

AC SPINDLE DRIVE SYSTEM
FRENIC[®] 5000V2

INSTRUCTION MANUAL

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

Contents

1. General	1
1-1 Preface	1
1-2 Inspection	1
1-3 Installation	1
1-4 Nameplate	2
2. Construction	4
2-1 Basic construction	4
2-2 List of types of basic construction component units	5
2-3 Layout diagram of main drive units	6
2-4 Type and quantity of important component parts of the main circuit	8
2-5 Specifications of terminal board and connector	9
3. Wiring and Connection	14
3-1 Connecting the power	14
3-2 Precautions for wiring	15
4. Test Operation	17
4-1 Check items	17
4-2 Procedure of test operation	19
4-3 Adjustment	20
5. Maintenance and Inspection	22
6. Troubleshooting	24
6-1 Checking power voltage	24
6-2 Classification of failures	25
6-3 Troubleshooting checklist	25

7. Spindle Orientation	33
7-1 Configuration of spindle orientation	33
7-2 Setting and adjustment of magnetic sensor system	34
7-3 Setting and adjustment of pulse encoder system	38
8. Collection of Diagrams	43
8-1 Interface	43
8-2 Drive unit internal connection diagram	45
8-3 PC board components layout diagram	46
(1) Main PC board	46
(2) Soft start-stop PC board	50
(3) Magnetic sensor system orient. P.C.B	51
(4) Pulse encoder system orient. P.C.B	52

1. General

1-1 Preface

This manual describes Fuji AC Spindle Drive Unit FRENIC 5000V2.
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 name plate 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 very careful not to give damage to the unit.

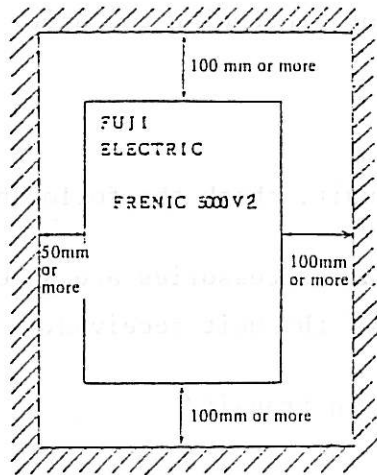
- (2) When keeping the unit in storage, keep it in a clean and dry place at moderate temperature in the packing box while shutting out direct sunlight.

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, dust, 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.

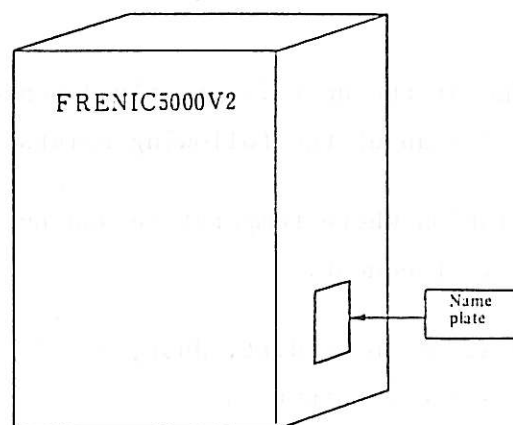
Remarks: As the unit is a heating element, be sure to provide a proper ventilation so that the temperature within the panel meets the allowable ambient temperature conditions of the drive unit in taking the heating value into account.



1-4 Nameplate

(1) Mounting position

The nameplate is mounted on the right side of the drive unit (when viewed from the front side).



(2) Characters to be written on the nameplate (Example)

FUJI ELECTRIC		
	FRENIC 5000V2	①
Type	FSD - 15 AR - 22	②
In Put	AC200/220, 230V, 50/60Hz	③
Out Put	11 kw, CONT	④
	15 kw, 30MIN	⑤
Series No	HH C66666ROO1	⑥
Mfd	SEPT 1983	⑦

(1) For their contents, see the Table below.

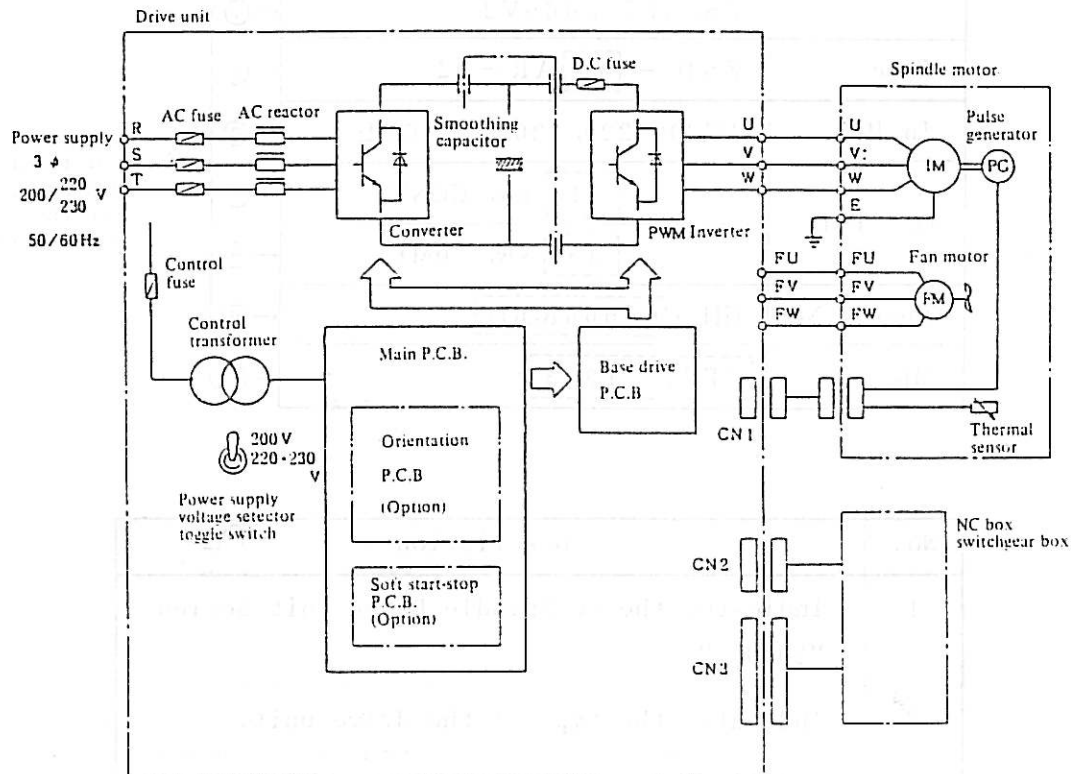
No.	Description
1	Indicates the AC Spindle Drive Unit Series "5000V2"
2	Indicates the type of the drive unit.
3	Indicates the input AC power specifications of the drive unit.
4	Indicates the rated capacity of the motor at the rated continuous output voltage.
5	Indicates the rated capacity of the motor at 30-minute rated output voltage.
6	Indicates Fuji's serial number of the drive unit.
7	Indicates the date of manufacture 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. Construction

2-1 Basic construction

Fuji AC Drive Units comprise the following component parts.



Standard component parts

- (1) Spindle motor
- (2) Spindle drive unit (FRENIC 5000V2)
- (3) Connector for external connection
- (4) Spare parts (Fuses, etc. by 100%)

Option

- (1) Digital/analog converter element
- (2) Soft start-stop control circuit
- (3) Electric type orientation control circuit

2-2 List of types of basic construction component units

(1) Standard units

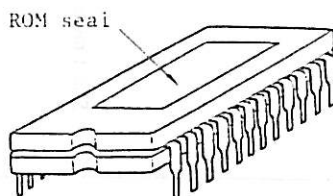
System name	Unit type	Type of main printed circuit board		Type of base drive printed circuit board	Type of applicable motor
		Type of main body	ROM indication (seal)		
FSD- 5A	FSD-5AR-22	EP-2248B	RFV2-0-2559	EP-2254BZ	MPF1114
FSD- 7A	FSD-7AR-22		RFV2-0-2759		MPF1116
FSD-11A	FSD-11AR-22		RFV2-0-2110	EP-2254B	MPF1134
FSD-15A	FSD15AR-22		RFV2-0-2150		MPF1136
FSD-18A	FSD-18AR-22		RFV2-0-2180	EP-2259AZ-1	MPF1138
FSD-25A	FSD-25AR-22		RFV2-0-2250		MPF1168
FSD-30A	FSD-30AR-22		RFV2-0-2300	EP-2259AY	MPF1186
FSD-37A	FSD-37AR-22		RFV2-0-2370		MPF1188

(2) Options (Common to every drive unit)

Item name		Type
D/A converter element	12-bits binary	DAC800-CBi-V
	BCD 2 digits	DAC80-CCD-V
Soft start-stop printed circuit board	0 ~ 15 sec	EP-2281A
Electric type orientation printed circuit board	Magnetic sensor type	EP-2258A
	Pulse encoder type	EP-2278A

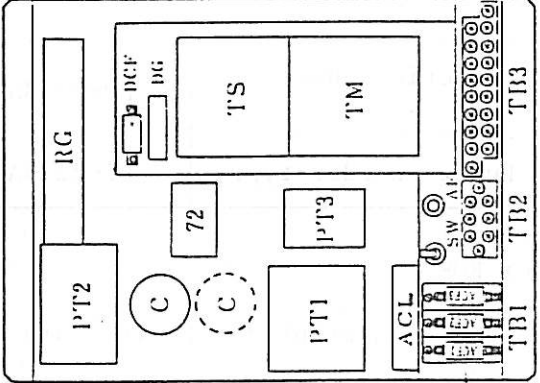
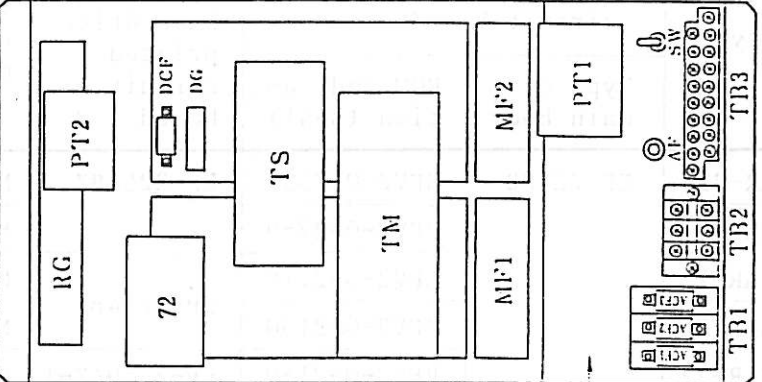
Note: Description of ROM

