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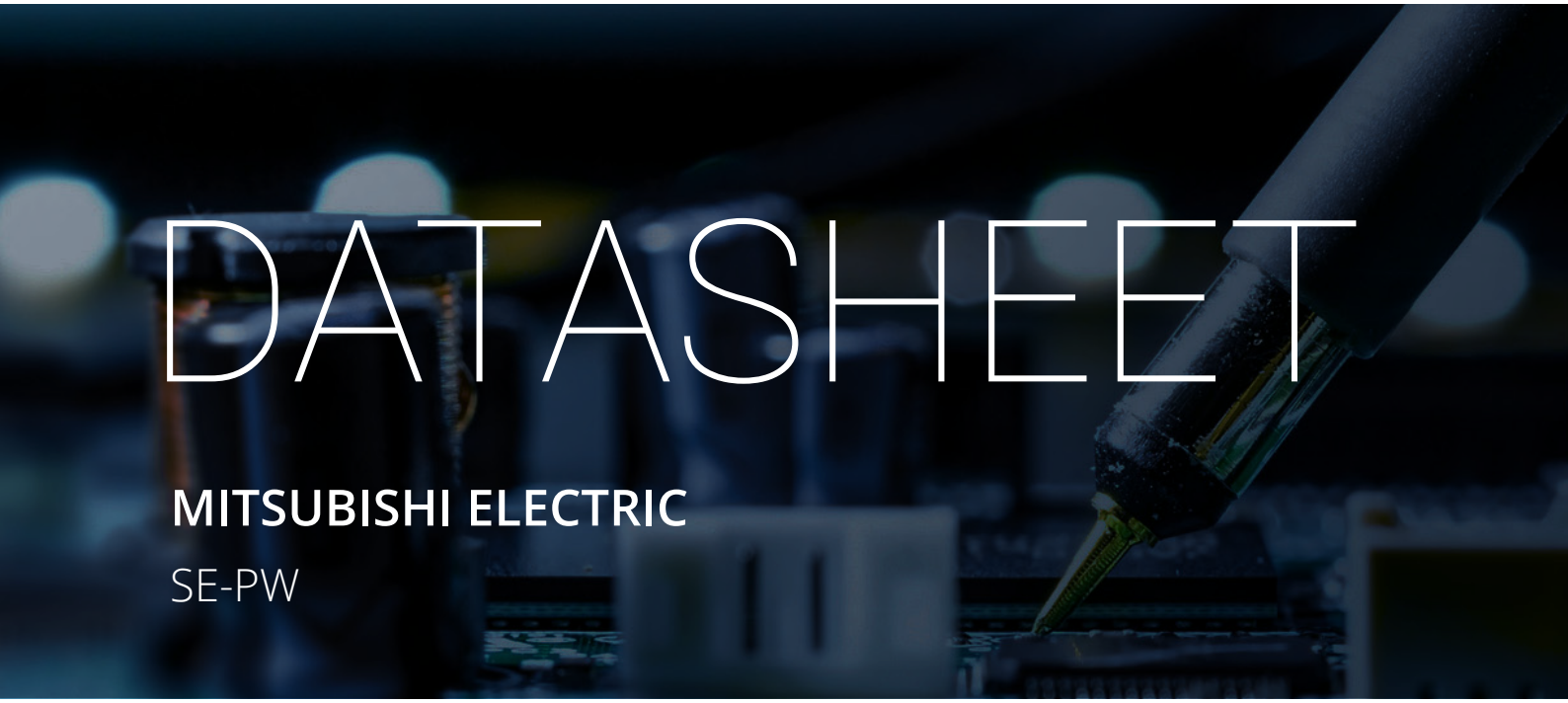

DATASHEET

MITSUBISHI ELECTRIC

SE-PW

OTHER SYMBOLS:

SEPW, SE PW, SE-PW

RGB ELEKTRONIKA AGACIAK CIACIEK SPÓŁKA JAWNA

Jana Dlugosza 2-6 Street
51-162 Wrocław
Poland

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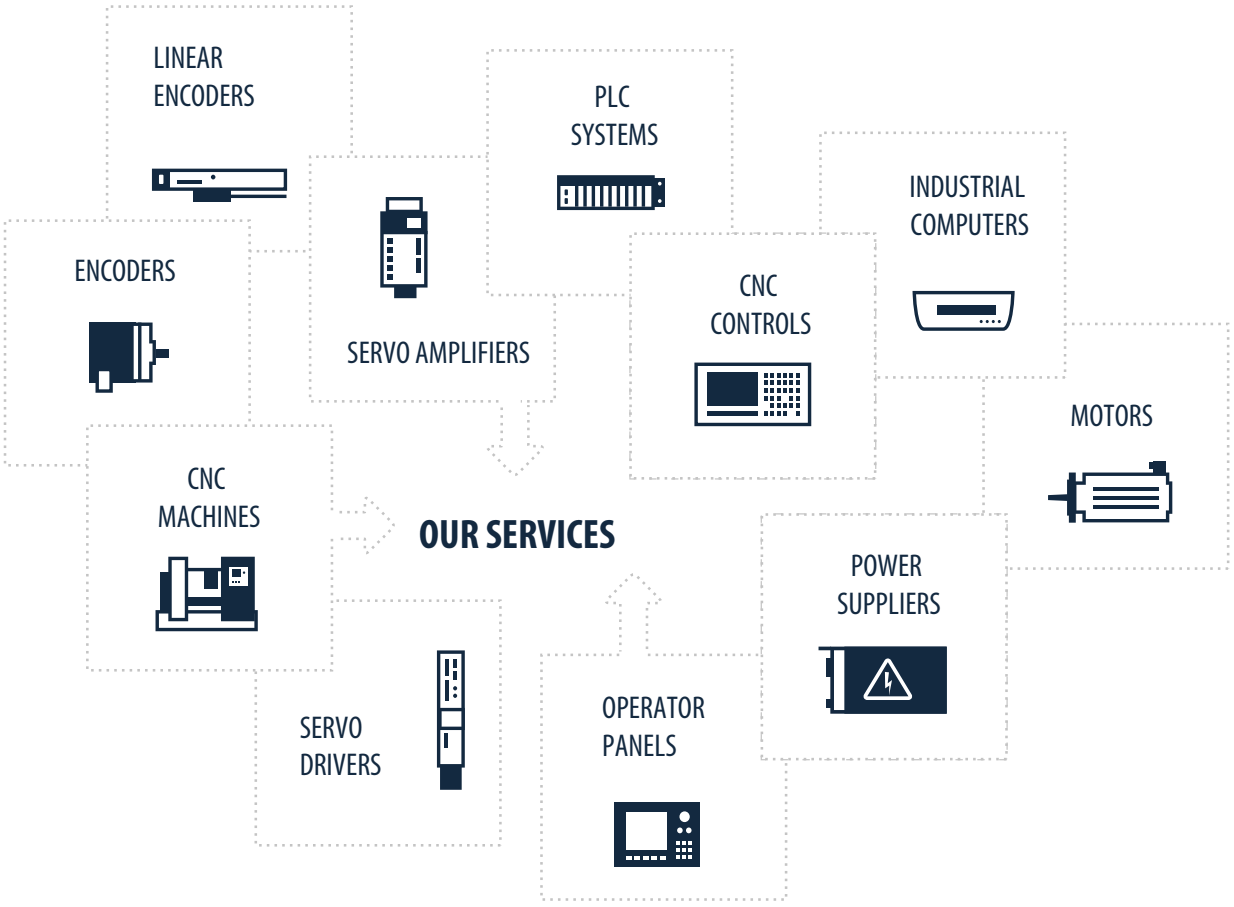

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FREQROL

MITSUBISHI ELECTRIC CORP. JAPAN

AC SPINDLE CONTROLLER model FR-SE

Version 3.00
Confidential:

Some material in this manual is for internal use only.

M0660-ES FR-SE MAINT MAN BNP-A7237-35A

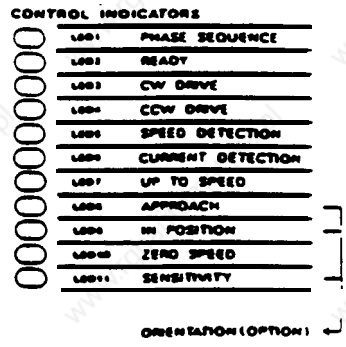
sw6-2 to a #(on) position
For open Loop

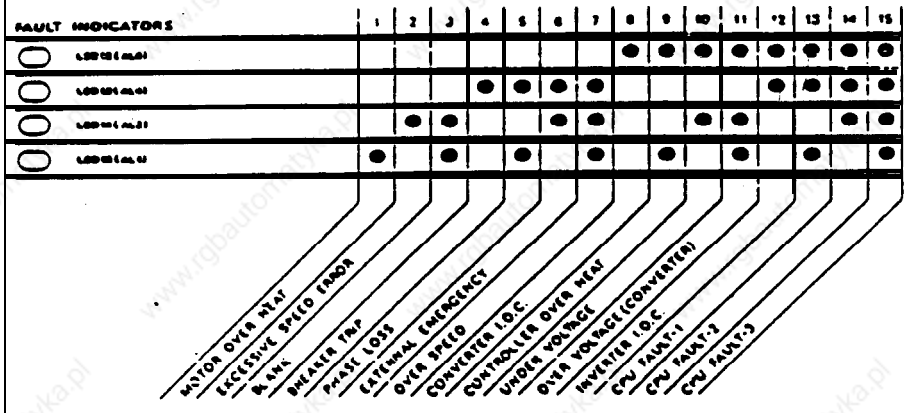
INDEX

FREQROL

MITSUBISHI ELECTRIC CORP. JAPAN

AC SPINDLE CONTROLLER model FR-SE





Note: When exchanging hinge panel the original front panel should stay with the machine. This is so that the original BN number will stay with the machine. The BN number indicates the switch settings for the spindle drive.

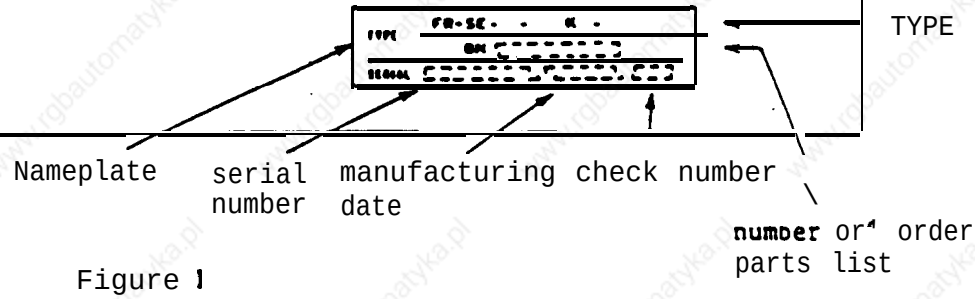


Figure 1

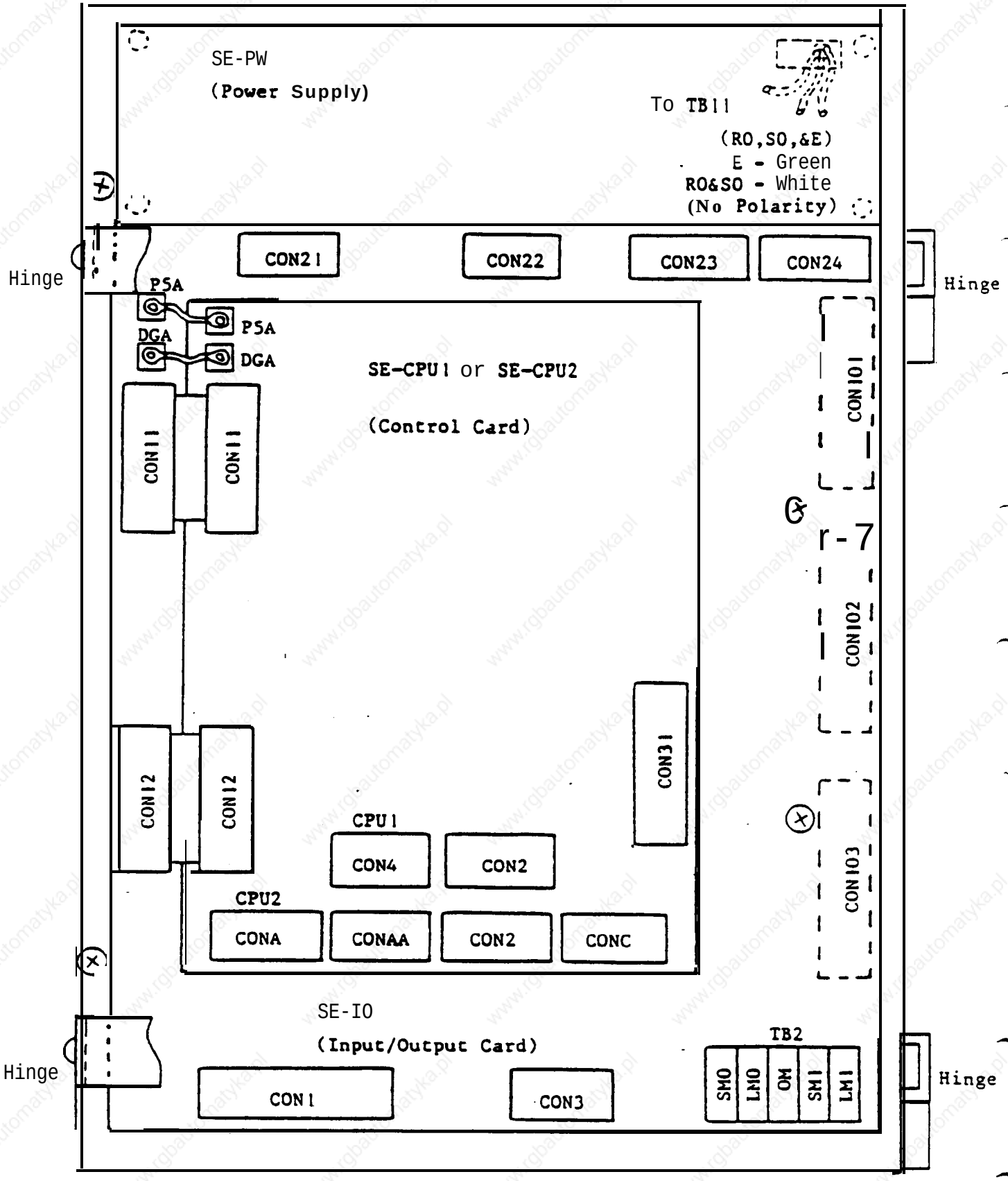

SE-PW
(Power Supply)
To TB11
(RO,SO,&E)
E - Green
RO&SO - White
(No Polarity)
Hinge
CON21
CON22
CON23
CON24
Hinge
P5A
P5A
DGA
DGA
SE-CPU1 or SE-CPU2
(Control Card)
CON11
CON11
CON101
CON102
CON103
CON12
CON12
CON31
CPU1
CON4
CON2
CPU2
CONA
CONAA
CON2
CONC
SE-IO
(Input/Output Card)
TB2
SMO
LMO
OM
SM1
LM1
CON1
CON3
Hinge
Hinge

Figure 2

General Instructions for Changing FR-SE Card's (PCB)

1. Remove power from unit. (Use Machine Main Breaker)
   Note: FR-SE CB1 breaker does not remove power from SE-PW and other PCB's.
   Note: If Main Breaker cannot be shut off. Power can be removed by CB1 breaker and removal of fuses F1,F2, & F3. CAUTION:F1,F2, & F3 are live at this time. Fuses are usually located inside of base unit on the line filter. Refer to Figures 17 to 22 (FR-SE Base).
2. Removal of SE-CPU card. (Refer to Fig. 2)
   (1) Remove the connectors for external connection of orientation detector, PLG, etc. On CPU1: CON4 and CON2. On CPU2: CONA, CONAA, CON2, and CONC. To SE-IO card remove CON11 and CON12. Unscrew power supply wires P5A and DGA.
   Note: Honda connectors have screws and retaining clips.
   (2) Remove the card while compressing the card installation spacer claws.
3. Removal of SE-IO card. (Refer to Fig. 2)
   (1) After removal of the CPU card connectors according to the above procedure, remove the load/speed meter wiring from TB2, CON1, and CON3 of the I/O card.
   (2) Remove CON101, CON102, and CON103 on the rear of the hinge panel.
   (3) Remove the small hinge panel upon which the CPU card was installed.
   (4) Remove the screws fixing the I/O card, and then pull out the upper guide strongly and pull the I/O card from the SE-PW connectors. (CON21 - CON24).
4. Remove the SE-PW power supply. (Refer to Fig. 2)
   (1) Remove the CPU card and I/O card according to the above procedure,.
   (2) Remove the three 200 volt AC power wires RO,SO, & E from the terminal block located on the base of the unit.
   Note: E is green and RO&SO are white with no polarity.
   (3) Remove the screws on the back of the hinge holding the SE-PW and the remove the SE-PW unit.
5. Assembly of hinge panel.
   (1) Install the new cards in the reverse order of the removal procedure.

Important Note: After replacement, confirm that all screws and connectors are tight and correct. Also verify positive insertion of the connectors.

Applying Power:

1. After replacement, all specific adjustment procedures should be observed. Especially current transformer offsets, meter calibration, and orientation.
2. Verify that EPROM's and switch settings are correct.
3. Optional: Verify that base driver waveforms are correct.
4. Verify spindle operation:
   (1) Confirm full speed range in each gear forward and reverse.
   (2) Confirm orient operation in each gear (Including ATC operation). Verify alignment before attempting ATC.

Magnetic sensor system with single point orientation unit

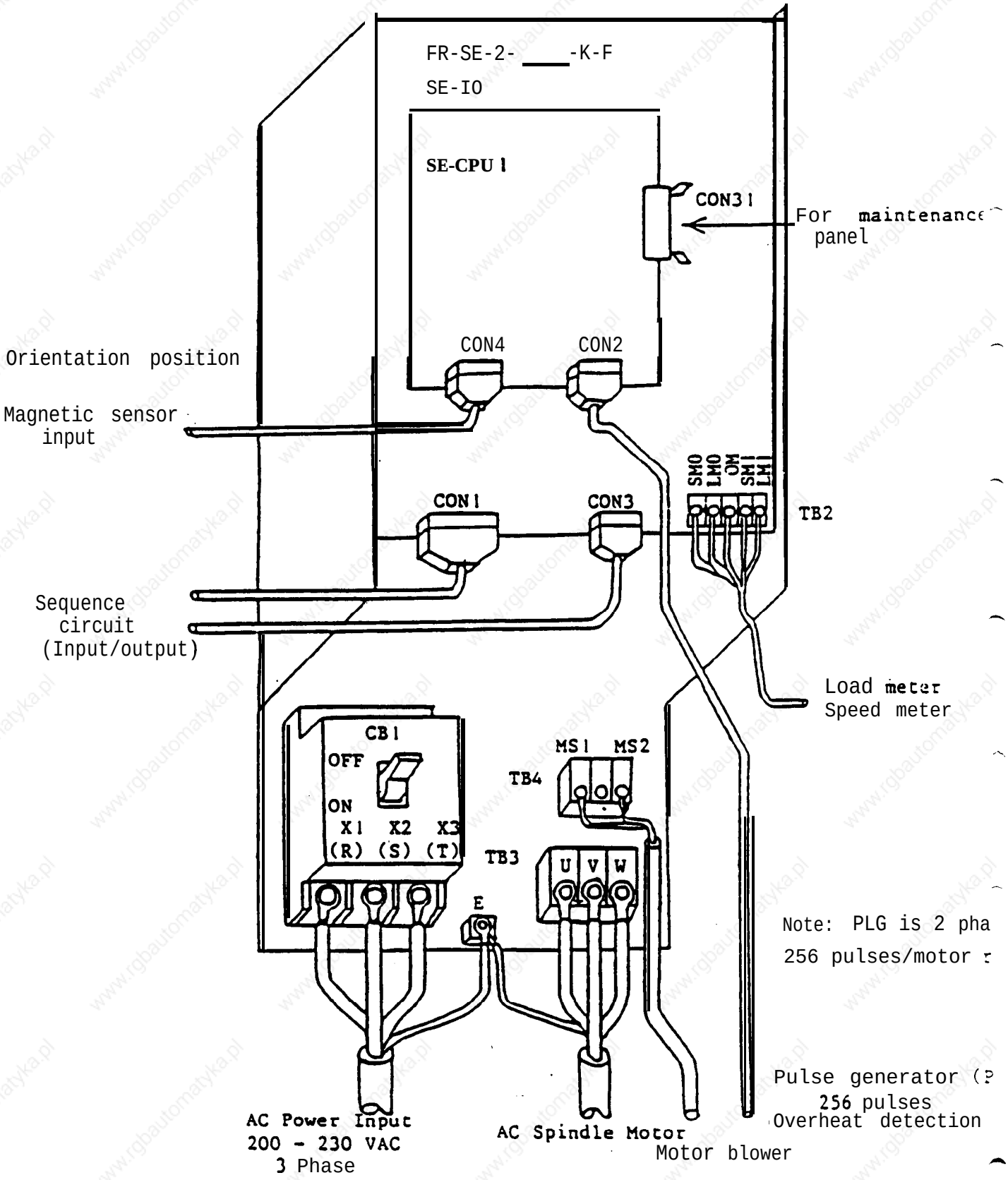


Figure 3

Encoder system with multiple point orientation unit

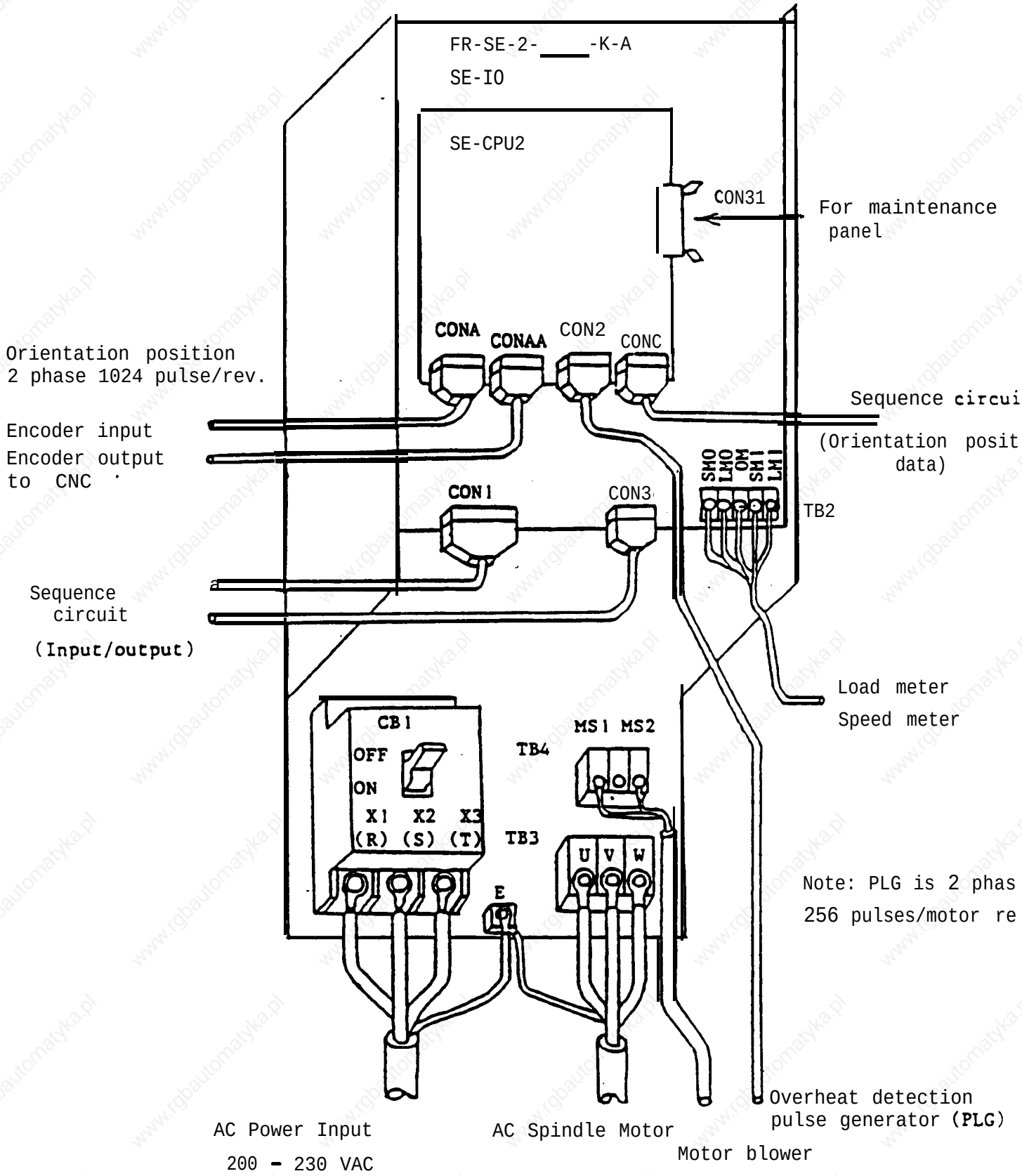


Figure 4

Freqrol SE-CPU1 Card

Refer to Figure 5 for location.

P5A.....+ 5 volt supply
DGA..... ..Digita l ground

Switch: (ON/OFF)

SW1..... ..Gea r ratio H
SW2.....Gear ratio M
SW3..... ..Gea r ratio L
SW4-1..... ..Cree p speed (20/30rpm)
SW4-2,3,4.....2nd deceleration point (25/16 degree)
SW4-5,6,7.....1s t deceleration point (212/149 degree)
SW4-8.....Mag. Sensor mounting direction (Fwd/Rev)
SW5-1,2..... ..Torqu e limit (10/50%) also external input
SW5-3,4,5.....Acceleration/decelleratio n time constant
SW5-6,7,8..... ..Spe ed detection range (2/58%)
SW6-1.....Orien t (Normal/test)
SW6-2.....Velocit .y loop (Closed/open)
SW6-3.....Digita 1 input (Binary/BCD)
SW6-4..... ..Spee d input (Emitter/collector)
SW6-5.....Serv o rigidity (High/low)
SW6-6.....Meter calibration (Off/On)
SW6-7.....Maximum speed (Low/high)
SW6-8.....Zer o speed (Low 25rpm/high 50rpm)
SW7-1.....Mag. Sensor orient in-position (1/5 deg.)
SW7-2.....Externa l E-Stop alarm display (On/Off)
SW7-3..... ..Loa d meter output (High 10v/low 3v)
SW7-4.....Bas e speed (1150rpm/1500rpm)
SW7-5,6,7,8..... ..Moto r size/type (2.2kw/rpm / 22kw/rpm)
SW8.....Spe ed loop proportional constant (25/240)
SW9..... ..S peed loop integral constant (1.5/14.4)
SW10.....Orientatio n speed (20/320rpm /gear ratio)
SW11-1,2..... ..Orientatio n direction select
SW11-3,4.....Orien t stop servo rigidity
ST1.....Rese t
ST2..... ..Orien t test

VR1.....Mechanica l orient position shift
VR2..... ..Mag. Sensor sensitivity adjust
CH53.....Mag. Sensor input

LED1..... ..A C Power phase identification
LED2..... ..Read y condition
LED3.....FWD CW rotation command
L&D4..... CCW rotation command
LED5.....Lo w speed detection (See SW5-6,7,8)
LED6.....Hig h motor current (110%)
LED7.....Up to speed (+/-15%)
LED8..... .Orientation approach
LED9..... In position orient stop
LED10.....Belo w zero speed
LED11.....Mag. Sensor signal level above 8.5v
LED12.....Spar e

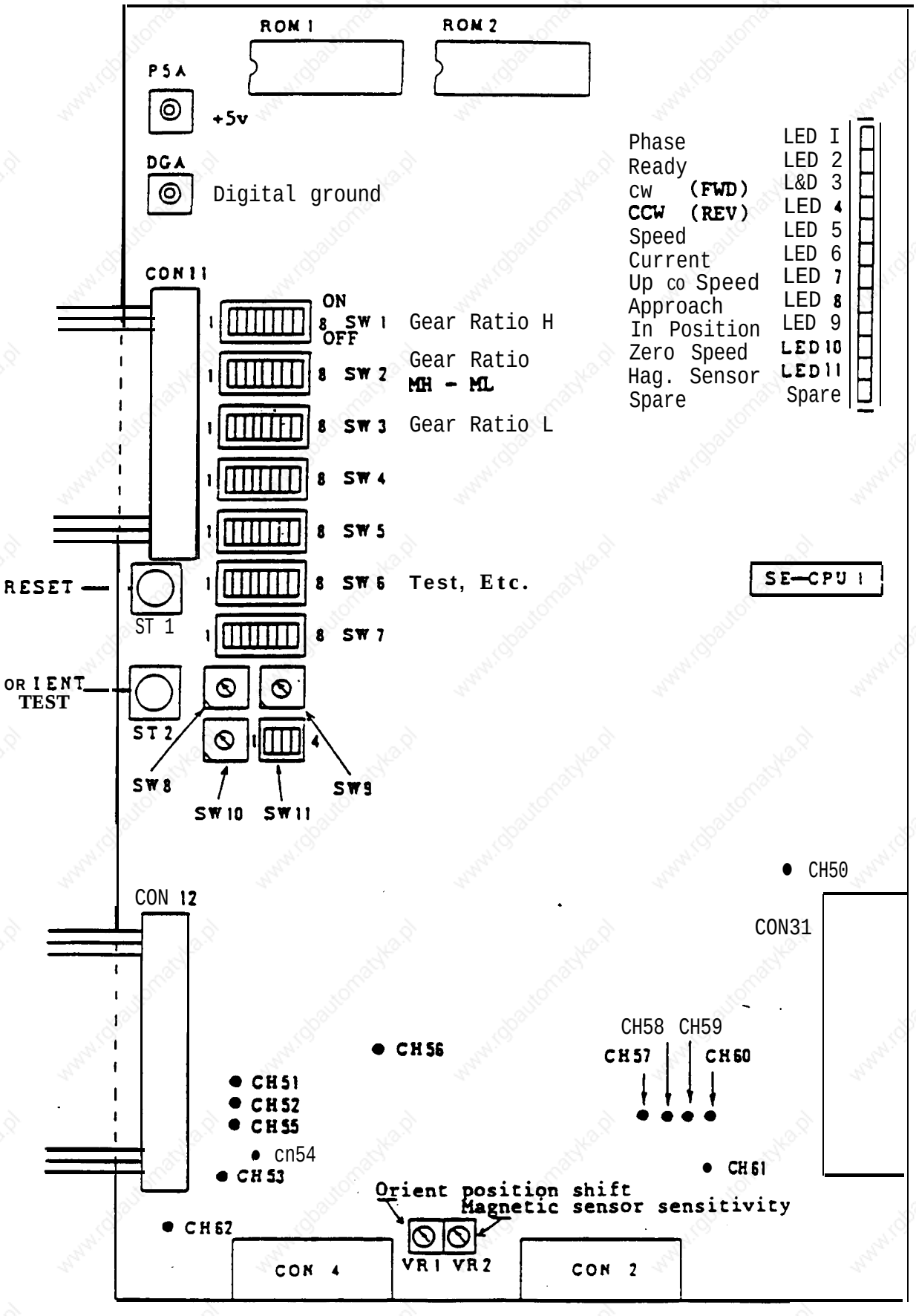


Figure 5

CH 41 IC V MAX. ONLY IN MANUAL MODE.

Freqrol SE-CPU2 Card

Refer to Figure 6 for location. Switch: (ON/OFF)

P5A.....+ 5 volt supply
DGA.....Digita l ground
SW1 .....Gea r ratio H
SW2 .....Gea r ratio M
SW3 .....Gea r ratio L
SW4-1 .....Cree p speed (20/30rpm)
SW4-2,3,4 .....2nd deceleration point (25/15 degree)
SW4-5,6,7 .....1s t deceleration point (225/146 degree)
SW4-8 .....Encoder mounting direction (Fwd/Rev)
SW5-1,2 .....Torqu e limit (10/50%) also external input
SW5-3,4,5 .....Acceleration/decelleratio n time constant
SW5-6,7,8 .....Spe ed detection range (2/58%)
SW6-1 .....Orien t (Normal/test)
SW6-2 .....Velocit y loop (Closed/open)
SW6-3 .....Digita 1 input (Binary/BCD)
SW6-4 .....Spee d input (Emitter/collector)
SW6-5 .....Positio n input (Emitter/collector)
SW6-6 .....Mete r calibration (Off/On)
SW6-7 .....Maximum speed (Low/high)
SW6-8 .....Zer o speed (Low 25rpm/high 50rpm)
SW7-1 .....Serv o rigidity (High/low)
SW7-2 .....Externa l E-Stop alarm display (On/Off)
SW7-3 .....Loa d meter output (High 10v/low 3v)
SW7-4 .....Bas e speed (1150rpm/1500rpm)
SW7-5,6,7,8 .....Moto r size/type (2.2kw/rpm / 22kw/rpm)
SW8 .....Spee d loop proportional constant (25/240)
SW9 .....Spe ed loop integral constant (1.5/14.4)
SW10 .....Orientatio n speed (20/320rpm /gear ratio)
SW11-1,2 .....Orientatio n direction select
SW11-3,4 .....Orien t stop servo rigidity
SW12 .....Orien t in-position range (.09/1.32 degree)
SW13 .....Orien t position shift (Course 22.5 deg.)
SW14 .....Orien t position shift (Medium 1.4 deg.1
SW15 .....Orien t position shift (Fine .088 deg.)
ST1 .....Rese t
ST2 .....Orien t test
PIN11 .....Encode r power supply (ON +5v)
PIN12 & PIN13 .....CON C Orient position input level select
SPARE PIN .....Extr a jumper strap
LED1 .....A C Power phase identification
LED2 .....Read y condition
LED3 ..... CW rotation command
LED4 ..... CCW rotation command
LED5 .....Lo w speed detection (See SW5-6,7,8)
LED6 .....Hig h motor current (110%)
LED7 .....U p to Speed (+/-15%)
LED8 .....Orientatio n approach
LED9 ..... In position orient stop.
LED10 .....Belo w zero speed
LED11 .....Spar e
LED12 .....Spar e

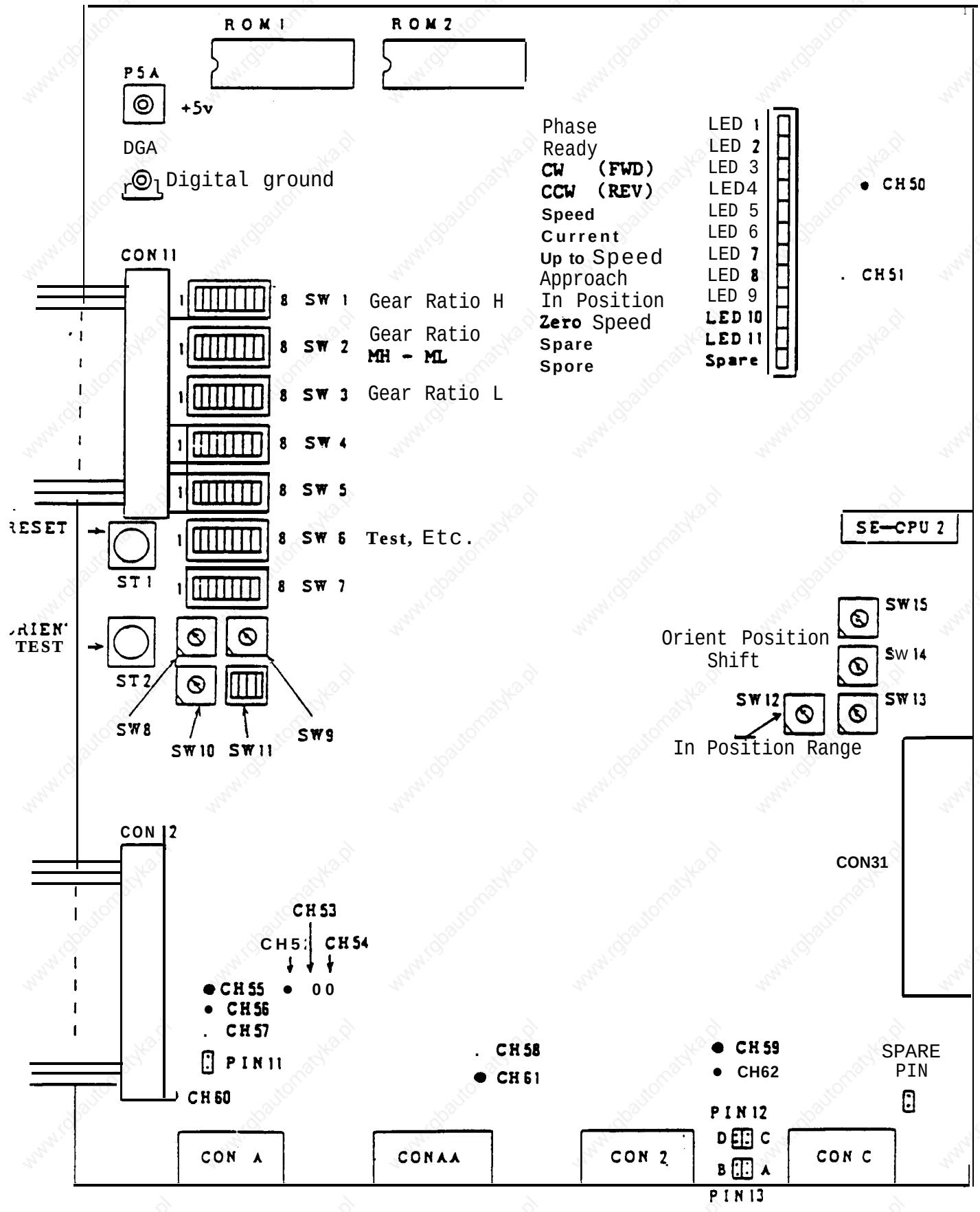

ROM 1
ROM 2
P5A
+5v
DGA
Digital ground
Phase
Ready
CW (FWD)
CCW (REV)
Speed
Current
Up to Speed
Approach
In Position
Zero Speed
Spare
Spore
LED 1
LED 2
LED 3
LED4
LED 5
LED 6
LED 7
LED 8
LED 9
LED 10
LED 11
Spare
CH50
CH51
CON11
SW 1 Gear Ratio H
SW 2 Gear Ratio MH - ML
SW 3 Gear Ratio L
SW 4
SW 5
SW 6 Test, Etc.
SW 7
RESET
ST1
ORIEN TEST
ST2
SW8
SW10
SW11
SW9
SE—CPU 2
SW15
Orient Position Shift
SW14
SW12
SW13
In Position Range
CON12
CON31
CH53
CH52
CH54
CH55
CH56
CH57
PIN11
CH60
CH58
CH61
CH59
CH62
SPARE PIN
PIN12
PIN13
CON A
CONAA
CON 2
CON C

Figure 6

Freqrol SE-IO Card

Refer to Figure 7 for location.(*) Factory set, don't change.

