* ACE 20 SERIES *
ADJUSTABLE FREQUENCY
AC MOTOR CONTROLLERS
TECHNICAL MANUAL
(1/8 - 10 HP)

MODEL NO. _____   SERIAL NO. _____

INPUT SUPPLY _____ VAC, 50/60 Hz   HORSEPOWER _____

Boston
Gear

An Altra Industrial Motion Company

ACE20TM
09/03

These instructions do not purport to cover all details or variations in equipment, nor to provide every possible contingency to be met during installation, operation, and maintenance. If further information is desired, or if particular problems arise that are not covered sufficiently for the user's purpose, the matter should be referred to Boston Gear, Quincy, MA, 02190, Phone: 617-328-3300.

This document contains proprietary information of Boston Gear and is furnished to its customer solely to assist that customer in the installation, testing, operation, and/or maintenance of the equipment described. This manual shall not be reproduced in whole or in part, nor shall its contents be disclosed to any third party without the written approval of Boston Gear.

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WARNING:

This equipment has the potential to cause electric shock or burn. Only personnel who are adequately trained and thoroughly familiar with the equipment and the instructions should install, operate, or maintain this equipment.

Isolation of test equipment from the equipment under test presents potential electrical hazards. If the test equipment cannot be grounded to the equipment under test, the test equipment's case must be shielded to prevent contact by personnel.

To minimize hazard of electrical shock or burn, approved grounding practices and procedures must be strictly followed.

WARNING:

To prevent personal injury or equipment damage caused by equipment malfunction, only adequately trained personnel should modify any programmable machine.

Table of Contents

CAUTIONS

- ACE 20 Series Drives are designed to drive a three-phase induction motor. Read through this instruction manual and be familiar with the correct method of handling the drive.

- Incorrect handling may cause mis-operation and shorten the life of ACE 20 Series Drives.

- This manual should be delivered to the user of the drive. This manual should be kept in a safe place until the ACE 20 Drive is de-commissioned.

- Refer to additional manuals for optional equipment.

Introduction

Safety precautions

Read through this manual before starting installation, connection (wiring), operation, maintenance or inspection. Be familiar with the drive, information about safety, and all the precautions before starting operation.

The safety precautions are classified into the following categories in this manual.

DANGER

Negligence in following precautions of this type can cause death or serious injuries.

CAUTION

Negligence in following precautions of this type can cause dangers including intermediate injuries or material losses.

Negligence in following precautions of this type under the CAUTION title can cause serious results in certain circumstances. These safety precautions are important and must be observed at all times.

Purposes

DANGER

- The ACE 20 Drive is designed to drive a three-phase induction motor. It should not be used for single-phase motors or other purposes. **Otherwise, fire could occur.**

- ACE 20 Series Drives may not be used for a life-support system or other purposes directly related to human safety.

- Although ACE 20 Series Drives are manufactured under strict quality control, safety devices should be installed for applications where serious accidents or material losses are possible.

Installation

DANGER

- Install the drive on a nonflammable material such as metal. **Otherwise, fire could occur.**

- Do not place flammable material nearby. **Otherwise, fire could occur.**

CAUTION

- Do not carry the drive by the cover. **Otherwise, the drive may drop and cause injuries.**

- Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter into the drive. **Otherwise, fire or an accident could occur.**

- Do not install or operate the drive if it is damaged or missing parts. **Otherwise, fire, an accident or injuries could occur.**

Wiring

DANGER

- When connecting the drive to the AC power supply, add a circuit breaker with ground fault protection. **Otherwise, fire could occur.**

- Be sure to connect the grounding cable. **Otherwise, electric shock or fire could occur.**

- Only qualified electricians should perform the wiring. **Otherwise, electric shock could occur.**

- Initiate wiring only after checking that the AC power supply is turned off. **Otherwise, electric shock could occur.**

- Begin wiring after mounting the main body of the drive. **Otherwise, electric shock or injuries could occur.**

- Both grounding terminals of 7-1/2 / 10 HP drives have to be tightened securely, even if one grounding terminal is used. **Otherwise, electric shock or fire could occur.**

CAUTIONS

- Check that the number of phases and the rated voltage of the drive agree with the phases and voltage of the AC power supply. **Otherwise, fire or an accident could occur.**

- Do not connect the AC power cables to the output terminals (U, V, W). **Otherwise, fire or an accident could occur.**

- Do not connect a braking resistor directly to the DC terminals (P (+), N (-)). **Otherwise, fire or an accident could occur.**

- The drive, motor and wiring generate electrical noise. Take care installing nearby sensors and devices. **Otherwise, an accident could occur.**

Operation

DANGER

- Be sure to install the drive cover before turning the power on. Do not remove the cover while power is applied. **Otherwise, electric shock could occur.**

- Do not operate switches with wet hands. **Otherwise, electric shock could occur.**

- If the retry function has been selected, the drive may automatically restart after tripping.

  (Design the machine so that human safety is ensured after restarting. **Otherwise, an accident could occur.)**

- If the torque limit function has been selected, the drive may operate at an acceleration/deceleration rate or speed different from the set ones. Design the machine so that safety is ensured. **Otherwise, an accident could occur.**

- The STOP key is only effective when a function code setting has been established to enable the STOP key. Prepare an emergency stop switch separately. **Otherwise, an accident could occur.**

- If an alarm reset is made with the reference signal present, a sudden start will occur. Check that the reference signal is turned off in advance. **Otherwise, an accident could occur.**

- Do not touch the drive terminals while power is applied to the drive, even if the the motor is stopped. **Otherwise, electric shock could occur.**

CAUTION

- Do not turn the main circuit power on or off to start or stop the motor. **Otherwise, failure could occur.**

- Do not touch the heat sink and braking resistor as they may become very hot. **Otherwise, burns could occur.**

- Check the performance of the motor and machine before running them at high speed. **Otherwise, injuries could occur.**

- The brake function of the drive does not provide mechanical holding. **Therefore, injuries could occur if precautions are not taken.**

DANGER

- Turn the AC power off and wait at least five minutes before starting inspection.

  (Check that the charge lamp is not lit, and check that the DC voltage across the P (+) and N (-) terminals is lower than 25 Vdc. **Otherwise, electric shock could occur.**)

- Maintenance, inspection and parts replacement should be made only by qualified persons.

  (Take off watches, rings and other metallic items before starting work.)

  (Use insulated tools.)

  Otherwise, electric shock or injuries could occur.

Disposal

CAUTION

- Handle the ACE 20 Drive as industrial waste when disposing of it. **Otherwise, injuries could occur.**

Others

DANGER

- Never re-work the drive. **Otherwise, electric shock or injuries could occur.**

General Precautions

Drawings in this manual may be illustrated without covers or safety shields for clearer explanation. Restore the covers and shields to the original state and observe the description in the manual before starting operation.

Compliance with low voltage directive in EU [Applicable to products with CE orTÜV mark]

• Safe separation for control interface of this drive is provided when this drive is installed in overvoltage category II. PELV(Protective Extra Low Voltage) circuit or SELV(Safety Extra Low Voltage) circuit should be connected to the interface directly.

• Basic insulation for control interface of this drive is provided when this drive is installed in overvoltage category III. An insulation transformer has to be installed between power supply mains and this drive when SELV circuit is connected to this drive directly. Otherwise, supplementary insulation between control interface of this drive and environment must be provided.

• The ground terminal G should always be connected to the ground. Don't use RCD as the sole method of electric shock protection.
Sizes of the external PE (ground) conductor should be the same size as the input phase conductor and capable of the same fault currents.

• Use MCCB or MC that conforms to EN or IEC standard.

• Where RCD (Residual-current-operated protective device) is used for protection of direct or indirect contact, only **RCD of type B** is allowed on the supply side of this EE (Electric equipment). Otherwise, other protective measures shall be applied such as separation of the EE from the environment by double or reinforced insulation or isolation of EE and supply system by a transformer.

• The drive is supplied as standard with a NEMA 1 enclosure.

• Use prescribed wire according to the EN60204 Appendix C.

• Install the drive, AC or DC reactor, output filter in an enclosure that meets the following requirements.

1) When a person can easily touch connecting terminals or live parts, install the devices in an enclosure with minimum of IP4X degree of protection.

2) When a person cannot easily touch connecting terminals or live parts, install the devices in an enclosure with a minimum of IP2X degree of protection.

• If it is necessary to install the drive with an appropriate RFI filter to conform to the EMC directive, it is the customer's responsibility to check whether the equipment is installed in accordance with EMC directives.

• Do not connect copper wire to ground terminals directly. Use crimp terminals with tin or equivalent plating to reduce electrochemical action.

• Do not remove the keypad panel before disconnecting power and do not insert/remove the extension cable for remote keypad panel while power is on. Confirm that the extention cable is securely latched to the keypad panel and the drive.

• Basic insulation for control interface of this drive is provided at altitudes up to 3000m. Use at altitudes over 3000m is not permitted.

• The neutral of the power supply has to be grounded for 460V input.

Compliance with UL/cUL standards [Applicable to products with UL/cUL mark]

CAUTION

1. [WARNING] Be sure to turn the AC power off to the ACE 20 Series Drive before starting work.

2. [CAUTION] When the charge lamp is lit, the ACE 20 Series Drive is still charged at a dangerous voltage.

3. [WARNING] There are live parts inside the ACE 20 Series Drive.

4. The ACE 20 Series Drive is approved as a part to be used inside a panel.

5. Wire to the input, output and control terminals of the ACE 20 Series Drive, referring to the table below. Use UL certified round crimp terminals on the input and output terminals with insulation cover removed to obtain the correct insulation distance. Use a crimping tool recommended by the terminal manufacturer.

6. Install a fuse or circuit breaker between the AC power supply and the ACE 20 Series Drive, using the table below.

THREE-PHASE SUPPLY	DRIVE CATALOG NO.	FUSE[a] (Amps)	CIRCUIT BREAKER (Amps)	POWER TERMINALS L1/R, L2/S, L3/T P1, P(+) DB, N(-) U, V, W		CONTROL TERMINALS	
				WIRE SIZE AWG[b]	TIGHTENING TORQUE Inch-Lbs (NM)	WIRE SIZE AWG[b]	TIGHTENING TORQUE Inch-Lbs (NM)
230 VAC	ACE202V3P0001N1	3	5	14	10.6 (1.2)	20	3.5 (0.4)
	ACE202V3P0002N1	6					
	ACE202V3P0005N1	10	10				
	ACE202V3P0010N1	15	15				
	ACE202V3P0020N1	20	20				
	ACE202V3P0030N1	30	30	12	15.9 (1.8)		
	ACE202V3P0050N1	40	40	10			
	ACE202V3P0075N1	50	50	8	31.0 (3.5)		
	ACE202V3P0100N1	60	60	6			
460 VAC	ACE204V3P0005N1	6	5	14	15.9 (1.8)		
	ACE204V3P0010N1						
	ACE204V3P0020N1	10	10				
	ACE204V3P0030N1	15	15				
	ACE204V3P0050N1	20	20				
	ACE204V3P0075N1	30	30	12	31.0 (3.5)		
	ACE204V3P0100N1	40	40	10			

a. Use UL approved AC600V "Class J fuse."
b. Use copper wire with allowable maximum temperature of 60 to 75 degrees C.

CAUTION

7. ACE 20 Series, 230V drives, are suitable for use on a circuit capable of delivering not more than 20,000 rms symmetrical amperes, 240V maximum.

8. ACE 20 Series, 460V drives, are suitable for use on a circuit capable of delivering not more than the following symmetrical amperes, 480V maximum: When a fuse is installed, 20,000A; when the circuit breaker is installed, 5000A.

9. ACE 20 Series Drives are supplied as standard with a NEMA 1 enclosure.

10. A class 2 circuit wired with class 1 wire.

ACE 20 Series Model Numbering System

ACE20   2V   3P   0010   N1

Drive Type

Input Voltage

2V = 230V, 50/60 Hz
4V = 460V, 50/60 Hz

Input Phase

3P = Three Phase

Horsepower

0001 = 1/8 HP	0030 = 3 HP
0002 = 1/4 HP	0050 = 5 HP
0005 = 1/2 HP	0075 = 7-1/2 HP
0010 = 1 HP	0100 = 10 HP
0020 = 2 HP	

Enclosure

N1 = NEMA 1
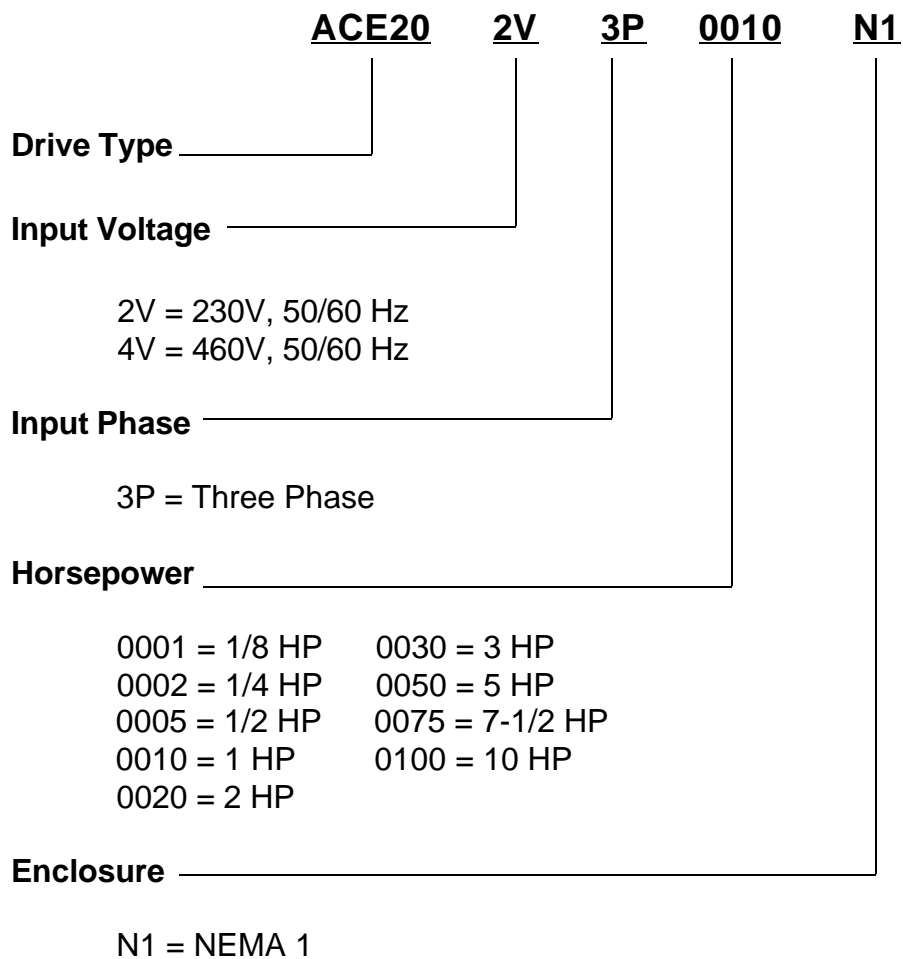
ACE 20 Series Weights & Dimensions

HP Rating	Enclosure	Output Current (A)	Overload (A) (150% 1min.)	Catalog No.	Item Code	Dimensions H* x W x D (inches)	Weight (lbs)
230VAC, 3 phase, 50/60Hz Input							
1/8	NEMA 1	0.7	1.1	ACE202V3P0001N1	43350	6.06 x 2.76 x 3.98	2.4
1/4	NEMA 1	1.4	2.1	ACE202V3P0002N1	43351	6.06 x 2.76 x 3.98	2.4
1/2	NEMA 1	2.5	3.8	ACE202V3P0005N1	43352	6.06 x 2.76 x 4.65	2.8
1	NEMA 1	4.0	6.0	ACE202V3P0010N1	43353	6.06 x 2.76 x 5.67	3.1
2	NEMA 1	7.0	10.5	ACE202V3P0020N1	43354	6.06 x 4.17 x 5.91	5.1
3	NEMA 1	10.0	15.0	ACE202V3P0030N1	43355	6.06 x 4.17 x 5.91	5.1
5	NEMA 1	16.5	24.8	ACE202V3P0050N1	43356	6.06 x 6.69 x 6.22	7.9
7.5	NEMA 1	23.5	35.3	ACE202V3P0075N1	43357	8.66 x 7.00 x 6.22	17.7
10	NEMA 1	31.0	46.5	ACE202V3P0100N1	43358	8.66 x 7.00 x 6.22	17.7

*With NEMA 1 Kit.

HP Rating	Enclosure	Output Current (A)	Overload (A) (150% 1min.)	Catalog No.	Item Code	Dimensions H* x W x D (inches)	Weight (lbs)
460VAC, 3 phase, 50/60Hz Input							
1/2	NEMA 1	1.4	2.1	ACE204V3P0005N1	43359	6.06 x 4.17 x 4.96	4.3
1	NEMA 1	2.1	3.2	ACE204V3P0010N1	43360	6.06 x 4.17 x 5.91	4.7
2	NEMA 1	3.7	5.6	ACE204V3P0020N1	43361	6.06 x 4.17 x 6.69	5.1
3	NEMA 1	5.3	8.0	ACE204V3P0030N1	43362	6.06 x 4.17 x 6.69	5.5
5	NEMA 1	8.7	13.1	ACE204V3P0050N1	43363	6.06 x 6.69 x 6.22	7.5
7.5	NEMA 1	12	18.0	ACE204V3P0075N1	43364	8.66 x 7.00 x 6.22	17.7
10	NEMA 1	16	24.0	ACE204V3P0100N1	43365	8.66 x 7.00 x 6.22	17.7

1.   Before Using ACE 20 Series Drives

1.1   Receiving Inspection

If you have any problems with the drive, contact the distributor or Boston Gear.

Unpack and check the following items.

(1) Check the ratings nameplate to confirm that the drive is the one that was ordered.

SOURCE: Number of input phases, input voltage, input frequency, input current

OUTPUT: Number of output phases, rated output capacity, rated output voltage, output frequency range, rated output current, overload current rating

1.2   External View

(1-1)   Overall view

(2) Check for breakage, missing parts, and dents or other damage on the cover and the main body that may have occurred during transportation.

(3) Instruction manual for the drive is included.

(1-2) Overall view (5-1/2, 7-1/2 HP)

Keypad panel mounting screw

Keypad panel

Intermediate cover

Ratings nameplate

Terminal block cover
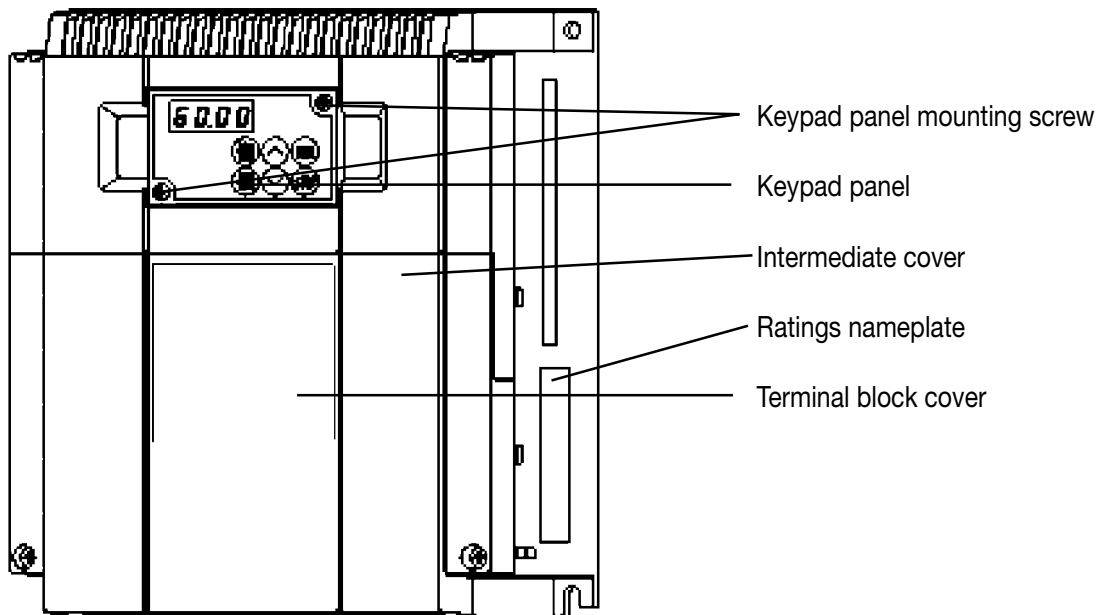
(2-1)   View of wiring part (5 HP or below)
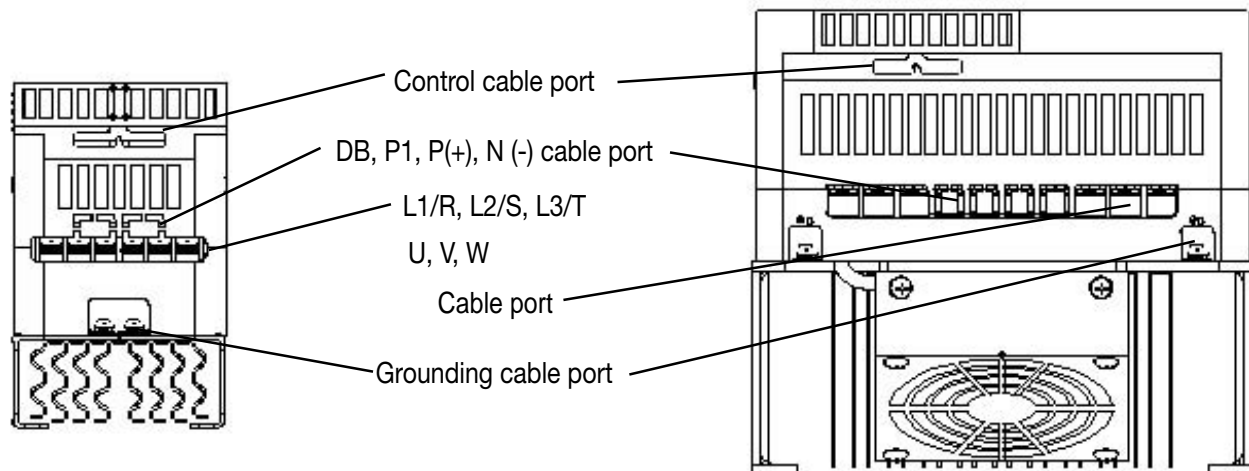
Control cable port

DB, P1, P(+), N (-) cable port

L1/R, L2/S, L3/T

U, V, W

Cable port

Grounding cable port

A barrier is provided in the cable cover for the P1, P(+), DB and N(-) cable port. Cut the barrier using nippers or the equivalent before wiring.

(2-2) View of wiring part (7-1/2, 10 HP)
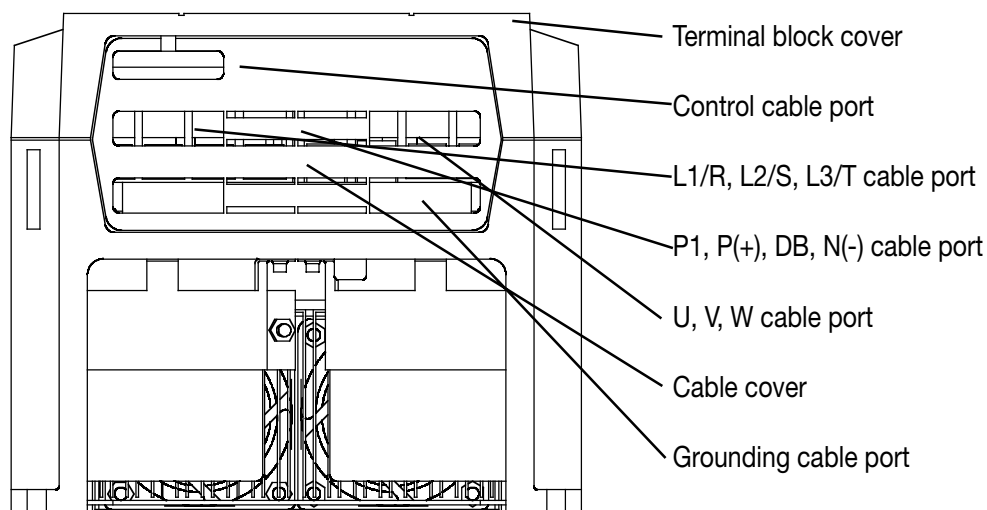
- Terminal block cover
- Control cable port
- L1/R, L2/S, L3/T cable port
- P1, P(+), DB, N(-) cable port
- U, V, W cable port
- Cable cover
- Grounding cable port

A barrier is provided in the cable cover for the P1, P(+), DB and N(-) cable port. Cut the barrier using nippers or the equivalent before wiring.

1.3   Handling

(1)   Removing the control terminal block cover (5 HP or below)

While lightly pushing in the sides of the control terminal block cover at the catches, lift the cover as shown in Fig. 1-3-1.
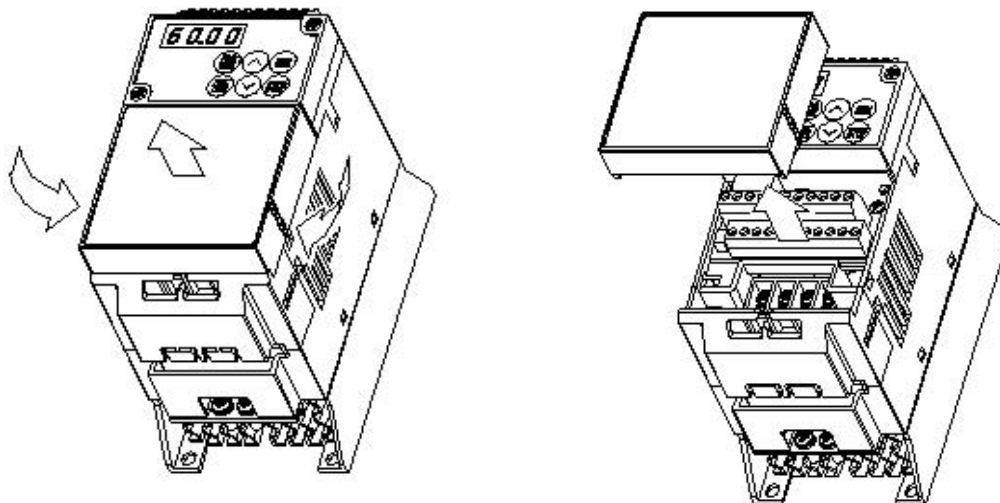
Fig. 1-3-1 Removing the control terminal block cover

(2)   Removing the main circuit terminal block cover (5 HP or below)

While lightly pushing in the sides of the main circuit terminal block cover at the catches, slide it toward you as shown in Fig. 1-3-2.
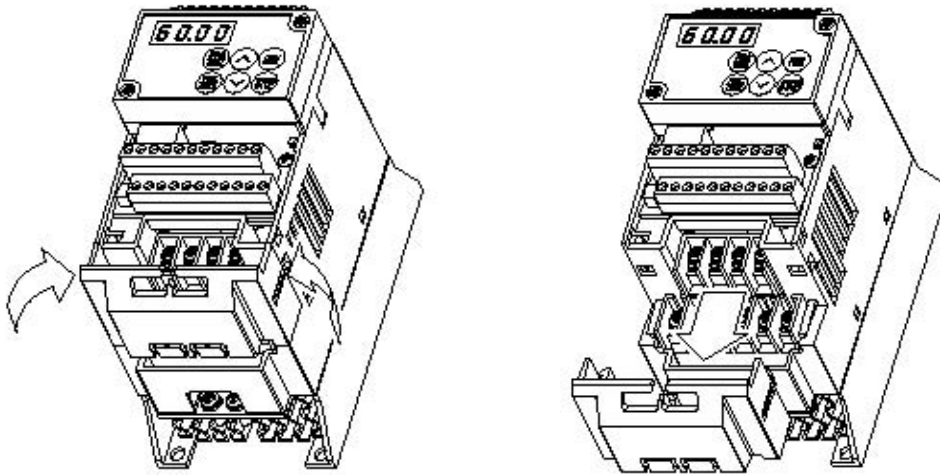
Fig. 1-3-2 Removing the main circuit terminal block cover

(3)   Removing the terminal block cover (7-1/2, 10 HP)

Loosen the screws holding the terminal block cover. While lightly pushing the sides of the terminal block cover at the catches, lift the cover as shown in Fig. 1-3-3.
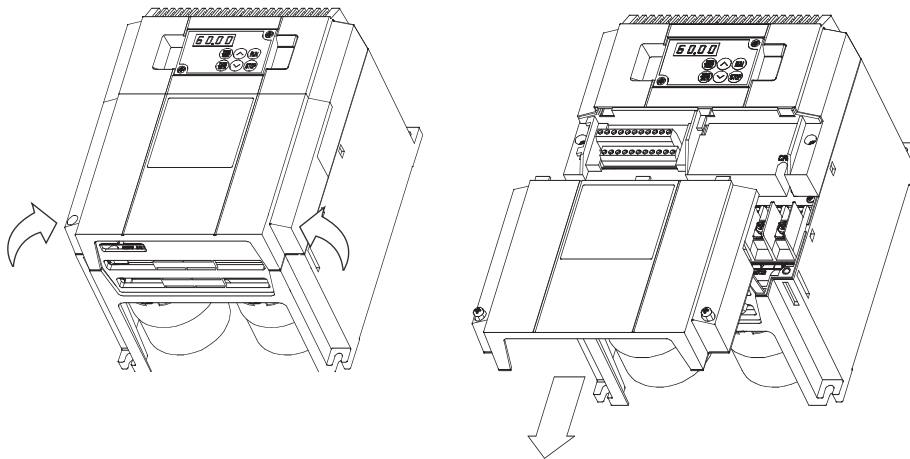
Fig. 1-3-3 Removing the terminal block cover

(4)   Removing the keypad panel

Loosen the keypad panel mounting screws and remove the keypad panel as shown in Fig. 1-3-4.
During the procedure, slowly remove the keypad panel from the unit. If the keypad panel is handled abruptly, the connector will be damaged.

Mounting screw (M3)
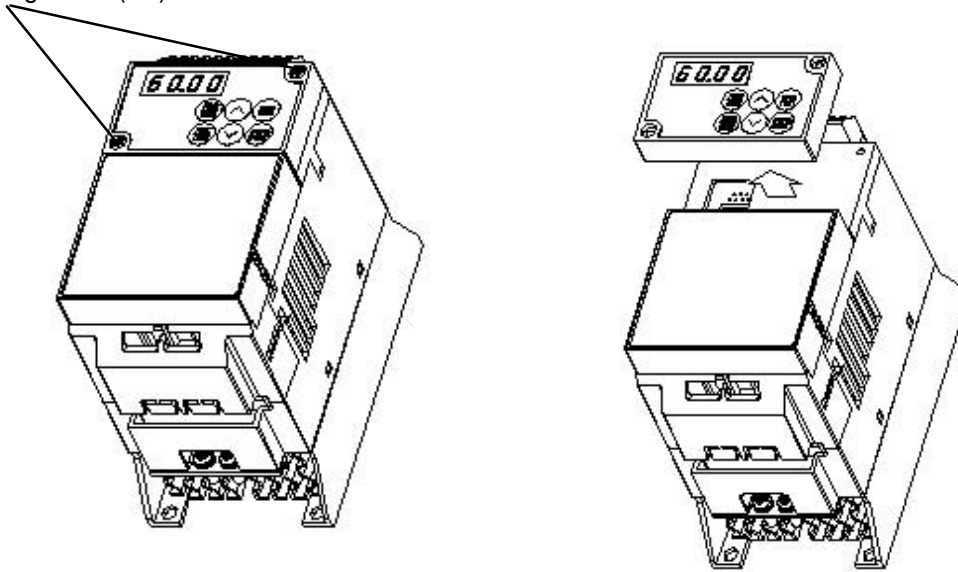
Fig. 1-3-4 Removing the keypad panel

Reverse the procedures to mount the terminal block cover and keypad panel.

1.4 NEMA 1 Kit

A NEMA 1 kit accompanies every ACE 20 Series controller. This kit converts the basic controller to a NEMA 1 configuration. If a NEMA 1 controller is desired, perform the instructions on page 1-6, 1-7 or 1-8, as applicable.

ACE20TM

TOP COVER: REMOVE THE PROTECTIVE FILM FROM THE STICKY BACK TAPE, AND ATTACH THE COVER TO THE CONTROLLER. COVER ALL OPENINGS.

ENCLOSURE COVER: SNAP INTO THE CONTROLLER. ADJUST THE SPRING TABS TO ENSURE A SNUG FIT.

NEMA 1 ENCLOSURE: SNAP THE ENCLOSURE INTO THE CONTROLLER. ADJUST THE SPRING TABS TO ENSURE A SNUG FIT.
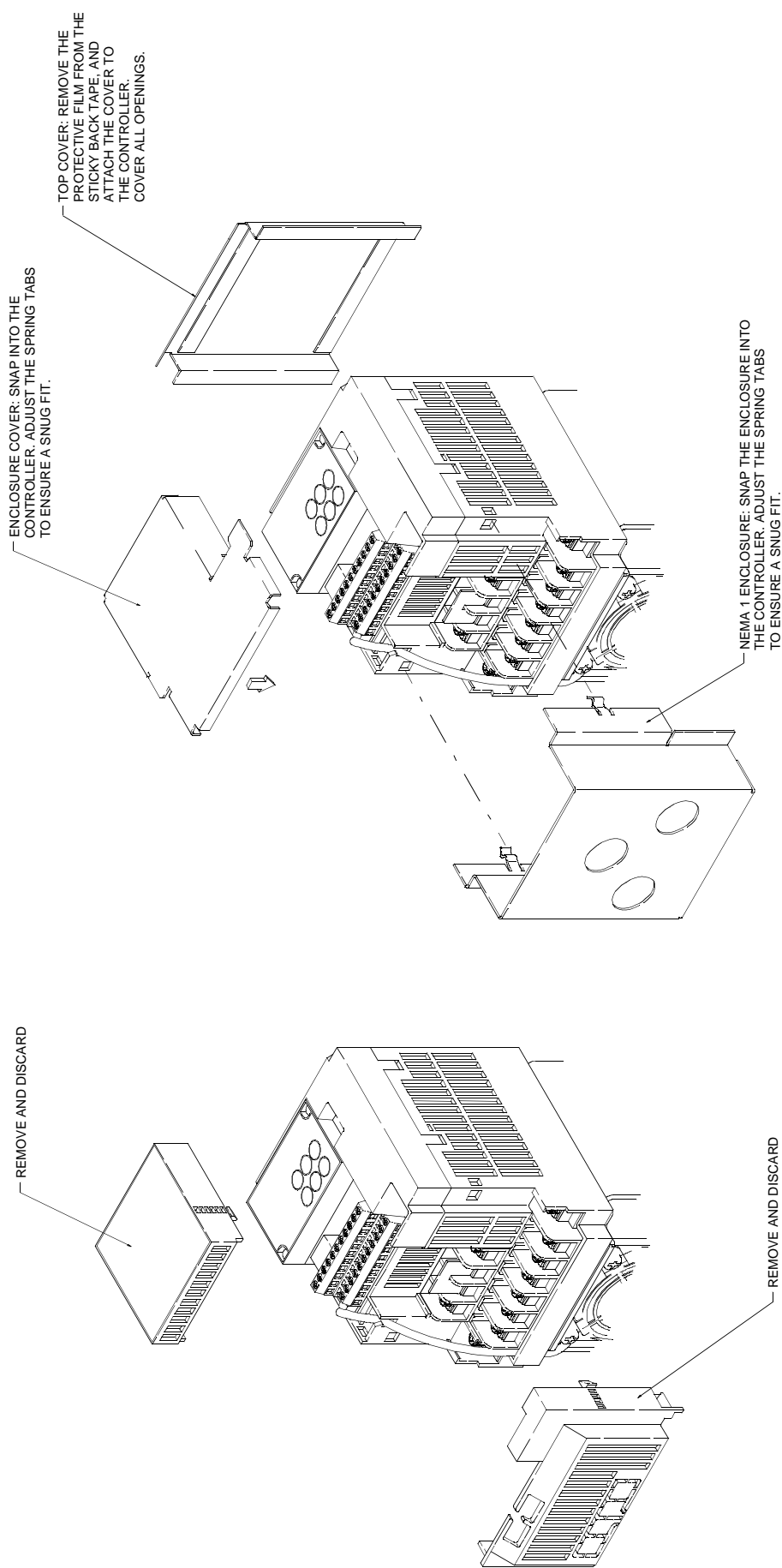
STEP 2

NOTE: SHAPE OF NEMA 1 PARTS MAY BE SLIGHTLY DIFFERENT THAN SHOWN.

ACE 20 SERIES, 1/8 - 3HP

REMOVE AND DISCARD

REMOVE AND DISCARD

STEP 1

ACE 20 SERIES, 5HP

STEP 3

REPLACE THE COVER.

STEP 4

TOP COVER: REMOVE THE PROTECTIVE FILM FROM THE STICKY BACK TAPE, AND ATTACH THE COVER TO THE CONTROLLER. ALIGN TO COVER ALL OPENINGS.

ENCLOSURE COVER: ATTACH WITH 6-32 HARDWARE SUPPLIED.

6-32 X 1/2 PAN HEAD PHILIPS SCREW.
#6 FLAT WASHER.
#6 LOCK WASHER.

STEP 1

REMOVE FOR WIRE HOOK-UP.
DO NOT DISCARD.

REMOVE & DISCARD PANEL

REMOVE THE TWO (2) SCREWS DO NOT DISCARD. USE THE SCREWS TO ATTACH THE NEMA 1 ENCLOSURE IN STEP 2.

STEP 2

ENCLOSURE

ATTACH THE ENCLOSURE WITH THE TWO (2) SCREWS REMOVED IN STEP 1.

TOP COVER: REMOVE THE PROTECTIVE FILM FROM THE STICKY- BACK TAPE, AND ATTACH THE TOP COVER TO THE CONTROLLER.

COVER: ATTACH WITH SCREW REMOVED IN STEP 1.

STEP 2 NEMA 1 ASSEMBLY

SAVE THE HARDWARE TO USE

REMOVE FOR WIRE HOOK-UP. RE-USE IN STEP 2.

REMOVE AND DISCARD THE PANEL.

STEP 1 DISASSEMBLY

ACE 20 SERIES 7-1/2 & 10HP

1.5   Transportation

AAlways hold the main unit when carrying the drive.

If covers or parts are held, the drive may break or it may separate and drop.

1.6   Storage

To store temporarily:

Store the drive in an environment described in Table 1-5-1.

Item	Specifications	
Ambient temperature	-10 to +40°C (+14 to +104°F)	Places not subjected to abrupt temperature changes or condensation or freezing
Storage temperature[1]	-25 to +65°C (-4 to +149°F)	
Relative humidity	5 to 95%[2]	
Atmosphere	The drive must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. There must be little salt in the atmosphere.	
Atmospheric pressure	86 to 106kPa (During storage)	
	70 to 106kPa (During transportation)	

Table 1-5-1 Storage environment

Note 1: The storage temperature is for a short time, such as for transportation, etc.

Note 2: Even if the humidity is within the requirements of the specifications, places with abrupt temperature changes are subject to condensation or freezing. AAvoid storing the drive in such places.

(1) Do not place the drive directly on the floor.

(2) If the ambient atmosphere is adverse, wrap the drive in a vinyl sheet or similar protection when storing.

(3) If humidity may be present, add a drying agent (such as silica gel) in the package prepared as described in item (2).

To store for long periods.

The long term storage method of the drive varies largely according to the environment of the storage site. GGeneral storage methods are described below.

(1) The storage site must satisfy the requirements of specifications for temporary storage.

However, for storage exceeding three months, the upper limit of the ambient temperature shall not exceed 30°C (86°F). This is to prevent deterioration of unpowered electrolytic capacitors.

(2) The package must be air tight so that moisture will not enter. Add a drying agent inside the package to maintain a relative humidity inside the package of 70%.

(3) A drive installed in an enclosure or control panel and stored is likely to be exposed to moisture and dust. If this is the case, remove the drive and move it to a preferable environment, as in item (1) or (2).

(4) Electrolytic capacitors left unpowered for an extended period of time may deteriorate. Do not store for more than one year without applying power to the drive.

1.7   *Drive Ratings Efficiency and Watts Loss*

HP Rating	Rated Output Current (Amps)	Rated Output (KVA)	Rated Output (KW)	Efficiency at 0.75KHz (%)	Efficiency at 15KHz (%)	Watts Loss at 0.75KHz (W)	Watts Loss at 15KHz (W)
230VAC Three phase input							
1/8	0.7	0.28	0.1	88.6	87.1	20	23
1/4	1.4	0.56	0.2	91.5	89.9	27	32
1/2	2.5	1.0	0.4	92.9	90.9	38	50
1	4	1.6	0.75	94.2	92.4	57	77
2	7	2.8	1.5	95.4	94.1	85	110
3	10	4.0	2.2	95.6	94.0	120	165
5	16.5	6.6	3.7	95.8	94.4	190	260
7.5	23.5	9.4	5.5	96.6	95.2	217	310
10	31	12.3	7.5	96.7	95.3	287	415
460VAC Three phase input							
0.5	1.4	1.1	0.4	95.1	91.8	26	45
1	2.1	1.7	0.75	96.3	93.6	36	64
2	3.7	2.9	1.5	97.0	94.5	55	103
3	5.3	4.2	2.2	97.1	94.6	78	149
5	8.7	6.9	3.7	97.4	94.9	116	235
7.5	12	9.6	5.5	97.8	95.5	137	289
10	16	12.7	7.5	97.8	95.5	189	389

2. Installation and Connections

2.1 Operating Environment

Install the drive in an environment as described in Table 2-1-1.

Table 2-1-1 Operating environment

Item	Specifications
Site	Indoors
Ambient Temperature	-10 to +40°C (+14 to 104°F)
Relative Humidity	5 to 95% (without condensation)
Atmosphere	The drive must not be exposed to dust, direct sunlight, corrosive gases, oil mist, vapor or water drops. There must be little salt. No condensation shall occur due to abrupt temperature changes.
Altitude	3,300 ft. (1,000m) max. [Refer to Table 2-1-2 for altitudes exceeding 3,300 ft. (1000m.)]
Atmospheric Pressure	86 to 106 kPa
Vibration	3mm 2 to 9 Hz 9.8m/s^2 9 to 20 Hz 2m/s^2 20 to 55 Hz 1m/s^2 55 to 200 Hz

Table 2-1-2 Output attenuation ratio in relation to altitude

Altitude	Output Current Attenuation Ratio
3300 ft. (1000-1500m)	1.00
3300-4950 ft. (1000-1500m)	0.97
4950-6600 ft. (1500-2000m)	0.95
6600-8250 ft. (2000-2500m)	0.91
8250-9900 ft. (2500-3000m)	0.88

2.2 Installation Method

(1) Securely mount the drive in the upright position on a rigid structure so that the drive keypad faces front. Avoid mounting the drive upside down or horizontally.

(2) Allow clearances for cooling as shown in Fig. 2-2-1. This allows the drive, which generates heat duringg operation, to cool. The generated heat is radiated upward. Do not install the drive below a heat sensitive device.

(3) The temperature of the heat sink rises to about 90 degrees C during operation of the drive. Mount the drive on a base made of a material able to with-- stand the temperature rise.
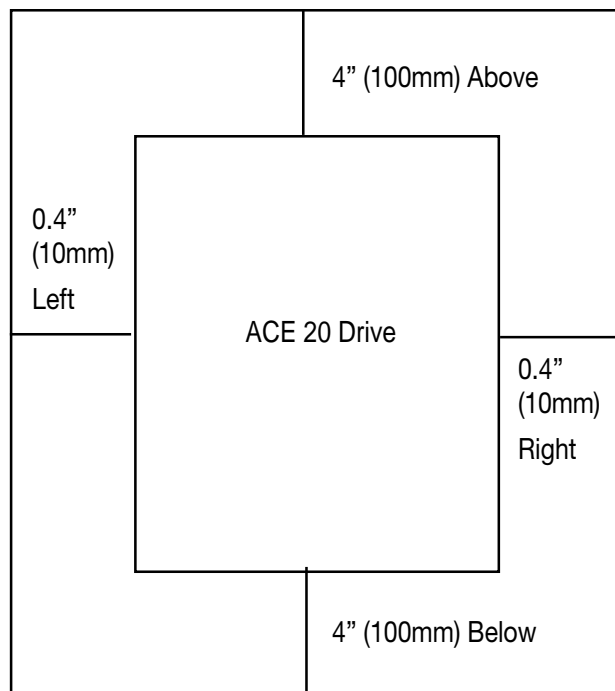
Figure 2-2-1

DANGER

Install the drive on a nonflammable material such as metal. **Otherwise, fire could occur.**

---

(4) When installing the drive inside an enclosure, take ventilation into consideration, so that the ambient temperature of the drive does not exceed the specified ratings. Do not install the drive in a poorly ventilated, undersized enclosure.

