FANUC – NSK SPINDLE UNIT series

DESCRIPTIONS

B-65352EN/02

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Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

SAFETY PRECAUTIONS

FANUC greatly appreciates your purchasing of the FANUC-NSK spindle unit.
This "Safety Precautions" describes the precautions which must be observed to ensure safety when using the spindle unit. The users of the spindle unit are requested to read this manual carefully before using the spindle unit. The users are also requested to read this manual carefully and understand each function of the spindle unit for correct use. The users are basically forbidden to do any behavior or action not mentioned in this manual. They are invited to ask FANUC previously about what behavior or action is prohibited. After reading this manual, the user is requested to store this manual at a place that are accessible to users at all times.

DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

⚠ WARNING
Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

⚠ CAUTION
Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE
The Note is used to indicate supplementary information other than Warning and Caution.

- Read this manual carefully, and store it in a safe place.

WARNING

⚠ WARNING

1 The spindle unit has a powerful built-in motor and is designed for use with a machine tool. The spindle turns with a tool at high speed, and a high voltage is applied to the motor. Take all necessary safety precautions when using the spindle unit. When designing, incorporate a proper interlock mechanism.
2 Be safely dressed when handling a spindle unit.
3 Use a crane or lift to move a spindle unit from one place to another. A spindle unit is heavy.
4 Do not touch a spindle unit with a wet hand. A failure to observe this caution is vary dangerous because you may get electric shocks.
5 Before starting to connect a spindle unit to electric wires, make sure they are isolated from an electric power source. A failure to observe this caution is vary dangerous because you may get electric shocks.
6 Do not bring any dangerous stuff near a spindle unit. If a flammable is placed near a spindle unit, it may be ignited, catch fire, or explode.
7 Be sure to ground a spindle unit frame.
8 Do not ground a power wire terminal or short-circuit it to another power wire terminal.
9 Be sure to secure power wires. A disconnected terminal can result in a grounding fault, short-circuiting, or electric shock.
10 Do not supply the power while any terminal is exposed. A failure to observe this caution is very dangerous because you may get electric shocks.
11 Do not get close to a rotary section of a spindle unit when it is rotating. You may get your clothes or fingers caught in a rotary section, and may be injured. Before starting a spindle unit, ensure that there is no stuff that can fly away on the spindle unit. In particular, be sure to check that the tool holder is securely clamped.
12 Before touching a spindle unit, shut off the power to it.
13 Do not touch any terminal of a spindle unit for a while (at least 5 minutes) after the power to the spindle unit is shut off.
14 To drive a motor, use a specified amplifier and parameters. If a motor is driven with an incorrect amplifier or parameters, an abnormal and dangerous operation can result.
15 When designing and assembling a machine tool, make it compliant with EN60204-1.

CAUTION

⚠ CAUTION

1 Do not touch a spindle unit when it is running or immediately after it stops. A spindle unit may get hot when it is running, and can cause you to get burned.
2 FANUC-NSK spindle units are designed to be used as a spindle with a machine tool. Do not use a FANUC-NSK spindle unit for any other purposes.
3 Ensure that a base or frame on which a spindle unit is mounted is strong enough.
4 Ensure that spindle units and related components are mounted securely.
5 Be sure to connect spindle unit cables correctly. An incorrect connection of a cable cause abnormal heat generation, equipment malfunction, or failure.
6 Do not apply shocks to a spindle unit or cause scratches to it. Otherwise, normal operation may be disabled.
7 Do not disassemble those portions of a spindle unit that are not specified by FANUC. Otherwise, the spindle unit can fail or malfunction.
8 Do not modify a spindle unit. Modifying a spindle unit may cause a failure or trouble in it.
9 Use a spindle unit under an appropriate environmental condition. Using a spindle unit in an adverse environment may cause a failure or trouble in it.
10 Do not apply a commercial power source voltage directly to a motor. Applying a commercial power source voltage directly to a motor may result in its windings being burned. Be sure to use a specified amplifier for supplying voltage to the motor.
11 To use a spindle unit as long as possible, perform periodic maintenance and inspection for it.
12 Warranty does not apply to troubles by not following directions for proper use.

TABLE OF CONTENTS

I. SPECIFICATION

1 FEATURES

The FANUC-NSK spindle unit is designed for use with a machining center and has the features described below.

- The spindle unit has a high-performance induction built-in spindle motor inside, and provides features such as low-speed large torque, high speed and high power, high control precision, and low heat generation by employing a spindle amplifier and spindle control techniques of FANUC.
  (S type: Model B*i*I 112S/20000, L type: Model B*i*I 112L/20000)
- A spindle of high rigidity is made available by employing four bearings at the front and two bearings at the rear, and a position preload structure, thus enabling both low-speed steel cutting and high-speed aluminum cutting.
- The latest grease lubrication system is employed to achieve 15000 min^{-1} and 20000 min^{-1}.
  (20000 min^{-1} model has a grease replenishing unit as standard.)
  - Compared with oil and air lubrication that consumes much factory air, grease lubrication can suppress the running cost.
  - Grease lubrication prevents oil mist from leaking from the spindle, thus contributing to a cleaner factory environment.
  - Grease lubrication, which does not blow air to the bearings, produces low noise even at high-speed rotation.

- User-friendly design that has pursued easiness in use and maintenance to a maximum extent
  - The spindle unit is of cartridge type for easier attachment and detachment.
  - The spindle unit has a drawbar unit, tool unclamp cylinder, tool clamp/unclamp, and drawbar position detection switch as standard.
  - A two-face hold spindle (HSK-A63), flood coolant nozzle, and rotary union for center through coolant are optionally available.
    (HSK-A63 is available only for 20000 min^{-1} models)

2 SPECIFICATIONS

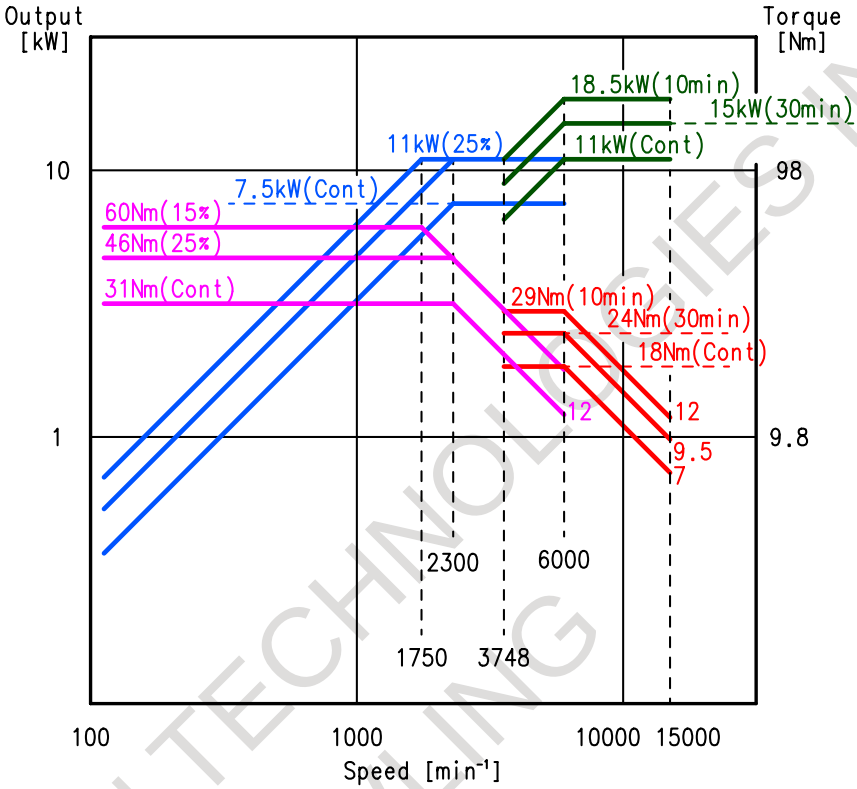
Spindle unit model name		MS112S/15000	MS112S/20000	MS112L/15000	MS112L/20000
Spindle unit specifications					
Major specifications					
	Used with	Machining center		Machining center	
	Mounting direction	Vertical (tool taper on lower side), Horizontal (drain hole on lower side)		Vertical (tool taper on lower side), Horizontal (drain hole on lower side)	
	Maximum speed	15000 min^{-1}	20000 min^{-1}	15000 min^{-1}	20000 min^{-1}
	Rotation direction	Both directions		Both directions	
Major dimensions					
	Outer diameter	ϕ210		ϕ230	
	Weight	120 kg		170 kg	
	Mounting bolt size	M12 $\times$ 6 pieces		M12 $\times$ 6 pieces	
	Mounting bolt PCD	ϕ240, equally spaced		ϕ260, equally spaced	
Motor					
	Model name	B*iI* 112S/20000		B*iI* 112L/20000	
	Output	11/18.5 kW (Continuous/10 min)		18.5/22 kW (Continuous/25%)	
	Torque	60 Nm (S3 15%)		118 Nm (S3 25%)	
Bearings					
	Front	NSK 70BNR series		NSK 70BNR series	
	Rear	NSK 55BNR series		NSK 55BNR series	
Lubrication specifications					
	Lubrication method	Grease	Replenishing grease	Grease	Replenishing grease
	Grease	NSK MTE		NSK MTE	
Rotation precision					
	Test bar swing At the opening	0.003 mm or less		0.003 mm or less	
	Test bar swing 300mm ahead	0.010 mm or less		0.010 mm or less	
Vibration grade		V3 (3μ p-p)		V3 (3μ p-p)	
Axis rigidity					
	Axial rigidity	90 to 120 N/μm	82 to 110 N/μm	90 to 120 N/μm	82 to 110 N/μm
	Radial rigidity	151 N/μm	122 N/μm	149 N/μm	120 N/μm
	Allowable static axial load	34500N		34500N	
Tool shank + pull stud					
	JIS B6339(MAS403)	Tool shank: 40T Pull stud: 40P		Tool shank: 40T Pull stud: 40P	
	DIN69871	Tool shank: #40 Pull stud: #40		Tool shank: #40 Pull stud: #40	

Spindle unit model name		MS112S/15000	MS112S/20000	MS112L/15000	MS112L/20000
Peripheral equipment					
Tool clamp mechanism (For details, see Chapter 5 in Part II.)					
	Cylinder drive source	Hydraulic		Hydraulic	
	Cylinder capacity	55.3 cc		55.3 cc	
	Clamping force (BT/HSK)	10000 N / 18000 N		10000 N / 18000 N	
	Unclamping force (reference)	30200 N		30200 N	
	Hydraulic pressure	6.0 to 6.5 MPa (Clamp 0.5 to 6.5 MPa)		6.0 to 6.5 MPa (Clamp 0.5 to 6.5 MPa)	
	Hydraulic fluid viscosity	ISO VG32		ISO VG32	
Cooling specifications					
	Coolant	Oil-cooled (Water is unusable.)		Oil-cooled (Water is unusable.)	
	Required cooling power	(4000W)		(4000W)	
	Temperature control method	Controlled to room temperature + 2°C. Feed oil temperature control		Controlled to room temperature + 2°C. Feed oil temperature control	
	Cooling oil viscosity	ISO VG2		ISO VG2	
	Joint diameter	Rc1/4		Rc1/4	
	Factory-set cooling channel	Parallel (stator periphery, bearing periphery)		Parallel (stator periphery, bearing periphery)	
Air supply					
	Required amount of air	50Nl/min		50Nl/min	
	Air quality	Clean air containing no water and impurities		Clean air containing no water and impurities	
	Taper air blow pressure	0.3 MPa (Joint diameter: Rc1/4)		0.3 Mpa (Joint diameter: Rc1/4)	
	Air seal pressure	0.05 MPa (Joint diameter: Rc1/4)		0.05 Mpa (Joint diameter: Rc1/4)	
Coolant		Water-soluble and oil-soluble only (Synthetic coolants are unusable.)		Water-soluble and oil-soluble only (Synthetic coolants are unusable.)	
Usable temperature range		20°C ± 10°C		20°C ± 10°C	
Tool clamp/unclamp detection switch		BALLUFF BR3-0801D × 2 pieces		BALLUFF BR3-0801D × 2 pieces	
Tool presence/absence detection switch		BALLUFF BES M08MG-GSC20B-BP03		BALLUFF BES M08MG-GSC20B-BP03	
Options					
Two-face hold (ISO12164-1) 20000 min^{-1} models only		-	HSK-A63	-	HSK-A63
Clamp error detection switch		-	BALLUFF BR5-0801D1	-	BALLUFF BR5-0801D1
Center through coolant (Rotary joint)		Maximum usable pressure 7.0 MPa (Joint diameter: Rc3/8)		Maximum usable pressure 7.0 MPa (Joint diameter: Rc3/8)	
Flood coolant		6 Nozzles ; inner diameter ϕ3		6 Nozzles ; inner diameter ϕ3	

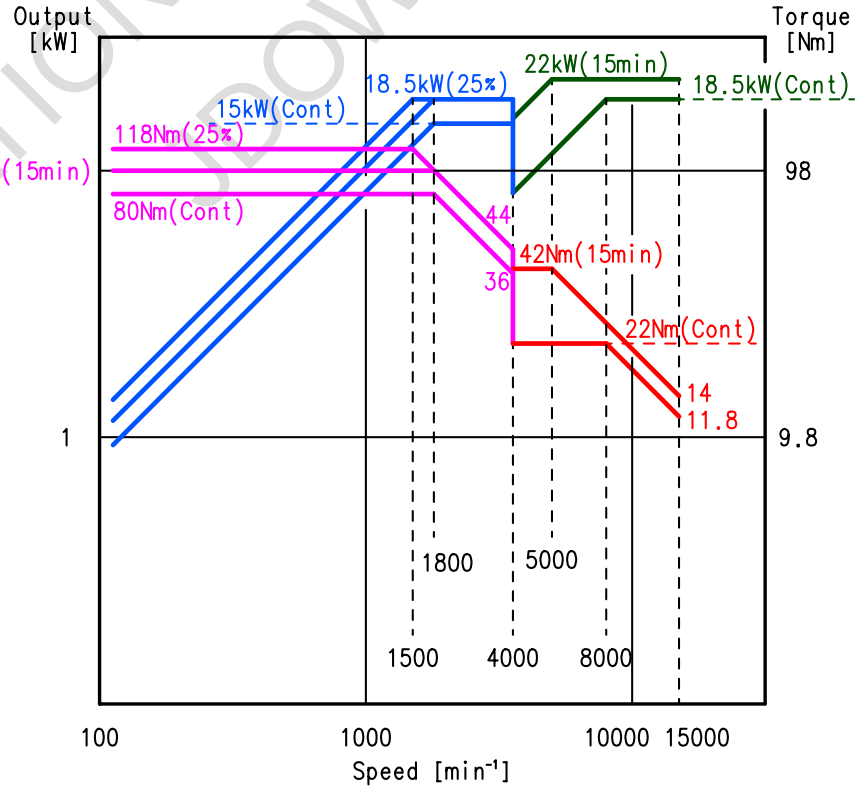
3 OUTPUT CHARACTERISTICS

3.1 15000 min^{-1}

S type (11/18.5kW)

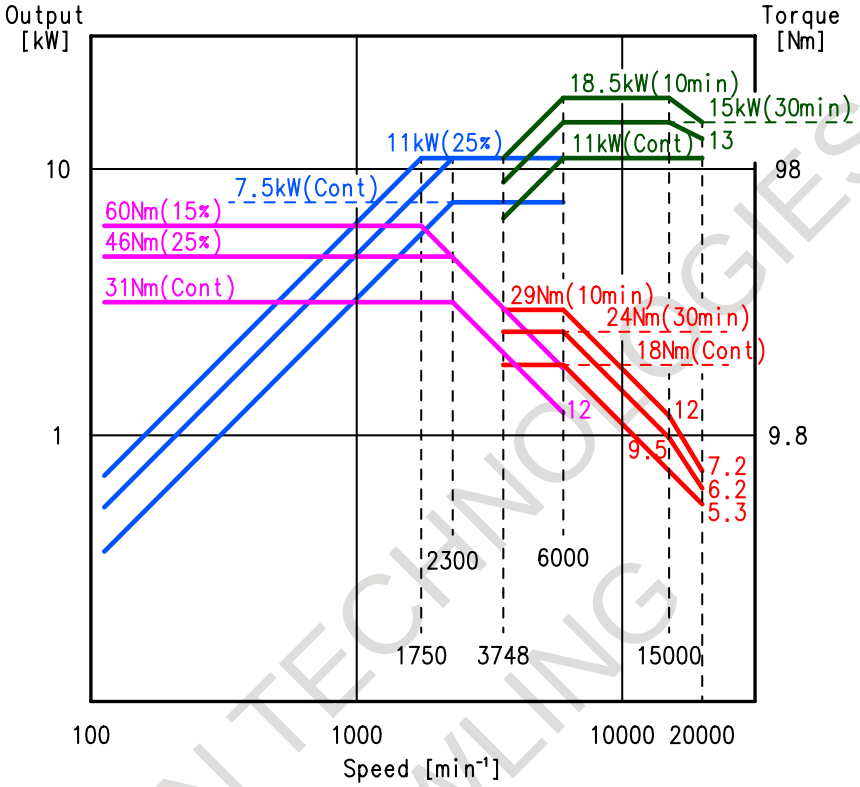


L type (18.5/22kW)

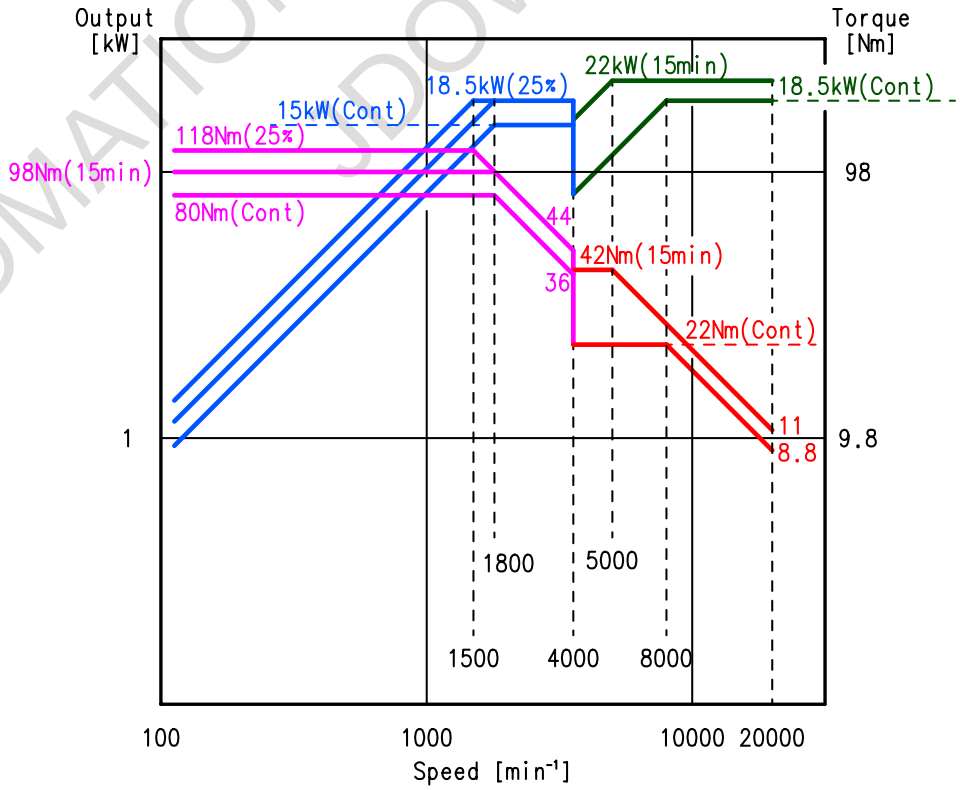


3.2 20000 min^{-1}

S type (11/18.5kW)



L type (18.5/22kW)



3.3 SPINDLE AMPLIFIER / MAXIMUM POWER AT ACCELERATION

S type (15000 min^{-1}, 20000 min^{-1})

Amplifier

αiSP 30 (TYPE A)

A06B-6111-H030#H550 (for FS15*i*, FS16*i*)

A06B-6111-H030#H570 (for FS30*i*)

Maximum power at acceleration

24.4 kW (Reference data for choice of αiPS , not guaranteed)

L type (15000 min^{-1}, 20000 min^{-1})

Amplifier

αiSP 30 (TYPE A)

A06B-6111-H030#H550 (for FS15*i*, FS16*i*)

A06B-6111-H030#H570 (for FS30*i*)

Maximum power at acceleration

27.9 kW (Reference data for choice of αiPS , not guaranteed)

4 EXTERNAL DIMENSIONS

Model name	Drawing No.
MS112S/15000 (BT-40)	Fig. 4(a)
MS112S/20000 (BT-40)	Fig. 4(b)
MS112L/15000 (BT-40)	Fig. 4(c)
MS112L/20000 (BT-40)	Fig. 4(d)
MS112S/20000 (HSK-A63)	Fig. 4(e)
MS112L/20000 (HSK-A63)	Fig. 4(f)
MS112L/20000 (HSK-A63, flood coolant , center through coolant)	Fig. 4(g)

For external dimensions not described here, please contact FANUC.

Fig. 4(a) MS112S/15000 (BT-40)

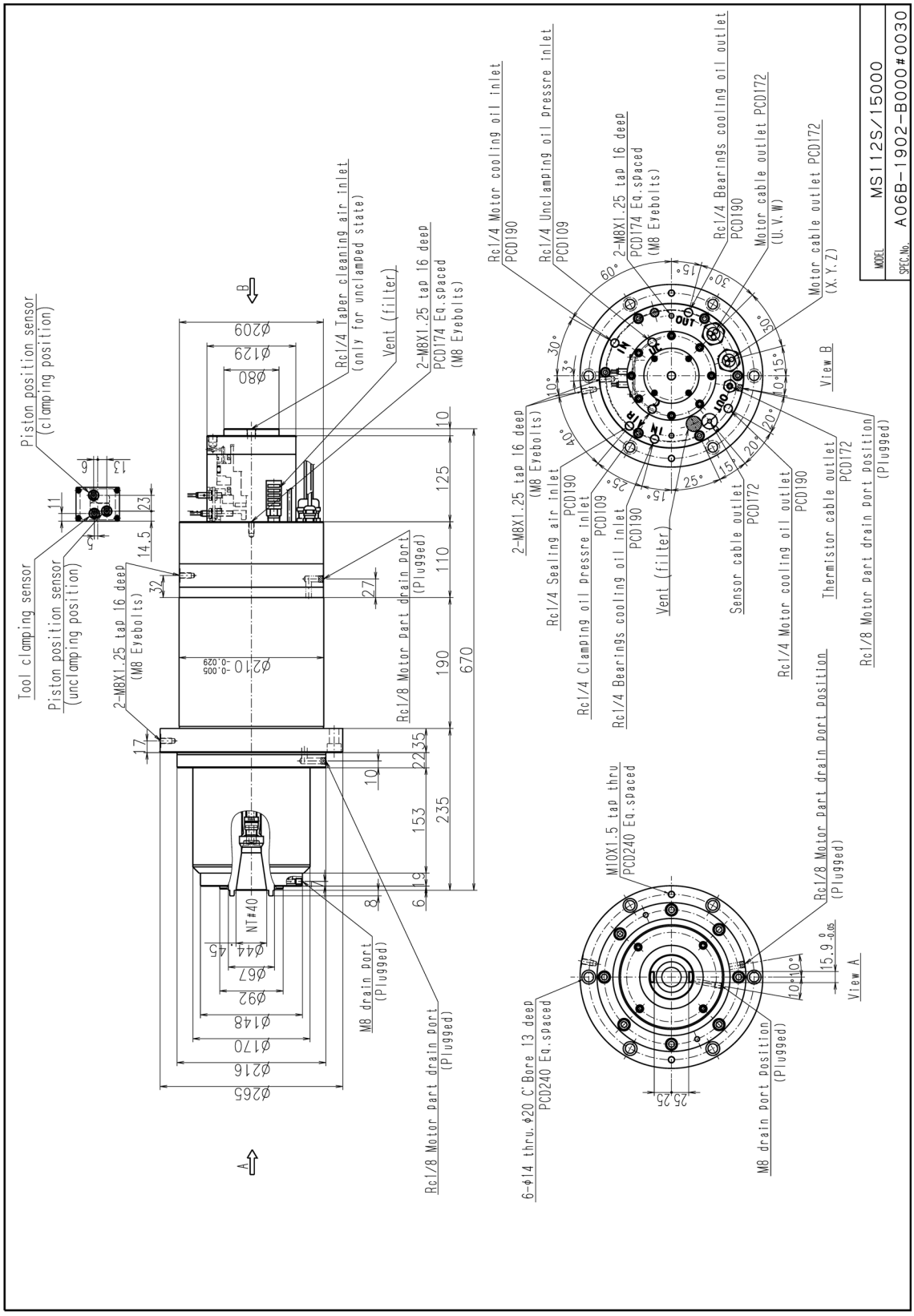


Fig. 4(b) MS112S/20000 (BT-40)

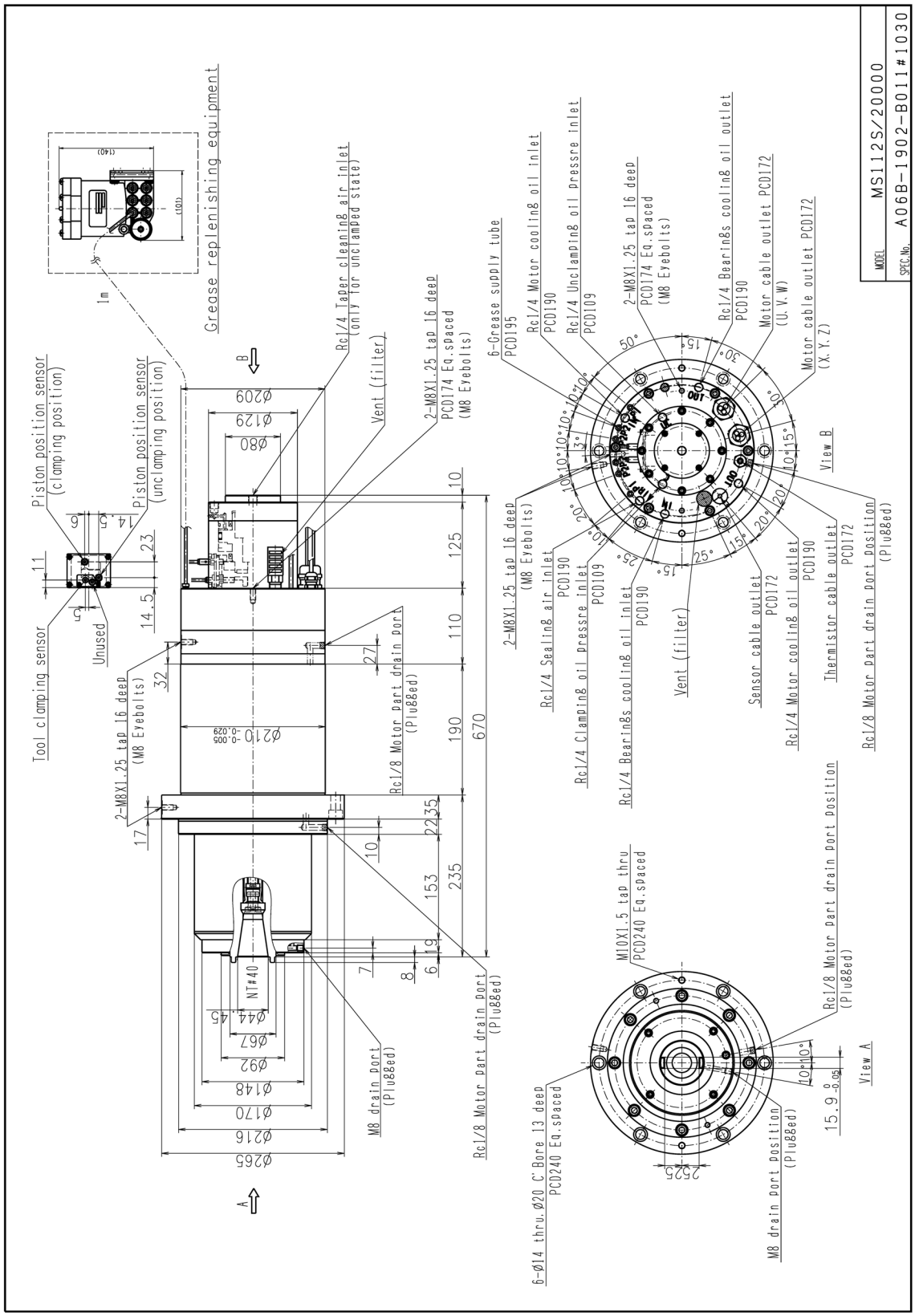


Fig. 4(c) MS112L/15000 (BT-40)

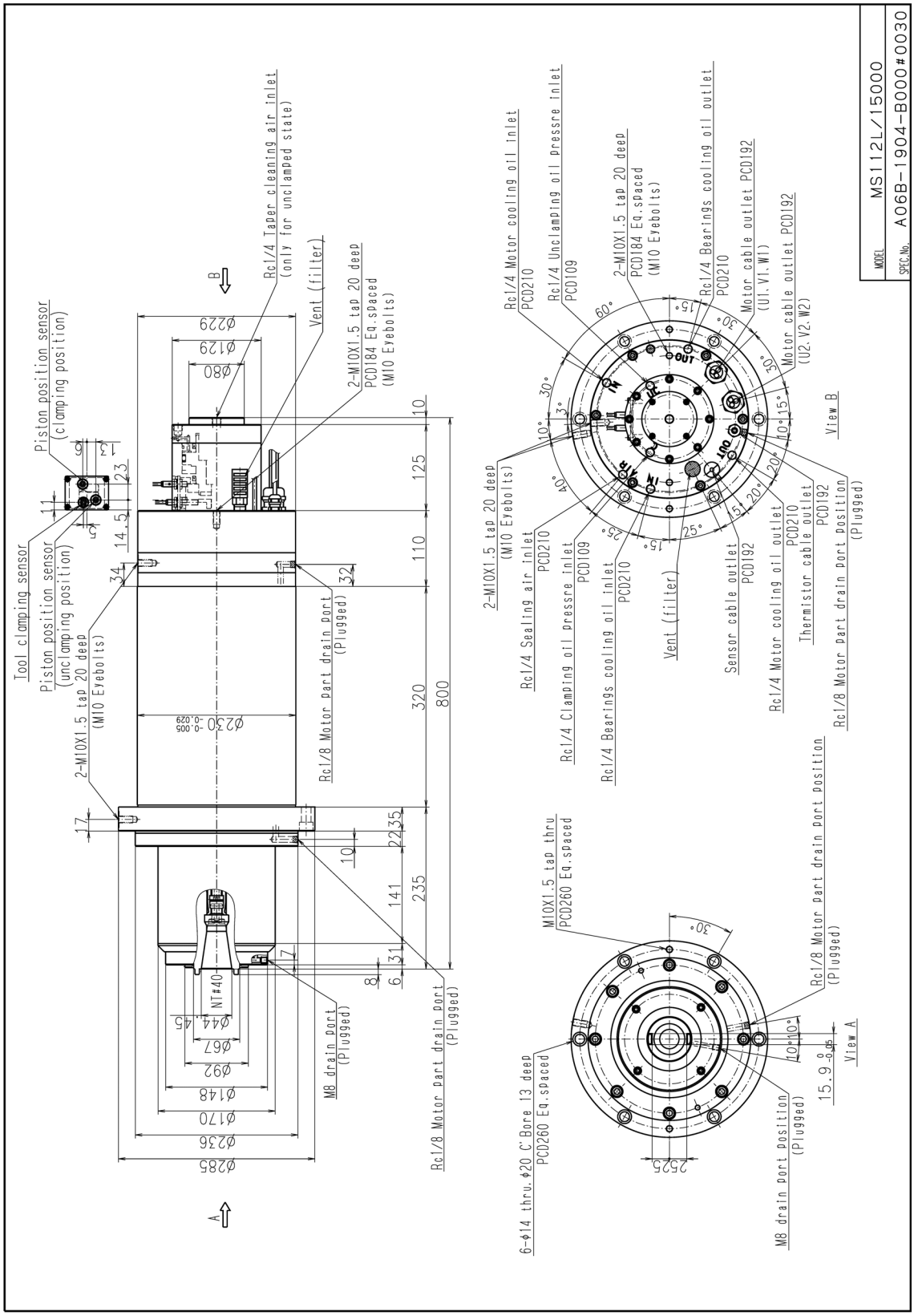


Fig. 4(d) MS112L/20000 (BT-40)

