FANUC

GE Fanuc Automation

Computer Numerical Control Products

AC Spindle Motor Series
(Serial Interface)

Descriptions Manual
(Volume 2 of 4)

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Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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CONSTITUTION OF THIS MANUAL

This manual (B-65042E) is composed of the following 4 volumes.

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PREFACE

The models covered by this manual, and their abbreviations are:

Series name	Model name
FANUC AC SPINDLE MOTOR S series	0.5S, 1S, 1.5S, 2S, 3S, 6S, 8S, 12S, 15S, 18S, 22S, 30S, 40S
FANUC AC SPINDLE MOTOR Power up series	8P, 10P, 12P, 15P, 16P, 18P, 22P, 30P, 40P, 50P, 60P
FANUC AC SPINDLE MOTOR High-speed series	6VH, 8VH, 12VH
FANUC AC SPINDLE MOTOR 380/415V series	30HV, 40HV, 60HV
FANUC AC SPINDLE MOTOR LTQUID-COOLED series	· Non hollow shaft/without speed range switching type L6/12000, L12/6000, L15/6000, L18/6000, L22/6000
	· Hollow shaft/with speed range switching type L12/10000, L15/10000, L22/10000, L26/10000, L40/8000, L50/8000
FANUC AC SPINDLE MOTOR IP65 series	1S, 1.5S, 2S, 3S

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VII. AC SPINDLE SERVO UNIT SERIAL INTERFACE S series

1. GENERAL

The FANUC Spindle Servo Unit Serial Interface S series employs the latest microprocessor and power electronics technology to achieve stable smooth movement with little noise and vibration over a wide range of speeds, super low to high. High-speed optical information transference and increased storage space have been achieved by communicating information to and from the CNC via optical cables. Functions hitherto not available (Cs contour control, spindle synchronization control) are provided, enabling the requirements of the latest CNC machine tools to be met with ease.

2. FEATURES

(1) Since the speed detecting method has been completely digitalized, rotation speed adjustment and speed offset adjustment have become unnecessary. The number of adjustment processes the user has to make has been reduced.

(2) Displaying/setting/changing of spindle parameters are performed conventionally by the PCB of the spindle servo unit, but because it has become operable by the CRT of the CNC, the number of operation and adjustment processes have been reduced.

(3) The spindle orientation control function has been widely made into software form, and improvements in adjustment locations have been made to markedly reduce them and to make adjustments easy. The number of adjustment processes has been greatly reduced.

(4) Since the interface has become 1 optical cable between the CNC and the spindle servo unit, the conventional 50-core connector cable existing between the PMC and the spindle servo unit has become unnecessary, and the number of connection operations has been reduced.

(5) Since the quantity of information transmission between the CNCs has appreciably increased, hitherto unavailable new functions (Cs contour control, spindle synchronization control) have become possible.

(6) The light and compact unit is achieved owing to the plastic case.

(7) The heat radiation part is cooled by the outside air and the electric circuit in the magnetics cabinet can be completely closed resulting in higher reliability.

(8) Adoption of a custom LSI and a high-performance processor enhances the motor control performance and flexibility.

(9) The rigid tapping process involving synchronous feed of the spindle and the Z axis in the machining center is possible.

(10) Power-saving (energy-saving) design

The spindle servo unit is designed for energy-saving to obtain high power with a small current owing to the unique power factor improvement design in the input part.

(11) Power supply regenerative braking is possible. (Model 1S~40S)

The unique driving method (patent pending) allows the motor to serve as a generator during AC spindle motor deceleration so as to return energy to the power source.

(12) Low noise drive

The unique driving method (patent pending) reduces noises, even if the AC spindle motor is operated at low speed.

(13) Smooth low-speed rotation

The unique driving method (patent pending) assures very smooth rotation down to low speed.

(14)Electric spindle orientation control is applicable (option).
Since the spindle orientation can be done pure-electrically, the mechanical section is simplified, and the machine spindle can be composed with high reliability and largely reduced orientation time.

(15)The load detection signal function is newly added. This function is used to detect the load status of the machine tool spindle. If the load is larger than the specified load, the contact signal is used to reduce the feed motor speed for moving the table and the cutting load, thus preventing the tools from being damaged.

(16)Override function with analog input
The override function with analog input has been added. This function is implemented by connecting a variable resistor to a spindle servo unit.
This function can apply override to spindle speed to obtain the optimum cutting conditions for an S command.

(17)Function for outputting an MCC cut-off check signal (for models 1S to 26S, and small models 6S, 15S, and 30S)
The newly added contact signal can check the cut-off state of the MCC in the spindle servo unit.

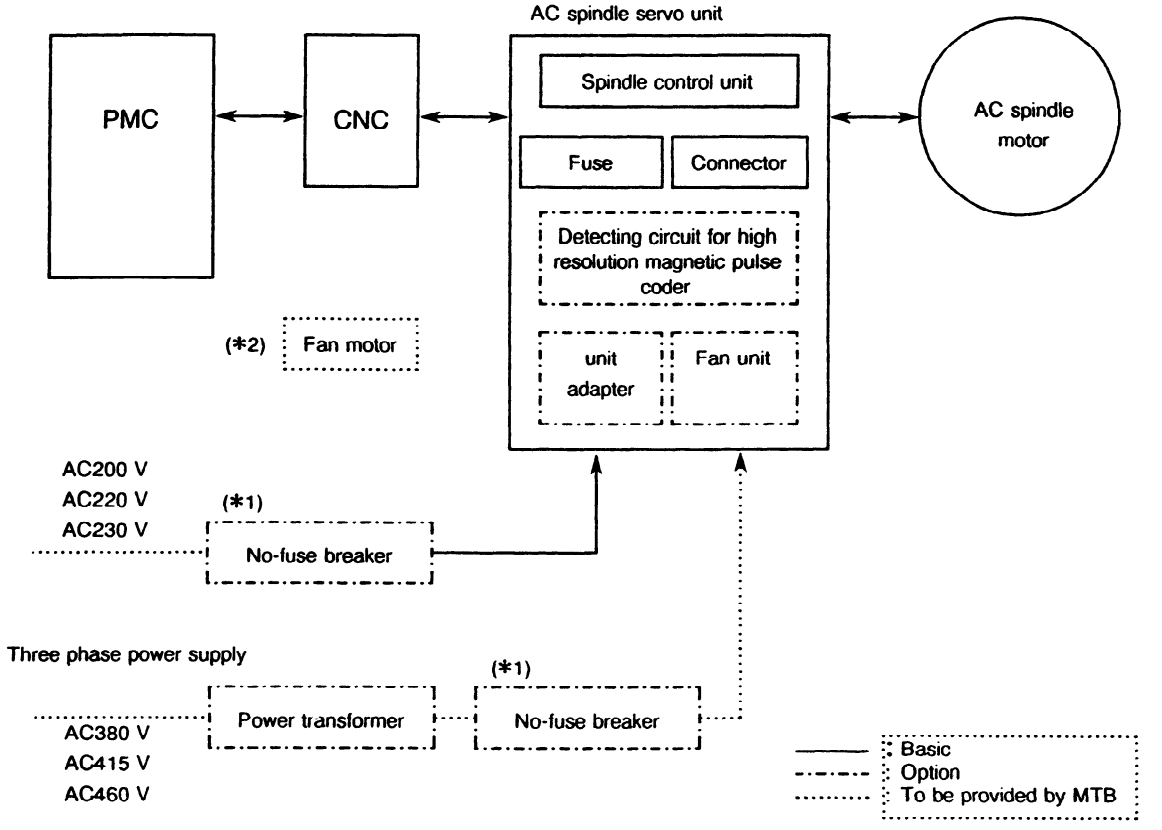
[Functions which have become unusable]
The analog speed command voltage has become unusable.

3. CONFIGURATION AND ORDER DRAWING NUMBER

3.1 Models 1S - 40S

FANUC Spindle Servo Unit Serial Interface S series (Models 1S, 2S, 3S, 6S, 8S, 12S, 15S, 18S, 22S, 26S, 30S, 40S) comprises the following units and components.

(1) Spindle control unit ..... (Basic)
(2) Fuse (spare) ..... (Basic)
(3) Connector (for connection) ..... (Basic)
(4) Detecting circuit for high resolution magnetic pulse coder ..... (Option)
(5) Power transformer ..... (Option)
(6) Unit adapter ..... (Special option for models 6S to 22S)
(7) Fan unit ..... (Special option for models 30S and 40S)



(*1) MTB to provide an overcurrent protector with a proper capacity such as a no-fuse breaker to the input power circuit of the AC spindle servo unit S series.

(*2) Make sure to prepare a fan motor to cool the spindle control unit forcibly. However, with respect to the models 1S to 3S, fan motors are built in. Moreover, a fan motor is not necessary either when unit adapters are used for models 6S to 22S, and when fan units are employed for models 30S and 40S.

3.2 Order Drawing Number

Type	Item		Code number	Remarks	
Basic	Spindle control unit for model 1S		A06B-6064-H301#H550		
	Spindle control unit for model 2S		A06B-6064-H302#H550		
	Spindle control unit for model 3S		A06B-6064-H303#H550		
	Spindle control unit for small type model 6S		A06B-6064-H305#H550		
	Spindle control unit for model 6S		A06B-6064-H306#H550		
	Spindle control unit for model 8S		A06B-6064-H308#H550		
	Spindle control unit for model 12S		A06B-6064-H312#H550		
	Spindle control unit for small type model 15S		A06B-6064-H313#H550		
	Spindle control unit for model 15S		A06B-6064-H315#H550		
	Spindle control unit for model 18S		A06B-6064-H318#H550		
	Spindle control unit for model 22S		A06B-6064-H322#H550		
	Spindle control unit for model 26S		A06B-6064-H326#H550		
	Spindle control unit for small type model 30S		A06B-6064-H327#H550		
	Spindle control unit for model 30S		A06B-6064-H230#H550	The analog override function has been added.	
	Spindle control unit for model 40S		A06B-6064-H240#H550	The analog override function has been added.	
	Spindle control unit for model 30S		A06B-6064-H030#H520	Use the new order drawing number for a new order.	
	Spindle control unit for model 40S		A06B-6064-H040#H520	Use the new order drawing number for a new order.	
Basic	Optical fiber cable		A02B-0094-K801	Length: 5 m (*)	
	Connectors	When the Cs contour control function is not used	A06B-6062-K103	Solder type	
			A06B-6062-K104	Crimp type	
		When the Cs contour control function is not used	A06B-6050-K110	Connector kit by AMP (motor model 0.5S)	
			A06B-6050-K111	Connector (D-sub) kit by Honda (motor model 0.5S)	
		When the Cs contour control function is used	A06B-6063-K105	Solder type	When the built-in spindle motor is used
			A06B-6063-K106	Crimp type	
			A06B-6063-K107	Solder type	When the spindle is separate from the spindle motor
			A06B-6063-K108	Crimp type	

(*) See the item of optical fiber cable for it's order drawing number.

Type	Item	Code number	Remarks	
Basic	Fuses	A06B-6064-K006	For models 1S to 3S	
		A06B-6064-K026	For models 6S to 26S	
		A06B-6044-K028	For model 30S	
		A06B-6044-K029	For model 40S	
Optional	Detection circuit for the high-resolution magnetic pulse coder	A06B-6064-J720	Spindle: ø65, Motor: ø65	
		A06B-6064-J721	Spindle: ø130, Motor: ø65	
		A06B-6064-J722	Spindle: ø195, Motor: ø65	
		A06B-6064-J723	Spindle: ø97.5, Motor: ø65	
		A06B-6064-J724	Spindle: ø65	
		A06B-6064-J725	Spindle: ø130	
		A06B-6064-J726	Spindle: ø195	
		A06B-6064-J727	Spindle: ø97.5	
Optional	Power transformer	A06B-6052-J001	Models 1S to 3S	Primary voltage: 380 VAC, 415 VAC, 460 VAC Secondary voltage: 200 VAC
		A06B-6044-J006	Models 6S, 8S and small type 6S	
		A06B-6044-J007	Models 12S, 15S and small type 15S	
		A06B-6044-J010	Models 18S to 26S	
		A06B-6044-J015	Models 30S, 40S and small type 30S	
	Unit adaptor	A06B-6059-K031	Models 6S to 12S	
		A06B-6059-K033	Small type model 15S	
		A06B-6059-K032	Models 15S to 22S Note)	
		A06B-6059-K038	Models 26S, small type 30S Note)	

(Note) When the motor model 40P is driven by the servo unit model 22S, use the unit adaptor of A06B-6059-K038.

Type	Item	Code number	Remarks
Optional	Fan unit	A06B-6044-K040	Models 30S and 40S
	Feedback cable for position detection (for the Cs contour control function)	A06B-6063-K801	Preamplifier to CN15
		A06B-6063-K802	Preamplifier to CN16

Optical fiber cable

Type	Item		Code number	Remarks
Basic	Optical fiber cable (with reinforced cover, for external wiring)	5m	A66L-6001-0009#L5R003	
		10m	A66L-6001-0009#L10R03	
		15m	A66L-6001-0009#L15R03	
		20m	A66L-6001-0009#L20R03	
		30m	A66L-6001-0009#L30R03	
		40m	A66L-6001-0009#L40R03	
		50m	A66L-6001-0009#L50R03	
		60m	A66L-6001-0009#L60R03	
		80m	A66L-6001-0009#L80R03	
		90m	A66L-6001-0009#L90R03	
		100m	A66L-6001-0009#L100R3	
	Optical fiber cable (without reinforced cover, for internal wiring)	1m	A66L-6001-0008#L1R003	Because of no reinforced cover, cable forming can be easily done. However, since this cable is inferior to cable with reinforced cover in strength, use only for internal wiring.
		1.5m	A66L-6001-0008#L1R503	
		2m	A66L-6001-0008#L2R003	
		3m	A66L-6001-0008#L3R003	
	Optical cable relay adaptor		A02B-0094-K841	Only one can be used on a single transmission line. When using an optical cable relay adaptor to relay data, the maximum total cable length is 100 m.

CNC software

Group	Name	FANUC Series 0				FANUC Series 15			
			Specification	Q'ty	Remarks		Specification	Q'ty	Remarks
Basic	Spindle serial output function		A02B-0098-J940		T, TT series		A02B-0094-J710		T, M, TT series
			A02B-0099-J940		M series				
Option	Cs contour control function		A02B-0098-J944		T, TT series		A02B-0094-J726		T, M, TT series
			A02B-0099-J944		M series				
	Spindle synchronous control function		A02B-0098-J945		TT series only		A02B-0094-J744		TT series
	Spindle orientation function		A02B-0098-J982		T, TT series		A02B-0094-J730		T, M, TT series
			A02B-0099-J982		M series				
	Speed ragne switching function		A02B-0098-J984		T, TT series		A02B-0094-J732		T , M, TT series
			A02B-0099-J984		M series				
	Spindle positioning function		A02B-0098-J880		T, TT series		A02B-0094-J836		T , M, TT series
	Rigid tapping function						A02B-0094-J648		T , M, TT series
			A02B-0099-J885		M series only				

Group	Name	FANUC Series 16				POWER MATE			
			Specification	Q'ty	Remarks		Specification	Q'ty	Remarks
Basic	Spindle serial output function		A02B-0120-J850		T, TT series				Depends on the PT board
			A02B-0121-J850		M series				
Option	Cs contour control function		A02B-0120-J852		T, TT series		Function not available		
			A02B-0121-J852		M series				
	Spindle synchronous control function		A02B-0120-J858		T, TT series		Function not available		
			A02B-0121-J858		M series				
	Spindle orientation function		A02B-0120-J853		T, TT series		A02B-0118-J803		PMA
			A02B-0121-J853		M series		A02B-0122-J803		PMB
	Speed ragne switching function		A02B-0120-J854		T, TT series		A02B-0118-J804		PMA
			A02B-0121-J854		M series		A02B-0122-J804		PMB
	Spindle positioning function		A02B-0120-J851		T, TT series		Without function		
	Rigid tapping function		A02B-0120-J828		T, TT series		A02B-0118-J802		PMA
			A02B-0121-J828		M series		A02B-0122-J802		PMB

4. SPECIFICATIONS AND FUNCTIONS

4.1 Specifications

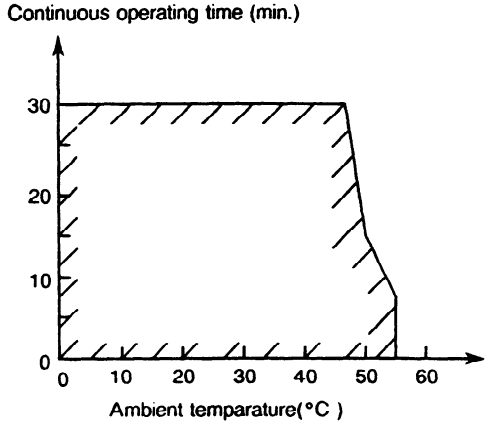
AC spindle servo unit

Item \ Model	1S	2S	3S	small type 6S (*5)	6S	8S	12S	small type 15S (*6)	15S	18S	22S	26S	small type 30S (*7)	30S	40S
30-min. rated power source capacity kVA	4	7	9	12	12	17	22	26	26	32	37	44	44	54	63
Power source (*1)	AC200V/220V/230V +10%, −15% 50/60Hz ± 1Hz														
Main circuit system	Transistor PWM invertor														
Feed back system	Speed feed back by pulse generator														
Braking system (Regenerative energy processing system)	Regenerative braking (Power regeneration)														
Speed control range	Speed ratio of the minimum to the maximum: 1:100 (When the maximum motor speed is 6000 min^{-1}, the ratio is 1:133.)														
Speed variation	Less than 0.1% of the maximum speed (Load variation 10 - 100%)														
Ambient temperature (*2)	0 - 55°C														
Weight kg	13				17				30					80	100

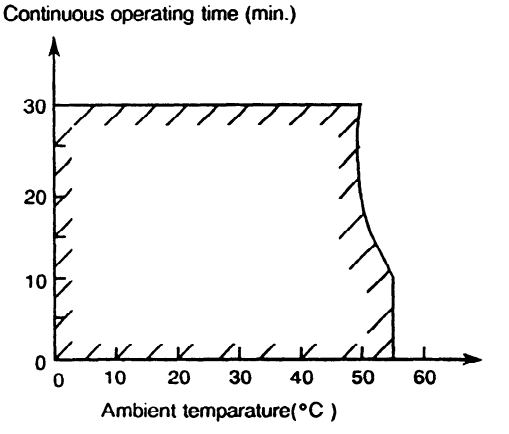
(*1) If the power voltage is other than specified herein, a transformer is needed.

(*2) The radiator fin of a servo unit needs to be cooled forcibly. When designing a cabinet for a servo unit, give special attention to the cooling fan and forced cooling system for the fin by referring to Chapter 7, "Cooling."

(*3) In Model 12S and Model 22S, the continuous operating time of the motor at 30-min. rated output is determined as follows by the thermal limitation of the unit.



Heat Restrictions on Continuous Operating Time for Model 12S

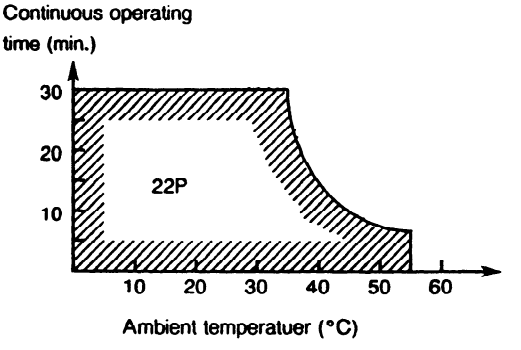


Heat Restrictions on Continuous Operating Time for Model 22S

(*4) - The 30-min. rated power source capacity may vary depending on the P series built-in motor to be used. For the power source capacity, refer to the specifications of the motor series.
- The total fluctuation rates of voltages applied to the power impedance and power transformer shall not exceed 7% when the motor is accelerating (for 1.2 × 30-min. rated power source capacity or for the maximum power source capacity).

(*5) Notes on the use of small model 6S
- The spindle parameters for standard model 6S can be used for this model.
- For applicable spindle motors, refer to the specifications of the motor series.
- There is no thermal limitation when the ambient temperature is high.

(*6) Notes on the use of small model 15S
- Some of the spindle parameters for small model 15S differ from those for standard model 15S. Refer to the parameters listed in the maintenance manuals (B-65045E/04 or later).
- For the applicable spindle motors, refer to the specifications of the motor series.
- In Model 22P, the continuous operating time of the motor 30-min. rated output is determined as follows by the thermal limitation of the unit.



Thermally limited continuous operating time of Model 22P used.

(*7) Notes on the use of small model 30S
- This model cannot be used as spindle motor model 30S.
- The continuous current at the rated output for this model is the same as that for model 26S. The current at the maximum output (during acceleration) is the same as that for model 30S. These currents can operate the required motors such as built-in motors B8/12000 and B8/20000.
- The power source capacity at the maximum output (when the motor is accelerating) is 54 kVA.

(*8) Output torque limit

1. Outline

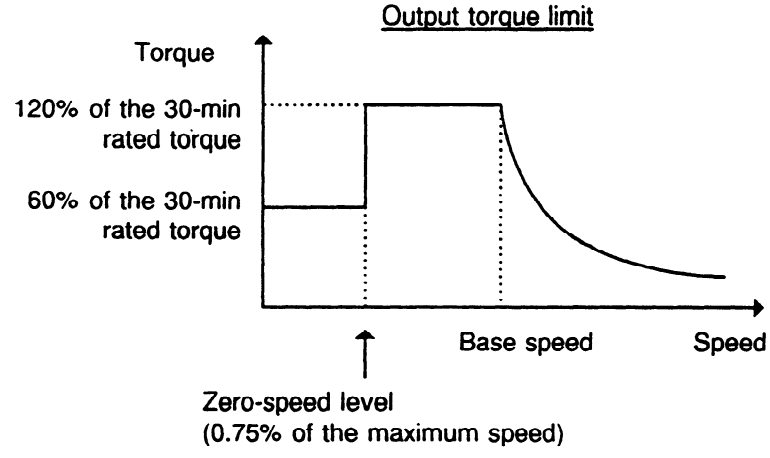
With the serial spindle amplifier, the motor output torque is limited to 60% of the 30-min rated torque to protect the power transistor when the motor speed is not greater than the zero-speed level (SST = 1).

2. Description

Generally, the following control modes are used at a level not greater than the zero-speed level. In those modes, the motor output torque is limited to 60% of the 30-min rated torque (50% ED):

1) When Cs contour control is exercised
2) When spindle orientation is completed
3) When the spindle is positioned
4) When the direction of tool motion is reversed at the bottom of a tapped hole in rigid tapping

The torque characteristics are shown at the right.



Example: When model 6S/6000 is used

Assume the following:

Zero-speed level = 6000 min^{-1} × 0.75% = 45 min^{-1}

30-min rated torque = 4.87 kg·m

Then, at a level not greater than the zero-speed level, the output torque is limited to the following:

4.87 × 60% = 2.92 kg·m

4.2 Major Component Functions and Application

4.2.1 Spindle control unit

The spindle control unit rectifies three-phase AC input, and converts it into DC so as to perform the velocity control of the AC spindle motor through transistor PWM inverter.
The spindle control unit is provided with a protective and fault detection function as shown in (1) for the purpose of protecting machine, AC spindle motor, and AC spindle servo unit, if a trouble has occurred. It also provides an auxiliary function as shown in (2) for monitoring the operating conditions of the spindle.

(1) Protective and fault detection functions

Display	Cause of Alarm	Description	Restoration Method
"A" displayed	Abnormal program ROM (not loaded)	Senses that control program is not operating (not installed, etc.)	Load correct program ROM.
AL-01	Motor overheat	Senses that interior temperature of motor has risen above specified value.	Cool motor then conduct alarm reset.
AL-02	Excessive speed deviation	Senses that motor speed has deviated markedly from requested speed.	Alarm reset.
AL-03	Fusing in DC link	Senses that the fuse F4 has melted in the DC link section. (Models 30S and 40S)	Check the power transistor, etc. Replace the fuse.
AL-04	Input fuse melted	Senses that the input fuse F1, F2 or F3 has melted, or open phase and instantaneous power failure have occurred. (Models 30S and 40S)	Check open phase and power regeneration circuit operation. Replace the fuse.
AL-05	Fusing in control power section	Senses that the control power fuse AF2 or AF3 has melted. (Models 30S and 40S)	Check whether or not the control power has short-circuited. Replace the fuse.
AL-07	Excessive speed	Senses that motor speed has exceeded rated speed by 115% or more.	Alarm reset.
AL-08	High input voltage	Senses that the input power voltage changeover switch in on the AC 200 side when the input voltage is AC 230V or more. (Models 30S and 40S)	Set the changeover switch to AC 230V side.
AL-09	Main circuit overload	Senses that temperature of power transistor radiator has become abnormally high.	Cool radiator then conduct alarm reset.
AL-10	Power input undervoltage	Senses drop in input power voltage.	Remove cause then conduct alarm reset.
AL-11	Overvoltage in DC link	Senses that DC power voltage in power circuit has become abnormally high.	Remove cause then conduct alarm reset.
AL-12	Overcurrent in DC link	Senses overcurrent in DC section of power circuit.	Remove cause then conduct alarm reset.

Display	Cause of Alarm	Description	Restoration Method
AL-13	Memory abnormality in CPU internal data	Senses abnormality in data memory of CPU.	Remove cause then conduct alarm reset.
AL-15	Spindle switching/output switching alarm	Senses that the switching sequence is illegal while spindle switching/output switching alarm.	Check the sequence.
AL-16	External RAM abnormality	Senses abnormality in external data memory (RAM). This check is only carried out when power is turned ON.	Remove causes then conduct alarm reset.
AL-18	Program ROM sumcheck abnormality	Senses abnormality in program ROM data. This check is only carried out when power is turned ON.	Remove cause then conduct alarm reset.
AL-19	Excessive offset in U-phase current detection circuit	Senses that offset of U-phase current detection circuit is too large. This check is only carried out when power is turned ON.	Remove cause then conduct alarm reset.
AL-20	Excessive offset in V-phase current detection circuit	Senses that offset of V-phase current detection circuit is too large. This check is only carried out when power is turned ON.	Remove cause then conduct alarm reset.
AL-24	Serial data transmission abnormality	Senses abnormality in serial transmission data. (NC power OFF, etc.)	Remove cause then conduct alarm reset.
AL-25	Serial data transmission halt	Senses that serial data transmission has halted.	Remove cause then conduct alarm reset.
AL-26	Speed detection signal for Cs spindle control discontinued	Senses abnormality in Cs spindle control speed detection signal (90000p). (Cable not connected, erroneous parameter setting, etc.)	Remove cause then conduct alarm reset.
AL-27	Position coder signal discontinued	Senses abnormality in position coder signal. (Cable not connected, erroneous parameter setting, etc.)	Remove cause then conduct alarm reset.
AL-28	Position detection signal for Cs spindle control discontinued	Senses abnormality in Cs spindle control position detection signal (90000p). (Cable not connected, erroneous parameter setting, etc.)	Remove cause then conduct alarm reset.
AL-29	Brief overload	Senses that excessive load was continuously imposed for a specified period. (Constrains motor shaft during positioning, etc.)	Remove cause then conduct alarm reset.
AL-30	Overcurrent in input circuit	Senses overcurrent in input circuit.	Remove cause then conduct alarm reset.
AL-31	Speed detection signal discontinued Motor constrained	Senses that motor cannot operate at requested speed (extremely slow or stationary). (Checks phase order.) (Checks the speed detection cable, etc.)	Remove cause then conduct alarm reset.

Display	Cause of Alarm	Description	Restoration Method
AL-32	RAM abnormality in serial data transmission-use LSI	Senses abnormality in RAM contained in LSI used for serial data transmission. This check is only carried out when power is turned ON.	Remove cause then conduct alarm reset.
AL-33	Insufficient recharging of DC link	Senses that DC voltage in power circuit is not sufficient when electromagnetic contacter in amp is turned ON.	Remove cause then conduct alarm reset.
AL-34	Parameter data setting exceeds allowable range	Senses that parameter data setting has exceeded allowable range.	Set correct data.
AL-35	Gear ratio setting too large	Senses that gear ratio data setting has exceeded allowable range.	Set correct data.
AL-36	Error counter overflow	Senses error counter overflow.	Remove cause then conduct alarm reset.
AL-37	Speed detector parameter error setting	Senses that the parameter setting for number of pulses of the speed detector is not correct.	Set correct data.
AL-39	Detection error of one rotation signal for Cs contour control	Senses that the one rotation signal for Cs contour control has not been captured correctly during Cs contour control.	Adjust the signal.
AL-40	One rotation signal for Cs contour control not detected	Senses that the one rotation signal for Cs contour control has not been generated during Cs contour control.	Adjust the one rotation signal.
AL-41	Detection error of position coder one rotation signal	Senses that the position coder one rotation signal has not been captured correctly.	Adjust the signal in case of signal conversion circuit. Check whether or not the cable is shielded correctly.
AL-42	Position coder one rotation signal not detected	Senses that the position coder one rotation signal has not been generated.	Adjust the one rotation signal in case of signal conversion circuit.
AL-43	Position coder signal for differential mode disconnected	Senses that the position coder signal of the main spindle for differential mode is not connected (wire breaking).	Check to make sure whether or not the position coder signal of the main spindle is connected to the connector CN12.
AL-46	Detection error of position coder one rotation signal while threading	Senses that the position coder one rotation signal has not been captured correctly while threading.	Adjust the signal in case of signal conversion circuit. Check whether or not the cable is shielded correctly.
AL-47	Abnormal position coder signal	Senses that the position coder signal is not being counted correctly.	Adjust the signal in case of signal conversion circuit. Check whether or not the cable is shielded correctly.

Display	Cause of Alarm	Description	Restoration Method
AL-48	Abnormal position coder one rotation signal	Senses that the position coder one rotation signal generation has ceased.	Adjust the one rotation signal in case of signal conversion circuit.
AL-49	The converted differential speed is too high.	Detects that speed of other spindle converted to speed of local spindle has exceeded allowable limit in differential mode.	Calculate differential speed by multiplying speed of other spindle by gear ratio. Check if calculated value is not greater than maximum speed of motor.
AL-50	Excessive speed command calculation value in spindle synchronization control	Detects that speed command calculation value exceeded allowable range in spindle synchronization control.	Calculate motor speed by multiplying specified spindle speed by gear ratio. Check if calculated value is not greater than maximum speed of motor.
AL-51	Undervoltage at DC link section	Detects that DC power supply voltage of power circuit has dropped (due to momentary power failure or loose contact of magnetic contactor).	Correct cause, then reset alarm.
AL-52	ITP signal abnormality I	Detects abnormality in synchronization signal (ITP signal) with CNC (such as loss of ITP signal).	Correct cause, then reset alarm.
AL-53	ITP signal abnormality II	Detects abnormality in synchronization signal (ITP signal) with CNC (such as loss of ITP signal).	Correct cause, then reset alarm.
AL-54	Overload current alarm	Detects that excessive current flowed in motor for long time.	Check if overload operation or frequent acceleration/ deceleration is performed.
AL-55	Power line abnormality in spindle switching/output switching	Detects that switch request signal does not match power line status check signal.	Check operation of magnetic contractor for power line switching. Check if power line status check signal is processed normally.

(2) Supplementary Functions

The following supplementary functions are provided as standard features. For details, refer to the CNC Connectiing Manual and the parameter section in the Spindle Motor Maintenance Manual.

Supplementary Function	Description
Motor speed display	The actual motor speed (min^{-1}) can be displayed as a 5-digit, 7-segment.
Load meter data	A 10V DC analog voltmeter can be connected.
Speed meter data	A 10V DC analog voltmeter can be connected.
Zero-speed signal output	It is possible to verify that the spindle motor has stopped.
Speed-achieved signal output	It is possible to verify that the speed of the spindle motor has reached the indicated speed.
Speed-detection signal output	It is possible to verify that the speed has dropped below a particular speed, such as that at which the clutch or gear can be changed.
Load detection signal output	When the size of the load exceeds the value specified in the corresponding parameter, it is output in 2 segments. Maximum output is divided into 100 units when set. This function reduces the feedrate to prevent the spindle from being stopped when the spindle is overloaded.
Torque restriction	This function can tentatively lower the output torque of the spindle motor while it operates.
Output restriction pattern selection	Parameter settings allow a number of output restriction patterns to be selected: • No output restriction • Output restriction during acceleration/deceleration only • Output restriction during normal rotation only • Restrict output over all operation areas Maximum output is divided into 100 units when set.
Soft start/stop	The gradient during alteration of speed command (i.e., during acceleration/deceleration) can be set.
Analog override (for models 1S to 26S and small type 30S)	This function applies override to spindle speed to obtain the optimum cutting conditions for an S command.
MCC cut-off check signal output (for models 1S to 26S and small type 30S)	This function can check that the MCC is cut off.

(3) Status error display function

This displays Er-XX on the display unit on the spindle control PCB when there is an erroneous parameter setting or the sequence is inappropriate. When the operation of the spindle motor is defective, check the error number on the display unit and remove the error by performing the following countermeasures.

(Note) Er- XX is not displayed on the NC screen.

Display	Contents	Countermeasure
Er-01	* Although ESP (there are 2 types: connection signal and PMC → CNC) and MRDY (machine ready signal) are not input, SFR/SRV is input. However, regarding MRDY, pay attention to the setting of use/not use spindle parameter MRDY.	* Confirm the sequence of ESP and MRDY.
Er-02	If spindle motor is not integrated with spindle in system with high-resolution magnetic pulse coder, speed detector of spindle motor is set to 128 p/rev. Attempt to excite motor fails if value other than 128 p/rev is set.	Set the spindle motor speed detector parameter to 128 p/rev.
Er-03	Parameter for high-resolution magnetic pulse coder is not set, but Cs contouring control command is entered. In this case, motor is not excited.	Check parameter setting for high-resolution magnetic pulse coder.
Er-04	Although parameter setting for using position coder was not performed, commands for servo mode and synchronous control are input. In this case, the motor will not be excited.	Confirm the parameter setting of the position coder.
Er-05	Although option parameter for orientation is not set, the orientation command (ORCM) is input.	Confirm the parameter setting of orientation.
Er-06	Although option parameter for output switchover is not set, LOW winding is selected.	Confirm the parameter setting for output switching and gravity line status signal.
Er-07	Although Cs contouring control command was entered, SFR/SRV is not entered.	Confirm the sequence.
Er-08	Although servo mode control command was input, SFR/SRV is not input.	Confirm the sequence.
Er-09	Although synchronous control command was input, SFR/SRV is not input.	Confirm the sequence.
Er-10	Cs control command was entered, but another mode (servo mode, synchronous control, orientation) is specified.	Never set another mode when Cs contouring control command is being processed. Before changing to another mode, clear Cs contouring control command.
Er-11	Servo mode command was entered, but another mode (Cs contouring control, synchronous control, orientation) is specified.	Do not command other modes during servo mode command. When moving to other modes, perform after releasing the servo mode command.

Display	Contents	Countermeasure
Er-12	Synchronous control command was entered, but another mode (Cs contouring control, servo mode, orientation) is specified.	Do not command other modes during synchronous control command. When moving to other modes, perform after releasing the synchronous control command.
Er-13	Orientation command was entered, but another mode (Cs contouring control, servo mode, synchronous control) is specified.	Do not command other modes during orientation command. When moving to other modes, perform after releasing the orientation command.
Er-14	SFR/SRV are simultaneously commanded.	Command one or the other.
Er-15	Cs contouring control command is entered when differential speed control function is enabled by parameter setting (No. 6500#5 = 1).	Check parameter setting and control input signal.
Er-16	Differential mode command (DEFMDA) is entered when differential speed function is disabled by parameter setting (No. 6500#5 = 0).	Check parameter setting and control input signal.
Er-17	Parameter setting (No. 6511#0,1,2) for speed detector is incorrect. (Specified speed detector is not present.)	Check parameter setting.
Er-18	Spindle orientation command of position coder type is entered when use of position coder signal is disabled by parameter setting (No. 6501#2 = 0).	Check parameter setting and control input signal.
Er-19	Although the command for orienting the magnetic sensor system was entered, another mode was issued.	Do not issue another mode while the orientation command is executed. Before issuing another mode, cancel the orientation command.
Er-20	Both the slave mode and the high-resolution magnetic pulse coder were enabled.	These two settings are incompatible. Check the parameter settings.
Er-21	The slave mode command (SLV = 1) was entered under position control (servo mode, orientation, etc.).	Enter the slave mode command in the normal operation mode.
Er-22	The position control command (servo mode, orientation, etc.) was entered in the slave operation mode (SLV = 1).	Enter the position control command in the normal operation mode.
Er-23	A slave mode command was entered when the slave mode is disabled.	Enable the slave mode.
Er-24	To perform continuous indexing in the mode for orienting the position coder system, incremental operation (INCMD = 1) was first performed, then the absolute position command (INCMD = 0) was entered.	Check the control input signal (INCMD). To execute the absolute position command continuously, be sure to perform orientation with the absolute position command first.

4.2.2 Fuse

Spare fuses are not attached to the AC spindle servo unit. Order more than one set of spare fuses for stock. Following fuses and parts are applied to each model of AC servo unit.

Name	Fuse Specifications FANUC Spec. Dwg. No.	Order specification			
		1S - 3S/ Small type 6S A06B-6064-K305	6S - 26S/ Small type 15S, 30S A06B-6064-K026	30S A06B-6044-K028	40S A06B-6044-K029
Fuse (225A)	A60L-0001-0183/225A			4	
Fuse (260A)	A60L-0001-0183/260A				4
Alarm fuse (S3.2A)	A60L-0001-0075/3.2			2	2
Alarm fuse (3.2A)	A60L-0001-0046/3.2	1	1	1	1
Fuse (5A)	A60L-0001-0031/5A	3	3	5	5
Fuse (1.0A)	A60L-0001-0175/1.0A	1	1		
Fuse (0.3A)	A60L-0001-0175/0.3A			4	4
Surge absorber	A50L-2001-0062/441-12			1	1
Surge absorber	A50L-2001-0155/20D431		3	3	3
Surge absorber	A50L-2001-0122/G431K	3			

4.2.3 Power transformer (optional)

When the input power voltage is out of range of 200 through 230 VAC, the power transformer is required.
Provide the transformer with the following specifications by the customer.

(1) Specifications

Item \ Model		1S	2S	3S	6S/ Small type 6S	8S	12S	15S/ Small type 15S	18S	22S	26S	30S/ Small type 30S	40S
Rated capacity (kVA)	30-minute	4	7	9	12	17	22	26	32	37	44	54	63
	Continuous	3	4	7	9	12	17	22	26	31	37	44	54
Secondary current (30-min.) (A)		12	21	26	35	48	62	72	88	105	130	156	182
Secondary tap output voltage		200V											
Secondary voltage regulation		5%											
Secondary tap voltage deviation		± 3%											

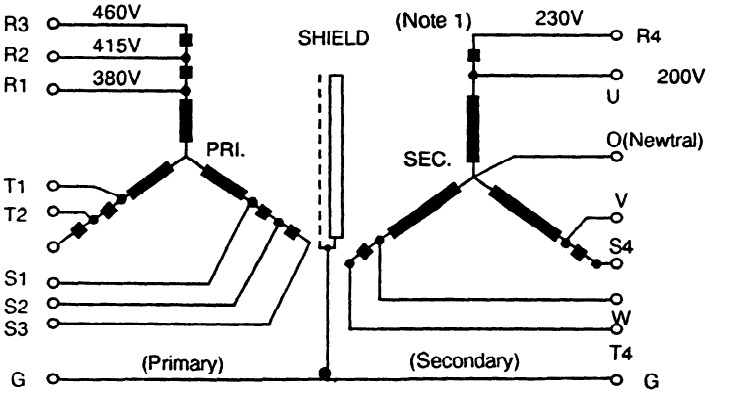
(2) FANUC power transformer specifications (Option)

Following five power transformers are available.

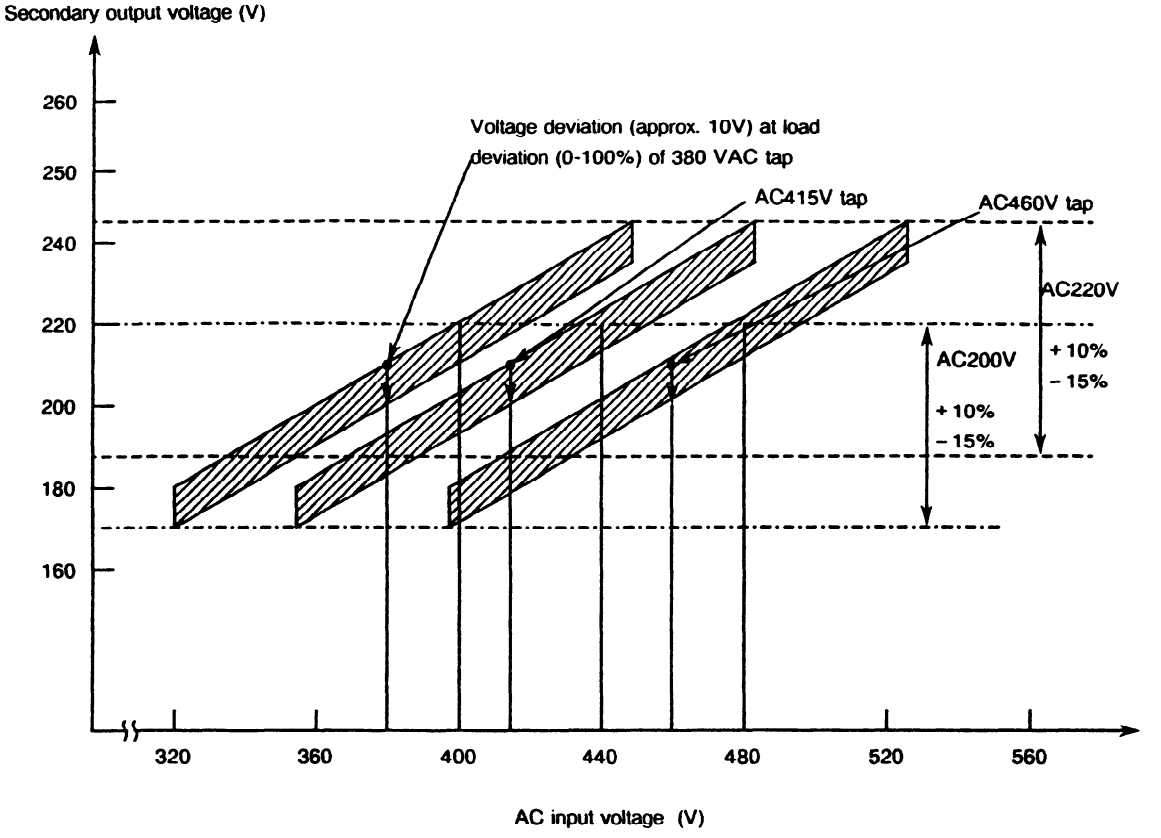
Select the servo unit according to the 30-minute rated power capacity.

Item \ Model		1S	1.5S	2S	3S	6S/ small type 6S	8S	12S	15S/ small type 15S	18S	22S	26S	30S/ small type 30S	40S
Order specification		A06B-6052-J001				A06B-6044-J006		A06B-6044-J007		A06B-6044-J010			A06B-6044-J015	
Entry drawing No.		A80L-0001-0496				A80L-0001-0313		A80L-0001-0314		A80L-0001-0352			A80L-0001-0452	
Rated capacity	Continuous	7kVA				15kVA		26kVA		40kVA			63kVA	
	30-minute	10kVA				20kVA		30kVA		45kVA			75kVA	
Rated primary voltage		380 / 415 / 460V + 10% − 15%, 230V + 10%, −15%, 50 / 60Hz ± 1Hz3φ (Secondary side is used for auto transformer)												
Rated primery current (continuous)		11A (at 380V) 10A (at 415V) 9A (at 460V)				23A (at 380V) 21A (at 415V) 19A (at 460V)		40A (at 380V) 36A (at 415V) 33A (at 460V)		61A (at 380V) 56A (at 415V) 51A (at 460V)			98A (at 380V) 90A (at 415V) 81A (at 460V)	
Rated secondary voltage		200V				200V		200V		200V			200V	
Rated secondary current (cont.)		20A				43A		74A		115A			185A	
Secondary voltage regulation		5%												
Secondary voltage deviation		± 3%												
Connection		Star-star connection												
Insulation		Class H (Max. temperature 180°C)												
Ambient temperature		0 - 45°C												
Allowable temperaturerise of transformer		135°C												
Humidy		MAX. 95%RH												
Type		All transformers are dry-type and self-cooling												
Dielectric voltage		2000 VAC, one minute												
Weight		Max. 61 kg				Max. 115 kg		Max. 165 kg		Max. 260 kg			Max. 375 kg	
External dimensions		8.1.10				8.1.11		8.1.12		8.1.13			8.1.14	

Connection



(3) Secondary output voltage



(4) Selection of Power Tap

Connect the transformer to the taps given in the following table according to AC input voltages.

Nominal input voltage	Taps used
AC380V + 10%, - 15%	R1, S1, T1, G (380V)
AC400V + 10%, - 15%	R1, S1, T1, G (380V)
AC415V + 10%, - 15%	R2, S2, T2, G (415V)
AC440V + 10%, - 15%	R2, S2, T2, G (415V)
AC460V + 10%, - 15%	R3, S3, T3, G (460V)
AC480V + 10%, - 15%	R3, S3, T3, G (460V)

(5) Cautions on use of transformer

(a) When mounting the transformer in a cabinet, separate it so as not to give a thermal influence to other unit.
(b) When mounting the transformer outside, be careful not to expose it to cutting chips and cutting oil slash directly.
(c) If the transformer may fall, mount it with bolts, etc.

4.2.4 Unit adapter

This unit is applied to the AC spindle servo unit models 6S to 26S, small type 15S and small type 30S with the inner ventilation type. When this stay is mounted the maximum depth is 345mm for models 6S-12S, small type 15S and 341mm for models 15S-22S, 26S. For details, refer to Chapter 8.

4.2.5 Fan unit (This unit is an option for models 30S and 40S.)

Order drawing No.: A06B-6044-K040
This is used when a fan is directly attached to the rear face of the unit for cooling the radiating section of the spindle servo unit for AC spindle motor models 30S and 40S.

[Fan motor specification]

Voltage V	Frequency Hz	Input W	Speed min^{-1}	Maximum air quantity mm^3/min	Maximum static pressure mmH_2O	Noise level phon	Highest allowable ambient temperature °C
200	50	43	2750	6.5	15	49	70
	60	40	3200	7.5	16	53	

Equivalent product:
Model 7556X made by TORYO KOSAN
FANUC order drawing No.:
Fan motor: A90L-0001-0049/A
Finger guard: A97L-0071-0001/A

5. INSTALLATION

5.1 Environemental Conditions

Install the AC spindle servo unit in a place which meets the following environmental conditions.

5.1.1 Ambient temperature

Ambient temperature of the unit: 0 to 55°C
Ambient temperature of the storage cabient: 0 to 45°C

5.1.2 Humidity

Normally 95% RH or below, and condensation-free

5.1.3 Vibration

In operation: Below 0.5G

5.1.4 Atmosphere

No corrosive or conductive mists or drops should deposit directly on the electronic circuits.

5.2 Input Power and Grounding

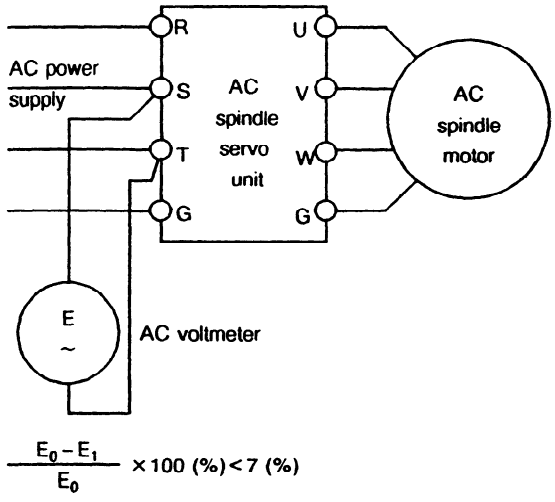
(1) Input power
- Nominal voltage rating: 200/220/230 VAC
- Allowable voltage deviation: − 15% to + 10%
- Power frequency: 50/60 Hz
- Allowable frequency deviation: ± 1 Hz
- Power impedance: Voltage deviation due to load (30 min. rating × 1.2 or when max. output range) should be less than 7%.

Such a system is adopted for AC spindle servo units that, during deceleration, the rotating energy of the motor is regenerated as shop power source using a transitor invertor (for models 1S to 26S, small type 6S, small type 15S and small type 30S) or a thyristor inverter (for models 30S, 40S, 30HV, 40HV and 60HV). For this reason, they are subject to the following restrictions or influences when the power impedance is large. Therefore, be careful when using a power transformer with a comparatively small capacity or a long cable.

(1) When power impedance is large, it may be necessary to reduce the regeneration current in order to lengthen the deceleration time.

(2) Other devices and the like may be influenced by the distortion of voltage waveform caused by the commutation change of a regenerative inverter.

- Method to check power impedance



$$\frac{E_0 - E_1}{E_0} \times 100\ (\%) < 7\ (\%)$$

where,

E_0: Voltage at motor stop

E_1: Voltage during motor acceleration or voltage immediately before the start of speed reduction with the application of load.

- Power supply unbalance: The range of voltage fluctuation between each phase of a 3-phase power supply is the rated voltage ± 5% or less.
- Install a breaker having an adequate voltage capacity for protection in the input section of the AC spindle servo unit. See 5.3.
- When the AC spindle motor provides most of the power for the entire machine, a low voltage phase advancing condensor must be installed.
- Alarm No. 4 may light up in response to input power supply open phase and momentary power failure. (Models 30S - 40S).
- Leakage current at AC spindle motor drive

  As the drive circuit uses a transistor-pulse duration modulation control system, high-frequency leakage current components flow to the earth via the spindle motor and connecting cables. However, for cables of 50 m or less in length, the 50/60 Hz leakage current is equal to or less than the non-operating current (15 mA) of the general high-sensitivity, high-speed earth leakage breaker.
- Radio noise

  As the drive circuit uses a pulse duration modulation control system, high-frequency current when switching over the transistor may cause generation of noise if a radio is installed close to the AC spindle motor and the drive circuit.

  The noise will have an effect on AM radio, but not on FM radio or TV. Consider the following items as measures related to mounting and machinery installation in order to minimize radio noise.

(a) Install the AC spindle servo unit in a metal cabinet.
(b) Run the connection cable which exists between the AC spindle servo unit and the AC spindle motor, through a metal duct and earth the duct.
(c) Make connections between the terminals of the AC spindle servo unit and the AC spindle motor (the G terminals of each unit) as specifications.

(2) Ground

Be sure to ground cables shown below.

- Ground cable of input power supply
- Ground cable of an AC spindle servo unit and motor

5.3 Protection against Overcurrent

The machine tool builder must prepare an overcurrent protector such as a circuit breaker with appropriate capacity and use it for the input power circuit. Select a protective device with a capacity that is 1.2 times the 30-min. rated power source capacity.

Rated current $\fallingdotseq$ 30-min. rated power source capacity $\times$ 1.2 $\div$ 200 [V] $\div \sqrt{3}$

6. UNIT CALORIFIC VALUE

Model	1S	2S	3S	6S/ small type 6S	8S	12S	15S/ small type 15S	18S	22S	26S	Small type 30S	30S	40S
Caloric value at continuous rated output [W]	230	250	290	360	440	600	750	900	1070	1250	1500	2000	2400

7. COOLING

The AC spindle servo unit S series employs the structure of eternal cooling for the radiating section of the power circuit. It is required to consider a forced-air cooling for cooling the radiating section of the power circuit.

(1) Models 1S - 3S, small type 6S
A fan motor for cooling has been built in. Give consideration to the inlet and output ports so that a sufficient wind speed may be obtained for forced-air cooling.

(2) Models 6S - 40S, small type 15S, small type 30S
A fan motor for cooling is not built in. A cooling fan motor required for forced-air cooling should by prepared by the machine manufacturer.

(Note) If he unit is not cooled properly, an overheat alarm or a problem may occur.

7.1 Cooling the AC Spindle Servo Unit

7.1.1 Models 1S - 3S, small type 6S

The AC spindle servo unit has such a construction that the radiating section of the power circuit section, the main heat generating section, is externally cooled by a built-in fan motor. Therefore, give consideration to the inlet and output ports so that a sufficient wind speed may be obtained for forced-air cooling, which can radiate 70% of the carolic value.

7.1.2 Models 6S - 22S

Cool the radiating section of the AC spindle servo unit using a wind and with a wind shown in Table 7.1.2, which can radiate 70% of the carolic value. See the diagram of the cooling system.

Table 7.1.2 Cooling the AC spindle servo unit

Model	6S - 12S	15S - 22S
Wind speed	More than 3 m/sec	More than 3.5 m/sec

(Note) When the servo unit model 22S drives motor model 40P, the cooling condition should be the same as model 26 described in 7.1.4.

7.1.3 Small model 15S

Cool the radiating section of the AC spindle servo unit using a wind as shown in Fig. 7.1. Use two fan motors equivalent to model 5915PT-20W-B30-S04 manufactured by Minebea Co., Ltd. See the diagram of the cooling system.

7.1.4 Model 26S, small type 30S

Cool the radiating section of the AC spindle servo unit using a wind. Use four fan motors equivalent to the model 5915PT-20W-B30-S04 made by N.M.B. See the diagram of the cooling system.

(Note) Magnetic cabinet structure to be employed to prevent fan motor wind leakage whenever a forced-air cooling is performed.

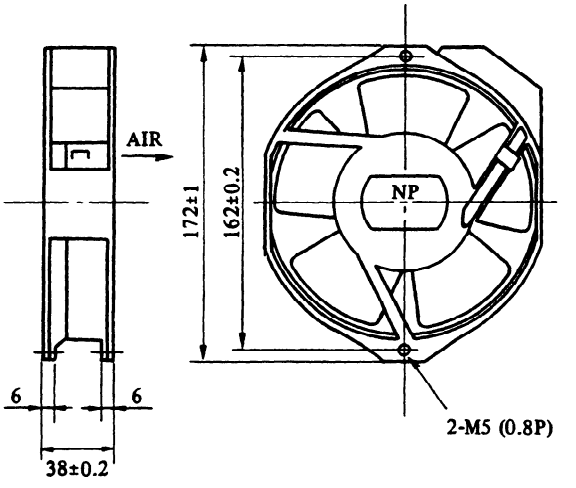
(Remarks) With respect to the models 6S to 22S, the required wind speed is obtained by using a unit adapter.

The unit adapter for models 6S to 12S has one 3-phase fan motor. The unit adapter for models 15S to 22S and small model 15S has two 3-phase fan motors. The unit adapter for models 26S and small model 30S has four 3-phase fan motors.
Each fan motor is a Minebea model 5915PT-20W-B30-S04.
An example of a 3-phase cooling fan motor, Minebea model 5915PT, is shown below.

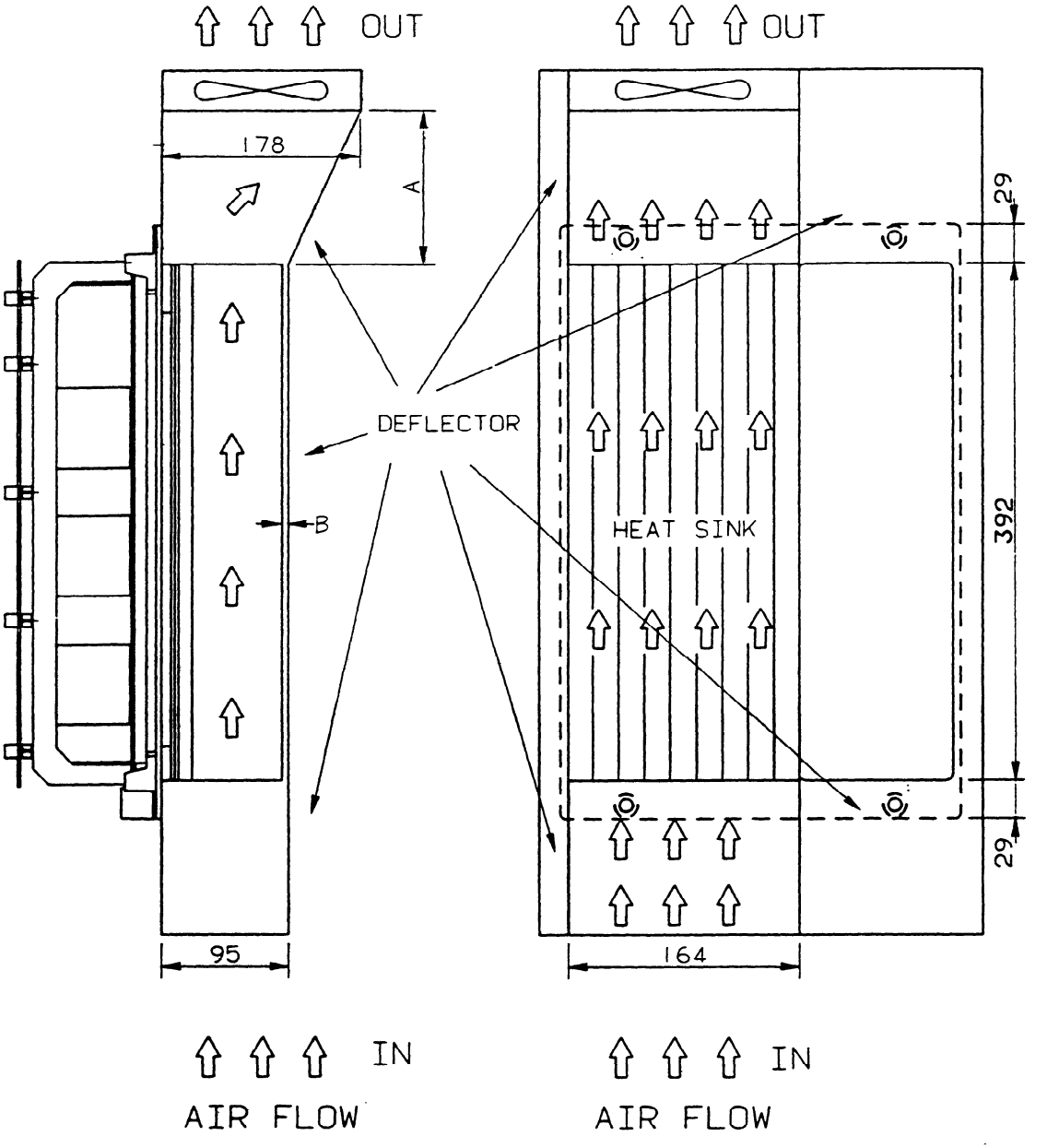
[Specifications]

Model		A90L-0001-0371 (5915PC-20W-B30-S04)	
Voltage	V	200, 3ϕ, +20%, −15%	200, 3ϕ, +30%, −15%
Frequency	Hz	50	60
Max. airflow	m^3/min	5.5	6.3
Max. static pressure	mmAq	13	14.5
Speed	min^{-1}	2650	2900
Current	A	0.18	0.22
Input power	W	26.0	26.0
Noise	dB	53	55
Weight	kg		
		0.8	

[External dimensions]



[Reference of Cooling system] Models 6S to 12S



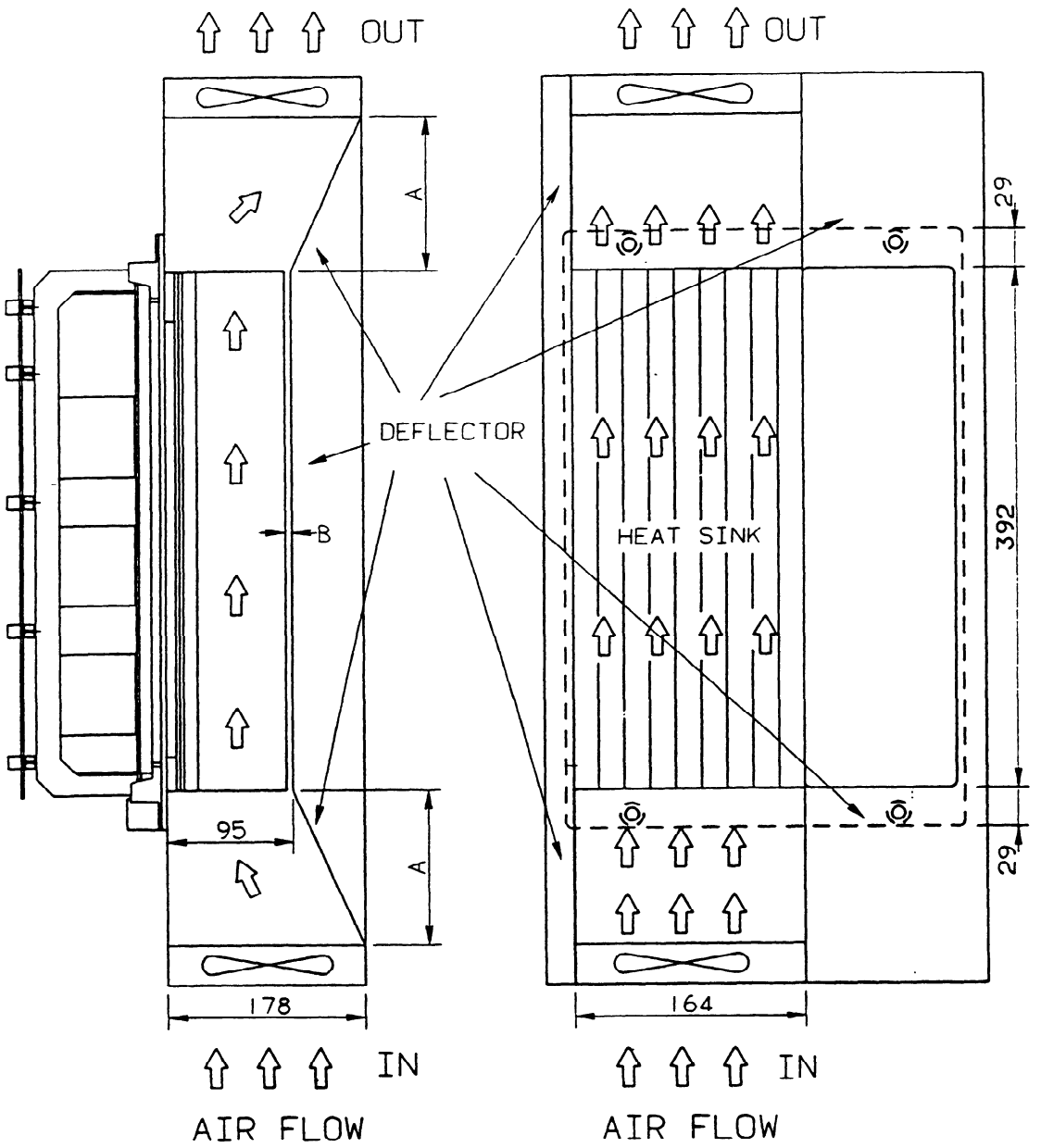
(Note 1) Dimension A must be 50mm or more.

(Note 2) Dimension B (gap between the radiator and duct) must be approx. 5mm so that the duct does not directly touch the radiator. This is because the radiating section (resistor) becomes very hot.

(Note 3) Use Minebea fan motors, model 5915PC-20W-B20-04 or equivalent. The air flow is 5.5m^3/min at 50 Hz or 6.0m^3/min at 60Hz. Prepare two fan motors for models 6S to 12S.

(Note 4) Mount a deflector so that air strikes the heat sink directly.

[Reference of Cooling system] Model 15S Small type



(Note 1) Dimension A must be 50 mm or more.

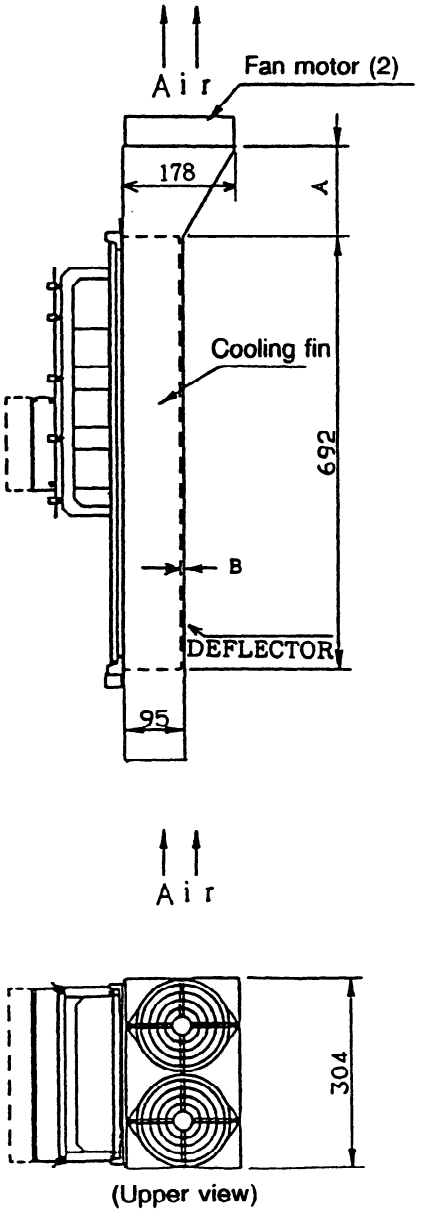
(Note 2) Dimension B (gap between the radiator and duct) must be approx. 5 mm so that the duct does not directly touch the radiator. This is because the radiating section (resistor) becomes very hot.

(Note 3) Use Minebea fan motors, model 5915PC-20W-B20-04 or equivalent. The air flow is 5.5 m^3/min at 50 Hz or 6.0 m^3/min at 60 Hz. Prepare two fan motors for small model 15S and models 15S.

(Note 4) Mount a deflector so that air strikes the heat sink directly.

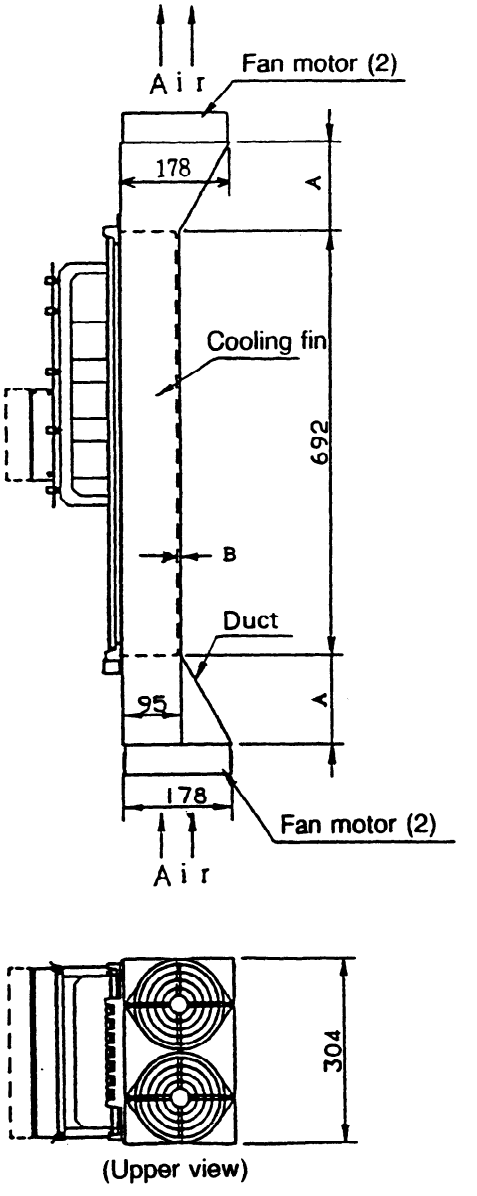
[Reference of Cooling system] Models 15S to 22S, 26S and 30S Small type

Models 15S to 22S



(Upper view)

Model 26S, 30S Small type



(Upper view)

(Note 1) Dimension A must be 50mm or more.