(5) When installing multiple drives inside an enclosure, horizontal installation is recommended to reduce mutual temperature effects. When a vertical layout is necessary, install a partition plate or the like between drives to isolate the heat of the lower drive.

CAUTION

Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter in the drive or allow them to remain on the heat sink.

Otherwise, a fire or an accident may occur.

2.3   Connections

Remove the control terminal block cover to connect to the control terminal block. Remove the main circuit terminal block cover to connect to the main circuit terminal block. Connect cables using the following precautions.

2-3-1   Basic Connections

(1) Be sure to connect the power cables to the main circuit power terminals L1/R, L2/S and L3/T of the drive. If the power cables are connected to other terminals, the drive will be damaged. Be sure the line voltage is within the allowable voltage range specified on the drive nameplate.

(2) Connect the grounding terminal according to national and local electric codes to prevent electric shock, fire or other disasters, and to reduce electric noise. Ground must be connected.

(3) Use reliable crimp terminals for connection of cables to the terminals.

(4) After wiring, check the following:

    a. Check that the cables are connected to the correct termianls.
    b. Check that there are no bad crimps or connections.
    c. Check that terminals or cables are not short circuited and there is no ground fault.

(5) To change connection of a drive that has been turned on, observe the following:

The smoothing capacitor in the direct current part of the main circuit takes time to discharge after it is turned off. To avoid danger, check the DC voltage (across main circuit terminals P(+) and N(-)) for a safe voltage (25 VDC or lower) using a multi-meter, after the charge lamp is off. Wait until the residual voltage is discharged before shorting a circuit, to avoid being hit by sparks caused by the voltage (electric charge).

DANGER

• Be sure to connect the grounding cable.

Otherwise, electric shock or fire could occur.

Only qualified electricians should wire the drive.

Otherwise, electric shock could occur.

• Perform wiring after checking that the power supply is turned off.

Otherwise, electric shock could occur.

Basic connection diagram
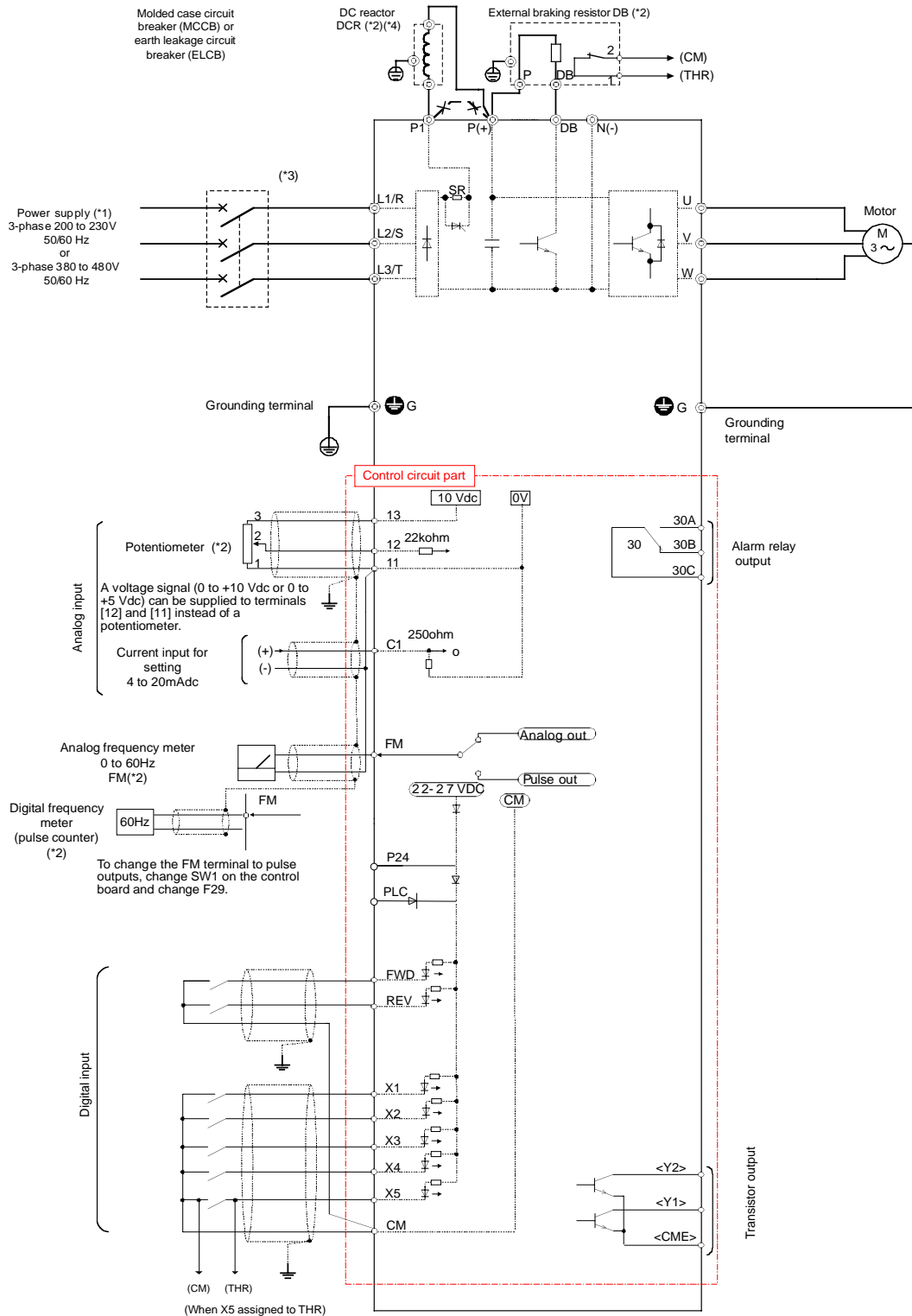
*1) The supply voltage must be suitable for the rated voltage of the drive.

*2) Optional part. Use when necessary.

*3) Peripheral equipment. Use when necessary.

*4) To connect a DC reactor (DCR) for power factor correcting, remove the jumper between the P1 and P(+) terminals.

2-3-2 Connection of Main Circuit and Grounding Terminal

Symbol	Name of Terminal	Description
L1/R, L2/S, L3/T	Main circuit power input	Connects a 3-phase power supply
U, V, W	Output	Connects a 3-phase induction motor
P1, P(+)	DC reactor	Connects an optional DC reactor
P(+), DB	External braking resistor	Connects an optional external braking resistor
P(+), N(-)	DC link circuit terminal	Connected to DC link circuit
G	Grounding	Grounding terminal of the drive chassis (housing). Connect to the protective ground.

(1) Main circuit power terminals (L1/R, L2/S, L3/T)

a. Connect these terminals to the power supply via a molded-case circuit breaker or ground-leakage circuit breaker for circuit protection. Phase-sequence matching is unnecessary.

b. To ensure safety, a magnetic contactor should be used to disconnect the drive from the power supply when the drive protective function activates.

c. Use control circuit terminal FWD/REV or the RUN/STOP key on the keypad panel to start and stop the motor. The main circuit power can be used to start and stop the motor only if absolutely necessary and then should not be used more than once every hour.

d. If there is a need to connect these terminals to a single-phase power supply, please contact the factory.

(2) Drive output terminals (U, V, W)

a. Connect these terminals to a 3-phase motor in the correct phase sequence. If the direction of motor rotation is incorrect, exchange any two of the U, V, and W phases.

b. Do not connect a power factor correction capacitor or surge protector to the drive output.

c. If the cable from the drive to the motor is too long, a high-frequency current may be generated by stray capacitance between the cables and result in an overcurrent trip of the drive, an increase in leakage current, or a reduction in current indication precision.

When a motor is driven by a PWM-type drive, the motor terminals and windings may be subject to surge voltage generated by drive element switching. If the motor cable (with 460V series motors, in particular) is particularly long, surge voltage will deteriorate motor insulation. To prevent this from occuring, use the following guidelines:

Drives 7-1/2 HP and larger

Motor Insulation Level	1000V	1300V	1600V
460 VAC Input Voltage	66 ft (20 m)	328 ft (100 m)	1312 ft (400 m) *
230 VAC Input Voltage	1312 ft (400 m) *	1312 ft (400 m) *	1312 ft (400 m) *

Drives 5 HP and smaller

Motor Insulation Level	1000V	1300V	1600V
460 VAC Input Voltage	66 ft (20 m)	165 ft (50 m) *	165 ft (50 m) *
230 VAC Input Voltage	328 ft (100 m) *	328 ft (100 m) *	328 ft (100 m) *
* The cable length is determined by secondary effects and not voltage spiking.			

Note: When a motor protective thermal O/L relay is inserted between the drive and the motor, the thermal O/L relay may malfunction (particularly in the 460V series), even when the cable length is 165 feet (50m) or less. To correct this problem, install a filter or reduce the carrier frequency. (Use Function Code "F26 Motor Sound.")

(3) DC reactor connecting terminals (P1, P(+))

a. Use these terminals to connect a DC reactor (option). Remove the jumper connected at the factory before connecting the DC reactor.

b. Do not remove the jumper if no DC reactor is used.

Cut the barrier in the main circuit terminal block cover for the P1, P(+), DB and N(-) cable port using nippers or the equivalent when connecting wiring.

CAUTION

A DC reactor does not come with the drive. Use a DC reactor or AC reactor under the conditions listed below.

---

1. When the capacity of the power supply transformer exceeds 500 kVA and exceeds10 times the rated capacity of the drive.
2. When a thyristor converter is a common load on the same transformer. If the communicating reactor is not used for the thyristor converter, an AC reactor is necessary at the drive input side.
3. Used to prevent a 0V trip from occuring when the phase advance capacitor in the power line is switched on and off.
4. When the voltage imbalance exceeds 3%

Imbalance rate between phases [%] =

$$\frac{(\text{Max. voltage [V]} - \text{Min voltage [V]})}{\text{3-phase average voltage [V]}} = 100\%$$
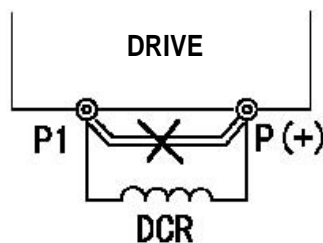
(4) External braking resistor connecting terminals (P(+), DB)

The drive is not equipped with a braking resistor. An external braking resistor (option) is necessary for frequent operation or heavy duty inertia load operation to enhance the braking performance.

a. Connect the P(+) and DB terminals of the external braking resistor to the P(+) and DB terminals of the drive.

b. Arrange devices so that the wiring length is within16.5 ft. (5m) and the cable is twisted or tied in parallel.
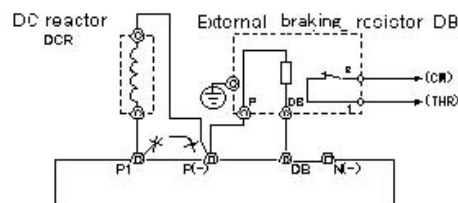
(5) Grounding terminal (G)

Ground the grounding terminal G for safety and noise reduction. The metallic frame of electrical equipment must be grounded in accordance with national and local electric codes to avoid electric shock, fire and other disasters.

CAUTION
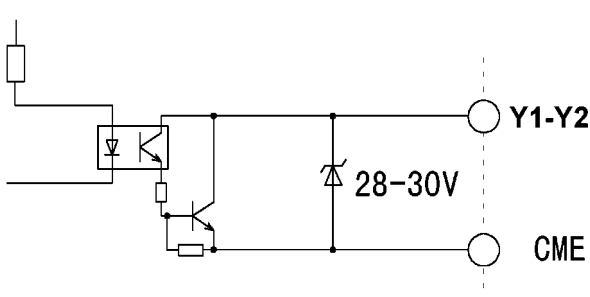
- Check that the number of phases and the rated voltage of the drive agree with the number of phases and the voltage of the AC power supply.

- Do not connect the AC power cables to the output terminals (U, V, W). **Otherwise, injuries could occur.**

- Do not connect a braking resistor directly to the DC terminals (P(+), N(-)). **Otherwise, fire could occur.**

2-3-3 Connection of Control Terminals

Table 2-3-2 shows the functions of the control circuit terminals. The method of connecting control terminals varies according to the function setting. Refer to the connection method for the function.

Table 2-3-2 Functions of control circuit terminals

Classification	Terminal Symbol	Terminal Name	Description of Function
Analog Input	13	Potentiometer power supply	+10 VDC power supply for frequency setting POT. G1 (POT: 5 kohms)
	12	Voltage input	(1) The frequency is set according to the external analog input voltage command. 0 to +10 VDC / 0 to 100% Reversible operation using +/- signal: 0 to +/-10 VDC / 0 to 100% Inverse mode operation: +10 to 0 VDC / 0 to 100% (2) The PID control feedback signal input. * Input resistance: 22 kohms
	C1	Current input	(1) The frequency is set according to the analog input current command. 4 to 20 mA DC / 0 to 100% Inverse mode operation: 20 to 4 mA DC/ 0 to 100% (2) The PID control feedback signal input. * Input resistance 250 ohms
	11	Common	Common for analog signals
Digital Input	FWD	Forward operation command	Forward operation with FWD-CM ON, and deceleration and stop with FWD-CM OFF
	REV	Reverse operation command	Reverse operation with REV-CM ON, and deceleration and stop with REV-CM OFF
	X1	Digital input 1	A coast-to-stop command from an external device, external alarm, alarm reset, multi-step frequency selection and other functions can be assigned to the X1 through X5 terminals. Refer to the terminal function E01 to 05 setting method in section 5-2, Detail Description of Each Function.
	X2	Digital input 2	
	X3	Digital input 3	
	X4	Digital input 4	
	X5	Digital input 5	
			<Digital input circuit specification>

Item		Minimum	Type	Maximum
Operation voltage	Level ON	0V	—	2V
	Level OFF	22V	24V	27V
Operation current at ON		—	4.2mA	6mA
Allowable leakage current at OFF		—	—	0.5mA

PLC	PLC terminal	The output signal power supply of the PLC. (Rated voltage: 24 VDC)
CM	Common	Common for digital input

Classification	Terminal Symbol	Terminal Name	Description of Function
Analog output/Pulse output	FM (11: Common terminal)	Analog monitor	The monitored signal is output as 0 to 10 VDC. The signal can be selected from the following: Output frequency 1 (before slip compensation) Output frequency 2 (after slip compensation) Output current Output torque Input power DC link circuit voltage Output voltage Load factor PID feedback value * Allowable connection impedance: 5 kohms minimum
		Pulse rate monitor	The monitored signal is output according to the pulse voltage. The signal description is the same as the FMA signal. * Allowable connection impedance: min. 5 k ohm. Use SW1 on the control board and Function Code F29 to change between the analog monitor and pulse rate monitor. (FMA: analog monitor, FMP: pulse rate monitor).
Transistor output	Y1	Transistor output 1	The Run signal, frequency equivalence signal, overload early warning signal and other signals are output to a transistor output. Refer to terminal function E20 to 21 setting methods in section 5-2, Detail Description of Each Function.
	Y2	Transistor output 2	<Transistor output circuit specification>
	CME	Common (Transistor output)	Common for transistor output signal. Isolated from terminals CM and 11.
	P24 (CM: common terminal)	DC voltage supply	Power supply for transistor output load. (24 Vdc 50 mAdc Max.) (When using P24, short the CM and CME terminals.) (If the P24 terminal is overloaded or connected with the CM terminal, the drive trips with Er3 indication. To reset, remove external causes and, after several minutes, turn the drive on again.)
Relay output	30A,30B, 30C	Alarm relay output	When the drive is stopped with an alarm, a relay contact output (1C) is issued. Contact capacity: 250 VAC, 0.3A cos = 0.3 When complying with low voltage directive: 48 VDC, 0.5A When complying with UL/cUL: 42 VDC, 0.5A Selection between excitation upon an alarm or excitation during normal operation is allowed.

Transistor output circuit specification table:

Item		Minimum	Type	Maximum
Operation voltage	Level ON	—	1V	2V
	Level OFF	—	24V	27V
Maximum load current at ON		—	—	50mA
Leakage current at OFF		—	—	0.1mA

(1)   Analog input terminals (13, 12, C1, 11)

a. Because analog signals are normally low voltage, they are especially susceptible to external noise effects. Route the wiring as short as possible (within 20m) and use shielded cables. Ground the shield of the shielded cable. If effects of external inductive noises are considerable, connection to terminal 11 may be effective.

b. Use a twin-contact relay for weak signals if a relay is used in the circuit. However, do not add a contact to terminal 11.

c. When the drive is connected to an external device outputting the analog signal, a malfunction may be caused by electric noise generated by the drive according to the circuit connection of the connected device. If this happens, connect a ferrite core or capacitor to the device outputting the analog signal.
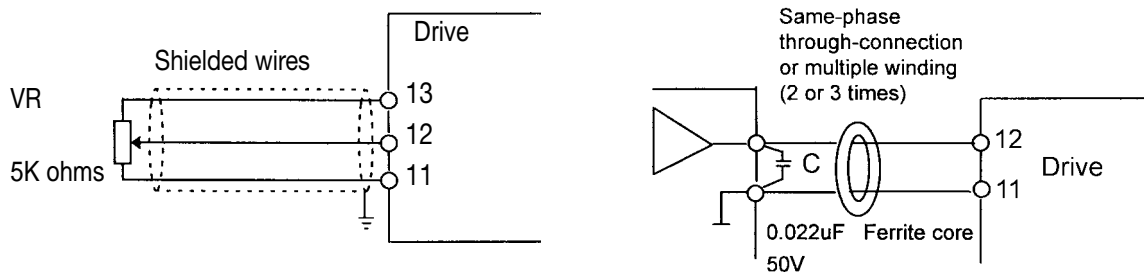
(2)   Digital input terminals (FWD, REV, X1 through X5, PLC, CM)

a. Generally, the digital input terminals (FWD, REV, X1-5) are turned on or off in relation to the CM terminal. When the terminals are turned on or off at the open collector output using an external power supply, malfunctions may be caused due to a routing circuit. If this happens, use the PLC terminal as shown in Table 2-3-2 (page 2-6).

b. To use the contact input, use a reliable contact, free from corrosion and debris.

(3)   Transistor output terminals (Y1-Y2, CME)

a. Circuit configuration shown in Table 2-3-2 (page 2-7) for transistor output is used. Note the polarity of the external power supply.

b. To connect a control relay, connect a surge protecting diode across the coil of the relay.

(4)   Others

a. Route the wiring of the control terminals as far from the wiring of the main circuit as possible. **Otherwise, electric noise may cause malfunctions.**

b. Fix the control cables inside the drive to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).
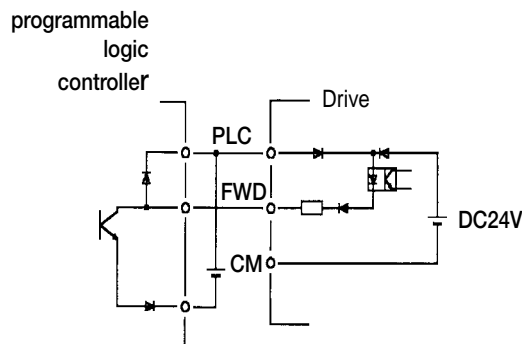
Prevention of Bypass Current by External Power

DANGER

If the control cables touch the live part of the main circuit, the insulation sheath of the control cable may be damaged and cause the high voltage of the main circuit to be fed to the control signal. This is not permissible in the low voltage directive models for Europe. **Electric shock could occur.**

CAUTION

Electric noise may be generated by the drive, motor or wiring. Note the possible malfunctions of nearby sensors and devices due to noise. **An accident could occur.**

2.3.4　Terminal Layout

(1) Main circuit terminal block

Catalog Number	Main circuit terminal drawing
ACE202V3P0001N1 ACE202V3P0002N1 ACE202V3P0005N1 ACE202V3P0010N1	

DB	P1	P(+)	N(-)

L1/R	L2/S	L3/T	U	V	W

| ⊖G | | ⊖G |
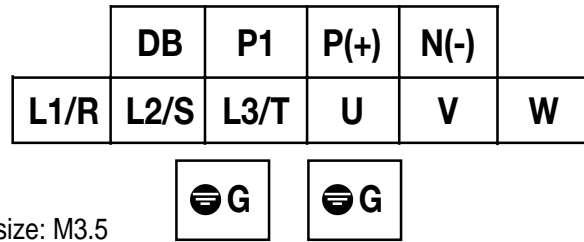
Screw size: M3.5

ACE202V3P0020N1
ACE202V3P0030N1

ACE204V3P0005N1
ACE204V3P0010N1
ACE204V3P0020N1
ACE204V3P0030N1

| ⊖G | | DB | P1 | P(+) | N(-) | | | | ⊖G |

| | L1/R | L2/S | L3/T | U | V | W | |
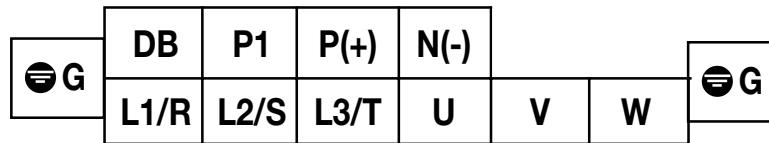
Screw size: M4

ACE202V3P0050N1
ACE202V3P0075N1
ACE202V3P0100N1

L1/R	L2/S	L3/T	DB	P1	P(+)	N(-)	U	V	W

| ⊖G | | | | | | | | | ⊖G |

ACE204V3P0050N1
ACE204V3P0075N1
ACE204V3P0100N1

Screw size: M4
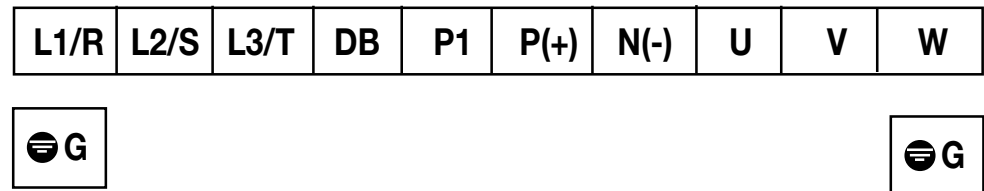
30A	30B	Y1	C1	FM	X1	X2	X3	X4	X5	PLC
	30C	Y2	CME	11	12	13	CM	FWD	REV	CM	P24
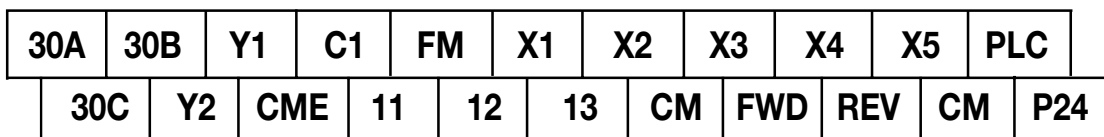
(2) Control terminal block

Screw size: M2.5
Tightening torque: 3.5 lb•Inch (0.4 N•m)

Note: Refer page to v for cable size, tightening torque and incoming device rating.

Notes:

3.   Operation

3.1 Inspection and Preparation Before Operation

Check the following before starting operation.

(1) Check if all power and control connections are correct.

Especially check if the motor power cables are connected to output Terminals U, V and W, and that the grounding cable is grounded. Note: Operation can be checked before connecting the motor.

(2) Check for short circuits between terminals, exposed live parts, and ground faults.

(3) Check for loose terminals, connectors and screws.

(4) Check if the motor is separated from mechanical equipment.

(5) Turn the switches off so that the motor does not start or operate at power-on.

(6) After the power is turned on, check the following.

   a.   Check if the keypad panel shows an alarm.

   b.   Check if the fan built in the drive rotates. (2 HP or above)

⏚G L1/R L2/S L3/T   U   V   W ⏚G

50/60 Hz AC

Power Supply

Motor
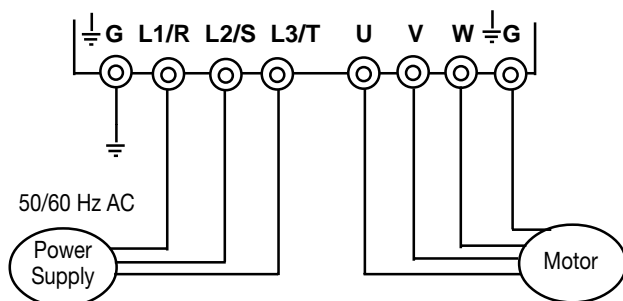
Fig. 3-1-1

Drive connection diagram

DANGER

• Be sure to install the terminal cover before turning the power on. Do not remove the cover when power is on.

• Do not operate switches with wet hands. **Otherwise, electric shock could occur.**

Note: The AC power supply must not be connected to Terminals U, V and W.

3.2 Operation Method

There are various operation methods. Refer to chapter 4 "Keypad Panel" and chapter 5 "Selecting Functions" to select the method most suitable for the application and operation specification. Table 3-2-1 shows general operation methods.

Table 3-2-1 General operation methods

Operation Method	Frequency Setting	Operation Command
Operation using keypad panel	Keypad panel keys ∧ ∨	Keypad panel keys RUN STOP
Operation using external signal terminal	∧ ∨	Contact input (switch), terminals FWD-CM, terminals REV-CM
	Potentiometer or analog voltage, current or multistep speed operation	

3.3 Test Operation

After checking for errors in section 3-1, perform a test operation.

When shipped from the factory, the drive is in the keypad panel operation mode.

(1) Turn the power on and check that the LED blinks while indicating 0.00 Hz frequency.

(2) Using the ∧ key, set the frequency to a low frequency, such as 5 Hz.

(3) Press the RUN key to start operation. To stop, press the STOP key.

(4) Check the following.

   a.   Check if the direction of rotation is correct.

   b.   Check for smooth rotation without motor humming or excessive vibration.

   c.   Check for smooth acceleration and deceleration.

(5) Using Function Code P04 Motor 1 (auto tuning), tune the motor constant.

If no abnormality is found, increase the operation frequency to check for full speed-range operation.

After checking for correct operation during the above test operation, start normal operation.

Caution 1:

If any operation abnormality is found, immediately stop operation and determine the cause by referring to chapter 7, Troubleshooting.

Caution 2:

If voltage is applied to the L1/R, L2/S and L3/T main circuit power supply terminals, even after the motor stops, the drive output Terminals U, V and W will have voltage present and can cause electric shock when the terminals are touched. Also, the smoothing capacitor does not discharge immediately after the power is turned off. It takes time for the capacitor to discharge and voltage is present.

Before touching an electric circuit, after turning the power off, check that the charge lamp is not lit and check for safe voltage using a multimeter by checking the various power circuit connections.

4.   Keypad Panel

The keypad panel provides various functions, such as operation (frequency setting and start/stop commands), monitor and alteration of function code data, and various confirmation functions.

Be familiar with the operation method of each function before starting operation.

4.1 Appearance of Keypad Panel

Digital display

Various function codes and data codes for programming will be shown. The output frequency, output current and other data will be displayed during operation, and the cause of trouble will be displayed using codes.

Unit and operation mode display

The unit of the data displayed at the digital display is indicated with an LED. The program mode is indicated. The PANEL CONTROL lamp lights in the keypad panel operation mode.

RUN key

Press this key to start operation. An LED lights up during operation.
When data code **F_0 2 = _ _ _ 1**, the key does not function.

STOP key

Press this key to stop operation.
When data code **F_0 2 = _ _ _ 1**, the key does not function.

UP/DOWN keys

Press these keys to increase or decrease the frequency or speed. In the programming mode, use these keys to change the function code or data setting.

Note: _ shows blank space.

Function (FUNC)/DATA key

Use this key to switch between frequency display, output current display, and other displays in the regular operation mode. In the programming mode, use this key to retrieve or write various function codes and various data codes.

Program (PRG)/RESET key

Press this key to switch between the regular operation mode and programming mode. Use this key to reset an alarm stopping state after activation of a protective function.

(1) Monitor switching method

Output frequency [1] ⟶ Output current [2] ⟶ Output voltage [2] ⟶ Synchronization rotation speed [2]

 6 6. 0 0   **_ 1. 2 0**   **_ 2 0 0**   **1 0 0 0**

Line Speed [2]

 1 0 0 0
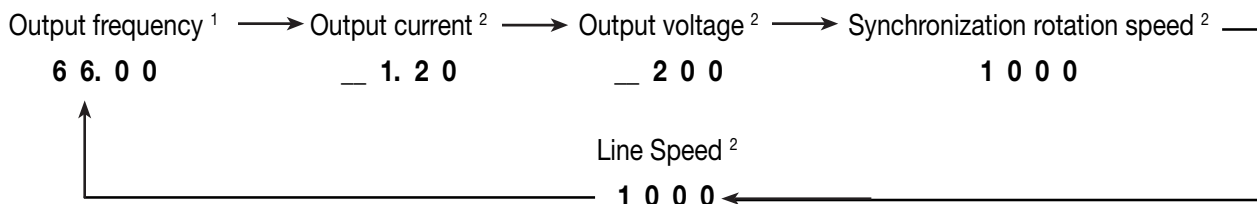
In the regular operation mode, press the [FUNC/DATA] key to switch between frequency display, output current display, and other displays.

1: In the PID control mode (when function H20 is at "1" or "2"), the value is in the percent display and the dot at the least significant digit always lights.

Example: 10%: **_ 1 0. 0.** , 100%: **1 0 0. 0.**

2: Press the [∧], [∨] key during display of these data to display the frequency setting.

(2) Stopping

Operation is started when the **RUN** is pressed, and is stopped when the **STOP** is pressed when function **F — 0 2** is set to **— — — 0, — — — 1** or **— — — 3**.

The direction rotation is Forward with FWD-CM ON, and Reverse with REV-CM ON.

(3) Changing the frequency

The frequency increases when the **∧** key is pressed and decreases when the **∨** key is pressed while function **F — 0 1 i**s set to **— — — 0.**

The speed change increases when the **FUNC DATA** key is pressed at the same time as the **∧** or **∨**

Note: Do not turn the power off for five seconds after performing a monitor change or function setting; otherwise, Er1 will occur.

(4) Function setting method

Description of Operation	Operation Procedure	Display Result
Initial condition.		**6 0. 0 0**
Start the program mode.	Press the **PRG RESET** key.	**F — 0 0**
Select a setting or monitoring function.	Press the **∧** or **∨** key.	**F — 0 1**
Have the data displayed.	Press the **FUNC DATA** key.	**— — — 1**
Change the data.	Press the **∧** or **∨** key.	**— — — 2**
Store the data.	Press the **FUNC DATA** key.	**F — 0 2**
Exit from the program mode. (Or select another function.)	Press the **PRG RESET** (Press the **∧** or **∨** key)	**6 0. 0 0**

Note: __ shows blank space.

(5) Changing the function code

The function code consists of an alphabetic character and a number. The alphabetic character is defined for each of the function groups.

Table 4-1-1 Major groups of function codes

Function Code	Function
F00 - F42	Fundamental functions
E01 - E41	Extension terminal functions
C01 - C33	Control functions of frequency
P01 - P10	Motor parameters
H01 - H46	High performance functions
A01 - A19	Alternative motor parameters

The function code changes each time the ⋀ or ⋁ key is pressed. (Press and hold the

⋀ or ⋁ key to continue changing the function code.)

While pressing and holding the ⋀ or ⋁ key during function code change, press the PRG/RESET key to change to the next group with another alphabetic character. (Press the ⋀ and PRG/RESET keys to jump to the top of the F, E, C, P, H or A code, or press the ⋁ and PRG/RESET key to jump to the last of the F, E, C, P, H or A code.)

Changing example:

F — 0 0 ⋀ → F — 0 1 ⋀ → F — 0 2 ⋀ + PRG/RESET → E — 0 1

C — 3 3 ⋁ → C — 3 2 ⋁ → C — 3 1 ⋁ + PRG/RESET → E — 4 2
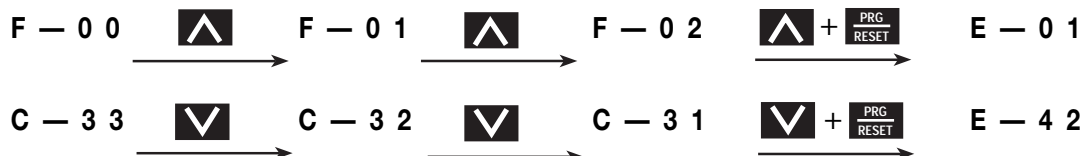
4-1-1 Alarm Occurrence

When an alarm occurs, the description of the alarm is displayed.

Press the ⋀ or ⋁ key during the alarm display to display the latest three alarms.

To display the previous four alarms, select H02 Trip history.

4-1-2 Digital Frequency Setting Method

Press the ⋀ or ⋁ key with the operation mode screen selcted. The LED displays changes made to the frequency setting. The displayed data increases or decreases with the unit of the least increment first. While the ⋀ or ⋁ key is held down, the changing digit moves to the upper order for easy increased rate of change.

Further, while pressing and holding the ⋀ or ⋁ key, and pressing the FUNC/DATA key, the rate of speed change will increase.

No special operation is necessary to store the new frequency setting. The setting is automatically stored when the drive is turned off.

4.2 Operation Methods

The following table lists three common operation methods. Examples of these operation methods are described on the following three pages.

Operation Method	Reference (Motor Speed)	Description	Page
Keypad	Keypad	This method requires no external wiring connections to the drive, and is commonly used for initial startup, testing, and out of the box configuration	4-4
2-Wire	4-20 mA DC	This method allows the motor to be started and stopped from a remote location, and the reference is supplied by a 4-20 mA DC signal from, for example, a PLC.	4-5
3-Wire	Speed Pot or 0-10 VDC	This method allows the motor to be started and stopped from a remote location, and the reference is supplied by a 5K ohm potentiometer or an external 0-10 VDC supply from, for example, a process controller.	4-6

Example 1: Start/Stop and Speed Changes from the Keypad (Factory Default)

When the drive is set up for start/stop functions and speed changes to be made from the keypad, it is considered local mode. Local mode is most often used during initial start-up to check the motor operation and rotation of the shaft. The drive is defaulted to local mode out of the box.

Operation
The frequency reference (speed changes) from the **UP** and **DN** keys located on the keypad.

The drive can be started by pressing the **RUN** key and stopped by pressing the **STOP** key on the keypad.

Programming Needed to Operate from the Keypad

Parameter	Display (Readout)	Description
F01	0	Frequency Command (speed change) from the keypad.
F02	0	Operation Command (start/stop) from the keypad.
F07/08	xx.x seconds	Acceleration and deceleration times. The time from stop to full speed and from full speed to stop.
F11	Motor full load Amps (FLA)	Enter the motor's FLA from the nameplate on the motor.

Example 2: Remote Start/Stop (2-wire) & Speed Changes from an External Source

Drive Control Wiring Schematic
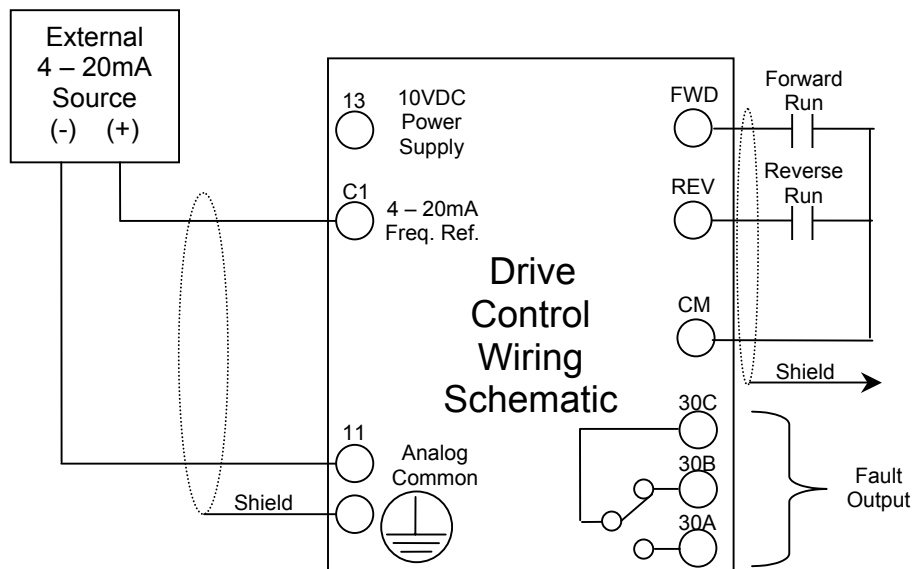
The above configuration is commonly used when the start/stop and the speed changes are supplied by a remote supply such as a PLC and relays. It can be used with a maintained switch when it is desirable to have the motor restart on restoration of power. It should not be used where safety of attending personnel might be threatened by a restart. A speed potentiometer may be used in this configuration by connecting the "100 end" to 13, the wiper to 12 and the zero end to 11. (5k ohms, 1/4 watt minimum with shielded wiring.)

Programming Needed for 2-wire Start/Stop and Speed Changes from an External Source

Parameter	Display (Readout)	Description
H03	1 (Hold STOP and UP key to change) Press the FUNC/DATA Key.	Resets all parameters to factory setting for a 2-wire configuration. (Caution: All previous settings will be lost) Once 1 is entered, the settings will return to their factory setting of 0.
F01	2	Frequency command (speed changes) via Terminal C1.
F02	1	Operation Method (start/stop) via terminals.
F07/F08	xx.x Seconds	Accelerating time and Deceleration time / The time from stop to full speed and from full speed to stop.
F11	Motor Full Load Amps (FLA)	Enter the motor's FLA from the nameplate on the motor.
F01 (OPTIONAL)	1	Program this parameter ONLY if speed changes are to be by remote speed pot via Terminal 12. Power source for the pot is Terminal 13. Pot value recommended is 5K ohms.

Notes:
The rotation depends on the FWD and REV terminals, as follows:
    FWD to CM connected runs forward direction.
    REV to CM connected runs in reverse direction.
No operation occurs when both FWD and REV terminals are connected or no connection is made to CM terminal.

Example 3: Remote Start/Stop/Speed Control (3-wire) from External Source
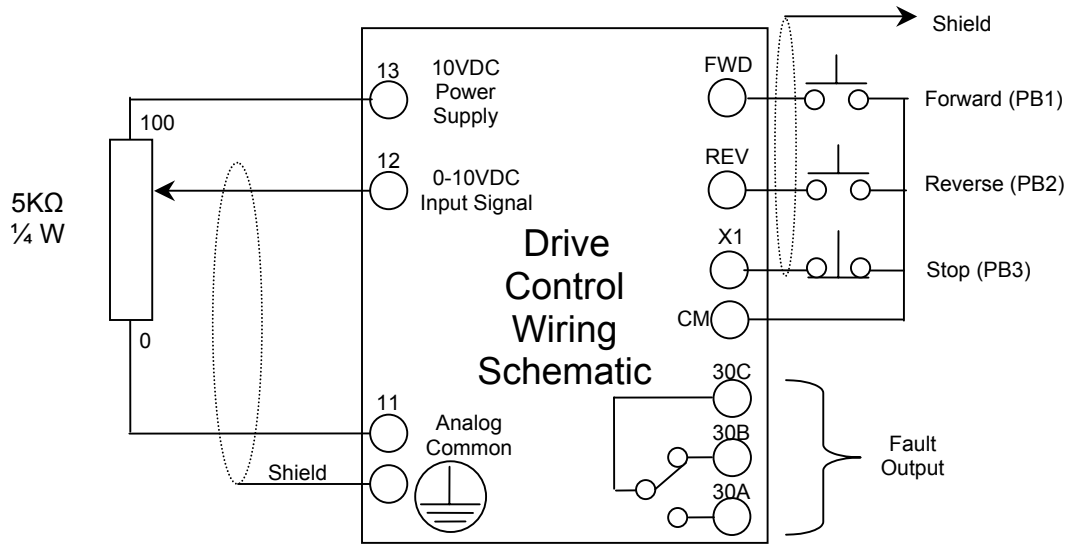
This configuration is common when the drive has replaced a contactor in an existing application and an operator must vary the speed from an external speed pot. It is recommended that the potentiometer value be 5k ohms with a minimum wattage of ¼ watt, and that shielded wiring be used.

Operation

Pushing Push-button PB1 momentarily enables the motor to start in the forward direction.
Pushing Push-button PB2 momentarily enables the motor to start in the reverse direction.
Pushing Push-button PB3 any time will stop the motor.
The speed changes are proportional to the input signal at Terminal 12.

Programming for 3-wire Start/Stop and External Source

Parameter	Display (Readout)	Description
E01	5	Configures the FWD, REV, and X1 terminals to accept 3-wire start/stop control logic.
F01	1	Frequency Command (speed change) via terminal 12.
F02	1	Operation Method (start/stop) via terminals.
F07/F08	xx.x Seconds	Accelerating time and Deceleration time / The time from Stop to full speed and from full speed to stop.
F11	Motor Full Load Amps (FLA)	Enter the motor's FLA from the nameplate on the motor.

4.3 Recalibration Instructions For ACE202V3P0001N1 Drives

The ACE202V3P0001N1 Drive has been calibrated at 1/8HP by the factory. However, if this drive is reset to factory settings, the drive will be calibrated at 1/4HP, and must be recalibrated for proper motor protection. To recalibrate the drive, set the four parameters as shown in the following table.

Catalog No.	Parameter Settings			
	F11 OL Level (Amps)	F12 OL Time Constant (Minutes)	P02 Motor Capacity (HP)	P03 Motor Rated Current (Amps)
ACE202V3P0001N1 (230V, 1/8HP)	.71	1.5	.13	.71

Notes:

5. Selecting Functions

5.1 Function Selection List

F: Fundamental functions

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
F00	Data protection	0: Data change enabled 1: Data protected	1	0	N	
F01	Frequency command 1	0: Keypad operation 1: Voltage input (terminal 12) 2: Current input (terminal C1) 3: Voltage and current input 4: Voltage input with polarity 5: Voltage input inverse mode operation (terminal 12) 6: Current input inverse mode operation (terminal C1) 7: UP/DOWN control mode 1 8: UP/DOWN control mode 2	1	0	N	
F02	Operation method	0: Keypad operation 1: Terminal operation (STOP key active) 2: Terminal operation (STOP key inactive) 3: Terminal operation (STOP key active with special software) 4: Terminal operation (STOP key inactive with special software)	1	0	N	
F03	Maximum frequency 1	50 to 400 Hz	1 Hz	60	N	
F04	Base frequency 1	25 to 400 Hz	1 Hz	60	N	
F05	Rated voltage 1 (at Base frequency)	OV: Output voltage is proportional to the source voltage 80 to 240V (230V class) 160 to 480V (460V class)	1V	 230 460	N	
F06	Maximum voltage 1 (at Maximum frequency)	80 to 240V (230V class) 160 to 480V (460V class)	1V	230 460	N	
F07	Acceleration time 1	0.01 to 3600 seconds	0.01s	6.0	Y	
F08	Deceleration time 1	0.01 to 3600 seconds	0.01s	6.00	Y	
F09	Torque boost 1	0: Automatic torque boost 1: Variable speed (fans/pumps) torque characteristics 2: Proportional torque characteristics 3 to 31: Constant torque characteristics	1		Y	
F10	Electronic thermal overload relay for motor 1 (Select)	0: Inactive 1: Active (for general purpose motors) 2: Active (for forced air extended operating range motors)	1	1	Y*	
F11	(Level)	20 to 135% of the rated motor current	0.01A	rated motor current	Y	
F12	(Thermal time constant)	0.5 to 10.0 min.	0.1 min	5.0	Y	
F13	Electronic thermal overload relay (for braking resistor)	0: In active 1: Active (for external braking resistor up to 5 HP 2: Active (for external braking resistor 7-1/2 / 10 HP	1	0	N	
F14	Restart mode after momentary power failure	0: Inactive (The drive trips immediately) 1: Inactive (The drive trips after the power failure recovers) 2: Active (The drive restarts at the frequency prior to power failure) 3: Active (The drive restarts at the starting frequency)	1	0	N	
F15	Frequency limiter (High)	0 to 400 Hz	1 Hz	70	Y	
F16	(Low)			0	Y	
F17	Gain (For frequency setting)	0.0 to 200.0%	0.10%	100	Y	
F18	Bias frequency	-400 to +400 Hz	1 Hz	0	Y	
F20	DC Brake (Starting frequency)	0.0 to 60.0 Hz	0.1 Hz	0.0	Y	
F21	(Braking level)	0 to 100%	1%	0	Y	
F22	(Braking time)	0.0 second (Inactive) 0.1 to 30.0 seconds	0.1s	0.0	Y	
F23	Starting frequency (Frequency)	0.1 to 60.0 Hz	0.1s	0.5	N	
F24	(Holding time)	0.0 to 10.0 seconds	0.1 Hz	0.0	N	
F25	Stop frequency	0.1 to 6.0 Hz	0.1 Hz	0.2	N	
F26	Motor sound (Carrier frequency)	0.75,1 to 15 kHz	1 kHz	2	Y	
F27	(Sound tone)	0 to 3	1	0	Y	

Y: The data can be changed with the UP or DOWN arrow key during operation. However, press the FUNC/DATA key to store the new data.