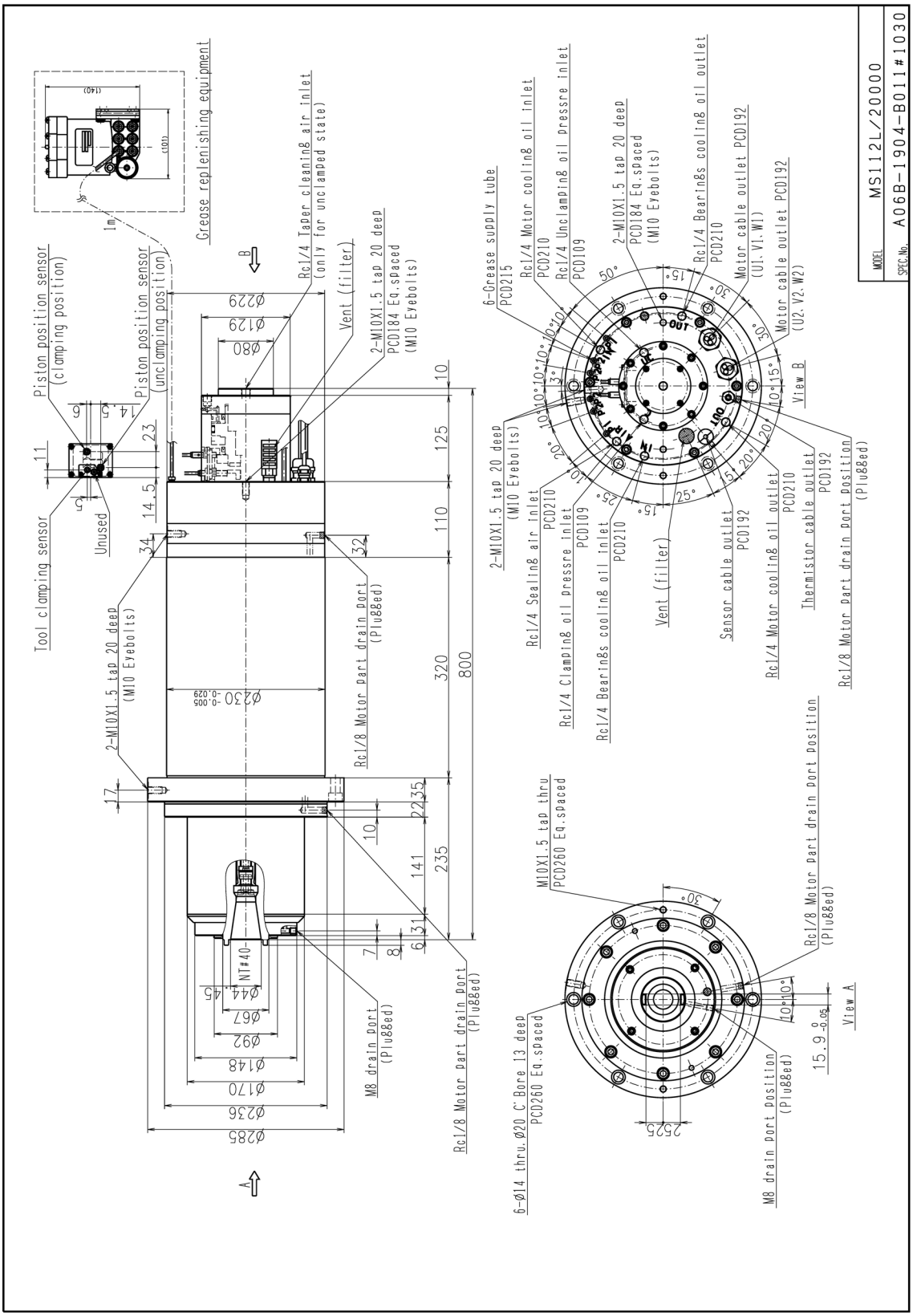


Fig. 4(e) MS112S/20000 (HSK-A63)

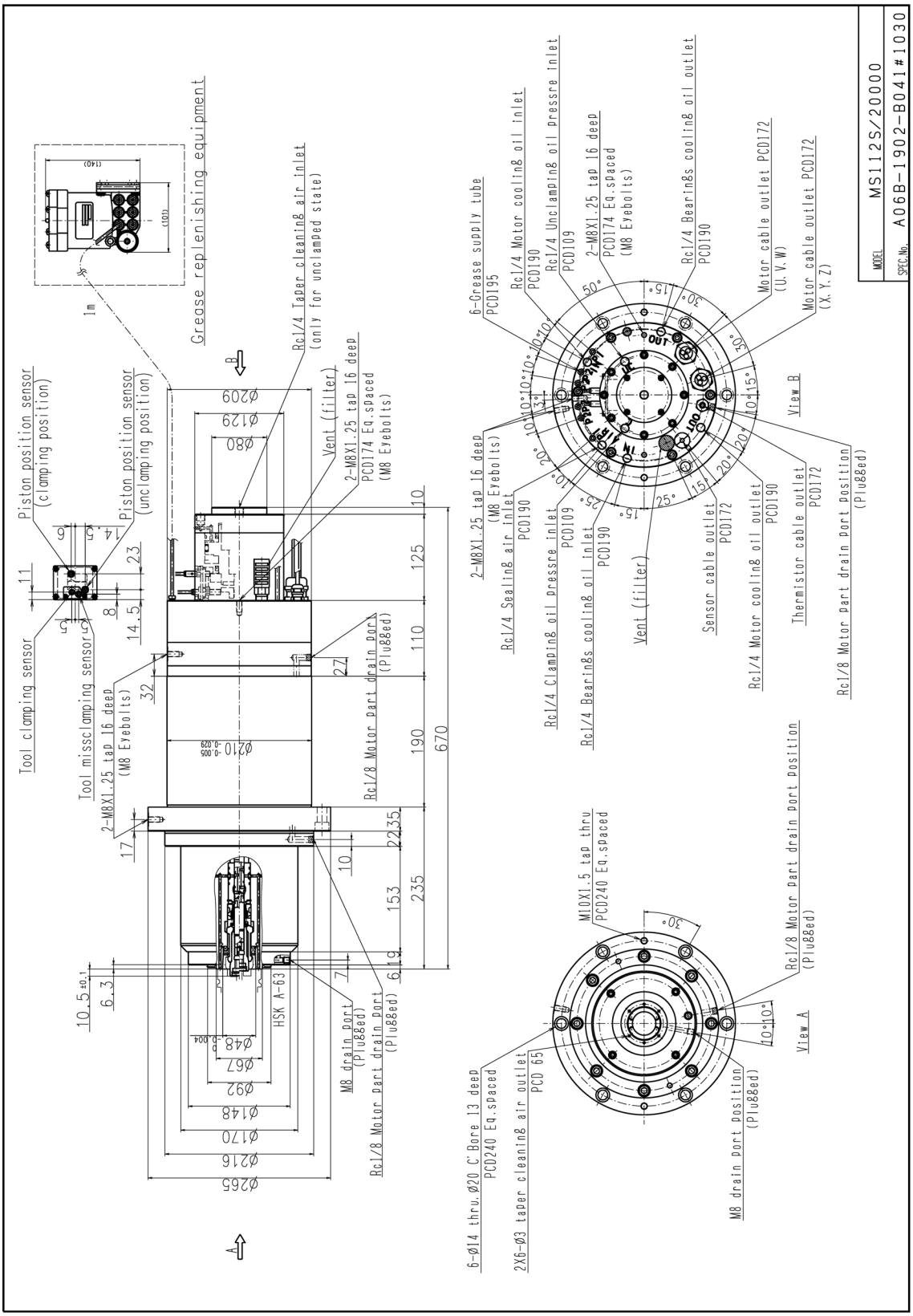


Fig. 4(f) MS112L/20000 (HSK-A63)

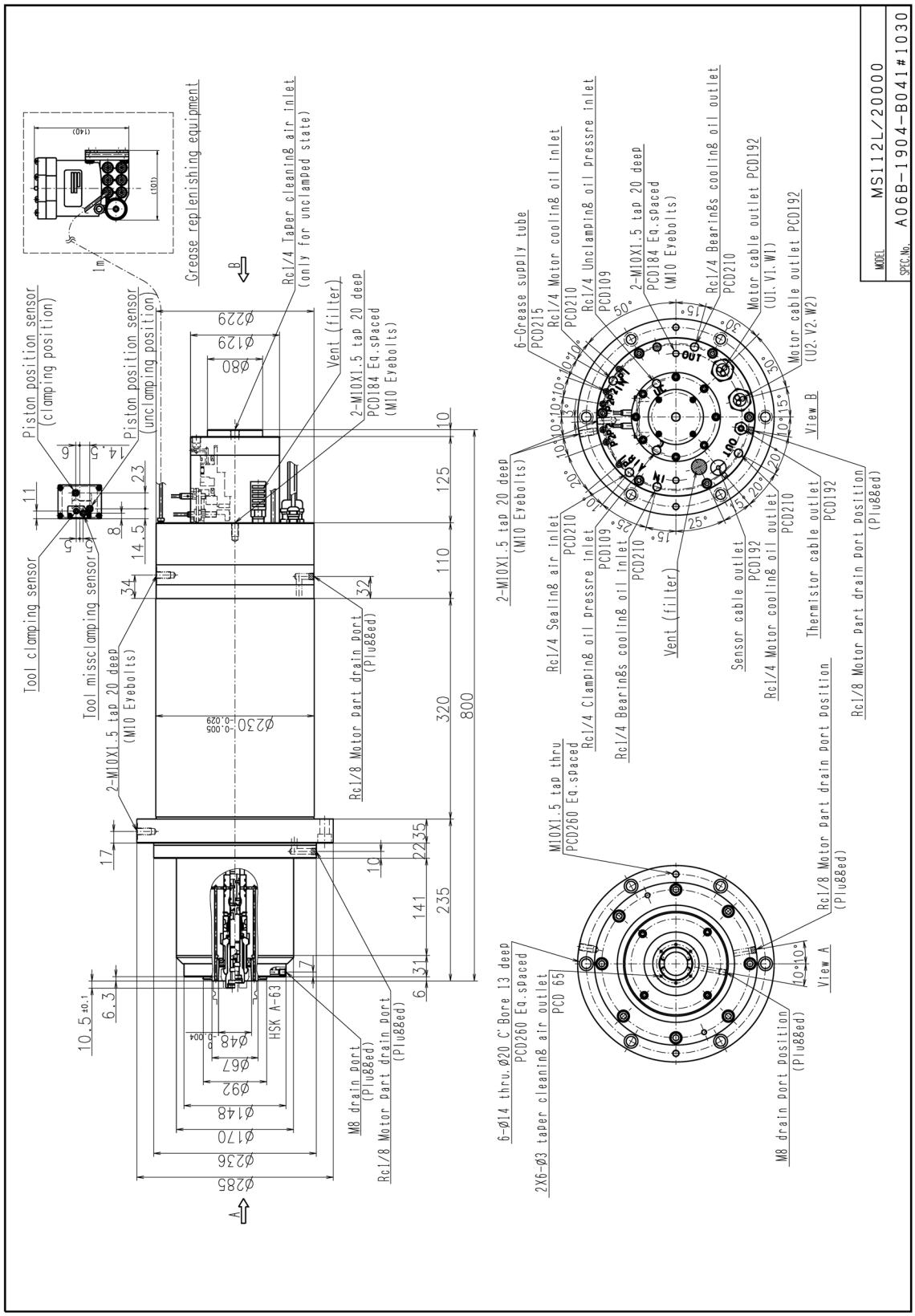
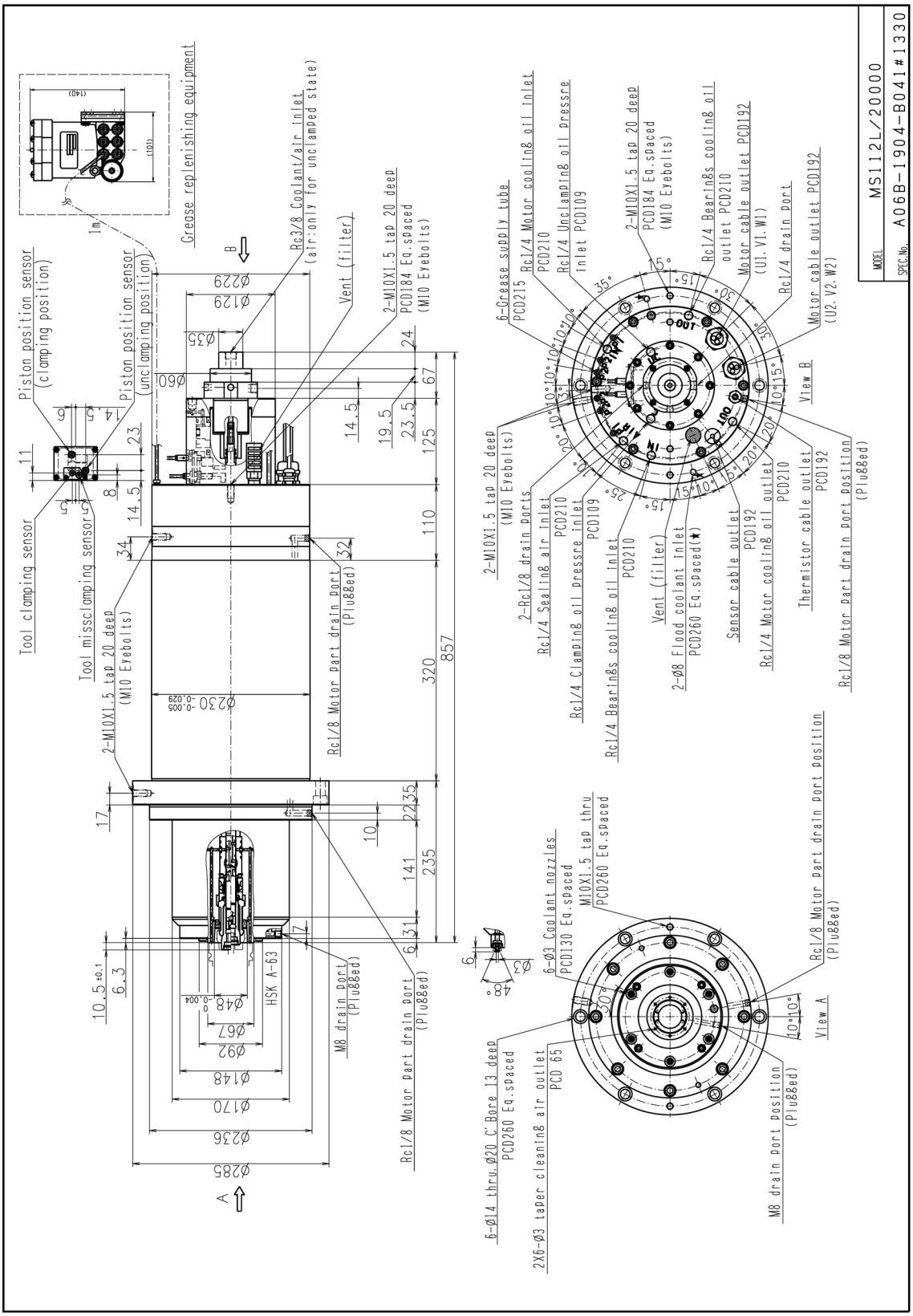


Fig. 4(g) MS112L/20000 (HSK-A63, flood coolant, center through coolant)

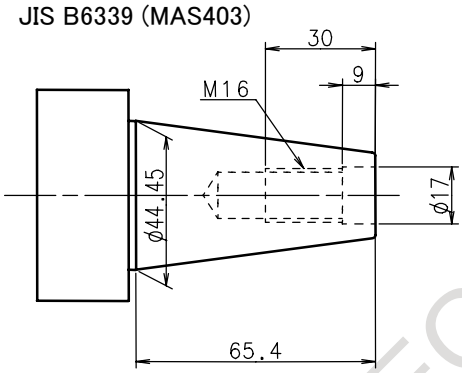


5 TOOL HOLDERS AND PULL STUDS

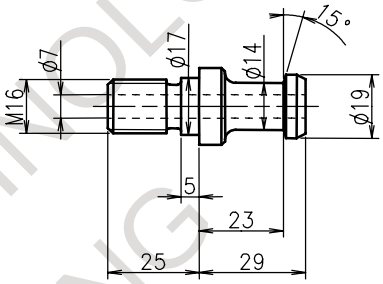
Tool holders and pull studs usable with the FANUC-NSK spindle unit are described below.
Use balanced tool that matches the speed. Moreover, be sure to use the tool within the allowable speed specified by the tool supplier.

〔BT40〕

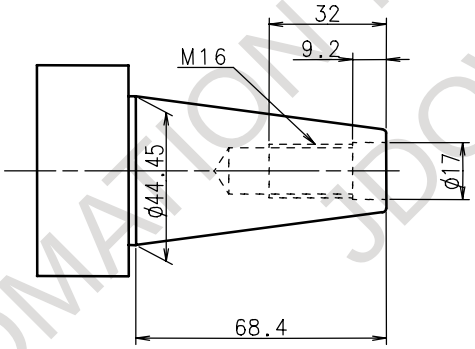
JIS B6339 (MAS403)



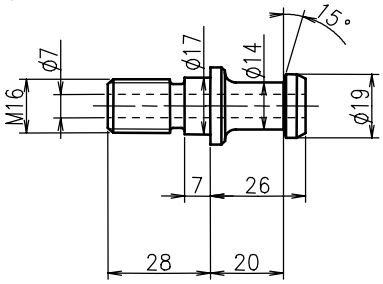
JIS B6339



DIN 69871

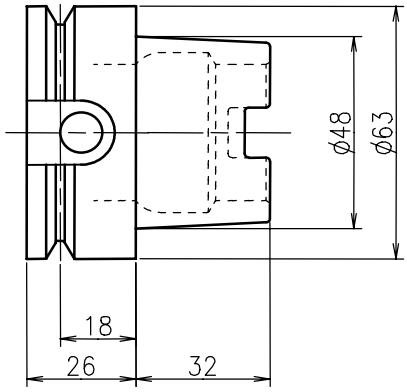


DIN 69872



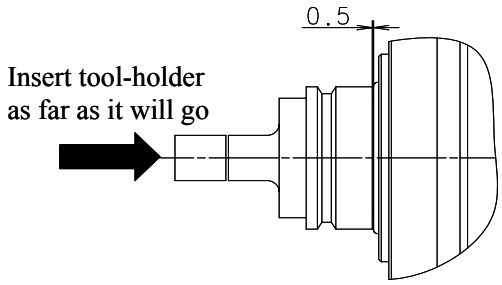
〔HSK-A63〕

ISO 12164-1

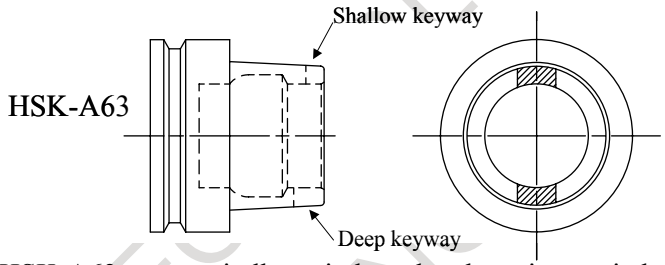


Caution in using HSK-A63

In case of changing HSK-A63 tool manually, the clearance between tool-holder and spindle nose face will be 0.5mm if a tool-holder is inserted correctly as far as it goes.

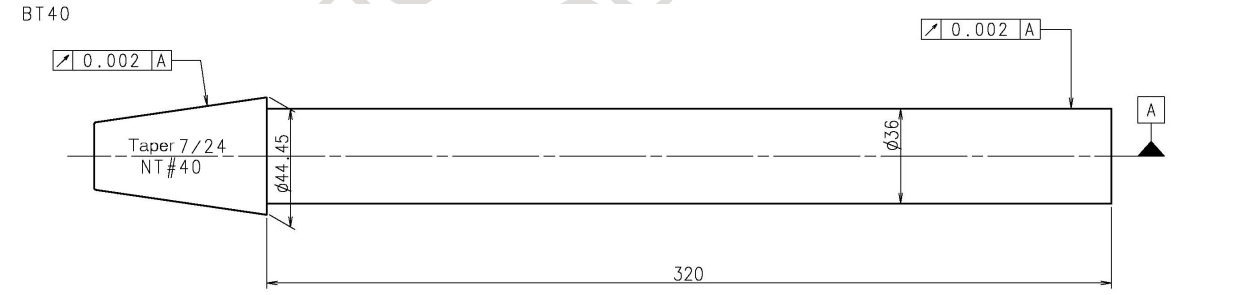


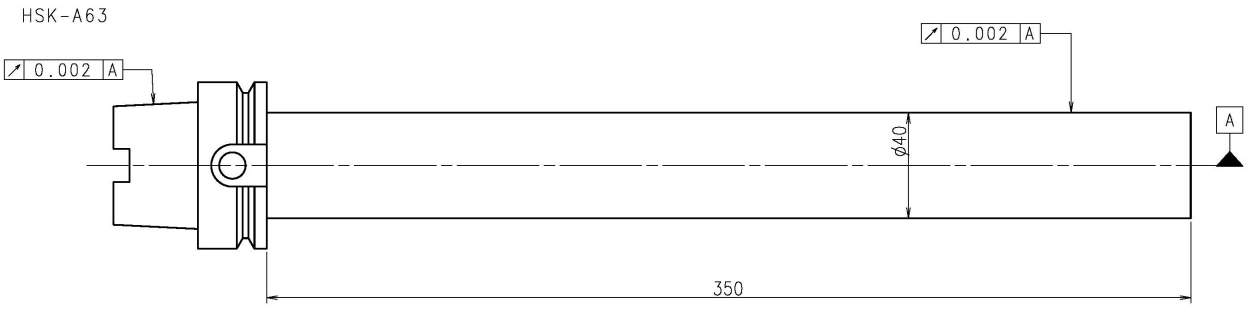
HSK tool holder has two keyways with different depth. If they are clamped incorrectly or misclamped, there will be a danger that tool-holder may be detached from spindle during rotation of spindle.



HSK-A63 type spindle unit has the detection switch which senses these clamping error. Be sure to use the clamp error detection switch and sense the clamp error alarm.

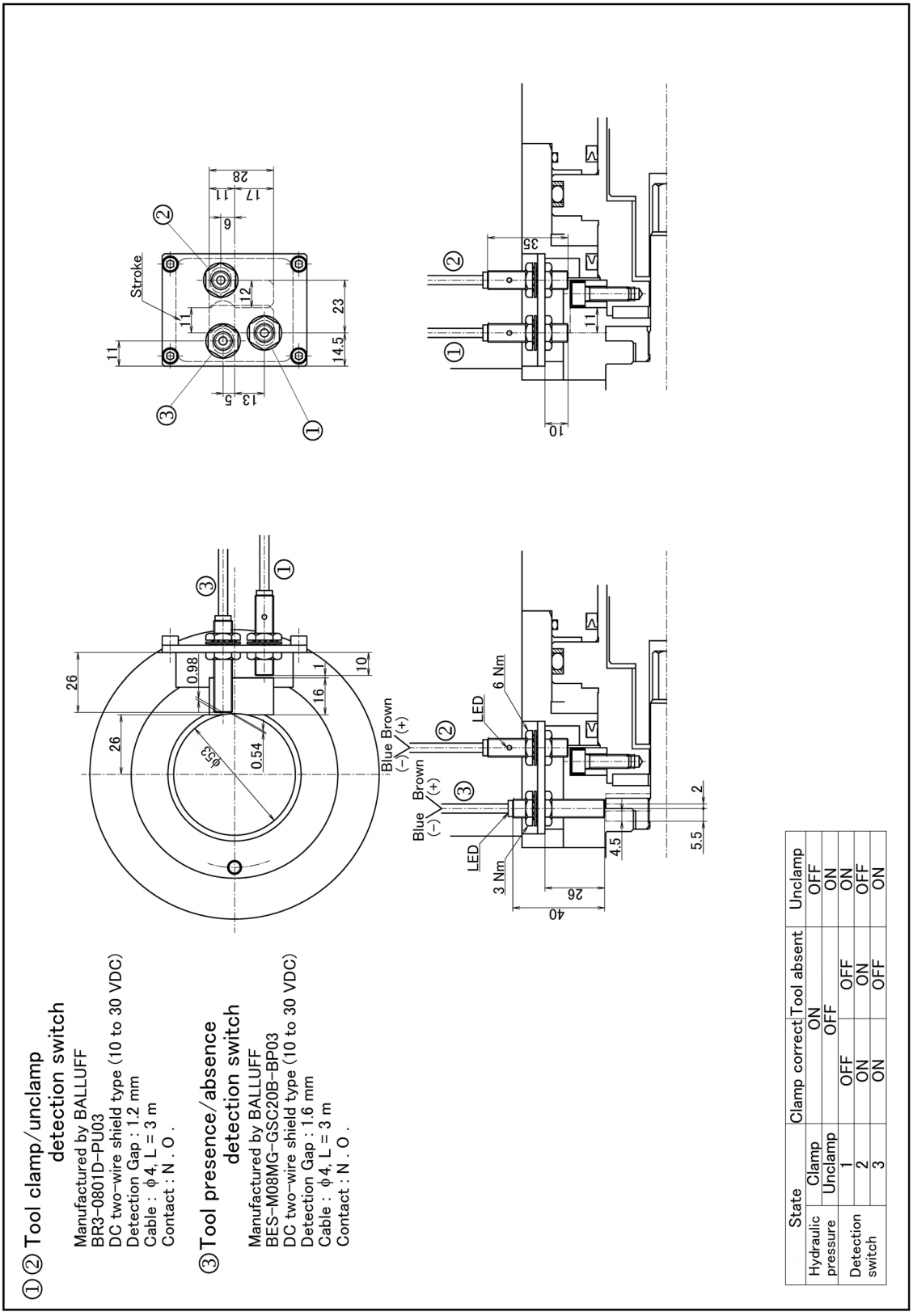
Reference) Test bar



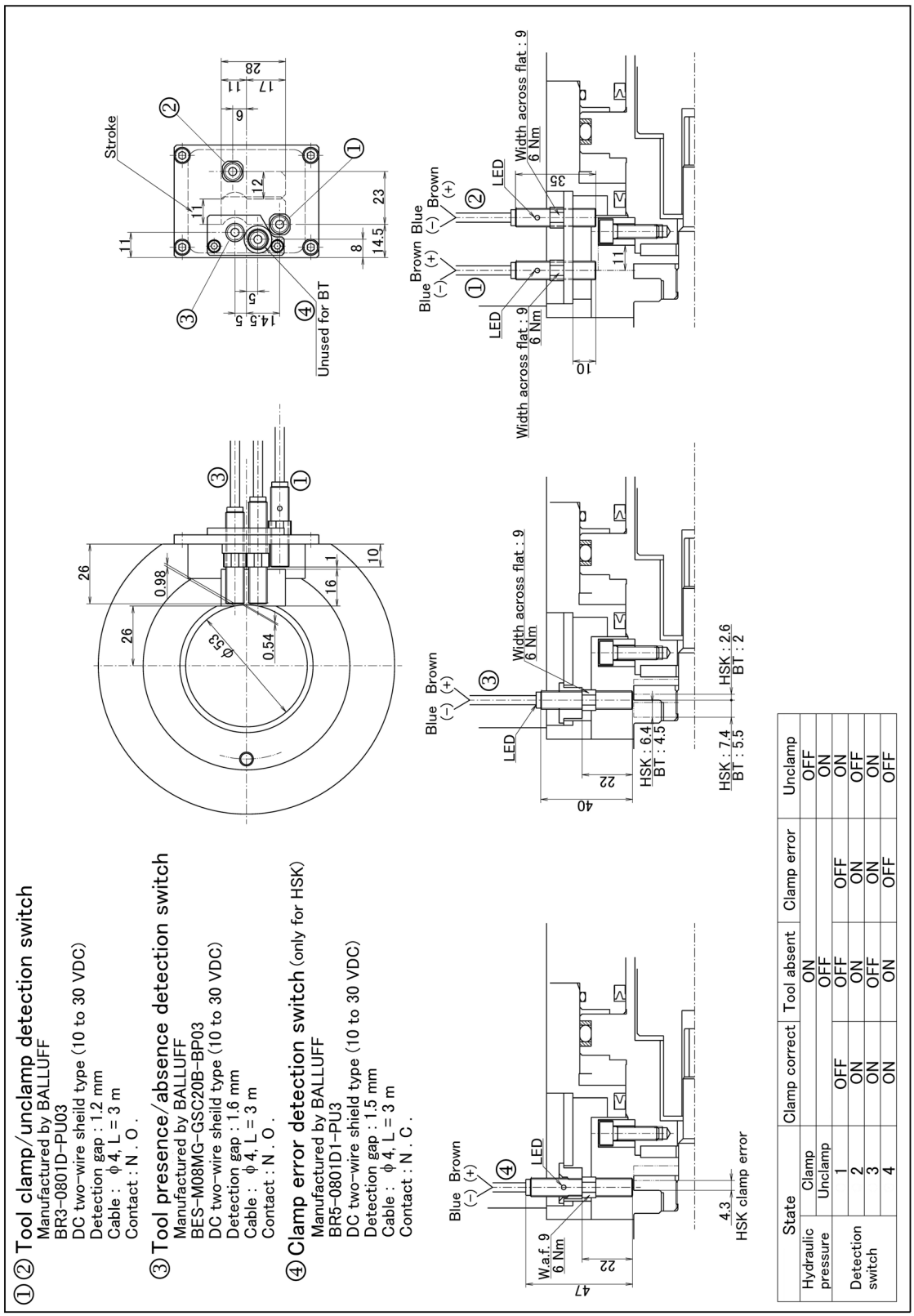


6 DETECTION SWITCHES

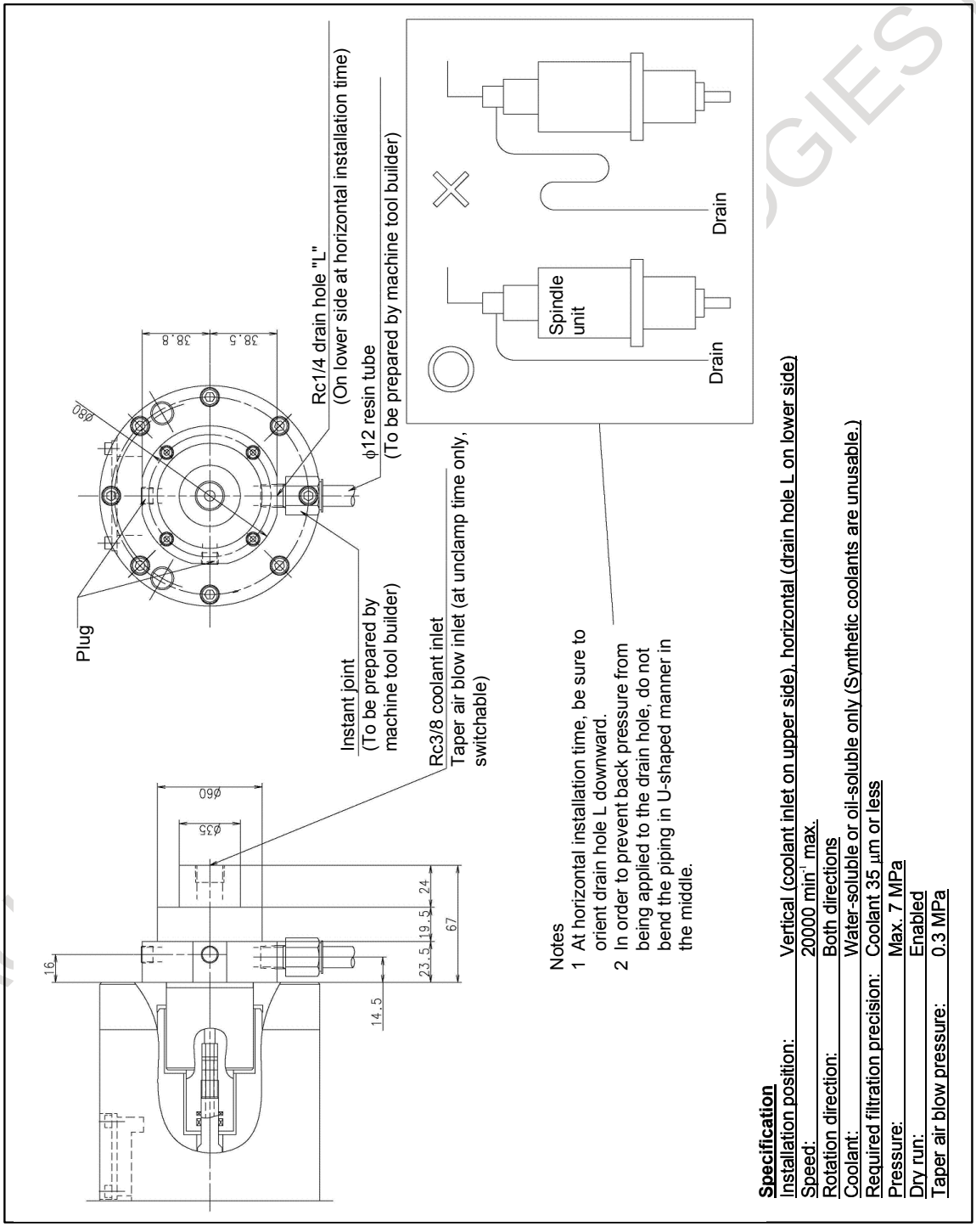
6.1 15000 min^{-1}



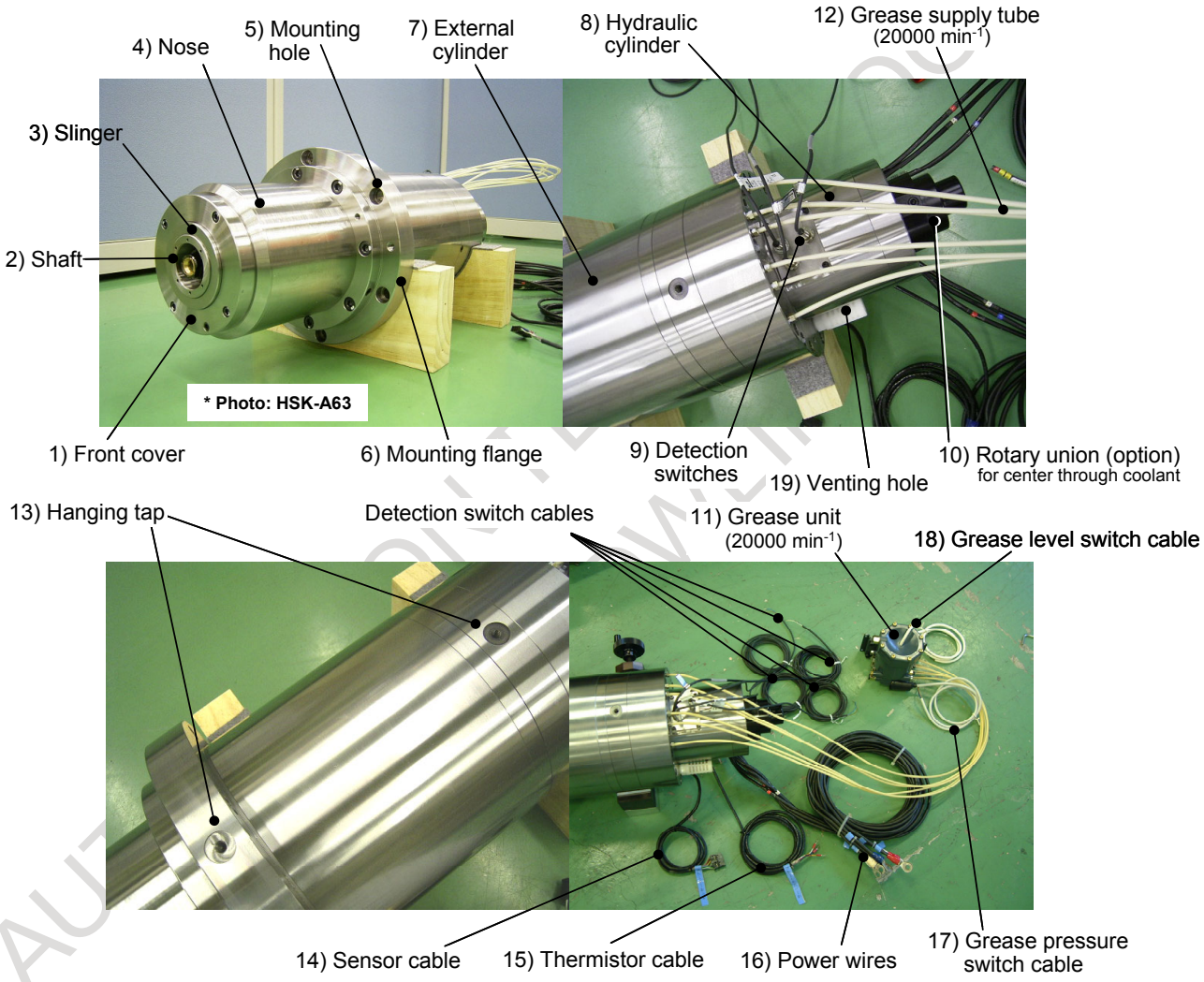
6.2 20000 min^{-1}



7 CENTER THROUGH COOLANT (OPTION)



8 COMPONENTS

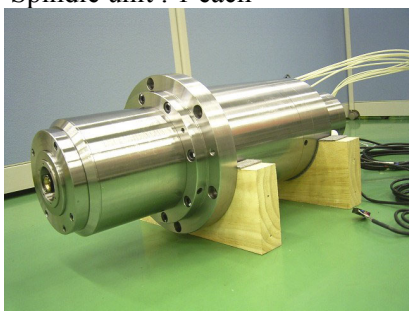


No.	Name	Function
1	Front cover	Prevents dust and coolant from entering the spindle unit.
2	Shaft	Tool holder should be attached.
3	Slinger	Rotates with the shaft to repel dust and coolant.
4	Nose	Placed outside the head cover to serve as a spindle projection.
5	Mounting hole	Bolt hole used to secure the spindle unit to the main machine body (spindle head).
6	Mounting flange	Flange used to secure the spindle unit to the main machine body (spindle head).
7	External cylinder	Mated into the hole of the main machine body (spindle head).
8	Hydraulic cylinder	Used to clamp/unclamp a tool.
9	Detection switches	Detects the hydraulic cylinder upper/lower limit and the presence/absence of a tool holder.
10	Rotary union (option)	Connects piping for center through coolant.
11	Grease unit (20000 min^{-1})	Lubrication equipment for supplying grease to the bearings.
12	Grease supply tube (20,000 min^{-1})	Tube used to supply grease to the bearings.
13	Hanging tap	Used with an eyebolt to lift the spindle unit.
14	Sensor cable (Approx. 1.0 m)	Detects the motor speed and one-rotation signal.
15	Thermistor cable (Approx. 1.8 m)	Detects the motor temperature.
16	Power wires (Approx. 1.8 m)	Supplies power to the motor.
17	Grease pressure switch cable	Detects the pressure inside the tank of the grease unit.
18	Grease level switch cable	Detects a shortage of the remaining amount of grease in the grease unit.
19	Venting hole	Air venting hole for ventilation inside the spindle unit

9 PACKAGE

The package contains the items indicated below. At the time of unpacking, check that all of the items below are contained.

