BCN-21735-S5A

SPINDLE DRIVE CONTROLLER

TYPE FR-SX

MAINTENANCE MANUAL

New publication effective February 1992
Translated from Japanese manual BCN-21735-S4A

MITSUBISHI ELECTRIC

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CHAPTER 1GENERAL

1.1 Purpose of the Service Manual

FR-SX Series is a line of AC spindle motor speed control units (inverter) of regenerative braking type.

This Service Manual mainly describes periodic maintenanca and troubieshooting practices that are very important for trouble-free, long use of your FR-SX.

Please read this Service Manual carefully until you make yourself familiar with the servicing practices of the unit.

1 2 Safety precautions and servicing personnel

The following cautions are very important to assure safety in maintenanca work.

- The unit should be started, maintained and checked by qualified person. It is very hazardous that a person having no electrical knowledge handles the unit.
- Before the unit under live condition is handled, remove finger ring, wrist watch. tiepin and other metallic objects from the body.
- It should be born in mind that electric shock might result in death.

  Care should be taken to the fact that some parts of the unit are at high voltage no matter whether the power source itself is ground or not.

  When any testing apparatus is applied to the unit, the testing person should not touch any grounded metallic part. Since test apparatus or equipment is usually not grounded and test apparatus is at high voltage against the ground, care should be taken not to touch a grounded part when the unit are operated at adjustment or remedy.
- Do nut wear loose cloths that might be involved in rotating or movable parts when gaining access to rotating or moving parts of unit
- Do not remove or install a card while the unit is fed with power supply or operated. Otherwise the unit may be seriously damaged.
- Do not touch the unit immediately after the power is turned off, but wait for at least one minute (time necessary for complete discharging of capacitors) before starting maintenance.

1-3 Storing

When the unit is not immediately installed and used, store it in a clean, dry place at moderate temperature using car8 not to allow entering of moisture and dust in the unit

Moisture or dust involved in the unit may cause deterioration of insulation.

When the unit is left out of use for any length of time, keep the unit in the same conditions as it is in operation. It is recommended, depending on the condition in the storing place, to use a space heater.

CHAPTER 2 SPECIFICATIONS

2.1 AC spindle motor

(1) Standard specification (I)

Output capacity	Continuous rating (kW)	3.7	5.5	7.5	11	15	18.5
	30 min. 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			
	Max. speed (RPM)	6000 Note 1		4500			
Frame No.		All2	B112	8132		C132	A160
Rated torque (cont.) (kg-m)		2.4	3.57	4.87	7.15	9.74	12.0
GD² (kg.m²)		0.07	0.093	0.2	0.25	0.35	0.5
Weight (kg)		65	75	100	115	130	190
Permissible radial load (kg)		150	200	300			
Cooling fan (W)		35					
Vibration		V10					
Noise (dB) (A)		72				77	
Installation		Output shaft: Horizontal or downward					
Overload capacity		120% of 30 min. rating, for one minute					
Ambient temperature (°C)		0 ~ 40					
Insulation class		F					
Paint color		Munsell N5.5					
Accessories		Pulse generator, overheat detector					
Standard applied		JIS-C4004					
Controller model FR-SX-2-		5.5K	7.5K	11K	15K	18.5K	22K
Power source requirement (kVA)		9	12	17	23	29	
Power source voltage and frequency		200/200~230V±10%, 50/60Hz±3%					

Note 1: For speed larger than 4,500 rpm, the output (capacity) is reduced to the value calculated with the following formula:

$$\text{Rated output} \times \frac{4500}{\text{Speed RPM}}$$

Nate 2: When power source other than specified above is used, a suitable transformer should be used.

(2) Standard specification (II)

When the Standard Specification (I) is not applicable because speed reduction ratio that meets 1,500 rpm base speed is not available, this Standard Specification (II) may be adapted.

Output capacity	Continuous rating (kW)	3.7	5.5	7.5	11	15	18.5
	30 min. 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)	1150					
	Max. speed (RPM)	4600					
Frame No.		B112	B132		C132	A160	B160
Rated torque (cont.) (kg-m)		3.13	4.66	6.35	9.32	12.7	15.7
GD² (kg.m²)		0.093	03	0.25	0.35	0.5	0.83
Weight (kg)		75	100	115	130	190	245
Permissible radial load (kg)		200	300				
Cooling fan (W)		35					
Vibration		V10					
Noise (dB) (A)		72			77		
Installation		Output shaft: horizontal or downward					
Overload capacity		120% of 30 min. raring, for one minute					
Ambient temperature (°C)		0 ~ 40					
Insulation class		F					
Paint color		Munsell N5.5					
Accessories		Pulse generator, overheat detector					
Controller model FR-SX-2-		5.5K	7.5K	11K	15K	18.5K	22K
Power source requirement (kVA)		9	12		17	23	28
Power source voltage and frequency		200/200~230V±10%, 50/60Hz±3%					

2.2 AC spindle controller

(1) Specification

Model FR-SX-2-		5.5K	7.5K	11K	15K	18.5K	22K
Output capacity (kW)		5.5	7.5	11	15	18.5	22
50% ED output	Output current (A)	43	55	74	100	125	148
	Power requirement (kVA)	9	12	17	23	28	33
Cont. rating output	Heat value (W)	340	400	490	590	700	810
Weight (kg)		42		55		73	
Main circuit		Transistor sine-wave PWM inverter					
Control circuit		Speed feedback control with pulse generator, digital closed-loop control, optimized F-V pattern control					
Braking method		Power regenerative braking					
Speed control range		35 ~ 6000 RPM					
Speed regulation		Less than 02% of maximum speed (with load changing within a range from 10% to 100%)					
Speed command		Digital command, binary 12 bits or BCD 2 digits Note Analog command, +10V Max. (Input impedance: approx. 10 Kohms)					
Acceleration/ deceleration method		Slip control acceleration/deceleration (Time limit accel./decel.: 0.5 ~ 10 sec.)					
Ambient temperature/ humidity		–5 ~ 50°C/Less than 85%					
Environmental condition		To be free from detrimental gas and dust (To conform with JEM1103, Grade "C")					
Vibration		Less than 0.5G					
Standard applied		IEC					
Cooling		Fan					

Now: Incorporated DIP switch is used to select digital speed command between "binary 12 bits' and "BCD 2 digits" and external signal is used to select analog speed command.

(2) Protective functions

Name	Function	Description
OVER HEAT (MOTOR)	Overload/overheat protection	When motor is overloaded, or overheats due to standstill of fan motor, the base and gate are shut off.
EXCESSIVE SPEED ERROR	Prevention of too large speed control error	If commanded speed differs From actually running speed to a degree larger than specified tolerance, the base and gate are shut off.
BREAKER TRIP	Short-circulating protection Grounding protection	If large current flows in the main circuit, the base and gate are shut off.
PHASE LOSS	Preventing of single-phase operation	If any phase of power source is disconnested at the time the power is turned on, the base and gate are shut off.
EXTERNAL EMERGENCY	Emergency stop with external signal	With emergency stop signal given by external device, motor is stopped and the base is shutoff.
OVER SPEED	Overspeed protection	If motor speed exceeds 115% of the maximum speed, the base and gate are shut off.
IOC TRIP (CONVERTER)	Instantaneous overcurrent protection	If overcurrent flows in the converter, the base and gate are shut off.
OVER HEAT (CONTROLLER)	Main circuit overload protection	If main circuit semiconductor overheats due to overload or standstill of fan, the base and gate are shut off.
UNDER VOLTAGE	Main circuit source voltage drop protection	If the source voltage drops below the specified level, the base and gate are shut off.
OVER VOLTAGE (REGENERATION)	Main circuit over-voltage protection	If regenerative voltage at main circuit capacitor exceeds the specified level, the base and gate are shut off.
IOC TRIP (INVERTER)	Instantaneous overcurrent protection	If overcurrent flows in the invener, the base and gate are shut off.

Note: If any protective means (except for EXTERNAL EMERGENCY) works, the base (inverter) and gate (converter) are shut off and the motor stops after inertia running.

(3) Auxiliary functions

Name of function	Application	Description	Output
LOAD METER SIGNAL	Connected to load meter	An one-way swing DC1mA meter is connected. Full scale corresponds to 150% load (adjustable within a range from 100% to 150%).	
SPEED METER SIGNAL	Connected to speed meter	An one-way swing DC1mA meter is connected. Full scale corresponds to the maximum speed.	
ZERO SPEED SIGNAL	Machine interlock	Signal for contacts that close when motor speed decreases below 50 or 20±10rpm.	Contacts open emitter
THESHOLD SPEED SINGAL	Response to NC	Output transistor turns on with this signal when speed reaches within a range of ±15% of preset speed	Open emitter
LOAD DETECT SIGNAL (CURRENT)	For prevention of plunging of cutter	The output transistor turns on with this signal when siippage exceeds the specified vaiue (110%) near the limit value (120% output).	Open emitter
OVERRIDE	For override in automatic operation	Override setting range: 50 ~ 120% Override can be reset by opening controller terminal DEF.	
SPINDLE ORIENT (Optional function)	Indexing of spindle	Magnetic sensor type single-point indexing and encoder type multi-point indexing are possible. With orientation start signals (ORCM1, ORCM2), start command signal, complexion signal and orientation completion signal are output	Contacts Open
TORQUE LIMIT	For gear shifting, etc.	When gearing is shifted, spindle motor is fun with a temporarily reduced torque. This function is used when torque is limited.	Open emitter

2.3 Controller unit composition

The AC spindle motor controller consists of the following 7 sections.

(1) Front panel (name plate)

(2) SX-C?U (1, 2) cards

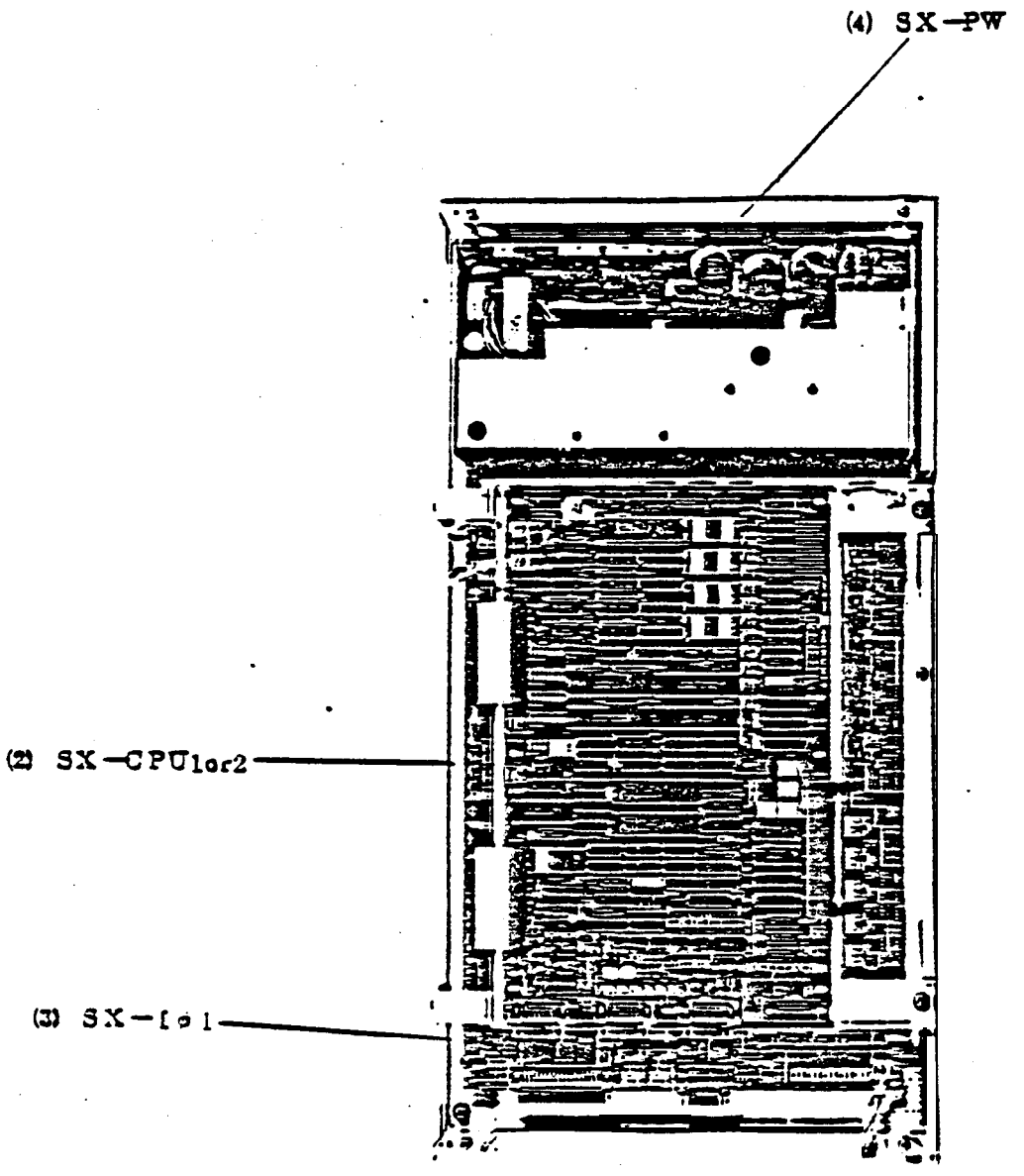
(3) SX-I01 card

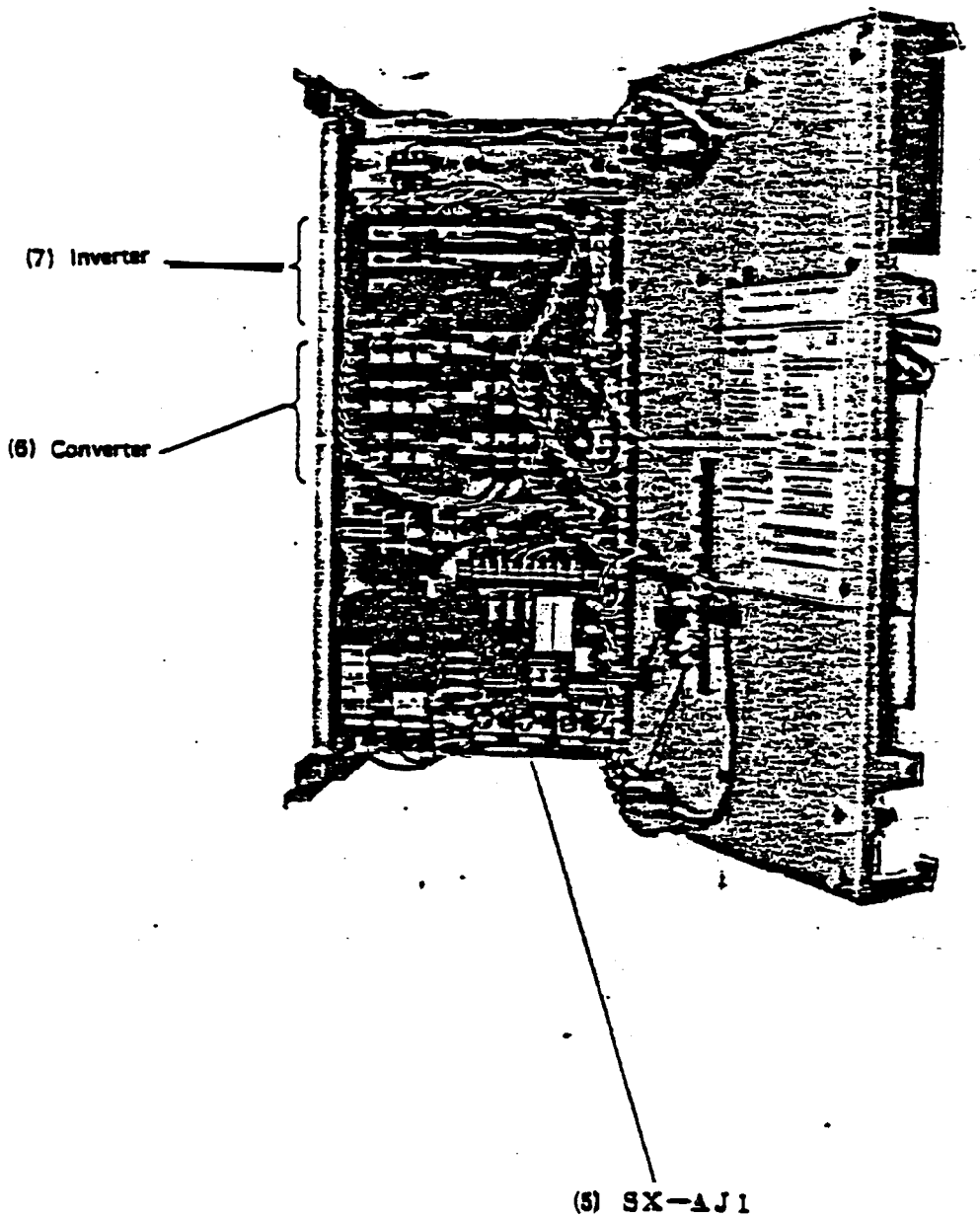
(4) SX-PW card

(5) SX-AJ1card

(6) Converter

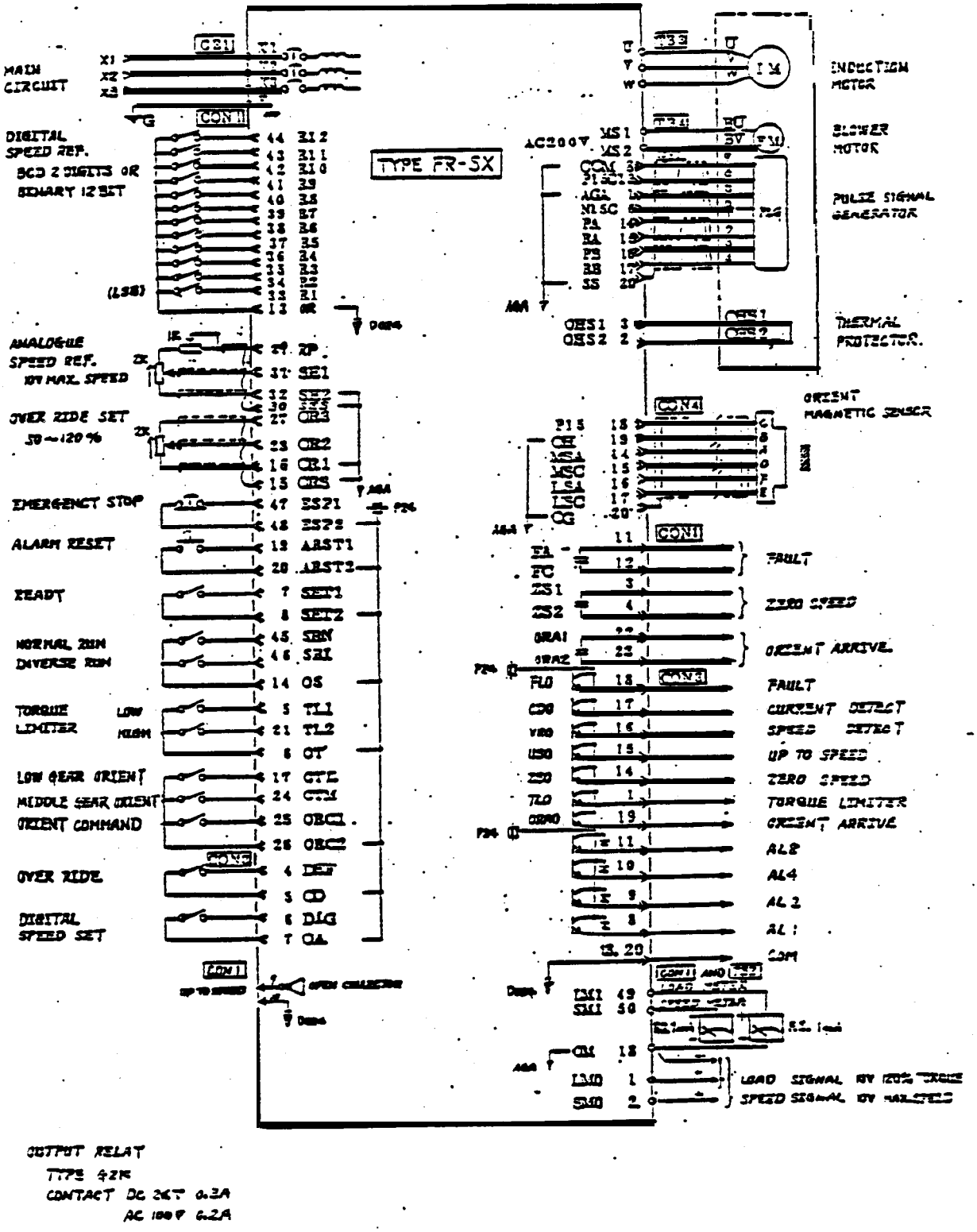
(7) Inverter



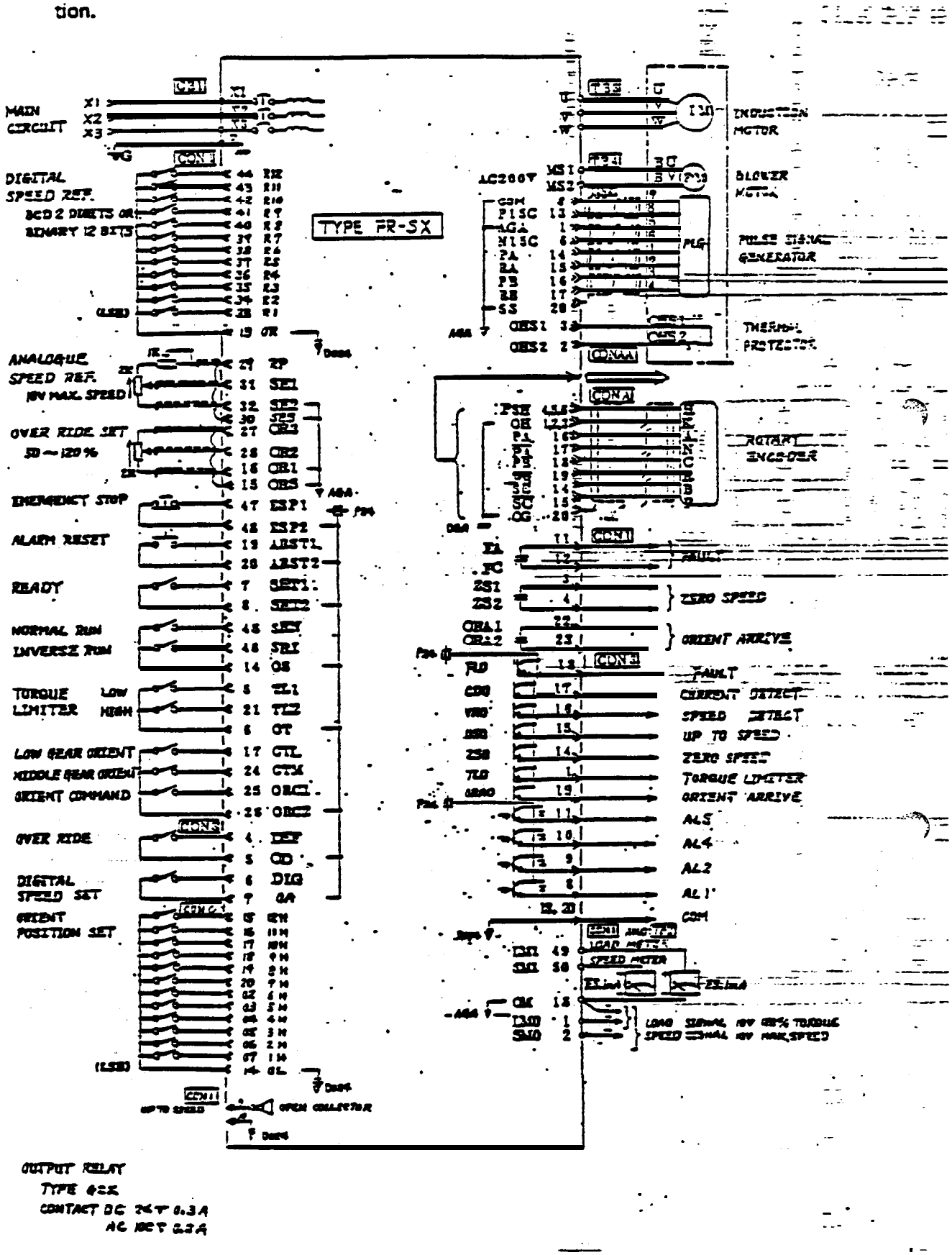

(7) Inverter
(6) Converter
(5) SX-AJ1

2.4 External wiring

(1) AC spindle motor controller equipped with magnetic sensor type signale-point orientation function.

