AC SPINDLE DRIVE UNITS
FREQROL-SE
MAINTENANCE MANUAL

NO. 1

MITSUBISHI ELECTRIC CORPORATION

NAGOYA WORKS

CONTENTS

CHAPTER 1 GENERAL

1.1 OBJECTIVES OF MANUAL

The FR-SE series of AC spindle drive units are energy-conserving DDC inverters which have been developed to drive machine tool spindles. They operate stably over a wide speed range with a high response and yet with low vibration and noise levels and their braking energy is regenerated in the AC power supply. This manual describes the maintenance procedures for such units and it centers on regular inspections and troubleshooting.

1.2 SAFETY MEASURES AND MAINTENANCE PERSONNEL

Listed below are the checkpoints which should be strictly adhered to during maintenance and adjustments in order to assure safety.

- Control units should be started up, maintained and inspected by qualified electricians. It is dangerous for non-qualified personnel to touch these units.
- When handling a "live" control unit, remove all rings, watches, tie-pins and other metallic objects from your person.
- Electric shocks sustained from the units can result in death.

  Regardless of whether or not the power supply is grounded, high voltages are supplied to various locations in the unit and so particular care should be taken in the selection and use of the test equipment.

  When attaching the test equipment to the item under test, the test personnel should take care not to touch any units which are grounded. Generally speaking, the chassis of the

test instruments must not be grounded for testing. Consequently, high voltages may pass between ground and the chassis of a test instrument during testing and so particular care should be taken when operating the units while adjusting or repairing them.

- o Do not wear loose apparel which may be caught up by rotating objects when approaching a drive unit which is operating.
- o Do not remove or replace any of the circuit boards while power is being supplied to the drive units or while they are operating. Failure to heed this caution may result in damage.
- o Do not touch the controller immediately after the power has been switched off. Proceed to maintain and inspect after checking that power lamp LED19 (SE-CPU1, 2 cards) has gone off. (Wait at least 3 minutes.)

1.3 STORAGE

When equipment is not to be installed or used immediately, store it away in a clean and dry environment at a suitable temperature and take care not to allow steam or vapor to enter inside the control units. Any steam, vapor or dust finding its way inside the equipment invites deterioration in the insulation. When suspending operation of the equipment for a long or short period of time, take care to maintain the same environment as that effective during operation. Depending on the conditions, a heater may prove useful.

CHAPTER 2 SPECIFICATIONS

2.1 AC SPINDLE MOTORS

(1) Standard specifications

Output power	Continuous rating (KW)	3.7	5.5	7.5	11	15	18.5
	30-minute rating (KW)	5.5	7.5	11	15	18.5	22
	50% ED rating (KW)	5.5	7.5	11	15	18.5	22
Speed	Base speed (RPM)	1500		1500			
	Maximum speed (RPM)	8000 (Note 1)		6000			4500
Frame number		A112	B112	B132		C132	A160
Continuous rated torque (Kg m)		2.4	3.57	4.87	7.15	9.74	12.0
GD² (Kg m²)		0.08	0.10	0.17	0.21	0.27	0.55
Weight (Kg)		60	70	100	110	130	175
Allowable radial load (Kg)		150	200	300			
Cooling fan (W)		35					100
Vibration		V5					V10
Noise (db)(A)		75					80
Mounting direction		Output shaft mounted horizontally or perpendicularly.					
Overload resistance		1 minute at 120% of 30-minute rated output.					
Ambient temperature (°C)		0 — 40					
Insulation		F type					
Color of paint		Munsell 5.2TG 2.46/0.21					
Accessories		Pulse generator, overheating detector					
Controller type FR-SE-2-		5.5K	7.5K	11K	15K	18.5K	22K
Power capacity (KVA)		9	12	17	23	28	33
Power supply and power line frequency		200/200 ~ 230V ± 10%, 50/60Hz ± 3% Note 2					

Note 1: A reduced output is obtained for speeds of 4500 rpm and above; this is calculated by:

$$\text{Rated output} \times \frac{4500}{\text{rotational speed}}$$

Note 2: A power transformer should be provided for use at all voltages not listed here.

(2) Semi-standard specifications

Use the 1150 rpm base given below if it is not possible to provide a high reduction gear ratio in the gear system.

Output power	Continuous rating [KW]	2.2	3.7	5.5	7.5	11	15	18.5
	30-minute rating [KW]	3.7	5.5	7.5	11	15	18.5	22
	50% ED rating [KW]	3.7	5.5	7.5	11	15	18.5	22
Speed	Base speed [RPM]	1150						
	Maximum speed [RPM]	8000		6000			4600	
Frame number		A112	B112	B132		C132	A160	B160
Continuous rated torque [Kgm]		1.86	3.13	4.66	6.35	9.32	12.7	15.7
GD² [Kgm²]		0.08	0.10	0.17	0.21	0.27	0.55	0.69
Weight [Kg]		60	70	100	110	130	175	200
Allowable radial load [Kg]		150	200	300				
Cooling fan [W]		35					100	
Vibration		V5					V10	
Noise [db](A)		75					80	
Mounting direction		Output shaft mounted horizontally or perpendicularly.						
Overload resistance		1 minute at 120% of 30-minute rated output.						
Ambient temperature [℃]		0 ~ 40						
Insulation		E type:						
Color of paint		Munsell 5.27G2.46/0.21						
Accessories		Pulse generator, overheating detector						
Controller type FR-SE-2-		3.7K	5.5K	7.5K	11K	15K	13.5K	22K
Power capacity [KVA]		6	9	12	17	23	28	33
Power supply and power line frequency		200/200 ~ 230V ± 10%, 50/60Hz ± 3%						

2.2 AC SPINDLE CONTROLLERS

(1) Specifications

Type FR-SE-2-		5.5K	7.5K	11K	15K	18.5K	22K
50% ED output	Output power (KW)	5.5	7.5	11	15	18.5	22
	Power capacity (KVA)	9	12	17	23	28	28
Weight (Kg)		25			37	48	
Main circuitry system		Transistorized sinusoidal wave PWM inverter					
Control system		Vector control, digital closed loop control, speed feedback with pulse generator					
Braking system		Power regenerative braking					
Speed control range		35 ~ 8000RPM					
Speed fluctuation rate		Max. 0.2% of maximum speed (at 10-100% load fluctuation)					
Speed commands		Digital commands: binary 12-bit or BCD 2-digits (Note 1) Analog commands: +10V max. (approx. 10 kilohms inputimpedance)					
Ambient temperature/humidity		-5 ~ 55°C / 45 ~ 85%					
Atmosphere		No noxious gases or dust (environmental resistance performance conforms to JEM1103 grade C)					
Vibration		Max. 0.5G					
Standards conformed to		IEC					
Cooling		Air cooling with fan					

Note 1: Selection between the binary 12-bit and BCD 2-digit formats is enabled by the internal DIP switches and that between the digital and analog commands is enabled by external inputs.

Name	Function	Description
OVER HEAT (MOTOR)	Overload protection	When an overload occurs or when the blower motor stops and the motor itself overheats, the base is cut off and the main circuitry contactor is set OFF.
EXCESSIVE SPEED ERROR	Excessive speed error	When the error between the command speed and current speed becomes excessive, the base is cut off and the main circuitry contactor is set OFF.
BREAKER TRIP	Short-circuit/ grounding protection	When a high current flows to the main circuitry, the base is cut off and the main circuitry contactor is set OFF.
PHASE LOSS	Phase loss protection	The main circuitry contactor is set OFF.
EXTERNAL EMERGENCY	External emergency stop	After the emergency stop signal has been received from the external source and the motor has stopped by regenerative braking, the base is cut off and the main circuitry contactor is set OFF.
OVER SPEED	Over speed protection	When the speed exceeds 115% of the maximum speed, the base is cut off and main circuitry contactor is set OFF.
IOC TRIP (CONVERTER)	Instantaneous over current protection	When an over current flows to the converter, the base is cut off and the main circuitry contactor is set OFF.
OVER HEAT (CONTROLLER)	Main circuitry overload protection Air cut-off protection	When an overload occurs or when the air-cooling fan stops and the main circuitry elements over heat, the base is cut off and the main circuitry contactor is set OFF.
UNDER VOLTAGE	Main power supply drop protection	When the supply voltage drops, the base is cut off and the main circuitry contactor is set OFF.
OVER VOLTAGE (REGENERATION)	Main circuitry over voltage protection	When an over voltage occurs with regeneration of the main circuitry's capacitor voltage, the base is cut off and the main circuitry contactor is set OFF.
IOC TRIP (INVERTER)	Instantaneous over current protection	When an over current flows to the inverter, the base is cut off and the main circuitry contactor is set OFF.

Note:
When any of these protection functions except the external emergency stop signal is activated, the base (the inverter and regenerative converter) is cut off, the main circuitry contactor is set OFF and the motor stops by free-running.

(3) Auxiliary functions

Function	Application	Details	Output
Load meter signal	Load meter connections	Connect a single-deflection DC 1mA meter; full-scale and 3V or 10V/120% load outputs under a 120% load (100-120% adjustable) are obtained.	
Speed meter signal	Speed meter connections	Connect a single-deflection DC 1mA meter; full-scale and 10V/maximum speed outputs at maximum speed are obtained.	
Zero speed signal	Machine interlock	An ON-setting contact signal is obtained at a motor speed of 50 rpm or less than 25 rpm.	Contact/open emitter
Speed arrival signal	Answer back to NC	Obtained is a signal which actuates the output transistors at within +/-15% of the set speed.	Open emitter
Load detection signal	Cutter intrusion prevention	Obtained is a signal which actuates the output transistors above a current value (110% output) near the current limit value (120% output).	Open emitter
Override	Override with automatic operation	Variable range: 50-120% Released by controller terminal DEF off	
Orient (optional function)	Orient	Single point positioning for magnetic sensor system and multiple point positioning for encoder system possible. Started by orient start signal (ORCM1, ORCM2); orient finish signal is output upon completion.	Contact/open emitter
Torque limitation	Gear shift, etc.	With gear shifting, etc., the torque limitation is temporarily reduced and the spindle motor is operated. During torque limitation.	Open emitter
Speed detection signal		Obtained is a signal which actuates the output transistors at less than a detection level with a motor speed absolute value. Speed detection value is set in 8 steps from 2% to 58% in 8% steps.	Open emitter
Acceleration/deceleration time constant		Acceleration/deceleration of speed command is restricted. 0.3 - 10 S	

2.3 CONTROLLER CONFIGURATIONS

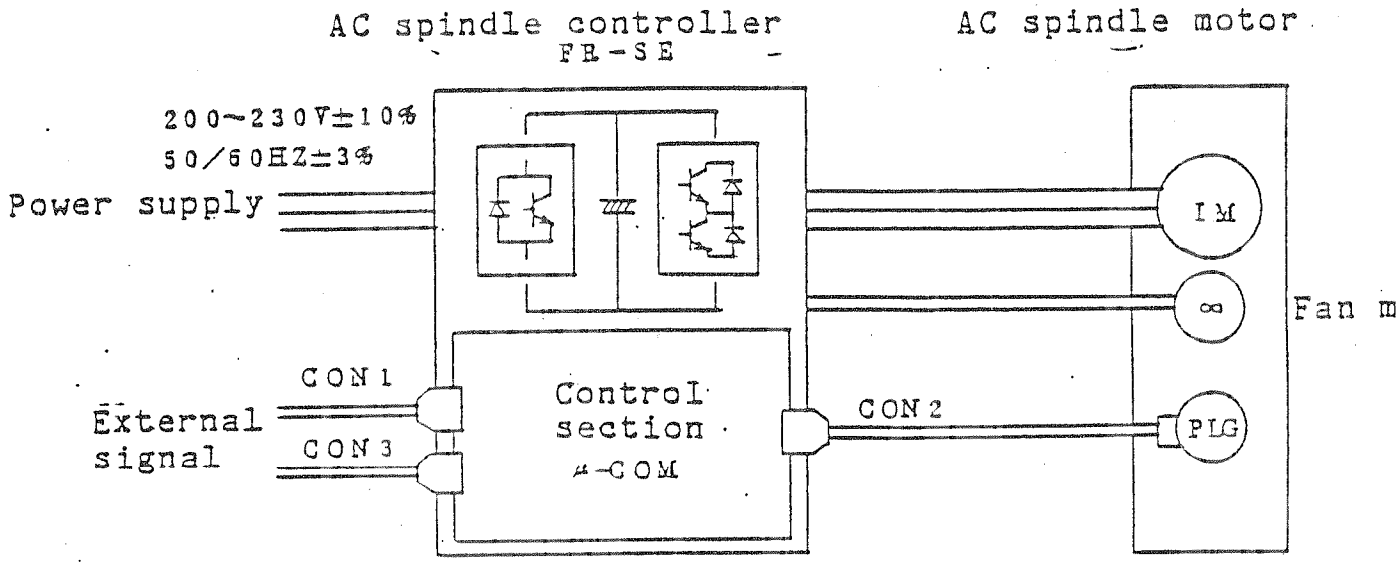
The basic configuration of the type FR-SE AC spindle unit is shown below.

(1) Basic configuration

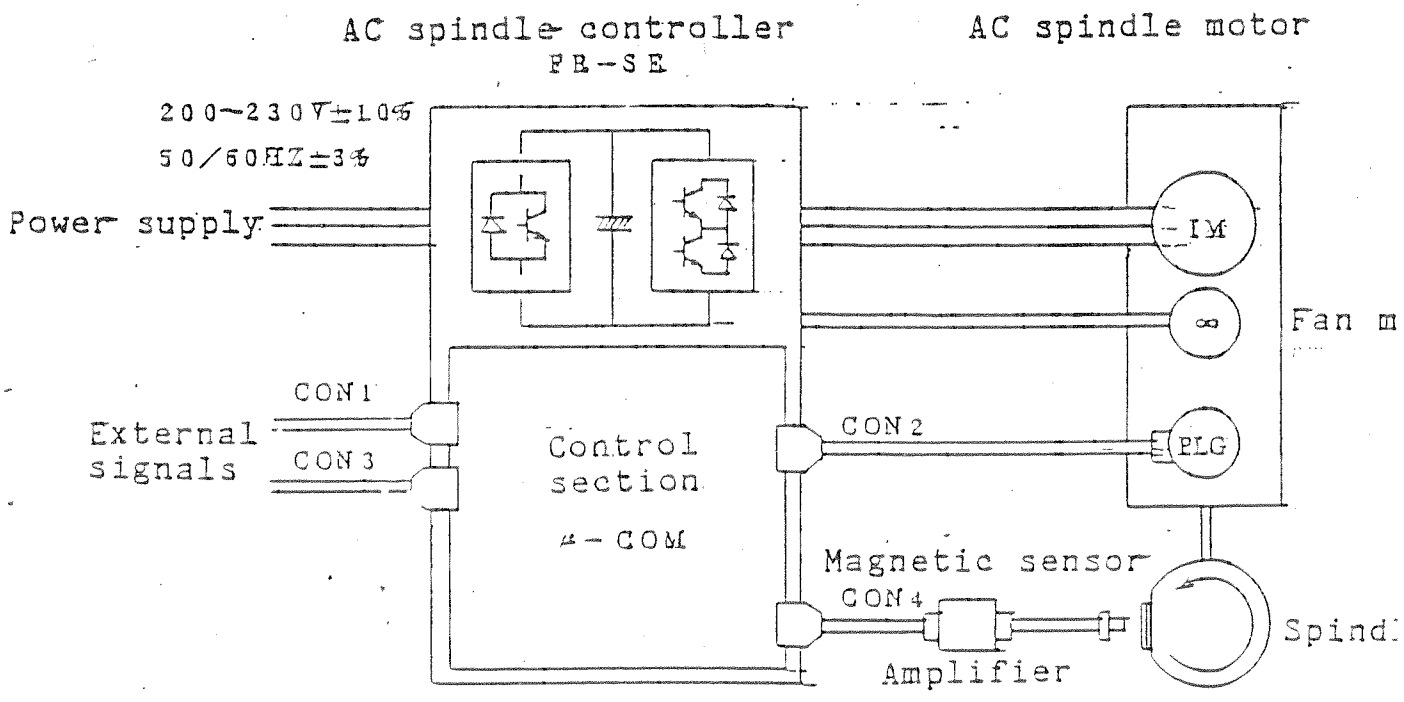
(a) Type SJ AC spindle motor (with speed detector)