Spindle unit : 1 each

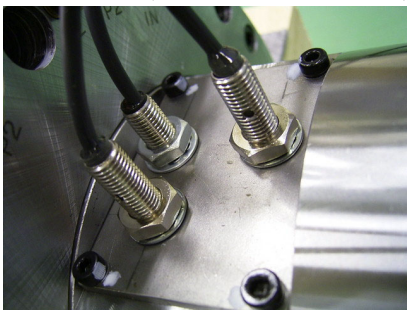


Rotary union (option, installed) : 1 each

Grease unit (piped) : 1 each
($20000min^{-1}$)

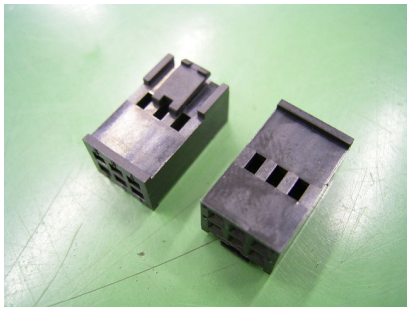
Older type grease unit
compatible mounting stay : 2 each
and bolts ($20000min^{-1}$)

Detection switches : 3 each
($15000min^{-1}$, installed)

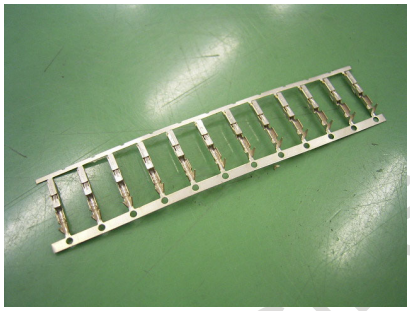


Detection switches : 4 each
($20000min^{-1}$, installed)

Connector for αiBZ sensor cable
: 2 each



Connector fitting for αiBZ sensor cable
: 1 set



II. INSTALLATION

1 HANDLING

The spindle unit is a precision machine. At the time of transportation and installation, be careful not to apply an impact to the spindle unit and drop the spindle unit. Otherwise, the spindle unit can fail or deteriorates in precision.

1.1 TRANSPORTATION

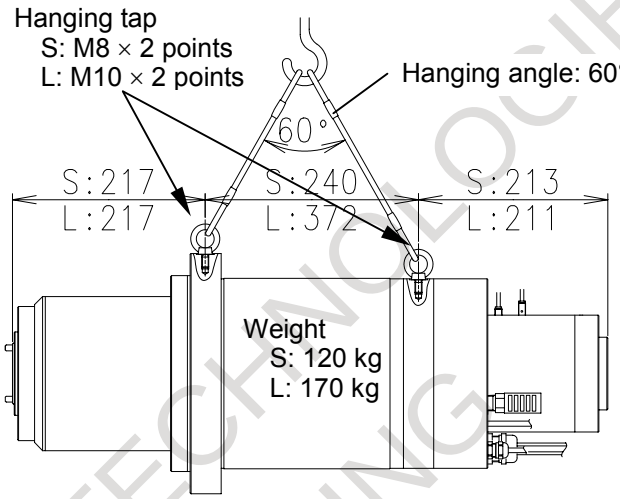
When shipping the spindle unit alone to a remote place or overseas, pay special attention to vibration, impact, and temperature changes. It is recommended to use a container designed for precision machines. The guideline for each item is indicated below.

Vibration and impact:
5 G or less (Impact and load on the spindle shaft is not allowed.)
Temperature change:
20°C ±5 °C
Humidity:
35% to 85%RH or less (no condensation)

1.2 HANGING

The spindle unit is heavy. Use equipment such as a crane to move the spindle unit. When using a crane, hang the spindle unit as described below.

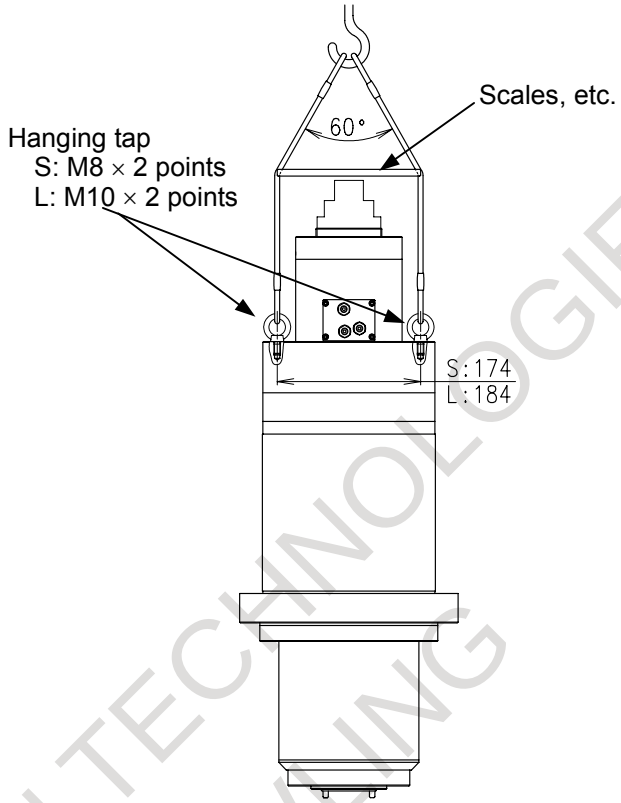
1.2.1 Hanging the Spindle Unit Horizontally



⚠ WARNING

1 Tighten the eyebolts until their bearing surfaces are closely in contact, and ensure that the rings of the two eyebolts are oriented on the same plane as shown in the figure above.
2 Use those sufficiently safe hanging tools that satisfy the required standards.

1.2.2 Hanging the Spindle Unit Vertically

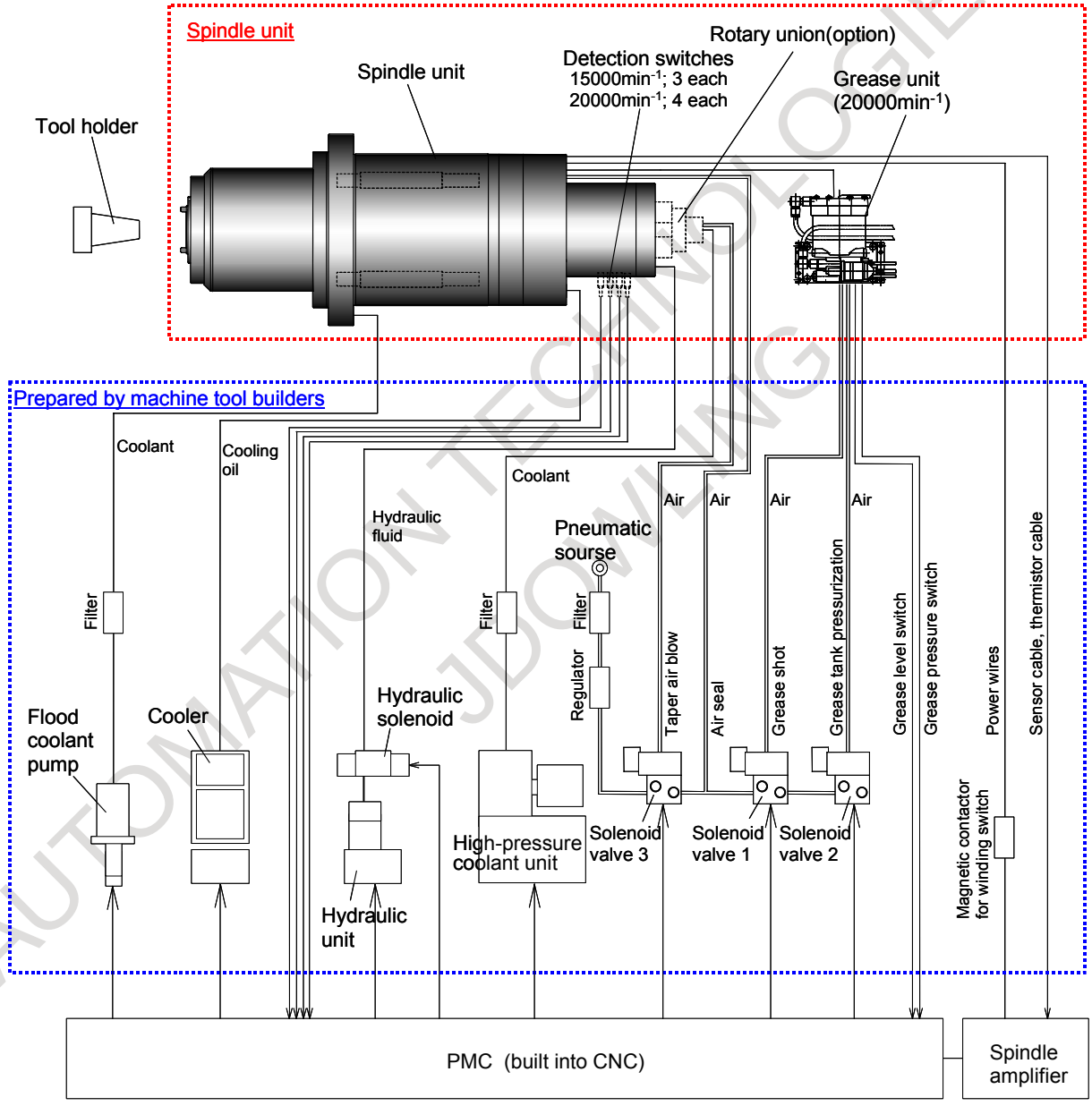


⚠ WARNING

1 Tighten the eyebolts until their bearing surfaces are closely in contact, and ensure that the rings of the two eyebolts are oriented on the same plane as shown in the figure above.
2 Use those sufficiently safe hanging tools that satisfy the required standards.

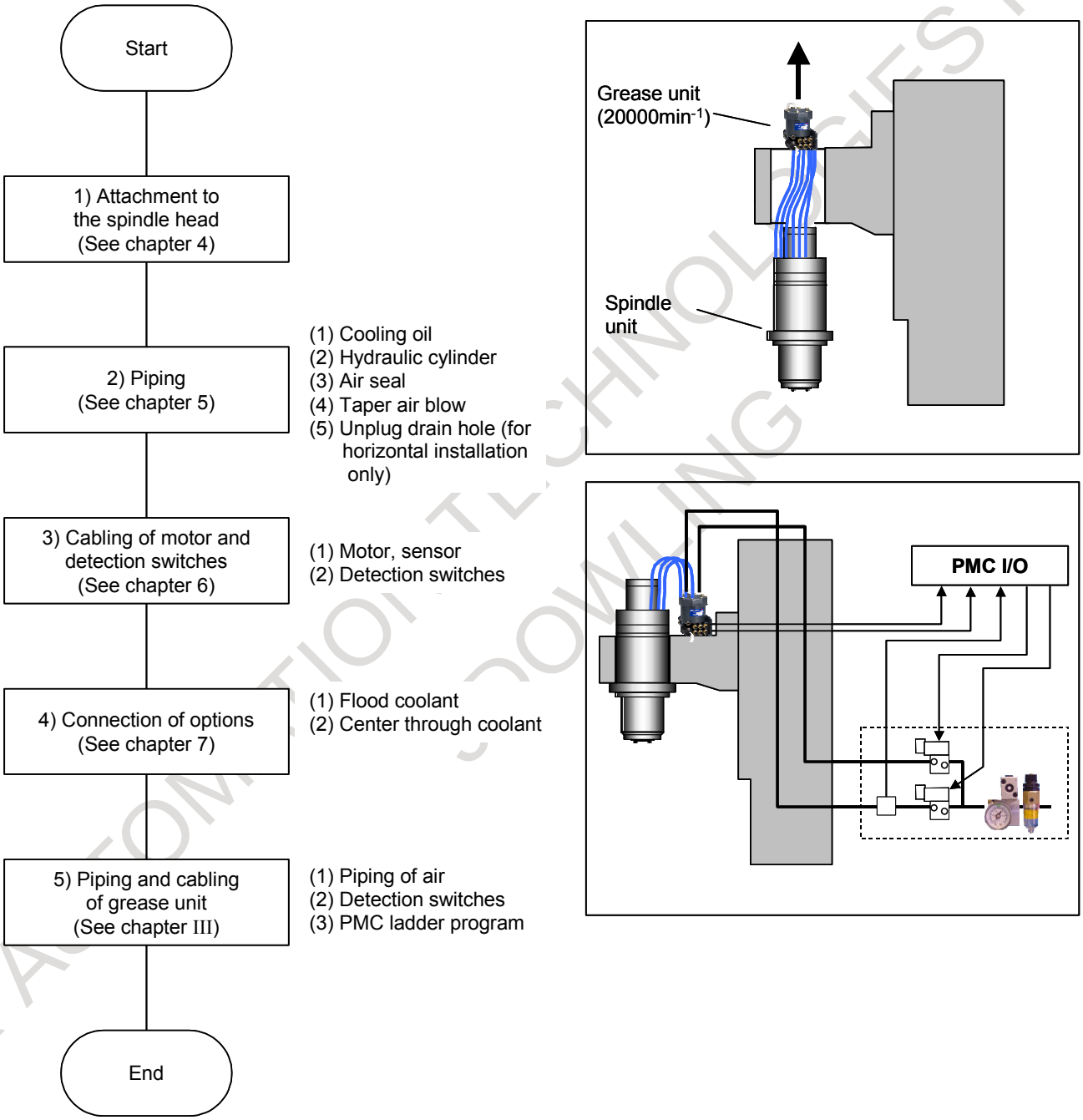
2 SYSTEM CONFIGURATION

The system configuration required to use the spindle unit is shown below. The customer is requested to prepare peripheral equipment.



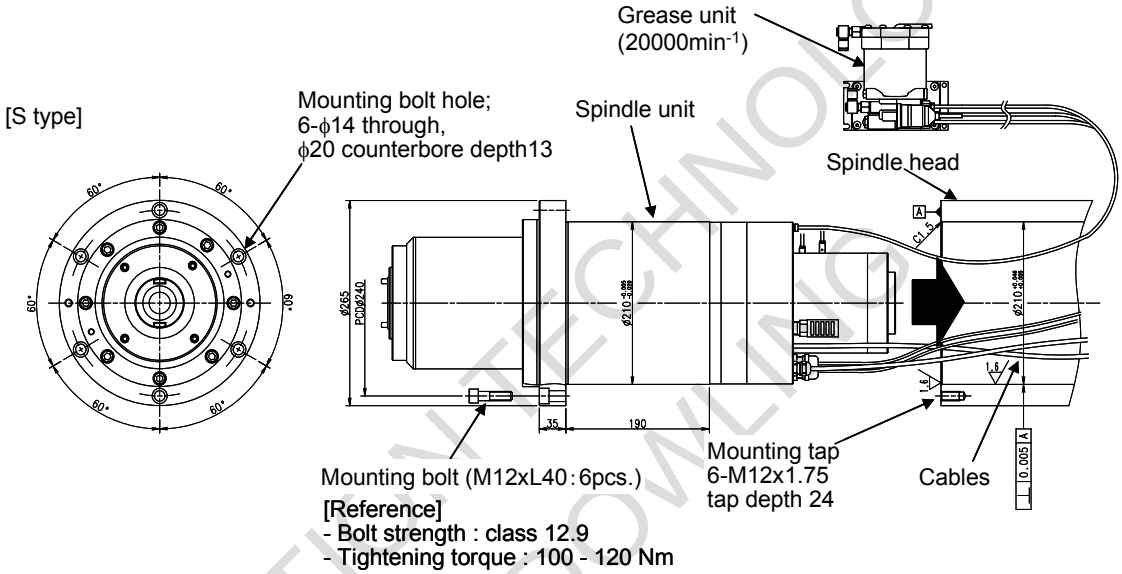
NOTE
Grease units are attached to 20000 min^{-1} models only.

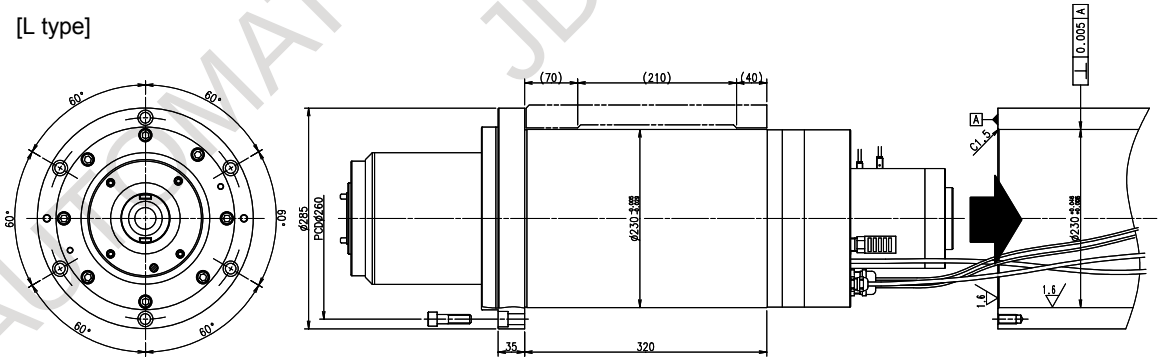
3 INSTRUCTION



4 MOUNTING

Into the spindle head of the main machine body, insert the spindle unit from its rear carefully not to damage cables then secure the spindle unit with bolts. When a grease unit is provided, first insert the grease unit through the mounting hole of the spindle head.
When removing the spindle unit by using the movement on the Z-axis, see the stroke drawing on the pages that follow.





Recommended hole figure

Hole dimension tolerance	S: ϕ210 $^{+0.045}_{+0.005}$ L: ϕ230 $^{+0.045}_{+0.005}$
Perpendicularity between hole and mounting face	0.005 mm or less
Mounting face roughness	Ra 1.6 μm or less (for both of inner hole surface and end face)
Recommended spigot length	S: 190 mm L: 230 to 320 mm (or thick lines in the figure above)

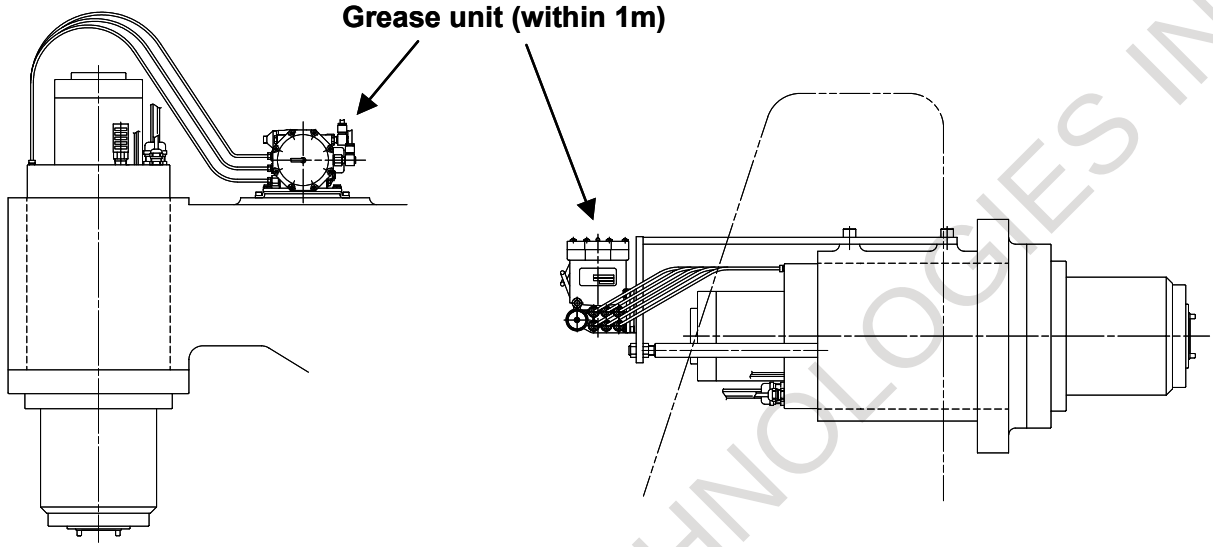
Reference 1) Example of installation on a machining center

[Vertical machining center]

Grease supply tube on operator side

[Horizontal machining center]

Grease supply tube on upper side

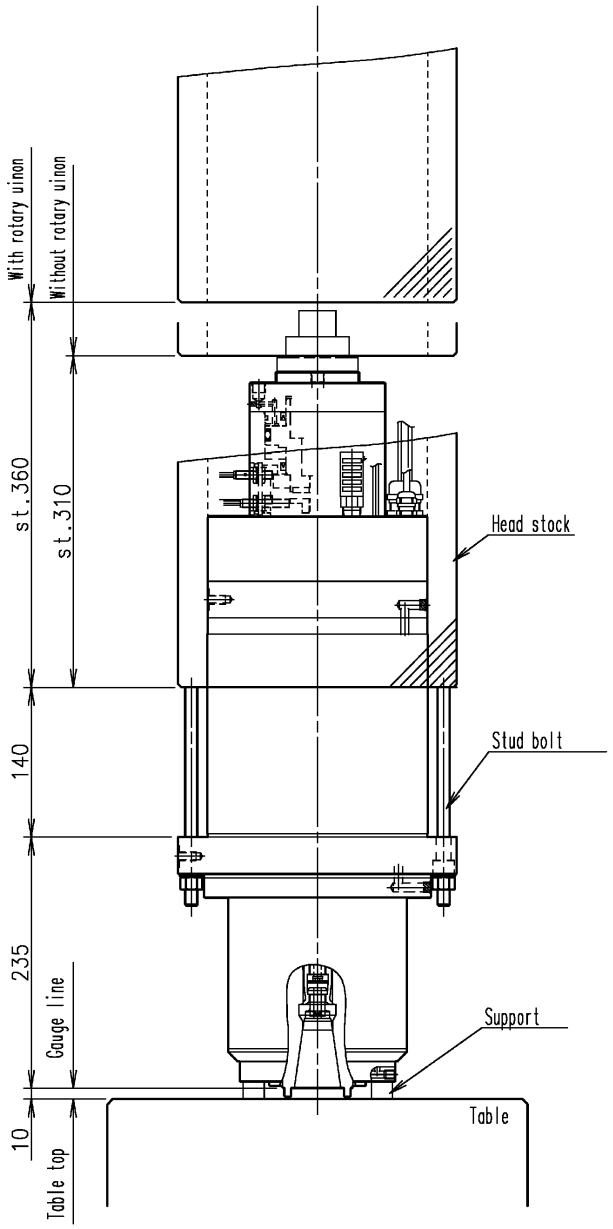


> ⚠ **CAUTION**
> Secure the grease unit firmly so that it does not vibrate. Moreover, secure the grease supply tube with a cable tie such as Insulock Tie so that it does not vibrate and interfere with peripheral materials.

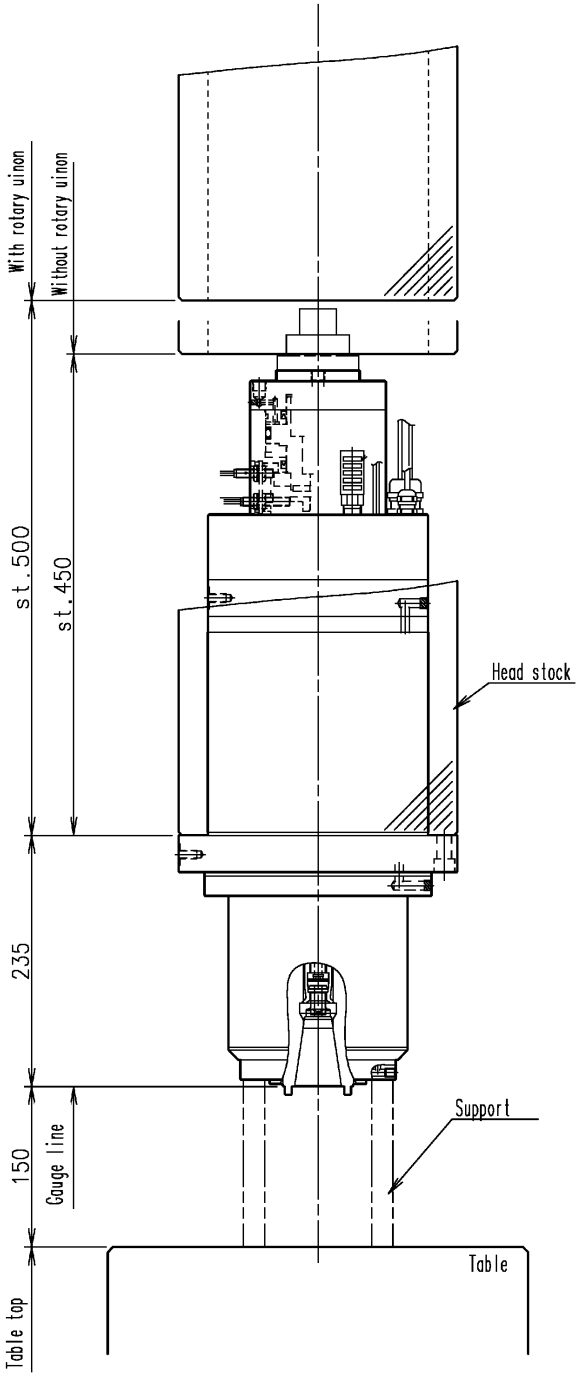
Reference 2) Z-axis stroke required with a vertical machining center

(1) S type

The case which takes down the spindle beforehand
(The shortest distance from table top to gauge line is 150mm)

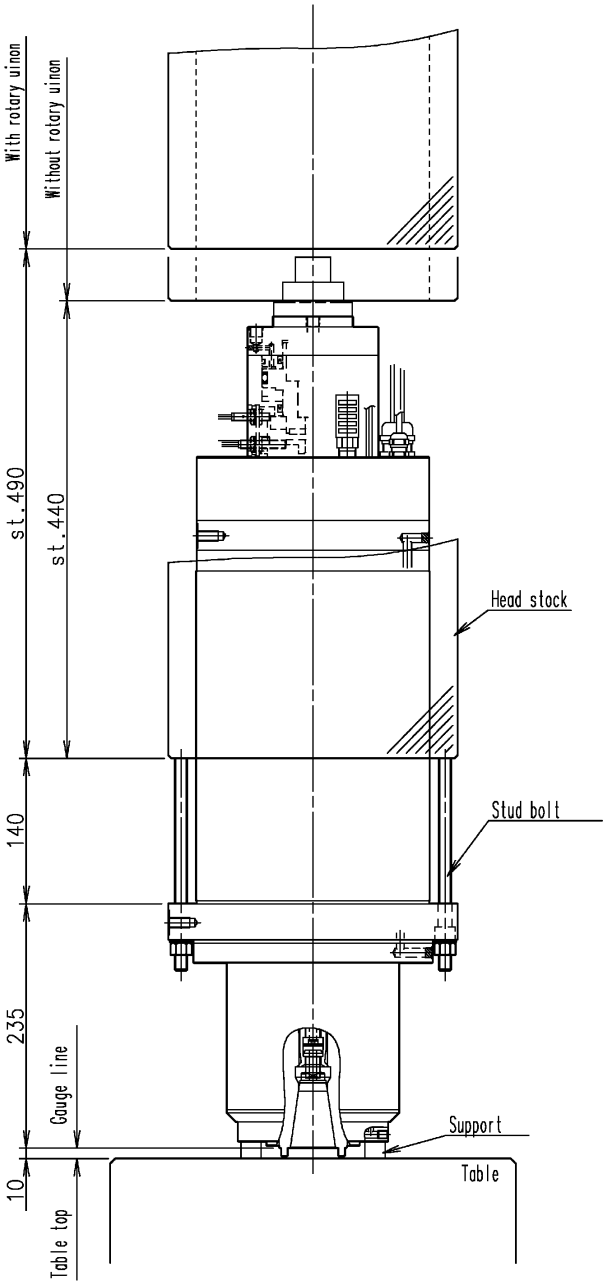


Case of supporting the spindle nose with a jig

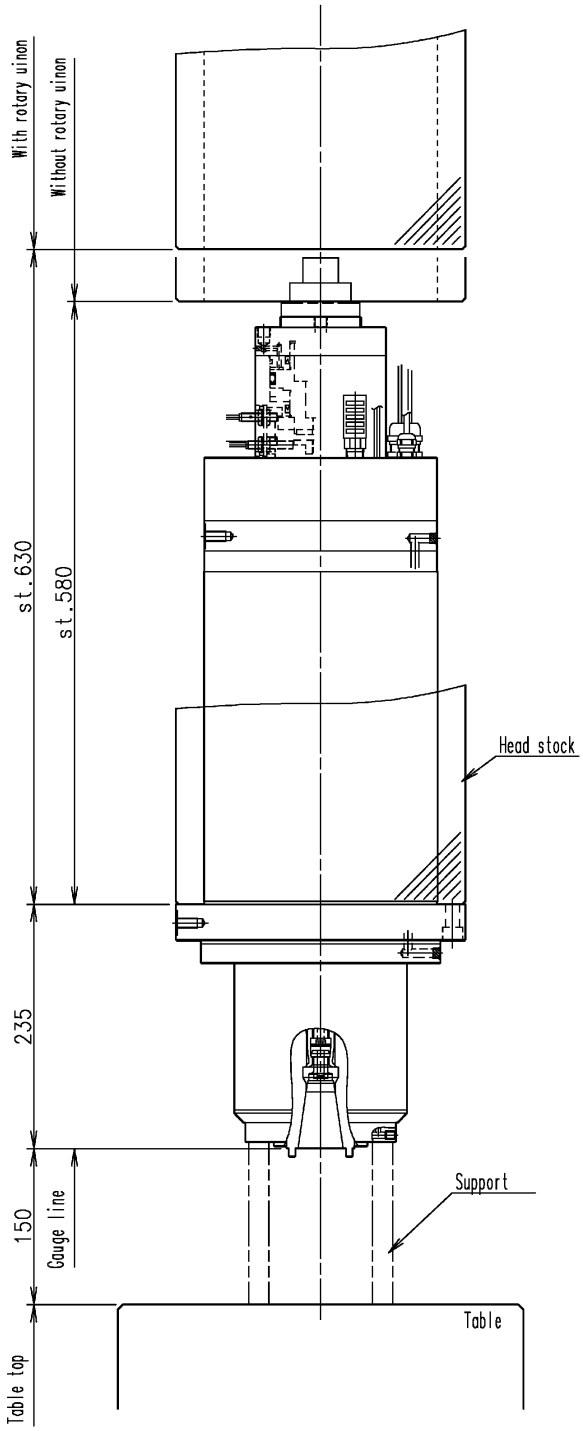


(2) L type

The case which takes down the spindle beforehand
(The shortest distance from table top to gauge line is 150mm)



Case of supporting the spindle nose with a jig

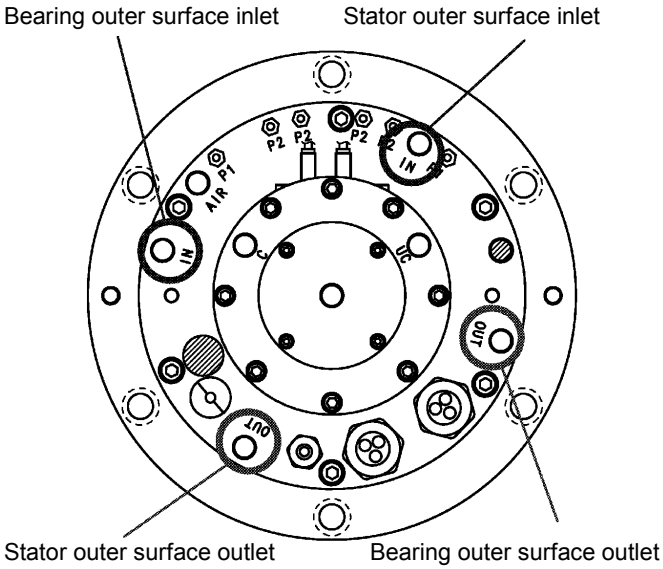


5 PIPING

5.1 COOLING OIL

The spindle unit has a built-in motor. So, be sure to perform cooling under the condition described below.

