

# High-speed Small Ball Milling Spindle User Manual

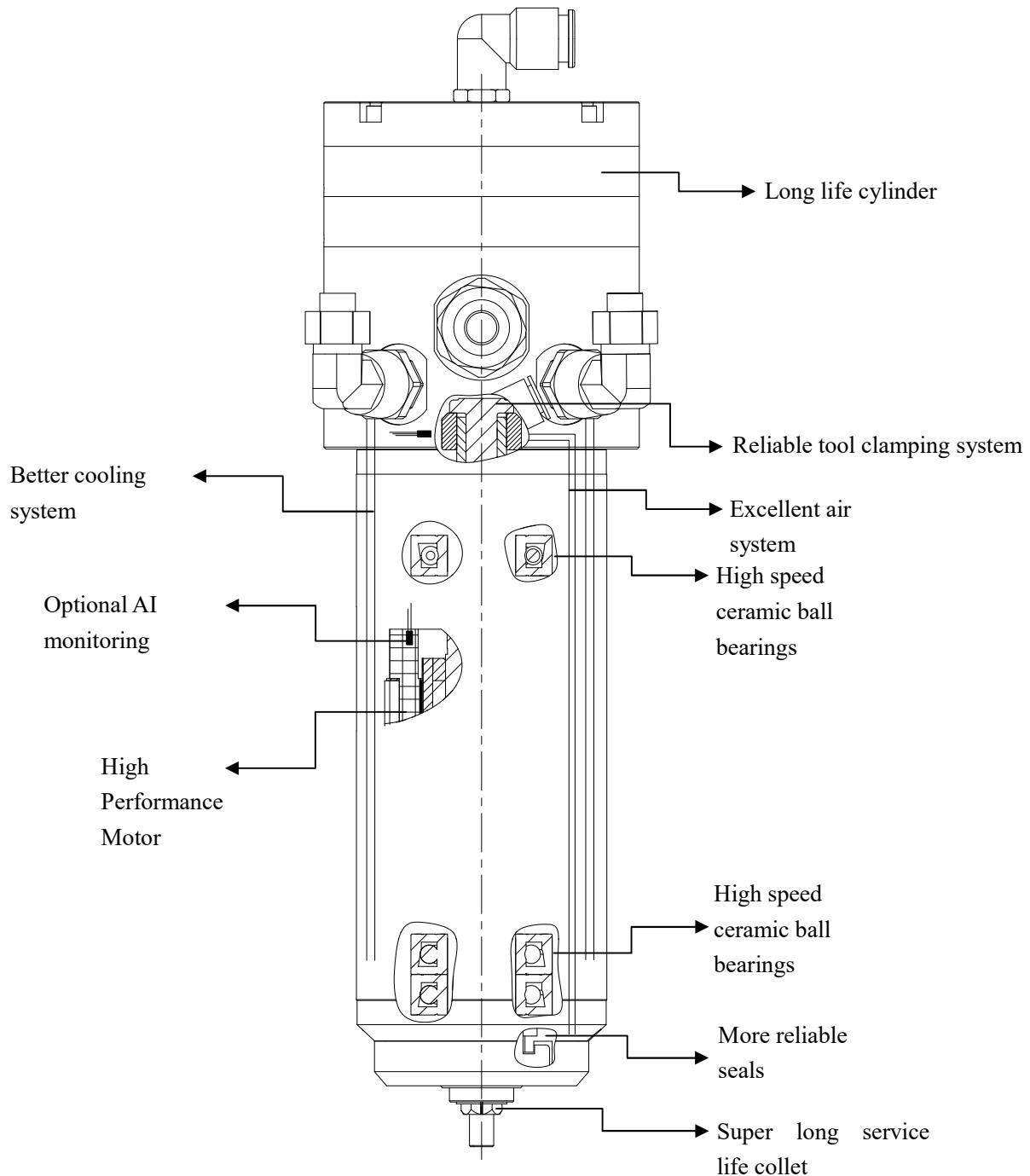
Guangzhou Haozhi Industry Co., Ltd



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## 1.General Information



### 1.1 Product Application

The product is the high-speed milling spindle. It mainly used in engraving machines or CNC for machining nonferrous copper alloy, aluminum alloy, glass, graphite, etc. In medical industry, it is applied in process dental cast and denture.

## 1.2 Product characteristics

This series of product is a built-in motor spindle. The product is provided with a built-in three-phase AC motor, is controlled by the diver through stepless speed change and has features of compact structure, small inertia, low vibration and low noise.

The series of product is provided with the high-precision bearings and adopts the optimal shafting arrangement, so that the product has the characteristics of high running accuracy, high stability, large rigidity and large bearing capacity.

This series of product can be equipped with an intelligent monitoring sensor according to the customer's needs. Sensors are applied to monitor the motor temperature in real time to meet various intelligent control and machining needs.

The company has strong RD resource, flexible and diverse design can be customized according to customer requirements of different functions, speed, and precision of the spindle.

## 1.3 User responsibility

Both reliable operation and service life of the spindle depend on the correct operation of the user. The user must read, understand and follow the instruction of this spindle carefully before using. In addition, accident prevention norms and safety guidelines must be complied.

This instruction shall be kept properly for inspection when it is necessary.