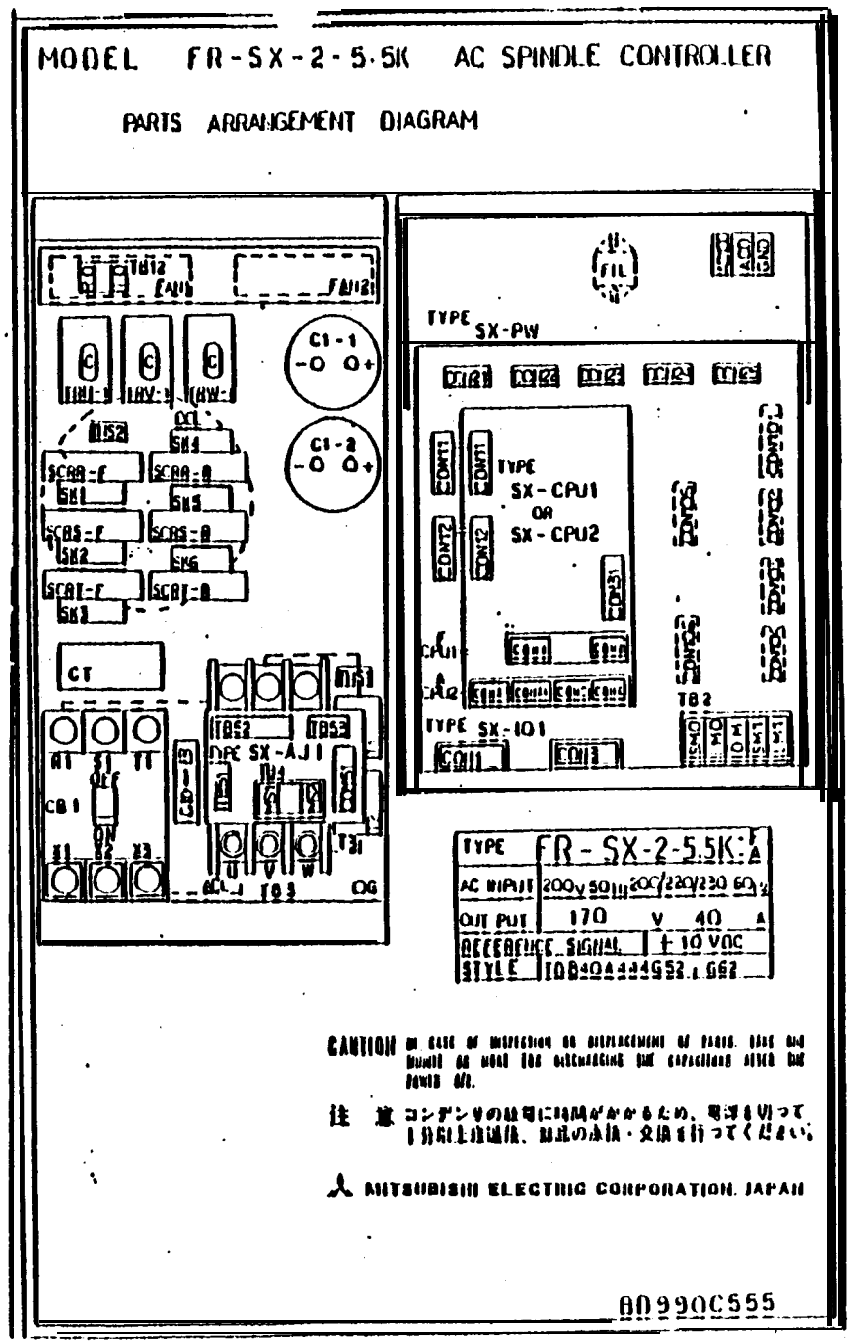


(2) AC spindle motor controller equipped with encoder type multi-point orientation function.



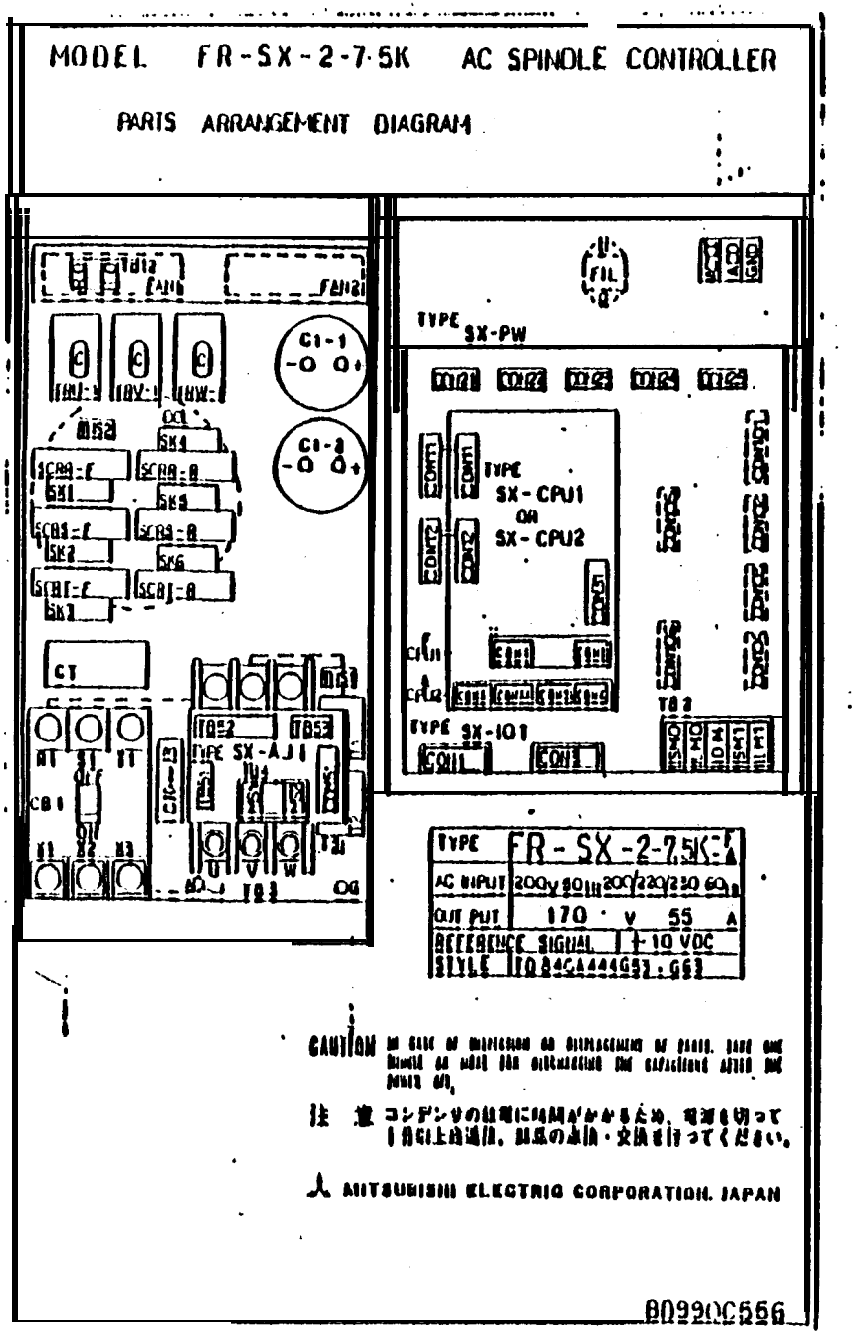
MODEL FR-SX-2-5.5K AC SPINDLE CONTROLLER

PARTS ARRANGEMENT DIAGRAM



MODEL FR-SX-2-7.5K AC SPINDLE CONTROLLER

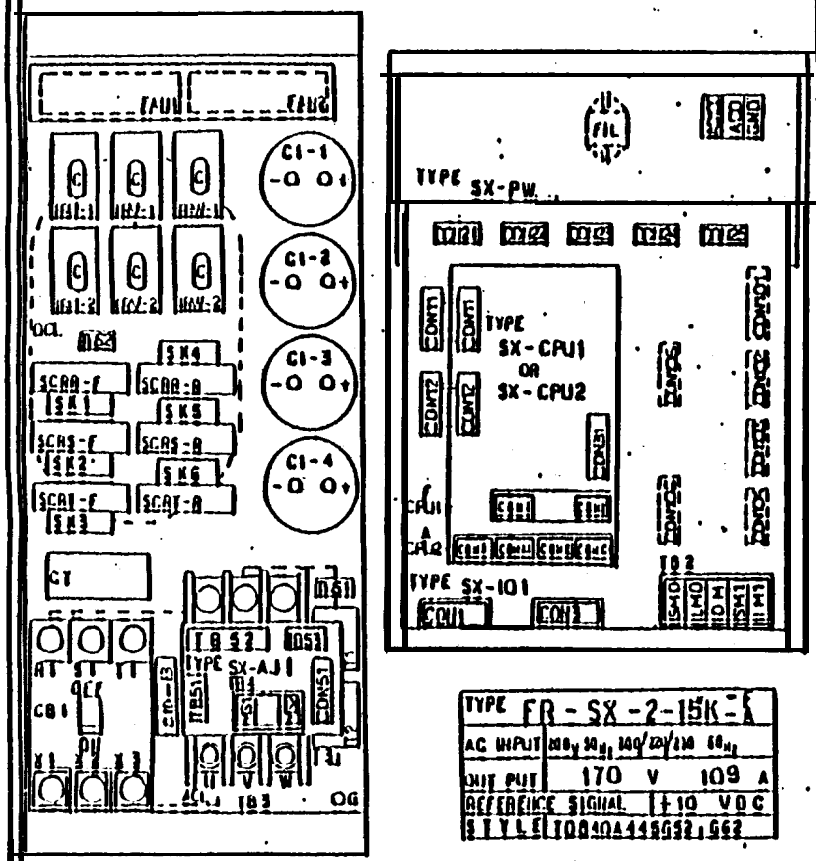
PARTS ARRANGEMENT DIAGRAM



BCN-21735-S5 N/12

MODEL FR-SX-2-15K AC SPINDLE CONTROLLER

PARTS ARRANGEMENT DIAGRAM



TYPE	FR-SX-2-15K-A		
AC INPUT	200V 50Hz 200/220/230V 60Hz		
OUTPUT	170	V	109 A
REFERENCE SIGNAL	±10	VDC	
STYLE	100A1445G52, G62		

CAUTION IN CASE OF INSPECTION OR REPLACEMENT OF PARTS, TAKE ONE HOUR OR MORE FOR DISCHARGING THE CAPACITORS AFTER THE POWER OFF.

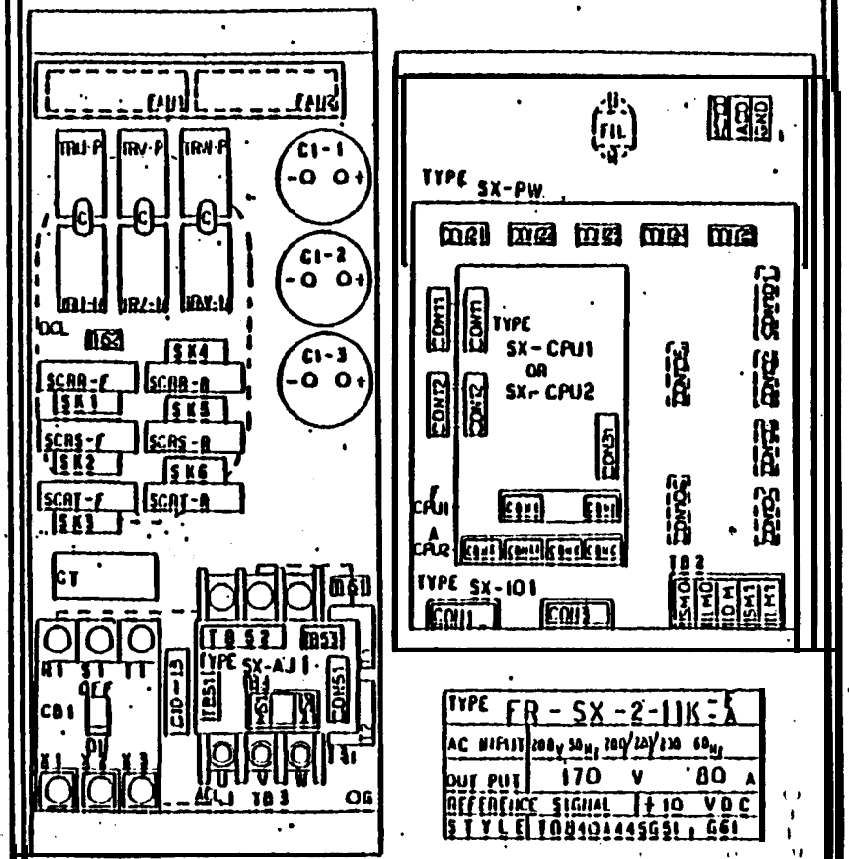
注 意 コンデンサの放電には時間がかかるため、電源を切って1時間以上経過後、部品の点検・交換を行ってください。

MITSUBISHI ELECTRIC CORPORATION. JAPAN

80990C558

MODEL FR-SX-2-11K AC SPINDLE CONTROLLER

PARTS ARRANGEMENT DIAGRAM



TYPE	FR-SX-2-11K-A		
AC INPUT	200V 50Hz 200/220/230V 60Hz		
OUTPUT	170	V	80 A
REFERENCE SIGNAL	±10	VDC	
STYLE	100A1445G51, G61		

CAUTION IN CASE OF INSPECTION OR REPLACEMENT OF PARTS, TAKE ONE HOUR OR MORE FOR DISCHARGING THE CAPACITORS AFTER THE POWER OFF.

注 意 コンデンサの放電には時間がかかるため、電源を切って1時間以上経過後、部品の点検・交換を行ってください。

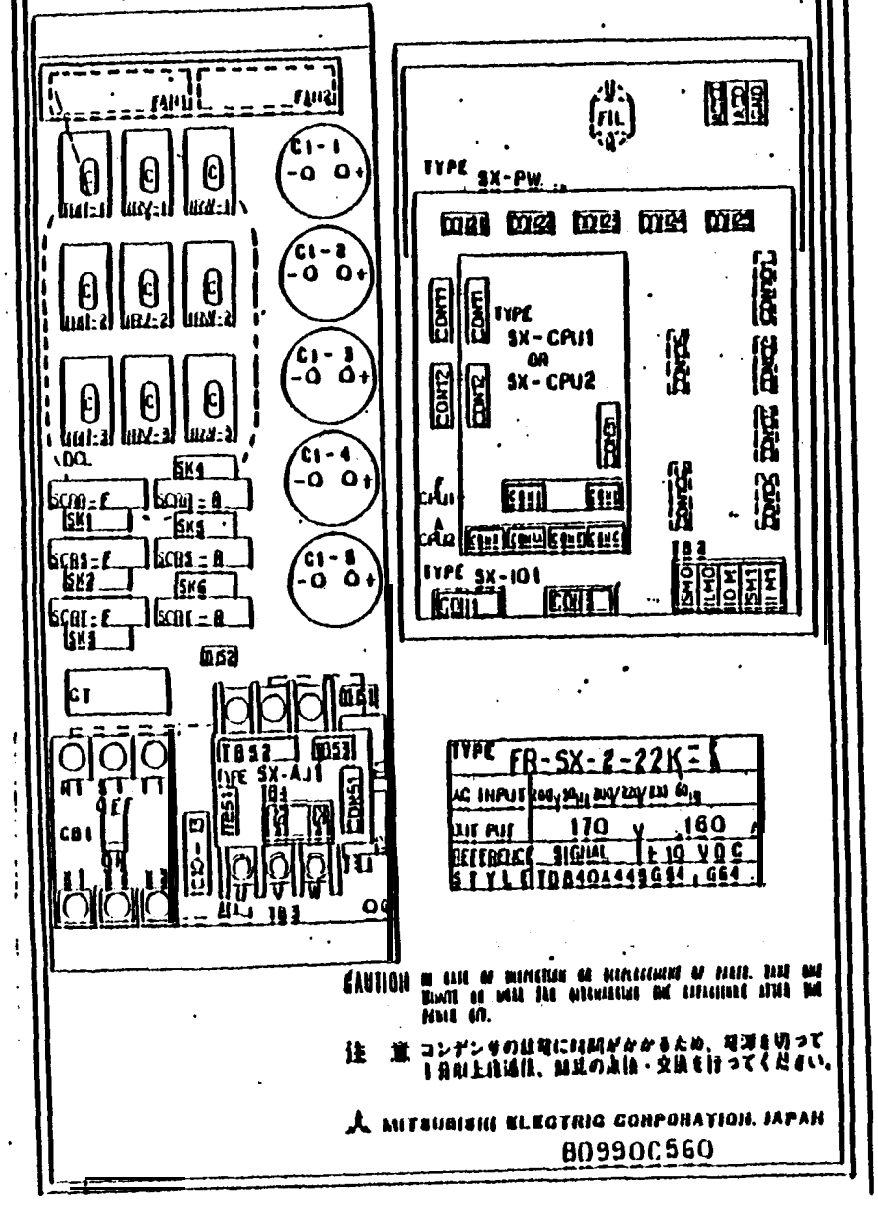
MITSUBISHI ELECTRIC CORPORATION. JAPAN

80990C557

BCP-21735-S5 N/13

MODEL FR-SX-2-22K AC SPINDLE CONTROLLER

PARTS ARRANGEMENT DIAGRAM



CAUTION IN CASE OF INSPECTION OR REPLACEMENT OF PARTS, TURN ONE MINUTE OR MORE FOR DISCHARGING OF CAPACITANCE AFTER THE POWER OFF.

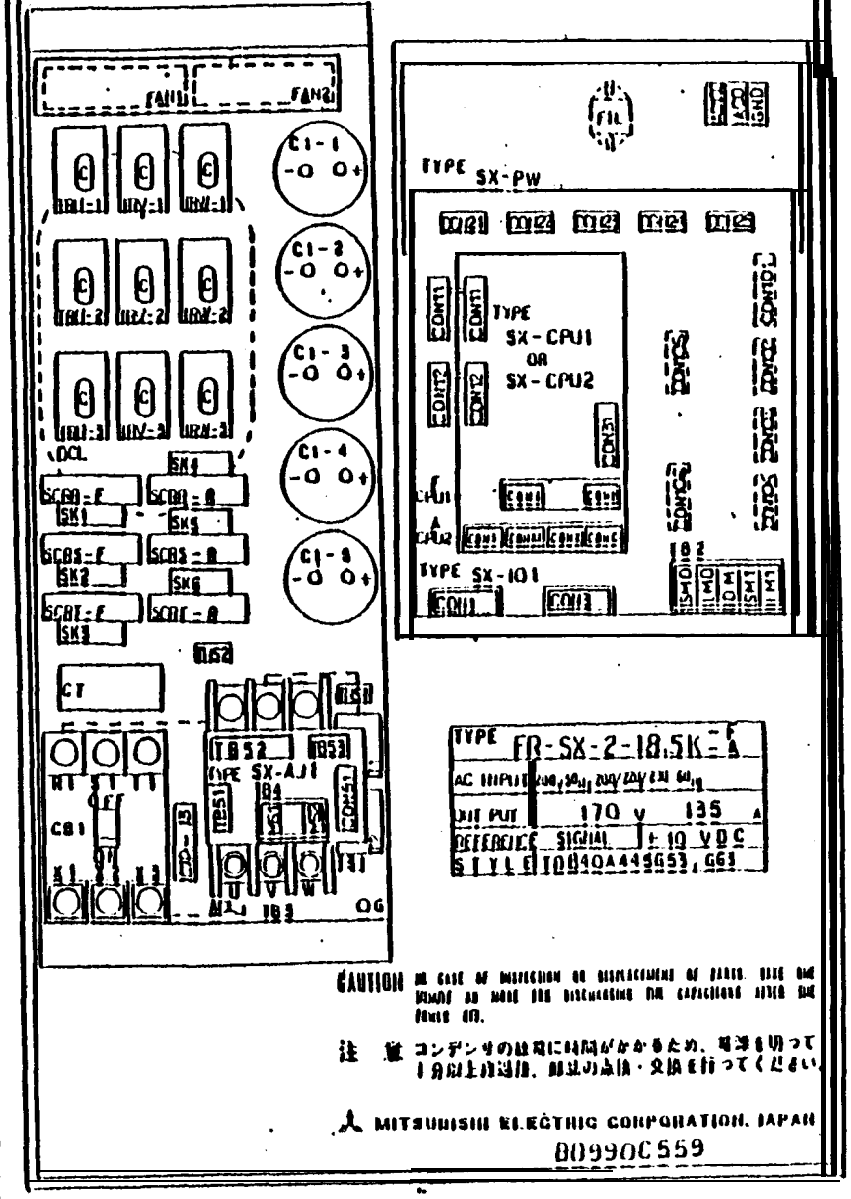
注 意 コンデンサの放電に時間がかかるため、電源を切って1分以上経過後、部品の点検・交換を行ってください。

MITSUBISHI ELECTRIC CORPORATION, JAPAN

809900560

MODEL FR-SX-2-18.5K AC SPINDLE CONTROLLER

PARTS ARRANGEMENT DIAGRAM



CAUTION IN CASE OF INSPECTION OR REPLACEMENT OF PARTS, TURN ONE MINUTE OR MORE FOR DISCHARGING OF CAPACITANCE AFTER THE POWER OFF.

注 意 コンデンサの放電に時間がかかるため、電源を切って1分以上経過後、部品の点検・交換を行ってください。

MITSUBISHI ELECTRIC CORPORATION, JAPAN

809900559

CHAPTER 3 OPERATION AND SETTING UP

3.1 Preparation for operation

When the AC spindle motor controller is fed with the power source for the first time, the following checking should be made.

(1) Has external wiring been completed in accordance with the wiring diagram?

(2) Are the motor and controller unit properly grounded?

(3) Are shielding wire ends properly connected?

- They should be connected to shielding terminals.
- They should be connected without looping.

(4) Are ail components not damaged, and securely installed?

(5) Is any foreign matter such as wire chip involved in the unit?

(6) Does each card present good appearance?

(7) Does ROM No. conform with the order sheet?

Do DIP switch settings conform with the order sheet?

3.2 Turning on the power

When the checking has bean completed, feed the controller unit with the power source as follows:

(1) Turn on the power.

(2) Make sure no alarm indication LED (LED12, 13, 14 and 15) on the controller front panel does not light

(3) Make sure status indication LEDs (LED2 "READY" and LED10 "ZERO SPEED") light.

Now the controller is ready for operation.

Although the power cable can be connected to the controller without noting the phase connection. phase sequence can be checked through LED1"PHASE SEQUENCE". 'LED1 lights when the power cable is connected in correct phase sequence.

3.3 Ad justment

(1) Speed meter calibration VR1 and load-meter calibration VR2

When speed meter it connected to the spindle inverter, turn and set the V R 1 so that the speed meter reads the maximum speed with DIP witches SW1–3 set at OFF.

Also adjust the load meter to 120% by setting the V R2.

When the two variable resistors have been set, set SW1~S to ON and set the RESET switch (ST1) to ON.

Since other variable resistors have been factory-adjusted, do not disturb these settings.

(2) DIP switches and setting pins

> Check that DIP switches and setting pins are set properly as specified in the other sheet.
> If not, correct setting.
> When setting is changed, be sure to operate the RESET switch (ST1) to ON.

When spindle indexing (stop) position must be changed, change the settings of DIP switches and setting pins for individual machine.

For setting procedure, refer to para. 3.5.