(1) Joint diameter
The Rc1/4 channel is shown below.



(2) Required cooling power
S type: 4000 W
L type: 4000 W
However, the capacity can be reduced according to the load level in actual use. (Consult with FANUC.)

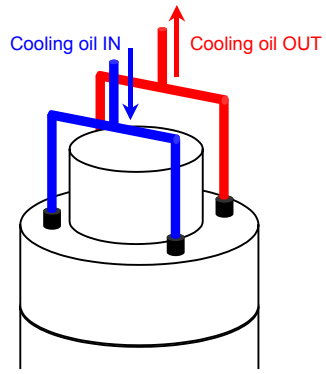
(3) Cooling oil viscosity
ISO VG2
If it is difficult to obtain VG2, VG10 or less may be used. In this case, however, a low cooling efficiency results. So, select a lower viscosity whenever possible. With the 20000 min^{-1} model, in particular, VG2 is recommended.

(4) Recommended pump output
20 L/min or more

(5) Temperature control method
Feed oil temperature control (Not return oil temperature control)
This control method keeps the temperature of oil output from the cooler at a constant value. On the other hand, the return oil temperature control method keeps the temperature of oil returning to the cooling unit at a constant value. This method is unusable because the temperature of output oil varies according to the use condition.

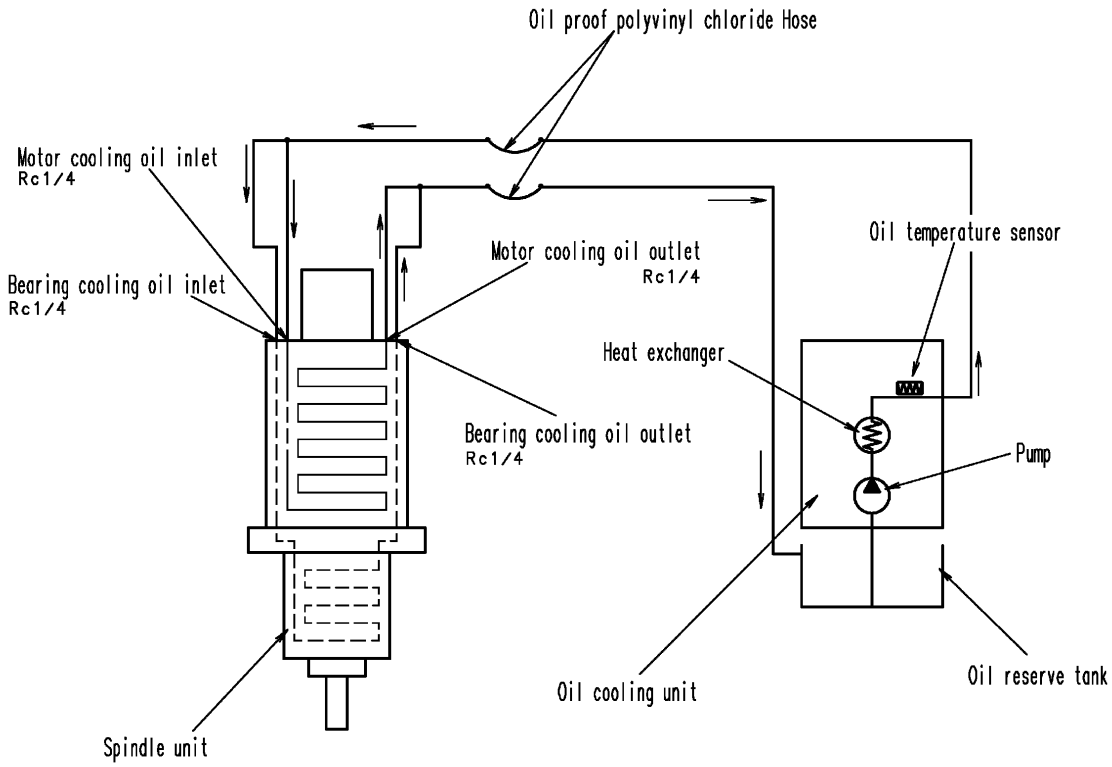
(6) Oil temperature control temperature
Room temperature + 2°C

(7) Cooling path
Bearing outer surface and stator outer surface parallel circuits (See the figure below.)



(8) Cooling unit operation
The cooling unit is always actuated when the machine is ready for operation.

Example of cooling oil schematics



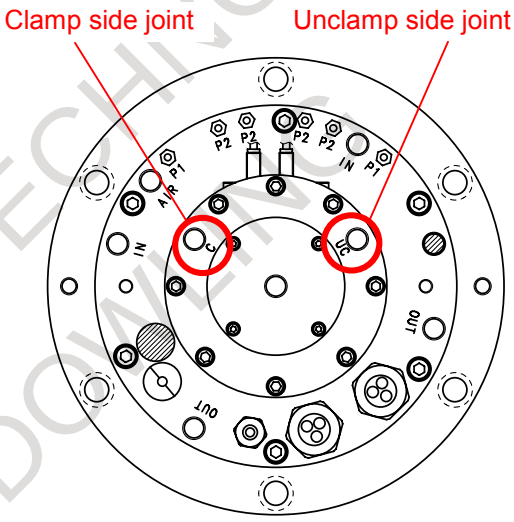
⚠ CAUTION
Under improper cooling condition, trouble may occur to the spindle unit.
FANUC assumes no responsibility for damage caused by not following directions for proper use.

5.2 HYDRAULIC CYLINDER

The spindle unit is equipped with a hydraulic cylinder for unclamping a tool as standard. In order to prevent a tool from being caught at ATC time and to protect the bearings, be sure to use the cylinder within the pressure indicated below.
Joint diameter: Rc1/4

[Cylinder specifications]

Pressure reception area	50.3 cm^2
Stroke	11 mm
Cylinder volume	55.3 cc
Recommended hydraulic fluid viscosity	ISO VG32
Specified oil pressure	6.0 to 6.5 MPa
Cylinder thrust (at unclamp)	29.0 kN (at 6.0 MPa) 31.4 kN (at 6.5 MPa)



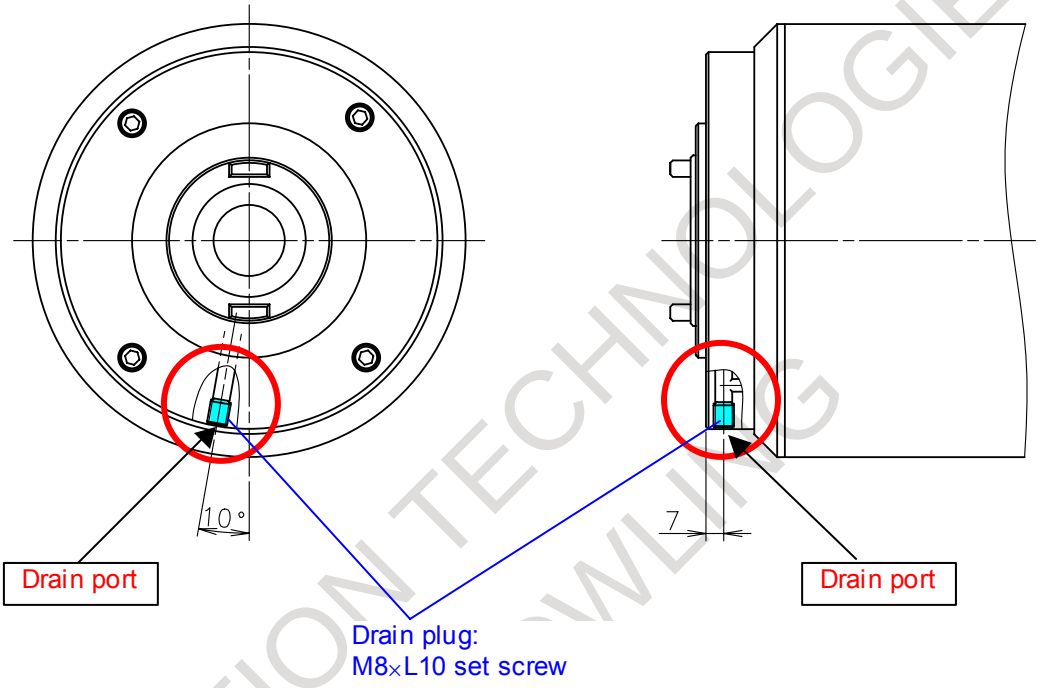
⚠ WARNING
Do not disassemble the unclamp cylinder.
Otherwise, your fingers may be caught and injured.

⚠ CAUTION
1 To prevent a tool from being caught at ATC time, Ensure that the tool holder taper shank is not degreased but is thinly greased.
2 Use a hydraulic hose for high pressure.
3 If the hydraulic hose is expanded by hydraulic pressure, the expansion volume needs to be added to the cylinder volume.
4 Under improper hydraulic condition, trouble may occur to the spindle unit.
FANUC assumes no responsibility for damage caused by not following directions for proper use.

5.3 DRAIN PLUG

This spindle unit has a drain port on the side of the front cover. The drain port is plugged at the time of shipment.

- For use with the vertical type, use the drain port as it is.
- For use with the horizontal type, detach the plug from the drain port.



⚠ CAUTION
FANUC assumes no responsibility for damage caused by not following directions for proper use.

5.4 AIR SEAL

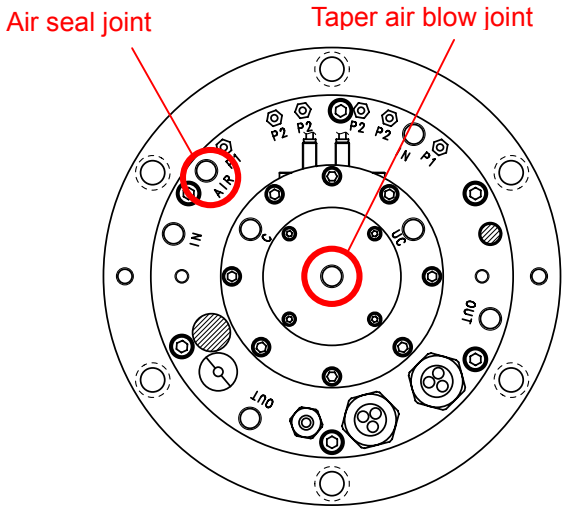
To prevent coolant from entering through the front of the spindle unit, supply air to the air seal joint. Start supplying air when the machine ready is ON, and stop air when the machine ready is OFF.
To prevent the absorption of air or mist due to a temperature drop inside the spindle, please turn off the machine ready state about 2 hours after the spindle stopped.
Joint diameter: Rc1/4 Air seal pressure: 0.05 MPa
Recommended filtration precision: 5 μm

> ⚠ **CAUTION**
> Be sure to pass air through a drier, filter, and mist separator. If air contains water and dust , the built-in motor can suffer a winding insulation failure, or bearing failure, rust, etc.
> FANUC assumes no responsibility for damage caused by not following directions for proper use.

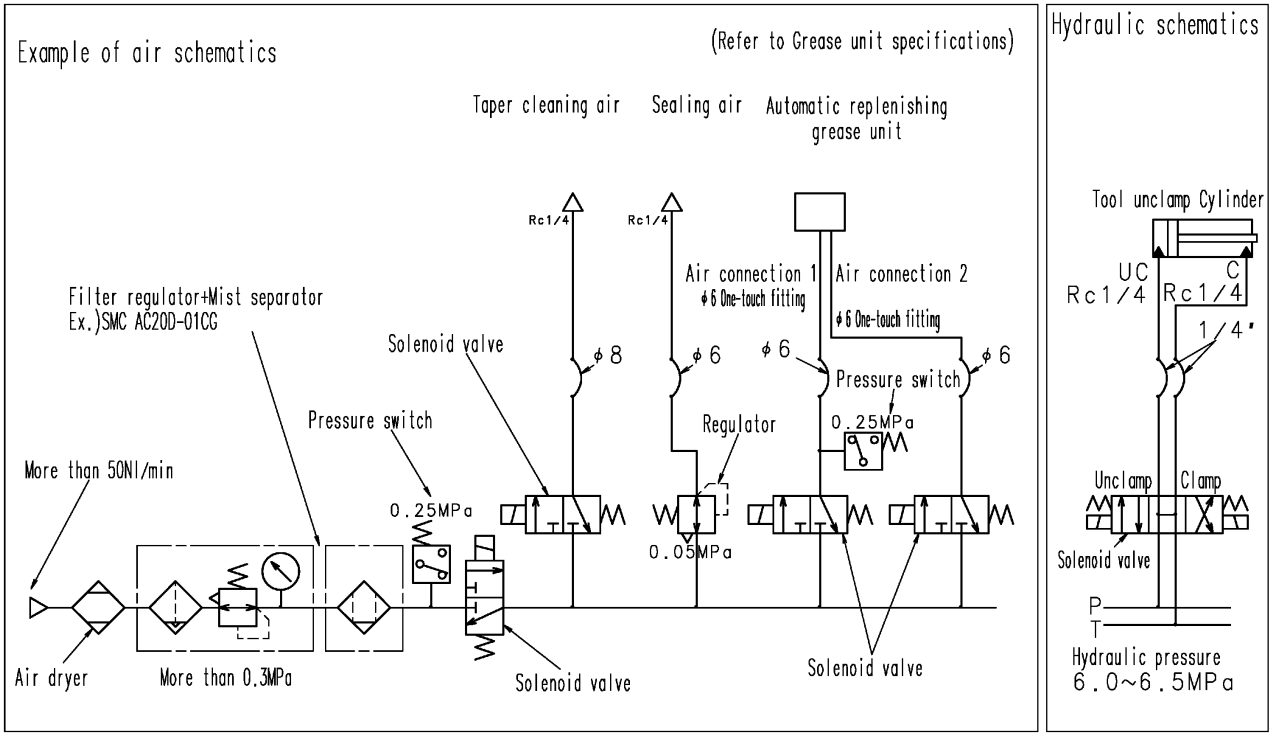
5.5 TAPER AIR BLOW

Connect a tube for taper air blow to prevent dust from entering the spindle taper portion at ATC time. Blow air with a 3-port solenoid valve, starting immediately before unclamping and ending immediately after clamping.
Joint diameter: Rc1/4 Supply pressure: 0.3 MPa

> ⚠ **CAUTION**
> Supply clean air as used for air seal.
> FANUC assumes no responsibility for damage caused by not following directions for proper use.



Example of hydraulic and pneumatic schematics



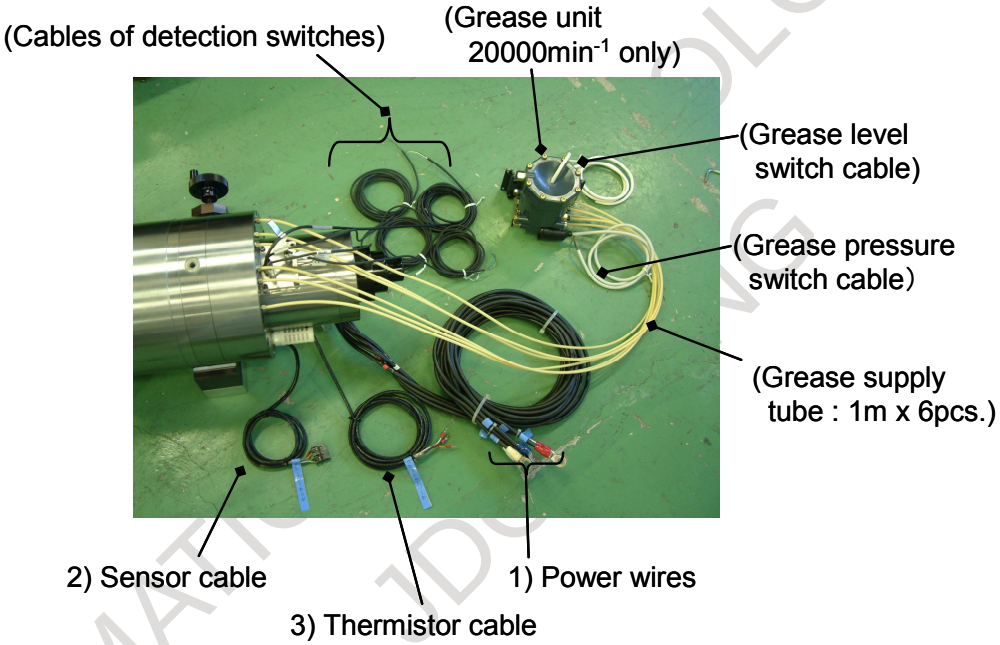
6 CABLING

6.1 MOTOR / SENSOR

The built-in motor cables running from the spindle unit are indicated below.

<1> Power wires
<2> Sensor cable
<3> Thermistor cable

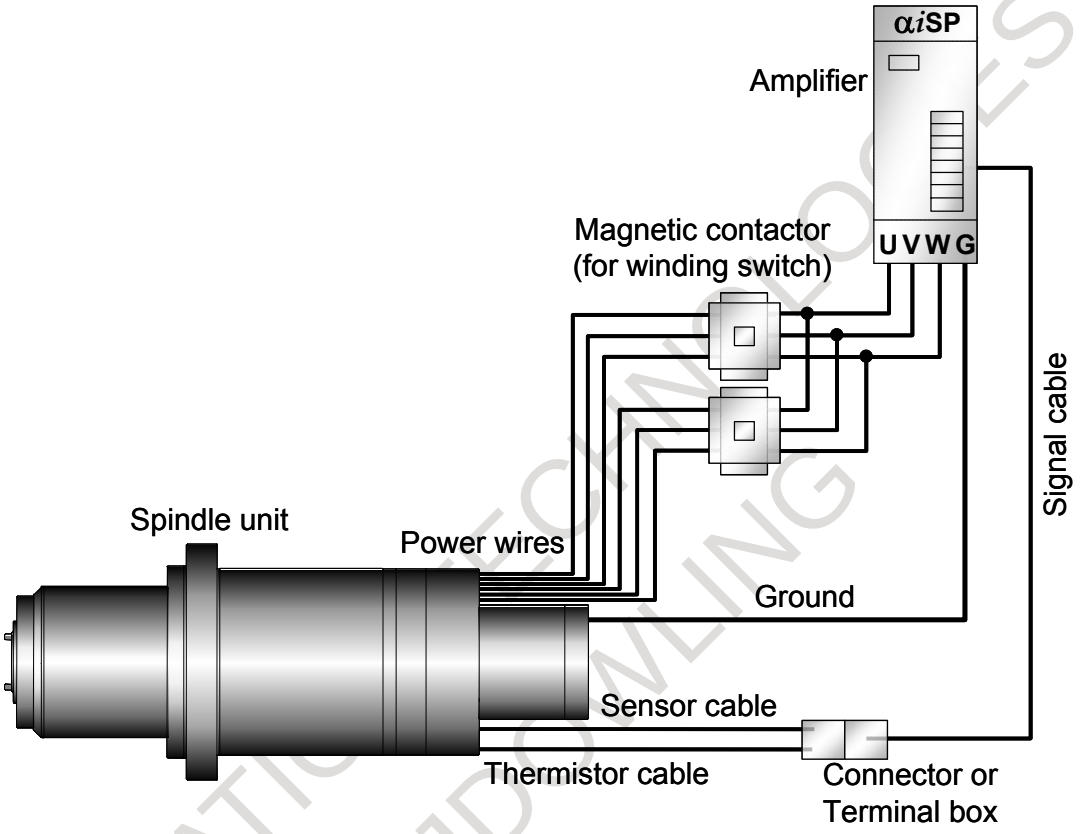
> ⚠ **WARNING**
> At the time of cabling, ensure that the power is turned off. Otherwise, you may be electrically shocked.



Cable name	Wire mark	Cable length	Remarks
1) Power wires	MS112S U, V, W X, Y, Z	Approx. 1.8 m	Connection with the amplifier : Y-Δ connection After cutting the power cable to match the machine, crimp a crimp terminal (14sq, for M8).
	MS112L U1, V1, W1 U2, V2, W2	Approx. 1.8 m	Connection with the amplifier : Y-Y connection After cutting the power cable to match the machine, crimp a crimp terminal (14sq, for M8).
2) Sensor cable	CN1, CN2	Approx. 1 m	Use the delivered connector for the cable side.
3) Thermistor cable	THR1, THR2, G	Approx. 1.8 m	With a crimp terminal for M4

6.1.1 Overview of Connections

Overview of cable connection is shown below.
Refer to the next page as concerns the connection of power wires.
Please pay attention to that the connection type is different between MS112S and MS112L.

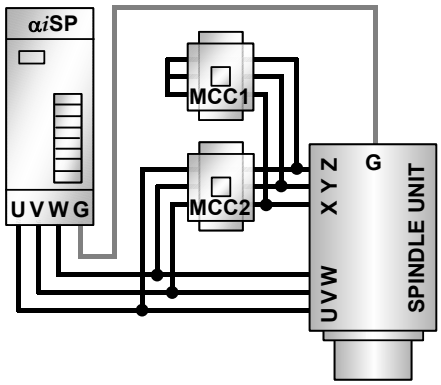


Please connect ground line with the spindle unit or something of conductive members to the spindle unit.

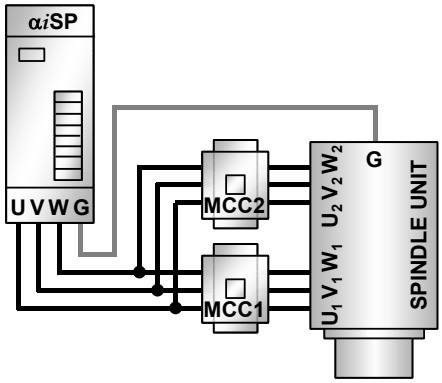
For matching CE mark, please use yellow-green stripe wire as a ground.

6.1.2 Power Wires

For MS112S (Mounted motor : B*i*I 112S/20000, Y-Δ switching)



For MS112L (Mounted motor : B*i*I 112L/20000, Y-Y switching)



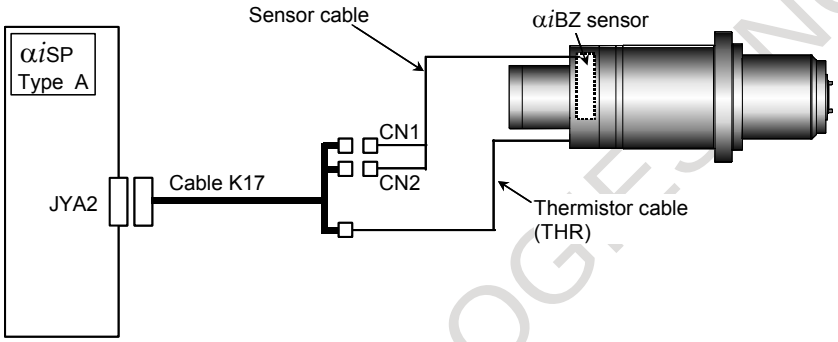
- Magnetic contactor operation pattern

	Low-speed winding	High-speed winding
MCC1	ON	OFF
MCC2	OFF	ON

NOTE
1 MCC is not attached to the spindle unit.
2 To support CE mark versions, use wire with yellow and green stripes as ground line. Connect ground lines to the spindle unit main frame or a machine-side component electrically connected to the spindle unit.
3 Be sure to use an O-type crimp terminal (with no tip opening) and spring washer so that the cable is not detached easily from the screw of the terminal block).
4 Be sure to connect one cable to one terminal. Do not connect multiple cables to one terminal at all times, except for a terminal block that enables multiple cables to be connected to one terminal.
5 For details of the motor and amplifier connection, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

6.1.3 Sensor Cable

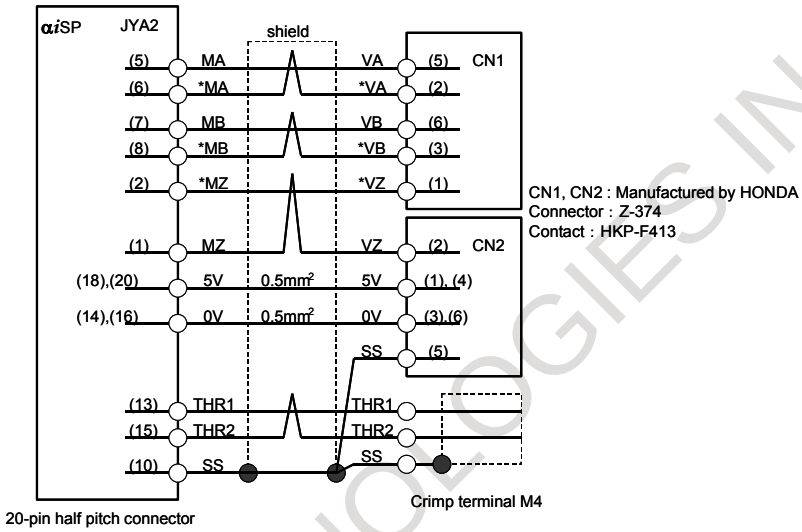
Connect the amplifier with the sensor as shown below.



For details of connection and connector pin assignment, see the next page. For further information, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

NOTE
1 The customer is to prepare cable K17.
2 The terminal wire is delivered as standard with the main spindle unit.
3 Cable K17 may be relayed halfway. At a relay point, however, the use of a connector of IP54 or up or a terminal box is recommended.
4 For detailed information about cable K17 and so forth, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

6.1.4 Details of Connections



Cable specification:

Four 0.18 mm^2 twisted pairs + group shielded cable of six 0.5 mm^2 wires

Recommended wire material:

A66L-0001-0368

NOTE
To prevent the sensor from being damaged when the connector is attached incorrectly, use a 20-pin or 16-pin connector when one 5V line and one 0V line only are connected.

6.1.5 Connector Pin Assignment

Connector JYA2

9	5V	10	#	19	#	20	5V
7	MB	8	*MB	17	#	18	5V
5	MA	6	*MA	15	THR2	16	0V
3	#	4	#	13	THR1	14	0V
1	MZ	2	*MZ	11	#	12	0V

NOTE
To a pin marked with #, an I/O signal for an optional PCB may be connected. So, do not make a connection to such a pin.

Connector CN1

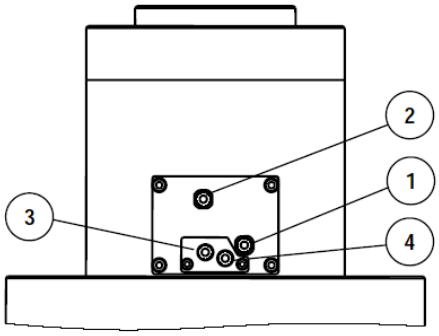
1	*VZ	4	
2	*VA	5	VA
3	*VB	6	VB

Connector CN2

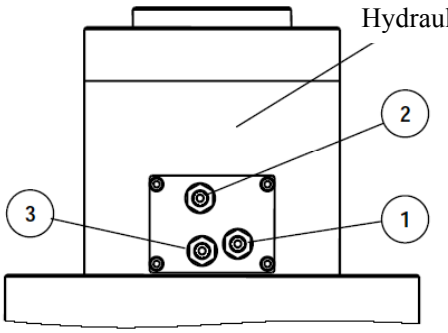
1	5V	4	5V
2	VZ	5	SS
3	0V	6	0V

6.2 TOOL CLAMP/UNCLAMP DETECTION SWITCH TOOL PRESENCE/ABSENCE DETECTION SWITCH CLAMP ERROR DETECTION SWITCH

<<20000min.$^{-1}$ models (HSK-A63, BT-40)>>



<<15000min.$^{-1}$ models (BT-40 only)>>



Switch	Wires	Cable	Remarks
(1) Tool unclamp detection switch	Brown(+) Blue(-) DC 2 wires, shielded	ϕ4mm × 3m	BR3- 0801D-PU03 (made by BALLUFF) 10 - 30V_{DC}, detection gap 1.2mm
(2) Tool clamp detection switch	Brown(+) Blue(-) DC 2 wires, shielded	ϕ4mm × 3m	BR3- 0801D-PU03 (made by BALLUFF) 10 - 30V_{DC}, detection gap 1.2mm
(3) Tool presence/ absence detection switch	White(+) Black(-) DC 2 wires, shielded	ϕ4mm × 3m	BES-M08MG-GSC20B(made by BALLUFF) 10 - 30V_{DC}, detection gap 1.6mm
(4) Clamp error detection switch	Brown(+) Blue(-) DC 2 wires, shielded	ϕ4mm × 3m	BR5-0801D1-PU3 (made by BALLUFF) 10 - 30V_{DC}, detection gap 1.5mm

*) Connect the cables of each switch to the input terminals of the PMC I/O module.
*) Unnecessary to cable clamp error detection switch in case of BT-40.

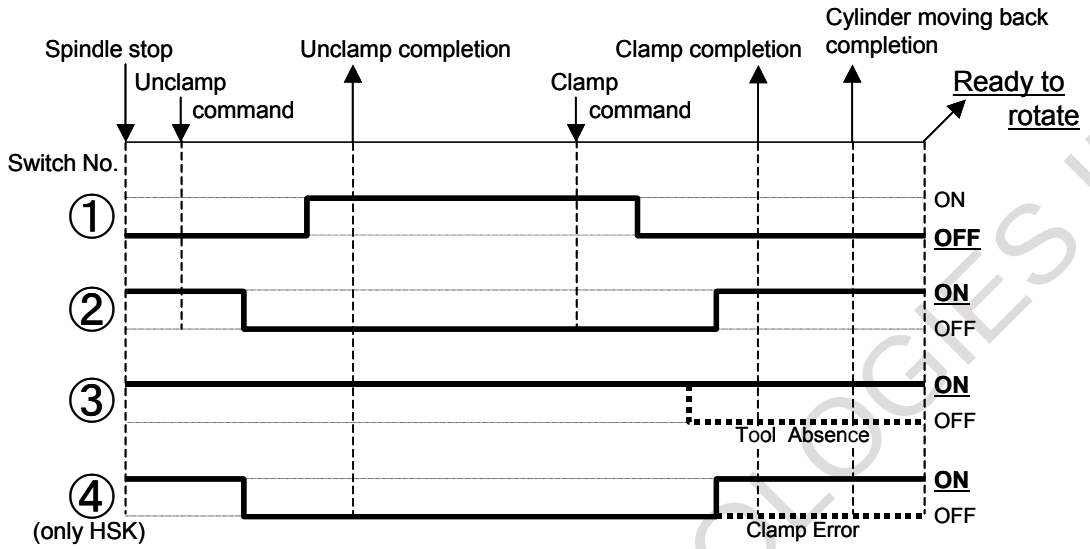
[Function of each detection switch]

No.	Name	Function	Application
(1)	Unclamp confirmation	ON at hydraulic cylinder lower limit (unclamp)	Tool clamp/unclamp control
(2)	Clamp confirmation	ON at unclamp cylinder upper limit (clamp)	Interlock at ATC or spindle rotation
(3)	Tool presence/ absence confirmation	ON at tool present in clamp position	Interlock at ATC or spindle rotation
(4)	Clamp error confirmation	OFF at HSK misclamp	Interlock at spindle rotation (Unnecessary for BT-40)

[State of each detection switch]

Switch No.	Tool presence		Tool absence	Unclamp
	Correctly Clamp	Clamp Error	Clamp	
(1)	OFF	OFF	OFF	ON
(2)	ON	ON	ON	OFF
(3)	ON	ON	OFF	ON
(4)	ON	OFF	ON	OFF

[Timing chart]



[State of each detection switch]

1) Before allowing the spindle to rotate, be sure to recognize a clamp-completed signal only after the conditions for "correctly clamped" have been satisfied.
   Never allow the spindle to rotate and never start cutting unless the conditions are satisfied.
2) Before allowing a tool to be detached from the spindle under ATC, be sure to recognize an unclamp-completed signal only after the conditions for "unclamp" have been satisfied (especially after the detection switch <1> has been set to ON).
3) If the piston oil pressure is in the clamp position and the detection switch <3> is OFF, it means that there is no tool (tool absence).
   Do not cause the spindle to rotate under this condition or a spindle's inner part may break down.
4) If the piston oil pressure is in the clamp position and the detection switch <4> is OFF, it means that a tool is not completely clamped ("clamp error"). Unclamp the tool and clamp it normally. This trouble can occur under ATC if the piston oil pressure is set to the clamp position too early. Check the ATC sequence.

