Bit 9	Frequency reference mode	1: Not communications 0: Communications
	Bit A	Run Command mode	1: Not communications 0: Communications
	Bit B	Overtorque detection	1: Detected
	Bit C	Frequency reference lost	1: Lost
	Bit D	Retrying error	1: Retrying
	Bit E	Error (including MEMOBUS communications time-out) 1:Error occurred	
	Bit F	MEMOBUS communications time-out 1: Timed out	
002DH	Multi-function contact output status		
	Bit 0	Multi-function contact output (terminal M1-M2) 1: ON 0: OFF	
	Bit 1	Multi-function PHC output 1 (terminal P1 - PC) 1: ON 0: OFF	
	Bit 2	Multi-function PHC output 2 (terminal P2 - PC) 1: ON 0: OFF	
	Bits 3 to F	Not used	
002EH - 0030H	Not used		
0031H	Main circuit DC voltage		
0032H	Torque monitor (Unit: 1/0.1%)		
0033H	Output power (U1-08)		
0034H - 0037H	Not used		
0038H	PID feedback quantity (Input equivalent to 100%/Max. output frequency; 10/1%; without sign)		
0039H	PID input quantity (±100%/±Max. output frequency; 10/1%; with sign)		
003AH	PID output quantity (±100%/±Max. output frequency; 10/1%; with sign)		
003BH	CPU software number		
003CH	Flash software number		
003DH	Communications error details		
	Bit 0	CRC error	
	Bit 1	Invalid data length	
	Bit 2	Not used	
	Bit 3	Parity error	
	Bit 4	Overrun error	
	Bit 5	Framing error	
	Bit 6	Time-out	
	Bits 7 to F	Not used	
003EH	kVA setting		
003FH	Control method		

Note Communications error details are stored until an fault reset is input (you can also reset while the Unit is operating).

Broadcast Data

The following table shows the broadcast data. You can also write this data.

Register Address	Contents	
0001H	Operation signal	
	Bit 0	Run Command 1: Operating 0: Stopped
	Bit 1	Reverse operation command 1: Reverse 0: Forward
	Bits 2 and 3	Not used
	Bit 4	External fault 1: Error (set using H1-01)
	Bit 5	Fault reset 1: Reset command (set using H1-02)
	Bits 6 to B	Not used
	Bit C	Multi-function contact input terminal S5 input
	Bit D	Multi-function contact input terminal S6 input
	Bit E	Multi-function contact input terminal S7 input
	Bit F	Multi-function contact input terminal S8 input
0002H	Frequency reference	30000/100%

Note Bit signals not defined in the broadcast operation signals use local node data signals continuously.

■ENTER Command

When writing constants to the Inverter from the PLC using MEMOBUS communications, the constants are temporarily stored in the constant data area in the Inverter. To enable these constants in the constant data area, use the ENTER command.

There are two types of ENTER commands: ENTER commands that enable constant data in RAM, and ENTER commands that write data to EEPROM (non-volatile memory) in the Inverter at the same time as enabling data in RAM.

The following table shows the ENTER command data. ENTER command data can only be written.

The ENTER command is enabled by writing 0 to register number 0900H or 0901H.

Register No.	Contents
0900H	Write constant data to EEPROM
0910H	Constant data is not written to EEPROM, but refreshed in RAM only.

INFO

The maximum number of times you can write to EEPROM using the Inverter is 100 thousand. Do not frequently execute ENTER commands (0900H) written to EEPROM.
The ENTER command registers are write-only. Consequently, if reading these registers, the register address will become invalid (Error code: 02H).

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■Error Codes

The following table shows MEMOBUS communications error codes.

Error Code	Contents
01H	Function code error A function code other than 03H, 08H, or 10H has been set by the PLC.
02H	Invalid register number error • The register address you are attempting to access is not recorded anywhere. • With broadcast sending, a start address other than 0000H, 0001H, or 0002H has been set.
03H	Invalid quantity error • The number of data packets being read or written is outside the range 1 to 16. • In write mode, the number of data packets in the message is not No. of packets x 2.
21H	Data setting error • A simple upper limit or lower limit error has occurred in the control data or when writing constants. • When writing constants, the constant setting is invalid.
22H	Write mode error • Attempting to write constants from the PLC during operation. • Attempting to write via ENTER commands from the PLC during operation. • Attempting to write constants other than A1-00 to A1-05, E1-03, or 02-04 when warning alarm CPF03 (defective EEPROM) has occurred. • Attempting to write read-only data.
23H	Writing during main circuit undervoltage (UV) error • Writing constants from the PLC during UV (main circuit undervoltage) alarm. • Writing via ENTER commands from the PLC during UV (main circuit undervoltage) alarm.
24H	Writing error during constants processing Attempting to write constants from the PLC while processing constants in the Inverter.

■Slave Not Responding

In the following cases, the slave will ignore the write function. If the slave address specified in the command message is 0, all slaves execute the write function, but do not return response messages to the master.

- When a communications error (overrun, framing, parity, or CRC-16) is detected in the command message.
- When the slave address in the command message and the slave address in the Inverter do not agree.
- When the data that configures the message and the data time length exceeds 24 bits.
- When the command message data length is invalid.

Application Precautions

Set a timer in the master to monitor response time from the slaves. Make the setting so that if no response is sent to the master from the slave within the set time, the same command message is sent again from the master.

■Self-Diagnosis

The Inverter has a built-in function for self-diagnosing the operations of serial communications interface circuits. This function is called the self-diagnosis function. The self-diagnosis function connects the communications parts of the send and receive terminals, receives the data sent by the Inverter, and checks if communications are being performed normally.

Perform the self-diagnosis function using the following procedure.

1. Turn ON the power supply to the Inverter, and set 67 (communications test mode) in constant H1-05 (Terminal S7 Function Selection).
2. Turn OFF the power supply to the Inverter.
3. Perform wiring according to the following diagram while the power supply is turned OFF.
4. Turn ON the terminating resistance. (Turn ON pin 1 on DIP switch 1.)
5. Turn ON the power supply to the Inverter again.

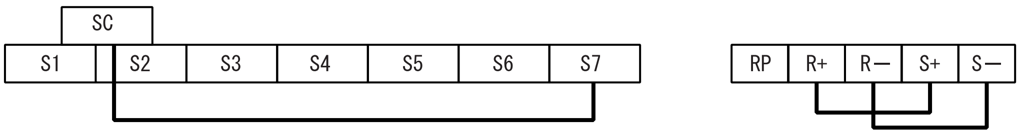

Fig 6.60 Details of Communications Terminals

"Pass" will be displayed if self-diagnosis is completed without an error occurring.

If an error occurs, a CE (MEMOBUS communications error) alarm will be displayed on the Digital Operator, the error contact output will be turned ON, and the Inverter operation ready signal will be turned OFF.

◆ Using the Timer Function

Multi-function contact input terminals S3 to S8 can be designated as timer function input terminals, and multi-function output terminals M1-M2, P1-PC, and P2-PC can be designated as timer function output terminals. By setting the delay time, you can erase chattering from the sensors and switches.

- Set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8) to 18 (timer function input).
- Set H2-01 to H2-03 (multi-function output terminals M1-M2, P1-PC, and P2-PC function selection) to 12 (timer function output).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b4-01	Timer function ON-delay time	Sets the timer function output ON-delay time (dead band) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-□□ or H2-□□.	0.0 to 300.0	0.0 s	No	A	A	A	A	1A3H
b4-02	Timer function OFF-delay time	Sets the timer function output OFF-delay time (dead band) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-□□ or H2-□□.	0.0 to 300.0	0.0 s	No	A	A	A	A	1A4H

■Setting Example

When the timer function input ON time is longer than the value set in b4-01, the timer output function is turned ON. When the timer function input OFF time is longer than the value set in b4-02, the timer output function is turned OFF. An example of timer function operation is given in the following diagram.

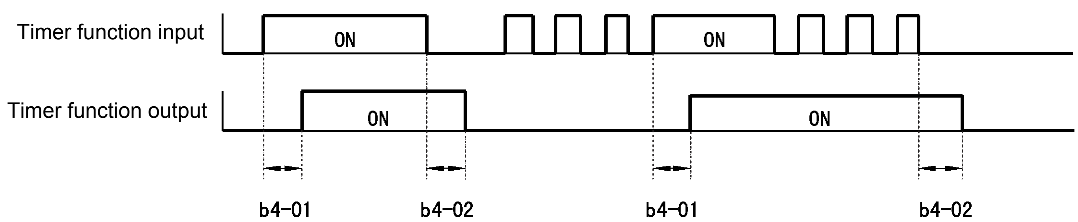

Fig 6.61 Timer Function Operation Example

◆ Using PID Control

PID control is a method of making the feedback value (detection value) match the set target value. By combining proportional control (P), integral control (I), and derivative control (D), you can even control targets (machinery) with play time.

The characteristics of the PID control operations are given below.

P control	Outputs the amount of operation proportional to the deviation. You cannot, however, set the deviation to zero using P control alone.
I control	Outputs the amount of operation that integrates the deviation. Used for matching feedback value to the target value. I control is not suited, however, to rapid variations.
D control	Outputs the amount of operation derived from the deviation. Can respond promptly to rapid variations.

■PID Control Operation

To understand the differences between each PID control operation (P, I, and D, the variation in the amount of operation (output frequency) is as shown in the following diagram when the deviation (i.e., the difference between the target value and feedback value) is fixed.

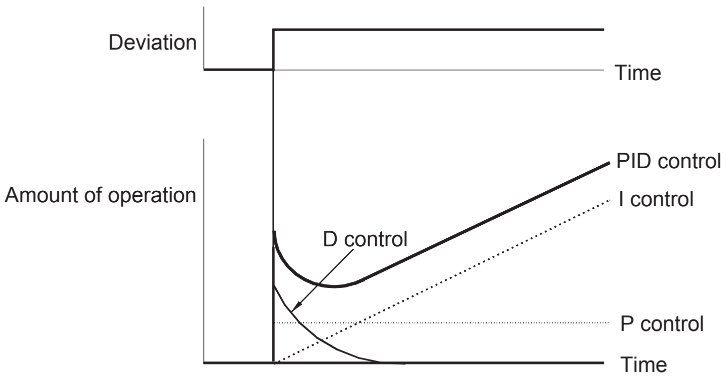

Fig 6.62 PID Control Operation

■PID Control Applications

The following table shows examples of PID control applications using the Inverter.

Application	Control Details	Example of Sensor Used
Speed Control	• Feeds back machinery speed information, and matches speed to the target value. • Inputs speed information from other machinery as the target value, and performs synchronous control using the actual speed feedback.	Tachometer generator
Pressure Control	Feeds back pressure information, and performs constant pressure control.	Pressure sensor
Flow Rate Control	Feeds back flow rate information, and controls the flow rate highly accurately.	Flow rate sensor
Temperature Control	Feeds back temperature information, and performs temperature adjustment control by rotating the fan.	• Thermocouple • Thermistor

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
b5-01	PID control method selection	0: Disabled 1: Enabled (Deviation is D-controlled.) 2: Enabled (Feedback value is D-controlled.) 3: PID control enabled (frequency reference + PID output, D control of deviation) 4: PID control enabled (frequency reference + PID output, D control of feedback value).	0 to 4	0	No	A	A	A	A	1A5H
b5-02	Proportional gain (P)	Sets P-control proportional gain as a percentage. P-control is not performed when the setting is 0.00.	0.00 to 25.00	1.00	Yes	A	A	A	A	1A6H
b5-03	Integral (I) time	Sets I-control integral time in 1-second units. I-control is not performed when the setting is 0.0.	0.0 to 360.0	1.0 s	Yes	A	A	A	A	1A7H
b5-04	Integral (I) limit	Sets the I-control limit as a percentage of the maximum output frequency.	0.0 to 100.0	100.0%	Yes	A	A	A	A	1A8H
b5-05	Derivative (D) time	Sets D-control derivative time in 1-second units. D-control is not performed when the setting is 0.00.	0.00 to 10.00	0.00 s	Yes	A	A	A	A	1A9H
b5-06	PID limit	Sets the limit after PID-control as a percentage of the maximum output frequency.	0.0 to 100.0	100.0%	Yes	A	A	A	A	1AAH
b5-07	PID offset adjustment	Sets the offset after PID-control as a percentage of the maximum output frequency.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	1ABH
b5-08	PID primary delay time constant	Sets the time constant for low pass filter for PID-control outputs in 1-second units. Not usually necessary to set.	0.00 to 10.00	0.00 s	Yes	A	A	A	A	1ACH
b5-09	PID output characteristics selection	Select forward/reverse for PID output. 0: PID output is forward. 1: PID output is reverse (highlights the output code)	0 or 1	0	No	A	A	A	A	1ADH
b5-10	PID output gain	Sets output gain.	0.0 to 25.0	1.0	No	A	A	A	A	1AEH
b5-11	PID reverse output selection	0: 0 limit when PID output is negative. 1: Reverses when PID output is negative. 0 limit when reverse prohibit is selected using b1-04.	0 or 1	0	No	A	A	A	A	1AFH

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
b5-12	Selection of PID feedback command loss detection	0: No detection of loss of PID feedback. 1: Detection of loss of PID feedback. Operation continues during detection, with the malfunctioning contact not operating. 2: Detection of loss of PID feedback. Coasts to stop during detection, and fault contact operates.	0 to 2	0	No	A	A	A	A	1B0H
b5-13	PID feedback command loss detection level	Sets the PID feedback loss detection level as a percent units, with the maximum output frequency at 100%.	0 to 100	0%	No	A	A	A	A	1B1H
b5-14	PID feedback command loss detection time	Sets the PID feedback loss detection level in s units.	0.0 to 25.5	1.0 s	No	A	A	A	A	1B2H
b5-15	PID sleep function operation level	Set the PID sleep function start level as a frequency.	0.0 to 400.0 *1 0.0 to 300.0 *2	0.0 Hz	No	A	A	A	A	1B3H
b5-16	PID sleep operation delay time	Set the delay time until the PID sleep function starts in seconds.	0.0 to 25.5	0.0 s	No	A	A	A	A	1B4H
b5-17	Accel/decel time for PID reference	Set the accel/decel time for PID reference in seconds.	0.0 to 25.5 0.0 to 6000.0	0.0 s	No	A	A	A	A	1B5H
H6-01	Pulse train input function selection	0: Frequency reference 1: PID feedback value 2: PID target value	0 to 2	0	No	A	A	A	A	42CH

* 1. When C6-01=0, the upper limit is 150.0.
* 2. When C6-01=1, the upper limit is 400.0.

Monitor Functions

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
U1-24	PID feedback value	Monitors the feedback value when PID control is used. The input for the max. frequency corresponds to 100%.	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	57H
U1-36	PID input volume	PID feedback volume Given as maximum frequency/ 100%	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	63H
U1-37	PID output volume	PID control output Given as maximum frequency/ 100%	10 V: Max. frequency (−10 to 10 V possible)	0.01 %	A	A	A	A	64H

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Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMOBUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U1-38	PID command	PID command + PID command bias Given as maximum frequency/ 100%	10 V: Max. frequency	0.01 %	A	A	A	A	65H

Multi-Function Contact Inputs (H1-01 to H1-06)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
19	PID control disable (ON: PID control disabled)	Yes	Yes	Yes	Yes
30	PID control integral reset (reset when reset command is input or when stopped during PID control)	Yes	Yes	Yes	Yes
31	PID control integral hold (ON: Hold)	Yes	Yes	Yes	Yes
34	PID soft starter ON/OFF	Yes	Yes	Yes	Yes
35	PID input characteristics switch	Yes	Yes	Yes	Yes

Multi-Function Analog Input (H3-05, H3-09)

Setting Value	Function	Contents (100%)	Control Methods			
			V/f	V/f with PG	Open Loop Vector	Flux Vector
B	PID feedback	Maximum output frequency	Yes	Yes	Yes	Yes
C	PID target value	Maximum output frequency	Yes	Yes	Yes	Yes

■PID Control Methods

There are four PID control methods. Select the method by setting constant b5-01.

Set Value	Control Method
1	PID output becomes the Inverter output frequency, and D control is used in the difference between PID target value and feedback value.
2	PID output becomes the Inverter output frequency, and D control is used in the PID feedback value.
3	PID output is added as compensation value of the Inverter output frequency, and D control is used in the difference between PID target value and feedback value.
4	PID output is added as compensation value of the Inverter output frequency, and D control is used in the PID feedback value.

■PID Input Methods

Enable PID control using constant b5-01, and set the PID target value and PID feedback value.

PID Target Value Input Methods

Select the PID control target value input method according to the setting in b1-01 (Reference Selection). Normally, the frequency reference selected in b1-01 is the PID target value, but you can also set the PID target value as shown in the following table.

PID Target Input Method	Setting Conditions
Multi-Function Analog Terminal A2, or A3 Input	Set H3-05 or H3-09 to C (PID target value). Also, be sure to set H6-01 (pulse train input function selection) to 1 (PID feedback value). The negative inputs cannot be used for target values.
MEMOBUS register 0006H	Set MEMOBUS bit 1 in register address 000FH to 1 (enable/disable PID target value from communications) to be able to use register number 0006H as the PID target value.
Pulse train input	Set H6-01 to 2 (PID target value).

PID Feedback Input Methods

Select one of the following PID control feedback input methods.

Input Method	Setting Conditions
Multi-function analog input	Set H3-09 (Multi-function Analog Input Terminal A2 Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) to B (PID feedback).
Pulse train input	Set H6-01 to 1 (PID feedback).

INFO

Adjust PID target value and PID feedback value using the following items.

- Analog input: Adjust using the analog input terminal gain and bias.
- Pulse train input: Adjust using pulse train scaling, pulse train input gain, and pulse train input bias.

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■PID Adjustment Methods

Use the following procedure to adjust PID while performing PID control and measuring the response waveform.

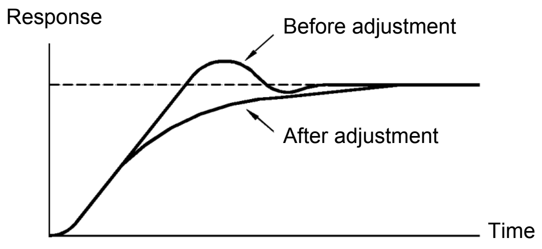
1. Set b5-01 (PID Control Method Selection) to 1 or 2 (PID control enabled).
2. Increase b5-02 (Proportional Gain (P)) to within a range that does not vibrate.
3. Reduce b5-03 (Integral (I) time) to within a range that does not vibrate.
4. Increase b5-05 (Derivative (D) time) to within a range that does not vibrate.

■PID Fine Adjustment Methods

This section explains the fine adjustment of PID after setting the PID control constants.

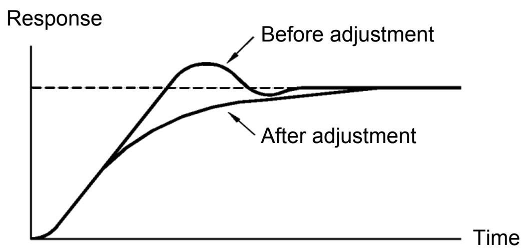
Suppressing Overshoot

If overshoot occurs, reduce derivative time (D), and increase integral time (I).



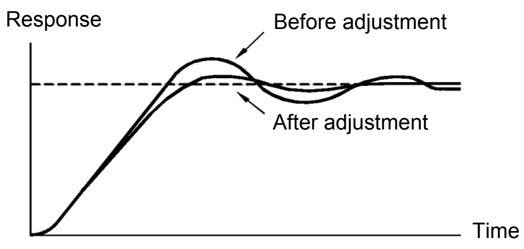
Set a Rapidly Stabilizing Control Condition

To rapidly stabilize the control even if overshoot occurs, reduce integral time (I), and lengthen derivative time (D).



Suppressing Long-cycle Vibration

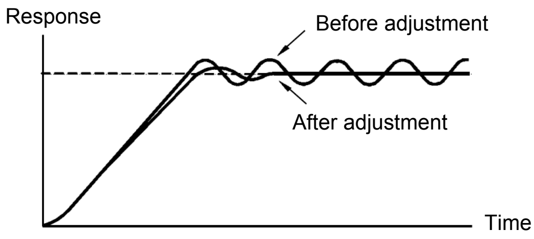
If vibration occurs with a longer cycle than the integral time (I) set value, the integral operation is too strong. Lengthen the integral time (I) to suppress the vibration.



Suppressing Short Cycle Vibration

If vibration occurs when the vibration cycle is short, and the cycle is almost identical to the derivative time (D) set value, the differential operation is too strong. Shorten the derivative time (D) to suppress the vibration.

If vibration continues even when the derivative time (D) is set to 0.00 (D control disabled), reduce the proportional gain (P), or increase the PID primary delay time constant.



■Setting Precautions

- In PID control, the b5-04 constant is used to prevent the calculated integral control value from exceeding a specified amount. If the load changes rapidly, the machine may be damaged or the motor may stall because of unpredictable response from the Inverter. In this case, reduce the set value.
- The b5-06 constant is used to prevent the arithmetic operation following the PID control calculation from exceeding a specified amount. Set taking the maximum output frequency to be 100%.
- The b5-07 constant is used to adjust PID control offset. Set in increments of 0.1%, taking the maximum output frequency to be 100%.
- Set the low pass filter time constant for the PID control output in b5-08. Enable this constant to prevent machinery resonance from occurring when machinery adhesive abrasion is great, or rigidity is poor. In this case, set the constant to be greater than the resonance frequency cycle. Increase this time constant to reduce Inverter responsiveness.
- Using b5-09, you can invert the PID output polarity. Consequently, if you increase the PID target value, you can apply this constant to applications to lower the Inverter output frequency.
- Using b5-10, you can apply gain to the PID control output. Enable this constant to adjust the amount of compensation if adding PID control output to the frequency reference as compensation.
- When PID control output is negative, you can use constant b5-11 to invert the Inverter. When b1-04 (Prohibition of Reverse Operation) is set to 1 (enabled), however, PID output limit is 0.
- With the Inverter, by setting an independent acceleration/deceleration time in constant b5-17, you can increase or decrease the PID target value using the acceleration/deceleration time. The acceleration/deceleration function (constant C1) used normally, however, is allocated after PID control, so depending on the settings, resonance with PID control and hunting in the machinery may occur. If this happens, reduce constant C1 until hunting does not occur, and maintain the acceleration/deceleration time using b5-17. Also, you can disable the set value in b5-17 from the external terminals during operation using multi-function input set value 34 (PID soft starter).

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■PID Control Block

The following diagram shows the PID control block in the Inverter.

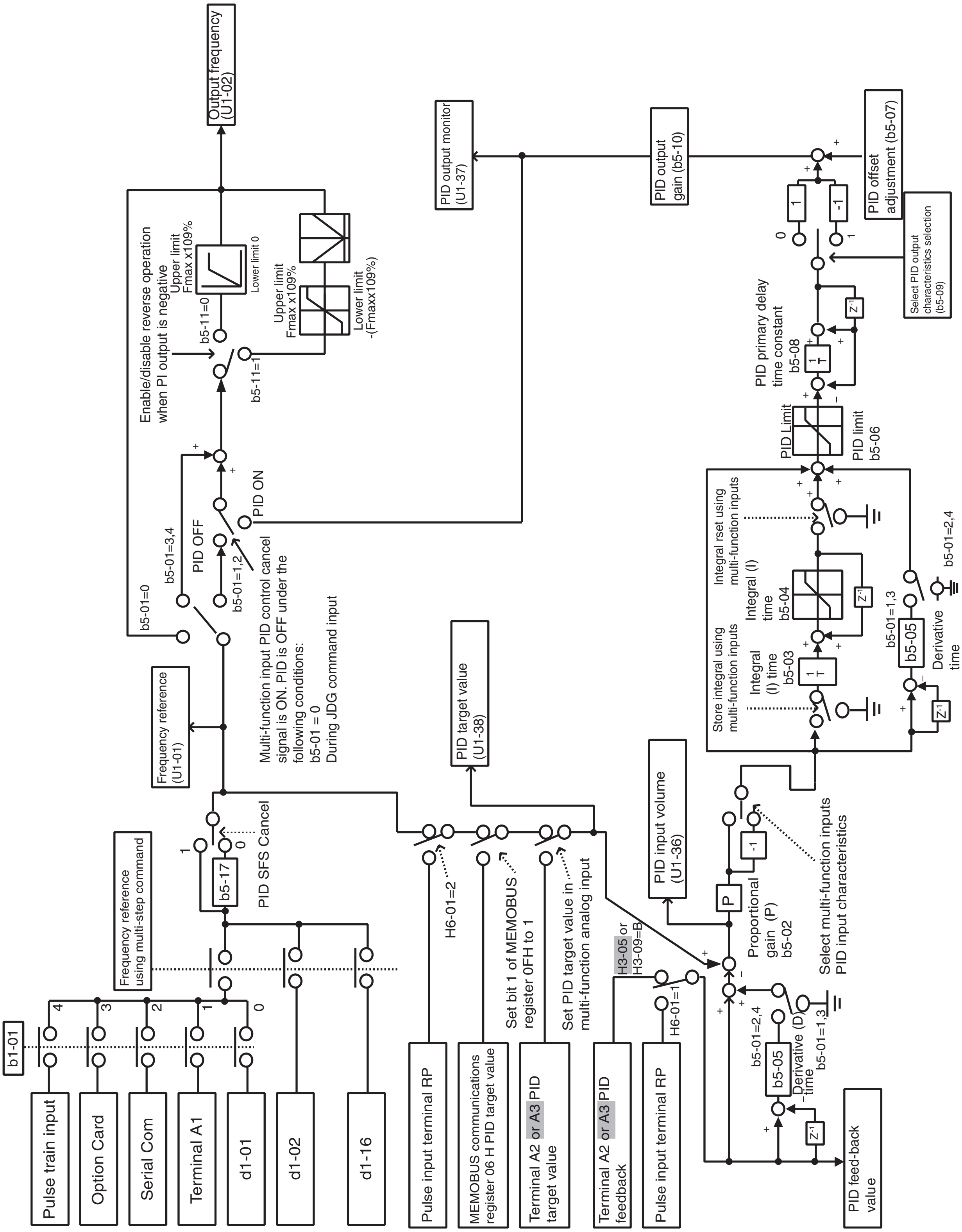

Fig 6.63 PID Control Block

■PID Feedback Loss Detection

When performing PID control, be sure to use the PID feedback loss detection function. If PID feedback is lost, the Inverter output frequency may accelerate to the maximum output frequency.

When setting b5-12 to 1 and the status of the PID feedback value detection level in b5-13 is insufficient and continues for the time set in b5-14, an FbL (PID feedback reference lost) alarm will be displayed on the Digital Operator and Inverter operation will continue.

When b5-12 is set to 2, an FbL (PID feedback reference lost) error alarm will be displayed on the Digital Operator, the error contact will operate, and Inverter operation will be stopped.

The time chart for PID feedback loss detection (set b5-12 to 2) is shown below.

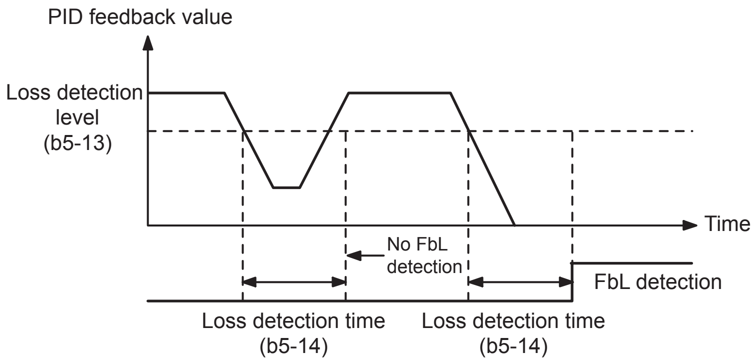

Fig 6.64 PID Feedback Loss Detection Time Chart

■PID Sleep

The PID sleep function stops the Inverter when the PID sleep function delay time continues while the PID control target value is at an insufficient level to operate the PID sleep function. When the PID sleep delay time continues and the PID control target value is above the PID sleep function operation level, Inverter operation will automatically resume.

When PID control is disabled, the PID sleep function is also disabled. When using the PID sleep function, select decelerate to stop or coast to stop as the stopping method.

The PID sleep time chart is shown below.

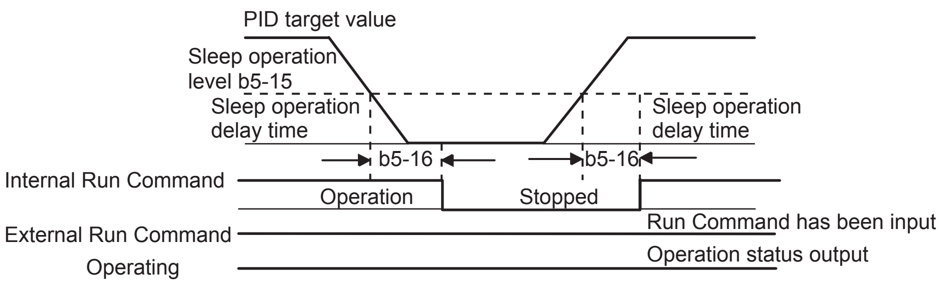

Fig 6.65 PID Sleep Time Chart

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◆ Energy-saving

To perform energy saving, set b8-01 (Energy Saving Mode Selection) to 1. Energy-saving control can be performed using both V/f control and vector control. The constants to be adjusted are different for each. In V/f control, adjust b8-04 to b8-06, and in vector control, adjust b8-02 and b8-03.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b8-01	Energy-saving mode selection	Select whether to enable or disable energy-saving control. 0: Disable 1: Enable	0 or 1	0	No	A	A	A	A	1CCH
b8-02	Energy-saving gain	Set the energy-saving gain with the vector control method.	0.0 to 10.0	0.7 *1	Yes	No	No	A	A	1CDH
b8-03	Energy-saving filter time constant	Set the energy-saving filter time constant with the vector control method.	0.00 to 10.00	0.50 s *2	Yes	No	No	A	A	1CEH
b8-04	Energy-saving coefficient	Set the maximum motor efficiency value. Set the motor rated capacity in E2-11, and adjust the value by 5% at a time until output power reaches a minimum value.	0.00 to 655.00	288.20 *3 *4	No	A	A	No	No	1CFH
b8-05	Power detection filter time constant	Set the time constant for output power detection.	0 to 2000	20 ms	No	A	A	No	No	1D0H
b8-06	Search operation voltage limiter	Set the limit value of the voltage control range during search operation. Perform search operation to optimize operations using minute variations in voltage using energy-saving control. Set to 0 to disable the search operation. 100% is the motor base voltage.	0 to 100	0%	No	A	A	No	No	1D1H
E2-02	Motor rated slip	Sets the motor rated slip in Hz units. These set values will become the reference values for slip compensation. This constant is automatically set during autotuning.	0.00 to 20.00	2.90 Hz *4	No	A	A	A	A	30FH
E2-11	Motor rated output	Set the rated output of the motor in units of 0.01 kW. This constant is automatically set during autotuning.	0.00 to 650.00	0.40 kW *4	No	Q	Q	Q	Q	318H

* 1. The factory setting is 1.0 when using flux vector control.
* 2. The factory setting is 2.00 s when Inverter capacity is 55 kW min.
The factory setting will change when the control method is changed. The open-loop vector factory setting is given.
* 3. By setting E2-11 (Motor rated output) the appropriate value will be set.
* 4. The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.

■Adjusting Energy-saving Control

The method of adjustment during energy-saving control operations differs depending on the control method. Refer to the following when making adjustments.

V/f Control

In V/f control method, the voltage for optimum motor efficiency is calculated and becomes the output voltage reference.

- b8-04 (Energy-saving Coefficient) is set at the factory for motor use applied to the Inverter. If the motor capacity differs from the motor applied to the Inverter, set the motor capacity in E2-11 (Motor Rated Output). Also, adjust the output voltage in steps of 5 until it reaches minimum. The larger the energy-saving coefficient, the greater the output voltage.
- To improve response when the load fluctuates, reduce the power detection filter time constant b8-05. If b8-05 is set too small, however, motor rotations when the load is light may become unstable.
- Motor efficiency varies due to temperature fluctuations and differences in motor characteristics. Consequently, control motor efficiency online to optimize efficiency by causing minute variations in voltage using the search operation. Constant b8-06 (Search Operation Voltage Limiter) controls the range that control the voltage using the search operation. For 200 V Class Inverters, set the range to 100%/200 V, and for 400 V Class Inverters, set the range to 100%/400 V. Set to 0 to disable the search operation.

Vector Control

In vector control method, control the slip frequency so that motor efficiency is maximized.

- Taking the motor rated slip for the base frequency as optimum slip, calculate the optimum slip for motor efficiency for each frequency. In vector control, be sure to perform autotuning, and set the motor rated slip.
- If the motor performs hunting when using energy-saving control in vector control, reduce the set value in b8-02 (Energy-saving Gain), or increase the set value in b8-03 (Energy-saving Filter Time Constant).

◆ Setting Motor Constants

In vector control method, the motor constants are set automatically using autotuning. If autotuning does not complete normally, set them manually.

■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
E2-01	Motor rated current	Sets the motor rated current in 1 A units. These set values will become the reference values for motor protection, torque limits and torque control. This constant is automatically set during autotuning.	0.32 to 6.40 *2	1.90 A *1	No	Q	Q	Q	Q	30EH
E2-02	Motor rated slip	Sets the motor rated slip in Hz units. These set values will become the reference values for slip compensation. This constant is automatically set during autotuning.	0.00 to 20.00	2.90 Hz *1	No	A	A	A	A	30FH
E2-03	Motor no-load current	Sets the motor no-load current in 1 A units. This constant is automatically set during autotuning.	0.00 to 1.89 *3	1.20 A *1	No	A	A	A	A	310H
E2-04	Number of motor poles	Sets the number of motor poles. This constant is automatically set during autotuning.	2 to 48	4 poles	No	No	Q	No	Q	311H
E2-05	Motor line-to-line resistance	Sets the motor phase-to-phase resistance in Ω units. This constant is automatically set during autotuning.	0.000 to 65.000	9.842 Ω *1	No	A	A	A	A	312H
E2-06	Motor leak inductance	Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage. This constant is automatically set during autotuning.	0.0 to 40.0	18.2% *1	No	No	No	A	A	313H
E2-07	Motor iron saturation coefficient 1	Sets the motor iron saturation coefficient at 50% of magnetic flux. This constant is automatically set during autotuning.	0.00 to 0.50	0.50	No	No	No	A	A	314H
E2-08	Motor iron saturation coefficient 2	Sets the motor iron saturation coefficient at 75% of magnetic flux. This constant is automatically set during autotuning.	0.50 to 0.75 *4	0.75	No	No	No	A	A	315H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
E2-09	Motor mechanical loss	Sets motor mechanical loss as a percentage of motor rated output (W). 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	No	No	No	No	A	316H
E2-10	Motor iron loss for torque compensation	Sets motor iron loss in W units.	0 to 65535	14 W *1	No	A	A	No	No	317H
E2-11	Motor rated output	Set the rated output of the motor in units of 0.01 kW. This constant is automatically set during autotuning.	0.00 to 650.00	0.40 kW *1	No	Q	Q	Q	Q	318H

* 1. The factory settings depend on the Inverter capacity. The values for a 200 V Class Inverter of 0.4 kW are given.

* 2. The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V Class Inverter of 0.4 kW is given. For the motor no-load current, set E2-03 to a value less than that of E2-01.

* 3. The setting range depends on the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given. The upper limit depends on the setting of E2-01.

* 4. The lower limit of E2-08 is the setting value of E2-07.

■Manual Motor Constant Setting Methods

The motor constants settings methods are given below. Make (enter) settings referring to the motor test report.

Motor Rated Voltage Setting

Set E2-01 to the rated current on the motor nameplate.

Motor Rated Slip Setting

Set E2-02 to the motor rated slip calculated from the number of rated rotations on the motor nameplate.

Amount of motor rated slip = Motor rated frequency (Hz) - No. of rated rotations (min^{-1}) x No. of motor poles/120.

Motor No-Load Current Setting

Set E2-03 to the motor no-load current using the rated voltage and rated frequency. The motor no-load current is not normally written on the motor nameplate. Consult the motor manufacturer.

Factory setting is the no-load current value for a standard Yaskawa 4-pole motor.

Number of Motor Poles Setting

E2-04 is displayed only when V/f control method with PG or flux vector control method is selected. Set the number of motor poles (number of poles) as written on the motor nameplate.

Motor Line-to-Line Resistance Setting

E2-05 is set automatically when performing motor line-to-line resistance autotuning. When you cannot perform tuning, consult the motor manufacturer for the line-to-line resistance value. Calculate the resistance from the line-to-line resistance value in the motor test report using the following formula, and then make the setting accordingly.

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- E-type isolation: [Line-to-line resistance (Ω) at 75°C of test report] × 0.92 (Ω)
- B-type isolation: [Line-to-line resistance (Ω) at 75°C of test report] × 0.92 (Ω)
- F-type isolation: [Line-to-line resistance (Ω) at 115°C of test report] × 0.87 (Ω)

Motor Leak Inductance Setting

Set the amount of voltage drop due to motor leak inductance in E2-06 using the percentage over the motor rated voltage. Make this setting when the high-speed motor inductance is small. If the inductance is not written on the motor nameplate, consult the motor manufacturer.

Motor Iron Saturation Coefficients 1 and 2 Settings

E2-07 and E2-08 and are set automatically using rotational autotuning.

Motor Mechanical Loss (SPEC: E or Later Only)

E2-09 is displayed only when the flux vector control method is selected. Adjust mechanical loss in the following cases. (There is normally no reason to make this adjustment.) The mechanical loss setting is used to compensate the torque.

- There is excessive torque loss from the motor bearings.
- There is excessive torque loss from a fan, pump, etc.

Motor Iron Loss for Torque Compensation Setting

E2-10 is displayed only when in V/f control method. To increase the torque compensation accuracy when in V/f control method, set the motor iron loss in Watts.

Motor Rated Output

Set the rated output value of the motor indicated on the motor nameplate to E2-11.

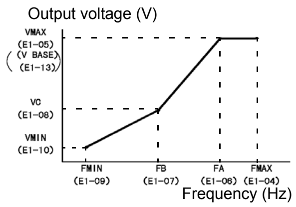
This constant is automatically set during autotuning.

◆ Setting the V/f Pattern

In V/f control method, you can set the Inverter input voltage and the V/f pattern as the need arises.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
E1-01	Input voltage setting	Set the Inverter input voltage in 1 volt. This setting is used as a reference value in protection functions.	155 to 255 *1	200 V *1	No	Q	Q	Q	Q	300H
E1-03	V/f pattern selection	0 to E: Select from the 15 preset patterns. F: Custom user-set patterns (Applicable for settings E1-04 to E1-10.)	0 to F	F	No	Q	Q	No	No	302H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register
E1-04	Max. output frequency		40.0 to 400.0 *6 40.0 to 300.0 *5	60.0 Hz *2	No	Q	Q	Q	Q	303H
E1-05	Max. voltage		0.0 to 255.0 *1	200.0 V *1*2	No	Q	Q	Q	Q	304H
E1-06	Base frequency		0.0 to 400.0 *6 0.0 to 300.0 *5	60.0 Hz *2	No	Q	Q	Q	Q	305H
E1-07	Mid. output 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 are set in the following manner: E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)	0.0 to 400.0 *6 0.0 to 300.0 *5	3.0 Hz *2	No	A	A	A	No	306H
E1-08	Mid. output frequency voltage		0.0 to 255 *1	15.0 V *1 *2	No	A	A	A	No	307H
E1-09	Min. output frequency		0.0 to 400.0 *6 0.0 to 300.0 *5	1.5 Hz *2	No	Q	Q	Q	A	308H
E1-10	Min. output frequency voltage		0.0 to 255.0 *1	9.0 V *1 *2	No	A	A	A	No	309H
E1-11	Mid. output frequency 2	Set only to fine-adjust V/f for the output range. Normally, this setting is not required.	0.0 to 400.0 *6 0.0 to 300.0 *5	0.0 Hz *3	No	A	A	A	A	30AH
E1-12	Mid. output frequency voltage 2		0.0 to 255.0 *1	0.0 V *3	No	A	A	A	A	30BH
E1-13	Base voltage		0.0 to 255.0 *1	0.0 V *4	No	A	A	Q	Q	30CH

* 1. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 2. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 3. E1-11 and E1-12 are disregarded when set to 0.0.
* 4. E1-13 is set to the same value as E1-05 by autotuning.
* 5. When C6-01=1, the upper limit is 400.0.
* 6. When C6-01=0, the upper limit is 150.0.

■Setting Inverter Input Voltage

Set the Inverter input voltage correctly in E1-01 to match the power supply voltage. This set value will be the standard value for the protection function and similar functions.

The overvoltage detection level (OV) and the braking transistor operation level (BTR) vary depending on the input voltage as shown in the following table.

Inverter Class	E1-01 Setting	OV Detection Level	BTR Operation Level*
200 V Class	All values	Approx. 410 V	Approx. 394 V
400 V Class	400 V or more	Approx. 820 V	Approx. 788 V
	Less than 400 V	Approx. 720 V	Approx. 682 V

* These are values of operation levels for braking transistors built in Inverters of 0.4 to 18.5 kW. Refer to *FOR VARISPEED-600 SERIES INVERTER BRAKING UNIT BRAKING RESISTOR UNIT INSTRUCTIONS (TOBPC720600000)* for operation levels for separately-installed type Braking Resistor Units.

If selecting a fixed V/f pattern (E1-03 = 0 to E) in V/f control the values of the max. voltage (E1-05), the mid. Output frequency voltage (E1-08), and the min. output frequency voltage (E1-10) will change if the value for the input voltage setting (E1-01) is changed.

■Setting V/f Pattern

Set the V/f pattern in E1-03 when using V/f control (with or without a PG). There are two methods of setting the V/f pattern: Select one of the 15 pattern types (set value: 0 to E) that have been set beforehand, or set a user-defined V/f pattern (set value: F).

The factory setting for E1-03 is F. The contents of E1-03 when factory-set to F are the same as when E1-03 is set to 1.

To select one of the existing patterns, refer to the following table.

Characteristic	Application	Set Value	Specifications
Constant Torque Characteristic	This pattern is used in general applications. Used when the load torque is fixed, regardless of rotation speed, for linear transport systems.	0	50 Hz specifications
		1 (F)	60 Hz specifications
		2	60 Hz specifications, voltage saturation at 50 Hz
		3	72 Hz specifications, voltage saturation at 60 Hz
Variable torque characteristic	This pattern is used for loads with torque proportional to two or three times the rotation speed, such as fans and pumps.	4	50 Hz specifications,× 3 decrement
		5	50 Hz specifications, × 2 decrement
		6	60 Hz specifications, × 3 decrement
		7	60 Hz specifications, × 2 decrement
High Startup Torque (See Note)*	Select the high startup torque V/f pattern only in the following cases. • The wiring distance between Inverter and motor is large (approx. 150 m min.) • A large torque is required at startup (elevator loads, etc.) • An AC reactor is inserted in the Inverter input or output. • You are operating a motor that is less than optimum.	8	50 Hz specifications, medium startup torque
		9	50 Hz specifications, large startup torque
		A	60 Hz specifications, medium startup torque
		B	60 Hz specifications, large startup torque
Fixed Output Operation	This pattern is used for frequencies of 60 Hz or higher. A fixed voltage is applied.	C	90 Hz specifications, voltage saturation at 60 Hz
		D	120 Hz specifications, voltage saturation at 60 Hz
		E	180 Hz specifications, voltage saturation at 60 Hz

* The torque is protected by the fully automatic torque boost function, so normally there is no need to use this pattern.

When you select these patterns, the values of constants E1-04 to E1-10 are changed automatically. There are three types of values for E1-04 to E1-10, depending on the Inverter capacity.

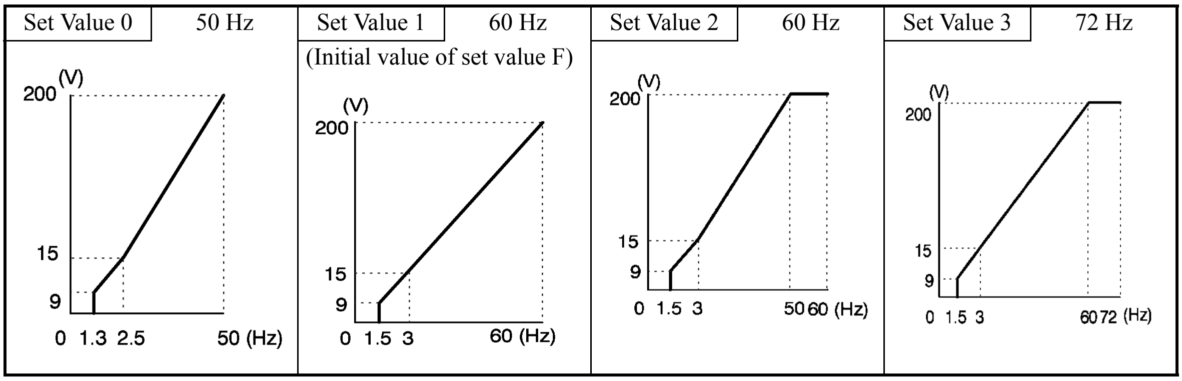
- 0.4 to 1.5 kW V/f pattern
- 2.2 to 45 kW V/f pattern
- 55 to 300 kW V/f pattern

The characteristics diagrams for each are shown in the following pages.

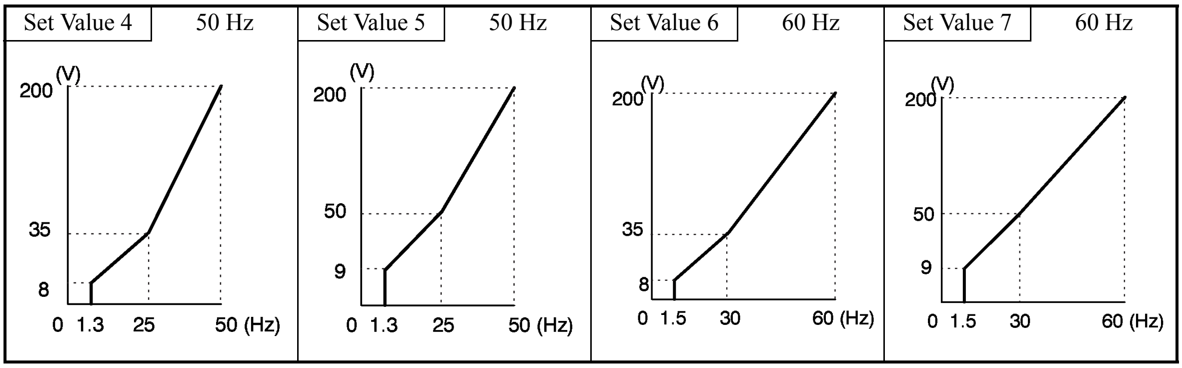
0.4 to 1.5 kW V/f Pattern

The diagrams show characteristics for a 200-V Class motor. For a 400-V Class motor, multiply all voltages by 2.

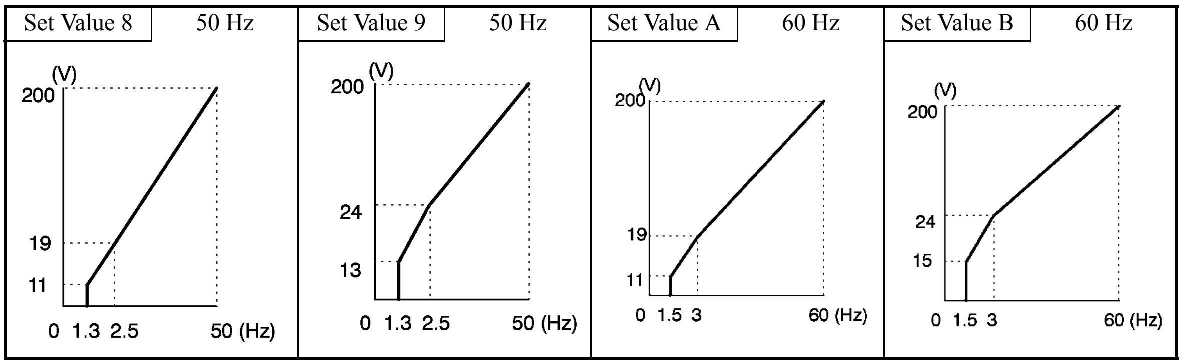
- Constant Torque Characteristics (Set Value: 0 to 3)



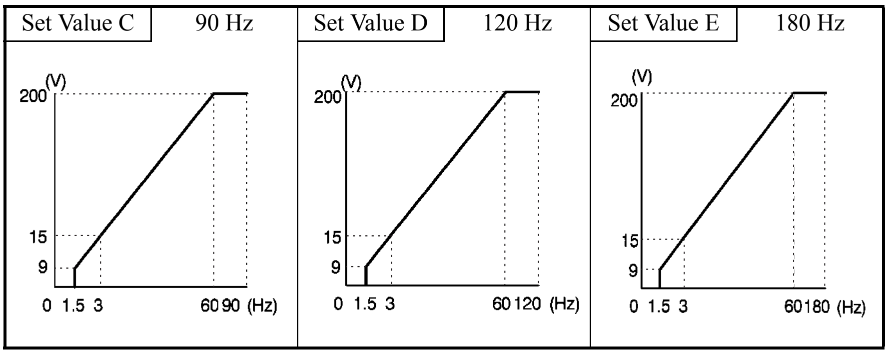
- Decrement Torque Characteristics (Set Value: 4 to 7)



- High startup torque (Set value 8: to B)



- Fixed Output Operation (Set Value: C to E)



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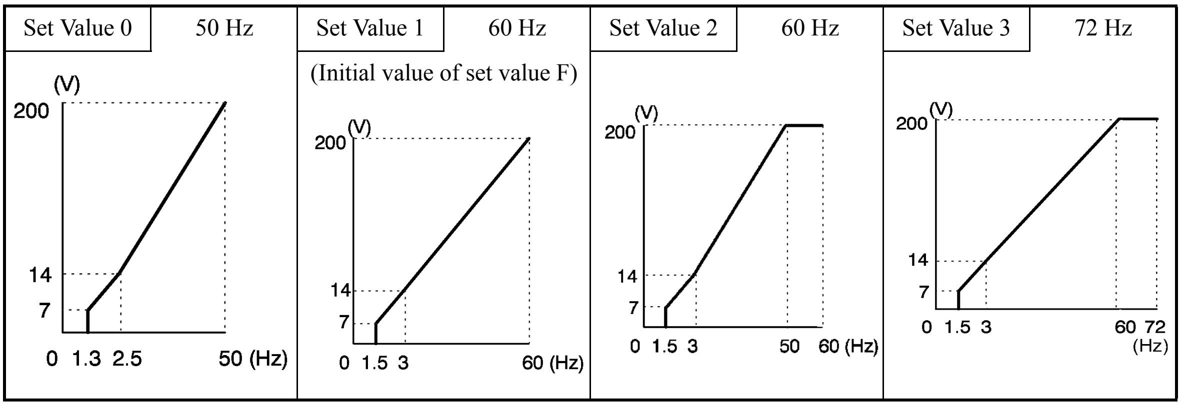
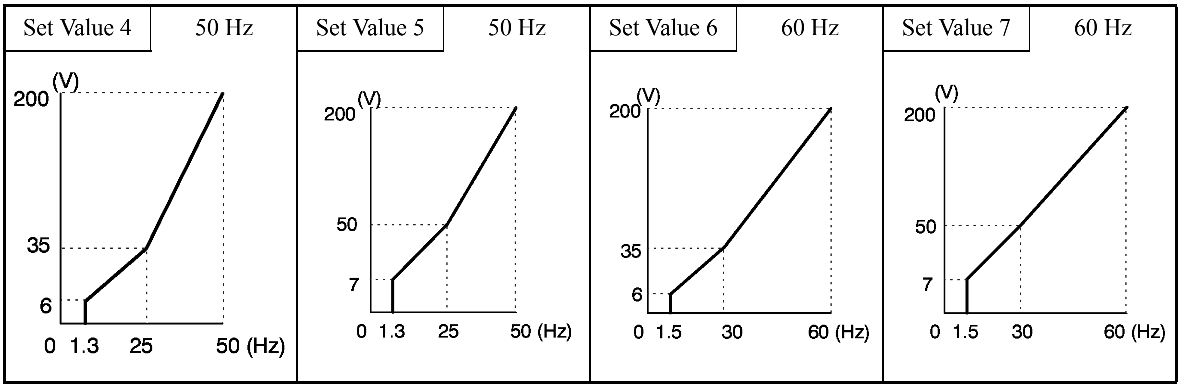
2.2 to 45 kW V/f Pattern

The diagrams show characteristics for a 200-V Class motor. For a 400-V Class motor, multiply all voltages by 2.

