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A06B-6041-H115

MANU.# PS00837

FANUC DC SPINDLE SERVO UNIT

FANUC 888-326-8287

MAINTENANCE MANUAL

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I. DC SPINDLE SERVO UNIT

MAINTENANCE MANUAL

for

MODEL 2, 3
HEADSTOCK

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1. GENERAL

This maintenance manual is applicable to Installation and adjustment and maintenance of the spindle servo unit which drives the FANUC DC spindle motor (Models 2 and 3) and the headstock for FANUC TAPE CHUCKER.

A diagram of the structure of the spindle servo unit follows.

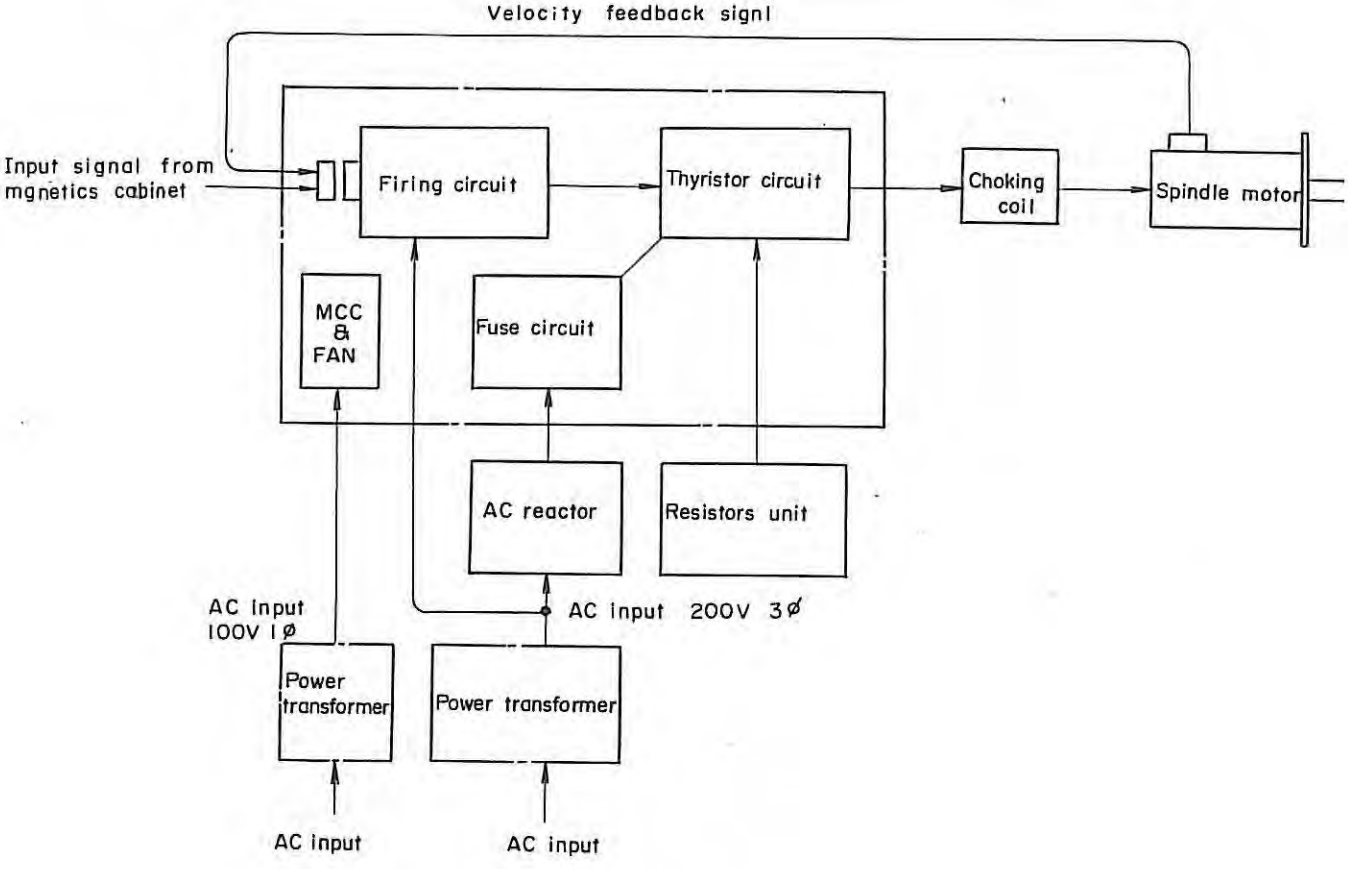


Fig.1 Spindle servo unit block diagram

A table of printed circuit board specifications follows.

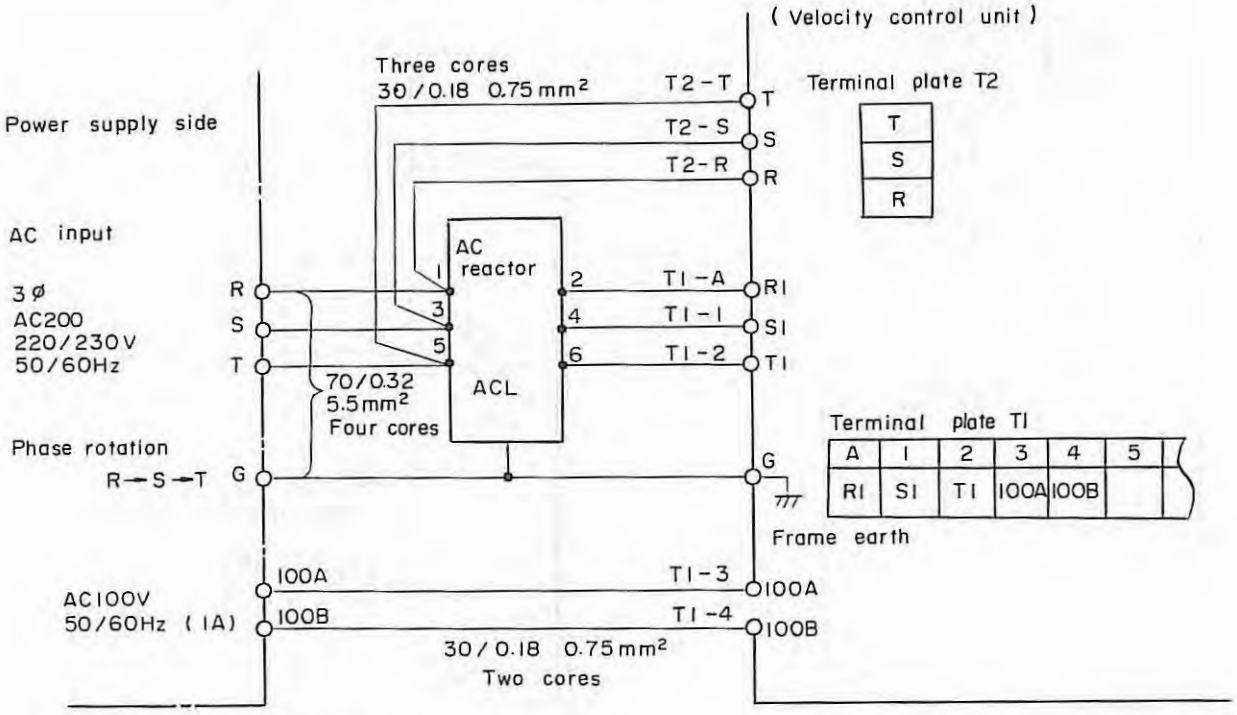
	P.C.B. No1	P.C.B. No2	P.C.B. No3
Model 2 and 3	A20B-0004-0780	A20B-0005-0583/T	A20B-0005-0584/T
Headstock	A20B-0004-0780	A20B-0005-0583/U	A20B-0005-0584/U
Remark	Manufactured from Jul. 1976 to Dec. 1977	Manufactured from Jan. 1978 to Aug. 1978	Manufactured from Sep. 1978

2. INSTALLATION AND ADJUSTMENT

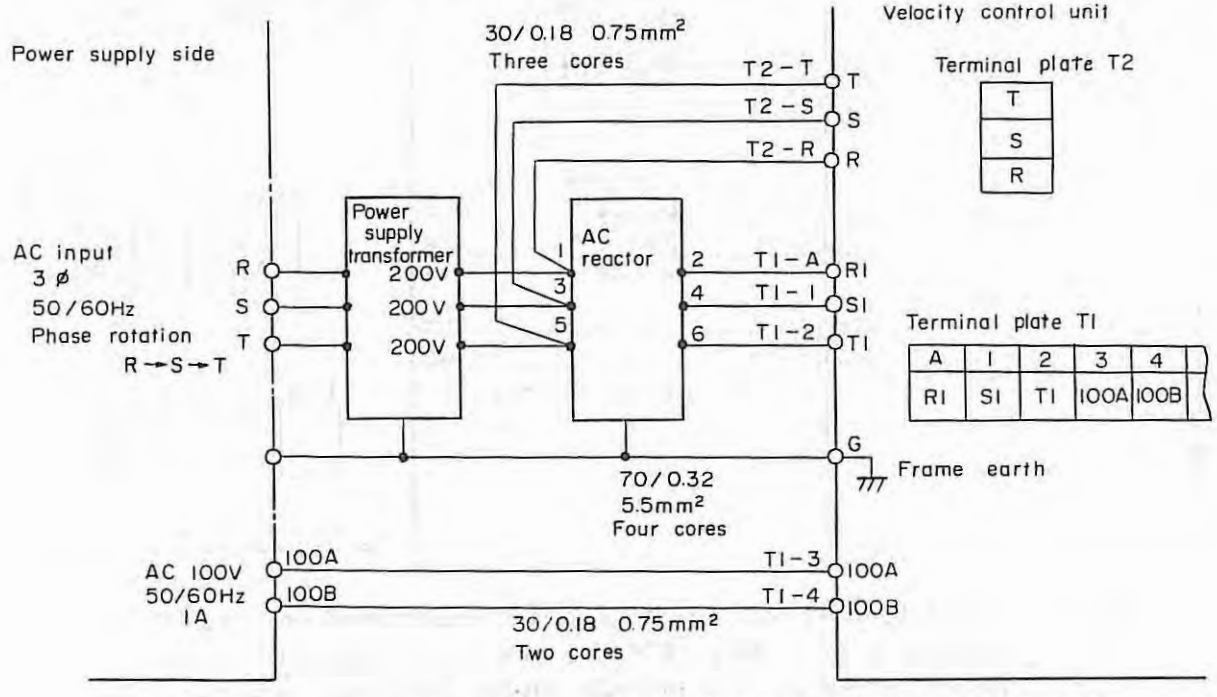
2.1 Connection

(1) Connection of power supply line

200/220/230V AC power supply line

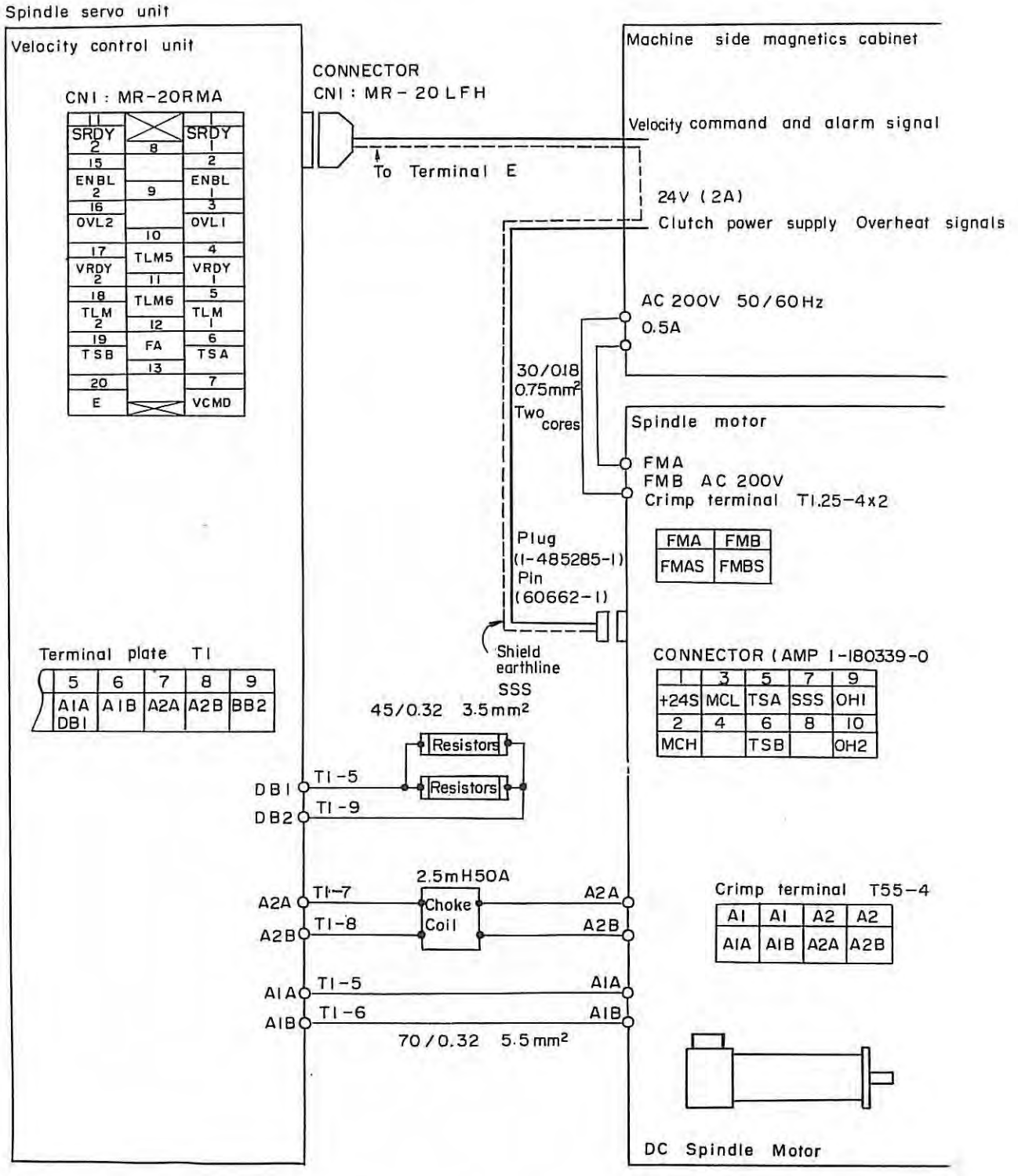


Except 200/220/230V AC power supply line



When the power supply input is other than AC200/220/230V

(2) Connection of spindle motor power and signal lines



11				SRDY		8		SRDY	1
2				15				2	
ENBL	2			16		9		ENBL	1
OVL2				17		10		3	
VRDY	2			18		TLM5		OVL1	
TLM	2			19		11		4	
TSB				20		TLM6		VRDY	1
E						12		5	
						FA		TLM	1
						13		6	
								TSA	
								7	
								VCMD	

FMA	FMB			
FMAS	FMBS			

1	3	5	7	9
+24S	MCL	TSA	SSS	OHI
2	4	6	8	10
MCH		TSB		OH2

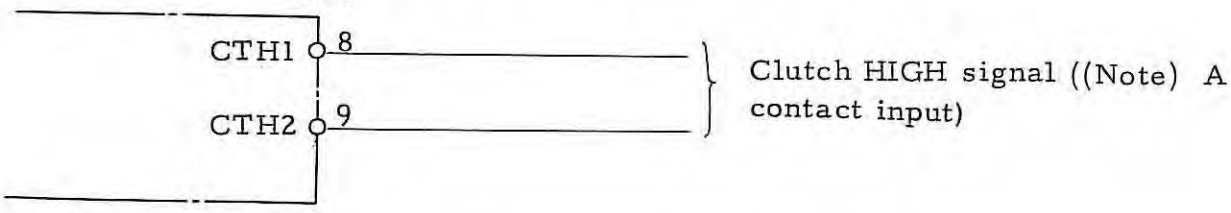
5	6	7	8	9
AIA DBI	AIB	A2A	A2B	BB2

AI	AI	A2	A2
AIA	AIB	A2A	A2B

Note) ENBL1, ENBL2, must be short circuitted on magnetics cabinet side. When ENBL1 and 2 are opened, no gate pulse is issued and spindle motor does not rotate.

(3) Connection of special signal lines (Only for PCB No. 2 A20B-0005-0583 and No. 3 A20B-0005-0584).

1) Connection of clutch switching signals



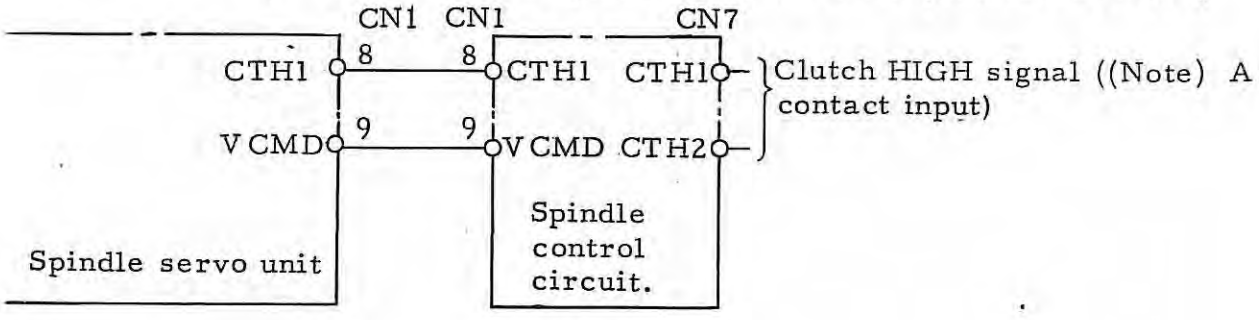
If this connection is performed, switch the setting on the printed circuit board (PCB).

o Setting

° Set the short pin as below.

° Short pin S15 ⟶ S16

2) Connection to spindle control circuit (A20B-0004-0990)



o Setting

In case no use the clutch HIGH signal.

° Short pin. S12 ⟶ S11

In case use the clutch HIGH signal.

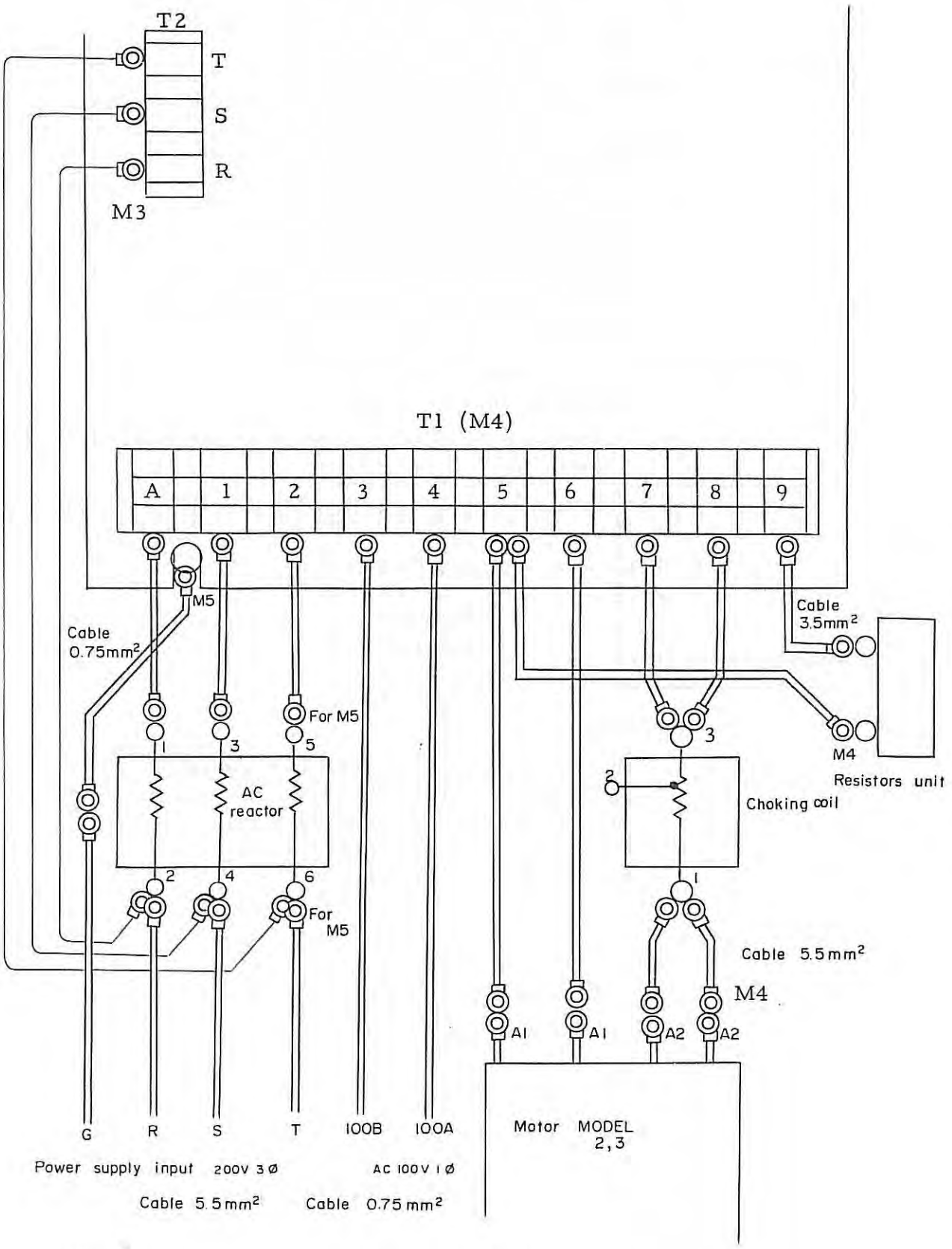
° Short pin S12 ⟶ S11

° Short pin S15 ⟶ S16

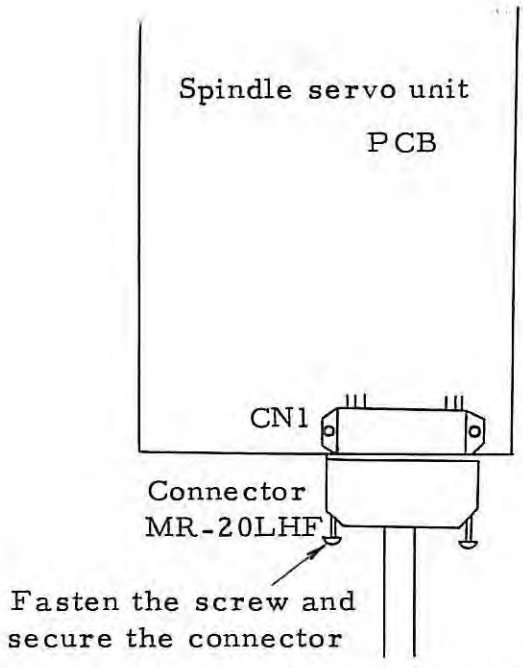
(Note)

A contact ; Normal open contact.

Spindle servo unit



Note) Always connect G terminal of GND to the earth.

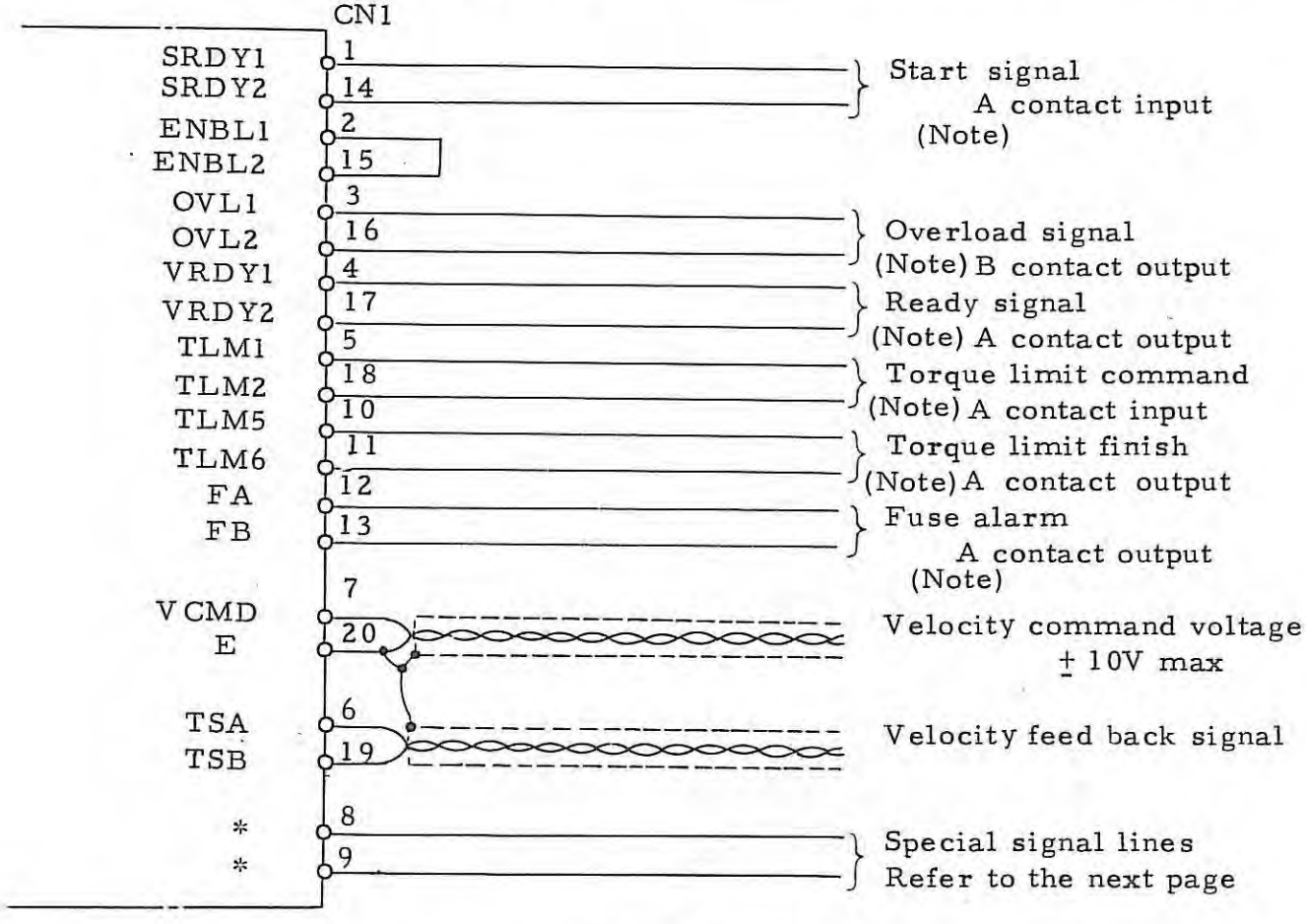


CN1

20	19	18	17	16	15	14
E	TSB	TLM2	VRDY2	OVL2	ENBL2	SRDY2

13	12	11	10	9	8
FB	FA	TLM6	TLM5	*	*

7	6	5	4	3	2	1
VCMD	TSA	TLM1	VRDY1	OVL1	ENBL1	SRDY1



(Note) A contact ; Normal open contact.
B contact ; Normal closed contact.

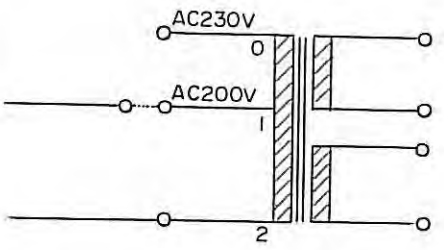
2.2 Checks the Setting

(1) Tap changing according to the AC input voltage

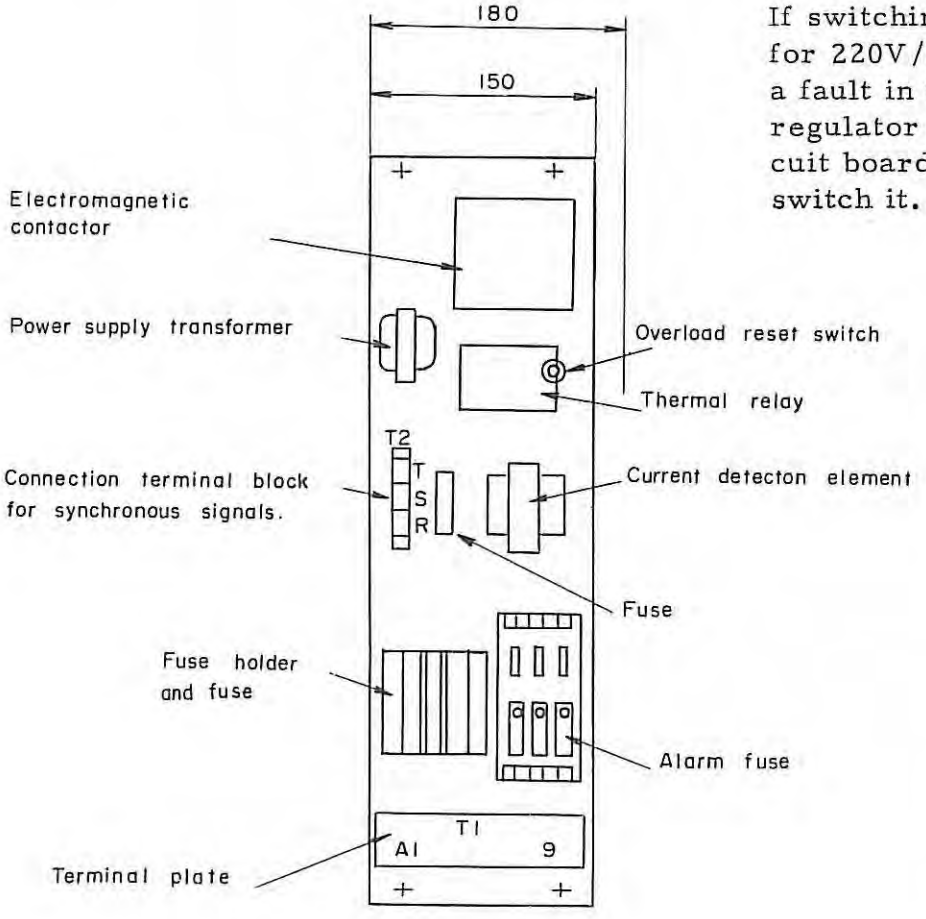
The transformer PT tap in the velocity control unit is set as follows in accordance with the AC input power supply voltage.

AC input voltate	Transformer PT Tap
AC200V +10% -15%	Connect to Tap 1
AC220V +10% -15% or AC230V +10% -15%	Connect to Tap 0

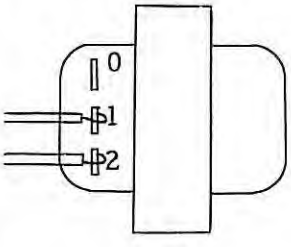
Transformer PT



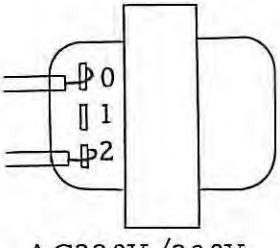
Primary side Secondary side



If switching is not performed for 220V/230V AC, it causes a fault in the power supply regulator on the printed circuit board. Make sure to switch it.



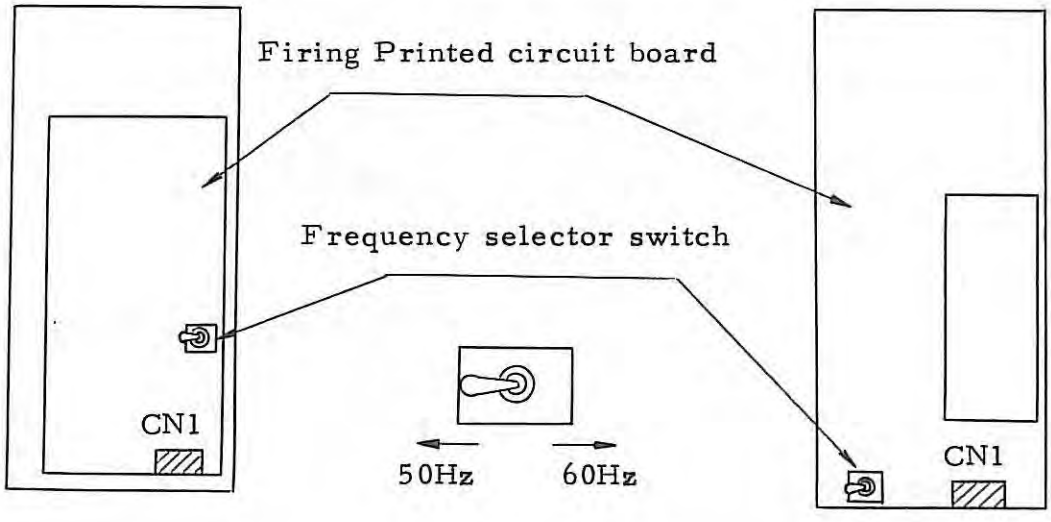
AC200V



AC220V/230V

(2) Setting the frequency selector switch (50/60Hz)

Check that the frequency selector switch is properly positioned in accordance with the line frequency (50/60 Hz).



P.C.B. No. 2
A20B-0005-0583

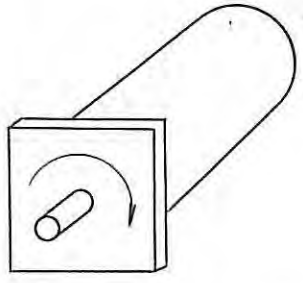
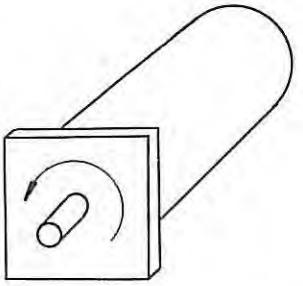
P.C.B. No. 3
A20B-0005-0584

P.C.B. No. 1
A20B-0004-0780

2.3 Checks Before Turning Power ON

(1) Testing the motor cable and T.G feedback signal connections.

Before turning on the power switch, check the polarity of the motor cable and T.G. feedback signal connections. Rotate the motor shaft clockwise by hands and check the voltage between terminals T1-5, 6 and T1-7, 8 and between CH2 to CH3 (GND)

No.	Motor Rotational Direction	Measuring apparature	Polarity of motor	Polarity of T.G feedback signal
1	Motor shaft to rotate clockwise 	Tester or Oscillo-scope	⊕voltage A1 (T1-5, 6) ↑ A2 GND (T1-7, 8)	CH2 ⊕voltage ↑ CH3 (GND)
2	Motor shaft to rotate counter-counterclockwise. 	Tester or Oscillo-scope	GND A2 (T1-7, 8) ↓ ⊖voltage A1 (T1-5, 6)	CH3 (GND) ↓ CH2 ⊖voltage

If polality is incorrect, the machine runs away by start signal.

Therefore, always check the polarity.

(2) Insulation resistance check

Check that the resistance between GND and terminals 5 thru 8 of T1 is 0.1M Ω or more.

2.4 Checks Phase Rotation

(1) In case P. C. B. No. 3 A20B-0005-0584

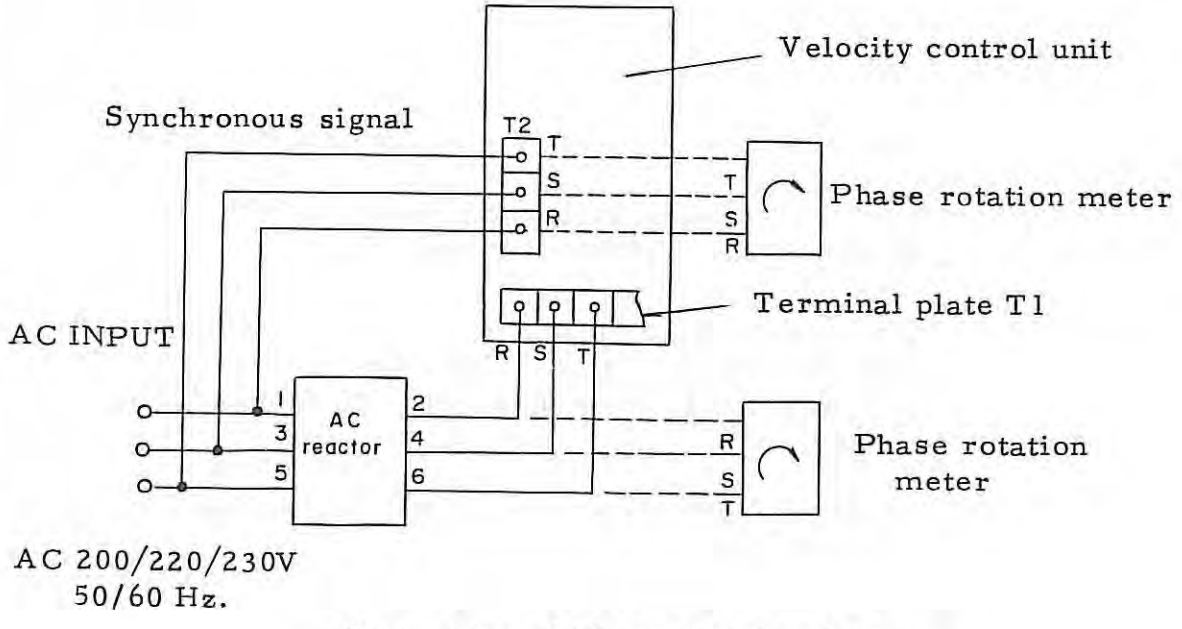
Added the opposite phase alarm circuit on this P. C. B. When the phase rotation is not correct or phase lacks, and then if power is on, opposite phase, lack of phase indicate alarm TGAL light on.

phase rotation is correct .....TGAL doesnot light on
opposite phase, lack. of phase .....TGAL lighs on

(2) The AC line is always connected to the input terminals so that the phase rotational direction is R→S→T.
If the phase rotation is not correct and power is supplied, the velocity control unit fuse may blow.

(Check)

Check that the phase rotation meter turns clockwise when connected in the order of R→S→T with terminal block T1 and T2. (Change the connection if not correct.)



Connection of Phase Rotation Meter

Precautions

The following methods must be used carefully when a phase rotation meter is not employed.

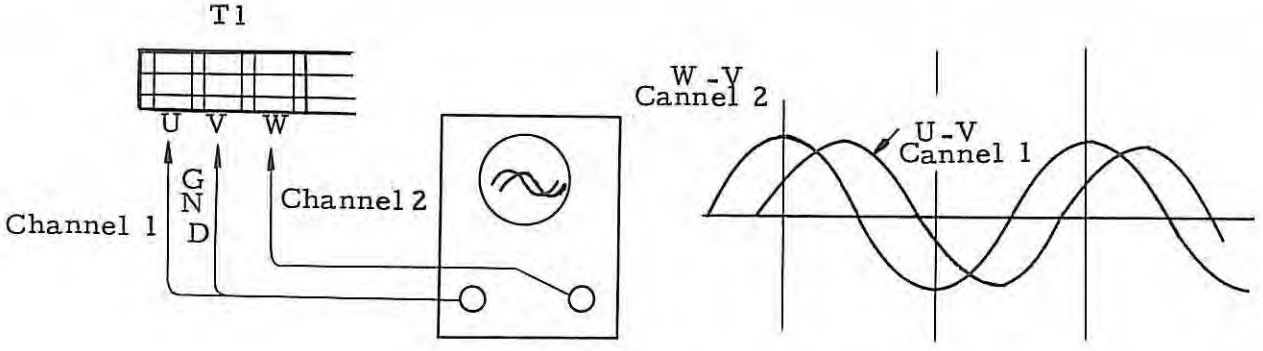
(1) Always insulate the oscilloscope from ground during measurement.

(2) Further, since the oscilloscope itself is at equipotential with the input voltage, do not touch its frame or metal parts.

A dual-trace oscilloscope can be used to check phase rotation as follows:

[Measurement procedure] [Waveform]

The following waveform is obtained if phase rotation is correct.



2.5 Adjustment

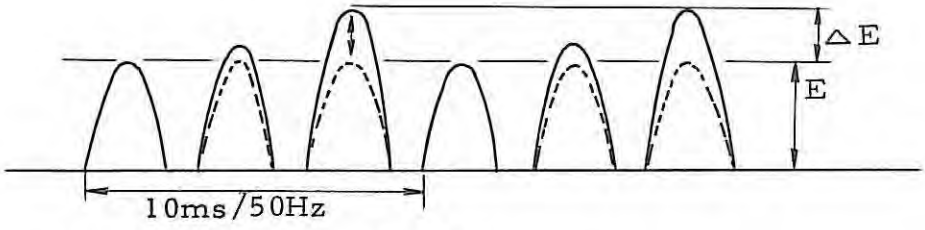
Only the following items are required for on-site adjustment.

(1) Synchronous pulse adjustment [only for PCB No. 1 A20B-0004-0780 and No. 2 A20B-0005-0583]

If the three-phase waveform is balanced, adjustment is not required, but if it is not balanced or if the inter-voltage varies, a synchronous pulse must be adjusted in the following manner.

Current waveforms are observed while slowly turning the spindle motor.

CH 11 waveform

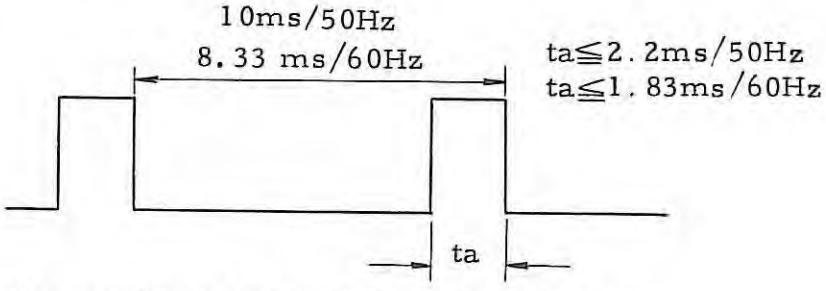


RV 10A RV 10B RV 10C

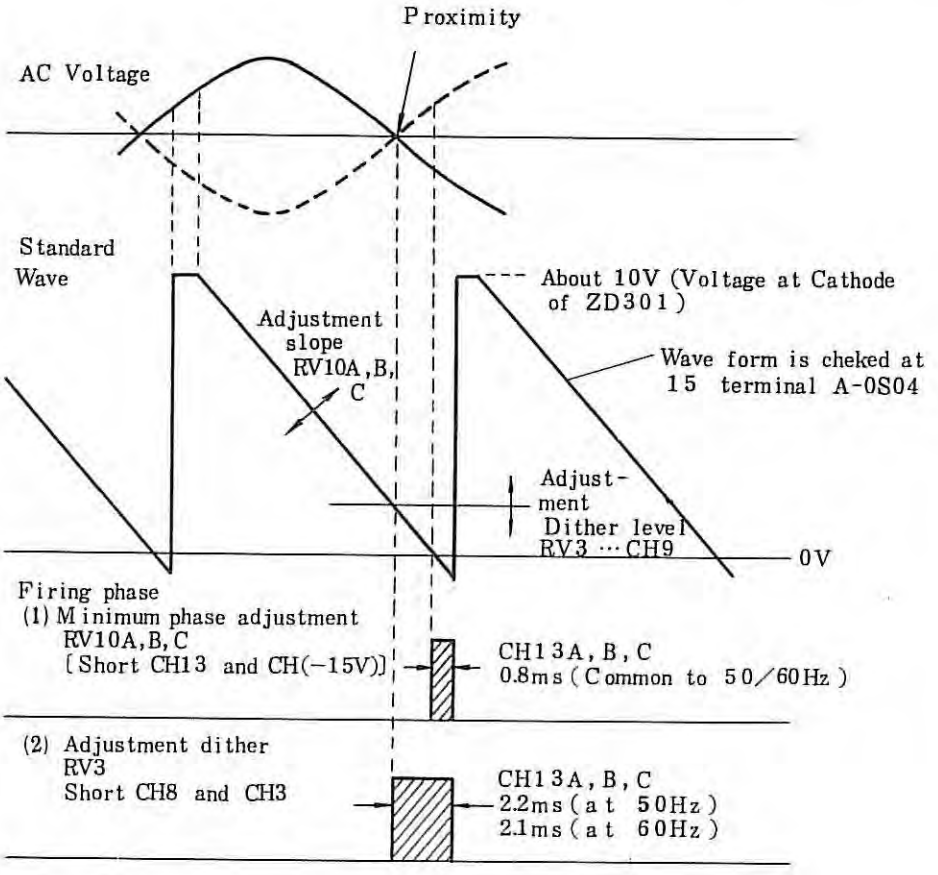
(Adjustment) Any two variable resistors RV 10A, B and C are turned counterclockwise so that the peak value of the current waveforms are within the following range.

$$\Delta E \leqq \pm 0.2E$$

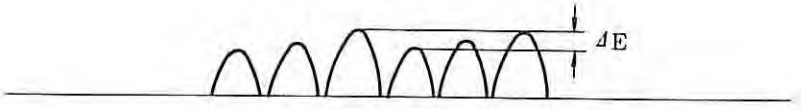
(Check) After adjustment, electromagnetic contactor MCC is turned OFF and the synchronous pulsewidth is checked by CH13 A, B and C. (check it after connects CH8 to the earth.)



Check again after readjusting for 50Hz ta > 2.2ms or 60Hz ta > 1.83ms.
In case A20B-0005-0584, no adjustment.



Current wave from at low speed.
(Check point CH11)



Check the wavefrom.

(2) Current detection circuit offset adjustment

Start signals are turned OFF and RV103 is adjusted so that the voltage at current waveform check terminal CH11 is zero.

Check terminal	Adjustment places	Adjustment method
CH11	RV103	0 ± 20mV

(3) Adjustment of rotation speed

When the speed command voltage is fed by 10V (maximum velocity command), the spindle is adjusted by RV4 so that the spindle turns at the maximum speed.

	P.C.B	Velocity command CH3	Spindle motor speed	Spindle speed	Adjustment place
MODEL 2, 3	A20B-0005-0583 /T A20B-0005-0584 /T	±10V	2000±8rpm	Maximum speed ±0.4%	RV4
Head stock	A20B-0005-0583 /U A20B-0005-0584/U	±10V	3400~3500 rpm	3400~3500 rpm	RV4

(4) Torque limit adjustment

The torque limit is set by adjusting the voltage of CH29. Adjustment locations are RV108 for clutch HIGH and RV122 for clutch LOW. Both are adjusted if a constant limit is required irrespective of the clutch setting.

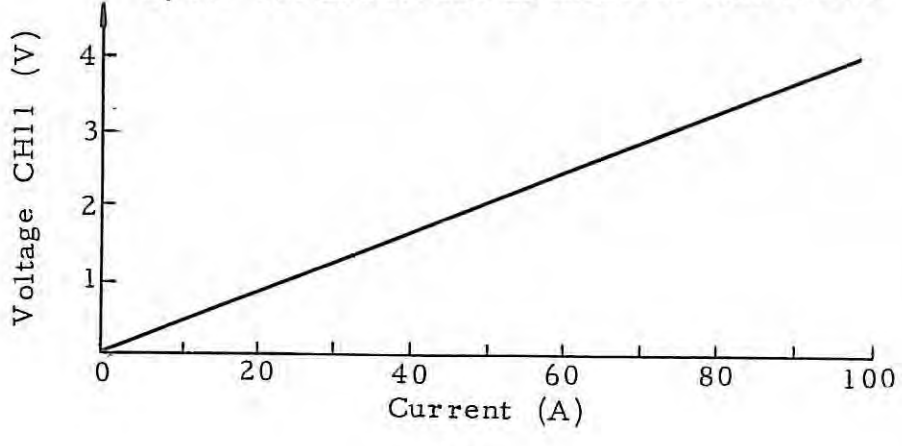
Further, if there is no clutch switching, only RV108 is effective.

Current value	0A	5A	10A	15A	20A	25A	30A	35A
Voltage of CH28	-1.2V	-1.6V	-1.9V	-2.05V	-2.15V	-2.27V	-2.4V	-2.53V

Standard Setting

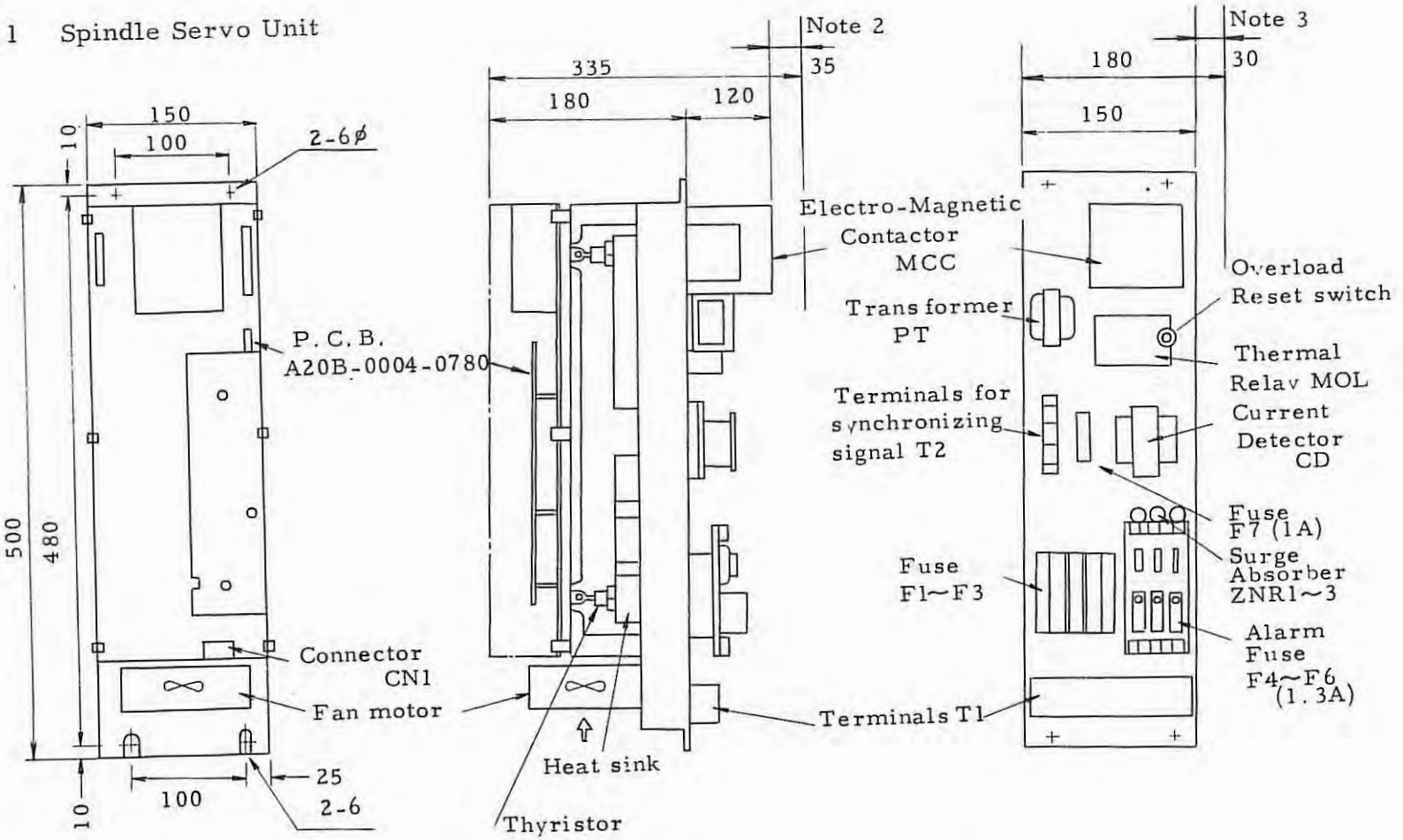
In case A20B-0005-0584

After torque limit is on, adjust the armature current by RV 108 and RV122 as measurement CH11.



3. MOUNTING DIAGRAM

3.1 Spindle Servo Unit

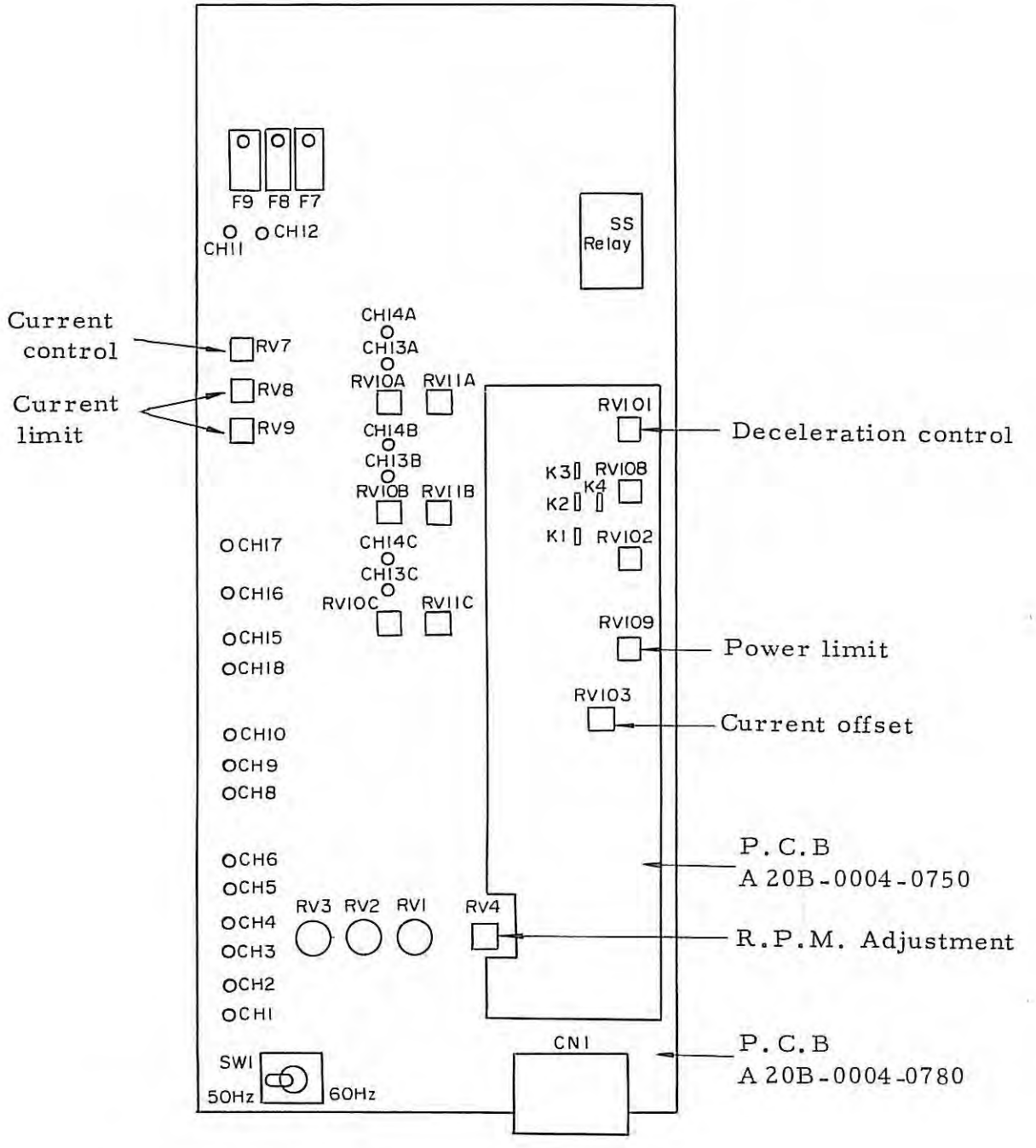


(Notes)

1. Maintenance surfaces are for both front and rear ones.
2. A minimum of 35 mm space is required to prevent the top of the electromagnetic contactor from arcing.
3. A minimum of 30 mm space is required on the side of the thermal relay to press the reset switch.

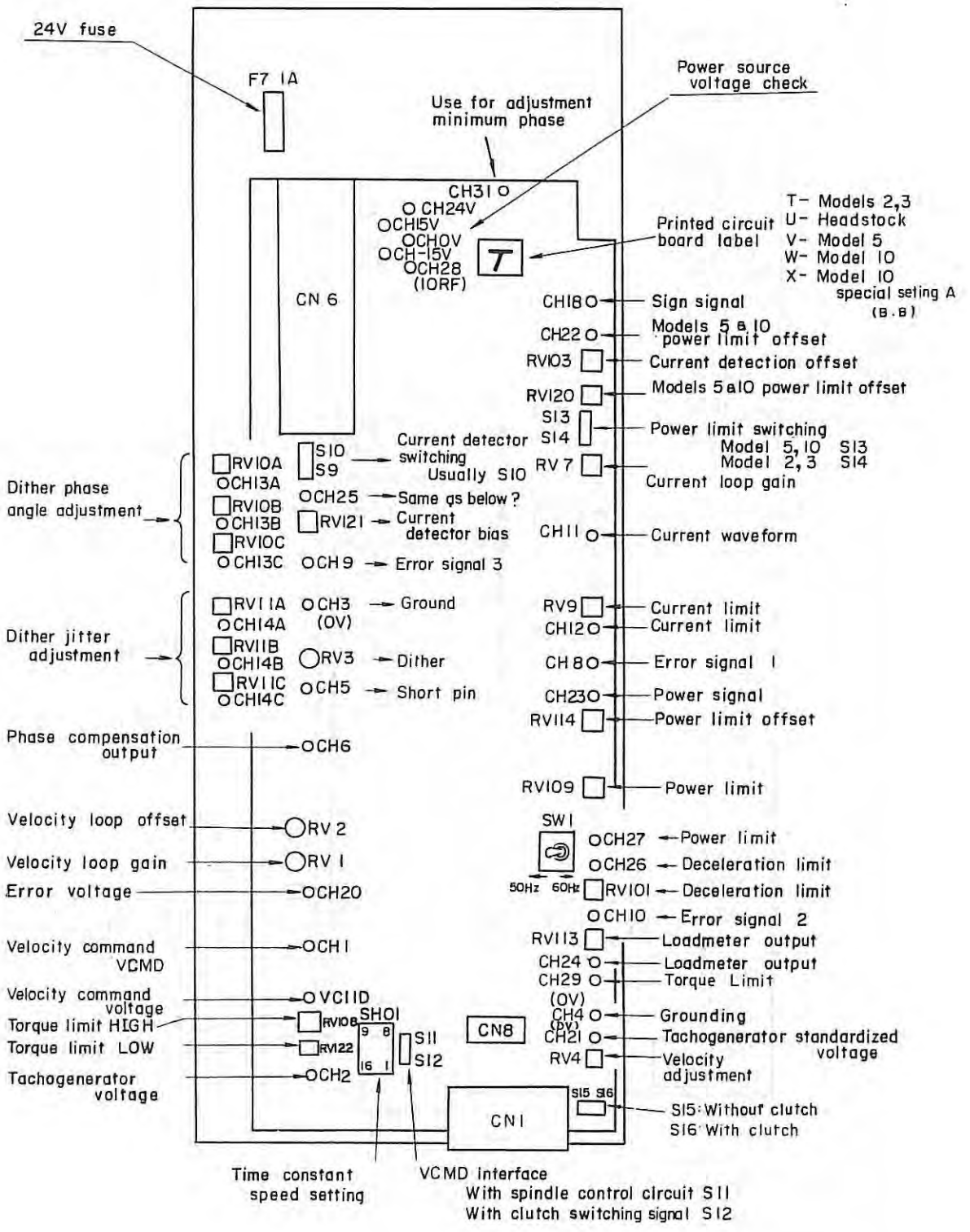
3.2 Firing Circuit

Printed Circuit Board No.1 A20B-0004-0780



Note) CH3, 4 : 0V
CH15 : +24V
CH16 : +15V
CH17 : -15V

Printed circuit board No. 2 A20B-0005-0583
No. 3 A20B-0005-0584



4. TROUBLE SHOOTING

Generally, the following items can be considered as faults and their causes.

If a fault has occured, first roughly determine where the cause lies (servo unst, spindle motor, etc.), and then trace out the cause. (Refer to Appendices I and II.)

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
1	The velocity control unit unit fuse is blows.	. Cabling mistake . Circuit gault Current limiting circuit defect, circuit adjustment defect, etc.	. T.G. WIRE contact defect or breaking . Driving cable shortcircuit . Excessive ripple of Tach Generator Vripple≦1V	
2	The spindle r.p.m. in not normal.	. Circuit gault Defect of error amplifier circuit. . D/A Converter	. T.G defect . Lowing of counter electromotive force of the motor.	. Faulty operation of the velocity command circuit.
3	Vibration and noise during spindle operation is abnormally large.	. 50/60Hz setting error. . Circuit adjustment defect Dither Gain . Current feedback control circuit adjustment defect	. Motor fault Bearing, clutch, etc. . Excessive ripple of Tach Generator	. The input power waveform is too disorted. . The load fluctuation is too large. . Gear engagement is not proper.
4.	The spindle operation during acceleration and deceleration is not normal.	. Deceleration limiting circuit adjustment defect. . Current feedback control circuit adjustment defect.		. Relation between the load inertia and the acceleration/deceleration time constant setting is not proper. (Refer to Appendix II) . The belt tension is not proper.