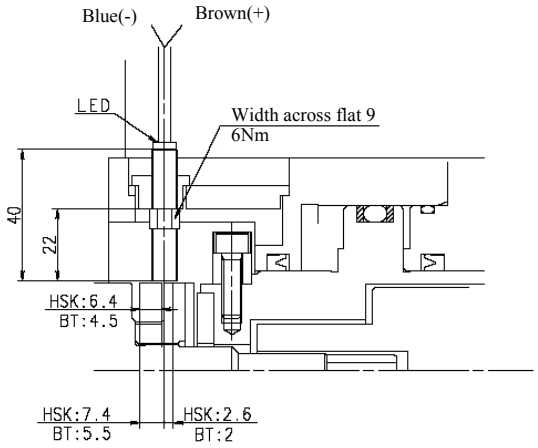
> ⚠ **WARNING**
> Do not rotate the spindle at high speed without a tool (switch 3 set to OFF). If a tool is clamped incompletely, the tool can be detached, resulting in a danger.

[Adjusting detection switches]

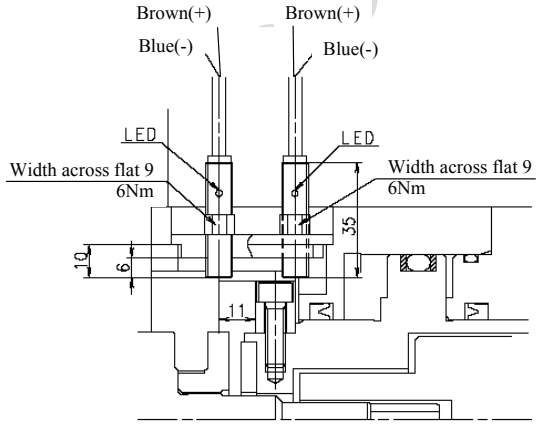
Each detection switch is mounted and adjusted before shipment. If a proximity switch fails and needs to be replaced, adjust the detection switch as shown below.
After adjustment, check that [State of each detection switch] described earlier appears. If not, make a fine adjustment.

<<20000min.$^{-1}$ models (HSK-A63, BT-40)>>

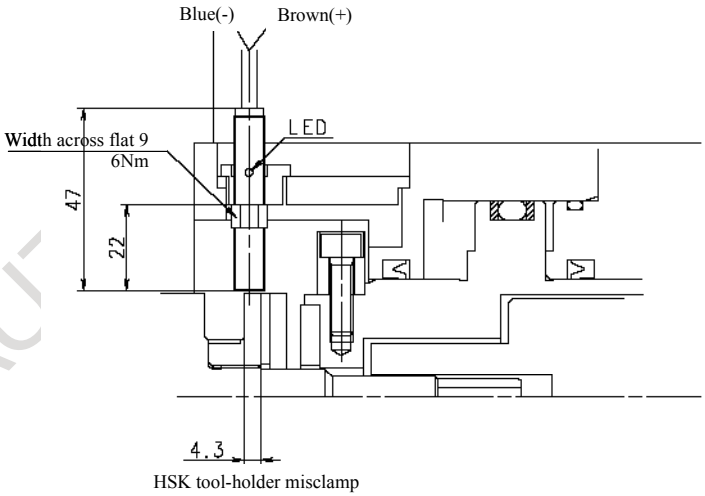
--Tool presence/absence detection switch--



--Tool clamp/unclamp detection switch--



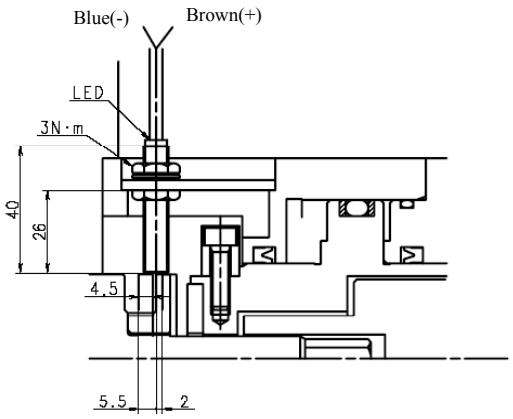
--Clamp error detection switch (use only for HSK)--



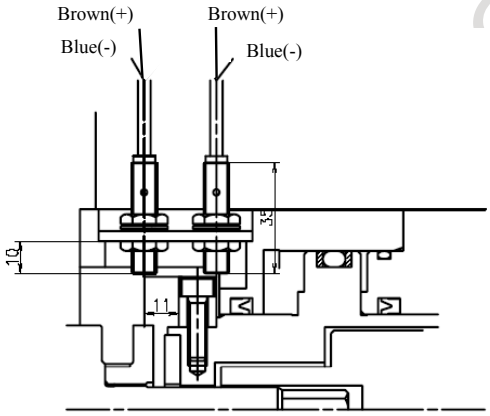
HSK tool-holder misclamp

<<15000min.$^{-1}$ models (BT-40 only)>>

--Tool presence/absence detection switch--



--Tool clamp/unclamp detection switch--

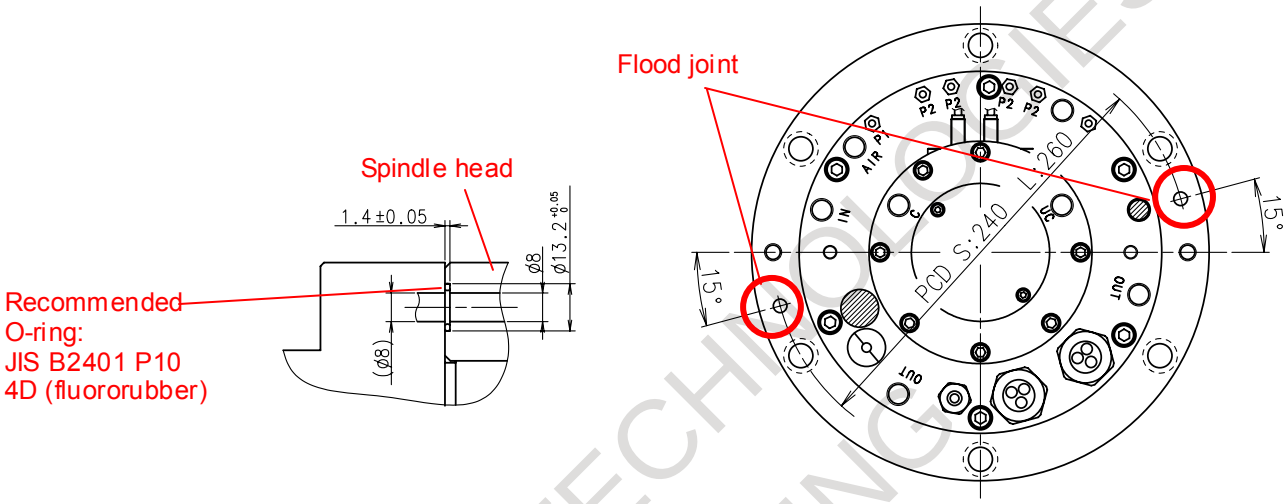


7 CONNECTION OF OPTIONS

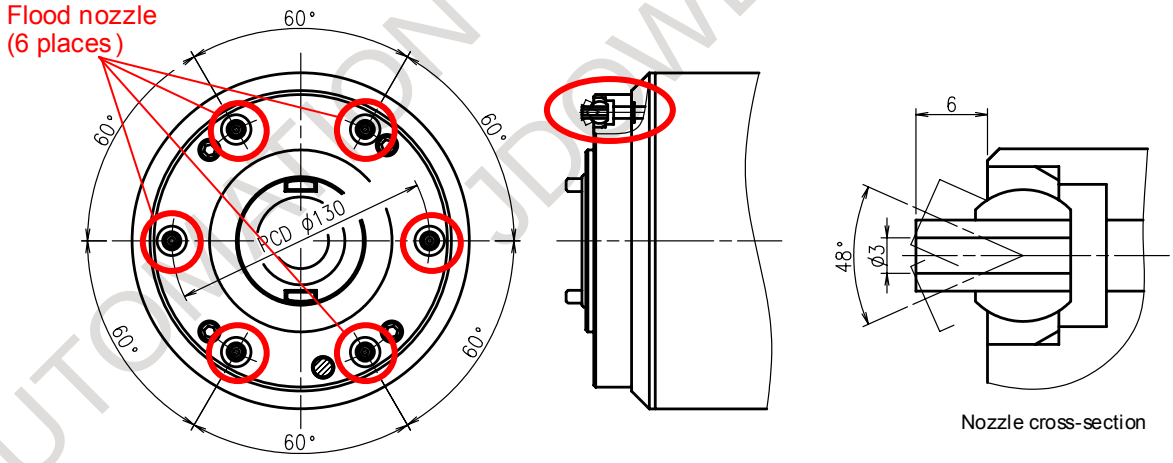
7.1 FLOOD COOLANT

Flood coolant through the nose tip is available as an option.
Please make a coolant supply hole on the mounting face of the spindle head.
Joint diameter: ϕ8 (2 places)

[Example of joint hole figure]



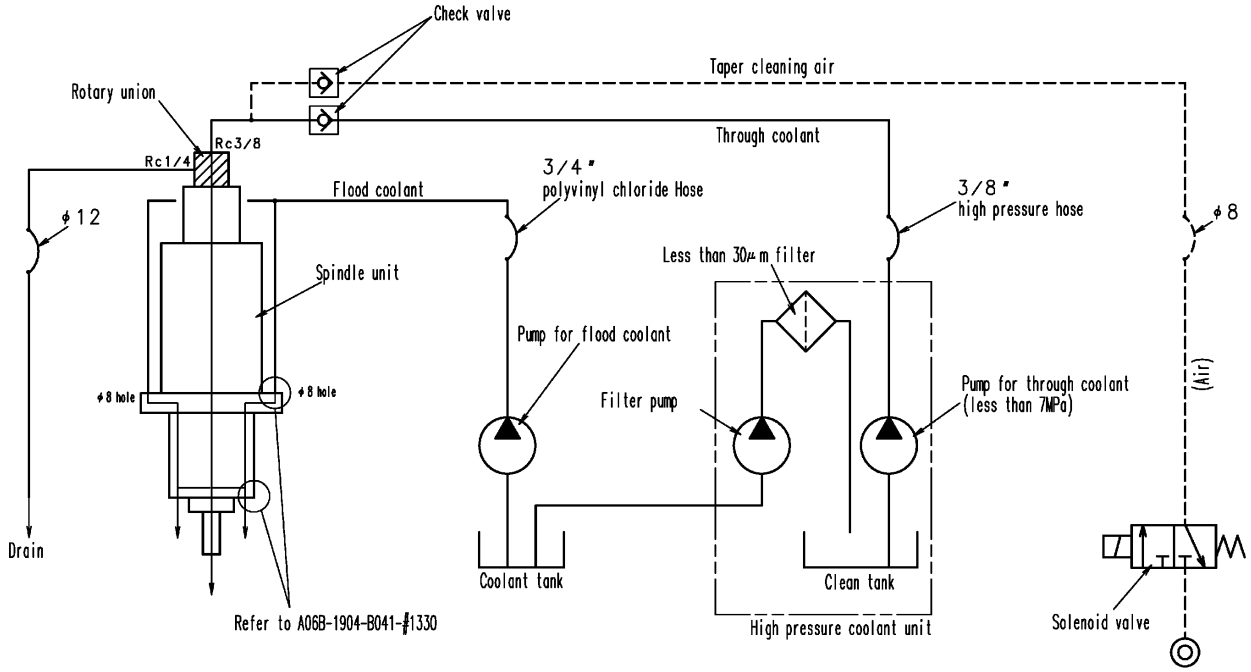
[Nozzle specification]



When changing the orientation of a nozzle, insert a bar of ϕ3 mm into the nozzle for adjustment.

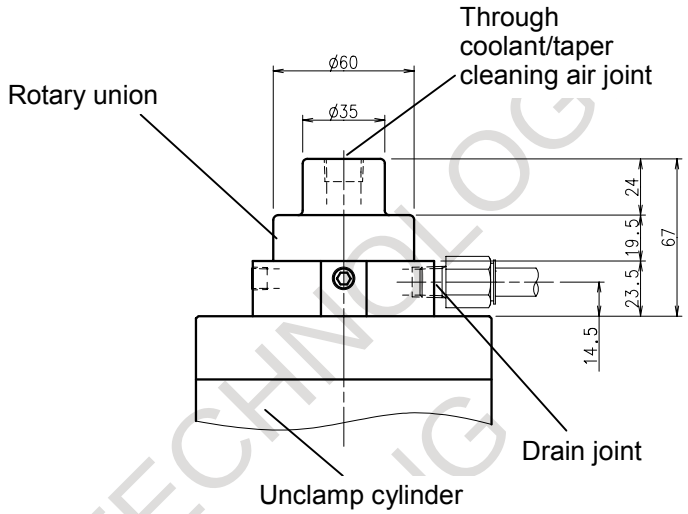
> ⚠ **CAUTION**
> Synthetic coolant can not be used.
> FANUC assumes no responsibility for damage caused by not following directions for proper use.

Example of coolant schematics



7.2 CENTER THROUGH COOLANT

Optionally, center through coolant can be used. Connect a coolant hose and drain hose to the rotary union attached to the end of the spindle unit.
At this time, taper cleaning air is also connected to the rotary union.
Joint diameter: Coolant: Rc3/8
Drain: Rc1/4

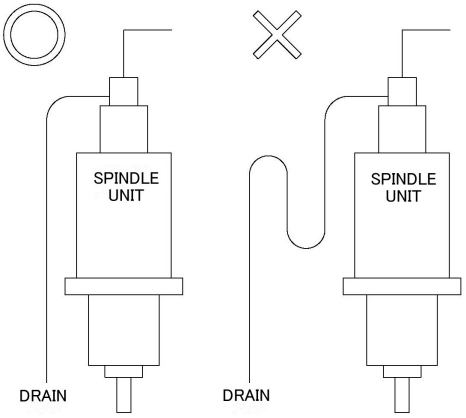


[Through coolant specification]

Media	Water-soluble or oil-soluble	*MQL
Maximum usable pressure	7.0MPa	1.0MPa
Required filter	35μm	5μm
Dry run	Allowed	

*MQL : Minimum Quantity Lubrication

For drain piping, use a tube with an outer diameter of ϕ12 mm or more.
To prevent back pressure from being applied, run the tube straightly downward without bending it.



> ⚠ **CAUTION**
> Synthetic coolant can not be used.
> FANUC assumes no responsibility for damage caused by not following directions for proper use.

> **NOTE**
> 1 When the spindle is rotating, through air blow is disabled.
> 2 Almost no coolant leaks from the drain hose in routine use.
> If much coolant leaks, replace the rotary union.

III. AUTOMATIC REPLENISHING GREASE UNIT

1 FOR SAFE USE

Automatic replenishing grease unit is used to output small amounts of grease to lubrication points by driving the pneumatic small amount output piston with compressed air. In particular, the grease unit is useful for lubrication of the bearings inside the high-speed spindle.
In order to make the most efficient use of the grease unit, observe the cautions below.

⚠ CAUTION

1 Do not apply impact to the grease unit, and do not scratch the grease unit. Otherwise, the grease unit can fail or malfunction.
2 Do not disassemble the grease unit except for the portions specified by FANUC. Otherwise, the grease unit can fail or malfunction.
3 Do not modify the grease unit, for example, by machining. Otherwise, the grease unit can fail or malfunction.
4 Lay grease tube (teflon) in such a way that it will not touch any machine part, spindle piping, or wiring. Otherwise, the tube may get damaged when it is subjected to vibration.
5 Use the grease unit in a proper environment and under a proper condition. Otherwise, the grease unit can fail or malfunction.
6 When storing the grease unit, avoid direct sunlight and high humidity.
7 When using the grease unit, use clean and dry compressed air.

2 FEATURES

The grease unit, which periodically supplies small amounts of grease to the bearings inside the spindle unit, has the following features:

- High-speed grease lubrication
  By periodically supplying small amounts of grease to the bearings inside the spindle unit, high-speed grease lubrication is achieved.

- Improved atmospheric environment
  Mist, which is generated by oil lubrication, is not generated in the atmosphere with the grease unit.
  When supplying grease into the bearings, the grease unit does not supply air into the spindle unit, so that annoying air noise can be eliminated.

- Energy saving
  When the grease unit is driven, little air is consumed.

3 ITEMS TO BE PREPARED BY THE CUSTOMER

To use the grease unit delivered with the FANUC-NSK spindle unit (20000 min^{-1}), the components described below are needed.

[Components for unit operation and monitoring]

Name	Quantity	Specification
Pressure switch (for air monitoring)	1	Operates at 0.25 Mpa.
Solenoid valve	2	3-port type

[Piping]

Name	Specification
Tube	Material: Resin (polyurethane) Outer diameter: ϕ6 Example) Manufacturer: SMC, Model: TU0604-C-20 Manufacturer: CKD, Model: NU-06-20

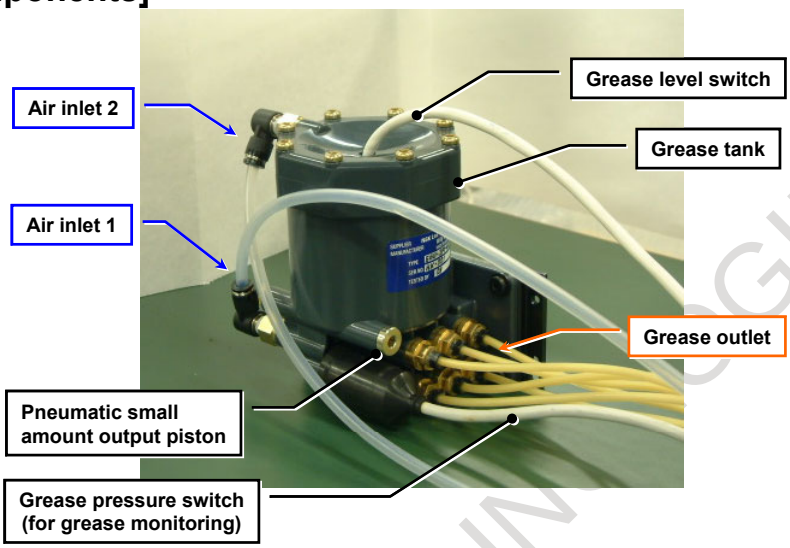
[Components for cleaning compressed air]

Name	Quantity	Specification
Regulator	1	-
Air filter	1	Filtration precision of about 5 μm
Mist separator	1	Filtration precision of about 0.3 μm
Air drier	1	-

4 SPECIFICATIONS

4.1 NAMES AND FUNCTIONS OF COMPONENTS

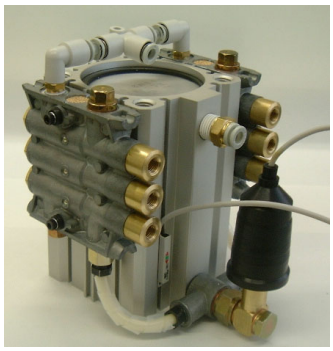
[Names of components]



[Functions of components]

Name	Function
Pneumatic small amount output piston	The piston of the pneumatic small amount output unit performs a stroke operation based on pressurization and depressurization of supply air to output small amounts of grease constantly and steadily.
Grease tank	The tank stores grease to be supplied to the pneumatic small amount output piston. The valid grease capacity is 200 cc ± 10 cc.
Grease pressure switch (for grease monitoring)	The pressure switch monitors the state of supply of grease from the tank to the pneumatic small amount output unit. When the piston and grease are pressurized by air supplied into the tank, the contact of the pressure switch is set to ON.
Grease level switch	The level switch monitors the remaining amount of grease in the tank. The contact is set to ON when the remaining amount of grease is 10 ± 5 cc.
Air inlet 1	This inlet is used to connect air piping for operating the piston of the pneumatic small amount output unit.
Air inlet 2	This inlet is used to connect air piping for pressurizing the tank.
Grease outlet	A constant amount of grease is output from this outlet.

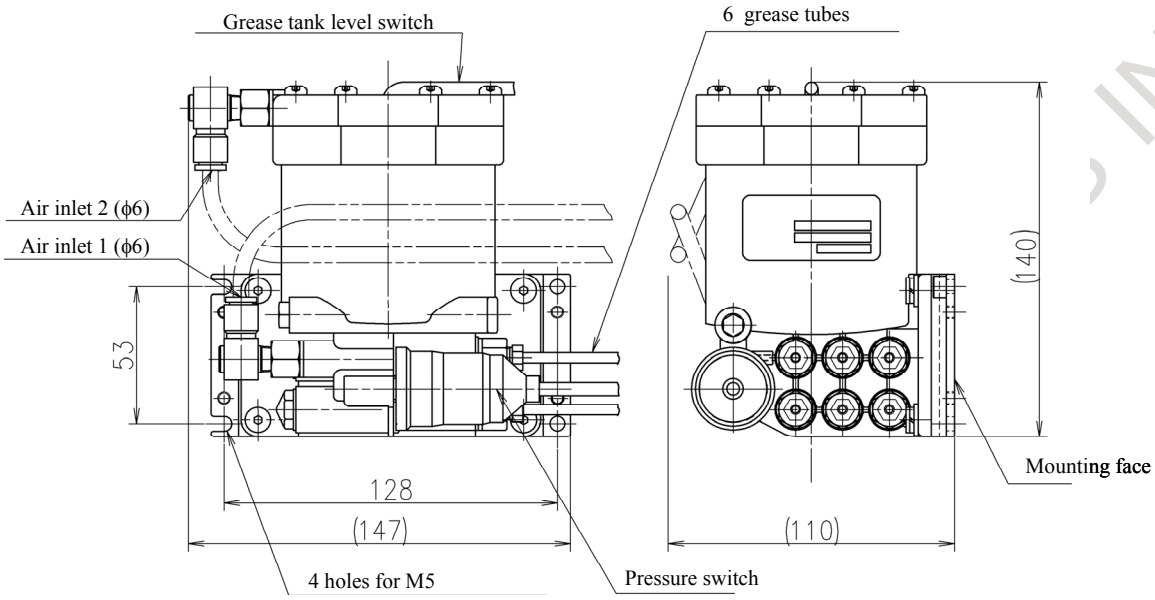
[Older type]



Older type grease units are attached to the spindle shipped before January 2006.
External view and control specification are different.
Please contact FANUC for further information.

Reference) NSK's model name : F-EGU1-2P1×4P2

4.2 DIMENSIONS



Name	Remarks
Grease tube	Length : 1 m
Pressure switch	Cable length: 1 m
Level switch	Cable length: 1 m

4.3 SPECIFICATIONS

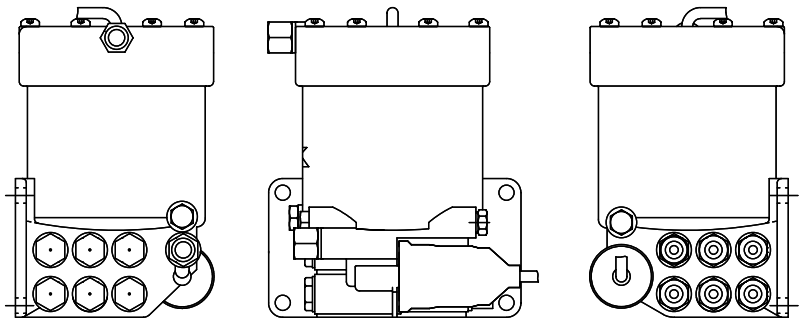
Item	Description
Grease to be used	NSK high-performance grease for high-speed spindle (MTE)
Grease output amount	0.01 cc/shot , 0.02 cc/shot.
Grease distribution method	Pneumatic constant-amount piston
Air pressure to be used	0.25 to 0.4 MPa (for both of air inlets 1 and 2)
Tank capacity Valid amount of grease	200±10 cc
Level switch	Wiring method : 2-wire Type of contact : NC contact (OFF for decreased grease) Applicable load : Max. DC100V / DC0.1A / 30VA
Pressure switch	Wiring method : 2-wire Type of contact : NO contact (ON for increased pressure) Applicable load : Max. DC42V / DC2.5A / 30VA
Grease supply tube	Outer diameter × inner diameter : ϕ4 × ϕ2.5 Length : 1 m
Atmospheric temperature range	20±10°C

4.4 MODEL NUMBER

FANUC's model number : A97L-0203-0226/ARPGU000
(Reference) NSK's model number : EGU-2P1-4P2

Output amount (cc/shot)	Mark No. (*)	Code	Lubrication point
0.01	10	P1	Rear bearing
0.02	20	P2	Front bearing

* A mark number is stamped on the brass plug on the side opposite to the output side of the small amount output piston.



Mark No.			
	10	10	20
	20	20	20

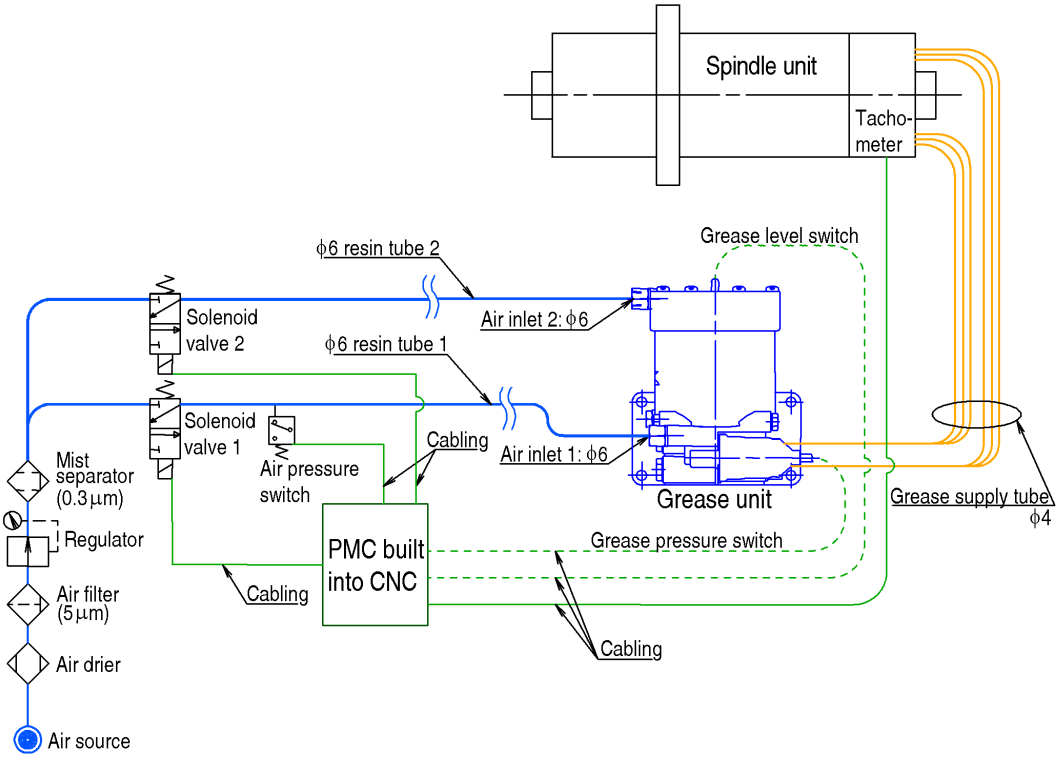
Code			
	P2	P1	P1
	P2	P2	P2

4.5 OPERATION

The pneumatic small amount output piston mounted on the grease unit has a built-in constant amount distributor of piston type for outputting constant small amounts of grease. This distributor supplies small amounts of grease from time to time to the bearings inside the spindle unit.

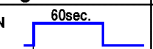
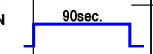
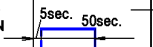
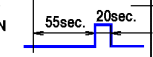
1 Solenoid valves 1 and 2 are turned on.
2 Air is supplied to air inlet 1 of the grease unit to operate the piston of the pneumatic small amount output unit. Thus, a constant amount of grease is output into the ϕ4 tube.
Grease output into the ϕ4 tube is output to the spindle unit and supplied to the inside of each bearing.
Air is supplied to air inlet 2 of the grease unit to pressurize the grease inside the grease tank.
3 When solenoid valve 1 is turned off, the piston of the pneumatic small amount output unit returns to the original position, and grease is supplied from the tank to the pneumatic small amount output unit.
4 Solenoid valve 2 is turned off.

[Piping control system diagram]



4.6 CONTROL SPECIFICATIONS

<1> Operation timing and monitoring time (one grease shot)

Name	Operation timing Monitoring time	Alarm	
		Operation	Description
Solenoid valve 1	60sec. ON 	—	—
Solenoid valve 2	90sec. ON 	—	—
Air pressure switch	*1) 	OFF	Air pressure : LOW
Grease pressure switch	*2) 	OFF	Grease tank pressure : LOW
Grease level switch	*3) 	OFF	Remaining grease : LOW

*1) Monitored for 50 seconds starting at 5 seconds after solenoid valve 1 is actuated
*2) Monitored for 20 seconds starting at 55 seconds after solenoid valve 1 is actuated
*3) Always monitored

<2> Grease output control of speed matching type
To prevent bearing burning and excessive grease supply, grease needs to be supplied at proper intervals. A grease supply interval should be set using the recommended grease output control method of speed matching type.

> **⚠ CAUTION**
> If grease is shot manually for the purpose of confirmation of ladder program during setting up machine, please operate "IV.3 Test run method" certainly.
> Without test run, trouble may occur to the bearings because of abnormal heat generation by too much grease inside the bearings.

Rank coefficient control

- A rank coefficient means a coefficient set for each speed area as shown below.
- Once in every 0.8 second, the speed is checked and converted to a rank coefficient for addition to the counter (database).
- When the cumulative value of the counter reaches 3105000, one grease shot is output and the counter is reset.

Rank coefficient	Rank D 1	Rank C 5	Rank B 25	Rank A 115
Speed area (min^{-1})	Up to 12009	12010 to 14009	14010 to 16509	16510 to 20009

Example 1)

Operation at a constant speed of 20000 min^{-1}

3105000/115×0.8

→ Grease is supplied once for every 21600 seconds (6 hours).

Example 2)

When a speed of 12000 min^{-1} or less is used (including a case where the power to the machine is on but the spindle unit is stopped)

3105000/1×0.8

→ Grease is supplied once for every 28.75 (4 weeks).

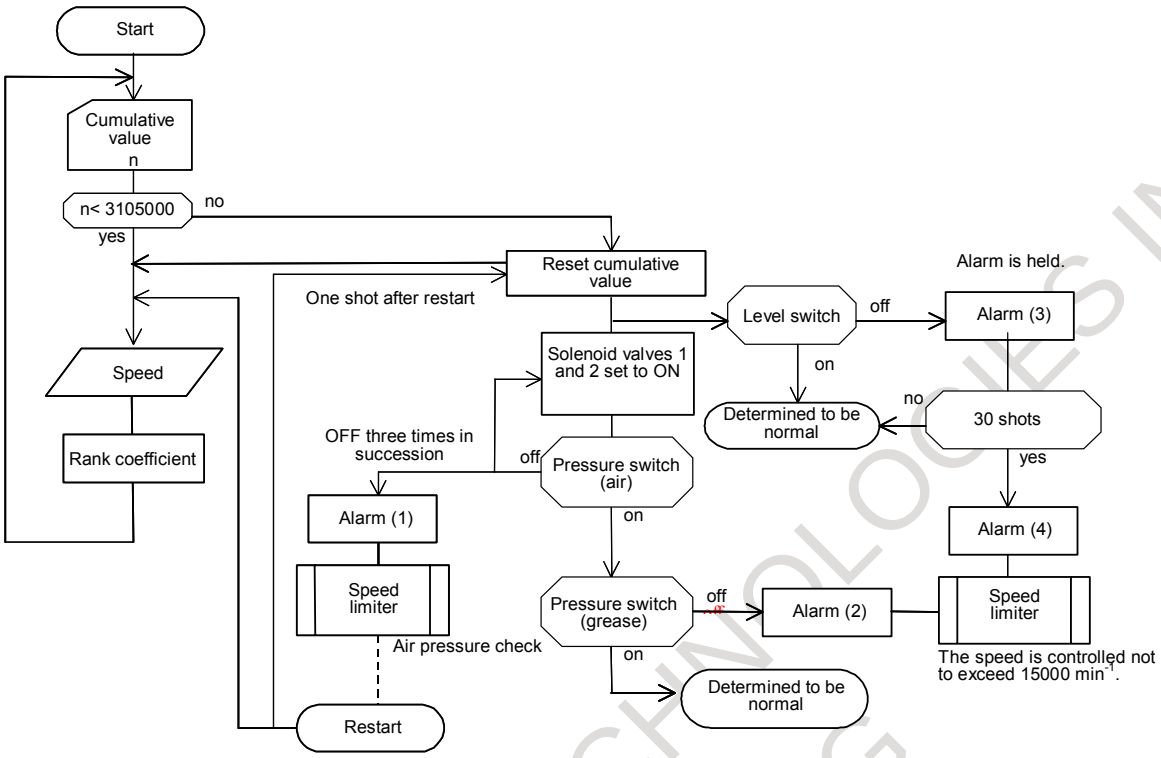
Others

If the maximum speed is not greater than 15000 (min^{-1}), operation in rank B is allowed at all times.