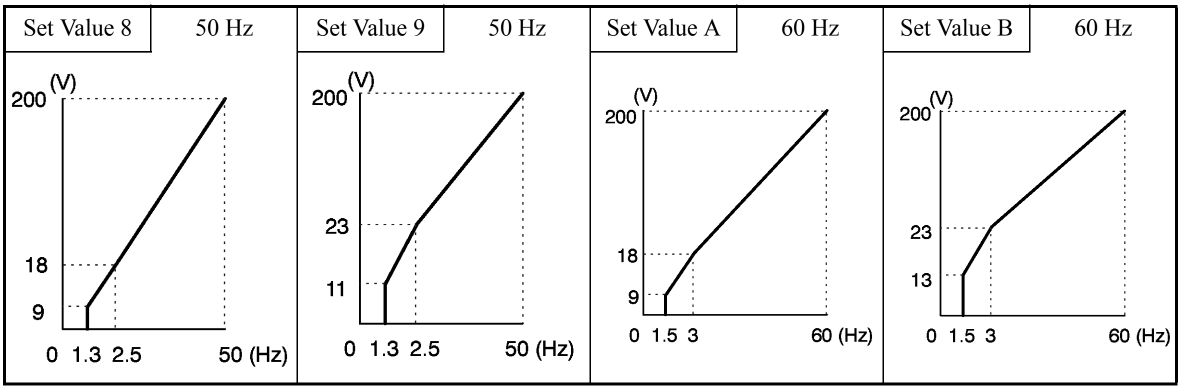
- Constant Torque Characteristics (Set Value: 0 to 3)



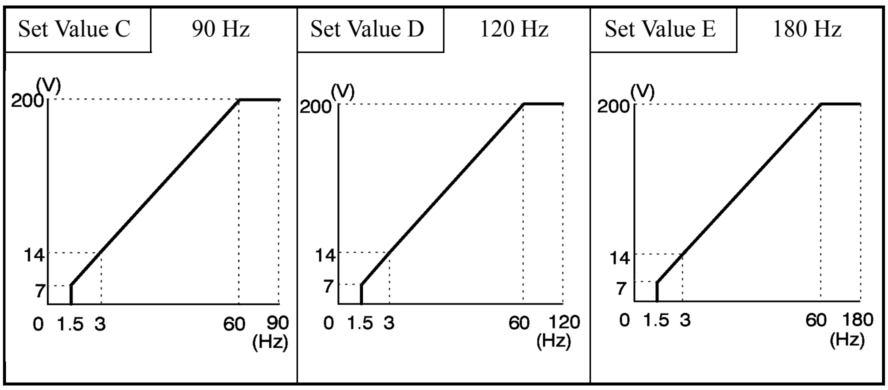
- Decrement Torque Characteristics (Set Value: 4 to 7)



- High Startup Torque (Set Value: 8 to B)



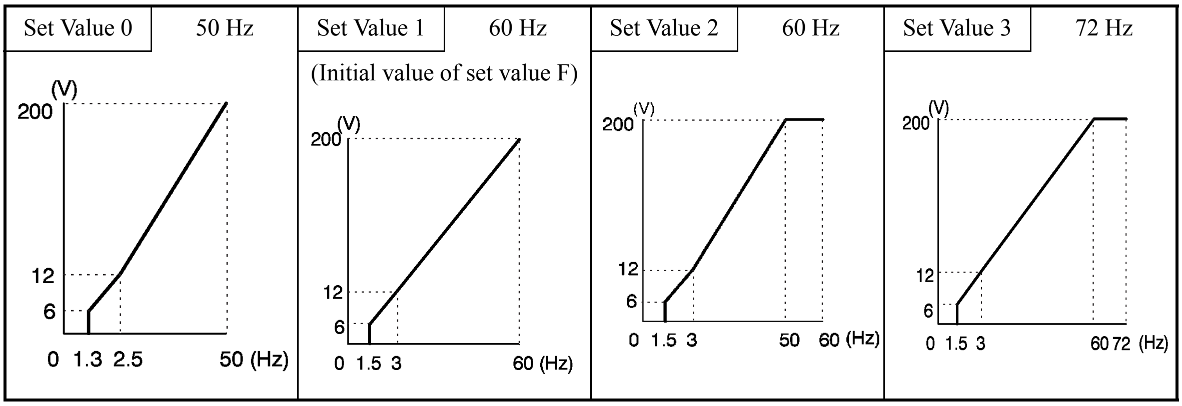
- Fixed Output Operation (Set Value: C to E)



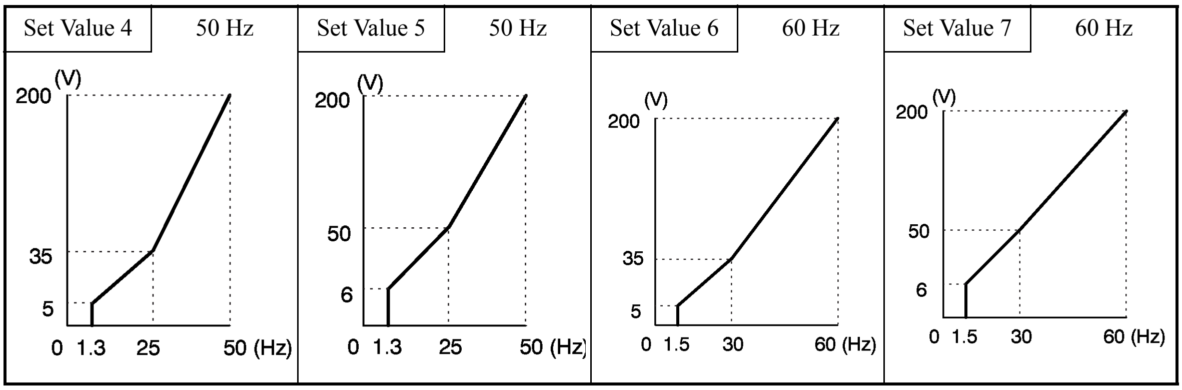
55 to 300 kW V/f Pattern

The diagrams show characteristics for a 200-V Class motor. For a 400-V Class motor, multiply all voltages by 2.

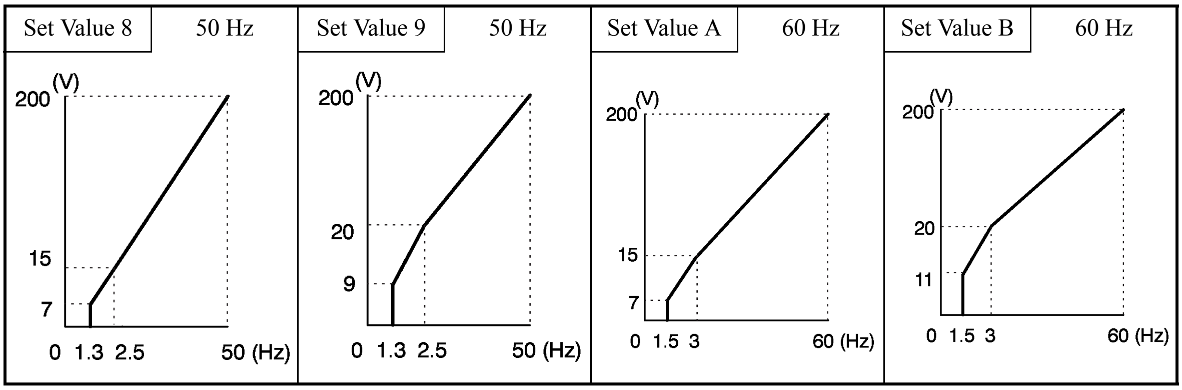
- Constant Torque Characteristics (Set Value: 0 to 3)



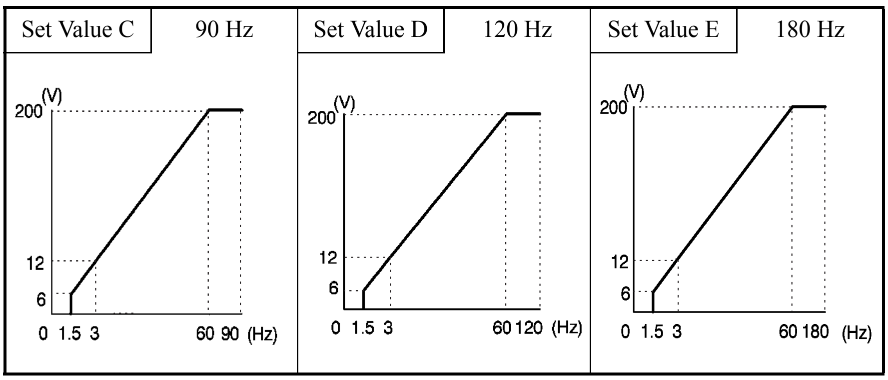
- Decrement Torque Characteristics (Set Value: 4 to 7)



- High Startup Torque (Set Value: 8 to B)



- Fixed Output Operation (Set Value: C to E)



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When E1-03 is set to F (User-defined V/f pattern), you can set constants E1-04 to E1-10. If E1-03 is set to anything other than F, you can only refer to constants E1-04 to E1-10. If the V/f characteristics are linear, set E1-07 and E1-09 to the same value. In this case, E1-08 will be ignored.

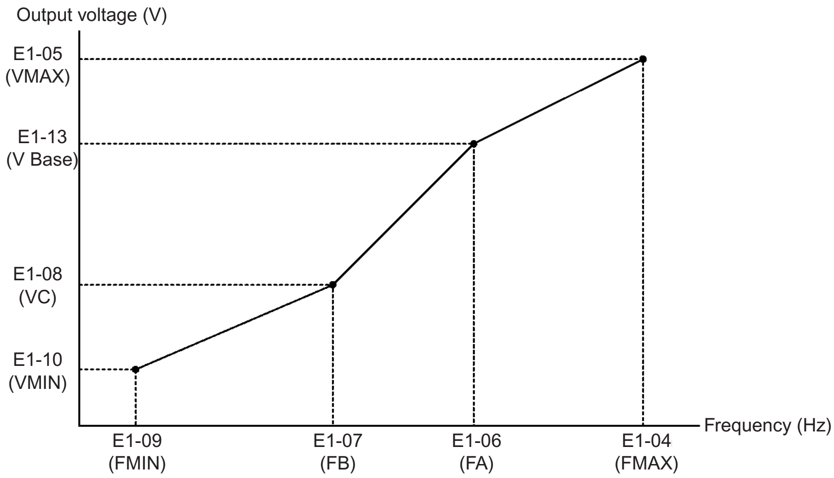

Fig 6.66 User-Set V/f Pattern

■Setting Precautions

When the setting is to user-defined V/f pattern, beware of the following points.

- When changing control method, constants E1-07 to E1-10 will change to the factory settings for that control method.
- Be sure to set the four frequencies as follows:
  E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)

◆ Torque Control (SPEC: E or Later Only)

With flux vector control, the motor's output torque can be controlled by a torque reference from an analog input. Set d5-01 to 1 to control torque.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
d5-01	Torque control selection	0: Speed control (C5-01 to C5-07) 1: Torque control This function is only available in flux vector control method. To use the function for switching between speed and torque control, set to 0 and set the multi-function input to "speed/torque control change."	0 or 1	0	No	No	No	No	A	29AH
d5-02	Torque reference delay time	Set the torque reference delay time in ms units. This function can be used to adjust the noise of the torque control signal or the responsiveness with the host controller. When oscillation occurs during torque control, increase the set value.	0 to 1000	0 ms	No	No	No	No	A	29BH
d5-03	Speed limit selection	Set the speed limit command method for the torque control method. 1: The analog input limit from a frequency reference (see b1-01) 2: Limited by d5-04 constant setting values.	1 or 2	1	No	No	No	No	A	29CH
d5-04	Speed limit	Set the speed limit during torque control as a percentage of the maximum output frequency. This function is enabled when d5-03 is set to 2. Directions are as follows. +: Run Command direction -: Run Command opposite direction	-120 to +120	0%	No	No	No	No	A	29DH
d5-05	Speed limit bias	Set the speed limit bias as a percentage of the maximum output frequency. Bias is given to the specified speed limit. It can be used to adjust the margin for the speed limit.	0 to 120	10%	No	No	No	No	A	29EH

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
d5-06	Speed/torque control switching timer	Set the delay time from inputting the multi-function input “speed/torque control change” (from On to OFF or OFF to ON) until the control is actually changed, in ms units. This function is enabled when the multi-function input “speed/torque control change” is set. In the speed/torque control switching timer, the analog inputs hold the values of when the “speed/torque control change” changes. Always be sure to allow time for this process to finish completely.	0 to 1000	0 ms	No	No	No	No	A	29FH
H3-04	Signal level selection (terminal A3)	0: −10 to 10 V 1: −10 to 10 V	0 or 1	0	No	A	A	A	A	413H
H3-05	Multi-function analog input (terminal A3) function selection	Select from the functions listed in the following table. Refer to the next page.	0 to 1F	1F	No	A	A	A	A	414H
H3-06	Gain (terminal A3)	Sets the input gain (level) when 10 V is input. Set according to the 100% value selected from H3-05.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	415H
H3-07	Bias (terminal A3)	Sets the input gain (level) when 0 V is input. Set according to the 100% value selected from H3-05.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	416H
H3-08	Signal level selection (terminal A2)	0: 0 to +10V, with lower limit 1: −10 to 10 V, without lower limit 2: 4 to 20 mA Switch current and voltage input using the switch on the control panel.	0 to 2	2	No	A	A	A	A	417H
H3-09	Multi-function analog input (terminal A2) function selection	Select multi-function analog input function for terminal A2. Refer to the next table.	0 to 1F	0	No	A	A	A	A	418H
H3-10	Gain (terminal A2)	Sets the input gain (level) when 10 V (20 mA) is input. Set according to the 100% value for the function set for H3-09.	0.0 to 1000.0	100.0%	Yes	A	A	A	A	419H
H3-11	Bias (terminal A2)	Sets the input gain (level) when 0 V (4 mA) is input. Set according to the 100% value for the function set for H3-09.	-100.0 to +100.0	0.0%	Yes	A	A	A	A	41AH

Multi-function Contact Input Functions (H1-01 to H1-06)

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector
71	Speed/torque control change (ON: Torque control)	No	No	No	Yes
78	Polarity Reverse Command for external torque reference	No	No	No	Yes

Multi-function Contact Output Functions (H2-01 to H2-03)

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector
32	Speed control circuit operating for torque control (except when stopped). The external torque reference will be limited if torque control is selected. Output when the motor is rotating at the speed limit.	No	No	No	Yes

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

Setting Value	Function	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector
0	Add to terminal A1	Yes	Yes	Yes	Yes
13	Torque reference/torque limit at speed control	No	No	No	Yes
14	Torque compensation	No	No	No	Yes

Monitor Function

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
U1-09	Torque reference	Monitor in internal torque reference value for vector control.	10 V: Motor rated torque (−10 to 10 V possible)	0.1%	No	No	A	A	48H

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■Inputting Torque References and Torque Reference Directions

The torque reference can be changed according to an analog input by setting H3-09 (Multi-function analog input terminal A2 selection) or H3-05 (Multi-function analog input terminal A3 selection) to 13 (torque reference) 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 to 10 V)	Between A3 and AC	H3-04 = 1 H3-05 = 13	Set H3-04 to 0 for a 0 to 10-V torque reference. To switch the torque reference between positive and negative torque, set a multi-function analog input to 78.
	Between A2 and AC (Turn OFF pin 2 of SW1.)	H3-08 = 1 H3-09 = 13	Set H3-08 to 0 for a 0 to 10-V torque reference. To switch the torque reference between positive and negative torque, set a multi-function analog input to 78. The input can be used for torque compensation by setting H3-09 to 14.

Torque Reference Input Method	Reference Location	Selection Method	Remarks
Current input (4 to 20 mA)	Between A2 and AC (Turn ON pin 2 of SW1.)	H3-08 = 2 H3-09 = 13	To switch the torque reference between positive and negative torque, set a multi-function analog input to 78. The input can be used for torque compensation by setting H3-09 to 14.
Option board (AI-14B) (−10 to 10 V)	Between TC2 and TC4	F2-01 = 0 H3-08 = 1 H3-09 = 13	The input can be used for torque compensation by setting H3-05 to 14.

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 to 10 V or 4 to 20 mA, a forward torque reference will not be applied. To apply reverse torque, use an input level of -10 V to 10 V or switch the direction using a multi-function input set to 78 (polarity Reverse Command for external torque reference).

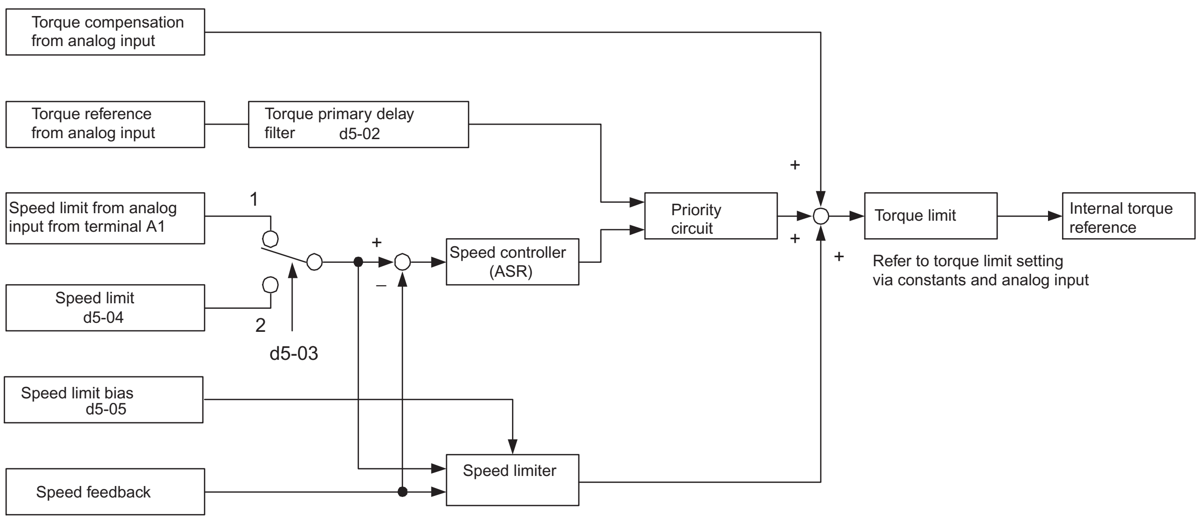


Fig 6.67 Torque Control Block Diagram

■Speed Limiter and Priority Circuit (Speed Limit Function)

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 limit function is used to limit the speed to a specified value and it consists of the speed limiter circuit and priority circuit.
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. The priority circuit switches the internal torque reference to ASR output so that the motor speed does not exceed the speed limit value.

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	Location of Reference	Constant Settings	Remarks
Voltage input (−10 to 10 V)	Set in d5-04	d5-03 = 2	-
	Between A1 and AC	b1-01 = 1 H3-01 = 1	Set H3-01 to 0 if the speed limit is always to be positive.
	Between A2 and AC	b1-01 = 0 H3-08 = 1 H3-09 = 1	The value will be added to the value input on A1 to determine the speed limit. Set H3-03 to 0 if the speed limit input on A2 is always to be positive. Turn OFF (V side) pin 2 of DIP switch S1 on the terminal board.
Current input (4 to 20 mA)	Between A2 and AC	b1-01 = 0 H3-08 = 2 H3-09 = 1	The value will be added to the value input on A1 to determine the speed limit. Turn ON (I side) pin 2 of DIP switch S1 on the terminal board.
Option board (AI-14B) (−10 to 10 V)	Between TC1 and TC4	b1-01 = 3 F2-01 = 0	If H3-09 is set to 0, the sum of the input between TC2 and TC4 will be added the input between TC1 and TC4 to determine the speed limit.

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.

■Torque Limit Operation Examples

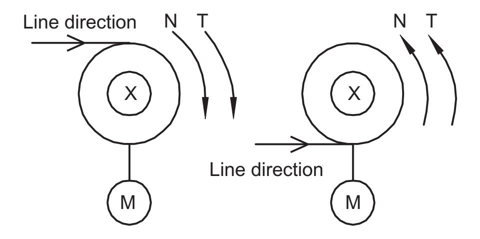
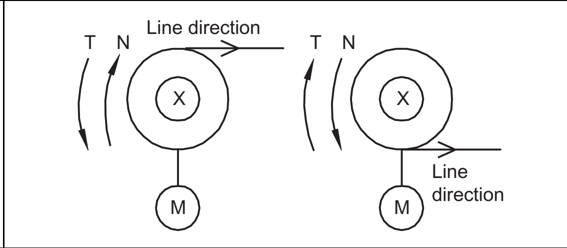
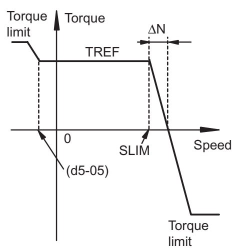
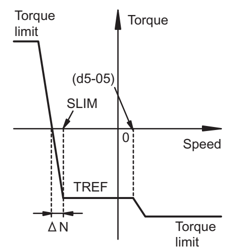
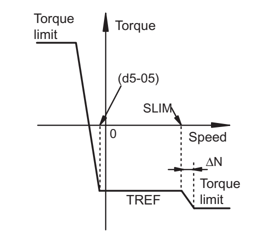
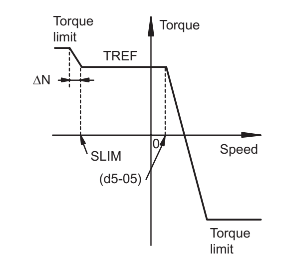
Operation examples will be described separately for winding operation, in which the speed and motor torque are in the same directions, and rewinding operation, in which the speed and motor torque are in opposite directions.

Winding Operation

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

Rewinding Operation

In a rewinding 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 the rewinding operation, the speed limit is positive and the torque reference input is negative. If the motor turns faster than the speed limit, a negative compensation value is output from the speed limiter circuit. If the motor is rotating in reverse, a negative 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 is used to maintain the motor speed between 0 and the speed limit. When the sum of the torque reference and the torque compensation output by the speed limiter is the same as the actual load, the motor will stop accelerating and run at a constant speed.

	Winding Operation		Rewinding Operation	
Configuration				
Normal Rotation Direction	Forward	Reverse	Forward	Reverse
Torque Reference Polarity (TREF)	+	−	−	+
Speed Limit Polarity (SLIM)	+	−	+	−
Generated Torque	 $\Delta N(\%) = \frac{TREF(\%)}{C5\text{-}01}$	 $\Delta N(\%) = \frac{TREF(\%)}{C5\text{-}01}$	 The lower value of $\Delta N(\%) = \frac{TREF(\%)}{C5\text{-}01}$ or d5-05(%)	 The lower value of $\Delta N(\%) = \frac{TREF(\%)}{C5\text{-}01}$ or d5-05(%)

■Torque Reference Adjustment

Consider the following information when adjusting the torque.

Torque Reference Delay Time: 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 A2 or A3 to torque compensation (setting 14). When the amount of torque loss for mechanical loss or other factor 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 (current): 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 to 10 V or 4 to 20 mA signal level has been selected. If you want to input reverse torque compensation, be sure to select the –10 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 inputs (H1-01 to H1-06) 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 switch speed/torque control.

■Setting the Speed/Torque Control Switching Timer

The delay between a change in the speed/control switching function input (ON to OFF or OFF to ON) and the corresponding change in the control method can be set in d5-06. During the timer delay, the value of 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 frequency reference (during speed control) is set in b1-01. The speed limit during torque control is set in d5-03.
- If the torque reference has been assigned to a multi-function analog input, terminal A2, or terminal A3, the input function changes when the control method is switched between torque control and speed control.
  During speed control: The analog input terminal is used as the torque limit input.
  During torque control: The 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 decelerate to a stop when the Run Command turns OFF.
- When A1-02 (control method selection) is set to 3 (flux vector control), the speed/torque change command (a setting of 71) can be set for a multi-function input (H1-01 to H1-06) to switch between speed and torque control during operation. An example is shown below.

Terminal No.	User Constant No.	Factory Setting	Setting	Function
S8	H1-06	8	71	Speed/torque control change
A1	b1-01	1	1	Frequency reference selection (terminals A1, A2)
	d5-03	1	1	Speed limit (terminals A1, A2)
A3	H3-05	0	13	Torque reference/torque limit

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

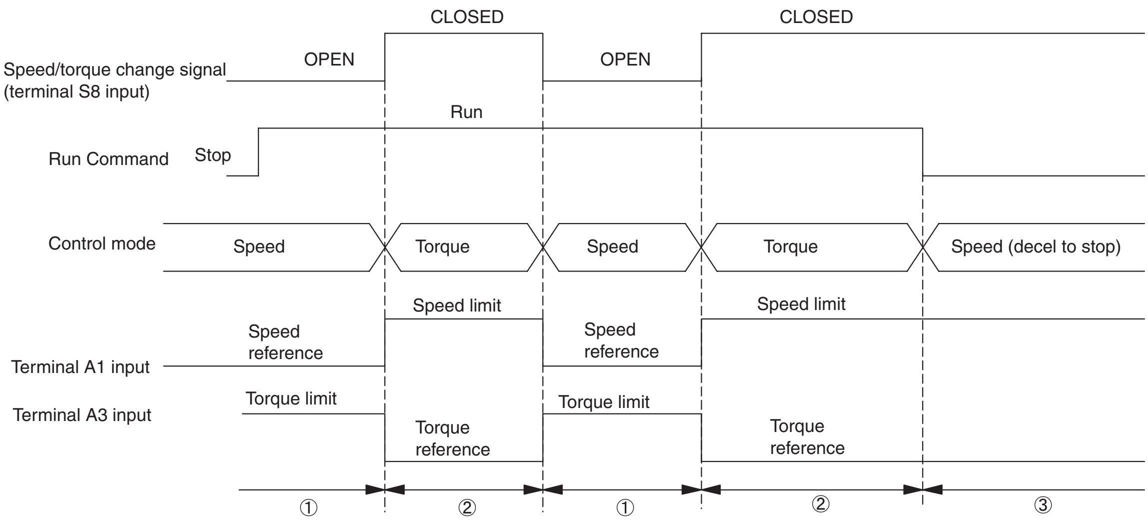


Fig 6.68 Speed/Torque Control Switching Time Chart.

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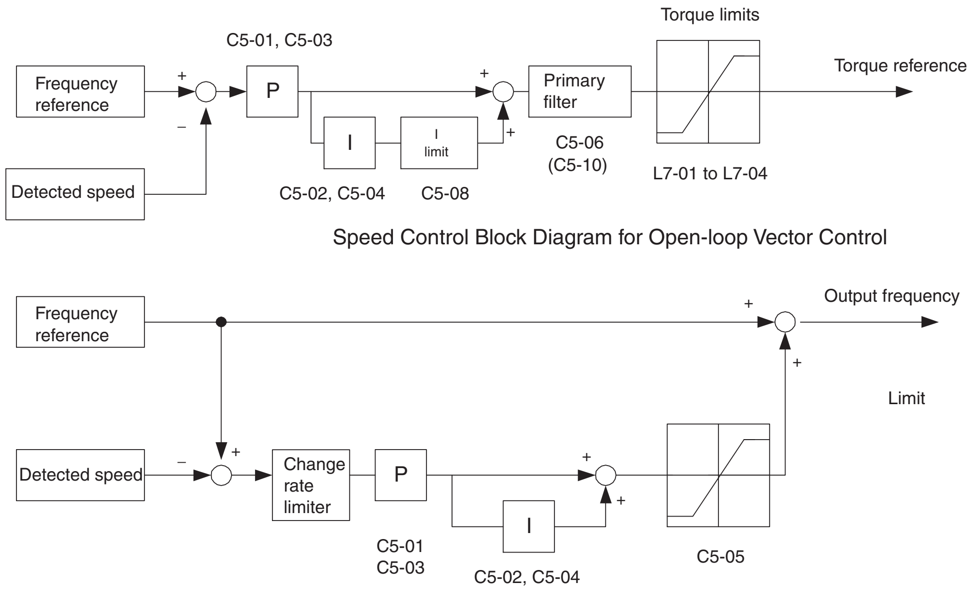
◆ Speed Control (ASR) Structure

Speed control (ASR) during flux vector control adjusts the torque reference so that the deviation between the speed reference and the estimated speed (PG feedback) is 0.

Speed control (ASR) during V/f control with a PG adjusts the output frequency so that the deviation between the speed reference and the estimated speed (PG feedback) is 0.

The following block diagram shows the structure of the speed control for open-loop vector or V/f control with a PG.



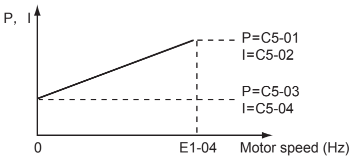
Speed Control Block Diagram for Open-loop Vector Control

Speed Control Block Diagram for V/f Control with a PG

Fig 6.69 Speed Control Block Diagrams

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMO BUS Register
C5-01	ASR proportional (P) gain 1	Sets the proportional gain of the speed loop (ASR.)	1.00 to 300.00 *1	20.00 *2	Yes	No	A	No	A	21BH
C5-02	ASR integral (I) time 1	Sets the integral time of the speed loop (ASR) in 1-second units.	0.000 to 10.000	0.500 s *2	Yes	No	A	No	A	21CH

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
C5-03	ASR proportional (P) gain 2	Usually setting is not necessary. Set to change the rotational speed gain.	1.00 to 300.00 *1	20.00 *2	Yes	No	A	No	A	21DH
C5-04	ASR integral (I) time 2		0.000 to 10.000	0.500 s *2	Yes	No	A	No	A	21EH
C5-05	ASR limit	Sets the upper limit for the compensation frequency for the speed control loop (ASR) to a percentage of the maximum output frequency.	0.0 to 20.0	5.0%	No	No	A	No	No	21FH
C5-06	ASR primary delay time	Sets the filter time constant for outputting torque references from the speed control loop (ASR). It is set in 1-second units. Usually setting is not necessary.	0.000 to 0.500	0.004 s	No	No	No	No	A	220H
C5-07	ASR switching frequency	Sets the frequency for switching between Proportion Gain 1, 2 and Integral Time 1, 2 in Hz units. The multi-function input “ASR switching proportional gain” has the priority.	0.0 to 300.0 *3	0.0 Hz	No	No	No	No	A	221H
C5-08	ASR integral (I) limit	Sets the upper limit for the integral (I) amount for the speed control loop (ASR) to a percentage of the rated load.	0 to 400	400%	No	No	No	No	A	222H

* 1. When using V/f with PG control, 0.00 to 300.00. The flux vector setting ranges are given.

* 2. When the control method changes, the factory setting is changed. The flux vector control factory settings are given. Refer to *Factory Settings that Change with the Control Method (A1-02)*.

* 3. When C6-01=1, the upper limit is 400.0.

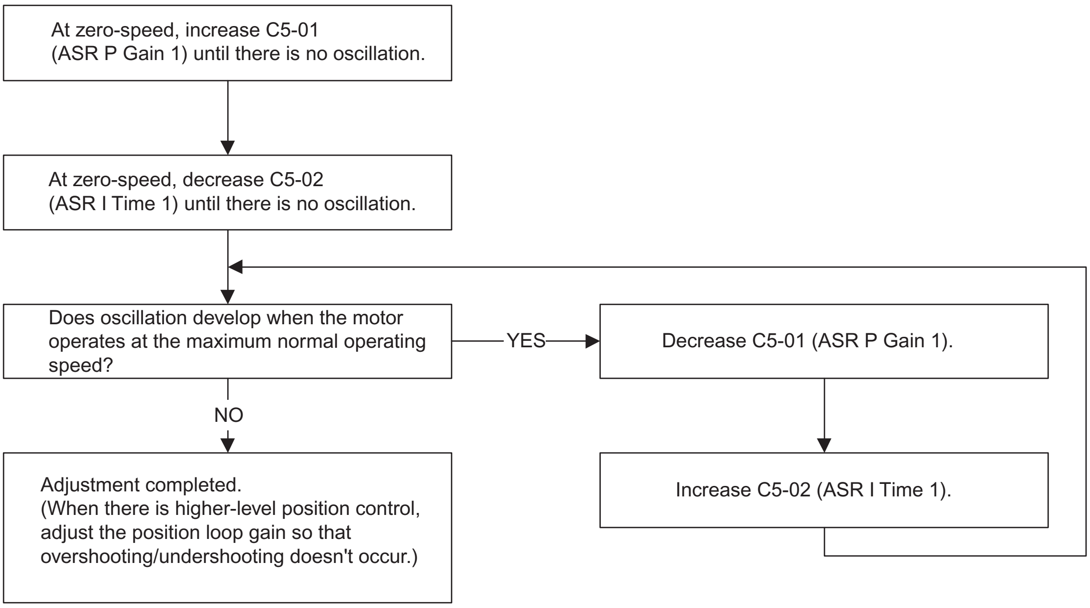
6

Multi-function Contact Input Functions (H1-01 to H1-06)

Setting Value	Function	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector
D	Speed control disable setting for V/f control with PG OFF: Use speed control V/f control with PG ON: Do not use speed control for V/f control with PG	No	Yes	No	No
E	Speed control integral reset Enables switching between PI and P control for the speed control loop.	No	No	No	Yes
77	Speed control (ASR) proportional gain switch (switching between C5-01 and C5-03) OFF: Use proportional gain in C5-01 ON: Use proportional gain in C5-03	No	No	No	Yes

■Speed Control (ASR) Gain Adjustment for Flux Vector Control (SPEC: E or Later Only)

Use the following procedure to adjust C5-01 and C5-03 with the mechanical system and actual load connected.



Fine Adjustments

When you want even finer gain adjustment, adjust the gain while observing the speed waveform. Constant settings like those shown in the following table will be necessary to monitor the speed waveform.

Constant No.	Name	Setting	Explanation
H4-01	Multi-function analog output 1 terminal FM monitor selection	2	Settings that allow multi-function analog output 1 to be used to monitor the output frequency.
H4-02	Multi-function analog output 1 terminal FM output gain	1.00	
H4-03	Multi-function analog output 1 terminal FM bias	0.0	
H4-04	Multi-function analog output 2 terminal AM monitor selection	5	Settings that allow multi-function analog output 2 to be used to monitor the motor speed.
H4-05	Multi-function analog output 2 terminal AM output gain	1.00	
H4-06	Multi-function analog output 2 terminal AM bias selection	0.00	
H4-07	Multi-function analog output 1 terminal signal level selection	1	Settings that allow a −10 to 10 V signal range to be monitored.
H4-08	Multi-function analog output 2 terminal signal level selection	1	

The multi-function analog outputs have the following functions with these constant settings.

- Multi-function analog output 1 (terminal FM): Outputs Inverter's output frequency (−10 to 10 V).
- Multi-function analog output 2 (terminal AM): Outputs actual motor speed (−10 to 10 V).

Terminal AC is the multi-function analog output common.
We recommend monitoring both the output frequency and the motor speed to monitor the response delay or deviations from the reference value, as shown in the following diagram.

Adjusting ASR Proportional Gain 1 (C5-01)

This gain setting adjusts the responsiveness of the speed control (ASR). The responsiveness is increased when this setting is increased. Usually this setting is higher for larger loads. Oscillation will occur if this setting is increased too much.

The following diagram shows the type of changes that can occur in the response when the ASR proportional gain is changed.

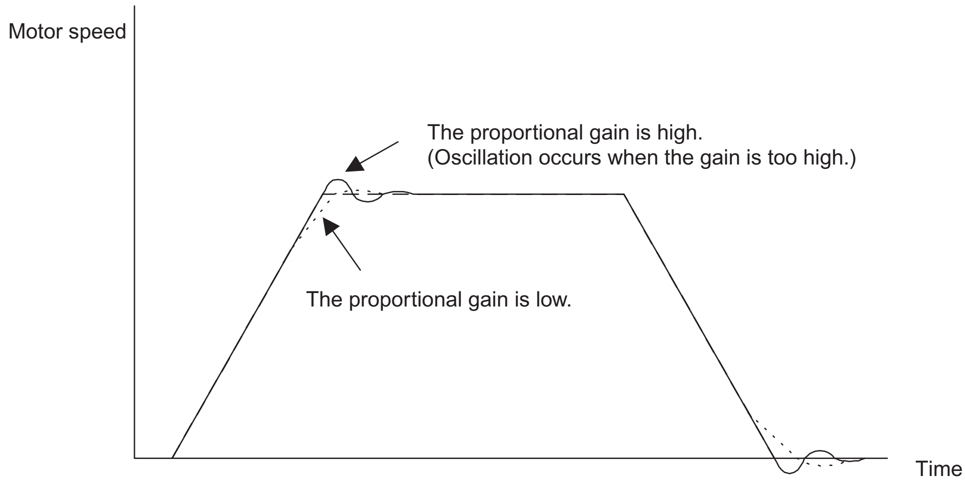


Fig 6.70 Responsiveness for Proportional Gain

Adjusting ASR Integral Time 1 (C5-02)

This constant sets the speed control (ASR) integral time.

Lengthening the integral time lowers the responsiveness, and weakens the resistance to external influences. Oscillation will occur if this setting is too short. The following diagram shows the type of changes that can occur in the response when the ASR integral time is changed.

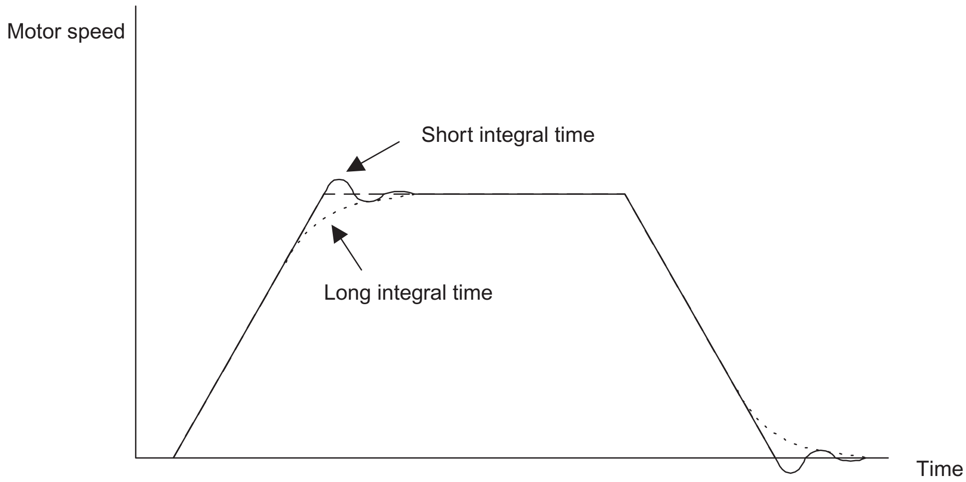


Fig 6.71 Responsiveness for Integral Time

Different Gain Settings for Low-speed and High-speed

Switch between low-speed and high-speed gain when oscillation occurs because of resonance with the mechanical system at low speed or high speed. The proportional gain P and integral time I can be switched according to the motor speed, as shown below.

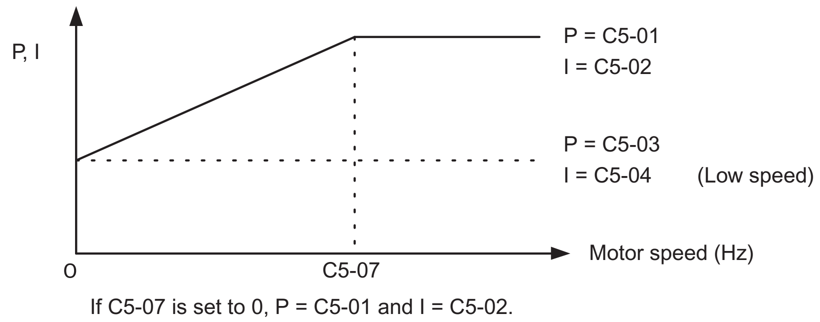


Fig 6.72 Low-speed and High-speed Gain Settings

Setting the Gain Switching Frequency (C5-07)

Set the switching frequency to about 80% of the motor operating frequency or the frequency at which oscillation occurs.

Low-speed Gain Adjustments (C5-03, C5-04)

Connect the actual load and adjust these constants at zero-speed. Increase C5-03 (ASR proportional gain 2) until there is no oscillation. Decrease C5-04 (ASR integral time 2) until there is no oscillation.

High-speed Gain Adjustments (C5-01, C5-02)

Adjust these constants at normal operating speed. Increase C5-01 (ASR proportional gain 1) until there is no oscillation. Decrease C5-02 (ASR integral time 1) until there is no oscillation. Refer to *Fine Adjustments* on page 6-138 for details on making fine adjustments of high-speed operation.

ASR Proportional Gain Switch Setting

When one of the multi-function inputs (H1-01 to H1-06) is set to 77, the input can be used to switch between C5-01 (proportional gain 1) and C5-03 (proportional gain 2). Proportional gain 2 is used when the multi-function input is ON. This input has higher priority than the ASR switching frequency set in C5-07.

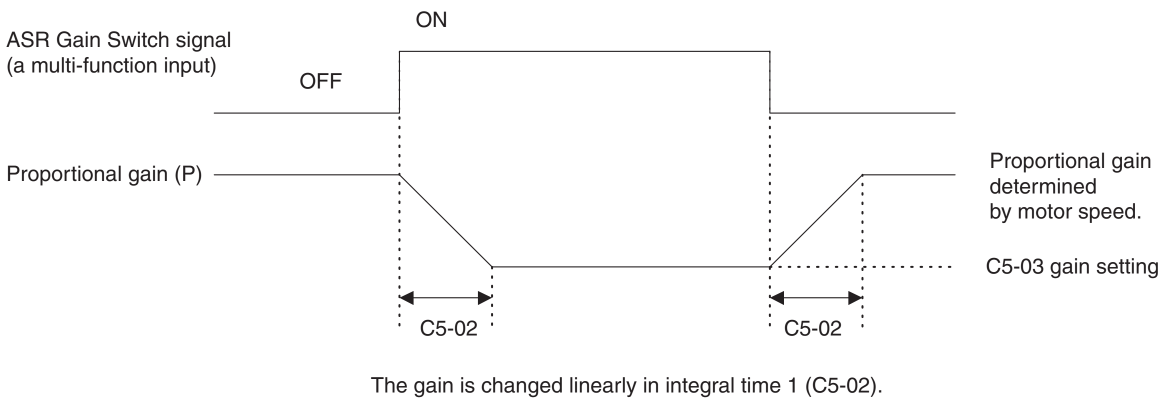


Fig 6.73 ASR Proportional Gain Switch

■Gain Adjustment for Speed Control during V/f Control with PG

When using V/f control with PG, set the proportional gain (P) and the integral time (I) at E1-09 (minimum output frequency) and E1-04 (maximum output frequency). *Speed Control Gain Integral Time Adjustment for V/f Control with PG* shows how the proportional gain and integral time change in linear fashion based on the speed.

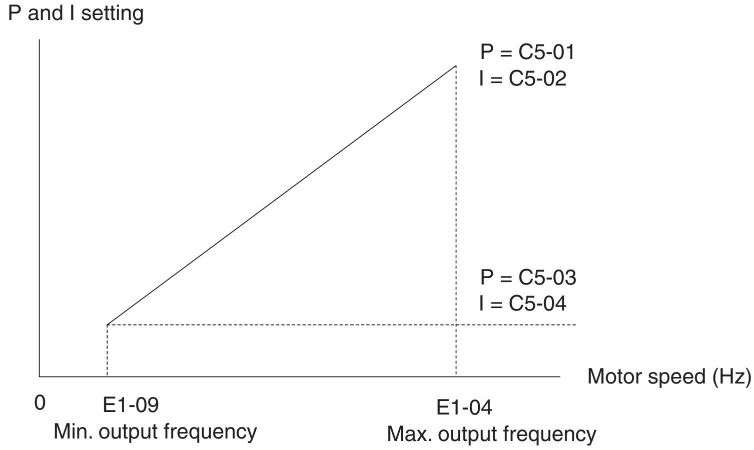


Fig 6.74 Speed Control Gain Integral Time Adjustment for V/f Control with PG

Gain Adjustments at Minimum Output Frequency

Operate the motor at the minimum output frequency. Increase C5-03 (ASR proportional gain 2) to a level where there is no oscillation. Decrease C5-04 (ASR integral time 2) to a level where there is no oscillation.
Monitor the Inverter's output current and verify that it is less than 50% of the Inverter rated current. If the output current exceeds 50% of the Inverter's rated current, decrease C5-03 and increase C5-04.

Gain Adjustments at Maximum Output Frequency

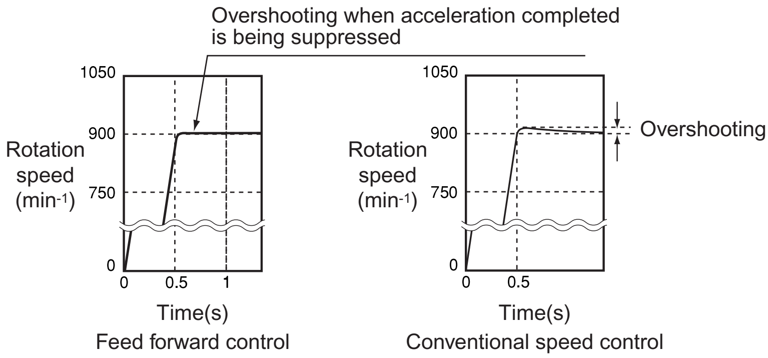
Operate the motor at the maximum output frequency. Increase C5-01 (ASR proportional gain 1) to a level where there is no oscillation. Decrease C5-02 (ASR integral time 1) to a level where there is no oscillation.

Fine Adjustments

When you want even finer gain adjustment, adjust the gain while observing the speed waveform. The adjustment method is the same as that for vector control.
Enable integral operation during acceleration and deceleration (by setting F1-07 to 1) when you want the motor speed to closely follow the frequency reference during acceleration and deceleration. Reduce the setting of C5-01 if overshooting occurs during acceleration, and reduce the setting of C5-03 and increase the setting of C5-04 if undershooting occurs when stopping. If overshooting and undershooting cannot be eliminated by adjusting only the gain, reduce the value of C5-05 speed control and reduce the limit of the frequency reference compensation value.

◆ Increasing the Speed Reference Response (Feed Forward Control) (SPEC: E or Later Only)

Use feed forward control to increase the responsiveness to speed references. This function is effective for machines for which the ASR gain cannot be increased to a large value because doing so would result in vibrations. There is also the additional effect of making the system less prone to overshoot.
This function is valid only in flux vector control.



Overshooting control effect

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
N5-01	Feed forward control selection	Select the feed forward control. 0: Disabled 1: Enabled	0 or 1	0	No	No	No	No	A	5B0H
N5-02	Motor acceleration time	Set the time required to accelerate the motor at the rated torque (T_{100}) to the rated speed (Nr). J: $GD^2/4$, P: Motor rated output $ta = \frac{2\pi \cdot J\,[kgm^2] \cdot Nr\,[min^{-1}]}{60 \cdot T_{100}\,[N \cdot m]}$ [s] However, $T_{100} = \frac{60}{2\pi} \cdot \frac{P\,[kW]}{Nr\,[min^{-1}]} \times 10^3$ [N · m]	0.001 to 10.000	0.178 s*	No	No	No	No	A	5B1H
N5-03	Feed forward proportional gain	Set the proportional gain for feed forward control. Speed reference response will increase as the setting of N5-03 is increased.	0.00 to 100.00	1.0	No	No	No	No	A	5B2H
N5-04	Response frequency for speed command	Sets the response frequency to a speed command in units of 0.01 Hz. Used when the machine rigidity is high and the N5-03 is correctly adjusted. Usually, setting is not required.	0.00 to 50.00	40.00	No	No	No	No	A	5B3H

* The factory setting depends on the Inverter capacity. The value for a 200 V Class Inverter for 0.4 kW is given.

■Feed Forward Control Structure

- The following block diagram shows the speed controller (ASR) and the feed forward control structure.