(b) Type FR-SE AC spindle controller

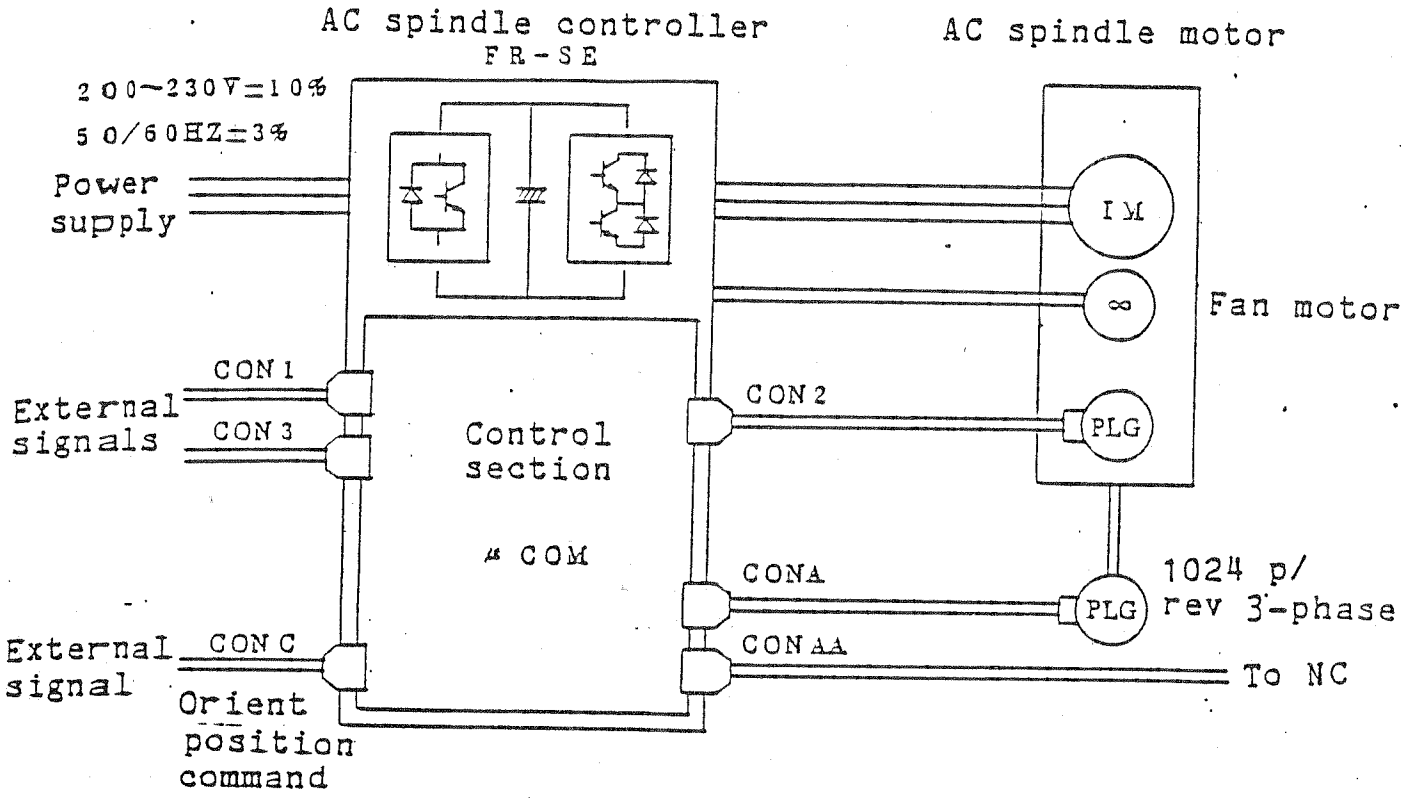
(c) Spare fuse 100%



(2) Magnetic sensor system with single point orient unit



(3) Encoder system with multiple point orient unit

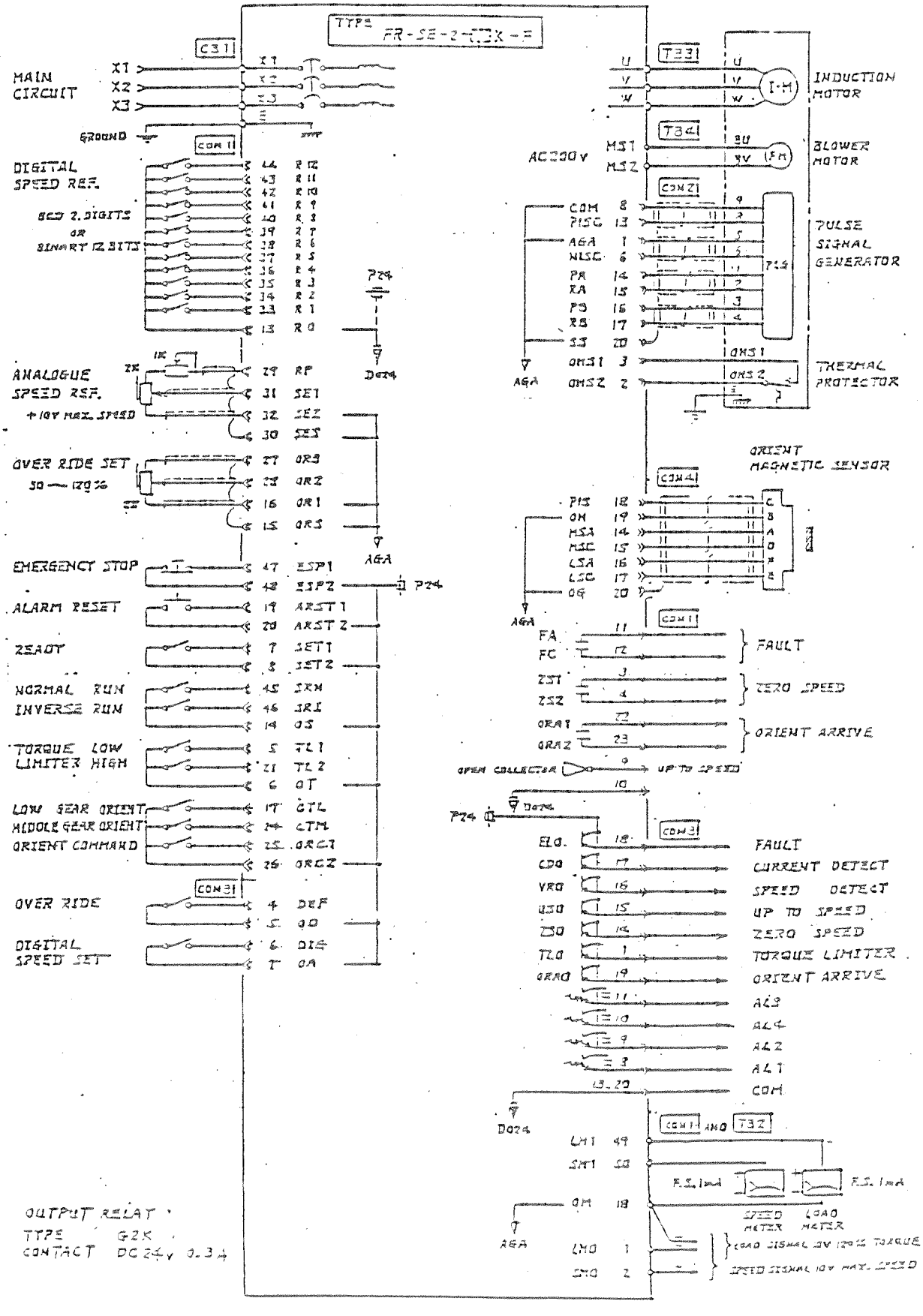


(4) Internal configuration of controller

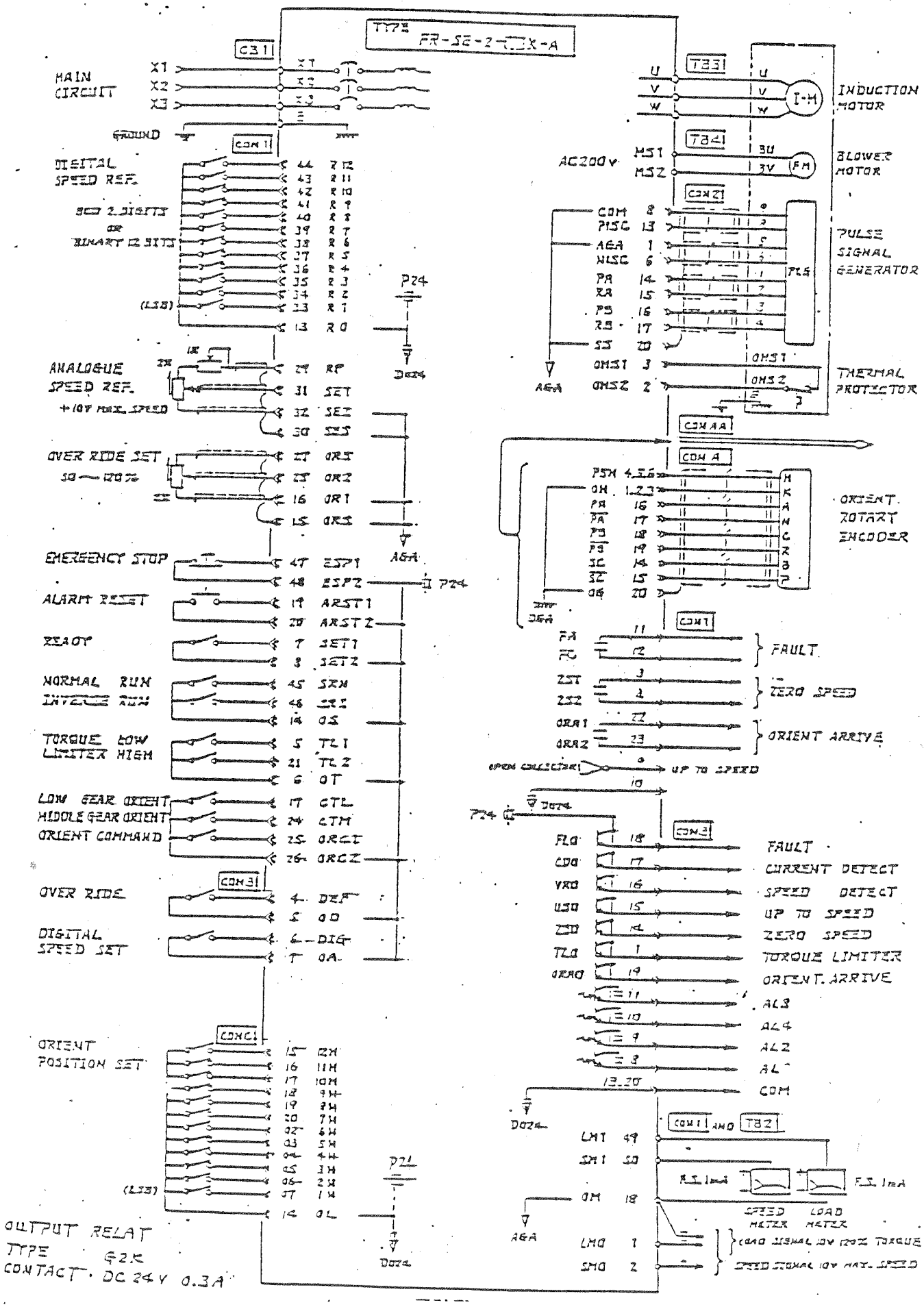
Configuration	Circuit board configuration
(a) Basic configuration	SE-PW, SE-IO1, SE-CPU1 or CPU2
(b) Magnetic sensor system With single point orient unit	SE-PW, SE-IO1, SE-CPU1
(c) Encoder system With multiple point orient unit	SE-PW, SE-IO1, SE-CPU2

2.4 EQUIPMENT CONNECTION DIAGRAMS

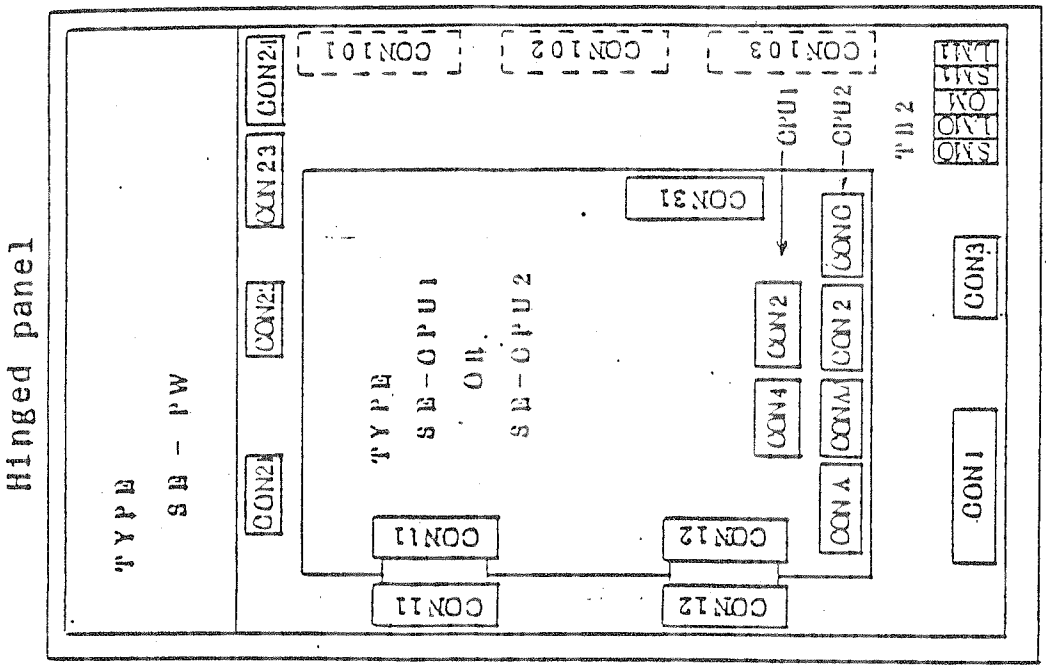
(1) Magnetic sensor type with single point orient unit

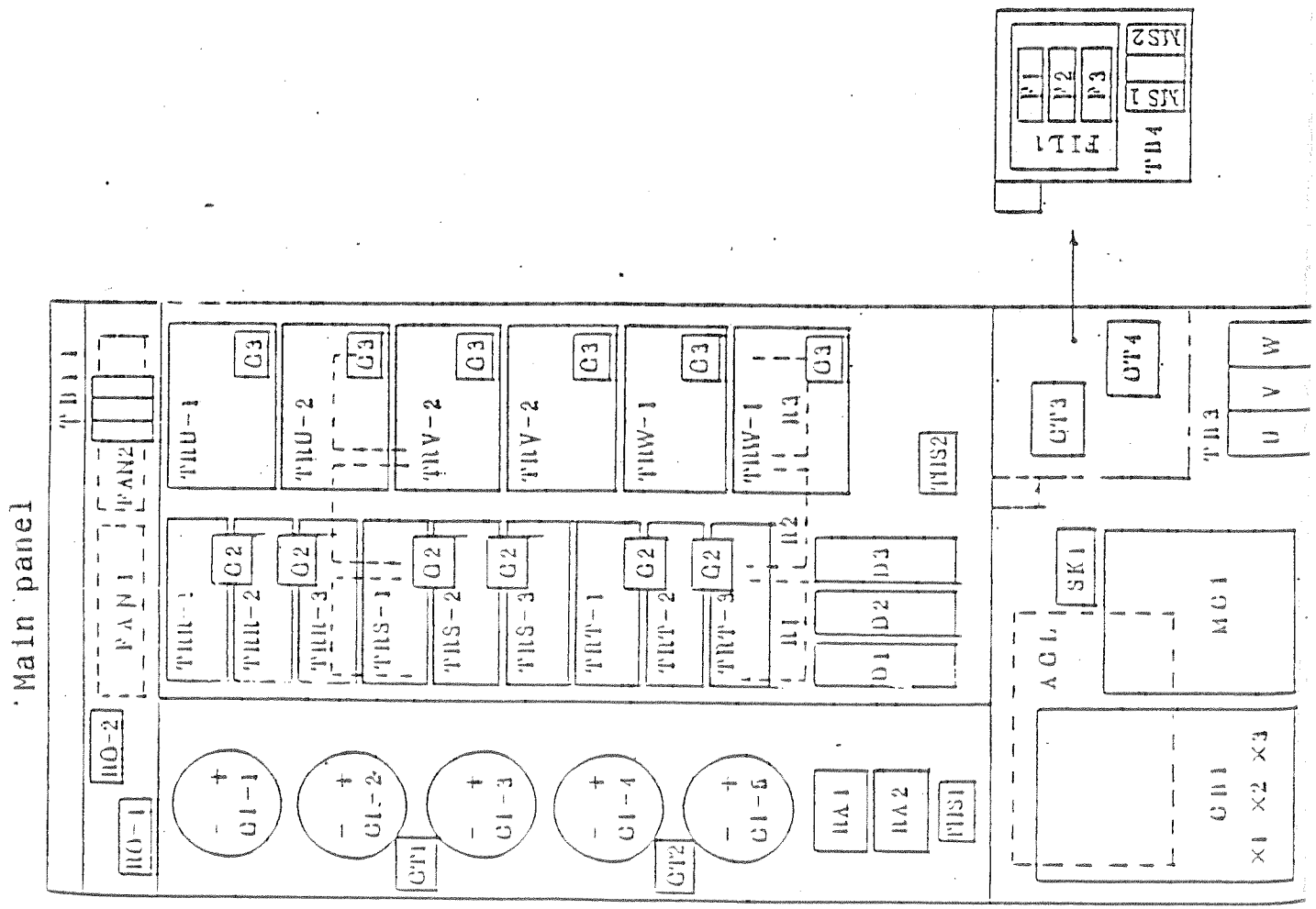


(2) Encoder type with multiple point orient unit



2.5 PLACEMENT OF EQUIPMENT





CHAPTER 3 OPERATIONAL ADJUSTMENTS

3.1 OPERATION PREPARATIONS

Check the following points when switching on the power to the controller for the first time:

(1) Has all the equipment been properly wired and connected as shown in the drawings?

(2) Have the motor and control panel been grounded properly?

(3) Have the shield wire terminations been connected properly?

- o Make the proper connections to the shield terminals.
- o Make the connections so that the shield areas do not form a loop.

(4) Check that the equipment is secured properly to avoid looseness and damage.

(5) Check that metal chips, pieces of wire and other foreign matter have not entered inside the equipment.

(6) Check that there is nothing abnormal with the exteriors of the printed circuit boards.

(7) Check that the ROM numbers and DIP switch settings are as per the order list.

3.2 RECEIVING POWER

If all items under section 3.1 are satisfactory, power up the equipment as follows:

(1) Switch on the incoming power.

(2) Check that light-emitting diodes LED13, 14, 15 and 16, which are designed to indicate trouble and which are located on the front of the controller, have not lighted.

(3) Check that light-emitting diodes LED2 (READY) and LED10 (ZERO SPEED), which are designed to indicate the status a which are located on the front of the controller, have lighted.

These procedures enable operation.

No problems are posed with the controller and re-connection is not necessary even if the phase sequence of the incoming power reversed. It is possible to check whether the phase sequence positive or reversed by observing LED1 (PHASE SEQUENCE). A positive phase sequence is indicated when LED1 lights.

3.3 ADJUSTMENT LOCATIONS

(1) Speed meter; VR14; load meter: VR15

When driving the speed meter with the spindle inverter:

Adjust VR14 so that the speed meter indicates the maximum speed by setting DIP switch SW6-6 to OFF.

Adjust VR15 so that the load meter indicates 120%.

Upon completion of the adjustments, set SW6-6 to ON and set the reset (ST1) switch to on once. Under no circumstances should the VRs be touched unless absolutely necessary.

(2) Setting DIP switches, setting pins

Re-check that the DIP switches and pins are set as in the order list in accordance with the machine. If they have not been set, change their settings. Set the reset (ST1) switch to ON the settings have been changed.

Adjust the orientation when changing the stop position in accordance with the machine. See Section 3.5 for details.

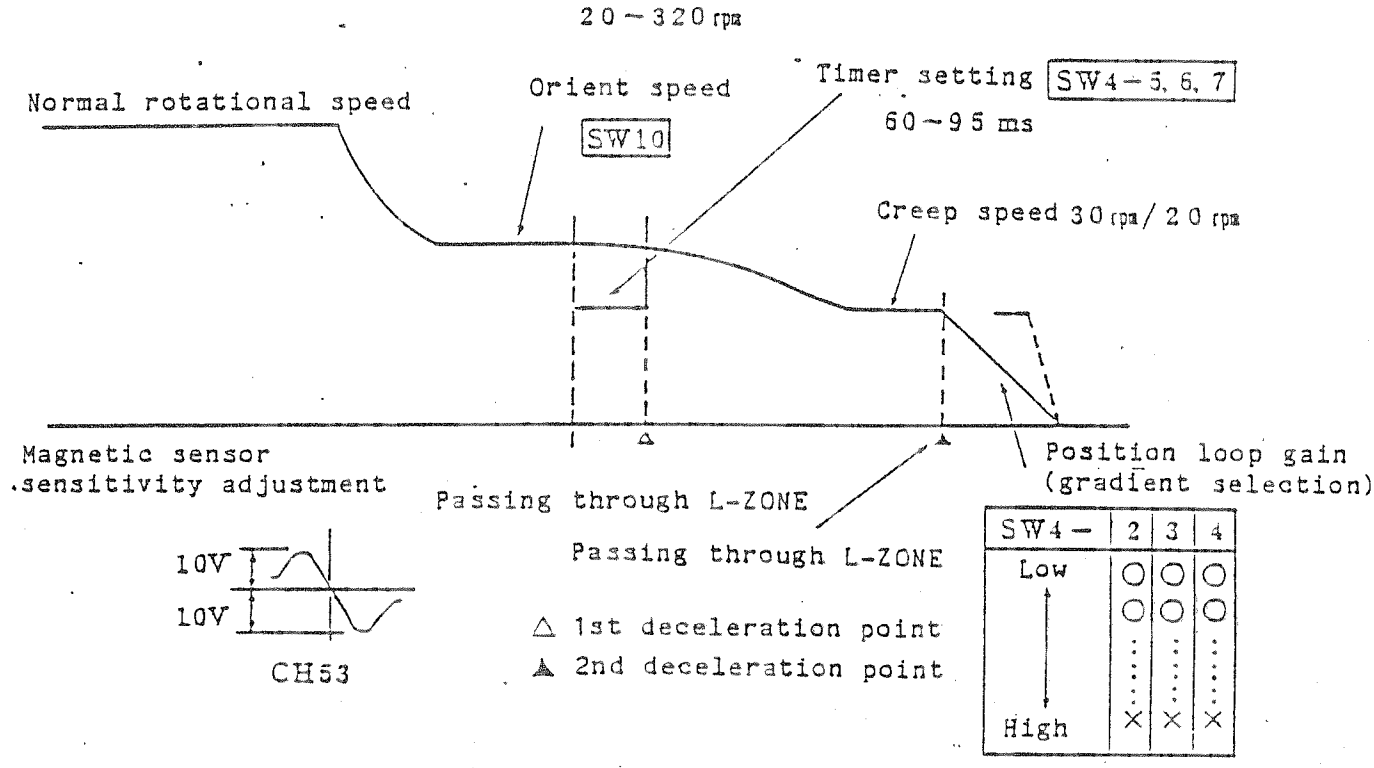
3.4 RUNNING-IN OPERATION

Couple the motor and machine and then check the machine running-in and control state. Next, operate the motor under actual load conditions and check that there is no:

- Abnormal noise
- Abnormal smells
- Abnormal bearing temperature

3.5 ORIENT ADJUSTMENT PROCEDURES

(1) Magnetic sensor system



Operate at the orient speed with SW6-10FF and ST2, adjust VR2 to the limit at which the magnetic sensor sensitivity LED11 lights and set CH53 to the peak voltage +/-10V.

The speed pattern for orient is now as shown in the figure above.

Therefore,

Proceed as follows when over shoot with stop:

- o Reduce the timer setting (SW4-5,6,7) time.
- o Reduce the position loop gain (SW4-2,3,4) gradient.
- o Reduce the orient speed. (SW10 F → E → .... → 0)
- o Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

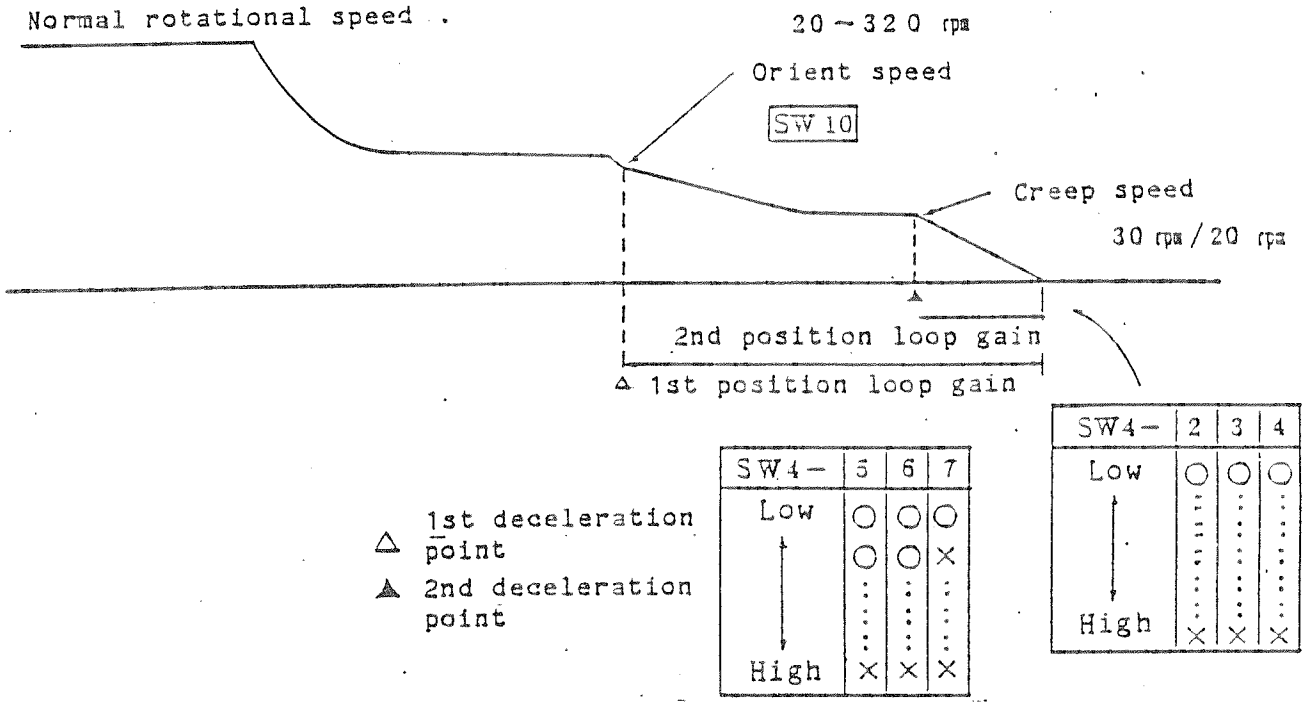
- o Increase the timer setting (SW4-5,6,7) time.
- o Increase the position loop gain (SW4-2,3,4) gradient.
- o Increase the orient speed. (SW10 0 → 1 → .....F)

Hunting when drive unit stops

- o Reduce the position loop gain (SW4-2,3,4) gradient.
- o Reduce the magnetic sensor sensitivity. (VR2)
- o Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift VR1.

(2) Encoder system



The speed pattern for orient is the same as that shown above.

Therefore,

Proceed as follows when over shoot with stop:

- o Reduce the 1st position loop gain.
- o Reduce the orient speed. (SW10 F → E → .... → 0)
- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Reduce the orient time.

- o Increase the 1st position loop gain.
- o Increase the orient speed. (SW10 0 → 1 → .... F)
- o Increase the 2nd position loop gain.

Hunting when drive unit stops

- o Reduce the 2nd position loop gain.
- o Reduce the creep speed. (SW4 OFF → ON)

Furthermore, adjust the stop position with position shift switches 13, 14 and 15.

CHAPTER 4 REGULAR INSPECTIONS

Regular inspection and maintenance are indispensable if the equipment is to do full justice to its performance, if breakdowns are to be prevented and if reliable operation is to be assured over a long period of time.

> WARNING
> Electric shocks can lead to death. Make sure that all power to the equipment is off before proceeding with the inspections.

4.1 CONTROLLER INSPECTIONS

Inspection item	Inspection period	Checkpoints	Remedy
1. Cooling fan	Monthly	1. Try rotating by hand. Does it rotate smoothly? 2. Try supplying power. Does it rotate effectively? 3. Any abnormal noise from bearing sections?	Replace fan.
2. Dirt, looseness	When appropriate	Clean parts regularly; tighten up input/output terminals and connections regularly.	
3. Small relay	Every 3 months.	1. Are contacts worn? 2. Is main circuitry contactor operating properly with operation of this relay?	Replace relay.
4. Wiring	When appropriate	Conductors must not touch case by wires being caught in hinge section.	

