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工作機械用デジタルACスピンドルドライブシステム

FRENIC5000M3

ドライブユニット

取扱説明書

DIGITAL AC SPINDLE DRIVE SYSTEM

FOR MACHINE TOOLS

FRENIC5000M3

DRIVE UNIT

INSTRUCTION MANUAL

この取扱説明書は和文英文併記しています。和文は1～24ページ，英文は25～48ページに記載します。

This instruction manual is written in Japanese on pages 1 to 24 and in English, on pages 25 to 48.

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Foreword

This manual describes instructions as mentioned in the contents. For other items, when the drive unit is incorporated in a machine, follow the instructions of the machine. And when you purchased your drive unit and motor separately, be sure to read the AC spindle motor manual and FRENIC5000M3 technical manual together. Only proper use leads to full performance as expected. Wrong handling will cause malfunction, short service life, and faults.

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1. Safety Precautions

WARNING

Improper lifting practices can cause serious or fatal injury. Lift only with adequate equipment and trained personel. Particular care must be taken to carry the unit by holding the main body, because holding the side covers or parts can cause damage or dropping.

Wrong connection can result in the damage of the drive unit or personal injury. Connections must follow the instructions of the machine.

Connect a molded-case circuit breaker (MCCB) on the power supply side to protect the unit from damage caused by power switching, overload on conductors, and a short-circuit current.

If there is a fear of fault expansion or disaster occurrence such as fire, open the MCCB immediately to stop power supply.

Be sure to ground the earth terminal E(G) for safety's sake and to suppress radio noise.

Do not service the equipment when power is applied since this could result in electrical shock or burn. When you can not avoid live-wire work, for example, in the measurement of main-circuit electric quantities, be fully careful with your work in addition to safety measures such as grounding of measuring instruments.

It takes time for the smoothing capacitor to discharge after the power is turned off. Fot the sake of safety, do not start work before you make sure with a tester or the like that the main-circuit DC voltage has dropped to a safe voltage after the charge lamp went out.

When power supply to the drive unit is recovered from power cutting or power failure and when a protection function in operation is canceled by the RST switch, the drive unit can start outputting to restart the motor as long as the forward or reverse command remains ON. Sufficient care must be taken against danger when using a machine incorporating such connection.

A cover is not provided in the front of this drive unit; therefore, be careful enough not to touch the live part. An optional front cover made of transparent acrylic resin is available. You are recommended to buy and install it to prevent danger.

Since the surface temperature of a braking resistor rises when a current flows in it, a cover or the like must be provided around it to prevent a human body from touching directly.

CAUTION

Never apply voltage exceeding the standard specifications. Excessive voltage will damage the drive unit.

Environmental conditions for installation and transport must satisfy the standard specifications. They have a great effect on performance and life. Explosion or fires may result from mounting the drive unit in hazardous area such as locations where inflammable or combustible vapor or dusts are present. The drive unit must be installed away from hazardous areas even if used with AC motors suitable for use in such locations.

Meggering, if applied improperly, can damage the electronic components. Follow the instructions in 5-5 Meggering.

When a drive unit protection function operates, examine the fault status following 6-2 Display and Retrieval of Fault Contents and 6-3 Retrieval of Fault Data. You are recommended to record this data to make good use of it in the future maintenance and inspection of the system.

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2. Receiving

WARNING

Improper lifting practices can cause serious or fatal injury. Lift only with adequate equipment and traind personel. Particular care must be taken to carry the unit by holding the main body, because holding the side covers or parts can cause damage or dropping.

(1) Drive units

Check the description of the nameplates on the side covers to see that the delivered drive unit agrees with your order.

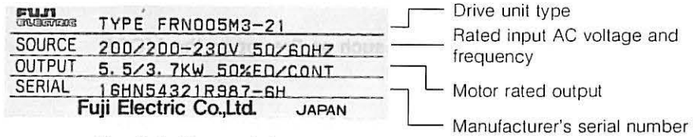


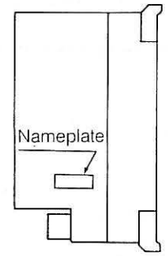
Fig. 2-1 Nameplate

Drive unit type code designation

FRN 005 M3 - 2 1

- Product type: FRENIC5000
- Motor output (50%ED)
  - 001 : 1.1 kW, 002 : 2.2 kW, 003 : 3.7 kW,
  - 005 : 5.5 kW, 007 : 7.5 kW, 011 : 11 kW,
  - 015 : 15 kW, 018 : 18.5 kW, 022 : 22 kW,
  - 030 : 30 kW, 037 : 37 kW
- Series name : Digital AC spindle drive system
- Supply voltage 2 : 200 V
- Model No. : 1

(a) Right side



(b) Left side

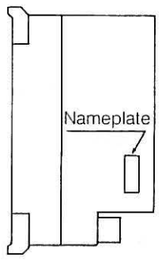


Fig. 2-2 Nameplate position

(2) Accessories

The standard accessories are a braking resistor(s) and a connector. Check the nameplates or the types marked on the product surface with the Table 2-1 to make sure that they match the drive unit you ordered.

Table 2-1 List of drive unit accessories

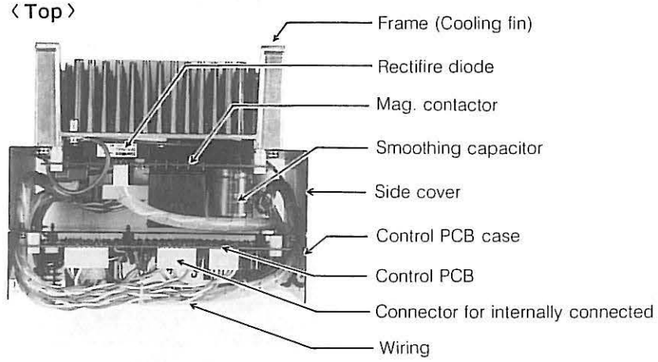
Item		Specification										
Motor output, [kW]	50%ED	1.1	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37
	Cont.	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30
Drive unit type		FRN001 M3-21	FRN002 M3-21	FRN003 M3-21	FRN005 M3-21	FRN007 M3-21	FRN011 M3-21	FRN015 M3-21	FRN018 M3-21	FRN022 M3-21	FRN030 M3-21	FRN037 M3-21
Braking resistor	Type	DB001 M3-21	DB002 M3-21	DB003 M3-21	DB005 M3-21	DB007 M3-21	DB011 M3-21	DB015 M3-21	DB018 M3-21	DB022 M3-21	DB030 M3-21	DB037 M3-21
	Qty.	1	1	1	1	2	2	3	1	1	1	1
Connector type, qty.		MR-34LF (HONDA TSUSHIN KOGYO CO., LTD.), 1 pc.										

Examine the articles for no damage due to transport such as a break, falling off of parts, and a dent on the enclosure. If you find a doubtful or defective point, inform the agent you bought them.

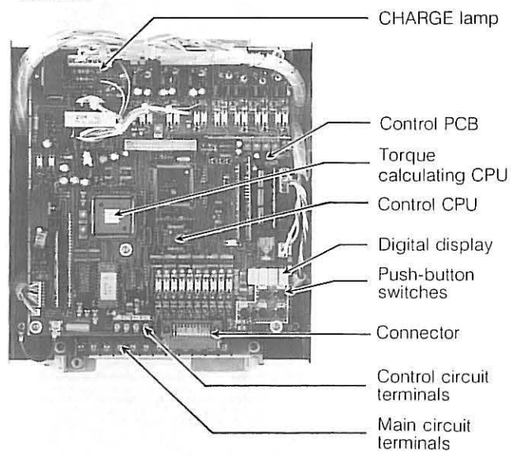
3. Drive unit Views

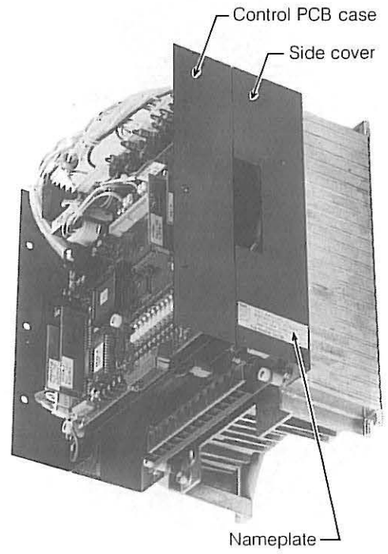
(1) Drive unit type: FRN001M3-21, FRN002M3-21, FRN003M3-21

