AC SPINDLE DRIVE SYSTEM

FRENIC® 5000M

INSTRUCTION MANUAL

FUJI ELECTRIC CO., LTD.
FUJI ELMES CO., LTD.

INV-E32 a

CONTENTS

1. GENERAL

1-1 Preface

This manual describes FUJI AC SPINDLE DRIVE UNIT "FRENIC 5000M."
Please read this manual before operating the unit.

1-2 Inspection

When you have received the unit, check the following points.

(1) If the specifications and accessories are as ordered?
(Check the nameplate of the unit received.)

(2) If there is any damage in transit?

(3) If there is any loose screw, nut, connector, etc.?

Remarks: (1) In unpacking or transporting, be careful not to give damage to the unit.
(2) When keeping the unit in storage, keep it in a clean and dry place at moderate temperature in the packing box while shutting out direct sunlight.

1-3 Installation

Since the life time of the unit is greatly dependent upon how it is installed, be careful about the following points.

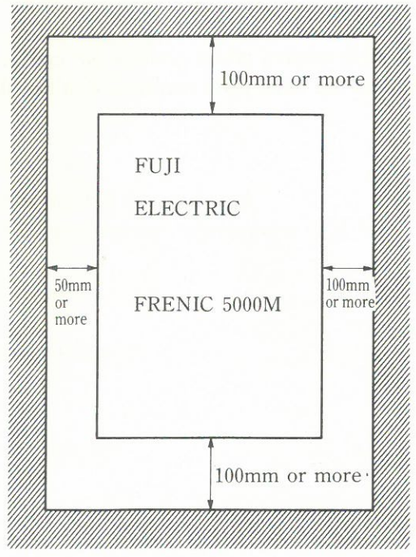
(1) Avoid installation where temperature and humidity are high or vibration is frequent.

(2) Avoid installation where dirt, durst, or oil is rich or where there is corrosive or other gas.

(3) Install the unit vertically.

(4) Since the unit is a heating element, never house it in a small sealed box, or gather heating elements or other parts around it.

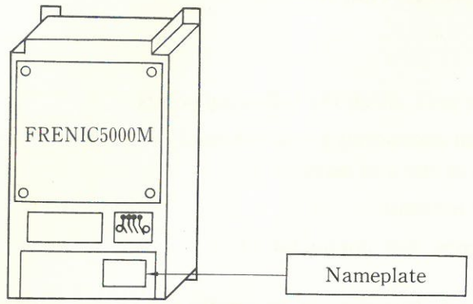
Remarks: As the unit is a heating element, be sure to provide a proper ventilation so that the temperature within the panel meets the allowable ambient temperature conditions, of the drive unit in taking heating value into account.



1-4 Nameplate

(1) Mounting position

The nameplate is mounted on the teminal block cover.



(2) Characters to be written on the nameplate.

(Example)

FMD− AN−21	①
SOUCE 200V 50Hz 200/220/230V 60Hz	②
OUTPUT kVA A	③
SERIAL	④
FUJI ELECTRIC JAPAN	

For their contents see the table bellow.

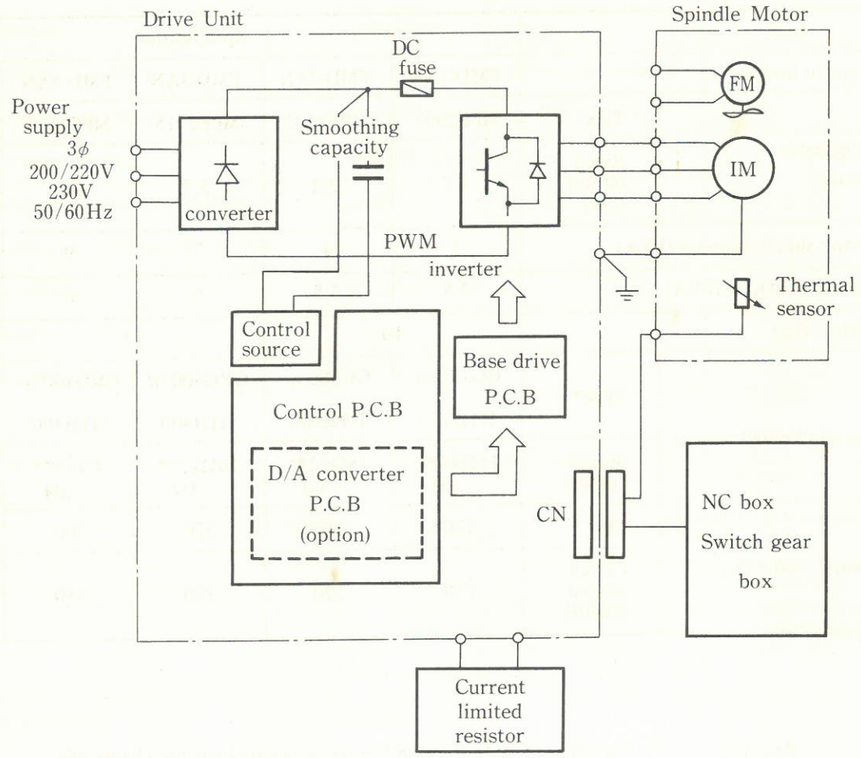
No.	Description
1	Indicates the type of the drive unit.
2	Indicates the input AC power specifications of the drive unit.
3	Indicates the rated capacity and rated amper of the motor at the rated continuous output voltage.
4	Indicates Fuji's serial number of the drive unit.

When any trouble occurs, please contact our company with reference to the items written on the nameplate mentioned in the above table.

2. SPECIFICATION

2-1 Basic configuration

Fuji A.C. Spindle Drive Unit is composed of the following parts:



Standard component parts

(1) Spindle motor
(2) Spindle drive unit (FRENIC 5000M)
(3) Connector for external connection
(4) Current limited resistor

Optional component parts

(1) Digital/analog converter printed circuit board.
(2) Simplified electrical type orientation (Correspond to ROM)
(3) Frequency meter
(4) Analog speed setting resistor
(5) Noise reduce reactor
(6) Radio noise suppressing reactor

2-2 List of standard specifications

(1) Individual specification

Item		Specification				
Type of inverter		FMD-1AN	FMD-2AN	FMD-3AN	FMD-5AN	FMD-7AN
Applicable motor	Type	MPF2097	MPF2107	MPF2115	MPF2133	MPF2135
	Rated output (kW)	1.5	2.2	3.7	5.5	7.5
Power supply capacity (kVA)		3	4	7	9	13
Inverter capacity (kVA)		2.5	3.5	6	8	12
Weight (kg)		10		12		15
Current limited resistor	Type*	GG150 or HTH150	GG300 or HTH300	GRG400 or HTH400	GRG400 or HTH400	GRG400 or HTH400
	Specification	15Ωx3** (s)	15Ωx2** (s)	10Ωx2** (s)	4Ωx3** (s)	10Ωx4*** (2s.2p)
Heating value (w)	Unit	120	150	220	300	400
	Current limited resistor	150	220	370	550	750

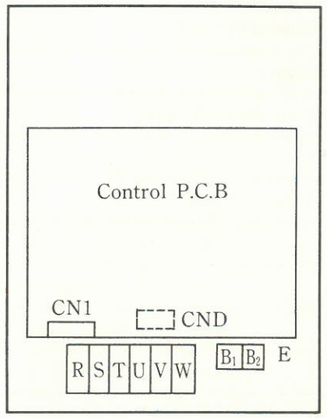
Remarks: *: Two type of current limited resistors specified are interchangeable.
**: Each number of pieces specified is to be connected in series.
***: Two pieces connected in series are to be connected in parallel.

(2) Common specification

	Item	Specification	Remarks
Environments	Installation place	Indoor, free from dust and corrosive gas	
	Ambient temperature	0°C ~ 50°C (Environment of unit)	
	Altitude	1,000 meters and below	
	Ambient humidity	20 ~ 90%RH (free from dew condition)	
Power supply	Input power voltage	AC 200/220· 230V	
	Frequency/phase	50/60Hz, 3 phase, 3 wire	
	Allowable voltage fluctuation	±10%	
	Allowable frequency fluctuation	–3 ~ +2 Hz	
Output specification	Rated voltage	AC 200V ± 10%	
	Phase	3-phase	
	Maximum frequency	200 Hz	
	Minimum frequency	0.5 Hz	
	Frequency accuracy	± 0.5% (at 25°C ± 10°C)	
	Frequency resolution	0.03 Hz (at 2.5 ~ 50 Hz)	
Control specification	V/F characteristic	12 kinds selectable	See 5-4
	Acceleration/deceleration system	Software start/stop (1 ~ 10 sec. 12 kind of settings) (With broken line acceleration/ deceleration and current limitting acceleration/deceleration)	Acceleration/ deceleration independent settings.
	Speed setting	[System] (1) Analog +10V/max. speed (Input impedance 10kΩ) (2) Analog-10V/max. speed (Input impedance 10kΩ) (3) Digital: 12 bits binary (4) Digital B.C.D: 2 digits. 3 digits	☐ Optional
Display	Individual failure display	0V, 0C, 0L, M0L, RT	
Accessory function	Override	Maximum ± 50%	
	Zero speed detection	"ON" at 0.5 Hz and below (DC 24V 50mA, max.)	
	Speed arrival detection	"ON" at ± 2.5 Hz and below (DC 24V 50mA max.)	
	Blanket failure output	"OFF" upon failure (DC 24V 50mA, max.)	
	Speed meter output	+10V/full scale	
Optional Component	D/A converter P.C.B.	EP-2343	
	Simplified electrical type orientation	Correspond to ROM	

(3) Specification of terminal board and connector

i) Mounting position



ii) Type and arrangement of terminal

Symbol	Use	Size of terminal
R	3-phase A.C. power supply (Main circuit)	M4
S		
T		
U	Motor side	M4
V		
W		
E	Earth terminal	M4
B_1	Current limited resistor	M3.5 (M4*)
B_2		

*M4 size is only FSD-7AN

iii) Connector type and pin arrangement

1 CN1: Control P.C.B.

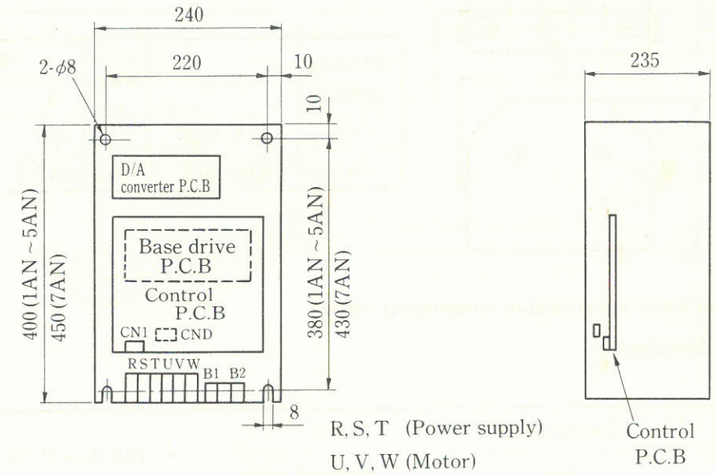
2 CND: Optional P.C.B.