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
5	The spindle does not rotate.	. Circuit fault The gate pulses are not generated, etc.	. Wire breaking	. The machine load is too large. . No SFR/SRV Signals

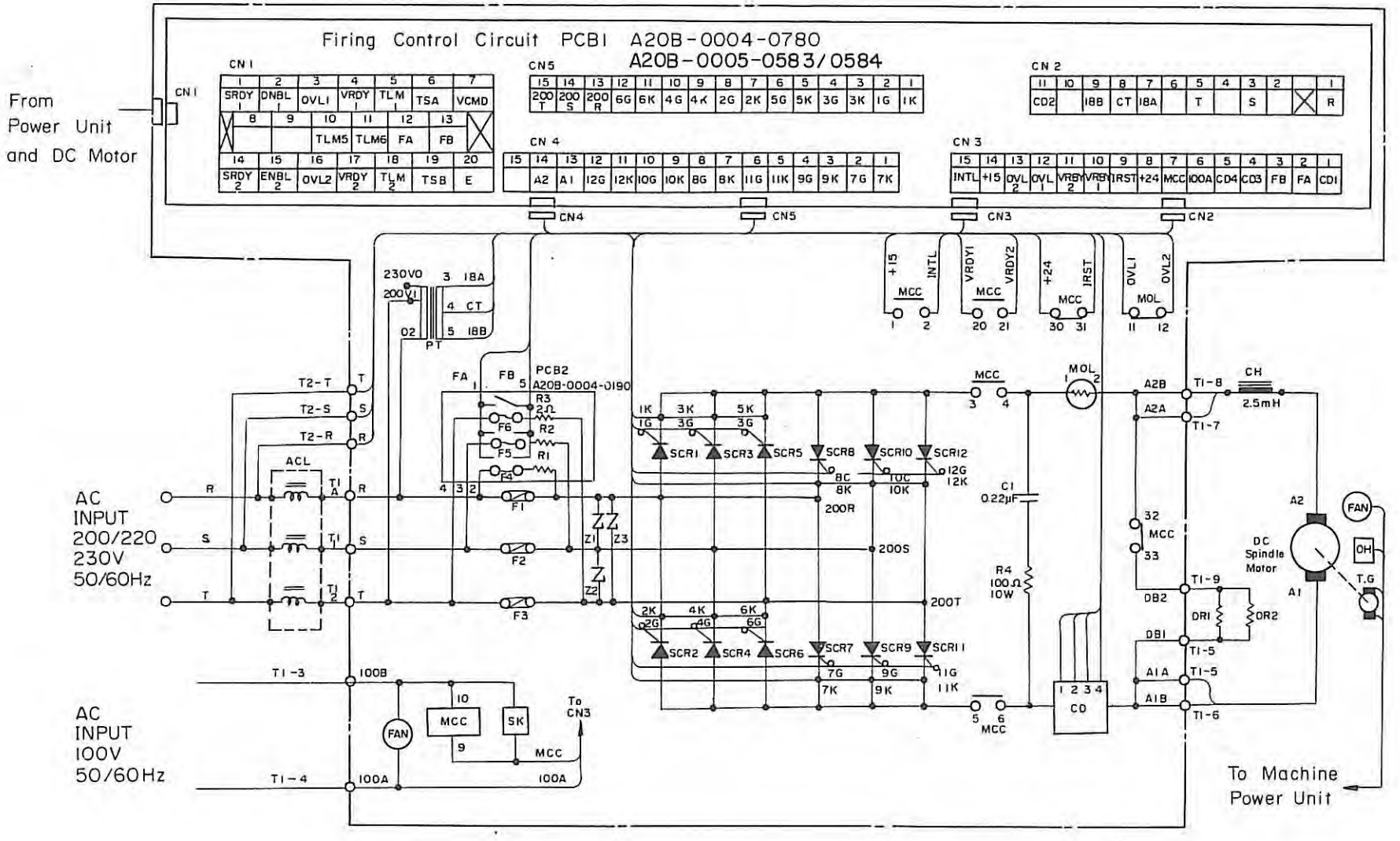
5. SPARE PARTS LIST

Arrange spare parts for maintenance in the following lists if necessary.

Items	Articles	Parts No.	Specification	Quantity
1	Fuse 75A	F1~3	A60L-0001-0061#GSA75	3
2	Alarm fuse 1.3A	F4~F6	S.Fab250/402A P413	3
3	Fuse 1A	F7	A60L-0001-0039#A1	1
4	Alarm fuse on P.C.B.		A60L-0001-0046#1.0	1
5	Surge absorber	ZNR1~3	A50L-2001-0062#441-12	3
6	Firing Circuit	PCB1	MODEL 2, 3 A06P-6035-H321#B Headstock A06P-6041-H001#B	1
7	Fuse circuit	PCB2	A20B-0004-0190	1
8	Thyristor	SCR1~12	A50L-5000-0011#A	12
9	Current detector	CD	A44L-0001-0048	1
10	Magnetic contactor	MCC	A58L-0001-0029	1
11	Fan motor	FM	A90L-0001-0001	1

6. CIRCUIT STRUCTURE

Spindle servo unit



7. APPENDIXES

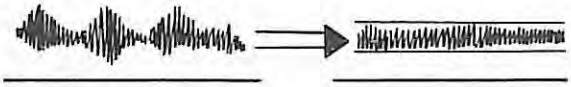
Appendix I Adjustment and check of firing circuit (P.C.B No.4 A20B-0004-0780)

The firing circuit has already been adjusted prior to the shipment. Therefore, there is no need to adjust the circuit, except for (1) below.

Further, the standard setting method is shown in (2). If a fault should occur, refer to (2) for checking the circuit.

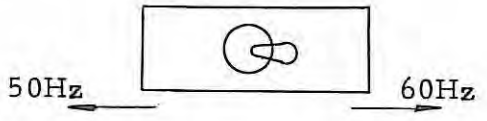
When changing a setting value from its standard value, be sure to record it on the data sheet.

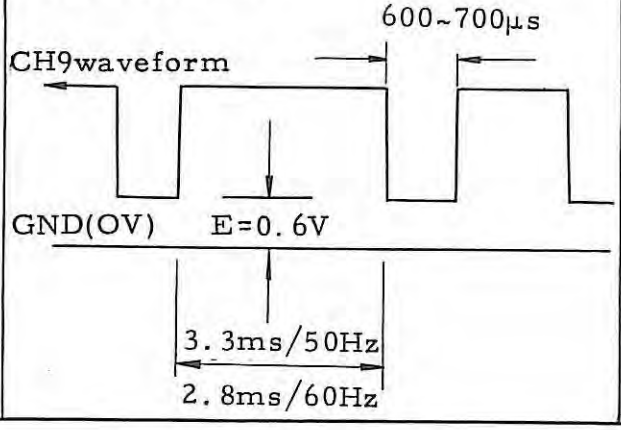
(1) Adjustment related to the spindle motor and machine system

No.	Item	Variable resistor	Method	Standard Setting
1	r.p.m adjustment	RV4	Adjust variable resistor RV4 so that the motor r.p.m. may be maximum when the velocity command voltage is ±10V. Model 2, 3 : 2000 rpm Head stack : 3500 rpm	R63: 82KΩ R63: 39KΩ
2	Gain of current feedback control circuit	RV7	Adjust the current feedback gain so as to minimize the motor vibration due to the fluctuation of spindle load. That is, while observing the current waveform at check terminal CH11, adjust variable resistor RV7 so as to minimize the deflection of the current waveform.  (RV7 Dial: 3-4) (Dial: 5-7) Current waveform at CH11	Dial: 5-7

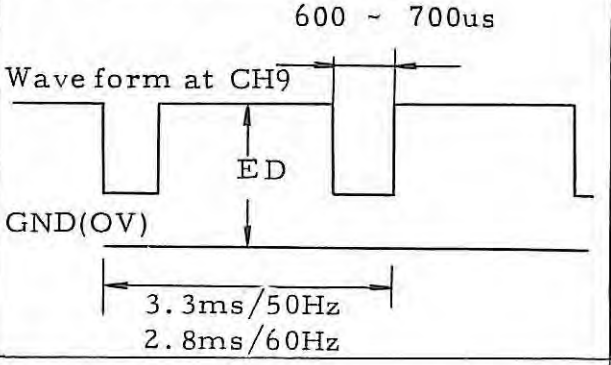
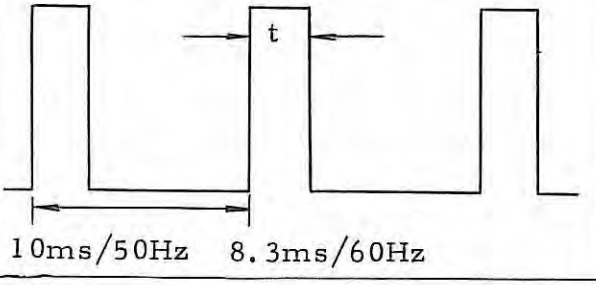
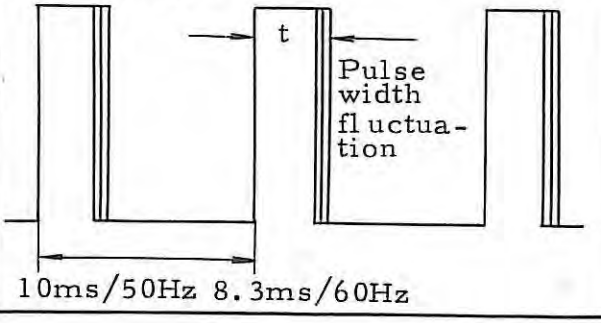
No.	Item	Variable Resistor	Method	Standard Setting
3	Torque limit value setting	RV108	This adjustment is required for reducing the torque which is generated at the time of spindle orientation. The setting value differs depending on the machine spindle load torque. Adjust variable resistor RV108 so that the shock of the machine at the time of spindle orientation may take a proper value. Adjustable range: 20kg.cm - 120kg.cm	The torque limit value increases as the variable resistor is turned clockwise.

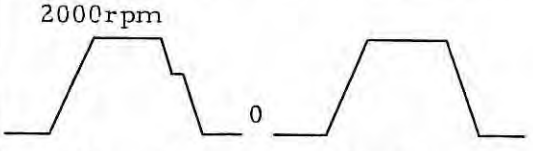
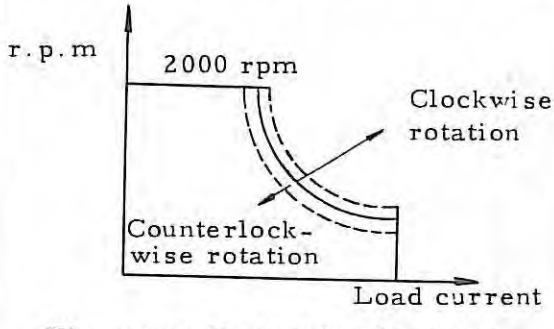
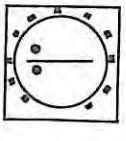
(2) Standard adjustment and check

No.	Item	Switch or variable resistor	Method	Standard setting
1	Power frequency setting (50/60Hz)	SW1	Set switch SW1 to the input power frequency.  	
2	Control power voltage check		Measure the voltage between check terminal CH3 (ground) and each of following check terminals using a oscilloscope or tester. +24V CH15: +22 - 27V +15V CH16: +14.5 - 15.5V -15V CH17: -15.5 - -14.5V	
3	Velocity loop gain	RV1	The velocity loop gain determines the servo system response and rigidity.	Dial: 4
4	Velocity loop offset	RV2	Short-circuit check terminals CH5 and CH6, and adjust variable resistor RV2 so that the voltage at check terminal CH8 becomes 0 volt.	

No.	Item	Switch or variable resistor	Method	Standard setting
5	Dither No.1	RV102	By this adjustment, the servo rigidity when the machine is stopped is deterimined. If the dither is too large, the motor vibrates, and if the dither is too small, the dead band enlarges. Short-circuit check terminals CH8 and CH3 (ground), and set level E of the voltage waveform at check terminal CH9 to 0.6V. CH9 waveform  	E = 0.6V

Note) It is necessary to remove the motor cable A1, A2 to adjust and check of the item 1, 2, 4 - 9.

No.	Item	Switch or variable resistor	Method	Standard setting
6	Dither No. 2	RV3	Short-circuit check terminals CH8 and CH3 (ground), and set level E_D of the boltage waveform at check terminal CH9 to the value shown in the right column. 	E_D: 1.5V ±0.2V (50Hz) 2.8V±0.2V (60Hz)
7	Dither No. 3	RV10A RV10B RV10C	Adjust the dither pulse width by setting the widths of the "1" level pulses at check terminals CH13A, and C to the value shown in the right column. Waveform at CH13A, B, C 	t: 2.1ms (50Hz) 1.8ms (60Hz)
8		RV11A RV11B RV11C	Adjust respective variable resistors so as to minimize the fluctuation of the dither pulse width. C H13A, B, C 	t: 2.1ms (50Hz) 1.8ms (60Hz)

No.	Item	Switch or variable resistor	Method	Standard setting
9	Offset of current feedback circuit	RV103	Adjust variable resistor RV103 so that the voltage between check terminals CH11 and CH3 may be 0V when no current is flowing through the motor (electromagnetic switch is OFF).	Dial: 5
10	Gain of current limiter	RV8	This variable resistor changes the current limiting effect. Refer to Table 1.	Dial: 6 Headstock Dial: 7
11	Current limit value	RV9	This variable resistor changes the current limit value. Refer to Table 1.	Dial: 2
12	Decele-ration control setting	RV101	Adjust variable resistor RV101 so that the velocity (ovserved at check terminal CH2) is smoothly reduced when the motor is decelerated from 2000 rpm. The velocity waveform becomes smoother when the variable resistor is turned counter clockwise.  	Dial: 2 Model 2, 3 Dial: 2 Headstock Dial: 5
13	Power limit setting	RV109	This adjustment is required for protecting the motor by reducing the motor r.p.m. when the spindle load exceeds the rating output of the motor due to heavy loading, etc.  The power limit value becomes larger when the variable resistor is turned clockwise.	Model 2, 3 Dial: 7.5 Head stock, Dial: 5  Dial setting (e.g. dial:2)

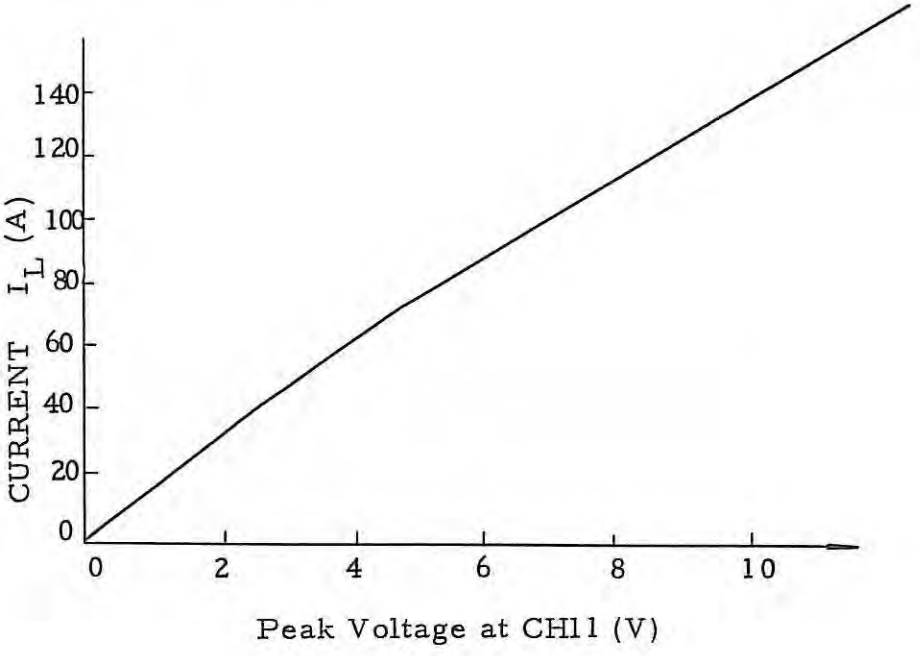
Appendix Table 1 Relation between the current limit value and the dial setting of RV8 and RV9

The current limit value is determined by the dial setting of variable resistors RV8 and RV9, as shown in the following table.

RV9 dial setting \ RV8 dial setting	5	6	7	8
0	82A	70A	54A	44A
1	85A	73A	61A	49A
2	97A	87A	73A	58A
3	110A	100A	86A	71A
4		111A	99A	84A
5			112A	97A
6				111A

optimal setting

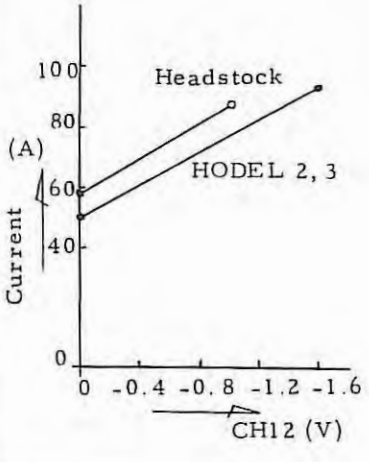
The relation between the above current and the peak voltage at check terminal CH11 is as follows.

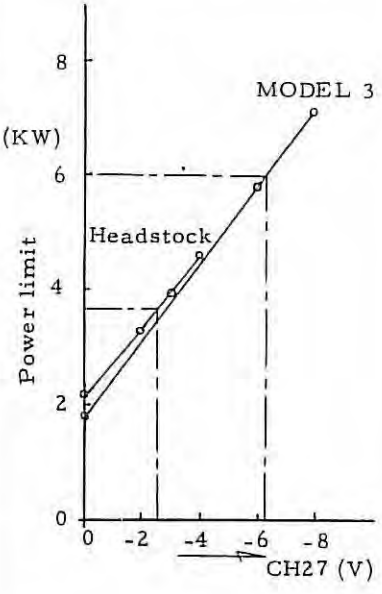


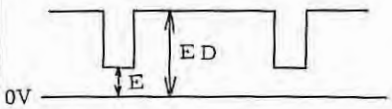
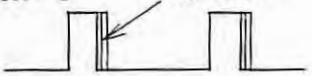
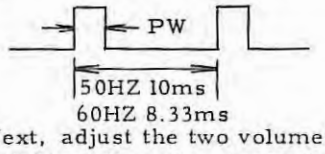
Appendix II Adjusting and checking the firing circuit (For PCB A20B-0005-0583)

Since the following adjustment is usually performed at the factory, adjustment and confirmation are not necessary.
Refer to the following for routine checking.

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Headstock</th></tr>
<tr><td>1</td><td>Time constant setting</td><td>SH01</td><td><table><tr><th></th><th>Clutch LOW</th><th>Clutch HIGH</th></tr><tr><td>5-12</td><td>0.6 sec</td><td>1 sec</td></tr><tr><td>6-11</td><td>1.2 sec</td><td>2 sec</td></tr><tr><td>7-10</td><td>1.8 sec</td><td>3 sec</td></tr><tr><td>8-9</td><td>2.4 sec</td><td>4 sec</td></tr></table></td><td>7-10</td><td>7-10</td></tr>
<tr><td>2</td><td>Tachogenerator voltage setting</td><td>SH01</td><td><table><tr><th>Setting</th><th>TG maximum voltage</th></tr><tr><td>1-16</td><td>10V</td></tr><tr><td>2-15</td><td>12V</td></tr><tr><td>3-14</td><td>19V</td></tr><tr><td>4-13</td><td>21V</td></tr></table></td><td>2-15
(12V/2000 rpm)</td><td>1-16
(10V/3500 rpm)</td></tr>
<tr><td>3</td><td>Current detector bias</td><td>S9
S10</td><td><table><tr><th>Detector specification</th><th>Setting</th></tr><tr><td>A44L-0001-0048</td><td>S10</td></tr><tr><td></td><td>S9</td></tr></table></td><td>S10</td><td>S10</td></tr>
<tr><td>4</td><td>VCMD interface setting</td><td>S11
S12</td><td><table><tr><th>Specification</th><th>Setting</th></tr><tr><td>Normally, a spindle control circuit is used</td><td>S11</td></tr><tr><td>Clutch switching is provided</td><td>S12</td></tr></table></td><td>S12</td><td>S11</td></tr>
<tr><td>5</td><td>Power limit setting</td><td>S13
S14</td><td><table><tr><th>Motor specification</th><th>Setting</th></tr><tr><td>MODEL 5, 10</td><td>S13</td></tr><tr><td>MODEL 2, 3, Headstock</td><td>S14</td></tr></table></td><td>S14</td><td>S14</td></tr>
<tr><td>6</td><td>Clutch switching is provided</td><td>S15
S16</td><td><table><tr><th>Clutch switching</th><th>Setting</th></tr><tr><td>Provided</td><td>S16</td></tr><tr><td>Not provided</td><td>S15</td></tr></table></td><td>S15</td><td>S15</td></tr>
<tr><td>7</td><td>Tachogenerator voltage regulation</td><td>RV4</td><td>The maximum rotation speed is adjusted when 10V is the velocity command voltage.
Maximum rotation speed: ±0.4%</td><td></td><td></td></tr>
</table>

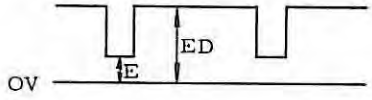
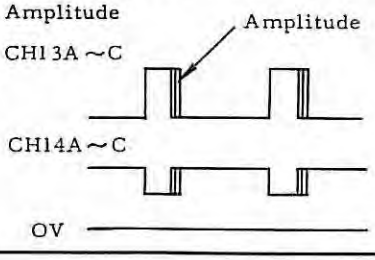
No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Headstock
8	Velocity loop gain adjustment	RV1	Determines the rigidity of the spindle motor. No special adjustment is required. If hunting and vibration are excessive, decrease them by about 5% to 10%.	45%	45%
9	Velotiey loop offset	RV2	Adjust the motors to halt when the velocity command voltage is OV.		
10	Current loop gain	RV7	Loop gain to current commands Reduce the gain 20% 30% when some swell is observed in the current.	100%	100%
11	Current detection offset	RV103	Adjust the CH11 voltage OV when current is not applied. If this adjustment varies excessively, the velocity is not uniform at low speeds.		
12	Power limit offset	RV114	Adjust the CH23 voltage to OV when current is not applied. If this adjustment varies excessively, the power limit at high speeds is inaccurate and motors can be damaged.		
13	Current limit setting	RV9	Set the CH12 voltage to the proper value when current is not applied. The relation of CH12 and the current limit is as shown in the following figure. 	-1.1V	-0.7V

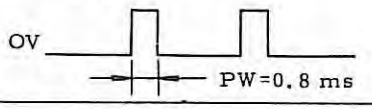
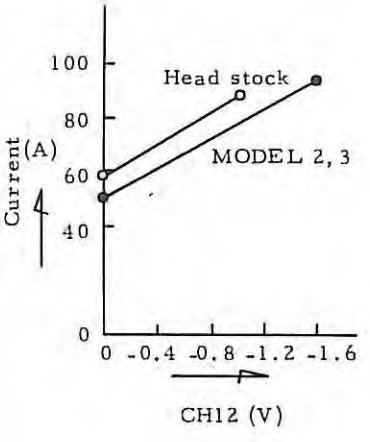
<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Headstock</th></tr>
<tr><td>14</td><td>Power limit setting</td><td>RV109</td><td>Set the CH27 voltage to the proper value when current is no spplied.
The relation between CH27 and the power is as shown in the following figure.
 
</td><td>-6.2V</td><td>-2.5V</td></tr>
<tr><td>15</td><td>Torque limit setting</td><td>RV108
RV122</td><td>Orientation is performed by applying the torque limit and adjusting the halt current.
Adjustment range is 0 to 35A.
<table><tr><th></th><th>Adjusting locations</th></tr><tr><td>Clutch HIGH</td><td>RV108</td></tr><tr><td>Clutch LOW</td><td>RV122</td></tr></table>Adjust both irrespective of clutch switching when a constant adjustment is required.</td><td colspan="2">Relationship between CH28 voltage and current.
<table><tr><td>0A</td><td>-1.2V</td></tr><tr><td>5A</td><td>-1.6V</td></tr><tr><td>10A</td><td>-1.9V</td></tr><tr><td>15A</td><td>-2.05V</td></tr><tr><td>20A</td><td>-2.15V ← Standard setting</td></tr><tr><td>25A</td><td>-2.27V</td></tr><tr><td>30A</td><td>-2.4V</td></tr><tr><td>35A</td><td>-2.53V</td></tr></table></td></tr>
<tr><td>16</td><td>Load meter output setting</td><td>RV113</td><td>The power limit offset RV114 is shifted and the voltage of CH23 is changed to 1V so that the CH24 voltage goes to 1V.
After this adjustment, the power limit offset must be adjusted.</td><td></td><td></td></tr>
</table>

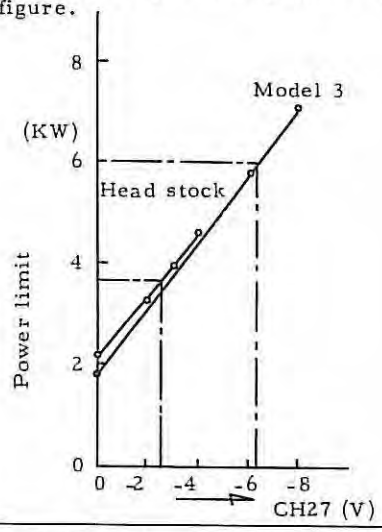
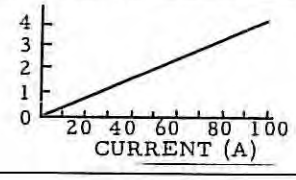
No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Headstock
17	Dither No.1	RV3	CH8 and CH3 are shorted. The CH9 voltage is set to the proper level. 	ED 50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V	ED 50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V
18	Dither No.2	RV11A RV11B RV11C	The pulse amplitude of CH13A to C or CH14 A to C is adjusted to the minimum to balance the firing phase of the synchronous pulse. Amplitude CH13A~C Amplitude  CH14A~C  0V		
19	Dither No.3	RV10A RV10B RV10C	Adjusts the dither pulsewidth.  Next, adjust the two volumes in RV10A to C so that the peak value of the current waveform at low speed can be arranged. It may be arranged into the smaller waveform. Refer to Item 2.5.1, 'Synchronous pulse adjustment' for details. 	50Hz 1.8ms 60Hz 1.6ms	50Hz 1.8ms 60Hz 1.6ms
20	Setting deceleration limit	RV101	After checking that CH21 is +10 or -10V when each motor is revolved at the maximum speed (refer to Item 7, 'Tachogenerator voltage adjustment'), the voltage of CH26 is set to the proper value.	9.0V $^{+0V}_{-0.2V}$	9.1V $^{+0V}_{-0.2V}$

Appendix III Adjusting and checking the firing circuit (For PCB A20B-0005-0584)

Since the following adjustment is usually performed at the factory, adjustment and confirmation are not necessary. Refer to the following for routine checking.

No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Head stock
1	Time constant setting	SH01	Clutch low / Clutch HIGH 5-12: 0.6 sec / 1 sec 6-11: 1.2 sec / 2 sec 7-10: 1.8 sec / 3 sec 8-9: 2.4 sec / 4 sec	7-10	7-10
2	Tachogenerator voltage setting	SH01	Setting: TG maximum voltage 1-16: 10V 2-15: 12V 3-14: 19V 4-13: 21V	2-15 (12V/ 2000 rpm)	1-16 (10V/ 3500 rpm)
3	Current detector bias	S9 S10	Detector specification: A44L-0001-0048 — Setting: S10 Setting: S9	S10	S10
4	VCMD interface setting	S11 S12	Specification: Normally, a spindle control circuit is used — Setting: S11 Specification: Clutch switching is provided — Setting: S12	S12	S11
5	Power limit setting	S13 S14	Motor specification: MODEL 5, 10 — Setting: S13 Motor specification: MODEL 2, 3, headstock — Setting: S14	S14	S14
6	Clutch switching is provided	S15 S16	Clutch switching: Provided — Setting: S16 Clutch switching: Not provided — Setting: S15	S15	S15
7	Dither No. 1	RV3	CH8 and CH3 are shorted. The CH9 voltage is set to the proper level. 	ED 50Hz 1.85V 60Hz 3.15V E 50Hz 1.0V 60Hz 2.4V	ED 50Hz 1.85V 60Hz 3.15V E 50Hz 1.0V 60Hz 2.4V
8	Dither No. 2	RV11A RV11B RV11C	The pulse amplitude of CH13A to C or CH14 A to C is adjusted to the minimum to balance the firing phase of the synchronous pulse. 		

No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Head stock
9	Minimum phase shift adjustment	RV 10A RV 10B RV 10C	CH31 and CH17 (-15V) are shorted. Adjust the pulse width of CH13 A ~ C. CH13 A ~ C  	0.8ms (50/60Hz)	0.8ms
10	Current loop gain	RV7	Loop gain to current commands Reduce the gain 20% ~ 30% when some swell is observed in the current.	100%	100%
11	Current detection offset	RV103	Adjust the CH11 voltage OV when current is not applied. If this adjustment varies excessively, the velocity is not uniform at low speeds.		
12	Power limit offset	RV114	Adjust the CH23 voltage to OV when current is not applied. If this adjustment varies excessively, the power limit at high speeds is inaccurate and motors can be damaged.		
13	Current limit setting	RV9	Set the CH12 voltage to the proper value when current is not applied. The relation of CH12 and the current limit is as shown in the following figure.  	-1.1V	-0.7V

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Head stock</th></tr>
<tr><td>14</td><td>Power limit</td><td>RV109</td><td>Set the CH27 voltage to the proper value when current is no spplied. The relation between CH27 and the power is as shown in the following figure.
 
</td><td>-6.2V</td><td>-2.5V</td></tr>
<tr><td>15</td><td>Velocity loop gain adjust-ment</td><td>RV1</td><td>Adjust as below by load inertia.
<table>
<tr><th>Max inertia</th><th>Setting</th><th>Max inertia</th><th>Setting</th></tr>
<tr><td>0~2kg cm S^2</td><td>45%</td><td>0~0.5kg cm S^2</td><td>60%</td></tr>
<tr><td>2~ "</td><td>70%</td><td>0.5~1 "</td><td>80%</td></tr>
</table></td><td colspan="2"></td></tr>
<tr><td>16</td><td>Velotiy loop offset</td><td>RV2</td><td>Adjust the motors to halt when the velocity command voltage is OV.</td><td></td><td></td></tr>
<tr><td>17</td><td>rpm adjust-ment</td><td>RV4</td><td>The maximum rotation speed is adjusted when 10V is the velocity command voltage.
Maximum rotation speed: ±0.4%</td><td>2000 rpm</td><td>3400
~
3500 rpm</td></tr>
<tr><td>18</td><td>Setting dece-leration limit</td><td>RV101</td><td>After checking that CH21 is +10 or -10V when each motor is re-volved at the maximum speed (refer to Item 7, 'Tachogenerator voltage adjustment'), the voltage of CH26 is set to the proper value.</td><td>9.0V $^{+0V}_{-0.2V}$</td><td>9.1V $^{+0V}_{-0.2V}$</td></tr>
<tr><td>19</td><td>Torque limit setting</td><td>RV108
RV122</td><td>Orientation is performed by apply-ing the torque limit and adjusting the halt current.
Adjust the torque limit by RV 108 and RV 122 during measurement current value on CH 11.
<table>
<tr><th></th><th>Adjusting locations</th></tr>
<tr><td>Clutch HIGH</td><td>RV108</td></tr>
<tr><td>Clutch LOW</td><td>RV122</td></tr>
</table>

</td><td colspan="2">Voltage of CH29 can be used for adjustment torque limit.
<table>
<tr><th>Current</th><th>CH11</th><th>CH29</th></tr>
<tr><td>5A</td><td>0.2V</td><td>-1.6V</td></tr>
<tr><td>10 "</td><td>0.4"</td><td>-1.9V</td></tr>
<tr><td>15 "</td><td>0.6"</td><td>-2.05V</td></tr>
<tr><td>20 "</td><td>0.8"</td><td>-2.15V</td></tr>
<tr><td>25 "</td><td>1.0"</td><td>-2.27V</td></tr>
<tr><td>30 "</td><td>1.2"</td><td>-2.4V</td></tr>
<tr><td>35 "</td><td>1.4"</td><td>-2.53V</td></tr>
</table></td></tr>
<tr><td>20</td><td>Load meter output setting</td><td>RV 113</td><td></td><td>50%</td><td>50%</td></tr>
</table>

II. DC SPINDLE SERVO UNIT

MAINTENANCE MANUAL

for

MODEL 2, 3
HEAD STOCK WITH SPINDLE CONTROL UNIT

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1. GENERAL

This maintenance manual is applicable to Installation and adjustment and maintenance of the spindle servo unit (with spindle control) which drives the FANUC DC spindle motor (Models 2 and 3) and the headstock for FANUC TAPE CENTER MODEL C D, H.

A diagram of the structure of the spindle servo unit (with spindle control) follows.

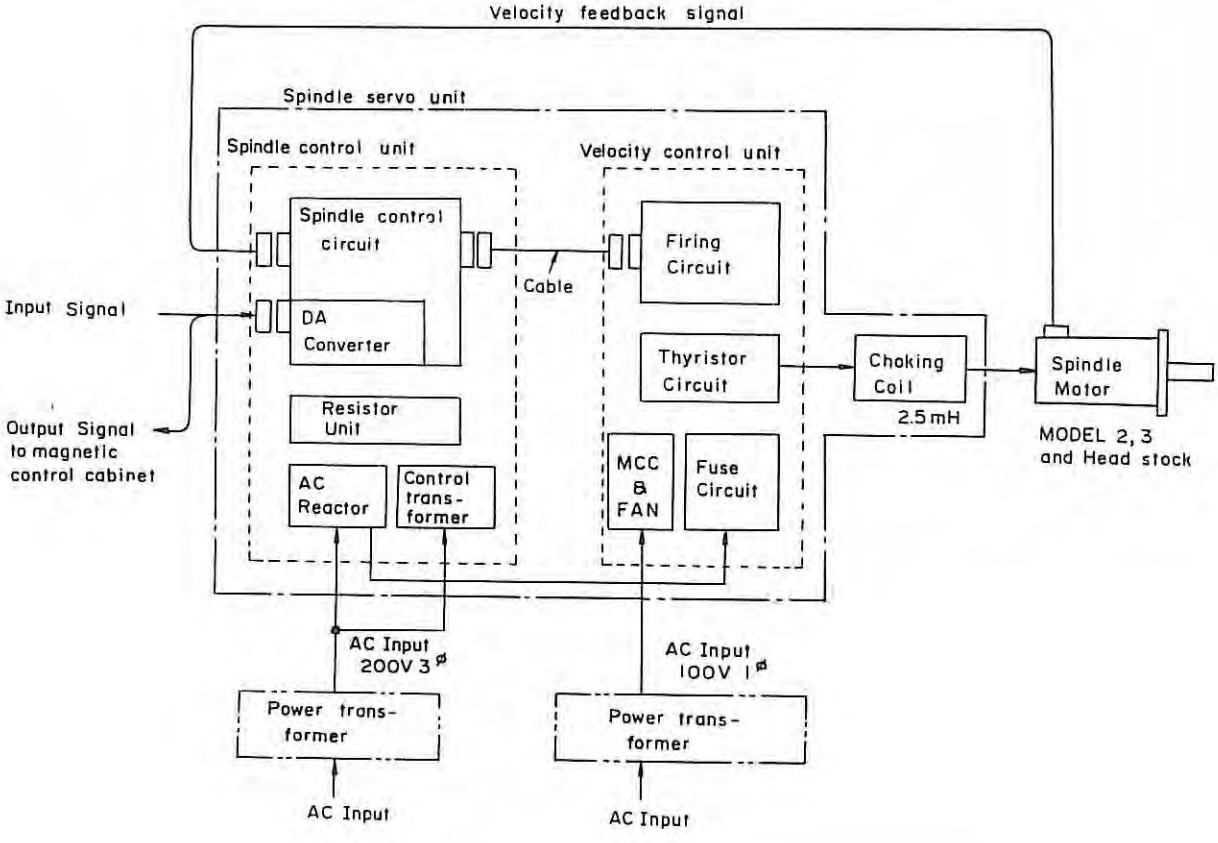


Fig. 1 Spindle servo unit block diagram

A table of printed circuit board specifications follows.

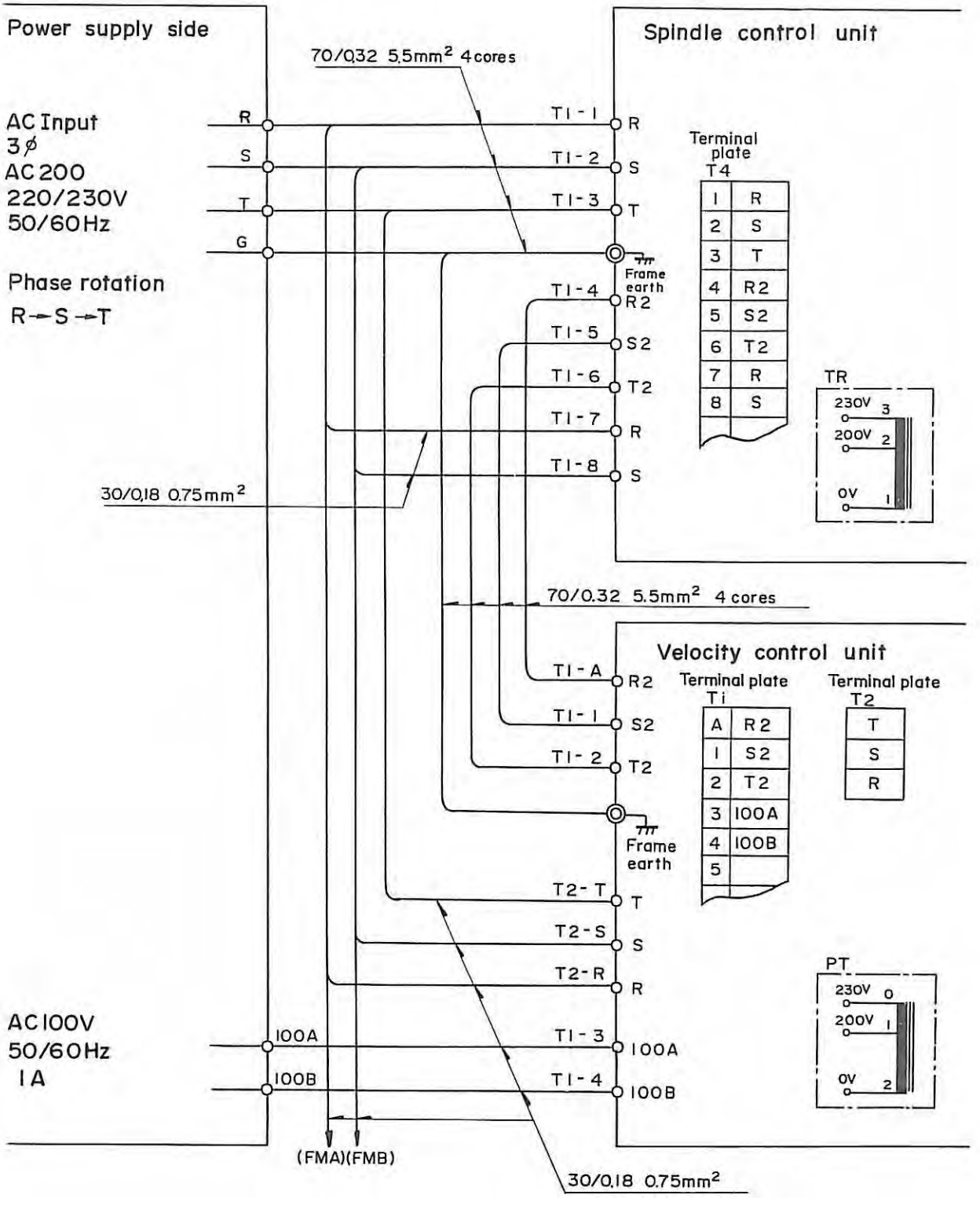
	P. C. B. No. 1	P. C. B. No. 2	P. C. B. No. 3
Model 2 and 3	A20B-0004-0780	A20B-0005-0583/T	A20B-0005-0584/T
Headstock	A20B-0004-0780	A20B-0005-0583/U	A20B-0005-0584/U
Spindle control circuit	A20B-0004-0990	A20B-0004-0990 (03A)	A20B-0004-0990 (08C)
Remark	Manufactured from Jul. 1976 to Dec. 1977	Manufactured from Jan. 1978 to Aug. 1978	Manufactured from Sep. 1978

2. FIELD ADJUSTMENT

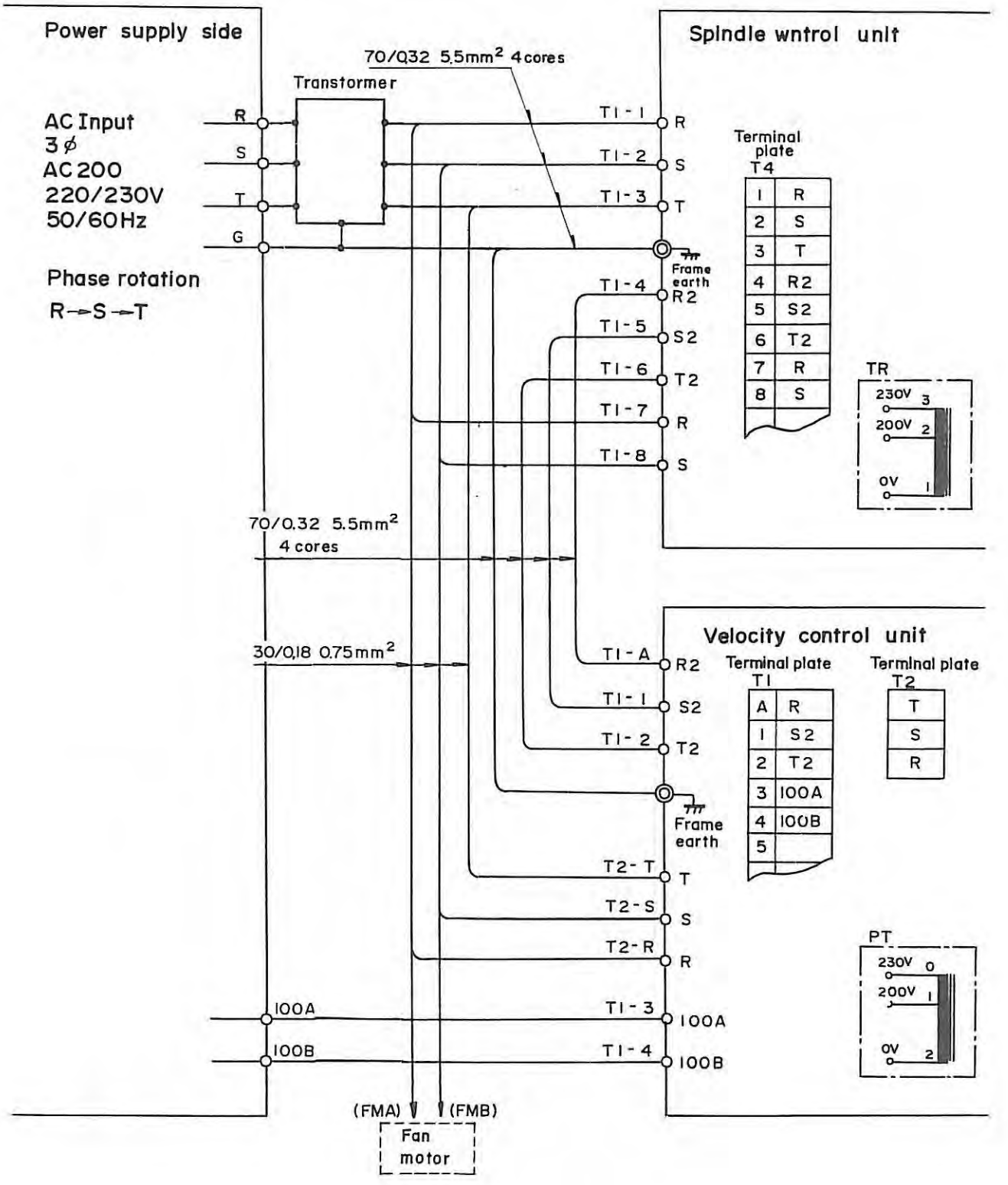
2.1 Connection

(1) Connection of power line.

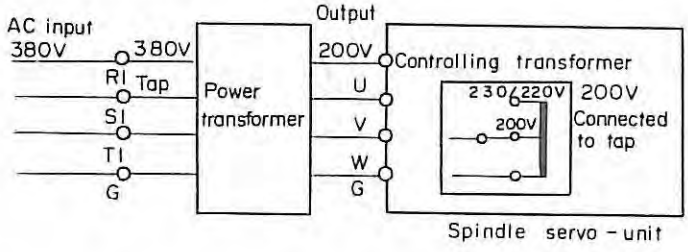
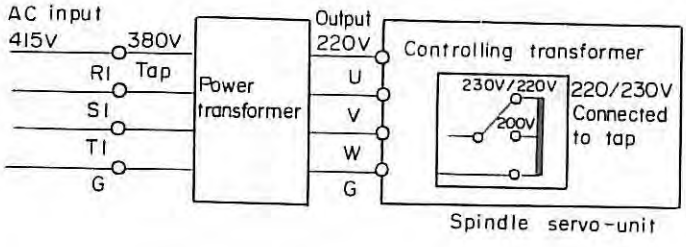
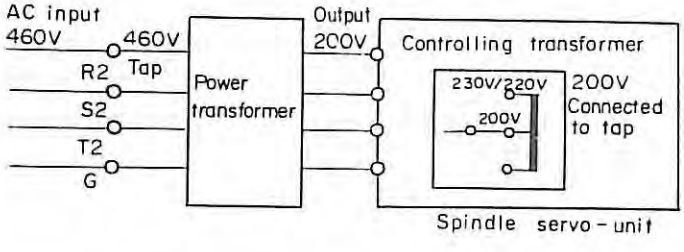
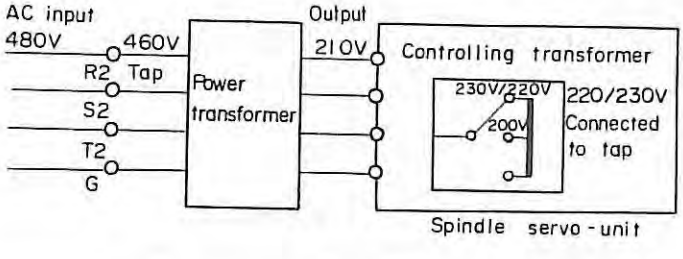
AC200/220/230V power supply line



AC200/220/230V power line (ex. 380V/460V)

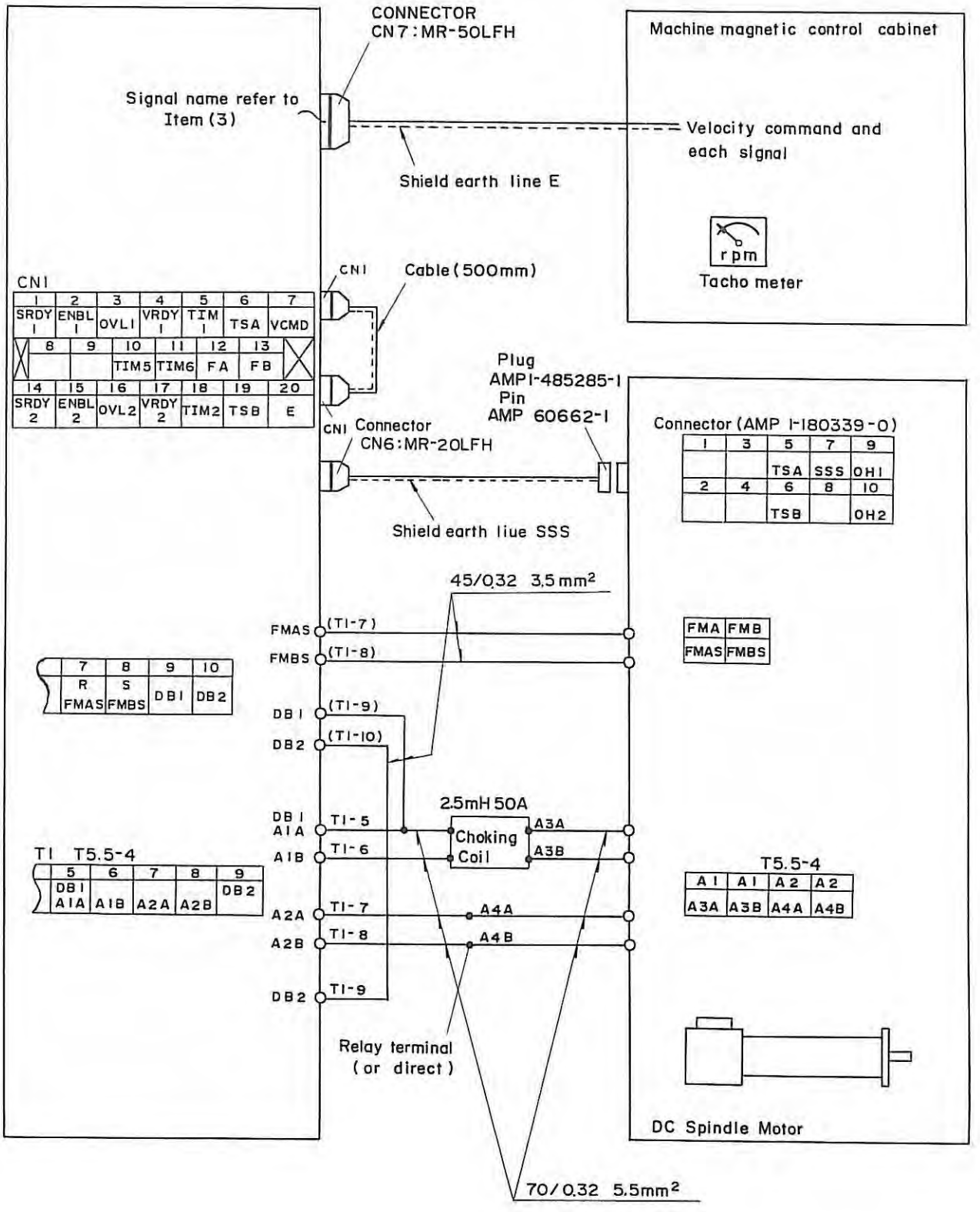


If the FUJITSU FANUC power transformer is used, the following connections must be made with input voltage of 380-480V.

No.	AC input voltage	Connection
1	380V $^{+10\%}_{-15\%}$	
2	400/415V $^{+10\%}_{-15\%}$	
3	460V $^{+10\%}_{-15\%}$ (440V ± 10%)	
4	480V $^{+10\%}_{-15\%}$	

Refer to 2.2(1) for the settings of the controlling power transformer.

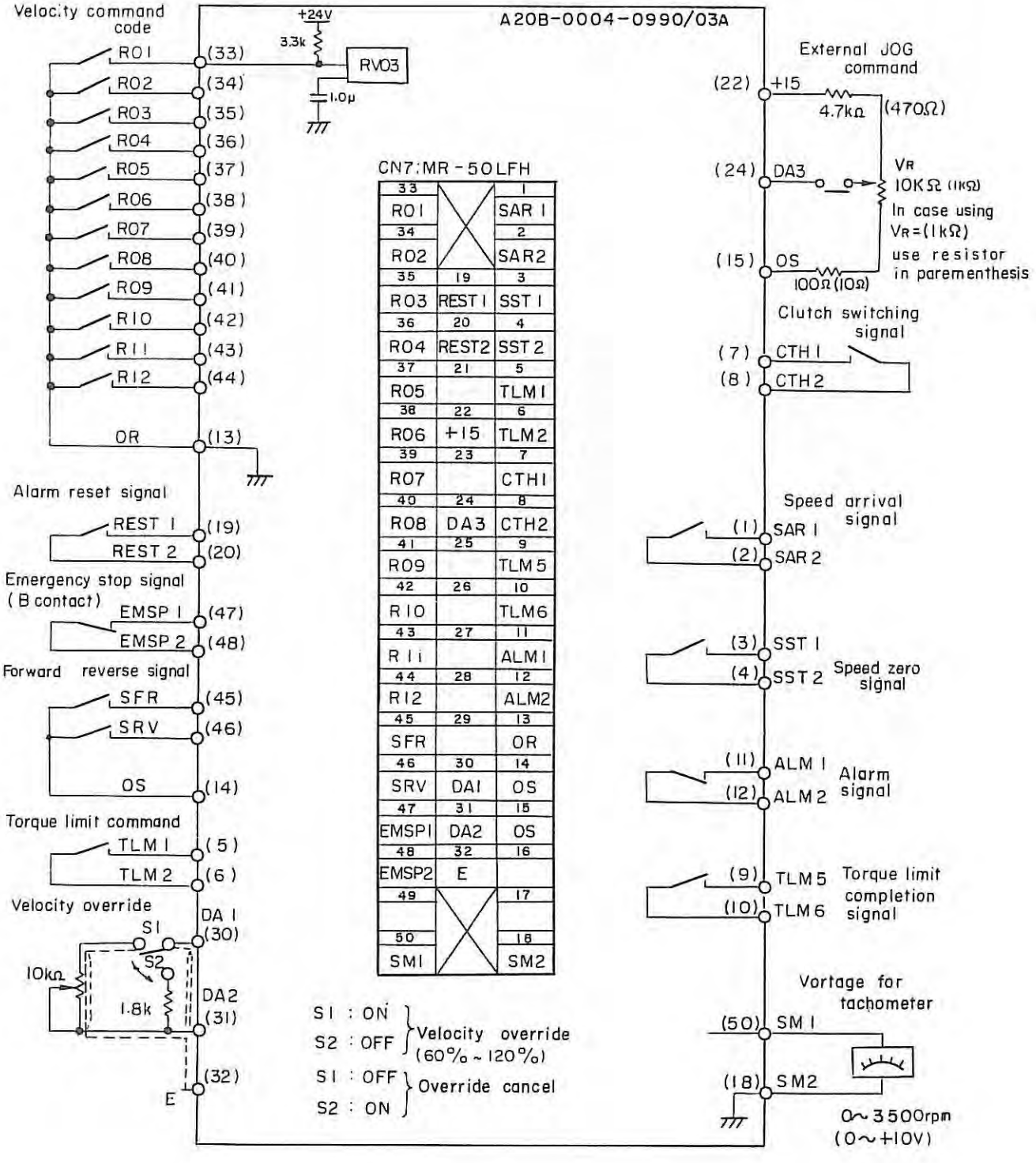
(2) Connection of spindle motor power line and signal line.



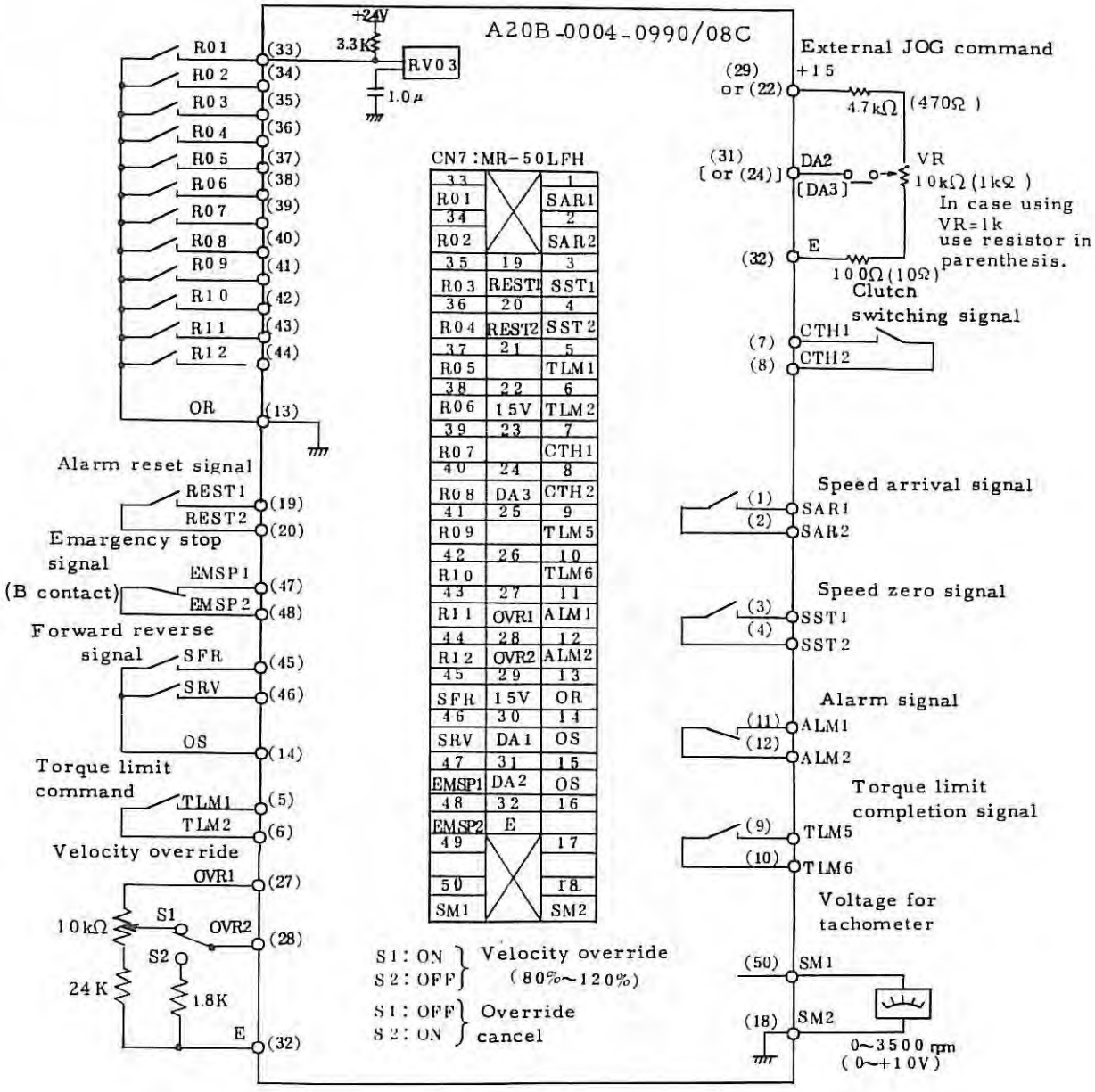
(3) Signal line check

The connection between the magnetics cabinet and the spindle servo-unit is as follows. Attention must be paid to the fact that the emergency stop signal input and the alarm signal output are both B contact.

In case before edition 03A of spindle control circuit A20B-0004-0990.



In case of edition 08C of spindle control circuit A20B-0004-0990



2.2 Check the Setting

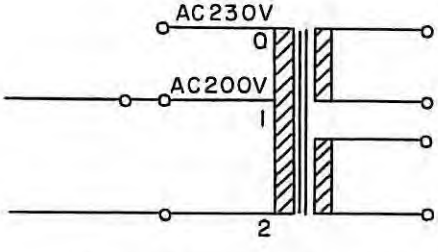
(1) Tap changing according to the AC input voltage

The transformer PT tap in the velocity control unit is set as follows in accordance with the AC input power supply voltage.

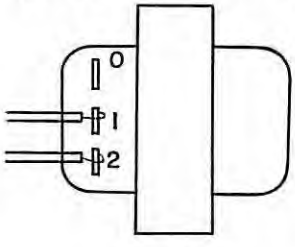
AC input voltage	Transformer PT Tap	Transformer TR Tap
AC200V +10% -15%	Connect to Tap 1	Connect to Tap 2
AC220V +10% -15% or AC230V +10% -15%	Connect to Tap 0	Connect to Tap 3

If switching is not performed for 220V/230V AC, it causes a fault in the power supply regulator on the printed circuit board. Make sure to switch it.

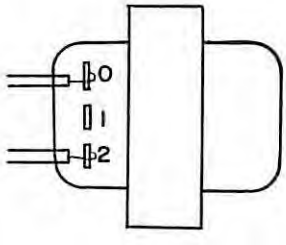
Transformer PT



Primary side Secondary side
(A44L-0001-0047)

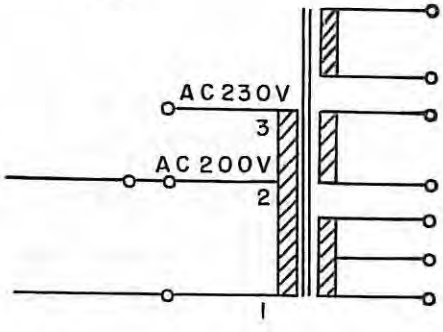


AC200V

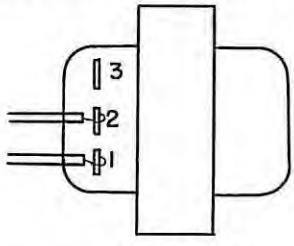


AC200V/230V

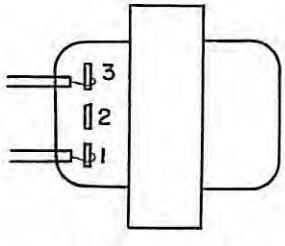
TR



Primary Secondary
(A44L-0001-0059)



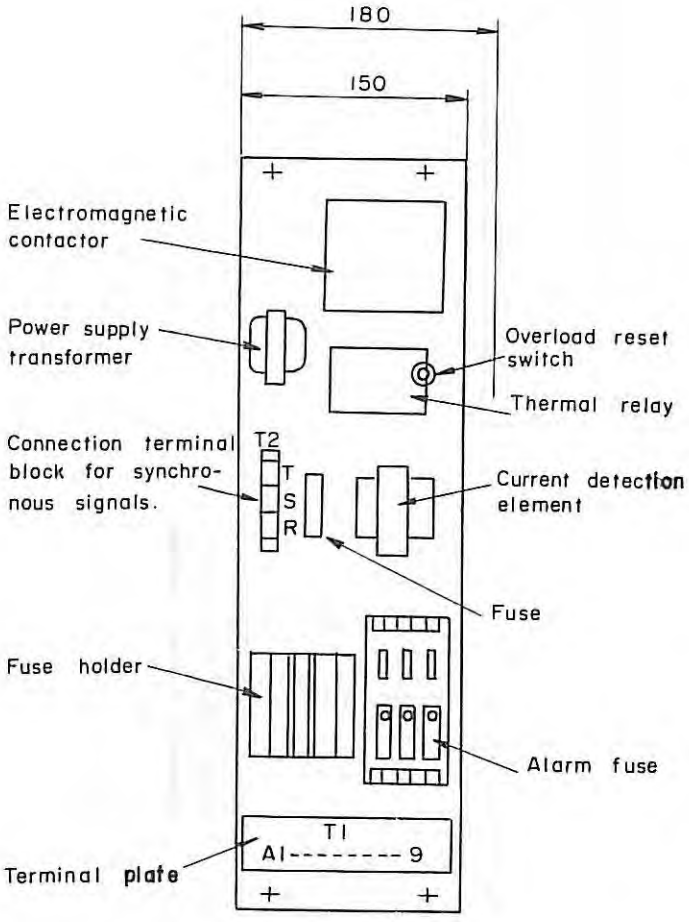
AC200V



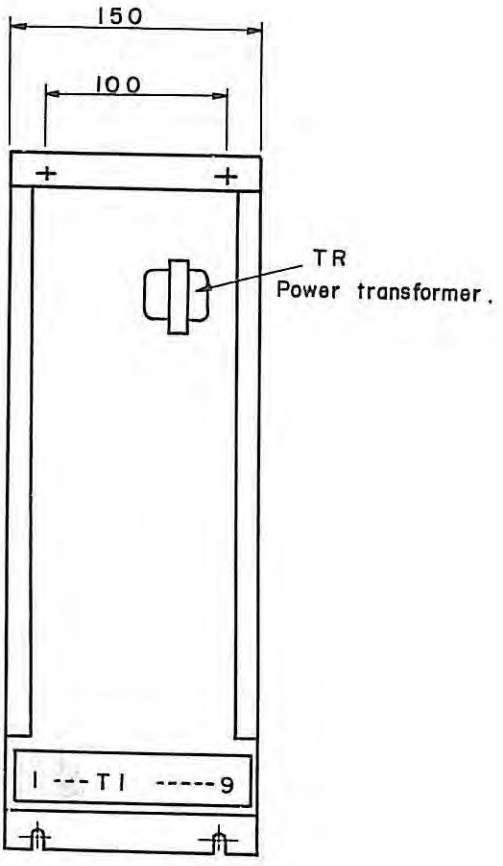
AC200V/230V

Power supply mounting location.