3 4 Startup operation (accommodation)

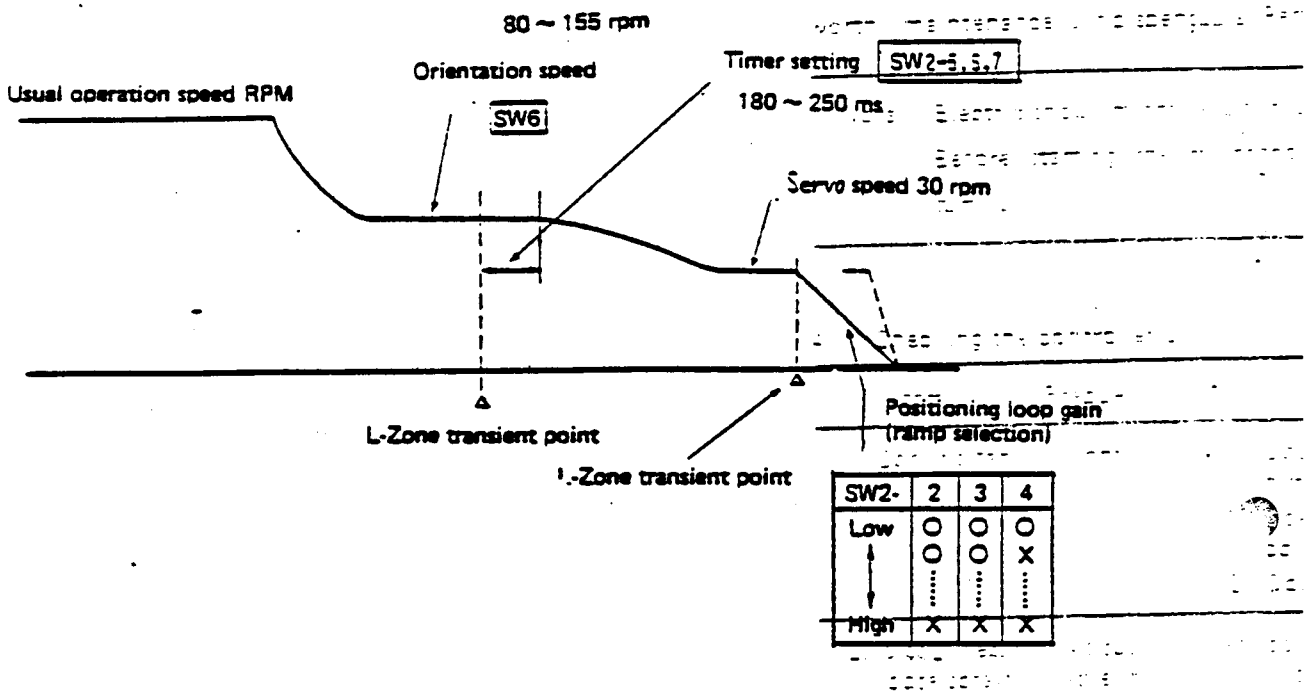
Connect the motor shaft with the machine shaft and start operation to check the controller unit for condition.

Then exert load on the motor and check the following items:

- Unusual sound
- Unusual odor
- Bearing temperature

3.5 Spindle orientation adjustment procedure

(1) Magnetic sensor type spindle orientation



SW2-	2	3	4
Low	O	O	O
↕	O	O	X
High	X	X	X

The speed change pattern at spindle orientation (indexing) is as illustrated above.

When the spindle stops running over the previously determined stop position (indexing position) .....

- Shorten setting of timer (SW2-5, 6, 7).
- Increase positioning loop gain (SW-2, 3, 4).
- Decrease orientation speed.

When shorter orientation time is desired .....

- Prolong setting of timer (SW2-5, 6, 7).
- Increase positioning loop gain (SW2-2,3, 4).
- Increase orientation speed.

When hunting occurs at spindle stop .....

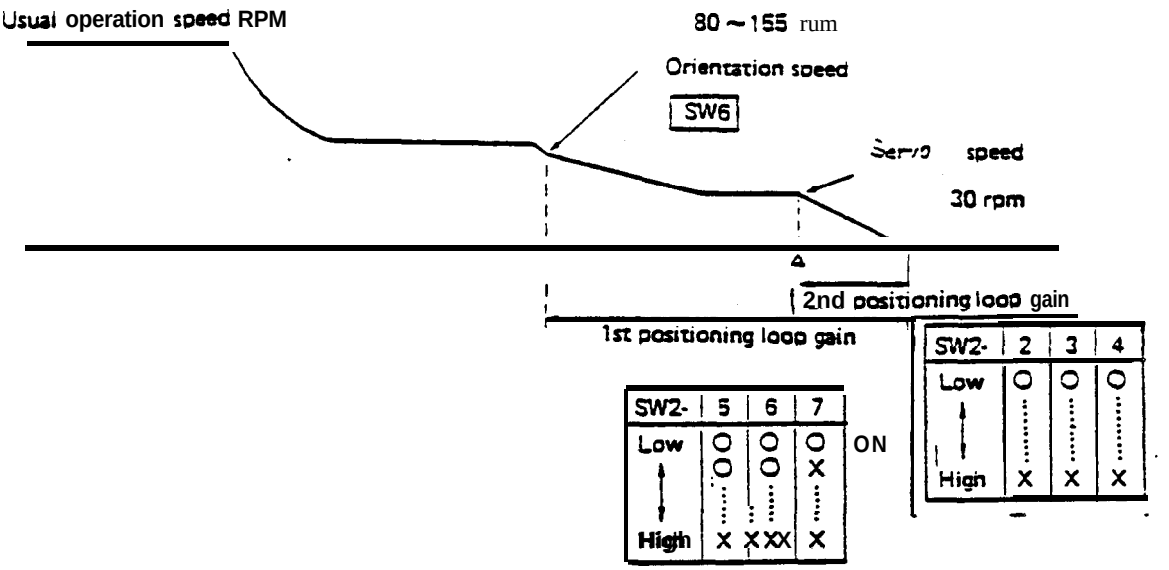
- Decrease positioning loop gain (SW2-2, 3, 4).
- Decrease sensitivity of magnetic sensor (VR4).

Stop position can be adjusted by VR5.

Notes: (1) The data of gearing ratio stored in the ROM should meet the gearing ratio in use.

(2) Adjustment may vary depending on gearing ratio.

(2) Encoder type spindle orientation



The speed change pattern a spindle stop is as illustrated above.

When the spindle stops running over the predetermined stop position (indexing posi-don).....

- Decrease 1st positioning loop gain.
- Decrease orientation speed.
- Decrease 2nd positioning loop gain.

When shorter orientation time is desired.. ...

- Increase 1st positioning loop gain.
- Increase orientation speed.
- Increase 2nd positioning loop gain.

When hunting occurs at spindle stop .....

- Decrease 2nd positioning loop gain.

Stop position can be adjusted by operating SW8, 9 and 10.

Notes: (1) The data of gearing ratio stored in the ROM should meet the gearing ratio in use.
(2) Adjustment may vary depending on gearing ratio.

CHAPTER 4 PERIODIC MAINTENANCE

In order to assure the full performance and trouble-free, long use of the controller unit, trustworthy maintenance is indispensable. Perform the periodic maintenance as instructed below.

> Note: Electric shock might result in death.
> Before starting the maintenance, do not faii to make sure all power sources are turned off.

4.1 Checking the controller unit

Item	Frequency	Checkup	Remedy
1. Cooling fan	Monthly	(1) Does the fan rotate smoothly when turned by hand? (2) Does the fan rotate powerfully when the power is given? (3) Does unusual sound occur in bearing?	Replace defective fan.
2 Cleanliness, loose screw	At suitabie interval	Periodically clean each part and retighten input/output terminal screws and other screws. .	
3. Miniature relay	Every 3 months	(1) Is contact not worn out? (2) Can miniature relay let work contactor in the main circuit?	Replace defective relay.
4. Wiring	At suitable interval	Is any conductor in contact with the casing (this may occur when wire is pinched by hinges)?	

4.2 Checking the motor

Item	Frequency	Checkup	Remedy
1. Noise, vibration	Monthly	o Does unusual sound or vibration occur? If u-l sound or vibration occurs, perform the following checking: (1) Check the foundation and installation. (2) Check alignment of shafts. (3) Check if vibration is transmitted from the machine connected with the motor. (4) Check bearings for condition (if noise is caused by bearing),. (5) Check if large noise or intense vibration is caused by speed reduction gears or drive belt (6) Check the controller unit for condition_ (7) Check the cooling fan for condition. (8) Check belt tension.	

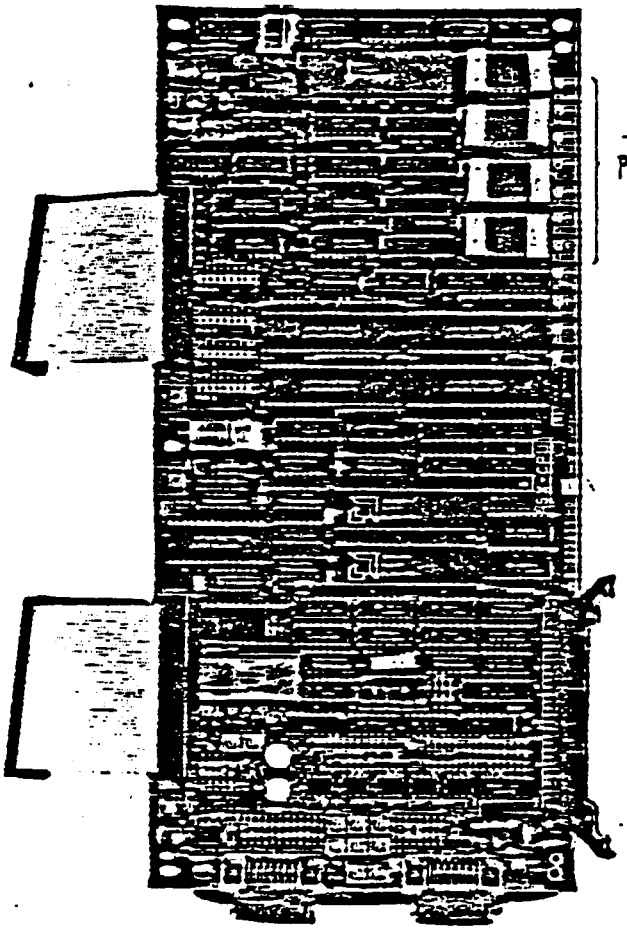
Item	Frequency	Checkup	Remedy
2. Temperature rise	Monthly	○ Is bearing temoerature not too high? (Usual bearing temoerature: +10 – 40°C) ○ Is motor frame temoerature not too high? (1) Check tnat the cooiing fan runs in good condition. (2) Check if cooiing air passage (space between the motor fame and the cover) is clogged with foreign matter. (3) Check if load is excessively large. (4) Check the controller unit for condition.	Clean. Refer to 'Trouble shooting".
3. Insulation resistance	Every 6 months	0 Is insulation resistance not too small? – To check insulation resistance, disconnect the motor from the controller unit and measure resistance between the entire circuit and the ground using a mager. (The insulation resistance should be larger than 1 Megohms when measured with 500V megger) If the insulation resistance is smaller than 1 Megohms, clean the motor interior and dry. To dry, breakdown the motor and place it in an oven at a temperature not exceeding 90°C.	
4. Cooling fan	Weekly, monthly	0 Does the cooling fan rotate satisfactorily without generating unusual sound and vibration?	

Note: Since all control cards have been factory-adjusted, do not disturb the settings.

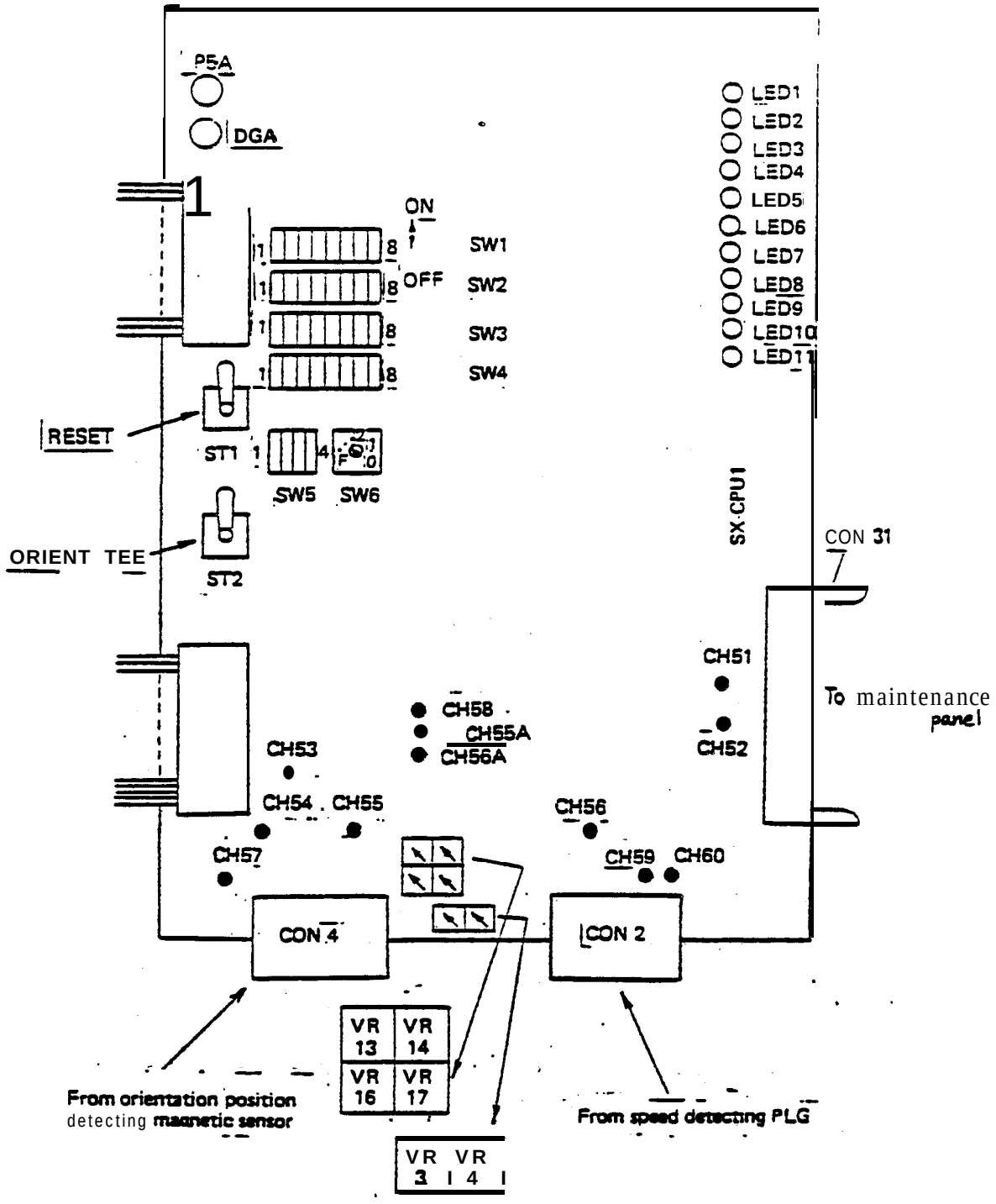
5.1 SX-CPU0 and CPU1 cards

SX-CPU0 ··· no orientation cad

SX-CPU1.** Magnetic orientation card



PROGRAM ROM.



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(1) List of LEDs

LED No.	Name	Application	Description
LED1	PHASE SEQUENCE	Power source phase discrimination	Lights when power source connection is in positive-phase sequence. Does *not* light when power source connection is in negative-phase sequence.Note
LED2	READY	Reedy for operation	Lights when the controller is ready for operation. Does not light when SET1 – SET2 input. of OFF and emergency sop command is given (base and gate shut off).
LED3	CW DRIVE	Motor Cw rotation command	Lights when motor CW rotation commend is input, or when the spindle is indexed.
LED4	CCW DRIVE	Motor CCW rotation command	Lights when motor CCW rotation command is input
LED5	SPEED *DETECTION*	Speed detection	Lights when motor speed decreases below *the speed* preset by DIP.
LED8	CURRENT DETECTION	Current detection	Lights when current larger than 110% of rated current flows in the motor.
LED7	UP TO SPEED	Threshold speed	Lights when motor speed reaches ±15% of commanded speed.
LED8	APPROACH	Access to orientation position	Lights when spindle enters orientation (indexing) area.
LED9	INPOSITION	Inposition	Lights when spindle stops within the range preset by rotary switch.
LED10	Z E R O SPEED	Zero speed	Lights when spindle speed goes down below the "zero" speed set by DIP switches.
LED11			Not used.

Note: The inverter works satisfactorily no matter whether its phase sequence is positive or negative.

List of DIP switches

Switch No.	Name	Description
SW1-1	NORMAL/TEST	ON .... "NORMAL" (Usual operation) OFF.. . "TEST" (Test operation) In usual operation, the switch is set as "NORMAL" position. When the circuit is checked or spindle orientation is checked, the switch is set at "TEST" position.
SW1-2	CLOSE/OPEN	ON .... "CLOSE" OFF . . . "OPEN" Speed control loop OPEN/CLOSE changeover. Speed detector function can be checked by comparing operating conditions when the switch is sat at "CLOSE" and "OPEN".
SW1-3	BINARY/BCD	ON .... "BINARY" OFF.. . "BCD" Digital speed command mode can be selected by this switch. Speed command is read ih binary 12-bit data with the switch sat at ON, and in BCD 2-digit data with the switch set at OFF.
SW1-4	ATTENUATED EXCITATION	ON .... "ATTENUATED EXCITATION" OFF... "NOT ATTENUATED EXCITATION" In usual operation, the switch is set at ON. With the switch set at ON, excitation voltage is decreased for reduction of noise (when slippage decreases).
SW1-5		
SW1-6	METER CALIBRA-TION	ON.. .. "METER CALIBRATION" OFF... "USUAL OPERATION" This switch is operated when speed meter or load meter is calibrated. With the switch set at ON, meter full-scale voltage is output permitting calibration of mater.

Switch No.	Name	Description
SW1-7	MAX. SPEED SETTING	ON .... "LOW SPEED" (PIN1 of SX-101 is set at "B") OFF ... "HIGH SPEED" (PIN1 of SX-IO1 is set at ● *iA") When base speed is 1500 rpm, HIGH SPEED-6000 rpm LOW SPEED = 4500 rpm When base speed is 1 150 rpm, HIGH SPEED = 4600 rpm LOW SPEED = 3450 rpm
SW1-8	ZERO SPEED SETTING	ON .... Zero speed signal is output when spindle speed goes down below 25 rpm. OFF ... Zero speed signal is output when spindle speed goes down below 50 rpm.
SW2-1		Not used
SW2-2 ~ SW2-4	MAGNET C SENSOR ORIENT POSITION-ING LOOP GAIN 1	(2) (3) (4) Mode 0: O O O Mode 1: O O X Mode 2: O X O Mode 3: O X X ⋮ Mode 7: X X X O ....ON X .... OFF This switch function is effective only for magn etic sensor type orientation. Positioning loop gain can be set for speed ranging from "orientation speed" to "servo control speed". The standard switch setting is "mode 0" and mode of larger number is selected to shorten orientation time.
SW2-5 ~ SW2-7	MAGNETIC SENSOR ORIENT SPEED TIMER	(5) (6) (7) 180 ms Mode 0: O O O 190 ms Mode 1: O O X Mode 2: O X O ⋮ 250 ms Mode 7: X X X O .... ON x .... OFF 10 ms increment This switch function is effective only for magnetic sen sor type orientation. Time taken for speed change f&n "orientation speed'" to "servo control speed" is set. If spindle stops running over the predetermined position, mode of larger number is selected.

<table>
<tr><th>Switch No.</th><th>Name</th><th>Description</th></tr>
<tr><td>SW2-8</td><td></td><td></td></tr>
<tr><td>SW3-1 ~
SW3-2</td><td>TORQUE LIMIT</td><td>
<table>
<tr><th colspan="2">External signal input
TL1 TL2</th><th colspan="2">1 2</th><th></th></tr>
<tr><td rowspan="4">0</td><td rowspan="4">x</td><td>0</td><td>0</td><td>Torque limited to 10%</td></tr>
<tr><td>0</td><td>0</td><td>Torque limited to 15%</td></tr>
<tr><td>x</td><td>0</td><td>Torque limited to 20%</td></tr>
<tr><td>x</td><td>x</td><td>Torque limited to 25%</td></tr>
<tr><td rowspan="4">x</td><td rowspan="4">0</td><td>0</td><td>0</td><td>Torque limited to 20%</td></tr>
<tr><td>0</td><td>x</td><td>Torque limited to 30%</td></tr>
<tr><td>x</td><td>0</td><td>Toque limited to 40%</td></tr>
<tr><td>x</td><td>x</td><td>Torque limited to 50%</td></tr>
</table>
The switch setting is not changed unless particular torque limit is required.</td></tr>
<tr><td>SW3-3 ~
SW3-5</td><td>Acceleration/Deceleration TIME CONSTANT</td><td>Speed command time constant for speed ranging from zero speed to maximum speed is set.
Standard setting: t .5 s
0 . . . . ON x . . . . OFF
<table>
<tr><th>3</th><th>4</th><th>5</th><th></th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0.3 s</td></tr>
<tr><td>0</td><td>0</td><td>x</td><td>1.5,</td></tr>
<tr><td>0</td><td>x</td><td>0</td><td>3</td></tr>
<tr><td>0</td><td>x</td><td>x</td><td>4</td></tr>
<tr><td>x</td><td>0</td><td>0</td><td>5</td></tr>
<tr><td>x</td><td>0</td><td>x</td><td>6</td></tr>
<tr><td>x</td><td>x</td><td>0</td><td>8</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>10</td></tr>
</table></td></tr>
<tr><td>SW3-6 ~
SW3-8</td><td>SPEED DETECTION RANGE</td><td>Speed detection range can be selected from 8 ranges (2%, 10%, 18%, 26%, 34%, 50% and 58%).
When speed enters the speed range set by these switches, the transistor for speed detection turns on.</td></tr>
</table>

<table>
<tr><th>Switch No.</th><th>Name</th><th>Description</th></tr>
<tr><td>SW3-6 ~
sw3-8</td><td></td><td>
<table>
<tr><th>6</th><th>7</th><th>8</th><th></th></tr>
<tr><td>O</td><td>O</td><td>O</td><td>2%</td></tr>
<tr><td>O</td><td>O</td><td>x</td><td>10</td></tr>
<tr><td>O</td><td>x</td><td>O</td><td>18</td></tr>
<tr><td>O</td><td>x</td><td>x</td><td>26</td></tr>
<tr><td>x</td><td>O</td><td>O</td><td>34</td></tr>
<tr><td>x</td><td>O</td><td>x</td><td>42</td></tr>
<tr><td>x</td><td>x</td><td>O</td><td>50</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>58</td></tr>
</table>
</td></tr>
<tr><td>SW4-1</td><td></td><td>Not used</td></tr>
<tr><td>SW4-2 ~
SW4-7</td><td>GEAR RATIO SETTING</td><td>Spindle orientation speed and servo control speed are set by these switches (gearing ratio is changed for individual application)</td></tr>
<tr><td>SW4-8</td><td></td><td>Not used.</td></tr>
<tr><td>SW5-1 ~
SW5-2</td><td>DIRECTION OF ORIENTATION</td><td>
<table>
<tr><th></th><th>SW
1 2</th><th>0 .....ON
x .....OFF</th></tr>
<tr><td>PRE</td><td>O O</td><td>Orientation in forward direction of motor rotation</td></tr>
<tr><td>CCW</td><td>O x</td><td>Orientation in counter-clockwise direction of motor rotation</td></tr>
<tr><td>CW</td><td>x O</td><td>Orientation in clockwise direction of motor rotation</td></tr>
<tr><td>CW</td><td>x x</td><td>Orientation in clockwise direction of motor rotation</td></tr>
</table>
</td></tr>
</table>

List of rotary switches

Switch No.	Name	Description
SW6	ORIENTATION SPEED SETTING	"Orientation speed" for magnetic sensor type orientation is sat by this rotary switch. The listed speeds are spindle speed RPM and motor speed depends on gearing ratio. Orientation speed should be decreased when spindle stops running over the predetermined stop position due to large load GD².

Setting	
0	80 rpm
1	85
2	90
3	95
4	100
5	105
6	110
7	115
8	120
9	125
A	130
B	135
C	140
D	145
E	150
F	155

List of toggle switches

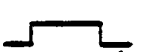
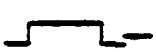
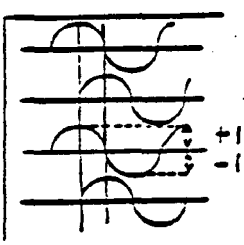
Switch No.	Name	Description
ST1	RESET	For initializing the inverter. This switch should not be operated while the motor is running. Whenever DIP switch setting is changed, this switch should be operated. DO NOT RESET WHILE THE MOTOR IS RUNNING
ST2	ORIENTATION TEST	The motor funs at "orientation speed" while this switch is held at ON position. When the switch is set to OFF, the motor stops after completion of one cycle of orientation.