(Note 2) Dimension B (gap between the radiator and duct) must be approx. 5mm so that the duct does not directly touch the radiator. This is because the radiating section (resistor) becomes very hot.

(Note 3) Use Minebea fan motors, model 5915PC-20W-B20-04 or equivalent. The air flow is 5.5m^3/min at 50 Hz or 6.0m^3/min at 60Hz. Prepare two fan motors for models 15S to 22S, and four fan motors for models 26S and small type model 30S.

(Note 4) Mount a deflector so that air strikes the heat sink directly.

7.1.5 Models 30S and 40S

70% of the carolic value generated by a unit can be radiated by attaching an appropriate fan motor.

(1) Fan motor with required wind speed/air quantity

Model	Models 30S and 40S
Wind speed	——
Air quantity output	4.5m³/min or larger
Fan motor	7556X by TORYO or equivalent (2)

(2) Required air quantity and ventilation route

Make sure to supply an air quantity of 4.5m³/min or more from the air inlet.
For supplying air, it is recommended to supply cooling air from the inlet so that the fan motor can be used for a long time. An optional fan unit can be attached directly to the air inlet as shown in the external dimensions in 8.1.6 or 8.1.7. In that occasion, keep a space of 50mm or more on the back side of the fan motor.
For designing a ventilation route, make good use of the M4 tap holes prepared around the inlet and outlet ports (six holes for each.

(3) Cautions for air supply

When the condition of the environment is not good, such troubles are expected that after a long time the radiation capacity will by reduced, leakage will occur due to the deterioration of insulation in the resistor section, and the like. To prevent these troubles, make sure to supply air through an air filter. For filter dimension, select one so that a required quantity of air can be obtained.
Air filter: VILEDON PS/600 (by JAPAN Vilene CO., LTD.)
Fan motor: Model 7556 (2) by TORYO KOSAN

(4) Cautions for outlet

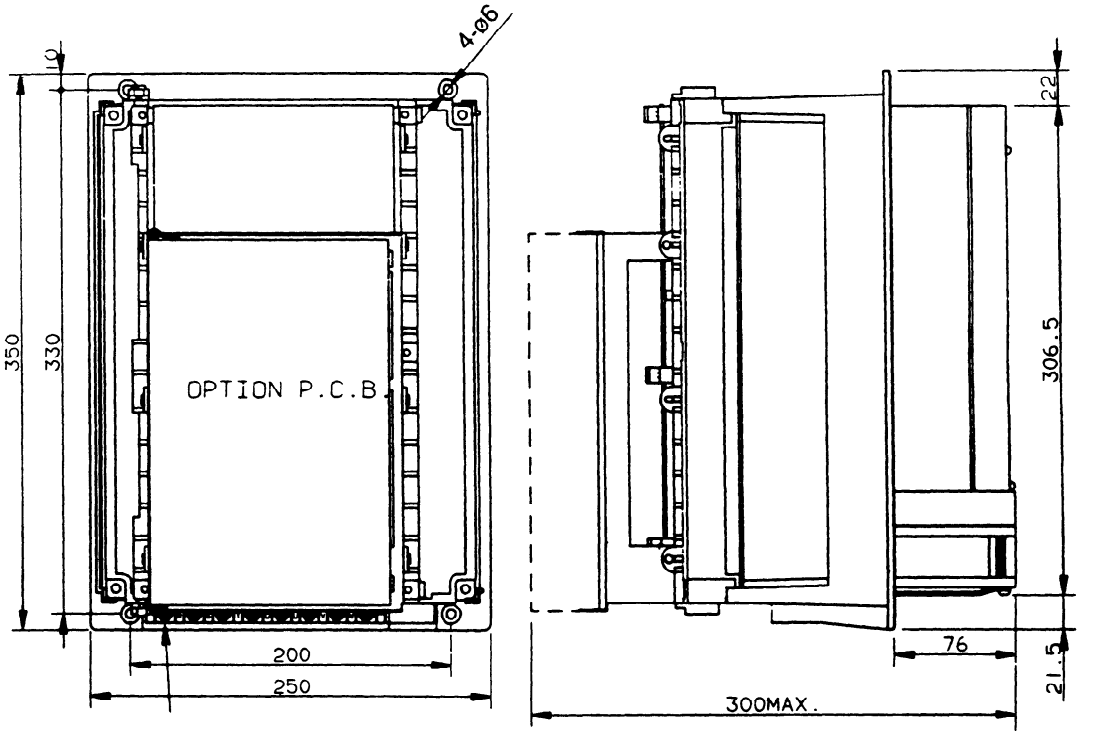
Take care so that machine oil may not flow in, or metal chips may not rush into through the outlet.

8. EXTERNAL DIMENSIONS AND MAINTENANCE AREA

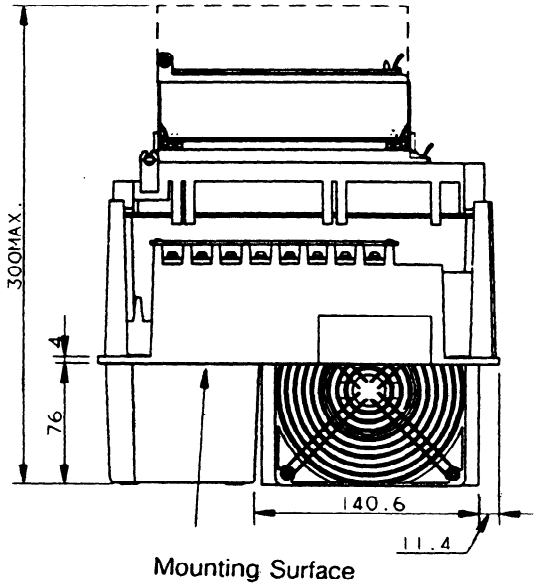
8.1 External Dimensions

Refer to the next subsection for the external dimensions of the basic unit. Also for the optional units, refer to each subsection for its external dimensions.

8.1.1 AC spindle servo unit models 1S - 3S, small type model 6S (with an option)



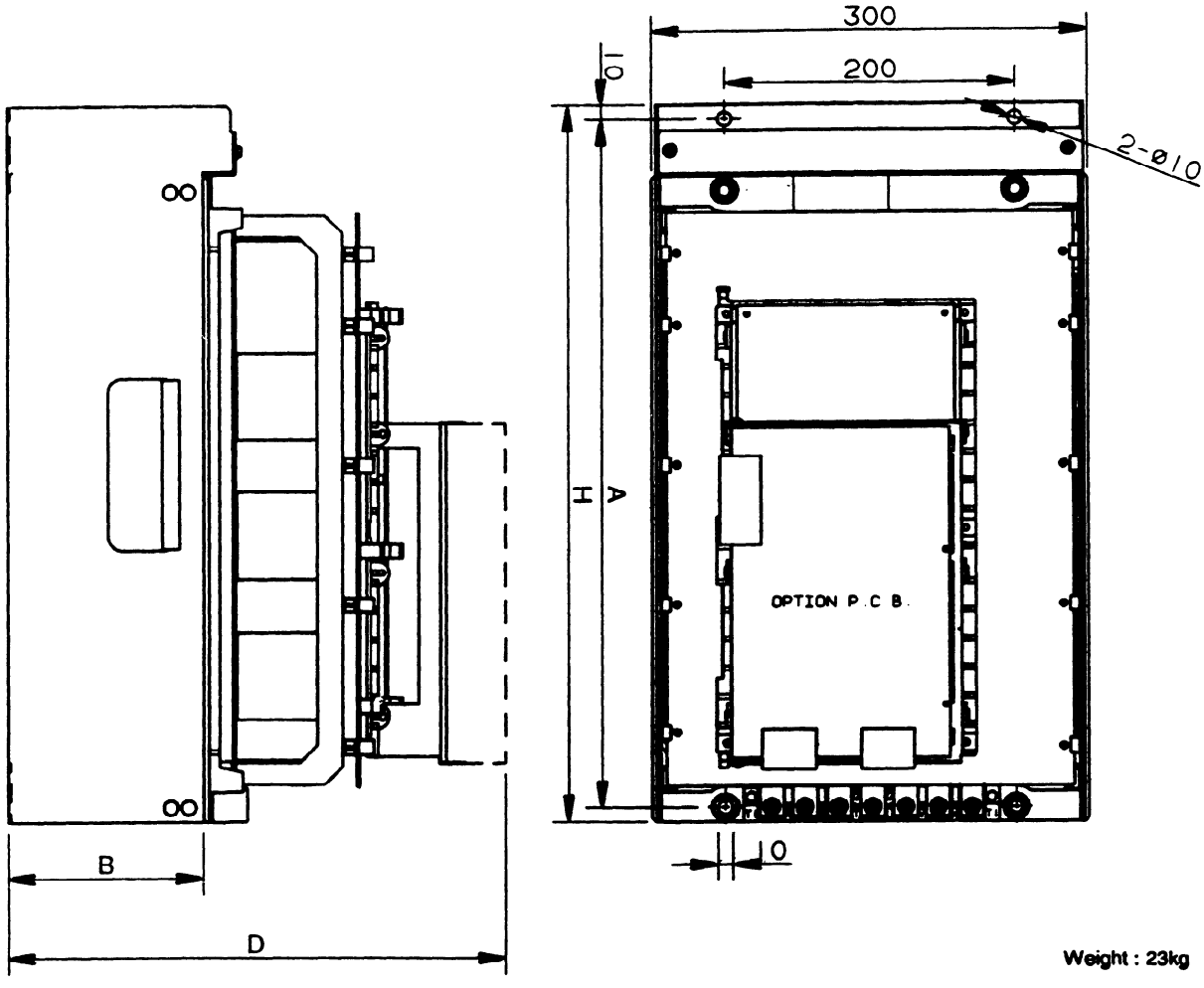
Terminal screw M4 (8 points)



Mounting Surface

Weight: 13kg

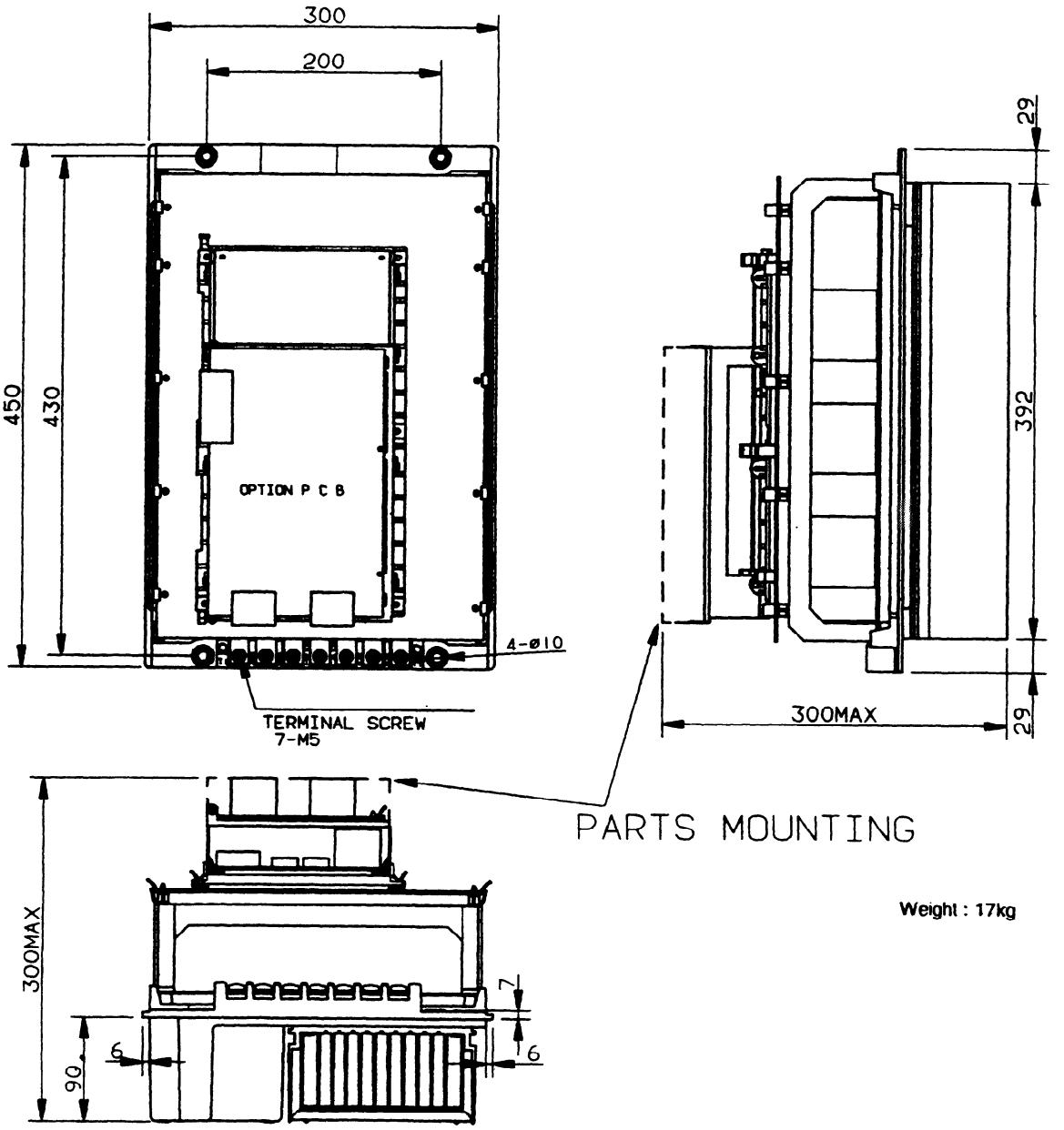
8.1.2 AC spindle servo unit models 6S - 12S, small type model 15S (with unit adaptor)



Weight : 23kg

Model	H mm	A mm	D mm	B mm
6S - 12S	500	480	345	135
Small type 15S	600	580	364	154

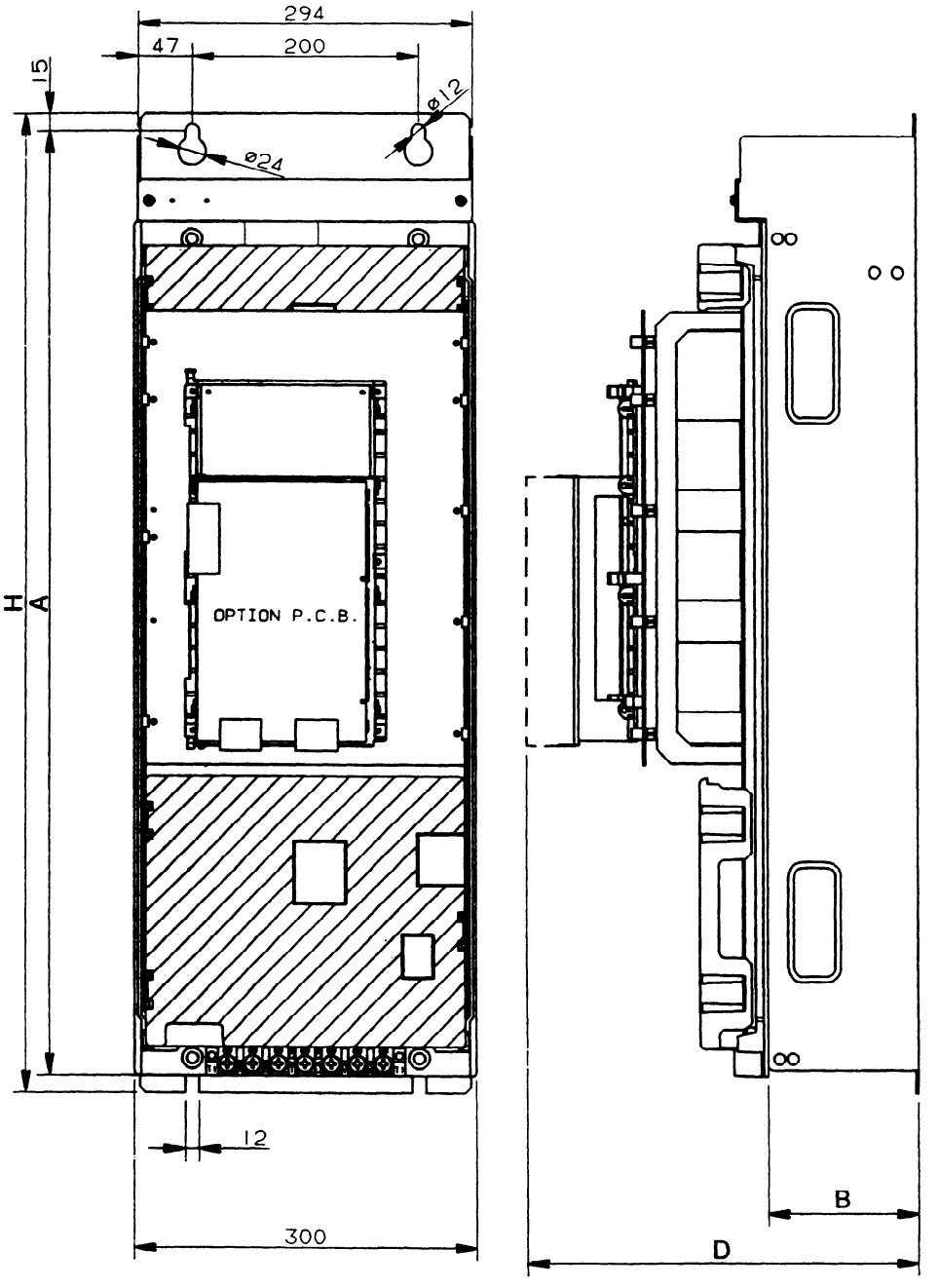
8.1.3 AC spindle servo unit models 6S - 12S, small type model 15S (without unit adaptor)



Weight : 17kg

8.1.4 AC spindle servo unit models 15S - 22S, 26S, small type model 30S (with unit adaptor)

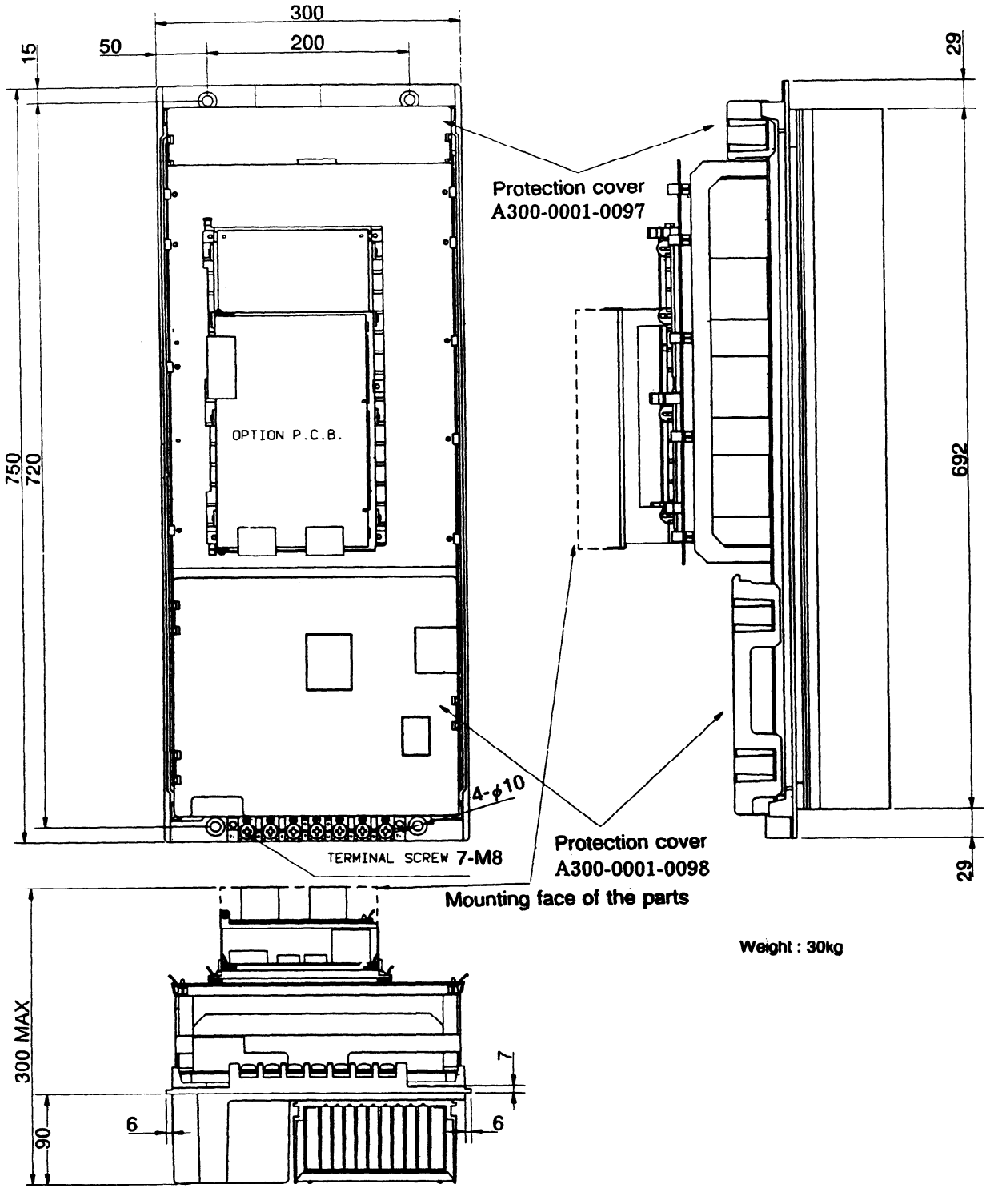
(Refer to 8.1.6 for the external dimensions for the unit adaptor.)



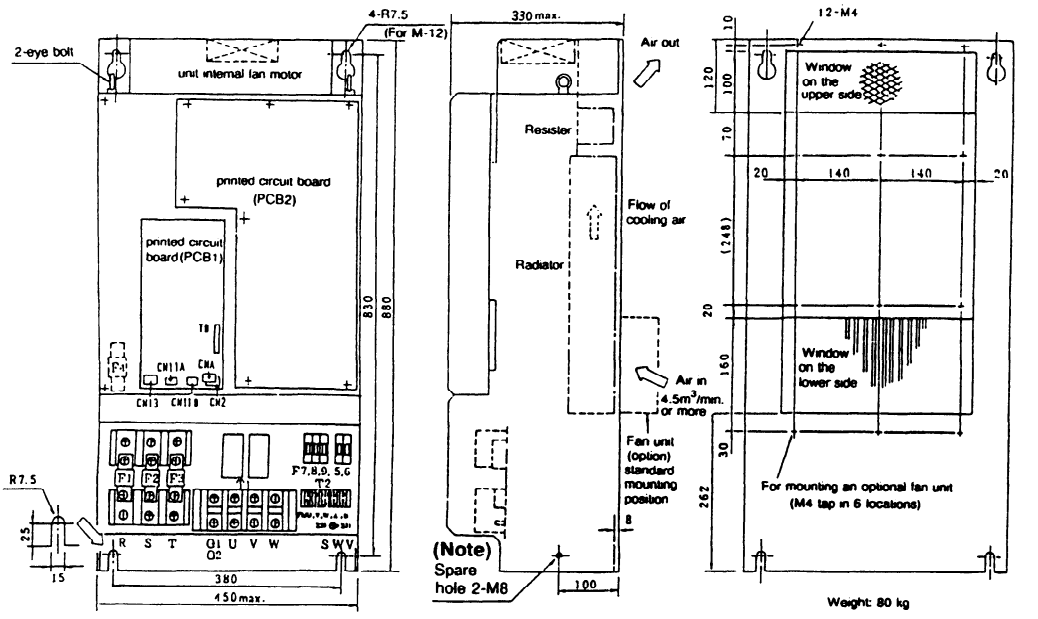
Weight : 40kg

Model	H mm	A mm	D mm	B mm
15S - 22S	860	830	341	131
Small type 15S	955	925	388	178

8.1.5 AC spindle servo unit models 15S - 26S, small type model 30S (without unit adaptor)

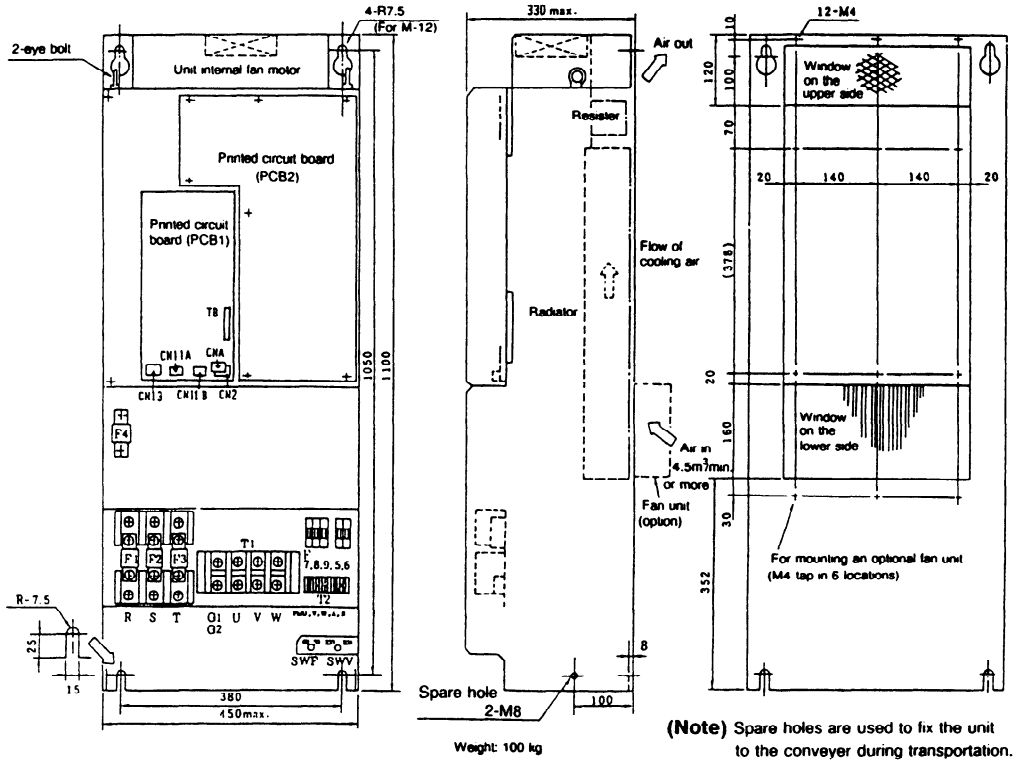


8.1.6 AC spindle servo unit model 30S



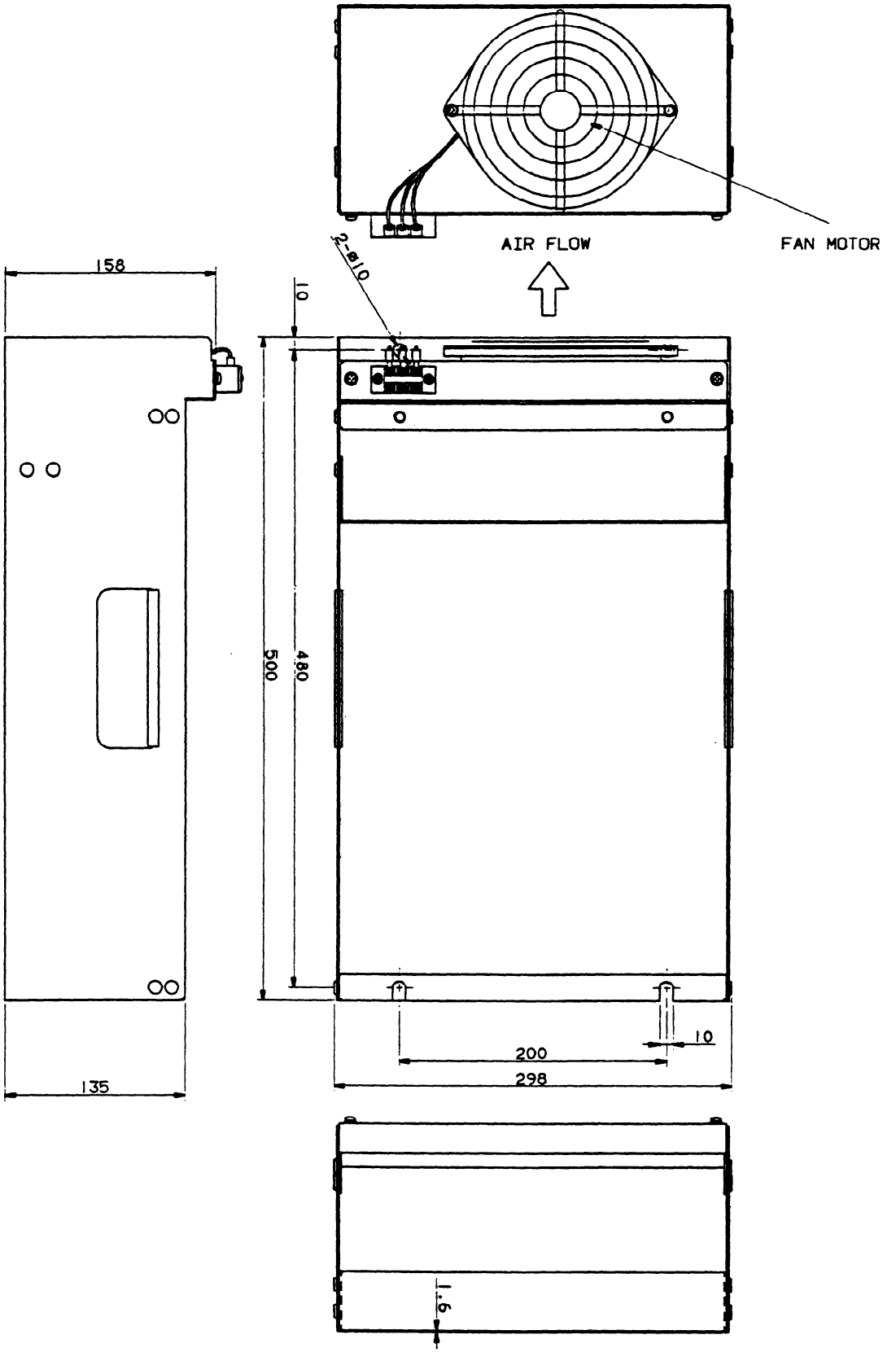
(Note) Spare holes are used to fix the unit to the conveyer during transportation.

8.1.7 AC spindle servo unit model 40S

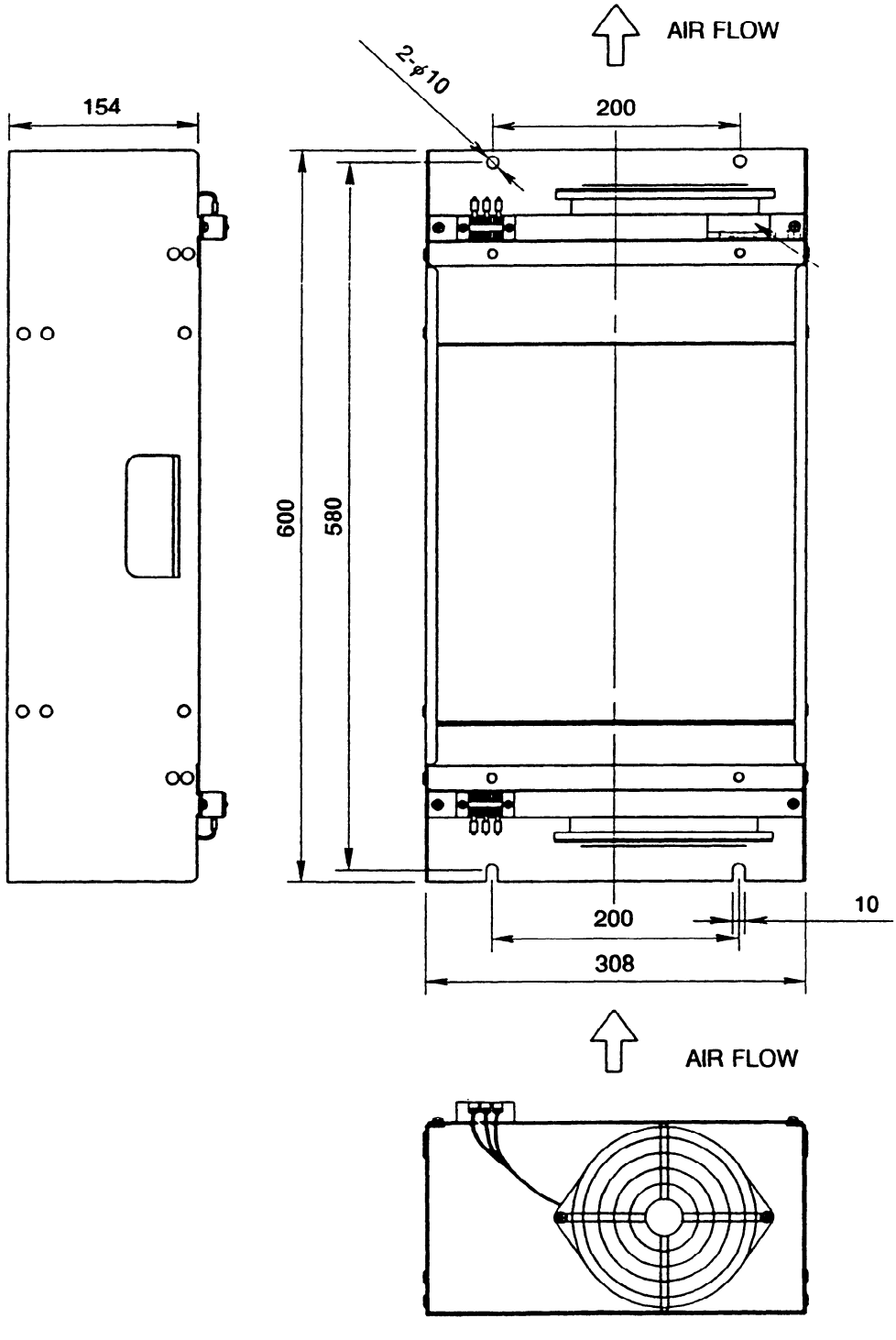


(Note) Spare holes are used to fix the unit to the conveyer during transportation.

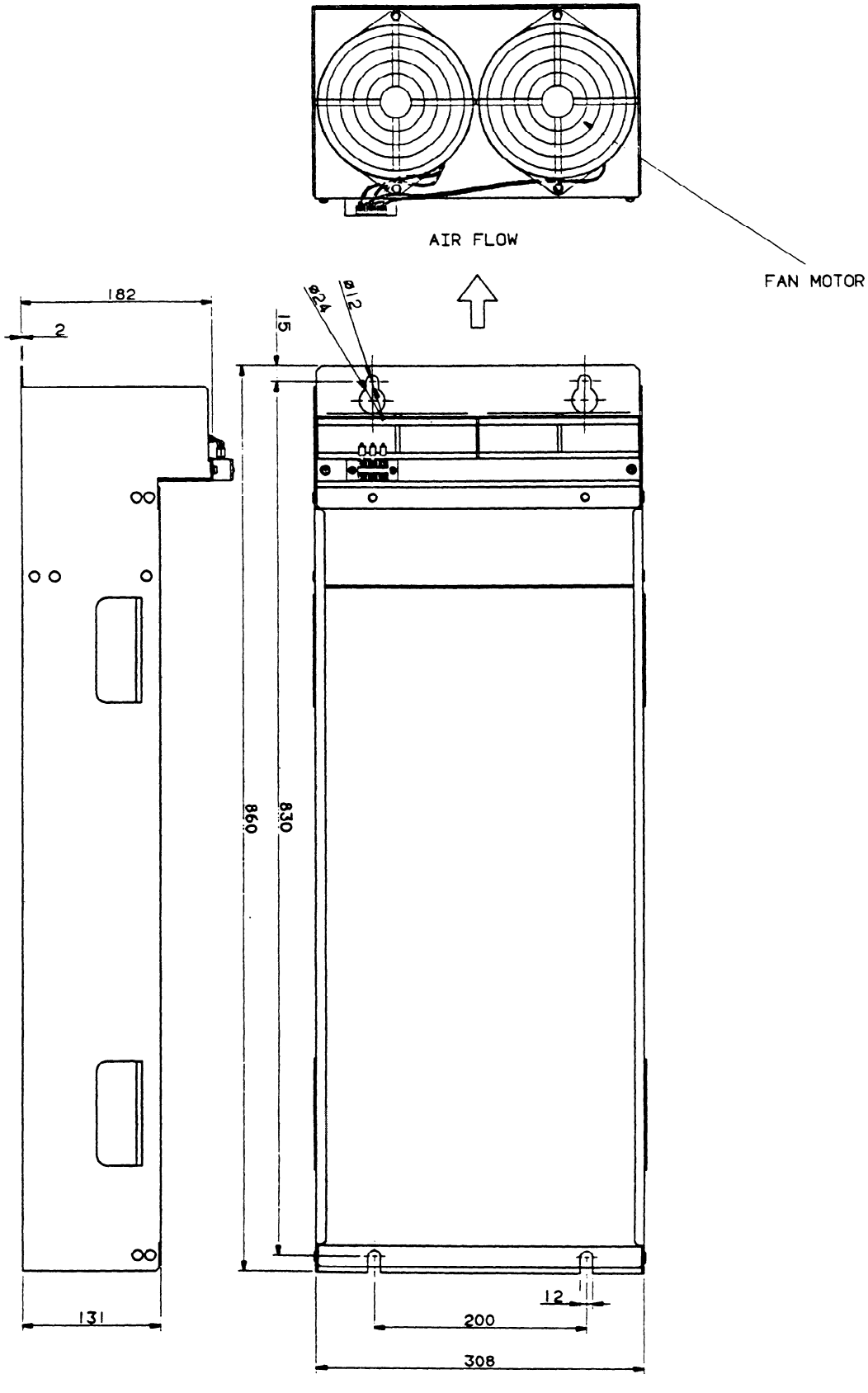
8.1.8 Unit adapter models 6S - 12S
(Order Spec. DWG No.: A06B-6059-K031)



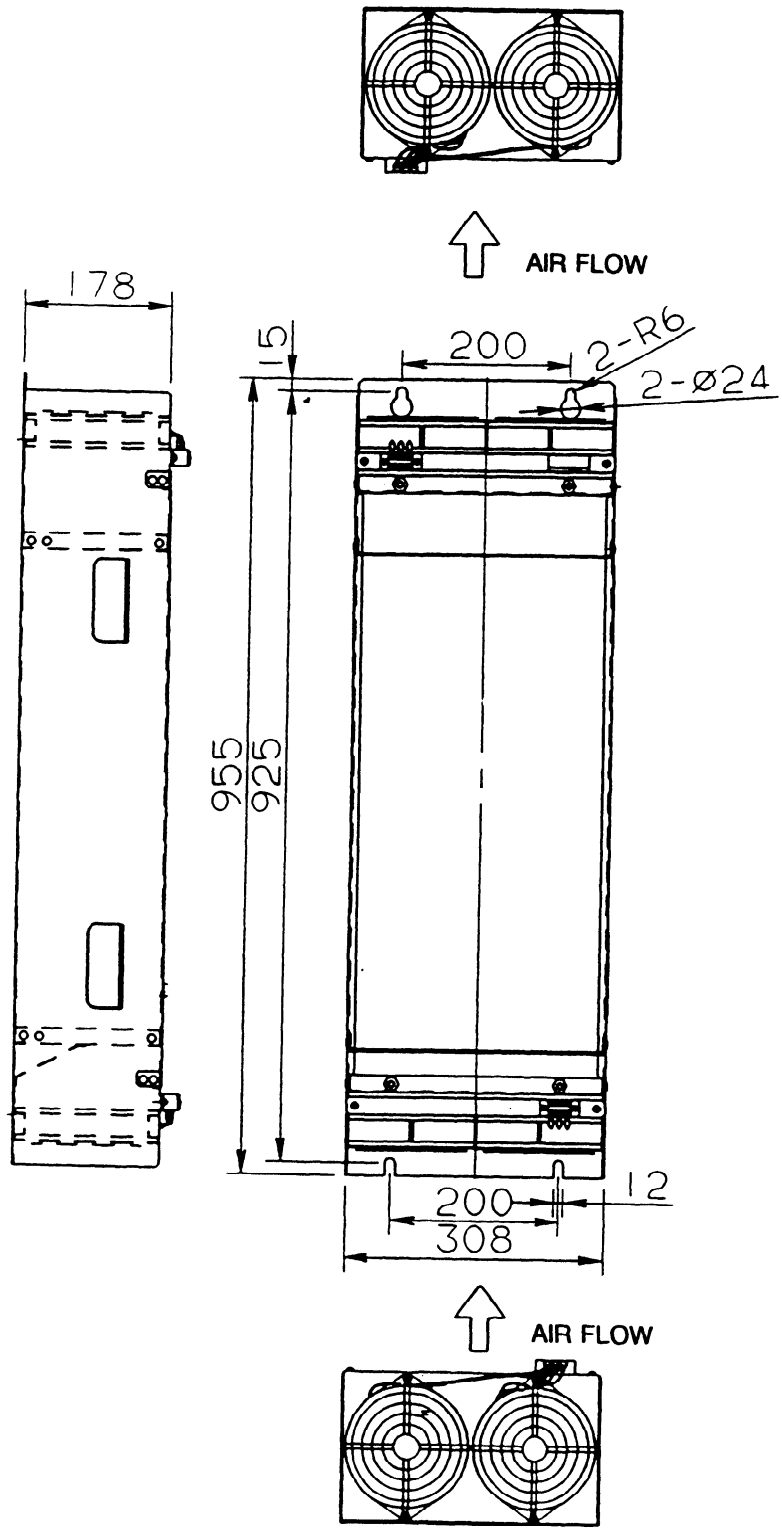
8.1.9 Unit adapter small type model 15S (Order Spec. DWG No.: A06B-6059-K033)



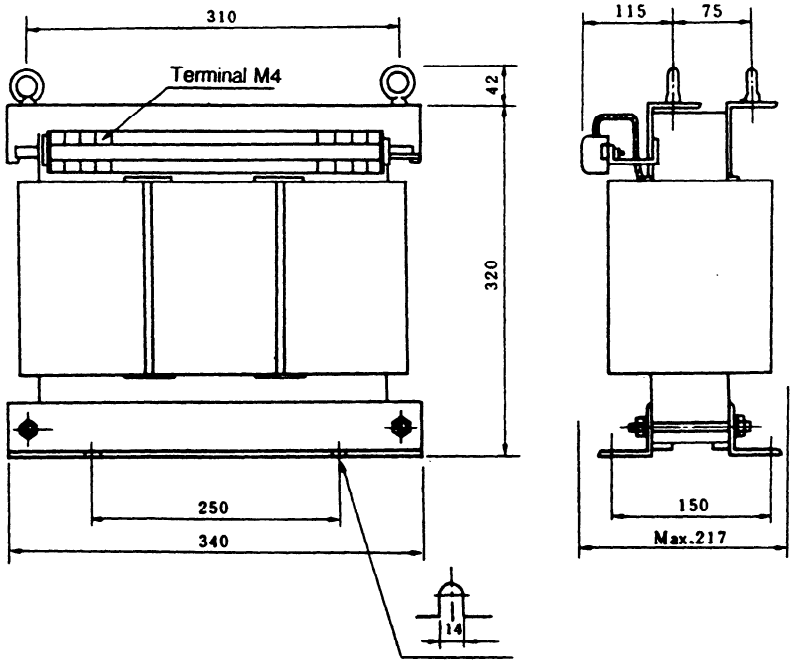
8.1.10 Unit adapter models 15S - 22S
(Order Spec. DWG No.: A06B-6059-K032)



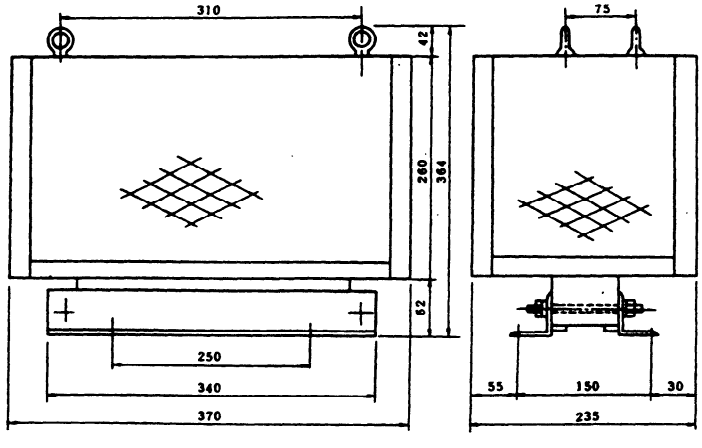
8.1.11 Unit adapter model 26S, small type model 30S (Order Spec. DWG No.: A06B-6059-K038)



8.1.12 Power transformer for models 1S - 3S (Order Spec. DWG No.: A06B-6052-J001)

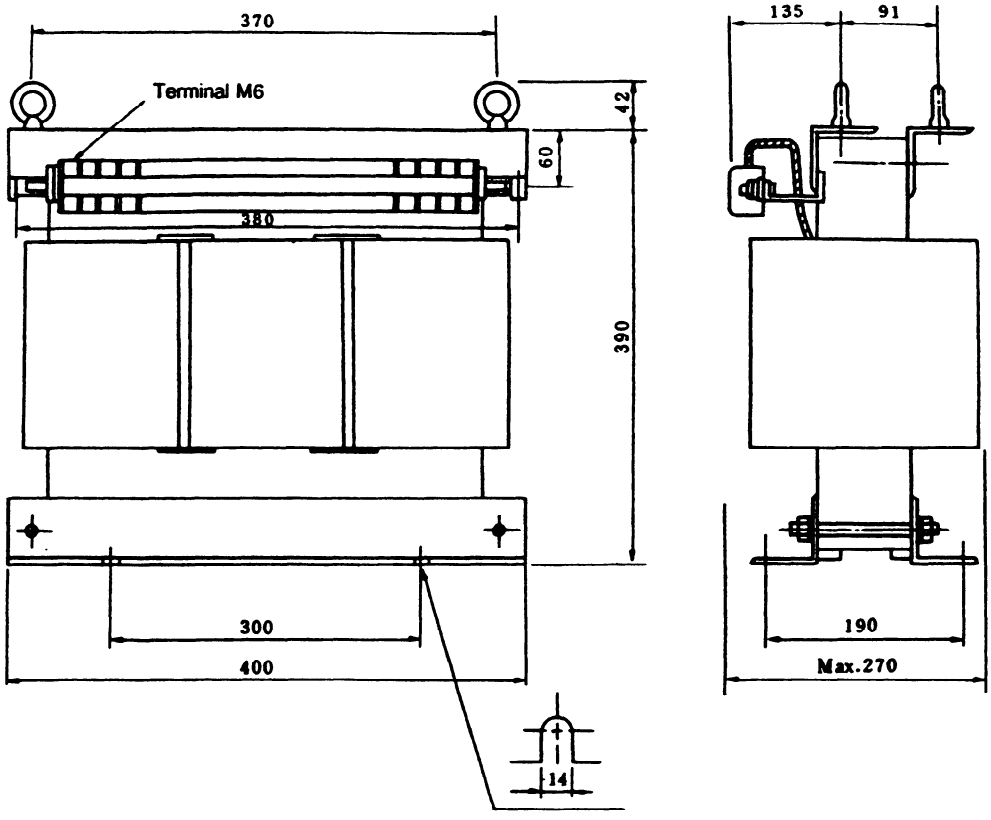


Dimensions of transformer without cover (Models 1S - 3S)

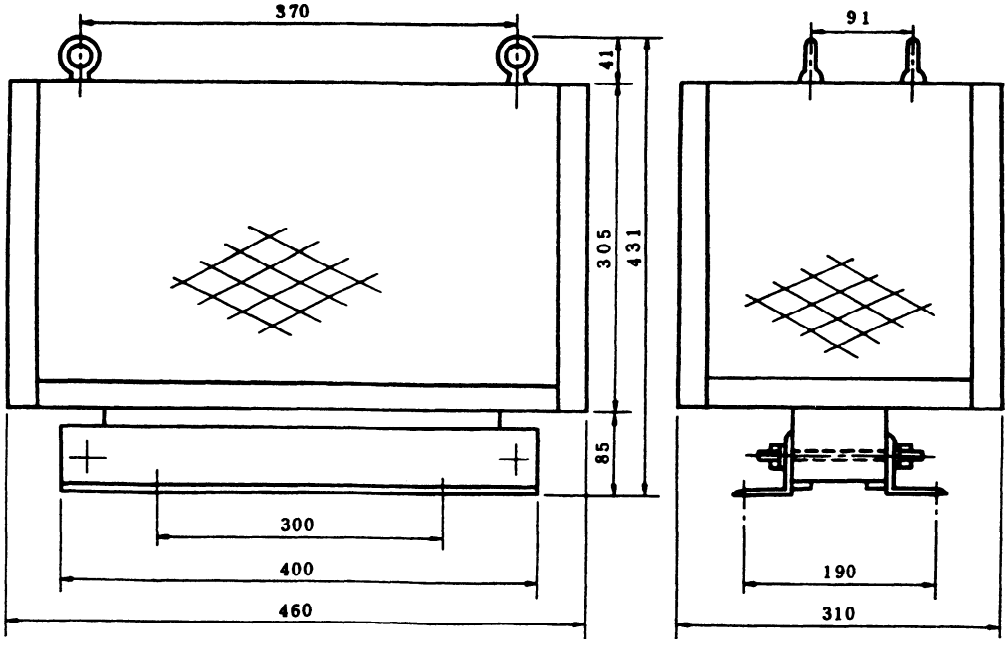


Dimensions of transformer with cover (Models 1S - 3S)

8.1.13 Power transformer for models 6S, 8S, small type model 6S (Order Spec. DWG No.: A06B-6044-J006)



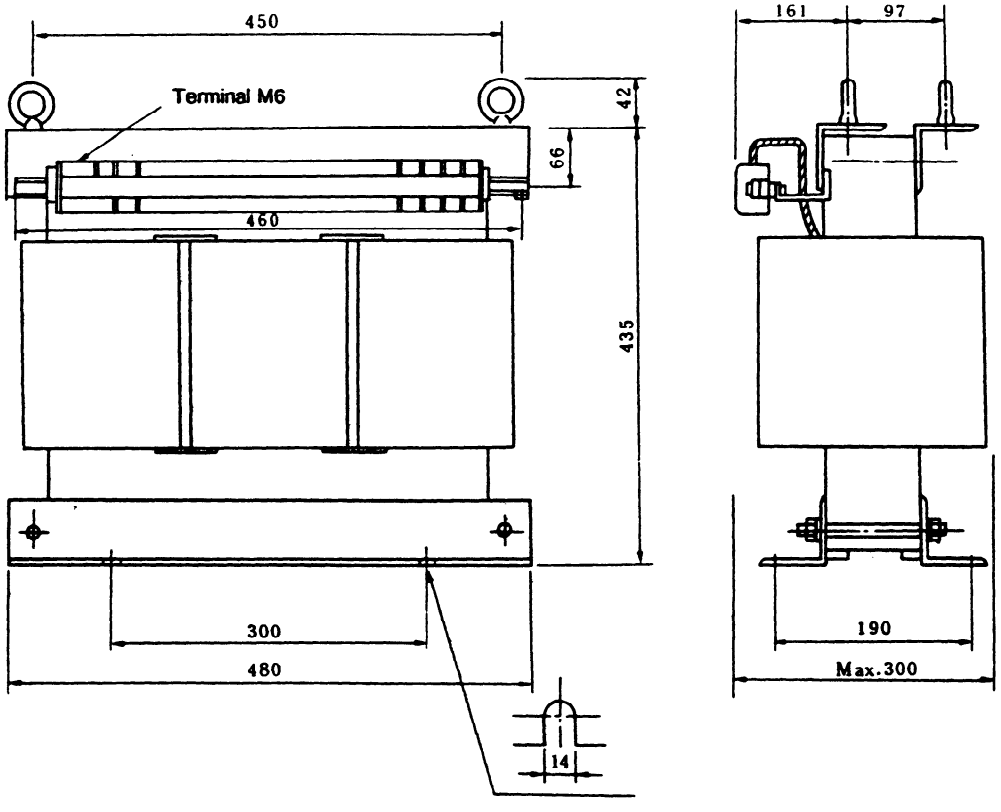
Dimensions of transformer without cover (Models 6S, 8S, small type 6S)



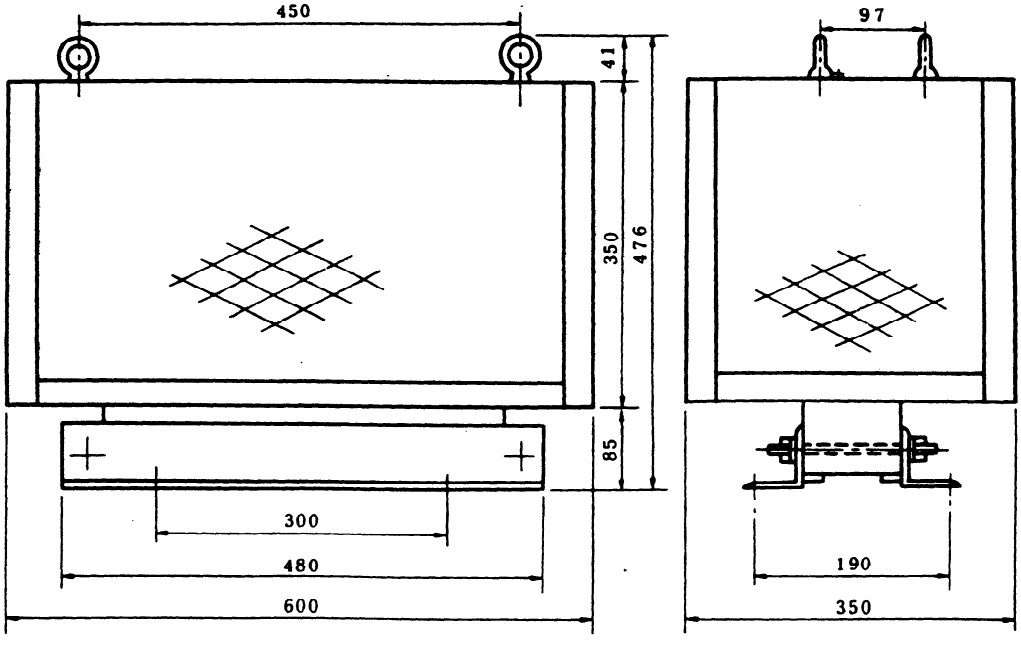
(Note) Nets are covered on four sides and the plate is covered on the top.

Dimensions of transformer with cover (models 6S, 8S, small type 6S)

8.1.14 Power transformer for models 12S, 15S, small type model 15S (Order Spec. DWG No.: A06B-6044-J007)



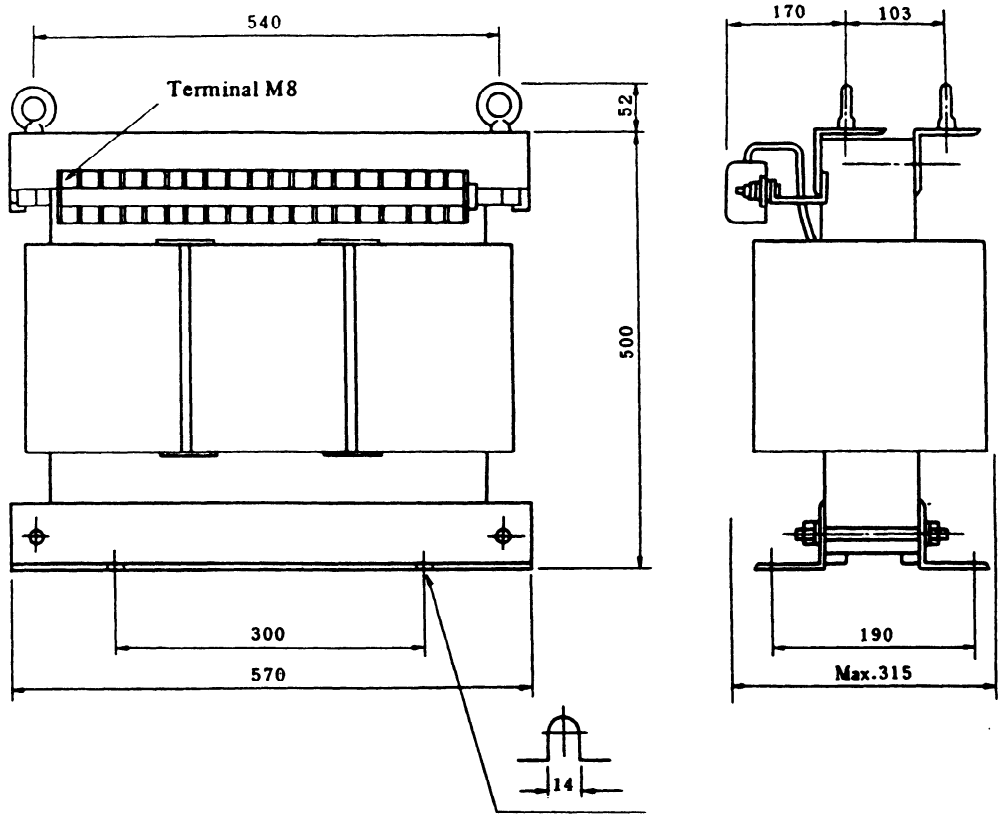
Dimensions of transformer without cover (Models 12S, 15S, small type 15S)



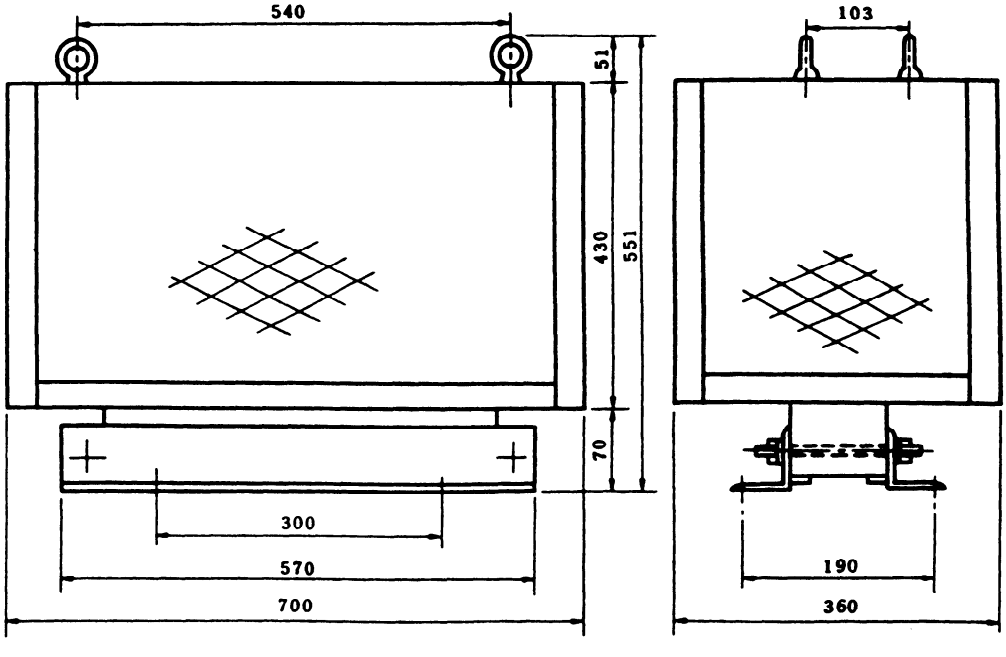
(Note) Nets are covered on four sides and the plate is covered on the top.

Dimensions of transformer with cover (Models 12S, 15S, small type 15S)

8.1.15 Power transformer for models 18S, 22S, 26S (Order Spec. DWG No.: A06B-6044-J010)



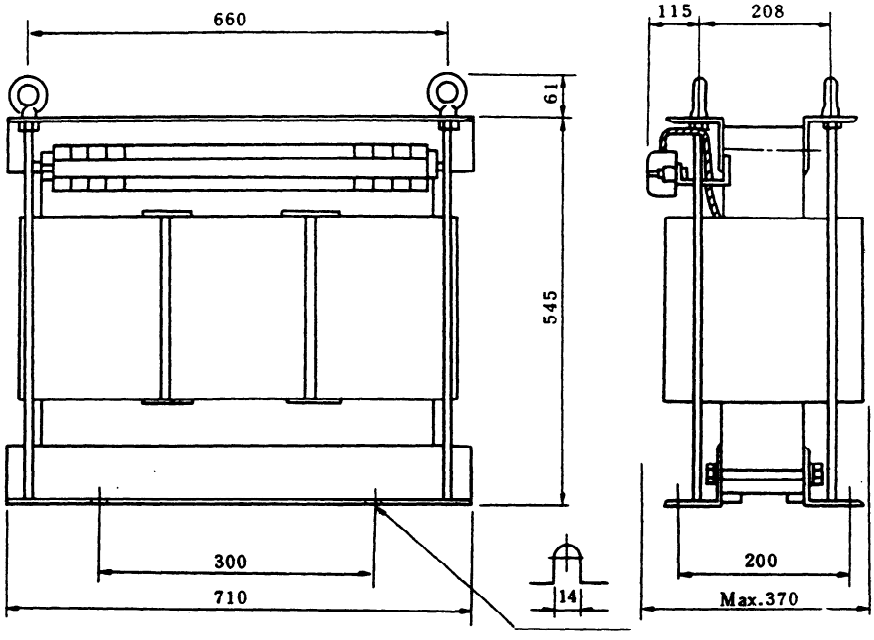
Dimensions of transformer without cover for models 18S, 22S



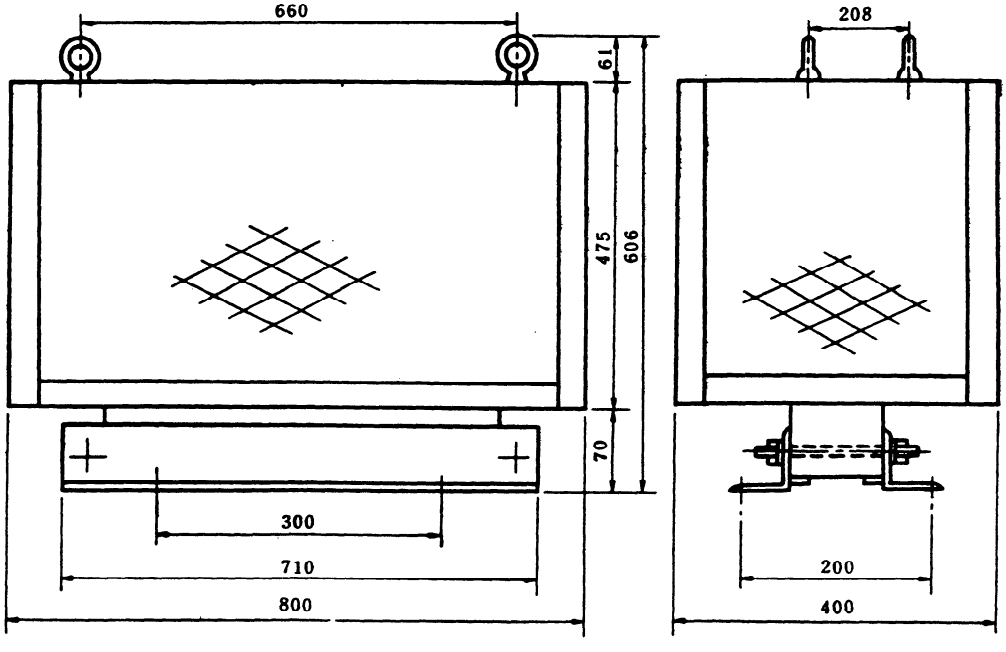
(Note) Nets are covered on four sides and the plate is covered on the top.

Dimensions of transformer with cover for models 18S, 22S, 26S

8.1.16 Power transformer for small type model 30S, models 30S, 40S (Order Spec. DWG No.: A06B-6044-J015)

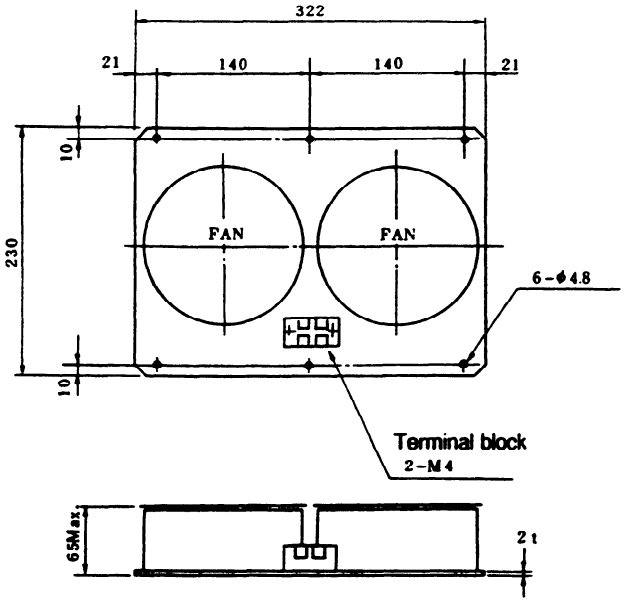


Dimensions of transformer without cover (small type 30S, models 30S, 40S)



Dimensions of transformer with cover (small type 30S, models 30S, 40S)

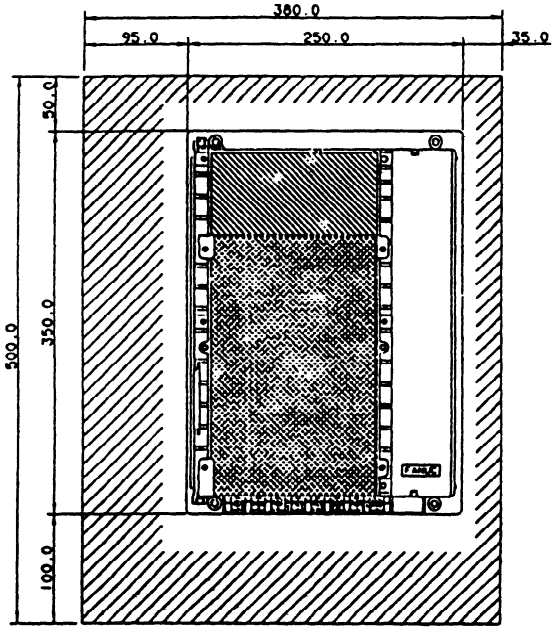
8.1.17 Fan unit for models 30S, 40S (Order Spec. DWG No.: A06B-6044-K040)



(Note) The six M4 screws for mounting the fan unit are to be prepared by the user.

