# 1. GENERAL

This manual is used for the maintenance of FANUC AC Spindle Servo Units A06B-6044-H007 through H011 and their related options.

FANUC AC Spindle Servo Units provide smooth, noiseless, and reliable control of AC spindle motors by unique driving methods using a microprocessor. By using a regenerative braking system, the energy regenerated at the time of deceleration is returned to the power source for efficient saving of power.

## 1.1 Structure

The FANUC AC Spindle Servo Unit is composed of the following units and parts.

(1) Spindle control unit
  (Basic) (1.1) Units
  (1.2) Printed circuit board
  (1.3) ROM
(2) Fuses (Spare) (Basic)
(3) Connectors (Basic)
(4) D/A converter (Optional)
(5) Power transformer (Optional)
(6) Spindle orientation control circuits (Optional)

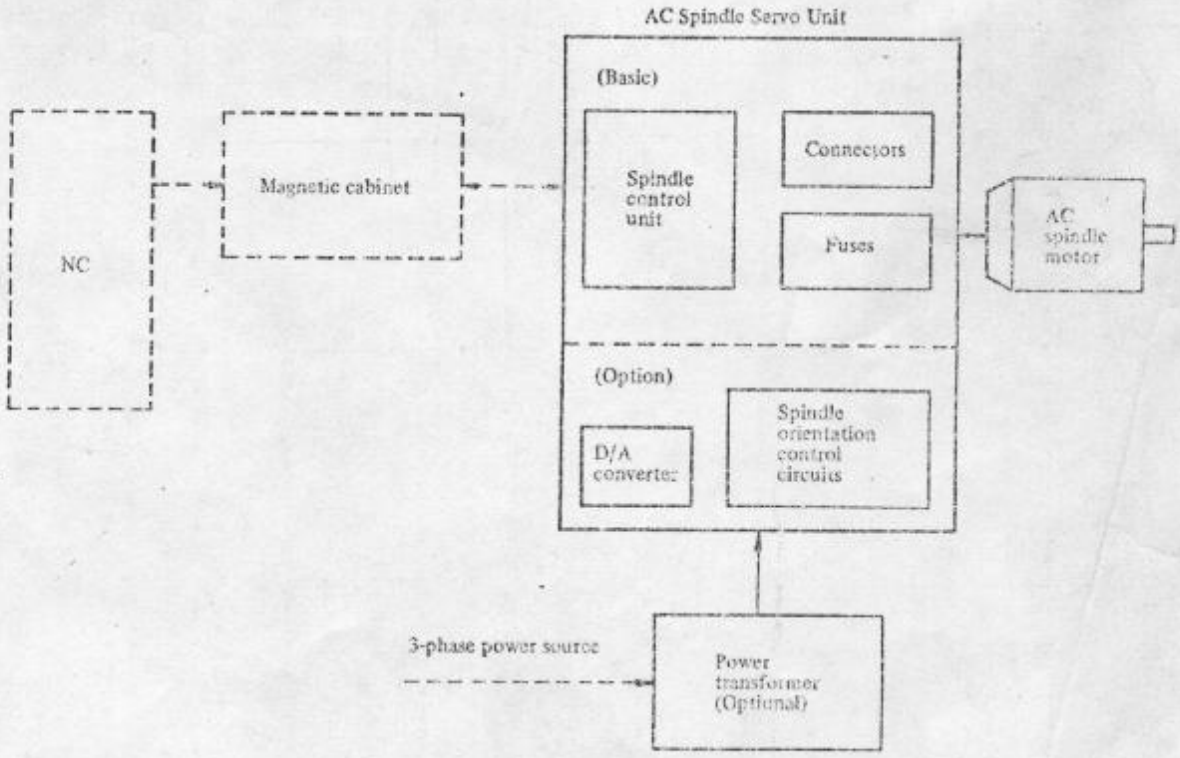



Fig. 1.1.1

## 1.2 Specification of main components of AC spindle servo unit

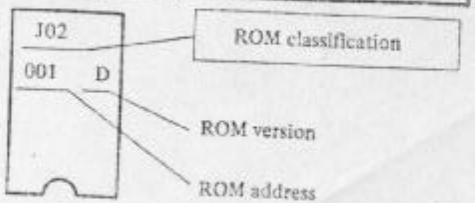
Table 1.2

| Application motor or name | Specification drawing number | Unit drawing number | PCB drawing number | ROM | | Specification drawing number of applicable AC spindle motor |
|---|---|---|---|---|---|---|
| | | | | Specification drawing number | Classification | |
| Spindle servo unit for model 3 | A06B-6044-H007 | A06B-6044-C008 | A20B-0009-0530 | A06B-6044-C507#J10 | J10 | A06B-0704-B001, 2 |
| Spindle servo unit for model 6 | " H008 | " C008 | " 0531 | " C508#J11 | J11 | A06B-0707-B001, 2 |
| Spindle servo unit for model 8 | " H009 | " C009 | " 0532 | " C509 | J02 | A06B-0706-B001, 2 |
| Spindle servo unit for model 12 | " H010 | " C010 | " 0533 | " C510 | J03 | A06B-0705-B001, 2 |
| Spindle servo unit for model 15 | " H011 | " C011 | " 0534 | " C511 | J04 | A06B-0708-B001, 2 |
| D/A converter (BCD) | A06B-6041-J031 | | | | | |
| D/A converter (BINARY) | " J032 | | | | | |
| Orientation circuits A | " J110 | | A20B-0008-0240 | | | |
| Orientation circuits B | " J111 | | " 0241 | | | |
| Orientation circuits B (2-level speed change) | " J120 | | " 0030 | | | |
| Orientation circuits D (3-level speed change) | " J121 | | A20B-0009-0520 | | | |

*(Note 1)* *The mounted parts (except ROMs) of printed circuit boards A20B-0009-0530 through 0534 are the same. Setting and adjustment of them are different.*

*(Note 2)* *The location of ROM is MD25. (See appendix I-7 PCB parts mounting diagram.)*

*(Note 3)* *The meanings of the codes printed on the ROMs are shown in the figure to the right.*



## 1.3 Maintenance equipment

### 1.3.1 Equipment and tools used for adjustment

Table 1.3.1

| Name | Specifications | Use |
|---|---|---|
| AC voltmeter | 1V through 300V (± 2%) | For measuring AC power supply voltage |
| Screwdriver | ⊕ : large, and medium size<br>⊖ : large, medium, and small size | ——— |

### 1.3.2 Equipment and tools used for repairs

Table 1.3.2

| Name | Specifications | Use |
|---|---|---|
| AC voltmeter | 1V through 300V (±1%) | For measuring AC power supply voltage |
| DC voltmeter | 1mV through 500V (±1%) | For comfirmation of DC power supply voltage and offset voltage |
| Multimeter | | For resistance check |
| Screwdriver | ⊕ : large, and medium size<br>⊖ : large, medium, and small size | ——— |

## 1.4 Operation start procedure at installation

Confirm the following items sequentially at installation.

Table 1.4.1

| Item | Contents | Remarks |
|---|---|---|
| 1 | Confirm whether the specifications of the motor, servo unit, and optional units are right. | Confirm that the correct unit, PCBs, and ROMs are used for the motor. (See Table 1.2) |
| 2 | Check for external damage. | Check that the power resistor or the parts on the PCB are not damaged. |
| 3 | Confirm the voltage, voltage regulation, power capacity (kVA), and frequency of the AC power source. | See Tables 2.1.1 |
| 4 | Connect the ground lines, power lines, and signal lines. | See items, 2.1, 2.2, 2.3 and appendix I-1. |
| 5 | Confirm the setting and adjustment. | See item 3.1. |
| 6 | Turn on the AC power, and confirm that the PIL lamp (green) on the PCB lights. | |
| 7 | Confirm that the motor rotates in both directions correctly in response to rotation commands. | |
| 8 | Confirm the motor operation for all speeds. | |
| 9 | Adjust the spindle orientation circuits. | See Chapter II. |

## 2. CONNECTION

Confirm the connections referring to the connection diagram (Appendix I-1, I-2) and the cable layout (Appendix I-3). See the cable specifications (Appendix I-4) for details on cables.

### 2.1 Connection of power source

#### 2.1.1 Confirmation of power voltage and capacity

Measure the AC power voltage before supplying AC power and take the necessary steps listed below according to the voltage.

Table 2.1.1-(1)

| AC power voltage | Nominal voltage | Procedure |
|---|---|---|
| 170V – 220V | 200V | Set toggle switch SW in the 200V position. |
| 210V – 242V | 220V | Set toggle switch SW in the 220V position. |
| 230V – 253V | 230V | It is necessary to reduce the voltage to 200V using a transformer (autotransformer). |
| 254V or more | 380V – 550V | It is necessary to reduce the voltage to 200V using an insulation transformer. |

The input power specifications of the AC spindle servo unit are listed in Table 2.1.1-(2). The power supply should be enough to avoid power drops even at maximum load.

Table 2.1.1-(2)

| | | | | | | |
|---|---|---|---|---|---|---|
| Nominal rating voltage | | AC 200V/220V (changeable) 3-phase | | | | |
| Allowable voltage regulation | | –15% ~ +10% | | | | |
| Frequency | | 50Hz/60Hz ± 1Hz (Unchangeable) | | | | |
| Power capacity | Motor model | 3 | 6 | 8 | 12 | 15 |
| | Capacity at 30 min. rating | 9KVA | 12 | 17 | 22 | 26 |

#### 2.1.2 Connection of the protecting ground line

Connect the ground line to ground terminal G before connecting the power cable. Use a wire that matches the breaker.

#### 2.1.3 Connection of power source cable

Connect the power source cable after connecting the ground line. There is no conditions on phase rotation of the AC spindle servo unit.

## 2.2 Connection of AC spindle motor

Connect the AC spindle motor referring to the connection diagram (Appendix I-1).
If the power lines are not connected correctly, the motor vibrates and stops (Alarm No. 2).

## 2.3 Connection of signal lines

Connect the signal lines referring to the connection diagram (Appendix I-1).
If the optional spindle orientation control circuits are added, connect them referring to the connection diagram for each option (Chapter II, Appendix II-1).

# 3. SETTING AND ADJUSTMENT

## 3.1 Setting on the unit and PCB

See the mounting diagram (Appendix I-6, I-7) for the locations of parts to be set on the unit and PCB. Confirm the following items before turning on the power.

Table 3.1.1

| No. | Item | Remarks |
|---|---|---|
| 1 | Setting of toggle switch SW for changing the voltage | See item 2.1. |
| 2 | Confirmation of setting terminals (short bars) | See Table 3.1.2. |

Table 3.1.2

| Terminal No. | Content | | Setting | At shipment from FANUC |
|---|---|---|---|---|
| S1 | Machine ready signal [MRDY] | Used | OFF ON | ON |
| | | Unused | ON ON | |
| S2 | Analog override | Used | OFF ON | ON |
| | | Unused | ON ON | |
| S3 | Same as above | Used | ON ON | ON |
| | | Unused | OFF ON | |
| S4 | Velocity command signal | External analog voltage command | OFF ON | ON |
| | | R01 through R12 commands | ON ON | |
| S5 | Setting of velocity feedback amount corresponding to the rated command | 4500 rpm | B: Short B o o o A | Depends on motor |
| | | 6000 rpm | A: Short B o o o A | |
| S6 ~ S7 | Phase compensation for velocity control | Motor's model | 3 / 6 / 8 / 12 / 15 | Depends on motor |
| | | S6 | ON ON / ON ON | |
| | | S7 | OFF / ON ON | |

Since variable resistors RV1 through RV19 have been adjusted by FANUC at shipment, they need not be adjusted. The variable resistors listed in Table 3.1.3 can be readjusted if necessary. If variable resistors listed in Table 3.1.4 must be adjusted for offset or rotational speed, it should be done after turning on the power.

(1) The following potentiometer can be adjusted by the user.

Table 3.1.3

| Variable resistor No. | Contents | Standard setting by FANUC at shipment | Adjustment procedure |
|---|---|---|---|
| RV3 | Setting of speed arrival level | If the motor speed is 85% through 115% of the rated speed, the speed arrival signal is issued. | See the Ap |
| RV4 | Speed detection level | 3% of the rated speed is detected. | |
| RV5 | Torque limit value | | |

(2) The following potentiometer are used for sight adjustments of the rated speed and offset.

Table 3.1.4

| Variable resistor No. | Contents | Adjustment procedure |
|---|---|---|
| RV1 | Adjustment of velocity command voltage level | See Appendix I-9 |
| RV2 | Adjustment of velocity command voltage offset | |
| RV9 | Slight adjustment of rated speed at forward rotation (SFR) | |
| RV11 | Slight adjustment of rated speed at reverse rotation (SRV) | |
| RV13 | Offset adjustment when a speed of zero is commanded. | |

*(Note 1) The other variable resistors have been adjusted by FANUC at shipment. Thus, they a adjusted by the user.*
*Appendix I-9 gives a list of adjustments for the potentiometer.*

## 3.2 Setting and adjustment of spindle orientation control circuits

The setting and adjustment of spindle orientation control circuits are described in Chapter II.

## 4. MAINTENANCE

Check and clean the AC spindle motor and the servo unit,as described below every six months so that they are in the best operating conditions. Checks should be made as often as required to keep the unit clean.

### 4.1 AC spindle motor

When the air duct, cooling fan, or fan guard of the AC spindle motor is dirty, the radiating efficiency will drop. Thus, they should be cleaned using compressed air or a vacuum cleaner.

### 4.2 AC spindle servo unit

Since a cooling fan is mounted in the upper part of the servo unit, resistors or other parts which are near the cooling fan will become dirty. Clean them with a vacuum cleaner.

## 5. TROUBLESHOOTING

If trouble occurs, find out the cause using the following list in item 5.1.

Before troubleshooting, confirmation of AC power voltage and DC power voltage on the printed circuit board should be performed.

**Table 5-(1)**

<table>
<tr><td>Confirmation of AC power voltage</td><td>Measure it at input terminals R, S, T, and G.<br>See 2.1</td></tr>
<tr><td>Confirmation of DC power voltage</td><td>
<table>
<tr><th>Voltage</th><th>Check terminal</th><th>Rated voltage</th></tr>
<tr><td>+24V</td><td>Between +24 and 0V</td><td>Approx. 25V ±10%,<br>Ripple: Approx. 0.5V</td></tr>
<tr><td>+15V</td><td>Between +15 and 0V</td><td>+15V ±4%<br>(Nonadjustable)</td></tr>
<tr><td>+5V</td><td>Between +5 and 0V</td><td>+5V ± 1%<br>(Adjustment: RV15)</td></tr>
<tr><td>−15V</td><td>Between −15 and 0V</td><td>−15V ±4%<br>(Nonadjustable)</td></tr>
</table>
</td></tr>
</table>

### 5.1 Classification of troubles

**Table 5-(2)**

| Item | Type of trouble | Reference |
|---|---|---|
| 1 | Power ON indicating lamp PIL does not light. | Item 5.1.1 |
| 2 | Alarm lamps on PCB are on. | Item 5.1.2 |
| 3 | Number of motor rotations differ from the specified number. | Item 5.1.3 |
| 4 | Motor does not operate. | Item 5.1.3 |
| 5 | Vibration and noise during operation are abnormal. | Item 5.1.4 |
| 6 | Noise is made during deceleration. | Item 5.1.5 |
| 7 | Speed overshoots or hunting in motor | Item 5.1.6 |
| 8 | Cutting power is too low. | Item 5.1.7 |
| 9 | Spindle orientation is not performed correctly. | Item 5.1.8 |
| 10 | Acceleration/deceleration is too long. | Item 5.1.9 |
| 11 | DC power voltage on PCB is not correct. | Item 5.1.1 |

### 5.1.1 Power ON indicating lamp PIL does not light.

Table 5.1.1

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | AC power source is not supplied | Measure the voltage at power input terminals R, S, and T. | |
| 2 | Fuse F4 has blown. | Refer to Appendix I-6 | Replace fuse F4 (5A). |
| 3 | Fuses AF1, AF2, and AF3 have blown. | Confirm whether the alarm indications of AF2 and AF3 have appeared. Refer to Appendix I-6. | Replace fuses AF1, AF2 and AF3. If the new fuses also below, the printed circuit board must be replaced. |
| 4 | Printed circuit board is not connected correctly to CN6 and CN7. | Confirm that a groove of the connector guide pin can be seen at the surface of the connector on PCB. | Insert the PCB correctly. |
| 5 | The power is not output to 19A and 19B due to problems in transformer TF. | Measure the voltage at the following terminals:<br>· Between 19A and CT<br>· Between 19B and CT<br>If voltage of about 19V AC is output to 19A and 19B, the transformer is not defective. | Replace transformer TF. |
| 6 | Power circuit on PCB is defective. | The power to lamp PIL is supplied using +5V and −15V.<br>Measure the voltage according to Table 5-(1). | Replace the PCB. |

### 5.1.2 Alarm lamps on PCB are on.

Four LED alarm indicators are mounted on the PCB and they correspond to the values of hexadecimal number.

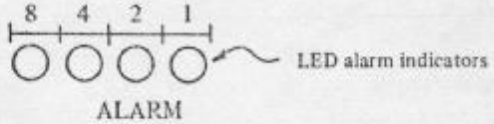



Fig. 5.1.2

The combinations of lighting alarm indicators indicate the alarm contents listed in Table 5.1.2.

| No. | Alarm indication (○ : lighting) | | | | Alarm c its |
|---|---|---|---|---|---|
| | 8 | 4 | 2 | 1 | |
| 1 | | | | ○ | Motor is overheated. (Thermostat i d.) |
| 2 | | | ○ | | Speed deviation amount has exceed owable range. |
| 3 | | | ○ | ○ | Fuse F7 in DC link circuit has blown. |
| 4 | | ○ | | | Fuse F1, F2, or F3 in AC link circuit wn. |
| 5 | | ○ | | ○ | Fuse AF1, AF2, or AF3 on PCB has |
| 6 | | ○ | ○ | | Motor speed has exceeded the maxi d speed. (Analog mode detection: 13% TYP) |
| 7 | | ○ | ○ | ○ | Motor speed has exceeded the maxi d speed. (Digital mode |
| 8 | ○ | | | | Power supply voltage (+24V) is too |
| 9 | ○ | | | ○ | Radiators for power semiconductors rheated. |
| 10 | ○ | | ○ | | Voltage of +15V power source has d normally. |
| 11 | ○ | | ○ | ○ | Voltage of DC link circuit is too high. |
| 12 | ○ | ○ | | | Overcurrent has flowed in the DC lin |
| 13 | ○ | ○ | | ○ | CPU alarm |
| 14 | ○ | ○ | ○ | | ROMs are not mounted correctly. |

(1) Alarm No. 1 Motor is overheated.