PSA.. .....+5v supply
DGA..... ..Digital groun d
VR1.(*)..... . Phase current command zero adjust
VR2.(*)..... . Phase current command zero adjust
VR3.(*)..... . Phase current. command zero adjust
VR5.(*)..... +/-10v Reference adjust (not used)
VR6 ....Hig h over-speed level adjust
VR7 ....L ow over-speed level adjust (not used)
VR8.(*)..... ..Converte r voltage gain adjust
VR9.(*).....Suppl y voltage peak value gain adjust
VR10 ....CTC 1 Converter offset adjust
VR11 ....CTC 2 fnverter offset adjust
VR12 ....CTC 4 V Phase motor current offset adjust
vR13 ....CTC 3 U Phase motor current offset adjust
VR14 ....SM 1 Speed meter output adjust
VR15.....LM1 Load meter output adjust
PIN1 ....Max. speed or Over-speed select (A used)
PIN2 & PIN3 ....CON 1 Digital speed input level select
PIN4 ..... .Breaker trip & overheat-alarm disable
PINS ....K w setting (new) OFF 18.5kw or larger
LED12,13,14,15... ..Driv e alarm indicators (binary output)
LED16 ....Spare
LED17 ....Unde r voltage indicator
LED18 ....Converte r regeneration indicator
LED19 ....Bas e transistor cut-off indicator
LED20 ....Converte r voltage charging
LED101 ....Spe ed command display (x2048)
LED102 ....Spee d command display (x1024)
LED103 - LED108 .. ..Spe ed command display
LED109 ..... .Speed command display (x8)
LED110 ....Spee d command display (x4)
LED111 ..... .Speed command display (x2)
LED112 ....Spee d command display (x1)

Spindle Alarms:

		LED12 AL8	LED13 AL4	LED14 AL2	LED15 AL1
1.	Motor Over Heat				ON
2.	Excessive Speed Error			ON	
3.	Blank			ON	O N
4.	Breaker Trip			ON	
5.	Phase Loss			ON	O N
6.	External Emergency			ON	ON
7.	Over Speed			ON	ON O N
8.	Converter I.O.C		ON		
9.	Controller Over Heat		ON		O N
10.	Under Voltage		ON		ON
11.	Over Voltage (Converter)		ON		ON O N
12.	Inverter I.O.C		ON	ON	
13.	CPU Fault 1		ON	ON	O N
14.	CPU Fault 2		ON	ON	ON
15.	CPU Fault 3		ON	ON	ON O N

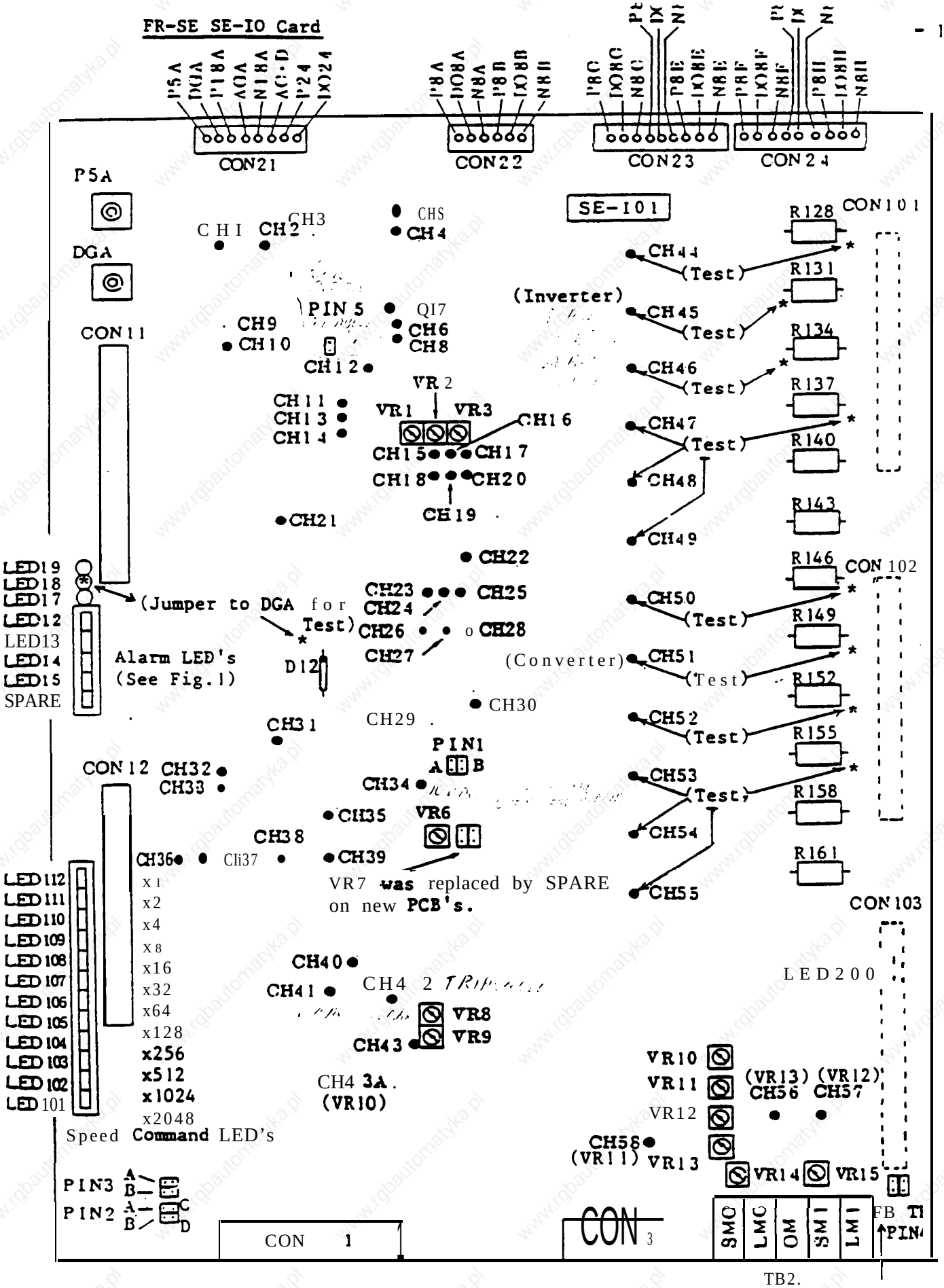

FR-SE SE-IO Card
CON21
CON22
CON23
CON24
P5A
DGA
CON11
CH1
CH2
CH3
CH5
CH4
PIN 5
QI7
CH9
CH10
CH6
CH8
CH12
VR2
VR1
VR3
CH11
CH13
CH14
CH16
CH15
CH17
CH18
CH20
CH19
CH21
CH22
CH23
CH25
CH24
CH26
CH28
CH27
CH30
CH29
CH31
PIN1
A
B
CON12
CH32
CH33
CH34
CH35
VR6
CH38
CH36
CH37
CH39
VR7 was replaced by SPARE on new PCB's.
CH40
CH41
CH42
VR8
VR9
CH43
CH44 (Test)
CH45 (Test)
CH46 (Test)
CH47 (Test)
CH48
CH49
CH50 (Test)
CH51 (Test)
CH52 (Test)
CH53 (Test)
CH54
CH55
(Inverter)
(Converter)
SE-101
R128
R131
R134
R137
R140
R143
R146
R149
R152
R155
R158
R161
CON101
CON102
CON103
LED200
LED19
LED18
LED17
LED12
LED13
LED14
LED15
SPARE
(Jumper to DGA for Test)
Alarm LED's (See Fig.1)
D12
LED112
LED111
LED110
LED109
LED108
LED107
LED106
LED105
LED104
LED103
LED102
LED101
x1
x2
x4
x8
x16
x32
x64
x128
x256
x512
x1024
x2048
Speed Command LED's
CH4 3A. (VR10)
VR10
VR11
VR12
VR13
VR14
VR15
(VR13) CH56
(VR12) CH57
CH58 (VR11)
PIN3
PIN2
CON 1
CON 3
SMO
LMC
OM
SM1
LM1
TB2.
Breaker tria
alarm dis

Figure 7

General Instructuions for Changing FR-SE Hinge

Before exchanging the FR-SE hinge panel please confirm the following:

(1) Remove the original hinge cover panel and keep it for later installation on the new hinge. This maintains the original BN number on the spindle drive. The BN number tells the service engineer the settings. of the pins, switches and the controller's ratings. Refer to Figure 1 if necessary.

Note: Spindle hinge will have either CPU1 or CPU2, not both.

(2) SE-CPU1 Card: Set adjustments VR1 and VR2 the same as the original card. Set dip and rotary switches SW1 through SW11 the same as the original card. Refer to Fig. 5 for locations.

(3) SE-CPU2 Card: Set shorting pins (PIN11 through PIN13) the same as the original card. Set dip and rotary switches SW1 through SW15 the same as the original card. Refer to Fig. 6.

(4) EPROM's SE-CPU1 and SE-CPU2: Verify that numbers on the new EPROM labels match the original EPROM. Newer versions of software EPROM's will have a higher number or letter on the label, which is ok. If unsure please call Mitsubishi and verify ERPOM version level. Please remove and install the original EPROM's in the new CPU card if the ROM1 and ROM2 sockets are empty. Use care in removing EPROM's and caution in installing EPROM's. Do not install upside down, as this will damage the EPROM. Refer to Figure 15 for detail.

(5) SE-IO Card: Set shorting pins (PIN1 through PIN5) the same as the original card. Do not make any adjustments other than those specified in the instructions. Refer to Fig. 7.

(6) Optional: Test base driver waveforms'before restoring full power (CB1 OFF). This test should be performed if output transistors were damaged and replaced or suspected of being damaged. Refer also to Testing Output Transistors, Diode, and Capacitor. See Procedure for Checking Base Driver Waveforms.

(7) After installing FR-SE hinge panel please readjust the offsets for the DC current transformers. Refer to Current Transformer Offset Adjustment Procedure.

(8) Confirm full speed range in all gears FWD and REV.

(9) Confirm alignment of spindle at orient in machines that require it for mechanical operations such as ATC. This may involve measuring the spindle orient position relative to axis movement as specified by the machine manufacturer. Confirm orientation in each gear. (Including ATC.)

Current Transformer Offset Adjustment Procedure FR-SE

(1) Offsets should be adjusted with zero current. This is done, by switching CB1 breaker OFF on FR-SE and disabling the BREAKER TRIP alarm(*) caused by CB1. Refer to Fig. 3 or 4 for location of CB1. (Note that up is OFF.)

Note: Computer Numerical Control (CNC)...OF F
FR-SE Fuses F1, F2, & F3.....I N (GOOD)
Machine Main Breaker.....O N
Pin 4 (FB) on SE-IO card.....O N (*)
FR-SE Breaker CB1.....OF F

Note(*): It may not be necessary to disable the breaker trip alarm to complete current transformer adjustments.

Disable CB1 breaker trip alarm by inserting jumper (FB) on Pin 4 of SE-IO PCS. This is located on the lower right corner of the PCB and to the right of the TB2 screw terminal. Refer to lower right corner of Figure 7. A SPARE jumper strap can usually be found on the SE-CPU or SE-IO printed circuit boards.

(2) Adjust all DCTC offsets to Ov +/-5mv (Note: +/-10mv is acceptable). Refer to bottom of Fig. 7 for location of adjustments and check points.

CTC1 Converter	VR10	CH43A to CH2 (AGA) or DGA for Ov.
CTC2 Inverter	VR11	CH58 to CH2 (AGA) or DGA for Ov.
CTC3 U Phase INV	VR13	CH56 to CH2 (AGA) or DGA for Ov.
CTC4 V Phase INV	VR12	CH57 to CH2 (AGA) or DGA for Ov.

(3) After adjustment return spindle drive to normal settings.

Note: CNC..... OFF
FR-SE Fuses F1, F2, & F3.....I N
Machine Main Breaker.....O N
Pin 4 (FB) on SE-IO card.....O FF
FR-SE Breaker CB1 .....O N

Refer to Figures 17 to 22 (FR-SE Base) for location of fuses.

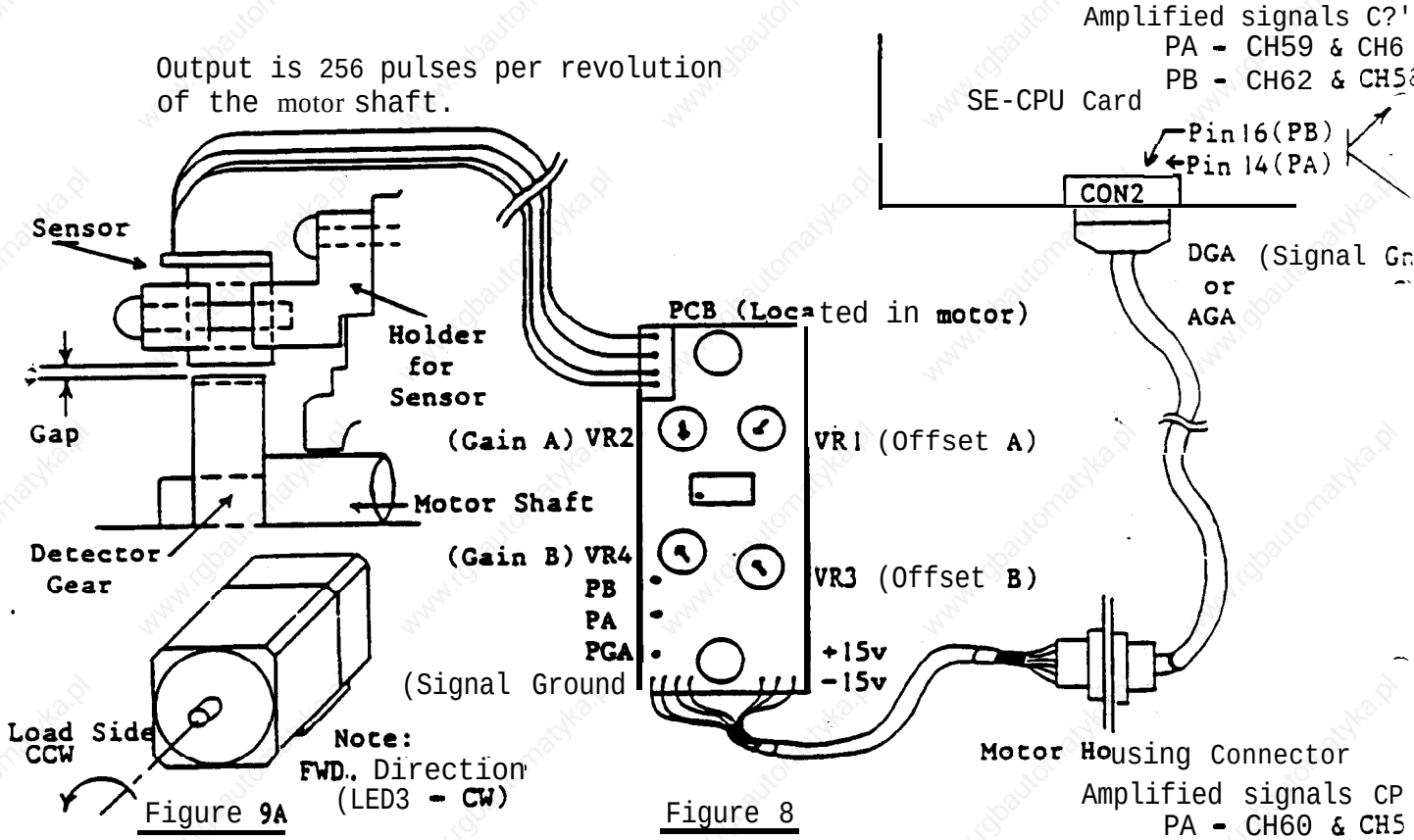
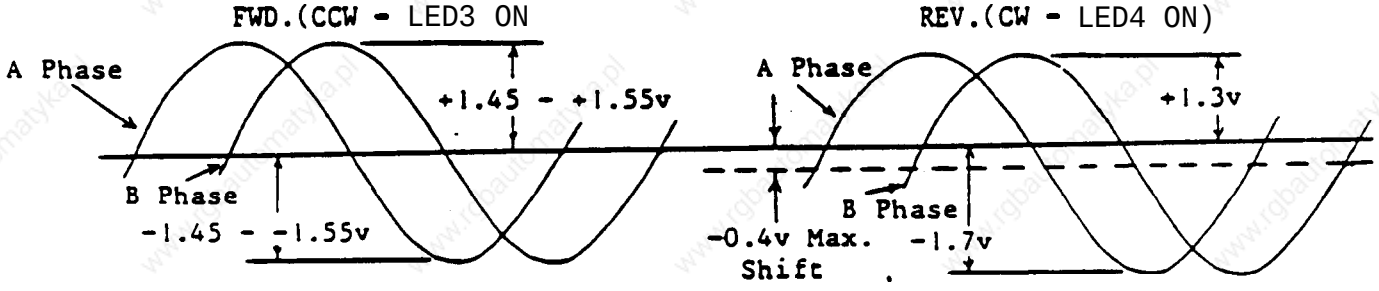


Figure 9A

Figure 8



Motor Shaft 1800 RPM (130.2 usec/7680Hz.)
Note: Motor shaft rotates CCW on CW or FWD. command.(LED 3)

Figure 9B

Peak values shown are 0.2v shi.

Figure 9C

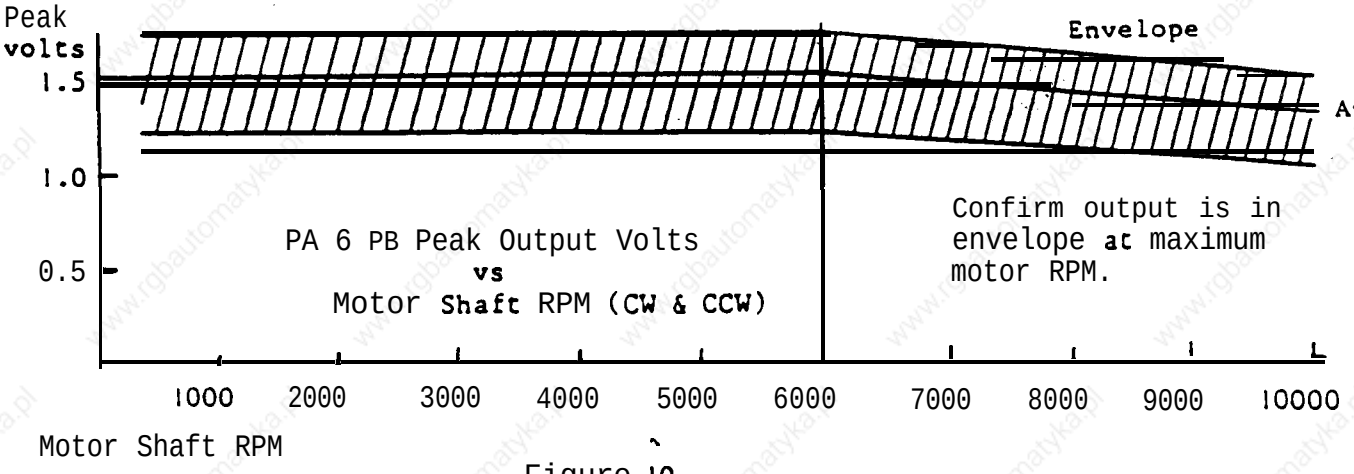


Figure 10

PLG Adjustment Procedure FR-SE

(1) Normally PLG adjustment is not necessary. The PLG should be adjusted in open loop to prevent the spindle drive from responding to PLG signal loss while adjustments are made. Caution: In open loop sudden speed changes can cause damage.

(2) With the CNC OFF. Set **SW6-2 OFF** (Open loop) and press ST1 (Reset) on the SE-CPU card. Refer to Figure 5 (**SE-CPU1**) and Figure 6 (**SE-CPU2**) for location.

(3) Turn the CNC ON. Command the spindle FWD and confirm LED3 CW on the FR-SE is ON. If not command REV instead.

(4) Caution: Increase and decrease motor speed slowly in open loop or damage may occur. Bring the spindle motor up to about 1800 RPM slowly in the **FWD** direction. See note on command RPM vs gear range. Make RPM adjustments manually if possible.

Note: This should be actual motor shaft RPM in CCW direction. (Refer to **Figure 9A.**) If the machine has gears, the commanded **RPM** should be compensated or else the spindle motor will be at an RPM greater than 1800 RPM.

Example: (Max. RPM for gear range / Max. motor RPM) x 1800
(4800 **RPM**/ 6000 **RPM**) x 1800 = 1440 Command RPM

Note: If the CNC has a spindle override be aware of its setting. It can also be used to bring the motor speed up and down **slowly.**

(5) Adjust **VR's** located on PCB in motor to obtain the waveforms in **Figure 9B** at PA and PB or Pin 14 & 16 of CON2. Refer to Figure 8 for locations.

VR1: Offset for A Phase
VR2: Gain for A Phase
VR3: Offset for B Phase
VR4: Gain for B Phase

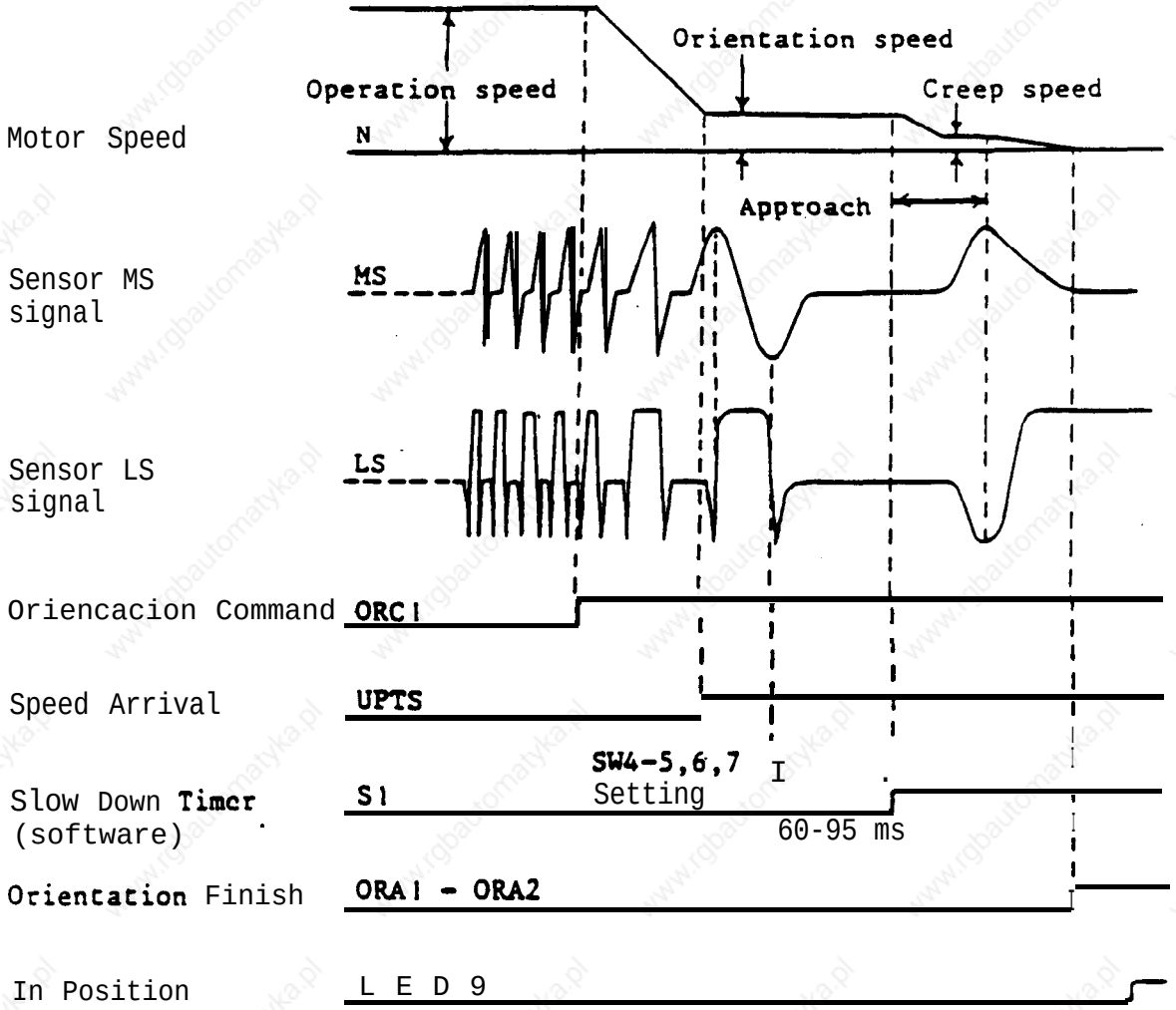
(6) Slow spindle to zero speed. Command spindle **REV** and verify LED4 CCW is ON. (If not command **FWD.**) Bring the spindle **slowly up** to about 1800 RPM and confirm that the waveforms in Fig. 9C are present at PA and **PB.** When the motor shaft is rotating CW the output could shift up to **-0.3v.** (**-0.4v** max.)

(7) Slow spindle to zero speed. Set **SW6-2** ON (Closed loop) and press ST1 on SE-CPU card. Refer to Fig. 5 or Fig. 6.

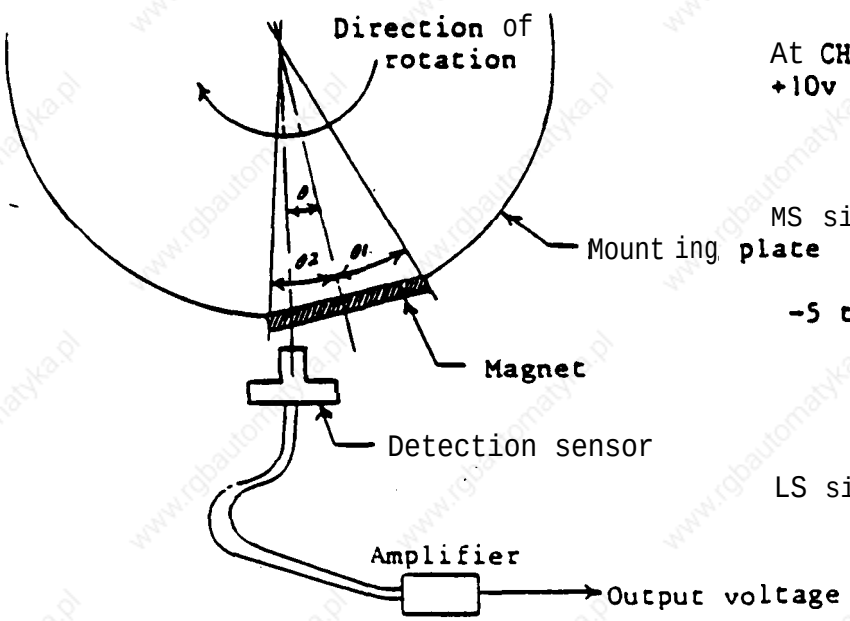
(8) 'If the correct output cannot be obtained in (5) & (6) it may be necessary to adjust the gap between the sensor and the detection gear. Refer to Fig. 8 and the FR-SE Maintenance Manual. Then repeat adjustment procedure as necessary.

(9) Check PA and PB output waveforms at 0 to Max. RPM in FWD and REV to conf-irm that they are within the envelope shown in Figure 10. Specifically Max. RPM in FWD and REV.

Magnetic Sensor Orient Timing Chart



Magnetic Sensor Mounting



Magnetic Sensor Output

At CH53 the output should be 20v p-p.
+10v to -10v LED11 ON at 8.5v p

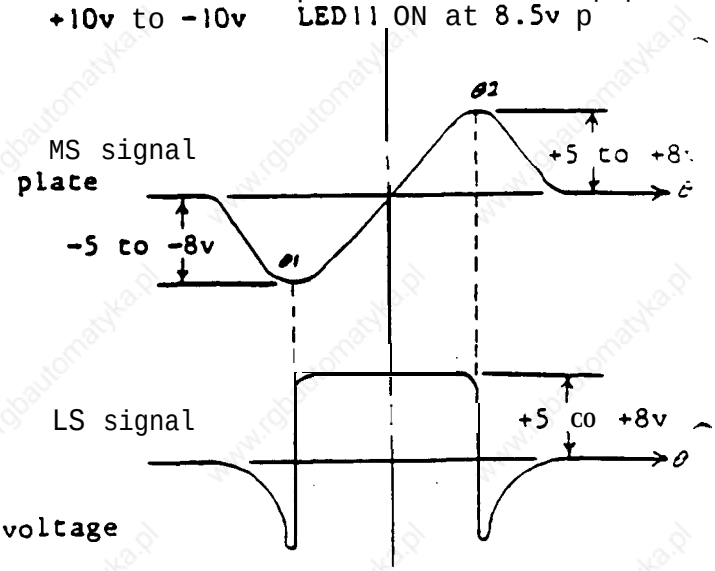


Figure 10A

Magnetic Sensor Adjustment Procedure SE-CPU1

Note : If VR1 and VR2 are set the same as the original hinge when a new hinge is installed, adjustment is probally not necessary. Adjustment would be necessary if magnet *or* sensor is replaced *or* the gap is adjusted.

(1) Refer to FR-SE Maintenance Manual for information on mounting magnet, sensor, and amplifier. Be sure gap, magnet, and sensor positioning meet specifications if the following adjustments do not work properly.

Note: Do not attempt tool change with ATC until- all adjustments are made and physical alignment is checked.

(2) Record the position of rotary switch SW10 (Orientation speed setting) for later use. Then set SW10 to position 2 (60 rpm) and set dip switch SW6-1 to OFF (Orient test). Then press ST1 (Reset). Refer to Fig. 5 or Fig. 6 for loactions.

Note: -Adjustments of magnetic sensor output should be made at spindle RPM's of 80 RPM or less.

(3) Turn VR2 (Sensitivity) fully counter clockwise. Refer to Fig. 5 or Fig. 6 for location of adjustments and check point.

Method 1 (Oscilloscope): Press ST2 and adjust VR2 until 20 Vp-p is obtained between CH53 and DGA at orient. Note that the 20 Vp-p waveform occurs only momentarily at orient. Refer to Figure 10A for waveform. Repeat Method 1, as necessary, increasing VR2 a half division each time until 20 Vp-p is obtained. If hunting occurs at orient, see SW4-8 setting.

Method 2 (LED11): Press ST2 and adjust VR2 slowly clock-wise until LED11 lights then stop imediately. LED11 lights only at orient stop the first time and will usually stay on until the next power up or spindle reset. Press ST2 again to verify orientation. Increase VR2 setting a half division to insure adequate signal amplitude. Power OFF, then ON or reset spindle and press ST2 to verify orient.

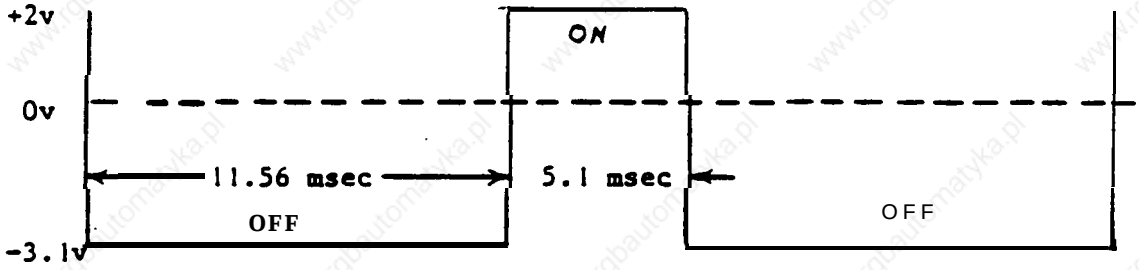
(4) Caution: Adjust VR1 (Position shift) as necessary to avoid any mechanical interference. This may involve measuring the spindle position relative to axis movement as specified by the machine manufacturer.

Example: At ATC, tool changer claw must align with spindle or damage may occur when tools are changed.

(5) After adjustment return SW10 to original position in step 2. Set SW6-1 to ON and press ST1 (Reset) to return the spindle controller to normal. Refer to Fig. 5 or Fig. 6 for location of switches.

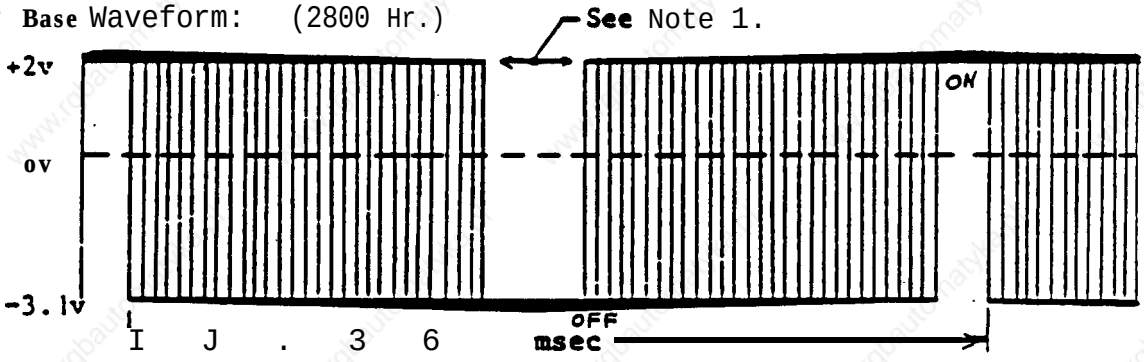
FR-SE Base Driver Waveforms

Converter Base Waveform: (60 Hz.)

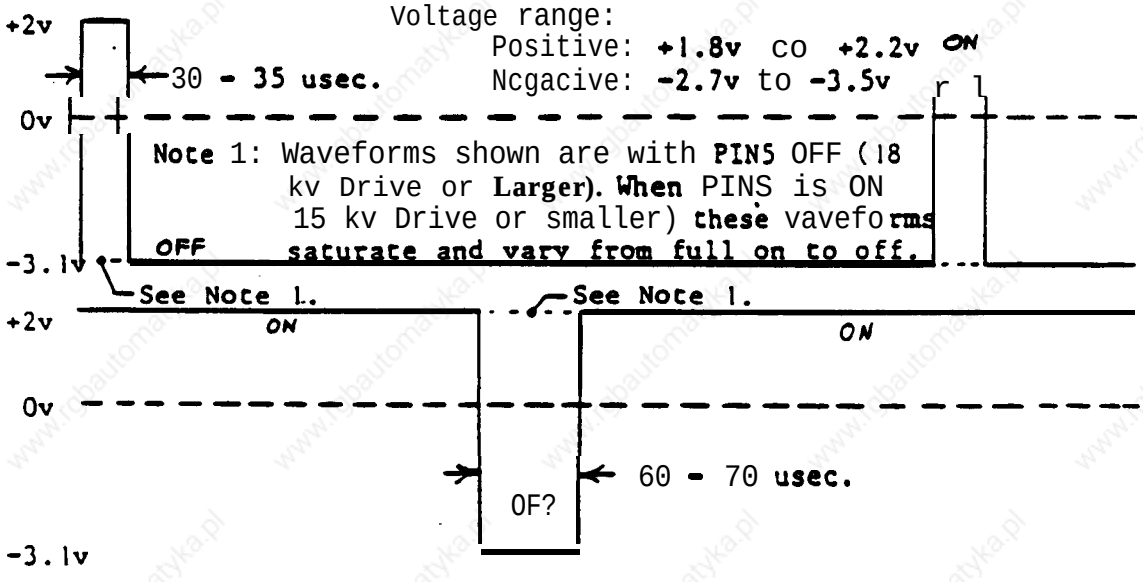


The converter waveform is visible only when the converter is enabled. L&D 18 should be ON. **Voltages may vary,** Positive range: +1.8v to +2.2v
Negative range: -2.7v to -3.5v

Inverter **Base** Waveform: (2800 Hr.)



The above waveform is **actually** changing betvecn the bottom two waveforms. **AtlowRPM's** the speed **at** which the **waveforms** change slows and is visible.



Note : Waveforms on the P side can not be seen on the oscilloscope at the same time. They do not share a common. It may be helpful to compare the voltages on one transistor **to** another. Hint: Compare P side to P side transistors and N side to N side transistors.

Figure 11

Procedure for Checking Base Driver Waveforms FR-SE

This procedure should be used if output transistors were damaged and replaced or output transistors are suspected of being damaged.

(1) Before restoring power to the machine switch CB1 OFF. This prevents power from being applied to the output transistors. Disable breaker trip alarm by inserting jumper (FB) on Pin 4 of SE-IO Card. This is located on the lower right corner of the card and to the right of the TB2 screw terminal. Refer to lower right corner of Figure 7. A SPARE jumper strap can usually be found on the SE-CPU or SE-IO Cards.

(2) Set dip switch SW6-2 (Open loop) OFF and press ST1 (Reset) on the SE-IO Card. Refer to Figure 7.

(3) Regeneration Transistor Check: (Converter)

1. Connect a short jumper wire between DGA and the cathode (top) side of D12 in middle of SE-IO Card. See Figure 7.
2. Power CNC ON. Confirm LED18 on SE-IO Card is ON. LED18 lights with converter regeneration.
3. Command the spindle FWD or REV (MO'3 or M04). Verify that LED2 and LED3 or LED4 on the SE-CPU Card are ON.
4. Check the waveforms at the following check points with an ungrounded (isolated) oscilloscope. See Figure 11 for voltage and duty cycle specifications. Refer to Figure 7 for locations of CH Point and resistor.

CH50 to right side R146	CH53 to right side. R155
CH51 to right side R149	CH54 to " " "
CH52 to right side R152	CH55 to " " "

Note: Leads of the resistors may have coating. Remove coating if necessary before making measurements.

5. Power CNC OFF.
6. Remove the short jumper wire from DGA and D12.

(4) Generation Transistor Check: (Inverter)

1. Power CNC ON. Verify LED2 is ON.
2. Command FWD or REV. Verify LED3 or LED4 is ON.
3. Input a speed command of about 1/10 of top speed.
4. Check the waveforms at the following check points with an ungrounded oscilloscope. See to Figure 11 for waveforms. Refer to Figure 7 for location of CH Point.

CH44 to right side R128	CH47 to right side R137
CH45 to left side R131	CH48 to " " "
CH46 to left side R134	CH49 to " " "

(5) Power CNC OFF and return spindle controller to normal. PIN4 OFF, SW6-2 ON, and press ST1. If check OK, turn CB1 ON.

Maximum Speed Adjustment FR-SE

Note: Overspeed alarm may be caused by missadjustment.

(1) Set PIN1 (on SE-IO card), SW6-7, and SW7-4 on the SE-CPU card according to the following information. For other capacity/rpm settings (SW7-5,6,7,8) refer to Switch Setting Sheet with the machine. Refer to Figure 5 or 6 for SE-CPU and Figure 7 for SE-IO PCB layout.

Note: Motor base speed, top speed, and Kw capacity can be found on the motor name plate.

Standard Motor:

Base Speed.....	1150/1500	1150/1500	1150/1500	1150/1500
SW7-4.....	ON/OFF	ON/OFF	ON/OFF	ON/OFF
Top Speed.....	3450/4500	4600/6000	6000/8000	8000/10000
PILL.....	B/B	A/A	A/A&B	A&B/A&B
SW6-7.....	ON	OFF	OFF	OFF
New SE-IO PCB.....	VR6	VR6	VR6	VR6
Old SE-IO PCB.....	VR7	VR6	VR6	VR6

Note: On old SE-IO PCB set VR7 to S (Middle of rotation) if A&B is specified for PIN1 above. In step 2 adjust VR7 in place of VR6 were specified in the above table. VR7 is no longer used on new SE-IO Cards.

(2) SET SW6-6 to OFF and press ST1 (Reset) on the SE-CPU PCB. Adjust VR6 fully clockwise and then counterclockwise to obtain 10v at CH34 to DGA. Refer to Figure 7 for location of adjustment and check point.

Alternate Method: This method has low accuracy and should only be used for rough adjustment. For EPROM versions 480-F/490-C and later. Adjust VR6 fully clockwise and then turn it slowly counter-clockwise until LED17 lights. LED17 lights when voltage at CH3 to DGA is 9.8 to 9.9v.

(3) The speed meter should be reading max RPM at this time. Adjust VR14 to set Maximum speed reading on the speed meter. If fixed output is used or encoder, VR14 will have no effect on the meter reading or display. Refer to Meter Output Adjustment Procedure for more information.

(4) Return SW6-6 to the ON position and press ST1 (Reset) on the spindle drive to return it to normal operation. Confirm switches and pins (PIN1, SW6-7, and SW7-4,5,6,7,8) are set according to the Switch Setting Sheet for the spindle controler on that machine. If not correct, record setting difference and repeat adjustment procedure.

Meter Output Adjustment FR-SE

(1) These adjustements, if used, should be made under normal operating conditions for the spindle. (CNC ready)

(2) Some machines use the fixed voltage outputs for which there is normally no adjustment on the spindle drive. (See step 3.) Outputs are available from CON1 and/or TB2. Refer to CON1/TB2 connection table below.

Note: Some machines used the encoder feedback for spindle rpm display and the spindle speed meter output is not used by the CNC.

CON1/TB2 Connections:

CON1-1 /LM0 . . ..Fixed Load Meter Output 3v/10v/120% (See note)
CON1-2 /SM0 . . ..Fixed Speed Meter Output 10v/MAX RPM (CH34)
CON1-18/OM.....Common (Ground)
CON1-49/LM1 . . ..Adjustable Load Meter Output VR15
CON1-50/SM1....Adjustable Speed Meter Output vR14

Note: LM0 and SM0 are voltage outputs, with current limited by 220 ohms. LM1 and SM1 are 1 ma. current outputs, with adjustment range of approximately .6 to 1.5 ma.