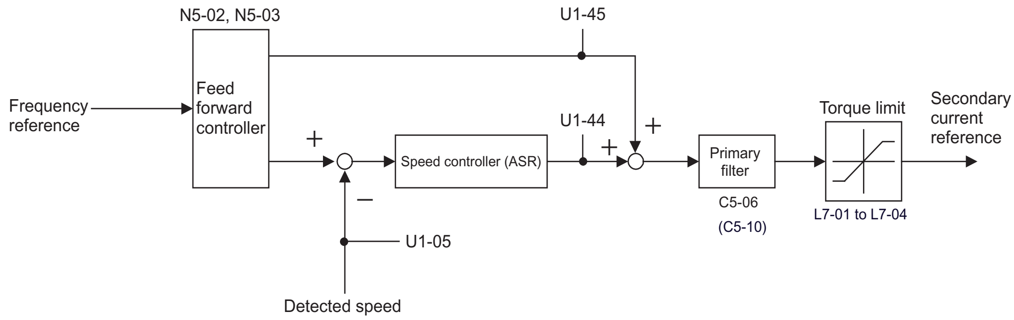


Fig 6.75 Structure of Speed Controller (ASR) and Feed Forward Control

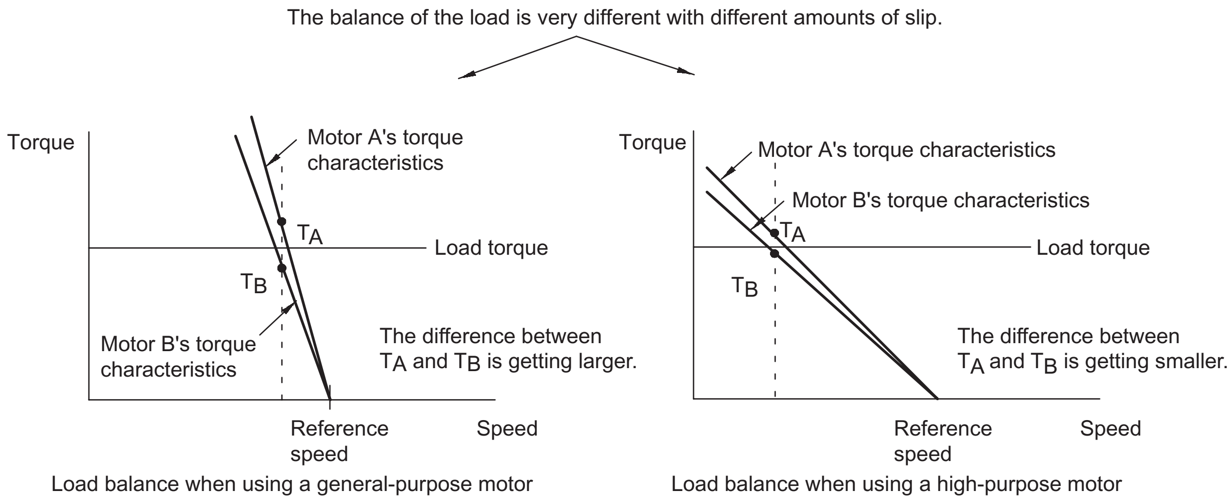
■Setting Precautions

- When N5-02 (Motor acceleration time) is not properly set, the acceleration time may not increase. The factory setting of N5-02 depends on the Inverter capacity. When the Inverter capacity is different from the motor capacity, calculate an appropriate acceleration time using the equation given in N5-02 of *Chapter 5 User Constants* or set the time that corresponds to the motor capacity referring to *Factory Settings that Change with the Control Method (A1-02)* (Page 5-81)
- When setting the feed forward proportional gain (N5-03), take the inertia of the motor to be equivalent to 1. If the speed reference response is slow, increase the feed forward proportional gain (N5-03). If overshoot occurs with the actual speed, or if a negative torque reference is output when acceleration is completed, reduce the feed forward proportional gain (N5-03).
- When using the droop control function (i.e., if b7-01 is not set to 0.0), disable feed forward control (i.e., set N5-01 to 0).

6

◆ Droop Control Function (SPEC: E or Later Only)

Droop control is a function that allows the user to set the amount of motor slip.
When a single load is operated with two motors (such as in a crane conveyor), a high-resistance motor is normally used. This is to use torque characteristics that exhibit proportion movements due to changes in the secondary resistor to maintain torque balance with the load and overall speed balance with the load.
If droop control is used, a high-resistance motor characteristics can be set for a general-purpose motor.



■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b7-01	Droop control gain	Sets the slip as a percentage of maximum frequency when the maximum output frequency is specified and the rated torque occurs. Droop-control is not performed when the setting is 0.0.	0.0 to 100.0	0.0	Yes	No	No	No	A	1CAH
b7-02	Droop control delay time	Droop control responsiveness constant When hunting or oscillation occurs, increase the value.	0.03 to 2.00	0.05 s	Yes	No	No	No	A	1CBH

■Setting Precautions

- Droop control is disabled if b7-01 is set to 0.0.
- Set b7-01 to the amount of slip as the percentage of slip when the maximum output frequency is input and the rated torque is generated.
- Constant b7-02 is used to adjust the responsiveness of droop control. Increase this setting if oscillation or hunting occur.
- Disable the feed forward control (N5-01 = 0) when using the droop control function.

■Setting the Droop Control Gain

Set the droop control gain as the speed reduction at a 100% motor torque, as a percentage of the maximum output frequency.

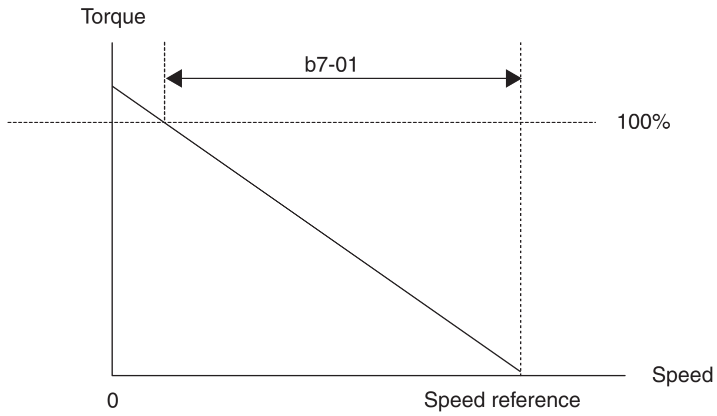


Fig 6.76 Droop Control Gain

◆ Zero-servo Function (SPEC: E or Later Only)

The zero-servo function holds the motor when the motor is stopped in what is call a zero-servo status. This function can be used to stop the motor even with an external force acts on the motor or the analog reference input is offset.

The zero-servo function is enabled when one of the multi-function inputs (H1-01 to H1-06) is set to 72 (zero-servo command). If the zero-servo command is ON when the frequency (speed) reference falls below the zero-speed level, a zero-servo status is implemented.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
b2-01	Zero-speed level (DC injection braking starting frequency)	Used to set the frequency which starts DC injection braking in units of Hz when deceleration to stop is selected. When b2-01 is less than E1-09, E1-09 is used to set the starting frequency for the DC injection braking. In flux vector control, b2-01 is used to set the starting frequency for the zero-speed control.	0.0 to 10.0	0.5 Hz	No	A	A	A	A	189H
b9-01	Zero-servo gain	Adjust the strength of the zero-servo lock. Enabled when the “zero-servo command” is set for the multi-function input. When the zero-servo command has been input and the frequency reference drop below excitation level (b2-01), a position control loop is created and the motor stops. Increasing the zero-servo gain in turn increases the strength of the lock. Increasing it by too much will cause oscillation.	0 to 100	5	No	No	No	No	A	1DAH
b9-02	Zero-servo completion width	Sets the output width of the zero-servo completion signal. Enabled when the “zero-servo completion (end)” is set for a multi-function input. The zero-servo completion signal is ON when the current position is within the range (the zero-servo start position± zero-servo completion width.) Set the allowable position displacement from the zero-servo start position to 4 times the pulse rate of the PG (pulse generator, encoder) in use.	0 to 16383	10	No	No	No	No	A	1DBH

6

Multi-function Contact Input Functions (H1-01 to H1-06)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
72	Zero-servo command (ON: Zero-servo)	No	No	No	Yes

Multi-function Contact Output Functions (H2-01 to H2-03)

Setting Value	Function	Control Methods			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
33	Zero-servo end ON: Current position is within zero-servo start position ± the zero-servo end width.	No	No	No	Yes

To output the zero-servo status externally, assign the Zero-Servo End signal (setting 33) to one of the multi-function outputs (H2-01 to H2-03).

Monitor Function

Constant Number	Name	Description	Output Signal Level During Multi-Function Analog Output	Min. Unit	Control Methods				MEMOBUS Register
					V/f	V/f with PG	Open Loop Vector	Flux Vector	
U1-35	Zero-servo movement pulses	Shows the number of PG pulses times 4 for the movement range when stopped at zero.	(Cannot be output.)	1	No	No	No	A	62H

■Time Chart

A time chart for the zero-servo function is given in *Time Chart for Zero-Servo*.

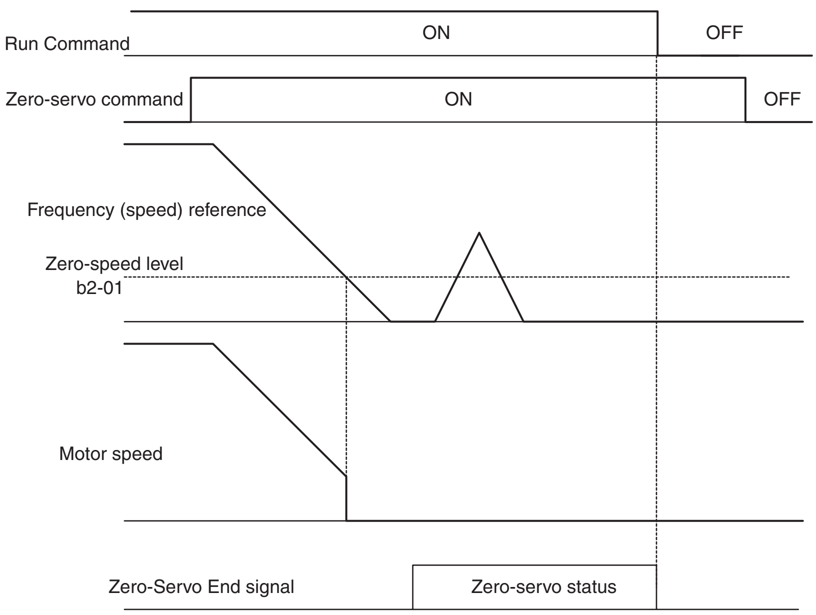


Fig 6.77 Time Chart for Zero-Servo

■Application Precautions

- Be sure to leave the Run Command input ON. If the Run Command is turned OFF, the output will be interrupted and the zero-servo function will become ineffective.
- The holding force of the zero-servo is adjusted in b9-01. The holding force will increase if the value of the setting is increased, but oscillation and hunting will occur if the setting is too large. Adjust b9-01 after adjusting the speed control gain.
- The zero-servo detection width is set as the allowable position offset from the zero-servo start position. Set 4 times the number of pulses from the PG.
- The Zero-Servo End signal will go OFF when the zero-servo command is turned OFF.

IMPORTANT

Do not lock the servo for extended periods of time at 100% when using the zero-servo function. Inverter errors may result. Extended periods of servo lock can be achieved by ensuring that the current during the servolock is 50% or less or by increasing the Inverter capacity.

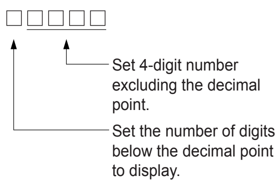
Digital Operator Functions

This section explains the Digital Operator functions.

◆ Setting Digital Operator Functions

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

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
o1-02	Monitor selection after power up	Sets the monitor item to be displayed when the power is turned on. 1: Frequency reference 2: Output frequency 3: Output current 4: The monitor item set for o1-01	1 to 4	1	Yes	A	A	A	A	501H
o1-03	Frequency units of reference setting and monitor	Sets the units that will be set and displayed for the frequency reference and frequency monitor. 0: 0.01 Hz units 1: 0.01% units (Maximum output frequency is 100%) 2 to 39: min^{-1} units (Sets the motor poles.) 40 to 39999: User desired display Set the desired values for setting and display for the max. output frequency.  Example: When the max. output frequency value is 200.0, set 12000	0 to 39999	0	No	A	A	A	A	502H
o1-04	Setting unit for frequency constants related to V/f characteristics	Set the setting unit for frequency reference-related constants. 0: Hz 1: min^{-1}	0 or 1	0	No	No	No	No	A	503H
o2-01	LOCAL/REMOTE key enable/disable	Sets the Digital Operator Local/Remote Key 0: Disabled 1: Enabled (Switches between the Digital Operator and the constant settings.)	0 or 1	1	No	A	A	A	A	505H

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
o2-02	STOP key during con-trol circuit terminal operation	Sets the Stop Key in the run mode. 0: Disabled (When the Run Command is issued from and external terminal, the Stop Key is disabled.) 1: Enabled (Effective even during run.)	0 or 1	1	No	A	A	A	A	506H
o2-03	User con-stant initial value	Clears or stores user initial val-ues. 0: Stores/not set 1: Begins storing (Records the set constants as user initial values.) 2: All clear (Clears all recorded user initial values) When the set constants are recorded as user initial values, 1110 will be set in A1-03.	0 to 2	0	No	A	A	A	A	507H
o2-05	Frequency reference set-ting method selection	When the frequency reference is set on the Digital Operator fre-quency reference monitor, sets whether the Enter Key is neces-sary. 0: Enter Key needed 1: Enter Key not needed When set to 1, the Inverter accepts the frequency reference without Enter Key operation.	0 or 1	0	No	A	A	A	A	509H
o2-07	Cumulative operation time setting	Sets the cumulative operation time in hour units. Operation time is calculated from the set values.	0 to 65535	0 hr	No	A	A	A	A	50BH
o2-10	Fan opera-tion time set-ting	Set the initial value of the fan operation time using time units. The operation time accumulates from the set value.	0 to 65535	0 hr	No	A	A	A	A	50EH

* The factory setting depends upon the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.

■Changing Frequency Reference and Display Units

Set the Digital Operator frequency reference and display units using constant o1-03. You can change the units for the following constants using o1-03.

- U1-01 (Frequency Reference)
- U1-02 (Output Frequency)
- U1-05 (Motor Speed)
- U1-20 (Output Frequency after Soft Start)
- d1-01 to d1-17 (Frequency references)

■Switching Monitors when the Power Supply Is ON

Using constant o1-02, select the monitor item (U1-☐☐ [status monitor]) to be displayed on the Digital Operator when the power supply is turned ON. For monitors that can be displayed, refer to U1-☐☐ in *Chapter 5 User Constants*.

6

Setting Precautions

If selecting monitor constants other than U1-01 (Frequency Reference), U1-02 (Output Frequency), and U1-03 (Output Current), first select the monitor items to be displayed in o1-01, and then set o1-02 to 4.

■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 an emergency Stop Command.

Set o2-02 to 0 to disable emergency Stop Commands from the STOP Key on the Digital Operator.

■Disabling the LOCAL/REMOTE Key

Set o2-01 to 0 to disable the LOCAL/REMOTE Key on the Digital Operator. You cannot switch Inverter reference inputs set using reference inputs from the Digital Operator, b1-01 (Reference Selection), or b1-02 (Operation Method Selection).

■Initializing Changed Constant Values

You can save to the Inverter constant set values that you have changed as constant initial values. Change the set values from the Inverter factory settings, and then set o2-03 to 1.

Set A1-03 (Initialize) to 1110 to initialize the Inverter constants using the user-set initial values in memory. To clear the user-set initial values in memory, set o2-03 to 2.

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

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

For example, enter the Run Command using a 0 Hz reference, and then continuously press the UP Key to increment the frequency reference by 0.01 Hz only for the first 0.5 s, and then by 0.01 Hz every 80 ms for 3 s thereafter. Press and hold down the UP Key for 3 s minimum to reach the maximum output frequency 10 s after that. The frequency reference that has been set will be stored in memory 5 s after the UP or DOWN Keys are released.

■Clearing Cumulative Operation Time

Set the cumulative operation time initial value in time units in constant o2-07. Set o2-07 to 0 to clear U1-13 (Inverter Operating Time).

■Clearing Inverter Cooling Fan Operation Time

Set the fan operation time initial value in time units in constant o2-10. Set o2-10 to 0 to clear U1-40 (Cooling Fan Operating Time).

◆ Copying Constants

The Digital Operator can perform the following three functions using the built-in EEPROM (non-volatile memory).

- Store Inverter constant set values in the Digital Operator (READ)
- Write constant set values stored in the Digital Operator to the Inverter (COPY)
- Compare constant set values stored in the Digital Operator with Inverter constants (VERIFY)

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
o3-01	Copy function selection	0: Normal operation 1: READ (Inverter to Operator) 2: COPY (Operator to Inverter) 3: Verify (compare)	0 to 3	0	No	A	A	A	A	515H
o3-02	Read permitted selection	0: Read prohibited 1: Read permitted	0 or 1	0	No	A	A	A	A	516H

■COPY Function Selection (SPEC: E or Later Only)

The available COPY functions (o3-01 “Copy function selection”) differ depending on the SPEC of Inverter as shown in the table below.

READ Source	Inverter with SPEC: C or earlier (PRG:101□)	Inverter with SPEC: C or earlier (PRG:101□)	Inverter with SPEC: E or earlier (PRG:103□)	Inverter with SPEC: E or earlier (PRG:103□)
COPY Destination	Inverter with SPEC: C or earlier (PRG:101□)	Inverter with SPEC: E or earlier (PRG:103□)	Inverter with SPEC: C or earlier (PRG:101□)	Inverter with SPEC: E or earlier (PRG:103□)
READ (Inverter → Operator)	Available	Available	Available	Available
READ (Inverter → Operator)	Available	Available*	N/A	Available
VERIFY	Available	N/A	N/A	Available

* The initial values of user constants that have been stored using the constant o2-03 cannot be copied.

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■Storing Inverter set values in the Digital Operator (READ)

To store Inverter set values in the Digital Operator, make the settings using the following method. Set 03-02 (Read permitted selection) to 1 (read permitted).

Table 6.1 READ Function Procedure

Step No.	Digital Operator Display	Explanation
1	A1-00 (DRIVE QUICK ADV VERIFY A.TUNE)	Press the Menu Key, and select advanced programming mode.
2	A1-00 (DRIVE QUICK ADV VERIFY A.TUNE)	Press the DATA/ENTER Key, and select the constants monitor display.
3	o3-01 (DRIVE QUICK ADV VERIFY A.TUNE)	Display o3-01 (Copy Function Selection) using the Increment Key and Decrement Key.
4	00 (DRIVE QUICK ADV VERIFY A.TUNE)	Press the DATA/ENTER Key, and select the constants setting display.
5	01 (DRIVE QUICK ADV VERIFY A.TUNE)	Change the set value to 1 using the Increment Key.
6	rEd (DRIVE QUICK ADV VERIFY A.TUNE)	Set the changed data using the DATA/ENTER Key. The READ function will start.
7	End → o3-01	If the READ function ends normally, End is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01.

An error may occur while saving to memory. If an error is displayed, press any key to cancel the error display and return to the o3-01 display. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using Digital Operator Copy Function.)*

Error Display	Meaning
PrE	You are attempting to set o3-01 to 1 while o3-02 is set to 0.
iFE	Read data length mismatch or read data error.
rdE	Tried to write constants to EEPROM on the Digital Operator, but unable to perform write operation.

Select READ Permitted

Prevent overwriting the data stored in EEPROM in the Digital Operator by mistake. With o3-02 set to 0, if you set o3-01 to 1, and perform the write operation, PrE will be displayed on the Digital Operator, and the write operation will be stopped.

■Writing Constant Set Values Stored in the Digital Operator to the Inverter (COPY)

To write constant set values stored in the Digital Operator to the Inverter, make the settings using the following method.

Table 6.2 COPY Function Procedure

Step No.	Digital Operator Display	Explanation
1	A1-00	Press the MENU Key, and select advanced programming mode.
2	A1-00	Press the DATA/ENTER Key, and select the constants monitor display.
3	o3-01	Display o3-01 (Copy Function Selection) using the Increment Key and Decrement Key.
4	00	Press the DATA/ENTER Key, and select the constants setting display.
5	02	Change the set value to 2 using the Increment Key.
6	CPy	Set the changed data using the DATA/ENTER Key. The COPY function will start.
7	End → o3-01	If the COPY function ends normally, End is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01.

During the copy operation, errors may occur. If an error is displayed, set the constants again. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using Digital Operator Copy Function.)*

Error Display	Meaning
CPE	Inverter product code and Inverter software number are different.
uAE	Inverter capacity with which you are trying to copy, and the Inverter capacity stored in the Digital Operator are different.
CrE	The Inverter control method in which you are trying to copy, and the Inverter control method stored in the Digital Operator are different.
CyE	Comparison between the constant written to the Inverter and the constant in the Digital Operator shows they are different.
CSE	After copying has ended, comparison between the sum value of the Inverter constant area and the sum value of the Digital Operator constant area shows they are different.

■Comparing Inverter Constants and Digital Operator Constant Set Values (VERIFY)

To compare Inverter constants and Digital Operator constant set values, make the settings using the following method.

Table 6.3 VERIFY Function Procedure

Step No.	Digital Operator Display	Explanation
1	A1-00 DRIVE QUICK ADV VERIFY A.TUNE	Press the MENU Key. and select advanced programming mode.
2	A1-00 DRIVE QUICK ADV VERIFY A.TUNE	Press the DATA/ENTER Key, and select the constants monitor display.
3	o3-01 DRIVE QUICK ADV VERIFY A.TUNE	Display o3-01 (Copy Function Selection) using the Increment Key and Decrement Key.
4	00 DRIVE QUICK ADV VERIFY A.TUNE	Press the DATA/ENTER Key, and select the function setting display.
5	03 DRIVE QUICK ADV VERIFY A.TUNE	Change the set value to 3 using the Increment Key.
6	vFY DRIVE QUICK ADV VERIFY A.TUNE	Set the changed data using the DATA/ENTER Key. The VERIFY function will start.
7	End → o3-01	If the VERIFY function ends normally, End is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01.

An error may occur during the comparison. If an error is displayed, press any key to cancel the error display and return to the o3-01 display. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using Digital Operator Copy Function.)*

Error Display	Meaning
vYE	Verify error (Settings in the Digital Operator and the Inverter do not match).
CPE	Inverter product code and Inverter software number are different.

■Application Precautions

- When using the copy function, check that the following settings are the same between the Inverter and the Digital Operator.
  - Inverter product and type
  - Inverter capacity and voltage
  - Software number
  - Control method
- Use the copy function off-line or with a communications option board removed.
- A CPF03 fault (EEPROM error) can occur if the power is shut down while the Inverter constants are being copied. Do not shut down the power while copying the constants.

◆ Prohibiting Writing Constants from the Digital Operator

If you set A1-01 to 0, you can refer to and set the A1 and A2 constant groups, and refer to drive mode, using the Digital Operator.

If you set one of the constants H1-01 to H1-06 (multi-function contact input terminal S3 to S8 function selection) to 1B (write constants permitted), you can write constants from the digital operator when the terminal that has been set is ON. When the set terminal is OFF, writing constants other than the frequency reference is prohibited. You can, however, reference constants.

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
A1-01	Constant access level	Used to set the constant access level (set/read.) 0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.) 1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.) 2: Advanced (Constants can be read and set in both quick programming mode and advanced programming (A) mode.)	0 to 2	2	Yes	A	A	A	A	101H

◆ Setting a Password

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When a password is set in A1-05, if the set values in A1-04 and A1-05 do not match, you cannot refer to or change the settings of constants A1-01 to A1-03, or A2-01 to A2-32.

You can prohibit the setting and referencing of all constants except A1-00 by using the password function in combination with setting A1-01 to 0 (Monitor only).

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
A1-01	Constant access level	Used to set the constant access level (set/read.) 0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.) 1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.) 2: Advanced (Constants can be read and set in both quick programming mode and advanced programming (A) mode.)	0 to 2	2	Yes	A	A	A	A	101H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
A1-04	Password	Password input when a password has been set in A1-05. This function write-protects some constants of the initialize mode. If the password is changed, A1-01 to A1-03 and A2-01 to A2-32 constants can no longer be changed. (Programming mode constants can be changed.)	0 to 9999	0	No	A	A	A	A	104H
A1-05	Password setting	Used to set 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 the password will be displayed.	0 to 9999	0	No	A	A	A	A	105H

■Setting Precautions

Constant A1-05 cannot be displayed using normal key operations. To display A1-05, hold down the RESET Key and press the MENU Key while A1-04 is displayed.

◆ Displaying User-set Constants Only

You can set and refer to constants necessary to the Inverter only, using the A2 constants (user-set constants) and A1-01 (Constants Access Level).

Set the number of the constant to which you want to refer in A2-01 to A2-32, and then set A1-01 to 1. You can set and refer to constants set in A1-01 to A1-03 and A2-01 to A2-32 only, using advanced programming mode.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
A2-01 to A2-32	User setting constants	Used to set the constant numbers that can be set/read. Maximum 32. Effective when the Constant Access Level (A1-01) is set to User Program (1). Constants set in constants A2-01 to A2-32 can be set/read in programming mode.	b1-01 to o3-02	-	No	A	A	A	A	106H to 125H

Options

This section explains the Inverter option functions.

◆ Performing Speed Control with PG

This section explains functions with V/f control with PG and flux vector control.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
F1-01	PG constant	Sets the number of PG (pulse generator or encoder) pulses. Sets the number of pulses per motor revolution.	0 to 60000	600	No	No	Q	No	Q	380H
F1-02	Operation selection at PG open circuit (PGO)	Sets the PG disconnection stopping method. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (To protect the motor or machinery, do not normally make this setting.)	0 to 3	1	No	No	A	No	A	381H
F1-03	Operation selection at overspeed (OS)	Sets the stopping method when an overspeed (OS) fault occurs. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (To protect the motor or machinery, do not normally make this setting.)	0 to 3	1	No	No	A	No	A	382H
F1-04	Operation selection at deviation	Sets the stopping method when a speed deviation (DEV) fault occurs. 0: Ramp to stop (Deceleration stop using Deceleration Time 1, C1-02.) 1: Coast to stop 2: Fast stop (Emergency stop using the deceleration time in C1-09.) 3: Continue operation (DEV is displayed and operation continued.)	0 to 3	3	No	No	A	No	A	383H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	Control Methods: V/f with PG	Control Methods: Open Loop Vector	Control Methods: Flux Vector	MEMOBUS Register
F1-05	PG rotation	0: Phase A leads with Forward Run Command. (Phase B leads with Reverse Run Command.) 1: Phase B leads with Forward Run Command. (Phase A leads with Reverse Run Command.)	0 or 1	0	No	No	A	No	A	384H
F1-06	PG division rate (PG pulse monitor)	Sets the division ratio for the PG speed control board pulse output. Division ratio = (1+ n) /m (n=0 or 1 m=1 to 32) F1-06 = □ □□ (n: first digit, m: last two digits) This constant is only effective when a PG-B2 is used. The possible division ratio settings are: 1/32 ≤ F1-06 ≤ 1.	1 to 132	1	No	No	A	No	A	385H
F1-07	Integral value during accel/decel enable/disable	Sets integral control during acceleration/deceleration to either enabled or disabled. 0: Disabled (The integral function isn't used while accelerating or decelerating; it is used at constant speeds.) 1: Enabled (The integral function is used at all times.)	0 or 1	0	No	No	A	No	No	386H
F1-08	Overspeed detection level	Sets the overspeed detection method. Frequencies above that set for F1-08 (set as a percentage of the maximum output frequency) that continue to exceed this frequency for the time set in F1-09 are detected as overspeed faults.	0 to 120	115%	No	No	A	No	A	387H
F1-09	Overspeed detection delay time		0.0 to 2.0	0.0 s *	No	No	A	No	A	388H
F1-10	Excessive speed deviation detection level	Sets the speed deviation detection method. Any speed deviation above the F1-10 set level (set as a percentage of the maximum output frequency) that continues for the time set in F1-11 is detected as a speed deviation. Speed deviation is the difference between actual motor speed and the reference command speed.	0 to 50	10%	No	No	A	No	A	389H
F1-11	Excessive speed deviation detection delay time		0.0 to 10.0	0.5 s	No	No	A	No	A	38AH
F1-12	Number of PG gear teeth 1	Sets the number of teeth on the gears if there are gears between the PG and the motor. $\frac{\text{Input pulses from PG}\times 60}{\text{F1-01}} \times \frac{\text{F1-13}}{\text{F1-12}}$ A gear ratio of 1 will be used if either of these constants is set to 0.	0 to 1000	0	No	No	A	No	No	38BH
F1-13	Number of PG gear teeth 2			0	No	No	A	No	No	38CH
F1-14	PG open-circuit detection time	Used to set the PG disconnection detection time. PGO will be detected if the detection time continues beyond the set time.	0.0 to 10.0	2.0 s	No	No	A	No	A	38DH

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

■Using PG Speed Control Board

There are four types of PG Speed Control Board that can be used in V/f control with PG.

- PG-A2: A-phase (single) pulse input, compatible with open collector or complimentary outputs.
- PG-B2: A/B-phase pulse input, compatible with complimentary outputs.
- PG-D2: A-phase (single) pulse input, compatible with line drivers.
- PG-X2: A/B/Z-phase pulse input, compatible with line drivers.

There are two types of PG Speed Control Boards that can be used for flux vector control.

- PG-B2: A/B phase pulse inputs, complementary outputs
- PG-X2: A/B/Z phase pulse inputs, line driver outputs

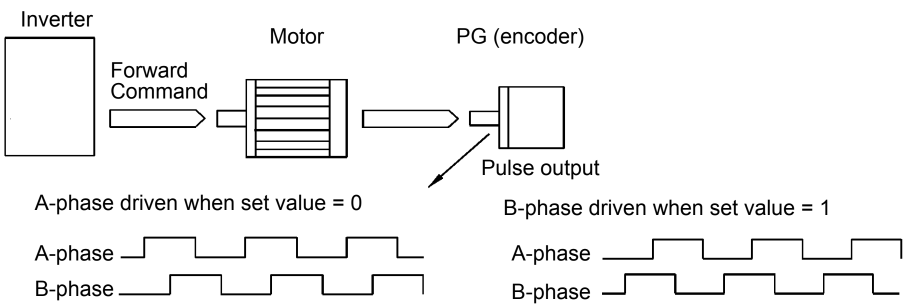
For the connection diagram, refer to page 2-36 to 2-38.

■Setting Number of PG Pulses

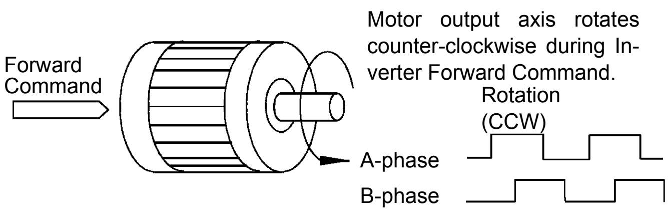
Set the number of PG (Pulse Generator/Encoder) pulses in pulses/rotation. Set the number of A-phase or B-phase pulses per 1 motor rotation in F1-01.

■Matching PG Rotation Direction and Motor Rotation Direction

Constant F1-05 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. Make this setting when using PG-B2 or PG-X2.



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



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

Fig 6.78 PG Rotation Direction Setting

Generally, PG is A-phase driven when rotation is clockwise (CW) see from the input axis. Also, motor rotation is counter-clockwise (CCW) seen from the output side when Forward Commands are output. Consequently, when motor rotation is forward, PG is normally A-phase driven when a load is applied, and B-phase driven when a load is not applied.

■Setting Number of Gear Teeth Between PG and Motor

Set the number of PG gear teeth in F1-12 and F1-13. If there are gears between the motor and PG, you can operate the motor by setting the number of gear teeth.

When the number of gear teeth has been set, the speed of motor rotations within the Inverter is calculated using the following formula.

Speed of motor rotations (min^{-1}.) = No. of input pulses from PG × 60 / F1-01 × F1-13 (No. of gear teeth on load side) / F1-12 (No. of gear teeth on motor side)

■Matching Motor Speed During Acceleration and Deceleration to Frequency Reference

You can select whether to enable or disable integral operation during acceleration and deceleration when using V/f with PG control.

To match the motor speed as closely as possible to the frequency reference even during acceleration and deceleration, set F1-07 to 1.

IMPORTANT

If F1-01 is set to 1, overshoot or undershoot may occur easily immediately after acceleration and deceleration. To minimize the possibility of overshoot or undershoot occurring, set F1-01 to 0.

■Setting PG Pulse Monitor Output Dividing Ratio

This function is enabled only when using PG speed control board PG-B2. Set the dividing ratio for the PG pulse monitor output. The set value is expressed as n for the higher place digit, and m for the lower place 2 digits. The dividing ratio is calculated as follows:

Dividing ratio = (1 + n)/m (Setting range) n: 0 or 1, m: 1 to 32

F1-06 = $\underbrace{\square}_{n}\ \underbrace{\square\square}_{m}$

The dividing ratio can be set within the following range: 1/32 ≤ F1-06 ≤ 1. For example, if the dividing ratio is 1/2 (set value 2), half of the number of pulses from the PG are monitor outputs.

■Detecting PG Open Circuit

Select the stopping method when PG cable disconnected is detected and the PG open circuit (PGO) detection time.

When the Inverter is operating with the frequency reference set to 1% minimum (except when operating on direct current), if the speed feedback from PG is greater than the time setting in F1-14, PGO is detected.

■Detecting Motor Overspeed

An error is detected when the number of motor rotations exceeds the regulated limit. An overspeed (OS) is detected when a frequency that exceeds the set value in F1-08 continues for longer than the time set in F1-09. After detecting an overspeed (OS), the Inverter stops according to the setting in F1-03.

■Detecting Speed Difference between the Motor and Speed Reference

An error is detected when the speed deviation (i.e., the difference between the designated speed and the actual motor speed) is too great. Speed deviation (DEV) is detected after a speed agreement is detected and when the speed reference and actual workpiece speed are within the setting of L4-02, if a speed deviation great than the set value in F1-10 continues for longer than the time set in F1-11. After a speed deviation is detected, the Inverter stops according to the setting in F1-04.

◆ Using Digital Output Boards

There are two types of Inverter digital output boards:

- DO-02C
  Relay contact output (DPDT contact)
- DO-08
  6 photocoupler output channels (shared commons)
  2 (independent) relay contact output channels (NC contact)

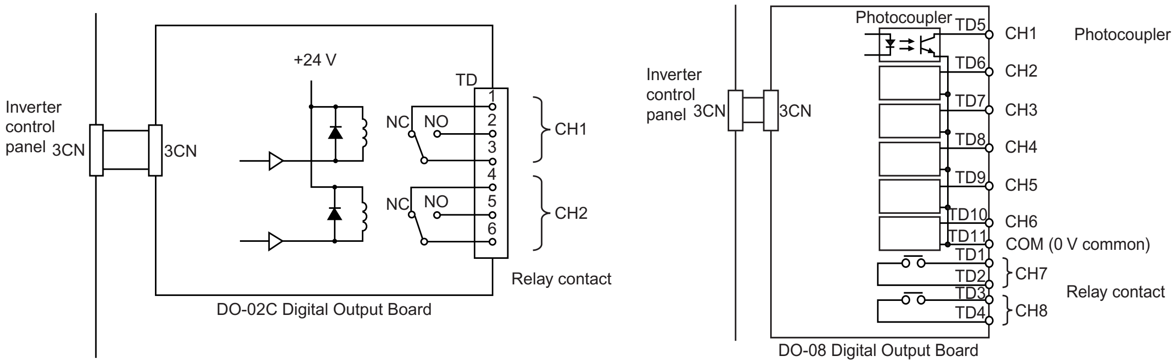


Fig 6.79 Digital Output Boards

■Related Constants

Con-stant Number	Name	Description	Setting Range	Factory Setting	Change during Opera-tion	Control Methods				MEMO BUS Regis-ter
						V/f	V/f with PG	Open Loop Vec-tor	Flux Vec-tor	
F5-01	Channel 1 output selec-tion	Effective when a Digital Output Board (DO-02C or DO-08) is used. Set the number of the multi-function output to be output.	0 to 37	0	No	A	A	A	A	399H
F5-02	Channel 2 output selec-tion	Effective when a Digital Output Board (DO-02C or DO-08) is used. Set the number of the multi-function output to be output.	0 to 37	1	No	A	A	A	A	39AH
F5-03	Channel 3 output selec-tion	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	2	No	A	A	A	A	39BH
F5-04	Channel 4 output selec-tion	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	4	No	A	A	A	A	39CH
F5-05	Channel 5 output selec-tion	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	6	No	A	A	A	A	39DH
F5-06	Channel 6 output selec-tion	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	37	No	A	A	A	A	39EH

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Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
F5-07	Channel 7 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	0F	No	A	A	A	A	39FH
F5-08	Channel 8 output selection	Effective when a DO-08 Digital Output Board is used. Set the number of the multi-function output to be output.	0 to 37	0F	No	A	A	A	A	3A0H
F5-09	DO-08 output mode selection	Effective when a DO-08 Digital Output Board is used. Set the output mode. 0: 8-channel individual outputs 1: Binary code output 2: Output according to F5-01 to F5-08 settings.	0 to 2	0	No	A	A	A	A	3A1H

■Setting Output Items for the DO-02C Digital Output Board

If using DO-02C Digital Output Board, set the output items using F5-01 and F5-02.

■Setting Output Items for the DO-08 Digital Output Board

If using DO-08 Digital Output Board, select one of the following three output modes according to the setting in F5-09.

F5-09 Set to 0

Set Value	Terminal Number	Output Details
0: 8 separate outputs	TD5-TD11	Overcurrent (SC, OC, GF)
	TD6-TD11	Overvoltage (OV)
	TD7-TD11	Inverter overload (OL2)
	TD8-TD11	Fuse blown (PUF)
	TD9-TD11	Overspeed (OS)
	TD10-TD11	Inverter overheated (OH1) or motor overload (OL1)
	TD1-TD2	Zero-speed detected
	TD3-TD4	Speed agreement

F5-09 Set to 1

Set Value	Terminal Number	Output Details	
1: Binary code output	TD5-TD11	bit 0	Encoded output (Refer to table below)
	TD6-TD11	bit 1	
	TD7-TD11	bit 2	
	TD8-TD11	bit 3	
	TD9-TD11	Zero-speed detected	
	TD10-TD11	Speed agreement	
	TD1-TD2	Operating	
	TD3-TD4	Minor fault	

The following table shows the code outputs.

Bits 3, 2, 1, and 0	Output Details	Bits 3, 2, 1, and 0	Output Details
0000	No error	1000	External fault (EFxx)
0001	Overcurrent (SC, OC, GF)	1001	Control board error (CPFxx)
0010	Overvoltage (OV)	1010	Motor overload (OL1)
0011	Inverter overload (OL2)	1011	Not used
0100	Inverter overheated (OH, OH1)	1100	Power loss (UV1, UV2, or UV3)
0101	Overspeed (OS)	1101	Speed deviation (DEV)
0110	Fuse blown (PUF)	1110	PG open circuit (PGO)
0111	Dynamic braking resistor (RH) Injection brake transistor error (RR)	1111	Not used

F5-09 Set to 2

Output depends on the settings in F5-01 to F5-08.

◆ Using an Analog Reference Board (SPEC: E or Later Only)

AI-14B provides 3 channels of bi-polar inputs with 13-bit A/D conversion accuracy (and a + sign bit). The function of each channel is determined by the setting of F2-01.

AI-14U provides 2 channels of bi-polar inputs with 14-bit A/D conversion accuracy. Channel 1 is a voltage input and channel 2 is a current input. The sum of channels 1 and 2 is a frequency input. F2-01 does not need to be set for the AI-14U.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
F2-01	Bi-polar or uni-polar input selection	Sets the functions for channel 1 to 3 which are effective when the AI-14B Analog Reference Board is used. 0: 3-channel individual (Channel 1: terminal A1, Channel 2: terminal A2, Channel 3: terminal A3) 1: 3-channel addition (Addition values are the frequency reference) When set to 0, select 1 for b1-01. In this case the multi-function input “Option/Inverter selection” cannot be used.	0 or 1	0	No	A	A	A	A	38FH

■Setting Precautions

Always set b1-01 (Reference selection) to 1 (control circuit terminal) when using the AI-14B for three channels of independent inputs. When this is done, H1-01 to H1-06 (multi-function contact inputs) cannot be set to 2 (Option/Inverter selection).

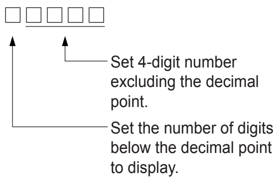
◆ Using a Digital Reference Board (SPEC: E or Later Only)

When using a DI-08 or DI-16H2 Digital Reference Board, set b1-01 (Reference selection) to 3 (Option Board).

The DI-16H2 can be used to set a frequency using a 16-bit digital reference. The DI-08 can be used to set a frequency using a 8-bit digital reference.

■Related Constants

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods: V/f	V/f with PG	Open Loop Vector	Flux Vector	MEMOBUS Register
F3-01	Digital input option	Sets the Digital Reference Board input method. 0: BCD 1% unit 1: BCD 0.1% unit 2: BCD 0.01% unit 3: BCD 1 Hz unit 4: BCD 0.1 Hz unit 5: BCD 0.01 Hz unit 6: BCD special setting (5-digit input) 7: Binary input 6 is only effective when the DI-16H2 is used. When o1-03 is set to 2 or higher, the input will be BCD, and the units will change to the o1-03 setting.	0 to 7	0	No	A	A	A	A	390H

Constant Number	Name	Description	Setting Range	Factory Setting	Change during Operation	Control Methods				MEMOBUS Register
						V/f	V/f with PG	Open Loop Vector	Flux Vector	
o1-03	Frequency units of reference setting and monitor	Sets the units that will be set and displayed for the frequency reference and frequency monitor. 0: 0.01 Hz units 1: 0.01% units (Maximum output frequency is 100%) 2 to 39: min^{-1} units (Sets the motor poles.) 40 to 39999: User desired display Set the desired values for setting and display for the max. output frequency.  Example: When the max. output frequency value is 200.0, set 12000	0 to 39999	0	No	A	A	A	A	502H

■Selecting Input Terminal Functions for the DI-16H2 Digital Reference Board

The frequency reference from the DI-16H2 Board is determined by the setting of F3-01 and the 12/16-bit switch on the option board. The possible settings are listed in the following table.

Terminal	Pin No.	12-bit Binary with Sign	16-bit Binary with Sign	3-digit BCD with Sign		4-digit BCD with Sign		5-digit BCD without Sign	
		F3-01 = 7 S1: 12 bit	F3-01 = 7 S1: 16 bit	F3-01 = 0 to 5 S1: 12 bit		F3-01 = 0 to 5 S1: 16 bit		F3-01 = 6 S1: 16 bit	
TC1	1	Bit 1 (2^0)	Bit 1 (2^0)	1	BCD digit 1 (0 to 9)	1	BCD digit 1 (0 to 9)	2	BCD digit 1 (0, 2, 4, 6, 8)
	2	Bit 1 (2^1)	Bit 1 (2^1)	2		2		4	
	3	Bit 1 (2^2)	Bit 1 (2^2)	4		4		8	
	4	Bit 1 (2^3)	Bit 1 (2^3)	8		8		1	BCD digit 2 (0 to 9)
	5	Bit 1 (2^4)	Bit 1 (2^4)	1	BCD digit 2 (0 to 9)	1	BCD digit 2 (0 to 9)	2	
	6	Bit 1 (2^5)	Bit 1 (2^5)	2		2		4	
	7	Bit 1 (2^6)	Bit 1 (2^6)	4		4		8	
	8	Bit 1 (2^7)	Bit 1 (2^7)	8		8		1	BCD digit 3 (0 to 9)
	9	Bit 1 (2^8)	Bit 1 (2^8)	1	BCD digit 3 (0 to 9)	1	BCD digit 3 (0 to 9)	2	
	10	Bit 1 (2^9)	Bit 1 (2^9)	2		2		4	
TC2	1	Bit 1 (2^{10})	Bit 1 (2^{10})	4		4		8	
	2	Bit 1 (2^{11})	Bit 1 (2^{11})	8		8		1	BCD digit 4 (0 to 9)
	3	-	Bit 1 (2^{12})		-	1	BCD digit 4 (0 to 9)	2	
	4	-	Bit 1 (2^{13})		-	2		4	
	5	-	Bit 1 (2^{14})		-	4		8	
	6	-	Bit 1 (2^{15})		-	8		1	BCD digit 5 (0 to 3)
	7	Sign signal (0: Forward, 1: Reverse)						2	
	8	SET (read) signal (1: Read)							
	9	Input signal common (0 V)							
TC3		Shield wire connection terminal							

■Application Precautions

- The maximum frequency (100% speed) reference will be used when the binary input is set (setting: 6 or 7) and all bits are 1.
- Setting F3-01 to 6 is valid only when the D1-16H2 is used. Using this setting, a frequency from 0.00 to 399.8 Hz can be set in BCD. The sign bit is used as a data bit, so only positive (plus) data can be set. Also, the digit starts from 0, so the minimum setting is 0.02 Hz.

■Selecting the Input Terminal Function for a DI-08 Digital Reference Board

The frequency reference from a DI-08 Board is determined by the setting of F3-01, as shown in the following table.

Terminal	Pin No.	8-bit Binary with Sign	2-digit BCD with Sign	
		F3-01 = 7	F3-01 = 0 to 5	
TC	1	Bit 1 (2^0)	1	BCD digit 1 (0 to 9)
	2	Bit 1 (2^1)	2	
	3	Bit 1 (2^2)	4	
	4	Bit 1 (2^3)	8	
	5	Bit 1 (2^4)	1	BCD digit 2 (0 to 15)
	6	Bit 1 (2^5)	2	
	7	Bit 1 (2^6)	4	
	8	Bit 1 (2^7)	8	
	9	Sign signal		
	10	SET (read) signal		
	11	Reference common signal (0 V)		

■Application Precautions

The DI-08 will not function if F3-01 is set to 6

■Selecting the Digital Reference

The range of the digital references is determined by the combination of the settings of o1-03 and F3-01. The information monitored in U1-01 (Frequency reference) will also change.

DI-16H2 Reference Ranges

When using the DI-16H2, the following ranges can be set depending on the settings of the constants.

o1-03	F3-01	Switch S1	Reference Input Mode	Reference Setting Range	U1-01 Monitor Unit	
					o1-03 = 0	o1-03 = 1
0 or 1	0	12 bits	3-digit BCD with sign, 1%	-110 to 110%	0.01 Hz	0.01%
		16 bits	4-digit BCD with sign, 1%	-110 to 110%		
	1	12 bits	3-digit BCD with sign, 0.1%	-110.0 to 110.0%		
		16 bits	4-digit BCD with sign, 0.1%	-110.0 to 110.0%		
	2	12 bits	3-digit BCD with sign, 0.01%	-15.99 to 15.99%		
		16 bits	4-digit BCD with sign, 0.01%	-110.0 to 110.0%		
	3	12 bits	3-digit BCD with sign, 1 Hz	-400 to 400 Hz		
		16 bits	4-digit BCD with sign, 1 Hz	-400 to 400 Hz		
	4	12 bits	3-digit BCD with sign, 0.1 Hz	-159.9 to 159.9 Hz		
		16 bits	4-digit BCD with sign, 0.1 Hz	-400.0 to 400.0 Hz		
	5	12 bits	3-digit BCD with sign, 0.01 Hz	-15.99 to 15.99 Hz		
		16 bits	4-digit BCD with sign, 0.01 Hz	-159.99 to 159.99 Hz		
	6	16 bits	5-digit BCD without sign, 0.01 Hz	000.00 to 399.98 Hz		
	7	12 bits	12-bit binary with sign, 100%/4095	-4095 to 4095		
		16 bits	16-bit binary with sign, 100%/30000	-33000 to 33000		

o1-03	F3-01	Switch S1	Reference Input Mode	Reference Setting Range	U1-01 Monitor Unit	
					o1-03 = 0	o1-03 = 1
2 to 39	-	12 bits	3-digit BCD with sign, 1 rpm	-1599 to 1599 rpm	1 rpm	
		16 bits	4-digit BCD with sign, 1 rpm	-15999 to 15999 rpm	1 rpm	
x0040 to x9999 (x = 0 to 3)	-	12 bits	3-digit BCD with sign, 100%/(1- to 4-digit setting of o1-03)	-1599 to 1599	5th digit of o1-03 setting: X = 0, unit: 1 X = 1, unit: 0.1 X = 2, unit: 0.01 X = 3, unit: 0.001	
	-	16 bits	4-digit BCD with sign, 100%/(1- to 4-digit setting of o1-03)	-9999 to 9999 (when o1-03 = 9999)		
x1000 (x = 1 to 3)	-	16 bits	4-digit BCD with sign, 100%/10000	-1000 to 1000		

DI-08 Reference Ranges

When using the DI-08, the following ranges can be set depending on the settings of the constants.

F3-01	Reference Input Mode	Reference Setting Range	U1-01 Monitor Unit	
			o1-03 = 0	o1-03 = 1
0	2-digit BCD with sign, 1%	-110 to 110%	0.01 Hz	0.01%
1	2-digit BCD with sign, 0.1%	-15.9 to 15.9%		
2	2-digit BCD with sign, 0.01%	-1.59 to 1.59%		
3	2-digit BCD with sign, 1 Hz	-159 to 159 Hz		
4	2-digit BCD with sign, 0.1 Hz	-15.9 to 15.9 Hz		
5	2-digit BCD with sign, 0.01 Hz	-1.59 to 1.59 Hz		
6	-			
7	8-bit binary with sign, 100%/255	-255 to 255		

Using Inverters for Elevating Machines

This section describes precautions to be observed when using the Varispeed F7 for elevating machines such as elevators and cranes.

◆ Brake ON/OFF Sequence

■Brake ON/OFF Sequence

For the holding brake's ON/OFF sequence, use the following Inverter output signals according to the set control method.

Control Method	Brake ON/OFF Signal		Brake ON/OFF Level Adjustment	
	Signal Name	Constant *1	Signal Name	Constant
V/f (A1-02 = 0, factory setting) V/f with PG (A1-02 = 1) Open-loop vector (A1-02 = 2)	Frequency detection 2	H2-01 = 05 *5	• Speed agree detection level • Speed agree detection width	• L4-01 = 1.0 to 3.0 Hz *2 • L4-02 = 0.1 to 0.5 Hz *3
	Frequency detection 5 *4	H2-01 = 36 *5		
Flux vector (A1-02 = 3)	During run 2	H2-01 = 37	Zero-speed level (OFF timing only)	b2-01 = 0.1 to 0.5 Hz

* 1. This example shows multi-function output terminals M1-M2 used for the holding brake ON/OFF signal. Do not set H2-01 to 0 (During run).

* 2. This is the standard setting range for open-loop vector control. For V/f control, set to approximately the motor rated slip frequency +0.5 Hz. If the set value is too low, the motor torque is insufficient and the load may slip when the brake is applied. Be sure to set L4-01 to a value larger than that of E1-09 (Min. output frequency) and larger than that of L4-02 shown in Figure 6.80. If the set value is too large, the motor may not run smoothly when it starts running.