**Table 5.1.2-(1)**

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Defective fan motor in the AC spindle motor | | eplace the fan motor. |
| 2 | Overload operation | Check the load using a load mete | hange the cutting condi- ions or cutting tool. |
| 3 | Contamination of the motor's cooling system | | lean around the cooling ystem using compressed r or a vacuum cleaner. |
| 4 | Defective wiring | Check the connection between t motor and servo unit. | |

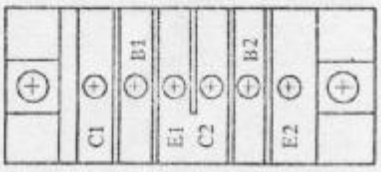
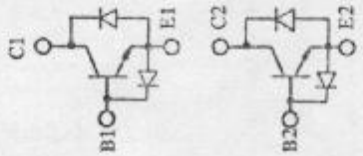
(2) Alarm No.[2] Speed deviation amount is too much.

Table 5.1.2-(2)

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Overload | Check the load using a load meter. | Change the cutting conditions or cutting tool. |
| 2 | Malfunction of the torque limit circuit | Check the load using a load meter. | Replace the PCB. |
| 3 | Speed feedback signal is trouble. | Check the level of feedback signal | Adjust RV18, RV19. |

(3) Alarm No.[3] Fuse F7 in the DC link circuit has blown.
If fuse F7 in the DC link circuit has blown, the power transistor module may be defective. The defective elements should be replaced according to the following procedures. If there is a possibility that the power transistor module was impaired due to PCB trouble, the PCB should also be replaced.
Please contact a FANUC service center if it is difficult to correct the trouble.

Table 5.1.2-(3)

| Procedure | Contents |
|---|---|
| 1 | Turn off the AC power source (turn off the circuit breaker in the magnetic cabinet), and remove the power line of the motor. |
| 2 | Measure the resistance values between the collector and emitter, and between the collector and base using multimeter (x10 ohm range).<br>  <br><br>Transistor module terminals<br>  <br><br>Normal: Several hundred ohms<br>Defective: 0 through 10 ohms |
| 3 | Replace the defective parts. Silicon grease should be used. |
| 4 | After replacement, measure the resistance values again listed in procedure 2. |
| 5 | Replace the printed circuit board if necessary. |
| 6 | Connect the motor power line, replace fuse F7, and start the operation again. |

(4) Alarm No.[4] Fuse F1, F2, or F3 in the AC link circuit has blown.

**Table 5.1.2-(4)**

| Item | Cause of trouble | Check procedure | Counterm |
|---|---|---|---|
| 1 | AC power impedance is too high.<br>ex. When 2 transformers, are connected serially or autotransformer is connected. | • Alarm lamp No. 4 goes on only during deceleration.<br>• Alarm lamp No. 4 goes on through fuse F1, F2, or F3 has not blown. | Change the p into low imp Looseness of connection. ex. Looseness loss of phase |
| 2 | Power transistor module is defective. | See alarm No. 3. | See alarm No. Replace the p tor module a |
| 3 | Diode module or thyristor module is defective. | Remove the connecting lines of diode modules DM1 through 3 and thyristor modules SM1 through 3, and check the resistance value between terminals A and K using a multimeter.<br>If they are defective, 0 ohm will be measured. | Replace the de parts and fuse |
| 4 | Surge absorber or capacitor is defective. | Check surge absorbers Z1 through 3 and capacitors C4 through 6. | Replace the d parts and fuse |

(5) Alarm No.[5] Fuse AF1, AF2, or AF3 on PCB has blown.

**Table 5.1.2-(5)**

| Item | Cause of trouble | Check procedure | Counterm |
|---|---|---|---|
| 1 | PCB is defective. | Check the AC input voltage. See item 5.1.1-5. | Replace the PC |
| 2 | Power source voltage is abnormal. | | |

(6) Alarm No.[6] Overspeed (Analog detection)

**Table 5.1.2-(6)**

| Item | Cause of trouble | Check procedure | Counterme |
|---|---|---|---|
| 1 | Setting and adjustment on PCB are not correct. | Confirm the setting and adjustment on the PCB. | Change S5. |
| 2 | Specification of ROM is different. | Check the specification referring to Table 1.2. | Replace the RO |
| 3 | PCB is defective. | | Replace the PC |

(7) Alarm No.[7] Overspeed (Digital detection)
Same as the above.

(8) Alarm No. 8 Overvoltage of +24V input

Table 5.1.2-(7)

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | AC power voltage has exceeded 110% of the rated voltage. | Check the power source voltage. | |
| 2 | Toggle switch for changing the voltage level is set in an incorrect position. | Check the power source voltage. | Set the toggle switch in the correct position. 200V → 220V |

(9) Alarm No. 9 Radiator overheating

Table 5.1.2-(8)

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Cooling fan is defective. | Check whether the cooling fan is operating. | Replace the cooling fan. |
| 2 | Overload operation | Check the load using a load meter. | Change the cutting conditions. |
| 3 | Contamination of radiator | | Clean the radiator using compressed air or a vacuum cleaner. |

(10) Alarm No. 10 Undervoltage of +15V input
This alarm indicates that the AC power voltage has dropped abnormally (−15% or less).

(11) Alarm No. 11 Overvoltage of DC link circuit

Table 5.1.2-(9)

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Fuses F5 or F6 has blown. | Check fuses F5 and F6 using a multimeter. If the fuses have blown the transistor modules should be checked in the same manner as described in alarm No. 3 | Replace the fuse. |
| 2 | Power source impedance is too high. | | Change the specification of the AC power source. |
| 3 | PCB is defective. | | Replace the PCB. |

(12) Alarm No. 12 Overcurrent of DC link circuit

Table 5.1.2-(10)

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Output terminal or motor winding is shorted. | Check the connection. | |
| 2 | Power transistor module is defective. | If this alarm occurs again immediately after resetting, the transistor modules should be checked in the same manner as described in alarm No. 3. | Replace the defective parts. |
| 3 | PCB is defective. | | Replace the PCB. |

(13) Alarm No. 13 CPU alarm
Replace the PCB.

(14) Alarm No. 14 Mounted ROM is not correct.
Mount the ROM chip whose specification is correct. Be sure to verify the chip is mounted. (See Table 1.2)

### 5.1.3 Motor does not operate or the revolution speed differ from the specified

Table 5.1.3

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Trouble analysis | Alarm lamp on the PCB of the spindle servo unit lights when a rotational command is issued. | See item 5.1.2. |
| | | The alarm lamp does not light. | See the following item No. 3. |
| 2 | Command signal line is connected incorrectly. | Check the connection of the signal line. | |
| 3 | PCB is defective. | | Replace the PCB. |

### 5.1.4 Vibration and noise during operation are abnormal.

Table 5.1.4

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Motor is defective. | | Replace or repair the motor. |
| 2 | PCB is defective. | | Replace the PCB. |

### 5.1.5 Noise during deceleration

Since the regenerated energy is returned to the power source through the regenerative circuits during deceleration, the regenerated energy limitation circuit is activated if the energy returned is too much. This may cause the motor to make noise due to the change in the motor current waveform. In this case, the noise can be reduced by turning potentiometer RV6 counterclockwise (Standard setting: 30%). However, the period required for deceleration becomes longer as the RV6 is turned counterclockwise.

### 5.1.6 Speed overshoots, hunting in motor

Table 5.1.6

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Setting and adjustment on PCB are incorrect. | Turn potentiometer RV12 clockwise to increase the gain. (Standard setting: 50%) | Change the setting. |
| 2 | Hunting in spindle | Decrease the gain (Turn potentiometer RV12 counte clockwise) | Readjustment |

### 5.1.7 Cutting power is too low.

Table 5.1.7

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Specification of ROM is different. | Confirm the specification referring to Table 1.2 | Replace the ROM chip with the proper one. |
| 2 | Torque limitation command is applied. | Confirm the signal line. | |
| 3 | Looseness of velt | Confirm the tension of velt | |

### 5.1.8 Spindle orientation is not performed correctly.

Table 5.1.8

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Setting and adjustment in the spindle orientation control circuits are incorrect. | Check whether the setting and adjustment confirm to the data sheet. | See Chapter II – Setting and adjustment in the spindle orientation control circuits. |
| 2 | PCB of the spindle orientation control is defective. | | Replace the PCB. |
| 3 | Setting on the spindle control PCB is adjusted incorrectly. | | Adjust the setting on the PCB. |

### 5.1.9 Acceleration/deceleration time is too long.

Table 5.1.9

| Item | Cause of trouble | Check procedure | Countermeasure |
|---|---|---|---|
| 1 | Torque limitation command is applied. | Confirm the signal line. | |
| 2 | Specification of ROM is different. | Confirm the specification referring to Table 1.2. | Replace the ROM chip with the proper one. |
| 3 | Setting on the PCB is adjusted incorrectly. | If the set value of potentiometer RV6 is too small, the time required for deceleration becomes longer. (See item 5.1.5.) | Readjust the RV6. |

## 6. REPLACING PRINTED CIRCUIT BOARD AND FUSE

### 6.1 Replacing fuses

To replace fuses F1 through F7 which are in the unit, it is necessary to open the cover of the unit. The following figure shows how to open the cover.

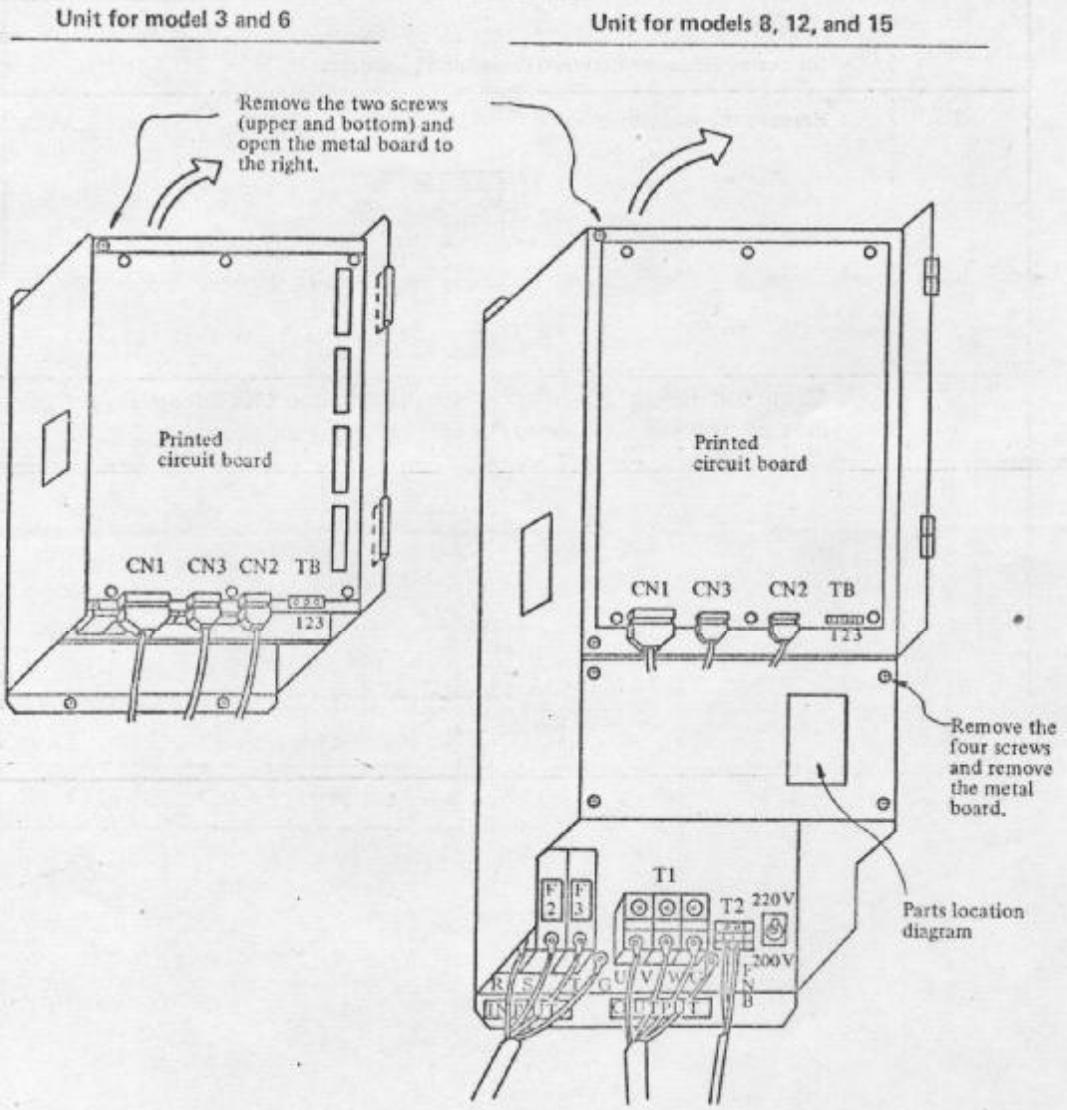
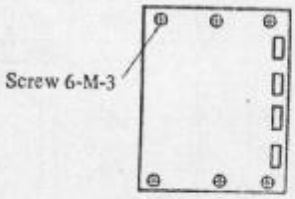
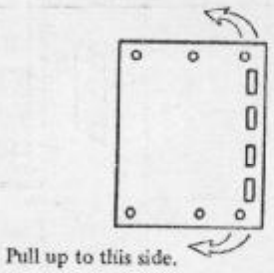



Fig. 6.1.1

## 6.2 Replacing printed circuit boards

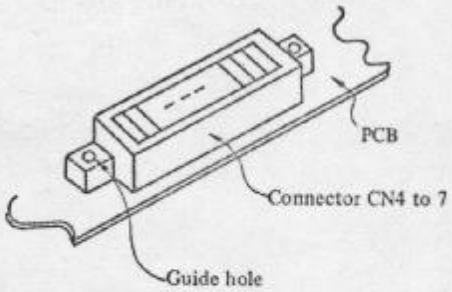
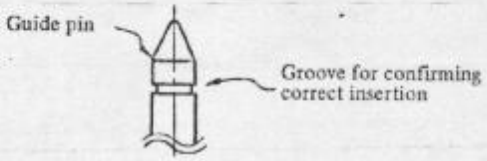
(1) Removal

Table 6.2.1

| Procedure | Contents |
|---|---|
| 1 | Turn off the power and remove the cables connected to the PCB ... ie, note the correspondence between cables and connectors. |
| 2 | Remove the six screws fixing the PCB.<br>  <br> |
| 3 | Slowly pull the right side of the PCB until connectors CN4 through ... are disconnected (pins are inserted from the back side) and remove the ...<br>  <br> |

(2) Mounting

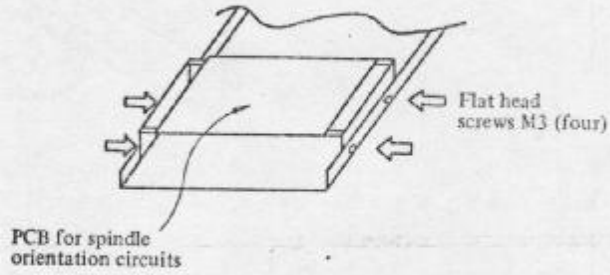
**Table 6.2.2**

| Procedure | Contents |
|---|---|
| 1 | Insert connectors CN4 through CN7 to the corresponding connectors on the unit fitting the guide holes to the guide pins until the grooves on the guide pins (see the figure below) can be seen at the surface of the connector on the PCB.     |
| 2 | Fix the PCB to the unit and tighten the six screws. See (1)-2 above. |
| 3 | Connect the cables to the connectors. |
| 4 | Check the specification of ROM and the setting on the PCB, and start the operation. |

## 6.3 Replacing the spindle orientation control circuits

(1) Removal

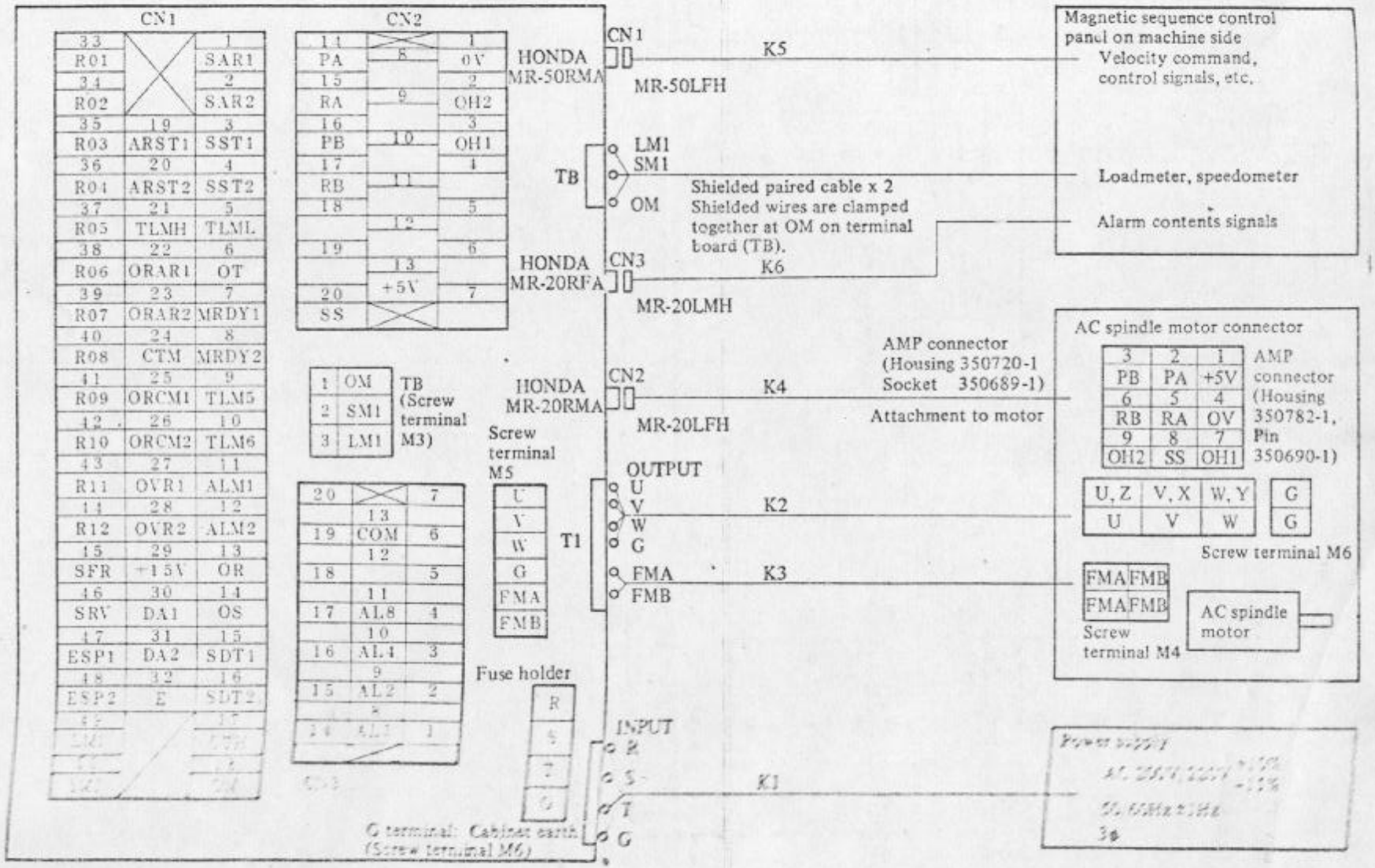
Table 6.3.1

| Procedure | Contents |
|---|---|
| 1 | Remove the PCB in the spindle control unit as described in item 6.2-(1). Remove the flat cables connecting between PCBs. |
| 2 | Remove the four screws fixing the stays of the PCB for the spindle orientation control circuits.   |