Y*: Press the UP or DOWN arrow key to change data. The new data takes effect after the FUNC/DATA key is pressed to store the data.

N: Data can be changed only while the motor is stopped.

F: Fundamental functions (continued)
5-2

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
F29	FMA and FMP terminals (Select)	0: Analog output (FMA) 1: Pulse train output (FMP)	1	0	N	
F30	FMA (Voltage adjust)	0 to 200%	1%	100	Y	
F31	(Function)	0: Output frequency 1 1: Output frequency 2 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback value 8: DC link circuit voltage	1	0	Y*	
F33	FMP (Pulse rate)	300 to 6000 p/s (Pulse count at 100%)	1 p/s	1440	Y	
F34	(Voltage adjust)	0%, 1 to 200%	1%	0	Y	
F35	(Function)	0 to 8 (Same as F31)	1	0	Y*	
F36	30Ry	0: Activated when tripped 1: Activated during regular operation	1	0	N	
F40	Torque limiter 1 (Driving)	20 to 200% 999: Inactive	1%	999	Y	
F41	(Braking)	0%: Automatic deceleration control 20 to 200% 999: Inactive	1%	999	Y	
F42	Torque vector control 1	0: Inactive 1: Active	1	0	N	

E: Extension terminal functions / Digital Input/Output functions

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
E01	X1 terminal function	0: Multistep frequency 1: Multistep frequency 2: Multistep frequency 3: Multistep frequency 4: Acceleration/deceleration time selection [RT1] 5: 3-wire operation stop command [HLD] 6: Coast-to-stop command [BX] 7: Alarm reset [RST] 8: Trip command (External fault) [THR] 9: Frequency setting 2 / Frequency setting 1 10: Motor 2 / Motor 1 [M2/M1] 11: DC brake command [DCBRK] 12: Torque limit 2 / Torque limit 1 [TL2/TL1] 13: UP command [UP] 14: DOWN command [DOWN] 15: Write enable for keypad 16: PID control cancel [Hz/PID] 17: Inverse mode changeover [IVS] (Terminals 12 and C1) 18: Communications link enable [LE]	1	0	N	
E02	X2 terminal function			1	N	
E03	X3 terminal function			2	N	
E04	X4 terminal function			6	N	
E05	X5 terminal function			7	N	
E10	Acceleration time 2	0.01 to 3600 seconds	0.01 second	10.0	Y	
E11	Deceleration time 2				Y	
E16	Torque limiter 2 (Driving)	20 to 200% 999: Inactive	1%	999	Y	
E17	(Braking)	0%: Automatic deceleration control, 20 to 200% 999: Inactive	1%	999	Y	
E20	Y1 terminal function	0: Drive run [RUN] 1: Frequency arrival at setpoint (FAR) 2: Frequency level detection 3: Under voltage detection signal [LV] 4: Torque polarity 5: Torque limiting [TL] 6: Auto restarting [IPF] 7: Overload early warning [OL] 8: Life time alarm [LIFE] 9: Frequency arrival at setpoint (FAR2)	1	0	N	
E21	Y2 terminal function			7	N	

Y: The data can be changed with the UP or DOWN arrow key during operation. However, press the FUNC/DATA key to store the new data.
Y*: Press the UP or DOWN arrow key to change the data. The new data will take effect after the FUNC/DATA key is pressed to store the data.
N: The data can be changed only while the motor is stopped.

E: Extension terminal functions / Digital Input/Output functions (continued)

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
E29	Frequency detection delay	0.01 to 10.0 seconds	0.01s	0.10	Y	
E30	FAR function signal (Hysteresis)	0.0 to 10.0 Hz	0.1 Hz	2.5	Y	
E31	FDT function signal (Level)	0 to 400 Hz	1 Hz	60	Y	
E32	(Hysteresis)	0.0 to 30.0 Hz	0.1 Hz	1.0	Y	
E33	OL function signal (Mode select)	0: Electronic thermal overload relay 1: Output current	1	0	Y*	
E34	(Level)	20 to 200% of the rated motor current	0.01A	Rated motor current	Y	
E35	(Timer)	0.0 to 60.0 seconds	0.1s	10.0	Y	
E40	Display (A)	0.00 to 200.0	0.01	0.01	Y	
E41	(B)	0.00 to 200.0	0.01	0.00	Y	
E42	LED display	0.0 to 5.0 seconds	0.1s	0.5	Y	

C: Control function of frequency

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
C01	Jump frequency (Jump frequency 1)	0 to 400 Hz	1 Hz	0	Y	
C02	(Jump frequency 2)			0	Y	
C03	(Jump frequency 3)			0	Y	
C04	(Hysteresis)	0 to 30 Hz		3	Y	
C05	Multistep frequency (Frequency 1)	0.00 to 400.0 Hz	0.01 Hz	0.00	Y	
C06	(Frequency 2)					
C07	(Frequency 3)					
C08	(Frequency 4)					
C09	(Frequency 5)					
C10	(Frequency 6)					
C11	(Frequency 7)					
C12	(Frequency 8)					
C13	(Frequency 9)					
C14	(Frequency 10)					
C15	(Frequency 11)					
C16	(Frequency 12)					
C17	(Frequency 13)					
C18	(Frequency 14)					
C19	(Frequency 15)					
C21	Timer operation auto-stop	0: Inactive 1: Active	1	0	N	
C22	Auto-stop time	0.00 to 3600 seconds	0.01s	0.00	Y	
C30	Frequency command 2	0 to 8 (same as F01)	1	2	N	
C31	Analog setting signal offset adjustment (Terminal 12)	-5.0 to +5.0%	0.1%	0.0	Y	
C32	(Terminal C1)	-5.0 to +5.0%	0.1%	0.0	Y	
C33	Analog setting signal filter	0.00 to 5.00 seconds	0.01s	0.05	Y	

P: Motor parameters

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
P01	Number of motor 1 poles	2 to 14	2	4	N	
P02	Motor 1 (Capacity)	0.01 to 7.5 HP (5 HP or less) 0.01 to 15 HP (7-1/2/10 HP)	0.01 HP	Nominal applied motor HP	N	
P03	(Rated current)	0.00 to 99.9A	0.01A	Standard rating	N	
P04	(Tuning)	0: Inactive 1: Active (%R1, %X) 2: Active (%R1, %X, Io)	1	0	N	
P05	(Online tuning)	0: Inactive 1: Active	1	0	N	

Y: The data can be changed with the UP or DOWN arrow key during operation. However, press the FUNC/DATA key to store the new data.
Y*: Press the UP or DOWN arrow key to change the data. The new data will take effect after the FUNC/DATA key is pressed to store the data.
N: The data can be changed only while the motor is stopped.

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
P: Motor parameters (continued)						
P06	(No-load current)	0.00 to 99.9A	0.01A	standard rating	N	
P07	(%R1 setting)	0.00 to 50.00%	0.01%	standard rating	Y	
P08	(%X setting	0.00 to 50.00%	0.01%	standard rating	Y	
P09	(Slip compensation control 1)	0.00 to 15.0 Hz	0.01 Hz	0.00	Y	
P10	(Slip compensation response time 1)	0.01 to 10.00 seconds	0.01s	0.50	Y	
H: High performance functions						
H01	Total operating time	Monitor only	10h	0	—	
H02	Trip history	Monitor only	—	—	—	
H03	Data initializing (Data reset)	0: Disabled 1: Initialize data functions	1	0	N	
H04	Auto-reset (Times)	0: Inactive 1 to 10 times	1 time	0	Y	
H05	(Reset interval)	2 to 20 seconds	1s	5	Y	
H06	Fan stop operation	0: Inactive 1: Active	1	0	Y	
H07	ACC/DEC pattern (Mode select)	0: Linear acceleration/deceleration 1: S-curve acceleration/deceleration (weak) 2: S-curve acceleration/deceleration (strong) 3: Non-linear	1	0	N	
H09	Start mode (Rotating motor pickup mode)	0: Inactive 1: Active (After momentary power failure) 2: Active (All start modes)	1	0	N	
H10	Energy saving operation	0: Inactive 1: Active	1	0	Y	
H11	Decel mode	0: Normal 1: Coast-to-stop	1	0	Y	
H12	Instantaneous overcurrent limiting	0: Inactive 1: Active	1	1	N	
H13	Auto-restart (Restart time)	0.1 to 5.0 seconds	0.1s	0.1	N	
H14	Frequency fall rate	0.00 to 100.0 Hz/second	0.01Hz/s	10.00	Y	
H20	PID control (Mode select)	0: Inactive 1: Forward operation 2: Reverse operation	1	0	N	
H21	(Feeback signal)	0: Terminal 12 (0 to +10 VDC) input 1: Terminal C1 (4 to 20 mA) input 2: Terminal 12 (+10 to 0 VDC) input 3: Terminal C1 (20 to 4 mA) input	1	1	N	
H22	P (Gain)	0.01 to 10.00 times (1 to 1000%)	0.01 time	0.10	Y	
H23	I (Integral time)	0.0: Inactive 0.1 to 3600 seconds	0.1s	0.0	Y	
H24	D (Differential time)	0.00: Inactive 0.01 to 10.0 seconds	0.01s	0.00	Y	
H25	(Feedback filter)	0.0 to 60.0 seconds	0.1s	0.5	Y	
H26	PTC thermistor (Mode select)	0: Inactive 1: Active		0	Y	
H27	(Level)	0.00--5.00V	0.01V	1.60	Y	
H28	Droop operation	-9.9 --0.0 Hz	0.1 Hz	0.0	Y	
H30	Serial link (Function select)	Monitor　　　　Frequency setting　　　Operation command 0:　X　　　　　　—　　　　　　　　　— 1:　X　　　　　　X　　　　　　　　　— 2:　X　　　　　　—　　　　　　　　　X 3:　X　　　　　　X　　　　　　　　　X	1	0	Y	

Y: The data can be changed with the UP or DOWN arrow key during operation. However, press the FUNC/DATA key to store the new data.

Y*: Press the UP or DOWN arrow key to change the data. The new data takes effect after the FUNC/DATA key is pressed to store the data.

N: The data can be changed only while the motor is stopped.

Function Code	Name	Setting Range	Min. Unit	Factory Setting	Change During Operation	User Setting
H: High performance functions (continued)						
H31	Modbus-RTU (Address)	0: Broadcast 1 to 247: Query	1	1	N	
H32	(Mode select on no response error)	0: Immediate Er8 1: Er8 after interval set by 2: Retry 3: Continuation of operation	1	0	Y	
H33	(Timer)	0.0 to 60.0 seconds	0.1s	2.0	Y	
H34	(Baud rate)	0: 19200 [bits/second] 1: 9600 2: 4800 3: 2400	1	1	Y	
H35	(Data length)	0: 8 bit (Fixed)	1	0	—	
H36	(Parity check)	0: None 1: Even parity 2: Odd parity	1	0	Y	
H37	(Stop bits)	0: 2 bits 1: 1 bit	1	0	Y	
H38	(No response error detection time)	0: Not detected 1: 1 to 60 seconds	1s	0	Y	
H39	(Response interval)	0.00 to 1.00 second	0.01s	0.01	Y	
H40	Maximum temperature of heat sink	Monitor only	degree C	—	—	
H41	Maximum effective current	Monitor only	A	—	—	
H42	Main circuit capacitor life	Monitor only	%	—	—	
H43	Cooling fan operation time	Monitor only	10h	—	—	
H44	Drive ROM version	Monitor only	—	—	—	
H45	Keypad ROM version	Monitor only	—	—	—	
H46	Option ROM version	Monitor only	—	—	—	
A: Alternative motor parameters						
A01	Maximum frequency 2	50 to 400 Hz	1 Hz	60	N	
A02	Base frequency 2	25 to 400 Hz	1 Hz	60	N	
A03	Rated voltage 2 (at base frequency 2)	0V, 80 to 240V (230V class) 0V, 160 to 480V (460V class)	1V	230 460	N	
A04	Maximum voltage 2 (at maximum frquency 2)	80 to 240 V (230V class) 160 to 480V (460V class)	1V	230 460	N	
A05	Torque boost 2	0, 1, 2, 3 to 31	1	13	Y	
A06	Electronic thermal overload relay (Select)	0: Inactive 1: Active (for general purpose motors) 2: Active (for forced air extended operating range motors)	1	1	Y*	
A07	(Level)	20 to 135% of the rated motor current	0.01A	rated motor current	Y	
A08	(Thermal time constant)	0.5 to 10 min.	0.1 min	5.0	Y	
A09	Torque vector control 2	0: Inactive 1: Active	1	0	N	
A10	Number of motor 2 poles	2 to 14	2	4	N	
A11	Motor 2 (Capacity)	0.01 to 7-1/2 HP (5 HP or smaller) 0.01 to 15 HP (7-1/2 / 10 HP)	0.01 HP	Nominal applied motor HP	N	
A12	(Rated current)	0.00 to 99.9A	0.01A	standard rating	N	
A13	(Tuning)	0: Inactive 1: Active (%R1, %X) 2: Active (%R1, %X, Io)	1	0	N	
A14	(Online tuning)	0: Inactive 1: Active	1	0	N	
A15	(No-load current)	0.00 to 99.9A	0.01A	standard rating	N	
A16	(%R1 setting)	0.00 to 50.00%	0.01%	standard rating	Y	
A17	(%X setting)	0.00 to 50.00%	0.01%	standard rating	Y	
A18	(Slip compensation control 2)	0.00 to 15.00 Hz	0.01 Hz	0.00	Y	
A19	(Slip compensation response time 2)	0.01 to 10.00 seconds	0.01s	0.50	Y	

Y: The data can be changed with the UP or DOWN arrow key during operation. However, press the FUNC/DATA key to store the new data.
Y*: Press the UP or DOWN arrow key to change the data. The new data takes effect after the FUNC/DATA key is pressed to store the data.
N: The data can be changed only while the motor is stopped.

5.1.1 Location of Parameter Function Descriptions

Function Code	Name	Page
A01	Maximum Frequency 2	5-40
A02	Base Frequency 2	5-40
A03	Rated Voltage 2 (At Base Frequency 2)	5-40
A04	Maximum Voltage 2 (At Maximum Frequency 2)	5-40
A05	Torque Boost 2	5-40
A06	Electronic Thermal Overload Relay For Motor 2 (Select)	5-40
A07	Electronic Thermal Overload Relay For Motor 2 (Level)	5-40
A08	Electronic Thermal Overload Relay for Motor 2 (Thermal Time Constant)	5-40
A09	Torque Vector Control 2	5-40
A10	Number of Motor 2 Poles	5-40
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A12	Motor 2 (Rated Current)	5-40
A13	Motor 2 (Tuning)	5-41
A14	Motor 2 (Online Tuning)	5-41
A15	Motor 2 (No-load Current)	5-41
A16	Motor 2 (%R1 Setting)	5-41
A17	Motor 2 (%X Setting)	5-41
A18	Motor 2 (Slip Compensation Control 2)	5-41
A19	Motor 2 (Slip Compensation Response Time 2)	5-41
C01	Jump Frequency 1	5-26
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C04	Jump Frequency Hysteresis	5-26
C05-C19	Multistep Frequency 1 through 15	5-27
C21	Timer Operation	5-28
C22	Timer Duration	5-28
C30	Frequency Command 2	5-28
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C32	Analog Signal Offset Adjustment (Terminal C1)	5-28
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Function Code	Name	Page
E01	X1 Terminal Function	5-20
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E03	X3 Terminal Function	5-20
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E05	X5 Terminal Function	5-20
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E16	Torque Limiter 2 (Driving)	5-23
E17	Torque Limiter 2 (Braking)	5-23
E20	Y1 Terminal Function	5-23
E21	Y2 Terminal Function	5-23
E29	Frequency Level Detection Delay	5-24
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E31	FDT Function Signal (Level)	5-24
E32	FDT Function Signal (Hysteresis)	5-24
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E34	OL Function Signal (Level)	5-25
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E40	Display Coefficient A	5-25
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E42	LED Display Filter	5-25
F00	Data Protection	5-8
F01	Frequency Command 1	5-8
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F03	Maximum Output Frequency 1	5-12
F04	Base Frequency 1	5-12
F05	Rated Voltage 1	5-12
F06	Maximum Voltage 1	5-12
F07	Acceleration Time 1	5-12
F08	Deceleration Time 1	5-12
F09	Torque Boost 1	5-13
F10	Electronic Thermal Overload Relay 1 (Select)	5-13
F11	Electronic Thermal Overload Relay 1 (Level)	5-14
F12	Electronic Thermal Overload Relay 1 (Thermal Time Constant)	5-14
F13	Electronic Thermal Overload Relay (For External Braking Resistor)	5-14

Function Code	Name	Page
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F15	Frequency Limiter (High)	5-16
F16	Frequency Limiter (Low)	5-16
F17	Gain (Frequency Setting Signal)	5-16
F18	Bias Frequency	5-16
F20	DC Brake (Starting Frequency)	5-16
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5.2   Detail Description of Each Function

F: Fundamental functions

F00 Data protection

F 0 0

0: Data can be changed

1: Data cannot be changed

Note: This function protects the system by blocking any data changes entered from the keypad.

Setting Procedure:

0 → 1: Press the **STOP** + **∧** keys simultaneously. Then press the **FUNC DATA** to save.

1 → 0: Press the **STOP** + **∨** keys simultaneously. Then press the **FUNC DATA** to save.

F01   Frequency command 1

F 0 1

This function determines the method used for setting the reference frequency.

0:   The frequency is set by the operation of **∧** and **∨** keys.

1:   The frequency is set by the voltage input at Terminal 12 (0 to +10 VDC).

2:   The frequency is set by the current input at Terminal C1 (4 to 20 mA dc).

3:   The frequency is set by the voltage and current input at Terminal 12 and Terminal C1 (-10 to +10 VDC) plus (4 to 20 mA dc). Inputs at Terminals 12 and C1 are added to determine the total frequency reference.

4:   The reverse frequency operation is set by the voltage input polarity operation at Terminal 12 (-10 to +10 VDC).

   Note: The input voltage polarity can result in motor rotation opposite the operation command.

5:   Frequency is set by voltage input-inverse mode operation at Terminal 12 (+10 to 0 VDC).

6:   The frequency is set by current input-inverse mode operation at Terminal C1 (20 to 4 mA dc).

7:   UP/DOWN control mode 1: The frequency is set by Terminal UP and Terminal DOWN.
   (initial set value = 0)

8:   UP/DOWN control mode 2: The frequency is set by Terminal UP and Terminal DOWN (initial value = last value during previous operation).

   Refer to the description of the **E01** to **E05** functions for details.

Description of forward and reverse operation
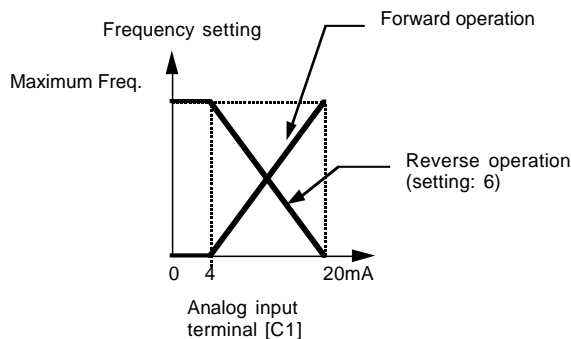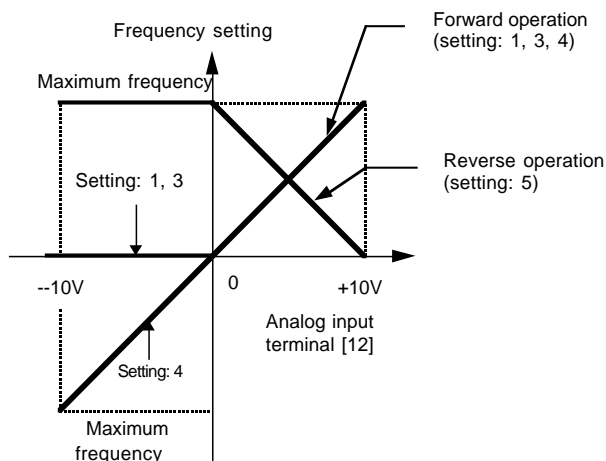
F02   Operation method

F 0 2

This function determines the input method for operation commands.

0:   Keypad operation (**RUN** **STOP** key)

   The motor runs when the **RUN** key is pressed and decelerates-to-stop when the **STOP** key is pressed.
   Note: The direction of rotation depends on the FWD and REV terminals as follows:

   FWD-CM connected: Forward
   REV-CM connected: Reverse

No operation occurs if both the FWD and REV terminals or neither of them are connected to the CM terminal.

1: External signal on the terminal board (FWD, REV). Forward operation with FWD-CM connected and deceleration to stop when opened.

Reverse operation with REV-CM connected and deceleration to stop when opened.

No operation occurs if both FWD-CM and REV-CM are connected.

`STOP` key active (see the chart on the following page for details)

2: External signal on the terminal boards (FWD, REV). Forward operation with FWD-CM connected and deceleration to stop when opened.

Reverse operation with REV-CM connected and deceleration to stop when opened.

No operation occurs if both FWD-CM and REV-CM are connected at the same time.

`STOP` key inactive (see the chart on the following page for details)

3: External signal on the terminal boards (FWD, REV). Forward operation with FWD-CM connected and deceleration to stop when opened.

Reverse operation with REV-CM connected and deceleration to stop when opened.

No operation occurs if both FWD-CM and REV-CM are connected at the same time.

`STOP` key active with special start software (see the chart on the following page for details)

4: External signal on the terminal boards (FWD, REV). Forward operation with FWD-CM connected and deceleration to stop when opened.

Reverse operation with REV-CM connected and deceleration to stop when opened.

No operation occurs if both FWD-CM and REV-CM are connected at the same time.

`STOP` key inactive with special start software (see the chart on the following page for details)

Note: This function can be changed only while the FWD and REV terminals are opened.

Special Start Software Selection During Terminal Operation

	Inactive: Setting 1 or 2	Active: Setting 3 or 4
POWER ON	POWER FWD OUTPUT ALARM	POWER FWD OUTPUT ALARM ER6
RESET	RESET FWD OUTPUT ALARM	RESET FWD OUTPUT ALARM Multi Alarms*
NETWORK MODE	NETWORK (LE-CM) FWD (TERMINAL) FWD (NETWORK) OUTPUT ALARM	NETWORK (LE-CM) FWD (TERMINAL) FWD (NETWORK) OUTPUT ALARM ER6 ER6 RESET

Note: Start Software does not work in AUTO RESET mode and PROGRAMMING mode.

Stop Key Mode Selection During Terminal Operation

	Inactive: Setting 2 or 4	Active: Setting 1 or 3
STOP KEY TERMINAL MODE	FWD STOP OUTPUT ALARM	FWD STOP OUTPUT ALARM ER6
STOP KEY NETWORK MODE	NETWORK (LE-CM) FWD (TERMINAL) STOP OUTPUT ALARM	NETWORK (LE-CM) FWD (TERMINAL) STOP OUTPUT ALARM ER6

Drive Frequency Setting Block Diagram
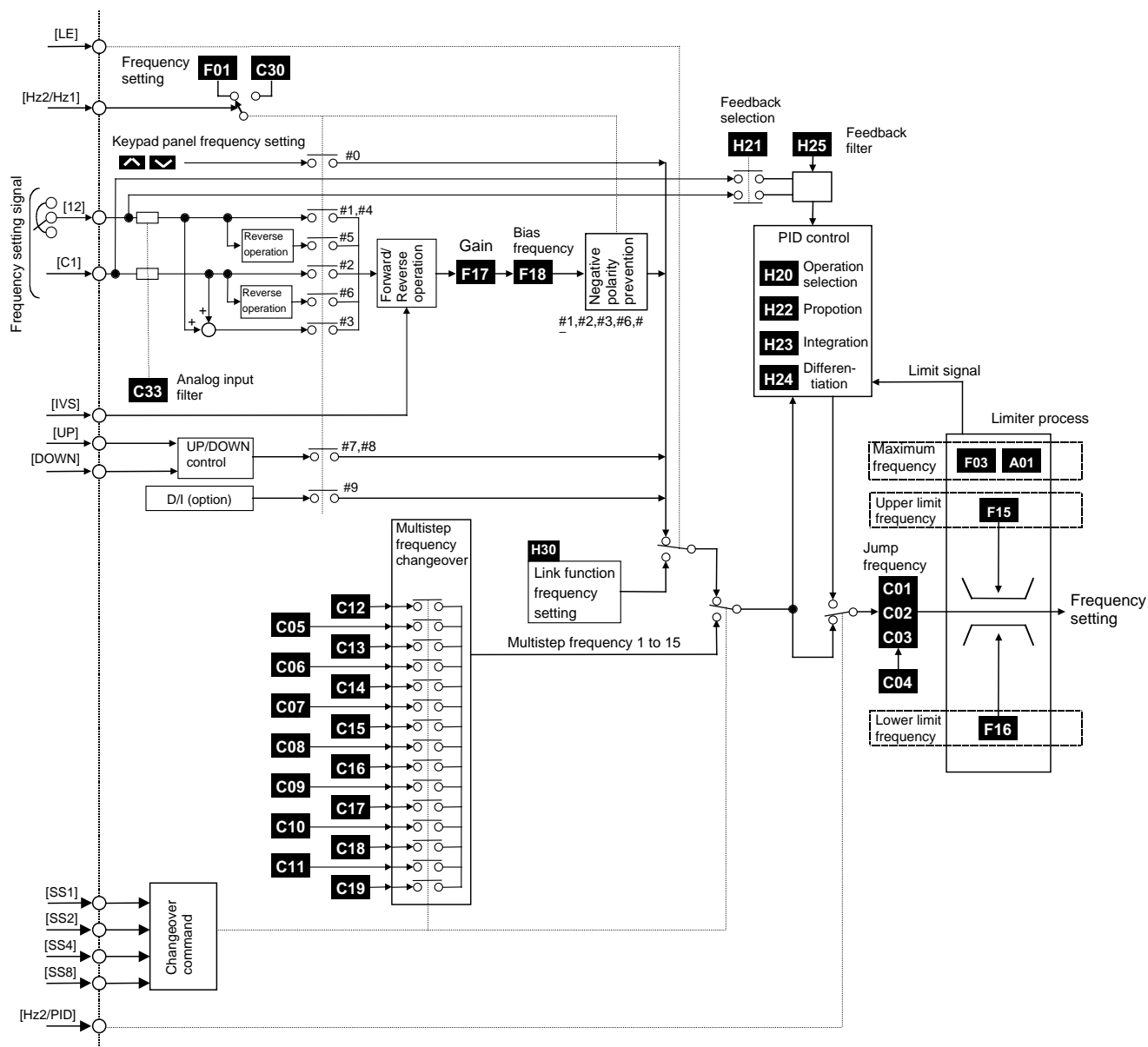
F03　Maximum output frequency 1

`F|0|3`

Setting range: 50 to 400 Hz

This function sets the maximum output frequency for Motor 1.

If a value larger than the rated maximum speed of the motor is set, the motor can be damaged.

F04　Base frequency 1

`F|0|4`

Setting range: 25 to 400 Hz

This sets the maximum output frequency in the constant torque range of Motor 1, or the output frequency at the rated output voltage. Set it to match the motor rating.

Note: If the value of base frequency 1 is larger than the value of maximum frequency 1, the output frequency will be limited by the maximum frequency, and the output voltage will not increase to the rated voltage.
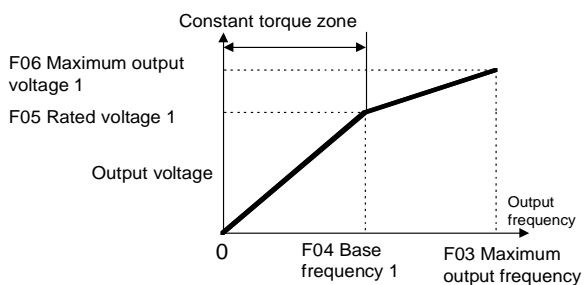
F05　Rated voltage 1

`F|0|5`

Setting range:　0, 80 to 240 V for 230V class
　　　　　　　　0, 160 to 480V for 460V class

This function sets the rated value of the output voltage of Motor 1. However, output voltage cannot exceed the supply (input) voltage.

A "0" setting stops the operation of the voltage regulator function. Therefore, the output voltage is proportional to the supply voltage.

Note: If the value of the rated voltage is higher than the value of the maximum output voltage, the voltage will be limited by the maximum output voltage and will not increase to the rated voltage.

F06　Maximum voltage 1

`F|0|6`

Setting range:　80 to 240 V for 230V class
　　　　　　　　160 to 480V for 460V class

This function sets the maximum value of the output voltage for Motor 1. However, output voltage cannot exceed the supply (input) voltage.

F07　Acceleration time 1

`F|0|7`

F08　Deceleration time 1

`F|0|8`

Setting range:　Acceleration time 1: 0.01 to 3600 s
　　　　　　　　Deceleration time 1: 0.01 to 3600 s

These functions set the acceleration time taken for the output frequency to reach the maximum frequency from the start command, and the deceleration time taken to stop from the maximum output frequency.

The number of significant digits of the acceleration and deceleration time is three. Therefore, only the upper-most three digits can be set.

The acceleration time and deceleration times are set based on the maximum frequency. The relationship between the frequency setting and the acceleration/deceleration time is as shown below.

Set frequency = max. frequency
The actual operation time matches the set value.
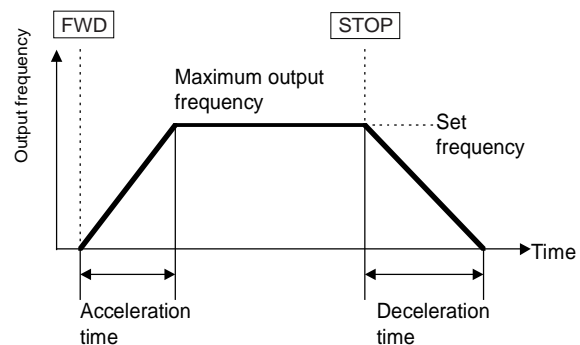
Set frequency < Maximum output frequency

The accel/decel times differ from the set value.

Acceleration/deceleration time = Set value x (Set frequency / Maximum output frequency)
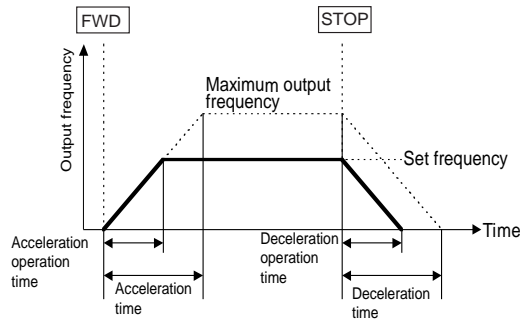
Note: If an excessively short acceleration or deceleration time is set and the load torque or moment of inertia of the load is large, the torque limiter or stall prevention function will activate. When these functions are activated, the time will become longer than the operation time explained above.

F09 Torque boost 1

F | 0 | 9

This function is for Motor 1. The following options can be selected.

- Selection of load characteristics such as automatic torque boost, variable torque load, proportional torque load and constant torque load.

- Correction of magnetic flux of the motor because of the voltage drop in the low frequency zone, and torque boost during low speed operation (boosting of V/f characteristics).

Setting Range	Description of Selection
0	Automatic torque boost characteristics. The torque boost value of the constant torque load is automatically adjusted (refer to Function Code P04 "Motor 1 (Tuning)".
1	Variable torque characteristics for fan and pump loads
2	Proportional torque characteristics for intermediate loads between the variable torque and constant torque characteristics.
3 to 31	Constant torque characteristics

Torque characteristics:

<Variable torque characteristics>
<Proportional torque characteristics>

<Constant torque characteristics>
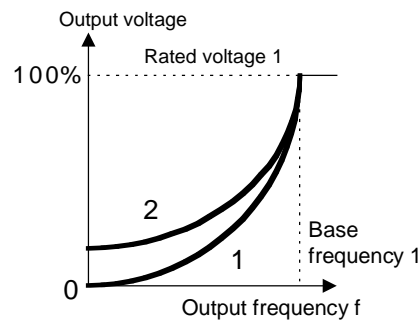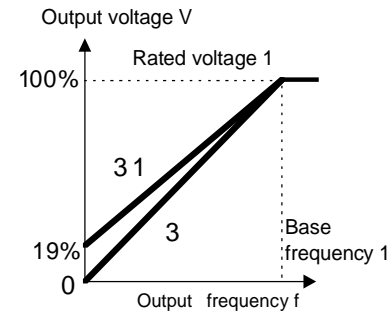
Note: When the torque boost value is excessively large, the motor will be over excited in the low speed zone for all types of characteristics. If operation continues in this state, motor performance will be reduced and the motor may overheat. Check the characteristics of the motor.

F10 Electronic thermal overload relay 1 (Select)

F11 Electronic thermal overload relay 1 (Level)

F12 Electronic thermal overload relay 1 (Thermal time constant)

The electronic thermal overload relay function monitors the output frequency, output current and operation time of the drive to prevent the motor from overheating. The protective function becomes active when 150% of the set amperage flows for the time set in F12 (thermal time constant).

F | 1 | 0

Setting 0: Inactive
          1: Active (for general purpose motor)
          2: Active (for forced air or extended operation range motor)

This function selects between active and inactive operation of the electronic thermal overload relay and also selects the motor's characteristics. When a general purpose motor is used, the operation level is low at low speeds, matching the cooling characteristics of the motor.

F 1 1

The operation level of the electronic thermal overload relay is set in amps. A value from 1.0 to 1.1 times rated current of the motor should be entered.

The setting range is 20 to 135% of the rated drive current.
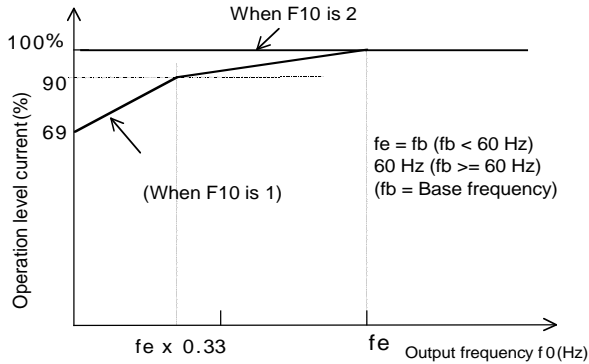
Graph of relationship between operation level current and output frequency

F 1 2

Setting range: 0.5 to 10.0 minutes
(minimum unit 0.1 minute)

This function sets the time allowed for 150% current flow, and operation of the overload fault.
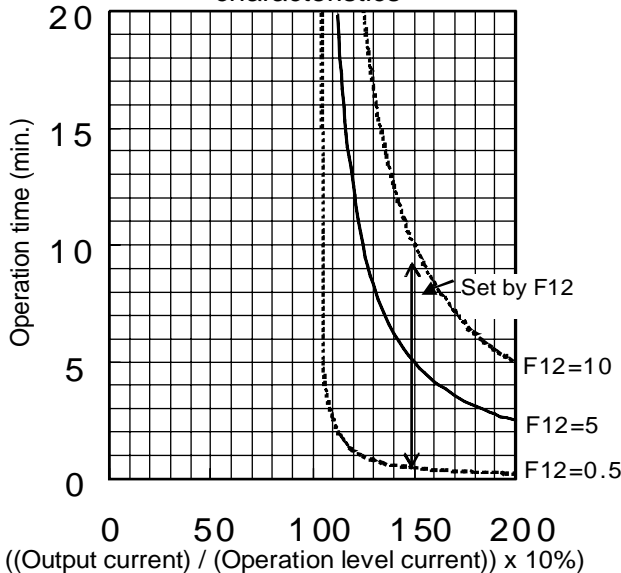
F13   Electronic thermal overload relay (for external braking resistor)

F 1 3

Setting   0: Inactive
          1: Active
          (For external braking up to 5 HP)
          2: Active
          (For external braking 7-1/2 to 10 HP)

This function prevents the braking resistor from being overheated due to the frequency of the braking as well as the duration of operation.

F14   Restart mode after momentary power failure

F 1 4

Setting range: 0 to 3 (Refer to the table on page 5-15 for details of the function.)

This function determines the response of the drive to momentary power failure.

Selection can be made for protective operation (alarm output, alarm display, and drive output shutoff) upon detection of power failure. Different responses to undervoltage and momentary power failure can be selected. Different types of restart options are also available per the table on page 5-15.

Function codes used for restart after momentary power failure include H13 and H14. Refer to the description of these codes. A rotating motor "pickup function" can be selected as the starting method after a momentary power failure. (Refer to Function Code H09 for details of setting.)

Setting	Name of Function	Operation Upon Power Failure	Operation Upon Power Recovery	
0	Inactive after momentary power failure (The drive trips immediately.)	Upon detection of undervoltage, a protective function activates to stop the output.	The motor does not restart.	The motor restarts after the protective function is reset and an operation command is input.
1	Inactive after momentary power failure (The drive trips after the power recovers.)	Upon detection of undervoltage, no protective function activates, but the output stops.	A protective function activates; the motor does not restart.	
2	Restart after momentary power failure (The motor restarts at the frequency effective at the time of power failure.)	Upon detection of undervoltage, no protective function activates, but the output stops.	The motor automatically restarts at the output frequency effective at the time of power failure.	
3	Restart after momentary power failure (The motor restarts at the starting frequency; for low inertia loads.)	Upon detection of undervoltage, no protective function activates but the output stops.	The motor automatically restarts at the starting frequency set in F23.	
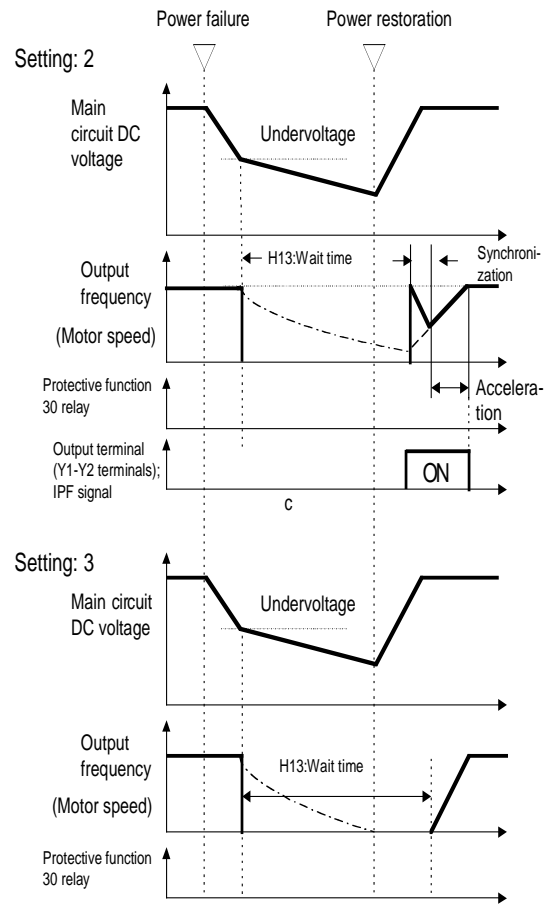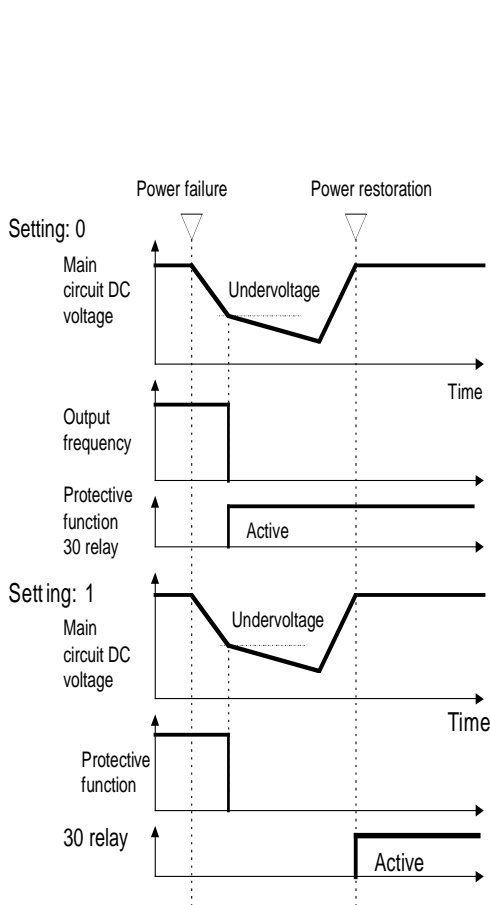
Set the upper and lower limits of the frequency setting.

When the "pickup function" is used, the speed of the coasting motor is detected and the motor is started without a shock. Because a speed detection time is necessary for the pickup function, it should not be used with systems with large inertia, since the loss in speed will be small.

The effective range of the pickup function is 5 to 120 Hz. If the detected speed is out this range, the motor restarts according to the restart function selected.

Note: The dotted-dashed line indicates the motor speed.

F15   Frequency limiter (High)

`F 1 5`

F16   Frequency limiter (Low)

`F 1 6`

Setting range: 0 to 400 Hz

These functions are used to define the upper and lower operating limits of the set frequency.
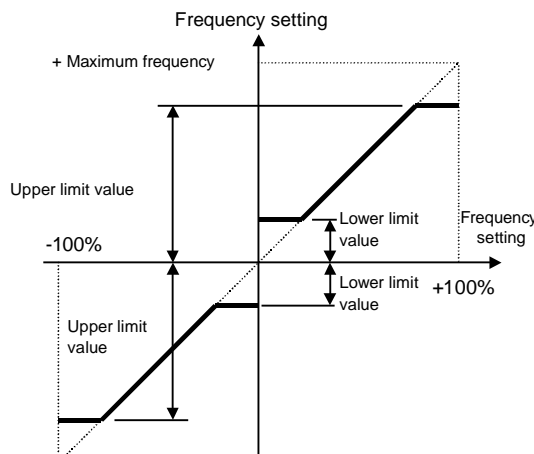
The starting frequency is output when the drive starts operation, and the stopping frequency is output when it stops operation.

Note: Low limit > High limit ... Priority is given to the High limit value.

F17   Gain (Frequency setting signal)

`F 1 7`

This function sets the ratio of the set frequency to the analog input.

The operation is as shown in the figure.
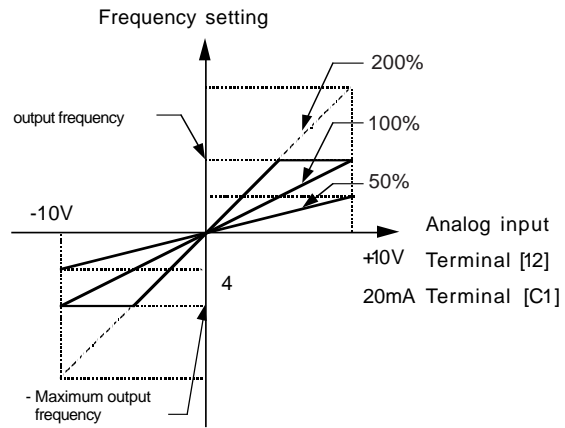
F18   Bias frequency

`F 1 8`

This function determines the set frequency from the addition of the analog input and a bias frequency. The operation is as shown in the figure below.

If the bias frequency is larger than the maximum frequency, the limit is set at the maximum output frequency. The same is true for bias frequency in the negative direction.
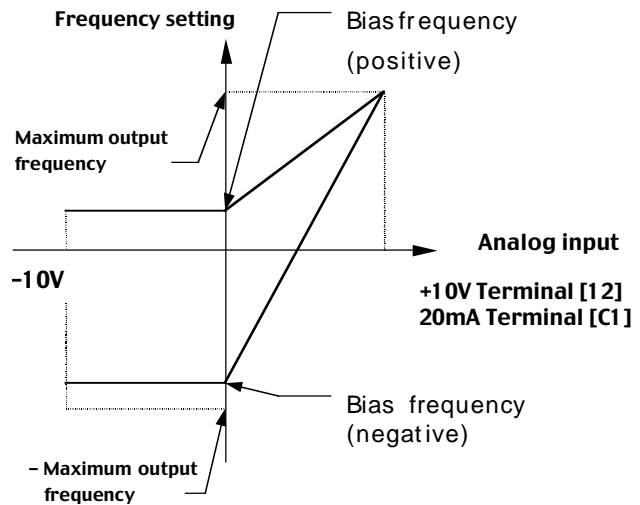
F20   DC brake (Starting frequency)
F21   DC brake (Braking level)
F22   DC brake (Braking time)

`F 2 0`

Setting range: 0.0 to 60.0 Hz

Starting frequency: Sets the frequency at which the DC braking starts during deceleration.