## 1.4 Statement of responsibility

The reliable operation and service life of the spindle depend on the correct operation of the user. The user must read carefully, understand and abide by this manual before operating the spindle. In addition, accident prevention regulations, safety regulations and environmental protection regulations must be observed.

Please keep this manual appropriately for reference when needed.

Haozhi shall not bear any responsibility for any personal or property damages and the loss of spindle quality due to failure to abide by this manual or arbitrary modification of spindle structure without authorization.

Please do not disassemble or assemble the spindle without authorization during the warranty period. Otherwise Haozhi is not responsible for maintenance service warranty.

## 1.5 Services and Consulting

As a professional supplier of spindle R&D and manufacturing, we are willing to help you solve your problems about spindle and provide you with corresponding consulting services. Welcome to dial our service hotline: +0086 4006189083 or contact our sales.

## 2. Spindle Safety Instructions

### 2.1 Cautions

- Technicians who are not designated by HAOZHI shall not set, disassemble or repair this electric spindle.
- You can judge whether the spindle is operating normally through monitoring the spindle temperature, vibration, abnormal sound, noise, etc., If an abnormality occurs, shut down the system immediately and notify the maintenance personnel.
- When the spindle is running, the rotating parts will generate huge centrifugal force, and necessary safety protection devices must be installed.
- The tool used in the spindle must undergo dynamic balance (in line with the dynamic balance level within G2.5 of ISO1940 Specification). Otherwise, the spindle vibration may be too large, the spindle accuracy may be reduced, and the equipment may be damaged in serious cases.
- Do not carry out operation beyond the technical parameters specified for the electric spindle. Otherwise, it will cause unpredictable serious consequences.
- Do not spray compressed air and liquid, etc. to the nose end of the spindle to prevent foreign matters from entering the spindle and damaging the spindle.
- The service life of the tool is strictly controlled, and the damaged tool has great influence on the service life of the spindle.

### 2.2 Symbol



Incorrect operation may cause personal injury and equipment damage.



Indicates “prohibition”, violation may result in unpredictable serious consequences;



Incorrect operation may cause death.



Indicate “mandatory operation”.



Danger! Electric shock!

### 3.Storage

The spindle allowed maximum storage time is 18 months, please follow the following instructions:

➤ Storage area must be dry, free of dust and dirt, recommended for storage at constant temperature (temperature 10°C ~35°C).

Maximum temperature shall not exceed 45°C. In order to prevent condensation water inside the spindle, the storage ambient temperature should be relatively stable so that the moisture in the air cannot reach the condensation point. For example: When the relative humidity is 65%, the maximum allowable temperature drops by 8°C. Please check the psychrometric table for details.



➤ The spindle needs to run in again every three months of storage. The run-in operation mode shall be performed according to Table 3.1.

Table 3.1 Run-in operation

Steps	Speed	Duration
1	25% maximum speed	5 minutes
2	Static	5 minutes
3	50% maximum speed	5 minutes
4	Static	5 minutes
5	80% of maximum speed	20 minutes

### 4.Installation operation

#### 4.1 Confirmation before installation

Please confirm if the spindle model is correct before installation.

#### 4.2 Driver Selection Principle

In general, under the same voltage level, the rated output power of the frequency converter is not less than 1.5 times of the rated output power of the same class motor, and the frequency converter power grade specified in the national standard should be selected according to the

principle of proximity. For example, if motor rated power is 1.2 kW, should select the 2.2 kW driver. Brake resistance can be selected according to the recommended value of each driver manufacturer.

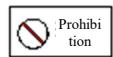
### 4.3 Preparation

When unpacking the spindle packaging, take appropriate protective measures to check whether the appearance of the spindle is damaged, if there is damage, please call the service hotline +0086 4006189083.

-  During the mounting process, the force of the rotary shaft of the spindle cannot be carried.
- Before assembly, all supply pipes and lines must be cleaned in case any impurities enter the spindle.
- After the installation, the exposed part must be rust-proof treatment.

### 4.4 Mechanical installation

#### 4.4.1 Mechanical connections



During installation, the rotating parts are placed or installed in a state of no force, and if the rotating parts are subjected to force, the bearing damage may happen, as shown in figure 4.1.