8.2 Maintenance Area

8.2.1 AC spindle servo unit models 1S - 3S, small type model 6S (with an optional PCB)



A

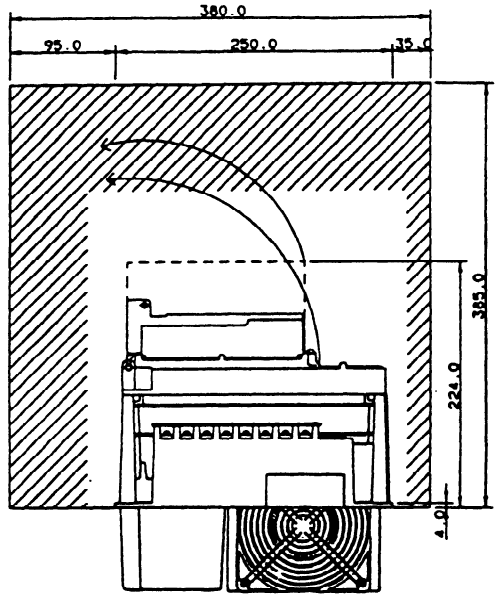
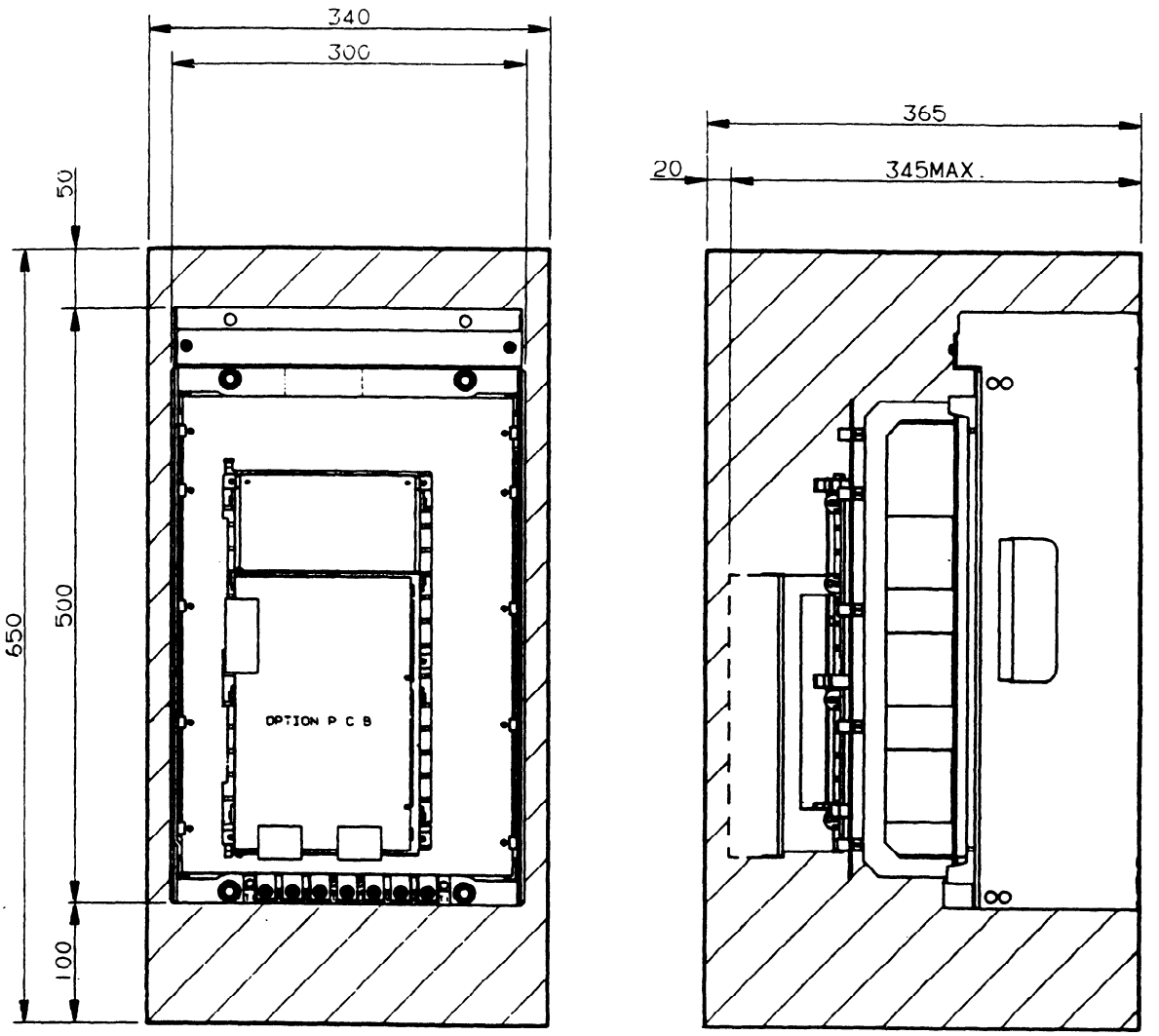


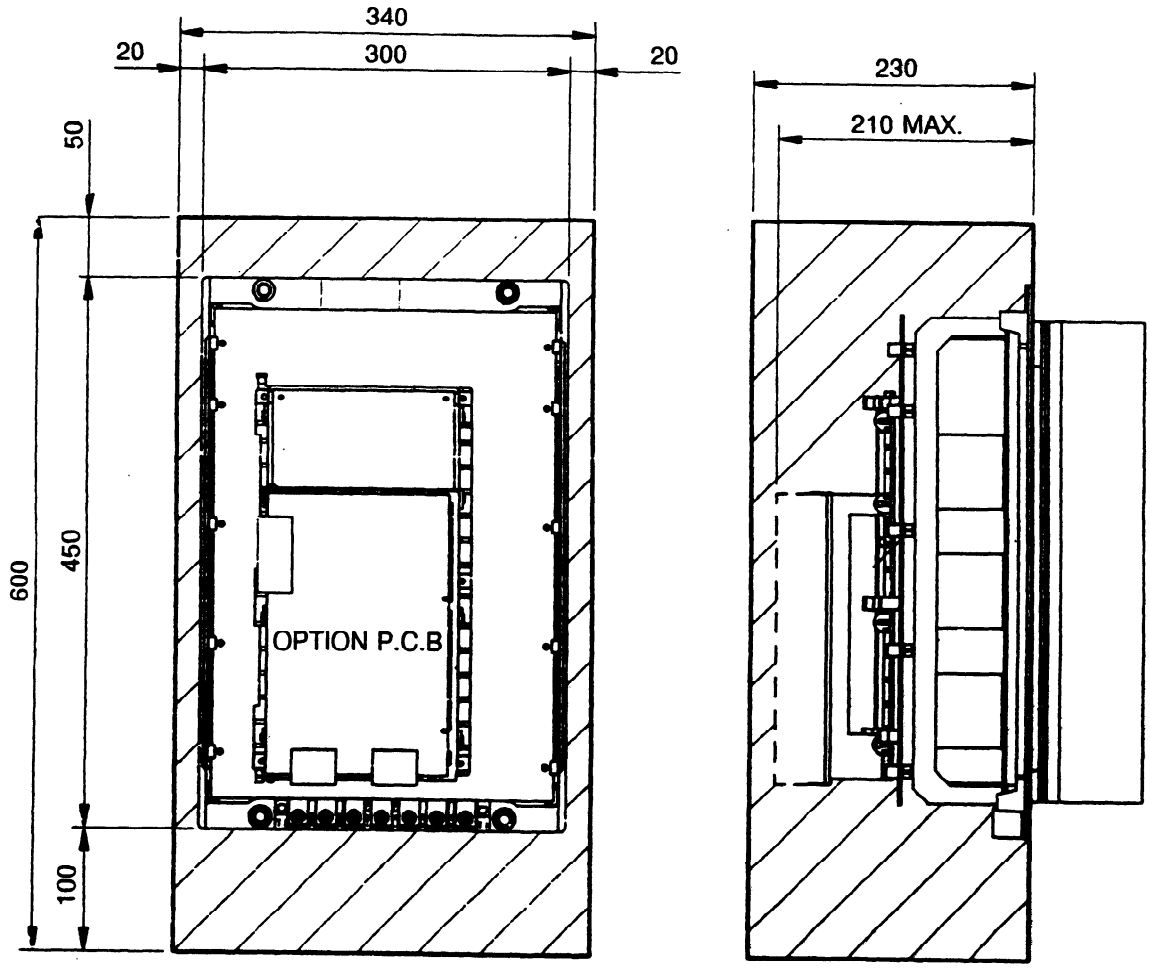
Figure viewed from A

8.2.2 AC spindle servo unit models 6S - 12S, small type model 15S (with unit adapter)

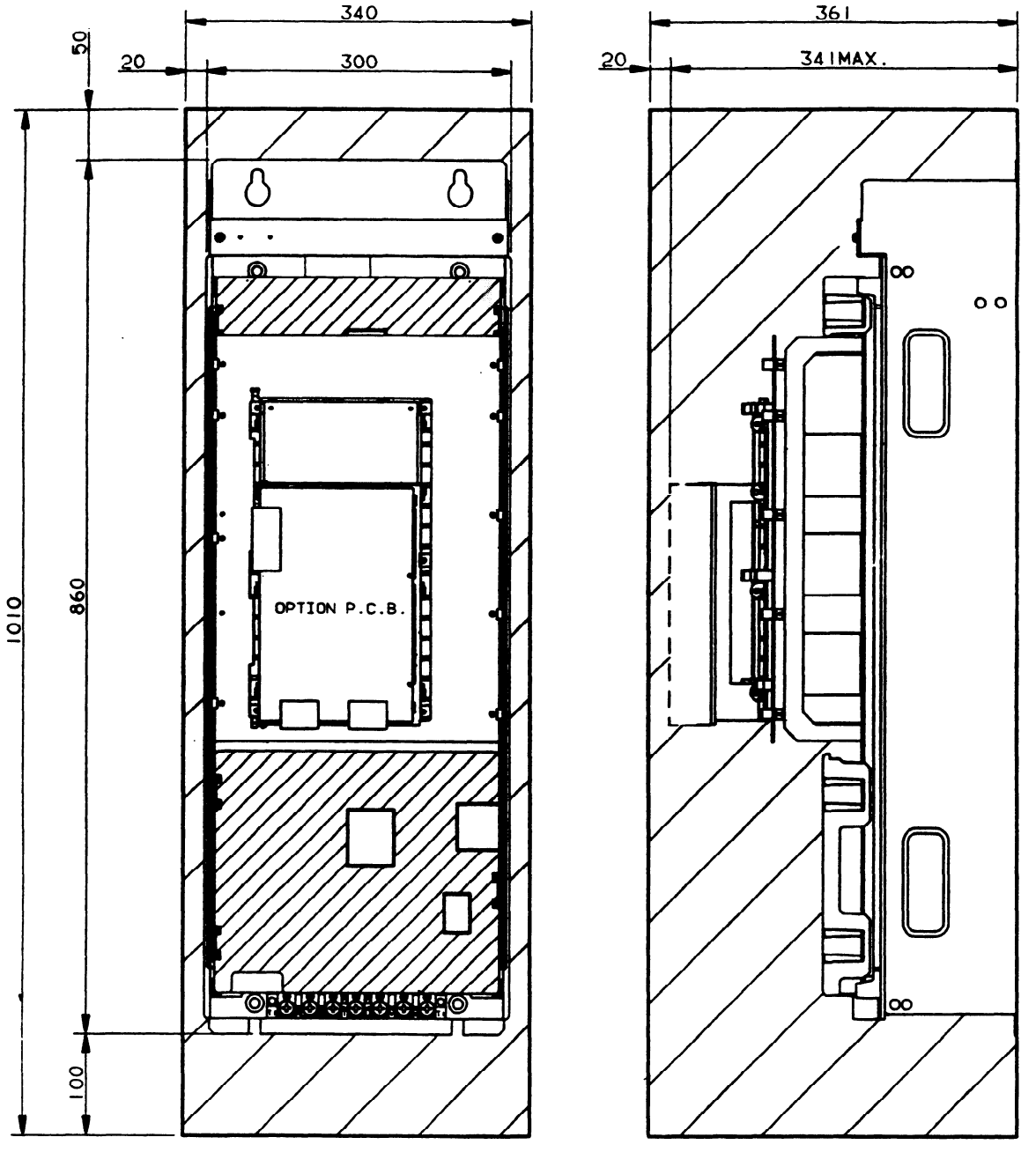


Model	A mm	H mm
6S - 12S	650	500
Small type 15S	750	600

8.2.3 AC spindle servo unit models 6S - 12S, small type model 15S (without unit adapter)

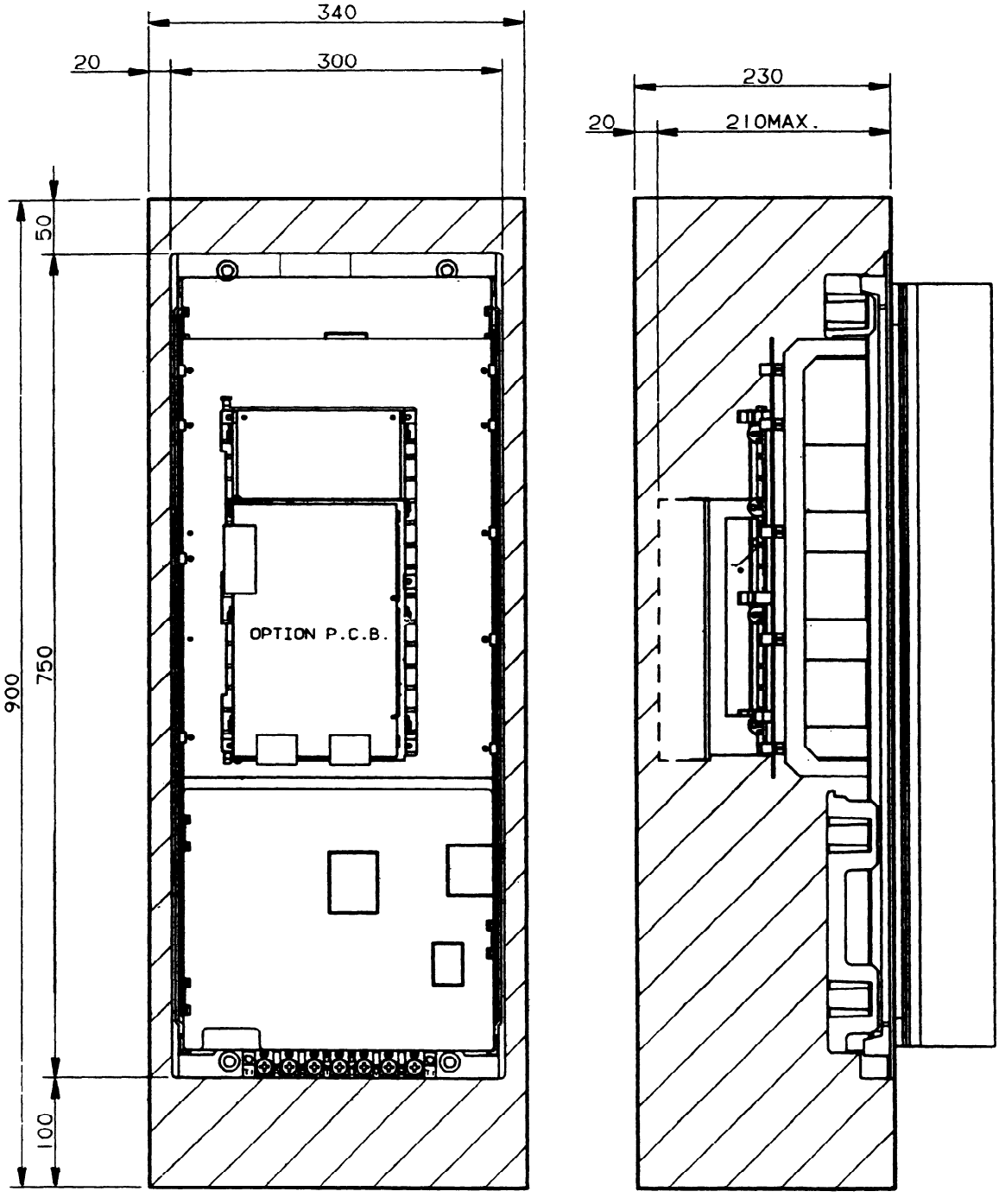


8.2.4 AC spindle servo unit models 15S - 22S, 26S, small type model 30S (with unit adapter)



Model	A mm	H mm
15S - 22S	1010	860
26S, small type 30S	1115	955

8.2.5 AC spindle servo unit models 15S - 26S, small type model 30S (without unit adapter)



8.2.6 AC spindle servo unit models 30S, 40S

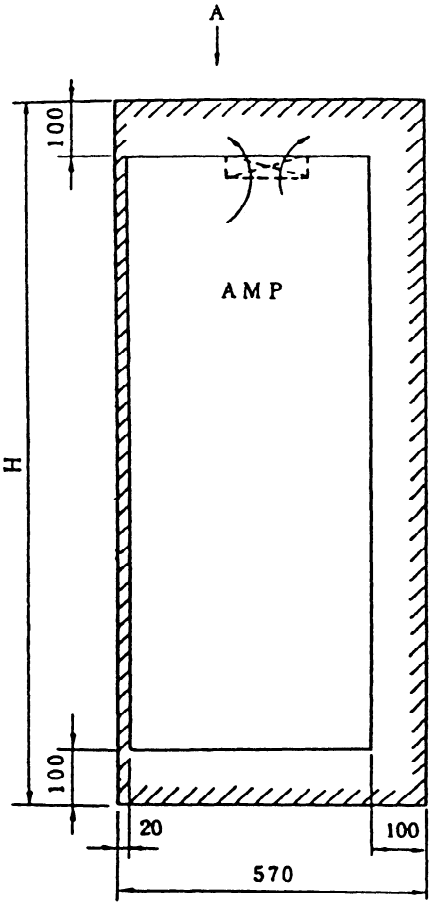
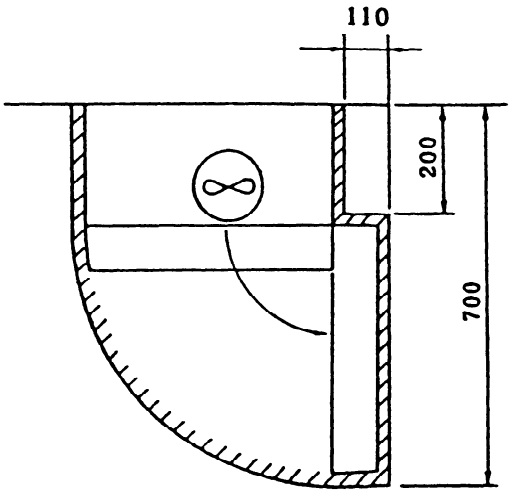


Figure viewed from A

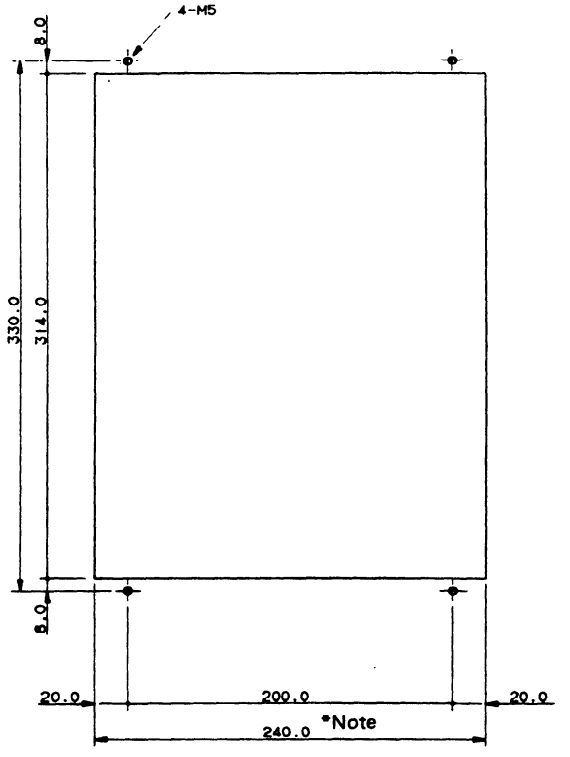


H = 1300 (Model 40S)
H = 1080 (Model 30S)

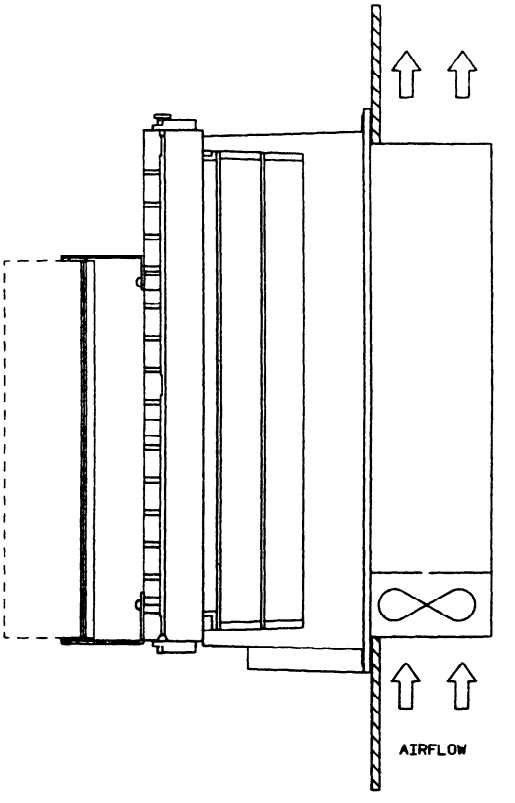
8.3 Panel Hole Machining Diagram and Mounting

8.3.1 AC spindle servo unit models 1S - 3S, small type model 6S

(Panel hole machining diagram)



(Mounting status and cooling air direction)

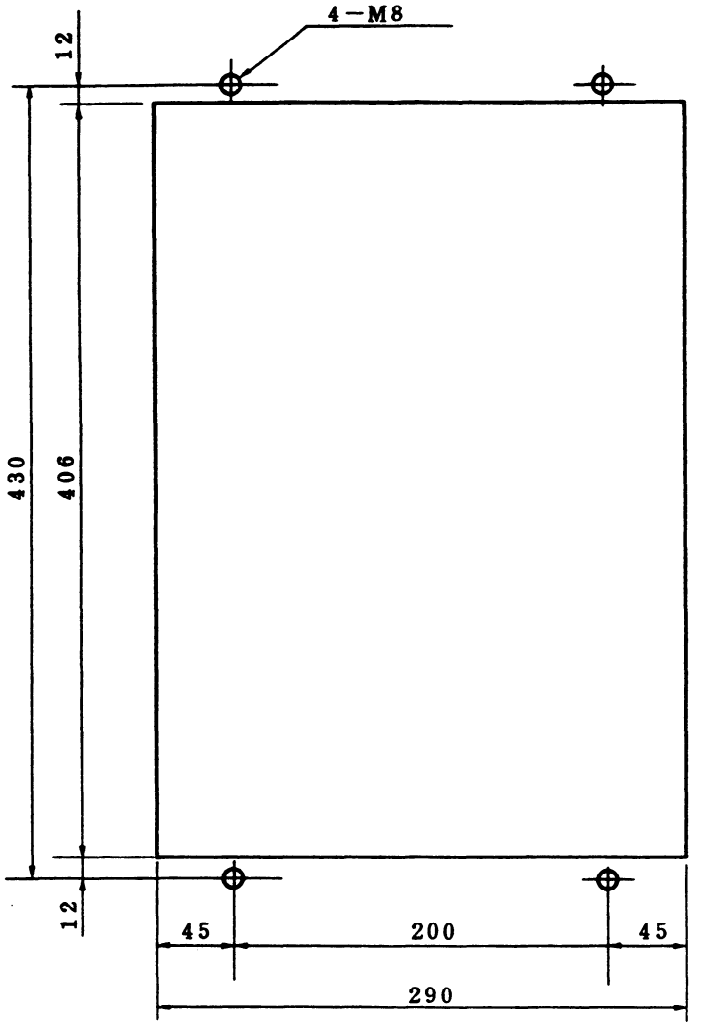


Mount the unit vertically with the terminal block located on the lower side.

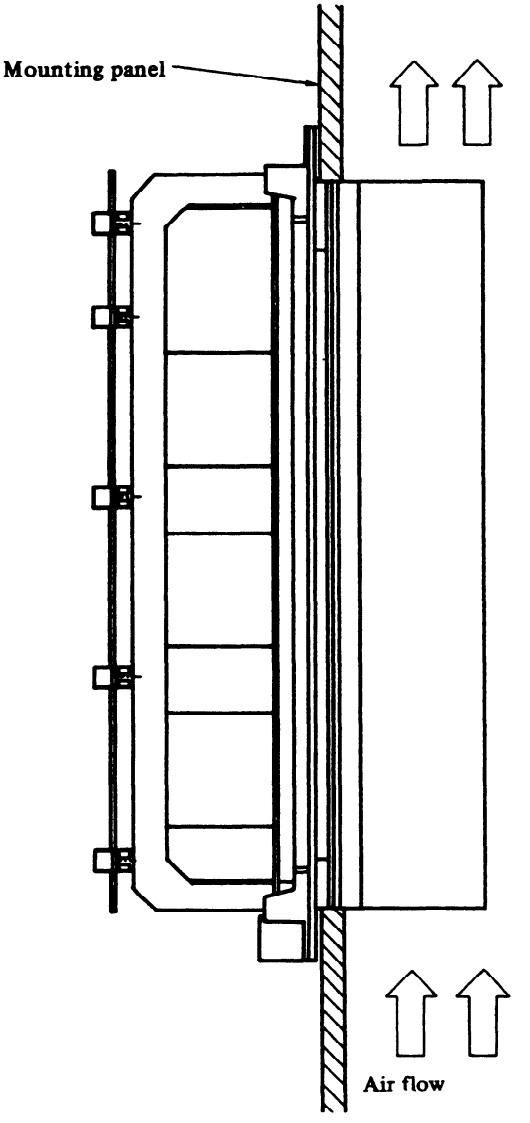
(Note) Though the dimension of the existing amplifiers 1S-3S is 244mm, 240mm is recommended for the serial amplifiers 1S-3S for increasing the sealing effect.

8.3.2 AC spindle servo unit models 6S - 12S, small type model 15S

(Panel hole machining diagram)

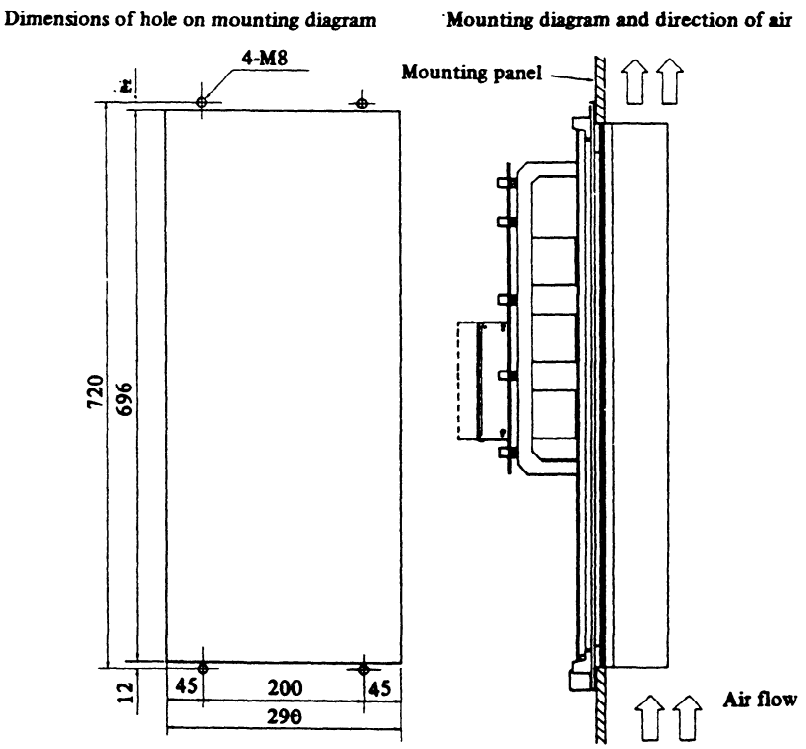


(Mounting status and cooling air direction)



(Note) The cooling fan is not provided for the spindle control unit. For cooling methods, see Chapter 7.

8.3.3 AC spindle servo unit models 15S - 26S, small type model 30S

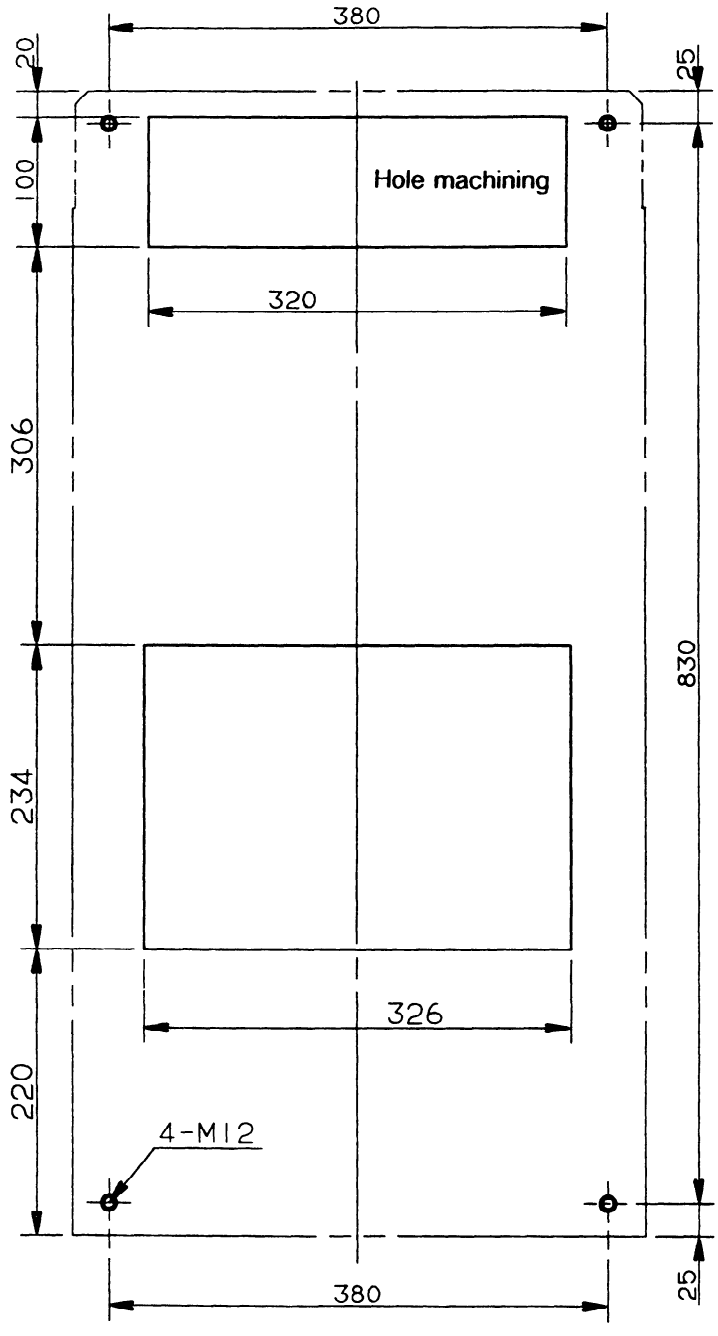


(Note) The cooling fan is not provided for the spindle control unit. For cooling methods, see Chapter 7.

It is recommended to provide a packing (acrylonitrile-butadiene rubber, NBR, soft type) illustrated in the figure above to protect from oil and dust by the MTB.

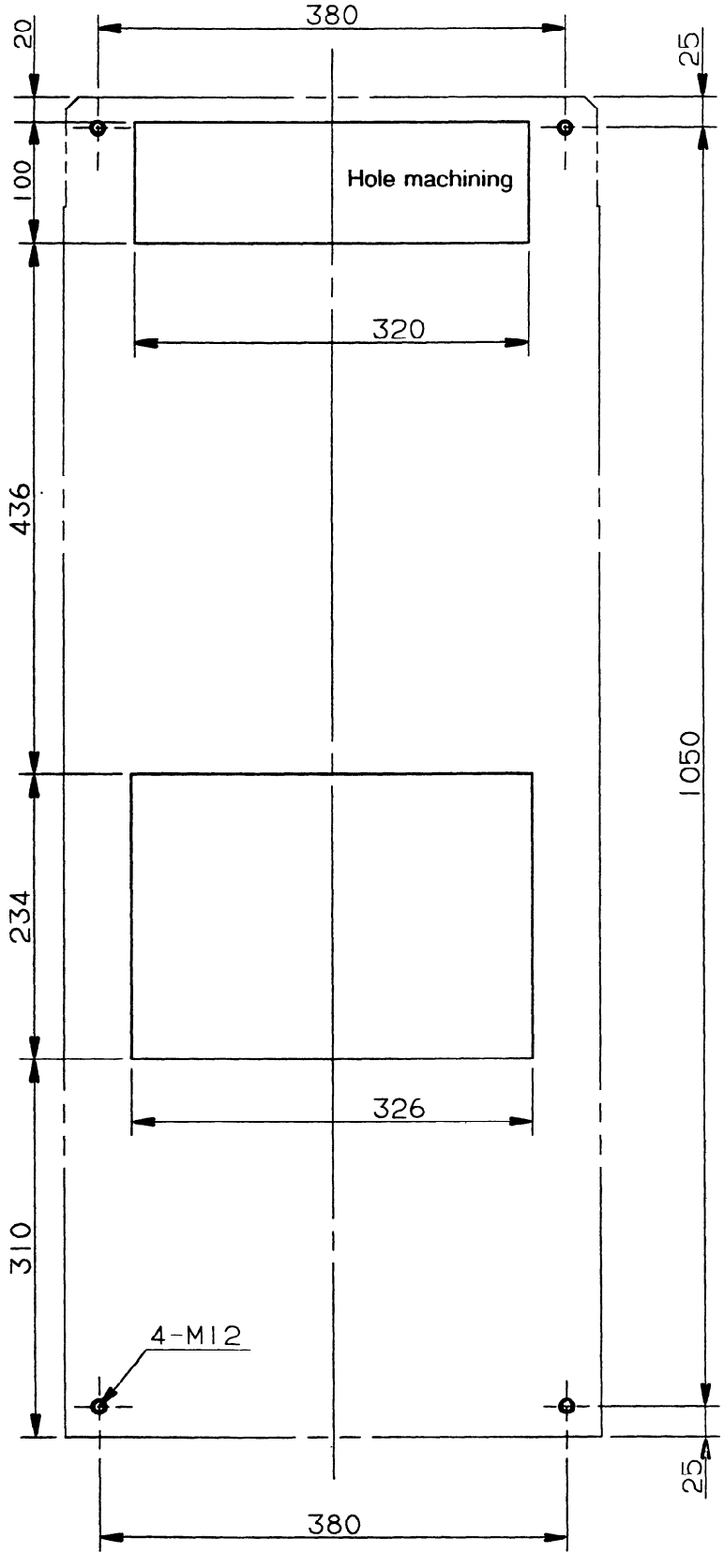
8.3.4 AC spindle servo unit model 30S (with fan unit)

[Panel hole machining diagram]



8.3.5 AC spindle servo unit model 40S (with fan unit)

[Panel hole machining diagram]



8.4 Cautions for Mounting

8.4.1 Cautions for mounting a unit for models 30S and 40S

(1) Unit construction

In order to prevent the temperature inside the locker and around the unit body from rising by the heat generated when loaded, the radiator and the resistor are separated from the radiating section.
A inlet and an outlet ports are provided on the rear face of the unit as shown in the external dimensions. When mounting the unit, set an angle steel in the vertical direction taking the ventilation route into consideration, then fix the unit to this angle using a bolt.

(2) Mounting a unit

As the unit is heavy, it is recommended to observe the following points when the unit is mounted to the locker.

① The unit is designed basically to be suspended by the eye bolts located above. Therefore, it is desirable to mount the unit keeping it suspended.

② If it is difficult to mount the unit keeping it suspended, it is recommended to attach the bottom plate temporarily using the M8 auxiliary tap holes on the lower side of the unit, and then mount the unit by lifting it up with a fork-lift or the like.

③ In both cases mentioned above, it is recommended to provide a guide piece for positioning at the bottom end of the unit.

8.5 Sealing

8.5.1 AC spindle servo unit models 1S - 3S, small type model 6S

When an AC spindle servo unit is mounted, seal between the unit and the mounting panel to prevent the unit from oil, dust and the like.
It is recommended to attach a packing with the specification shown below by the machine manufacturer.

8.5.2 AC spindle servo unit models 6S - 26S, small type models 15S, 30S

When an AC spindle servo unit is mounted, it is recommended to attach a packing (acrylonitrilebutadiene robber (NBR) soft type) by the machine manufacturer to prevent the unit from oil, dust and the like.

8.5.3 AC spindle servo unit models 30S, 40S

When it is needed to seal the unit body side and the rear side completely, attache the following sealing tape on the outer circumference on the rear side.

Nitto Ept Sealer (by NITTO DENKO)

Width	10mm
Thickness	5mm
Length	4m

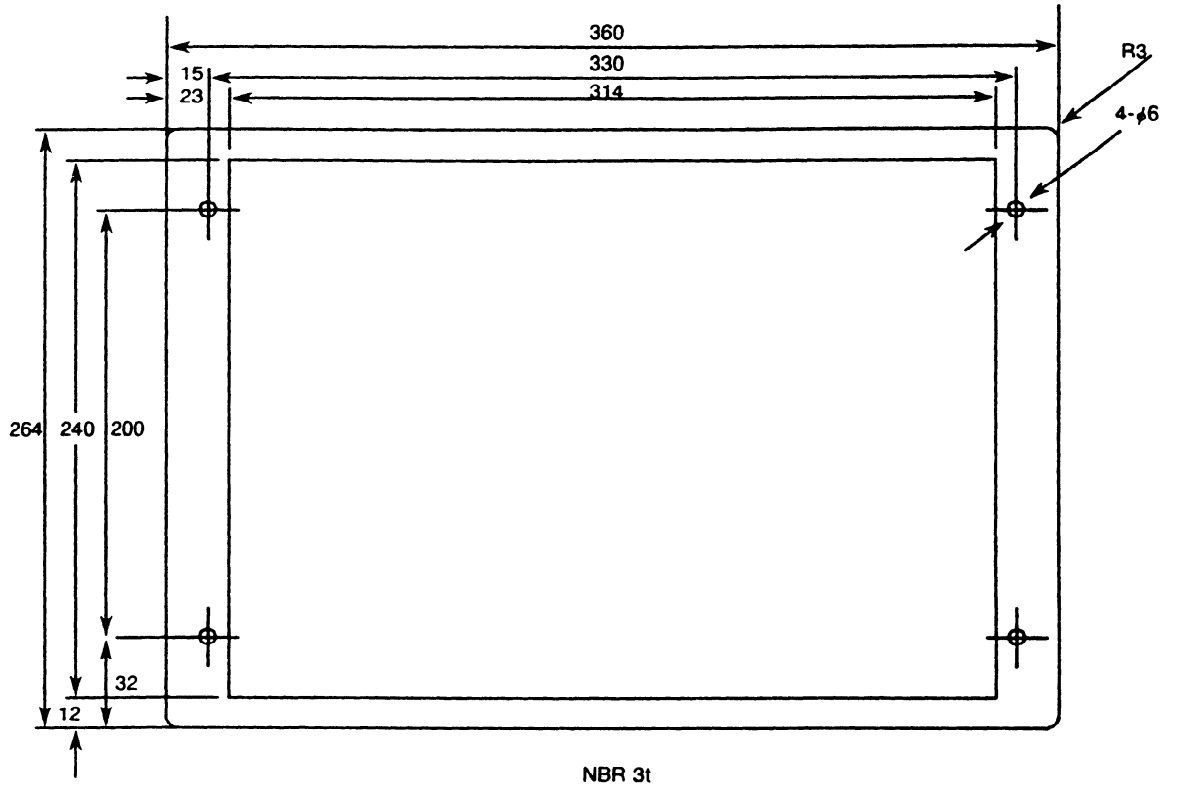
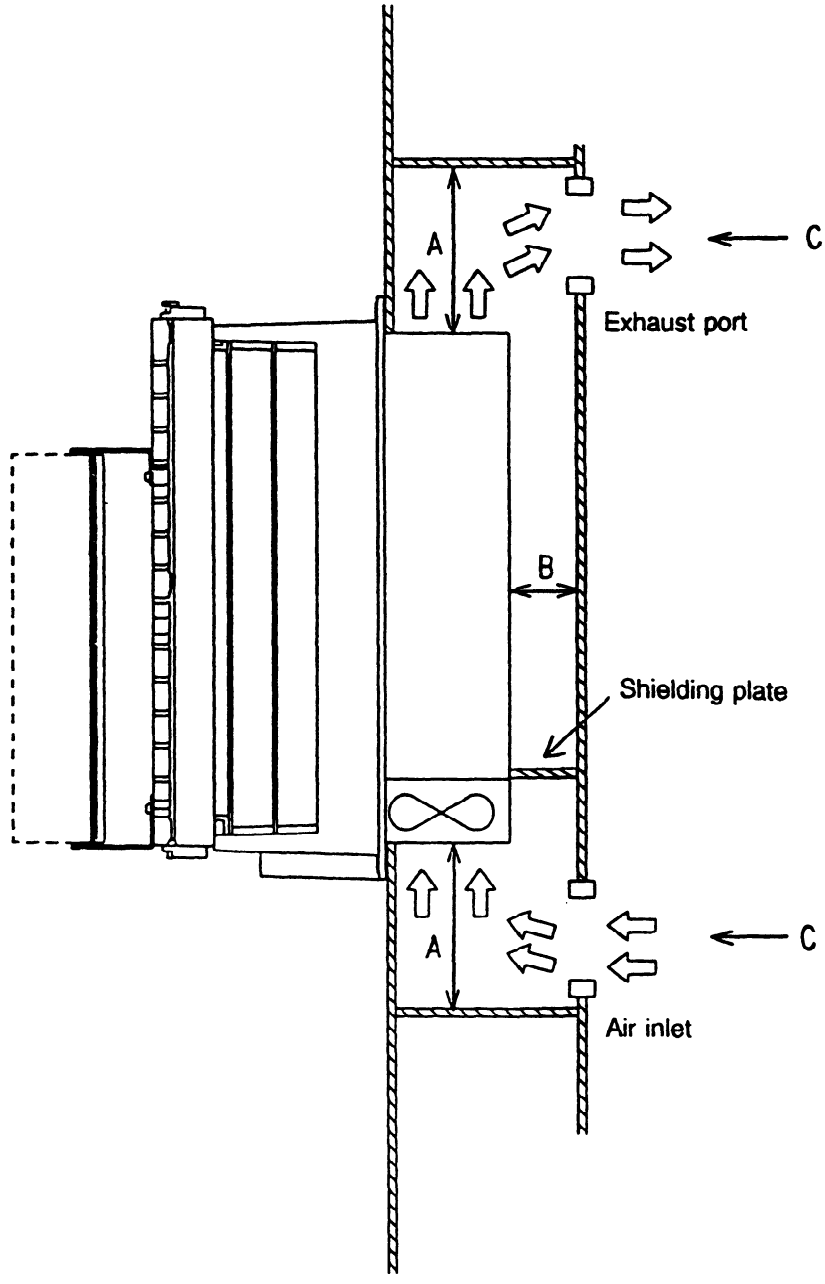


Figure 8.5.1 Example packing (for models 1S - 3S, small type model 6S)

8.6 Consideration to Inlet and Outlet Ports

8.6.1 AC spindle servo unit models 1S - 3S, small type model 6S

The AC spindle servo unit has such a construction that the radiating section of the power circuit section, the main heat generating section, is externally cooled by a built-in fan motor. Therefore, give consideration to the inlet and output ports so that a sufficient wind speed may be obtained for forced-air cooling.



A: Keep apart 100mm or more.

B: As the radiating section becomes very hot, give careful consideration to space.

C: Keep 15,000mm^2 or larger.

9. CONNECTION

9.1 Connection Diagram

9.1.1 Motor model 0.5S (Amplifier model 1S)

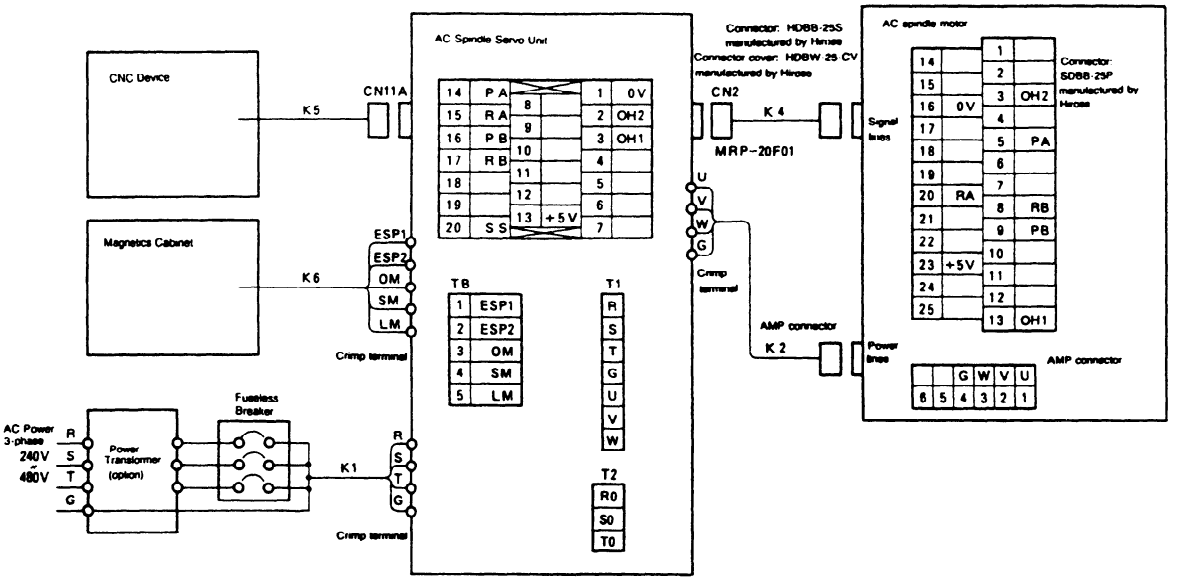
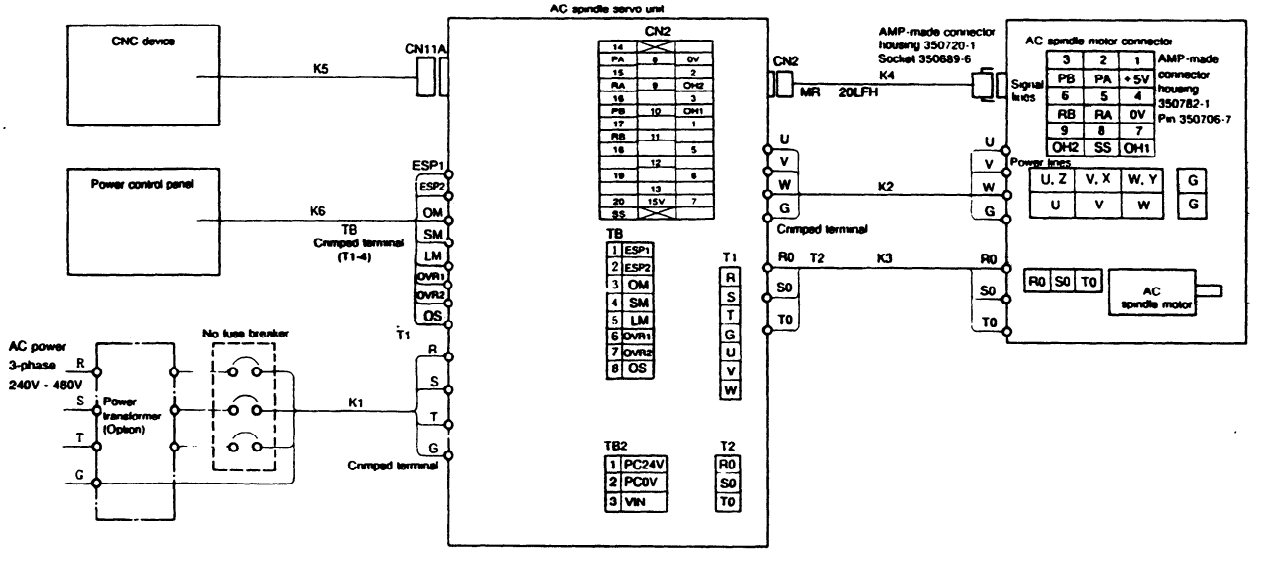


Fig. 9.1.1 Connection diagram (Models 0.5S, Amplifier model 1S)

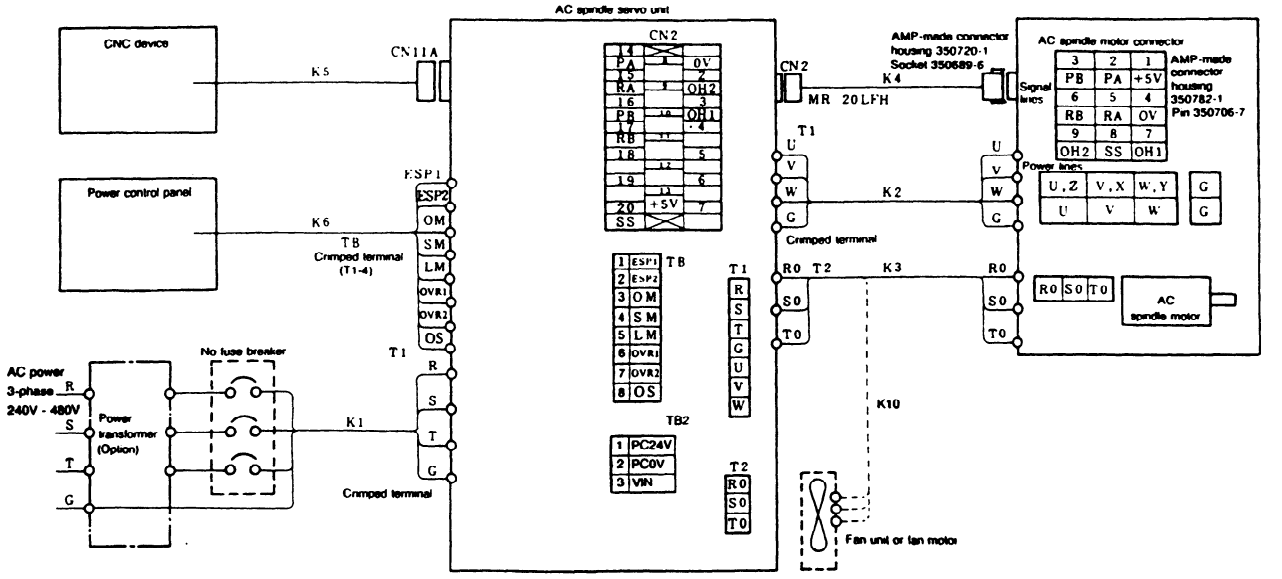
9.1.2 Motor models 1S - 3S, small type model 6S



(Note) The parts enclosed in dotted lines must be prepared by the machine tool builder.

Fig. 9.1.2 Connection diagram (Models 1S - 3S, small type model 6S)

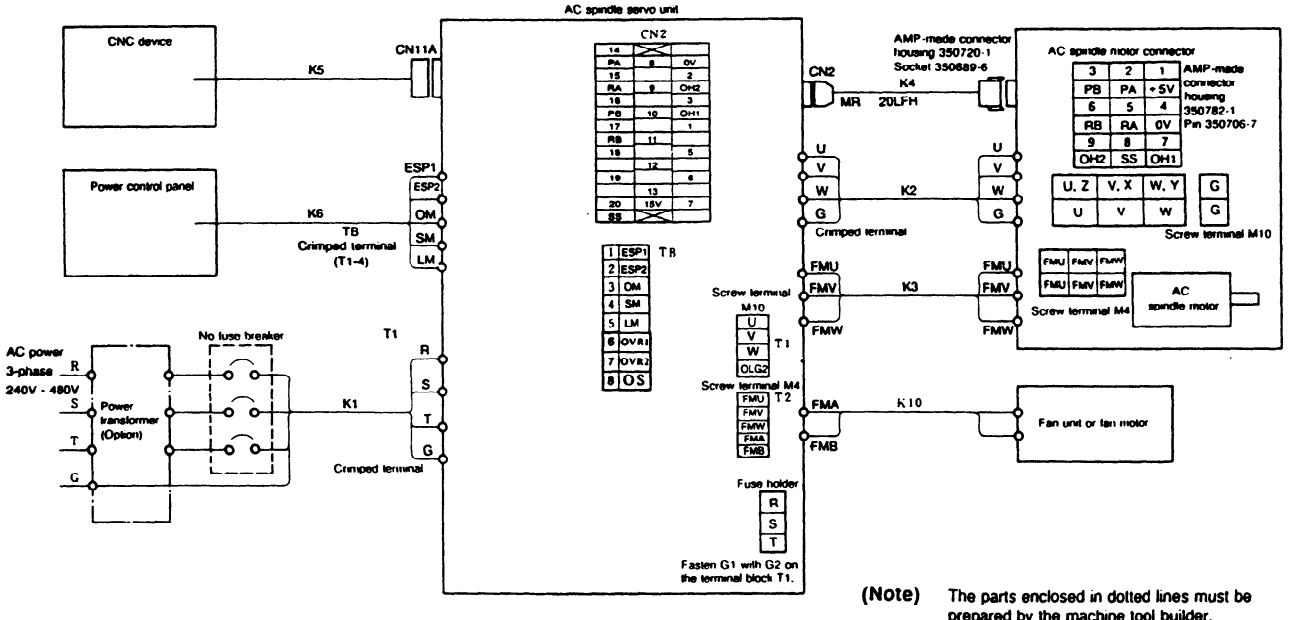
9.1.3 Motor models 6S - 26S, small type model 15S, small type model 30S



(Note) The fan motor and parts enclosed in dotted lines must be prepared by the machine tool builder.

Fig. 9.1.3 Connection diagram (Models 6S - 26S, small type 15S, small type 30S)

9.1.4 Motor models 30S, 40S



(Note) The parts enclosed in dotted lines must be prepared by the machine tool builder.

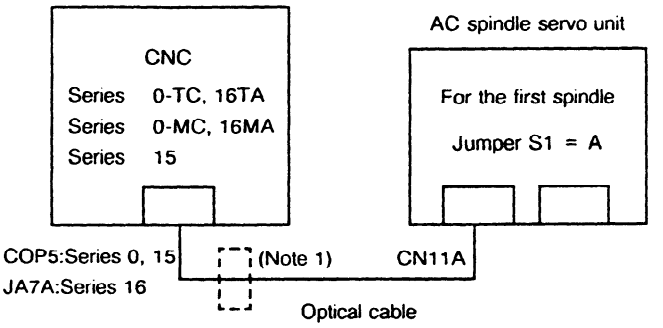
(Note) Added starting with A06B-6064-H230#H550 and A06B-6064-H240#H550

Fig. 9.1.4 Connection diagram (Models 30S, 40S)

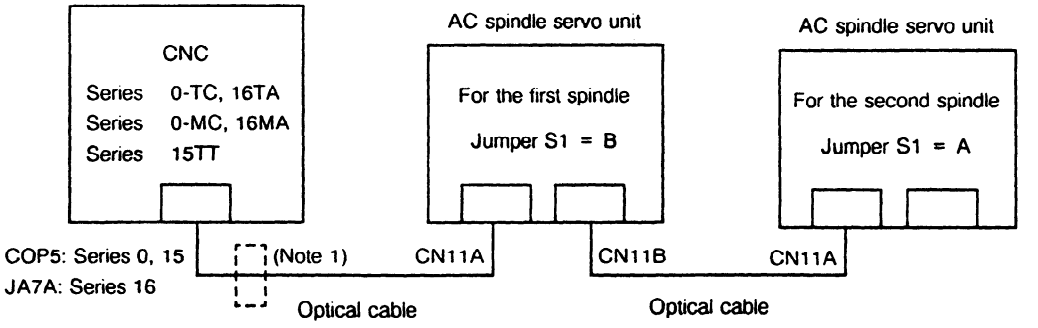
9.1.5 Connection between the CNC and AC spindle servo unit

(1) For the Series 0-TC, 0-MC, 15, and 16

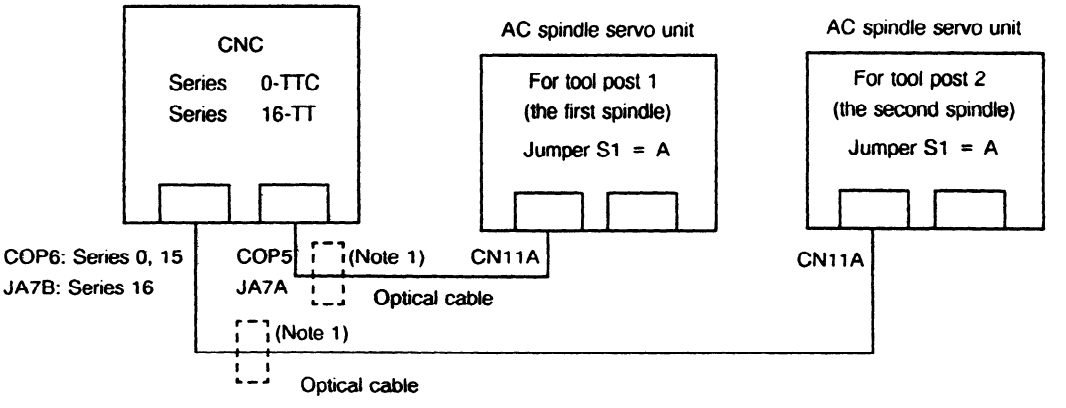
(a) When one AC spindle servo unit is used



(b) When two AC spindle servo units are used



(2) For the Series 0-TTC, 16-TT



(Note 1) The optical I/O Link adaptor is required for the Series 16.

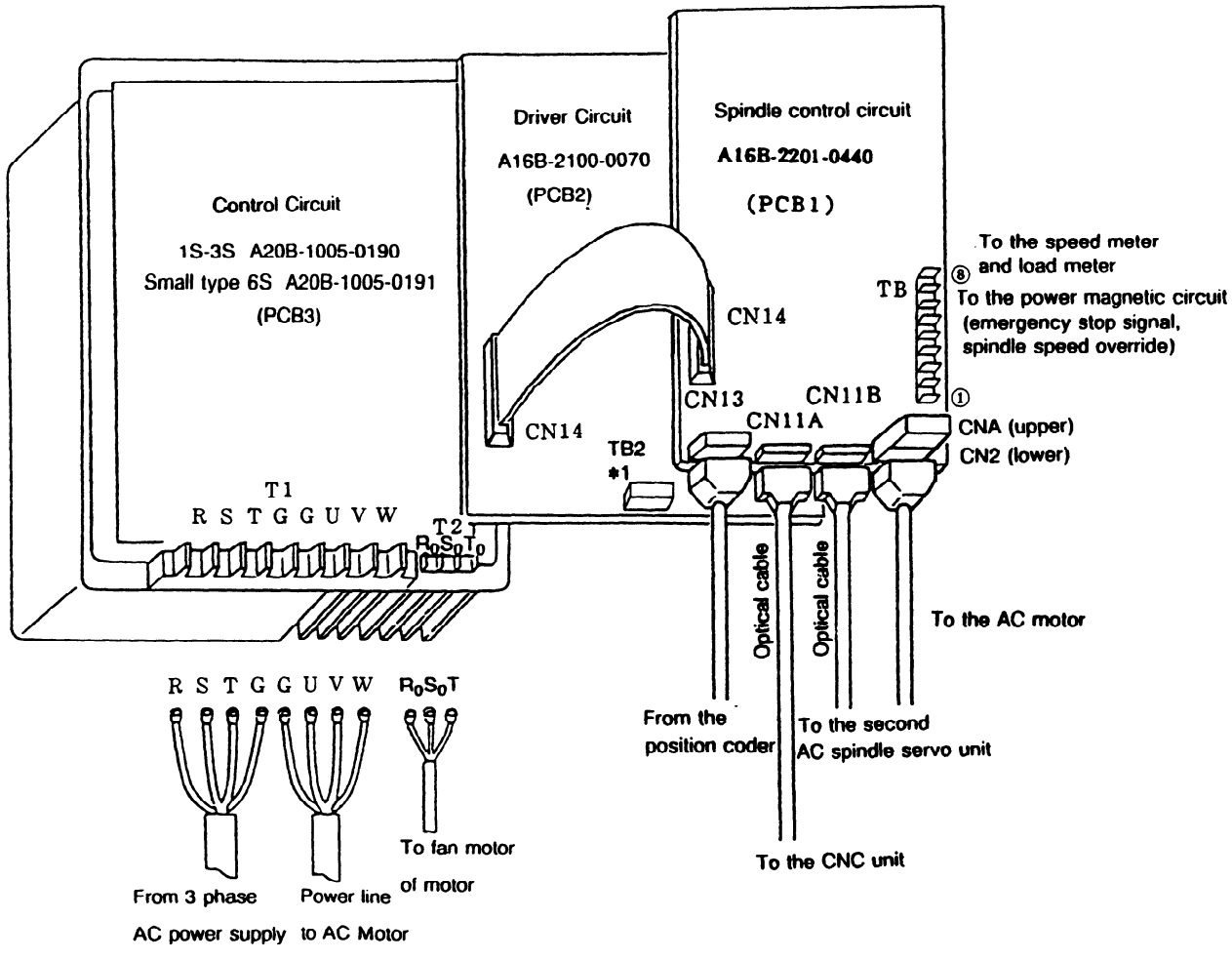
(Note 2) The parameter number for an AC spindle servo unit for tool post 2 is the same as that for the first spindle on the parameter screen for tool post 2.

(Note 3) When the second spindle is connected to a tool post, set jumper S1 for the AC spindle servo unit for the first spindle of the tool post to B.

9.2 Cable Routing

See Appendix 1.