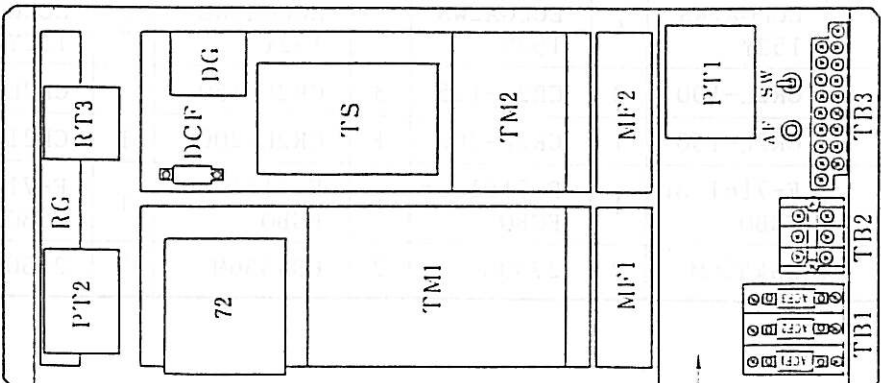
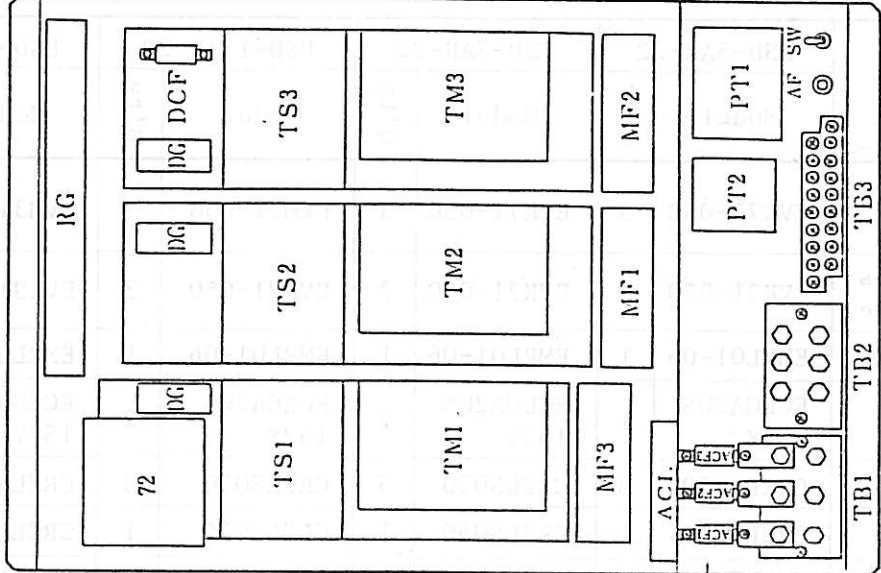
Every ROM mounted on a printed circuit board has a seal put on it to indicate its content as shown below.



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

2-3 Layout diagram of main drive units

FSD-5AR-22 · FSD-7AR-22	FSD-11AR-22 · FSD-15AR-22
 <p>Sheet metal</p> <p>Cooling fan is located beneath the sheet metal</p>	 <p>Sheet metal</p> <p>Capacitor, PT3, and ACL are located beneath the sheet metal.</p>
<p>TM: Transistor modules (Motor side) TS: Transistor modules (Power supply side) DG: Diode (DC circuit)</p> <p>C : Smoothing capacitor DCF : DC fuse ACF : AC fuse AF : Control fuse</p>	<p>PT1 ~ PT3 : Control transformer ACL : AC reactor MF : Cooling fan RG : Register</p> <p>SW : Power selector switch TB1 : AC input terminal TB2 : AC output terminal TB3 : Fan motor terminal</p>

<p>FSD-18AR-22 · FSD-25AR-22</p>	<p>FSD-30AR-22 · FSD-37AR-22</p>
 <p>Sheet metal</p> <p>Cooling fan is located beneath the sheet metal.</p>	 <p>Sheet metal</p> <p>Capacitor, PT3, and ACL are located beneath the sheet metal.</p>
<p>TM: Transistor modules (Motor side) TS: Transistor modules (Power supply side) DG: Diode (DC circuit)</p>	<p>PT1 ~ PT3: Control transformer ACL: AC reactor MF: Cooling fan RG: Register</p>
<p>C: Smoothing capacitor DCF: DC fuse ACF: AC fuse AF: Control fuse</p>	<p>SW: Power selector switch TB1: AC input terminal TB2: AC output terminal TB3: Fan motor terminal</p>

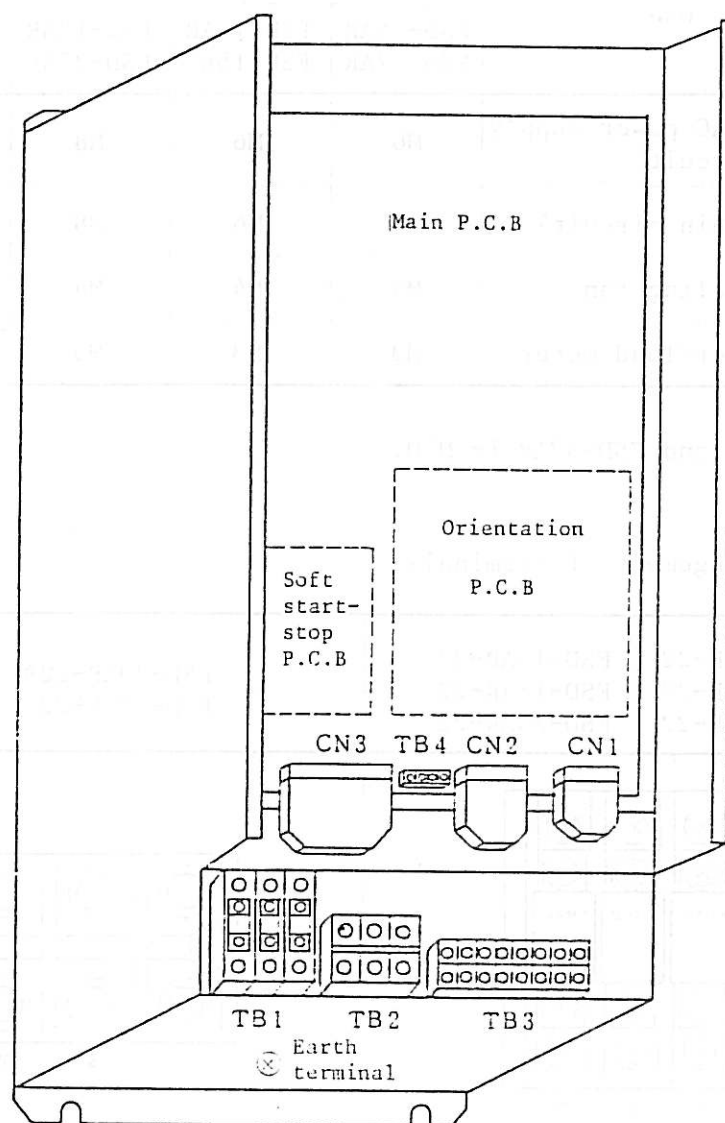
2-4 Type and quantity of important component parts of the main circuit

Unit model Name	FSD-5AR-22		FSD-7AR-22		FSD-11AR-22		FSD-15AR-22	
	Model	Q'ty	Model	Q'ty	Model	Q'ty	Model	Q'ty
Transistor modules (Motor side)	EVK71-050	3	EVK71-050	3	EVM31-050	3	EVM31-050	3
Transistor modules (Power supply side)	EVK31-050	3	EVK31-050	3	EVK71-050	3	EVL31-050	3
Diode (DC circuit)	EMRL01-06	1	EMRL01-06	1	EMRL01-06	1	EMRL01-06	1
Smoothing capacity	ECEGA2WS 152Y	1	ECEGA2WS 152Y	2	ECEGA2WS 152Y	2	ECEGA2WS 152Y	3
AC fuse	CR2LS050	3	CR2LS050	3	CR2LS050	3	CR2LS075	3
DC fuse	CR2LS050	1	CR2LS050	1	CR2LS075	1	CR2L100	1
Control fuse	F-7161 or FGBO	1	F-7161 or FGBO	1	F-7161 or FGBO	1	F-7161 or FGBO	1
Cooling fan	HS4556M	1	HS4556M	1	HS4556M	2	HS4556M	2

Unit model Name	FSD-18AR-22		FSD-25AR-22		FSD-30AR-22		FSD-37AR-22	
	Model	Q'ty	Model	Q'ty	Model	Q'ty	Model	Q'ty
Transistor modules (Motor side)	EVM32-050	6	EVM32-050	6	EVM32-050	9	EVM32-050	9
Transistor modules (Power supply side)	EVL31-050	3	EVM31-050	3	ETN81-050	6	ETN81-050	6
Diode (DC circuit)	EMRL01-06	2	EMRL01-06	2	EMRL01-06	3	EMRL01-06	3
Smoothing capacity	ECEGA2WS 152Y	4	ECEGA2WS 152Y	4	ECEGA2WS 152Y	6	ECEGA2WS 152Y	7
AC fuse	CR2L-100	3	CR2L-125	3	CR2L-150	3	CR2L-200	3
DC fuse	CR2L-150	1	CR2L-200	1	CR2L-200	1	CR2L-225	1
Control fuse	F-7161 or FGBO	1	F-7161 or FGBO	1	F-7161 or FGBO	1	F-7161 or FGBO	1
Cooling fan	HS4556M	2	2750M	2	HS4556M	3	2750M	3