4.2 MOTOR INSPECTIONS

Inspection item	Inspection period	Checkpoints	Reme
1 Noise	Monthly	Any noise or abnormal vibration not previously perceived? If present, check out the following: 1 Check foundation, installation. 2 Check centering accuracy of coupling. 3 Vibration from coupled equipment? 4 Bearing damage or abnormal noise? 5 Reduction gear or belt drive noise? 6 Trouble with controller? 7 Trouble with cooling fan? 8. Belt tension.	
2 Temperature rise	Monthly	Abnormal bearing temperature? (Normally, ambient temperature of +10 to 40 deg.C) Motor frame temperature different from usual? If so, check points below: 1 Is cooling fan rotating normally? 2 Any foreign matter in cooling path (between frame and cover) which is blocking path? 3 Abnormally increased load? 4 Trouble with controller?	Clea Refe to trou shoo

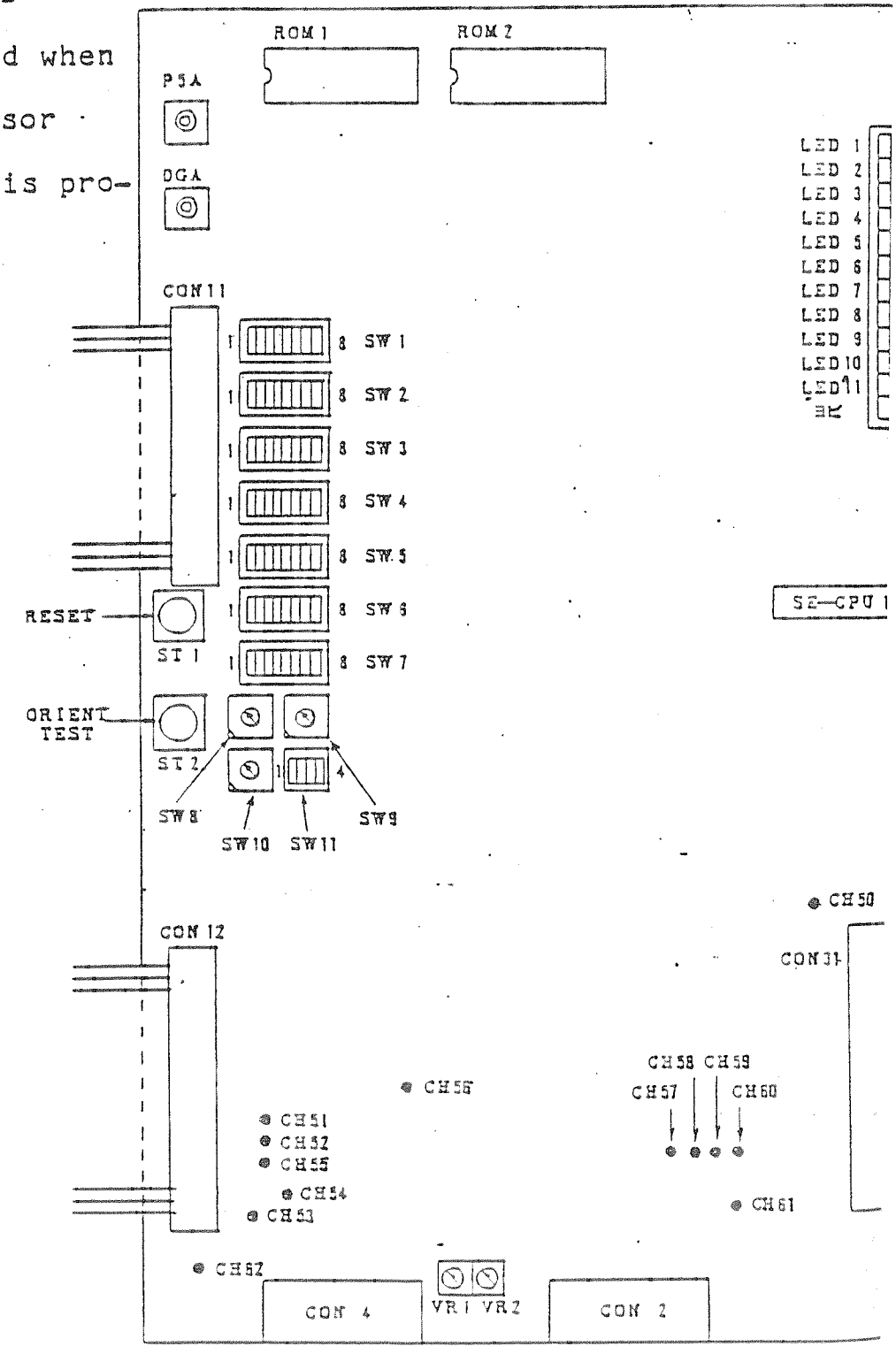
3 Insulation resistance	Every 6 months	Abnormally low insulation resistance? Isolate connections to control panel and use megger to measure across circuitry and ground. (No problem if 1 megaohm or more when measured with 500V megger.) If less than 1 Megaohm, inside of motor must be cleaned and dried. Disassemble motor and dry in an oven at a temperature not exceeding 90 deg.C.
4 Cooling fan	Every week Every month	Is fan rotating and cooling properly? Any abnormal noise or vibration present?

CHAPTER 5 CARD CHECKS

All the adjustments on the control cards have been made prior t shipment to the machine builders. Avoid, therefore, rotating the controls (VRs).

5.1 SE-CPU1 CARD

This card is used when the magnetic sensor orient function is provided.



(1) List of LEDs

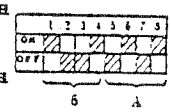
LED	Name	Application	Description
LED1	PHASE SEQUENCE	Power supply phase identification	Lights when power supply phase rotation is positive. OFF when power supply phase rotation is negative.
LED2	READY	Ready.	Lights when controller is ready to operate; OFF when SET1-SET2 inputs are OFF or when alarm occurs.
LED3	CW DRIVE	Motor forward (CW) rotation command	Lights when forward rotation command is input; also lights with orient stop.
LED4	CCW DRIVE	Motor reverse (CCW) rotation command	Lights when reverse rotation command is input.
LED5	SPEED DETECTION	Speed detection	Lights when motor speed falls below DIP switch setting.
LED6	CURRENT DETECTION	Current detection	Lights when a current equivalent to 110% of rated current flows to motor.
LED7	UP TO SPEED	Speed arrival	Lights when actual motor speed is +/-15% of command speed.
LED8	APPROACH	Approach	Lights during period from 1st to 2nd deceleration point.
LED9	IN-POSITION	In-position	Lights with orient stop within range of pulse number set by rotary switch.

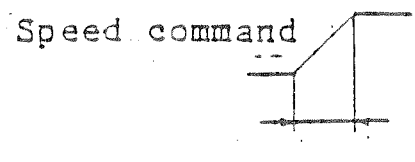
LED	Name	Application	Description
LED10	ZERO SPEED	Zero	Lights when speed is below zero speed set by DIP switch.
LED11	SENS	Magnetic sensor sensitivity	Lights when magnetic sensor output during orient is 8.5V or more.
LED12	———	———	Not used.

List of DIP switches

Note 1: "O" denotes DIP switch ON setting.

"X" denotes DIP switch OFF setting

<table>
<tr><th>Switch</th><th>Name</th><th>Description</th></tr>
<tr><td>SW1</td><td>Gear ratio
(H range)</td><td rowspan="3">Used to set gear ratio.
Gear ratio = $\frac{\text{Maximum spindle speed}}{\text{Maximum motor speed}} \times 80^{H}$
Setting example:
When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Hexa-decimal
Gear ratio = 5000/6000 x 128 ≒ 106D = $6A^{H}$
SW1 all switches ON .. Gear ratio = 80^{H}
SW2 all switches ON .. Gear ratio = 40^{H}
SW3 all switches ON .. Gear ratio = 20^{H}
 
</td></tr>
<tr><td>SW2</td><td>Gear ratio
(M range)</td></tr>
<tr><td>SW3</td><td>Gear ratio
(L range)</td></tr>
<tr><td>SW4-1</td><td>Creep speed</td><td>Used to set creep speed with orientation.
1 —— Creep speed
0 ····· 20 rpm
X ····· 30 rpm</td></tr>
<tr><td>SW4-2
~4</td><td>Position loop gain</td><td>Used to set position of 2nd deceleration point.
2 3 4
0 0 0 ···· 25 deg.
0 0 X ···· 23.75 deg.
0 X 0 ···· 22.5 deg.
0 X X ···· 21.25 deg.
X 0 0 ···· 20 deg.
X 0 X ···· 18.75 deg.
X X 0 ···· 17.5 deg.
X X X ···· 16.25 deg.</td></tr>
<tr><td>SW4-5
~7</td><td>Magnetic sensor orient speed timer</td><td>Used to set timer time up to 1st deceleration point after L-ZONE passing subsequent to orient speed arrival.</td></tr>
</table>

		5 6 7 0 0 0 ··· 60 ms (212 deg.) 0 0 X ··· 65 ms (203 deg.) 0 X 0 ··· 70 ms (194 deg.) 0 X X ··· 75 ms (185 deg.) X 0 0 ··· 80 ms (176 deg.) X 0 X ··· 85 ms (167 deg.) X X 0 ··· 90 ms (158 deg.) X X X ··· 95 ms (149 deg.)
SW4-8	Magnetic sensor mounting direction	8 0 -- Forward X -- Reverse Set to reverse position i... high degree of hunting oc... curs with orient stop.
SW5-1 ~2	Torque limit	Used when limiting motor torque. External input TL1--ON TL2--OFF: 1 2 — Torque limit 0 0 ··· 10% 0 X ··· 15% X 0 ··· 20% X X ··· 25% TL1--OFF TL2--ON: 0 0 ··· 20% 0 X ··· 30% X 0 ··· 40% X X ··· 50% Note: 30-minute rated torque is 100%.
SW5-3 ~5	Cushion time constant	Used to set time constant of maximum spee... command from 0. 3 4 5 — Cushion time constant 0 0 0 ··· 0.3 s —— Standard setting 0 0 X ··· 1.5 s 0 X 0 ··· 3 s 0 X X ··· 4 s X 0 0 ··· 5 s X 0 X ··· 6 s X X 0 ··· 8 s X X X -10 s 

<table>
<tr><td>SW5-6
~8</td><td>Speed detection range</td><td>Output transistors are activated when speed falls below set motor speed.

<table>
<tr><th>6</th><th>7</th><th>8</th><th>Speed detection range</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>…2%</td></tr>
<tr><td>0</td><td>0</td><td>X</td><td>…10%</td></tr>
<tr><td>0</td><td>X</td><td>0</td><td>…18%</td></tr>
<tr><td>0</td><td>X</td><td>X</td><td>…26%</td></tr>
<tr><td>X</td><td>0</td><td>0</td><td>…34%</td></tr>
<tr><td>X</td><td>0</td><td>X</td><td>…42%</td></tr>
<tr><td>X</td><td>X</td><td>0</td><td>…50%</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>…58%</td></tr>
</table>
Note: Maximum speed is 100%.</td></tr>
<tr><td>SW6-1</td><td>Normal/test</td><td>1
0 …Normal mode
X …Test mode

Normal mode is used for normal operation.

Test position is used for orient tests.</td></tr>
<tr><td>-2</td><td>Closed/open</td><td>2
0 …Closed loop
X …Open loop

Used for switching between open/closed speed loop.

Used with closed loop for normal operation.

Speed detector go/no go is identified by comparison of open and closed operation states.</td></tr>
<tr><td>SW6-3</td><td>Binary/BCD</td><td>3
0 …Speed command binary
X …Speed command BCD

Used to select digital speed command format.

Speed command is read as binary 12-bit input for binary and as BCD 2-digit input for BCD.</td></tr>
<tr><td>-4</td><td>Speed input emitter/ collector</td><td>4
0 …Speed input open emitter
X …Speed input open collector

First refer to the I01 card pin 2 and 3 settings on page 49 and then set.</td></tr>
<tr><td>-5</td><td>Position input emit-</td><td>5
0 …Position input open emitter
X …Position input open collector</td></tr>
</table>

	ter/collector	First refer to IO1 card pin 12 and 13 settings on page 46 and then set.
-6	Meter calibration	6 O ··· Meter OFF X ··· Meter ON Used to calibrate speed meter and load meter full scale. In ON mode, the meter full scal voltage is output and so adjust speed meter (VR14-SE-IO1 card) and load meter (VR-15-SE-IO1 card) VRs.
SW6-7	Maximum speed	7 O — Maximum speed LOW X — Maximum speed HIGH Used to select 3450/4600, 4500/6000, 6000/10000 rpm speed. Set to HIGH for 8000 rpm specifications.
-8	Zero speed	8 O — Zero speed LOW (25 rpm) X — Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting c below.
SW7-1	Magnetic sensor orient in-position range	1 O — Magnetic sensor in-position range LOW (1 deg.) X — Magnetic sensor in-position range HIGH (5 deg.)
-2	External emergency stop	2 O — LED ON with emergency stop X — LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external emergency stop.

SW7-3	Load meter output	3 O — Load meter output HIGH (10V) X — Load meter output LOW (3V) Used to select output voltage with 120% output.
-4	Base speed	4 O — 1150 rpm base speed X — 1500 rpm base speed Used to select base speed of applicable motor
SW7-5 ~8	Motor type	

1150 rpm base speed

5	6	7	8	Capacity	Top speed
O	O	O	O	Spare	Spare
O	O	O	×	2.2/3.7KW	3450/4600 rpm
O	O	×	O	3.7/5.5	〃
O	O	×	×	5.5/7.5	〃
O	×	O	O	7.5/11	〃
O	×	O	×	11/15	〃
O	×	×	O	15/18.5	〃
O	×	×	×	18.5/22	〃
×	O	O	O	Spare	Spare
×	O	O	×	Spare	Spare
×	O	×	O	2.2/3.7	8000
×	O	×	×	3.7/5.5	〃
×	×	O	O	5.5/7.5	6000
×	×	O	×	7.5/11	〃
×	×	×	O	11/15	〃
×	×	×	×	Spare	Spare

1500 rpm base speed

5	6	7	8		
O	O	O	O	Spare	Spare
O	O	O	×	2.2/3.7KW	4500/5000
O	O	×	O	3.7/5.5	〃
O	O	×	×	5.5/7.5	〃
O	×	O	O	7.5/11	〃
O	×	O	×	11/15	〃
O	×	×	O	15/18.5	〃
O	×	×	×	18.5/22	〃
×	O	O	O	Spare	Spare
×	O	O	×	Spare	Spare
×	O	×	O	3.7/5.5	8000
×	O	×	×	5.5/7.5	〃
×	×	O	O	7.5/9	〃
×	×	O	×	2.2/3.7	6000/10000
×	×	×	O	2.2/3.7/5.5	〃
×	×	×	×	5.5/7.5	〃

Used to select applicable motor in combination with maximum speed selection (SW6-7) and base speed selection (SW7-4).

SW11-1,2	Orient rotation direction	1 2 0 0 ··· Pre mode Orient from previous motor rotation direction 0 X ··· Reverse mode Motor reverse rotation direction orient X 0 ··· Forward mode Motor forward rotation direction orient X X ··· Forward mode Motor forward rotation direction orient
-3,4	Control with orient stop	3 4 0 0 ··· PI control 0 X ··· Delay/advance control W_T = 1.17 rad/ X 0 " = 0.78 rad/ X X " = 0.39 rad/ Enables delay/advance control when servo rigidity is to be increased with orient sto

List of rotary switches

Switch	Name	Description

SW8 — Speed control loop Proportional gain ... Kp

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

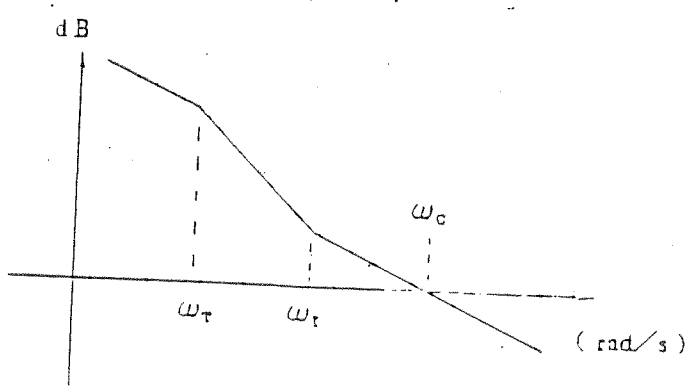
(rad/s)

SW9 — Speed control loop Integral gain ... Ki

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_I	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/s)

Used to determine loop transfer function of speed control loop in combination with SW11-3,4 mode selection.



Note: The following condition must be met: $\omega_T > \omega_I > \omega_c$

Standard settings: notch 8 for both SW8 and SW9.

SW10	Orient speed setting	Notch	
		0	20
		1	40
		2	60
		3	80
		4	100
		5	120
		6	140
		7	160
		8	180
		9	200
		A	220
		B	240
		C	260
		D	280
		E	300
		F	320

Used to set orient speed with encoder orient.
Speeds on left are spindle speeds.
Motor speed depends on gear ratio.
Orient speed should be reduced with switch when load GD^2 is high and there is tendency to over shoot during orient.

List of snap switches

No.	Name	Description
ST1	Reset	Used for initialization of inverter operations. Must not be used while motor is operating. The ST1 switch must be pressed with DIP switch resetting. When reset during motor operation, motor free-runs and then stops.
ST2	Orient test	Motor operates at motor orient speed while this switch is ON. When OFF, orient is performed once and then motor stops.

List of variable resistors

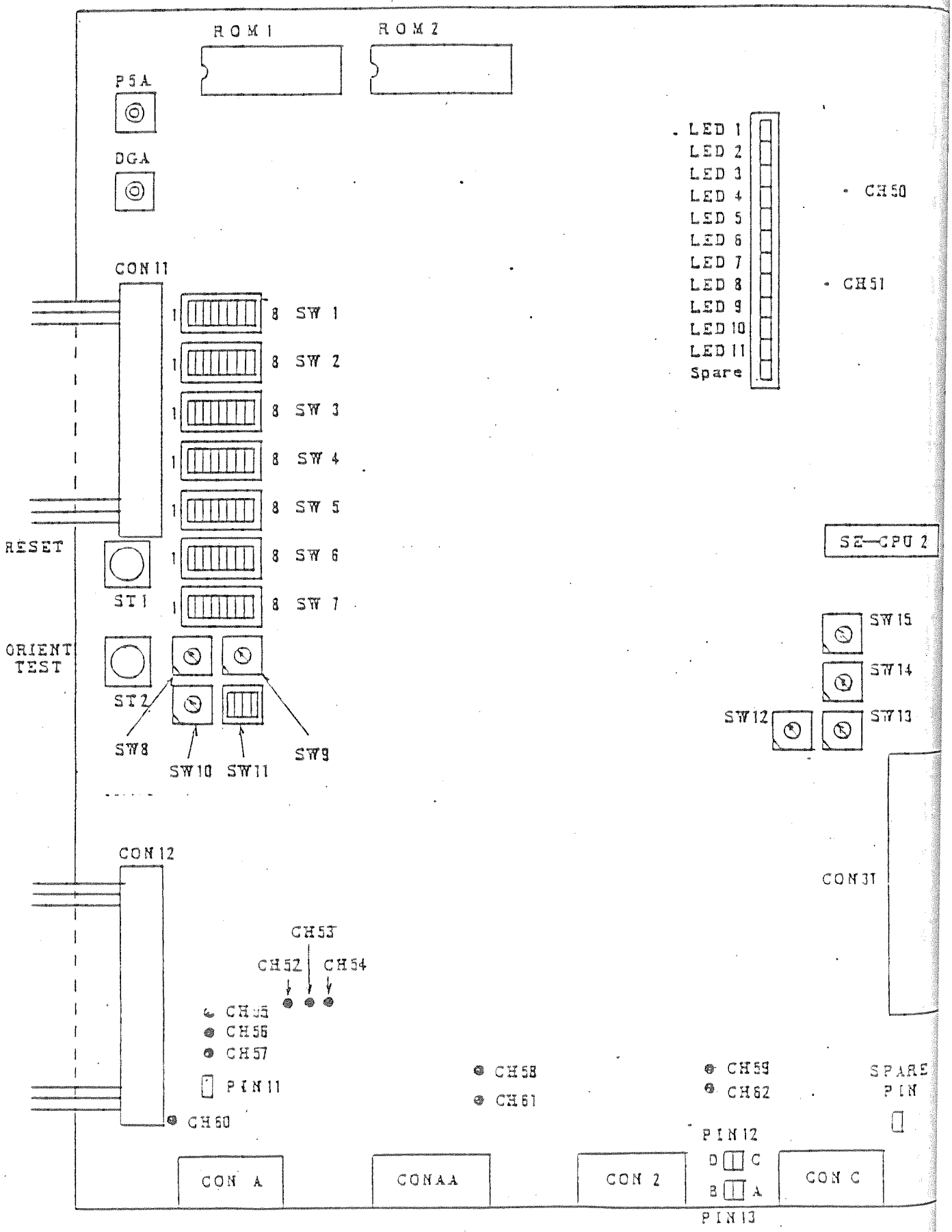
VR	Name	Description
VR1	Position shift	Enables fine adjustment of stop point.
VR2	Magnetic sensor sensitivity	Adjusted so that magnetic sensor sensitivity LED 11 lights.

List of check pins

No.	Description
P5A	+5
DGA	+0V (digital ground)
CH50	Speed feedback, phase A, square wave
CH51	-15V
CH52	+15V
CH53	Magnetic sensor output
CH54	+0V (analog ground)
CH55	+15V
CH56	A/D converter input
CH57	Speed feedback, phase B, sinusoidal wave
CH58	Speed feedback, phase $\overline{B}$, sinusoidal wave
CH59	Speed feedback, phase $\overline{A}$, sinusoidal wave
CH60	Speed feedback, phase A, sinusoidal wave
CH61	Speed feedback, phase B, square wave
CH62	+24V

5.2 SE-CPU2 CARD

This card is used when the 1024 p x 4/rev encoder type of multip point orient function is provided.



(1) List of LEDs

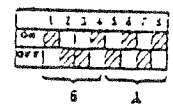
LED	Name	Application	Description
LED1	PHASE SEQUENCE	Power supply phase identification	Lights when power supply phase rotation is positive. OFF when power supply phase rotation is negative.
LED2	READY	Ready	Lights when controller is ready to operate; OFF when SET1-SET2 inputs are OFF or when alarm occurs.
LED3	CW DRIVE	Motor forward (CW) rotation command	Lights when forward rotation command is input; also lights with orient stop.
LED4	CCW DRIVE	Motor reverse (CCW) rotation command	Lights when reverse rotation command is input.
LED5	SPEED DETECTION	Speed detection	Lights when motor speed falls below DIP switch setting.
LED6	CURRENT DETECTION	Current detection	Lights when a current equivalent to 110% of rated current flows to motor.
LED7	UP TO SPEED	Speed arrival	Lights when actual motor speed is +/-15% of command speed.
LED8	APPROACH	Approach	Lights during period from 1st to 2nd deceleration point.
LED9	IN-POSITION	In-position	Lights with orient stop within range of pulse number set by rotary switch.

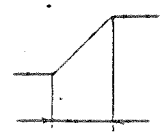
LED10	ZERO SPEED	Zero speed	Lights when speed is below zero speed set by DIP switch.
LED11	———	———	Not used
LED12	———	———	Not used.

List of DIP switches

Note 1: "O" denotes DIP switch ON setting.

