# Series HSV-180S AC Spindle Drive

# User's Manual

**V2.0**

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Wuhan Huazhong Numerical Control Co., LTD

Wuhan China

# Contents

# 1. Safety Precautions

Thank you very much for buying AC spindle drive, HSV-180S. HSV-180S AC spindle drive unit and spindle motor are applicable to the general industrial environment, not to the strong vibrating environment. Pay attention to the followings:

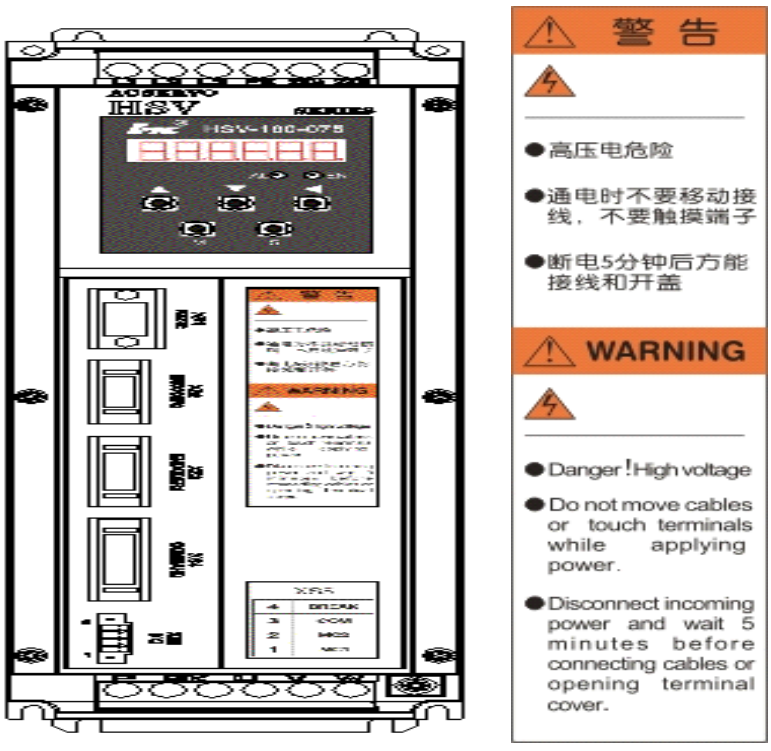
- It is inapplicable to the medical equipment which related to life safety.
- The spindle drive is not water proof. It must be avoid moisture and direct sunlight.
- Do not perform any change to the spindle drive and drive motor.

Before installation and wiring, read through this manual. Before operation, understand the safety information, safety precautions and operating instruction of this equipment.

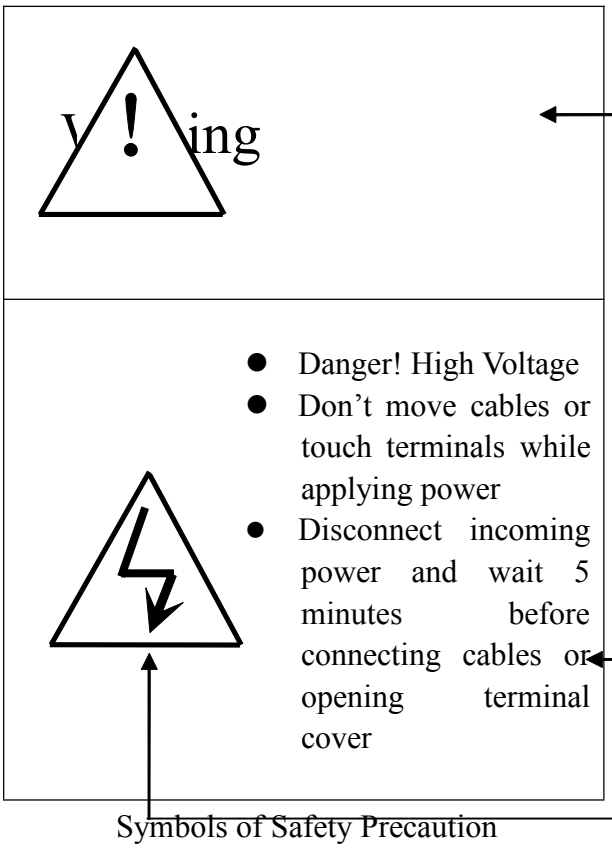
## 1.1 Symbols of Safety Precautions

Symbols of safety precautions are displayed on the front panel of the spindle drive.