〈 Top 〉

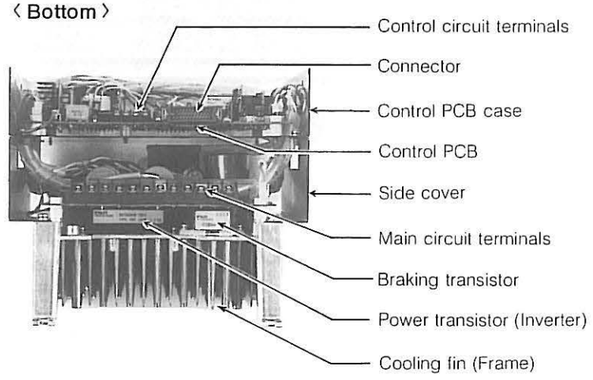


〈 Front 〉



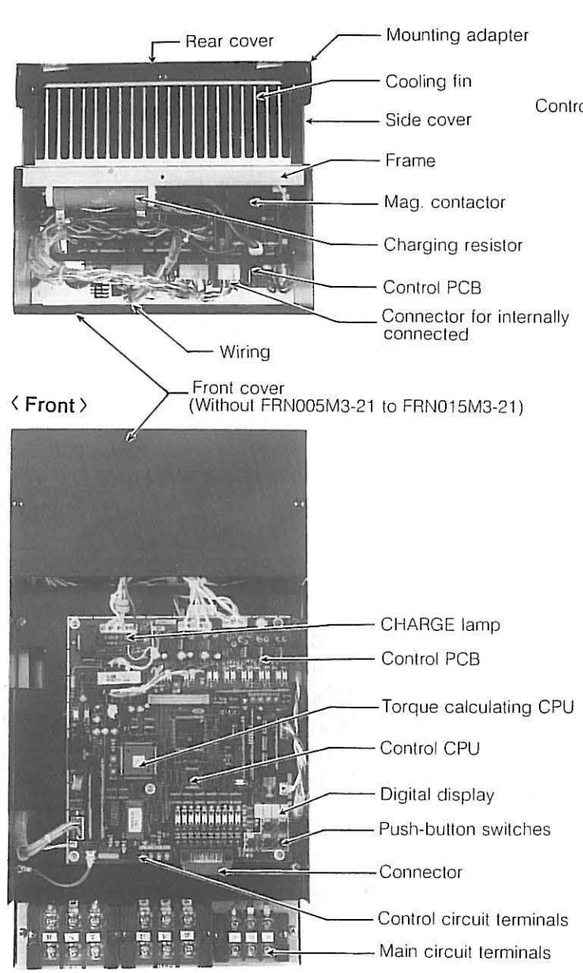


〈 Bottom 〉

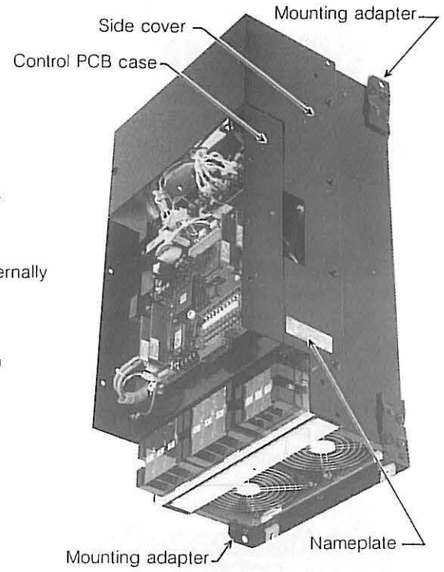


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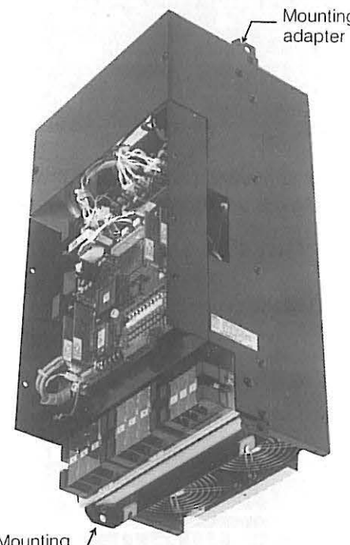
(2) Drive unit type: FRN005M3-21 to FRN037M3-21



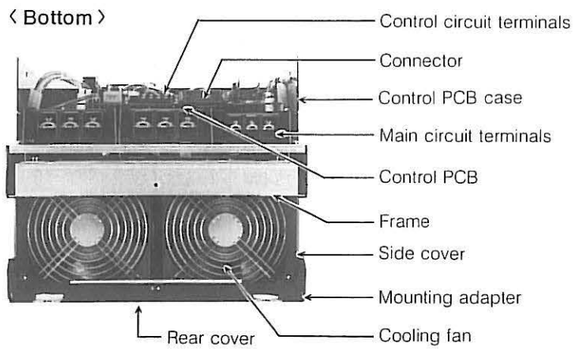
〈 In-board type 〉



〈 External cooling type 〉



〈 Bottom 〉



4. Checking and Setting of Operation Data

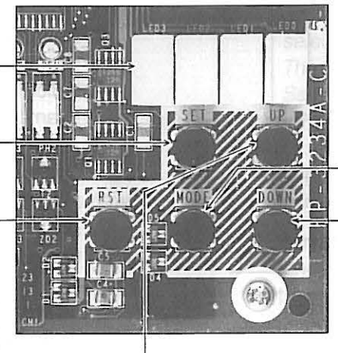
WARNING
A cover is not provided in the front of this drive unit; therefore, be careful enough not to touch the live part.

Before putting the drive system in operation, make sure that data for parameters agree with the machine indications. Set correct data to parameters of which setting differs from the indications. You can check or set data with the digital display on the control printed circuit board (PCB) and the push-button switches.

4-1 Functions of Digital Display and Push-button Switches

Digital display
Indicates a function code or setting/ operation data shown in the Function Table on pp.47, 48.

Fig.	Display	Eng. char.	Display
0	0	A	A
1	1	B	b
2	2	C	C
3	3	D	d
4	4	E	E
5	5	F	F
6	6	H	H
7	7	L	L
8	8	O	o
9	9	P	P
Active	o	U	u
Inactive	-	V	U

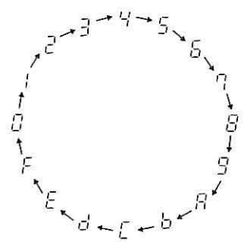


Mode switch
- Selects an indication mode of function codes or setting/ operation data.
  ON: Function codes
  OFF: Setting/operation data
- This switch, when combined with UP or DOWN switch, gives function codes.

SET switch
To be switched on to input data set in the RAM into the memory to update parameter data.

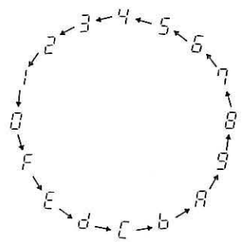
RST switch
- In parameter mode
  To be switched on to change data indication into operation mode function indication.
- In fault mode
  To be switched on to cancel drive unit protection function in operation after fault restoration.

UP switch
Shifts a figure or code of setting/ display data as illustrated below:



- LED1 shifts in order as above when LED0 shifts from F to 0; LED2, when LED1 shifts from F to 0; and LED3, when LED2 shifts from F to 0.
- Figures and codes that are not designated to drive unit functions are skipped.
- Data setting is limited by the upper limit of setting range.
- Setting of code o .

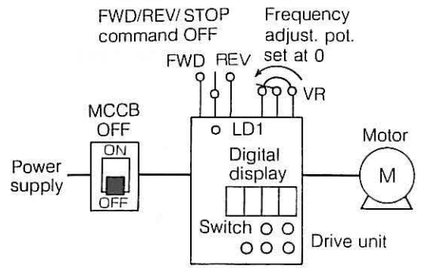
DOWN switch
Shifts a figure or code of setting/ display data as illustrated below:



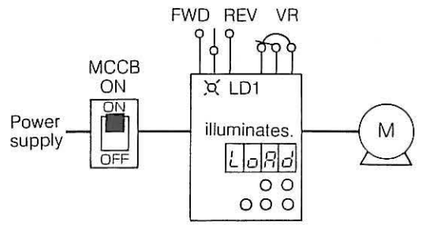
- LED1 shifts in order as above when LED0 shifts from 0 to F; LED2, when LED1 shifts from 0 to F; and LED3, when LED2 shifts from 0 to F.
- Figures and codes that are not designated to drive unit functions are skipped.
- Data setting is limited by the upper limit of setting range.
- Setting of code - .

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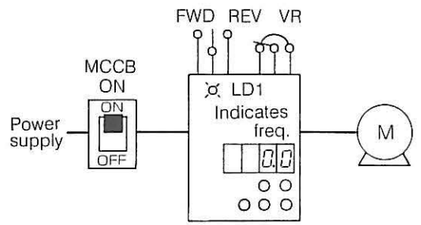
4-2 Function Selection and Operation Data Checking



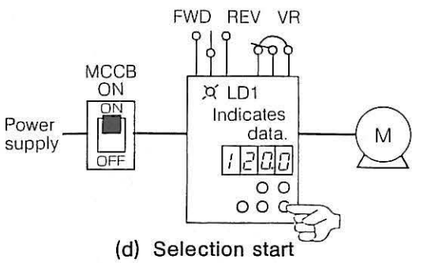
(a) Standby



(b) Power on



(C) Ready for selection



(d) Selection start

Fig. 4-1 Preparation for function selection

When power is supplied to the drive unit, the CPU on the control PCB starts reading internal data. It takes about 2 seconds and the digital display indicates LoAd. After 2 seconds, the display indicates an output frequency value (displays 0.0 during stoppage). The CHARGE lamp (LD1) on the same PCB illuminates.
Now operation for selecting a function can be started.

① The digital display always indicates output frequency of the drive unit.
Example: Output frequency is 0 during stoppage; indication is 0.0.

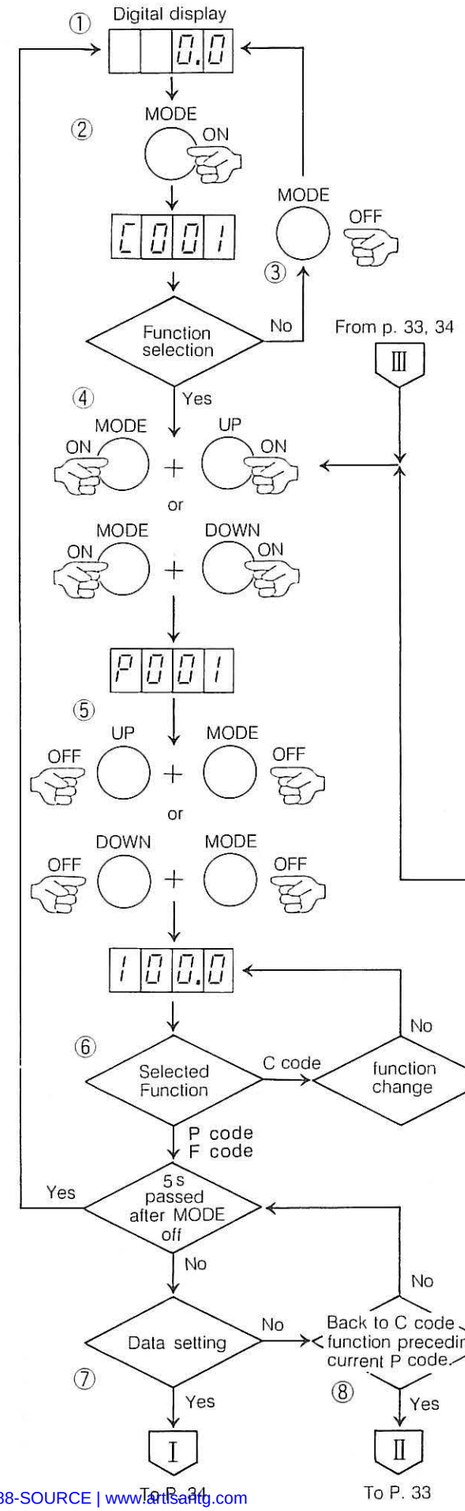
② Switch on the MODE, and the digital display indicates the function code of data being indicated.
Example: When an output frequency value is indicated, function code C001 for output frequency is indicated.