Note: Some adjustement may still be necessary on the machine or CNC side even when fixed voltage outputs are used.

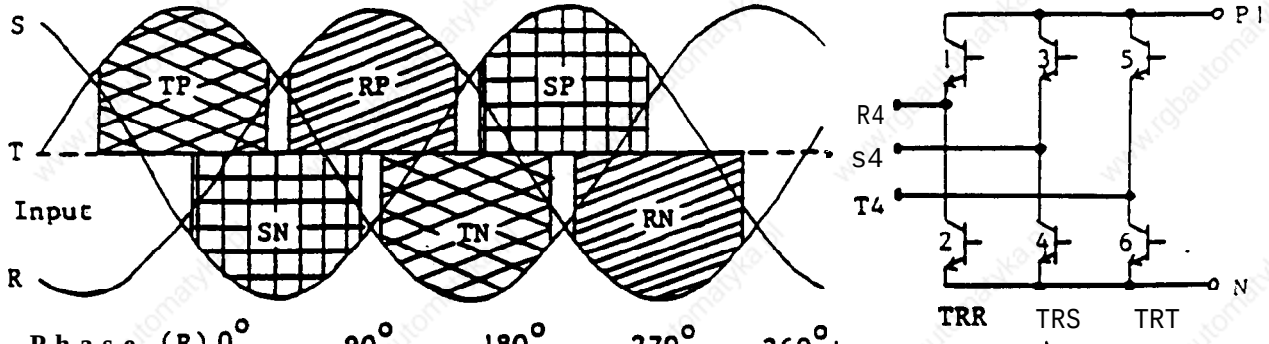
(3) CNC ON and READY (LED2 on SE-CPU ON). Set Dip Switch 6-6 (Meter calibration) OFF and press ST1 (Reset) *on* SE-CPU card. Refer to left center of Fig. 5 for CPU1 and Fig. 6 for CPU2. OPTIONAL: Verify LM0 is 3v or 10v and SM0 is 10v when disconnected. If fixed outputs are incorrect refer to the following note and Maximum Speed Adjustment Procedure.

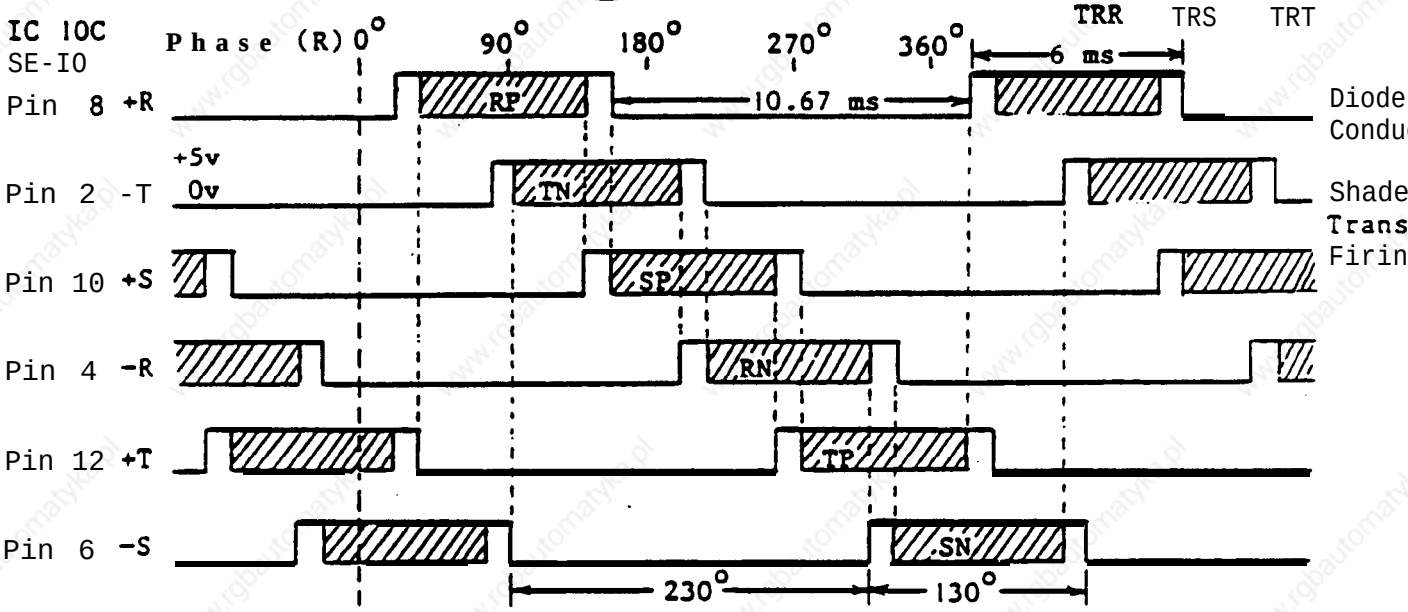
Note: If the speed meter output is incorrect, check CH34 for 10v to DGA. If CH34 is high or low, refer to Maximum Speed Adjustment Procedure. Misadjustment can cause over speed alarm. Load meter output can be set for 3v/10v by dip switch SW7-3. ON is 10v/120% and OFF is 3v/120%.

(4) The Load meter should read 120% and Speed meter, if used, should read Maximum RPM. This is usually full scale on the external panel meter/s. Adjust VR15 and VR14 respectively if LM1 and SM1 are used for the *correct* meter reading. Refer to bottom right of Fig. 7 for adjustment.location.

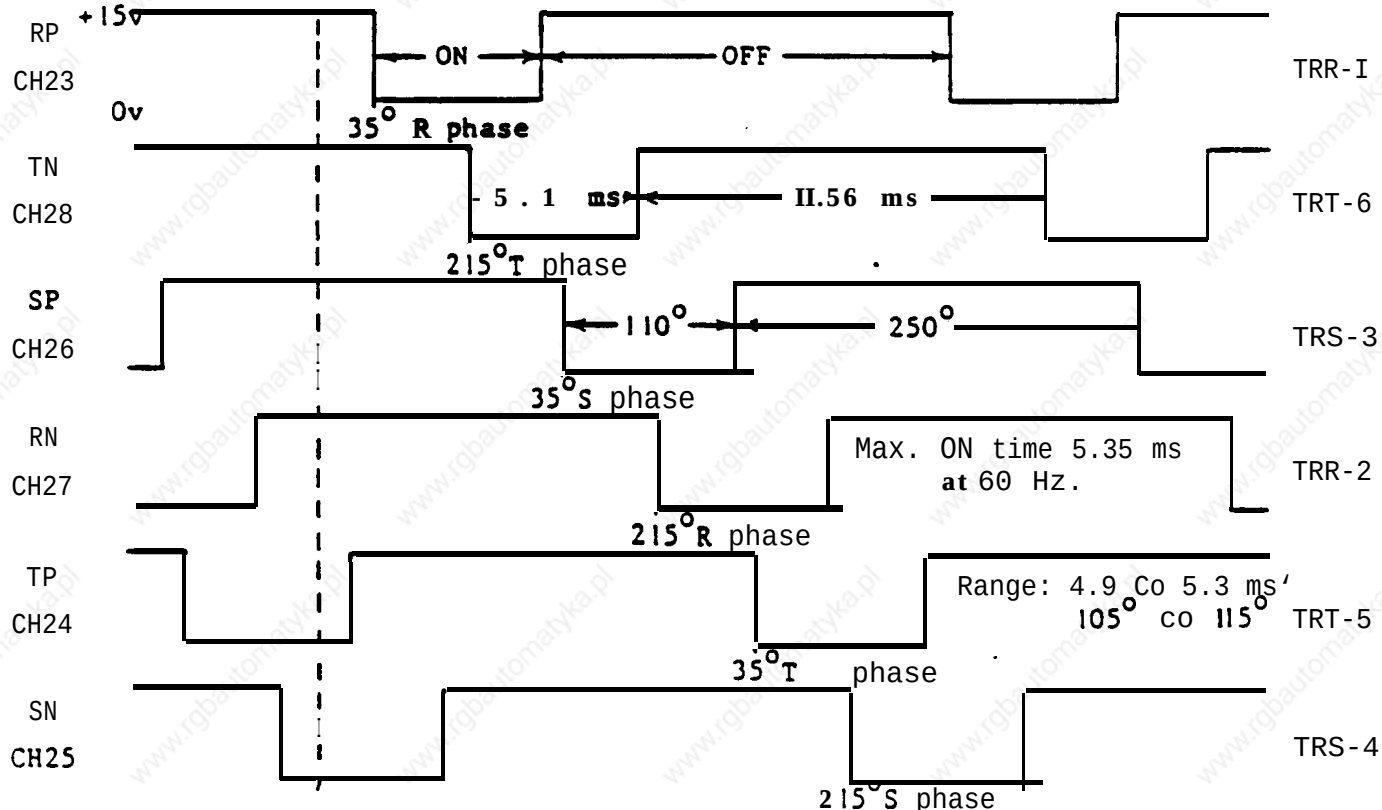
Note: Outputs may come from CON1 instead of TB2.

(5) After adjustment is complete, set SW6-6 ON and press ST1 (Reset) on SE-CPU or power CNC OFF/ON to reset if CNC provides a reset signal to the Spindle Drive. (Normal)





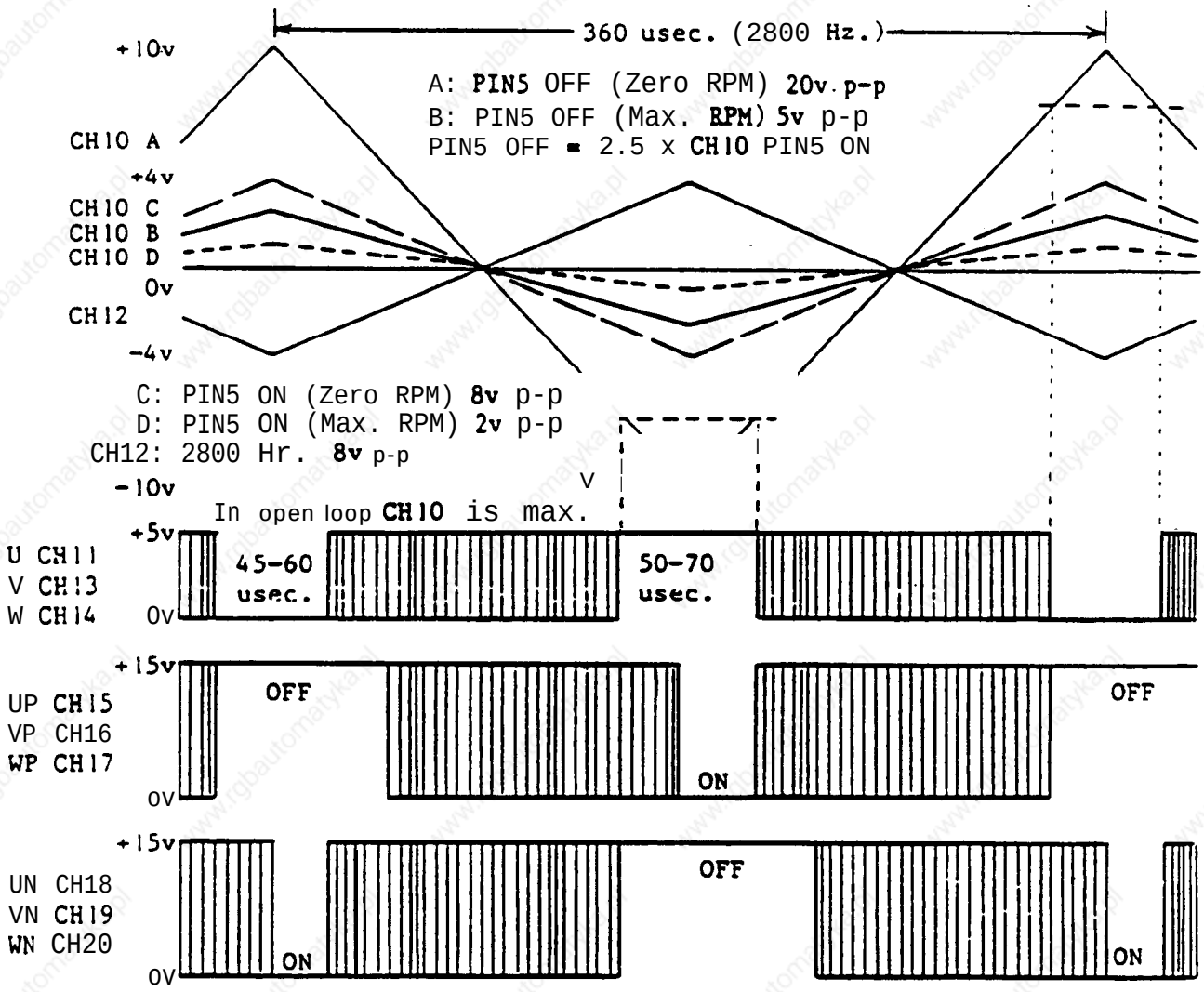
The following wave forms can be seen at decel or with the converter enabled.



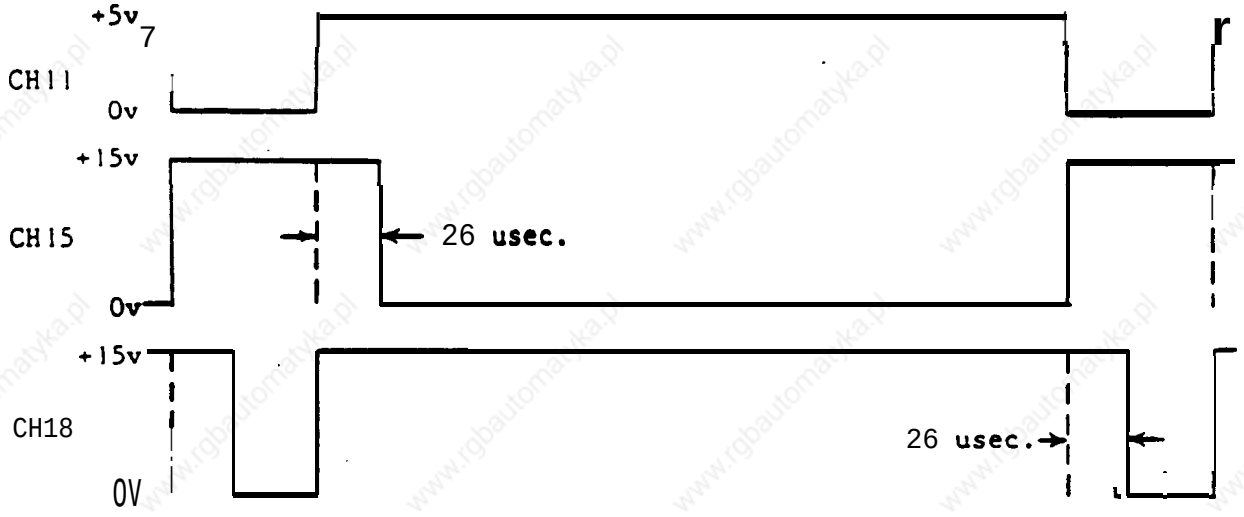
The above check points can be seen ac the same time using AGA or DGA.

Figure 12

FR-SE Inverter Waveforms

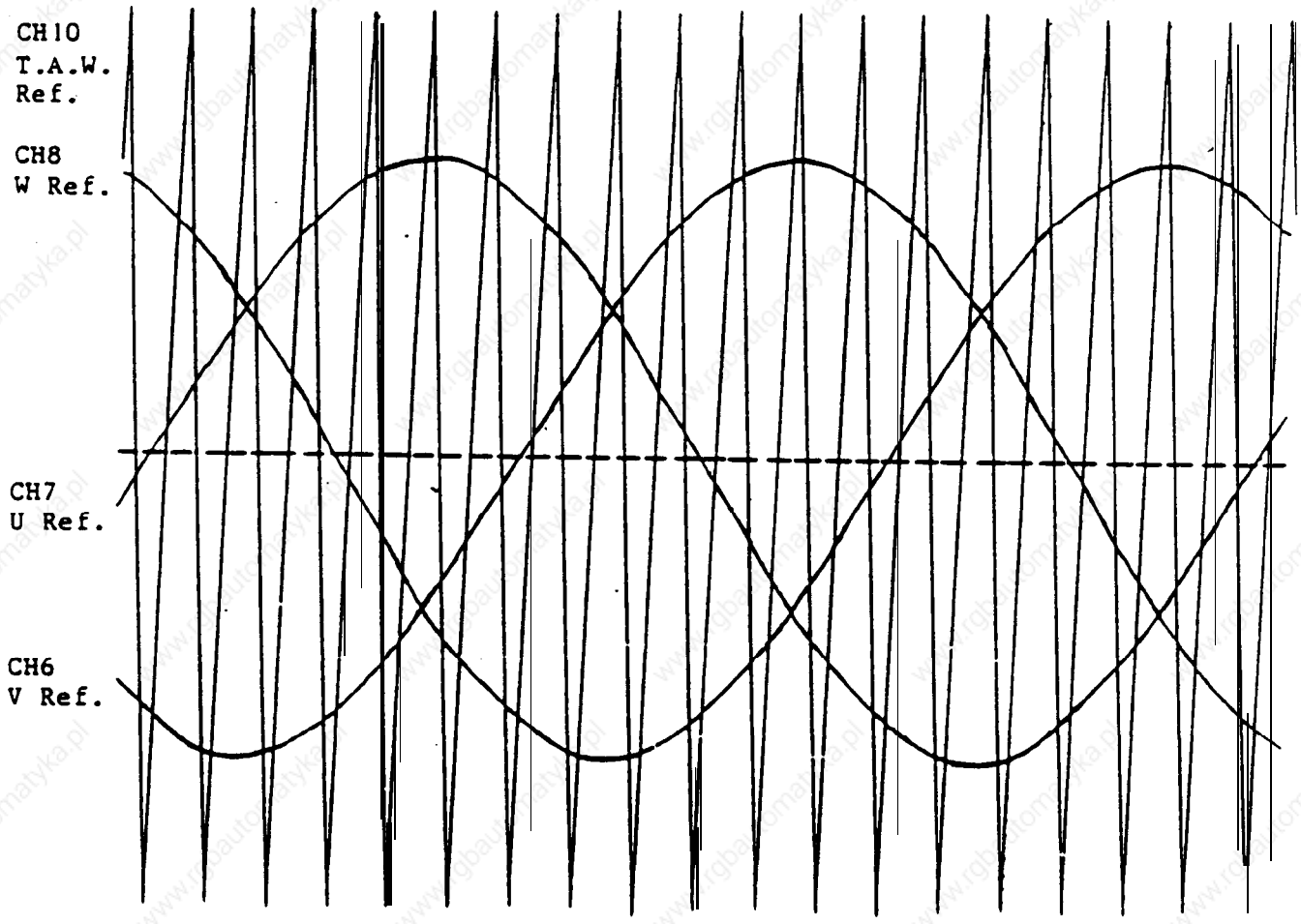


The waveforms shown are with PIN5 OFF (18Kw drive or larger). When PIN5 is on these waveforms may saturate and vary from full on to full off. (Openloop)
Example waveforms showing 26 usec. interlock for output transistors.



Note: Times and voltages may vary with differrent drives.

Figure 13



Does not show current feedback or complete error signals. Voltages and timming may be differrent. Conditions: TAW = 2800 Hz., Motor frequency approx. 1.55 Hz, 4670 r

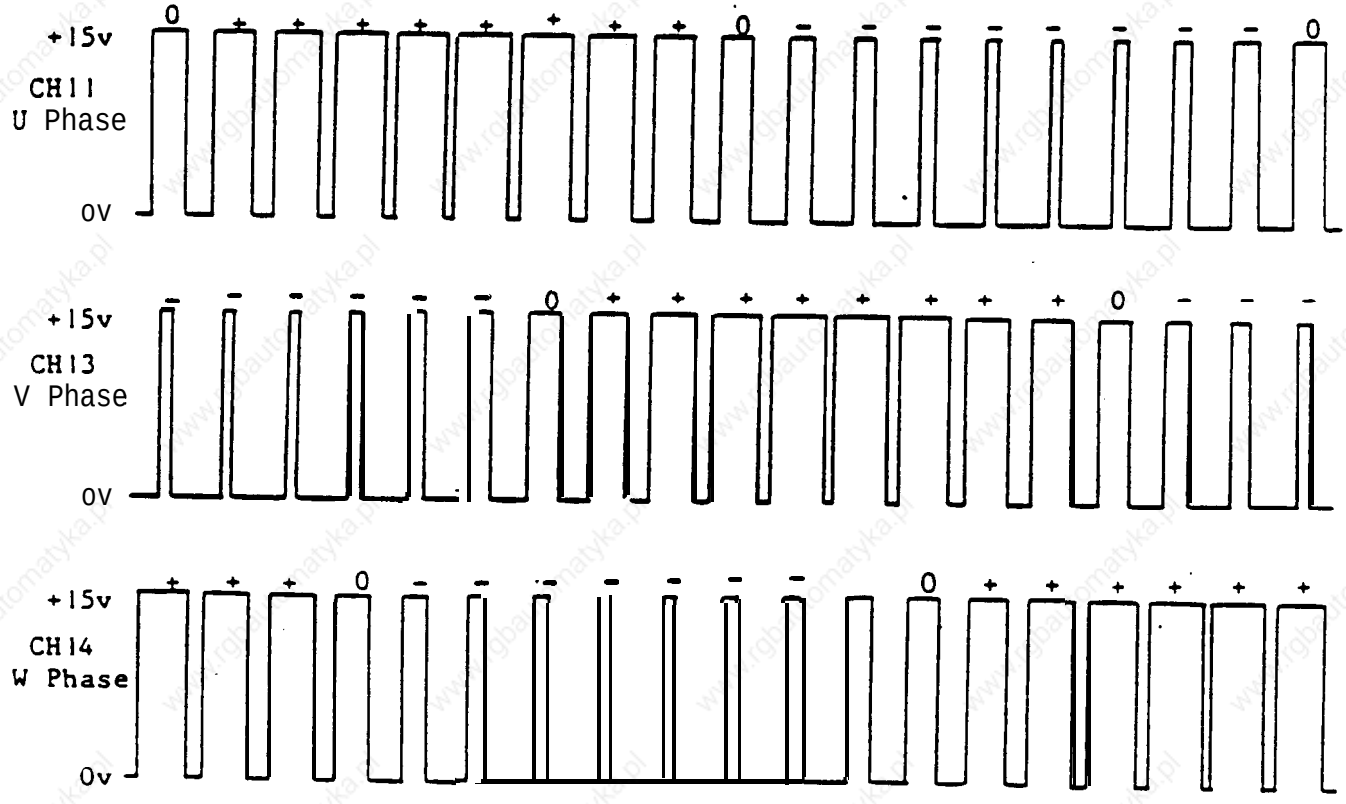


Figure 14

Adjustment of Converter Enable Circuit FR-SE

Note: If VR8 and VR9 are misadjusted the converter will not turn off (LED 18 ON) or the converter will not turn on quick enough and cause damage to output transistors or capacitors.

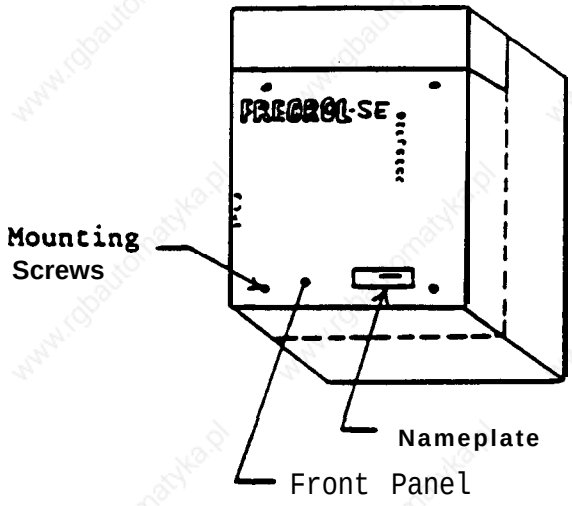
(1) The drive should be in ready condition only. Verify LED19 and LED20 are ON and LED18 is OFF. The condition of converter enabled indicator (LED18) and base transistor cutoff indicator (LED19) may be incorrect if VR8 & VR9 are misadjusted.

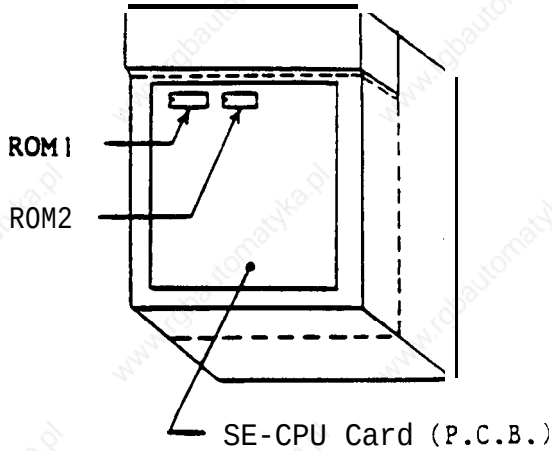
(2) The basic adjustment involves adjusting VR8 & VR9 to obtain equal positive and negative voltages at CH42 and CH43. Repeat adjustment until equal. Refer to Figure 7 for location of check points and adjustments. Use the following table as a guide for approximate voltages that should be obtained.

P-N DC Voltage	CH42 P-N VR8	CH43 Line VR9	Approx. VAC Input at CB1
272v	+6.80 v	-6.80v	192 V
274v	+6.85v	-6.85v	194 V
276v	+6.90v	-6.90v	195 V
278v	+6.95v	-6.95v	197 V
280v	+7.00 V	-7.00v	198 V
282v	+7.05v	-7.05v	199 V
284v	+7.10 V	-7.10v	201 V
286v	+7.15 V	-7.15v	202 V
288v	+7.20v	-7.20v	204 V
290v	+7.25v	-7.25v	205 V
292v	+7.30 V	-7.30v	206 V
294v	+7.35v	-7.35v	208 V
296v	+7.40 V	-7.40v	209 V
298v	+7.45 V	-7.45v	211 V
300v	+7.50 V	-7.50v	212 V
302v	+7.55 V	-7.55v	214 V
304v	+7.60 V	-7.60v	215 V
306v	+7.65v	-7.65v	216 V
308v	+7.70v	-7.70v	218 V
310v	+7.75v	-7.75v	219 V
312v	+7.80 V	-7.80v	221 V
314v	+7.85 V	-7.85v	222 V
316v	+7.90v	-7.90v	223 V
318v	+7.95 V	-7.95v	225 V
320v	+8.00v	-8.00v	226 V
322v	+8.15v	-8.15v	228 V
324v	+8.10 V	-8.10v	229 V
326v	+8.15v	-8.15v	230 V
328v	+8.20 V	-8.20v	232 V
330v	+8.25v	-8.25v	233 V
332v	+8.30 V	-8.30v	235 V
334v	+8.35v	-8.35v	236 V

Note: This table is based on DC output of 400v generating 10v at CH42 and an AC input of 200v producing -7.07-v at CH43.

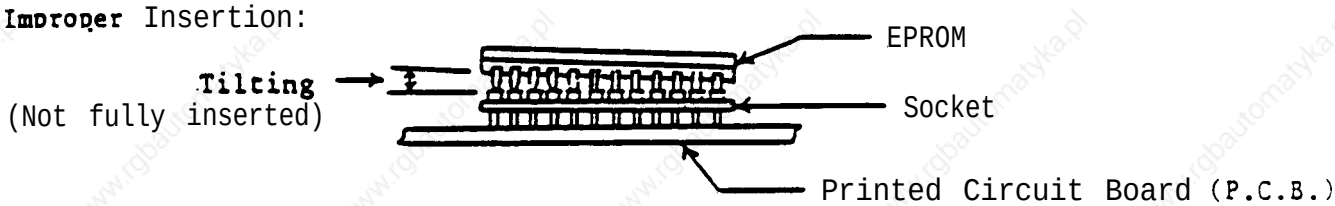
EPROM Location



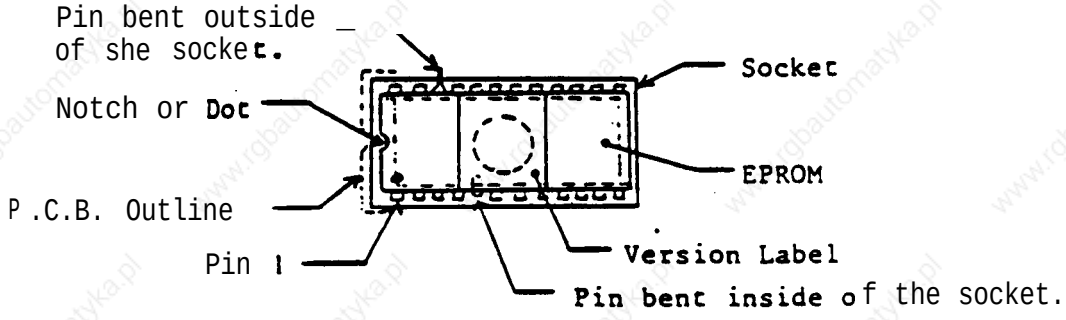


EPROM Insertion

Improper Insertion:



Bent Pins:



Details of the Nameplate:

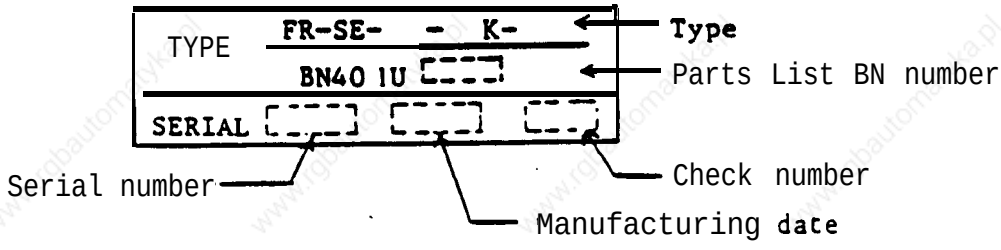


Figure 15

Instructions for Changing FR-SE EPROM

(1) Please make sure that all power sources are turned off before changing EPROM. Because CB1 in the spindle drive does not remove power from the circuit boards it is necessary to turn off the machine main breaker.

(2) Note the position of the name plate and the locations of the EPROM's in Figure 15. The SE-CPU card is located just behind the front panel. Two EPROM's (ROM1 & ROM2) are located on the upper left side of the CPU card.

(3) Remove the EPROM very carefully with a ROM puller. Be sure not to bend the pins on the EPROM. The EPROM can be removed by prying very carefully on the corners between the EPROM and the socket with a small flat screw driver. Do not pry against or damage the printed circuit board.

(4) Confirm the version on the EPROM label and note number for proper socket location. Example: Al in ROM1 socket.

(5) Locate notch or dot on EPROM and align that end of the EPROM with the notch on the printed circuit board outline. Refer to Figure 15 for detail. Carefully start all pins of the EPROM in the socket. Then apply firm pressure to seat the EPROM in the socket. Support the printed circuit board so that excessive bending does not occur. In the case of a new EPROM it may be necessary to bend all of the pins at right angles to the EPROM case before attempting insertion.

(6) Make sure all of the pins on the EPROM are properly inserted in the socket. Inspect for tilting of the EPROM and pins bent under the EPROM or bent out. Refer to Figure 15 for detail.

(7) Please record the machine serial number, the new EPROM version from the label, and the information form the spindle drive nameplate. Please return this information and the old EPROM's to Mitsubishi.

(8) Refer to Figure 15 for location and details of the nameplate.

Machine Serial Number..._____
Spindle Drive Type..._____
BN Number..._____
SE Serial Number..._____
Manufacturing Date..._____
Check Number..._____
EPROM Version..._____

Note: Always keep the original hinge cover panel with the machine. This keeps the above information correct for that machine which is necessary for proper servicing of the drive.

FR-SE Base Layout:

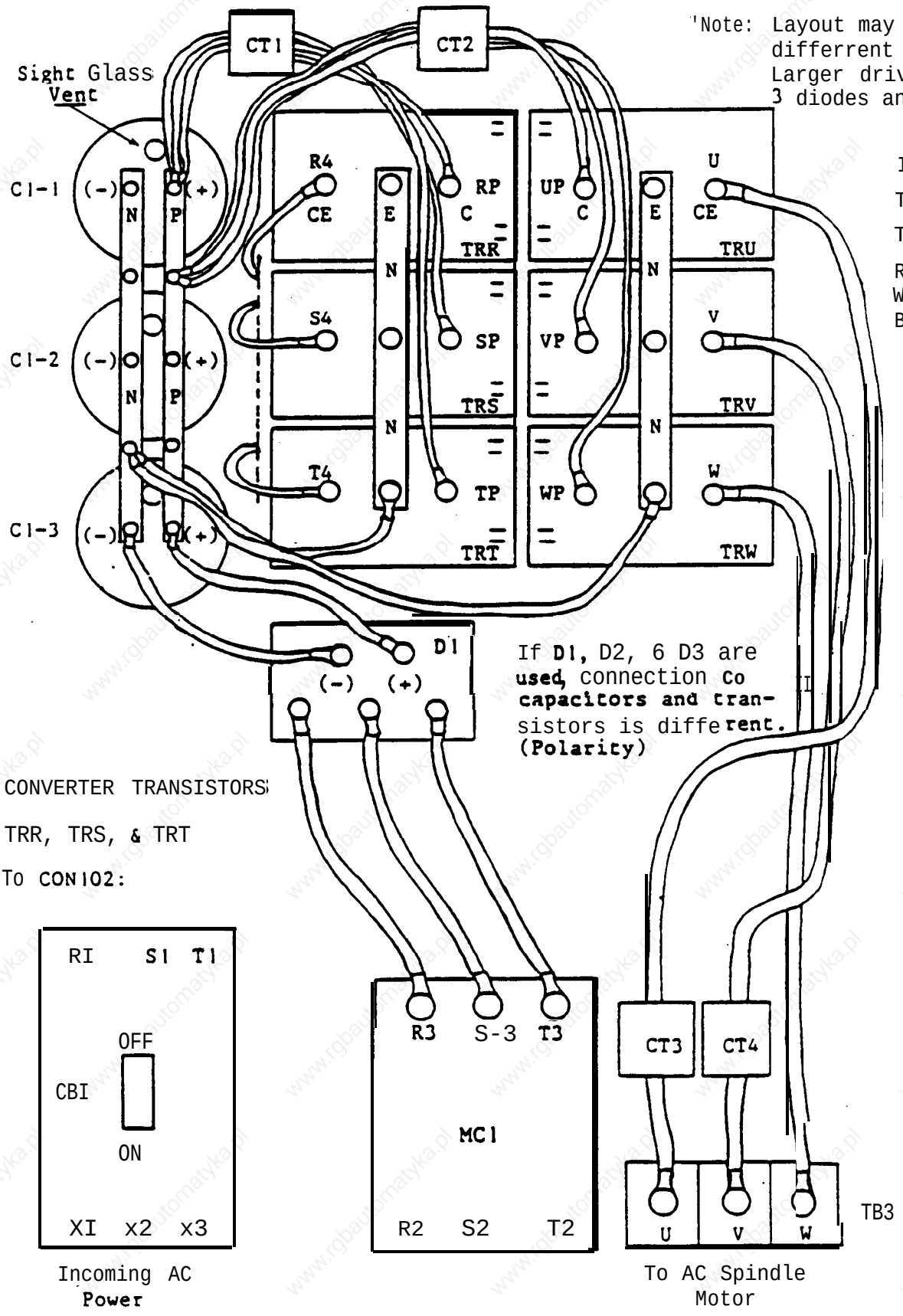


Figure 16

Testing Output Transistors, Diode, and Capacitors FR-SE

This is a basic resistance test designed to pinpoint defective components with minimal connection removal.. It will indicate a shorted diode or output transistor. The normal meter reading obtained will vary with meter type and transistor type or lot. Refer to Figure 16 for location of components and check points in the following **procedures.**

(1) Turn machine main breaker OFF. Switch spindle **CB1** OFF as an additional precaution. Up is OFF. It is located on the bottom left of the spindle controller.

(2) Disconnect motor leads from U,V, and W. Located on the bottom right of the spindle controller.

(3) Capacitor Check **(C1):** Locate large blue capacitors with shorting bars connecting **them** in parallel. Check the condition cf the sight glass on the top of each capacitor. If it is damaged **or** blown the capacitor is bad and needs to be replaced. Be sure Cl is discharged before removal.

(4) Converter Section: Locate **(P)** and **(N)** on Cl. Locate R3, S3, and T3 on contactor **MC1.** Refer to Figure 16. Discharge Cl through a 100 ohm **10w** resistor across **(P)&(N)** or wait until zero volts is measured across **(P)&(N).** This is approximately one minute. In the following tests if a reading **of SO ohms or** less is obtained a diode or transistor is bad. Use an ohmmeter to check the resistance between the following points.

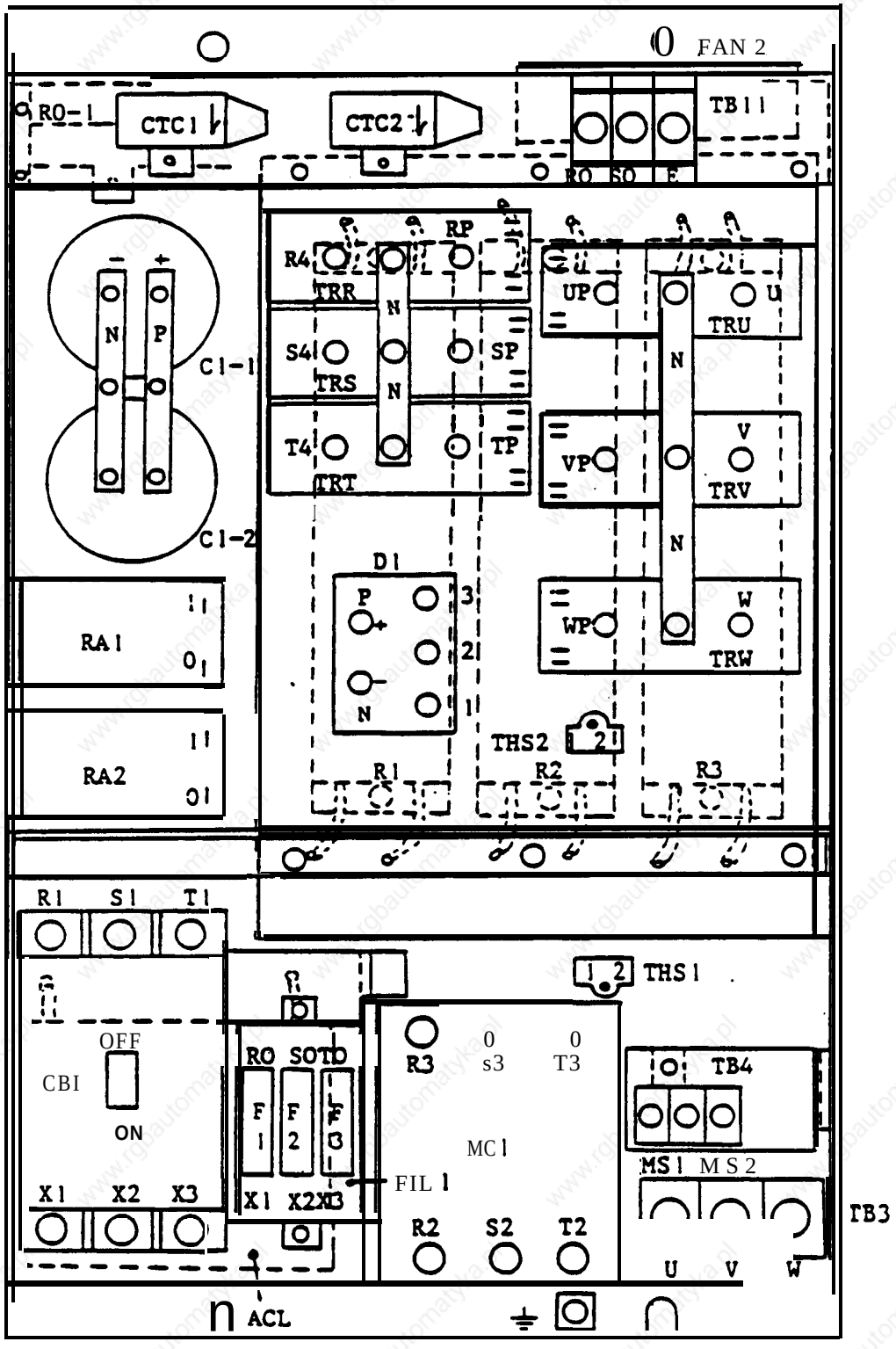
Test Point	Bad Device	Test Point	Bad Device
P to **R3**.....**TRR** or **D1**		N to **R3**. . . . . **..TRR** or **D1**	
P to **S3**.....TRS or **D1(D2)**		N to S3. . . . . ..TRS or **D1(D2)**	
P to **T3**.....TRT or **D1(D3)**		N to T3. . . . . ..TRT or **D1(D3)**	

(5) Inverter Section: Locate **(P)** and **(N)** on Cl. Locate U,V, and W on **TB3** motor terminal. Refer to Figure 16. Discharge Cl, see step 5. In the following tests if a reading of 50 ohms or less is obtained a transistor is bad. Use an ohmmeter to check the resistance between the following points.