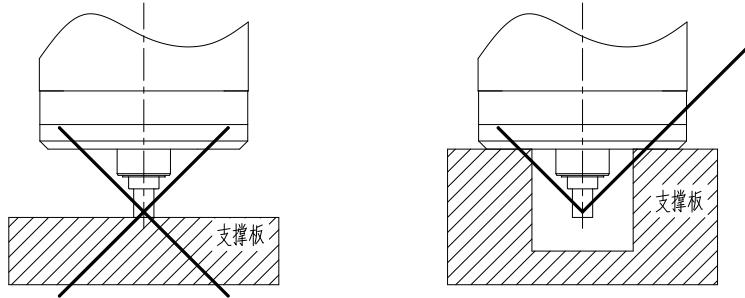


Figure 4.1 Spindle Mounting Force

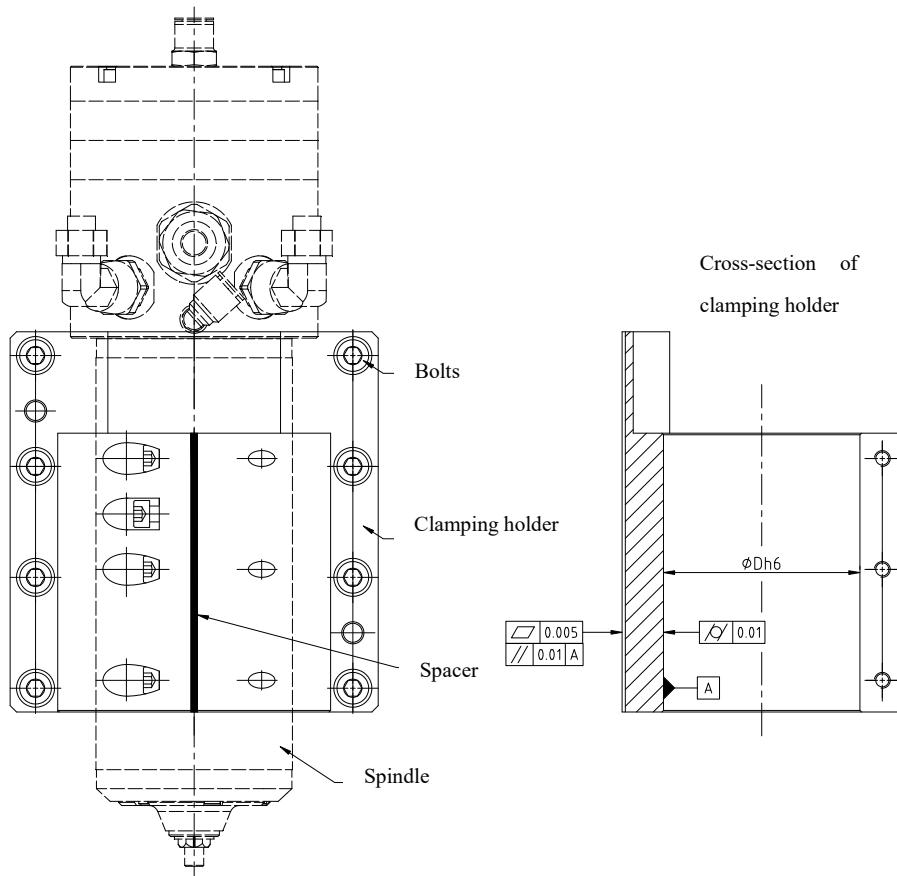
#### 4.4.2 Clamp installation

The tolerance requirement of clamping bracket for spindle installation is  $\Phi D$  H6, and cylindricity is 0.01mm. It is recommended to use a slit-type clamping device with protective gaskets, as shown in Figure 4.2.

- Please wipe the assembly surface with industrial alcohol and other cleaning agents.



➤ During clamping process, please make sure that the clamping force is homogeneous in order to avoid the shell deformation caused by excessive locking force that will affect the bearing accuracy, and cause large noise, short service life and poor machining accuracy.



*Fig .4.2 Schematic diagram of the mounting of the slit clasp*

## 4.5 Electrical connection

### 4.5.1 Power line connection



➤ High voltage! Careful operation, the spindle housing must be grounded.

➤ To ensure that the connection of plug and play switch is safe and reliable, please ensure the correct insertion or pull-out;

➤ The following steps are referred to connect a single wire:

1) Connecting ground wire at first when installing the spindle, then connecting the phase wire, the opposite procedure is for when removing the motorized spindle (first removing the phase wire, then removing the ground wire);

2) Pay attention to whether the phase sequence is connected correctly, when the motor is reversed, please exchange the phase sequence.

#### 4.5.2 Signal line connection

- If there is an aviation plug, to ensure that the connection is safe and reliable, to ensure the correct insertion and pull-out;
- The shielding line in the signal cable must be reliably grounded.

##### 4.5.2.1 Temperature sensor signal

Temperature sensor embedded winding coil inside for real-time monitoring of motor temperature. Temperature sensor standard configuration type: PTC/PT100/KTY, specific model is shown in technical parameters table, for detailed description, please refer to the appendix.

##### 4.5.2.2 Speed sensor signal

This series product standard does not contain the speed measuring sensor, only specific type product is configured with the speed measuring sensor, the sensor model is shown in technical parameter table, for the detailed explanation, please refer to the appendix.

##### 4.5.2.3 Position sensor signal

This series product standard does not contain the position sensor, only specific type product is equipped with position sensor, the specific sensor model is shown in spindle technical parameter table, for the detailed explanation, please refer to the appendix.

##### 4.5.2.4 Encoder signal

This series product standard does not contain the encoder, the specific type product is equipped with the encoder, the encoder model is shown in technical parameter table, for the detailed description, please refer to the appendix.

#### 4.5.3 Cooling system connection

This series of products adopts the optimal cooling system, which can take away the heat of the body, stator and bearing, so as to ensure the full cooling of the motorized spindle, avoid the risk of malfunction of the motorized spindle, and improve the processing stability of the product.



➤ The default cooling medium is water. If the customer uses oil cooling, it must be approved by Haozhi (under the same conditions, the oil flow should reach 2 times than the water flow rate to have the same cooling effect).

