Air-cooled automatic tool-change electrical spindle
(WFIT-24/4.5)

Thank you very much for patronizing our products. In order to have better understanding and application of GDL series tool-change electrical spindle, and have correct installation and maintenance to the products, please read the instruction carefully, and then perform the installation and commissioning after mastering the performances of the products.

I. Preparation before Installation

1. The working temperature of GDL series electrical spindle normally shall be -10℃~40℃;
2. Turn the spindle head by hand before installation; it shall feel smooth without any retardation;
3. Check the insulation resistance of stator by 500V meg ohm-meter; it shall be no less than 50MΩ;
4. Check the runout of BT taper hole at the front end of electrical spindle by 1μm lever dial gauge, and it shall be ≯3μm;
5. Install the electrical spindle which fulfills all above-mentioned requirements into the base, and the connection between housing of electrical spindle and the mounting holes of base shall be sliding fit. The electrical spindle is forbidden to be clamped at the front and rear bearings (the clamping position shall be comply with the clamping drawings that provided by our company), so as to avoid the deformation of bearing cell to stuck the bearings, and cause the advanced damages. The clamping force should not be too large, and the electrical spindle shall not become loosen after mounted into base.

II. Correct Application

1. Connect the inlet and outlet water-pipe connectors strictly according to marked requirements of electrical spindle; check the water-leakage and patency conditions of the joints; the cooling system of the electrical spindle shall be connected with the

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master switch of machine tool; the cooling system shall keep working continuously after the startup of machine till the stop of machine; the water of cooling liquid shall be calculated with 2.5 l/kw • min, and the flow of cooling liquid with 3~6 l/min; the cooling liquid is required to be stored in individual tank with anti-rust agent, and shall be replaced regularly every month; the cooling liquid is forbidden to be mixed with cutting fluid to avoid the chips and dirt in cutting fluid entering into cooling duct of water-cooling electrical spindle to block the duct and cause the heating and damage of electrical spindle. The tank of GDL series electrical spindle shall be set with cooling device, and the constant temperature 20±2℃ is required for precision machine tools. The performance of oil cooling for electrical spindle is not good, therefore, it is recommended to apply water cooling. The performance of compressor oil cooling for electrical spindle is not good, therefore, it is recommended to apply water cooling (it shall apply 150 watts of compressor water cooling for per thousand watts of electrical spindle). And the cooling liquid shall apply purified water or soft water, and it is forbidden to apply tap water or well water in case of incrustation.

2. Frequency inverter shall be selected and applied by matching the voltage, power and frequency of electrical spindle. The setting of frequency inverter shall be started by setting of reference frequency which shall be set according to the highest frequency of electrical spindle. The highest frequency, corner frequency and corresponding voltage of frequency inverter shall be set according to the frequency-voltage curve of electrical spindle; the current of frequency inverter shall be set according to the rated current of electrical spindle; the carrier frequency shall be set according to the power of electrical spindle, with 8kHz if smaller than 10kw, and with 5kHz if larger than 10kw; the time for acceleration and deceleration shall be set around 10s, and shall be prolonged accordingly for the protection if the startup current exceeds the rated current. The shortage of acceleration and deceleration time would easily cause the loose of front screws.

3. Connect the U, V and W three phases of frequency converter with the three-color power wire of electrical spindle; the yellow-green wire is connected with ground, and two fine wires of PTC thermistor is connected externally with

temperature-controlled protector. And then connect the frequency converter with the external power supply. And then connect frequency inverter with outside power; and observe whether the rotary direction of electrical spindle is consistent with indicated direction; if the direction is not consistent, turn off immediately, and the electrical spindle is forbidden to operate with wrong rotary direction. The connection wire between electrical spindle and frequency inverter should not be longer than 25m. It shall take water-proof measures when connect the power wire of electrical spindle to the plug, and the connection between power wires and joints shall be sealed with therm-plastic pipes, and fixed after bending into U form under joints to avoid the condensate water or oil of power wires entering into joints and cause short circuit of power.