2-5 Specifications of terminal board and connector

(1) Mounting position



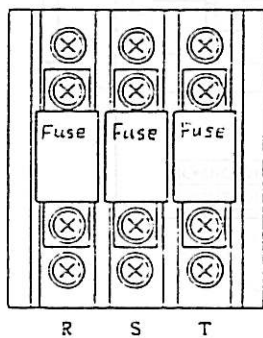
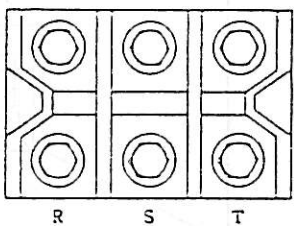
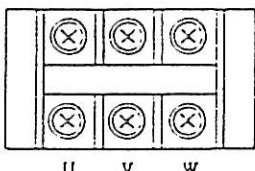
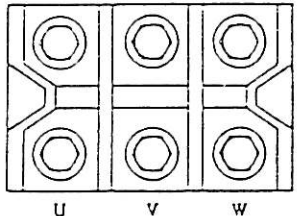
(2) Type and arrangement of terminals

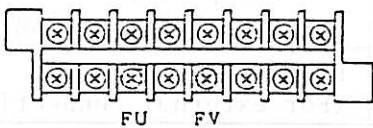
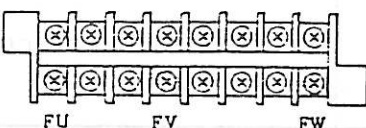
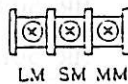
(i) Type of terminal

Symbol	Use	Size of terminal			
		FSD- 5AR FSD- 7AR	FSD-11AR FSD-15AR	FSD-18AR FSD-25AR	FSD-30AR FSD-37AR
TB1	3-phase AC power supply (main circuit)	M6	M6	M8	M8, M10*
TB2	Motor (main circuit)	M5	M6	M8	M10
TB3	Motor cooling fan	M4	M4	M4	M4
TB4	Tachometer/load meter	M3	M3	M3	M3

* FSD-30AR is M8, and FSD-37AR is M10.

(ii) Arrangement of terminals

Drive unit model Symbol	FSD- 5AR-22 FSD- 7AR-22 FSD-11AR-22	FSD-15AR-22 FSD-18AR-22 FSD-25AR-22	FSD-30AR-22* FSD-37AR-22
TB1*	 <p>Used also as fuse holder with a symbol seal</p>	 <p>Hexagon nut with a symbol seal</p>	
TB2	 <p>With a symbol seal</p>	 <p>Hexagon nut with a symbol seal</p>	

Drive unit model	FSD- 5AR-22 FSD-15AR-22 FSD- 7AR-22 FSD-18AR-22 FSD-11AR-22 FSD-25AR-22	FSD-30AR-22* FSD-37AR-22
Symbol		
TB3	 <p>With a symbol seal</p>	 <p>With a symbol seal</p>
TB4	 <p>LM SM MM</p>	<p>Mounted on the main printed circuit board</p> <p>With a symbol seal</p>

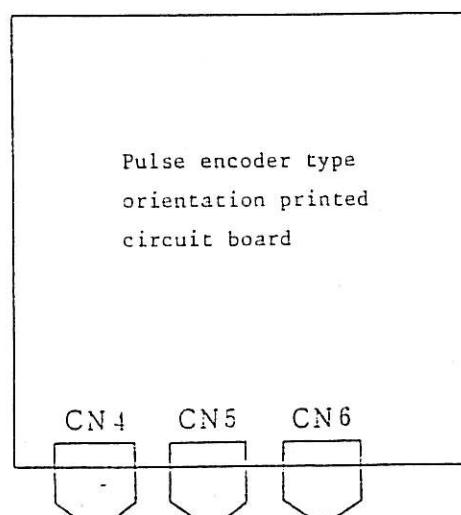
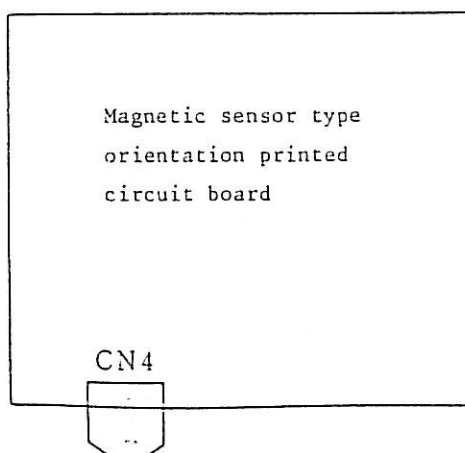
* Terminal board TB1 of FDS-30AR-2 is used also as the fuse holder shown in the left of the above figure.

(3) Connector type and pin arrangement

(i) Connector type

Symbol	Use (For connection)	Receptacle (For PCB mounting)	Manufacturer
		Plug (For external connection)	
CN1	Motor (Speed-detecting PG, Thermal sensor)	MR-16RMA	Honda Communi- cation
		MR-16LF	
CN2	NC box (interface signal)	MR-25RMA	
		MR-25LF	
CN3	NC box/switch-gear box (interface signal)	MR-50RMA	
		MR-50LF	
CN4*	Magnetic sensor type orientation (Magnetic sensor)	MR-20RMA	
		MR-20LF	
CN4*	Pulse encoder type orientation (Pulse encoder)	MR-20RMA	
		MR-20LF	
CN5*	Pulse encoder type orientation (NC box)	MR-20RMA	
		MR-20LF	
CN6*	Pulse encoder type orientation (Switch-gear box)	MR-20RMA	
		MR-20LF	

*: Mounted on orientation printed circuit boards. The mounting position of each connector is as shown below.



(ii) Pin arrangement

1 CN1 : Motor (PG, TC)

2 CN2 : NC

11	PA	7		1		17	R12	10	R11	1	R04
12	RA	8	RB	2		18	R10	11	R09	2	R03
13	SV	9	PB	3		19	R08	12	R07	3	R02
14	COH	10		4		20		13	R06	4	R01
15	OH1			5	SS	21		14	R05	5	RM
16	OH2			6	OV	22		15		6	
						23	SAR4	16	SAR3	7	
						24	FALT4			8	FALT3
						25	SST4			9	SST3

3 CN3 : NC box/switch-gear box

4 CN4 : Magnetic sensor (MS type orientation)

33	AL8			1	SST2	14	SP	8		1	
34	AL4			2	SAR1	15	MD	9		2	
35	TLM2	19	SDT1	3	SST1	16	SHIELD	10		3	
36	ALCM	20	AL2	4	FALT1	17	SO	11		4	
37	SDT2	21	TLM1	5	FALT2	18	MA	12		5	
38	LM	22	AL1	6	SAR2	19	SI	13		6	
39	OVS	23	SM	7	CM	20	MA			7	
40	OVP	24	ASS	8	MMS						
41	MG	25	DAO	9	MM						
42	ORT	26	SFC	10	OVMS						
43	REV	27	UCL	11	OVM						
44	FOR	28	TLML	12	ASMS						
45	ES	29	CM	13	CM						
46	RDY	30	RORT	14	CM						
47	CM	31	LG	15	CM						
48	RES	32	TLMH	16	ORAR1						
49	CM			17	ORAR2						
50	ASM			18	ASP						

5 CN4,CN5 : Pulse encoder (PG) type orientation

6 CN6 : Pulse encoder (PG) type orientation

14	SC	8		1	OH	14	ES07	8	ES01	1	ESM
15	*SC	9		2	OH	15	ES08	9	ES02	2	ESM
16	PA	10		3	OH	16	ES09	10	ES03	3	
17	*PA	11		4	5H	17	ES10	11	ES04	4	
18	PB	12		5	5H	18	ES11	12	ES05	5	
19	*PB	13		6	5H	19	ES12	13	ES06	6	
20	SHIELD			7		20	ESM			7	

3. Wiring and Connection

3-1 Connecting the power

(1) Specifications of the power supply

The following table shows the specifications of the power supply which can be connected to the drive unit. For other specifications, provide a proper power transformer.

Rated nominal voltage		AC200/220·230V, 50/60Hz, 3 phases							
Rated nominal voltage		10% of rated voltage							
Power supply capacity*	Unit model	FSD -5AR-22	FSD -7AR-22	FSD -11AR-22	FSD -15AR-22	FSD -18AR-22	FSD -25AR-22	FSD -30AR-22	FSD -37AR-22
	KVA	9	12	17	22	28	37	45	55

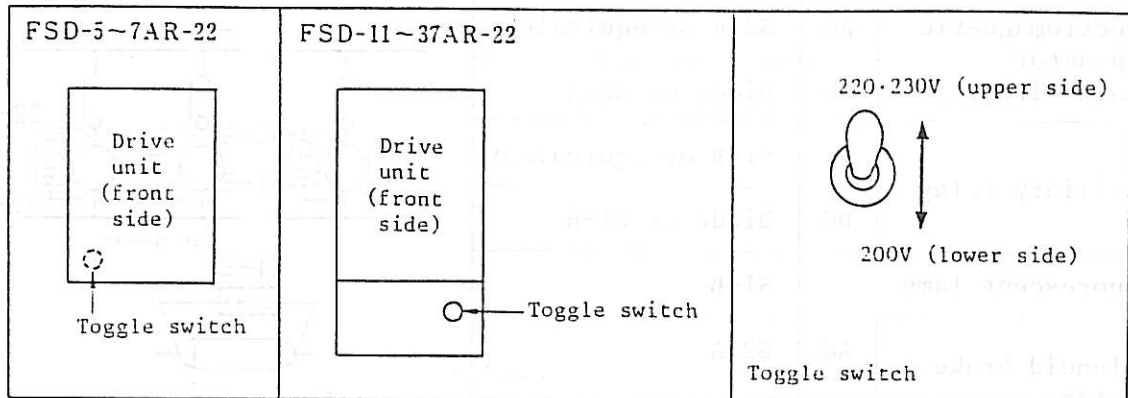
*: Indicates a required power supply capacity at 30-minute 50% ED output. To avoid inconveniences resulting from voltage drop even at the maximum load, use the power supply having a sufficient capacity.

