

SPINDLE DRIVE CONTROLLER **TYPE** FR-SD

MAINTENANCE MANUAL

C O N T E N T S -

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1.1 Scope of Maintenance Manual

FR-SD Series is a line of regenerative type inverters used to drive a machine tool spindle on the AC power source.

This Maintenance Manual mainly describes the information necessary to perform the periodic maintenance and troubleshooting.

To assure long life and trustworthy operation of the FR-SD inverter, read the manual carefully and practice the periodic maintenance and troubleshooting.

1.2 Safety Provisions and Maintenance Personnel

In order to assure safety in maintenance and adjustment, the following cautions are very important.

- Start-up, maintenance and checking should be performed by qualified electrician. Note that it is very hazardous that unqualified persons handle the unit.

- Remove ring, wrist watch, tie tack, and other metallic objects from the body when the unit under live condition is handled.

- Electric shock is very dangerous, and may result in fatal accident.

Carefully select and use testing apparatus because some parts of the unit are at high voltage no matter whether the power source is grounded or not.

When test apparatus is applied to the unit, testing person should take care not to touch any grounded object.

Usually, testing apparatus case is not grounded and therefore high voltage is produced between the testing apparatus case and the ground during the testing.

- Do not wear loose working wears that may be involved into a rotating body of the machine *when you gains* access to the working machine in maintenance or setting up.
- Do not load or unload a PC board (card) while the unit is fed with the power source, or in operation, otherwise the unit may be damaged.
- Immediately after the power source is turned off, do not touch the unit, but wait for at least one minute (time taken for discharge of capacitor) and then start the maintenance or adjustment.

1.3 Storage

When the unit is not immediately installed nor used, store it in a clean, dry environment at moderate temperature. Since vapor and dust in the unit cause deterioration to the insulated parts of the unit, keep the unit away from vapor and dust.

When the unit is left out of use for any length of time, maintain the unit under the ambient conditions same as those while the unit is in operation. It is recommended in same cases to use a space heater in the room where the unit is stored.

CHAPTER II

SPECIFICATIONS

2.1 AC Spindle Motor

Standard Specifications

Output capacity	Continuous rating (kW)	3.7	5.5	7.5	11	15	
	30 min. rating (kW)	5.5	7.5	11	15	18.5	
	50% ED rating (kW)	5.5	7.5	11	15	18.5	
Sp. e.e.	Basic speed (RPM)	1500		1500			
	Max. speed (RPM)	6000 ^{Note 1}		4500			
Frame No.		A112	B112	B132		c132	
Rated torque (cont. rating) (kg-m)		2.4	3.57	4.87	7.15	9.74	
GD ² (kg.m ²)		0.08	0.12	0.22	0.25	0.35	
Weight (kg)		70	80	110	120	140	
Allowable radial load (kg)		150	200	300			
Cooling fan (W)		75					
Vibration		V10					
Noise level (dB)(A)		75				80	
Installation		Vertical or horizontal					
Overload capacity		120% of 30min. rating, for 1min.					
Ambient temperature (°C)		0 ~ 40					
Insulation class		F					
Paint color		Munsell N5.5					
Accessories		Brushless tacho-generator, overheat detector					
Standard applied		JIS C4004					
Controller Model: FR-SD-2-		5.5K	7.5K	11K	15K	18.5K	
Power capacity (kVA)		9	12	17	23	28	
Power supply		200/200 ~ 230V±10%, 50/60Hz±3%					

Note 1: For speeds over 4,500RPM, the output is equal to the following

calculation result:

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

Note 2: When the line power source other than specified above is employed,
use a suitable power transformer.

Standard Specifications (2)

Adapt the following specifications (basic speed: 1,150PRM) when a large gear reduction ratio is not available.

Out put capacity	Continuous rating (kW)	3.7	5.5	7.5	11	15	
	30min. rating (kW)	5.5	7.5	11	15	18.5	
	50% ED rating (kW)	5.5	7.5	11	15	18.5	
Sp'ed	Basic speed (RPM)	1,150					
	Max. speed (RPM)	4,600					
Frame No.		B112	B132		C132	B160	
Rated torque (cont. rating) (kg-m)		3.13	4.66	6.35	9.32	12.7	
GD ² (kg.m ²)		0.12	0.22	0.25	0.35	0.65	
Weight (kg)		80	110	120	140	220	
Allowable radial load (kg)		200	300				
Cooling fan (W)		75				200	
Vibration		V10					
Noise level (dB)(A)		75			80		
Installation		Vertical or horizontal					
Overload capacity		120% of 30min. rating, for 1 min.					
Ambient temperature (°C)		0 ~ 40					
Insulation class		F					
Paint color		Munsell N5.5					
Accessories		Brushless tacho-generator, overheat detector					
Controller Model: FR-SD-2-		5.5K	7.5K	11K	15K	18.5K	
Power consumption (kVA)		9	12	17	23	28	
Power supply		200/200~230V±10%, 50/60Hz±3%					

2.2 AC Spindle Speed Controller

Specifications

Model FR-SD-2-		5.5K	7.5K	11K	15K	18.5K	
At 50% ED output	Output capacity (kW)	5.5	7.5	11	15	18.5	
	Output current (A)	43	55	74	100	125	
	Power source capacity (kVA)	9	12	17	23	28	
	Heat value (W)	450	590	760	970	1150	
Weight (kg)		40		53	58	65	
Main circuit		Pulsewidth modulation (PWM) inverter					
Control method		Slip control (Optimized V/F pattern control)					
Braking method		Regenerative braking					
Speed control range		35 ~ 6000 RPM					
Speed regulation		Below 0.2% of the max. speed (at load regulation ranging from 10 to 100%)					
Speed control command signal voltage		±10V DC (Input impedance: 10Kohm)					
Acceleration/deceleration control		Slip regulation (Time constant at accel./decel.: 0.5~10sec.)					
Ambient temperature/humidity		-5 ~ 50°C/below 85%					
Environmental requirements		To be free from detrimental gas and dust (JEM 1103, Grade C)					
Vibration		below 0.5G					
Standard applied		IEC					
Cooling		Air-cooling by fan					

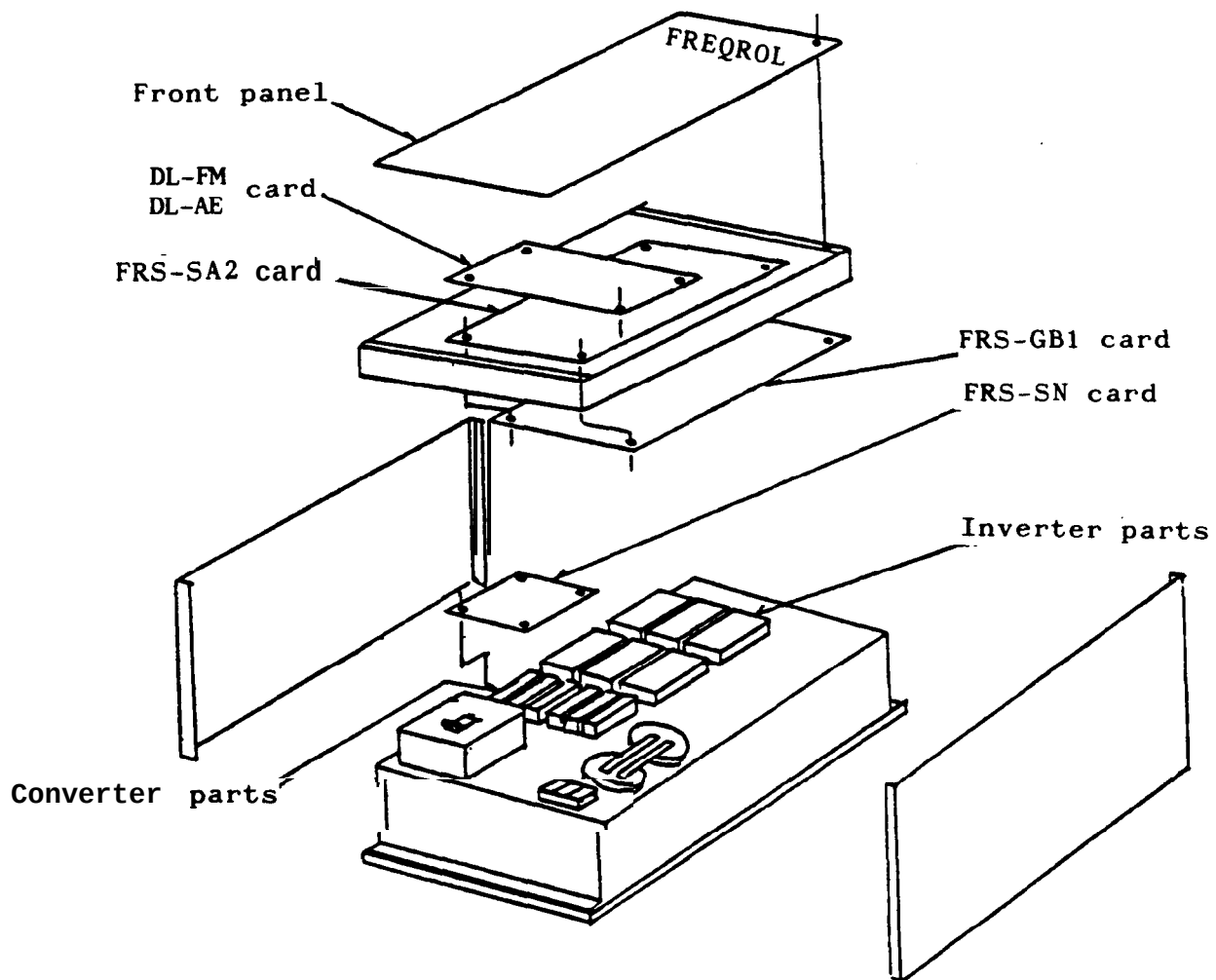
Auxiliary functions

Function (Signal)	Application	Remarks
Load meter signal	Load meter	Connected to single-swing DC ammeter Full scale: 150% of rated load (adjustable within a range from 100% to 150%)
Speed meter signal	Speed meter	Connected to single-swing DC ammeter Full scale: Max. speed
Zero speed signal	Interlock	Contacts open when motor speed goes down below 50 ± 10 rpm.
Speed arrival signal	Feedback to NC equipment	Contacts close when speed is within $\pm 15\%$ of the pre-set speed.
Speed detect signal	Mechanical brake operation . Clutch shifting	Contacts close if motor speed goes down below 500 rpm (adjustable from 50 to 1150 rpm).
Load detect signal	Prevention of stabbing of tool	Contacts close if slippage reaches near slip limit value (120% of output)
Override	Override in automatic operation	Can be set within a range from 50% to 120%. Override can be reset by opening the circuit connected to controller terminals "DEF"

2.3 Speed Controller Composition

The speed controller unit mainly consists of the following seven components:

- (1) Front panel
- (2) Main control card, FRS-SA2
- (3) Control card, FRS-GB1
- (4) Orient card, DL-FM (Option)
- (5) Snubber card, FRS-SN
- (6) Converter
- (7) Inverter



3.1 Preparation for Operation

When the controller is fed with the power source for the first time, perform the following checking before turning on the power switch.