List of variable resistors

Since the variable resistors in this card have been properly set by us, do not disturb the settings.

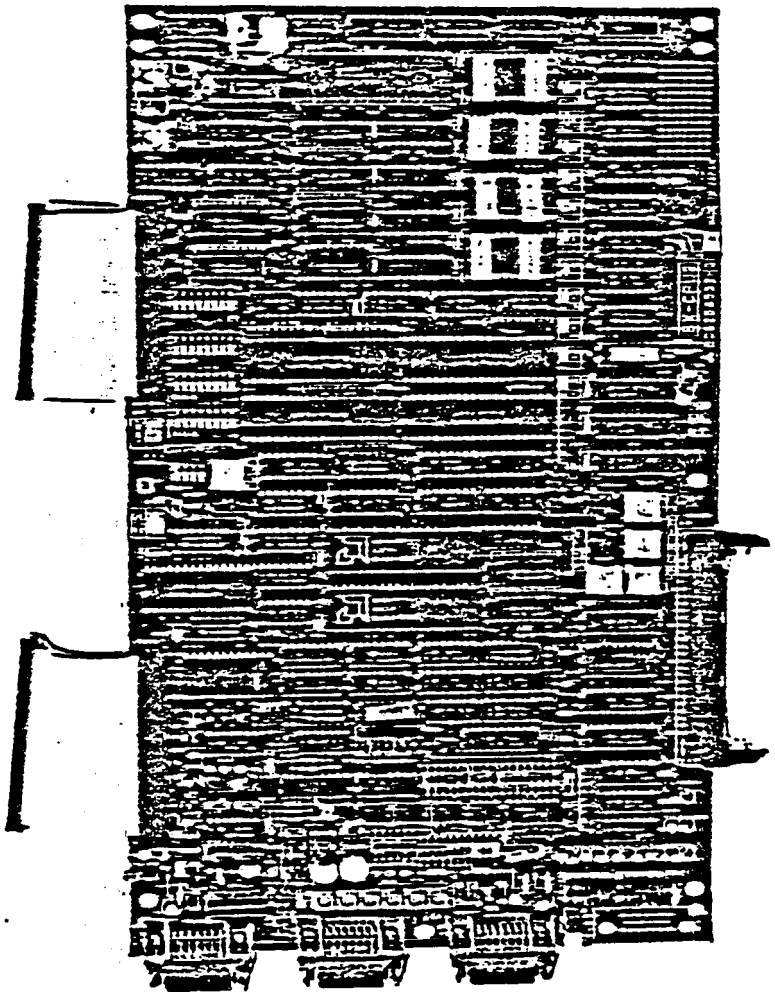
VR No.	Name	Description
VR16	"B" phase zero adjustment	00 not change the setting.
VR13	"A" phase zero adjustment	Do not change the setting.
VR14	"A" phase gain adjustment	CH56, Speed feedback, Sine wave PLG (Pulse generator) Adjusted to ±10V
VR15	"B" phase gain adjustment	CH55, Speed feedback. Sine wave "LOW SPEED" Adjusted to ±10V
VR3	Position shift	Fine adjustment of stop position is possible.
VR4	Magnetic sensor	To be a so that magnetic sensor sensitivity indicator LED11 lights.

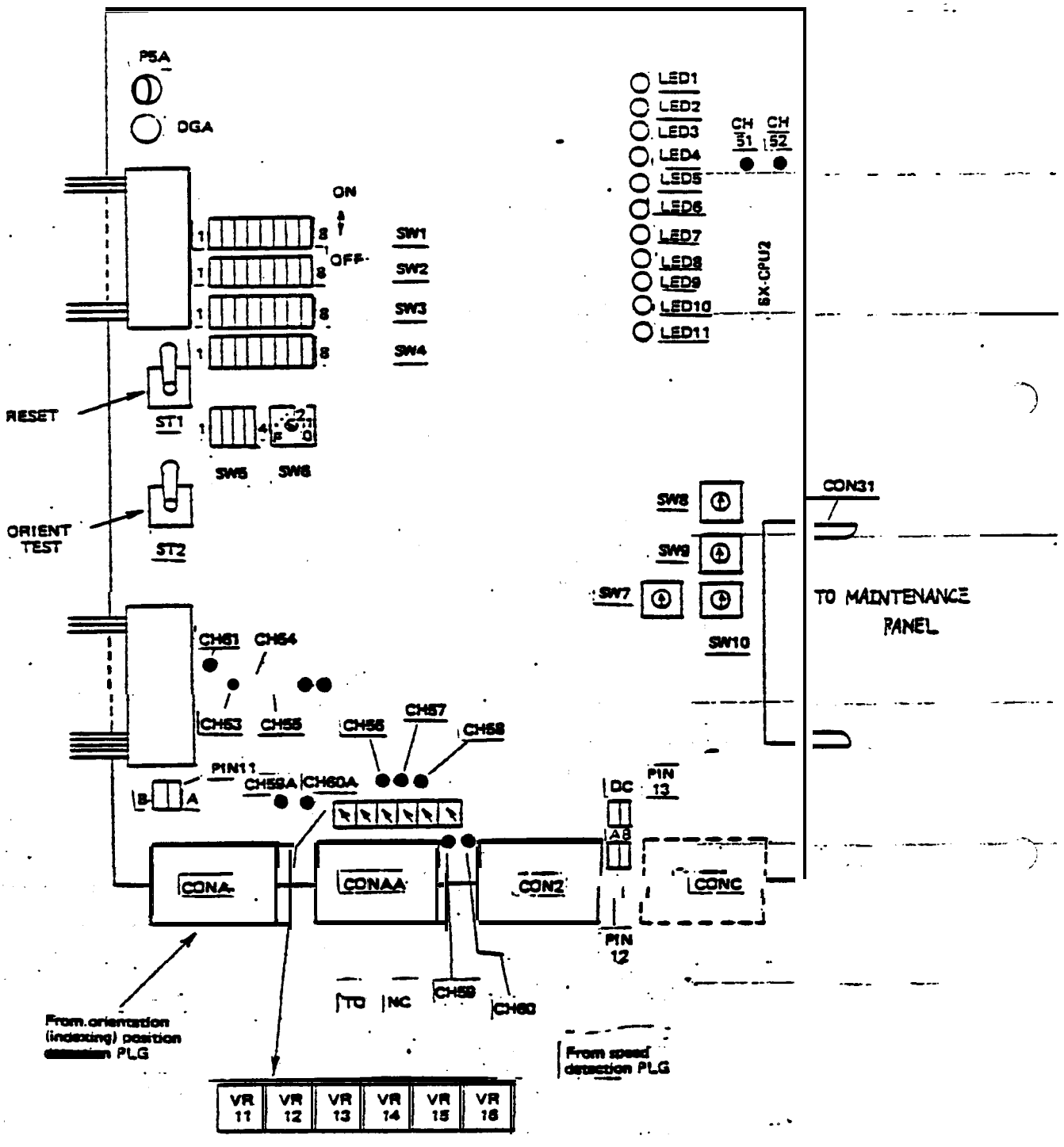
List of check terminals

erminal No.	Description
P5A	+5V
DGA	+0V (Digital ground)
CH52	Speed feedback "A" phase, rectangular waveform  For CW rotation
CH51	Speed feedback "B" phase, rectangular waveform  For C.CW rotation
CH57	Linear zone detection signal
CH58	AC converter input
CH60	−15V
CH54	+0V (Analog ground)
CH59	+15V
CH66	Speed feedbadc "A" phase  For CW rotation
CH55	Speed 'feedback "B" phase
CH56A	Speed feedback "A" phase +10V − 10V For low speed rotation
CH55A	Speed feedback "B" phase
CH53	+24V

5.2 SX-CPU2 card

When the controller unit is equipped with 1024Px4/Rev. encoder type multi-point orientation, this card is used.




P5A
DGA
LED1
LED2
LED3
LED4
LED5
LED6
LED7
LED8
LED9
LED10
LED11
CH 51
CH 52
SX-CPU2
ON
OFF
SW1
SW2
SW3
SW4
RESET
ST1
SW5
SW6
ORIENT TEST
ST2
SW8
SW9
SW7
SW10
CON31
TO MAINTENANCE PANEL
CH61
CH64
CH63
CH65
CH66
CH67
CH68
PIN11
CH59A
CH60A
B
A
DC
PIN 13
A
B
CONA
CONAA
CON2
CONC
PIN 12
From orientation (indexing) position detection PLG
TO
NC
CH59
CH60
From speed detection PLG
VR 11
VR 12
VR 13
VR 14
VR 15
VR 16

(1) List LEDs

LED No.	Name	Application	Description
LED 1	PHASE / SEQUENCE	Power soure sequence discrimination	Lights when power source phase sequence is posirive. Does not light when power source phase sequence is negative. (Note 1)
LED2	R E A D Y	Reaoy for operation	Lights when the controller is ready for operation. *Does not light when SET7* – SET2 input is OFF and emergency stop command is input (base and gate shut off).
LED3	CW DRIVE	Motor CW rotation command	Lights when motor CW rotation command is input, or when the spindle is indexed.
LED4	CCW DRIVE	Motor CCW rotation command	Lights when *motor CW* rotation command is input.
LED5	SPEED DETECTION	Speed detection	Lights when motor speed decreases below the speed preset by DIP switches.
LED6	CURRENT DETECTION	Current detection	Lights when current larger than 110% of rated current flows in the motor.
LED7	UP TO SPEED	Threshold speed	Lights when motor speed reaches ±15% of commanded speed.
LED8	APPROACH	Access to orientation position	Lights when spindle enters orientation (indexing) area.
LED9	INPOSITION	Inposition	Lights when spindle stops within a ange preset by rotary switch.
LED10	ZERO SPEED	Zero speed	Lights when spindle speed goes down below the "zero" speed set by DIP switches.
LED11			Not used.

Note 1: The inverter work satisfactorily no matter whether phase sequence is positive or negative.

List of DIP switches

Switch No.	Name	Description
SW1-1	NORMAL/TEST	ON .... "NORMAL" (Usual operation) OFF ... "TEST" (Test operation) In usual operation, tie switch is set at "NORMAL" position. When the circuit is checked or spindle orientation is checked, the switch is set at 'TEST' position.
SW1-2	CLOSE/OPEN	ON .... "CLOSE" OFF ... "OPEN" For switching of speed control loop between "OPEN" and "CLOSE ".
SW1-3	BINARY/BCD	ON .... "BINARY" OFF ... "BCD" Digital speed command made can be selected by this switch. Speed command is read in binary 12 bit data with the witch set at ON, and in BCD 2-digit data with the switch set at OFF.
SW1-4	ATTENUATED EXCITATION	ON .... "ATTEN UATED EXCITATION" OFF ... "NOT ATTENUATED EXCITATION" In usual operation, the switch is set at ON. With the switch set at ON, excitation voltage is decreased for reduction of noise level when slippage decreases.
SW1-5		
SW1-6	METER CALIBRATION	ON .... "METER CALIBRATION" OFF ... "NORMAL OPERATION" This switch is operated when speed meter or load meter is calibrated.
SW1-7	MAX. SPEED SETTING	ON .... "LOW SPEED" (PIN1 of SX-101 is set at "B" OFF ... "HIGH SPEED" (PIN1 of SX-101 is set at "A") When basic speed is 1500 rpm, HIGH SPEED = 6000 rpm LOW SPEED = 4500 rpm When basic speed is 1150 rpm, HIGH SPEED = 4600 rpm LOW SPEED = 3450 rpm

Switch No.	Name	Description
SW1-8	ZERO SPEED SETTING	ON . . . . Zero speed signal is output when spindle speed goes down below 25 rpm. OFF . . . Zero speed signal is output when spindle speed goes down below 50 rpm.
SW2-1		Not used
SW2-2 ~ 4	ENCODER ORIENT POSITIONING LOOP GAIN 2	(2) (3) (4) Mode 0: O O O Mode 1: O O x Mode 2: O x x Mode 3: O x x Mode 7: x x x O . . . ON x . . . OFF This switch function is effective only for encoder type orientation Positioning loop gain can be set for speed tanging from "servo control speed" to "creeping speed". The standard witch setting is "mode 0" and mode of larger number is selected to shorten orientation time.
SW2-5 ~ 7	ENCODER ORIENT POSITIONING LOOP GAIN 1	(5) (6) (7) Mode 0: O O O Mode 1: O O x Mode 2: O x O Mode 7: x x x 0 . ..ON X . . . OFF This witch function is effective only for encoder type orientation. Time taken for speed change from "orientation speed" to "servo control speed is set". The standard switch setting is "mode 0" and a mode of larger number is selected to shorten orientation time.
SW2-8	ENCODER ORIENT ENCODER MOUNT DIRECTION	ON . . . . CW OFF . . . CCW This switch function is effective only for encoder type orientation. cw rotation is that direction of rotation of the encoder is same as that of motor.

Switch No.	Name	Description
SW3-1 2	TORQUE LIMIT	External signal input TL1 TL2 / 1 / 2 O x / O / O — Torque limited to 10% O / x — Torque limited to 15% x / O — Torque limited to 20% x / x — Torque limited to 25% x 0 0 / 0 / 0 — Torque limited to 20% 0 / x — Torque limited to 30% x / 0 — Torque limited to 40% x / x — Torque limited to 50% The switch setting is not changed when particular torque limit is not required.
SW3-3 4 5	Acceleration/Deceleration TIME CONSTANT	Speed command time constat for speeds ranging from zero speed to maximum speed is set. Standard setting: 1.5S 0 : ON X : OFF 3 / 4 / 5 / . 0 0 0 0.3S 0 0 x 1.5S 0 x 0 3S O x x 4S X 00 5S X 0 x 6S X X O 8S x x x 10S
SW3-6 7 8	SPEED DETECTION RANGE	Speed detection range can be selected from 8 ranges (2%, 10%. 18%, 26%. 34%, 50% and 58%). When speed enters the speed range set by these switches, the transistor for speed detection turns on. 6 / 7 / 8 / 0 0 0 2% 0 0 x 10 0 x 0 18 0 x x 26 X O O 34 X 0 x 42 x x 0 50 x x x 58

Switch No.	Name	Description		
SW4-1		Not used.		
SW4-2 3 4 5 6 7	GEAR RATIO SETTING	Spindle orientation speed and servo control speed are set by these switches (gearing ratio is changed from individual application).		
SW4-8				
SW5-1 2	DIRECTION OF ORIENTATION		SW 1 2	0 ... ON X... OFF
		PRE	0 0	Orientation in forward direction of motor rotation.
		CCW	o x	Orientation in counter-clockwise direction of motor rotation.
		cw	X O	Orientation in clockwise direction of motor rotation.
		cw	xx	Orientation in clockwise direction of motor rotation.

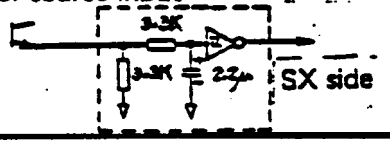
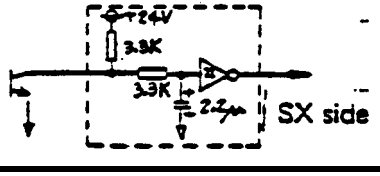
List of rotary switches

Switch NO.	Name	Description
SW6	ORIENTATION SPEED SETTING	Setting / 0: 80 rpm; 1: 85; 2: 90; 3: 95; 4: 100; 5: 105; 6: 110; 7: 115; 8: 120; 9: 125; A: 130; B: 135; C: 140; D: 145; E: 150; F: 155 "Orientation speed" for encoder type orientation is set by this rotary switch. The listed speeds are spindle speed RPM and motor speed depends on gearing ratio. Orientation speed should be decreased when spindle stops running over the predetermined stop position due to large load GD^2.
SW7	ENCODER ORIENTATION ORIENT INPOSITION RANGE	Setting / 0: 0; 1: 0.09°; 2: 0.18°; 3: 0.26°; 4: 0.35°; 5: 0.44°; 6: 0.53°; 7: 0.62°; 8: 0.70°; 9: 0.79°; A: 0.88°; B: 0.97°; C: 1.06°; D: 1.14°; E: 1.23°; F: 1.32° Range of positioning error in orient completion signal can be set. One turn of spindle is divided into 4096 points. Error range = $360° \times \frac{(\text{Setting})}{4096}$ Standard setting: "A"
SW8 SW9 SW10	ORIENT POSITION SHIFT	SW10 0 ~ F x256 SW9 0 ~ F x16 } 12-bit binary SW8 0 - F x1 Position shift value = $360° \times \frac{\text{Setting}}{4096}$ Least increment = $360° \times \frac{1}{4096}$ When the encoder is installed, setting should be made so that spindle stops at the predetermined position.

Switch No.	Name	Description
		Orientation (indexing position) does not change even when setting is changed when the orientation is not in operation. Position can be shifted in spindle reverse rotating direc-rion with the encoder installed in CW direction, and in spindle forward rotating direction with encoder installed in CCW direction, when rotary switch is turned in direction.

List of toggle switches

Switch No.	Name	Description
ST1	RESET	For initializing the invener This switch should not be operated while the motor is running. Whenever DIP switch setting is changed, this should be operated. DO NOT RESET WHILE THE MOTOR IS RUNNING.
ST2	ORIENTATION TEST	The motor runs at "orientation speed" while this switch is held at ON position. When the switch is set to OFF, the motor stops after the completion of one cycle of orientation.

Pin Na.	Name	Description
PIN11	ORIENT POSITION DETECT P L G ON/OFF	"A" side should be set to supply the power source to orient position detect pulse generator from the spindle control unit "B" side should be set to supply the power source to orient position detect pulse generator from the NC.
PIN12	ORI ENT POSITION INPUT	For source input  PIN12 . . . A PIN13 . . . D
		For sync. input  PIN12 . . . B PIN13 . . . C

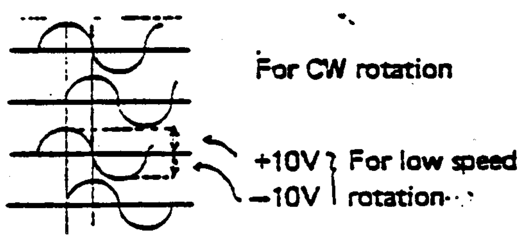
List of variabie resistors

Since the variable resistors in this card have been properiy set by us, not change the setting.

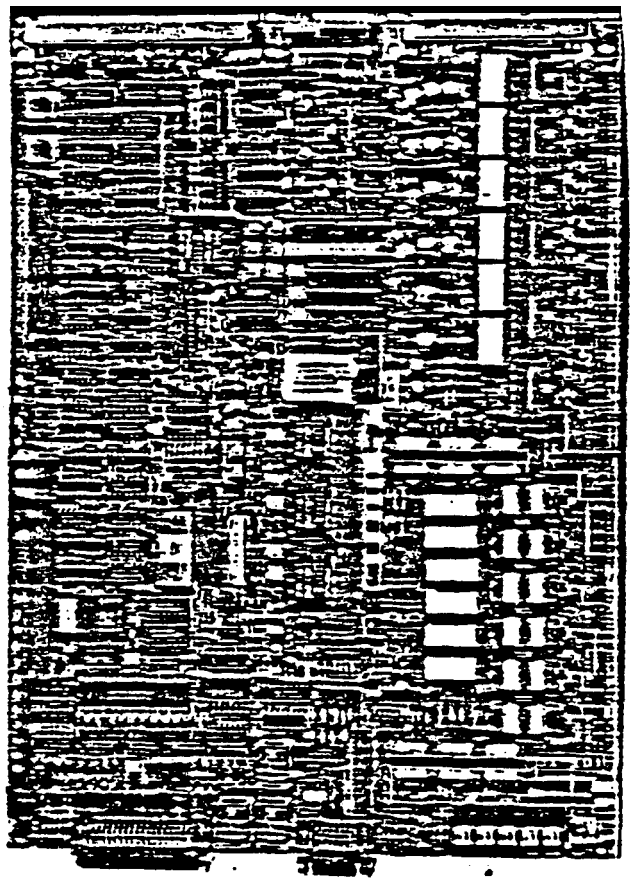
VR No.	Name	Description
VR11	"6" phase zero adjustment	Do not change the setting.
VR12	"A" phase rem. adjustment	Do not change the setting.
VR13	"A" phase gain adjustment	CH59A, Speed feedback, Sine wave PLG Adjusted to ±10V
VR14	"B" phase gain	CH60A, Speed feedback, Sine wave PLG "LOW SPEED" to ±10V
VR15	Not used	
VR16	Not used	

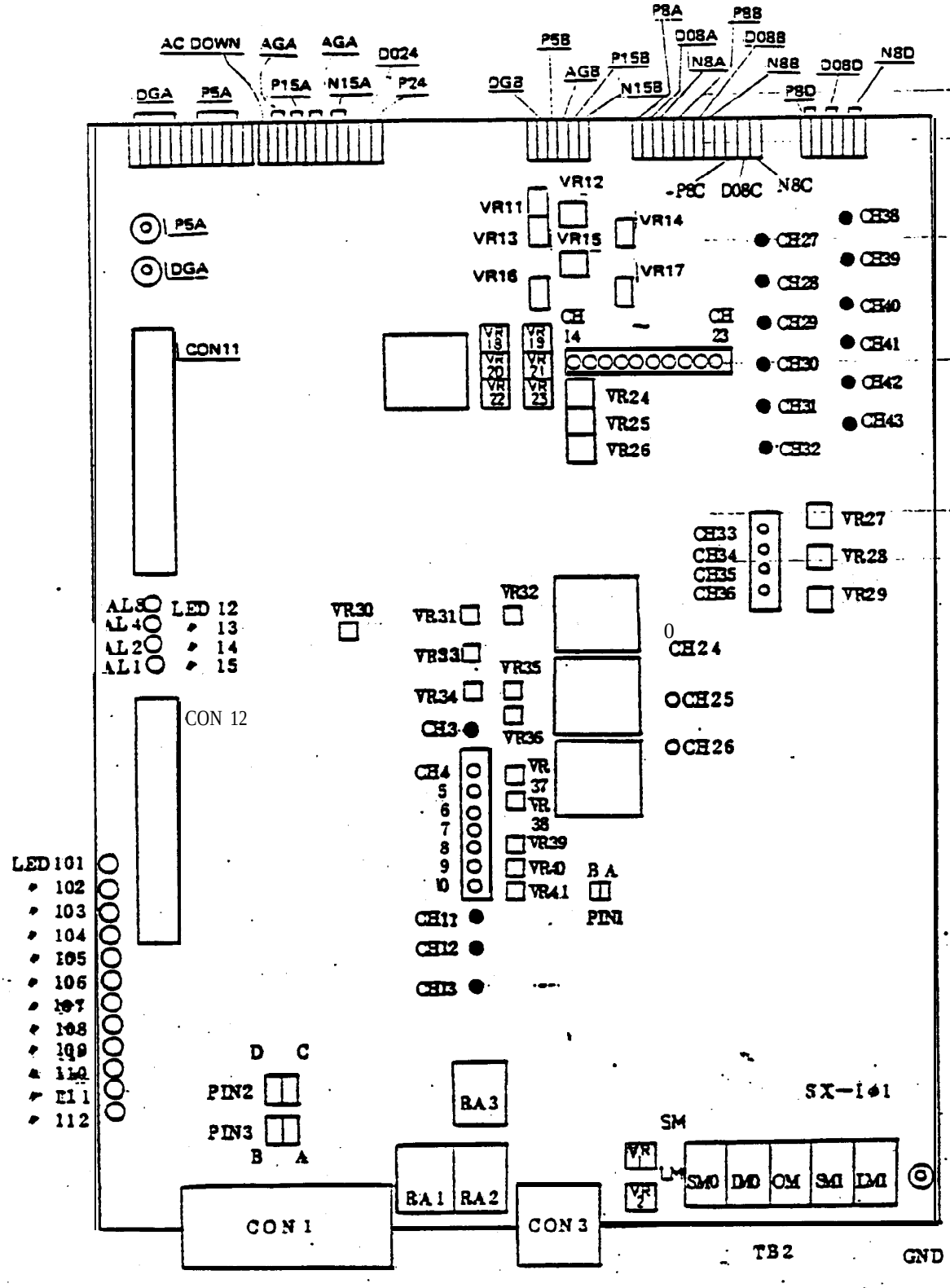
List of check terminals

Terminal No.	Description
P5A	+5V
DGA	+0V (Digital ground)
CH51	Speed feedback "A" phase, rectangular waveform -For CW rotation
CH52	Speed feedback "B" phase, rectangular waveform For CCW rotation
CH53	Orient position feedback mark pulse
CH54	Orient position feedback "A" phase
CH55	Orient p&on feedback "B" phase
CH56	−15V
CH57	+0V (Analog ground)
CH58	+15V
CH59	Speed feedback "A" phase
CH60	Speed feedback "B" phase
CH59A	Speed feedback "A" phase
CH60A	Speed feedback "8" phase
CH61	+24V



5.3 SX-101 card




AC DOWN
AGA
AGA
D024
P15A
N15A
P24
DGA
P5A
DGB
P5B
AGB
P15B
N15B
P8A
P8B
D08A
D08B
N8A
N8B
D08D
N8D
P8D
-P8C
D08C
N8C
P5A
DGA
CON11
VR11
VR12
VR13
VR14
VR15
VR16
VR17
VR18
VR19
VR20
VR21
VR22
VR23
CH 14
CH 23
VR24
VR25
VR26
CH38
CH27
CH39
CH28
CH40
CH29
CH41
CH30
CH42
CH31
CH43
CH32
CH33
CH34
CH35
CH36
VR27
VR28
VR29
AL8
AL4
AL2
AL1
LED 12
13
14
15
CON 12
VR30
VR31
VR32
VR33
VR34
VR35
VR36
CH3
CH24
CH25
CH26
CH4
5
6
7
8
9
10
VR 37
VR 38
VR39
VR40
VR41
B A
PIN1
CH11
CH12
CH13
LED 101
102
103
104
105
106
107
108
109
110
111
112
D C
PIN2
PIN3
B A
RA3
SX-101
SM
VR 1
VR 2
SM0
DM0
OM
SM1
DM1
RA1
RA2
CON 1
CON 3
TB2
GND

List of LEDs

LED No.	Symbol	Description
LED12 LED13 LED14 LED75	AL8 AL4 AK AL1	Alarm display (For details, refer to "List of alarm signals".)
LED101) LED112		Speed command display X1, X2, x4, ..., X2048 — 12 bits

List of setting pins

Pin No.	Symbol	Description
PIN 1	Seeed setting	A-TOP (full) speed: 6000 rpm (Base speed 1500 rpm) 4600 rpm (Base speed 1150 rpm) B = TOP (full) speed: 4500 rpm (Base speed 1500 rpm) 3460 rpm (Base speed 1150 rpm)

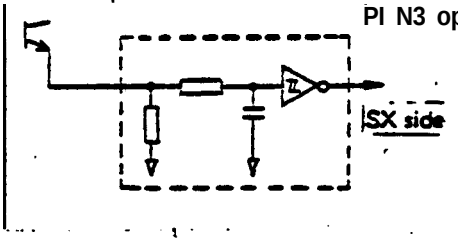
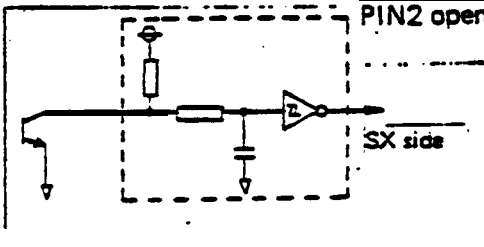
Note: Different ROM is used for 1500 rpm and 1150 rpm base speeds.