③ Switch off the MODE when you do not select another function. The display indicates a function code for about 5 seconds after the MODE is switched on, and after that, it automatically indicates data (an output frequency value).
When the MODE is switched off after an on-state exceeds 5 seconds, data is indicated immediately.

④ When you select another function, switch on the UP or DOWN while keeping the MODE on.

Selecting order of functions
- MODE + UP
  A function is selected in the downward order of the functions described in the Function Table. F009 is followed by C001.
- MODE + DOWN
  A function is selected in the upward order of the functions described in the Function Table. C001 is followed by F009.
- The fault mode F001 to F005 can be selected only when a drive unit protection function operates.

NOTE
Note that when P000: set data protection is set at - (data setting abled), if you switch on UP or DOWN before MODE while a parameter mode function is indicated, the set data will be changed. This step is the same as the operation in Section 4-3 (page 33).



⑤ When the display indicates a selected function code, switch off UP or DOWN, and then MODE. The displayindicates the data of the selected function.
Example: Shows that the maximum frequency has been set to 100.0 Hz.

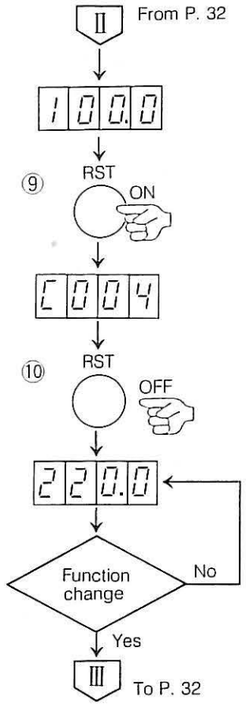
NOTE
Note that when P000: set data protection is set at - (data set abled), if you switch off MODE before UP or DOWN while a parameter mode function is selected, the set data will be changed. This step is the same as the operation in Section 4-3 (page 33).

⑥ Data indication time differs according to a selected function code.
- When an operation mode (C code) function is selected, the display continues to indicate the data till another function is selected.
- When a parameter mode (P code) function or a fault mode (F code) function is selected, the display indicates the selected function data about 5 seconds after MODE is switched off.
  It automatically shifts to an output frequency value in 5 seconds.

⑦ For the setting or changing of a parameter mode function data, refer to Section 4-3 (page 33).

⑧ While parameter mode (P code) function data is indicated, the operation mode (C code) function that had monitored before this P code function was selected can be selected by the following operation.

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⑨ Switch on the RST while P code function data is indicated (about 5 seconds). The display indicates the C code function that had monitored before the P code function was selected.
Note that while a function code (P code) is indicated, RST switching can not shift indication to a C code function.
Example: Before a P code function was selected, C004: output voltage set value had monitored.

⑩ When the RST is switched off, the C code function data is indicated. Even if the RST is kept on, the display will shift to data indication after certain seconds. The data indication continues till a next function is selected.
Example: The output voltage set value is 220 V.

4-3 Operation Data Setting

① Stop the drive unit output. During operation, data can be set to certain functions, but not to almost all the functions. For details, refer to the Function Table (pages 47 and 48).

② Select the P000: protection of set data, and check for protection active or inactive.
Data indication – : Data setting abled. ▫ : Data setting disabled. When – is indicated, you can set data. When ▫ is indicated, change the indication to – following the instructions below and then set data.

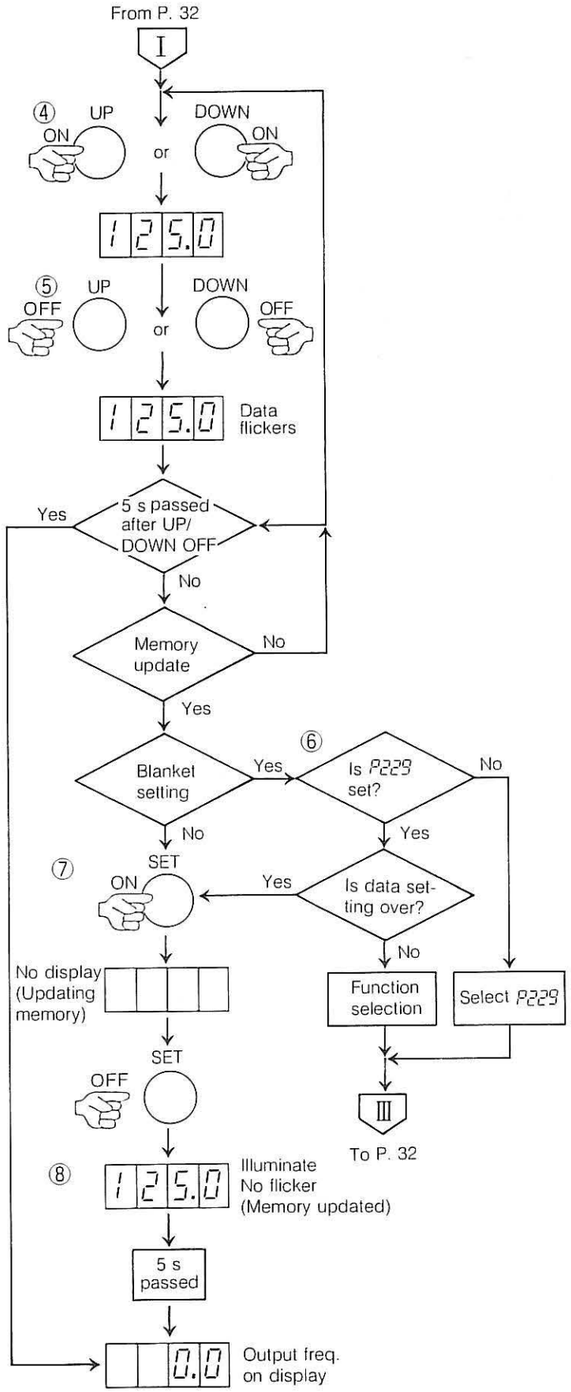
③ Select a required function following the steps in Section 4-2, and get data on display.

④ Switch on UP or DOWN to change data on the digital display. Adjust excess or deficiency to a setting value by repeating ON/OFF of UP or DOWN.
Example: The maximum frequency setting value is 125 Hz.

NOTES

The drive unit will be operated by data indicated on the digital display even if you fail to switch on the SET. It is designed to be operated by input data in the RAM. The SET is to be switched on to update the memory.

Methods of returning data on display to the previous one (stored in the memory) are as follows:
ⓐ To return data to the previous one by switching on the UP or DOWN.
ⓑ To turn off the power once.
ⓒ To select and set P228: resetting standard setting data.
Note that this function returns data to the one set by the drive unit factory before shipping (See the List of Functions).
In the case that you purchased your drive combined with a machine, follow the instructions of the machine.



NOTE

When you selected a function that does not allow setting or changing data, it is not possible to change data on the digital display by switching on the UP or DOWN. The drive unit can not be subjected to a trouble by this operation.

⑤ The display indicates data about 5 seconds after the UP or DOWN is switched off. The data flickers. Switch on the SET to update the memory. The display automatically shifts to output frequency value in 5 seconds.
To update the memory after output frequency is on display, select the function code again, check the data and switch on the SET within 5 seconds.

⑥ When setting more than one data, you can use the P229: blanket parameter setting, to dispense with setting each for a function. You can select and set the P229 at any time during a data setting process, and can set the whole data that were set around the time of P229 setting at a time by switching on the SET as mentioned in.

⑦ When you switch on the SET, the indication on the digital display goes out and memory updating starts. Then switch off the SET.

NOTE

The switching off of the SET after output frequency value appeared will have no effect on the drive unit and motor; however, make a rule of switching it off when the indication goes out.

⑧ When the memory is updated, the set data is indicated again. In about 5 seconds, an output frequency value will be indicated.

⑨ To make setting each for a function without setting the P229, repeat the steps to this point for each.

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5. Maintenance and Inspection

WARNING

Do not service the equipment when power is applied since this could result in electrical shock or burn. When you can not avoid live-wire work, for example, in the measurement of main-circuit electric quantities, be fully careful with your work in addition to safety measures such as grounding of measuring instruments.

The drive unit is composed of many parts and it can not bring its performance into full play unless those parts operate properly. Proper maintenace and inspection is necessary in order to prevent drive unit trouble from occurring and to continue its reliable operation for a long time. For the inspection items and methods, see Section 7. Inspection List on page 44.

5-1 Precautions in Maintenance and Inspection

WARNINGS

Turn off the power without fail before you will touch the drive unit.

Make the worker himself check the power ON/OFF and forbid power operation by others who are not in charge.

The smoothing capacitor remains charged for some time after the power is turned off. Start work after CHARGE lamp LD1 on the control PCB is off and the main-circuit DC voltage measured with a tester is as low as safe voltage.

CAUTION

Hold the housing, not the cable, to pull out the connectors. Be careful not to insert them into wrong positions.

5-2 Daily Inspection

① The fundamentals of daily inspection is to check for abnormal noise, unusual smell or visual abnormality from outside during operation.

② When you find an abnormality, investigate the location and extent immediately.

③ Check the contents of the abnormality and judge whether operation can be continued or not. If not, stop the equipment immediately and remove the cause of the abnormality.

5-3 Periodical Inspection

Turn off the power. Check the places that can be inspected only when operation is stopped, and check places and parts that require periodical inspection. If you find an abnormal place or part, remove the cause of the abnormality or replace the part.

5-4 Periodical Replacement of Parts

Though the service life of drive unit parts depends on the working environment and operation time of the unit, the life expectancy of electrolytic capacitors is about 5 years and that of cooling fans, about 3 years when they are operated continuously within the allowable limits of the standard specifications. You are recommended particularly to replace these parts before a trouble occurs.