"X" denotes DIP switch OFF setting

Switch	Name	Description
SW1	Gear ratio (H range)	Used to set gear ratio. $\text{Gear ratio} = \frac{\text{Maximum spindle speed}}{\text{Maximum motor speed}} \times 80^{H}$ Setting example: When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Gear ratio = 5000/6000 x 128 ≒ 106D = $6A^{H}$ (Hexa-decimal) SW1 all switches ON .. Gear ratio = 80^{H} SW2 all switches ON .. Gear ratio = 40^{H} SW3 all switches ON .. Gear ratio = 20^{H} 
SW2	Gear ratio (M range)	
SW3	Gear ratio (L range)	
SW4-1	Creep speed	Used to set creep speed with orientation. 1 — Creep speed 0 ···· 20 rpm X ···· 30 rpm
SW4-2 ~4	2nd position loop gain	Used to set position of 2nd deceleration point. 2 3 4 0 0 0 ---25 deg. 0 0 X ---24 deg. 0 X 0 ---23 deg. 0 X X ---21 deg. X 0 0 ---20 deg. X 0 X ---18 deg. X X 0 ---17 deg. X X X ---15 deg.
SW4-5 ~7	1st position loop gain	Used to set position of 1st deceleration point.

<table>
<tr><td></td><td></td><td>
<table>
<tr><th>5</th><th>6</th><th>7</th><th>—</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>··· 225 deg.</td></tr>
<tr><td>0</td><td>0</td><td>X</td><td>··· 214 deg.</td></tr>
<tr><td>0</td><td>X</td><td>0</td><td>··· 203 deg.</td></tr>
<tr><td>0</td><td>X</td><td>X</td><td>··· 191 deg.</td></tr>
<tr><td>X</td><td>0</td><td>0</td><td>··· 180 deg.</td></tr>
<tr><td>X</td><td>0</td><td>X</td><td>··· 169 deg.</td></tr>
<tr><td>X</td><td>X</td><td>0</td><td>··· 158 deg.</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>··· 146 deg.</td></tr>
</table>
</td></tr>
<tr><td>SW4-8</td><td>Magnetic sensor mounting direction</td><td>
<table>
<tr><th>8</th><th></th></tr>
<tr><td>0</td><td>··Forward</td></tr>
<tr><td>X</td><td>··Reverse</td></tr>
</table>
Set to reverse position if high degree of hunting occurs with orient stop.
</td></tr>
<tr><td>SW5-1, 2</td><td>Torque limit</td><td>
Used when limiting motor torque.
<table>
<tr><th></th><th>1</th><th>2</th><th>—Torque limit</th></tr>
<tr><td rowspan="4">External input
TL1--ON
TL2--OFF</td><td>0</td><td>0</td><td>··· 10%</td></tr>
<tr><td>0</td><td>X</td><td>··· 15%</td></tr>
<tr><td>X</td><td>0</td><td>··· 20%</td></tr>
<tr><td>X</td><td>X</td><td>··· 25%</td></tr>
<tr><td rowspan="4">TL1--OFF
TL2--ON</td><td>0</td><td>0</td><td>··· 20%</td></tr>
<tr><td>0</td><td>X</td><td>··· 30%</td></tr>
<tr><td>X</td><td>0</td><td>··· 40%</td></tr>
<tr><td>X</td><td>X</td><td>··· 50%</td></tr>
</table>
Note: 30-minute rated torque is 100%.
</td></tr>
<tr><td>SW5-3 ~5</td><td>Cushion time constant</td><td>
Used to set time constant of maximum speed command from 0.
<table>
<tr><th>3</th><th>4</th><th>5</th><th>—Cushion time constant</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>··· 0.3 s —— Standard setting</td></tr>
<tr><td>0</td><td>0</td><td>X</td><td>··· 1.5 s</td></tr>
<tr><td>0</td><td>X</td><td>0</td><td>··· 3 s</td></tr>
<tr><td>0</td><td>X</td><td>X</td><td>··· 4 s</td></tr>
<tr><td>X</td><td>0</td><td>0</td><td>··· 5 s</td></tr>
<tr><td>X</td><td>0</td><td>X</td><td>··· 6 s</td></tr>
<tr><td>X</td><td>X</td><td>0</td><td>··· 8 s</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>··· 10 s</td></tr>
</table>
Speed command

Cushion time constant
</td></tr>
</table>

SW5-6 ~8	Speed detection range	Output transistors are activated when speed falls below set motor speed. 6 7 8 ··· Speed detection range 0 0 0 ··· 2% 0 0 X ··· 10% 0 X 0 ··· 18% 0 X X ··· 26% X 0 0 ··· 34% X 0 X ··· 42% X X 0 ··· 50% X X X ··· 58% Note: Maximum speed is 100%.
SW6-1	Normal/test	1 0 ··· Normal mode X ··· Test mode Normal mode is used for normal operation. Test position is used for orient tests.
-2	Closed/open	2 0 ··· Closed loop X ··· Open loop Used for switching between open/closed speed loop. Used with closed loop for normal operation. Speed detector go/no go is identified by comparison of open and closed operation states.
SW6-3	Binary/BCD	3 0 ··· Speed command binary X ··· Speed command BCD Used to select digital speed command format. Speed command is read as binary 12-bit input for binary and as BCD 2-digit input for BCD.
-4	Speed input emitter/ collector	4 0 ··· Speed input open emitter X ··· Speed input open collector First refer to the IO1 card pin 2 and 3 settings on page 49 and then set.
-5	Position input emit-	5 0 ··· Position input open emitter X ··· Position input open collector

	ter/collector	First refer to IO1 card pin 12 and 13 settings on page 46 and then set.
-6	Meter calibration	6 O ··· Meter OFF X ··· Meter ON Used to calibrate speed meter and load mete full scale. In ON mode, the meter full sca voltage is output and so adjust speed meter (VR14-SE-IO1 card) and load meter (VR-15-SE IO1 card) VRs.
SW6-7	Maximum speed	7 O ··· Maximum speed LOW X ··· Maximum speed HIGH Used to select 3450/4600, 4500/6000, 6000/ 10000 rpm speed. Set to HIGH for 8000 rpm specifications.
-8	Zero speed	8 O ··· Zero speed LOW (25 rpm) X ··· Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting below.
SW7-1	Magnetic sensor orient in-position range	1 O ··· Magnetic sensor in-position range LOW (1 deg.) X ··· Magnetic sensor in-position range HIGH (5 deg.)
-2	External emergency stop	2 O ··· LED ON with emergency stop X ··· LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external eme gency stop.

SW7—3	Load meter output	3 O ··· Load meter output HIGH (10V) X ··· Load meter output LOW (3V) Used to select output voltage with 12% output.
—4	Base speed	4 O ··· 1150 rpm base speed X ··· 1500 rpm base speed Used to select base speed of applicable motor
SW7—5 ~8	Motor type	

1150 rpm base speed

5	6	7	8	— Capacity	Top speed
O	O	O	O	··· Spare	Spare
O	O	O	×	··· 2.2/3.7KW	3450/4600 rpm
O	O	×	O	··· 3.7/5.5	〃
O	O	×	×	··· 5.5/7.5	〃
O	×	O	O	··· 7.5/11	〃
O	×	O	×	··· 11/15	〃
O	×	×	O	··· 15/18.5	〃
O	×	×	×	··· 18.5/22	〃
×	O	O	O	··· Spare	Spare
×	O	O	×	··· Spare	Spare
×	O	×	O	··· 2.2/3.7	8000
×	O	×	×	··· 3.7/5.5	〃
×	×	O	O	··· 5.5/7.5	6000
×	×	O	×	··· 7.5/11	〃
×	×	×	O	··· 11/15	〃
×	×	×	×	··· Spare	Spare

1500 rpm base speed

5	6	7	8		
O	O	O	O	··· Spare	Spare
O	O	O	×	··· 2.2/3.7KW	4500/6000 rpm
O	O	×	O	··· 3.7/5.5	〃
O	O	×	×	··· 5.5/7.5	〃
O	×	O	O	··· 7.5/11	〃
O	×	O	×	··· 11/15	〃
O	×	×	O	··· 15/18.5	〃
O	×	×	×	··· 18.5/22	〃
×	O	O	O	··· Spare	Spare
×	O	O	×	··· Spare	Spare
×	O	×	O	··· 3.7/5.5	8000
×	O	×	×	··· 5.5/7.5	〃
×	×	O	O	··· 7.5/9	〃
×	×	O	×	··· 2.2/3.7	6000/10000
×	×	×	O	··· 2.2/3.7/5.5	〃
×	×	×	×	··· 5.5/7.5	〃

Used to select applicable motor in combination with maximum speed selection (SW6-7) and base speed selection (SW7-4).

SW11-1,2	Orient rotation direction	1 / 2	
		0 / 0	···Pre mode Orient from previous motor rotation direction
		0 / X	···Reverse mode Motor reverse rotation direction orient
		X / 0	···Forward mode Motor forward rotation direction orient
		X / X	···Forward mode Motor forward rotation direction orient
-3,4	Control with orient stop	3 / 4	
		0 / 0	···PI control
		0 / X	···Delay/advance control W_T = 1.17 rad/
		X / 0	" = 0.78 rad/
		X / X	" = 0.39 rad/
		Enables delay/advance control when servo rigidity is to be increased with orient sto	

List of rotary switches

SW8 — Speed control loop Proportional gain ... Kp

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

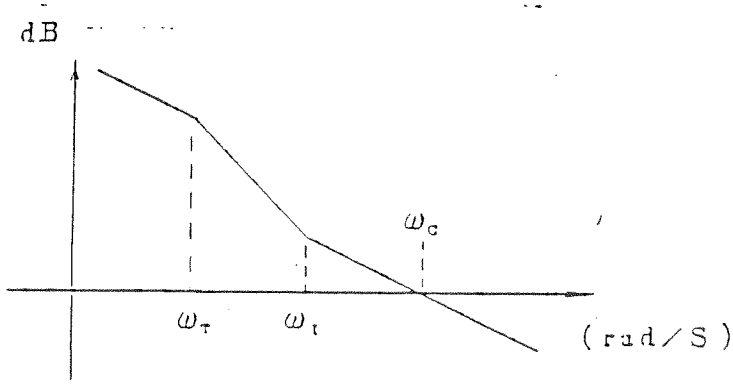
(rad/S)

SW9 — Speed control loop Integral gain ... Ki

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_1	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/S)

Used to determine loop transfer function of speed control loop in combination with SW11-3,4 mode selection.



Note: The following condition must be met: $\omega_\tau > \omega_I > \omega_c$

Standard settings: notch 8 for both SW8 and SW9.

SW10 — Orient speed setting

Notch	
0	20
1	40
2	60
3	80
4	100
5	120
6	140
7	160
8	180
9	200
A	220
B	240
C	260
D	280
E	300
F	320

Used to set orient speed with encoder orient.

Speeds on left are spindle speeds. Motor speed depends on gear ratio.

Orient speed should be reduced with switch when load GD^2 is high and there is tendency to over shoot during orient.

SW12 — Encoder orient in-position range

Notch	
0	0
1	0.09 deg.
2	0.18 deg.
3	0.26 deg.
4	0.35 deg.
5	0.44 deg.
6	0.53 deg.
7	0.62 deg.
8	0.70 deg.
9	0.79 deg.
A	0.88 deg.
B	0.97 deg.
C	1.06 deg.
D	1.14 deg.
E	1.23 deg.
F	1.32 deg.

Used to set position error range in which orient finish signal is output. Since a single spindle rotation is divided into 4096 parts:

Error range =

$$360 \text{ deg.} \times \frac{\text{set value}}{4096}$$

Standard notch A setting

SW13 Orient position shift
SW14
SW15

SW13 0 - F x 256

SW14 0 - F x 16, 12-bit binary

SW15 0 - F x 1

$$\text{Position shift} = 360 \text{ deg.} \times \frac{\text{set value}}{4096}$$

$$\text{Least increment} = 360 \text{ deg.} \times \frac{1}{4096} = 0.09$$

Set for stopping at regular orient position with encoder mounting.

Position will not shift even when selected during orient stop and so re-orient.

List of snap switches

No.	Name	Description
ST1	Reset	Used for initialization of inverter operations. Must not be used while motor is operating. The ST1 switch must be pressed with DIP switch re-setting. When reset during motor operation, motor free-runs and then stops.
ST2	Orient test	Motor operates at motor orient speed while this switch is ON. When OFF, orient is performed once and then motor stops.

Setting pins

Note: ▩ denotes that pin is inserted.

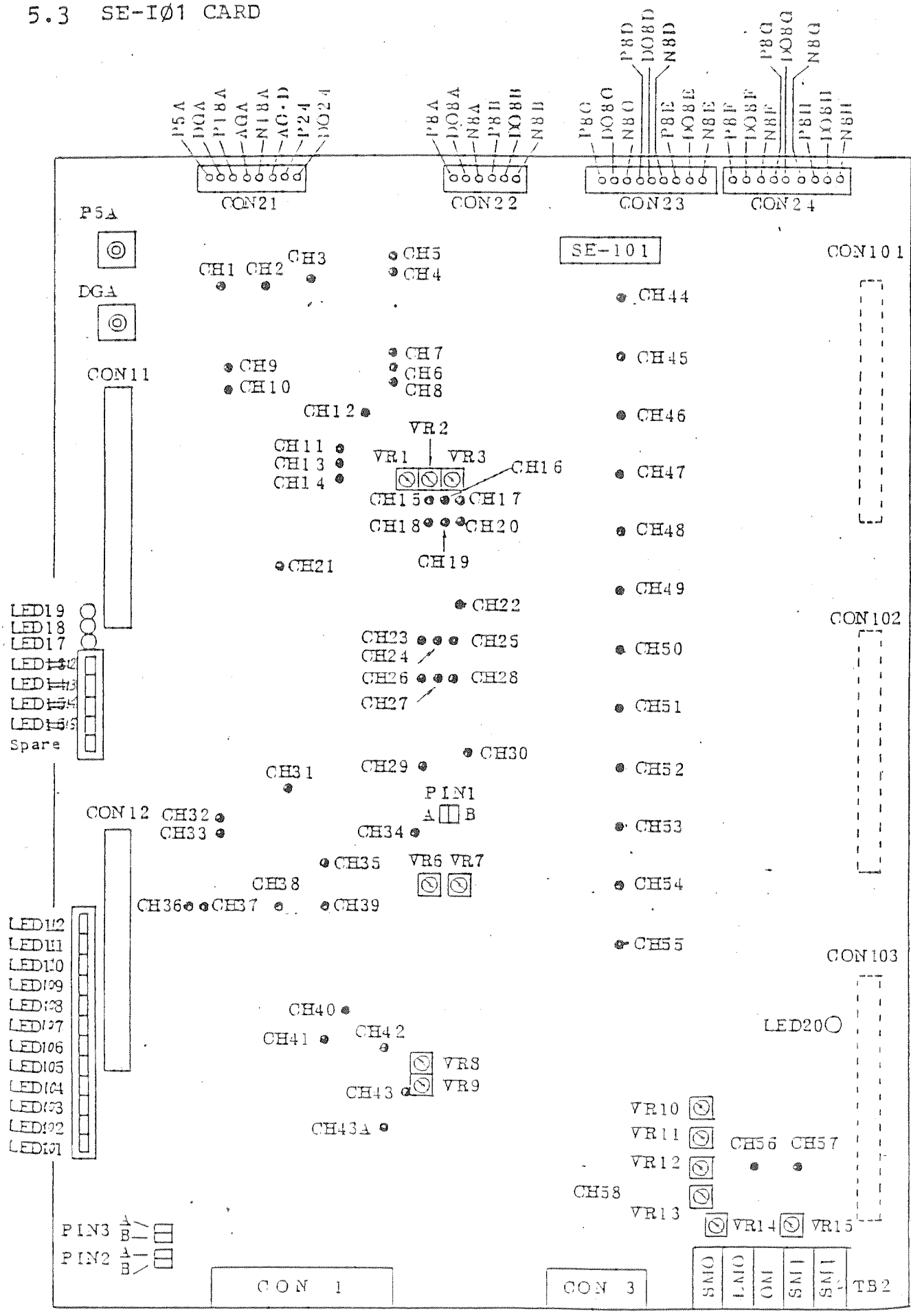
▯ denotes that pin is removed.

No.	Name	Description
PIN 11	Orient encoder power supply	C1 Supply from NC Yes — PIN11 ▯ — SPARE PIN ▩ C2 Supply from NC No — PIN11 ▩ — SPARE PIN ▯
PIN 12 13	Orient position command interface setting	B1 Source drive (open emitter) — PIN12 D ▯ C — PIN13 B ▩ B2 Sync drive (open collector) — PIN12 D ▩ C — PIN13 B ▯ Refer to pages 27 and 39 and set at the same time as SW-6-5.

List of check pins

No.	Description
P5A	+5V
DGA	+0V (digital ground)
CH50	Speed feedback, phase B, square wave
CH51	Speed feedback, phase A, square wave
CH52	Orient position feedback, phase B
CH53	Orient position feedback, phase A
CH54	Orient position feedback, mark pulse
CH54A	A/D input signal
CH55	+15V
CH56	+0V (analog ground)
CH57	-15V
CH58	Speed feedback, phase $\overline{B}$, sinusoidal wave
CH59	Speed feedback, phase A, sinusoidal wave
CH60	+24V
CH61	Speed feedback, phase $\overline{A}$, sinusoidal wave
CH62	Speed feedback, phase B, sinusoidal wave

5.3 SE-IØ1 CARD



List of LEDs

No.	Symbol	Description
LED 13 LED 14 LED 15 LED 16	AL 8 4 2 1	Refer to separate sheet for details on fault code displays.
LED 17		Indicates undervoltage. Lights with voltage drop of less than 170V, more than 15mS.
LED 18		Lights with converter regeneration.
LED 19		Lights with base cut-off of inverter, converter transistors.
LED 20		Lights with converter voltage charging.
LED112 LED101		Speed command display X 1 X 2 X 4 X 2048 — 12 bits

List of setting pins

No.	Name	Description
PIN 1	Speed setting	Max. speed setting: HH 10000 / 8000 (RPM) — PIN1 A / B — SPARE PIN; H 6000 / 4600 (RPM) — PIN1 A / B — SPARE PIN; L 4500 / 3450 (RPM) — PIN1 A / B — SPARE PIN
PIN 2 3	Digital speed command interface setting	A1 Source drive (open emitter) — PIN3 A / B — PIN2 C / D A2 Sync drive (open collector) — PIN3 A / B — PIN2 C / D Refer to pages 27 and 39, and set these pins at the same time as SW6-4.

Alarm signals

0: LED OFF, output = High (transistors cut off)

1: LED ON, output = Low (transistors activated)

No.	Output AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)	Alarm-signal significance	Details	Reset method
1	0	0	0	1	Motor overheating	This is detected when the temperature inside the motor has exceeded the prescribed level.	Alarm reset or reset PB after motor has cooled off
2	0	0	1	0	Excessive speed error	This is detected when the motor speed differs greatly from the command value.	After the motor has stopped, eliminate the cause and use alarm reset or reset PB
3	0	0	1	1	(Spare)		
4	0	1	0	0	Breaker trip	This signal is output when an abnormal current flows to the input and the breaker trips.	
5	0	1	0	1	Phase loss	This detects phase loss in the input with resetting and power switch-on.	
6	0	1	1	0	Emergency stop	This indicates that the emergency stop pushbutton on the external control panel is ON.	External emergency stop PB to OFF
7	0	1	1	1	Over speed	This occurs when the motor speed exceeds 115% of its rated speed.	
8	1	0	0	0	Converter overcurrent	This detects an overcurrent in the converter.	
9	1	0	0	1	Controller overheating	Overheating is detected when the temperature of the heat sinks of the semiconductors, etc. is abnormally high.	
10	1	0	1	0	Undervoltage detection	This detects that the input voltage is more than 15ms and less than 170V.	
11	1	0	1	1	Overvoltage detection	This detects that the converter's DC voltage is abnormally high.	
12	1	1	0	0	Inverter overcurrent	This detects an overcurrent in the inverter.	
13	1	1	0	1	CPU fault 1	Microcomputer fault	
14	1	1	1	0	CPU fault 2	〃	
15	1	1	1	1	CPU fault 3	〃	

List of check pins

No.	OV	Description
P5A	DGA	+5V
DGA	DGA	OV (digital ground)
CH1	AGA	+15V
CH2	AGA	OV (analog ground)
CH3	AGA	-15V
CH4	AGA	Phase V, reference sinusoidal wave
CH5	AGA	Phase U, reference sinusoidal wave
CH6	AGA	Phase V, voltage command
CH7	AGA	Phase U, voltage command
CH8	AGA	Phase W, voltage command
CH9	AGA	Current amplitude signal
CH10	AGA	Triangular wave carrier
CH11	DGA	Phase U, PWM waveform
CH13	DGA	Phase V, PWM waveform
CH14	DGA	Phase W, PWM waveform
CH15	DGA	Phase U, base amplifier drive signal
CH16	DGA	Phase V, base amplifier drive signal
CH17	DGA	Phase W, base amplifier drive signal
CH18	DGA	Phase $\overline{U}$, base amplifier drive signal
CH19	DGA	Phase $\overline{V}$, base amplifier drive signal
CH20	DGA	Phase $\overline{W}$, base amplifier drive signal
CH21	DGA	Phase sequence detection, positive sequence: High
CH22	DGA	Base cut-off during regeneration
CH23	DGA	Phase R, base amplifier drive signal
CH24	DGA	Phase T, base amplifier drive signal
CH25	DGA	Phase $\overline{S}$, base amplifier drive signal

CH26	DGA	Phase S, base amplifier drive signal
CH27	DGA	Phase $\overline{R}$, base amplifier drive signal
CH28	DGA	Phase $\overline{T}$, base amplifier drive signal
CH29	AGA	Overcurrent setting level
CH30	AGA	Inverter side, phases U, V, W, full-wave rectification waveforms
CH31	AGA	Override command
CH32	AGA	-10V, reference voltage
CH33	AGA	+10V, reference voltage
CH34	AGA	Speed meter output
CH35	DGA	Regenerative converter, overcurrent level: Low
CH36	DGA	Speed arrival signal
CH37	DGA	Zero speed signal
CH37A	DGA	Orient finish
CH38	DGA	Regenerative side current limiting: high while limiting
CH39	DGA	Regenerative side current limiting
CH40		
CH41	AGA	Analog-speed command input, max. speed at +10V
CH42	AGA	Converter voltage, 10V at 400V
CH43	AGA	Supply voltage, peak rectification
CH43A	AGA	Regenerative side converter current
CH44	Non insulated D08F	Inverter side base amplifier output, phase U
CH45	Non insulated D08G	Inverter side base amplifier output, phase V
CH46	Non insulated D08H	Inverter side base amplifier output, phase W
CH47	Non insulated D08A	Inverter side base amplifier output, phase $\overline{U}$
CH48	Non insulated D08A	Inverter side base amplifier output, phase $\overline{V}$