List of alarm signals

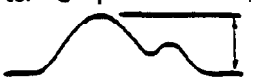
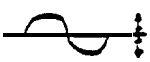
0: LED does not light. Output = H level (Transistor turned off)
1: LED lights. Output = L level (Transistor turned on)

	Output						
No.	AL8 (LED 12)	AL4 (LED 13)	AL2 (LED 14)	AL1 (LED 15)	Alarm	Cause	Resetting method
1	0	0	0	1	MOTOR OVERHEAT	Temperature in the motor goes up over the limit (150±8°C)	After cooling the motor, operate ALARM RESET or RESET button.
20		0		1 0	EXCESS SPEED CONTROL ERROR	Motor speed largely differs from commanded speed. Detection speed error 5% (3000 rpm)	Stop the motor, eliminate the cause and depress ALARM RESET or RESET button.
3	0	0	1	1	For provision		
4	0	1	0	0	BREAKER TRIP	Unusually high source current flows causing tripping of breaker.	
so		1	0	1	PHASE LOSS	Any phase is disconnected.	
6	0	1	1	0	EMERGENCY STOP	Emergency stop pushbutton on an external operation panel is depressed to "ON".	Operate the emergency stop pushbutton to set it "OFF".
7	0	1	1	1	OVERSPEED	Motor speed exceeds 115% of rated speed.	
8	1	0	0	0	CONVERTER OVER-CURRENT	Overcurrent flows in the converter.	(Peak value = (Rated current) x 400%
9	1	0	0	1	CONTROLLER OVERHEAT	Temperature of heatsink is too high	(Unit: 60±5°C Heatsink: 100±5°C
10	1	0	1	0	SOURCE VOLTAGE DROP	The input source voltage is below 170V for 15 ms or longer.	

No.	Output AL8 (LED 12)	AL4 (LED 131	AL2 (LED I 14)	AL1 (LED 15)	Alarm	Cause	Resening method
11	1	0	1	1	OVER-VOLTAGE	DC voltage in the converter is too high.	
12	1	1	0	0	INVERTER OVER-CURRENT	Overcurrent flows in the inverter.	Peak value = (Rated current) x 200%
13	1	1	0	1	CPU TROUBLE 1	Traubie occurs with microprocessor.	Currently not used
14	1	1	1	0	CPU TROUBLE 2	Trouble occurs with microprocessor.	
15	1	1	1	1	CPU TROUBLE 3	Trouble occurs with microprocessor.	

Pin No.	Name	Description
PIN2	DIGITAL SPEED COMMAND INPUT MODE SELECTION	For source input C, D short-circuited PI N3 opened 
PIN3		For sync input A, B short-circuited PIN2 opened 

List of check terminals

Terminal No.	0V	Description
P5A		+5V
DGA		OV (Digital ground)
CH3	AGA	Analog speed command input TOP (full) speed +10V
CH4		Overcurrent setting level (Operat. level +10V)
CH5		Overcurrent setting level (Operat. level +10V)
CH6		Converter voltage, feedback 5V ... VDC = 200V
CH7		"U" phase ... Inverter current detection
CH8		"W" phase ... Inverter current detection
CH9		Source current detection. 10V ... ±AC = (Rated current) x $\sqrt{2}$ x4
CH10 CH11		Inverter "U" phase and "W" phase current rectified  5V ... I_{UVM} = (Rated current) x$\sqrt{2}$
CH12		Reference voltage +10V } Adjustable by VR39
CH13		Reference voltage -10V }
CH1		Override command +10V ... 120%
CH14	AG8	"W" phase reference sine wave  6.5V = TOP (full speed) 6.5V = TOP (full speed)
CH15	AGB	"V" phase reference sine wave
CH16	AGB	"U" phase reference sine wave
CH17		
CH18		
CH19		
CH20	AGB	"U" phase voltage integrator output
CH21	AGB	"V" phase voltage integrator output
CH22	AGB	"W" phase voltage integrator output
CH23		

Terminal No.	0V	Description
CH24	MAIN CIRCUIT SIDE	Converter voltage on main circuit side.
CH25	MAIN CIRCUIT SIDE	Inverter current "U" phase on main circuit side
CH26	MAIN CIRCUIT SIDE	Inverter current "W" phase on main circuit side
CH27	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "U" phase +15V 0V 0V main circuit transistor "ON"
CH28	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "V" phase 0V main circuit transistor "ON"
CH29	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "W" phase 0V main circuit transistor "ON"
CH30	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "U" phase 0V main circuit transistor "ON"
CH31	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "V" phase 0V main circuit transistor "ON"
CH32	MAIN CIRCUIT SIDE	Inverter transistor base drive signal "W" phase 0V mdn circuit transistor "ON"
CH33	AGB	Inverter "U" phase voltage feedback +5.7V −5.7V VDC = 140V
CH34	AGB	Inverter "V" phase voltage feedback
CH35	AGB	Inverter "W" phase voltage feedback
CH36		
CH38	D08A	Inverter "U" phase base amplifier output
CH39	D08B	Inverter "V" phase base amplifier output
CH40	D08C	Inverter W" phase base amplifier output
CH41	D08D	Inverter "$\overline{U}$" phase base amplifier output
CH42	D08D	Inverter "$\overline{V}$" phase base amplifier output
CH43	D08D	Inverter "$\overline{W}$" phase base amplifier output

List of variable resistors

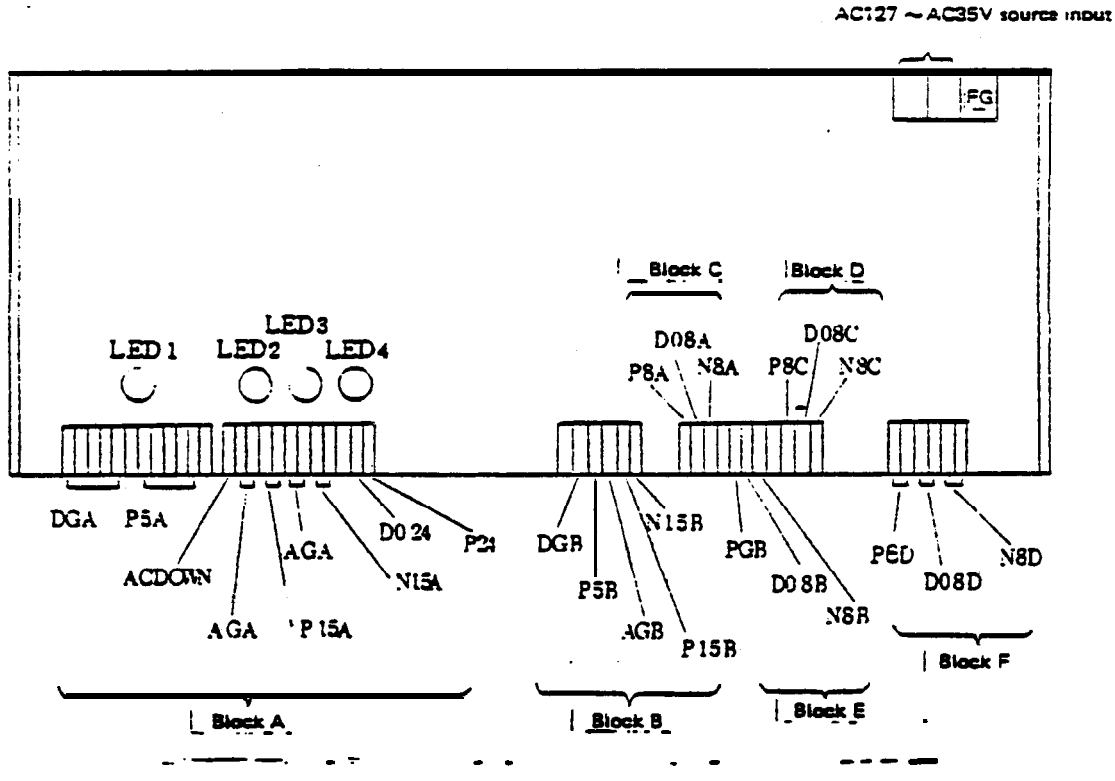
Since all variable resistors except for VR1 and VR2 have been set by us, do not change the settings.

No.	Description	
VR1	*Speed meter* calibration	To be set by user
VR2	Load meter calibration	
VR11	Reference sine wave "U" phase D/A converter gain adjustment	
VR12	Reference sine wave "U" phase zero adjustment	
VR13	Reference sine wave "V" phase D/A converter gain adjustment	
VR14	Referenda sine wave "U" phase gain adjustment	CH16
VR15	Reference sine wave "V" phase zero adjustment	
VR16	Reference sine wave "W" phase gain adjustment	
VR17	Reference sine wave "V" phase gain adjustment	CH15
VR18	"U" phase current balance adjustment	
VR19	"U" phase current balance adjustment after gain selection (low speed)	
VR20	"V" phase currant balance adjustment	
VR21	"V" phase current balance adjustment after gain selection (low speed)	
VR22	"W" phase current balance adjustment	
VR23	"W" phase current balance adjustment after gain selection (low speed)	
VR24	Reference sine wave "W" phase level adjustment at gain selection	
VR25	Reference sine wave "V" phase level adjustment at gain selection	
VR26	Reference tine wave "U" phase level adjustment at gain selection	
VR27	Inverter "U" phase voltage feedback adjustment	CH33
VR28	Inverter ● *V'* phase voltage feedback adjustment	CH34
VR29	Inverter "W" phase voltage feedback adjustment	CH35
VR31	A/D converter zero adjustment	
VR32	Converter voltage feedback gain adjustment	CH6
VR33	Current limit level setting	CH4
VR34	Overcurrent level setting	CH5
VR35	"U" phase current feedback zero adjustment	CH 7
VR36	"U" phase current feedback gain adjustment	CH?
VR37	"W" phase current feedback zero adjustment	CH8
VR38	"W" phase current feedback gain adjustment	CH8
VR39	±1 OV Reference source voltage	CH12, CH13
VR40	Overspeed level adjustment at "L" speed setting	PIN1-8
VR41	Overspeed level adjustment at "H" speed *setting*	PIN1-A

5.4 SX-PW card

This *card is* the power supply unif that provide FR-SX wifh all necessary DC sources.

Mote: Although there are two types of SX-PW card, which differ from each omer in part loading pattern, rhey are completely comoatible.



Notes: 1. The card is divided into 7 blocks ranging from block "A" block to block "F" and "0" lint of each block is separated and insulated ("0" lines in block an connected).

2. Blocks "B" ~ "F" are not insulated from the main circuit

Block	Name	Voltage	
Block "A"	P5A DGA (0V)	+5V ± 3%	
	AC DOWN	Control source voltage drop detection signal	
	P15A	+15V ± 1.5%	Control power source
	AGA (0V)	0V	
	N15A	−15V ± 1.5%	
	P24 D024 (0V)	+24V	
Block "8"	P5B DGB (0V)	+5V ± 3%	
	P15B	+15V ± 1.5%	Uninsulated part control power source
	AGB (0V)		
	N15B	−15V ± 1.5%	
Block "C"	P8A	+8V +15% −5%	"U" phase base power source
	D08A	0V	
	N8A	−8V +15% −5%	
Block "D"	P8B	+8V +15% −5%	"V" phase base power source
	DO80	0V	
	N8B	−8V +15% −5%	
Block "E"	P8C	+8V +15% −5%	"W" phase base power source
	D08C	0V	
	N8C	−8V +15% −5%	
Block "F"	P8D	+8V +15% −5%	"U", "V", "W" base power source
	0080	0V	
	N8D	−8V +15% −5%	

List of LEDs used in SX-PW

LED No.	Description
LED1	+5V (P5A) Lights when voltage is at normal level.
LED2	+15V (P15A) Lights when voltage is at normal level.
E D 3	−15V (N15A) Lights when voltage is at normal level.
LED4	+24V (P24A) Lights when voltage is at normal level.

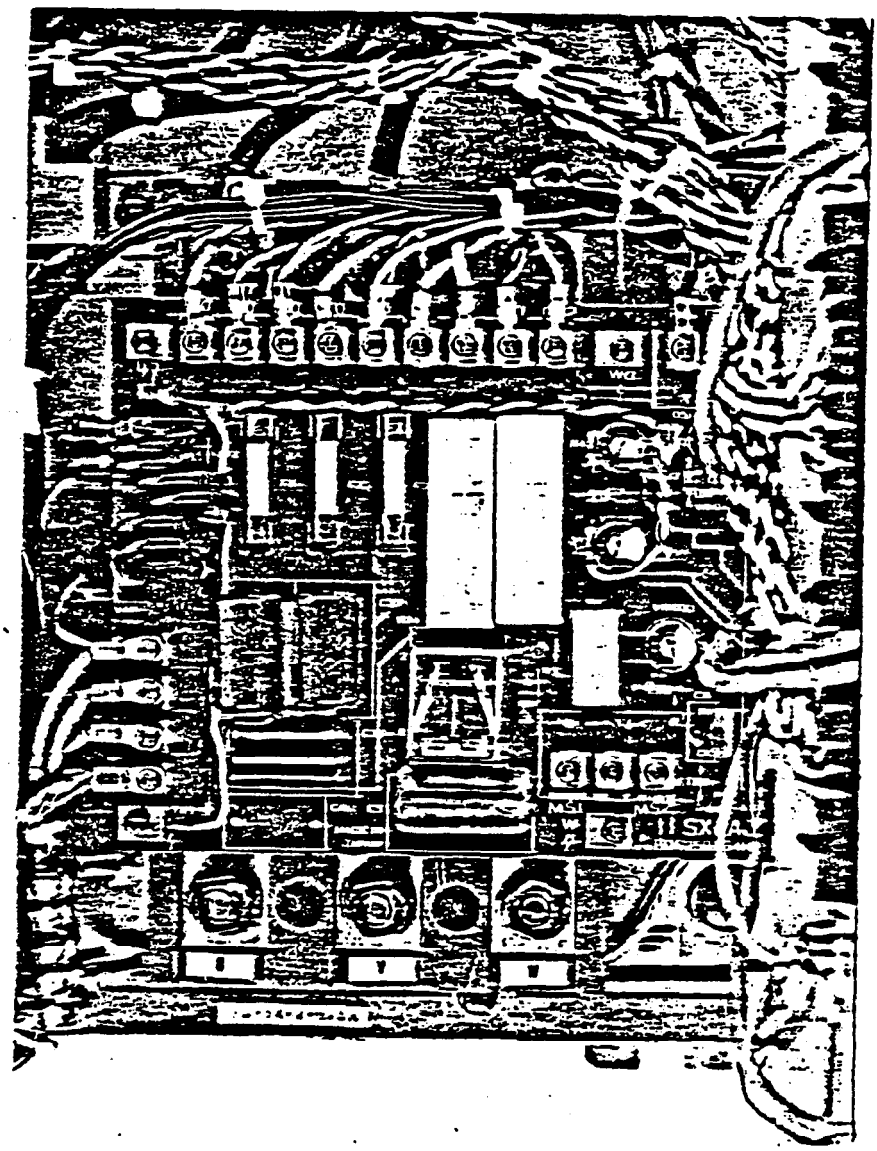
Nom The power source is unusual if the output voltage is not within the range listed in the previous pages even when the LEDs light oh

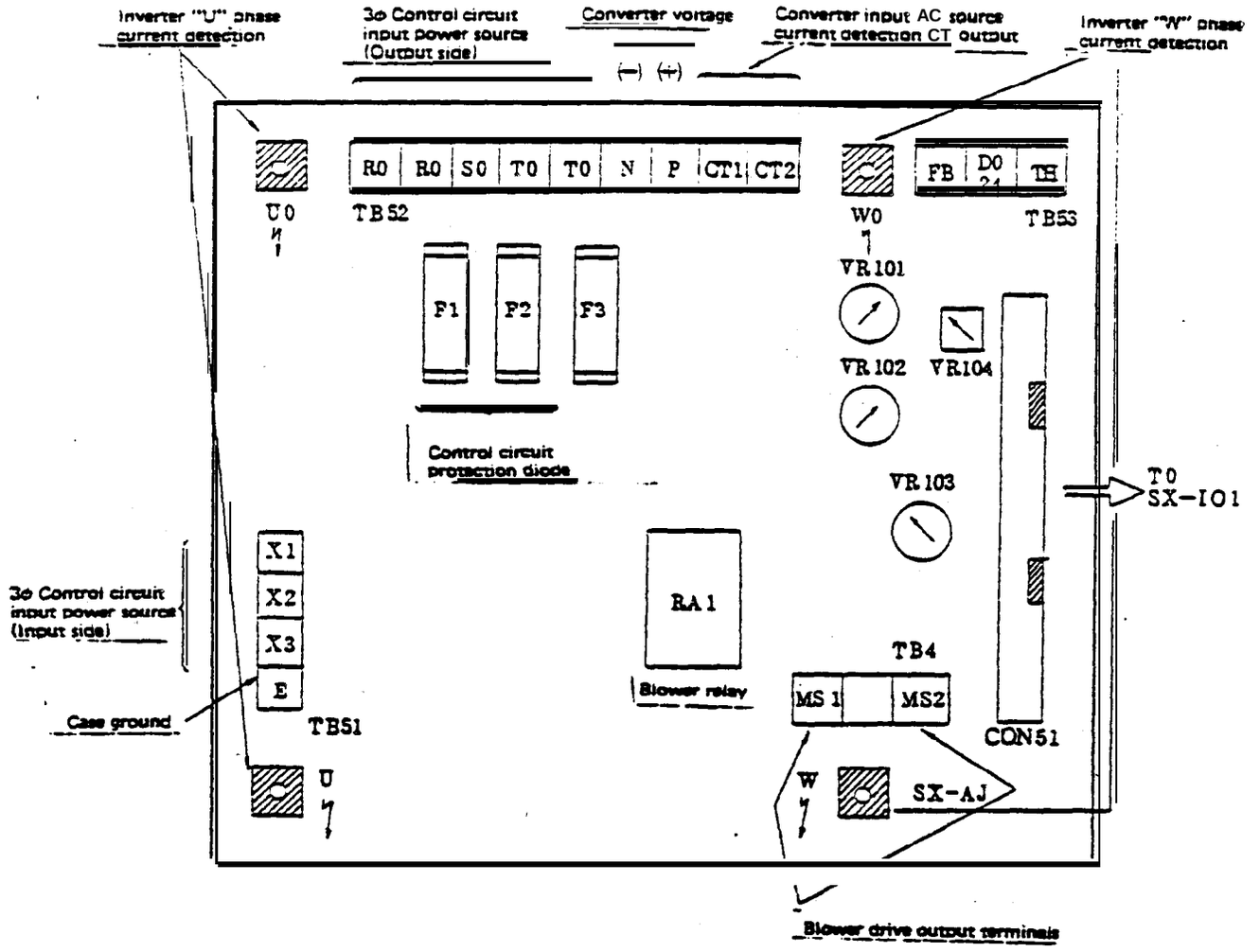
The input power source to this card is specified to AC127 ~ AC85V, 50/60Hz.

5.5 SX-AJ1card

This card is used for auxiliary level settings necessary to adjust the input power source, protection(safety) circuit, current, voltage and feedback

SX-IO1 becomes replaceable by adjusting this card.





Variable resistor No.	Description
VR101	Inverter "U" phase current detect level adjustment
VR102	Inverter 'W" phase current detect level adjustment
VR103	Inverter voltage feedback ± voltage balance adjustment
VR104	Input current feedback level adjustment

6.1 Magnetic sensor singie-point orientation (SX-CPU 1 card is used)

6.1.1 Principle

The sensor (detector element) produces two different types of voltage, as shown in Fig. 6.1, depending on its location in reference to the magnet.

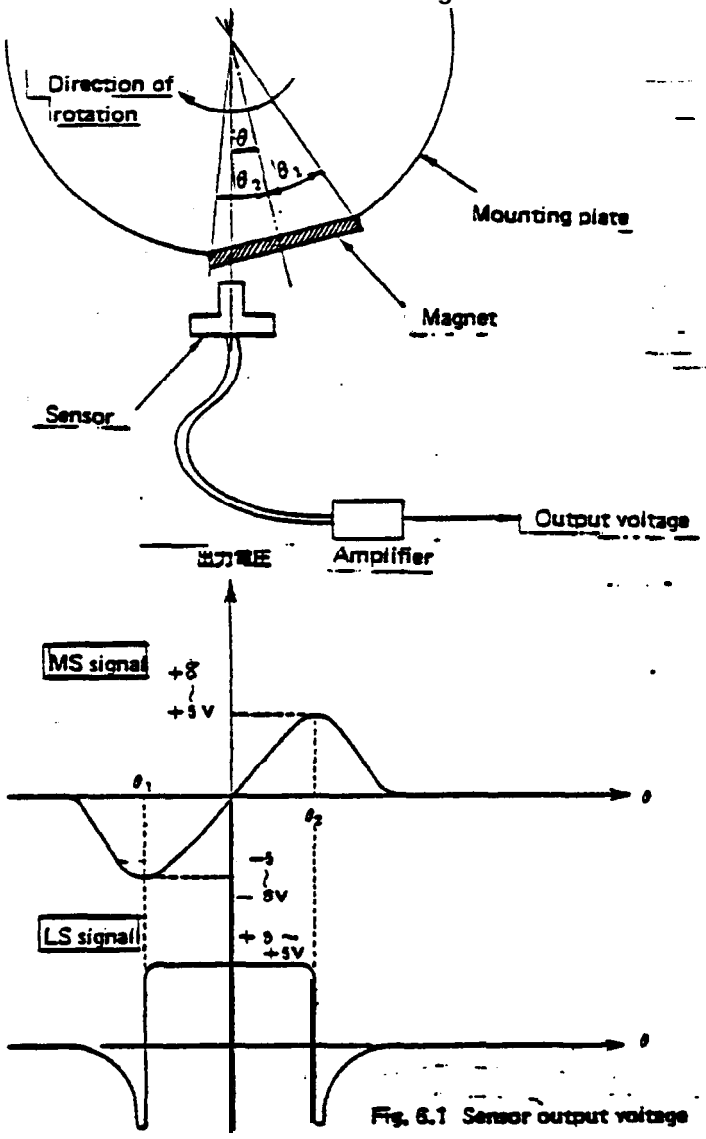


Fig. 6.1 Sensor output voltage

MS signal ..... Output voltage is zero when the sensor is located at the center of the magnet, and maximum at both ends of the magnet. The position control is based on the zero voltage position.