Control flow

Example of alarm indication

Alarm (1)	CAUTION	Compressed air for grease replanishing unit is lacking. Check to be make sure the pressure of compressed air.
Alarm (2)	ERROR	Abnormal grease pressure, Grease pressure may be lacking, Call seviceman of Machine Tool Builder or FANUC. Spindle speed is restricted at 15000min^{-1}.
Alarm (3)	CAUTION	Maintenance timing will be in the near future. Call a sericeman of Machine Tool Builder or FANUC.
Alarm (4)	WARNING	Spindle Unit should be maintained, call serviceman as soon as quickly. Spindle speed is restricted at 15000min^{-1}.



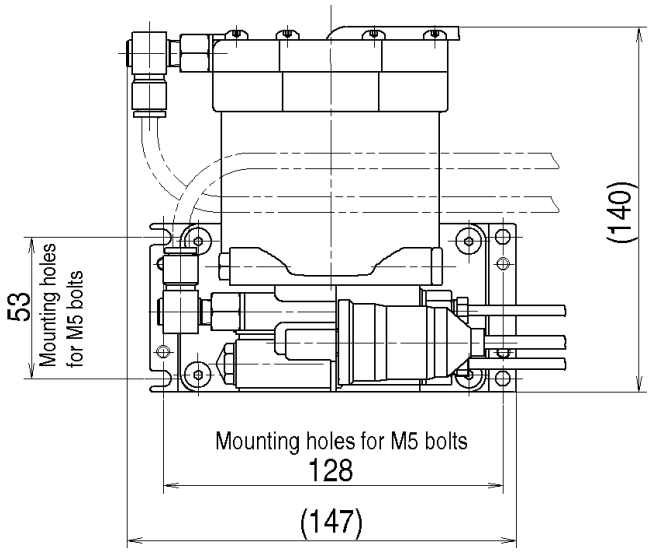
The level switch is set for actuation when the remaining amount of grease in the grease tank is 10 ± 5 cc.
30 shots → One-week operation in rank A (highest speed area) based on 24-hour operation

- Refer to the detailed flowcharts and descriptions in the appendix.

5 HANDLING

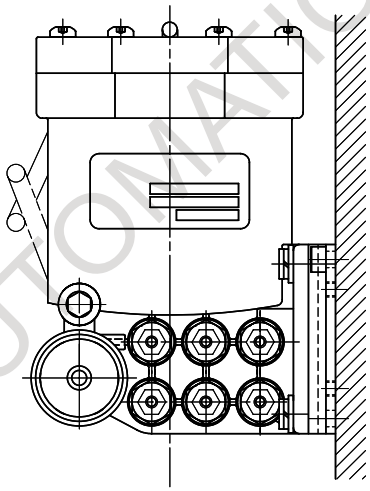
5.1 INSTALLATION

[Mounting holes]

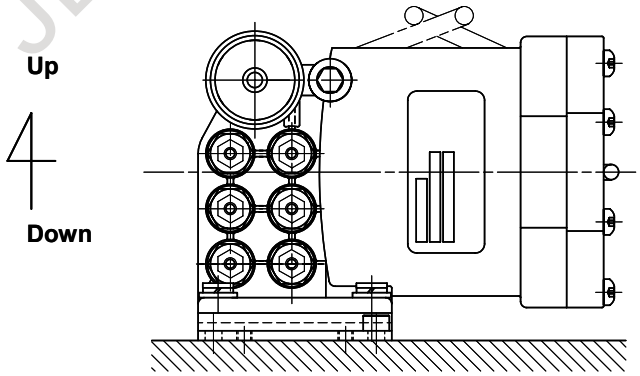


[Mounting position]

The unit can be installed either vertically or horizontally.



Vertical position



Horizontal position

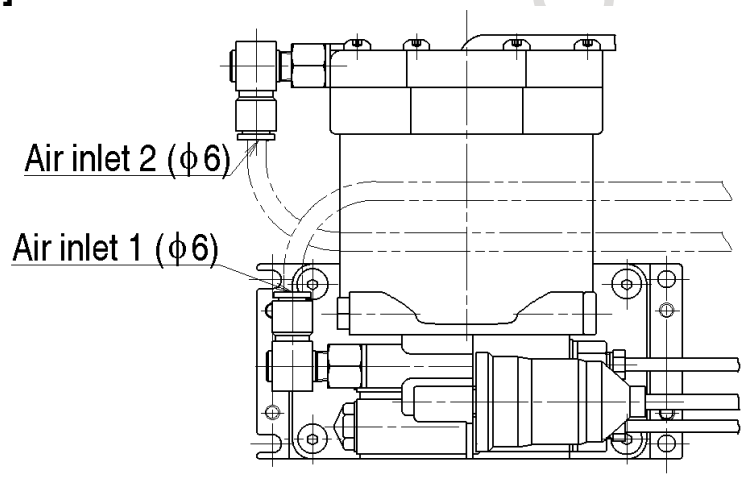
5.2 AIR PIPING

Connect an air tube of ϕ6 to air inlet 1 and air inlet 2.

[Specifications]

Item	Description
Tube	Material: Resin (Polyurethane) Outer diameter: ϕ6 Example) Manufacturer: SMC, Model: TU0604-C-20 Manufacturer: CKD, Model: NU-06-20
Joint	ϕ6 instant joint
Air pressure	0.25 to 0.4 MPa

[Piping diagram]



⚠ CAUTION
When connecting an air tube, ensure that no foreign matter such as dust does not enter the instant joint. Otherwise, a failure or malfunction can occur.

6 ERRORS AND ACTIONS

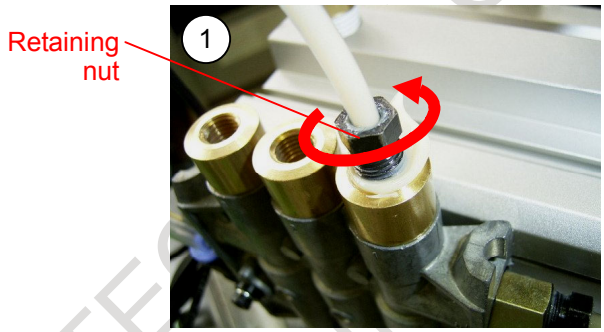
Error	Cause	Action required
The pressure switch (grease) is not actuated.	Insufficient supply air pressure Solenoid valve 2 failure	Check if the supply air pressure is 0.25 Mpa or more. Check the operation of solenoid valve 2.
The pressure switch (air) is not actuated.	Insufficient supply air pressure Solenoid valve 1 failure	Check if the supply air pressure is 0.25 Mpa or more. Check the operation of solenoid valve 1.
The level switch is actuated.	Insufficient remaining amount of grease	Supply grease into the tank.(*)

* Consult with FANUC.

7 CONNECTING TUBES (REFERENCE)

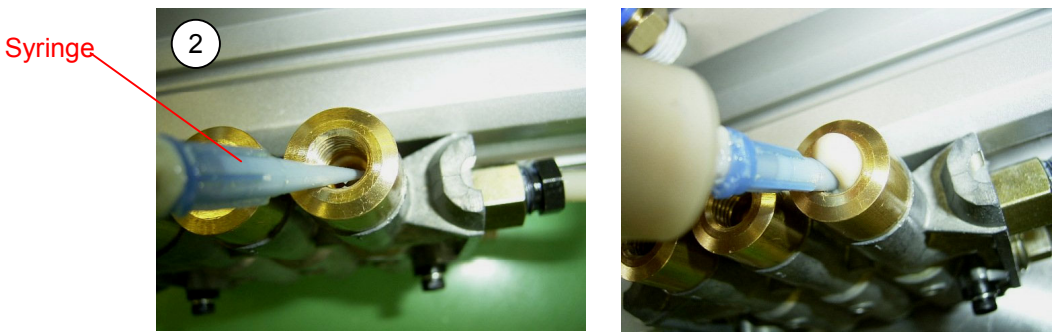
If the grease supply tube needs to be detached when a spindle unit is attached to the spindle head, use the procedure below to reconnect the tube. (A configuration that allows the grease unit to be mounted without detaching the tube is most desirable.)

<1> Detach the grease supply tube connected to the grease unit, by removing the six retaining nuts with a wrench (8 mm).

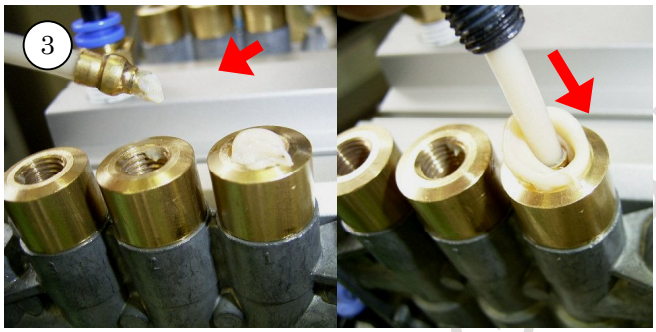


⚠ CAUTION
The inside of a detached tube is exposed to the outside through the tip. So, cover the tip with vinyl sheeting to protect against dust at the time of reconnection.

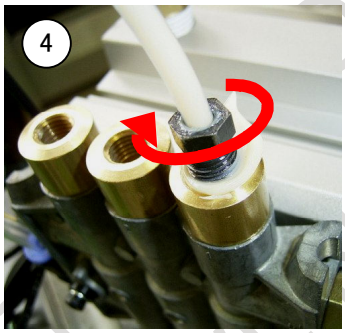
<2> Fill the space of the tube joint with the dedicated grease NSK MTE by using a syringe to prevent air from being mixed. If MTE grease and a syringe are unavailable, the space can be filled by five to six manual grease shots. For manual shots, use the manual button of the solenoid valve after air supply.



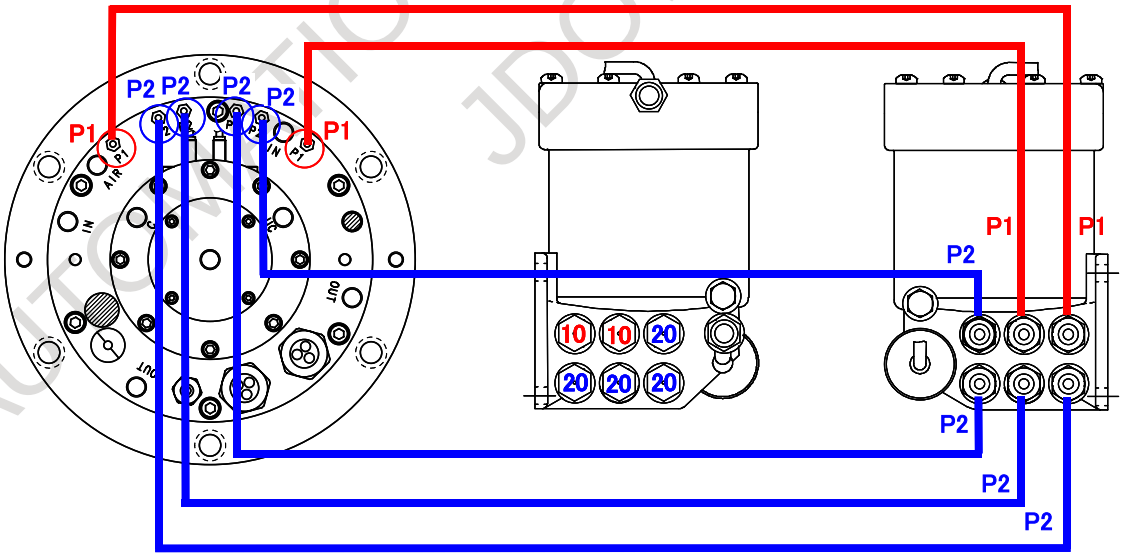
<3> Apply a sufficient amount of grease to the tip of a tube, then insert the tube, allowing grease to be forced out.



<4> Do not pull out a tube once inserted. In this state, tighten the retaining nut, then wipe off grease forced out.



[Piping diagram]



IV. OPERATION METHOD

1 CHECK ITEMS BEFORE A TEST RUN

Before operating the spindle unit for the first time after installation, check the following items:

	Item	Check
1	Check if the spindle unit is secured using specified bolts and tightening torque.	
2	Check if the bolts used to install the spindle unit are not loose.	
3	Check if the axis, when turned manually, rotates lightly and smoothly.	
4	Check if a correct tool holder and pull stud are installed.	
5	Check if the room temperature is 20°C ± 10°C.	
6	Check if the piping of II.5 is correct and is not loose.	
7	Check if the cabling of II.6 is correct and is not disconnected or broken.	
8	Check if the cooling unit operates normally.	
9	Check if the grease unit operates normally.	
10	Check if the air pressure is raised to a specified level.	

> ⚠ **WARNING**
> When turning the axis manually, be sure to turn off the power to the machine.

2 USABLE TEMPERATURE RANGE

When using the spindle unit, ensure that the room temperature is 20°C±10°C. If the room temperature is lower, an excessive pilot pressure may be applied to the bearings, resulting in burning. If the room temperature is higher, grease deteriorates, resulting in degraded lubrication. By using a thermistor, the temperature of the motor windings can be monitored. So, the use of an interlock mechanism is recommended.
If a temperature beyond this range is unavoidable, measures such as imposing a limitation on the speed are required. Be sure to consult with FANUC.

3 TEST RUN METHOD

Before shipment, all spindle units undergo a test run at the factory. In any of the cases listed below, however, the customer must perform a test run. If the temperature increases over the value shown in the "Table 1", or an abnormal sound is generated during a test run, immediately return the spindle unit to FANUC. The spindle unit is rechecked and inspected by FANUC. In this case, however, the user may be billed for a cost actually incurred by the result of recheck and inspection or by the lapse from the shipment.

> ⚠ **CAUTION**
> Test run is very important. If spindle units start normal operation without any test run, troubles may occur. FANUC assumes no responsibility for damage caused by not following directions for proper use.

(1) If any of the following cases applies, be sure to perform a test run as described on the next page:

- If the spindle unit is first rotated after it is unpacked
- If the spindle unit is first rotated after attached to the spindle head
- If the spindle unit has undergone delivery, relocation or transportation to end-users after attached to the spindle head
- If the spindle unit alone has been stored for a period longer than six months
- If the spindle unit is not used for one month or more after installation
- If grease is shot manually for the purpose of confirmation of ladder program during setting up machine (20000min^{-1} model)

> ⚠ **CAUTION**
> - FANUC-NSK spindle units have adopted grease lubrication. In the grease lubricated spindles, grease which has been spread from rolling contact surface of rolling element might be returned to rolling contact surface by shock and vibration when it is raised or lowered by such as cranes or forklifts, or transported by ship or truck. In this case, agitation resistance will cause abnormal temperature increase when spindle will be rotated next time.
> - In the grease lubricated spindles, base oil of grease may be dried after long period storage without any operation. This may cause improper lubrication.

[Test run cycle (2 hours)]

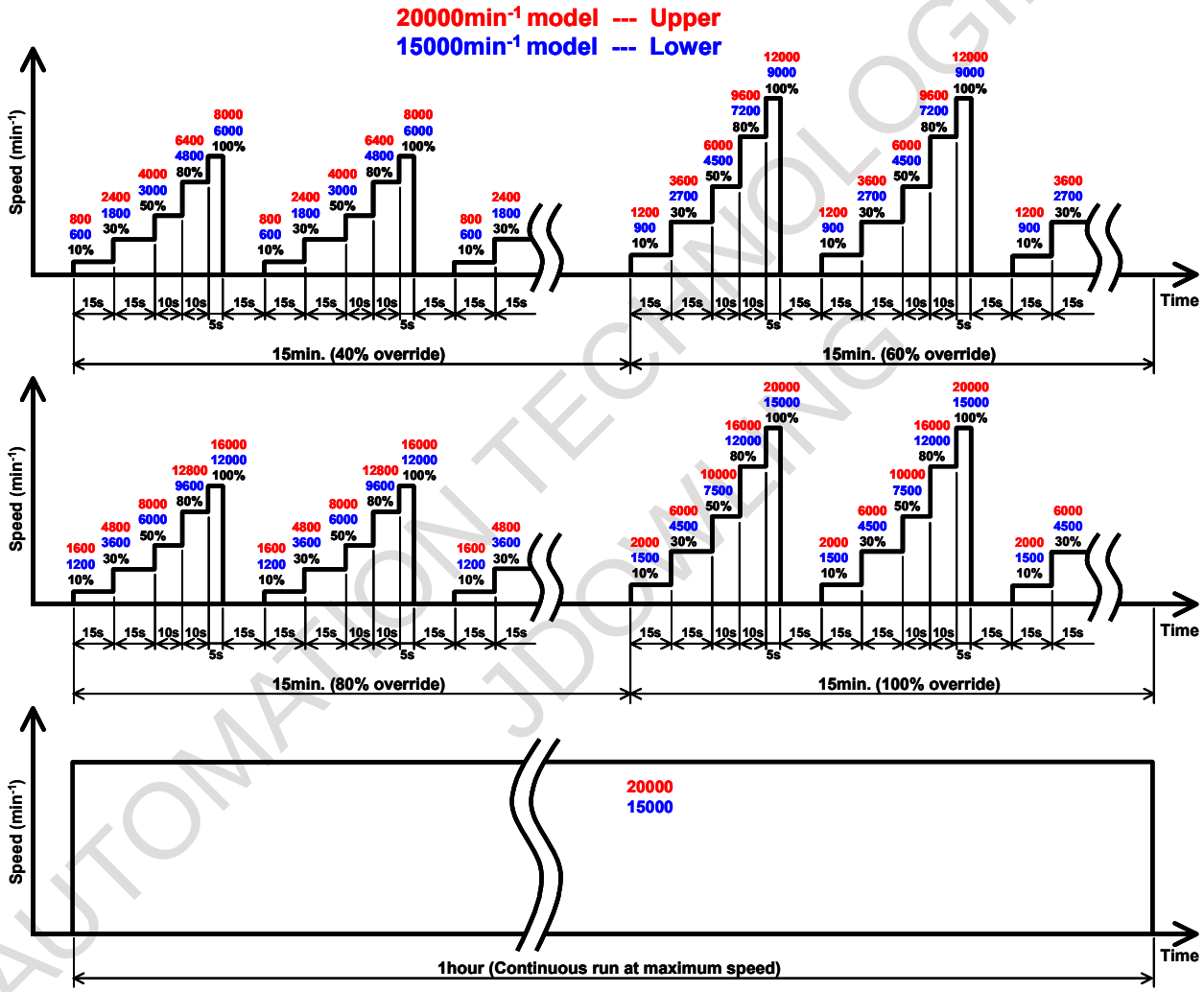
<1> Increase the override of the maximum spindle speed from 40% to 100% in steps of 20%.

15,000 min^{-1} model : S6000, S9000, S12000, S15000
20,000 min^{-1} model : S8000, S12000, S16000, S20000

<2> Perform a run for 15 minutes at each override.

<3> The operation cycle at each override is shown below.

<4> Finally, perform a run at a spindle override of 100% (max. speed 20,000 or 15,000 min^{-1}) for one hour.



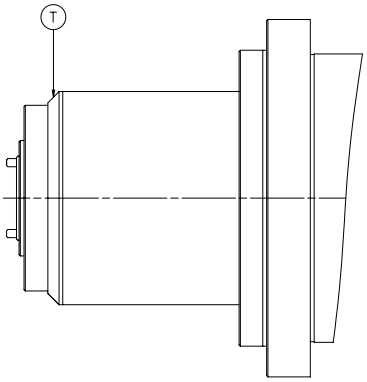
NOTE
The operation of <1> may be performed using a program if overriding is disabled.

<5> During the test run, please determine the temperature of the outer surface of the nose tip, "T-point" shown in the illustration, and check the rise to room temperature as below

(Table 1)

Model	MS112S		MS112L	
Max. speed	15000min^{-1}	20000min^{-1}	15000min^{-1}	20000min^{-1}
Temperature rise (reference)	≤ about 12°C	≤ about 14°C	≤ about 10°C	≤ about 12°C

(Measurement point)



<6> After the test run, please check the load meter at the maximum speed without any load as shown below. If the load meter is not stabile and increase up to about 20-30% and decrease within a moment, please retry the test run from the beginning. Several times of the test run may be required according to the circumstances.

Model	MS112S		MS112L	
Max. speed	15000min^{-1}	20000min^{-1}	15000min^{-1}	20000min^{-1}
Load meter (reference)	≤ about 8%	≤ about 16%	≤ about 7%	≤ about 11%

These value is for reference and not guaranteed, however, if the load meter doesn't hold the steady value after the test run of several times, please contact to FANUC.

(2) Before starting daily work, be sure to perform test run below

[Test run cycle (36 minutes)]

Order	Speed (min^{-1})	Operation time
1	3,000	5 minutes
2	6,000	5 minutes
3	10,000	5 minutes
4	15,000	5 minutes
5	20,000	1 minute
6	10,000	5 minutes
7	15,000	5 minutes
8	20,000	5 minutes

V. MAINTENANCE

> ⚠ **CAUTION**
> 1 The inspection and maintenance work described in this manual represents a condition for guaranteeing the operation of the spindle unit. So, be sure to perform the inspection and maintenance work.
> 2 Performing a test run described in Chapter 3, "TEST RUN METHOD", in part IV, and the inspection and maintenance work described in Chapters 1 and 2 is the condition for guaranteeing the operation of the spindle unit.

1 ROUTINE INSPECTION

The spindle is a precision machine. Perform the following routine inspections every day at the start of operation so that stable performance can be obtained from the spindle:

	Item	Check
1	Check if the axis, when turned manually, rotates lightly and smoothly.	
2	Check if cuttings and coolant residuals are attached to the periphery of a slinger.	
3	Check if dust such as cuttings is attached to the spindle taper portion.	
4	For operation at 15,000 min^{-1} or more immediately after power-up, increase the speed gradually by using the spindle override function. (This substitutes for a simple test run.)	
5	Check if an abnormal sound is generated.	
6	Check if an abnormal vibration is generated.	
7	Check if an abnormal heat is generated.	

⚠ WARNING
When turning the axis manually, be sure to turn off the power to the machine.

2 MAINTENANCE

If a spindle unit with a grease unit attached is used, and all grease contained in the grease unit is used up (the grease level switch is set to OFF), grease needs to be supplied. Likewise, periodical maintenance is required for consumable/wear parts.
Depending on the use frequency of and damage to parts, maintenance becomes necessary in general when two years have elapsed after the start of machine use or when the spindle is used for 10,000 hours. Be sure to contact FANUC or the machine tool builder when maintenance becomes necessary.

Consumable part	Guideline for maintenance	Maintenance work	Maintenance method
Bearing	10,000 hours	Replace the bearing and grease.	To be sent back to FANUC for repair
Draw bar	2,000,000 times	Replace the spring or the whole draw bar.	To be sent back to FANUC for repair
Rotary joint	10,000 hours	Replace the rotary joint.	To be replaced by the machine tool builder by using a part supplied by FANUC

NOTE
To minimize down time of machine at maintenance, please prepare spare items.

3 STORAGE

STORAGE METHOD

Apply rust-proof oil to the surface of the spindle unit, then pack the spindle unit and store the packed spindle unit at a location that satisfies the conditions described below.

- Indoor place not exposed to direct sunlight (place where the temperature varies little, the room temperature is within 5°C to 40°C, and the humidity is 35% to 85% RH)
- Place well ventilated
- Place subject to little vibration and dust
- On the shelf (Do not place the spindle unit directly on the floor.)

USING A SPINDLE UNIT STORED FOR A LONG TIME

When using a spindle unit stored for one month or more at a place satisfying the conditions above, check the external view to see if an abnormality such as rust has occurred and turn the axis to check for an irregular movement before installing the spindle unit on the machine. After installation, perform a test run according to the cycle described in Chapter 3, "TEST RUN METHOD" in Part IV, depending on the storage period.

APPENDIX

A SPECIFICATION NUMBERS

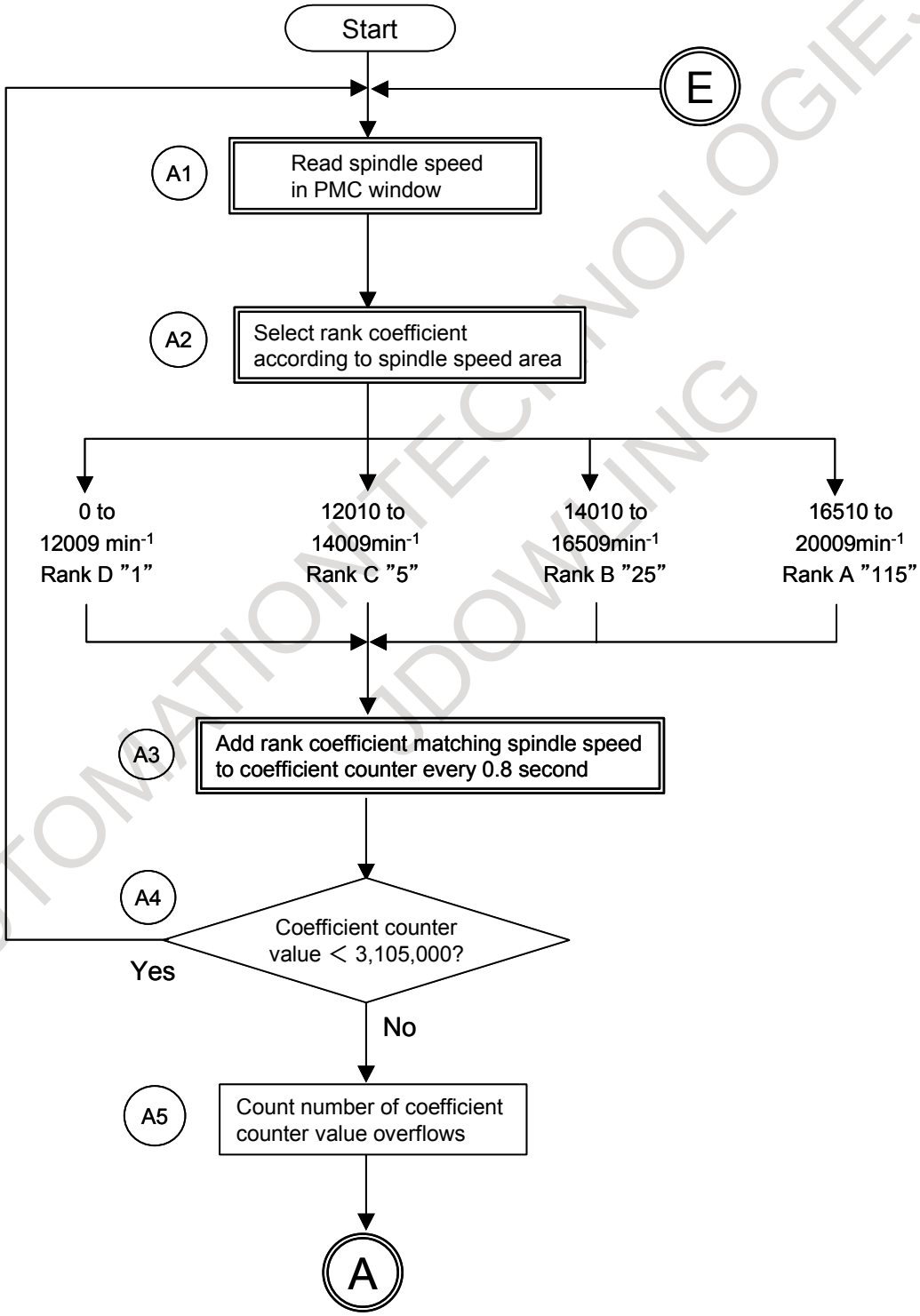
Spindle taper : BT40

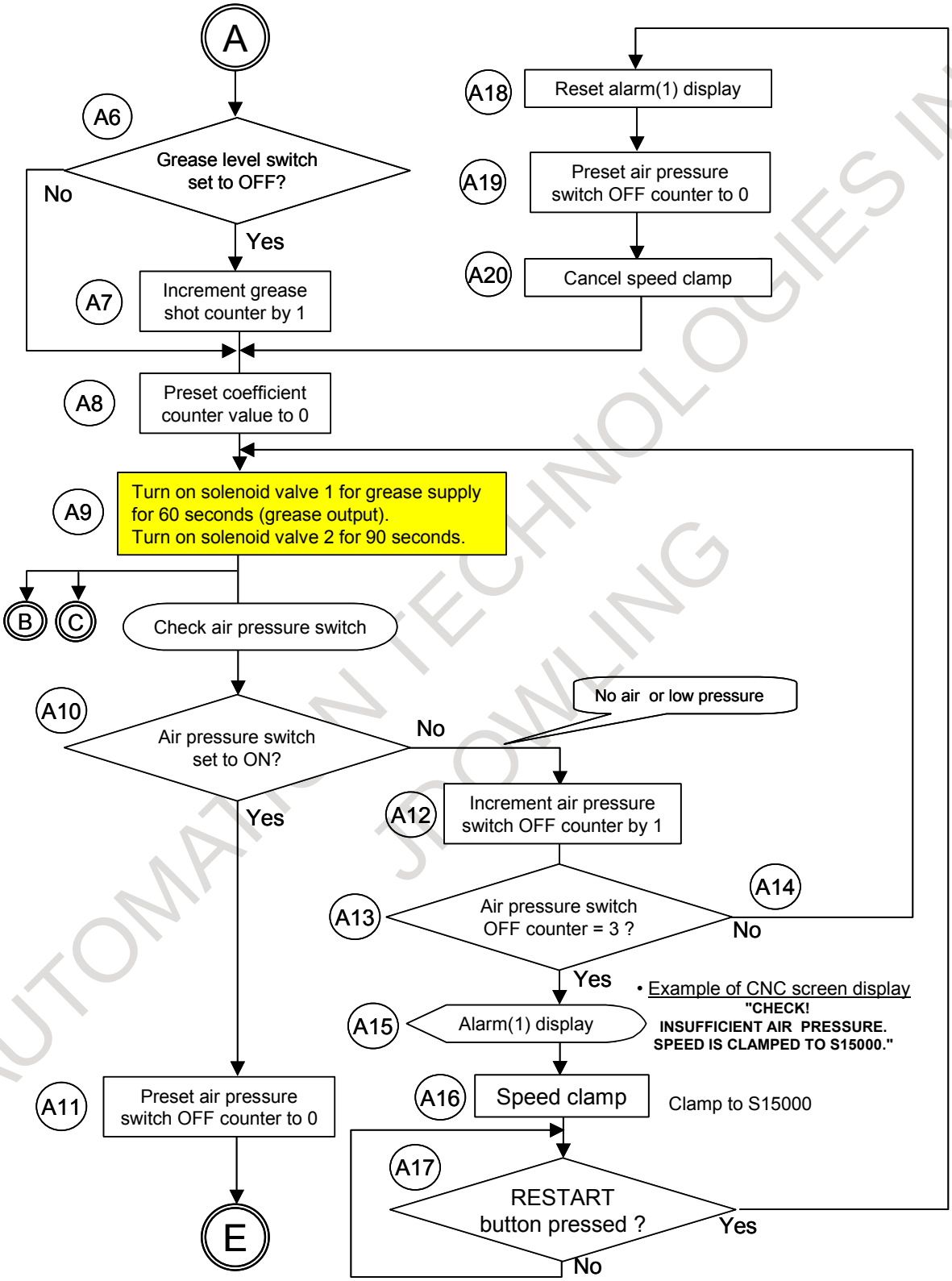
Type	Name	Spindle unit specification number	Tool clamp/unclamp, Tool presence/absence detection switch	Clamp error detection switch	Grease supply lubrication	Center through coolant	Flood coolant
1	MS112S /15000	A06B-1902-B000#0030	○	-	-	-	-
2		A06B-1902-B000#0130				○	-
3		A06B-1902-B000#0230				-	○
4		A06B-1902-B000#0330				○	○
5	MS112S /20000	A06B-1902-B011#1030		○	○	-	-
6		A06B-1902-B011#1130				○	-
7		A06B-1902-B011#1230				-	○
8		A06B-1902-B011#1330				○	○
9	MS112L /15000	A06B-1904-B000#0030	○	-	-	-	-
10		A06B-1904-B000#0130				○	-
11		A06B-1904-B000#0230				-	○
12		A06B-1904-B000#0330				○	○
13	MS112L /20000	A06B-1904-B011#1030		○	○	-	-
14		A06B-1904-B011#1130				○	-
15		A06B-1904-B011#1230				-	○
16		A06B-1904-B011#1330				○	○