5-5 Meggering

CAUTION

Carry out meggering in accordance with the following instructions. Note that wrong application may cause drive unit damage.

(1) Main circuits

Use a 250 V DC megger.
Do not use a 500 V DC megger because a leakage current due to the voltage characteristics of the surge suppressor connected on the power supply side may cause incorrect indications.

① Remove the external connections from all the drive unit terminals (including control circuit terminals). Connect all the main circuit terminals with a common wire as shown in Fig. 5-1.

② Carry out meggering only between the main circuit common wire and earth terminal E(G). Never apply meggering to control circuits and others.

③ The drive unit is normal when the megger indicates more than 5MΩ.

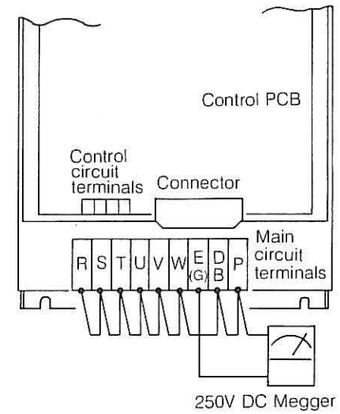


Fig. 5-1 Meggering connection

(2) Control circuits

Remove the external connections from control circuit terminals and carry out noncontinuity-to-earth test.
Use a high-resistance-range tester.
Never use a megger.

(3) Precautions in the tests of external main and control circuits

When you apply dielectric test or meggering to external circuits, detach all the external connections at the drive unit terminals so that test voltage can not be impressed on the unit.

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5-6 Measurement of Main Circuit DC Voltage

Measuring terminals are the main circuit terminal P for positive (+) and the signal check terminal DCN on the control PCB for negative (−). Use a tester or the like.

WARNING

Take the utmost care that the voltage during current carrying sometimes exceeds 310 V.

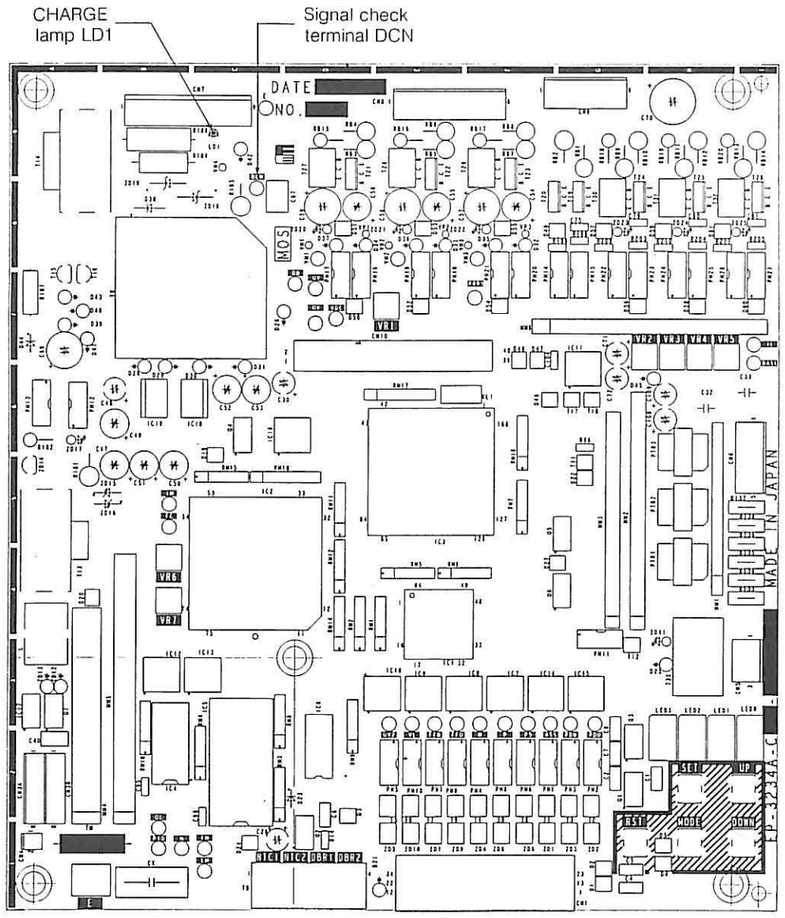


Fig. 5-2 Rough sketch of the control printed circuit board

6. Troubleshooting

6-1 Protection Functions

WARNINGS

A cover is not provided in the front of this drive unit: therefore, be careful enough not to touch the live part.

If there is a fear of fault expansion or disaster occurrence such as fire, open the MCCB immediately to stop power supply.

The drive unit has protection functions as shown in Tables 6-11 and 6-12. The operation of a protection function in Table 6-12 (fault occurrence) cuts off the power transistor base current and the drive unit stops output immediately to protect the unit and motor. Then the motor runs free and the indication of the digital display on the drive unit automatically shifts to the indication of the contents (type) of a fault. The contents and data of more than one fault can be retrieved by operating the push-button switches on the control PCB. After you switch on the RST to cancel the operating protection function, you can not select or retrieve the functions (F001 to F005) for the contents of faults and operation status at fault. Therefore, you are recommended to record these data.

Table 6-11 Protection functions (I)

Function	Description
Stall prevention	Increases acceleration time automatically to suppress overcurrent at rapid acceleration so that overcurrent trip can be prevented. Similarly, increases deceleration time automatically to suppress overcurrent/overvoltage at rapid deceleration so that overcurrent/overvoltage trip can be prevented.
Current limiting	Suppresses overcurrent by our own method when the drive unit output current reaches the current limiting level.
Instataneous power failure	Running continues about 15 ms after the power fails under a continuous rated load. (Under a lighter load, running time is longer.)
Input surge	Protects the drive unit from 5 kV standard impulse voltage that comes in from the main circuit power supply.

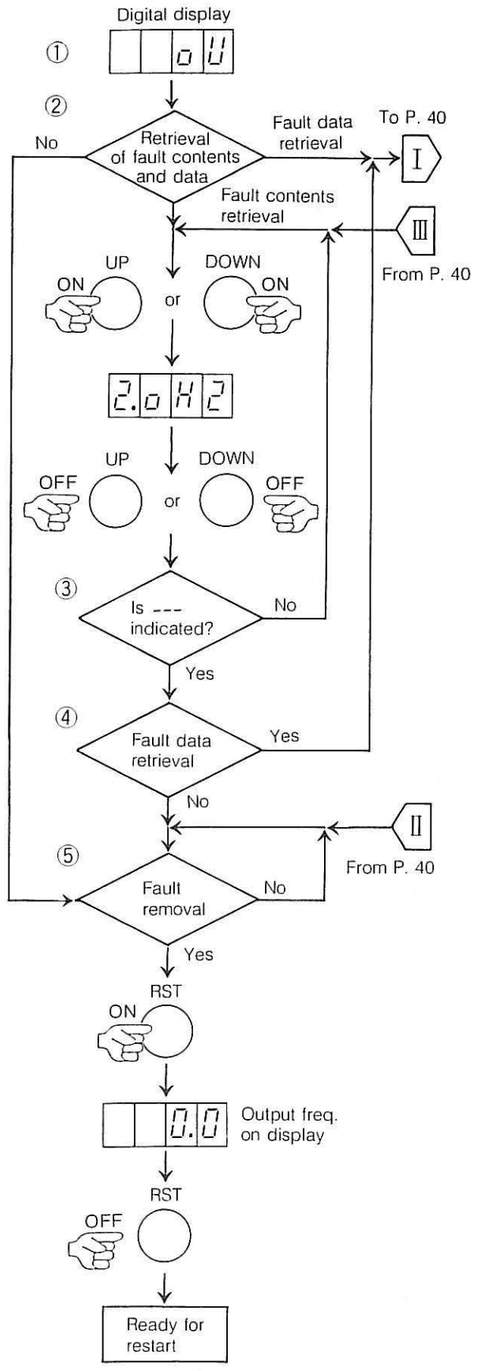
Table 6-12 Protection functions (II)

Function	Display	Description
Under-voltage protection	LU	When the main-circuit DC voltage drops below the undervoltage level, the drive unit stops output immediately and holds a trip condition. When a power failure is so long that control power fails, the function is automatically reset.
Overvoltage protection	oU	When the main-circuit DC voltage reaches the overvoltage protection level, the drive unit stops output immediately.
Overcurrent protection	oC	When the drive unit output current reaches the overcurrent protection level, the unit stops output immediately.
Overload	oL1	When the drive unit operation exceeds the overload capacity (inverse-time characteristic), the unit stops output immediately.
Motor overload	oL2	When the temperature detection thermistor built in the motor detects the overload level, the drive unit stops output immediately to protect the motor surely from burnout due to overload.
inverter overheating	oH1	When the drive unit cooling fins is overheated or unit temperature is too high, the unit stops output immediately.
External faults	oH2	When an external alarm signal, such as from the thermal relay for braking resistor overheat detection, inputs, the drive unit stops output immediately.

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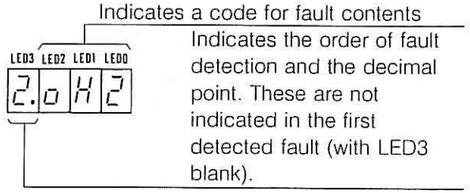
6-2 Display and Retrieval of Fault Contents

For the functions of the digital display and push-button switches, refer to Section 4-1 on page 30.



① When a protection function operates, the display automatically shifts to a fault mode and indicates the code of the contents (type) of a fault first detected.
Example: The first detected fault was due to overvoltage.

② To check for combined faults, switch on the UP or DOWN and retrieve the second and third fault contents. The contents of faults are all indicated by codes.
The retrieval of fault contents can be omitted; however, you are recommended to carry it out to clear up the cause of faults.
Example: The second detected fault was due to an external alarm.

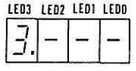


NOTES

The contents of 7 faults, that is, up to 7th faults, can be retrieved and indicated.

The contents of a fault remains on display till next operation is performed.