Velocity control unit

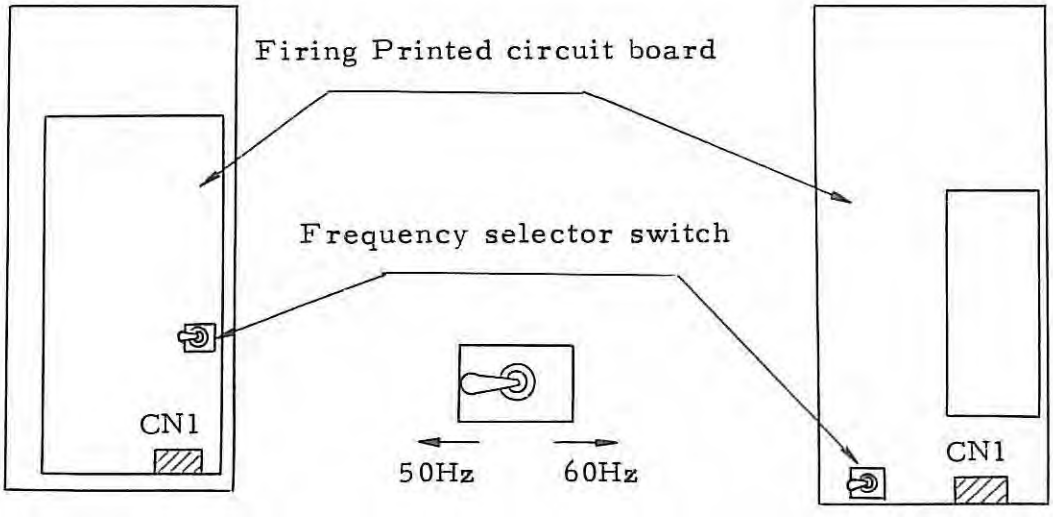


Spindle control unit



(2) Setting the frequency selector switch (50/60Hz)

Check that the frequency selector switch is properly positioned in accordance with the line frequency (50/60 Hz).



P.C.B. No.2
A20B-0005-0583

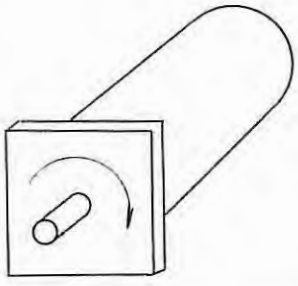
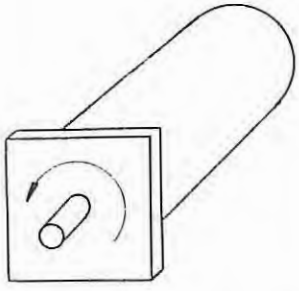
P.C.B. No.1
A20B-0004-0780

P.C.B. No.3
A20B-0005-0584

2.3 Checks Before Turning Power ON

(1) Testing the motor cable and T.G feedback signal connections.

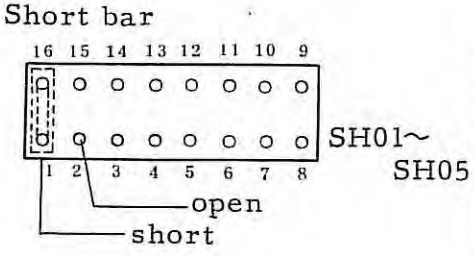
Before turning on the power switch, check the polarity of the motor cable and T.G. feedback signal connections. Rotate the motor shaft clockwise by hands and check the voltage between terminals T1-5, 6 and T1-7, 8 and between CH2 to CH3 (GND)

No.	Motor Rotational Direction	Measuring apparature	Polarity of motor	Polarity of T.G feedback signal
1	Motor shaft to rotate clockwise 	Tester or Oscillo-scope	⊕voltage A1 (T1-5, 6) ↑ A2 GND (T1-7, 8)	CH2 ⊕voltage ↑ CH3 (GND)
2	Motor shaft to rotate counterclock-wise. 	Tester or Oscillo-scope	GND A2 (T1-7, 8) ↓ ⊖voltage A1 (T1-5, 6)	CH3 (GND) ↓ CH2 ⊖voltage

If polality is incorrect, the machine runs away by start signal. Therefore, always check the polarity.
In case of PCB. No.3 A20B-0005-0584, motor rotates at first, but alarm occur at once and FA/FB alarm signal send out.

(2) Checking of isolated resistor check the resistor between GND and 5~8 terminal of terminal plate T1 and whether it's ualue is more 0.1 MΩ.

(3) Setting of spindle control circuit PCB (A20B-0004-0990)

Unit		Pin No.	Setting CCD	Setting CBI	Contents	Remarks
SH01		01-16	O		Set the left data by DA conuerter, BCD S2 digits, Binary 12 bit. 	
		02-15	O			
		03-14	O			
		04-13	O			
		05-12		O		
		06-11		O		
		07-10		O		
		08-09		O		
SH02		01-16	O			
		02-15	O			
		03-14	O			
		04-13	O			
		05-12		O		
		06-11		O		
		07-10		O		
		08-09		O		
SH03		01-16	O			
		02-15	O			
		03-14	O			
		04-13	O			
		05-12		O		
		06-11		O		
		07-10		O		
		08-09		O		
SH04		01-16	O			
		02-15		O		
		03-14		O		
		04-13	O			
	1	05-12			In case setting of external analog voltage input in PCB making before edition 03A.	Refer to circuit 1.
		06-11		O		
		07-10				
		08-09		O		
	2	05-12		O	In case using D/A convertor and no using override function in PCB making before edition 03A.	Refer to circuit 1, 3, 4.
		06-11		O		
		07-10				
		08-09				
	3	05-12			In case using D/A converter and external JOG command (analog voltage input) in PCB making before edition 03A.	Refer to circuit 2.
		06-11		O		
		07-10				
		08-09		O		

<table>
<tr><th colspan="2" rowspan="2">Unit</th><th rowspan="2">Pin No.</th><th colspan="2">Setting</th><th rowspan="2">Contents</th><th rowspan="2">Remarks</th></tr>
<tr><th>CCD</th><th>CBI</th></tr>
<tr><td rowspan="5">SH04</td><td rowspan="4">4</td><td>05-12</td><td></td><td></td><td rowspan="4">In case using spindle override function (range 60 120%) in PCB making before edition 03A.

(08-09 is spare short bar)</td><td rowspan="4">Refer to circuit 3, 4.</td></tr>
<tr><td>06-11</td><td></td><td></td></tr>
<tr><td>07-10</td><td>O</td><td></td></tr>
<tr><td>08-09</td><td>O</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="3">In case edition 08C of spindle control circuit.</td><td rowspan="5">Refer to circuit 5.</td></tr>
<tr><td colspan="2">05-12</td><td colspan="3">Open in giving external analog input.</td></tr>
<tr><td colspan="2">06-11</td><td colspan="3">Open in using override function.</td></tr>
<tr><td colspan="2">07-10</td><td colspan="3">Open in using override function as uper limit is 100%.</td></tr>
<tr><td colspan="2">08-09</td><td colspan="3">Spare short bar.</td></tr>
<tr><td rowspan="8">SH05</td><td colspan="2">01-16</td><td></td><td rowspan="8" colspan="2">Setting by TG output voltage.
(MODEL 2, 3 headstock)
common to all edition.
<table><tr><th>Motor</th><th>Output voltage</th></tr><tr><td>Model 2, 3</td><td>12V/2000 rpm</td></tr><tr><td>Head stock</td><td>10V/3500 rpm</td></tr></table></td><td rowspan="8"></td></tr>
<tr><td colspan="2">02-15</td><td>O</td></tr>
<tr><td colspan="2">03-14</td><td>O</td></tr>
<tr><td colspan="2">04-13</td><td></td></tr>
<tr><td colspan="2">05-12</td><td></td></tr>
<tr><td colspan="2">06-11</td><td>O</td></tr>
<tr><td colspan="2">07-10</td><td></td></tr>
<tr><td colspan="2">08-09</td><td></td></tr>
<tr><td colspan="2">SH06</td><td colspan="2">01-02</td><td colspan="3">Short in giving external analog command from CN7-(24).</td><td></td></tr>
<tr><td colspan="2">SH07</td><td colspan="2">01-02</td><td colspan="3">Setting of speed error excessive alarm detecting level. Short: 20% Open: 50%</td><td>Note 1.</td></tr>
</table>

O mark: Short No mark: Open

Note 1) SH07 is short bar of pitch 2.54 mm.
SH07 is open (level 50%) at shipping time if no required.

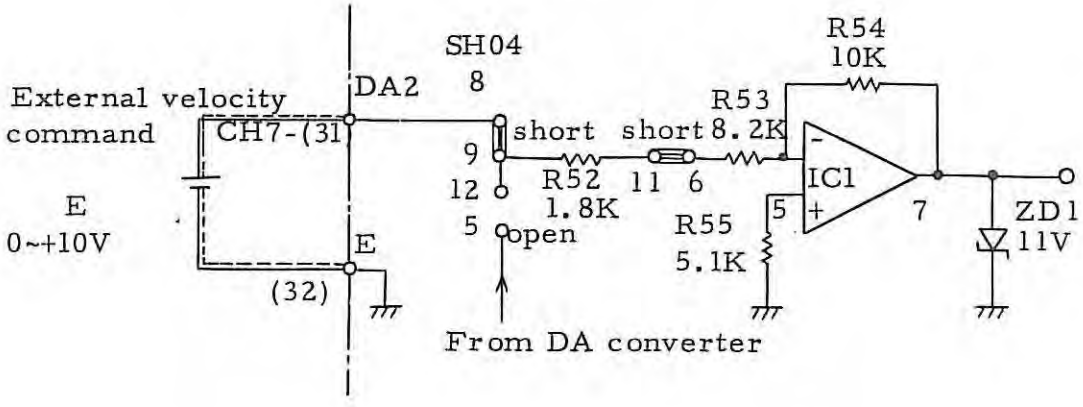
generaly for lathe set 50% SH07 01-02 open (standard)

for machining-center set 20% SH07 01-02 short

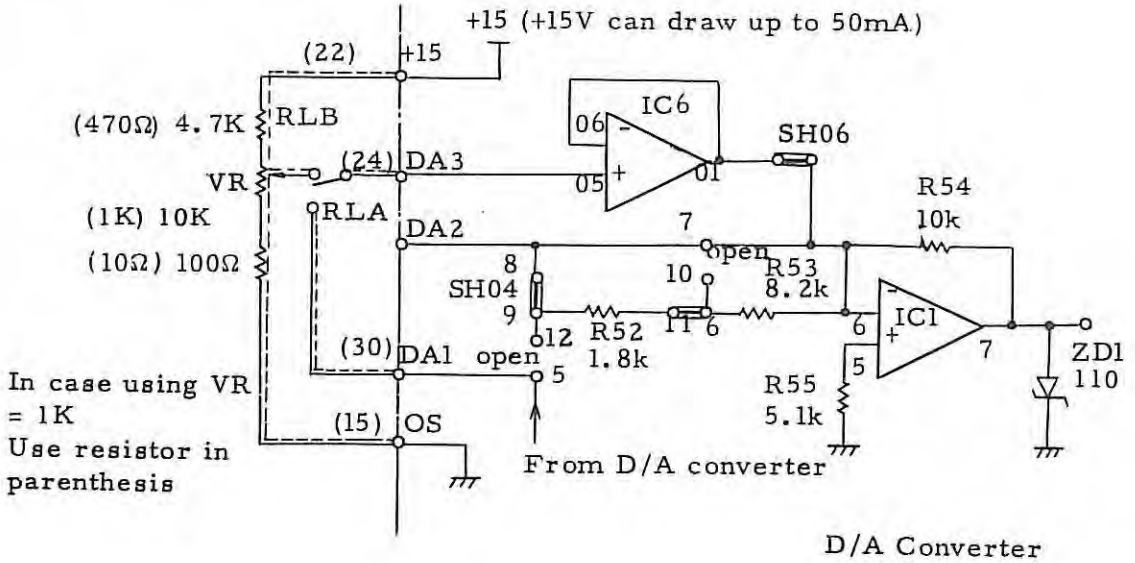
External connection and internal setting.

In case before edition 03A of spindle control circuit A20B-0004-0990.

Setting for external analogue voltage input



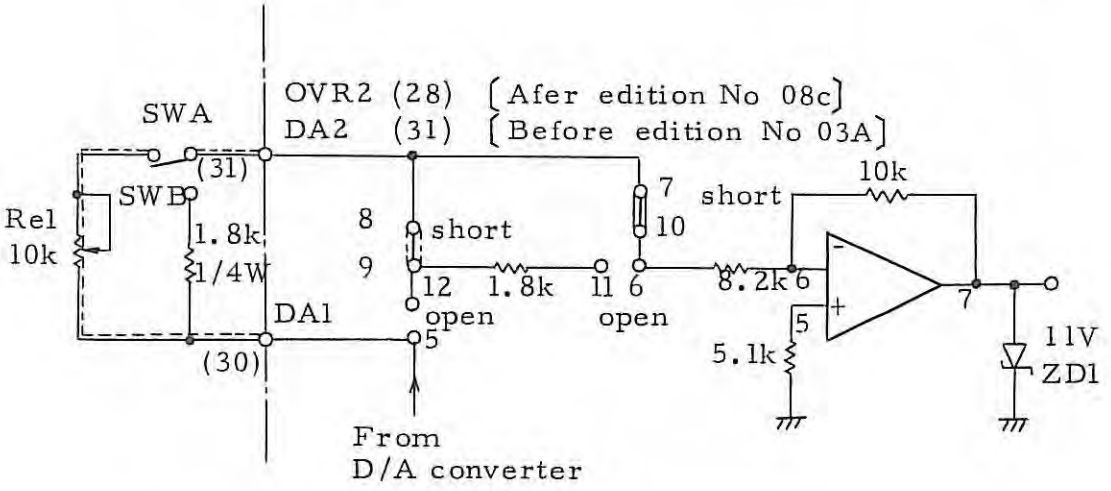
Setting when using both D/A converter input and external JOG command.



D/A Converter
RLA "ON"
RLB "OFF"
External JOG command
RLA "OFF"
RLB "ON"

(4) Setting for spindle override function

(a) This is used to change the spindle motor speed by 60 - 120% of the command value in order to improve cutting conditions.



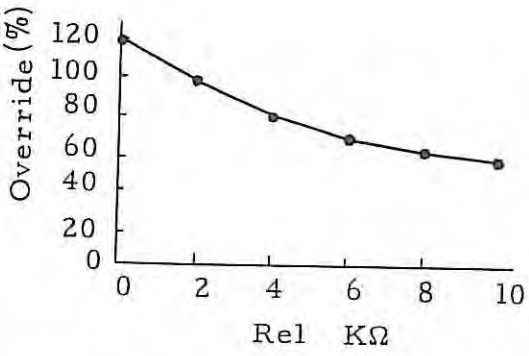
Override can be cancelled with external switches SWA and SWB.

SWA "ON" (closed)	SWB "OFF" (open)	..... With override
SWA "OFF"	SWB "ON"	..... Without override

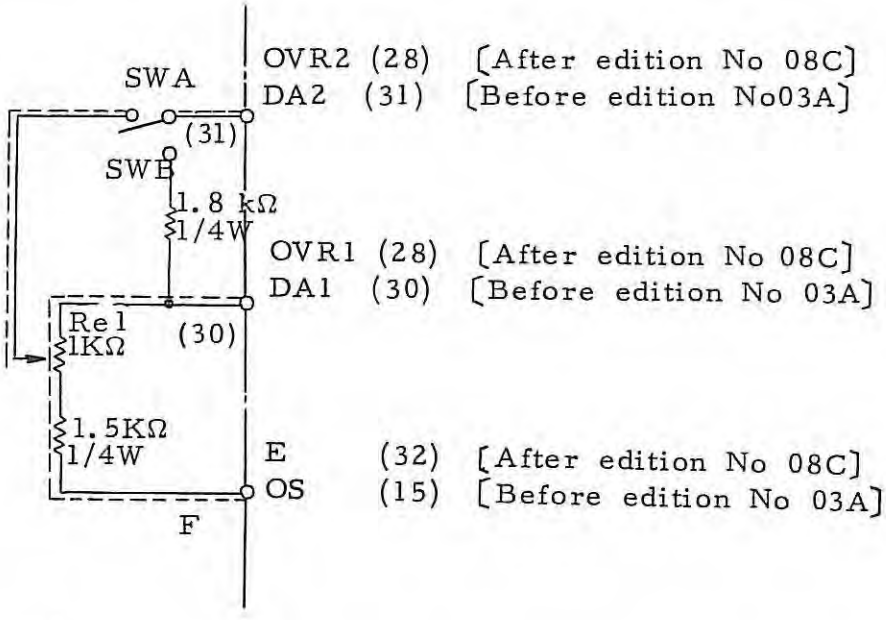
Override region

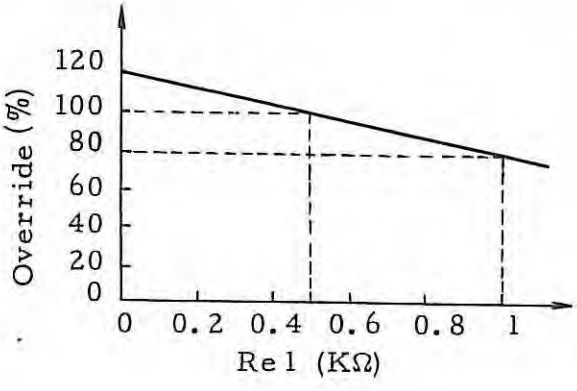
Rel = 0Ω	Approximately 120%
Rel = 10 KΩ	Approximately 55% (nominal 60%)

With above connections, the relationship of the variable resistor and the override are as in the graph at the right.



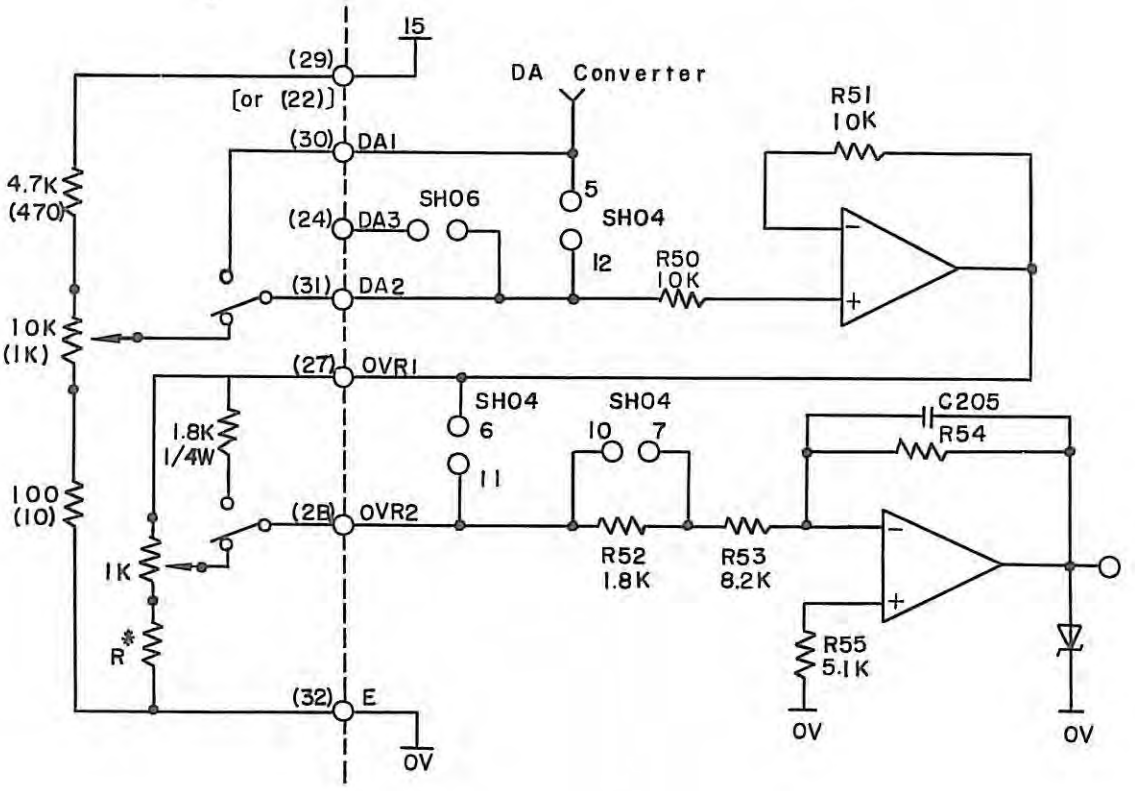
(b) To make the override proportional to the value of the external variable resistor, the following external connections must be made; however, the internal setting remains the same.
In this case, up to 70-120% of the command value is variable.





In case edition 08C of spindle control circuit A20B-0004-0990

Circuit diagram about setting



* Where R = 1k : Override is 60% ~ 120%
R = 2.4k : Override is 80% ~ 120%

Override is changed in linear as above.

Provided that SH04 10-7 PIN is short.

2.4 Checks Phase Rotation

(1) In case P. C. B. No. 3 A20B-0005-0584

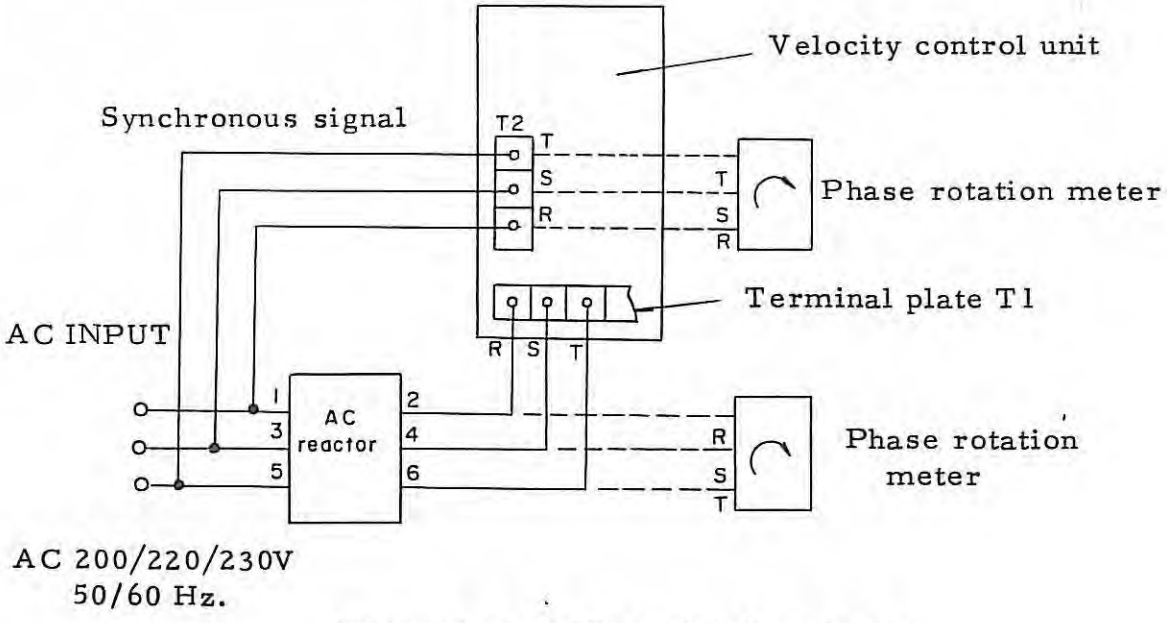
Added the opposite phase alarm circuit on this P. C. B. When the phase rotation is not correct or phase lacks, and then if power is on, opposite phase, lack of phase indicate alarm TGAL light on.

phase rotation is correct .....TGAL doesnot light on
opposite phase, lack. of phase .....TGAL lighs on

(2) The AC line is always connected to the input terminals so that the phase rotational direction is R→S→T.
If the phase rotation is not correct and power is supplied, the velocity control unit fuse may blow.

(Check)

Check that the phase rotation meter turns clockwise when connected in the order of R→S→T with terminal block T1 and T2. (Change the connection if not correct.)



Connection of Phase Rotation Meter

Precautions

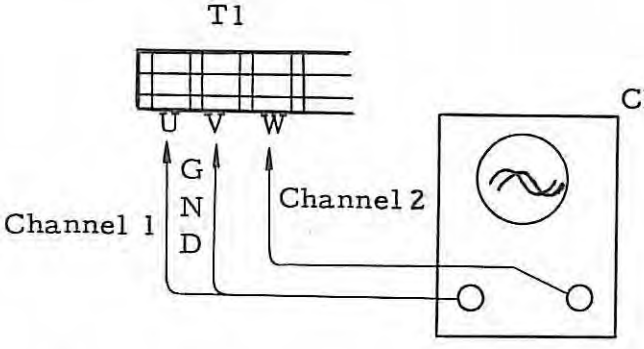
The following methods must be used carefully when a phase rotation meter is not employed.

(1) Always insulate the oscilloscope from ground during measurement.

(2) Further, since the oscilloscope itself is at equipotential with the input voltage, do not touch its frame or metal parts.

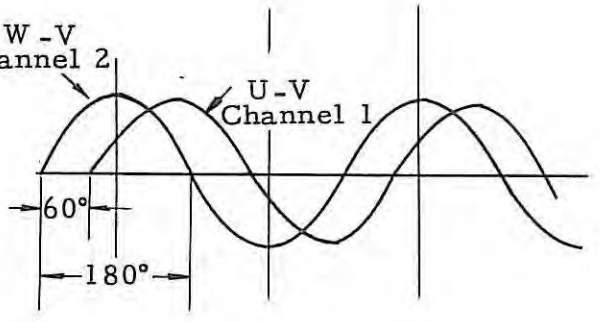
A dual-trace oscilloscope can be used to check phase rotation as follows:

[Measurement procedure]



[Waveform]

The following waveform is obtained if phase rotation is correct.



2.5 Adjustment

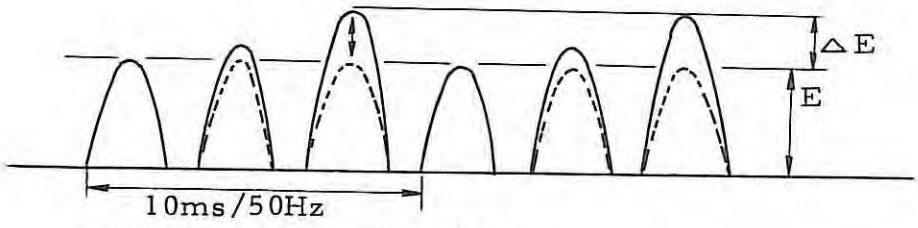
Only the following items are required for on-site adjustment.

(1) Synchronous pulse adjustment [only for PCB No. 1 A20B-0004-0780 and No. 2 A20B-0005-0583]

If the three-phase waveform is balanced, adjustment is not required, but if it is not balanced or if the inter-voltage varies, a synchronous pulse must be adjusted in the following manner.

Current waveforms are observed while slowly turning the spindle motor.

CH 11 waveform

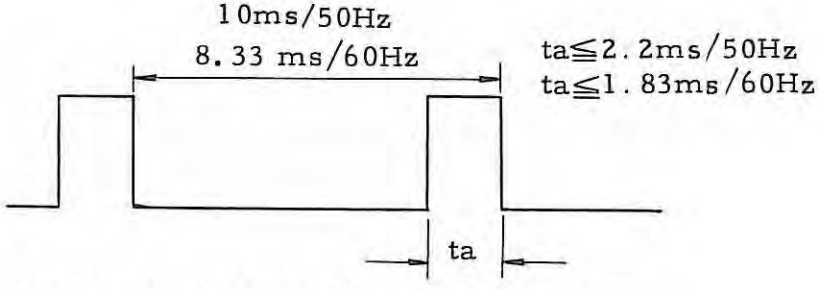


RV 10A RV 10B RV 10C

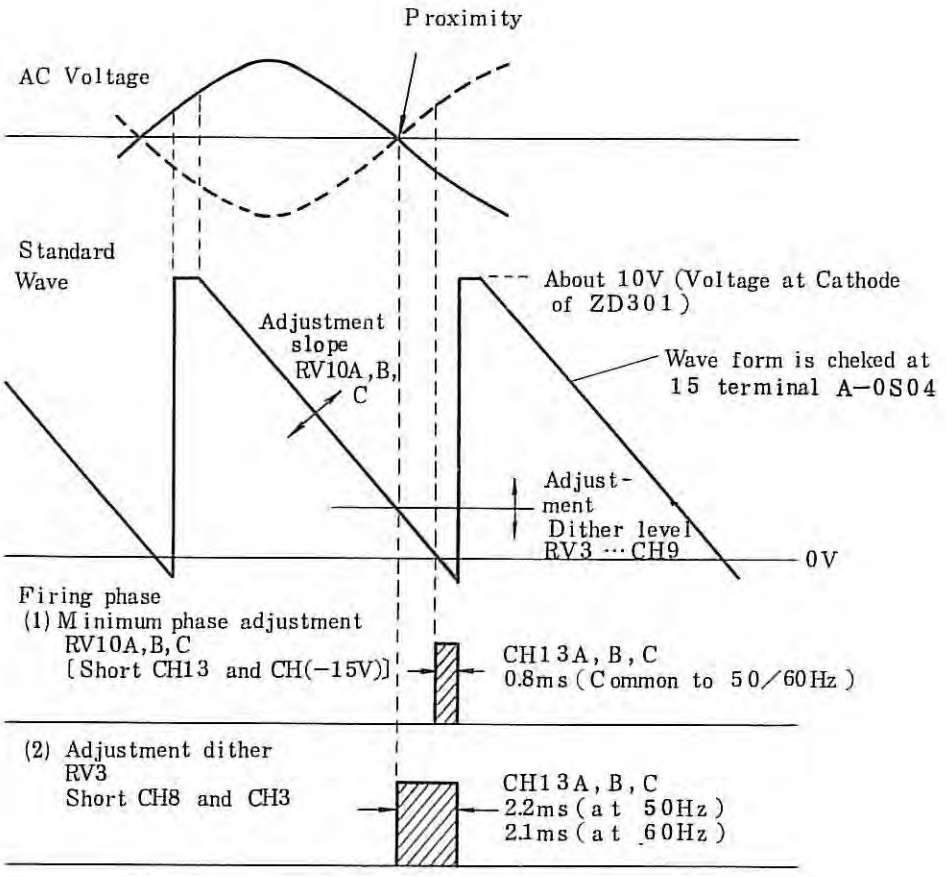
(Adjustment) Any two variable resistors RV 10A, B and C are turned counterclockwise so that the peak value of the current waveforms are within the following range.

$$\Delta E \leqq \pm 0.2E$$

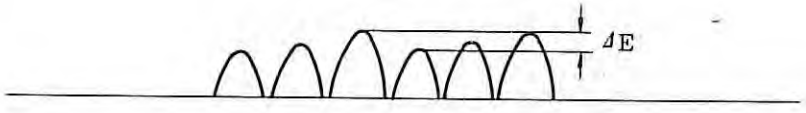
(Check) After adjustment, electromagnetic contactor MCC is turned OFF and the synchronous pulsewidth is checked by CH13 A, B and C. (check it after connects CH8 to the earth.)



Check again after readjusting for 50Hz ta > 2.2ms or 60Hz ta > 1.83ms.
In case A20B-0005-0584, no adjustment.



Current wave form at low speed
(Check point CH 11)



(2) Current detection circuit offset adjustment

Start signals are turned OFF and RV103 is adjusted so that the voltage at current waveform check terminal CH11 is zero.

Check terminal	Adjustment places	Adjustment method
CH11	RV103	0 ± 20mV

(3) Adjustment of rotation speed

When the speed command voltage is fed by 10V (maximum velocity command), the spindle is adjusted by RV4 so that the spindle turns at the maximum speed.

	P.C.B	Velocity command CH3	Spindle motor speed	Spindle speed	Adjustment place
MODEL 2, 3	A20B-0005-0583 /T A20B-0005-0584 /T	±10V	2000±8rpm	Maximum speed ±0.4%	RV4
Head stock	A20B-0005-0583 /U A20B-0005-0584/U	±10V	3400~3500 rpm	3400~3500 rpm	RV4

(4) Torque limit adjustment

The torque limit is set by adjusting the voltage of CH29. Adjustment locations are RV108 for clutch HIGH and RV122 for clutch LOW. Both are adjusted if a constant limit is required irrespective of the clutch setting.

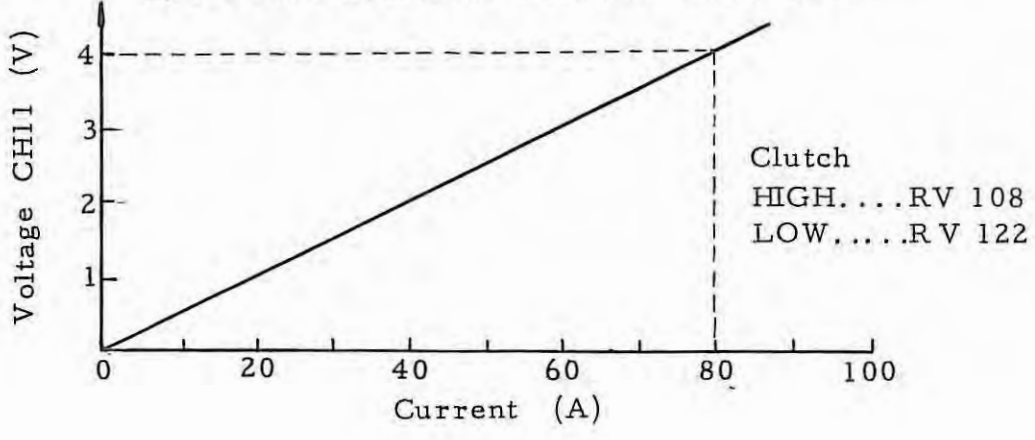
Further, if there is no clutch switching, only RV108 is effective.

Current value	0A	5A	10A	15A	20A	25A	30A	35A
Voltage of CH28	-1.2V	-1.6V	-1.9V	-2.05V	-2.15V	-2.27V	-2.4V	-2.53V

Standard Setting

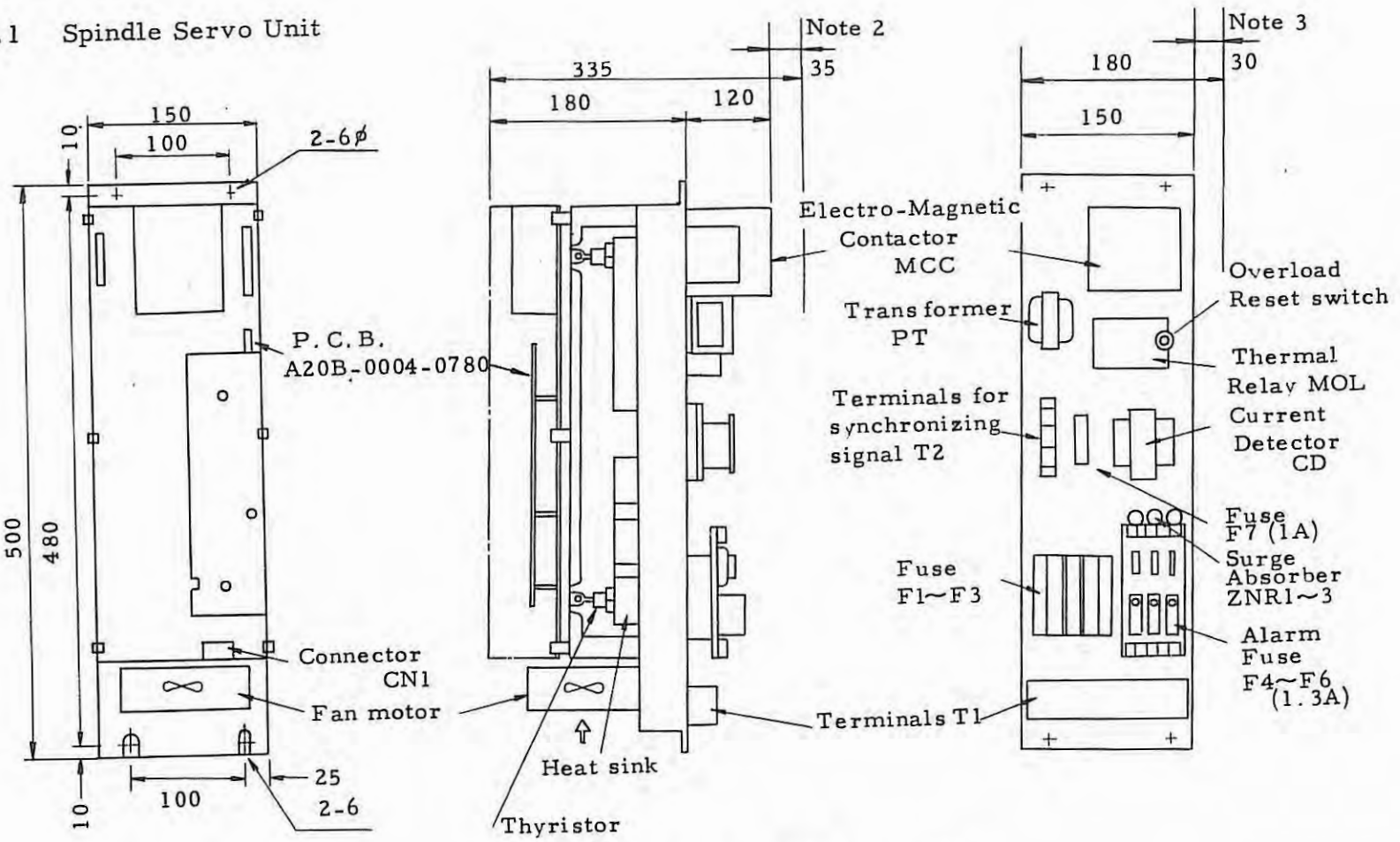
In case A20B-0005-0584

After torque limit is on, adjust the armature current by RV 108 and RV122 as measurement CH11.



3. MOUNTING DIAGRAM

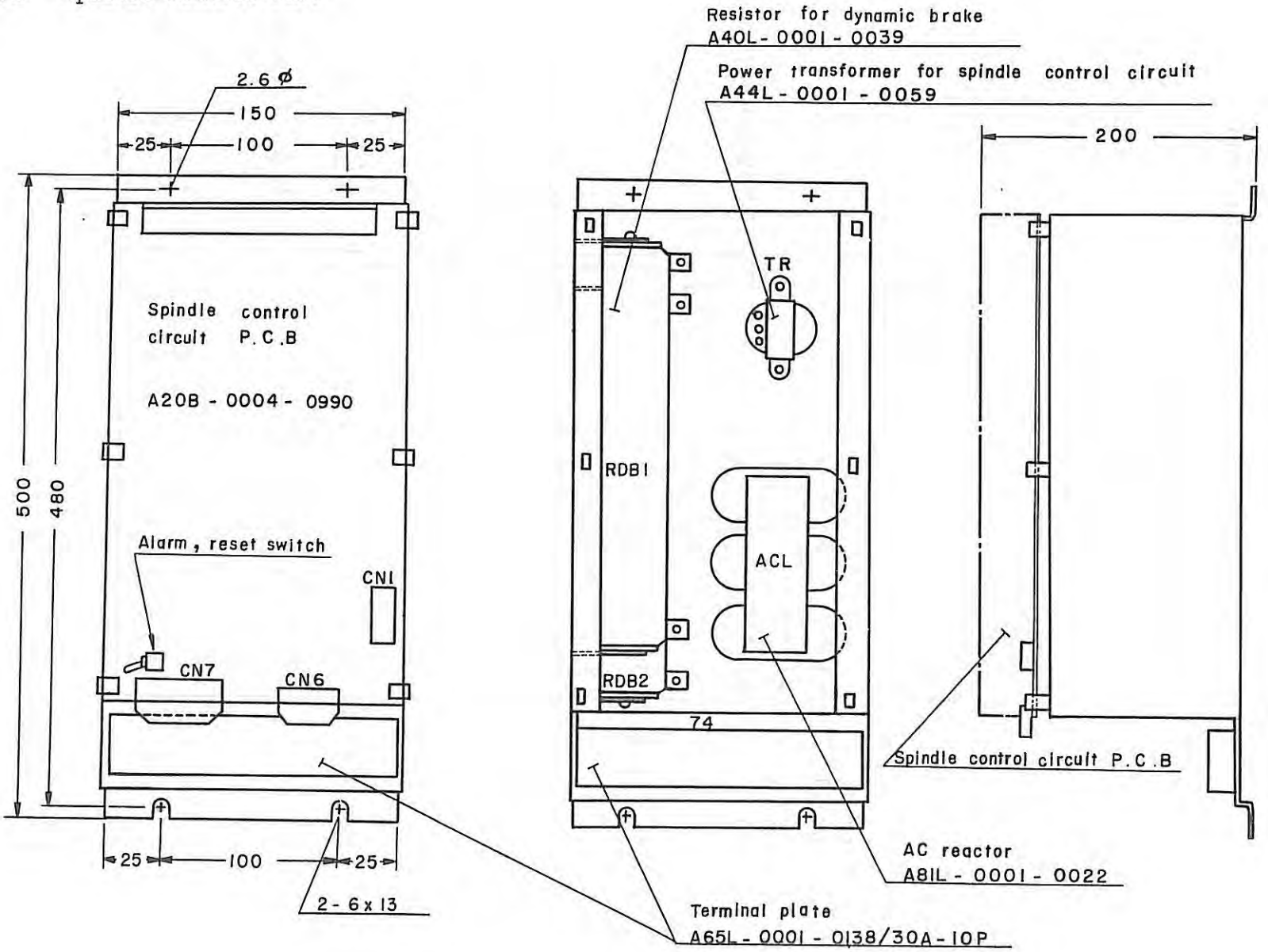
3.1 Spindle Servo Unit



(Notes)

1. Maintenance surfaces are for both front and rear ones.
2. A minimum of 35 mm space is required to prevent the top of the electromagnetic contactor from arcing.
3. A minimum of 30 mm space is required on the side of the thermal relay to press the reset switch.

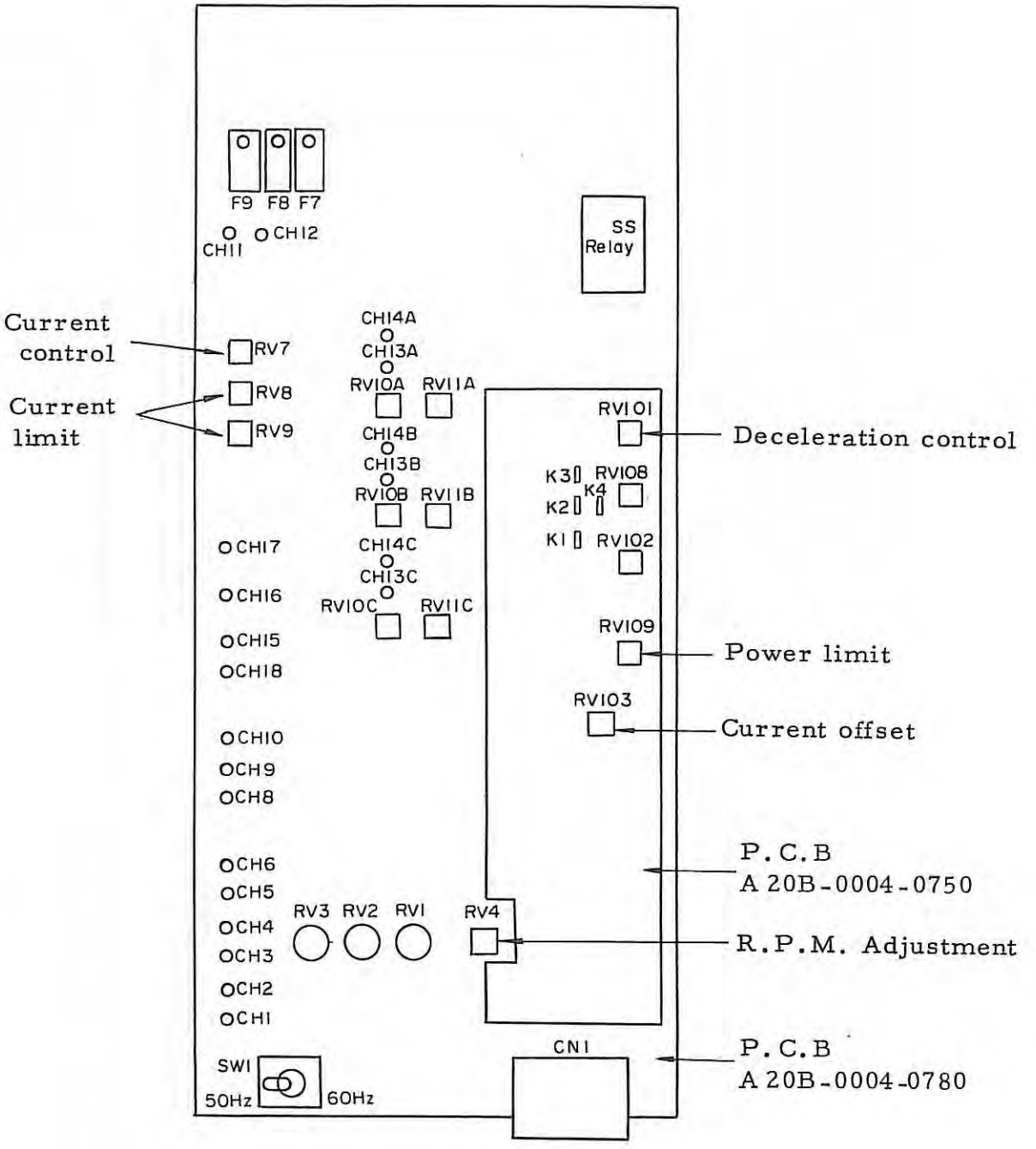
3.2 Spindle Control Unit



3. 3 PCB Mounting Drawing

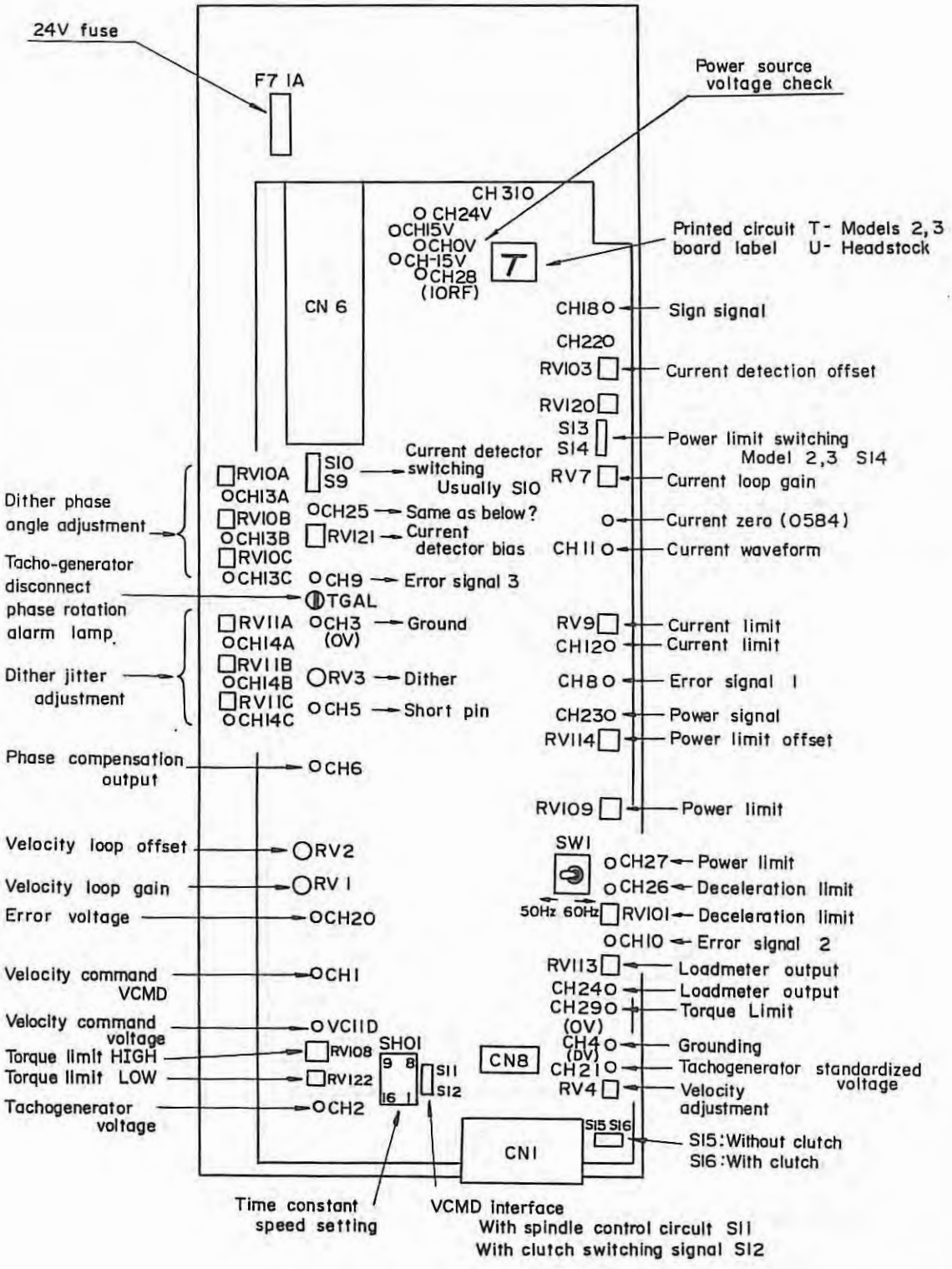
(1) Firing Circuit

Printed Circuit Board No.1 A20B-0004-0780



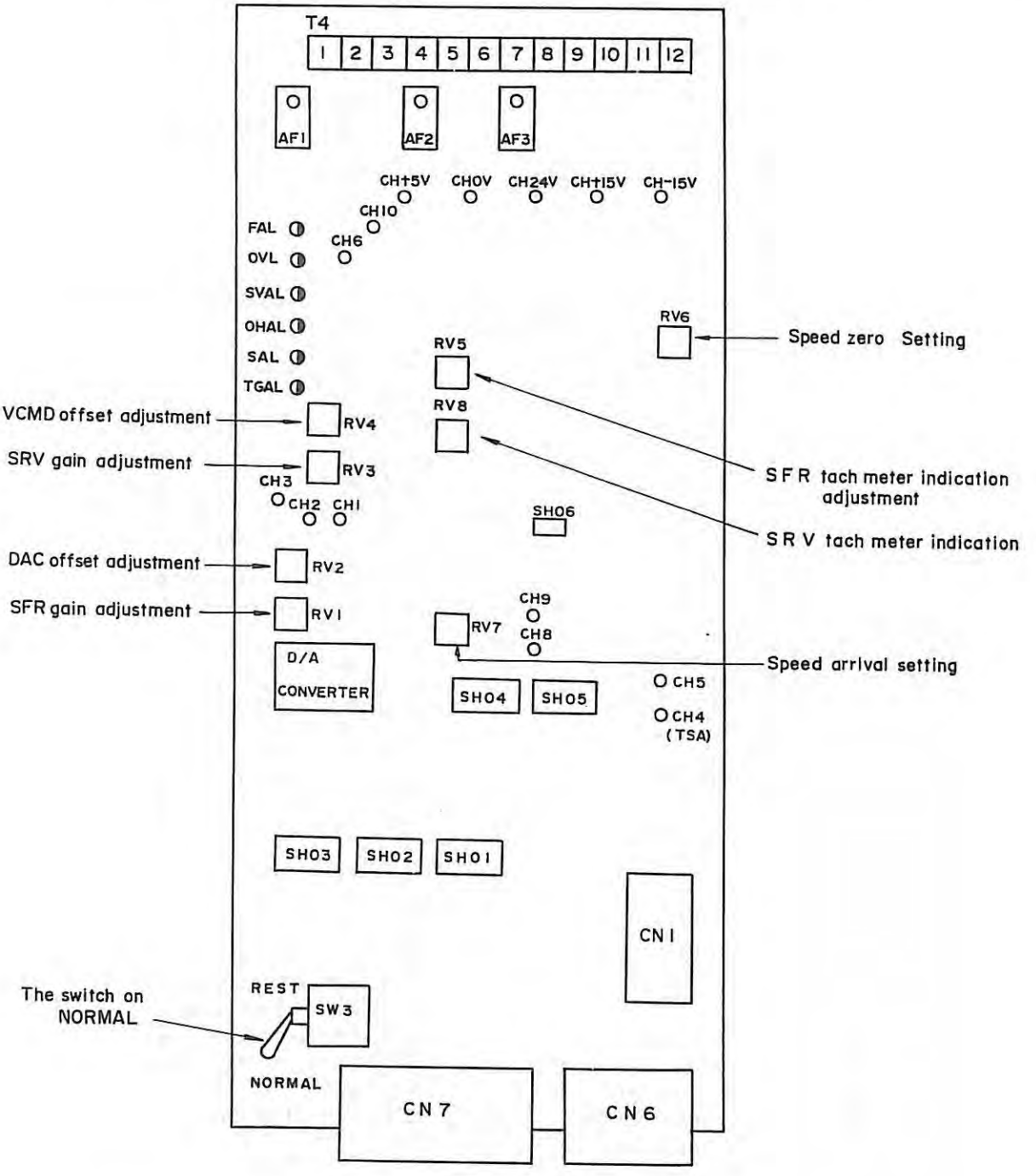
Note) CH3, 4 : 0V
CH15 : +24V
CH16 : +15V
CH17 : -15V

Printed circuit board No. 2 A20B-0005-0583
No. 3 A20B-0005-0584



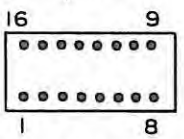
(2) Spindle control circuit

In case before edition 03A of spindle control circuit A20B-0004-0990



PCB A20B-0004-0990

Short Circuit

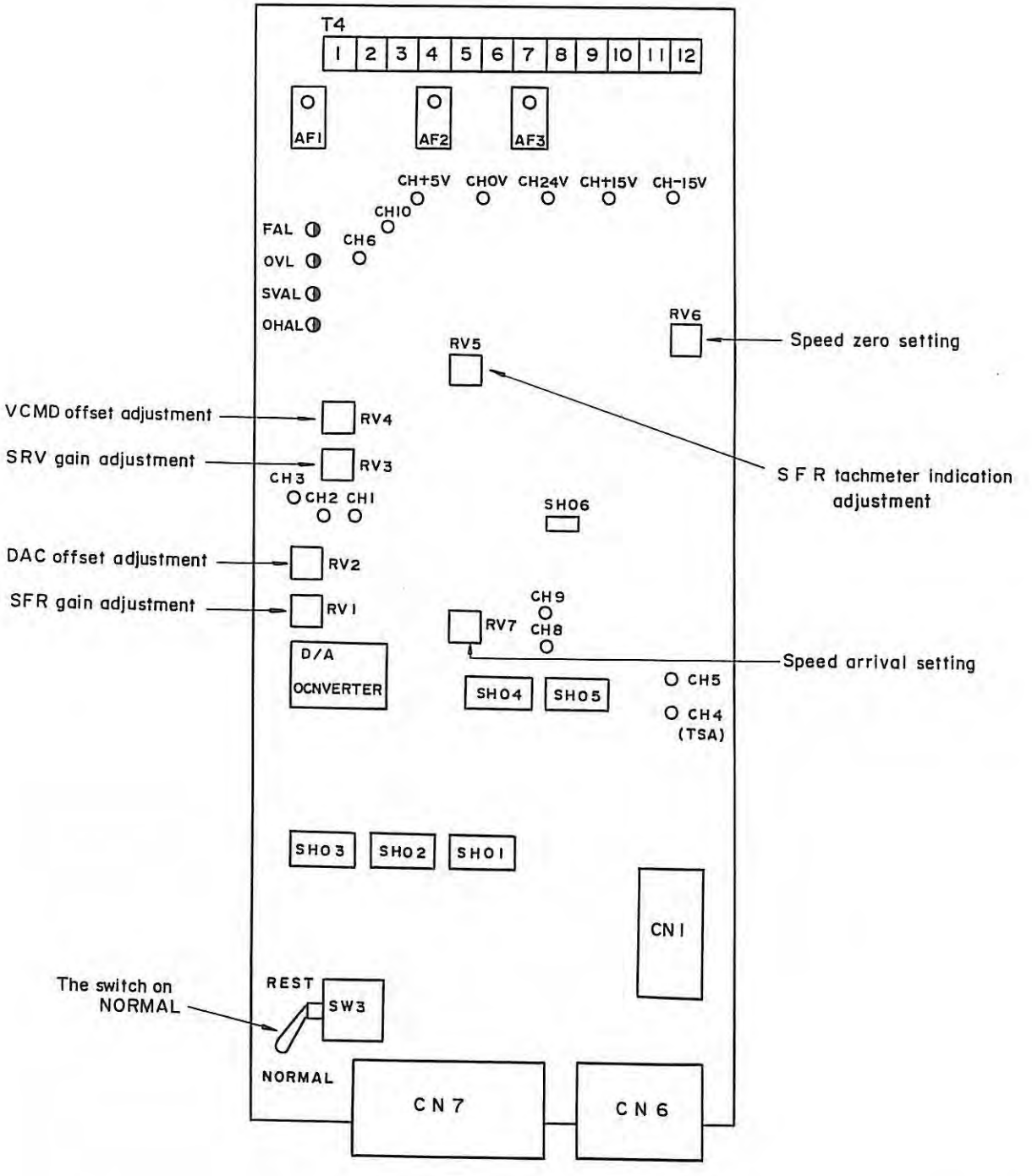


SH01 ~ SH05

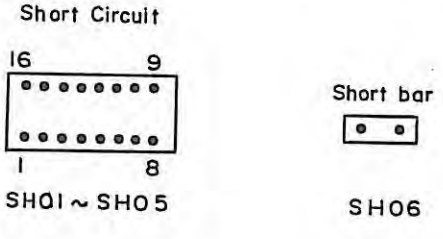
Short bar

SH06

In case of edition 08C of spindle control circuit A20B-0004-0990



PCB A20B-0004-0990



4. TROUBLE SHOOTING

Generally, the following items can be considered as faults and their causes.

If a fault has occured, first roughly determine where the cause lies (servo unst, spindle motor, etc.), and then trace out the cause. (Refer to Appendices I and II.)

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
1	The velocity control unit fuse is blows.	. Cabling mistake . Circuit gault Current limiting circuit defect, circuit adjustment defect, etc.	. T.G. WIRE contact defect or breaking . Driving cable shortcircuit (Refer to item 2.3 (2)) . Excessive ripple of Tach Generator Vripple≦1V	
2	The spindle r.p.m. in not normal.	. Circuit gault Defect of error amplifier circuit. . D/A Converter	. T.G defect . P.C defect	. Faulty operation of the velocity command circuit.
3	Vibration and noise during spindle operation is abnormally large.	. 50/60Hz setting error. . Circuit adjustment defect Dither Gain . Current feedback control circuit adjustment defect	. Motor fault Bearing, clutch, etc. . Excessive ripple of Tach Generator	. The input power waveform is too disorted. . The load fluctuation is too large. . Gear engagement is not proper.
4.	The spindle operation during acceleration and deceleration is not normal.	. Deceleration limiting circuit adjustment defect. . Current feedback control circuit adjustment defect.		. Relation between the load inertia and the acceleration/deceleration time constant setting is not proper. (Refer to Appendix II) . The belt tension is not proper.