LS signal ..... Constant voltage is maintained within the tangs of the magnet, This signal is used to verify that the spindle is positioned within the range of the magnet

6.1.2 Time chart

Fig. 6.2 shows the time chart of each signal.

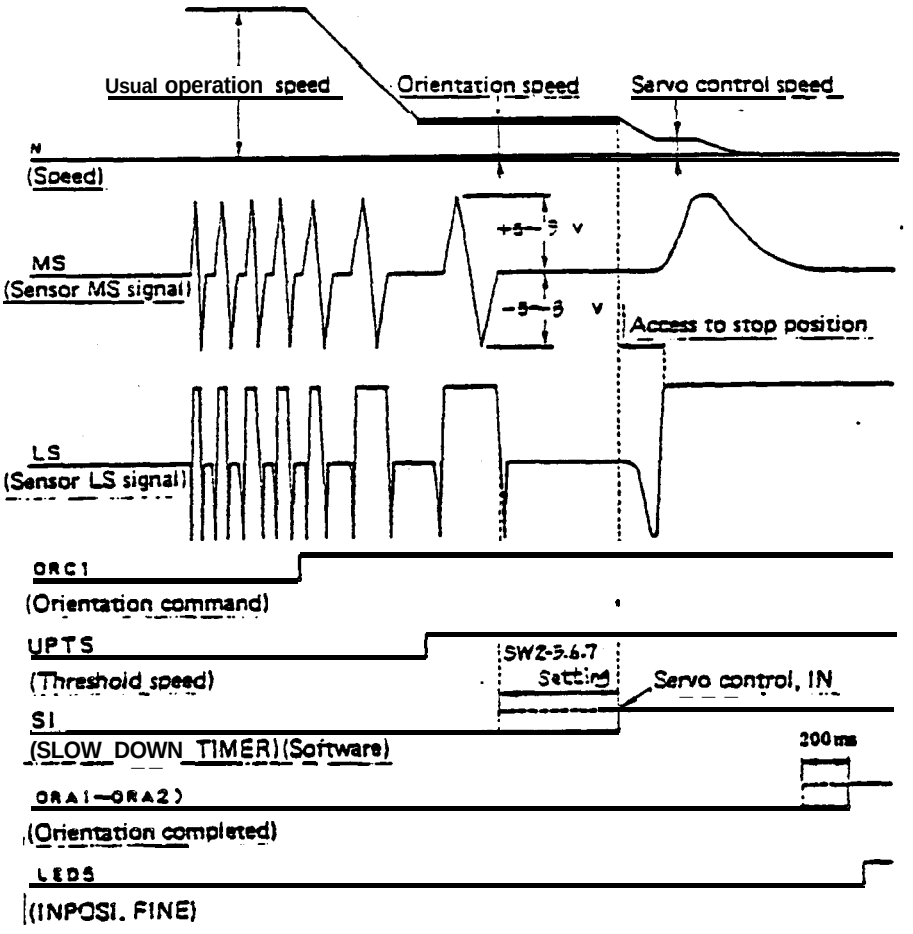


Fig. 6.2 Time chart

(1) When ORC1 (orientation command) turns on, the motor speed changes from usual operation speed to the orientation speed.

(2) When the motor speed reaches the orientation speed, the threshold speed signal (LED7) rises.

(3) After the occurrence of threshold speed signal and when the sensor LS signal turns to "L" level (when the magnet just passes over the sensor), the "slow down timer" (software) starts counting.

(4) The timer is set at SW2-5,6,7 When the timer counts up, orient speed control mode changes from the speed control loop to the position control loop (servo, IN).

(5) Under the position loop control, the spindle stops when the sensor MS signal reaches zero volt.

(6) When the spindle stops at the predetermined position, the orient completion signal rises and ORA1-ORA2 (orient completion contact signal output) closes in 200 ms after the stopping.

6.1.3 Direction of installation of magnet and sensor

The magnet and sensor must be installed in the specified direction, as shown in Fig. 6.3, 4 and 5.

(1) The center reference hole of magnet and the key groove of sensor should be on the same side.

(2) The center reference hole should be on the right side when tool attached to the spindle is on the left side (the reference hole should be opposite to the tool).

Case 1 When the magnet is installed on circumferential surface of rotating disc .....

The key groove and reference hole should be on counter-load side of the spindle, as shown in Fig. 6.3.

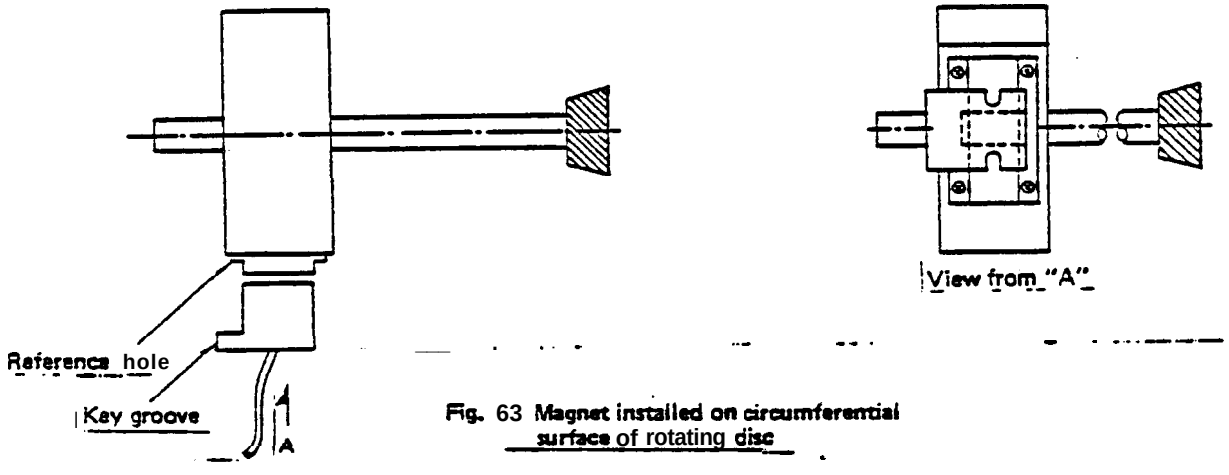


Fig. 63 Magnet installed on circumferential surface of rotating disc

Case 2 When the magnet is installed on the side face of rotating disc .....

(1) When the magnet and sensor are installed on. the counter-load side of the spindle, the reference hole and key groove should be inward.

(2) When the magnet and sensor are installed on the load side of the spindle,' the reference hole and key groove should be outward.

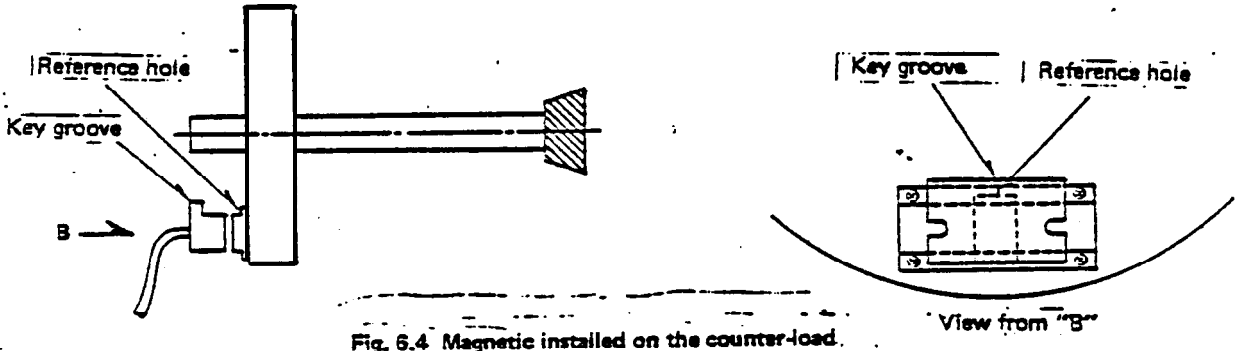


Fig. 6.4 Magnetic installed on the counter-load side face of rotating disc

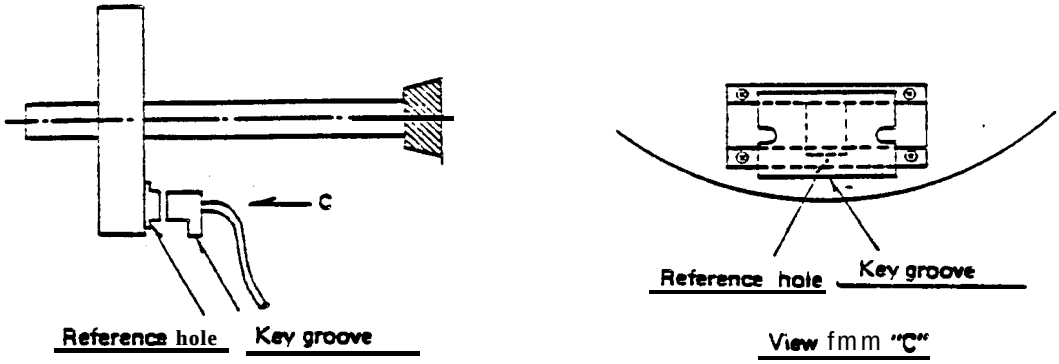


Fig. 6.5 Magnetic installed on the load side face of rotating disc

Notes: 1. When the magnet and sensor am installed in wrong direction, as exemplified in Fig. 6.6, the spindle is indexed not depending on direction of rotation of spindle.

2. If the magnet reference hole and the key groove are not on the same side, oscillation occurs between both edges of magnet and indexing is impossible.

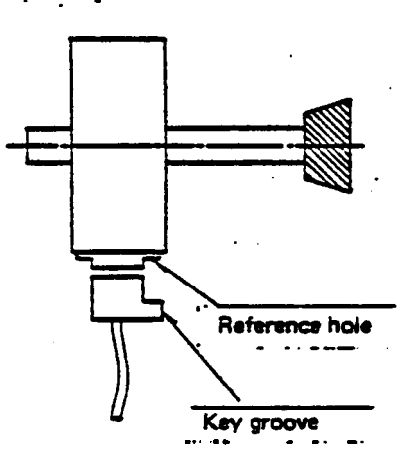


Fig. 6.6

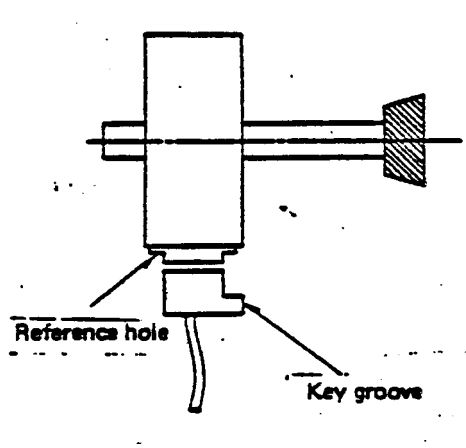


Fig. 6.7

6.1.4 Cautions on installation of magnet

The magnet should be installed with the following cautions:

(1) Do not allow access of any other powerful magnetic object to the magnet.

(2) Do not give physical shock to the magnet.

(3) Secure the magnet to the spindle using M4 screws.

(4) After the magnet has been installed, check and adjust the balance of the spindle.

(5) Adjust the magnet so that the center reference hole of magnet is aiigned with the center of rotating disc (its direction should be as iilusted in Rg. 6.3, 4 and 5).

(6) Clean the vicinity so that malfunction due to adhesion of imn particles to the magnet does not occur.

(7) Apply "lock paint" to the damping screws to prevent the screws from becoming loose.

(8) Since a ground rotating disc may have been magnetized, demagnetize the disc when the magnet is installed on a ground rotating disc.

(9) The diameter of rotating disc on which the magnet is installed should be within a range fmm 80 mm to 120 mm. However, disc of large; diameter may be used when the spindle rotates a low speed.

6. 1.5 Cautions on installation of sensor

The sensor should be installed with the following cautions:

(1) Install tie sensor so that the key groove of sensor and the magnet reference hole are on the same side.

(2) Align the center of sensor with the center of magna (see Fig. 6.3, 4 and 5)

(3) Adjust the gap between the magnet and the sensor to 1.5 mm ± 0.5 mm for installation shown in Fig. 6.3, and to 4.5 mm ± 0.5 mm for installation shown in Fig. 6.4, 5.

*It is recommended for mass production to prepare a gauge for this adjustment.

(4) Although the connector of the amplifier is of oilproof, it should be located away from oil.

(5) Segregage the cable between the amplifier and the controller unit from the power circuit cables.

(6) Check the connector wiring, securely set the plugs and tighten lock screws of each connector.

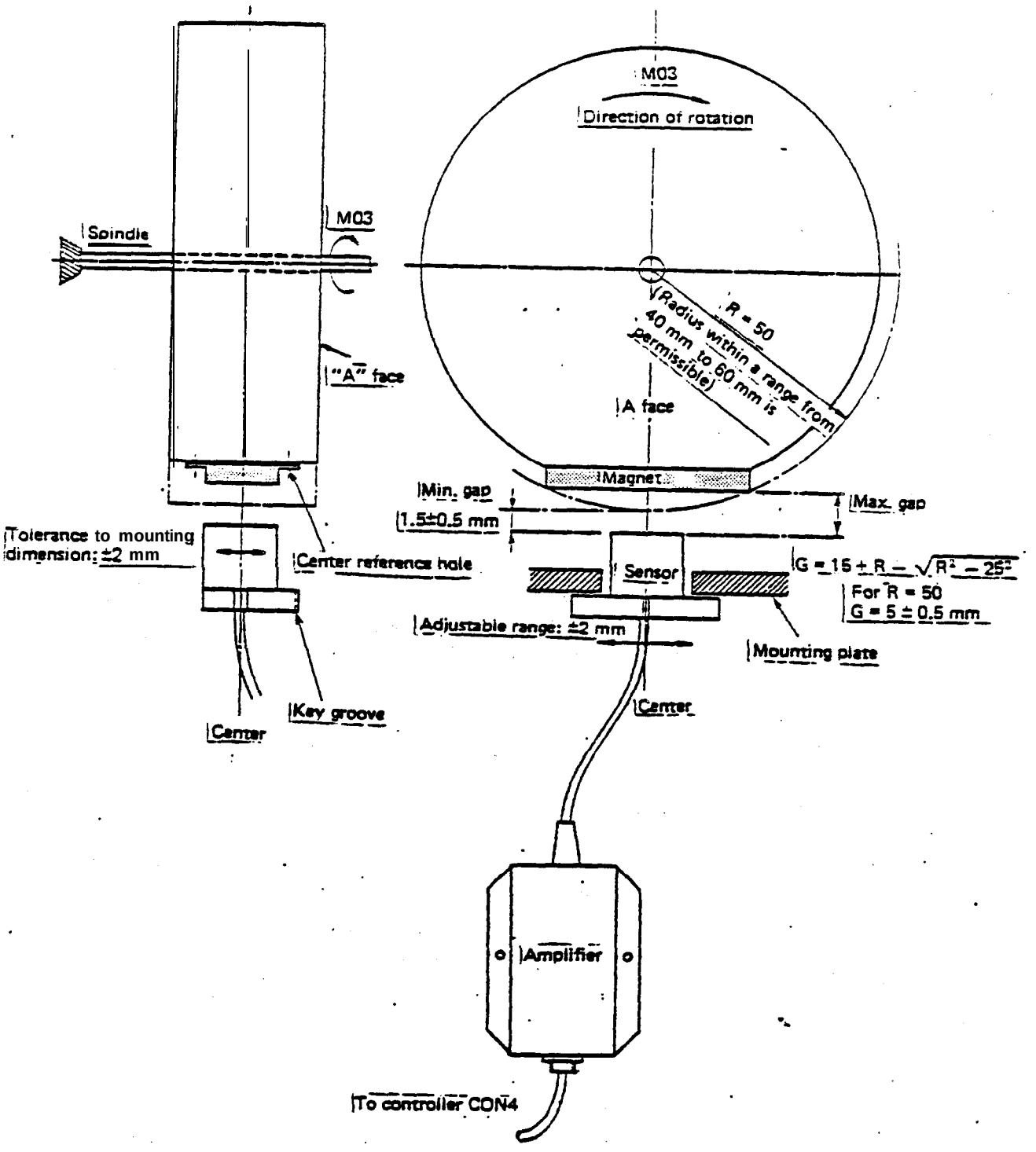
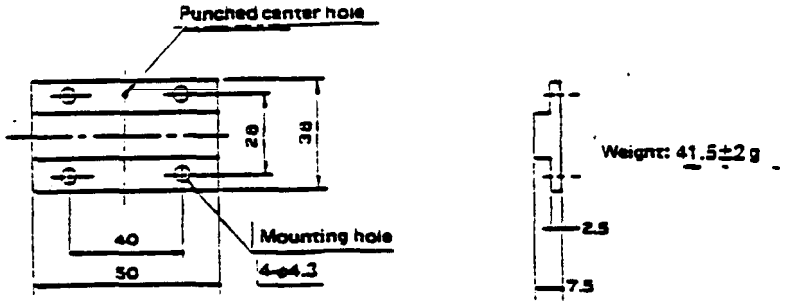


Fig. 6.8 Installation of sensor

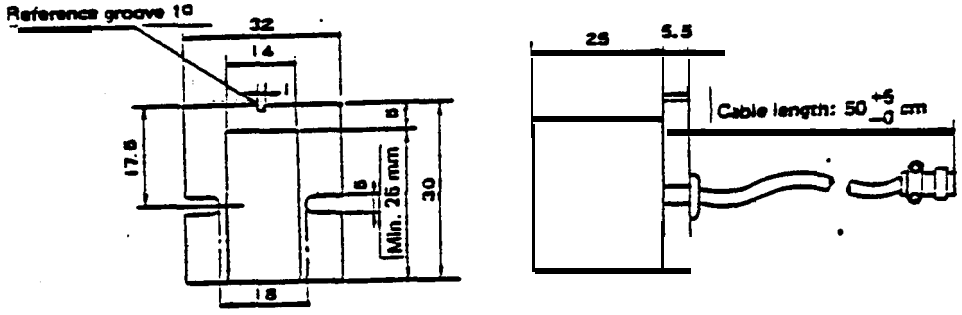
6.1 .S Overall view of magnetic sensor

(1) Magnetic sensor

1 Magnet



2 Sensor



3 Ampfilier

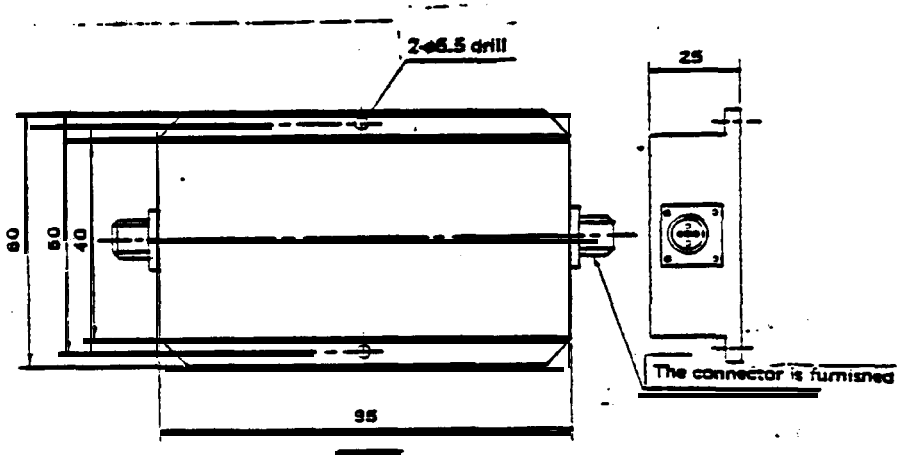


Fig. 6.9

6.2 Encoder type multi-point orientation

6.2. 1 Principle

Fig 6.10 schematically snows the principie of the encoder type multi-point orientation in the form of time chart.

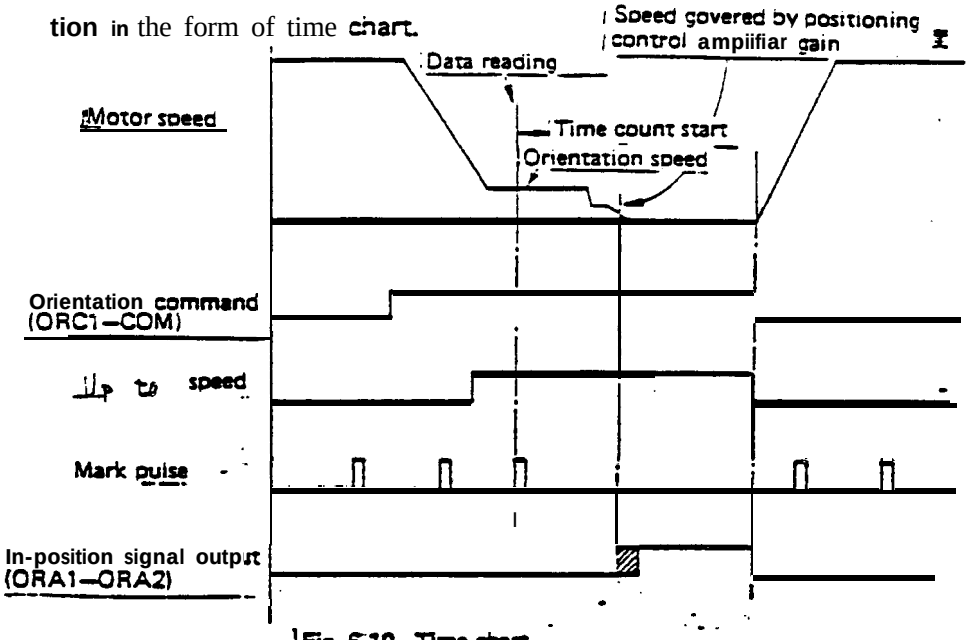


Fig. 6.10 Time chart

(1) Wii orientation command, motor speed changes to "orientation speed".

(2) When motor speed reaches the orientation speed, UP to speed signal (that is detected by comparator) rises. (soft-ware)

(3) When a mark pulse is accepted after the UP to speed signal rises, indexing position data (12-bit binary) is read and at the same time count starts.
The motor speed remains at the orientation speed.

(4) When the spindle reaches before the predetermined indexing (orientation) position, the control mode changes from the speed control loop to the position control loop and the motor speed changes from the orientation speed to the speed governed by gain of the positioning control amplifier.
setting valve of SW2-5.6.7

(5) The spindle enters the positioning control loop linear zone at before the predetermined indexing position and the motor is decelerated and then stops at the predetermined indexing position.
setting valve of SW 2-2.3.4

(6) "In-position" signal rises when the spindle reaches the point before the predeterminad indexing position by a distance (angle) equal to SW7 setting. In about 200 ms after that, "In-position" signal output contact closes.

(7) When the orientation command is removed, the motor starts rotating at the commanded (S command) speed.

(8) Repeating of orientation is possible after one turn of the spindle.
However, the spindle rotates over one turn depending on externally commanded indexing position and settings of SW10, SW9 and SW.