* 3. The hysteresis in frequency detection 2 can be adjusted (from 0.1 to 0.5 Hz) by L4-02 (speed agree detection width). Change the setting to approximately 0.1 Hz if there are drops while stopping.

* 4. Applicable for F7-Series Inverters with software versions PRG:1032 or later.

* 5. When using frequency detection 2, set L4-01 before H2-01. If H2-01 is set before L4-01, the holding brake will engage while stopping. For Inverters with software versions PRG: 1032 or later, use frequency detection 5 in which a holding brake signal is OFF when the Inverter is baseblocked.

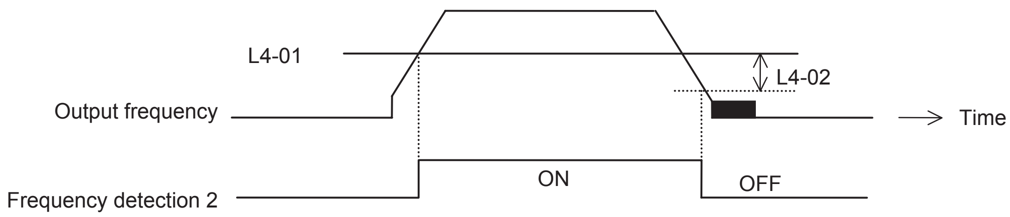
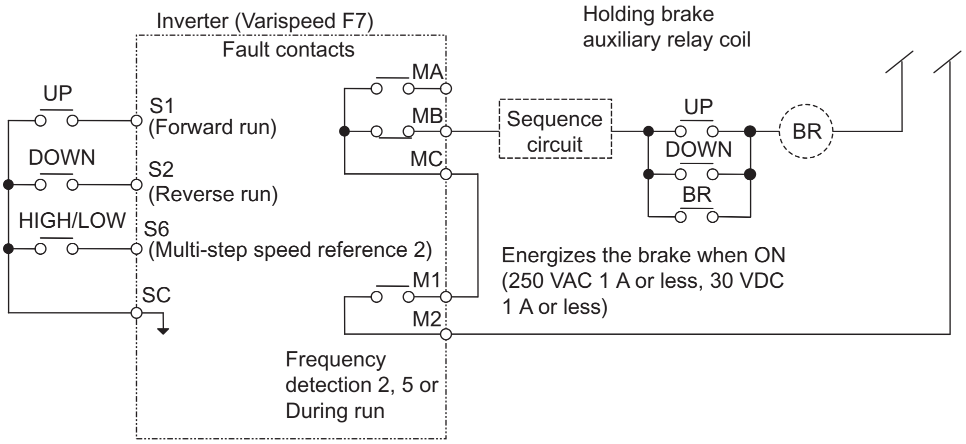


Fig 6.80

■Sequence Circuit Configuration

The brake ON/OFF sequence circuit configuration is shown below.

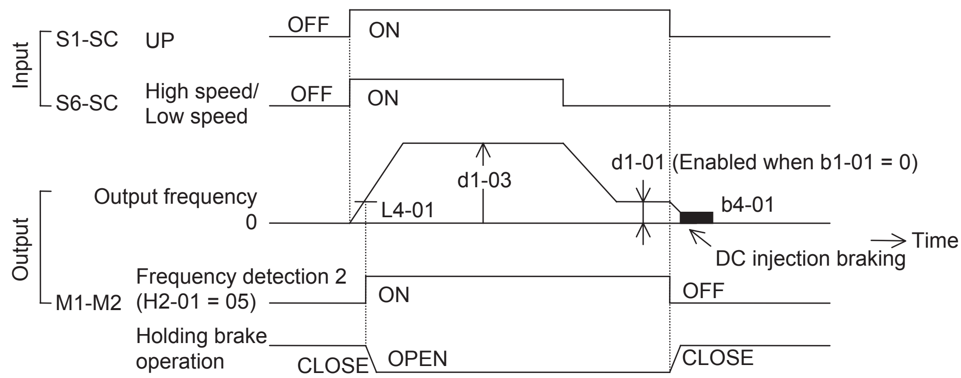


Note Design the sequence so that the holding brake contact is open when the sequence operation conditions are satisfied and the contact between M1 and M2 is closed (ON).
Make sure that the holding brake contact is closed when the emergency stop signal or Inverter fault contact output signal is ON.
Also, make sure that the holding brake is released when an up/down command is issued (ON.)

Fig 6.81 Brake ON/OFF Sequence Circuit Configuration

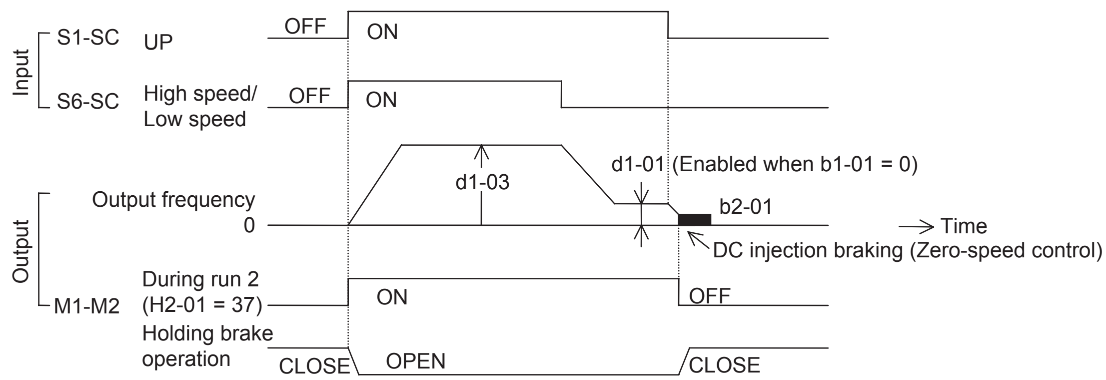
■Time Chart

The brake ON/OFF sequence time charts are shown in Figs. 6.82 and 6.83.



Note For variable speed operation by an analog signal, set to b1-01 = 1.

Fig 6.82 Brake ON/OFF Sequence Time Chart (V/f, V/f with PG, open-loop vector)



Note For variable speed operation by an analog signal, set to b1-01 = 1.

Fig 6.83 Brake ON/OFF Sequence Time Chart (Flux Vector)

◆ Stall Prevention during Deceleration

If connecting a braking resistor to discharge regenerative energy, be sure to set Stall prevention selection during decel (L3-04) to 0 (Disabled).

IMPORTANT

If Stall prevention selection during decel (L3-04) is set to 1, 2, or 3, the motor may not stop within the specified decelerating time.
Stall prevention selection during accel (L3-01) and Stall prevention selection during running (L3-05) should be set to their initial values 1 (Enabled) to enable these functions.

◆ Autotuning

Always perform autotuning with the motor before operating using vector control. Be sure to disconnect the motor from the load before conducting autotuning. Conducting autotuning while the motor is connected to an elevating machine system is dangerous because it automatically runs the motor for approximately one minute.

IMPORTANT

1. When the motor cannot be disconnected from the load, perform stationary autotuning 1 (T1-01 = 1) or stationary autotuning 2 (T1-01 = 4). For F7-series Inverters with SPEC: E or later, perform stationary autotuning 2 (T1-01=4). Stationary autotuning will apply current to the motor in its stopped condition and automatically measure the motor data. In the initial running period after autotuning 1 (T1-01 = 1) (20% speed min., fixed speed for 1 s min.), the motor data measured by autotuning will automatically be corrected.
2. To improve low-speed torque characteristics using V/f control, conduct stationary autotuning for line to line resistance only (T1-01 = 2).
3. When conducting autotuning on wound motor or other special types of motors, obtain a test report for the motor in advance and confirm that the E2 motor constants after autotuning do not vary greatly from those of the test report.

◆ Braking Resistor Overheating Protection

When using a braking resistor other than the Braking Resistor Unit, provide a sequence with a thermal overload relay or similar means to turn off the power input to the Inverter when it detects resistor overheating. See the Connection Diagram on page 2-3 for this sequence circuit.

◆ Momentary Power Loss Restart

Do not use the momentary power loss restart and fault restart functions in applications for elevating machines. Make sure that L2-01=0 and L5-01=0. If these functions are used, the motor coasts to a stop with the brake contact open when a momentary power loss or fault occurs during operation, possibly resulting in serious accidents.

◆ Torque Limit

The torque limit values (L7-01 to L7-04) are the motor's rated torque. When there is a possibility of insufficient torque at start-up or other time, increase the Inverter capacity and set the torque limit value to between 200% and 300% (factory setting is 200%).

◆ I/O Open-phase Protection and Overtorque Detection

To prevent the machine from falling when the motor is open-phase or a similar situation, enable L8-05 and L8-07 (Input and output open-phase protection selection) and L6-01 to L6-06 (Overtorque detection) (factory setting is Disabled).

Falling detection or a similar safety measure should also be provided on the machine side.

◆ External Baseblock Signal

If the external baseblock command (settings 8 and 9 of H1-01 to H1-06) is input while the motor is running, the motor will immediately coast to a stop. Do not input the external baseblock command while the motor is running unless necessary.

Make sure that the holding brake operates when using the external base block command for an emergency stop or interlock to start the Inverter.

If the external baseblock command is input and immediately reset, the Inverter does not output voltage during the value of L2-03 (Min. baseblock time), which factory setting is 0.5 to 2.0 seconds depending on the Inverter capacity. Do not use the external baseblock command in an application where the motor is frequently started and stopped.

◆ Acceleration/Deceleration Time

If the delay time for the holding brake's mechanical operation is not taken into consideration and the acceleration/deceleration time on the Inverter side is set to a time that is too short, and overcurrent or wear on the brakes may occur at staring or the load will slip at stopping because the holding brake does not operate on time. If so, use the dwell function at start described on page 6-175 or the dwell function at stop described on page 6-176 to tune the timing for the holding brake.

◆ Magnetic Contactor on the Inverter's Output-side

Do not install a magnetic contactor between the Inverter and the motor. If a magnetic contactor must be installed because of local electrical codes or regulations or to operate motors with an Inverter, excluding emergencies, open or close the magnetic contactor only when the holding brake is fully closed and the Inverter is in baseblock status with the baseblock signal ON.

If the magnetic contactor is opened or closed while the Inverter is controlling the motor or DC injection braking (Zero-speed control), surge voltage or a current from the motor by full-voltage starting may cause an Inverter fault.

When a magnetic contactor is installed between the Inverter and the motor, set L8-07 (Output open-phase protection selection) to 1 or 2 (Enabled).

◆ Control-related Adjustments

The Varispeed F7 is designed to provide sufficient performance for elevating machines. However, if problems related to controllability should occur, such as vibration or slipping, adjust the following constants in accordance with the control method. Only constants that frequently require adjustment are listed in this table.

Table 6.4 Control-related Adjustments

Control Method	Constant Number	Name	Performance	Factory Setting	Recommended Setting	Adjustment Method
Open-loop vector control (A1-02 = 2)	N2-01	Speed feedback detection control (AFR) gain	• Increasing torque and speed response • Controlling hunting and vibration in middle-range speeds (10 to 40 Hz)	1.00	0.50 to 2.00	• Torque or speed response is insufficient: Reduce the setting • Hunting or vibration occurs: Increase the setting
	C4-02	Torque compensation primary delay time constant	• Increasing torque and speed response • Controlling hunting and vibration	20 ms	20 to 100 ms	• Torque or speed response is insufficient: Reduce the setting • Hunting or vibration occurs: Increase the setting
	C3-02	Slip compensation primary delay time	• Increasing speed response • Improving speed stability	200 ms	100 to 500 ms	• Speed response is slow: Reduce the setting • Speed is not stable: Increase the setting
	C3-01	Slip compensation gain	• Improving speed accuracy	1.0	0.5 to 1.5	• Speed is slow: Increase the setting • Speed is too fast: Reduce the setting
	C6-02	Carrier frequency selection	• Reducing motor magnetic noise • Controlling hunting and vibration at low speeds (10 Hz or lower)	*1	1 to F	• Motor magnetic noise is high: Increase the setting • Hunting or vibration occurs at low speeds: Reduce the setting
	E1-08	Mid. output frequency voltage (VC)	• Improving torque and speed response at low speeds • Controlling shock at startup	11.0 V*2	12.0 to 13.0 V*2	• Torque or speed response is insufficient: Increase the setting • Shock at startup is large: Reduce the setting
	E1-10	Min. output frequency voltage (VMIN)		2.0 V*2	2.0 to 3.0 V*2	

Table 6.4 Control-related Adjustments (Continued)

Control Method	Constant Number	Name	Performance	Factory Setting	Recommended Setting	Adjustment Method
Flux vector control (A1-02 = 3)	C5-01	ASR proportional (P) gain 1	• Increasing torque and speed response • Controlling hunting and vibration	20.00	10.00 to 50.00	• Torque or speed response is insufficient: Increase the setting • Hunting or vibration occurs: Reduce the setting
	C5-03	ASR proportional (P) gain 2				
	C5-02	ASR integral (I) time 1	• Increasing torque and speed response • Controlling hunting and vibration	0.500 s	0.300 to 1.000 s	• Torque or speed response is insufficient: Reduce the setting • Hunting or vibration occurs: Increase the setting
	C5-04	ASR integral (I) time 2				
	C5-07	ASR switching frequency	Switching the ASR proportional gain and integral time according to the output frequency.	0.0 Hz (no switching)	0.0 to max. output frequency	Set the output frequency at which to change the ASR proportional gain and integral time when the same values cannot be used for both high-speed and low-speed operation.
	C5-06	ASR primary delay time	• Controlling hunting and vibration	0.004 s	0.004 to 0.020	Machine rigidity is low and the system vibrates easily: Increase the setting
V/f control (A1-02 = 0 or 1)	N1-02	Hunting-prevention gain	• Controlling hunting and vibration in middle-range speeds (10 to 40 Hz)	1.00	0.50 to 2.00	• Torque is insufficient for heavy loads: Reduce the setting • Hunting or vibration occurs for light loads: Increase the setting
	C6-02	Carrier frequency selection	• Reducing motor magnetic noise • Controlling hunting and vibration at low and medium speeds	*1	1 to F	• Motor magnetic noise is high: Increase the setting • Hunting or vibration occurs at low to middle-range speeds: Reduce the setting
	C4-01	Torque compensation gain	• Improving torque at low speeds (10 Hz or lower) • Controlling hunting and vibration for light loads	1.00	0.50 to 1.50	• Torque is insufficient at low speeds: Increase the setting • Hunting or vibration occurs for light loads: Reduce the setting
	E1-08	Mid. output frequency voltage (VC)	• Improving torque at low speeds • Controlling shock at startup	15.0 V*2	13.0 to 16.0 V*2	• Torque is insufficient at low speeds: Increase the setting • Shock at startup is large: Reduce the setting
	E1-10	Min. output frequency voltage (VMIN)		9.0 V*2	7.0 to 10.0 V*2	

* 1. Varies depending on capacity.
* 2. The setting is given for 200 V Class Inverters. Double the voltage for 400 V Class Inverters.

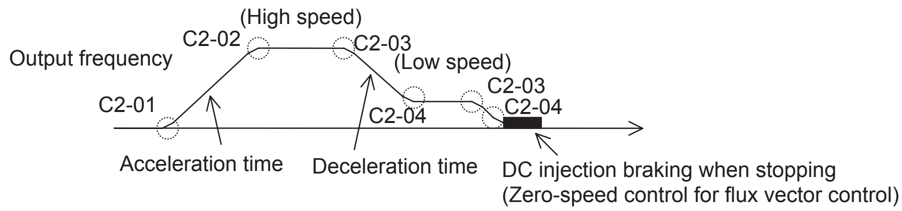
Note 1. Do not change C4-01 (Torque compensation gain) from its factory setting of 1.00 when using open-loop vector control.
2. If speeds are inaccurate during regeneration in open-loop vector control, enable Slip compensation selection during regeneration (C3-04 = 1). If speeds are inaccurate in the high-speed range, enable Output voltage limit operation selection (C3-05 = 1).
3. Do not use Slip compensation gain (C3-01) during V/f control (A1-02 = 0). (It is not used with the factory setting.)

4. Use the ASR constants (C5-01 to C5-05) in their factory settings when using V/f control with PG (A1-02 = 1). Vibration may occur if these constants are changed greatly from their factory settings.
5. The torque and speed response of high-resistance (high-slip) motors are insufficient. Use appropriate adjustments to improve them. On the contrary, low-resistance (low-slip) motors are easily subject to hunting and vibration. Here too, use appropriate adjustments to improve them.
6. The current during startup may increase when C4-02 (Torque compensation primary delay time constant) is increased. Check the current during startup while adjusting this constant.

◆ Reducing Shock during Elevating Machine Start, Stop, Acceleration, and Deceleration

When the riding comfort during start, stop, acceleration, and deceleration is of high importance, as it is for elevators in which people ride, adjust the following constants.

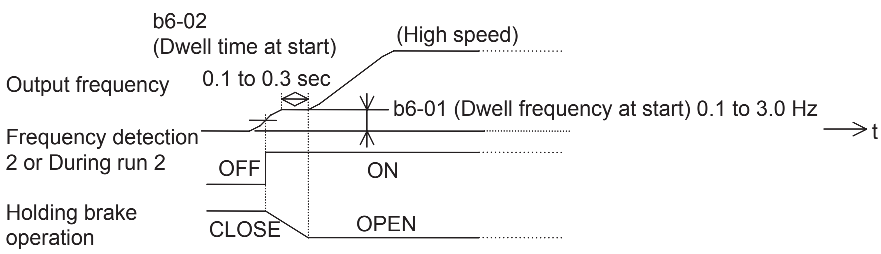
■S-curve Characteristics, Acceleration/Deceleration Times



IMPORTANT

1. The factory setting for C2-04 (S-curve characteristic time at deceleration end) is 0.00 second, while the factory setting for all other S-curve characteristic times is 0.20 second. Make appropriate settings for the accel/decel times and S-curve characteristic times at each point. (S-curve characteristic time = Approximately 0.2 to 1.0 second)
2. The accel/decel rate can be automatically switched during acceleration and deceleration by using C1-11 (Accel/decel time switching frequency). (Factory setting: Disabled)
   Output frequency ≥ set frequency: C1-01, C1-02 accel/decel times
   Output frequency < set frequency: C1-07, C1-08 accel/decel times
3. If the output frequency during the S-curve characteristic time for deceleration falls below the value set for E1-09 (Min. output frequency), the S-curve characteristic will be cancelled, and the DC injection braking (Zero-speed control) will be applied.
4. Do not use the S-curve characteristic for applications where a short run time is desired, such as in cranes and hoists. (S-curve characteristic time = Approximately 0.0 to 0.2 second)

■Dwell Function at Start



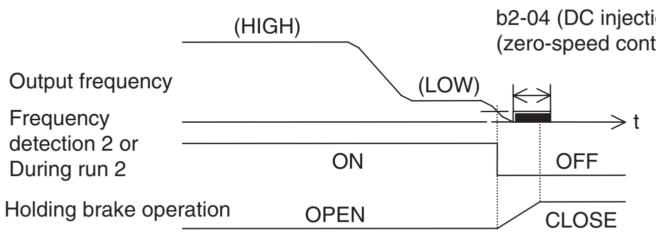
6

If the mechanical operation of the holding brake is slow, use the dwell function at start to prevent brake wear, and accelerate after the brake is completely open.

IMPORTANT

1. When using open-loop vector control and V/f control, set b6-01 (Dwell frequency at start) higher than frequency detection 2 (frequency when brakes open).
2. If the motor tends to have insufficient torque when started, use the DC injection braking function to allow sufficient motor current (torque) before starting.
   - b2-03 (DC injection braking time at start): 0.2 to 0.5 s
   - b2-02 (DC injection braking current): 50% to 80% (open-loop vector control, V/f control only)

■Stopping with DC Injection Braking and Zero-speed Control



- b2-01 [Zero speed level (DC injection braking starting frequency)]: 0.1 to 3.0 Hz
- b2-02 (DC injection braking current): 50% to 80% (open-loop vector control, V/f control only)

When the holding brake's mechanical operation is slow, use DC injection braking (zero-speed control for flux vector control) until the brakes are fully closed to prevent the brakes from slipping when stopping.

IMPORTANT

1. When the load cannot be maintained sufficiently using DC injection braking with open-loop vector control and V/f control, use the dwell functions at stop.
   - b6-03 (Dwell frequency at stop): Min. output frequency to 3.0 Hz.
     The value must be less than the frequency when frequency detection 2 is OFF (L4-01 – L4-02).
   - b6-04 (Dwell time at stop): 0.3 to 0.5 s
     [b2-04 (DC injection braking at stop): 0.0 s]
2. If the Inverter and motor must be isolated while stopping using a magnetic contactor, for example in an elevator, fully close the holding brakes and isolate the Inverter during baseblock (during baseblock signal: ON) as stipulated by law in the EU.
   During motor control or DC injection braking (zero-speed control), an Inverter error may occur due to surge voltage. When a magnetic contactor is used between the Inverter and motor, set L8-07 (Output open-phase protection) to 1 (enabled).

■Torque Compensation (Flux Vector Control Only) (SPEC: E or Later Only)

When flux vector control is used, the torque compensation signals corresponding to the load can be input from the multi-function analog input terminals in advance to reduce shock, such as that caused by opening and closing holding brakes. The load size and motoring/regenerating status must be detected at the machine side in advance. Check that polarity is correct. Incorrect polarity will increase the shock.

Sequence Circuit Configuration

The following diagram shows the sequence circuit configuration for torque compensation.

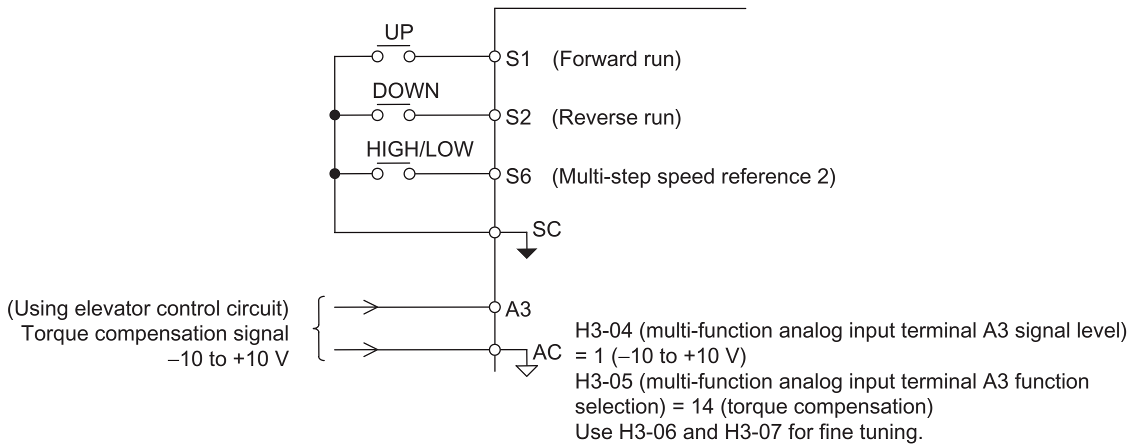


Fig 6.84 Torque Compensation Sequence Circuit Configuration

Time Chart

- Lifting

The analog signals corresponding to the load size are input as torque compensation signals from before the Inverter starts until operation stops. (Factory setting: 10 V/100% torque)
Positive polarity is input for motor loads and negative polarity is input for regenerative loads.
The following diagram shows the time chart for lifting.

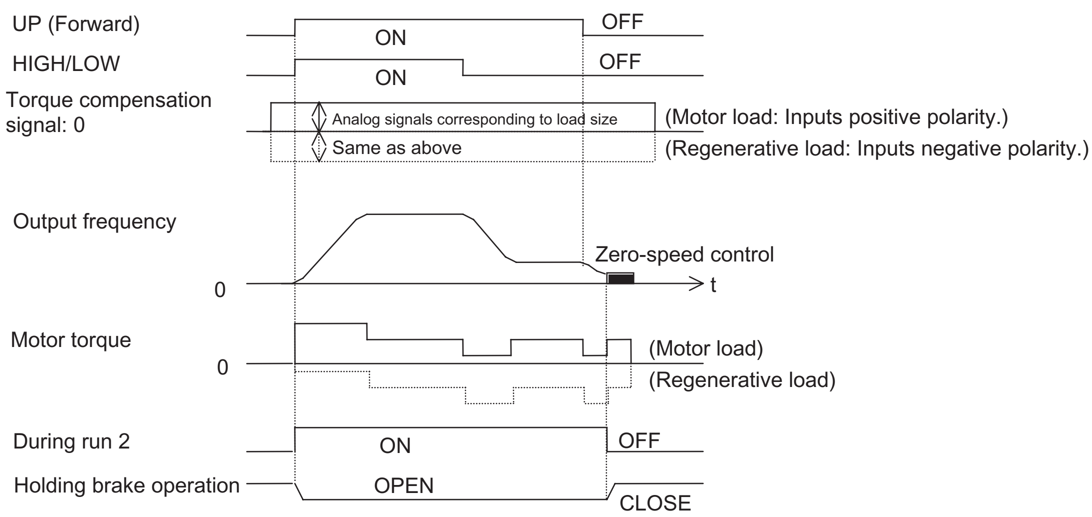


Fig 6.85 Torque Compensation Time Chart (Lifting)

- Lowering

In the same way as for lifting, when the torque decreases, the analog signals corresponding to the load size are input as torque compensation signals from before the Inverter starts until operation stops. (Factory setting: 10 V/100% torque)
Negative polarity is input for motor loads and positive polarity is input for regenerative loads.

The following diagram shows the time chart for lowering.

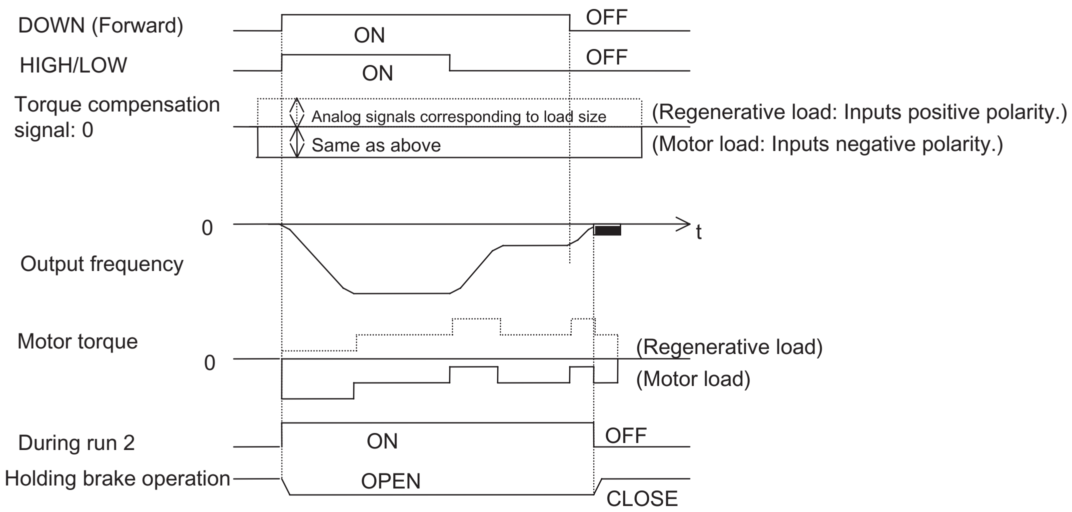


Fig 6.86 Torque Compensation Time Chart (Lowering)

IMPORTANT

1. For either increasing or decreasing torque, externally maintain the torque compensation signals during operation to prevent them from fluctuating. Fluctuation in compensation signals during operation may result in vibration.
2. If reverse run is used for lifting and forward run is used for lowering, the torque compensation signal polarity must be reversed.

■Analog Input Filter Time Constant

If noise enters the analog frequency reference during operation using analog frequency reference (b1-01 = 1), and operation becomes rough, implement noise countermeasures and also set H3-12 (Analog input filter time constant) to between 0.01 and 0.10 s.

◆ Confirming Startup Current and Reducing Carrier Frequency

When performing trial operation, check the motor current using the Digital Operator or a clamp ammeter with and without a mechanical load. An extremely large current will flow if the motor torque at start is insufficient, or if timing is not correct and the motor locks with the holding brake.

For applications with repetitive loads (cranes, elevators, presses, washing machines, etc.), if a current exceeding 125% of the Inverter rated current or more flows repeatedly, the IGBT in the Inverter will be subject to heat stress, resulting in a shortened life span. In this case, select CT instead of VT and reduce the load, lengthen the acceleration/deceleration time, or increase the frame size of the Inverter so that the peak current for repetitive operation will drop to less than 125% of the Inverter rated current. If performing a trial operation with repetitive loads, make sure that the peak current for repetitive operation is less than 125% of the Inverter rated current. If particularly low noise is not required, do not increase the Inverter's carrier frequency to reduce the influence of heat stress.

◆ Overvoltage Inhibit Function (SPEC: E or Later Only)

Leave L3-11 (Overvoltage inhibit function selection) set to 0 (disabled: factory setting). This function is used to prevent overvoltage tripping when the braking resistor is not used with a regenerative load. When this function is enabled, the torque reference on the regenerative side is automatically inhibited in the Inverter during regeneration. Using this function in elevating machines is dangerous because the elevator may slip and fall.

Contact your Yaskawa representative for details on applications such as high-speed elevators (speed: 2 m/s or higher), direct-drive elevators, or Inverters designed for cranes.

7

Troubleshooting

This chapter describes the fault displays and countermeasure for the Inverter and motor problems and countermeasures.

Protective and Diagnostic Functions

This section describes the alarm functions of the Inverter. The alarm functions include fault detection, alarm detection, operation error detection, and autotuning error detection.

◆ Fault Detection

When the Inverter detects a fault, the fault contact output operates, and the Inverter output is shut OFF 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.) A fault code is displayed on the Digital Operator.

When a fault has occurred, refer to the following table to identify and correct the cause of the fault.

Be sure to turn Run Command to OFF first, use one of the following methods to reset the fault before restarting the Inverter.

- Set a multi-function contact input (H1-01 to H1-06) 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 OFF and then ON again.

Table 7.1 Fault Displays and Processing

Display	Meaning	Probable Causes	Corrective Actions
oC	Overcurrent The Inverter output current exceeded the overcurrent detection level. (200% of rated current)	• A short-circuit or ground fault occurred at the Inverter output. (A short or ground fault can be caused by motor burn damage, worn insulation, or a damaged cable.) • The load is too large or the acceleration/deceleration time is too short. • A special-purpose motor or motor with a capacity too large for the Inverter is being used. • A magnetic contactor was switched at the Inverter output.	Reset the fault after correcting its cause. Note) Before turning the power ON again, make sure that no short-circuit or ground fault occurs at the Inverter output.
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
GF	Ground Fault* The ground fault current at the Inverter output exceeded approximately 50% of the Inverter rated output current.	A ground fault occurred at the Inverter output. (A ground fault can be caused by motor burn damage, worn insulation, or a damaged cable.)	Reset the fault after correcting its cause. Note) Before turning the power ON again, make sure that no short-circuit or ground fault occurs at the Inverter output.
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)

* The ground fault here is one which occurs in the motor wiring while the motor is running. A ground fault may not be detected in the following cases.
- A ground fault with low resistance which occurs in motor cables or terminals.
- A ground fault occurs when the power is turned ON.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
PUF	Fuse Blown The fuse in the main circuit is blown.	• The output transistor has failed because of a short-circuit or ground fault at the Inverter output. Check whether there is a short-circuit between the following terminals. A short-circuit will damage the output transistor: B1 (⊕3) ←→ U, V, W ⊖ ←→ U, V, W • Input power was supplied from the output side. (Improper wiring, the sequence for switching commercial power supply was wrong, etc.)	Replace the Inverter after correcting the cause.
OU	Main Circuit Overvoltage The main circuit DC voltage exceeded the overvoltage detection level. 200 V Class: Approx. 410 V 400 V Class: Approx. 820 V (E1-01 ≥ 400 V) Approx. 720 V (E1-01 < 400 V)	The deceleration time is too short and the regenerative energy from the motor is too large.	Increase the deceleration time or connect a braking resistor (or Braking Resistor Unit).
		Motor ground fault (Ground fault current flowed to the capacitor in the control circuit of the Inverter through the power supply.)	Check the output cable, relay terminal, or motor terminal box and correct the cause of ground fault.
		Incorrect constant setting for speed search (The speed search can be performed during momentary power loss recovery and auto restart after a fault.)	• Use the speed search function. • Adjust the settings of the Speed search operating current (b3-02) and Speed search deceleration time (b3-03). • Use the estimated speed search function. (Perform stationary autotuning for line-to-line resistance only.)
		Improper PG cable connection (PG noise, PG disconnection)	Check to see if the PG cable is connected properly.
		The regenerative energy when an overshoot occurs after acceleration is completed is too large.	In vector control, enable (Set to 1) the overvoltage inhibit selection (L3-11).
		The power supply voltage is too high.	Decrease the voltage so it's within specifications.
UU1	Main Circuit Undervoltage The main circuit DC voltage is below the Undervoltage Detection Level (L2-05). 200 V Class: Approx. 190 V 400 V Class: Approx. 380 V Main Circuit Magnetic Connector Operation Failure The magnetic connector stopped responding during Inverter operation. Applicable Inverter Capacities 200 V Class: 37 to 110 kW 400 V Class: 75 to 300 kW	• An open-phase occurred with the input power supply. • A momentary power loss occurred. • The wiring terminals for the input power supply are loose. • The voltage fluctuations in the input power supply are too large. • A fault occurred in the surge prevention circuit. • The magnetic contactor in the control circuit was released (Contact failure in the auxiliary contact). • The contact of the magnetic contactor in the control circuit was corroded due to environmental dust or gas.	• Reset the fault after correcting its cause. • Improve the power supply environment. (Check to see if the correct power tap is selected.) • Improve the operating environment. • Replace the Inverter.

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Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
Uu2	Control Power Fault The control power supply voltage dropped.	• The wiring of the control power circuit is incorrect. • A Backup Capacitor Unit for Momentary Power Loss is not attached to a 200 V/400 V Class Inverter of 11 kW or less and the value of the Momentary power loss ridethru time (L2-02) factory setting has been changed to the larger value.	• Fix the wiring. • Try turning the power supply off and on. • Replace the Inverter if the fault continues to occur. • Attach a Backup Capacitor Unit for Momentary Power Loss.
Uu3	Inrush Prevention Circuit Fault Malfunction in the inrush prevention circuit. The magnetic contactor did not respond for 10 s even though the magnetic contactor ON signal has been output. Applicable Inverter Capacities 200 V Class: 37 to 110 kW 400 V Class: 75 to 300 kW	• The magnetic contactor in the main circuit failed. • The magnetic contactor excitation coil is burned out.	• Try turning the power supply off and on. • Replace the Inverter if the fault continues to occur.
PF	Main Circuit Voltage Fault The main circuit DC voltage oscillates unusually (not when regenerating). This fault is detected if a load is greater than approximately 80% of the maximum motor capacity. This fault is detected when L8-05 is set to 1.	• An open-phase occurred in the input power supply. • A momentary power loss occurred. • The wiring terminals for the input power supply are loose. • The voltage fluctuations in the input power supply are too large. • The voltage balance between phases is bad.	Reset the fault after correcting its cause.
LF	Output Open-phase An open-phase occurred at the Inverter output. This fault is detected when L8-07 is set to 1 or 2.	• There is a broken wire in the output cable. • There is a broken wire in the motor-winding. • The output terminals are loose.	Reset the fault after correcting its cause.
		The motor being used has a capacity less than 5% of the Inverter rated output current.	Check the motor and Inverter capacity.
oH (oH1)	Cooling Fin Overheating The temperature of the Inverter's cooling fins exceeded the setting in L8-02 or the overheat protection level. OH: The temperature exceeded the setting in L8-02 (Stopping method can be changed by L8-03.). OH1: The temperature exceeded 100°C (Stopping method: Coast to stop).	The ambient temperature is too high.	Install a cooling unit.
		There is a heat source nearby.	Remove the heat source.
		The Inverter's cooling fan has stopped.	Replace the cooling fan. (Contact our sales representative.)
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
	Inverter's Cooling Fan Fault (11 kW or more) This fault is detected when L8-32 is set to 1.	• The Inverter's cooling fan has stopped. • The heatsink is clogged.	• Replace the cooling fan. (Contact our sales representative.) • Clean the heatsink.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
FAn	Inverter's Cooling Fan Fault An Inverter's cooling fan fault was detected, and the Inverter-overload protection was activated based on the internal electric thermal value. This fault is detected when L8-32 is set to 0.	The Inverter continued running with an overload after the cooling fan stopped.	Replace the cooling fan. (Contact our sales representative.)
oH3	Motor Overheating Alarm The Inverter will stop or will continue to operate according to the setting of L1-03.	The motor has overheated.	Check the size of the load and the length of the acceleration, deceleration, and cycle times.
			Check the V/f characteristics.
			Check the motor temperature input on terminals A2 and A3.
			Check the setting of E2-01 (motor rated current).
oH4	Motor Overheating Fault The Inverter will stop according to the setting of L1-04.	The motor has overheated.	Check the size of the load and the length of the acceleration, deceleration, and cycle times.
			Check the V/f characteristics.
			Check the motor temperature input on terminals A2 and A3.
			Check the setting of E2-01 (motor rated current).
rH	Installed Braking Resistor Overheating The braking resistor is overheated and the protection function has operated if it has been enabled in L8-01.	The deceleration time is too short and the regenerative energy from the motor is too large.	• Reduce the load, increase the deceleration time, or reduce the motor speed. • Change to a Braking Resistor Unit.
rr	Internal Braking Transistor Fault The braking transistor is not operating properly.	• The braking transistor is damaged. • The Inverter's control circuits are faulty.	• Try turning the power supply off and on. • Replace the Inverter if the fault continues to occur.
oL1	Motor Overload The motor overload protection function has operated based on the internal electronic thermal value.	The load is too heavy. The acceleration time, deceleration time, and cycle time are too short.	Check the size of the load and the length of the acceleration, deceleration, and cycle times.
		The constant setting for speed search is incorrect. (Motor overload occurred due to motor hunting and vibration.)	• Use the speed search function. • Adjust the settings of the Speed search operating current (b3-02) and Speed search deceleration time (b3-03). • Use the estimated speed search function. (Perform stationary autotuning for line-to-line resistance only.)
		• Motor overload occurred when running at low speed. (If a general-purpose motor is used, motor overload can occur when running at low speed even if running within the rated current.) • Motor protection selection (L1-01) is set to general-purpose motor protection (1) when an Inverter duty motor is used.	• Check the size of the load. • Check the setting of L1-01. • Increase the frame size of the Inverter.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
oL1	Motor Overload The motor overload protection function has operated based on the internal electronic thermal value.	The directions of the motor and PG are different. (Only in flux vector control)	• Correct the PG wiring. • Correct the motor wiring. • Change the setting of PG rotation (F1-05).
		The V/f characteristics voltage is too high or too low.	Check the V/f characteristics.
		The Motor Rated Current (E2-01) and Motor 2 Rated Current (E4-01) is incorrect.	Check the Motor Rated Current (E2-01) and Motor 2 Rated Current (E4-01).
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
oL2	Inverter Overload The Inverter overload protection function has operated based on the internal electronic thermal value.	The load is too heavy. The acceleration time, deceleration time and cycle time are too short.	Check the size of the load and the length of the acceleration, deceleration, and cycle times.
		The constant setting for speed search is incorrect. (Motor overload occurred due to motor hunting and vibration.)	• Use the speed search function. • Adjust the settings of the Speed search operating current (b3-02) and Speed search deceleration time (b3-03). • Use the estimated speed search function. (Perform stationary autotuning for line-to-line resistance only.)
		The directions of the motor and PG are different. (Only in flux vector control)	• Correct the PG wiring. • Correct the motor wiring. • Change the setting of PG rotation (F1-05).
		The V/f characteristics voltage is too high or too low.	Check the V/f characteristics.
		The Inverter capacity is too low.	Replace the Inverter with one that has a larger capacity.
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
		Inverter overload occurred when running at a low speed of 6 Hz or less.	• Reduce the load. • Increase the frame size of the Inverter. • Lower the carrier frequency.
oL3	Overtorque Detected 1 There has been a current greater than the setting in L6-02 for longer than the setting in L6-03.	-	• Make sure that the settings in L6-02 and L6-03 are appropriate. • Check the mechanical system and correct the cause of the overtorque.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
oL4	Overtorque Detected 2 There has been a current greater than the setting in L6-05 for longer than the setting in L6-06.	-	• Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
oL7	High-slip Braking OL The output frequency did not change for longer than the time set in N3-04.	The inertia returned to the load is too large.	• Make sure the load is an inertial load. • Set the system so that the deceleration time that does not produce OV is the value of N3-04 or less.
UL3	Undertorque Detected 1 There has been a current less than the setting in L6-02 for longer than the setting in L6-03.	-	• Make sure that the settings in L6-02 and L6-03 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
UL4	Undertorque Detected 2 There has been a current less than the setting in L6-05 for longer than the setting in L6-06.	-	• Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
oS	Overspeed The speed has been greater than the setting in F1-08 for longer than the setting in F1-09.	Overshooting/Undershooting are occurring.	Adjust the gain again.
		The reference speed is too high.	Check the reference circuit and reference gain.
		The settings in F1-08 and F1-09 aren't appropriate.	Check the settings in F1-08 and F1-09.
PGo	PG Disconnection Detected PG pulses were input when the Inverter was outputting a frequency (soft start output ≥ E1-09).	There is a break in the PG wiring.	Fix the broken/disconnected wiring.
		The PG is wired incorrectly.	Fix the wiring.
		Power isn't being supplied to the PG.	Supply power to the PG properly.
		Brake is applied to the motor.	Check for open circuit when using brake (motor).
dEv	Excessive Speed Deviation The speed deviation has been greater than the setting in F1-10 for longer than the setting in F1-11.	The load is too heavy.	Reduce the load.
		The acceleration time and deceleration time are too short.	Lengthen the acceleration time and deceleration time.
		The load is locked.	Check the mechanical system.
		The settings in F1-10 and F1-11 aren't appropriate.	Check the settings in F1-10 and F1-11.
		Brake is applied to the motor.	Check for open circuit when using brake (motor).
CF	Control Fault The torque limit was reached continuously for 3 seconds or longer during a deceleration stop during open-loop vector control.	The settings for torque limit aren't appropriate.	Check the settings for torque limit.
		The settings of motor constant aren't appropriate.	• Check the motor constants. • Perform autotuning.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
FbL	PID Feedback Reference Lost A PID feedback reference loss was detected (b5-12 = 2) and the PID feedback input was less than b5-13 (PID feedback loss detection level) for longer than the time set in b5-14 (PID feedback loss detection time).	The settings in b5-13 and b5-14 aren't appropriate.	Check the settings in b5-13 and b5-14.
		The wiring of the PID feedback circuit is incorrect.	Fix the wiring.
EF0	External Fault input from Communications Option Board	-	Check the Communications Option Board and communications signals.
EF3	External Fault (Input Terminal S3)	An "external fault" was input from a multi-function input terminal (S3 to S8).	• Reset external fault inputs to the multi-function inputs. • Remove the cause of the external fault.
EF4	External Fault (Input Terminal S4)		
EF5	External Fault (Input Terminal S5)		
EF6	External Fault (Input Terminal S6)		
EF7	External Fault (Input Terminal S7)		
EF8	External Fault (Input Terminal S8)		
SvE	Zero-Servo Fault The rotation position moved during zero-servo operation.	The torque limit is too small.	Increase the limit.
		The load torque is too large.	Reduce the load torque.
		-	Check for signal noise.
SEr	Exceeded Allowable Number of Speed Search Retrials The speed search has been retried more than the number of times set in b3-19 (Number of speed search retrials).	The settings in b3-17 and b3-18 aren't appropriate.	Make sure that the settings in b3-17 and b3-18 are appropriate.
oPr	Digital Operator Connection Fault The connection to the Digital Operator was broken during operation for a Run Command from the Digital Operator.	-	Check the connection to the Digital Operator.
CE	MEMOBUS Communications Error A normal reception was not possible for 2 s or longer after control data was received once.	-	Check the communications devices and communications signals.
bUS	Option Communications Error A communications error was detected during a Run Command or while setting a frequency reference from a Communications Option Board.	-	Check the communications devices and communications signals.
E5	SI-T Watchdog Error Consistency error of received control data	Synchronization error between master controller and Inverter for control data.	Check the communications timing such as communications cycle. Refer to *MECHATROLINK COMMUNICATIONS INTERFACE CARD INSTRUCTIONS (TOBPC73060008)* for details.

Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
E-10	SI-F/G Option Board CPU Failure SI-F/G Option Board operation failed.	Digital Operator connection is faulty.	Disconnect and then reconnect the Digital Operator.
		Inverter control circuit is faulty.	Replace the Inverter.
CPF00	Digital Operator Communications Error 1 Communications with the Digital Operator were not established within 5 seconds after the power was turned on.	The Digital Operator's connector isn't connected properly.	Disconnect the Digital Operator and then connect it again.
		The Inverter's control circuits are faulty.	Replace the Inverter.
	CPU External RAM Fault	-	Try turning the power supply off and on again.
		The control circuits were destroyed.	Replace the Inverter.
CPF01	Digital Operator Communications Error 2 After communications were established, there was a communications error with the Digital Operator for more than 2 seconds.	The Digital Operator isn't connected properly.	Disconnect the Digital Operator and then connect it again.
		The Inverter's control circuits are faulty.	Replace the Inverter.
CPF02	Baseblock Circuit Error	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
CPF03	EEPROM Error	-	Try turning the power supply off and on again.
		The Inverter power supply was shut off while writing data to the Inverter constants.	Initialize the constant settings (A1-03).
		The control circuit is damaged.	Replace the Inverter.
CPF04	CPU Internal A/D Converter Error	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
CPF05	CPU External A/D Converter Error	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)

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Table 7.1 Fault Displays and Processing (Continued)

Display	Meaning	Probable Causes	Corrective Actions
CPF06	Option Board Connection Error	The option board is not connected properly.	Turn off the power and insert the board again.
		The Inverter or option board is faulty.	Replace the option board or the Inverter.
CPF07	ASIC Internal RAM Fault	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
CPF08	Watchdog Timer Fault	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
CPF09	CPU-ASIC Mutual Diagnosis Fault	-	Try turning the power supply off and on again.
		The control circuit is damaged.	Replace the Inverter.
CPF10	ASIC Version Fault	The Inverter control circuit is faulty	Replace the Inverter.
CPF20	Communications Option Board A/D Converter Error	The option board is not connected properly.	Turn off the power and insert the board again.
		The option board's A/D converter is faulty.	Replace the Communications Option Board.
CPF21	Communications Option Board Self Diagnostic Error	Communications Option Board fault.	Replace the option board.
CPF22	Communications Option Board Model Code Error		
CPF23	Communications Option Board DPRAM Error	Communications Option Board fault.	Replace the option board.
		The copy function of the Digital Operator was used during communications.	• Use the copy function off-line. • Use the copy function with an option board removed.
		The option board is not connected properly.	Turn off the power and insert the board again.

Table 7.2 Causes and Corrective Actions When the Digital Operator Goes Dark

Display	Meaning	Probable Causes	Corrective Actions
No display	There was a drop in control power voltage.	• A short-circuit between +V, −V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
		The short-circuit bar between +1 and +2 terminals in the control circuit has been removed.	Attach the short-circuit bar.
		P terminal and N terminal of the Braking Unit are connected in reverse.	• Check the wiring for the Braking Unit, including cables connected to the Braking Unit and relay terminals. • Replace the Inverter.
		Control power circuit failure	Charge indicator is lit: • Replace the Digital Operator. • Replace the control circuit terminal board or the Inverter. Charge indicator is not lit: • Check the input power supply voltage. • Replace the Inverter.
		Malfunction occurred in the control power circuit.	Turn OFF the power, wait for 5 minutes, and turn ON the power again.

◆ Alarm Detection

Alarms are detected as a type of Inverter protection function that do not operate the fault contact output. The system will automatically returned to its original status once the cause of the alarm has been removed.

The Digital Operator display blinks and an alarm is sent from the multi-function outputs (H2-01 to H2-03) if selected.

When an alarm occurs, take appropriate countermeasures according to the table below.

Table 7.3 Alarm Displays and Processing

Display	Meaning	Probable causes	Corrective Actions
EF (blinking)	Forward/Reverse Run Commands Input Together Both the forward and Reverse Run Commands have been ON for more than 0.5 s.	-	Check the sequence of the forward and Reverse Run Commands. Since the rotational direction is unknown, the motor will be decelerated to a stop when this minor fault occurs.
UV (blinking)	Main Circuit Undervoltage The following conditions occurred when there was no Run signal. • The main circuit DC voltage was below the Undervoltage Detection Level Setting (L2-05). • The surge current limiting magnetic contactor opened. • The control power supply voltage when below the CUV level.	See causes for UV1, UV2, and UV3 faults in the previous table.	See corrective actions for UV1, UV2, and UV3 faults in the previous table.
OV (blinking)	Main Circuit Overvoltage The main circuit DC voltage exceeded the overvoltage detection level. 200 V Class: Approx. 410 V 400 V Class: Approx. 820 V	The power supply voltage is too high.	Decrease the voltage so it's within specifications.
OH (blinking)	Cooling Fin Overheating The temperature of the Inverter's cooling fins exceeded the setting in L8-02.	The ambient temperature is too high.	Install a cooling unit.
		There is a heat source nearby.	Remove the heat source
		The Inverter cooling fan has stopped.	Replace the cooling fan. (Contact your Yaskawa representative.)
		• A short-circuit between +V, –V, and AC terminals occurred. • Overload in the control circuit terminal.	• Make sure that incorrect wiring has not been done. • Check the resistance and wiring for the frequency setting potentiometer, etc. (Check that the current for terminals +V and –V is 20 mA or less.)
FAn (blinking)	Inverter's Cooling Fan Fault An Inverter's cooling fan fault was detected. This fault is detected when L8-32 is set to 0.	The Inverter's cooling fan has stopped.	Replace the cooling fan. (Contact our sales representative.)
OH2 (blinking)	Inverter Overheating Pre-alarm An OH2 alarm signal (Inverter overheating alarm signal) was input from a multi-function input terminal (S3 to S8).	-	Clear the multi-function input terminal's overheating alarm input.