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
5	The spindle does not rotate.	. Circuit gault The gate pulses are not generated, etc. contact defect.	. Wire breaking . Clutch high/low switching defect.	. The machine load is too large. . No SFR/SRV Signals

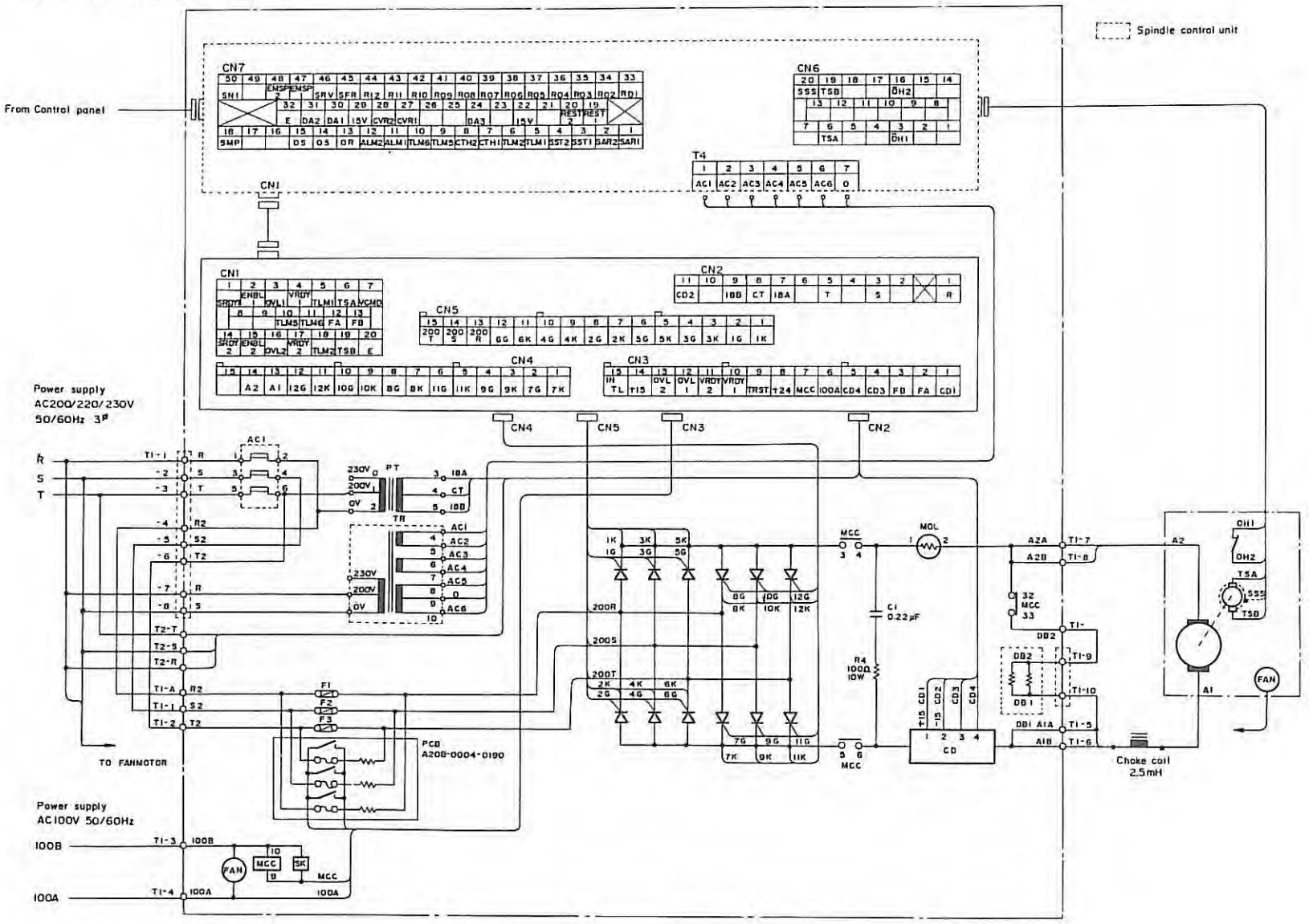
5. SPARE PARTS LIST

Arrange spare parts for maintenance in the following lists if necessary.

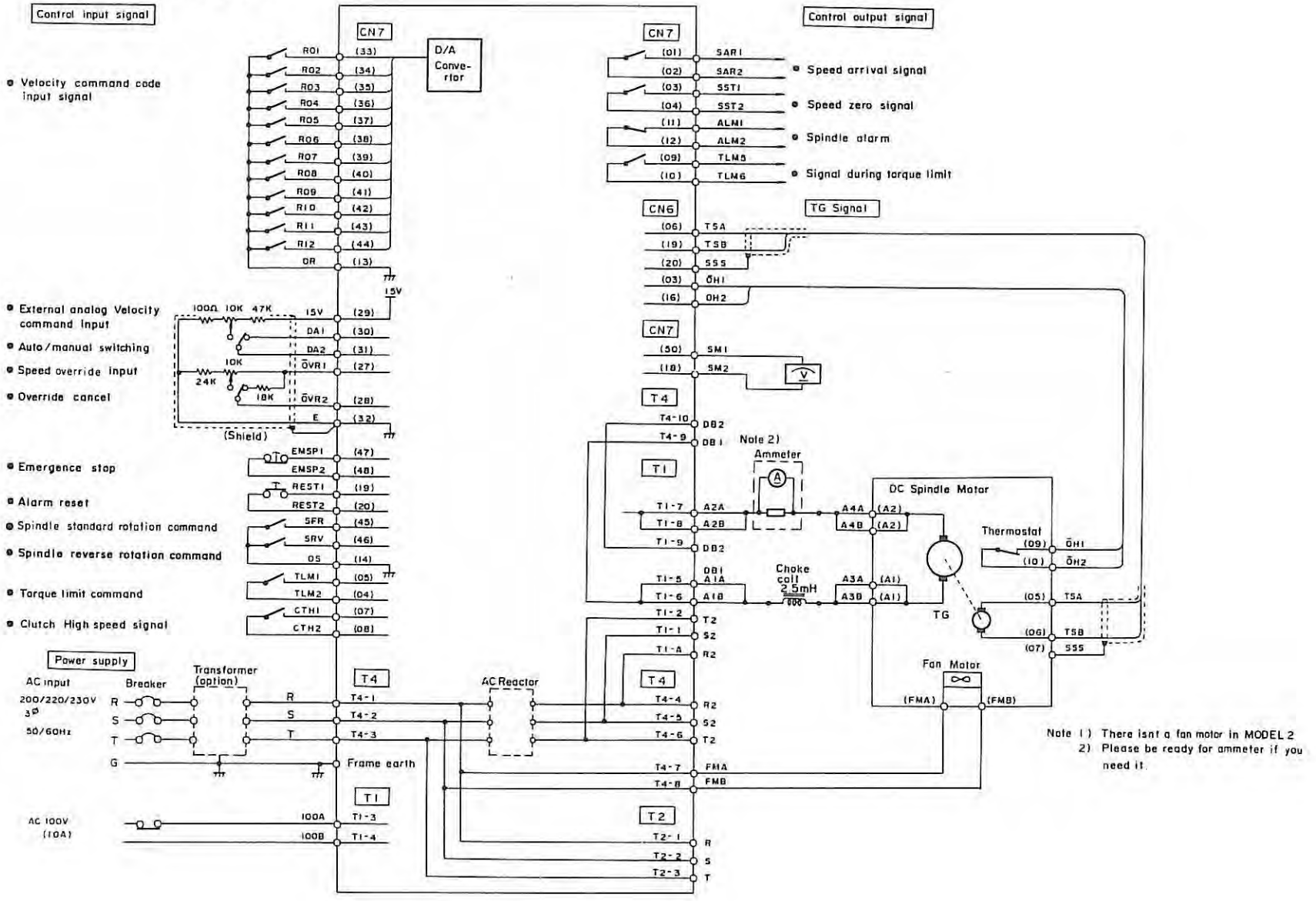
Items	Articles	Parts No.	Specification	Quantity
1	Fuse 75A	F1～3	A60L-0001-0061#GSA75	3
2	Alarm fuse 1.3A	F4～F6	S. Fab250/402A P413	3
3	Fuse 1A	F7	A60L-0001-0039#A1	1
4	Alarm fuse on P. C. B.		A60L-0001-0046#1.0	1
5	Surge absorber	ZNR1～3	A50L-2001-0062#441-12	3
6	Fuse circuit	PCB2	A20B-0004-0190	1
7	Thyristor	SCR1～12	A50L-5000-0011#A	12
8	Current detector	CD	A44L-0001-0048	1
9	Magnetic contactor	MCC	A58L-0001-0029	1
10	Fan motor	FM	A90L-0001-0001	1
11	Firing Circuit	PCB1	MODEL 2, 3 A06P-6035-H321#B Headstock A06P-6041-H001#B	1
12	Spindle control circuit	PCB 3	A06P-6041-H082#B	1

6. CONSTRUCTION OF CIRCUIT

6.1 Power Part



6.2 General connection diagram of spindle servo unit for MODEL 2, 3



Note 1) There isn't a fan motor in MODEL 2
2) Please be ready for ammeter if you need it.

7. APPENDIXES

Appendix I Adjustment Reference Material

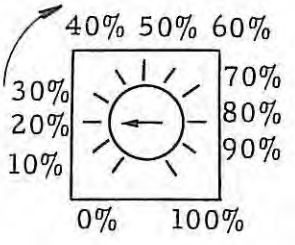
(1) Ajustment and checking precedure for the spindle control circuit

The following adjustments are normally performed at installation, so further adjustment and checking should not be necessary. Please refer to this section for checking in case of failure.

No.	Item	Adjustment places	Adjustment and checking	Standard setting
1	D/A converter offset adjustment	RV2	Adjust CH1 voltage to 0±5mV when D/A converter input R01 - 12 are all OFF.	Approximately 50%
2	D/A converter offset adjustment	RV4	Adjust CH3 voltage to 0±5mV when SFR and SRV inputs are turned on in the same status as above.	Approximately 50%
3	D/A converter gain adjustment	RV1	Adjust so that CH3 becomes 10V when SFR command is issued in the state where D/A converter inputs are all ON (BCD -- S99, Binary 4095).	45~50%
4	D/A converter gain adjustment	RV3	In the same status as above, adjust CH3 to 10V with the SRV command is issued. For the external analogue command, adjust the rotation speed in the reverse direction is the standard maximum rotation with 10V input.	35~50%
5	Speed 0 adjustment	RV6	Adjust so that CH7 voltage is 50mV. The standard value for speed 0 is 0.5%.	20%

No.	Item	Adjustment places	Adjustment and checking	Standard setting
6	Speed arrival signal	RV7	This is a signal issued when the motor speed is 80-85% of the commanded speed. Until it is issued, the SAL (SAR) photodiode is turned on.	
			Adjust to get 6Vat CH8 with the speed command 10V on A20B-0004-0990/02 P.C.B.	20%
			Adjust to get 1.5V (85%) at CH8 when the speed command 10V on A20B-0004-0990/03 P.C.B.	20%
7	Tachometer voltage (CW direction)	RV5	Adjust so that CH6 is exactly 10V while at maximum speed by SFR command.	Approximately 50%
8	Tachometer voltage (CCW direction)	RV8	Adjust CH6 to be exactly 10V while at maximum speed by SRV command.	Approximately 40%

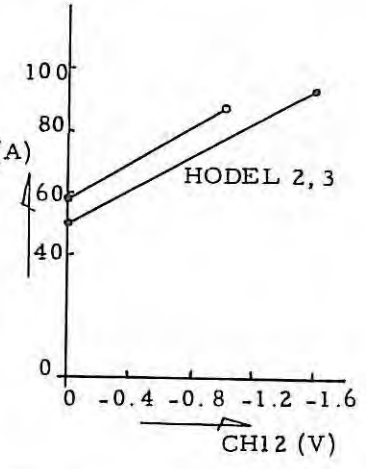
Note 1. The position of the control and the % have the following relationship. The % increases in the clockwise direction.

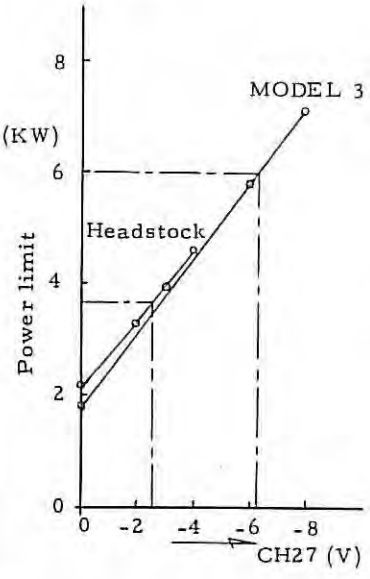


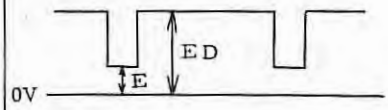
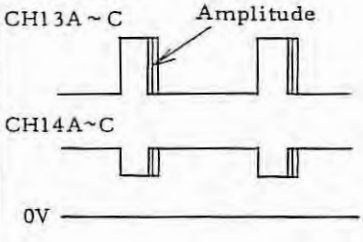
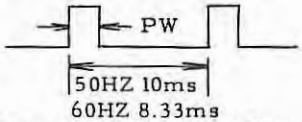
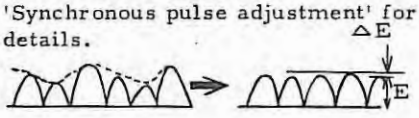
Appendix II Adjusting and checking the firing circuit (For PCB A20B-0005-0583)

Since the following adjustment is usually performed at the factory, adjustment and confirmation are not necessary.
Refer to the following for routine checking.

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Headstock</th></tr>
<tr><td>1</td><td>Time constant setting</td><td>SH01</td><td><table><tr><th></th><th>Clutch LOW</th><th>Clutch HIGH</th></tr><tr><td>5-12</td><td>0.6 sec</td><td>1 sec</td></tr><tr><td>6-11</td><td>1.2 sec</td><td>2 sec</td></tr><tr><td>7-10</td><td>1.8 sec</td><td>3 sec</td></tr><tr><td>8-9</td><td>2.4 sec</td><td>4 sec</td></tr></table></td><td>7-10</td><td>7-10</td></tr>
<tr><td>2</td><td>Tachogenerator voltage setting</td><td>SH01</td><td><table><tr><th>Setting</th><th>TG maximum voltage</th></tr><tr><td>1-16</td><td>10V</td></tr><tr><td>2-15</td><td>12V</td></tr><tr><td>3-14</td><td>19V</td></tr><tr><td>4-15</td><td>21V</td></tr></table></td><td>2-15
(12V/2000 rpm)</td><td>1-16
(10V/3500 rpm)</td></tr>
<tr><td>3</td><td>Current detector bias</td><td>S9
S10</td><td><table><tr><th>Detector specification</th><th>Setting</th></tr><tr><td>A44L-0001-0048</td><td>S10</td></tr><tr><td></td><td>S9</td></tr></table></td><td>S10</td><td>S10</td></tr>
<tr><td>4</td><td>VCMD interface setting</td><td>S11
S12</td><td><table><tr><th></th><th>Setting</th></tr><tr><td>Normally, a spindle control circuit is used</td><td>S11</td></tr><tr><td>Clutch switching is provided</td><td>S12</td></tr></table></td><td>S11</td><td>S11</td></tr>
<tr><td>5</td><td>Power limit setting</td><td>S13
S14</td><td><table><tr><th>Motor specification</th><th>Setting</th></tr><tr><td>MODEL 5, 10</td><td>S13</td></tr><tr><td>MODEL 2, 3, Headstock</td><td>S14</td></tr></table></td><td>S14</td><td>S14</td></tr>
<tr><td>6</td><td>Clutch switching is provided</td><td>S15
S16</td><td><table><tr><th>Clutch switching</th><th>Setting</th></tr><tr><td>Provided</td><td>S16</td></tr><tr><td>Not provided</td><td>S15</td></tr></table></td><td>S15</td><td>S15</td></tr>
<tr><td>7</td><td>Tachogenerator voltage regulation</td><td>RV4</td><td>The maximum rotation speed is adjusted when 10V is the velocity command voltage.
Maximum rotation speed: ±0.4%</td><td></td><td></td></tr>
</table>

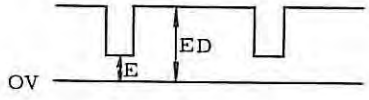
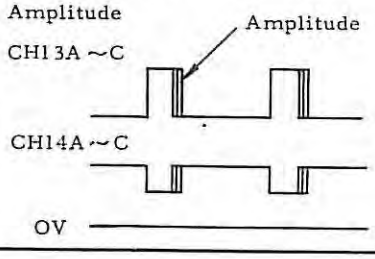
Item	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Headstock
8	Velocity loop gain adjustment	RV1	Determines the rigidity of the spindle motor. No special adjustment is required. If hunting and vibration are excessive, decrease them by about 5% to 10%.	45%	45%
9	Velotiey loop offset	RV2	Adjust the motors to halt when the velocity command voltage is OV.		
10	Current loop gain	RV7	Loop gain to current commands Reduce the gain 20%～30% when some swell is observed in the current.	100%	100%
11	Current detection offset	RV103	Adjust the CH11 voltage OV when current is not applied. If this adjustment varies excessively, the velocity is not uniform at low speeds.		
12	Power limit offset	RV114	Adjust the CH23 voltage to OV when current is not applied. If this adjustment varies excessively, the power limit at high speeds is inaccurate and motors can be damaged.		
13	Current limit setting	RV9	Set the CH12 voltage to the proper value when current is not applied. The relation of CH12 and the current limit is as shown in the following figure. 	-1. 1V	-0. 7V

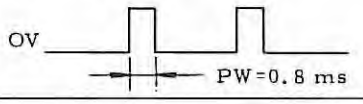
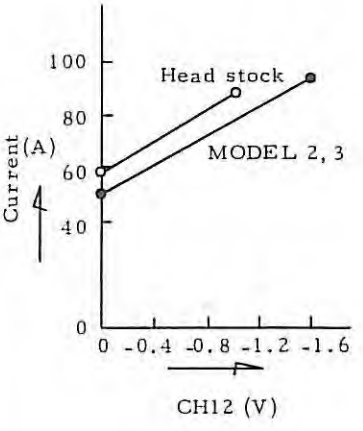
<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Headstock</th></tr>
<tr><td>14</td><td>Power limit setting</td><td>RV109</td><td>Set the CH27 voltage to the proper value when current is no spplied.
The relation between CH27 and the power is as shown in the following figure.
 
</td><td>-6.2V</td><td>-2.5V</td></tr>
<tr><td>15</td><td>Torque limit setting</td><td>RV108
RV122</td><td>Orientation is performed by applying the torque limit and adjusting the halt current.
Adjustment range is 0 to 35A.
<table><tr><th></th><th>Adjusting locations</th></tr><tr><td>Clutch HIGH</td><td>RV108</td></tr><tr><td>Clutch LOW</td><td>RV122</td></tr></table>Adjust both irrespective of clutch switching when a constant adjustment is required.</td><td colspan="2">Relationship between CH29 voltage and current.
<table><tr><td>0A</td><td>-1.2V</td></tr><tr><td>5A</td><td>-1.6V</td></tr><tr><td>10A</td><td>-1.9V</td></tr><tr><td>15A</td><td>-2.05V</td></tr><tr><td>20A</td><td>-2.15V ← Standard setting</td></tr><tr><td>25A</td><td>-2.27V</td></tr><tr><td>30A</td><td>-2.4V</td></tr><tr><td>35A</td><td>-2.53V</td></tr></table></td></tr>
<tr><td>16</td><td>Load meter output setting</td><td>RV113</td><td>The power limit offset RV114 is shifted and the voltage of CH23 is changed to 1V so that the CH24 voltage goes to 1V.
After this adjustment, the power limit offset must be adjusted.</td><td></td><td></td></tr>
</table>

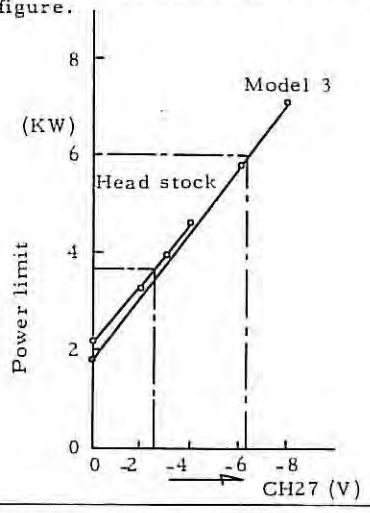
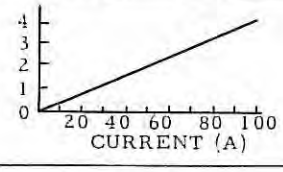
No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Headstock
17	Dither No.1	RV3	CH8 and CH3 are shorted. The CH9 voltage is set to the proper level. 	ED 50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V	ED 50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V
18	Dither No.2	RV11A RV11B RV11C	The pulse amplitude of CH13A to C or CH14 A to C is adjusted to the minimum to balance the firing phase of the synchronous pulse. Amplitude 		
19	Dither No.3	RV10A RV10B RV10C	Adjusts the dither pulsewidth.  Next, adjust the two volumes in RV10A to C so that the peak value of the current waveform at low speed can be arranged. It may be arranged into the smaller waveform. Refer to Item 2.5.1, 'Synchronous pulse adjustment' for details. 	50Hz 1.8ms 60Hz 1.6ms	50Hz 1.8ms 60Hz 1.6ms
20	Setting deceleration limit	RV101	After checking that CH21 is +10 or -10V when each motor is revolved at the maximum speed (refer to Item 7, 'Tachogenerator voltage adjustment'), the voltage of CH26 is set to the proper value.	9.0V +0V -0.2V	9.1V +0V -0.2V

Appendix III Adjusting and checking the firing circuit (For PCB A20B-0005-0584)

Since the following adjustment is usually performed at the factory, adjustment and confirmation are not necessary. Refer to the following for routine checking.

No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Head stock
1	Time constant setting	SH01	Clutch low / Clutch HIGH 5-12: 0.6 sec / 1 sec 6-11: 1.2 sec / 2 sec 7-10: 1.8 sec / 3 sec 8-9: 2.4 sec / 4 sec	7-10	7-10
2	Tachogenerator voltage setting	SH01	Setting: TG maximum voltage 1-16: 10V 2-15: 12V 3-14: 19V 4-13: 21V	2-15 (12V/ 2000 rpm)	1-16 (10V/ 3500 rpm)
3	Current detector bias	S9 S10	Detector specification: Setting A44L-0001-0048: S10 : S9	S10	S10
4	VCMD interface setting	S11 S12	Specification: Setting Normally, a spindle control circuit is used: S11 Clutch switching is provided: S12	S12	S11
5	Power limit setting	S13 S14	Motor specification: Setting MODEL 5, 10: S13 MODEL 2, 3, headstock: S14	S14	S14
6	Clutch switching is provided	S15 S16	Clutch switching: Setting Provided: S16 Not provided: S15	S15	S15
7	Dither No. 1	RV3	CH8 and CH3 are shorted. The CH9 voltage is set to the proper level. 	ED 50Hz 1.85V 60Hz 3.15V E 50Hz 1.0V 60Hz 2.4V	ED 50Hz 1.85V 60Hz 3.15V E 50Hz 1.0V 60Hz 2.4V
8	Dither No. 2	RV11A RV11B RV11C	The pulse amplitude of CH13A to C or CH14 A to C is adjusted to the minimum to balance the firing phase of the synchronous pulse. 		

No.	Item	Setting and adjustment locations	Method of adjustment and check	Standard setting	
				Model 2, 3	Head stock
9	Minimum phase shift adjustment	RV 10A RV 10B RV 10C	CH31 and CH17 (-15V) are shorted. Adjust the pulse width of CH13 A ~ C. CH13 A ~ C  	0.8ms (50/60Hz)	0.8ms
10	Current loop gain	RV7	Loop gain to current commands Reduce the gain 20% ~ 30% when some swell is observed in the current.	100%	100%
11	Current detection offset	RV103	Adjust the CH11 voltage OV when current is not applied. If this adjustment varies excessively, the velocity is not uniform at low speeds.		
12	Power limit offset	RV114	Adjust the CH2.3 voltage to OV when current is not applied. If this adjustment varies excessively, the power limit at high speeds is inaccurate and motors can be damaged.		
13	Current limit setting	RV9	Set the CH12 voltage to the proper value when current is not applied. The relation of CH12 and the current limit is as shown in the following figure.  	-1.1V	-0.7V

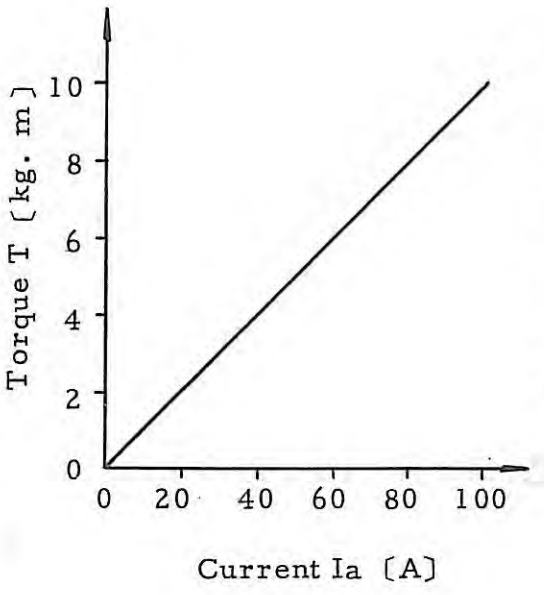
<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Setting and adjustment locations</th><th rowspan="2">Method of adjustment and check</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 2, 3</th><th>Head stock</th></tr>
<tr><td>14</td><td>Power limit</td><td>RV109</td><td>Set the CH27 voltage to the proper value when current is no supplied. The relation between CH27 and the power is as shown in the following figure.
 
</td><td>-6.2V</td><td>-2.5V</td></tr>
<tr><td>15</td><td>Velocity loop gain adjustment</td><td>RV1</td><td>Adjust as below by load inertia.
<table><tr><td>Max inertia</td><td>Setting</td><td>Max inertia</td><td>Setting</td></tr><tr><td>0～2kg cm S^2</td><td>45%</td><td>0～0.5kg cm S^2</td><td>60%</td></tr><tr><td>2～ "</td><td>70%</td><td>0.5～1 "</td><td>80%</td></tr></table></td><td colspan="2"></td></tr>
<tr><td>16</td><td>Velotic y loop offset</td><td>RV2</td><td>Adjust the motors to halt when the velocity command voltage is OV.</td><td></td><td></td></tr>
<tr><td>17</td><td>rpm adjustment</td><td>RV4</td><td>The maximum rotation speed is adjusted when 10V is the velocity command voltage.
Maximum rotation speed: ±0.4%</td><td>2000 rpm</td><td>3400
～
3500 rpm</td></tr>
<tr><td>18</td><td>Setting deceleration limit</td><td>RV101</td><td>After checking that CH21 is +10 or -10V when each motor is revolved at the maximum speed (refer to Item 7, 'Tachogenerator voltage adjustment'), the voltage of CH26 is set to the proper value.</td><td>9.0V $^{+0V}_{-0.2V}$</td><td>9.1V $^{+0V}_{-0.2V}$</td></tr>
<tr><td>19</td><td>Torque limit setting</td><td>RV108
RV122</td><td>Orientation is performed by applying the torque limit and adjusting the halt current.
Adjust the torque limit by RV 108 and RV 122 during measurement current value on CH 11.
<table><tr><td></td><td>Adjusting locations</td></tr><tr><td>Clutch HIGH</td><td>RV108</td></tr><tr><td>Clutch LOW</td><td>RV122</td></tr></table> 
</td><td colspan="2">Voltage of CH29 can be used for adjustment torque limit.
<table><tr><td>Current</td><td>CH11</td><td>CH29</td></tr><tr><td>5A</td><td>0.2V</td><td>-1.6V</td></tr><tr><td>10 "</td><td>0.4 "</td><td>-1.9V</td></tr><tr><td>15 "</td><td>0.6 "</td><td>-2.05V *</td></tr><tr><td>20 "</td><td>0.8 "</td><td>-2.15V</td></tr><tr><td>25 "</td><td>1.0 "</td><td>-2.27V</td></tr><tr><td>30 "</td><td>1.2 "</td><td>-2.4V</td></tr><tr><td>35 "</td><td>1.4 "</td><td>-2.53V</td></tr></table>* Standard setting</td></tr>
<tr><td>20</td><td>Load meter output setting</td><td>RV 113</td><td></td><td>50%</td><td>50%</td></tr>
</table>

Appendix IV

(1) Spindle motor Model 2, 3

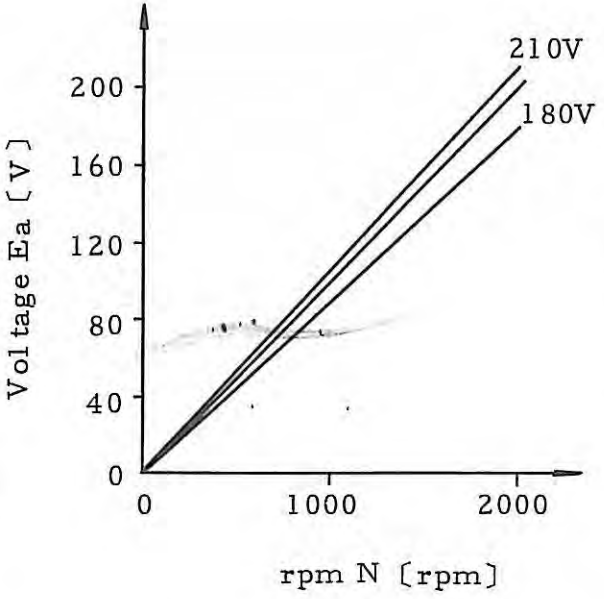
Torque-current

$T = 0.098Ia$

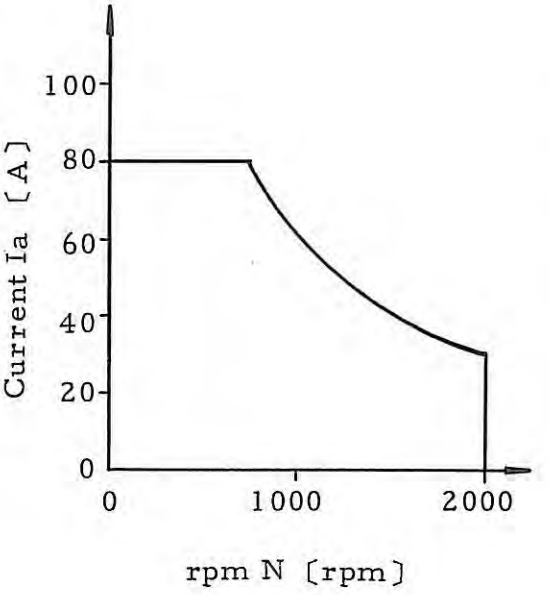


Voltage-rpm

$Ea = \frac{98N}{1000}$



Current limit



III. DC SPINDLE SERVO UNIT
MAINTENANCE MANUAL
for
MODEL 5,10

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1. GENERAL

This maintenance manual should be used for the spindle servo-unit which drives FANUC DC spindle motor Models 5 & 10.

The general structures of the spindle servo-unit is as follows.

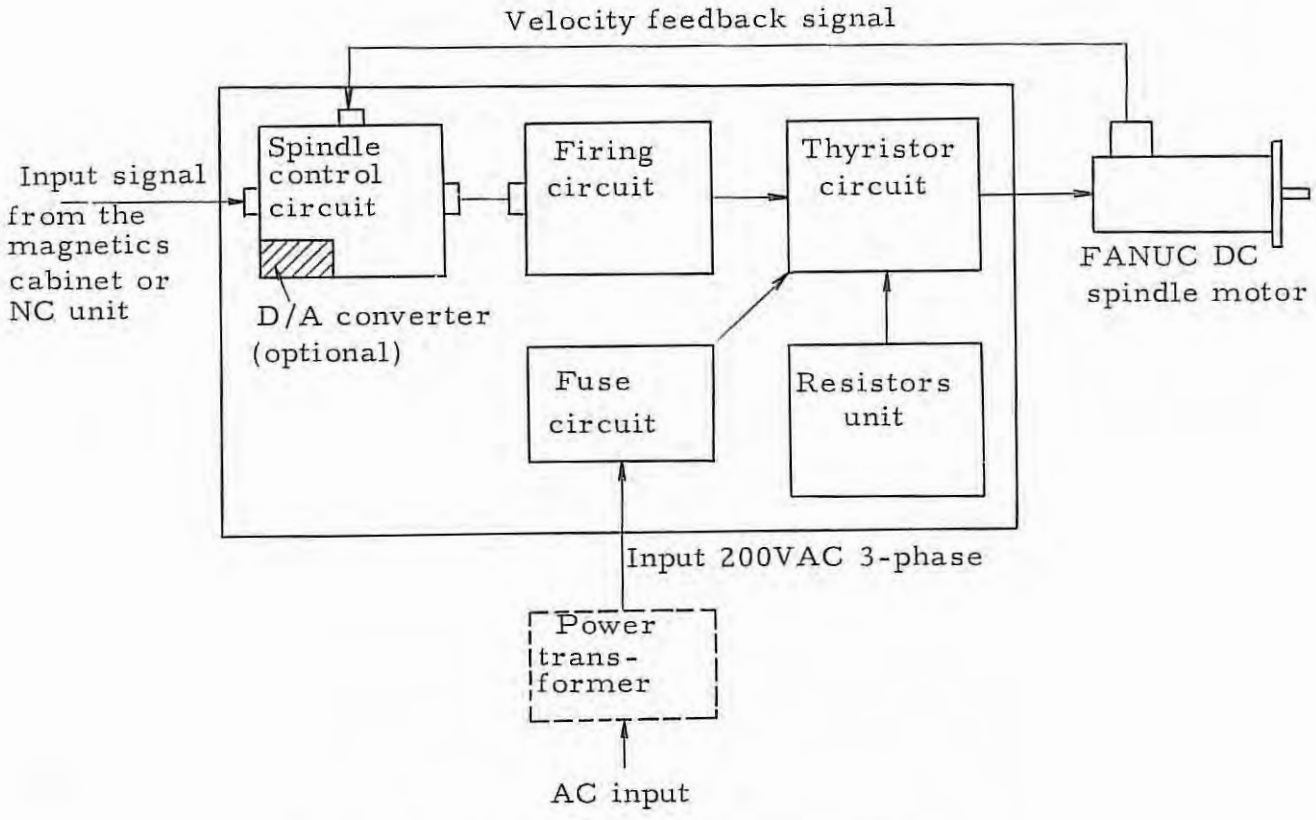


Fig.1 Structure of spindle servo-unit

During Installation and adjustment, refer to the FANUC DC Spindle Motor Series DESCRIPTIONS, and confirm that signal lines are properly connected from the magnetics cabinet or NC unit.

A table of printed circuit board specification follows

		P.C.B. No. 1	P.C.B. No. 2	P.C.B. No. 3
Firing circuit	Model 5	A20B-0004-0781	A20B-0005-0583/V	A20B-0005-0585/V
	Model 10	A20B-0004-0781	A20B-0005-583/W	A20B-0005-0585/W
	Special setting A	A20B-0004-0781	A20B-0005-0583/X	A20B-0005-0585/X
Spindle control circuit		A20B-0004-0990	A20B-0004-0990 (03 A)	A20B-0004-0990 (08 C)
Remarks		Manufactured from Jul. 1976 to Dec. 1977	Manufactured from Jan. 1978 to Aug. 1978	Manufactured from Sep. 1978

2. INSTALLATION AND ADJUSTMENT

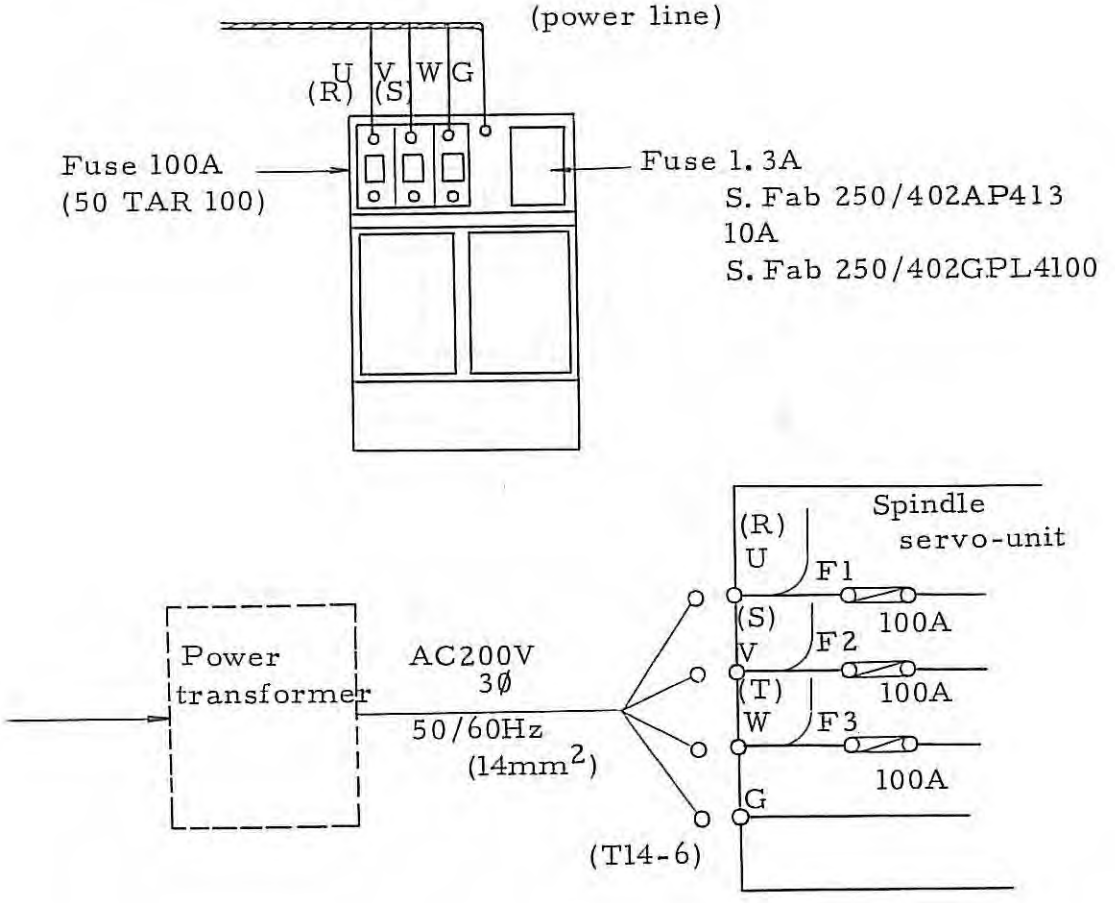
2.1 Connection

(1) Connection of power line

After confirming the rating of the external power source, the line should be connected.

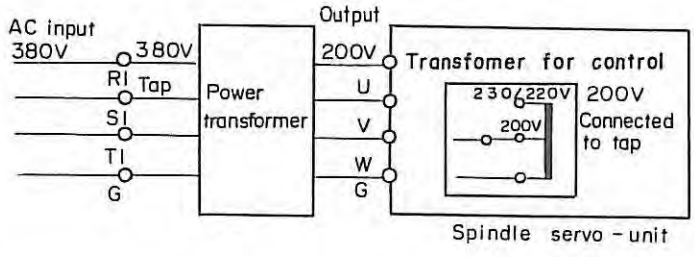
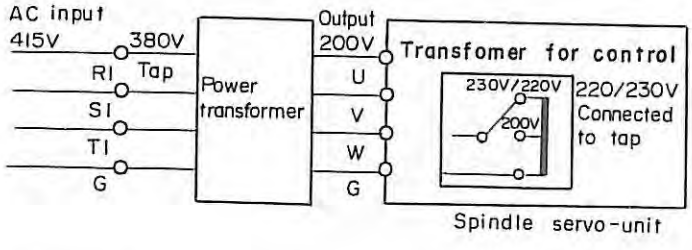
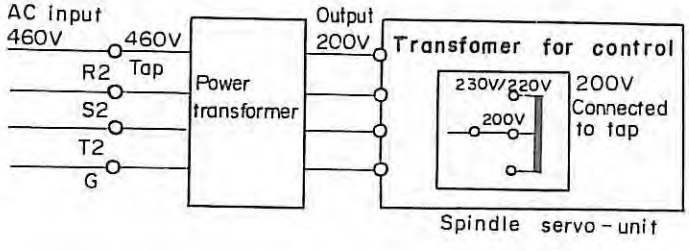
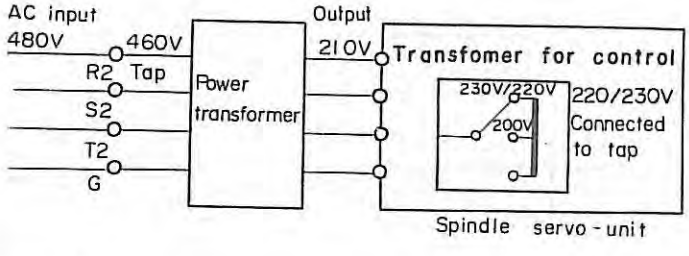
Motor type	Power requirement
Model 5	20 KVA
Model 10	30 KVA

Connection of power line



In regions where line voltage is within the standard voltage range 200-230V AC $^{+10\%}_{-15\%}$, the power transformer is unnecessary, but in regions where AC input is 380-550V, the power transformer is required.

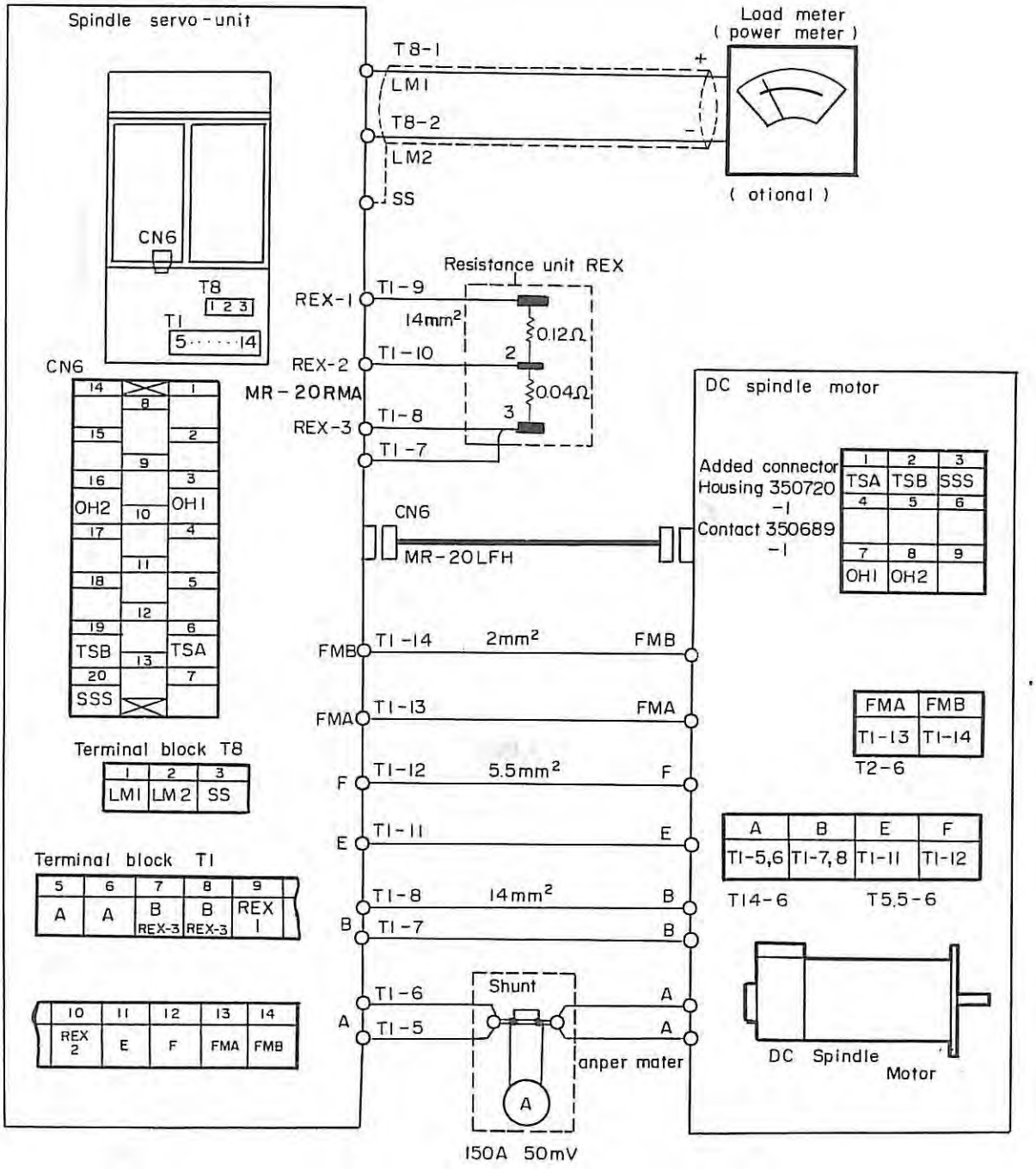
If the FUJITSU FANUC power transformer is used, the following connections must be made with input voltage of 380-480V.

No.	AC input voltage	Connection
1	380/400 +10% -15%	
2	400/450V +10% -15%	
3	460V +10% -15% (440V ± 10%)	
4	480V +10% -15%	

Refer to 2.2(1) for the settings of the controlling power transformer.

(2) Connection of power line

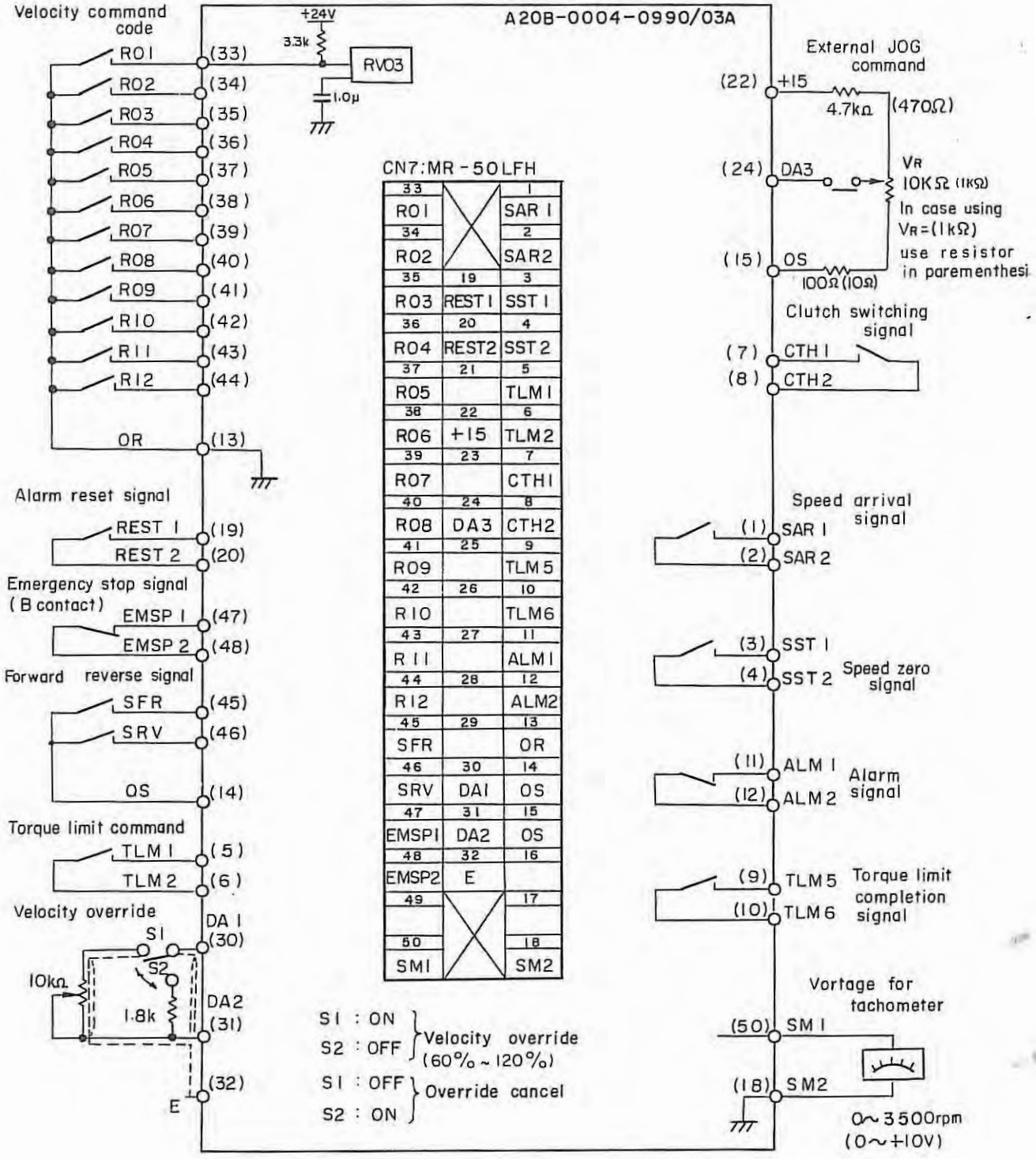
The connection of the spindle motor and the servo-unit is as follows. Since motor control is impossible if the polarity of the magnetic field coil, the power line, or the T.G is reversed, each line must be connected by referning to the labels. In addition, confirm that the resistance differs between terminals 1-2 and 2-3 of the resistance unit and then make the connection.



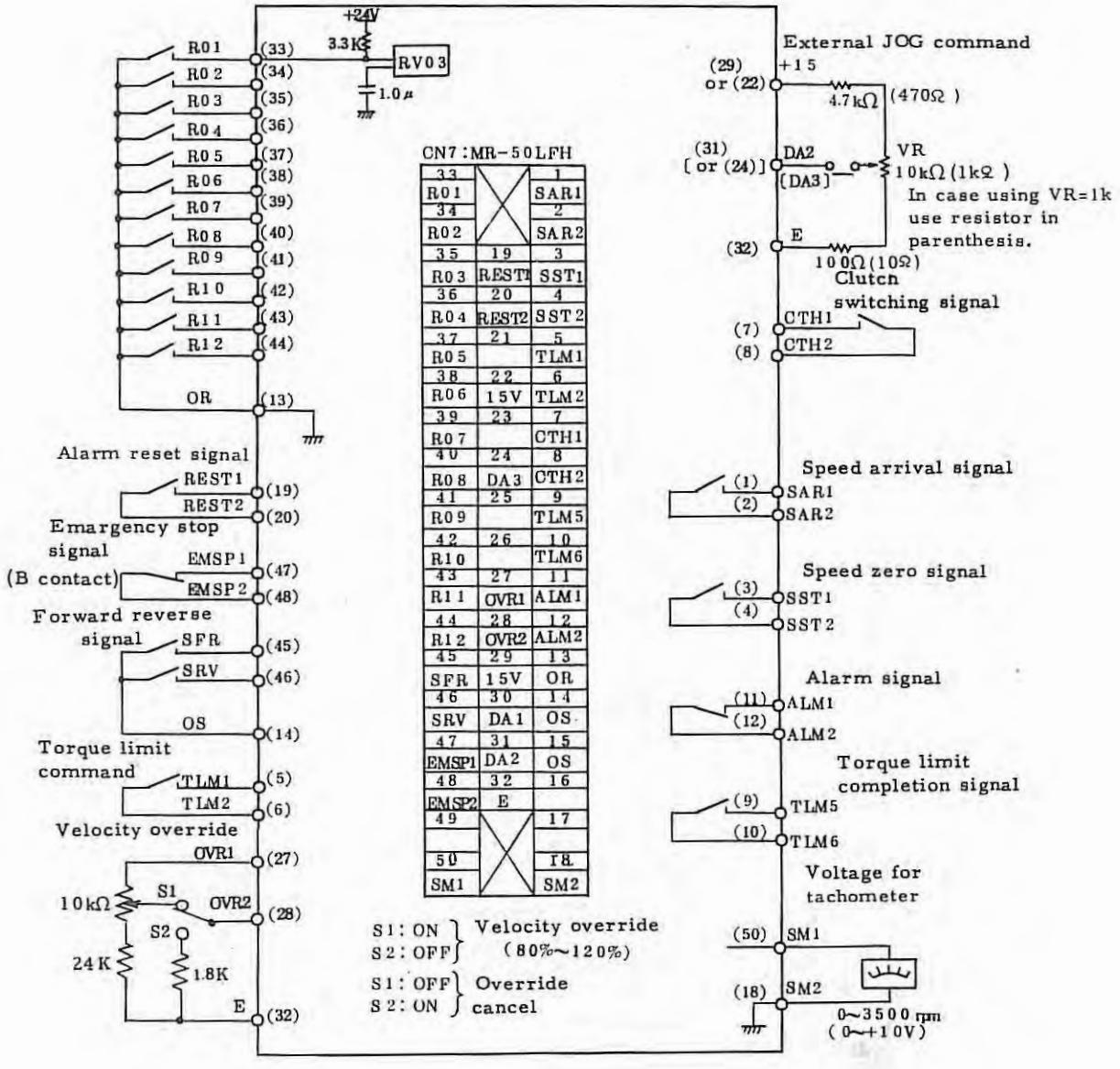
(3) Signal line check

The connection between the magnetics cabinet and the spindle servo-unit is as follows. Attention must be paid to the fact that the emergency stop signal input and the alarm signal output are both B contact.

In case before edition 03A of spindle control circuit A20B-0004-0990.



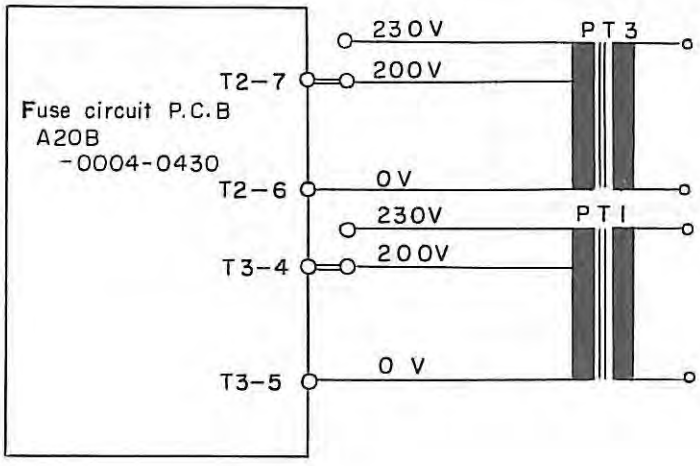
In case edition 08C of spindle control circuit A20-0004-0990

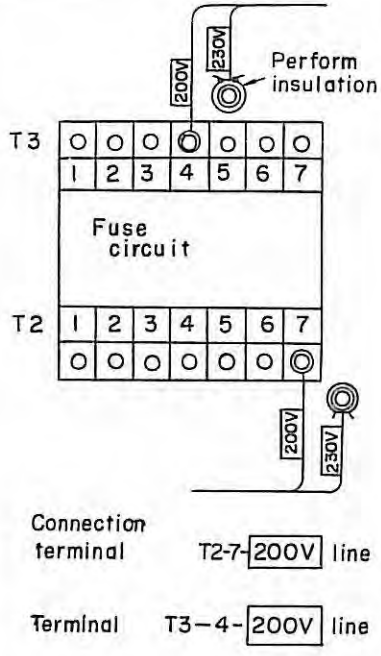
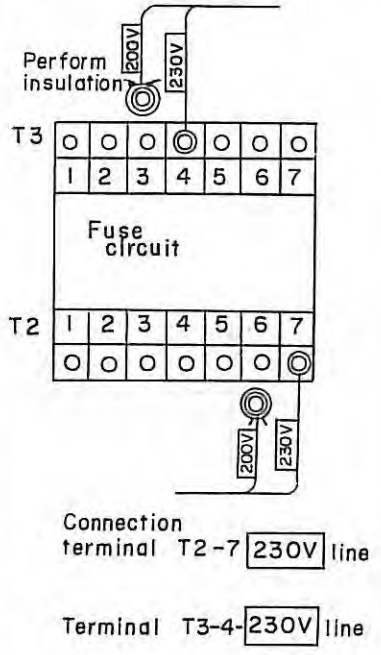


2.2 Checks the Setting

(1) Controlling transformer settings for AC input power voltages

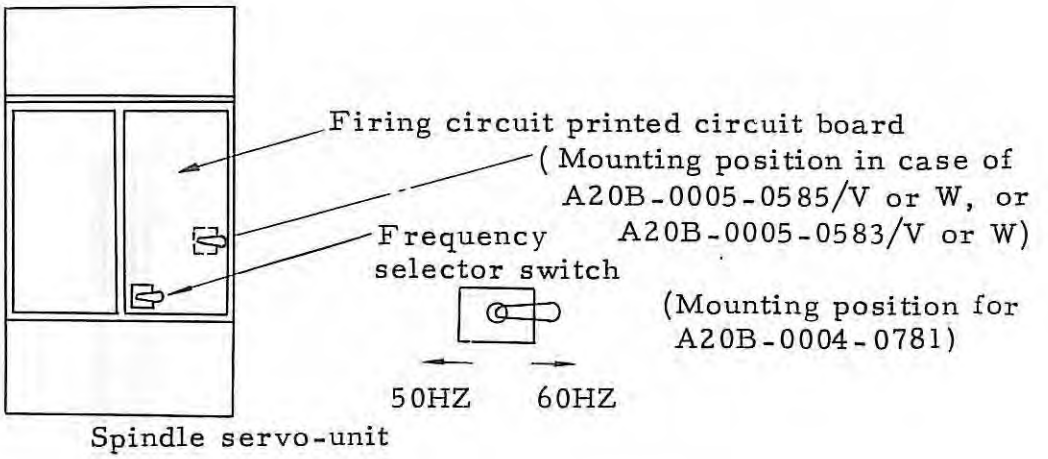
The power tap should be set at terminal of the fuse circuit printed circuit board according to the power voltages 200 / AC220VAC, 230VAC.



Power supply voltage	AC200V +10% -15%	AC220, 230V +10% -15%
Setting		

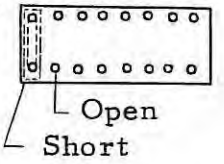
(2) Setting of the power source frequency switch

The frequency selector switch is set to conform to the AC line frequency (50 / 60 Hz).



(3) Setting short-bar for different uses

Set the follows according to the external analogue input and D/A converter (B.C.D, Binary) input.

Short-bar 

SH01~SH05 (Refer to 4.2 for the position of terminal panel setting)

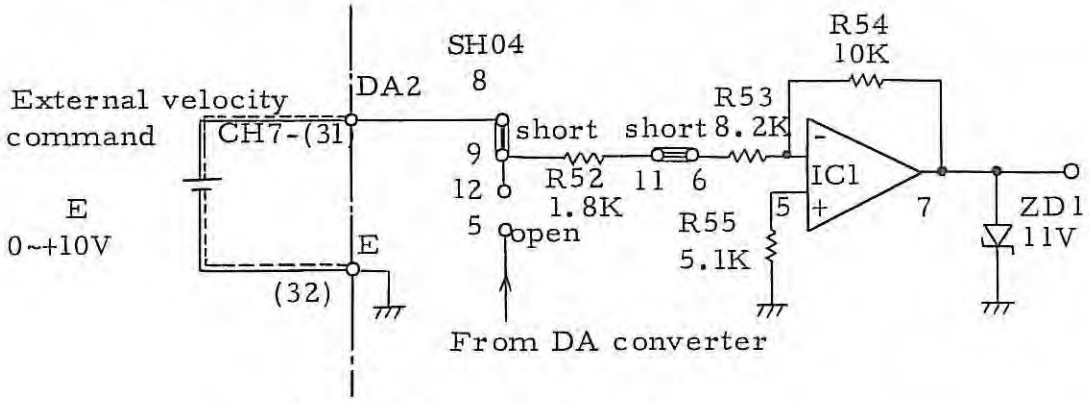
(a) Setting for various input conditions

Set as follows according to the kind of D/A converter.

Setting / Number / Kind	SH01								SH02								SH03								SH04			
	16 | 1	15 | 2	14 | 3	13 | 4	12 | 5	11 | 6	10 | 7	9 | 8	16 | 1	15 | 2	14 | 3	13 | 4	12 | 5	11 | 6	10 | 7	9 | 8	16 | 1	15 | 2	14 | 3	13 | 4	12 | 5	11 | 6	10 | 7	9 | 8	16 | 1	15 | 2	14 | 3	13 | 4
DA Converter (80-CCD-V) BCD S2 digit	O	O	O	O					O	O	O	O					O	O	O	O					O			O
DA Converter (80-CBI-V) Binary 12 bits					O	O	O	O					O	O	O	O					O	O	O	O		O	O	

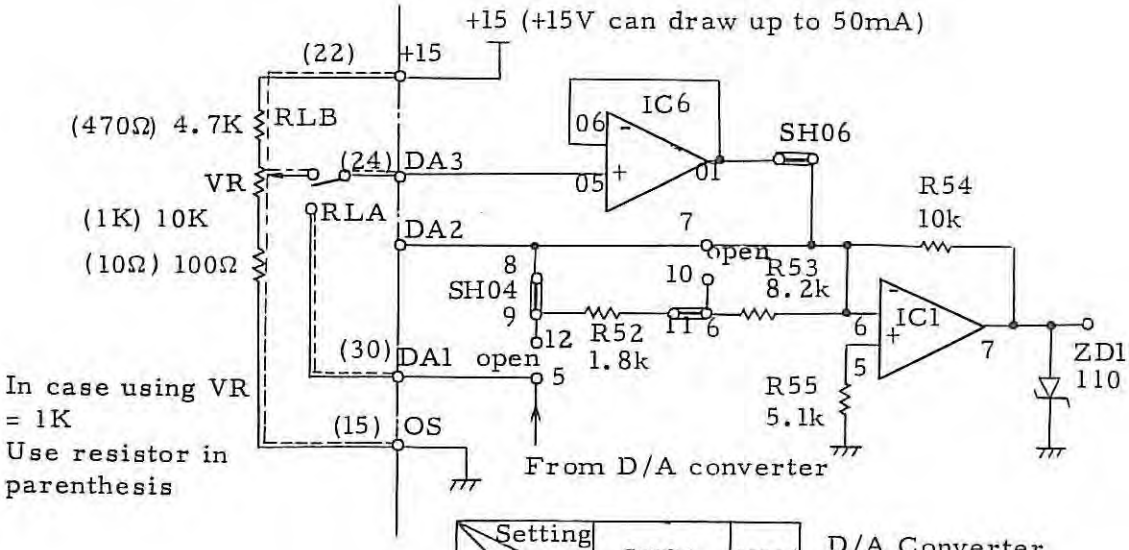
With O shorted,
Without open

In case before edition 03A of spindle control circuit A20B-0004-0990.
Setting for external analogue voltage input



Setting / Number / Kind	SHO4 12-5	SHO4 11-6	SHO4 10-7	SHO4 9-8
For dxternal analogue voltage input		○		○
For D/A converter input	○	○		

Setting when using both D/A converter input and external JOG command.