6.22 Encoder type multi-point orientation system composition

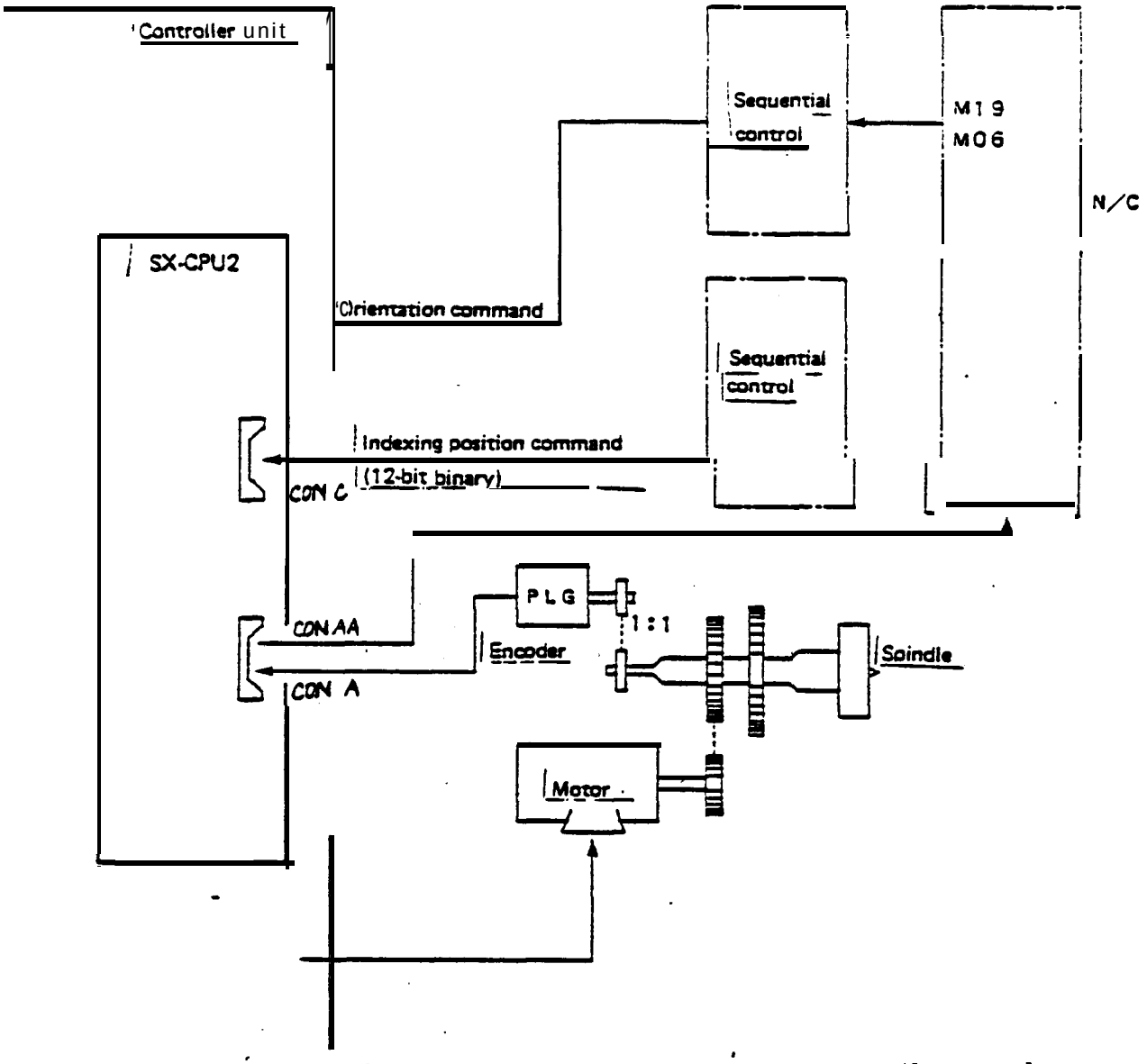
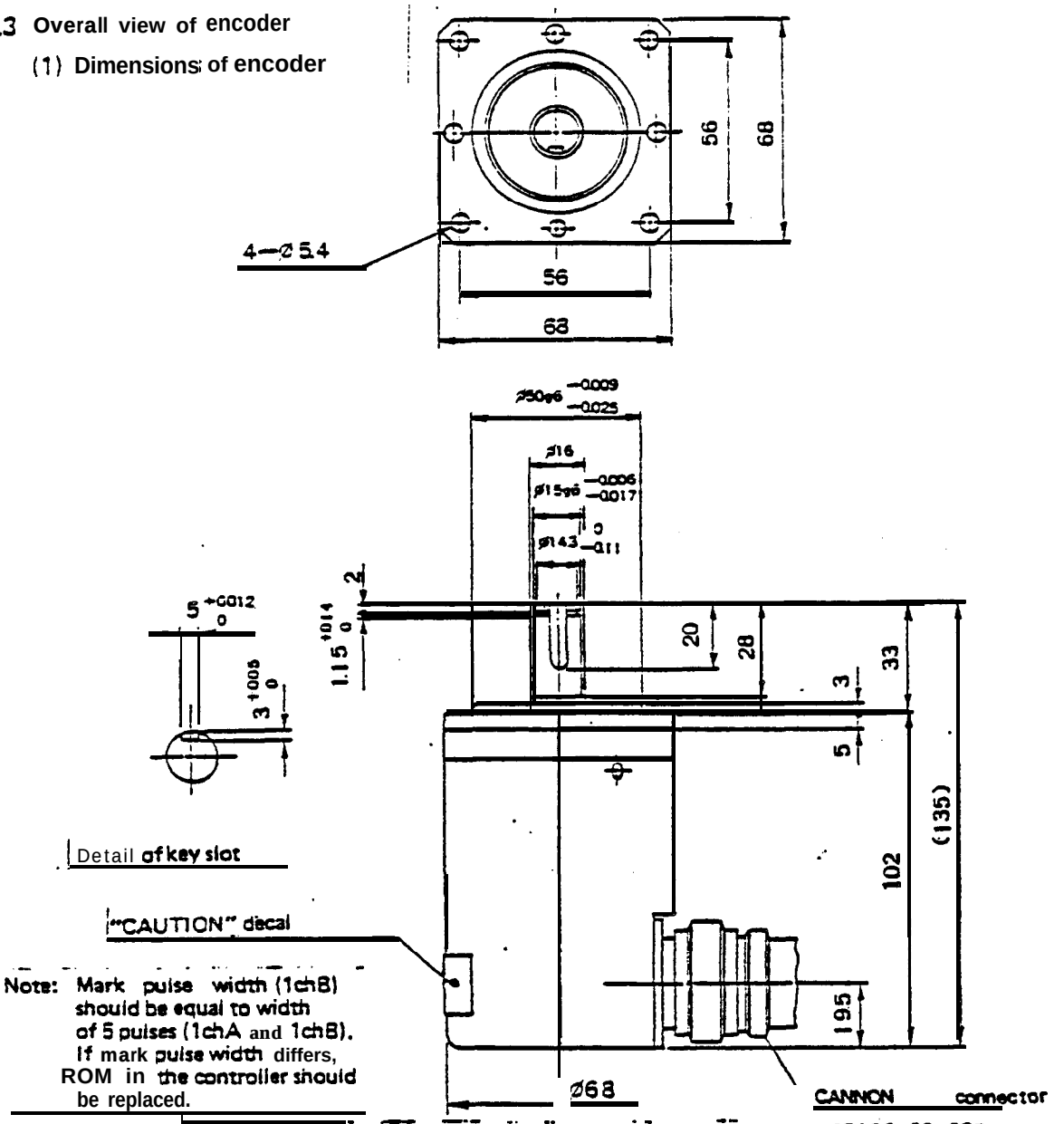


Fig. 6.11

Note: If direction of rotation differs between the motor and encoder, due to reduction gear meshing, adjust it by operating DIP switches SW2 – 8 of SX-CPU2.

6.2.3 Overall view of encoder

(1) Dimensions of encoder



Note: Mark pulse width (1ch8) should be equal to width of 5 pulses (1chA and 1ch8). If mark pulse width differs, ROM in the controller should be replaced.

Output terminal arrangement

A	1chA	K	0V
B	2chA	L	
C	1ch8	M	
D		N	*1chA
E	Case GND	P	*2chA
F		R	*1ch8
G		S	
H	+5V	T	
J			

CANNON connector

MS3102A20-29P

MS3106A20-29S

MS3057-12A

(Cable connector is not furnished)

*Reversing signal.

CHAPTER 7 TROUBLESHOOTING

7.1 Preliminary checking

If any trouble occurs with the controller unit, it is recommended to perform the following simple checking before starting the troubleshooting.

The preliminary checking is very helpful when you consult with our service agency.

Preliminary checking in case of controller trouble

1. Does any alarm lamp on the controller front panel light? If yes, identify the lamp.
2. Is any fuse blown out?

   If yes, identify the phase, fuse of which was blown out (R, S and T phases).
3. Is the same failure or trouble reproducible?
4. Are the ambient temperature and panel inside temperature within the specified range?
5. Did the trouble occur during acceleration, or deceleration or steady-speed operation7
6. Is direction of rotation proper?
7. Did momentary power failure not occur?
8. Does the same failure or trouble occur with specific operation or command?
9. Does the same failure or trouble occur frequently?
10. Did the trouble occur when load is exerted, or when load is removed?
11. Was any part replaced, or any remedy is *done* by yourself?
12. How many year has been operated the controller?
13. Is the source (line) voltage proper and stable? Does it change depending on time?

7.2 1st step troubleshooting

Perform the following checking at the 1st step of troubleshooting.

(1) Source voltage ..... 200V ± 10% 50/60Hz, 210V·220V·230V ± 10% 60Hz

In any case, the source voltage should not be below -10% of 200V.

Examples of source voltage drop:

- Voltage drops at a certain time every day.
- Voltage drops at start of a specific machine.

(2) Are peripheral control functions proper?

Examples of checking:

- Are NC and sequential control circuit in good condition?
- Is any failure or defect found in parts or wiring when checked visually?

(3) Is the temperature around the controller unit (and in the unit) within 50°C?

(4) Does the controller unit present good appearance?

Examples of checking:

- Are card components, circuit patterns, etc. in good condition?
- Are all wires securely connected?

  Is any part not damaged?

  It: there any foreign matter?

(5) Is the DC source output SW-PW at the soeciiied level?

The cause of the trouble may be roughly identified after the above checking. The *most likely troubles* with FR-SX can be categorized as follows:

- Trouble "A"
  - The controller turned on for me fim rime does not work satisfactorily . . . . . (I)
  - The controller that had been working in good condition came into standstill . . . . . (II)
  - The controller comes into standstill from time to time and stop position is not always exact . . . . . (III)

- Trouble "B"
  - Controller trouble
    - Defective semiconductor element in main circuit
    - Control circuit trouble
  - Detector trouble
    - Speed detection encoder trouble
    - Multi-point orientation encoder trouble
    - Single-point orientation encoder trouble
  - Power source trouble
  - Motor trouble
  - Other troubles (incomplete input signal conditions, open circuit due to disconnected wire or cable, etc.)

7.3 2nd step troubleshooting

Trouble (I)	Check-up	Remedy
Controller turned on for the first time does not work satisfactorily . . .	Since all units strictly and repeatedly checked before shipping, the most likely cause of the trouble is, (1) The controller was damaged due to large shock or intense strike during transport or installation.	(1) Visually check the appearance of the controller for damage.
	(2) Wrong external wiring, sequential control error, wire/cable disconnection Is grounding wire connected? Note: Difference in phase sequence does not cause any trouble.	(2) Make sure LED1 ~ LED4 (power indication) of SX-PW light Check the external wiring and sequential control.
	(3) Check ROM No. and DIP switch settings against the the order sheet.	(3) Replace ROM or change DIP switch settings if necessary.
	*(4) The motor does not run at the specified speed.	(4) Interchange motor armature connection between any two of three wires (U, V, W).
	(5) The motor can run satisfactorily only when load is not exerted.	(5) Check that the load meets the design value.
	(6) Exact indexing is impossible (stop position is not exact).	(6) Adjust
	(7) Controller alarm LED AL8, AL4, AL2 or All (LED12, LED13, LED14 or LED15) lights.	(7) Refer to para. 7.4.

Trouble (II)	Check-up	Remedy
Controller that had been woring in good condition came into standstill ...	(1) Check if fuse is blown out, or main circuit no-fuse breaker is tripped.	(1) Replace blown out fuse. If the new fuse is blown out again, perform the 3rd stop troubleshooting.

Trouble (II)	Check-up	Remedy
	(2) Check the input power source. AC200V ± 10% 50Hz AC200 ~ 230V ± 10% 60Hz	(2) Restore the power source if necessary. The power source should be that the power requirement shown to the left can be satisfied at all times.
	(3) Controller alarm LED AL8, AL4, AK or AL1 (LED12, LED13, LED14 or LED15) lights.	Refer to pas 7.4.
	(4) Check the input signals from NC or sequence control. LED? (READY) should light when the system is ready for operation. LED3 (CW) should light for CW rotation start. LED4 (CCW) should light for C.CW rotation start.	14) Enter the correct external signals.
	(5) SW1-2 "OFF" open SW3-3, 4, 5 "OFF" cushion Check if "open" operation is possible by operating RESET button (10S).	(5) Speed feedback encoder is defective if operation is possible (replace the encoder). If operation is impossible, the trouble will be attributable to the main circuit (alarm LED will light).

Trouble (III)	Check-up	Remedy
Controller comes into standstill from time to time . . . Stop position is not exact at all timer Alarm LED lights. Condition is restored by turning on and off the power, or by resetting.	It is very important to be exactly aware of the conditions under which the trouble occurs (load condition, operation mode). The cause (3) is posisible.	
	(1) Instantaneous power failure or source voltage drop or "NF TRIP" (when instantaneous power failure occurs during generative braking) "CONVERTER IOC" alarm LED may light.	(1) Check the power source for source voltage regulation.

Trouble (III)	Check-up	Remedy
	(2) Malfunction due to extremely large noise The controller itself can withstand the line power noise up to 1600V/ins (max. 2000V/ lus) in both common mode and normal mode.	(2) Identify noise source and install noise suppressor to the noise source. Check grounding (particularly grounding of detector). Check case grounding.
	(3) Check if load increases momentarily due to vibration, or the like. Check with a particular care if indexing error occurs	(3) Carefully check the mechanism.

7.4 Detailed checking for each trouble

1. If alarm LED lights. ..

The alarm LED of the protection that first gets into function lights.

(1) MOTOR OVER HEAT

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	0	0	1

Current does not fiow into OHS1 and OHS2

Cause	Check-up	Remedy
Over-load	1. Check the motor loading condition. 2 Check start/stop frequency.	1. Lighten the load. 2. Decrease the start/stop frequency.
Fan trouble	Check the fan motor for condition.	Remedy or replace the fan/fan motor.
Motor air intake dogged	Check ventilation (air feed rate).	Clean.
Thermal protector aoubie	Check if resetting is possible after rotating the motor fan for several minutes with the motor stopped	1. Short-circuit between OHS1 and OHS2 and continue the operation. 2 Replace the motor.

(2) EXCESSIVE SPEED ERROR

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	0	1	1

When speed control error (difference between commanded speed and actual speed) is larger than specified level (500rpm) . . .

Cause	Check-up	Remedy
Over load	1. Check the motor loading condition.	1. tighten the load.
Speed detection encoder trouble	1. "Open" operation is possible.	1. Replace the encoder.
Card trouble	1. SX-CPU1 or 2 card, SX-IO1 card Double	1. Replace the card CPU 1 or CPU2 first and then 101.

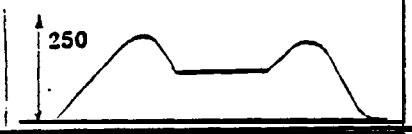
(3) BREAKER TRIP

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	1	0	0

LED lights when the main no-fuse breaker trips.

It is possible that IOC (converter, inverter) lights first.

Cause	Check-up	Remedy
Power source voltage drops below 180V.	Check if source voltage goes down the specified level during deceleration (regenerative braking).	Since transient voltage is likely to drop below 180V if source voltage is near 180V during usual operation, boost the source voltage.
IOC trip (Refer to the description about IOC trip)	RefRefer to the descriptionut a b o u t IOCIOC trip.	

Cause	Check-up	Remedy
Converter voltage oscillates during deceleration	Check the maximum speed start/stop waveform when the converter is under full-voltage load condition. 	○ Change acceleration/deceleration constat. ○ Change load GD^2 ○ Replace card SX-101 if necessary.
Phase disconconection	Any phase of input power source is disconnected and PLL is released from locking.	Open and close the no-fuse breaker (power) to check the power.

(4) PHASE LOSS (PHASE DISCONNECTION)

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	1	0	1

Check to see if the corresponding alarm LEDs light when the power is turned OR.

Cause	Check-up	Remedy
Any phase is disconnected	Check voltage at each phase.	Three phases should be connected.
Fuse Ft, 2 or 3 is blow out	Check the cause of blowing out of fuse (short-circuiting, for example).	Replace the blown out fuse.

(5) EXTERNAL EMERGENCY

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	1	1	0

The corresponding LEDs light when external emergency stop signal is given.

Check the cause of emergency stop and then reset.

(6) OVER SPEED

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
0	1	1	1

The LEDs lights as shown above when the motor speed exceeds 115% of the maximum speed and the over speed detector trips.

Cause	Check-up	Remedy
Improper max. speed setting	Check the settings of SX-IO1 PIN1 and SX-CPU SW1-7.	Correctly set if necessary.
Speed detector trouble	Check the encoder output CPU card (CH59 ~ CH57, CH60 ~ CH57) CPU1 card (CH56 ~ CH54, C ~ CH52)	Replace the detector. $\frac{512 \times 1500}{60}$ = 12.3 KHz at 1600 rpm
Speed control detecting circuit trouble	Defective cards	Replace the card SX-CPU first and then SX-101.

(7) IOC TRIP (INVERTER, CONVERTER)

Converter IOC

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	0	0	0

Inverter IOC

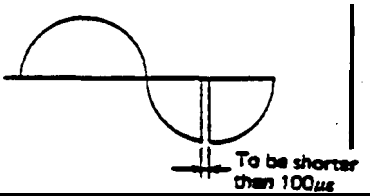
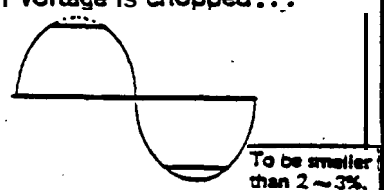
AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	1	0	0

IOC trip occurs on the inveter side as well as the converter side, due to overcurrent.

Check the cause of overcurrent.

It is likely that any main circuit semiconductor element is damaged if IOC trip occurs again when the RESET button is depressed..

Cause	Check-up	Remedy
Power transistor is damaged.	Remove the connection between the controller and the motor and operate only the controller to see if the alarm LEDs (IOC TRIP) light or not. • If LEDs light the power transistor is defective. • If LEDs does not light, proceed with the next step.	Replace the power transistor.

Cause	Check-up	Remedy
To large motor load	Check the load to the motor.	tighten the load.
Wrong motor wiring	Check the motor wiring. Check terminal screws for looseness.	Correct motor wiring if necessary Tighten loose screw.
Motor winding layer short-circuiting or grounding	Measure the insulation resistance. If insulation resistance is smaller than 1 Megohms, the motor is defective.	Replace defective motor.
Commutation fails at re-generative braking, due to low source voltage.	The source voltage should be larther than 180V at R, S and T phases.	Boost the power voltage.
Too small power source capacity	Source voltage should be at least 180V at acceleration/deceleration as well as under loaded condition	Increase power source capacity.
Power source voltage wave-form trouble	Observe the source voltage wave-form during acceleration and deceleration using a synchro-scope. 1. *If voltage* discontinues partially . . .  2 If voltage is chopped . . .  	Improve waveform. 1. increase the power source capacity or us8 a cable of larger size. 2. Remedy semiconductor unit that causes deformed wave-form.
Source frequency trouble	Source frequency should not hang8 over ±3%.	Improve tie power source.
Current detector circuit trouble	Inverter CH11 ~ AGA: 10V peak Converter CH9 ~ AGA: 10V peak	Replace card SX-101.

(8) CONTROLLER OVER HEAT

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	0	0	1

Tine alarm LEDs light as shown above when the controller thermal protection works (cooling fan installed).

Cause	Check-up	Remedy
Overload	1. Check motor ioading condition. 2 Check start/stop frequency.	1. Lighten the load. 2. Decrease start/stop frequency.
Ambient temperature is too high.	Measure the ambient temperature around the controller.	If the temperature exceeds 50°C, cooling method shouid be improved.
Thyristor cooling fan trouble	Check the cooling fan operation.	Replace the cooling fan.

(9) UNDER VOLTAGE (VOLTAGE DROP)

AL8 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	0	1	0

The LEDs light as shown above, when the input source voltage goes down beiow 170V ~ 164V for 15 ms or longer.

Cause	Check-up	Remedy
When usual operation can resumed after resetting.	The LEDs light when speed is changed or too large bad is exerted.	Increase the power source capacity.
When the LEDs light continuously.	When the input power source is normal, the most likely cause is SX-PW card trouble. Signal level across SX-PW terminals ACDOWN and D05A is to be "H" level when the control circuit is normal (+5V).	Replace SX-PW card.

(10) OVER VOLTAGE (CONVERTER)

AL3 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	0	1	1

The LEDs light when the voltage in the incorporated smoothing capacitor exceeds the permissible level.

Cause	Check-up	Remedy
Overload	If the LEDs light during deceleration of motor, check the load.	Lighten the load.
GD^2_L is too large.	If the LEDs light during deceleration of motor, check the load.	tighten the load. Acc/DEC time constant increase SW3-3,4,5
Converter voltage control is not in good condition.	Check that voltage across P and N terminals of main circuit capacitor is below DC250V under usual operating condition, and if it changes depending on the	If the voltage exceeds 250V, or does not change depending on the speed, the cause of the trouble is defective converter. Replace SX101 card ↓ Replace SX-CPU card
Detector circuit trouble	If the cause of trouble is other than described above, trouble with the detector circuit is' possible.	Replace SX-101 card.

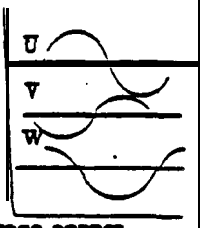
(11) CPU trouble

AL3 (LED12)	AL4 (LED13)	AL2 (LED14)	AL1 (LED15)
1	1	0	1
1	1	1	0
1	1	1	1

CPU troubles include arithmetic operation error or logic error.
Reset and try operation again to see the condition. Card or CPU chip must be replaced depending on the trouble.

2. Troubles that do not cause lighting of alarm LED

(1) The motor does not run at all though no alarm LED lights. . .

Cause	Check-up	Remedy
Wrong wiring or wire disconnected.	Check the wiring.	Properiy connect wirer
Unusual power source Voltage change	Check that the source voltage is at 200V 50Hz/200 ~ 230V 60Hz	Restore the power source.
DC source trouble	Check all output voltages of SX-PW card using a multi-meter.	Replace the card if necessary.
Card trouble	Operate SW1-SW2 to "OFF" (usually "ON") for "open" mode and check that the reference sine wave occurs when commanded speed is increased. SX-101 card CH16-AGB CH15-AGB CH14-AGB  The converter voltage across terminals P and N should be DC50V when the power is turned on.	When the card is in good condii tion. Replace card SX-101 fim and then SX-CPU.

(2) The motor can run only at low speed, though no alarm LED lights. . .

Cause	Check-up	Remedy
Wrong motor wiring	Check that motor cable is connected to the output terminals (U, V, W) of controller in correct phase sequence.	Change connection if necessary.
Power source trouble	Check that the power source is in good condition at each phase.	Restore the power source.
Improper speed command (external)	Check that the motor speed follows the external speed command	Improve the external speed command circuit.

Cause	Check-up	Remedy
Speed detector encoder trouble	Set SW1-2 to "OFF" to make sure "open" mode operation is possible.	Replace the encoder ii necessary.

(3) The motor does not run at the commanded speed within a specific speed range. . .

cause	Check-up	Remedy
Improper external speed command	Check that external speed command can linearly very from OV to 10V (CH3-AGA).	Remedy or improve the external speed command circuit

(4) Motor torque is not sufficient.

Perform the checking per steps (5), (6) and (7).

(5) Times taken for start and stop become longer. . .

Cause	Check-up	Remedy
increase load	Check the load.	Lighten the load.

(6) Threshold speed signal (UP-TO SPEED) does not output.. .