Table 7.3 Alarm Displays and Processing (Continued)

Display	Meaning	Probable causes	Corrective Actions
oH3 (blinking)	Motor Overheating E was set for H3-05 or H3-09 and the motor temperature thermistor input exceeded the alarm detection level.	The motor has overheated.	Check the size of the load and the length of the acceleration, deceleration, and cycle times.
			Check the V/f characteristics.
			Check the motor temperature input on terminals A2 and A3.
oL3 (blinking)	Overtorque 1 There has been a current greater than the setting in L6-02 for longer than the setting in L6-03.	-	• Make sure that the settings in L6-02 and L6-03 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
oL4 (blinking)	Overtorque 2 There has been a current greater than the setting in L6-05 for longer than the setting in L6-06.	-	• Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
UL3 (blinking)	Undertorque 1 There has been a current less than the setting in L6-02 for longer than the setting in L6-03.	-	• Make sure that the settings in L6-02 and L6-03 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
UL4 (blinking)	Undertorque 2 There has been a current less than the setting in L6-05 for longer than the setting in L6-06.	-	• Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate. • Check the mechanical system and correct the cause of the overtorque.
oS (blinking)	Overspeed The speed has been greater than the setting in F1-08 for longer than the setting in F1-09.	Overshooting/undershooting are occurring.	Adjust the gain again.
		The reference speed is too high.	Check the reference circuit and reference gain.
		The settings in F1-08 and F1-09 aren't appropriate.	Check the settings in F1-08 and F1-09.
PGo (blinking)	The PG is Disconnected The Inverter is outputting a frequency, but PG pulses aren't being input.	There is a break in the PG wiring.	Fix the broken/disconnected wiring.
		The PG is wired incorrectly.	Fix the wiring.
		Power isn't being supplied to the PG.	Supply power to the PG properly.
		Brake is applied to the motor.	Check for open circuit when using brake (motor).
dEv (blinking)	Excessive Speed Deviation The speed deviation has been greater than the setting in F1-10 for longer than the setting in F1-11.	The load is too large.	Reduce the load.
		The acceleration time and deceleration time are too short.	Lengthen the acceleration time and deceleration time.
		The load is locked.	Check the mechanical system.
		The settings in F1-10 and F1-11 aren't appropriate.	Check the settings in F1-10 and F1-11.
		Brake is applied to the motor.	Check for open circuit when using brake (motor).

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Table 7.3 Alarm Displays and Processing (Continued)

Display	Meaning	Probable causes	Corrective Actions
EF0 (blinking)	External Fault Detected for Communications Board Other Than SI-K2 Continuing operation was specified for EF0 (F6-03 = 3)and an external fault was input from the option board.	-	Remove the cause of the external fault.
EF3 (blinking)	External Fault (Input Terminal S3)	An external fault was input from a multi-function input terminal (S3 to S8).	• Reset external fault inputs to the multi-function inputs. • Remove the cause of the external fault.
EF4 (blinking)	External Fault (Input Terminal S4)		
EF5 (blinking)	External Fault (Input Terminal S5)		
EF6 (blinking)	External Fault (Input Terminal S6)		
EF7 (blinking)	External Fault (Input Terminal S7)		
EF8 (blinking)	External Fault (Input Terminal S8)		
FbL (blinking)	PID Feedback Reference Lost A PID feedback reference loss was detected (b5-12 = 2) and the PID feedback input was less than b5-13 (PID feedback loss detection level) for longer than the time set in b5-14 (PID feedback loss detection time).	The settings in b5-13 and b5-14 aren't appropriate.	Check the settings in b5-13 and b5-14.
		The wiring of the PID feedback circuit is incorrect.	Fix the wiring.
CE (blinking)	MEMOBUS Communications Error Normal reception was not possible for 2 s or longer after received control data.	-	Check the communications devices and signals.
bUS (blinking)	Option Board Communications Error A communications error occurred in a mode where the Run Command or a frequency reference is set from a Communications Option Board.	-	Check the communications devices and signals.
CALL (blinking)	Communications on Standby Control data was not normally received when power was turned ON.	-	Check the communications devices and signals.
CrST (blinking)	Reset during Run Command Input Error The reset signal was input during Run Command input from an external terminal or other source.	-	Check that a Run Command is not being input from an external terminal or other source.

Table 7.3 Alarm Displays and Processing (Continued)

Display	Meaning	Probable causes	Corrective Actions
E5 (blinking)	SI-T Watchdog Error Detected A Watchdog error was detected when the Run Command or a frequency reference was set from an option board and continuous operation was set for the E5 operation selection.	Synchronization error between master controller and Inverter for control data.	Check the communications timing such as communications cycle. *
AEr (blinking)	SI-T Station Number Setting Error Station number of SI-T option board was out of setting range.	Station number setting error.	Check the setting of the station number.*
		Circuit of SI-T option board is faulty.	Check the communications devices and signals.*
CyC (blinking)	SI-T Communications Cycle Setting Error Communications cycle of SI-T option board was out of range.	Communications cycle of SI-T option board set in master controller was out of range.	Check the communication cycle of SI-T option board set in master controller.*
bb (blinking)	Receiving External Baseblock Command External baseblock was input from external terminal again while it was input.	-	-

* Refer to *MECHATROLINK COMMUNICATIONS INTERFACE CARD INSTRUCTIONS (TOBPC73060008)* for details.

◆ Operation Errors

An operation error will occur if there is an invalid setting or a contradiction between two constant settings. It won't be possible to start the Inverter until the constants have been set correctly. (The alarm output and fault contact outputs will not operate either.)

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

Table 7.4 Operation Error Displays and Incorrect Settings

Display	Meaning	Incorrect settings
oPE01	Incorrect Inverter Capacity Setting	The Inverter capacity setting doesn't match the Unit. (Contact your Yaskawa representative.)
oPE02	Constant Setting Range Error	The constant setting is outside of the valid setting range. Press the ENTER Key on the Digital Operator to display OPE fault constant (U1-34).
oPE03	Multi-function Input Selection Error	One of the following errors has been made in the multi-function input (H1-01 to H1-06) 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 used together.) • The up/down commands (10 and 11) and Accel/Decel Ramp Hold (A) were selected at the same time. • Speed Search 1 (61, maximum output frequency) and Speed Search 2 (62. set frequency) were selected at the same time. • The up/down commands (10 and 11) were selected while PID Control Method Selection (b5-01) was enabled. • Positive and negative speed commands have not been set at the same time. • The emergency Stop Command NO and NC have been set at the same time. • Deceleration at momentary power loss (KEB) command (65 or 66) and High-slip braking (HSB) (68) were selected at the same time.
oPE05	Option Board Selection Error	The option board was selected as the frequency reference source by setting b1-01 to 3, but an option board isn't connected (C option).
oPE06	Control Method Selection Error	1 (V/f with PG) or 3 (Flux vector) was selected in A1-02, but a PG Speed Control Board isn't connected.
oPE07	Multi-function Analog Input Selection Error	The same setting has been selected for the analog input selection and the PID function selection. • H3-09 or H3-05 = B and H6-01 = 1 • H3-09 or H3-05 = C and H6-01 = 2 b1-01 (Reference Selection) is set to 4 (pulse input) and H6-01 (Pulse Train Input Function Selection) is set to a value other than 0 (frequency reference). H3-13 (Terminal A1/A2 switching) is set to 1 and H3-09 is set to other than 2 or H3-05 is set to 0 or 2. The same value is set to H3-05 and H3-09.
oPE08	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 V/f control. Press the ENTER Key on the Digital Operator to display OPE fault constant (U1-34).
oPE09	PID Control Selection Error	The following settings have been made at the same time. • b5-01 (PID Control Method Selection) has been set to a value other than 0. • b5-15 (PID Sleep Function Operation Level) has been set to a value other than 0. • b1-03 (Stopping Method Selection) has been set to 2 or 3.

Table 7.4 Operation Error Displays and Incorrect Settings (Continued)

Display	Meaning	Incorrect settings
oPE10	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) • E3-02 (FMAX) ≥ E3-04 (FA) > E3-05 (FB) ≥ E3-07 (FMIN)
oPE11	Constant Setting Error	One of the following constant setting errors exists. • C6-05 (Carrier Frequency Gain) > 6, the Carrier Frequency Lower Limit (C6-04) > the Carrier Frequency Gain(C6-05) • Upper/lower limit error in C6-03 to 05. • C6-01 is 0 and C6-02 is 2 to E. • C6-01 is 1 and C6-02 is 7 to E.
Err	EEPROM Write Error	A verification error occurred when writing EEPROM. • Try turning the power supply off and on again. • Try setting the constants again.

Note: If the settings for the constants of an Inverter with a different version of software are copied, an OPE error can occur. Contact your Yaskawa representative if wanting to copy the settings with a different software version.

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◆ Errors During Autotuning

The errors that can occur during autotuning are given in the following table. If an error is detected, the motor will coast to a stop and an error code will be displayed on the Digital Operator. The error contact output and alarm output will not function.

Table 7.5 Errors During Autotuning

Display	Meaning	Probable causes	Corrective Actions
Er-01	Motor data error	There is an error in the data input for autotuning. There is an error in the relationship between the motor output and the motor rated current. The is an error between the no-load current setting and the input motor rated current (when autotuning for only line-to-line resistance is performed for vector control).	• Check the input data. • Check the capacity of the Inverter and motor. • Check the motor rated current and no-load current.
Er-02	Alarm	A minor fault occurred during autotuning (xxx).	• Check the input data. • Check wiring and the machine. • Check the load.
Er-03	STOP key input	The STOP Key was pressed to cancel autotuning.	
Er-04	Line-to-line resistance error	Autotuning was not completed in the specified time. The results of autotuning has exceeded the setting range for a user constant.	• Check the input data. • Check the motor wiring. • If the motor is connected to the machine, disconnect it.
Er-05	No-load current error		
Er-08	Rated slip error		
Er-09	Acceleration error (detected only for rotational autotuning)	The motor did not accelerate in the specified time.	• Increase C1-01 (Acceleration Time 1). • Increase L7-01 and L7-02 (Reverse Torque Limits) if they are low. • If the motor is connected to the machine, disconnect it.
Er-10	Motor Direction Error	There is a faulty connection between the Inverter and PC (A or B phase) or the Inverter and Motor (U, V, or W).	• Check the PG wiring. • Check the motor wiring. • Check the PG rotation direction and F1-05 (PG rotation).
Er-11	Motor speed error (detected only for rotational autotuning)	The torque reference was too high (100%) during acceleration (for open-loop vector control only).	• If the motor is connected to the machine, disconnect it. • Increase C1-01 (Acceleration Time 1). • Check the input data (particularly the number of PG pulses and the number of motor poles).
Er-12	Current detection error	The current flow exceeded the motor rated current.	Check the current detection circuit, motor wiring, current detector, and installation methods.
		The detected current sign was the opposite of what it should be.	
		There is a phase fault for U, V, or W.	
Er-13	Leakage inductance error	Autotuning was not completed in the specified time.	Check the motor wiring.

Table 7.5 Errors During Autotuning (Continued)

Display	Meaning	Probable causes	Corrective Actions
PGo	PG Disconnection Detected	PG pulses were input when the Inverter was outputting a frequency.	Fix the broken/disconnected wiring.
End1	V/f settings excessive* (detected only for rotational autotuning)	The torque reference exceeded 100% and the no-load torque exceeded 70% during autotuning.	• Check and correct the settings. • Disconnect the load from the motor.
End2	Motor core saturation error (detected only for rotational autotuning)	The results of autotuning has exceeded the setting range for a user constant so a temporary setting was made for the motor core saturation coefficient.	• Check the input data. • Check motor wiring. • If the motor is connected to the machine, disconnect it.
End3	Rated current setting alarm*	The rated current is set high.	Check the input data (particularly the motor output current and motor rated current).
End4	Adjusted slip value fell below lower limit	As a result of stationary autotuning 1, the slip value has fallen to 0.2 Hz or below.	• Check the input data. • If rotational autotuning is possible, perform it. If impossible, perform stationary autotuning 2.

* Displayed after autotuning has been completed. For constants in which no error is detected, the settings are reset to the values determined by autotuning.

◆ Errors when Using the Digital Operator Copy Function

The errors that can occur when using the copy function from the Digital Operator are given in the following table. An error code will be displayed on the Digital Operator. If a Digital Operator key is pressed when an error code is being displayed, the display will be cleared and 03-01 will be displayed. The error contact output and alarm output will not function.

Table 7.6 Errors during Copy Function

Function	Display	Meaning	Probable causes	Corrective Actions
Read	PrE	Digital Operator write-protected	o3-01 was set to 1 to write a constant when the Digital Operator was write-protected (o3-02 = 0).	Set o3-02 to 1 to enable writing constants with the Digital Operator.
	iFE	Illegal read data	The read data length does not agree. The write data is incorrect.	Repeat the read. Check the Digital Operator cable. Replace the Digital Operator.
	rdE	Illegal write status	An attempted write of a constant to EEPROM on the Digital Writer failed.	A low Inverter voltage has been detected. Repeat the read. Replace the Digital Operator.

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Table 7.6 Errors during Copy Function (Continued)

Function	Display	Meaning	Probable causes	Corrective Actions
Copy	CPE	ID not matched	The Inverter product code or software number is different.	Use the copy function for the same product code and software number.
	vAE	Inverter capacity matched	The capacity of the Inverter being copied and the capacity in the Digital Operator are different.	Use the copy function for the same Inverter capacity.
	CrE	Control method matched	The control method of the Inverter being copied and the control method in the Digital Operator are different.	Use the copy function for the same control method.
	CYE	Verify error	The constant written to the Inverter was compared with the constant in the Digital Operator and they were different.	Retry the copy.
	CSE	Checksum error	The checksum in the Inverter constant area was compared with the checksum in the Digital Operator constant area and they were different.	Retry the copy.
Verify	vYE	Verify error	The Digital Operator and Inverter settings do not agree.	Retry the copy and verify again.
	CPE	ID not matched	The Inverter product code or software number is different.	Use the copy function for the same product code and software number.

Troubleshooting

Due to constant setting errors, faulty wiring, and so on, the Inverter and motor may not operate as expected when the system is started up. If that should occur, use this section as a reference and apply the appropriate measures.

If the contents of the fault are displayed, refer to *Protective and Diagnostic Functions*.

◆ If Inverter 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 is input.

This occurs when "constant write enable" (set value: 1B) is set for a multi-function input terminal (H1-01 to H1-06). If the constant write enable input is OFF, the constants cannot be changed. Turn it ON and then set the constants.

Passwords do not match. (Only when a password is set.)

If the constant A1-04 (Password) and A1-05 (Password Setting) numbers are different, the constants for the initialize mode cannot be changed. Reset the password.

If you cannot remember the password, display A1-05 (Password Setting) by pressing the Reset/Select Key and the Menu Key simultaneously while in the A1-04 display. Then reset the password. (Input the reset password in constant A1-04.)

■OPE01 through OPE11 is displayed.

The set value for the constant is wrong. Refer to *Operation Errors* in this chapter and correct the setting.

■CPF00 or CPF01 is displayed.

This is a Digital Operator communications error. The connection between the Digital Operator and the Inverter may be faulty. Remove the Digital Operator and then re-install it.

◆ If the Motor Does Not Operate

Use the following information if the motor does not operate.

■The motor does not operate when the RUN Key on the Digital Operator is pressed.

The following causes are possible.

IMPORTANT

If the Inverter is not in drive mode and the DRIVE indicator on the Digital Operator (JVOP-161) does not light up, the Inverter will remain in ready status and will not start. Press the Menu Key to make the DRIVE indicator flash, and enter the drive mode by pressing the DATA/ENTER Key. The DRIVE indicator will light when drive mode is entered.

The operation method setting is wrong.

If constant b1-02 (Operation Method Selection) is set to 1 (control circuit terminal), the motor will not operate 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 to 1 and disabled by setting o2-01 to 2. It is enabled when the drive mode is entered.

The frequency reference is too low.

If the frequency reference is set below the frequency set in E1-09 (Minimum Output Frequency), the Inverter will not operate.

Raise the frequency reference to at least the minimum output frequency.

There is a multi-function analog input setting error.

If H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) is set to 1 (frequency gain), and if no voltage (current) is input, then the frequency reference will be zero. Check to be sure that the set value and analog input value are correct.

■The motor does not operate 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 and the DRIVE indicator on the Digital Operator (JVOP-161) does not light up, the Inverter will remain in ready status and will not start. Press the MENU Key make the DRIVE indicator flash, and enter the drive mode by pressing the DATA/ENTER Key. The DRIVE indicator will light when drive mode is entered.

The operation method selection is wrong.

If constant b1-02 (reference selection) is set to 0 (Digital Operator), the motor will not operate when an external operation signal is input. Set b1-02 to 1 (control circuit terminal) and try again.

Similarly, the motor will also not operate 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 to 1 and disabled by setting o2-01 to 2. It is enabled when the drive mode is entered.

A 3-wire sequence is in effect.

The input method for a 3-wire sequence is different than when operating by forward/stop and reverse/stop (2-wire sequence). When 3-wire sequence is set, the motor will not operate even when an input terminal suitable for forward run/stop and reverse run/stop is turned ON.

When using a 3-wire sequence, refer to the timing chart, set the multi-function input terminal (H1-01 through H1-06, terminals S3 to S8) to 0, and input the proper signals.

When using a 2-wire sequence, set the multi-function input terminal (H1-01 through H1-06, terminals S3 to S8) to a value other than 0.

The frequency reference is too low.

If the frequency reference is set below the frequency set in E1-09 (Minimum Output Frequency), the Inverter will not operate. Raise the frequency reference to at least the minimum output frequency.

There is a multi-function analog input setting error.

If multi-function analog inputs H3-05 or H3-09 is set to 1 (frequency gain), and if no voltage (current) is input, then the frequency reference will be zero. Check to be sure that the set value and analog input value are correct.

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■The motor stops during acceleration or when a load is connected.

The load may be too heavy. The Inverter has a stall prevention function and an automatic torque boost 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 Inverter does not operate.

Probable Causes	Descriptions	Corrective Actions
Run command is not sent.	Inverter does not operate if a Run command is not sent.	If the indicator on the RUN Key is not lit, the Run Command is not sent. Input the Run Command.
The operation method selection is wrong.	b1-02 has to be set according to the Run Command input method to be used. b1-02= 0: Digital Operator 1: Control circuit terminal (factory setting) 2: MEMOBUS communications 3: Option board 4: Pulse train input	Set b1-02 according to the Run Command input method to be used.

Probable Causes	Descriptions	Corrective Actions
The frequency reference is too low.	The frequency reference has to be set above the frequency set in E1-09 (Minimum Output Frequency).	If the indicator on the STOP Key is flashing, check the frequency reference monitor (U1-01) and set the frequency reference above the frequency set in E1-09.
The frequency reference selection is wrong.	b1-01 has to be set according to the frequency reference input method to be used. b1-01= 0: Digital Operator 1: Control circuit terminal (factory setting) 2: MEMOBUS communications 3: Option board 4: Pulse train input	Set b1-01 according to the frequency reference input method to be used.
The MENU Key was pressed. The ESC Key was pressed twice.	If the MENU Key is pressed once or the ESC Key is pressed twice, the Inverter will exit the drive mode and will not operate. If the MENU Key is pressed during operation, the Inverter will not start even if the Run Command is sent at the next operation.	• Press the DATA/ENTER Key. • Try turning the power supply off and on again. • Set b8-01 (Run Command selection in programming modes) to 1(Cannot operate) to remain in the drive mode and continue operation even if the MENU Key or ESC Key is pressed.
The LOCAL/REMOTE Key was pressed.	If the LOCAL/REMOTE Key is pressed while the Inverter is stopped, the Inverter will switch to Digital Operator operation and cannot be operated with the external input terminals.	• Press the LOCAL/REMOTE Key. • Try turning the power supply off and on again. • Set o2-01 (LOCAL/REMOTE Key enable/disable) to 0 (Disabled) to disable the LOCAL/REMOTE Key.
The STOP Key was pressed.	If the STOP Key is pressed during operation, the Inverter will decelerate to a stop.	• Turn the Run Command off and then on again. • Set o2-02 (STOP key during control circuit terminal operation) to 0 (Disabled) to disable the STOP Key.
Wrong selection of a 2-wire or a 3-wire sequence.	If 0 is set to one of H1-01 to H1-10, a 3-wire sequence is set.	Make sure that H1-01 to H1-10 are set to a value other than 0 to use a 2-wire sequence.
"Reverse run prohibited" is selected.	If b1-04 (Prohibition of reverse operation) is set to 1 (Reverse disabled), the motor will not start if the Reverse Run Command is sent.	Check the setting of b1-04.
Autotuning has just been completed.	The Inverter remains in the autotuning mode right after autotuning has been completed and cannot be operated even if the Run Command is sent.	Press the MENU Key to display the drive mode on the Digital Operator and press the DATA/ENTER Key to enter the drive mode.

■The motor does not accelerate.

If the torque limit settings (L7-01 to L7-04) or the torque reference input (torque control) are too small, the motor may not be able to accelerate. Check the settings and 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 run prohibited), the Inverter will not receive Reverse Run Commands. To use both forward and reverse operation, set b1-04 to 0.

◆ If the Direction of the Motor Rotation is Reversed

If the motor operates in the wrong direction, the motor output wiring is faulty. When the Inverter T1(U), T2(V), and T3(W) are properly connected to the motor T1(U), T2(V), and T3(W), the motor operates 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 among T1(U), T2(V), and T3(W).

◆ If the Motor Does Not Put Out Torque or If Acceleration is Slow

Use the following information if the motor does not output torque or if acceleration is too slow.

■The torque limit has been reached.

When a torque limit has been set in constants L7-01 to L7-04, 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 suitable.

If torque limits have been set for the multi-function analog input (H3-09 or H3-05 = 10 to 12 or 15), check to be sure that the analog input value is suitable.

■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 suitable.

■The stall prevention level during running is too low.

If the value set for L3-06 (Stall Prevention Level during Running) is too low, the speed will drop before outputting torque. Check to be sure that the set value is suitable.

■Autotuning has not been performed for vector control

Vector control will not be perform if autotuning has not been performed. Perform autotuning separately for the motor, or set the motor constants through calculations. Alternatively, change the Control Method Selection (A1-02) to V/f control (0 or 1).

◆ If the Motor Operates Higher Than the Reference

Use the following information if the motor operates higher than the reference.

■The analog frequency reference bias setting is wrong (the gain setting is wrong).

The frequency reference bias set in constant H3-03 is added to the frequency reference. Check to be sure that the set value is suitable.

■A signal is being input to the frequency reference terminal A2 or A3.

When 0 (Add to terminal A1) is set for constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection), a frequency corresponding to the terminal A2 or A3 input voltage (current) is added to the frequency reference. Check to be sure that the set value and analog input value are suitable.

◆ 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 slip compensation limit set in constant C3-03. Check to be sure that the set value is suitable.

◆ If There is Low Speed Control Accuracy at High-speed Rotation in Open-loop Vector Control Method

The motor's rated voltage is high.

The Inverter's maximum output voltage is determined by its input voltage. (For example, if 200 VAC is input, then the maximum output voltage will be 200 VAC.) If, as a result of vector control, the output voltage reference value exceeds the Inverter output voltage maximum value, the speed control accuracy will decrease. Use a motor with a low rated voltage (i.e., a special motor for use with vector control), or change to flux vector control.

◆ If Motor Deceleration is Slow

Use the following information when the motor deceleration is slow.

■The deceleration time is long even when braking resistor is connected.

The following causes are possible.

"Stall prevention during deceleration enabled" is set.

When braking resistor is connected, set constant L3-04 (Stall Prevention Selection during Deceleration) to 0 (disabled) or 3 (with braking resistor). When this constant is set to 1 (enabled, the factory setting), braking resistor does not fully function.

The deceleration time setting is too long.

Check the deceleration time setting (constants C1-02, C1-04, C1-06, and C1-08).

Motor torque is insufficient.

If the constants are correct and there is no overvoltage fault, then the motor's power is limited. Consider increasing the motor capacity.

The torque limit has been reached.

When a torque limit has been set in constants L7-01 to L7-04, no torque will be output beyond that limit. This can cause the deceleration time to be too long. Check to be sure that the value set for the torque limit is suitable.

If H3-09 (Multi-function Analog Input Terminal A2 Function Selection) or H3-05 (Multi-function Analog Input Terminal A3 Function Selection) is set to 10, 11, 12 or 15 (positive and negative torque limit), check to be sure that the analog input value is suitable.

■If the Vertical-axis Load Drops When Brake is Applied

The sequence is incorrect. The Inverter goes into DC injection braking status for 0.5 seconds after deceleration is completed. (This is the factory-set default.)

To ensure that the brake holds, set frequency detection 2 (H2-01 = 5) for the multi-function contact output terminals (M1 and Mw) so that the contacts will turn OFF when the output frequency is greater than L4-01 (3.0 to 5.0 Hz). (The contacts will turn ON below L4-01.)

There is hysteresis in frequency detection 2 (i.e., a frequency detection width, L4-02 = 2.0 Hz). Change the setting to approximately 0.5 Hz if there are drops during stop. Do not use the multi-function contact output run signal (H2-01 = 0) for the brake ON/OFF signal.

◆ If the Motor Overheats

Take the following steps if the motor overheats.

■The load is too big.

If the motor load is too heavy and the motor is used with the effective torque exceeding the motor's rated torque, the motor will overheat. Some motor rating are given 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.

■The withstand voltage between the motor phases is insufficient.

When the motor is connected to the Inverter output, a surge is generated between the Inverter switching and the motor coil. Normally the maximum surge voltage is three times the Inverter's input power supply voltage (i.e., 1,200 V for 400 V Class). Be sure to use a motor with a withstand voltage between the motor phases that is greater than the maximum surge voltage. In particular, when using a 400 V Class Inverter, use a special motor for Inverters.

■Autotuning has not been performed for vector control

Vector control will not perform if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations. Alternatively, change the Control Method Selection (A1-02) to V/f control (0 or 1).

◆ If There is Noise When the Inverter is Started or From an AM Radio

If noise is generated by Inverter switching, implement the following countermeasures:

- Change the Inverter's Carrier Frequency Selection (C6-02) to lower the carrier frequency. This will help to some extent by reducing the amount of internal switching.
- Install an Input Noise Filter at the Inverter's power supply input area.
- Install an Output Noise Filter at the Inverter's power supply output area.
- Use metal tubing. Electric waves can be shielded by metal, so encase the Inverter with metal (steel).
- Ground the Inverter and motor.
- Separate main circuit wiring from control wiring.

◆ If the Ground Fault Interrupter Operates When the Inverter is Run

The Inverter performs internal switching, so there is a certain amount of leakage current. This may cause the ground fault interrupter to operate and cut off the power supply. Change to a ground fault interrupter with a high leakage detection level (i.e., a sensitivity current of 200 mA or greater per Unit, with an operating time of 0.1 s or more), or one that incorporates high frequency countermeasures (i.e., one designed for use with Inverters). It will also help to some extent to change the Inverter's Carrier Frequency Selection (C6-02) to lower the carrier frequency. In addition, remember that the leakage current increases as the cable is lengthened.

◆ If There is Mechanical Oscillation

Use the following information when there is mechanical oscillation.

■The machinery is making unusual sounds.

The following causes are possible.

There may be resonance between the mechanical system's characteristic frequency and the carrier frequency.

If the motor is running with no problems and the machinery is oscillating with a high-pitched whine, it may indicate that this is occurring. To prevent this type of resonance, adjust the carrier frequency with constants C6-02 to C6-05.

There may be resonance between a machine's characteristic frequency and the output frequency of the Inverter.

To prevent this from occurring, either use the jump frequency functions in constants d3-01 to d3-04 or install rubber padding on the motor base to reduce oscillation.

■Oscillation and hunting are occurring with open-loop vector control.

The gain adjustment may be insufficient. Reset the gain to a more effective level by adjusting constants C4-02 (torque compensation time constant), C2-01 (S-curve Characteristic Time at Acceleration Start), and C3-02 (Slip Compensation Primary Delay Time) in order. Lower the gain setting and raise the primary delay time setting.

Vector control will not perform if autotuning has not been performed. Perform autotuning separately for the motor, or set the motor constants through calculations. Alternatively, change the control method selection (A1-02) to V/f control (0 or 1).

■Oscillation and hunting are occurring with V/f control.

The gain adjustment may be insufficient. Reset the gain to a more effective level by adjusting constants C4-02 (Torque Compensation Primary Delay Time Constant), N1-02 (Hunting Prevention Gain), and C3-02 (Slip Compensation Primary Delay Time) in order. Lower the gain setting and raise the primary delay time setting.

■Oscillation and hunting are occurring with V/f w/PG control.

The gain adjustment may be insufficient. Adjust the various types of speed control loop (ASR) gain.

If the oscillation cannot be eliminated in this way, set the hunting prevention selection (constant N1-01) to 0 (disabled) and then try adjusting the gain again.

■Oscillation and hunting are occurring with 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 primary delay time constant for speed control (ASR) in C5-06 and then readjust the gains.

If autotuning is not performed, proper performance cannot be achieved for vector control. Perform autotuning or set the motor constants according to calculations.

■Oscillation and hunting are occurring with PID control.

If there is oscillation or hunting during PID control, check the oscillation cycle and individually adjust P, I, and D constants. (Refer to page 6-113.)

■Autotuning has not been performed with vector control.

Vector control will not perform if autotuning has not been performed. Perform autotuning separately for the motor, or set the motor constants through calculations. Alternatively, change the Control Method Selection (A1-02) to V/f control.

◆ If the Torque Generated for 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 problem occurs after performing stationary autotuning, perform rotational autotuning.

◆ If the Motor Rotates Even When Inverter Output is Stopped

If the motor rotates even when the Inverter output is stopped, the DC injection braking is insufficient. If the motor continues operating at low speed, without completely stopping, and after a deceleration stop has been executed, it means that the DC injection braking is not decelerating enough. Adjust the DC injection braking as follows:

- Increase the constant b2-02 (DC Injection Braking Current) setting.
- Increase the constant b2-04 (DC Injection Braking (initial excitation) Time at Stop) setting.

◆ If OV is Detected When the Fan is Started, or Fan Stalls

Generation of OV (main circuit voltage) and stalling can occur if the fan is turning when it is started. The DC injection braking is insufficient when starting.

This can be prevented by slowing fan rotation by DC injection braking before starting the fan. Increase the constant b2-03 (DC injection braking time (initial excitation) at start) setting.

◆ 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 Jump Frequency (constants d3-01 to d3-03) and Jump Frequency Width (constant d3-04) settings are suitable.

■The frequency reference upper limit has been reached.

The output frequency upper limit is determined by the following formula:
Maximum Output Frequency (E1-04) × Frequency Reference Upper Limit (d2-01) / 100
Check to be sure that the constant E1-04 and d2-01 settings are suitable.

8

Maintenance and Inspection

This chapter describes basic maintenance and inspection for the Inverter.

Maintenance and Inspection

◆ Outline of Free Warranty

The free warranty period of the Inverter is as follows:

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

◆ Daily Inspection

Check the following items with the system in operation.

- The motor should not be vibrating or making unusual noises.
- There should be no abnormal heat generation.
- The ambient temperature should not be too high.
- The output current value shown on the monitor displays should not be higher than normal.
- The cooling fan on the bottom of the Inverter should be operating normally.

◆ Periodic Inspection

Check the following items during periodic maintenance.

Always turn OFF the power supply before beginning inspection. Turn OFF the main circuit power supply, wait for the time indicated on the front cover, and make sure the CHARGE indicator light has gone out, and then perform maintenance and inspection. Be sure not to touch terminals right after the power has been turned off. Doing so can result in electric shock.

Table 8.1 Periodic Inspections

Item	Inspection	Corrective Procedure
External terminals, mounting bolts, connectors, etc.	Are all screws and bolts tight?	Tighten loose screws and bolts firmly.
	Are connectors tight?	Reconnect the loose connectors.
Heatsinks	Are the fins dirty or dusty?	Clean off any dirt and dust with an air gun using dry air at a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 to 6 kg•cm^2).
PCBs	Is there any conductive dirt or oil mist on the PCBs?	Clean off any dirt and dust with an air gun using dry air at a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 to 6 kg•cm^2). Replace the boards if they cannot be made clean.
Cooling fan	Is there any abnormal noise or vibration or has the total operating time exceeded 20,000 hours?	Replace the cooling fan.
Power elements	Is there any conductive dirt or oil mist on the elements?	Clean off any dirt and dust with an air gun using dry air at a pressure of 39.2×10^4 to 58.8×10^4 Pa (4 to 6 kg•cm^2).
Smoothing capacitor	Are there any irregularities, such as discoloration or odor?	Replace the capacitor or Inverter.

◆ Periodic Maintenance of Parts

The Inverter is configured of many parts, and 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. In order to keep the Inverter operating normally over a long period of time, it is necessary to perform period inspections and replace parts according to their service life.

Periodic inspection standards vary depending the Inverter's installation environment and usage conditions. The Inverter's maintenance periods are noted below. Keep them as reference.

Refer to *Cooling Fan Replacement Outline* (Page 8-6) for replacing a cooling fan and *Circulation Fan Replacement Outline* (Page 8-16) for replacing a circulation fan.
To replace other parts, contact your Yaskawa representative or YASKAWA ELECTRIC ENGINEERING CORPORATION for details on preventive maintenance for Inverters.

Table 8.2 Part Replacement Guidelines

Part	Standard Replacement Period	Replacement Method
Cooling fan	2 to 3 years	Replace with new part.
Smoothing capacitor	5 years	Replace with new part. (Determine need by inspection.)
Breaker relays	-	Determine need by inspection.
Fuses	10 years	Replace with new part.
Aluminum capacitors on PCBs	5 years	Replace with new board. (Determine need by inspection.)

Note 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. per day

◆ Procedure for Adjusting Constants after Replacement of Control Board

Before replacing the control board, use the COPY function of the Digital Operator to copy the settings of the constants of the control board from the Inverter to the Digital Operator.

When using the copy function of the Digital Operator, check that the following settings are the same between the Inverter and the Digital Operator.

- Inverter product and type
- Software number
- Inverter capacity and voltage
- Control method

Refer to *Copying Constants* of Chapter 6 on page 6-151.

After replacing the board, use the following procedure to adjust the constants.

Contact your Yaskawa representative if a control board with older version is used.

Step No.	Digital Operator Display	Description
1	o2-04 → DATA ENTER → 2F (DRIVE QUICK ADV VERIFY A.TUNE)	Set o2-04 (kVA selection) to the capacity of the Inverter that you use.
2	A1-03 → DATA ENTER → 2220 (DRIVE QUICK ADV VERIFY A.TUNE)	Set A1-03 (Initialize) to 2220 (2-wire initialization) or 3330 (3-wire initialization). This example is a typical setting for initialization by a 2-wire sequence.
3	-	After initialization has been completed, use the copy function of the Operator to copy the settings of the constants of the control board from the Operator to the Inverter before replacing the board. If the copy function is not available, change the setting of the constants manually.*
4	F 0.00 → DATA ENTER → F 0.00 (DRIVE QUICK ADV VERIFY A.TUNE)	Switch the mode to the DRIVE, and then press the DATA/ENTER Key to display the frequency setting display. The operation becomes enabled.

* The factory settings of C6-01(CT/VT selection) between Inverters with software version PRG:101□ and PRG: 103□ are different. Be sure to check the C6-01 setting of the Inverter before replacing the control board, and set C6-01.

◆ Types and Number of Cooling Fans Used in the Drive

Cooling fans used for the Drive has two types; Heatsink cooling fan and heatsink circulation fan. Heatsink cooling fan blows air to the Drive cooling fin. Heatsink circulation fan stirs up the air inside the Drive unit.

Table 8.3 shows the number of cooling fans used in the Drive. For more information on models and specifications of cooling fans, contact your Yaskawa representative or YASKAWA ELECTRIC ENGINEERING CORPORATION.

When replacing the fan, use the specified type of the fan. If the inapplicable fans are used, performance of the Drive will not be fully obtained.

Table 8.3 Number of Cooling Fans to be Used

Maximum Motor Capacity (kW)	200 V Class		400 V Class	
	Heatsink Cooling Fan	Heatsink Circulation Fan	Heatsink Cooling Fan	Heatsink Circulation Fan
0.4	-	-	-	-
0.75	-	-	-	-
1.5	-	-	-	-
2.2	-	-	1	-
3.7	1	-	1	-
5.5	1	-	1	-
7.5	2	-	2	-
11	2	1	2	1
15	2	-	2	-
18.5	2	1	2	1

Table 8.3 Number of Cooling Fans to be Used (Continued)

Maximum Motor Capacity (kW)	200 V Class		400 V Class	
	Heatsink Cooling Fan	Heatsink Circulation Fan	Heatsink Cooling Fan	Heatsink Circulation Fan
22	2	-	2	-
30	2	-	2	-
37	2	1	2	-
45	2	1	2	-
55	2	1	2	-
75	2	1	2	1
90	2	1	2	1
110	2	1	2	1
132	-		2	1
160			2	1
185			4	2
220			4	2
300			5	2

◆ Cooling Fan Replacement Outline

■200 V and 400 V Class Inverters of 18.5 kW or Less

A cooling fan is attached to the bottom of the Inverter.

If the Inverter is installed using the mounting holes on the back of the Inverter, the cooling fan can be replaced without removing the Inverter from the installation panel.

Removing the Cooling Fan

1. Press in on the right and left sides of the fan cover in the direction of arrows 1 and pull the fan out in the direction of arrow 2.
2. Pull out the cable connected to the fan from the fan cover and disconnect the relay connector.
3. Open the fan cover on the left and right sides and remove the fan cover from the fan.

Mounting the Cooling Fan

1. Attach the fan cover to the cooling fan. Be sure that the airflow direction indicated by the arrows above faces into the Inverter.
2. Connect the relay connector securely and place the relay connector and cable into the fan cover.
3. Mount the fan cover on the Inverter. Be sure that the tabs on the sides of the fan cover click into place on the Inverter.

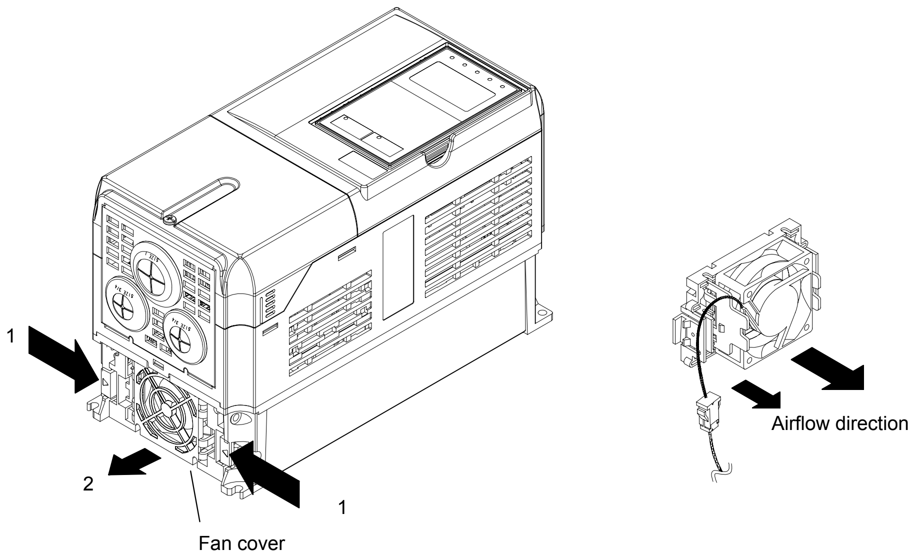


Fig 8.1 Cooling Fan Replacement (200 V Class Inverters of 5.5 kW)

■200 V and 400 V Class Inverters of 22 kW or More

A cooling fan is attached to the top panel inside the Inverter.

The cooling fan can be replaced without removing the Inverter from the installation panel.

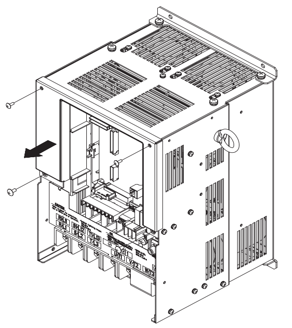
200 V Class Inverters of 22 kW, 30kW and 400 V Class Inverters of 22 kW to 55 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove the control board bracket to which the boards are mounted. Remove all cables connected to the control board. The cables connected to the control circuit terminals can be removed at the same time by removing them together with the control circuit terminal board. This procedure is not required for 400 V Class Inverters of 37 kW, 45 kW, and 55 kW. (Refer to page 8-21.)
3. Remove the cooling fan power cable connector (CN26 and CN27) from the gate drive board positioned at the back of the controller.
4. Remove the fan cover screws and pull out the fan cover from the Inverter.
5. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components. Refer to the next page for attaching the fan cover.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.



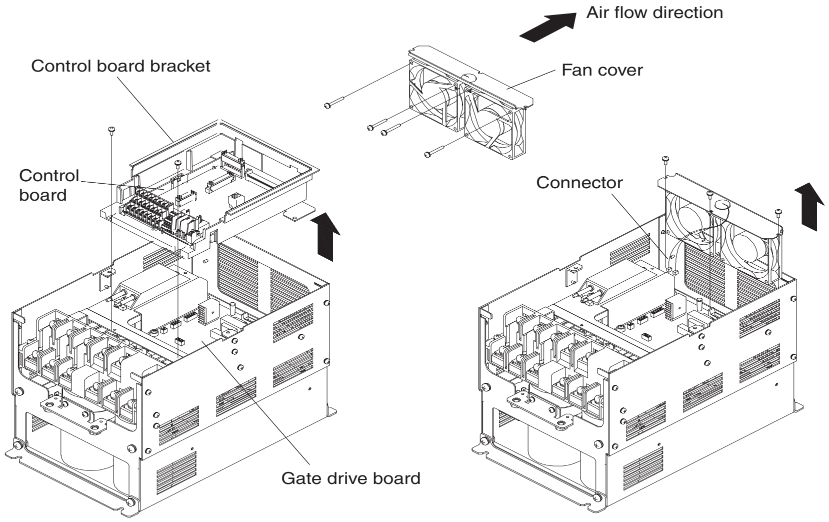


Fig 8.2 Cooling Fan Replacement (200 V Class Inverters of 22 kW)

Attaching the Fan Cover

1. Tilt the fan cover toward the bottom of the Inverter as shown in Fig 8.3 and insert it to the mounting hole until it meets with A.

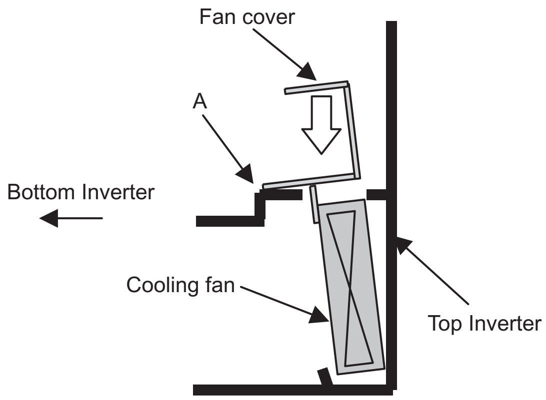


Fig 8.3

2. Push the fan cover toward the top of the Inverter.

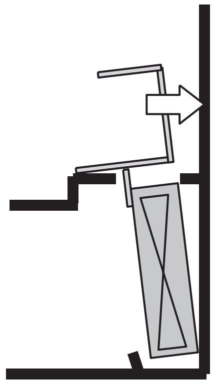


Fig 8.4

3. Make sure that there is no gap between the fan cover and A. Then screw it in place with the three screws.

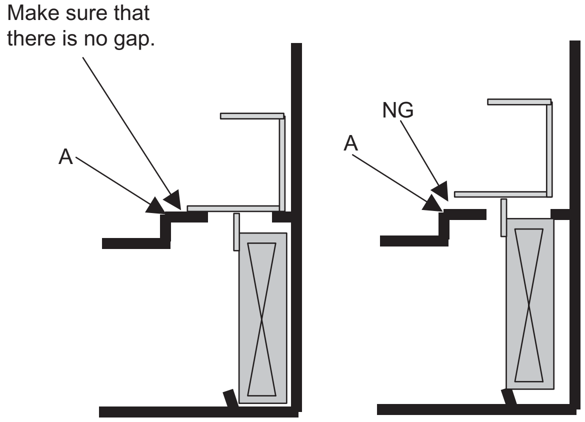


Fig 8.5

200 V Class Inverters of 55 kW, 75 kW and 400 V Class Inverters of 75 kW, 90 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Pull the cooling fan power cable connector that extends from the fan cover cable hole out of the cooling fan power relay board.
3. Only for 400 V Class Inverters of 75 kW and 90 kW, loosen the resistor unit mounting screws and slide the resistor unit to remove it. Take care as the resistor unit is hot.
4. Remove the fan cover screws and pull out the fan cover from the Inverter.
5. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.

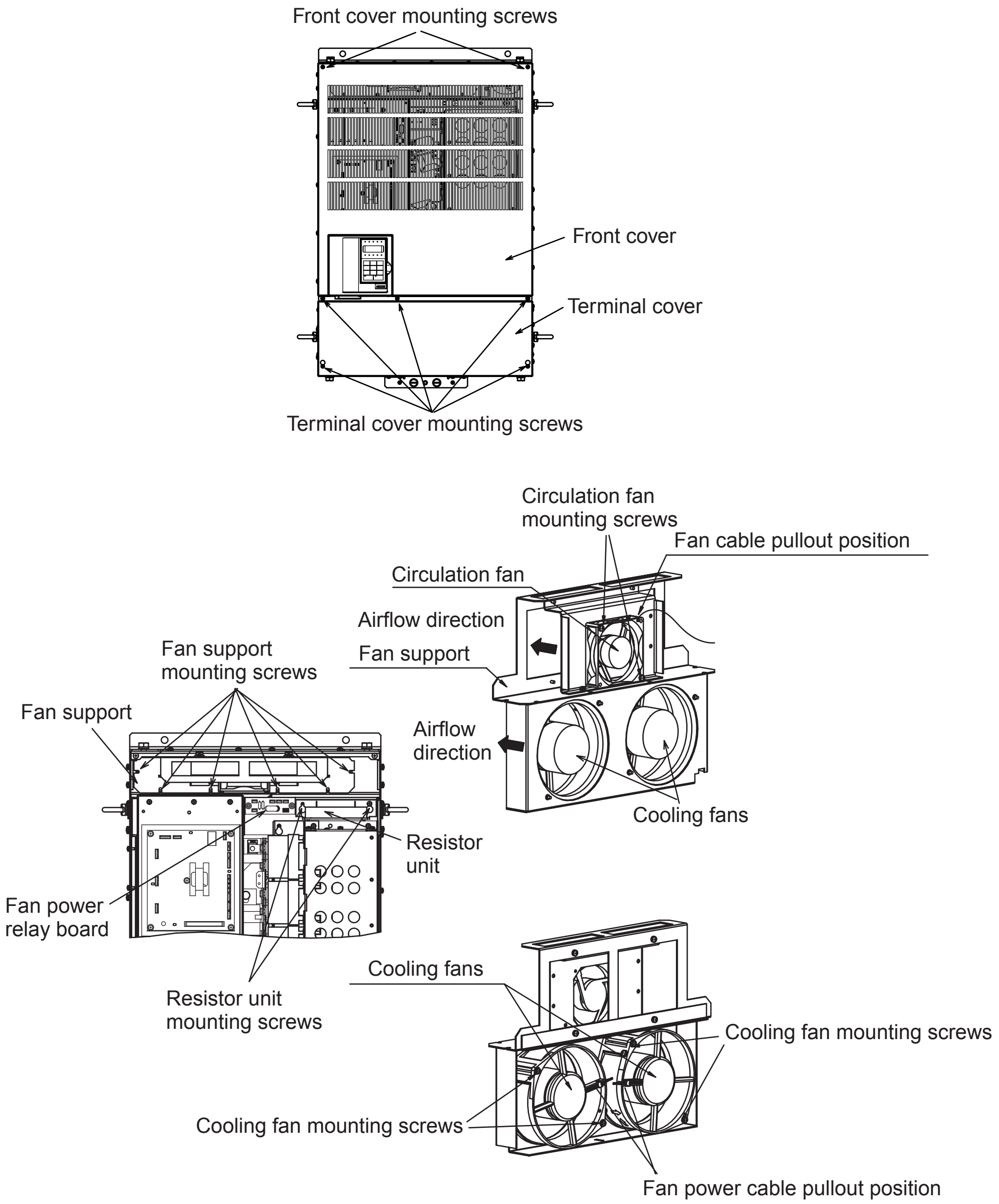


Fig 8.6 Cooling Fan Replacement (400 V Class Inverters of 75 kW and 90 kW)

200 V Class Inverters of 37 kW and 45 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove the panel to which the control board, the gate drive board, and the cooling fan power relay board are mounted. Remove any cables that are connected to the control board, the gate drive board, and the cooling fan power relay board. The cable that is connected to the control circuit terminals can be removed together with the control circuit terminal board. (Refer to page 8-21.)
3. Remove the fan cover screws and pull out the fan cover from the Inverter.
4. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.