Test Point	Bad Device	Test Point	Bad Device
P to u.....**..TR** u		N to U.....**TRU**	
P to v.....**..TR** v		N to V.....**TRV**	
P to w.....**..TR** w		N to W.....**..TRW**	

(6) After changing transistors please check base driver waveforms. See Procedure for Checking Base Driver Waveforms. Return all connections and breakers to normal.

Note: Output transistor have an internal diode connected **between** C & E. Removing CON101 and CON102 isolates output transistors from drivers on the SE-IO card. Removing R4, S4, & T4 isolates converter diodes from converter transistors.


FAN 2
RO-1
CTC1
CTC2
TB11
RO SO E
RP
R4
TRR
S4
TRS
T4
TRT
SP
TP
N
P
C1-1
C1-2
D1
UP
VP
WP
U
V
W
TRU
TRV
TRW
RA1
RA2
THS2
R1
R2
R3
R1 S1 T1
THS1
OFF
CBI
ON
RO SO TO
F1
F2
F3
X1 X2 X3
FIL 1
MC1
0 0
R3 s3 T3
R2 S2 T2
TB4
MS1 MS2
TB3
U V W
ACL

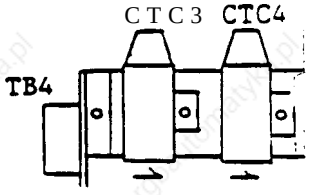
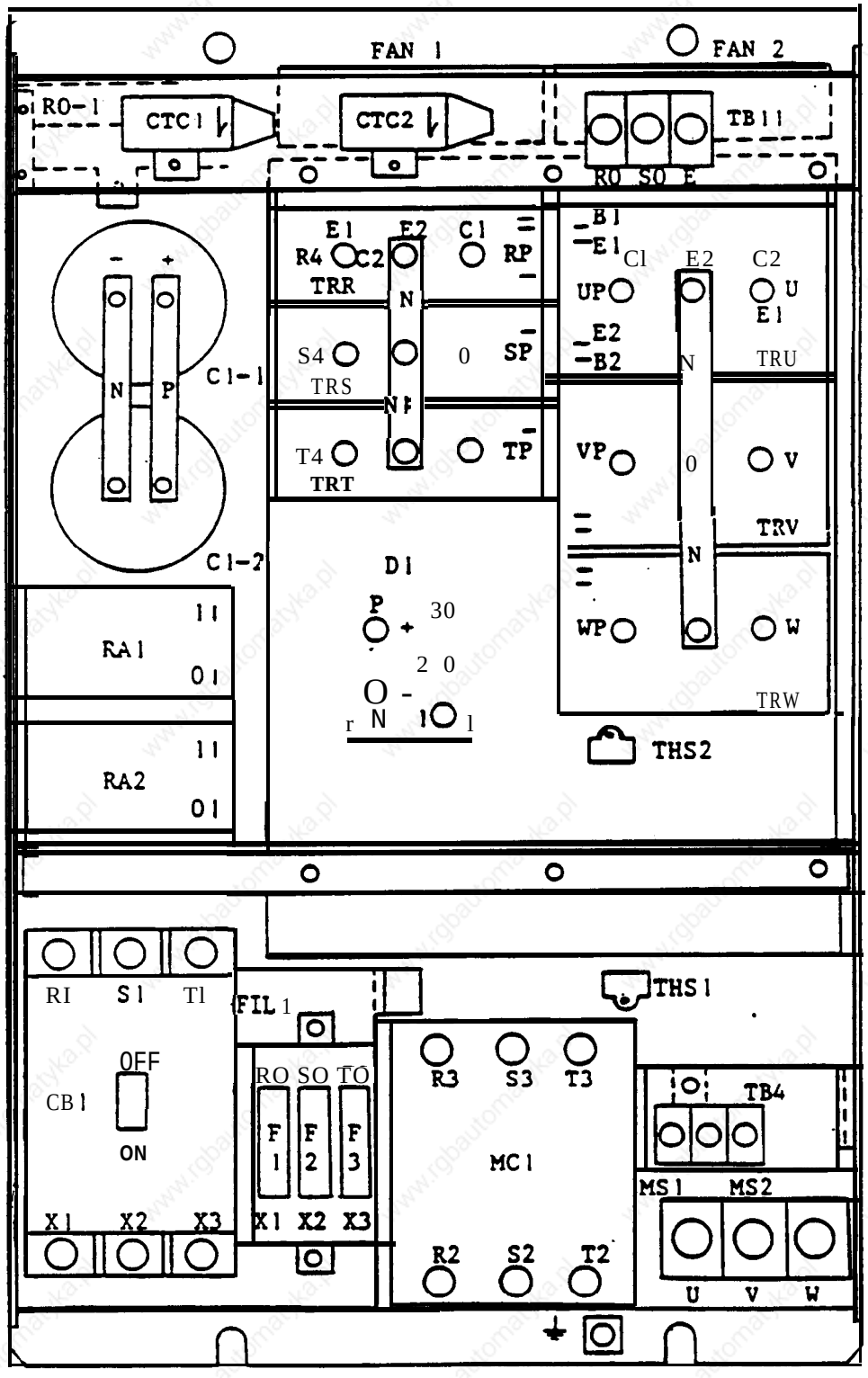

CTC3 CTC4
TB4

Figure 17

FR-SE 7 .5Kw Base



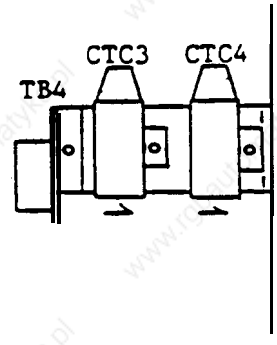
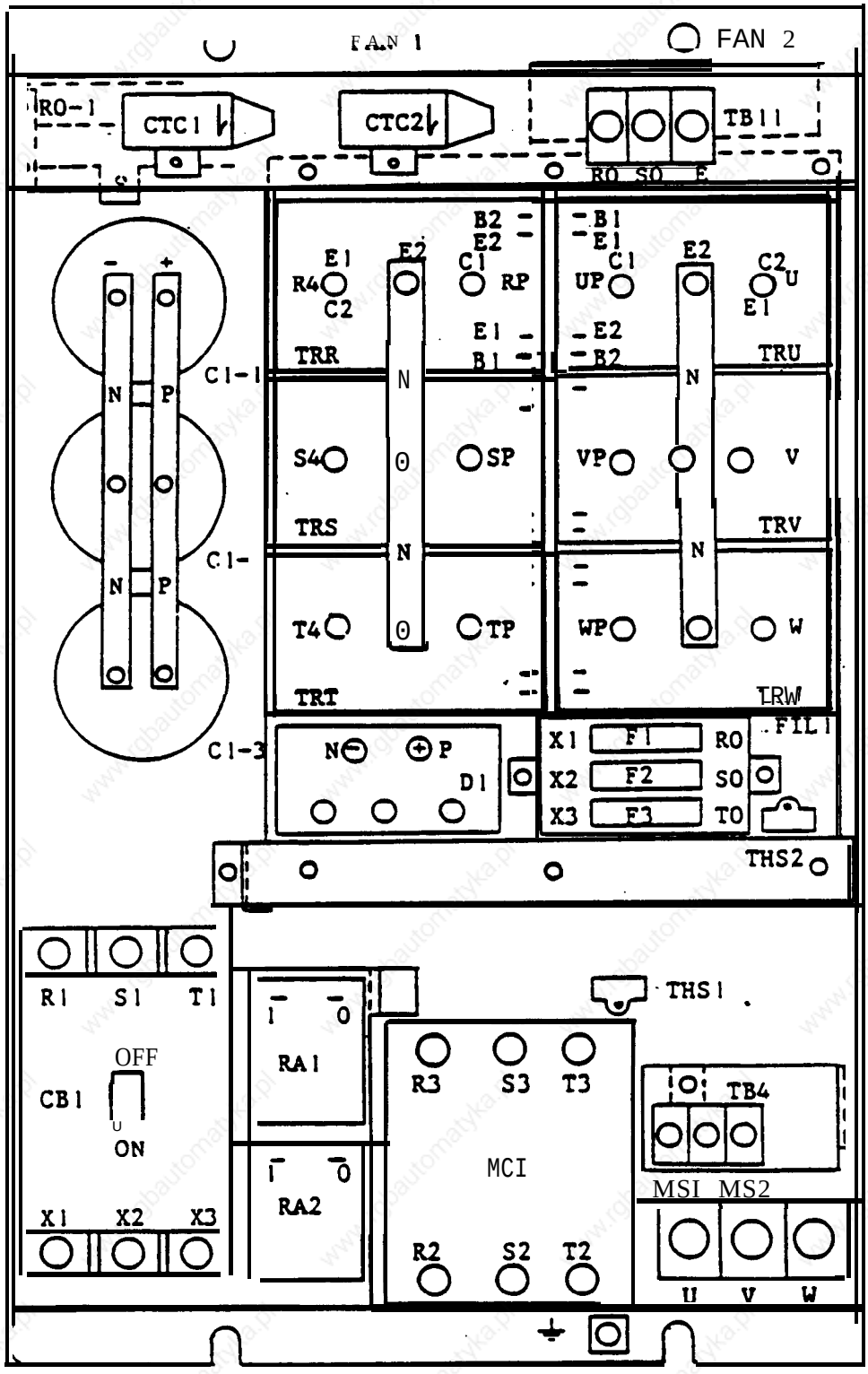


Figure 18


FAN 1
FAN 2
RO-1
CTC1
CTC2
TB11
RO SO E
B2 E2 C1 RP
B1 E1 C1 UP
E1 R4 C2
E2
C2 U
E1
TRR
TRU
C1-1
N P
S4
SP
VP
V
TRS
TRV
C1-
T4
TP
WP
W
TRT
TRW
C1-3
N P D1
X1 F1 RO
X2 F2 SO
X3 F3 TO
FIL1
THS2
THS1
R1 S1 T1
OFF
CB1
ON
RA1
RA2
R3 S3 T3
MCI
R2 S2 T2
TB4
MS1 MS2
TB3
U V W
X1 X2 X3

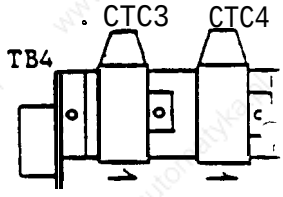

CTC3
CTC4
TB4

Figure 19

FR-SE 15Kw Base

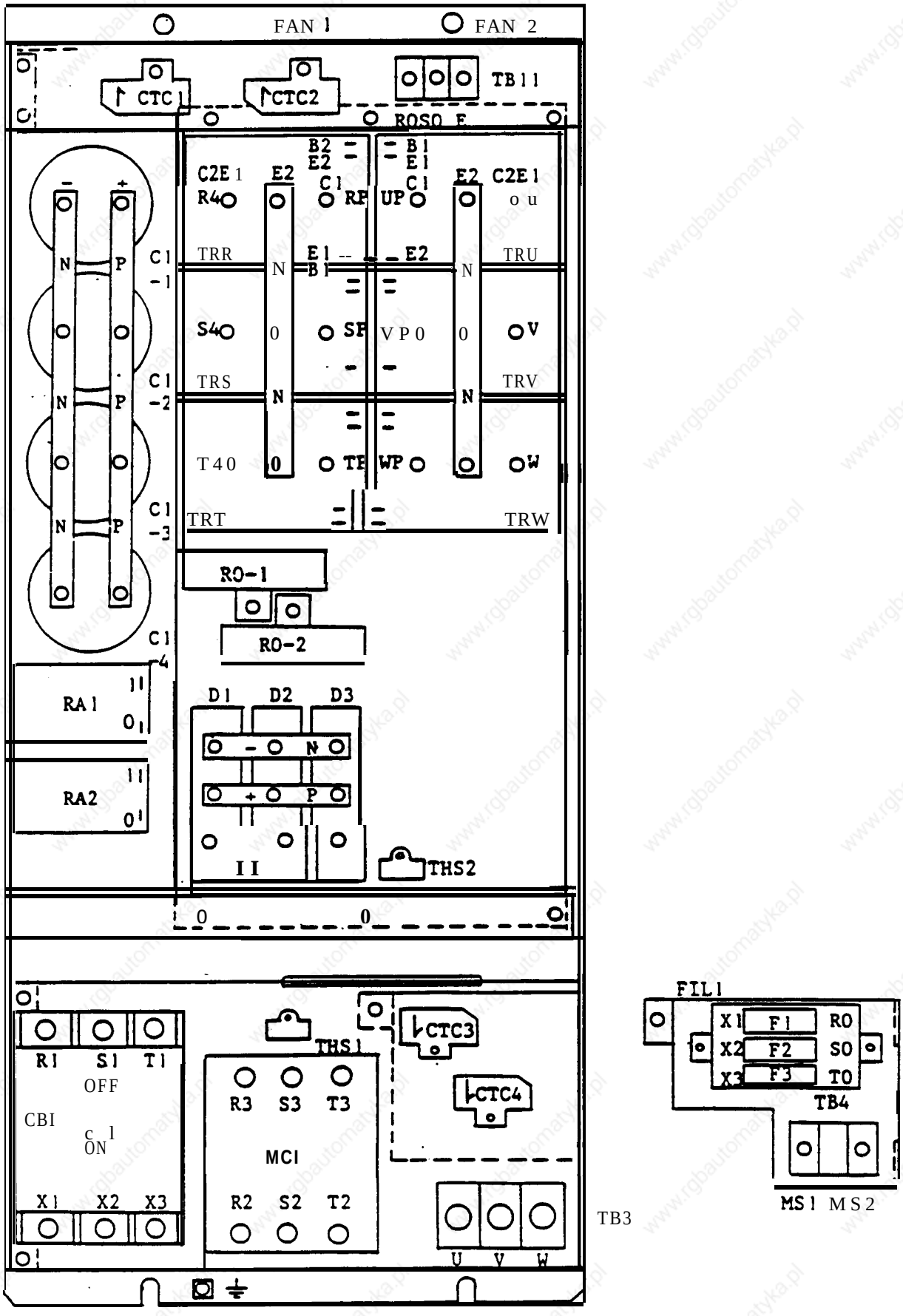
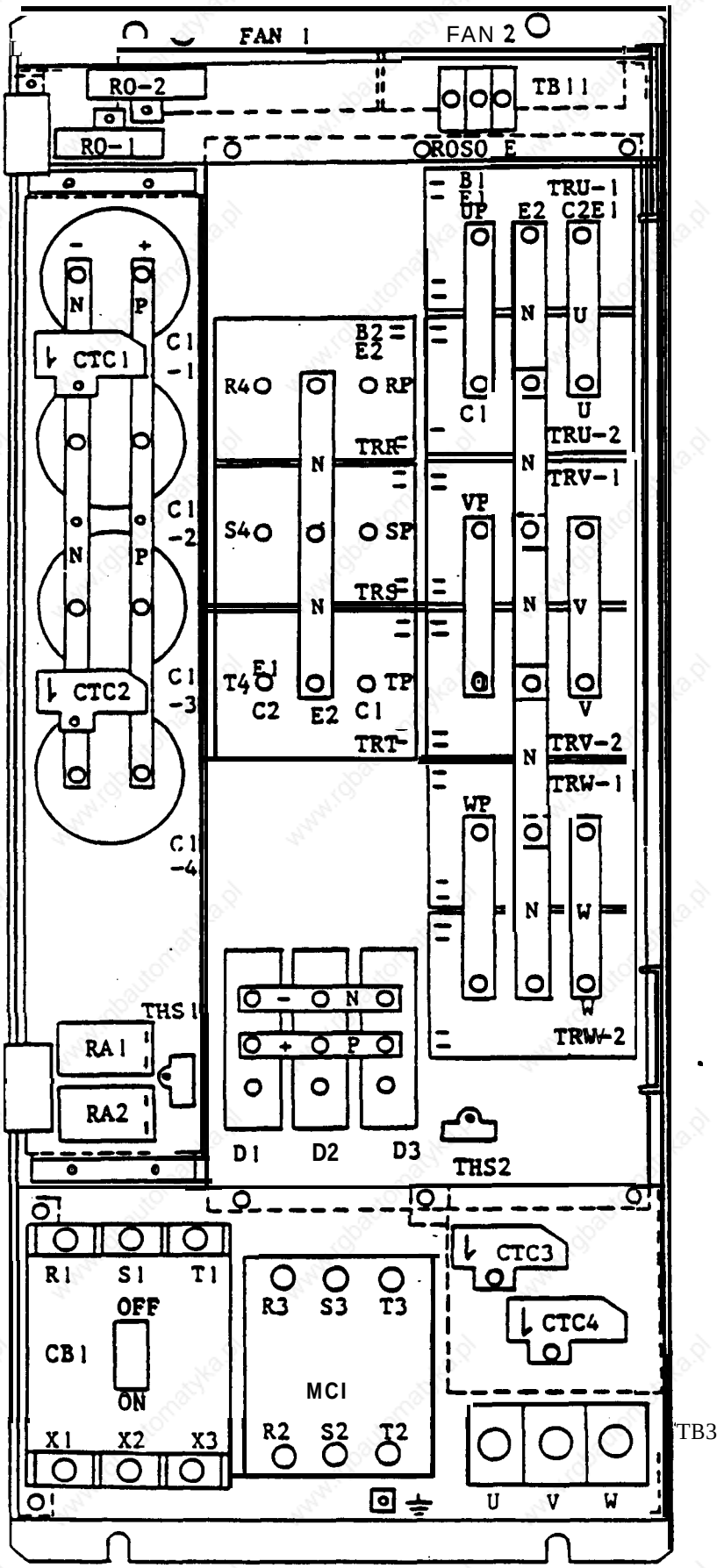


Figure 20


FAN 1
FAN 2
RO-2
RO-1
TB11
ROSO E
TRU-1
TRU-2
TRV-1
TRV-2
TRW-1
TRW-2
CTC1
CTC2
CTC3
CTC4
C1 -1
C1 -2
C1 -3
C1 -4
R4
S4
T4
RP
SP
TP
TRR
TRS
TRT
VP
WP
THS1
THS2
RA1
RA2
D1
D2
D3
R1
S1
T1
R2
S2
T2
R3
S3
T3
CB1
OFF
ON
MC1
X1
X2
X3
U
V
W
TB3

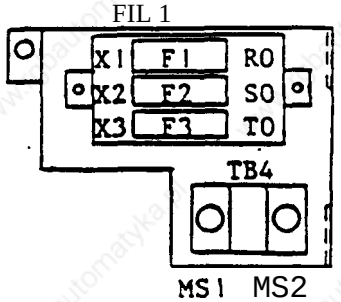

FIL 1
X1
X2
X3
F1
F2
F3
RO
SO
TO
TB4
MS1
MS2

Figure 21

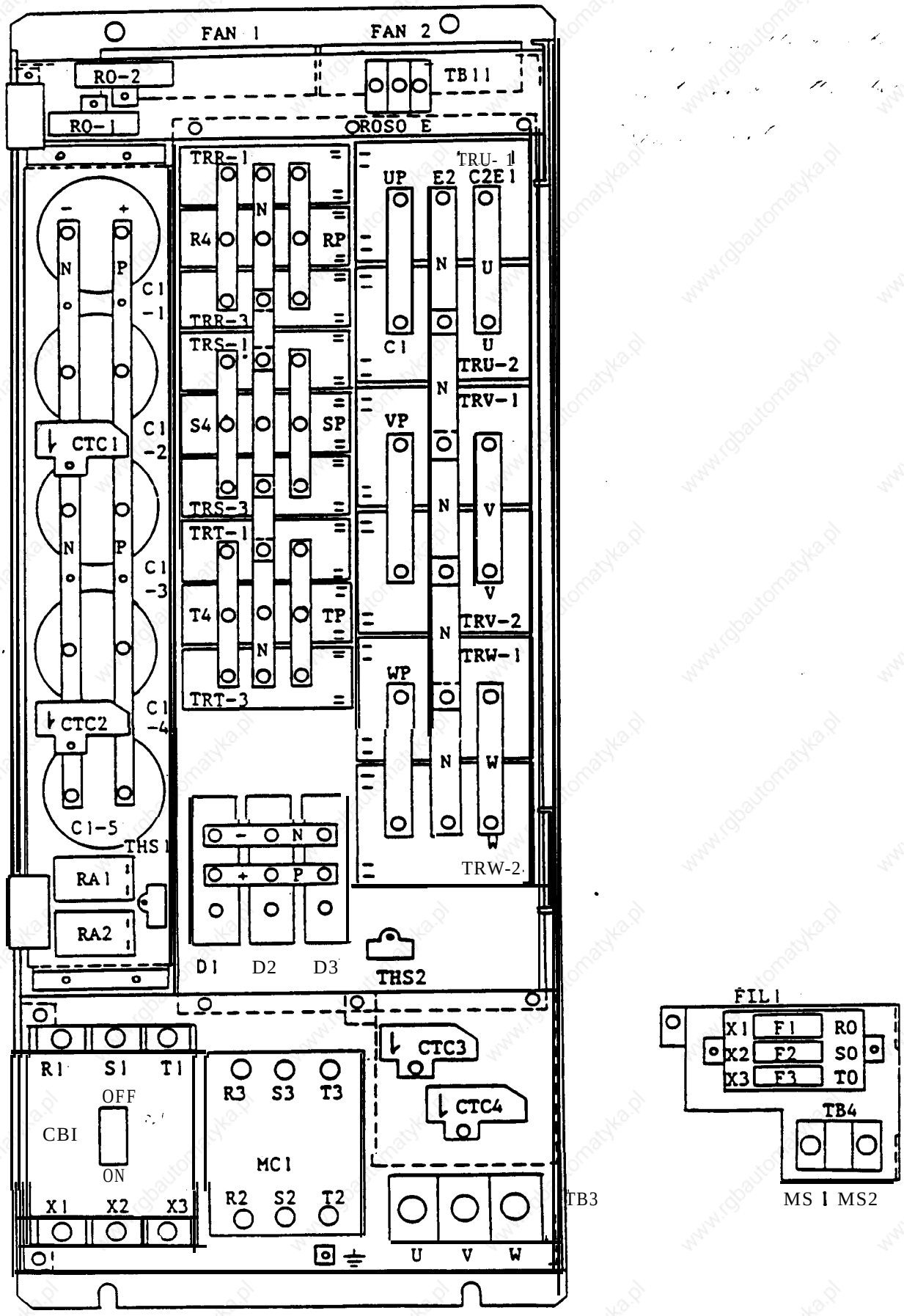

FAN 1
FAN 2
RO-2
RO-1
TB11
ROSO E
TRR-1
TRR-3
TRS-1
TRS-3
TRT-1
TRT-3
R4
RP
S4
SP
T4
TP
TRU-1
UP
E2
C2E1
C1
U
TRU-2
VP
TRV-1
V
TRV-2
WP
TRW-1
W
TRW-2
CTC1
CTC2
C1-1
C1-2
C1-3
C1-4
C1-5
THS1
RA1
RA2
D1
D2
D3
THS2
CTC3
CTC4
R1
S1
T1
OFF
CBI
ON
X1
X2
X3
R3
S3
T3
MC1
R2
S2
T2
TB3
U
V
W
FIL1
F1
F2
F3
RO
SO
TO
TB4
MS1 MS2

Figure 22

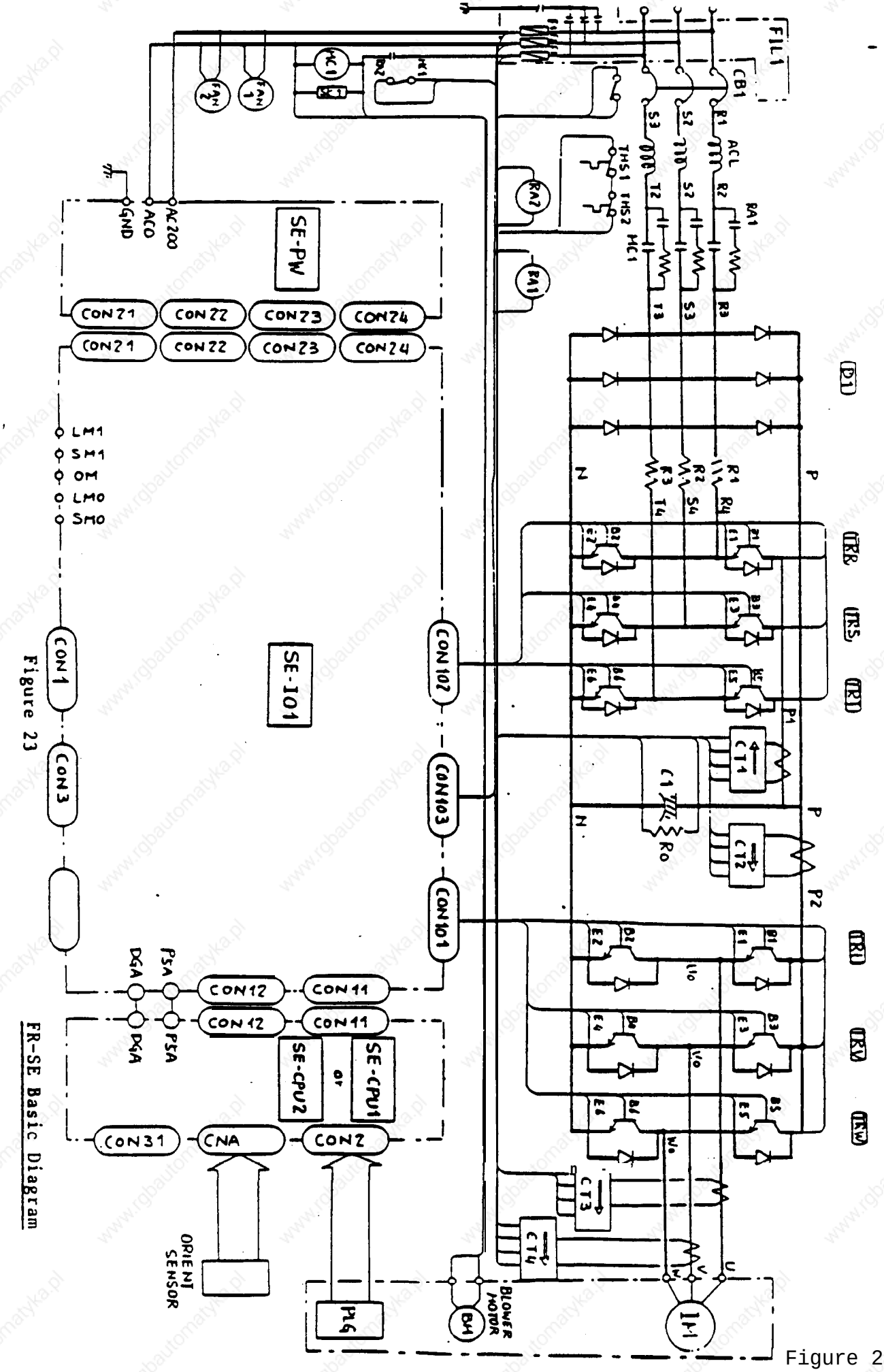


Figure 23

FR-SE Basic Diagram

Figure 23

FR-SE Main Power Circuit

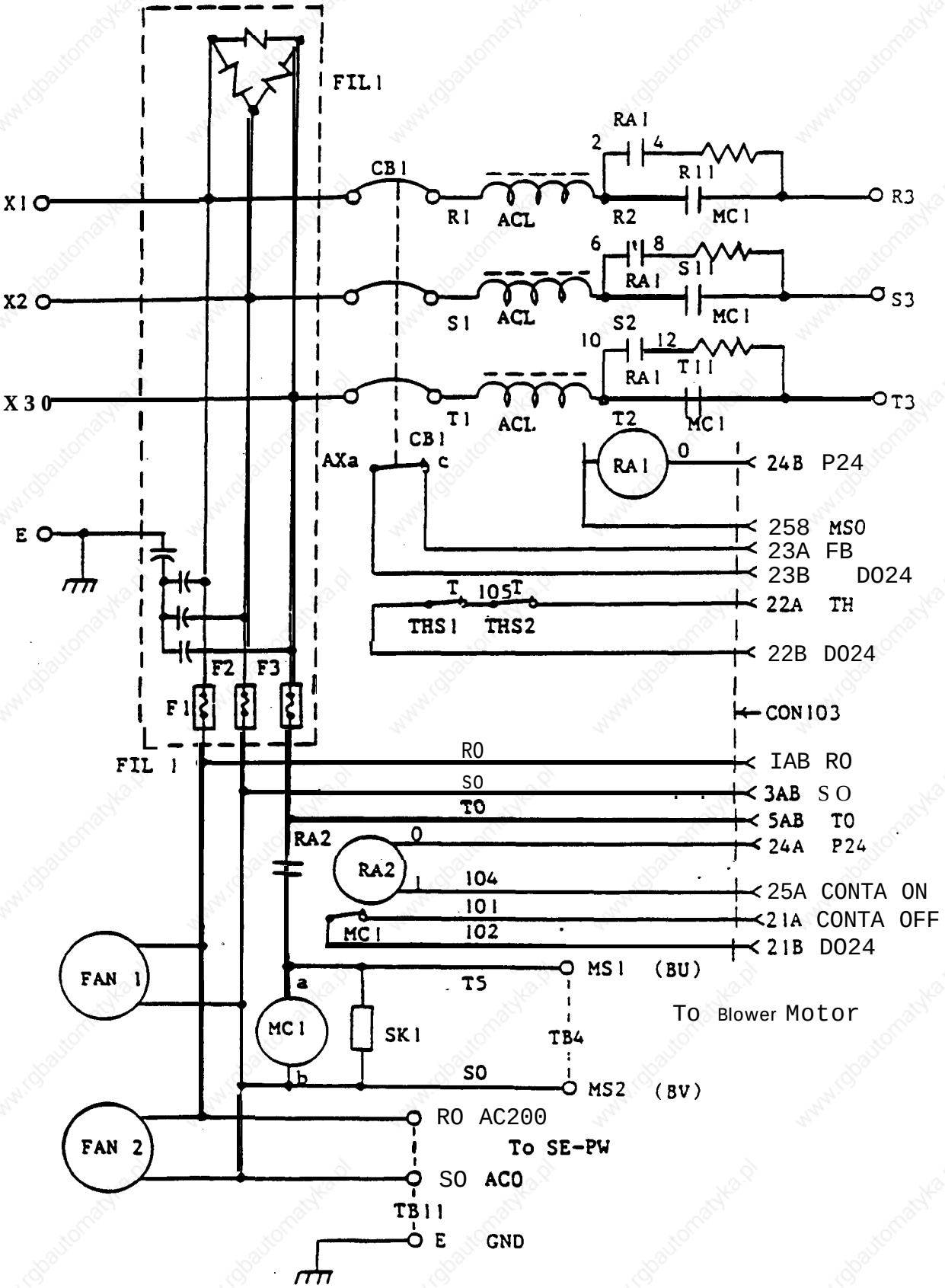


Figure 24

FR-SE Converter

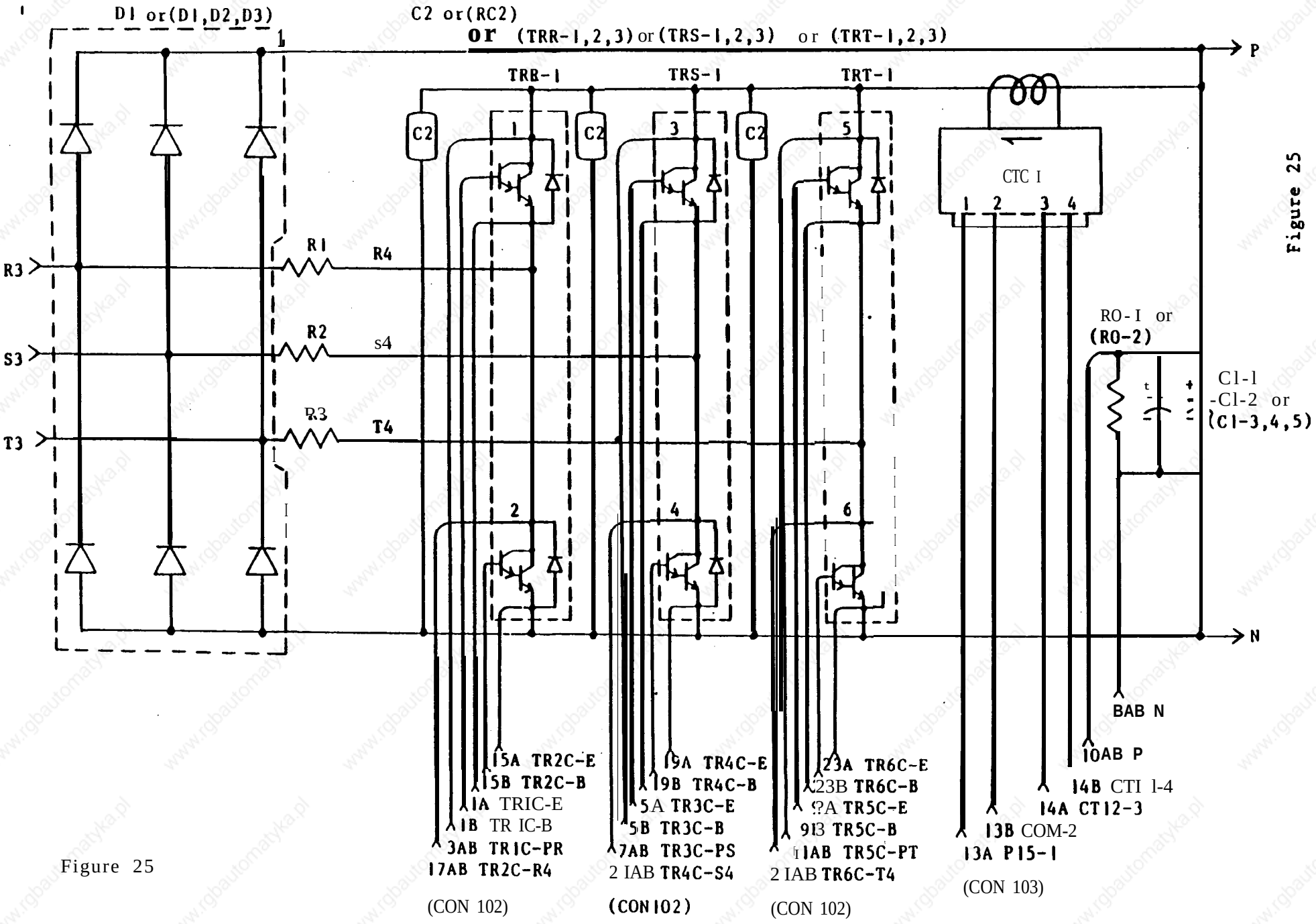


Figure 25

Figure 25

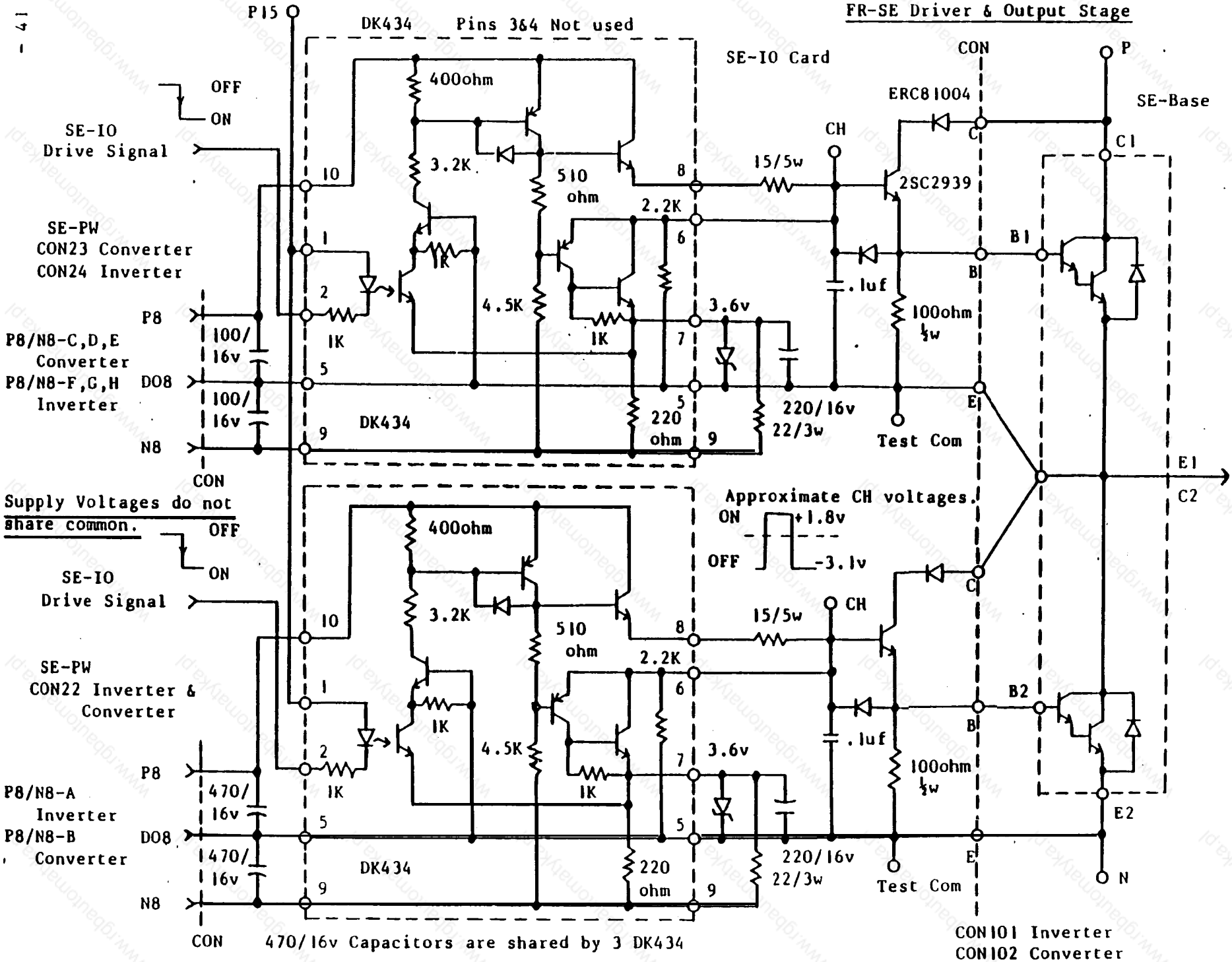


Figure 27

Figure 27

CAUTION: Use corr common for each check point. (Isolated Supplies

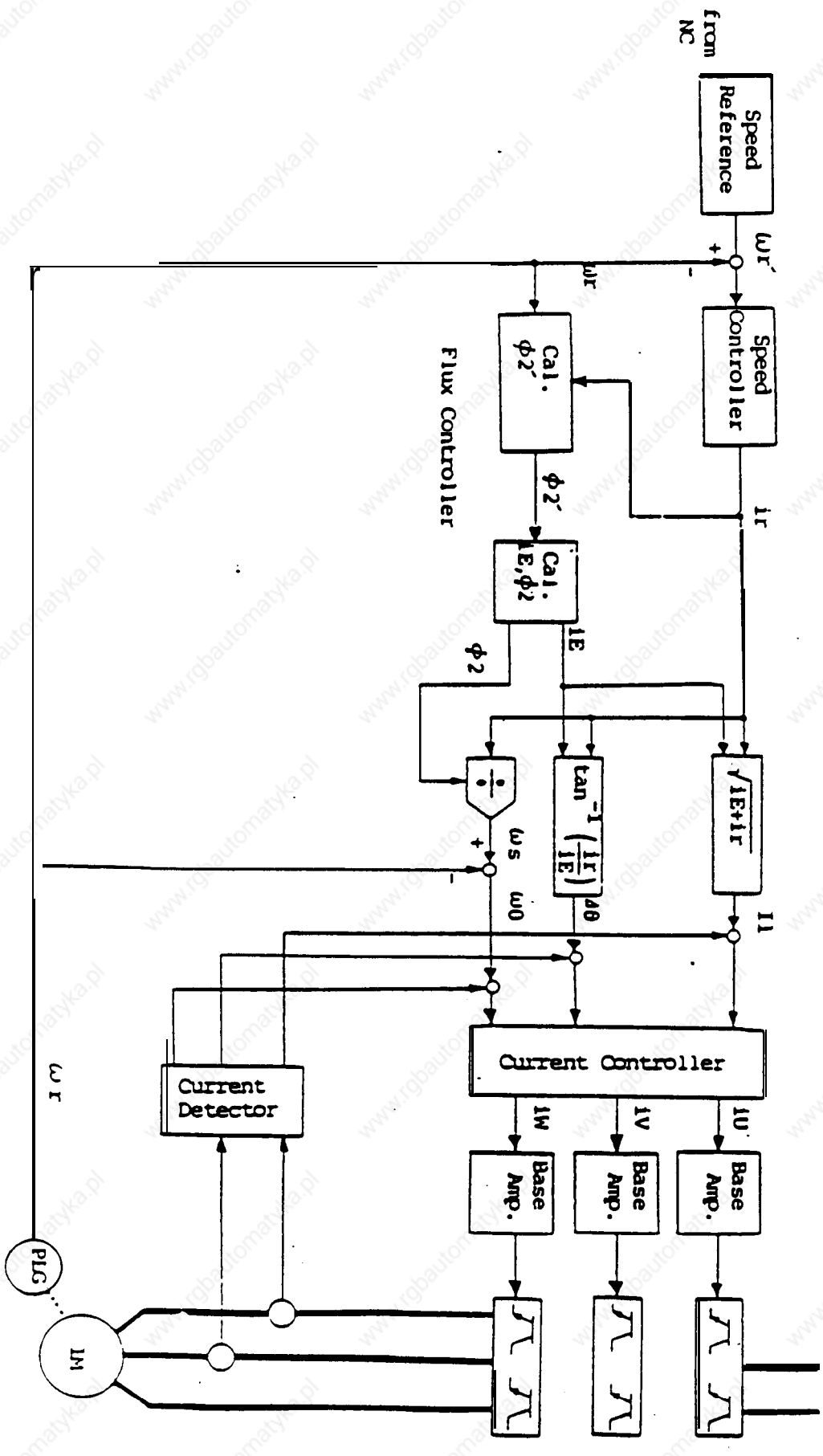


Figure 28

Figure 28

MITSUBISHI ADJUSTABLE SPEED DRIVE SERIES

AC SPINDLE DRIVE UNITS
FREQROL-SE
MAINTENANCE OPERATION MANUAL

MITSUBISHI ELECTRIC CORPORATION

NAGOYA WORKS

BNP-A7237-35-*

CONTENTS

CHAPTER 1 GENERAL

1.1 OBJECTIVES OF MANUAL

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

1.2 SAFETY MEASURES AND MAINTENANCE PERSONNEL

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

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

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

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

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

- Do notwearloose apparel which may be caught up by rotating objects when approaching a drive unit which is operating.
- Do notremoveor replace anyofthe circuit boards while power is being suppliedtothe drive units or while they are operating. Failure to heed this caution may result in damage.
- Do not touch the controller immediately after the power has been switched off. Proceed to maintain and inspect after checking that power lamp LED20 (SE-101 card) has gone off. (Wait at least 3 minutes.)