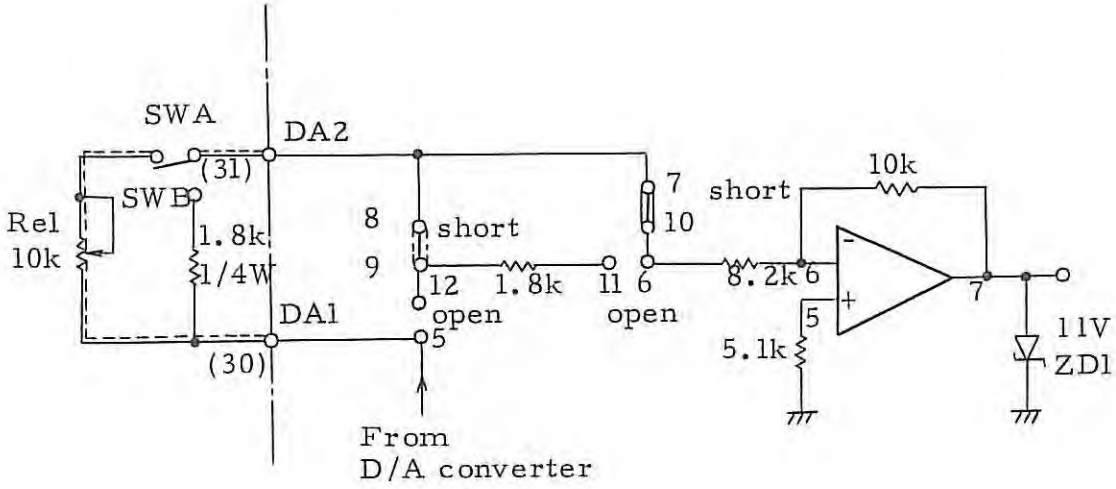


Setting / Number / Kind	SHO4 12-5	SHO4 11-6	SHO4 10-7	SHO4 9-8	SH06 2-1
DA Converter and external JOG command		○		○	○

D/A Converter
RLA "ON"
RLB "OFF"
External JOG command
RLA "OFF"
RLB "ON"

Setting for spindle override function

This is used to change the spindle motor speed by 60 - 120% of the command value in order to improve cutting conditions.



Setting / Number / Kind	SHO4 12-5	SHO4 11-6	SHO4 10-7	SHO4 9-8
Spindle override 60~120%			○	○ *1
Without spindle override	○	○		

* : Short bar (spare)

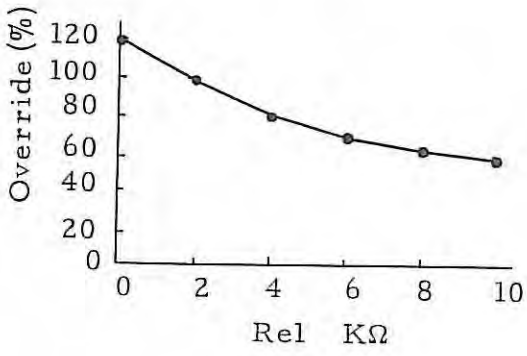
Override can be cancelled with external switches SWA and SWB.

SWA "ON" (closed)	SWB "OFF" (open)	..... With override
SWA "OFF"	SWB "ON"	..... Without override

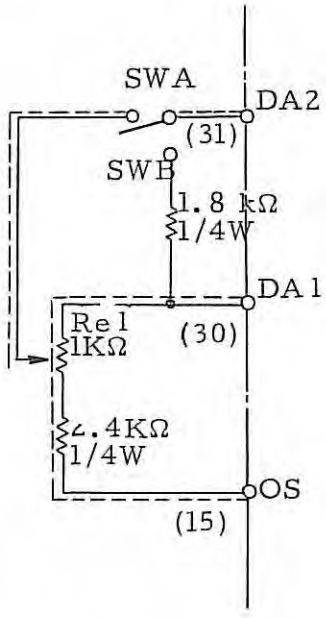
Override region

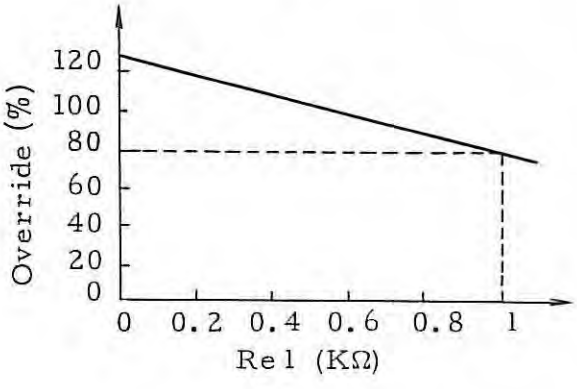
Rel = 0Ω	Approximately 120%
Rel = 10 KΩ	Approximately 55% (nominal 60%)

With above connections, the relationship of the variable registor and the override are as in the graph at the right.



To make the override proportional to the value of the external variable resistor, the following external connections must be made; however, the internal setting remains the same.
In this case, up to 80-120% of the command value is variable.





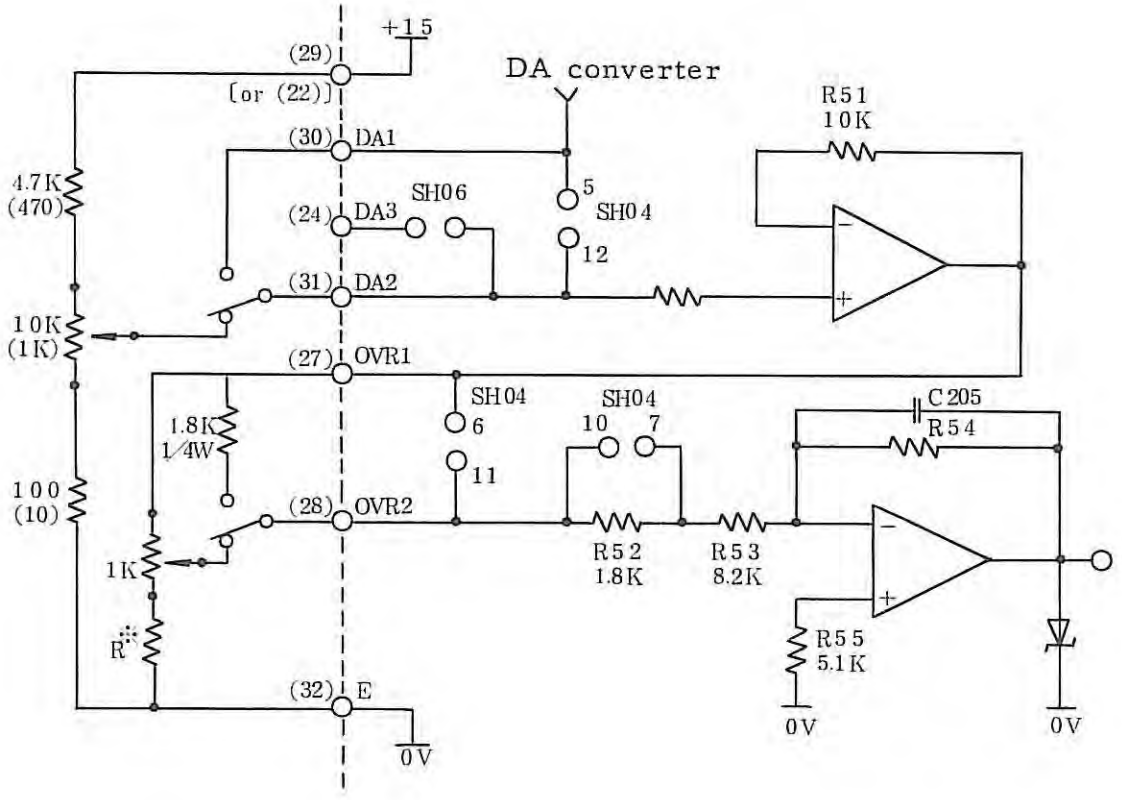
In case edition 08C of spindle control circuit A20B-0004-0990

Setting

Short pin		Contents
SH04	05-12	Open 05-12 when external analogue input is applied
	06-11	Open 06-11 when override is used
	07-10	Open 07-10 when override is used at upper limit 100%
	08-09	Space for spare short bar
SH06		Short SH06 when external analogue command is applied to CN7-24PIN
SH07 Note		Velocity variation alarm detecting level is Short : 20% Open : 50

Note: SH07 is short bar of 2.54mm pitch. If it is not required at shipping time, it is setted open (level 50%).

Circuit diagram about setting



* Where R = 1k : Override is 60% ~ 120%
R = 2.4k : Override is 80% ~ 120%

Override is changed in linear as above.

Provided that SH04 10-7 PIN is short.

(c) Setting by T.G. output voltage

Standard setting of the spindle motor Models 5 & 10 is as follows. When the spindle control circuit (A20B-0004-0990) is used for Models 2 & 3 and for the headstock the setting is as follows.

Setting / Number / Kind	SH05							
	16 - 1	15 - 2	14 - 3	13 - 4	12 - 5	11 - 6	10 - 7	9 - 8
Models 5 & 10 (standard) 20V/3500 rpm		O	O		O			

2.3 Polarity Check

(1) Checks phase rotation

(a) In case P.C.B. No. 3 A20B-0005-0585

Added the opposite phase alarm circuit on this P.C.B. When the phase rotation is not correct or phase lacks, and then if power is on, opposite phase, lack of phase indicate alarm TGAL lights on

Phase rotation is correct ..... TGAL doesn't light on

Opposite phase, lack of phase ..... TGAL lights on

(b) After connecting AC input power source, be sure to check the direction of phase rotation U(R) - V(S) - W(T) with a phase rotation meter or the like. Be careful, because if the phase rotation direction is reversed, the input fuse will blow.

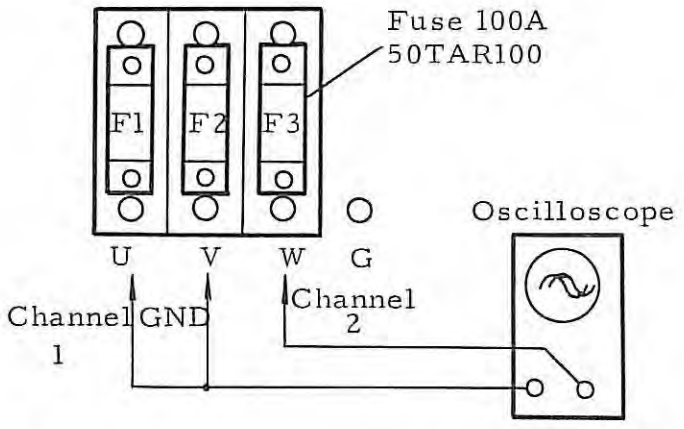
Precautions:

The following method should be used only when there is no phase rotation meter available. Pay particular attention to the following two points.

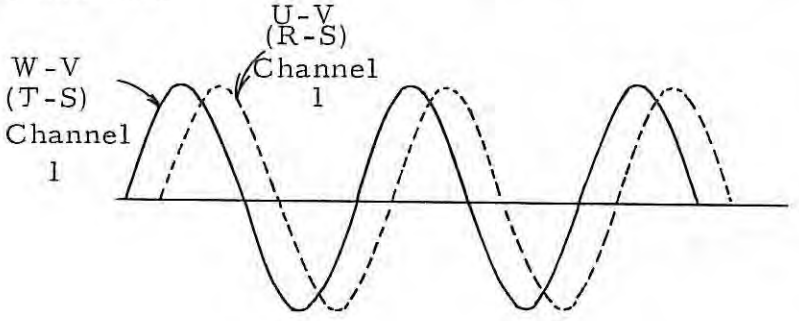
1) During measurement, insulate the osciloscope from ground.

2) Since the osciloscope itself is at equipotential with the circuit, do not touch its frame or any metal parts. A dual-trace oscilloscope can be used to check the phase as follows:

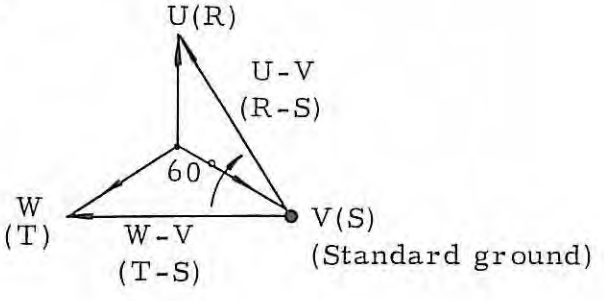
(Measuring points)



When the phase rotation is correct, the following waveform is obtained



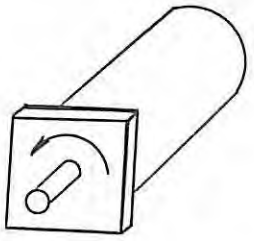
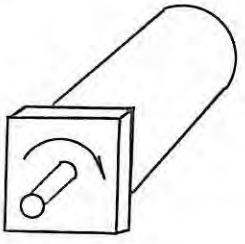
Vector



(2) Check the moter power line and polarity of T.G feed back signal.

Before turning on the power, always check whether the polarity of DC motor power circuit and T.G signal line are as in the following table.

If the polarity is not correct, the motor will go out of control when the power is turned on, so please be sure to check it.

No.	Motor rotation direction	Measuring device	Motor polarity	Polarity of T.G feedback
1	Turned counter-clockwise (as seen from the shaft) 	Tester or oscillos-cope	B (T1-7.8) GND A (T1-5.6) ⊖	CH3 (GND) CH2 ⊖
2	Turned clockwise (as seen from the shaft) 	Tester or oscillos-cope	(T1-5.6) ⊕ A (T1-7.8) GND B	CH2 ⊕ CH3 GND

(3) Check polarity of magnetic field coil

Wire labels E&F are attached to the magnetic field coil when the motor is installed, so please connect properly with the servo-unit.

T1-11 ..... E
T1-12 ..... F

If the connection is incorrect, DC motor will go out of control during acceleration when the velocity command and rotation direction command are issued.

2.4 Adjustment

Only the following items are necessary during Installation and adjustment.

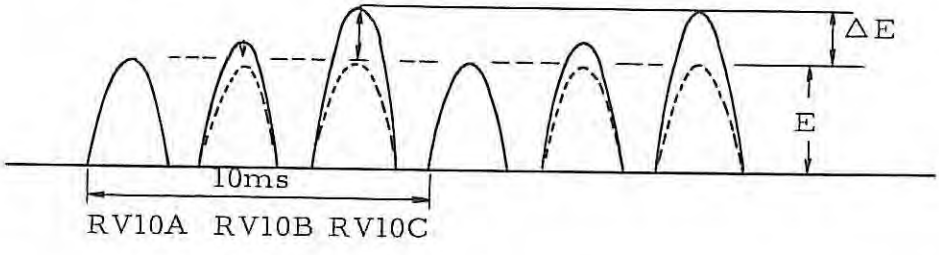
Refer to the reference material 2.5 for a more detailed adjustment procedure.

(1) Adjustment of synchronizing pulse

Adjustment is not necessary when the three-phase input waveform is balanced but when three phases are not balanced, or the inter-phase voltage is different in each phase, the synchr onizing pulse should be adjusted in the following matter.

Rotate the spindle motor slowly and look at the current waveform.

CH 11 waveform



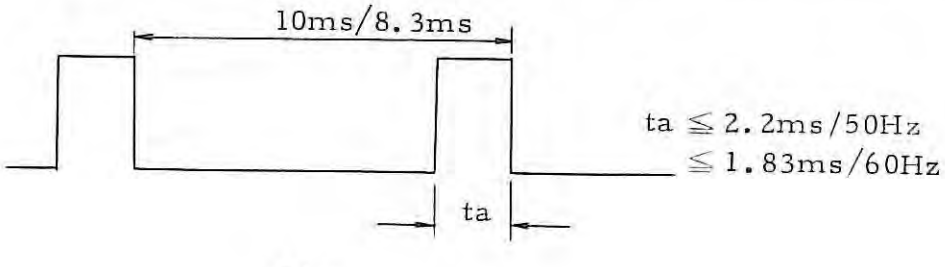
(Adjustment)

Turn any two variable resistors RV10A, B, or C, so that the peak value of the current waveform is within the range.

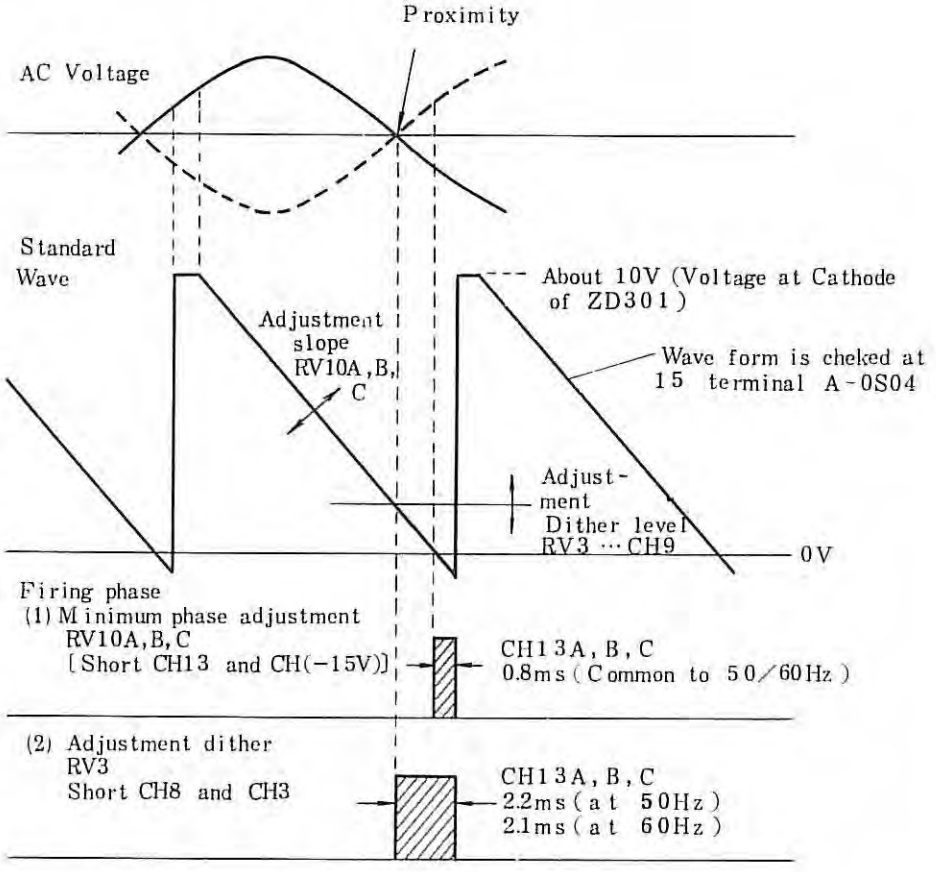
$$\Delta E \leqq \pm 0.2E$$

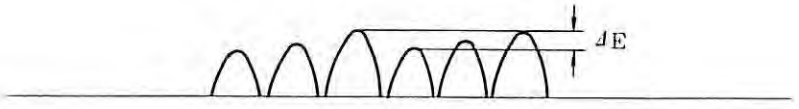
(Check)

After adjustment, turn OFF the electromagnetic relay MCC, and check the synchronizing pulse width by CH13A, B, C. (Connect the CH8 to the ground).



However, re-adjustment is necessary when ta $>$ 2.2ms/50Hz or ta $>$ 1.83ms/60Hz.





(2) Current detection circuit offset adjustment

Turn OFF the electromagnetic contactor MCC and adjust RV103 so that the voltage at the current waveform check terminal CH11 will be 0.

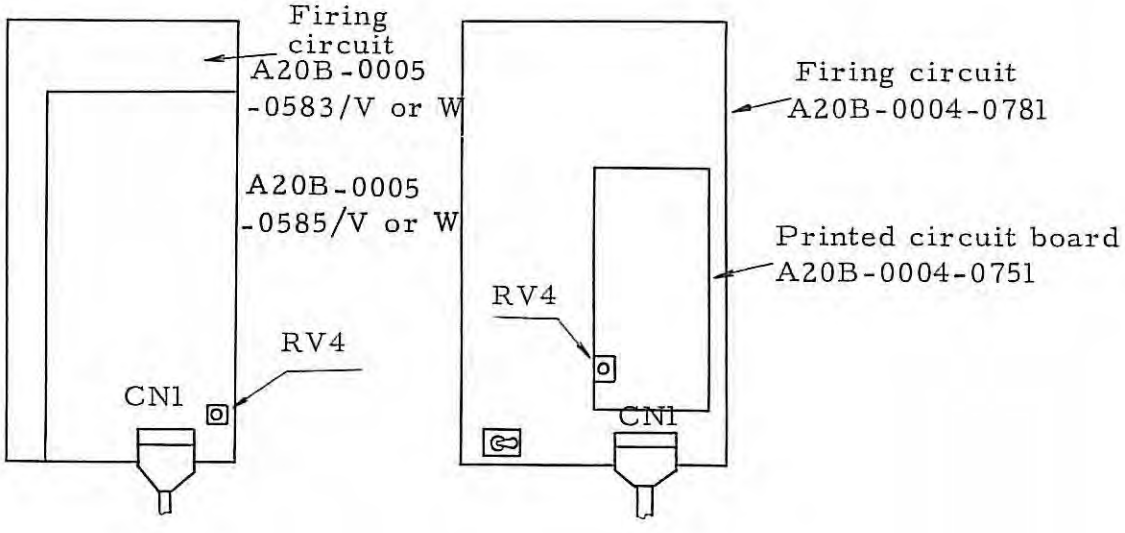
(Adjustment)

Check terminal : CH11
Adjustment VR : RV103
CH11 voltage : 0 $\pm$ 20mV

(3) Rotation speed adjustment

Adjust to get ± 10V at CH3 in spindle control circuit when maximum external analog input voltage (10V) is applied or maximum D/A converter command (S99 by B.C.D., 4095 by Binary) is applied. And after this adjust RV4 in firing control circuit so that the spindle motor or spindle has maximum rotation at 10V.

Velocity command CH3	Spindle motor rotation speed	Spindle rotation speed	Adjustment location
±10V	3500 ± 14 rpm	Maximum rotation speed ±0.4%	RV4 (Firing circuit)



2.5 Adjustment Reference Material

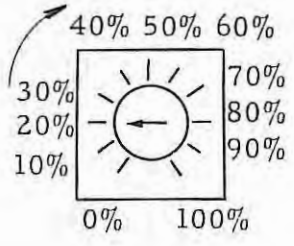
(1) Ajustment and checking precedure for the spindle control circuit (A20B-0004-0990)

The following adjustments are normally performed at installation, so further adjustment and checking should not be necessary. Please refer to this section for checking in case of failure.

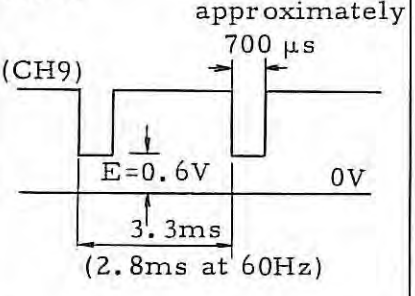
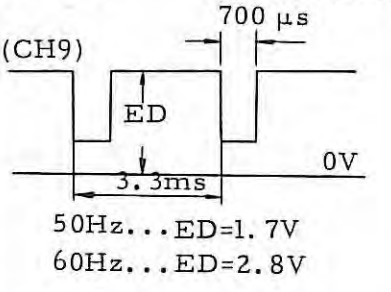
No.	Item	Adjustment places	Adjustment and checking	Standard setting
1	D/A converter offset adjustment	RV2	Adjust CH1 voltage to 0±5mV when D/A converter input R01 - 12 are all OFF.	Approximately 50%
2	D/A converter offset adjustment	RV4	Adjust CH3 voltage to 0±5mV when SFR and SRV inputs are turned on in the same status as above.	Approximately 50%
3	D/A converter gain adjustment	RV1	Adjust so that CH3 becomes 10V when SFR command is issued in the state where D/A converter inputs are all ON (BCD -- S99, Binary 4095).	45~50%
4	D/A converter gain adjustment	RV3	In the same status as above, adjust CH3 to -10V with the SRV command is issued. For the external analogue command, adjust the rotation speed in the reverse direction is the standard maximum rotation with 10V input.	35~50%
5	Speed 0 adjustment	RV6	Adjust so that CH7 voltage is 50mV. The standard value for speed 0 is 0.5%.	20%

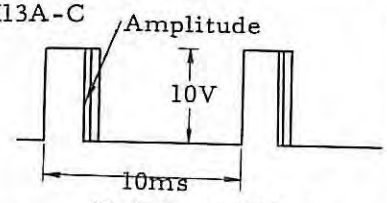
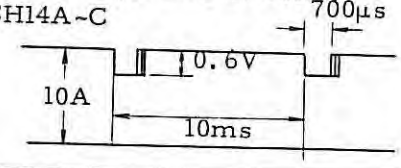
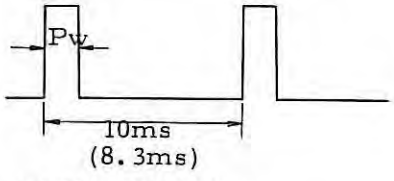
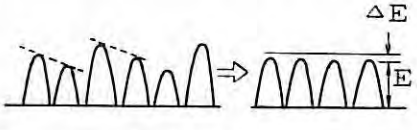
No.	Item	Adjustment places	Adjustment and checking	Standard setting
6	Speed arrival signal	RV7	This is a signal issued when the motor speed is 80-85% of the commanded speed. Until it is issued, the SAL (SAR) photodiode is turned on.	
			Adjust to get 6Vat CH8 with the speed command 10V on A20B-0004-0990/(03A) P.C.B.	20%
			Adjust to get 1.5V (85%) at CH8 when the speed command 10V on A20B-0004-0990/(08C) P.C.B.	20%
7	Tachometer voltage (CW direction)	RV5	Adjust so that CH6 is exactly 10V while at maximum speed by SFR command.	Approximately 50%
8	Tachometer voltage (CCW direction)	RV8	Adjust CH6 to be exactly 10V while at maximum speed by SRV command. RV8 is removed since A20B-0004-0990/08C.	Approximately 40%

Note 1. The position of the control and the % have the following relationship. The % increases in the clockwise direction.



(2) Adjustment and checking of the firing circuit (In case of A20B-0004-0781)

No.	Item	Adjustment places	Adjustment and checking	Standard setting	
				Model 5	Model 10
1	Gain adjustment	RV1	Determines the rigidity of the spindle motor, but since there is no need for precise adjustment, set it in the vicinity of 35 - 45%.	40%	
2	Offset adjustment	RV2	After zeroing the velocity command voltage (short CH1 and GND, CH3), short CH5 and CH6 so that CH8 is OV, i.e. Adjust so that the spindle motor rotation becomes almost 0.	Approximately 50%	
3	Dither No.1	RV102	Determines the servo rigidity during halt. Measure CH9 and Set E= 0.6V. 	20%	
4	Dither No.2	RV3	Short CH8 and CH3 (GND) Measure CH9 and Set as follows.  50Hz...ED=1.7V 60Hz...ED=2.8V	50~60%	

No.	Item	Adjustment place	Adjustment and checking	Standard setting	
				Model 5	Model 10
5	Dither No. 3	RV11A RV11B RV11C	To balance the firing phase of the synchronizing circuit, adjust RV11A-C so that the pulse Amplitude of CH13A-C or CH14A-C is minimized. CH13A-C  CH14A-C  	Approximately 50%	
6	Dither No. 4	RV10A RV10B RV10C	First, adjust the pulse width of dither to the following values. Check terminal: CH13A-C  at 50Hz PW=1.8ms at 60Hz PW=1.6ms Next, adjust the two RV10A-C controls so that the peak values of the current waveform are even.  		

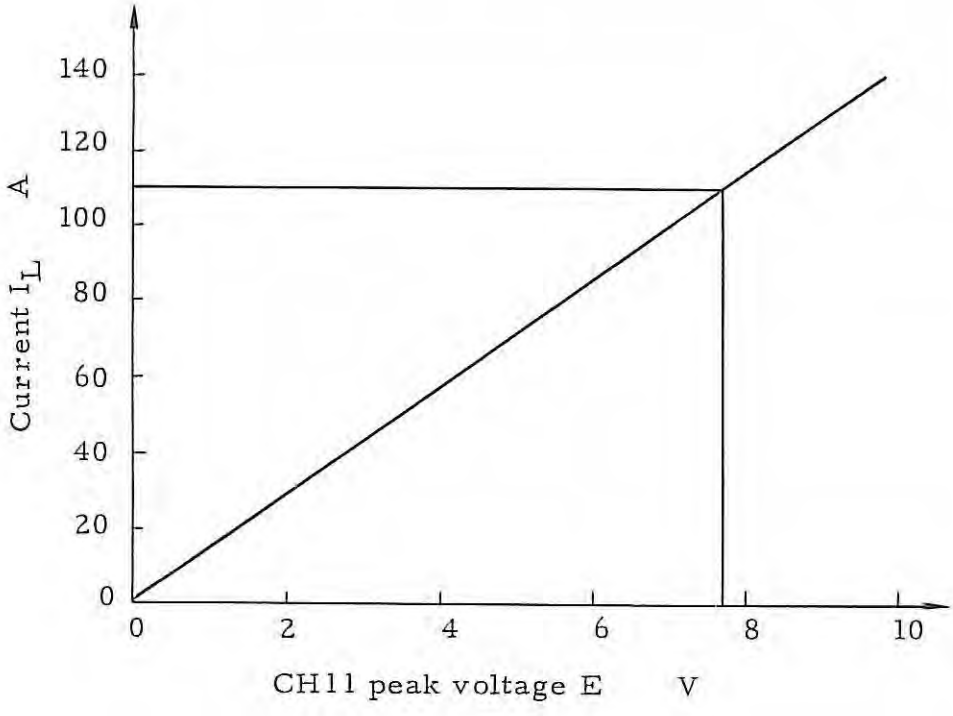
No.	Item	Adjustment place	Adjustment and checking	Standard setting	
				Model 5	Model 10
7	Current feed-back circuit offset	RV103	Adjust CH11 voltage to 0V with the electromagnetic contactor MCC at OFF.	Approximately 50%	
8	Current feed-back circuit gain	RV7	The spindle motor of models 5 & 10 has large motor inertia so, ajust-ment is not necessary. Simply set it at 35%.	35%	
9	Current limit circuit gain	RV8	Determines the current limit. Refer to Table 1.	70%	
10	Current limita-tion value.	RV9	Determines the current limit. Refer to Table 1.	30%	50%
11	Deceleration control	RV101	This regulates the primary current during decelerating from 3500 rpm.	0 ~ 10%	
12	Power limit again	RV109	This regulates the motor output at approximately 110% of the rated output. The current is regulated hyperbolically as shown in Fig. 2 over the base speed.	70%	85% --- Special Setting A 35%
13	Rotation speed adjustment.	RV4	Adjust the motor or spindle rotation to the standard when the velocity command voltage is 10V. Models 5 & 10: 3500 rpm ±14 rpm	Adjust during Installation and adjust-ment.	
14	Setting the torque limit	RV108	Used to reduce the torque occurring in the spindle orientation. It differs according to the spindle load torque. So adjust it so that machine shock is resonable during orien-tation.	Adjust during Installation and adjust-ment.	

Table 1 Relationship between the current limit and RV8, RV9

The current limits are approximately as follows according to the value of variable resistors RV8 and RV9. Set according to the output of models 5 & 10.

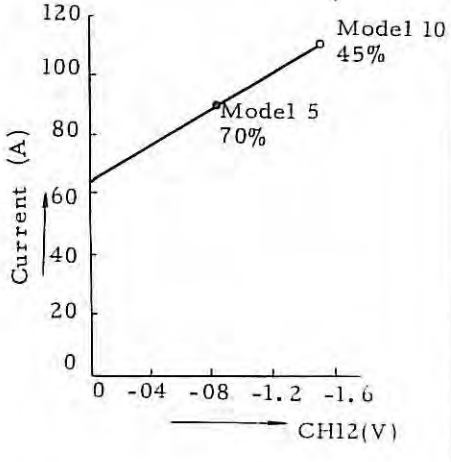
RV8 scale / RV9 scale	50%	60%	70%	80%
0	82A	70A	54A	44A
10%	85A	73A	61A	49A
20%	97A	87A	73A	58A
30%	110A	100A	87A	71A
40%	120A	111A	99A	84A
50%		124A	112A	97A
60%			123A	111A

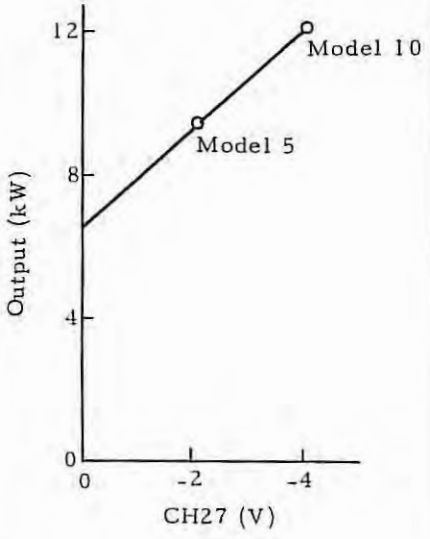
Note 1. Do not set the hatched part values. The current have the following relationship with the check terminal CH11.

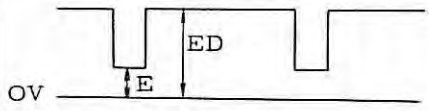
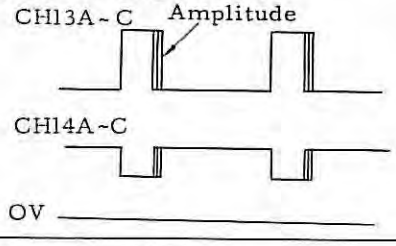
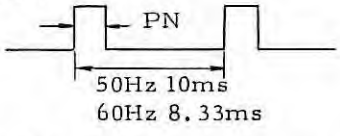
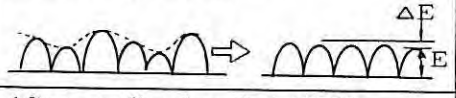


(3) Reference material for adjustment (For A20B-0005-0583/V -- Model 5
A20B-0005-0583/W -- Model 10

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Set adjustment places</th><th rowspan="2">Adjustment and checking</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 5</th><th>Model 10</th></tr>
<tr><td>1</td><td>Time constant setting</td><td>SH01</td><td><table><tr><th></th><th>Clutch LOW</th><th>Clutch HIGH</th></tr><tr><td>5-12</td><td>0.6 sec</td><td>1 sec</td></tr><tr><td>6-11</td><td>1.2 sec</td><td>2 sec</td></tr><tr><td>7-10</td><td>1.8 sec</td><td>3 sec</td></tr><tr><td>8-9</td><td>2.4 sec</td><td>4 sec</td></tr></table></td><td>7-10
(3 sec)</td><td>7-10
(3 sec)</td></tr>
<tr><td>2</td><td>Tachometer voltage setting</td><td>SH01</td><td><table><tr><th>Setting</th><th>TG maximum voltage</th></tr><tr><td>1 - 16</td><td>10V</td></tr><tr><td>2 15</td><td>12V</td></tr><tr><td>3 - 14</td><td>19V</td></tr><tr><td>4 - 13</td><td>21V</td></tr></table></td><td>4-13
(21V/
3500
rpm)</td><td>4-13
(21V/
3500 rpm)</td></tr>
<tr><td>3</td><td>Current detector bias</td><td>S9
S10</td><td><table><tr><th>Detector specification</th><th>Setting</th></tr><tr><td>A44L-0001-0048</td><td>S10</td></tr><tr><td></td><td>S9</td></tr></table></td><td>S10</td><td>S10</td></tr>
<tr><td>4</td><td>VCMD inter-face setting</td><td>S11
S12</td><td><table><tr><th></th><th>Setting</th></tr><tr><td>For normal spindle control circuit</td><td>S11</td></tr><tr><td>With clutch changing function</td><td>S12</td></tr></table></td><td>S11</td><td>S11</td></tr>
<tr><td>5</td><td>Power limit setting</td><td>S13
S14</td><td><table><tr><th>Motor specification</th><th>Setting</th></tr><tr><td>Model 5, 10</td><td>S13</td></tr><tr><td>Model 2. 3 Headstock</td><td>S14</td></tr></table></td><td>S13</td><td>S13</td></tr>
<tr><td>6</td><td>With/without clutch changing function</td><td>S15
S16</td><td><table><tr><th>Clutch changing function</th><th>Setting</th></tr><tr><td>Yes</td><td>S16</td></tr><tr><td>No.</td><td>S15</td></tr></table></td><td>S15</td><td>S15</td></tr>
<tr><td>7</td><td>Tachometer voltage adjustment</td><td>RV4</td><td>Adjust the maximum rotation number when the velocity command voltage is 10V.
Maximum rotation ±0.4%</td><td></td><td></td></tr>
</table>

No.	Item	Set adjustment places	Adjustment and checking	Standard setting	
				Model 5	Model 10
8	Velocity loop gain adjustment	RV1	Determines the spindle motor rigidity. There is no special necessity for adjustment. In case the hunting vibration is excessive, lower to 5% - 10%.	45%	45%
9	Velocity loop offset	RV2	Adjust so that the motor stops when the speed command voltage is OV.		
10	Current loop gain	RV7	This is the loop gain for the current command. Reduse the gain 20%~30% when some swell is observed in the current	100%	100%
11	Current detection offset	RV103	Adjust so that CH11 voltage becomes 0 when current does not flow. If this adjustment is incorrect, there will be uneveness at a low speeds.		
12	Power limit offset	RV 120 RV 114	Adjust by RV120 so that CH22 voltage becomes 0 when current does not flow. And adjust so that CH23 voltage becomes 0 by RV114.		
13	Current limit value setting	RV9	Set the CH12 voltage to the value at right when current does not flow. CH12 and the limit current are as shown in the graph below. 	-0.55V (70%)	-1.2V (45%) special setting A -0.7V

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Set adjustment places</th><th rowspan="2">Adjustment and checking</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 5</th><th>Model 10</th></tr>
<tr><td>14</td><td>Power limit setting</td><td>RV109</td><td>Set the CH27 voltage to the value at right when current does not flow. The relationship between CH27 and power is indicated as below.
 
</td><td>-2V
(85%)</td><td>-4V
(70%)
special setting
A
-1V</td></tr>
<tr><td>15</td><td>Setting the torque limit</td><td>RV108
RV122</td><td>Apply the torque limit, perform orientation, and adjust the halt current. The adjustment region is 0 - 35A.
<table><tr><th></th><th>Adjustment locations</th></tr><tr><td>Clutch HIGH</td><td>RV108</td></tr><tr><td>Clutch LOW</td><td>RV122</td></tr></table>
Adjust both even when using a constant value disregarding the clutch. If there is no clutch shift, only RV108 is used.</td><td colspan="2">The relation ship between voltage current of CH29
<table><tr><td>5A</td><td>-1.25V</td></tr><tr><td>10A</td><td>-1.45V</td></tr><tr><td>15A</td><td>-1.60V</td></tr><tr><td>20A</td><td>-1.77V</td></tr><tr><td>25A</td><td>-1.93V</td></tr><tr><td>30A</td><td>-2.09V</td></tr><tr><td>35A</td><td>-2.29V</td></tr><tr><td>40A</td><td>-2.49V</td></tr></table>* Standard setting</td></tr>
<tr><td>16</td><td>Setting of load-meter output</td><td>RV113</td><td>In case special setting
Shift the power limit offset RV114, set CH23 voltage to 1V, and then adjust CH24 to 1.2V. After adjustment, be sure to readjust the power limit offset as well.</td><td>Setting max 100%</td><td>1.0V
Special setting
A
setting max 100%</td></tr>
</table>

No.	Item	Set adjustment places	Adjustment and checking	Standard setting	
				Model 5	Model 10
17	Dither No.1	RV3	Short-circuit CH8 and CH3. Set the CH9 voltage to the value at right. 	ED 50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V	50Hz 1.5V 60Hz 2.8V E 50Hz 1.0V 60Hz 2.4V
18	Dither No.2	RV11A RV11B RV11C	Adjust the pulse jitter of CH13A-C or CH14A-C to the minimum to balance the firing phase of the synchronizing circuit. 		
19	Dither No.3	RV10A RV10B RV10C	Adjust the pulsewidth of Dither. Next, adjust the two RV10A-C controls so that the peak values of the waveform at low speeds are even.  Try to adjust to the smaller waveforms. For details, refer tc Section 2.5.1, "Synchronizing Pulse Adjustment." 	50Hz 1.8ms 60Hz 1.6ms	50Hz 1.8ms 60Hz 1.6ms
20	Setting the deceleration limit	RV101	After confirming that CH27 becomes either +10 or -10V at maximum rotation of each motor (refer to Section 7, 'Tacho-generator Voltage Adjustment'), set the CH26 voltage to the value at right.	8.5V	8.5V

(4) Reference material for adjustment (For A20B-0005-0585/V -- Model 5
A20B-0005-0585/W -- Model 10

<table>
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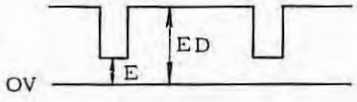
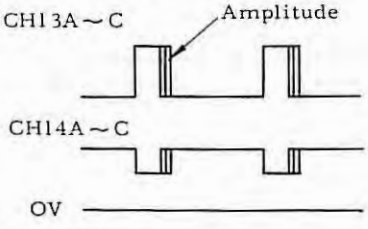
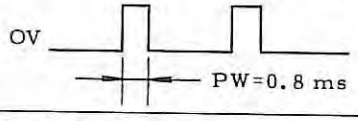
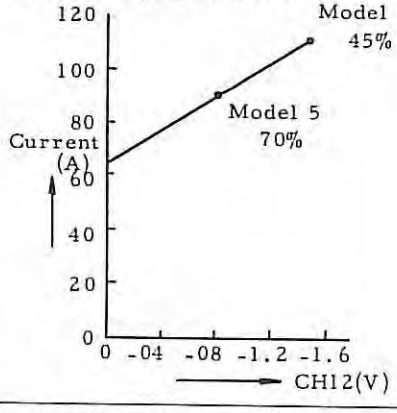
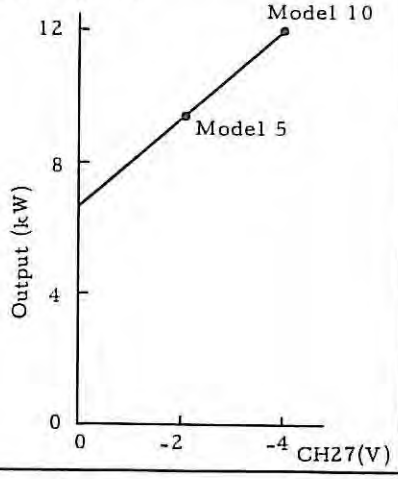
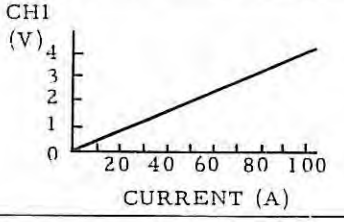
(21V/
3500rpm)</td><td>4-13
(21V/
3500rpm)</td></tr>
<tr><td>3</td><td>Current detector bias</td><td>S9
S10</td><td><table><tr><th>Detector specification</th><th>Setting</th></tr><tr><td>A44L-0001-0048</td><td>S10</td></tr><tr><td></td><td>S9</td></tr></table></td><td>S10</td><td>S10</td></tr>
<tr><td>4</td><td>VCMD interface setting</td><td>S11
S12</td><td><table><tr><th></th><th>Setting</th></tr><tr><td>For normal spindle control circuit</td><td>S11</td></tr><tr><td>With clutch changing function</td><td>S12</td></tr></table></td><td>S11</td><td>S11</td></tr>
<tr><td>5</td><td>Power limit setting</td><td>S13
S14</td><td><table><tr><th>Motor specification</th><th>Setting</th></tr><tr><td>Model 5, 10</td><td>S13</td></tr><tr><td>Model 2, 3 headstock</td><td>S14</td></tr></table></td><td>S13</td><td>S13</td></tr>
<tr><td>6</td><td>With/without clutch changing function</td><td>S15
S16</td><td><table><tr><th>Clutch changing function</th><th>Setting</th></tr><tr><td>Yes</td><td>S16</td></tr><tr><td>No</td><td>S15</td></tr></table></td><td>S15</td><td>S15</td></tr>
<tr><td>7</td><td>Dither No. 1</td><td>RV3</td><td>Short-circuit CH8 and CH3.
Set the CH9 voltage to the value at right.
  </td><td>ED
50Hz 1.85V
60Hz 3.15V
E
50Hz 1.0V
60Hz 2.4V</td><td>ED
50Hz 1.85V
60Hz 3.15V
E
50Hz 1.0V
60Hz 2.4V</td></tr>
<tr><td>8</td><td>Dither No. 2</td><td>RV11A
RV11B
RV11C</td><td>Adjust the pulse jitter of CH13A-C or CH14A-C to the minimum to balance the firing phase of the synchronizing circuit.
  </td><td></td><td></td></tr>
</table>

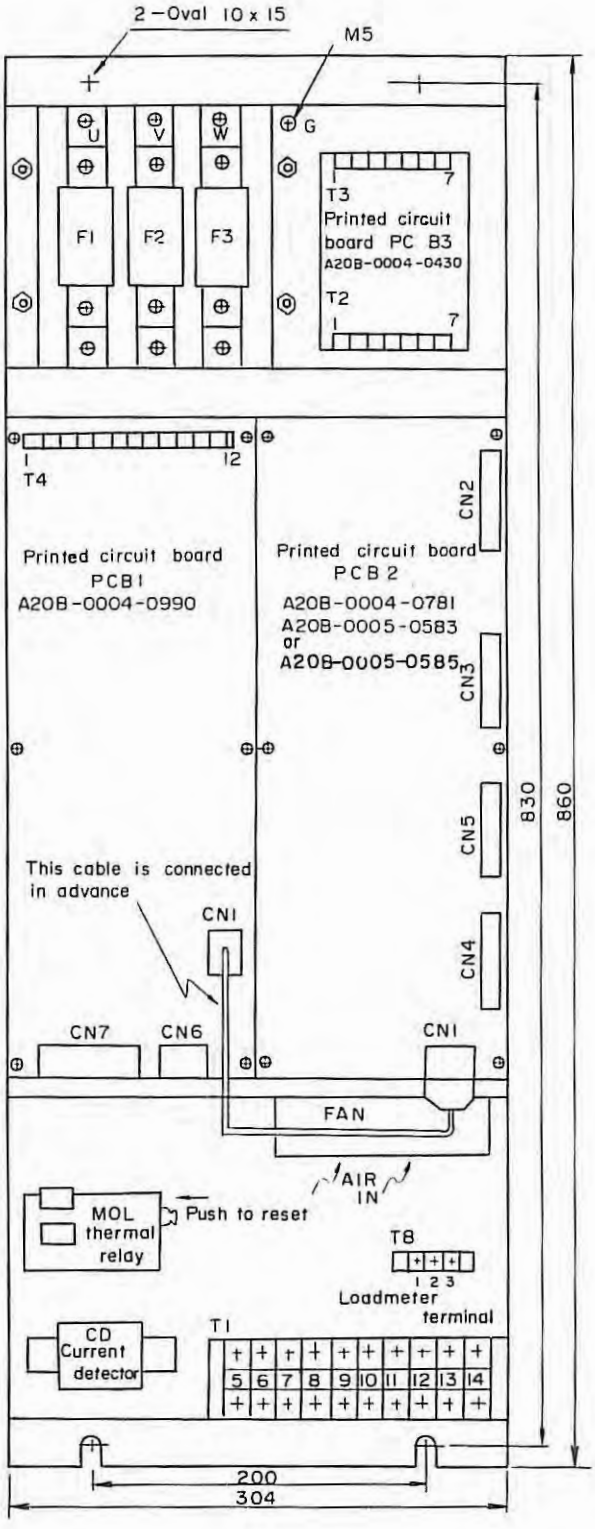
No.	Item	Set adjustment places	Adjustment and checking	Standard setting	
				Model 5	Model 10
9	Minimum Phase shift sdjusment -	RV10A RV10B RV10C	CH13 and CH17 (-15V) are shorted adjust the pulse width of CH13 A～C CH13 A～C 	0.8ms (50/60Hz)	0.8ms
10	Current loop gain		This is the loop gain for the current command. Reduse the gain 20% 30% when some swell is observed in the current.	100%	100%
11	Current detection offset	RV103	Adjust so that CH11 voltage becomes 0 when current does not flow. If this adjustment is incorrect, there will be uneveness at a low speeds.		
12	Power limit	RV120	Adjust by RV120 so that CH22 voltage becomes 0 when current does not flow. And adjust so that CH23 voltage becomes 0 by RV114.		
13	Current limit value setting	RV9	Set the CH12 voltage to the value at right when current does not flow. CH12 and the limit current are as shown in the graph below. 	-0.55V (70%)	-1.2V (45%) Special setting A -0.7V
14	Power limit setting	RV109	Set the CH27 voltage to the value at right when current does not flow. The relationship between CH27 and power is indicated in the table below. 	-2V	-4V Special setting A -1V

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Set adjust-ment places</th><th rowspan="2">Adjustment and checking</th><th colspan="2">Standard setting</th></tr>
<tr><th>Model 5</th><th>Model 10</th></tr>
<tr><td>15</td><td>Velocity loop gain adjust-ment</td><td>RV1</td><td>Adjust as below by load inertia.
<table><tr><td>Max inertia</td><td>Setting</td></tr><tr><td>0～5kg cmS^2</td><td>45%</td></tr><tr><td>5～ "</td><td>70%</td></tr></table></td><td></td><td></td></tr>
<tr><td>16</td><td>Velocity loop offset</td><td>RV2</td><td>Adjust so that the motor stops when the speed command voltage is OV.</td><td></td><td></td></tr>
<tr><td>17</td><td>rpm adjust-ment</td><td>RV4</td><td>Adjust the maximum rotation number when the velocity command voltage is 10V.
Maximum rotation ±0.4%</td><td>3500 rpm</td><td>3500 rpm</td></tr>
<tr><td>18</td><td>Setting the deceleration limit</td><td>RV101</td><td>After confirming that CH27 becomes either +10 or -10V at maximum rotation of each motor (refer to Section 7, 'Tachogene-rator Voltage Adjustment'), set the CH26 voltage to the value at right.</td><td>8.5V</td><td>8.5V</td></tr>
<tr><td>19</td><td>Setting the torque limit</td><td>RV108
RV122</td><td>Apply the torque limit, perform orientation, and adjust the halt current.
Adjust the torque limit by RV108 and RV122 during measurement current value on CH11.
<table><tr><td></td><td>Adjustment locations</td></tr><tr><td>Clutch HIGH</td><td>RV108</td></tr><tr><td>Clutch LOW</td><td>RV122</td></tr></table>  </td><td colspan="2">Voltage of CH29 can be used for adjustment torque limit
<table><tr><td>Current</td><td>CH11</td><td>CH29</td></tr><tr><td>5V</td><td>0.2V</td><td>-1.25V</td></tr><tr><td>10"</td><td>0.4"</td><td>-1.45V</td></tr><tr><td>15"</td><td>0.6"</td><td>-1.60V</td></tr><tr><td>20"</td><td>0.8"</td><td>-1.77V</td></tr><tr><td>25"</td><td>1.0"</td><td>-1.93V</td></tr><tr><td>30"</td><td>1.2"</td><td>-2.09V</td></tr><tr><td>35"</td><td>1.4"</td><td>-2.29V</td></tr></table></td></tr>
<tr><td>20</td><td>Load meter output setting</td><td>RV113</td><td></td><td>80%</td><td>50%</td></tr>
</table>

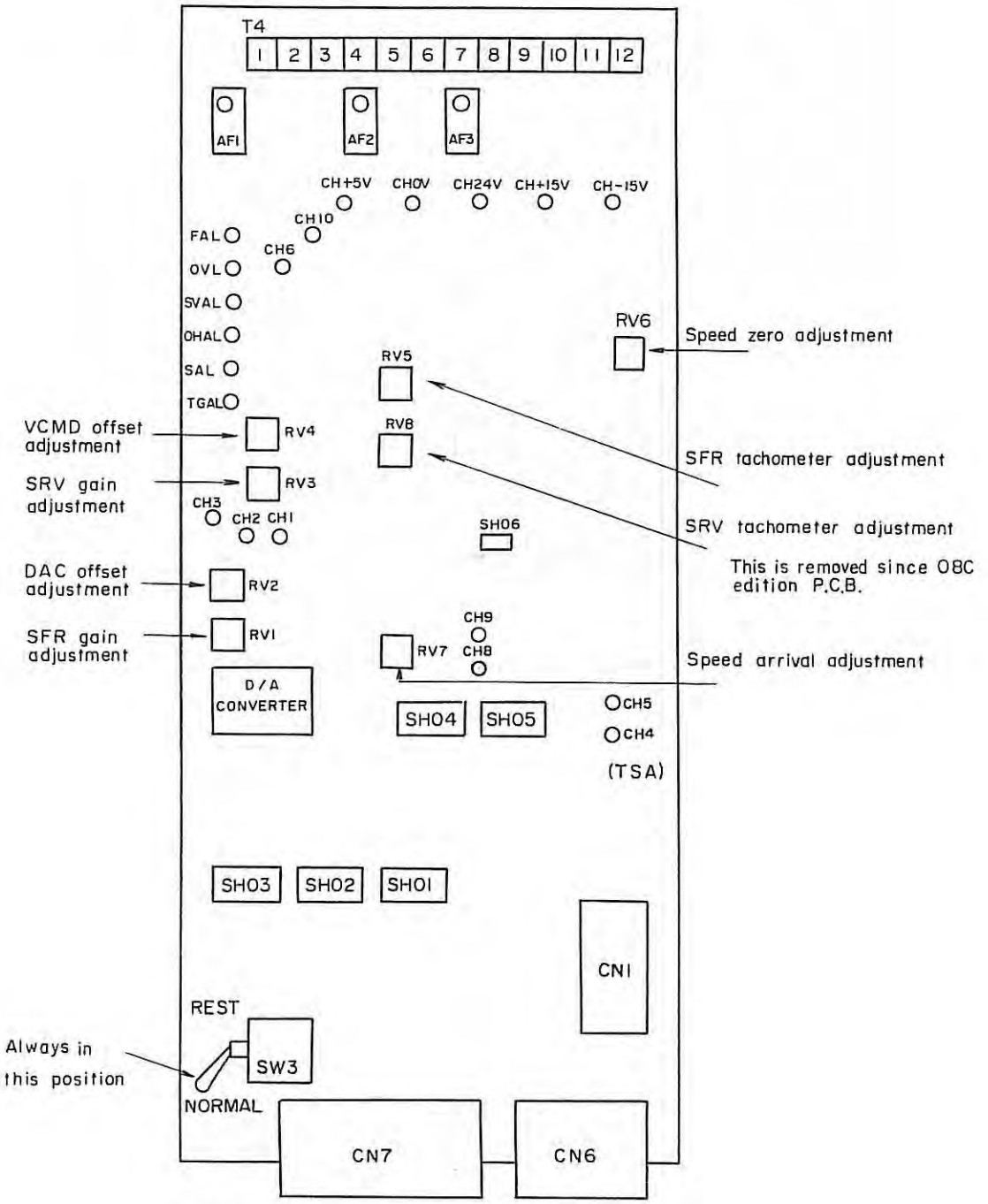
3. MOUNTING DIAGRAM

The device can be serviced from one side and the parts are mounted as follows as seen from the front.

3.1 Spindle Servo-unit

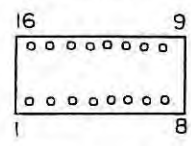


3.2 Spindle Control Circuit A20B-0004-0990



PCB A20B-0004-0990

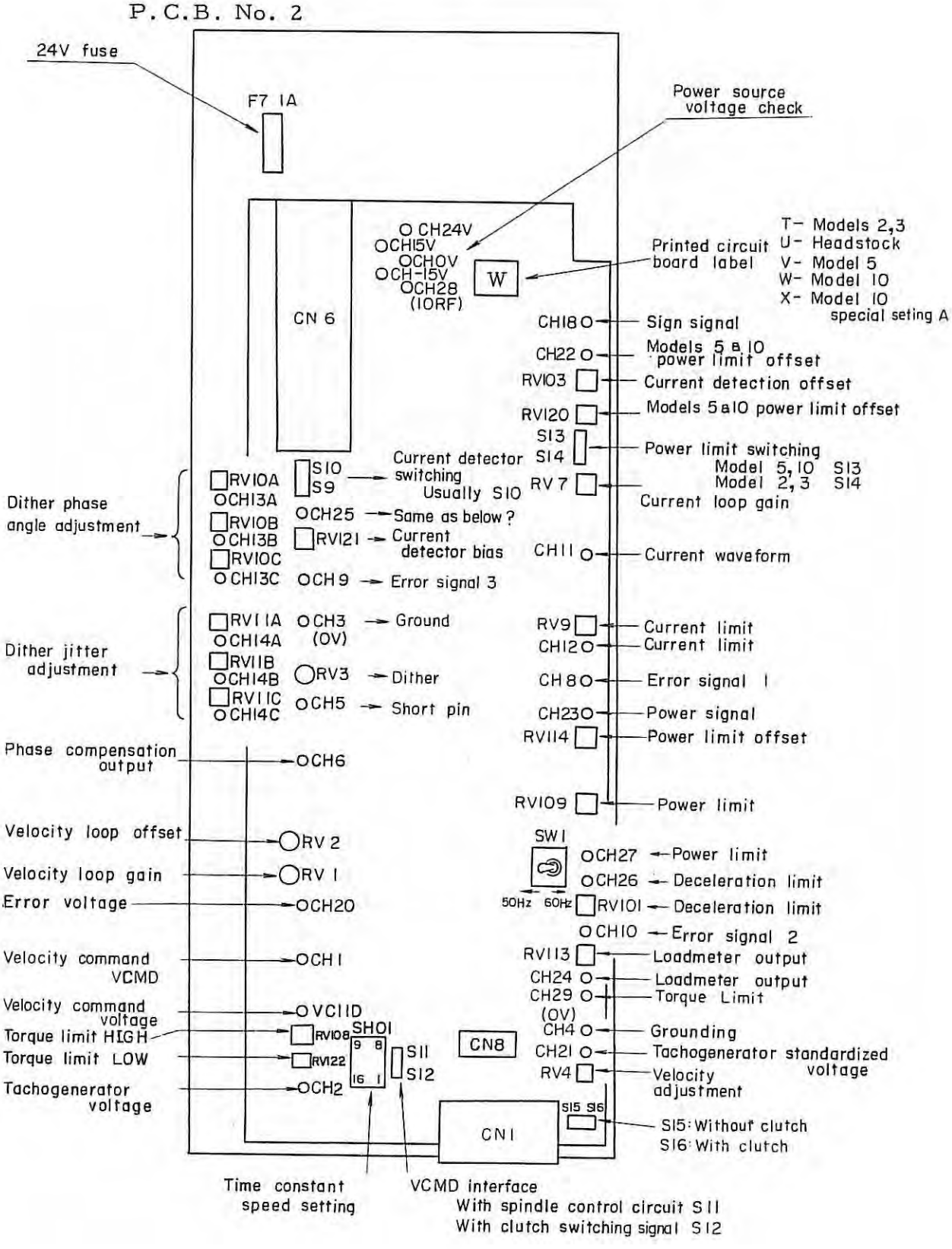
Short-circuit



SH01 SH05

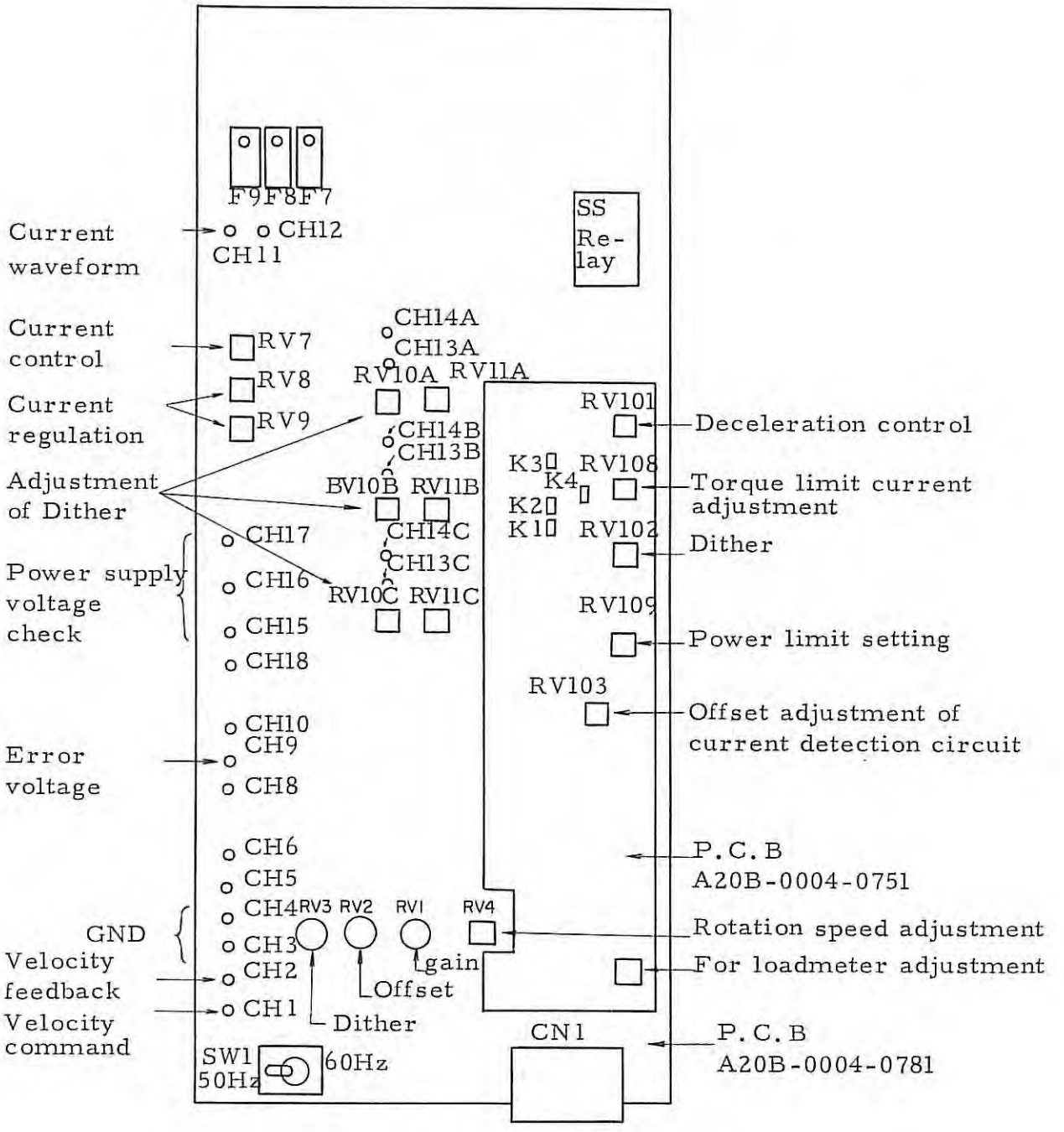
SH06

3.3 Firing Circuit A20B-0005-0583/A20B-0005-0585



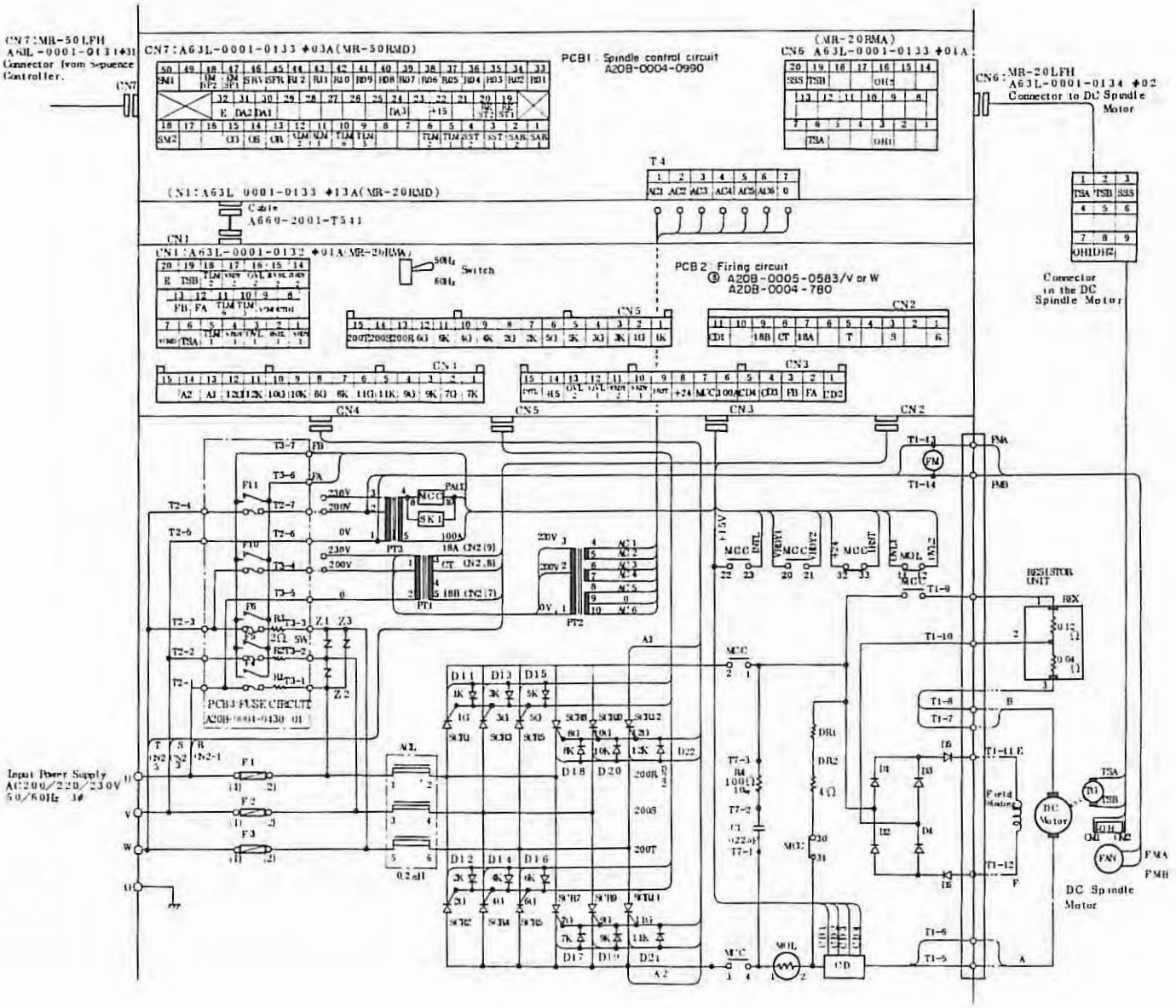
3.4 Firing Circuit A20B-0004-0781

P.C.B. No. 1



Note) CH3, 4 : 0V
CH15 : +24V
CH16 : +15V
CH17 : -15V

4. CIRCUIT STRUCTURE



5. TROUBLESHOOTING

Generally, the following items can be considered as faults and their causes.