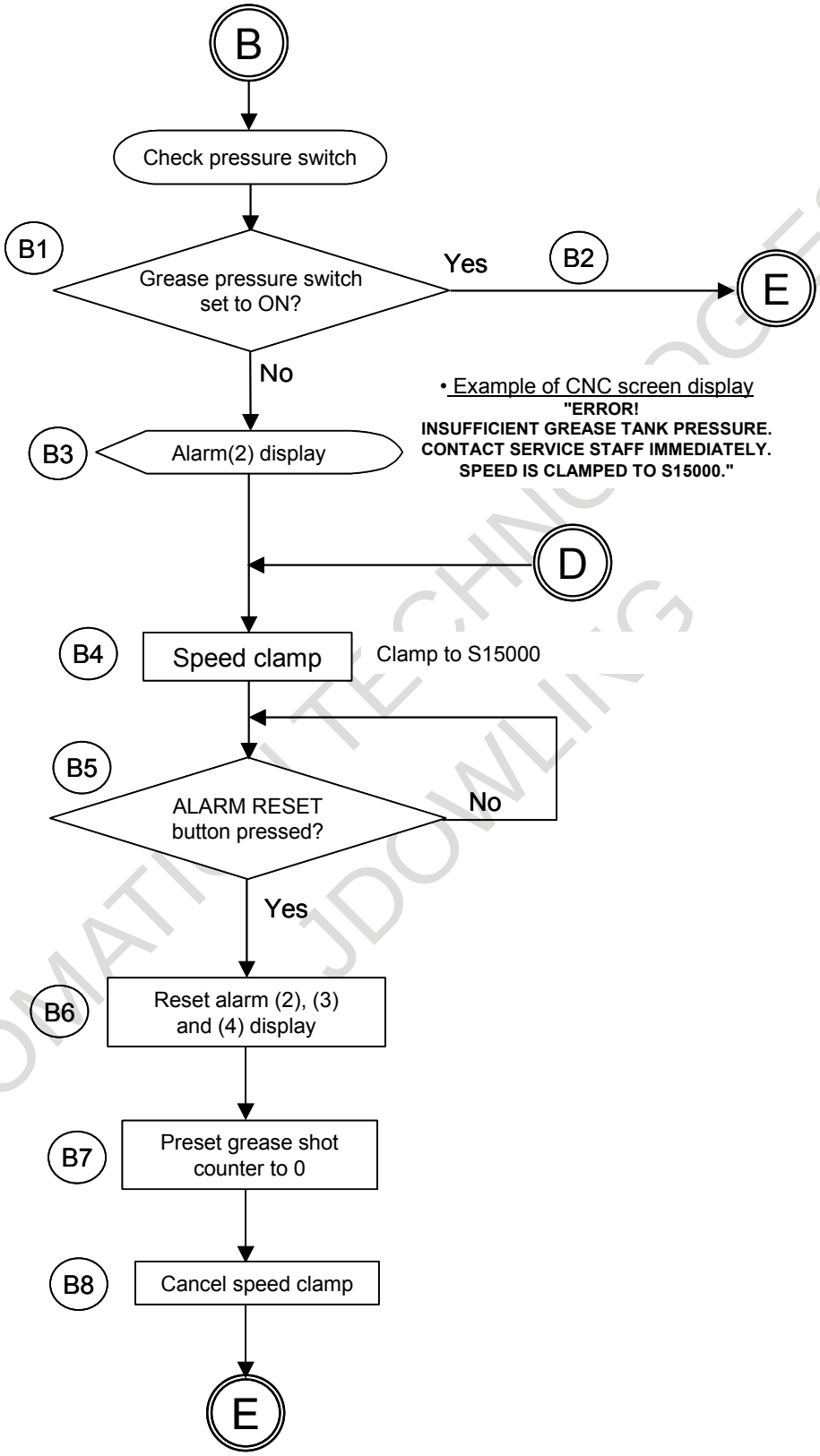
Spindle taper : HSK-A63 (20000min^{-1} only)

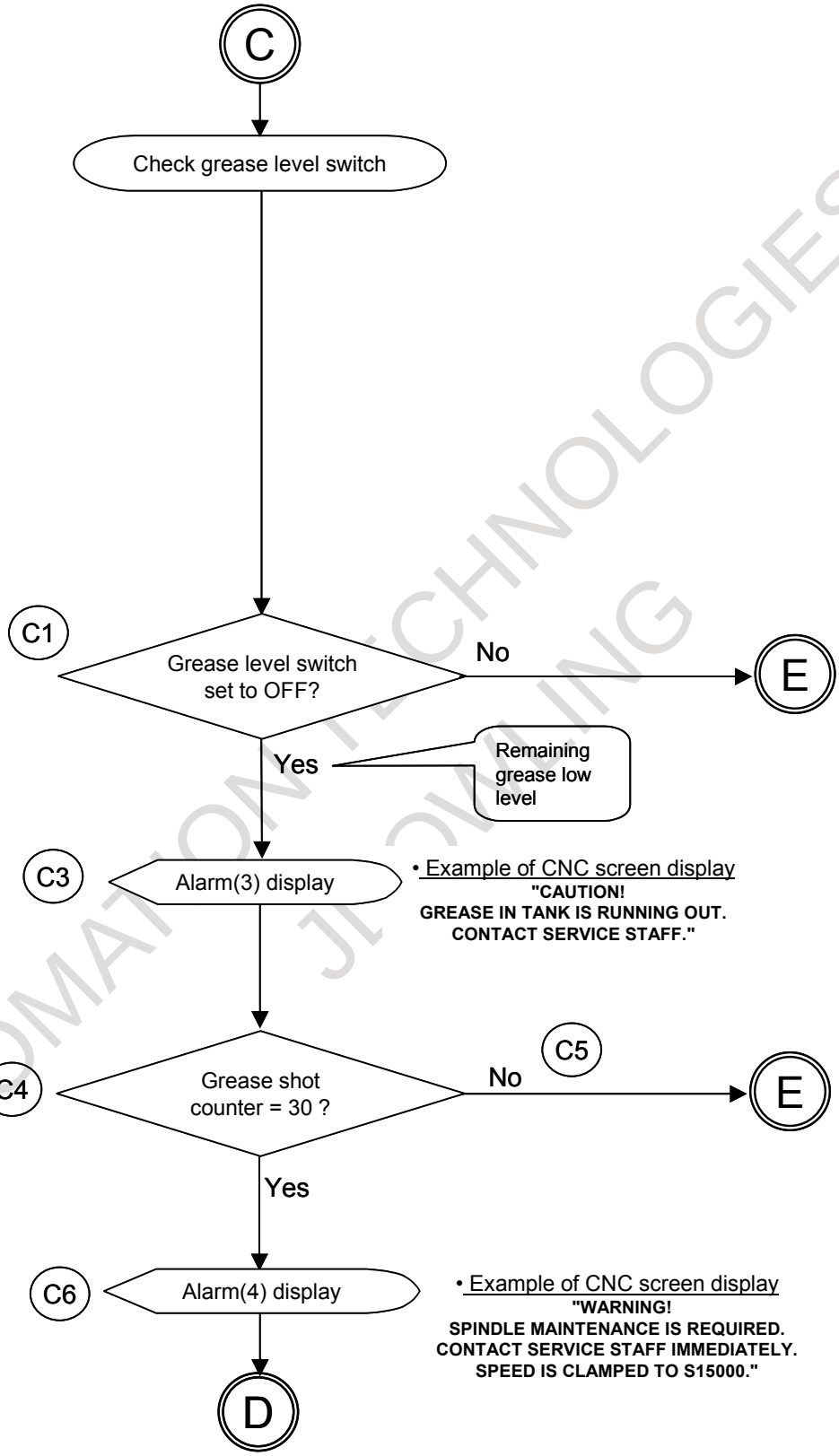
Type	Name	Spindle unit specification number	Tool clamp/unclamp, Tool presence/absence detection switch	Clamp error detection switch	Grease supply lubrication	Center through coolant	Flood coolant
1	MS112S /20000	A06B-1902-B041#1030	○	○	○	-	-
2		A06B-1902-B041#1130				○	-
3		A06B-1902-B041#1230				-	○
4		A06B-1902-B041#1330				○	○
5	MS112L /20000	A06B-1904-B041#1030	○	○	○	-	-
6		A06B-1904-B041#1130				○	-
7		A06B-1904-B041#1230				-	○
8		A06B-1904-B041#1330				○	○

B EXAMPLE OF GREASE UNIT LADDER PROGRAM FLOW CHART









B.1 FLOWCHART OF PMC PROGRAM FOR GREASE OUTPUT

B.1.1 Grease Output Main Routine

A1 The spindle speed is read from the PMC window.

A2 A "rank coefficient" is selected according to the spindle speed area.

A3 The result of "spindle speed" × "rank coefficient" is added to the "coefficient counter" every 0.8 second.
(To increase the grease output interval at low speed or decrease the grease output interval at high speed)

A4 Coefficient counter < 3,105,000? Yes → To A1
(If the value of the coefficient counter exceeds 3105000, control goes to the grease output routine.)

A5 No → The number of times the coefficient counter exceeds 3,105,000 is counted.
(Grease output count monitoring)

A6 Is the grease level reduction alarm set to OFF?
(The remaining amount of grease in the grease tank is checked.)

A7 Yes → The grease shot counter is incremented by 1.
(The remaining amount of grease becomes lower than the specified level.)

A8 No → The "coefficient counter" is preset to 0.

A9 Solenoid valve 1 for grease supply is turned on for 60 seconds.
(Grease output)
Solenoid valve 2 is turned on for 90 seconds.
(The grease tank piston is pressurized then depressurized.)
→ Routines B and C start.

A10 Is the air pressure switch set to ON?
No → To check sequence. A12

A11 Yes → The "OFF counter" of the pressure switch (air) is preset to 0. To A1

B.1.2 Air Pressure Switch Check Routine

A12 The "OFF counter" of the air pressure switch air is incremented by 1. (Low air pressure, first time)
A13 "OFF counter" = 3? (If Yes, a message is displayed.)
A14 No → Control returns to A9 of the main routine.
(A retry is performed if the counter value has not reached 3.)
A15 Yes → PMC program should display the following sentence on CNC screen.
" Check! Insufficient air pressure ----- "
A16 The maximum speed is clamped to 15000 revolutions.
A17 Is the "RESTART" button pressed?
(When No, the program waits for Yes.)
A18 Yes → The CNC screen display is erased.
A19 The OFF counter of the air pressure switch is preset to 0.
A20 The speed clamp is canceled, and control returns to A8.

B.1.3 Grease Pressure Switch Check Routine

B1 Is the grease pressure switch set to ON?
B2 Yes → Control returns to E (A1). (Normal)
B3 No → PMC program should display the following sentence on CNC screen.
"Error! Insufficient grease tank pressure ----- "
B4 The maximum speed is clamped to 15000 revolutions.
B5 Is the "ALARM RESET" button pressed?
(When No, the program waits for Yes.)
B6 Yes → An error is displayed on the CNC screen.
Screen display (2), (3) and (4) (B3, C3, and C6) are reset.
B7 The grease shot counter is preset to 0.
B8 The speed clamp is cancelled.
To E (A1).

B.1.4 Grease Low Level Alarm Routine

C1 Is the grease level switch set to OFF?
C2 No → To E (A1) (Normal)
C3 Yes → PMC proguram should display the following sentence on CNC screen.
"Caution! Grease in tank is running out -------"
C4 Grease shot counter = 30?
C5 No → To E (A1)
C6 Yes → PMC proguram should display the following sentence on CNC screen.
"Warning! Spindle maintenance is required -------"
To D (B4)

C PARAMETER LIST

MS112S/15000 [SPINDLE HRV control]

Amplifier : αiSP 30 (TYPE A) A06B-6111-H030#H550 (for FS16*i*, FS15*i*)
A06B-6111-H030#H570 (for FS30*i*)

Low speed range				High speed range			
Parameter No.			7.5/11 kW	Parameter No.			11/15/18.5 kW
FS15*i*	FS16*i*	FS30*i*	2300/6000 min^{-1}	FS15*i*	FS16*i*	FS30*i*	6000/15000 min^{-1}
				3001	4001	4001	00000001
				3002	4002	4002	00000001
				3003	4003	4003	00000000
				3004	4004	4004	00000000
				3006	4006	4006	00000000
				3007	4007	4007	00000000
				3008	4008	4008	00010000
				3009	4009	4009	00000000
				3010	4010	4010	00000001
				3011	4011	4011	00001010
				3012	4012	4012	10000010
				3013	4013	4013	01010000
				3019	4019	4019	00000100
				3020	4020	4020	15000
				3023	4023	4023	400
3156	4156	4156	0	3039	4039	4039	0
3166	4166	4166	23125	3080	4080	4080	7253
3138	4138	4138	2000	3100	4100	4100	6200
3139	4139	4139	80	3101	4101	4101	95
3140	4140	4140	4053	3102	4102	4102	8859
3141	4141	4141	0	3103	4103	4103	0
3142	4142	4142	2500	3104	4104	4104	1500
				3105	4105	4105	0
3143	4143	4143	4000	3106	4106	4106	2500
				3107	4107	4107	0
3144	4144	4144	0	3108	4108	4108	0
3145	4145	4145	25	3109	4109	4109	25
3146	4146	4146	2623	3110	4110	4110	1724
3147	4147	4147	600	3111	4111	4111	328
3148	4148	4148	200	3112	4112	4112	200
3149	4149	4149	1058	3113	4113	4113	1058
3150	4150	4150	0	3114	4114	4114	0
3151	4151	4151	100	3115	4115	4115	100
3152	4152	4152	9998	3116	4116	4116	8996
3153	4153	4153	90	3117	4117	4117	90
3154	4154	4154	100	3118	4118	4118	100
3165	4165	4165	20	3119	4119	4119	9
				3120	4120	4120	0
3155	4155	4155	0	3124	4124	4124	0
3093	4093	4093	176	3127	4127	4127	202
3158	4158	4158	110	3128	4128	4128	0
3159	4159	4159	0	3129	4129	4129	0
3161	4161	4161	25700	3130	4130	4130	25700
				3134	4134	4134	140
					4169	4169	0
Max. power at acceleration (for selecting αiPS) : 24.4 kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
If you don't want to initialize adjusted parameters, you should not load parameters automatically.

(2) Change parameters manually according to the table.

(3) Power off/on to activate the SPINDLE HRV parameters surely.

MS112S/20000 [SPINDLE HRV control]

Amplifier : αiSP 30 (TYPE A) A06B-6111-H030#H550 (for FS16*i*, FS15*i*)
A06B-6111-H030#H570 (for FS30*i*)

Low speed range				High speed range			
Parameter No.			7.5/11 kW	Parameter No.			11/15/18.5 kW
FS15*i*	FS16*i*	FS30*i*	2300/6000 min^{-1}	FS15*i*	FS16*i*	FS30*i*	6000/20000 min^{-1}
				3001	4001	4001	00000001
				3002	4002	4002	00000001
				3003	4003	4003	00000000
				3004	4004	4004	00000000
				3006	4006	4006	00000000
				3007	4007	4007	00000000
				3008	4008	4008	00010000
				3009	4009	4009	00000000
				3010	4010	4010	00000001
				3011	4011	4011	00001010
				3012	4012	4012	10000010
				3013	4013	4013	01010000
				3019	4019	4019	00000100
				3020	4020	4020	20000
				3023	4023	4023	300
3156	4156	4156	0	3039	4039	4039	0
3166	4166	4166	23125	3080	4080	4080	7253
3138	4138	4138	2000	3100	4100	4100	6200
3139	4139	4139	80	3101	4101	4101	95
3140	4140	4140	4053	3102	4102	4102	8859
3141	4141	4141	0	3103	4103	4103	0
3142	4142	4142	2500	3104	4104	4104	1500
				3105	4105	4105	0
3143	4143	4143	4000	3106	4106	4106	2500
				3107	4107	4107	0
3144	4144	4144	0	3108	4108	4108	0
3145	4145	4145	25	3109	4109	4109	25
3146	4146	4146	2623	3110	4110	4110	1724
3147	4147	4147	600	3111	4111	4111	328
3148	4148	4148	200	3112	4112	4112	200
3149	4149	4149	1058	3113	4113	4113	1058
3150	4150	4150	0	3114	4114	4114	0
3151	4151	4151	100	3115	4115	4115	100
3152	4152	4152	9998	3116	4116	4116	8996
3153	4153	4153	90	3117	4117	4117	90
3154	4154	4154	100	3118	4118	4118	100
3165	4165	4165	20	3119	4119	4119	9
				3120	4120	4120	0
3155	4155	4155	0	3124	4124	4124	0
3093	4093	4093	176	3127	4127	4127	202
3158	4158	4158	110	3128	4128	4128	0
3159	4159	4159	0	3129	4129	4129	0
3161	4161	4161	25700	3130	4130	4130	25700
				3134	4134	4134	140
					4169	4169	0
Max. power at acceleration (for selecting αiPS) : 24.4 kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
If you don't want to initialize adjusted parameters, you should not load parameters automatically.

(2) Change parameters manually according to the table.

(3) Power off/on to activate the SPINDLE HRV parameters surely.

MS112L/15000 [SPINDLE HRV control]

Amplifier : αiSP 30 (TYPE A) A06B-6111-H030#H550 (for FS16*i*, FS15*i*)
A06B-6111-H030#H570 (for FS30*i*)

Low speed range				High speed range			
Parameter No.			15/18.5 kW	Parameter No.			18.5/22 kW
FS15*i*	FS16*i*	FS30*i*	1800/4000 min^{-1}	FS15*i*	FS16*i*	FS30*i*	8000/15000 min^{-1}
				3001	4001	4001	00000001
				3002	4002	4002	00000001
				3003	4003	4003	00000000
				3004	4004	4004	00000000
				3006	4006	4006	00000000
				3007	4007	4007	00000000
				3008	4008	4008	00010000
				3009	4009	4009	00000000
				3010	4010	4010	00000001
				3011	4011	4011	00001010
				3012	4012	4012	10000010
				3013	4013	4013	01010000
				3019	4019	4019	00000100
				3020	4020	4020	15000
				3023	4023	4023	267
3156	4156	4156	0	3039	4039	4039	0
3166	4166	4166	90	3080	4080	4080	12895
3138	4138	4138	1640	3100	4100	4100	5000
3139	4139	4139	100	3101	4101	4101	100
3140	4140	4140	2047	3102	4102	4102	5537
3141	4141	4141	0	3103	4103	4103	0
3142	4142	4142	6000	3104	4104	4104	2000
				3105	4105	4105	0
3143	4143	4143	6000	3106	4106	4106	2000
				3107	4107	4107	0
3144	4144	4144	0	3108	4108	4108	0
3145	4145	4145	25	3109	4109	4109	25
3146	4146	4146	1231	3110	4110	4110	670
3147	4147	4147	246	3111	4111	4111	167
3148	4148	4148	200	3112	4112	4112	200
3149	4149	4149	1145	3113	4113	4113	1005
3150	4150	4150	0	3114	4114	4114	0
3151	4151	4151	100	3115	4115	4115	100
3152	4152	4152	10911	3116	4116	4116	9613
3153	4153	4153	90	3117	4117	4117	90
3154	4154	4154	100	3118	4118	4118	100
3165	4165	4165	5	3119	4119	4119	7
				3120	4120	4120	0
3155	4155	4155	0	3124	4124	4124	0
3093	4093	4093	148	3127	4127	4127	143
3158	4158	4158	0	3128	4128	4128	0
3159	4159	4159	0	3129	4129	4129	0
3161	4161	4161	25700	3130	4130	4130	25700
				3134	4134	4134	180
					4169	4169	0
Max. power at acceleration (for selecting αiPS) : 27.9kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
If you don't want to initialize adjusted parameters, you should not load parameters automatically.

(2) Change parameters manually according to the table.

(3) Power off/on to activate the SPINDLE HRV parameters surely.

MS112L/20000 [SPINDLE HRV control]

Amplifier : αiSP 30 (TYPE A) A06B-6111-H030#H550 (for FS16*i*, FS15*i*)
A06B-6111-H030#H570 (for FS30*i*)

Low speed range				High speed range			
Parameter No.			15/18.5 kW	Parameter No.			18.5/22 kW
FS15*i*	FS16*i*	FS30*i*	1800/4000 min^{-1}	FS15*i*	FS16*i*	FS30*i*	8000/20000 min^{-1}
				3001	4001	4001	00000001
				3002	4002	4002	00000001
				3003	4003	4003	00000000
				3004	4004	4004	00000000
				3006	4006	4006	00000000
				3007	4007	4007	00000000
				3008	4008	4008	00010000
				3009	4009	4009	00000000
				3010	4010	4010	00000001
				3011	4011	4011	00001010
				3012	4012	4012	10000010
				3013	4013	4013	01010000
				3019	4019	4019	00000100
				3020	4020	4020	20000
				3023	4023	4023	200
3156	4156	4156	0	3039	4039	4039	0
3166	4166	4166	90	3080	4080	4080	12895
3138	4138	4138	1640	3100	4100	4100	5000
3139	4139	4139	100	3101	4101	4101	100
3140	4140	4140	2047	3102	4102	4102	5537
3141	4141	4141	0	3103	4103	4103	0
3142	4142	4142	6000	3104	4104	4104	2000
				3105	4105	4105	0
3143	4143	4143	6000	3106	4106	4106	2000
				3107	4107	4107	0
3144	4144	4144	0	3108	4108	4108	0
3145	4145	4145	25	3109	4109	4109	25
3146	4146	4146	1231	3110	4110	4110	670
3147	4147	4147	246	3111	4111	4111	167
3148	4148	4148	200	3112	4112	4112	200
3149	4149	4149	1145	3113	4113	4113	1005
3150	4150	4150	0	3114	4114	4114	0
3151	4151	4151	100	3115	4115	4115	100
3152	4152	4152	10911	3116	4116	4116	9613
3153	4153	4153	90	3117	4117	4117	90
3154	4154	4154	100	3118	4118	4118	100
3165	4165	4165	5	3119	4119	4119	7
				3120	4120	4120	0
3155	4155	4155	0	3124	4124	4124	0
3093	4093	4093	148	3127	4127	4127	143
3158	4158	4158	0	3128	4128	4128	0
3159	4159	4159	0	3129	4129	4129	0
3161	4161	4161	25700	3130	4130	4130	25700
				3134	4134	4134	180
					4169	4169	0
Max. power at acceleration (for selecting αiPS) : 27.9kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
If you don't want to initialize adjusted parameters, you should not load parameters automatically.

(2) Change parameters manually according to the table.

(3) Power off/on to activate the SPINDLE HRV parameters surely.

D ELECTROMAGNETIC CONTACTOR FOR WINDING SWITCHING

D.1 SWITCHING UNIT

D.1.1 Overview

The switching unit is used for an electromagnetic contactor to switch power lines for spindle switching control for two motors or for speed range switching control for a motor in the following cases:

(1) Switching a power line from one motor to another motor (spindle switching control)
(2) Switching a power line for a motor which has two types of windings (speed range switching control)

D.1.2 Specification No.

Specification No.	Application	Applicable amplifier
A06B-6078-K037	Y-Δ switching (for MS112S)	αiSP 30
A06B-6078-K036	Y-Y switching (for MS112L)	

D.1.3 Specifications

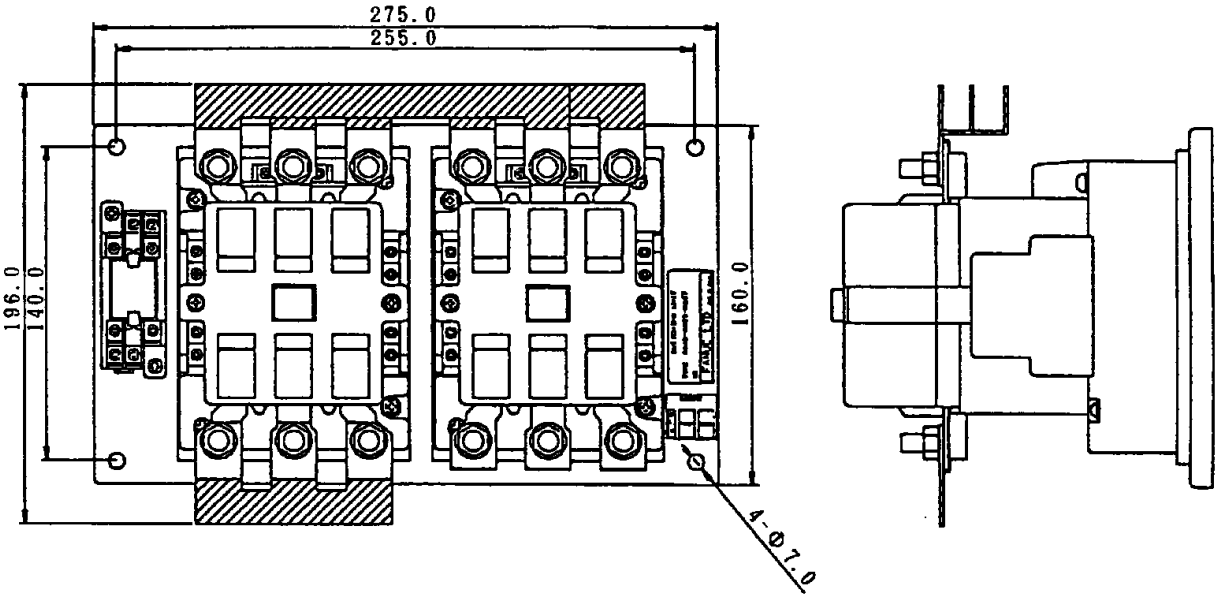
Specifications of Electromagnetic Contactors (MCC)

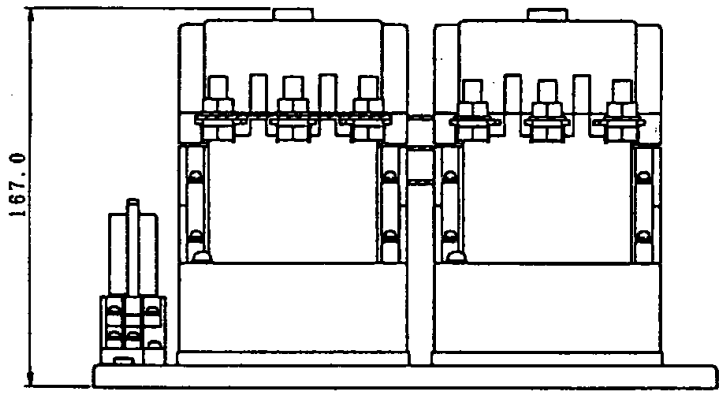
FANUC purchase code No.	A58L-0001-0312 (SC-6N manufactured by Fuji Electric)	
Rated operating voltage	220 V	
Rated operating current	125 A	
Current capacity for the closed circuit and shut-off	Closed circuit	1500 A
	Shut-off	1250 A
Frequency of switching operation	1200 times/hour or more	
Life expectancy of the switching operation	Mechanical ; 5 million times or more	
	Electrical ; 1 million times or more	
Rating of the electromagnetic operation coil	200V/220V 15% to +10% 50/60Hz ±1Hz	
Applicable spindle amplifier module	αiSP 30 or less	

Specifications of the Relay

FANUC purchase code No.	A58L-0001-0307 (LY2-D manufactured by Omron)
Rated voltage	24V ±10%
Rated current	36.9 mA

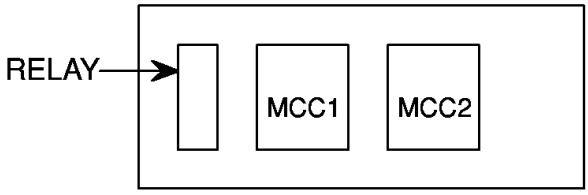
(1) External dimensions of 人-Δ connection speed range switching unit (for MS112S)



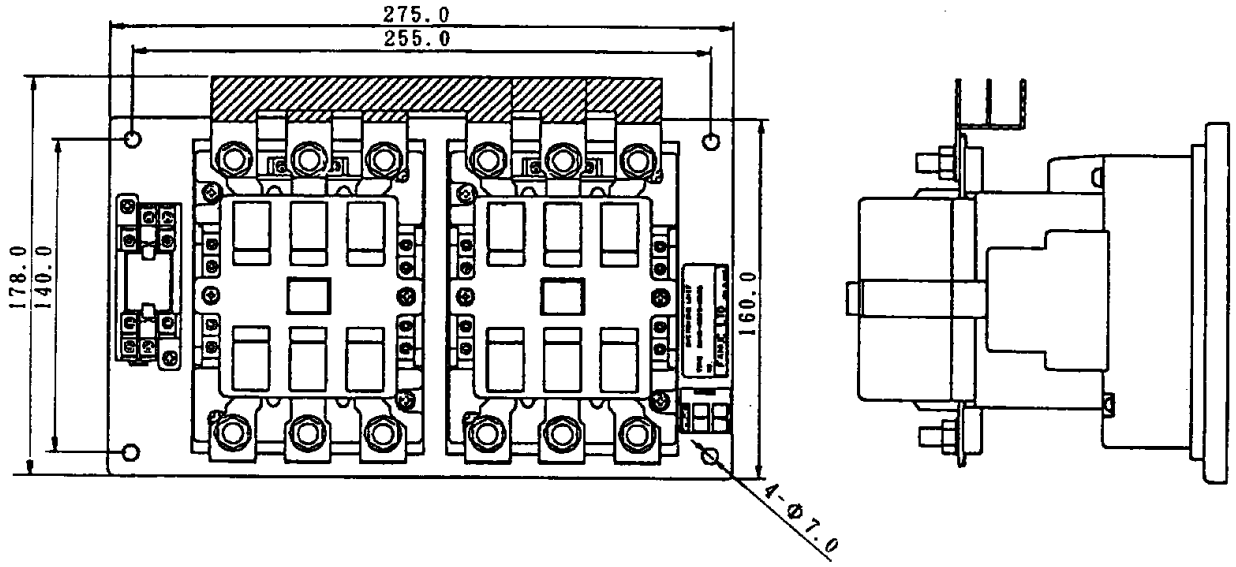


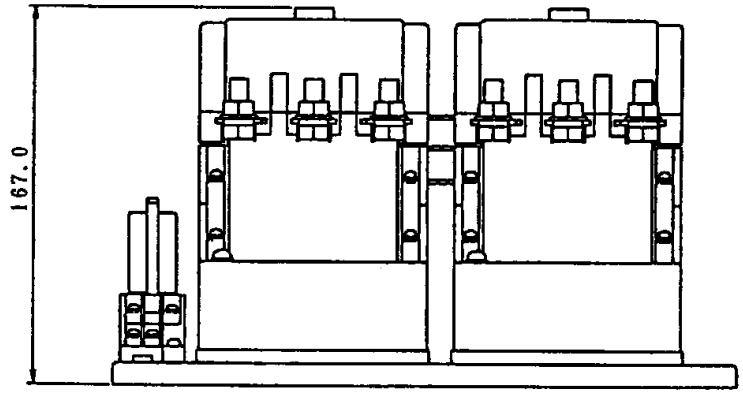
A06B-6078-K037

Layout Drawing



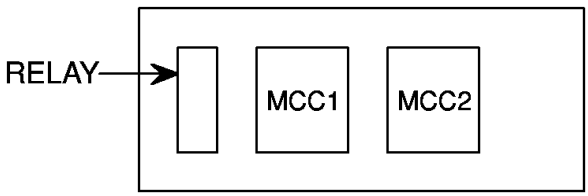
(2) External dimensions of 人-人 connection speed range switching unit (for MS112L)