CH49	Non insulated D08A	Inverter side base amplifier output, phase $\overline{W}$
CH50	Non insulated D08C	Converter side base amplifier output, phase R
CH51	Non insulated D08D	Converter side base amplifier output, phase S
CH52	Non insulated D08E	Converter side base amplifier output, phase T
CH53	Non insulated D08B	Converter side base amplifier output, phase $\overline{R}$
CH54	Non insulated D08B	Converter side base amplifier output, phase $\overline{S}$
CH55	Non insulated D08B	Converter side base amplifier output, phase $\overline{T}$
CH56	AGA	Phase U, inverter side current detection
CH57	AGA	Phase V, inverter side current detection
CH58	AGA	Converter side DC current detection

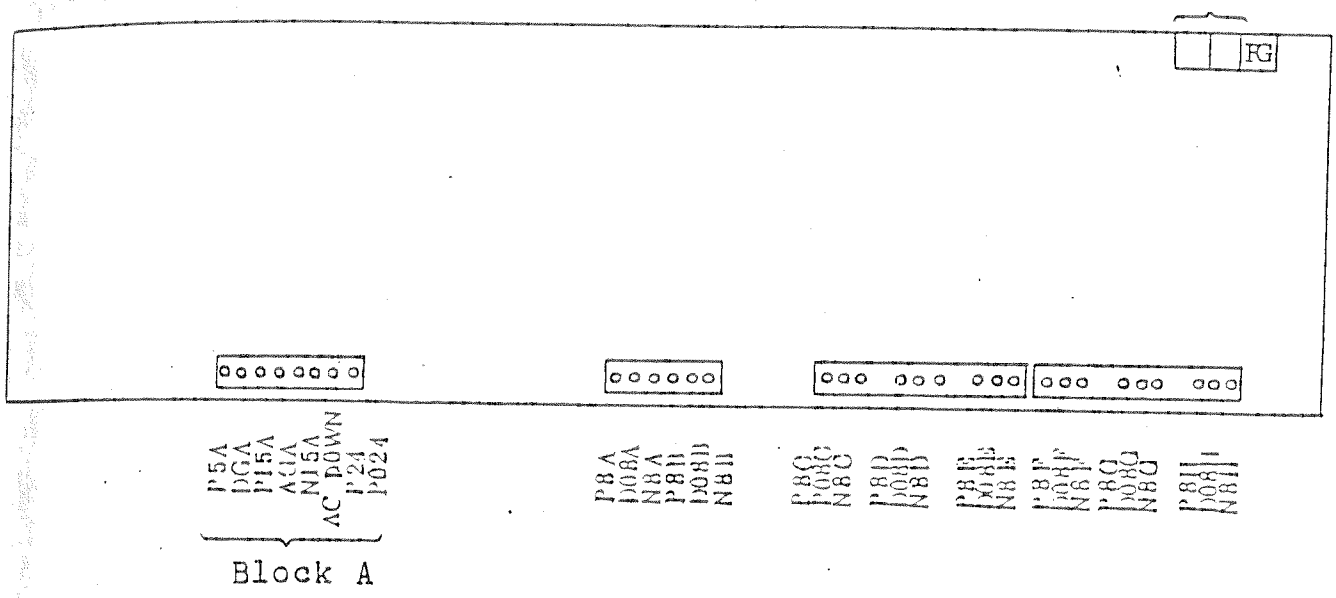
List of VRs

No.	Description
VR1	Phase W, current command zero adjustment
VR2	Phase V, current command zero adjustment
VR3	Phase U, current command zero adjustment
VR5	+/-10V, reference power supply
VR6	High speed setting, over-speed level adjustment, PIN1-A
VR7	Low speed setting, over-speed level adjustment, PIN1-B
VR8	Converter voltage feedback gain adjustment
VR9	Supply voltage peak value gain adjustment
VR10	Regenerative converter current zero adjustment, CH43A
VR11	Converter DC current zero adjustment, CH58
VR12	Inverter side, phase V, current feedback zero adjustment, CH57
VR13	Inverter side, phase U, current feedback zero adjustment, CH56
VR14	Speed meter adjustment
VR15	Load meter adjustment

5-4 SE-PW CARD

This is the power supply card which supplies all the FR-SE DC power.

AC 170-253V input



Notes:

(1) Note that except for block A no insulation is provided with the main circuitry.

(2) Line 0 in block A is connected.

Block	Name	Ground		DC output voltage
A	P5A	DGA	Com-	+5V +/-3%
	P24A	DO24	mon	+24V +/-10%
	P18A	AGA	ground	+18V +/-10%
	N18A			-18V +/-10%
B	P8F	DO8F		+8V, +15%/-5%
	N8F			-8V, +15%/-5%
C	P8G	DO8G		+8V, +15%/-5%
	N8G			-8V, +15%/-5%
D	P8H	DO8H		+8V, +15%/-5%
	N8H			-8V, +15%/-5%
E	P8A	DO8A		+8V, +15%/-5%
	N8A			-8V, +15%/-5%
F	P8C	DO8C		+8V, +15%/-5%
	N8C			-8V, +15%/-5%
G	P8D	DO8D		+8V, +15%/-5%
	N8D			-8V, +15%/-5%
H	P8E	DO8E		+8V, +15%/-5%
	N8E			-8V, +15%/-5%
I	P8B	DO8B		+8V, +15%/-5%
	N8B			-8V, +15%/-5%
J	AC DOWN signal			

CHAPTER 6 ORIENT POSITION DETECTOR MOUNTING PROCEDURE

6.1 MAGNETIC SENSOR TYPE OF SINGLE POINT ORIENT

(SE-CPU1 card is used)

1.1 MAGNET AND SENSOR OPERATION

Depending on the position relationship with the magnet, the sensor generates two kinds of voltages (see Fig. 6.1).

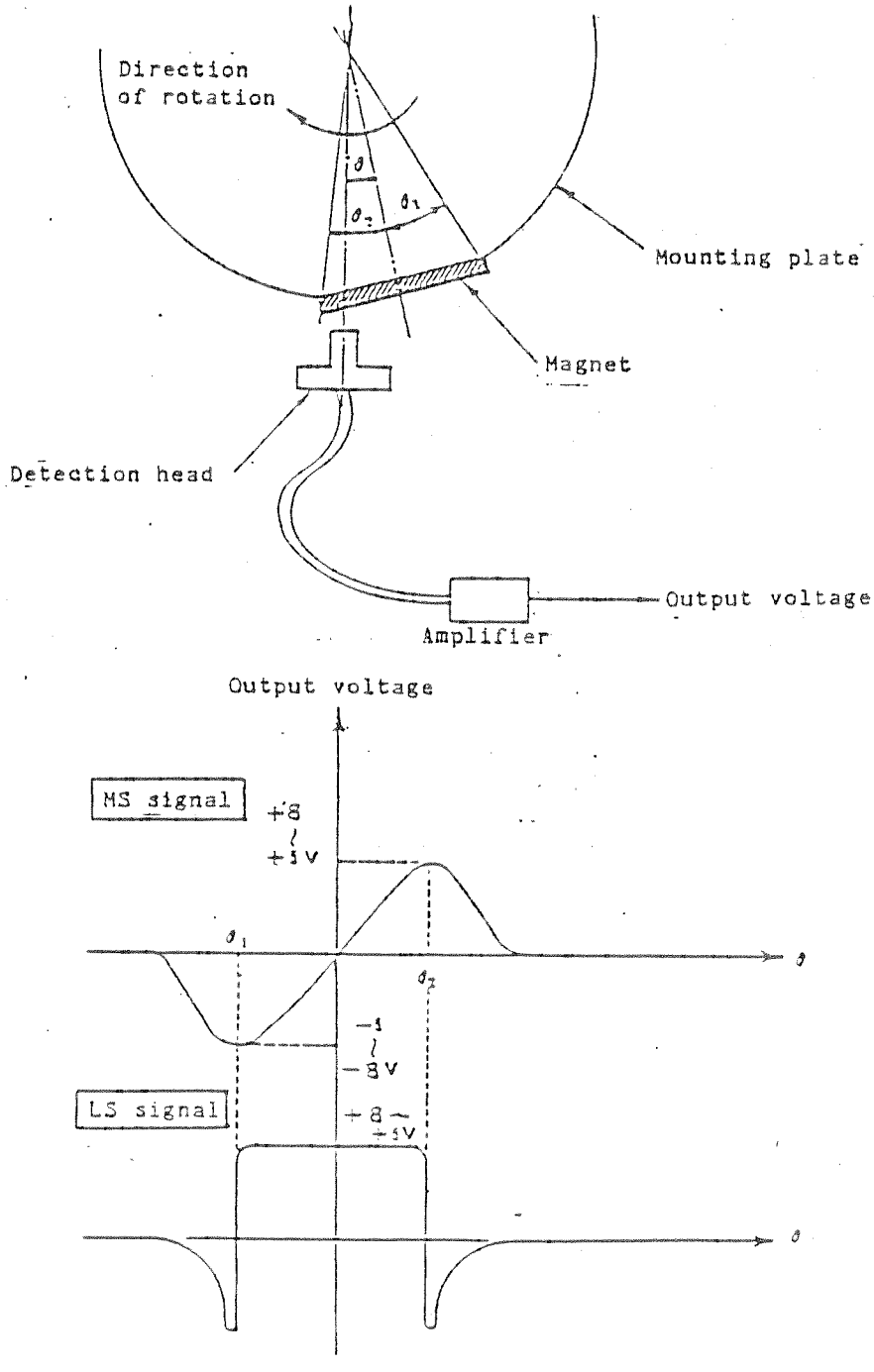


Fig. 6.1 Sensor output voltages

MS signal

This is characterized by the fact that its output voltage is 0 at the center position of the magnet and that it reaches a pea at both ends of the magnet. It is controlled so that the 0V voltage position is always the home position.

LS signal

This is characterized by the fact that it is a constant voltag within the area of the magnet. It is employed for checking th stopping has without fail occurred within the magnet area.

1.2 TIME CHART

Fig. 6.2 is a time chart of the various signals.

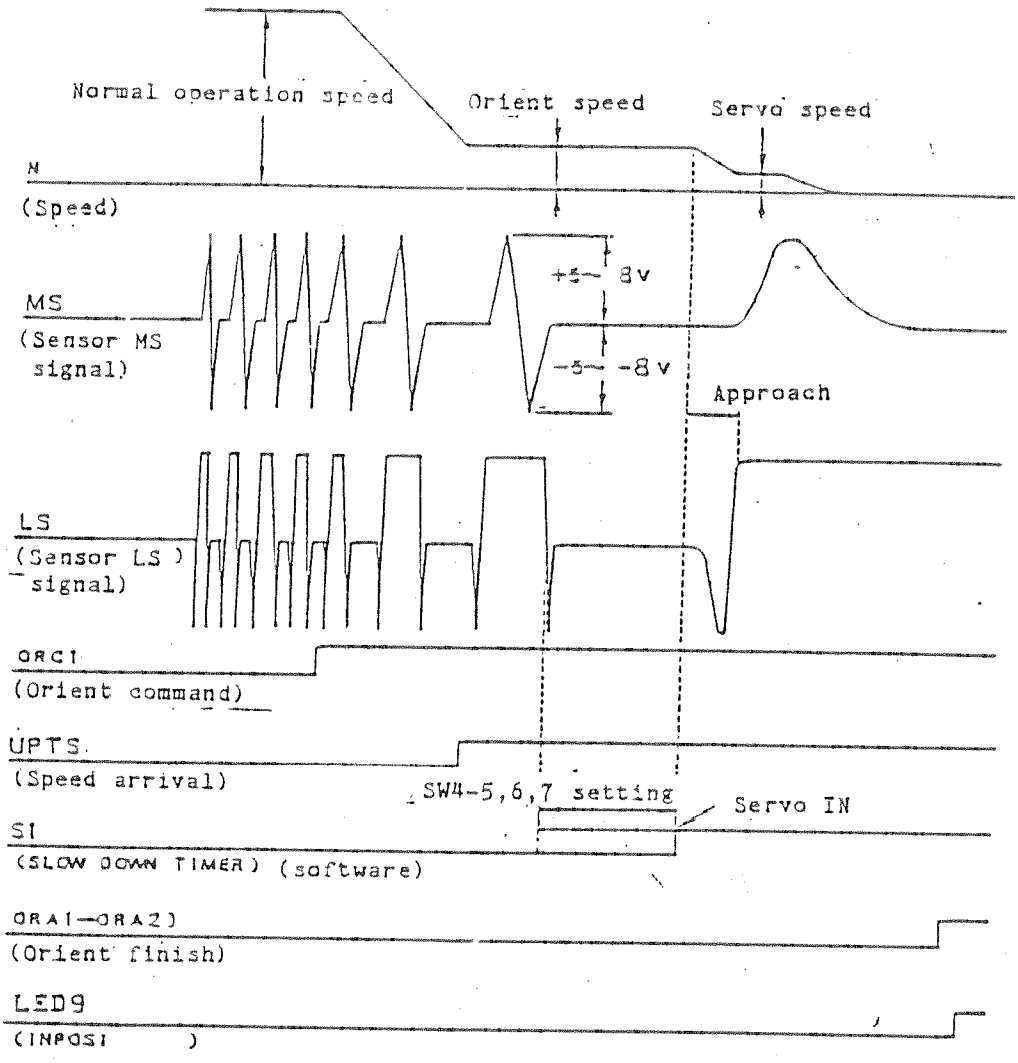


Fig. 6.2 Time chart

(1) When the ORCI (orient signal) is set ON, the motor speed is switched over from the normal operation speed to the orient speed.

(2) When the motor speed arrives at the orient speed, the speed arrival signal rises.

(3) After the speed arrival signal has risen, the software slowdown timer starts operating at the timing (at the very time the magnet passes in front of the sensor) during which the sensor LS signal falls.

(4) The slowdown timer is set by SW4-5,6,7. When the timer counts up, the orient speed loop is switched to the positio servo loop (servo IN).

(5) The sensor MS signal stops at the 0V position due to the position loop control.

(6) The orient finish signal rises at the target position and ORA1-ORA2 (orient finish contact signal outputs) are set to closed.

1.3 MAGNET AND DETECTION HEAD MOUNTING DIRECTIONS

The mounting directions for the magnet and detection head are specified as shown in Figs. 6.3, 4 and 5.

(1) Mount so that the index hole in the center of the magnet and the key slot on the detection head are positioned on the same side.

(2) Mount the index hole on the right side (on the opposite side to that of the tool) when the spindle tool is on the left side.

Case 1 Mounting the magnet onto the circumference of a rotating body

As shown in Fig. 6.3, mount so that the key slot and index hole point to the non-load side of the spindle.

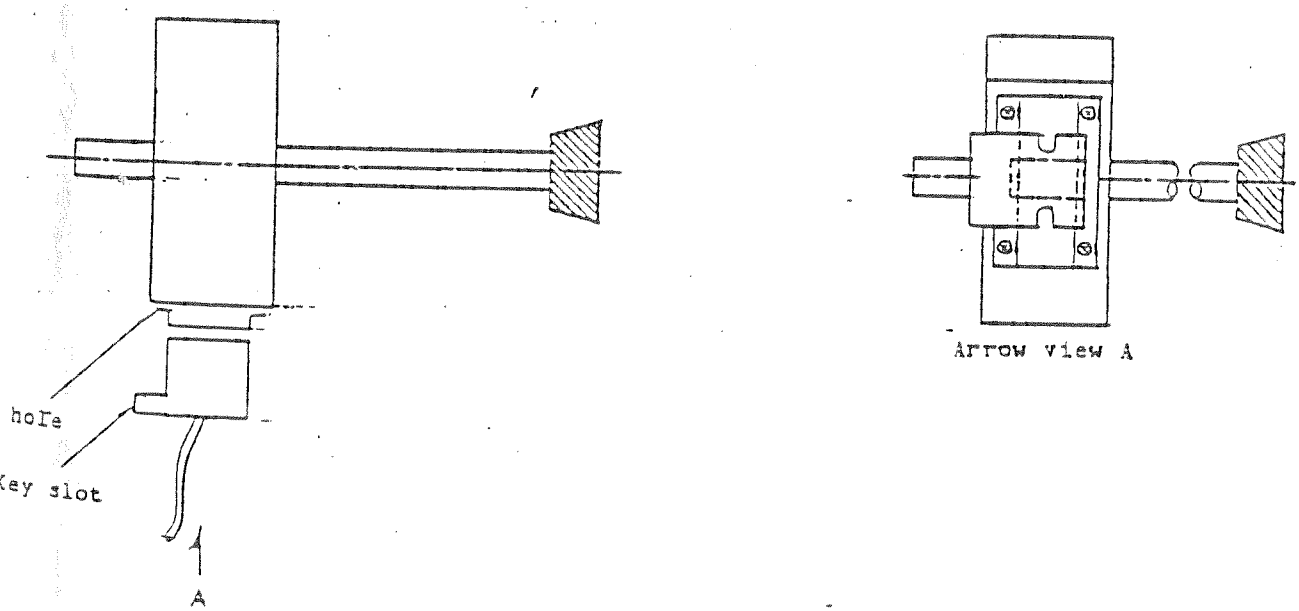


Fig. 6.3 Mounting onto the circumference of a rotating body

Case 2 Mounting the magnet onto the flat surface of a rotatin body

(1) When the mounting surface is on the non-load side of the spindle, mount so that the index hole and key groove are pointing toward the center side, as shown in Fig. 6.4.

(2) When the mounting surface is on the spindle load side, mo so that the index hole and key groove are on the circumference side, as ahown in Fig. 6.5.

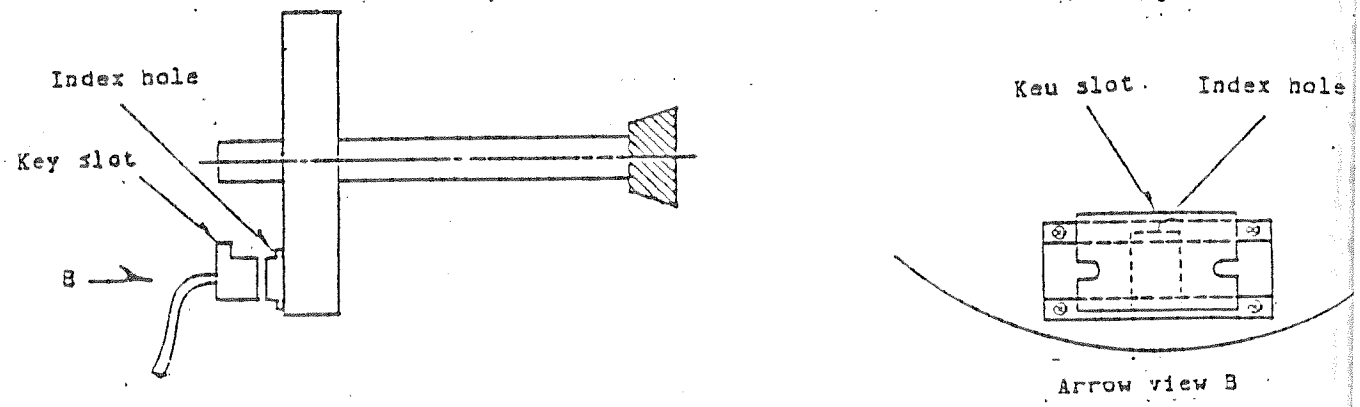


Fig. 6.4 Mounting onto a flat surface on the non-load side o the rotating body

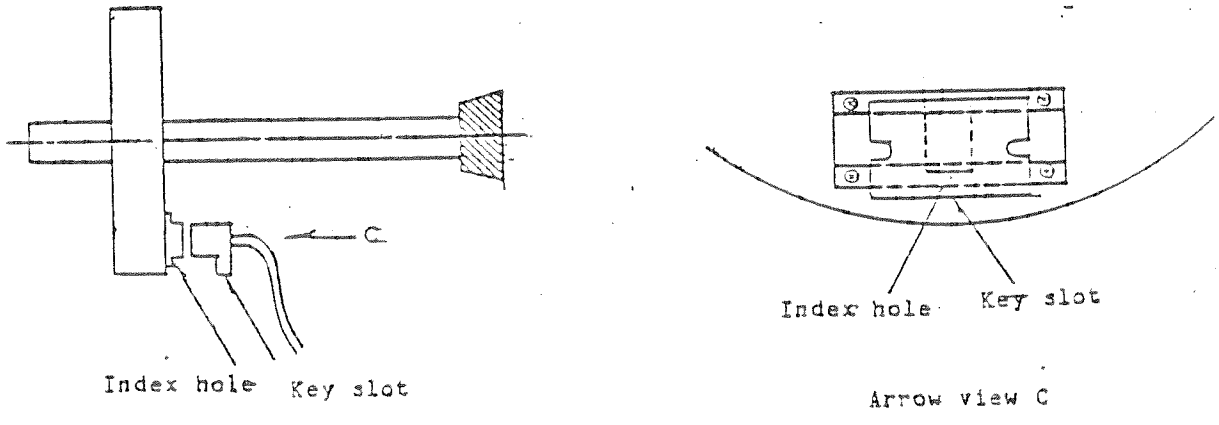


Fig. 6.5 Mounting onto a flat surface on the load side of t rotating body

Notes

(1) Orientation will remain normal even if the magnet and detector are mounted, as shown in Fig. 6.6, in the opposite way to that shown in Figs. 6.3, 4 and 5.

(2) Unless the directions in which the magnet and detector point tally, as shown in Fig. 6.7, a high level of vibration results at both ends of the magnet and orientation is disabled.

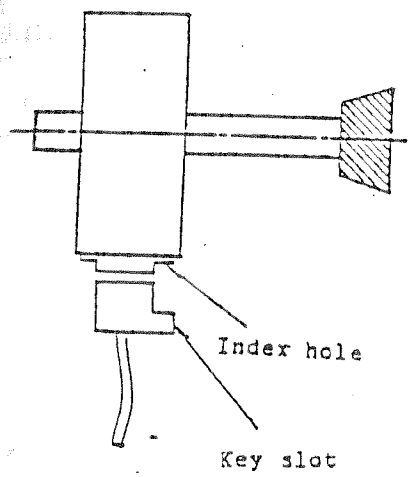


Fig. 6.6

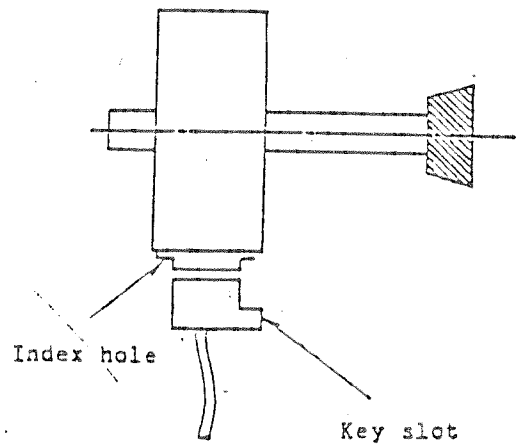


Fig. 6.7

1.4 CHECKPOINTS WHEN MOUNTING MAGNET

Bear in mind the following points when mounting the magnet onto the spindle.