(2) Connecting the power supply

After making sure of the power supply specifications, take the following steps depending on the power supply voltage.

Rated nominal voltage	Supply voltage	Steps taken
200 V	180 V to 220 V	Set the power supply voltage selector toggle switch located at the lower part of the unit to the 200 V side.
220/230 V	198 V to 253 V	Set the power supply voltage selector switch located at the lower part of the unit to the 220/230V side.
Above 230 V and below 200 V	Above 254 V and below 180 V	Use an insulating transformer with a proper capacity to set the voltage at 200 V or 220 V.

* Power supply voltage toggle switch is located as shown below.



3-2 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 and inverter control panels, be sure to connect an antiparallel diode or CR filter to the AC-controlled coils, and a CR filter to the AC-controlled coils. (See the figure below.)
 - (a) CR FILTER and diode applications (Circuit voltage: 250 V or less)

Applicable parts		CR filter or diode	Examples of connection
Electromagnetic contactor (main circuit)	AC	S2-A or equivalent	<p>AC ÷ DC</p> <p>S2-A S2-A S2-A</p> <p>S1-B S1-B S1-B</p> <p>or diode</p> <p>S1-B</p> <p>Fluorescent lamp</p>
	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 μ F, 500 VDC (Nittsuko Ltd.)

R: 500 ohm

S1-B C: 0.1 μ F, 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.

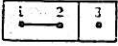
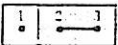
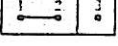
4. Test Operation

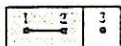
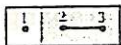
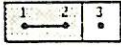
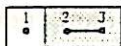
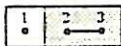
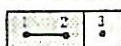
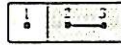
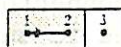
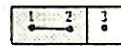
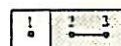

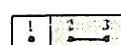
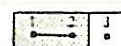
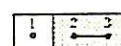
4-1 Check items

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 page
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?	
7	If set terminals (short pins) on the printed circuit board are preset as specified?	See the Table below.

• Checking of set terminals (short pins)

Set terminal	Content		Setting	Remarks
SW1	Speed reference input select	Analog speed reference		
		Digital speed reference		
		Analog and digital speed reference used in combination		

Set terminal	Content		Setting	Remarks
SW2	Analog override	Used		
		Unused (Invalid)		
SW3 SW4	Selecting D/A converter chip	Digital speed reference in BCD 2 digits	SW3 	Check if D/A converter chip is mounted?
			SW4 	
		Digital speed reference in 12-bits binary	SW3 	
			SW4 	
SW5	Soft start-stop	Used		Possible to cancel it by means of external signal.
		Unused		
SW7	"Ready" signal	Used		
		Unused		
SW8	"Starting failure" detect	Used		Short between 2-3 when a torque limiter is used.
		Unused (invalid)		
SW11	Thermal sensor select (spindle motor)	Normal circuit used		Switch over to the spare circuit when the thermister down occurs.
		Spare circuit used		



marks indicate short pins.

4-2 Procedure of test operation

Item	Content	Procedure and check point
1	"Power" ON	<ol style="list-style-type: none"> 1 The power supply display LED5 (green) lights up. 2 The main circuit power ON display LED6 (orange) lights up. 3 The CPU running display LED9 (green) blinks (with an interval of 1 sec).
2	"Ready" signal ON	<p>The spindle motor fan motor rotates. Check for the rotating direction of the fan motor.</p> <p>Note: The emergency stop input must be in the reset status at this time.</p> <p>Set the minimum speed reference to check for the rotating direction of the motor.</p>
3	"Drive" signal ON (Forward/reverse drive signal)	<p>When set to the forward rotation: The motor rotates counterclockwise (CCW).</p> <p>When set to the reverse rotation: The motor rotates clockwise (CW).</p> <p>Note: The rotating direction is viewed from the motor output shaft.</p>
4	Fine adjusting of speed feedback value (Adjusting variable resistor: VR29*)	<p>Run the motor in the forward direction at 100 to 120 rpm (motor speed) and adjust the speed by means of VR29 so that LED7 (green) lights up.</p> <p>Note: (i) Adjust VR29 at around 8~10 notches normally.</p> <p>(ii) When hunting occurs, adjust VR6 or VR7 in the direction of 0 notch.</p>
5	Fine adjusting of speed control-loop gain (Adjusting variable resistors: VR6* and VR7*)	<p>While reising the speed reference gradually up to the maximum speed, increase the P-gain of the speed control amplifier (ASR) by means of VR6 or VR7. (It increases when the variable resistor is turned clockwise.)</p> <p>Note: (i) VR6: Effective when the L-gear/M-gear signal is input.</p> <p>VR7: Effective when the H-gear signal is input (without the M-gear signal).</p> <p>(ii) When the ASR-P gain is raised too much, the hunting phenomenon is apt to occur. When it is lowered too much, the quality of response becomes poor and overshoot and other faults are apt to occur.</p>

Item	Content	Procedure and check point
6	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.

* For adjusting method of VR6, VR7, and VR8, see 4-3, "Adjustment of speed control loop", too.

4-3 Adjustment

(1) Adjusting of speed control loop

Of the variable resistors given in the table below, adjust VR6 and VR7 (VR29) to their optimum value according to the load in combined operation with the machine. Since VR5 and VR30 have already been adjusted well when they are shipped from Fuji Electric, no adjustment is necessary for users in principle.

VR	Function	Check terminal/ check point	Adjusting method
VR5	Adjustment of analog speed reference voltage	CH8-M(0V)	<ul style="list-style-type: none"> After adjusting the speed by means of VR5 so that the voltage of CH8 becomes +10.00 V at the maximum forward rotation speed, check if the voltage of CH8 becomes -9.95 to -10.05 V when the reverse rotating reference is given (the voltage becomes the maximum in the direction of).
VR6 VR7	Adjusting of speed control-loop P-gain	Spindle	<ul style="list-style-type: none"> Adjust the speed by means of VR6* or VR7* according to the load conditions lest should hunting or overshooting occur (the gain becomes larger in the direction of). * : VR6 is effective when the L-gear and M-gear signals are input. VR7 is effective when the H-gear single (without the M-gear signal) is input.

VR	Function	Check terminal/ check point	Adjusting method
VR29	Adjusting of speed feedback value	LED7 (green)	Rotate the motor in the forward direction (at 100~120 rpm in terms of motor) and adjust the speed by means of VR29 until LED7 (green) lights up.
VR30	Adjusting of maximum speed (change in the maximum speed)	Spindle	<ul style="list-style-type: none"> When the maximum speed is changed, give the maximum speed reference (10V) and adjust the value by means of VR30 so that the spindle becomes the rated rpm (the speed is reduced when the variable resistor is turned in the direction of).

(2) Adjusting of auxiliary functions

Since the variable resistors given in the table below have already been adjusted well when they are delivered from Fuji Electric, no adjustment is necessary in principle.

Adjusting VR	Function	Content	Preset by Fuji Electric
VR10	Setting of torque limit "Low area"	Possible to set a range from 0 to 50% of the rated torque continuously.	50% (... notches)
VR11	Setting of torque limit "High area"	Possible to set a range from 0 to 100% of the rated torque continuously.	100% (... notches)
VR20	Setting of the detecting range of speed arrival	Possible to set detection level with a width from ± 1 to $\pm 10\%$ upon the arrival to the set speed.	$\pm 5\%$ (... notches)
VR21	Setting of speed detect value	Possible to set the speed detect level in a range from 0 to 100% of the maximum speed.	15% (... notches)
VR22	Adjusting of output voltage for speed meter	Possible to adjust the voltage in a range from 7 to 10.5% at 10-ohm load (at the maximum speed).	10V/maximum speed

* These are set values unless specified otherwise when ordered.

As switches and variable resistors other than those given in the above table have already been well adjusted when they are delivered from Fuji Electric, do not readjust them at random. When adjusting, be sure to contact our company.

5. Maintenance and Inspection

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 (LED6, 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	<ul style="list-style-type: none">• 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 capacitor PC board	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• Check if the fan rotates powerfully when conducted.• Check if bearing unit sounds abnormally.	If does, replace the fan.
4	Terminal and connector	<ul style="list-style-type: none">• Check if any terminal or connector is loosened.	If any of them is loosened, retighten the loose one.

Remarks: When dust or other deposit is rich, use compressed air or other means to remove the deposit without giving shock to the parts. However, if there is a conductive dust or fine deposit which may cause the relay or other parts to make poor contact, draw it into a vacuum cleaner, etc.

6. Troubleshooting

In case any abnormal event occurs at the start or in the middle of operation, trace the event correctly and take corrective actions to recover it based on the troubleshooting checklist, while observing the precautions given below. If impossible to recover from the trouble or any part is found to be defective, please contact our company.

Precautions

- (a) Unless authorized, never repair or adjust any equipment.
- (b) Use a tester, vacuum-tube voltmeter, synchroscope, or other proper meter to check any circuit.
- (c) Never connect or disconnect the wiring while the power is ON. Doing so will cause a shortcircuit.
- (d) Do not adjust any switch or variable resistor which has already been adjusted. If adjustment is inevitable, keep the pre-adjustment position (number notches) recorded so that they could return to the original conditions.

6-1 Checking power voltage

When any trouble occurs, check for the supply voltage mentioned in the table below first of all.