If a fault has occurred, first roughly determine where the cause lies (servo unit, spindle motor, etc.), and then trace out the cause.

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
1	The velocity control unit unit fuse is blows.	. Cabling mistake . Circuit gault current limitint circuit defect, circuit adjustment defect, etc.	. T.G. WIRE contact defect or breaking . Driving cable shortcircuit . Field coil is shorted to the ground. . Too much T.G ripple V ripple $\leqq$ 1V	
2	The spindle r.p.m. in not normal.	. Circuit gault Defect of error amplifier circuit. etc. . Faulty D/A converter	. T.G defect . Lowing of counter electromotive force of the motor.	. Faulty operation of the velocity command circuit.
3	Vibration and noise during spindle operation is abnormally large.	. 50/60Hz setting error. . Circuit adjustment defect Dither Gain . Current feedback control circuit adjustment defect	. Motor fault bearing, clutch, etc. . Too much T.G. ripple	. The input power waveform is too disorted. . The load fluctuation is too large. . Gear engagement is not proper.

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Power unit
4	The spindle operation during acceleration and deceleration is not normal.	. Deceleration limiting circuit adjustment defect. . Current feedback control circuit adjustment defect		. Relation between the load inertia and the acceleration/deceleration time constant setting is not proper. . The belt tension is not proper.
5	The spindle does not rotate.	. Circuit fault The gate pulses are not generated, etc.	. Wire breaking . Clutch high/low switching defect.	. The machine load is too large. . SFR/SRV is not issued,

6. SPARE PARTS LIST

When requesting parts for maintenance, please use the following list as reference.

No.	Part name, symbol	Specifications	Quantity used
1	Fuse (100A)F1~3	A60L-0001-0060 #50T100	3
2	Alarm fuse (1.3A) F4, 5, 6	S. Fab 250/402A P413	3
3	Alarm fuse (10A) F10, F11	S. Fab 250/402 G PL4100	2
4	Surge absorber Z1, 2, 3	A50L-2001-0062 #441-12	3
5	Firing circuit PCB	MODEL 5 A06P-6040-H005#B " 10 A06P-6041-H010#B Special A A06P-6041-H011#B	1
6	Spindle control circuit PCB	A20B-0004-0990	1
7	Fuse circuit PCB3	A20B-0004-0430	1
8	Tyristor SCR1-12	A50L-5000-0014 (71RC80)	12
9	Diode D1, 3, 6	(10M80) A50L-2001-0081 #80	3
10	Diode D2, 4, 5	(10MA80) A50L-2001-0082 #80	3
11	Current detector CD	A44L-0001-0048	1
12	Electromagnetic contactor MCC	A58L-0001-0080	1
13	Fan motor FM	A90L-0001-0082	1

Control Bd.
A20B-0008-037□/02 Ø8D Edition
(New) #7,354 74 } 81016329 Q0
#2,022.55 }

IV. DC SPINDLE SERVO UNIT
MAINTENANCE MANUAL
for
MODEL 6, 8, 12, AND 15
SPINDLE SERVO UNIT

SP15

Draw # A08B-6041-H115

Manual # K11-Ø2Ø2Ø

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1. GENERAL

This maintenance manual is applicable to the spindle servo unit used to drive the FANUC DC spindle motor Model 15, Model 12, Model 8 or Model 6.

The general structure of the spindle servo unit is diagrammed as follows.

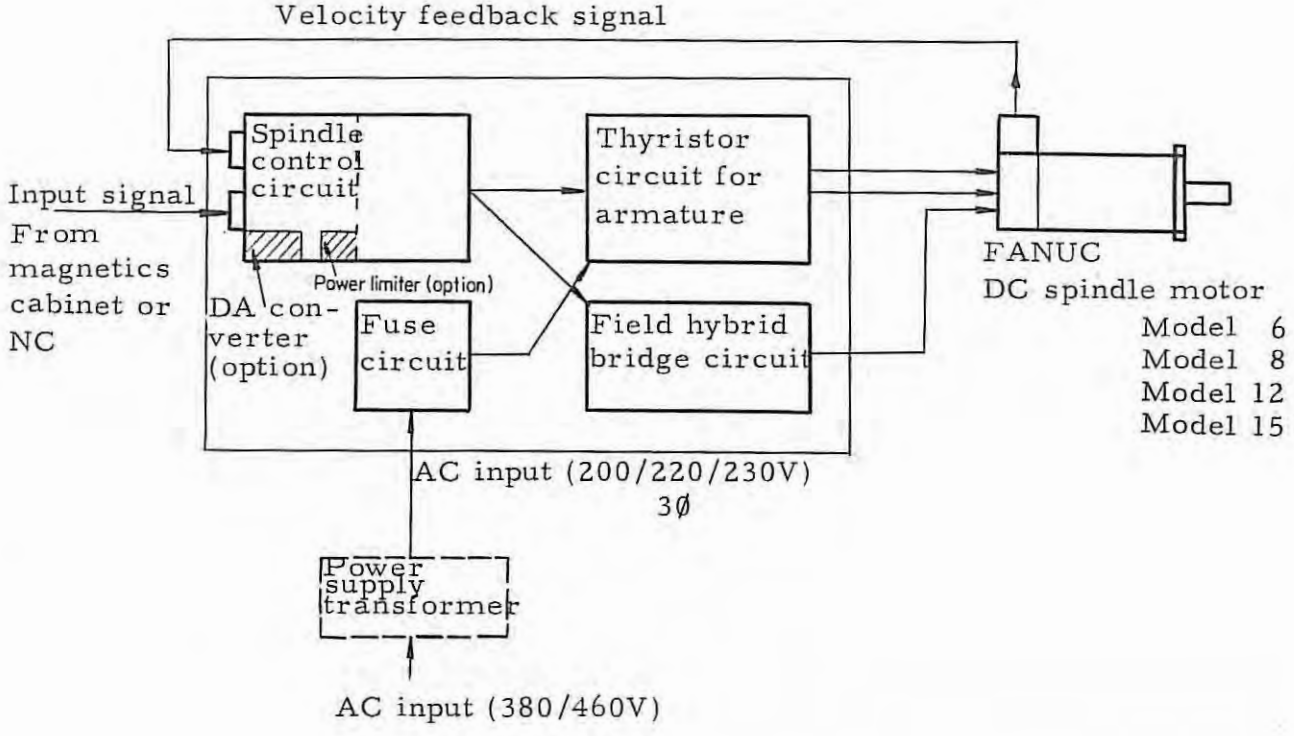


Fig.1 Spindle servo unit block diagram

During Installation and adjustment check the signal line connections to the magnetics cabinet or NC by referring to the DESCRIPTIONS of the FANUC spindle motor series.

A table of printed circuit board specification follows

		Specification No.
Spindle control circuit	for Model 6	A20B - 0005 - 0374
	Model 8	A20B - 0005 - 0373
	Model 12	A20B - 0005 - 0372
	Model 15	A20B - 0005 - 0371

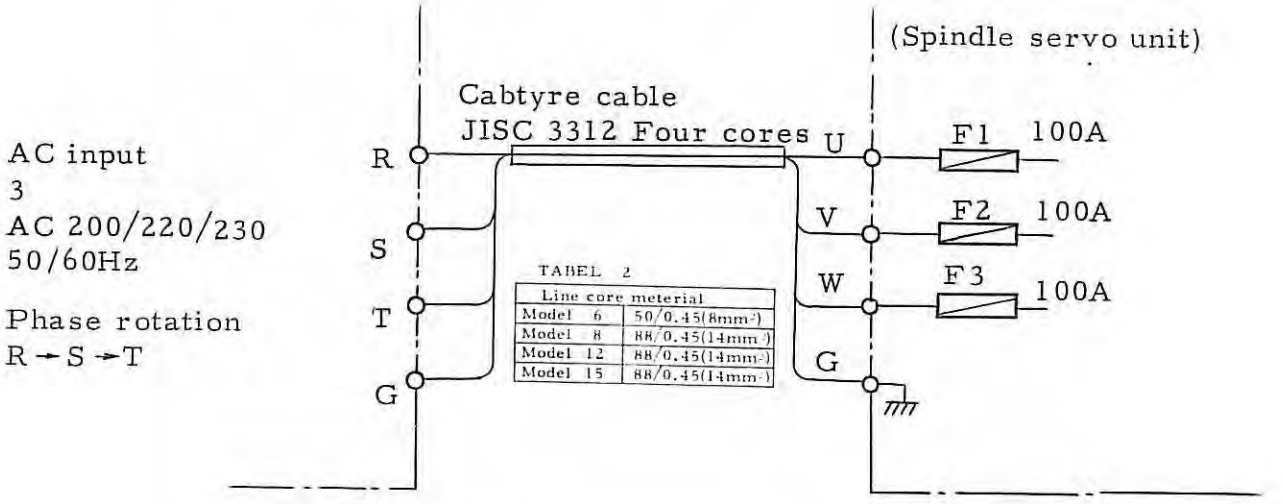
2. INSTALLATION AND ADJUSTMENT

2. 1 Connection

(1) Power supply line connection

(a) 200/220/230V AC power supply input

(Power supply)



TABEL 2

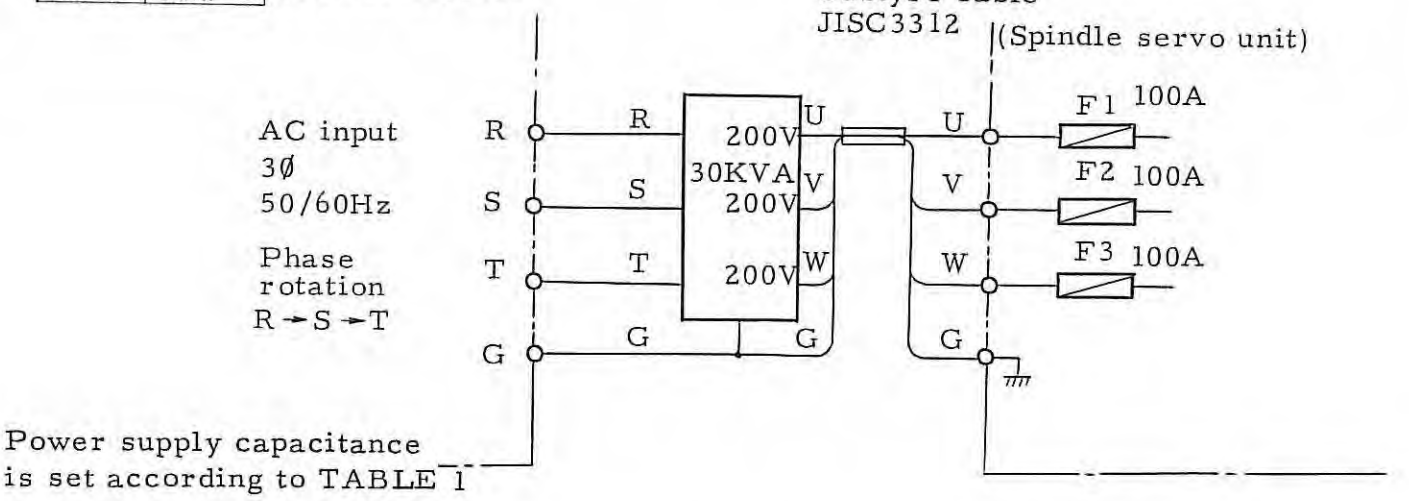
Line core meterial	
Model 6	50/0.45(8mm²)
Model 8	88/0.45(14mm²)
Model 12	88/0.45(14mm²)
Model 15	88/0.45(14mm²)

(b) Power supply input other than 200/220/230V AC
(Example, 380/400/415/460/480V AC, ETC.)

TABLE 1

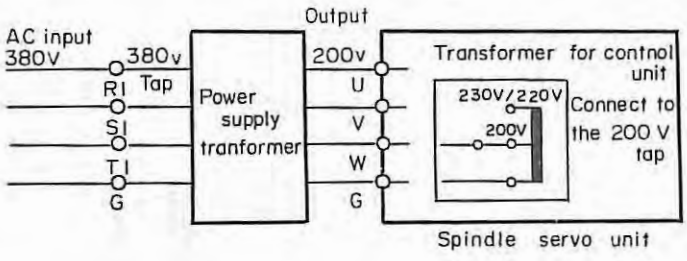
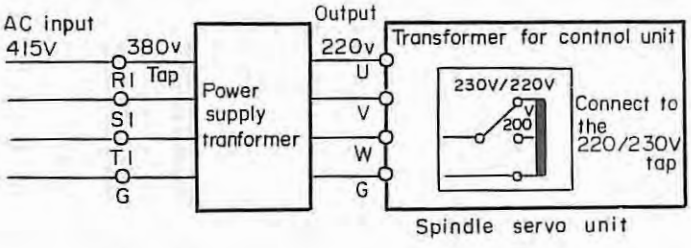
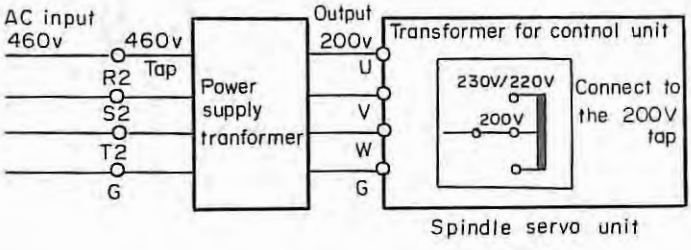
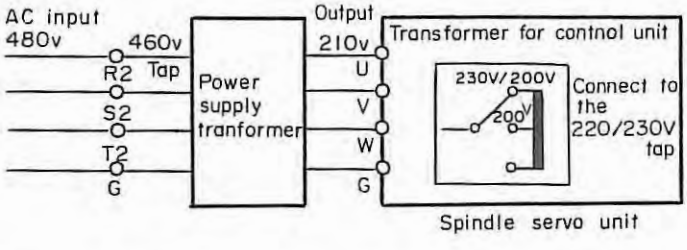
Power supply capacitance	
Model 6	13kVA
Model 8	19kVA
Model 12	24kVA
Model 15	30kVA

(Power supply)



The power source lines can be connected without transformers when the AC input is within the rated voltage range (200 to 230V $^{+10\%}_{-15\%}$), but a power supply transformer is required for 380 to 550V AC.

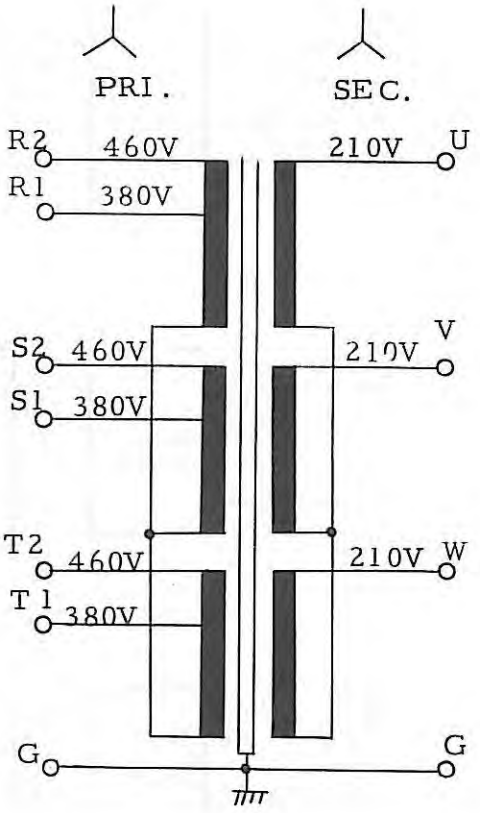
If the FUJITSU FANUC power supply transformer is used, connect it as follows for 380 to 480V AC.

No.	AC input voltage	Connection
1	380/400V +10% -15%	
2	400/415V +10% -15%	
3	460V +10% -15% (440V ± 10%)	
4	480V +10% -15%	

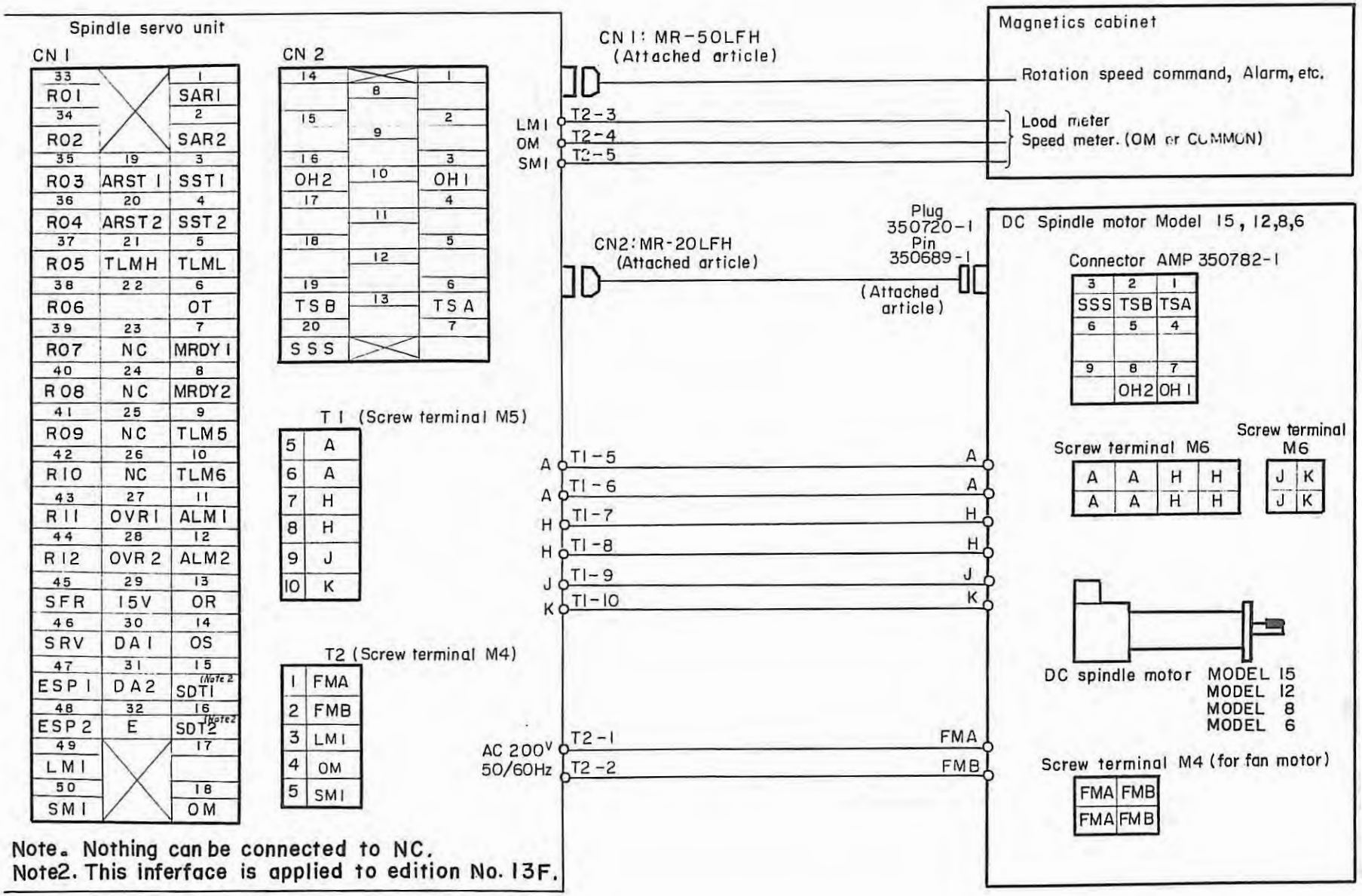
Refer to 2.2(1) for setting the power supply transformer for control.

Transformer connection diagram

FUJITSU FANUC POWER SUPPLY TRANSFORMER



(2) Connection of spindle motor power and signal lines

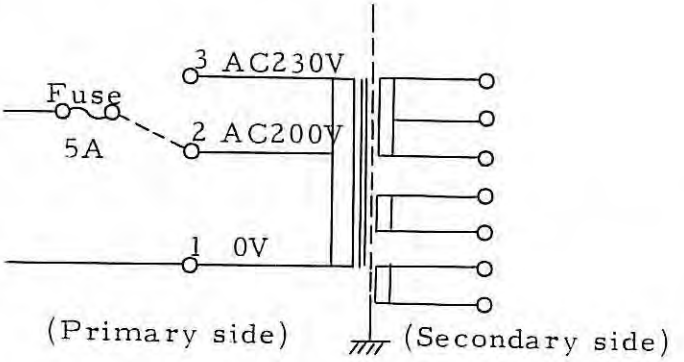


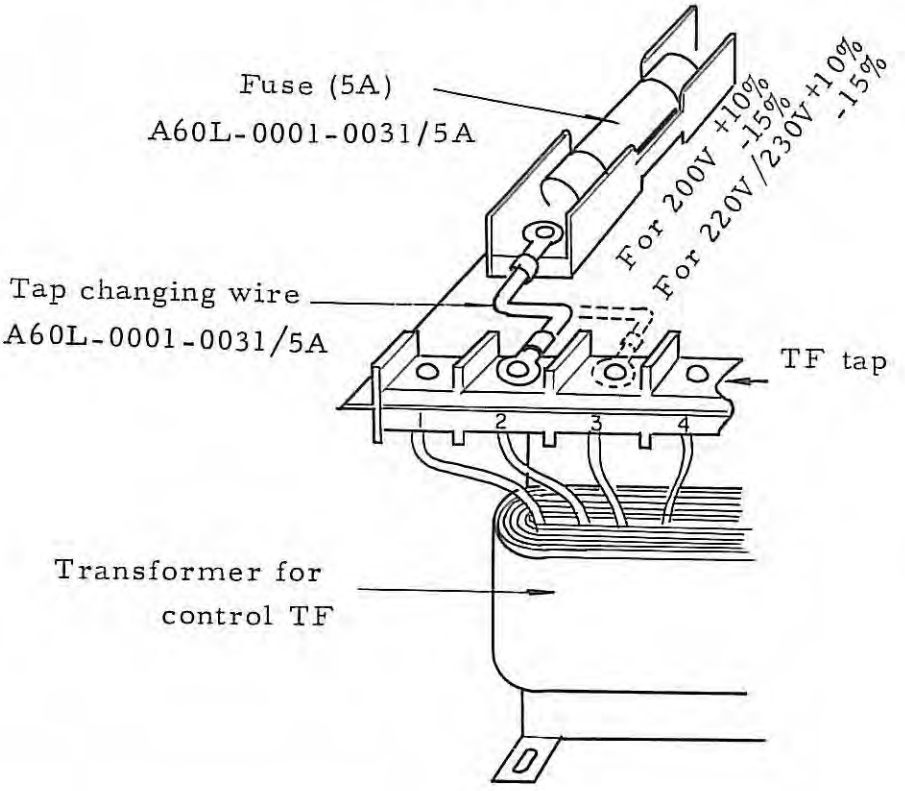
2.2 Confirmation for Settings

(1) Setting the transformer for control by the AC input voltage

The transformer TF tap on the spindle servo unit is set as follows in accordance with the AC input voltage.

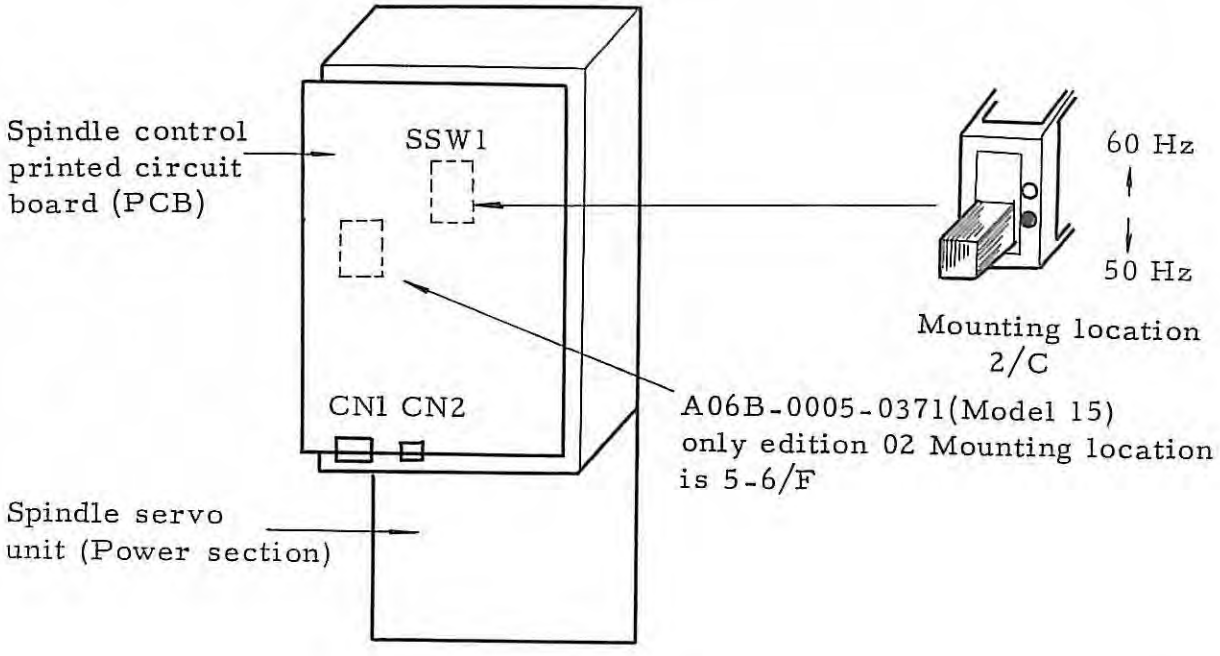
Nominal AC input voltage	Taps of TF
AC200V $^{+10\%}_{-15\%}$	Connection to tap 2
AC220V $^{+10\%}_{-15\%}$ or AC230V $^{+10\%}_{-15\%}$	Connection to tap 3





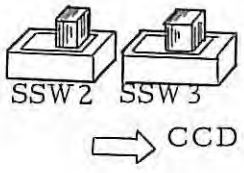
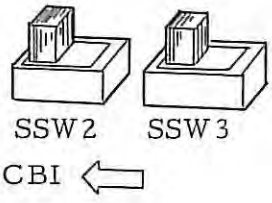
(2) Setting the frequency selector switch (50/60Hz)

Check that the frequency selector switch (SSW1) is properly set in accordance with the frequency of the AC input.



(3) Checking the D/A converter selector switch

The following setting is performed in accordance with the specifications (BCD/Binary) of the D/A converter.

Specification	Part symbol	Setting
A06B-6041-J031 (A50L-8001-0056) (12 Bit BCD code)	DAC-HY12DC (Manufactured by Datel company) DAC-80-CCD-V (Manufactured by Micro-network) DAC-80-CCD-V (Manufactured by Burr-brown)	
A06B-6041-J032 (A50L-8001-0045) (12 Bit BINARY code) USE FOR 1909 LATHE	DAC-HY12BC (Manufactured by Datel company) DAC-80-CBI-V (Manufactured by Micro-network) DAC-80-CBI-V (Manufactured by Burr-brown)	

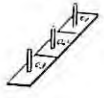
(4) Setting check for shorts (◎: Short X: Open)

No.	Contents		SLIDE SWITCH		SH01								SH02		SH	SH	SH05		SH	SH	Remarks
No.			SSW1	SSW^{2}_{3}	01 | 16	02 | 15	03 | 14	04 | 13	05 | 12	06 | 11	07 | 10	08 | 09	01 | 02	02 | 03	03	04	01 | 02	02 | 03	06	07	
1	Frequence	60 Hz	⇧																		Check this setting before operation
2		50 Hz	⇩	⇦																	
3	DA Converter	CBI BINARY 12BITS		⇦					◎		×	◎									Setting is made in accordance with the type of D/A converter
4		CCD BCD 2 DIGITS		⇨					×		◎	×									
5	Constant position is not used				◎																Open when constant position is used
6	Signal MRDY is always ON					◎															Open when MRDY is used
7	Override is not used						◎	×													
8	Override is used						×	◎													
9	External speed command is not used									◎											Open when external speed command is used
10	Setting for special Speed detector	Pulse coder											◎								Both open in standard TG. (6V/1000rpm, 21V/3500 rpm)
11		(Tachogenerator without brush.												◎							
12	Without output control circuit														◎						Open with output limit (option) standard is short
13	Velocity variable excessive alarm detection limit ±20%															×					Short when velocity variable excessive alarm is ±50%
14	Method of cancelling torque limit	Cancelling condition															◎	×			Used orientation
15		Direct cancelling															×	◎			Used in gear shift
16	Current setting is for Model 15/08																		◎		Open in Model 12/06
17	Connect AC 220/230V of control transformer																			◎	Open when input is AC200V (open in domestic)

(Note) Item 10 and 11 apply to since edition No 13F

(Note) Item since 13 does not apply to 0371/02

SH01 

SH02 

SH03 

For 1909 Lathe

A20B-0005-0371/13F (1909)

(5) Standard Setting

Standard setting for short circuit is as follows

O : Short × : Open

	Unit	Pin	Setting		
	SH01	01-16	O	Orientation is not used	O
		02-15	O	MRDY (Machine ready) is not used	O
		03-14	O	Override is not used	O
		04-13	×		×
		05-12	—	Depends on D/A converter	O
		06-11	O	External velocity command is not used	O
		07-10	—	Depends on D/A converter	×
		08-09	—		O
Note1	SH02	01-02	×	Use the tacho-generafor that rating output voltage is 21V/3500RPM.	×
		02-03	×		×
	SH03	01-02	O	Output limit circuit is not used	O
Note2	SH04	01-02	×	Variable excessive detection limit	×
	SH05	01-02	O	Cancelling of torque limit according to below condition (cancelling of torque limit command). (1) (forward, reverse rotation no command). (2) (speed zero).	O
		02-03	×		×
	SH06	01-02	—	According to P.C.B. specification O 0372/0374 × 0371/0373	O
Note3	SH07	01-02	×	Tap 2 of control transformer TF (input: 200V)	O

Note1. Since PCB edition No 13F needs this setting.
Note2. SH04~07 setting does not apply to edition No 02 of 0371
Note3. Confirm the setting the top of transformer with this SH07 setting.

2.3 Polarity Check

(1) Phase rotation check

Always check the direction of phase rotation U(R) → V(S) → W(T) with a phase rotation indicator.

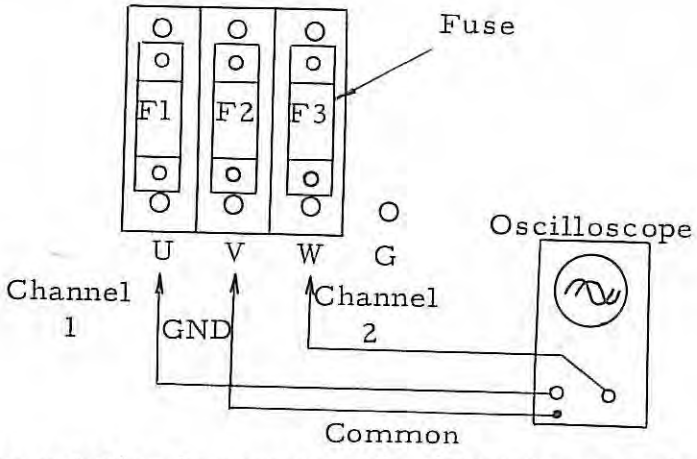
If the direction of phase rotation is reversed, operation can not be performed by means of phase rotation alarm and interlock.

Precautions
Perform the following procedures with caution when there is no phase rotation indicator.

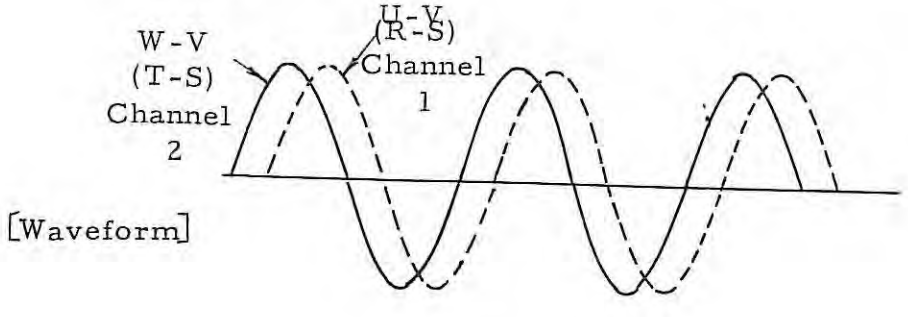
(1) Insulate the oscilloscope from ground during measurement.

(2) Since the oscilloscope itself is at equipotential with the input voltage, do not touch its frame or metal parts. A dual-trace oscilloscope can be used to check phase rotation as follows.

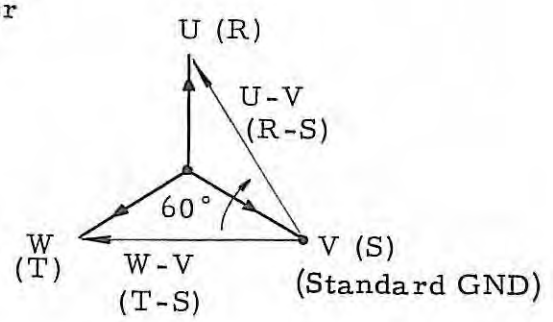
(Measurement locations)



If phase rotation is correct, the following waveform is obtained.

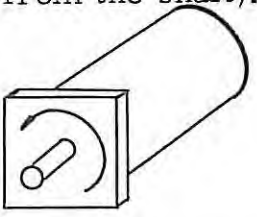
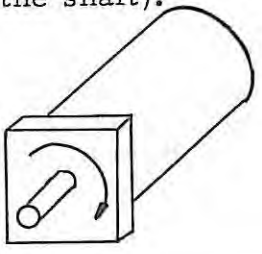


Vector



(2) Checking spindle motor power line connection

Before turning on the power switch check that the DC motor power line polarity is correct as follows.
Check the following items by turning the shaft of the DC motor clockwise or counterclockwise.

No.	Motor Rotation direction	Measuring device	Motor polarity
1	Turn the motor counter-clockwise (as viewed from the shaft). 	Voltmeter or Oscilloscope	Measuring locations (T1-7.8) H — GND (T1-5.6) A — - Voltage
2	Turn the motor clock-wise (As viewed from the shaft). 	Voltmeter or Oscilloscope	Measuring locations (T1-5.6) A — + Voltage (T1-7.8) H — GND

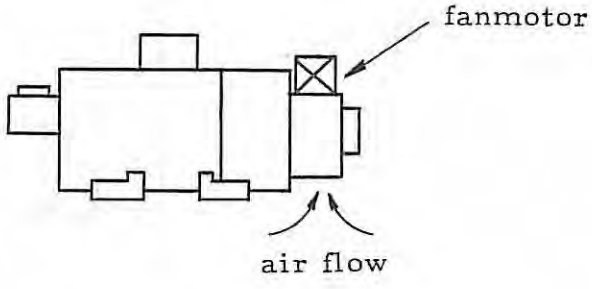
(3) Checking spindle motor field connection

When power is applied, field current is automatically applied. Make the connection in accordance with the J-K label. Check item (2) in this status, and if it has the motor polarity or the polarity shown in Item (2), it is a correct connection.

If it has inverse polarity, the field current is inversely applied, so reverse the connection of J-K.

(4) Confirmation the rotation of fanmoter for heatpipe
Confirm the rotation of fanmotor to cool the heatpipe

in spindle motor

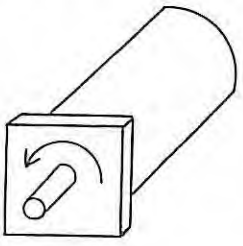
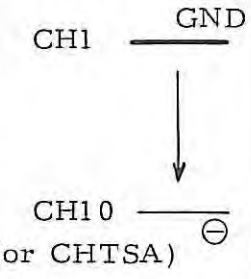
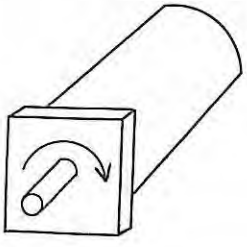
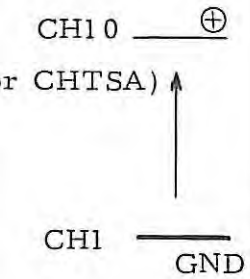


(5) Checking the connection of tachogenerator (T.G) feedback signals

Check the polarity of the T.G feedback voltage in the DC motor as follows with the power on.

This check is made by manually rotating the shaft of the DC motor clockwise and counterclockwise.

If the connection is reversed, be careful because the DC motor runs uncontrolled.

No.	Motor rotation direction	Measuring device	T.G feedback polarity
1	Turn the motor counter-clockwise (as viewed from the shaft) 	Voltmeter or oscilloscope	Measuring locations 
2	Turn the moter clock-wise (as viewed from the shaft) 	Voltmeter or oscilloscope	Measuring locations 

2.4 Adjustment

(1) Dither shift circuit gain adjustment according to power frequency

When switching of 50/60 Hz for PCB 0371/01 Edition Setting No. 14 of 2.5.1 must be also performed.

(2) Adjustment of motor rotation speed and velocity command voltage

When the velocity command voltage and velocity command code (S code) is the maximum, adjust the motor with RV3 so that the rotation speed of the axis has the following value.

Spindle motor	Speed command voltage [V]	Maximum rotation speed [r.p.m]	Adjustment locations
MODEL 6, 8, 12, 15	Measuring point CH12±10V	3500±14 rpm	RV3

Refer to 3.3 for location of variable resistor RV3.

2.5 Reference Material for Adjustment

Since the following adjustment is made at the factory, readjustment is not requireed. Refer to this item for maintenance.

2.5.1 Adjustment

(1) P.C.B A20B-0005-0371/02 (Model 15) (04C～08C edition)

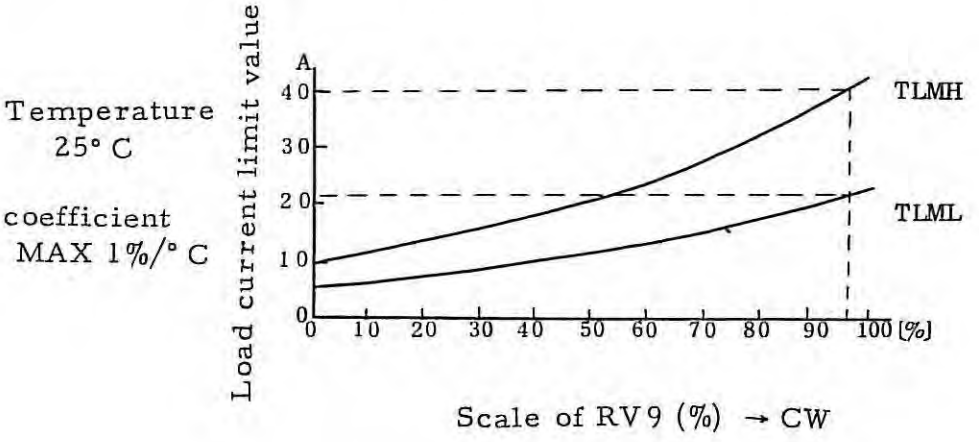
No	Item	Adjusting method	Trimmer	Observation	Standard
1	Velocity command voltage	Turn the all inputs of D/A Converter ON (BCD:S99, CBI:4095)	RV1	CH8 Note 1) (CH12)	+10.0V (±10.0V)
2	Velocity command voltage offset	Turn the all inputs of D/A converter OFF (BCD:S00, CBI:0)	RV2	CH8	0V±5mV
3	Revolution speed	Maximum speed (BCD:S99, CBI: 4095)	RV3	Motor Shaft Note 2)	3500±14rpm
4	Tachogenerator circuit offset	Set at STOP mode Note 4)	RV4	CH10	0V±5mV
5	Caribration of Load meter	Insert the ammeter into armature circuit and flow load current 82A.	RV6	Loadmeter	100%
6	Velocity loop offset	Drive the motor when S00 or 0V	RV7	Motor shaft	No rotation
7	Velocity loop gain	Observe the current wave form driving the motor at light load	RV8	CH14	Small swelling
8	Torque limit	Specifing T LML (or TLMH), drive the motor at low speed and give some load	RV9	Load current or Torque meter	7A~20A Note 3) (10A~40A)
9	Current detect offset	Set at STOP mode Note 4)	RV10	CH14	0V±5mV

No.	Item	Adjusting method	Trimmer	Observation	Standard	
					50Hz	60Hz
10	Current setting	Acceleration/ deceleration at 3500 rpm	RV11	Load current	82A	
11	Current loop phase compensation	Observe the current waveform driving the motor at light load	RV12	CH14	No or Small swell at about 20 Hz	
12	Current loop gain	Observe the current waveform during acc/dec.	RV13	CH14	Current peak value must be less than 6V (Note 5)	
13	Dither shift circuit balance	STOP mode. Adjust the pulse width of high level (Note 6)	RV14a ~ RV14c	CH18a ~ CH18c	1.2ms	1.4ms
14	Synchronous pulse balance	$\tau 1 = \tau 2$ Note 7)	RV15a ~ RV15c	CH17a ~ CH17c	0.95 ~ 1.20ms	0 8 ~ 1.0ms
15	Armature voltage	Drive the motor at 2000 rpm	RV16	Voltage between 5 and 7 of T1	210V	
16	Speed arrival	Specify 3500 rpm and compare with the level of CH10	RV20	Between SAR1-2 of CH1	RV20 (20%) Note 8) 5~50% adjustable	
17	Speed zero	Issue STOP command when motor is rotating about 200 rpm, and compare with CH10	RV21	Between SST1-2 of CN1	RV21 (15%) Note 9) 0.5~3% Adjustable	

Note 1) Strictly speaking, CH12 must become ±10.0V when motor is rotating.

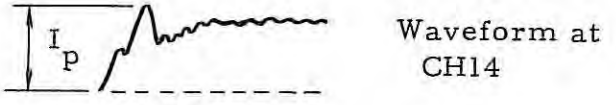
Note 2) Measure actually using tachmeter.

Note 3) Current limit value and scales of RV9

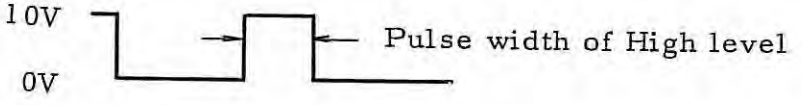


Note 4) STOP mode means that both SFR and SRV are OFF.

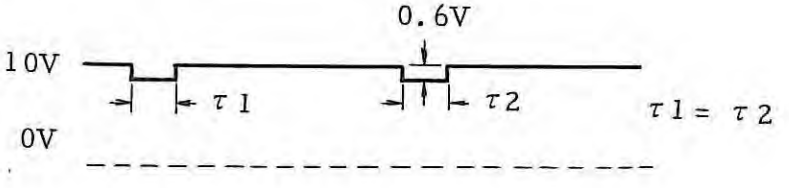
Note 5) Rising current detect (CH14) peak value Ip



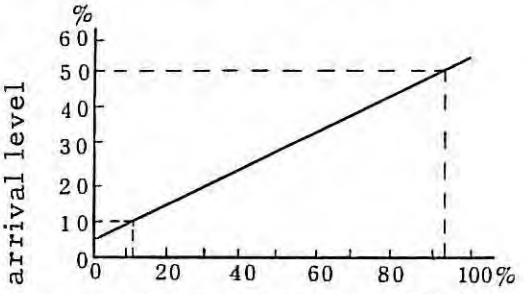
Note 6) CH18 waveform



Note 7) CH17 waveform



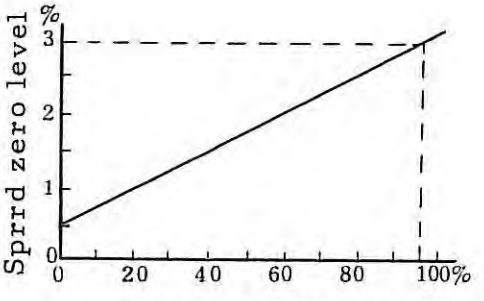
Note 8) Speed arrival level and RV20



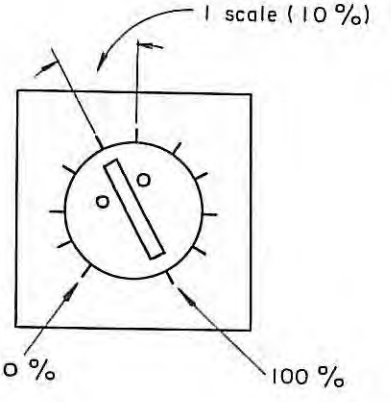
Scale of RV20 →CW

When 3500 rpm is commanded

Note 9) Speed zero level and RV21



Scale of RV21 →CW



(2) P.C.B. A20B-0005-0371/03 for Model 15
0372/03 for Model 12 [only 09D edition]

No.	Item	Adjusting method	Trimmer	Observation	Standard	
					50Hz	60Hz
1	Velocity command voltage	Turn the all inputs of D/A converter ON. (BCD:S99, CBI:4095)	RV1	CH8 Note 1) (CH12)	+10.0V (±10.0V)	
2	Velocity command voltage offset	Turn the all inputs of D/A converter OFF (BCD:S00, CBI:0)	RV2	CH8	OV±5mV	
3	Revolution speed	Maximum speed (BCD:S99, CBL:4095)	RV3	Motor Shaft Note 2)	3500±14rpm	
4	Carribration of Load meter	Insert the ammeter into armature circuit and flow load current [M15]78A[M12]60A	RV6	Loadmeter	100%	
5	Velocity loop offset	Drive the motor when S00 or OV.	RV7	Motor Shaft	No rotation	
6	Velocity loop gain	Observe the current waveform driving the motor at light load.	RV8	CH14	Small swelling RV 8 (70%)	
7	Torque limit	Specifing TLML (or TLMH) drive the motor at low speed and give some load.	RV9	Load current or Torque meter	Note 4) 5A～40A (10A～50A)	
8	Current detect offset	STOP mode	RV10	CH14	OV±5mV	
9	Current setting	Adjust the limited current during acc/dec.	RV11	Load current	Model 12 102A Model 15 120A	
10	Current loop phase compensation	Observe the current waveform driving the motor at light load.	RV12	Scale of RV12	[M15]RV12(35%) [M12]RV12(70%)	

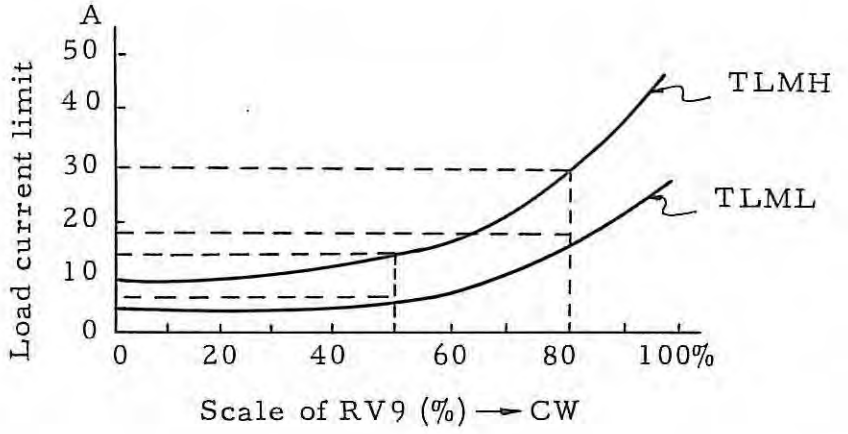
No.	Item	Adjusting method	Trimmer	Observation	Standard	
					50Hz	60Hz
11	Current loop gain	Observe the current waveform during acc/dec.	RV13	Scale of RV13	[M15]RV13(75%) [M12]RV13(55%)	
12	Minimum pulse width (each phase)	Take off the connector CN2, short between CH3 and TSA. Adjust the pulse width of high level (Note 5)	RV14a ~ RV14c	CH18a ~ CH18c	1.2msec	1.4msec
13	Synchronizing pulse balance	Note 6)	RV15a ~ RV15c	CH17a ~ CH17c	0.95 ~ 1.05ms	0.8 ~ 0.9ms
14	Armature voltage	Drive the motor at 2000rpm.	RV16	Voltage between 5 and 7 of T1	220V input is 210V or more	
15	Field coil current	Drive the motor at low-speed (1000rpm)	RV17	Field current	6.8A	
16	Output limit circuit	Drive the motor at higher speed than base speed (1167rpm). And adjust after acc/dec time.	RV18	CH13	Limiting Rate 1/2 2.2V Limiting Rate 1/3 0.87V	
17	Speed arrival detect level	Set this level according to note 7.	RV20	CH28	RV20(20%) 0.5~5V Note 7)	
18	Speed zero detect level	Set this level according to note 8.	RV21	CH29	RV21(15%) 50~300mV · Note 8)	

Note 1) Strictly speaking, CH12 must become ±10.0V when motor is rotating.

Note 2) Measure actually using tach meter.

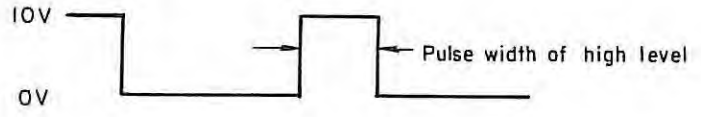
Note 3) STOP mode means that both SFR and SRV and OFF.

Note 4) Relation between limited current and RV9 in torque limit.

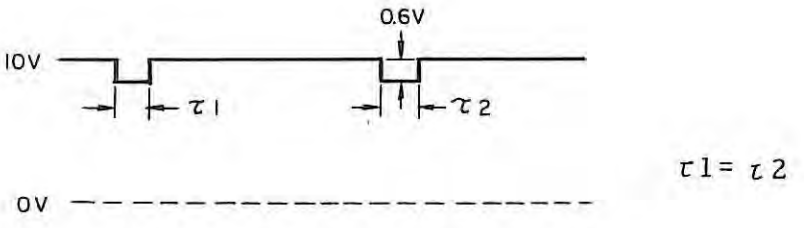


Kint of motor	Standard torque
Model 12	140 Nm (14.3kg f-m)
Model 15	173 Nm (17.6kg f-m)

Note 5) Waveform at CH19

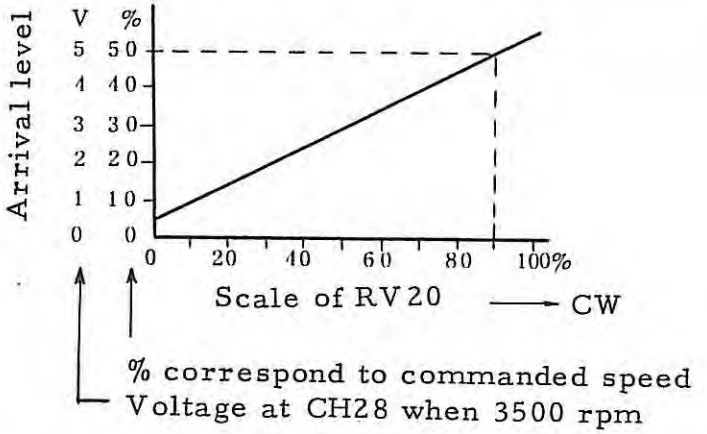


Note 6) Waveform at CH19

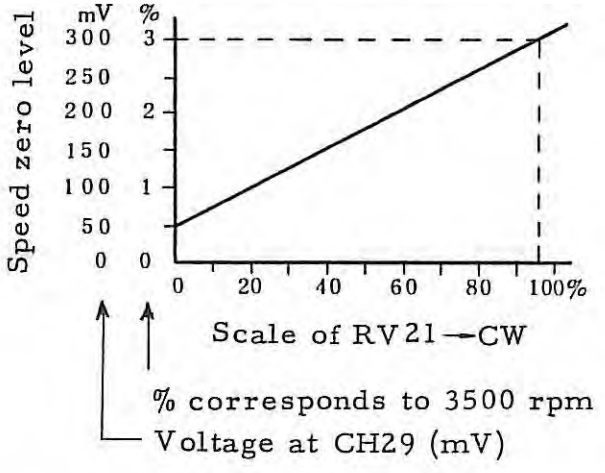


$\tau 1 = \tau 2$

Note 7) Relation between arrival detect level and RV20



Note 8) Relation between Speed zero level and RV21



2.5.2 Adjustment P.C.B

This item apply to P.C.B. A20B-0005-0371～2/04 (for Model 15, 12) and P.C.B. A20B-0005-0373～4/01 (for Model 8, 6) [edition 10E, 11E, 12E and 13F]

(1) In case only P.C.B. is delivered.

P.C.B. is adjusted with unit on shipping time check the below items when connect delivered P.C.B. and another unit or change a P.C.B. (No. 1～ No. 9)

(2) When D/A converter is in external.

It is necessary to adjust offset and velocity command voltage level.

(3) Touch another setting volume in mistake set the P. C. B. according to No. in this item.

No.	Item	Adjusting method	Trim-mer	Obser-vation	Standard 50Hz 60Hz	
1	Velocity command offset	Adjust a difference between voltage of obsavation when com-mand SFR and that when command SRV as N(0) note 1 to standard valve or less by volume	RV2	CH12	±2 mV or less	
2	Current detect offset	In stop mode (note 3)	RV10	CH14	±5mV or less	
3	Speed offset	In stop mode	RV7	CH25	±10mV or less	
4	Synchro-nize circuit balance	Observe and adjust the amplitude of synchronize pulse width by osilloscope (note 4)	RV15a 15b 15c	CH17a 17b 17c	Amplitude is ± 0.1 msec or less	
5	Adjust-ment of minimum palse width	Take off the connector CN2, short between CH3 and TSA. (Note 5) After adjustment take off the connection and connect the CN2. And then return to former condition by push-ing the alarm reset button.	RV14a 14b 14c	CH18a 18b 18c	1.0 ±0.15 ms	1.2 ±0.1 ms

<table>
<tr><th>No.</th><th>Item</th><th>Adjusting method</th><th>Trim-mer</th><th>Obser-vation</th><th>Standard 50Hz 60Hz</th></tr>
<tr><td>6</td><td>Velocity command voltage level</td><td>Commanded SFR, N (3500) and adjust it. Confirm -10.0 +0.02V changing to SRV.</td><td>RV1</td><td>CH12</td><td>10.0 ±0.01V</td></tr>
<tr><td>7</td><td>Rotation speed (rpm)</td><td>Commanded SFR, N (3500) and adjust the spindle speed by tachometer</td><td>RV3</td><td>Spindle</td><td>Standard valve ±0.5% Note 6</td></tr>
<tr><td>8</td><td>Current setting</td><td>Introduce an ammeter in series with motor armature. Connect check terminal (ALM) to OV(CH1) and open a field circuit and perform current setting rapidly. Perform next item in this condition.</td><td>RV11</td><td>Am-meter</td><td><table><tr><th>Motor model</th><th>Current limit</th></tr><tr><td>15</td><td>102A</td></tr><tr><td>12</td><td>85A</td></tr><tr><td>8</td><td>75A</td></tr><tr><td>6</td><td>51A</td></tr></table></td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">Caribration of load meter</td><td>° Standard setting (without output limit option) Adjust the load meter to standard value when limit current flows in an armature.</td><td>RV6</td><td>Load meter</td><td rowspan="2"><table><tr><th>Motor model</th><th>Current limit</th></tr><tr><td>15</td><td>120%</td></tr><tr><td>12</td><td>136%</td></tr><tr><td>8</td><td>178%</td></tr><tr><td>6</td><td>162%</td></tr></table>Full range Model 15.12 150% Model 8.6 200%</td></tr>
<tr><td>° With output limit option adjust the maximum value of indicator in acc/dec.</td><td>RV6</td><td>Load meter</td></tr>
<tr><td>10</td><td>Velocity loop gain</td><td>Standard setting</td><td>RV8</td><td>RV8</td><td>Scale 7</td></tr>
<tr><td>11</td><td>Torque limit value</td><td>Setting torque limit value according to Appendix I</td><td>RV9</td><td>CH30</td><td>Indicate Appendix I</td></tr>
<tr><td>12</td><td>Current loop phase compensa-tion</td><td>Standard setting</td><td>RV12</td><td>RV12</td><td>Scale 5</td></tr>
<tr><td>13</td><td>Current loop gain</td><td>Standard setting</td><td>RV13</td><td>RV13</td><td>Scale 5</td></tr>
</table>

No.	Item	Adjusting method	Trim-mer	Obser-vation	Standard 50Hz 60Hz
14	Armature voltage	Adjust armature voltage of H area in appendix II. Rotation speed is N(2000). Refer to No. 17	RV16	Direct voltage between 5 and 7 of T1	DC 220V
15	Field current	Rotation speed is N (0 ~ 1000). Insert a 10A amm ammeter into a field circuit.	RV17	Indicator of ammeter	6.8A
16	Output limit circuit limit value standard	Command the SFR, N(2000) and adjust it after accelerate time. In case no output limit circuit (option), this adjustment is not useful.	RV18	CH18	Rate of output limit 1/2 2.2V 1/3 0.87V
17	Armature voltage clamp	Adjust armature voltage of L area in Appendix II. Adjust it after conformation the input voltage. Open SH07 when input tap of control transformer TF is set 2(200V) or short SH07 when input tap of control transformer TF is set 3(230V). Rotation speed is set N(2000)	RV19	Direct voltage between 5 and 7 of T1	Refer to Appendix II
18	Speed arrival detecting level	Set this according to Appendix III. Setting value is based on request of user.	RV20	CH28	Refer to Appendix III (Note 8)
19	Speed zero detecting level	Set this according to Appendix IV. Setting value is vased on request of user.	RV21	CH29	Refer to Appendix IV (Note 9)
Next item applies to edition No 13F.					
20	Speed detecting level	This adjusts the speed detecting level which enable to chang gear and clutch. Adjustable range 50rpm (0.14V)~2500rpm(7.14V) In unusing clutch and gear It is not necessary to adjust.	RV4	CH9	using clutch 3.0V using gear 0.3V.