1.3 STORAGE

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

CHAPTER 2 SPECIFICATIONS

2.7 AC SPINDLE MOTORS

(1) Standard specifications

Output power	Continuous rating (KW)	3.7	5.5	7.5	11	15	18.5
	30-minute rating (KW)	5.5	7.5	11	15	18.5	22
	50% ED rating (KW)	5.5	7.5	11	15	18.5	22
Speed	Base speed (RPM)	1500		1500			
	Maximum speed (RPM) (Note 1)	8000		6000			4500
Frame number		A112	B112	B132		C132	A160
Continuous rated torque	(Kgm)	2.4	3.57	4.07	7.15	9.74	12.0
GD^2	(Kgm^2)	0.08	0.10	0.17	0.21	0.27	0.55
Weight	(Kg)	60	70	100	110	130	175
Allowable radial load	(Kg)	150	200	300			
Cooling fan	(W)	35					100
Vibration		V5					V10
Noise	(db)(A)	75					80
Installation		Output shaft is horizontal or vertically downward.					
Allowable overload		1 minute at 1202 of 30-minute rated output.					
Ambient temperature	(°C)	0 - 40					
Insulation		class F					
Color of paint		Munsell 5.2 7 G 2.46/0.21					
Accessories		Pulse generator, overheating detector					
Controller type FR-SE-2-		5.5 K	7.5 K	11 K	15 K	18.5 K	22 K
Power capacity	(KVA)	9	12	17	23	28	33
Power supply and power line frequency	(Note 2)	200/200~230V ± 10%, 50/60Hz ± 3%					

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

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

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

(2) Semi-standard specifications

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

Output power	Continuous rating (KW)	2.2	3.7	5.3	7.5	11	15	18.5
	30-minute rating (KW)	3.7	5.3	7.5	11	15	18.5	22
	50% ED rating (KW)	3.7	5.5	7.5	11	15	18.5	22
Speed	Base speed (RPM)	1150						
	Maximum speed (RPM) (Note 3)	8000		6000		4600		
Frame number		A112	B112	B132		C132	1160	B160
Continuous rated torque (Kgm)		1.86	3.13	4.66	6.35	9.32	12.7	15.7
GD² (Kgm²)		0.08	0.10	0.17	0.21	0.27	0.55	0.69
Weight (Kg)		60	70	100	110	130	175	200
Allowable radial load (Kg)		150	200	300				
Cooling fan (W)		135					100	
Vibration		V5					V10	
Noise (db) (A)		75					80	
Installation		Output shaft is horizontal or vertically downward.						
Allowable overload		1 minute at 120% of 30-minute rated output.						
Ambient temperature (°C)		0 ~ 40						
Insulation		class F						
Color of paint		Munsell 5.2 7G 2.46 / 0.21.						
Accessories		Pulse generator, overheating detector						
CDFR-SE-2-ne		3.7K	5.5K	7.5K	11K	15K	18.5K	22K
Power capacity (KVA)		6	9	13	17	23	28	33
Power supply and power line frequency (Note 4)		200/200 ~ 230V ± 10%, 50/60Hz ± 3%						

Note 3: A reduced output is obtained for speeds of 3450 rpm and above: this is calculated by:

$$\text{Rated output} \times \frac{\text{rotational speed}}{3450}$$

Note 4: A power transformer should be provided for use at all voltages not listed here.

2.2 AC SPINDLE CONTROLLERS

(1) Spedifications

Type FR-SE-2-		5.5K	7.5K	11K	15K	18.5K	22K
50% ED output	Output power (KW)	5.5	7.5	11	15	18.5	22
	Power capacity (KVA)	9	12	17	23	28	33
Weight (kg)	Open type unit	25		30	37	48	
	Closed type unit	30		36	45	56	
Total heat generation (W) (Note 2)		340	400	490	590	700	810
Main circuitry ststen		Transistorized sinusoidal wave PWM inverter					
Control system		Vector control, digital closed loop control, speed feedback vith pulse generator					
Braking system		Power regenerative braking					
Speed control range		35 - 10000 RPM					
Speed fluctuation rate		Max. 0.2% of maximum speed (at 10-100% load fluctuation1					
Speed commands		Digital commands: binary 12-bit or BCD 2-digits (Note 1) Analog commands: +10V max. (approx. 10 kilohms input impedance)					
Ambient temperature/humidity		-5 - 55°C/45 - 85%					
Atmosphere		No noxious gases or dust (environmental resistancc performance conforms to JEM1103 grade C) .					
Vibration		Max. 0.5G					
Standards conf ormed to		I E C.					
Cooling		Air cooling with fan					

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

Note 2: This is the total amount of heat generated at the continuous rating. In the case of the enclosed type unit, the amount of heat generated outside the panel is approximately equivalent to (total heat generation - 120) x 0.7 'W').

Name	Function	Description
OVER HEAT (MOTOR)	Overload protection	When an overload occours or when the blower motor stops And the motor itself overheats, the base amp. is cut off And the main circuitry contactor is set OFF.
EXCESSIVE SPEED ERROR	Excessive speed error	When the error between the command speed And current speed becomes excessive, the base amp. is cut off and the main circuitry contactor is set OFF.
BREAKER TRIP	Short-circuit/ grounding protection	When A high current flows to the main circuitry, the base amp. is cut off and the main circuitry contactor is set OFF.
PHASE LOSS	Phase loss protection	The main circuitry contactor is set OFF.
EXTERNAL EMERGENCY	External emergency stop	After the emergency stop signal has bee.. received from the external source and the motor has stopped by regenerative braking, the base Amp. is cut off and the main circuitry contactor is set OFF.
OVER SPEED	Over speed protection	When the speed ● xc*eds*llSr of the maximum spud, the base amp. is cut off end main circuitry contactor is set OFF.
IOC TRIP (CONVERTER)	Instantaneous over current protection	when an over current flows to the converter, the base amp. is cut off and the main circuitry contactor is set OF?.
OVER HEAT (CONTROLLER)	Main circuitry overload protection Air cut-off protection	When the ambient temperature is abnomal or when an overload occurs or when the air-cooling fan stops and themain circuitry elements over heat, the basc amp. is cut off and the main circuitry con tactor is set OFF.
UNDER VOLTAGE	Main power supply drop protectron	When the supply voltage drops, the base amp. is cut off and the main circuitry contactor is set OFF.
OVER (VOLTAGE REGENERATION)	Main circuitry over voltage protection	When An over voltage occurs with regeneration of the main circuitry's capacitor voltage, the base amp. is cut off and the main circuitry contactor is set OFF.
IOC TRIP (INVERTER)	Instantaneous over current protection	When an over current flows to the inverter, the base amp. is cue off and the main circuitry contactor is set OFF.

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

(3) AUXILIARY FUNCTIONS

Function	Application	Details	oucpuc
Load meter signal	Load meter connections	Connect a single-deflection DC 1mA meter; full-rule and 3V or 10V/120% load outputs under a 120% (100-120% ● dfuitablt) art obtained.	
Speed meter signal	Sptfd meter connections	Connect a single-deflection DC 1mA meter; full-scale end 10V/maximum speed outputs at maximum speed aft obtained.	
Zero speed sign1	Machine inctrlock	An ON-setting contact signal is obtained at less than , motor speed of SO rpm or 25 rpm.	Contact/open emitter
Up co sptfd signal	Answer back to NC	Obtained is a signal which • ctuats cht outut transistors at within +/- 15% of the set sptfd.	Open emitter
Load detection signal	Cutctr intrusion prevention	Obtained is a signal which actuates the oucpuc transistors above a current value (110% oucpuc) near the current limit value (120% oucpuc).	Open emitter
Overried	Overriede with automatic operation	Variable range: 50-120% Released by coneroller terminal signal DEF off.	
Orientation (optional function)	Orientation	Single point positioning possible for magnetic sensor system, multiple-point positioning possible for encoder system. Started by orientation start signals (ORC1, ORC2); orientation finish signal is oucpur upon completion.	Contact/open emitter
Torque limitation	Gear shift, etc.	With gear shifting, etc., the corqut limitation is temporarily reduced and the spindle motor is operated. During torque limitation, signal for output transistor continuity..	Open emitter
Speed detection signal		Obtained is a signal which activates the oucpuc transistors with a motor speed absolute value of less than the prescribed detection level. Speed detection value ranges from 2% to 58% in 8% steps and can be set to any of 8 steps.	Optn emitter
Acceleration/ deceleration time constant		Acceleration/deceleration of sptfd command is restricted.	

2.3 CONTROLLER CONFIGURATIONS

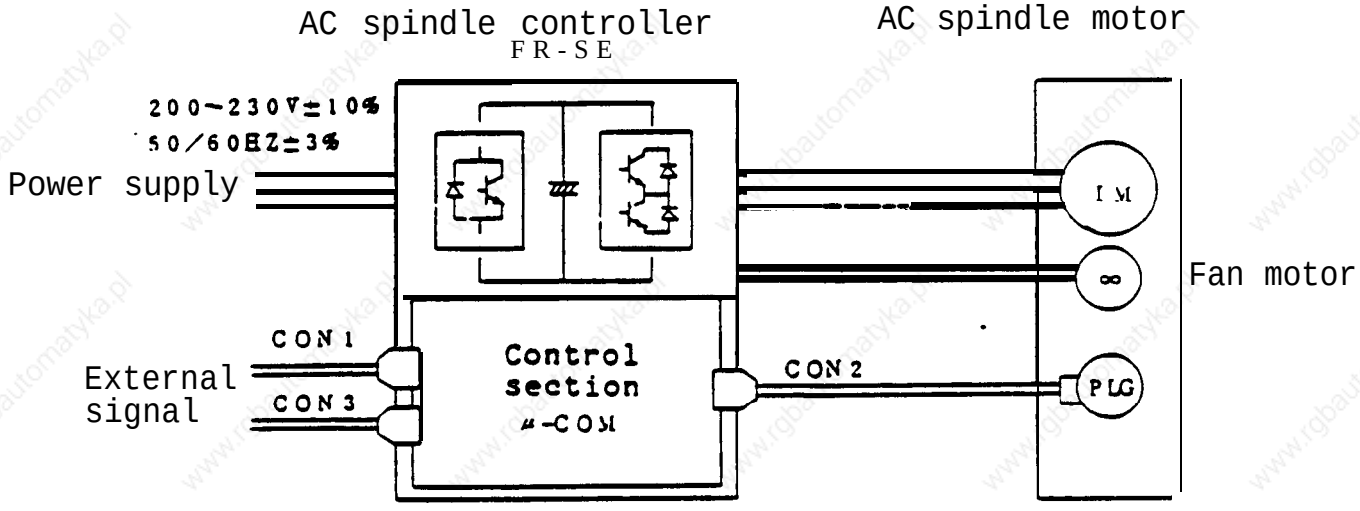
The basic configuration of the type FR-SE AC spindle unit is shown below.

(1) Basic configuration

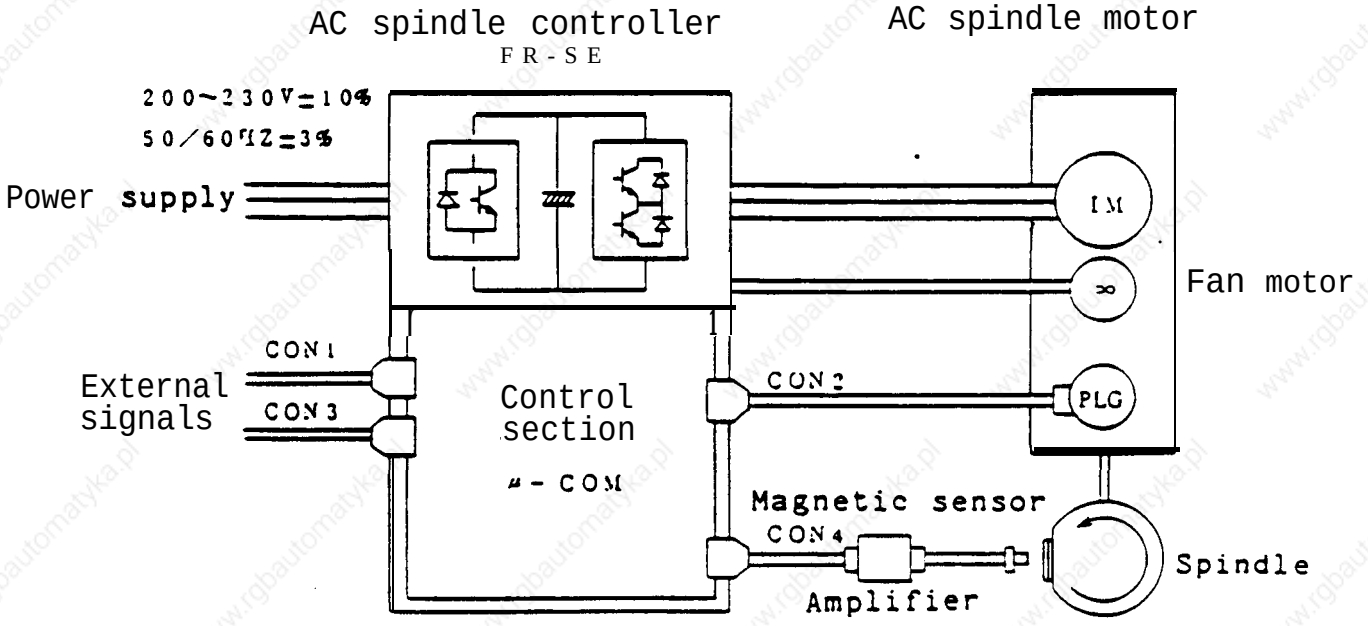
(a) Type SJ AC spindle motor (with speed detector)

(b) Type FR-SE AC spindle controller

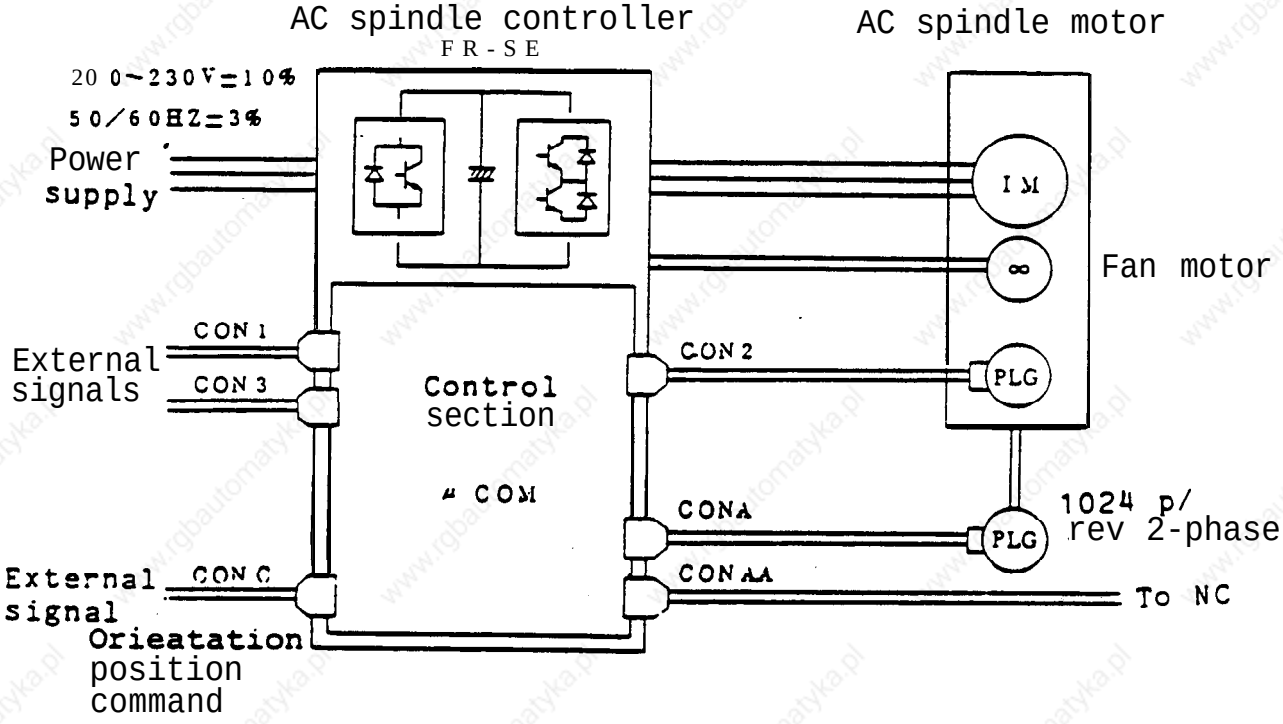
(c) Spare fuse



(2) Magnetic sensor system with single point orientation unit



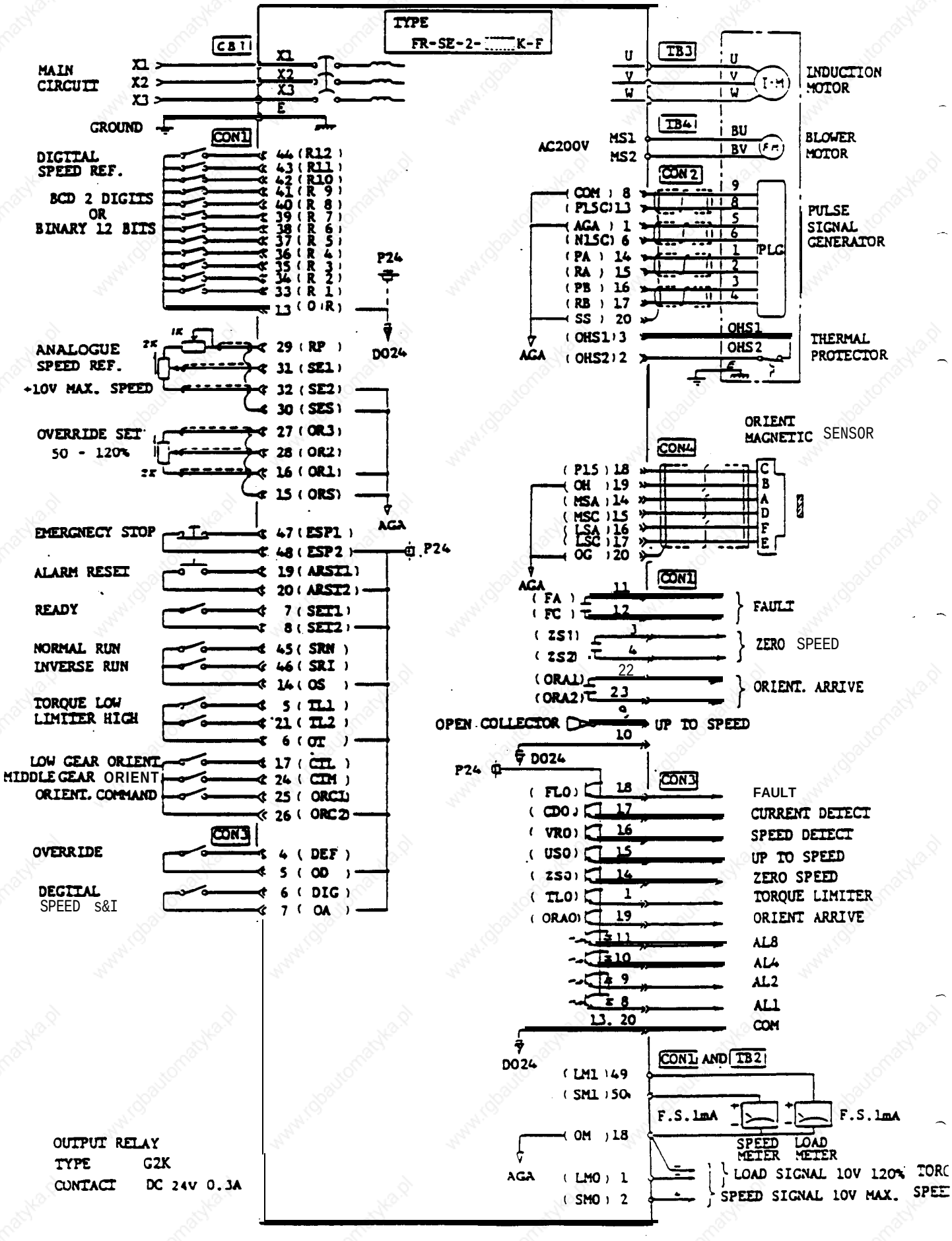
(3) **Encoder** system with multiple point orientation unit



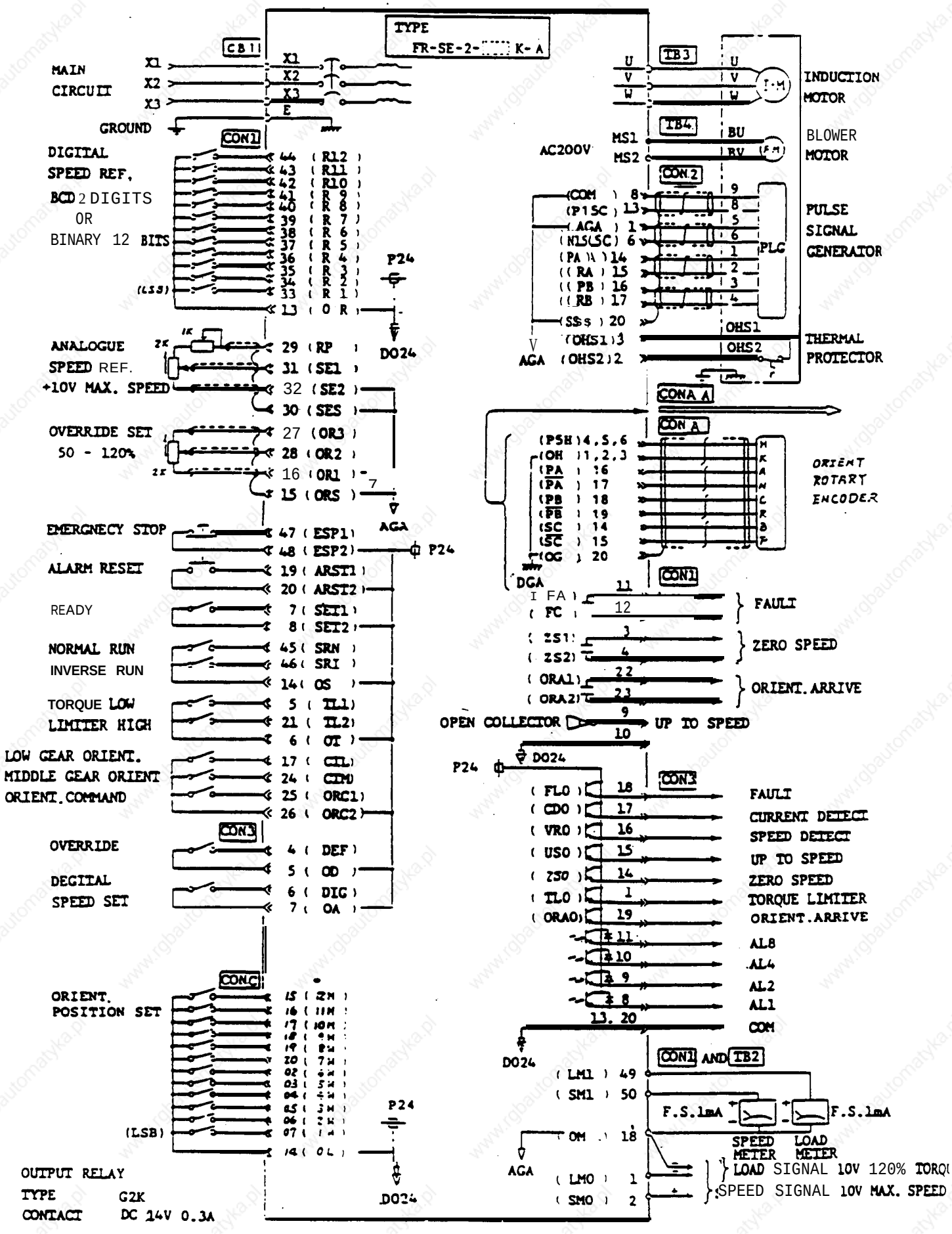
(4) Internal configuration of controller

Configuration	Circuit board configuration
(a) Basic configuration	SE-PW, SE-101, SE-CPU1 or CPU2
(b) Magnetic sensor system With single point orientation unit	SE-PC;, SE-107, SE-CPU1
(c) Encoder system With multiple point orientation unit	SE-PU, SE-101, SE-CPU2

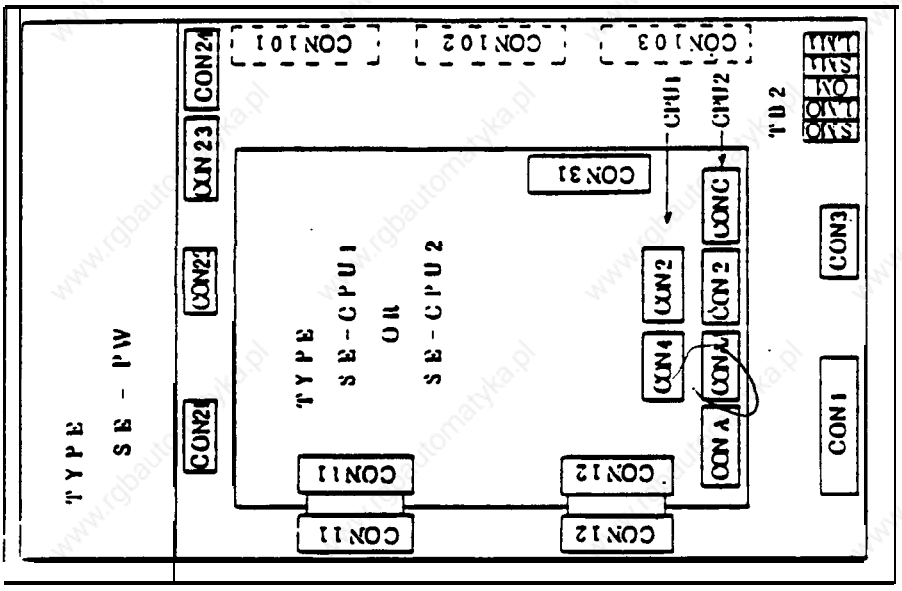
(1) Magnetic sensor type with single point orientation unit

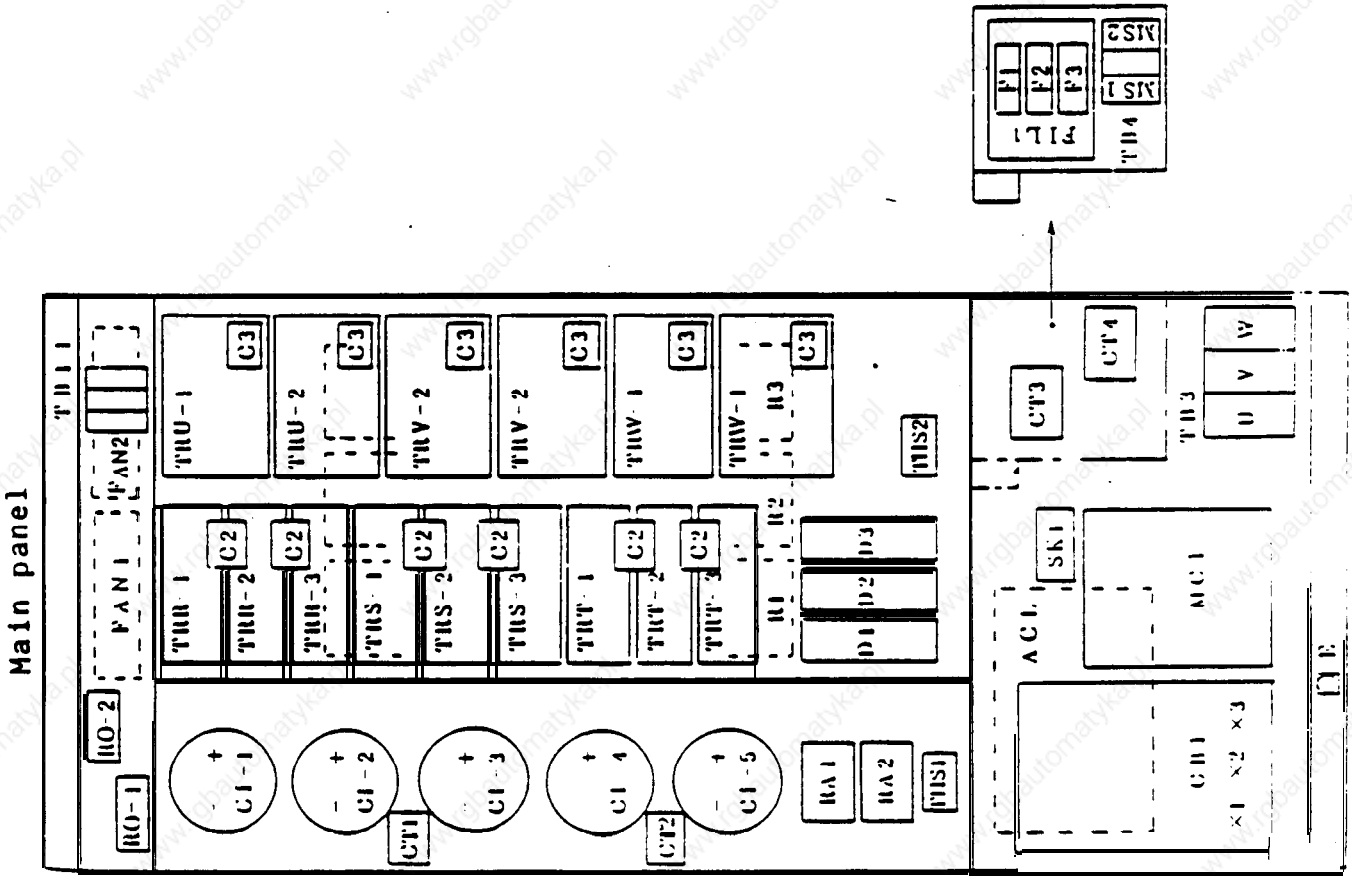


(2) Encoder type with multiple point orientation unit



2.5 PLACEMENT OF EQUIPMENT





CHAPTER 3 OPERATIONAL ADJUSTMENTS

3.1 OPERATION PREPARATIONS

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

(1) Check that all the equipments are properly wired and connected as shown in the drawings?

(2) Check that the motor and control panel are grounded properly?

(3) Check that the shield wire terminations are connected properly?

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

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

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

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

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

3.2 INCOMING POWER

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

(1) Switch on the incoming power.

(2) Check that light-emitting diodes LED12, 13, 14 and 15, which are designed to indicate trouble and which are located on the front of the controller, have nto lighted.

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

These procedures enable operation.

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

3.3 ADJUSTMENT LOCATIONS

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

When driving the speed meter with the spindle inverter: set the DIP switch SW6-6 to OFF and then adjust VR14 so that the speed meter indicates the maximum speed.

Adjust VR15 so that the load meter indicates 120%.

Upon completion of the adjustments, return SW6-6 to the ON position and set the reset (ST1) swtich to ON once.

Under no circumstances should the VRs be touched unless absolutely necessary.

(2) Setting DIP switches, setting pins

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

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

3.4 RUNNING-IN OPERATION

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

0 Abnormal noise

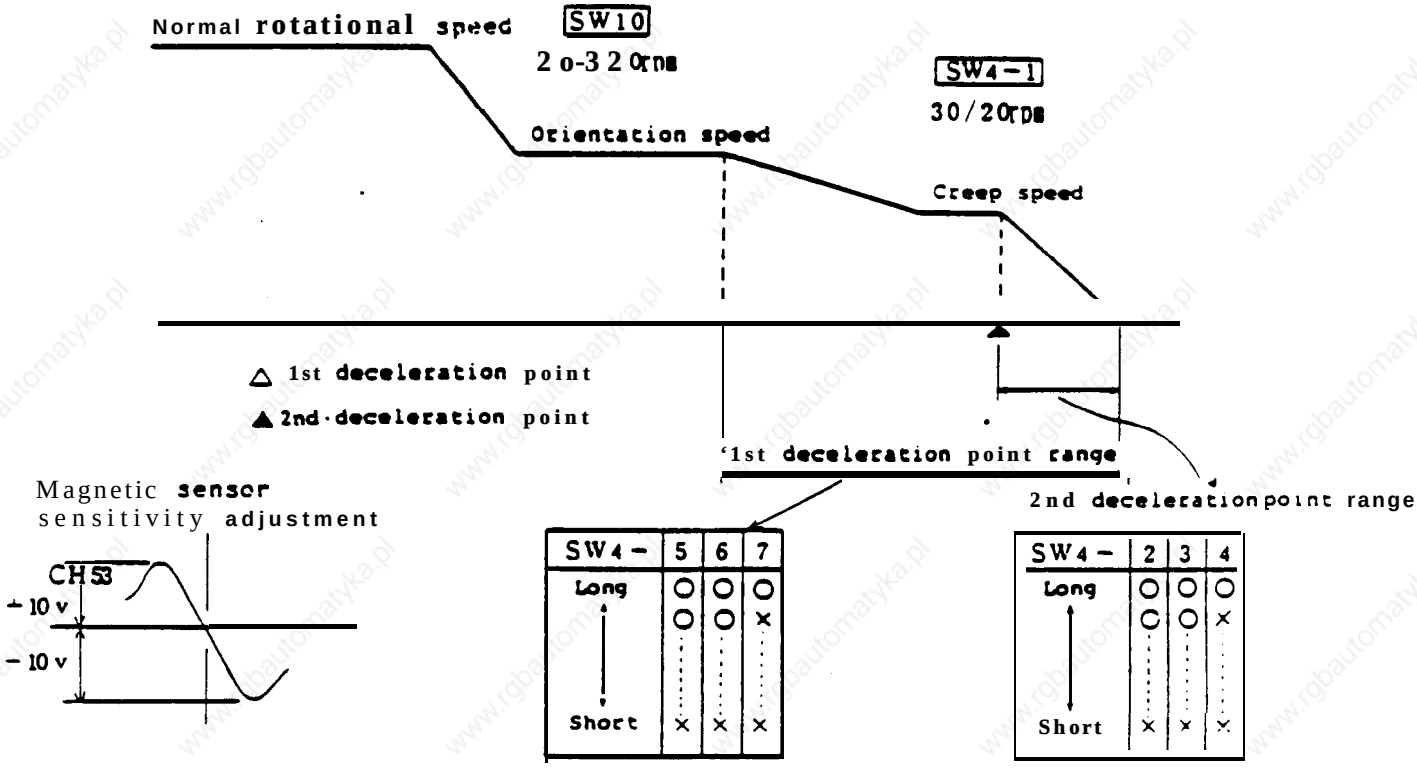
0 Abnormal smells

o Abnormal bearing temperature

3.5 ORIENTATION ADJUSTMENT PROCEDURES

Note: Setting DIP Switches and setting pins may vary slightly depending on the ROM No. and bar *zone* of the printed circuit board. check these on the order parts list.

(1) Magnetic sensor system



Operate at the creep speed (20 to 30 rpm) and VR2 is adjusted to the limit at which the magnetic sensor sensitivity LED 11 lights, then CH53 will be the peak voltage ± 10V.
The speed pattern for orientation is shown in the figure above.