17	ASM	10	ASP	1	ASS1
18	FOR	11	OVP	2	ASS2
19	REV	12	OVS	3	MM
20	FST	13	OVM	4	FM
21	RES	14	CM	5	Short
22	SST	15	OVMS	6	
23	SAR	16	ASMS	7	PTC1
24	AL			8	PTC2
25	P			9	M

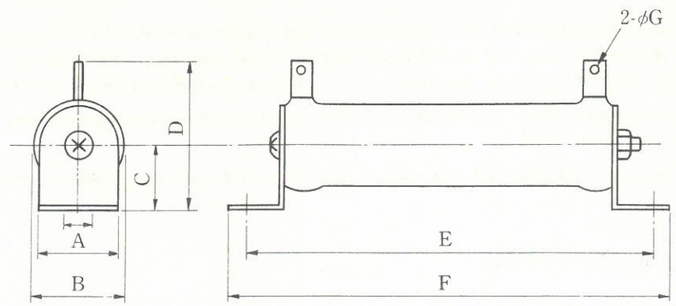
14	CM	8	R08	1	R01
15	CM	9	R09	2	R02
16	DAO	10	R10	3	R03
17	ORTP	11	R11	4	R04
18	ORT	12	R12	5	R05
19	PDT	13	RM	6	R06
20	ORTS			7	R07

(4) Outline

(i) Outline of unit

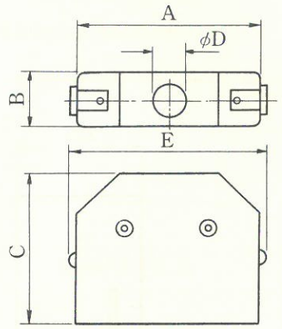


(ii) Current limited resistor



Type	Dimention								Applicable unite
	A	B	C	D	E	F	G	H	
GG150 HTH150	26	28	22	54	217	236	3.2	6	1AN
GG300 HTH300	40	42	40	78.5	289	315	5.5	9.5	2AN
GRG400 HTH400	40	48	40	78.5	364	390	8.2	9	3AN ~ 7AN

(iii) Connector



Connector symbol	Type	Wire	Dimention 〔mm〕				
			A	B	C	φD	E
CND	MR-20LF	20	39.3	18	39.8	11	44.9
CN1	MR-25LF	25	44.5	18	40.5	13.5	50.1

2-3 List of basic construction component units

(1) Standard

Type of unit	Control P.C.B.		Base drive P.C.B. type	Applicable motor
	Type	ROM seal display		
FMD-1AN	EP-2327B or EP-2476	RFM0-0-13G* (ORT**) or RFM0-0-52*** (ORT)	EP-2328A or EP-2477	MPF2097
FMD-2AN				MPF2107
FMD-3AN		RFM0-0-29A* (ORT**) or RFM0-0-53*** (ORT)	EP-2330A or EP-2478	MPF2115
FMD-5AN				MPF2133
FMD-7AN				MPF2135

*: This ROM is employed on a standard basis with the above-mentioned exclusive motors applied. It should be noted that an ROM seal display model may vary with characteristics of a related machine or if the motor employed is different from the one specified in the table above.

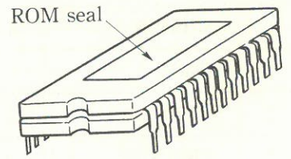
**: Those models which are provided with the simplified orientation function have their model numbers suffixed with "ORT."

***: This is an ROM mounted only when Control Printed Circuit Board MODEL EP2476 is employed.

(2) Optional components

Name		Type of P.C.B	Remarks
D/A converter	12 bits binary	EP-2343	Type of element: DAC80-CBi-V
	BCD 2 digits	EP-2343	Type of element: DAC80-CCD-V
Symplified electrical type orientation (correspond to ROM)			See**

Note: ROM
The ROM mounted on the control printed circuit board has its information indicated on a seal as follow:



Mounted on a socket at the section indicated as IC80 on a printed circuit board.

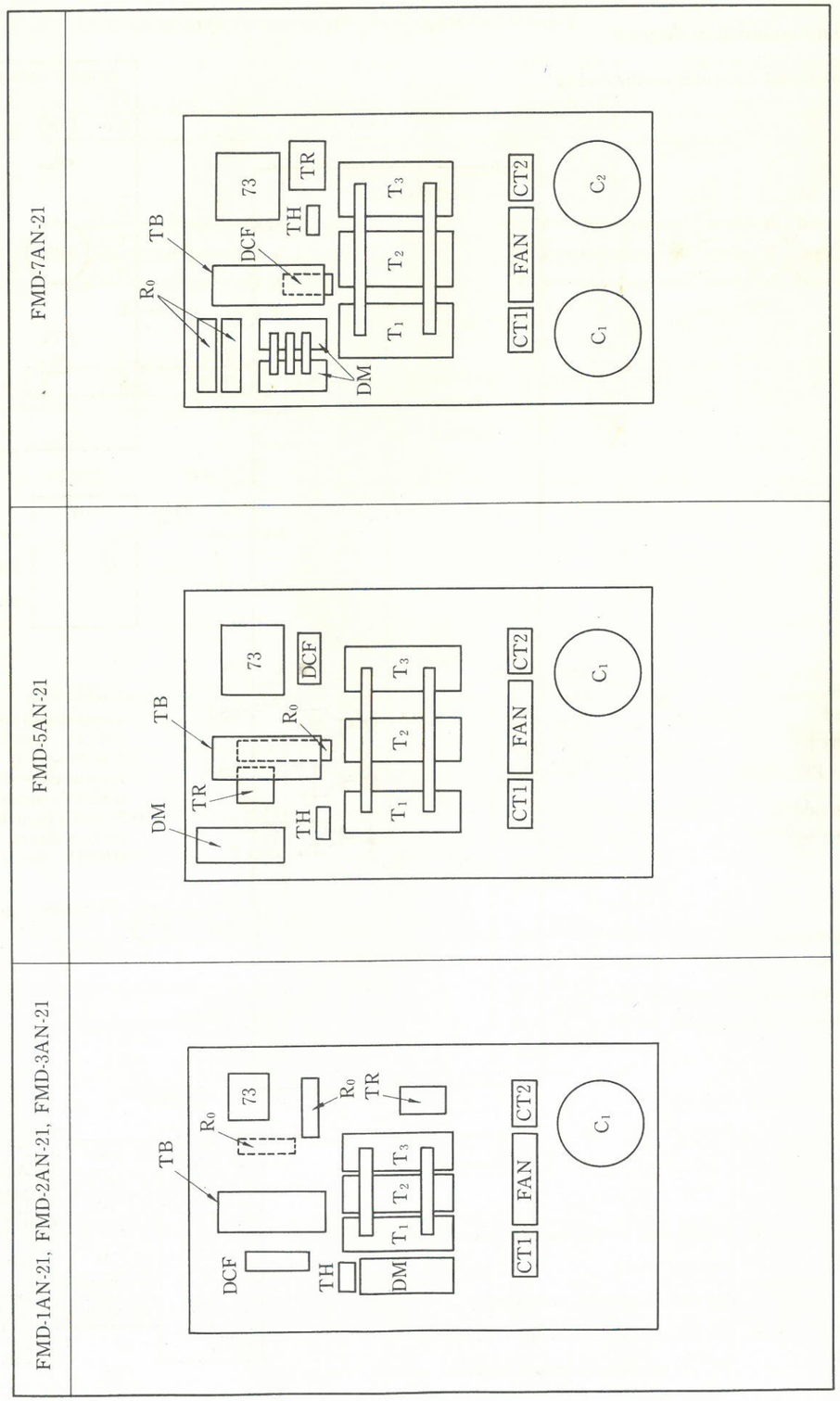
2-4 Type and quantity of component parts of the main circuit

Type of unit	FMD-1AN		FMD-2AN		FMD-3AN	
Name	Type	Q'ty	Type	Q'ty	Type	Q'ty
Main transistor module	EVG-31-050	3	EVK31-050	3	EVK71-050	3
Main diode*	RM15TA-H or ESAE31-08	1	RM30TA-H or ESAE31-08	1	PT758 or ESAG32-08	1
Transistor* (D.B side)	MG15G1AL3 or ETF81-050	1	MG30G1BL3 or ETG81-050	1	MG30G1BL3 or ETG81-050	1
Smoothing capacitor	400LFSN-1.000	1	400LGSN-1.500	1	400LGSN-2.200	1
Charging resistor	MGS10A	1	MHS20A	1	MHS30A	1
Magnetic contactor	HM625	1	FMC-0	1	FMC-0	1
Hall current transformer	NC10-GA	2	NC10-GA	2	NC10-GA	2
DC fuse	CR2LS30	1	CR2LS30	1	CR2LS50	1
Cooling fan	HS4556M or Mu1238A-51B	1	HS4556M or Mu1238A-51B	1	HS4556M or Mu1238A-51B	1
Temperature sensor	OHD-90B	1	OHD-90B	1	OHD-90B	1

Type of unit	FMD-5AN		FMD-7AN	
Name	Type	Q'ty	Type	Q'ty
Main transistor module	EVL31-050	3	EVM31-050	3
Main diode*	PT758 or ESAG32-08	1	PT758 or ESAG32-08	1
Transistor* (D.B side)	MG50G1BL3 or ETK81-050	1	MG50G1BL3 or ETK81-050	1
Smoothing capacitor	400LGSN-3300	1	400LGSN-2.200	2
Charging resistor	MGS40A	1	MHS40N	2
Magnetic contactor	FMC-1	1	FMC-2	1
Hall current transformer	NC10-GA	2	NC10-GA	2
DC fuse	CR1LS75	1	CR2LS100	1
Cooling fan	HS4556M or Mu1238A-51B	1	HS4556M or Mu1238A-51B	1
Temperature sensor	OHD-90B	1	OHD-90B	1

*: Parts are interchangeable between two models specified above. The main diode in the FMD-2AN only, however, is not interchangeable (dimensions).