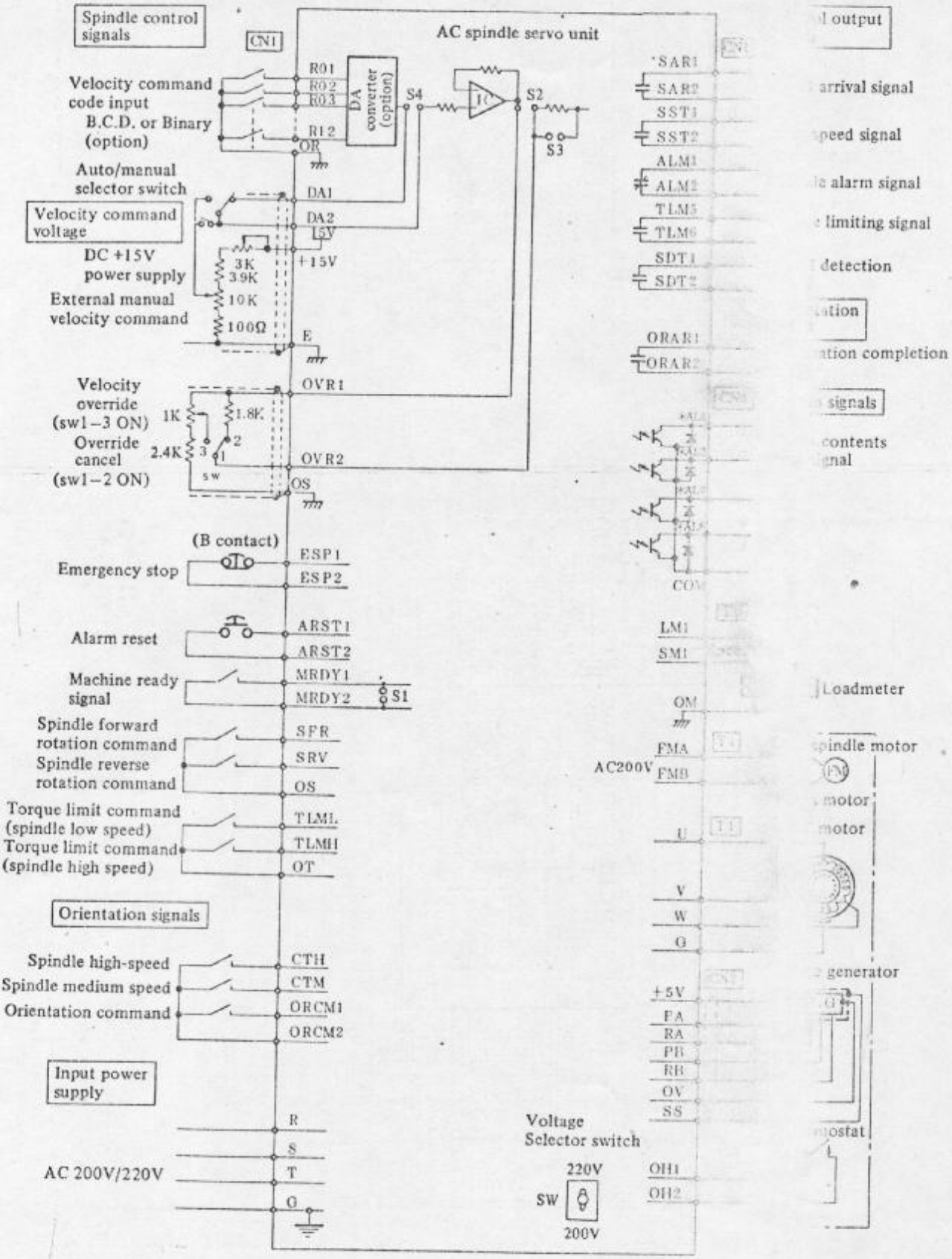
(2) Mounting

Mount the PCBs by reversing the procedures mentioned above.

## Appendix I-1 Connection diagram

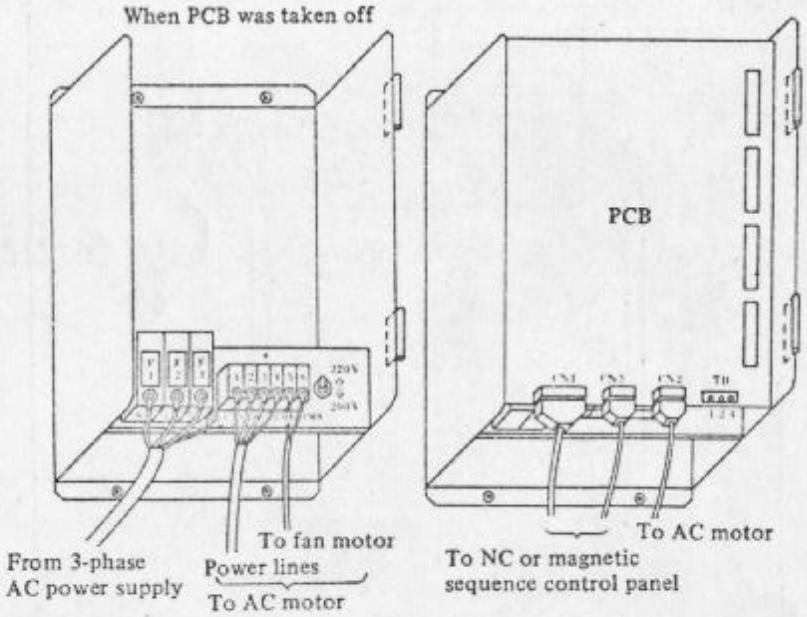


## Appendix I-2 Detailed connections



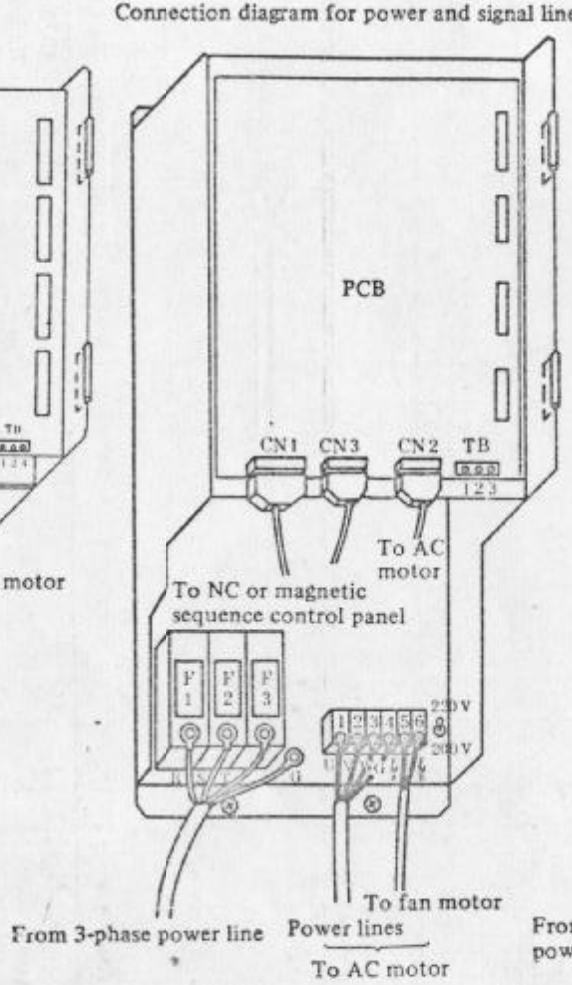
## Appendix I-3 Cable layout

### (1) For Models 3, 6

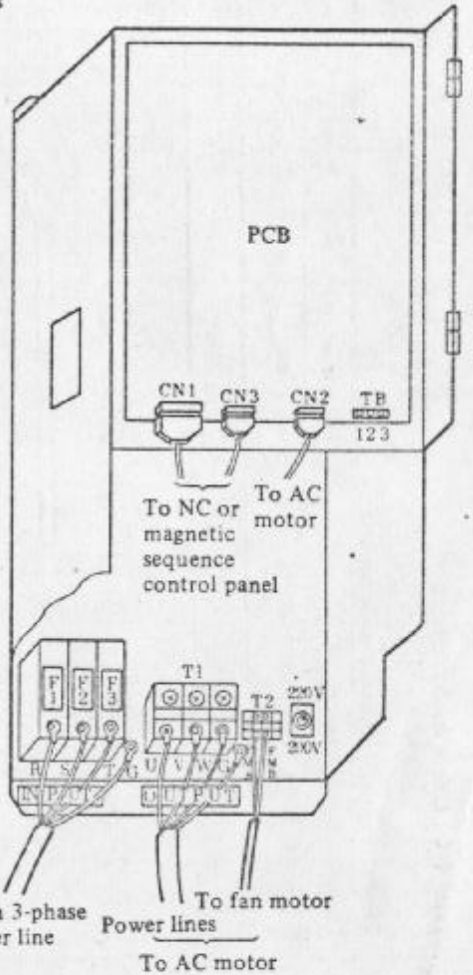



### (2) For Models 8, 12

Connection diagram for power and signal lines



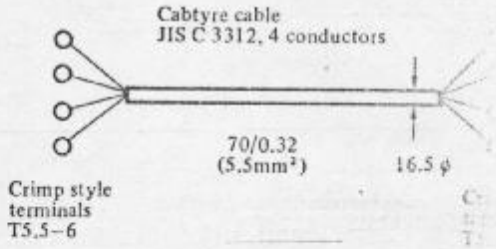
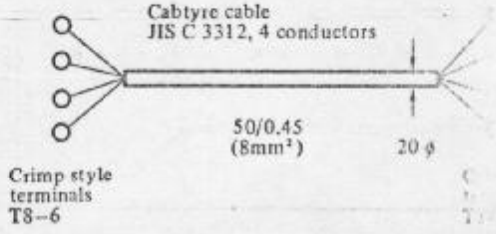
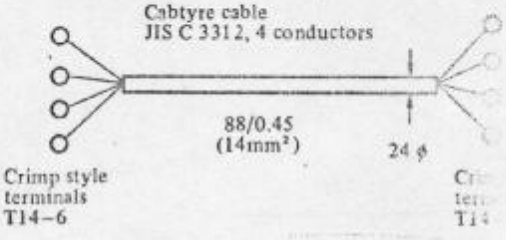
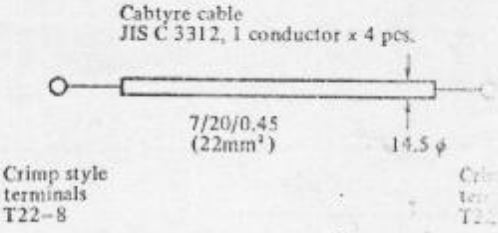

### (3) For Model 15



## Appendix I-4 Cable specifications

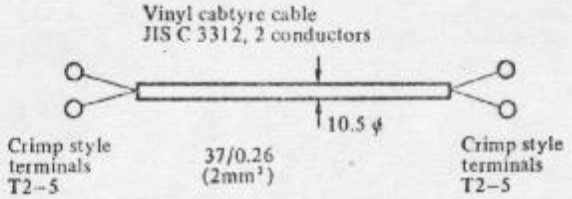
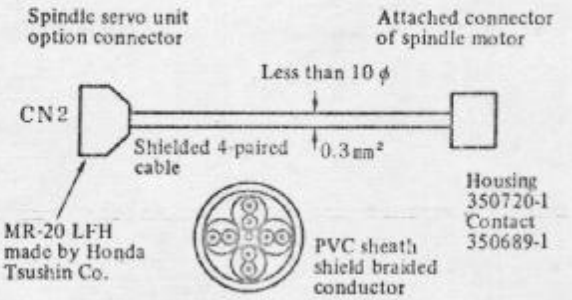
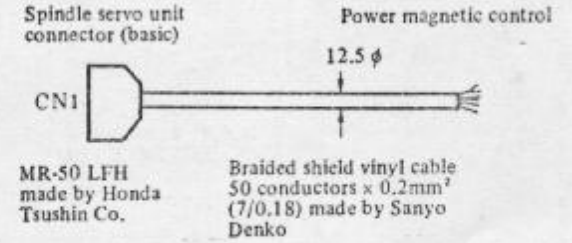
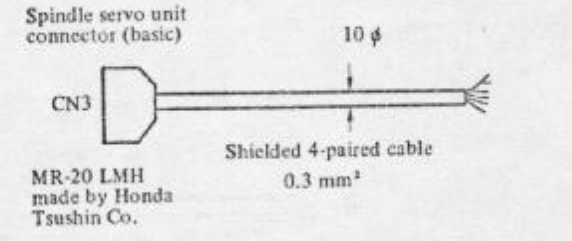
The cable specifications are as shown below.
Prepare cables by users.

(1) Power line and motive power line for respective motor models

| Use | Symbol | Specifications | Remarks |
|---|---|---|---|
| For model 3 (Lower than 12 KVA) | K1<br>K2 |  | A02B-0008-K853<br>7m long |
| For model 6 (Lower than 16 KVA) | K1<br>K2 |  | A02B-0008-K854<br>7m long |
| For model 8, 12 (Lower than 25 KVA) | K1<br>K2 |  | A02B-0008-K855<br>7m long |
| For model 15 (Lower than 30 KVA) | K1<br>K2 |  | A14mm² cable is employable, if model 15 is not continuously operated with a heavy load of exceeding 25 KVA. |

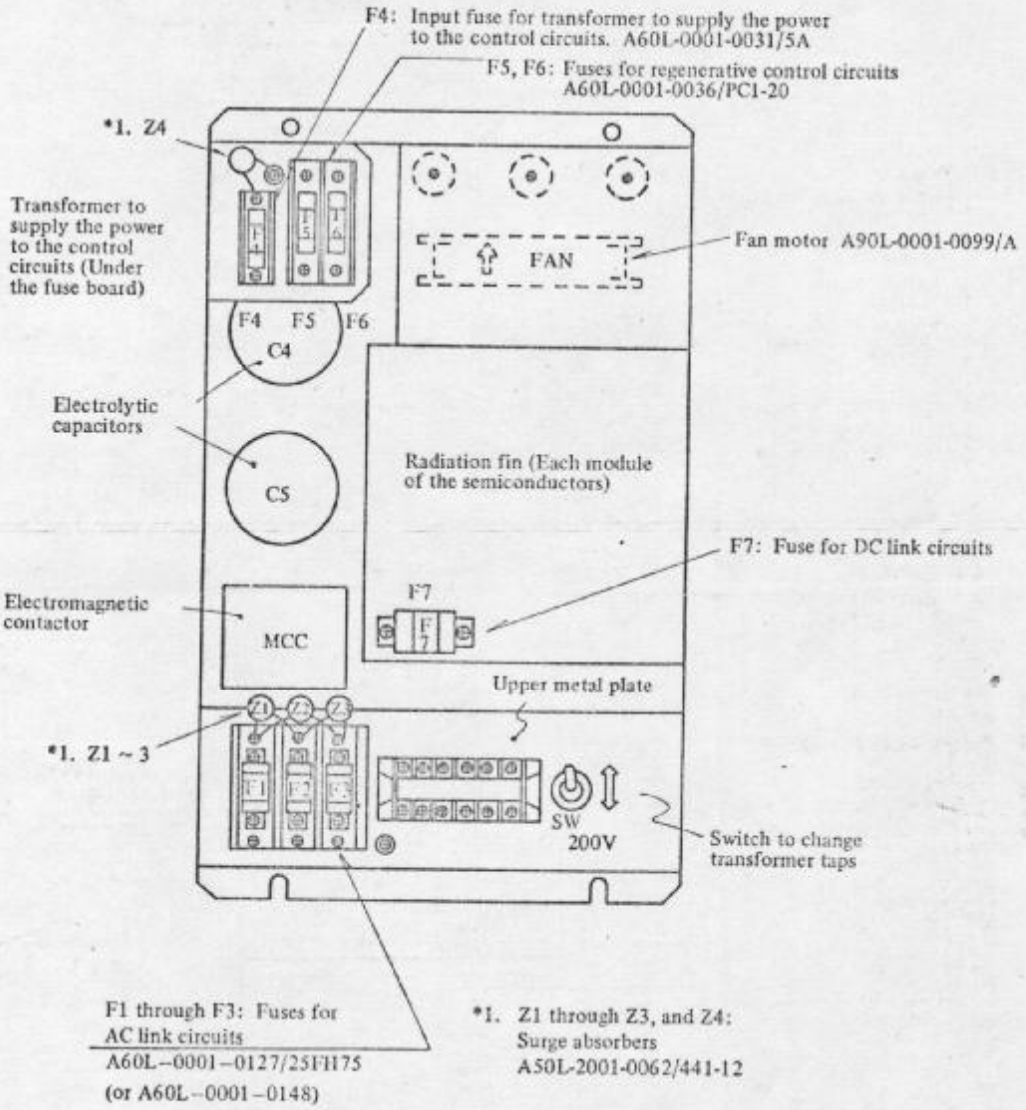
(2) Common line

The following cables are common to each model.