➤ After the machine stops working, please close the refrigerator to avoid excessive

temperature difference to form condensate water.

#### 4.5.3.1 Coolant requirements

Distilled water is recommended with corrosion inhibitors added, such as Femox protectors F1 (using a ratio of 1:200). If the workshop temperature is below freezing point, it is strongly recommended to add antifreeze. The user needs to configure cooling water to ensure that extreme conditions such as precipitation, corrosion and water freezing are prevented.

#### 4.5.3.2 Refrigerator setting

Using a differential temperature control water cooler, the coolant setting temperature is consistent with the ambient temperature (below the ambient temperature of 0~3°C), for example: the ambient 30°C, the water cooler setting temperature is 27°C~30°C.

Cooling water over temperature monitoring setting: monitoring temperature set at 35°C.

#### 4.5.3.3 Cooling management setting requirements

It is recommended to set the flow switch in the backwater pipe of the cooling system in order to control the flow rate of the coolant and ensure the normal supply of the spindle coolant. After installation, the signal / parameter of motor temperature and cooling water flow must be checked before testing procedure.

#### 4.5.4 Air connection

##### 4.5.4.1 Compressed air quality requirements



Compressed air must be filtered, separated by oil and water. The gas quality requirements are as follows:

- 1) anhydrous, oil-free, oil content :<0.01 mg/m<sup>3</sup>;
- 2) Air filter <40μm dry;
- 3) Pressure dew point :< 7.5°C (0.7 MPa).

##### 4.5.4.2 Air connection requirements

After all compressed air is connected to the spindle, it is necessary to confirm whether the air pressure reaches the required range indicated in technical parameter table, and if it does not match, it should be adjusted to the correct value.

When installing the air pressure pipe, the compressed air pressure should be adjusted first, to confirm that the air pressure is in accordance with the specified pressure value indicated in the spindle technical parameter table before connecting the air pressure pipe to the corresponding

joint.



In order to avoid water or dirt into the spindle, the compressed air to air curtain seal should be started while starting the machine tool, if the operator cannot meet the above conditions, air sealing must be started first, and then open cutting fluid. And for the completion of processing, the cutting fluid should be closed first and then the air sealing is closed. After the spindle is off, the seal air pressure is kept about 1~2 minutes before closing air.

#### 4.5.4.3 Compressed air requirements

Compressed air should be based on the information of the equipment manufacturer or on the length of the line. The air must be kept dry and pure. For water separation, generally select the oil-water separator with automatic discharge function.

#### 4.5.5 Description of pipeline marking

The letter meaning of marking in the spindle housing according to the spindle structural characteristics is shown in Table 4.1 below.

*Table 4.1 Symbols of the main marks*

Joint Classification	Name of joint	Type marking
Power line function connector	Power line connector	EC
Signal function joints	Signal line connector	SE
	Tool clamping signal leading end	TI SE
	Tool releasing signal leading end	TO SE
	No tool signal leading end	NT SE
	Encoder signal connector	EN
Water function joints	Cooling water inlet	WA IN /COOLANT IN
	Cooling water outlet	WA OUT /COOLANT OUT
Air function joints	Compressed air inlet	AIR
	Air curtain sealing joint	AS
	Air cooled inlet joint	AIR IN
	Air cooled outlet joint	AIR OUT
	Air connector for tool releasing	TO
	Air connector for tool clamping or cylinder reset	TI

## 4.6 Operation

### 4.6.1 Check before operation



Please ensure that the spindle is in a state that can be stopped urgently at any time. If the tool is not fixed, it is strictly forbidden to rotate the spindle, and otherwise it will endanger the operator.

Please follow the following table items for inspection.

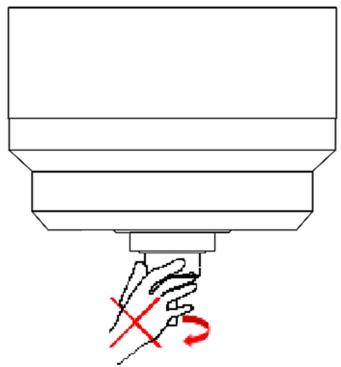
*Table 4.3 Pre-operational items*

Cooling	Leakage of cooling circuit
	Spindle motor leakage
	Circulating water pump running
	Whether the cooling flow is satisfied
Compressed air	Compressed air system is opened
Tool changing system	Should be in clamping status before running
System parameters	System parameter setting is correct

### 4.6.2 Operational description



During the operation of the spindle, it is strictly forbidden to touch its rotating part.



*Figure 4.3 Do not touch the spindle when rotating*

The motor must be pre-heat before the machine is turned on daily, or the machine is operating directly from cold down condition.

#### Function of the run-in:

- 1) It can guarantee the homogeneous distribution of grease in the bearing and prolong the service life of bearing.

2) If the machine and spindle is preheated before finishing, then heat elongation is generated ahead. After finishing, the machining size can be guaranteed to be the minimum change due to spindle heat.

#### Run-in procedure:

25% of the maximum speed runs for 5 minutes, then 50% of the maximum speed runs for 5 minutes, and finally the actual finishing speed (such as 48000 rpm) runs for 20 minutes.