③ Switch on UP or DOWN till the digital display LED2, 1, and 0 indicates - .
The mark - shows that the contents of faults are not detected. Now the retrival of fault contents is over.



Example: The third fault is not detected.

④ Next, retrieve fault data when protection function operates and the fault record. For details, refer to Section 6-3 on page 40.

⑤ When you finish the retrieval of fault data or you do not intend to do it, remove the cause of the fault and switch on the RST. The indication will shift to an output frequency value and the motor can be restarted.
Example: Since the drive unit has stopped output, 0.0 is indicated.

NOTES

If the operation mentioned below is performed when the cause of a fault is not removed, the fault will be detected as new one, which will cause the protection function to operate again and will update the fault record.

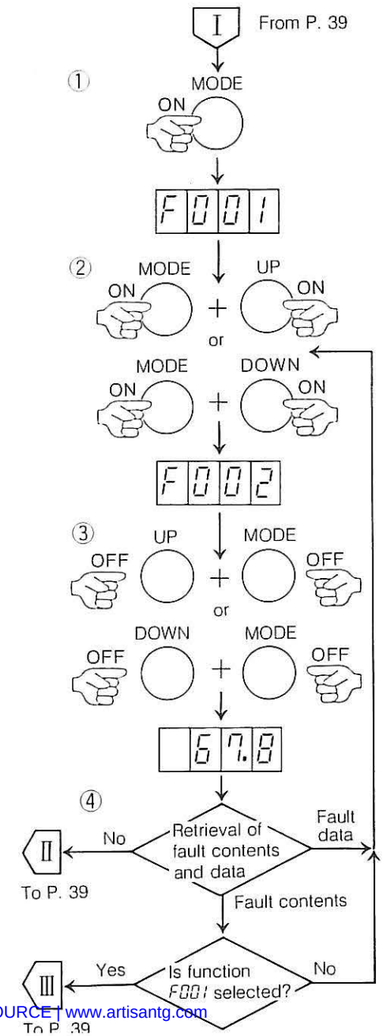
ⓐ *To switch on RST,* ⓑ *To turn off the power and turn it on again.*

When RST is switched on while a protection function is not in operation, the fault record is not updated.

While a protection function is in operation, other functions than fault mode ones can not be selected. To select a function of operation mode, parameter mode or protection mode, switch on RST to cancel the operation of the protection function.

If you switch on RST to cancel a protection function in operation with the forward or reverse command kept ON, the drive unit will start to output and the motor will start running. Take the utmost care not to switch on RST before you turn off the forward or reverse command.

6-3 Retrieval of Fault Data



① Switch on MODE to shift the display from fault contents to function code indication.
Example: Indicates a function code for fault contents, F001.

② To select a required function, switch on MODE first, then UP or DOWN. Function codes shift as in Fig. 6-1.

NOTE

If you switch on UP or DOWN first, the retrieval of fault contents will be indicated. Be sure to operate MODE first, then UP or DOWN

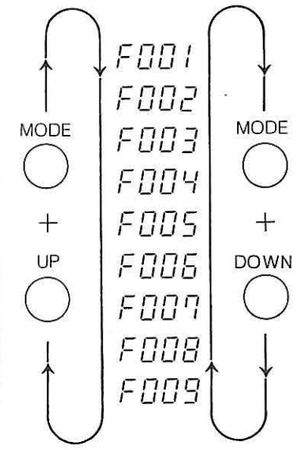


Fig. 6-1 Order of fault mode functions

③ When the digital display indicates aselected function code, switch off UP or DOWN, and then switch off MODE immediately. The digital display will indicate the data of the selected function.
Example: Output frequency at fault (F002) is selected and data at fault was 67.8 Hz.

NOTE

The indicated data remains on display till next operation is performed.

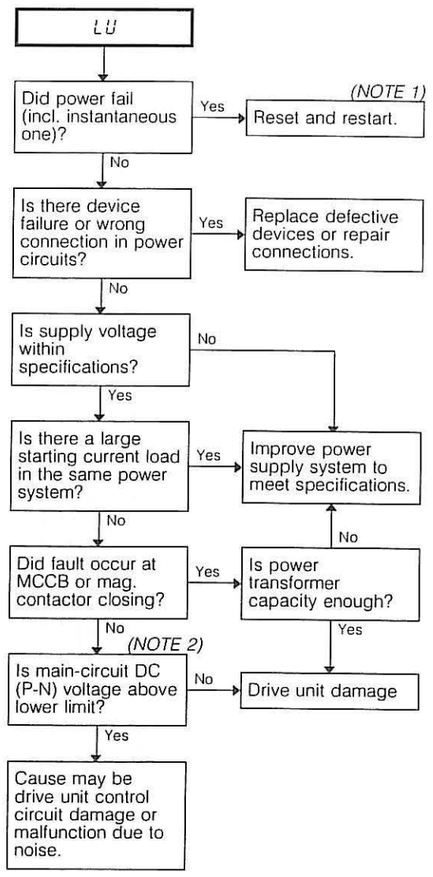
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④ Repeat ② and ③ to retrieve fault data. After retrieval is over, follow Section 6-2 ⑤ on page 39.
To select fault contents again, select function code F001. After that, follow Section 6-2 on page 39.

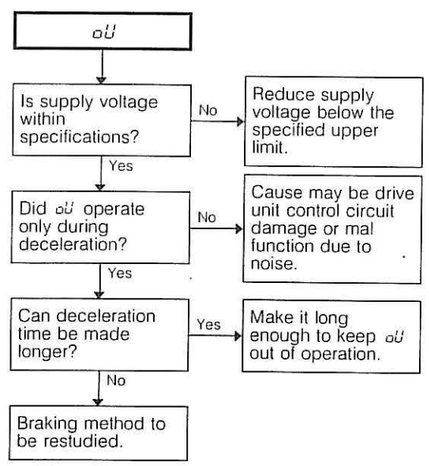
6-4 Diagnosis and Steps at Fault

When a fault occurs and the drive unit protection function operates, refer to the steps shown below to find its cause and remedy it. If these steps are not applicable to your fault or your drive unit has been damaged, inform the machine supplier or Fuji Electric.

(1) Undervoltage



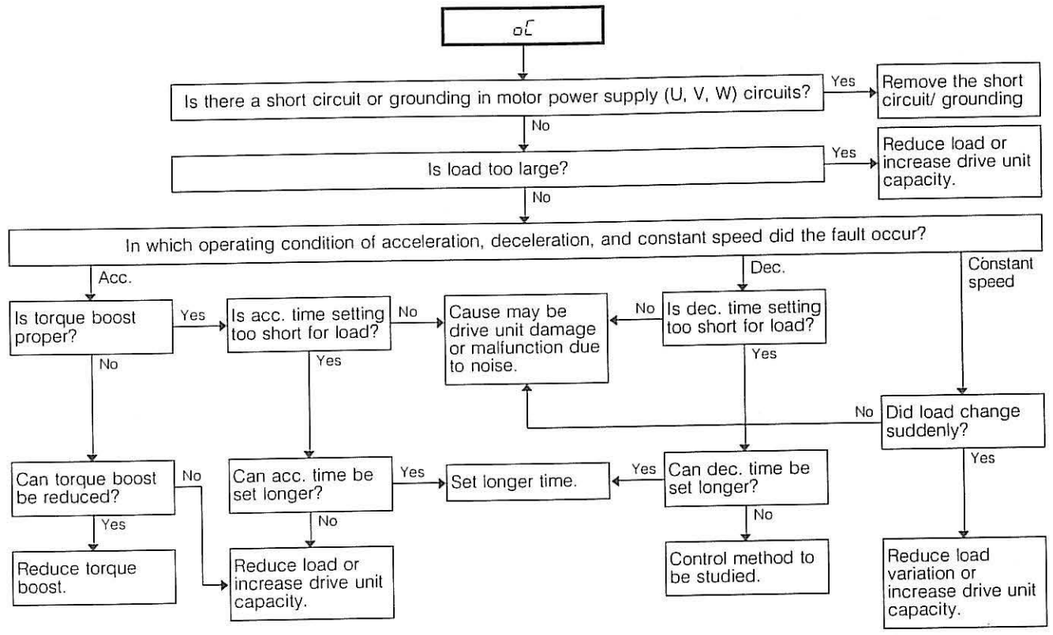
(2) Overvoltage



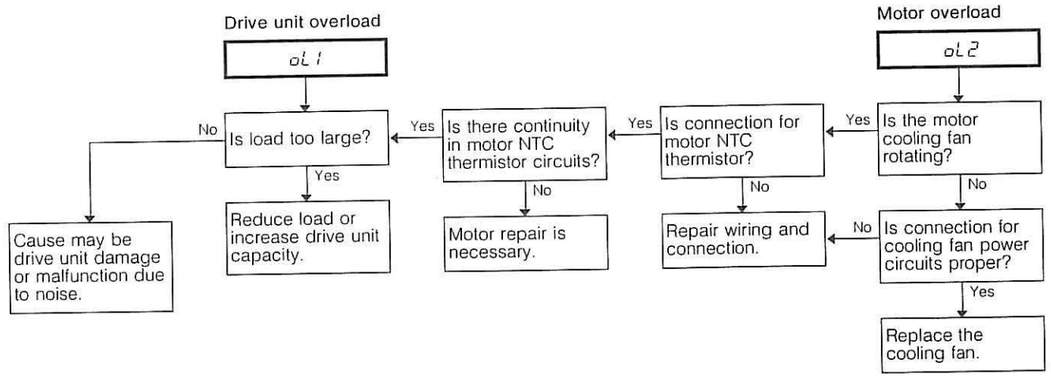
(Note 1) When the smoothing capacitor discharges and drive unit control power fails, the fault function is automatically reset.

(Note 2) When the main-circuit DC voltage drops below 200 V, the undervoltage protection gives an indication and alarm.