- (1) Is the wiring in conformity with the corresponding wiring diagram?
- (2) Are the motor and control panel properly grounded?
- (3) Are all shielding wires properly connected?
 - Are they correctly connected to shielding wire terminals?
 - Are shielding brades not looped?
- (4) Are all parts not damaged, and securely fastened?
- (5) Is there any wire chip or foreign matter in the unit?
- (6) Do all PC boards (cards) present good appearance?

3.2 Turning on the power source

When the checking has been completed, apply the power source to the controller unit as follows:

- (1) Set the breaker (CB1) in the controller to OFF.
- (2) Set the source frequency select switch LINE FREQ on the front panel to the frequency of the available power source.
- (3) Turn on the incoming power source and make sure the lamp PHASE SEQUENCE1 lights. If the lamp does not light, interchange the connection bewteen the two wires.

(4) Make sure no alarm lamp on the controller front panel lights.

(5) Set the breaker (CB1) in the controller unit to ON.

Now the controller unit is ready for operation.

3.3 Adjustment

Although all potentiometers have been factory-adjusted, readjust them to correct error that may be caused by connection with peripheral equipment.

*Slip adjustmenta.... VR7

*Speed meter adjustment VR6

*Load meter adjustment VR3

3.4 Initial operation

After directly connecting the controller unit to the motor, start the initial operation for accommodation of the controller system and verification of the operation.

If hunting or overshoot of motor speed occurs, adjust as follows:

*Hunting Somewhat turn VR2 counter-clockwise.

*Overshoot Somewhat turn SW2 clockwise.

Then apply a load to the motor and start the regular operation to check the following:

- Unusual sound
- Foreign smell
- Temperature rise on bearings

Because it is imperative for long-lasting, trouble free operation of the controller unit to perform trustworthy checking, be sure to practice the periodic maintenance as follows:

Warning: Electric shock may result in serious accident or death.

Before starting the maintenance, do not fail to make sure the entire control system has been disconnected from the line power source.

4.1 Checking the controller unit

Item	Frequency	Checking	Remedy
1. Cooling fan	Monthly	(1) Can the fan shaft smoothly be turned by hand? (2) Does the fan powerfully rotate? (2) Does unusual sound not occur in bearings?	Replace the fan.
2. Cleanliness and looseness of screws	At suitable interval	Periodically clean each part and retighten terminal screws and other clamping screws and nuts.	
3. Miniature relay	Every 3 months	(1) Are contacts not worn out? (2) Does the relay permit the main circuit contactor to close and open satisfactorily?	Replace the relay.

Item	Frequency	Checking	Remedy
4. Wiring	At suitable interval	Is any wire conductor in contact with the case or other metallic part?	

4.2 Checking the motor

Item	Frequency	Checking	Remedy
1. Noise, vibration	Monthly	Check if unusual sound or vibration occurs. If yes, perform the following checking: (1) Are foundation and installation proper? (2) Are the shafts accurately aligned? (3) Is vibration not transmitted from the coupled machine or device (load)? (4) Is bearing not damaged? Is unusual sound not caused by bearing? (5) Is unusual vibration or noise not caused by speed reduction gear, belt, or transmission system? (6) Is there any trouble associated with controller unit? (7) Is there any trouble associated with fan? (8) Check belt tension.	

Item	Frequency	Checking	Remedy
2. Temperature rise	Monthly	Is temperature on bearings usual? (Usual temperature: +10°C ~ 40°C over ambient temperature) Is motor frame temperature usual? If not, perform the following checking: (1) Is cooling fan running as usual? (2) Is cooling air stream not obstructed by foreign matter (between frame and cover)? (3) Does load not abruptly increase? (4) Is there any trouble with the controller?	Clean. Refer to TROUBLE-SHOOTING.
3. Insulation resistance	Every 6 months	Check if insulation resistance unusually decreases. To check, disconnect the motor from the controller and measure resistance across the entire circuit and the ground using a 500V megger. (Resistance should be over 1Mohm) If the resistance is below 1 Mohm, clean the motor interior and dry. (To dry the	

Item	Frequency	Checking	Remedy
		motor, disassemble and place it in a drying oven at a temperature below 90°C.	
4. Cooling fan	Weekly Monthly	Check if cooling fan runs properly, and if unusual sound or vibration occurs.	

Note: All control cards are factory-adjusted at shipping.

User should not change the settings of variable resistors used in the cards.

5.1 Main Control Card FRS-SA2

Fig. 5.1 shows the main control card FRS-SA2. In the figure, lines shown in and are insulated. Wave form measured at N01 is shown in , and that measured at NO in in .

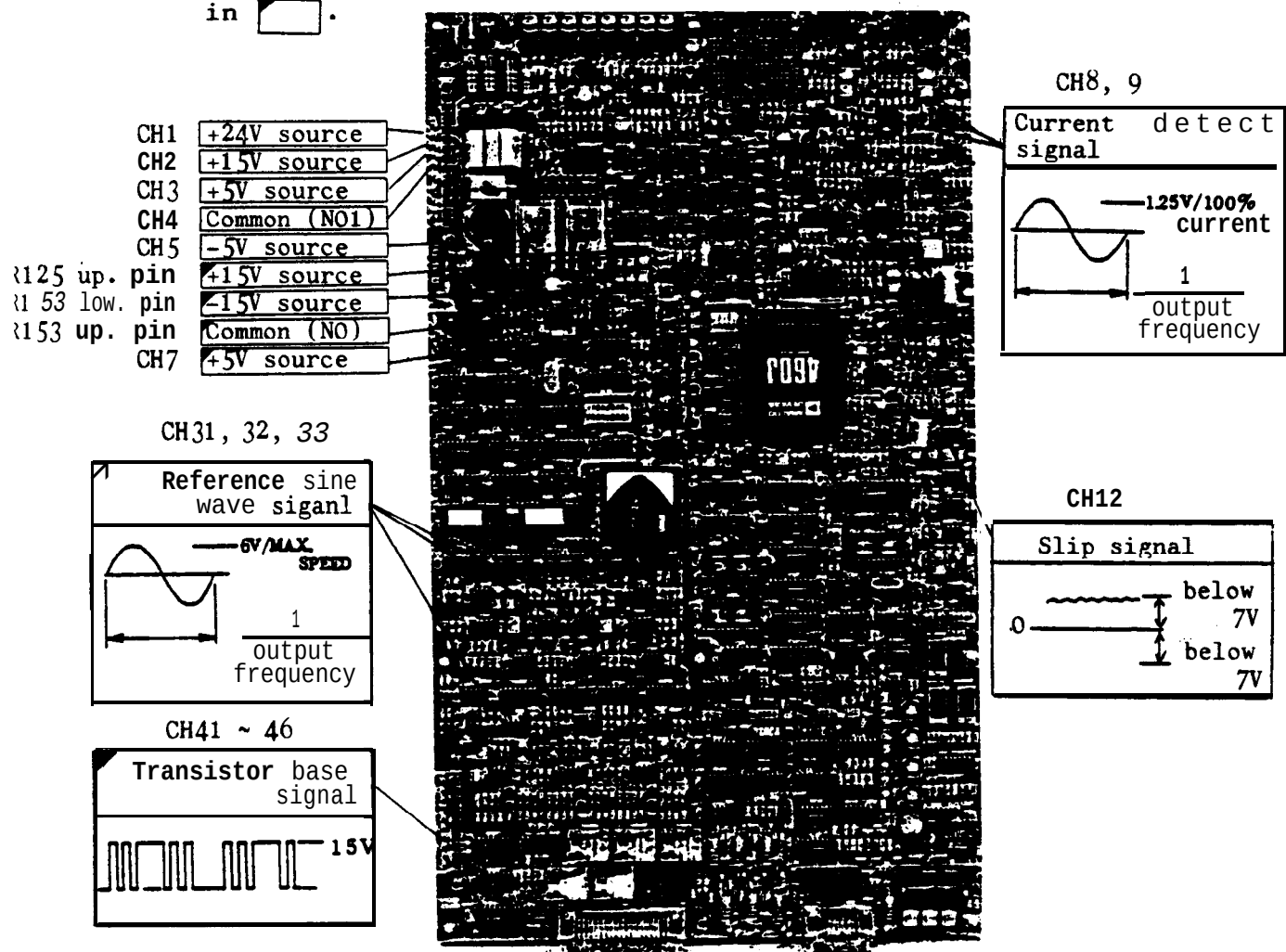


Fig. 5.1 Card FRS-SA2

CH10 Current detect signal: -2.5V/100% current

CH19 TG feedback: +10V/CW max. speed, -10V/C.CW max. speed

CH26 Speed command signal: -10V/CW max. speed, +10V/C.CW max. speed

5.2 Control Card FRS-GB1

Voltage wave form measured at each common of the card FRS-GB1

Warning: The terminal board TB102 of this card is at the main circuit voltage. Carefully handle it avoiding electric shock.