(1) Do not bring strong magnetic objects near the magnet.

(2) Take care not to subject the magnet to shocks.

(3) Use M4 screws to secure the magnet rigidly to the spindle.

(4) Provide the rotational balance of the whole spindle with t magnet mounted.

(5) Bring the index hole in the center of the magnet to the center of the mounting disc and align its direction with that shown in Figs. 6.3, 4 and 5.

(6) Make sure that the surroundings are clean so that metal chips and dust do not adhere to the magnet and thereby cau errors.

(7) Paint over the mounting screws to lock them in position so as to avoid any looseness.

(8) When the magnet is to be mounted onto a polished disc, the disc may have become magnetized. Steps should therefore b taken to demagnetize it.

(9) The diameter of the disc onto which the magnet is mounted should be not less than 80 mm and not more than 120 mm. I may be larger if the spindle speed is low.

(10) When the spindle onto which the magnet is mounted rotates a speed higher than 6,000 rpm, the magnet must be replace with a high-speed version (which can be used up to 10,000 rpm).

1.5 CHECKPOINTS WHEN MOUNTING SENSOR

Bear in mind the following points when mounting the sensor.

(1) Ensure that the key slot on the detection head and the index hole in the magnet are pointing in the same direction.

(2) Mount the sensor so that the center line on the end of the head and the center of the magnet are aligned (see Figs. 6-3, 4 and 5).

(3) Refer to Table 1 for the size of the gap between the magnet and detector when the mounting method in Fig. 6.3 is adopted. Refer to Table 2 when the methods in Fig. 6.4 or 6.5 is employed.

* It is recommended that jigs be made for mass production.

(4) Although the pre-amplifier connector is oil-proof, it should be mounted where the chances for oil to come into contact with it are minimal.

(5) Lay the cable to the controller from the pre-amplifier at a distance from the power supply circuitry wires so that it is isolated from them.

(6) First check the connector connections and ensure that the connectors have been inserted properly into the receptacles, and then tighten up their lock screws.

Table 1

	Sony product		Makome product	
Radius (mm)	Max. gap (mm)	Min. gap (mm)	Max. gap (mm)	Min. gap (mm)
40	11.5 +/-0.5	2.7 +/-0.5		
50	9.5 +/-0.5	2.8 +/-0.5	8 +/-0.5	1.31 +/-0.5
60	8.5 +/-0.5	3.0 +/-0.5	7 +/-0.5	1.5 +/-0.5
70			7 +/-0.5	2.38 +/-0.5

Table 2

	Sony product	Makome product
Radius (mm)	Gap (mm)	Gap (mm)
40	6 +/-0.5	5 +/-0.5
50	"	"
60	"	"

Fig. 6.8 Mounting the detector

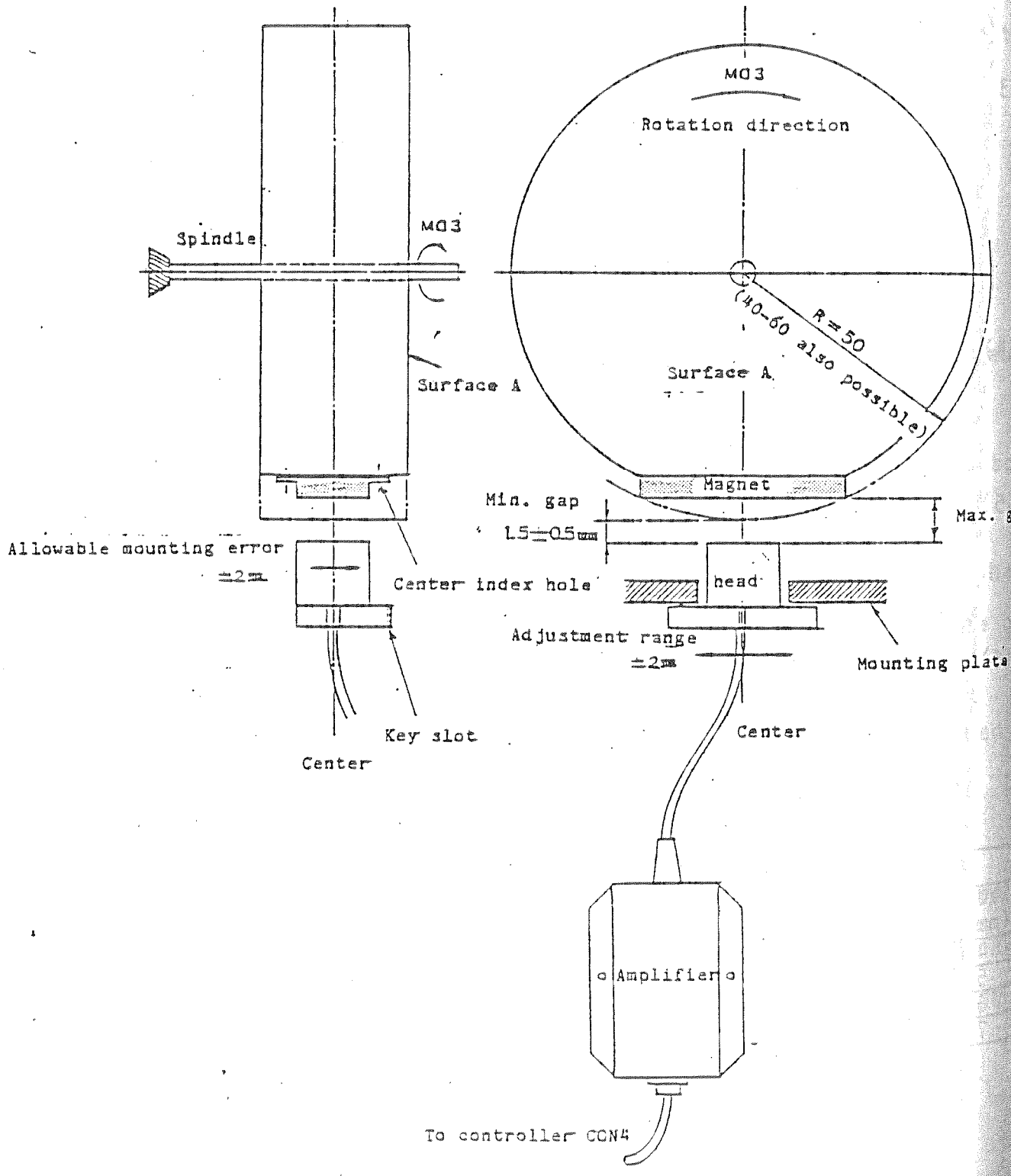
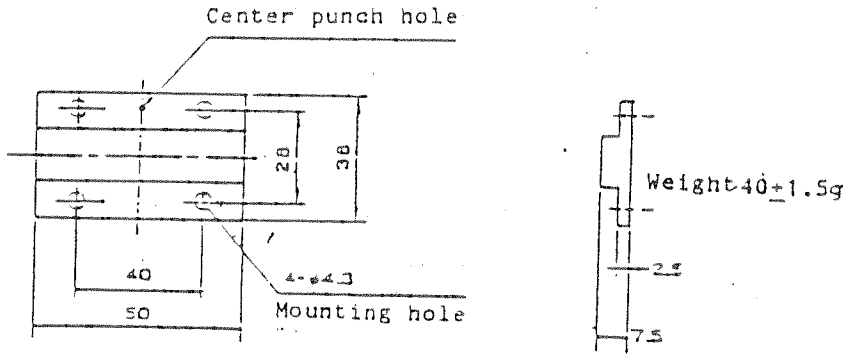


Fig. 6.8 Mounting the detector

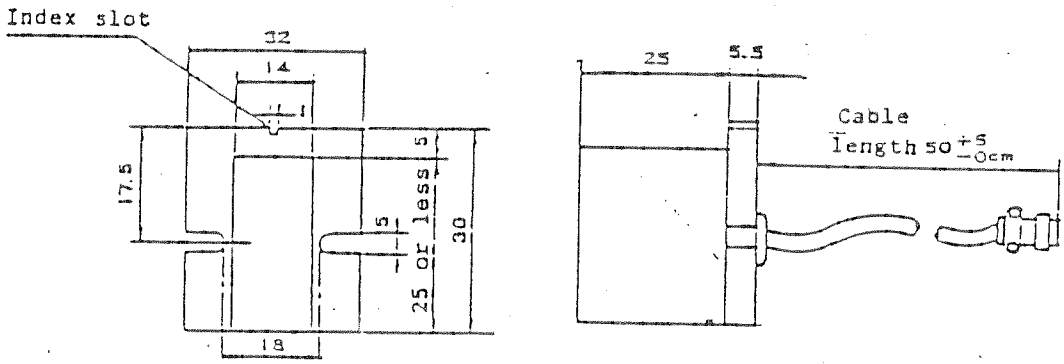
1.6 EXTERNAL VIEWS

3.1 Magnetic sensor

(1) Magnet



(2) Detection head



(3) Amplifier

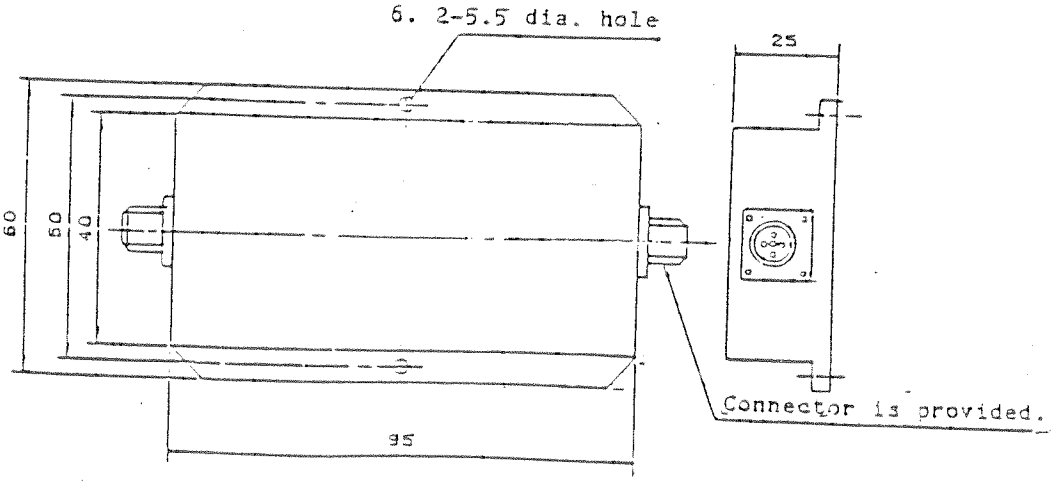


Fig. 6.9

6.2 ENCODER TYPE OF MULTIPLE POINT ORIENT

2.1 DESCRIPTION OF OPERATION

Operation is shown below in the form of a time chart.

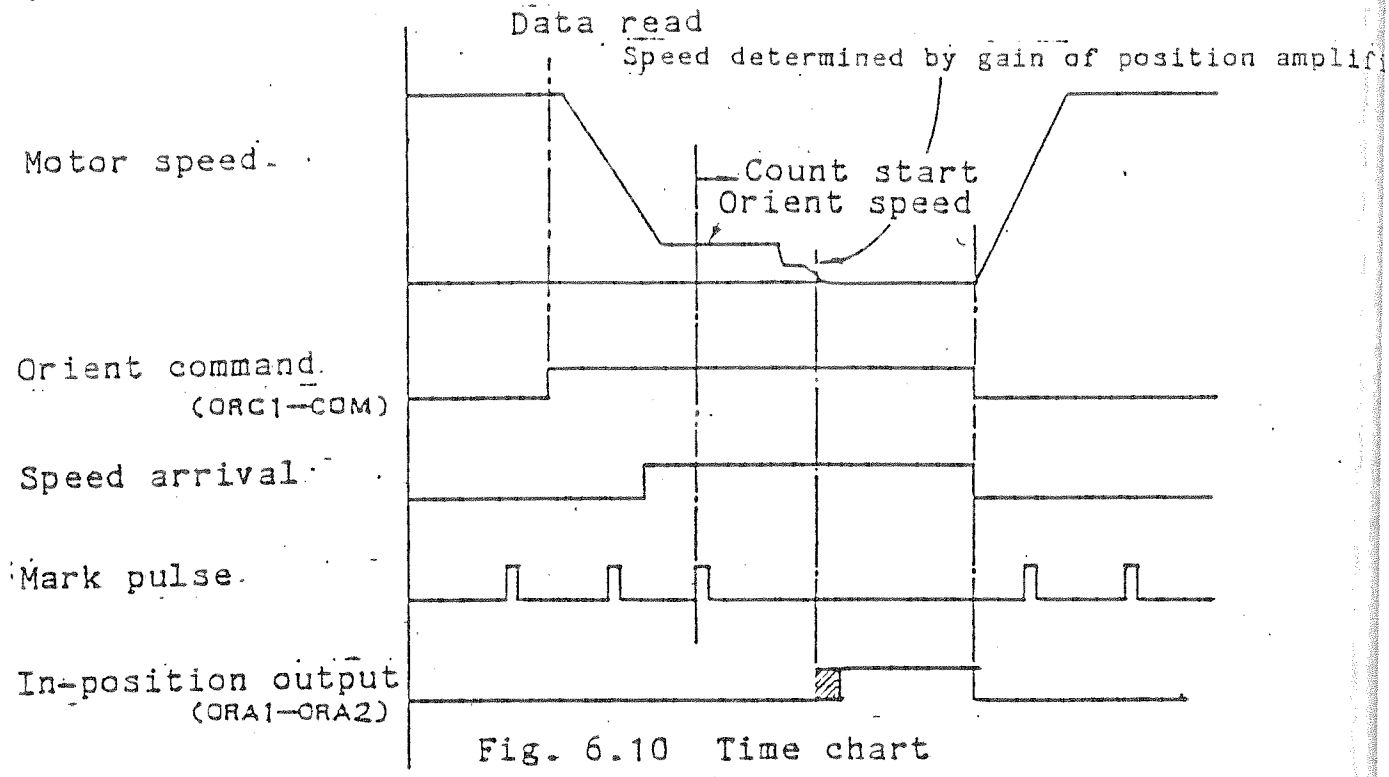


Fig. 6.10 Time chart

(1) The orient position is read in with the orient command and the motor speed is switched to the orient speed.

(2) When the motor speed arrives at the orient speed, the speed arrival signal, which is detected by the comparator, rises.

(3) After the speed arrival signal has risen, the orient position count given in 12-bit binary code from the external source starts when the mark pulse is input. The motor spee remains at the orient speed at this time.

(4) The control loop is switched from the speed loop to the position loop when the value set with SW4 5, 6 and 7 is reached from the target point. The motor speed is further switched from the orient speed to a speed determined by the gain of the position amplifier.

(5) The linear zone of the position loop is entered at the value set by SW4 2, 3 and 4 from the target point, and the motor starts decelerating and it stops at the target point.

(6) The IN-POSITION signal rises before the target point by an amount equivalent to the SW12 setting value and then the IN-POSITION signal output contact closes.

(7) When the orient command is released, the motor is reset to the speed of the S command given at that time.

(8) When re-orienting from the orient mode, the spindle rotates once and orientation is performed.

Depending on the settings of SW13, SW14 and SW15 for position adjustment and on the orient position given externally, the spindle will rotate more than once.

2.2 CONFIGURATION

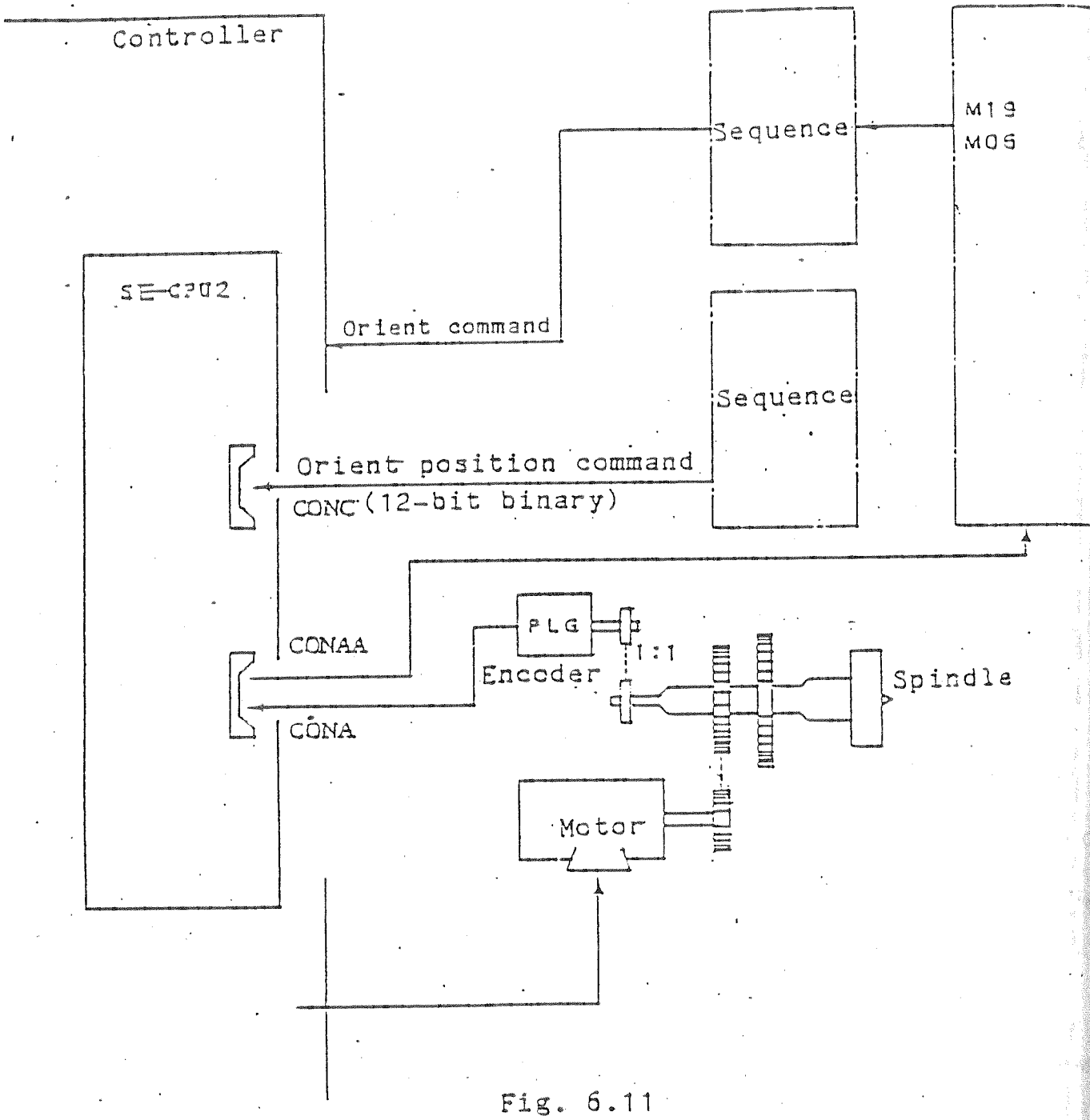
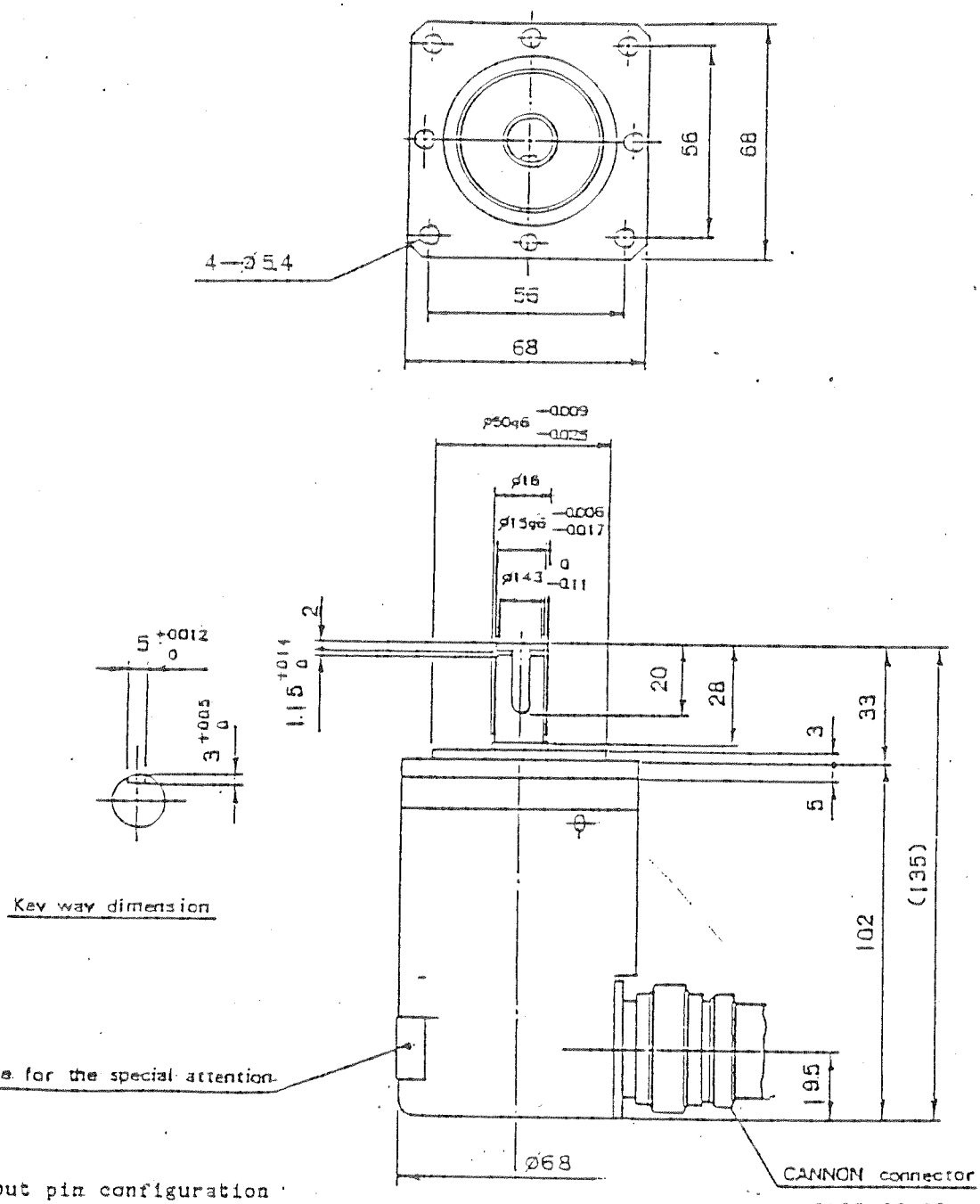


Fig. 6.11

Note: When the motor rotation direction and encoder rotation direction differ, make the adjustment using DIP switch SW-8 on SE-CPU2.

2.3 ENCODER DIMENSIONS



Output pin configuration

A	1 ch A	K	0 V
B	2 ch A	L	
C	1 ch B	M	
D		N	* 1 ch A
E	Chassis ground	P	* 2 ch A
F		R	* 1 ch B
G		S	
H	+ 5 V	T	
J			

(Cable connector is not supplied.)