F 2 1

Setting range: 0 to 100%

Braking level: Sets the output current level during DC braking. The level can be set in increments of 1% of the rated drive output current.

F 2 2

Setting range: 0.0 Inactive
                   0.1 to 30.0 seconds

Braking time: Sets the operation time of DC braking.

> **CAUTION**
>
> The brake function of the drive is not a substitute for a mechanical brake. **Injuries could occur.**

F23   Starting frequency (Frequency)
F24   Starting frequency (Holding time)
F25   Stop frequency

The starting frequency can be used to help ensure torque during starting. Holding time at the start frequency can be used to wait for the establishment of the magnetizing flux of the motor.

F 2 3

Setting range: 0.1 to 60.0 Hz

Frequency: Sets the starting frequency.

F 2 4

Setting range: 0.0 to 10.0 seconds

Holding time: Sets the time for maintaining the starting frequency before acceleration occurs.

* The Holding time is not used during continuous operation between forward and reverse directions.
* The Holding time is not included in the acceleration time.
* The function is effective even when C21 (Timer Operation) is selected; the time is included in the timer value.

F 2 5

Setting range: 0.1 to 6.0 Hz

Sets the stop frequency.
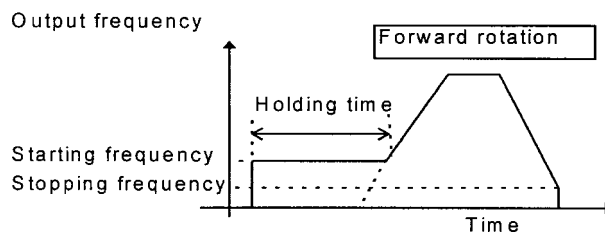
When the starting frequency is less than the stop frequency, or the set frequency is smaller than the stop frequency, this function is not used.

F26   Motor sound (Carrier frequency)

F 2 6

Setting range: 0.75 to 15 (0.75 to 15 kHz)

This function adjusts the drive's carrier frequency. It can be used for reduction of the motor noise, avoidance of resonance of the mechanical system, reduction of leakage current from the output circuit wiring, reduction of drive noise, and other performance issues.

Carrier frequency	Lower		Higher
Motor noise	More	to	Less
Output current waveform	Worse	to	Better
Leakage current	Less	to	More
Noise generation	Less	to	More

Note: Lower settings cause a distorted output current waveform with high harmonic content which causes an increase in motor losses, resulting in slightly higher motor temperatures.

For example, when 0.75 kHz is set, reduce the motor rated torque by about 15%. When a large value is set, the drive losses increase, raising the drive temperature.

F27   Motor sound (Sound tone)

F 2 7

Setting range: 0, 1, 2, 3

The sound tone of motor noise can be changed when the carrier frequency is 7 kHz or lower. The function can be used according to preference. It acts as a sweep frequency.

F29   FMA and FMP terminals (Select)

F 2 9

Selects the operation method of the FM terminal.
         0: Analog output (FMA function)
         1: Pulse output (FMP function)

F30   FMA (Voltage adjust)

F31   FMA (Function)

The output frequency, current and other monitored parameters can be output to the FM terminal as a DC voltage. The amplitude can be adjusted to match customer needs.

Note: To use the FM terminal for analog outputs, set F29 at "0" and set SW1 on the control board to FMA.

F|3|0

Setting range: 0 to 200%

This parameter adjusts the voltage corresponding to 100% of the monitored parameter selected in F31. The range is from 0 to 200% in increments of 1%.
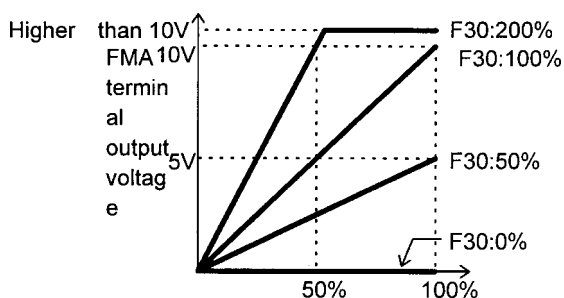
F|3|1

Selects the monitored item for the FM terminal output.

Setting	Target of Monitoring	Definition of 100% of Monitoring Amount
0	Output frequency 1 (before slip compensation)	Maximum output frequency
1	Output frequency 2 (after slip compensation)	Maximum output frequency
2	Output current	2 times rated drive output current
3	Output voltage	250V (230V class) 500V (460V class)
4	Output torque	2 times rated motor torque
5	Load factor	2 times rated motor load
6	Input power	2 times rated drive output
7	PID feedback value	100% feedback value
8	DC link circuit voltage	500V (230V class) 1000V (460V class)

F33   FMP (Pulse rate)

F34   FMP (Voltage adjust)

F35   FMP (Function)

The output frequency, output current and other monitored data can be output to the FM terminal as pulse voltages. The output can be connected to an analog meter.

To configure the pulse output, set the F33 pulse rate to a desired value, and set the F34 voltage to 0%.

To configure the average voltage, set the F34 voltage to determine the average voltage; the F33 pulse rate is fixed at 2670 p/s.

Note: To use the FM terminal for the pulse output, set F29 to "1" and set SW1 on the control board to FMP.

F|3|3

Setting range: 300 to 6000 p/s

This function sets the pulse rate corresponding to 100% of the monitored parameters selected by F35.
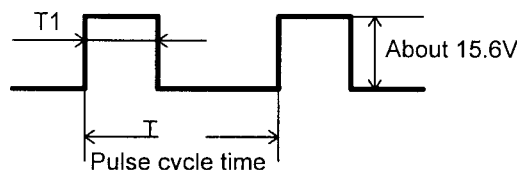
Pulse period [p/s] = 1/T

Duty [%] = T1/T x100

Average voltage [V] = 15.6 x T1/T

F|3|4

Setting range: 0 to 200%

Sets the average voltage of the pulse output at the FM terminal.
If "0" is set, the pulse frequency varies according to the monitored item selected by F35 (with the maximum value being the F33 setting). If a value between 1 and 200 is set, the pulse frequency is fixed at 2670 p/s. The average voltage corresponding to 100% of the monitored item selected by F35 can be adjusted in a range between 1 and 200% (in increments of 1%.) (The duty cycle of the pulse changes.)

Note : FMP has approximately 0.2V offset voltage even if FMP outputs zero value.

F|3|5

Selects the monitored item for the FM terminal output. The selected options are the same as F31.

F36 30Ry operation mode

| F | 3 | 6 |

This function determines whether the alarm output relay (30Ry) activates (picks up) during normal operation or picks up during a trip.

Setting	Operation	
0	Drive no power	30A – 30C: OFF, 30B – 30C: ON
	At normal	30A – 30C: OFF, 30B – 30C: ON
	At alarm	30A – 30C: ON, 30B – 30C: OFF
1	Drive no power	30A – 30C: OFF, 30B – 30C: ON
	At normal	30A – 30C: ON, 30B – 30C: OFF
	At alarm	30A – 30C: OFF, 30B – 30C: ON

Note: Because the contact between 30A and 30C closes when the drive is turned on (about 1 second) care must be taken in the logic sequence design. This occurs if the setting is "1."

F40 Torque limiter 1 (Driving)

F41 Torque limiter 1 (Braking)

| F | 4 | 0 |
| F | 4 | 1 |

Setting range: 20 to 200,999%

The torque limit operation calculates the motor torque from the output voltage, current, resistance of the primary winding of the motor and other data to control the frequency so that the calculated value does not exceed the control value. This ensures drive operation without tripping upon abrupt changes in the load torque while the limit value is maintained.

Selects the limit values of the driving torque and braking torque.

The acceleration/deceleration times may be extended during activation of this function. When the driving torque is limited during constant speed operation, the frequency is lowered to reduce the load torque. (When the braking torque is limited, the opposite occurs.)

Set "999" to deactivate the torque limiter.
Set the braking torque to "0" to automatically avoid OU tripping caused by power regeneration of high inertia loads.

DANGER

If the torque limiter has been selected, the drive may operate at an acceleration/deceleration time or speed different from the set ones. Design the machine and select the drive so that safety is ensured.

F42 Torque vector control 1- sensorless

| F | 4 | 2 |

The torque vector control calculates the torque suitable for the load to make the best use of the motor torque. It controls the voltage and current vectors to optimize motor operation.

Setting	State of Operation
0	Inactive
1	Active

When "1" (active) is selected, the settings of the following function codes are changed to the following:

1. F09 Torque Boost 1: Operates as "0" value (automatic torque boost).

2. P09 Slip Compensation Control: Slip compensation is automatically activated.

3. When "0" is set, the slip compensation for a standard three-phase motor is assumed. When the setting is other than "0," the programmed setting is used.

Use the torque vector control function under the following conditions:

1. A single motor

   Note: If two or more motors are connected, accurate control cannot be maintained.

2. The data in Motor 1's function codes (P03 "Rated Current," P06 "No-load Current," P07 "%R1" and P08 "%X") must be accurate.

   Note: If a standard three-phase motor is used, the above data is automatically input when Function Code P02 "Capacity" is set. When another motor is used, execute auto tuning (P04).

3 The rated motor current must not be significantly smaller than the rated drive current. Though it depends on the motor design, one or two sizes smaller than the drive rating is the smallest motor rating allowed.

4. The wiring distance between the drive and motor must not be greater than 165 ft. (50 m). Long cable runs make accurate control difficult due to the leakage current flowing between the cable and ground.

5. When a reactor is connected between the drive and motor or when the wiring impedance is large enough not to be overlooked, change the data using P04 "Auto Tuning."
   If these conditions cannot be satisfied, this function should not be used.

E: Extension Terminal Functions/Digital Input/Output

E01   X1 terminal function

E02   X2 terminal function

E03   X3 terminal function

E04   X4 terminal function

E05   X5 terminal function

E	0	1
E	0	2
E	0	3
E	0	4
E	0	5

The function of each Digital Input Terminal X1 to X5 can be set per the following table:

Setting	Function
0,1,2,3	Multistep frequency selection (1 to 15 steps)
4	Acceleration/deceleration selection (1 step)
5	Self holding selection [HLD]
6	Coast-to-stop command [BX]
7	Alarm reset [RST]
8	External alarm [THR]
9	Frequency setting 2 / frequency setting 1 [Hz2 / Hz1]
10	Motor 2 / motor 1 [M2 / M1]
11	DC injection brake command [DCBRK]
12	Torque limit 2 / torque limit 1 [TL2 / TL1]
13	UP command [UP]
14	DOWN command [DOWN]
15	Editing permission command (data change allowed) [WE-KP]
16	PID control cancel [Hz / PID]
17	Normal/Inverse switching (Terminals 12 and C1) (IVS)
18	Link operation selection (RS485 standard, BUS Option) [LE]

Note: The data numbers not in the above table assigned to E01 through E05 will be inactive.

Multistep frequency

Frequencies set in Function Codes C05 through C19 can be selected according to external digital inputs. Set digital inputs per the following table to select the desired running frequency.

Multistep frequency selection
Value: 0-3

Combination of Input Signals				Selected Frequency
3	2	1	0	
*[SS8]	[SS4]	[SS2]	[SS1]	
off	off	off	on	C05 Multistep frequency 1
off	off	on	off	C06 Multistep frequency 2
off	off	on	on	C07 Multistep frequency 3
off	on	off	off	C08 Multistep frequency 4
off	on	off	on	C09 Multistep frequency 5
off	on	on	off	C10 Multistep frequency 6
off	on	on	on	C11 Multistep frequency 7
on	off	off	off	C12 Multistep frequency 8
on	off	off	on	C13 Multistep frequency 9
on	off	on	off	C14 Multistep frequency 10
on	off	on	on	C15 Multistep frequency 11
on	on	off	off	C16 Multistep frequency 12
on	on	off	on	C17 Multistep frequency 13
on	on	on	off	C18 Multistep frequency 14
on	on	on	on	C19 Multistep frequency 15

* BCD code designation

Acceleration/deceleration time selection
Value: 4

Acceleration/deceleration times set to Function Codes E10 and E11 can be selected according to the following external digital inputs.

Input Signal	Selected Acceleration/Deceleration Time
4[RT1]	
Off	F07 Acceleration time 1
	F08 Deceleration time 1
On	E10 Acceleration time 2
	E11 Deceleration time 2

3-wire operation start/stop command [HLD]
Value: 5

Used for three-wire operation. When HLD-CM is ON, the FWD or REV signal is maintained, and when it is OFF, the signal is reset.

Note: The drive operates when FWD-CM or REV-CM is on, even if HLD-CM is off. An external interlock sequence, which makes FWD-CM and REV-CM off when HLD-CM is off, is required.
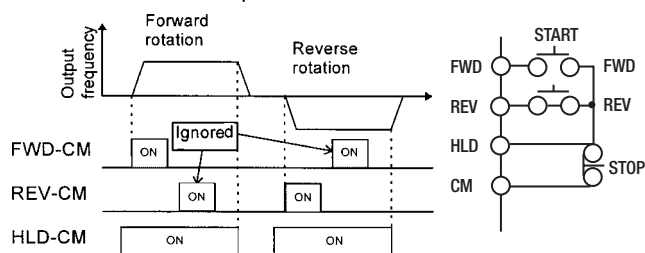
Coast-to-stop command [BX]
Value: 6

When the BX terminal connects to the CM terminal, the drive output is immediately shut off and the motor coasts-to-stop. No alarm signal is output nor is the signal maintained.

When the operation command (FWD or REV) is ON and the BX terminal is disconnected from the CM terminal, the motor starts at the starting frequency.
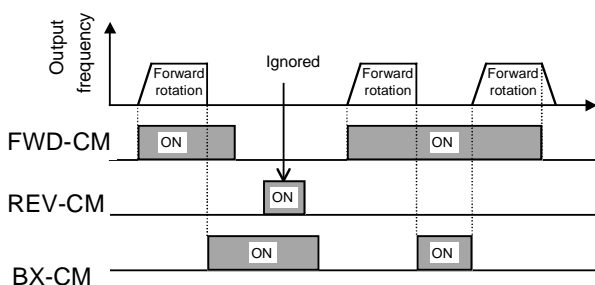
Alarm reset [RST]
Value: 7

When the connection between the RST and CM terminals is made, the alarm output is removed. When the connection is turned off, the trip display is removed and the drive resets.

Trip command (External alarm) [THR]
Value: 8

When the connection between the THR and CM terminals opens, the drive output shuts off (causing the motor to coast to a stop), and an alarm [OH2] is output. This signal is maintained until an RST (reset) input is triggered. This function is used to protect the external braking resistor from being overheated and other external fault condition inputs. When this terminal function is not set, an ON input is assumed.

Frequency setting 2/1 [Hz2 / Hz1]
Value: 9

An external digital input signal switches the frequency setting method defined by Function Codes F01 and C30. The signal operation also changes under PID control. (Refer to H20 through H25.)

Input Signal 9[Hz2/Hz1]	Selected Frequency Setting
Off	F01 Frequency setting 1
On	C30 Frequency setting 2

Motor 2/1 [M2 / M1]
Value: 10

An external digital input signal switches between two sets of motor constants. This input is effective only when the operation command to the drive is turned off and the motor is stopped. Operation at 0 Hz reference setpoint is not included.

Input Signal 10[M2/M1]	Selected Motor
Off	Motor 1
On	Motor 2

DC injection brake command (DCBRK)
Value: 11

This function is used for DC braking operation during stopping as well as starting into a rotating load. When the external digital input signal is on and a stop command is given, DC injection braking starts when the drive's output frequency drops below the frequency preset in Function Code F20. (The operation command goes off when the STOP key is pressed during keypad panel operation or when both Terminals FWD and REV go off during terminal block operation.) The DC injection braking continues while the digital input signal is on. In this case, the longer of the following times is selected:

- The time set with Function Code F22
- The time during which the input signal is set ON

Input Signal 13	Selected Operation
Off	DC injection brake command not given
On	DC injection brake command given
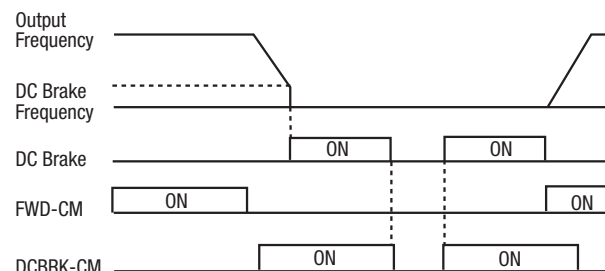
Torque limiter 2/Torque limiter 1 [TL2 / TL1]
Value: 12

An external digital input signal switches between the torque limiter values set in Function Codes F40 and F41 or E16 and E17.

Input Signal 12[TL2/TL1]	Selected Torque Limit Value
Off	F40 Torque limiter 1 (Driving)
Off	F41 Torque limiter 1 (Braking)
On	E16 Torque limiter 2 (Driving)
On	E17 Torque limiter 2 (Braking)

UP command [UP] / DOWN command [DOWN]
Value: 13, 14

The output frequency can be increased or decreased according to the external digital input signal while the run command is present. The range is 0 to the maximum output frequency. Operation in a reverse direction to that of the operation command is not allowed.

Input Signal		Selected Function
13 UP	14 DOWN	(When operation command is ON)
Off	Off	The output frequency is maintained.
Off	On	The output frequency decreases at the deceleration time.
On	Off	The output frequency increases at the acceleration time.
On	On	The output frequency is maintained.

Edit Permission for Keypad [WE-KP]
Value: 15

This function allows program changes only while the external signal is input. This protects the program from inadvertent changes.

Input Signal 15[WE-KP]	Selected Function
Off	Data change disabled
On	Data change enabled

Note: If data 15 is set to a terminal erroneously, turn that "X" terminal ON, then change to another number.

PID control cancel [Hz/PID]
Value: 16

An external digital input signal can disable the PID control.

Input Signal 16 [Hz/PID]	Selected Function
Off	PID control valid
On	PID control invalid (Frequency setting through keypad panel)

Inverse mode changeover
(Terminals 12 and C1) [IVS]
Value: 17

An external digital input signal switches between the forward and reverse operations of analog inputs (Terminals 12 and C1).

Input Signal 17[IVS]	Selected Function
Off	When forward operation is set > forward operation
Off	When reverse operation is set > reverse operation
On	When forward operation is set > reverse operation
On	When reverse operation is set > forward operation

Link enable (RS485) [LE]
Value: 18

An external digital input signal is used to enable or disable operation commands from the communications link. The source of the command can be set at H30, Link function.

Input Signal 18[LE]	Selected Function
Off	Link command invalid
On	Link command valid

E10   Acceleration time 2

E11   Deceleration time 2

Additional acceleration and deceleration times can be selected besides F07 and F08. The operation and setting range are the same as those for F07 and F08. Refer to these functions.

To switch between the acceleration and deceleration parameters, select any terminal from E01 "X1 terminal (Function selection)" through E05 "X5 terminal (Function selection)" as the switching signal input terminal. Set the selected terminal to "4" (acceleration/deceleration 2 time selection) and supply a signal to the terminal. Switching is effective during acceleration, deceleration or during constant speed operation.

E16   Torque limiter 2 (Driving)
E17   Torque limiter 2 (Braking)

```
E 1 6
E 1 7
```

These functions switch to the torque limiter levels set in F40 and F41. The external signal is supplied to a control input terminal (X1 through X5). The "X" input must be set to torque control 2/torque control 1 (Value = 12).

E20   Y1 terminal function
E21   Y2 terminal function

```
E 2 0
E 2 1
```

Selected control and monitor signals can be output at the Y1 and Y2 terminals. They are as follows:

Setting	Digital Output Signal
0	Drive running [RUN]
1	Frequency arrival [FAR]
2	Frequency level detection [FDT]
3	Undervoltage detection signal [LV]
4	Torque polarity [B/D]
5	Torque limiting [TL]
6	Restart after momentary power failure [IPF]
7	Overload early warning [OL]
8	Life time alarm [LIFE]
9	Frequency level detection 2 [FAR2]

Drive running [RUN]
Value: 0

"Drive running" means that the drive is outputting a running frequency as an ON signal. However, if the DC braking function is active, the signal is turned off.

Frequency arrival [FAR]
Value: 1

Refer to the description for Function Code E30, Up-to-speed function frequency equivalence (detection width).

Frequency level detection [FDT]
Value: 2

Refer to the description for Function Codes E31 and E32, Frequency level detection.

Undervoltage detection signal [LV]
Value: 3

When the undervoltage protection function is active, that is, when DC bus voltage is below the undervoltage detection level), an ON signal is output. After the voltage is restored and becomes higher than the undervoltage detection level, the signal turns off. The ON signal is output also during activation of the undervoltage protection function.

Undervoltage detection level: About 200 VDC

Torque polarity [B/D]
Value: 4

The polarity of the torque is calculated inside the drive and is outputed.

When the calculated torque is driving torque, an OFF signal is output, and when it is braking torque, an ON signal is output.

Torque limiting [TL]
Value: 5

When the torque limit function is set, a torque limiting signal is output to indicate an excessive load.

The ON signal is output during torque limit, regeneration avoidance operation and current limit.

A stall prevention function automatically operates to change the output frequency at this time.

Restart after momentary power failure [IPF]
Value: 6

Momentary power failure, start-up of restart mode after momentary power failure, and automatic synchronization and recovery are reported through this function.

When the power is recovered and synchronization starts after a momentary power failure, an ON signal is output. The signal changes to an OFF signal after the previous running frequency is achieved.

Completion of restart is assumed at the time of power recovery, and the signal is turned off after this timing. (Refer to the description of F14.)

Overload early warning [OL]
Value: 7

An overload early warning level before the thermal protection trip (electronic thermal overload relay) of the motor energizes.

Either the electronic thermal overload forecast or output current overload forecast can be selected for this overload signal.

For setting, refer to Overload early warning (Operation selection E33) and Overload early warning (Operation level E34).

Note: This function is effective only for motor 1.

Life time alarm [LIFE]
Value: 8

Main bus capacitors life judgement output.

Refer to section 8-2 (1) "Measurement of Capacitance of Capacitor in Main Circuit" for description.

Frequency level detection 2 [FAR2]
Value: 9

This is a frequency level detection (detection width) signal where Function Code E29 "Frequency Level Detection Delay" takes effect. Detection level of the frequency is at the output and before the torque limiter.

E29   Frequency level detection delay

Setting range: 0.01 to 10.0 seconds

The delay is valid only for FAR2, and it can be adjusted between 0.01 and 10.0 seconds. The hysteresis can be adjusted in a range of 0 to +/-10 Hz of the output frequency.

E30   FAR function signal (Hysteresis)

Setting range: 0.0 to 10.0 Hz

Adjusts the hysteresis and signal output delay of the output frequency.
The output frequency changes according to the torque limiting operation. When the frequency exceeds the setting range (width), the signal turns off in a mode (FAR: E20, 21 set to "1") or it does not turn off in another mode (FAR2: E20, 21 set to "9").
An ON signal can be output from the terminal within the detection range (width).

E31   FDT function signal (Level)

E32   FDT function signal (Hysteresis)

| E | 3 | 1 |
| E | 3 | 2 |

Setting range: (Operation level): 0 to 400 Hz
(Hysteresis width): 0.0 to 30.0 Hz

Determines the operation (detection) level of the output frequency and the hysteresis width of operation. When the output frequency exceeds the set FTD operation level, an ON signal can be output from the terminal.
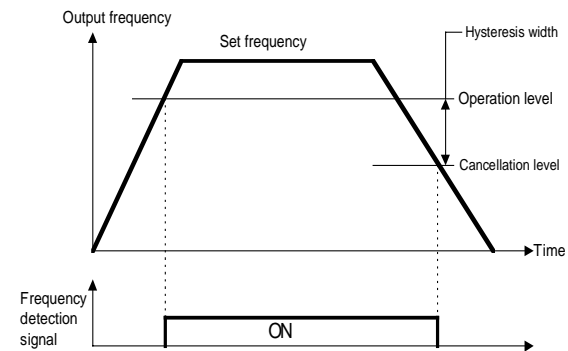
E33   OL function signal (Mode select)

| E | 3 | 3 |

Setting: 0: Electronic thermal overload relay
1: Output current

The OL function signal includes two variations: "overload forecast by means of the electronic thermal overload relay" and "overload forecast by means of output current."

Setting	Function	Outline
0	Electronic thermal overload relay	Overload forecast using the characteristics of the electronic thermal overload relay which show inverse time limit characteristics against the output current. The operation selection of the inverse time limit characteristics and the thermal time constant are the same characteristics as those of the electronic thermal overload relay (F10, F12) for motor protection. To use a forecast, set at a lower level than the electronic thermal overload relay for motor protection.
1	Output current	When the output current exceeds the set current for a period longer than the set time, an overload forecast is issued.

E34 OL function signal (Level)

E 3 4

Setting range:
Rated drive output current x (20 to 200%)

Determines the level of the electronic thermal overload relay or output current. The operation cancellation level is 90% of the set value.

E35 OL function signal (Timer)

E 3 5

Setting range: 0.1 to 60.0 seconds

When E33 "OL Function Signal (Mode Select)" is set at "1" (output current), E35 sets the time taken until the output is initiated.

E40 Display coefficient A

E41 Display coefficient B

E 4 0
E 4 1

Setting range:
Display coefficient A: 0.00 to 200.0
Display coefficient B: 0.00 to 200.0

Use these functions as conversion coefficients for determining the displayed value (process amount) of the load speed, line speed, and target value and feedback amount of the PID loop.
For load speed and line speed, use E40 "Display Coefficient A."

- (Displayed value) = (Output frequency) x (0.01 to 200.0)
  The effective value of the display data is 0.01 to 200.0. Therefore, the display is limited by the minimum value of 0.01 and the maximum value of 200.0 even if the value exceeds the range.

- Target value and feedback amount of PID loop:
  Set the maximum value of the displayed data of E40 "Display Coefficient A" and set the minimum value of E41 "Display Coefficient B."
  Display value = (Target value or feedback amount) x (Display coefficient A - B) - B

E42 LED display filter

E 4 2

Setting range: 0.0 to 5.0 seconds

The data available to the "LED monitor" includes data that changes rapidly. This type of data can be displayed with a suppression filter.

The target display items are the output current and output voltage.

C: Control Functions of Frequency

C01 Jump frequency 1

C02 Jump frequency 2

C03 Jump frequency 3

C04 Jump frequency hysteresis

These functions jump the output frequency to avoid the mechanical load resonance points.

- Three jump frequencies can be set.

- This function is inactive when all the jump frequencies
(1 through 3) are set at 0 Hz.

- The frequencies are not jumped during acceleration or deceleration.

If the setting ranges of jump frequencies overlap, the sum of the setting ranges is jumped.

C01 C02 C03 (Jump Frequencies)

```
C 0 1
C 0 2
C 0 3
```

Setting range: 0 to 400 Hz
Minimum unit: 1 Hz

C04 (Hysteresis)

```
C 0 4
```

Setting range: 0 to 30 Hz
Minimum unit: 1 Hz
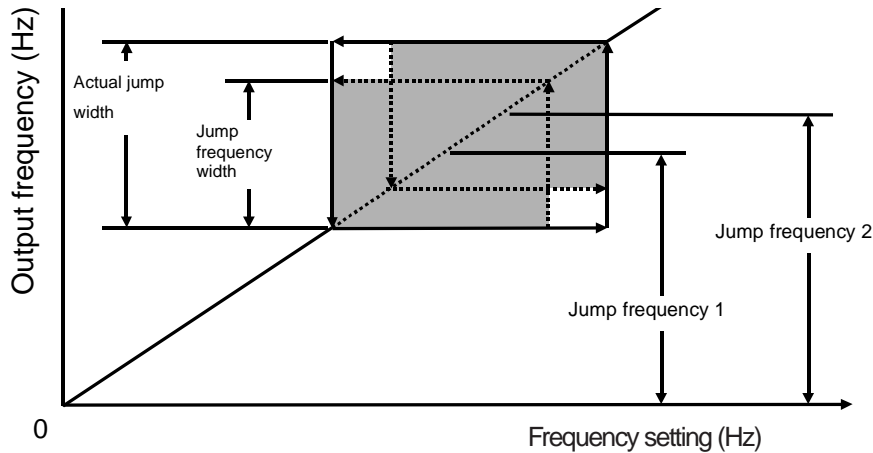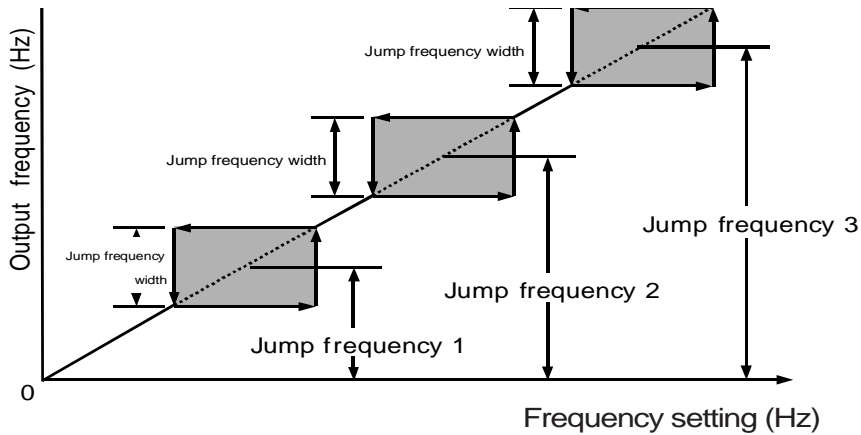
C05-C19   Multistep frequency 1 through 15

C	0	5
C	0	6
C	0	7
C	0	8
C	0	9
C	1	0
C	1	1
C	1	2
C	1	3
C	1	4
C	1	5
C	1	6
C	1	7
C	1	8
C	1	9

Terminal Functions SS1, SS2, SS4 and SS8 are turned on or off to switch multistep frequencies 1 through 15. (Refer to E01 through E05 for the definition of the terminal function.)

Undefined terminals among Terminal Functions SS1, SS2, SS4 and SS8 are assumed to be turned off.
Setting range: 0.00 to 400.0 Hz
Minimum unit: 0.01 Hz
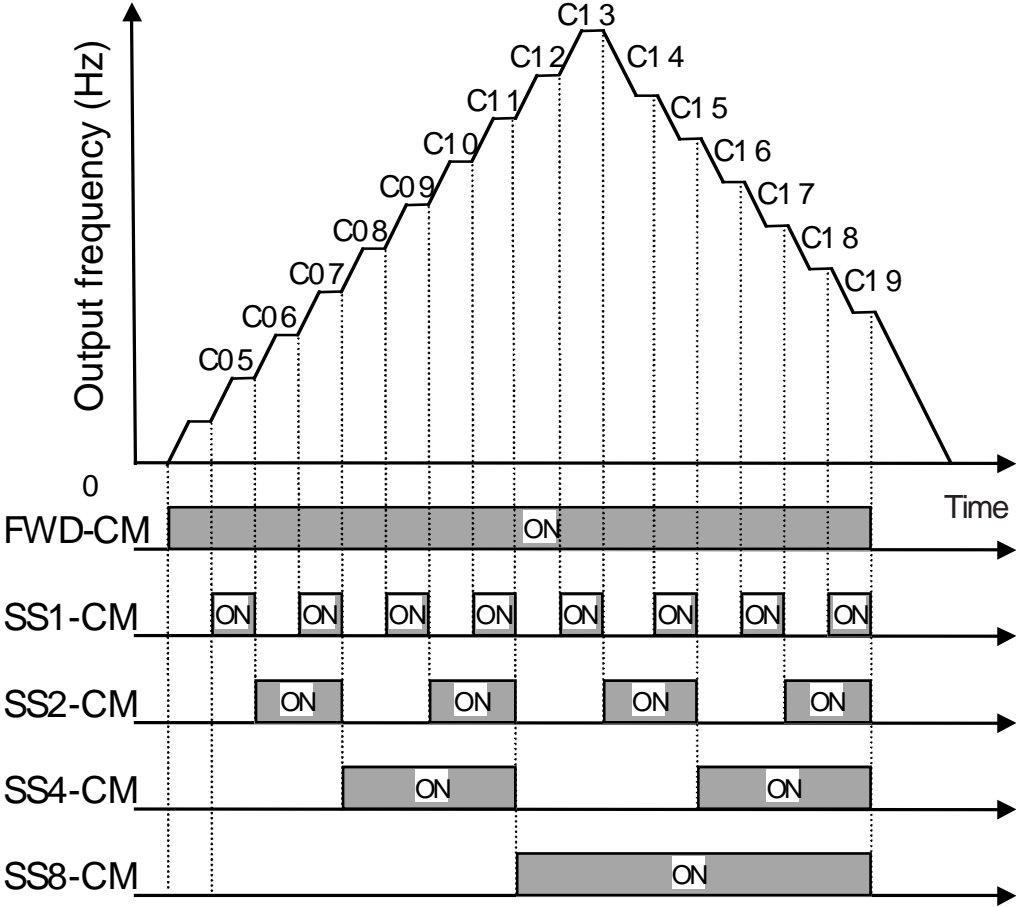
C21   Timer operation

`C` `2` `1`

Select active or inactive timer operation.

    0: Inactive timer operation
    1: Active timer operation

C221 Timer duration

`C` `2` `2`

Setting range: 0.00 to 3600 seconds

A timer operation from the start of operation to automatic stop can be created.

Set the time from the start of operation to automatic stop.

Note: If the power is turned off or the drive is stopped or trips during timer operation, the counted time resets.

C30   Frequency command 2

`C` `3` `0`

Select the frequency setting method.

For the selectable frequency setting methods, refer to the description of F01.

C31   Analog signal offset adjustment (Terminal 12)

C32   Analog signal offset adjustment (Terminal C1)

`C` `3` `1`
`C` `3` `2`

Sets the offset on the analog input (Terminal 12 or Terminal C1).
The offset can be set in the range between -5.0% and + 5.0% of the maximum output frequency (in 0.1% step).

Terminal   12
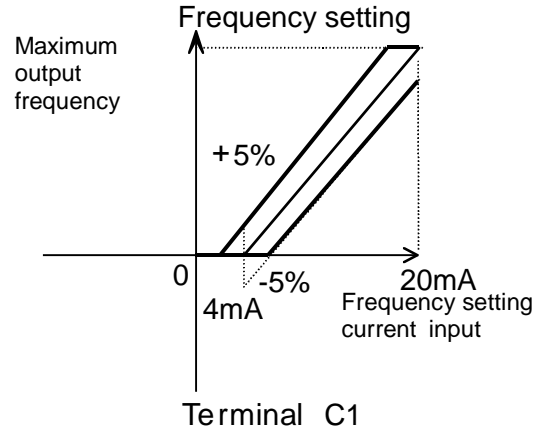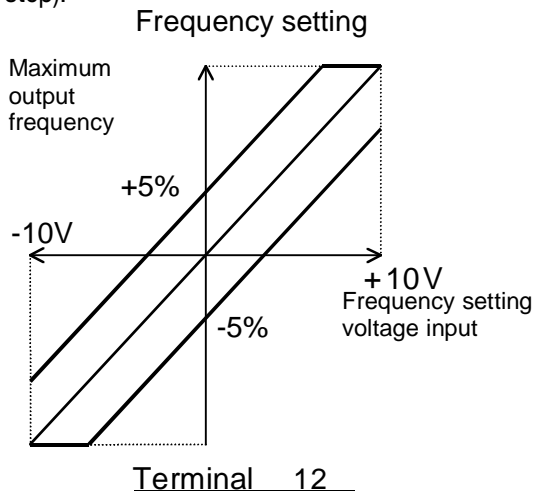
Terminal   C1

C33 Analog signal filter

`C` `3` `3`

Setting range: 0.00 to 5.00 seconds

The analog signal supplied to Control Terminal 12 or C1 sometimes includes electric noise. Electric noise may make the control unstable. Adjust the time constant of the input filter to remove the effects of electrical noise.

With a large time constant (setting), the drive becomes stable but there is a delay in the drive response. With a small time constant, the response is quicker, but if the signal has electrical noise, the drive's output varies and can become unstable.
If the adjustment has been determined, change the setting when the drive is unstable, or when the response is slow.

Note: The function applies to both Terminals 12 and C1 (in common). However, when a PID feedback signal is input, H25 "PID Control Feedback Filter" is applied.

P: Motor parameters

P01 Number of motor 1 poles

| P | 0 | 1 |

Setting range: 2, 4, 6, 8, 10, 12 or 14

This function sets the number of poles in Motor 1. A correct value is needed to display correct motor speeds (synchronous speeds) on the keypad LED.

P02 Motor 1 (Capacity)

| P | 0 | 2 |

Setting range: 0.01 to 7-1/2 HP (5 HP or smaller)
                 0.1 to 15 HP (7-1/2 to 10 HP)

A standard motor capacity is set before shipment from the factory. Change the setting to use a motor rated other than the standard default motor capacity.

Set the standard motor capacity specified in Section 9-1 "Standard Specifications." The setting range should be between one rating higher or two ratings lower than the standard motor capacity. If this range is exceeded, accurate motor speed control may not be possible. If a value between the standard applicable motor capacity and the capacity of another rating is set, the data of the lower capacity is automatically used.

After the value of this function is changed, the settings of the following related functions also change to the data for a three-phase standard motor.

P03 "Motor 1 (Rated current)"
P06 "Motor 1 (No-load current)"
P07 "Motor 1 (%R1)"
P08 "Motor 1 (%X)"

P03 Motor 1 (Rated current)

| P | 0 | 3 |

Setting range: 0.00 to 99.9 Amps

This parameter sets the rated current of Motor 1.

P04 Motor 1 (Tuning)

| P | 0 | 4 |

This function measures and automatically stores motor data.

Setting	State of Operation
0	Inactive
1	The primary resistance (%R1) of the motor and the leakage reactance (%X) at the base frequency are measured while the motor is stopped and the data is automatically written to P07 and P08.
2	The primary resistance (%R1) of the motor and the leakage reactance (%X) at base frequency are measured while the motor is stopped, then the no-load current (Io) is measured while the motor turns and P06, P07 and P08 are automatically re-programmed.

Perform an auto tuning if the P06, P07 and P08 data written in the drive differs from the actual motor data. For example:

- When a motor other than a standard three-phase motor (4 poles) is used.

- When additional impedance on the output cannot be ignored, such as a long wire run between the drive and the motor or connection of an output reactor.

- When %R1 or %X is unknown due to a nonstandard or special motor.

Tuning Procedure:

1. Adjust the voltage and frequency according to the characteristics of the motor. Adjust "F03," "F04," "F05" and "F06."

2. Enter the motor constants which cannot be tuned; P02 "Capacity," P03 "Rated current," P06 "No-load current" (The no-load current is not necessary in tuning mode 2, that is P04 = 2.)

3. To tune for no-load current, disconnect the motor from the machine. Check that no danger occurs when the motor turns.

4. Set P04 "Tuning" to "1" (no motor rotation) or "2" (motor rotation) and press the FUNC/DATA key. Then issue an operation command (press the RUN key or turn the FWD or REV terminal on) to start tuning. Tuning takes several seconds to several minutes. When "Tune -2" is used, the motor accelerates to half of base frequency in the set acceleration time, then decelerates. The time necessary for tuning varies according to the set acceleration/deceleration time.

5. During tuning, the tuning parameter ("1" or "2") blinks rapidly. When tuning is complete, the next function code (P05) is displayed. If the FWD or REV terminal board input is used to start tuning, disconnect them at the end of the tune.

Note: Turn the BX and RST terminals off, if used, before starting the tuning.

WARNING

If auto tuning is set at "**2**," the motor turns at half of the base speed. Be sure that the motor is disconnected from the mechanical machine and that no danger results from the rotation. **Injuries may occur.**

P05 Motor 1 (Online tuning)

P	0	5

The motor temperature changes after a long operation, which changes the motor speed. Use online tuning to reduce speed changes caused by temperature changes of the motor.

Setting	State of Operation
0	Inactive
1	Active

P06 Motor 1 (No-load current)

P	0	6

Setting range: 0.00 to 99.9 Amps

This parameter is the no-load current (magnetizing current) of Motor 1.

P07 Motor 1 (%R1 setting)
P08 Motor 1 (%X setting)

P	0	7
P	0	8

Use these parameters when a motor other than a standard three-phase motor is used, and the impedance between the drive and motor and the motor are known.

Calculate %R1 in the following formula.

$$\%R1 = \frac{R1 + Cable\ R}{V / (\sqrt{3} \bullet I)} \times 100\ [\%]$$

Where R1: Resistance of the single phase, primary coil of the motor [ohms].

Cable R: Resistance of the single-phase output cable [ohms].

V: Rated voltage [V]

I: Rated motor current [A]

Calculate %X in the following formula.

$$\%X = \frac{X1 + X2 \bullet XM / (X2 + XM) + cable\ X}{V / (\sqrt{3} \bullet I)} \times 100\ [\%]$$

where

X1: Primary leakage reactance of the motor [ohms]

X2: Secondary leakage reactance of the motor (converted to primary reactance) [ohms]

XM: Motor excitation reactance [ohms]

Cable X: Reactance of the output cable [ohms]

V: Rated voltage [V]

I: Rated motor current [A]

Note: Use the reactance specified at F04 "Base frequency 1."

Add the value of a reactor and filter connected to the output of the drive. If the cable value can be ignored, the cable value should be "0."

P09 Motor 1 (Slip compensation control 1)

P	0	9

Setting range: 0.00 to 15.00 Hz

When the load torque changes, the motor slip changes and the motor speed changes. With the slip compensation control, a frequency proportional to the motor load is added to the output frequency of the drive. This minimizes the change of motor speed caused by torque change.

Calculate the slip compensation data in the following formula.

Slip compensation amount =

$$Base\ frequency \times \frac{Slip\ (r/min)}{Synchronous\ speed\ [r/min]}\ [Hz]$$

P10 Motor 1 (Slip compensation response time 1)

This function sets the response time of slip compensation.

Note: With a low setting, the response time becomes shorter, but regeneration may cause overvoltage tripping with some loads.

H:High Performance Functions

H01 Total operation time

The total power-on time of the drive is displayed.
A number between 0 and 6500 is displayed, indicating 0 to 65000 hours. (The time is displayed in tens of hours, though the drive counts each hour. Time shorter than one hour is not counted.)

H02 Trip history

A history of the latest four faults is stored in memory. To call up each event, press the ▼ or ▲ key.

		Display Example	Remarks
1	Call up H 02	H 02	
2	FUNC DATA ↓ ▲ ↑	1.OU2	The latest fault operation is displayed.
3	▼ ↓ ▲ ↑	2.OH1	The fault operation before the previous one is displayed.
4	▼ ↓ ▲ ↑	3.OC1	The fault operation before the two previous ones is displayed.
5	▼ ↓ ▲ ↑	4.– – –	The fault operation before the three previous ones is displayed.
6	▼ ↳ ↑	END	

A new fault is stored in the latest location, and the previous records are shifted up, one by one. Oldest faults are deleted.

H03 Data initializing (Data reset)

H 0 3

Setting   0: Function stop
               1: Initialize to factory defaults
This function restores (initializes) the factory data settings and writes over changes made by the user.

Press the STOP and ▲ keys <u>simultaneously</u> to change the setting to "1," then press the FUNC DATA key to initialize the settings. After initialization is complete, the parameter setting automatically returns to "0."

H04 Auto-reset (Times)

H05 Auto-reset (Reset interval)

When a fault is activated, operation of the drive protective function is canceled and the drive automatically restarts and no alarm occurs.

H 0 4

Setting range: 0 to 10 (0: retry inactive)
Sets the number of fault resets attempted.

H 0 5

Setting range: 2 to 20 seconds
Sets the wait time from activation of a fault to resetting.

Drive faults that can be "auto-reset" are:

OC1, OC2, OC3	Overcurrent
OU1, OU2, OU3	Overvoltage
OH1	Overheated heat sink
dbH	Overheated damping resistor
OL1	Overloaded motor 1
OL2	Overloaded motor 2
OLU	Overloaded drive

When the value of H04, Auto-reset (Times) is set from 1 to 10, retry operation starts and the time set in H05, "Reset interval" elapses, the drive start command is automatically input. If the cause of the alarm has been removed, the drive starts without entering the alarm mode. If the cause of the alarm remains, the fault is activated again to wait for the time set at H05 "Retry (Times)." If the cause of the alarm is not removed after the number of repetition cycles set at H04 "Retry (Reset interval)," the drive enters the alarm mode.