4. If vector frequency inverter is applied, firstly set the inverter according to the procedure in chapter 2.3, and then set the phase resistance and slippage rate of stator according to the data provided by manufacturer of electrical spindle, hence, the vector frequency inverter could control electrical spindle by vector. The setting of vector frequency inverter shall be carried out according to frequency-voltage curve of electrical spindle. If orientation is required, the vector frequency inverter can only be applied when the encoder on electrical spindle is modulated into square wave by oscilloscope. It's better to use KEB Inverter as vector frequency inverter. If servo system is applied, it is not necessary to modulate the encoder on electrical spindle. The power wire to connect vector frequency inverter shall apply shielded wires to avoid interference.
5. Numerically controlled machine tool shall be equipped with control system of thermistor of electrical spindle. Then the temperature of stator of electrical spindle reaches 110℃, the control system of thermistor shall cut off the power of electrical spindle to prevent the burning out of stator.
6. Connect proximity switch (24V NPN/PNP of NO type; please refer to figure below for its connection diagram). When mount tool holder to electrical spindle, the indicating light of the broach control system that connected with proximity switch shall be green, and the electrical spindle can only operate normally when it is

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interlocked with the broach control system. The manual tool-change electrical spindle normally applies one proximity switch, and the automatic one normally applies two proximity switches.

7. The tool-change structure of automatic tool-change electrical spindle normally applies pneumatic tool change one; the pneumatic source is clean air passing through oil-water separator; connect the inlet, return, de-dusting of cylinder according to the marks on the rear cover of electrical spindle. Pressure of these three air source shall be controlled within the range of 0.6~0.7MPa. Pressure of air-seal shall be controlled within the range of 0.1~0.2MPa. The pneumatic control system of numerically controlled machine tool shall be equipped with solenoid valves to control respectively the inlet, de-dusting, return and air-seal of cylinder. After completion of machining process of components, before tool-change and after electrical spindle stops completely, the control sequence shall be as follows: firstly, the inlet valve of cylinder controls the inlet and de-dusting; when cylinder intakes the air, it depresses the disc spring to remove tool holder, and at the moment, the indicating light of broach control system is red, and the indicating light of tool-change control system is green; at the same time, the de-dusting is performed; when new tool holder enters into the taper hold, the inlet and de-dusting of cylinder stop; at this time, the inlet valve of cylinder shall connect through with atmosphere to discharge the cylinder. Then the return valve of cylinder controls the return of cylinder to complete the process of mounting of new tool holder; the indicating light of broach control system is green, and the indicating light of tool-change system is red to indicate that new tool holder has been mounted. The proximity switches shall be interlocked with the switches of electrical spindle; only when the indicating light of proximity switch of broach system is green, and the indicating light of tool-change control system is red, the electrical spindle could operate normally. It is required that the machine tool is interlocked with air-seal from startup to stop, so as to protect the bearing from the pollution of cutting liquid, chips and dust.
8. The ER taper hole and surface of spring collet shall be cleaned when installing tools on ISO and BT tool holders in order to avoid any impact on the precision. The installation and dismounting of tools shall apply special tools. Pay attention that it is

forbidden to apply too much effort during installation and dismounting. Clean the taper hole on electrical spindle and the surface of ISO and BT tool holder when install tool holder on spindle to avoid any impact on the precision.

9. Because of the limitation of extreme rotating speed of grease lubrication of precise angular contact ball bearing, the electrical spindle is not allowed to operate with over-speed, which may cause the burning out of precise angular contact ball bearing.
10. During normal operation of electrical spindle, it shall perform three steps of works, i.e., hear, touch and watch. Step of “Hear” means to hear if there is any abnormal sound for electrical spindle, if yes, turn off immediately to make inspection; step of “Touch” means to touch to feel if the heating and vibration are stable, if not, turn off immediately to make inspection; and step of “Watch” means to watch if the surface quality of components are stable, if not, turn off immediately to make inspection.
11. It shall apply PARFAITE tool holder, ISO20 with pop-rivet MAS403-1982ISO/1(15°), BT30, BT40 with pop-rivet MAS403-1982BT/1(45°). High speed tool holder shall perform precise dynamic balance. Normally, the ISO 20, BT 30 and BT40 would apply the tool holder without button.

III. Common failures during operation of electrical spindle

1. Regarding to the open loop variable frequency speed regulation system, the torque of electrical spindle would have significant reduction at low frequency, which could cause the electrical spindle with constant torque failed to operate under low speed; normally the torque will not decrease when operate within 50%~100% frequency range; if low speed is inevitable, it can be set according to the U/F curve provided by our company.
2. Normally the resonance point of electrical spindle is about 75% frequency which can cause the increase of noise and vibration of spindle; therefore, it shall avoid machining under the frequency.
3. During normal operation, the electrical spindle would have heating phenomenon; it can be considered as heating if the surface temperature of spindle is 15℃ higher than environmental temperature. Under this circumstance, it shall turn off to make

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inspection. Firstly, it shall check the temperature of cooling liquid in cooling water tank by thermometer; if the temperature is higher than environmental temperature, it shall change the cooling liquid whose temperature is lower than environmental temperature. If there is no problem in cooling water tank, then check whether the cooling duct of spindle is blocked, and whether the cooling liquid is clean; if the cooling liquid is not clean, it will block the cooling duct. And the cooling liquid shall be replaced regularly every month. And dust-proof device is required on the top of cooling water tank.