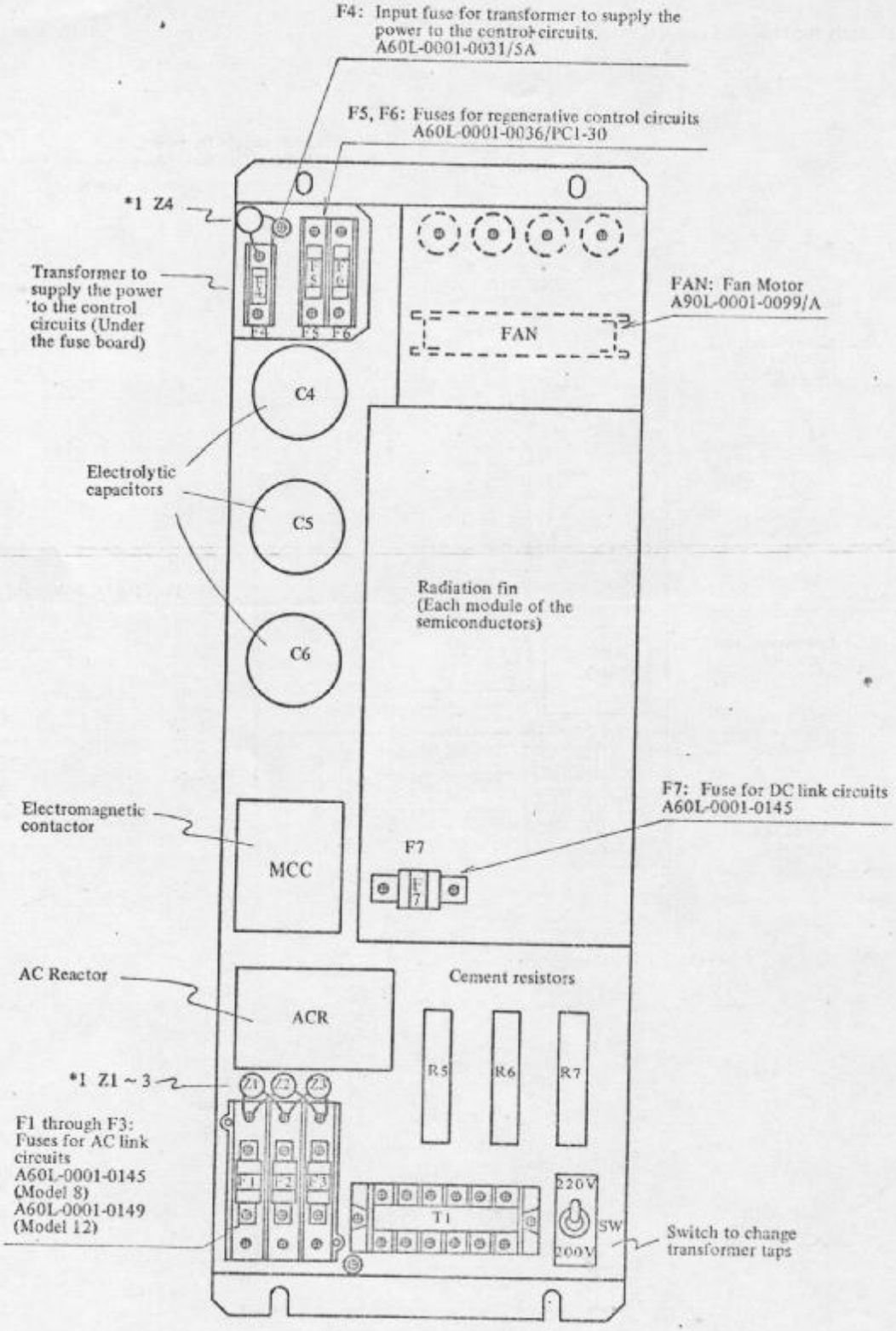
| Use | Symbol | Specifications | Remarks |
|---|---|---|---|
| Spindle servo unit<br><br>AC spindle motor (Cooling fan) | K3 |  | A660-8001-T865 /L7R03<br>7m long |
| Spindle servo unit<br><br>AC spindle motor (for signal) | K4 |  | Cable only<br>A66L-0001-0139 /L10R03<br>10m long |
| Spindle servo unit<br><br>Power magnetic control (for signal) | K5 |  | Cable only<br>A66L-0001-0042 /L10R03<br>10m long |
| Spindle servo unit<br><br>Power magnetic control (for signal) | K6 |  | Cable only<br>A66L-0001-0139 /L7R03<br>7m long |

## Appendix I-6 Unit parts mounting diagram

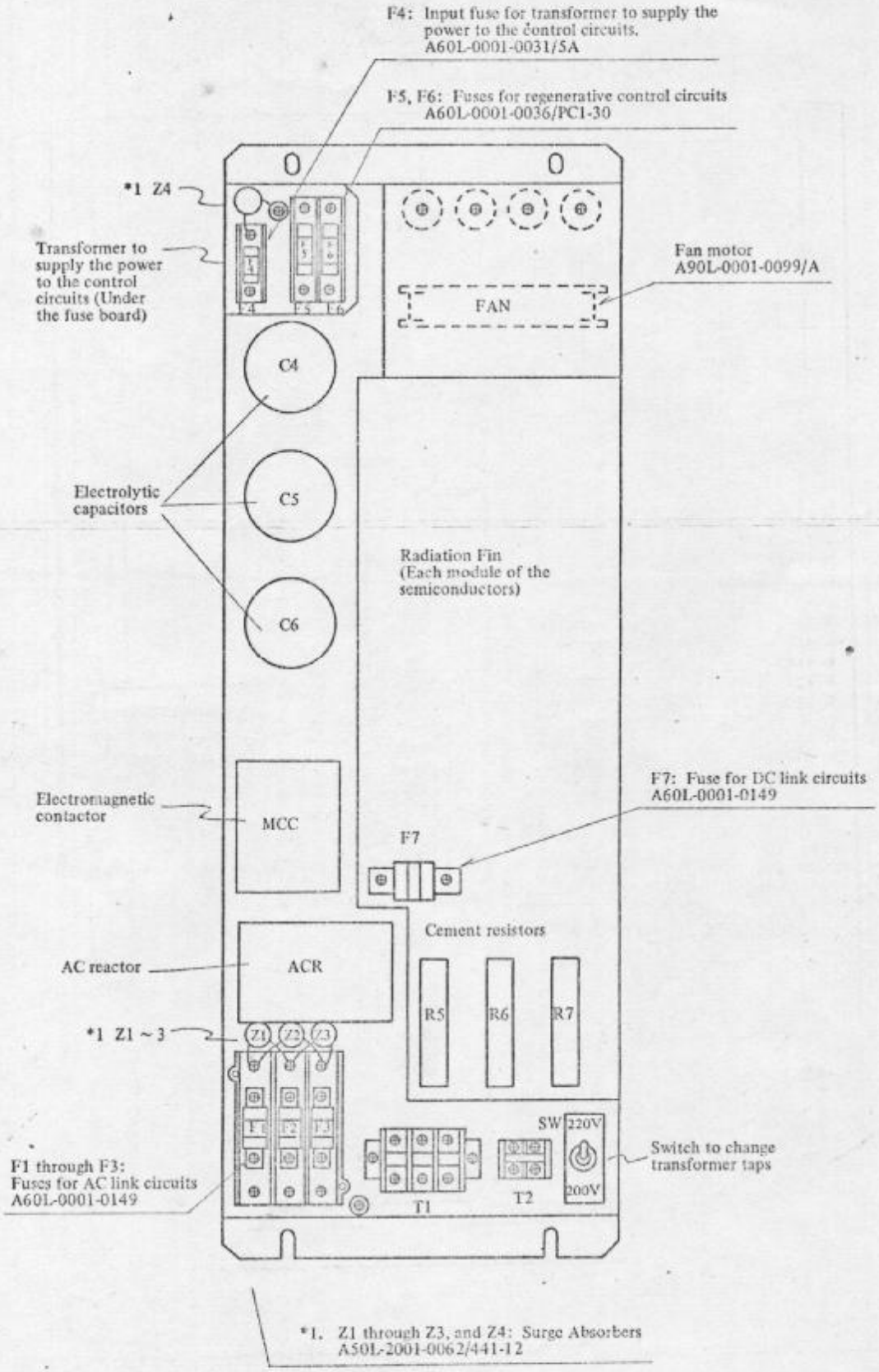
(1) Unit for Models 3 and 6 (A06B-6044-C008)



(2) Unit for Models 8 and 12 (A06B-6044-C009, C010)

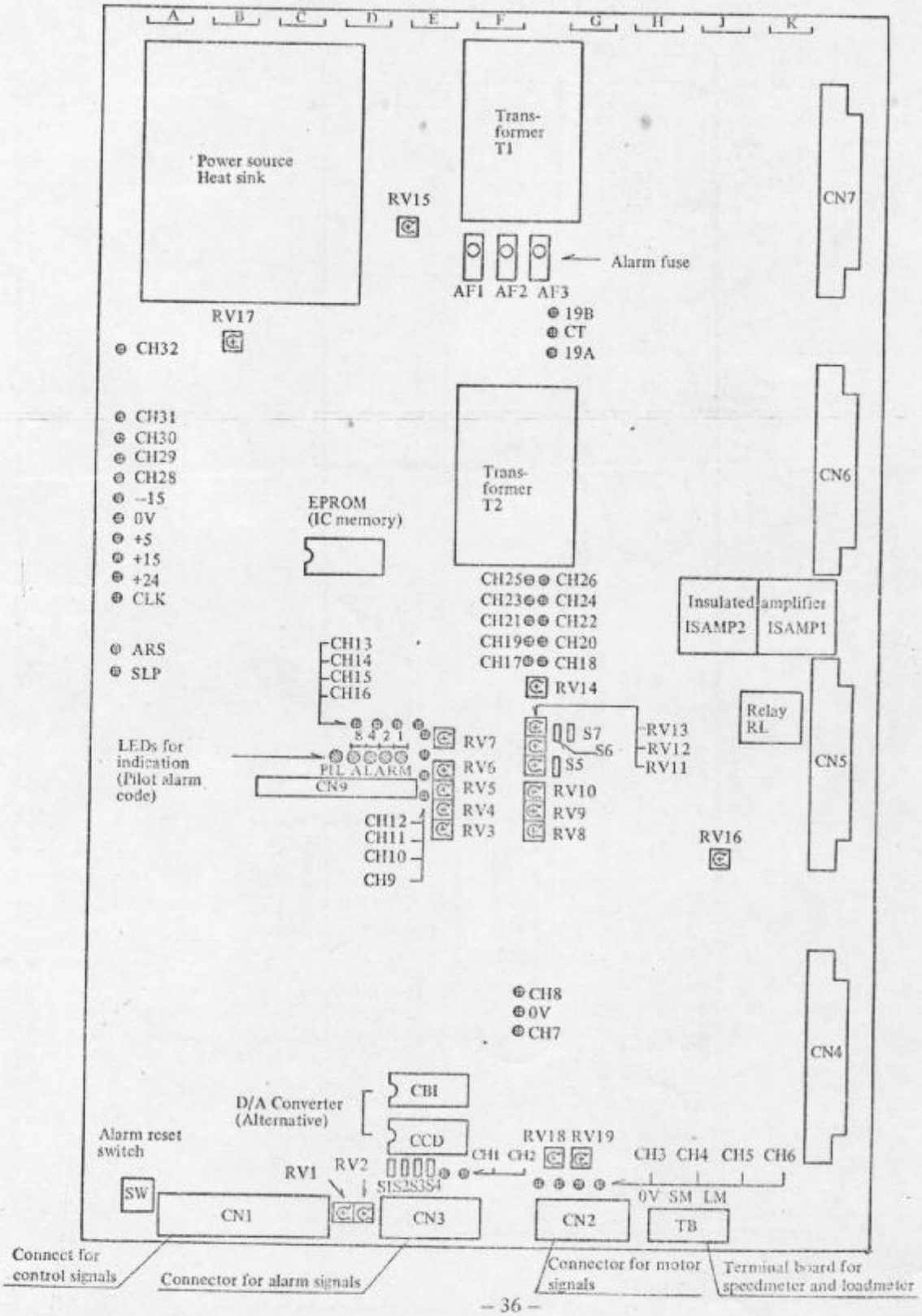


(3) Unit for Model 15 (A06B-6044-C011)



## Appendix I-7 PCB parts mounting diagram

*Notes*
- ⊕ : *Check Terminal (CH 1 to 32, etc.)*
- 🎛 : *Potentiometer (RV1 to 19)*
- ▯ : *Terminal for setting (S1 to 7)*



## Appendix I-8 Main parts list

(1) Fuses and surge absorbers

| Item | Symbol | Name | Specification | | | | |
|---|---|---|---|---|---|---|---|
| | | | Model 3 | Model 6 | Model 8 | Model 12 | Model 15 |
| 1 | F1 ~ 3 | Fuse | A60L-0001-0127/25FH75 | | A60L-0001-0145 | A60L-0001-0149 | |
| 2 | F4 | Fuse | A60L-0001-0031/5A | | | | |
| 3 | F5, 6 | Fuse | A60L-0001-0036/PC1-20 | | A60L-0001-0036/PC1-30 | | |
| 4 | F7 | Fuse | A60L-0001-0147 | | A60L-0001-0145 | | A60L-0001-0149 |
| 5 | Z1 ~ 4 | Surge absorber | A50L-0221-0062/441-12 | | | | |
| 6 | AF1 | Fuse on PCB | A60L-0001-0046/3.2 (3.2A) | | | | |
| 7 | AF2, 3 | 〃 | A60L-0001-0075/3.2 (3.2AS) | | | | |

(2) Main parts

| Item | Symbol | Name | Specification | | | | |
|---|---|---|---|---|---|---|---|
| | | | Model 3 | Model 6 | Model 8 | Model 12 | Model 15 |
| 1 | P.C.B. | Printed circuit board | A20B-0009-0530 | A20B-0009-0531 | A20B-0009-0532 | A20B-0009-0533 | A20B-0009-0534 |
| 2 | ROM | Memory element | J10 | J11 | J02 | J03 | J04 |
| 3 | TM1 ~ 11 | Transistor module | A50L-0001-0096 | | | | |
| 4 | SM1 ~ 3 | SCR module | A50L-5000-0029/30 | | A50L-5000-0029/50 | | |
| 5 | DM1 ~ 3 | Diode module | A50L-2001-0138 | | A50L-2001-0146 | | |
| 6 | D1 ~ 3 | Diode | A50L-2001-0103/12JH11 | | | | |
| 7 | D4 ~ 6 | Diode | A50L-2001-0103/12JG11 | | | | |
| 8 | D7 | Diode | A50L-2001-0081/60 | | | | |
| 9 | D8 | Diode | A50L-2001-0097/U06G | | | | |
| 10 | C1 ~ 3 | Capacitor | A42L-0001-0103 | | | | |
| 11 | MCC | Electromagnetic contactor | A58L-0001-0094/200V1A1B | | A58L-0001-0092/A | | |
| 12 | TF | Transformer | A80L-0001-0276 | | | | |
| 13 | FAN | Cooling fan | A90L-0001-0099/A | | | | |
| 14 | TH | Thermostat | A57L-0001-0028 | | | | |
| 15 | SW | Switch | A57L-0001-0030/2 | | | | |

## Appendix I-9 Adjustment of potentiometers on PCB

*Notes* *1. This table is applicable to PCBs of versions A20B-0009-0530 to 0534.*

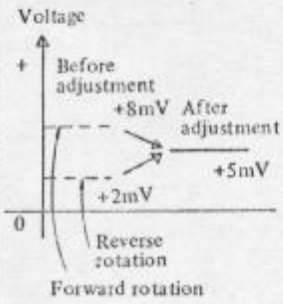
*2. Since the potentiometers, RV7, 8, 14 through 19, are adjusted by FANUC at shipment, they must not be readjusted by the user.*

| No. | Symbol | Item | Standard setting | Check terminals | Procedure |
|---|---|---|---|---|---|
| 1 | RV1 | Velocity command voltage level | | CH13-0V | See Subsection (1) on the next page. |
| 2 | RV2 | Velocity command voltage offset | | CH13-0V | See Subsection (1) on the next page. |
| 3 | RV3 | Speed arrival detection level | | CH10-0V | See subsection (4) |
| 4 | RV4 | Speed detection level | | CH9-0V | See subsection (5) |
| 5 | RV5 | Torque limitation level | | | See subsection (6) |
| 6 | RV6 | Regenerated power limitation | 3 scale | | See item 5.1.5. |
| 7 | RV7 | VF conversion level (1) | | CH23-0V | When the voltage between LM and 0M is 10V, the frequency is 200 ± 2 kHz. |
| 8 | RV8 | Setting for speed detection circuit | | CH18-0V | When the voltage between CH17 and 0V is 0.2V, 2.2 ± 0.1V. |
| 9 | RV9 | Adjustment of forward motor speed | | Number of motor revolutions | See Subsection (2) on the next page. |
| 10 | RV10 | Speed detection offset | | CH17-0V | When the spindle is stopped, the offset voltage must be within ±2 mV. |
| 11 | RV11 | Adjustment of reverse motor speed | | Number of motor revolutions | See Subsection (2) on the next page. |
| 12 | RV12 | Velocity loop gain | 5 scale | | |
| 13 | RV13 | Velocity loop offset | | Spindle | See Subsection (3) on the next page. |
| 14 | RV14 | Adjustment of loadmeter amplitude | | LM-0M | 10 ± 0.1V at acceleration (without torque limit) |
| 15 | RV15 | Voltage adjustment of +5V | | +5V–0V | 5 ± 0.05V |
| 16 | RV16 | Regenerated voltage limitation level | 4 scale | | |
| 17 | RV17 | VF conversion level (2) | | CH32-0V | When input voltage is 200V AC, the frequency is 24 ± 0.2 kHz. |
| 18 | RV18 | Adjustment of RA offset | | CH5-0V | 2.5 ± 0.05V in the state that CN2 is open. |
| 19 | RV19 | Adjustment of RB offset | | CH6-0V | Same as the above. |