WARNING

If the Auto-restart function has been selected, the drive may automatically restart. (The machine should be designed so that human safety is ensured after restarting. **Otherwise, an accident could occur.**)

Upon success of retry
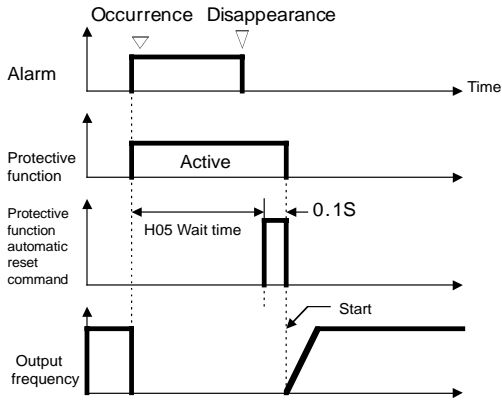
Upon failure of retry
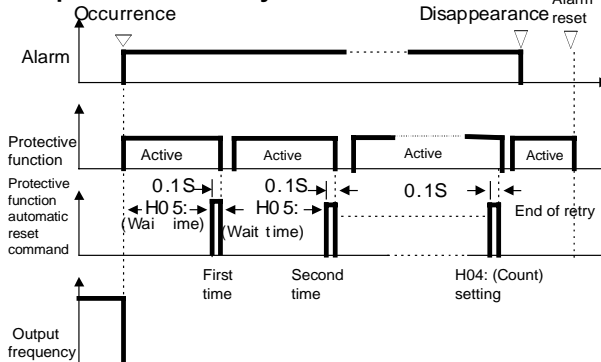
H06 Fan stop operation

H 0 6

Setting   0: On/off control disabled
              1: On/off control enabled

With this function, the temperature of the heat sink is monitored while the drive is turned on, and the cooling fan is automatically turned on and off. If this function is not selected, the cooling fan operates continuously.

H07   ACC/DEC pattern (Mode select)

H 0 7

Setting   0: Inactive
                (linear acceleration/deceleration)
              1: S-curve acceleration/deceleration
                (Weak)
              2: S-curve acceleration/deceleration
                (Strong)
              3: Non-linear (for variable torque)

Selects the acceleration/deceleration ramp shape.

When the function is set at "1", "2" or "3," a change in the acceleration or deceleration time is not reflected immediately. The setting becomes effective only after a constant speed is reached or the drive is stopped.

Note: 1and 2 [S-curve acceleration/deceleration]

To reduce shock to the mechanical system, the change in the output frequency is made smooth when the reference is changed.

<Constant of each pattern>
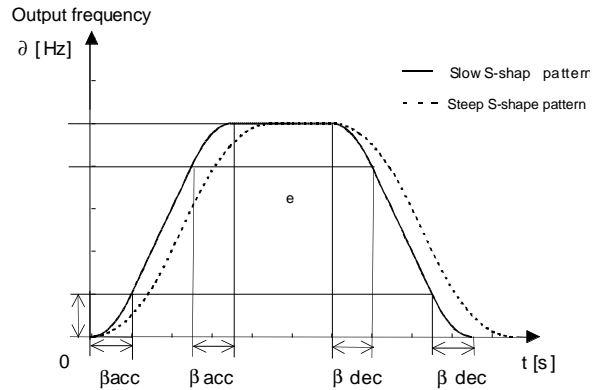
	H07=1 (Slow S-Curve Pattern)	H07=2 (Steep S-Curve Pattern)
Range of S-curve(∂)	0.05 x (Maximum output frequency [Hz])	0.10 x (Maximum output frequency [Hz])
S-curve time during acceleration (ß acc)	0.10 x (Acceleration time [s])	0.20 x (Acceleration time [s])
S curve time during deceleration (ß decc)	0.10 x (Deceleration time [s])	0.20 x (Deceleration time [s])

When the acceleration/deceleration time is extremely long or short, the result is linear acceleration/deceleration.

3. [Curved acceleration/deceleration]

This function is used to modify the acceleration/ deceleration curve for a motor operating above base frequency.
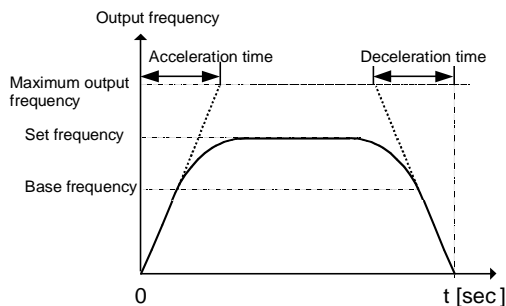
H09　Start mode (Rotating motor pickup)

`H` `0` `9`

This function smoothly starts a coasting motor after a momentary power failure.

The speed of the motor is detected upon power recovery and that same frequency is applied to the motor. Therefore, the motor starts smoothly without a shock. However, when the coasting speed of the motor exceeds the setting of F03 "Maximum frequency 1" or of F15 "Frequency limiter (High)," the normal starting method is used.

Setting	Regular Starting	Restarting After Momentary Power Failure
0	Inactive	Inactive
1	Inactive	Active
2	Active	Active

Description of setting:

1: This function is effective when the value of F14 "Restart after momentary power failure (Operation selection)" is "2" or "3."

Starting is attempted at the same frequency as the rotating motor.

2: Upon restart, after momentary power failure, the speed of the coasting motor is detected and starting is made at the same frequency as that of the coasting motor.

Note: When this function is used, use the following settings to determine the speed of the motor.

1. Set F09 Torque boost to "0" (automatic torque boost).

2. When a non-standard motor is used, or when the wiring length is long, perform P04 Tuning.

H10　Energy-saving operation

`H` `1` `0`

Setting　0: Inactive
　　　　　1: Active

When the output frequency is constant (constant speed operation) and the load is light, and the setting of F09 "Torque boost 1" is other than "0," the output voltage is automatically lowered to minimize the power output.

Notes:

1. Use this function for fans or pumps only. If this function is applied to a constant torque load or to an application with a rapidly changing load, there will be a delay in the control response.

2. The energy-saving operation is automatically canceled during acceleration or deceleration or when the torque limiter function is activated.

H11　Dec mode

`H` `1` `1`

Setting　　　　0: Normal
　　　　　　　　　(Deceleration to stop based on the value of H07 "ACC/DEC pattern")
　　　　　　　　1: Coast-to-stop

This function determines the stopping method of the drive when a Stop command is entered.

Note: This function is not activated when the set frequency is set to zero. The function is activated only when a Stop command is entered.

H12 Instantaneous overcurrent limiting

`H` `1` `2`

Setting　　　　0: Inactive
　　　　　　　　1: Active

An overcurrent trip generally occurs when current flows above the drive protective level, following a rapid change in motor load. The instantaneous overcurrent limiting function controls drive output and prohibits the flow of current exceeding the protective level, even if the load changes.

Since the operation level of the instantaneous overcurrent limiting function cannot be adjusted, the torque limiting function must be used.

Motor generation torque may be reduced when instantaneous overcurrent limiting is applied. Set this function to be inactive for equipment such as elevators, which are adversely affected by reduced motor generation torque, in which case an overcurrent trip occurs when the current flow exceeds the drive protective level. A mechanical brake should be used to ensure safety.

H13 Auto-restart (Restart time)

`H` `1` `3`

Setting range: 0.1 to 5 seconds

Instantaneous switching to another power line (when the power of an operating motor is cut off or power failure occurs) creates a large phase difference between the line voltage and the voltage remaining in the motor, which may cause electrical or mechanical failure. To rapidly switch power lines, set the voltage attenuation time to wait for the voltage remaining in the

motor to decay. This function operates at restart after a momentary power failure.

If the momentary power failure time is shorter than the wait time value, a restart occurs following the wait time. If the power failure time is longer than the wait time value, a restart occurs when the drive is ready to operate (after about 0.2 to 0.5 second).

H14 Auto-restart (frequency fall rate)

H 1 4

Setting range: 0.00, 0.01 to 100.00 Hz/second

 If H14 = 0.00, the frequency is reduced according to the set deceleration time.

This function determines the reduction rate of the output frequency for synchronizing the drive output frequency with the motor speed. This function is also used to reduce the frequency and thereby prevent stalling under a heavy load during normal operation.

Note: A frequency reduction rate that is set too large may temporarily increase the regeneration energy from the load and activate the overvoltage protective function. Conversely, a rate that is too small extends the operation time of the current limiting function and may activate the drive overload protective function.

H20 PID control (mode select)

H 2 0

Set value	0: No operation
	1: Normal operation
	2: Inverse operation

PID control detects the amount of feedback from a sensor and compares it with the target value (e.g., reference temperature). If the values differ, this function produces an output to eliminate the deviation. In other words, this control matches the feedback amount with the target value.

This function can be used for flow control, pressure control, temperature control, and other process controls.
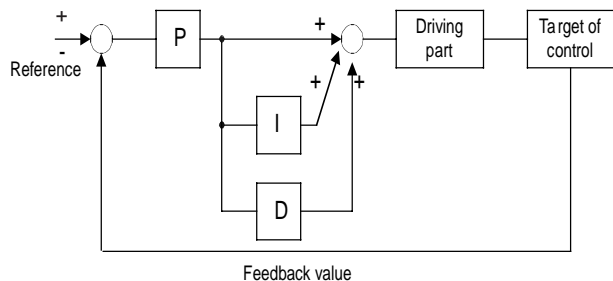
Forward or reverse operations can be selected for PID controller output. This enables motor speed to be faster or slower according to the PID controller output.
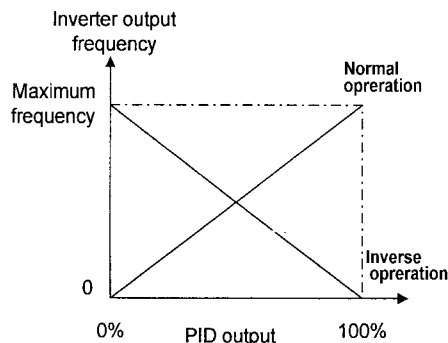
The target value can be entered using F01, Frequency setting 1, or directly from the keypad panel.

For entry from F01, Frequency setting 1, input a signal to the selected terminal. For direct entry from the keypad panel, turn on keypad operation. Select any of the digital Terminals X1 (E01) to X9 (E09) and assign a value of 11 (frequency setting switching).

Note: For the target value and feedback amount, the process amount can be displayed according to the values set in E40 Display coefficient A, and E41 Display coefficient B.
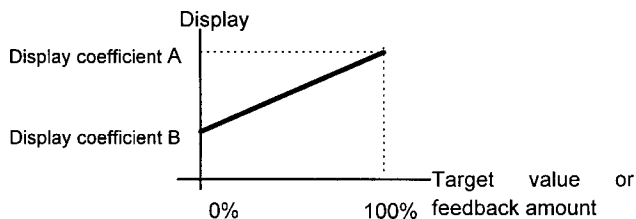
H21 PID control (feedback signal)

H 2 1

This function selects the terminal, direction of operation, and feedback input. Select a value from the table below according to sensor specifications.

Value	Description
0	Terminal 12, forward operation, 0 to 10V voltage input
1	Terminal C1, forward operation, 4 to 20mA current input
2	Terminal 12, reverse operation, 10 to 0V voltage input
3	Terminal C1, reverse operation, 20 to 4mA current input

Only positive values can be input for this feedback amount of PID control. Negative values (e.g., 0 to -10V, -10 to 0V) cannot be input, therefore, the function cannot be used for reverse operation by an analog signal.

Feedback signal setting (H21) must be different from the type of setpoint value.

Feedback value
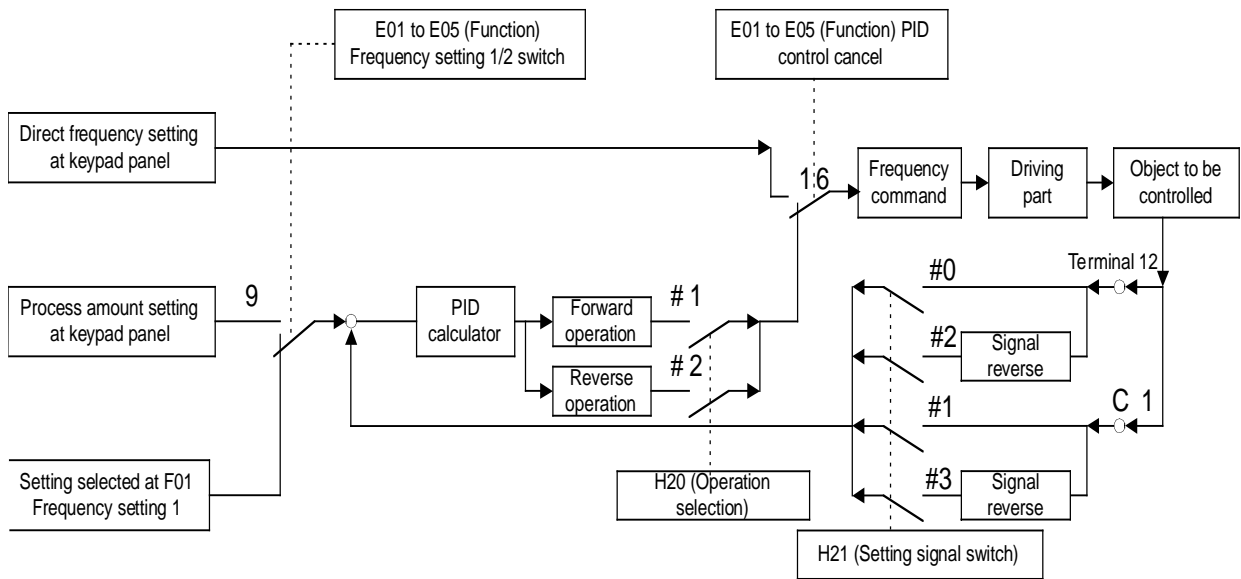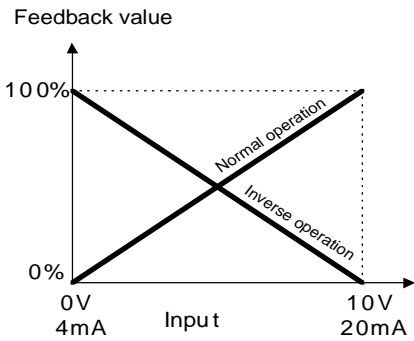
Note: Numbers marked # indicate the feedback options of H21

H22 PID control (P-gain)

These functions are not generally used alone but are combined like **P** control, **PI** control, **PD** control, and **PID** control.

P operation

An operation using an output frequency proportional to deviation is called **P** operation, which outputs an operation amount proportional to deviation, though it cannot eliminate deviation alone.
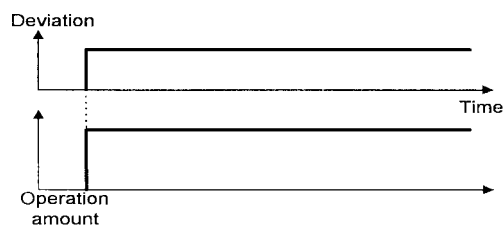
`H 2 2`

Setting range: 0.01 to 10.0 times

P (gain) is the parameter that determines the response

level for the deviation of **P** operation. Although an increase in gain speeds up response, an excessive gain causes vibration, and a decrease in gain delays response.
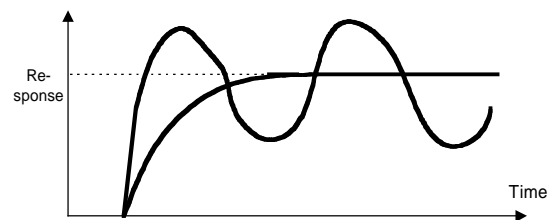
H23 PID control I (integral time)

I operation

An operation where the speed change of the output frequency is proportional to the deviation is called an **I** operation. An **I** operation outputs an operation amount as the integral of deviation and, therefore, has the effect of matching the feedback control amount to the target value (e.g., set frequency), though it deteriorates response for significant changes in deviation.

H 2 3

Setting range: 0.0 (Inactive), 0.1 to 3600 seconds

H23 I-gain is used as a parameter to determine the effect of I operation. A longer integration time delays response and weakens resistance to external elements. A shorter integration time speeds up response, but an integration time that is too short causes vibration.

H24 PID control (D (Differential time)

D operation

An operation where the output frequency is proportional to the deviation differential is called a **D** operation. It outputs an operation amount as the deviation differential and, therefore, is capable of responding to sudden changes.
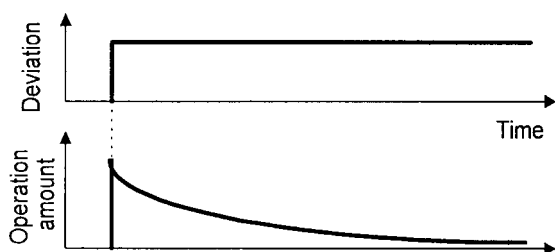
H 2 4

Setting range: 0.00 (Inactive), 0.01 to 10.0 seconds

H24 D-gain is used as a parameter to determine the effect of a **D** operation. A longer differentiation time causes vibration by **P** operation quickly attenuating at the occurrence of deviation. Excessive differentiation time could cause vibration. Shortening the differentiation time reduces attenuation at the occurrence of deviation.

PI control

P operation alone does not remove deviation completely. **P** + **I** control (where **I** operation is added to **P** operation) is normally used to remove the remaining deviation. **PI** control always operates to eliminate deviation, even when the target value is changed or there is a constant disturbance. When **I** operation is strengthened, however, the response for rapidly changing deviation deteriorates. **P** operation can also be used individually for loads containing an integral element.

PD control

If deviation occurs under **PD** control, an output frequency larger than that of **D** operation alone occurs

rapidly and prevents the deviation from expanding. For a small deviation, **P** operation is restricted. When the load contains an integral element, **P** operation alone may allow responses to vibrate due to the effect of the integral element, in which case **PD** control is used to attenuate the vibration of **P** operation and stabilize responses. In other words, this control is applied to loads in processes without a braking function.

PID control

PID control combines the **P** operation, the **I** operation which removes deviation, and the **D** operation which suppresses vibration. This control achieves deviation-free, accurate, and stable responses.

H25 PID control (Feedback filter)

H 2 5

Setting range: 0.0 to 60.0 seconds

This function provides a filter for the feedback signal input at Terminal 12 or C1. The filter makes the operation of the **PID** control system stable. However, an excessively large setting causes a poor response.

H26 PTC thermistor (Mode select)

H 2 6

Setting   0: Inactive
　　　　 1: Active

This function is used for a motor equipped with a PTC thermistor for overtemperature protection.
Connect the PTC thermistor as shown in the following figure. The protective operation is common with the external alarm input. Therefore this protective function operates as the "external alarm."
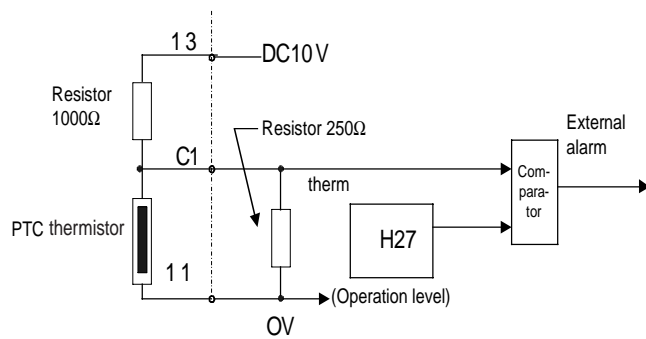
H27   PTC thermistor (Level)

H 2 7

The voltage input at Terminal C1 is compared with the set voltage and, when the input voltage at Terminal C1 is larger than the set voltage (operation level), H26 "PTC thermistor (Operation selection)" activates.
Setting range: 0.00 to 5.00V
(The set values lower than 0.10 are handled as 0.10.)

The alarm temperature is determined by the PTC thermistor and its internal resistance. The thermistor resistance changes greatly at the alarm temperature. Use this characteristic to set the voltage level to be used.
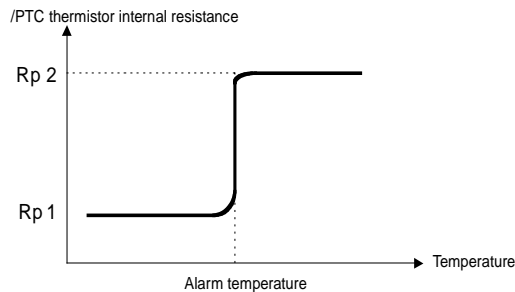
The figure for H26 PTC thermistor (Mode select) shows that a 250 ohm resistor and the thermistor (resistance value Rp) are connected in parallel. Hence, voltage Vc1 at Terminal C1 can be calculated using the following formula:

$$V_{C1} \; \frac{\dfrac{250 \cdot Rp}{250 + Rp}}{1000 + \dfrac{250 \cdot Rp}{250 + Rp}} \times 10 \; [V]$$

The operation level can be set by bringing Rp in the Vc1 calculation formula into the following range.

    $Rp1 < Rp < Rp2$

To calculate Rp, use the following formula:

$$Rp \; \frac{Rp_1 + Rp_2}{2} \; [Ohm]$$

H28 Droop operation

H 2 8

Set value : -9.9Hz to 0.0Hz

When two or more drive motors operate a single machine, a higher load is placed on the motor that is rotating the fastest. Droop operation achieves a good load balance by applying drooping characteristics to speed against load variations.

Calculate the droop amount using the following formula:

$$\text{Droop amount} = \text{Base frequency} \; X$$
$$\frac{\text{Speed droop at rated torque [r/min.]}}{\text{Synchronous speed [r/min.]}} \; [Hz]$$
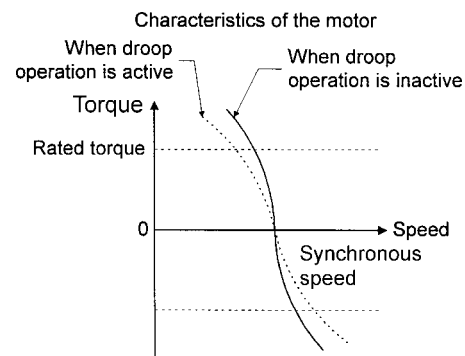
H30   Serial link (Function select)

Setting range: 0 to 3

RS485 Modbus RTU (standard accessory) can be connected as a field bus connection (communication function).

As a field bus function, the following items are possible.

1) Monitoring (monitoring of various data, confirmation of function code data)

2) Frequency setting

3) Operation command (FWD, REV and other commands set for digital input)

4) Function code data writing

The monitor function and function code data writing function are always valid. When the communication is disabled by means of a digital input, a state similar to setting "0" is obtained.

H31　RS485 (address) through

This function sets the various conditions of RS485 communication. It must be set according to the specifications of the host unit. Refer to Section 12 for protocol and other specifications.

The mode of communication can be switched by a digital input. Mode settings are available through the communications link.

Setting	Frequency Setting	Operation Command
0	Invalid	Invalid
1	Valid	Invalid
2	Invalid	Valid
3	Valid	Valid

H	3	1

This function sets the station address of RS485.
Setting range: 0 to 247 (0: Broadcast, 1 to 247 Query)

H32　RS485
　　　　(Mode select on no response error)

H	3	2

This function sets the communication error handling process and the error handling timer value.
Setting range: 0 to 3

Setting	Communication Error Handling Process
0	Immediate Er 8 trip (forced stop)
1	Operation continues until the timer elapses, then Er 8 trip.
2	Operation continues and retry is made until the timer elapses, then Er 8 trip upon a communication error or continued operation if no communication error.
3	Operation continues.

H33　RS485 (Timer)

H	3	3

This function sets the error handling timer value.
Setting range: 0.0 to 60. 0 seconds

H34　RS485 (Baud rate)

H	3	4

This function sets the transmission speed.

Setting	Transmission Speed
0	1 9 2 0 0 bits/second
1	9 6 0 0 bits/second
2	4 8 0 0 bits/second
3	2 4 0 0 bits/second

H35　RS485 (Data length)

H	3	5

This function sets the data length.

Setting	Data Length
0	8 bits

H36　RS485 (Parity check)

H	3	6

This function sets the parity bit.

Setting	Parity Bit
0	None
1	Even
2	Odd

H37　RS485 (Stop bits)

H	3	7

This function sets the stop bit.

Setting	Stop Bit
0	2 bits
1	1 bit

H38　RS485 (No response error detection time)

H	3	8

Setting range:　0 (no detection)
　　　　　　　　1 to 60 seconds

In a system where there is always an access to the station at certain intervals, no access caused by a broken wire or other errors is detected and the drive trips in Er8.

H39　RS485 (Response interval)

H	3	9

Setting range: 0.00 to 1.00 second

This function sets the time taken for a response to be sent back to the host unit after a request.

H40   Maximum temperature of heat sink

The maximum value in each hour is displayed.

H41   Maximum effective current

The maximum value in each hour is displayed.

H42   Main circuit capacitor life

The capacity of the capacitors in the DC Bus is displayed in %. For the measuring conditions, refer to Section 8-2 (1) "Measurement of capacitance of capacitor in main circuit."

H43   Cooling fan operation time

Integral hours is displayed. The displayed time is 0 to 6500, indicating 0 to 65000 hours. (Though the displayed value is in ten hours, the drive adds each hour. Operation shorter than one hour is not counted.)

H44   Drive ROM version

The revision of the software in the drive is displayed.

H45   Keypad panel ROM version

The revision of the software in the keypad panel is displayed.

H46   Option ROM version

For drives with optional equipment, the revision of the optional software is displayed.

A: Alternative motor parameters

A01 Maximum frequency 2

| A | 0 | 1 |

The maximum frequency allowed by the drive for Motor 2. This parameter functions in the same way as F03 "Maximum output frequency 1." For the description, refer to F03 "Maximum output frequency 1."

A02 Base frequency 2

| A | 0 | 2 |

The output frequency in the constant torque zone of Motor 2, that is, the output frequency at the rated output voltage. This parameter functions in the same way as F04 "Base frequency 1." For the description, refer to F04 "Base frequency 1."

A03 Rated voltage 2 (at base frequency 2)

| A | 0 | 3 |

The rated output voltage supplied to Motor 2. This parameter functions in the same way as F05 "Rated voltage 1." For the description, refer to F05 "Rated voltage 1."

A04 Maximum voltage 2 (at maximum frequency 2)

| A | 0 | 4 |

The maximum output voltage of the drive for Motor 2. This parameter functions in the same way as F06 "Maximum voltage 1." For the description, refer to F06 "Maximum voltage 1."

A05 Torque boost 2

| A | 0 | 5 |

The torque boost function of Motor 2. This parameter functions in the same way as F09 "Torque boost 1." For the description, refer to F09 "Torque boost 1."

A06 Electronic thermal overload relay for Motor 2 (Select)
A07 Electronic thermal overload relay for Motor 2 (Level)
A08 Electronic thermal overload relay for Motor 2 (Thermal time constant)

A	0	6
A	0	7
A	0	8

These are the electronic thermal overload relay functions of Motor 2. These parameters function in the same way as F10 through F12 "Electronic thermal overload relay for Motor 1." For the description, refer to F10 through F12.

A09 Torque vector control 2

| A | 0 | 9 |

The torque vector function of Motor 2. This parameter functions in the same way as F42 "Torque vector control 1." For the description, refer to F42 "Torque vector control 1."

A10 Number of motor 2 poles

| A | 1 | 0 |

The number of poles of Motor 2. This parameter functions in the same way as P01 "Number of motor 1 poles." For the description, refer to P01 "Number of motor 1 poles)."

A11 Motor 2 (Capacity)

| A | 1 | 1 |

The capacity of Motor 2. This parameter functions in the same way as P02 "Motor 1 (Capacity)." For the description, refer to P02 "Motor 1 (Capacity)." However, the motor data functions are A12 "Motor 2 (Rated current)," A15 "Motor 2 (No-load current)," A16 "Motor 2 (%R1 setting)" and A17 "Motor 2 (%X setting)."

A12 Motor 2 (Rated current)

| A | 1 | 2 | M | 2 | – | L | R | | | | | |

The rated current of Motor 2. This parameter functions in the same way as P03 "Motor 1 (Rated current)." For the description, refer to P03 "Motor 1(Rated current)."

A13　Motor 2 (Tuning)

`A` `1` `3`

Tuning of Motor 2. This parameter functions in the same way as P04 "Motor 1 (Tuning)." For the description, refer to P04 "Motor 1 (Tuning)."

A14　Motor 2 (Online turning)

`A` `1` `4`

Online tuning of Motor 2. This parameter functions in the same way as P05 "Motor 1 (Online tuning)." For the description, refer to P05 "Motor 1 (Online turning)."

A15　Motor 2 (No-load current)

`A` `1` `5`

The no-load current of Motor 2. This parameter functions in the same way as P06 "Motor 1 (No-load current)." For the description, refer to P06 "Motor 1 (No-load current)."

A16　Motor 2 (%R1 setting)

A17　Motor 2 (%X setting)

`A` `1` `6`
`A` `1` `7`

%R1 and %X of Motor 2. These parameters function in the same way as P07 "Motor 1 (%R1 setting)" and P08 "Motor 1 (%X setting)." For the description, refer to P07 and P08.

A18　Motor 2 (Slip compensation control 2)

`A` `1` `8`

This function sets the slip compensation control of Motor 2. This parameter functions in the same way as P09 "Motor 1 (Slip compensation control 1)." For the description, refer to P09 "Motor 1 (Slip compensation control 1)."

A19　Motor 2 (Slip compensation response time 2)

`A` `1` `9`

This function sets the response time for slip compensation of Motor 2. This parameter functions in the same way as P10 "Motor 1 (Slip compensation response time)." For the description, refer to P10 "Motor 1 (Slip compensation response time)."

Notes

6. Protective Operation

6-1 List of Protective Operations

When an error occurs to the drive, a protective function activates to trip the drive immediately, displaying the name of the alarm on the keypad display, and allowing the motor to coast-to-stop.

Table 6-1-1 List of alarm display and protective operations

Name of Alarm	Display	Description of Operation	
Overcurrent protection	OC1	During acceleration	The protective function activates when an overcurrent flowing in the motor, or a short circuit or ground fault in the output circuit, causes the instantaneous drive output current to exceed the overcurrent detection level.
	OC2	During deceleration	
	OC3	During constant speed operation	
Overvoltage protection	OU1	During acceleration	The protective function activates when the regenerative power from the motor increases to cause the DC link voltage of the main circuit to exceed the overvoltage detection level (400 VDC for 230V input, 800 VDC for 460V input). When an excessive voltage is added to the source voltage, the drive trips due to the overvoltage, but drive protection against the overvoltage is not practical.
	OU2	During deceleration	
	OU3	During constant speed operation	
Undervoltage protection	LU	The protective function activates when the source voltage drops causing the DC link voltage in the main circuit to become lower than the undervoltage detection level (200 VDC for 230V input, 400 VDC for 460V input). If F14 "Restart after momentary power failure" has been selected, no alarm display is given. If the voltage drops below the control power maintenance level, no alarm is displayed.	
Input phase loss protection	Lin	If Input power L1/R, L2/S, L3/T has any phase of the 3 phase power "OPEN" or if there is a significant disparity between the phases, the rectifying diodes or smoothing capacitors may be damaged. An alarm is displayed and the protective function activates.	
Heat sink overheat	OH1	The protective function activates when the temperature of the heat sink of the drive is high.	
External alarm input	OH2	The protective function activates by a contact signal from an alarm contact of an external device such as the braking unit, braking resistor, or external thermal overload relay connected to the control circuit Terminal (THR). Or an overheat protective function is activated by the PTC thermistor.	
Braking resistor overheat	dbH	If the electronic thermal overload relay (for the braking resistor) has been selected by Function Code F13, the protective function activates upon a high operation frequency of the braking resistor to prevent the resistor from being burned due to the temperature rise.	
Motor 1 overload	OL1	If electronic thermal overload relay 1 has been selected by Function Code F10, the protective function activates when motor current exceeds the set operation level.	
Motor 2 overload	OL2	If Motor 2 has been selected and is running, and electronic thermal overload relay 2 has been selected by Function Code A06, the protective function activates when the current in Motor 2 exceeds the set operation level.	
Drive overload	OLU	The protective function activates when an output current exceeds the overload current rating to protect the semiconductor elements in the main circuit of the drive from high temperatures.	
Memory error	Er1	The protective function activates by a data writing error or other errors in the memory.	
Keypad panel communication error	Er2	The protective function activates when a data transmission error or transmission stoppage is detected between the keypad panel and the control section in the keypad panel operation mode.	
CPU error	Er3	The protective function activates by electric noise or other errors developed in the CPU.	
Option error	Er4	Error during operation of an option.	
	Er5		
Operating error	Er6	Detects drive operating procedure error during drive startup. FWD or REV connected to Terminal CM when main power is applied to the drive (F02 setting 3 or 4). Stop key on keypad is pressed in terminal operation (F02 setting 1 or 3).	
Output phase loss	Er7	The protective function activates during auto tuning when there is a broken wire or no connection in the drive output circuit.	
RS485 communication error	Er8	The protective function activates when a communication error occurs during communication through RS485.	

6-2   Alarm Reset

If the drive trips, remove the cause, then press the PRG/RESET key on the keypad panel or input a reset command from the RST control terminal to reset the tripped state. Because the reset command activats by an edge, supply the command in an OFF - ON - OFF sequence as shown in Fig. 6-2-1.

When resetting the tripped state, deactivate the operation command. If the operation command is left turned on, the drive will start immediately after the error is reset.
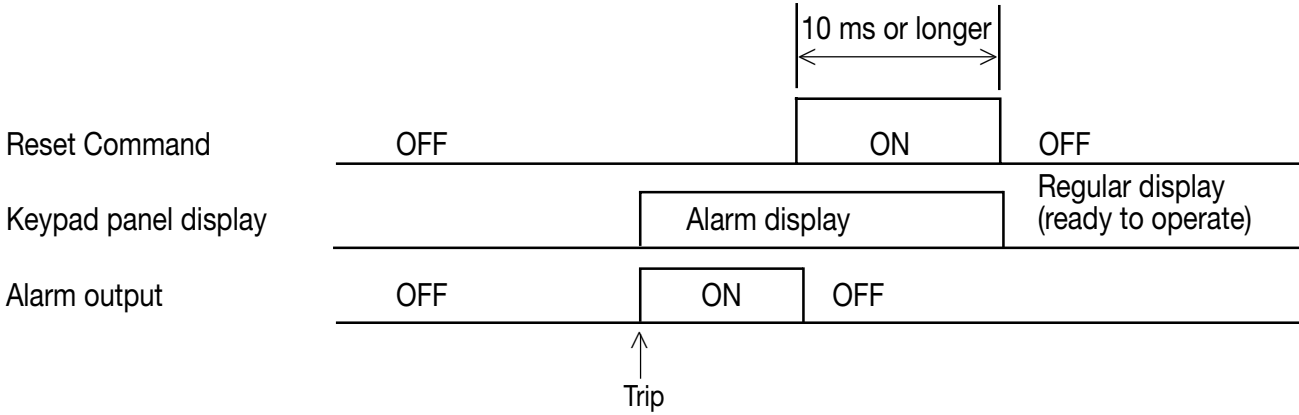
Figure 6-2-1

DANGER

If an alarm reset is made with the operation signal turned on, a sudden start will occur. Check that the operation signal is turned off in advance. **Otherwise, an accident could occur.**

---

7. Troubleshooting

7.1 Protective function activation

(1) Overcurrent

```
┌──────────────────┐   ┌──────────────────┐   ┌──────────────────┐
│ Overcurrent during│   │ Overcurrent during│   │ Overcurrent running at│
│ acceleration OC1 │   │ deceleration OC2 │   │ constant speed OC3│
└──────────────────┘   └──────────────────┘   └──────────────────┘
```

┌──────────────────────┐
│ Remove the short-circuit │ YES   Are the motor connecting terminals (U, V, W) short-circuited or grounded?
│ and ground fault.   │ ◄────
└──────────────────────┘
                            NO   NO   NO

┌──────────────────────────┐
│ Reduce the load or increase │ YES   Is the load excessive?
│ the drive capacity.   │ ◄────
└──────────────────────────┘
                            NO   NO

NO   Can the torque boost   NO   Torque boost
     be reduced?   ◄── correct?

        YES   YES

┌────────────────────┐
│ Reduce the torque boost. │   Is the acceleration time
└────────────────────┘ NO   setting too short
                             compared with the load?

                             YES   NO   Is the deceleration time
                                          setting too short
                                          compared with the load?

┌────────────────────────┐   YES
│ Faulty drive or error due to │   NO   Has the load changed
│ noise. Contact factory.   │ ◄───   suddenly?
└────────────────────────┘
                                                           YES

   YES   Can the acceleration time
         setting be incxreased?

            NO
                 YES   Can the deceleration time
                       setting be increased?

┌──────────────────┐
│ Increase time settings. │ ◄─────
└──────────────────┘   NO

┌──────────────────────┐ ┌──────────────────┐ ┌──────────────────────┐
│ Reduce the load or increase │ │ The braking method │ │ Reduce the load or increase │
│ the drive capacity.   │ │ requires inspection. │ │ the drive capacity.   │
└──────────────────────┘ │ Contact factory. │ └──────────────────────┘
                              └──────────────────┘

(2) Overvoltage

```
┌─────────────────┐  ┌─────────────────┐  ┌─────────────────┐
│ Overvoltage     │  │ Overvoltage     │  │ Overvoltage     │
│ during          │  │ during          │  │ running at      │
│ acceleration OU1│  │ deceleration OU2│  │ constant speed  │
│                 │  │                 │  │ OU3             │
└─────────────────┘  └─────────────────┘  └─────────────────┘
```

Reduce the supply voltage to less than the specified upper limit. ◄── NO ── Is the power supply voltage within the specified value?

YES   YES   YES

Does OU activate when the load is suddenly removed? ── YES

NO   NO   NO

Faulty drive or error due to noise. Contact factory. ◄── NO ── Does the main circuit DC link voltage exceed the protection level?

YES   YES   YES

Check if the operation is possible after sudden acceleration. ── NO ──► (Faulty drive or error due to noise. Contact factory.)

Can the deceleration time be increased? ── YES

NO   NO

YES   YES

Can the acceleration time be increased? ──── YES ────► Increase.

NO

Reduce. ◄── YES ── Can the amount of load inertia be reduced?

NO   NO   NO

Is the braking device or DC control function in use? ── NO ──► Consider using a braking system or DC brake function.

YES   YES   YES

Review the braking method. Contact factory.

(3) Undervoltage

```
┌──────────────┐
│ Undervoltage │
│ LU           │
└──────────────┘
```

Has a momentary power failure occurred? ── YES ──► Reset and restart operation.

NO

Faulty parts or loose connection in the power circuit? ── YES ──► Replace the faulty part and repair the connection.

NO

Is the power supply voltage within the specified value? ── YES ──► Is there a load requiring a large starting current within the same power distribution group? ── NO ──► Does LU activate when the circuit breaker or magnetic contactor is switched on? ── NO ──► Is the main circuit DC voltage (between P-N) higher than the detection level specified in Section 6.1.1?

NO   YES   YES

Faulty drive control circuit or error due to noise, etc. Contact factory.

Modify power distribution system to satisfy the specified value.

Is power transformer capacity adequate? ── YES ──► The drive may be faulty. Contact factory.

**(4) Overheating
of heat sink**

```
┌─────────────────────┐
│  Overheating at     │
│  heatsink OH1       │
└─────────────────────┘
          ┊
┌─────────────────────┐
│ Check the temperature of the │
│ heat sink using the alarm    │
│ information displayed on the │
│ keypad panel. (H40)          │
└─────────────────────┘
          │
```

Does the heat sink temperature indicate -10°C or lower? → **YES** → Increase ambient temperature.

NO

Is the load excessive? → **YES** → Reduce the load.

NO

Is the cooling fan rotating? → **NO** → Replace the cooling fan.

YES

Is the cooling air passage blocked? → **YES** → Remove obstacles.

NO

Is the ambient temperature within the specified value? → **YES** → Faulty drive or error due to noise, etc. Contact factory.

NO

Arrange peripheral conditions to meet the specified value.

(5) Drive overload and motor overload

```
┌──────────────┐   ┌──────────────┐
│ Drive overload│  │ Motor overload│
│ OLU          │   │ OL1, OL2     │
└──────────────┘   └──────────────┘
```

Do the characteristics of the electronic thermal O/L relay and motor overload match? → **NO** → Connect a thermal O/L relay externally.

YES

Is the electronic thermal O/L relay setting correct? → **NO** → Set to the correct level.

YES

Is the load excessive? → **NO** → Faulty drive or error due to noise, etc. Contact factory.

YES

Reduce the load or increase drive capacity.

(6) External thermal relay tripped

```
┌─────────────────────────┐
│ External thermal relay tripped │
│ OH2                     │
└─────────────────────────┘
```

Is PTC Mode H26 enabled? → **NO** (down)

YES

Is PTC operating? → **YES** → Incorrect motor load or inadequate cooling. Check the motor side.

NO

Is PTC level H27 set correctly? → **NO** → Set to correct value.

YES

Is the external circuit (including constants) regular? → **NO** → Change to regular external circuit.

YES

Faulty drive or error due to noise, etc. Contact factory.

Is data input to the Control Terminals THR-X1 to X9? Are alarm signals from external equipment input to the terminals and the CM? → **NO** → Connect the alarm signal contact.

YES

Is the alarm function of the external equipment operating correctly? → **NO** → Remove the cause of alarm function activation.

YES

Faulty drive or error due to noise, etc. Contact factory.

(7) Memory error Er1,
Keypad panel communication error Er2,
CPU error Er3

(8) Output wiring error

```
Er1, 2, 3 indicated. Abnormal
display or indication goes out.
```

```
Turn the power off then on
again after the CHARGE lamp
(CRG) goes off.
```

Is data displayed on the
LED monitor correctly?

NO

Are the connectors, plugs,
and ICs inserted correctly?
Is there noise generating
source nearby?

YES → Remedy accordingly.

NO

```
Drive may be faulty.
Contact factory.
```

YES

```
Drive is normal.
Continue operation.
```

```
Output wiring error
Er7
```

Did the error occur
during tuning?

YES

NO

Are the braking unit and
braking resistor connected
incorrectly?

YES →
```
Connect
correctly or
replace the
cable.
```

NO

```
Faulty drive or error due
to noise, etc.
Contact factory.
```

Is the U, V, W terminal wiring not
connected or is there an open
circuit?

YES →
```
Connect
correctly or
replace the
cable.
```

NO

The keypad panel
connector is loose.

YES →
```
Secure the
connector.
```

NO

Is connection between
Control Terminals FWD,
REV - CM enabled?

YES →
```
Disable the
connection.
```

NO

```
Faulty drive or error
due to noise, etc.
Contact factory.
```

(9) Input PhaseLoss

```
Input phase loss
Lin
```

Are all main circuit power supply
Terminals L1/R, L2/S and L3/T
connected to the power supply?

NO →
```
Connect all three
phases.
```

YES

Are there loose screws on
the terminal block?

YES →
```
Tighten the screws on
the terminal block.
```

NO

Is there a significant
unbalanced voltage
between phases?

YES →
```
Faulty drive or error
due to noise, etc.
Contact factory.
```

NO

```
Faulty drive or error
due to noise, etc.
Contact factory.
```

7.2 Abnormal motor rotation

(1) If motor does not rotate

```
Motor does not rotate.  ─┬─  Charge lamp (CRG) lights and LCD monitor lights up?  ─NO→  Are the circuit breaker and magnetic contactor on the power supply side switched on?  ─NO→  Turn on.
```

Remove the cause of alarm function activation and reset the alarm, then run the motor. ←YES─ Is the LCD monitor displaying an alarm mode screen?

Are the voltages at the Power Terminals (R/L1, S/L2, T/L3) normal? ─NO→ Check for problems (low voltage, an open phase, a loose connection, poor contact). Remedy accordingly.

Is input method from keypad panel or control terminal? (NO)

Is a jumper or DC reactor connected between terminals P1 and P(+)? ─NO→ Connect.

Drive may be faulty. Contact factory. (YES)

Keypad panel / Control terminals

If no error is detected, continue operation. ←YES─

Does the motor run if FWD or REV is pressed? ─NO→ Was the forward or reverse operation command given? ─NO→ Is external wiring between control circuit Terminals FWD, REV - CM connected correctly? ─YES→ Replace faulty switch or relay.

Press the UP key and set the frequency. ←YES─ Has the frequency been set? ─NO→ Is the external wiring between control Terminals 13, 12, 11, and C1 or between X1-X9 and CM for the multi-step frequency selection connected correctly? ─NO→ Correct the wiring error.

Does the motor start when the UP key is pressed? (NO)

Set the frequency correctly.

Are the frequency limiter (High) and the frequency setting lower than the starting frequency? (YES) Replace the faulty frequency setting POT, (VR), signal converter, switch, or relay contacts as required.