* Reverse rotation signal

Fig. 6.12

CHAPTER 7 TROUBLESHOOTING

7.1 INTRODUCTION

When trouble occurs in the controller, check out the following points as far as possible. Then proceed with inspection and repair work as outlined in the sections below.

The following points are extremely useful when making contact with servicing personnel and explaining what has happened.

Checkpoints when trouble occurs

(1) Have trouble lamps on controller's cosmetic panel lighted? Which lamps have lighted?

(2) If a fuse has blown, is it the R, S or T phase? (Control circuit input fuses)

(3) Does the trouble or failure recur?

(4) Are the ambient temperature and temperature inside the pane at the regular levels?

(5) Does the trouble occur during acceleration, deceleration or during constant speed operation? What is the speed at the time of the trouble?

(6) Is there any difference with forward and reverse rotation?

(7) Was there a momentary power failure?

(8) Does the trouble ocur with a specific operation or command?

(9) What is the frequency with which the trouble occurs?

(10) Does the trouble occur with a load added or reduced?

(11) Have parts been replaced or any other stopgap measures taken?

(12) How many years have passed since the equipment was first operated?

(13) Is the supply voltage normal? Does it vary greatly depending on the time zone.

7.2 STEP 1

Check the following points as the first step in troubleshooting.

(1) Supply voltage:

200V +/-10%, 50/60Hz, 210/220/230V +/-10%, 60Hz

The power supply should not be allowed to fall below 200V -10% even for short periods of time.

Examples: Voltage drops at certain times every day.

Voltage drops when certain machines are started.

(2) Is anything wrong with the control functions around the controller?

Examples: Anything wrong with NC, sequence circuitry?

Visually inspect parts, connections for trouble.

(3) Is the temperature around the controller (temperature inside panel) less than 55 deg.C.

(4) Anything wrong with exterior of controller?

Examples: Card parts, pattern burnouts, trouble, etc.

Loose connections, damage, foreign matter.

(5) Do all the SE-PW DC power outputs correspond with the prescribed voltages?

Once the above checks have been carried out, it should be possible to determine which parts are the cause of the trouble and to identify what the trouble is. Trouble in the FR-SE series can be broadly divided as follows:

Trouble group A

- Power is supplied to the controller for the first time but it does not operate properly (I)

- The controller has been operating properly to date but has suddenly ceased to do so (II)
- The controller does not operate properly from time to time and position shift trouble occurs (III)

Trouble group B

- Trouble in the controller
    - Trouble in main circuitry semiconductors
    - Trouble in control circuitry
- Trouble in the detector
    - Trouble in encoder for speed detection
    - Trouble in encoder for multiple point orient
    - Trouble in magnetic sensor for single point orient
- Trouble in power supplies
- Trouble in motor
- Other trouble (inadequate input signal conditions, cable disconnection, etc.)

7.3 STEP 2

Trouble group I	Checkpoints	Remedy
Power is supplied to controller for first time but it does not operate properly.	Stringent tests were conducted when unit was shipped but if unit does not operate properly when power is turned on for first time, cause may be:	
	1 Controller sustained a heavy blow during operation or installation and was damaged.	1 Visually inspect exterior of unit for signs of trouble.
	2 External wiring or sequence error, disconnection. Has unit been grounded? Note 1: Power supply phase sequence is unrelated.	2 Check that power LEDs 1-4 inside SE-PW light. Check that nothing is wrong with external wiring and sequence. (Note 1).
	3 Check again that ROM numbers and DIP switch settings are identical to those on order form list.	3 If they differ, replace ROM or reset.
	*4 Motor speed does not increase.	4 Change over any 2 of U, V, W phases of motor

		armature wiring.
	5 OK if only motor operates.	5 Re-check that load co responds to design value.
	6 Irregular operation with orient stop only. (over shoot, etc.)	6 Re-adjustment require
	7 Controller fault LEDs light: AL8, AL4, AL2, AL1 (LED13)(LED14)(LED15)(LED16).	Refer to Section 7.4.

Note 2: The start signal CW and CCW inputs must be set ON after the READY signal and speed command have been supplied.

Trouble group II	Checkpoints	Remedy
Controller has been operating properly to date but has suddenly ceased to do so.	1 Check for blown fuses, main circuitry no-fuse breaker tripping.	1 Replace any blown fuses; if fuse blows even after replacement, check under step 3.
	2 Check input power. AC200V +/-10%, 50/60Hz AC200-230V +/-10%, 60Hz	2 Reset to normal value if incorrect. Make available power supply so that voltage on left is maintained even in transient state.
	3 Controller fault LEDs light: AL8, AL4, AL2, AL1 (LED13)(LED14)(LED15)(LED16).	Refer to Section 7.4.
	4 Input signal from NC or sequencer OK? LED2 (READY) lights in ready state; LED3 (CW) lights with forward rotation; LED4 (CCW) lights with reverse rotation.	4 Restore external input to normal.
	5 Check whether open operation is possible	5 If operation possible, trouble lies

	with SW6-2 OFF open, SW5-3,4,5 OFF cushion 10S, reset PB ON.	in speed feedback encoder. Try replacing encoder. If operation is still disabled, trouble lies in mai circuitry: fault LE will light.

Trouble group III	Checkpoints	Remedy
Controller does not operate properly from time to time. Orient stop position shifts. Fault LED lights. Switching on power or resetting after power has been switched off results in resetting and normal operation.	In this case, whole situation must be clearly grasped. (Load situation, operation mode) Cause may be (3) below.	
	1 Input power is sudden-cut off or reduced, undervoltage LED or LED17 lights.	1 Check fluctuations in input power and other details.
	2 Control circuitry malfunctions with abnormally high noise level. Controller is guaranteed to withstand 1600V/1us power line noise in both common and normal modes.	2 Locate source of noise, and mount surge killer at source. Ground (particularly, detector) connection method. Re-check that chassis has been grounded properly.
	3 Is load overloaded momentarily under effect of vibration, etc? Check thoroughly with orient errors, etc.	3 Check out machine system. Check backlash with spindle encoder and spindle.

7.4 SYMPTOMS AND REMEDIES

1. When the fault lamps light

The trouble code related to which fault LED has been activated the fastest is indicated.

(1) MOTOR OVER HEAT

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	0	0	1

OHS1 and OHS2 are not activated.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load 2 Start/stop frequency	1 Reduce load. 2 Reduce frequency.
Fan failure	Is fan motor working properly?	Repair or replace fan.
Blocked motor air intake	Sufficient air passing through?	Clean.
Thermal protector device failure	Reset after motor fan is operated for several minutes in motor stop state?	1 Shortcircuit OHS1-OHS2 as stopgap measure and continue operating. 2 Replace motor.

(2) EXCESSIVE SPEED ERROR

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	0	1	0

When an error (500 rpm) greater than prescribed between command speed and present speed occurs for 12 seconds.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load	1 Reduce load.
Speed detec-	1 Open operation pos-	1 Replace encoder.

tion encoder trouble	sible	
Card trouble	1 SE-CPU1 or SE-IO1 card trouble	1 Replacement sequence: CPU1, 2 → IO1

(3) BREAKER TRIP

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	0	0

Lights when main input NFB is tripped.

IOC (converter/inverter) LED may light first.

Trouble	Checkpoints	Remedy
Supply voltage of 180V or less	Check that supply voltage during deceleration (regeneration) does not fall below prescribed value.	When voltage is near 180V in normal mode, it may fall below this value in transient mode and so it should be increased. Or increase power supply capacity.
Refer to IOC trip.	Refer to IOC trip.	Refer to IOC trip.

(4) PHASE LOSS

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	0	0

This is checked and lights up only when power is ON.

Trouble	Checkpoints	Remedy
Phase loss	Check voltage of input phases.	Return 3-phase power supply to normal.
Blown fuse F1, 2, 3	Check cause, inspect for shortcircuiting.	Replace unless something is wrong.

(5) EXTERNAL EMERGENCY

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	1	0

When SW7-2 is ON

This lights when the external emergency stop input (norma
ON) is cut off. Inspect thoroughly for causes and then s
input to ON. Return to normal operation.

When SW7-2 is OFF

External emergency stop lamp does not light.

(6) OVER SPEED

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
0	1	1	1

This lights when the motor speed reaches 115% of the maxi
speed and the over-speed detector circuit is activated.

Trouble	Checkpoints	Remedy
Incorrect max. speed setting	SE-IO1 PIN1 setting Check if SE-CPU SW7-4~8/ SW6~7 are set properly.	Reset if incorrect.
Speed detector trouble	Check encoder output frequency: CH59/CH62 on CPU2 card CH60/CH57 on CPU1 card	Replace detector. $\frac{256 \times 1500}{60}$ at 1500 rp = 6.4 kHz
Speed detector command circuit trouble	Defective card.	Replacement sequence: CPU1, 2 → IO1

(7) IOC TRIP (INVERTER, CONVERTER)

Converter IOC

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	0	0

Inverter IOC

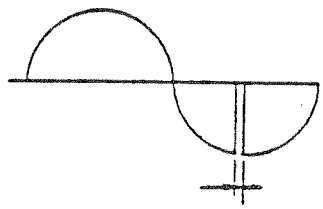
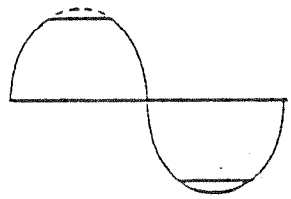
AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	1	0	0

IOC tripping can occur at the inverter or converter side.

Overcurrent is denoted when either lamp lights.

The main circuitry semiconductors may be damaged when the IOC fault recurs even if the reset signal is suppressed.

Trouble	Checkpoints	Remedy
Damage to power transistors	Disconnect connection between controller and motor and operate controller alone. Does IOC trip light? o If it lights, power transistors are damaged. o If it does not light, advance to following checks.	Replace power transistors.
High motor load	Check motor load.	Reduce load.
Faulty motor connections	Check wires around motor. Inspect for looseness in terminal screws.	Correct wiring. Tighten up screws.
Shorting of motor winding or grounding	Measure with megger; motor is defective if less than 1 Mohm.	Replace motor.
Incorrect power sup-	Must be 180V or more even under load conditions during acceleration/decel-	Increase power capacity.

ply capa-ity	eration.	
Abnormal supply voltage waveforms	Observe supply voltage waveforms with synchroscope and check that they are normal during acceleration and deceleration. 1 When there is a partial drop  Must be less than 100μs  Must be less than 2-3%	Eliminate wa form distort 1 Increase c acity or i crease pow cable size 2 Improve ot semiconduc unit in wh waveform d tortion oc curs.
Abnormal power frequency	Must not change more than +/-3% of prescribed frequency.	Improve fre-quency fluct tions.
Defective current detector circuit	Inverter CH30-AGA Trouble at 10V peak Converter CH43A-AGA Trouble at 10V peak.	Replace SE-I card.

(8) CONTROLLER OVER HEAT

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	0	1

Controller's thermal protector (mounted on cooling fan) is activated.

Trouble	Checkpoints	Remedy
Overloading	1 Motor load 2 Start/stop frequency	1 Reduce load. 2 Reduce frequency.
High ambient temperature	Measure controller's ambient temperature.	Consider cooling if it exceeds 55 deg.C.
Failure of fin cooling fan	Is fan working properly?	Replace fan.

(9) UNDERVOLTAGE

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	1	0

LED lights when input power is 25ms, 170V-164V or less.

Trouble	Checkpoints	Remedy
Usually, operation normal; normal operation with resetting	Lights with speed change or under heavy load conditions.	Increase power capacity.
Lights usually	If input power is normal: SE-PW card trouble SE-PW pins ACDOWN-D05A High when control circuitry is normal (+5V)	Replace SE-PW card.

(10) OVERVOLTAGE (CONVERTER)

AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	0	1	1

This LED lights when voltage of internal smoothing capaci-
tors has risen above the value permitted for the protectio
of the unit.

Trouble	Checkpoints	Remedy
High power impedance		Increase power capacity.
Momentary drop or momentary power failure during deceleration	Check if LED17 has come on.	Reset and then observe state.
Detector circuit trouble	When above cases do not apply, fault may lie in detector circuit.	Replace SE-IO1 car

(11) Trouble in CPU

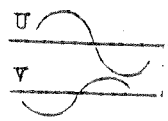
AL8 (LED13)	AL4 (LED14)	AL2 (LED15)	AL1 (LED16)
1	1	0	1
1	1	1	0
1	1	1	1

This consists of errors in the logic or in the operations
(such as division errors) inside the CPU cards. Observe t
state after resetting. It may be necessary to replace the
cards (or the CPU chips).

Trouble lies in the CPU when the CPU fault lamps (LED13-16
on the CPU1 or 2 card do not light during resetting. The
CPU1 or 2 card must be replaced.

2. When the fault lamps do not light

(1) The motor does not operate at all even though there is no fault display.

Trouble	Checkpoints	Remedy
Incorrect connections or disconnection	Check wiring and inspect for disconnections.	Wire properly.
Incorrect input voltage	200V, 50Hz/200-230V, 60Hz for all 3 phases?	Return power supply to normal.
Incorrect DC power	Check all output voltages of cards and SE-PW with multimeter.	Replace if defective.
Defective card	Set SW6-2 to OFF (normally ON), establish open mode and increase command speed. Are reference sine waves produced? SE-IO1 card CH 5 AGB CH 4 AGB 	If trouble is found: replace cards starting with SE-IO1 card finishing with SE-CPU card.
External emergency stop or reset signal input	Check if LED19 has lighted.	Check connections.

(2) Motor operates only slowly even though there is no fault display.

Trouble	Checkpoints	Remedy
Faulty motor	Is motor connected in proper	Re-connect pro-

connection	sequence to output terminals U, V and W on controller?	perly.
Incorrect input power	Is input power normal for all 3 phases?	Return power to normal.
Incorrect external speed command	When speed command from external source is increased, does motor speed increase in proportion?	Reset external spe command circuit.
Speed detection encoder trouble	Is open operation possible with SW6-2 OFF?	Replace encoder.

(3) Motor operates at specific speed only and not as commanded

Trouble	Checkpoints	Remedy
Incorrect external speed command	Does speed command from external source change linearly from 0V to 10V? (CH41-AGA)	Reset external spe command circuit.

(4) Insufficient torque

Inspect as indicated in (5), (6) and (7).

(5) Motor takes longer to start.

Trouble	Checkpoints	Remedy
Increased load	Check load.	Reduce load.

(6) No speed arrival signal (CP-TO SPEED)

Trouble	Checkpoints	Remedy
SE-IO1 card output circuit failure	Does LED7 on SE-CPU light upon completion of acceleration/deceleration?	Replace SE-IO1 car
Speed arrival detector cir-	LED7 (UP TO SPEED) on SE-CPU card does not light.	SE-CPU card failur if otherwise norma

	operation; replace card.

(7) No NC feed operation

This is caused by the failure of the UP-TO SPEED signal to operate. Inspect in the same way as for the relay sequence and (10).

(8) No speed detection signal

Trouble	Checkpoints	Remedy
SE-IO1 card failure	Does SE-CPU1 LED5 light above set speed? If it lights, failure lies in output circuitry.	Replace SE-IO1 card.
Speed detector circuit failure	SE-CPU2 LED5 does not light.	SE-CPU card failure if otherwise normal operation; replace card.

(9) No zero speed detection signal

Trouble	Checkpoints	Remedy
RA-1 relay failed on SE-IO1 card	Does SE-CPU LED10 light at motor speed of under 25 rpm or 50 rpm? Relay has failed if signal is not output even when LED10 lights.	Replace RA1 relay or replace SE-IO1 card.
Zero speed detector circuit failure	Failure in detector circuit if LED10 does not light.	Replace SE-CPU1 or 2 card.

(10) No speed range selection

This is caused by the speed detection or zero speed signal

not functioning. Inspect as for (12) and (13).

(11) Speed does not increases beyond a certain value.

Review settings to see whether maximum speed has been set properly. Check whether override input is not being supplied.

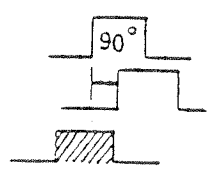
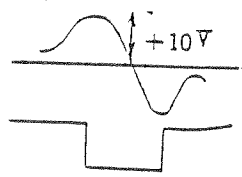
Is the load meter value too high? Check the load.

(12) High vibration, noise levels

Trouble	Checkpoints	Remedy
Poor dynamic balance		Review dynamic balance.
Drop in insulation resistance	Disconnect R, S, T phases from power supply and measure with 500V megger (disconnect wires connected to ground terminals). a Across main circuitry and ground: 20Mohms or more (terminals X1, X2, X3, U, V, W, MS1 and MS2) b Across control circuit COM and ground; 20Mohms or more (IO1 card, terminal block TB1 OM) c Across main circuity and control circuit COM: 20 Mohms or more	When this has dropped, inspect for places where insulation may have deteriorated, and restore.
Defective motor bearing	Try rotating motor alone by hand. Does it rotate smooth-	Replace bearings.

	ly?	
Motor screws not tight enough	Are any of the motor screws loose?	Re-tighten screws.
Motor shaft movement	Does motor shaft show any trace of having been bumped into something?	Repair or replace motor.
Unbalanced reference sine waves	Are SE-IO1 card CH5, CH6-AGA waveforms balanced?	Replace SE-IO1 card.

(13) Speed control operates normally but trouble with orient operation.

Trouble	Checkpoints	Remedy
Orient speed established but motor does not stop	Is position feedback encoder or magnetic sensor operating normally? Operate motor under speed control only and check if position feedback is normal. SE-CPU2 card, forward rotation CH52 - DGA CH53 - DGA CH54 - DGA Mark pulse  SE-CPU1 card, forward rotation CH53 - AGA IC 21A-7 - AGA  	Replace detector. Defective SE-CPU card interfacce; replace card.

Stop positions differ for forward and reverse rotation orient with multiple-point orient	Check backlash at encoder mounting area.	
Hunting during stop	Reduce position gain and observe. Reduce orient speed.	SE-CPU2 SW4-2~4 SW4-5~7 (Position loop gai SW10 Orient speed SE-CPU2 SW4-2~4 SW10 5~7 Orient speed
Stop state differs according to gear	Check that gear ratio setting is normal. DIP switch setting	Change if differe If normal, re-set position loop gai and orient speed.
Poor servo rigidity	Check that gear ratio setting is normal. DIP switch setting	Increase speed loo gain. SW8
Speed over-shooting		Reduce speed loop gain. SW9

CHAPTER 8 PARTS REPLACEMENT METHODS

8.1 CARD REPLACEMENT

(1) SE-PW card

Replace this card if something is wrong with the DC voltages.

> The SE-IØ1 card must be removed in order to replace the card.

(2) SE-CPU1 card

> First check the ROM number, DIP switch settings and setting pin positions again before proceeding with replacement.

Magnetic sensor sensitivity (VR2)
Orient shift (VR1)
} Re-adjust these controls.

(3) SE-CPU2 card

> First check the ROM number, DIP switch settings and setting pin positions again before proceeding with replacement.

(4) SE-IØ1 card

> First check the setting pinpositions again before proceeding with replacement. When replacing the card, bear in mind that the connectors hooking up the main circuitry are located on the rear side of panel B.

- CH56-AGA (U phase reference sinusoidal wave) ... VR13
  CH43A-AGA regenerative converter DC current ... VR10
  CH57-AGA (V phase reference sinusoidal wave) ... VR12
  CH58-AGA converter DC current ... VR11
  Re-set the zero adjustments.
- Set the maximum speed using pin 1 on the IO1 card and SW6-7 on the CPU card.
- Set the meter calibration SW6-6 to OFF and re-adjust VR6 and

7 so that the CH34 voltage is made 10V.

o After the above calibrations re-adjust the speed meter (VR14) and load meter (VR15).

8.2 DIODE AND TRANSISTOR MODULES

(1) Removal of defective module

Detach the wires connecting the module and remove the mo from the heat-dissipating fin.

In this case, bearing in mind that emitter pin E and bas pin B of the transistor module can be detached and re-inserted, remove these pins.

(2) Application of silicon grease

Apply an even layer of silicon grease to the rear side c the module.

(3) Tightening up

Restore the wires to their original state using the specified tightening torque. Cover the base and emitte pins of the transistor module with silicon tubes as bef

Note:	Only the diodes and transistors listed in the specifications may be used. Replacements or spares must, therefore, be purchased from Mit bishi or its authorized representative.

	Model	Screw size	Max. tightening torque (kg-cm)	Recommended tightening torqu (kg-cm)
Diodes	RM 30TA RM 60DZ-H RM100DZ-H	M5 x 0.8	20	17 +/-2
Transistors	QM 75DY-H QM100DY-H QM150DY-H			

Table 6.1 Tightening torques

8.3 TYPE SJ AC SPINDLE MOTOR DISASSEMBLY AND RE-ASSEMBLY

[1] Cables and PCB

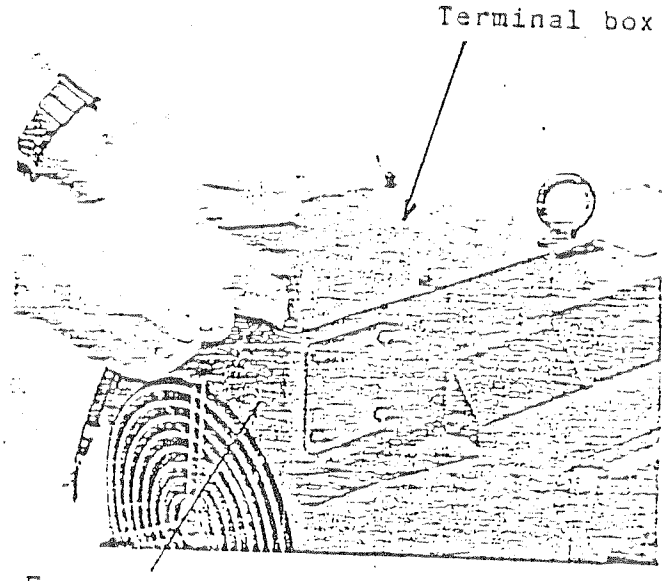
1. Remove the lid of the terminal box on top of the fan case.
2. Disconnect the cables from the power board to the motor.

a) 3 motor main leads (U, V, W)

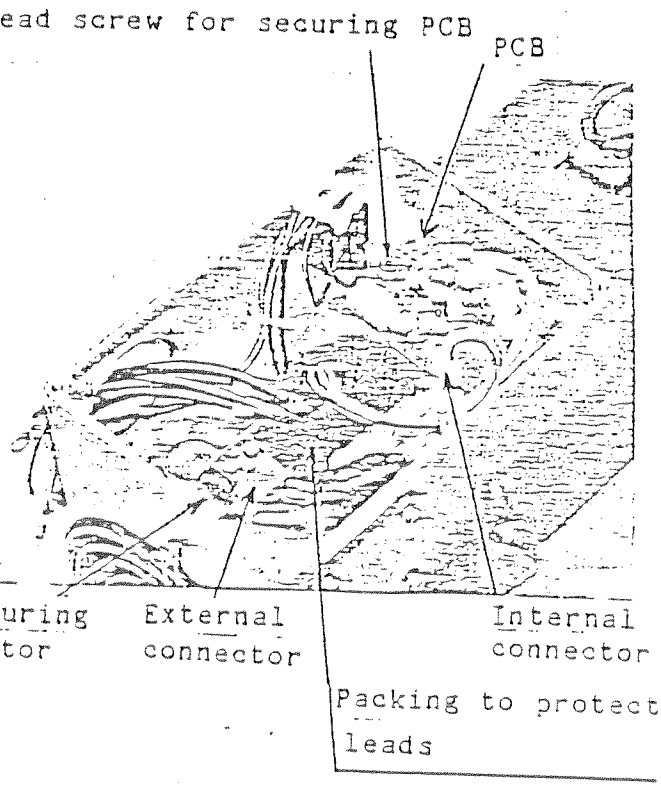
b) 2 cooling fan leads (BU, BV)

c) 2 thermal protector leads (OHS1, OHS2)

d) Companion plug for PCB's external connector

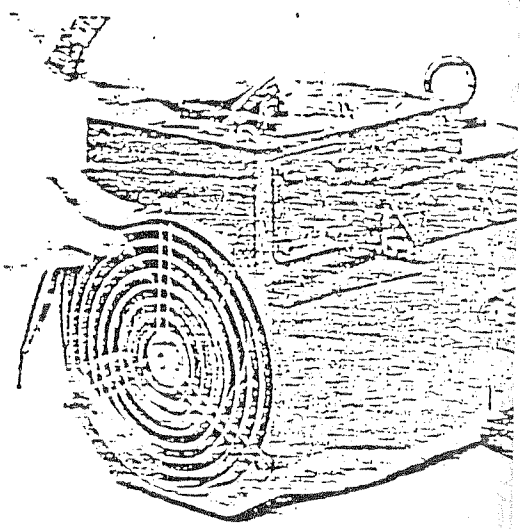


3. Remove the external connector from the fitting which secures it and remove the internal connector from the socket.
4. The PCB can be removed once the panhead screw securing it is removed.
5. For re-assembly, follow the above steps (1)-(4) in the reverse order.