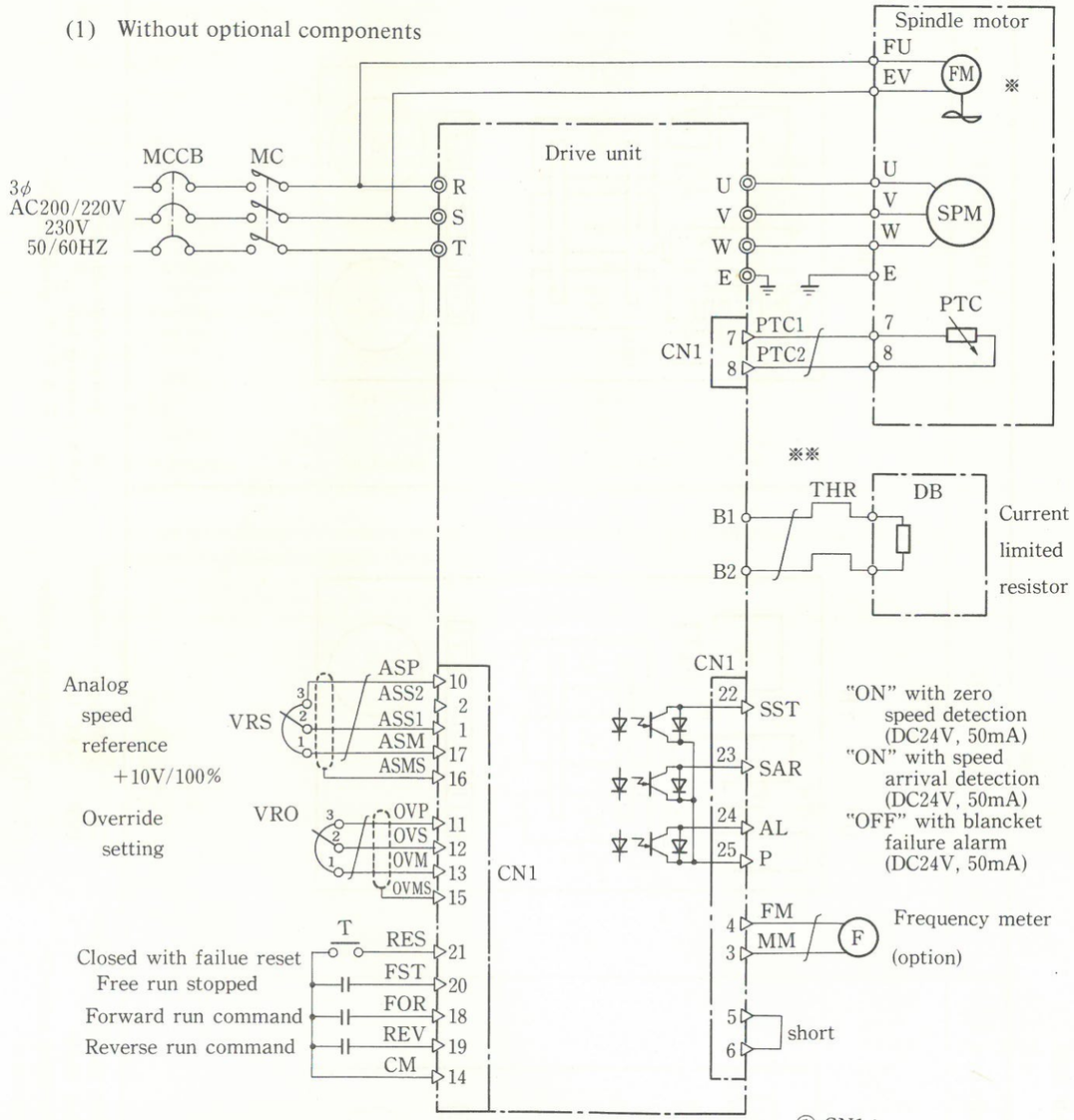
2-5 Arrangement of main parts in unit



3. WIRING AND CONNECTION

3-1 Standard connection diagram

(1) Without optional components



◎ : Terminal block

△ : Connector

※ 1.5kW and 2.2kW models are off self-cooling type
No fan employed, accordingly

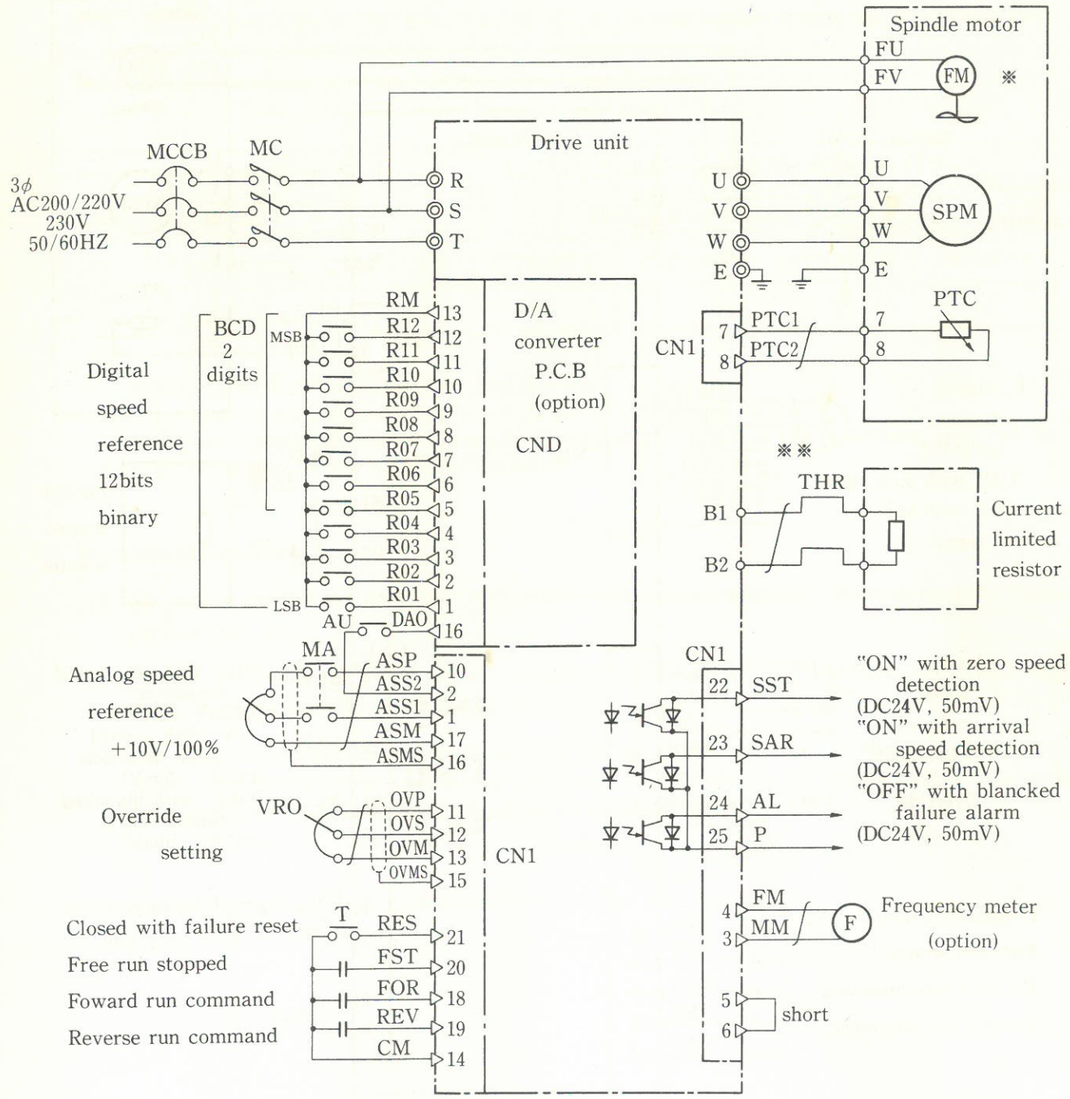
※※ To be interlocked with a MCCB or MC at auxiliary contact (manual reset) THR

≠ Show twist wiring

① CN1 :

17	ASM	10	ASP	1	ASS1
18	FOR	11	OVP	2	ASS2
19	REV	12	OVS	3	MM
20	FST	13	OVM	4	FM
21	RES	14	CM	5	short
22	SST	15	OVMS	6	
23	SAR	16	ASMS	7	PTC1
24	AL			8	PTC2
25	P			9	M

(2) Standard connection diagram (with D/A converter P.C.B)