IV. Transportation, maintenance and service

1. The electrical spindle is sophisticated product, whose package shall apply foamed plastics, and the housing shall be fixed by carton or wooden box. Handle with care and strictly no bump during transportation, especially the stretch end.
2. Once abnormal sound or vibration appeared during operation of the spindle, it shall turn off immediately to make inspection; change with a new bearing if necessary. If abnormal smell or sudden stop appeared during operation, it shall cut off the power immediately; check the resistance to ground and three phase resistance of stator by megohm meter; if the insulation resistance is lost, it means the stator is burn out, and shall be replaced by returning back to manufacturer.
3. The lubricating grease of the electrical spindle shall be replaced regularly, which shall be performed by professional maintenance personnel or by returning back to our company.
4. If the downtime of the electrical spindle is long, it shall blow the cooling duct out by compressed air and perform antirust treatment to the spindle. After 6 months of storage or downtime, it shall replace with new grease for the electrical spindle before application, otherwise, it will influent the lifetime of the spindle.
5. In order to prolong the lifetime of the electrical spindle, the new spindle or spindle with new bearing shall be divided into 4~8 levels within range of spindle speed; accelerate after 30 min of operation at each level; avoid high speed operation directly which would shorten the lifetime of the spindle. Each time after vacation, keep the electrical spindle running with no load for half hour before operation.

6. If the electrical spindle needs to be repaired, please return it back to our company. Our company will provide sincere service for you.

V. Service lifetime of electrical spindle

The guarantee period for the service lifetime of spindle motor will be 1 year. And the guarantee period for the service lifetime of bearing shall be: 2000h for imported one.

VI. Declaration for no free warranty of electrical spindle

If the user doesn't operate according to operation instruction which caused the damages of electrical spindle, our company will not bear the free warranty obligations, and will perform pay-for-maintenance under following circumstances:

1. The service voltage does not comply with the nameplate, and cause the burning out of stator;
2. Operation under phase loss condition, and cause the burning out of stator;
3. Process the fine powder material without air-seal, and cause the damage of bearing;
4. Apply the air without passing through oil-water separator for air-seal, and cause the damage of bearing;
5. Collision of electrical spindle because of the mis-operation of user, and cause the damage of the spindle;
6. Unauthorized dismounting of electrical spindle by user, and cause the damage of the spindle;
7. User doesn't change cooling liquid regularly which cause the block of cooling duct, and cause the burning out of electrical spindle;
8. Temperature of cooling liquid is too high to damage the electrical spindle;
9. Unauthorized increase of cutting parameters by user, and cause the damage of electrical spindle.

VII. Frequency-voltage curve

The frequency-voltage curve of electrical spindle shall be as figures below:

1. Curve with constant torque:

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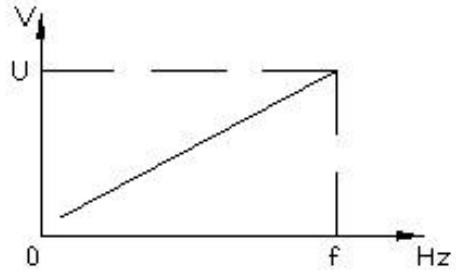
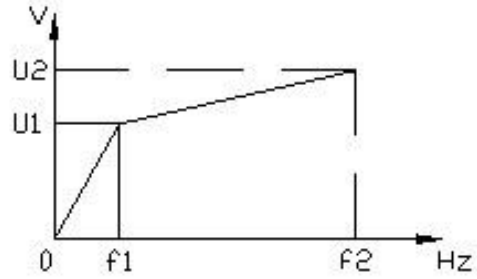
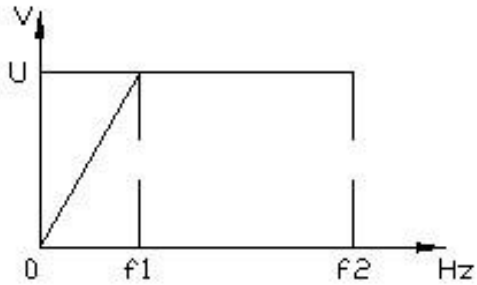