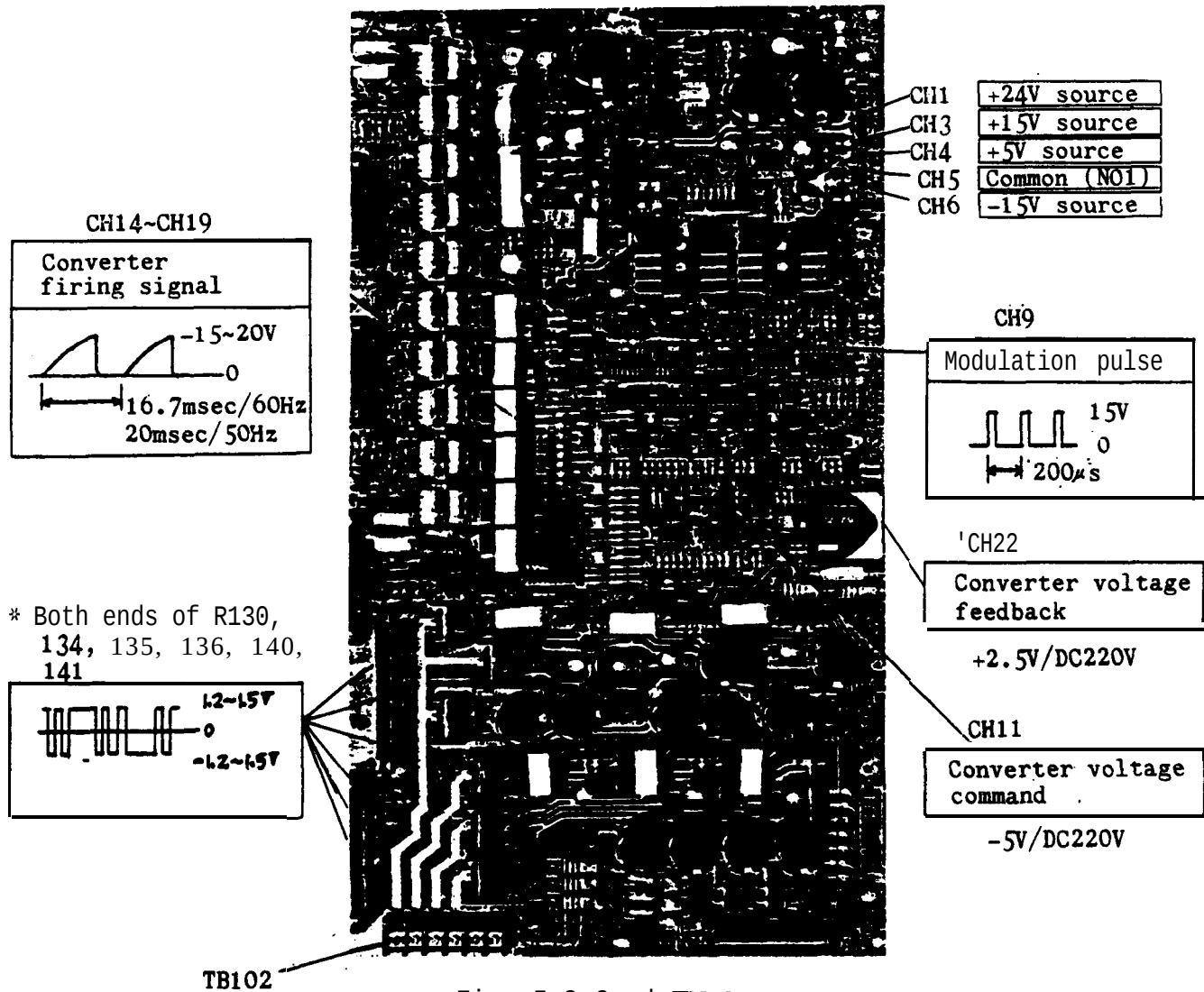


Fig. 5.2 Card FRS-GB1

- * This signal is for driving the main transistor and its wave form is not measured at N01, but measured on each both sides of R 130, 134, 135, 136, 140 and 141.

5.3 Snubber Card FRS-SN

This card has the snubber circuit with thyristor on the converter side, and requires no adjustment.

*Warning: The terminals of this card are at the main circuit voltage.
Carefully handle the card avoiding electric shock.*

5.4 Optional Cards

Optional cards are available for special specification.

For details of optional cards, refer to the respective instruction manual.

- 1) Orient Card, DL-FM BCN-21374-S2
- 2) Orient Card, DL-AE BCN-18564-S2

6.1 General

If any trouble occurs with the controller unit, it is recommended to perform the preliminary checking instructed below before the regular troubleshooting.

The preliminary checking will be very helpful when you consult manufacturer's service personnel.

Preliminary checking in case of trouble

1. Does any alarm lamp that indicates occurrence of trouble light? If yes, identify the lamp.
2. Is any fuse brown out? If yes, identify the fuse.
3. Is recurrence of the same trouble possible?
4. Are ambient and unit interior temperatures proper?
5. Does the trouble occur during acceleration, or deceleration, or steady state operation?
What is the speed when the trouble occurs?
6. Is there any difference between CW operation and C.CW operation?
7. Did momentary power interruption not occur?
8. Does the same trouble occurs under a specific operation or command?
9. What is the frequency on that trouble? (Does the same trouble occur frequently or rarely?)
10. Did the trouble occur when load is engaged, or disengaged?
11. Has any unit part been replaced or remedied before the the trouble?

12. How many years has been used the unit?
13. Is the source voltage proper? Is there voltage change at a certain interval?

6.2 Checking before regular troubleshooting

At the first step of troubleshooting, check the following:

- (1) Power source voltage $200V \pm 10\%$, 50/60Hz; 210V, 220V, $230V \pm 10\%$, 60Hz (200V should not be below -10%.)
- (2) Check if equipment and devices associated with the controller unit are satisfactory.
Ex.: NC, sequence control circuit, wiring, etc.
- (3) Check if the ambient temperature (unit interior temperature) is below 50°C .
- (4) Visually check the unit exterior for damage.

Ex.: Damaged card component, burnt circuit pattern, etc.
Loose connection, damage, foreign matter, etc.

6.3 Indicator Lamp List

The indicator lamps used in the controller unit are as listed below. Among them, LED1 ~ LED10 are alarm (trouble indicating) lamps.

Card	No.	Name	Description
FRS-SA2	PL1	PHASE SEQUENCE	Lights when the line power source is correctly connected.
	LED1	IOC TRIP (INVERTER)	Lights when overcurrent flows into the inverter.
	LED2	OVER REGENERATION	Lights when voltage across the capacitor in the main circuit goes over 400V.
	LED3	IOC TRIP(CONVERTER)	Lights when overcurrent flows into the converter.
	LED4	OVER HEAT (CONTROLLER)	Lights when temperature at heat-sink of semiconductor in the main circuit goes over 100°C.
	LED5	MOTOR BREAKER TRIP	Not used
	LED6	OVER HEAT (MOTOR)	Lights when motor overheats.
	LED7	BREAKER TRIP	Lights when overcurrent flows into the main circuit.
	LED8	OVER SPEED	Lights when motor speed exceeds. 115% of the maximum speed.
	LED9	UNDER VOLTAGE (P15)	Lights when 15V power source goes down below 14V.
	LED10	UNDER VOLTAGE (LINE)	Lights when the line power source goes down below 170V.
	LED11 LED12	TACH FB FINE	Two LEDs light when slip adjustment is optimized during operation at the maximum speed.

Card	No.	Name	Description
FRS-SA2	LED13	NOR (SRN)	Lights when CW input command is "ON" .
	LED14	INV (SRI)	Lights when C.CW input command is "ON" .
	LED15	DEF	Lights when override input is "ON" .
	LED16	CURRENT DETECTION	Lights when load current reaches the preset value.
	LED17	ZERO SPEED	Lights when motor speed goes down below 25rpm.
	LED18	SPEED DETECTION	Lights when motor speed reaches the preset speed.
	LED19	UP-T0 SPEED	Lights when motor speed is $\pm 15\%$ of the preset speed.
	LED20	READY	Lights when the unit is ready for operation.
FRS-GB1	LED51	GATE PULSE(U-PHASE)	Lights when U-phase gate pulse is output.
	LED52	GATE PULSE(V-PHASE)	Lights when V-phase gate pulse is output.
	LED53	GATE PULSE(W-PHASE)	Lights when W-phase gate pulse is output.
	LED54	GATE PULSE(X-PHASE)	Lights when X-phase gate pulse is output.
	LED55	GATE PULSE(Y-PHASE)	Lihgts when Y-phase gate pulse is output.
	LED56	GATE PULSE(Z-PHASE)	Lights when Z-phase gate pulse is output.
	LED61	POWER RUNNING FIRING	Lights in power running firing.
	LED62	REGENERATIVE FIRING	Lights in regenerative firing.

6.4 Typical Troubles

There may be many kinds of trouble associated with the controller unit and it is impossible to foresee or predict all possible troubles.

In this section, description is restricted only to the most likely troubles.

In the troubleshooting described here, the card should be judged to be defective and therefore replaced with a new one if the required adjustment is impossible on potentiometers in the card.

1. Alarm lamp will light when the following troubles occur.

- (1) OVER HEAT (CoNTROLLER, MOTOR)
- (2) BREAKER TRIP
- (3) IOC TRIP (INVERTER, CONVERTER)
- (4) OVER REGENERATION
- (5) UNDER VOLTAGE (P15)
- (6) UNDER VOLTAGE (LINE)
- (7) OVER SPEED

2. Many alarm lamps light at the same time.

3. No alarm lamp lights, but the motor does not start at all , or stops from time to time.

4. No alarm lamp lights, but the motor does not run at high speed.

5. The motor does not run at the commanded speed within a specific speed range.

6. Sufficient torque is not obtainable.

7. The motor comes to delay in starting and stopping.
8. Acceleration/deceleration end signal (UP-TO SPEED) is not output.
9. Feed motion commanded by the NC does not occur.
10. Speed detect signal (SPEED DETECT) is not output.
11. Zero speed signal (ZERO SPEED) is not output.
12. Speed range change-over is impossible.
13. The motor runs clockwise, but does not run counter-clockwise, or vice versa, or braking is impossible.
14. Motor speed cannot be accelerated over a certain speed.
15. Reading of the load meter or speed meter is not stable.
16. Large noise or vibration occurs.