※, ※※, ≠ refer to P.12

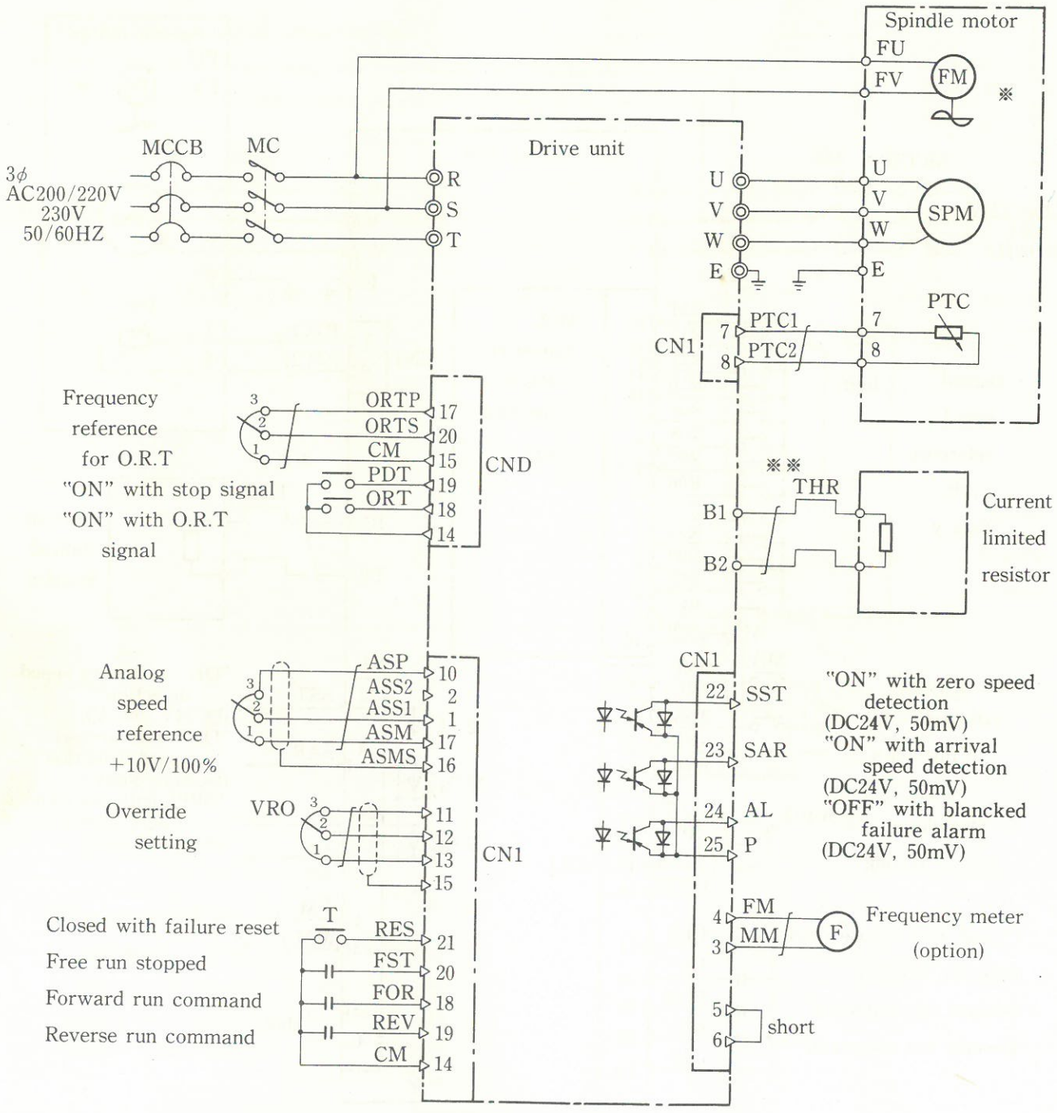
① CN1 : Control P.C.B

17	ASM	10	ASP	1	ASS1
18	FOR	11	OVP	2	ASS2
19	REV	12	OVS	3	MM
20	FST	13	OVM	4	FM
21	RES	14	CM	5	short
22	SST	15	OVMS	6	
23	SAR	16	ASMS	7	PTC1
24	AL			8	PTC2
25	P			9	M

② CND : Option

14	CM	8	R08	1	R01
15	CM	9	R09	2	R02
16	DAO	10	R10	3	R03
17	ORTP	11	R11	4	R04
18	ORT	12	R12	5	R05
19	POT	13	RM	6	R06
20	ORTS			7	R07

(3) Standard connection diagram (with simplified electrical type orientation)



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※※ } refer to P.12
≠

① CN1 : Control P.C.B

17	ASM	10	ASP	1	ASS1
18	FOR	11	OVP	2	ASS2
19	REV	12	OVS	3	MM
20	FST	13	OVM	4	FM
21	RES	14	CM	5	short
22	SST	15	OVMS	6	short
23	SAR	16	ASMS	7	PTC1
24	AL			8	PTC2
25	P			9	M

② CND : Option

14	CM	8	R08	1	R01
15	CM	9	R09	2	R02
16	DAO	10	R10	3	R03
17	ORTP	11	R11	4	R04
18	ORT	12	R12	5	R05
19	PDT	13	RM	6	R06
20	OPTS			7	R07

3-2 Connecting the power

Specifications of the power supply

The following table shows the specifications of the power supply which can be connected to drive unit.

For other specifications, provide a proper power transformer.

Rated normal voltage		AC200/220·230V 50/60 Hz, 3 phase				
Rated normal voltage		10% of rated voltage				
Power supply capacity	Type of unit	FMD-1AN	FMD-2AN	FMD-3AN	FMD-5AN	FMD-7AN
	kVA	3	4	7	9	13

* Select a pattern from the rated output.
** Indicates a required power supply capacity at continuous output.
To avoid inconvenience resulting from voltage drop even at the maximum load, use the power supply having a sufficient capacity.

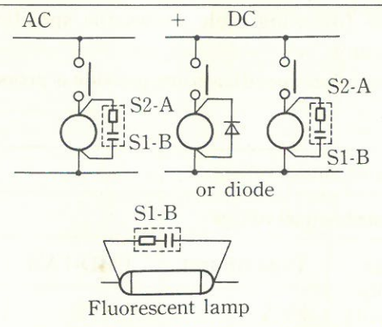
3-3 Precautions for wiring

(1) Be sure to ground the drive unit and spindle motor earth terminals. Never ground the other parts in the unit.

(2) Be sure to shield the signal wires (marked ≠) as shown in the "Interface connection diagram" to prevent malfunction due to noise.

(3) For all electromagnetic contactor, auxiliary relay, and other coils in the inverter control panels, be sure to connect an antiparallel diode or CR filter to the AC-controlled coils, and CR filter to the AC controlled coils. (See the figure below.)

(a) CR FILTER and diode applications (Circuit voltage: 250V or less.)

Applicable parts		CR filter or diode	Examples of connection
Electromagnetic contactor (Main circuit)	AC	S2-A or equivalent	
	DC	Diode or S2-A	
Auxiliary relay	AC	S1-B or equivalent	
	DC	Diode or S1-B	
Fluorescent lamp		S1-B	
Solenoid brake clutch	AC	S2-A	
	DC	Diode	

(b) CR filter and diode specifications

1 CR filter capacity

S2-A C : 0.2 μF, 500 VDC (Nittsuko Ltd.)
R : 500 ohm

S1-B C : 0.1 μF, 500 VDC (Nittsuko Ltd.)
R : 200 ohm

2 Diode capacity (for coil current of 1 A or less)

ERE24-06C, 600 V, 1 A

(4) Route the control circuits as separately from the motor circuit as possible, or route them apart from each other.

4. TEST OPERATION

4-1 Check items

Check the following points before turning on the power (operation).

Item	Content	Remarks
1	If the input power voltage fluctuation and power capacity are as specified? (Check the power supply voltage selector toggle switch.)	See pos. 3-1
2	If the phase rotation of the power supply connected to the power supply input terminals (R, S, and T) are in order of R → S → T.	Do not mistake the drive unit power supply input terminals (R, S, and T) for the motor output terminals (U, V, and W)
3	If the phase rotation between the drive unit motor output terminals (U, V, and W) and between spindle motor power supply input terminals (U, V, and W) is in a right order?	
4	If the connector or terminal board is connected to external circuits correctly?	
5	If wirings of the power circuit and control circuit are grounded or short-circuited?	
6	If there is any metal or other foreign matters put in or deposited on the drive unit?	

4-2 Procedure of test operation

Item	Content	Procedure and check point
1	"Power" ON	1 The main circuit power ON display CHG (LED1 orange) lights up. 2 The CPU running display (green) blinks (with an interval of 1 sec).
2	"Ready" signal ON	The spindle motor fan motor rotates. Check for the rotating direction of the fan motor. Note: The emergency stop input must be in the reset status at this time. Set the minimum speed reference to check for the rotating direction of the motor.
3	"Drive" signal ON (Forward/reverse drive signal)	When set to the forward rotation: The motor rotates counterclockwise (CCW). When set to the reverse rotation: The motor rotates clockwise (CW). Note: The rotating direction is viewed from the motor output shaft.
4	Final check	Run the unit in forward and reverse directions and at various speeds to check if no trouble occurs in the spindle motor, drive unit, and in the spindle rotation.

5. ADJUSTMENT

5-1 Display function

Parts code	Display function	Information display
CPU	Abnormalitiy in CPU	Illuminated in the event of an abnormality in CPU or an alarm lamp has come on.
CHG	Main circuit charged	Illuminated with power supplied.
OC	Overcurrent alarm	Illuminated with output current exceeding a limit value.
OV	Overvoltage alarm	Illuminated with DC intermediate circuit voltage exceeding a limit value.
OL	Cooling fin overheating alarm	Illuminated with power device cooling fin temperature exceeding a limit value.
MOL	Motor overheating alarm	Illuminated with spindle motor temperature exceeding a limit value.
RT	Current limited resistor overheating alarm	Illuminated with current limited resistor temperature abnormally risen.

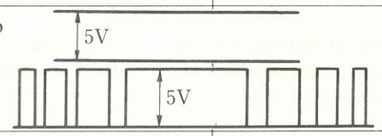
5-2 Adjustment resistors

Parts code	Object to be adjusted	Description and procedure
VR2*	Adjusting the offset of an amplifier in frequency setting circuit	Adjust so that CH1 will have an oscillating frequency of 1Hz and below in setting the frequency at 0V.
VR4*	Adjusting current feed back	The level at which an inverter output is detectable is adjusted.
FIN (VR3)	Finely adjusting a frequency manually	A frequency to be set is finely adjusted, with the manual speed command dial connected. The frequency is adjustable within a range of +15%** turning the dial clockwise will increase the frequency.
ADJ (VR1)	Adjusting the frequency meter	Already adjusted upon shipment to attain 10V at the maximum frequency.