(3) Overcurrent

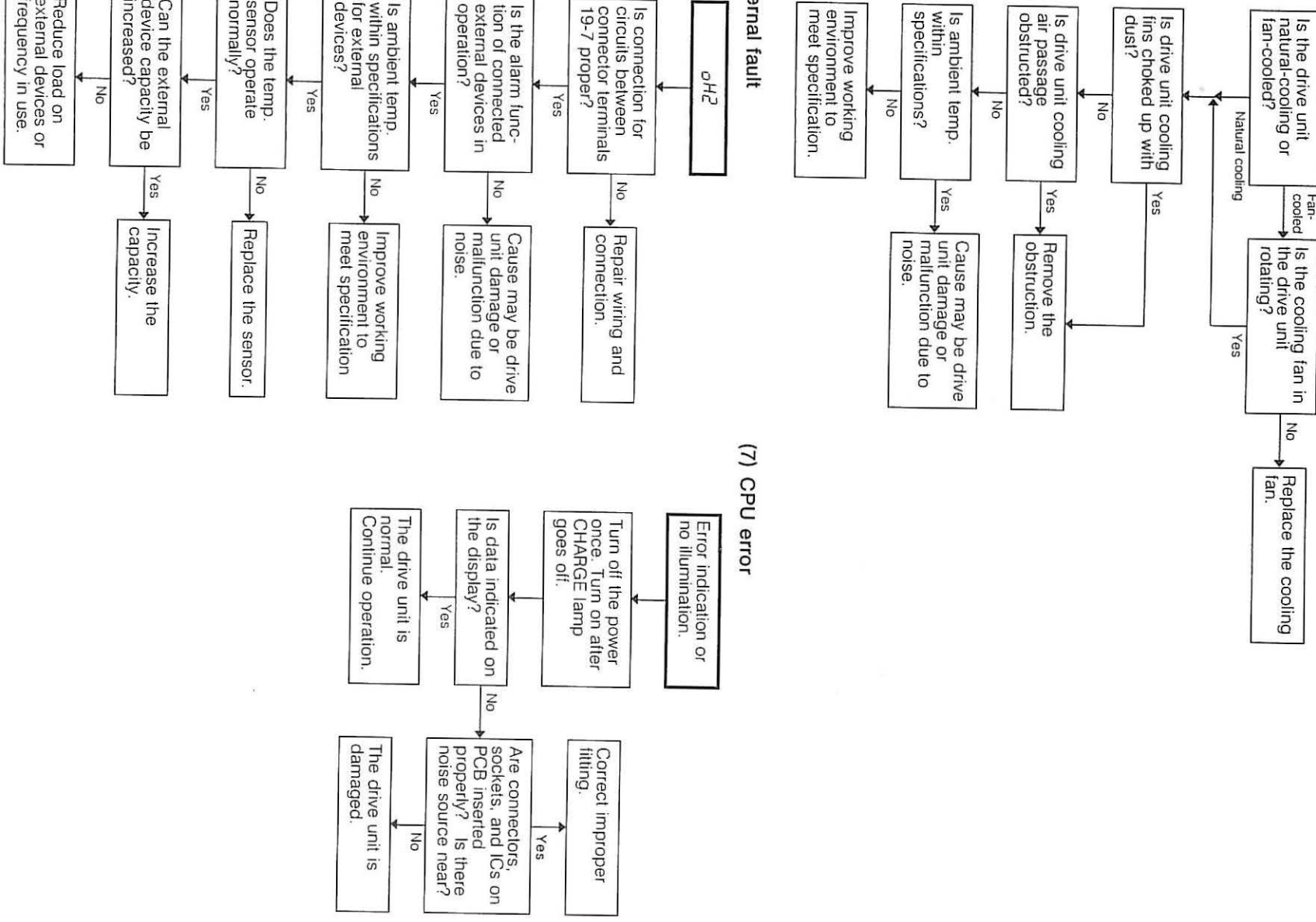


(4) Overload

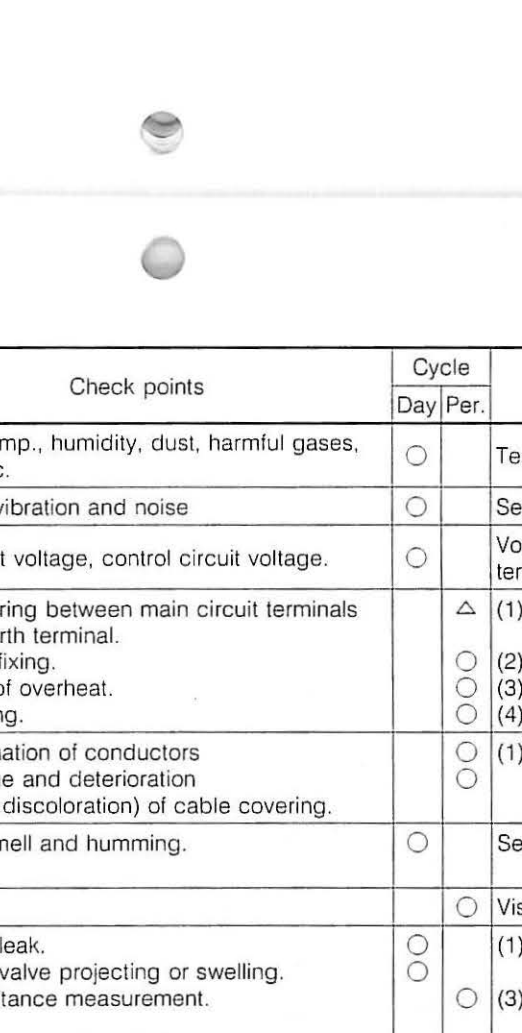


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(5) Inverter overheating



(6) External fault



(7) CPU error

7. Inspection List

Place	Item	Check points	Cycle Day	Cycle Per.	Inspection method	Acceptance criteria
General	Environment	Ambient temp., humidity, dust, harmful gases, oil mist, etc.	○		Testers, seeing, smelling.	Satisfies standard specifications.
	Whole equip.	Abnormal vibration and noise	○		Seeing and hearing.	No abnormality.
	Supply voltage	Main-circuit voltage, control circuit voltage.	○		Voltage measurement between power input terminals R, S, T.	Satisfies standard specifications.
Main circuit	General	(1) Meggering between main circuit terminals and earth terminal. (2) Loose fixing. (3) Trace of overheat. (4) Cleaning.		△ ○ ○ ○	(1) See 5-5 Meggering. (2) Add tightening. (3) Visual inspection. (4) Remove dust with a vacuum cleaner.	(1) 5MΩ or more. (2), (3) No abnormality.
	Conductors, wires	(1) Deformation of conductors (2) Damage and deterioration (crack, discoloration) of cable covering.		○ ○	(1), (2) Visual inspection.	(1), (2) No abnormality.
	Transformer, reactors	Unusual smell and humming.	○		Seeing, hearing, smelling	No abnormality.
	Terminal blocks	Damage		○	Visual inspection.	No abnormality.
	Smoothing capacitors	(1) Liquid leak. (2) Safety valve projecting or swelling. (3) Capacitance measurement.	○ ○	 ○	(1), (2) Visual inspection. (3) Use an capacitance measuring instrument.	(1), (2) No abnormality. (3) Not less than 85% of imitial capacitance.
	Relays, contactors.	(1) Chattering during operation. (2) Wear of contacts.		○ ○	(1) Hearing. (2) Visual inspection.	(1), (2) No abnormality.
	Resistors	(1) Crack of insulation. (2) Breaking of wire.		○ ○	(1) Visual inspection. (2) Open connection at one side and check with tester.	(1) No abnormality. (2) Error shall be within ±10% of indicated resistance.
Control circuit	Operation check	(1) Balance check of phase output voltages in independent drive unit operation. (2) Check for no abnormality in protection and display circuits during sequential protective operation test.		○ ○	(1) Measure voltages between drive unit output terminals U, V, W. (2) Simulate by shorting contact input terminals and common terminal for drive unit control.	(1) Voltage difference between terminals shall not exceed 2% of output voltage. (2) No error in external sequential operation check
	Parts, general	(1) Unusual smell, discoloration. (2) Serious rust.		○	(1), (2) Visual inspection.	(1), (2) No abnormality.
	Capacitors	Liquid leak, deformation.	○		Visual inspection.	No abnormality.
Cooling	Cooling fan	(1) Abnormal vibration and noise. (2) Loose connection.	○	 ○	(1) Seeing and hearing. Turn the fan by hand with the power off. (2) Add tightening.	(1) Smooth rotation and no abnormal noise. (2) No abnormality.
Display	Display	(1) Lighting of digital display and CHARGE lamp. (2) Cleaning.	○	 ○	(1) Check for abnormality in the display and lamp. (2) Clean with a cloth.	(1) Lighting confirmed.

NOTE: Mark △ in the column Per. (periodical inspection) may be performed when required.