6.5 Troubleshooting Practice for Each Trouble

6.5.1 When trouble can be identified by alarm lamp.....

(1) OVER HEAT

Troubles

- A. The thermal protector in the controller was tripped..... Install heatsink to thyristor
- B. The thermal protector in the controller was not tripped, but that used in the motor was tripped OHS1— OHS2 is not conductive.
- C. Both the thermal protectors in the controller and the motor were not tripped..... Resumption of operation will be possible by once turning off the power source and then turning on again.

Trouble	Cause	Checking	Remedy
A	Over load	1. Check loading condition of the motor. 2. Check if start and stop are too frequent.	1. Lighten the load. 2. Decrease start and stop frequency.
	High ambient temperature	Measure the ambient temperature around the controller.	3. If the temperature is over 50°C, improve ventilation.
	Thyristor cooling fan trouble	Check if the cooling fan is working satisfactorily.	Replace the fan.
B	Over load	1. Check loading condition of the motor. 2. Check if start and stop are too frequent.	1. Lighten the load. 2. Decrease start and stop frequency.
	Cooling fan trouble	Check if the cooling fan is working satisfactorily.	Repair or replace the fan.
	Clogged motor air inlet	Check if sufficient air is fed into the motor.	Clean
	Thermal protector semiconductor trouble	Check if condition is improved after the motor fan is operated for several minute while the spindle motor is kept in stand-still.	1. Short-circuit between OHS1 and OHS2 for provisional remedy. 2. Replace the motor.
C	FRS-SA card trouble	If trouble occurs although voltage across TH and N02 is 0V, the card is defective.	Replace FRS-SA card.

(2) BREAKER TRIP

The lamp BREAKER TRIP lights when the main (line source) input NFB trips.

Troubles

- A. The main input NFB tripped.
- B. Although the NFB did not trip, the lamp BREAKER TRIP lights.

Trouble		Checking	Remedy
A	Refer to description "IOC TRIP".	Refer to description "IOC TRIP".	Refer to description "IOC TRIP".
B	FRS-SA card trouble	If trouble occurs although the NFB does not trip and voltage across terminals TH and N02 is 0V, the FRS-SA2 card is defective.	Replace FRS-SA2 card.

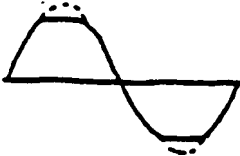
(3) IOC TRIP (INVERTER, CoNVERT ER)

IOC TRIP is caused either on the inverter side, or converter side and each one alarm lamp is provided for inverter and converter.

The lamps light when overcurrent flows.

Cause	Checking	Remedy
Defective power transistor	Check if lamp IOC TRIP lights when only controller disconnected from the motor is operated. - If yes; the power transistor is defective.	Replace the power transistor.

Cause	Checking	Remedy
	- If not, proceed to the next step.	
Too large motor load	Check the load.	Lighten the load.
Wrong phase rotation	Check if lamp PHASE SEQUENCE light. If not, the phase rotation is not correct.	Correct phase rotation.
Wrong motor wiring	Check the motor wiring, and the terminal screws for looseness.	Correct the wiring. Retighten loose terminal screws.
Short-circuited or grounded motor winding	Measure insulation resistance using a megger. If the resistance is less than 1 Mohm, the motor is defective.	Replace the motor.
Commutation fails due to low source voltage. Insufficient power capacity	Voltage should be at least 180V in R, S and T phases. 180V should be assured during acceleration and deceleration as well as loaded operation.	Increase the source voltage. Increase the power capacity.
Deformed source voltage wave form	Measure the source voltage wave form in acceleration and deceleration as well. 1. If voltage partly fails.  To be shorter than 100 S.	Collect the wave form. 1. Increase the power capacity or use power cable of large size. 2. Also remedy other

Trouble	Checking	Remedy
	2. If crest is chopped  Chopped crest should be less than 2 ~3%.	solid-state equipment that causes deformation.
Large source frequency re-regulation	Frequency regulation should be less than $\pm 3\%$ of the rated frequency.	Improve frequency regulation.
Speed detect circuit trouble	Check that $-2.5\text{V}/100\%$ is measured at CH10. If lamp IOC TRIP lights while CH10 is not defective, the speed detect circuit is defective.	Replace FRS-SA card

(4) OVER REGENERATION

The lamp OVER REGENERATION lights if voltage across the incorporated smoothing capacitor exceeds the permissible voltage.

Cause	Checking	Remedy
Over load	Check the load if the lamp OVER LOAD lights while the motor is in deceleration.	Lighten the load.
Too large GD^2	Check GD^2 if the alarm lamp lights while the motor is in deceleration,	Decrease GD^2 .
Too short deceleration time	The time taken for deceleration to 0rpm from the maximum speed should be longer than 2 sec. If it is shorter than 2 sec., prolong the time.	Turn VR27 in FRS-SA2 card clockwise.
Speed detect circuit trouble	If the trouble cannot be remedied, one of the most likely causes of the trouble is defective speed detect circuit.	Replace FRS-SA2 card.

(5) UNDER VOLTAGE

The lamp UNDER VOLTAGE lights when +15V power source in the control circuit goes down below 14V.

Cause	Checking	Remedy
Speed detect circuit trouble	Check that +15V is measured across CH2 — CH4 of FRS-SA2 card. The speed detect circuit is defective.	Replace FRS-SA2 card.

Cause	Checking	Remedy
Power circuit (in control circuit) trouble	If +15V is not measured across CH2 and CH4 of FRS-SA2 and FRS-GB1 cards, the power source circuit is defective.	Replace FRS-GB1 card

(6) UNDER VOLTAGE (LINE)

If the line source voltage drops below 170V even momentarily, the lamp UNDER VOLTAGE lights for warning, but the operation does not stop and no adverse effect is given to the controller unit.

- When the lamp lights continuously Increase the source voltage.
- When the lamp lights at speed change or heavy duty operation Increase the power capacity.

(7) OVER SPEED

The lamp OVER SPEED lights if motor speed reaches 115% of the rated speed and the over speed detect circuit gets into function.

Cause	Checking	Remedy
Command input clamp circuit trouble	Measure voltage across CH26 and CH4 of FRS-SA2 card during high speed operation.	If voltage is over $\pm 10V$, the clamp circuit is defective. Replace FRS-SA2 card.
Unsatisfactory adjustment on TG feedback	When operation is at the maximum speed, measure voltage across CH19 and CH4 of FRS-SA2 card.	If voltage is not within a range of $\pm 10V$, TG feedback adjustment is not satisfactory. Adjust per "TG FEEDBACK ADJUSTMENT".

Cause	Checking	Remedy
Speed detect circuit trouble		If voltage is within $\pm 10V$, the speed detect circuit is defective. Replace FRS-SA2 card.
Overshoot of the speed	Check if speed overshoots only in start at maximum speed.	Turn SW2 and VR2 clockwise in FRS-SA2.

6.5.2 When many alarm lamps light at the same time

The most likely cause of the trouble is loose plugging at connectors CON1 and CON2. Make sure the connector plugs are locked.

6.5 3 When no alarm lamp lights, but the motor does not run at all, or stops from time to time

Cause	Checking	Remedy
Wrong wiring or open circuit	Check the wiring.	Remedy the wiring.
Input source voltage trouble	Voltage should be 200V 50Hz/200, 210, 220, 230V 60Hz.	Restore the source voltage.
Wrong phase rotation	Check if lamp PHASE SEQUENCE lights.	If not, correct phase rotation sequence.
FRS-GB1 card trouble	Check that LEDs 51-56 light.	If any one of them does not light, FRS-GB1 card is defective. Replace FRS-GB1 card.
FRS-SA2 card trouble	Check if LEDs 13, 14 light when SRN or SRI is input.	If lights, FRS-SA2 card is defective. If not, the external sequence is not satisfactory.

6.5.4 When no alarm lamp lights, but the motor does not run at high speed

Cause	Checking	Remedy
Wrong motor cable connection	Check if the motor cable is connected in correct phase sequence (U,V,W).	Correct motor cable connection.
Input source voltage trouble	Check that input power source is adequate.	Restore input source voltage.
Wrong phase rotation sequence	Check if lamp PHASE SEQUENCE lights.	Correct the phase rotation sequence.
Improper setting of phase change-over switch	Check if the line source frequency meets the setting of the phase change-over switch.	If not, set the switch properly.
Improper external speed command signal	Check that motor speed increases in proportion to the external speed command signal voltage.	Repair or adjust the external speed command circuit.

6.5.5 When the motor does not run at the command speed within a specific speed range

Cause	Checking	Remedy
Improper external speed command signal	Check that the external speed command signal voltage increases linearly from 0V to 10V.	Repair or adjust the external speed command circuit.

6.5.6 When sufficient torque is not obtainable

Perform the checking according to para. 6.5.3, 4 and 5.

6.5.7 When the motor comes to delay in starting and stop-
ping

Cause	Checking	Remedy
Large load	Check the load.	Lighten the load.

6.5.8 When acceleration/deceleration end signal (UP-TO SPEED)
is not output.....

Cause	Checking	Remedy
FRS-SA2 card relay (RA5) trouble	Check if LED19 lights when acceleration or deceleration is completed. If yes, the relay is defective.	Replace the relay (RA5) or FRS-SA2 card.
Acceleration/deceleration checking circuit trouble	15V should be measured at pin 10 of IC113.	FRS-SA2 card trouble

6.5.9 When feed motion commanded by the NC does not occur

The cause of the trouble is that UP-TO SPEED does not get into function. Check the control sequence and perform the checking per 6.5.8.