*: Do not turn unnecessarily since the adjustment has been already made upon shipment.

**: The maximum output frequency is limited to a maximum of 107% with a frequency control ROM soft limiter.

5-3 Check terminal

Check terminal	Item	During	During run	Measuring instrument	Remarks
P.Po-M N-M P5-M5 P4,5*-M5	Control source	+15V +10V -15V +5V +4.5V	See "During stop"	Digital tester or oscilloscope	
CH1-M5	Frequency setting	0 kHz	0 ~ 100 kHz	Frequency counter or oscilloscope	Use FIN for adjustment
CH2-M5	Frequency	0 Hz	Set frequency multiplied by 3 in Hz	"	
CH3-M5	Overcurrent failure	"H" normally but "L" with, overcurrent fuse blown out		Oscilloscope	
CH4-M5	Overcurrent suppression	"H" normally but "L" with an overcurrent		"	
CH5-M5	Overvoltage failure	"H" normally but "L" with an overvoltage in intermediate circuit		"	
CH6-M5	Overvoltage suppression	"H"		"	
CH8-M5 CH9-M5 CH10-M5 CH11-M5 CH12-M5	PWM modulated output	During stop During run 			
CH14**-M5	Major failure	"L" with an overcurrent or overvoltage failure and with CPU overrun		"	
CH15-M5**	Undervoltage detection reset	"L" with a decrease in DC intermediate circuit voltage		"	
CH16-M5**	Undervoltage detection	"L" with a decrease in DC intermediate circuit voltage		"	
CH17-M5	73 x relay closed	"H" with a DC intermediate circuit voltage available			
CH18-M5**	Minor failure	"L" cooling fin, current limited resistor and motor overheated		"	
CH19-M CH-20M**	Frequency setting voltage	0 V	0 ~ –10V 0 ~ +10V	"	
CH21	Do not measure this check terminal, which is very high.				
CH22-M	Auxiliary input	–	Min. Max. 0 ~ –10V	Oscilloscope	D/A output
CH23-M	Set input	–	0 ~ +10V	"	Manually set input
CH28	Do not measure this check terminal, which is very high.				
CH29-M	Base shut-off	Base shut-off "H" with an over-current failure		Oscilloscope	
CH30	Do not measure this check terminal, which is very high.				

Remarks: "H" and "L" have reference values as follows:

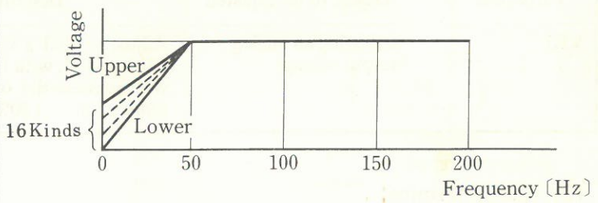
*: Main printed circuit board Model EP-2476 only is provided with this check terminal.

**: Main printed circuit board Model EP-2326 only is provided with this check terminal.

5-4 Selector switches (Hexadecimal: 0 ~ F notches)

<table>
<tr><th>Parts code</th><th>Object to be adjust</th><th>Description and procedure</th></tr>
<tr><td>V/F</td><td>Selecting a voltage to frequency ratio</td><td>This switch permits a voltage to frequency ratio to be selected out of 12 patterns.
These V/F ratio patterns and procedure for selecting one of them are as summarized below. Carry out setting according to a power supply voltage and to a V/F ratio pattern.
<table>
<tr><th>Notch</th><th>V/F ratio pattern</th><th>Power supply</th></tr>
<tr><td>0
1
2
3</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>200 V</td></tr>
<tr><td>4
5
6
7</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>220 V</td></tr>
<tr><td>8
9
A
B</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>230 V</td></tr>
<tr><td>C
D
E
F</td><td></td><td>Not used</td></tr>
</table>
Note: Nomenclature of a V/F pattern
(Example) 0.5 ~ 50/150 Hz
0.5 ~ 50 Hz : Constant torque area
50 ~ 150 Hz : Constant power area</td></tr>
<tr><td>ACCEL

DCCEL</td><td>Selecting an acceleration time
Selecting an deceleration time</td><td>An adjustable range of 1 thru 10 seconds is availabe for both.
Each notch represents an acceleration or deceleration time as follow:
<table>
<tr><td>Notch</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Time</td><td>1.0</td><td>1.5</td><td>1.8</td><td>2.0</td><td>2.3</td><td>2.4</td><td>2.8</td><td>3.0</td></tr>
<tr><td>Notch</td><td>8</td><td>9</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr>
<tr><td>Time</td><td>3.2</td><td>3.5</td><td>4.0</td><td>4.7</td><td>5.0</td><td>6.2</td><td>8.4</td><td>10.0</td></tr>
</table>
If the OC trip lamp should come on during the acceleration, if indicates that the acceleration time too short. Then, turn the ACCEL switch clockwise by 1 or 2 notches.
If the OS or OV trip lamp should come on during the deceleration, if indicates that the deceleration time too short.
Then, turn the DECEL switch clockwise by 1 or 2 notches.</td></tr>
</table>

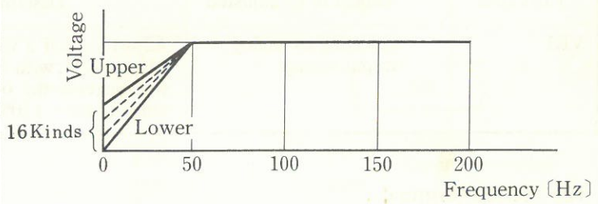
<table>
<tr><th>Parts code</th><th>Object to be adjust</th><th>Description and procedure</th></tr>
<tr><td>BOOST</td><td>Offsetting a starting torque</td><td>This switch allows setting a higher torque in the low frequency range (constant torque range).
(Function of intensifying a starting voltage)
 

Turning the switch notch clockwise will put the voltage into the higher level. Heighting it too much, however, will increase the exciting current (load current), resulting in a higher level of viobrations and motor heating.
Normally, notch 6 and bellow is appropriate.</td></tr>
<tr><td>DCBR</td><td>Selecting a DC braking level</td><td>This switch allows setting a DC breaking level upon stop and upon positioning through the simplified electric orientation. Turning the switch notch clockwise will increase the DC breaking level, which may be moreover increased with the torque intensified by the BOOST switch.
DC breaking level = $\alpha \cdot T_B$
α : Coefficient dependent upon a nothc of DBR
T_B : Torque dependent upon a notch BOOST</td></tr>
<tr><td colspan="3">A notch in selector switches mentioned above should be changed while the inverter is stopping (with forward run or reverse run command singnal OFF). With forward run or reverse run command ON, a set value is read into the ROM.</td></tr>
</table>

5-4 Selector switches (Hexadecimal: 0 ~ F notches)

<table>
<tr><th>Parts code</th><th>Object to be adjust</th><th>Description and procedure</th></tr>
<tr><td>V/F</td><td>Selecting a voltage to frequency ratio</td><td>
This switch permits a voltage to frequency ratio to be selected out of 12 patterns.
These V/F ratio patterns and procedure for selecting one of them are as summarized below. Carry out setting according to a power supply voltage and to a V/F ratio pattern.
<table>
<tr><th>Notch</th><th>V/F ratio pattern</th><th>Power supply</th></tr>
<tr><td>0
1
2
3</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>200 V</td></tr>
<tr><td>4
5
6
7</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>220 V</td></tr>
<tr><td>8
9
A
B</td><td>0.5 ~ 50 Hz
0.5 ~ 50/100 Hz
0.5 ~ 50/150 Hz
0.5 ~ 50/200 Hz</td><td>230 V</td></tr>
<tr><td>C
D
E
F</td><td></td><td>Not used</td></tr>
</table>
Note: Nomenclature of a V/F pattern
(Example) 0.5 ~ 50/150 Hz
0.5 ~ 50 Hz : Constant torque area
50 ~ 150 Hz : Constant power area
</td></tr>
<tr><td>ACCEL

DCCEL</td><td>Selecting an acceleration time
Selecting an deceleration time</td><td>
An adjustable range of 1 thru 10 seconds is availabe for both.
Each notch represents an acceleration or deceleration time as follow:
<table>
<tr><td>Notch</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Time</td><td>1.0</td><td>1.5</td><td>1.8</td><td>2.0</td><td>2.3</td><td>2.4</td><td>2.8</td><td>3.0</td></tr>
<tr><td>Notch</td><td>8</td><td>9</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr>
<tr><td>Time</td><td>3.2</td><td>3.5</td><td>4.0</td><td>4.7</td><td>5.0</td><td>6.2</td><td>8.4</td><td>10.0</td></tr>
</table>
If the OC trip lamp should come on during the acceleration, if indicates that the acceleration time too short. Then, turn the ACCEL switch clockwise by 1 or 2 notches.
If the OS or OV trip lamp should come on during the deceleration, if indicates that the deceleration time too short.
Then, turn the DECEL switch clockwise by 1 or 2 notches.
</td></tr>
</table>

<table>
<tr><th>Parts code</th><th>Object to be adjust</th><th>Description and procedure</th></tr>
<tr><td>BOOST</td><td>Offsetting a starting torque</td><td>
This switch allows setting a higher torque in the low frequency range (constant torque range).
(Function of intensifying a starting voltage)


Turning the switch notch clockwise will put the voltage into the higher level. Heighting it too much, however, will increase the exciting current (load current), resulting in a higher level of viobrations and motor heating.
Normally, notch 6 and bellow is appropriate.
</td></tr>
<tr><td>DCBR</td><td>Selecting a DC braking level</td><td>
This switch allows setting a DC breaking level upon stop and upon positioning through the simplified electric orientation. Turning the switch notch clockwise will increase the DC breaking level, which may be moreover increased with the torque intensified by the BOOST switch.
DC breaking level = $\alpha \cdot T_B$
α : Coefficient dependent upon a nothc of DBR
T_B : Torque dependent upon a notch BOOST
</td></tr>
<tr><td colspan="3">A notch in selector switches mentioned above should be changed while the inverter is stopping (with forward run or reverse run command singnal OFF). With forward run or reverse run command ON, a set value is read into the ROM.</td></tr>
</table>

5-5 D/A converter

(1) Variable resistor

Parts code	Object to be adjusted	Description and adjustment procedure.
VR1	Adjusting an analog output voltage	Adjust so that a voltage of −10 volts will be available between CH-1 and M, with full bits inputted. Turning the dial clockwise will increase the output voltage, which is adjustable within a range of 80 ~ 120%.