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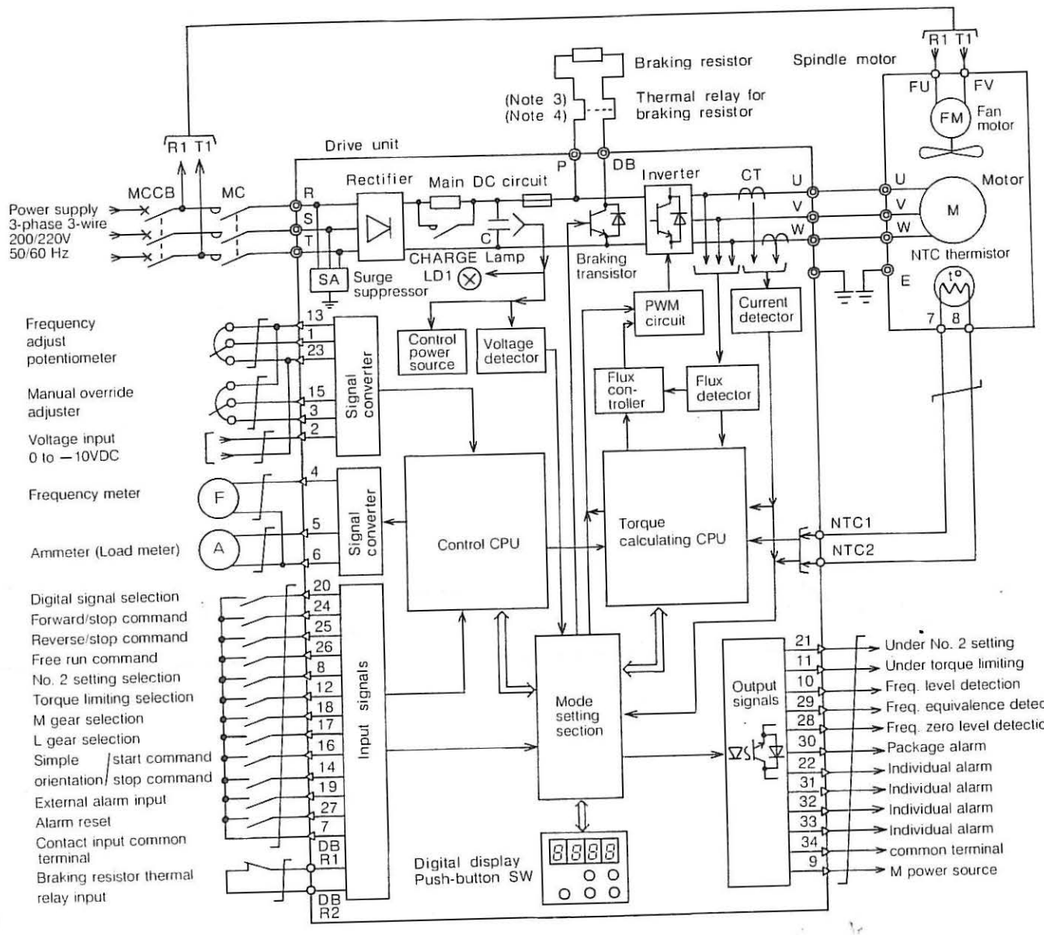
8. Standard Specifications

Item		Specification										
Motor rated output, [kW]	50%ED	1.1	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37
	Cont.	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30
Drive unit type		FRN001 M3-21	FRN002 M3-21	FRN003 M3-21	FRN005 M3-21	FRN007 M3-21	FRN011 M3-21	FRN015 M3-21	FRN018 M3-21	FRN022 M3-21	FRN030 M3-21	FRN037 M3-21
Power supply	Ratings	3-phase 3-wire 200V/50Hz, 200 to 230V/60Hz										
	Permissible regulation	Voltage: +10 to −15%, voltage unbalance ratio: 3% or less (*1), frequency: ±5%										
Overload capacity		120% for 60 seconds with 50%ED rated output										
Control	Main-circuit system	Transistor sinusoidal PWM VVVF inverter										
	Control system	V / f control with flux control loop (2 selectable V / f patterns)										
	Drive / brake system	4-quadrant drive, resistor dynamic braking (with the braking resistor installed separately)										
	Acceleration / deceleration	Torque limiting acceleration / deceleration, soft start / soft stop (0.1to 99.9s)										
	Output frequency	Control range : 0.5 to 270Hz										
		Base frequency : 30 to 200Hz										
		Accuracy Analog signal: ±0.2% of maximum frequency at 25±10℃ Digital signal: ±0.04% of maximum frequency at −10 to 55℃										
	Additional functions	Torque limiting control, current limiting control, automatic flux reducing control, slip compensator, restart at instantaneous power failure, simple orientation.										
Protection		Stall prevention, current limiting, overvoltage, undervoltage, overcurrent, drive unit overload, drive unit overheating, motor overload, external fault, CPU error, incoming surge.										
Input	Frequency setting signal	Analog signal: 0 to +10VDC, 0 to −10VDC (maximum frequency / 10V) Digital signal: 12-bit binary, BCD 2 digits, BCD 3 digits (*2)										
	Override signal	−A to +A of frequency setting signal, A: 20 to 50% (at 1% intervals)										
	Contact	Digital signal selection, forward / stop command, reverse / stop command, free run command, No.2 setting selection, torque limiting selection, M gear selection, L gear selection, simple orientation start command, simple orientation stop command, external alarm input, alarm reset										
Output	Instrument	0 to +10VDC for frequency meter, ammeter (load meter)										
	Open emitter	Under No.2 setting, under torque limiting control, output frequency level detection, frequency equivalence detection, output frequency zero level detection, package alarm, individual alarm										
Indication	Digital display	Indicates a function code and setting / operation data. See the Function Table.										
	Charge lamp	The LED illuminates with smoothing capacitor charge voltage present.										
Construction / cooling		In-board (natural cooling) | In-board / external cooling (fan-cooling)										
Color		Munsell N1.2, semigloss										
Environment	Location	Indoor, not more than 1000m above sea level.										
	Atmosphere	Free of inflammable gases, corrosive gases, oil mist, moisture, waterdrops, and direct sunlight. Salts and dusts must be little.										
	Ambient temp.	−10 to +55℃ | Non-condesing and free of ice.										
	Transport / storage temp.	−20 to +70℃										
	Humidity	20 to 90% RH										
	Vibration	Not more than 4.9m/s² {0.5G} (Conforming to JIS C 0911)										

*(*1) Voltage unbalance ratio* $= \dfrac{\textit{max. phase voltage} - \textit{min. phase voltage}}{\textit{3-phase average voltag}} \times 100\ [\%]$

*(*2) Frequency setting with digital signals requires a option control printed circuit card.*

9. Block Diagram and Terminals



Note 1. Use shielded wires for the wiring marked with ⌐. PVC wires must be twisted when they have to be used.

2. The terminal mark ◎ indicates a main-circuit terminal; ○, a control circuit terminal; ◁ or ▷ , a connector terminal.

3. Since the fan-cooled braking resistor (for the capacity of drive unit type FRN018M3-2 or above) incorporates a thermal relay, connect the relay contacts to DBR1 and DBR2.

4. The braking resistor thermal relay sometimes operates when main circuit DC voltage rises; therefore, external sequential circuits must be arranged so as to be turned off by the MCCB or MC when the thermal relay operates.

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10. Function Table

Opertion mode	Function			Data			Factory setting
	Code	Ref.mark	Name	Setting range	Unit	Min.Unit	
Operation monitoring	C001	▲	Output frequency	Display of operating data	Hz	0.1 Hz	—
	C002	▲	Reference frequency		Hz	0.1 Hz	
	C003	▲	Ammeter / Load meter		%	1 %	
	C004	▲	Output voltage (Reference)		V	1 V	
	C005	▲	Input-signal status (checking)	HEX notation	—	—	
	C006	▲	Output-signal status (checking)				
	C007		Stop position setting value				
	C008		Shaft position deflection				
Basic parameter	P000	▲	Changeover of basic mode / multifunction mode	Basic mode (o), Multifuction mode (-)	—	—	o
	P001	□ ▲	Maximum frequency	50.0~270.0	Hz	0.1 Hz	150.0 Hz
	P002	▲	Base frequency	30.0~200.0	Hz	0.1 Hz	50.0 Hz
	P003	▲	Voltage at base frequency	140~200	V	1 V	
	P004	▲	Acc.time	0.1~99.9	s	0.1 s	10.0 s
	P005	▲	Dec.time	0.1~99.9	s	0.1 s	10.0 s
	P006	▲	Torque boost	0~100	%	1 %	20 %
	P007	▲	Setting for flux control level	25~100	%	1 %	75 %
	P008	▲	Gain for frequency setting signal	−10.0~0.0~+10.0	%	0.1 %	0.0 %
	P009		Frequency of acc. / dec.pattern setting f1	1~50	Hz	1 Hz	20 Hz
	P00A		Frequency of acc. / dec.pattern setting f2	1~270	Hz	1 Hz	50 Hz
	P00b		Frequency of acc. / dec.pattern setting f3	1~270	Hz	1 Hz	100 Hz
	P00C		Frequency of acc. / dec.pattern setting f4	1~270	Hz	1 Hz	150 Hz
	P00d		Acc. / dec.pattern setting K0	10~100	—	1	50
	P00E		Acc. / dec.pattern setting K1	10~100	—	1	60
	P00F		Acc. / dec.pattern setting K2	10~100	—	1	100
	P010		Acc. / dec.pattern setting K3	10~100	—	1	100
	P011		Acc. / dec.pattern setting K4	10~100	—	1	100
	P012		Torque limiting selection	Active (o), Inactive (-)	—	—	o
	P013		Torque limiter (driving mode) setting	20~120	—	1	120
	P014		Torque limiter (braking mode) setting	20~120	—	1	120
	P015		Slip frequency compensation level	0.0~3.0	Hz	0.1 Hz	1.0 Hz
Multifunction parameter	P101	□	No.2 maximum frequency	50.0~270.0	Hz	0.1 Hz	150.0 Hz
	P102		No.2 base frequency	30.0~200.0	Hz	0.1 Hz	50.0 Hz
	P103		No.2 voltage at base frequency	140~200	V	1 V	
	P104		No.2 acc.time	0.1~99.9	s	0.1 s	10.0 s
	P105		No.2 dec.time	0.1~99.9	s	0.1 s	10.0 s
	P106		No.2 torque boost	0~100	%	1 %	20 %
	P107		No.2 setting for flux control level	25~100	%	1 %	75 %
	P108		No.2 gain for frequency setting signal	−10.0~0.0~+10.0	%	0.1 %	0.0 %
	P109		No.2 frequency of acc. / dec.pattern setting f1	1~50	Hz	1 Hz	20 Hz
	P10A		No.2 frequency of acc. / dec.pattern setting f2	1~270	Hz	1 Hz	50 Hz
	P10b		No.2 Frequency of acc. / dec.pattern setting f3	1~270	Hz	1 Hz	100 Hz
	P10C		No.2 Frequency of acc. / dec.pattern setting f4	1~270	Hz	1 Hz	150 Hz
	P10d		No.2 acc. / dec.pattern setting K0	10~100	—	1	50
	P10E		No.2 acc. / dec.pattern setting K1	10~100	—	1	60
	P10F		No.2 acc. / dec.pattern setting K2	10~100	—	1	100
	P110		No.2 acc. / dec.pattern setting K3	10~100	—	1	100
	P111		No.2 acc. / dec.pattern setting K4	10~100	—	1	100
	P112		No.2 torque limiting selection	Active (o), Inactive (-)	—	—	o
	P113		No.2 torque limiter (driving mode) setting	20~120	—	1	120
	P114		No.2 torque limiter (braking mode) setting	20~120	—	1	120
	P115		No.2 slip frequency compensation level	0.0~3.0	Hz	0.1 Hz	1.0 Hz
	P181		DC braking voltage	1~10	%	1 %	2 %
	P182		DC braking time	0~300	s	1 s	1 s
	P183		Frequency level detection	1~270	Hz	1 Hz	150 Hz
	P184		Frequency equivalence detection range	0.5~5.0	Hz	0.1 Hz	2.5 Hz
	P185		DC braking starting frequency	0.5~5.0	Hz	0.1 Hz	0.5 Hz
	P186		Override selection	Active (o), Inactive (-)	—	—	-
	P187		Override band setting	20~50	%	1 %	50 %
	P188		M gear selection	1.0~9.9	—	0.1	2.0
	P189		L gear selection	1.0~9.9	—	0.1	4.0
	P161		ORT creeping frequency setting	0.5~10.0	Hz	0.1 Hz	1.0 Hz
	P162		ORT stopping signal ON timer setting	20~1000	ms	20ms	500 ms
	P163		ORT completion signal ON timer setting	20~1000	ms	20ms	100 ms