9.2.1 Cable routing diagram of models 1S - 3S, small type model 6S



Change of pin arrangement in TB2

(*1) Printed circuit board with general version 02A or earlier

③	②	①
VIN	PC0V	PC24V

Printed circuit board with version 03A or later

①	②	③
PC24V	PC0V	VIN

Fig. 9.2.1 Cable routing (Models 1S - 3S, small type model 6S)

9.2.2 Cable routing diagram of models 6S - 12S, small type model 15S

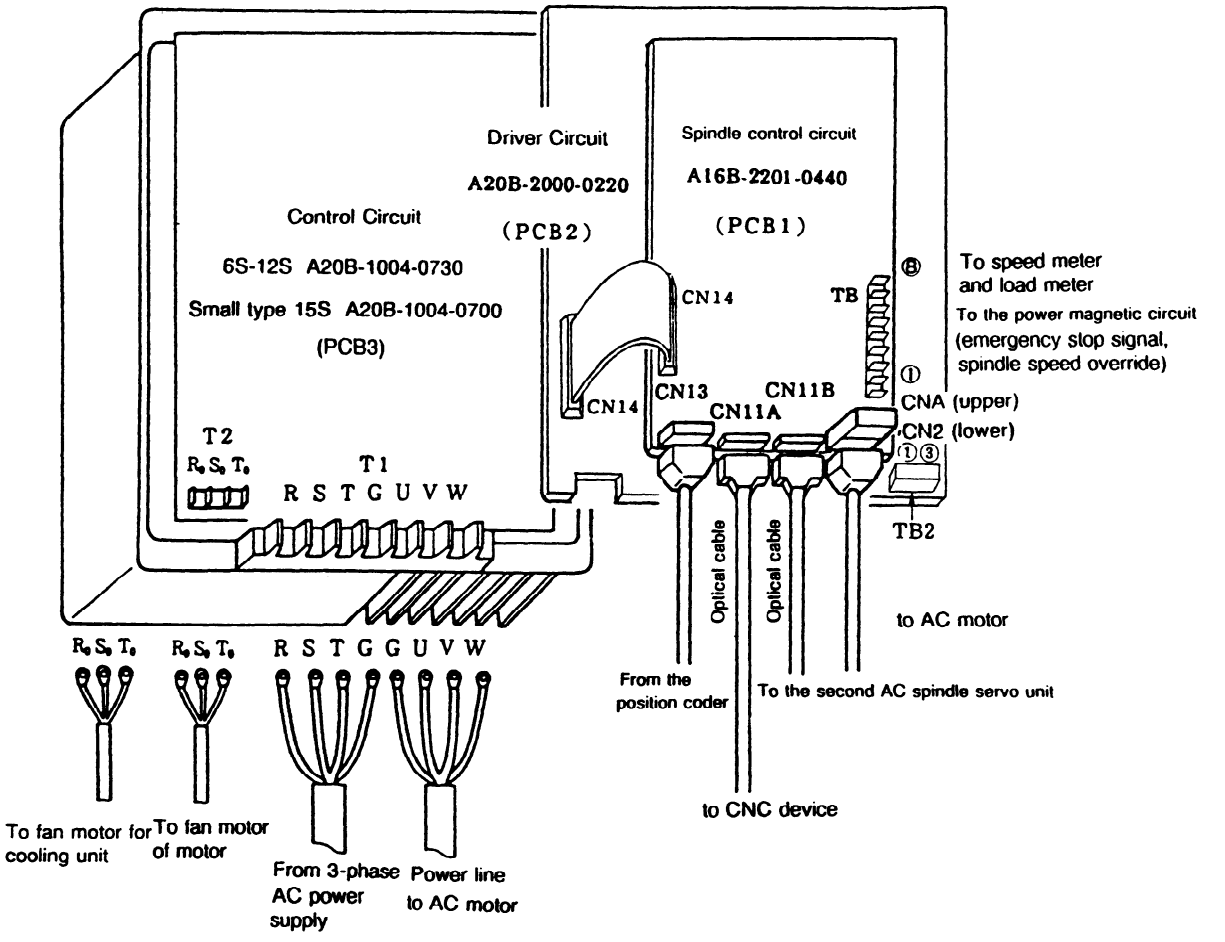


Fig. 9.2.2 Cable routing (Models 6S - 12S, small type 15S)

9.2.3 Cable routing diagram of models 15S - 26S, small type model 30S

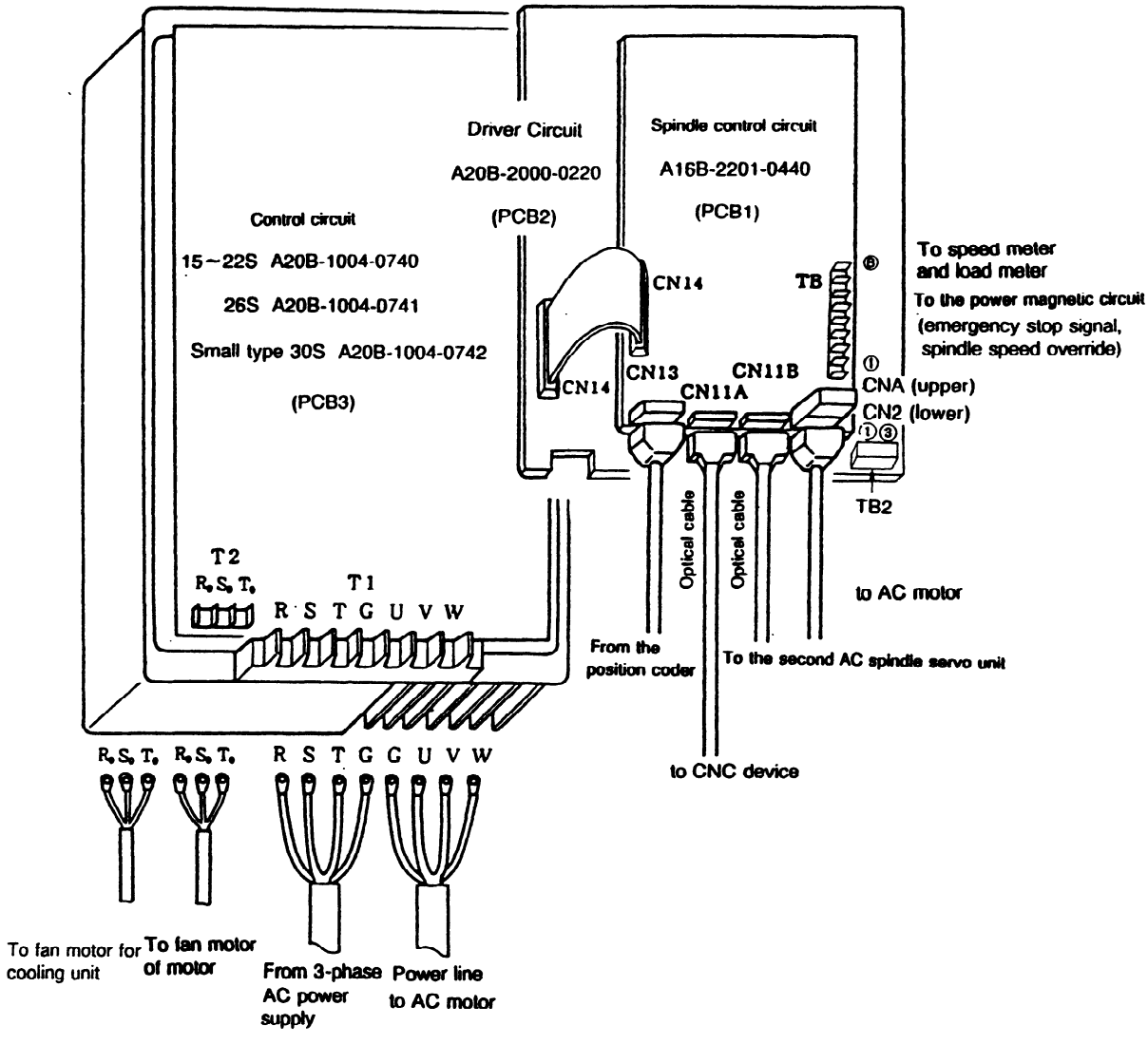
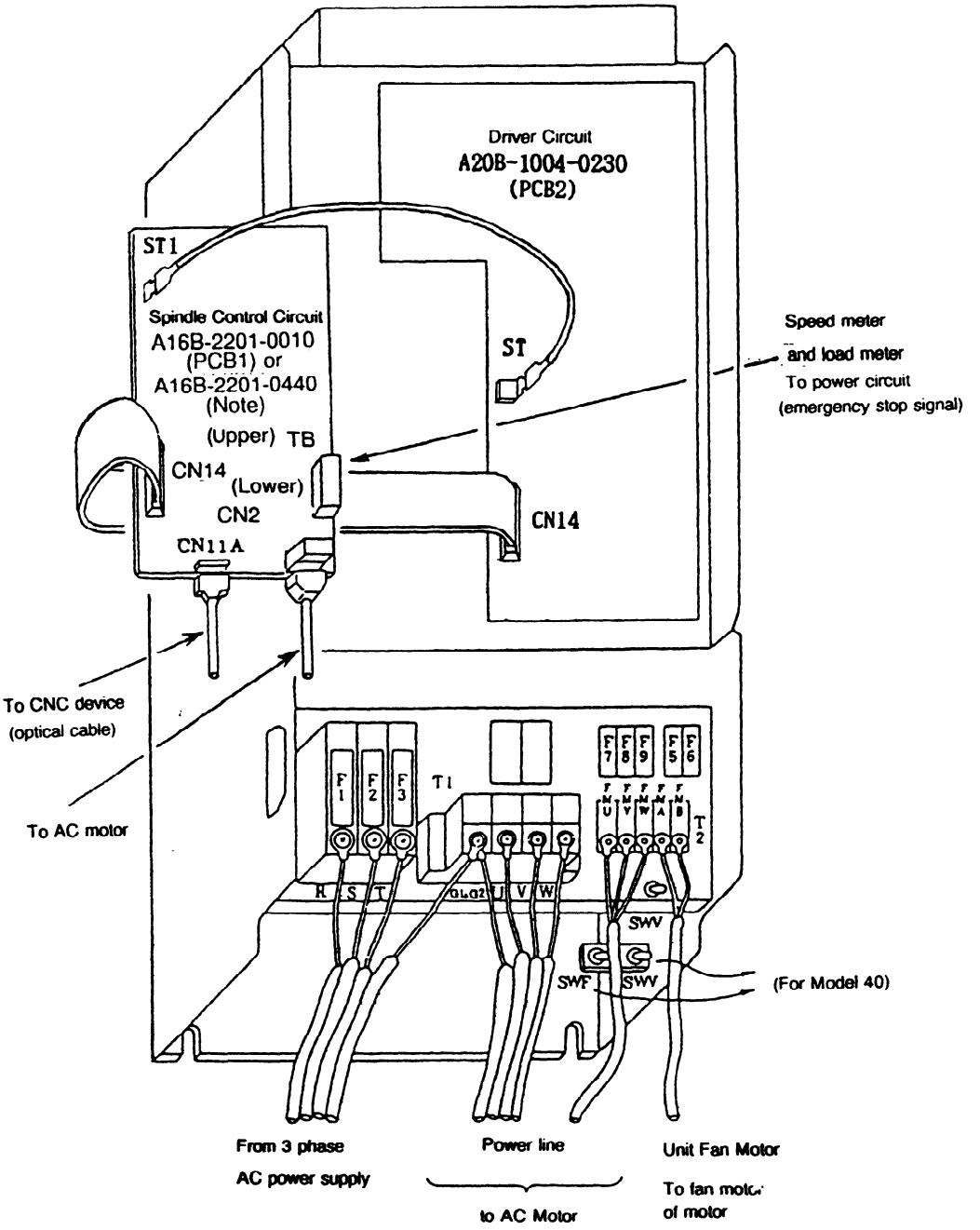


Fig. 9.2.3 Cable routing (Models 15S - 26S, small type model 30S)

9.2.4 Cable routing diagram of models 30S, 40S



(Note) A16B-2201-0440 is used for A06B-6064-H230#H550 and A06B-6064-H240#H550.

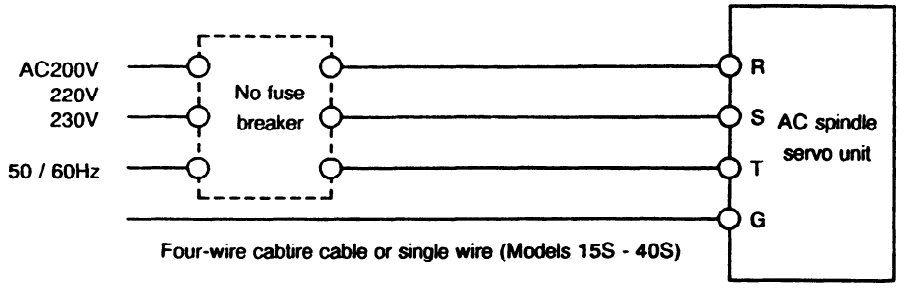
Fig. 9.2.4 Cable routing (Models 30S , 40S)

9.3 Detailed Connection Diagram

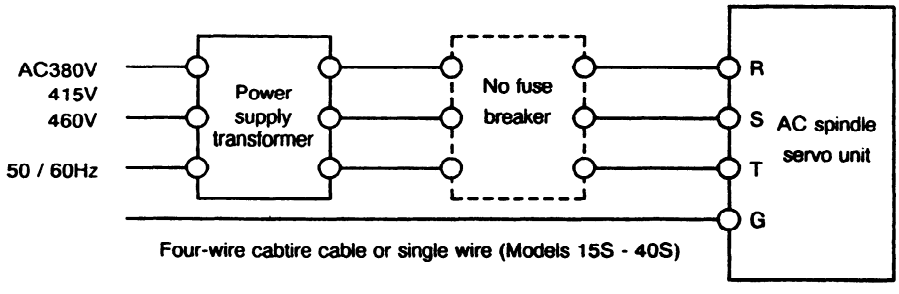
9.3.1 Connection of power source

(1) AC spindle servo unit Models 1S - 40S

- Without power transformer



- With power transformer

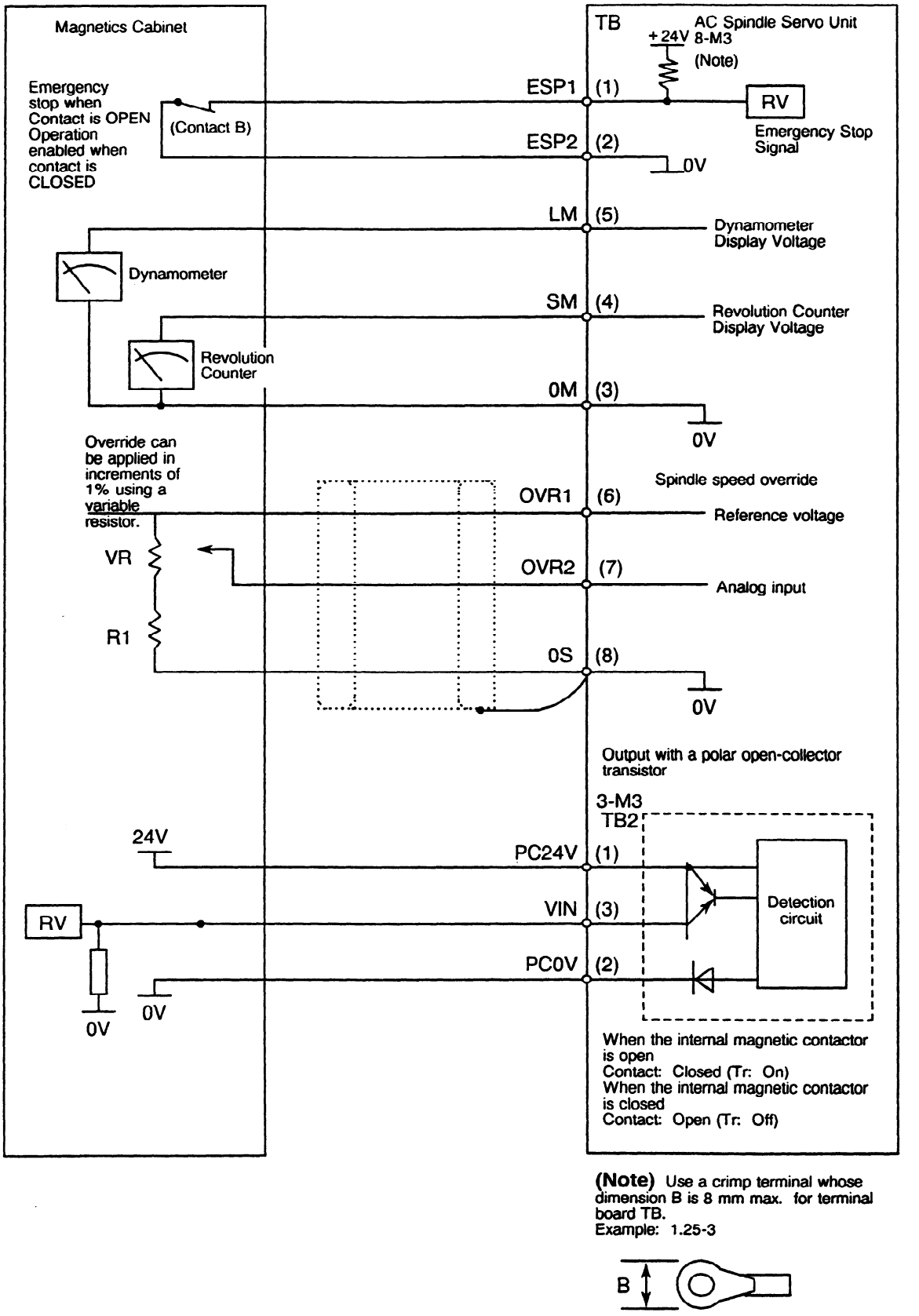


Model	Applicable wire		Unit terminal screw
1S	2 mm^2 or more		M4
2S	3.5 mm^2 or more		
3S	5.5 mm^2 or more		
Small type 6S	8 mm^2 or more		
6S	8 mm^2 or more		M5
8S,12S	14 mm^2 or more		
Small type 15S	Single wire of 14 mm^2 or thicker (heat resistant) (*1)		
15S	Single wire of 14 mm^2 or thicker (heat resistant) (*1)		M8
18S-26S	Single wire of 22 mm^2 or thicker (heat resistant) (*1)		
Small type 30S	Between power suuply to amplifier	Single wire of 22 mm^2 or thicker (heat resistant) (*1)	M8
	Between amplifier to motor	R,S,T : Single wire of 38 mm^2 or thicker (heat resistant) (*1) G : Single wire of 22 mm^2 or thicker (heat resistant) (*1)	
30S	R,S,T : Single wire of 38 mm^2 or thicker (heat resistant) (*1) G : Single wire of 22 mm^2 (heat resistant)		M10
40S	R,S,T : Single wire of 50 mm^2 or thicker (heat resistant) (*1) G : Single wire of 22 mm^2 (heat resistant)		M10

(*1) Use the flame retardant poli-flex cable (MLFC)(Maximum temperature of conductor: 105°C)

(Note) See sections about connection of each motor series for motor terminal screw.

9.3.2 Connection of AC spindle servo unit and magnetics cabinet

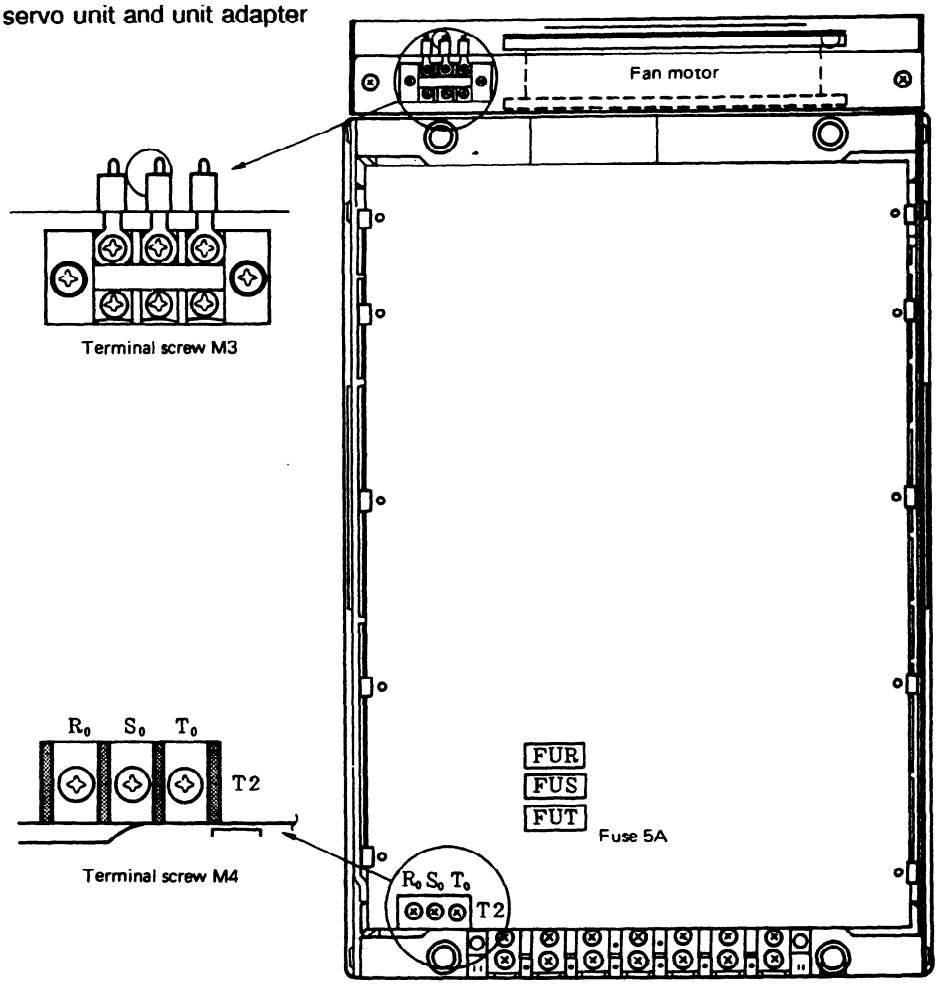


(Note) Use a crimp terminal whose dimension B is 8 mm max. for terminal board TB.
Example: 1.25-3

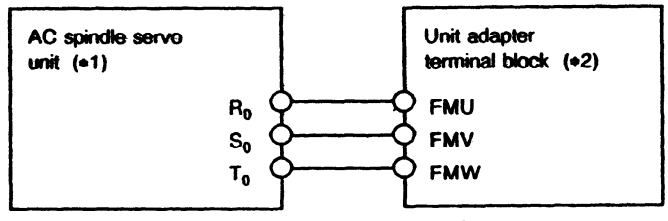
9.3.3 Connecting AC spindle servo unit with unit adapter (models 6S - 26S, small type model 15S, small type model 30S)

For connecting the unit adapter to the fan motor, use the terminal block T2 of the AC spindle servo unit for a fan motor. Fuses (FUR, FUS, FUT) are built in. (Fig. 9.3.3.)

AC spindle servo unit and unit adapter



Wiring



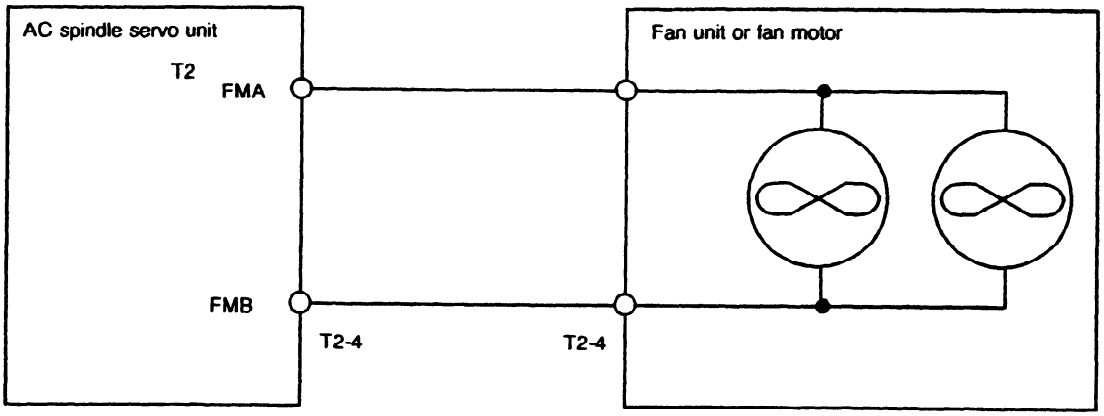
Cable specification: 37/0.26 ($2mm^2$)

Cable length:
Models 6S to 12S and small model 15S: At least 60 cm
Models 15S to 26S and small model 30S: At least 90 cm

(•1) Use a crimp terminal whose dimension B is 8.0 mm max. for the terminal board of the unit adapter.

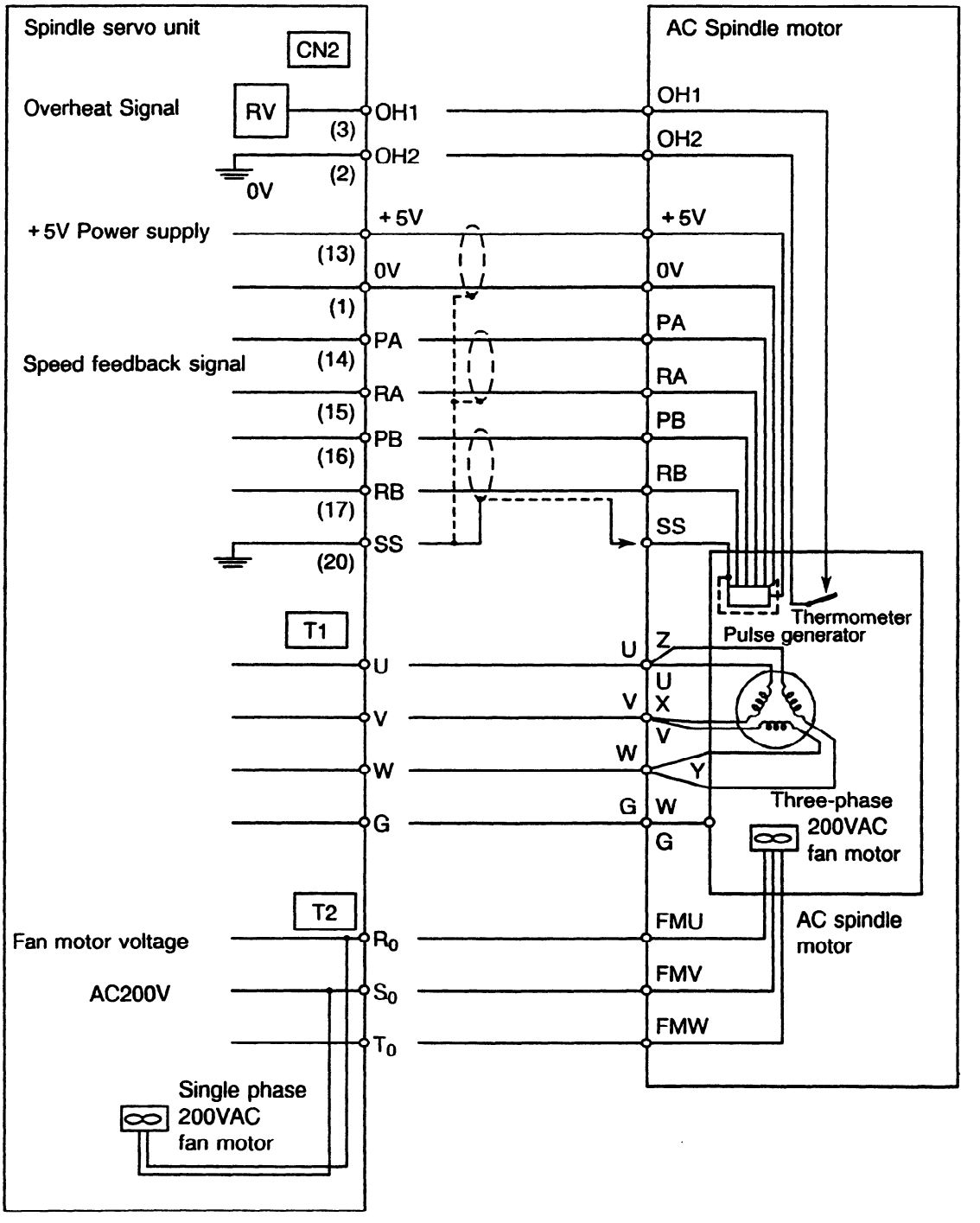
(•2) Two terminal boards, an upper board and lower board, are provided for small model 15S, models 15S to 26S, and small model 30S.
Connect the boards in parallel.

9.3.4 Connection diagram of AC spindle servo unit and fan unit (Models 30S, 40S)

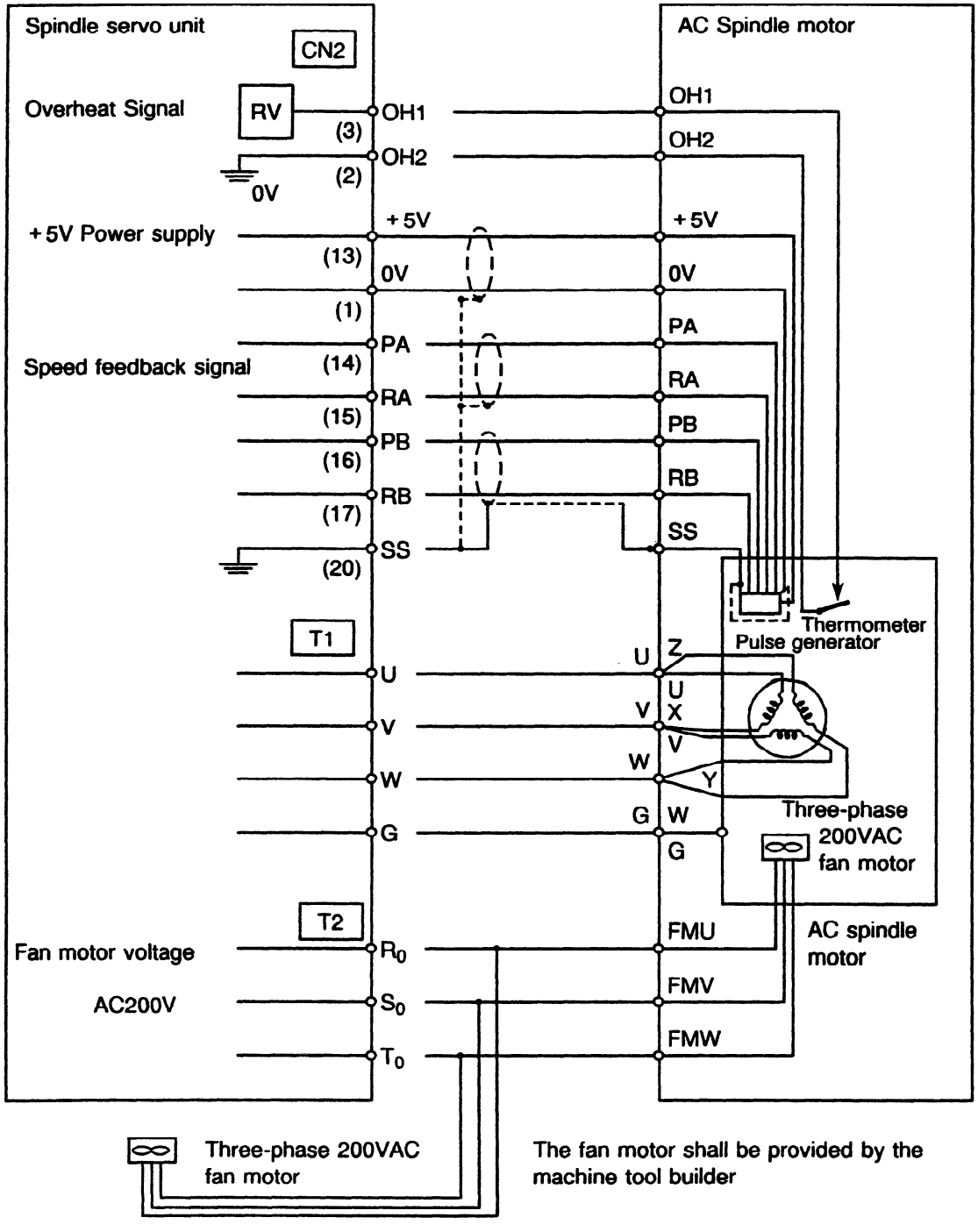


9.3.5 Connection of AC spindle servo unit and AC spindle motor

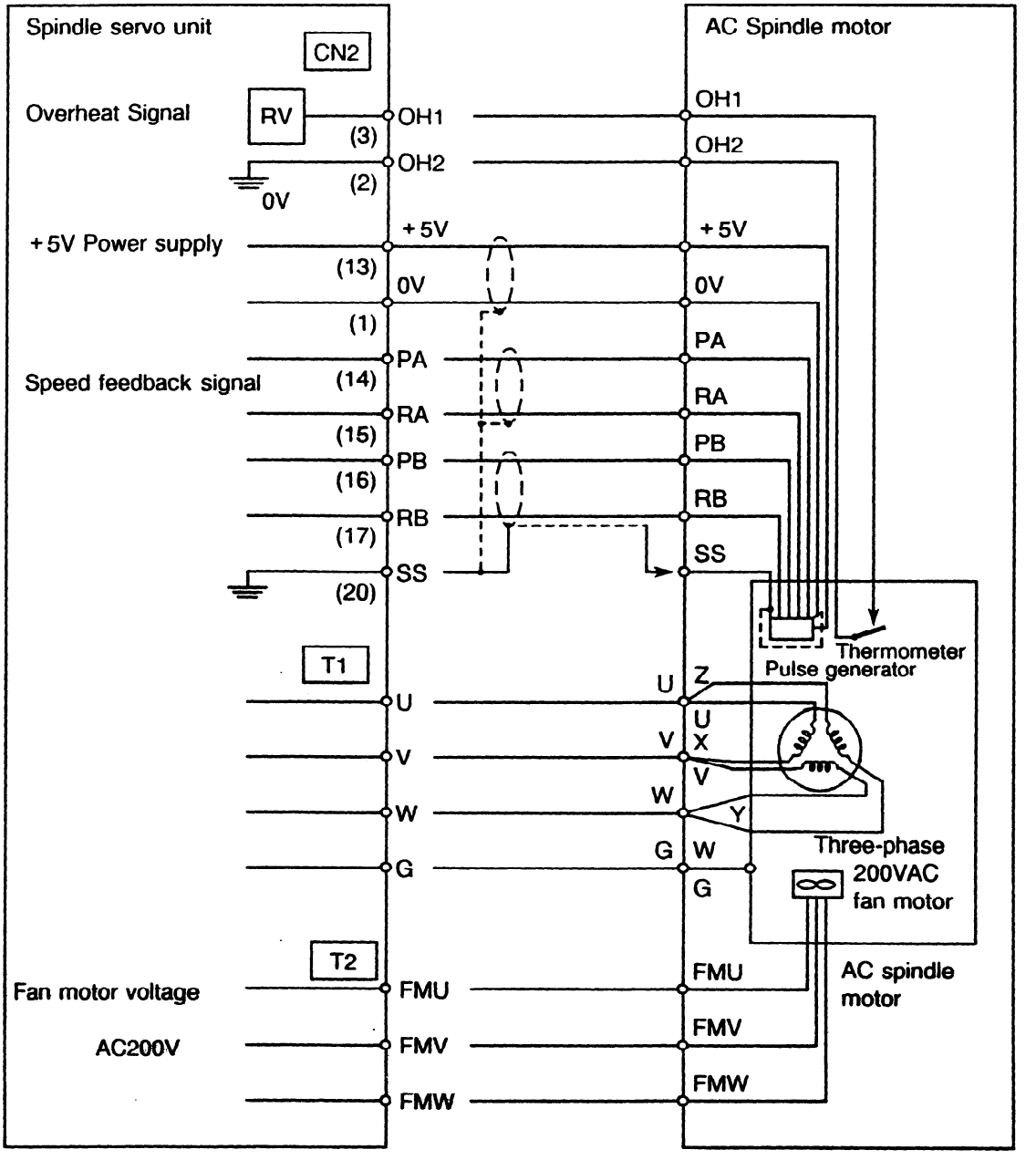
(1) Models 1S - 3S, small type 6S



(2) Models 6S - 26S, small type 15S, small type 30S



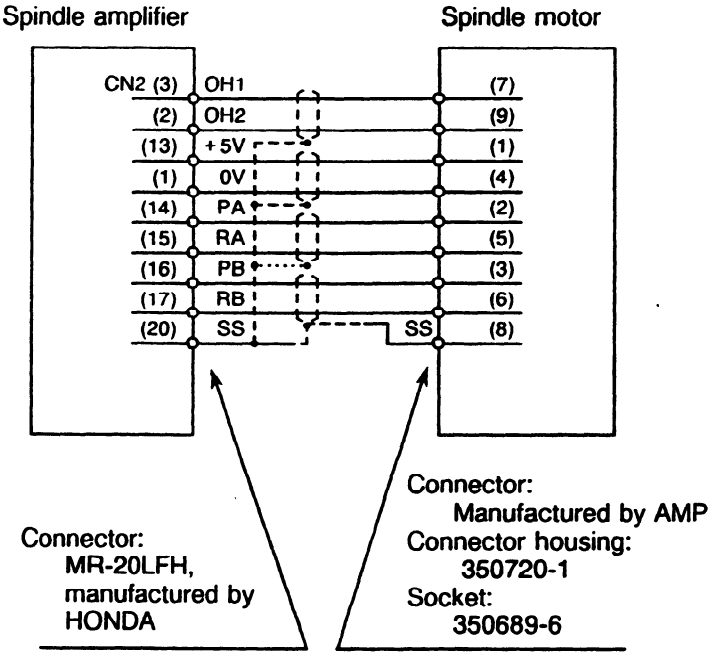
(3) Models 30S, 40S



9.4 Cable

9.4.1 Details of cable K4

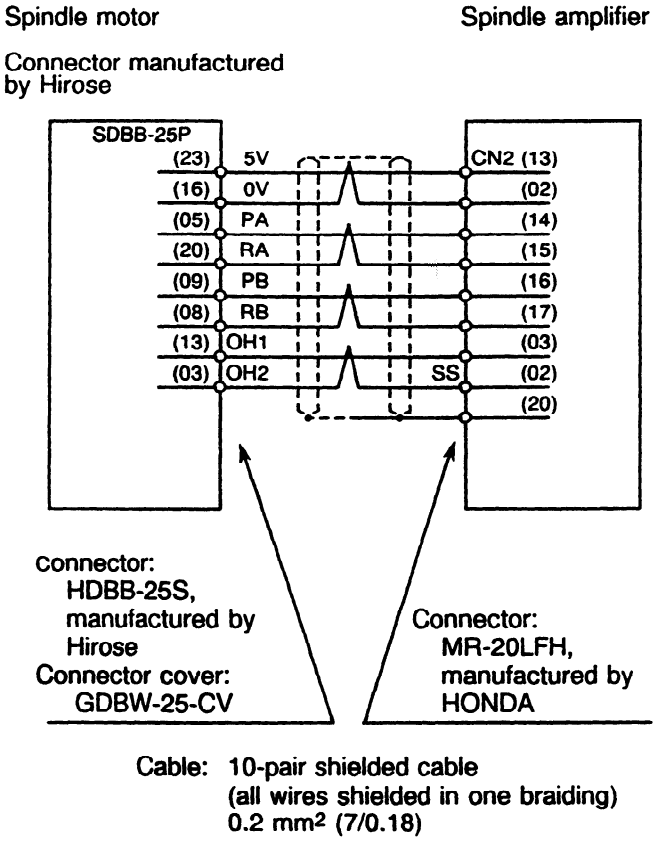
(1) For models 1S to 40S



Cable: 4-pair shielded cable
PVC sheath shield braid conductor
0.3 mm^2 (12/0.18)

(Note) See 9.4.2 for Cable length of K4

(2) For motor model 0.5S



Cable: 10-pair shielded cable
(all wires shielded in one braiding)
0.2 mm^2 (7/0.18)

(Note) See 9.4.2 for Cable length of K4

9.4.2 Cable length

Specifications of the pulse generator

Internal impedance	165.2 Ω
Current used	28.75 mA

The total voltage drop across a cable both ways must not exceed 0.15 V max.
If a cable with resistance A is used, the maximum length of the cable one way is determined using the formula:

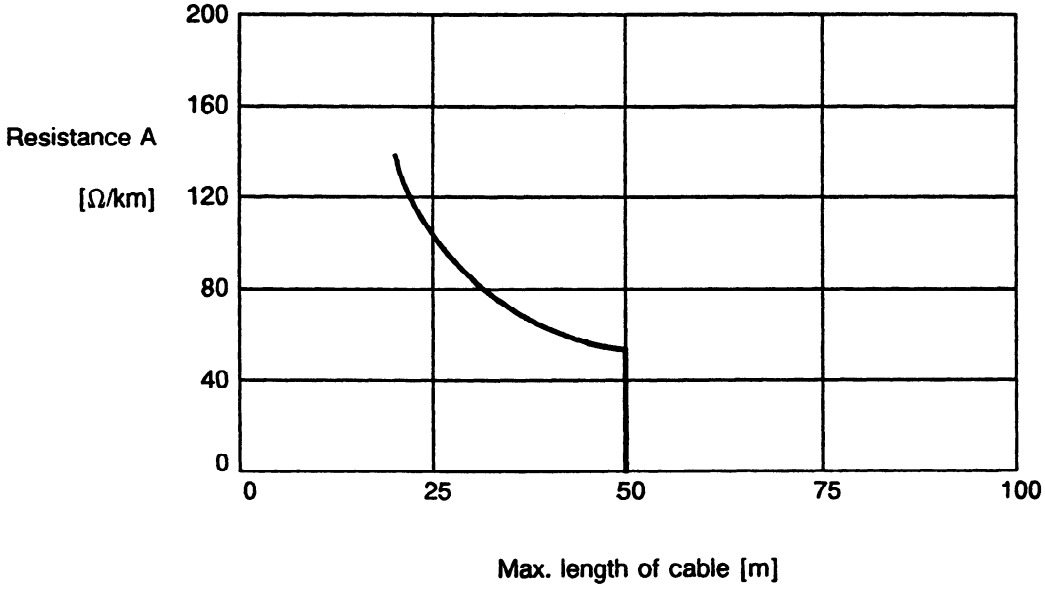
$$L = \frac{2608.7}{A}$$

L: Maximum cable length [m]
A: Resistance of a cable used [Ω/km]

Reference: Cable resistance

7/0.18 (0.2mm²) 110Ω/km
12/0.18 (0.3mm²) 66Ω/km
10/0.18 (0.5mm²) 40Ω/km

The following figure shows the relationship between resistance and the maximum cable length.



(Note) A cable must not exceed 50 m.

10. INTERFACE SIGNALS

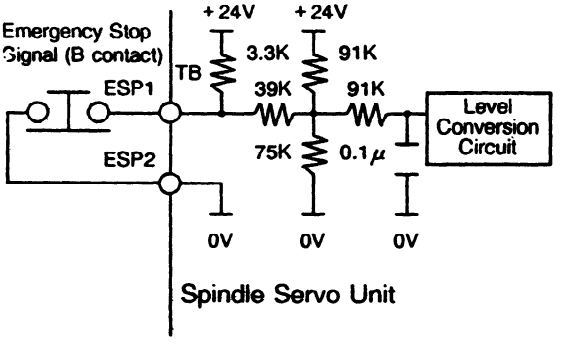
10.1 Emergency Stop Signals (ESP1,ESP2) —Contact Input Signal—

A terminal is provided in the hardware of the AC spindle servo to switch the electromagnetic contacter OFF in the event of an emergency stop. Be sure to use this terminal.

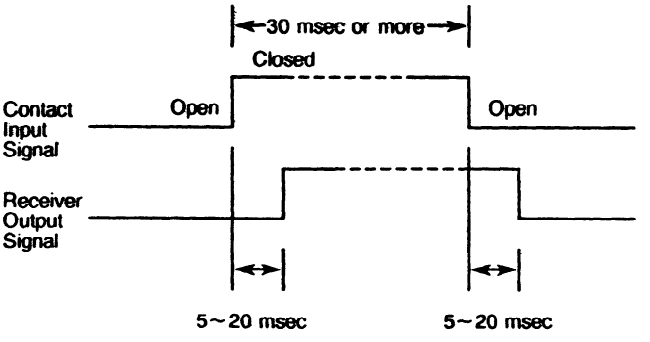
(1) The spindle motor and servo unit become operable when the contact is ON (i.e., CLOSED). When the contact is OFF (i.e., OPEN), the contacter within the servo unit is turned OFF, and the spindle motor will not operate.

(2) Turning the contact OFF (OPEN) when the motor is operating causes the spindle motor to quickly lose speed and stop. After it has stopped, the electromagnetic contacter switches OFF.

(3) If the contact is then switched ON (CLOSED) again, the spindle motor enters the rotatable state, and so will begin to rotate as soon as a rotation command is issued. For this reason, the command signal (speed command, normal operation command, or reverse operation command) to the spindle servo unit should be reset at the same time an emergency stop signal is input.



(4) The environment of the contact input signal is as follows:
   (a) The external contact rating must be 30V or more, 16mA or more.
   (b) The delay of the output signal from the receiver in response to the contact input signal is shown in the diagram below.



This means that when the contact input signal switches ON or OFF, the signal is actually received by the servo unit 5-20msec later.

(c) The receiver circuit on the servo unit side is organized as shown in the above figure. Use this information when using noncontact input, etc.

Significant Level with No Contact (at voltage between input terminals)
LOW level "Logic 0": 2V or less
HIGH level "Logic 1": 20V or more

10.2 Signals for Checking the Contact of the Magnetic Contactor in the Spindle Amplifier (VIN, PC24V, and PC0V) for models 1S to 26S

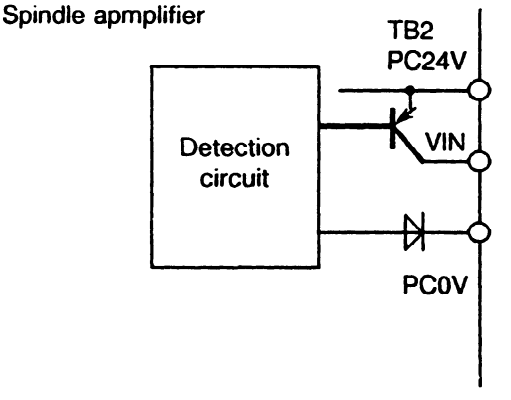
These signals check the status of the contact of the magnetic contactor in the spindle amplifier.

(1) When the magnetic contactor in the spindle amplifier turns off (contact open), the signal turns on (closed).
When the magnetic contactor in the spindle amplifier turns on (contact closed), the signal turns off (open).

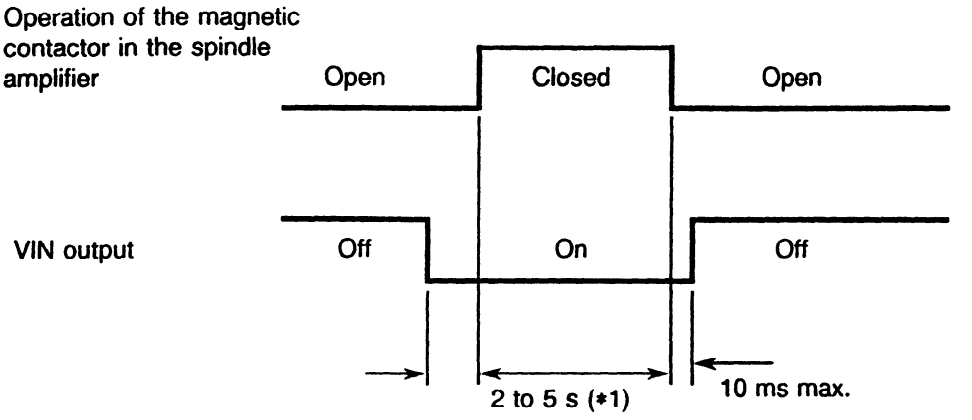
(2) The signals are output from the spindle with the polar open-collector transistor.
The output rating is as follows:
i. Rated voltage: 50 VDC max.
ii. Output current: 100 mADC max.
iii. Saturation current: - 0.25 V max. (Ic = 10 mA)

(3) The polarity of the signals is as follows:

Polarity	
Positive (+)	Negative (−)
PC24V	VIN PC0V



(4) Detection circuit
Consumption current: 5 mA max.



(*1) The VIN signal is output before the magnetic contactor is turned on (contact closed) according to the precharge circuit operation for an electrolytic capacitor.

10.3 Spindle Control Signals

The abbreviations used in this manual stand for the following:
PM: Power Mate
0C: Series 0-MC or 0-TC
0TTC: Tool post 2 of Series 0-TTC
15: Series 15
16: Series 16

10.3.1 First spindle control DI signal (PMC to CNC)

PM	0C	0TTC HEAD2	15	16 (*2)	7	6	5	4	3	2	1	0
G112	G229	G1429	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
G113	G230	G1430	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
G114	G231	G1431	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA
G115	G232	G1432	G228	G073						MPOFA	SLVA	MORCMA
G072	G124	G1324		G032	R08I	R07I	R06I	R05I	R04I	R03I	R02I	R01I
G073	G125	G1325		G033	SIND	SSIN	SGN		R12I	R11I	R10I	R09I
			G024		RISGN			RI12	RI11	RI10	RI09	RI08
			G025		RI07	RI06	RI05	RI04	RI03	RI02	RI01	RI00
	G110	G1310	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
	G111	G1311	G230	G079					SHA11	SHA10	SHA09	SHA08
G083	G103	G1303					SPC	SPB	SPA			
G120					SOVE	SOV6	SOV5	SOV4	SOV3	SOV2	SOV1	SOV0
			G029							SPC	SPB	SPA
				G030	SOV7	SOV6	SOV5	SOV4	SOV3	SOV2	SOV1	SOV0
G068	G120	G1320				*SSTP	SOR	SAR	FIN			
			G005								FIN	
				G029		*SSTP	SOR	SAR				
				G004					FIN			
	G123 (*1)	G1323			CON(M)	SPSTP	*SCPF	*SUCPF	GR2	GR1		COFF(T)
	G118 (*1)	G1318							GR2	GR1		
				G027	CON(T/M)							
			G67, 71 . .		SCNTR1, 2 . .							
	G146			G038					SPPHS	SPSYC		
			G111		SPPHS	SPSYC						
	G123 (*3)										RGTP	
G099	G135 (*3)			G061								RGTAP
			G026			GS4	GS2	GS1	*SECLP	*SEUCL		SPSTP

(*1) Depends on bit 5 (ADDCF) of parameter 31

(*2) Refer to the manual B-61803E/03 or later for DI/DO address of 16-TT on the HEAD2 side.

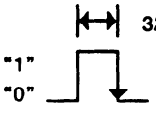
(*3) Depends on bit 4 (SRGTP) of parameter 19

PM	0C	0TTC HEAD2	15	16	7	6	5	4	3	2	1	0
				G028		SPSTP	*SCPF	*SUCPF		GR2	GR1	
	G104							ESRSYC				
	G145	G1345			GR31	GR21	*SSTP3	*SSTP2	*SSTP1	SWS3	SWS2	SWS1
				G027			*SSTP3	*SSTP2	*SSTP1	SWS3	SWS2	SWS1
				G029						GR31		GR21
	G146	G1346		G028	PS2SLC							

10.3.2 Second spindle DI signal (PMC to CNC)

0C	0TTC HEAD2	15	16	7	6	5	4	3	2	1	0
G233	G1433	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB
G234	G1434	G234	G075	RCHB	RSLB	INTGB	SOCNB	MCFNB	SPSLB	*ESPB	ARSTB
G235	G1435	G237	G076	RCHHGB	MFNHGB	INCMDA	OVRB	DEFMDB	NRROB	ROTAB	INDXB
G236	G1436	G236	G077						MPOFB	SLVB	MORCMB
G112	G1312	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
G113	G1313	G238	G081					SHB11	SHB10	SHB09	SHB08
G106	G1306		G034	M2R08I	M2R07I	M2R06I	M2R05I	M2R04I	M2R03I	M2R02I	M2R01I
G107	G1307		G035	M2SIND	M2SSIN	M2SGN		M2R12I	M2R11I	M2R10I	M2R09I
G108	G1308		G036	M3R08I	M3R07I	M3R06I	M3R05I	M3R04I	M3R03I	M3R02I	M3R01I
G109	G1309		G037	M3SIND	M3SSIN	M3SGN		M3R12I	M3R11I	M3R10I	M3R09I

Spindle control DI signals

Symbol	Signal	Description
TLMLA, B	Torque limit command (low)	Limits the output torque of the spindle motor. Set the limit using the spindle parameter. TLML TLMH 0 0 : No torque limit 0 1 : Limits the torque to the value specified with the parameter. 1 0 : Limits the torque to half of the value for TLMH. 1 1 : Limits the torque to half of the value for TLMH.
TLMHA, B	Torque limit command (high)	
CTH1, 2A, B	Clutch or gear signal	Specify one of the following conditions according to the clutch or gear status. Used to select a spindle control parameter. CTH1 CTH2 0 0 : High gear 0 1 : Medium high gear 1 0 : Medium low gear
SRVA, B	Reverse rotation command	Specifies the rotation direction when the spindle motor is viewed from the shaft. SRV SFR 0 0 : Stop 0 1 : Normal rotation (CCW: Counterclockwise) 1 0 : Reverse rotation (CW: Clockwise) 1 1 : Stop
SFRA, B	Normal rotation command	
ORCMA, B	Spindle orientation command	Used for spindle orientation control. 0 : – 1 : Spindle orientation control is performed.
MRDYA, B	Machine ready signal	Used to open or close the magnetic contactor in the spindle servo unit. 0 : The magnetic contactor is opened. 1 : The magnetic contactor is closed.
ARSTA, B	Alarm reset signal	Used to reset the spindle alarm.  The alarm is reset when the level of the signal is changed from 1 to 0.
*ESPA, B	Emergency stop signal	0 : Emergency stop 1 : Normal operation
SPSLA, B	Spindle select signal	0 : Main spindle 1 : Sub spindle
MCFNA, B	Power line change completion signal	0 : Main spindle 1 : Sub spindle
SOCNA, B	Soft start/stop cancel signal	0 : The soft start/stop function is canceled. 1 : The soft start/stop function is enabled.
INTGA, B	Velocity integral control signal	0 : Velocity integral control is enabled. 1 : Velocity integral control is disabled.

Symbol	Signal	Description
RSLA, B	Output change request signal	0 : High-speed output characteristics 1 : Low-speed output characteristics
RCHA, B	Power line status check signal	0 : High-speed output characteristics 1 : Low-speed output characteristics
INDXA, B	Orientation stop position change signal	"1" "0"  New stop position data is obtained when the level of the signal is changed from 1 to 0. Then, the spindle is moved to the new stop position, and is stopped.
ROTAA, B	Rotation direction command while changing the orientation stop position	0 : CCW (counterclockwise) 1 : CW (clockwise)
NRROA, B	Short-distant movement command while changing the orientation stop position	0 : The rotation direction depends on the setting of ROTA (= bit 1) 1 : Short-distance movement control (within ±180°)
DEFMDA, B	Differential mode command	1 : Differential control mode
OVRA, B	Analog override command	0 : Analog override is disabled. 1 : Analog override is enabled.
INCDA, B	Incremental command	1 : Incremental command spindle orientation 0 : Usual orientation
MFNHGA, B	Main-spindle MCC status signal while changing spindles	0 : The MCC in the main spindle is opened. 1 : The MCC in the main spindle is closed.
RCHHGA, B	High-output MCC status signal while changing output	0 : The MCC for high output is opened. 1 : The MCC for high output is closed.
MORCMA, B	Command for spindle orientation with a magnetic sensor	1 : Spindle orientation with the magnetic sensor is controlled.
SLVA, B	Slave operation command	1 : Slave operation is controlled.
MPOFA, B	Motor power stop signal	1 : Motor power stop
R12I - R01I SGN, SSIN SIND RI12 - RI00 RISGN	Spindle speed command	Specifies a spindle speed command.
SHA11 - SHA00 SHB11 - SHB00	Stop position command for spindle orientation with a position coder	The stop position is specified externally spindle orientation with the position coder.
*SSTP	Spindle stop signal	0 : Velocity command voltage = 0 1 : Velocity command voltage = specified value
SOR	Spindle orientation in progress	1 : Outputs the velocity command specified with the parameter.
SAR	Velocity reached signal	1 : The actual spindle speed reaches the specified speed.

Symbol	Signal	Description
FIN	M function completion signal	1 : The M function is completed.
CON, COFF SCNTR1, 2 . .	Cs contour control command	Specifies the Cs contour control mode .
GR1, 2 GS1, 2, 4	Gear select signal (T-system)	Used for velocity command calculation under constant surface speed
*SUCPF *SEUSL	Spindle unclamp signal	Used for spindle positioning control
*SCPF *SEUCL	Spindle clamp signal	
SPSTP	Spindle stop check signal	
SPSYC	Spindle speed synchronization control command	1 : Spindle speed synchronization control
SPPHS	Spindle phase synchronization control command	1 : Spindle phase synchronization control
RGTP RGTAP	Rigid tapping command	1 : Rigid tapping control

10.3.3 First spindle control DO signals (CNC to PMC)

PM	0C	0TTC HEAD2	15	16	7	6	5	4	3	2	1	0
F228	F281	F1481	F229	F045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
F229	F282	F1482	F228	F046	MOAR2A	MOAR1A	POAR2A	SLVSA	RCFNA	RCHPA	CFINA	CHPA
F230	F283	F1483	F231	F047							INCSTA	PC1DTA
F216	F172	F1372		F036	R08O	R07O	R06O	R05O	R04O	R03O	R02O	R01O
F217	F173	F1373		F037					R12O	R11O	R10O	R09O
			F010 (F006)		RO15	RO14	RO13	RO12	RO11	RO10	RO09	RO08
			F011 (F007)		RO07	RO06	RO05	RO04	RO03	RO02	RO01	RO00
F194	F150	F1350		F007						SF		MF
			F008								SF	MF
F193	F149	F1349		F001				ENB				
	F164	F1364		F038					ENB3	ENB2	SCLP	SUCLP
			F042			SPCO	SPBO	SPAO		SPAL	SSLP	SUCLP
	F154	F1354		F035								SPAL
F196	F152	F1352		F034						GR30	GR20	GR10
			F001		CSS							
				F002						CSS		
	F178			F044				SYCAL	FSPPH	FSPSY	FSCSL	
			F67, 71 . .		MCNTR1, 2							
			F111		MSPPHS	MSPSYC	SPSYAL					
			F040					RTAP				
			F020	F025	S31	S30	S29	S28	S27	S26	S25	S24
			F021	F024	S23	S22	S21	S20	S19	S18	S17	S16
			F022	F023	S15	S14	S13	S12	S11	S10	S09	S08
			F023	F022	S07	S06	S05	S04	S03	S02	S01	S00
			F012	F041	AR15	AR14	AR13	AR12	AR11	AR10	AR09	AR08
			F013	F040	AR07	AR06	AR05	AR04	AR03	AR02	AR01	AR00

The codes for Series 15-TT are enclosed in parentheses.

0C	0TTC HEAD2	15	16	7	6	5	4	3	2	1	0
		F232		SLDM15	SLDM14	SLDM13	SLDM12	SLDM11	SLDM10	SLDM09	SLDM08
		F233		SLDM07	SLDM06	SLDM05	SLDM04	SLDM03	SLDM02	SLDM01	SLDM00
		F234		SSPD15	SSPD14	SSPD13	SSPD12	SSPD11	SSPD10	SSPD09	SSPD08
		F235		SSPD07	SSPD06	SSPD05	SSPD04	SSPD03	SSPD02	SSPD01	SSPD00
		F236		SSPAA7	SSPAA6	SSPAA5	SSPAA4	SSPAA3	SSPAA2	SSPAA1	SSPAA0

10.3.4 Second spindle control DO signals (CNC to PMC)

0C	0TTC HEAD2	15	16	7	6	5	4	3	2	1	0
F285	F1485	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB
F286	F1486	F244	F050	MOAR2B	MOAR1B	POAR2B	SLVSB	RCFNB	RCHPB	CFINB	CHPB
F287	F1487	F247	F051							INCSTB	PC1DTB

Spindle control DO signals

Symbol	Signal	Description
ALMA, B	Alarm signal	Output when a spindle alarm occurs. 0 : Normal state 1 : Alarm state
SSTA, B	Speed zero detection signal	Output when the actual spindle motor speed does not exceed the speed zero detection level. 1 : Zero speed
SDTA, B	Speed detection signal	Output when the actual spindle motor speed does not exceed the preset speed. 1 : Less than preset speed
SARA, B	Speed match signal	Output to the velocity command when the actual spindle motor speed reaches the preset range. 1 : Speed match
LDT1A, B	Load detection signal 1	Output when the detected load is greater than the specified load detection level. LDT1 and LDT2 can be set to a different level. 1 : Greater than the specified load
LDT2A, B	Load detection signal 2	Output when the detected load is greater than the specified load detection level. 1 : Greater than the specified load
TLM	Torque limiting signal	1 : The limit is applied to the torque.
ORAR	Orientation complete signal	Output when the spindle stops near the specified position after the orientation command is entered. 1 : Orientation is completed.
CHPA	Power line change signal	0 : Main spindle 1 : Sub spindle
CFIN	Spindle change completion signal	0 : Main spindle 1 : Sub spindle
RCHP	Output change signal	0 : High-speed output characteristics 1 : Low-speed output characteristics
RCFN	Output change completion signal	0 : High-speed output characteristics 1 : Low-speed output characteristics
SLVSA, B	Slave operation status	1 : Slave operation status
PRAR2A, B	Signal for approximate spindle orientation with a position coder	1 : Near the orientation stop position
MOAR1A, B	Signal for completion of spindle orientation with a magnetic sensor	1 : Completion of orientation
MOAR2A, B	Signal for approximate spindle orientation with a magnetic sensor	1 : Near the orientation stop position
PC1DTA, B	Signal indicating the status of the detected one-rotation position coder signal	1 : Status of the detected one-rotation position coder signal

Symbol	Signal	Description
INCSTA, B	Incremental method orientation signal	1 : Under incremental method spindle orientation
R12O - R01O RO15 - RO00	Spindle speed command	Outputs the spindle speed command.
MF	M function strobe signal	1 : The M code is effective.
SF	Spindle function strobe signal	1 : The S code is effective.
ENB	Spindle enable signal	0 : The velocity command indicates 0. 1 : The velocity command indicates other than 0.
SUCLP	Spindle unclamp completion signal	1 : Unclamping the spindle is completed.
SCLP	Spindle clamp completion signal	1 : Clamping the spindle is completed.
SPAL	Spindle fluctuation alarm signal	1 : The actual speed of the spindle is out of the allowed range.
SPAO, SPBO SPCO	Spindle speed override check signal	
GR10, 20, 30	Gear select signal	
CSS	Constant surface speed control signal	1 : Under constant surface speed control
FSCSL NCBTR1, 2	Cs contour control signal	1 : Under Cs contour control
FSPSY MSPSYC	Spindle synchronization control signal	1 : Under spindle synchronization control
FSPPH MSPPHS	Spindle phase synchronization control signal	1 : Under spindle phase synchronization control
SYCAL SPSYAL	Spindle synchronization control alarm signal	1 : Spindle synchronization control alarm
RTAP	Rigid tapping signal	1 : Rigid tapping in progress
S31 - S00	Spindle function code signal	
AR15 - AR00	Actual spindle speed signal	
SLDM15 - SLDM00	Load meter data	0 to 32737 (+10 V)
SSPD15 - SSPD00	Motor speed data	0 to 16384 (maximum motor speed)
SSPAA7 - SSPAA0	Spindle alarm data	Alarm number

(Note) Up to now TLML (torque restriction command signal) has been set to ON when performing rigid tap for the spindle amplifier, but now in the serial interface spindle amplifier it is not necessary to set the TLML signal to ON.

10.4 Detailed Explanation of Spindle Control Signal

10.4.1 Torque restriction command signal (TLMLA, TLMHA)

(1) The torque restriction (torque limit) is used in order to rotate the spindle motor to temporarily reduce the spindle motor output torque at such times as machine type spindle orientation.

(2) Set the rotation speed at orientation and the output torque at orientation of each machine type at the machine manufacture in order to lessen shocks even when hitting the machine stopper.

(3) It is possible to adjust the output torque at orientation by parameter

(4) If the torque restriction command is 1, the torque restriction state occurs. Even if commanded during motor rotation it will be immediately enabled. If the torque restriction state occurs, the torque restriction signal (TLMA) is immediately transmitted to the outside.

(5) At the time of performing machine type orientation at the machining center ATC, consider the following points when designing the magnetics cabinet sequence such that damage does not occur to the machine stopper.
① The output torque at orientation should not be excessive.
② The rotation speed at orientation should not be excessive. For example, when the rotation speed is excessive at the speed detection signal, the interlock should be set such that the stopper does not emerge.
③ When the torque restriction is released, the stopper should be securely stored.

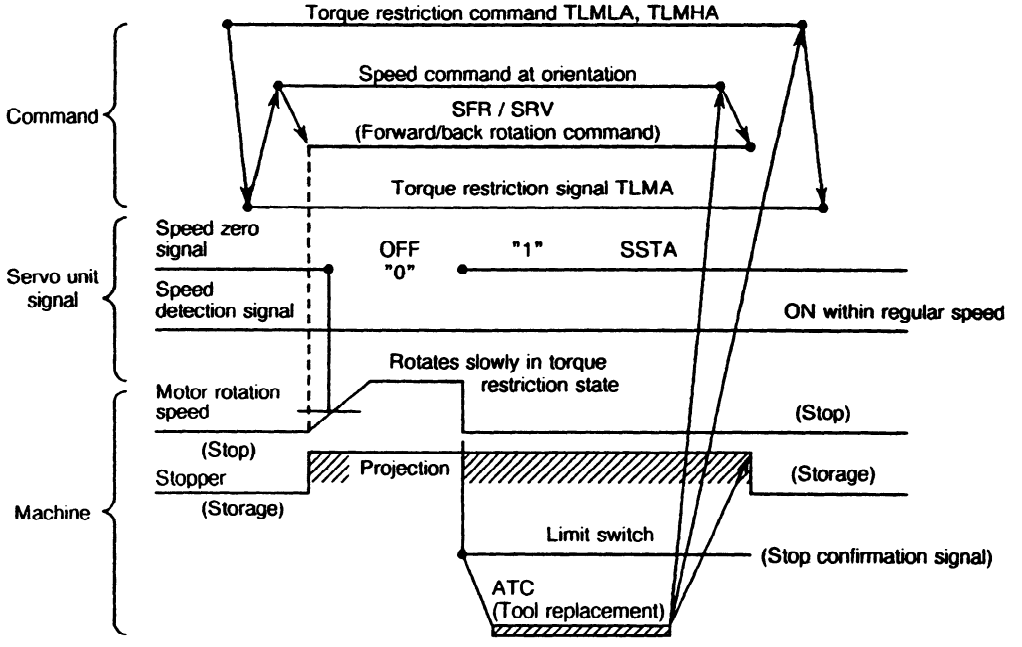


Fig. 10. 4. 1 Example of machine type orientation sequence

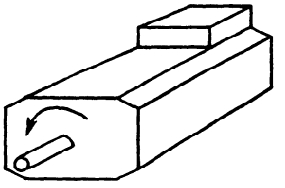
When the conditions desicribed on the privious page are difficult, use the purely electric type spindle orientation (option) which does not use a stopper.

10.4.2 Forward rotation command signal (SFRA)

(1) When the following four conditions hold, the spindle motor starts a forward rotation corresponding to the speed command (positive value).

① Emergency stop signal *ESPA is 1
② Machine ready signal MRDYA is 1
③ Forward rotation command signal SFRA is 1
④ Contact signal ESP1, 2 (TB) is ON (closed)

(2) While SFRA = 1, the spindle motor rotates in an counterclockwise direction (CCW) viewed from the shaft side according to the commanded speed (positive value).



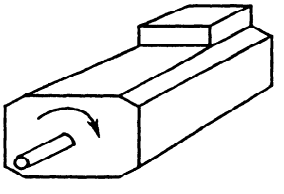
(3) If SFRA = 0 occurs, the spindle motor stops by the regenerative braking. After stopping, it cuts the power supply to the spindle motor by intercepting the transister excitation signal.

10.4.3 Reverse rotation command signal (SRVA)

(1) When the following four conditions hold, the spindle motor starts a reverse rotation corresponding to the speed command (positive value).

① Emergency stop signal *ESPA is 1
② Machine ready signal MRDYA is 1
③ Forward rotation command signal SFRA is 1
④ Contact signal ESP1, 2 (TB) is ON (closed)

(2) While the contact is ON (closed), the spindle motor is rotated in a clockwise direction (CW) looked at from the shaft side according to the speed command (Positive value).



(3) When the forward rotation command signal (SFRA) and the reverse rotation command signal (SRVA) are simultaneiusly ON, the spindle motor stops.

10.4.4 Machine ready signal (MRDYA)

(1) The table contents result from the parameter setting.

Mode	Parameter setting		Contents	
	Series15:3001-bit0 Series0:6501-bit0	Series15:3001-bit1 Series0:6501-bit1		
(A)	0	0 or 1	Machine ready signal is not used. At this time, the spindle motor enters the operable state only when emergency stop signal is input.	
(B)	1	0	Uses the machine ready signal to create operable state by double signal.	Performs motor power interception by electromagnetic contactor OFF with MRDYA = 0.
(C)	1	1		Performs power interception by switching the inverter section transistor excitation signal interception with MRDYA = 1. At this time, the electromagnetic contactor remains ON.

(Note) The method of using the machine ready signal in the various modes is as shown in (2)-(4).

(2) Mode (A)

Used when minimizing the input signal.

(3) Mode (B)

① When controlling the operable state by the double signal. Used when necessary to install in 2 locations (1 is the emergency stop signal, the other 1 is the machine ready signal) the electromagnetic contactor ON/OFF signal input terminals for machines when the operator directiy touches the spindle by hand in order to connect/disconnect the workpiece and tool.

② Electromagnetic contactor becomes ON by MRDYA = 1, and motor enters the operable state.

③ Electromagnetic contactor becomes OFF by MRDYA = 0, and power to the motor is intercepted.

④ If MRDYA = 0 is set during motor rota-tion, the spindle motor smoothly decelerates and stops. After stopping, set the electromagnetic contactor to OFF.

⑤ Arising from the restrictions of the open/close life of the electromagnetic contactor, do not use in such a manner that there is a high frequency of open/close of over a few hundred times in one day.

(4) Mode (C)

① Used when it is anticipated that there will be a high frequency of open/close of the electromagnetic contactor.

② During the automatic tool replacement (ATC) orientation operation, in a machine where the spindle motor is restrained by the tool unclamp signal,there are cases where the power measurement becomes large and a large motor current flows by a slight slip from the orientation stop position.

In order to prevent this, set CIRDYA = 0 and release the orientation state during tool unclamp.