(1) Velocity command voltage (RV1, RV2)

When the velocity command voltage is 10V, the motor rotates at the rated speed.

| Item | Measuring terminals | Adjustment procedure |
|---|---|---|
| Offset | CH13-0V | Set the motor in operating status and supply a velocity command voltage of 0V (equivalent to S00) to the motor. Adjust RV2 so that the voltage between the measuring terminals will not change when forward rotation and reverse rotation commands are issued alternately. See the following NOTE. |
| Level | CH13-0V | Next, supply a rated rotational command voltage of 10V to the motor, and adjust RV1 so that the voltage between the measuring terminals becomes +10V ± 0.05V when the spindle forward rotation command is issued. |



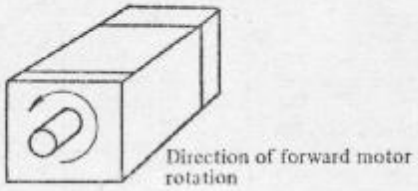

*(NOTE) For example, if the voltage at CH13 is +5.0mV when the spindle rotates forward and it is +5.0 mV ± 1.0 mV when the spindle rotates in reverse, the offset error of the vecocity command voltage is ± 1.0 mV.*

(2) Rotational speed adjustment (RV9, RV11)

The number of motor revolutions can be adjusted accurately by the following procedure. At this time, the number of motor revolutions should be measured directly using a stroboscope or tachometer.

| Item | Measuring point | Adjusting procedure |
|---|---|---|
| Number of forward motor revolutions | Spindle | Supply the rated velocity command voltage to the motor.<br>Adjust RV9 so that the motor rotates at the rated speed when a forward rotation (SFR) command is issued. |
| Number of reverse motor revolutions | Spindle | Adjust RV11 so that the motor rotates at the rated speed when a reverse rotation (SRV) command is issued. |

*(NOTE) The forward rotation means that the AC spindle motor rotates counterclockwise (forward rotation) as seen from the shaft. Thus, it may not correspond to the forward rotation of the machine spindle.*



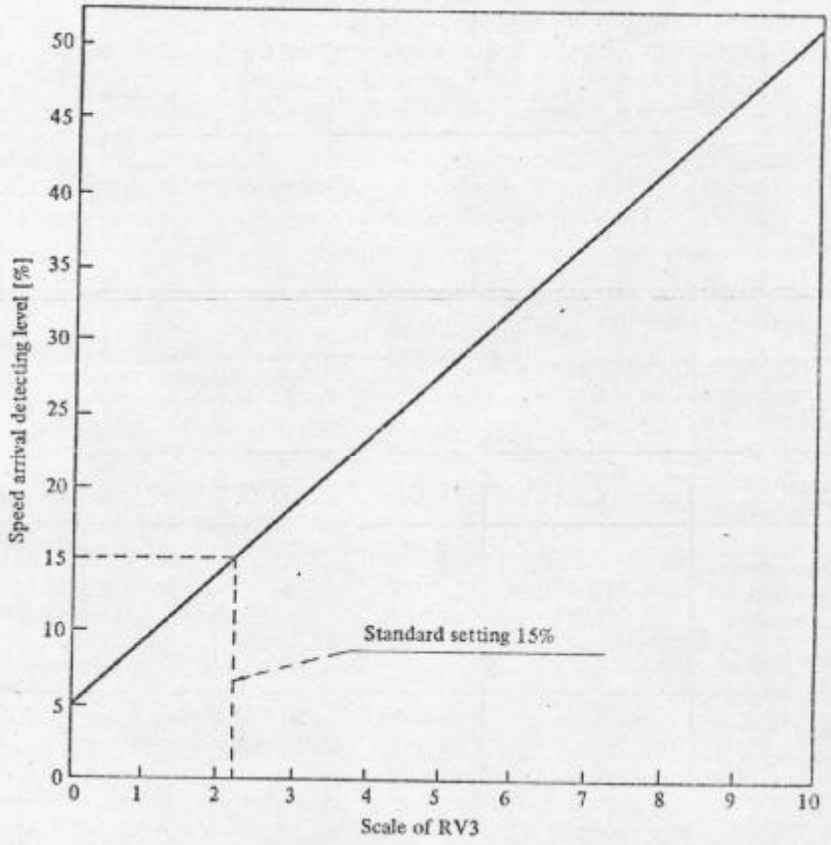

(3) Velocity offset (RV13)

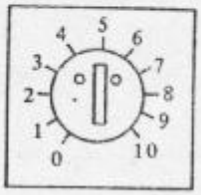
This adjustment is made so that the spindle will not rotate at low speed when a velocity command voltage of 0V is supplied. This should be performed after the previous adjustments.

| Item | Measuring point | Adjusting procedure |
|---|---|---|
| Velocity offset | Spindle (or Motor) | Supply a velocity command voltage of 0V. Adjust RV13 so that the spindle will not rotate when forward or reverse rotation commands are issued. |

(4) Speed arrival detection level (RV3)

Setting of the speed arrival detection level can be performed by using the following graph.

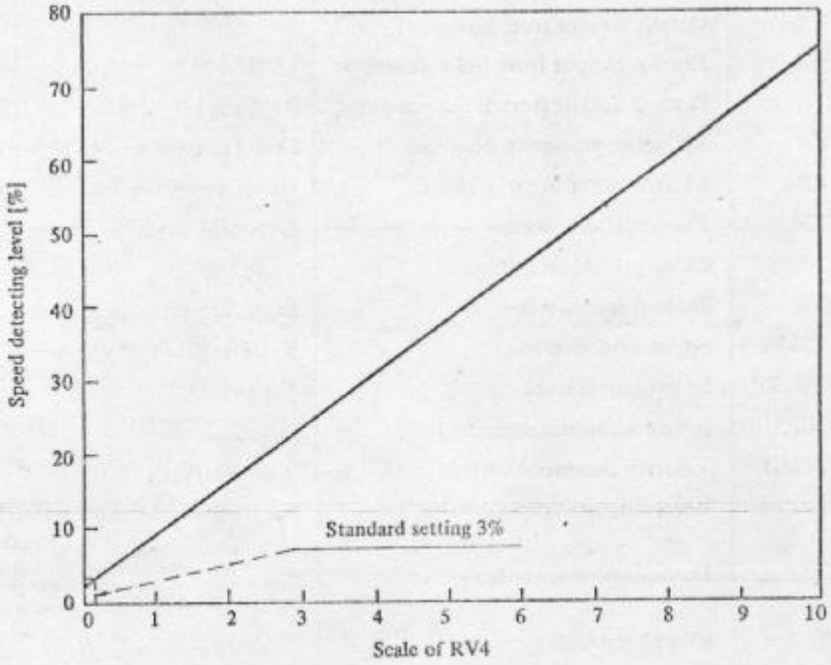



How to read the scale of potentiometer

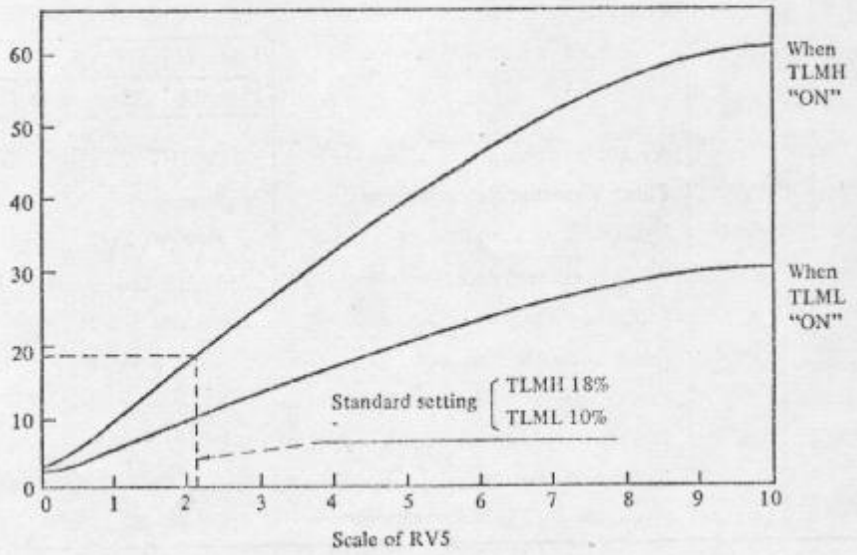
(5) Speed detecting level (RV4)

Vertical axis is the percentage of motor speed when rated value is assumed as 100%. This signal can be used for confirmation when clutch or gear is being changed.




(6) Torque limit level (RV5)

Vertical axis is the percentage of torque when 30 minutes rated torque is assumed as 100%.



## Appendix I-10 Description of check terminals

| Terminal name | Signal name | Contents | Remarks |
|---|---|---|---|
| CH1 | DA2 | Analog command voltage | 0 ∼ 10.0V |
| CH2 | DA1 | Output voltage from D/A converter | 0 ∼ 10.0V |
| CH3 | PA | Phase A output from pulse generator | (2.5V ± 5%) ± $0.2V_{TYP.}$ |
| CH4 | PB | Phase B output from pulse generator | PA leads PB by 90° when CW rotation |
| CH5 | RA | Reference voltage of phase A | Direct current of PA: ±25 mV |
| CH6 | RB | Reference voltage of phase B | Direct current of PB: ±25 mV |
| CH7 | PSA | Phase A square wave | Duty 50% (at constant speed) ±10% |
| 0V | 0V | 0V of printed circuit board | |
| CH8 | PSB | Phase B square wave | Duty 50% (at constant speed) ±10% |
| CH9 | SDTRF | Speed detection level | Variable 0.14V through 7.4V by RV4 |
| CH10 | SARRF | Speed arrival level | Variable by RV3 |
| CH11 | BUZY | Acceleration/deceleration busy |  1: During Acc/Dcc |
| CH13 | VCMD | Velocity command voltage | 0 ∼ ±10.0V⊕; CCW, ⊖CW |
| CH14 | RVP | Reverse rotation speed pulse | Pulse width: 3.2 microseconds (Only for reverse rotation) |
| CH15 | FWP | Forward rotation speed pulse | Pulse width: 3.2 microseconds (Only for forward rotation) |
| CH16 | 0V | 0V of printed circuit board | |
| CH17 | TS1 | F/V output of velocity feedback | 6000 rpm (CCW): −10V |
| CH18 | TS2 | Low speed detection signal | 120 rpm (CCW): −2.2V |
| CH20 | TSA | Velocity feedback signal | Rated rotational speed: ±10V, CCW:⊖ |
| CH21 | LTRF | Output torque limitation voltage | Output = −[(\|$V_{CH21}$\|+ 1.8)/10] X Maximum output |
| CH22 | CRU | Phase U current detection signal | Current per 1V<br>M3, 6 \| M8 \| M12 \| M15<br>16.7A \| 25A \| 35.7A \| 50A |
| CH23 | ERP | VF conversion output | CH28 10V: 20 kHz, width; 0.4 μs |
| CH24 | CRV | Phase V current detection signal | V phase motor current detection signal |
| CH25 | TRWF | Triangle wave signal |  $10V_{p-p}$ |
| CH26 | CRW | Phase W current detection signal | W phase motor current detection signal |
| CLK | CLK | Clock signal | 312.5 kHz 200 ns typ |
| +24 | 24V | Power source voltage of +24V | DC 25.6 Vtyp, Ripple: $0.5V_{p-p}$ 100 Hz |
| +15 | 15V | Power source voltage of +15V | −15V ± 4% |
| +5 | 5V | Power source voltage of +5V | +5V ± 1% (Preadjusted by RV15) |
| 0V | 0V | 0V of printed circuit board | 0V, same as CH16 |
| −15 | −15V | Power source voltage of −15V | −15V ± 4% |

## APPENDIX

# II. SPINDLE ORIENTATION CONTROL CIRCUITS

Revision Record

FANUC AC SPINDLE SERVO UNIT MAINTENANCE MANUAL (B-53425E)

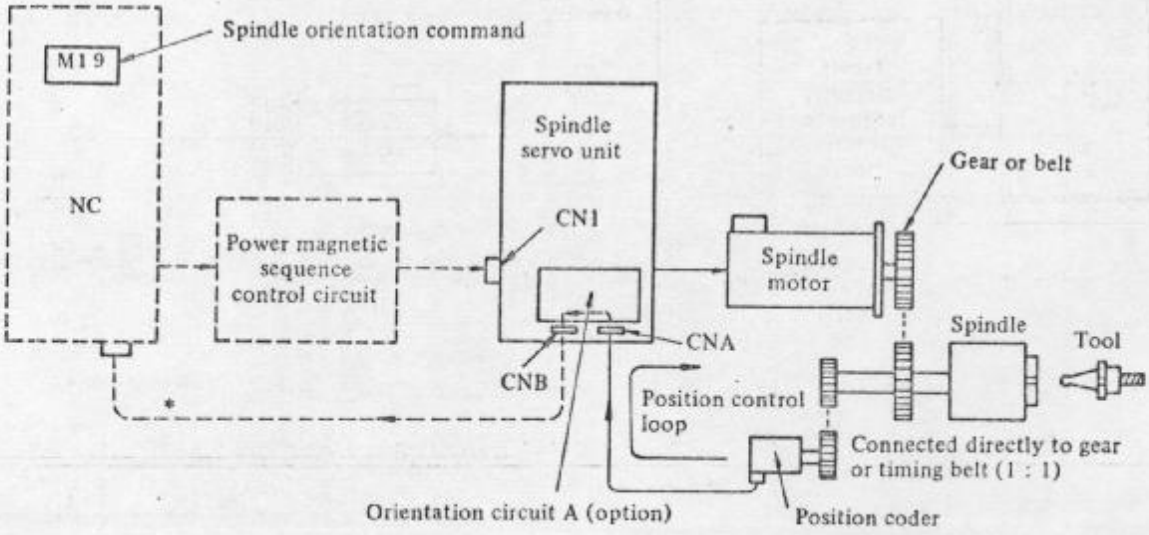
| Edition | Date | Contents | Edition | Date | Contents |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| 02 | '81.10 | correction of error. | | | |
| 01 | '81. 9 | | | | |

| Terminal name | Signal name | Contents | Remarks |
|---|---|---|---|
| CH28 | ER | Error voltage | 0 – 10V |
| CH29 | UCM | Phase U command voltage | |
| CH30 | VCM | Phase V command voltage | |
| CH31 | WCM | Phase W command voltage | |
| CH32 | 24VP | | |
| 19A | 19A | Input voltage of 19V AC | |
| CT | CT | 0V | |
| 19B | 19B | Input voltage of 19V AC | |

# 1. GENERAL

## 1.1 Structure

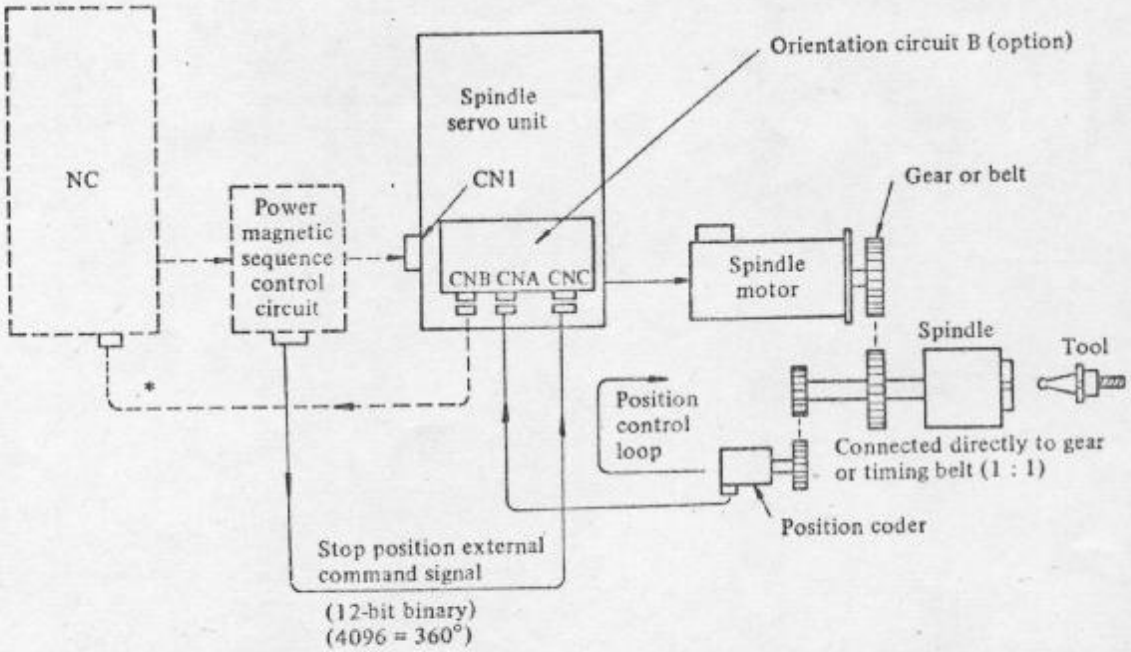
### 1.1.1 Position coder (Stop position internal setting)



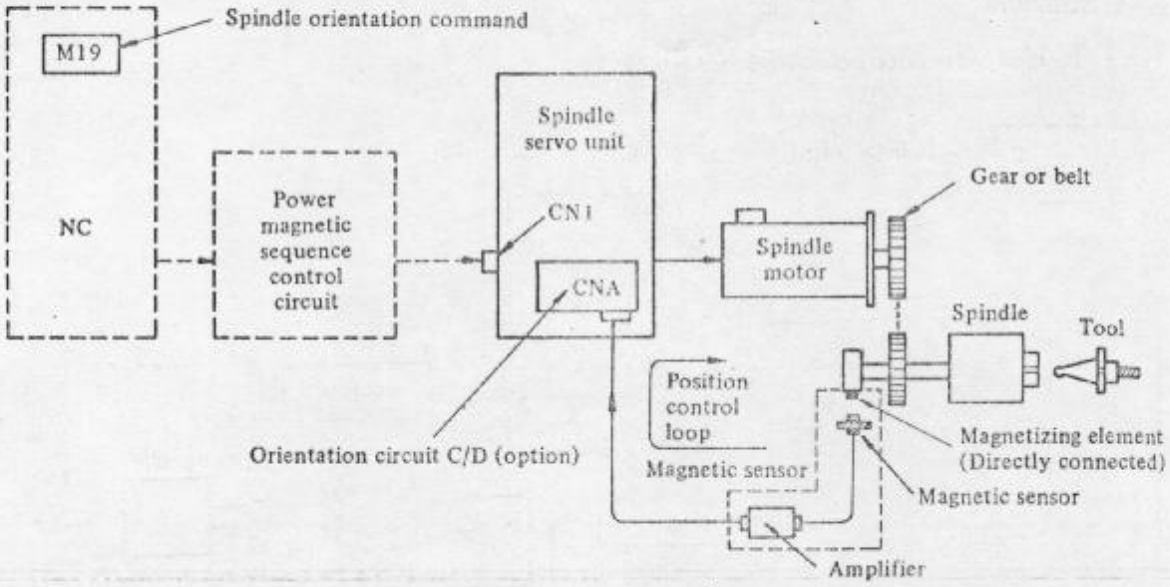

*(Note 1)* *When a position coder is attached to lathe, etc., it can be used for this purpose.*

*(Note 2)* *The broken line marked with * is the cable route when the position coder attached to lathe or the position coder for the synchronous feed for machining center is used concurrently.*

### 1.1.2 Position coder (Stop position external setting)



### 1.1.3 Magnetic sensor



## 2. ADJUSTMENT OF MAGNETIC SENSOR SYSTEM SPINDLE ORIENTATION

### 2.1 Mounting magnetizing element and magnetic sensor

Determine the mounting direction for the magnetizing element and magnetic sensor as follows. Incorrect mounting may cause repeating of clockwise and counterclockwise rotation of spindle without stopping during positioning, hunting, and the end of the magnetizing element and sensor head to stop in the opposite position.