(2) Check terminal

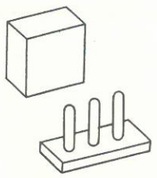
Parts code	Function	Description and reference value
CH1	Analog output voltage	−10 volts/maximum speed, with full bits inputted.

(3) Selector switch (short-curcuiting pin)

	Function	Short-circuiting pin	Description
SW1	Selecting a digital speed command	1 – 2	12 bits binary input
		2 – 3	BCD input
SW2		1 – 2	BCD input
		2 – 3	12 bits binary input

Setting selector pins:

Use an accessory short-circuiting chip (blue) to set selector pins.

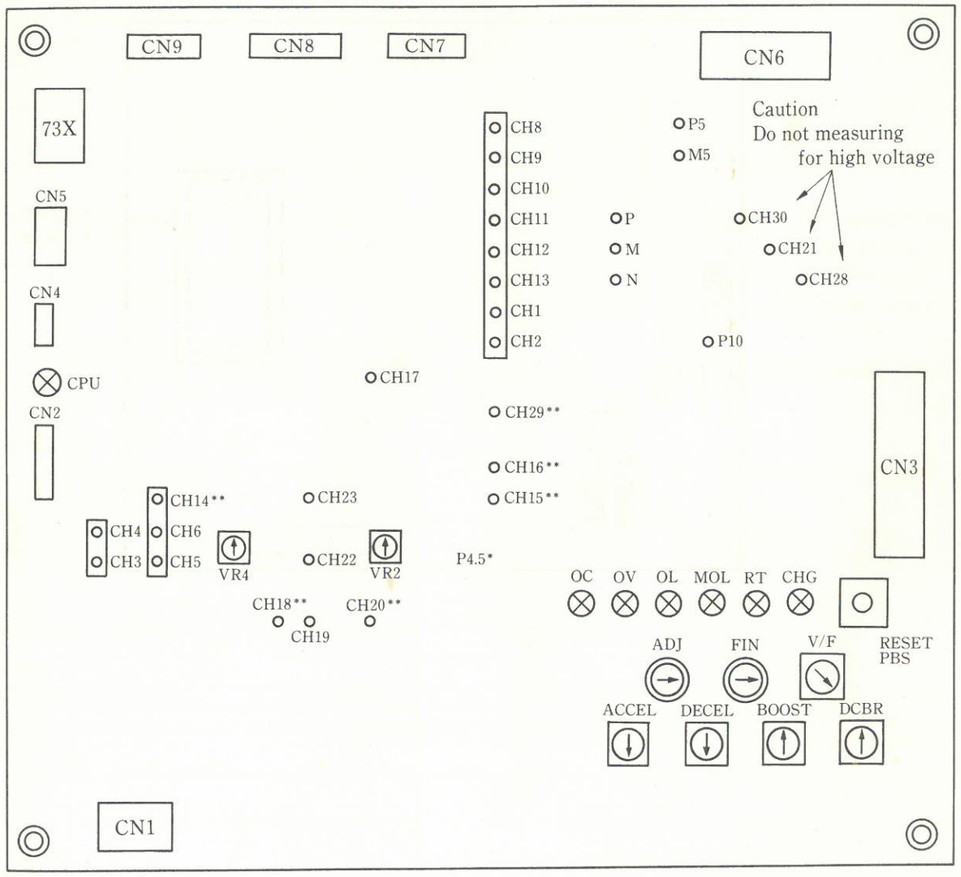


Short-circuiting chip (blue)

Short-circuiting pin
(mounting on control P.C.B)

5-6 P.C. board components layout diagram

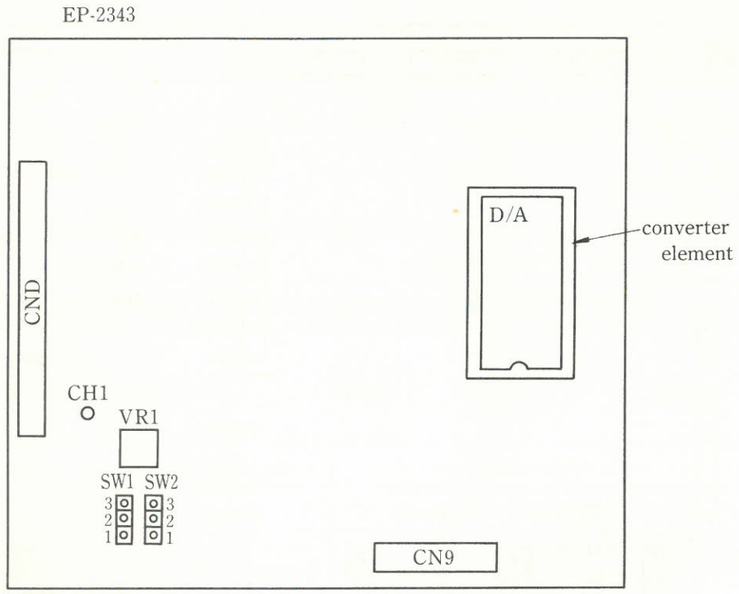
(1) Control P.C.B



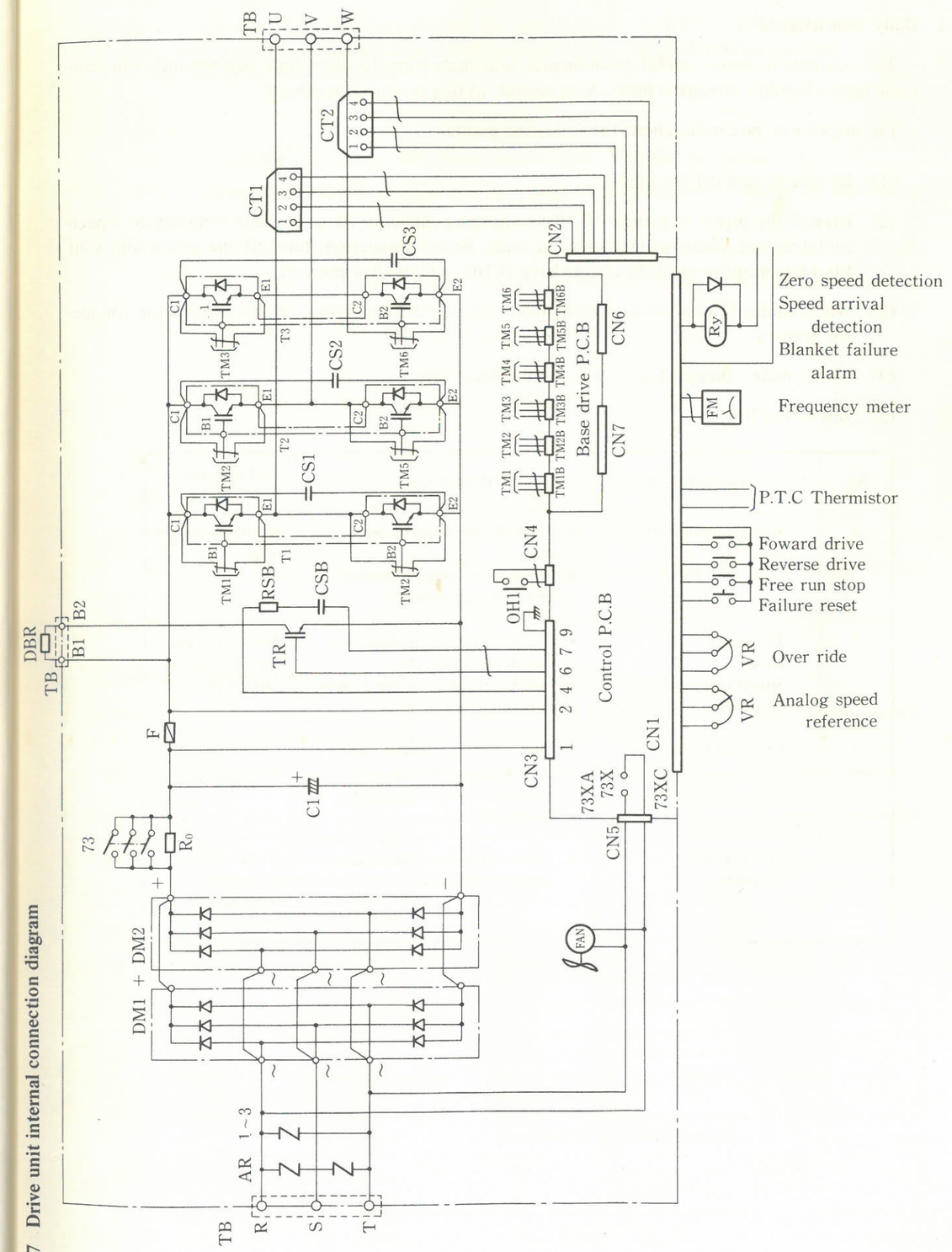
* : "with" P.C.B type EP-2476 only

** : "with" P.C.B type EP-2327B only

(2) D/A converter P.C.B



5-7 Drive unit internal connection diagram



6. MAINTENANCE AND INSPECTION

6-1 Daily maintenance

The equipment needs careful maintenance and inspection to exert high performance and continue high-reliability operation over a long period, while preventing accidents.

For inspection, be careful about the following points.

(1) Be sure to turn off the power.

(2) Even if the power is turned off, the smoothing capacitor (large capacity electrolytic capacitor) does not discharge electricity at once. Before inspection, turn off the power and wait for a few minutes until the charge lamp (CHG, yellow) has gone off.

(3) When connecting or disconnecting the connector or other parts, be sure to hold the connector housing.

(4) Never make a megger test or withstand voltage test.