Checking the AC power supply voltage	Check if the voltage is as rated in the "Specifications of power connection".			
Checking the control power supply voltage	Check if the control power supply voltage on the main PC board is as rated in the table below.			
	Voltage	Use	Check terminal	Rated value
	+24V	Relay circuit	P ₁ -M	+24V \pm 15%
	+15V	Analog circuit	P -M	+15V \pm 5%
	-15V	Analog circuit	N -M	-15V \pm 5%
	+5V	Digital circuit	P _D -M	+5V \pm 1%

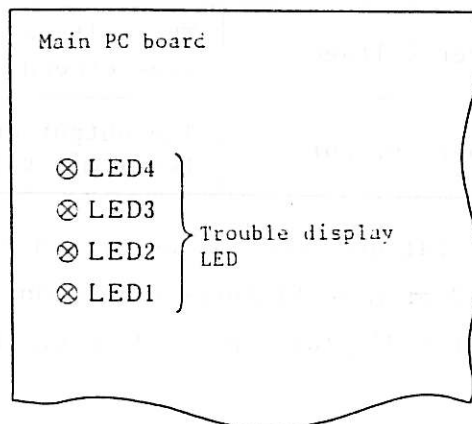
6-2 Classification of failures

Item	Fault conditions	Remarks
1	Power supply breaker trips.	
2	The control power supply display LED5 does not light up even when the power is turned ON.	
3	The CPU running display LED9 does not blink even when the power is turned ON.	
4	The alarm display LED lights up.	
5	The motor does not rotate even when the running command is issued.	
6	The motor does not boost, nor reaches the speed as instructed.	
7	The motor noise and vibration are too big.	
8	The speed overshoot is too large.	
9	The cutting force is too low	
10	The orientation is not performed correctly.	

6-3 Troubleshooting checklist

(1) When the trouble display LED lights up

The content of the alarm is displayed by 4 LEDs on the PC board.



Item	Trouble display (● : Lighting)				Name	Content of display
	LED4	LED3	LED2	LED1		
1				●	Starting failuar	The spindle motor does not start due to overload, etc.
2			●		Motor over-heat	The internal temperature of the speindle motor exceeds the rated value.
3			●	●	AC power line fuse trip	The fuse of AC power line input section is blown out.
4		●			DC power line fuse trip	The fuse of DC power line input section is blown out.
5		●		●	Control fuse trip	The fuse of control power line input section is blown out.
6		●	●		Over speed (Analogue detected)	The motor exceeds 115% of the rated rpm.
7		●	●	●	Overspeed (Digital detected)	The motor exceeds 120% of the maximum rpm.
8	●				Overload	The braking power circuit becomes overload or overcurrent.
9	●			●	Overload	The power semiconductor cooling fan is overheated abnormally.
10	●		●		Motor thermistor fault	The motor thermistor is faulty.
11	●		●	●	Power supply voltage down	The power supply voltage lowers abnormally.
12	●	●			Over voltage	The voltage of the DC power line exceeds the rated value.
13	●	●		●	Over current	The output current exceeds the limit value.

Notes: 1. When two or more failures occur, the system displays the first one only. When 2 or more fialures occur concurrently, however, the system displays the failure which is higher in terms of code.

2. The failure reset becomes enabled when the failure causes are all cleared. Consequently, if the cause of failure after the 2nd one remains uncleared after the 1st failure cause is removed, the system displays the highest one in order.

Item	Name of failure	Cause of failure	Checking method	Corrective action taken
1	Starting failure	Overload/machine locking	Check it with a load meter.	Review the cutting conditions and tools used.
		Torque limiter circuit failure	Check it with a load meter.	Raise the limit.
		Wiring failure (between the motor and unit)	Check the wiring.	
		Speed detection PG failure	Check the PG signal.	Replace the PG.
2	Motor overheat	Overload	Check it with a load meter.	Review the cutting conditions and tools used.
		Cooling system failure		Clean the motor and replace the fan motor.
3	AC power line fuse trip	Power transistor module failure	Check the power supply side transistor module.	Replace the transistor module and fuse.
		Surge absorber capacitor failure	Check the surge absorber capacitor.	Replace faulty parts and fuses.
4	DC power line fuse trip	Power transistor module failure	Check the motor side transistor module.	Replace the transistor module and fuse.
		Shortcircuit or ground fault of output wiring	Check the wiring and motor.	Remove the faulty points due to shortcircuit or ground fault and replace faulty parts and fuses.
5	Control circuit fuse trip	Shortcircuit of control circuit fuse inside of the control PC board	Check the control power supply voltage and wiring.	After replacing the faulty PC board and repairing the wiring, replace the fuse.
		Control power supply transformer failure	Check the control power supply transformer.	Replace the control power supply transformer.

Item	Name of failure	Cause of failure	Checking method	Corrective action taken
6	Overspeed (analog detected)	Failure of speed detector circuit in PC board		Replace the PC board.
		Speed set value is too large.	Check the speed in CH8.	Lower the speed set value.
7	Overspeed (digital detected)	Failure or poor adjustment of the speed detector circuit in the PC board.	Check it in CH56.	Replace the PC board or readjust it with VR30.
		Mistake in the ROM specifications	Check the ROM seal.	Replace the ROM.
8	Overload (the power supply side inverter)	The control responsibility is too heavy.		Review the running cycle.
		Power transistor module failure	Check the power supply side power transistor module.	Replace the power transistor module.
9	Overload (the motor side inverter)	Overload	Check the inverter with a load meter.	Review the cutting conditions and tools used.
		Unit cooling system failure		Clean the unit and replace the fan motor.
10	Thermistor failure	Wiring failure or loose connector	Check the wiring and connector.	Switch over to the spare thermistor circuit.
		Thermistor failure (interior)		
11	Power supply voltage down	The input AC power supply voltage is too low (less than 170V).	Check it through power supply input terminals R, S, and T.	Review the power supply specifications.
		Power supply voltage down due to lightning (for 20 msec).		

Item	Name of failure	Cause of failure	Checking method	Corrective action taken
12	Overvoltage (DC power line circuit)	The input AC power supply voltage is too big.	Check it through power supply input terminals R, S, and T.	Review the power supply specifications.
		The power supply impe- dance is too high.		Review the power supply specifications.
		Control PC board failure		Replace the PC board.
13	Overcurrent (inverter)	Shortcircuit or ground fault of the motor circuit power transistor module failure	Check the motor side power transistor module.	Remove the faulty points due to shortcircuit or ground fault and replace the transistor module.

(2) When the trouble display LED does not light up

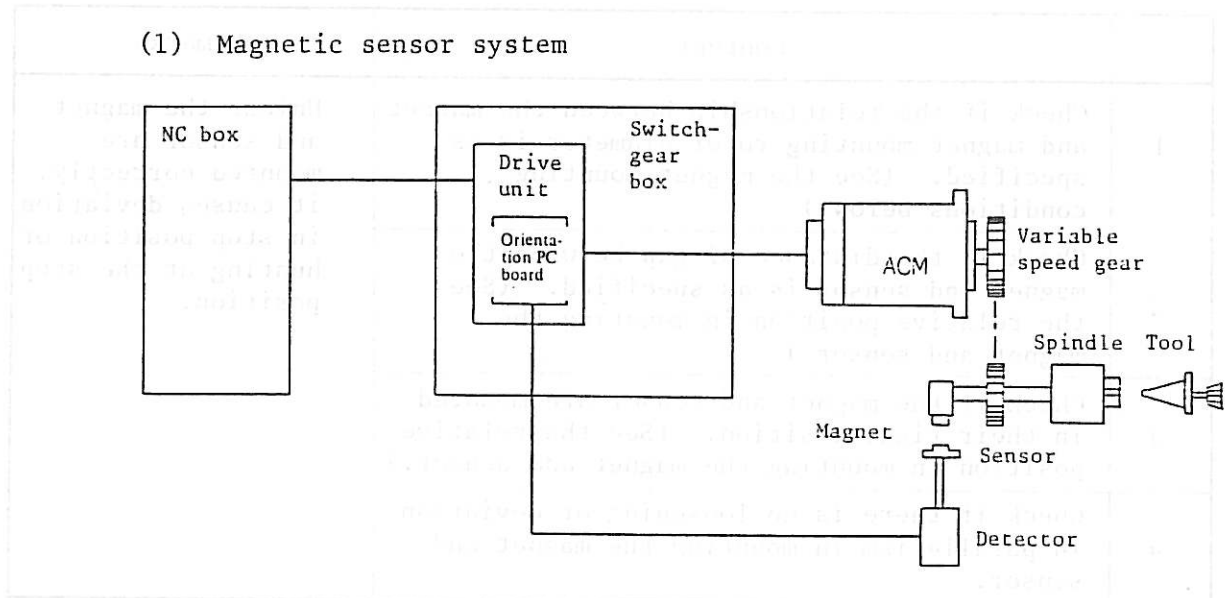
Item	Trouble conditions	Cause of trouble	Check and corrective actions taken
1	The input side power supply breaker trips.	Shortcircuit or ground fault of the main circuit wiring	Remove faulty points due to shortcircuit or ground fault.
		The rated current of the breaker is too small.	Review the capacity of the breaker.
2	The control power supply display LED does not light up even when the power is turned on.	Control circuit fuse trip	See the table in (1) above.
		The AC power is not supplied.	Review the power supply system wiring.
		Power supply control transformer and control PC board circuit failure	Replace the power supply transformer and PC board.
3	The CPU running display LED9 does not light up even when the power is turned on.	ROM failure	Replace the ROM.
		Control PC board failure	Replace the PC board.
		Control power supply circuit failure	See Item 2 above.
4	The motor does not rotate or does reach the instructed value.	The "Ready" and "Drive" signals are not input.	Check and correct the sequence signal.
		The "Emergency Stop" and "Unclamp" signals are input.	
		The start-failure protection circuit is in operation.	See the table in (1) above.
		Control PC board failure	Replace the PC board.
5	The noise and vibration of the motor are too big.	Motor mounting is no good.	Recheck the mounting and coupling of the motor.
		Motor failure	Replace the motor.
		The motor is operated out of phase.	After checking the trouble display, replace faulty parts, if any.
		Control PC board failure	

Item	Trouble conditions	Cause of trouble	Check and corrective actions taken
6	The speed overshoot is too big.	Poor adjustment of the control PC board	Raise the P-gain of the speed control amplifier (by means of VR6 or VR7).
7	Cutting force is too low.	Torque limit is applied.	Check the external torque input signal.
		Control PC board failure	Replace the PC board.