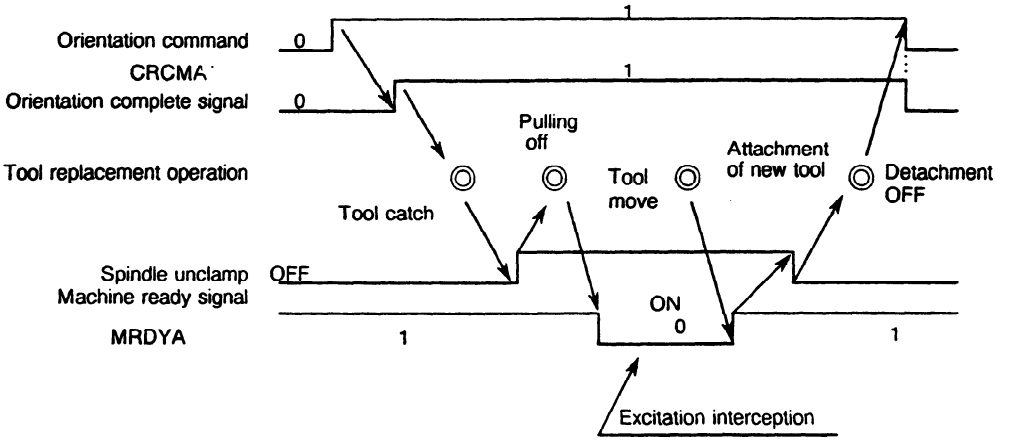
If MRDYA = 1 is set at tool unclamp end, it is possible to re-enter the orientation state.

③ Regarding the purpose of the above described ②, if the orientation command signal remains at ORCMA = 1, even if the machine ready signal is set to MRDYA = 0/1, there is no orientation again after 1 rotation as it only moves by the amount of the stop position slip.

Timing chart

[Conditions]

(Note) Perform by mode (C) parameter setting.



10.4.5 Alarm reset signal (ARSTA)

(1) After removing the various alarm causes such as motor overheating, excess speed deviation, short-circuiting, excess speed, excess voltage, excess current, excess load, and voltage drop, if the alarm reset signal is inputted, the alarm is released and the usable state occurs.

(2) Even if this signal isinputted when there is no alarm, it is disabled.

(3) In the servo unit internal section also, there is a reset function, and the function is the same as this alarm reset signal.

10.4.6 Emergency stop signal (*ESPA)

(1) Spindle motor and servo unit enter the operable state by *ESPA = 1.
In *ESPA = 0 the internal servo unit electromagnetic contactor is in the OFF state and the spindle motor does not operate.

(2) If *ESPA = 0 is set during the motor rotation, the spindle motor smoothly decelerates to a stop. After stopping, the electromagnetic contactor enters the OFF state.

(3) If *ESPA = 1 then occurs again, the spindle motor enters the rotateable state, and so will begin to rotate as soon as a rotation command is issued. For this reason, the command signal (speed command, normal operation command, or reverse operation command) to the spindle servo unit should be reset at the same time an emergency stop signal is input.

10.4.7 Spindle alarm signal (ALMA)

(1) If the state occurs in which the spindle motor operation cannot be continuously executed, the power to the spindle motor will become OFF and the spindle motor will be stopped.

(2) At the same time the alarm signal ALMA = 1 occurs. Regarding the alarm contents, confirm by the display section of the spindle amplifier.

(3) Set the command signal to the spindle servo unit (speed command, forward/reverse rotation command, torgue limit command, spindle orientation command) in the reset state using the alarm signal output. If it is not in the reset state (state that signal from PMC device is all clear), when the alarm on the spindle amplifier is released there is a danger that the spindle motor may rotate.

(4) Because the spindle motor enters the power OFF, coasting operates at the same time as the alarm signal is outputted, it is necessary to set in an emergency stop state and to set the feedhold state at the CNC or magnetics cabinet side.

(5) When the alarm state has occurred, ALMA = 1 occurs.
While the alarm signal is 1, the spindle motor enters coasting operates state regardless of any command from the outside.

(6) The relationship between the alarm signal and the alarm reset signal is as shown in Fig. 10.3.7.

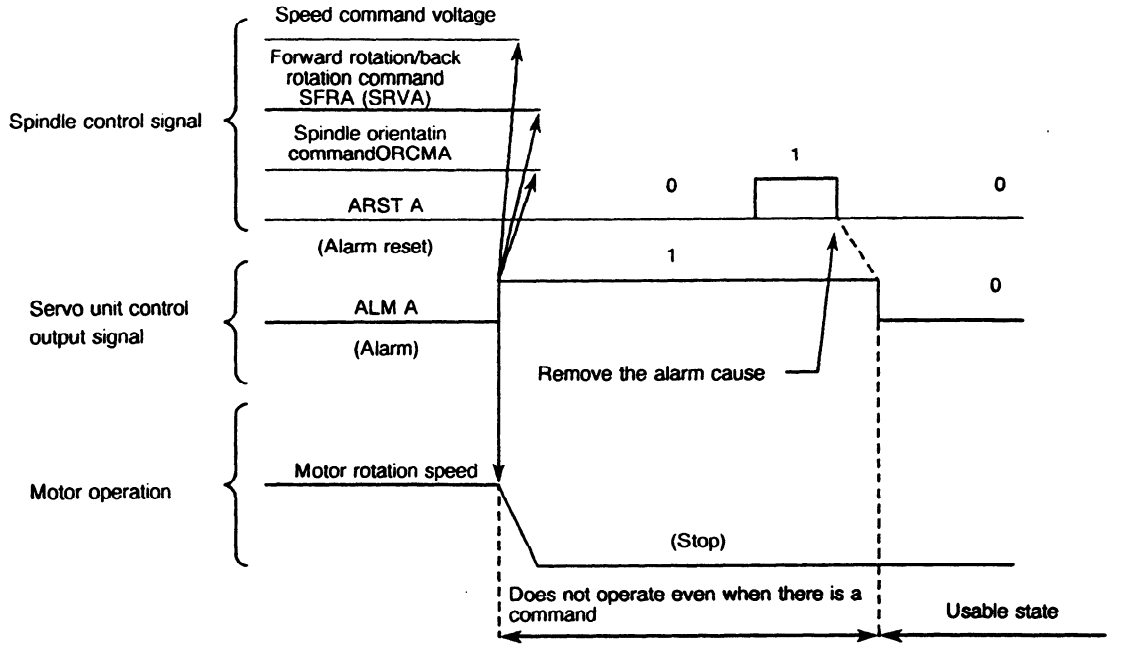


Fig. 10.4.7 Timing Chart of the Spindle Alarm Signal

10.4.8 Zero-speed detecting signal (SSTA)

(1) If the actual rotation speed of the spindle motor is reduced to be lower than the zero-speed detection point for the stop command, SSTA = 1 occurs.

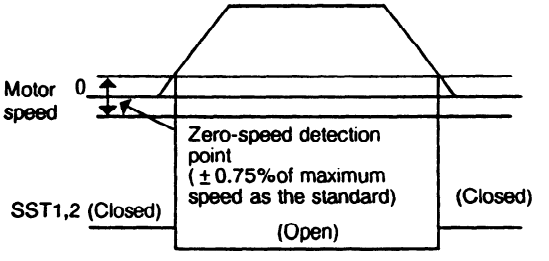


Fig. 10.4.8 Signal Indicating that the spindlespeed dropped to close to zero

(2) The zero-speed detection point is fixed at 0.75% of the maximum speed as the standard. In other words, the zero-speed detection signal becomes DSTA = 1 when the rotation speed is lower than about 33, 45, or 60 min^{-1}.

(3) This signal is outputted when the above condition is satisfied, irrespective of rotation commands (SFR, SRV).

(4) The minimum pulse width value of this signal is about 40 ms. Refer to section 10.3.10 (5).

10.4.9 Speed detecting signal (SDTA)

(1) SDTA = 1 occurs when the motor speed is lower than the speed which is set by parameter.

(2) This signal is used to detect that the rotation speed has become lower than a certain speed set such as clutch selectable speed or gear selectable speed.

(3) The speed detecting range can be set by parameter.
It is usually set 3% of the maximum speed in the case of gear change or 30% of the maximum speed in the case of clutch change.

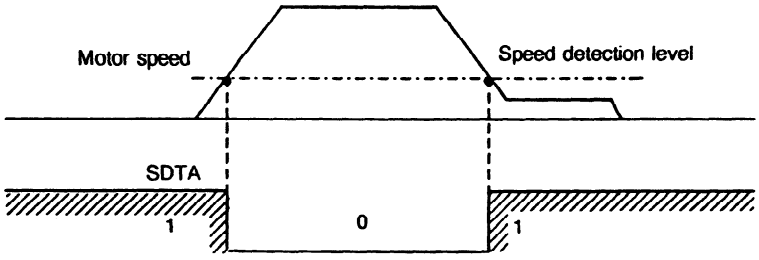


Fig. 10.4.9 (a) Speed Detection Signal

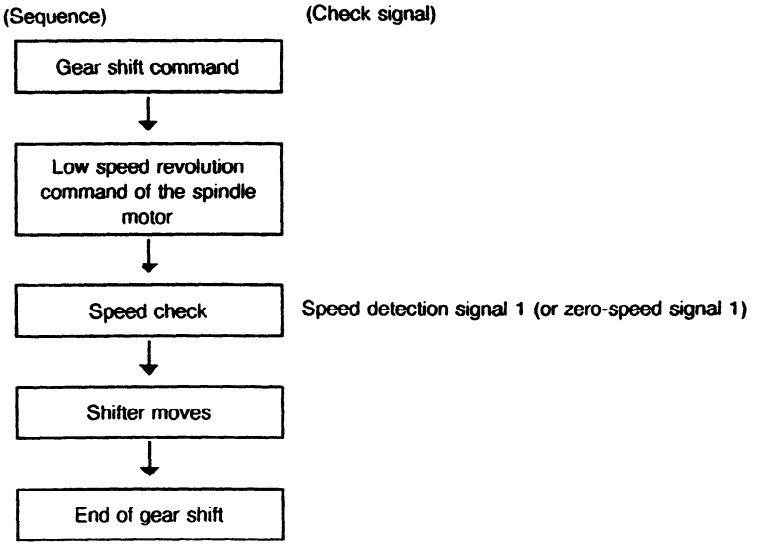
(4) For this signal, SDTA = 1 occurs when the absolute value of the motor speed is reduced to be lower than the preset detection level, irrespective of rotation commands (SFR, SV).

(Reference) Sequence of the gear shift

The gear shift in the CNC machine tool is one of the sequence controls. The electric circuit signal in the sequence is used to move the spindle gear, which is an important component of the machine. It is then necessary to check that the spindle motor revolution is in low speed to switch the gear safely.

The following is an example of sequence at gear shift, when the speed detection signal (gear selectable signal) was used. This example can be referred to when designing the magnetics sequencer.

① An example of gear shift sequence using speed detectionsignal



To change the gear safely, it must be checked that the spindle motor revolution is low enough before moving the shifter. If the zero-speed signal is also applied, the safety can be doubly checked.
(Essential reason) If the shifter moves when the spindle motor is rotating at high speed, the gear will break.

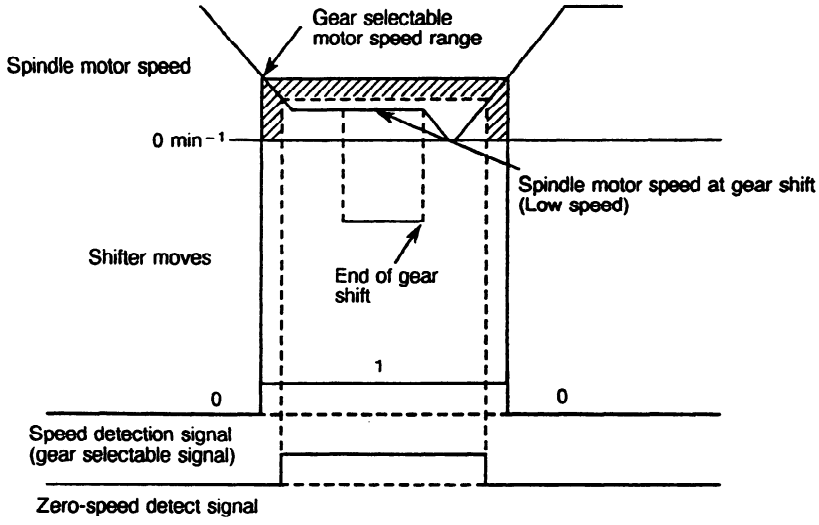


Fig. 10.4.9 (b) Speed Detection Signal

10.4.10 Speed arrival signal (SARA)

(1) SARA = 1 occurs when the actual rotation speed of the spindle motor arrives within the range set by the speed command.

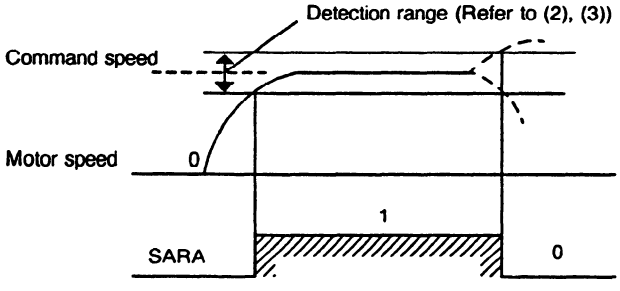


Fig. 10.4.10 (a) Speed-reached Signal 1

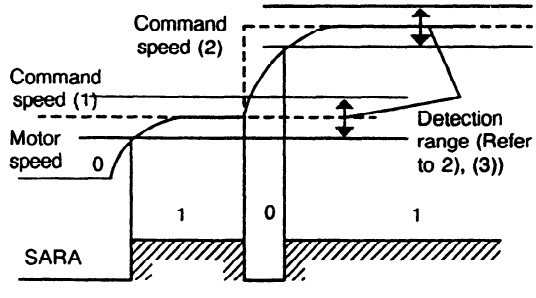


Fig. 10.4.10 (b) Speed-reached Signal 2

(2) The setting range is ±1 to 100% of the command speed. However, when the speed is less than 10% of the maximum rotation speed, the detection range becomes wider than the preset range.

(3) The standard setting at shipment is ±15%. However, the detection range of this speed arrival signal at low speed widens as shown in the diagram below.Namely, the arrival signal is outputted when actual motor rotation speed is 435/60/80 min^{-1} ±76% by a speed command of 45/60/80 min^{-1}.

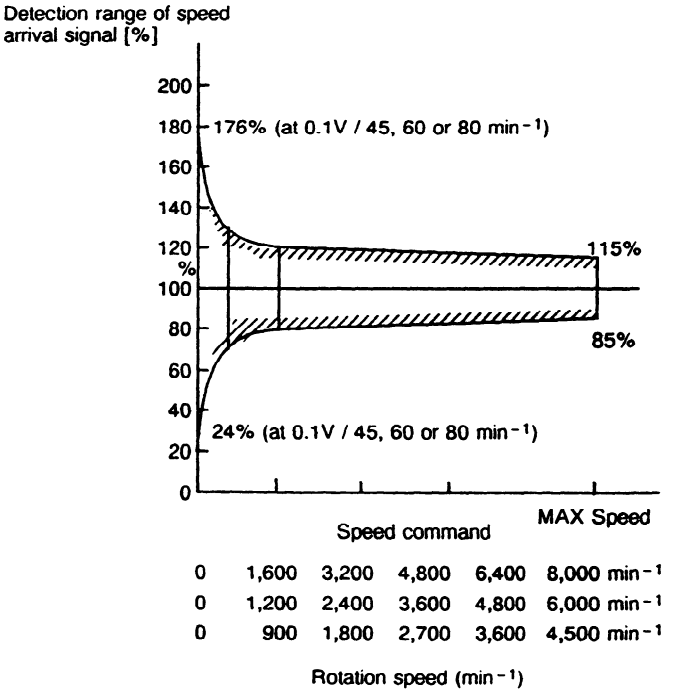
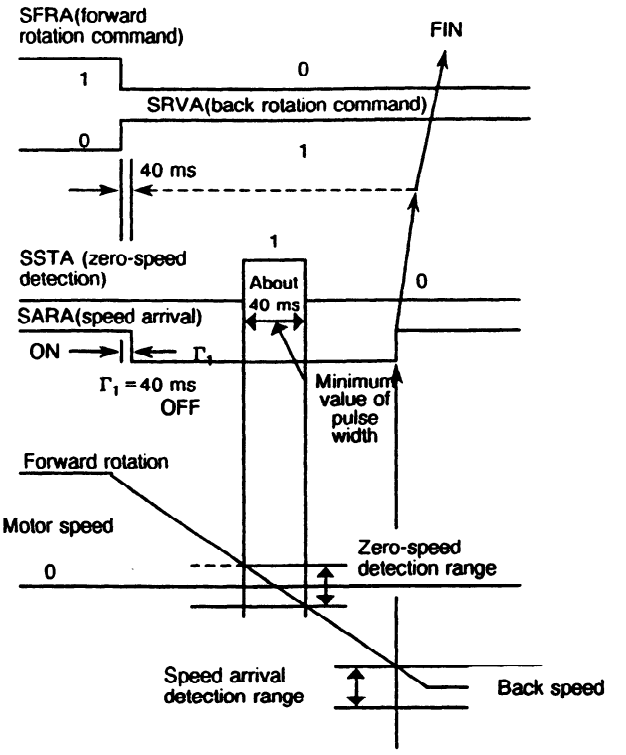


Fig. 10.4.10 (c) Detection Range of the Speed-reached Signal

(4) If one of these signals, SFRA or SRVA, is not 1, it is not outputted.

(5) It is possible to control the back rotation of the tapping cycle in the following manner by using this signal.



(Note) The time is delayed until the SARA signal becomes 0.

Fig. 10.4.10 (d) Timing Chart of the Speed-reached Signal

If the back rotation command is transmitted, the spindle motor starts deceleration and, because the arrival signal becomes 0 at under 40 ms, it next detects the speed arrival signal has again become 1 via speed zero and sets the end of the back command.

(6) This signal is used as the confirmation signal (FIN signal) for the forward rotation (M03) and back rotation (M04) commands.

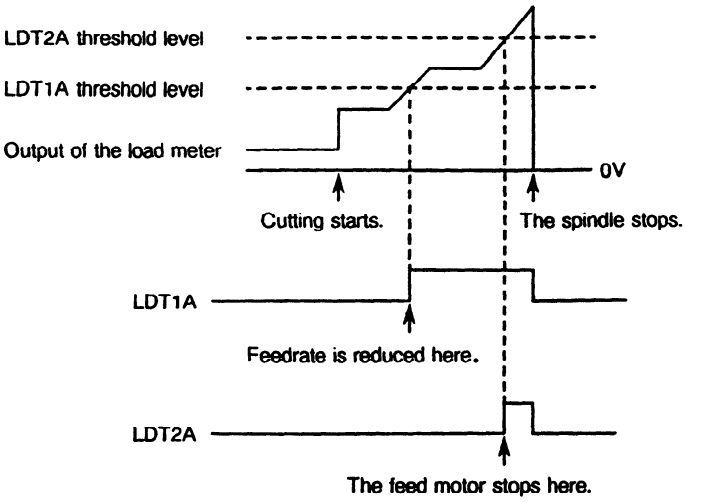
10.4.11 Load detection signal (LDT1A, LDT2A)

(1) Assume that the maximum output (10 V) of the load meter is 100%. When the output of the load meter reaches the parameter settings (%), these signals are set to 1.

(2) Parameter settings for these signals are set independently.

(3) Using these signals, the PMC reduces the feedrate or stops the feed to prevent the spindle from stopping when cutting overload is applied to the spindle.

(4) The following example shows the case in which the spindle is controlled with two load-detection levels set.



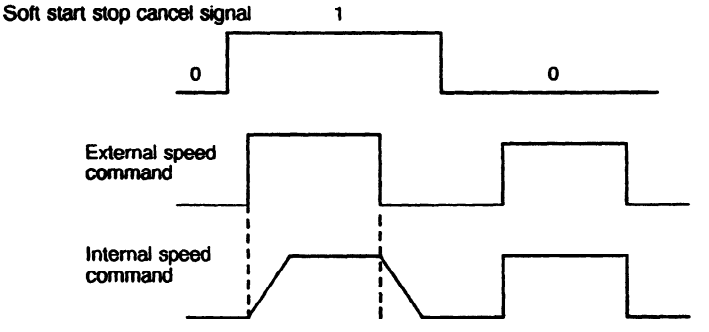
(5) When using only one load-detection level to stop the feed motor, perform spindle control according to the specifications.

(6) After the speed command is changed, this signal is not output until 10 seconds elapse. (The delay is specified by parameter 6582.)

10.4.12 Soft start stop cancel signal (SOCAN)

(1) If the soft start stop cancel signal becomes 0, the soft start stop function is disabled.

(2) In the state that the soft start stop cancel signal is 1, the soft start stop function is enabled and the gradient of the speed command changing at acceleration/ deceleration can be set in the following manner.

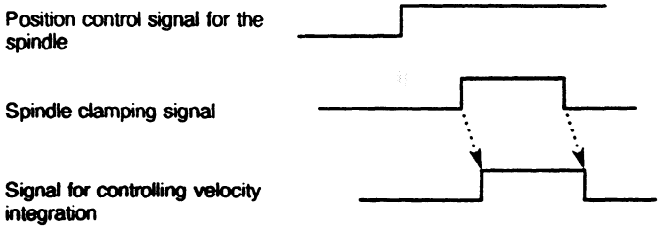


(3) If the emergency tsop signal input is set to *ESPA=0, the soft start stop function is automatically disabled.

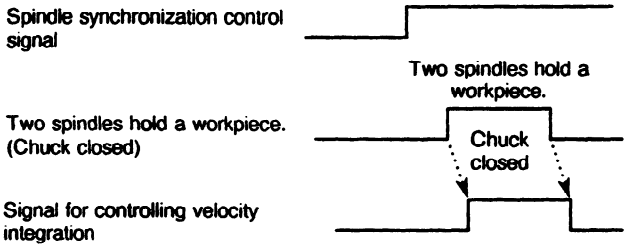
(4) The change in the speed to be specified is set by parameters. (For FS-0C, these parameters are 6530 and 6670.) Set the change to at least 1 when the soft start-stop function is enabled (SOCNA = 1).

10.4.13 Signal for controlling velocity integration (INTGA)

(1) When the position of the spindle is being controlled in a mode such as spindle orientation control, spindle index control, or Cs contour control mode, the spindle may be clamped with a brake.
If the spindle is kept clamped with a small positional deviation, the integration control for the velocity attempts to correct the deviation to zero, resulting in excessive flow of current into the motor.
Disabling the integration control for the velocity by setting this signal prevents excessive current from flowing into the motor when a small positional deviation exists.



(2) When two spindles hold a workpiece in the spindle synchronization control mode with a small synchronous error, the integration control for the velocity attempts to correct the error to zero, resulting in excessive flow of current into the motor.
Disabling the integration control for the velocity by setting this signal prevents excessive current from flowing into the motor when a small synchronous error exists.



10.4.14 Spindle override command (function) with analog input voltage (OVRA)

This function can be used only when unit A06B-6064-H3XX#H550 or A06B-6064-H230#H550, A06B-6064-H240#H550 is used.

(1) In the normal speed control mode (including when the soft start/stop function is used), this function overrides speed, with analog voltage input from an external unit to the serial spindle amplifier.

(2) The override function with analog input voltage is enabled when this signal is set to 1 in the normal speed control mode (including when the soft start/stop function is used).

(3) A limit (100% or 120%) of this function is assigned to bit 5 of parameter No. 6506 in the Series 0C.

The maximum analog input voltage is +4.5 V. If an override speed exceeds the maximum speed, it is clamped by the maximum speed.

Parameter	PM	0C	15	16	#7	#6	#5	#4	#3	#2	#1	#0
For the first spindle	3006	6506	3006	4006			bit5					
For the second spindle	_	6646	3146	_								

bit5 = 0 : A limit of 100%
= 1 : A limit of 120%

(4) The following figure shows a system configuration in terms of this function.)

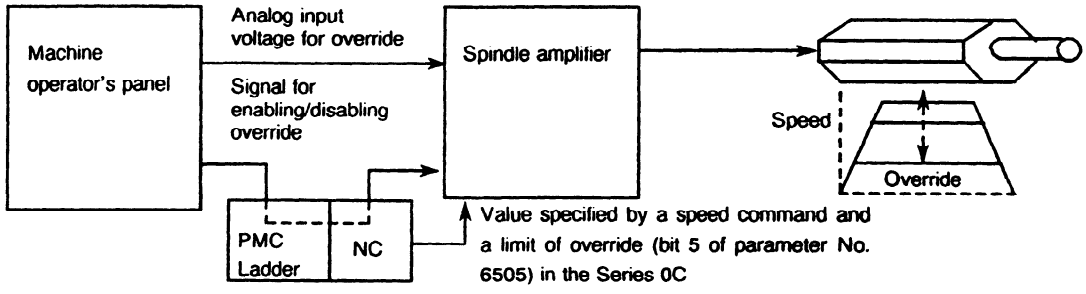


Fig. 10.4.14 (a) System Configuration

(5) The following figure shows the connection of units when analog voltage is input.
The limit for voltage input into the OVR2 terminal is 4.5 V.
Override can be set in increments of 1%.
Total resistance of resistors VR and R1 must be 1 kΩ to 10 kΩ .
The following values are examples for the conventional analog spindle:
VR = 1.0 kΩ , R1 = 1.0 kΩ or 2.4 kΩ

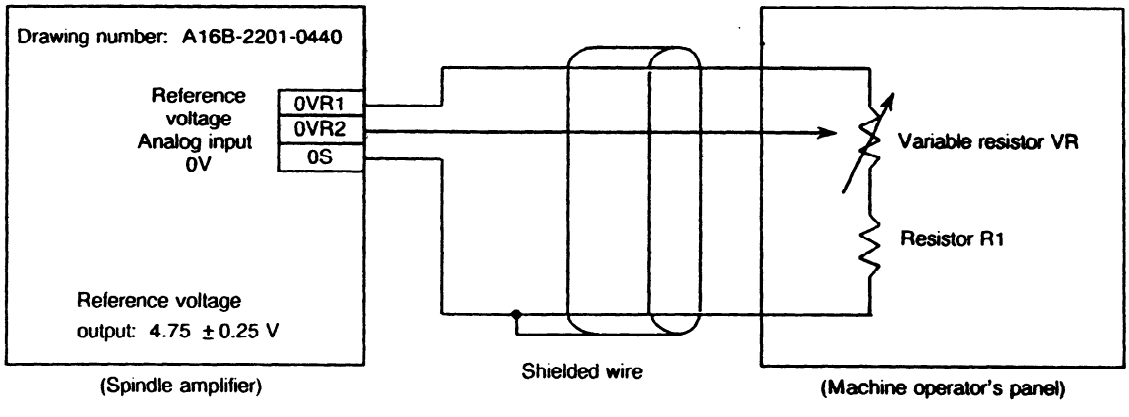


Fig. 10.4.14 (b) Connection between a Spindle Amplifier and Machine Operator's Panel

(6) When the signal for enabling/disabling this override function is set, or the parameter for an override limit is changed, the speed of the motor may change substantially. Stop the motor first, and then set the signal or change the parameter.

10.4.15 Motor power off signal (MPOF)

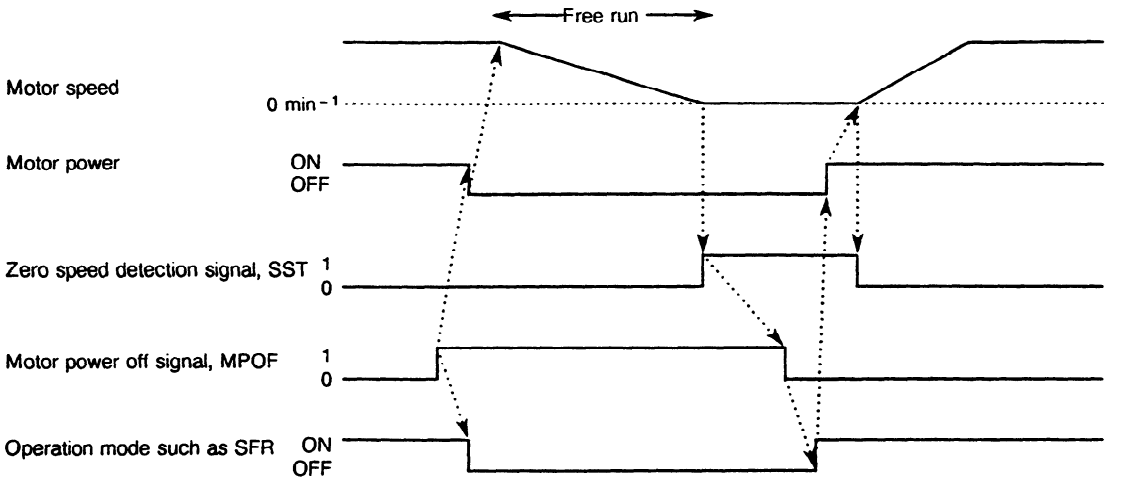
(1) This signal is used to cut the power of the motor when a failure occurs while the spindle is synchronously controlled or the gear cutting machine is operating. When the power is cut, the motor runs free.
This function is applied to the following unit: A06B-6064-H3xx#H550 (Version 9A50.I or later)

(2) This signal only cuts the power of the motor.
After the power is cut, turning off the emergency stop or machine ready signal turns off the magnetic contactor in the spindle amplifier.

(3) The power can be restored to the motor again after the motor stops (zero speed signal, SST = 1).
If the signal is canceled, the power cannot be restored to the motor while the motor is operating (SST = 0).

(4) After the power of the motor is cut, all the operation modes(*1) must be canceled for safety.
After the motor stops (SST = 1), set the operation modes again.
When the power is cut during position control, an alarm such as excessive deviation may occur because position control remains effective.
(*1) Example of operation modes:
- Forward rotation command
- Reverse rotation command
- Spindle orientation (ORCM)
- Rigid tapping (RGPT, RGTAP)
- Spindle synchronization control (SPSYC, SPPHS)
- Cs-axis control
- Cs contour control (COFF, CON, SCNTR1, SCNTR2, etc.)
- Differential mode (DEFMD)

(5) Example of the sequence

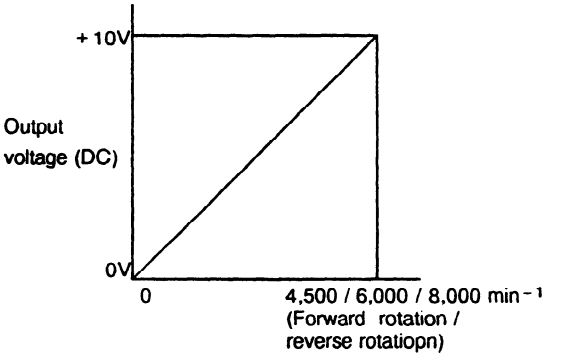


(6) Setting bit 2 of parameter 6509 to 1 cuts off the power of the motor as soon as the AL-24 spindle alarm (serially transmitted data error) occurs. The motor usually decelerates and stops when the alarm occurs.

10.5 Speed Indication Voltage Signal (SM, OM)

(1) The rotation speed of the AC spindle motor can be indicated by externally connecting a speedmeter.

A voltage (DC) proportional to the rotation speed is outputted, irrespective of the forward or reverse rotation of the motor. A +10V is outputted at the maximum revolution 4,500/6,000 min-1.



Motor rotation speed

(2) Use the following speedmeter

(DC voltmeter)

- One-sided deflection DC voltmeter
- DC voltage 10V full scale
- Internal resistance higher than 10 kilo ohms

Example) DC voltmeter LM-80: Kuwano Electrical Manufacturing Co., Ltd.

(3) With respect to the speed indication voltage, the forward rotation/reverse rotation output voltage is calibrated by a parameter. The voltage accuracy is max. ±3%..

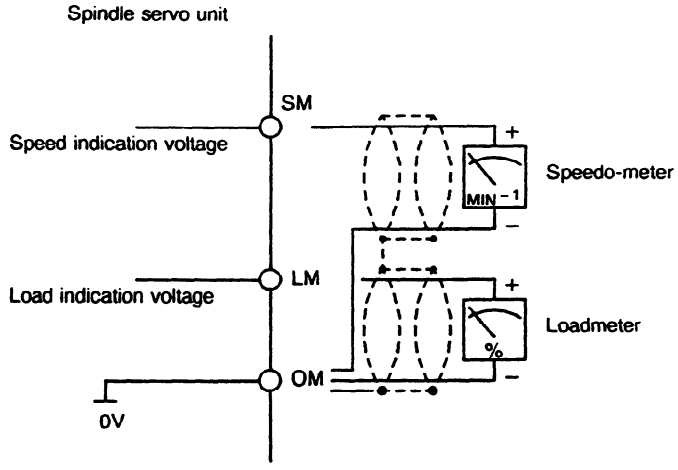


Fig. 10.5 Connecting the Spindle Servo Unit to a Speedmeter and a Load Meter

(4) Terminal board TB can be used as the display interface for this signal.
Use a 2-core shielded cable.

10.6 Load Indication Voltage (LM, OM)

(1) The load indicator indicates the load factor, which is the ratio of the load to the maximum output obtainable by the spindle motor at the input voltage and working revolutions when the machine tool spindle is rotating without load or when cutting is in progress.

(2) When the rated input voltage is applied, the revolutions-to-spindle motor output relation, revolutions-to-torque relation and revolutions-to-indicating voltage relation are as shown in Figs. 10.6 (a), 10.6 (b), and 10.6 (c).

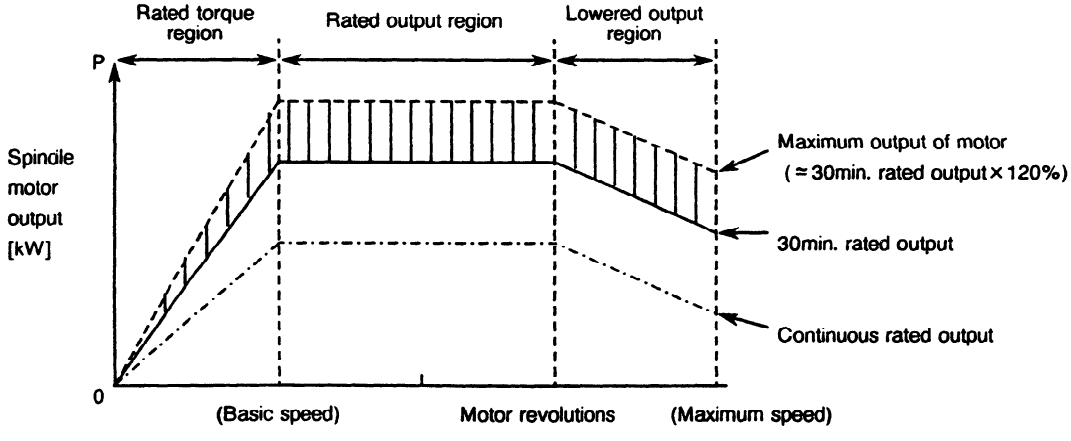


Fig. 10.6 (a) Spindle Motor Output

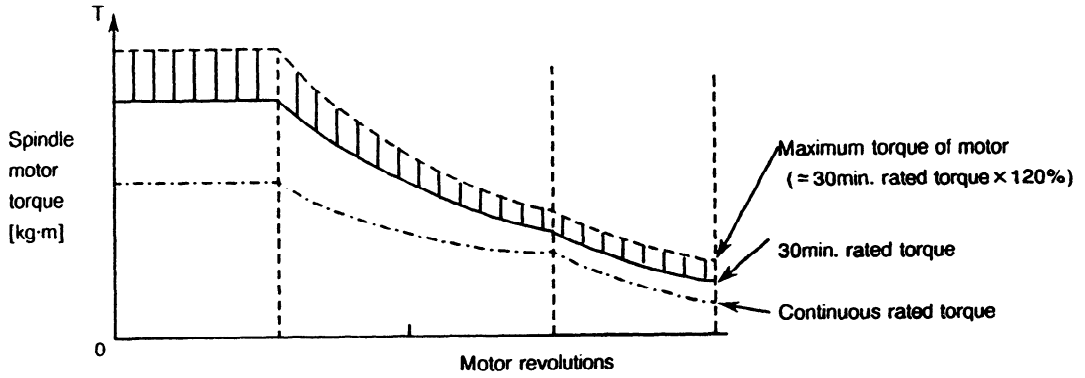


Fig. 10.6 (b) Spindle Motor Torque

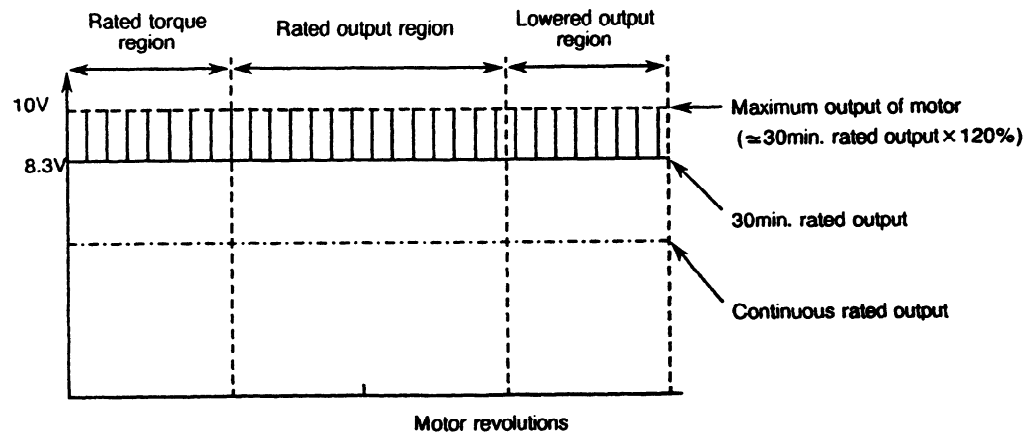


Fig. 10.6 (c) Voltage Used for Operating a Load Meter

(3) The relation between each spindle motor output and the indicating voltage of the load indicator is as shown in Table 10.5 (a), assuming that the continuous rated output of the spindle motor is 100%.

(4) Four types of indications of the load indicator may be considered approximately from Table 10.5 (a). For the indication of the load indicator in this case, refer to examples shown in Table 10.5 (b).

(5) Machine tool builders are requested to prepare a load indicator (DC voltmeter) which complies with the following specification.
- One-side deflecting DC voltmeter
- DC voltage 10V, full scale
- Internal resistance 10 kilo ohms

Example) DC voltmeter LM-80 made by KUWANO DENKI

(6) Terminal board TB can be used as the display interface for this signal.
Use a 2-core shielded cable.

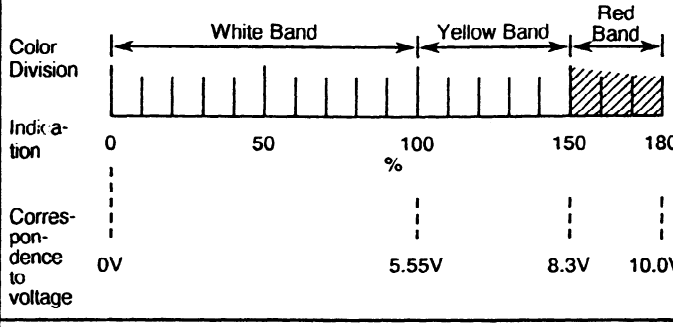
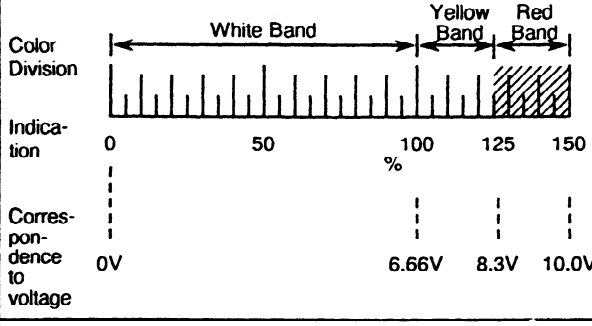
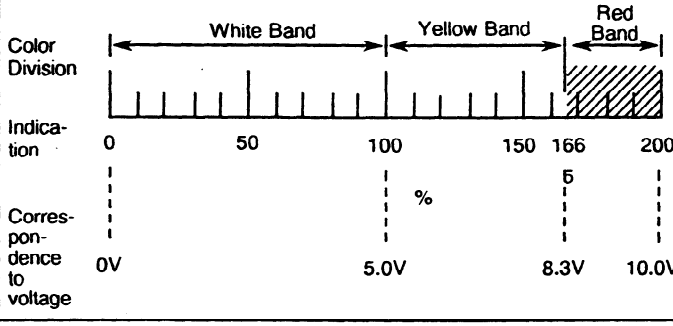
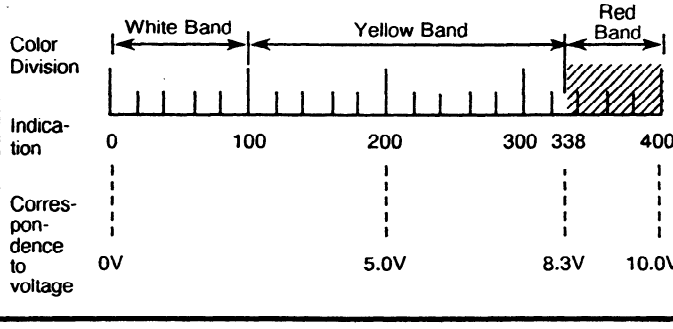
Table 10.6 (a) Relation between each spindle motor output and indicating voltage of load indicator

Model	Output (kw)	Indicating voltage of load indicator (V) (Note)	Ratio asuming that continuous rated is 100% (%)	Example of load indicatror	
				Type of applicable load indicator	Ratio to full scale (%)
0.5S	0.65	4.9	100	C	100
	1.1	8.3	169		166
	1.32	10.0	203		200
1S	1.5	5.7	100	A	102.2
	2.2	8.3	147		150
	2.64	10.0	176		180
1.5S	1.1	2.5	100	D	100
	3.7	8.4	338		338
	4.4	10.0	400		400
2S	2.2	5.0	100	C	101
	3.7	8.3	166		166
	4.4	10.0	200		200
3S	3.7	5.6	100	A	100.8
	5.5	8.3	148		150
	6.6	10.0	178		180
6S	3.7	6.1	100	A	109.8
	5.5	8.3	136		150
	6.6	10.0	164		180
8S	7.5	5.7	100	A	102.6
	11.0	8.3	146		150
	13.2	10.0	175		180
12S	11	6.1	100	A	109.8
	15	8.3	136		150
	18	10.0	164		180
15S	15	6.7	100	B	100.5
	18.5	8.3	124		125
	22.2	10.0	149		150
18S	18.5	7.0	100	B	105
	22.0	8.3	118		125
	26.4	10.0	142		150
22S	22.0	7.0	100	B	105
	26.0	8.3	118		125
	26.0	10.0	142		150

Model	Output (kw)	Indicating voltage of load indicator (V) (Note)	Ratio asuming that continuous rated is 100% (%)	Example of load indicatror	
				Type of applicable load indicator	Ratio to full scale (%)
30S	30.0	6.7	100	B	105.5
	37.0	8.3	124		125
	44.4	10.0	149		150
40S	37.0	6.8	100	B	103
	45.0	8.3	122		125
	54.0	10.0	146		150

(Note) Accuracy of the load indicator voltage depends upon the speed used or the input voltage. The maximum deviation is approximately ±15%.

Table 10.6 (b) Examples of load indicator type

Type	Indication of load indicator	Remarks	Value of CNC parameter 2234 in Series 10,11,12,15
A		Motor Models 1S, 3S, 6S, 8S, 12S, 8P, 12P, 22P, 50P, 6VH, 8VH, 12VH	199
B		Motor Models 15S, 18S, 22S 30S, 40S, 30HV, 40HV, 60HV, 15P, 18P, 30P, 40P	213
C		Motor Models 0.5S, 2S	192
D		Motor Model 1.5S	160

(Note 1) Data Calculation Formula

$$\text{Parameter setting data} = \frac{\text{Load meter output voltage during continuous rated output}}{10\text{V}} \times 128 + 128$$

(7) FANUC Series 0-TC/0-MC

Reading load meter and speed meter of spindle through PMC window.

(a) Settings

G202 - In case of load meter: 19h
In case of speed meter: 1Ah
G203 - 01h
G204 - 00h
G205 - 00h

Settings are designated as those given above. These settings invert the transmission request bit (G200.0).
Data from the load meter and speed meter are received from F252 in binary word form. Note that if the load meter has been set in G202, setting 02h in G203 makes it possible to read the load meter data in F252 and the speed meter data in F254.

(b) Load Meter Data Units

The output of the load meter is regulated so that the maximum attainable value is +32767. The percentage data of the maximum output when continuous rated output is 100% is set in parameter no. 6627.

Ex: If the continuous rated output of the motor of a certain model is taken as 100% and its maximum output then becomes 180%, the parameter data becomes "180".
Conversion to percentage data is made according to the following formula:
% data =
(Load meter data) / 32767 × (parameter data)

Ex: When load meter data = 10000
parameter data = 180,
% data = 10000/32767x180 = approx, 55%

(c) Calculating Motor Speed

The speed of the motor is regulated to that the maximum attainable speed is +16383 min^{-1}. The maximum speed data (in min^{-1}) is set in parameter no. 6520.

Conversion to min^{-1} data is made according to the following formula:
min^{-1} data = (speed data) / 16383 × (parameter data)

Ex: When speed data = 5000
and parameter data = 6000,
min^{-1} data = 5000/16383 × 6000
= approximately 1833 min^{-1}

(Note) Speed data represents the speed of the motor. In order to find the spindle speed, it is necessary to multiply this value by the gear ratio.

VIII. AC SPINDLE SERVO UNIT HV series

1. GENERAL

This part describes the AC Spindle Servo Unit HV series (30HV/40HV/60HV). For the topics other than those described below, see Part V.

The AC spindle servo unit HV series does not require a power transformer to be connected to a 380/415 VAC input power supply. The AC spindle servo unit HV series can be directly connected to a 380/415 VAC power supply.

2. FEATURES

(1) With the state-of-the-art power electronics technology, a 380/415 VAC power supply can be connected not via a power transformer but directly to the AC spindle servo unit for driving.

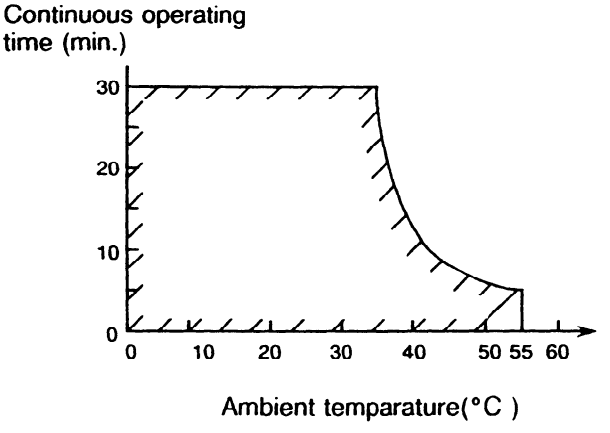
(2) Since the spindle servo unit is designed so that its main circuits are cooled by outside air, the electronic circuits in the power magnetics cabinet can be sealed completely in severe environments, thereby improving reliability.

3. SPECIFICATIONS

Item \ Model		30HV	40HV	60HV
30-min rated power source capacity	kVA	54	63	100
Power source(*1)		380/415VAC + 10%, – 15% 50/60Hz ± 1Hz		
Main circuit system		Transistor PWM inverter		
Feedback system		Speed feedback by pulse generator		
Braking system (regenerative energy processing system)		Regenerative braking (power regeneration)		
Speed control range (speed ratio)	rpm	45 to 4500 (1:100)		
Speed variation		Less than 0.1% of the maximum speed (load variation: 10 % to 100%)		
Ambient temperature(*2)	°C	0 to 55		
Weight		76	76	110

(*1) When a power supply voltage not specified here is used, a transformer is required.

(*2) With model 60HV, the continuous operating time of the motor at the 30-min rated output in a high ambient temperature depends on the thermal limitation of the unit as shown below. (For detailed information about the method of cooling the unit, see Chapter 6.)

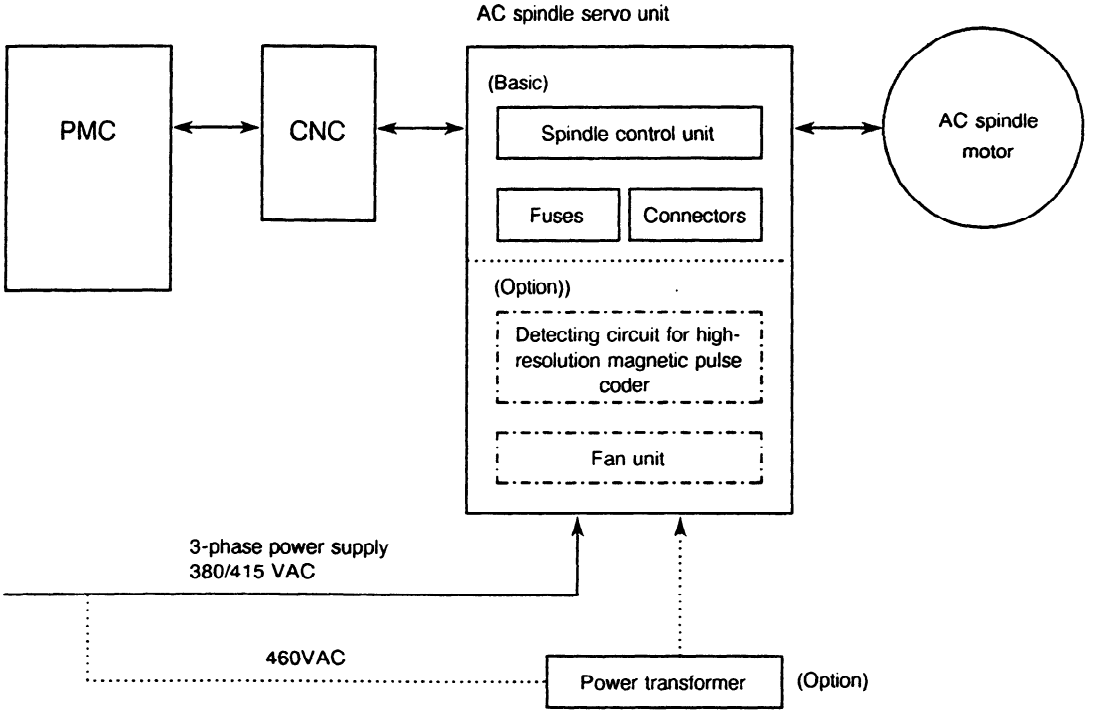


4. CONFIGURATION AND ORDER SPECIFICATIONS

4.1 Configuration

The FANUC AC Spindle Servo Unit HV series (Model 30HV/40HV/60HV) consists of the following units and components:

(1) Spindle control unit (basic)
(2) Fuses for spare (basic)
(3) Connectors for connection (basic)
(4) Detecting circuit for high-resolution magnetic pulse coder (optional)
(5) Power transformer (for 30HV/40HV) (optional)
(6) Fan unit (optional)



4.2 Order Specifications

For options other than those listed below, see Part V.

Classification	Name		Specification number	Remarks
Basic	Spindle control unit model 30HV		A06B-6065-H030#H550	
	Spindle control unit model 40HV		A06B-6065-H040#H550	
	Spindle control unit model 60HV		A06B-6065-H060#H550	
Basic (option)	Optical fiber cable		A02B-0094-K801	5 m long
	Connectors	Without Cs axis control function	A06B-6062-K103	Solder type
			A06B-6062-K104	Crimp type
	Fuses		A06B-6065-K040	Model 30HV/40HV
			A06B-6065-K060	Model 60HV
Option	Power transformer		A06B-6054-J003	Model 30HV/40HV
	Fan unit		A06B-6044-K040	
			A06B-6065-K301	Model 60HV

5. INSTALLATION

Install the AC spindle servo unit in a location that meets the environment conditions described below.

5.1 Ambient Temperature

Ambient temperature of the unit:	0°C to 55°C
Ambient temperature of the storage cabinet (at air inlet):	0°C to 40°C

5.2 Humidity

Normally 95% RH or below (no condensation)

5.3 Vibration

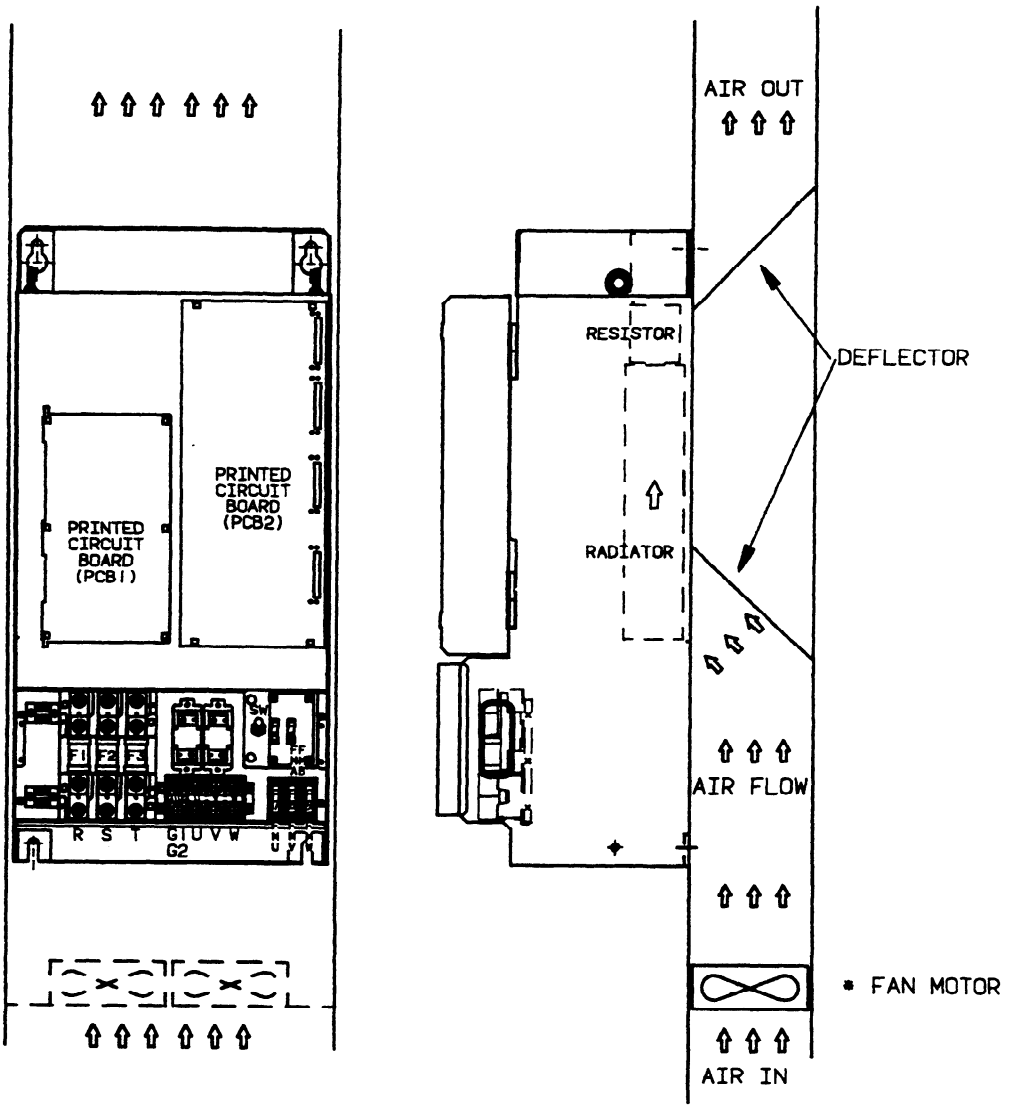
In operation: 0.5G or less

5.4 Atmosphere

No corrosive or conductive mist or drops must deposit directly on the electronic circuits.

6. COOLING

- No fan motor for cooling is provided as basic. A fan motor for forced-air cooling is to be prepared by the machine tool builder.
- For model 30HV/40HV, maintain an air flow of 4.5^3/min or more at the air inlet. When no fan unit is provided, see Fig. 6.2.
- For model 60HV, see Fig. 6.2.
- An optional fan unit can be directly installed at the air inlet shown in Chapter 7. When installing a fan motor, provide a clearance of 50 mm or more at the back of the fan motor.

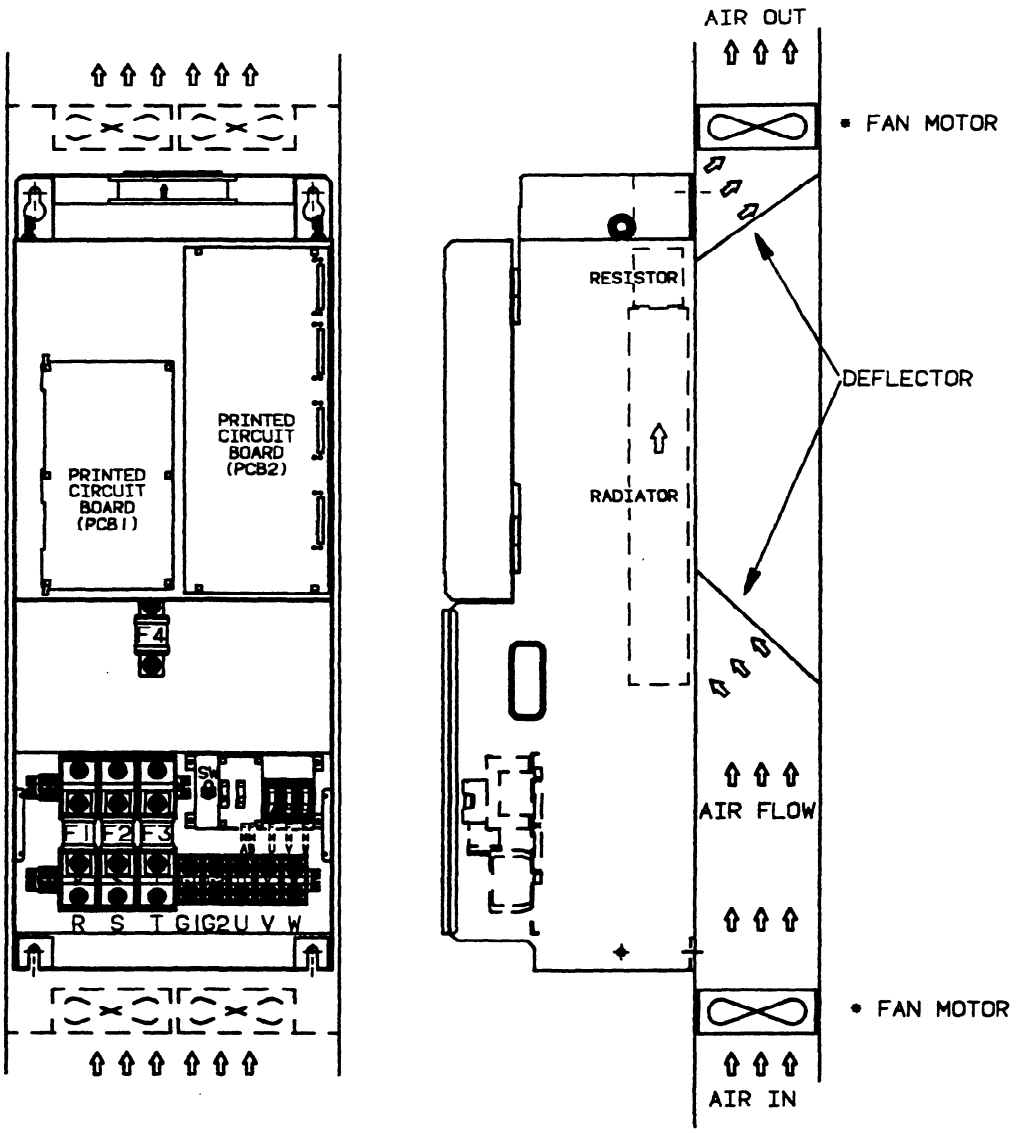


* Specifications of Fan Motor

Voltage	(V)	200	
Frequency	(Hz)	50	60
Input	(W)	43	40
Speed	(min^{-1})	2750	3200
Maximum air flow	(m^3/min)	6.5	7.5
Maximum static pressure	($mm\text{-}H_2O$)	15	16

Example) Part number: T755DX (manufactured by Toyo Denki)

Fig. 6.1 Cooling AC Spindle Servo Unit Model 30HV/40HV (without Fan Unit)



* Specifications of Fan Motor

Voltage	(V)	200	
Frequency	(Hz)	50	60
Input	(W)	43	40
Speed	(min^{-1})	2750	3200
Maximum air flow	(m^3/min)	6.5	7.5
Maximum static pressure	($mm\text{-}H_20$)	15	16

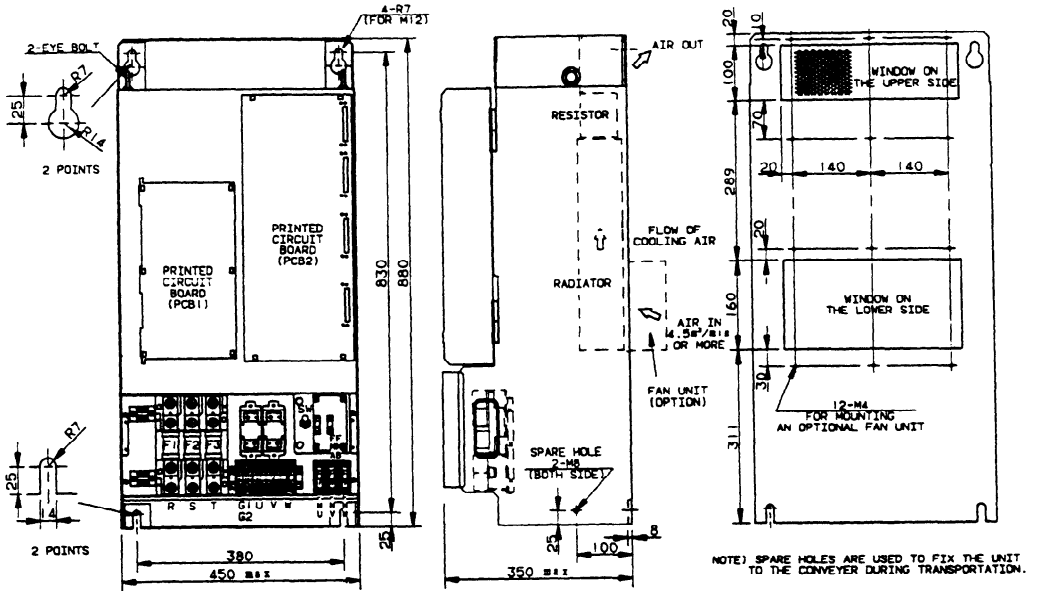
Example) Type number: T755DX (manufactured by Toyo Denki)

Fig. 6.2 Cooling AC Spindle Servo Unit Model 60HV (without Fan Unit)

7. EXTERNAL DIMENSIONS AND SERVICE CLEARANCE

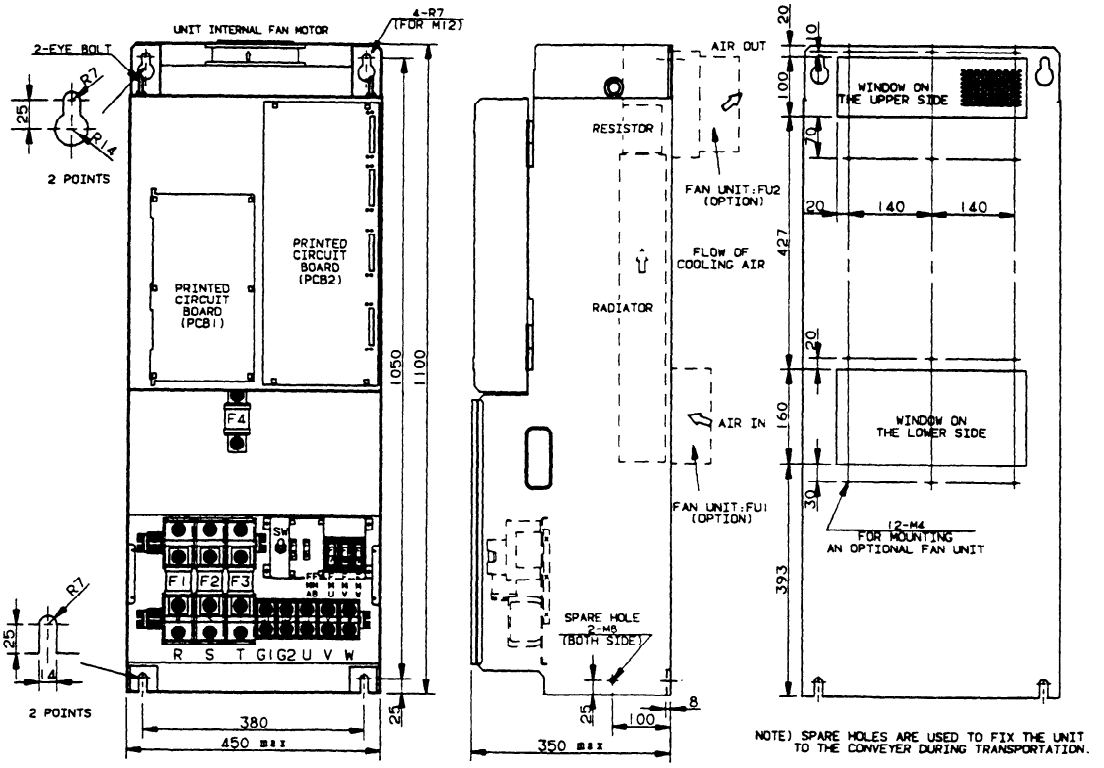
7.1 External Dimensions

7.1.1 AC spindle servo unit model 30HV/40HV



NOTE) SPARE HOLES ARE USED TO FIX THE UNIT TO THE CONVEYER DURING TRANSPORTATION.