Mounting magnetizing element and sensor

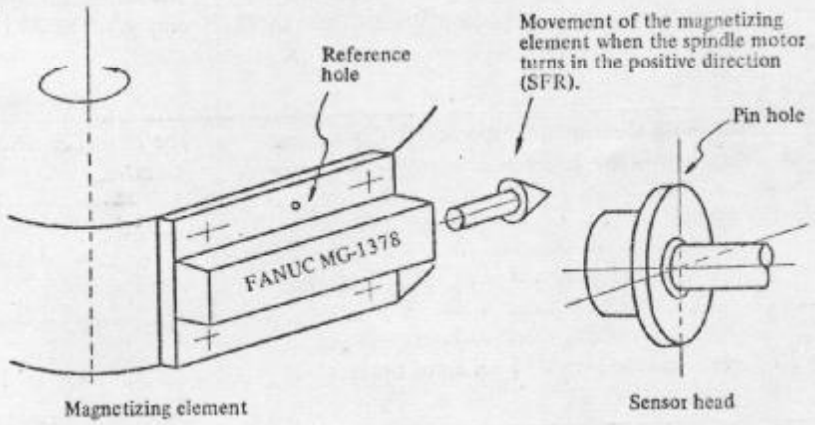
| Item | Explanation |
|---|---|
| 1 | Mount the magnetizing element so that the reference hole moves and faces as shown in Figure 1 when the spindle rotates in the positive direction by the command of spindle motor CW rotation (SFR and VCMD positive). |
| 2 | Mount the magnetic sensor head so that the pin hole of the flange and the reference hole of the magnetizing element face in opposite directions. |
| 3 | The gap between the magnetizing element and sensor head should be a minimum of 1.5 ± 0.5 mm. |
| 4 |  |

Figure 1 Mounting magnetizing element

## 2.2 Setting and adjustment of two speed steps type

Spindle orientation circuit C ..... A06B-6041-J120
Orientation circuit C PCB ..... A20B-0008-0030

### 2.2.1 Setting and function of jumper terminal (SH)

The connection and function of jumper terminals (SH) which can be freely selected, are listed below. SH01 should be connected after the power is on since it is used only for adjustment and testing. It should be disconnected after adjustment making sure that LED7 goes off.

Connection and functions of jumper terminals (SH)
(A double outline indicates the standard setting)

| (Note 1) Status | | | Function | Remarks |
|---|---|---|---|---|
| SH | 1-2 | 2-3 | | |
| 01 | / | ○ | Test mode (Note 2) | Connected only for adjustment. |
| 02 | ○ | × | When an orientation instruction is issued after power is turned on and before driving the spindle, the motor shaft end rotates in a clockwise direction. | The setting on SH03 takes priority of the setting on SH02. |
| | × | ○ | When an orientation instruction is issued after power is turned on and before driving the spindle, the motor shaft end rotates in a counterclockwise direction. | The setting on SH02 is effected only when SH03 1-2 is connected. |
| 03 | ○ | × | Moves in the direction the spindle was turning just before the orientation instruction was issued. | The setting on SH02 becomes effective. |
| | × | ○ | The orientation direction is always CCW. | |
| | × | × | The orientation direction is always CW. | |
| 04 | × | × | Initial orientation speed is about 60 × [spindle position loop gain $s^{-1}$] r.p.m. of the spindle. (usual rate) | Since spindle position loop gain is generally close to 5 $sec.^{-1}$, the usual rate is about 300 r.p.m. |
| | ○ | × | The initial rate of speed is limited to 1/3 the usual rate. | |
| | × | ○ | The initial rate of speed is limited to 2/3 the usual rate. | |

*Notes: (1) ○ indicates connected, × indicates not connected.*

*(2) When in Test Mode*

*(a) The orientation instruction is issued.*

*(b) Orientation end signal (ORAR 1,2) is not transferred.*

*(c) The spindle turns at the initial speed while SW1 (INITIALIZING BUTTON) is pressed. When it is released, the spindle stops at a fixed position.*

*(d) The red light emitting diode (LED 7) is on in this mode.*

### 2.2.2 LED indicators

Seven display lamps (LED 1 – 7), indicating the meanings listed below, are mounted on this option board. (LED 1 and LED 2 are not mounted on board 01A.)

LED indicators

| LED | Meaning | Color | Explanation |
|---|---|---|---|
| 1 | ORIENTATION | Green | Lights during execution of an orientation instruction. (ORCM 1 and 2 are connected: ON) |
| 2 | CLUTCH (gear) LOW | Green | Lights when the clutch (gear) LOW signal is on. (*CTH 1 and 2 are connected: ON) |
| 3 | MS PEAK LEVEL | Green | Lights while the peak value of the magnetic flux detection signal (MS) is out of the range of ±10V. Adjustment indicator. |
| 4 | SLOWDOWN PERIOD | Green | Lights during the low turning speed period when the spindle position approaches the stop position during orientation. |
| 5 | IN-POSITION FINE | Green | Lights when the value of MS output approaches within +0.1° of the spindle angle. Sometimes lights when the sensor is not on the magnetizing element. |
| 6 | IN-POSITION | Green | Lights when orientation has been completed and the spindle is within ±1° of the adjustment position. When it lights while not in TEST MODE, the Orientation Completion signal is transmitted. (ORAR 1 and 2 are connected: ON) |
| 7 | TEST MODE | Red | Lights when SH01 pins are connected. In this mode, the Adjustment Completion signal is not transmitted and ORCM is on. The orientation motion can be repeatedly confirmed by pressing SW1. |

### 2.2.3 Potentiometer (POT) setting

Set the POT according to the following values followed by, table before adjustment. * will be reset at a later stage.

Potentiometer settings

| POT name | RV | 1* | 2* | 3 | 4 | 5 | 6* | 7* | 8 | 9 | 11* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POT scale position | | 5.0 | 6.0 | ① | ① | ② | 2.0 | 5.0 | ③ | 7 | 5.0 |

① RV3 and RV4 settings

Set RV3 and RV4 according to the distance H between the turning ax magnetizing element and the center of the sensor head.

| H (mm) | 60 ~ 65 | ~70 | ~75 | ~80 | ~85 | ~90 | ~95 | ~10 | ~110 |
|---|---|---|---|---|---|---|---|---|---|
| Scale position | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.5 | 2.0 | 1.5 | 0.5 |

② RV5 setting

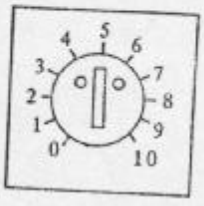
Set RV5 according to the number of revolutions ($N_{HM}$) when the sp es at rated speed.

| $N_{HM}$ (rpm) | 2,000 ~ 2,200 | ~ 2,500 | ~ 2,700 | ~ 3,100 | ~ 3,500 | ~ 4,000 | ~ 4,500 | ~ 5,00 | ~ 6,000 |
|---|---|---|---|---|---|---|---|---|---|
| Scale position | 7.5 | 6.5 | 5.5 | 4.5 | 3.5 | 2.5 | 2.0 | 1.5 | 0.5 |

③ RV8 setting

Set RV8 according to the transmission ratio of $R_{H/L}$ of spindle HIGH/LO

| $R_{H/L}$ | ~2.0 | ~2.2 | ~2.5 | ~2.8 | ~3.2 | ~3.7 | ~4.4 | ~5.3 | ~7.0 |
|---|---|---|---|---|---|---|---|---|---|
| Scale position | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10 |




Scale of potentiometer

### 2.2.4 Potentiometer adjustment

Adjust RV1 ~ RV11 according to the following table. Adjustment of orientation PCB must be performed after the adjustment of spindle control PCB. Orientation position may be shifted if the adjustment of RV12 or RV13 on spindle control PCB is altered.

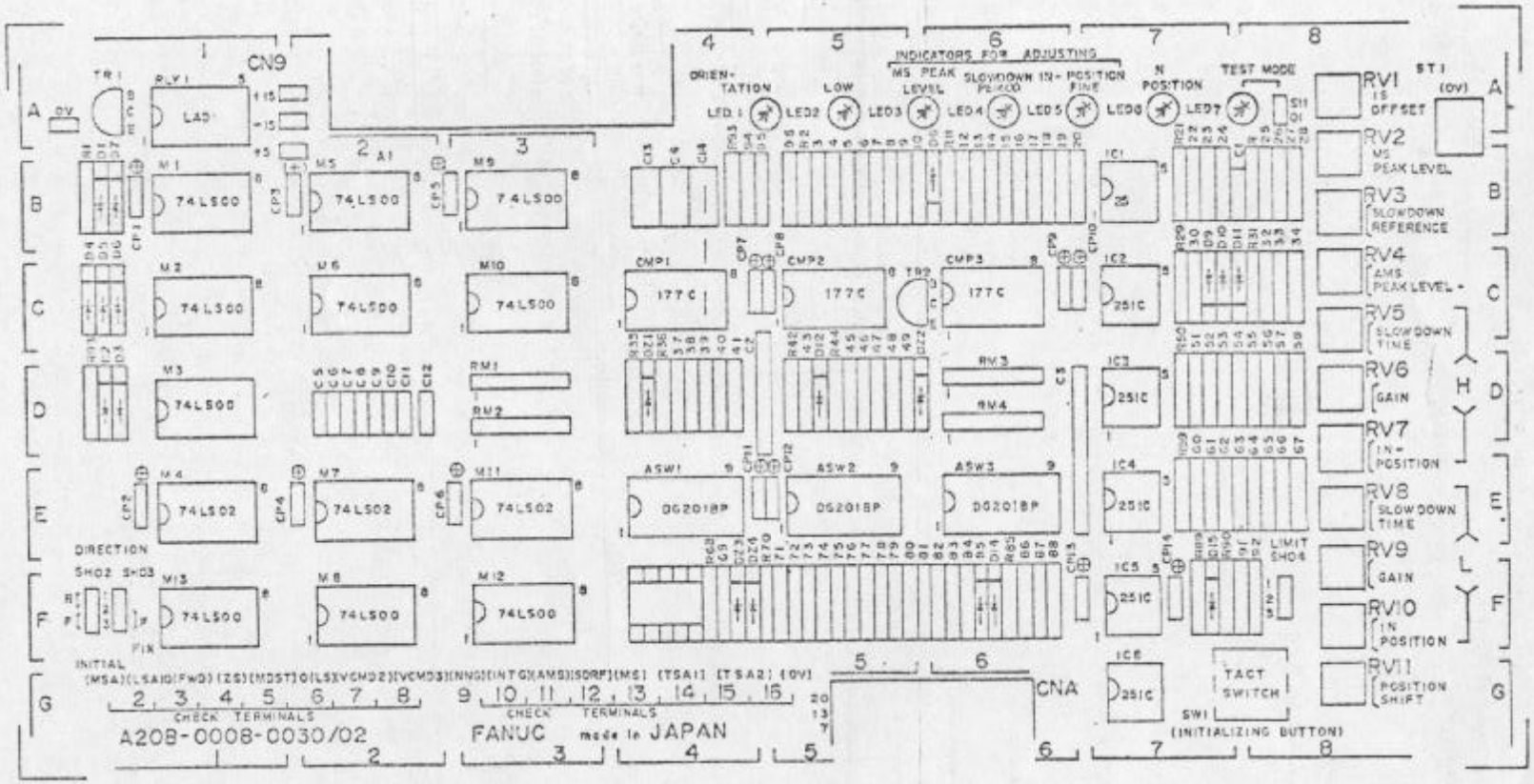
**Potentiometer adjustment**

The following adjustments should be performed in Test Mode by connecting SH01 pins.

| Term | POT name | Adjustment purpose | Condition | Adjustment method (Specification) |
|---|---|---|---|---|
| 1 | RV1 | TS OFFSET | The spindle should be stopped. | Voltage across check 15 (TSA2) and 16 (0V) should be within ± 1.0 mV. |
| 2 | RV2 | MS PEAK LEVEL | Keep pressing SW1 (INITIALIZING BUTTON) | Adjusted position until LED3 (MS PEAK LEVEL) begins to light. |
| 3 | RV3 | SLOWDOWN REFERENCE | | According to the setting terms. |
| 4 | RV4 | AMS PEAK LEVEL | | According to the setting terms. |
| 5 | RV5 | SLOWDOWN TIME IN HIGH MODE | Clutch (gear) is HIGH. Press SW1 to stop the spindle at the fixed position. The *CTH signal is off (open). | Just before stopping LED4 (SLOW DOWN PERIOD) should immediately light up clearly. |
| 6 | RV6 | GAIN [H] | Clutch (gear) is HIGH. Press SW1 to stop the spindle at the fixed position. The *CTH signal is off (open). | Turn in the CW direction being careful not overshoot when stopping. |
| 7 | RV8 | IN-POSITION | Clutch (gear) is HIGH. Press SW1 to stop the spindle at the fixed position. The *CTH signal is off (open). | LED5 (IN-POS. FINE) should light while LED 6 (IN-POSITION) is on. |
| 8 | RV8 | SLOWDOWN TIME IN LOW MODE | Clutch (gear) is LOW. Press SW1 to stop the spindle at the fixed position. The *CTH signal is on (closed). | LED4 (SLOWDOWN PERIOD) should immediately light up clearly just before stopping. (See term 5) |
| 9 | RV9 | GAIN [L] | Clutch (gear) is LOW. Press SW1 to stop the spindle at the fixed position. The *CTH signal is on (closed). | Turn in the CW direction being careful not to overshoot when stopping. |
| 10 | RV10 | IN-POSITION [L] | Clutch (gear) is LOW. Press SW1 to stop the spindle at the fixed position. The *CTH signal is on (closed). | LED 5 (IN-POS. FINE) should be on when LED 6 (IN-POSITION) is on. |

| Term | POT name | Adjustment purpose | Condition | Adjustment method (Specification) |
|---|---|---|---|---|
| 11 | RV11 | POSITION SHIFT | | The stop position can be finely adjusted to within ±1° of the spindle angle. |

After adjustment, release Test Mode making sure that LED 7 (Red) is off.




**Parts mounting diagram**

Location of check terminals and potentiometers.

## 2.3 Setting and adjustment of three speed steps type

Orientation circuit D . . . . . A06B-6041-J121
Orientation circuit D
PCB drawing number . . . . . A20B-0009-0520

The spindle speed range is as listed below.

| | Spindle speed range |
|---|---|
| High | 4000 – 8000 rpm |
| Medium | 1000 – 2000 rpm |
| Low | 250 – 667 rpm |

### 2.3.1 Setting and function of jumper terminal (SH)

See 2.2.1

### 2.3.2 LED indicators

| LED No. | Meaning | Color | Contents |
|---|---|---|---|
| LED1 | ORIENTATION | Green | Lights during execution of an orientation command. |
| LED2H | GEAR/CLUTCH | Green | Lights when the gear/clutch is shifted to high position. |
| LED2M | | | Lights when the gear/clutch is shifted to middle position. |
| LED2L | | | Lights when the gear/clutch is shifted to the low position. |
| LED3 | MS PEAK LEVEL | Green | Lights when the peak value of the MS signal sent from the magnetic sensor is out of the range of ±10V. |
| LED4 | SLOWDOWN PERIOD | Green | Lights during low turning speed and goes out when the magnetizing element reaches the sensor. |
| LED5 | IN-POSITION FINE | Green | Lights when orientation has been completed and the spindle is within ±0.1° of the adjustment position. |
| LED6 | IN-POSITION | Green | Lights when orientation has been completed and the spindle is within ±1° of the adjustment position. When it lights while not in TEST mode, the orientation completion signal is transmitted. |
| LED7 | TEST MODE | Red | Lights when terminals 01 and 02 of SH01 are shorted. |

### 2.3.3 Adjustments

The following adjustments should be performed in TEST mode after turning on the power.