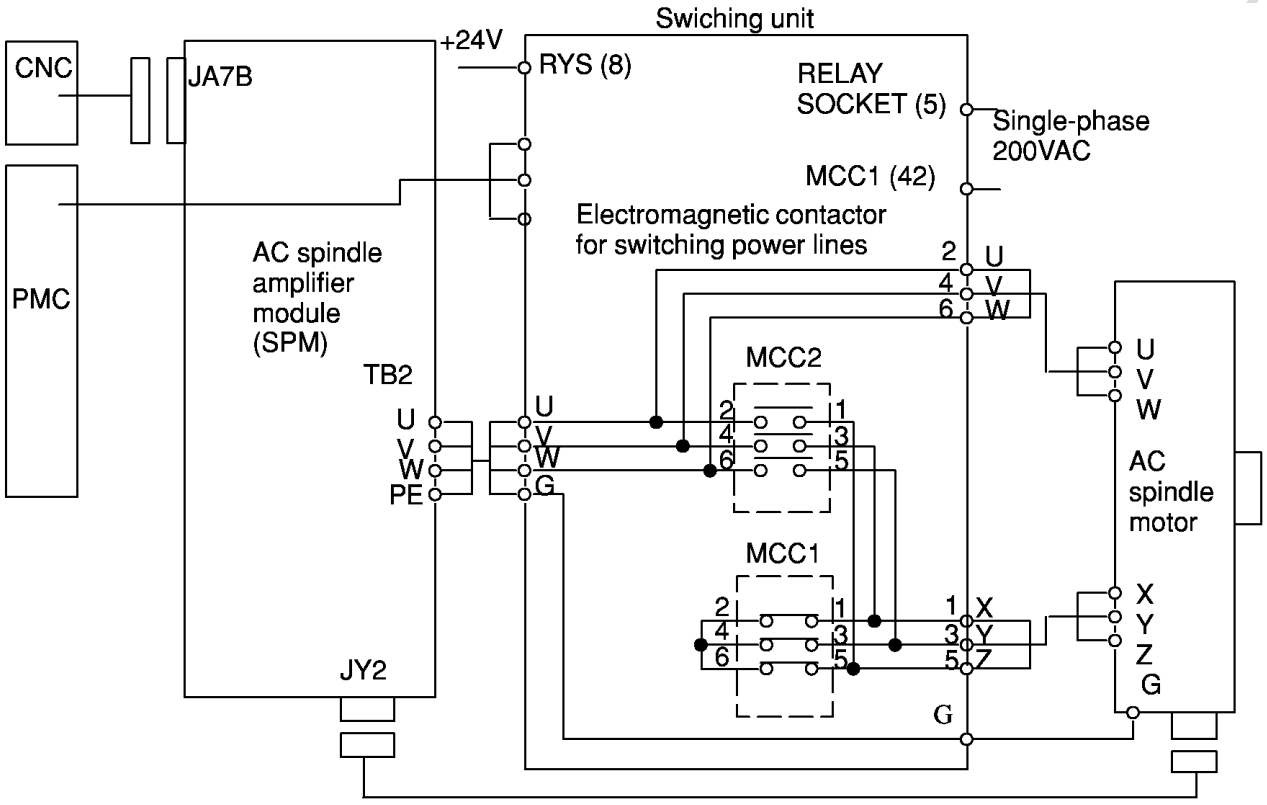


A06B-6078-K036

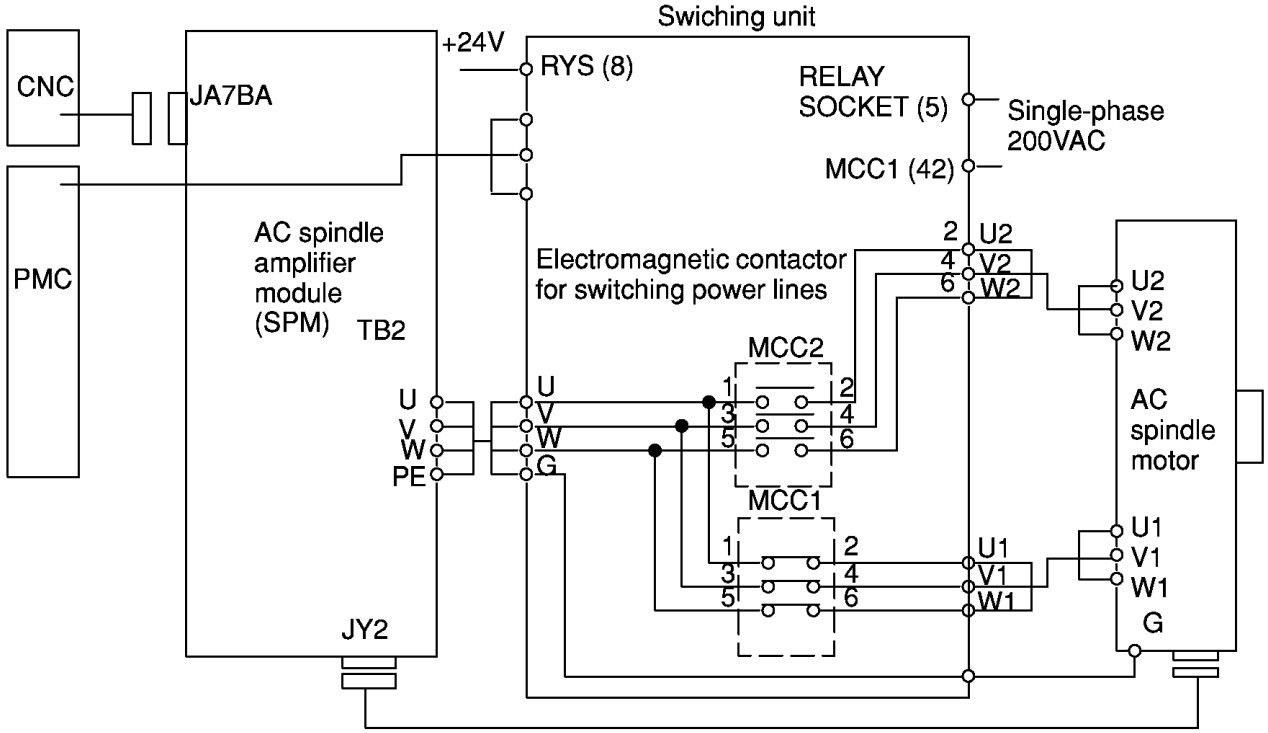
Layout Drawing



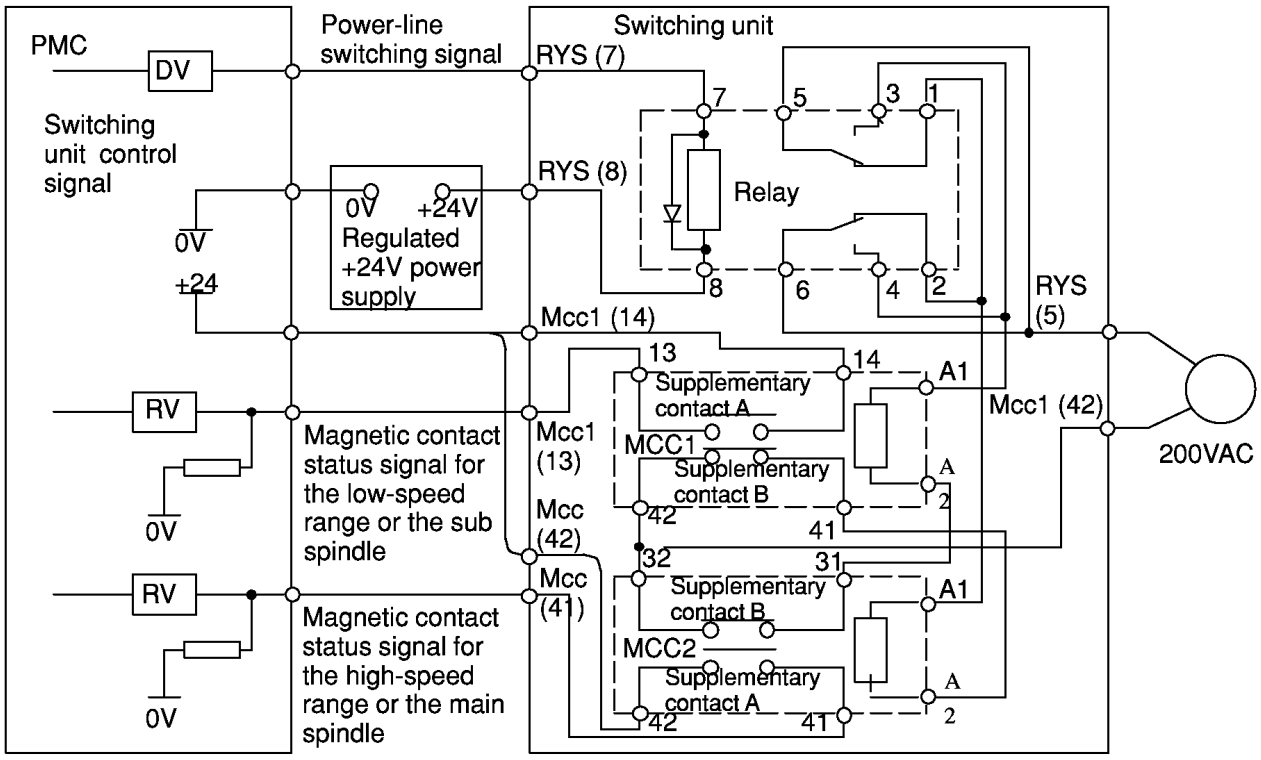
(3) Schematic drawing of 人-Δ connection speed range switching unit (for MS112S)



(4) Schematic drawing of 人-人 connection speed range switching unit (for MS112L)



(5) Detailed diagram of connections between the PMC and the switching unit



NOTE
1 Connect the PMC to the switching unit at the screw terminals of the electromagnetic contactor and relay socket with screws.
2 For detailed information about interface signals, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

D.1.4 Caution in Use

(1) Install the switching unit under the same conditions as for a spindle amplifier.
Conditions for installing the switching unit
- Ambient temperature :
  0 to 55°C for the unit
  0 to 45°C for the cabinet
- Ambient humidity: 90%RH or less, no condensation
- Vibration : 0.5 G or less during operation
- Ambient air :
  Corrosive, conductive mist or water drops must not come into direct contact with electronic circuits.

(2) Install the switching unit according to Fig. D.1.4(a). An inclination of 15 degrees is permitted in the right, left, front, and back.

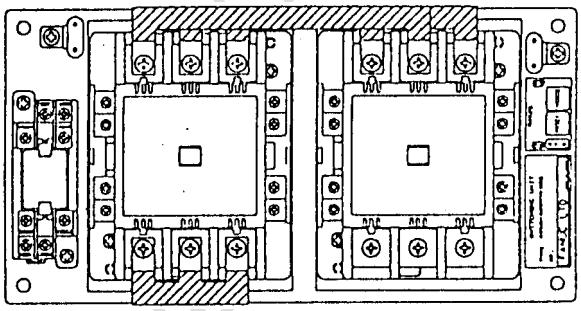


Fig. D.1.4 (a) Standard Installation (for A06B-0659-K035)

(3) It may be necessary to install the unit on its side as shown in Fig. D.1.4(b), due to wiring or space limitations. The characteristics of the electromagnetic contactor will not be affected, however, the mechanical life of the unit and the number of times the contactor can be opened and closed will be decreased.

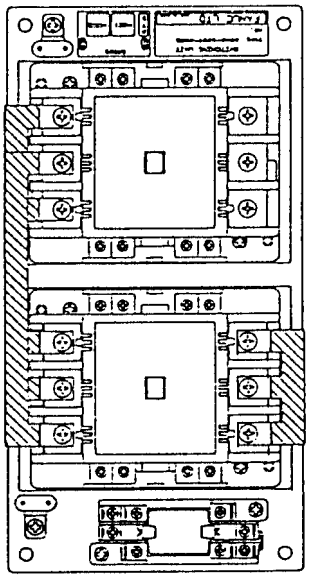


Fig. D.1.4(b) Non-standard Installation (for A06B-0659-K035)

(4) Leave enough space to prevent arc from affecting other units, as shown in Fig. D.1.4(c).

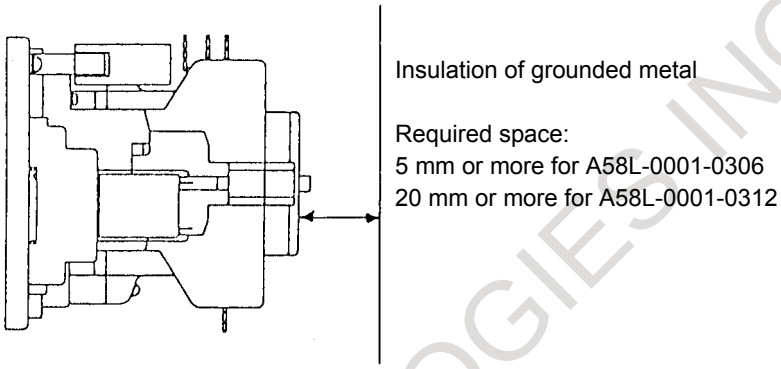


Fig. D.1.4(c) Required Space

(5) If an electromagnetic contactor is installed incorrectly, contacts may jump at power on or its life may be decreased. If a cable is not connected to the contactor securely, the connected part may generate heat or the cable may loosen and come off, resulting in a serious accident.

Tightening torque (Electromagnetic contactor)

Item	Tightening torque [kg·cm]	
	A58L-0001-0306	A58L-0001-0312
MCC main terminal	62.0 (M6.0)	84.0 (M8.0)
MCC supplementary terminal	14.0 (M3.5)	14.0 (M3.5)

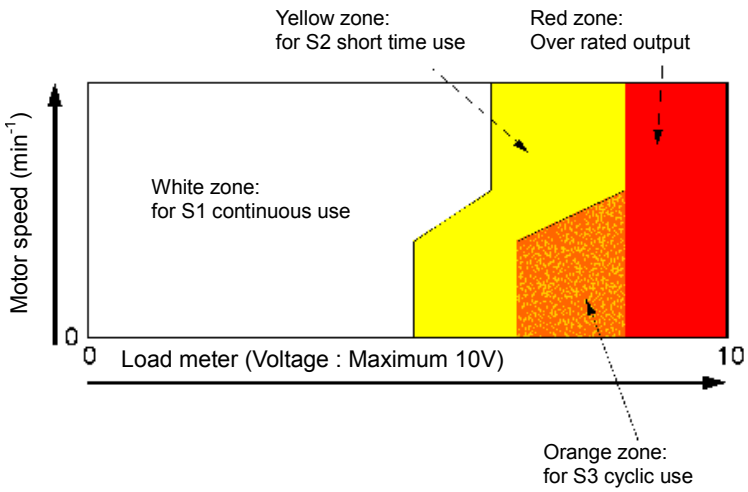
Tightening torque (Relay socket)

Item	Tightening torque [kg·cm]
Relay socket	14.0 (M3.5)

E LOAD METER

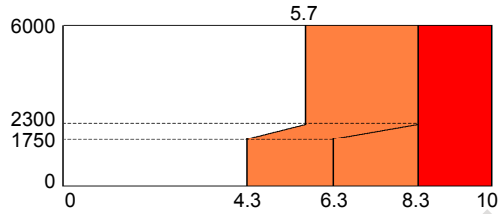
A load meter (dynamometer) indicates the load factor. The load factor is the ratio of average output to the maximum output of the spindle motor when the spindle of the machine tool operates with no load and during cutting. Maximum output is equal to 10V. The voltage is output to pin No.16 of JY1 connector in spindle amplifier module(SPM). Refer to the DESCRIPTIONS (B-65282EN) of FANUC SERVO AMPLIFIER αi series for details of connector and pin assignment.

• Explanation

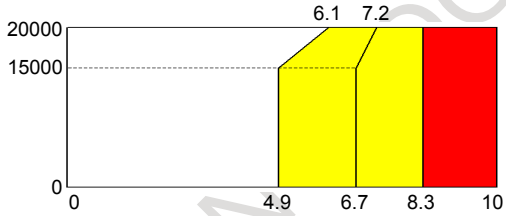


MS112S

♦ Low speed range

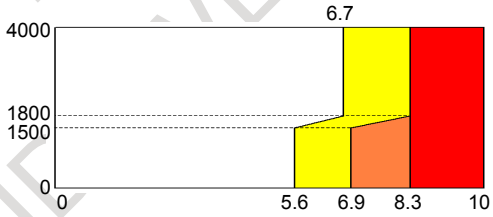


♦ High speed range

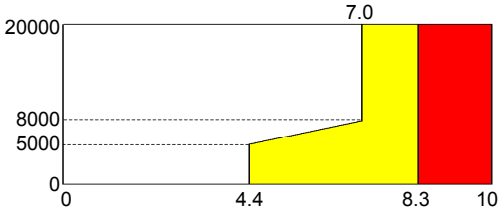


MS112L

♦ Low speed range



♦ High speed range



ADDITIONAL INFORMATION

Specification change of FANUC-NSK SPINDLE UNIT series (B-65352EN/02)

1. Type of applied documents

Name	FANUC-NSK SPINDLE UNIT series
Spec. No./Ver.	B-65352EN/02

2. Summary of Change

Group	Name / Outline	New, Add Correct, Del	Applicable Date
Basic Function	Cancellation of MS112L/15000 models ($20000min^{-1}$ models only available at MS112L)	Delete	September 2006
Optional Function			
Unit			
Maintenance Parts			
Notice			
Correction			
Others			

				TITLE Specification change of FANUC-NSK SPINDLE UNIT series	
01	06.08.29	FUKUDA	Newly designed	DRAW. No. B-65352EN/02-01	CUST.
Ed.	Date	Design.	Description	FANUC LTD	SHEET 1/2

We report several specification changes of FANUC-NSK SPINDLE UNIT series (B-65352EN/02). Please take notice.

Cancellation of MS112L/15000 models

As for the spindle unit, four models, MS112S/15000, MS112S/20000, MS112L/15000 and MS112L/20000 have been selectable, but MS112L/15000 will be canceled.
MS112L will be available only for 20000 min^{-1} models.

• Execution schedule ; September 2006

Spindle nose figure : BT-40 specifications (Cancellation of MS112L/15000 models)

Model	Spindle unit drawing number	Grease supply lubrication	Center through coolant option	Flood coolant option
MS112S /15000	A06B-1902-B000#0030	--	--	--
	A06B-1902-B000#0130		O	--
	A06B-1902-B000#0230		--	O
	A06B-1902-B000#0330		O	O
MS112S /20000	A06B-1902-B011#1030	O	--	--
	A06B-1902-B011#1130		O	--
	A06B-1902-B011#1230		--	O
	A06B-1902-B011#1330		O	O
MS112L /20000	A06B-1904-B011#1030	O	--	--
	A06B-1904-B011#1130		O	--
	A06B-1904-B011#1230		--	O
	A06B-1904-B011#1330		O	O

Spindle nose figure : HSK-A63 specifications (Without modification)

Model	Spindle unit drawing number	Grease supply lubrication	Center through coolant option	Flood coolant option
MS112S /20000	A06B-1902-B041#1030	O	--	--
	A06B-1902-B041#1130		O	--
	A06B-1902-B041#1230		--	O
	A06B-1902-B041#1330		O	O
MS112L /20000	A06B-1904-B041#1030	O	--	--
	A06B-1904-B041#1130		O	--
	A06B-1904-B041#1230		--	O
	A06B-1904-B041#1330		O	O

Correction of the manual B-65352EN/02

Page 4-5 ; Specification table / Deletion of MS112L/15000
Page 7 ; Output characteristics of 15000 min^{-1} models / Deletion of L type
Page 9 ; Spindle amplifier, Max. power at acceleration / Deletion of L type 15000 min^{-1}
Page 13 ; External dimensions / Deletion of Fig.4(c)
Page 97 ; Specification numbers / Replacement with the table above
Page 107 ; Parameter list / Deletion of MS112L/15000

				TITLE	
				Specification change of FANUC-NSK SPINDLE UNIT series	
01	06.08.29	FUKUDA	Newly designed	DRAW. No. B-65352EN/02-01	CUST.
Ed.	Date	Design.	Description	FANUC LTD	SHEET 2/2

Additional safety instructions for FANUC-NSK SPINDLE UNIT series (B-65352EN/02)

1. Type of applied documents

Name	FANUC-NSK SPINDLE UNIT series
Spec. No./Ver.	B-65352EN/02

2. Summary of Change

Group	Name / Outline	New, Add Correct, Del	Applicable Date
Basic Function			
Optional Function			
Unit			
Maintenance Parts			
Notice	Add safety instructions	Add	Aug. 2009
Correction			
Others			

				TITLE Specification change of FANUC-NSK SPINDLE UNIT series	
01	09.08.05	FUKUDA	Newly designed	DRAW. No. B-65352EN/02-02	CUST.
Ed.	Date	Design.	Description	FANUC LTD	SHEET 1/5

We report several additional safety instructions for FANUC-NSK SPINDLE UNIT series (B-65352EN/02).
In order to avoid failure, please read the safeguard and check the condition of FANUC- NSK spindle unit.

No modifications

Modifications to FANUC-NSK spindle unit will void your warranty whether failure has been caused by the modification or not. Please do not modify FANUC-NSK spindle unit.

For grinding use or machining ceramic workpieces

For grinding use or machining ceramic workpieces, please select the spindle unit without center through coolant option.
It is not easy to remove powdery substance or cutting chips perfectly from cutting fluid of center through coolant, trouble may ocurr on the sealing lip of rotary joint or other part of spindle unit in a brief period of time.

Nevertheless cutomers want to use center through coolant, please understand that spindle units must be periodically overhauled at cost to customers.
Safeguards which seem to be effective for longer life are described as in the following

Please install a filter with nominal filtration rating of 1 micro meter or smaller and remove powdery substance or cutting chips from cutting fluid.
Please attach a covering for the rear part of spindle unit. (Will be seen later.)
Furthermore, check the rotary joint periodically, especially leakage from drain. Normally there is almost no leakage from drain port. Rotary joint needs replacing when you can see some leakage.
Also please check the motor insulation.

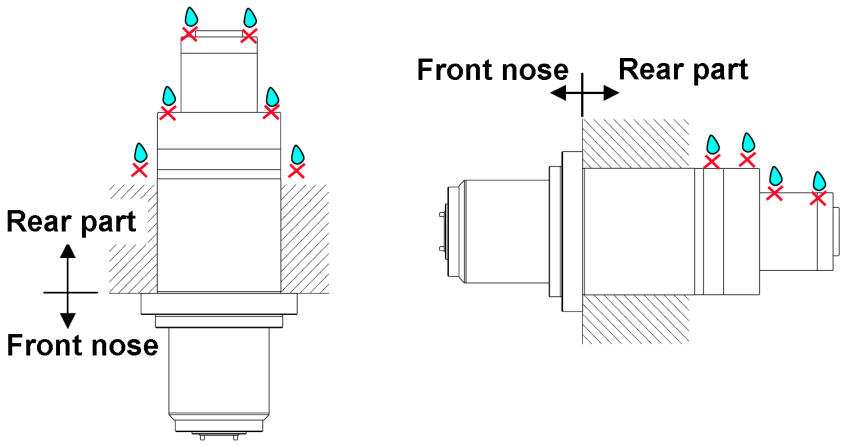
For machining graphite or carbon workpieces

For machining graphite or carbon workpieces, there is a danger that a spark may ignite the powdery carbon or graphite under dry condition and cause dust explosion or rapid combustion.
Trouble also may ocurr on the sealing lip of rotary joint or other part of spindle unit in a brief period of time by the powdery carbon or praphite.

Nevertheless cutomers want to use spindle unit for machining graphite or carbon workpieces, please understand that spindle units must be periodically overhauled at cost to customers.

Prevent splashes of cutting fluids

Please prevent splashes of cutting fluids or machine oil onto the rear part of the flange.
They may penetrate into the spindle, and cause electrical breakdown or washing away of the bearing grease. Please separate the rear part from the front nose mechanically. Covering the rear part will be also effective.
Then please check the contidion of rear part periodically. When you can see splashes of cutting fluids, please reinforce sealing.



Concerning the frot nose, spindle unit has enough water resistance or dustproofness, but FANUC does not guarantee all condition. Sometimes careful consideration will be required.

General note in respect of the cutting fluids (Reference)

The cutting fluid containing strong active sulfur, the oil-free cutting fluid named synthetic, or the strong alkaline water-soluble type cutting fluid can influence the spindle unit terribly. Even if kind consideration is taken: the cutting fluid should not splash on the surface of these products directly, the following failures can be occurred, so please pay attention to them.

Synthetic cutting fluid is not suitable for spindle unit, please refrain from using.

The cutting fluid containing the strong active sulfur

The cutting fluids containing the extremely strong active sulfur exist among the cutting fluids containing the sulfur. If they penetrate into the CNC, the motor or the amplifier, they can corrode the metals such as silver and copper that are applied to the materials of parts and the failures of parts can be occurred.

The synthetic type cutting fluid with strong permeability

The cutting fluids with strong permeability exist among the synthetic type cutting fluids that contain PAG (polyalkylene glycol) as the lubricant. They can penetrate easily into even the good sealed motor. If they penetrate into the CNC, the motor or the amplifier, the insulation inferiority of products or the failure of parts can occur.

The strong alkaline water-soluble type cutting fluid

The strong alkaline water-soluble type cutting fluids whose pH is 10 or more exist among the cutting fluids whose alkaline is strengthen by alkanol amine. If they penetrate into the CNC, the motor or the amplifier, they can occur chemical reaction to the molding resins and deteriorate them.

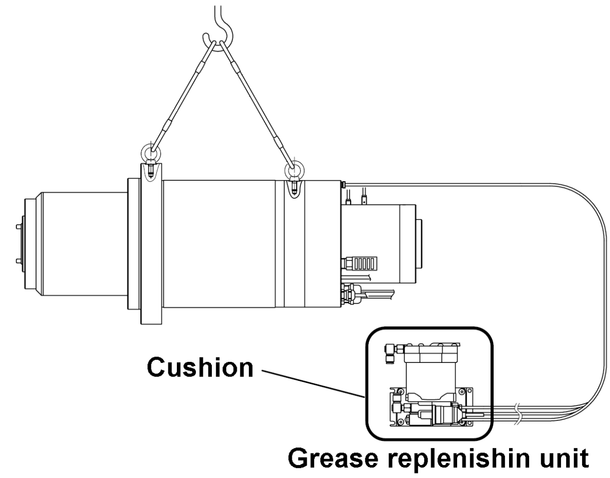
Grease replenishing unit (only for 20000min^{-1} models)

Please check the air pressure is correct. If the air pressure is higher than the designated value, grease will leak from relief valve. In that case, it is difficult to return the leaked grease to tank again and grease replenishing unit needs replacing. Please adjust air pressure correctly with the regulator.

Please check if grease replenishing control ladder program works correctly.
If replenishing period is shorter than the designated time, bearings may seize up because of frictional resistance by too much grease.
If replenishing period is longer than the designated time, bearings may also seize up because of depleted grease.

Please add a shot counter to PMC program. Shot counter helps to check if shot interval is correct, and also helps to forecast when the spindle unit will need overhaul.

Grease replenishing unit is made of plastic and connected to the spindle unit with tubes. Please take care when handling the spindle. Wrapping with cushioning material would be better for handling grease unit.



Center through coolant (Option)

In case of HSK tool holder, coolant pipe is required. When customer supply center through coolant into HSK tool holder without coolant pipe, spindle internal parts may damaged so that it makes difficult to change tools.

Please use center through coolant correctly. Do not supply coolant to the tools without through holes nor HSK coolant pipes. Even if tool has through holes, please take care that the flow rate of coolant at the tool tip is enough.

Taper air blowing is required every time before tool change when customer used center through coolant.

Coolant
Max. pressure : 7.0MPa , Min. pressure : 1.0MPa , Cleanliness : ISO4406 -/17/14
Required filtration 35 micro meters

Oil cooler

Please check if temperature setting of oil cooler is correct. The designated valule is "Room temp. +2 degrees centigrade at the outlet of a cooler".
Inappropriate temperature setting or control method causes insufficient cooling or supercooling, then bearings may seize up.

When a cooler controls temperature with "ON/OFF control", actual temperature fluctuates against the setting temperature. In this case, please adjust temperature setting as the lowest temperature of fluctuation becomes equal to the room temperature +2°C.
Generally, inverter controls temperature with much less fluctuation against the designated value. FANUC recommends oil cooler with inverter control.

Thermal sensor of oil cooler detecting room temperature should be placed where the detected temperature could be similar to around the spindle unit and where the temperature does not change suddenly by the external perturbations.

Dried air

Air purge is required for spindle unit. Please supply dried air using air drier, filter and mist separator. Wet air will cause internal rust, electrical breakdown or bearing troubles.
Dew point temperature : -10°C (at atmospheric pressure)

Clamping/unclamping tools

Please do not unclamp a tool when a spindle unit is rotating. If hydraulic cylinder moves during rotation and contacts spindle shaft, spindle internal parts will be damaged seriously.

In motion of tool clamping, please do not back off hydraulic cylinder too early, or drawbar will clamp tools insufficiently. In case of HSK, insufficient tool clamp will be detected by a sensor, but you cannot detect in case of BT tool holders. If a tool is clamped incompletely, the tool can be detached, resulting in a danger.

Please take care of clamping BT tools manually. If phase of keyway is not fixed, a tool is clamped incompletely and the tool can be detached by small force.
Once the tool is detached, drawbar is released at a moment, resulting serious damage for spindle internal parts.

Cleaning pipes

Pipes and connecting blocks should be cleaned up before assembling process or when rebuilding at maintenance. If contamination remains in the pipes or blocks, trouble may occur on a built-in spindle motor or bearings.

Chip removal

Please remove cutting chips as soon as possible. If chips remains around the spindle unit, spindle rotation may produce abnormal heat by friction, resulting troubles on bearings or other parts.

Specification change of amplifier for FANUC-NSK SPINDLE UNIT series (B-65352EN/02)

1. Type of applied documents

Name	FANUC-NSK SPINDLE UNIT series
Spec. No./Ver.	B-65352EN/02

2. Summary of Change

Group	Name / Outline	New, Add Correct, Del	Applicable Date
Basic Function			
Optional Function			
Unit			
Maintenance Parts			
Notice			
Correction			
Others	Specification change of amplifier	Correct	Apr. 2011

We report the change of amplifier for MS112S of FANUC-NSK SPINDLE UNIT series (B-65352EN/02). Also parameter lists are revised.

Concerning MS112L, there is no change for amplifier nor parameter lists.
We show latest specification number for amplifier.

MS112S/15000 and MS112S/20000

Change the amplifier from α*i*SP 30 to α*i*SP 26

α*i*SP 30	A06B-6111-H030#H550 (for FS15i, FS16i) A06B-6111-H030#H570 (for FS30i)
↓	
α*i*SP 26	A06B-6141-H026#H580 A06B-6220-H026#H600 (for FS30i-B)

MS112L/20000

Latest specification number for amplifier

α*i*SP 30	~~A06B-6111-H030#H550 (for FS15i, FS16i)~~ ~~A06B-6111-H030#H570 (for FS30i)~~ A06B-6141-H030#H580 A06B-6220-H030#H600 (for FS30i-B)

				TITLE Specification change of amplifier for FANUC-NSK SPINDLE UNIT series	
01					
	11.04.26	FUKUDA	Newly designed	DRAW. No. B-65352EN/02-03	CUST.
Ed.	Date	Design.	Description	FANUC CORPORATION	SHEET 2/4

MS112S/15000 [SPINDLE HRV control]

Amplifier : αiSP 26 A06B-6141-H026#H580

A06B-6220-H026#H600 (for FS30*i*-B)

Low speed range				High speed range			
Parameter No.			7.5/11 kW	Parameter No.			11/15/18.5 kW
30*i*-B	30*i*-A	0*i*-D	2300/6000 min^{-1}	30*i*-B	30*i*-A	0*i*-D	6000/15000 min^{-1}
				4001	4001	4001	00000001
				4002	4002	4002	00000001
				4003	4003	4003	00000000
				4004	4004	4004	00000000
				4006	4006	4006	00000000
				4007	4007	4007	00000000
				4008	4008	4008	00010000
				4009	4009	4009	00000000
				4010	4010	4010	00000001
				4011	4011	4011	00001010
				4012	4012	4012	10000010
				4013	4013	4013	01010000
				4019	4019	4019	00000100
				4020	4020	4020	15000
				4023	4023	4023	400
4156	4156	4156	0	4039	4039	4039	0
4166	4166	4166	23125	4080	4080	4080	7253
4138	4138	4138	2000	4100	4100	4100	6200
4139	4139	4139	80	4101	4101	4101	95
4140	4140	4140	4053	4102	4102	4102	8859
4141	4141	4141	0	4103	4103	4103	0
4142	4142	4142	2500	4104	4104	4104	1500
				4105	4105	4105	0
4143	4143	4143	4000	4106	4106	4106	2500
				4107	4107	4107	0
4144	4144	4144	0	4108	4108	4108	0
4145	4145	4145	25	4109	4109	4109	25
4146	4146	4146	1968	4110	4110	4110	1293
4147	4147	4147	600	4111	4111	4111	328
4148	4148	4148	200	4112	4112	4112	200
4149	4149	4149	1058	4113	4113	4113	1058
4150	4150	4150	0	4114	4114	4114	0
4151	4151	4151	100	4115	4115	4115	100
4152	4152	4152	9998	4116	4116	4116	8996
4153	4153	4153	90	4117	4117	4117	90
4154	4154	4154	100	4118	4118	4118	100
4165	4165	4165	20	4119	4119	4119	9
				4120	4120	4120	0
4155	4155	4155	0	4124	4124	4124	0
4093	4093	4093	176	4127	4127	4127	202
4158	4158	4158	110	4128	4128	4128	0
4159	4159	4159	0	4129	4129	4129	0
4161	4161	4161	25700	4130	4130	4130	25700
				4134	4134	4134	140
				4169	4169	4169	0
Max. power at acceleration (for selecting αiPS) : 24.4 kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
If you don't want to initialize adjusted parameters, you should not load parameters automatically.

(2) Change parameters manually according to the table.

(3) Power off/on to activate the SPINDLE HRV parameters surely.

Ed.	Date	Design.	Description	TITLE / DRAW. No.	CUST.
				Specification change of amplifier for FANUC-NSK SPINDLE UNIT series	
01					
	11.04.26	FUKUDA	Newly designed	B-65352EN/02-03	
				FANUC CORPORATION	SHEET 3/4

MS112S/20000 [SPINDLE HRV control]

Amplifier : α*i*SP 26 A06B-6141-H026#H580

A06B-6220-H026#H600 (for FS30*i*-B)

Low speed range				High speed range			
Parameter No.			7.5/11 kW	Parameter No.			11/15/18.5 kW
30*i*-B	30*i*-A	0*i*-D	2300/6000 min^{-1}	30*i*-B	30*i*-A	0*i*-D	6000/15000 min^{-1}
				4001	4001	4001	00000001
				4002	4002	4002	00000001
				4003	4003	4003	00000000
				4004	4004	4004	00000000
				4006	4006	4006	00000000
				4007	4007	4007	00000000
				4008	4008	4008	00010000
				4009	4009	4009	00000000
				4010	4010	4010	00000001
				4011	4011	4011	00001010
				4012	4012	4012	10000010
				4013	4013	4013	01010000
				4019	4019	4019	00000100
				4020	4020	4020	20000
				4023	4023	4023	300
4156	4156	4156	0	4039	4039	4039	0
4166	4166	4166	23125	4080	4080	4080	7253
4138	4138	4138	2000	4100	4100	4100	6200
4139	4139	4139	80	4101	4101	4101	95
4140	4140	4140	4053	4102	4102	4102	8859
4141	4141	4141	0	4103	4103	4103	0
4142	4142	4142	2500	4104	4104	4104	1500
				4105	4105	4105	0
4143	4143	4143	4000	4106	4106	4106	2500
				4107	4107	4107	0
4144	4144	4144	0	4108	4108	4108	0
4145	4145	4145	25	4109	4109	4109	25
4146	4146	4146	1968	4110	4110	4110	1293
4147	4147	4147	600	4111	4111	4111	328
4148	4148	4148	200	4112	4112	4112	200
4149	4149	4149	1058	4113	4113	4113	1058
4150	4150	4150	0	4114	4114	4114	0
4151	4151	4151	100	4115	4115	4115	100
4152	4152	4152	9998	4116	4116	4116	8996
4153	4153	4153	90	4117	4117	4117	90
4154	4154	4154	100	4118	4118	4118	100
4165	4165	4165	20	4119	4119	4119	9
				4120	4120	4120	0
4155	4155	4155	0	4124	4124	4124	0
4093	4093	4093	176	4127	4127	4127	202
4158	4158	4158	110	4128	4128	4128	0
4159	4159	4159	0	4129	4129	4129	0
4161	4161	4161	25700	4130	4130	4130	25700
				4134	4134	4134	140
				4169	4169	4169	0
Max. power at acceleration (for selecting α*i*PS) : 24.4 kW							

[Parameter setting procedure]

(1) Load parameters automatically with the model code "400".

Note)
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				TITLE	Specification change of amplifier for FANUC-NSK SPINDLE UNIT series
01					
	11.04.26	FUKUDA	Newly designed	DRAW. No. B-65352EN/02-03	CUST.
Ed.	Date	Design.	Description	FANUC CORPORATION	SHEET 4/4

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Revision Record

FANUC - NSK SPINDLE UNIT series DESCRIPTIONS (B-65352EN)

02	May, 2006	Sweeping revision			
01	Nov., 2003	———————————————			
Edition	Date	Contents	Edition	Date	Contents

B-65352EN/02

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