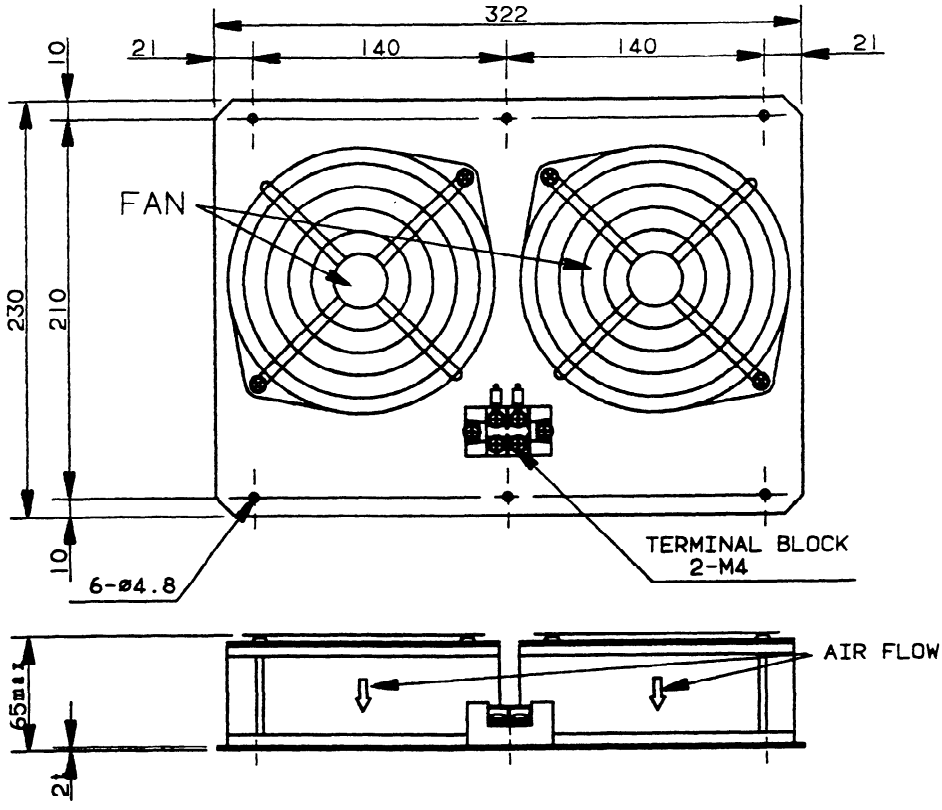
7.1.2 AC spindle servo unit model 60HV



NOTE) SPARE HOLES ARE USED TO FIX THE UNIT TO THE CONVEYER DURING TRANSPORTATION.

7.2 Fan Unit

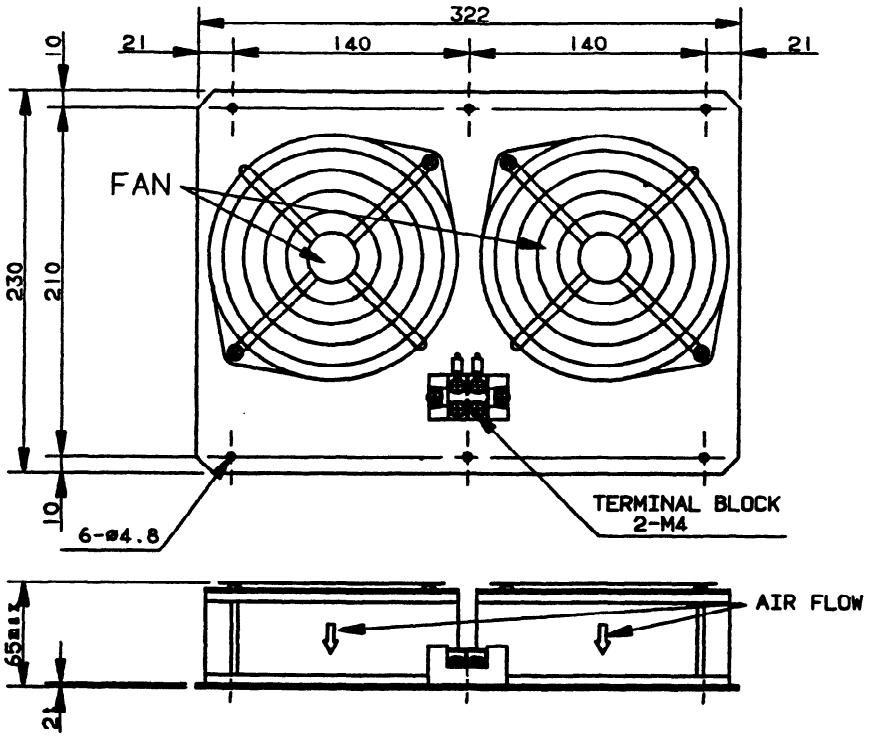
7.2.1 For model 30HV/40HV (specification number: A06B-6044-K040)



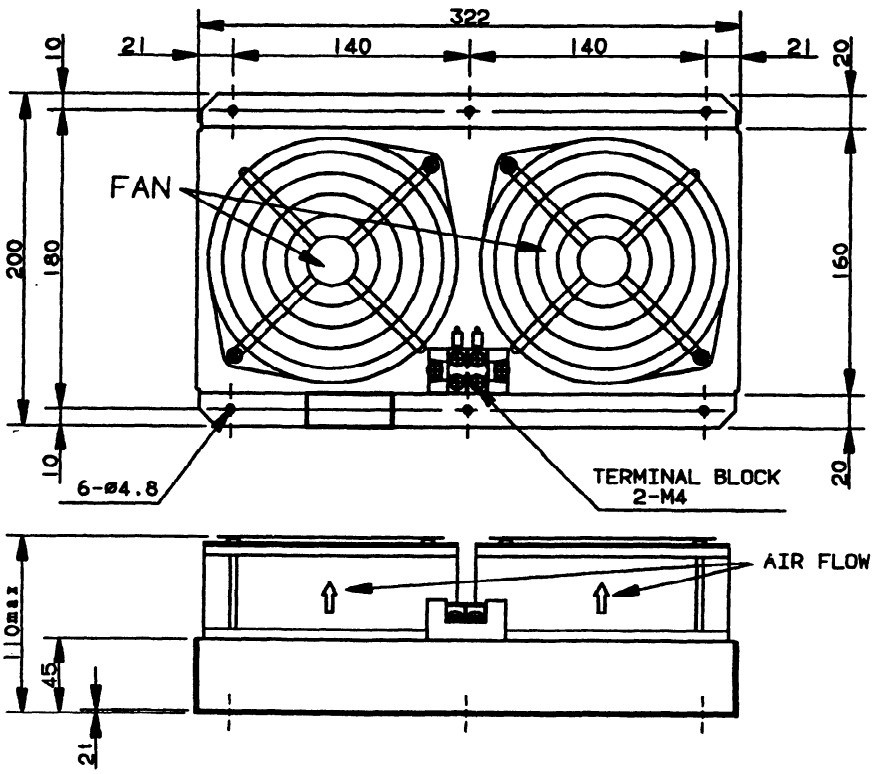
(Note) M4 screws for mounting the fan unit are to be prepared by the user.

7.2.2 For model 60HV (specification number: A06B-6065-K301)

(1) Fan unit 1 (FU1)

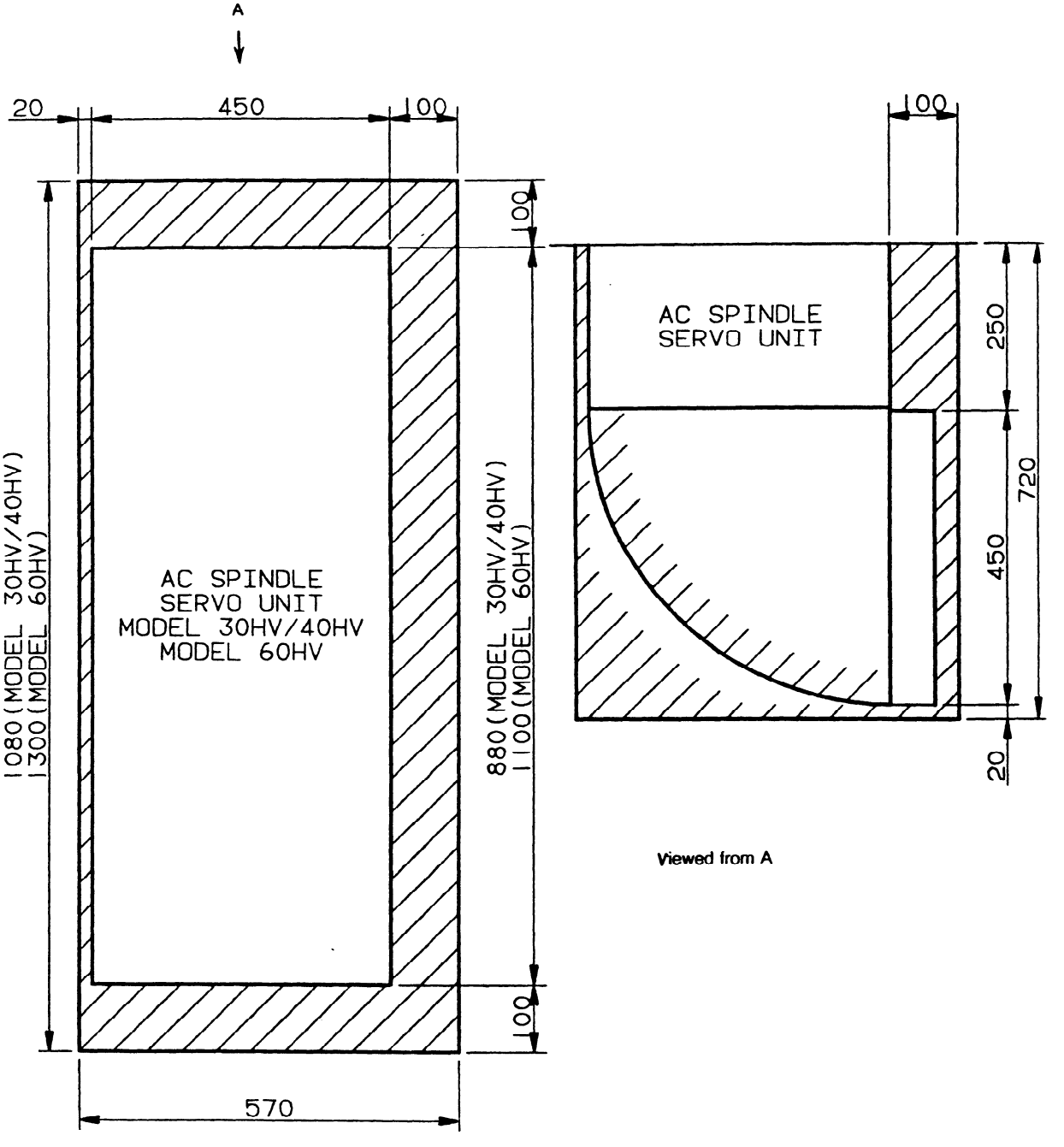


(2) Fan unit 2 (FU2)



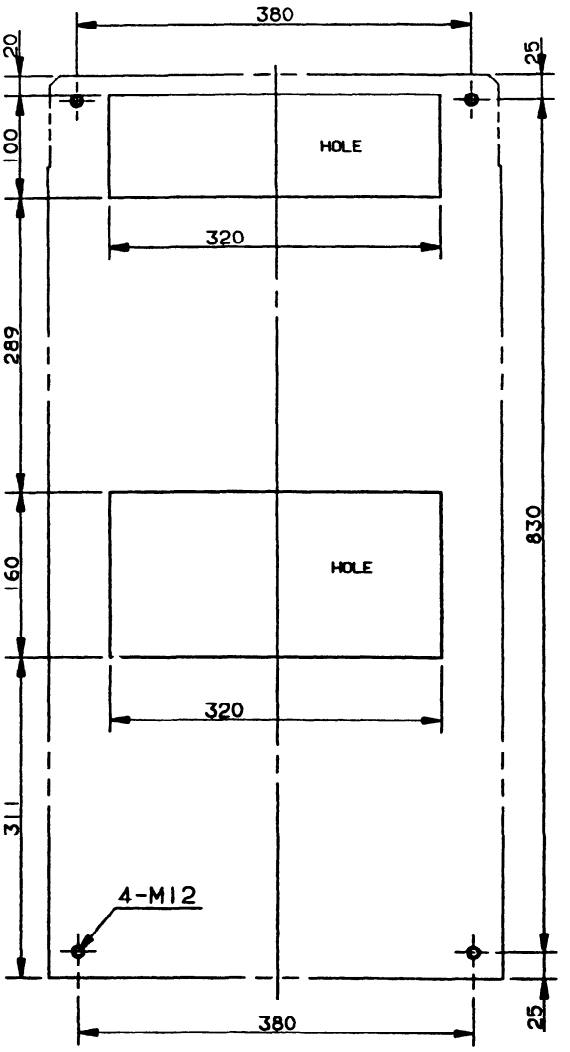
(Note) M4 screws for mounting the fan unit are to be prepared by the user.

7.3 Maintenance Area

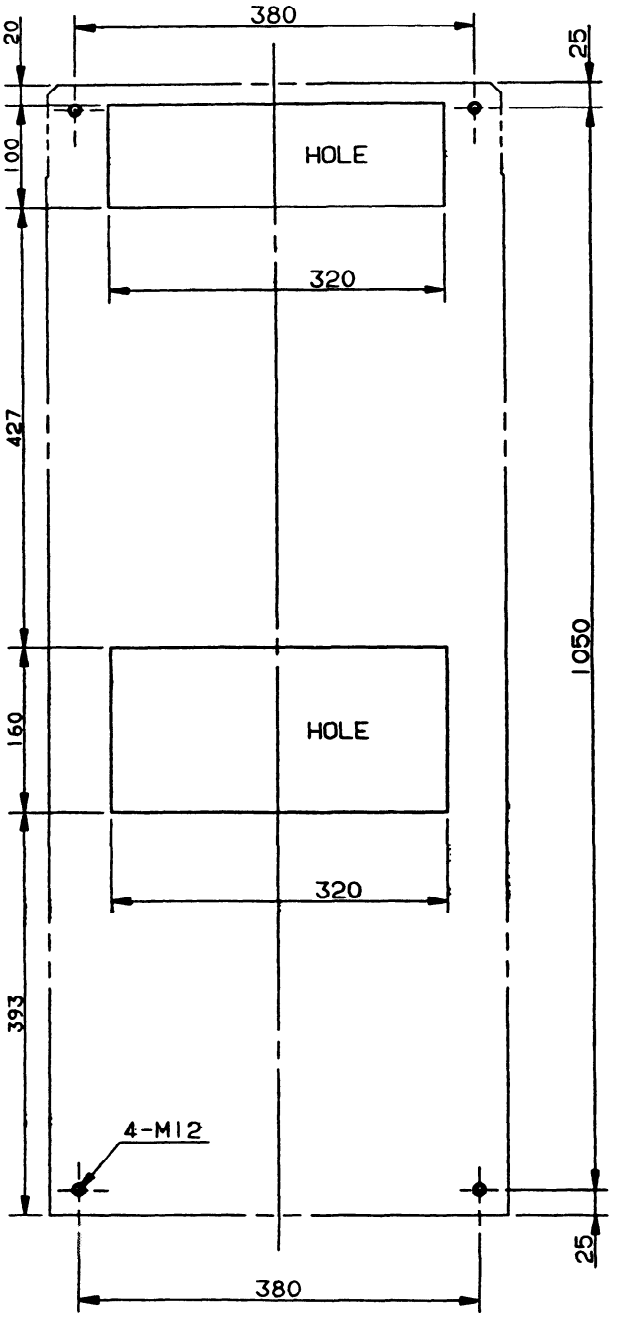


7.4 Panel Holes

(1) Model 30HV/40HV



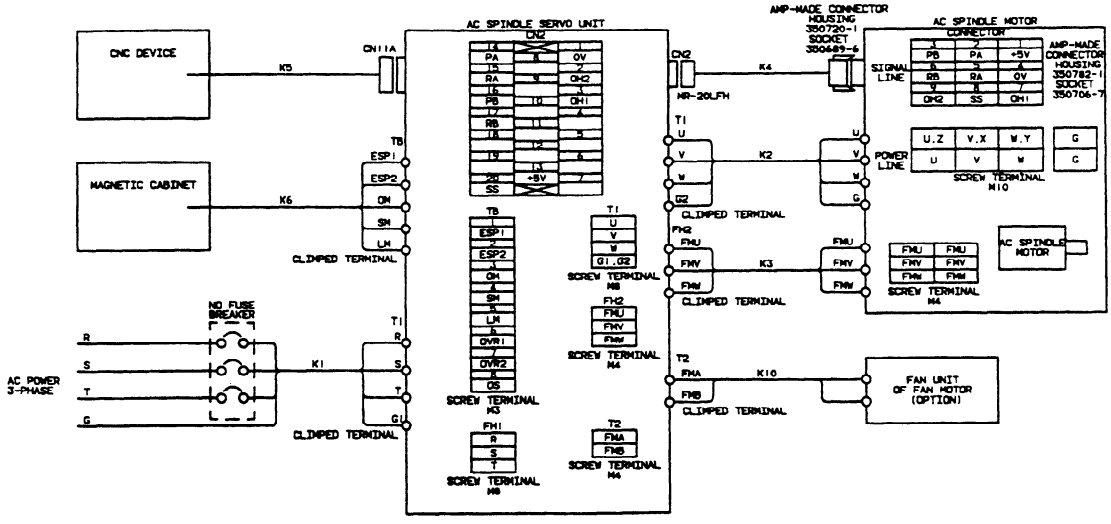
(2) Model 60HV



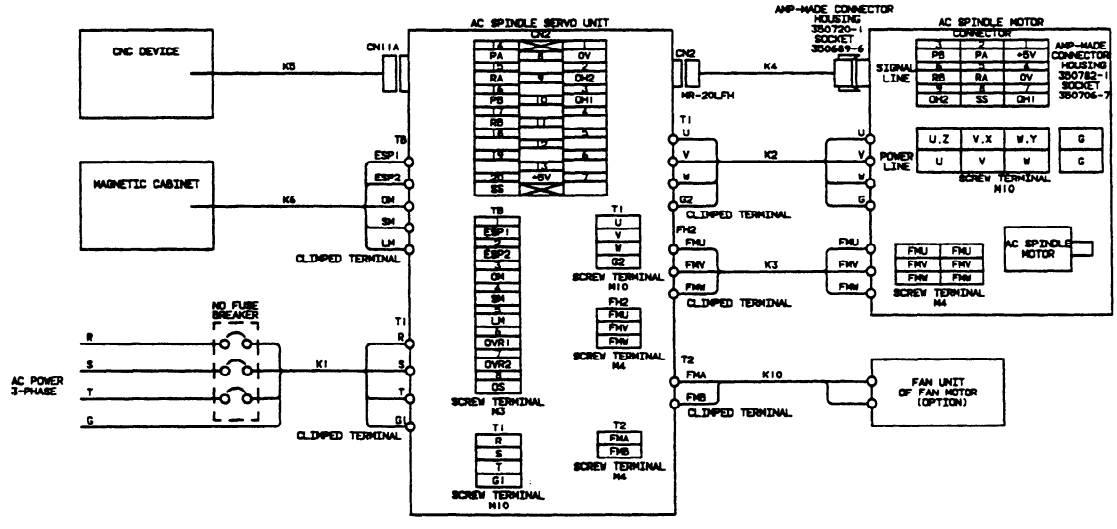
8. CONNECTION

8.1 Connection Diagram (without High-Resolution Magnetic Sensor Pulse Coder)

8.1.1 AC spindle servo unit model 30HV/40HV

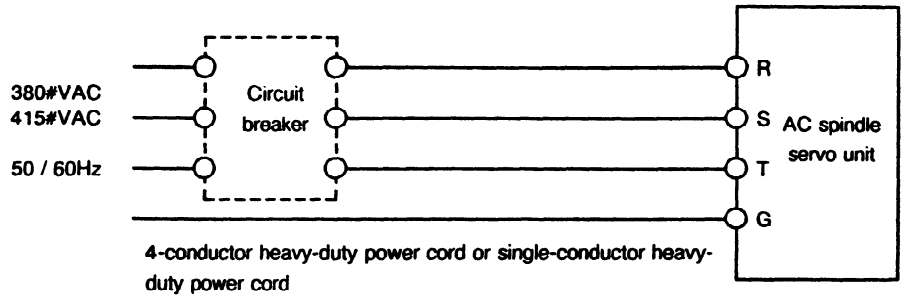


8.1.2 AC spindle servo unit model 60HV



8.2 Detailed Connection Diagram

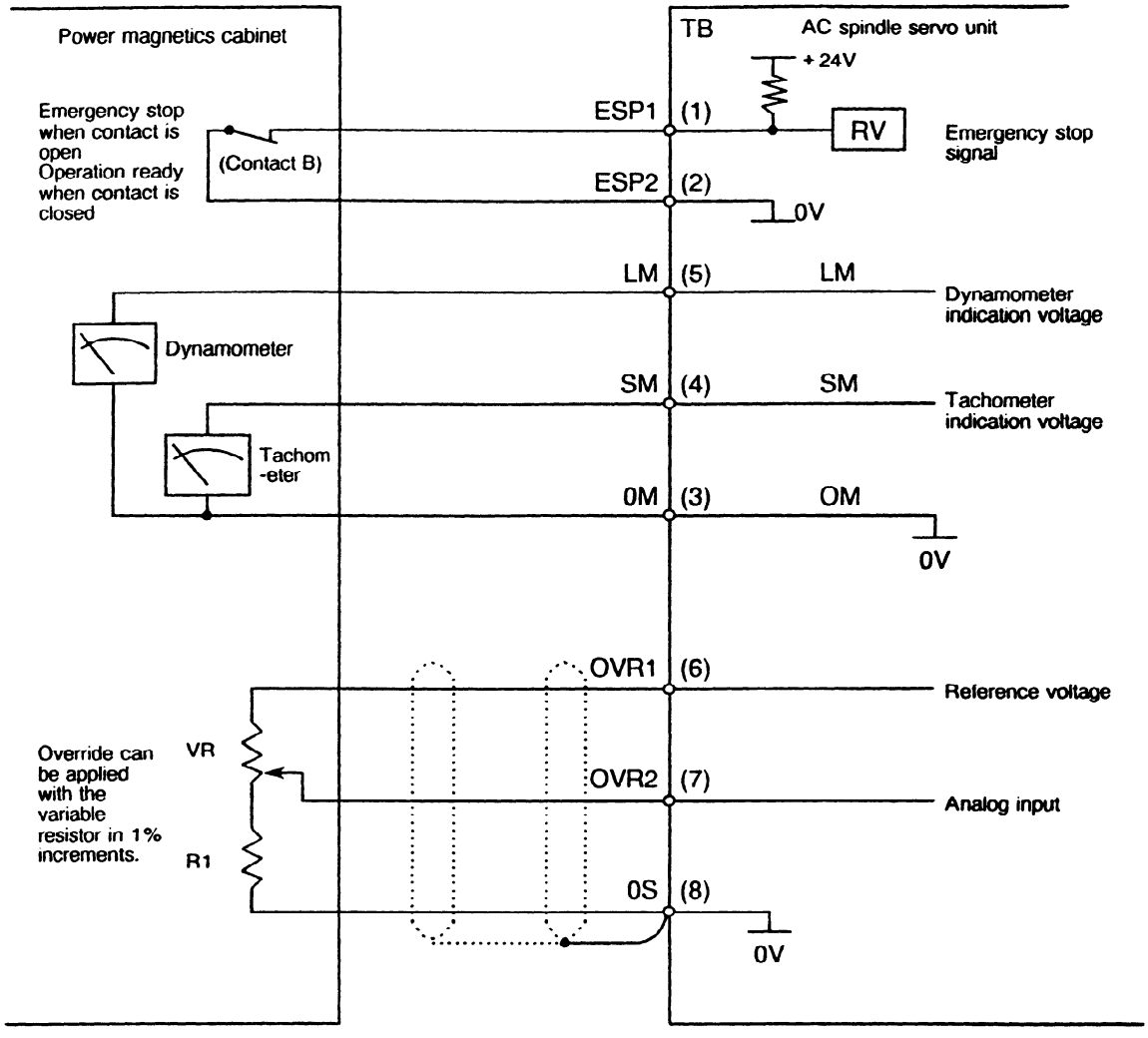
(1) Connection of power source



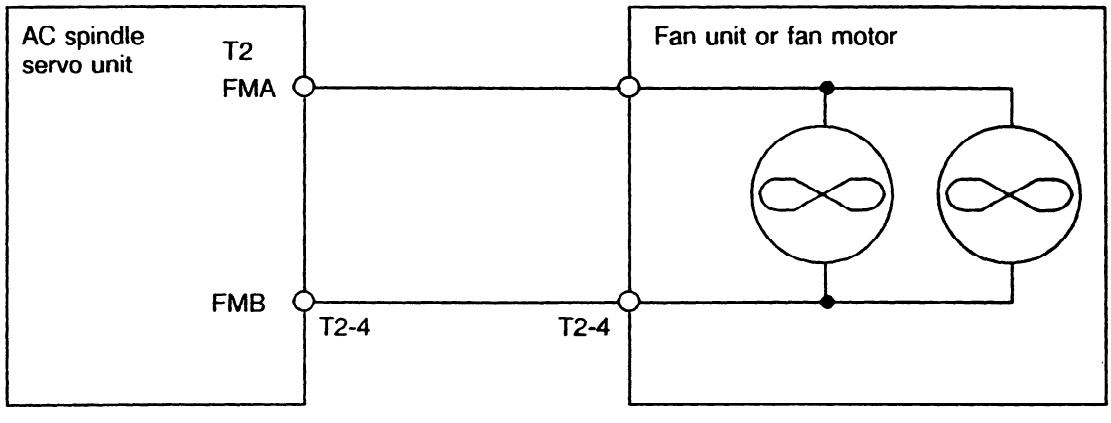
Model	Applicable power cable	Amplifier terminal screw
30HV	R,S,T : Single-conductor, 30 mm² or more (heat-resistant) G : Single-conductor, 22 m² (heat-resistant)	M8
40HV	R,S,T : Single-conductor, 38 mm² or more (heat-resistant) G : Single-conductor, 22 m² (heat-resistant)	
60HV	R,S,T : Single-conductor, 50 mm² or more (heat-resistant) G : Single-conductor, 22 m² (heat-resistant)	M10

(Note) See sections about connection of each motor series for motor terminal screw.

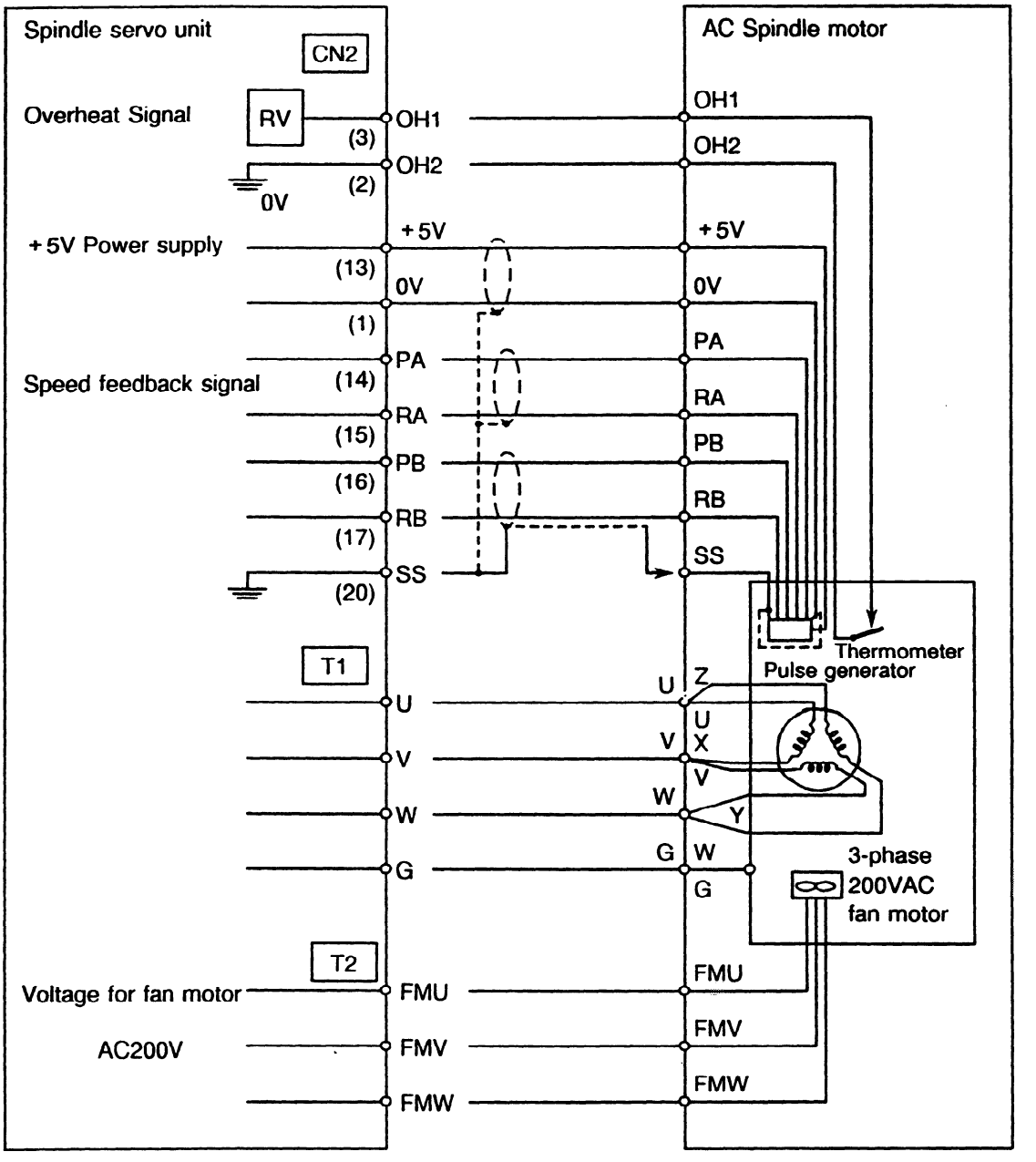
(2) Connection of AC spindle servo unit and power magnetics cabinet



(3) Connection of AC spindle servo unit and fan unit



(4) Connection diagram of AC spindle servo unit and AC spindle motor



8.3 Cables

See APPENDIX 1 for cables.

9. CAUTION IN USE

9.1 Unit Structure

The radiator and resistor are separated as a radiator section to prevent the ambient temperature of the cabinet and main unit from rising due to heat produced by loads. As shown by the outline drawing, an air inlet and outlet are provided at the back of the unit.
When installing the unit, orient the unit to provide an angle in the longitudinal direction, and tighten the bolts at the angle, taking the ventilation route into consideration.

9.2 Installing the Unit

The unit is heavy. So, note the following when installing the unit.

① The unit is designed to that it is hung using the upper eyebolts. So make an arrangement so that the unit can be installed while it is hung.

② If it is difficult to install the unit by hanging it, temporarily fix a base plate by using the auxiliary tapped holes (M8) provided at the bottom on the sides of the unit. Then install the unit by lifting it, for example, with a forklift.

③ In either case, it is recommended to provide positioning guides at the bottom of the unit.

9.3 Sealing

When the front and back of the unit need to be completely sealed, attach the following sealing tape onto the perimeter of the sides:

Nitto Eptsealer (Nitto Denko Corporation)

Width: 10 mm
Thickness: 5 mm
Length: 4 m

IX. POSITION CODER METHOD SPINDLE ORIENTATION

1. GENERAL

Unlike conventional mechanical spindle orientation using stoppers, etc., the spindle orientation stops the spindle at a fixed position by directly feeding back position signals from the position coder directly connected to the machine spindle.

2. FEATURES

(1) Mechanical parts are not required.
This orientation is accomplished simply by connecting the position coder to the spindle without any need of a mechanical orientation mechanism (stoppers, pin, etc.) for spindle orientation.

(2) Reduction of orientation time
Since the spindle motor connected to the spindle is utilized and the orientation can be done directly from high-speed rotation, irrespective of gear shift, the orientation time is largely reduced.

(3) Simplified power magnetic sequence control
This sequence consists of the spindle orientation command, its completion signal, spindle high/low speed signal and spindle medium speed signal only without any need of other signals. Neither orientation speed command sequence nor torque limit command sequence is needed.

(4) High reliability
Electrical system assures improved reliability without any damage to the mechanical section against an external impact.

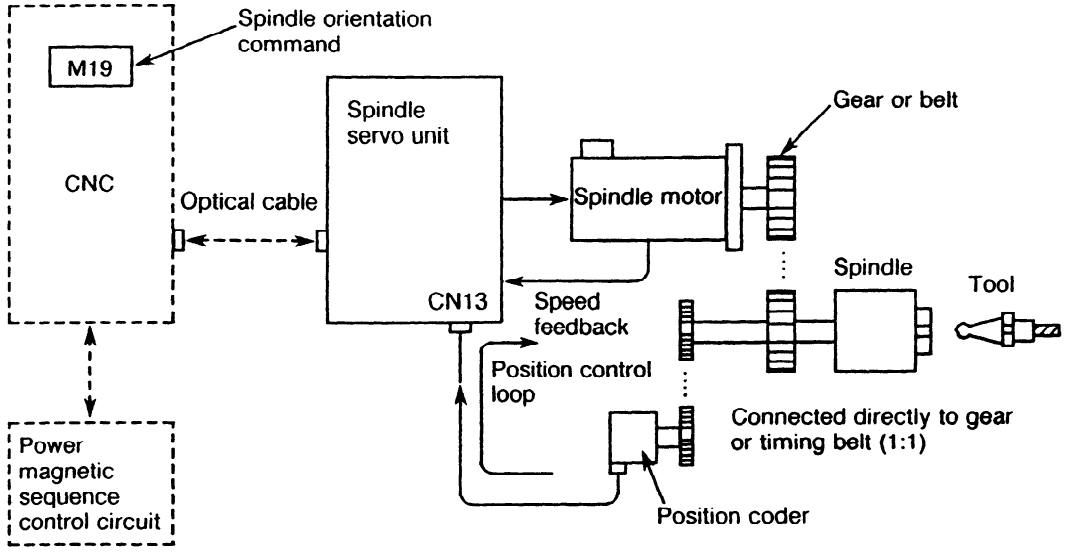
(5) High accuracy and rigidity
The spindle orientation accuracy and rigidity are enough to execute automatic tools exchange (ATC).

(6) Positioning of workpiece
Workpieces can be positioned to arrange their loading and unloading directions in lathe.

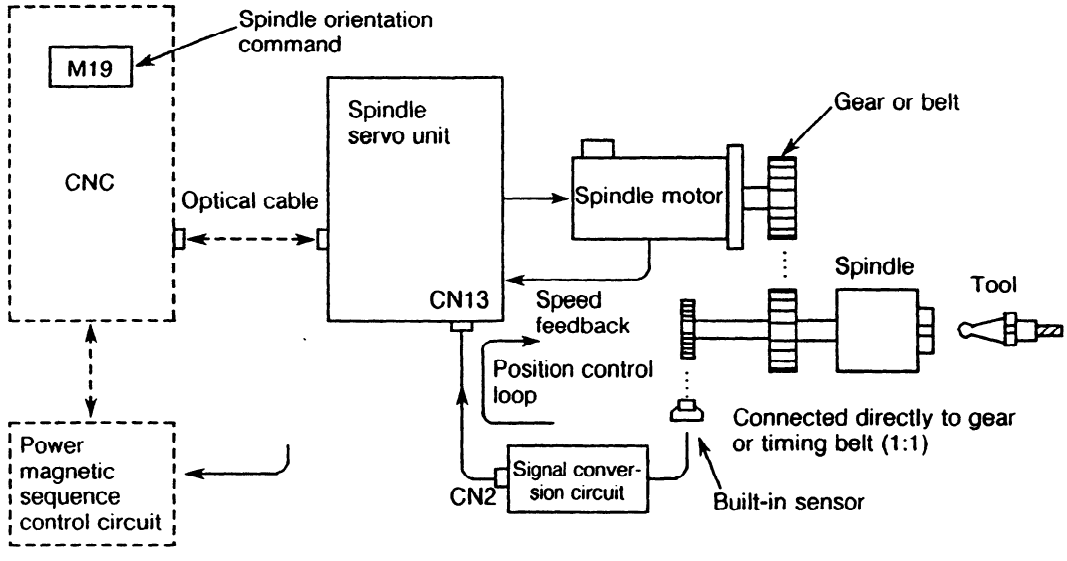
(7) Reduction of the number of processes in boring
Since the spindle orientation can be done in the same direction as the rotating direction of the spindle when boring ends, workpieces will not be damaged by tool blades.
Since these tool blades can be mounted or dismounted in a fixed direction with reference to workpieces, programming is easy.

3. CONFIGURATION AND ORDER DRAWING NUMBER

3.1 Orientation Using Position Coder



3.2 Orientation Using Built-in Sensor



(Note) Only the separate type signal conversion circuit can be used with the built-in sensor.

3.3 Order Drawing Number

3.3.1 Position coder

Classifi-cation	Name	Specification Number	Remarks
Option	Position Coder C	A86L-0027-0001/101	Balanced transmission type □160 with flange 4000 min^{-1} specification
	Position Coder D	A86L-0027-0001/001	Balanced transmission type □160 with flange 6000 min^{-1} specification
	Position Coder G	A86L-0027-0001/201	Balanced transmission type □160 with flange 8000 min^{-1} specification
	Position Coder J	A86L-0027-0001/102	Balanced transmission type □68 with flange 4000 min^{-1} specification
	Position Coder K	A86L-0027-0001/002	Balanced transmission type □68 with flange 6000 min^{-1} specification
	Position Coder L	A86L-0027-0001/202	Balanced transmission type □68 with flange 8000 min^{-1} specification
	Position Coder E	A86L-0027-0001/103	Balanced transmission type with no flange 4000 min^{-1} specification
	Position Coder F	A86L-0027-0001/003	Balanced transmission type with no flange 6000 min^{-1} specification
	Position Coder H	A86L-0027-0001/203	Balanced transmission type with no flange 8000 min^{-1} specification

3.3.2 Spindle orientation function software (optional CNC software)

Series 15M/T : A02B-0094-J730
Series 0MC : A02B-0099-J982
Series 0TC, TT : A02B-0098-J982
Series 16M : A02B-0121-J853
Series 16T, TT : A02B-0120-J853
Power Mate-MODEL A : A02B-0118-J803
Power Mate-MODEL B : A02B-0122-J803

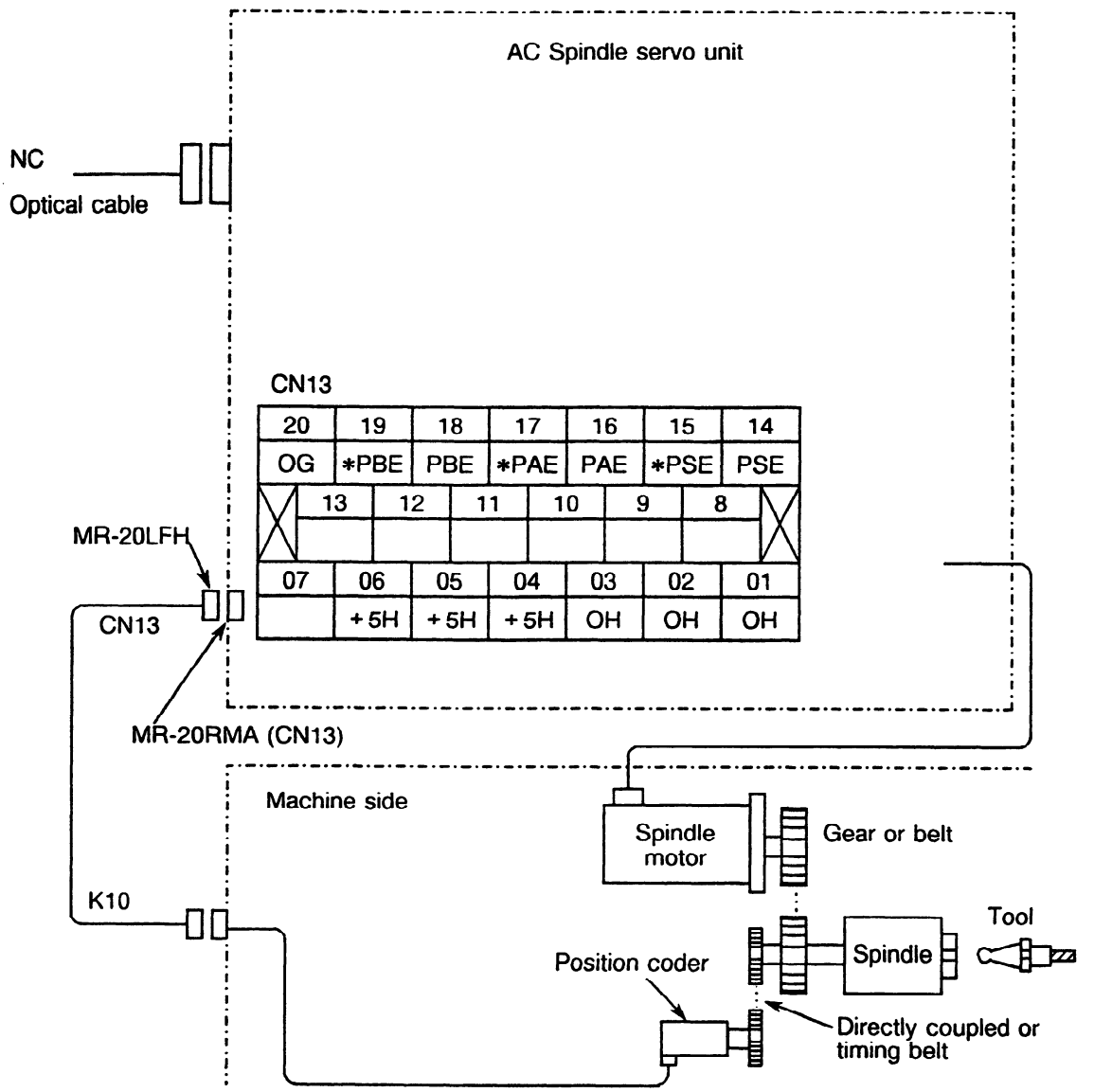
4. SPECIFICATIONS

No.	Item	Explanation	
		Stop position internal setting	Stop position external command
1	Position coder	Coupled to the spindle one to one ratio. 1024 pulses/rotation (A-phase and B-phase signals) 1 pulse/rotation (One pulse/rev. signal) Parallel transmission type for 4,000 min^{-1}, 6,000 min^{-1} or 8000 min^{-1}.	
2	Detection units	One spindle rotation (360°) is divided by 1024 x 4 (4096) pulses, i.e. 0.088° is made one pulse unit (detection unit). 360°/4096 pulses = 0.088°/pulse (*1)	
3	Stop position setting	The distance between the point indicated by the position coder one pulse/rev. signal and the actual stopping position is set for the number of pulse (N) using parameters.	——
4	Precision repeated positionings	± 0.2° (spindle angle) (*1) Machine error factors (for example, the backlash of the coupling betweer the spindle and position coder) are excluded. Depending on the fineness of the position gain adjustment, the spindle may move for one	
5	Stop positionsetting	——	Position to be stopped can be specified by parameter. Stops at the position of the number of pulses of pulses specified from the position of the 1 rotation signal of the position coder.
6	Operation	——	When orientation command is given, spindle rotates $\frac{1}{2}$ to $2\frac{1}{2}$ turns after spindle speed spindle orientation speed, and stops at the specified stop position.

(*1) For the built-in sensor, refer to XII-10.

5. CONNECTION

Interface (for position coder)



(Note) When using the position coder signal from the built-in sensor, refer to XII-8.

6. SIGNAL EXPLANATION

6.1 Spindle Control Signals

6.1.1 DI signals (PMC to CNC)

	PM	0C	15	16	7	6	5	4	3	2	1	0
First :	G126	G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
Second :		G112	G239	G080								
First :	G127	G111	G230	G079					SHA11	SHA10	SHA09	SHA08
Second :		G113	G238	G081								
First :	G112	G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
Second :		G233	G235	G074								
First :	G113	G230	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
Second :		G234	G234	G075								
First :	G114	G231	G229	G072	RCHHGA	MFNHG	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA
Second :		G235	G237	G076								

6.1.2 DO signals (CNC to PMC)

	PM	0C	15	16	7	6	5	4	3	2	1	0
First :	F228	F281	F229	F045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
Second :		F285	F245	F049								
First :	F229	F282	F228	F046	MOAR2A	MOAR1A	POAR2A	SLVSA	RCFNA	RCHPA	CFINA	CHPA
Second :		F286	F244	F050								
First :	F230	F283	F231	F047							INCSTA	PC1DTA
Second :		F287	F247	F051								

6.2 Details of Signals

6.2.1 Orientation (fixed position stop) command (ORCMA)

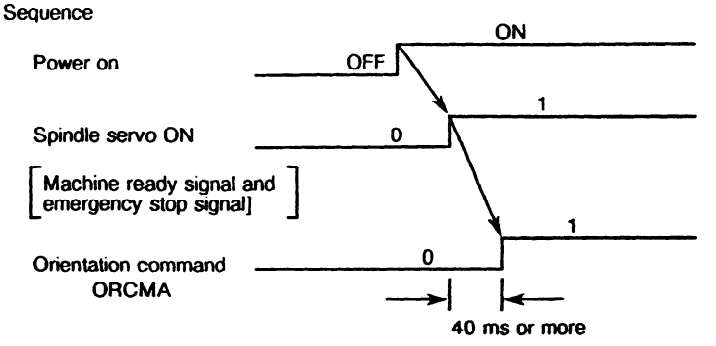
(1) This command signal is used to stop spindle movement at the preset position to allow tool change and workpiece loading/unloading.

(2) When this signal is specified as "1" while the spindle is rotating, the rotation decelerates immediately and the spindle stops at the preset position.

(3) When the orientation command is issued, set the spindle forward/reverse rotation command (SFRA, SRVA) to "0" for safety. By means of this, the spindle will not start to rotate even in the unlikely event ORCMA becomes "0" during tool change.

(4) Set this signal to "0" by the tool change completion signal or workpiece loading/unloading completion signal.

(5) Always set the orientation command signal to "0" when turning on power.



(6) When an emergency stop occurs during orientation, the orientation command signal must be reset ("0").
Return the ATC arm to the safe position so that it will not be dameged if the spindle or tool rotates when the power is turned on.

6.2.2 Orientation (fixed position stop) completion signal (ORARA)

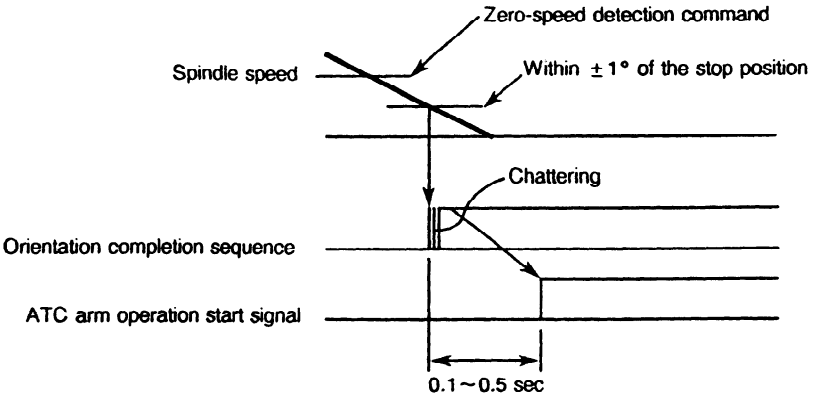
(1) When the orientation command is inputted and the spindle has stopped near the preset fixed position (for example, within +1), it becomes "1".

$$\text{(Condition for ORARA to become "1"} = \frac{\text{(ORCMA is "1")} \times \text{(zero-speed signal)}}{\text{Near to fixed position}}$$

Near to fixed position is set to the parameter in case of Series 16 (PRM4075 = Orientation complete signal detection level).
If the above 3 conditions are satisfied, the orientation complete signal is outputted.
If the orientation completion signal is not issued within a set period of time after the orientation command signal is input, it is considered to be abnormal. So it should be detected by the power magnetic sequence and an orientation alarm should be issued.

(2) Tool change or workpiece loading/ unloading operations can be started when this signal is "1".

(3) The spindle orientation completion signal is issued when the spindle is within +% of the preset position and so it does not always indicate that the spindle has stopped completely. Some machines allow a very short operation time for the ATC arm to grip the tool. In this case, start the ATC arm operation after a short time (0.1 to 0.5 sec.) so that the arm will grip the tool when the spindle has stopped completely.



(4) This signal will become "0" during a tool change if the spindle is pushed away from the preset position by external force.
In this case, design a power magnetic sequence so that the tool change operation is interrupted.
However, do not release the orientation command, and if the orientation completion signal is issued again, perform a tool change.

(5) If the automatic tool change (ATC) structure is such that it may cause serious damage if a malfunction occurs, install a proximity switch to generate a verification signal when the ATC enters an area in which the automatic tool change operation can be performed. In addition to this, perform a double safety check by the power magnetic sequence and carry out a tool change.

6.2.3 Gear/clutch signal (CTH1A, CTH2A)

(1) These signal are used in order to shorten the orientation time when there are 2 speed change stages of high/low between the spindle and spindle motor.

(2) Set the following conditions corresponding to the clutch or gear state. They are used in order to select the spindle control parameter (position gain, gear ratio).

CTH1A	CTH2A	
0	0	: HIGH GEAR
0	1	: MEDIUM HIGH GEAR
1	0	: MEDIUM LOW GEAR
1	1	: LOW GEAR

6.2.4 Command for changing the stop position in spindle orientation (INDXA)

(1) This command is used when the orientation position is changed again immediately after spindle orientation was just performed.
This command is valid when the spindle orientation command (ORCMA) is issued.

(2) Changing this signal from 1 to 0 orients the spindle within one rotation to a new position (absolute position within one rotation) specified by new stop position data (SHA11 to SHA00).

(3) The direction of spindle rotation is specified by the direction command for the shorter route (NRROA) or the command specifying the direction of rotation (ROTTA).

(4) This function is valid when the CNC parameter corresponding to the spindle orientation function in which the stop position is specified externally is set.

6.2.5 Direction command for the shorter route when the stop position changes in spindle orientation (NRROA)

(1) This command is used for specifying the direction of rotation, whichever is shortest, (within +180 degrees) when the orientation position is changed again immediately after spindle orientation has just been performed.

(2) When this signal is set to 1, positioning is performed in the direction that provides a shorter route, irrespective of the command specifying the direction of rotation when the stop position changes in spindle orientation.

6.2.6 Command specifying the direction of rotation when the stop position changes in spindle orientation (ROTAA)

(1) This command is used for specifying the direction of rotation when the orientation position is changed again immediately after the spindle orientation was just performed.
When the signal is 0, the spindle rotates counterclockwise to the specified position and stops.
When the signal is 1, the spindle rotates clockwise to the specified position and stops.

(2) This command is valid when the direction command for the shorter route when the stop position changes in spindle orientation (NRROA) is 0.

6.2.7 Spindle orientation command in which the stop position is specified externally (SHA11 to SHA00)

(1) This command is used for specifying a stop position with an absolute position within one rotation in the following equation:

Stop position (degrees)

$$= \frac{360}{4096} \times \sum_{i=0}^{11} \times (2_i \times Pi)$$

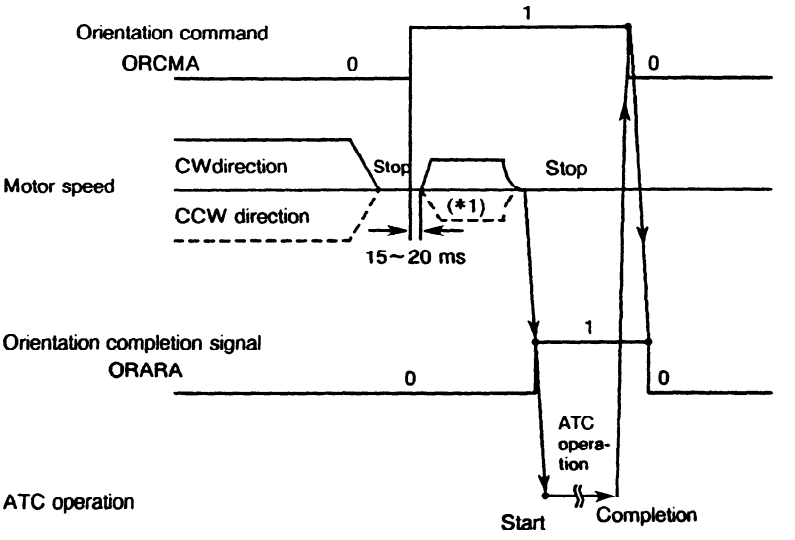
where
Pi = 0 when SHAi = 0
Pi = 1 when SHAi = 1

(2) When this command is used, the stop position parameters in spindle orientation with a position coder (In case of Series 0: No. 6531 and 6671) are invalid.

(3) When parameter 6577 for the amount of shift is set, the stop position is shifted by the value set in the parameter.

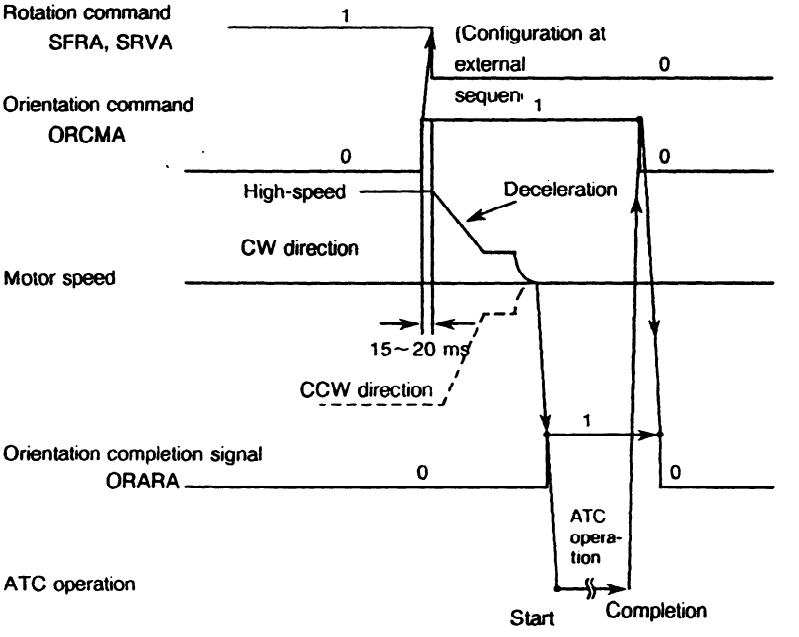
6.3 Sequences

6.3.1 Orientation command while stopping

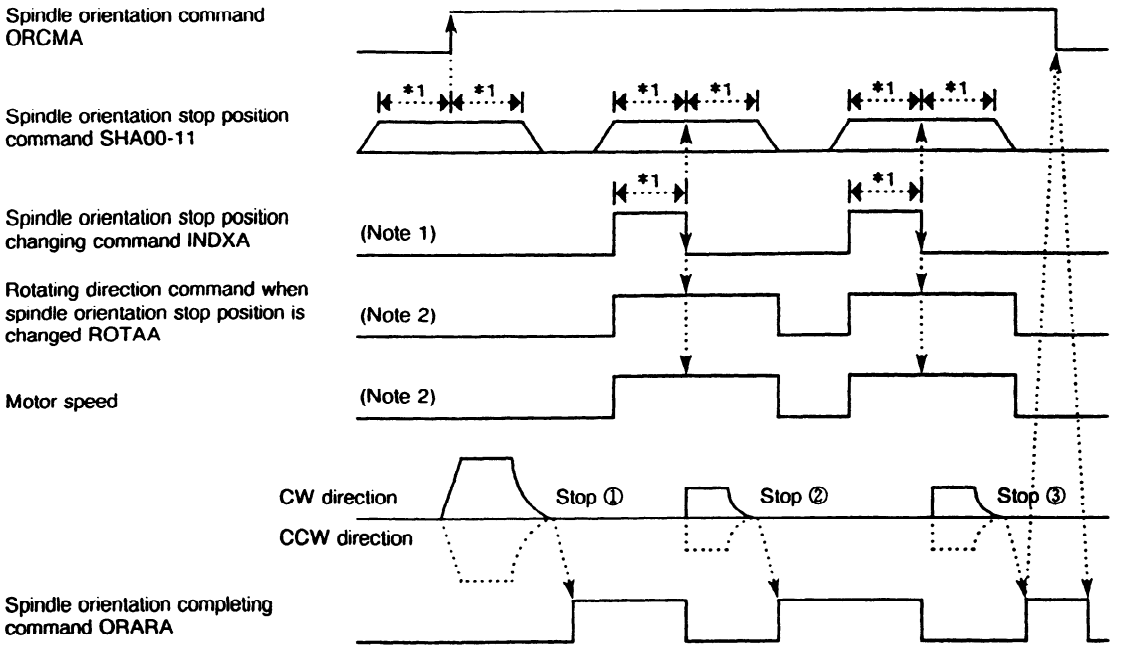


(*1) The spindle motor rotation direction can be changed by setting. In standard setting, the spindle motor will stop at the fixed position in the direction the spindle motor was rotating before this orientation command signal was generated.

6.3.2 Orientation command during high-speed rotation



6.4 When Stop Position External Setting Type Spindle Orientation Function is Used



Set *1 to 50msec or more.

Stop ①

- Stopping in a specified position through a normal orientation command
- The rotating direction of the spindle motor is specified by setting a parameter.
- When the motor rotates first after the power has been turned on, it rotates at the orientation speed and stops in a specified position after the one rotation signal has been captured. When it rotates next or later, it stops in the specified position within one rotation.
- With the spindle orientation function in which a stop position is externally specified, if the data of SHA11-00 (spindle orientation stop position command) is decided in a second or later stop operation, the motor stops at a position ([one-rotation signal position] + [data specified by SHA11-00] + [PRM4077]) shifted by the value seized on a rising edge of ORCMA (spindle orientation command).

Stop ② and ③

- Stopping in a specified position using the stop position external setting type spindle orientation function
- The rotating direction of the spindle motor is specified by the following command: (1) rotating direction command when spindle orientation stop position is changed (ROTA) or, (2) shortcut command when spindle orientation stop position is changed (NRROA).

(Note 1) INDXA, the spindle orientation stop position changing command, is effective only when NRROA, the shortcut command when spindle orientation stop position is changed, has been set to HIGH.

(Note 2) Specify when it is needed for the machine tool builders.

Other Cautions:

1. Then spindle orientation is executed during rotation, keep the spindle normal rotation/reverse rotation command (SFRA/SRVA) to "0" for safety while issuing the spindle orientation command ORCMA.
2. Set the spindle orientation command ORCMA to "0" using the tool change completing signal or the work attaching/detaching completing signal prepared by the machine manufacturer.
3. Make sure to set ORCMA, the spindle orientation command, to "0" before turning the power on.
4. Make sure to reset ORCMA, the spindle orientation command, (in other words, set it to "0") in case of emergency stop during spindle orientation.

6.5 Using the Spindle Orientation Function with the Incremental Command Set Externally (Spindle Speed Control)

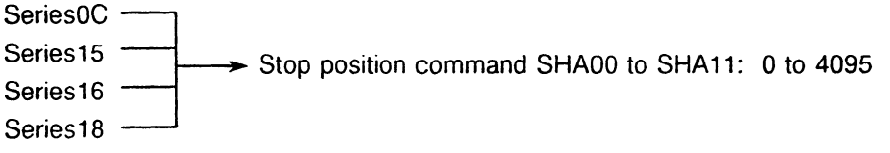
6.5.1 General

The spindle orientation function with the incremental command set externally is added as a feature of spindle orientation by a position coder with the stop position set externally. The new function moves the spindle from the position specified by the spindle orientation command to the position specified by the incremental command. The spindle is positioned as follows.
When the incremental command is sent from the PMC through the CNC, the spindle in the position specified by the spindle orientation command is turned accordingly and positioned. At the end of positioning, a completion signal is returned to the PMC through the CNC.

When this function is used, the following operations can be performed:
(1) A turret can be positioned by the spindle motor.
(2) When the command multiplication is set to 4096, the spindle speed can be controlled.

Applicable serial spindle amplifier (IGBT type)
A06B-6064-H3xx#H550
Applicable control software series: 9A50, I and later editions

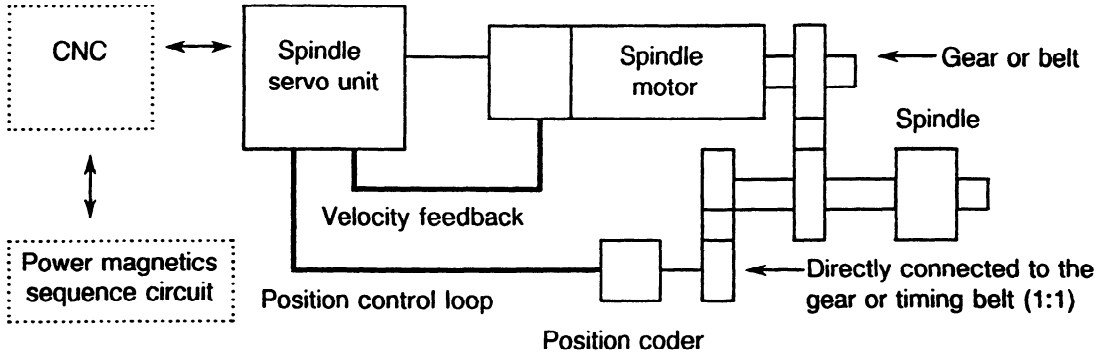
Applicable CNC



6.5.2 System configurations

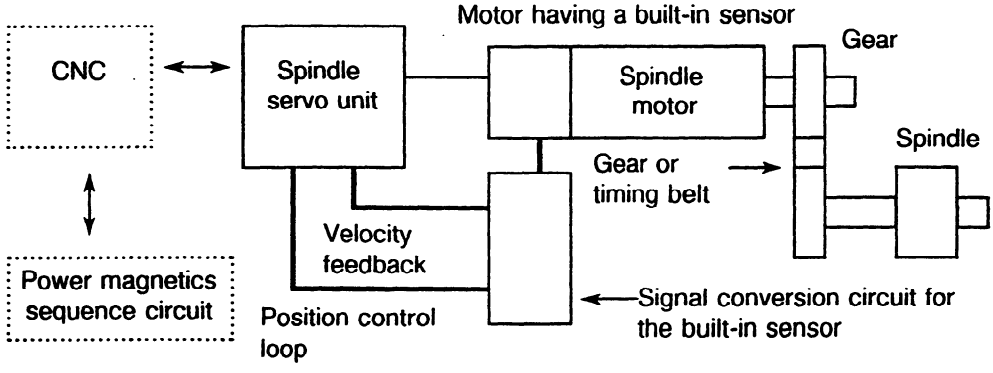
The spindle orientation function with the incremental command set externally can be executed in the following system configurations:

(1) System in which the position coder is linked to the spindle

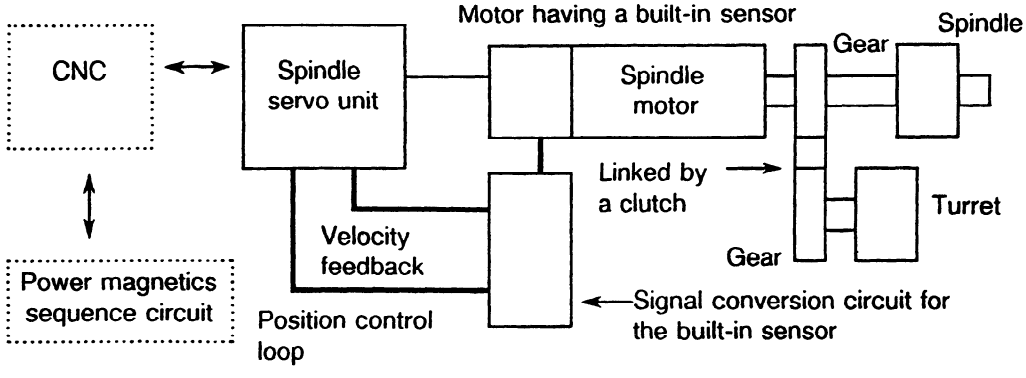


(2) Motor system built into the spindle

(3) System in which the spindle and the motor having a built-in sensor are linked by a gear or timing belt

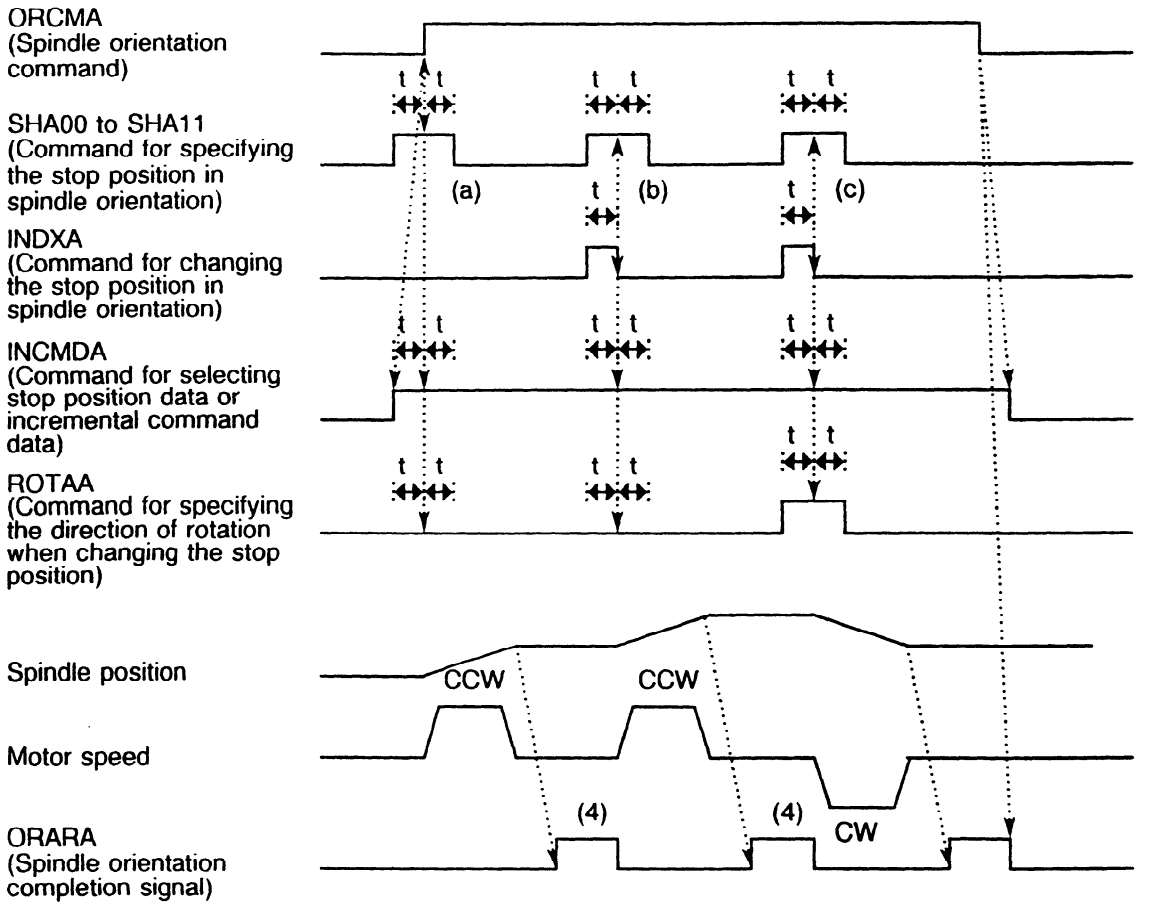


(4) System in which the turret and the motor having a built-in sensor are linked by gears and clutches (for turret positioning)



6.5.3 Control sequence

(1) Incremental action



(a) If the rising edge of ORCM is detected when the spindle stops (zero speed detection signal SSTA is set to 1) and INCMDA is set to 1, the data of SHA00 to SHA11 is read as incremental command data. The spindle starts rotating as specified by the incremental command and stops. ROTAA determines the direction of rotation.