Note

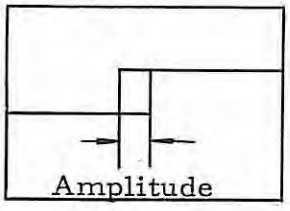
1) N (****) ..... Value in a parenthesis shows rotation speed of motor shaft in R.P.M.

   ex. S99 (S 2 digit) ..... N (3500)
   S00 ..... N (oc)

2) SFR ..... Motor forward rotation (CCW) command
   SRV ..... Motor reverse rotation (CW) command

3) Stop mode ... Condition that both SFR and SRV is OFF.

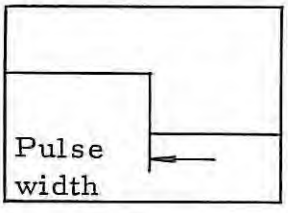
4) Amplitude of synchronize pulse width.



AC range

0.2V/div (vertical range)
0.2ms/div (horizontal range)

5) CH18 waveform.



DC range

2V/div (vertical range)
0.2ms/div (horizontal range)

6) Standard value

   Standard value correspond to motor shaft rotation speed 3500 rpm. If adjust actually spindle rotation, replace standard value by value corresponding to gear ratio.

7) Readjust No. 2 if adjustment of No. 8 is performed.

   In check limit current value at overload, apply heavier load to grow speed error in 100 rpm or more. Confirm setting of SH06 (Model 6, 12..... open, Model 8, 15 ..... short).

8) Standard value

   <Condition> N 3500 command SFR <Standard> 1.5 ± 0.1V
   (Corresponding to 15%)

9) Standard value

   <Condition> free <Standard> 75mV (0.75% $\fallingdotseq$ 26 rpm)

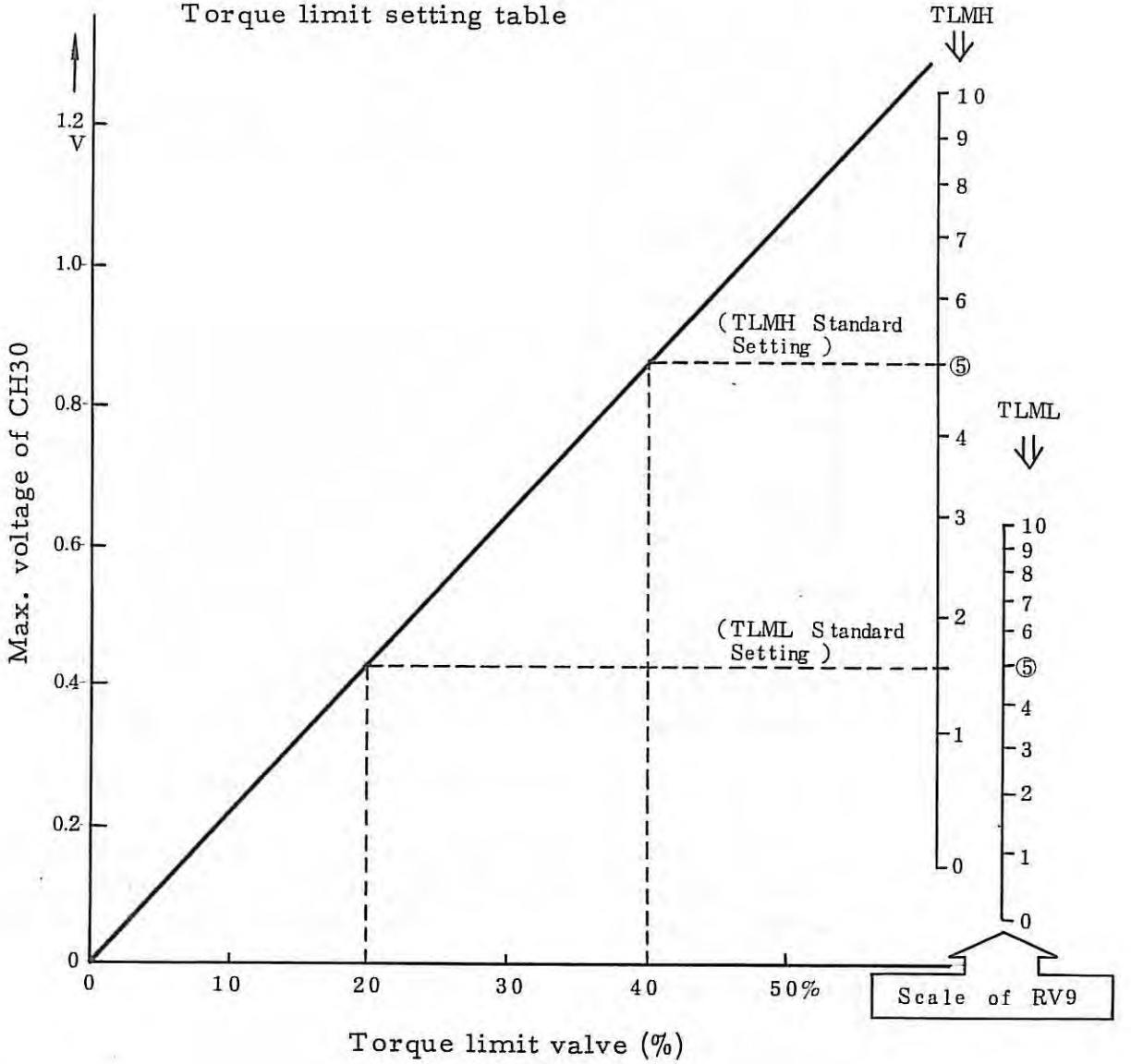
Appendix I Torque limit setting

Adjust torque limit value according to below drawing by scale of RV9. Limit torque is decided by adjusting voltage of CH30 in torque limit operation by RV9.

$$\frac{\text{Limit current [A]}}{\text{k Coefficient}} = \text{Percentage}$$

Motor	15	12	8	6
k	0.85	0.71	0.63	0.50

Torque limit setting table



Appendix II Armature voltage characteristic

Armature voltage setting value in armature voltage constant control operation area controls as function of input power voltage such below drawing.

Adjustment at shipping time

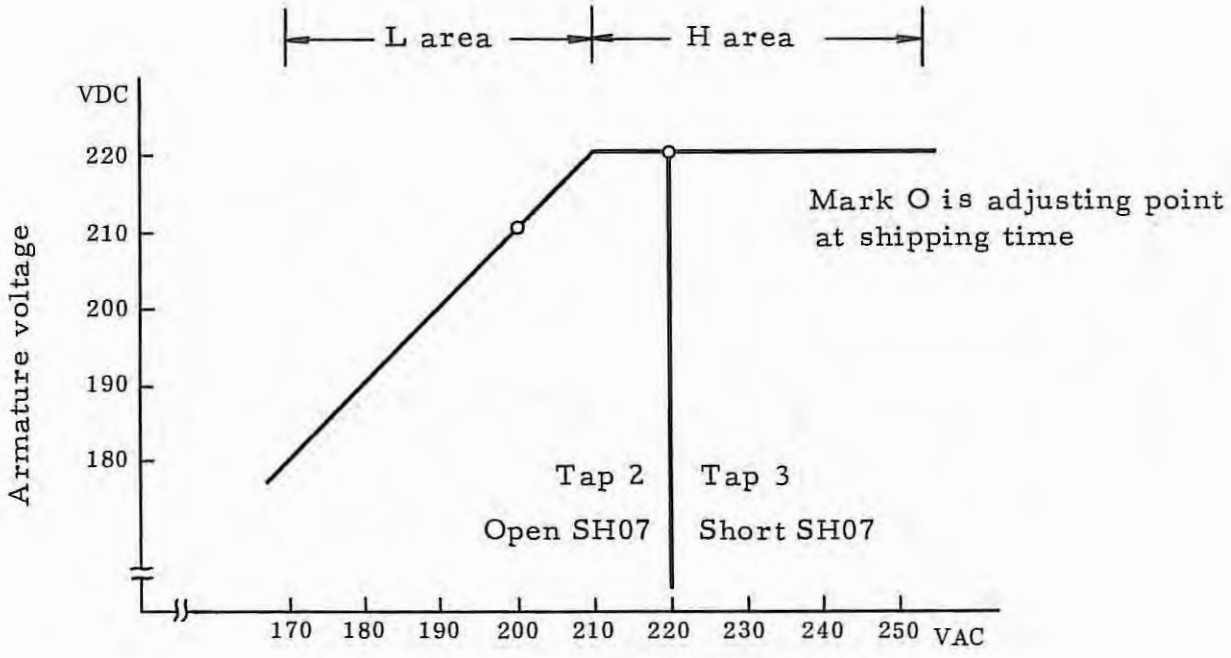
1) Setting the armature voltage to 220V for 220V by RV16.

2) Setting the armature voltage to 210V for 200V by RV19.

At constallation and adjustment, confirm a input voltage and set it to +20% of value in below graph. Adjusting volume is RV16 in H area or RV19 in L area.

Precaution)

Change a input tap (2 or 3) of control transformer according to nominal input power voltage. And then open or short always short circuit SH07.



Appendix III Speed arrival range

Adjust speed arrival range according to below drawing by scale of RV20. If adjust strictly it, depend on below process.

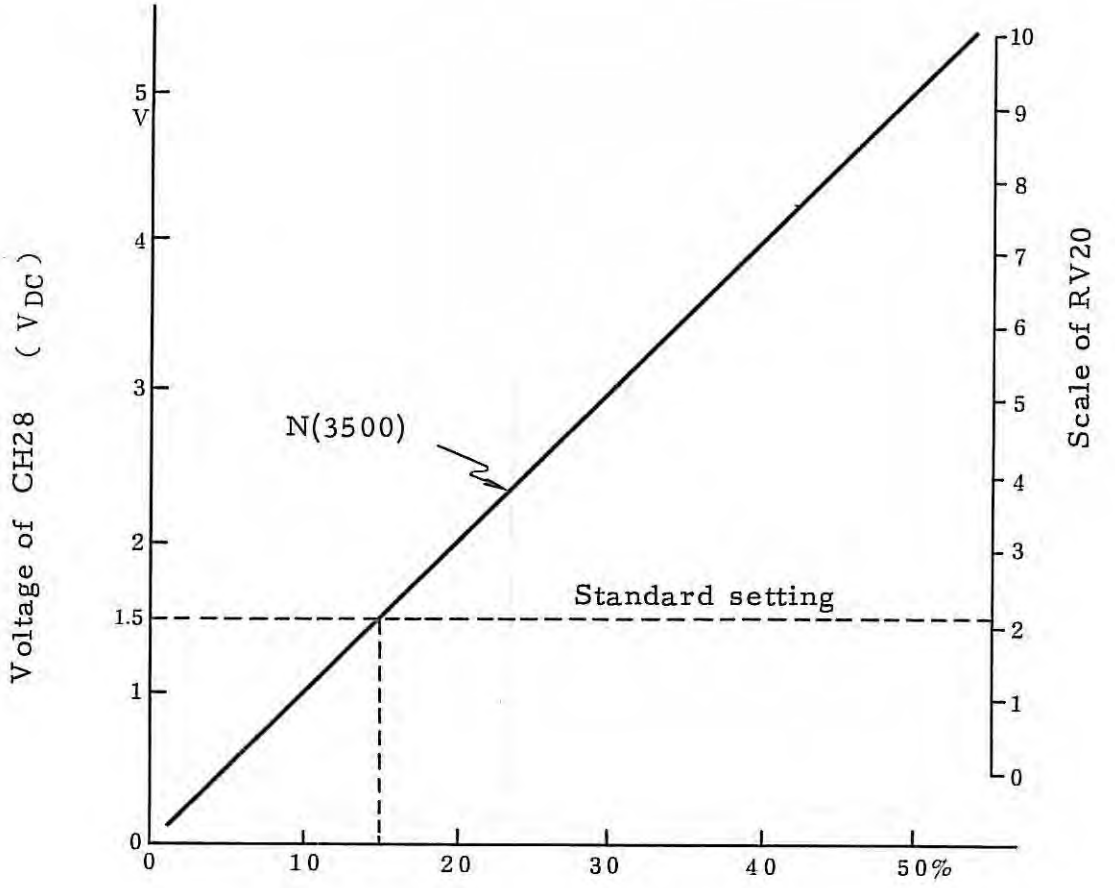
[Process]

1) Command N (3500) and SFR (or SRV)

2) Adjust voltage of CH 28 to voltage value from below drawing.

Precaution)

It command low rotation, speed arrival range extend. But there is no influence in N (3500) or more.



Speed arrival range (%)

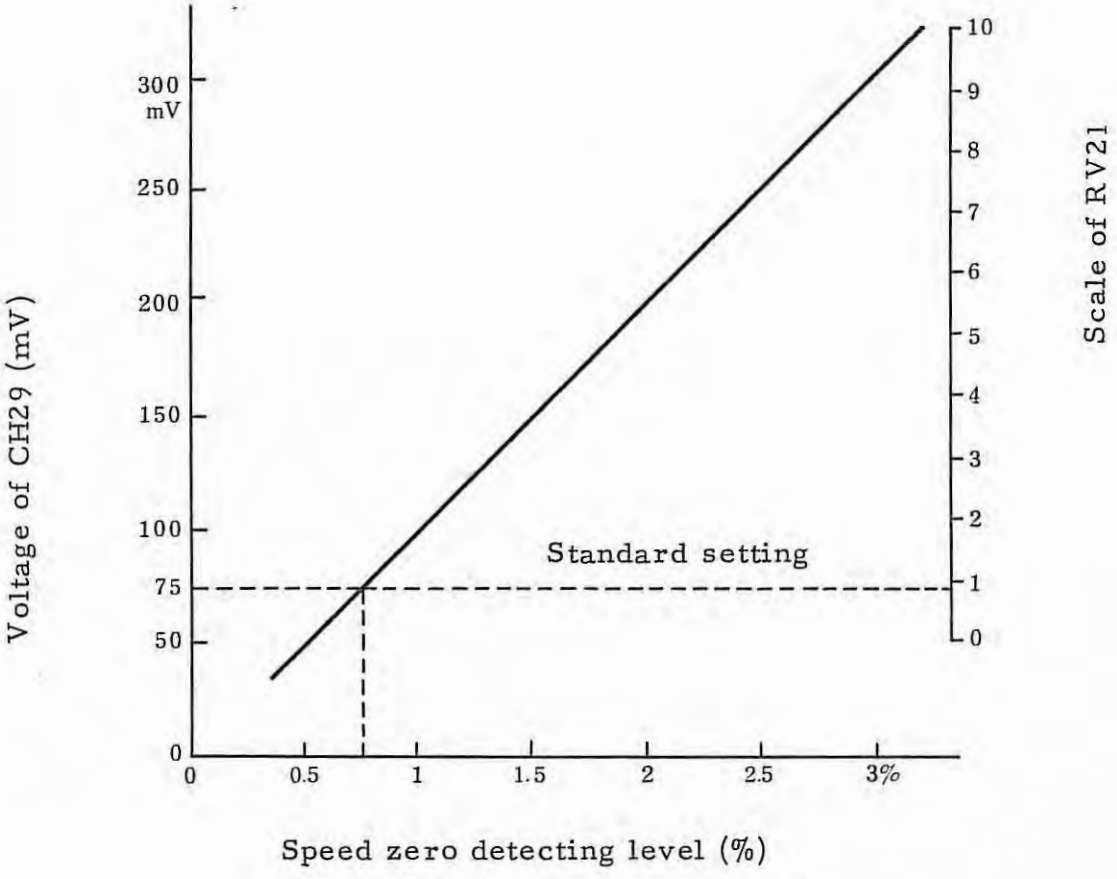
Percentage for command speed

Appendix IV Speed zero detecting level

Adjust speed zero detecting level according to below drawing by scale of RV21. If adjust strictly it, depend on below process.

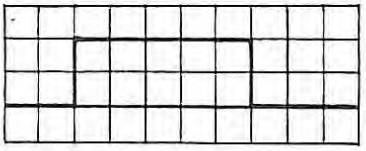
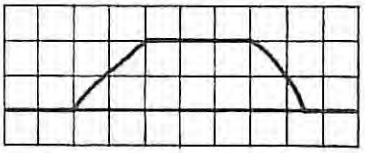
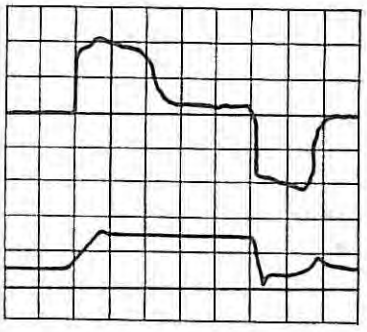
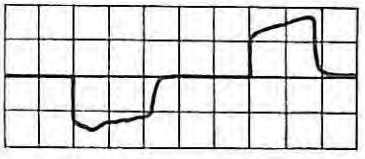
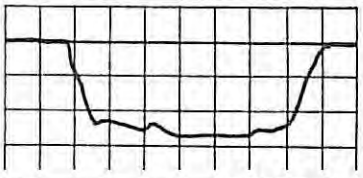
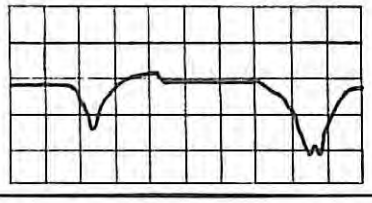
[Process]

Adjust voltage of CH29 to voltage value from below drawing.



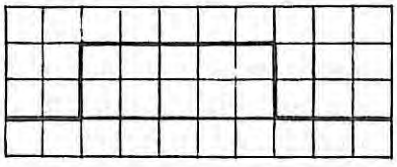
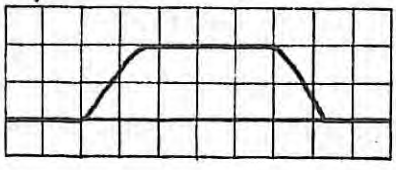
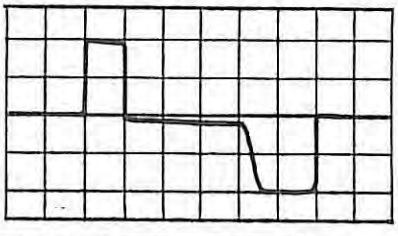
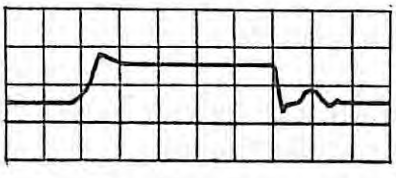
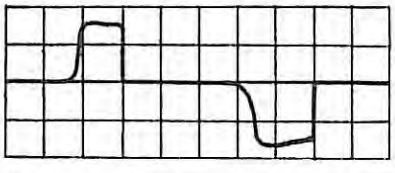
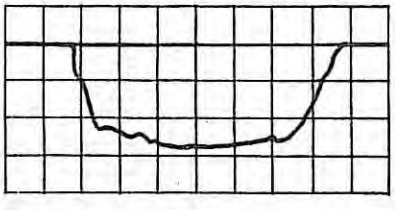
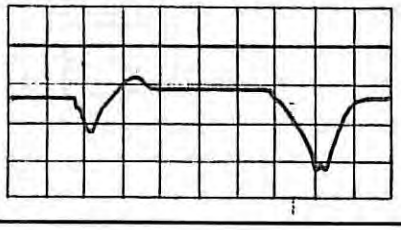
2.5.3 Waveforms

(1) Waveforms at check terminals (Edition 02) Model 15

Waveform name	Acceleration and deceleration waveform	Check terminal	Measurement condition
Velocity command voltage		CH12	N: 3500 rpm Range: 5V/div TIME: 1.0 sec/div
Velocity feedback voltage waveform		CH10	Voltage range (Volume standard setting)
Armature current waveform		CH14	N: 3500 rpm Voltage range: 20V/div TIME : 1.0sec/div
ER voltage waveform		CH15	N: 3500 rpm Voltage range: 5V/div TIME: 1.0sec/div
Current command waveform		CH25	N: 3500 rpm Voltage range: 5V/div TIME: 1.0sec/div
Armature voltage waveform		CH20	N:3500 rpm Voltage range: 2V/div TIME: 1.0 sec/div
Field current waveform		CH19	

(2) Waveforms at check terminals (Edition 03) [Model 15 / Model 12]

A20B-0005-0373~4

Waveform name	Acceleration and deceleration waveform	Check terminal	Measurement condition
Velocity command voltage		CH12	N: 3500 rpm Range: 5V/div TIME: 1.0 sec/div Voltage range (Volume standard setting)
Velocity feedback voltage waveform		CH10	
Armature current waveform		CH14	N: 3500 rpm Voltage range: 20V/div TIME : 1.0sec/div
ER voltage waveform		CH15	N: 3500 rpm Voltage range: 5V/div TIME: 1.0sec/div
Current command waveform		CH25	N: 3500 rpm Voltage range: 5V/div TIME: 1.0sec/div
Armature voltage waveform		CH20	N: 3500 rpm Voltage range: 2V/div TIME: 1.0 sec/div
Field current waveform		CH19	

2.6 Spindle Servo Unit Alarm Display

1. A20B-0005-0371/02 (For Model 15)

The meaning of each alarm is as follows.

(1) OVL alarm ..... Spindle motor overload detection

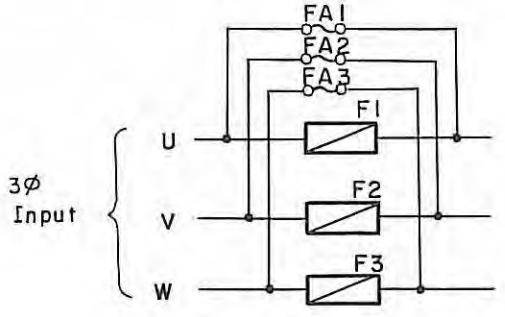
When operated for a long time in an overloaded condition, an alarm is displayed. The spindle motor brakes with the dynamic brake and the spindle decelerates. To reset this alarm, press the OLR reset button.

(2) OH alarm ..... Spindle motor overheat detection

When the temperature inside the spindle motor exceeds the regulated value (100°C), an alarm is displayed. The spindle motor brakes with the dynamic brake and decelerates. This alarm is not reset until the temperature within the spindle motor is less than the regulated value (automatic reset).

(3) FA alarm ..... Fuse alarm detection

When a three-phase input fuse is blown, an alarm is displayed.
However, the alarm fuses FA1 to FA3 also display.
When the servo unit is operated again, replace 3Ø fuse 100A and alarm fuse 1.3A.
3Ø input



(4) SA1 alarm ..... T.G disconnection alarm

Speed error excess alarm display

(1) Indicates when T.G disconnection.

(2) With velocity command voltage output, alarm indication is given when an error excedes 700 rpm in the spindle motor rotation command speed.

When this alarm is issued, the spindle motor brakes with the dynamic brake.

Alarm reset is possible by external input of the alarm reset signal (connector CN1 19-20 pins are shorted)or with the alarm reset switch on the printed circuit board.

(5) SA2 alarm ..... Overcurrent detection and field loss detection

(1) When a current 2.5 times as large as the maximum current allowed in the motor is applied, an alarm is displayed.

(2) When a field coil or field connection cable are disconnected, an alarm is displayed.

The alarm can be reset in the same manner as SA1.

2. Alarm of PCB A20B-0005-0371～2/04 (Model 15, 12)
A20B-0005-0373～4/01 (Model 8, 6)

(1) LED1 ..... (OVER SPEED)
When spindle speed reached 115% of Maximum spindle speed (3500 rpm).
(TACH LOSS)
Disconnection or short circuit of Tach generator signal lines.

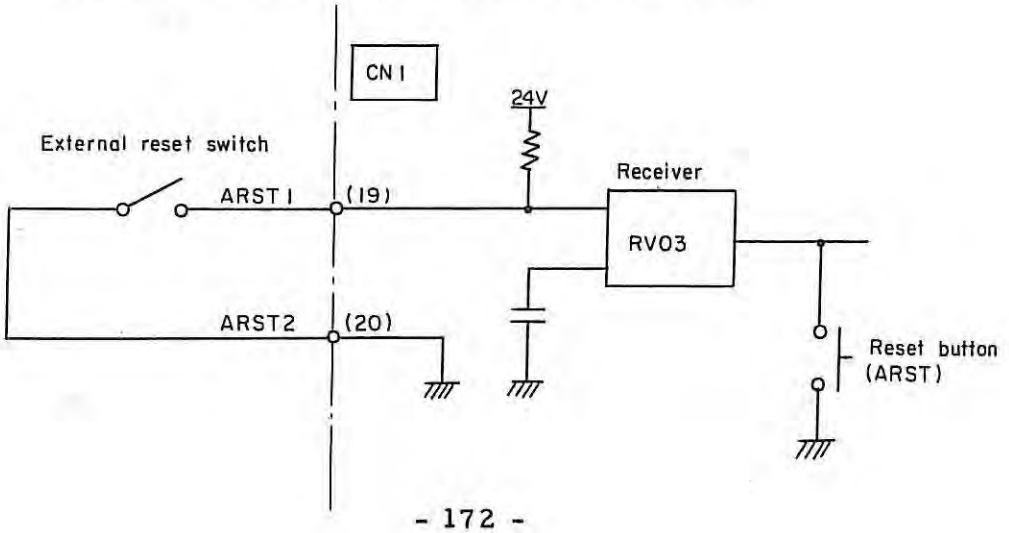
(2) LED2 ..... (OVER CURRENT)
When the motor current exceeds 2.5 times as large as set value, this alarm occurs.
(FIELD LOSS)
Disconnection of field coil or abnormal fall of field coil current.

(3) LED3 ..... (ERROR EXCESS)
When spindle speed becomes lower than 50% of Maximum spindle speed or when spindle motor is stopped by overload.
(PHASE SEQUENCE)
When phase rotation of AC input voltage is not correct.

(4) LED4 ..... (OVER HEAT)
When motor inside temperature exceeds 120°C.
(OVER LOAD)
When motor is driven with overload for a long time.

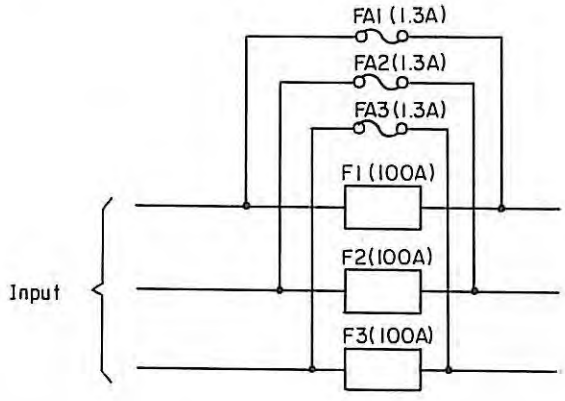
Dynamic brake is applied to the motor if any of above alarms is generated.

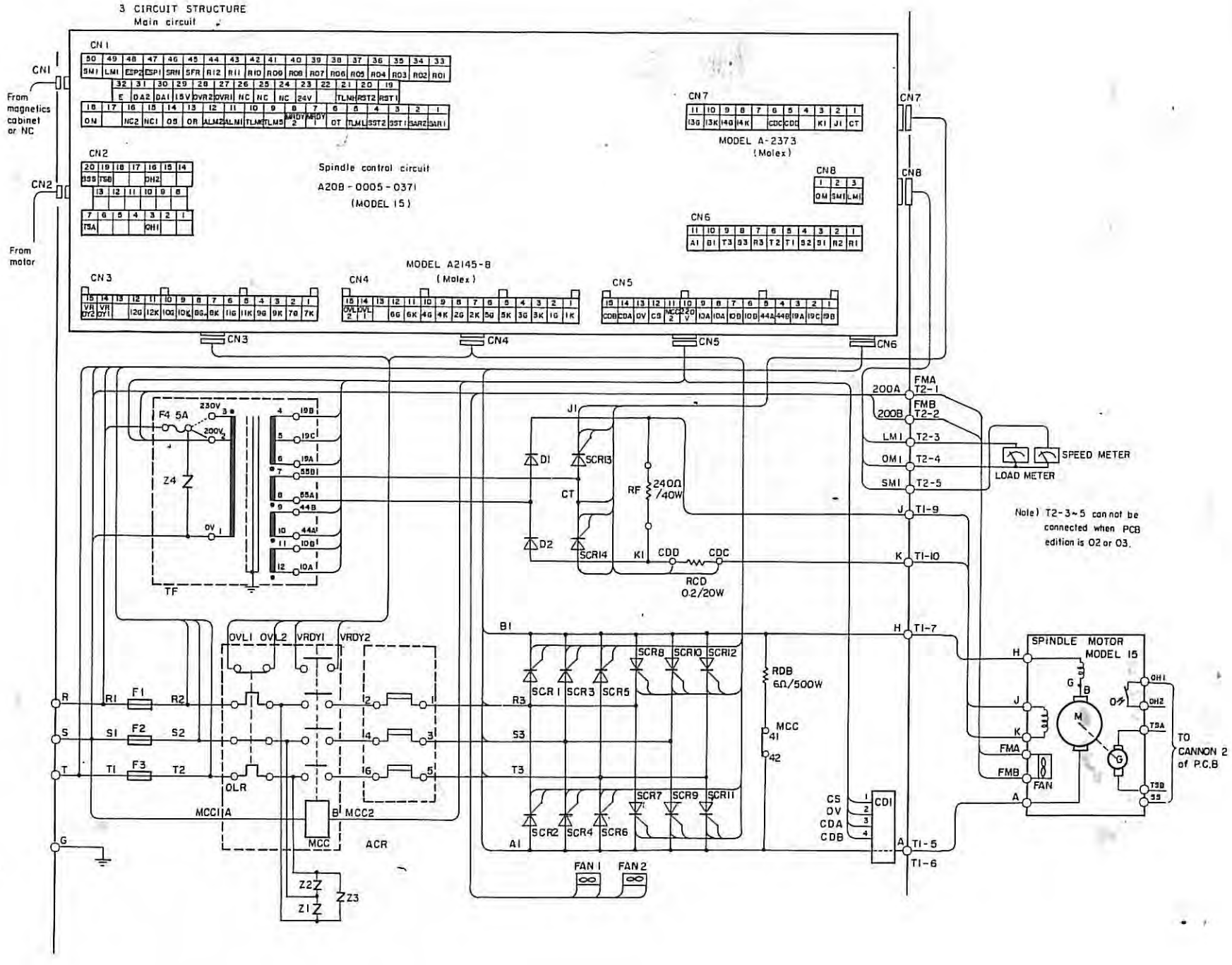
Alarm (1)~(3) can be reset by reset button or shortcircuit between CN1 (19)-(20) (external reset input).



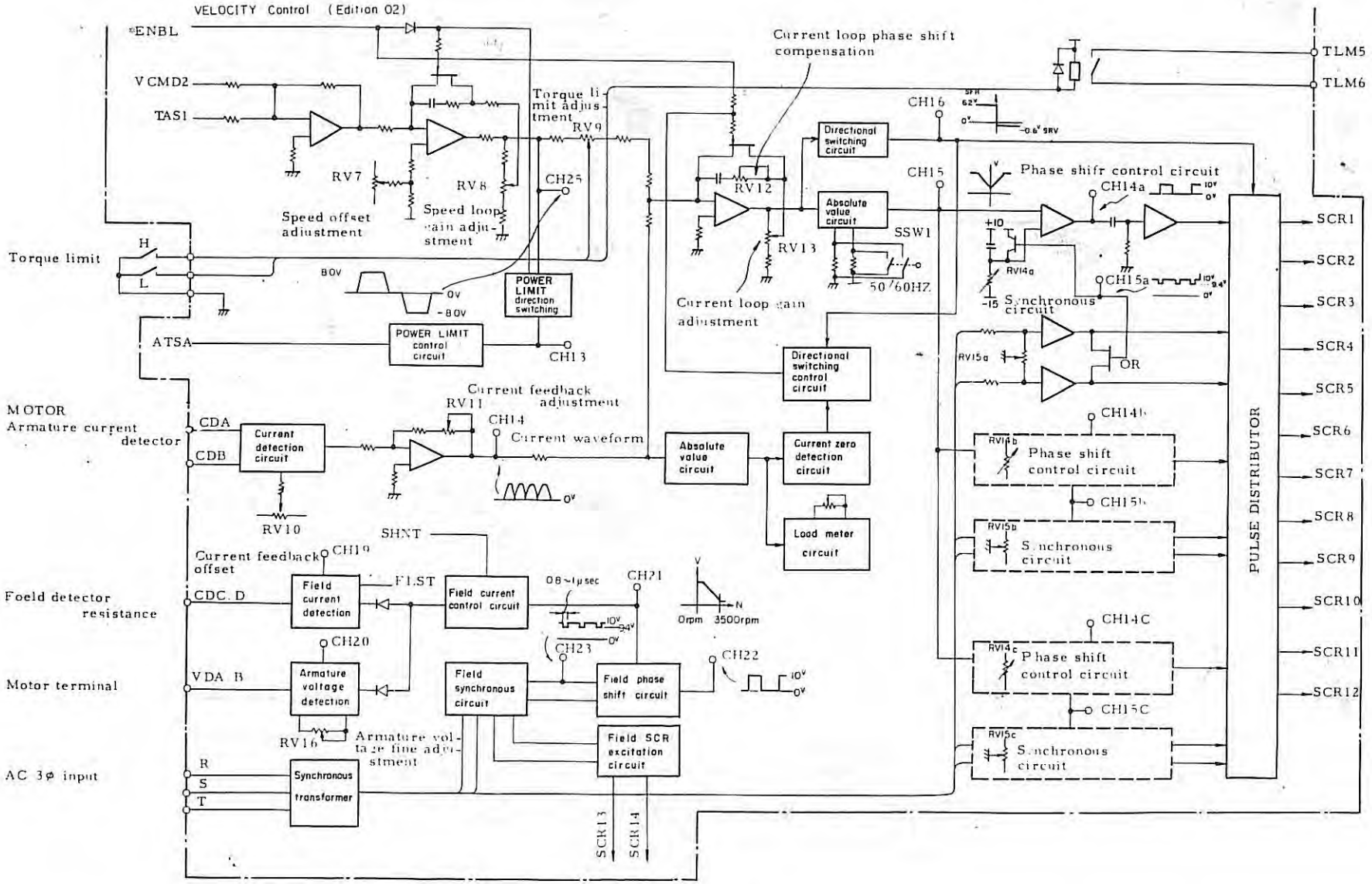
Alarm (4) is reset when motor temperature become less than 120°C or by depressing reset button of thermal switch

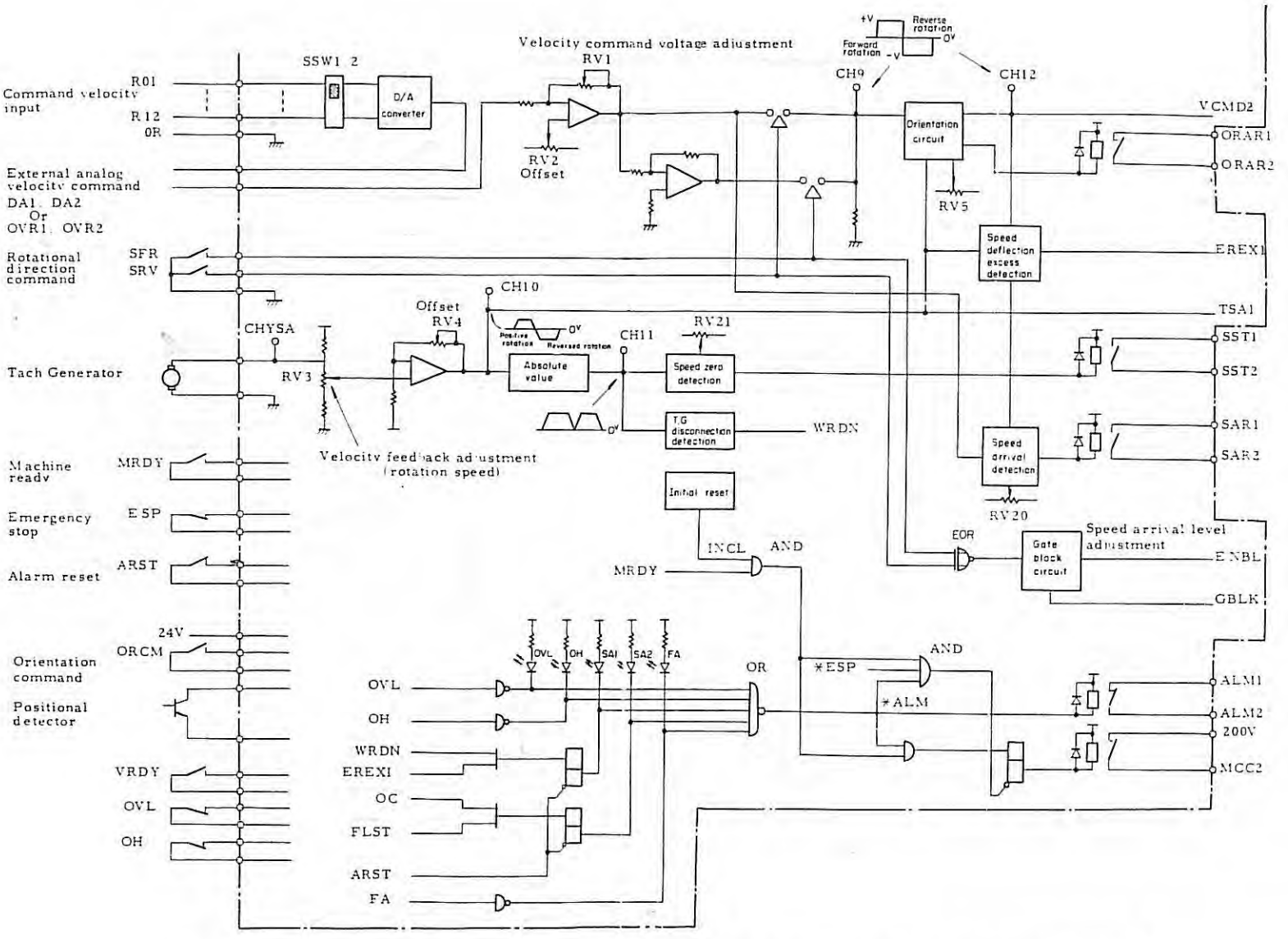
(5) FA1~3 .... (FUSE ALARM)
When fuse blows. FA1~3 indicates Fuse blow.
To start driving replace F1~3 (100A) and
FA1~3 (1.3A)



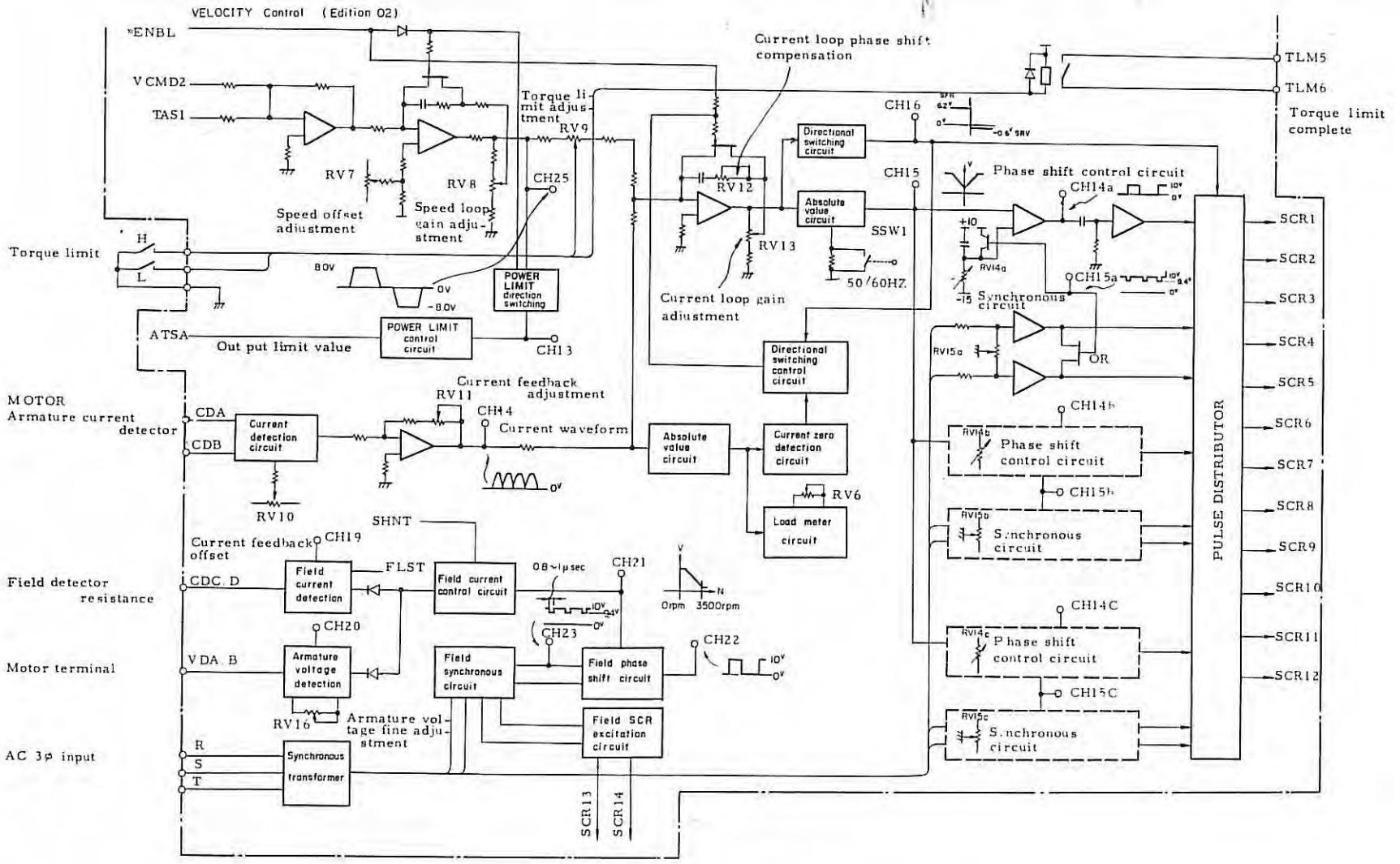

3 CIRCUIT STRUCTURE
Main circuit
CN1
From magnetics cabinet or NC
CN2
From motor
Spindle control circuit
A20B-0005-0371
(MODEL 15)
MODEL A2145-B
(Molex)
CN3
CN4
CN5
CN6
CN7
CN8
MODEL A-2373
(Molex)
CN7
CN8
CN6
CN3
CN4
CN5
CN6
F4 5A
230V
200V
Z4
0V
TF
19B
19C
19A
55B
55A
44B
44A
10B
10A
J1
D1
SCR13
CT
RF 240Ω /40W
D2
SCR14
K1
CDD
CDC
RCD 0.2/20W
B1
A1
SCR1
SCR3
SCR5
SCR2
SCR4
SCR6
SCR8
SCR10
SCR12
SCR7
SCR9
SCR11
RDB 6Ω/500W
MCC
41
42
OVL1
OVL2
VRDY1
VRDY2
R
S
T
G
R1
S1
T1
F1
F2
F3
R2
S2
T2
OLR
MCC1A
MCC2
MCC
ACR
Z2
Z1
Z3
R3
S3
T3
FAN1
FAN2
CS
OV
CDA
CDB
CD1
200A
200B
LMI
OMI
SMI
FMA T2-1
FMB T2-2
T2-3
T2-4
T2-5
J
K
T1-9
T1-10
H
T1-7
A
T1-5
T1-6
SPEED METER
LOAD METER
Note) T2-3~5 can not be connected when PCB edition is 02 or 03.
SPINDLE MOTOR MODEL 15
H
J
K
FMA
FMB
A
G
B
M
G
FAN
OH1
OH2
TSA
TSB
33
TO CANNON 2 of P.C.B

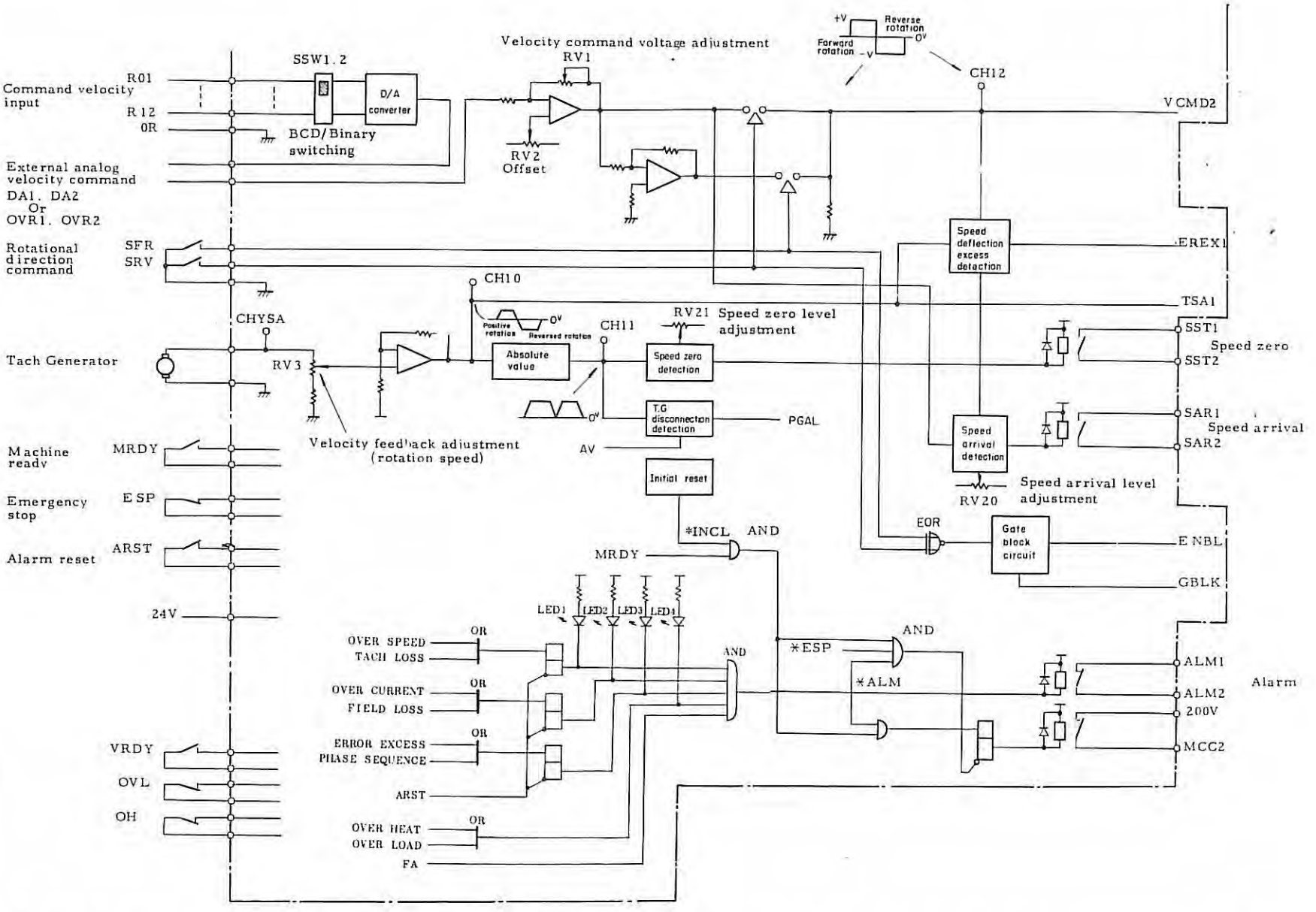
3. CIRCUIT STRUCTURE





Printed circut board, block diagram I (Spindle control section) Edition 02

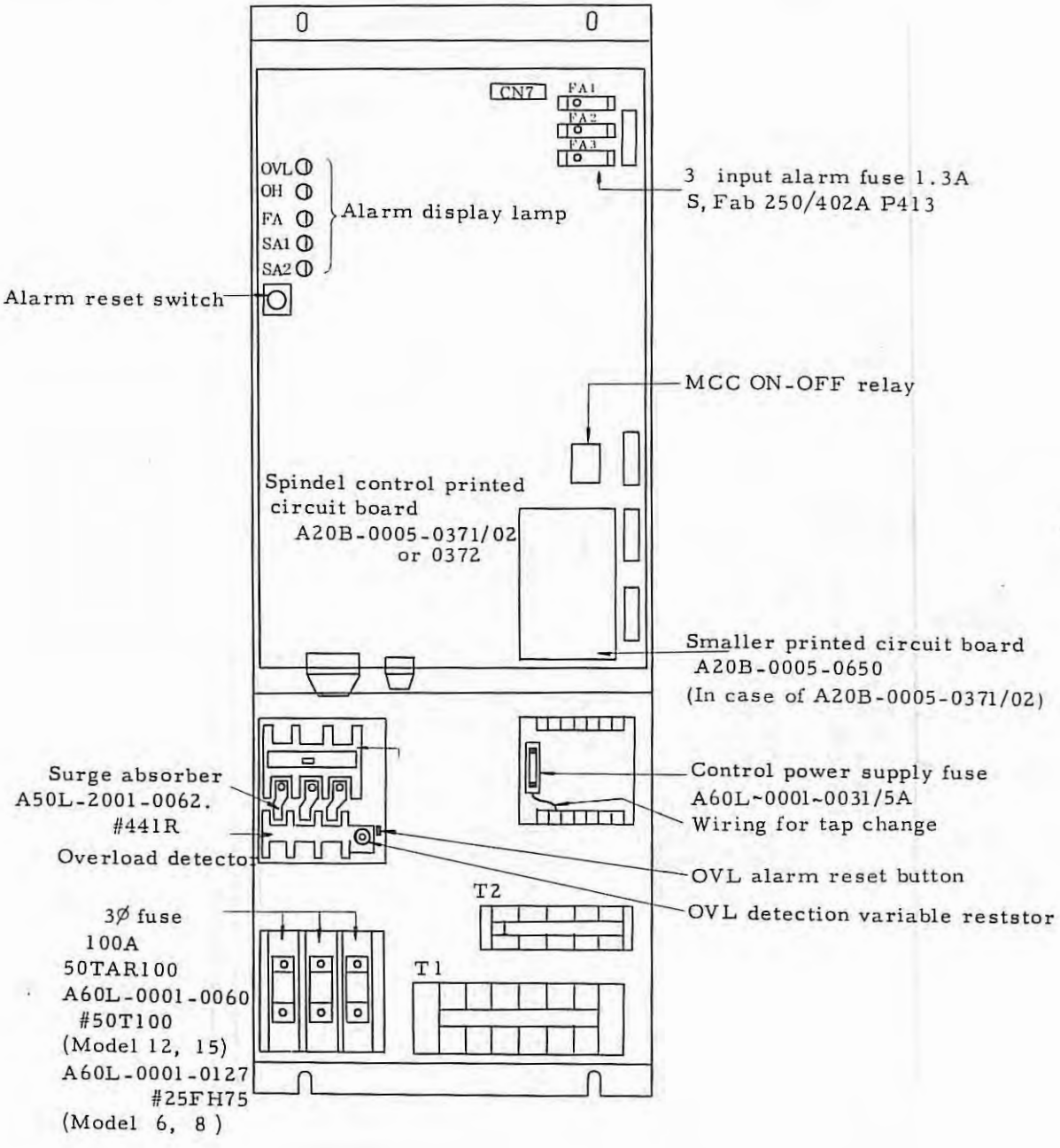

VELOCITY Control (Edition 02)
*ENBL
VCMD2
TAS1
RV7
RV8
Speed offset adjustment
Speed loop gain adjustment
Torque limit adjustment
RV9
CH25
Torque limit
H
L
80V
0V
-80V
POWER LIMIT direction switching
ATSA
Out put limit value
POWER LIMIT control circuit
CH13
Current loop phase shift compensation
RV12
RV13
Current loop gain adjustment
Directional switching circuit
Absolute value circuit
SSW1
50/60HZ
CH16
CH15
Phase shift control circuit
CH14a
CH15a
Synchronous circuit
OR
RV15a
Directional switching control circuit
MOTOR
Armature current detector
CDA
CDB
Current detection circuit
RV10
RV11
Current feedback adjustment
CH14
Current waveform
Absolute value circuit
Current zero detection circuit
RV6
Load meter circuit
CH14b
RV14b
Phase shift control circuit
CH15b
RV15b
Synchronous circuit
SHNT
Current feedback offset
CH19
Field detector resistance
CDC. D
Field current detection
FLST
Field current control circuit
0.8~1μsec
CH21
CH23
0rpm
3500rpm
CH14C
RV14c
Phase shift control circuit
CH15C
RV15c
Synchronous circuit
CH20
Motor terminal
VDA. B
Armature voltage detection
Field synchronous circuit
Field phase shift circuit
CH22
RV16
Armature voltage fine adjustment
Field SCR excitation circuit
AC 3φ input
R
S
T
Synchronous transformer
SCR13
SCR14
PULSE DISTRIBUTOR
SCR1
SCR2
SCR3
SCR4
SCR5
SCR6
SCR7
SCR8
SCR9
SCR10
SCR11
SCR12
TLM5
TLM6
Torque limit complete



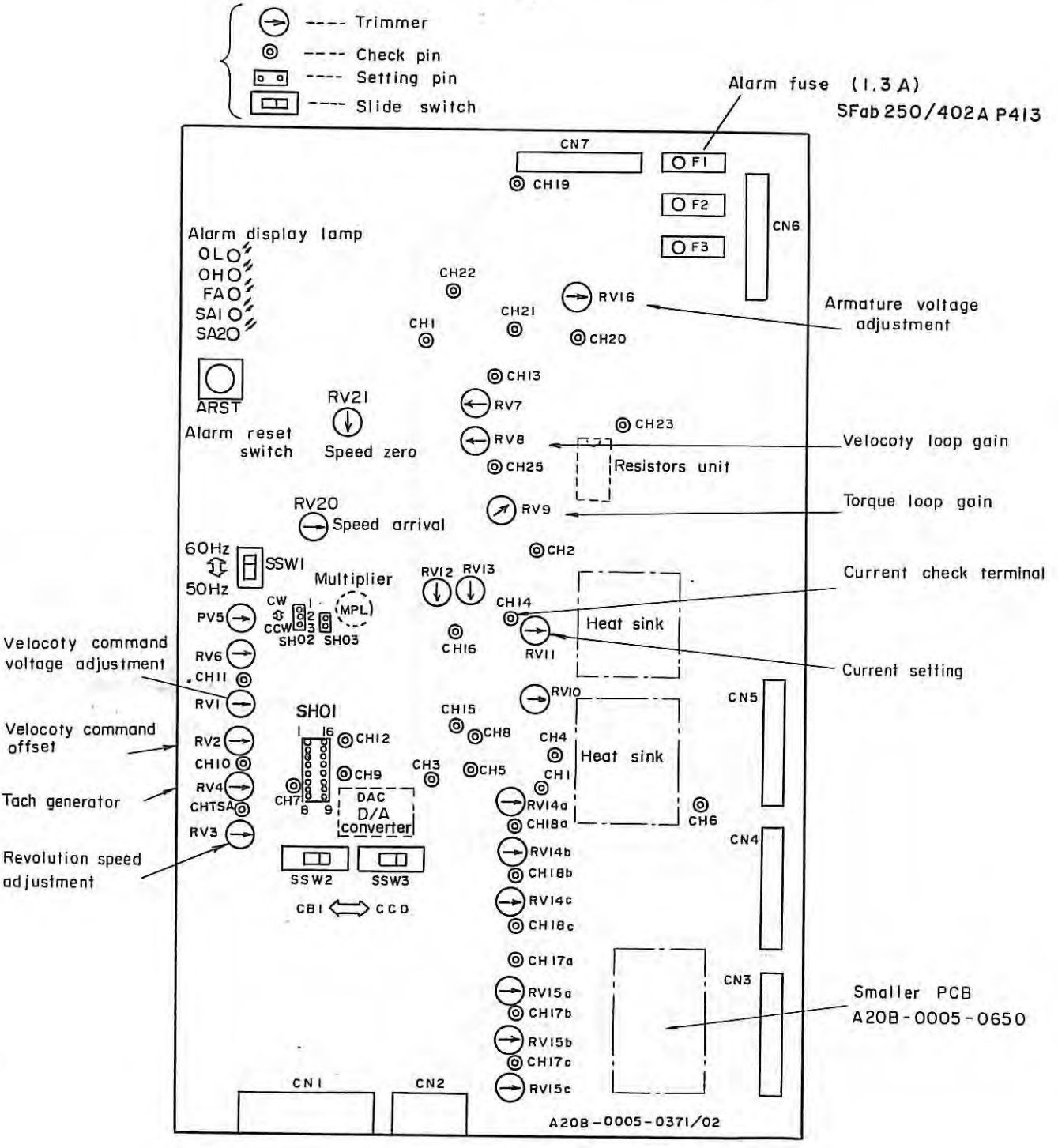
Printed circuit board, block diagram I (Spindle control section) Model 6, 8, 12, 15 371 ~ 2/04
373 ~ 4/01

4. PARTS ARRANGEMENT DIAGRAM

4.1 Spindle Servo Unit

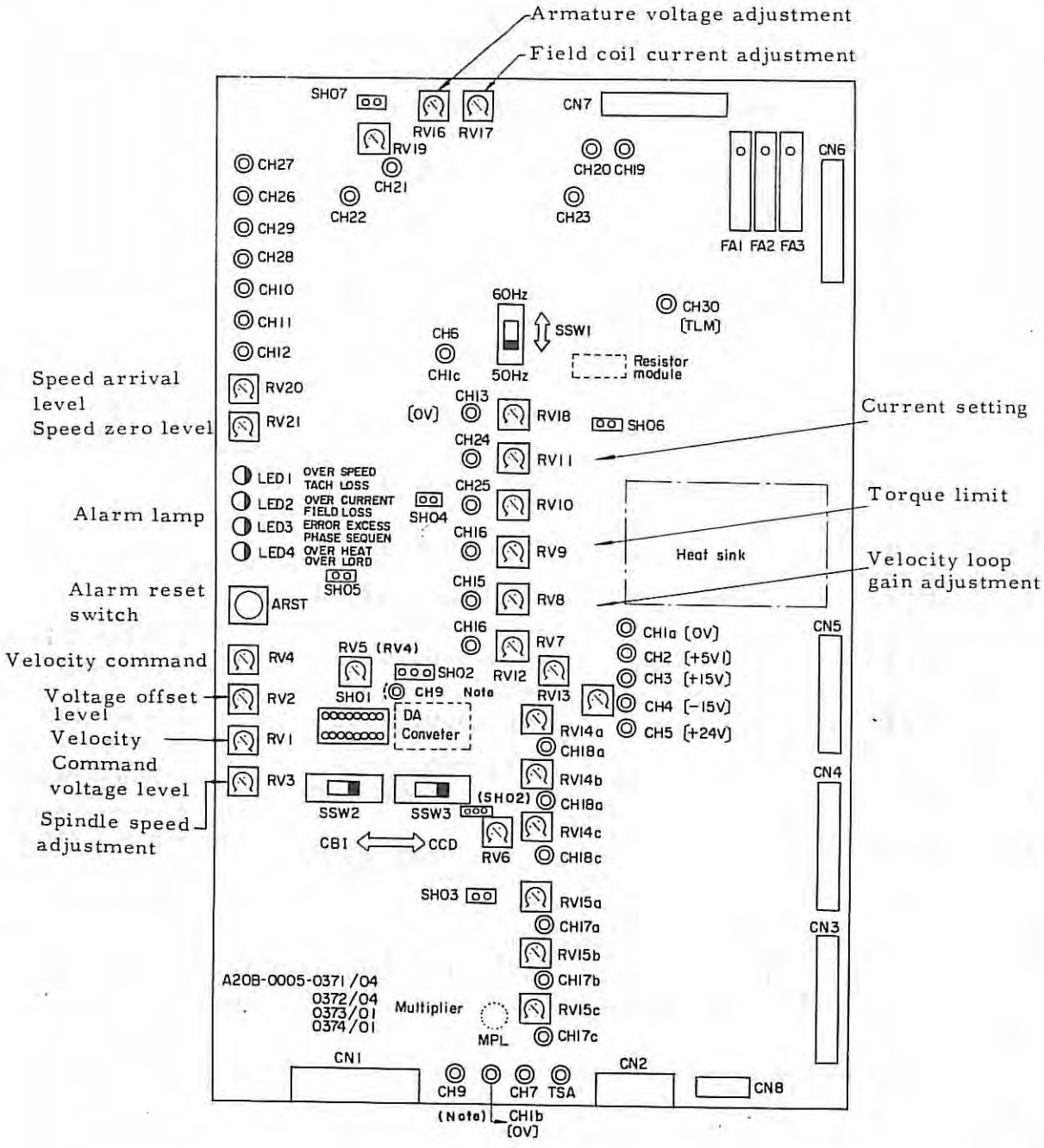


4.2 Spindle Control Printed Circuit Board (0371/02) (only for Model 15)



4.3 Spindle Control P.C.B

0371 2/04 (Model 15, 12)
0373 4/01 (Model 8, 6)



Note Mounting positions of RV5, RV4, SH02, and CH9 are diferent between edition No 10 12E and 13F
In edition No 13F . RV5 is not mounted.