Are the drive output Terminals (U, V, W) provided with the proper voltage? ─NO→ Drive may be faulty. Contact factory.

Faulty motor. ←NO─ Excessive load? ←YES─ Are the cables to the motor connected correctly? ─NO→ Correct the wiring error.

Is the torque boost set correctly? ─YES→ The load is excessive, resulting in motor lock. Reduce the load and check that the brake is released (if a mechanical brake is used.)

Increase the torque boost. (NO)

Note: Monitor the operation command or frequency setting values, etc., on the LED or LCD monitor after selecting the respective functions.

The motor will not rotate when the following commands are issued.
— An operation command is issued while the coast-to-stop or DC braking command is being inputted.
— Both FWD and REV operation commands are being inputted.

(2) If the motor rotates but the speed does not change

```
┌─────────────────────┐     ╱Is the maximum ╲      YES   ┌──────────────────────┐
│ The motor rotates    │────▶  frequency setting too ──────▶│ Increase the setting. │
│ but the speed does   │     ╲ low?          ╱            └──────────────────────┘
│ not change.          │          │ NO
└─────────────────────┘
```

```
┌──────────────────┐   YES  ╱Is the upper or lower╲
│ Change the setting.│◀──────  frequency limiter
└──────────────────┘        ╲ activated?          ╱
                                  │ NO
```

Set the frequency.

```
                              YES
   ╱Does the speed change when╲   NO
   ╲the UP or DOWN key is pressed?╱
```

Keypad panel operation

```
            Pattern        ╱Which frequency setting ╲
            operation       method is used: keypad panel,
   ╱Is the timer timing╲◀── analog signal, multi-step
   ╲ too long?         ╱    frequency, or UP/DOWN
        │ NO             ╲ control? Is the pattern
                           operation activated?    ╱
```

```
                                    Can the frequency      YES
   ╱Is the pattern operation╲    Analog signal ╱setting signal (0 to 10 V,╲──
   ╲ competed?              ╱                   ╲4 to 20 mA) be changed?   ╱
        │ NO                                          │ NO
```

```
YES  ╱Are all acceleration and╲
     ╲ deceleration times
        identical?          ╱
            │ NO
```

Multi-step frequency
UP/DOWN

```
   ╱Are the external connections╲  NO  ┌──────────────────┐  NO  ╱Are the external      ╲
   ╲ between X1-X5 and CM       ─────▶│ Correct the       │◀─────  connections between
      correct?                 ╱      │ connection error. │      ╲Control Terminals 13, 12,
        │ YES                         └──────────────────┘         11 and C1 correct?    ╱
                                                                        │ YES
```

```
   ╱Are the frequencies for ╲  NO   ┌──────────────────┐       ┌────────────────────────┐
   ╲ each multi-step         ─────▶│ Change the        │       │ Replace the faulty      │
      frequency different?  ╱      │ frequency setting. │       │ frequency setting POT   │
        │ YES                      └──────────────────┘       │ (VR) or signal          │
                                                               │ converter as required.  │
                                                               └────────────────────────┘
```

```
┌──────────────────┐  NO   ╱Is the acceleration or ╲
│ Faulty drive or   │◀──────  deceleration time set
│ error due to      │       ╲ too long?             ╱
│ noise, etc.       │            │ YES
│ Contact factory.  │
└──────────────────┘
```

```
       ┌────────────────────────┐
       │ Change the time setting to│
       │ conform to load values.   │
       └────────────────────────┘
```

In the following cases, changing the motor speed will also be restricted.
— Signals are inputted from Control Terminals 12 and C1 when "F01 Frequency command 1" and "C30 Frequency command 2" are set to 3, and there is no significant change in the added value.
— The load is excessive, and the torque limiting and current limiting functions are activated.

(3) If the motor stalls during acceleration

```
┌─────────────────┐      ╱──────────────╲  YES  ┌──────────────────┐
│ The motor stalls │─────▶│ Is the acceleration time├──────▶│ Increase the time. │
│ during           │      │   too short?  │       └──────────────────┘
│ acceleration.    │      ╲──────────────╱
└─────────────────┘              │ NO
                                 ▼
                      ╱──────────────╲  YES   ╱──────────────╲  YES  ┌──────────────────┐
                      │ Is the inertia of the ├──────▶│ Is a special motor used? ├─────▶│ Contact factory. │
                      │ motor or the load excessive?  ╲──────────────╱       └──────────────────┘
                      ╲──────────────╱                     │ NO
                              │ NO                          ▼
                              ▼                    ┌──────────────────┐
┌──────────────────────┐ YES  ╱──────────────╲    │ Reduce the inertia │
│ Use a thicker cable between │◀─────│ Has the motor terminal │    │ of the load or increase the │
│ the drive and the motor or  │      │ voltage dropped?│    │ drive capacity. │
│ shorten the cable length.   │      ╲──────────────╱    └──────────────────┘
└──────────────────────┘              │ NO
                                      ▼
┌──────────────────────┐ YES  ╱──────────────╲
│ Reduce the load torque │◀─────│ Is the load torque │
│ or increase the drive  │      │   excessive?   │
│ capacity.              │      ╲──────────────╱
└──────────────────────┘              │ NO
                                      ▼
                          ╱──────────────╲  YES  ┌──────────────────┐
                          │ Is the torque boost ├──────▶│ Faulty drive or error due │
                          │ set correctly? │       │ to noise, etc. │
                          ╲──────────────╱       │ Contact factory. │
                                  │ NO           └──────────────────┘
                                  ▼
                      ┌──────────────────────┐
                      │ Increase the torque boost. │
                      └──────────────────────┘
```

(4) Excessive heat generation from motor

```
┌─────────────────┐      ╱──────────────╲  YES  ┌──────────────────┐
│ The motor generates │─────▶│ Is the torque boost ├──────▶│ Reduce the torque boost. │
│ abnormal heat.   │      │   excessive?  │       └──────────────────┘
└─────────────────┘      ╲──────────────╱
                                 │ NO
                                 ▼
                      ╱──────────────╲  YES   ┌──────────────────┐
                      │ Has the motor been ├──────▶│ Use a motor exclusive │
                      │ operating continuously at a   │ to the drive. │
                      │ very low speed? │       └──────────────────┘
                      ╲──────────────╱
                              │ NO
                              ▼
                      ╱──────────────╲  YES   ┌──────────────────┐
                      │ Is the load excessive? ├──────▶│ Reduce the load or increase │
                      ╲──────────────╱       │ motor capacity. │
                              │ NO           └──────────────────┘
                              ▼
                      ╱──────────────╲  YES   ┌──────────────────┐
                      │ Is the drive output voltage. ├──────▶│ Faulty motor. │
                      │ Terminals (U, V, W) │       └──────────────────┘
                      │ balanced? │
                      ╲──────────────╱
                              │ NO
                              ▼
                      ┌──────────────────┐
                      │ Faulty drive or error │
                      │ due to noise, etc. │
                      │ Contact factory. │
                      └──────────────────┘
```

Note: Motor overheating following a higher frequency setting is likely the result of the current wave form. Contact factory.

Notes:

8. Maintenance and Inspection

Perform daily and periodic inspection to avoid trouble and keep the operation reliable.
Take care of the following items.

8.1 Daily Inspection

Visually inspect the drive from the
outside without removing drive covers while the drive operates or while it is turned on.

1. Check if the expected performance (satisfying the standard specification) is obtained.

2. Check if the surrounding environment satisfies the standard specification.

3 Check that the display of the keypad panel is free from errors.

4. Check for abnormal noise, excessive vibration and unpleasant odors.

5. Check for traces of overheating, discoloration and other defects.

8.2 Periodic Inspection

After stopping the operation, turn the power off and remove the front cover to perform periodic inspections.

The smoothing capacitor at the DC section of the main circuit takes time to discharge after the power is turned off. After checking that the charge lamp (CRG) is not lit, check that the DC voltage is lower than the safety level (25 VDC) using a multimeter or equivalent before starting work.

DANGER

Turn the power off and wait for at least five minutes before starting inspection. (Further, check that the charge lamp is not lit. Measure the DC voltage across the P (+) and N (-) terminals to check that it is lower than 25V.) **Otherwise, electric shock could occur.**

Maintenance and inspection and parts replacement should be made only by qualified persons. Take off the watch, rings and other metallic objects before starting work. Use insulated tools.

**Otherwise, electric shock
or injuries could occur.**

Table 8-2-1 List of periodic inspection

Check part	Check item	How to inspect	Evaluation criteria
Environment	1) Check the ambient temperature, humidity, vibration and atmosphere (dust, gas, oil mist, water drops).	1) Check visually or measure using instruments.	1) The standard specification must be satisfied.
	2) Check if tools or other foreign matter or dangerous objects are left around the equipment.	2) Visual inspection	2) Remove foreign and dangerous objects.
Voltage	Check if the voltages of the main circuit and control circuit are correct.	Measure using a multimeter.	The standard specification must be satisfied.
Keypad panel	1) Check if the display is clear. 2) Check if there are missing parts in the characters.	1), 2) Visual inspection	1, 2) The display can be read and there is no fault.
Structure such as frame and cover	1) Abnormal noise and excessive vibration 2) Loose bolts (tightened parts) 3) Deformation and breakage 4) Discoloration and deformation caused by overheat 5) Stains and dust	1) Visual or hearing inspection 2) Retighten 3), 4), 5) Visual inspection	1),2),3),4),5) No abnormalities

Main Circuit	Common	1) Check if bolts and screws are tight and not missing. 2) Check the devices and insulators for deformation, cracks, breakage and discoloration caused by excessive heat or deterioration. 3) Check for stains and dust.	1) Retighten. 2), 3) Visual inspection	1), 2), 3) No abnormalities
	Conductor and wire	1) Check the conductor for discoloration and distortion caused by excessive heat. 2) Check the sheath of the cable for cracks and discoloration.	1), 2) Visual inspection	1), 2) No abnormalities
	Terminal block	Damage	Visual inspection	No abnormalities
	Smoothing capacitor	1) Check for electrolyte leakage, discoloration, cracks and swelling of the case. 2) Check for safety valve protrusion. 3) Measure the capacitance.	1), 2) Visual inspection 3) Monitor H42 Life judgement and measure with capacitance probe.	1), 2) No abnormalities 3) Capacitance ÅÜ (Initial value) x 0.85
Main Circuit	Resistor	1) Check for odor caused by overheating. 2) Check for broken wire.	1) Smelling and visual inspection 2) Visual inspection or measurement with a multimeter with one lead disconnected	1) No abnormalities 2) Within ± 10% of displayed resistance
	Transformer	Check for abnormal buzzing noise and odor.	Hearing, visual and smelling inspection	No abnormalities
	Relay	1) Check for chatters during operation. 2) Check for rough contacts.	1) Hearing inspection 2) Visual inspection	1),2) No abnormalities
Control circuit	Control printed circuit board, connector	1) Check for loose screws and connectors. 2) Check for odor and discoloration. 3) Check for cracks, breakage, deformation and rust. 4) Check the capacitors for electrolyte leaks and deformation.	1) Retighten. 2) Smelling and visual inspection 3), 4) Visual inspection	1),2),3),4) No abnormalities
Cooling system	Cooling fan	1) Check for abnormal noise and excessive vibration. 2) Check for loose bolts. 3) Check for discoloration caused by overheat.	1) Hearing and visual inspection, or turn manually (be sure to turn the power off). 2) Retighten. 3) Visual inspection 4) Life judgement based on maintenance data*	1) Smooth rotation 2),3) No abnormalities
	Ventilation path	Check the heat sink, intake and exhaust ports for clogging and foreign matter.	Visual inspection	No abnormalities

Remarks: Remove dirt using a cleaning cloth which is chemically neutral. Use a vacuum cleaner to remove dust.

Judgement of life using maintenance data

The maintenance data of Function Codes H42 and H43 can be used to display data for the judgement of the capacitance of the capacitor in the main circuit and the life of the cooling fan to obtain a measure for the judgement of parts replacement. The capacitor life forecast signal is issued at the Y1 and Y2 terminals according to the measured capacitance after the capacitance of the capacity reaches 85%.

(1) Measurement of capacitance of capacitor in main circuit

This drive is provided with a function where the capacitance of the main circuit capacitor is automatically measured upon shutoff of the drive under certain conditions, and it is displayed on the keypad panel upon power-up.

The capacitance of the capacitor is displayed in the reduction ratio (% display) of the initial value stored inside the drive before shipment.

Procedure of measuring capacitor capacitance

1. Remove the optional card (if installed) from the drive. Disconnect the braking unit or direct current bus to another drive from the P (+) and N (-) terminals of the main circuit, if applicable. The power factor improving reactor (DC reactor) need not be disconnected.

2. Turn the digital inputs (FWD, REV, X1-X5) off at the control terminals. Disconnect the RS485 communication terminal, if it is connected.

3. Turn the main power supply on. Check that the cooling fan rotates. Check that the drive is stopped. (The "OH2 external alarm" caused by deactivated digital input terminals does not cause a problem.)

4. Turn the main power supply off.

5. After the charge lamp turns off completely, turn the main power supply on again.

6. Monitor Function Code H42 to check the capacitor capacitance (%).

(2) Life of cooling fan

Function Code H43 indicates the total operation time of the cooling fan. The time is integrated in units of an hour and fractions shorter than an hour are ignored.

The actual life of the fan is largely affected by the temperature. Take the time as a measure.

Table 8-2-2 Measure for judgement of life based on maintenance data

Part	Judgement Level
Main Circuit capacitor	85% or lower of the initial value
Cooling fan	30,000 hours (5 HP or less), 25,000 hours (7-1/2 HP or more)*1

*1: Assumed life of cooling fan at ambient drive temperature of 40°C

8.3 Measurement of Electrical Amounts in Main Circuit

Because the voltage and current of the power supply (input) of the main circuit of the drive and the output (motor) include harmonic components, the indicated value varies according to the type of the meter. Use meters indicated in Table 8-3-1 when measuring with meters for commercial frequencies.

Marketed power factor meters measuring phase difference between the voltage and current cannot measure the power factor. To obtain the power factor, measure the power, voltage and current on each of the input and output sides, and calculate power factor using the following formulas.
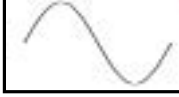
Three-phase input:

$$\text{Power factor} = \frac{\text{Electric power [W]}}{\sqrt{3} \times \text{Voltage [V]} \times \text{Current [A]}} \times 100 \ [\%]$$

Single-phase input:

$$\text{Power factor} = \frac{\text{Electric power [W]}}{\text{Voltage [V]} \times \text{Current [A]}} \times 100 \ [\%]$$

Table 8-3-1 Meters for measurement of main circuit

Item	Input (power supply) side			Output (motor) side			Link Voltage (P(+)-N(-))
	Voltage	Current		Voltage	Current		
Name of meter	Ammeter AR,S,T	Voltmeter VR,S,T	Wattmeter WR,S,T	Ammeter AU,V,W	Voltmeter VU,V,W	Wattmeter WU,V,W	DC voltmeter V
Type of meter	Moving iron type	Rectifier or moving iron type	Digital power meter	Moving iron type	Rectifier type	Digital power meter	Moving coil type
Symbol of meter							

Note) When the output voltage is measured with a rectifier type meter, an error may occur. To increase the accuracy, use a digital AC power meter.
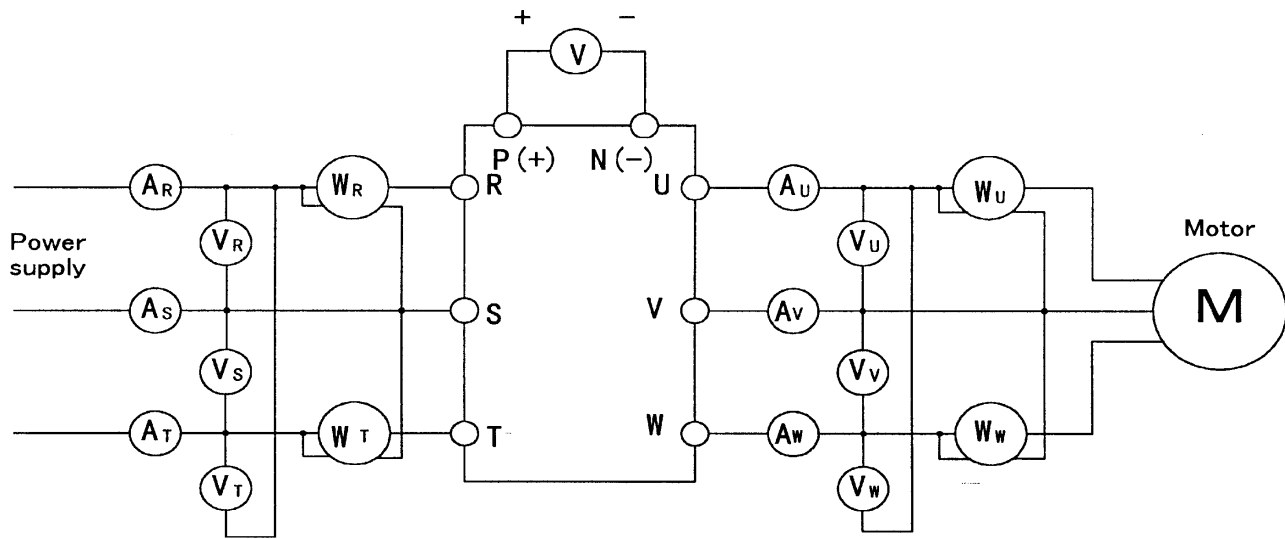
Fig. 8-3-1 Connection of meters

8.4 Insulation Test

Because an insulation test is made at the factory before shipment, avoid a Megger test. If a Megger test is unavoidable, follow the procedure below. Because a wrong test procedure will damage the drive, take sufficient care.

A withstand voltage test will damage the drive similar to the Megger test if the test procedure is wrong. When the withstand voltage test is necessary, contact your distributor or Boston Gear.

(1) Megger test of main circuit

1. Use a 500 VDC Megger and shut off the main power supply during measurement.

2. If the test voltage leaks to the control circuit due to the wiring, disconnect all the control wiring.

3. Connect the main circuit terminals with a common cable as shown in Fig. 8-4-1.

4. The Megger test must be limited to across the common line of the main circuit and the ground terminal ($\oplus$G).

5. 5MΩ or a larger value displayed at the Megger indicates a correct state. (The value is for the drive only.)

(2) Do not perform a Megger test or withstand voltage test to the insulation test control circuit of the control circuit. Prepare a high resistance range tester for the control circuit.

1. Disconnect all the external wiring from the control circuit terminals.

2. Perform a continuity test to the ground. 1 M or a larger measurement indicates a correct state.

(3) External main circuit and sequence control circuit.

Disconnect all the drive terminals so that the test voltage is not applied.

8.5 Replacement Parts

The life of the part is determined by the type of the part. The life of the part varies according to the environment and operating conditions, and replacement according to Table 8-5-1 is recommended.

Name of Part	Standard replacement years	Replacement method and others
Cooling fan	3 years	Replace with a new part
Smoothing capacitor	5 years	Replace with a new part (replace after inspection)
Electrolytic capacitors on printed circuit board	7 years	Replace with a new circuit board (replace after inspection)
Other parts	—	Determine after inspection

Table 8-5-1 Replacement parts
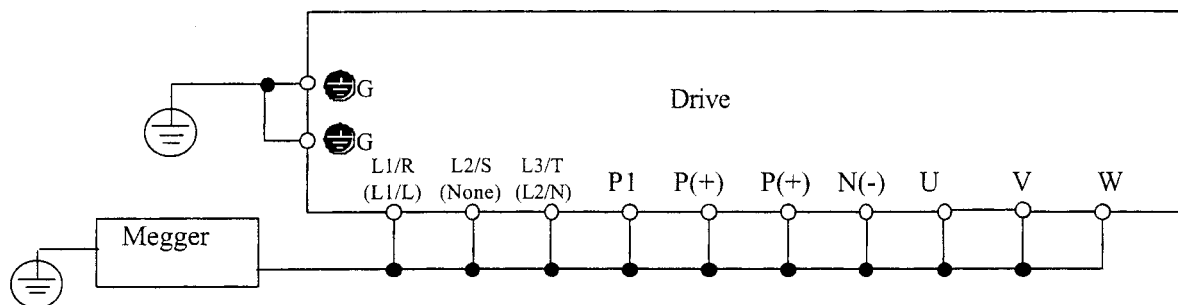
Figure 8-4-1 Megger Test
Symbols in parentheses ( ) are for the single-phase 230V series.

Notes:

9. Warranty, Parts and Service

The purpose of this section is to provide specific instructions to the user of the standard drive referenced in this manual regarding warranty administration and how to obtain assistance on both in-warranty and out-of-warranty equipment.

For all warranty procedures, refer to section 10 of this instruction manual to identify the part or assembly.

If assistance is required to determine warranty status, identify defective parts, or obtain the name of your local distributor, call:

Boston Gear
14 Hayward Street
Quincy, MA 02171   USA
Phone: + 1 800 816 5608 (United States)

Fax: + 1 617 479 6238

("+" indicates the international access code required when calling from outside of the USA.)

WARRANTY COVERAGE

The warranty covers all major parts of the drive such as the main printed circuit boards, transistor modules, etc. The warranty does not cover replacement of fuses or of the entire drive.

"Warranty period is 24 months after shipment from the Company.

However, the guarantee will not apply in the following cases, even if the guarantee term has not expired:

1.   Damage was caused by incorrect use or inappropriate repair or modification.
2.   The product was used in an environment outside the standard specified range.
3.   Damage was caused by dropping the product after purchase or damage occurred during transportation.
4.   Damage was caused by an earthquake, fire, flooding, lightning, abnormal voltage, or other natural calamities and secondary disasters.

Before calling the number at the left to determine warranty status, the drive serial number will be required. This is located on the drive nameplate. If the drive is still under warranty, further information will be required per the "In-Warranty Failure Checklist" shown on page 9-2 of this instruction manual.

OUT-OF WARRANTY PROCEDURES

When the defective part has been identified, contact your local authorized Boston Gear distributor to order replacement parts.

MOTORS

For specific instructions on
your motor, call the distributor from which it was purchased and be prepared to furnish complete nameplate data.

IN-WARRANTY FAILURE CHECKLIST
To assist with warranty troubleshooting, the following information is required. This data is needed to evaluate the cause in an effort to eliminate any further failures.

Model No.: _____

Serial No.: _____

Start-Up Date: _____

Failure Date: _____

Status When Failure Occurred (check one):

Power-Up _____ Running _____ Accel _____ Decel _____

Explanation of Failure _____

Application Information (check Yes or No)

Input Transformer: Yes _____ No _____

If Yes: KVA _____

L1 Volts _____ L2 Volts _____ L3 Volts _____

Power Factor Correction Capacitors: Yes _____ No _____

If Yes: Microfarrad _____

Other Equipment on Same Power Yes _____ No _____

If Yes, what?

Line Reactor on Input Yes _____ No _____

Input Starter Yes _____ No _____

Output Starter Yes _____ No _____

Motor Overloads Yes _____ No _____

Control Terminals Used (circle if used)

30A	30B	Y1	C1	FM	X1	X2	X3	X4	X5	PLC
	30C	Y2	CME	11	12	13	CM	FWD	REV	CM	P24

Function Codes Different From Factory Settings

Function Code	Setting	Function Code	Setting

Failure Message (see Section 4)

Latest Fault _____ Previous Faults: No Message _____

Hz _____ 1. _____

A _____ 2. _____

V _____ 3. _____

After all of the Checklist information is acquired, contact the following number for assistance: 800-816-5608.

10. Replacement Parts

CE20TM (top right header)

Catalog No.	Note	1/8	1/4	1/2	1	2	3	5	7.5	10
230VAC Three phase										
Main Control Card										
6608031		1	1	1	1	1	1	1		
6608032									1	1
CPU PCB										
6608034		1	1	1	1	1	1	1		
TRANSFORMER PCB										
3411288		1	1	1	1	1	1	1		
POWER PCB										
6608039									1	
6608040										1
POWER MODULE										
3301260		1								
3301261			1							
3301262				1						
3301263					1					
3301264						1				
3301265							1			
3301266								1		
3301269	Converter								1	1
3301270	IGBT								1	
3301271	IGBT									1
KEYPAD										
6608038		1	1	1	1	1	1	1	1	1
DC CAPACITOR UNIT										
3402509									1	
3402510										1
FAN										
5101183						1	1			
5101184								1		
5101185									1	1

Replacement Parts (cont.)

Catalog No.	Note	Drive HP & Quantity per drive						
		1/2	1	2	3	5	7.5	10

460VAC Three phase

Main Control Card

Catalog No.	Note	1/2	1	2	3	5	7.5	10
6608032							1	1
6608033"""""B		1	1	1	1	1		

CPU PCB

Catalog No.	Note	1/2	1	2	3	5	7.5	10
6608034		=========-1=====-1================1						
6608035============================-1=====-1								

TRANSFORMER PCB

Catalog No.	Note	1/2	1	2	3	5	7.5	10
3411289		1	1	1	1	1		
3411290								

POWER PCB

Catalog No.	Note	1/2	1	2	3	5	7.5	10
6608036							1	
6608037								1

POWER MODULE

Catalog No.	Note	1/2	1	2	3	5	7.5	10
3301255		1						
3301256			1					
3301257				1				
3301258					1			
3301259						1		
3301267	Converter						1	1
3301268	IGBT						1	1

KEYPAD

Catalog No.	Note	1/2	1	2	3	5	7.5	10
6608038		1	1	1	1	1	1	1

DC CAPACITOR UNIT

Catalog No.	Note	1/2	1	2	3	5	7.5	10
3402509							1	
3402510								1

FAN

Catalog No.	Note	1/2	1	2	3	5	7.5	10
5101183				1	1			
5101184						1		
5101185							1	1

11. Specifications

11.1 Standard Specifications

(1) Three-phase 230V input

Item		Detail Specifications								
Drive HP		1/8	1/4	1/2	1	2	3	5	7.5	10
Nominal applicable motor[1] [HP]		1/8	1/4	1/2	1	2	3	5	7.5	10
Output ratings	Rated capacity[2] [kVA]	0.3	0.6	1.2	2.0	3.2	4.4	6.8	9.9	13.1
	Rated Voltage[3] [V] [13]	Three-phase 200V / 50 Hz, 200V, 220V, 230V / 60 Hz (with AVR[12] function)								
	Rated current [A][4]	0.7	1.4	2.5	4.0	7.0	10.0	16.5	23.5	31.0
		(0.8)	(1.5)	(3)	(5)	(8)	(11)	(17)	(25)	(33)
	Overload current rating	150% of rated output current for 1 minute								
		200% of rated output current for 0.5 second								
	Rated frequency [Hz]	50, 60 Hz								
Input ratings	Number of phases, voltage, frequency	Three-phase 200 to 230 V / 50 to 60 Hz[11]								
	Voltage and frequency fluctuation	Voltage:	+10 to -15%, Voltage unbalance 2% or less[10]							
		Frequency:	+5 to -5%							
	Resistance to instantaneous voltage drop[5]	Operation continues at 165V or higher voltage. When the input voltage drops below 165V, operation continues for 15 ms.								
	Rated input current [A] (With DCR)	0.59	0.94	1.6	3.1	5.7	8.3	14	19.7	26.9
	Rated input current [A] (Without DCR)[9]	1.1	1.8	3.4	6.4	11.1	16.1	25.5	40.8	52.6
	Power requirement[6] [kVA]	0.3	0.4	0.6	1.1	2.0	2.9	4.9	6.9	9.4
Braking	Braking torque[7] [%]	100			70			40		20
	Braking torque[8] [%]	150								
	DC braking	Starting frequency: 0.2 to 60.0 Hz, braking current (0 to 100% in 1% increment), braking time (0.0 to 30.0 seconds)								
Enclosure (IEC60529)		NEMA 1 standard, IP20 chassis optional								
Cooling method		Self-cooling				Fan cooled				
Weight (lbs)		2.4	2.4	2.8	3.1	5.1	5.1	7.9	17.7	17.7

*1 The applicable standard motor refers to a 4-pole standard motor.
*2 The rated capacity is based on a 230V input.
*3 Voltages greater than the source voltage cannot be supplied.
*4 Amperage values in parentheses ( ) are applicable to operation with 3 kHz or lower carrier frequency (F26 = 3 or less). These values also apply when the ambient temperature is below 40°C (104°F).
*5 Tests are performed under standard load conditions (load equivalent of 85% with an applicable standard motor) defined by NEMA.
*6 Data is with a DC reactor (DCR) installed.
*7 Indicates the average braking torque for decelerating and stopping one motor from 60 Hz. Varies according to the efficiency of the motor.
*8 Indicates the value with an external braking resistor (optional).
*9 Calculated on the assumption that the drive is connected to a 500 kVA power supply.
*10 Refer to IEC61800-3 5.2.3.
*11 Safe separation for control interface of the drive is provided when the drive is installed in overvoltage category II (CE Standard). Basic insulation for control interface of the drive is provided when the drive is installed in overvoltage category III (CE Standard).
*12 Automatic voltage regulator. (Function Code F05.)
*13 For single-phase operation, de-rate the drive by 1/2, (e.g., if a 10HP drive is to operate from a single-phase 230V line, use the 5HP column for ratings).

(2) Three-phase 460V input

Item		Detail Specifications						
Drive HP		1/2	1	2	3	5	7.5	10
Nominal applicable motor[1] [HP]		1/2	1	2	3	5	7.5	10
Output ratings	Rated capacity[2] [kVA]	1.2	2.0	2.9	4.4	7.2	10.3	14.3
	Rated Voltage[3] [V]	Three-phase 380,400, 415V / 50 Hz; 380, 400, 440 / 60 Hz (with AVR[12] function)						
	Rated current[4] [A]	1.4	2.1	3.7	5.3	8.7	12	16
		(1.5)	(2.5)	(3.7)	(5.5)	(9)	(13)	(18)
	Overload current rating	150% of rated output current for 1 minute						
		200% of rated output current for 0.5 second						
	Rated frequency [Hz]	50, 60 Hz						
Input ratings	Number of phases, voltage, frequency	Three-phase 380 to 480 V / 50 to 60 Hz[11]						
	Voltage and frequency fluctuation	Voltage:	+10 to -15% Voltage unbalance 2% or less[10]					
		Frequency:	+5 to -5%					
	Resistance to instantaneous voltage drop[5]	Operation continues at 300V or higher voltage. When the input voltage drops below 300V, operation continues for 15 ms.						
	Rated input current [A] (With DCR)	0.82	1.5	2.9	4.2	7.1	10	13.5
	(Without DCR)[9]	1.8	3.5	6.2	9.2	14.9	21.5	27.9
	Power requirement[6] [kVA]	0.3	0.4	0.6	1.1	2.0	2.9	4.9
Braking	Braking torque[7] [%]	70			40		20	
	Braking torque[8] [%]	150						
	DC braking	Starting frequency: 0.2 to 60.0 Hz, braking current (0 to 100% in 1% increment), braking time (0.0 to 30.0 seconds)						
Protective structure (IEC60529)		NEMA 1 standard, IP20 chassis optional						
Cooling method		Self-cooling		Fan cooled				
Weight (lbs)		4.3	4.7	5.1	5.5	7.5	17.7	17.7

*1 The applicable standard motor refers to a 4-pole standard motor.

*2 The rated capacity indicates a 460V input rating.

*3 Voltages greater than the source voltage cannot be output.

*4 Amperage values in parentheses ( ) are applicable to operation with 3 kHz or lower carrier frequencies (F26 = 3 or less). These values also apply when the ambient temperature is below 40°C.

*5 Tests are performed under standard load conditions (load equivalent of 85% with an applicable standard motor) defined by NEMA.

*6 Data is with DC reactor (DCR) installed.

*7 Indicates the average braking torque for decelerating and stopping one motor from 60 Hz. (Varies according to the efficiency of the motor.)

*8 Indicates the value with an external braking resistor (option).

*9 Calculated on assumption that the drive is connected to a 500 kVA power supply.

*10 Refer to IEC61800-3 5.2.3.

*11 Safe separation for control interface of the drive is provided when the drive is installed in overvoltage category II (CE Standard). Basic insulation for control interface of the drive is provided when the drive is installed in overvoltage category III (CE Standard).

*12 Automatic voltage regulator. (FO5)

11.2 Common Specifications

Item			Detail Specifications
Output frequency	Adjustment	Maximum frequency	50 to 400 Hz
		Base frequency	25 to 400 Hz
		Starting frequency	0.1 to 60.0 Hz, Holding time : 0.0 to 10.0 seconds
		Carrier frequency	0.75 to 15 kHz (The carrier frequency may automatically drop to 0.75 kHz to protect the drive.)
	Accuracy		Analog reference: Within ±0.2% (25°, ±10°C)
			Digital reference: Within 0.01% (-10° to +50°C)
	Reference resolution		Analog reference: 1/3000 of maximum output frequency Keypad panel reference: 0.01 Hz (99.99 Hz or lower), 0.1 Hz (100.0 to 400.0 Hz) LAN reference : 1/20000 of maximum frequency (0.003 Hz at 60 Hz, 0.006 Hz at 120 Hz, 0.02 Hz at 400 Hz), or 0.01 Hz (Fixed)
Control	Voltage/freq. Characteristics		Adjustable at base and maximum frequency, with AVR control : 80 to 240V (200V rating),160 to 480V (400V rating)
	Torque boost		Automatic: Automatic torque boost can be selected with a function code setting. Manual: Setting by codes 1 to 31 (Boost for variable torque available)
	Starting torque		200% or above (with dynamic torque vector turned on, during 0.5 Hz operation)
	DC braking		Braking time (0.0 to 30.0 seconds), braking current (0 to 100%), braking starting frequency (0.0 to 60.0 Hz)
	Control method		Sinusoidal PWM (Dynamic torque vector control) with "current vibration suppression function" and "dead time compensation function"
	Operation method		Keypad operation: starting and stopping with RUN and STOP keys. (Keypad panel)
			Digital input signal: forward (reverse) operation, stop command (3-wire operation possible), coast-to-stop command, external alarm, error reset, etc.
			Link operation: RS485 Modbus RTU (Standard) Profibus-DP, Interbus-S, DeviceNet, Modbus Plus, CAN open (Options)

*1 Automatic voltage regulator (FO5).

	Item	Specifications
Control	Frequency reference	Keypad operation: UP key and DOWN key.
		Potentiometer (external potentiometer: 5 k ohms, 1/2 W)
		0 to ± 5 VDC.
		0 to ± 10 VDC.
		4 to 20 mA DC.
		0 to +10 VDC / 0 to 100% speed can be switched externally to +10 to 0 VDC / 0 to 100% speed.
		4 to 20 mA DC/0 to 100% speed can be switched externally to 20 to 4 mA DC/0 to 100% speed.
	(UP/DOWN control)	An external signal can be used to control the UP or DOWN command.
	(Multistep frequency)	Up to 16 different frequencies can be selected by digital input signals.
	(Link operation)	Link operation: RS485 (Standard)
		Profibus-DP, Interbus-S, DeviceNet, Modbus Plus, CAN open (Options)
	Acceleration / deceleration time (Mode select)	Adjustable within 0.01 to 3600 second range. (2 sets of time parameters can be set internally for each acceleration and deceleration.) Linear, S-curve (weak,strong), Non-linear available.
	Frequency limiter	The high and low frequency limits can be set in Hz.
	Bias frequency	Can be set within -400 to 400 Hz range.
	Gain (frequency setting)	Can be set within a 0 to 200% range.
	Jump frequency control	Three jump frequencies and jump width (0 to 30 Hz) can be set.
	Rotating motor pickup (Flying start)	Operation without shock is possible.
	Auto-restart after momentary power failure	The motor speed can be detected after power recovery so that the drive is started at that speed.
	Slip compensation control	The load can be detected for the control of the output frequency. The compensation value can be set in a 0.00 to +15.00 Hz range of the rated frequency.
	Droop operation	The load can be detected for the control of the frequency. The compensation value can be set within a 9.9 to 0.0 Hz range of the rated frequency. (Speed droop characteristics)
	Torque limiter	When the load torque in the driving or braking mode exceeds the setting, the output frequency is adjusted to control the load torque to an almost constant level.
		The limiting torque can be set between 20 to 200% and the driving and braking torque values can be set independently. The second torque limits can also be set.

	Item	Specifications
Control	PID control	This function can control flow rate, pressure, etc. with analog feedback signal.
		The reference and feedback values are displayed in %.
		Reference signal
		Keypad operation UP key and DOWN key. : 0.0 to 100%
		Voltage input (Terminal 12) : 0 to 10 VDC
		Current input (Terminal C1) : 4 to 20 mA DC
		Multistep frequency setting : Setting freq./max. freq. x 100%
		RS485 : Setting freq./max. freq. x 100%
		Feedback signal
		Terminal 12 (0 to +10Vdc or +10 to 0Vdc)
		Terminal C1(4 to 20mAdc or 20 to 4mAdc
	Second motor's setting	The V/f pattern of the second motor can be selected with an external signal.
		The motor constants of the second motor can be set with an external signal.
		The electronic thermal overload relay of the second motor can be internally set for selection with an external signal.
	Energy saving operation	Weak magnetic flux can be set for light loads which allows operation with an increased motor efficiency.
Display	During operation/stop	The keypad panel can be extended. (Optional 5 meter extension cable is available.)
		7-segment LED display items
		• Set frequency • Output frequency
		• Output current • Motor RPM
		• Output voltage • Line speed
		• PID setting/feedback values
		(A soft filter is provided to attenuate the fluctuation in the displayed value.)
		A charge lamp indicates the power supply is energized.
	When setting	The function code and data code are displayed.
	When tripped	[The cause of trip is displayed.]
		• OC1 (overcurrent: during acceleration)
		• OC2 (overcurrent: during deceleration)
		• OC3 (overcurrent: during constant speed operation)
		• OU1 (overvoltage: during acceleration)
		• OU2 (overvoltage: during deceleration)
		• OU3 (overvoltage: during constant speed operation)
		• LU (undervoltage)
		• Lin (input phase loss)
		• dbH (external braking resistor overheated (thermal overload relay))
		• OH1 (overheat: heat sink)
		• OH2 (overheat: external thermal overload relay)
		• OL1 (overload: motor 1)
		• OL2 (overload: motor 2)
		• OLU (overload: drive)
		• Er1 (memory error)
		• Er2 (keypad panel communication error)
		• Er3 (CPU error)
		• Er4 (option error)
		• Er5 (option error)
		• Er6 (operating error)
		• Er7 (output wiring error) (impedance imbalance)
		• Er8 (RS485 communication error)
	During operation, when tripped	The last four records of trip history are stored and displayed.