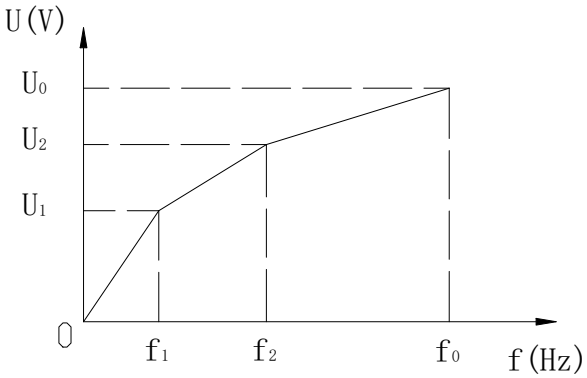
2. Curve with constant power



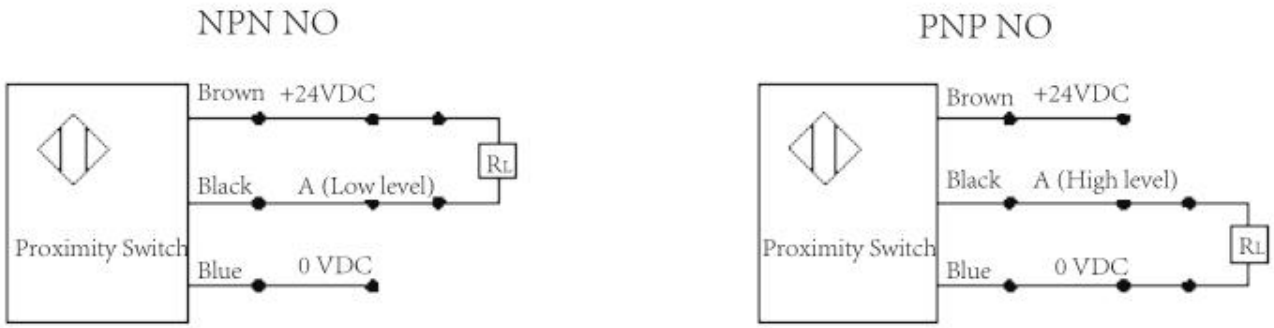
3. Curve with approximate constant power



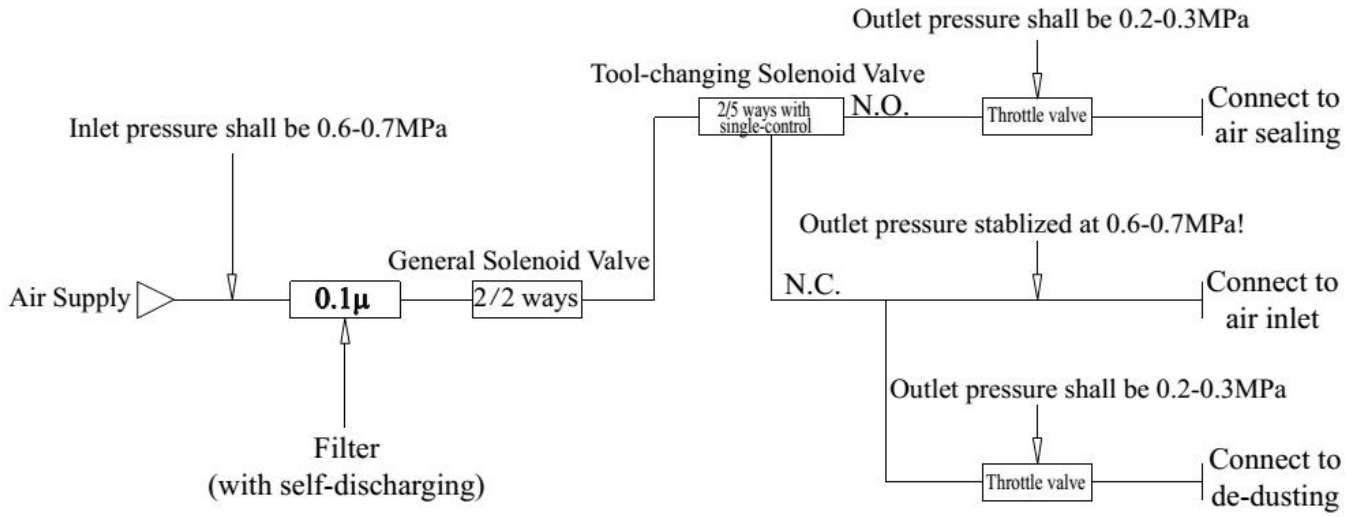
4. Multipoint Frequency-Voltage Curve



VIII. Connection diagram of proximity switch



IX. Diagram of pneumatic control



Specification:

1. The general solenoid valve is linked with the general switch of machine tool; it shall connect with air once machine tool started.