*Table 4.4 Heat motor procedure*

Steps	Speed	Operating time
1	25% maximum speed	5 minutes
2	50% maximum speed	5 minutes
3	operating speed	20 minutes

If the spindle has been cooled to room temperature or lower, after a long period of shutdown, it should not be restarted at the maximum value, in order to protect the spindle, the speed should be gradually increased.



The spindle is strictly forbidden to work at the highest speed; otherwise it will seriously affect the service life of the spindle! It is suggested that the working speed of the spindle should not exceed 80% of the maximum speed of the spindle.

## 5.Maintenance

### 5.1 Cooling system maintenance

1) real-time monitoring whether the water level of the water cooler is normal or not, if it is below the specified water level, please supplement it in time with proper operation.

2) Check the cooling water surface every week whether there is scale or floating matter, if there is, please replace the cooling water in time with proper operation.

### 5.2 Collet maintenance

Collet mounted in spindle is Haozhi self-made as straight-handle type, mounting mode is binding type (lock type or dead-positioning type), the maintenance method refer to "straight-handle collet maintenance" issued by Haozhi.

## 6.Error diagnosis

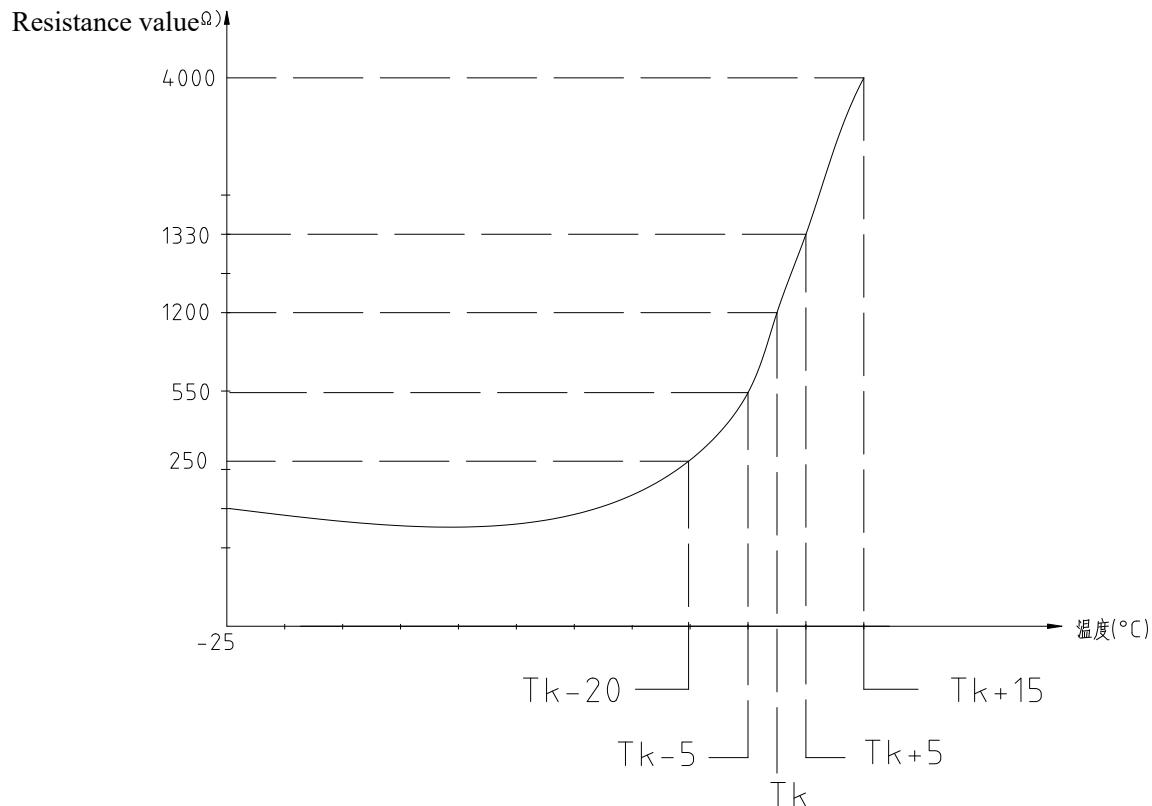
When Spindles operate improperly, please refer to table 6.1, to see possible failures and check one by one, if problem is not still solved please contact our sales department.

*Table 6.1 Errors diagnosis table*

Issues	Possible causes	Remedy
The spindle cannot start	Abnormal power supply	➤ Check the power cable connection and the frequency converter is set correctly
	Spindle jammed	➤ Back to factory maintenance
	change tool is in releasing status	➤ Close the pressure of the air to ensure the cylinder is reset in tool clamping status
Overheat of spindle housing	Insufficient supply of coolant	➤ Wrong direction of pump rotation, two-phase interchange ➤ The cooling pipe is blocked, clean the cooling system and check whether the cooling pipe is bent or not
	Too high coolant temperature	➤ Cooling system not working
	Overload operation	➤ Check whether the normal output current is exceeded
	Bearing damaged	➤ Back to factory maintenance
Spindle sound loud	Tool is not installed in a right position	➤ Check tool installation correctly
	Bearing damage	➤ Back to factory maintenance
	The tool fails to meet the dynamic balance requirements	➤ Adjust the tool according to G2.5 dynamic balance level as specified in ISO 1940
	Overload processing	➤ Reduce the load
Tool cannot be released	Tool releasing air pressure is too low	➤ Check that the air pressure meets the requirements
	Improper connection or breakage of air pipe	➤ Check and replace the air pipe if necessary
	Air leakage in cylinder	➤ Back to factory maintenance