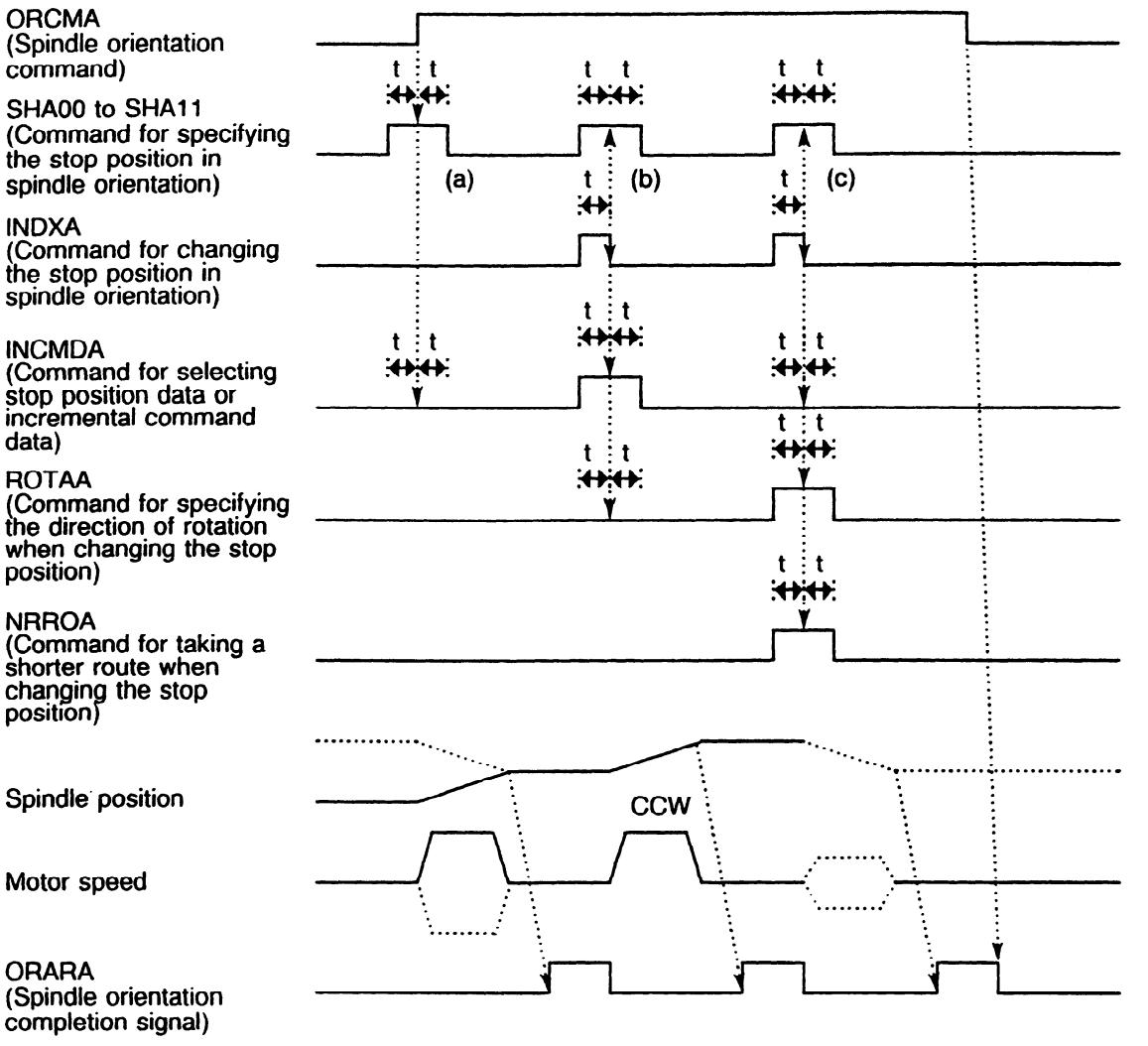
(b) Another incremental action can then be executed. If the falling edge of INDXA is detected when both ORCM and INCMDA are set to 1, the data of SHA00 to SHA11 is read as incremental command data. The spindle starts rotating as specified by the incremental command and stops. ROTAA determines the direction of rotation.

(c) The incremental command data is specified in units of pulses. The data range is 0 to +4096 pulses. ROTAA determines the direction of rotation. When a command multiplication parameter (Series 16: PRM4328) is specified, the spindle stops rotating after reaching the value obtained by the following expression: [Command multiplication parameter] × [Incremental command data]. During incremental motion, the parameter indicating the direction of rotation, NRROA (Series 16: PRM4003, bits 2 and 3), is invalid.

(d) When the position deviation comes within the range specified by the parameter (Series 16: PRM4075), ORARA is output.

(Note) Set t to 50 ms or more. The signals require this time period to stabilize.

(2) When spindle orientation and incremental motion are both executed



(a) Stopping the spindle in place using the usual orientation command

- In the first orientation after the power is turned on, the spindle rotates at the orientation speed. After a single rotation signal is detected, the spindle stops in place. In the second and subsequent orientations, the spindle stops in place before it turns once.
- The parameter specifying the direction of rotation (Series 16: PRM4003, bits 2 and 3) applies to the spindle motor.
- If the rising edge of ORCMA is detected when INCMDA is set to 0, the data of SHA00 to SHA11 is read as stop position data. The spindle stops after shifting by the distance obtained by the following expression: [Value of SHA00 to SHA11] + [Parameter of shift distance of the stop position in orientation (Series 16: PRM4077)]

(b) Stopping the spindle in place by an incremental command

- For incremental motion, see (1) above.
- When the command multiplication parameter (Series 16: PRM4328) is set to 4096, the spindle speed can be controlled.

(c) Stopping the spindle in place by setting the stop position externally

- If the falling edge of INDXA is detected when ORCMA is set to 1 and INCMDA is set to 0, the data of SHA00 to SHA11 is read as stop position command data. The spindle rotates and stops at the specified position.
- NRROA and ROTAA determine the direction of rotation. When NRROA is set to 1, the spindle rotates from the current stop position to the specified stop position by taking the shorter route (within ±180°). When NRROA is set to 0, ROTAA determines the direction of rotation.

6.5.4 PMC signals (DI/DO signals)

This section describes PCM signals (DI/DO signals) used for executing the spindle orientation function with the incremental command set externally.

(1) PMC → CNC (DO signals)

	(PC address) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
No.1	G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
No.2	G112	G239	G080								
No.1	G111	G230	G079					SHA11	SHA10	SHA09	SHA08
No.2	G113	G238	G081								

- SHA00 to SHA11 (Stop position data or incremental command data)

  This 12-bit signal specifies stop position data or incremental command data. INCMDA determines whether the data specified by the signal is used as stop position data or incremental command data.

  The data can be specified in the range of 0 to +4095 pulses.

	(PC address) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
No.1	G229	G227	G070		ORCMA			CTH1A	CTH2A		
No.2	G233	G235	G074								

- ORCMA (Spindle orientation command signal)

  The spindle orientation function with the incremental command set externally is validated during spindle orientation.

  1: The spindle oriented.

- CTH1A, CTH2A (Signal for selecting a gear or clutch)

  The signals select the proper spindle control parameters (position gain, gear ratio, etc.) for the selected gear or clutch.

  The parameters selected by this signal are described in Section 6.6.5, "Parameters." These parameters select the following gear or clutch statuses. Select the appropriate parameter from those listed in the table below.

CTH1A	CTH2A	Gear or clutch status	
0	0	High Gear	(High)
0	1	Medium High Gear	(High)
1	0	Medium Low Gear	(Low)
1	1	Low Gear	(Low)

	(PC address) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
No.1	G231	G229	G072			INCMDA			NRROA	ROTAA	INDXA
No.2	G235	G237	G076								

- INCMDA (Signal for selecting the stop position data or incremental command data)

  This signal determines whether to use the data of SHA00 to SHA11 set externally as stop position data or incremental command data.

  0: The data is used as stop position data.
  1: The data is used as incremental command data.

- NRROA (Signal for taking a shorter route)

  When the stop position is changed and stop position data is selected (INCMDA is set to 0), the spindle rotates to the target stop position by taking the shorter route. When INCMDA is set to 1, the NRROA signal is invalidated.

  0: The spindle rotates as specified in ROTAA (Series 16: PRM4003, bits 2 and 3).
  1: The spindle rotates by taking the shorter route.

- ROTAA (Signal for specifying the direction of rotation)

  This signal specifies the direction of rotation when the stop position of the spindle is changed in the stop status.

  0: The spindle rotates counterclockwise (CCW).
  1: The spindle rotates clockwise (CW).

- INDXA (Signal for changing the stop position)

  This signal changes the stop position of the spindle. At the falling edge of the INDXA signal, the data of INCMDA and ROTAA and stop position data or incremental command data are read.

  1 to 0: Command for changing the stop position

(2) PMC ← CNC (DI signals)

(PC address)				b7	b6	b5	b4	b3	b2	b1	b0
	0C	15	16								
No.1	F281	F229	F045	ORARA							
No.2	F285	F245	F049								

- ORARA (Orientation completion signal)

  When set to 1, the ORARA signal indicates that orientation is completed. The signal is output when the following three conditions are satisfied:

  a. The spindle is close to the specified stop position (within the effective area). (Series 16: PRM4075)
  b. Spindle orientation is in progress. (ORCMA is set to 1.)
  c. The speed is zero. (SSTA is set to 1.)

(PC address)				b7	b6	b5	b4	b3	b2	b1	b0
	0C	15	16								
No.1	F283	F231	F047							INCSTA	
No.2	F287	F247	F051								

- INCSTA (INCMDA status signal)

  This signal indicates the status of INCMDA (signal for selecting the stop position data or incremental command data).

  0: INCMDA is set to 0.
  1: INCMDA is set to 1

6.5.5 Parameters

This section describes the spindle control parameters that must be noted when executing the spindle orientation function with the incremental command set externally.
For other parameters, refer to the manual, "Descriptions of Quickest Spindle Orientation Control by a Position Coder."

(Parameter No.)			
0C	15	16	Stop position in orientation by a position coder
6531	3031	4031	
6671	3171		

Data unit: 1 pulse (360°/4096 pulses)
Data range: 0 to 4095 (Standard setting: 0)

- This parameter is invalid when either of the following functions is executed: The spindle orientation function with the stop position set externally or the spindle orientation function with the incremental command set externally. The data of SHA00 to SHA11 specified by PMC is validated instead. Set this parameter to 0.

(Parameter No.)

0C	15	16	
6577	3077	4077	Shift distance of stop position in orientation
6717	3217		

Data unit: ±1 pulse

Data range: −4095 to +4095 (Standard setting: 0)

- This parameter is used when the stop position is shifted. When a positive value is specified, the spindle shifts in the counterclockwise (CCW) direction. When a negative value is specified, the spindle shifts in the clockwise (CW) direction. Specify the stop position with this parameter.

(Parameter No.)

0C	15	16	
6292	3472	4328	Command multiplication for spindle orientation by a position coder (Main spindle with the spindle switching function)
6472	3692		

Data unit: 0

Data range: 0 to 32767 (Standard setting: 0 Command multiplication is 1.)

This parameter specifies the command multiplication for the spindle orientation function with the incremental command set externally.

When this parameter is set to 0, command multiplication is automatically set to 1. To control the spindle speed, set this parameter to 4096.

(Parameter No.)

0C	15	16	
6293	3473	4329	Command multiplication for spindle orientation by a position coder (Sub-spindle with the spindle switching function)
6473	3693		

6.6 Quickest Spindle Orientation Control by a Position Coder

6.6.1 General

The function for quickest spindle orientation control by a position coder is added as a feature for spindle orientation control by a position coder. When a spindle orientation command is entered, the new function stops the spindle in place according to the deceleration constant which allows full utilization of the deceleration capability of the spindle motor. This reduces the orientation time.
When related parameters are specified, the quickest spindle orientation control can be executed for the following functions: The spindle orientation function with the position set externally and the spindle orientation function with the incremental command set externally.

(Note 1) This manual describes only the action to stop the spindle in place by the spindle orientation command (ORCM). Quickest orientation control can be executed for the following orientation functions. For details, refer to the corresponding descriptions:

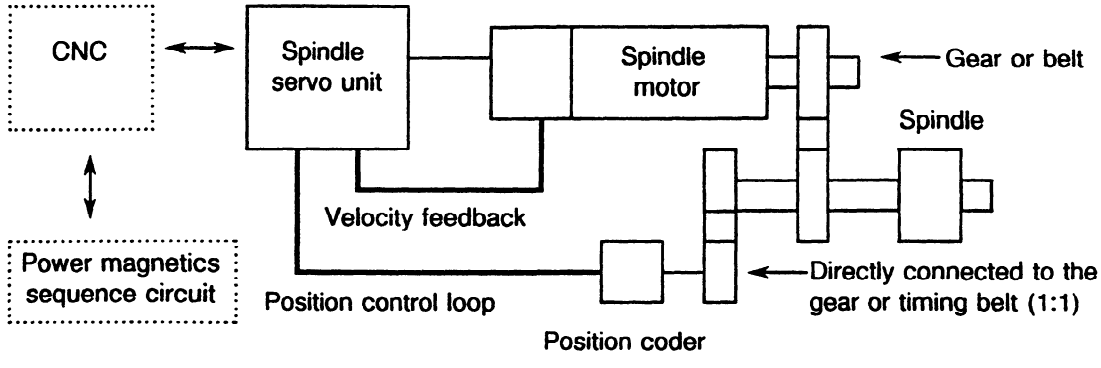
(1) Spindle orientation function with the position set externally
(2) Spindle orientation function with the incremental command set externally

(Note 2) Applicable serial interface spindle amplifier (IGBT type):
A06B-6064-H3xx#H550
Applicable control software series:
9A50, I and later editions

(Note 3) Applicable CNC: Series 0-C, 15, 16, and 18

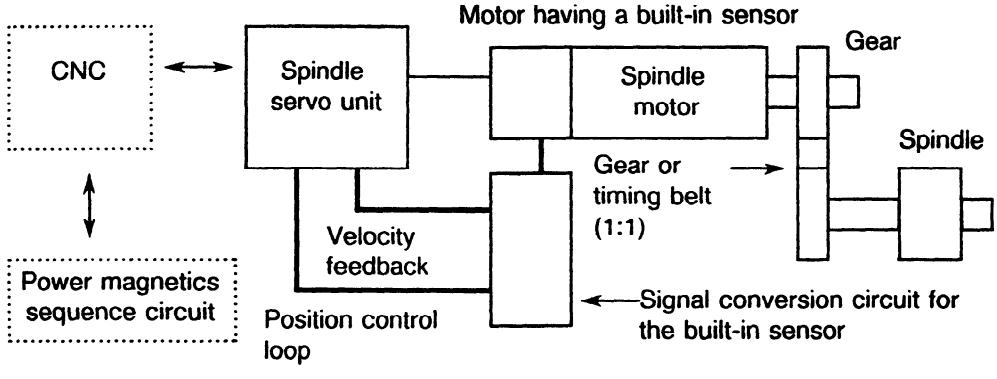
6.6.2 System configurations

(1) System in which the position coder is linked to the spindle



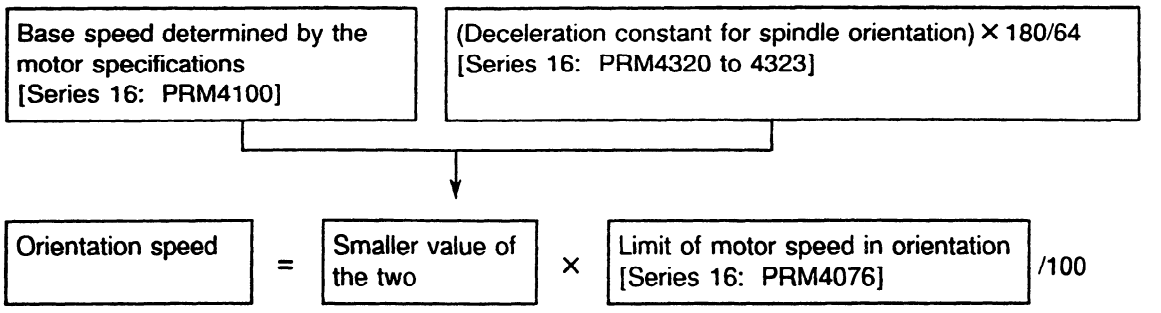
(2) Motor system built into the spindle

(3) System in which the spindle and the motor having a built-in sensor are directly linked by a gear or timing belt at a ratio of 1:1



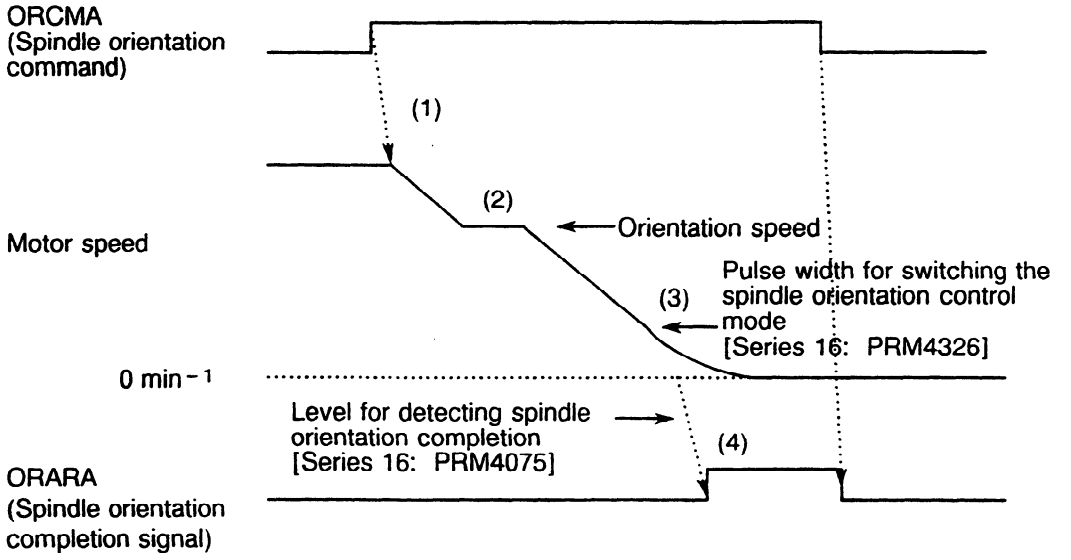
6.6.3 Quickest orientation action

The orientation speed is calculated as follows:



[Example] Base speed in the specifications of the motor output = 1500 min^{-1}
Constant for quickest orientation = 640 → 640 × 180/64 = 1800 min^{-1}
Limit of motor speed in orientation = 100%
Orientation speed = 1500 × 100/100 = 1500 min^{-1}

(1) Stopping in place the spindle rotating at the orientation speed or higher



(a) When spindle orientation command ORCMA is entered while the spindle is rotating at the orientation speed or higher, the spindle speed is reduced to the orientation speed.

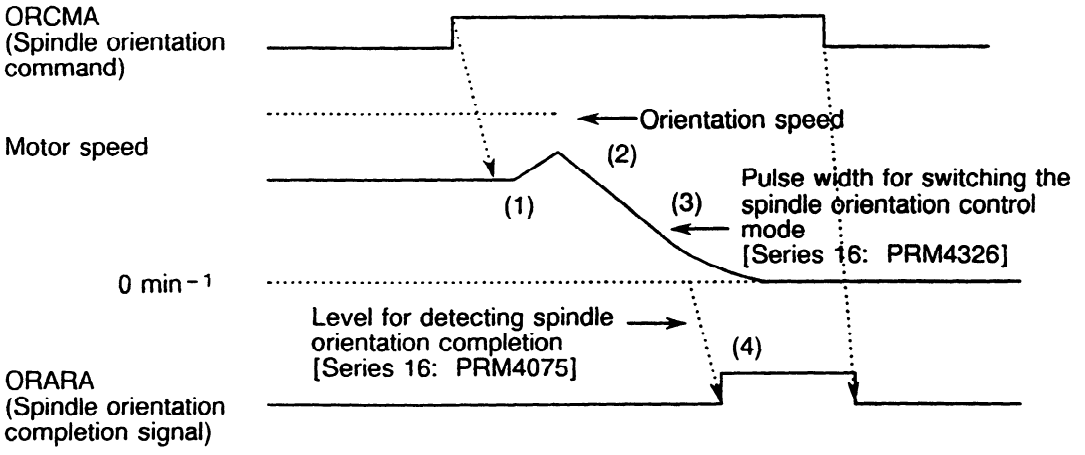
(b) When the single rotation signal is detected (only in the first orientation after the power is turned on) at the orientation speed and the position loop is completed, the spindle speed is reduced according to the deceleration constant for spindle orientation [Series 16: PRM4320 to PRM4323]. In the second and subsequent orientations, the spindle need not be rotated at the orientation speed because the single rotation signal has already been detected. So, the corresponding time is reduced.

(c) When an error pulse becomes less than or equal to the pulse width for switching the spindle orientation control mode [Series 16: PRM4326], the spindle reduces speed according to the position gain calculated by the software.

(d) When an error pulse becomes less than or equal to the level for detecting spindle orientation completion [Series 16: PRM4075], spindle orientation completion signal ORARA is output. The spindle is controlled according to the position gain in spindle orientation [Series 16: PRM4060 to PRM4063]. The spindle stops at the position obtained by the following expression:

[Position of the single rotation signal] + [Orientation stop position + Shift distance parameter] (Series 16: PRM4031 + PRM4077)

(2) Stopping in place the spindle rotating at the orientation speed or lower



(a) When spindle orientation command ORCMA is entered while the spindle is rotating at the orientation speed or lower, the single rotation signal is detected (only in the first orientation after the power is turned on) and the position loop is completed. The spindle speed is increased a little so that the stop position can be adjusted. In the second and subsequent orientations, acceleration is not required because the single rotation signal has already been detected. So, the corresponding time is reduced.

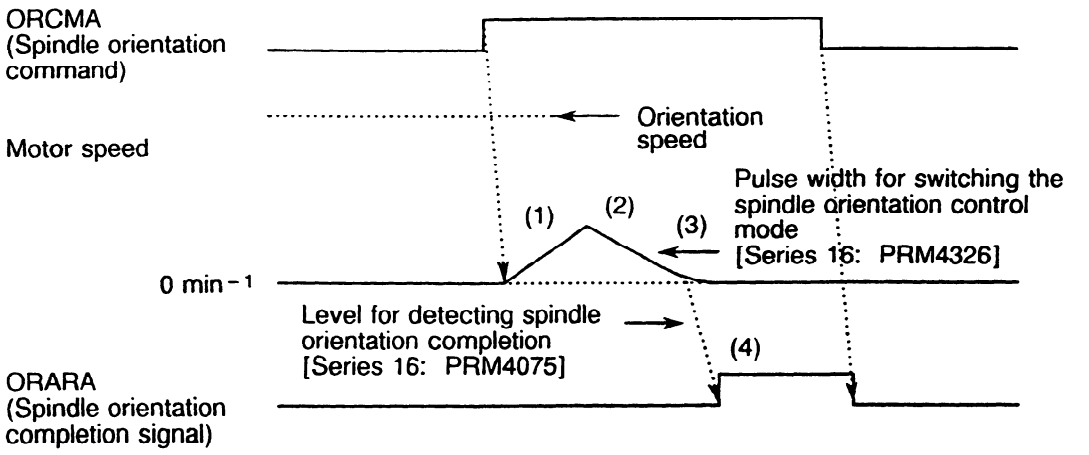
(b) The spindle reduces its speed according to the deceleration constant for spindle orientation [Series 16: PRM4320 to PRM4323].

(c) When an error pulse becomes less than or equal to the pulse width for switching the spindle orientation control mode [Series 16: PRM4326], the spindle reduces speed according to the position gain calculated by the software.

(d) When an error pulse becomes less than or equal to the level for detecting spindle orientation completion [Series 16: PRM4075], spindle orientation completion signal ORARA is output. The spindle is controlled according to the position gain in spindle orientation [Series 16: PRM4060 to PRM4063]. The spindle stops at the position obtained by the following expression:

[Position of the single rotation signal] + [Orientation stop position + Shift distance parameter] (Series 16: PRM4031 + PRM4077]

(3) Stopping the spindle in the stop status in place



(a) In the first orientation after the power is turned on, the spindle stops in place after the single rotation signal is detected. When the speed is less than the zero speed level (SST is set to 1) in the second and subsequent orientations, the spindle stops in place before it turns once. The parameter specifying the direction of rotation [Series 16: PRM4003, bits 2 and 3] applies to the spindle motor. When the rising edge of spindle orientation command ORCMA is detected, a position loop is completed.

(b) The spindle reduces speed according to the deceleration constant for spindle orientation [Series 16: PRM4320 to PRM4323].

(c) When an error pulse becomes less than or equal to the pulse width for switching the spindle orientation control mode [Series 16: PRM4326], the spindle reduces speed according to the position gain calculated by the software.

(d) When an error pulse becomes less than or equal to the level for detecting spindle orientation completion [Series 16: PRM4075], spindle orientation completion signal ORARA is output. The spindle is controlled according to the position gain in spindle orientation [Series 16: PRM4060 to PRM4063]. The spindle stops at the position obtained by the following expression:
[Position of the single rotation signal] + [Orientation stop position + Shift distance parameter] (Series 16: PRM4031 + PRM4077]

(Note) When NRROA (signal for taking the shorter route) is specified, the spindle rotates to the target stop position by taking the route and stops. Rotation by the shorter route (up to ±180°) can be executed only when the following conditions are satisfied:

- NRROA (Series 16: G072, bit 2) is set to 1.
- NRROEN (Series 16: 4017, bit 7) is set to 1.
- RFCHK3 (Series 16: 4016, bit 7) is set to 0.
- The speed is zero. (SST is set to 1.)

6.6.4 PMC signals (DI/DO signals)

This section describes the PMC signals (DI/DO signals) used for quickest spindle orientation control.

(1) PMC → CNC (DO signals)

	(PC address)			b7	b6	b5	b4	b3	b2	b1	b0
	0C	15	16								
No.1	G229	G227	G070		ORCMA			CTH1A	CTH2A		
No.2	G233	G235	G074								

- ORCMA (Spindle orientation command signal)
  1: Spindle orientation is executed.

- CTH1A, CTH2A (Signals for selecting a gear or clutch)
  These signals select the proper spindle control parameters (position gain, velocity loop gain, gear ratio, etc.) for the gear or clutch selected.
  The parameters selected by these signals are described in Section 6.6.5, "Parameters." These parameters select the following gear or clutch statuses. Select the appropriate parameter from those listed in the table below.

CTH1A	CTH2A	Spindle control parameter status	
0	0	(High)	(High)
0	1	(Medium High)	(High)
1	0	(Medium Low)	(Low)
1	1	(Low)	(Low)

	(PC address)			b7	b6	b5	b4	b3	b2	b1	b0
	0C	15	16								
No.1	G231	G229	G072						NRROA		
No.2	G235	G237	G076								

- NRROA (Signal for taking the shorter route)
  When this signal is set to 1 during spindle orientation from the stop status, the spindle rotates by taking the shorter route and stops at the target stop position.
  1: The spindle rotates by taking the shorter route.

  The spindle can rotate by taking the shorter route only when the following conditions are satisfied:

  - NRROEN (Series 16: 4017, bit 7) is set to 1.
  - RFCHK3 (Series 16: 4016, bit 7) is set to 0.
  - The speed is zero. (SST is set to 1.)

(2) PMC ← CNC (DI signals)

	(PC address) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
No.1	F281	F229	F045	ORARA							
No.2	F285	F245	F049								

- ORARA (Orientation completion signal)

  ORARA is set to 1 when orientation is completed. The signal is output when the following conditions are satisfied:

  a. The spindle is close to the specified stop position (within the effective area). (Series 16: PRM4075)
  b. Orientation is in progress. (ORCMA is set to 1.)
  c. The speed is zero. (SSTA is set to 1.)

	(PC address) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
No.1	F282	F228	F046			PORAR2					
No.2	F286	F244	F050								

  The signal is validated when the parameter (Series 16: PRM4312) is set to a value other than zero.

- PORAR2 (Signal 2 of orientation completion by a position coder)

  PORAR2 is set to 1 when the stop position is within effective area 2 specified for orientation completion by a position coder. This signal is output when the following conditions are satisfied:

  a. The spindle is close to the specified stop position (within effective area 2). (Series 16: PRM4312)
  b. Orientation by a position coder is in progress. (ORCMA is set to 1.)
  c. The speed is zero. (SSTA is set to 1.)

6.6.5 Parameters

This section describes the spindle control parameters to be specified for quickest spindle orientation control.

(Parameter No.) 0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
6500	3000	4000						POSC1		ROTA1
6640	3140									

ROTA1: The spindle and motor rotate:

0: In the same direction.

1: In opposite directions.

POSC1: The spindle and position coder rotate:

0: In the same direction.

1: In opposite directions.

(Parameter No.)

0C	15	16
6501	3001	4001
6641	3141	

b7	b6	b5	b4	b3	b2	b1	b0
CAXIS3	CAXIS2	CAXIS1			POSC2		

POSC2: The position coder signal is:

1: Used. (Always specify this value.)

CAXIS1: A high-resolution magnetic pulse coder (to be installed in the spindle) is:

0: Not used.

1: Used.

CAXIS2: The position detection signal of the high-resolution magnetic pulse coder is:

0: Not used for speed detection. (The spindle and spindle motor are installed separately.)

1: Used for speed detection. (The spindle has a built-in motor.)

CAXIS3: The high-resolution magnetic pulse coder is mounted so that the spindle and the position detector rotate:

0: In the same direction.

1: In opposite directions.

(Parameter No.)

0C	15	16
6503	3003	4003
6643	3143	

b7	b6	b5	b4	b3	b2	b1	b0
PCPL2	PCPL1		PCTYPE	DIRCT2	DIRCT1		PCMGSL

PCMGSL: Orientation is executed:

0: In the PC method. (Always specify this value.)

DIRCT2, DIRCT1: The direction of rotation in the orientation is:

00: Determined by the direction of the most recent rotation. (In the first rotation, the direction is counterclockwise.)

01: Determined by the direction of the most recent rotation. (In the first rotation, the direction is clockwise.)

10: Counterclockwise (CCW), when viewed from the motor shaft.

11: Clockwise (CW), when viewed from the motor shaft.

(Note) When 00 or 01 is specified, the direction of rotation is determined by the direction of the most recent rotation whose speed is greater than or equal to the zero speed level (SST signal is set to 0).

PCTYPE: The number of pulses per revolution of the position coder is:

0: 1024 p/rev.

1: 512 p/rev.

PCPL2, PCPL1: The number of pulses of the position coder containing a high-resolution magnetic pulse coder is:

00: 1024 p/rev. (The diameter of the detector is 65 mm.)
01: 2048 p/rev. (The diameter of the detector is 130 mm.)
10: 3072 p/rev. (The diameter of the detector is 195 mm.)
11: 1536 p/rev. (The diameter of the detector is 97.5 mm.)

(Parameter No.)

0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
6515	3015	4015								ORIENT
6655	3155									

ORIENT: The spindle orientation function which requires CNC software option is:

1: Provided. (Always specify this value.)

(Parameter No.)

0C	15	16	b7	b6	b5	b4	b3	b2	b1	b0
6517	3017	4017	NRROEN					RFCHK4		
6657	3157									

RFCHK4: During normal rotation, the single rotation signal of the position coder is:

0: Not detected. (Conventional function)
1: Detected.

When this parameter is set to 1, the time required for spindle orientation by the position coder can be reduced immediately after the rotation speed exceeds the maximum speed for detecting the position coder signal [Series 16: PRM4098].

NRROEN: If this parameter is set to 1, the shorter route function is validated when the command for executing orientation from the stop status is entered. The shorter route function is executed only when the following conditions are satisfied:

- NRROEN is set to 1.
- RFCHK3 (Series 16: 4016, bit 7) is set to 0.
- The speed is zero. (SST is set to 1.)
- NRROA (Series 16: G72, bit 2) is set to 1.

(Parameter No.)

0C	15	16	
6531	3031	4031	Stop position in orientation by a position coder
6671	3171		

Data unit: 1 pulse (360°/4096 pulses)
Data range: 0 to 4095 (Standard setting: 0)

(Parameter No.)

0C	15	16	
6542 6682	3042 3182	4042	Proportional gain of velocity loop in orientation (high)
6543 6683	3043 3183	4043	Proportional gain of velocity loop in orientation (low)

Data range: 0 to 32767 (Standard setting: 10)

These parameters adjust the response during orientation deceleration and the rigidity in the stop status. Specify the highest possible value which will not cause vibration while orientation is stopped.

(Parameter No.)

0C	15	16	
6550 6690	3050 3190	4050	Integral gain of velocity loop in orientation (high)
6551 6691	3051 3191	4051	Integral gain of velocity loop in orientation (low)

Data range: 0 to 32767 (Standard setting: 10)

These parameters adjust the rigidity in the orientation stop status. Specify a value of up to five times the proportional gain of velocity loop in orientation.

(Parameter No.)

0C	15	16	
6556 6696	3056 3196	405C	Gear ratio (high)
6557 6697	3057 3197	4057	Gear ratio (medium high)
6558 6698	3058 3198	4058	Gear ratio (medium low)
6559 6699	3059 3199	4059	Gear ratio (low)

Data unit: Motor speed for one rotation of the spindle × 100 (or 1000)

Data range: 0 to 32767 (Standard setting: 100)

- Specify the gear ratio of the spindle motor to the spindle.
  (Example) When the motor turns 2.5 times while the spindle turns once, specify 250 (2.5 × 100).
  (Note) When bit 1 of PRM4006 is set to 1 in the Series 16, specify a multiple of 1000.

(Parameter No.)

0C	15	16	
6560	3060	4060	Position gain in orientation (high)
6700	3200		
6561	3061	4061	Position gain in orientation (medium high)
6701	3201		
6562	3062	4062	Position gain in orientation (medium low)
6702	3202		
6563	3063	4063	Position gain in orientation (low)
6703	3203		

Data unit: 0.01 sec^{-1}

Data range: 0 to 32767 (Standard setting: 1000)

The position gain specified in this parameter is validated when the orientation is completed (ORAR is set to 1) in quickest spindle orientation. If the pulse width for switching the spindle orientation control mode (Series 16: PRM4326) is set to 0, the mode is switched when the number of pulses becomes 205. The position gain can be increased to the value obtained by the following expression:

[Deceleration constant for spindle orientation (PRM4320 to PRM4323)] × 106/ $\sqrt{205}$

If the spindle vibrates while it is stopped, specify a value less than that obtained by the expression above.

(Parameter No.)

0C	15	16	
6564	3064	4064	Modification rate of position gain after orientation is completed
6704	3204		

Data unit: 1%

Data range: 0 to 1000 (Standard setting: 100)

(Parameter No.)

0C	15	16	
6575	3075	4075	Level for detecting the orientation completion signal (effective area)
6715	3215		

Data unit: ±1 pulse

Data range: 0 to 100 (Standard setting: 10)

(Parameter No.)

0C	15	16	
6576	3076	4076	Limit of motor speed in orientation
6716	3216		

Data unit: 1%

Data range: 0 to 100 (Standard setting: 33)

Change this parameter from 33 to 100.

- In quickest orientation control, usually specify 100 for this parameter. If PRM4100 of Series 16 is set to 3000 or a larger value, specify the value obtained by the following expression:

$$\text{Value of this parameter} = \frac{3000}{\text{Value of PRM4100}} \times 100$$

[Series 16: PRM4100] = Base speed determined by the rated motor output (Standard setting: Depends on the motor model)

(Parameter No.)

0C	15	16	
6577	3077	4077	Shift distance of stop position in orientation
6717	3217		

Data unit: ±1 pulse

Data range: −4095 to +4095 (Standard setting: 0)

- This parameter is specified when the stop position is shifted. When a positive value is specified, the spindle stop position is shifted counterclockwise. When a negative value is specified, the spindle stop position is shifted clockwise.

(Parameter No.)

0C	15	16	
6584	3084	4084	Motor voltage in orientation
6724	3224		

Data unit: 1%

Data range: 0 to 100 (Standard setting: Depends on the motor model)

(Parameter No.)

0C	15	16	
6598	3098	4098	Maximum speed for detecting the position coder signal
6738	3238		

Data unit: 1 rpm (10 rpm when PRM4006, bit 2 of Series 16 is set to 1)

Data range: 0 to 32767 (Standard setting: 0, maximum motor speed)

(Parameter No.)

0C	15	16	
6284	3464	4320	Deceleration constant for spindle orientation (high)
6464	3684		
6285	3465	4321	Deceleration constant for spindle orientation (medium high)
6465	3685		
6286	3466	4322	Deceleration constant for spindle orientation (medium low)
6466	3686		
6287	3467	4323	Deceleration constant for spindle orientation (low)
6467	3687		

Data range: 0 to 32767 (Standard setting: 0 When this parameter is set to 0, the conventional control method is applied.)

$$\text{Value of the parameter} = \sqrt{\frac{Nb}{Tb} \times \frac{120}{1} \times \frac{GEAR}{GEARUNIT}} \times (0.8 \sim 0.9)$$

Nb = Base speed of spindle motor (rpm)
Tb = Time required to accelerate to the base speed of the spindle motor (s)
GEAR = Gear ratio [Series 16: PRM4056 to PRM4059]
GEARUN = Unit of gear ratio
[Series 16: When PRM4006, bit 1 is set to 0, GEARUN is 100.]
[Series 16: When PRM4006, bit 1 is set to 1, GEARUN is 1000.]

Specify the value obtained by the expression above. When the value must be specified in units of 10 rpm [Series 16: PRM4006, bit 2 is set to 1], specify one tenth of the value obtained by the expression above.

[Example] Nb = 1500 rpm: Base speed of the spindle motor (rpm)
Tb = 1 s: Time required to accelerate to the base speed of the spindle motor (s)
GEAR = 200: Gear ratio [Series 16: PRM4056 to PRM4059]
GEARUN = 100: Unit of gear ratio [Series 16: PRM4006, bit 1 is set to 0]
[1 rpm when PRM4006, bit 2 is set to 0 in Series 16]
In this example, the base speed of the spindle motor is 1500 rpm. The spindle speed is 750 rpm. Tb is the time required to increase the spindle speed to 750 rpm.

$$\text{Value of the parameter} = \sqrt{\frac{Nb}{Tb} \times \frac{120}{1} \times \frac{GEAR}{GEARUNIT}} \times (0.8 \sim 0.9)$$

$$= \sqrt{\frac{1500}{1} \times \frac{120}{1} \times \frac{200}{100}} \times (0.8 \sim 0.9) = 480 \sim 540$$

An approximate value of Nb/Tb can be obtained by making the following calculation: Nb/Tb = Tm/(Jm + JL) × $60/2\pi$, where Tm is the 30-min. rated torque [Kgm] and Jm + JL is rotor + load inertia (Kgmsec^2).

(Parameter No.)
0C 15 16
6290 3470 4326
6470 3690

Pulse width for switching the spindle orientation control mode

Data unit: (Number of pulses for switching the control mode)$^{1/2}$ × 64
Data range: 0 to 32767 (Standard setting: 0)

If this parameter is set to 0, the mode of positioning by a position gain is selected when the position deviation becomes 205 pulses (5% of 4096 pulses) or less. To switch the orientation control mode when the position deviation becomes 256 pulses or less, specify the value obtained by the following expression:

$$\text{Value of parameter} = \sqrt{256 \times 64} = 16 \times 64 = 1024$$

(Parameter No.)

0C	15	16	
6294	3474	4330	Motor activation delay in spindle orientation
6474	3694		

Data unit: ms

Data range: 0 to 32767 (Standard setting: 0)

When this parameter is set to 0, the delay time is 50 ms. This is validated only when the spindle speed is less than or equal to the orientation speed and greater than or equal to the zero speed level. If the spindle orientation is started when the spindle speed is less than or equal to the orientation speed and greater than or equal to the zero speed level, an overshoot can occur when stopping. This overshoot may be prevented by setting a value of 50 ms or more in this parameter.

(Parameter No.)

0C	15	16	
6276	3456	4312	Level 2 for detecting the signal of orientation completion by a position coder
6456	3676		

Data unit: ±1 pulse

Data range: 0 to 32767 (Standard setting: 0)

When the stop position is within this data range, PORAR2 is set to 1. The signal is validated when the parameter is set to a value other than 0.

Parameters of the sub-spindle with the function for switching the spindle

FS0	FS15	FS16	
6140 to 6159 6320 to 6339	3320 to 3339 3540 to 3559	4176 to 4195	Bit parameter area (Example) Series 16 The contents of bit parameter area PRM4000 to PRM4019 of the main spindle with the function for switching the spindle correspond to those of PRM4176 to PRM4195 of the sub-spindle with the function for switching the spindle.
6168 6348	3348 3568	4204	Stop position in orientation by a position coder
6172 6352	3352 3572	4208	Proportional gain of velocity loop in orientation (high)
6173 6353	3353 3573	4209	Proportional gain of velocity loop in orientation (low)
6177 6357	3357 3577	4213	Integral gain of velocity loop in orientation
6180 6360	3360 3580	4216	Gear ratio (high)
6181 6361	3361 3581	4217	Gear ratio (low)
6182 6362	3362 3582	4218	Position gain in orientation (high)
6183 6363	3363 3583	4219	Position gain in orientation (low)
6184 6364	3364 3584	4220	Modification rate of position gain after orientation is completed
6190 6370	3370 3590	4226	Level for detecting the orientation completion signal (effective area)
6191 6371	3371 3591	4227	Limit rate of motor speed in orientation
6192 6372	3372 3592	4227	Shift distance of stop position in orientation
6201 6381	3381 3601	4237	Motor voltage in orientation
6280 6460	3460 3680	4316	Level 2 for detecting the signal of orientation completion by a position coder
6288 6468	3468 3668	4324	Deceleration constant for spindle orientation (high)
6289 6469	3469 3669	4325	Deceleration constant for spindle orientation (low)
6291 6471	3471 3691	4327	Pulse width for switching the spindle orientation control mode
6295 6475	3475 3695	4331	Motor activation delay in spindle orientation

(Note 1) The sub-spindle with the function for switching the spindle may not have some of the parameters of the main spindle with the function for switching the spindle. The sub-spindle shares these parameters with the main spindle.

(Note 2) The sub-spindle with the function for switching the spindle can be made to set high or low in the spindle control parameter by the signals for selecting a gear or clutch, CTH1A and CTH2A.

6.6.6 Precautions

Take the following precautions in orientation:

(1) ORCMA (orientation command)

(a) Set ORCMA to 0 when the power is turned on.
(b) Before turning the power on, return the ATC arm to the safety area. The arm will not be broken even if the spindle or tool turns.
(c) When entering ORCMA, set SFRA (forward spindle rotation) or SRVA (reverse spindle rotation) and the speed command to 0 for the sake of safety. The spindle will not rotate even if ORCMA is set to 0.
(d) Set ORCMA to 0 by the signal indicating that a tool is changed or the signal indicating that a workpiece is loaded or unloaded.
(e) Reset ORCMA to 0 if an alarm or emergency stop occurs during orientation.

(2) ORARA (orientation completion signal)

(a) If ORARA is not returned during the specified time period after ORCMA is specified, an error may have occurred. Design the power magnetics sequence circuit so that it identifies this error and issues an orientation alarm.
(b) Start changing a tool or loading or unloading a workpiece when ORARA is set to 1.
(c) ORARA indicates that the spindle is close to the specified stop position. ORARA is not a true stop signal. For a machine with an ATC having a short action time, allow a short time (0.1 to 0.5 s) before starting an action so that the arm can hold a tool after the spindle is fully stopped.
(d) ORARA is set to 0 when an external force is applied and the spindle is out of place. In this case, stop changing a tool, but do not release the orientation signal. Resume changing the tool after ORARA is returned to 1.

7. POSITION CODER

7.1 Electrical Specifications

(1) Number of square waves/rotation

Channel	Signal
1ch	1024 pulses/rotation (A, B phases)
2ch	1 pulse/rotation (C phase)

(2) Power supply

Voltage	Current
+5V +5% −10%	350 mA or less

(3) Working ambient temperature range
0 ~ +50°C

(4) Output terminal
- Canon connector
  MS3102A20-29P (Position coder side)
  MS3106A20-29S (Cable side)
  The cable side Canon connector and the cable clamp are provided with the position coder.

(5) Output terminal

A	B	C	D	E	F	G	H	J
PA	PZ	PB					+5V	
K	L	M	N	P	R	S	T	
0V			*PA	*PZ	*PB			

7.2 Mechanical Specifications

(1) Input axis inertia 1.0 × 10^{-3} kg·cm·s^2 or less

(2) Input axis torque 1000 g·cm or less

(3) Input axis load tolerance

	When stopped	During rotation
Thrust load	10 kg or less	5 kg or less
Radial load	20 kg or less	10 kg or less

(4) Structure dust proof and oil-proof. (IP43)

(5) Weight: about 1 kg (without flange)

(6) Accessories

	Name	Specifications	No. of pieces
1	Canon connector	MS3106B20-29S	1
2	Cable clamp	MS3057-12A	1

7.3 Storage

Avoid storing in a humid place.
When moving the product, put it in a packing case and do not drop or throw it.

7.4 Caution in Use

(1) If there is backlash in the interface between the position coder and the spindle, the stop position will vary. Therefore, the position coder should be linked to the spindle so as to eliminate backlash. If the position coder is installed with a timing belt or a gear, check carefully and periodically for backlash due to ageing or mechanical wear.

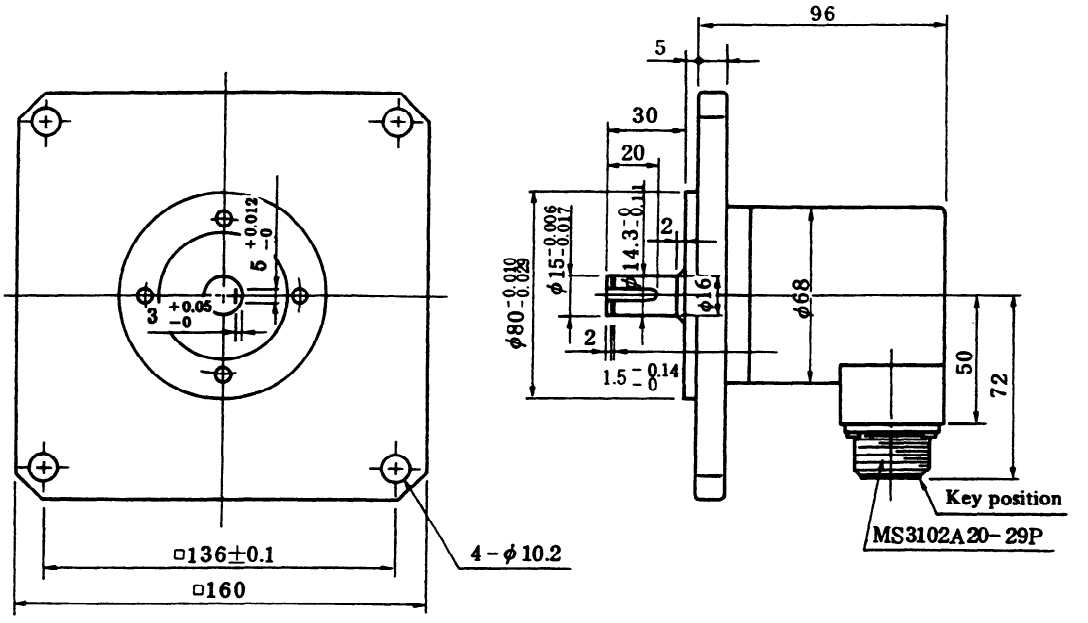
(2) Eccentricity of the body and the center of the axis should be 0.02 or less.

(3) Do not give strong mechanical impact as plate glass is used.
To avoid penetration of oil or water from the Canon connector, install the latter upside down.

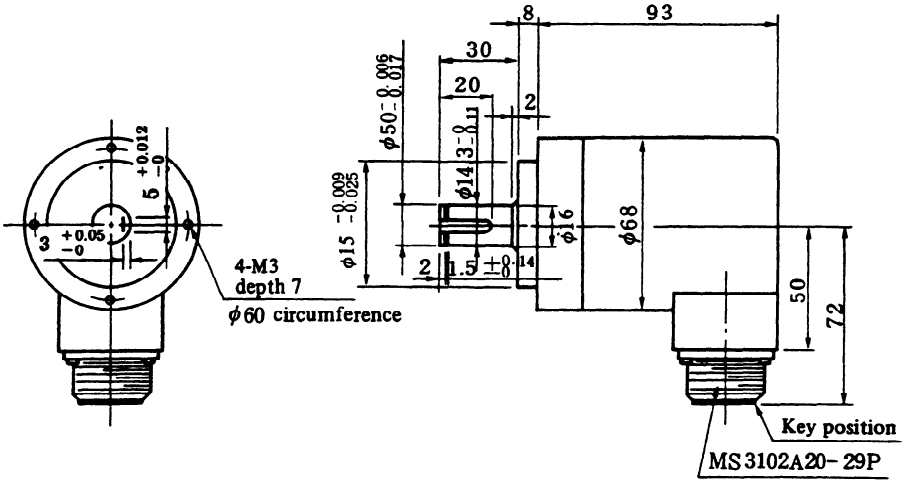
(4) Keep at least 50 cm away from the magnetics cabinet.
Keep at least 30 cm away from the cable line of a motor or the like; out of which a substantial amount of instantaneous current flows at the time of ON-OFF. In particular, when an object which generates radiation noise (such as discharge processing device, electric welder and the like) is in the vicinity, electro-magnetic shielding should be considered.

7.5 External Dimensions

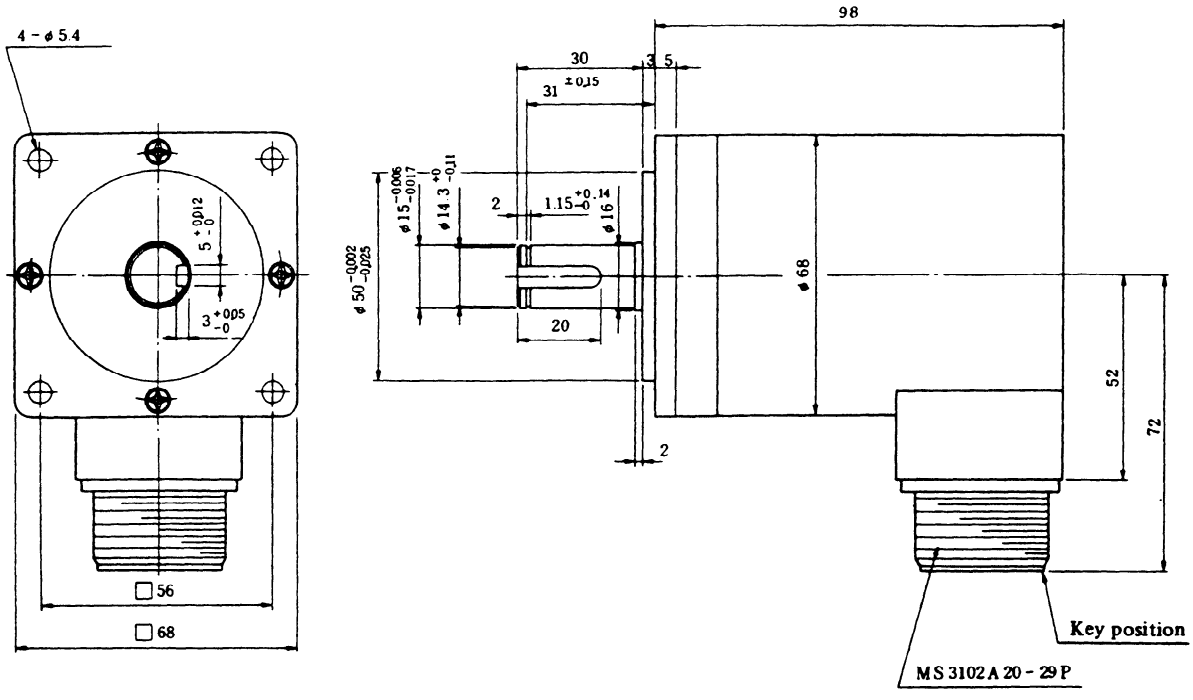
(1) Position coder C, D, G (with 160 × 160 flange)



(2) Position coder E,F,H (without flange)



(3) Position coder J,K,L (with 68 × 68 flange)



X. MAGNETIC SENSOR METHOD SPINDLE ORIENTATION

1. GENERAL

Unlike conventional mechanical spindle orientation using a stopper, etc., the spindle orientation stops the spindle at a fixed position by directly feeding back position signals from the magnetic sensor directly connected to the machine spindle.

2. FEATURES

(1) Mechanical parts are not required.
This orientation is accomplished simply by connecting the magnetic sensor to the spindle without any need of mechanical orientation mechanism (stopper, pin, etc.) for spindle orientation.

(2) Reduction of orientation time
Since the spindle motor connected to the spindle is utilized and the orientation can be performed directly from high-speed rotation, irrespective of gear shift, the orientation time is largely reduced.

(3) Simplified power magnetic sequence control
This sequence consists of the spindle orientation command, its completion signal, spindle high/low signal and spindle medium speed signal only without any need of other signals. Neither orientation speed command sequence nor torque limit command sequence is needed.

(4) High reliability
Electrical system assures improved reliability without any damage to the mechanical section against an external impact.

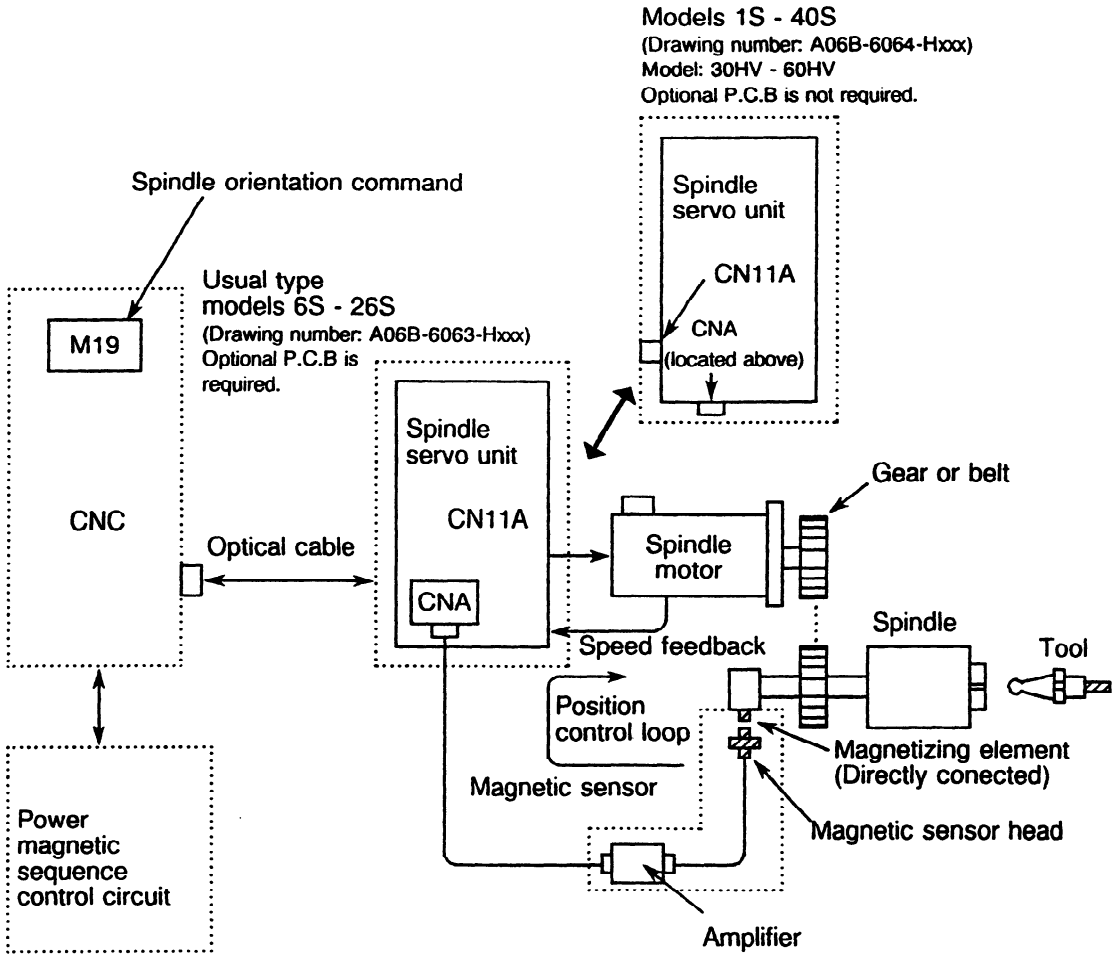
(5) High accuracy and rigidity
The spindle orientation accuracy and rigidity are enough to execute automatic tool exchange (ATC).

(6) Positioning of workpiece
Workpieces can be positioned to arrange their loading and unloading directions in lathe.

(7) Reduction of the number of processes in boring
Since the spindle orientation can be done in the same direction as the rotating direction of the spindle when boring ends, workpieces will not be damaged by tool blades.
Since these tool blades can be mounted or dismounted in a fixed direction with reference to the workpieces, programming is easy.

3. CONFIGURATION AND ORDER DRAWING NUMBER

3.1 Configuration



3.2 Order Drawing Numbers

3.2.1 Magnetic sensor signal input circuit

Classification	Name	Specification No.	Remarks
Option	Magnetic sensor signal input circuit	A06B-6063-J700	Models 6S - 26S Needed only for units A06B-6063-H2XX.

(Note) The magnetic-sensor-signal input circuit is not necessary for improved models 1S to 40S, 30HV to 60HV.

3.2.2 Magnetic sensor

Classification	Name	Specification No.	Remarks
Option	No specification, standard	A57L-0001-0037	Spindle speed: 12,000 min^{-1} or less Standard: (TYPE II)
	Magnetic sensor N	A57L-0001-0037 / N	
	Magnetic sensor P	A57L-0001-0037 / P	Spindle speed: 12,000 min^{-1} or less Small type (TYPE III)
	Magnetic sensor Q	A57L-0001-0037 / Q	Spindle speed: 20,000 min^{-1} or less Cylindrical type with ID of 40 (TYPE IV)
	Magnetic sensor R	A57L-0001-0037 / R	Spindle speed: 20,000 min^{-1} or less Cylindrical type with ID of 50 (TYPE V)
	Magnetic sensor S	A57L-0001-0037 / S	Spindle speed: 15,000 min^{-1} or less Cylindrical type with ID of 60 (TYPE VI)
	Magnetic sensor T	A57L-0001-0037 / T	Spindle speed: 15,000 min^{-1} or less Cylindrical type with ID of 70 (TYPE VII)

3.2.3 Spindle orientation function software (CNC optional software)

Series15M/T : A02B-0094-J730
Series 0MC : A02B-0099-J982
Series 0TC : A02B-0098-J982
Series 16M : A02B-0121-J853
Series 16T, TT : A02B-0120-J853
Power Mate-MODEL A : A02B-0118-J803
Power Mate-MODEL B : A02B-0122-J803

3.2.4 Setting parameters for the spindle orientation function with magnetic sensor (parameter address)

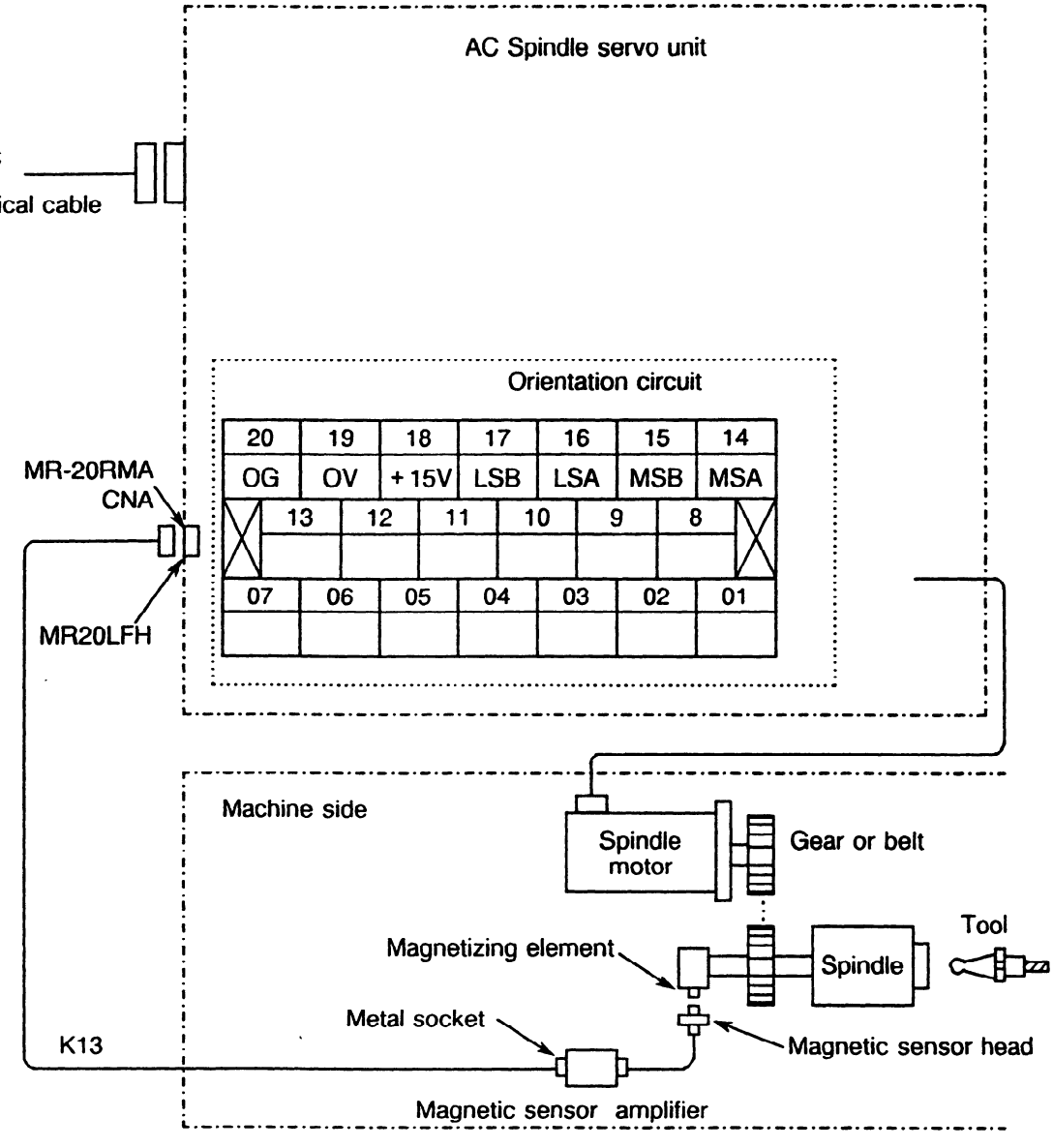
PM	0C	15	16	Data
3003 #0	6503 #0	3003 #0	4003 #0	Set the parameter to 1.

4. SPECIFICATIONS

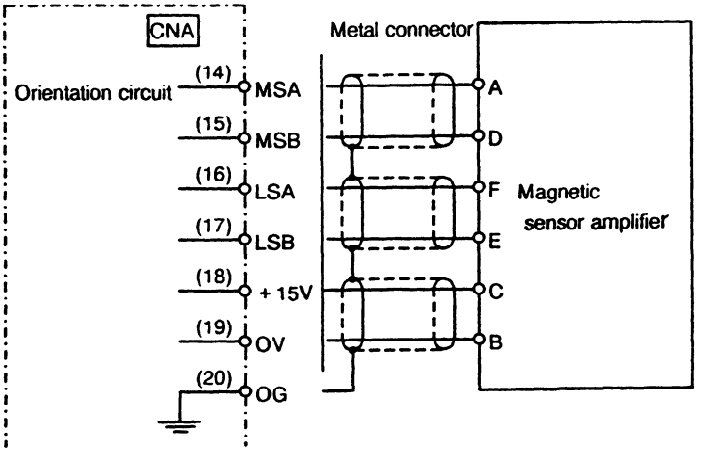
No.	Item	Description
1	Magnetic sensor	Refer to Chapter 7
2	Stop position	Stops when the center of the sensor head faces the center of the magnetizing element or the stop position check scale of the magnetizing element. The stop position can be adjusted to within ±1° by the circuit.
3	Repeatability	±0.2° or less. Excluding factors such as errors from the machine side, for example, setting errors.
4	Max. hold torque at orientation	Continuous rated torque of the AC spindle motor.
5	Range where spindle can be orientated	Orientation stop position ±240°

5. CONNECTION

5.1 Interface



5.1.1 Connection when magnetic sensor



The length of the cable connecting the AC spindle servo unit with the magnetic sensor amp should be not more than 20m.

6. SIGNAL EXPLANATION

6.1 Spindle Control Signals

6.1.1 DI signals (PMC to CNC)

PM	0C	15	16	7	6	5	4	3	2	1	0
First : G112	G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
Second :	G233	G235	G074								
First : G113	G230	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
Second :	G234	G234	G075								

6.1.2 DO signals (CNC to PMC)

PM	0C	15	16	7	6	5	4	3	2	1	0
First : F228	F281	F229	F045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
Second :	F285	F245	F049								
First : F229	F282	F228	F046					RCFNA	RCHPA	CFINA	CHPA
Second :	F286	F244	F050								

6.2 Details of Signals

6.2.1 Orientation (fixed position stop) command (ORCMA) (ORCMA: First spindle side)

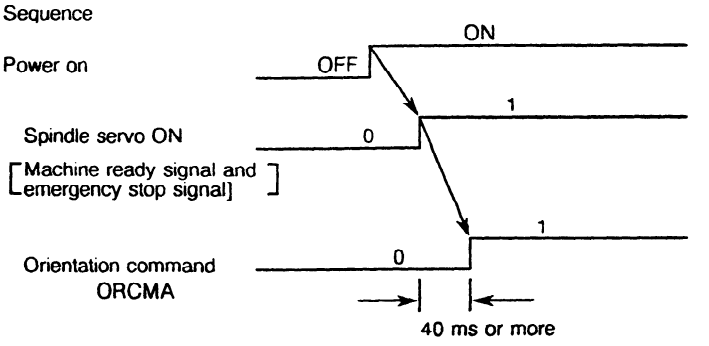
(1) This command signal is used to stop spindle movement at the preset position to allow tool change and workpiece loading/unloading.

(2) When this signal is specified as "1" while the spindle is rotating, the rotation decelerates immediately and the spindle stops at the preset position.

(3) When the orientation command is issued, set the spindle forward/reverse rotation command (SFR, SRV) to "0" for safety. By means of this, the spindle will not start to rotate even in the unlikely event ORCMA becomes "0" during tool change.

(4) Set this signal to "0" by the tool change completion signal or workpiece loading/unloading completion signal.

(5) Always set the orientation command signal to "0" when turning on power.