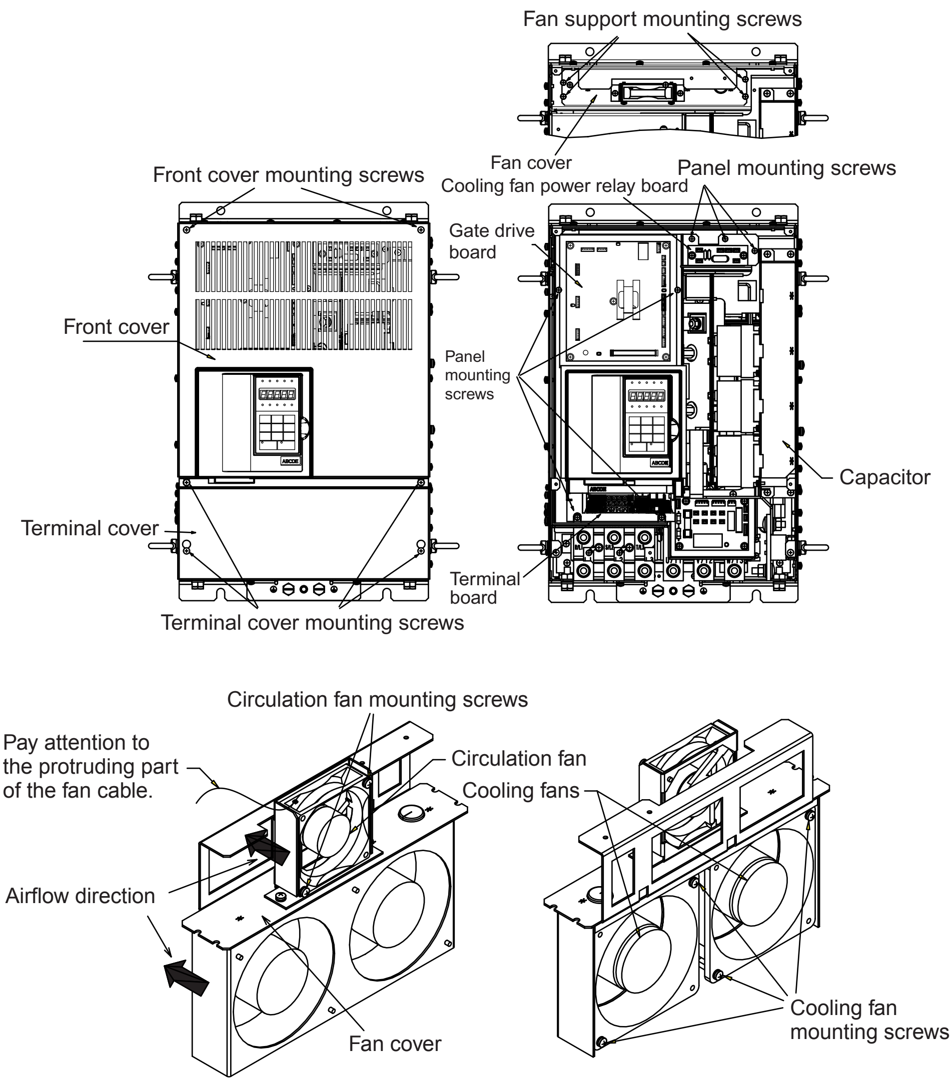


Fig 8.7 Cooling Fan Replacement (200 V Class Inverters of 37 kW and 45 kW)

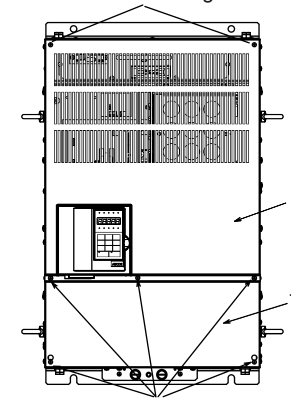
200 V Class Inverters of 90 kW

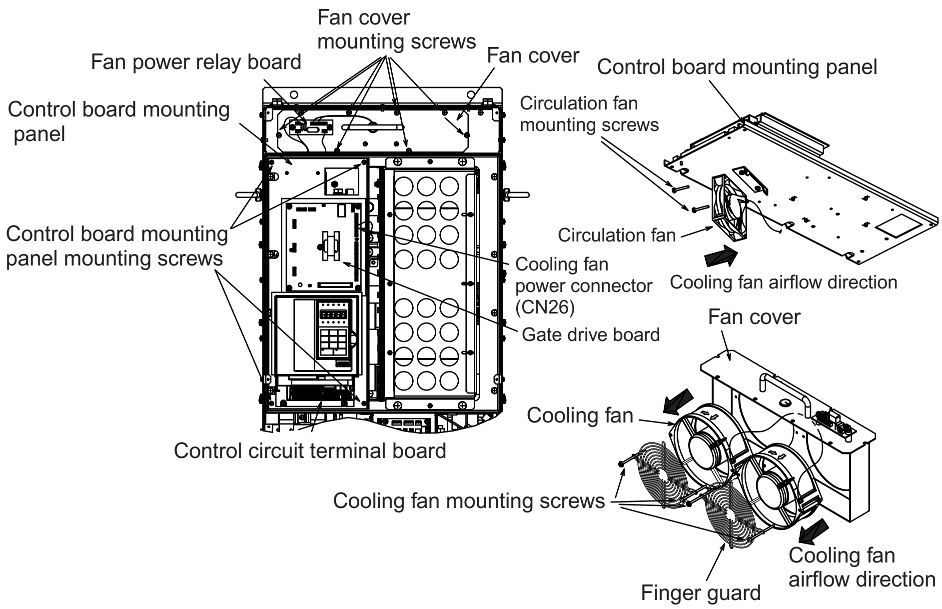
Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove the panel to which the control board, the gate drive board, and the cooling fan power relay board are mounted. Remove any cables that are connected to the control board, the gate drive board, and the cooling fan power relay board. The cable that is connected to the control circuit terminals can be removed together with the control circuit terminal board. (Refer to page 8-21.)
3. Remove the fan cover screws and pull out the fan cover from the Inverter.
4. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.





Note: A finger guard is not provided on lnverter with slits.

Fig 8.8 Cooling Fan Replacement (200 V Class Inverters of 90 kW)

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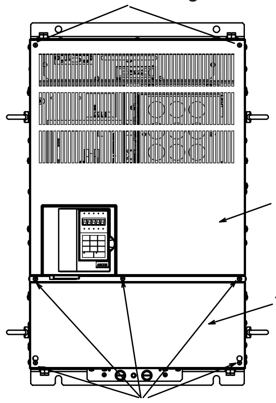
400 V Class Inverters of 110 kW and 132 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove any cables that are connected to the cooling fan power relay board. The cable that is connected to the control circuit terminals can be removed together with the control circuit terminal board. (Refer to page 8-21.)
3. Remove the fan cover screws and pull out the fan cover from the Inverter.
4. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.



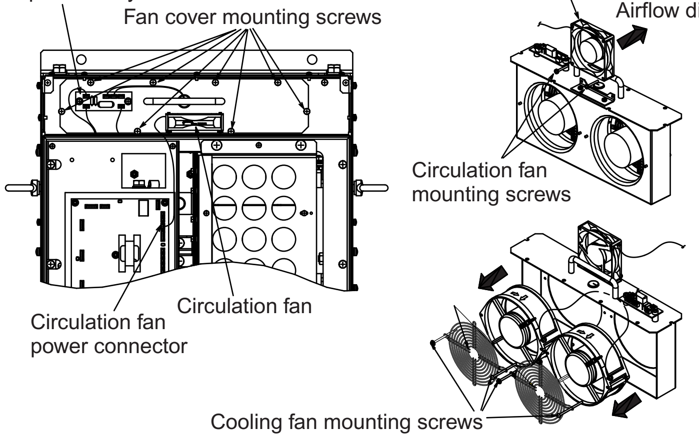


Fig 8.9 Cooling Fan Replacement (400 V Class Inverters of 110 kW)

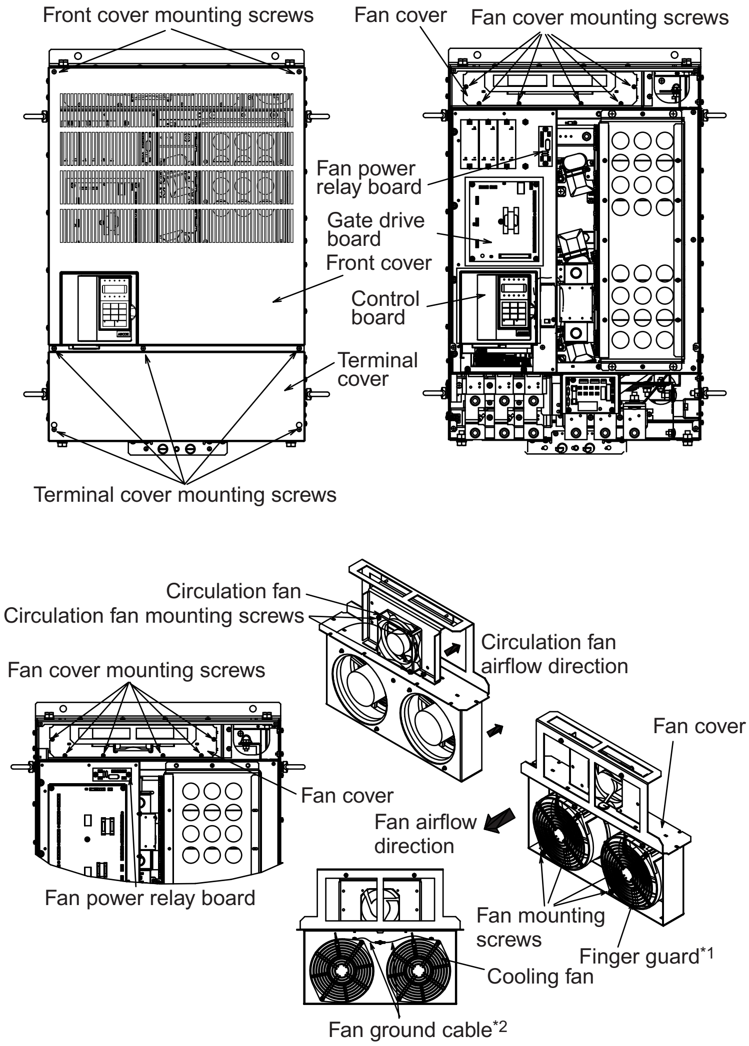
200 V Class Inverters of 110 kW and 400 V Class Inverters of 160 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove any cables that are connected to the cooling fan power relay board. The cable that is connected to the control circuit terminals can be removed together with the control circuit terminal board. (Refer to page 8-21.)
3. Remove the fan cover screws and pull out the fan cover from the Inverter.
4. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.



* 1. There is no finger guard mounted to the fan for some capacities. (There is a guard on the Inverter side.)
* 2. There is no fan ground cable for the capacities without a finger guard.

Fig 8.10 Cooling Fan Replacement (200 V Class Inverters of 110 kW)

400 V Class Inverters of 185 kW and 220 kW

Removing the Cooling Fan

1. Remove the terminal cover and top and bottom front covers from the front of the Inverter.
2. Remove any cables that are connected to the cooling fan power relay board.
3. Remove the fan cover screws and pull out the fan covers from the Inverter.
4. Remove the cooling fan from the fan cover and replace it with a new one.

Mounting the Cooling Fan

After attaching a new cooling fan, reverse the above procedure to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the airflow faces the top of the Inverter.
Make sure that the fan cable and the fan ground cable are not tangled or pinched.

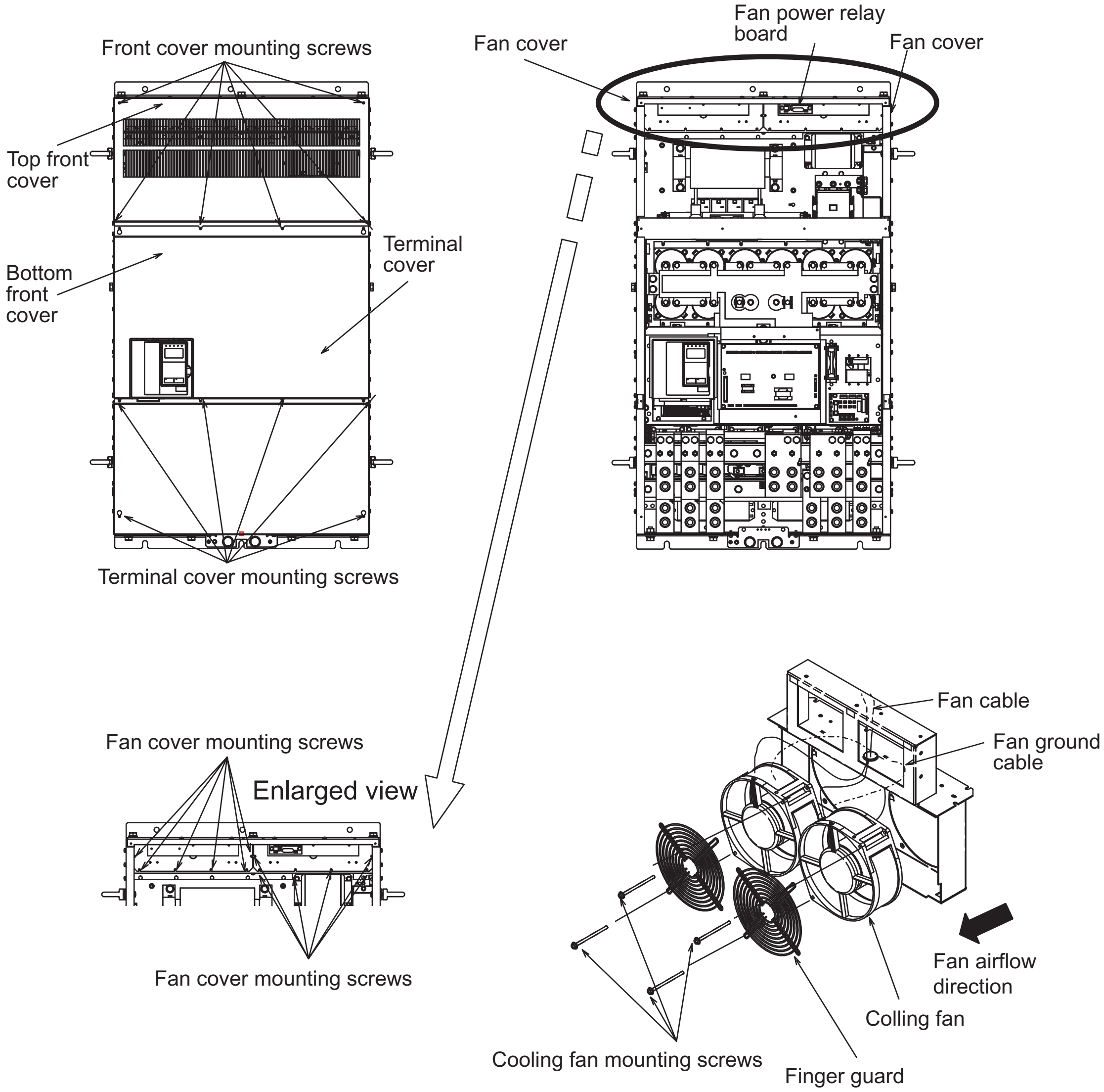


Fig 8.11 Cooling Fan Replacement (400 V Class Inverters of 185 kW and 220 kW)

400 V Class Inverters of 300 kW

Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the front of the Inverter.
2. Remove any cables that are connected to the cooling fan power relay board. The cable that is connected to the terminal board can be removed together with the terminal board.
3. Remove the fan unit screws and pull out the fan units from the Inverter.
4. Replace the fan units with new ones.
   And, remove the screws for the fan power relay board and attach this board to the new unit.

Mounting the Cooling Fan

After attaching a new cooling fan unit, reverse the above procedure to attach all of the components.

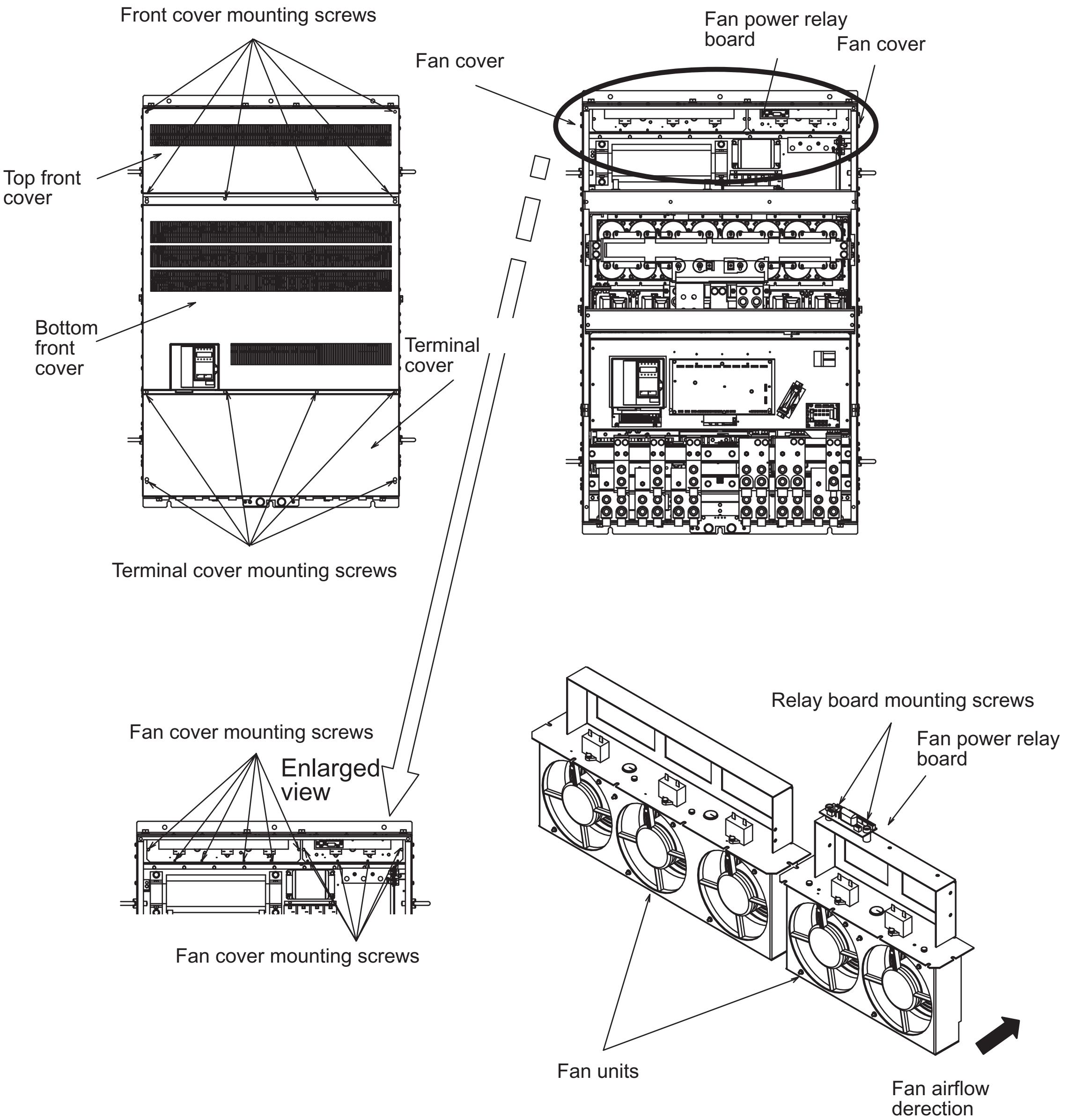


Fig 8.12 Cooling Fan Replacement (400 V Class Inverters of 300 kW)

8

◆ Circulation Fan Replacement Outline

With some capacities, there is a small fan installed inside the Inverter for the purpose of increasing circulation in areas where heat has built up. These fans have built-in fan sensors that output an alarm when the rotation rate of the fan drops to indicate that replacement is necessary.

■200 V and 400 V Class Inverters of 11 kW

The circulation fan is installed behind the control circuit terminal board inside the Inverter.

The circulation fan can be replaced by removing the control circuit terminal board.

Removing the Circulation Fan

1. Remove the Digital Operator, the terminal cover, and the front cover.
2. Remove the control circuit terminal board. Remove the cables connected to the terminals if necessary.
3. While pushing the two tabs (A) in direction 1, pull the fan out in direction 2.
4. Remove the relay connector connected to the fan.

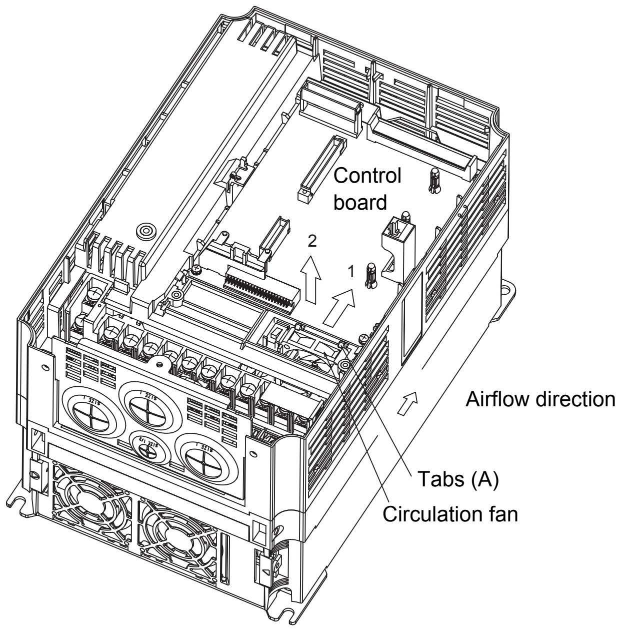
Mounting the Circulation Fan

Reverse the above procedure to mount the fan.

Be sure to mount the fan so that the air flows towards the top of the Inverter (direction indicated by the arrow).

Mount the fan securely using the tabs (A).

Confirm that there are no cables in contact with the fan’s rotating parts.



Inverter with Control Circuit Terminal Board Removed

Fig 8.13   Circulation Fan Replacement (200 V and 400 V Class Inverters of 11 kW)

■200 V and 400 V Class Inverters of 18.5 kW

The circulation fan is installed at the top-left corner of the Inverter interior.

Removing the Circulation Fan

1. Remove the Digital Operator, the terminal cover, and the front cover.
2. While pushing the relay connector tab (A) in direction 1, pull the relay connector out in direction 2.
3. While pushing the fan tabs (B) in direction 3, pull the fan out in direction 2.
4. Remove the relay connector connected to the fan.

Mounting the Circulation Fan

Reverse the above procedure to mount the fan.

Be sure to mount the fan so that the air flows towards the bottom of the Inverter (direction indicated by the arrow).

Mount the fan securely using the fan tabs (B).

Confirm that there are no cables in contact with the fan's rotating parts.

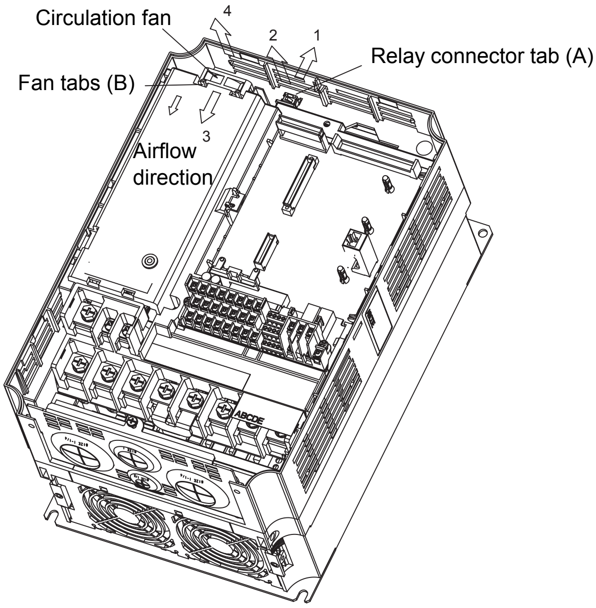


Fig 8.14 Circulation Fan Replacement (200 V and 400 V Class Inverters of 18.5 kW)

■200 V Class Inverters of 37 kW or More and 400 V Class Inverters of 75 to 160 kW

The circulation fan is installed in front of the fan cover inside the Inverter. Remove the circulation fan using the procedure for replacing the cooling fan and replace it with the new fan. (The installation position for 200 V Class Inverters of 75 kW is different.)

200 V Class Inverters of 90 kW

The circulation fan is installed behind the control board mounting panel. Do not subject the fan to shock during replacement.

Removing the Circulation Fan

1. Remove the terminal cover, the Inverter cover, the Digital Operator, and the control board cover.
2. Pull out the cables connected to the control circuit terminal board, the gate drive board, and the cooling fan power relay board.
3. Remove the control board mounting panel.
4. Replace the circulation fan installed behind the control board mounting panel.

Mounting the Circulation Fan

Reverse the above procedure to mount the fan.

Be sure to mount the fan so that the air flows in the direction indicated by the arrow in the corresponding diagram.

Confirm that there are no cables in contact with the fan's rotating parts.

Refer to *Fig 8.8 Cooling Fan Replacement (200 V Class Inverters of 90 kW)* for details.

400 V Class Inverters of 185 kW and 220 kW

Two circulation fans are installed as described in the following sections.

Removing the Circulation Fan

1. Remove the terminal cover and top and bottom front covers.
2. Unscrew the frame fixing screws and take off the frame.
3. Remove the relay connector connected to the fan.
4. Remove the fan cover mounting screws and pull the fan cover out.
5. Remove the fan from the fan cover and replace it with a new one.

Mounting the Circulation Fan

Reverse the above procedure to mount the fan.

Be sure to mount the fan so that the air flows in the direction indicated by the arrow in the corresponding diagram.

Confirm that there are no cables in contact with the fan's rotating parts.

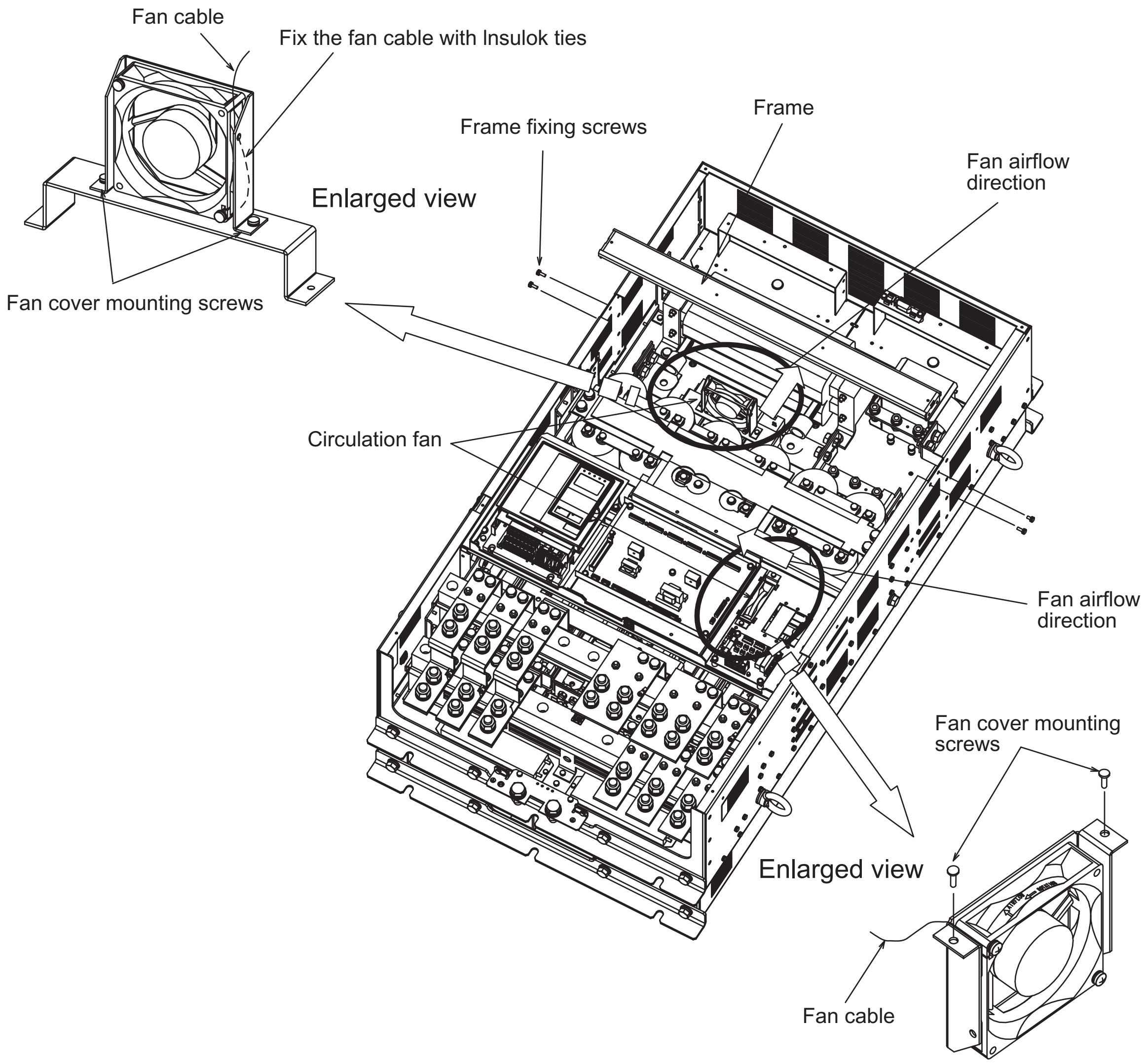


Fig 8.15 Circulation Fan Replacement (400 V Class Inverters of 185 kW and 220 kW)

400 V Class Inverters of 300 kW

Two circulation fans are installed as described in the following sections.

Removing the Circulation Fan

1. Remove the terminal cover and top and bottom front covers.
2. Unscrew the frame fixing screws and takeoff the frame.
3. Remove the relay connector connected to the fan.
4. Remove the fan cover mounting screws and pull the fan cover out.
5. Remove the fan from the fan cover and replace it with a new one.

Mounting the Circulation Fan

Reverse the above procedure to mount the fan.

Be sure to mount the fan so that the air flows in the direction indicated by the arrow in the corresponding diagram.

Confirm that there are no cables in contact with the fan’s rotating parts.

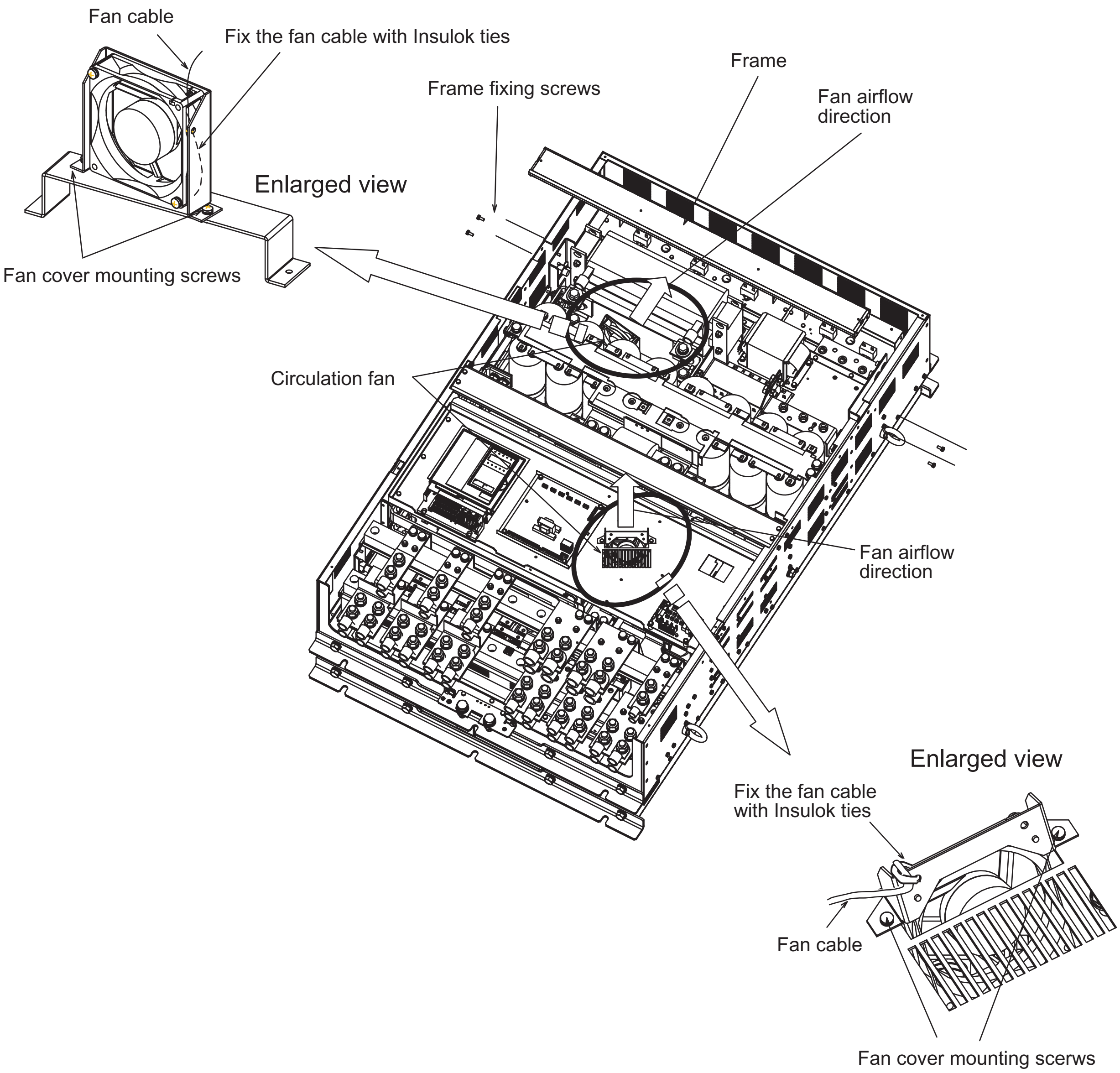


Fig 8.16 Circulation Fan Replacement (400 V Class Inverters of 300 kW)

◆ Removing and Mounting the Control Circuit Terminal Board

The control circuit terminal board can be removed and mounted without disconnecting the cables.

IMPORTANT

Always confirm that the charge indicator is not lit before removing or mounting the control circuit terminal board.

■Removing the Control Circuit Terminal Board

1. Remove the Digital Operator and front cover.
2. Remove the connecting line connectors connected to FE and NC on the control circuit terminal board.
3. Loosen the mounting screws (1) on the left and right sides of the control terminals until they are free. (It is not necessary to remove these screws completely. They are self-rising.)
4. Pull the terminal board out sideways (in direction 2) with the screws sticking out from the board.

■Mounting the Control Circuit Terminal Board

Reverse the removal procedure to mount the terminal board.

Confirm that the control circuit terminal board and the control board properly meet at connector CN5 before pressing in on the board.

The connector pins may be bent if the board is forced into place, possibly preventing correct Inverter operation.

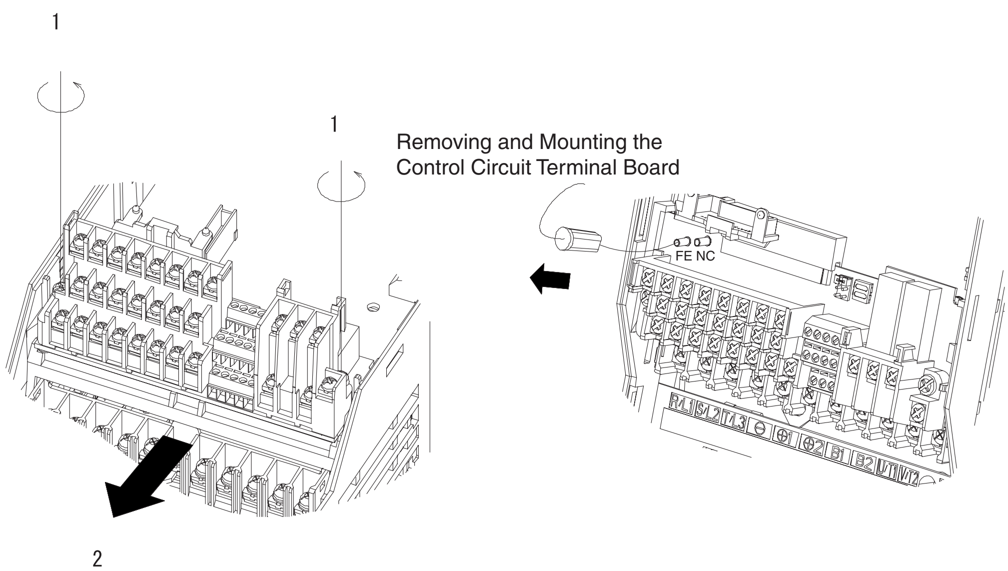


Fig 8.17   Removing the Control Circuit Terminal Board

8

9

Specifications

This chapter describes the basic specifications of the Inverter and specifications for options and peripheral devices.

Standard Inverter Specifications

The standard Inverter specifications are listed by capacity in the following tables.

◆ Specifications by Model

Specifications are given by model in the following tables.

■200V Class

Table 9.1 200 V Class Inverters

	Model Number CIMR-F7A□		20P4	20P7	21P5	22P2	23P7	25P5	27P5	2011	2015	2018	2022	2030	2037	2045	2055	2075	2090	2110
	Max. applicable motor output (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110
	Rated input current (A)		3.8	4.9	8.4	11.5	18	24	37	52	68	84	94	120	160	198	237	317	381	457
Output ratings	Rated output capacity (kVA)		1.2	1.6	2.7	3.7	5.7	8.8	12	17	22	27	32	44	55	69	82	110	130	160
	Rated output current (A)		3.2	4.1	7.0	9.6	15	23	31	45	58	71	85	115	145	180	215	283	346	415
	Max. output voltage (V)		3-phase; 200, 208, 220, 230, or 240 VAC (Proportional to input voltage.)																	
	Max. output frequency (Hz)		CT selected (low carrier, constant torque applications): 150 Hz max. 300 Hz max. VT selected (high carrier, variable torque applications): 400 Hz max.																	
Power supply characteristics	Rated voltage (V) Rated frequency (Hz)		3-phase, 200/208/220/230/240 VAC, 50/60 Hz																	
	Allowable voltage fluctuation		+ 10%, - 15%																	
	Allowable frequency fluctuation		±5%																	
Control characteristics	Measures for power supply harmonics	DC reactor	Optional										Built in							
		12-phase rectification	Not possible										Possible*3							

* 1. The maximum applicable motor output is given for a standard 4-pole Yaskawa motor. When selecting the actual motor and Inverter, be sure that the Inverter's rated current is applicable for the motor's rated current.

* 2. The startup torque for a 200 V Class Inverter for 110 kW is 120% (low carrier).

* 3. A 3-wire transformer is required on the power supply for 12-phase rectification.

■400 V Class

Table 9.2 400 V Class Inverters

		Model Number CIMR-F7A□	40P4	40P7	41P5	42P2	43P7	45P5	47P5	4011	4015	4018
		Max. applicable motor output (kW) *1	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
		Rated input current (A)	2.2	2.5	4.4	6.4	9.0	15	20	29	37	47
Output ratings		Rated output capacity (kVA)	1.4	1.6	2.8	4.0	5.8	9.5	13	18	24	30
Output ratings		Rated output current (A)	1.8	2.1	3.7	5.3	7.6	12.5	17	24	31	39
Output ratings		Max. output voltage (V)	3-phase; 380, 400, 415, 440, 460, or 480 VAC (Proportional to input voltage.)									
Output ratings		Max. output frequency (Hz)	CT selected (low carrier, constant torque applications): 150 Hz max. 300 Hz max. VT selected (high carrier, variable torque applications): 400 Hz max.									
Power supply characteristics		Rated voltage (V) Rated frequency (Hz)	3-phase, 380, 400, 415, 440, 460 or 480 VAC, 50/60 Hz									
Power supply characteristics		Allowable voltage fluctuation	+ 10%, - 15%									
Power supply characteristics		Allowable frequency fluctuation	±5%									
Control characteristics	Measures for power supply harmonics	DC reactor	Optional									
Control characteristics	Measures for power supply harmonics	12-phase rectification	Not possible									

		Model Number CIMR-F7A□	4022	4030	4037	4045	4055	4075	4090	4110	4132	4160	4185	4220	4300
		Max. applicable motor output (kW)*1	22	30	37	45	55	75	90	110	132	160	185	220	300
		Rated input current (A)	50	66	83	100	120	165	198	238	286	334	407	557	743
Output ratings		Rated output capacity (kVA)	34	46	57	69	85	110	140	160	200	230	280	390	510
Output ratings		Rated output current (A)	45	60	75	91	112	150	180	216	260	304	370	506	675
Output ratings		Max. output voltage (V)	3-phase, 380, 400, 415, 440, 460, or 480 VAC (Proportional to input voltage.)												
Output ratings		Max. output frequency (Hz)	CT selected (low carrier, constant torque applications): 150 Hz max. 300 Hz max. VT selected (high carrier, variable torque applications): 400 Hz max.												
Power supply characteristics		Max. voltage (V) Rated frequency (Hz)	3-phase, 380, 400, 415, 440, 460, or 480 VAC, 50/60 Hz												
Power supply characteristics		Allowable voltage fluctuation	+ 10%, - 15%												
Power supply characteristics		Allowable frequency fluctuation	±5%												
Control characteristics	Measures for power supply harmonics	DC reactor	Built in												
Control characteristics	Measures for power supply harmonics	12-phase rectification	Possible*2												

* 1. The maximum applicable motor output is given for a standard 4-pole Yaskawa motor. When selecting the actual motor and Inverter, be sure that the Inverter's rated current is applicable for the motor's rated current.

* 2. A 3-wire transformer is required on the power supply for 12-phase rectification.

◆ Common Specifications

The following specifications apply to both 200 V and 400 V Class Inverters.

Table 9.3 Common Specifications

Model Number CIMR-F7A□		Specification
Control characteristics	Control method	Sine wave PWM Flux vector control, Open-loop vector control, V/f control, V/f with PG control (switched by constant setting)
	Torque characteristics	CT selected (low carrier, constant torque applications): 150% /0.5 Hz (Open-loop vector control) VT selected (high carrier, variable torque applications): 120%/0.5 Hz (Open-loop vector control) CT selected (low carrier, constant torque applications): 150%/0 min^{-1} (Flux vector control) VT selected (high carrier, variable torque applications): 120%/0 min^{-1} (Flux vector control)
	Speed control range	1:100 (Open-loop vector control), 1:1000 (Flux vector control) *1
	Speed control accuracy *4	±0.2% (25°C ± 10°C, Open-loop vector control), ±0.02% (25°C ± 10°C, Flux vector control) *1
	Speed control response	5 Hz (Open-loop vector control), 40 Hz (Flux vector control) *1
	Torque limits	Provided for vector control only (4 quadrant steps can be changed by constant settings.)
	Torque accuracy *4	±5%
	Frequency control range	0.01 to 150 Hz 300 Hz (CT selected.), 0.01 to 400 Hz (VT selected.)
	Frequency accuracy (temperature characteristics)	Digital references: ± 0.01% (-10°C to +40°C)
		Analog references: ±0.1% (25°C ±10°C)
	Frequency setting resolution	Digital references: 0.01 Hz
		Analog references: 0.06 Hz/60 Hz (+10 bit) 0.03 Hz/60 Hz (±11 bit)
	Output frequency resolution	0.001 Hz
	Overload capacity and maximum current *2	CT selected (low carrier, constant torque applications): 150% of rated output current per minute *3, *6, *8 VT selected (high carrier, variable torque applications): 120% of rated output current per minute *6, *8
	Frequency setting signal	-10 to +10V, 0 to 10 V, 4 to 20 mA, pulse train
	Acceleration/Deceleration time	0.01 to 6000.0 s (4 selectable combinations of independent acceleration and deceleration settings)
	Braking torque	Approximately 20% (Approximately 125% with Braking Resistor option *5, braking transformer built into 200 V and 400 V Class Inverters for 18.5 kW or less.)
	Main control functions	Restarting for momentary power loss, speed searches, overtorque detection, torque limits, 17-speed control (maximum), acceleration/deceleration time changes, S-curve acceleration/deceleration, 3-wire sequence, autotuning (rotational or stationary), dwell functions, cooling fan ON/OFF control, slip compensation, torque compensation, jump frequencies, upper and lower limits for frequency references, DC braking for starting and stopping, high-slip braking, PID control (with sleep function), energy-saving control, MEMOBUS communications (RS-485/422, 19.2 kbps maximum), fault reset, Droop control, function copying, torque control, speed/torque control switching, etc.
Protective functions	Motor protection	Protection by electronic thermal overload relay.
	Instantaneous overcurrent protection	Stops at approx. 200% of rated output current.
	Fuse blown protection	Stops for fuse blown.
	Overload protection	CT selected (low carrier, constant torque applications): 150% of rated output current per minute *3 VT selected (high carrier, variable torque applications): 120% of rated output current per minute
	Overvoltage protection	200 Class Inverter: Stops when main-circuit DC voltage is above applox. 410 V. 400 Class Inverter: Stops when main-circuit DC voltage is above applox. 820 V.
	Undervoltage protection	200 Class Inverter: Stops when main-circuit DC voltage is below applox. 190 V. 400 Class Inverter: Stops when main-circuit DC voltage is below applox. 380 V.
	Momentary power loss ride-thru, *9	Stops for 15 ms or more. With a suitable constant setting, operation can be continued if power is restored within 2 s.
	Cooling fin overheating	Protection by thermistor.
	Stall prevention	Stall prevention during acceleration, deceleration, or running.
	Grounding protection *7	Protection by electronic circuits. (Overcurrent level)
	Charge indicator	Lit when the main circuit DC voltage is approx. 50 V or more.
Environment	Ambient operating temperature	-10°C to 40°C (Enclosed wall-mounted type) 10°C to 45°C (Open chassis type)
	Ambient operating humidity	95% max. (with no condensation)
	Storage temperature	- 20°C to + 60°C (short-term temperature during transportation)
	Application site	Indoor (no corrosive gas, dust, etc.)
	Altitude	1000 m max.
	Vibration	10 to 20 Hz: 9.8 m/s^2 20 to 50 Hz: 2.0 m/s^2

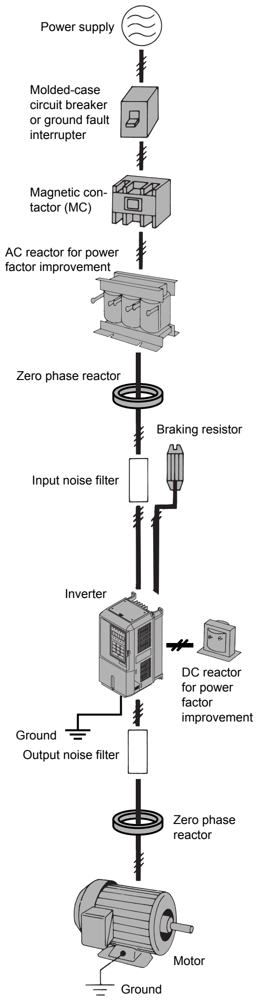
* 1. Rotational autotuning must be performed to ensure obtaining the specifications given for flux or open-loop vector control.
* 2. Increase the Inverter capacity if loads exceeding these current values are expected.
* 3. Only VT can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.
* 4. The speed control accuracy depends on the installation condition and types of motor used. Contact your Yaskawa representative for details.
* 5. When connecting a Braking Resistor or Braking Resistor Unit, set L3-04 (Stall prevention selection during deceleration) to 0 (disabled). Stopping may not be possible in the specified deceleration time if this function is not disabled.
* 6. Derating is required for applications that use repetitive loads. (Refer to page 10-6 for details.)
* 7. The ground fault here is one which occurs in the motor wiring while the motor is running. A ground fault may not be detected in the following cases.
• A ground fault with low resistance which occurs in motor cables or terminals.
• A ground fault occurs when the power is turned ON.
* 8. If running at a speed of 6 Hz or less, the overload protection function can operate even if running within 150% of rated output current per minute when CT is selected, 120% of rated output current per minute when VT is selected.
* 9. Attach a Backup Capacitor Unit for Momentary Power Loss if compensation for power interruptions of up to 2.0 seconds is required for 200 V/400 V Class Inverters with outputs of 0.4 to 11 kW.

Specifications of Options and Peripheral Devices

The following options and peripheral devices can be used for the Inverter. Select them according to the application.

Table 9.4 Options and Peripheral Devices

Purpose	Name	Model (Code)	Descriptions
Protect Inverter wiring	MCCB or Ground Fault Interrupter*1	NF□	Always connect a breaker to the power supply line to protect Inverter wiring. Use a ground fault interrupter suitable for high frequencies.
Prevents burning when a Braking Resistor is used.	Magnetic Contactor	SC series	Install to prevent the braking resistor from burning out when one is used. Always attach a surge absorber to the coil.
Contains switching surge	Surge Absorber	DCR2-□	Absorbs surge from the magnetic contactor and control relays. Connect surge absorbers to all magnetic contactors and relays near the Inverter.
Isolates I/O signals	Isolator	DGP□	Isolates the I/O signals of the Inverter and is effective against inductive noise.
Improve the input power factor of the Inverter	DC Reactor AC Reactor	UZDA-□ UZBA-□	Used to improve the input power factor of the Inverter. All Inverters of 22 kW or higher contain built-in DC reactors. These are optional for Inverters of 18.5 kW or less. Install DC and AC reactors for applications with a large power supply capacity (600 kVA or higher).
Reduce the affects of radio and control device noise	Input Noise Filter	LNFD-□ FN-□	Reduces noise coming into the Inverter from the power supply line and to reduce noise flowing from the Inverter into the power supply line. Connect as close to the Inverter as possible.
	Finemet zero-phase reactor to reduce radio noise*2	F6045GB (FIL001098) F11080GB (FIL001097) F200160BP (300-001-041)	Reduces noise from the line that sneaks into the Inverter input power system. Insert as close to the Inverter as possible. Can be use on both the input side and output side.
	Output Noise Filter	LF-□	Reduces noise generated by the Inverter. Connect as close to the Inverter as possible.
Enable stopping the machine in a set time	Braking Resistor	ERF-150WJ□□ (R00□□□□)	Consumes the regenerative motor energy with a resistor to reduce deceleration time (use rate: 3% ED).
	Braking Resistor Unit	LKEB-□ (75600-K□□□0)	Consumes the regenerative motor energy with a resistor to reduce deceleration time (use rate: 10% ED).
	Braking Unit	CDBR-□ (72600-R□□□0)	Used with a Braking Resistor Unit to reduce the deceleration time of the motor.
Operates the Inverter externally	VS Operator (small plastic Operator)	JVOP-95•□ (73041-0905X-□)	Allows frequency reference settings and ON/OFF operation control to be performed by analog references from a remote location (50 m max.). Frequency counter specifications: 60/120 Hz, 90/180Hz
	VS Operator (Standard steel-plate Operator)	JVOP-96•□ (73041-0906X-□)	Allows frequency reference settings and ON/OFF operation control to be performed by analog references from a remote location (50 m max.). Frequency counter specifications: 75 Hz, 150 Hz, 220 Hz
	Digital Operator Connection Cable	1 m cable: (72616-WV001) 3 m cable: (72616-WV003)	Extension cable to use a Digital Operator remotely. Cable length: 1 m or 3 m
Controls an Inverter system	VS System Module	JGSM-□	A system controller that can be match to the automatic control system to produce an optimum system configuration.
Provides Inverter momentary power loss recovery time	Backup Capacitor Unit for Momentary Power Loss	P00□0 (73600-P00□0)	Handles momentary power losses for the control power supply for models 11 kW or less (maintains power for 2 s).
Set/monitor frequencies and voltages externally.	Frequency Meter	DCF-6A	Devices to set or monitor frequencies externally.
	Frequency Setter	RV30YN20S (2 kΩ)	
	Frequency Setter Knob	CM-3S	
	Output Voltmeter	SCF-12NH	Measures the output voltage externally and designed for use with a PWM Inverter.
Correct frequency reference input, frequency meter, ammeter scales	Variable Resistor Board for Frequency Reference	2 kΩ (ETX003270) 20 kΩ (ETX003120)	Connected to the control circuit terminals to input a frequency reference.
	Frequency Meter Scale Correction Resistor	(RH000850)	Calibrates the scale of frequency meters and ammeters.