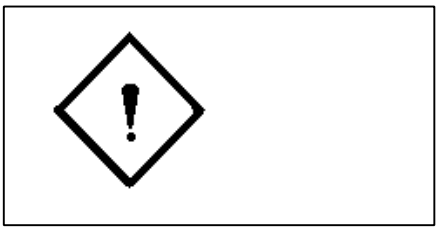
Figure 1-1 Symbol of safety precaution for HSV-180S-025, 035, 050, 075



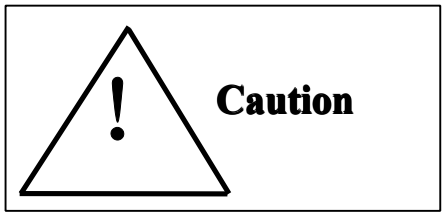
## 1.2 Meaning of Safety Precaution Symbols




## 1.3 Explanation of Safety Precaution Symbols



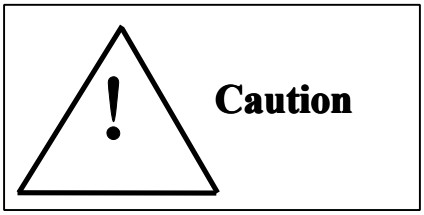
It indicates a potentially hazardous situation which, if not avoided, will result in death.




It indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury or death and damage to the machine.

## 1.4 Safety Regulations

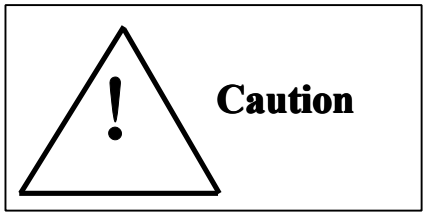
### 1. Products Confirmation




Do not install damaged drive units.

Failure to follow this instruction could result in injury.

### 2. Installation




- Hold the bottom of the machine.

  If only hold the panel, the main engine may fall off which may result in injury.

- Fit to noncombustibles such as metal.

  Failure to follow this instruction could result in fire hazard.

- If necessary, set a cooling fan and keep the inlet air at 45℃ or less.

  Overheating may result in fire and other hazards.

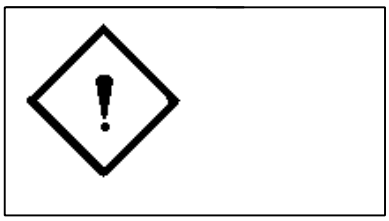
- Don't block the inlet and outlet. Avoid foreign matter entering into the internal part of the machine.

  It may cause the aging of internal components, which can result in malfunction or fire hazard.

- When installing, make sure a specified intervals between drive unit and control cabinet or other machines.

  Failure to follow this instruction could result in fire hazard or malfunction.

### 3. Wiring



- Before wiring, confirm whether the power is off.

  Failure to follow this instruction could result in electric shock and fire hazard.
- Only electrical engineer can do the wiring.

  Failure to follow this instruction could result in electric shock and fire hazard.
- Make sure the ground terminal grounded.

  Failure to follow this instruction could result in electric shock and fire hazard.
- After the wiring of the emergency stop circuit, check whether the wiring is effective.

  Failure to follow this instruction could result in injury. (Users shall be responsible for the wiring.)
- Do not touch the output terminal directly nor connect external shield to the output wire of a spindle drive unit. Avoid short circuit of output wires.

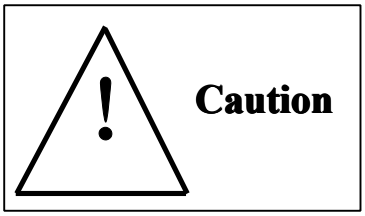
  Failure to follow this instruction could result in electric shock and short circuit.


- Confirm whether the power voltage of the main AC circuit is subject to the rated voltage of the spindle drive unit.

  Failure to follow this instruction could result in injury and fire hazard.
- Do not make withstand test for the spindle drive unit.

  Failure to follow this instruction could result in damage to components such as semi-conductor.
- Do not connect power cable to the output U, V, W terminals so as to avoid

damage of spindle drive unit internal parts.