(6) When an emergency stop occurs during orientation, the orientation command signal must be reset ("0").
Return the ATC arm to the safe position so that it will not be dameged if the spindle or tool rotates when the power is turned on.

6.2.2 Orientation (fixed position stop) completion signal (ORARA) (ORARB: Second spindle side)

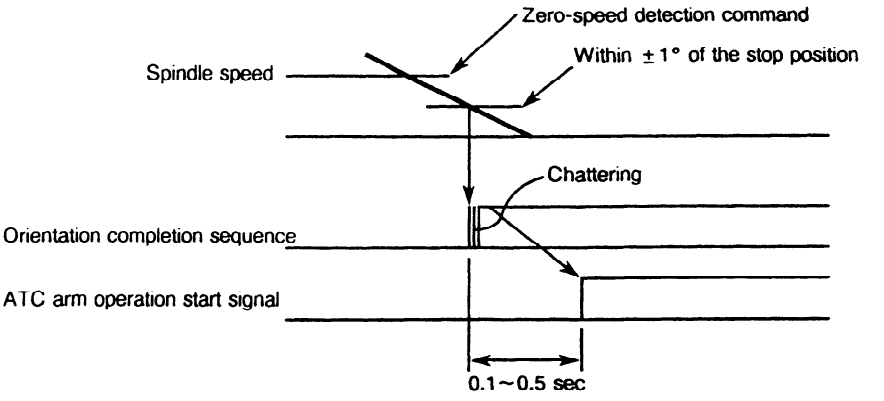
(1) When the orientation command is inputted and the spindle has stopped near the preset fixed position (for example, within +1), it becomes "1".

$$\text{(Condition for ORARA to become "1"} = \frac{\text{(ORCMA is "1")} \times \text{(zero-speed signal)}}{\text{Near to fixed position}}$$

Near to fixed position is set to the parameter in case of Series 16: RRM4075 = Orientation complete signal detection level.
If the above 3 conditions are satisfied, the orientation complete signal is outputted.
If the orientation completion signal is not issued within a set period of time after the orientation command signal is input, it is considered to be abnormal. So it should be detected by the power magnetic sequence and an orientation alarm should be issued.

(2) Tool change or workpiece loading /unloading operations can be started when this signal is "1".

(3) The spindle orientation completion signal is issued when the spindle is within +% of the preset position and so it does not always indicate that the spindle has stopped completely. Some machines allow a very short operation time for the ATC arm to grip the tool. In this case, start the ATC arm operation after a short time (0.1 to 0.5 sec.) so that the arm will grip the tool when the spindle has stopped completely.



(4) This signal will become "0" during a tool change if the spindle is pushed away from the preset position by external force.
In this case, design a power magnetic sequence so that the tool change operation is interrupted.
However, do not release the orientation command, and if the orientation completion signal is issued again, perform a tool change.

(5) If the automatic tool change (ATC) structure is such that it may cause serious damage if a malfunction occurs, install a proximity switch to generate a verification signal when the ATC enters an area in which the automatic tool change operation can be performed. In addition to this, perform a double safety check by the power magnetic sequence and carry out a tool change.

6.2.3 Gear/clutch signal (CTH1A, CTH2A)

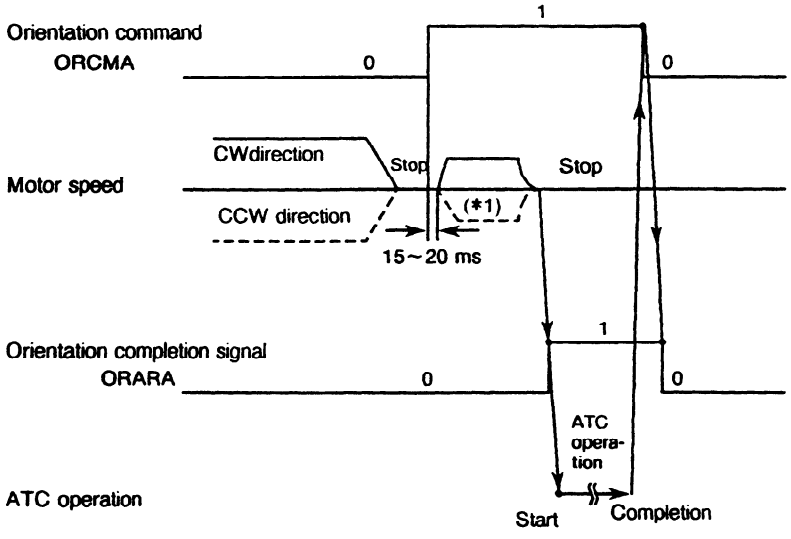
(1) These signal are used in order to shorten the orientation time when there are 2 speed change stages of high/low between the spindle and spindle motor.

(2) Set the following conditions corresponding to the clutch or gear state. They are used in order to select the spindle control parameter (position gain, gear ratio).

CTH1A	CTH2A	
0	0	: HIGH GEAR
0	1	: MEDIUM HIGH GEAR
1	0	: MEDIUM LOW GEAR
1	1	: LOW GEAR

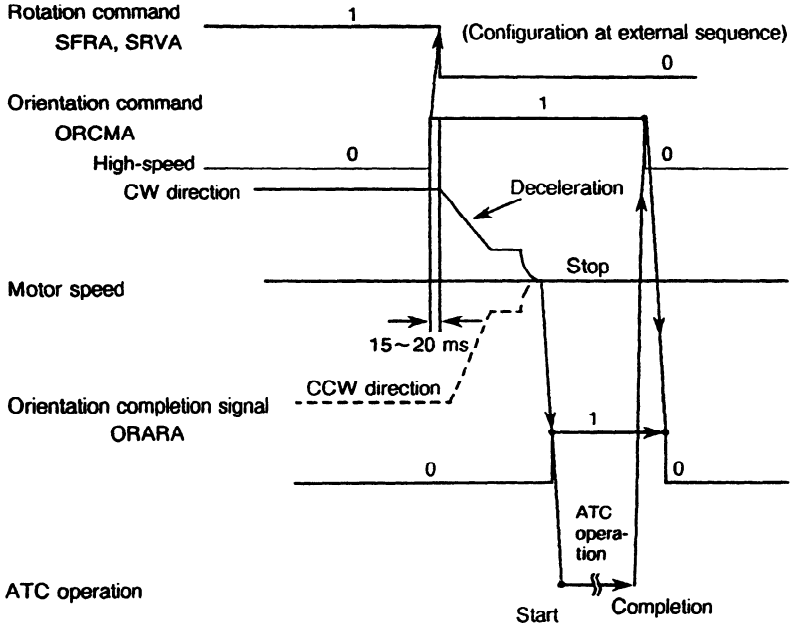
6.3 Sequences

6.3.1 Orientation command while stopping



(*1) The spindle motor rotation direction can be changed by setting. In standard setting, the spindle motor will stop at the fixed position in the direction the spindle motor was rotating before this orientation command signal was generated.

6.3.2 Orientation command during high-speed rotation



6.4 Parameter Setting for the MS Signal Gain through Magnetizing Element

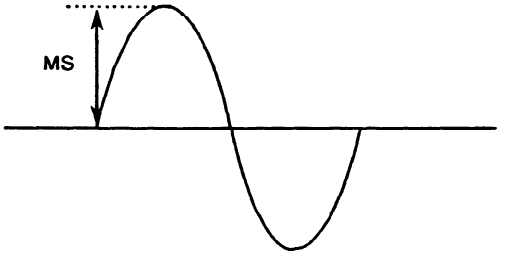
	Parameter Number	
	No. 1 spindle	No. 2 spindle
Series 15 :	3079	3219
Series 0 :	6579	6719
Series 16 :	4079	
Power Mate :	3079	

Name	Specification No.	Magnetizing element		MS signal gain
		Type	Length (mm)	
No specification, standard	A57L-0001-0037	Standard (TYPE II)	50	0
Magnetic sensor N	A57L-0001-0037 / N			0
Magnetic sensor P	A57L-0001-0037 / P	Small type (TYPE III)	50	-20
Magnetic sensor Q	A57L-0001-0037 / Q	Cylindrical type with ID of 40 (TYPE IV)	31	70
Magnetic sensor R	A57L-0001-0037 / R	Cylindrical type with ID of 50 (TYPE V)	37	50
Magnetic sensor S	A57L-0001-0037 / S	Cylindrical type with ID of 60 (TYPE VI)	43	70
Magnetic sensor T	A57L-0001-0037 / T	Cylindrical type with ID of 70 (TYPE VII)	49	40

(Note 1) Specify one of the values in the above table as the MS signal gain. The MS signal gain can, however, be determined as follows.

MS signal gain = 500/MS - 100

MS: Peak voltage (V) for the MS signal at check pin MS on the magnetic sensor signal input circuit measured with an oscilloscope



(Note 2) Install the magnetizing element and the magnetic sensor so that the gap between them is 1.0 to 2.0 mm. See Section 7.2.

6.5 Parameter Setting for the MS Signal Constant

	Parameter Number	
	1st spindle	2nd spindle
Series 15 :	3078	3218
Series 0 :	6578	6718
Series 16 :	4078	
Power Mate :	3078	

How to determine the MS signal constant

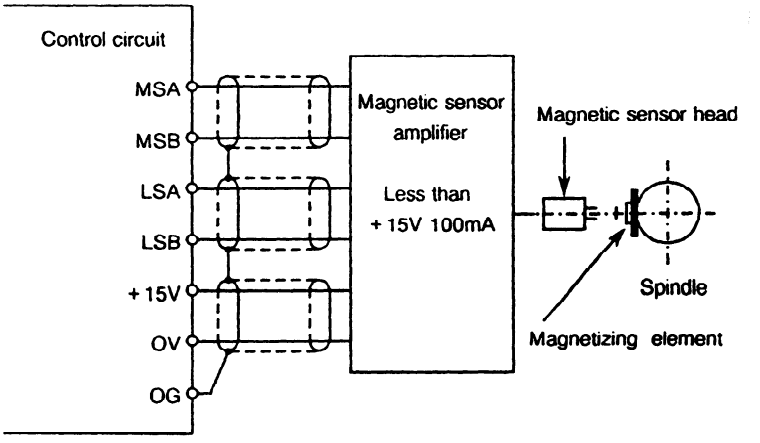
MS signal constant = (L/2)(2 × π × H) × 4096

L: Length of the magnetizing element (mm) (See the above table.)

H: Distance between the center of the spindle and the magnetizing element (mm) (See Section 7.3.)

7. MAGNETIC SENSOR

In the magnetic sensor method a magnetizing element is installed in the rotating chassis of the spindle. The spindle is made to stop at the fixed position by means of the installation of a magnetic sensor at the stop position.
The magetic sensor generates an analog signal corresponding to the position of the magnetizing element which has been installed in the spindle.



Use shielded cables in the wiring.
Other than the shield casing, all should be connected to OG.

The following shows the electrical specifications and the installation method for the magnetic sensor.

7.1 Electrical Specifications

(1) Number of square waves/rotation

Channnel	Signal
1ch	1 pulse/rotation (MSA-MSB)
2ch	1pulse/rotation (LSA-LSB)

(2) Power supply

Voltage	Current
+15V + 10%, −10%	100 mA or less

(3) Maximum response rotation speed (magnetizing element) 8000 min^{-1}

(4) Working ambient temperature range (magnetic sensor) 0～+50°C

(5) Output terminal

Installation is performed by the metal socket method on the cable side of the magnetic sensor amplfier provided.

(6) Output terminal arrangement (magnetic sensor amplifier)

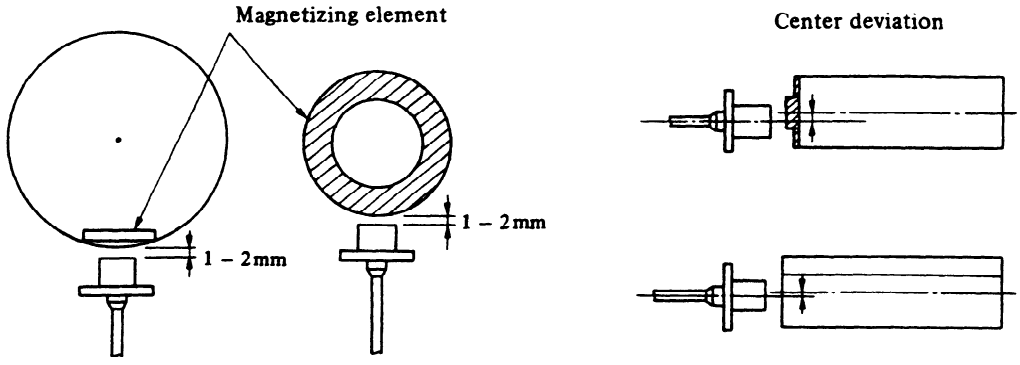
Terminal	A	B	C	D	E	F
Signal name	MSA	0 V	+ 15V	MSB	LSB	LSA

7.2 External View

(1) Types of magnetic sensor

Items	Unit	Sensor N	Sensor P	Sensor Q	Sensor R	Sensor S	Sensor T
Maximum spindle speed	min^{-1}	12,000		20,000		15,000	
Magnetizing element weight	g	33 ± 1.5	14.8 ± 0.7	315 ± 10	460 ± 10	770 ± 15	1000 ± 20
Allowable centrifugalforce (*1)	kg	255	130	——			
Mounting radius from the spindle center to the magnetizing element (*1)	mm	40~110		20	25	30	35
Gap width from magnetizing element to sensor (*2)	mm	1.0~2.0					
Deviation between the magnetizing element center and the sensor center (*3)	mm	0~ ± 2.0					
Working temperature	°C	0~ +50					
Diameter of applicable axis	mm	——		$\phi 40^{+0}_{-0.025}$	$\phi 50^{+0}_{-0.025}$	$\phi 60^{+0}_{-0.030}$	$\phi 70^{+0}_{-0.030}$

(*1) (*2)

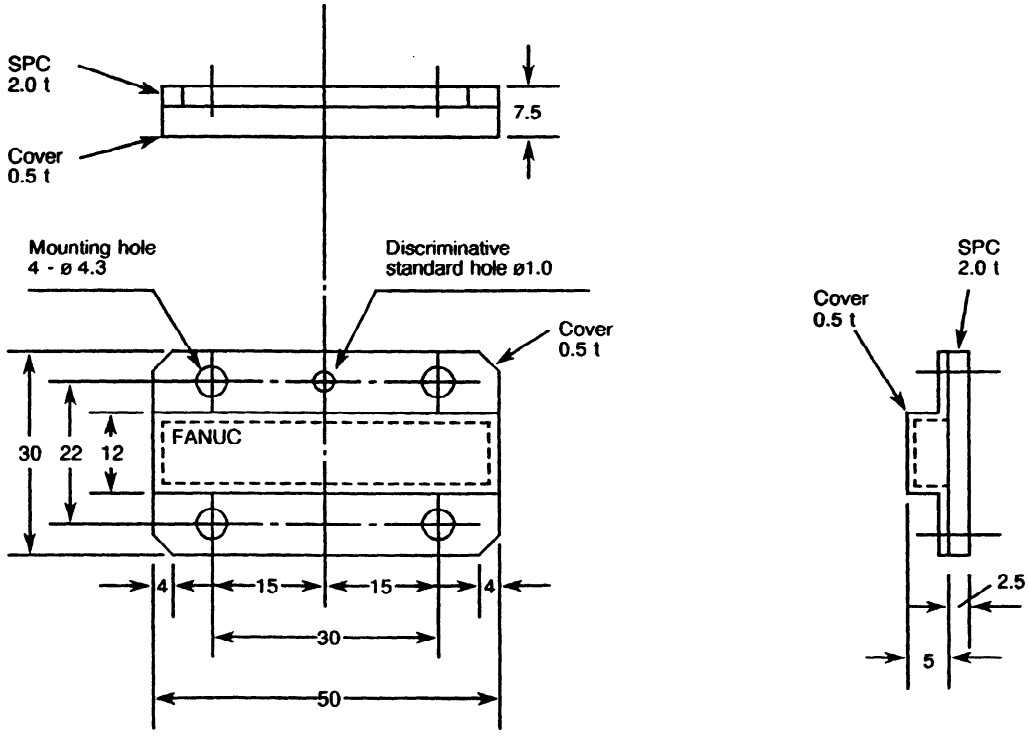


(*1) When the radius of the magnetizing element is large, maximum revolution is restricted due to allowable centrifugal force.

(*2) It is recommended to mount the magnetizing element using high-strength bolt.

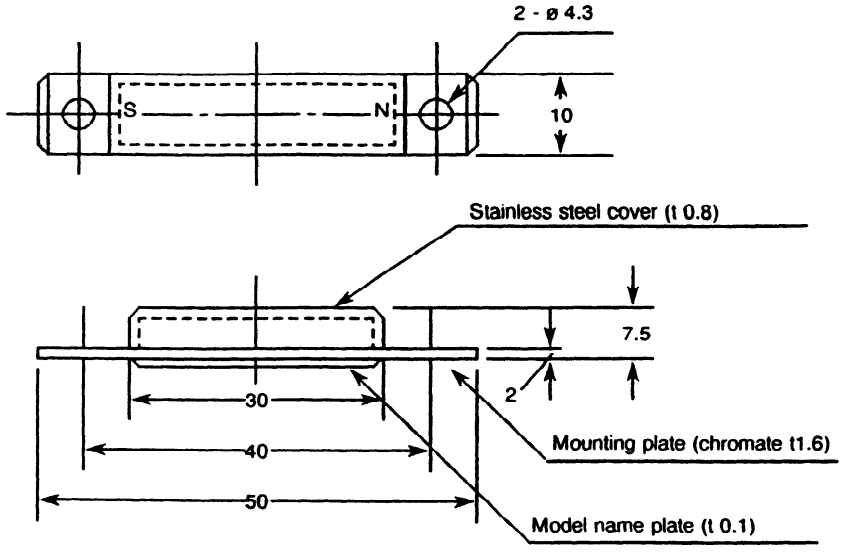
(2) Magnetizing element

(a) External drawing of the magnetizing element for the magnetic sensor N.

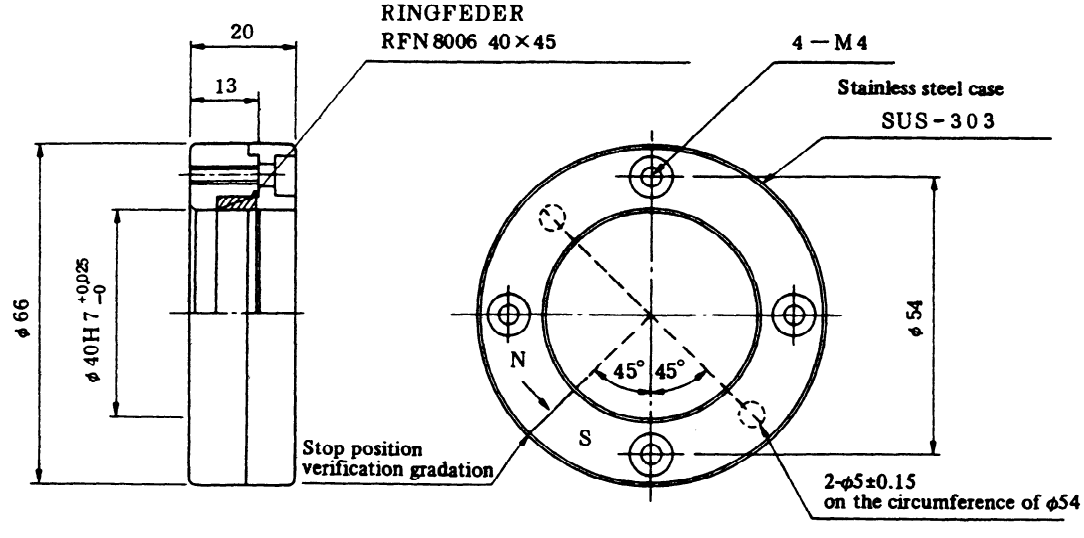


Weight 33 g ± 1.5 g (Take care in respect of spindle balance)

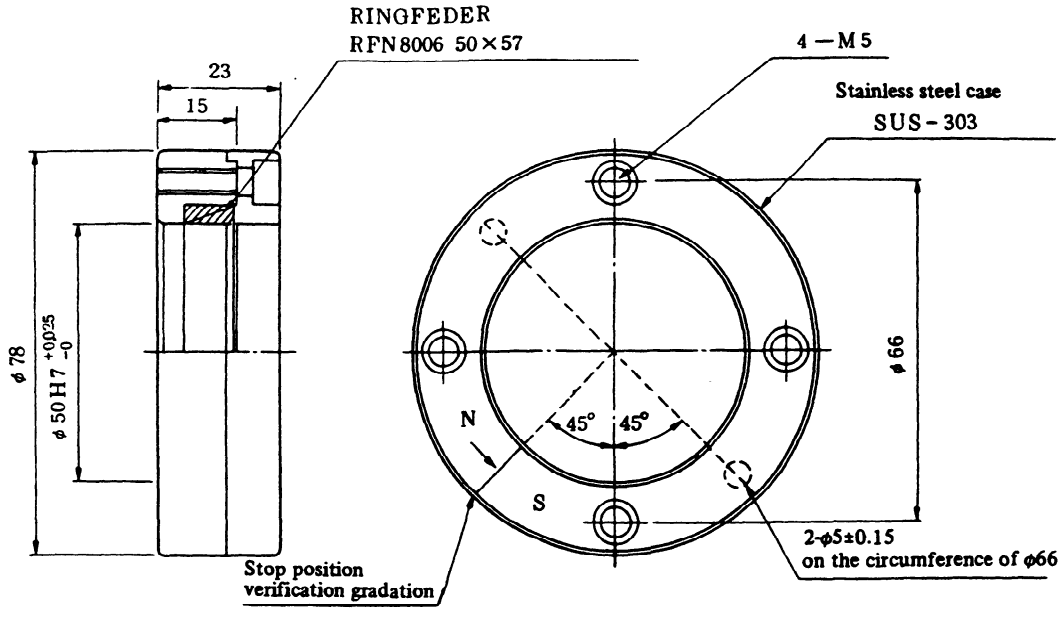
(b) External drawing of the magnetizing element for the magnetic sensor P



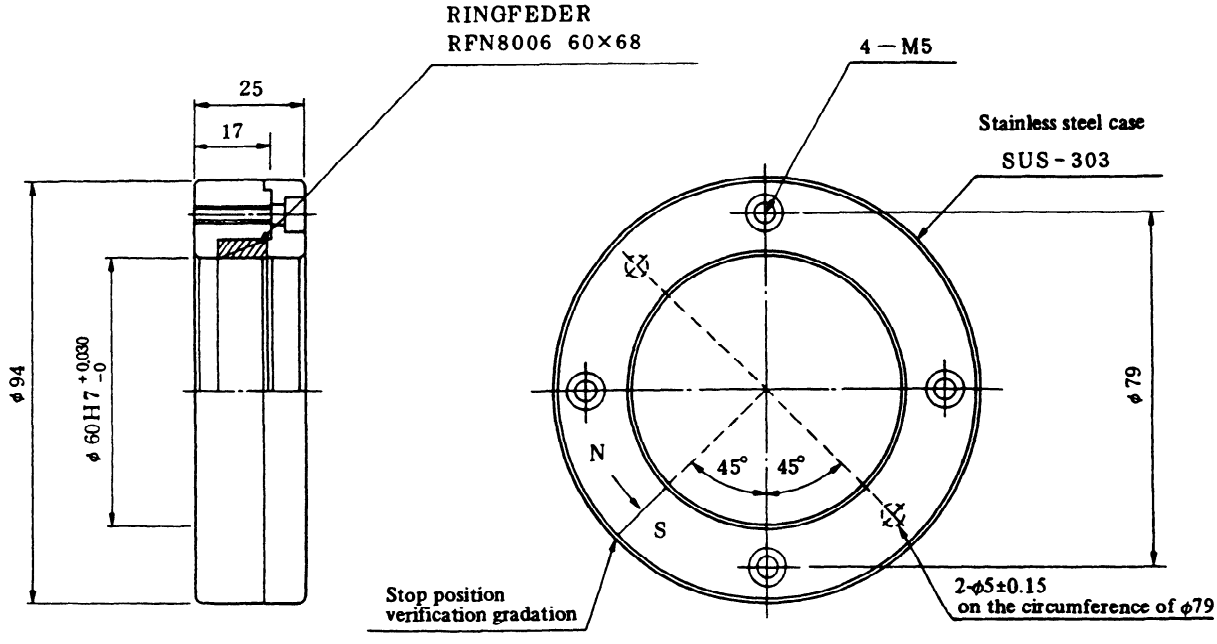
(c) External drawing of the magnetizing element for the magnetic sensor Q



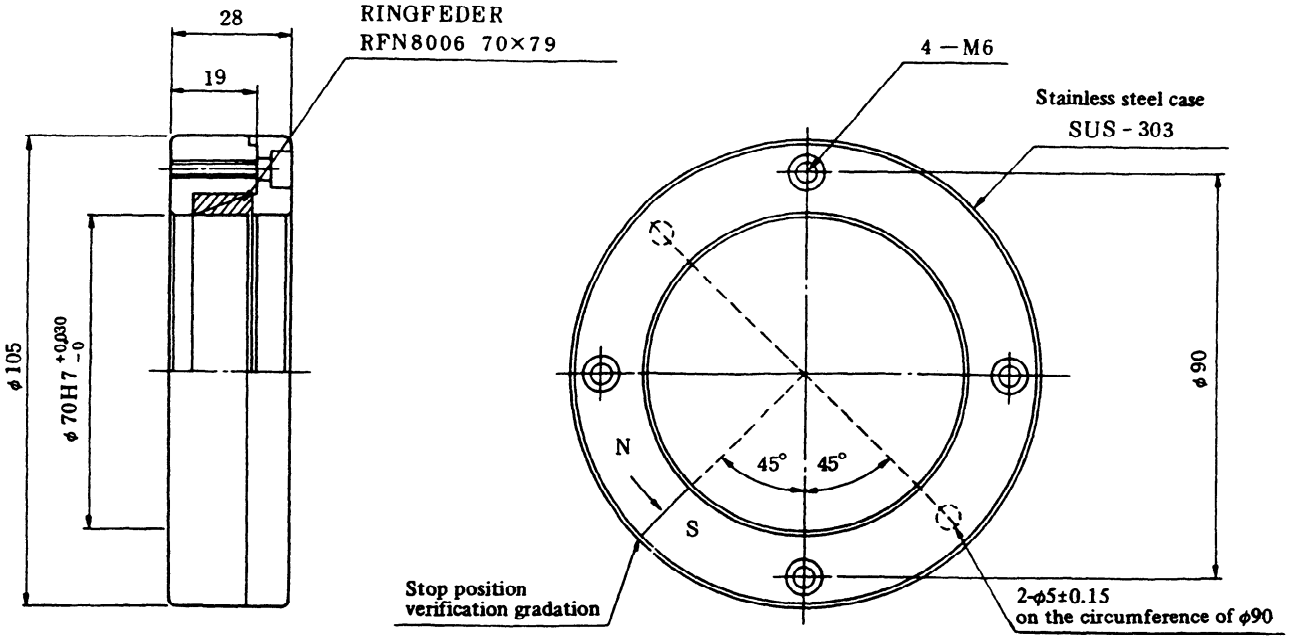
(d) External drawing of the magnetizing element for the magnetic sensor R



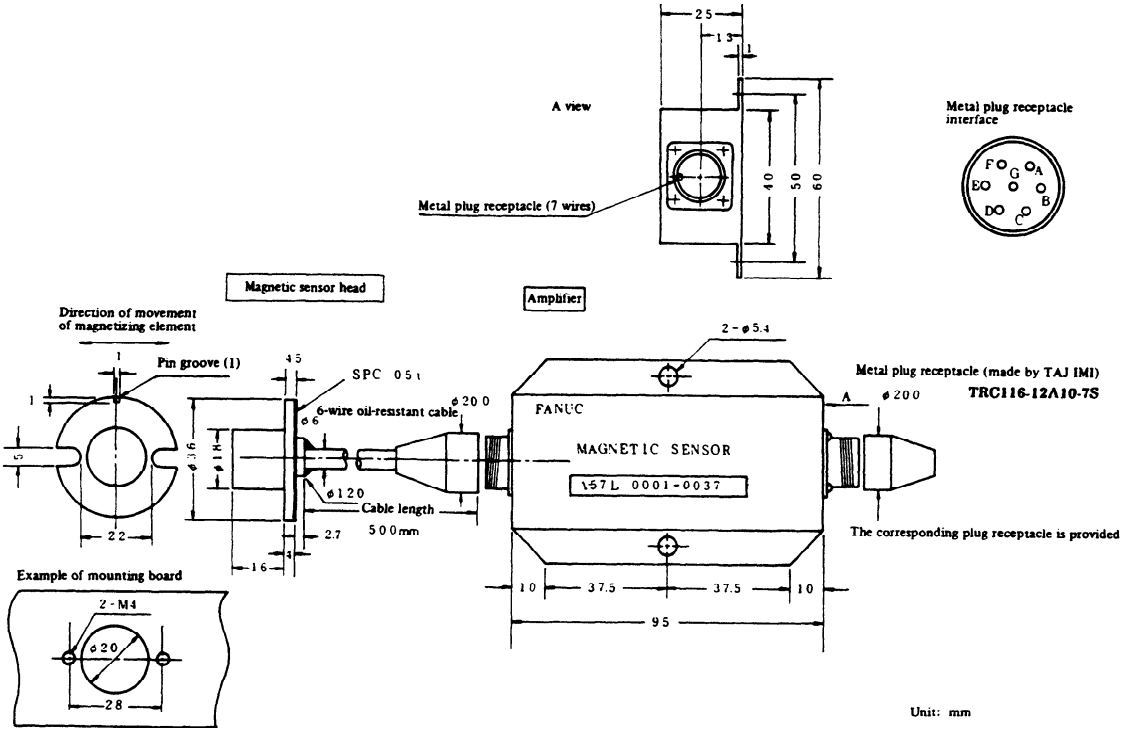
(e) External drawing of the magnetizing element for the magnetic sensor S



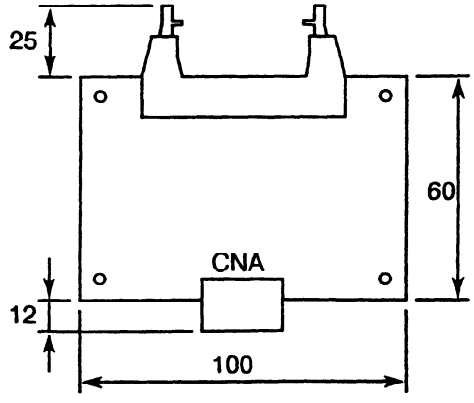
(f) External drawing of the magnetizing element for the magnetic sensor T



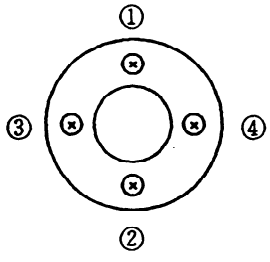
(3) Magnetic sensor



(4) Printed circuit board for controlling orientation (only for conventional types of models 6S to 26S)
This board is used in units A06B-6063-H2XX.

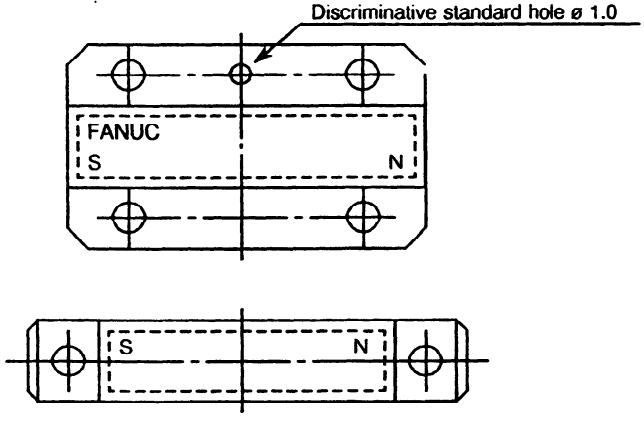


(5) Precautions on use
(a) As a spann element (RING-FEEDER) is used in the magnetizing element, use 4 bolts to conduct uniform tightening.



Conduct gradual repeated tightening in the order from 1 to 4.

(b) Relation between the discriminative standard hole and magnet polarity is shown in the diagram below.



(c) Use the 2 5.0 holes on the opposite side of the screw clamp of magnetic sensors Q, R, S, and T for the orientation positioning jig.

7.3 Magnetic Sensor Mounting Method

The following show magnetic sensor mounting examples Fig. 7.3(a), (b), (c), (d).

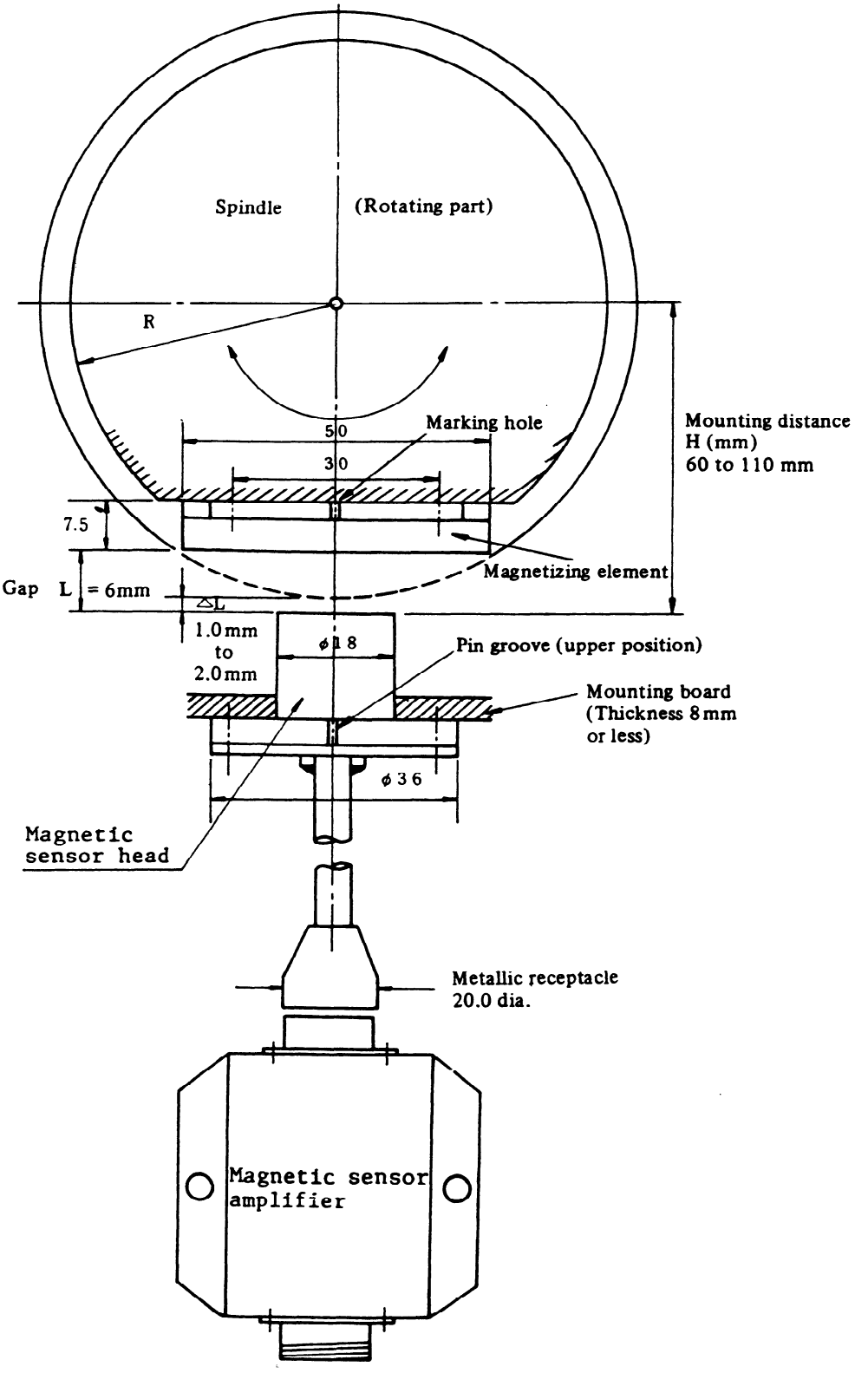
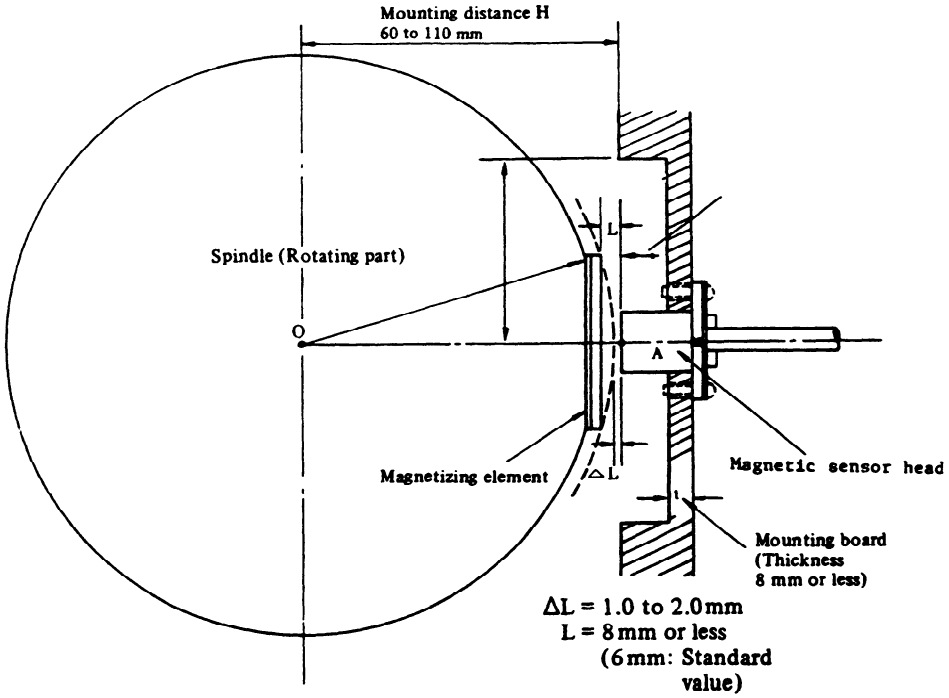


Fig. 7.3 (a) Magnetic sensor mounting example (1)



Note) Gap between mounting board and magnetizing element is 8 mm or more.

Fig. 7.3 (b) Magnetic sensor mounting example (2) (When mounted on cylinder)

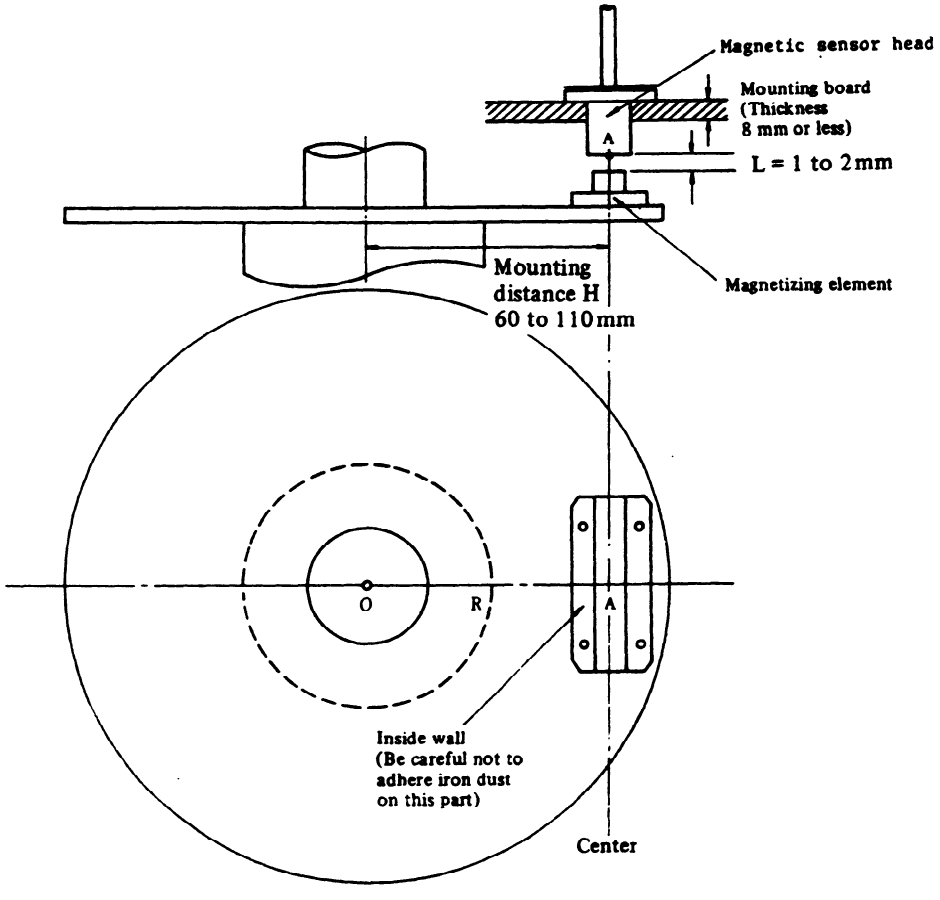


Fig. 7.3 (c) Magnetic sensor mounting example (3) (When mounted on disk)

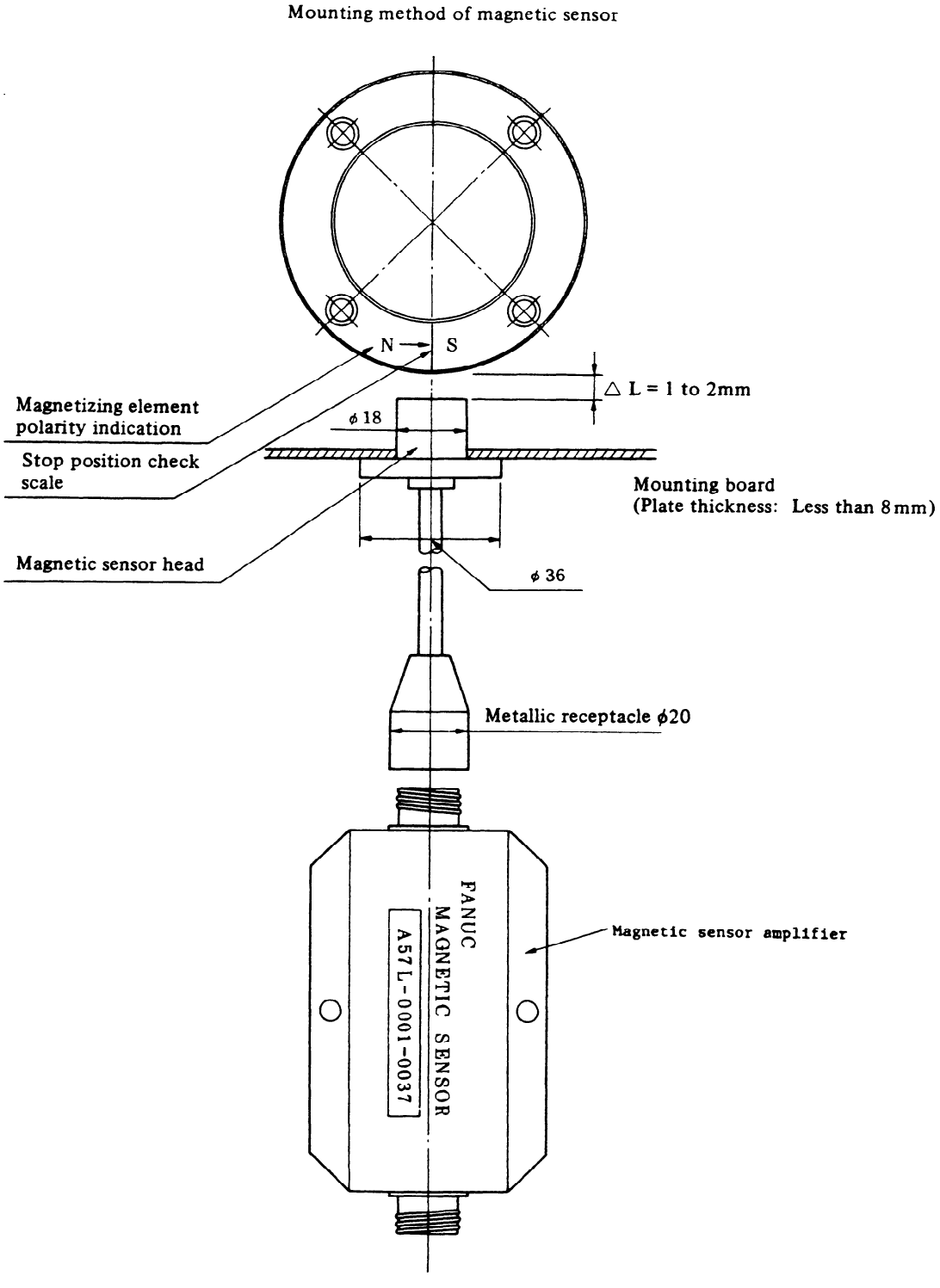


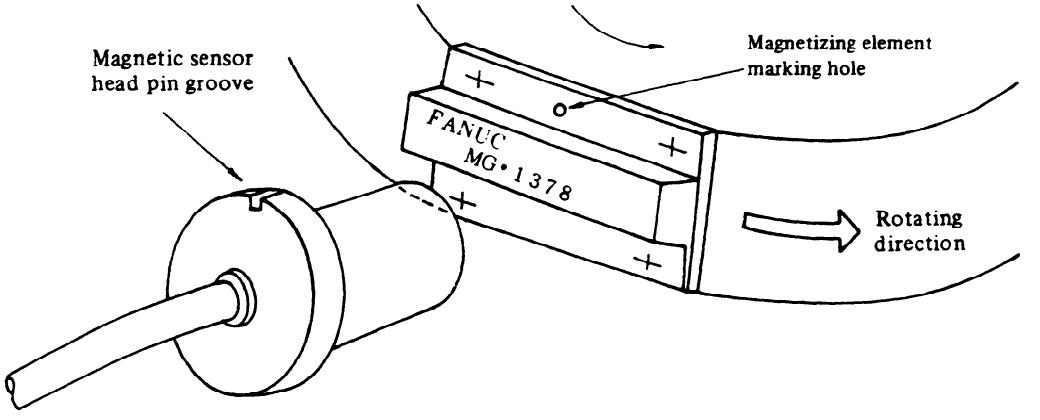
Fig. 7.3 (d) Magnetic sensors mounting example (4) (Q, R, S, T)

(1) Magnetic sensor head pin groove

When a magnetizing element is mounted to the spindle of a machine tool, the polarity is produced between the magnetic element and the magnetic sensor, and the mounting direction differs according to the composition of the spindle (belt transmission, gear coupling, etc.)

For the connection shown in the magnetic sensor interface, arrange the relative positions of the magnetizing element marking hole and pin groove of the magnetic sensor as illustrated below.

If this mounting is wrong, the spindle motor will repeatedly turn in the forward and reverse directions without being stopped.



The spindle motor rotates counterclockwise (CCW) as viewed from the motor shaft by forward rotation command (signal SFR contact ON (closed), speed command VCMD (positive voltage). Arrange the magnetizing element marking hole and the magnetic sensor pin hole face to face by forward rotation command ON, so that the spindle motor rotates in the rotating direction specified in the figure.

7.4 Cautions on Installation

(a) Since the magnetizing element is mounted onto the rotating body of the spindle, be careful not to allow the magnetizing element to be detached by means of centrifugal force.
Limit the circumferential speed of the magnetizing element to lower than 3770m/min (N, P type).
(Take the depth of the screw holes of M4 x 4 into consideration)

(b) Mount the magnetic sensor amplifier as close to the sensor as possible.

(c) Do not allow a magnetic field producing substance to be close to the magnetic sensor (stop position changes). Do not arrange any solenoid in the vicinity of the magnetizing element, in particular.

(d) Be careful not to attach iron powder and other substances sensible to the magnetism to the magnetizing element.

(e) If the spindle is provided with a built-in electromagnetic clutch for HIGH/LOW selection and other parts which may compose a magnetic loop, mount the magnetizing element on a non-magnetic substance (aluminum, etc.) without fail.

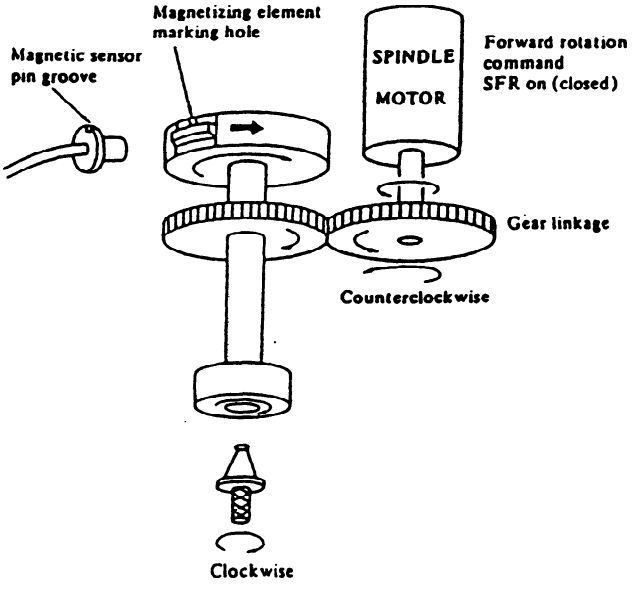
The magnetic flux of the magnetizing element is zero at the stop position. However, if it is affected by a magnetic loop of the electromagnetic clutch, the magnetic flux is added normally when the magnetic clutch is turned on.

It should be carefully noted that if the clutch is turned on and off during the stop at the fixed position, the stop position changes due to a change of the steady-state magnetic flux.

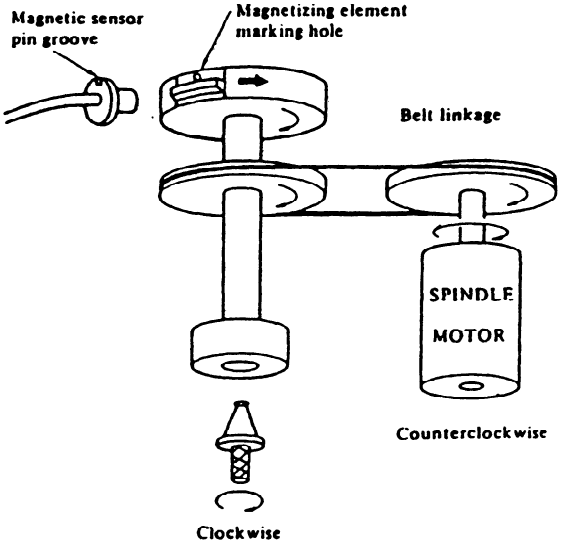
(f) Do not contaminate the magnetic sensor cable, sensor amplifier, and connecting cables with lubrication oil and cutting oil.

(g) Mount the magnetizing element of the magnetic sensor onto the spindle directly.If the magnetizing element is mounted by gear coupling or spindle coupling, the repetition orientation accuracy may fluctuate by a backlash quantity between the spindle and the magnetizing element.

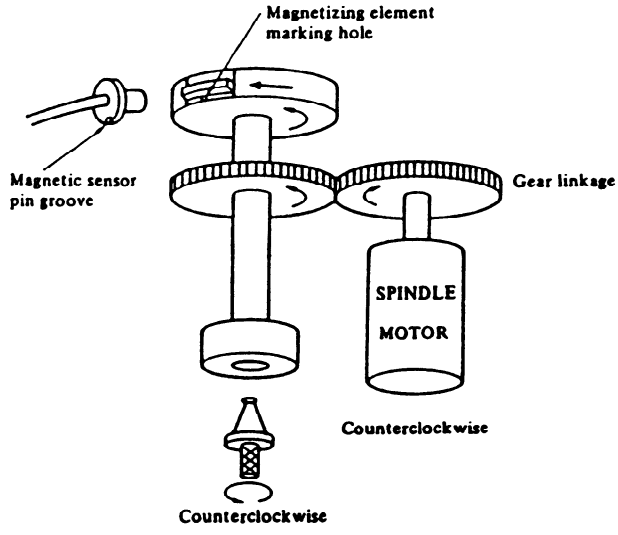
(Installation example 1)



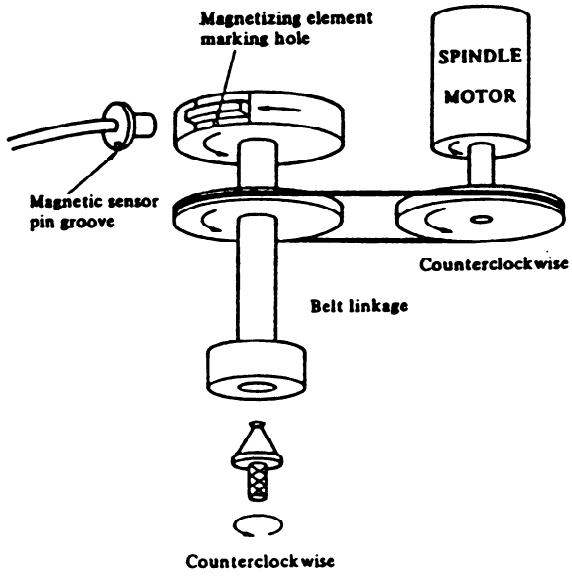
(Installation example 2)



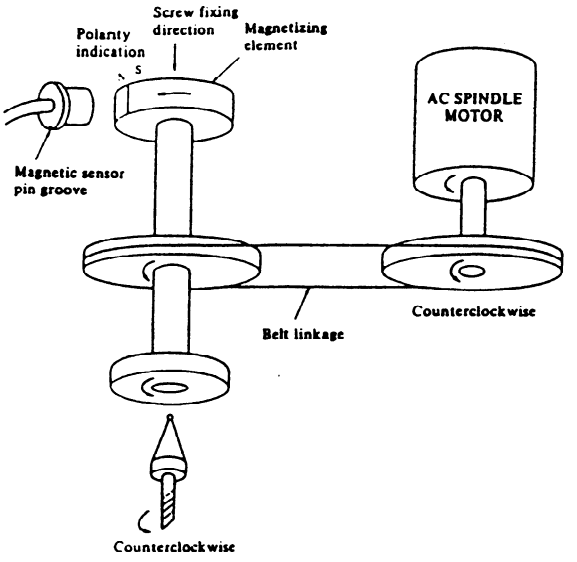
(Installation example 3)



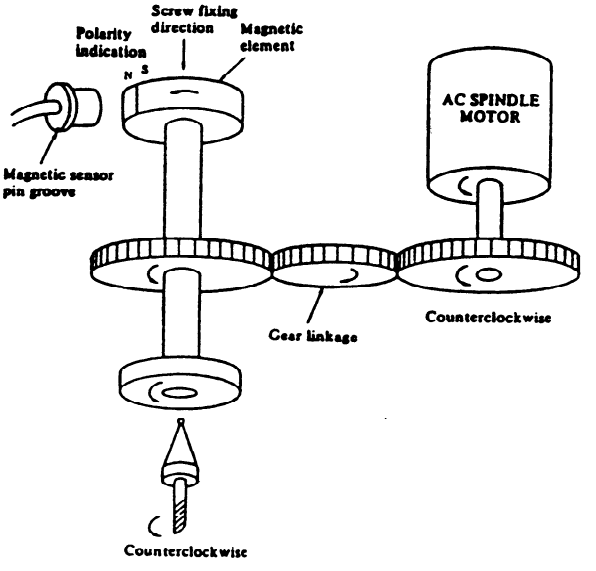
(Installation example 4)



(Installation example 5)



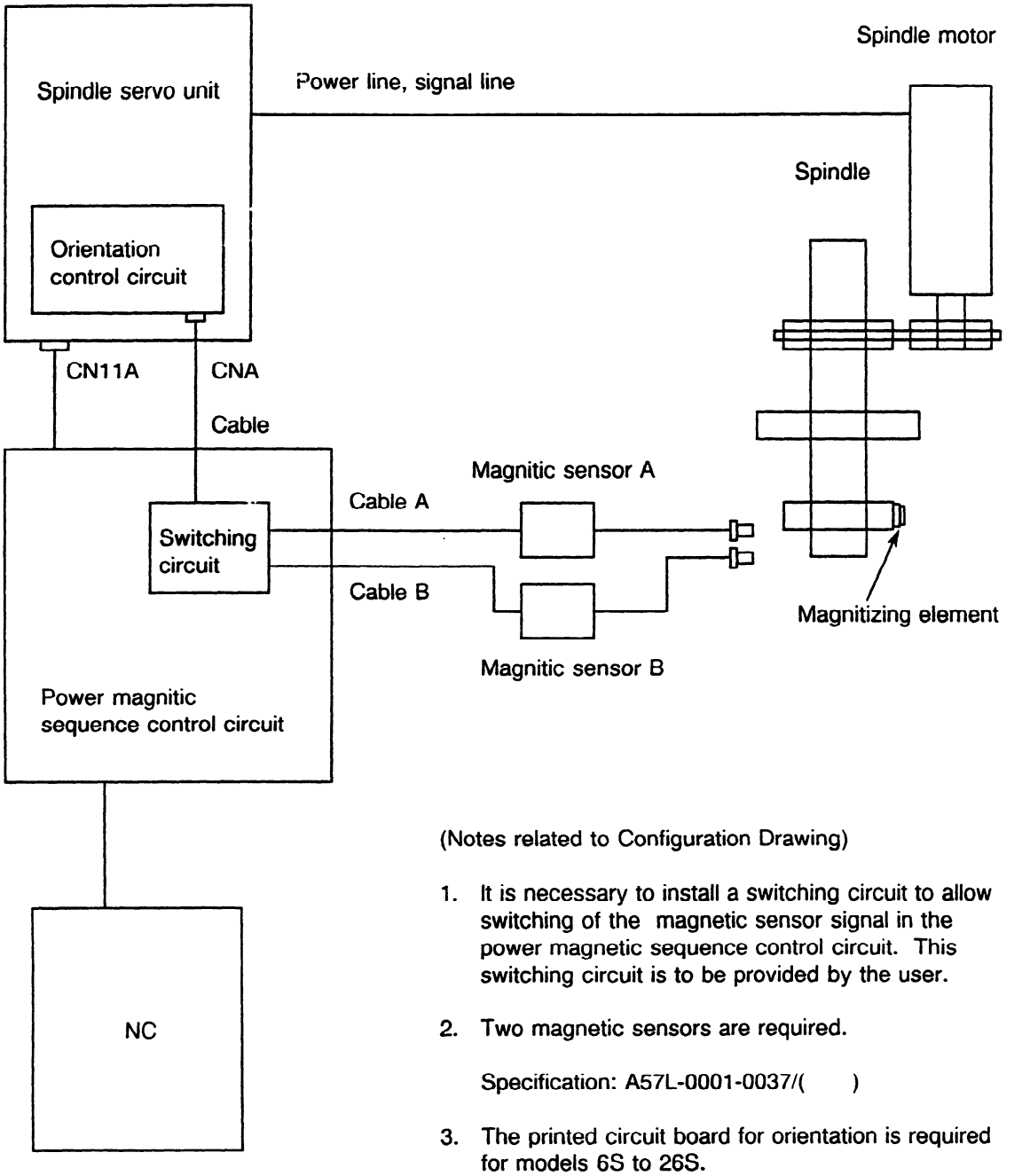
(Installation example 6)



8. TWO-MAGNETIC SENSOR ORIENTATION

According to this chapter, a spindle can be selectively stopped at two different orientated positions by two magnetic sensors.

8.1 Configuration



(Notes related to Configuration Drawing)

1. It is necessary to install a switching circuit to allow switching of the magnetic sensor signal in the power magnetic sequence control circuit. This switching circuit is to be provided by the user.

2. Two magnetic sensors are required.

   Specification: A57L-0001-0037/( )

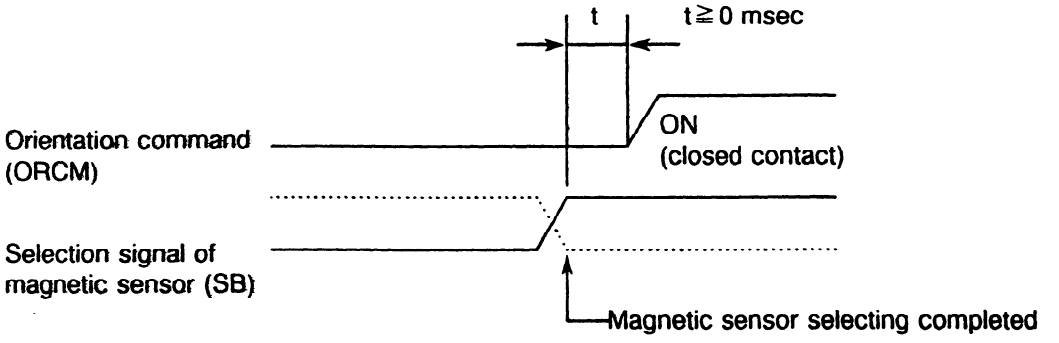
3. The printed circuit board for orientation is required for models 6S to 26S.
   (This board is used in units A06B-6063-H2XX.)

8.2 Change-over Circuit

The change-over circuit is shown in Fig. 8.2.2.
The MSA and LSA signals of the magnetic sensor A and B are transferred to the orientation circuit by shifting them within a change-over circuit.

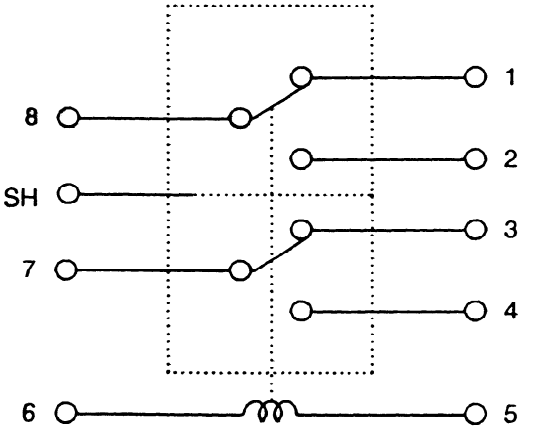
8.2.1 Selection signal of magnetic sensor (SB signal)

When the SB signal is set at HIGH LEVEL, the magnetic signal A is selected. When set at LOW LEVEL, the magnetic sensor B is selected by actuating the relay.
The power +V supplies voltage to the relay solenoid. For changing timing, select the selection signal of magnetic sensor (SB) so that it may be completed before turning ON the orientation command (ORCM) as in the figure below.



8.2.2 Signal change-over relay

(1) Contacting point type
Contacting points for two circuits are switching simultaneously with a single operation coil and contacting point between 1 and 2 (or point 3 and 4) may not be shorted out.



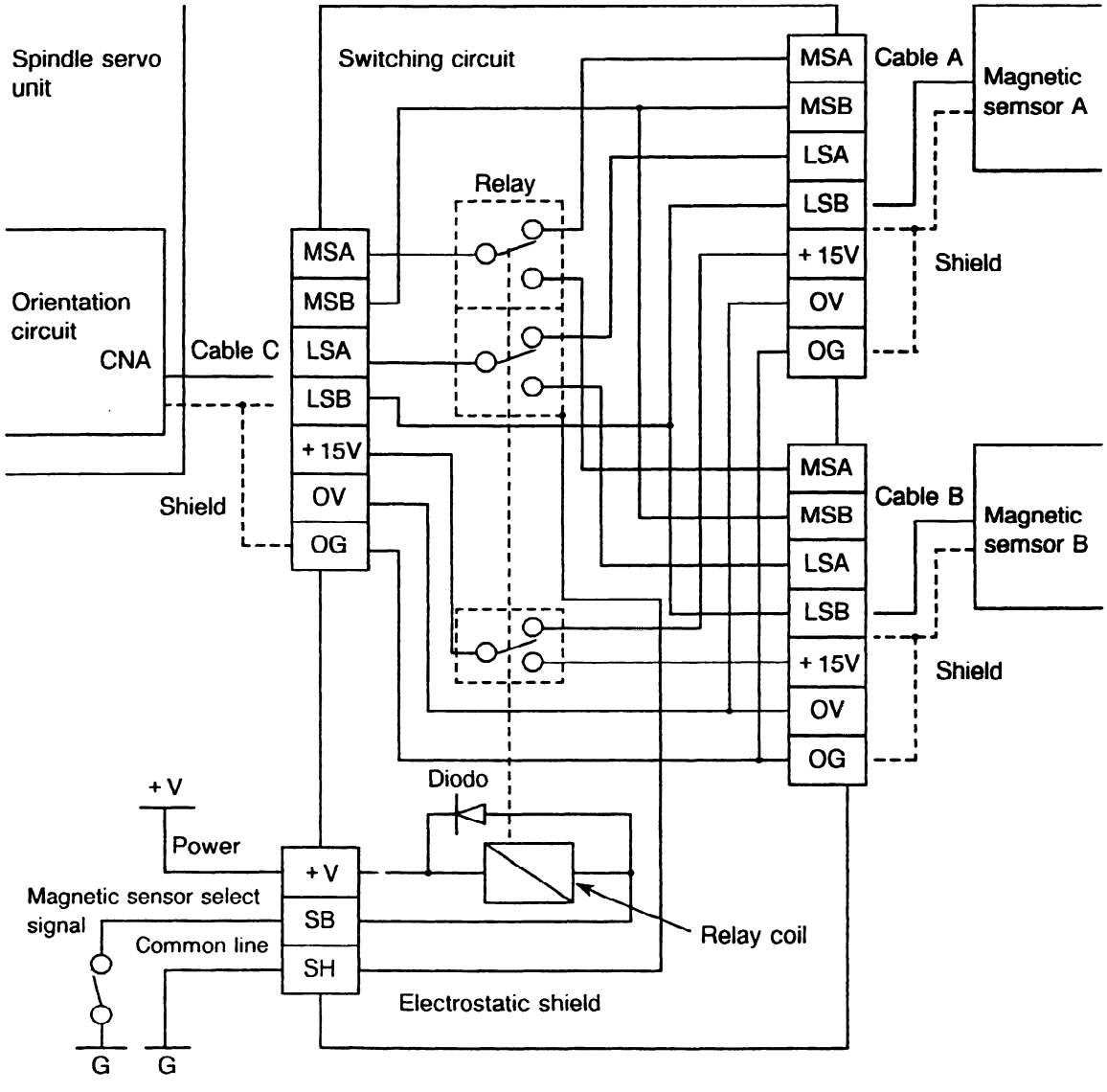
(Note 1) Numbers are given for conve-nience.
(Note 2) The SH terminal is used for shielding statics.

(2) Contact resistance :
100 mL or less

(3) Capacity of contacting point :
1 VA or greater

(4) Switching life of contacting point :
Select according to the actual frequency of use.

Switching circuit interface



Internal wiring of circuit should be as short as possible.

Fig. 8.2.2 Switching Circuit Interface

8.3 Fine Adjustment of Stop Position

In two-magnetic sensors type, design on machine side is required to enable fine adjustment for the other side stop position since fine adjustment for stop position can be done at only one side.