6.5.10 When speed detect signal (SPEED DETECTION) is not output

Cause	Checking	Remedy
FRS-SA2 card relay (RA4) trouble	Check if LED18 lights when motor speed exceeds the pre-set speed. If yes, the relay is defective.	Replace relay (RA4) or FRS-SA2 card.

Cause	Checking	Remedy
Speed detect circuit trouble	If LED18 does not light , the speed detect circuit is defective.	Replace the FRS-SA2 card.

6.5.11 When zero speed signal (ZERO SPEED) is not output

Cause	Checking	Remedy
FRS-SA2 card relay (RA6) trouble	Check if LED17 lights when motor speed is below 25rpm. If signal is not output although LED17 lights, the relay is defective.	Replace relay (RA6) or FRS-SA2 card.
Zero speed detect circuit trouble	If LED17 does not light, the zero speed detect circuit is defective.	Replace FRS-SA2 card.

6.5.12 When speed range change-over is impossible

The cause of the trouble is the SPEED DETECT function or ZERO SPEED function does not work satisfactorily.

Perform the checking per para. 6.5.10 and 6.5.11.

6.5.13 When the motor runs clockwise, but does not run counter-clockwise, or vice versa, or braking is impossible

The most likely cause of the trouble is defective thyristor switching circuit in FRS-GB1 card.

Replace the FRS-GB1 card.

6.5.14 When speed cannot be accelerated over a certain speed . . .
.....

Perform the checking per para. 6.5.5.

6.5.15 When reading of the load meter or speed meter is not suitable

Cause	Checking	Remedy
Low tacho-generator output voltage	Check the output voltage from the tacho-generator. Check if $2^{+0}_{-10}\%$V/1000rpm (motor speed) is measured across PG1 and PG2 of connector CON1. Check if ripple of tacho-generator output voltage becomes large. Ripple should be below 3%.	If voltage is too low, replace the tacho-generator. If ripple is too large, replace the tacho-generator.
Card trouble	If reading of the load meter or speed meter is not stabilized although the tacho-generator works satisfactorily, the most likely cause of the trouble is defective FRS-SA2 card.	Replace FRS-SA2 card.

6.5.16 When large noise or vibration occurs

Cause	Checking	Trouble
Too high or low converter voltage	Voltage measured across terminals P and N of FRS-GB1 card while the motor is in standstill should be within a range from DC28 to 32V.	Adjust converter voltage by turning VR52 of FRS-GB1 card. If the adjustment is impossible, replace FRS-GB1 card.
Too high voltage applied to motor	Check if voltage at CH5A of FRS-SA2 card is +5.5V when measured while the motor runs at the maximum speed.	Adjust the voltage by turning VR24 of FRS-SA2 card.

Cause	Checking	Trouble
Improper phase rotation sequence	Check if the lamp PHASE SEQUENCE lights. If not, the phase sequence is inverse.	Correct the phase rotation sequence
Decreased insulation resistance	Disconnect the power cable at R, S and T phases and measure resistances between, CH17 and Ground CH4 and Ground All I/O terminals and Ground (Resistance should be larger than 1 Mohm when measured by 500V megger.)	If insulation resistance is found decreased, locate deteriorated portion and remedy.
Defective motor bearing	Check that the motor shaft can be turned lightly by hand.	Replace defective bearing if found.
Loose motor mounting bolt	Check if any motor mounting bolt is loose.	Retighten loose bolts.
Runout of motor shaft	Check if any trace of physical impact is found on the motor shaft.	Repair or replace the motor.
Irregular reference sine wave	Check if wave form at CH31, 32 and 33 is well balanced.	Replace FRS-SA2 card.

7.1 Replacement of Each Control Card

7.1 .1 FRS-SA2 card

When this card is replaced, the following potentiometers should be adjusted.

(1) VR10, VR12 (DCCT zero adjustment)

Set these potentiometers so that voltages at CH8 and CH9 are $0 \pm 5\text{mV}$ while the motor is in standstill.

(2) VR7 (TG feedback adjustment)

Set this variable resistor so that LED11 or LED12 lights while the system is in operation with command signal of about 1V. Then gradually increase command signal voltage and set the variable resistor so that the LED11 and LED12 light at the same time when the voltage reaches 10V.

(3) VR29 (CW speed command signal adjustment)

Turn this potentiometer when the maximum speed deviates from the speed preset for speed command in CW operation.

Since the VR has been factory-adjusted, no readjustment is required for usual operation.

(4) VR28 (C.CW speed command signal adjustment)

Turn this potentiometer when the maximum speed deviates from the speed preset for speed command in C.CW operation.

No readjustment is required for usual operation.

(5) VR5 (Speed detect setting)

This potentiometer is used to set the speed to be detected. Usually this is set at 500rpm. Do not change setting of this potentiometer unless it is particularly necessary.

(6) VR6 (Speed meter calibration)

Set this potentiometer so that the speed meter reads 100% when the motor speed reaches the maximum speed. To verify that the motor is actually running at the maximum speed, use a tachometer or the like.

7.1.2 FRS-GB1 card

In general, no adjustment is required. Care should be taken, however, to assure secure plugging of connectors.

7.1.3 FRS-SN card

No particular adjustment is required. Care should be taken to securely tighten terminal screws.

7.1.4 Option cards

For details of option cards including DL-FM or DL-AE card, refer to the respective instruction manual.

(1) DL-FM card BCN-21374-S2

(2) DL-AE card BCN-18564-S2

7.2 Thyristor Module and Transistor Module

1. Removal of defective module

Disconnect wires from the defective module and remove the module from the heatsink.

In the removal, it should be noted that thyristor gate terminal "G", transistor module base terminal "B" and emitter terminal "E" are of plug type.

2. Greasing

Uniformly apply silicon grease to the reverse surface of each module.

3. Installation

To install module again, tighten the mounting screw with the specified torque and connect the wires.

Be sure to cover the thyristor gate terminal, transistor module base terminal and emitter terminal with silicon tube.

Note: Since the thyristors and transistors based on our specifications are used in the unit, be sure to place order with us for spares or replacement.

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

Table 6.1 Clamp torque list

7.3 Diode

1. Removal of defective diode

Disconnect wires from the defective diode and remove the diode from the heatsink.

2. Greasing

Uniformly apply silicon grease where the diode is in contact with the heatsink to assure good heat radiation.

Since the silicon grease is non-conductive, do not apply it to the screw where conductivity is required.

3. Installation

Install a new greased diode by tightening its mounting screw with the specified torque and connect the wires.

Clamp torque: 220kg-cm

7.4 DCCT

When the DCCT is replaced, use care not to turn the potentiometer in the DCCT because it has been factory-adjusted.

Whenever the DCCT is replaced, be sure to perform the zero adjustment per para. 7.1.1.

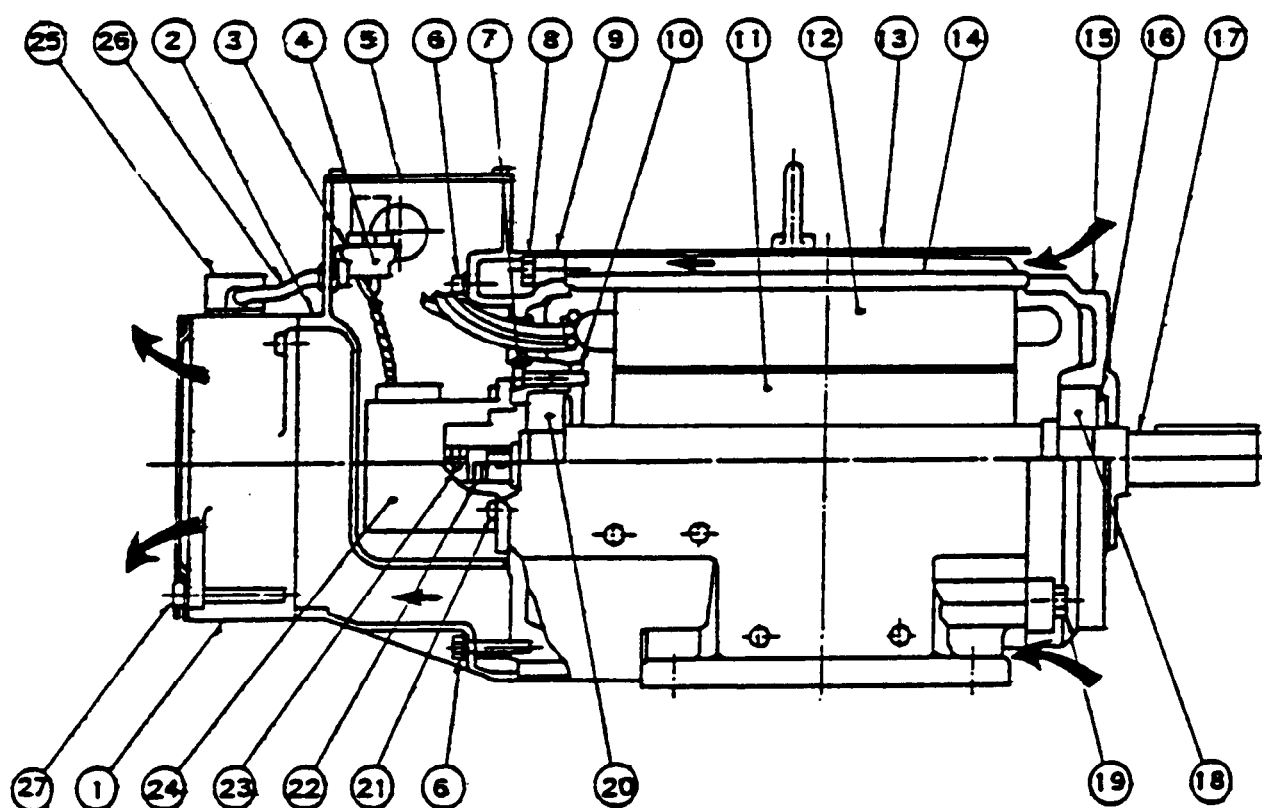
7.5 Brushless Tacho-generator and Coupling

Replace tacho-generator and coupling, referring to Fig. 7.1, as follows:

- (1) Remove Terminal Box Cover (9) and disconnect the cables from the controller.