In case of overshooting during stop:

- Increase the 1st deceleration point range. (SW4-5,6,7)
- Increase the 2nd deceleration point range. (SW4-2,3,4)
- Reduce the orientation speed. (SW10 F→E→... →0)
- Reduce the creep speed (SW4-1 OFF-ON)

Reduce the orientation time:

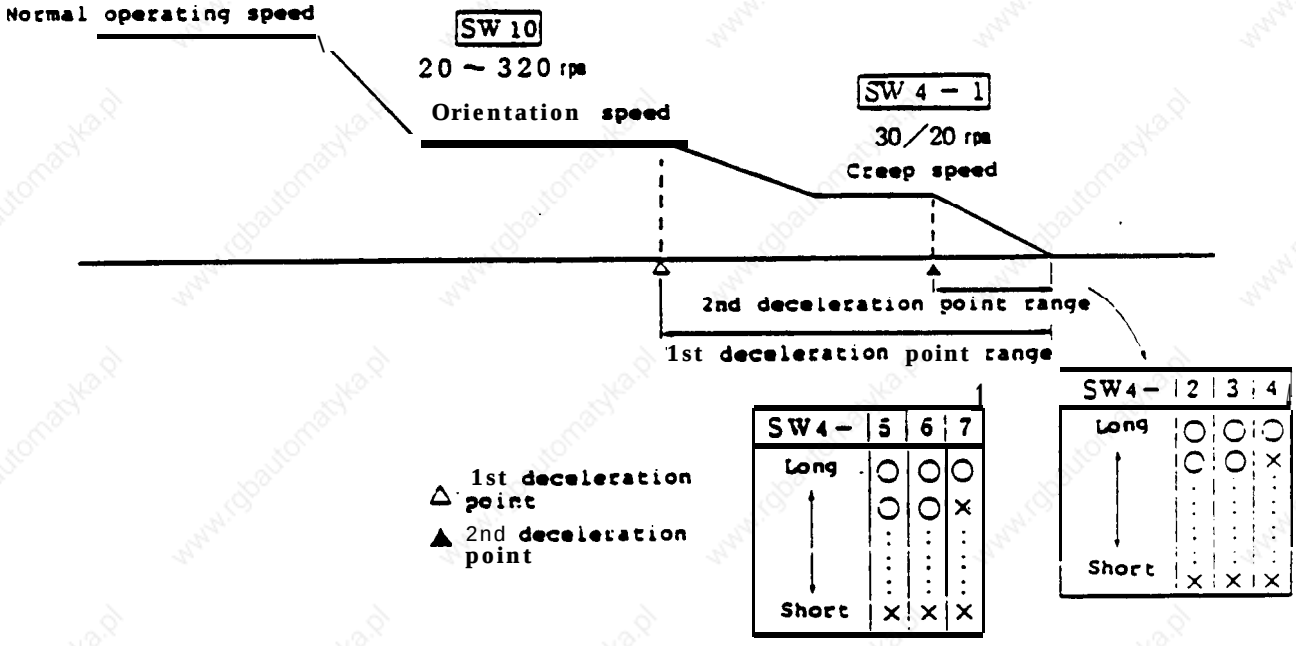
- Reduce the 1st deceleration point range. (SW4-5,6,7)
- Increase the orientation speed. (SW10 0-1-... →F)
- Reduce the 2nd deceleration point range. (SW4-2,3,4)

In case of hunting during stop:

- Increase the 2nd deceleration point range. (SW4-2,3,4)
- Reduce the magnetic sensor sensitivity. (VR2)
- Reduce the creep speed. (SW4-1 OFF→ON)

Furthermore, the stop position is adjusted with the VR1 position shift.

(2) Encoder system



The speed pattern during orientation is shown in the figure above.

In case of overshoorting during stop:

o Increase the 1st deceleration point range. (SW4-5,6,7)

o Reduce the orientation speed (SW10 F→E→... → 0)

o Increase the 2nd deceleration point'ranqe.

(SW4-2,3,4)

o Reduce the creep speed.(SW4-1 OFF→ ON)

Reduce the orientation time:

o Reduce the 1st deceleration point range. (SW4-5,6,7)

o Increase the orientation speed.(SW10 0→1→... →F)

o Reduce the 2nd deceleration point range. (SW4-2,3,4)

In case of hunting during stop:

o Increase the 2nd deceleration point range.
(SW4-2, 3, 4)

o Reduce the creep speed. (SW4-1 OFF → ON)

Furthermore, the stop position is adjusted with the position shift SW13, 14 and 15.

CHAPTER 4 REGULAR INSPECTIONS

Maintenance and inspection are indispensable in order for the equipment to do full justice to its performance, for breakdown to be prevented and for reliable operation to be assured over a long period of time.

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

4.1 CONTROLLER INSPECTIONS

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

4.2 MOTOR INSPECTIONS

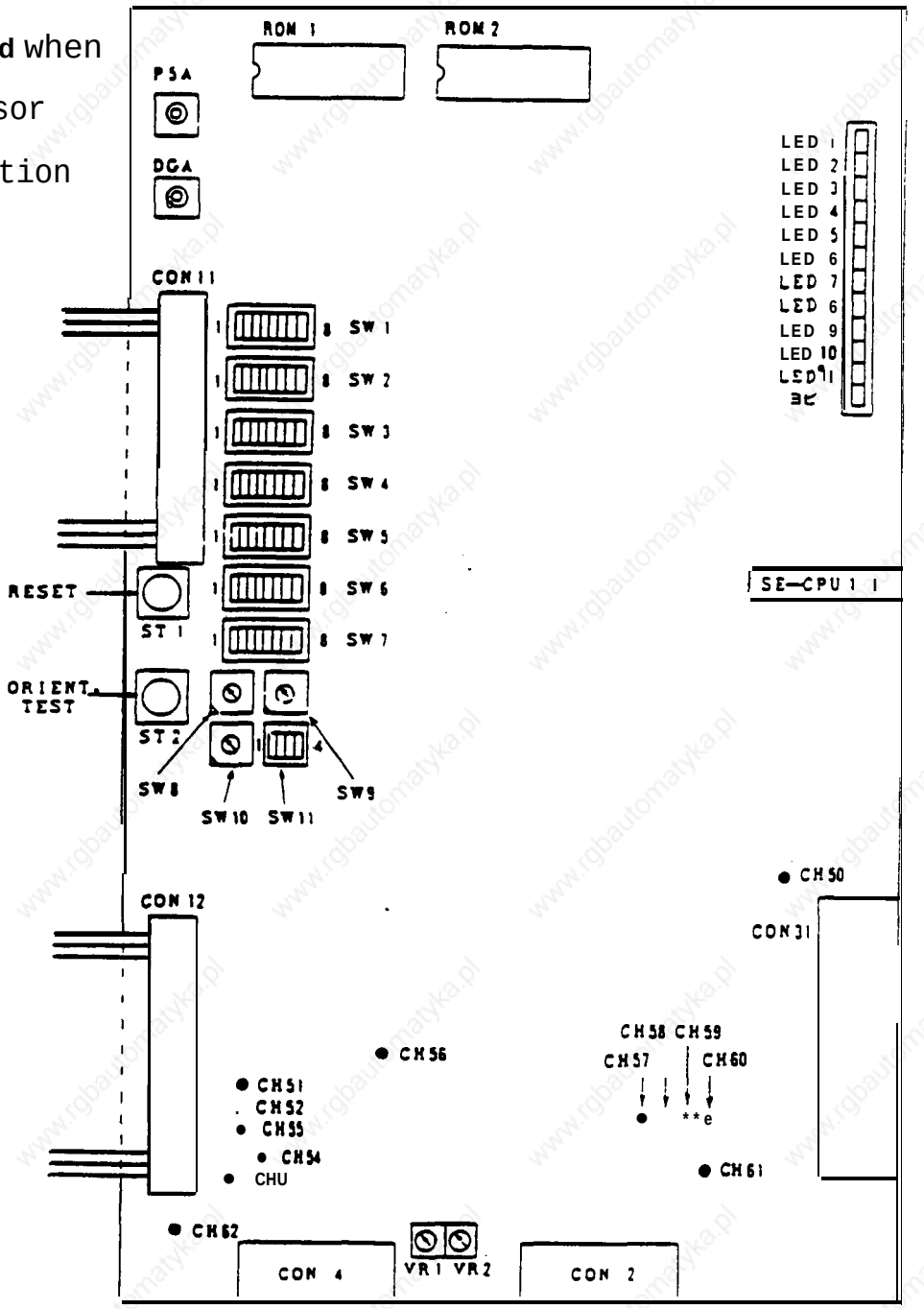
Inspection item	Inspection period	Checkpoints	Remedy
1 Noise	Monthly	Any noise or abnormal vibration not previously perceived? If present, check out the following: 1 Check foundation, installation. 2 Check centering accuracy of coupling. 3 Vibration from coupled equipment?' 4 Bearing damage or abnormal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

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

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

5.1 SE-CPU1 CARD

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



(1) List of LEDs

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

LED	Name	Application	Description
LED9	I N - POSITION	In-position	Lights with orientation stop within angle range set by DIP switch.
LED10	ZERO SPEED	Zero	Lights when speed is below zero speed set by DIP switch.
LED11	SENS	Magnetic sensor sensitivity	Lights when magnetic sensor output during orientation is 8.5V or more.
LED12	—	—	Not used.

(2) List of DIP switches and rotary switches

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

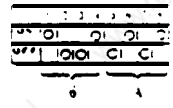
"X" denotes DIP switch OFF setting.

Note 2: The settings may differ slightly depending on the ROM used and so reference should be made to the order parts list.

Note 3: Make the setting marked with an asterisk apply from ROM 490-D or following.

Note 4: Make the settings marked with a double asterisk apply from ROM 490-C or following.

Switch	Name	Description
SW1	Gear ratio (H range)	Used to set gear ratio. Gear ratio = $\frac{\text{Maximum apindle speed}}{\text{Maximum motor speed}}$ x 80H ($=128^{D}$) Setting example:
SW2	Gear ratio (M range)	When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Hexa-decimal Gear ratio = 5000/6000 x 128^{D} = 106^{D} = $6A^{H}$
SW3	Gear ratio (L range)	This is treated as-the values below when the following switches are all ON. SW1 all switches ON ... Gear ratio = 80^{H} SW2 all switches ON ... Gear ratio = 40^{H} SW3 all switches ON ... Gear ratio = 20^{H}



<table>
<tr><th>Switch</th><th>Name</th><th>Description</th></tr>
<tr><td>SW4-1</td><td>Creep speed</td><td>Used to set creep speed with orientation.

1 ... Creep speed
0 ... 20 rpm
x . . . 30 rpm</td></tr>
<tr><td>SW4-2 ~ 4</td><td>2nd decelera-tion point range</td><td>Used to set the 2nd deceleration point range.

2 3 4 — 2nd deceleration point range
o o o ... 25 deg.
o o x ... 24 deg.
o x o ... 23 deg.
o x x ... 21 deg.
x o o ... 20 deg.
x o x ... 19 deg.
x x o ... 18 deg.
x x x ... 16 deg.</td></tr>
<tr><td>SW4-5 ~ 7</td><td>1st decele-ration point range</td><td>Used to set the 1st deceleration point range.</td></tr>
</table>

<table>
<tr><th>Switch</th><th>Name</th><th>Description</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>5</th><th>6</th><th>7</th><th></th></tr>
<tr><td>o</td><td>o</td><td>o</td><td>... 212 deg.</td></tr>
<tr><td>o</td><td>o</td><td>x</td><td>... 203 deg.</td></tr>
<tr><td>o</td><td>x</td><td>o</td><td>... 194 deg.</td></tr>
<tr><td>o</td><td>x</td><td>x</td><td>... 185 deg.</td></tr>
<tr><td>x</td><td>o</td><td>o</td><td>... 176 deg.</td></tr>
<tr><td>x</td><td>o</td><td>x</td><td>... 167 deg.</td></tr>
<tr><td>x</td><td>x</td><td>o</td><td>... 158 deg.</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>... 149 deg.</td></tr>
</table>
1st deceleration point range
</td></tr>
<tr><td>SW4-8</td><td>Magnetic sensor mounting direction</td><td>
<table>
<tr><td>8</td><td></td></tr>
<tr><td>o</td><td>..Forward</td></tr>
<tr><td>x</td><td>..Reverse</td></tr>
</table>
Set to reverse position if high degree of hunting occurs with orientation stop.
</td></tr>
<tr><td>SW5-1,2</td><td>Torque limit</td><td>
Used when limiting motor torque.
<table>
<tr><th></th><th>1</th><th>2</th><th>Torque limit</th></tr>
<tr><td rowspan="4">External input
TL1 ... ON
TL2 ... OFF</td><td>o</td><td>o</td><td>... 10%</td></tr>
<tr><td>o</td><td>x</td><td>... 15%</td></tr>
<tr><td>x</td><td>o</td><td>... 20%</td></tr>
<tr><td>x</td><td>x</td><td>... 25%</td></tr>
<tr><td rowspan="4">TL1 ... OFF
TL2 ... ON</td><td>o</td><td>o</td><td>... 20%</td></tr>
<tr><td>o</td><td>x</td><td>... 30%</td></tr>
<tr><td>x</td><td>o</td><td>... 40%</td></tr>
<tr><td>x</td><td>x</td><td>... 50%</td></tr>
</table>
(Note) 30-minute rated torque is 100%.
</td></tr>
</table>

Switch	Name	Description
SW5-3 ~ 5**	Cushion time constant	Used to set the time constant of the maximum speed command from 0.

Acc/Dec

3	4	5	
o	o	o	... 0.3s
o	o	x	... 1.5s
o	x	o	... 3s
o	x	x	... 4s
x	o	o	... 5s
x	o	x	... 6s
x	x	o	... 8s
x	x	x	... 10s

**

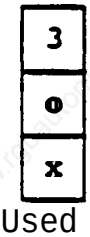
3	4	5			
o	o	o	...	0.3s	1st cushion
o	o	x	...	1.5s	
o	x	o	...	1s	
o	x	x	...	2s	
x	o	o	...	0.3s	2nd cushion
o	o	x	...	0.65	
o	x	o	...	1s	
x	x	x	...	2s	

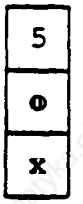
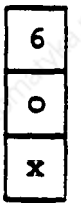
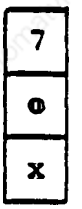
(Note) Adopted for the 2nd cushion is a system which limits the acceleration changes of the motor.

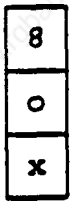
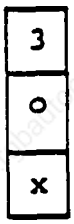
SW5-6 ~ 8	Speed detection range	Output transistors are activated when the speed is whithin the set motor speed range.

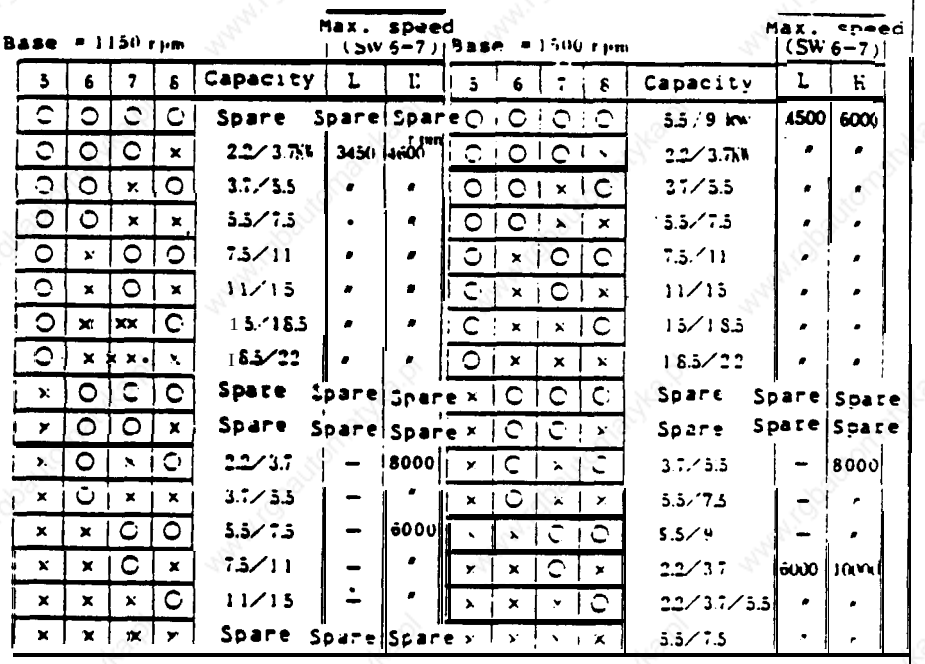
6	7	8	Speed detection range
o	o	o	... 2% or below
o	o	x	... 10% "
o	x	o	... 18% "
o	x	x	... 26% "
x	o	o	... 34% "
x	o	x	... 42% "
x	x	o	... 50% "
x	x	x	... 58% "

(Note) Maximum speed is 100%.

Switch	Name	Description
SW6-1	Normal/test OFF	 ...Normal mode ... Test mode Normal mode is used for normal operation. Test position is used for orientation tests.
-2	Closed/open	 Used for switching between open/closed speed loop. ... Closed loop ... Open loop Used with closed loop for normal operation. Speed detector go/no go, etc. can be identified in the open and closed. operation states.
SW6-3	**Binary/BCD**	 ... Speed command binary ... Speed command BCD Used to select digital speed command format. **Speed command is read as** binary 12-bit input for binary and as BCD 2-digit input for BCD.
-4	Speed input emitter/ collector	 ... Speed input open emitter ... Speed input open collector (Note) Refer to the settings of P59 I01 card pins 2 and 3.

Switch	Name	Description
• SW6-5	Servo rigidity selection	 ... Servo rigidity HIGH ... Servo rigidity LOW
-6	Meter calibration	 ... Meter OFF ... Meter ON Used to calibrate speed meter and load meter full scale. In ON mode, the meter full scale voltage is output and so adjust speed meter (SM1, VR14 SE-I01 card) and load meter (LM1, VR-15 SE-101 card) VRs.
SW6-7	Maximum speed	 ... Maximum speed LOW ...Maximum speed HIGH Used to switch the maximum speed (3450/4600, 4500/6000, 6000/10000 rpm) in accordance with the motor type setting.

Switch	Name	Description
SW6-8	Zero speed	 ... Zero speed LOW (25 rpm) ... Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting or below.
SW7-1	Magnetic sensor orientation in-position range	 ... Magnetic sensor in-position range LOW (1 deg.) .*.- Magnetic sensor in-position range HIGH (5 deg.)
-2	External emergency stop	 ... LED ON with-emergency stop ... LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external emergency stop.
SW7-3	Load meter output	 ... Load meter output HIGH (10V) ... Load meter output LOW (3V) Used to select output voltage with 120% output.

Switc	Name	Description
SW7-4	Base speed	4 o ... 1150 rpm base speed x ... 1500 rpm base speed Used to select base speed of applicable motor.
SW7-5 -8	Motor type	

Base = 1150 rpm					Max. speed (SW6-7)	
5	6	7	8	Capacity	L	H
O	O	O	O	Spare	Spare	Spare
O	O	O	x	2.2/3.7kW	3450 rpm	4600 rpm
O	O	x	O	3.7/5.5	"	"
O	O	x	x	5.5/7.5	"	"
O	x	O	O	7.5/11	"	"
O	x	O	x	11/15	"	"
O	x	x	O	15/18.5	"	"
O	x	x	x	18.5/22	"	"
x	O	O	O	Spare	Spare	Spare
x	O	O	x	Spare	Spare	Spare
x	O	x	O	2.2/3.7	—	8000
x	O	x	x	3.7/5.5	—	"
x	x	O	O	5.5/7.5	—	6000
x	x	O	x	7.5/11	—	"
x	x	x	O	11/15	—	"
x	x	x	x	Spare	Spare	Spare

Base = 1500 rpm					Max. speed (SW6-7)	
5	6	7	8	Capacity	L	H
O	O	O	O	5.5/9 kw	4500 rpm	6000 rpm
O	O	O	x	2.2/3.7kW	"	"
O	O	x	O	3.7/5.5	"	"
O	O	x	x	5.5/7.5	"	"
O	x	O	O	7.5/11	"	"
O	x	O	x	11/15	"	"
O	x	x	O	15/18.5	"	"
O	x	x	x	18.5/22	"	"
x	O	O	O	Spare	Spare	Spare
x	O	O	x	Spare	Spare	Spare
x	O	x	O	3.7/5.5	—	8000
x	O	x	x	5.5/7.5	—	"
x	x	O	O	5.5/9	—	"
x	x	O	x	2.2/3.7	6000	10000
x	x	x	O	2.2/3.7/5.5	"	"
x	x	x	x	5.5/7.5	"	"

Select the compatible motor in combination with the selection of the maximum speed (SW6-7) and of the base speed (SW7-4).

Switch	Name	Description
SW8	Speed control loop Proportional constant ..... K_P	

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

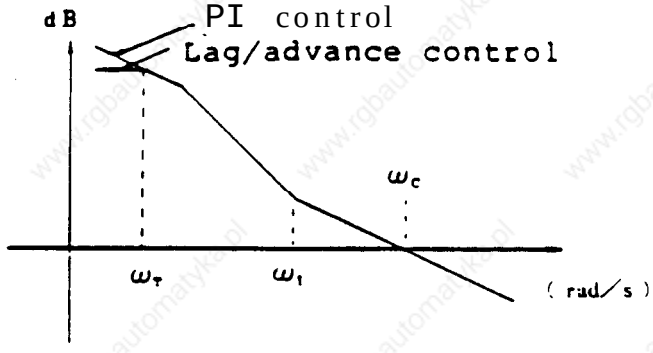
(rad/s)

SW9	**Speed control loop Integral constant ... K_i**	

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_1	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/s)

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



Standard settings: notch 4 for both SW8 and SW9.

Switch	Name	Description
SW10	Orientation speed setting	Speeds on left are spindle speeds. Motor speed depends on gear ratio. When there is a tendency toward overshooting with orientation, reduce and adjust the orientation speed using this switch.

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

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

(3) List of pushbutton switches

No.	Name	Description
ST1	Reset	Press the ST1 switch when the inverter operation is to be initialized totally and when the DIP switches and other settings have been reset. Do not set the switch while the motor is operating. If it is reset while the motor is operating, the motor free-runs and then stops.
ST2	Orientation test	Motor operates at orient. speed while this switch is ON. When OFF, orient is performed once and then motor stop. (Note) This is effective only when SW6-1 is OFF.

(4) List of variable resistors

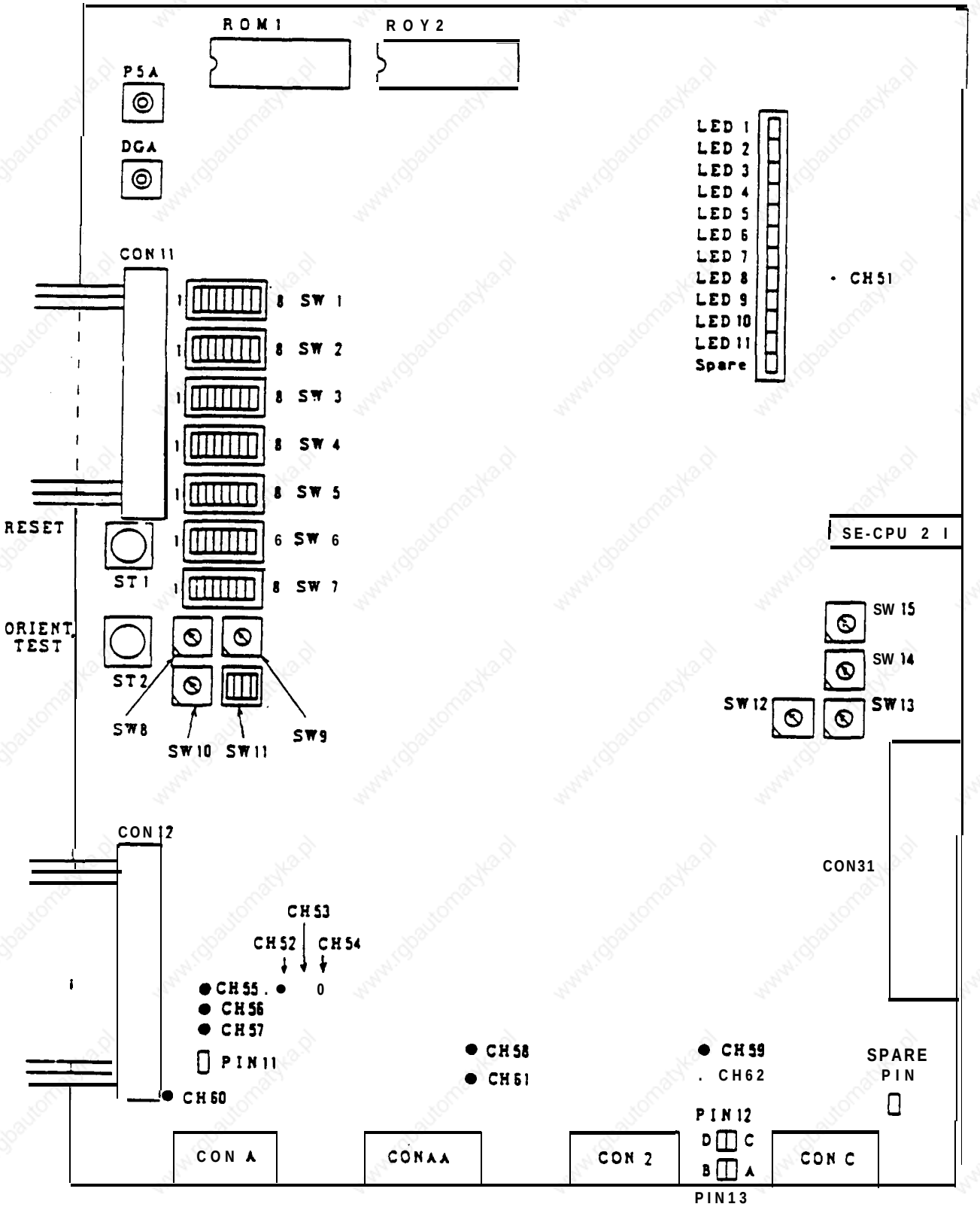
VR	Name	Description
VR1	Position shift	This enables the stop position to be finely adjusted.
VR2	Magnetic sensor sensitivity	This is adjusted so that the magnetic sensor sensitivity display LED11 lights during operation at the creep speed (20-30 rpm).

(5) List of check pins

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

5.2 SE-CPU2 CARD

This card is used when the 1024P/rev 2 phase encoder type of multiple point orientation function is provided.



(1) List of LEDs

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

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

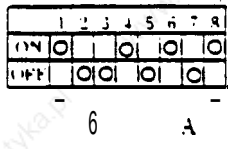
(2) List of DIP switches and rotary switches

Note 1: "0" denotes DIP switch ON setting.
"X" denotes DIP switch OFF setting.

Note 2: The settings may differ slightly depending on the ROM used and so reference should be made to the order parts list.

Note 3: Make the settings marked with an asterisk apply from ROM 480-E or following.

Note 4: Make the settings marked with a double asterisk apply from ROM 480-F or following.

Switch	Name	Description
SW1	Gear ratio (H range)	Used to set gear ratio. Gear ratio = $\frac{\text{Maximum spindle speed}}{\text{Maximum motor speed}}$ x 80H ($= 128^{D}$) Setting example: When max. spindle speed is 5000 rpm with a maximum H gear motor speed of 6000 rpm Hexa-decimal Gear ratio = 5000/6000 x 128^{D} = 106^{D} = $6A^{H}$ This is treated as the values below when the following switches are all ON.  SW1 all switches ON ... Gear ratio = 80^{H} SW2 all switches ON ... Gear ratio = 40^{H} SW3 all switches ON . . . Gear ratio = 20^{H}
SW2	Gear ratio (M range)	
SW3	Gear ratio (L range)	

<table>
<tr><th>Switch</th><th>Name</th><th>Description</th></tr>
<tr><td>SW4-1</td><td>Creep speed</td><td>Used t0 set creep speed with orientation.
<table><tr><th>1</th><th>Creep speed</th></tr><tr><td>o</td><td>... 20 rpm</td></tr><tr><td>x</td><td>... 30 rpm</td></tr></table></td></tr>
<tr><td>SW4-2
~ 4</td><td>2nd decele-
ration point
range</td><td>Used to set the 2nd deceleration point range.
<table><tr><th>2</th><th>3</th><th>4</th><th>2nd deceleration point range</th></tr><tr><td>o</td><td>o</td><td>o</td><td>... 25 deg.</td></tr><tr><td>o</td><td>o</td><td>x</td><td>... 24 deg.</td></tr><tr><td>o</td><td>x</td><td>o</td><td>... 23 deg.</td></tr><tr><td>o</td><td>x</td><td>x</td><td>... 21 deg.</td></tr><tr><td>x</td><td>o</td><td>o</td><td>... 20 deg.</td></tr><tr><td>x</td><td>o</td><td>x</td><td>... 18 deg.</td></tr><tr><td>x</td><td>x</td><td>o</td><td>... 17 deg.</td></tr><tr><td>x</td><td>x</td><td>x</td><td>... 15 deg.</td></tr></table></td></tr>
<tr><td>SW4-5
~ 7</td><td>1st decele-
ration point
range</td><td>Used to set the 1st deceleration point range.
<table><tr><th>5</th><th>6</th><th>7</th><th>1st deceleration point range</th></tr><tr><td>o</td><td>o</td><td>o</td><td>... 225 deg.</td></tr><tr><td>o</td><td>o</td><td>x</td><td>... 214 deg.</td></tr><tr><td>o</td><td>x</td><td>o</td><td>... 203 deg.</td></tr><tr><td>o</td><td>x</td><td>x</td><td>... 191 deg.</td></tr><tr><td>x</td><td>o</td><td>o</td><td>... 180 deg.</td></tr><tr><td>x</td><td>o</td><td>x</td><td>... 169 deg.</td></tr><tr><td>x</td><td>x</td><td>o</td><td>... 158 deg.</td></tr><tr><td>x</td><td>x</td><td>x</td><td>... 146 deg.</td></tr></table></td></tr>
</table>

<table>
<tr><th>Switch</th><th>Name</th><th>Description</th></tr>
<tr><td>SW4-8</td><td>Encoder mounting direction</td><td>8
o .. Forward
x .. Reverse
Set to reverse position if high degree of hunting occurs with orientation stop.</td></tr>
<tr><td>SW5-1,2</td><td>Torque limit</td><td>Used when limiting motor torque,
External input
TL1 ... ON
TL2 ... OFF
TL1 ... OFF
TL2 ... ON
<table>
<tr><th>1</th><th>2</th><th>Torque limit</th></tr>
<tr><td>o</td><td>o</td><td>... 10%</td></tr>
<tr><td>o</td><td>x</td><td>... 15%</td></tr>
<tr><td>x</td><td>o</td><td>... 20%</td></tr>
<tr><td>x</td><td>x</td><td>... 25%</td></tr>
<tr><td>o</td><td>o</td><td>... 20%</td></tr>
<tr><td>o</td><td>x</td><td>... 30%</td></tr>
<tr><td>x</td><td>o</td><td>... 40%</td></tr>
<tr><td>x</td><td>x</td><td>... 50%</td></tr>
</table>
(Note) 30-minute rated torque is 100%.</td></tr>
</table>

Switch	Name	Description
SW5-3 ~ 5	Cushion time constant	Used to set the time constant of the maximum speed command from 0.

3	4	5	
o	o	o	... 0.3S
o	o	x	... 1.5S
o	x	o	... 3S
o	x	x	... 4S
x	o	o	... 5S
x	o	x	... 6S
x	x	o	... 8S
x	x	x	... 10S

3	4	5			
o	o	o	...	0.3S	1st cushion
o	o	x	...	1.5S	
o	x	o	...	1S	
o	x	x	...	2S	
x	o	o	...	0.3S	2nd cushion
x	o	x	...	0.6S	
x	x	o	...	1S	
x	x	x	...	2S	

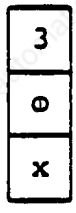
(Note) Adopted for the 2nd cushion is a system which limits the acceleration changes of the motor.

Switch	Name	Description
SW5-6 ~ 8	Speed detection range	Output transistors are activated when the speed is within the set motor speed range.

6	7	8			
o	o	o	...	2% or	below
o	o	x	...	10%	"
o	x	o	...	18%	"
o	x	x	...	26%	"
x	o	o	...	34%	"
x	o	x	...	42%	"
x	x	o	...	50%	"
x	x	x	...	58%	"

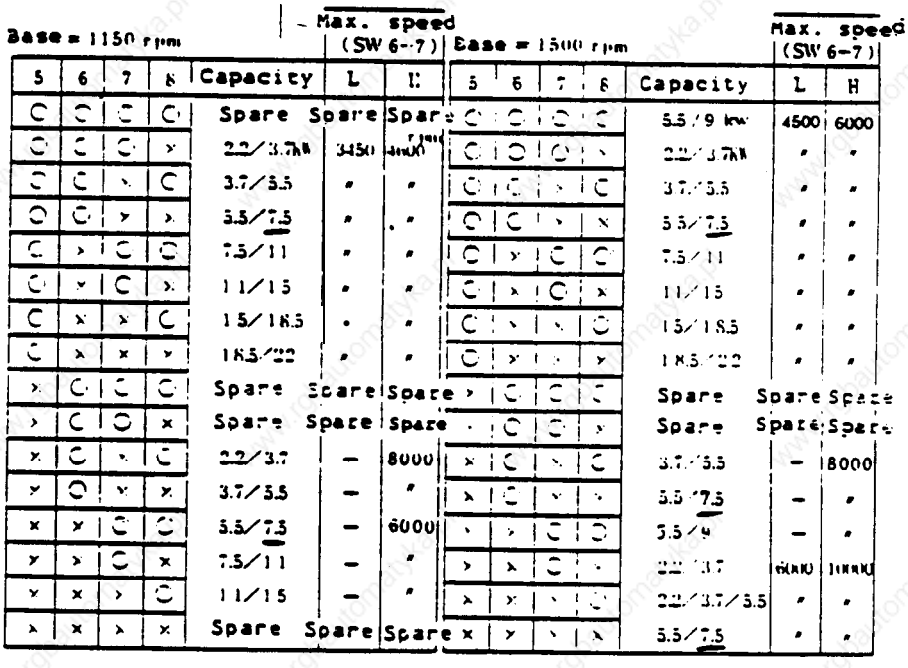
Speed detection range

Note: Maximum speed is 100%.

Switch	Name	Description
SW6-1	Normal/test	 ... Normal mode ...Test mode Normal mode is used for normal operation. Test position is used for orientation tests.
-2	Closed/open	 ... Closed loop ... **Open** loop Used for switching between open/closed speed loop. Used with closed loop for normal operation. Speed detector go/no go, etc. can be identified in the open and closed operation states.
SW6-3	**Binary/BCD**	 ... Speed command binary ... Speed command BCD Used to select digital speed command format. Speed command is read as binary 12-bit input for binary and as BCD 2-digit input for **BCD.**

Switch	Name	Description
SW6-4	Speed input emitter/ collector	4 o ... Speed input open emitter x .. Speed input open collector (Note) Refer to the settings of P59 101 card pins 2 and 3.
-5	Position input emitter/ collector	5 o ... Position input open emitter x ... Position input open collector (Note) Refer to the settings of P59 101 card pins 2 and 3.
-6	Meter calibration	6 o ... Meter OFF x ... Meter ON Used to calibrate speed meter and load meter full scale. In ON mode, the meter full scale voltage is output and so adjust speed meter (SM1, VR14 SE-101 card) and load meter (LM1, VR-15 SE-101 card) VRs.

Switch	Name	Description
SW6-7	Maximum speed	 ... Maximum speed LOW ... Maximum speed HIGH Used to switch the maximum speed (3450/4600, 4500/6000, 6000/10000 rpm) in accordance with the motor type setting.
-8	Zero speed	 ... Zero speed LOW (25 rpm) ... Zero speed HIGH (50 rpm) Zero speed is output at zero speed setting or below.
SW7-1	Servo rigidity selection	 ... Servo rigidity HIGH ... Servo rigidity LOW
-2	External emergency stop	 . . . LED ON with emergency stop . . LED OFF with emergency stop Used to select mode with alarm display or mode without alarm display in external emergency stop.

Switch	Name	Description
SW7-3	Load meter output	3 / o ... Load meter output HIGH (10V) x ... Load meter output LOW (3V) Used to select output voltage with 120% output.
-4	Base speed	4 / o ... 1150 rpm base speed x ... 1500 rpm base speed Used to select base speed of applicable motor.
SW7-5 ~ 8	Motor type	

Base = 1150 rpm					Max. speed (SW 6-7)	
5	6	7	8	Capacity	L	H
○	○	○	○	Spare	Spare	Spare
○	○	○	×	2.2/3.7kW	3450 rpm	4000 rpm
○	○	×	○	3.7/5.5	"	"
○	○	×	×	5.5/7.5	"	"
○	×	○	○	7.5/11	"	"
○	×	○	×	11/15	"	"
○	×	×	○	15/18.5	"	"
○	×	×	×	18.5/22	"	"
×	○	○	○	Spare	Spare	Spare
×	○	○	×	Spare	Spare	Spare
×	○	×	○	2.2/3.7	—	8000
×	○	×	×	3.7/5.5	—	"
×	×	○	○	5.5/7.5	—	6000
×	×	○	×	7.5/11	—	"
×	×	×	○	11/15	—	"
×	×	×	×	Spare	Spare	Spare

Base = 1500 rpm					Max. speed (SW 6-7)	
5	6	7	8	Capacity	L	H
○	○	○	○	5.5/9 kw	4500	6000
○	○	○	×	2.2/3.7kW	"	"
○	○	×	○	3.7/5.5	"	"
○	○	×	×	5.5/7.5	"	"
○	×	○	○	7.5/11	"	"
○	×	○	×	11/15	"	"
○	×	×	○	15/18.5	"	"
○	×	×	×	18.5/22	"	"
×	○	○	○	Spare	Spare	Spare
×	○	○	×	Spare	Spare	Spare
×	○	×	○	3.7/5.5	—	8000
×	○	×	×	5.5/7.5	—	"
×	×	○	○	5.5/9	—	"
×	×	○	×	2.2/3.7	6000	10000
×	×	×	○	2.2/3.7/5.5	"	"
×	×	×	×	5.5/7.5	"	"

Select the compatible motor in combination with the selection of the maximum speed (SW6-7) and of the base speed (SW7-4).

Switch	Name	Description
SW8	Speed control loop Proportional constant..K_P	

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_c	25	34	44	53	63	72	81	91	100	120	140	160	180	200	220	240

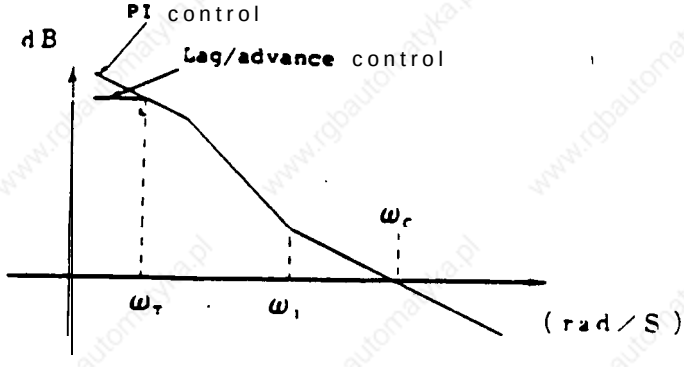
(rad/S)

SW9	Speed control loop Integral constant..K_I

Notch	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭
Magnification	8/32	11/32	14/32	17/32	20/32	23/32	26/32	29/32	1	1.2	1.4	1.6	1.8	2	2.2	2.4
ω_1	1.5	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4

(rad/S)

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



Standard settings: notch 4 for both SW8 and SW9.

Switch	Name	Description
SW10	Orientation speed setting	Notch / Orientation Speed rpm: 0 = 20; 1 = 40; 2 = 60; 3 = 80; 4 = 100; 5 = 120; 6 = 140; 7 = 160; 8 = 180; 9 = 200; A = 220; B = 240; C = 260; D = 280; E = 300; F = 320 Speeds on left are spindle speeds. Motor speed depends on gear ratio. When there is a tendency toward overshooting with orientation, reduce and adjust the orientation speed using this switch.

SW11- 1,2	Orientation rotation direction	1 2 0 0 ··· Pre mode Orient from previous motor rotation direction 0 X ··· Reverse mode Motor reverse rotat'ion direction orientation X 0 ··· Forward mode Motor forward rotation direction orientation X X ··· Spare
-3,4	Control with orientation stop	3 4 0 0 ··· PI control (Normal Select) 0 X X 0 ··· Delay/advance control W_T = 1.17 rad/sec X X " = 0.78 rad/sec " = 0.39 rad/sec Enables delay/advance control when servo rigidity is to be increased with orientation stop.