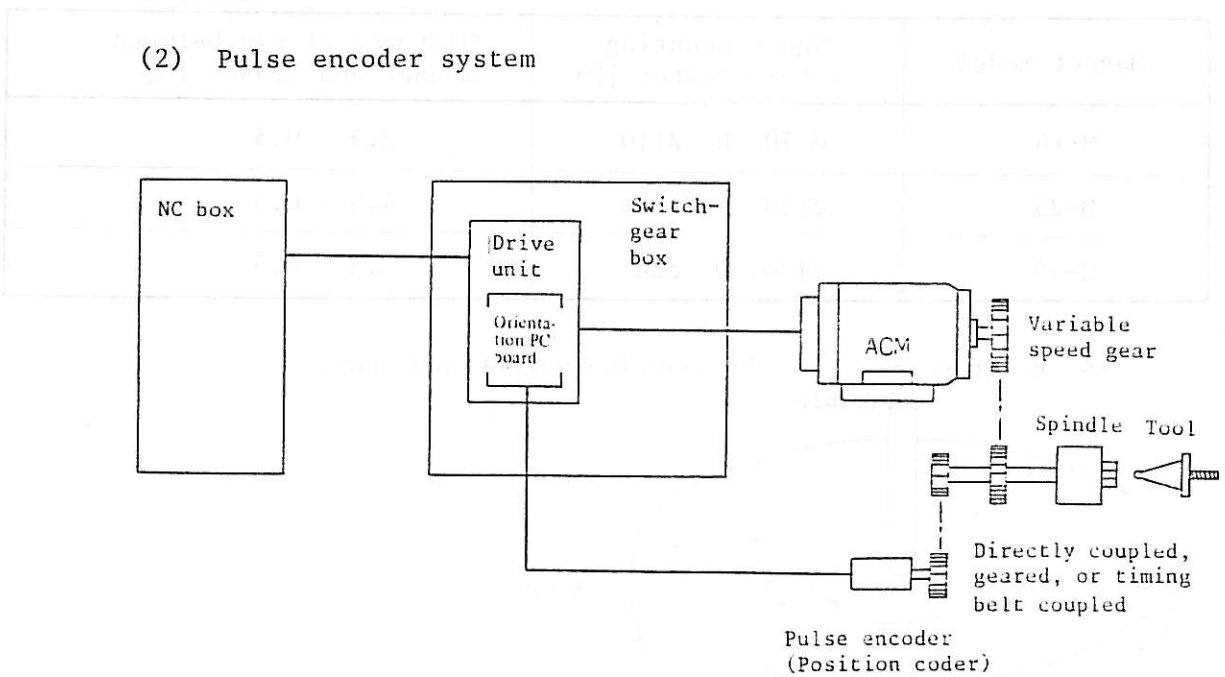
7. Spindle Orientation

7-1 Configuration of spindle orientation

(1) Magnetic sensor system



(2) Pulse encoder system



7-2 Setting and adjustment of magnetic sensor system

(1) Checking the mounting of magnet and sensor

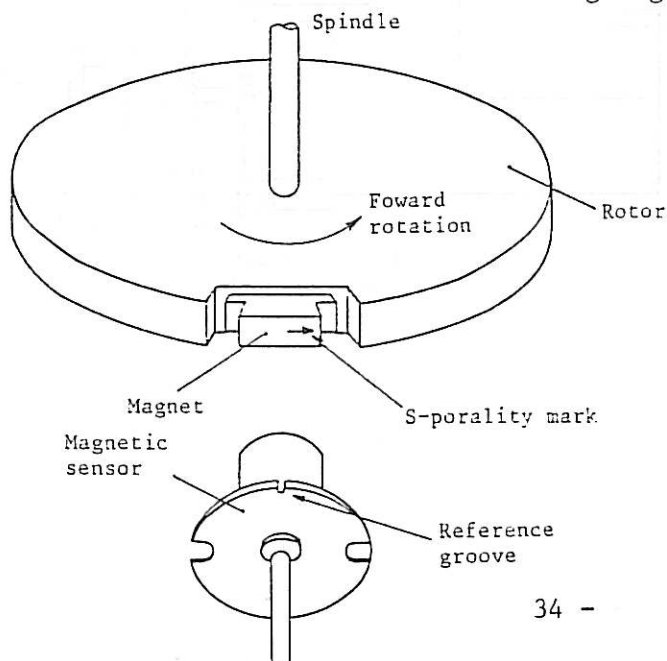
	Content	Remarks
1	Check if the relationship between the magnet and magnet mounting rotor diameter is as specified. (See the magnet mounting conditions below.)	Unless the magnet and sensor are mounted correctly, it causes deviation in stop position or hunting at the stop position.
2	Check if the distance of gap between the magnet and sensor is as specified. (See the relative position in mounting the magnet and sensor.)	
3	Check if the magnet and sensor are mounted in their right position. (See the relative position in mounting the magnet and sensor.)	
4	Check if there is no loosening or deviation in parallelism in mounting the magnet and sensor.	

* Magnet mounting conditions

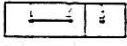
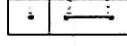
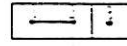
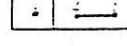
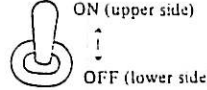
Unit: mm

Magnet model	Magnet mounting rotor diameter [D]	Distance of gap between magnet and sensor [G]
M-16	$\phi 70 \leq D < \phi 110$	3.5 ± 0.5
M-25	$\phi 110 \leq D < \phi 170$	4.5 ± 0.5
M-40	$\phi 170 \leq D < \phi 260$	5.5 ± 0.5

** Relative position in mounting magnet and sensor

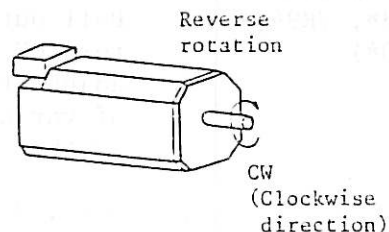
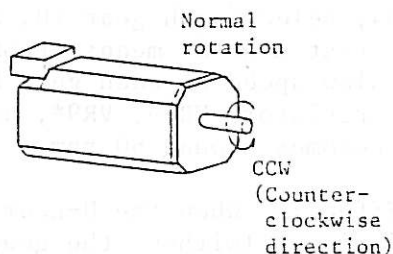


(2) Checking set terminals (short pins) and snap switches

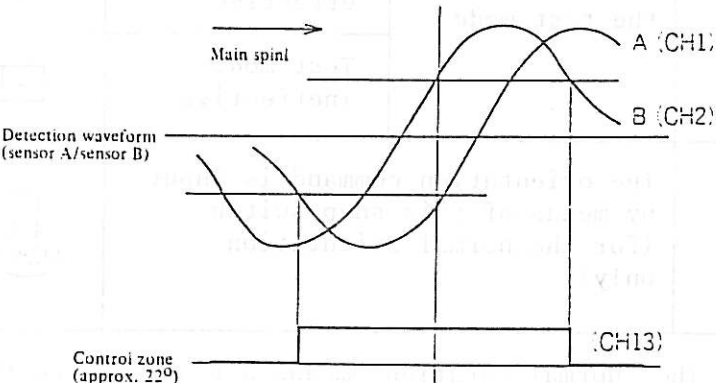
Set terminal	Content		Setting	Remarks
SW1	Selection of the main spindle rotating direction (magnetism generating element mounting shaft)	Normal rotation*		Preset to the "normal rotation" side when delivered from Fuji Electric
		Reverse rotation*		
SW2	Selection of the test mode	Test mode effective		Preset to the "test mode ineffective" when delivered.
		Test mode ineffective		
SNSW1	The orientation command is input by means of this snap switch (for the normal orientation only).			Preset to the "OFF" side when delivered.

* : The "normal rotation" means a status where the spindle motor makes a normal rotation (CCW) when the main spindle rotates normally.

The "reverse rotation" means a status where the spindle motor makes a reverse rotation (CW) when the main spindle rotates normally.



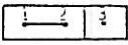
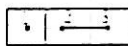
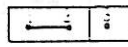
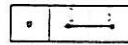
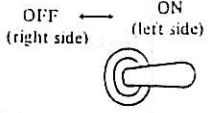
(3) Adjustment

Item	Content	Adjusting method and check point
1	Checking the sensor waveform	<p>Run the system at 100~200 rpm (main spindle speed) in normal rotation to check if LED (green) blinks.</p> <p>(i) No distortion is allowed in each waveform of A and B (CH1/CH2).</p> <p>(ii) Phase sequence of each waveform of A and B must be correct (CH1/CH2).</p> <p>(iii) CH13 must be in "H" level in the control zone (22°).</p>  <p>Check the above conditions (i), (ii), and (iii) with a synchroscope.</p>
2	Adjustment of slow speed (Adjusting variable resistors VR8*, VR9*, and VR10*)	<ol style="list-style-type: none"> 1 Select the test mode by means of SE2 (shortcircuit 1-2) to check if LD4 (green) lights up. 2 Pull out CN4, select each gear (H, M, and L), turn ON the test mode by means of SNSW1, and adjust the slow speed of each gear by means of variable resistors VR8*, VR9*, and VR10* so that it becomes around 60 rpm. <ul style="list-style-type: none"> * : VR8 : Effective when the H-gear signal is input (without the gear signal) ... LD3 (green) lights up. VR9 : Effective when the M-gear signal is input ... LD2 (green) lights up. VR10: Effective when the L-gear signal is input ... LD1 (green) lights up. 3 Set CN4.