Three motor leads (U, V, W), two cooling fan leads (BU, BV), overheat detector leads (OHS1, OHS2), and plug of tacho-generator (TG) connector ④

- (2) Depress the lock lug of TG connector ④ and remove the connector from the TG connector block ③.
- (3) Remove four cover mounting bolts ⑥ using hexagon wrench key and remove the cover ③ together with the cooling fan ① from the bracket ⑨ on the counter-load side.
- (4) Loosen two set screws ② used to secure the coupling ② using a hexagon wrench key passed through a hole in the bracket side wall of the tacho-generator ④ .
- (5) Remove two tacho-generator mounting screws ② from the tacho-generator bracket and remove the tacho-generator ④ from the bracket ⑨ on the counter-load side and the coupling ② .
- (6) Loosen another pair of coupling set screw ② used to secure the coupling ② to the shaft ① using a hexagon key wrench and remove the coupling ② from the shaft ①.
- (7) Replace the tacho-generator ④ or coupling ② .
- (8) To assemble again, perform the procedure (1) ~ (6) in reverse order to the disassembling.



No.	Name of part	No.	Name of part
1	Cooling fan	15	Bracket, load side
2	Cover	16	Pre-load spring
3	TG connector block	17	Shaft
4	TG connector	18	Bearing, load side
5	Terminal box cover	19	Bracket mounting bolt, load side
6	Cover mounting bolt	20	Bearing, counter-load side
7	Bearing hold plate screw	21	TG mounting screw
8	Bracket mounting bolt, counter-load side	22	Coupling
9	Bracket, counter-load side	23	Coupling set screw
10	Bearing hold plate	24	Tacho-generator (TG)
11	Rotor	25	Cooling fan terminal box
12	Stator	26	Cooling fan leads
13	Frame cover	27	Cooling fan mounting screw
14	Frame		

Fig. 7.1 AC Spindle Motor Part List

7.6 Cooling Fan

Disassemble the unit and replace the cooling fan, referring to Fig. 7.1 as follows:

- (1) Remove the screws securing the cooling fan terminal box (25) using a screwdriver and remove the terminal box (25) from the cooling fan (1).
- (2) Remove two screws securing the cooling fan leads (26) in the cooling fan terminal box (25) and remove the leads (26) from the cooling fan (1).
- (3) Remove four cooling fan mounting screws (27) using a screwdriver and remove the cooling fan (1) from the cover (1).
- (4) Replace the cooling fan (1) with a new one.
- (5) Perform the procedure (1) ~ (3) in reverse order to the disassembling to assemble again.

7.7 Bearing

- (1) Remove the tachogenerator (TG) (24) and coupling (22) as instructed for disassembling of the brushless tachogenerator and coupling (7.5).
- (2) Remove four bracket mounting bolts (8) (counter-load side) that secure the bracket (9) on the counter-load side from the frame (14) using a spanner.
- (3) Remove four bearing hold plate mounting screws (7) using a screwdriver and disconnect the bearing holding plate (10) from the bracket (9).

(4) Remove the bracket ⑨ from the frame ⑭ and the bearing ① (counter-load side).

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

Note: Make sure the pre-load spring ⑩ installed in the load side bracket ⑬ are in position.

(6) Replace the load side bearing ⑱ and counter-load side bearing ② with new ones.

Note: When the counter-load side bearing ① is replaced, make sure the bearing hold plate ⑩ is positioned between the counter-load side bearing ① and the rotor ⑪ .

(7) To assemble again, fit the counter-load side bracket ⑨ with the counter-load side bearing ② , lightly tighten four bearing hold plate mounting screws ⑦ and position the counter-load side bearing ⑨ and bearing hold plate ⑩ .

(8) Align the motor leads with the lead hole of the counter-load side bracket ⑨ and insert the rotor ⑪ with the counter-load side bracket ⑨ into the stator.

Note: Make sure the pre-load spring ⑩ is placed between the load side bracket ⑬ and the counter-load side bearing ⑱ .

(9) Tighten four counter-load side bracket mounting screws ⑧ using a spanner and secure the counter-load side bracket ⑨ to the frame ⑭ .

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

Note: Make sure the rotor ① can be lightly rotated by hand without causing foreign sound.

- (11) For assembling of the coupling 0 22 , tacho-generator 0 24 and cover 0 2 , refer to 7.5 "Brushless Tacho-generator and Coupling".

CHAPTER IIx PARTS LIST

8.1 TYPE FR-SD-2

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

ITEM	DESCRIPTION	TYPE				MANUFACTURER	SYMBOL	Q 'TY	SPARE PARTS				NOTE
									STAND.	OPTION			
										A	B	C	
1	CIRCUIT BREAKER	5.5 kW	NF100CB3P 100A05	MITSUBISHI ELECTRIC	CB1	1	0	0	0	0	1		
		7.5 kW											
		11 kW						NF225CB3P 150A05					
		15 kW						NF225CB3P 200A05					
2	THYRISTOR	5.5 kW	TM90DZ-H	MITSUBISHI ELECTRIC	SCRR-F SCRS-F SCRT-F	3	0	0	0	0	3	FOR CONVERTER	
		7.5 kW											
		11 kW											
		15 kW											
3	THYRISTOR	5.5 kW	TM55DZ-H	MITSUBISHI ELECTRIC	SCRR-R SCRS-R SCRT-R	3	0	0	0	0	3	FOR CONVERTER	
		7.5 kW											
		11 kW											
		15 kW											
4	TRANSISTOR	5.5 kW	QM100DY-H	MITSUBISHI ELECTRIC	TRU TRV TRW	6	0	0	0	0	6	FOR INVERTER	
		7.5 kW											

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	ORIGINAL PART NO				NOTE
							STAND.	OPTION			
								A	B	C	
4	TRANSISTOR	11 kW	QM100DY-H	MITSUBISHI ELECTRIC	TRU	9	0	0	0	9	
		15 kW						0	0	12	
5	CAPACITOR	5.5 kW	4000UF BKO-C1784H01	NITSUKO	C1-1 C1-2 C1-3 C1-4	2	0	0	2	2	
		7.5 kW						0	0	3	
		11 kW				3	0	0	3	3	
		15 kW				4	0	0	4	4	
6	FAN	5.5 kW	8550M	TOOB1SHI	FAN1-1 FAN1-2 FAN1-3	3	0	1	1	3	
		7.5 kW						1	1	3	
		11 kW				1	1	3			
		15 kW				1	1	3			
7	DC REACTOR	5.5 kW	1MH10A BKO-C1737-B-H02	YOSHIKAWA	L1	1	0	0	0	1	
		7.5 kW						0	0	1	
		11 kW	1MH23A BKO-C1737-B-H03			0	0	1			
		15 kW	1MH29A BKO-C1737-B-H04			0	0	1			

ITEM	DECRPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
8	TRANSFORMER	5.5 kW	3PH8KVA BKO-C1736-H05	YOSHIKAWA	T4	1	0	0	0	1	
		7.5 kW									
		11 kW	3PH12KVA BKO-C1736-H06								
		15 kW	3PH15KVA BKO-C1736-H07								
9	TRANSFORMER	-	3PH10KVA BKO-C1796-H01	YOSHIKAWA	T3	1	0	0	0	1	
10	TRANSFORMER	-	BKO-C1797-H01	YOSHIKAWA	T2	1	0	0	0	1	
11	TRANSFORMER	-	BKO-C1798-H01	YOSHIKAWA	T1	1	0	0	0	1	
12	CT		NNC-05AMS BKO-C1734-H01	NANA ELECTRONIC	CT1, 2	2	0	0	0	1	
13	CT		BKO-C1268-H04	YOSHIKAWA	CT3	1	0	0	0	1	
14	OVERLOAD		OHD-100B	TOHOKU KINZOKU	THS1~3	3	0	0	1	3	
15	THERMAL DETECTOR		OHD-60B	TOHOKU KINZOKU	THS4	1	0	0	1	1	
16	FILTER		ZGB2202-1	TDK	FIL1	1	0	0	1	1	
17	RELAY		MY2-DC24V	TATEISHI ELECTRONIC	RA1	1	0	0	1	3	
18	FUSE		MF60NR-5A-S	TOYO	F1-3	3	3	3	3	6	

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
19	RESISTOR		KHZ1S30W2KOHM	JAPAN RESISTOR	R1, 2	2	0	0	0	0	
20	RESISTOR		MO4HA20W200HM	MICRON	R3	1	0	0	0	0	
21	CAPACITOR	-	MEU7107K60A BKO-NA1061-H05	SUIZUKI	C2-V1,V2 C2-W1,W2	6	0	0	3	6	
22	PRINTED CIR- CUIT BOARD	-	FRS-SA2	MITSUBISHI ELECTRIC		1	0	0	1	1	
23	PRINTED CIR- CUIT BOARD		FRS-GB1	MITSUBISHI ELECTRIC		1	0	0	1	1	
24	PRINTED CIR- CUIT BOARD	-	FRS-SN2	MITSUBISHI ELECTRIC		1	0	0	1	1	
25	PRINTED CIR- CUIT BOARD	-	DL-FM/DL-AE	MITSUBISHI ELECTRIC		1	0	0	1	1	OPTION CARD
26	TACHOCENE- RATOR	-	TS3033E2	TAMACAWA SEIKI		1	0	0	0	1	
27	AC REACTOR	5.5 kW	0.2MH50A BKO-C1793-H02	CHUO DENKI		1	0	0	0	1	FOR EXTERNAL WIRING
		7.5 kW									
		11 kW	0.17MH60A BKO-C1793-H04								
		15 kW	0.1MH100A BKO-C1793-H05								
28	COUPLING		M976Z104H03	NIHON MINIATURE COUPLING		1	0	0	1	1	FOR TACHOGENE- RATOR
29	FAN		PFA-600	AKAMATSU ELECTRIC		1	0	1	1	2	FPR MOTOR