- Do not connect capacitance and LC or LR noise filter to the output circuit so as to avoid damage of spindle drive.
- Do not connect electromagnetic switch and electromagnetic contactor to the U, V, and W output circuit. If the spindle drive running with load, surging current could activate over-current protection of the spindle drive unit.

## 4. Testing and Commissioning


- Do not remove or modify anything when the external wirings are made, or the power is on.

  Failure to follow this instruction could result in electric shock.
- Do not approach to the machine on the trial-operations, after resetting of spindle drive unit (Take physical safety into consideration when perform electrical and mechanical design).
- Arrange an external emergency stop device.

  Failure to follow this instruction could result in injury.


- Before operating, reconfirm some information such as the use range of the motor and machines.

  Failure to follow this instruction could result in injury.

- Do not touch the machine while operating or just cut off the power, because the radiator, brake resistor motor etc. may be at high temperature.

Failure to follow this instruction could result in burn.

- If necessary, arrange external brake. Do not touch the machine.

Failure to follow this instruction could result in injury.

- Do not check signal while operating to avoid damage to the equipment.

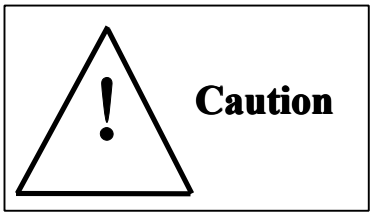
## 5. Troubleshooting


- Do not remove wiring within 5 minutes or touch terminals after power-off of a spindle drive unit, because the high voltage will last for a while.

  Failure to follow this instruction could result in electric shock.

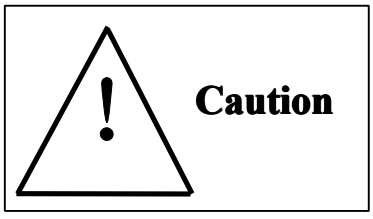
- Operations (such as wiring, installation, operation, remove and maintenance) must be performed by the specified professional personnel.

  Failure to follow this instruction could result in electric shock and damage to the spindle drive unit.




- The control circuit board adopts the CMOS IC. When maintaining, do not touch it directly with your fingers, because electrostatic induction could damage the control circuit board.

## 6. System Configuration



- The rated torque of the spindle motor must be larger than continuous effective load torque. Otherwise, the spindle motor could be damaged by long-time overload operation.
- The ratio of load inertia and spindle motor inertia must be less than the recommended value.
- Make sure that the motor is properly matching the spindle drive unit.

  Failure to follow this instruction could result in damage of the equipment.

## 7. Others


- Do not make alterations independently.

  Failure to follow this instruction could result in electric shock and injury.

# 2. Overview

Series HSV-180S AC spindle motor drive is a new generation of full digital AC servo spindle drive developed by Wuhan Huazhong Numerical Control Co., Ltd.. This product features high performance, compact structure, easy-to-use operation, and high reliability.

## 2.1 Introduction

Series HSV-180S AC spindle motor drive adopts the latest technologies such as special motion control digital signal processor (DSP), large-scale field programmable logic arrays (FPLA) and intelligent power module (IPM), and achieves the closed-loop servo control of spindle motor. It has various specifications such as 25A, 35A, 50A, 75A and different ranges of power options. Users can configure various types of spindle drive motor and AC spindle motor to form high reliability and performance AC spindle drive systems.

**Characteristics of Series HSV-180S**:

1. Easy and flexible operation

By modifying the parameter, you can modify the control methods of the spindle drive and the interior parameters so as to meet the requirements for different environment and conditions, and can be compatible with various types of spindle motors.

2. Full display of status

Series HSV-180S provide a series of status display, which enables users to view related status parameters of the spindle drive during commissioning and operation. In addition, it provides a range of troubleshooting information.

3. Various interfaces, and flexible control methods

HSV-180S spindle drive can provide various interfaces and flexible control methods as follows:

- Pulse input interface
- Analog input interface
- Feedback interface of spindle motor optical -electrical encoder

- Feedback interface of spindle motor encoder
- Serial communication interface
- Programmable I/O interface

4. Spindle orientation function

Series HSV-180S can provide an independent function for spindle orientation. Through feedback devices such as spindle motor optic-electrical encoder, spindle encoder and zero switch, it can realize the spindle orientation control independently.