(5) Inspection items

No.	Inspection item	Description	Corrective action taken
1	Magnetic contactor relay	• Check if any contact is worn out. • Check if the relay is operated smoothly and correctly.	If not, replace the relay.
2	Transistor Diode Smoothing capcitor PC board	• Check if there is any discoloration or bad smell, etc. • Check if there is any metal, wire, or other mixed chips.	After checking, replace defective parts, if any.
3	Unit cooling fan	• Check if the fan rotates powerfully when conducted. • Check if bearing unit sounds abnormally.	If does, replace the fan.
4	Terminal and connector	• Check if any terminal or connector is loosened.	If any of them is loosened, retighten the loose one.

7. TROUBLE SHOOTING

Should any abnormality take place during the operation or when putting the unit into operation, observe the precautions specified below and correctly grasp the phenomenon to take action in accordance with the trouble-shooting chart.

Precautions:

a) Nobody other than the responsible person must repair or adjust the equipment.

b) Use an appropriate means, such as a tester, digital voltmeter, synchroscope or the like to check the circuit.

c) With the system powered, never removed or install wiring. It will result in a short circuit.

d) Do not unnecessarily adjust any switches and/or dial which have been already adjusted. If a readjustment is inevitably made, record its position prior to the adjustment (number of notches) so that the original condition can be restored.

FIN	(to finely adjust a frequency setting)
ADJ	(to adjust a frequency meter reading)
ACCEL	(to select an acceleration time)
DECEL	(to select a deceleration time)
V/F	(to select a voltage to frequency ratio)
BOOST	(to compensate for a starting torque)
DCBR	(to selecting a DC braking stroke)

Whenever an adjustment other than those enumerated above may be made, please do not fail to contact us.

7-1 Providing instrumentation

Unless appropriate measuring instruments are used for adjustments and checks, it will result in an improper adjustment and/or in damage to the equipment and instrumentation.

Instrument	Application	Precautions in use
Tester	To measure resistance and to determine whether or not a semiconductor device working properly.	
Digital voltmeter	To measure AC and DC voltages	Carefully prevent the meter from coming into contact with an adjacent pin or pins.
Synchroscope	To measure AC and DC voltages	
AC voltmeter	To measure AC voltages	Use a rectifier type voltmeter to measure inverter output voltages. To take measurements by means of a movable iron core type, use a CT with large VA.
AC ampermeter	To measure AC ampers	
Frequency counter	Adjustment of frequency	

7-2 Procedure for tracing

In the event of trouble, follow procedure to shoot in.

(1) Make certain of the power supply voltage (AC input and control power supplies).

(2) Check wiring for possible looseness.

(3) Use a trouble shooting chart given later to confirm and take action.

7-3 Trouble shooting

(1) When power for inverter is switched on, six alarm lamps is standed as following condition. (= normal operating)

3-1 Diagnostic by alarm lamp

A	OC ● OV ○ OL ○ MOL ○ RT ○ CHG ●	Over current	Motor free stop
Check point		Disposition	
1 Doesn't spindle more smoothly. (ex. belt tension.) 2 Doesn't inertia of spindle come to so big. (ex. with large Chack or work.) 3 Does trouble occurs at change speed or stop (MO5) operation.		1 In case that trouble occurs only one or two times per day, please turn multiswitch ("ACCEL") to clock wise more than one or two notch. 2 If "OC" alarm lamp lights always, power transister for braking come to brake down, it's need to check with authority. 3 In case that "OC" alarm's stop come to in rare frequency, please try to turn multi-switch ("DECEL") to clock wise more than one or two notch.	
B	OC ○ OV ● OL ○ MOL ○ RT ○ CHG ●	Over voltage	Motor free stop
Check point		Disposition	
1 Doesn't inertia became to so big. 2 Doesn't braking circuit connection		1 Refer to (A)– 3 ' 2 Refer to (A)– 2 '	

C	OC ○ OV ○ OL ● MOL ○ RT ○ CHG ●	Over load	Motor free stop
Check point		Disposition	
1 Doesn't inverter come to over load. 2 Doesn't temperature of cubicle inside rise to high value. (Temperature must be less than 50°C)		1 Omit that cause. 2 Please ventirate inside of cubicle.	
D	OC ○ OV ○ OL ○ MOL ● RT ○ CHG ●	Motor high temp.	Motor braking stop
Cehck point		Disposition	
1 Doesn't motor stand on over load. 2 Isn't working duty cycle short interval.		1 Omit that cause. 2 Standard working duty cycle (0 ⇄ top speed) is shown	

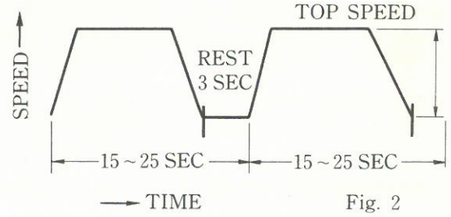
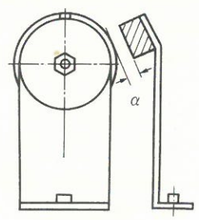
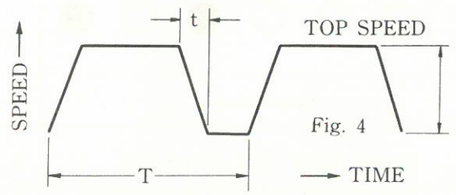


Fig. 2

in Fig. 2 one tact time is 15 ~ 25 seconds. If this time become to more short time (ex. less than 10 seconds), average current of motor increases, and motor temperature reises.

In this case, PTC thermister provided in motor winding operates.

E	OC	OV	OL	MOL	RT	CHG	Current limited resistor over heat	Motor braking stop
	○	○	○	○	●	●		

Check point	Disposition
1 Doesn't temperature senser more approach to braking resistor. (ex. senser contacts to resister) 2 Duty cycle check.	 $\alpha = 15m/m$ Fig. 3  Fig. 4 Capacity of resistor is designed by following equation. $b < \frac{t}{T} \times 100 = 10\%$ t : braking time

7-3-2 Trouble with out alarm lamp

< In this case, it's necessary to check with authority. >

(2) In case where the failure pilot LED dose not come on

Problem	Cause	Point to be checked	Action to be taken
Motor does not run	Main circuit power is not inputted.	Main circuit charging pilot "CHG" (red) on P.C.B does not come on.	Turn on wiring circuit breaker and/or magnetic contactor.
	Power supply voltage is too low.	CH16 may be at "H" level	Review power supply voltage
	CPU has failed.	CPU failure pilot "CPU" (green) on P.C.B has come on.	Replace CPU
	Run command (forward or reverse run command) may have been input.	Check input signals	Correct sequence
	Speed command has not been inputted.	Check with CH22 and CH23	Repair speed command input wiring and NC output signals.
		Check D/A converter for output with CH1 (D/A converter P.C.B) and selector pins SW1 and 2.	Correct NC output signals (digital). Replace D/A converter device and/or P.C.B.
	Load is too heavy	CH4 may have been at "L" level. (Motor has stalled.)	Review load.
Acceleration requires too long a time.	Acceleration time has been set to short.	CH4 may at "L" level upon acceleration.	Set acceleration time long. (Turn ACCEL switch clockwise.)
Speed does not reach setting.	V/F pattern has been wrongly set.	F/V switch should be set to pattern as specified.	Reset
	Speed command voltage is too low (or high).	Check with CH22 and CH23	Correct NC output signals.
		Check D/A converter for output with CH1 (D/A converter P.C.B).	Correct NC output signals (digital) and/or replace D/A converter device and/or P.C.B.
	Override has functioned	Override setting circuit	Repair.
Speed is fluctuating	Speed setting voltage is fluctuating.	Check with CH22 and CH23	Correct NC output signals.
		Check D/A converter wigh CH1 D/A converter P.C.B.	Replace D/A converter device and/or P.C.B.

7-4 Procedures for replacing parts and for checking specifications there of

(1) Procedures for checking and replacing power transistor modules.
Once approximately 5 minutes have passed after turning off the A.C power supply, follow the procedure given below to carry out checking and replacement.

a) Checking

Remove the terminal block cover in the lower part of the unit body and take wiring off the motor connected with output terminals U, V, and W.

(2) Use a tester to measure and check the resistance between output terminals.
(See the illustration below.)

Measuring terminal	Reference value	Abnormal value
U – V	Several hundred kiloohms	Several ten kiloohms
V – W		
U – W		

b) Procedure for replacing

If an abnormality has been found in an above, replace the transistor module in accordance with following procedure.

1 Remove upper and lower covers on the front face of the unit.

2 Remove connectors CN1 thru CN7 (CN8 and CN9) all on the control P.C.B. Then, remove the P.C.B. itself. It should be noted that a protective iron plate is tightened together on the back of the P.C.B.

3 Remove connectors TMB1 thru TMB6 for the emitter, base and collector (hereinafter referred as E, B and C), all on the base drive P.C.B. Then, remove the P.C.B. itself.

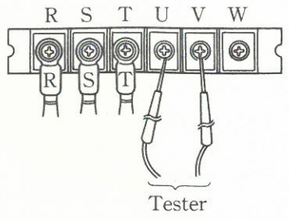
4 Use a tester to measure the resistance of terminals specified in a table below and make certain in what phase the transistor has ruptured.

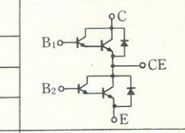
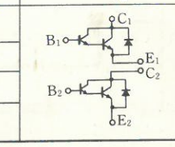
5 Unfasten the screw mounting E, B and C and remove the bus bar and lead.

6 Unfasten transistor module mounting screw and remove the body.

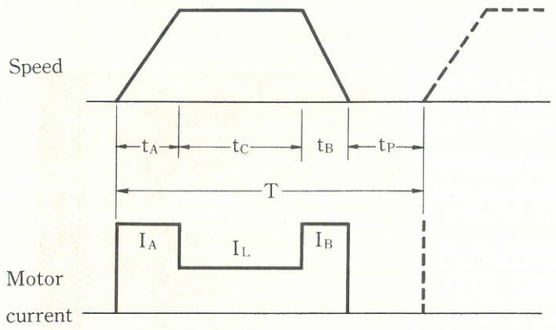
7 Reversely follow the steps mentioned above and mount the transistor module, base drive and control P.C.B. In this case, be careful not to mistake any connectors in inserting them.