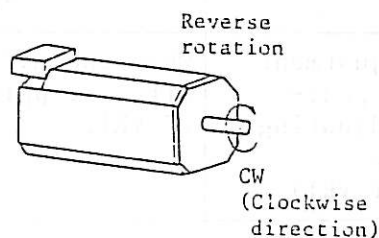
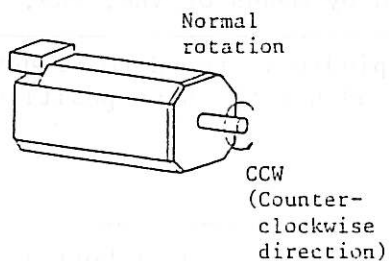
Item	Content	Adjusting method and check point
3	Adjustment of the orientation operation (Adjusting variable resistors VR6*, VR7*, VR8**, and VR9**)	<p>Select each gear (H, M, and L), turn ON the test mode by means of SNSW1 to have the orientation operation start, and adjust the speed control amplifier (ASR) P-gain by means of VR8** and VR9** and position control amplifier (ASR) P-gain by means of VR6* and VR7*. (The gain increases when turned in the direction of .)</p> <p>* : VR6: Effective when the H-gear signal is input. VR7: Effective when the M- and L-gear signals are input.</p> <p>** : VR8 and VR9 are mounted on the main PC board. VR8: Effective when the M- and L-gear signals are input. VR9: Effective when the H-gear signal is input.</p> <p>Notes: (1) After adjusting the minor loop ASR-P gain, adjust the APR-P gain. (2) When the ASR-P gain is too high, the overshoot and hunting phenomena occur at the time of stopping. (3) When the APR-P gain is too high, the hunting phenomenon occurs after stopping. (4) When the ASR-P gain and AOR-P gain are both impossible to be adjusted, readjust them by lowering the slow speed by means of VR8, VR9, and VR10.</p>
4	Fine adjustment of stop position (Adjusting variable resistor VR1)	When the main spindle is found to be deviated after stopping, adjust the stop position by means of VR1.
5	Final check	Return SW2 to the normal mode (shortcircuit 2-3), turn SNSW1 to "OFF" to start the orientation operation in the normal operation mode to check if no trouble exists.

7-3 Setting and adjustment of pulse encoder system

(1) Checking of set terminal (short pin) and snap switch

Set terminal	Content		Setting	Remarks
SW2	Selection of the mains spindle rotating direction (magnet mounting spindle)	Normal rotation*		Preset to the 'normal rotation' side when delivered from Fuji Electric.
		Reverse rotation*		
SW4	Selection of the test mode	Test mode effective		Present to the 'ineffective' side when delivered
		Test mode ineffective		
SNSW1	Input the orientation command by means of this snap switch (for the normal rotation orientation only).			Preset to the "OFF" side when delivered

* : The "normal rotation" is a status where the motor makes a normal rotation (CCW) when the main spindle rotates normally.
 The "reverse rotation" is a status where the motor makes a reverse rotation when the main spindle rotates normally.



(2) Adjustment

Item	Content	Adjusting method and check points
1	Checking of the encoder waveform	<p>Run the unit at 100~200 rpm (main spindle speed) to check the encoder input pulse waveform.</p> <p>(i) Check if no pulse split exists in each pulse of the clock signal in phases A and B (CH1, CH2, and CH3).</p> <p>(ii) CH15 must be "L" level for 1 cycle (control zone) of the saw tooth wave of the D/A converter output.</p> <div data-bbox="702 757 1428 1008"> <p>Main spindle rotating direction →</p> <p>D/A converter output $\approx 10 \sim 12V$ CH20</p> <p>Control zone CH15</p> </div> <p>Check the above conditions (i) and (ii) with a synchroscope.</p>
2	Adjustment of slow speed (Adjusting variable resistors VR1*, VR2*, and VR3*)	<ol style="list-style-type: none"> 1 Select the test mode by means of SW4 (shortcircuit 1-2) to check if LD7 (green) lights up. 2 Pull out CN4 and CN5, select each gear (H, M, and L), turn ON the test mode, and adjust the slow speed of each gear by means of VR1*, VR2*, and VR3* so that it becomes around 60 rpm. <p>* : VR1 : Effective when the H-gear signal is input (without the gear signal) ... LD3 (green) lights up.</p> <p>VR2 : Effective when the M-gear signal is input ... LD2 (green) lights up.</p> <p>VR3 : Effective when the L-gear signal is input ... LD1 (green) lights up.</p> <ol style="list-style-type: none"> 3 Set CN4 and CN5.

Item	Content	Adjusting method and check points
3	Adjustment of orientation operation (Adjusting variable resistors VR5*, VR6*, VR8**, and VR9**)	<p>Select each gear (H, M, and L), turn ON the test mode by means of SNSW1 to start the orientation operation, and adjust the speed control amplifier (ASR) P-gain by means of VR8** and VR9** and the position control amplifier (APR) P-gain by means of VR5* and VR6*. (The gain increases when rotated in the direction of .)</p> <p>* : VR5: Effective when the M- and L-gear signals are input. VR6: Effective when the H-gear signal is input.</p> <p>** : VR8 and VR9 are mounted on the main PC board. VR8: Effective when the M- and L-gear signals are input. VR9: Effective when the H-gear signal is input.</p> <p>Notes: (1) After adjusting the minor loop ASR-P gain, adjust APR-P gain. (2) When the ASR-P gain is too high, the overshoot and hunting phenomena occur at the time of stopping. (3) When the APR-P gain is too high, the hunting phenomenon occurs after stopping. (4) When the ASR-P gain and APR-P gain are both impossible to be adjusted, readjust the slow speed by lowering the slow speed by means of VR8, VR9, and VR10.</p>
4	Final check	Return SW2 to the normal mode (2-3 shortcircuit), turn "OFF" SNSW1 to start the orientation operation in the normal operation mode to check if no trouble exists.
5	Stop position set (internal setting) (Setting switches DIS1, DISW2, and DISW3)	<p>In case the stop position is not set from the external unit, set the stop position by means of digital switches DISW1-DISW3 inside of the orientation PC board.</p> <p>1 Perform the orientation and move the stopped position to a position wanted to be stopped actually by means of digital switches DISW1 ~ DISW3.</p>