5. C axis function

Series HSV-180S achieve the closed-loop servo control of spindle motor. With the C axis function, it achieves the function for rigid tapping and thread cutting.

## 2.2 Introduction to Control Modes

Series HSV-180S spindle drive motor provides four control modes:

**1. Position control mode (pulse interface)**

Under this mode, HSV-180S spindle drive can set to external position control mode by setting internal parameters. It can receive three types of external pulse command such as orthogonal pulse command, pulse + direction command, and positive and negative pulse command.

**2. External speed control mode (pulse interface)**

Under this mode, HSV-180S spindle drive can set to external speed control mode by setting internal parameters. It can receive three types of external pulse command such as orthogonal pulse command, pulse + direction command, and positive and negative pulse command.

**3. External speed control mode (analog interface)**

Under this mode, HSV-180S spindle drive can set to external speed control mode by setting internal parameters. It can receives external analog command with amplitude varies from -10 V to 10 V or from 0 V to 10 V.

**4. JOG mode**

Under this mode, HSV-180S spindle drive can run based on the key setting

(instead of external instruction). This mode is provided for users to test whether the spindle drive system is correctly installed and connected.

### 5. Internal speed control mode

Under this mode, HSV-180S spindle drive can run at a present speed in the system without external instruction. This mode is provided for users to test whether the spindle drive system is correctly installed and connected.

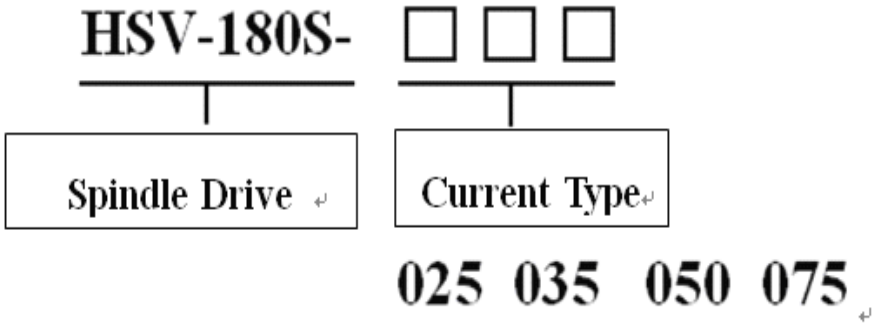
# 3. Order Information

## 3.1 Specifications of Spindle Drive

### 3.1.1 Specification for HSV-180S

The following figure shows the specification of HSV-180S.

Figure 3-1 Current type of HSV-180S




### 3.1.2 Current Type of HSV-180S

Table 3-1 Current Types of HSV-180S spindle drives

| Type | Continuous Current (A) | Short-time Peak Current(A) | Maximum Power of Applicable Motor (KW) |
|---|---|---|---|
| HSV-180S-025 | 10 | 15 | 2.2 KW |
| HSV-180S-035 | 14 | 21 | 3.7 KW |
| HSV-180S-050 | 20 | 30 | 5.5 KW |
| HSV-180S-075 | 28 | 43 | 7.5 KW |

### 3.1.3 Technical Specification of HSV-180S

The following table describes the technical specification of HSV-180S

Table 3-2 Technical specification of HSV-180S spindle drives

| Item | Description |
|---|---|
| Main circuit power | Three phrase AC 380 V<br>-15% to +10% 50/60 Hz |

<table>
<tr><td rowspan="4">Control modes</td><td rowspan="2">Position control</td><td>Pulse input</td><td>● Two phrase A/B positive pulse<br>● Pulse + direction<br>● CCW pulse/CW pulse</td></tr>
<tr><td rowspan="2">External speed control</td><td>Pulse input</td><td>● Two phrase A/B positive pulse<br>● Pulse + direction<br>● CCW pulse /CW pulse</td></tr>
<tr><td>Analog input</td><td>-10 to +10 V or 0 to +10 V</td></tr>
<tr><td colspan="3">JOG control</td></tr>
<tr><td colspan="3">Internal speed control</td></tr>
<tr><td>Speed range</td><td colspan="3">1 r/min to 10000 r/min</td></tr>
<tr><td>Control input</td><td colspan="3">Run enable<br>Alarm clear<br>Forward and reverse running enable<br>Spindle orientation ready<br>Control modes switch<br>Indexing incremental orientation ratio input selection</td></tr>
<tr><td>Control output</td><td colspan="3">Spindle ready<br>Spindle alarm<br>Spindle orientation-finished<br>Speed-reached<br>Zero-speed reached</td></tr>
<tr><td>Feedback</td><td colspan="3">Optic-electrical encoder line numbers: 1000 p/r, 1024 p/r, 2000 p/r, 2500 p/r</td></tr>
<tr><td>The precision of speed stabilization</td><td colspan="3">Speed change less than 5 r/min(load varies from 0% to 100%).</td></tr>
<tr><td>Monitoring function</td><td colspan="3">Speed<br>Flux current<br>Torque current<br>Motor load current<br>Switch-value input status display<br>Switch-value output status display<br>Control mode display</td></tr>
</table>