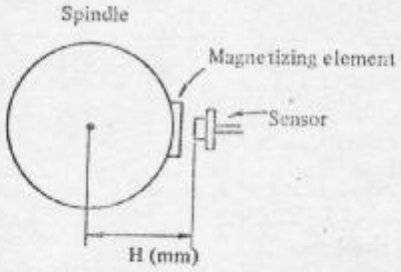
| Item | Variable resistor | Adjustment item | Condition | Adjustment procedure |
|---|---|---|---|---|
| 1 | RV1 | TSA OFFSET<br>Tachogenerator offset | The spindle should be stopped. | Voltage across check terminals CH15 (TSA2) and 16 (0V) should be within 0 ± 1.0 mV. |
| 2 | RV2 | MS PEAK LEVEL<br>Amplitude adjustment of MS signal | SW1 should be kept pressed. | Adjust the position until LED3 begins to light. |
| 3 | RV3 | SLOWDOWN REFERENCE<br>Setting of the slowdown level | Measure the distance form the center of the spindle to the sensor head | See NOTE 1. |
| 4 | RV4 | AMS PEAK LEVEL<br>Amplitude value of AMS signal | | |
| 5 | RV5 | SLOWDOWN TIME<br>Adjusting slowdown time | Shift the gear to the HIGH position and LED2H goes on. Turn SW1 on and off repeatedly. | Just before stopping, LED4 should immediately light up clearly (about 0.2 sec.) |
| 6 | RV6 | GAIN [HIGH]<br>Position loop gain | | Turn clockwise to increase the gain being careful not to overshoot when stopping. |
| 7 | RV7 | IN-POSITION [H]<br>Adjusting the spindle stop position | | Adjust so that LED5 lights while LED6 is on. LED5 may flicker. |
| 8 | RV8 | SLOWDOWN TIME [LOW]<br>Adjustment of slowdown time | Shift the gear to the LOW position and LED2L goes on. Turn SW1 on and off repeatedly. | Same as item 5 above. |
| 9 | RV9 | GAIN [LOW]<br>Position loop gain | | Same as item 6 above. |
| 10 | RV10 | IN-POSITION [LOW]<br>Adjusting the spindle stop position | | Same as item 7 above. |
| 11 | RV12 | SLOWDOWN TIME [MEDIUM]<br>Adjusting slowdown time | Shift the gear to the MEDIUM position and LED2M goes on. Turn SW1 on and off repeatedly. | Same as item 5 above. |
| 12 | RV13 | GAIN [MEDIUM]<br>Position loop gain. | | Same as item 6 above. |
| 13 | RV13 | IN-POSITION [MEDIUM]<br>Adjusting the spindle stop position | | Same as item 7 above. |
| 14 | RV11 | POSITION SHIFT<br>Shifting of spindle stop position | The stop position can be finely adjusted within a range of ±1° of the spindle angle. | Match the key position of the ATC arm to the groove position of the spindle. |

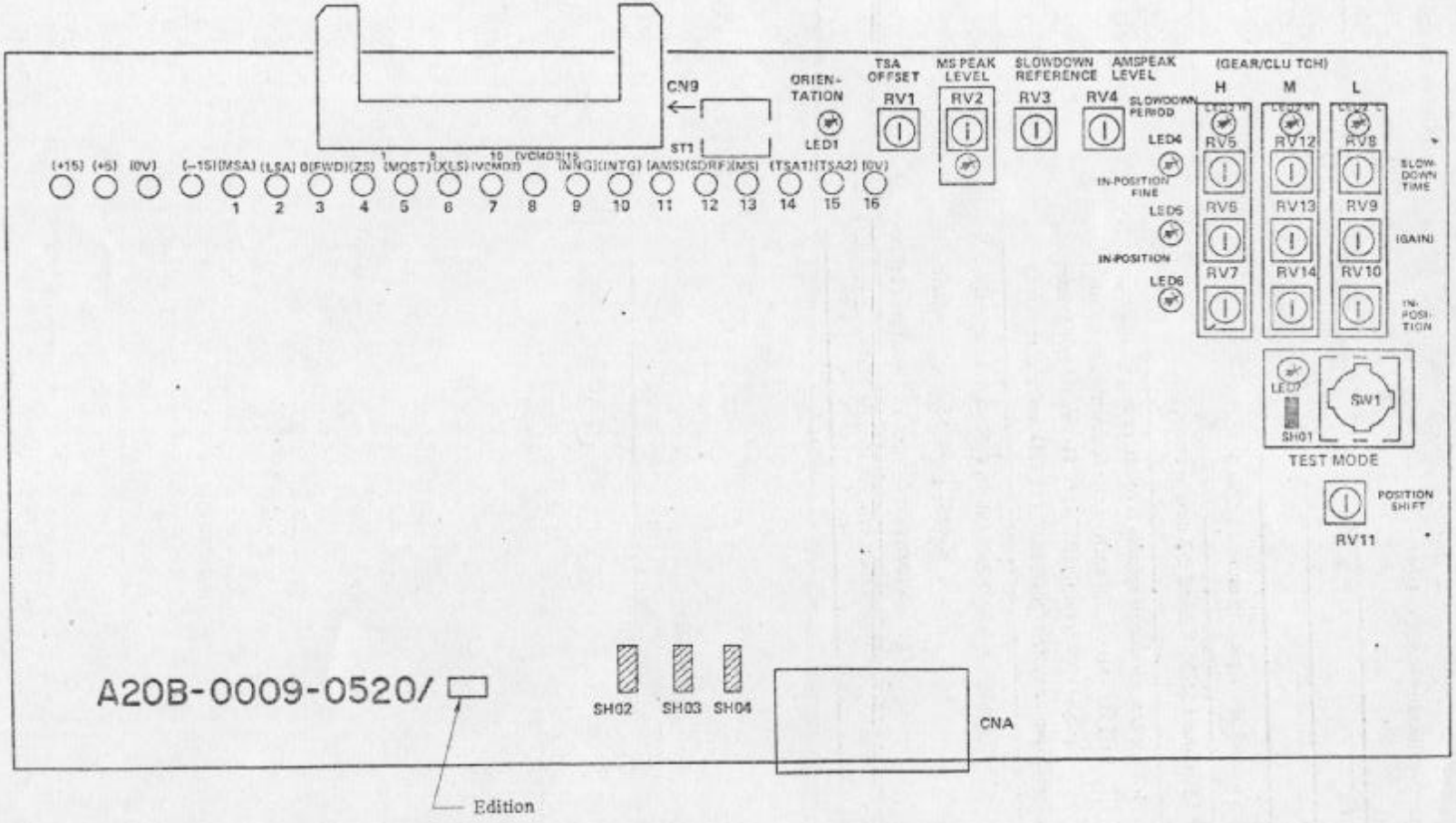
After adjustment, release test mode making sure that LED7 (Red) is off.

*(NOTE 1) Adjust RV3 and RV4 based on the distance (Hmm) from the center of the spindle to the sensor as listed below.*

| H (mm) | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|---|---|---|---|---|---|---|---|---|
| Position RV3, 4 | 9.5 | 6.5 | 4.5 | 3.0 | 2.2 | 1.5 | 1.0 | 0.5 |

Scale






Location of check terminals and potentiometers.

## 3. ADJUSTMENT OF POSITION CODER SYSTEM SPINDLE ORIENTATION

### 3.1 Printed circuit board

Spindle control circuit A20B-0009-0530 ~ 0534

Position coder method spindle orientation control circuit

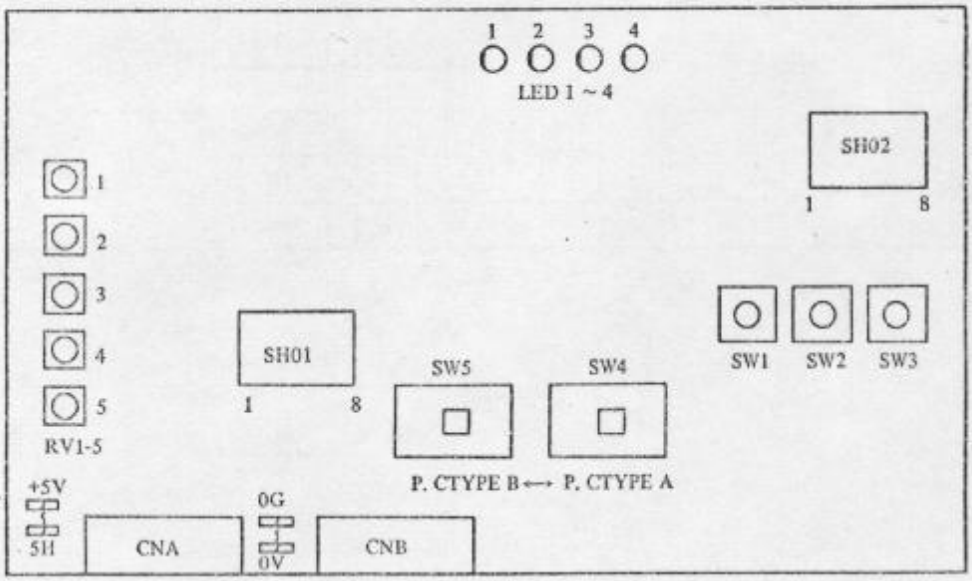
(1) Stop position internal setting A20B-0008-0240
(2) Stop position external setting A20B-0008-0241

### 3.2 Display

Light emitting diode

LED1 ORIENTATION ..... Lights when orientation command (ORCM1, 2 ON) is issued.
LED2 LOW ..... Lights when the contact of clutch change signal *CTH is closed. Lighting indicates that clutch LOW is selected.
LED3 IN-POSITION OUT ..... Lights when orientation completion signal ORAR 1-2 is issued.
LED4 IN-POSITION ADJUST ..... Lights when spindle enters within one pulse of orientation position.
Stop position can be the same at HIGH and LOW by adjusting POT RV3/RV5 for OFFSET adjustment so that this LED lights at gear HIGH/LOW.

### 3.3 Setting



(1) +5V – 5H
0G – 0V

When the power of +5V for position coder is supplied from spindle amplifier, connect between +5V and 5H and between 0G and 0V. When the power of +5V is supplied from NC, open between +5V and 5H and between 0G and 0V.

(2) Setting of SW5 and SW4

| Position coder | Type | SW4 | SW5 |
|---|---|---|---|
| Balanced type | Type A | Right | Right |
| Unbalanced type | Type B | Left | Left |

(3) Setting of SH01 and SH02

Follow the next table.

## Table 1 Setting of SH01, SH02

○: Connected ×: Open

| No. | Contents | | SH01 | | | | | | | | SH02 | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 \| 16 | 2 \| 15 | 3 \| 14 | 4 \| 13 | 5 \| 12 | 6 \| 11 | 7 \| 10 | 8 \| 9 | 1 \| 16 | 2 \| 15 | 3 \| 14 | 4 \| 13 | 5 \| 12 | 6 \| 11 | 7 \| 10 | 8 \| 9 | |
| 1 | Initial orientation direction immediately after turning on power | CCW | ○ | × | | | | | | | | | | | | | | | (Standard) |
| | | CW | × | ○ | | | | | | | | | | | | | | | |
| 2 | Orientation direction after initial orientation | CCW only | | | × | ○ | | | | | | | | | | | | | (Standard) |
| | | CW only | | | × | × | | | | | | | | | | | | | |
| | | Spindle rotational direction | | | ○ | × | | | | | | | | | | | | | (Standard) |
| 3 | Orientation speed which is set by position gain | 1 | | | | | × | × | | | | | | | | | | | |
| | | 2/3 | | | | | ○ | × | | | | | | | | | | | |
| | | 1/3 | | | | | × | ○ | | | | | | | | | | | |
| 4 | Rotational direction of spindle and position coder | Same direction | | | | | | | ○ | × | | | | | | | | | Different from machine tool to machine tool. Incorrect setting will cause hunting. |
| | | Reverse direction | | | | | | | × | ○ | | | | | | | | | |
| 5 (Note) | In-position width to issue orientation completion signal (ORAR 1, 2) | ±2 pulses | | | | | | | | | ○ | ○ | ○ | ○ | ○ | ○ | | | ±16 pulses correspond to ±1.3° |
| | | ±4 pulses | | | | | | | | | | ○ | ○ | ○ | ○ | ○ | | | |
| | | ±8 pulses | | | | | | | | | | | ○ | ○ | ○ | ○ | | | |
| | | ±16 pulses | | | | | | | | | | | | ○ | ○ | ○ | | | |
| | | ±32 pulses | | | | | | | | | | | | | ○ | ○ | | | |
| | | ±64 pulses | | | | | | | | | | | | | | ○ | | | |
| 6 | Setting due to position coder hysteresis | No pulse | | | | | | | | | | | | | | | × | × | (Standard) |
| | | +1 pulse | | | | | | | | | | | | | | | ○ | × | |
| | | −1 pulse | | | | | | | | | | | | | | | × | ○ | |

*(Note) The condition (c) of issue of orientation completion signal*

*c = (Spindle is within the in-position width) and (Velocity zero signal is ON) and (ORCM is ON)*

(4) Setting of stop position SW1, 2, 3

| Switch | Contents |
|---|---|
| SW1 (16 positions) | 1 position is 4096/16 = 256 pulses, equivalent to 22.5°. |
| SW2 (16 positions) | 1 position is 256/16 = 16 pulses, equivalent to 1.4°. |
| SW3 (16 positions) | 1 position is 16/16 = 1 pulse, equivalent to 0.088°. |

An arbitrary position in a rotation can be positioned by the unit of 0.088° = 1/4096 X 360° by setting in the order of SW1, 2 and 3.

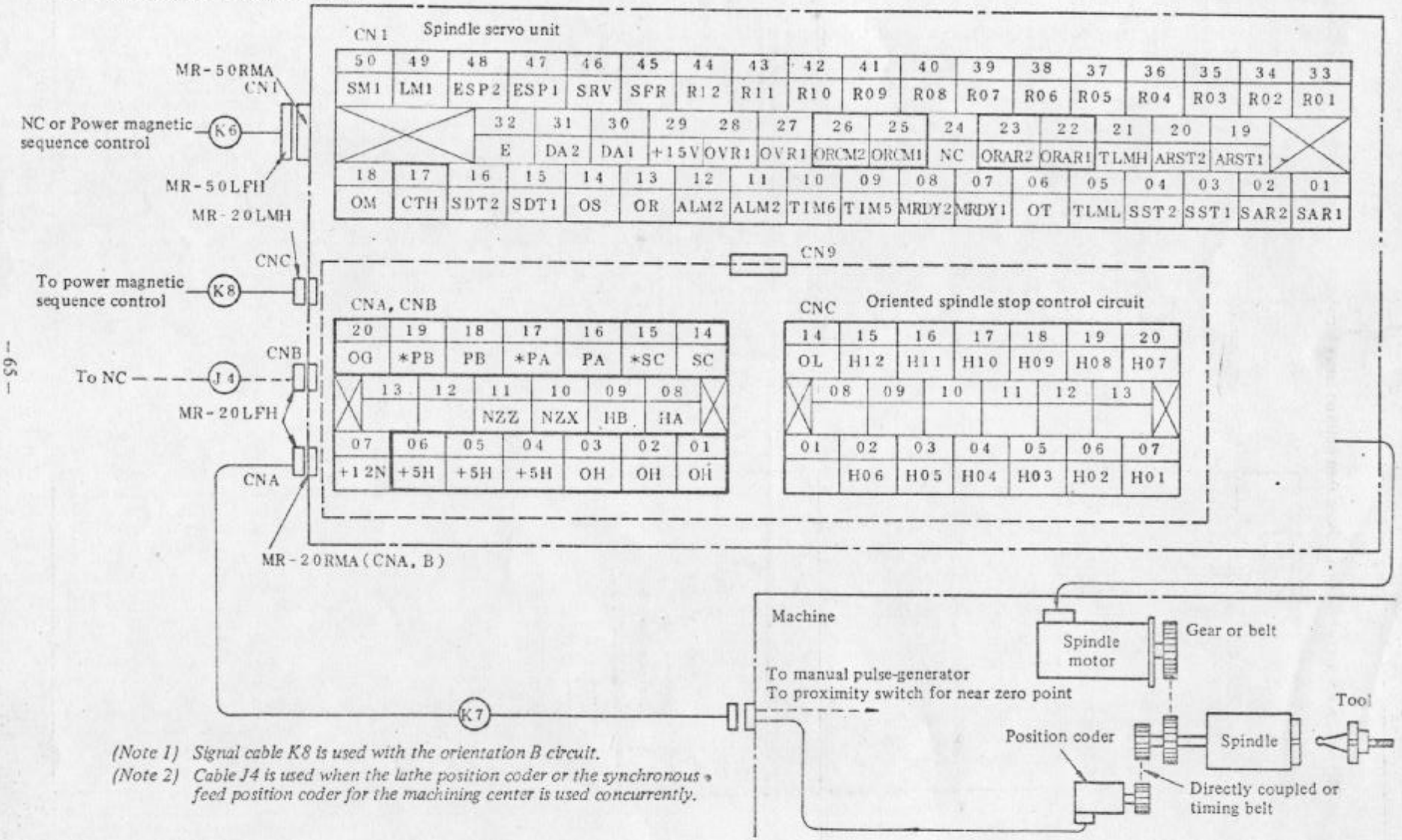
## 3.4 Adjustment

| No. | | Variable resistor | Measuring point | Standard Adjustment | Note |
|---|---|---|---|---|---|
| 1 | Velocity feedback offset | RV1 | TSA2 CH14 | 5 scale | The voltage at TSA2 should be ±1 mV. |
| 2 | Position gain at gear High | RV2 | Do not let spindle overshoot | 3∼4 scale | |
| 3 | Offset at gear High | RV3 | Let LED4 ADJUST light | About 5 scale | Gleaming of the LED is sufficient. |
| 4 | Position gain at gear Low | RV4 | Do not let spindle overshoot | 3∼6 scale | |
| 5 | Offset at gear Low | RV5 | Let LED4 ADJUST light | About 5 scale | |


Scale of potentiometer

## Appendix II-1 Connection diagram

### 1.1 Interface (For position coder)




| 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SM1 | LM1 | ESP2 | ESP1 | SRV | SFR | R12 | R11 | R10 | R09 | R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 |
| | | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | | |
| | | E | DA2 | DA1 | +15V | OVR1 | OVR1 | ORCM2 | ORCM1 | NC | ORAR2 | ORAR1 | TLMH | ARST2 | ARST1 | | |
| 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 |
| OM | CTH | SDT2 | SDT1 | OS | OR | ALM2 | ALM2 | TIM6 | TIM5 | MRDY2 | MRDY1 | OT | TLML | SST2 | SST1 | SAR2 | SAR1 |