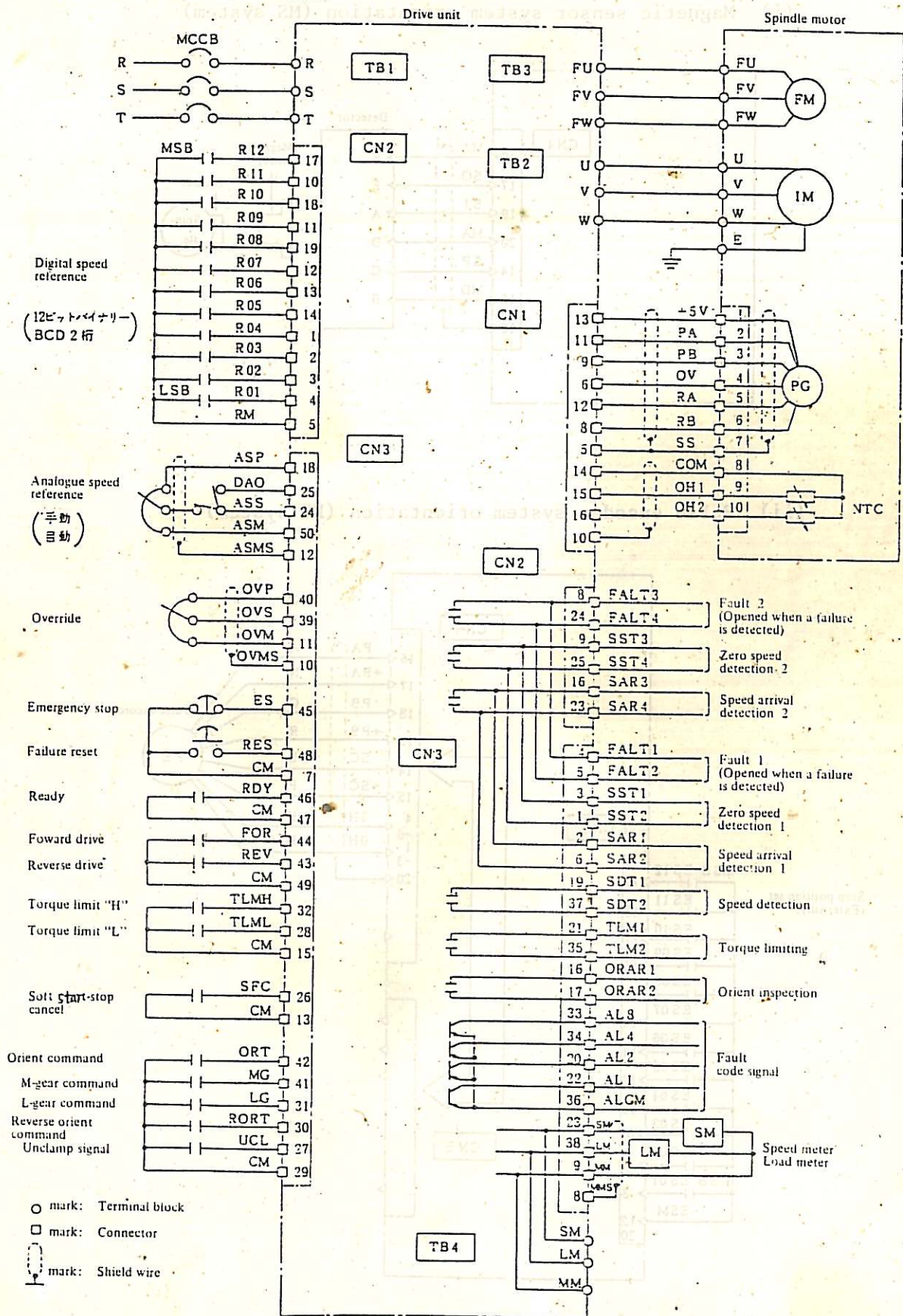
Item	Content	Adjusting method and check points																
		<p>2 The number of pulses per 1 scale of digital switches DISW1~DISW3 and moving angle are as follows.</p> <table><thead><tr><th></th><th>Number of pulses</th><th>Angle</th></tr></thead><tbody><tr><td>DISW1</td><td>256 pulses</td><td>22.5°</td></tr><tr><td>DISW2</td><td>16 pulses</td><td>1.4063°</td></tr><tr><td>DISW3</td><td>1 pulse</td><td>0.088°</td></tr></tbody></table>		Number of pulses	Angle	DISW1	256 pulses	22.5°	DISW2	16 pulses	1.4063°	DISW3	1 pulse	0.088°				
	Number of pulses	Angle																
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6	Stop position setting (external setting)	<p>The external setting of the stop position is made by means of contact input ES1~ES12 (CN6).</p> <p>1 Set DISW1~DISW3 to 0.</p> <p>2 Perform the orientation by setting the stop position setting contacts ES1~ES12 to the "H" level (open).</p> <p>3 Measure the angle between the position stopped by the orientation and the position wanted to be stopped actually in the reverse rotating direction and convert this angle (θ) into the number of pulses (X) according to the following equation.</p> $\text{Number of pulses } X = \theta \times \frac{4096}{360}$ <p>4 Convert the number of pulses (X) obtained into 12-bit binary code and input it to ES1~ES12.</p> <p>An example is given as follows.</p> $X = 55 \times \frac{4096}{360} \approx 626 \text{ pulses}$ <p>When converted into 12-bit binary, it becomes as follows.</p> <table><thead><tr><th>Input</th><th>Logical value</th></tr></thead><tbody><tr><td>ES 1</td><td>0</td></tr><tr><td>ES 2</td><td>1</td></tr><tr><td>ES 3</td><td>0</td></tr><tr><td>ES 4</td><td>0</td></tr><tr><td>ES 5</td><td>1</td></tr><tr><td>ES 6</td><td>1</td></tr><tr><td>ES 7</td><td>1</td></tr></tbody></table>	Input	Logical value	ES 1	0	ES 2	1	ES 3	0	ES 4	0	ES 5	1	ES 6	1	ES 7	1
Input	Logical value																	
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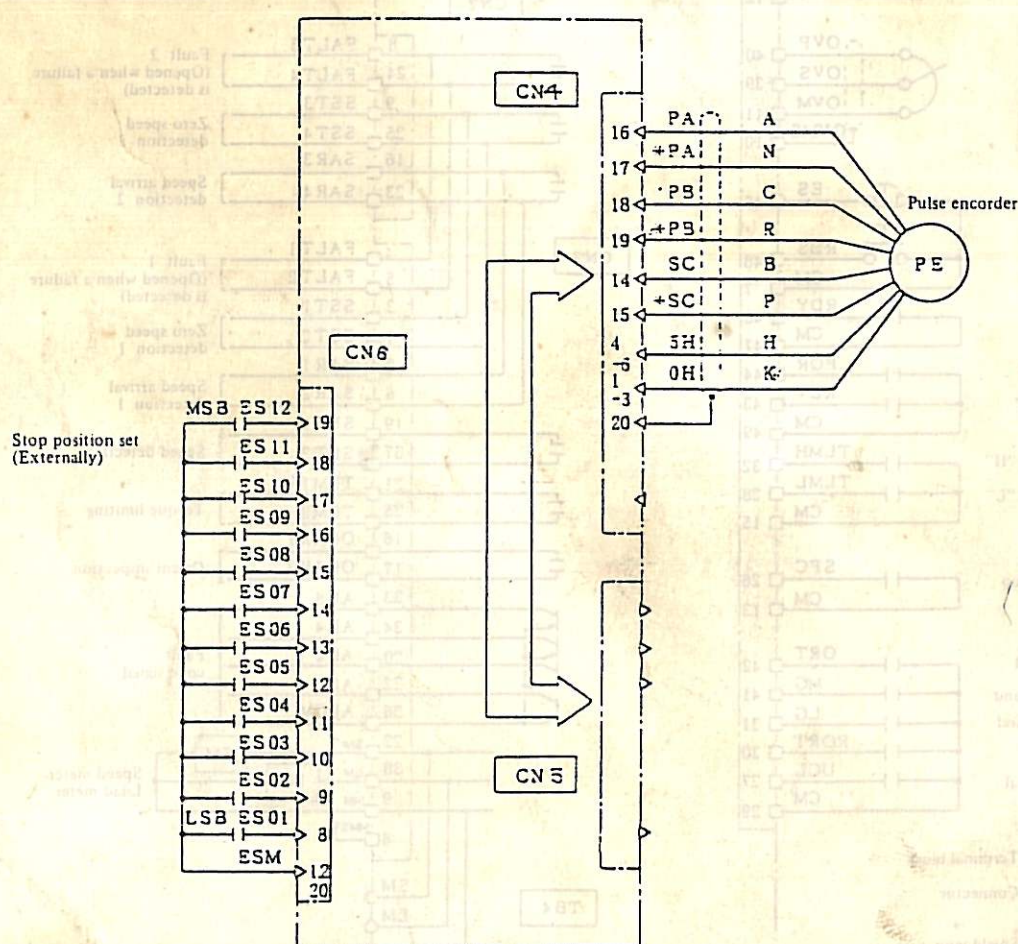
Item	Content	Adjusting method and check points
		ES 8 - 0 ES 9 - 0 ES 10 - 1 ES 11 - 0 ES 12 - 0 * Input of ES1~ES12 is read as logical "1" when it is shortcircuited to M-potential (0V).

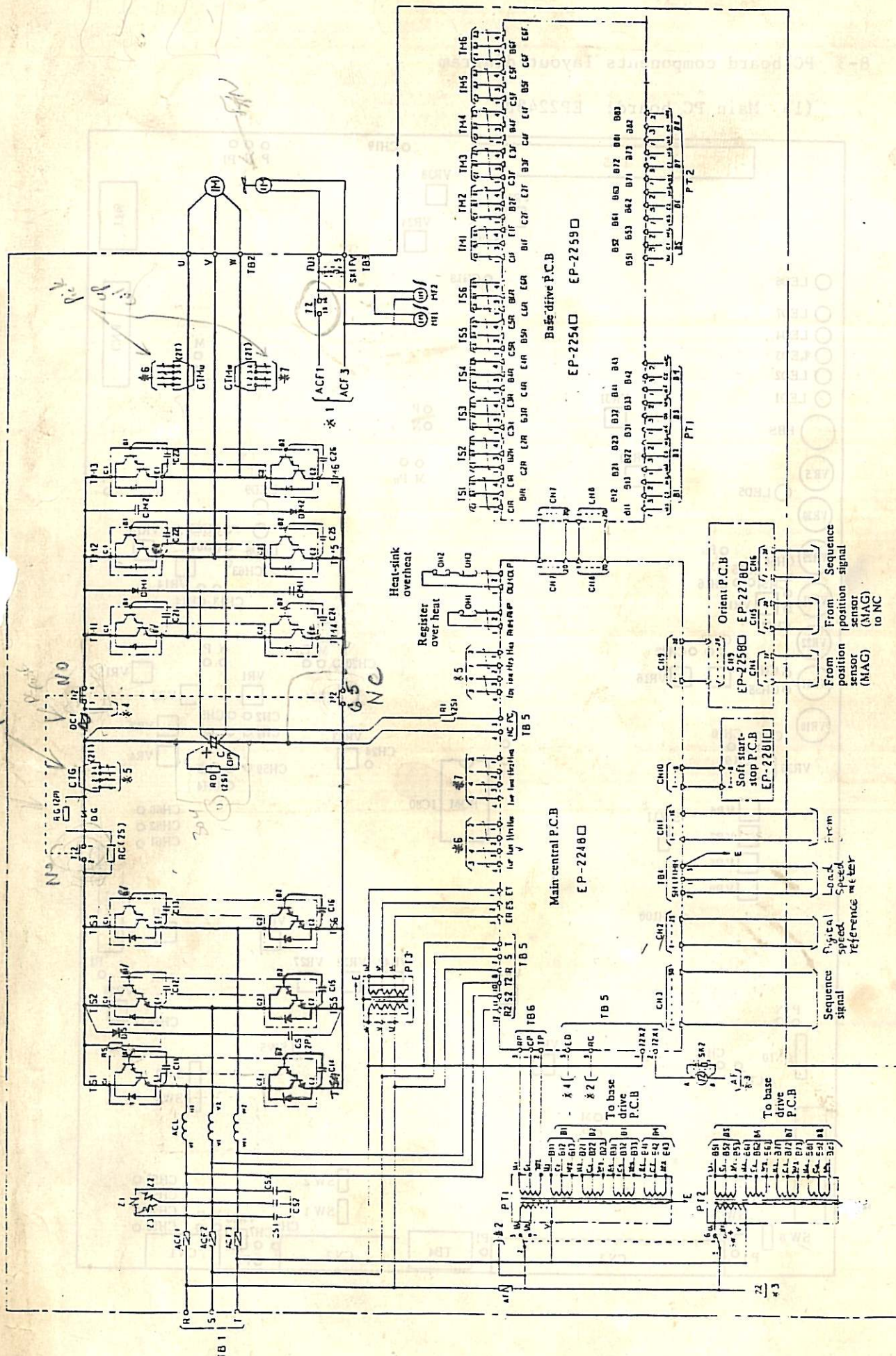
8. Collection of Diagrams

8-1 Interface

(1) Basic interface







8-3 PC board components layout diagram

(1) Main PC board: EP2248B