Cause	Check-up	Remedy
Card SX-101 trouble of output circuit trouble	Check that LED7 of SX-CPU lights when acceleration/deceleration is completed. If it lights, tire cause of trouble will be defective output circuit	Replace card SX-101.
Threshold speed detector trouble.	LED7 (UP-TO SPEED) of SX-CPU will not light	Card SX-CPU trouble. Replace the card

(7) NC feed is ineffective. . .

The most likely cause of this type of trouble is that the threshold speed detection does not function properly. Check the relay sequential operation and also perform checking per step (10).

(8) Speed detection signal does not output ...

Cause	Check-up	Remedy
Card SX-101 trouble	Check that LED5 of SX-CPU1 lights when the motor speed exceeds the preset speed. If it lights, the output circuit is defective.	Replace the card SX-101.
Speed detector circuit trouble	LED5 of SX-CPU2 will not light	Card SX-CPU trouble. Replace the card.

(9) Zero speed detection signal does not output. ..

Cause	Check-up	Remedy
Trouble with relay RA1 of card SX-101	Check that LED 10 of SX-CPU lights at motor speed below 25 rpm or 50 rpm. If signal does not output even though LED 10 fights, the most fikeiy cause of the trouble is defective relay.	Replace relay RA1 or card sx-tot.
Zero speed d-r cir-cuit trouble	If LED10 does not light, the cause of the trouble will be defective detector circuit.	Replace card SX-CPU1 or CPU2

(10) Speed range is not selectable.. .

The most likely cause of this type of troulbe is that the speed detect function or zero speed function does not work properly.

Perform checking per steps (12) and (13).

(11) Motor speed cannot be accelerated over a certain speed ...

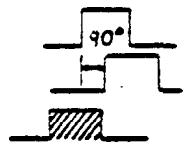
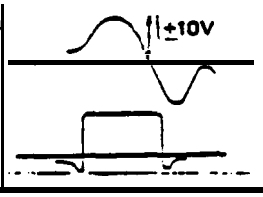
Perform checking per step (7).

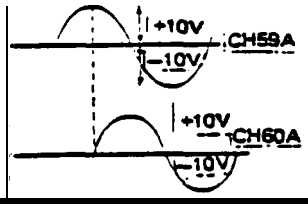
(12) Vibration/noises are too large. ..

Cause	Check-up	Remedy
Converter voltage is too high or low.	Voltage across terminals P and N should be DC50V when it is measured with the motor stopped after turning on the power.	Adjust the voltage by turning VR32 of card SX101. If adjustment is impossible, replace card SX-101.
Too large voltage is applied to the motor.	Voltage at CH5A of SX-101 should be ±5.5V when the motor runs at the maximum speed.	Ad just the voltage by turning VR24 of card SX-101.

Cause	Check-up	Remedy
Decreased insulation resistance	Disconnect the power cable connection (R, S, T) and measure insulation resistance as follows, using a multimeter (each wire connected to GND terminals should be disconnected). (a) Between entire main circuit and ground ... At least 20 Megohms (Terminals: X_1, X_2, X_3, U, V, W, MS1, MS2) (b) Between control circuit COM and ground. .. At least 20 Megohms (Terminal: OM of terminal block TB1 (Card I01)) (c) Between entire control circuit and COM of control circuit ... At feast 20 Megohms	if insulation resistance is found decreased, remedy or replace deteriorated part
Motor bearing rouble	Turn the motor by hand to check that the motor can rotate smoothly.	Replace bearings if necessary.
Poor motor installation	Check motor mounting screw for looseness.	Retighten the screws.
Motor shaft runout	Check if any trace of strike is found on the motor shaft	Remedy or replace the motor.
Unbalanced reference sine waves	Check balance of waveform observed at CH16, CH15 and CH14 ~ AGB of card SX-I01.	Adjust balance of current in card SX-I01 or replace the card.

(13) Speed control is **usual but orientation (indexing) is out of control ...**

Cause	Check-up	Remeay
Spindle does not stop at the predetermined position, though orientation speed can be achieved.	**Check the position detecting encoder *or* magnetic sensor for function.** **Run the motor under only speed control and check position detecting (feedback) function.** **SX-CPU2 (in CW rotation)** CH55-DGA CH54-DGA CH53-DGA Mark pulse  **SX-CPU1 (in CW rotation)** CH58-AGA (I16-6) CH57-AGA  	**Replace** encoder or magnetic sensor. **Replace card SX-CPU if the card interface is defective.** ENCODER ORIENTATION Check the SW2-8 in SX-CPU2 CARD
Stop position differs depending on direction of orientation.	**Mark pulse width is improper.** **Mark pulse width is not equal to 5 pulses (FBx4 times).**	**Replace detector (encoder or magnetic sensor).** **Replace with RFH- 1024-22-I -68, or equivalent, or replace ROM.** NICON
Hunting occurs when spindle stops.	**Try to decrease position control loop gain.** **Decrease the orientation speed.**	**SX-CPU2 SW2-2 ~ 4** **SW2-5 ~ 7** **(Position control loop gain)** **SW6** **Orientation sped** **SX-CPU1 SW5-3 ~ 4** **SW6** **Orientation speed**
Stop position differs depending on gearing ratio.	**Check gearing ratio setting.** **Check setting of DIP switches SW4-2 ~ 7.** **Check ROM No.**	**Change gearing ratio setting if necessary. When gearing ratio setting is proper, adjust is proper, adjust position control loop gain and/or orientation sped**

Faint servo STIFFNESS	o Check that converter voltage is about 30V. when the spindle is indexed. o Check that inverter current of SX-IO1 (CH11 ~ AGA) is A (about V). *0 Run the motor at low speed to observe the* waveform at CH59A and CH60A. CW rotation 	When voltage is improper, replace card SX-I01. When current is improper, replace card SX-I01. If the waveforms are not as shown to the right, adjust them by turning V R 13 of card SX-CPU2 Adjust by turning VR14.

8.1 Replacement of each card

(1) Card SX-PW

If DC voltage is unusual, replace this card.

To replace this card, card SX-IO1 should be removed.

(2) Card SX-CPU1

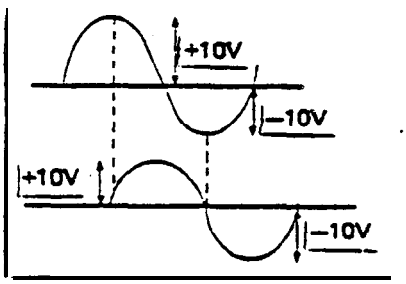
Replace this card after checking ROM No. DIP switch settings and set pin settings.

Adjust magnetic sensor sensitivity (VR4) and orientation shift (VR3) again.

(3) Card SX-CPU2

Replace this card after checking ROM No., DIP switch settings and set pin settings.

If indexing (spindle stop) position is problematic, run the motor at low speed and adjust as follows:



CH59A-AGA (CH57) VR13 (SX-CPU2)
CH56A-AGA (CH54) ---- VR14 (SX-CPU1)

CH60A-AGA (CH57) VR14 (SX-CPU2)
CH55A-AGA (CH54) ---- VR17 (SX-CPU1)

If the voltages are not adjusted to ±10V, turn and set VRf3 and 14 to adjust.

(4) Card SX-IO1

Replace this card after checking set in pin settings.
Note that the connectors for connection to the main circuit is on the back of B panel.

Usually no adjustment is required when this card is replace. If large gear sound or speed ripple occurs, however, perform balance adjustment.

CH16-AGB ("U" phase reference sine wave)
CH15-AGB ("V" phase reference sine wave)
CH14-AGB ("W" phase reference sine wave)

(5) Card SX-AJ1

No trouble will occur with the parts of this card, except for blower control relays. If the card is replaced, all variable resistors must be set again.

8.2 Thyristor module and transistor module

1. Removal of defective module

Disconnect the wires connected to the module, remove the heatsink and then defective module.

Note that plug-in terminal is used for thyristor module gate terminal G, transistor module base terminal B and emitter terminal E.

2. Applying the silicon grease to the module

Evenly apply silicon grease to the reverse surface of the module.

3. Securing the module

Secure each wire *with the specified* damping torque

Be sure to put a silicon tube to the thyristor module gate terminal, transistor module base terminal and emitter terminal as they were.

Note: SINCE THYRISTOR AND TRANSISTOR ARE OF SPECIAL SPECIFICATION, ORDER THEM TO US FOR REPLACMENT OR SPARE.

	Model	Screw size	Max. damping torque (kg-cm)	Recommended damping torque (kg-cm)
Tyristor	TM55DZ-H TM90DY-H	M6 x 1.0 M6 x 1.0	30 30	20±2 20±2
Transistor	QM100DY-H DM200HA-H DM150DY-H	M5 x 0.8	20	17±2

Table 6.1 Camping torque list

8.3 Speed detector and shaft coupling

Referring to Fig. 8.1 "AC spindle motor construction" and Table 8.2 "Parts list", replace pares of speed detector and/or shaft coupling as follows:

(1) Remove terminal box cover 5 and disconnect the cables used to connect the motor to the electrical panel.
Three motor main leads (U, V, W), two cooling fan leads (BU, BV), overheat detector leads (OHS1, OHS2) and plugs of speed detector connecter 4 .

(2) Remove the terminal box cover with unused wiring hole and loosen two coupling set screws 23 (distant at about 90' from each to other) that secure the motor shaft to coupling 22 using a hexagon wrench key (M4) passed through the wiring hoie,

(3) Remove four speed detector mounting screws 21 and remove speed detector 24 from coupiing 22 .

(4) Loosen other two coupling set screws 23 and remove coupling 22 from the shaft.

(5) Replace speed detector 24 and/or coupling 22 .

(6) Assemble in the reverse steps to the above steps.

> Notes: 1. Do not exert force to protection cover 2 in such a manner that the flange of speed detector 24 is mis-aligned with the motor shaft
> 2. Do not exert force to the bellows of coupling in such a manner that the bellows are bent or expanded.

8.4 Cooling fan

Referring to Fig 8.1 "AC spindle motor construction", Table 8.2 "Parts list" and Fig. 8.2 "Cooling fan leads", replace the cooling fan as follows:

(1) Remove terminal box cover 5 and cut four cooling. fan leads 26 that extend forward from the back of the terminal box from the portion shown in Fig. 7.2.

(2) Remove four cooling fan mounting screws 25 and gird net and remove cooling fan 1 from protection cover 2 .

(3) Install a new cooling fan and pass cooling fan leads 26 through the hole at the back of terminal box.
Connect four leads (green, white, black and red) to each corresponding lead using crimp type terminal or by soldering.

(4) Tighten cooling fan mounting screws 25 and install the gird net.

> Note: Connected portion of each cooling fan lead 26 should be i&&ted by adhesive tape.

8.5 Bearings

Referring to Fig.8.1 "AC spindle motor construction" and Table 8.2 "Parts fist", replace bearing as follows:

(1) Remove speed detector 24 and coupling 22 as described at para. 8.3.

(2) Remove four protection cover mourning bolts 6 using a hexagon spanner-and-remove protection cover 2 together with cooling fan I from the bracket-9 on the counter-load side.

> Note: Carefully draw out motor main leads (U, V, W) and overheat detector leads (OHS1, OHS2) from the lead hole of protection cover 2 .

(3) Remove four bracket mounting bolts 8 that secure bracket 9 on the counter-load side to frame 14 using a spanner.

(4) Remove four bearing holder plate mounting screws 7 with screwdriver and disconnect bearing holder plan 10 from bracket 9 on the counter-load side.

(5) Draw out rotor 11 toward the counter-load side and remove stator 12 from the interior.

(6) Using a press or bearing remover, remove bearing 18 on the load side and bearing on the counter-load side are replace them.

> Note: Make sure preload spring is located at bracket 15 on the load side, and bearing holder plate 10 between bearing 20 on the counter-load side and rotor 11.

(7) To reassemble, fit bracket 9 on the counter-load side to bearing 20 on the counter-load side, tighten four bearing holder plate mounting screws 7 and properly position bracket 9 and bearing holder plate 10 .

(8) Align the motor leads in reference to the lead hole 'of bracket 9 on the counter-load side and insert rotor 1 1 attached to bracket 9 into stator 12 .

> Note: Preload spring 16 should be inserted between bracket 15 on the load side and bearing 18 on the load side.
> Care should be taken not to damage the coil when the rotor is inserted into the stator.

(9) Tighten four bracket mounting bolts 8 on me counter-load and secure bracket 9 to frame 14 .

(10) Tighten four bearing holder plate mounting screws 7 using a screwdriver and secure bearing holder plate 10 to bracket 9 on the counter-load side.

(11) Remove the sealing agent from the surface where bracket 9 and protection cover 2 are in contact with each other and apply a new oil-resistant sealing agent there. While drawing out the leads from the lead hole, securely fit protection cover 2 to bracket 15 by hand.

Placing cooling fan 1 upward, alternately tighten two (left and right) protection cover mounting bolts 6 .

Tighten one lower protection cover mounting bolt 6 and then upper one.

> Note: Since accuracy of installation of protection cover 2 to bracket 9 on the counter-load side is largely influential to adequacy of shaft connection, accurately install protection cover 2 as instructed above.
> It is recommended to ma&e sure runout of motor shaft, and the flange of speed detector 24 is within about 0.2 mm (TIR).

(12) For reassembling of speed detectors 24 and 22, refer to para. 8.3.

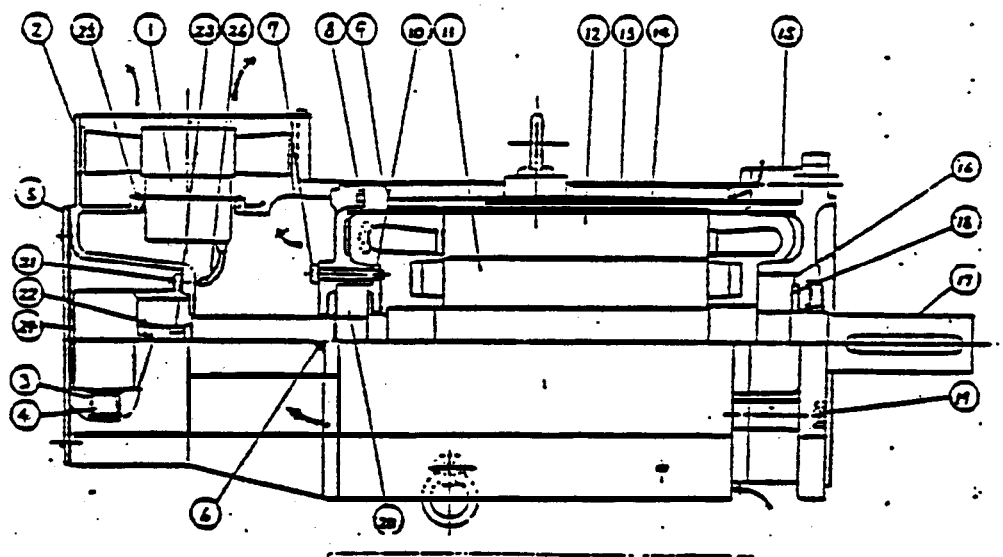


Fig. 8.1 AC spindle motor construction

Table 8.2 Parts list

No.	Name	No.	Name
1	Cooling fan	15	Bracket on load side
2	Protection cover	16	Preload spring
3	Speed detector connector mounting plate	17	Shaft
4	Speed detector connector	18	Bearing on load side
5	Terminal box cover	19	Bracket mounting block on load side
6	Protection cover mounting bolt	20	Bearing on counter-load side
7	Bearing holder plate mounting screw	21	Speed detector mounting screw
8	Bracket mounting bolt on counter-load side	22	Coupling
9	Brakcet on counter-load side	23	Coupling set screw
10	Bearing holder plate	24	Speed detector (ENCODER)
11	Rotor	25	Cooling fan mounting screw
12	Stator	26	Cooling fan leads
13	Frame cover		
14	Frame		

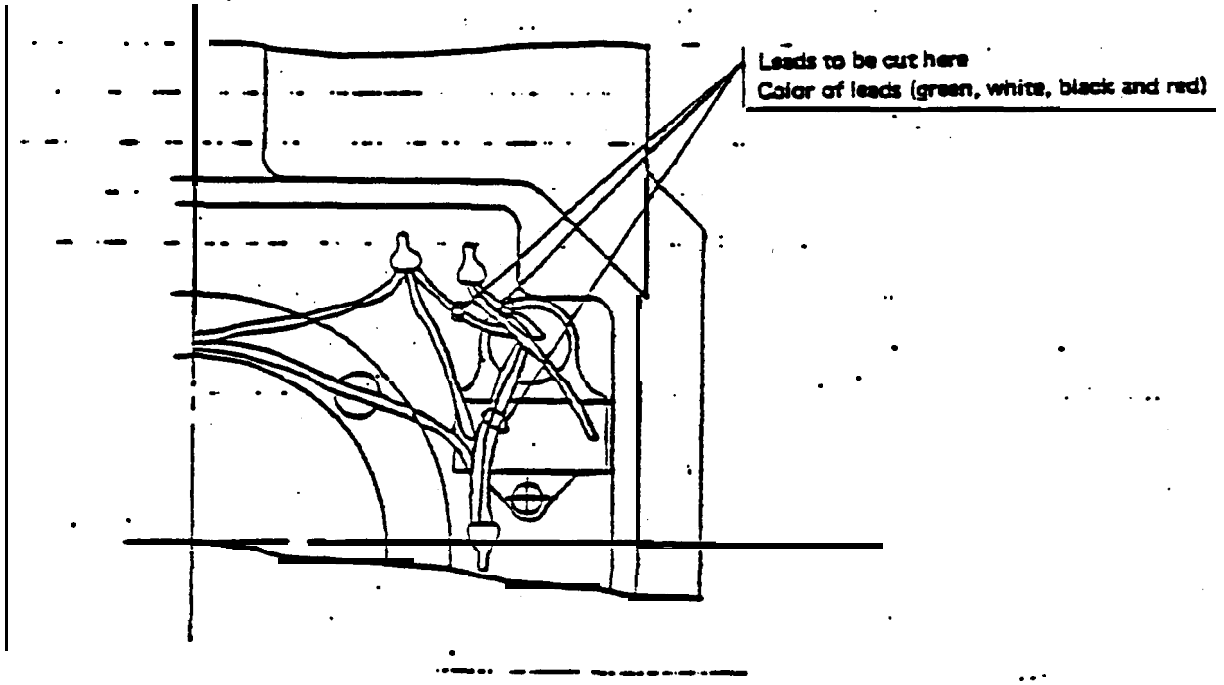


Fig. 8.2 Cooling fan leads

AC SPINDLE CONTROLLER & MOTOR (TYPE FR-SX-2)

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

EM	DECRIPTION	TYPE kW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	OPTION A	OPTION B	OPTION C	NOTE
1	CIRCUIT BREAKER	5.5 7.5	NF50CB BK0-C1572-35-50A	MITSUBISHI ELECTRIC	CB1	1	0	0	0	1	
		11 15	NF100CB BK0-C1572-37-100A								
		18.5 22	NF225CB BK0-C1572-39-150A								
2	THYRISTOR	6.6 7.6 11 15 16.5 22	TM90DZ-H	MITSUBISHI ELECTRIC	SCRR-F SCRS-F SCRT-F	3	0	0	0	3	FOR CONVERTER
3	THYRISTOR	5.5 7.5	TM55DZ-H	MITSUBISHI ELECTRIC	SCRR-R SCRS-R SCRT-F	3	0	0	0	3	FOR CONVERTER
		11 15 18.5 22	TM90DZ-H								
4	TRANSISTOR	5.5	QM100DY-H	MITSUBISHI ELECTRIC	TRU TRV TRW	3	0	0	0	3	FOR INVERTER
		7.5	QM150DY-H			3	0	0	0	3	
		11	QM200HZ-H			6	0	0	0	6	
		15 18.5 22	QM150DY-H			6 9 9	0 0 0	0 0 0	0 0 0	6 9 9	
5	CAPACITOR	6.6 7.6 11 15 18.5	400UF BK0-C1784-H01	NITSUKO	C1-1 1-2 1-3 1-4 1-5	2 2 3 4 6	0 0 0 0 0	0 0 0 0 0	2 2 3 4 5	2 2 3 4 5	
		22	4700UF BK0-C1784-H02	NITICON		6	0	0	5	5	
6	FAN	6s 7s	N3951ML	TOOBISHI	FAN1 2	2	0	2	0	2	
		11 16 18.5 22	HS4556ML								

ITEM	DESCRIPTION	TYPE kW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	OPTION A	OPTION B	OPTION C	NOTE
7	TRANSISTOR	5.5 7.5 11 15 18.5	1PH 8K0-C1840-H01	CHINO	T3	1	0	0	0	1	
8	TRANSISTOR	5.5 7.5 11 15 18.5 22	1PH 8K0-C1836-H01	CHINO	R.2	2	0	0	0	2	
9	AC REACTOR	5.5 7.5	0.2MH50A 8K0-C1883-H02	CHUO	ACL	1	0	0	0	1	
		11	0.17MH75A 8K0-C1883-H04								
		15	0.1MH100A 8K0-C1883-H05								
		18.5 22	0.065MH150A 8K0-C1883-H07								
10	DC REACTOR	5.5 7.5	1MH45A 8K0-C1894-H02	CHUO	L	1	0	0	0	1	
		11	1MH65A 8K0-C1894-H04								
		15	1MH90A 8K0-C1894-H05								
		18.5 22	1MH130A 8K0-C1894-H07								
11	CAPACITOR	5.5	MEUZ105K 600A 8K0-NA1061-05	NITSUKO	C2	3	0	0	3	3	
		7.5				3	0	0	3	3	
		11				3	0	0	3	3	
		15				6	0	0	6	6	
		18.5				9	0	0	9	9	
		22				9	0	0	9	9	
12	RESISTOR	5.5 7.5	-		- RU RV RW	-	-	-	-	-	
		11 15	3.5MOHM 8K0-C1925-H01	MICRON		3	0	0	0	3	
		18.5 22	2MOHM 8K0-C1925-H02								
13	CT	5.5 7.5 11 15	150/0.05A 8K0-C1268-H04	YOSIKAWA	CT	1	0	0	0	1	
		18.5 22	300/0.05A 8K0-C1268-H05								

ITEM	DESCRIPTION	kW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	OPTION A	OPTION B	OPTION C	NOTE
14	SURGE KILLER	–	BKO-C1855-H01	NISIN	SK1~6	6	0	0	0	6	
15	FILTER	–	BKO-C1938-H01	NISIN		1	0	0	0	1	
16	THERMAL DETECTOR	–	OHD-60B	TOOKIN	THS1	1	0	0	0	1	
17	THERMAL DETECTOR	–	OHD-100B	TOOKIN	THS2	1	0	0	0	1	
18	FILTER	–	ZM82202-11	TDK	FIL	1	0	0	0	1	
19	FUSE	–	MF60NR-5A-S	TOYO	F1~3	3	3	0	0	3	
20	PRINTED CIRCUIT BOARD	5.5 11 18.5	BKO-C1872-H02	YAMABISHI	SX-PW	1	0	0	0	1	
		7.5 15 22	BKO-C1872-H01	TAMURA							
21	PRINTED CIRCUIT BOARD	–	SX-AJ1	MITSUBISHI ELECTRIC	–	1	0	0	0	1	
22	PRINTED CIRCUIT BOARD	–	SX-I01	MITSUBISHI ELECTRIC	–	1	0	0	1		
23	PULSE SIGNAL GENERATOR			TAMA-GAWA SEIKI	–	1	0	0	1	1	
24	COUPLING	–	M976Z104-H03	NIHON MINUATURE COUPLING	–	1	0	0	1	1	FOR PULSE SIGNAL GENERATOR
25	FAN	–	PFA-600	AKAMATSU ELECTRIC	–	1	0	0	1	1	FOR MOTOR
26	BEARING (LOAD SIDE)	5.5 7.5 11 15 18.5 22	6307ZZ 6310ZZ	NIHON SEIKO OR NTN TOYO BEARING	–	1	0	0	0	1	FOR MOTOR
27	BEARING (OPPOSITE SIDE)	5.5 7.5 11 15 18.5 22	6306ZZ 6308ZZ	NIHON SEIKO OR NTN TOYO		1	0	0	1	1	FOR MOTOR

OPTION CARD

ITEM	DESCRIPTION	TYPE kW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
41	MAGNE-SENSOR ORIENT P.C.B		SX-CPU1	MITSUBISHI ELECTRIC	—	1	0	0	0	1	
42	ENCODER ORIENT P.C.B		SX-CPU2	MITSUBISHI ELECTRIC	—	1	0	0	0	1	