Overload protection	Drive electronic thermal overload relay
Overvoltage protection	Detects high voltage in the DC link circuit (approx. 400 VDC for 230V class, approx. 800 VDC for 460V class).
Overcurrent protection	The drive is protected against an overcurrent on the output.
Surge protection	The drive is protected against a surge voltage between the power cable of the main line and ground.
Undervoltage protection	Detects voltage level (approx. 200 VDC for 230V class, approx. 400 VDC for 460V class) in the DC link circuit.
Overheat protection	The drive is protected against failure and overload of the cooling fan.
Short-circuit protection	The dri ve is protected against an overcurrent caused by a short-circuit on the output.
Ground fault protection	The drive is protected against an overcurrent caused by ground fault in the output wiring * Detection when starting
Motor protection	Electronic thermal overload relays protect general purpose motors and forced air motors. The thermal time constant can be adjusted from 0.5 to 10.0 minutes. Second electronic thermal overload relay can be provided. (Switched with external signal)
Braking resistor protection	Upon overheating of the braking resistor (external unit), the motor stops.
Stall prevention (simple torque limit)	• When the output current exceeds the setting during acceleration, the speed change is stopped to avoid an overcurrent fault. • When the output current exceeds the setting during constant speed operation, the frequency decreases to maintain constant torque. • When the DC voltage exceeds the limit during deceleration, the speed change stops to avoid an overvoltage fault.
Input phase loss protection	The drive is protected against input voltage phase loss.
Output phase loss protection	An unbalance in the impedance of the output circuit is detected and outputs an alarm. (Error during tuning only)
Auto reset	The number of retries and wait time can be set before an alarm stop.
Installation location	• Indoors • Locations without corrosive gases, flammable gases or dust (degree of pollution: 2) • Locations without direct sunlight
Ambient temperature	-10 to +40°C
Relative humidity	5 to 95% RH (without condensation)
Altitude	1000 meters max. (Atmospheric pressure 86 to 106 kPa)
Vibration	3mm 2 to 9 Hz 9.8m/s^2 9 to 20 Hz 2m/s^2 20 to 55 Hz 1m/s^2 55 to 200 Hz
Storage temperature	-25 to +65°C
Storage humidity	5 to 95% RH (without condensation)

11.3 External Dimensions
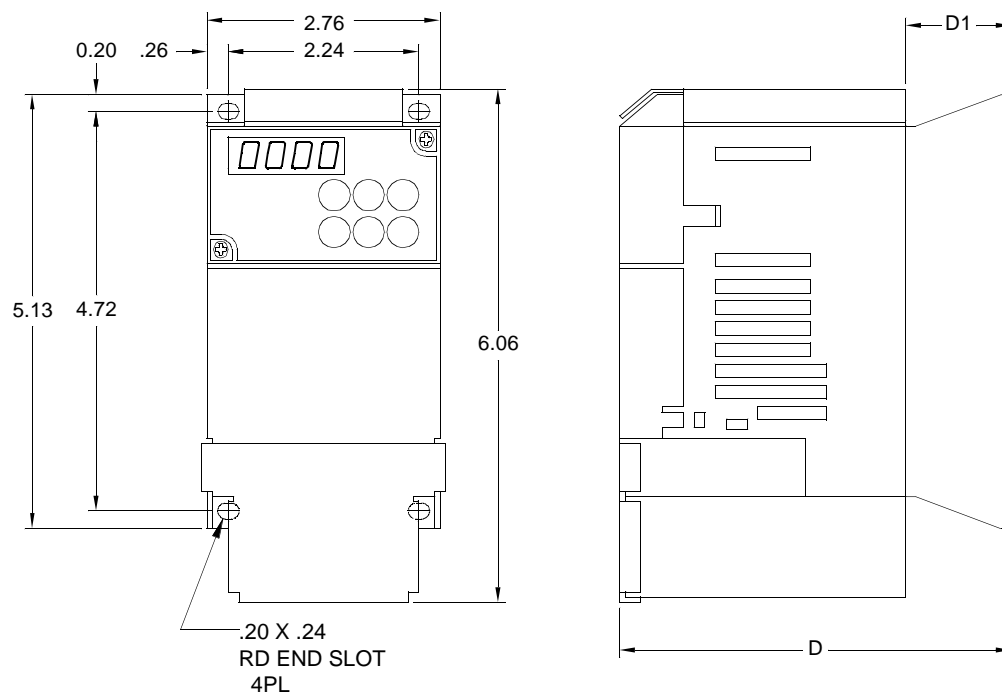
CATALOG NO.	NOMINAL MOTOR HP	D	D1
ACE202V3P0001N1	1/8	3.98	.39
ACE202V3P0002N1	1/4	3.98	.59
ACE202V3P0005N1	1/2	4.65	1.26
ACE202V3P0010N1	1	5.67	2.28

ACE20TM
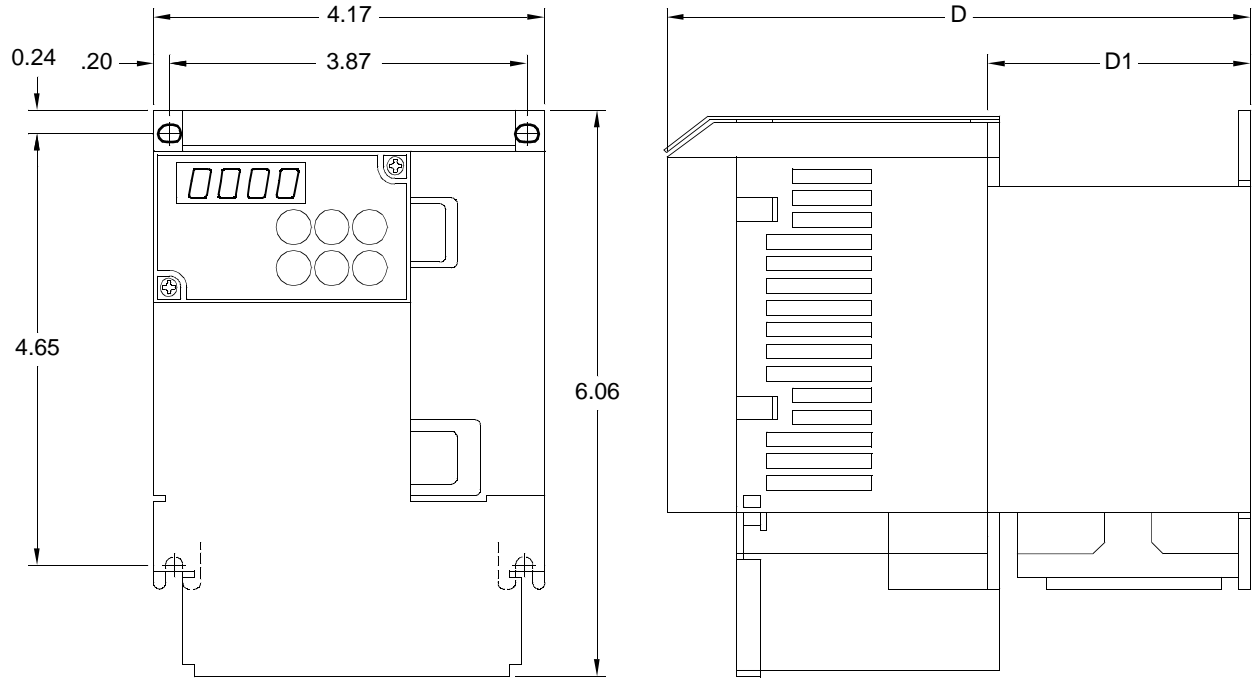
CATALOG NO.	NOMINAL MOTOR HP	D	D1
ACE202V3P0020N1	2	5.91	2.52
ACE202V3P0030N1	3	5.91	2.52
ACE204V3P0005N1	1/2	4.96	1.57
ACE204V3P0010N1	1	5.91	2.52
ACE204V3P0020N1	2	6.69	2.52
ACE204V3P0030N1	3	6.69	2.52

.20 X .24
RD END SLOT
2PL

0.24

0.24

6.69

6.21

6.06

4.65

FULL R

0.24

.20

6.22

2.83
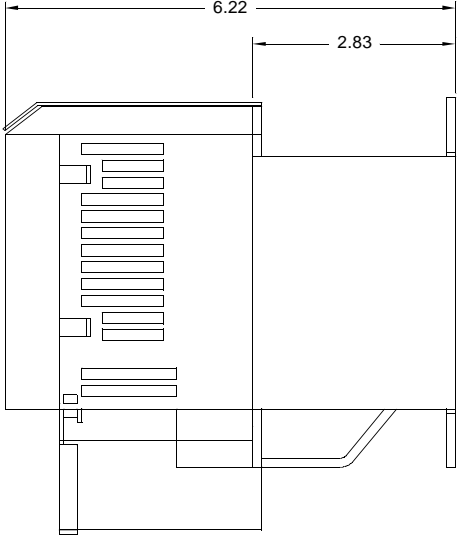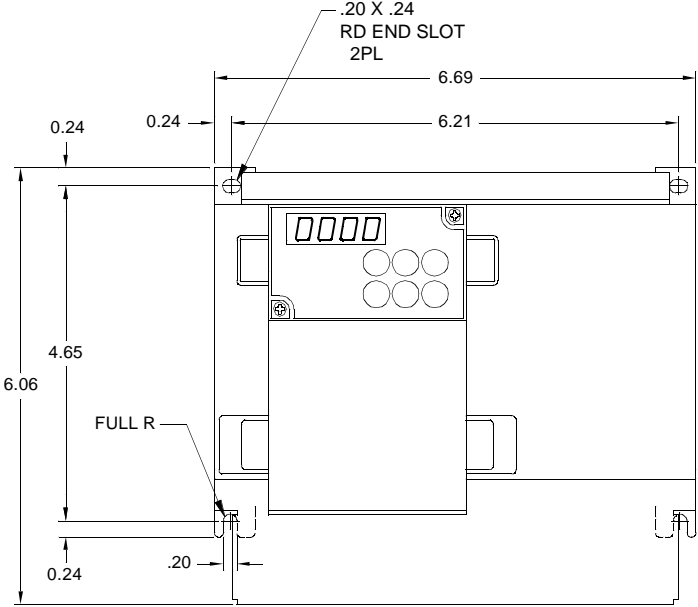
CATALOG NO.	NOMINAL MOTOR HP
ACE202V3P0050N1	5
ACE204V3P0050N1	5
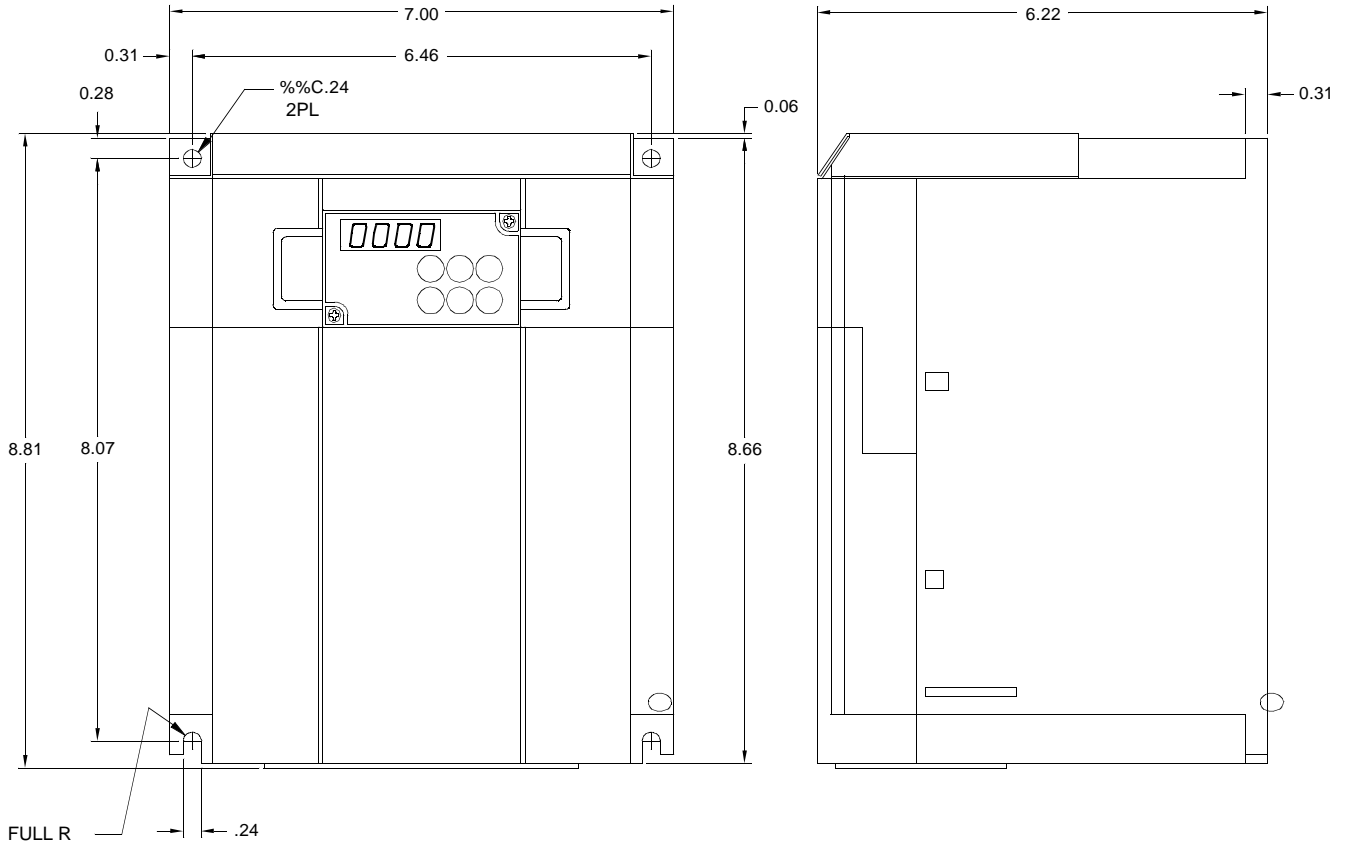
CATALOG NO.	NOMINAL MOTOR HP
ACE202V3P0075N1	7-1/2
ACE202V3P0100N1	10
ACE204V3P0075N1	7-1/2
ACE204V3P0100N1	10

12. RS485 RTU Serial Communication

1. Outline

Modbus RTU protocol is a communication specification established to allow PLC to PLC communication or PLC to slave stations (i.e., drive) using a Modicon PLC.

- Broadcast and Query-Response type of messages are supported.

- A host computer (master) will transmit a query message to the drive. The drive will transmit a response message back to the master that transmitted the query.

- The drive supports RTU – High Density Transmission . The drive does not support RTU – ASCII mode (a standard Modbus protocol transmission mode).

- CRC (Cyclic Redundancy Check) error check is performed to secure data transmission.

2. Communication specification

	Item	Specifications	Remarks
Communication (PC side)			
	Electrical specification	EIA RS485	Corresponds to RS232C with communication level converter
	Transmission distance	500 meters maximum	
	Communication speed	2400, 4800, 9600, 19200 bps	
	Synchronization method	Start - Stop synchronization (UART)	
	Transmission mode	Half duplex	
	Communication configuration	Direct connection to inverters 1 : N (1≤N≤31)	
	Station address	0 : Broadcast 1-247 : Slave stations	Maximum number of stations is 31
	Transmission mode	Supports RTU mode (ASCII mode is not supported)	RTU has a high transmission density. ASCII has a one second timeout before an error occurs.
	Data length	8 bits	Fixed
	Parity/stop bit	No parity Stop bit 2 bits Even number parity Stop bit 1 bit Odd number parity	Stop bit is automatically set according to the selection of parity bit
	Error check method	CRC - 16 method (software)	Created polynominal : $X16+X15+X2+1$
	Transmission protocol	Based on Modicon's Modbus protocol	
	Wire breaking detection time	No response time (time-out) x (# of retries)	Timeout time is software setable. (H39)
	Retry times	Software setting for both physical layer error (parity, framing, overrun) and software error (processing status, check sum)	
Protocol			
	Function code	3: Reading of function	
		6: Writing to single function	
		8: Maintenance code	
		16: Writing to continuous function	
	Data length	2 bytes per register	
	Number of register (preset multiple registers)	16 max.	

3. Connection

3.1 Connection method

Connect the wires between the Control Terminals (DX+, DX-) of the drive and the host unit so as to surely become drawing in one stroke.

Notes:

1) Keep all communication cable lengths to a minimum in order to reduce the effects of EMI noise.
2) An RS485/RS232 converter must be used when connecting to a PLC/Computer that has an RS232C port.
3) Each Modbus RTU station, connected to the wire, must be assigned a unique station address.

Control terminals (only for communication)

Terminal Marking	Terminal Name	Function Description
DX+	RS485 communication data (+)	Input/output terminals for RS485 communication. A maximum number of 31 stations can be connected to the multi-drop network.
DX -	RS485 communication data (-)	

Control terminal arrangement   In detail, refer to the instruction manual of the drive.
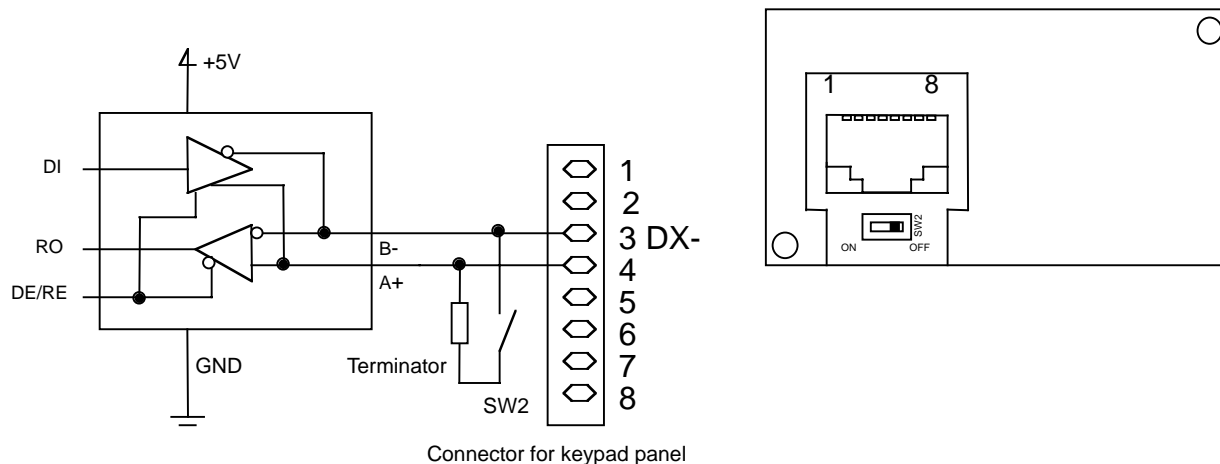
Equivalent circuit of RS485 interface

3.2 RS485 (Host unit interface)

RS485 interface is used when performing multi-drop bidirectional communication. The input/output terminals of the interface only allow a 2-wire connection.

Sort	Description	Example of Terminals
2 - wire connection	Input and output (driver and receiver) are internally connected.	TRD+ Differential input terminal (hot side)
		TRD- Differential output terminal (common side)
		FG Frame ground

3.3 Connector and Communication Cable

Use standard products for the connector, the communication cable and branch adapter.
The following table shows the specification of each of them.

Item	Specification
Connector	RJ45 connector
Cable	Cable complying with EIA568 (for 10BASE-T Straight connection)
	(Max. wiring length: 500m)
Branch adapter	MS8-BA-JJJ (SK KOHKI CO., LTD. or equivalent.)

3.4 Example of connections
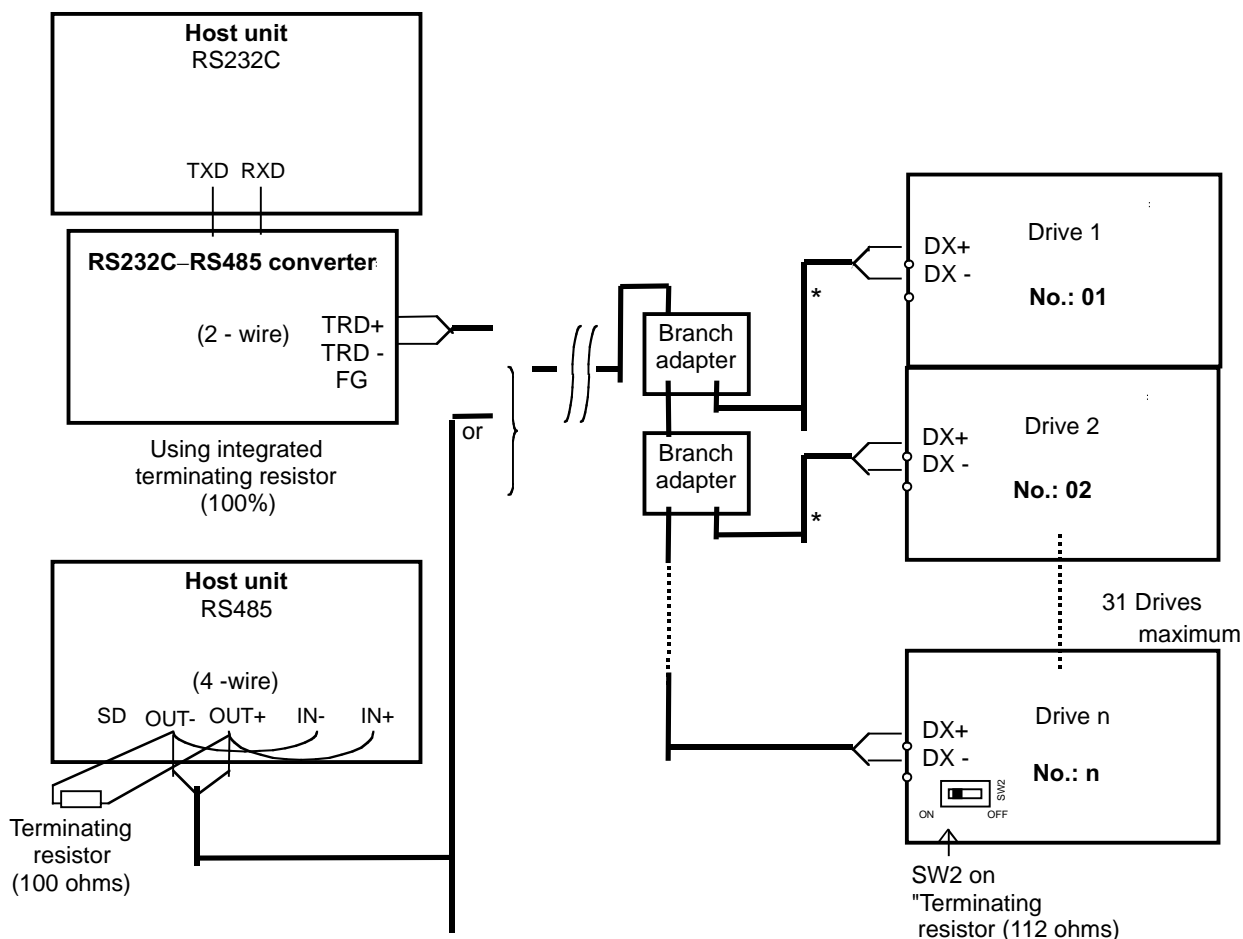
*: As short as possible (3 feet or less)

3.5 Communication level converter

An RS485/RS232 converter must be used when connecting to an RS232C serial interface port.

Use a converter that meets the following criteria.

- Specifications of recommended communication level converter

- Change over method of sending/receiving...........................Automatic changeover by monitoring the sending data on host side (RS232C).

- Isolate .... Shall be isolated from RS485 side.

- Fail safe .... With fail safe function.

- Others .... High noise immunity.

4. Message format

The normal formats to send RTU message are as follows:

1. Query processing

2. Broadcast processing

Master   Query Message

Slave   Response

Query Transaction

Master   Broadcast Message

Slave   (No Response)

Broadcast Transaction
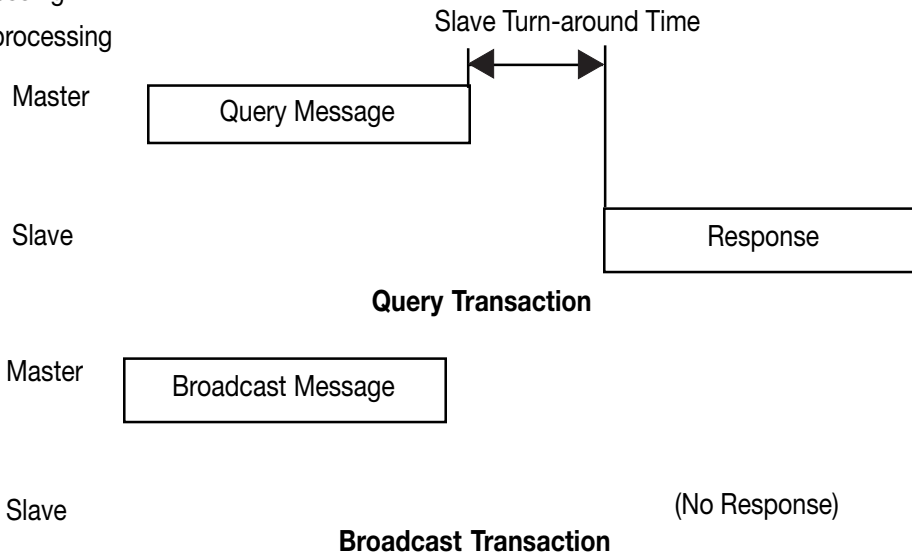
5. Message type

RTU protocol message types consist of the query, normal response, error response and broadcast.

1) Query

    The master transmits a request to a single slave.

2) Normal Response

    The slave performs the requested processing and returns a normal response RTU protocol message to the master in response to the query.

3) Error Response

    The error response is returned to the master if the required function, from the master's query, cannot be performed because of the reasons mentioned later. A message showing the reason why the request cannot be performed is attached to the error message. Note: An error response is not returned when the error is caused by either a CRC error or physical transmission error.

4) Broadcast

    The master sends the message to all slaves using address 0. All slaves will receive the broadcast message and perform the requested function. Because there will be no normal response messages, this process will terminate at the time-out time of the master. The master may then transmit the next outgoing message.

6. Message frame

The following are typical message frames. The details vary with the function code.

1 Byte	1 Byte	37 Bytes Maximum	2 Bytes
Station address	Function code	Information	Error check

6.1 Message field

Station address

0 is reserved for broadcast messages.

1–247 valid station addresses (1 byte in length).

Function Code (FC)

The Function Code is a single byte parameter. The following table shows the function codes used by the drive.

FC: There are two function codes mentioned in this manual. One is the Modbus RTU message function code which will be referred to as "FC." The second is the drive parameter function codes.

FC	Description
0_2	Not used
3	Reading of function
4_5	Not used
6	Writing to single function
7	Not used
8	Maintenance code
9_15	Not used
16	Writing to continuous function (maximum 16 data)
17_127	Not used
128_255	Reserved for exception response

Information

Refer to Section "8. Sort of Messages" (see page 12-9) for detailed specification of the information field for each message type (broadcast, query, normal response and error response).

Error Check

The error check field is 2 bytes length data of CRC - 16 checksum. As for details of CRC - 16 calculation or algorithm, refer to Åg7. CRC - 16Åh.

Since the information field length is variable, the frame length necessary to calculate CRC - 16 code from FC and byte count data. As for byte count, refer to Åg8. Sort of MessageÅh.

6.2 Character format

Each byte of a message is called a character. The character formats are shown below.

A character is configured with a start bit (logic 0), 8-data bits, addition of parity bit (selection) and stop bit (logic1).

Without parity

LSB									MSB	
0	1	2	3	4	5	6	7	8	9	10
Start				Data					Stop	

With Parity

LSB										MSB
0	1	2	3	4	5	6	7	8	9	10
Start				Data					Parity (optional)	Stop

7. CRC - 16

CRC (Cyclic Redundancy Check) is one of the most effective checksum algorithyms used today to verify message data integrity. The transmitting station calculates a CRC and adds the CRC (2 bytes in length) to the last frame. The receiving station also calculates a CRC for the received data and compares the calculated to the received CRC. If the two CRC's agree, then the message is accepted.

The short description of calculating a CRC is as follows.

- The data is converted to polynomial form (for example, 1100 0000 0010 0001Æ$X^{15}+X^{14}+X^5+1$) is divided by a created polynomial (17bitÅF $X^{16}+X^{15}+X^2+1$). CRC is the remainder (16 bits) of this division.

- The quotient is neglected. The remainder is sent as the CRC-16.

- The receiving side divides this message (added CRC) by the created polynomial, and considers the transmission complete and correct when the remainder is 0.

The created polynomial represents the data algebraically with exponent of X such as X^3+X^2+X, instead of description such as a binary code 1101. The created polynomial is allowed any length and any bit patterns, but several standard created polynomials are defined to optimize the error detection. In RTU protocol, the created polynomial (**$X^{16}+X^{15}+X^2+1$**) that is binary 1 1000 0000 0000 0101 is used. In this case the created CRC is known as CRC-16.

7.1 CRC algorithm

- CRC data: This is a single word memory location. Updated during the calculation process and included in the transmission frame as a message checksum.

- The CRC is calculated after the entire message has been loaded into the transmit/sending buffer. The CRC may be calculated as each word of the message is loaded into the transmit/sending buffer to reduce processor overhead and timing.

- The receiving process is the same algorithm as above. But a code used to compare the CRC of sent data and the CRC calculated on receiving side is added.

```
                    START

              Initial setting
           Remainder R ← "FFFF"
         Created polynominal P ← "A001"
           Data length counter n ← 0

      Data lemgth calculation  N ← Data length

                    n==N ?  ──No──
                      │                         │
                     n++                        │
                                                │
           Set sending byte at A=n th position  │
           to lower level byte of word data     │
           Upper level byte is "00"             │
                                                │
                Shift count ← 0                 │
                                                │
                      │ ◄──────────────Yes──────┤
   ─No─  Shift Count==0 ?                        │
     │                │Yes                       │
     │             n==1? ──Yes─                  │
  CRC DATA ←        │No      │                   │
  CRC DATA XOR P  CRC DATA ← │                   │
                  CRC DATA XOR A                 │
                           CRC DATA ← A XOR R    │
                                                │
                Shift count++                    │
                                                │
              Shift count>8 ? ──Yes──────────────┤
                   │No                           │
           CRC data>>1bit shift ──No──           │
                   │                  │          │
           Bit shift carry exists? ───┘          │
                   │────────────────Yes──────────┘

              Add CRC data to the
              last of sending frame

                    END
```

7.2 Calculation example of CRC - 16

Here is an example of a function code = Reading message.
Station address=1_C FC=3_C function code=P49 (0331H = 0817 decimal)_C number of variables to read=20 (Note: max.16 for ACE 20)_C G.P is created polynomial (1010 0000 0000 0001 = A001h)
Note: A variable is a word data type (2 bytes).

Station Address	FC	Function Code		Number of Variables to Read	
01H	03H	03H	31H	00H	14H

N	Process	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
1	Initial data R="FFFF"	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	1st data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	CRC=No.1 Xor No.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
4	Shift>>2 (up to Flag=1)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CRC=No.4 Xor G.P	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
6	Shift>>2	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7	CRC= o.6 Xor G.P	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
8	Shift>>2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
9	CRC=No.8 Xor G.P	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift>>2 (8shift finish)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC=No.10 Xor G.P	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
12	2nd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13	CRC=No.11 Xor No.12	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
14	Shift>>1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
15	CRC=No.14 Xor G.P	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
16	Shift>>1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
17	CRC=No.16 Xor G.P	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
18	Shift>>2	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
19	CRC=No.18 Xor G.P	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
20	Shift>>2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1
21	CRC=No.20 Xor G.P	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift>>2 (8shift finish)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
23	3rd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
24	CRC=No.22 Xor No.23	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	
25	Shift>>	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
26	CRC=No.25 Xor G.P	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	
27	Shift>>6	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
28	CRC=No.27 Xor G.P	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	
29	Shift>>1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1
30	CRC=No.29 Xor G.P	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	
31	4th data byte	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	
32	CRC=No.30 Xor No.31	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1	
33	Shift>>1	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1
34	CRC=No.33 Xor G.P	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1	
35	Shift>>1	0	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1
36	CRC=No.35 Xor G.P	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1	
37	Shift>>1	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1
38	CRC=No.37 Xor G.P	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	
39	Shift>>1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1
40	CRC=No.37 Xor G.P	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	
41	Shift>>3	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1
42	CRC=No.41 Xor G.P	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1	
43	Shift>>1	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1
44	CRC=No.43 Xor G.P	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
45	5th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	CRC=No.44 Xor No.45	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
47	Shift>>5	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1
48	CRC=No.47 Xor G.P	1	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	
49	Shift>>3	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	0
50	6th data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
51	CRC=No.49 Xor No.50	0	0	0	1	0	1	0	0	1	1	1	0	1	0	0	0	
52	Shift>>4	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1
53	CRC=No.52 Xor G.P	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	
54	Shift>>1	0	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1
55	CRC=No.54 Xor G.P	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	0	
56	Shift>>2	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1
57	CRC=No.56 Xor G.P	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	
58	Shift>>1	0	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0
Transmission CRC		4				E				1				4				

The complete message to be sent by the Master to the drive is given below. (The drive should respond to this query with the appropriate error response message)

Station Address	FC	Function Code		Number of Variables to Read		CRC Check	
01H	03H	03H	31H	00H	14H	14H	4EH

Note: In this example, a length of 20 bytes of read data was requested. The drive has a maximum limitation of 16 bytes of read data.

7.3 Calculation of frame length

It is necessary to determine the length of a variable length message in order to calculate the CRC-16 for the message. The length of any message type can be calculated using the table below.

FC	Description	Message length of query and broadcast (except CRC code)	Response message length (except CRC code)
3	Reading of function	6 bytes	3+(3rd) bytes
6	Writing to single function	6 bytes	6 bytes
8	Maintenance code	6 bytes	6 bytes
16	Writing to continuous function	7+(7th) byte	6 bytes
128_255	Exception Function	Not used	3 bytes

* 7th, 3rd: Shows the data field length stored bytes-count which is at 7th and 3rd characters in the frame.

8. Sort of messages

This section defines the RTU message formats and the field information. For the error responses, refer to "9. Transmission error"Åh

8.1 Reading of functions

8.2 Reading of data

Query

1 byte	1 byte	2 bytes		2 bytes	2 bytes
Station address	03H	Function code	Number of variables to read		Error check
		Hi Lo	Hi	Lo	

Normal Response

1 byte	1 byte	1	2-32 bytes	2bytes
Station address	03H	Byte count	Variables Read data	Error check
			Hi, Lo (data 0), Hi, Lo (data 1), Hi, Lo (data 2)...	

Query

- Broadcast of address 0 can not be used (No response if it is used).

- The drive will not respond to a broadcasted ("Station address"=0) Read (FC=03) query.

- FC=3 (03H)

- The drive's parameter function code is 2 bytes in length. The high byte corresponds to the sort of functions (F, E, C, P, H, A, O, S, M). The low byte corresponds to the function numbers (0-99). Consequently, the setting data range of function sort is 0-8, 250-252 (F-M, u-t) and the function numbers are 0-99. However, the function numbers shall be set to the number subtracted 1 from the address.

For example, address 001FH shows F30 and the communication function code becomes 001EH.

Code	Sort	Name	Code	Sort	Name
0	F	Basic function	6	o	Option function
1	E	Terminal function	7	S	Command/function data
2	C	Control function	8	M	Monitor data
3	P	Motor 1 function	250		
4	H	High level function	251		
5	A	Motor 2 function	252		

- "Number of variables to read" is a 2 byte length (word). The range is 1-16 (01h-10h).

  The "Function code" + "Number of variables to read" shall not exceed the upper limit of that particular function code. (Example: up to 42 for F). If the data exceeds this range, a transmission error will occur (refer to "9. Transmission error").

- If a read is requested from a function code that is "not yet used," the drive will return a zero for data. No error will be generated.

Response

- The "byte count" range is 2-32. The "bytes count" (in the response) is equal to double the "number of variables read" (in the query) value (1-16).

- The variables being read are loaded high byte first.

- The requested function code address (in the query) is read and loaded first into the message, then the proceeding addresses contents follows. (When reading plural functions, if function code not yet used is included in and after the second functions, the reading data become unsettled).

8.3 Writing to single function

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06H	Function code	Write data	Error check
			Hi Lo	

Normal Response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06H	Function code	Write data	Error check

Query

- This message may be broadcasted (transmitting to address 0). A broadcast message will result in all slave stations executing the command, but not returning a response.

- FC=6 (06H)

- The "Function code" is 2 bytes in length. See Section "8.1 Reading of functions " for the "Function code" definitions.

- The "Write data" is 2 bytes in length. The write data is the data that will be written to the specified function address in the "Function code."

Response

- The "Normal response" message is the same as the query message.

8.4 Writing to continuous function

Query

1 byte	1 byte	2 bytes	2 bytes	1 byte	2_32 bytes	2 bytes
Station address	10H	Function code	No. of write data	Byte count	Write data	Error check
		Hi Lo	Hi Lo		Hi, Lo (data 0), Hi, Lo (data 1), Hi, Lo (data 2)	

Normal Response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	10H	Function code	No. of write data	Error check

Query

- This message may be broadcasted (transmitting to address 0). A broadcast message will result in all slave stations executing the command, but not returning a response.

- FC=16 (10H)

- The "Function code" is 2 bytes in length. See Section "8.1 Reading of functions" for the "Function code" definitions.

- The "Number of write data" is 2 bytes in length and is the number of drive variables to be written. The "Write data" range is 1-16.

  The "Function code" + "Number of write data" shall not exceed the upper limit of that particular function code. (Example: up to 42 for F). If the data exceeds this range, a transmission error will occur (Refer to "9. Transmission error").

- The "Byte count" is 1 byte in length. The "Byte count" range is 2-32. The "Byte count" should be double the "Write data" value.

- The write data is the data that will be written starting at the specified function address in the "Function code." The "Write data" is word wide data with the high byte (Most Significant Byte) first. The first word of data corresponds with the address given in the "Function code."

- If a function code that is not yet used is included in the continuous write, that function code (address) is neglected and no error is generated.

Response

- The "Function code" and "Number of write data" is the same as that in the query.

8.5 Maintenance code

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08H	Diagnostic code 0000H	Data	Error check
	Hi Lo Hi	Lo		

Normal Response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08H	Diagnostic code 0000H	Data	Error check

Query

- The drive will not respond to a broadcasted ("Station address"=0) "Maintenance code" (FC=08h) query.

- FC=8 (08H)

- The "Diagnostic code" is 2 bytes (1 word) in length and fixed to 0000H.

- The "Data" field is 2 bytes (1 word) in length.

Response

- The normal response message is the same as the query message.

9.Transmission error

9.1 Sort of transmission error

The Modbus RTU serial link transmission errors are categorized into the following 3 groups.

- Illegal query message

- Time out of serial link.

- Illegal processing

9.1.1 Illegal query message

When an illegal message is received, the query can not be performed and the following error response is returned.

Response format for illegal query

1 byte	1 byte	1 byte	2 bytes
Station address	Exception function	Subcode	Error check

- The station address is the same value as that in the query.

- The exception function of the response message = ("FC"(of the query)+128).

  For example, if FC of the query equals 3, then the exception function of the response equals 131 (83H). [Exception Function = FC+128 = 3+128 =131].

- The following table defines the various "Subcode."

Subcode	Item		Remarks
1	Illegal FC		Received FC other than 3, 6, 8, 16.
2	Illegal address	Illegal function code	Received function code not used or a function code out of the range. When an unused function code is included - Function reading: 0 is read - Function writing: writing is neglected
		Illegal number of data	- "Number of variables to read"/"Number of write data" is not 1-16. - In the case of number of "Function code"+ data exceeds the range of particular function code (example: up to 42 for F).
		The diagnostic code error in maintenance code	-The "Diagnostic code" was not 0.
3	Illegal data	Data range error	The "Write data" exceeds the writing range.
7	NAK	Link prior	If a link/LAN option card is installed, then writing to the "Command data" or "Operation command data" of the drive is not allowed over the serial link RTU. Drive control/operation is only allowed via the link/LAN option card.
		No write access	The link/LAN option card is writing to a function code. A function code write over the serial link RTU is not allowed until the write from the link/LAN option card is completed.
		Forbidden writing	Attempting to write to functions that are not allowed to be written over the serial link RTU, or not allowed to be written during drive operation.

9.1.2 Serial link time out

- The RTU communication time out protocol is defined as three missing characters in a data flow. An example would be when the slave station does not return a response message. However, since the drive can set the communication interruption time with a function code, this rule is neglected.

- There is a 500ms time out that starts when the Master completes transmitting a query message until a response is given by the slave station. If the slave does not respond within 500ms, a communication retry action is then performed with a longer time interval than 500ms. However, since the completion of writing to continuous functions may take more than 500ms, depending on the number and sort of the functions to be written, this time must be extended.

 (Refer to "14.1 Response interval time" for details).

9.1.3 Illegal processing

Communication errors other then those mentioned in "9.1.1" and "9.1.2," are defined as illegal processing. The drive will not return a response message.

- Physical errors (Parity, framing, overrun)

- CRC errors

- When a message length exceeds 41 bytes.

9.2 Action at transmission error

The drive can be configured to take appropriate actions once a transmission error or serial link time out error has occurred (See the table below).

To perform the appropriate error action, it is necessary that normal character receiving has been performed once or more, and other means of operation (keypad, terminal, link/LAN option card) are performing correctly.

9.2.1 Action at occurring transmission error

Function Code H32 can be used to select the desired drive operation upon recognition of a transmission error.

H32	Action at Occurring Error		Remarks
0	Immediate force stop	Er8	
1	Continue operation until timer time (H33) has elapsed and then force stop	Er8	Continue operation until the timer times out, then either force a stop, or continue listening to the communications if re-established.
2	Continue operation until timer time (H33) has elapsed and then force stop, unless the communications has been re-established prior to the timer timing out.	Er8	
3	Continue operation. (Ride through) Listen to communications if re-established	Ride through (do not error)	

H33 is the error timer value used for time out (see H32): 0.0–60.0 seconds.

9.2.2 Factors of transmission error action

(1) Transmission error

The drive performs the error action when it detects the transmission errors 8 times continuously.

1) Condition of transmission errors

- In the case of the frame for own station become CRC error

- In the case of occurring receiving error (parity, framing, overrun)

  (Because the receiving error is restricted once a frame, if an error occurred once, the errors that occurred during the period until the first normal character will be received are not counted by the frame size amount. But when FC was abnormal, 8 bytes are not counted because the frame length is not clear).

2 Clearing condition of transmission error counter

  In the case where CRC check of frame for own station or other stations is normal.

(2) Serial link time out error

The drive takes error action when the interruption of the communication through this protocol is detected.

1) Setting of communication interruption time (H38)

  0 second (no detection), 1–60 seconds

2) Clearing condition for communication interruption detecting timer

  In the case of CRC check of frame for own station or other stations are normal.

9.2.3 Description of action at occurring transmission error

If H32=0 (Mode of immediate forced stop at occurring transmission error)

Error

Transmission state — Normal — Error — Normal — Alarm reset

Display — Normal — Er8

Command from RS485
- FWD — ON — ON — Transmission failure
- Setting frequency

Internal operation of drive
- Operation command — Operation — Stop — Operation
- Setting frequency
- Output frequency — Free run
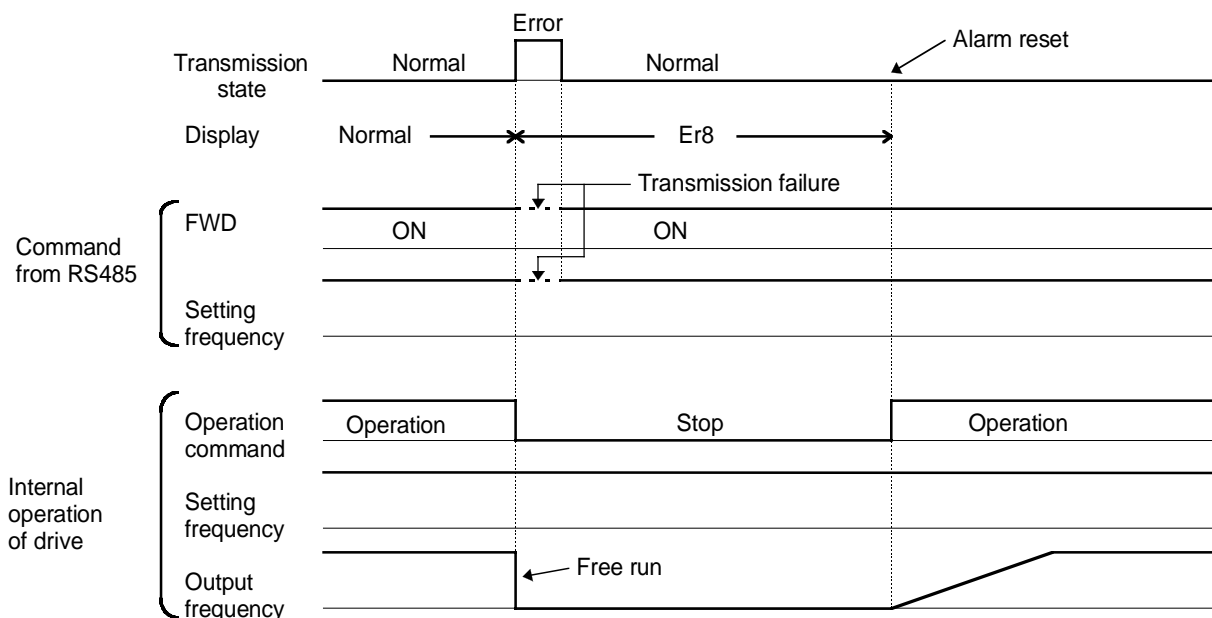
If H32=1, H33=5.0 seconds (mode of immediate forced stop after 5 seconds at occurring transmission error)
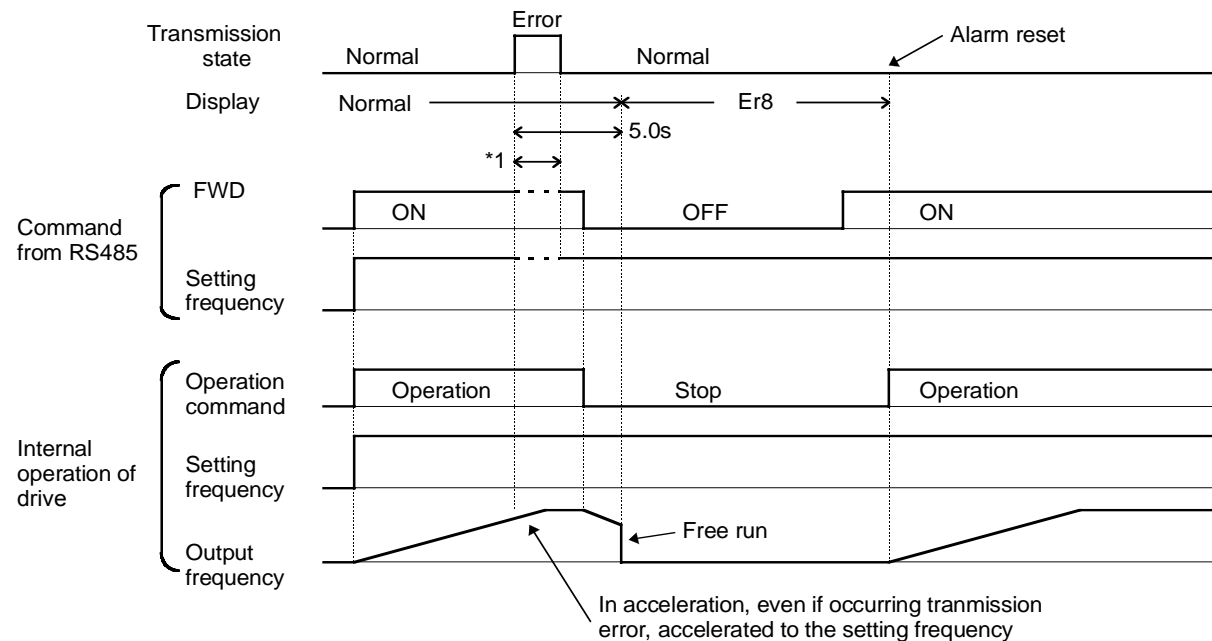
Error

Transmission state — Normal — Error — Normal — Alarm reset

Display — Normal — Er8 — 5.0s

Command from RS485
- FWD — ON — OFF — ON — *1
- Setting frequency

Internal operation of drive
- Operation command — Operation — Stop — Operation
- Setting frequency
- Output frequency — Free run

In acceleration, even if occurring tranmission error, accelerated to the setting frequency

1) In a period until restoring the communication, the commands (command data and operation data) just before the error are kept.

If H32=2, H33=5.0 seconds (the communication does not restore after 5 seconds elapse from occurring transmission error, and drive trips Er8)

```
Transmission                    Error
state          Normal        ┌────────┐        Normal                    ↙ Alarm reset
```

Transmission state: Normal | Error | Normal

Display: Normal — Er8 — (Alarm reset)

5.0s | *1

Command from RS485
- FWD: ON | ON
- Setting frequency

Internal operation of drive
- Operation command: Operation | Stop | Operation
- Setting frequency
- Output frequency — Free run

In acceleration, even if occurring tranmission error, accelerated to the setting frequency

If H32=2, H33=5.0 seconds (a transmission error occurs, but is restored within 5 seconds)
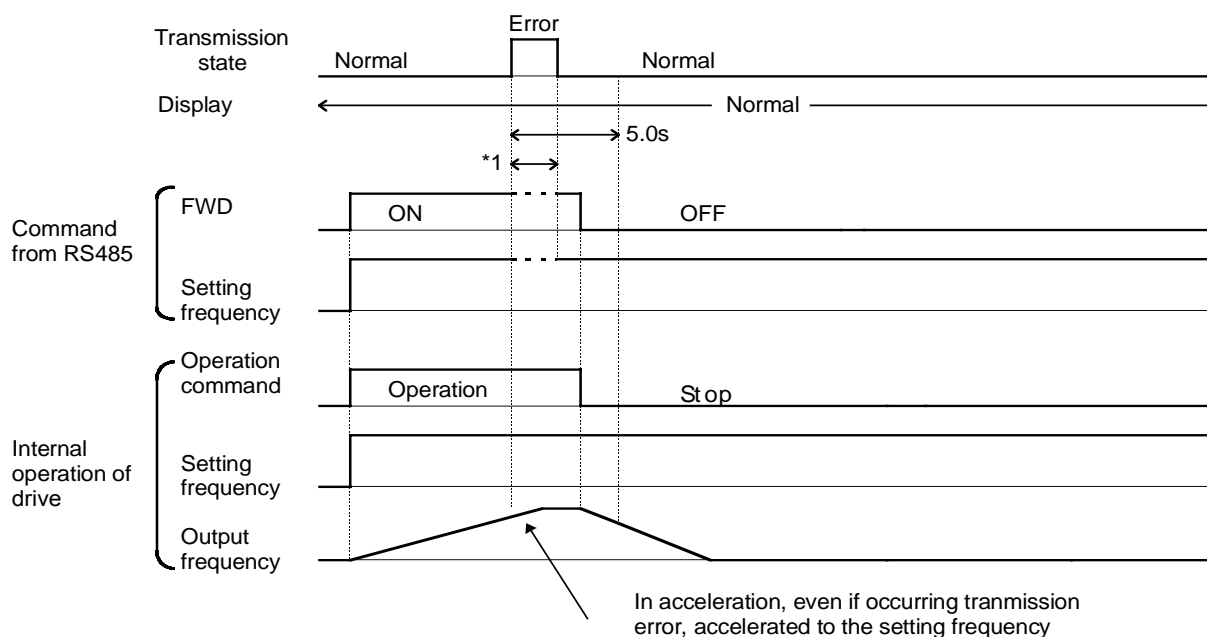
Transmission state: Normal | Error | Normal

Display: Normal

5.0s | *1

Command from RS485
- FWD: ON | OFF
- Setting frequency

Internal operation of drive
- Operation command: Operation | Stop
- Setting frequency
- Output frequency

In acceleration, even if occurring tranmission error, accelerated to the setting frequency

*1) In a period until restoring the communication, the commands (command data and operation data) just before the transmission error are kept.