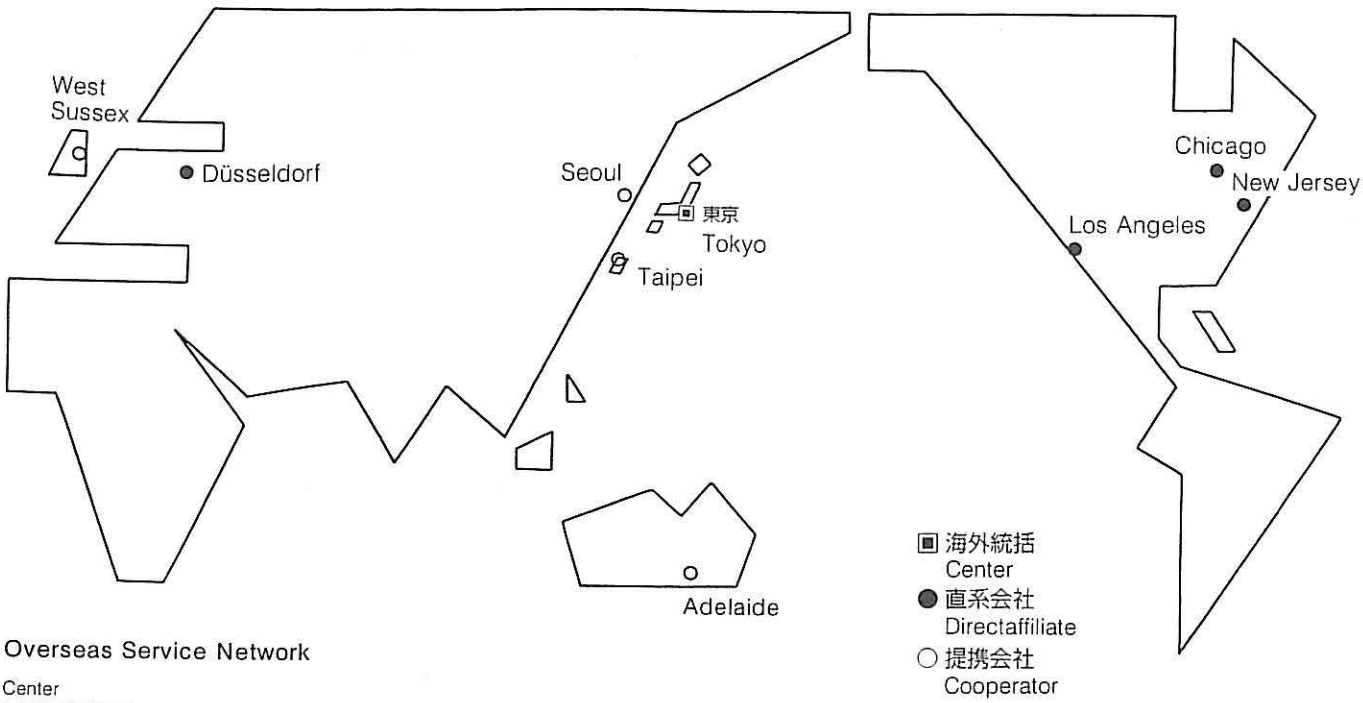
Opertion mode	Function			Data			Factory setting
	Code	Ref.mark	Name	Setting range	Unit	Min.Unit	
Calibration parameter	P201		Adjustment of frequency signal offset	−10.0~0.0~+10.0	%	0.1 %	—
	P202		Adjustment of aux. frequency signal offset	−10.0~0.0~+10.0	%	0.1 %	
	P203		Adjustment of aux. frequency signal gain	−10.0~0.0~+10.0	%	0.1 %	
	P204		Adjustment of override signal offset	−10.0~0.0~+10.0	%	0.1 %	
	P205		Adjustment of override signal gain	−10.0~0.0~+10.0	%	0.1 %	
	P211	▲	Ammeter / load meter selection	Ammeter (o), Load meter (-)	—	—	—
	P212	□ ▲	Frequency meter calibration	70~110	%	1 %	100 %
	P213	□ ▲	Ammeter / load meter calibration	50~220	%	1 %	120 %
	P214	□	No.2 frequency meter calibration	70~110	%	1 %	100 %
	P215	□	No.2 ammeter / load meter calibration	50~220	%	1 %	120 %
	P221		No.1 motor capacity correction	001~110	—	—	001
	P222		No.1 motor primary resistance correction	50~150	%	10 %	100 %
	P223		No.2 motor capacity correction	001~110	—	—	Same as NO.1
	P224		No.2 motor primary resistance correction	50~150	%	10 %	100 %
	P225		Frequency signal selection	Main (o), Sub (-)	—	—	o
	P226		NTC / PTC selection	NTC (o), PTC (-)			o
	P227		Load meter test mode	Test (o), Normal (-)			-
	P228		Back to factory setting	Active (o), Inactive (-)			-
	P229		Blanket setting	Active (o), Inactive (-)			-
Option parameter	P301		Creeping speed frequency command (ORT H gear)	0.5~25.0	Hz	0.1 Hz	2.0 Hz
	P302		Creeping speed frequency command (ORT M gear)	0.5~25.0	Hz	0.1 Hz	2.0 Hz
	P303		Creeping speed frequency command (ORT L gear)	0.5~25.0	Hz	0.1 Hz	2.0 Hz
	P304		Position regulator gain (ORT H gear)	0000~0255	—	1	0032
	P305		Position regulator gain (ORT M gear)	0000~0255	—	1	0032
	P306		Position regulator gain (ORT L gear)	0000~0255	—	1	0032
	P307		ORT completion range setting	0000~0127	Pulse	1 pulse	0005 pulse
	P308		ORT completion range setting (After stopping)	0000~0127	Pulse	1 pulse	0010 pulse
	P309		ORT completion signal ON timer setting	0.0~1.0	s	0.1 s	0.1 s
	P30A		ORT completion signal OFF timer setting	0.0~010.0	s	0.1 s	0.1 s
	P30b		Pulse encoder phase selection	A-phase lead at CCW (o) / A-phase lead at CW (-)	—	—	-
	P30C		ORT internal position setting	000~FFF (HEX.)		—	-
Protection	P00P	▲	Protection of set data	Active (o), Inactive (-)	—	—	o
Fault	F001	▲	Fault conditions	Indicates operation status at fault	—	—	—
	F002	▲	Output frequency at fault		Hz	0.1 Hz	
	F003	▲	Reference frequency at fault		Hz	0.1 Hz	
	F004	▲	Output voltage at fault		%	1 %	
	F005	▲	Operation mode at fault		—	—	
	F006	▲	Fault record (the last)				
	F007	▲	Fault record (the last but one)				
	F008	▲	Fault record (the last but two)				
	F009	▲	Clear fault record	Clear (o), Memory (-)			-

Note 1. The functions with a ref.mark ▲ can be selected in a basic mode. In a multifunction mode,all the functions of the FunctionTable can be selected.

2. The functions with a ref. mark □ allow data setting during operation.

3. ORT: Orientation.

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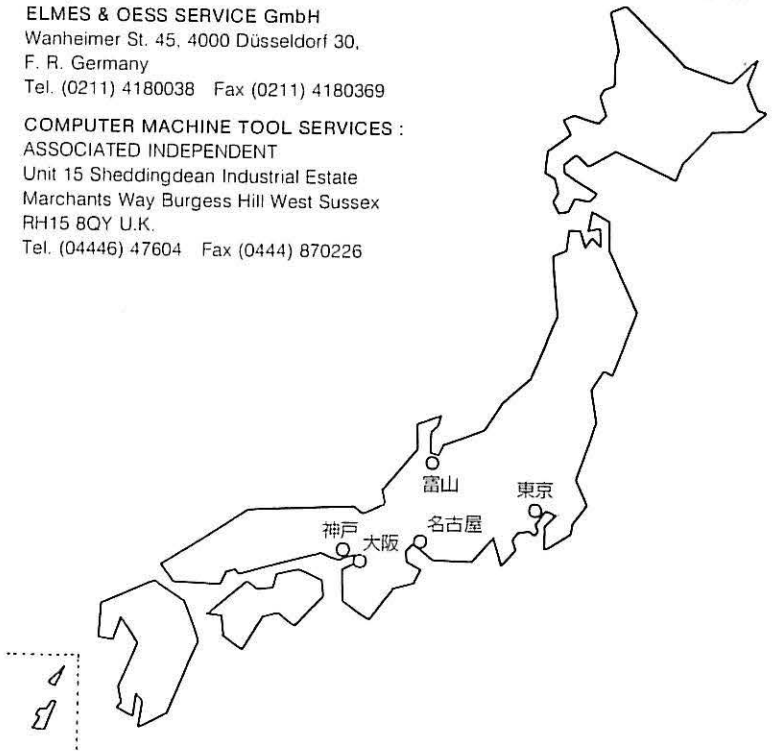
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