1-888 FANUC US
326 8287 Repair 847-898-5025
#1,173.00
PCB A20B-0008-0371/02 OSD-

4.4 Parts List for Servo Unit (Model 12, 15)

No.	Symbol	Name	Specification	Remarks
1	P.C.B	P.C.B	A20B-~~0005~~ 0008-0371~2	A20B-0005-0371/13F
2	F1~3	Fuse	A60L-0001-0060#50T100	Nippon International
3	F4	"	A60L-0001-0031/5A	Toyo Fuse
4	MCC	Magnetic contactor	A58L-0001-0092	Fuji Electric
5	ACR	AC reactor	A81L-0001-0030	Tamura
6	TF	Control transformer	A44L-0001-0072	"
7	CD1	Current detector	A44L-0001-0069	Nana Electronics
8	SCR1~12	Thyristor	A50L-5000-0014	
9	SCR13~14	"	A50L-5000-0006/A	
10	D1~2	Diode	A. G1820B (S20C)	
11	FAN1~2	Fan motor	A90L-0001-0043	Nihon Servo CT360E
12	RDB	Resistor	A40L-0001-0064	Iwaki Musen
13	RF	"	A40L-0001-0066 /40SH200K	200Ω/40W
14	RCD	"	" /20SH0R2F	0.2 /20W
15	SK	Spark killer	S2 - A	Fujitsu
16	Z1~4	Surge absorber	A50L-2001-0062/441-12	Fuji Electric
17				
18				
19				

Cooper Account # 3132

4.5 Parts List for Servo Unit (Model 6, 8)

No.	Symbol	Name	Specification	Remarks
1	P.C.B	P.C.B	A20B-0005-0373～4	
2	F1～3	Fuse	A60L-0001-0127/25FH75	
3	F4	"	A60L-0001-0031/5A	Toyo Fuse
4	MCC	Magnetic contactor	A58L-	
5	ACR	AC reactor	A81L-	
6	TF	Control transformer	A44L-	
7	CD1	Current detector	A44L-	
8	SCR1～12	Thyristor	A50L-	
9	SCR13～14	"	A50L-	
10	D1～2	Diode	A. G1	
11	FAN1～2	Fan motor	A90L-0001-0043	Nihon Servo
12	RCB	Resistor	A40L-0001-0064	Iwaki Musen
13	RF	"	A40L-0001-0066 /40SH200K	200 /40W
14	RCD	"	A40L-0001-0066 /20SH0R2F	0.2Ω /20W
15	SK	Spark killer	S2-A	Fujitsu
16	Z1～4	Surge absorber	A50L-2001-0062/441-12	Fuji Electric
17				
18				
19				

UPS 223904

#8200904

5. FAULT AND TROUBLESHOOTING

Generally, the following items can be considered as faults and their causes.

If a fault has occurred, first roughly determine where the cause lies (servo unit, spindle motor, etc.), and then trace out the cause.

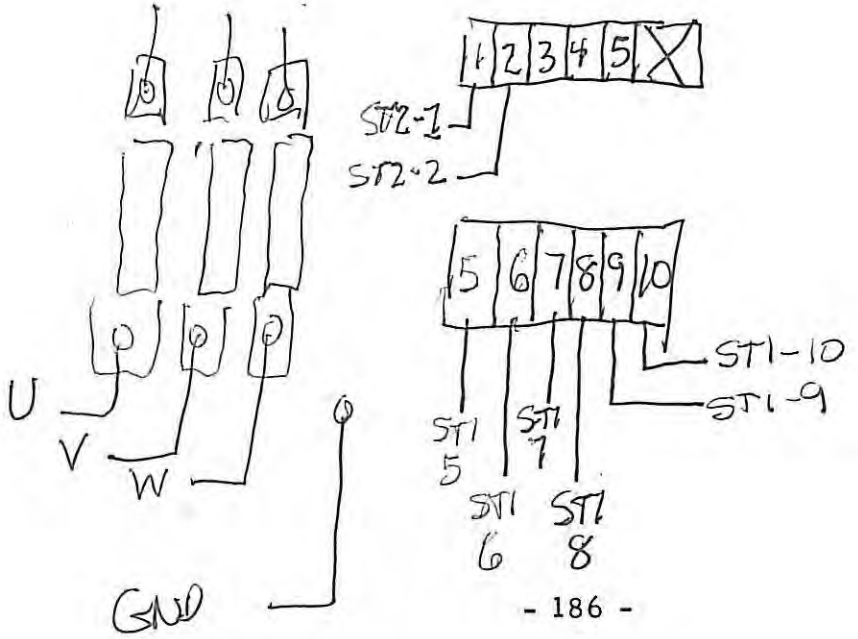
No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Magnetics cabinet
1	The velocity control unit fuse (F1 F3) is blows	° Between A and H of armature is short ° Circuit fault current limit circuit defect etc. ° Connector on Pt. is bad connection or short	° Power cable short circuit ° Short circuit of motor	
2	The spindle rpm is not normal	° Rotation fault defect of error amplifier circuit	° T.G defect	° Faulty operation of the velocity command circuit
3	Vibration and noise during spindle operation is abnormally large	° Circuit adjustment defect Gain ° Current feedback control circuit adjustment defect	° Motor fault bearing ° Fan motor ° Heat pipe fin adjustment fault	° The input power waveform is too disorted ° The load flactuation is too large ° Gear engagement is not proper or assembling of motor is unsociable ° Tension of belt is not proper
4	The spindle operation during acc/dec is not normal	° Current feedback control circuit adjustment defect defect (minimum pulse width setting)		

No.	FAULT	CAUSE		
		Spindle servo unit	Spindle motor	Machine or Magnetics cabinet
5	The spindle does not rotate	° Circuit fault the gate pulse are not generated	° Wire breaking	° The machine load is too large ° Contactor of relay defect
6	Fuse (F4) of control transformer on velocity control unit blows	° The pin of CN3 ~ 5 on PCB is short ° Power regulator fault	° Field circuit is short ° Fan for cooler heat pipe is short	

6. SPARE PARTS

The spare parts of the spindle servo unit are as follows.

Device name	Name	Contents		
		Article name	Specifications (FANUC specifications)	Customer Type
FANUC DC spindle servo unit	F1~3	Fuse	F60L-0001-0060#50T100	Nippon Inter K.K
	F4	Fuse	A60L-0001-0031#5A	Toyo fuse K.K
	FA1~3	Alarm fuse	S.Fab250/402AP413	Daito Tsushinki K.K P-413
	Z1~4	Surge absorber	A50L-2001-0062#4412	Juji Denki K.K



V. SPINDLE ORIENTATION

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1. GENERAL

This manual describes the maintenance and field adjustment for the electric spindle orientation function which is applied to the spindle of NC machine tools.

2. MAGNETIC SENSOR SYSTEM SPINDLE ORIENTATION ADJUSTMENT

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 $\pm$0.5mm.

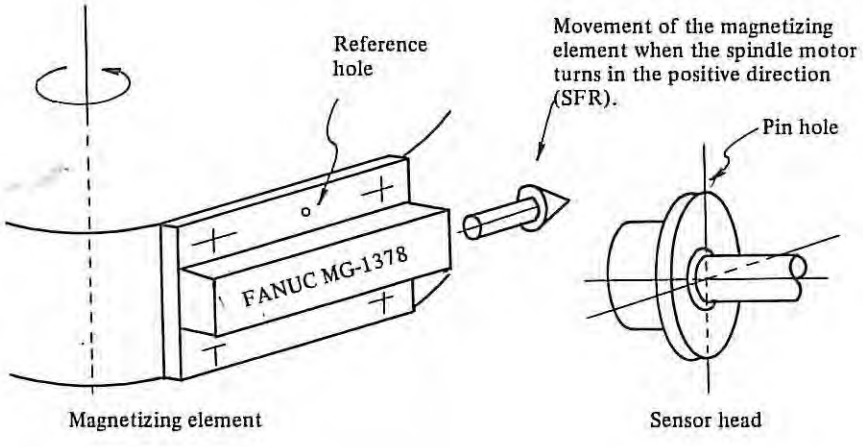


Figure 1. Mounting magnetizing element

2.2 Connection 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		O	Test mode (Note 2)	Connected only for adjustment.
02	O	X	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. The setting on SH02 is effected only when SH03 1-2 is connected.
	X	**O**	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.	
	O	**X**	Moves in the direction the spindle was turning just before the orientation instruction was issued.	The setting on SH02 becomes effective.
03	X	O	The orientation direction is always CCW.	When the edition of this PCB is 01A, these settings cannot be used.
	X	X	The orientation direction is always CW.	

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

(Note 1) Status			Function	Remarks
SH	1-2	2-3		
04	**X**	**X**	Initial orientation speed is about 60 x [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.
	O	X	The initial rate of speed is limited to 1/3 the usual rate.	
	X	O	The initial rate of speed is limited to 2/3 the usual rate.	

Notes:

(1) O indicates connected, X 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.

2.3 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.

2.4 Potentiometer (POT) Setting

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

Potentiometer settings												
POT name	RV	1*	2*	3	4	5	6*	7*	8	9*	10*	11*
POT scale position		5.0	6.0	①	①	②	2.0	5.0	③	2.0	5.0	5.0

① RV3 and RV4 settings

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

H (mm)	60 ∫ 65	~70	~75	~80	~85	~90	~95	~100	~105	~110
Scale position	7.0	6.0	5.0	4.0	3.0	2.5	2.0	1.5	1.0	0.5

② RV5 setting

Set RV5 according to the number of revolutions (N_{HM}) when the spindle rotates at a high rate of speed.

N_{HM} (rpm)	2,000 ≀ 2,200	~ 2,500	~ 2,700	~ 3,100	~ 3,500	~ 4,000	~ 4,500	~ 5,000	~ 5,500	~ 6,000
Scale position	7.5	6.5	5.5	4.5	3.5	2.5	2.0	1.5	1.0	0.5

③ RV8 setting

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

$R_{H/L}$	~2.0	~2.2	~2.5	~2.8	~3.2	~3.7	~4.4	~5.3	~6.0	~7.0
Scale position	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	9.5	10

2.5 Potentiometer Adjustment

Adjust RV1 - RV11 according to the following table.

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)	Adjust the 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.

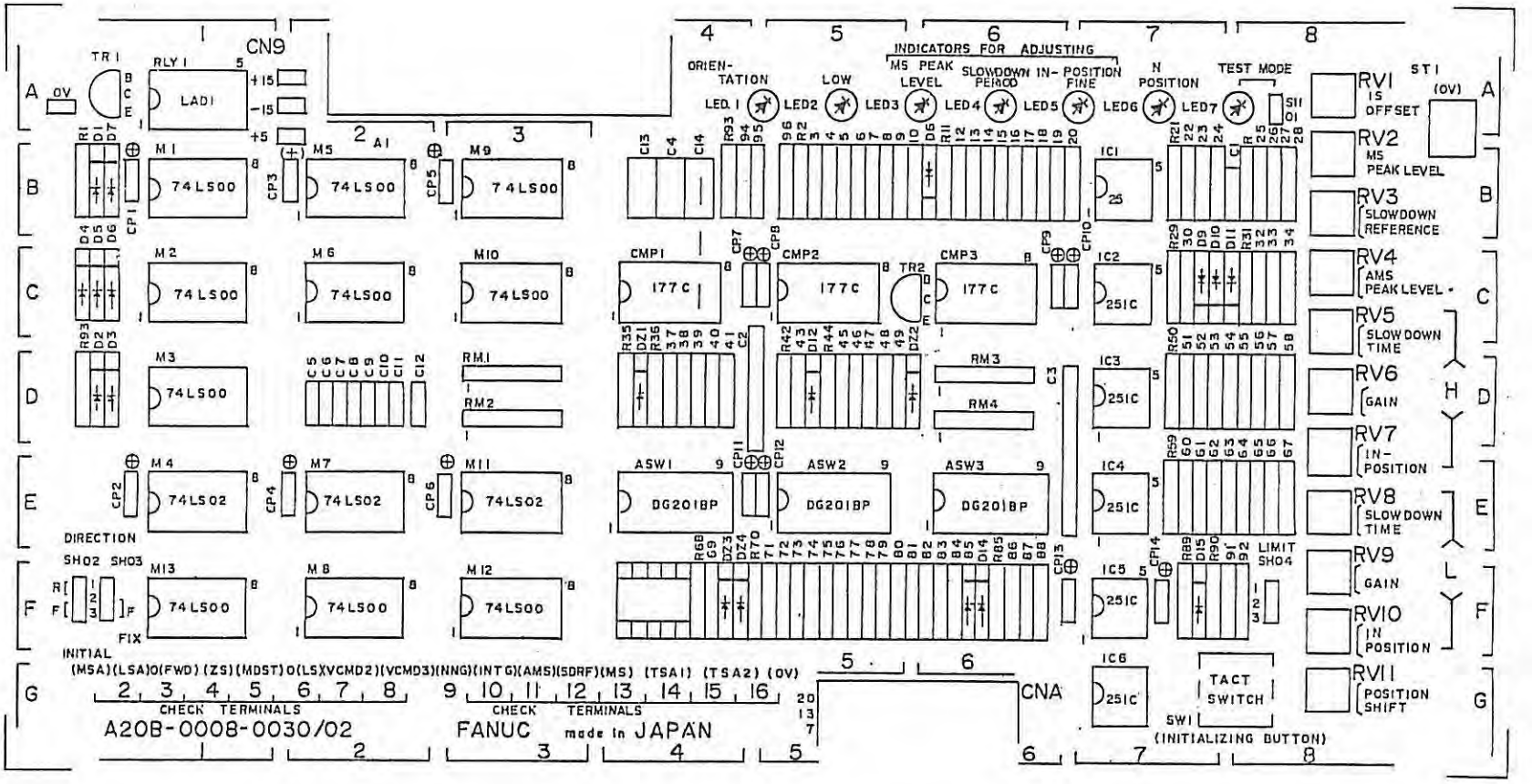
Item	POT name	Adjustment purpose	Condition	Adjustment method (Specification)
7	RV7	IN-POSITION [H]	Clutch (gear) is HIGH. Press SW1 to stop the spindle at the fixed position. The *CTH signal is off (open).	LED5 (IN-POS. FINE) should light while LED6 (IN-POSITION) is on.
8	RV8	SLOWDOWN TIME IN LOW MODE	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).	LED5 (IN-POS.FINE) should be on when LED6 (IN-POSITION) is on.
11	RV11	POSITION SHIFT		The stop position can be finely adjusted to within $\pm 1°$ of the spindle angle.
After adjustment, release Test Mode making sure that LED7 (Red) is off.				

Note: Adjustment of the fixed position stop control circuit should be performed after each offset and gain adjustment of the base board (spindle control circuit). The following POTs should not be readjusted after fixed position stop control circuit adjustment. Otherwise, the stop position may deviate from the one desired. RV7 (velocity offset), RV8 (velocity gain), and RV10 (current offset) on A20B-0008-0371~7.

2.6 Test of the Spindle Position Loop Gain

The spindle position loop gain should be tested after fixed position stop control circuit adjustment by using the procedure outlined in the next table.

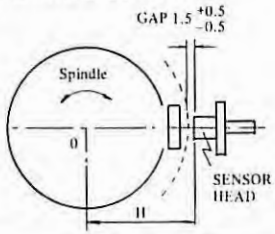
Spindle position loop gain	
Procedure	
1	Connect SH01 pins, to enter Test Mode (LED7 goes on).
2	Disconnect SH04 1-2 and 2-3 pins to remove limits.
3	Measure the number of spindle revolutions $N_{S(H)}$ and $N_{S(L)}$ (r.p.m) when SW1 (INITIALIZING BUTTON) is on, for each of the following condition. Spindle clutch (gear) HIGH (*CTH1 and 2 not connected) Spindle clutch (gear) LOW (*CTH1 and 2 connected)
4	The spindle position loop gain can be determined using the following equations: $K_{p(H \text{ or } L)} \fallingdotseq N_{s(H \text{ or } L)} \div 55 \ (sec^{-1})$, where $K_{p(H)}$: Position loop gain for spindle HIGH gear (clutch) $K_{p(L)}$: Position loop gain for spindle LOW gear (clutch)



A350-0008-T032/02
A350-0008-Z033/02

Parts Mounting Diagram

MAINTENANCE SHEET FOR POSITIONING C.K.T WITH MAGNETIC FLUX SENSOR
P.C.B: A20B-0008-0030

NOTES				DATA SHEET			
MACHINE MAKER				SETTING FOR SHORT-BAR	TEST MODE SELECTION	SH01	ON, OFF
CLASSIFICATION/NAME					INITIAL ORIENTATION DIRECTION	SH02	REV FWD 1-2, 2-3
SPINDLE MOTOR	MODEL				DIRECTION SELECTION	SH03	AUTO FWDREV 1-2, 2-3, OPEN
NUMERICAL CONTROLLER					ORIENTATION SPEED LIMIT	SH04	1/3, 2/3, 3/3 1-2, 2-3, OPEN
PARAMETERS				SETTING FOR POTS	TACHO-SIGNAL OFFSET	RV1	
1	HIGHT OF SENSOR HEAD	H	mm		MAGNETIC-FLUX SIGNAL PEAK LEVEL	RV2	
2	HIGH GEAR (CLUTCH) MAX. SPINDLE SPEED	N_{HM}	RPM		SLOW DOWN REFERENCE	RV3	
3	H/L GEAR RATIO	$R_{H/L}$			AMS PEAK LEVEL	RV4	
POSITION LOOP GAIN	LOW sec^{-1}	HIGH sec^{-1}			HIGH GEAR (CLUTCH) SLOW DOWN TIME	RV5	
REFERENCE DRAWING		REMARKS			(H) " POSITION LOOP GAIN	RV6	
					(H) " IN-POSITION ADJ.	RV7	
					LOW GEAR (CLUTCH) SLOW DOWN TIME	RV8	
					(L) " POSITION LOOP GAIN	RV9	
					(L) " IN-POSITION ADJ.	RV10	
					POSITION SHIFT	RV11	

3. ADJUSTMENT FOR POSITION CODER METHOD SPINDLE ORIENTATION

3.1 Printed Circuit Board

Spindle control circuit ..... A20B-0008-0371 ~0377

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

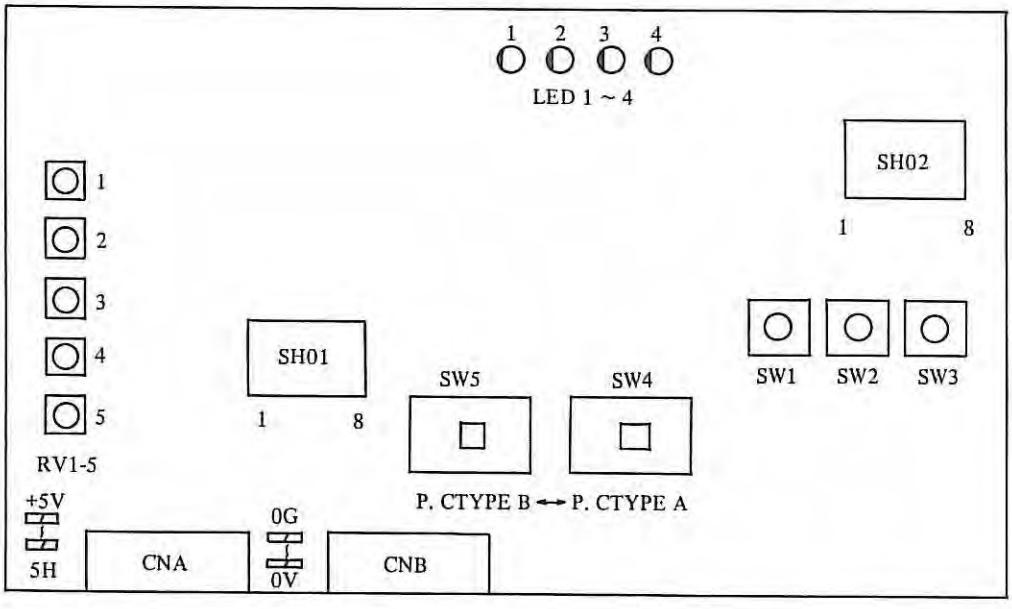
LED1 ORIENTATION ..... Lights when orientation command (ORCM1, 2 ON) is issued.

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

O: Connected X: 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	O	X															(Standard)
		CW	X	O															
2	Orientation direction after initial orientation	CCW only			X	O													(Standard)
		CW only			X	X													
		Spindle rotational direction.			O	X													(Standard)
3	Orientation speed which is set by position gain	1					X	X											
		2/3					O	X											
		1/3					X	O											
4	Rotational direction of spindle and position coder	Same direction							O	X									Different from machine tool to machine tool. Incorrect setting will cause hunting
		Reverse direction							X	O									
5 (Note)	In-position width to issue orientation completion signal (ORAR 1,2)	±2 pulses									O	O	O	O	O	O			±16 pulses correspond to ±1.3°
		±4 "										O	O	O	O	O			
		±8 "											O	O	O	O			
		±16 "												O	O	O			
		±32 "													O	O			
		±64 "														O			
6	Setting due to position coder hysteresis	No pulse															X	X	(Standard)
		+1 pulse															O	X	
		-1 pulse															X	O	

(Note) The condition (c) of issue of orientation completion signal
c = (Spindle is within the in-position width) and (Velocity zero signal is NO) and (ORCM is ON)

(4) Setting of stop position SW 1, 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.	Item	Variable resistor	Measuring point	Standard Adjustment	Note
1	Velocity feed-back offset	RV1	TSA2 CH14	50%	The voltage at TSA2 should be ± 1mV.
2	Position gain at gear High	RV2	Do not let spindle overshoot	30 ~ 40%	
3	Offset at gear High	RV3	Let LED4 ADJUST light	About 50%	Gleaming of the LED is sufficient.
4	Position gain at gear Low	RV4	Do not let spindle overshoot	30~ 60%	
5	Offset at gear Low	RV5	Let LED4 ADJUST light	About 50%	

REFERENCE DATA 1

CUTTING

POWER OF MACHINE

1. CUTTING POWER OF MACHINE

An output (Hp or Kw) of spindle motor specified in machine tool. Generally speaking, it shows amount that machine can cut. This explanation shows relation between rate of metal removal and output power for milling processing, lathe processing and drilling processing.

Reference documents

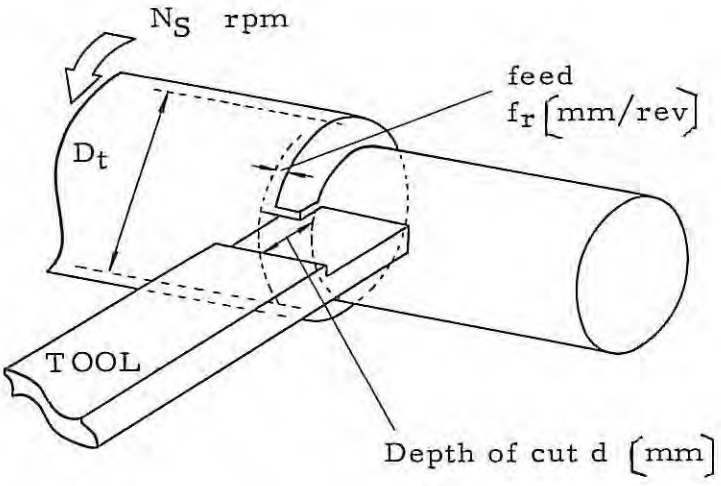
MACHINE DATA HAND BOOK
AIR FORCE MATERIAL LABORATRY

A. Lathe turning processing.

B. Milling processing.

C. Drilling processing.

A. Turning



[Condition of cutting]

(1)	Spindle rotation speed	Ns	[rpm]
(2)	Workpiece diameter	Dt	[mm]
(3)	Feed	fr	[mm/rev]
(4)	Depth of cut	d	[mm]

[Formula of cutting]

(1) Cutting speed $Vc = \pi \times Dt \times Ns$ [mm/min]

(2) Feed rate $fm = fr \times Ns$ [mm/min]

(3) Rate of metal removal

$Q = d \times fr \times Vc/1000$ [cm^3/min]

$= d \times fr \times \pi\ Dt \times Ns/1000$ [cc/min]

$\boxed{Q = \pi \times Dt \times d \times fm/1000}$ [cc/min]

(4) Power required at spindle

$PS = Q/MRt$ [kW]

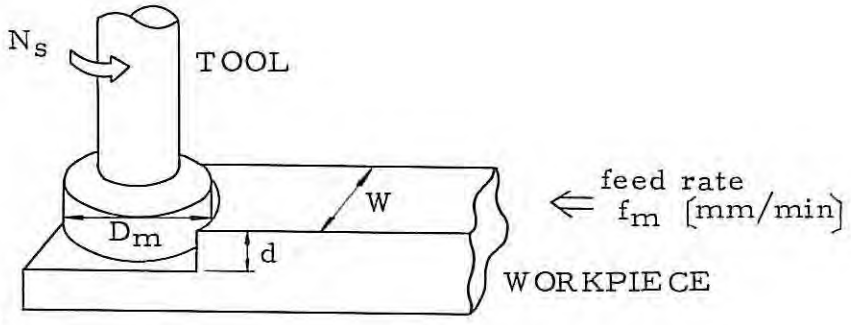
where MRt: Cutting amount per 1 kW [cc/min/kW]

(5) Power required at spindle motor

$PM = \frac{1}{\eta} \times Q/MRt$

where η : Spindle driving efficiency [%]

B. Milling



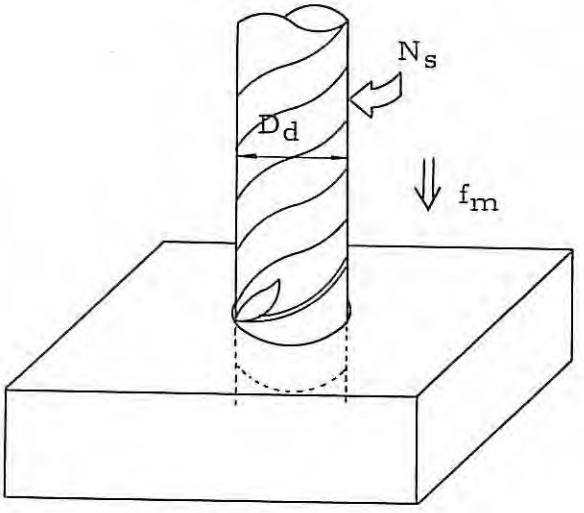
〔Condition of cutting〕

(1)	Spindle rotation speed	Ns	〔rpm〕
(2)	Diameter of milling cutter	Dm	〔mm〕
(3)	Width of cut	W	〔mm〕
(4)	Depth of cut	d	〔mm〕
(5)	Number of teeth in cutter	n	
(6)	Feed	ft	〔mm/tooth〕

〔Formula of cutting〕

(1)	Cutting speed	$Vc = \pi \times Dm \times Ns$	〔mm/min〕
(2)	Feed rate	$fm = ft \times n \times Ns$	〔mm/min〕
(3)	Rate of metal removal	$Q = w \times d \times ft \times n \times Ns/1000$	〔cm^3/min〕
		$Q = w \times d \times ft/1000$	〔cc/min〕
(4)	Power required at spindle	$PS = Q/MRm$	〔kW〕
	where	MRm: Cutting amount per 1 kW	〔cc/min/kW〕
(5)	Power required at spindle motor	$PM = \frac{1}{\eta} \times Q/MRm$	〔kW〕
	where	η : Spindle driving efficiency	〔%〕

C. Drilling



〔Condition of cutting〕

(1)	Spindle rotation speed	Ns	〔rpm〕
(2)	Drill diameter	Dd	〔mm〕
(3)	Feed	fr	〔mm/rev〕

〔Formula of cutting〕

(1)	Cutting speed	$Vc = \pi \times Dd \times Ns$	〔mm/min〕
(2)	Feed rate	$fm = fr \times Ns$	〔mm/min〕
(3)	Rate of metal removal	$Q = \frac{\pi}{4} \times Dd^2 \times fr \times Ns/1000$	〔cm^3/min〕
		$Q = \frac{\pi}{4} \times Dd^2 \times fm/1000$	〔cc/min〕
(4)	Power required at spindle	$PS = Q/MRd$	〔kW〕
	where	MRd: Cutting amount per 1 kW	〔cc/min/kW〕
(5)	Power required at spindle motor	$PM = \frac{1}{\eta} \times Q/MRd$	〔kW〕
	where	η : Spindle driving efficiency	〔%〕

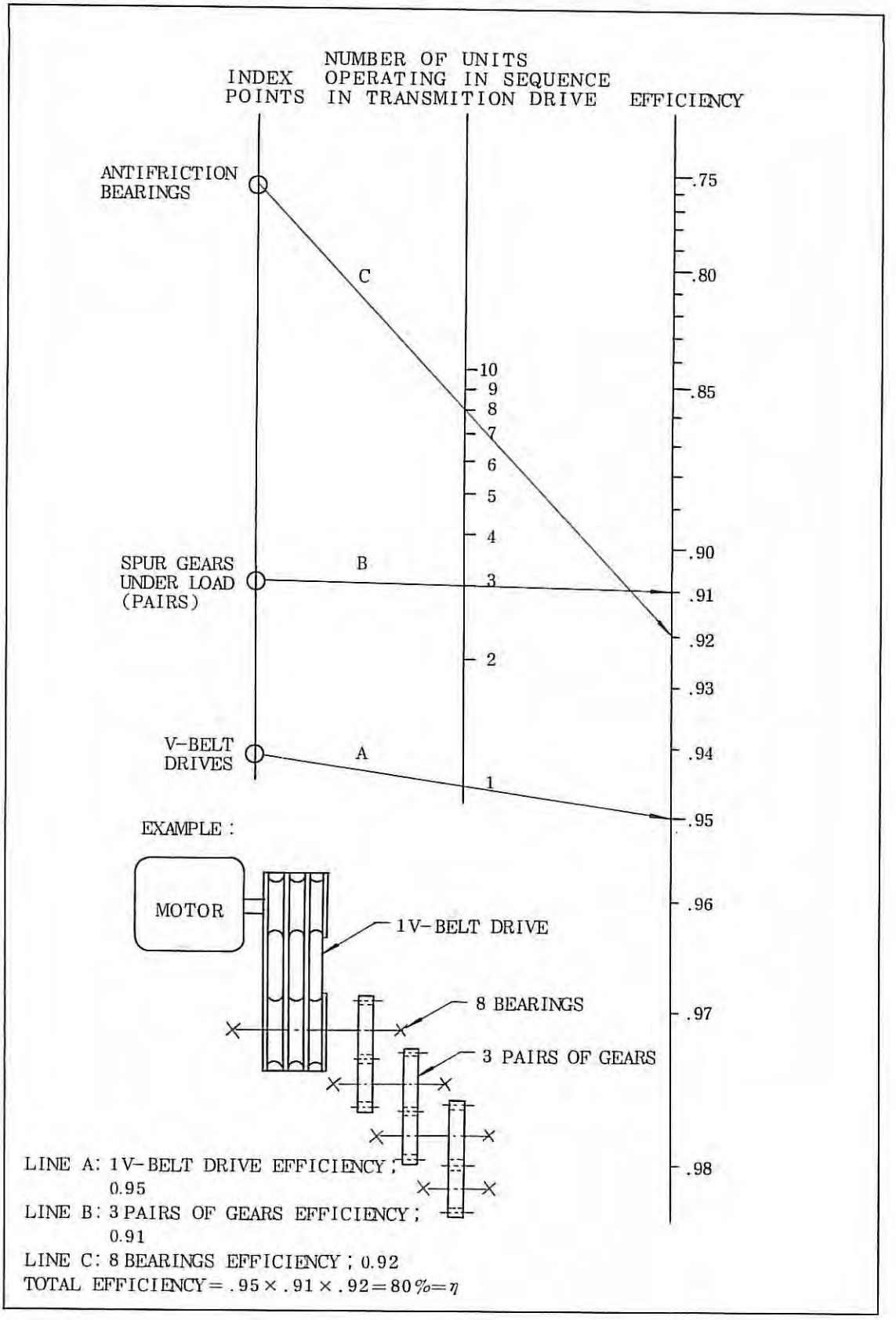
Cutting amount per 1 kW cc/min/kW (Average)
〔Spindle driving efficiency 80%〕

MATERIAL	HARDNESS BHN *1) Brinel hardness	MR : Cutting Amount per 1 kW 〔cc/min/kW〕					
		TURNING MRt HSS AND CARBIDE TOOLS feed 0.127~0.381 mm/rev		MILLING MRm CARBIDE TOOLS feed 0.127~0.305 mm/tooth		DRILLING MRd HSS DRILLS feed 0.05~0.203 mm/rev	
		SHARP TOOL	DULL TOOL	SHARP TOOL	DULL TOOL	SHARP TOOL	DULL TOOL
STEEL-WROUGHT AND CAST Plain Carbon Alloy Steels Tool Steels	85-200 *4)	20	15.7	20	15.7	21.9	16.8
	35-40R_C *2)	15.7	12.9	14.6	11.5	15.7	12.9
	40-50R_C	14.6	11.5	12.2	10	12.9	10.4
	50-55R_C	10.9	8.7	10.4	8.4	10.4	8.4
	55-58R_C	6.4	5.2	8.4	6.8	8.4	6.8 *5)
CAST IRONS Gray, Ductile and Malleable	110-190	31.3	24.4	36.6	27.4	21.9	18.3
	190-320	15.7	12.9	20	15.7	13.7	10.9
STAINLESS STEELS Ferritic, Austenitic and Martensitic	135-275	16.8	13.7	15.7	12.9	20	15.7
	30-45R_C	15.7	12.9	14.6	11.5	18.3	14.6
PRECIPITATION HARDENING STAINLESS STEELS	150-450	15.7	12.9	14.6	11.5	18.3	14.6
TITANIUM	250-375	18.3	14.6	20	15.7	20	15.7
HIGH TEMPERATURE ALLOYS Nickel and Cobalt Base	200-360	8.7	7.0	10.9	8.7	10.9	8.7
Iron Base	180-320	13.7	10.9	13.7	10.9	18.3	14.6
REFRACTORY ALLOYS··· Tungsten	321	7.8	6.2	7.5	6.1	8.4	6.6 *5)
Molybdenum	229	10.9	8.7	13.7	10.9	13.7	10.9
Columbium	217	12.9	10.4	14.6	11.5	15.7	12.9
Tantalum	210	7.8	6.2	10.9	8.7	10.4	8.4
NICKEL ALLOYS	80-360	10.9	8.7	11.5	9.1	12.2	10
ALUMINUM ALLOYS	30-150 500kg	87.8	73.2	68.6	54.9	137.2	109.8
MAGNESIUM ALLOYS	40-90 500kg	137.2	109.8	137.2	109.8	137.2	109.8
COPPER	80R_B *3)	21.9	18.3	21.9	18.3	24.4	20
COPPER ALLOYS	10-80R_B	34.3	27.4	34.3	27.4	45.7	36.6
	80-100R_B	21.9	18.3	21.9	18.3	27.4	21.9

*1) Brinell hardness standard testing method
*2) R_C : Rockwell hardness C scale
*3) R_B : Rockwell hardness B scale
*4) It is correspond to the hardness of plain carbon S45C
*5) Carbide

Efficiency of spindle driving system

Efficiency of spindle driving system is decided from below drawing by V belt, pairs of gears, number of bearing.



Measured Data Example

In case of using FANUC DC spindle motor model 5 or model 10, the measuring data about cutting amounts are as follows.

ex 1 Model 10 Face mill

[Cutting condition]

Spindle rotation speed	Ns = 320 rpm
Cutter diameter	Dm= 100 mm
Cutting width	W = 100 mm
Cutting depth	d = 4 mm
Feed rate	fm = 840 mm/min

[Cutting effect]

Material CAST IRON	
Rate of metal removal at 10kw output	Q = w x d x fm/1000 = 336 cc/min
Cutting amount per 1 kw	MRm = 33.6 cc/min

ex 2 Model 10 Face mill

[Cutting condition]

Spindle rotation speed	Ns = 130 rpm
Cutter diameter	Dm= 254 mm (=10 inches)
Cutting width	w = 254 mm
Cutting depth	d = 3 mm
Feed rate	fm = 350 mm/min

[Cutting effect]

Meterial CAST IRON	
Rate of metal removal at 10kw output	Q = 254 x 3 x 350/1000 = 266 cc/min
Cutting amount per 1 kw	MRm = 26.6 cc/min

However, the loss under no load condition of this machine is too much.

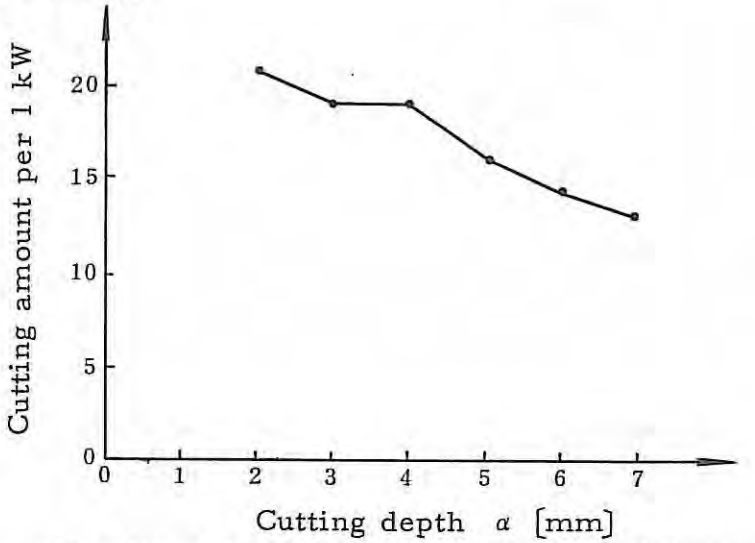
ex 3 Model 5 Face mill

The data changing the cutting depth "d" of workpiece S45C at output power 6.3 kw are as follows.

[Cutting condition]

Material	S45C
Spindle rotation speed	Ns = 180 rpm
Cutter diameter	Dm= 152 mm
Cutting width	w = 135 mm
Cutting depth	d = 4 mm
Feed rate	fm = 80～480 mm/min

[Cutting effect]



At face mill cutting the deeper the cutting depth becomes, the less the cutting amount becomes.

ex 4 Model 5 End mill cutting

At end mill cutting, the cutting amount scarcely changes at the cutting depth, range of d = 20 to 50 mm the cutting data at the output power approx. 5 kw are as follows.

ex 5 Model 5 Drill

[Cutting condition]

Material	S45C
Drill diameter	Dd = 50
Spindle rotation speed	Ns = 140 rpm
Feed rate	fr = 0.36 mm/rev

[Cutting effect]

Cutting speed	Vc = 22 m/min
Cutting amount at output power 6.3 kw	Q = 98.9 cc/min
Cutting amount per 1 kw	MRd = 15.7 cc/min/kw

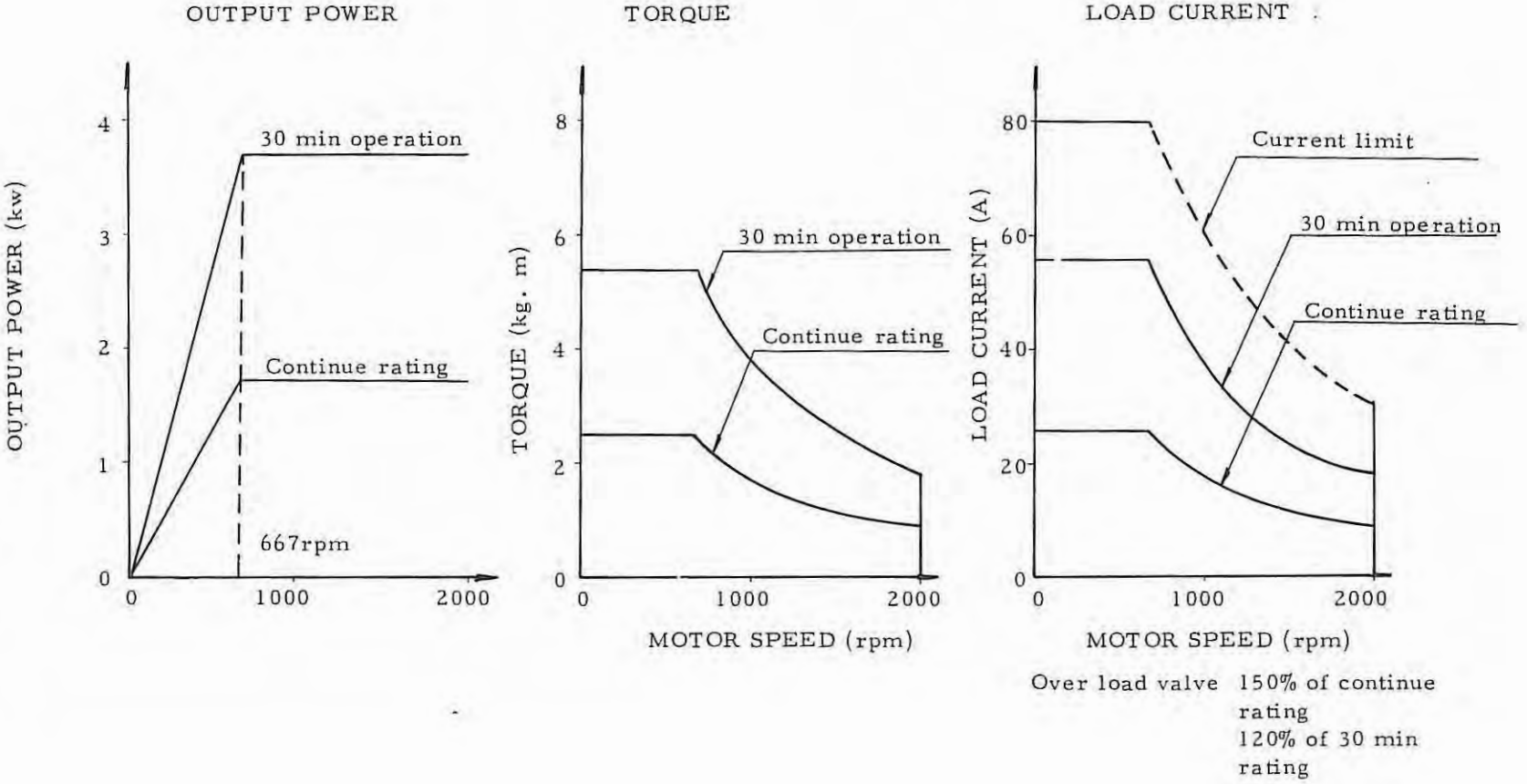
REFERENCE DATA 2

OUTPUT

POWER OF MOTOR

FANUC DC SPINDLE MOTOR MODEL 2

OUTPUT, TORQUE, LOAD CURRENT - MOTOR SPEED

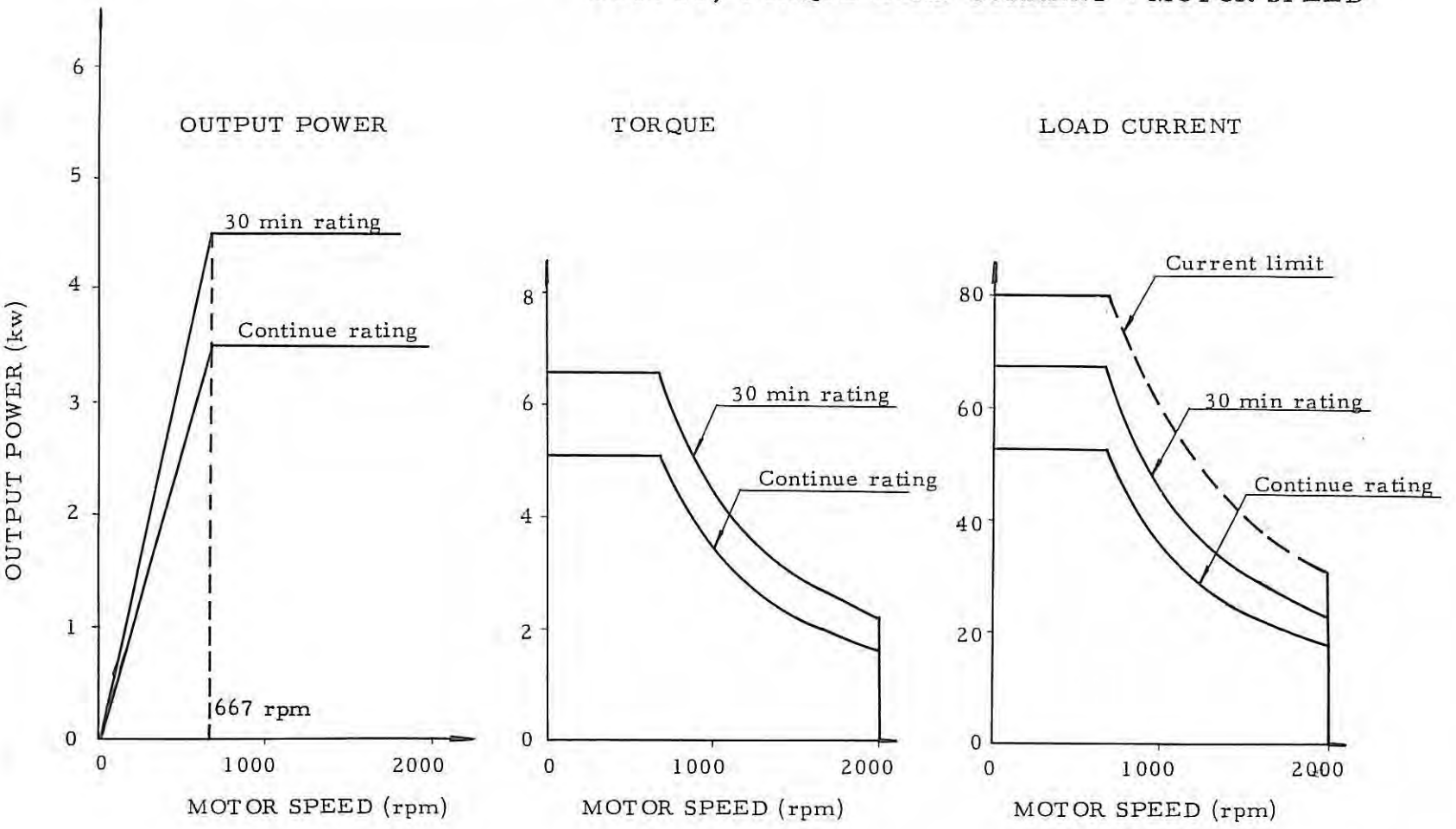


Over load valve 150% of continue rating
120% of 30 min rating

A. Ar-2190-55 (001/6)

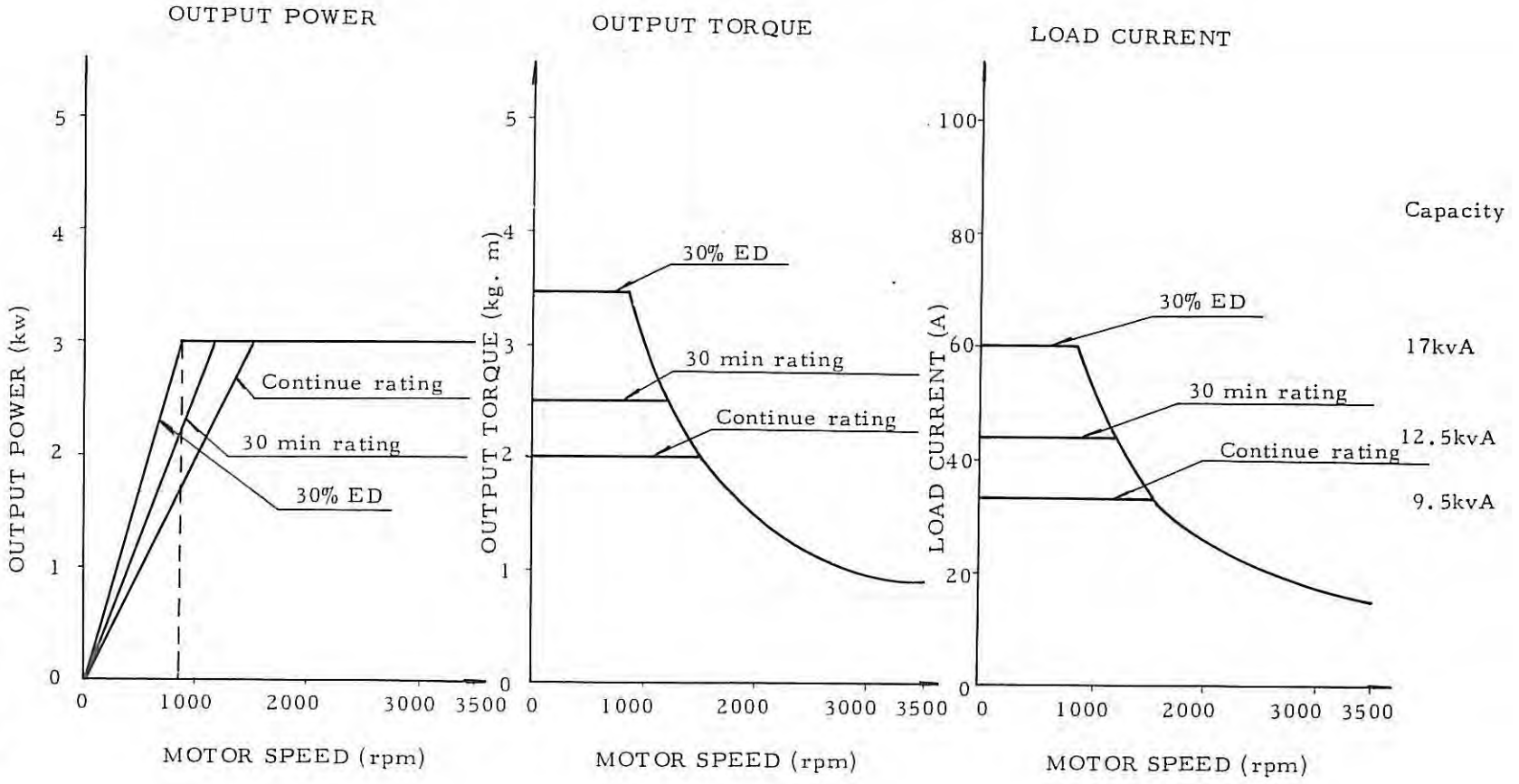
FANUC DC SPINDLE MOTOR MODEL 3

OUTPUT, TORQUE LOAD CURRENT - MOTOR SPEED

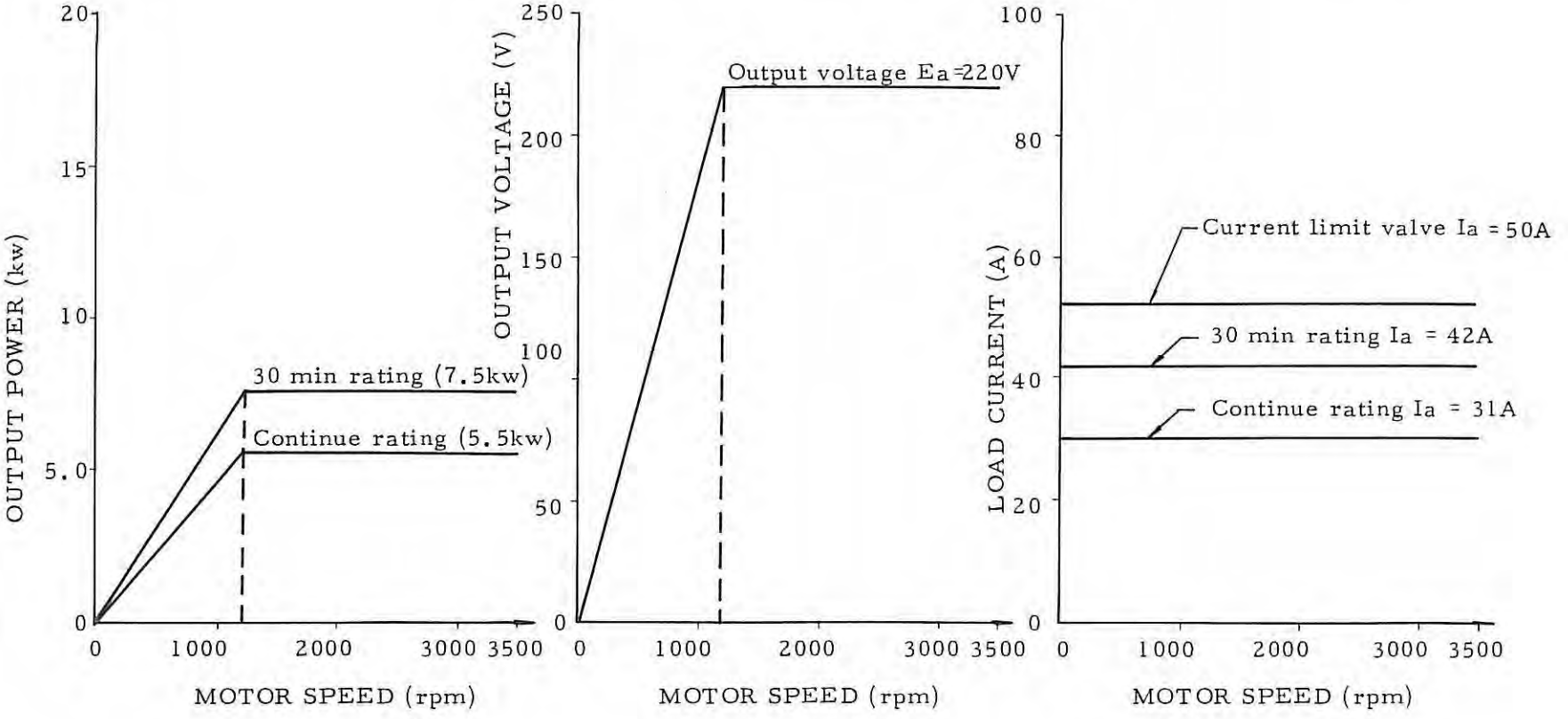


Over load valve 150% of continue rating
120% of 30 min rating

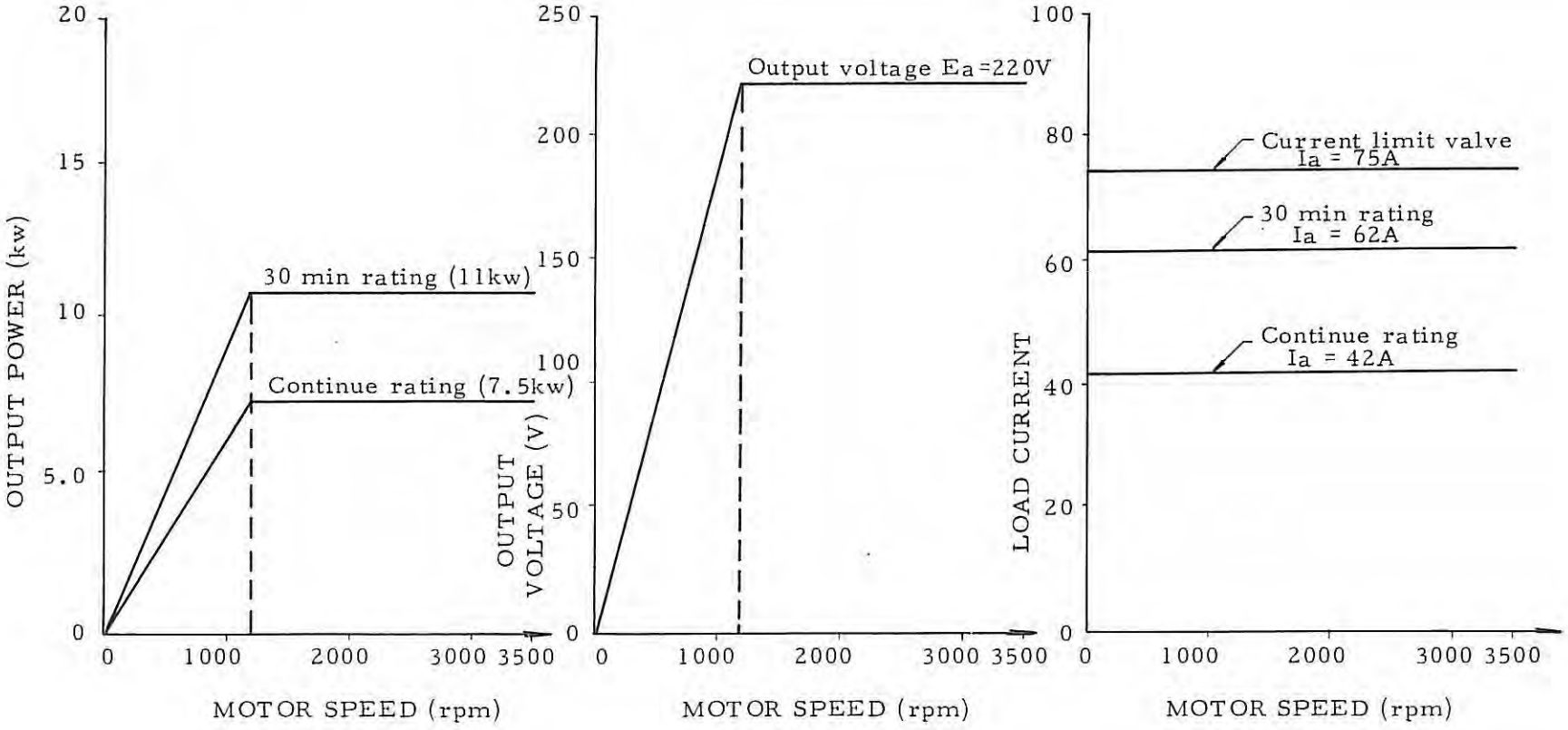
DIRECT SPINDLE MOTOR MODEL S for FANUC TAPE CHUCKER



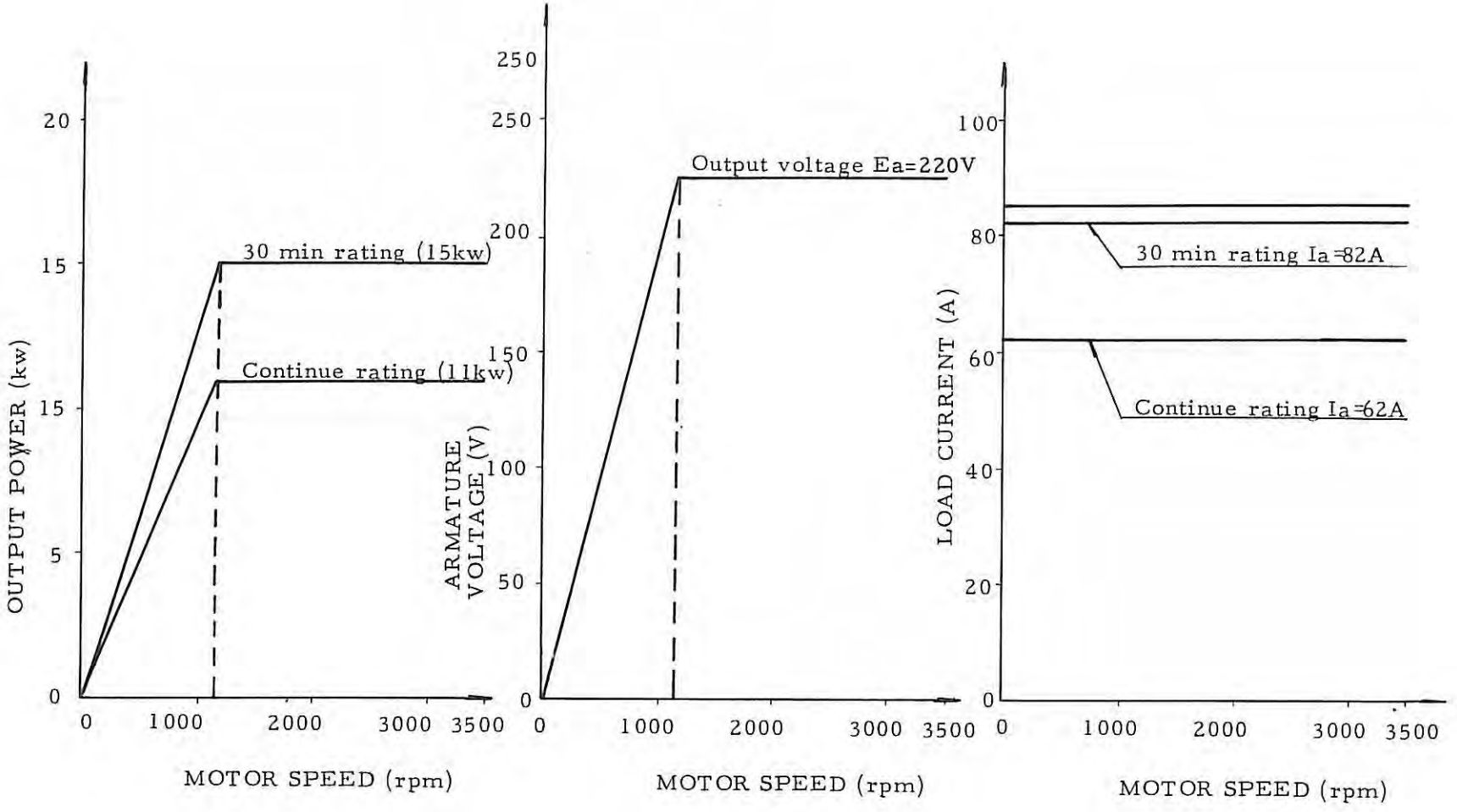
A. Ar-2190-77
(002/3)


OUTPUT POWER (kw)
20
15
10
5.0
0
30 min rating (7.5kw)
Continue rating (5.5kw)
0 1000 2000 3000 3500
MOTOR SPEED (rpm)
OUTPUT VOLTAGE (V)
250
200
150
100
50
0
Output voltage Ea=220V
0 1000 2000 3000 3500
MOTOR SPEED (rpm)
LOAD CURRENT (A)
100
80
60
40
20
0
Current limit valve Ia = 50A
30 min rating Ia = 42A
Continue rating Ia = 31A
0 1000 2000 3000 3500
MOTOR SPEED (rpm)

FANUC DC SPINDLE MOTOR MODEL 8 Standard setting



FANUC DC SPINDLE MOTOR MODEL 12 Standard setting



(047)

FANUC DC SPINDLE MOTOR MODEL 15

Standard setting