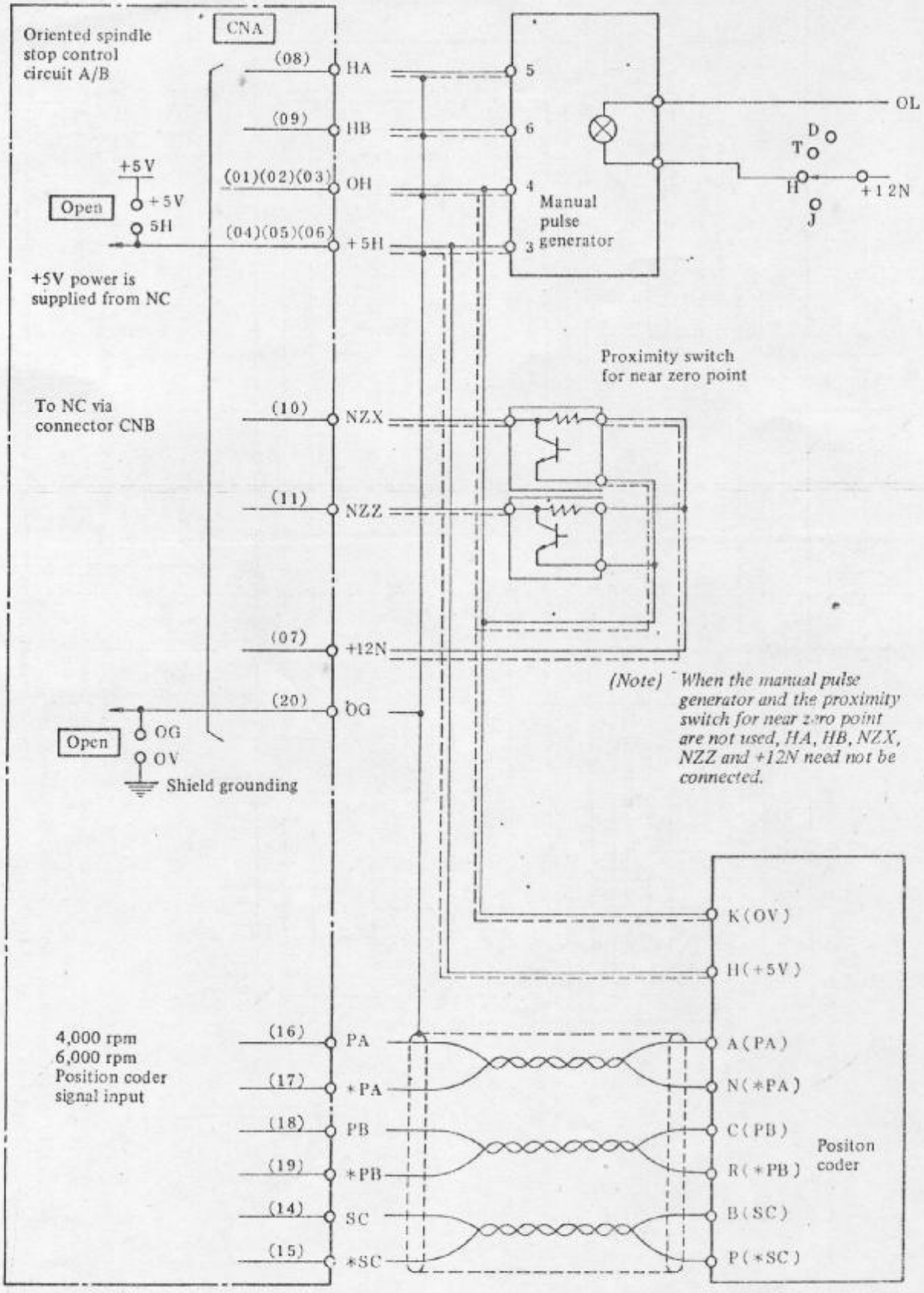
| 20 | 19 | 18 | 17 | 16 | 15 | 14 |
|---|---|---|---|---|---|---|
| OG | *PB | PB | *PA | PA | *SC | SC |
| 13 | 12 | 11 | 10 | 09 | 08 | |
| | | NZZ | NZX | HB | HA | |
| 07 | 06 | 05 | 04 | 03 | 02 | 01 |
| +12N | +5H | +5H | +5H | OH | OH | OH |

| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|
| OL | H12 | H11 | H10 | H09 | H08 | H07 |
| 08 | 09 | 10 | 11 | 12 | 13 | |
| | | | | | | |
| 01 | 02 | 03 | 04 | 05 | 06 | 07 |
| | H06 | H05 | H04 | H03 | H02 | H01 |

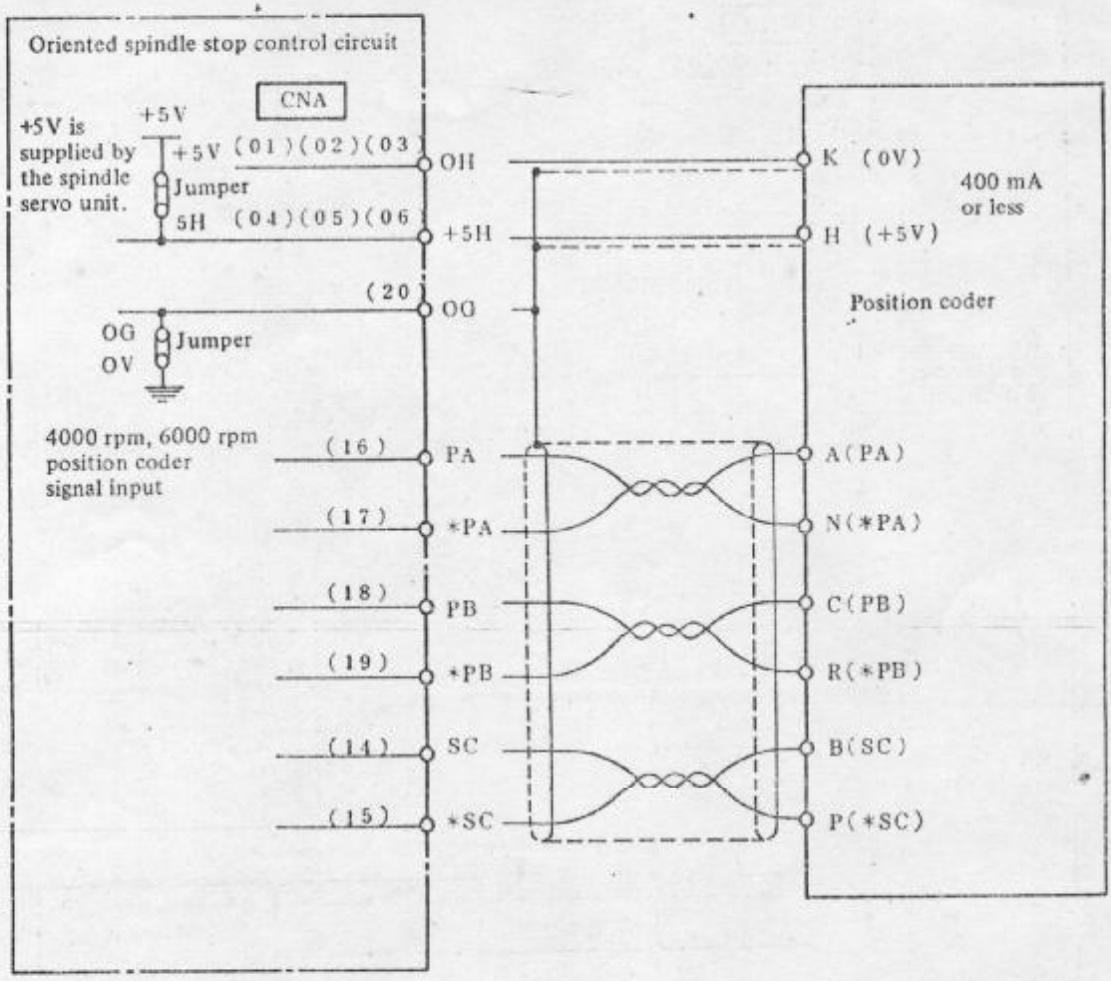
*(Note 1) Signal cable K8 is used with the orientation B circuit.*

*(Note 2) Cable J4 is used when the lathe position coder or the synchronous feed position coder for the machining center is used concurrently.*

### 1.1.1 Connection when synchronous feed position coder is concurrently used for lathes and machining centers.

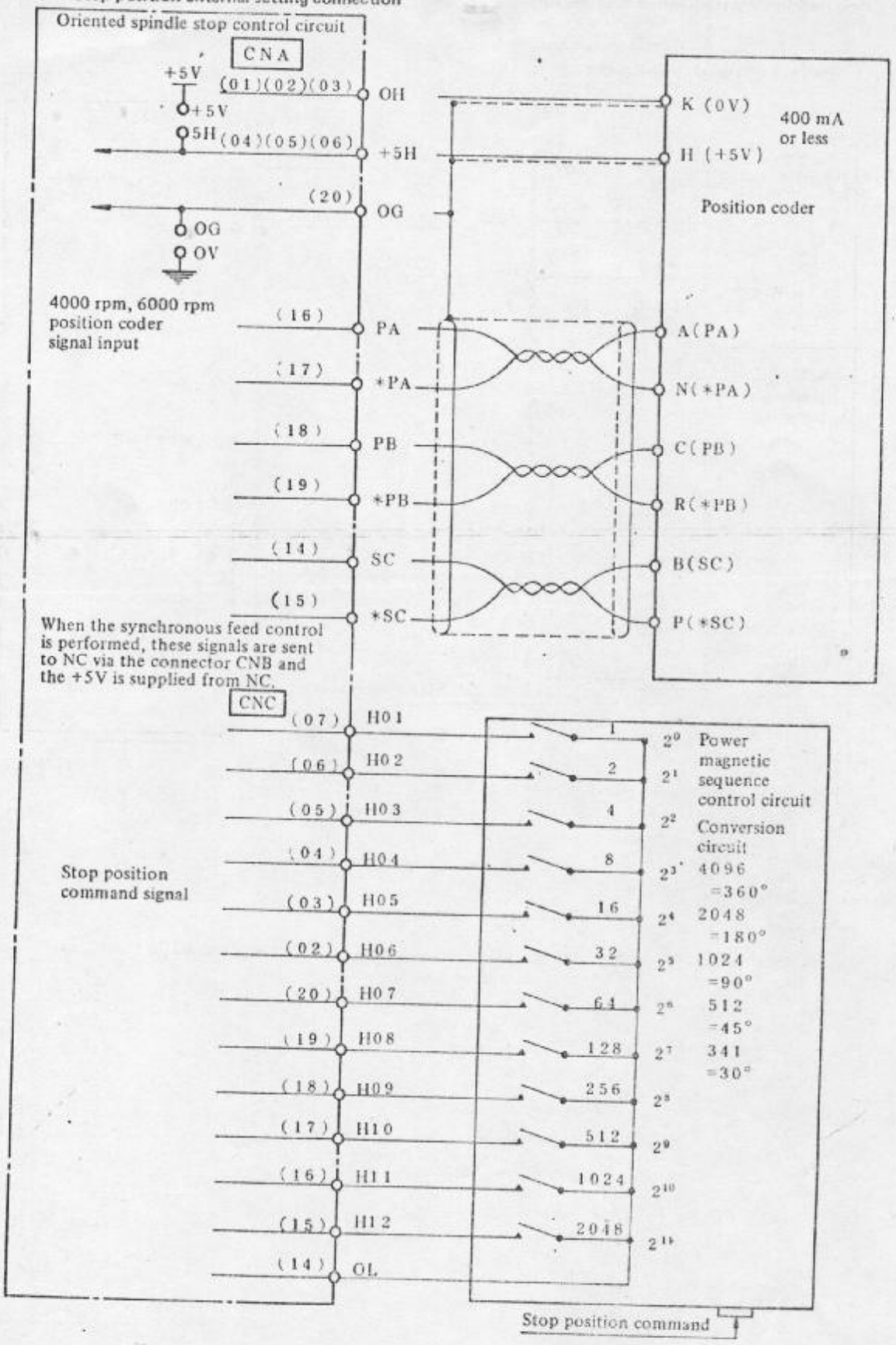


### 1.1.2 Connection for machining center spindle orientation only

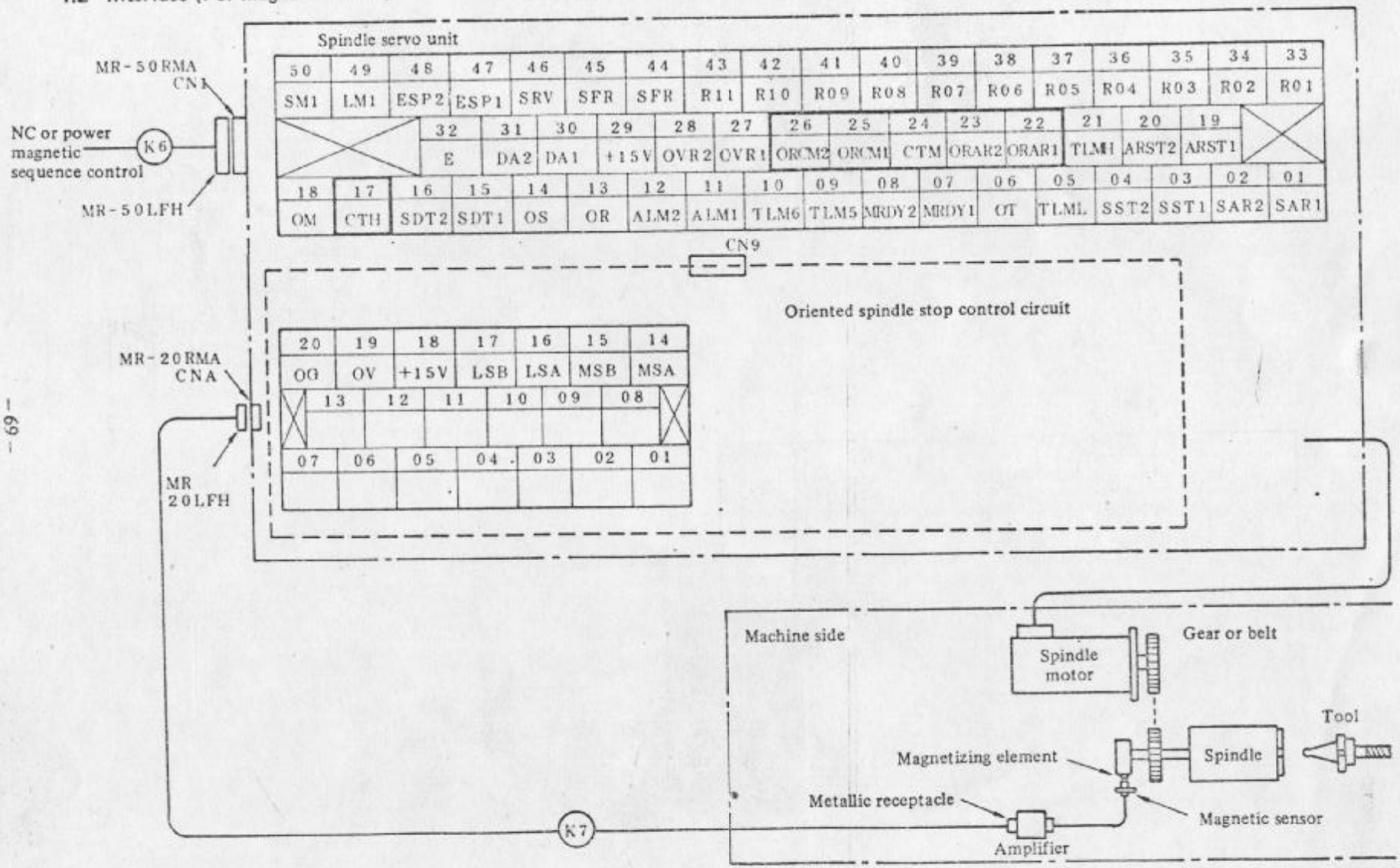



*(Note) The cable between the servo unit and the position coder must not exceed 20 meters.*

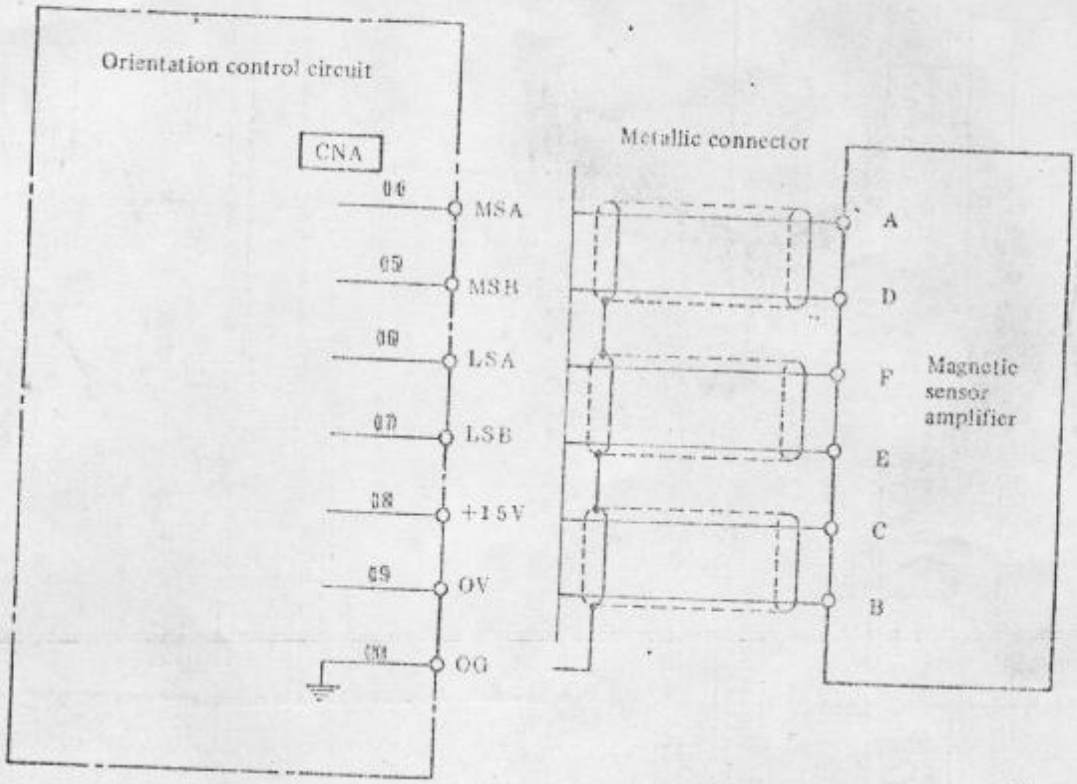
### 1.1.3 Stop position external setting connection



## 1.2 Interface (For magnetic sensor)



1.2.1 Magnetic sensor connection




The cable between the servo unit and the magnetic sensor amplifier must not exceed 20 meters.