* 1. Use a ground fault interrupter with a current sensitivity of 200 mA minimum and an operating time of 0.1 s minimum to prevent operating errors. The interrupter must be suitable for high-frequency operation.
Example:NV series by Mitsubishi Electric Corporation (manufactured in or after 1988)
EG, SG series by Fuji Electric Co., Ltd. (manufactured in or after 1984)

* 2. The Finemet Zero-phase Reactor is manufactured by Hitachi Metals, Ltd.

The following option boards are available

Table 9.5 Option Boards

Type		Name	Code Number	Function	Document Number
Built-in (connect to connector)	Speed (Frequency) Reference Option Boards	Analog Reference Board AI-14U	73600-C001X	Enables high-precision, high-resolution setting of analog speed references. • Input signal ranges: 0 to 10 V (20 kΩ), 1 channel 4 to 20 mA (250 Ω), 1 channel • Input resolution: 14-bit (1/16384)	TOE-C736-30.13
		Analog Reference Board AI-14B	73600-C002X	Enables high-precision, high-resolution setting of analog speed references. • Input signal ranges: −10 to 10 V (20 kΩ) 4 to 20 mA (500 Ω), 3 channels • Input resolution: 13-bit + sign (1/8192)	TOE-C736-30.14
		Digital Reference Board DI-08	73600-C003X	Enables 8-bit digital setting of speed references. • Input signal: 8-bit binary 2-digit BCD + sign signal + set signal • Input voltage: +24 V (isolated) • Input current: 8 mA	TOE-C736-30.15
		Digital Reference Board DI-16H2	73600-C016X	Enables 16-bit digital setting of speed references. • Input signal: 16-bit binary 4-digit BCD + sign signal + set signal • Input voltage: +24 V (isolated) • Input current: 8 mA With 16-bit/12-bit switch.	TOE-C736-40.7
	Monitoring Option Boards	Analog Monitor Board AO-08	73600-D001X	Converts analog signals to monitor the Inverter's output status (output frequency, output current, etc.) to absolute values and outputs them. • Output resolution: 8 bits (1/256) • Output voltage: 0 to +10 V (not insulated) • Output channels: 2 channels	TOE-C736-30.21
		Analog Monitor Board AO-12	73600-D002X	Output analog signals to monitor the Inverter's output status (output frequency, output current, etc.). • Output resolution: 11 bits (1/2048) + sign • Output voltage: -10 to +10 V (not insulated) • Output channels: 2 channels	TOE-C736-30.22
		Digital Output Board DO−08	73600-D004X	Outputs isolated digital signals to monitor the Inverters operating status (alarm signals, zero-speed detection, etc.) Output form: Photocoupler output, 6 channels (48 V, 50 mA max.) Relay contact outputs, 2 channels (250 VAC: 1 A max., 30VDC: 1 A max.)	TOE-C736-30.24
		2C-Relay Output Board DO−02C	73600-D007X	Provides two multi-function outputs (DPDT relay contacts) in addition to those provided by the Inverter.	TOE-C736-40.8
	PG Speed Control Boards	PG−A2	73600-A012X	Used for V/f with PG control. Speed feedback is performed using the PG attached to the motor to compensate for speed fluctuations caused by slipping. • A-phase pulse (single pulse) input (voltage, complementary, open-collector input) • Maximum input frequency: 32767 Hz • Pulse monitor output: +12 V, 20 mA (PG power supply output: +12 V, 200 mA max.)	TOE-C736-40.1

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Table 9.5 Option Boards (Continued)

Type		Name	Code Number	Function	Document Number
Built-in (connect to connector)	PG Speed Control Boards	PG−B2	73600-A013X	• Used for V/f control with PG and flux vector control. • A-, B-phase input (complimentary input) • Maximum input frequency: 32767 Hz • Pulse monitor output: Open-collector (PG power supply output: +12 V, 200 mA max.)	TOE-C736-40.2
		PG−D2	73600-A014X	• Differential input. • A-phase pulse (differential pulse) input, for V/f control • Maximum input frequency: 300 kHz • Input: Conforms to RS-422 • Pulse monitor output: RS-422 (PG power supply output: +5 or +12 V, 200 mA max.)	TOE-C736-40.3
		PG-X2	73600-A015X	• A-, B-, Z-phase pulse (differential pulse) input • Maximum input frequency: 300 kHz • Input: Conforms to RS-422 • Pulse monitor output: RS-422 (PG power supply output: +5 or +12 V, 200 mA max.)	TOE-C736-40.4
Built-in (connected to connector)	Communications Option Boards	DeviceNet Communications Interface Board SI-N1	73600-C021X	Used to communicate with an Inverter from a host computer using DeviceNet communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		ProfiBus-DP Communications Interface Board SI-P1	73600-C033X	Used to communicate with an Inverter from a host computer using ProfiBus-DP communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		InterBus-S Communications Interface Board SI-R	*	Used to communicate with an Inverter from a host computer using InterBus-S communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		CANopen Communications Interface Board SI-S	*	Used to communicate with an Inverter from a host computer using CANopen communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		CC-Link Communications Interface Board SI-C	73600-C032X	Used to communicate with an Inverter from a host computer using CC-Link communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		LONWORKS Communications Interface Board SI-J	73600-C035X	Used to communicate with an Inverter from a host computer using LONWORKS communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	-
		LONWORKS Communications Interface Board SI-W1	73600-C034X	Used to communicate with an Inverter from a host computer using LONWORKS communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.). With Display Data Channel (DDC) function.	-

Table 9.5 Option Boards (Continued)

Type		Name	Code Number	Function	Document Number
Built-in (connected to connector)	Communications Option Boards	MECHATROLINK-Communications Interface Board SI-T	73600-C030X	Used to communicate with an Inverter from a host computer using MECHATROLINK communications to start/stop Inverter operation, read/set parameters, and read/set monitor constants (output frequencies, output currents, etc.).	

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Appendix

This chapter provides precautions for the Inverter, motor, and peripheral devices and also provides lists of constants.

Varispeed F7 Control Methods

Details of the Varispeed F7-Series Inverter control methods and their features are provided in this section.

◆ Control Methods and Features

Varispeed F7-Series Inverters support the following four control methods, allowing the selection of a control method to suit the required purpose. *Table 10.1* provides an overview of the control methods and their features.

Table 10.1 Overview and Features of Control Methods

Control Method			V/f Control	V/f Control with PG	Open-loop Vector Control	Flux Vector Control
Constant Setting			A1-02 = 0 (factory setting)	A1-02 = 1	A1-02 = 2	A1-02 = 3
Basic Control			Voltage/frequency fixed ratio control	Voltage/frequency fixed ratio control with speed compensation using a PG	Current vector control without a PG	Current vector control with a PG
Main Applications			Variable speed control, particularly for control of multiple motors with a single Inverter and for replacing existing Inverters	Applications requiring high-precision speed control using a PG on the machine side	Variable speed control, applications requiring high performance without a PG on the motor side, and for replacing open-loop vector control of the previous VS-616G5.	Very high-performance control with a PG on the motor side (simple servodrives, high-precision speed control, torque control, and torque limiting)
PG Speed Control Board (Option)			Not required.	Required (PG-A2 or PG-D2).	Not required.	Required (PG-B2 or PG-X2).
Basic Performance	Speed Control Range*1		1:40	1:40	1:100	1:1000
	Speed Control Accuracy*2		±2 to 3%	±0.03%	±0.2%	±0.02%
	Speed Response*3		Approx. 1 Hz	Approx. 1 Hz	5 Hz	40 Hz
	Maximum Output Frequency	CT	150 Hz 300 Hz	150 Hz 300 Hz	150 Hz 300 Hz	150 Hz 300 Hz
		VT	400 Hz	400 Hz	400 Hz	400 Hz
	Starting Torque*4	CT	150%/3 Hz	150%/3 Hz	150%/0.5 Hz	150%/0 min^{-1}
		VT	120%/3 Hz	120%/3 Hz	120%/0.5 Hz	120%/0 min^{-1}

Table 10.1 Overview and Features of Control Methods (Continued)

Control Method		V/f Control	V/f Control with PG	Open-loop Vector Control	Flux Vector Control
Application Functions	Autotuning	Line-to-line resistance (Normally not required.)	Line-to-line resistance (Normally not required.)	Rotational autotuning, stationary autotuning 1, 2, stationary autotuning for line-to-line resistance only	Rotational autotuning, stationary autotuning 1, 2, stationary autotuning for line-to-line resistance only
	Torque Limiting*5	No	No	Yes (except during acceleration/deceleration, below minimum frequency, or during reverse rotation)	Yes
	Torque Control*6	No	No	No	Yes
	Droop Control*7	No	No	No	Yes (except for 0 min^{-1} and during reverse rotation)
	Zero-servo Control*8	No	No	No	Yes
	Speed Estimation (Detection) Instantaneous Speed Search*9	Yes (speed and rotation direction estimation)	Yes (speed detection and rotation direction estimation)	Yes (speed and rotation direction estimation)	Yes (speed and rotation direction detection)
	Automatic Energy-saving Control*10	Yes	Yes	Yes	Yes
	High-slip Braking*11	Yes	Yes	No	No
	Feed Forward Control*12	No	No	No	Yes

* 1. The variable speed control range. (For continuous operation, the motor's temperature rise must be considered.)
* 2. The speed deviation in relation to the maximum speed with a rated load and when the load is stable. (For open-loop vector control, the motor temperature must be 25 °C ± 10 °C.)
* 3. The speed response guidelines indicating the extent of the motor's actual speed gain in proportion to the speed reference, which changes in a sinusoidal wave form, within a range where motor torque does not become saturated.
* 4. A guideline for the motor torque that can be generated when started at a low speed and its output frequency (rotations) at that time.
* 5. This function limits the maximum motor torque to protect the machine and the load.
* 6. This function directly controls the amount of torque being generated at the motor and its rotation direction, e.g., to control force.
* 7. This function controls the amount of motor slip that occurs to prevent mechanical shock, when replacing a torque motor, etc.
* 8. This function performs simple positioning control (servo lock), without using an external positioning control device.
* 9. This function instantaneously estimates (or detects) the speed and rotation direction of a coasting motor, and quickly starts it without subjecting it to shock.
* 10.This function automatically adjusts the voltage applied to the motor to optimize the motor's efficiency with light loads.
* 11.This function improves the deceleration time without using a braking resistor by making the motor winding absorb regenerative power. As a standard, this function is effective with a motor running on 160 kW or less with a high-inertia load.
* 12.This function enables proportional gain in relation to changes in the speed reference, even for low rigidity (corresponds to the servo's model gain control).

■Application Function Precautions

Observe the following precautions when using the application functions.

- Perform rotational autotuning during trial operation whenever it is possible to separate the motor and machine. To achieve the characteristics of vector control described in *Table 10.1*, the control must be adjusted within a range that the machine will not vibrate after rotational autotuning has been performed.
- With vector control, the motor and Inverter must be connected 1:1. Vector control is not possible when multiple motors are connected to a single Inverter. Select an Inverter capacity so the rated motor current is 50% to 100% of the rated Inverter current.
- For estimated speed searching, the motor and Inverter must be connected 1:1. The speed search must be performed at a frequency of 130 Hz or less and with a motor with the same number of frames as or one frame less than the Inverter capacity.
- During high-slip braking, motor loss increases, so use a high-slip braking frequency of 5% ED or less, and a braking time of 90 seconds or less. Once high-slip braking has started, the motor cannot be restarted until it has stopped.
- Feed forward control is a function that improves the proportional gain of the motor speed in relation to the change in the speed reference. Adjust the response to interference loads using the speed controller (ASR) constants.
- The torque limit function will not operate during acceleration or deceleration (during soft start transition) when using a control method such as open-loop vector control. Even if the motor speed drops due to torque limiting while set to a fixed speed, the speed will not fall below the minimum frequency and the motor will not slip into reverse rotation.

◆ Control Methods and Applications

Application examples for the Inverter control methods are provided here.

■V/f Control (A1-02 = 0)

V/f control is suitable for applications where multiple motors are operated with a single Inverter, such as with multi-motor drives.

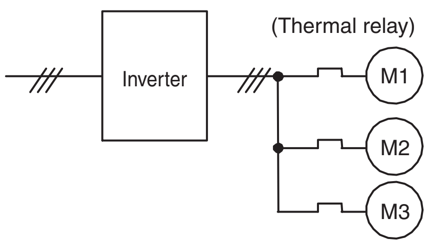


Fig 10.1

■V/f Control with PG (A1-02 = 1)

V/f control with a PG enables precise control of machine line speed. Speed control using the speed feedback of the machine shaft is possible in this mode.

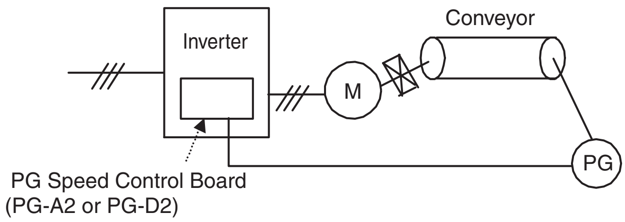


Fig 10.2

■Open-Loop Vector Control (A1-02 = 2)

Open-loop vector control enables the use of high-performance drives without a speed detector. PG (pulse generator) wiring is not required.

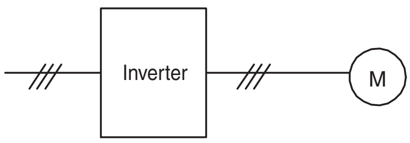


Fig 10.3

■Flux Vector Control (A1-02 = 3) (SPEC: E or Later Only)

Flux vector control is suitable for applications using high-precision drives with PG feedback. High-precision positioning, zero-speed control, and torque control are possible with this mode.

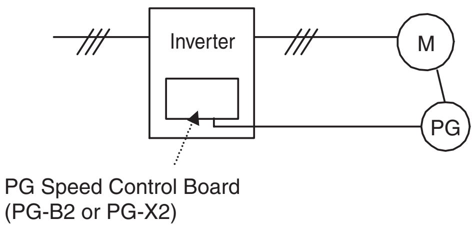


Fig 10.4

Inverter Application Precautions

This section provides precautions for selecting, installing, setting, and handling Inverters.

◆ Selection

Observe the following precautions in selecting an Inverter.

■Installing Reactors

A large peak current will flow in the power input circuit when the Inverter is connected to a large-capacity power transformer (600 kVA or higher) or when switching a phase advancing capacitor. Excessive peak current can destroy the convertor section. To prevent this, install a DC or AC reactor (optional) to improve the power supply power factor.

DC reactors are built into 200 V Class Inverters of 22 to 110 kW and 400 V Class Inverters of 22 to 300 kW.

If a thyristor convertor, such as a DC drive, is connected in the same power supply system, connect a DC or AC reactor regardless of the power supply conditions shown in the following diagram.

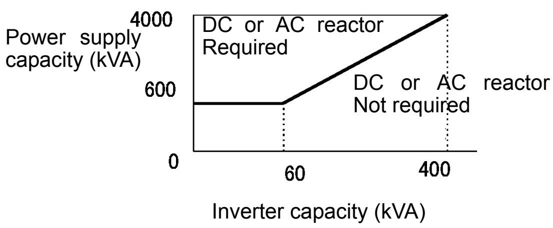


Fig 10.5

■Inverter Capacity

When connecting special motors or multiple motors in parallel to an Inverter, select the Inverter capacity so that the rated output current of the Inverter is 1.1 times the sum of all the motor rated currents.

■Applications with Repetitive Loads

Applications with repetitive loads (cranes, elevators, presses, washing machines, etc.) using Inverters require derating for the repetitive load [reducing carrier frequency and current (changing accel/decel timing, increasing the frame size of the Inverter)]. Contact your Yaskawa representative for details.

■Initial Torque

The startup and acceleration characteristics of the motor are restricted by the overload current ratings of the Inverter that is driving the motor. The torque characteristics are generally less than those required when starting using a normal commercial power supply. If a large initial torque is required, select an Inverter with a somewhat larger capacity or increase the capacity of both the motor and the Inverter.

■Emergency Stop

Although the Inverter's protective functions will stop operation when a fault occurs, the motor will not stop immediately. Always provide mechanical stop and protection mechanisms on equipment requiring an emergency stop.

■Options

Terminals B1, B2, ⊖, ⊕1, ⊕2, ⊕3 are for connecting only the options specifically provided by Yaskawa. Never connect any other devices to these terminals.

◆ Installation

Observe the following precautions when installing an Inverter.

■Installation in Enclosures

Either install the Inverter in a clean location not subject to oil mist, air-bourne matter, dust, and other contaminants, or install the Inverter in a completely enclosed panel. Provide cooling measures and sufficient panel space so that the temperature surrounding the Inverter does not go beyond the allowable temperature. Do not install the Inverter on wood or other combustible materials.

■Installation Direction

Mount the Inverter vertically to a wall or other horizontal surface.

◆ Settings

Observe the following precautions when making settings for an Inverter.

■Upper Limits

The Digital Operator can be used to set high-speed operation up to a maximum of 400 Hz (depends on the carrier frequency). Incorrect settings can be dangerous. Use the maximum frequency setting functions to set upper limits. (The maximum output frequency is factory-set to 60 Hz.)

■DC Injection Braking

The motor can overheat if the DC injection braking voltage or braking time is set to a large value.

■Acceleration/Deceleration Times

The motor's acceleration and deceleration times are determined by the torque generated by the motor, the load torque, and the load's inertial moment ($GD^2/4$). If the stall prevention functions are activated during acceleration or deceleration, increase the acceleration or deceleration time. The stall prevention functions will increase the acceleration or deceleration time by the amount of time the stall prevention function is active.

To reduce the acceleration or deceleration times, increase the capacity of the motor and Inverter.

◆ Handling

Observe the following precautions when wiring or performing maintenance for an Inverter.

■Wiring Check

The Inverter will be internally damaged if the power supply voltage is applied to output terminal U, V, or W. Check wring for any mistakes before supplying power. Check all wiring and sequences carefully.

■Magnetic Contactor Installation

Do not start and stop operation frequently with a magnetic contactor installed on the power supply line. Doing so can cause the Inverter to malfunction. Do not turn the Inverter ON and OFF with a magnetic contactor more than one time every 30 minutes.

■Setting the Power Supply Voltage Jumper (400 V Class Inverters of 75 kW or higher)

If the jumper is inserted into a power tap that does not match the actual power supply voltage, the lifetime of the transformer for the power supply or the wind capacity of the cooling fan may be reduced.

If the jumper is inserted and the voltage setting is too low for the actual power supply, a power surge may occur on the transformer for the power supply and reduce the lifetime of the transformer.

If the jumper is inserted and the voltage setting is too high for the actual power supply, the wind capacity of the cooling fan is reduced.

Insert the jumper into the power tap with the voltage setting nearest to the voltage of the actual power supply.

Refer to *Chapter 4 Trial Operation* for the procedure.

■Maintenance and Inspections

After turn OFF the main circuit power supply, always confirm that the CHARGE indicator is not lit before performing maintenance or inspections. The voltage remaining in the capacitor may cause electric shock.

Motor Application Precautions

This section provides precautions for motor application.

◆ Using the Inverter for an Existing Standard Motor

When a standard motor is operated with the Inverter, power loss is slightly higher than when operated with a commercial power supply. Observe the following precautions when using an Inverter for an existing standard motor.

■Low Speed Ranges

Cooling effects diminish in the low-speed range, resulting in an increase in the motor temperature. Therefore, the motor torque should be reduced in the low-speed range whenever using a motor not made by Yaskawa. If 100% torque is required continuously at low speed, consider using a special Inverter or vector motor.

■Installation Withstand Voltage

If the input voltage is higher than the motor rated voltage (440 V or higher) or the wiring distance is long, the motor insulation voltage must be considered. Contact your Yaskawa representative for details.

■High-speed Operation

When using the motor at a speed higher than the rated speed, problems may arise in dynamic balance and bearing durability. Contact your Yaskawa representative for details.

■Torque Characteristics

The motor may require more acceleration torque when the motor is operated with the Inverter than when operated with a commercial power supply. Check the load torque characteristics of the machine to be used with the motor to set a proper V/f pattern.

■Vibration

The Inverter uses a high carrier PWM to reduce motor vibration. (A constant can be set to select low carrier, PWM modulation control as well.) The factory setting of the Inverter with SPEC: C or earlier is for a high carrier PWM and the one with SPEC: E or later is for a low carrier PWM. When the motor is operated with the Inverter that uses a high carrier PWM, motor vibration is almost the same as when operated with a commercial power supply.
Motor vibration may, however, become greater in the following cases.

Resonance with the Natural Frequency of the Mechanical System

Take special care when a machine that has been operated at a constant speed is to be operated in variable speed mode. If resonance occurs, install vibration-proof rubber on the motor base or use the frequency jump function to skip any frequency resonating the machine.

Imbalanced Rotor

Take special care when the motor is operated at a speed higher than the rated speed.

■Noise

Noise varies with the carrier frequency. At high carrier frequencies, the noise is almost the same when the motor is operated with a commercial power supply. Motor noise, however, becomes louder when the motor is operated at a speed higher than the rated speed.

◆ Using the Inverter for Special Motors

Observe the following precautions when using a special motor.

■Pole-changing Motor

The rated input current of pole-changing motors differs from that of standard motors. Select, therefore, an appropriate Inverter according to the maximum input current of the motor to be used. Before changing the number of poles, always make sure that the motor has stopped. Otherwise, the overvoltage protective or overcurrent protective mechanism will be actuated, resulting in an error.

■Submersible Motor

The rated input current of submersible motors is higher than that of standard motors. Therefore, always select an Inverter by checking its rated output current. When the distance between the motor and Inverter is long, use a cable thick enough to connect the motor and Inverter to prevent motor torque reduction.

■Explosion-proof Motor

When an explosion-proof motor is to be used, it must be subject to an explosion-proof test in conjunction with the Inverter. This is also applicable when an existing explosion-proof motor is to be operated with the Inverter. Since the Inverter itself is, however, not explosion-proof, always install it in a safe place.

■Gearmotor

The speed range for continuous operation differs according to the lubrication method and motor manufacturer. In particular, continuous operation of an oil-lubricated motor in the low speed range may result in burning. If the motor is to be operated at a speed higher than the rated speed, consult with the manufacturer.

■Synchronous Motor

A synchronous motor is not suitable for Inverter control. If a group of synchronous motors is individually turned ON and OFF, synchronism may be lost.

■Single-phase Motor

Do not use an Inverter for a single-phase motor. The motor should be replaced with a 3-phase motor.

◆ Power Transmission Mechanism (Speed Reducers, Belts, and Chains)

If an oil-lubricated gearbox or speed reducer is used in the power transmission mechanism, oil lubrication will be affected when the motor operates only in the low speed range. The power transmission mechanism will make noise and experience problems with service life and durability if the motor is operated at a speed higher than the rated speed.

Conformance to UL Standard

To comply with UL standard, follow the appropriate installation instructions.

■Installation Site

Install the Inverter in a pollution degree 2 environment or equivalent.

■Specification of Closed-Loop Connector

The closed-loop connectors must be installed on conductors before installing to terminal blocks.
Use UL Listed closed-loop connectors shown below.

Table 10.2 JST Closed-Loop Connector Model

Inverter Model CIMR-F7A	JST Kit P/N	
	Input	Output
2011	14-5	14-5
2015	38-6	22-6
2018	38-8	38-8
2022	60-8	38-8
2030	60-8	60-8
2037	100-10	100-10
2045	150-10	150-10
2055	60-10 (2perPh)	60-10 (2perPh)
2075	100-10 (2perPh)	80-10 (2perPh)
2090	150-12 (2perPh)	100-12 (2perPh)
2110	150-12 (2perPh)	150-12 (2perPh)
4022	22-6	14-6
4030	38-6	22-6
4037	38-8	38-8
4045	60-8	60-8
4055	70-8	70-8
4075	100-10	80-10
4090	60-10 (2perPh)	100-10
4110	70-10 (2perPh)	60-10 (2perPh)
4132	70-10 (2perPh)	70-10 (2perPh)
4160	80-12 (2perPh)	80-12 (2perPh)
4185	150-16 (2perPh)	150-16 (2perPh)
4220	325-16 (2perPh)	200-16 (2perPh)
4300	150-16 (4perPh)	150-16 (4perPh)

■Control Circuit Terminal

A UL Listed, Class 2 power supply must be used for the control circuits. See below table.

Table 10.3 Power Supply for Control Circuits

Input/Output	Terminal	Power Supply
Open Collector Outputs	P1, P2, PC	Class 2 power supply
Digital Inputs	S1, S2, S3, S4, S5, S6, S7, S8, SC	LVLC power supply when using internal power supply. Class 2 power supply when using external power supply.
Analog Inputs	RP, +V, -V, A1, A2, A3, AC	

■Interrupting Rating

Varispeed F7 is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 240 VAC maximum (200 V Class) and 480 VAC maximum (400 V Class).
Use a circuit breaker or fuses having an interrupting rating not less than 100,000 RMS symmetrical amperes, 600 VAC maximum.

■Motor Overheat Protection

To protect the motor from overheating, set the E2-01 constant in the Inverter to the same value as the level of the motor rated current.

Conformance to CE Markings

Points regarding conformance to CE markings are given below.

◆ CE Markings

CE markings indicate conformance to safety and environmental standards that apply to business transactions (including production, imports, and sales) in Europe. There are unified European standards for mechanical products (Machine Directive), electrical products (Low Voltage Directive), and electrical noise (EMC Directive). CE markings are required for business transactions in Europe (including production, imports, and sales).

The Varispeed F7-Series Inverters bear CE markings indicating conformance to the Low Voltage Directive and the EMC Directive.

- Low Voltage Directive: 73/23/EEC
  93/68/EEC
- EMC Directive: 89/336/EEC
  92/31/EEC
  93/68/EEC

Machinery and installations that incorporate the Inverter are also subject to CE markings. It is ultimately the responsibility of customers making products incorporating the Inverter to attach CE markings to the finished products. The customer must confirm that the finished products (machines or installations) conform to the European Standards.

◆ Requirements for Conformance to CE Markings

■Low Voltage Directive

Varispeed F7-Series Inverters satisfy testing for conformance to the Low Voltage Directive under the conditions described in European Standard EN50178.

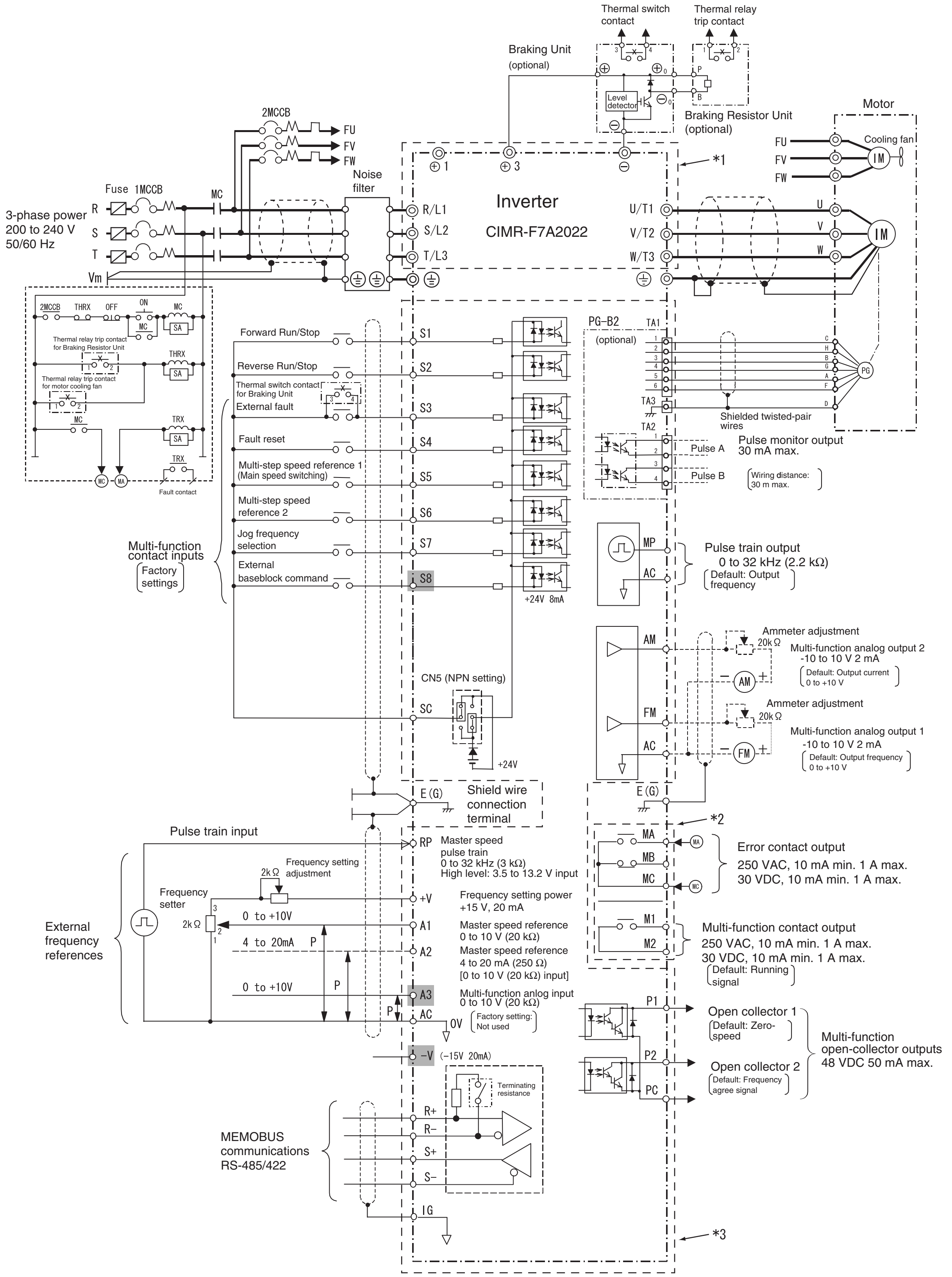
Requirements for Conformance to the Low Voltage Directive

Varispeed F7-Series Inverters must satisfy the following conditions in order to conform to the Low Voltage Directive.

- It must be used under conditions corresponding to overvoltage category 3 or less and pollution degree 2 or less as specified in IEC664.
- Input fuses:
  For details on selecting fuses, refer to *Table 10.4 Selection Requirements for Input Fuses with Examples*.
- With Inverters CIMR-F7A2022 to 2110 and CIMR-F7A4022 to 4300, an enclosure preventing foreign matter from entering from the top or front sides is required (IP4X or higher: panel installation).

Wiring Example

This example shows wiring for conforming to undervoltage reference.



* 1. The main circuit is separated from the terminal cover for safety reasons.

* 2. The contact output circuit is separated from the main circuit and the control circuit by reinforced insulation. It can be connected to extra-low voltage circuits or circuits that are 250 VAC 1 A, 30 VDC 1 A or less.

* 3. The control circuit is an extra-low voltage circuit and separated from the main circuit and the contact output circuit by reinforced insulation. Always connect it to extra-low voltage circuits.

Fig 10.6

Input Fuses

In order to conform to the Low Voltage Directive, fuses must be provided for inputs. Use UL-compatible input fuses with ratings higher than the voltages and currents, and fusing I^2t specifications within the ranges shown in the table below.

Table 10.4 Selection Requirements for Input Fuses with Examples

Voltage Class	Inverter Model Number CIMR-F7A	Selection Requirements			Input Fuse (Examples)			
		Voltage (V)	Current (A)	Fusing I^2t (A^2sec)	Model Number	Manufacturer	Ratings	Fusing I^2t (A^2sec)
200 V Class	20P4	240	10	12 to 25	A60Q12-2	FERRAZ	600 V 12 A	17
	20P7	240	10	12 to 25	A60Q12-2	FERRAZ	600 V 12 A	17
	21P5	240	15	23 to 55	CR2LS-20/UL	FUJI	250 V 20 A	27
	22P2	240	20	34 to 98	CR2LS-30/UL	FUJI	250 V 30 A	60
	23P7	240	30	82 to 220	CR2LS-50/UL	FUJI	250 V 50 A	200
	25P5	240	40	220 to 610	CR2LS-75/UL	FUJI	250 V 75 A	276
	27P5	240	60	290 to 1300	CR2LS-75/UL	FUJI	250 V 75 A	560
	2011	240	80	450 to 5000	CR2LS-100/UL	FUJI	250 V 100 A	810
	2015	240	100	1200 to 7200	CR2L-125/UL	FUJI	250 V 125 A	1570
	2018	240	130	1800 to 7200	CR2L-150/UL	FUJI	250 V 150 A	2260
	2022	240	150	870 to 16200	CR2L-150/UL	FUJI	250 V 150 A	2260
	2030	240	180	1500 to 23000	CR2L-200/UL	FUJI	250 V 200 A	4010
	2037	240	240	2100 to 19000	CR2L-260/UL	FUJI	250 V 260 A	7320
	2045	240	300	2700 to 55000	CR2L-300/UL	FUJI	250 V 300 A	9630
	2055	240	350	4000 to 55000	CR2L-350/UL	FUJI	250 V 350 A	16000
	2075	240	450	7100 to 64000	CR2L-450/UL	FUJI	250 V 450 A	31000
	2090	240	550	11000 to 64000	CR2L-600/UL	FUJI	250 V 600 A	40000
	2110	240	600	13000 to 83000	CR2L-600/UL	FUJI	250 V 600 A	52000

Table 10.4 Selection Requirements for Input Fuses with Examples (Continued)

Voltage Class	Inverter Model Number CIMR-F7A	Selection Requirements			Input Fuse (Examples)			
		Voltage (V)	Current (A)	Fusing I^2t (A^2sec)	Model Number	Manufacturer	Ratings	Fusing I^2t (A^2sec)
400 V Class	40P4	480	5	6 to 55	CR6L-20/UL	FUJI	600 V 20 A	26
	40P7	480	5	6 to 55	CR6L-20/UL	FUJI	600 V 20 A	26
	41P5	480	10	10 to 55	CR6L-20/UL	FUJI	600 V 20 A	26
	42P2	480	10	18 to 55	CR6L-20/UL	FUJI	600 V 20 A	26
	43P7	480	15	34 to 72	CR6L-30/UL	FUJI	600 V 30 A	59
	44P0	480	20	50 to 570	CR6L-30/UL	FUJI	600 V 30 A	59
	45P5	480	25	100 to 570	CR6L-50/UL	FUJI	600 V 50 A	317
	47P5	480	30	100 to 640	CR6L-50/UL	FUJI	600 V 50 A	317
	4011	480	50	150 to 1300	CR6L-50/UL	FUJI	600 V 50 A	317
	4015	480	60	400 to 1800	CR6L-75/UL	FUJI	600 V 75 A	564
	4018	480	70	700 to 4100	CR6L-100/UL	FUJI	600 V 100 A	1022
	4022	480	80	240 to 5800	CR6L-100/UL	FUJI	600 V 100 A	1022
	4030	480	100	500 to 5800	CR6L-100/UL	FUJI	600 V 100 A	1022
	4037	480	125	750 to 5800	CR6L-150/UL	FUJI	600 V 150 A	3070
	4045	480	150	920 to 13000	CR6L-150/UL	FUJI	600 V 150 A	3070
	4055	480	150	1500 to 13000	CR6L-200/UL	FUJI	600 V 200 A	5200
	4075	480	250	3000 to 55000	CR6L-300/UL	FUJI	600 V 300 A	17700
	4090	480	300	3800 to 55000	CR6L-300/UL	FUJI	600 V 300 A	17700
	4110	480	350	5400 to 23000	A70P350-4	FERRAZ	700 V 350 A	15000
	4132	480	400	7900 to 64000	A70P400-4	FERRAZ	700 V 400 A	19000
	4160	480	450	14000 to 250000	A70P450-4	FERRAZ	700 V 450 A	24000
	4185	480	600	20000 to 250000	A70P600-4	FERRAZ	700 V 600 A	43000
	4220	480	700	34000 to 400000	A70P700-4	FERRAZ	700 V 700 A	59000
	4300	480	900	52000 to 920000	A70P900-4	FERRAZ	700 V 900 A	97000

■EMC Directive

Varispeed F7-Series Inverters satisfy testing for conformance to the EMC Directive under the conditions described in European Standard EN61800-3.

Installation Method

In order to ensure that the machinery or installation incorporating the Inverter conforms to the EMC Directive, perform installation according to the method below.

- Install a noise filter that conforms to European Standards on the input side. (Refer to *Table 10.5 EMC Noise Filters*).
- Use a shielded line or metal piping for wiring between the Inverter and Motor. Make the wiring as short as possible.
- To suppress harmonics, install a DC reactor in CIMR-F7A20P4, 20P7, 40P4, and 40P7 models. (Refer to *Table 10.6 DC Reactors for Suppressing Harmonics*.)

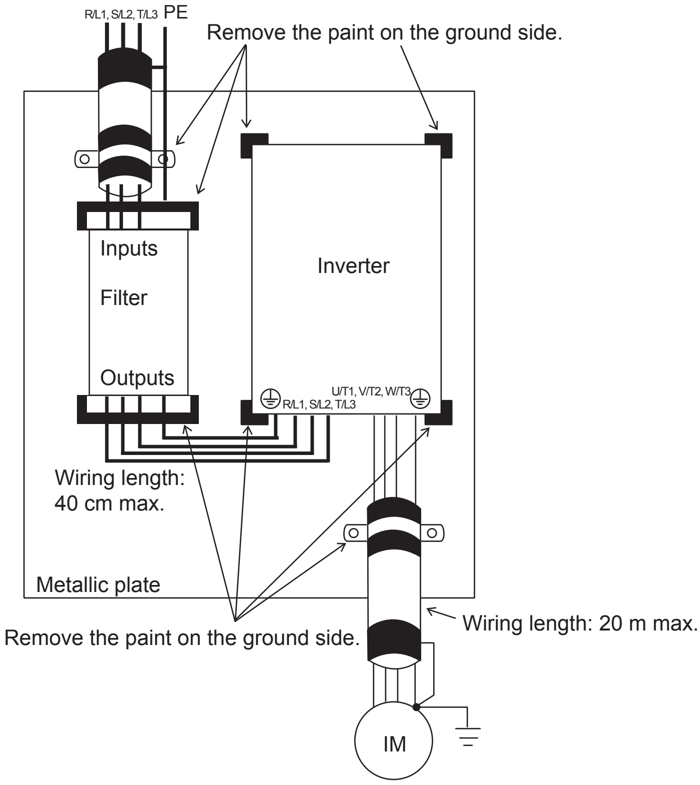


Fig 10.7 Installation Method for Filter and Inverter (CIMR-F7A20P4 to 2018, 40P4 to 4018)

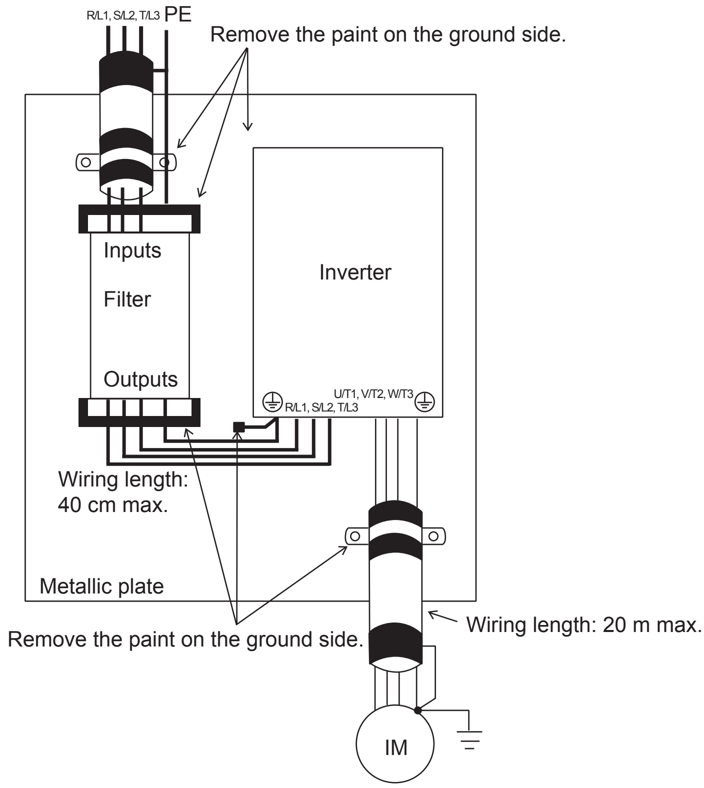


Fig 10.8 Installation Method for Filter and Inverter (CIMR-F7A2022 to 2110, 4022 to 4300)

Table 10.5 EMC Noise Filters

Voltage Class	Inverter Model Number CIMR-F7A	Noise Filter (Made by Shaffner)			
		Model Number	Rated Current (A)	Weight (kg)	Dimensions (mm) W × D × H
200V Class	20P4	FS5972-10-07	10	1.1	141 × 46 × 330
	20P7				
	21P5				
	22P2	FS5972-18-07	18	1.7	141 × 46 × 330
	23P7	FS5973-35-07	35	1.4	141 × 46 × 330
	25P5				
	27P5	FS5973-60-07	60	3	206 × 60 × 355
	2011				
	2015	FS5973-100-07	100	4.9	236 × 80 × 408
	2018				
	2022	FS5973-130-35	130	4.3	90 × 180 × 370
	2030				
	2037	FS5973-160-40	160	6	120 × 170 × 451
	2045	FS5973-240-37	240	11	130 × 240 × 610
	2055				
	2075	FS5972-410-99	410	10.5	260 × 115 × 386
	2090				
	2110	FS5972-600-99	600	11	260 × 135 × 386

Table 10.5 EMC Noise Filters (Continued)

Voltage Class	Inverter Model Number CIMR-F7A	Noise Filter (Made by Shaffner)			
		Model Number	Rated Current (A)	Weight (kg)	Dimensions (mm) W × D × H
400V Class	40P4	FS5972-10-07	10	1.1	141 × 46 × 330
	40P7				
	41P5				
	42P2				
	43P7				
	44P0	FS5972-18-07	18	1.3	141 × 46 × 330
	45P5				
	47P5	FS5972-21-07	21	1.8	206 × 50 × 355
	4011	FS5972-35-07	35	2.1	206 × 50 × 355
	4015	FS5972-60-07	60	4	236 × 65 × 408
	4018				
	4022	FS5972-70-52	70	3.4	80 × 185 × 329
	4030				
	4037	FS5972-100-35	100	4.5	90 × 150 × 330
	4045				
	4055	FS5972-130-35	130	4.7	90 × 180 × 370
	4075	FS5972-170-40	170	6	120 × 170 × 451
	4090	FN3359-250-28	250	7	230 × 125 × 300
	4110				
	4132	FS5972-410-99	410	10.5	260 × 115 × 386
	4160				
	4185				
	4220	FS5972-600-99	600	11	260 × 135 × 386
	4300	FS5972-800-99	800	31	300 × 160 × 716

Table 10.6 DC Reactors for Suppressing Harmonics

Voltage Class	Inverter Model Number CIMR-F7A	DC Reactor			
		Model Number	Manufacturer	Ratings	Code Number
200 V Class	20P4	UZDA-B	YASKAWA	5.4 A 8 mH	X010084
	20P7				
400 V Class	40P4	UZDA-B	YASKAWA	3.2 A 28 mH	X010052
	40P7				

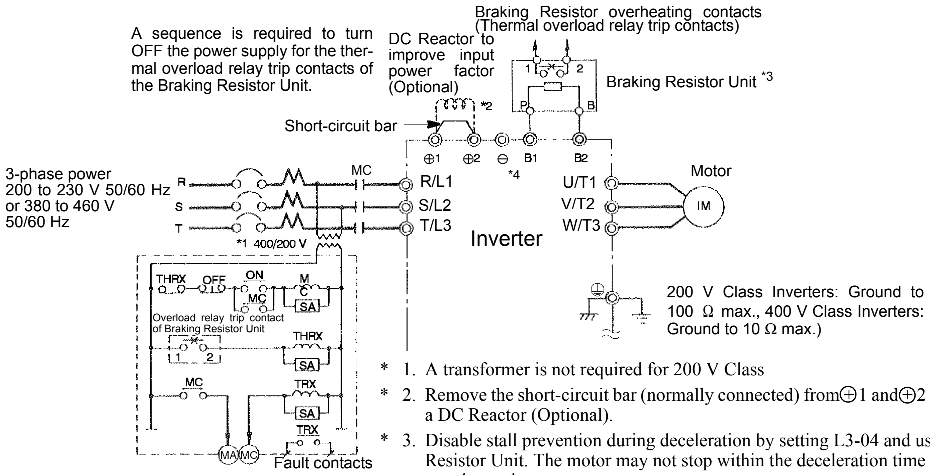
Wiring Examples

This section provides wiring examples to connect a Braking Unit and other peripheral devices to the main circuits, examples of wiring a transformer to Inverter I/O, and other aspects of Inverter wiring.

◆ Using a Braking Resistor Unit

This example shows wiring for a Braking Resistor Unit.

CIMR-F7A20P4 to -F7A2018 (200 V Class Inverters of 0.4 to 18.5 kW)
CIMR-F7A40P4 to -F7A4018 (400 V Class Inverters of 0.4 to 18.5 kW)



* 1. A transformer is not required for 200 V Class

* 2. Remove the short-circuit bar (normally connected) from⊕1 and⊕2 when connecting a DC Reactor (Optional).

* 3. Disable stall prevention during deceleration by setting L3-04 and using a Braking Resistor Unit. The motor may not stop within the deceleration time if this setting is not changed.

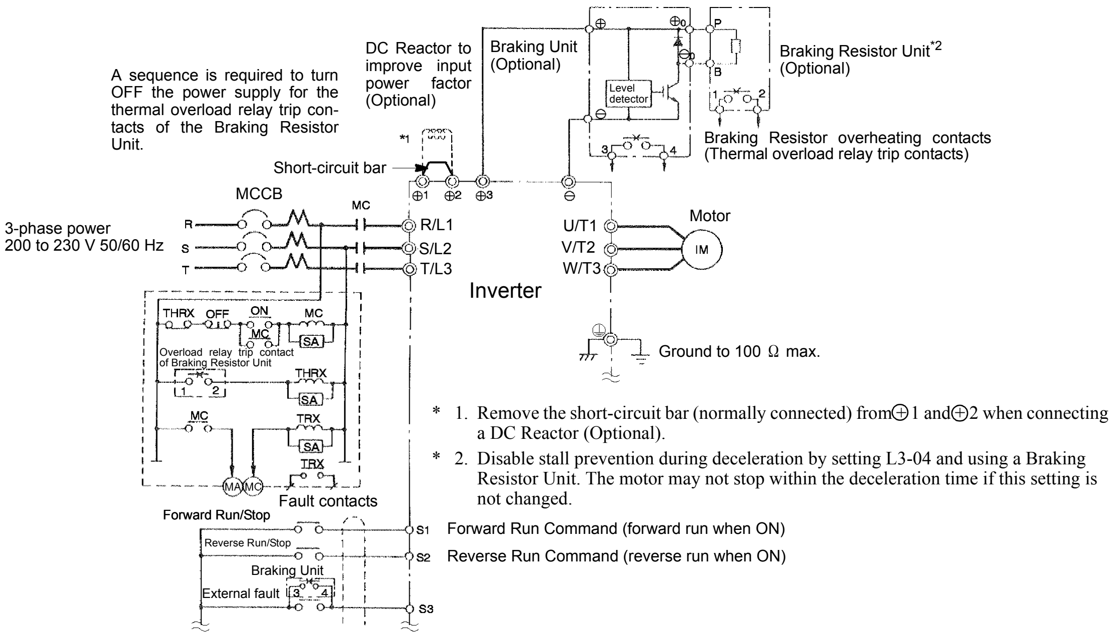
* 4. When connecting a separately-installed type Braking Unit (model CDBR) to Inverters with built-in braking transistor (200 V/400 V 18.5 kW or less), connect the B1 terminal of the Inverter to the + terminal of the Braking Unit and connect the – terminal of the Inverter to the – terminal of the Braking Unit. The B2 terminal is not used in this case.

Fig 10.9

◆ Using a Braking Unit and Braking Resistor Unit

This example shows wiring for a Braking Unit and Braking Resistor Unit.

CIMR-F7A2022, -F7A2030 (200 V Class Inverters of 22 kW, 30 kW)



* 1. Remove the short-circuit bar (normally connected) from⊕1 and⊕2 when connecting a DC Reactor (Optional).

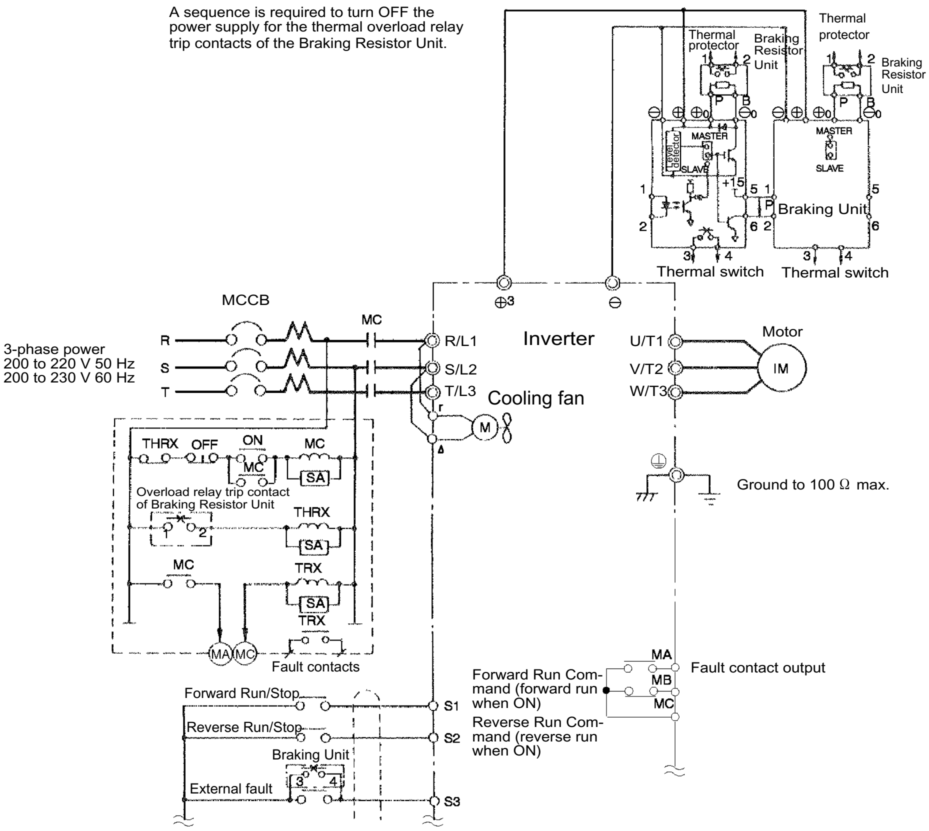
* 2. Disable stall prevention during deceleration by setting L3-04 and using a Braking Resistor Unit. The motor may not stop within the deceleration time if this setting is not changed.