ITEM	DESCRIPTION	TYPE				MANUFACTURER	SYMBOL	Q'TY	STANDARD	OPTION A B C	NOTE
30	BEARING (LOAD SIDE)	5.5 kW	6308ZZ			NIHON SEIKO OR NTN TOYO BEARING	-	1	0	0 1 1	FOR MOTOR
		7.5 kW									
		11 kW									
		15 kW	6310ZZ								
31	BEARING (OPPOSITE SIDE)	5.5 kW	6306ZZ			NIHON SEIKO OR NTN TOYO BEARING	-	1	0	0 1 1	FOR MOTOR
		7.5 kW									
		11 kW									
		15 kW	6308ZZ								

a.2 TYPE F'R-SD-2A

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

ITEM	DESCRIPTION	TYPE					MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
										STAND.	OPTION			
											A	B	C	
1	CIRCUIT BREAKER	5.5 kW	NF100CB3P 100A05	MITSUBISHI ELECTRIC	CB1	1		0	0	0	0	1		
		7.5 kW												
		11 kW	NF225CB3P 150A05											
		15 kW	NF225CB3P 200A05											
		18.5 kW												
2	THYRISTOR	5.5 kW	TM90DZ-H	MITSUBISHI ELECTRIC	SCRR-F SCRS-F SCRT-F	3		0	0	0	0	3	FOR CONVERTER	
		7.5 kW												
		11 kW												
		15 kW												
		18.5 kW												
3	THYRISTOR	5.5 kW	TM55DH-Z	MITSUBISHI ELECTRIC	SCRR-R SCRS-R SCRT-R	3		0	0	0	0	3	FOR CONVERTER	
		7.5 kW												
		11 kW	TM90DH-Z											
		15 kW												
		18.5 kW												

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
							A	B	C		
4	TRANSISTOR	5.5 7.5 kW	QM100DY-H	MITSUBISHI ELECTRIC	TRU TRV TRW		6	0	0	6	FOR INERTER
		11 kW					0	0	9		
		15 18.5 kW	QM100DY-HE BKO-C1810-H04 QM200HA-H				0	0	0	12	
5	CAPACITOR	5.5 7.5 kW	4000UF BKO-C1784H01	MITSUKO	C1-1 C1-2 C1-3 C1-4	2	0	0	2	2	
		11 kW					0	0	3	3	
		15 18.5 kW					0	0	4	4	
6	FAN	5.5 kW	8550M	TOOBISHI	FAN1-1 FAN1-2 FAN1-3	3	0	1	1	3	
		7.5 kW									
		11 kW									
		15 kW									
		18.5 kW									

ITEM	DESCRIPTION	TYPE	MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE		
						STAND.	OPTION					
							A	B	C			
7	DC REACTOR	5.5 kW	1MH BKO-C1737-H02	CHINO	L1	1	-	-	-	1		
		7.5 kW										
		11 kW										1MH BKO-C1737-H03
		15 kW 18.5 kW										1MH BKO-C1737-H04
8	TRANSFORMER	5.5 kW	3PH 11KVA BKO-C1736-H13	CHINO	T4	1	-	-	-	1		
		7.5 kW										
		11 kW										3PH 23KVA BKO-C1736-H14
		15 kW 18.5 kW										3PH 30KVA BKO-C1736-H17
9	TRANSFORMER		3PH 10VA BKO-C1796-H01	YOSHIKAWA	T3	1	-	-	-	1		
10	TRANSFORMER	-	1PH 100VA BKO-C1797-H01	CHINO	T2	1	-	-	0	1		
11	TRANSFORMER	-	1PH4VA BKO-C1798-H01	CHINO	T1	1	-	-	-	1		
12	CT	-	NNC-05AMS BKO-C1724-H11	NANA ELECTRONIC	CT1,2	2	2	-	-	1		
13	CT	-	150/0.05A BKO-C1268-H04	YOSHIKAWA	CT3	1	-	-	-	1		

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
14	OVERMOTOR		OHD-1009	TOHOKU KINZOKU	THS1-3	3	0	0	0	3	
15	OVERMOTOR		OHD-609	TOHOKU KINZOKU	THS4	1	0	0	0	1	
16	FILTER		ZMB2202-11	TDK	FIL1	1	0	0	1	1	
17	RELAY		MY2-DC24	TATEISHI ELECTRO.	RA1	1	0	0	1	3	
18	FUSE		MF60NR-5A-S	TOYO	F1-3	3	3	3	3	6	
19	RESISTOR		KHZIS30W2KOHM	JAPAN RESISTOR	R1,2	2	0	0	0	2	
20	RESISTOR		MO4HA20W200HM-K	MICRON	R3	1	0	0	0	0	
21	CAPACITOR	-	CQ921M1H103K	SHIN-EI TUSHIN	C3-8	6	0	0	3	6	
22	PRINTED BOARD	-	FRS-SA2	MITSUBISHI ELECTRIC		1	0	0	1	1	
23	PRINTED CIR- CUIT BOARD	-	FRS-GB1	MITSUBISHI ELECTRIC		1	0	0	1	1	
24	PRINTED CIR- CUIT BOARD	-	FRS-SN2	MITSUBISHI ELECTRIC		1	0	0	1	1	
25	PRINTED CIR- CUIT BOARD	-	FRS-VC	MITSUBISHI ELECTRIC		1	0	0	1	1	
26	TACHO-GENE- RATOR		TS3033N5E2	TAMAGAWA SEIKI		1	0	0	1	1	

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
27	AC REACTOR	5.5 kW	0.2MH50A BKO-C1793-H02	CHUO DENKI		1	0	0	0	1	
		7.5 kW									
		11 kW	0.17MH60A BKO-C1793-H04								
		15 kW	0.1MH100A BKO-C1793-H05								
		18.5 kW	0.08MH120A BKO-C1793-H06								
28	COUPLING		M976Z104H03	NIHON MINIATURE COUPLING		1	0	0	1	1	FOR TACHO- GENERATOR
29	FAN		PFA-600	AKAMATUS ELECTRIC		1	0	1	1	2	FOR MOTOR
30	BEARING (LOAD SIDE)	5.5 kW	630722	NIHON SEIKO OR NTN TOYO BEAR- ING		1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6310ZZ								
		15 kW									
		18.5 kW									
31	BEARING (OPPOSITE SIDE)	5.5 kW	6306ZZ	NIHON SEIKO OR NTN TOYO BEAR- ING		1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6308ZZ								
		15 kW									
		18.5 kW									

ITEM	DESCRIPTION	TYPE	MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE	
						STAND.	OPTION				
							A	B	C		
32	CAPACITOR	5.5 kW	MEUZ105K600A BKO-NA1061-H05	SHIZUKI	C2-U1,U2 U3,U4	3	0	0	3	3	
		7.5 kW				6			6		
		11 kW				9			9		
		15 kW				12			12		
		18.5 kW									

OPTION CARD

41	MAGNE-SENSOR ORIENT P.C.B.	DL-FM30	mitsubishi ELECTRIC		1	0	0	0	1	BMFRSD00290
42	ENCODER ORIENT P.C.B.	DL-AE10	mitsubishi ELECTRIC		1	0	0	0	1	BMFRSD00
43	OPERATIONAL AMP. P.C.B.	FRS-OP	mitsubishi ELECTRIC		1	0	0	0	1	

8.3 TYPE FR-SD-2B

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

ITEM	DESCRIPTION	TYPE				MANUFACTURER	SYMBOL	Q'TY	GRADE FAKIS				NOTE
									STAND.	OPTION			
										A	B	C	
1	CIRCUIT BREAKER	5.5 kW	NF100CB3P 100A05	MITSUBISHI ELECTRIC	CB1	1	0	0	0	1			
		7.5 kW											
		11 kW											
2	TRANSISTOR	5.5 kW	TM90DZ-H	MITSUBISHI ELECTRIC	SCRR-F SCRS-F SCRT-F	3	0	0	0	3		FOR CONVERTER	
		7.5 kW											
		11 kW											
3	TRANSISTOR	5.5 kW	TM90DZ-H	MITSUBISHI ELECTRIC	SCRR-R SCRS-R SCRT-R	3	0	0	0	3		FOR CONVERTER	
		7.5 kW											
		11 kW											
4	TRANSISTOR	5.5 kW	QM100DY-H	MITSUBISHI ELECTRIC	TRU TRV TRW	6	0	0	0	6		FOR INVERTER	
		7.5 kW											
		11 kW											
						12	0	0	0	12			

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
5	CAPACITOR	$\frac{kW}{7.5}$	4000UF BKO-C1784H01	NITSUKO	C1-1 C1-2 C1-3 C1-4	2	0	0	2	2	
		$\frac{kW}{11}$									
		$\frac{kW}{11}$									
6	FAN	$\frac{5.5 kW}{11}$	8550M	TOOBISHI	FAN1-1 FAN1-2 FAN1-3	3	0	1	1	3	
		$\frac{7.5 kW}{11}$									
		$\frac{kW}{11}$									
7	DC REACTOR	$\frac{5.5 kW}{11}$	1MH BKO-C1737-H04	CHINO	L1	1	0	0	0	1	
		$\frac{7.5 kW}{11}$	1MH BKO-C1737-H06								
		$\frac{kW}{11}$									
8	TRANSFORMER	$\frac{5.5 kW}{11}$	3PH 30KVA BKO-C1736-H15	CHINO	T4	1	0	0	0	1	
		$\frac{7.5 kW}{11}$	3PH 48KVA BKO-C1736-H16								
		$\frac{kW}{11}$									