## Appendix 1. PTC Stator Temperature Measuring Sensor

Single PTC Temperature Sensor Temperature – Resistance Curve

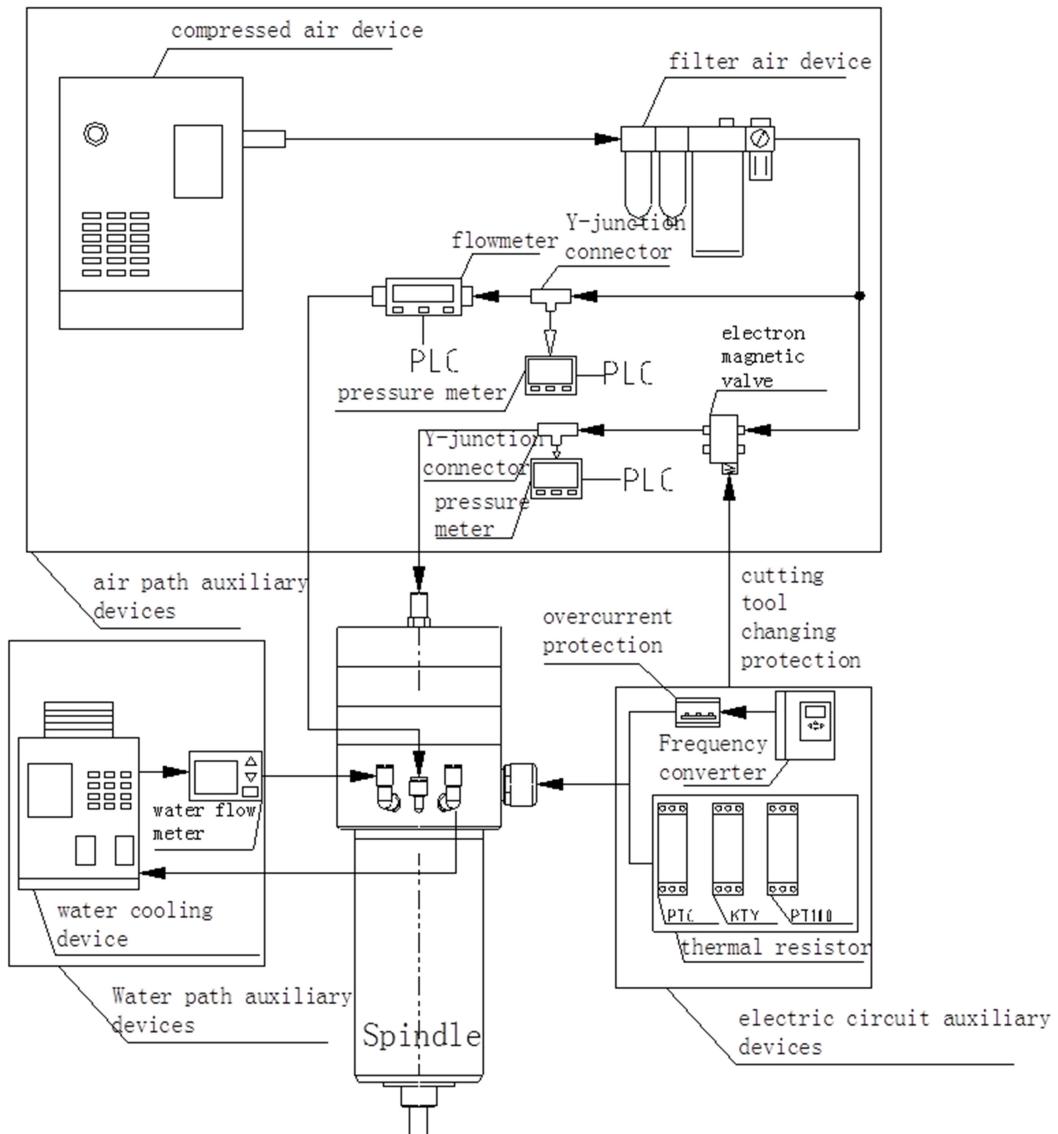


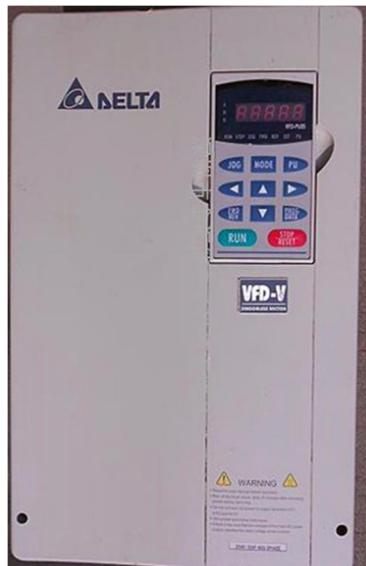
### Technical Parameters:

- 1) Sensor type: PTC (Positive temperature coefficient), normal temperature resistance value  $R_{20} \leq 85\Omega$ .
- 2) Switch characteristics:  
Temperature control point  $T_k = 145^{\circ}\text{C}$ ,  $T_{k-5} \leq 550\Omega$ ,  $T_{k+5} \geq 1330\Omega$ .
- 3)  $T_k$  deviation  $\Delta T = \pm 5^{\circ}\text{C}$ ,  $T_k$  repeatability  $\Delta T = \pm 0.5^{\circ}\text{C}$ .
- 4) Thermal action time:  $\leq 2\text{S}$ .
- 5) The maximum working voltage is 30V (DC), and the dielectric strength is 2.5KV.
- 6) The maximum allowable working temperature is  $180^{\circ}\text{C}$ , and the minimum allowable working temperature is  $-25^{\circ}\text{C}$

## Appendix 2-5: Please check technical specification.

## Appendix 6. Water, Gas and Electricity Supporting Facilities





Name:	Frequency converter
Usage:	Drive the spindle to run, monitor the motor condition, and detect the thermal sensitivity, etc.
Brand and model:	Delta frequency converter, SIE & MEYER driver, CT converter, etc.
Parameters:	Power, voltage, current, frequency, etc.
Selection basis:	The selection of frequency converter should be based on the maximum voltage and power of spindle motor. The voltage of frequency converter should be greater than the voltage of spindle, and the power of frequency converter should be greater than the maximum power of spindle. Taking DGZ-06260/2.5-PWM as an example, its maximum voltage is 220V, its power is 2.5kW, so the frequency converter should select the voltage of 220V and its power should be greater than 3.7kW.



Name:	Overcurrent protection relay
Usage:	When the current is too high, it will be automatically disconnected to prevent the motor from burning down.
Brand and model:	Meilan Power D100A
Parameters:	Maximum carrying current; number of connection ports (3p/4p)
Selection basis:	The maximum breaking current shall be determined according to the maximum allowable current and the maximum current duration of the

	<p>spindle. The maximum breaking current of the relay shall be higher than the maximum allowable current of the spindle, and the breaking time shall be equal to the maximum allowable current passing time of the spindle. Taking DGZ-06260/2.5-PWM as an example, its maximum allowable passing current is 32.4A and its maximum allowable current duration is 2s, so the relay should select the relay with the maximum breaking current greater than 31A and the maximum allowable current passing time equal to 2s.</p>
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Name:	KTY thermistor relay
Usage:	When the temperature is too high, it will be automatically disconnected to prevent the motor from overheating.
Brand and model:	Schneider TeSys LT3
Selection basis:	The thermistor relay shall be selected according to the specific thermistor type of the spindle and the maximum thermistor resistance value required by the spindle.



Name:	PT100 temperature monitoring relay
Usage:	When the temperature is too high, it will be automatically disconnected to prevent the motor from overheating.
Brand and model:	ABB CM-TCS.23S
Selection basis:	The thermistor relay shall be selected according to the specific thermistor type of the spindle and the maximum thermistor resistance value required by the spindle.

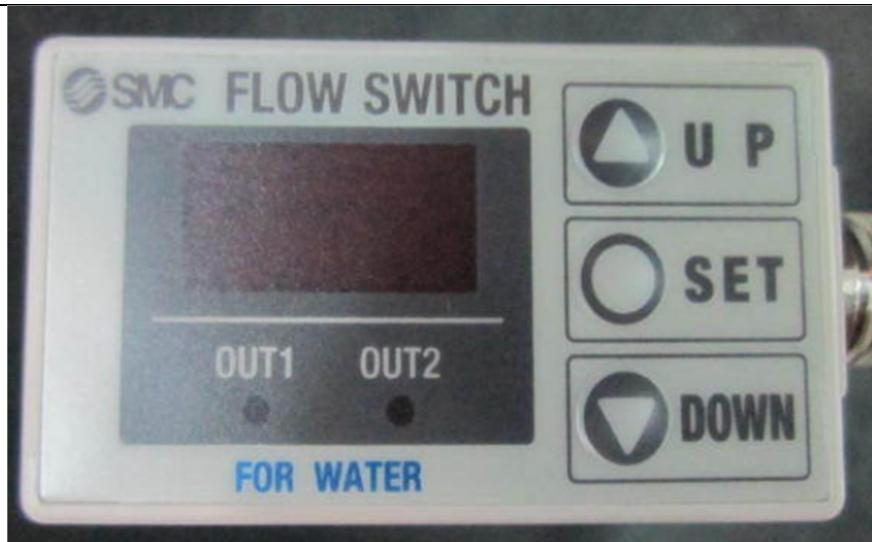


Name:	PTC thermistor relay
Usage:	When the temperature is too high, it will be automatically disconnected to prevent the motor from overheating.
Brand and model:	ABB CM-MSE 24VAC
Selection basis:	The selection of the thermistor relay shall be determined according to the specific thermistor type of the spindle and the maximum thermistor resistance value required by the spindle. Taking DGZ-06260/2.5-PWM as an example, the thermistor type is PTC, and the resistance value of the normally working

thermistor is required to be less than or equal to  $550\Omega$ , so the thermistor relay shall select PTC thermistor relay, and its maximum breaking resistance value should be greater than  $550\Omega$ .