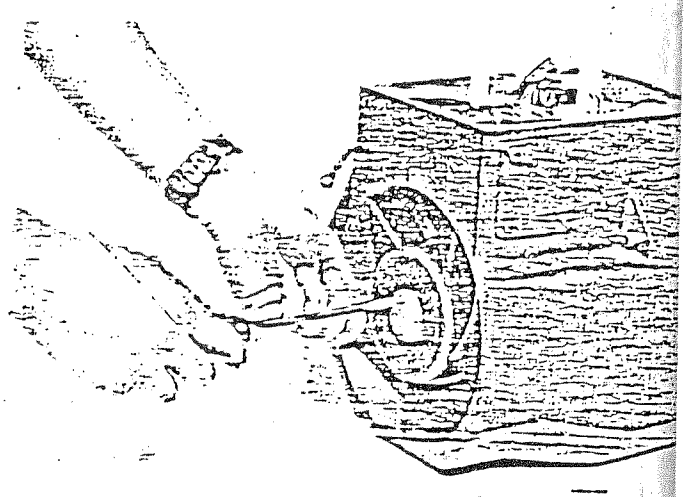


[2] Cooling fan

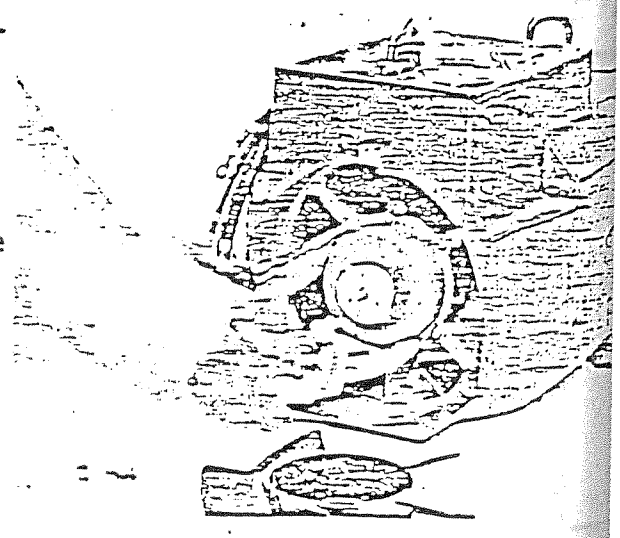
1. Remove the hexagon socket head bolts which secure the finger guard.



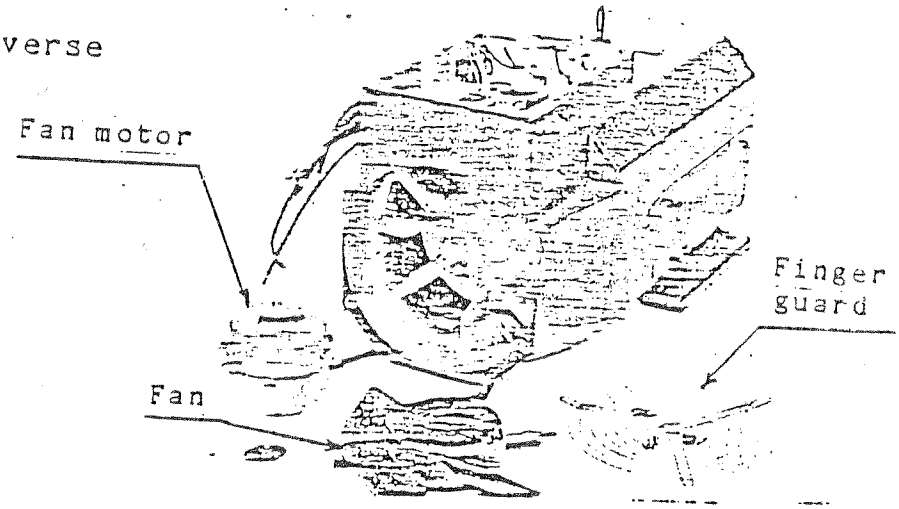
2. The fan alone can be removed once the flat-head screws at the center of the cooling fan are removed.



3. Cut the 4 cooling fan leads connected inside the terminal box. The fan motor itself can be removed from the fan case once the panhead screws which attach it are removed.

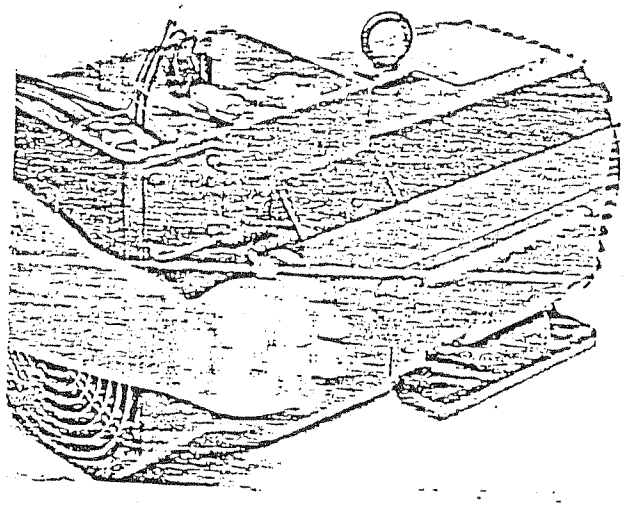


4. For re-assembly, follow steps (1)-(3) above in the reverse order.



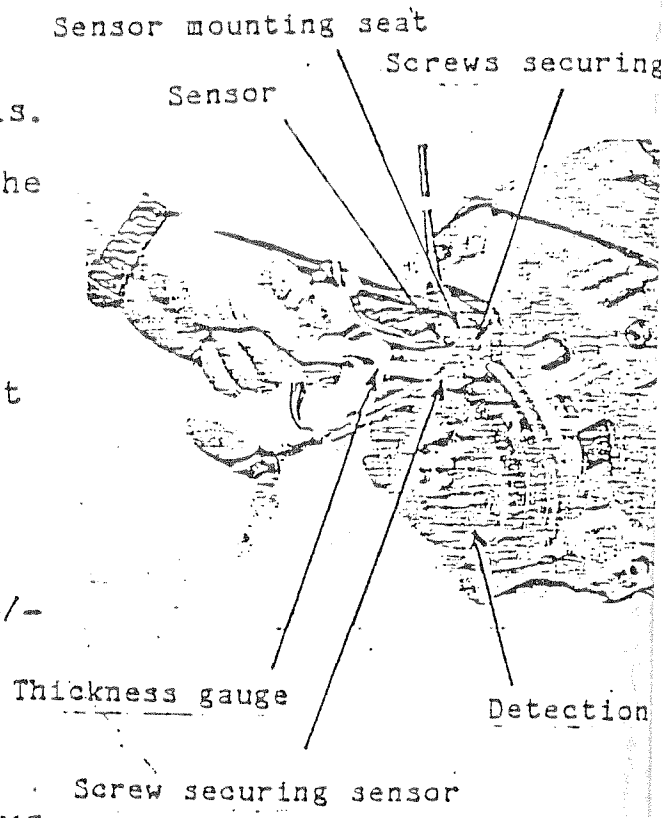
[3] Sensor and detection gear

1. Detach the internal connector of the sensor from the PCB inside the terminal box.
2. Remove the 3 hexagon socket head bolts attaching the fan case, and the fan case with the cooling fan attached can be removed once the fan case is pulled out toward the rear.



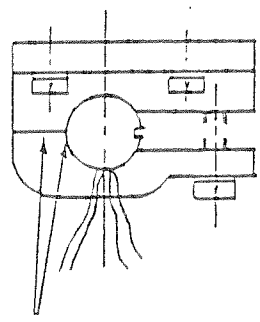
3. Once the 2 panhead screws securing the sensor mounting seat are removed, the seat with sensor attached can be removed. Take care not to bring the sensor into contact with the detection gear while doing this.

4. To adjust the sensor, loosen the screw securing the sensor with the sensor mounting seat still secured and make the adjustment with a thickness gauge so that the gap between the detection gear and sensor is made 0.15 +/- 0.01. Check that the marks (index lines) on the sensor tally, and tighten up the screws securing the sensor to secure the sensor.
(See figure on right)



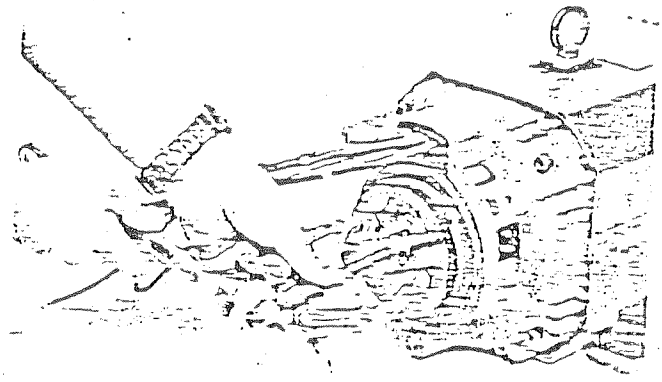
5. Paint over the screws securing both the sensor and its mounting seat to prevent looseness.

6. When re-assembling the fan case, draw it sufficiently into the terminal box so that the sensor leads are not sandwiched inside.



Align the marks (index l

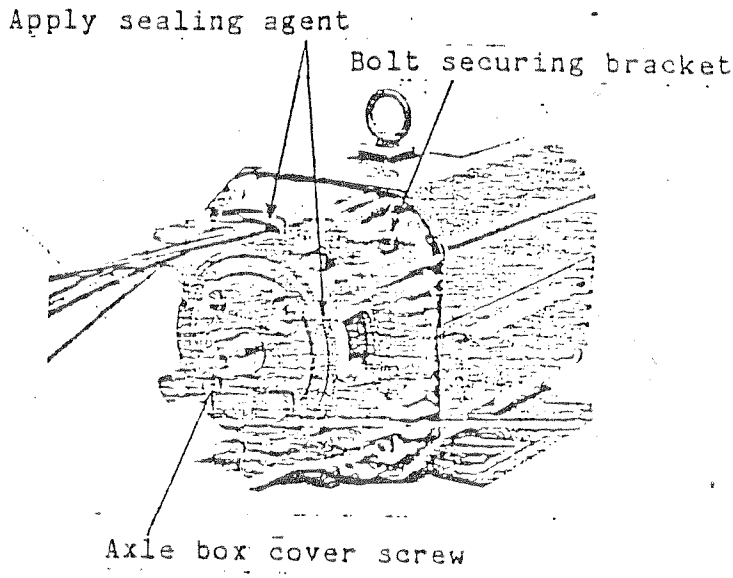
7. The detection gear is removed by screwing the eyebolt into the screw (M8) hole, drawing it out with a removal tool and then rotating the bolt using a wrench or similar tool.



8. When re-assembling the detection gear, insert it into the axle at a shrink-fit temperature within 100-150 deg.C, taking care not to wrench it into place.
An excessively high shrink-fit temperature will cause distortion in the detection gear.

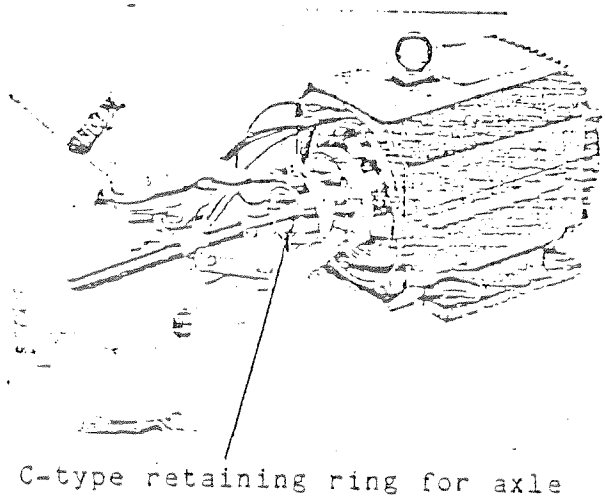
[4] Bearings

1. The non-load side bracket can be removed once the screws securing the axle box cover and the hexagon socket-head bolts securing the bracket are all removed.

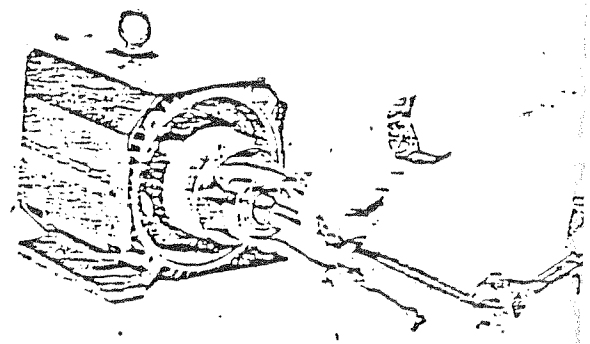


2. When re-assembling the non-load side bracket, apply a sealing agent to the interlocking surface.

3. The non-load side bearing is removed by first removing the C-type retaining ring for the axle, using a bearing removal tool to

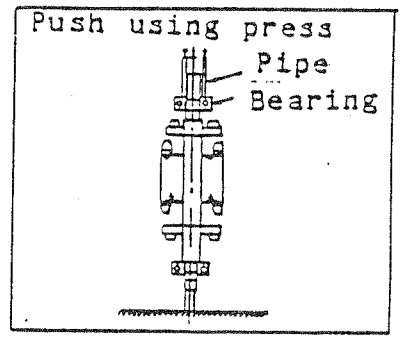


remove the bearing along with the axle box cover and by rotating the bolts with a wrench.



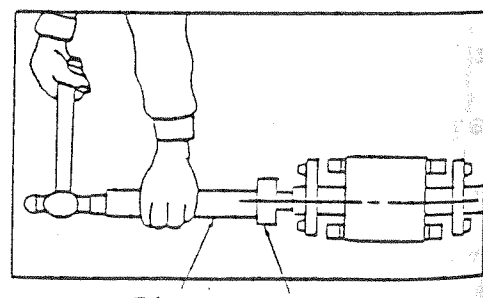
4. Remove the load-side bearing by applying the pawl of the removal tool to its inner ring and rotating the handle.

5. When fitting the bearing into the axle, wipe clean the part of the bearing which interlocks to remove marks and projections.



Mounting the bearing using a pr

6. Apply oil to the inner diameter of the bearing and interlocking surface of the axle, interlock the bearing at right angles, place a suitable appropriate pipe on the inner ring and insert gently under pressure using a press.



Pipe Bearing

Mounting the bearing using a ha

7. If a press is unavailable, tap gently into place. Take care not to force the bearing into position or to bring the pipe into contact with the outer ring area.

CHAPTER 9 PARTS LIST

AC SPINDLE CONTROLLER & MOTOR (TYPE. FR-SE-2)

NOTE: Option spare parts A-----Maintenance spare parts for every two years.
Option spare parts B-----Maintenance spare parts for every five years.
Option spare parts C-----Maintenance spare parts for machine maker's stock.

ITEM	DESCRIPTION	TYPE KW	TYPE		MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
1	CIRCUIT BREAKER	5.5	NF 50CB 3P	40A05	MITSUBISHI ELECTRIC	CB1	1	0	0	0	1	
		7.5										
		11		50A05								
		15	NF100CB 3P	75A05								
		18.5		100A05								
		22										
2	TRAN-SISTOR	5.5	QM75DY-H		MITSUBISHI ELECTRIC	TRR TRS TRT	3	0	0	0	3	FOR CONVERTER
		7.5										
		11	QM100DY-H									
		15	QM150DY-H									
		18.5										
		22	QM75DY-H				9	0	0	0	9	
3	TRAN-SISTOR	5.5	QM75DY-H		MITSUBISHI ELECTRIC	TRU TRV TRW	3	0	0	0	3	FOR INVERTER
		7.5	QM100DY-H									
		11	QM150DY-H									
		15										
		18.5	QM100DY-H									
		22	QM150DY-H				6	0	0	0	6	
4	DIODE STACK	5.5	RM30TA-H		MITSUBISHI ELECTRIC	D1	1	0	0	0	1	FOR CONVERTER
		7.5										
		11	PT758		NIHON INTER							
		15	RM60DZ-H		MITSUBISHI ELECTRIC	D1-1 D1-2 D1-3	3	0	0	0	3	
		18.5										
		22	RM100DZ-H									

ITEM	DESCRIP-TION	KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
5	CAPACT-TOR	5.5	3200UFX 350V BKO-NC 1043-H05	NITSUKO	C1-1 C1-2 C1-3 C1-4 C1-5	2	0	0	2	2	
		7.5									
		11				3	0	0	3	3	
		15				4	0	0	4	4	
		18.5									
		22				5	0	0	5	5	
6	CONTAC-TOR	5.5	SK50 AC200V	MITSUBISHI ELECTRIC	MC1	1	0	0	0	1	
		7.5									
		11									
		15									
		18.5	SK65- AC200V								
		22									
7	FAN	5.5	N3951ML	TOOBISHI	FAN1 FAN2	2	0	2	0	2	
		7.5									
		11									
		15									
		18.5	HS4556ML								
		22									
8	AC REACTOR	5.5	BKO-NC6 NC6132- H02	CHUO DENKI	ACL	1	0	0	0	1	
		7.5	H03								
		11	H04								
		15	H05								
		18.5	H06								
		22	H07								
9	CAPACT-TOR	5.5	MEUZ105 600A BKO- NA1061-05	SIZUKI DENKI	C2 C3	6	0	0	6	6	FOR CONVER, INVERT
		7.5									
		11			C2	3	0	0	3	3	
10	SURGE KILLER	11	BKO-C1916 H02	SIZUKI DENKI	C3	3	0	0	0	3	FOR INVERT
		15									
		18.5				6	0	0	0	6	
		22									
11	SURGE KILLER	15	BKO-C1916 H01	SIZUKI DENKI	C2	3	0	0	0	3	FOR CONVER
		18.5									
		22				6	0	0	0	6	

ITEM	DESCRIPTION	TYPE KW	TYPE		MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
12	RESISTOR	5.5	BKO-NC1072-	H02	MICRON	R1 R2 R3	3	0	0	0	3	
		7.5		H03								
		11		H04								
		15		H05								
		8.5		H06								
		22		H07								
13	RESISTOR	5.5	MFS30A 802K		MICRON	R0	1	0	0	0	1	
		7.5										
		11				R0-1 R0-2	2	0	0	0	2	
		15										
		18.5										
		22										
14	RELAY	—	G4J3342J DC24V		OMRON	RA1 RA2	2	0	0	0	2	
15	THERMAL DETECTOR	—	OHD- 60B		TOOKIN	THS1	1	0	0	0	1	
16	THERMAL DETECTOR	—	OHD-100B		TOOKIN	THS2	1	0	0	0	1	
17	CT	5.5	BKO-NC6131-	H02		CT1 CT2 CT3 CT4	4	0	0	0	4	
		7.5		H03								
		11		H04								
		15		H05								
		18.5		H06								
		22		H07								
18	TERMINAL	5.5	TE-K14-3		MITSUBISHI ELECTRIC	TB3	1	0	0	0	1	
		7.5										
		11	TE-K22B-3									
		15										
		18.5	TE-K60B-3									
		22										
19	TERMINAL	—	TE-K2-3		MITSUBISHI ELECTRIC	TB4 TB11	2	0	0	0	2	
20	FILTER	—	BKO-NC6143 H01		SIZUKI DENKI	FIL1	1	0	0	1	1	

ITEM	DESCRIPTION	KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND	OPTION A	OPTION B	OPTION C	NOTE
21	FUSE	—	MF60NR-6A-S	TOYO	SE-FW	3	3	0	0	3	
22	PRINTED CIRCUIT BOARD	—	REO-NC6135	YAMABISHI	SE-IO1	1	0	0	0	1	
23	PRINTED CIRCUIT BOARD	—	SE-IO1	MITSUBISHI ELECTRIC		1	0	0	0	1	
24	PULSE SIGNAL GENERATOR	—	TS1860N2	TAMAGAWA DENKI		1	0	0	1	1	FOR MOT
25	FAN	5.5 7.5 11 15 18.5	IA-15101	UNION SEIKO		1	0	0	1	0	FOR MO
		22	-	ASAMATSU ELECTRIC							
26	BEARING (LOAD SIDE)	5.5 7.5	6307M2ZZCS19	TOYO BEARING		1	0	0	0	1	FOR MO
		11 15 18.5	6310M2ZZCS22								
		22	6312M2ZZCS16								
27	BEARING (OPPOSITE SIDE)	5.5 7.5	6306M2ZZCS16	TOYO BEARING		1	0	0	1	1	FOR MO
		11 15 18.5 22	6308M2ZZCS19								
28	MAGNETIC SENSOR ORIENT P.C.B		SE-CPU1	MITSUBISHI ELECTRIC		1	0	0	0	1	
29	ENCODER ORIENT P.C.B		SE-CPU2	MITSUBISHI ELECTRIC		1	0	0	0	1	