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
9	TRANSFORMER	-	3PH 10VA BKO-C1796-H01	YOSHIKAWA	T3	1	0	0	01		
10	TRANSFORMER	-	1PH 100VA BKO-C1797-H01	CHINO	T2	1	0	0	01		
11	TRANSFORMER	-	1PH 4VA BKO-C1798-H01	CHINO	T1	1	0	0	01		
12	CT		NNC-05AMS BKO-C1724-H11	NANA ELECTRONIC	CT1,2	2	0	0	01		
13	CT		150/0.05A BKO-C1268-H04	YOSHIKAWA	CT3	1	0	0	01		
14	THERMAL DETECTOR	-	DHD-1009	TOHOKU KINZONKU	THS1-3	3	0	0	03		
15	THERMAL DETECTOR	-	DHD-609	TOHOKU KINZOKU	THS4	1	0	0	01		
16	FILTER	-	ZMB2202-11	TDK	FIL1	1	0	0	11		
17	RELAY	-	MY2-DC24V	TATEISHI ELECTRONIC	RA1	1	0	0	13		
18	FUSE	-	MF60NR-5A-S	T O Y O	F1-3	3	3	3	6		
19	RESISTOR	-	KHZ1S30W2KOHM	JAPAN RESISTOR	R1,2	2	0	0	02		
20	RESISTOR	-	MO4HA20W200HM-K	MICRON	R3	1	0	0	00		
21	CAPACITOR	-	CO921M1H103K	SHIN-EI TUSHIN	C3-8	6	0	0	36		
22	PRINTED CIR- CUIT BOARD	-	FRS-SA2	MITSUBISHI ELECTRIC		1	0	0	11		
23	PRINTED CIR- CUIT BOARD	-	FRS-GB1	MITSUBISHI ELECTRIC		1	0	0	11		

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
24	PRINTED CIR- CUIT BOARD	-	FRS-SN2	MITSUBISHI ELECTRIC		1	0	0	1	1	
25	PRINTED CIR- CUIT BOARD	-	FRS-VC	MITSUBISHI ELECTRIC		1	0	0	1	1	
26	GENERATOR	-	TS3033N5E2	SHIMADAWA		1	0	0	1	1	
27	AC REACTOR	5.5 kW	0.2MH50A BKO-C1793-H02	CHUO DENKI		1	0	0	1	1	
		7.5 kW									
		11 kW	0.17MH60A BKO-C1793-H04								
28	COUPLING		M976Z104H03	NIHON MINIATURE COUPLING		1	0	0	1	1	FOR TACHOGENERATOR
29	FAN		PFA-600	AKAMATSU ELECTRIC		1	0	1	1	2	FOR MOTOR
30	BEARING (LOAD SIDE)	5.5 kW	630722	NIHON SEIKO OR NTN TOYO BEAR- ING		1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6310ZZ								
31	(OPPOSITE SIDE)	5.5 kW	630622	NIHON SEIKO OR NTN TOYO BEAR- ING		1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6308ZZ								

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS			NOTE	
							STAND.	OPTION			
								A	B		C
32	CAPACITOR	5.5 kW	MEUZ105K600A BKO-NA1061-H05	SHIZUKI	C2-U1,U2, U3	3	0		3	3	
		C2-V1,V2, V3			6			6	6		
		C2-W1,W2, W3			9	0		9	9		

OPTION CARD

41	MAGNE-SENSOR ORIENT P.C.B	DL-FM30	MITSUBISHI ELECTRIC		1	0	0	0	1	BMFRSD00290
42	ENCODER ORIENT P.C.B.	DL-AE10	MITSUBISHI ELECTRIC		1	0	0	0	1	BMFRSD00
43	PERATIONAL AMP P.C.B	FRS-OP	MITSUBISHI ELECTRIC		1	0	0	0	1	

8.4 TYPE FR-SD-2T

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

ITEM	DESCR PTION	TYPE	MANUFACTURER	SYMBOL	Q'TY	STAND.	OPTION			NOTE
							A	B	C	
1	CIRCUIT BREAKER	5.5 kW	MITSUBISHI ELECTRIC	CB1	1	-	0	0	1	
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								
2	THYRISTOR	5.5 kW	MITSUBISHI ELECTRIC	SCRR-F SCRS-F SCRT-F	3	-	0	0	3	FOR CON- VEYOR
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								
3	THYRISTOR	5.5 kW	MITSUBISHI ELECTRIC	SCRR-R SCRS-R SCRT-R	3	-	0	0	3	FOR CON- VEYOR
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								

ITEM	DESCRIPTION	TYPE	MANUFACTURER	SYMBOL	Q'TY	STANDARD				NOTE
						STAND.	OPTION			
							A	B	C	
4	TRANSISTOR	5.5 kW	MITSUBISHI ELECTRIC	TRU TRV TRW	6	0	0	0	6	FOR INVERTER
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								
5	CAPACITOR	5.5 kW	NITSUKO	C1-1 C1-2 C1-3 C1-4	2	0	0	2	2	
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								
6	FAN	5.5 kW	TOOBISHI	FAN1-1 FAN1-2 FAN1-3	3	0	1	1	3	
		7.5 kW								
		11 kW								
		15 kW								
		18.5 kW								

ITEM	DESCRI PTION	TYPE		MANUFACTURER	SY MBOL	Q 'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
7	DC REACTOR	5.5 kW	1MH BKO-C1737-H07	CHINO	L1	1	0	0	0	1	
		7.5 kW									
		11 kW	1MH BKO-C1737-H08								
		15 kW	1MH BKO-C1737-H09								
		18.5 kW									
8		5.5 kW	3PH 25.7KVA BKO-C1736-H51	CHINO	T4	1	0	0	0	1	
		7.5 kW									
		11 kW	3PH 37.4KVA BKO-C1736-H52								
		15 kW	3PH 56KVA BKO-C1736-H53								
		18.5 kW									
9	TRANSFORMER	-	3PH 100VA BKO-C1796-H01	YOSHIKAWA	T3	1	0	0	0	1	
10	TRANSFORMER	-	1PH 100VA BKO-C1797-H01	CHINO	T2	1	0	0	0	1	
11	TRNASFORMER	-	1PH 100VA BKO-C1798-H01	CHINO	T1	1	0	0	0	1	
12	CT		NMC 05AMS BKO-C1724-H11	NANA ELECTRONIC	CT1,2	2	0	0	0	1	
13	CT		150/5 25A BKO-C1268-H04	YOSHIKAWA	CT3	1	0	0	0	1	
14	THERMAL DETECTOR		OHD-1009	TOHOKU KINZOKU	THS1-3	1	0	0	0	1	

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS			NOTE
							STAND.	OPTION		
							A	B	C	
15	THERMAL DETECTOR	-	OHD-60B	TOHOKU KINZOKU	THS4	1	0	0	01	
16	FILTER		ZMB2202-11	TDK	FIL1	1	0	0	1 1	
17	RELAY		MY2-DC24V	TATEISHI 'ELECTRO.	RA1	1	0	0	1 3	
18	FUSE		MF60NR-5A-S	TOYO	FI-3	3	3	3	3 6	
19	RESISTOR		KHZ1S30W2KOHM	JAPAN RESISTOR	R1,2	2	0	0	0 2	
20	RESISTOR		MO4HA20W200HM-K	MICRON	R3	1	0	0	0 0	
21	CAPACITOR	-	CQ921MIH103K	SHIN-EI TUSHIN	C3-9	6	0	0	3 6	
22	PRINTED CIR- CUIT BOARD	-	FRS-SA2	mitsubishi ELECTRIC	-	1	0	0	1 1	
23	PRINTED CIR- CUIT BOARD	-	FRS-GB1	mitsubishi ELECTRIC		1	0	0	1 1	
24	PRINTED CIR- CUIT BOARD	-	FRS-SN2	mitsubishi ELECTRIC		1	0	0	1 1	
25	PRINTED CIR- CUIT BOARD	-	FRS-VC	mitsubishi ELECTRIC		1	0	0	1 1	
26	TACHO- GENERATOR	-	TS3033N5E2	TAMAGAWA SEIKI	-	1	0	0	1 1	
27	AC REACTOR	5.5 kW	0.2MH50A BKO-C1793-H02	CHUO DENKI		1	0	0	01	
		7.5 kW								
		11 kW	0.17MH60A BKO-C1793-H04							
		13 kW	0.1MH100A BKO-C1793-H05							
		18.5 kW	0.08MH120A BKO-C1793-H06							

ITEM	DESCRIPTION	TYPE		MANUFACTURER	SYMBOL	Q'T	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
28	COUPLING	-	M976Z104H03	NIHON MINIATURE COUPLING		1	0	0	1	1	FOR TACHOGENERATO
29	FAN	-	PFA-600	AKAMATUS ELECTRIC	-	1	0	1	1	2	FOR MOTOR
30	BEARING (LOAD SIDE)	5.5 kW	6307ZZ	NIHON SEIKO OR NTN TOYO BEARING	-	1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6310ZZ								
		15 kW									
		18.5 kW									
31	BEARING (OP- POSITE SIDE)	5.5 kW	630622	NIHON SEIKO OR NTN TOYO BEARING	-	1	0	0	1	1	FOR MOTOR
		7.5 kW									
		11 kW	6308ZZ								
		15 kW									
		18.5 kW									
32	CAPACITOR	5.5 kW	MEUZ105K600A BKO-NA1061 -HO5	SHIZUKI	C2-U1, u2	3	0	0	3	3	
		U3, U4			6	6			6		
		C2-V1, v2			9	9			9		
		V3, V4									
		C2-W1, w2			12	12			12		
					W3, W4						

OPTION CARD

ITEM	DESCR IPTION	TYPE		MANUFACTURER	SYMBOL	Q'TY	SPARE PARTS				NOTE
							STAND.	OPTION			
								A	B	C	
41	MAGNE-SENSOR ORIENT P.C.B.		DL-FM30	mitsubishi ELECTRIC		1	0	0	01	BMFRSD00290	
42	ENCODER ORIENT P.C.B		DL-AE10	mitsubishi ELECTRIC		1	0	0	01	BMFRSD00	
43	OPERATIONAL AMP P.C.B.		FRS-OP	mitsubishi ELECTRIC		1	0	0	01		