If of H32=3 (mode of operation continuation at occurring transmission error)

Continue operation keeping the setting at occurring transmission error
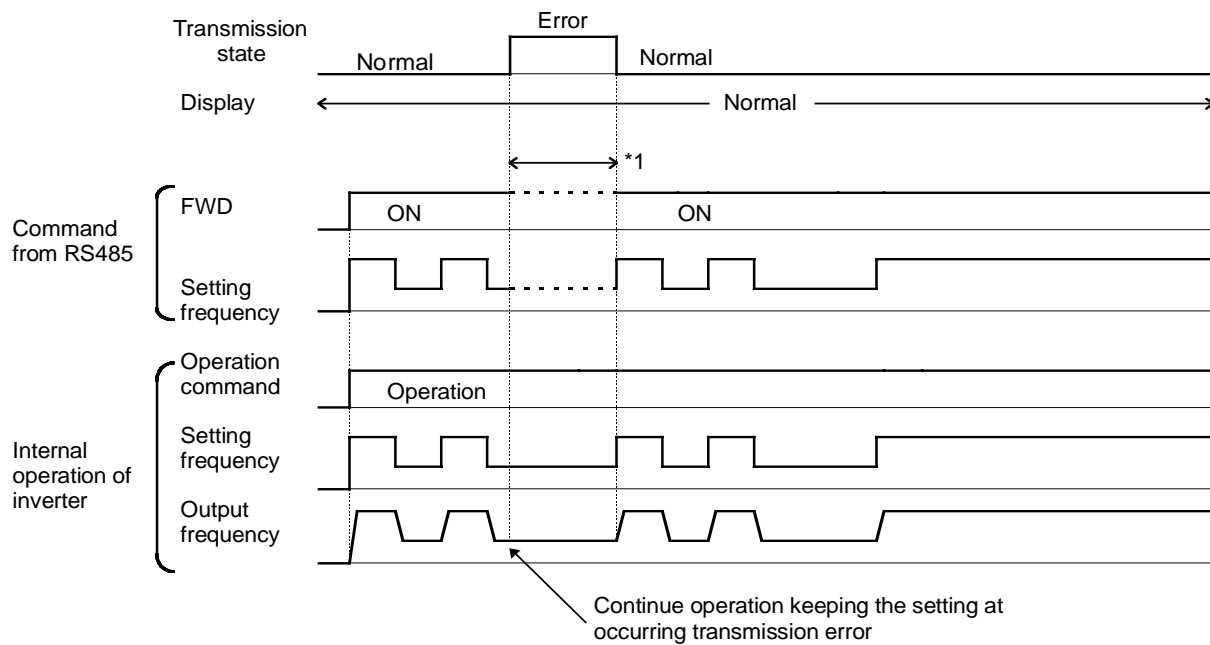
10. Functions specific for communication

To operate the drives or to monitor the state via communication, the following functions are specifically available for communication, in addition to the functions for parameter change of the drives. These functions are adopted the common data format applicable to the types on and the ACE 20 Series, so that it is possible to access to the different type by the same program of the host side.

10.1 Command data

Code	Name	Unit	Variable Range	Min. Unit	Read/Write
S01	Frequency command	-	- 20000_20000 (max. frequency at ±20000)	1	R/W
S05	Frequency command	Hz	0.00_400.00	0.01	R/W

R: Reading
W:Writing

Notes:

1) The frequency command is handled as the synchronous frequency which provides a speed regulator.
2) If both S01 and S05 are set (data writing except 0), command of S01 becomes valid.
3) The data writing exceeding the setting range is impossible, and the drive returns "Data range error" response.
4) When the command data shown here are read, it is not the command data of actual action but the command data communicated before (the final command data can be obtained by reading the monitoring data described later).

1) During the period, until communication is restored, the commands transmitted just before the transmission error occurred (command data, operation data), are stored.

10.2 Operation command data

Code	Name	Unit	Variable Range	Min. Unit	Read/Write
S06	Operation command	-	Refer to the data format [14]	-	R/W

Notes:

1) The frequency command is handled as the synchronous frequency which provides a speed regulator.

2) If both S01 and S05 are set (data writing except 0), command of S01 becomes valid.

3) The data writing exceeding the setting range is impossible, and the drive returns "Data range error" response.

4) When the command data shown here are read, it is not the command data of actual action but the command data communicated before (the final command data can be obtained by reading the monitoring data described later).

Classification		Symbol	Name	Transmission	Terminal Block
Operation command		FWD/REV	FWD/REV command	Valid	Invalid
Multi-function command	0_3	SS1, 2, 4, 8	Multi - step frequency	Valid	Invalid
	4	RT1	Changeover of ACC/DEC time		
	5	HLD	Self hold signal	Invalid	
	6	BX	Free run command	Valid	
	7	RST	Alarm reset		
	8	THR	External alarm	Invalid	Valid
	9	Hz2/Hz1	Frequency setting 2/1	Valid	
	10	M2/M1	Motor 2/1	Invalid	Invalid
	11	DCBRK	DC braking command		
	12	TL2/TL1	Torque limit 2/1		
	13, 14	UP, DOWN	UP, DOWN command		
	15	WE-KP	Edit permission command	Valid	Valid
	16	Hz/PID	PID control cancel	Invalid	Invalid
	17	IVS	Forward/reverse switching		
	18	LE	Link operation selection		

10.3 Function data

Code	Name	Unit	Variable range	Min. unit	Read/Write
S08	Acceleration time F07	s	0.1_3600.0	0.1	R/W
S09	Deceleration time F08	s	0.1_3600.0	0.1	R/W
S10	Torque limit level 1 (driving) F40	%	20.00_200.00 (P11S: 20.00_150.00), 999	1	R/W
S11	Torque limit level 2 (braking) F41	%	0.00, 20.00_200.00 (P11S: 20.00_150.00), 999	1	R/W

Notes:

1) Writing to "out of range" is treated as an out of range error.

2) The acceleration and deceleration time S08 and S09 are assigned to "F07: Acceleration timeÇP"and "F08: Deceleration time ÇP," respectively.

3) The acceleration and deceleration time S08 and S09 are rounded down by four digits or more by the drive. (e.g., when 123.4 seconds are written, it is rounded down to 123 seconds.)

4) The torque limit level 1 and 2 of S10ÅCS11 are assigned to "F40: Torque limit ÇP (driving)" and "F41:Torque limit 1 (braking)," respectively.

10.4 Monitoring data

Code	Description	Unit	Range	Min. unit	Read/Write
M01	Frequency command (final command)	-	- 20000_20000	1	R
			(maximum frequency at ±20000)		
M05	Frequency command (final command)	Hz	0_400.00 (P11S: 0.00_120.00)	0.01	R
M06	Actual frequency	-	- 20000_20000	1	R
			(maximum frequency at ±20000)		
M07	Actual torque value	%	- 200.00_200.00	0.01	R
M08	Torque current	%	- 200.00_200.00	0.01	R
M09	Output frequency	Hz	0.00_400.00 (P11S: 0.00_120.00)	0.01	R
M10	Motor output (input electric power)	%	0.00_200.00	0.01	R
M11	Output current r. m. s.	%	0.00_200.00 (inverter rating at 100.00)	0.01	R
M12	Output voltage r. m. s.	V	0.0_600.0	1	R
M13	Operation command (final command)	-	Refer to the data format [14]	-	R
M14	Operating state	-	Refer to the data format [16]	-	R
M15	Universal output terminal data	-	Refer to the data format [15]	-	R
M16	Fault memory 0	-			
M17	Fault memory (1st prior)	-	Refer to the data format [10]	-	R
M18	Fault memory (2nd prior)	-			
M19	Fault memory (3rd prior)	-			
M20	Integrated operating time	h	0_65535	1	R
M21	DC link voltage	V	0_1000	1	R
M23	Type code	-	Refer to the data format [17]	-	R
M24	Motor capacity code	-	Refer to the data format [11]	-	R
M25	ROM version	-	0_64999	1	R
M26	Transmission error processing code	-	Refer to the data format [20]	-	R
M27	-	-	-	-	-
M31	-	-	-	-	-
M32	-	-	-	-	-
M33	-	-	-	-	-
M34	-	-	-	-	-
M35	-	-	-	-	-
M36	-	-	-	-	-
M37	-	-	-	-	-
M38	-	-	-	-	-
M39	-	-	-	-	-
M40	-	-	-	-	-
M41	-	-	-	-	-
M42	-	-	-	-	-
M43	-	-	-	-	-
M44	-	-	-	-	-
M45	-	-	-	-	-
M46	Life of main circuit capacitor.	%	0.0_100.0	0.1	R
M47	-	-	-	-	-
M48	Life of cooling fan.	h	0_65535	1	R

Notes:

1) The frequency command with speed regulator is treated as the synchronous frequency.

2) The actual torque without speed regulator is treated as the calculated result of torque.

11. Function data format

The table below defines the data formats for various drive function data. The data shall be prepared according to the following data format specifications. The drive's instruction manual should be referred to for the data units and range.

11.1 List of function data format

Code	Name	Data Format	Code	Name	Data Format
F00	Data protection	[1]	E01	X1 terminal function	[1]
F01	Frequency command 1	[1]	E02	X2 terminal function	[1]
F02	Operation method	[1]	E03	X3 terminal function	[1]
F03	Maximum output frequency 1	[1]	E04	X4 terminal function	[1]
F04	Base frequency 1	[1]	E05	X5 terminal function	[1]
F05	Rated voltage 1	[1]	E06	-	-
F06	Maximum output voltage 1	[1]	E07	-	-
F07	Acceleration time 1	[12]	E08	-	-
F08	Deceleration time 1	[12]	E09	-	-
F09	Torque boost 1	[1]	E10	Acceleration time 2	[12]
F10	Electronics thermal overload relay 1 (selection)	[1]	E11	Deceleration time 2	[12]
F11	Electronics thermal overload relay 1 (level)	[19]	E12	-	-
F12	Electronics thermal overload relay 1 (thermal time constant)	[3]	E13	-	-
F13	Electronics thermal overload relay (braking resistor)	[1]	E14	-	-
F14	Restart after momentary power failure (selection)	[1]	E15	-	-
F15	Frequency limit (upper)	[1]	E16	Torque limit 2 (driving)	[1]
F16	Frequency limit (lower)	[1]	E17	Torque limit 2 (braking)	[1]
F17	Gain (frequency setting signal)	[3]	E20	Y1 terminal function	[1]
F18	Bias frequency	[2]	E21	Y2 terminal function	[1]
F20	DC braking (starting frequency)	[3]	E22	-	-
F21	DC braking (braking level)	[1]	E23	-	-
F22	DC braking (braking time)	[3]	E24	-	-
F23	Starting frequency	[3]	E25	-	-
F24	Starting frequency (holding time)	[3]	E29	Frequency level detection delay	[12]
F25	Stopping frequency	[3]	E30	Frequency arrival (FAR) (detecting width)	[3]
F26	Motor sound (carrier frequency)	[1] *1	E31	Frequency detection (operation level)	[1]
F27	Motor sound (sound tone)	[1]	E32	Frequency detection (FDT) (hysteresis width)	[3]
F29	FMA and FMP terminals	[1]	E33	Overload early warning (selection)	[1]
F30	FMA terminal (voltage adjust)	[1]	E34	Overload early warning 1 (level)	[19]
F31	FMA terminal (function selection)	[1]	E35	Overload early warning (timer time)	[3]
F33	FMP terminal (pulse rate multiplier)	[1]	E36	-	-
F34	FMP terminal (voltage adjust)	[1]	E37	-	-
F35	FMP terminal (function selection)	[1]	E40	Display coefficient A	[12]
F36	30Ry action mode	[1]	E41	Display coefficient B	[12]
F40	Torque limit 1 (driving)	[1]	E42	Display filter	[3]
F41	Torque limit 1 (braking)	[1]	E43	-	-
F42	Torque vector control 1	[1]	E44	-	-
			E45	-	-
			E46	-	-
			E47	-	-

*1) 0.75 Hz is treated as 0.

Code	Name	Data Format	Code	Name	Data Format
C01	Jump frequency 1	[1]	H11	Deceleration mode	[1]
C02	Jump frequency 2	[1]	H12	Instantaneous overcurrent limit	[1]
C03	Jump frequency 3	[1]	H13	Auto-restart (restart time)	[3]
C04	Jump frequency (width)	[1]	H14	Auto-restart (frequency fall rate)	[5]
C05	Multi-step frequency 1	[5]	H15	-	-
C06	Multi-step frequency 2	[5]	H16	-	-
C07	Multi-step frequency 3	[5]	H18	-	-
C08	Multi-step frequency 4	[5]	H19	-	-
C09	Multi-step frequency 5	[5]	H20	PID control (mode selection)	[1]
C10	Multi-step frequency 6	[5]	H21	PID control (feedback signal selection)	[1]
C11	Multi-step frequency 7	[5]	H22	PID control (P-gain)	[5]
C12	Multi-step frequency 8	[5]	H23	PID control (I-time)	[3]
C13	Multi-step frequency 9	[5]	H24	PID control (D-time)	[5]
C14	Multi-step frequency 10	[5]	H25	PID control (feedback filter)	[3]
C15	Multi-step frequency 11	[5]	H26	PTC thermistor (mode selection)	[1]
C16	Multi-step frequency 12	[5]	H27	PTC thermistor (level)	[5]
C17	Multi-step frequency 13	[5]	H28	Droop control	[4]
C18	Multi-step frequency 14	[5]	H30	Serial link operation (function selection)	[1]
C19	Multi-step frequency 15	[5]	H31	Modbus-RTU (address)	[1] *2
C20	-	-	H32	Modbus-RTU (selection on error)	[1] *2
C21	Pattern operation	[1]	H33	Modbus-RTU (timer)	[3] *2
C22	Stage 1	[12]	H34	Modbus-RTU (baud rate)	[1] *2
C23	-	-	H35	Modbus-RTU (data length)	[1] *2
C24	-	-	H36	Modbus-RTU (parity check)	[1] *2
C25	-	-	H37	Modbus-RTU (stop bit)	[1] *2
C26	-	-	H38	Modbus-RTU (no response error detection time)	[1] *2
C27	-	-	H39	Modbus-RTU (response interval)	[5] *2
C28	-	-	H40	Maximum temperature of heat sink	[1]
C30	Frequency setting	[1]	H41	Maximum effective current	[19]
C31	Analog input offset (terminal 12)	[4]	H42	Main circuit capacitor life	[3]
C32	Analog input offset (terminal C1)	[4]	H43	Cooling fan operation time	[1]
C33	Analog setting signal filter	[5]	H44	Inverter ROM version	[1]
P01	Motor 1 (number of poles)	[9]	H45	Keypad panel ROM version	[1]
P02	Motor 1 (capacity)	[5]	H46	Option ROM version	[1]
P03	Motor 1 (rated current)	[19]	A01	Maximum output frequency 2	[1]
P04	Motor 1 (auto-tuning)	[21] *3	A02	Base frequency 2	[1]
P05	Motor 1 (on-line tuning)	[1]	A03	Rated voltage 2	[1]
P06	Motor 1 (no-load current	[19]	A04	Maximum output voltage 2	[1]
P07	Motor 1 (%R1)	[5]	A05	Torque boost 2	[1]
P08	Motor 1 (%X)	[5]	A06	Electronics thermal 2 (selection)	[1]
P09	Motor 1 (slip compensation control)	[5]	A07	Electronics thermal 2 (level)	[19]
P10	Motor 1 (Slip compensation response time 1)	[5]	A08	Electronics thermal 2 (thermal time constant)	[3]
			A09	Torque vector control 2	[1]
H01	Total operation time	[1]	A10	Motor 2 (number of poles)	[9]
H02	Trip history	-	A11	Motor 2 (capacity)	[5]
H03	Data initializing	[1] *3 *4	A12	Motor 2 (rated current)	[19]
H04	Retry (times)	[1]	A13	Motor 2 (tuning)	[21] *3
H05	Retry(reset interval)	[1]	A14	Motor 2 (on-line tuning)	[1]
H06	Fan stop operation	[1]	A15	Motor 2 (no-load current)	[19]
H07	ACC/DCC pattern (mode select)	[1]	A16	Motor 2 (%R1 setting)	[5]
H08	-	-	A17	Motor 2 (%X setting)	[5]
H09	Start mode	[1]	A18	Motor 2 (slip compensation amount)	[5]
H10	Energy-saving operation	[1]	A19	Motor 2 (Slip compensation response time 2)	[5]

*1) 999 is treated as 03E7H (99.9).

*2) The writing from the transmission is impossible.

*3) In the case of the continuous function writing of FC=16, if number of the writing data are 2 or more, it is impossible to write the data other than 0.

*4) When the data are initialized, the transmission may not be continued because the data of the H31_H39 related to communication are also returned to the initial value

Code	Name	Data Format	Code	Name	Data Format
o01	-	-	M01	Frequency command (final command)	[2]
o02	-	-	M05	Frequency command (final command)	[5]
o03	-	-	M06	Actual frequency	[2]
o04	-	-	M07	Actual torque value	[6]
o05	-	-	M08	Torque current	[6]
o06	-	-	M09	Output frequency	[5]
o07	-	-	M10	Motor output	[5]
o08	-	-	M11	Output current effective value	[5]
o09	-	-	M12	Output voltage effective value	[3]
o10	-	-	M13	Operation command (final command)	[14]
o11	-	-	M14	Operating state	[16]
o12	-	-	M15	Universal output terminal data	[15]
o13	-	-	M16	Fault memory 0	[10]
o14	-	-	M17	Fault memory (1st prior)	[10]
o15	-	-	M18	Fault memory (2nd prior)	[10]
o16	-	-	M19	Fault memory (3rd prior)	[10]
o17	-	-	M20	Integrated operating time	[1]
o18	-	-	M21	DC link voltage	[1]
o19	-	-	M23	Type code	[17]
o20	-	-	M24	Capacity code	[11]
o21	-	-	M25	ROM version	[1]
o22	-	-	M26	Transmission error processing code	[20]
o23	-	-	M27	-	-
o24	-	-	M31	-	-
o25	-	-	M32	-	-
o26	-	-	M33	-	-
o27	-		M34	-	-
o28	-		M35	-	-
o29	-		M36	-	-
			M37	-	-
			M38	-	-
			M39	-	-
S01	Frequency command	[2]	M40	-	-
S05	Frequency command	[5]	M41	-	-
S06	Operation command	[14]	M42	-	-
S07	-	-	M43	-	-
S08	Acceleration time	[3]	M44	-	-
S09	Deceleration time	[3]	M45	-	-
S10	Torque limiter level 1	[5] *1	M46	Life of main circuit capacitor	[3]
S11	Torque limiter level 2	[5] *1	M47	-	-
S12	-	-	M48	Life of cooling fan	[1]

*1) 999 is handled as 7FFF$_H$

12. Data format specification

All data within the data field of the communication frame shall be represented by a 1 bit length.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
							16 bits binary data								
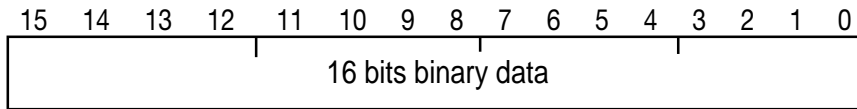
Data format [1] Integer data (Positive): Minimum unit 1

Example) If F15 (Frequency limiter, upper limit)= 60Hz

Since 60 = 003C$_H$

00H	3CH

Data format [2] Integer data (Positive, negative): Minimum unit 1

Example) If being -20

Since -20 = FFEC$_H$

FFH	ECH

Data format [3] Decimal data (Positive): Minimum unit 0.1

Example) If F17 (gain frequency setting signal) = 100.0%

Since 100.0 x 10 = 1000 = 03E8$_H$

03H	E8H

Data format [4] Decimal data (Positive, negative): Minimum unit 0.1

Example) If C31 (Analog input offset adjust, Terminal12) = - 5.0%

Since - 5.0 x 10= - 50 = FFCE$_H$

FFH	CEH

Data format [5] Decimal data (Positive): Minimum unit 0.01

Example) If C05 (multi-step frequency 1) = 50.25Hz

Since 50.25 x 100 = 5025 = 13A1

13H	A1H

Data format [6] Decimal data (Positive, negative): Minimum unit 0.01

Example) If M07 (actual torque value)= - 85.38%

Since - 85.38 x100= - 8538=DEA6$_H$

DEH	A6H

Data format [7] Decimal data (Positive): Minimum unit 0.001

Example) If o05 (follow - up side ASR 1 constant) = 0.105 second

Since 0.105 x 1000 = 105 = 0069$_H$

00H	69H

Data format [8] Decimal data (Positive, negative): Minimum unit 0.001

Example) If being -1.234

Since - 1.234 x 1000 = - 1234 = FB2E$_H$

FBH	2EH

Data format [9] Integral data (Positive): Minimum unit 2

Example) If P01 (Motor 1 number of poles) =2 poles

Since 2 = 0002$_H$

00H	02H

Data format [10] Alarm code

Code	Description		Code	Description	
0	No alarm	---	-	-	-
1	Overcurrent, during acceleration (INV output)	OC1	31	Memory error	Er1
2	Overcurrent, during deceleration (INV output)	OC2	32	Keypad panel transmission error	Er2
3	Overcurrent, during steady state operation (INV output)	OC3	33	CPU error	Er3
-	-	-	34	Option communication error	Er4
6	Overvoltage, during acceleration	OU1	35	Option error	Er5
7	Over voltage, during deceleration	OU2	36	PL error	Er6
8	Overvoltage, during steady state operation	OU3	37	Output wiring error	Er7
10	DC undervoltage	LU	38	RS485 communication error	Er8
11	Power supply open phase	Lin			
-	-	-			
16	Output wiring error	Er7			
17	Overheat, heat sink, drive	OH1			
18	Overheat, outside thermal	OH2			
-	-	-			
22	Overheat, DB resistor	dbH			
23	Overload, motor 1	OL1			
24	Overload, motor 2	OL2			
25	Overload, drive	OLU			
-	-	-			

Example) If overvoltage, during acceleration (OU1)

      Since 6 = 0006_H

00H	06H

Data format [11] Capacity code

Code	Capacity (HP)	Code	Capacity (HP)	Code	Capacity (HP)
12	1/8				
25	1/4				
50	1/2				
100	1				
200	2				
300	3				
500	5				
750	7-1/2				
1000	10				

Example) If being 10 HP

      Since 10 x 100 = 1000 = $03E8_H$

03H	E8H

Data format [12] Index data (ACC/DEC time, display coeffient)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polarity	0	0	0	Index portion					Data portion						

	Not yet used	0: 0.01	x	001 999	(0.00 9.99)
		1: 0.1	x	100 999	(10.0 99.9)
		2: 1	x	100 999	(100 999)
		3:10	x	100 999	(1000 9990)

0: Positive (+)
1: Negative (-)

Example) If F07 (acceleration time 1) = 20.0 seconds

04H	C8H

Since $20.0 = 0.1 \times 200 > 0400_H + 00C8_H = 04C8_H$

Data format [13] Pattern operation

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Direction of rotation	0	Time		Index portion					Data portion						

Not used	0: 0.01	x	001 999	(0.00 9.99)
	1: 0.1	x	100 999	(10.0 99.9)
	2: 1	x	100 999	(100 999)
	3:10	x	100 999	(1000 9990)

0: 1st ACC/DEC time
2: 2nd ACC/DEC time
3: 3rd ACC/DEC time
4: 4th ACC/DEC time

0: Forward rotation
1: Reverse rotaton

Example) If C22 (Stage 1) = 10.0s R2 (10 seconds, reverse rotation, acceleration time 2/decelertation time 2)

94H	64H

Since $10.0 = 0.1 \times 100 > 9000_H + 0400_H + 0064_H = 946_H$

Data format [14] Operation Command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RST	0	0	0	0	0	0	0	0	X5	X4	X3	X2	X1	REV	FWD

Alarm Reset | Not used | Multi-function command FWD: Forward | Rotation command REV: Reverse rotation command (all bit are ON by 1)
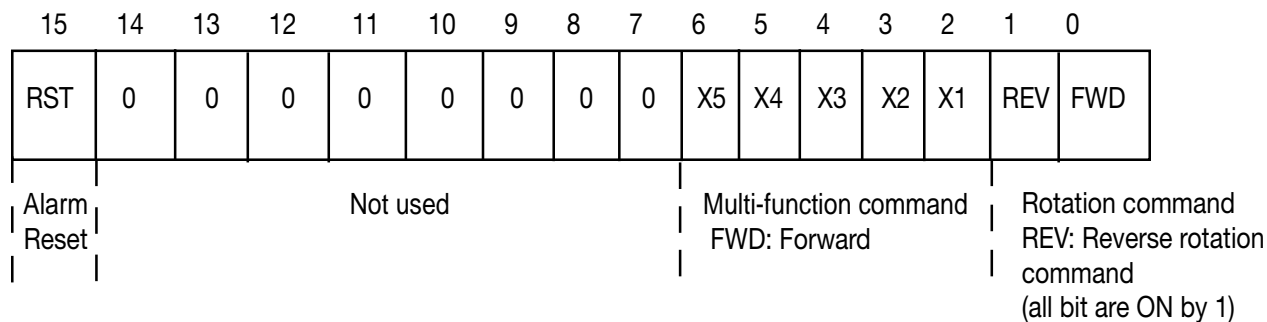
Example) If S06 (operation command) = FWD, X1 and X5 = ON
Since 0000 0000 0100 0101$_b$ = 0045$_H$

00H	45H

Data format [15] Universal output terminal

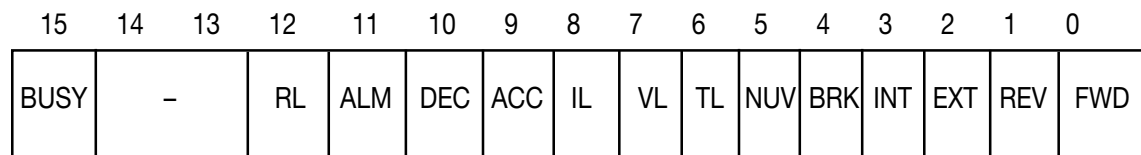| 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	Y2	Y1

Not used | Universal output (all bit are ON by1)
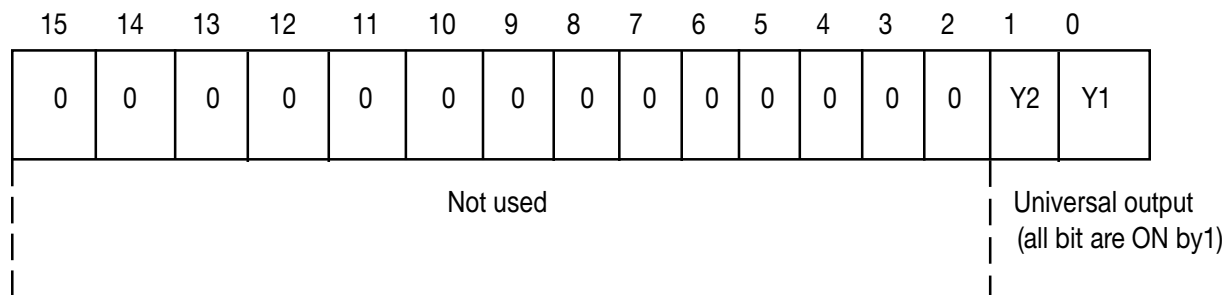
Example) If M15 (Universal output terminal) = Y1 and Y2 = ON
Since 0000 0000 0000 0011$_b$ = 0011$_H$

00H	03H

Data format [15] Operation Command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	–		RL	ALM	DEC	ACC	IL	VL	TL	NUV	BRK	INT	EXT	REV	FWD

(All bits are ON or active by 1)

FWD: Under forward operation
REV: Under reverse operation
EXT: Under DC braking (or under pre-excitation)
INT: Drive trip
BRK: Under braking
NUV: DC link voltage is established (undervoltage at 0)
TL: Under torque limiting
VL: Under voltage limiting

IL: Under current limiting
ACC: Under acceleration
DEC: Under deceleration
ALM: Lump alarm
RL: Transmission valid

BUSY: Under data writing (processing)

Example) Omission (Monitoring method is similar as in the formats [14] and[15].)

Data format [16] Type Code

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Type				Generation				Series				Voltage series			

Code	Type	Generation	Series	Voltage series
1	-	1 1	-	-
2	-	-	-	200V single phase
3	-	-	-	200V three phase
4	E	-	-	400V three phase
5	-	-	For USA	-
6	-	-	-	-

Data format [17] Code setting (1 4 figures)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data 4				Data 3				Data 2				Data 1			

Example) If o22 (Ai function selection)=123

Since 123=0123$_H$

01H	23H

Data format [18] Current value [Decimal data (positive): Minimum unit 1.01.]

Note 1) It is impossible to write the value which exceeds 99.99A in 10 HP or less.

Example) If F11 (electronics thermal overload relay 1 level) = 3.60A (1 HP)

Since 3.60 x 100 = 360 = 0168$_H$

| 01H	68H

Data format [19] Transmission error code

Code	Description	Code	Description
1	FC (function code) error	71	CRC error (no response)
2	Illegal address	72	Parity error (no response)
3	Illegal data (Data range error)	73	Other errors (no response)
7	NAK		- Framing error
	- Priority for link		- Overrun error
	- No right for writing error		- Bufferfull error
	- Forbidden writing error		

Example) If illlegal address

Since 2 = 0002$_H$

00H	02H

Data format [20] Auto Tuning

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	REV	FWD	0	0	0	0	0	0	Data portion	
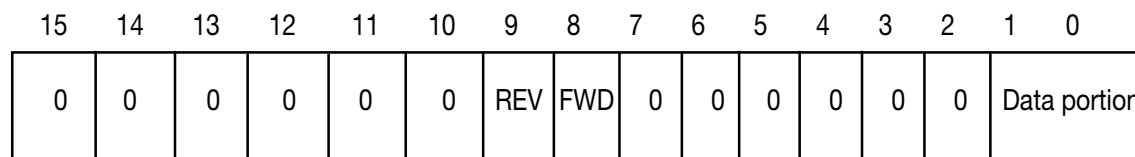
Not yet used

0 2

0: Without forward rotation command.

1: With forward rotation command.

0: Without reverse rotation command.

1: With reverse rotation command.

Note 1) When the host reads it, 0 is read always.

Note 2) When only one of bits either are set in "1," the operation becomes effective.

Example) If P04 (motor 1 auto - tuning)=1: Forward rotation

Since 0000 0001 0000 0001$_b$=0101$_H$

01H	01H

13. Changeover of communication

To perform the drive operation through the communication (by command data/operation data), the communication shall be switched to valid under the condition that 1–3 of ÅhH30ÅFLink function (selection)Åh has been selected (the reading and writing of function data/functions are possible at any time regardless valid or invalid of the communication).
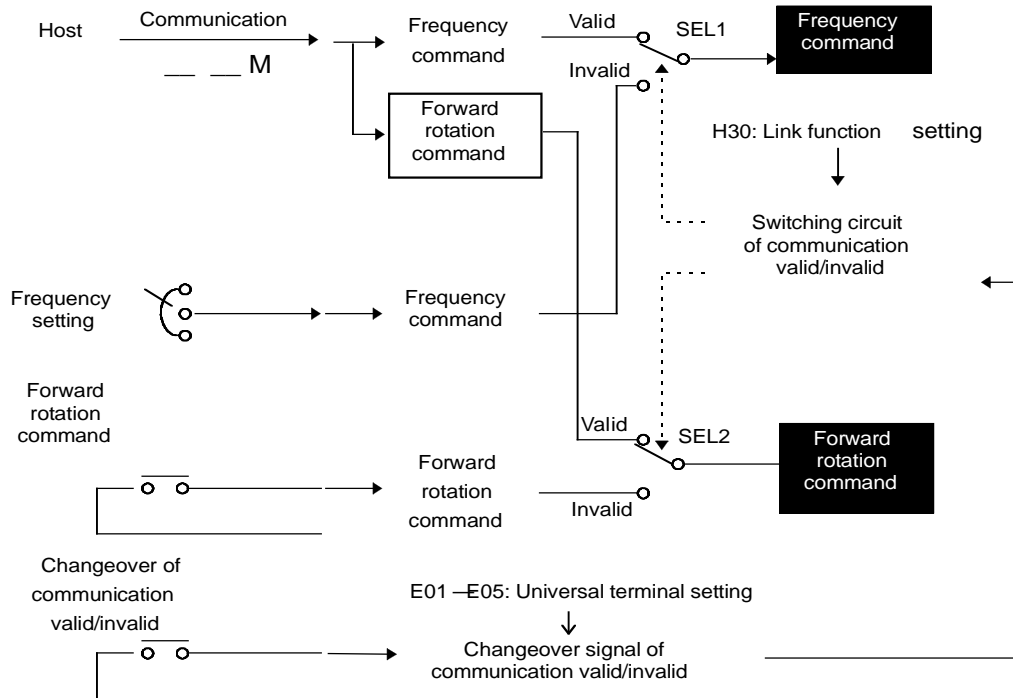
13.1 Changeover method for valid/invalid of communication

The changeover of the communication valid/invalid can be performed by universal input terminals (X1-X5 terminals) on the drive. However, it is necessary to set the inverterÅfs universal input terminals (E01–E05: X1–X5 terminals) to link operation selection (data 18). If universal input terminals have not been set to the link operation selection, the communication becomes valid automatically.

| Input Terminals	State
OFF	Communication invalid mode
ON	Communication valid mode

Notes:

- Since all memories are initialized when power is switched on, the command data/operation data transmitted through communication must be write again from the upstream units.

- Even when the communication is invalid, the writing of command data/operation data are valid, but they are not reflected by SEL1/SEL2. The changing over without shock is possible by the way where the data is set during the communication invalid mode at first, then the mode is changed over to the communication valid mode.

13.2 Link function (function selection)

The setting (valid/invalid) during the communication valid period is possible individually for command data/operation data, by the setting of "H30: Link function." (Making the communication always valid at all times by no setting of universal input terminals, and changing over the H30 data valid/invalid, changeover of the communication valid/invalid is possible similarly to the changeover by universal input terminals.)

Link Function	When Communication Is Valid		When Communication Is Invalid
H30	SEL1 (Command data)	SEL2 (Operation data)	SEL1, SEL2
0	Invalid	Invalid	Invalid
1	Valid	Invalid	
2	Invalid	Valid	
3	Valid	Valid	

14. Response time
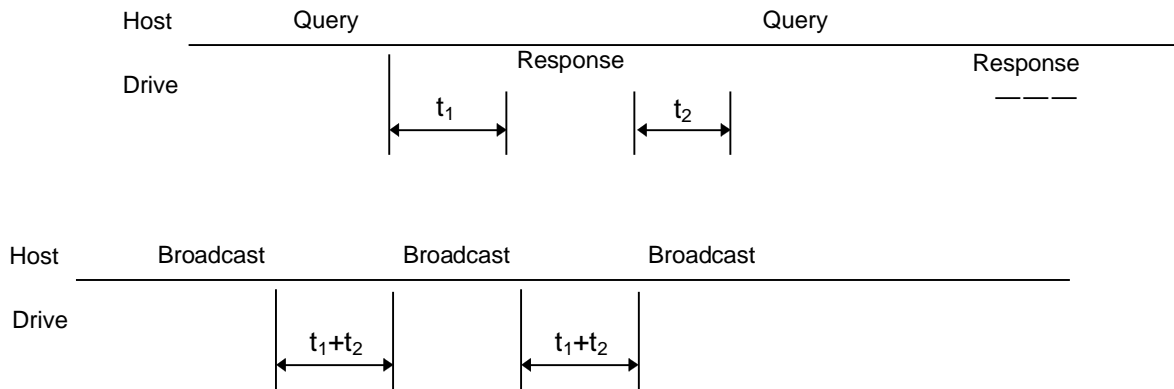
14.1 Response interval time

The time interval from receiving a query of the host, such as a PC, to commencement of response sending can be set. By means of the response interval time setting, it is possible to match the sending time even with the host having slow processing speed.

- Response interval time (t_1)

t_1: Response interval time setting (H39)+t_d

t_d: Processing time of drive

t_d	FC	Processing	Remarks
≤30ms	3	Reading of function	
≤10ms			S01_S06: Command
≤100ms	6	Writing to single function	Except S01_S06, H03, P02, A11
≤500ms			P02, A11: Motor capacity
≤5s			H03: Data initializing
≤10ms	8	Maintenance code	
≤1.6s	16	Writing to continuous function	When the data is 16 pieces (100ms¥16) Refer to the above if S01_S06, H03, P02, A11 are included.

Notes:

1) During broadcast, the setting of response interval is invalid (0 second) because the drive does not return the response.

2) If auto-tuning of P04 and A13 is written by single/continuous functions, no response returns until completion of the tuning or occurring of Er7. If tuning start is commanded by the terminal blocks or FWD/REV on the keypad panel during the invalid state of communication, take care that the waiting state continues until receiving.

14.2 Receiving preparation completion time

The time from returning of response by the drive to the completion of receiving preparation of input port is defined as the receiving preparation completion time.

t_2: Receiving preparation completion time £ 10ms

of the starting command.

13. Compliance with standards

13.1 UL/cUL standards

13.1.1 General

The UL standards stand for Underwriters Laboratories Inc. and they are safety standards aimed at preventing fire and other accidents in the United States, thereby providing protection for operators, service personnel and other persons.

The cUL standards are established by UL to be in compliance with the CSA standards. The effect on products certified for the cUL standards is equal to that of products certified for the CSA standards.

13.1.2 Precautions

When using UL/cUL certified products, refer to "Compliance with UL/cUL standards" on page vi and vii in the introduction.

13.2 Electromagnetic Compatibility (EMC) [Available only for products with CE mark]

13.2.1 General

The CE mark indicated on the ACE 20 Series refers to the European minister directorate directive 89/336/EEC concerning the environmental electromagnetic compatibility, EMC. Other directives are not included.

The CE mark on the drive does not attest that the entire machine or system housing complies with the EMC directive. Therefore, application of the CE mark to the entire machine or system will be done at the responsibility of the manufacturer of the machine. This is because:

1) The CE mark attached on the drive supposes operation of the product under "certain conditions." Satisfaction of the conditions is up to the manufacturer of the machine.

2) Generally speaking, various devices are used in a machine or system in addition to the drive. Therefore, consideration of the entire machine or system must be addressed by the manufacturer of the machine.

The EMC directive includes immunity to incoming noise and emission of outgoing noise. The general purpose drive houses an internal element switching at high speed which generates electrical noise.

EMC product standard EN61800-3/1996

Immunity : **Second environment** [Industrial environment]

Emission : **First environment** [Domestic environment for 230V Single phase, 460V Three phase]

Emission : **Second environment** [Industrial environment for 230V Three phase]

Above-mentioned "certain conditions" include installation of a dedicated RFI filter in a metallic control panel.

13.2.2 RFI filter

Please contact the drive distributor for the recommended RFI filter.

Remark : Refer to the RFI filter manual for details.

To minimize the conducted radio disturbance in the power distribution system, the length of the motor cables should be as short as possible. It is the user's responsibility to confirm that the apparatus, into which the drive is installed, conforms to the EMC directive when longer motor cables are used and when other installation conditions are different from those described in the recommended RFI filter manual.

13.2.3 Recommended Installation Instructions

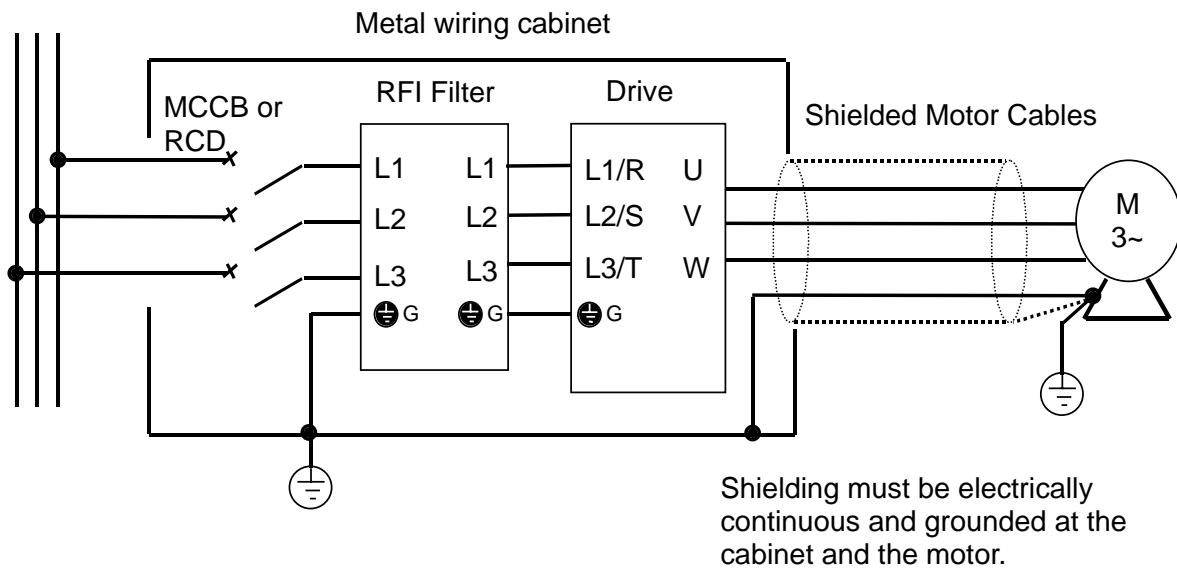These instructions must be followed to conformed to the EMC Directive.

Follow the usual safety procedures when working with electrical equipment. All electrical connections to the filter, drive and motor must be made by a qualified electrical technician.

(Refer to Fig. 13-2-1)

1) Use the correct recommended filter.

2) The back panel of the cabinet should be prepared for the mounting dimensions of the filter. Care should be taken to remove any paint, etc., from the mounting holes and face area of the panel. This will ensure the best possible grounding of the filter.

3) Install the RFI filter to the cabinet and securely mount the drive on it with screws.

(230V Three phase filter is separated type)

4) Connect the supply mains to the RFI filter input terminal (LINE) and connect the ground terminal on the filter to ground. Then connect the filter output (LOAD) to the drive input terminal with shortest possible cable. Cover the hole in the cabinet with the shield of the cable and verify that the shield is electrically connected to the cabinet.

5) Connect the drive output to the motor with shielded cable.

6) Use shielded cable for the control circuit wiring. This shield also has to be securely grounded. It is important that all wire lengths are kept as short as possible and that incoming mains and outgoing motor cables are kept well separated.

Three-phase power supply

Metal wiring cabinet

MCCB or RCD

RFI Filter

Drive

Shielded Motor Cables

L1   L1   L1/R   U
L2   L2   L2/S   V
L3   L3   L3/T   W
G   G   G

M 3~

Shielding must be electrically continuous and grounded at the cabinet and the motor.

13.3 Compliance with low voltage directive in EU [Available only for products with TÜV or CE mark]

13.3.1 General

The general purpose drive is applicable for the low voltage directive in EU. Compliance of the ACE 20 Series with EN 50178/1997 has been obtained from a testing organization in EU, and compliance with the low voltage directive is assured.

13.3.2 Precautions

Refer to "Compliance with low voltage directive in EU" on pages iv and v in the introduction when using this product as one complying with the low voltage directive in EU.

Notes:

ACE20TM
09/03