Fig 10.10

◆ Using Braking Units in Parallel

This example shows wiring for using two Braking Units in parallel.

There are connectors for selecting whether each Braking Unit is to be a Master or Slave. Select "Master" for the first Braking Unit only, and select "Slave" for all other Braking Units (i.e.) from the second Unit onwards.

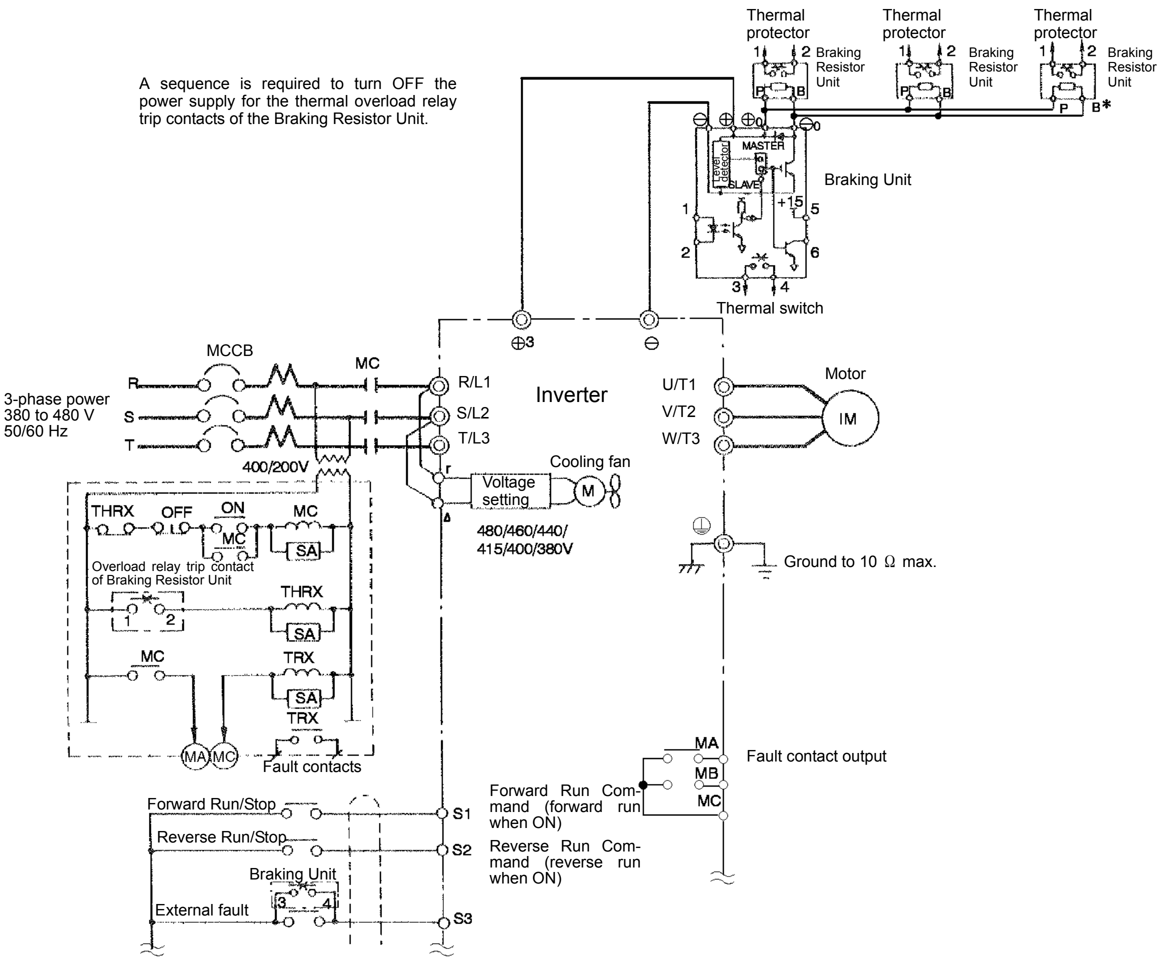


* Disable stall prevention during deceleration by setting L3-04 to Resistor Unit. The motor may not stop within the deceleration time if this setting is not changed.

Fig 10.11

◆ Using a Braking Unit and Three Braking Resistor Units in Parallel

This example shows wiring for using three Braking Resistor Units in parallel.



* Disable stall prevention during deceleration by setting L3-04 to Resistor Unit. The motor may not stop within the deceleration time if this setting is not changed.

Fig 10.12

◆ Using a VS Operator

This example shows wiring for using a VS Operator. The VS Operator model number is JVOP-95•☐ or JVOP-96 •☐.

CIMR-F7A27P5 (200 V Class Inverters of 7.5 kW)

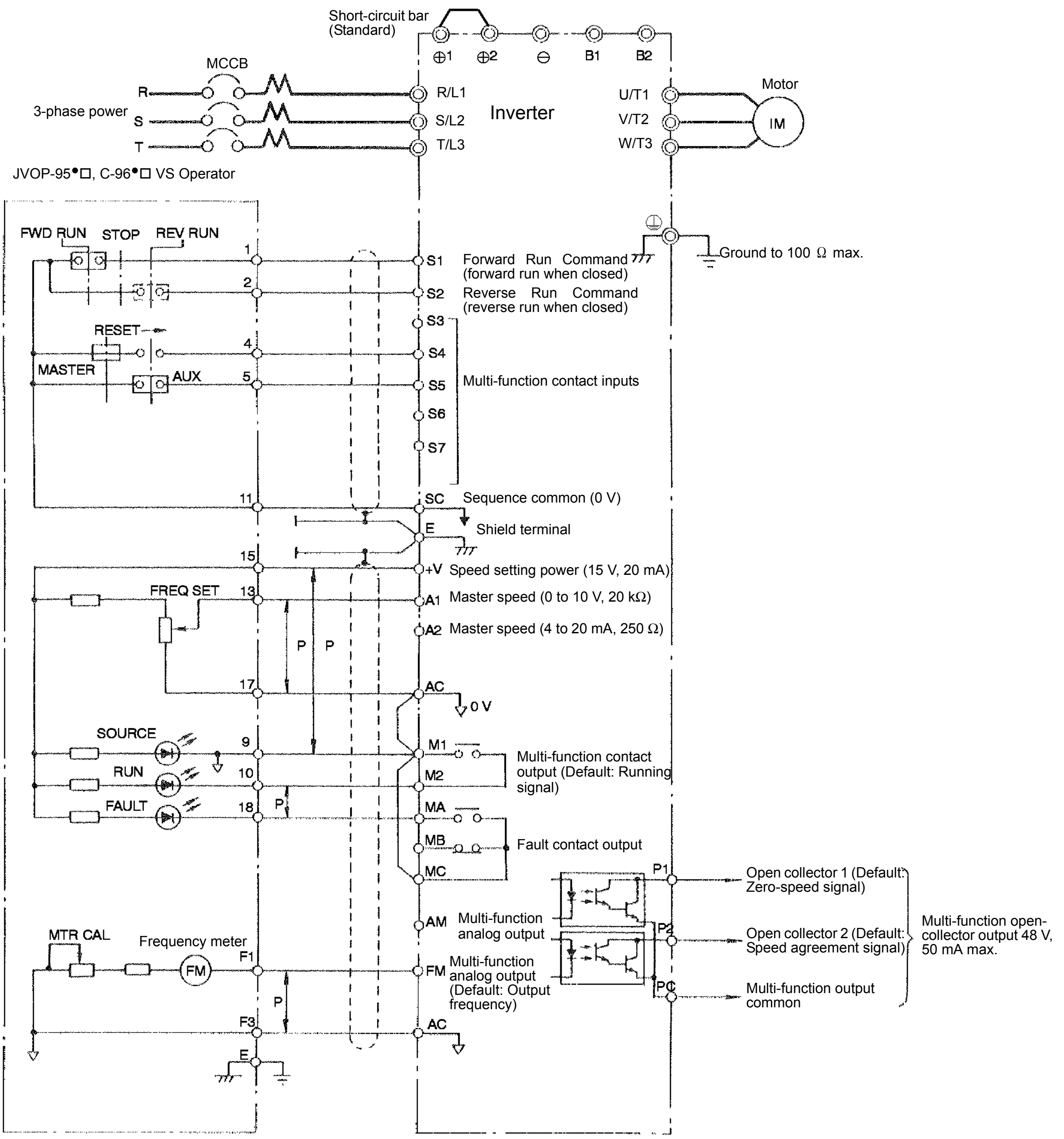


Fig 10.13

◆ Using Transistors for Input Signals and a 0-V Common in Sinking Mode with an Internal Power Supply

Set CN5 (shunt connector) on the control board to NPN as shown below for a sequence that uses an NPN transistor for an input signal (0-V command and sinking mode) and an internal +24-V power supply.

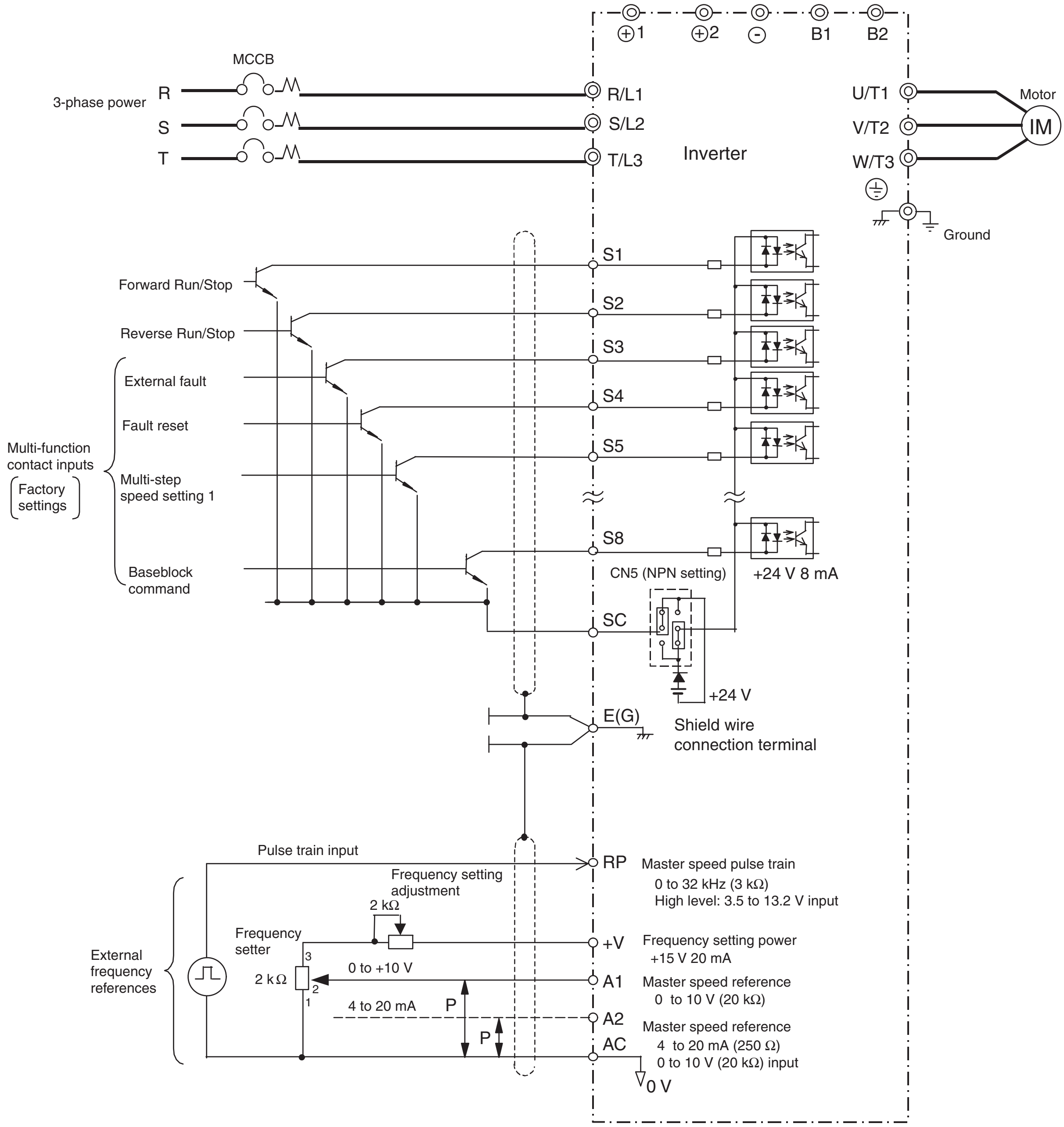


Fig 10.14

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◆ Using Transistors for Input Signals and a +24-V Common in Sourcing Mode

Set CN5 (shunt connector) on the control board to PNP as shown below for a sequence that uses a PNP transistor for an input signal (+24-V common and sourcing mode) and an internal +24-V power supply.

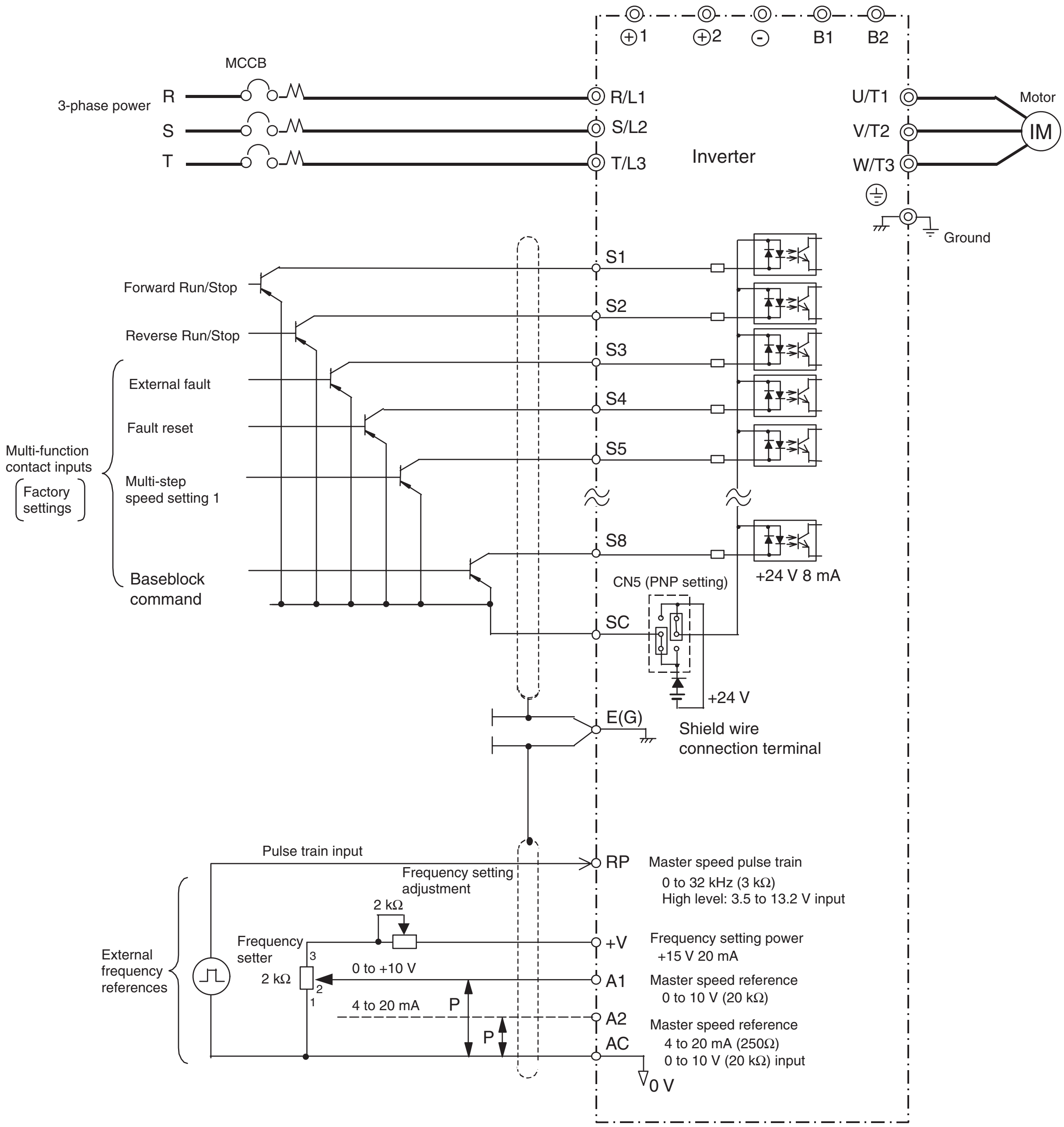
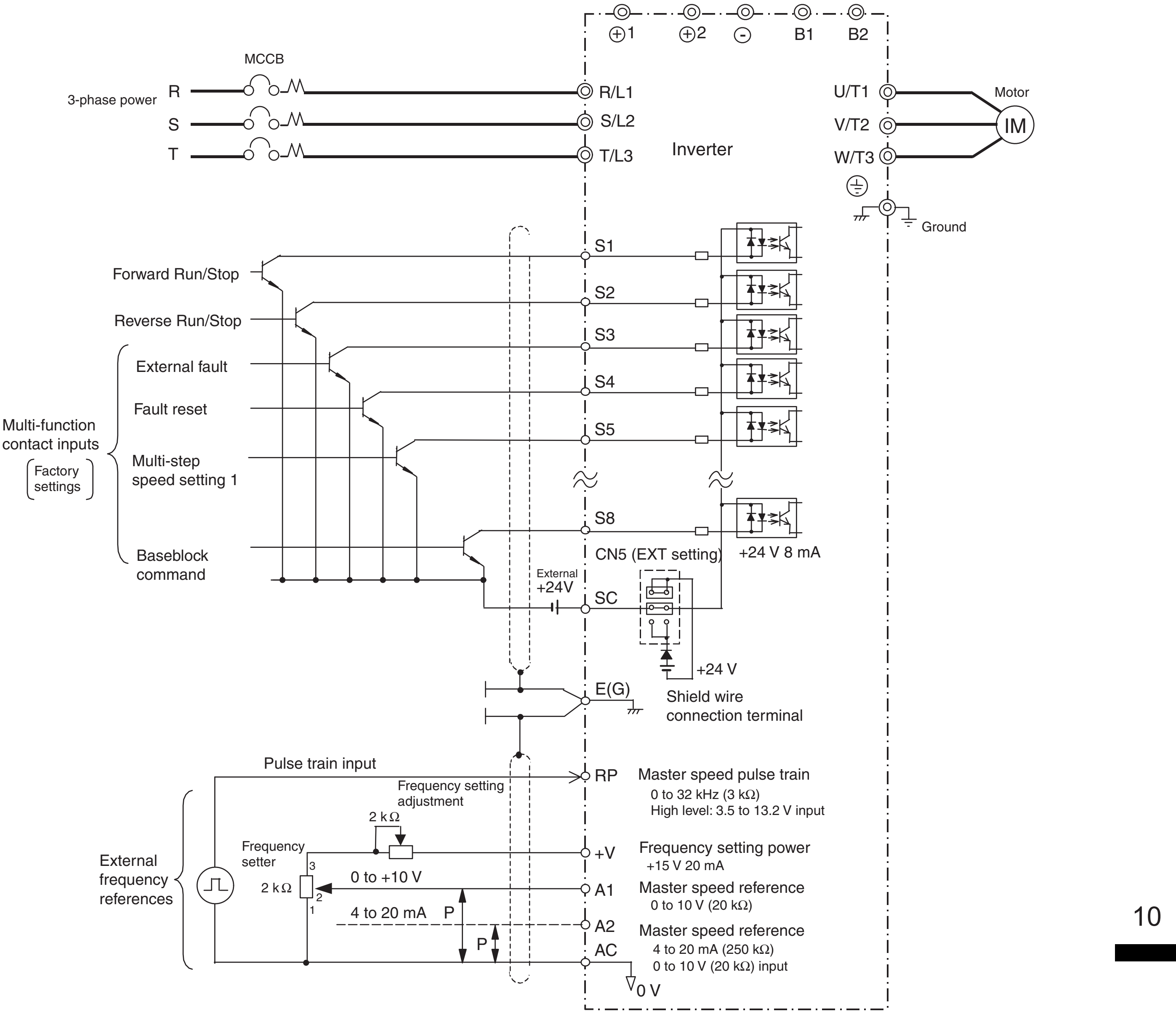


Fig 10.15

◆ Using Transistors for Input Signals and a 0-V Common in Sinking Mode with an External Power Supply

Set CN5 (shunt connector) on the control board to EXT as shown below for a sequence that uses an NPN transistor for an input signal (0-V command and sinking mode) and an external +24-V power supply.



Note:
Set EXT as shown at the right even for a PNP input signal transistor sequence connection (+24-V common/sourcing mode) with a +24-V external power supply.

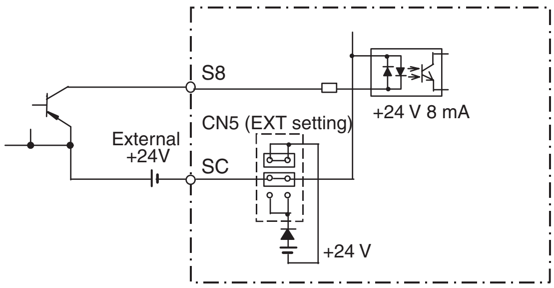


Fig 10.16

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◆ Using Contact and Open Collector Outputs

This example shows wiring for contact outputs and open collector outputs.

The following example is for the CIMR-F7A27P5 (200 V Class Inverter for 7.5 kW).

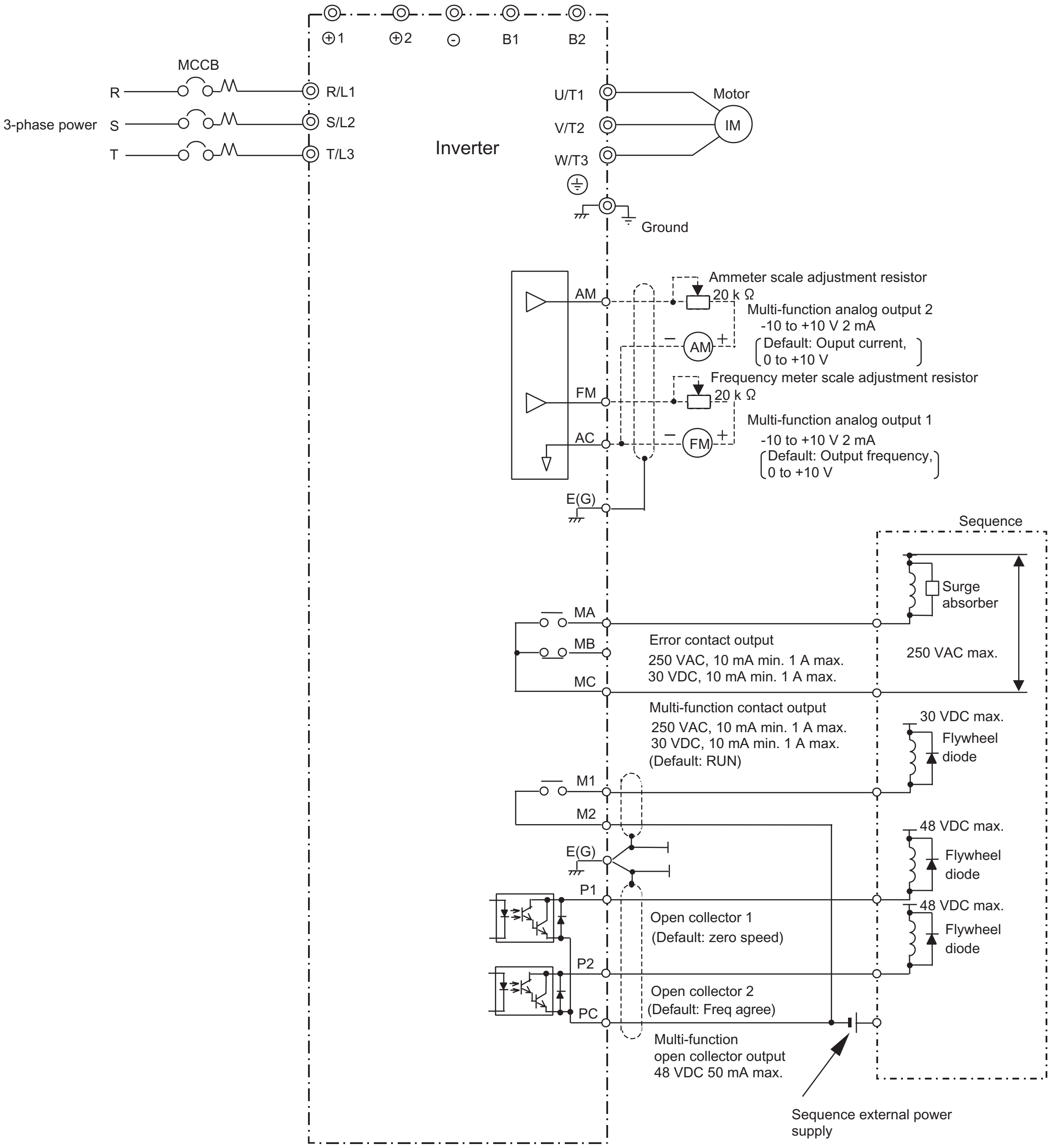

Fig 10.17

User Constants

Factory settings are given in the following table.

Table 10.7 User Constants

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
A1-00	Language selection for Digital Operator display	1*1		b3-05	Speed search wait time	0.2	
A1-01	Constant access level	2		b3-10	Sets the magnetic flux compensation as a percentage of the no-load current.	1.10	
A1-02	Control method selection	0*1		b3-14	Rotation direction search selection	1	
A1-03	Initialize	0		b3-17	Speed search retrial current level	150*14	
A1-04	Password	0		b3-18	Speed search retrial detection time	0.10	
A1-05	Password setting	0		b3-19	Number of speed search retrials	0	
A2-01 to A2-32	User setting constants	-		b4-01	Timer function ON-delay time	0.0	
b1-01	Reference selection	1		b4-02	Timer function OFF-delay time	0.0	
b1-02	Operation method selection	1		b5-01	PID control method selection	0	
b1-03	Stopping method selection	0		b5-02	Proportional gain (P)	1.00	
b1-04	Prohibition of reverse operation	0		b5-03	Integral (I) time	1.0	
b1-05	Operation selection for setting E1-09 or less	0		b5-04	Integral (I) limit	100.0	
b1-06	Read sequence input twice	1		b5-05	Derivative (D) time	0.00	
b1-07	Operation selection after switching to remote mode	0		b5-06	PID limit	100.0	
b1-08	Run Command selection in programming modes	0		b5-07	PID offset adjustment	0.0	
b2-01	Zero-speed level (DC injection braking starting frequency)	0.5		b5-08	PID primary delay time constant	0.00	
b2-02	DC injection braking current	50		b5-09	PID output characteristics selection	0	
b2-03	DC injection braking time at start	0.00		b5-10	PID output gain	1.0	
b2-04	DC injection braking time at stop	0.50		b5-11	PID reverse output selection	0	
b2-08	Magnetic flux compensation volume	0		b5-12	Selection of PID feedback command loss detection	0	
b3-01	Speed search selection	2*2		b5-13	PID feedback command loss detection level	0	
b3-02	Speed search operating current	120*2 *14 150*2 *14		b5-14	PID feedback command loss detection time	1.0	
b3-03	Speed search deceleration time	2.0		b5-15	PID sleep function operation level	0.0	

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Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
b5-16	PID sleep operation delay time	0.0		C1-09	Emergency stop time	10.0	
b5-17	Acceleration/deceleration time for PID reference	0.0		C1-10	Accel/decel time setting unit	1	
b6-01	Dwell frequency at start	0.0		C1-11	Accel/decel time switching frequency	0.0	
b6-02	Dwell time at start	0.0		C2-01	S-curve characteristic time at acceleration start	0.20	
b6-03	Dwell frequency at stop	0.0		C2-02	S-curve characteristic time at acceleration end	0.20	
b6-04	Dwell time at stop	0.0		C2-03	S-curve characteristic time at deceleration start	0.20	
b7-01	Droop control gain	0.0		C2-04	S-curve characteristic time at deceleration end	0.00	
b7-02	Droop control delay time	0.05		C3-01	Slip compensation gain	0.0*2	
b8-01	Energy-saving mode selection	0		C3-02	Slip compensation primary delay time	2000*2 *3	
b8-02	Energy-saving gain	0.7*3		C3-03	Slip compensation limit	200	
b8-03	Energy-saving filter time constant	0.50*4		C3-04	Slip compensation selection during regeneration	0	
b8-04	Energy-saving coefficient	288.20 *5*6		C3-05	Output voltage limit operation selection	0	
b8-05	Power detection filter time constant	20		C4-01	Torque compensation gain	1.00	
b8-06	Search operation voltage limiter	0		C4-02	Torque compensation time constant	200*2	
b9-01	Zero-servo gain	5		C4-03	Forward starting torque	0.0	
b9-02	Zero-servo completion width	10		C4-04	Reverse starting torque	0.0	
C1-01	Acceleration time 1	10.0		C4-05	Starting torque time constant	10	
C1-02	Deceleration time 1	10.0		C5-01	ASR proportional (P) gain 1	20.00*7	
C1-03	Acceleration time 2	10.0		C5-02	ASR integral (I) time 1	0.500*7	
C1-04	Deceleration time 2	10.0		C5-03	ASR proportional (P) gain 2	20.00*7	
C1-05	Acceleration time 3	10.0		C5-04	ASR integral (I) time 2	0.500*7	
C1-06	Deceleration time 3	10.0		C5-05	ASR limit	5.0	
C1-07	Acceleration time 4	10.0		C5-06	ASR primary delay time	0.004	
C1-08	Deceleration time 4	10.0		C5-07	ASR switching frequency	0.0	

Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting
C5-08	ASR integral (I) limit	400	
C6-01	CT/VT selection	1*8 0*8	
C6-02	Carrier frequency selection	1 (C6-01 = 0) 6*6 (C6-01 = 1)	
C6-03*15	Carrier frequency upper limit	15.0*6 2.0	
C6-04*15	Carrier frequency lower limit	15.0*6 2.0	
C6-05*15	Carrier frequency proportional gain	00	
d1-01	Frequency reference 1	0.00	
d1-02	Frequency reference 2	0.00	
d1-03	Frequency reference 3	0.00	
d1-04	Frequency reference 4	0.00	
d1-05	Frequency reference 5	0.00	
d1-06	Frequency reference 6	0.00	
d1-07	Frequency reference 7	0.00	
d1-08	Frequency reference 8	0.00	
d1-09	Frequency reference 9	0.00	
d1-10	Frequency reference 10	0.00	
d1-11	Frequency reference 11	0.00	
d1-12	Frequency reference 12	0.00	
d1-13	Frequency reference 13	0.00	
d1-14	Frequency reference 14	0.00	
d1-15	Frequency reference 15	0.00	
d1-16	Frequency reference 16	0.00	

No.	Name	Factory Setting	Setting
d1-17	Jog frequency reference	6.00	
d2-01	Frequency reference upper limit	100.0	
d2-02	Frequency reference lower limit	0.0	
d2-03	Master speed reference lower limit	0.0	
d3-01	Jump frequency 1	0.0	
d3-02	Jump frequency 2	0.0	
d3-03	Jump frequency 3	0.0	
d3-04	Jump frequency width	1.0	
d4-01	Frequency reference hold function selection	0	
d4-02	+ - Speed limits	10	
d5-01	Torque control selection	0	
d5-02	Torque reference delay time	0	
d5-03	Speed limit selection	1	
d5-04	Speed limit	0	
d5-05	Speed limit bias	10	
d5-06	Speed/torque control switching timer	0	
d6-01	Field weakening level	80	
d6-02	Field frequency	0.0	
d6-03	Field forcing function selection	0	
d6-06	Field forcing limit	400	
E1-01	Input voltage setting	200*9	
E1-03	V/f pattern selection	F	
E1-04	Max. output frequency	60.0*2	
E1-05	Max. voltage	200.0 *2 *9	

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Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
E1-06	Base frequency	60.0[*2]		E3-06	Motor 2 mid. output frequency voltage 1 (VC)	15.0 [*9]	
E1-07	Mid. output frequency	3.0[*2]		E3-07	Motor 2 min. output frequency (FMIN)	1.5 [*2]	
E1-08	Mid. output frequency voltage	15.0 [*2*9]		E3-08	Motor 2 min. output frequency voltage (VMIN)	9.0 [*9]	
E1-09	Min. output frequency	1.5[*2]		E4-01	Motor 2 rated current	1.90 [*6]	
E1-10	Min. output frequency voltage	9.0[*2*9]		E4-02	Motor 2 rated slip	2.90 [*6]	
E1-11	Mid. output frequency 2	0.0[*10]		E4-03	Motor 2 no-load current	1.20 [*6]	
E1-12	Mid. output frequency voltage 2	0.0[*10]		E4-04	Motor 2 number of poles (number of poles)	4	
E1-13	Base voltage	0.0[*11]		E4-05	Motor 2 line-to-line resistance	9.842[*6]	
E2-01	Motor rated current	1.90[*6]		E4-06	Motor 2 leak inductance	18.2[*6]	
E2-02	Motor rated slip	2.90[*6]		E4-07	Motor 2 rated capacity	0.40[*6]	
E2-03	Motor no-load current	1.20[*6]		F1-01	PG constant	600	
E2-04	Number of motor poles	4		F1-02	Operation selection at PG open circuit (PGO)	1	
E2-05	Motor line-to-line resistance	9.842[*6]		F1-03	Operation selection at overspeed (OS)	1	
E2-06	Motor leak inductance	18.2[*6]		F1-04	Operation selection at deviation	3	
E2-07	Motor iron saturation coefficient 1	0.50		F1-05	PG rotation	0	
E2-08	Motor iron saturation coefficient 2	0.75		F1-06	PG division rate (PG pulse monitor)	1	
E2-09	Motor mechanical loss	0.0		F1-07	Integral value during accel/decel enable/disable	0	
E2-10	Motor iron loss for torque compensation	14[*6]		F1-08	Overspeed detection level	115	
E2-11	Motor rated output	0.40[*6]		F1-09	Overspeed detection delay time	0.0[*7]	
E3-01	Motor 2 control method selection	0		F1-10	Excessive speed deviation detection level	10	
E3-02	Motor 2 max. output frequency (FMAX)	60.0		F1-11	Excessive speed deviation detection delay time	0.5	
E3-03	Motor 2 max. voltage (VMAX)	200.0[*2]		F1-12	Number of PG gear teeth 1	0	
E3-04	Motor 2 max. voltage frequency (FA)	60.0		F1-13	Number of PG gear teeth 2	0	
E3-05	Motor 2 mid. output frequency 1 (FB)	3.0 [*2]		F1-14	PG open-circuit detection time	2.0	

Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
F2-01	Bi-polar or uni-polar input selection	0		F6-08*17	Operation selection after SI-T WDT error	1	
F3-01	Digital input option	0		F6-09*17	Number of SI-T BUS error detection	2	
F4-01	Channel 1 monitor selection	2		H1-01	Terminal S3 function selection	24	
F4-02	Channel 1 gain	1.00		H1-02	Terminal S4 function selection	14	
F4-03	Channel 2 monitor selection	3		H1-03	Terminal S5 function selection	3 (0)*12	
F4-04	Channel 2 gain	0.50		H1-04	Terminal S6 function selection	4 (3)*12	
F4-05	Channel 1 output monitor bias	0.0		H1-05	Terminal S7 function selection	6 (4)*12	
F4-06	Channel 2 output monitor bias	0.0		H1-06	Terminal S8 function selection	8 (6) *12	
F4-07	Analog output signal level for channel 1	0		H2-01	Terminal M1-M2 function selection (contact)	0	
F4-08	Analog output signal level for channel 2	0		H2-02	Terminal P1 function selection (open collector)	1	
F5-01	Channel 1 output selection	0		H2-03	Terminal P2 function selection (open collector)	2	
F5-02	Channel 2 output selection	1		H3-01	Signal level selection (terminal A1)	0	
F5-03	Channel 3 output selection	2		H3-02	Gain (terminal A1)	100.0	
F5-04	Channel 4 output selection	4		H3-03	Bias (terminal A1)	0.0	
F5-05	Channel 5 output selection	6		H3-04	Signal level selection (terminal A3)	0	
F5-06	Channel 6 output selection	37		H3-05	Multi-function analog input (terminal A3) function selection	1F	
F5-07	Channel 7 output selection	0F		H3-06	Gain (terminal A3)	100.0	
F5-08	Channel 8 output selection	0F		H3-07	Bias (terminal A3)	0.0	
F5-09	DO-08 output mode selection	0		H3-08	Signal level selection (terminal A2)	2	
F6-01	Operation selection after communications error	1		H3-09	Multi-function analog input (terminal A2) function selection	0	
F6-02	Input level of external fault from Communications Option Board	0		H3-10	Gain (terminal A2)	100.0	
F6-03	Stopping method for external fault from Communications Option Board	1		H3-11	Bias (terminal A2)	0.0	
F6-04	Trace sampling from Communications Option Board	0		H3-12	Analog input filter time constant	0.00	
						0.03	
F6-06	Torque reference/torque limit selection from optical option	0		H3-13	Terminal A1/A2 switching	0	

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Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
H4-01	Monitor selection (terminal FM)	2		L1-02	Motor protection time constant	1.0	
H4-02	Gain (terminal FM)	1.00		L1-03	Alarm operation selection during motor overheating	3	
H4-03	Bias (terminal FM)	0.0		L1-04	Motor overheating operation selection	1	
H4-04	Monitor selection (terminal AM)	3		L1-05	Motor temperature input filter time constant	0.20	
H4-05	Gain (terminal AM)	0.50		L2-01	Momentary power loss detection	0	
H4-06	Bias (terminal AM)	0.0		L2-02	Momentary power loss ridethru time	0.1*6	
H4-07	Analog output 1 signal level selection	0		L2-03	Min. baseblock time	0.2*6	
H4-08	Analog output 2 signal level selection	0		L2-04	Voltage recovery time	0.3*6	
H5-01	Slave address	1F		L2-05	Undervoltage detection level	190*9	
H5-02	Communication speed selection	3		L2-06	KEB deceleration time	0.0	
H5-03	Communication parity selection	0		L2-07	Momentary recovery time	0.0*13	
H5-04	Stopping method after communication error	3		L2-08	Frequency reduction gain at KEB start	100	
H5-05	Communication error detection selection	1		L3-01	Stall prevention selection during accel	1	
H5-06	Send wait time	5		L3-02	Stall prevention level during accel	120*14 150*14	
H5-07	RTS control ON/OFF	1		L3-03	Stall prevention limit during accel	50	
H5-10 *18	Unit Selection for MEMOBUS Register 0025H	0		L3-04	Stall prevention selection during decel	1	
H6-01	Pulse train input function selection	0		L3-05	Stall prevention selection during running	1	
H6-02	Pulse train input scaling	1440		L3-06	Stall prevention level during running	120*14 150*14	
H6-03	Pulse train input gain	100.0		L3-11	Overvoltage inhibit selection	0	
H6-04	Pulse train input bias	0.0		L3-12	Overvoltage inhibit voltage level	380V*9	
H6-05	Pulse train input filter time	0.10		L4-01	Speed agreement detection level	0.0	
H6-06	Pulse train monitor selection	2		L4-02	Speed agreement detection width	2.0	
H6-07	Pulse train monitor scaling	1440		L4-03	Speed agreement detection level (+/-)	0.0	
L1-01	Motor protection selection	1		L4-04	Speed agreement detection width (+/-)	2.0	

Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
L4-05	Operation when frequency reference is missing	0		L8-15	OL2 characteristics selection at low speeds	1	
L5-01	Number of auto restart attempts	0		L8-18	Soft CLA selection	1*2	
L5-02	Auto restart operation selection	0		L8-32*16	OH1 detection of Inverter's cooling fan	1	
L6-01	Torque detection selection 1	0		N1-01	Hunting-prevention function selection	1	
L6-02	Torque detection level 1	150		N1-02	Hunting-prevention gain	1.00	
L6-03	Torque detection time 1	0.1		N2-01	Speed feedback detection control (AFR) gain	1.00	
L6-04	Torque detection selection 2	0		N2-02	Speed feedback detection control (AFR) time constant	50	
L6-05	Torque detection level 2	150		N2-03	Speed feedback detection control (AFR) time constant 2	750	
L6-06	Torque detection time 2	0.1		N3-01	High-slip braking deceleration frequency width	5	
L7-01	Forward drive torque limit	200		N3-02	High-slip braking current limit	150	
L7-02	Reverse drive torque limit	200		N3-03	High-slip braking stop dwell time	1.0	
L7-03	Forward regenerative torque limit	200		N3-04	High-slip braking OL time	40	
L7-04	Reverse regenerative torque limit	200		N5-01	Feed forward control selection	0	
L7-06	Integral time setting for torque limit	200		N5-02	Motor acceleration time	0.178*6	
L7-07	Control method selection for torque limit during acceleration and deceleration	0		N5-03	Feed forward proportional gain	1.0	
L8-01	Protect selection for internal DB resistor (Type ERF)	0		N5-04	Response frequency for speed command	40.00	
L8-02	Overheat pre-alarm level	95*6		o1-01	Monitor selection	6	
L8-03	Operation selection after overheat pre-alarm	3		o1-02	Monitor selection after power up	1	
L8-05	Input open-phase protection selection	0		o1-03	Frequency units of reference setting and monitor	0	
L8-07	Output open-phase protection selection	0		o1-04	Setting unit for frequency constants related to V/f characteristics	0	
L8-09	Ground protection selection	1		o1-05	LCD brightness adjustment	3	
L8-10	Cooling fan control selection	0		o2-01	LOCAL/REMOTE key enable/disable	1	
L8-11	Cooling fan control delay time	60		o2-02	STOP key during control circuit terminal operation	1	
L8-12	Ambient temperature	45		o2-03	User constant initial value	0	

Table 10.7 User Constants (Continued)

No.	Name	Factory Setting	Setting	No.	Name	Factory Setting	Setting
o2-04	kVA selection	0*6		T1-00	Motor 1/2 selection	1	
o2-05	Frequency reference setting method selection	0		T1-01	Autotuning mode selection	2*2	
o2-06	Operation selection when digital operator is disconnected	0		T1-02	Motor output power	0.40*6	
o2-07	Cumulative operation time setting	0		T1-03	Motor rated voltage	200.0*9	
o2-08	Cumulative operation time selection	0		T1-04	Motor rated current	1.90*6	
o2-09 *19	For factory adjustment	0		T1-05	Motor base frequency	60.0	
o2-10	Fan operation time setting	0		T1-06	Number of motor poles	4	
o2-12	Fault trace/fault history clear function	0		T1-07	Motor base speed	1750	
o2-14	Output power monitor clear selection	0		T1-08	Number of PG pulses when turning	600	
o3-01	Copy function selection	0		T1-09	Motor no-load current	1.20*6	
o3-02	Read permitted selection	0					

* 1. Not initialized. (Japanese standard specifications: A1-01 = 1, A1-02 = 2)
* 2. The factory setting will change when the control method is changed. The V/f control factory settings are given.
* 3. The factory setting is 1.0 when using flux vector control.
* 4. The factory setting is 2.00 s when Inverter capacity is 55 kW min.
The factory setting will change if the control method is changed. The open-loop vector factory setting is given.
* 5. By setting E2-11 (Motor rated output) the appropriate value will be set.
* 6. The factory setting depends on the Inverter capacity. The values for a 200 V Class Inverter for 0.4 kW are given.
* 7. The factory setting will change when the control method is changed. The flux vector control factory settings are given.
* 8. Only 1 (VT) can be set for 200 V Class 110 kW as well as 400 V Class 220 kW and 300 kW Inverters.
* 9. Setting for 200 V Class Inverters. For 400 V Class Inverters, double the value.
* 10.E1-11 and E1-12 are disregarded when set to 0.0.
* 11.E1-13 is set to the same value as E1-05 by autotuning.
* 12.The values in parentheses indicate factory settings when initialized in 3-wire sequence.
* 13.If the setting is 0, the axis will accelerate to the specified speed over the specified acceleration time (C1-01 to C1-08).
* 14.C6-01 = 1:120%, C6-01 = 0:150%
* 15.This constant can be monitored or set only when F is set for C6-02.
* 16.Applicable for F7-Series Inverters with software versions PRG:1031 or later.
* 17.Refer to *MECHATROLINK COMMUNICATIONS INTERFACE CARD INSTRUCTIONS (TOBPC73060008)* for details.
* 18.Applicable for F7-series Inverters with software versions PRG: 1032 or latter.
* 19.Applicable for F7-series Inverters with software versions PRG: 1033 or latter.

Index

Symbols

Numerics

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Revision History

The revision dates and numbers of the revised manuals are given on the bottom of the back cover.

MANUAL NO. TOE-S616-55.1
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Revision number
Date of printing
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Date of Printing	Rev. No.	Section	Revised Content
December 2000	–	–	First edition
April 2001	◇1	Chapter 4	Addition: Precautions before Using Autotuning etc.
		Chapter 6	Revision: Description of carrier frequency and inverter overload current level
May 2001	◇2		Addition: Index
April 2002	◇3	Chapter 10	Revision: Conformance to CE markings Addition: Setting the power supply voltage jumper
		7-8 and 9-4 page	Revision: Description about detection level of over voltage and under voltage
August 2002	◇4	Back cover	Revision: Address
March 2003	◇5		Revision: NEMA1 → NEMA1 (Type1)
		Chapter 4	Addition: LCD brightness adjustment (o1-05)
		Chapter 6	Addition: Using Frequency Detection
August 2003	◇6	Chapter 4	Revision: Autotuning
September 2004	◇7		Addition: Information on Inverters with SPEC: E or later.
January 2005	◇8	Chapter 3	Addition: • DATA/ENTER Key is invalid when UV is detected. • Table 3.2 Relation of Inverter to RUN and STOP Indicators
		Chapter 7	Revision: Note about GF in Table 7.1 Fault Displays and Processing. Addition: Note about OC and GF in the Meaning column in Table 7.1 Fault Displays and Processing.

Date of Printing	Rev. No.	Section	Revised Content
July 2005	9	Preface	Addition: Safety Precautions Maintenance and Inspection • Precaution about using an Inverter with an elevator • Precaution about times when a holding brake is necessary
		Chapter 2	Revision: IMPORTANT 2 in *Connection Diagram* Addition: • IMPORTANT 13 in *Connection Diagram* • IMPORTANT in *Standard Connection Diagrams*
		Chapter 5	Revision: Note *2 about E2-01 Addition: • L8-32 • 36 and 3D settings of multi-function output terminal • Note *7 about C4-02 in the table in *Factory Settings that Change with the Control Method (A1-01)*
		Chapter 6	Revision: • Fig.6.49 Baseblock Commands • Fig.6.63 PID Control Block • Examples of torque-limit operation in *Torque Control* • *Application Precautions* in *Copying Constants* • Fig.6.81 Brake ON/OFF Sequence Circuit Configuration • *Confirming Startup Current and Reducing Carrier Frequency* in *Using Inverters for Elevating Machines* Addition: • Information on frequency detection 5 in *Using Frequency Detection* • Operation Selection After Cooling Fan Fault • Description about the changes in the OV and BTR levels that depend on the input voltage in *Setting the V/f Pattern* • Description about frequency detection 5, which is an Inverter output signal to engage a holding brake, in *Using Inverters for Elevating Machines*
		Chapter 7	Addition: • Fault and Alarm Detections Descriptions of FAN • Probable causes and corrective actions for the OC, GF, OH (OH1), OL1, OL2, CPF04, and CPF05 faults as well as the OH alarm Descriptions about a short-circuit between, the +V, -V, and AC terminals. • Note in Table 7.3 Operation Error Displays and Incorrect Settings Revision: Probable causes and corrective actions for the CPF23 fault
		Chapter 8	Addition: • Descriptions in *Periodic Maintenance of Parts* • Description of how to attach the fan cover for 200 V Class Inverters of 22 kW or 30 kW and 400 V Class Inverters of 22 kW to 55 kW • Description of how to replace the cooing fan and circulation fan for 400 V Class Inverters of 185 kW, 220 kW, and 300 kW
		Chapter 10	Addition: Note *4 in Fig.10.9
March 2006	10	Preface	Addition: Safety Precautions Trial Operation Inverter settings precautions
		Chapter 1	Revision: Table 1.9 Removing the Terminal Cover (Model CIMR-F7A20P4 Shown Above)
		Chapter 2	Addition: • Note in Table 2.4 Main Circuit Terminal Functions • IMPORTANT 14 and 15 in *Connection Diagram* Revision: Description of installing a ground fault interrupter in *Wiring the Main Circuits*
		Chapter 4	Revision: Description of stationary autotuning 2
		Chapter 5	Addition: • Following constants H5-10, o2-09 • Note in the table of L2 constants Revision: Note *3 about E2-03 and E4-03
		Chapter 6	Addition: • *Inputting Master Speed Frequency Reference Only (Current Input)* in *Frequency Reference* • Following items in *Continuing Operation* • IMPORTANT in *Speed Search* • Additional description of master speed analog input in *Continuing Operation at Constant Speed When Frequency Reference Is Lost* Revision: • *Restarting Operation After Transient Fault (Auto Restart Function)* in *Continuing Operation* • *Torque Control* in *Individual Operation* Example Diagrams of winding and rewinding operation during torque control
		Chapter 7	Addition: • Table 7.2 Causes and Corrective Actions for When the Digital Operator Goes Dark • *The Inverter does not operate* in *Troubleshooting* Revision: Probable causes and corrective actions for the OC, GF, PUF, OV, UV1, UV2, UV3, OH (OH1), OL1, OL2, and CPF03 to CPF05 faults and OH, PGO, and DEV alarms
		Chapter 9	Addition: Notes *8 and *9 in Table 9.3
		Chapter 10	Revision: Table 10.5 EMC Noise Filters

Varisspeed F7

INSTRUCTION MANUAL

Safety Precautions

This Inverter is for variable-speed applications with three-phase AC motors for general industrial use.

· This Inverter was not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health. Customers 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.

· Wiring must be performed by an authorized person qualified in electrical work.

· Do not use this product with any load other than a three-phase AC motor.

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In the event that the end user of this product is to be the military and said product is to be employed in any weapons systems or the manufacture thereof, the export will fall under the relevant regulations as stipulated in the Foreign Exchange and Foreign Trade Regulations. Therefore, be sure to follow all procedures and submit all relevant documentation according to any and all rules, regulations and laws that may apply.

Specifications are subject to change without notice for ongoing product modifications and improvements.

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