8 Check for resistance between output terminals all over again.
In this case, moreover, measure the insulation between input and output terminals (unit body, etc.) and the ground and make certain that the insulation has a resistance of ∞ Ω.



Inverter capacity	Transistor terminal tester polarity		Resistance		Transistor circuit
	–	+	Reference value	Abnormal value	
1AN 3AN	$B_{1,2}$	E, CE	several 100Ω	0Ω or ∞	
	$B_{1,2}$	CE, C	”	”	
	CE, C	$B_{1,2}$	∞	”	
	Ce, C	E, CE	∞	”	
3AN 5AN 7AN	$B_{1,2}$	$E_{1,2}$	several 100Ω	”	
	$B_{1,2}$	$C_{1,2}$	”	”	
	$C_{1,2}$	$B_{1,2}$	∞	”	
	$C_{1,2}$	$E_{1,2}$	∞	”	

(2) Procedure for checking machine cycle and control duty cycle.



t_A : acceleration time
t_c : cutting run time
t_b : deceleration time
t_p : down time
T : 1 cycle machining time

I_A : accelerating current
I_L : cutting current
I_B : decelerating current

1 Checking motor for load condition

Use the square mean method and the load is to be as follow:

$$I_1 \geq \sqrt{\frac{I_A^2 t_A + I_L^2 t_C + I_B^2 t_B}{T}} \quad [A]$$

I_1 : motor rated current

2 Checking brakes for duty cycle

The current limited resistor has had its capacity selected, based on a braking duty of 10% ED. In the illustration give above. The following requirement is to be satisfied.

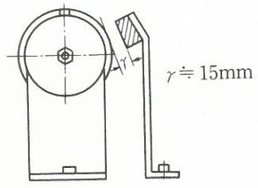
$$\frac{t_b}{T} \times 100 < 10\%$$

3 Procedure for checking motor thermistor circuit

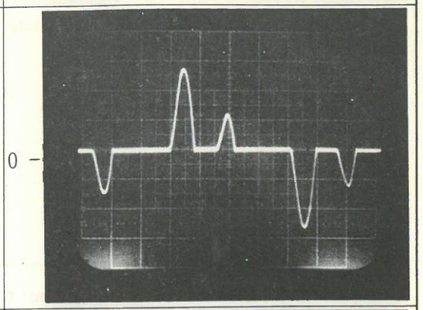
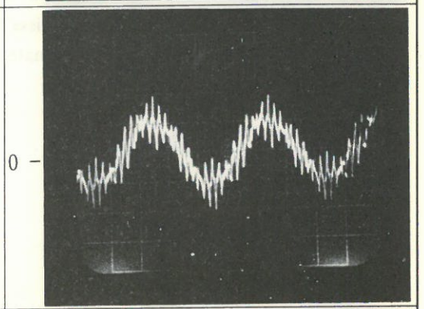
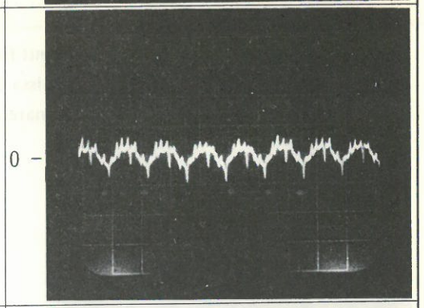
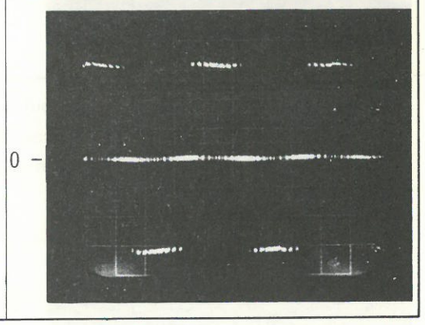
In the normal condition, the resistance between PTC1 and PTC2 is 300 ~ 500 ohms and below.
During the operation (with motor heated) or once the circuit has been disconnected, the resistance rises to the order of megohm to infinite level.

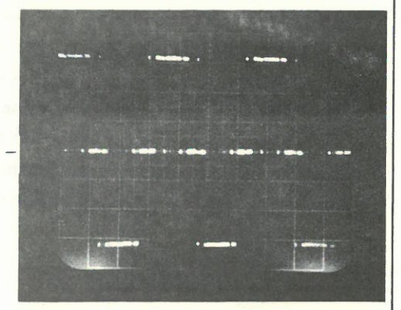
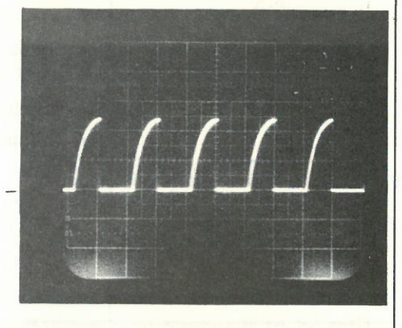
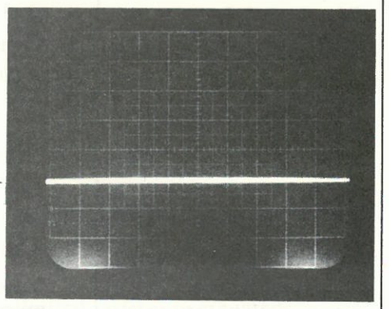
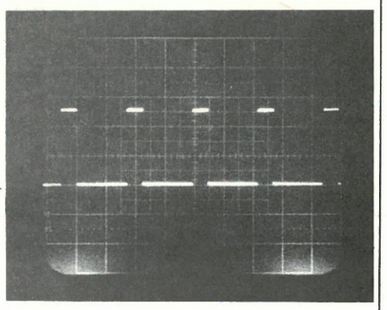
4 Installing a temperature sensor to detect the current limited resistor overheated:

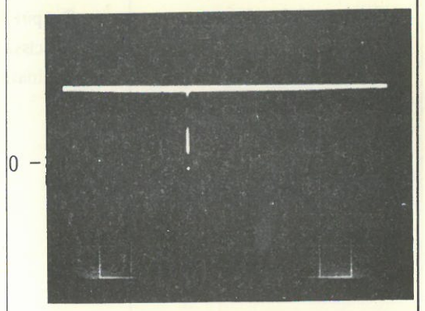
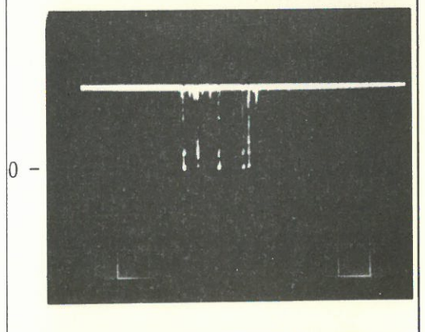
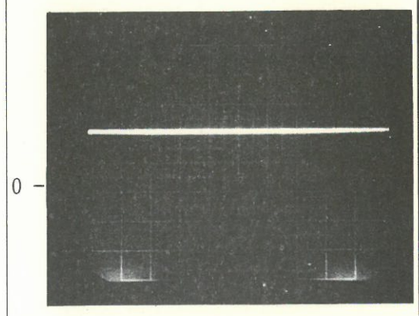
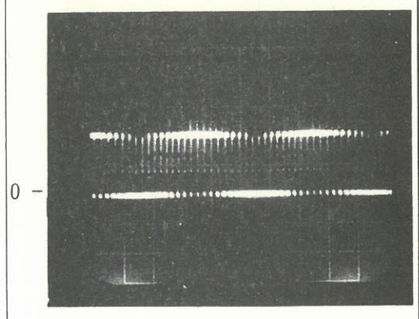
With this temperature sensor employed, make certain that the current limited resistor if relatively positioned as illustrated below.
In case of wiring subject to the standard connection diagram, however, the temperature sensor is not employed (with pins 5 and 6 short-circuited in the connector).



7-5 Photos of component waveforms

Designation	Condition	Wave-forms (synchroscope)
Input current	• During acceleration • GDℓ² = 5 x GDm² • Abscissa 2m sec/div • Ordinate 20A/div	
Output current (Motor current)	• Output frequency 50 Hz • GDℓ² = 5 x GDm² • Abscissa 5m sec/div • Ordinate 20A/div	
Output current (Motor current)	• Output frequency: 150 Hz • GDℓ² = 5 x GDm² • Abscissa 5m sec/div • Ordinate 20A/div	
Output voltage (Motor terminal voltage)	• Output frequency: 50 Hz • GDℓ² = 5 x GDm² • Abscissa 5m sec/div • Ordinate 100V/div	

Designation	Condition	Wave-forms (Synchroscope)
Output voltage (Motor terminal voltage)	• Output frequency: 150 Hz • $GD\ell^2 = 5 \times GDm^2$ • Abscissa 2m sec/div • Ordinate 100V/div	
Frequency setting CH1-M5	• Output frequency: 0 Hz • Abscissa 5 μsec/div • Ordinate 2V/div	
Frequency setting CH2-M5 (Output frequency x 3)	• Output frequency: 0 Hz • Abscissa 1m sec/div • Ordinate 2V/div	
Frequency setting CH2-M5 (Output frequency x 3	• Output frequency: 150 Hz • Abscissa 1m sec/div • Ordinate 2V/div	

Designation	Condition	Wave-forms (synchroscope)
Overvoltage failure CH5-M5	• "L" level with an over-overvoltage • Abscissa: 0.5 sec/div • Ordinate: 2V/div	
Overvoltage suppression CH6-M5	• "L" level with an overvoltage suppressed • Abscissa: 0.5 sec/div • Ordinate: 2V/div	
PWM modulated output CH8-M5	• Output frequency: 0 Hz • Abscissa: 5m sec/div • Ordinate: 2V/div	
PWM modulated output CH8-M5	• Output frequency: 50 Hz • Abscissa: 5m sec/div • Ordinate: 2V/div	

Designation	Condition	Wave-forms (synchroscope)
PWM modulated output CH8-M5	• Output frequency: 150 Hz • Abscissa 1m sec/div • Ordinate 2V/div	0 –