| | |
|---|---|
| Protecting function | Provides protection against:<br>Over speed<br>Main power over-voltage and under-voltage<br>Over current<br>Overload<br>Motor over heat<br>Big speed error<br>IPM fault etc |
| Operation | Six LED digital tubes, two light-emitting diodes(LED), five bottoms (HSV-180S-025, 035, 050, 075) |

### 3.1.4 Dimension and Size of Spindle Drive

The following figures show the installation dimension of series HSV-180S spindle drives.

Figure 3-2 Dimension and size of HSV-180S-025, 035, 050, 075 (without auxiliary devices Unit: mm)

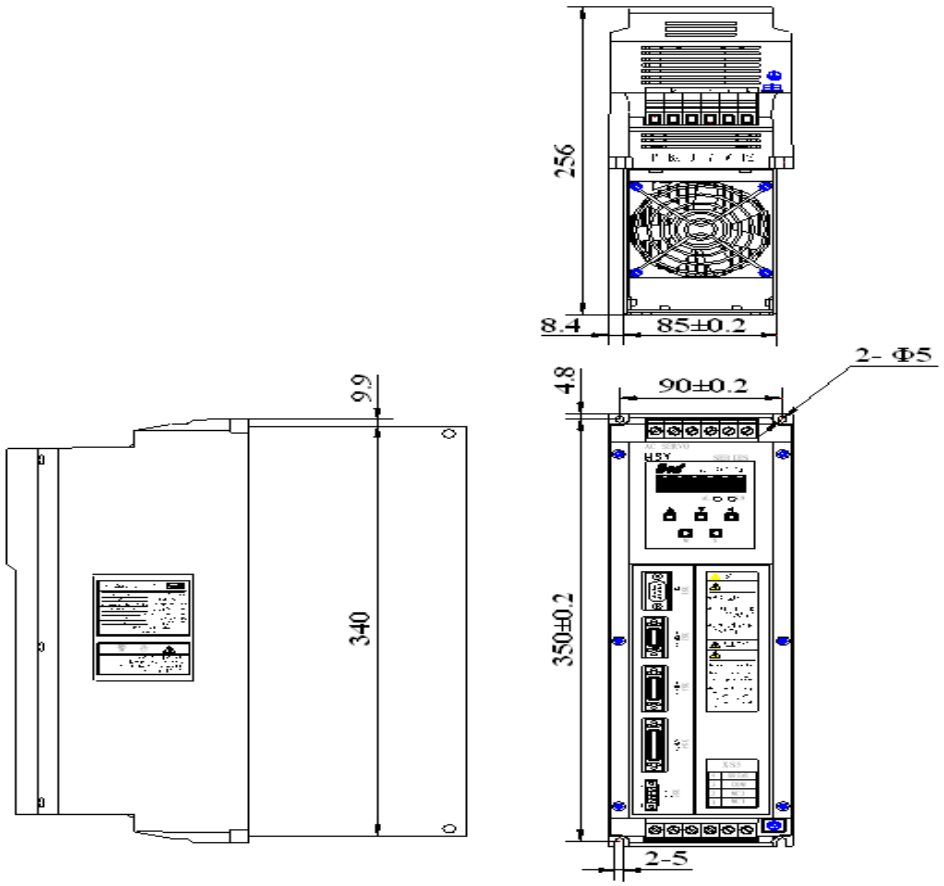
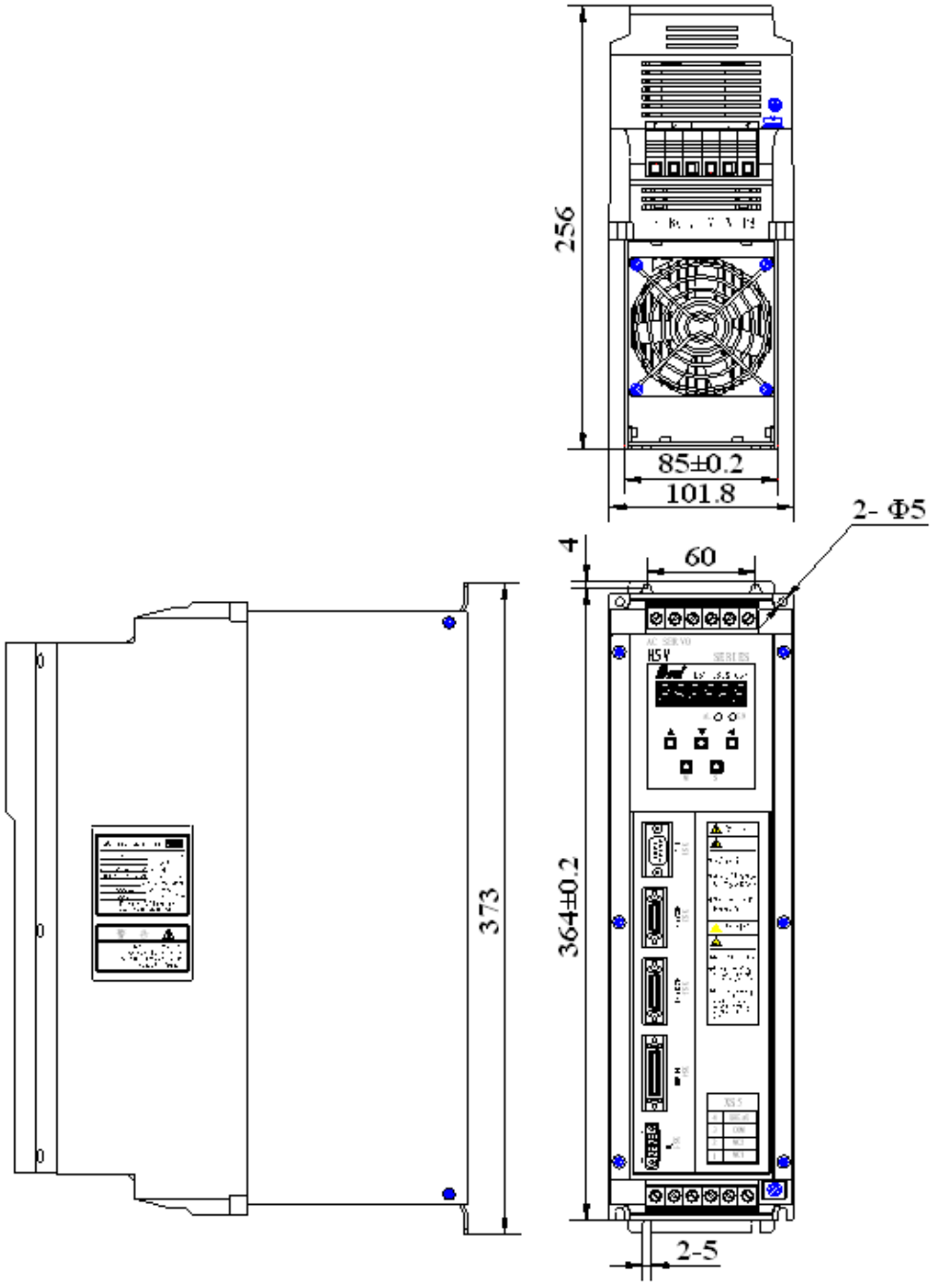


Figure 3-3 Dimension and size of HSV-180S-025, 035, 050, 075 (with auxiliary devices Unit: mm)