Name:	Chiller
Usage:	Ensure sufficient flow and stable temperature of cooling medium.
Brand and model:	RUCOL RCW-20P
Alarm pressure and temperature:	XX MPa (lift or pressure), XX°C; It must be connected to the machine PLC for monitoring.
Functions:	If the water pressure is insufficient or the temperature is too high, it needs to give an alarm and must be connected to the machine PLC for monitoring.
Selection basis:	The selection of the chiller shall be determined according to the cooling flow and cooling temperature of the shift. The maximum cooling flow of chiller should be greater than the cooling flow required by the spindle, the working temperature should meet the cooling temperature required by the spindle, and the cooling capacity should be greater than 20% of the spindle power



Name:	Water flow meter
Usage:	Monitor the flow of the cooling medium.
Brand and model:	SMC PF2W720T-00-27N
Alarm flow:	XX L/min (the water flow rate is not less than the recommended water flow rate of the spindle, and the recommended water flow rate of the spindle can refer to the technical parameter table in the manual of the spindle), which must be connected to the machine PLC for monitoring.
Selection basis:	The maximum flow rate monitored by the water flow meter shall be greater than the flow rate of water chiller.



Name:	Pressure gauge
Usage:	Monitor the safe air pressure.
Brand and model:	SMC ISE40A-01-R
Alarm air	XXX MPa (the air pressure shall not be lower than the recommended

pressure:	minimum air pressure of the spindle, and the recommended air pressure of the spindle can refer to the technical parameter table in the manual of the spindle), which must be connected to the machine PLC for monitoring.
Selection basis:	The monitoring flow range shall cover the normal working air pressure of the spindle.



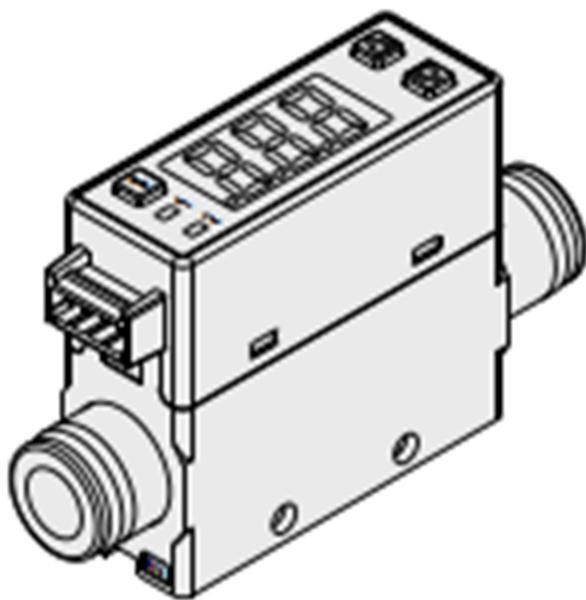
Name:	Vacuum filter
Usage:	Three-stage filtration of water, oil and other impurities in air source.
Brand:	SMC F.R.L., SMC air dryer IDG50A-03
Filter element model:	af30p-060s (5um) (fluid and water of pre-filter) afm30p-060as (0.3um) (oil removal of coalescent filter) afd30-f03d (0.01um) (oil steam removal of activated carbon)
Replacement cycle of filter element:	It should be replaced once within four months, and the drainage period should be one month.
Selection basis:	The air flow into the spindle requires that the filtration accuracy should be less than 1μm, the oil content should be less than 0.01mg/m <sup>3</sup> , and the solid particles should be less than 1μm.



Name:	Check valve
Usage:	Switch the water vapor to ensure the water vapor required for processing
Brand:	DETER ORS01/3
Selection basis:	The maximum bearing pressure of unidirectional switching high-pressure water vapor is greater than the pressure of the spindle. For example, at present, the water pressure of spindle with coolant through shaft is 0.25MPa, so the bearing water pressure should be greater than 0.25MPa.



Name:	High-pressure cutting fluid cooling system
Usage:	Provide high-pressure water for coolant through shaft with the maximum water pressure over 6MPa
Brand and model:	Yinkai Precision Machinery (Shanghai) Co., Ltd PJ-30M-70F
Selection basis:	The pressure provided by the high-speed cutting fluid cooling system should be greater than the pressure required by the spindle. Taking DGZ-06260/2.5-PWM as an example, its water pressure range is 0.25 MPa, so the water pressure provided by the high-pressure cutting fluid cooling system should be higher than such water pressure.



Name:	Air flow meter
Usage:	Monitor the blockage
Brand and model:	SMC PF2A721-03-27
Alarm flow:	XXL/min, which must be connected to the machine PLC for monitoring.
Selection basis:	The monitoring flow range should cover the normal working flow of the spindle.

Name:	Air source
Usage:	Ensure the normal operation and conversion of the spindle
Air pressure:	0.25MPa for coolant through shaft supporting facility, 0.5-0.7MPa for oil-air lubrication supporting facility, and 0.6MPa for gas circuit supporting facility
Selection basis:	According to the application needs of the spindle, select the air source with appropriate pressure.

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