Switch	Name	Description
SW12	Encoder orientation in-position range	Used to set position error range in which orientation finish signal is output. Since a single spindle rotation is divided into 4096 parts: Error range = 360 deg. x $\frac{\text{set value}}{4096}$ Standard notch A setting

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

Switch	Name	Description
SW13 **SW14** **SW15**	**Orientation,** **Position** **Shift**	**SW13 0 - F x 256** 22.5° **SW14 0 - F x 16, 12 bit binary** 1.4° **SW15 0 - F x 1** .088° **Position** shift = **360** deg. x $\frac{\text{set value}}{4096}$ Least increment = 360 deg. x $\frac{1}{4096}$ = 0.09 Set for stopping at prescribed orientation position with encoder mounting. Position will not shift even when **selected** during orientation stop and so **re-orientation**

(3) List of pushbutton switches

No.	Name	Description
ST1	Reset	Press the ST1 switch when the inverter operation is to be initialized totally and when the DIP switches and other settings have been reset. Do not set the switch while the motor is operating. If it is reset while the motor is operating, the motor *free-runs* and then stops.
ST2	Orientation test	Motor operates at motor orientation speed while this switch is ON. When OFF, orientation is performed once and then motor stops. (Note) This is effective only when SW6-1 is OFF.

Setting pins

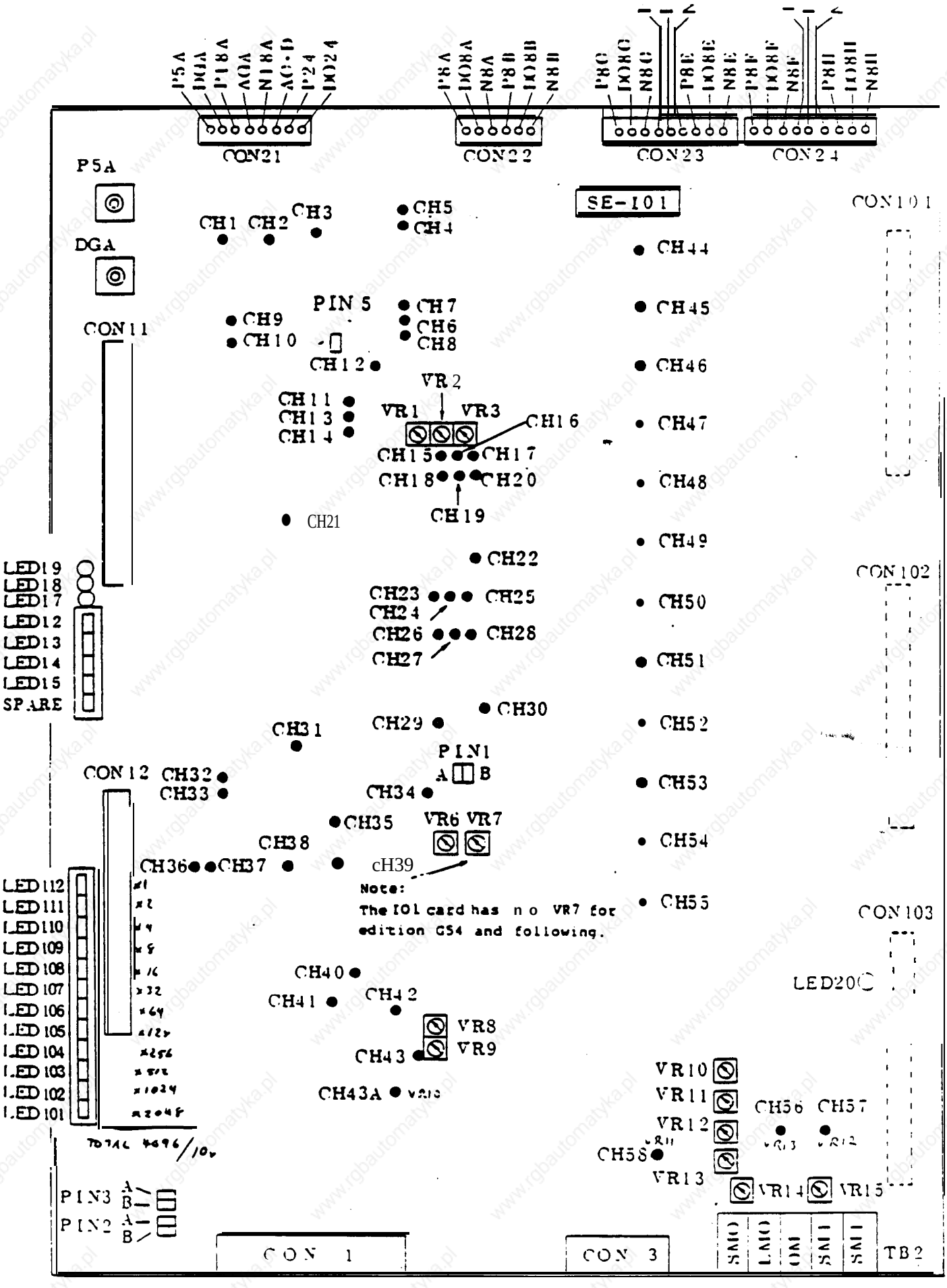
Note: ▩ **denotes** that pin is **inserted.**

▯ **denotes** that pin is removed.

No.	Name	Description
PIN 11	**Orientation** encoder power **supply**	C1 **Supply from NC Yes** — PIN11 ▯ — SPARE PIN ▩ C2 **Supply from NC No** — PIN11 ▩ — SPARE PIN ▯
PIN 12 13	**Orientation position inter-** face setting	B1 **Source drive (open emitter)** — PIN12 D ▯ C — PIN13 B ▩ A B2 **Sink drive (open collector)** — PIN12 D ▩ C — PIN13 B ▯ A (Note) With reference **to page** 3 1 and 47 set **SW6-5** also at the **same time.**

(5) List of check pins

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


CON21
CON22
CON23
CON24
P5A
DGA
CON11
SE-101
CON101
CON102
CON103
CON12
PIN5
PIN1
PIN3
PIN2
VR1
VR2
VR3
VR6
VR7
VR8
VR9
VR10
VR11
VR12
VR13
VR14
VR15
LED19
LED18
LED17
LED12
LED13
LED14
LED15
SPARE
LED112
LED111
LED110
LED109
LED108
LED107
LED106
LED105
LED104
LED103
LED102
LED101
LED20
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH10
CH11
CH12
CH13
CH14
CH15
CH16
CH17
CH18
CH19
CH20
CH21
CH22
CH23
CH24
CH25
CH26
CH27
CH28
CH29
CH30
CH31
CH32
CH33
CH34
CH35
CH36
CH37
CH38
cH39
CH40
CH41
CH42
CH43
CH43A
CH44
CH45
CH46
CH47
CH48
CH49
CH50
CH51
CH52
CH53
CH54
CH55
CH56
CH57
CH58
Note:
The IO1 card has no VR7 for edition G54 and following.
CON 1
CON 3
TB2

(1) List of LEDs

No.	Symbo	Description
LED 1; LED 1: LED 14 LED 1:	AL 8 4 2 1	Refer to separate sheet for details on fault code displays.
LED 17		Indicates undervoltage. Liqhts with voltage drop of less than 170V or more than 15 ms.
LED 18		Lights with converter regeneration.
LED 19		Lights with base cut-off of inverter, converter transistors.
LED 20		Lights with converter voltage charging.
LED112 ~ LED 101		Speed command display 12 bit binary

(2) List of setting pins

No.	Name	Description
PIN 1	Speed setting	Max. speed setting: HH 10000 8000 (RPM) PIN1 A B SPARE PIN; H 6000 4600 (RPM) PIN1 A B SPARE PIN; L 4500 3450 (RPM) PIN1 A B SPARE PIN
'PIN 2 3	Digital speed command inter-face setting	A1 Source drive (open emitter) PIN3 A B PIN2 C D A2 Sink drive (open collector) PIN3 A B PIN2 C D Refer to pages 30 and 47, and set these pins at the same time as SW6-4.

(3) Alarm signals

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

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

No.	Output AL6 LED12	AL4 LED13	AL2 LED14	AL1 LED15	Alarm signal significance	Details	Reset method
1	0	0	0	1	Motor over heating	This is detected when the temperature inside the motor has exceeded the prescribed level.	Alarm reset PB after motor has cooled OFF.
2	0	0	1	0	Excessive speed error	This is detected when the motor speed differs greatly from the command value.	After the motor has stopped, eliminate the cause and use alarm reset or reset PB.
3	0	0	1	1	(Spare)		
4	0	1	0	0	Breaker trip	This signal is output when an abnormal current flows to the input and the breaker trips.	
5	0	1	0	1	Phase loss	This detects phase loss in the input with resetting and power switch an.	
6	0	1	1	0	Emergency stop	This indicates that the emergency stop pushbutton on the external control panel is ON.	External emergency stop PB to OFF
7	0	1	1	1	Over speed	This occurs when the motor speed exceeds 115% of its rated speed.	
8	1	0	0	0	Converter over-current	This detects an over-currant in the converter.	
9	1	0	0	1	Controller over-heating	Overheating is detected when the temperature of the heat sinks OC the semiconductors, the ambient temperature etc. is abnormally high.	
10	1	0	1	0	Under voltage detection	This detects that the input voltage is more than 15ms and less than 170 V.	
11	1	0	1	1	over voltage detection	hi8 detects that the converter's DC voltage is abnormally high.	
12	1	1	0	0	Inverter over-current	This detects an over-current in the inverter.	
13	1	1	0	1	CPU fault 1	Microcomputer fault	
14	1	1	1	0	2		
15	1	1	1	1	3		

(4) List of check pins

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

CH26	DGA	Phase S, base amplifier drive signal
CH27	DCA	Phase R, base amplifier drive signal
CH28	DGA	Phase T, base amplifier drive signal
CH29	AGA	Trouble detection level
CH30	AGA	Inverter side, phases U, V, W, full-wave rectification waveforms
CH31	AGA	Override command
CH32	AGA	-10V, reference voltage
CH33	AGA	+10V, reference voltage
CH34	AGA	Speed meter output
CH35	DGA	Regenerative converter, overcurrent level: Low
CH36	DCA	'Speed arrival signal
CH37	DCA	Zero speed signal
CH37A	DGA	Orientation finish
CH38	DCA	Regenerative side current limiting: high while limiting
CH39	DGA	Regenerative side current limiting
CH40		
CH41	AGA	Analog speed command input, max. speed at +10V
CH42	AGA	Converter voltage, 10V at 400V
CH43	AGA	Supply voltage, peak rectification
CH43A	AGA	Regenerative side converter current
CH44	Non insulated D08F	Inverter side base amplifier output, phase U
CH45	Non insulated D08G	fnverter side base amplifier output, phase V
CH46	Non insulated D08H	Inverter side base amplifier output, phase W
CH47	Non insulated D08A	Inverter side base amplifier output, phase $\overline{U}$
CH48	Non insulated D08A	Inverter side base amplifier output, phase $\overline{V}$

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

(5) List of VRs

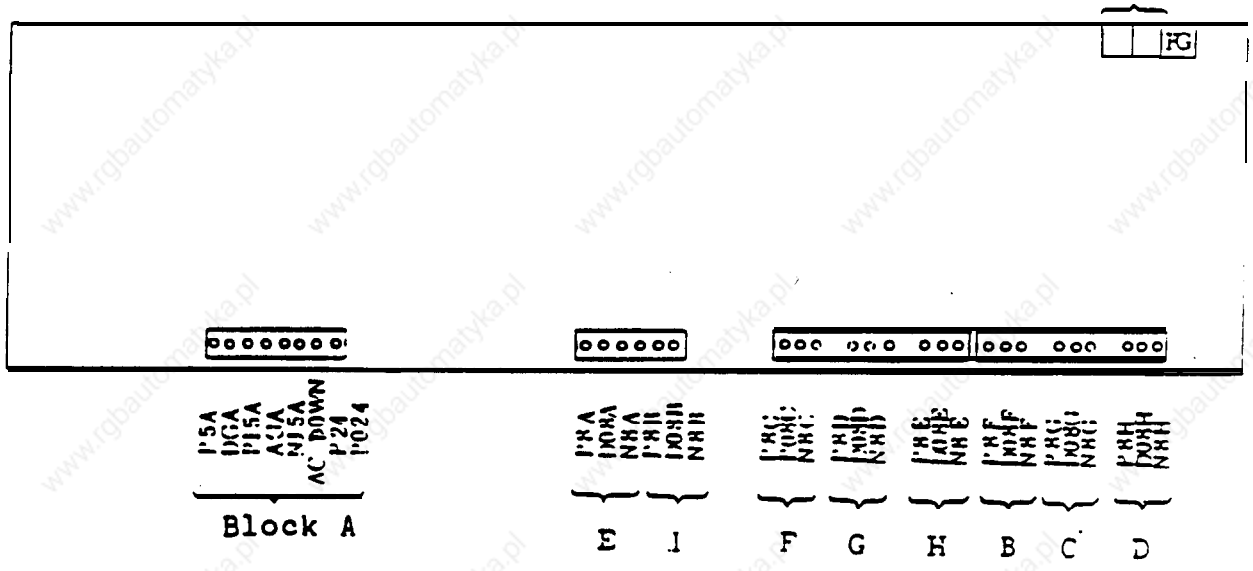
No.	Description
VR1	Phase W, current command zero adjustment
VR2	Phase V, current command zero adjustment
VR3	Phase U, current command zero adjustment
VR5	+/-10V, reference power supply (Note 1)
VR6	Over-speed level adjustment, corresponding to PIN1-A (Note 2)
VR7	Over-speed level adjustment, corresponding to PIN1-B (Note 1)
VR8	Converter voltage gain adjustment,
VR9	Supply voltage beak value gain adjustment
VR10	Regenerative converter current zero adjustment, CH43A
VR11	Converter DC current zero adjustment, CH58
VR12	Inverter side, phase V, current feedback zero adjustment, CH57
VR13	Inverter side, phase U, current feedback zero adjustment, CH56
VR14	Speed meter adjustment
VR15	Load meter adjustment

Note 1: Starting with edition G54, VR5 and VR7 have been discontinued on the IO1 card.

Note 2: Over-speed is adjusted by VR6 and PIN1-A and B.

5.4 SE-PW

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



Notes:

(1) Notethatexcept for block A no insulation is provided with the main circuitry..

(2) Line 0 in block A is connected.

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

CHAPTER 6 ORIENTATION POSITION DETECTOR MOUNTING PROCEDURE

6.1 MAGNETIC SENSOR TYPE OF SINGLE POINT ORIENTATION

(SE-CPU1 card is used)

6.1.1 MAGNET AND SENSOR OPERATION .

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

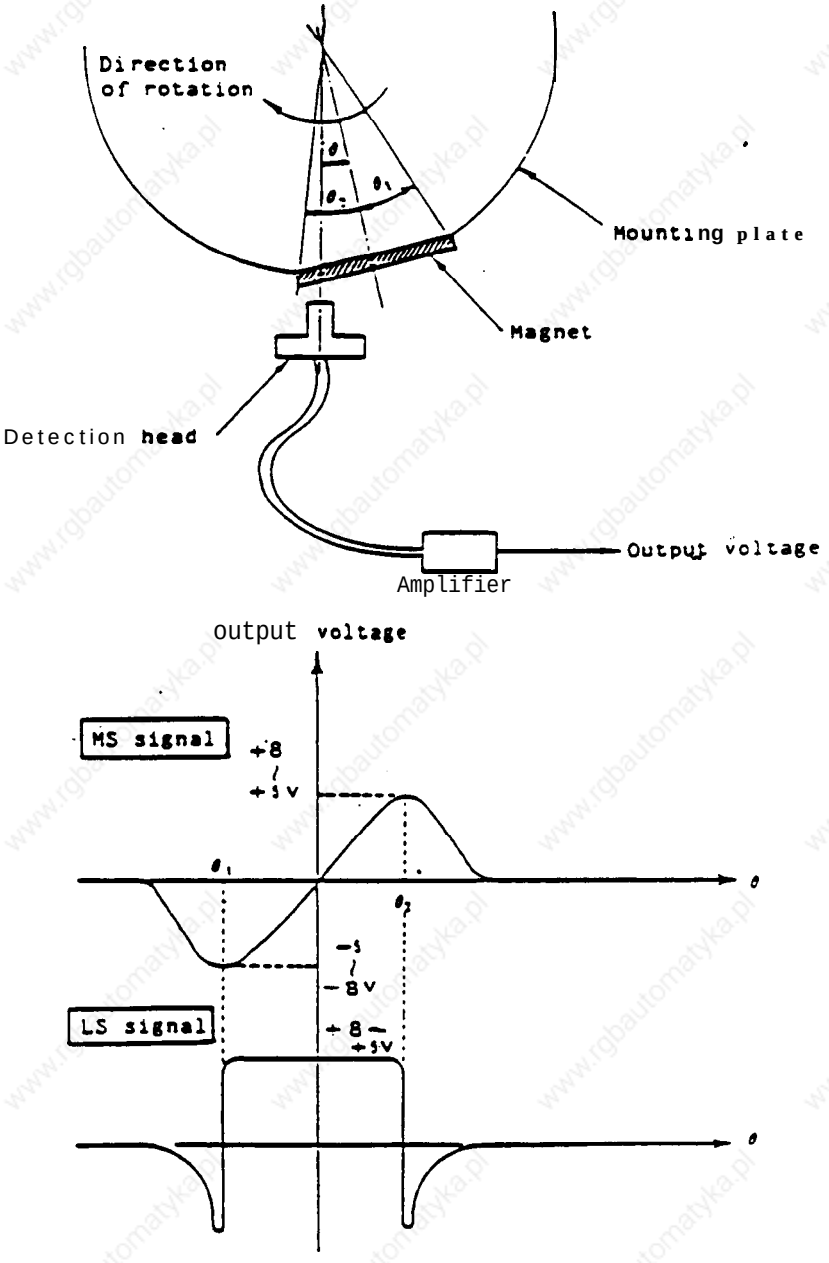


Fig. 6.1 Sensor output voltages

MS signal

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

LS signal

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

6.1.2 TIME CHART

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

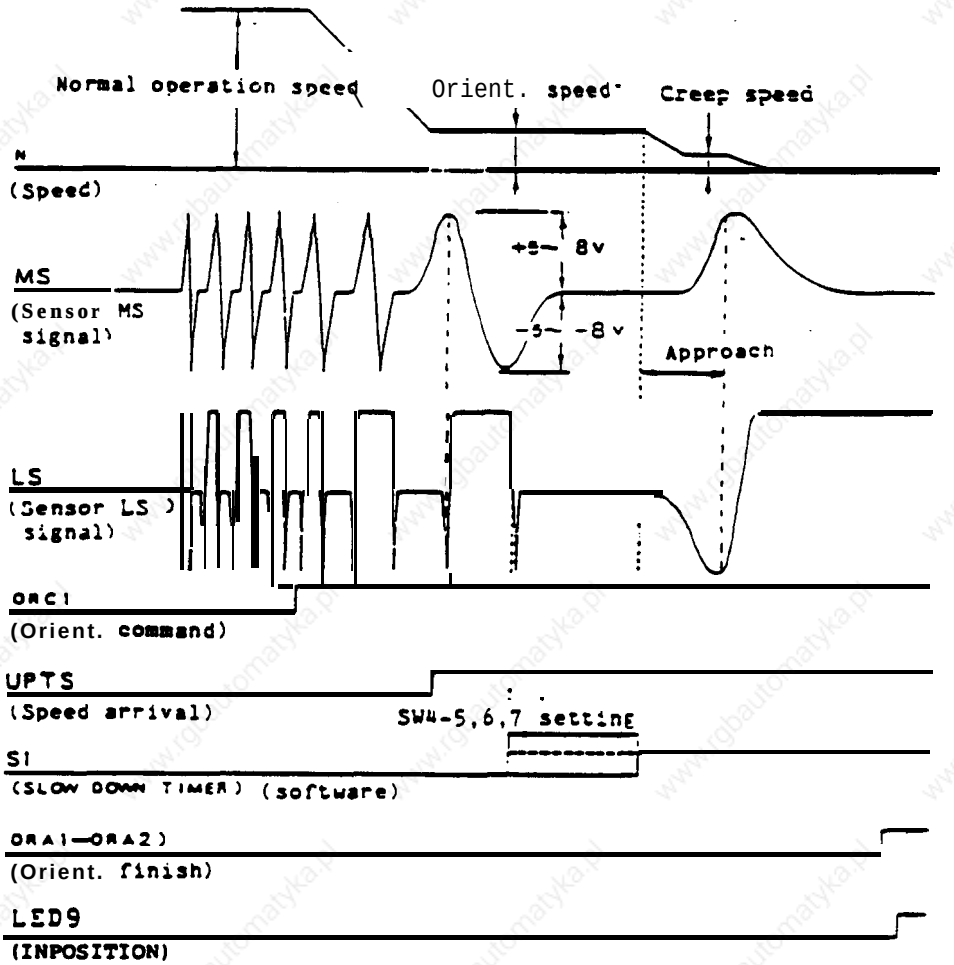


Fig.6.2 Time chart

(1) When the **ORC1** (orientation signal) is set ON, the motor speed is switched **over** from the normal operation speed to the orientation speed.

(2) When the motor speed arrives at'the orientation speed, the speed arrival **signal** rises.

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

(4) The slowdown timer is set by **SW4-5,6,7.**
When the timer counts up, a switch is made from the orientation speed to the creep **speed.** (1st deceleration point)

(5) At the creep speed, a switch is made to the position loop by the timing at which the LS signal has risen to the high "level. (2nd **deceleration** point)

(6) The sensor **MS** signal stops at the OV position due to the position loop control.

(7) The orientation finish signal rises at the target position and **ORA1-ORA2** are set to closed.

6.1.3 MAGNET AND DETECTION HEAD MOUNTING DIRECTIONS

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

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

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

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

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

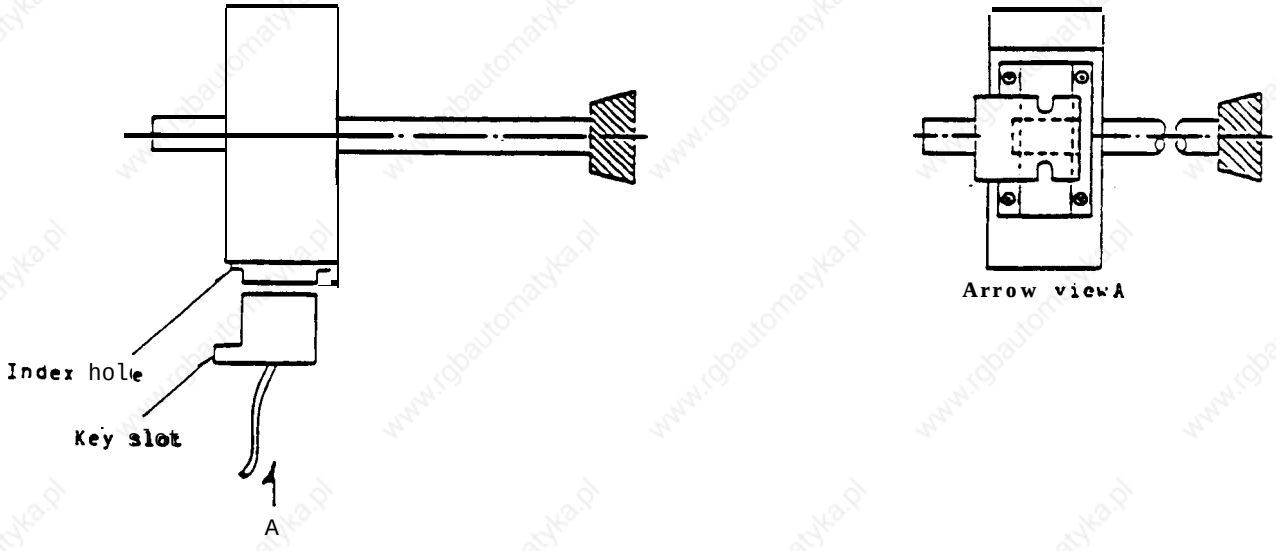


Fig. 6.3 Mounting onto the circumference of a rotating body

Case 2 Mounting the magnetontothe flat surface of a rotating body

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

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

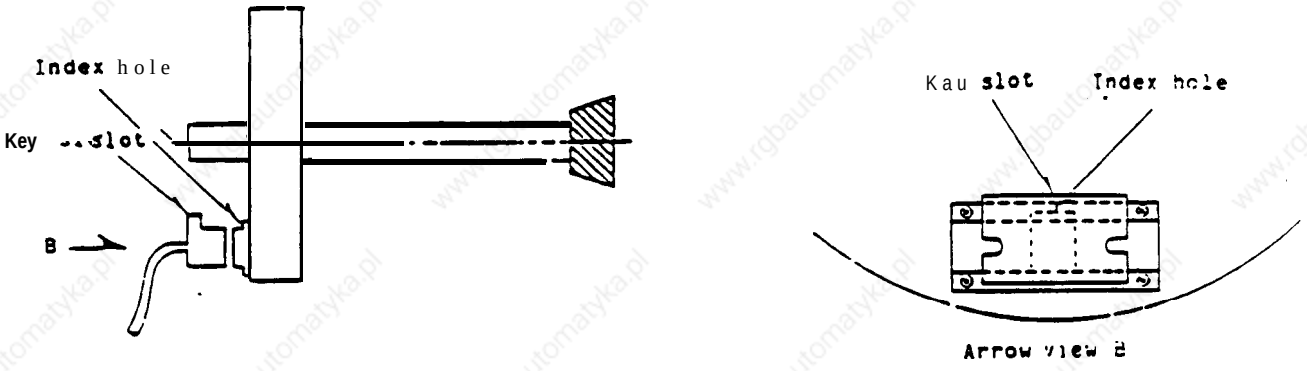


Fig. 6.4 Mounting onto a flat surface oh the non-load side of the rotating body

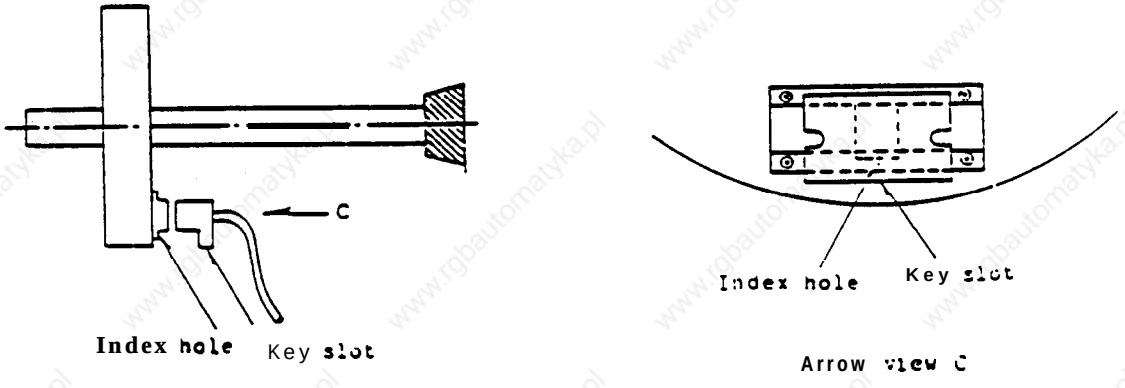


Fig. 6.5 Mounting onto a flat surface on the load side of the rotating body

Notes

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

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

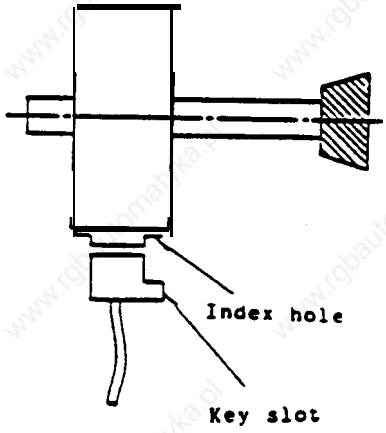


Fig. 6.6

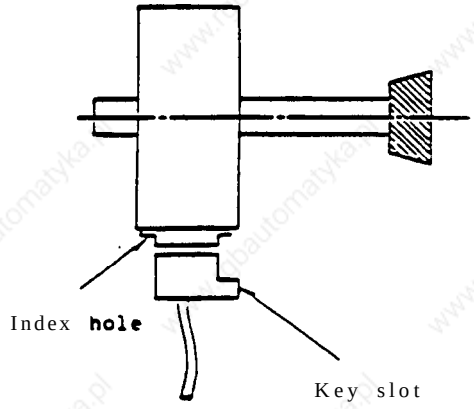


Fig. 6.7

6.1.4 CHECKPOINTS WHEN MOUNTING MAGNET

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

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

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

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

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

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

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

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

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

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

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

6.1.5 CHECKPOINTS WHEN MOUNTING SENSOR

Bear in mind the following points when mounting the sensor.

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

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

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

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

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

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

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

Table 1

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

Table 2

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

Fig.6.8 Mounting the detector

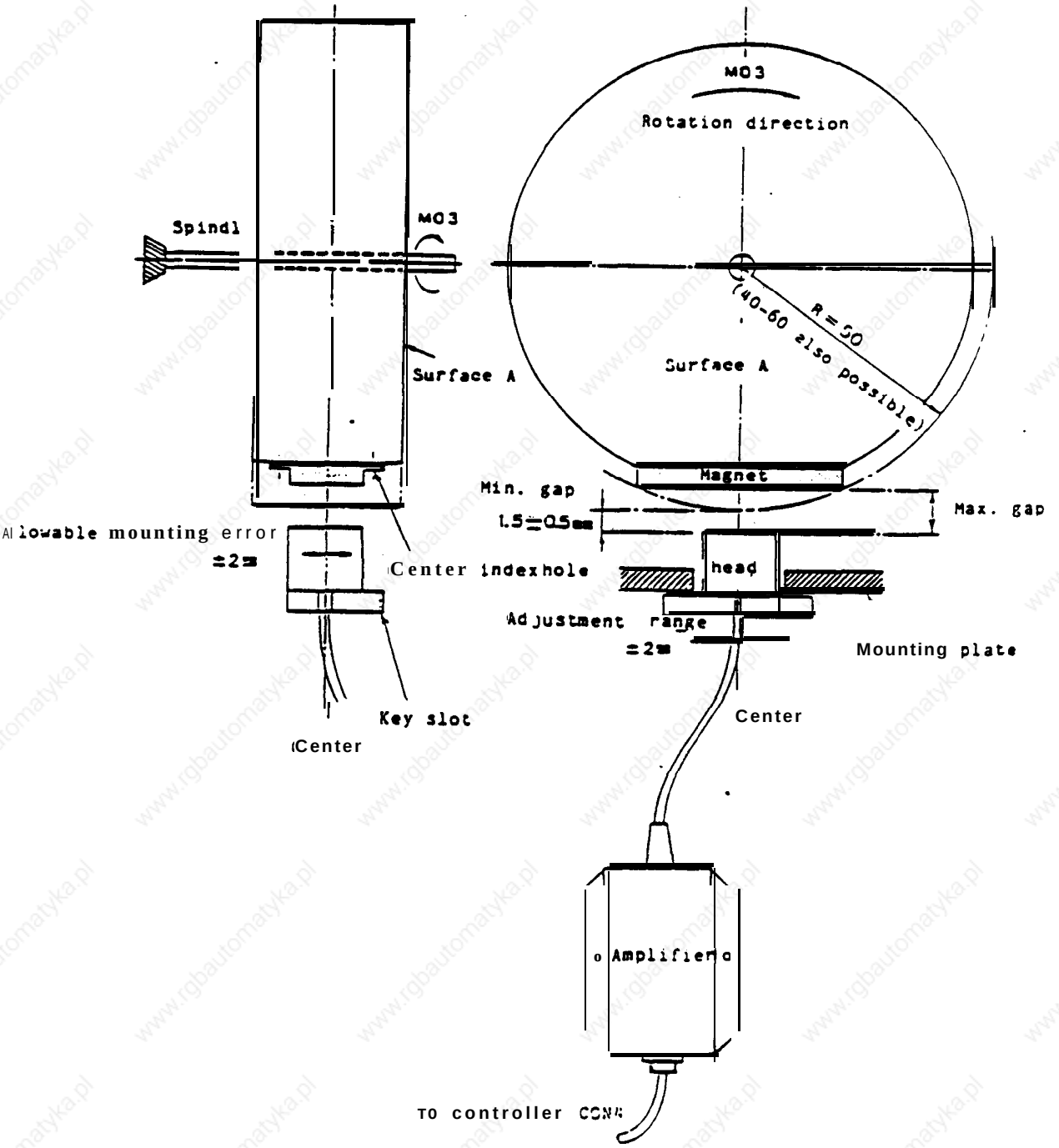
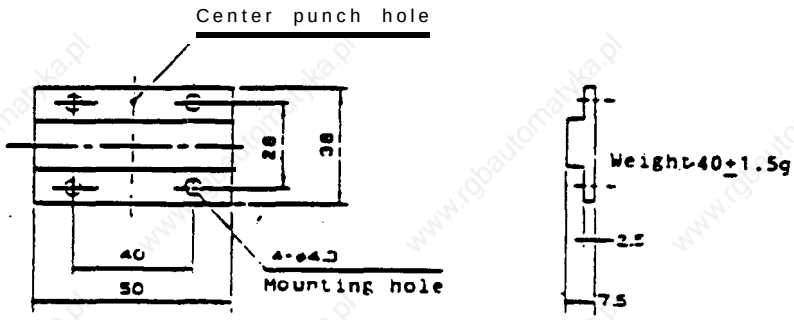


Fig. 6.8 Mounting the detector

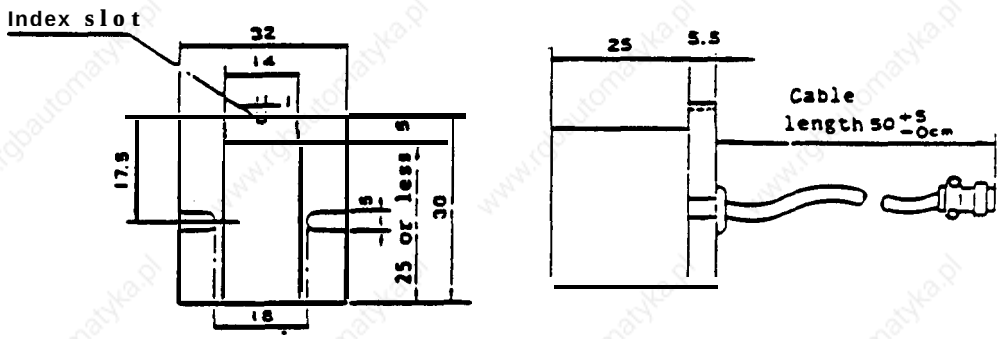
6.1.6 EXTERNAL VIEWS

3.1 Magnetic sensor

(1) Magnet



(2) Detection head



(3) Amplifier

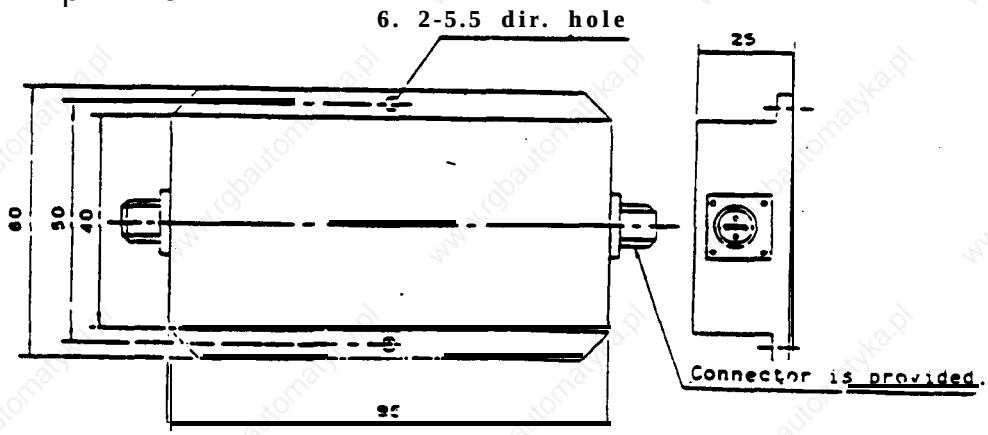


Fig. 6.9

6.2 ENCODER TYPE OF MULTIPLE POINT ORIENTATION(SE-CPU2 card is used)

6.2.1 DESCRIPTION OF OPERATION

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

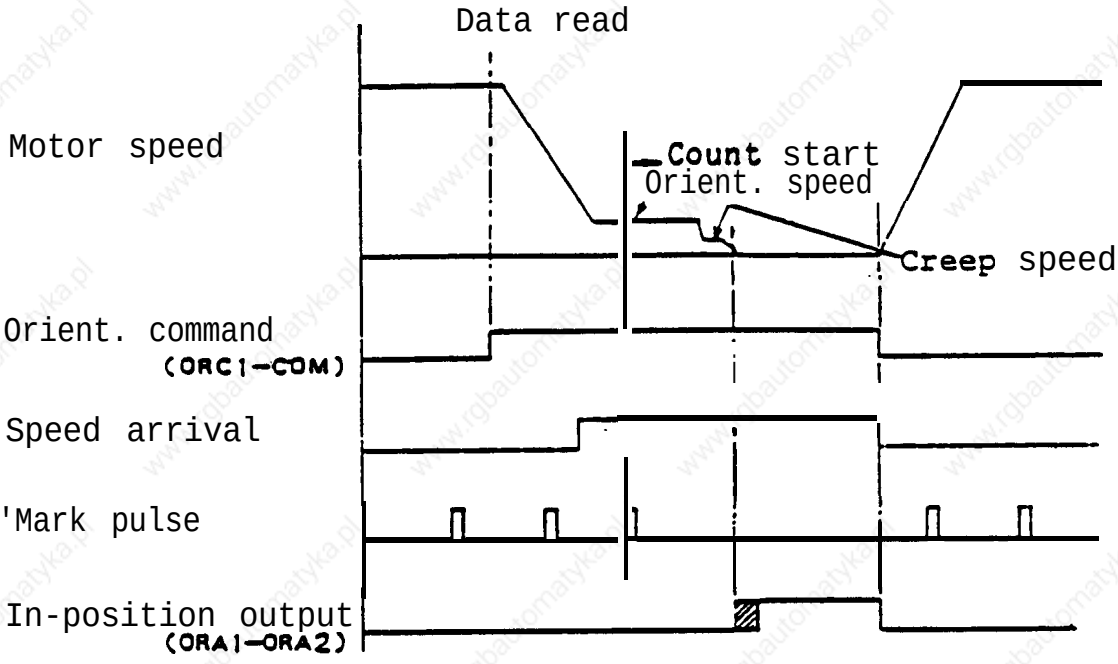


Fig. 6.10 Time chart

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

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

(3) When the mark pulse is input from the encoder after the speed arrival signal has risen, the orientation position count given in 12-bit binary code from the external source starts.

(4) When the value (1st deceleration point) set by SW4-5, 6 and 7 from the target point is reached,. the motor speed switches from the orientation speed to the creep speed.

(5) A switch, is made to the position loop at the value (2nd deceleration point) set by SW4-2, 3 and 4 from the target point, the motor starts decelerating and it stops at the target point.

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

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

(8) When re-orientationing from the orientation mode, the spindle rotates once and orientation is performed,. Depending on the settings of SW13, SW14 and SW15 for position adjustment and on the orientation position given externally, the spindle will rotate more than once.