2. The N.O. air circuit of solenoid valve of 2/5 ways with single control shall be connected to air sealing, and the N.C. air circuit shall be connected to inlet and de-dusting.

When the electric spindle completely stops, the tool-changing solenoid energized to connect the N.C. air circuit to inlet, the other air circuit shall be connected to de-dusting inlet, and the cylinder operates to complete the tool changing and the tool-changing de-dusting as well. The air sealing is closed by then. When the new tool handle enters into the cone hole of spindle, the tool changing solenoid valve de-energized to close the inlet and de-dusting; the cylinder recover the spindle to lock the new tool handle; the air sealing is connected to air by then, and the tool changing action completed.

3. The pressure for tool changing shall be stable; otherwise it would cause the

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instability of tool-changing signals.

4. The manual tool-change can be realized when button switch directly controls the 2/5 ways solenoid valve with single control.

5. The automatic tool-change can be realized when the proximity switch fits with tool-change solenoid valve and tool changer.

X. Application method of PTC Thermistor

Our company applies the PTC thermistor used for thermal protection of motor, level 110 ℃, which produced by Shanghai Dadi Communication Electronics Co., Ltd.

Contact No.: 021-58583005

	110 ℃ temperature characteristic of single core thermistor	110 ℃ temperature characteristic of three-core thermistor
-20～25℃	≤100Ω	≤300Ω
≤90℃	≤250Ω	≤750Ω
105℃	≤550Ω	≤1650Ω
115℃	≤1330Ω	≤3990Ω
≥125℃	≥4KΩ	≥12KΩ

Allowed storage temperature: -25℃～160℃, the maximum operation voltage: 25Vmax, and the maximum current: 100mAmax.

The application rage of 100 ℃ single core thermistor of our company should be: GDL80 Serial water-cooling tool-change electrical spindle, GDF46 Serial air-cooling square electrical spindle and GDF53 Serial air-cooling square electrical spindle.

The application rage of 100 ℃ three-core thermistor of our company should be: GDL110 Serial water-cooling tool-change electrical spindle, GDL120 Serial water-cooling tool-change electrical spindle, GDL125-BT30 water-cooling tool-change electrical spindle, GDL125-BT40 water-cooling tool-change electrical spindle, GDL150-BT40 Serial water-cooling tool-change electrical spindle, GDL170-BT40 Serial water-cooling tool-change electrical spindle, GDL70 Grade 2 and Grade 4 air-cooling tool-change electrical spindle and GDF53 Grade 2 and Grade 4 Serial

air-cooling Serial square electrical spindle and GDF60 Serial air-cooling square electrical spindle.

Application method 1 for thermistor: connect the thermistor into the control end of frequency converter; set the thermistor to control the parameters of frequency converter. Please consult the technical service people of frequency converter for detailed information.

Application method 2 for thermistor: apply intermediate relay with large and medium power to connect with the three-phase power line of electrical spindle; apply the thermistor to control the controlling circuit of intermediate relay to realize the open and close of relay, so as to control the automatic stop of electrical spindle and the overheat protection of the motor of electrical spindle.

XI. Common failures and its troubleshooting methods

Failures	Causes	Troubleshooting methods
The spindle does not running after startup	1. No output or wrongly setting of frequency inverter	check the output voltage and the setting of frequency
	2. Unplugged	Check the plug and its wiring
	3. Wiring of plug is not good	
	4. Coil of stator is failed	Change the coil
After startup, running for few seconds, then stop	1. Insulation of coil damaged by water leakage	Dry the coil
	2. Insulation of coil damaged by high temperature	Change the coil
	3. Over-current protection caused by operation under phase loss	Check the wiring of motor
	4. Startup time is too short	Prolong acceleration time
Smoke or heating appears on the motor after few seconds	1. Frequency inverter has no output voltage, the frequency does not comply with nameplate of spindle	Check the fundamental frequency setting of frequency inverter

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Failures	Causes	Troubleshooting methods
running	2. Setting of frequency inverter is wrong	Reset frequency inverter
	3. Water duct has problems	Check whether the water duct is unblocked
Screw loosen when startup	Turning direction is wrong	Change the turning direction according to nameplate
Noise loud or vibration large	1. Wear serious for bearing	Replace the bearing
	2. Damaged precision of components influents the dynamic balance	Adjust the dynamic balance
	3. Runout of spindle is too large	Replace spindle
Screw loosen when stop	Time to stop is too short	Prolong the deceleration time