6.2.2 CONFIGURATION

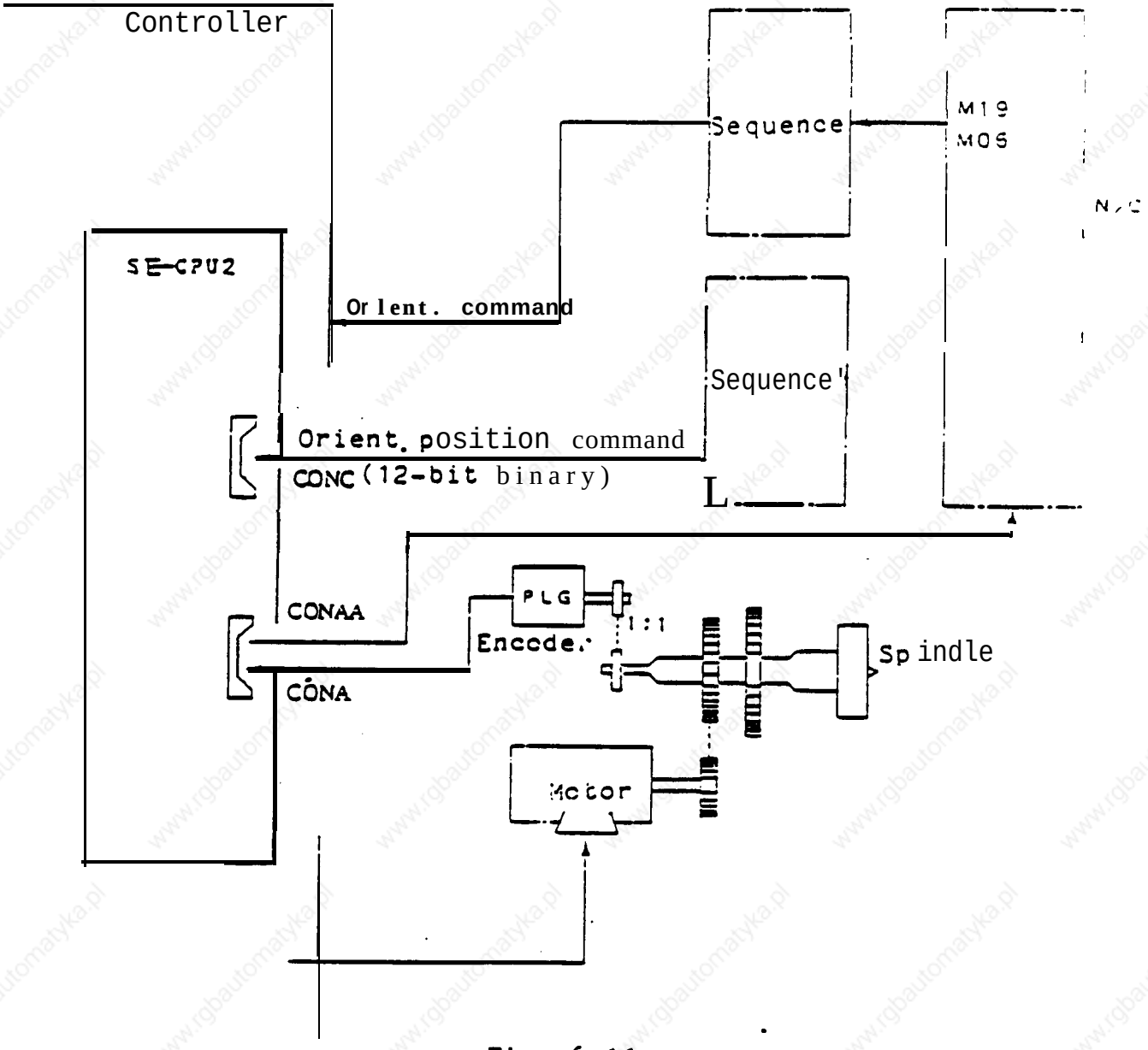
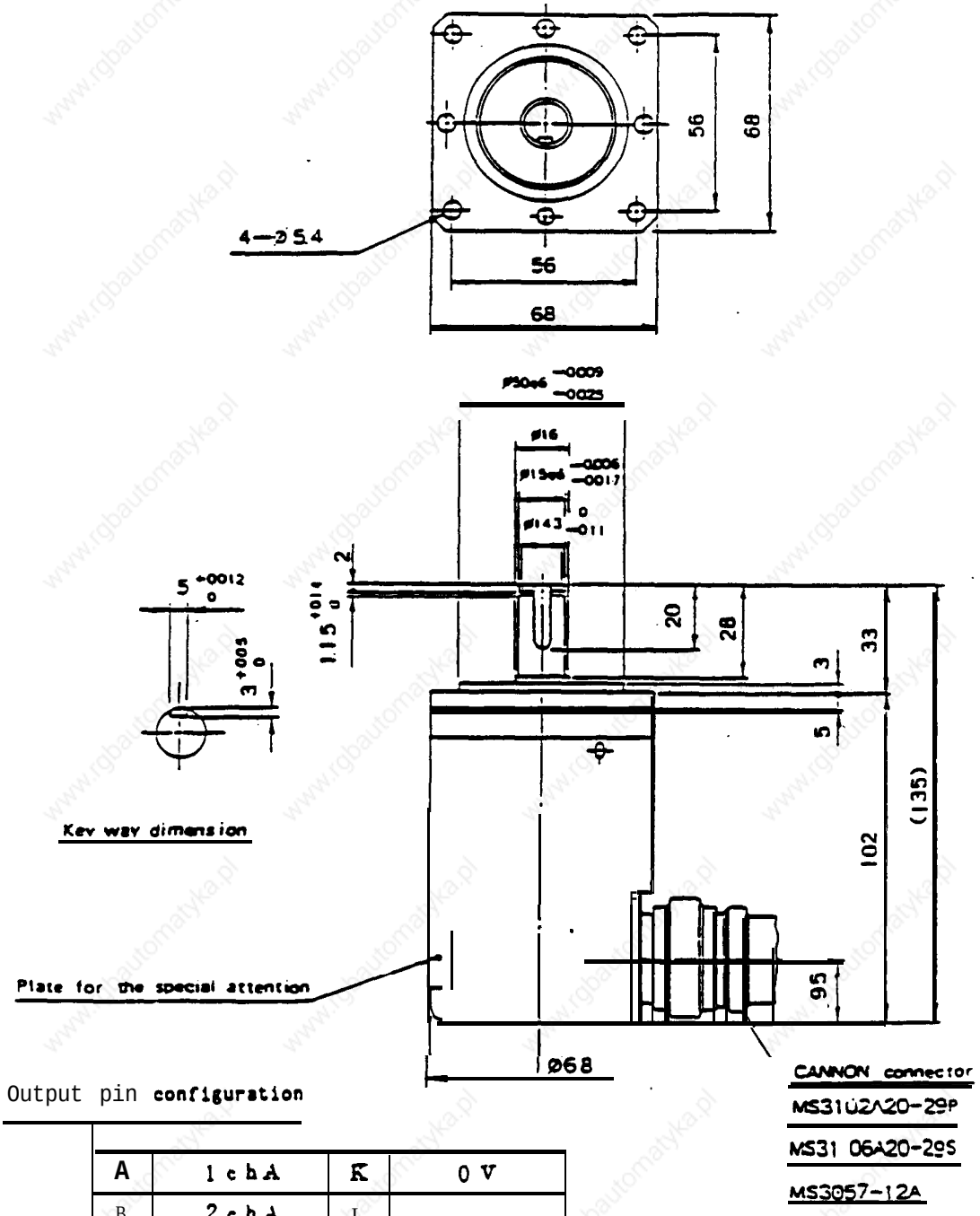


Fig. 6.11

Note: When the motor rotation direction and encoder rotation direction differ, make the adjustment using DIP switch SW4--8 on SE-CPU2.

6.2.3 ENCODER DIMENSIONS



Output pin configuration

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

(Cable connector is not supplied.)

• Reverse rotation signal

Fig. 6.12

CHAPTER 7 TROUBLESHOOTING

7.1 INTRODUCTION

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

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

Checkpoints when trouble occurs

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

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

(3) Does the trouble or failure recur?

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

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

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

(7) Was there a momentary power failure?

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

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

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

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

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

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

7.2 'STEP 1

Check the following points as the first step in troubleshooting.

(1) Supply voltage:

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

The power supply should not be allowed to fall below 200V -101 even for short periods of time.

Examples: Voltage drops at certain times every day.
Voltage drops when certain machines are started.

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

Examples: Anything-wrong with NC, sequence circuitry?
Visually inspect parts, connections for trouble.

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

(4) Anything wrong with exterior of controller?

Examples: Card parts, pattern burnouts, trouble, etc.
Loose connections, damage, foreign matter.

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

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

Trouble group A

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

- The controller has been operating properly to date but has suddenly ceased to do so (II)
- The controller does not operate properly from time to time, the orientation stop position shifts and the fault lamp lights (III).

Trouble group B

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

7.3 STEP 2

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

		armature wiring.
	5 OK if only motor operates.	5 Re-check that load corresponds to design value.
	6 Irregular operation with orientation stop. only. (overshoot, etc.)	6 Re-adjustment required.
	7 Controller fault LEDs light: AL8, AL4, AL2, AL1 (LED12) (LED13) (LED14) (LED15)	Refer to Section 7.4.

Note 1: The start signal CW and CCW inputs must be set ON after the READY signal and speed command have been supplied.

Trouble group II	Checkpoints	Remedy
Controller has been operating properly to datt but **has suddenly ceased to do so.**	1 Check for blown fuses, main' circuitry no-fuse breaker tripping.	I Replace any blown. fuses; if fuse blows even after replacement, check under step 3.
	2 Check input power. **AC200V +/-10%, 50/60Hz AC200-230V +/-10%, 60H**	: Reset to normal value if incorrect. Make available power supply so that voltage **on** left is maintained even in transient state.
	3 Controller fault **LEDs** light: **AL8, AL4**, AL2, **AL1 (LED12) (LED13) (LED14) (LED15)**	**Refer** to Section 7.4.
	4 Input signal from NC **or** sequencer OK? LED2 (READY) lights in ready state; LED3 **(CW)** lights with forward **rotation;** LED4 (CCW) lights with reverse **rotation.**	Restore external input to normal.
		; If operation possible, trouble lies

Trouble group II	Check points	Remedy
	Check whether open operation is possible with SW6-2 OFF (open), SWS-3, 4 and 5 OFF and reset PB ON.	in speed feedback encoder. Try replacing encoder. If operation is still disabled, trouble lies in main circuitry: Fault display LED will lights.

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

7.4 SYMPTOMS AND REMEDIES

1. When the fault display LEDs light

The trouble code activated the fastest indicates the trouble. (1 signifies "ON" or lights and 0 "OFF" or goes out.)

(1) MOTOR OVER HEAT

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

OHS1 and OHS2 are not activated.

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

(2) EXCESSIVE SPEED ERROR

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

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

Trouble	Checkpoints	Remedy
Overloading	Motor load	Reduce load.
Speed detec-	Is open operation possible?	Replace-encoder.

tion encoder trouble	sible	1
Card trouble	1 SE-CPU1 or SE-101 card trouble	1 Replacement sequence: CPU 1, 2 → 101

(3) BREAKER TRIP

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

Lights when main input NFB is tripped.

IOC (converter/inverter) LED may light first.

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

(4) PHASE LOSS

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

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

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

(5) EXTERNAL EMERGENCY

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

When SW7-2 is ON

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

When SW7-2 is OFF

External emergency stop lamp does not light.

(6) OVER SPEED

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

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

Trouble	Checkpoints	Remedy
Incorrect max. speed setting	Check SE-101 PIN1 settings and SE-CPU SW7-4~8/SW6-7 settings.	Reset if incorrect.
Speed detector trouble	Check encoder output frequency: CH59, CH62 on CPU2 card CH60, CH57 on CPU1 card	Replace detector. $\frac{256 \times 1500}{60}$ at 1500 rpm = 6.4 kHz
Speed detector command circuit trouble	Defective card	Replacement sequence: CPU1, 2 → 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

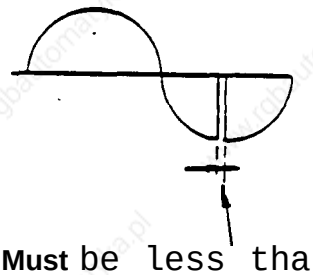
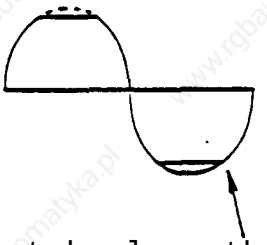
IOC tripping can occur at the inverter or converter side. Overcurrent is denoted when either LED lights.

The main circuitry semiconductors may be damaged when the IOC fault recurs even after resetting.

Trouble	Checkpoints	Remedy
Damage to power transistors	Disconnect connection between controller and motor and operate controller alone. Does IOC trip light? o If it lights, power transistors are damaged. o If it does not light, advance to following checks.	Replace power transistors.
High motor load	Check motor load.	Reduce load.
Faulty motor connections	Check wires around motor. Inspect for looseness in terminal screws.	Correct wiring if it has been connected incorrectly.

Trouble	Checkpoints	Remedy
Grounding or shorting of motor winding	**Measure** with megger; motor is **defective** if less than 1 Mohm.	Replace motor.
Incorrect power supply **capacity**	Must be 180V or more even under load conditions during **acceleration/deceleration.**	Increase power capacity.

Toc 1

Trouble	*Checkpoints	Remedy
Abnormal supply voltage waveforms	Observe supply voltage waveforms with synchroscope and check that they are normal during acceleration and deceleration. 1 When there is a partial drop  Must be less than 100μs 2 When the peak value drops  Must be less than 2-3%	Eliminate waveform distortion 1 Increase capacity or increase power cable size. 2 Improve other semiconductor unit in which waveform distortion occurs.
Abnormal power frequency	Must not change more than +/-3% of prescribed frequency.	Improve frequency fluctuations.
Defective current detector circuit	Inverter CH30-AGA Trouble at 10V peak Converter CH43A-AGA Trouble at 4.5V peak.	Replace SE-101 card.

(8) CONTROLLER OVER HEAT

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

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

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

(9) UNDERVOLTAGE

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

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

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

(10) OVERVOLTAGE (CONVERTER)

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

This LED lights when the voltage of the internal smoothing capacitor has risen above the allowable value.

Trouble	Checkpoints	Remedy
High power impedance		Increase power capacity.
Momentary drop or momentary power failure during deceleration	Check if LED17 has come on.	Reset and then observe state.
Detector circuit trouble	When above cases do not apply, fault may lie in detector circuit.	Replace SE-101 card.

(11) Trouble in CPU

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

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

When LEDs 12 through 15 on the IO1 card do not light with resetting, the CPU card is faulty. Cards CPU1 and 2 must be replaced.

2. **When the fault** display lamps do not light

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

Trouble	Checkpoints	Remedy
Incorrect connections or disconnection	Check wiring and inspect for disconnections.	Wire properly.
Incorrect input voltage	200V, 50Hz/200-230V, 60Hz for all3 phases?	Return power supply to normal.
Incorrect DC power	Check all output voltages of cards and SE-PW with multimeter.	Replace if defective.
Defective card	Set SW6-2 to OFF (normally ON), establish open mode and increase command speed. Are reference sine waves produced? SE-101 card CHS-AGA U CH4-AGA V	If trouble is found: replace cards starting with SE-101 card finishing with SE-CPU card.
External emergency stop or reset signal input	Check if LED19 has lighted.	Check connections.

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

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

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

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

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

(4) Insufficient torque

Inspect as indicated in (1), (2) and (5).

(5) Motor takes longer to start.

Trouble	Checkpoints	Remedy
Increased load	Check load.	Reduce load.

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

Trouble	Checkpoints	Remedy
SE-101 card output circuit failure	Does LED7 on SE-CPU light upon completion of acceleration/deceleration?	Replace SE-101 card.
Failure in speed arrival detector circuit	LED7 (UP TO SPEED) on SE-CPU card does not light.	SE-CPU card failure if otherwise normal

		operation; replace card.

(7) No NC feed operation

This is caused by the failure of the UP TO SPEED signal to operate. Inspect in the same way as for the relay sequence and (6).

(8) No speed detection signal

Trouble	Checkpoints	Remedy
SE-101 card failure	Does SE-CPU card LED5 light above set speed? If it lights, failure lies in output circuitry.	Replace SE-101 card.
Speed detector circuit failure	SE-CPU2 LEDS does not light.	SE-CPU card failure if otherwise normal operation; replace card.

(9) *No zero* speed detection signal

Trouble	Checkpoints	Remedy
RA-1 relay failed on SE-101 card	Does SE-CPU LED10 light at motor speed of under 25 rpm or SO rpm? Relay has failed' if signal is not output even when LED10 lights.	Replace RA1 relay or replace SE-101 card.
Zero speed detector circuit failure	Failure in detector circuit if LED10 does not light.	Replace SE-CPU1 or 2 card.

(10) No speed range selection

This is caused by the speed detection or zero speed signal

not functioning. Inspect as for (8) and (9).

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

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

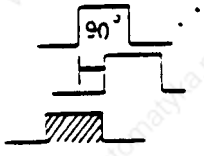
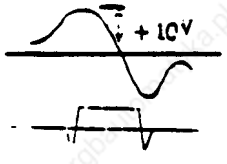
Is the load meter value too high? Check the load.

(12) High vibration, noise levels

Trouble	Checkpoints	Remedy
Poor dynamic balance		Review dynamic balance.
Drop in insulation resistance	Disconnect R, S, T phases from power supply and measure ped with 500V megger (disconnect wires connected to ground terminals). a Across main'circuitry and ground: 20Mohms or more (terminals Xl, X2, X3, U, V, W, MS1 and MS2) b Across control circuit COM and ground; 20Mohms or more (IO1 card, terminal block TB1 OM) c Across main, circuity and control circuit COM: 20 Mohms or more	When this has dropped, inspect for places where insulation may have deteriorated, and restore.
Defective motor bearing	Does the motor rotate smoothly when it is rotated by hand?	Replace bearings.

Motor screws not tight enough	Are any of the motor screws loose?	Re-tighten screws.
Motor shaft movement	Does motor shaft show any trace of having been bumped into something?	Repair or replace motor.
Unbalanced reference sine waves	Are SE-101 card CH5, CH4-AGA waveforms balanced?	Replace SE-101 card.

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

Trouble	Checkpoints	Remedy
Orientation speed established but motor does not stop	Is position feedback encoder or magnetic sensor operating normally? Operate motor under speed control only and check if position feedback.is normal. SE-CPU2 card, forward rotatio CH52 - DCA CH53 - DGA CH54 - DCA Mark pulse)  SE-CPU 1 card, forward rotatior CH53- AGA IC 21A-7 - AGA  	Replace detector. Or defective SE-CPU card interface: replace'card.

Trouble	Checkpoints	Remedy
Stop positions differ for forward orientation and reverse orientation with multiple-point orientation.	Check backlash at encoder mounting area.	
Hunting during stop	Increase 1st deceleration point range and observe result.	SE-SPU1 or 2 SW4-2-4 (2nd deceleration point range) SW4-5-7 (1st deceleration point range) SW10 (Orientation speed)
Stop state differs according to rear	Check that gear ratio setting is normal. DIP switch setting	Change if different. If normal, re-set st deceleration point range and orientation speed.
Poor servo rigidity	Check that gear ratio setting is normal. DIP switch setting	Increase speed loop constant. SW8
Speed overshooting		Reduce speed loop constant. SW9

CHAPTER 8 PARTS REPLACEMENT METHODS

8.1 CARD REPLACEMENT

(1) SE-PW

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

> The SE-101, CPU card must be removed in order to replace the card.

(2) SE-CPU1 card

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

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

(3) SE-CPU2 card

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

(4) SE-101 card

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

- CH56-AGA (U phase reference sinusoidal wave> . . . VR13
  CH43A-AGA regenerative converter DC current . . . VR10
  CH57-AGA (V phase reference sinusoidal wave) . . . VR12
  CH58-AGA converter DC current . . . VR11
  Re-set the above zero adjustments.
- Set the maximum speed using pin 1 on the 101 card and SW6-7 on .the CPU card.
- Set the meter calibration SW6-6 to OFF and re-adjust VR6 and

7 so that the CH34 voltage is made 10V.

For the 107 G54 edition and following, adjust VR6.

- After the above calibrations re-adjust the speed meter (VR14) and load meter (VR15).
- Upon completion of the re-adjustments, return the meter calibration SW6-6 to ON.

8.2 DIODE AND TRANSISTOR MODULES

(1) Removal of defective module

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

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

(2) Application of silicon' grease

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

(3) Tightening up

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

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

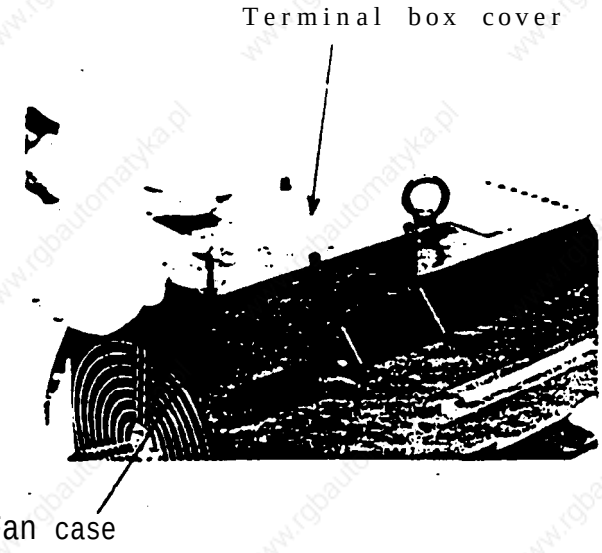
Table 6.1 Tightening torques

	Model	Screw size	Max. tightening torque (kg-cm)	Recommended tightening torque (kg-cm)
Diodes	PT768 (RM 30TA-H) PD608 (RM 60DZ-H) PD1008 (RM100DZ-H)	M5 x 0.8	20	17 +/-2
Transistors	QM 75DY-H QM100DY-H QM150DY-H			

6.3 TYPE SJ AC SPINDLE MOTOR DISASSEMBLY AND RE-ASSEMBLY

[1] Cables and P.C.board

1. Remove the cover of the terminal box on top of the fan case.



2. Disconnect the cables from the power board to the motor.

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

b) 2 cooling fan leads (BU, BV)

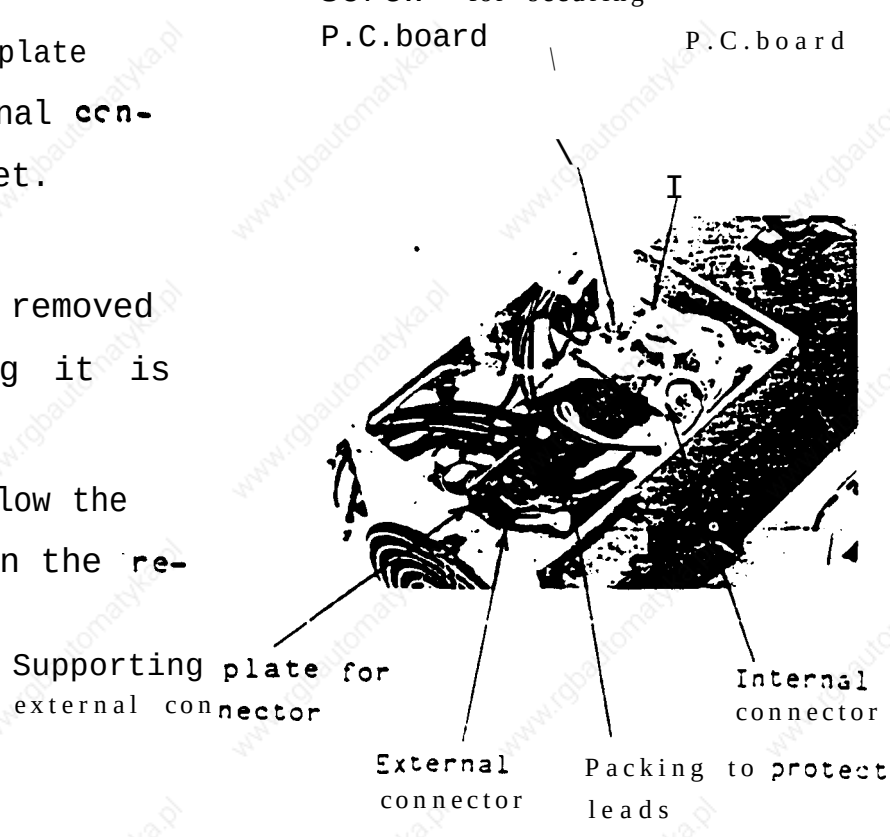
c) 2 thermal protector leads (OHS1, OHS2)

d) Companion plug for external connector.

3. Remove the external connector from the supporting plate and remove the internal connector from the socket.

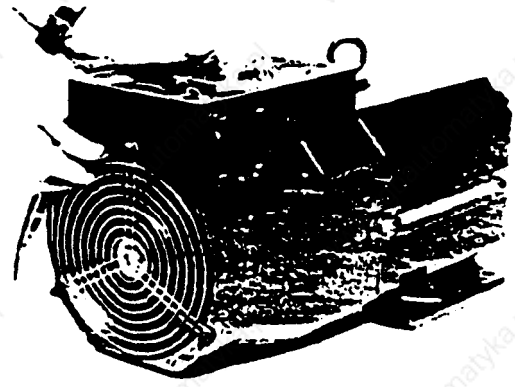
4. The P.C.board can be removed once the screw securing it is removed.

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

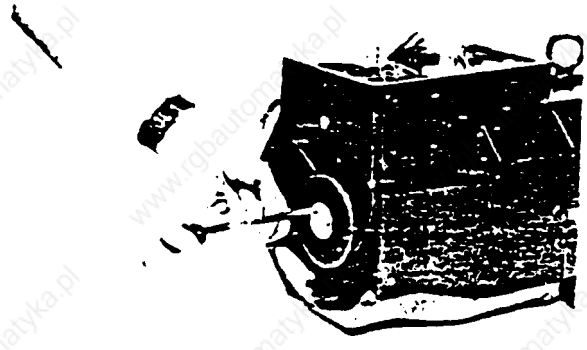


[2] Cooling fan

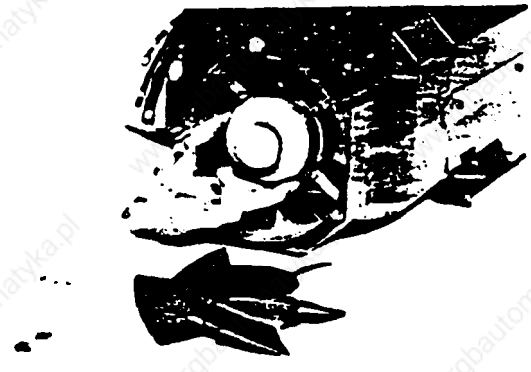
1. Remove the hexagon socket head bolts which secure the finger guard.



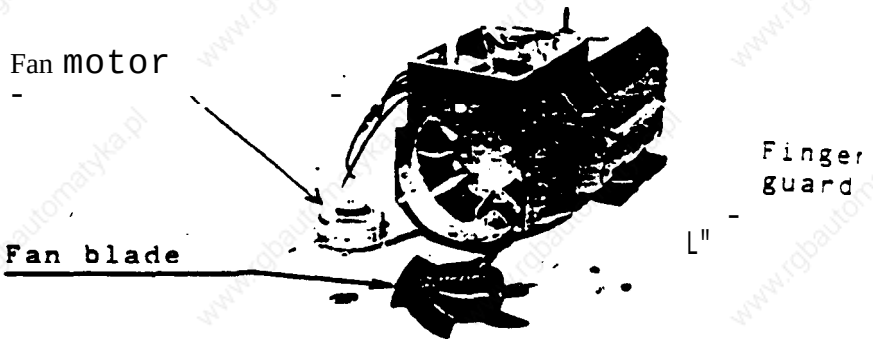
2. The fan blade can be removed once the screws at the center of the cooling fan are removed.



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

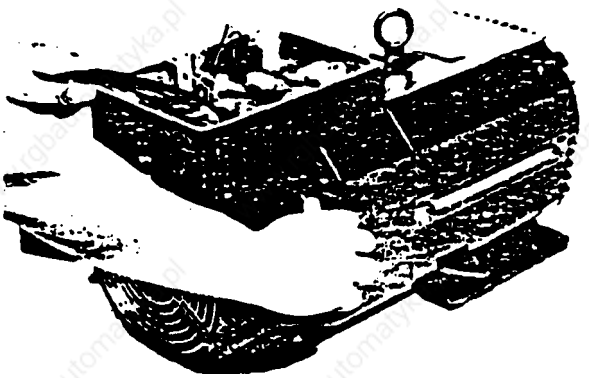


4. For re-assembly, follow steps (1)-(3) above in the **reverse order.**



[3] Sensor and detection gear

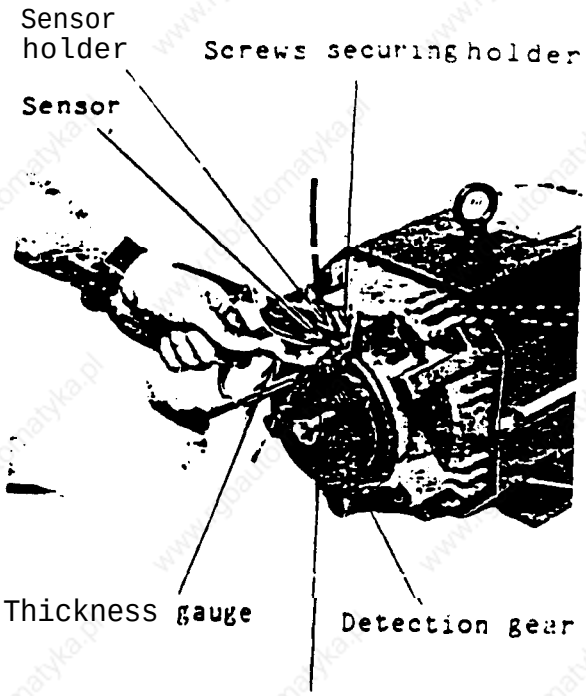
1. Remove the internal connector of the sensor from the socket inside the terminal box.
2. Remove the 3 hexagon socket head bolts attaching the fan case, and the fan case can be removed once it is pulled out toward the rear.



3. Once the 2 screws securing the sensor holder are removed, theholder can be removed-

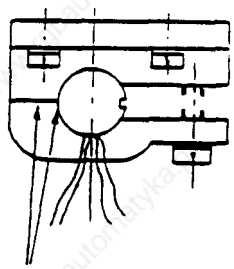
Take care not to bring the sensor into contact with the detection gear while doing this.

4. To adjust the sensor, loosen the screw securing the sensor with the sensor holder secured and make the adjustment with a thickness gauge so that the gapbetween the detection gear and the sensor is made 0.15 ± 0.01.
Check if the marks (index lines) on the sensor and the holder be aligned,and tighten UP the screws securing the sensor.
(See figure on right)

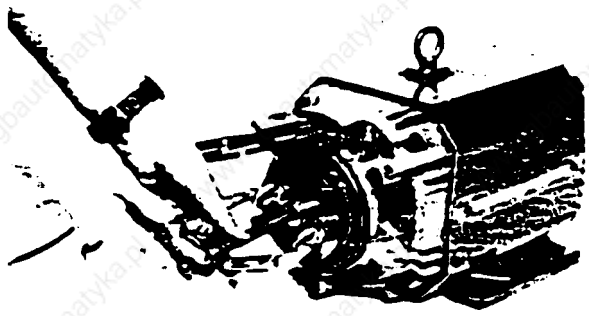


5. Apply some screw locking agent on the screws for Preventing them from loosening.

6. When Fe-assembling the fan case, draw the sensor leads sufficiently into the terminal box so that they are not sandwiched between the bracket and the fan case.


Align the marks (index lines)

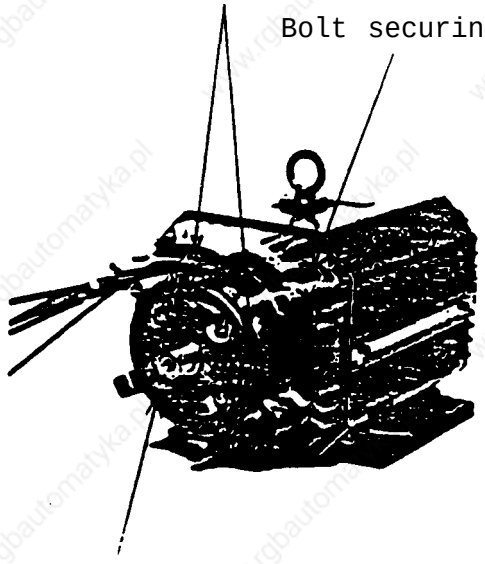
7. The detect-ion gear is removed by screwing the eyebolt into the screw (M8) hole, drawing it out with a removal tool and then rotating the handle.



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

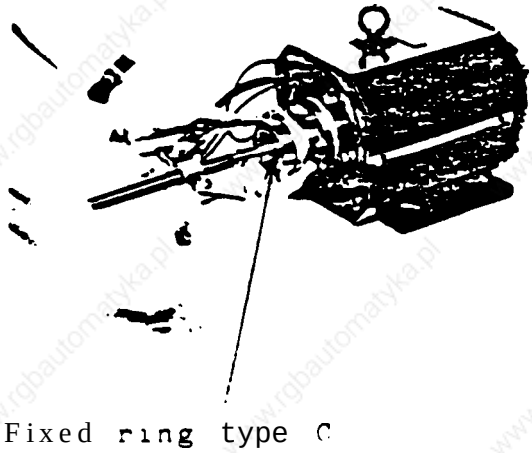
[4] Bearings

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



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

3. The anti-load side bearing is removed by removing the fixed ring type C, by using a bearing removal tool to remove the bearing

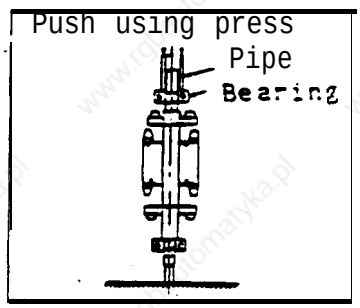


along with the housing cover and by rotating the handle..

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

5. To insert the bearing into the shaft, remove the wipe smears and projections from the *insertion* sections.

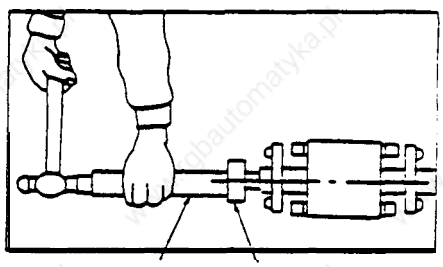
6. After applying grease on the inner surface of the bearing and the surface of the shaft, place the beaing on the shaft by pressing the inner ring with a pipe. Care should be taken to keep the bearing be at right angles to the shaft.



Mounting the bearing 'using a press

7. If a press is unavailable, place the bearing on the shaft by tapping the inner ring gently with a hammer and a pipe.

Care should be taken net to twist the bearing or not to hit the outer ring with the pipe.



Mounting the bearing using a hammer

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

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

ITEM	DESCRIPTION	TYPE KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
1	CIRCUIT BREAKER	5.5	NF 50CB 3P 40A05	MITSUBISHI ELECTRIC	CB1	1	0	0	0	1	
		7.3									
		11	50A05								
		15	NF100CB 3P 75A05								
		1815									
		22	100A05								
2	TRAN-SISTOR	5.5	QM75DY-H	MITSUBISHI ELECTBI C	TRR TRS TRT	3	0	0	0	3	FOR CONVERTER
		7.5									
		11	QM100DY-H								
		15	QM150DY-H								
		18.5									
		22	QM75DY-H			9	0	0	0	9	
3	TRAN-SISTOR	5.5	QM75DY-H	MITSUBISHI ELECTRIC	TRU TRV TRW	3	0	0	0	3	FOR INVERTER
		7.5	QM100DY-H								
		11	QM150DY-H								
		15									
		18.5	QM100DY-H			6	0	0	0	6	
		22	QM150DY-H								
4	DIODE STACK	5.5	PT768 (RM30TA-H)	NIHON INTER MITSUBISHI	D1	1	0	0	0	1	FOR CONVERTER
		7.5									
		11									
		1s	PD608 (RM60DZ-H)		D1-1 D1-2 D1-3	3	0	0	0	3	
		18.5									
		22	PD1008 (RM100DZ-H)								

ITEM	DESCRIPTION	KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
5	CAPACTOR	55	3200UFX 350V BKO-NC 1043-H05 AC200V	NITSUKO	C1-1	2	o -	0	2	2	
		75			C1-2 C1-3	3	0	0	3	3	
		11			C1-4 C1-5	4	0	0	4	4	
		15				5	0	0	5	5	
		185									
		22									
6	CONTACTOR	11	SK65- AC200V	MITSUBISHI ELECTRIC	MC1	1	0	0	0	1	
		15									
		18.5									
		22									
		15	SK65- AC200V								
		18.5									
		22									
7	FAN	5.5	N3951ML	TOBISHI	FAN1	1	o	1	0	1	
		7.5			FAN1 FAN2	2	0	2	0	2	
		11									
		15									
		18.5 22	HS4556ML								
8	AC REACTOR	55	BKO-NC6132-H02	CHUO DENKI	ACL	1	0	0	0	1	
		7.5	BKO-NC6132-H03								
		11	BKO-NC6132-H04								
		15	BKO-NC6132-H05								
		18.5	BKO-NC6185-H06								
		22	BKO-NC6122-H07								
9	CAPACTOR	5.5	MEU2105 600A BKO-NA1061-05	SHIZUKI DENKI	C2 C3	6	0	0	6	6	FOR CONVERTER, INVERTER
		11			C2	3	o	o	3	3	
10	SURGE KILLER	11	BKO-C1916 H02	SHIZUKI DENKI	C3	3	0	0	0	3	FOR INVERTER
		15									
		185				6	0	0	0	6	
		22									
11	SURGE KILLER	15	BKO-C1916 H01	SHIZUKI DENKI	C2	3	0	0	0	3	FOR CONVERTER
		18.5									
		22				6	0	0	0	6	

ITEM	DESCRIPTION	KW	TYPE		MAKER	SYMBOL	QTY	SPARE PARTS STAND.	OPTION A	OPTION B	OPTION C	NOTE
12	RESISTOR	53	BKO-NC1072-	HO2	MICRON	R1 R2 R3	3	0	0	0	3	
		7.5		H03								
		11		HO4								
		15		HO5								
		8.5		HO6								
		22		HO7								
13	RESISTOR	55	MFS30A 8026		MICRON	RO	1	0	0	0	1	
		7.5										
		11				RO-1 RO-2	2	0	0	0	2	
		15										
		185										
		22										
14	RELAY	—	G4J3342T DC24V		OMRON	RA1 RA2	2	0	0	0	2	
15	THERMAL DETECTOR	—	OHD-6 OB		TOOKIN	THS1	1	0	0	0	1	
16	THERMAL DETECTOR	—	OHD-100B		TOOKIN	THS2	1	0	0	0	1	
17	CT	5.5	BKO-NC6131- H	H02		CT1 CT2 CT3 CT4	4	0	0	0	4	
		7.5		H03								
		11		HO4								
		15		HO5								
		18.5		HO6								
		22		HO7								
18	TERMINAL	5.5	TE-K14-3		MITSUBISHI ELECTRIC	TB3	1	0	0	0	1	
		7.5										
		11	TE-K22B-3									
		15										
		18.5	TE-K60B-3									
		22										
19	TERMINAL	—	TE-62-z		MITSUBISHI ELECTRIC	TB4 TB11	2	0	0	0	2	
20	FILTER	—	BKO-NC6143 HO1		SHIZUKI DENKI	FIL1	1	0	0	1	1	

ITEM	DESCRIPTION	TYPE KW	TYPE	MAKER	SYMBOL	QTY	SPARE PARTS STAND.	SPARE PARTS OPTION A	SPARE PARTS OPTION B	SPARE PARTS OPTION C	NOTE
21	FUSE	—	MF60NR -5A -S	TOYO	SE-W'	3	3	0	0	3	
22	PRINTED CIRCUIT BOARD	—	BKO—NC6135	YAMABISHI	SE-IO1	1	0	0	0	1	
23	PRISTED ICIRCUIT BOARD	—	SE-IO 1	MITSUBISHI ELECTRIC		1	0	0	0	1	
24	PULSE SIGNAL GENERATOR	—	TS1860N13	TAMAGAWA SEIKI		1	0	0	1	1	FOR MOTOR
25	FAN	5.5 7.5 11 15 185	IA-15101	UNION SEIKO		1	0	0	1	0	FOR MOTOR
		22	R200P59	TOBISHI							
26	BEARING (LOAD S IDE)	5.5 7.5	6307M2ZZCS 19	TOYO BEARING		1	0	0	0	1	FOR MOTOR
		11 15	6310M2ZZCS22								
		18.5 22	6312M2ZZCS28								
27	BEARING (OPPOSI-TE SIDE)	5.5 7.5	6306M2ZZCS 16	TOYO BEARING		1	0	0	1	1	FOR MOTOR
		11 15 18.5 22	6308M2ZZCS 19								
28	MAGNETIC SENSOR ORIENT P.C.B		SE-CPU 1	MITSUBISHI ELECTRIC		1	0	0	0	1	
29	ENCODER ORIENT P.C.B		SE-CPU 2	MITSUBISHI ELECTRIC		1	0	0	0	1	