## 3.2 Specification of Spindle Motor

### 3.2.1 Introduction to Series GM7 AC Servo Spindle Motor

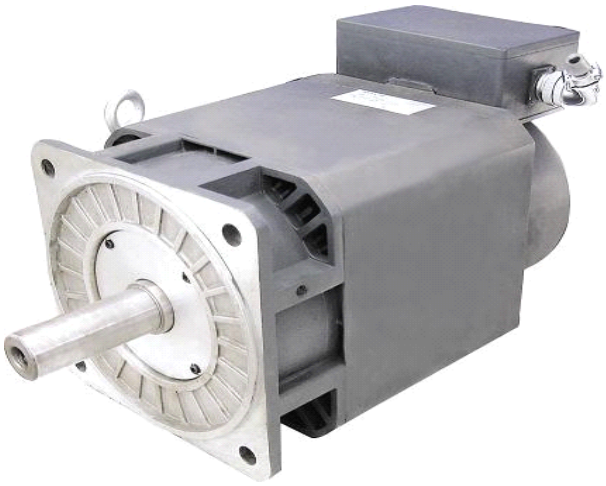
Series HSV-180S spindle drive matched with the series GM7 AC servo spindle motor which achieves the closed-loop control and has an excellent performance.

It is widely used in the fields that require AC servo spindles such as machine tool, building material, textile, light industry, machinery, and metallurgy industries. Series GM7 AC servo drive consists of stator, rotor, low-noise fans, high-precision encoder and other components. Based on the structural optimization design and magnetic circuit optimization, it adopts class F insulation structure, machine processing and high-precision dynamic balance technologies.

### 3.2.2 Features of Series GM7 AC Servo Spindle Motor

- Compact structure, small size, light weight, high power density
- Low magnetic vibration, low noise, high-precision rotation, large speed range of constant torque and wide constant power speed range
- Low rotor inertia and short response time
- Uniform air gap, high-precision dynamic balance, and small torque ripple
- Sealed design and the protection grade reached IP54
- Adopting class F insulation structure to preventing surge current and corona so as to ensure reliable and long-life operation
- High capability and low price

Figure 3-4 Series GM7 AC servo spindle motor



### 3.2.3 Technical index of Series GM7AC servo spindle motor

The following table describes the technical index of series AC GM7 servo spindle motor.

Table 3.3 Technical index of series GM7AC servo spindle motor

| Item | Description |
|---|---|
| Motor type | Full-digital AC servo inverter motor (squirrel-cage AC induction motor) |
| Insulation class | Class F insulation, special insulation structure |
| Feedback component | Incremental square-wave encoder or incremental sine-wave encoder |
| Temperature protection | positive temperature coefficient (PTC) thermistor |
| Force cooling fun connection<br><br>optic-electrical encoder connection | ● Terminal in the terminal box<br><br>● Circular socket connector |
| Types of mounting<br>Protection level<br>Cooling<br><br>Surface paint | ● Types of mounting: IMB5 IMB35<br>● Protection level: IP54 Alternative: IP55<br>● Cooling: forced air cooling and air flow from drive end to non-drive end<br>● Flat grey paint or customized color |
| Bearing<br>Shaft ends | ● Deep groove ball bearing double sealed<br>● Standard model: with key way and key, or determined by the customers' requirements |
| Vibration level&<br>Rotation accuracy | Vibration level : Level N Alternative: level R<br>Rotation accuracy: Level N Alternative: level R |
| Noise | 100 and 132 base ≤ 70 dB (A)<br>160 base ≤ 72 dB (A)<br>110 base ≤ 76 dB (A)<br>225 base ≤ 77 dB (A) |

### 3.2.4 Technical Index of Series GM7 AC Servo Spindle Motor

Adhere to the following principles when choosing the spindle drive:

- Generally the maximum current or rated current is equal or greater than 2.
- For rigid tapping, the maximum current or rated current is equal or greater than 3.
- For the situation that requires low inertia loads and common dynamic response characteristics, the maximum current or rated current is equal

or greater than 1.6.

The following table describes the technical index of series GM7 AC servo spindle motor.

Table 3.4 Technical index of series GM7 AC servo spindle motor

| Motor Type | Rated Power Kw | Rated Torque Nm | Rated Current A | Rated Rotary Speed r/min | Maximum Speed * r/min | Rotating Inertia Kgm² | Weight Kg | Adaptive Spindle Drive |
|---|---|---|---|---|---|---|---|---|
| GM7100-4SB61 | 2.2 | 14 | 6 | 1500 | 6000/9000 | 0.015 | 25 | HSV-180S-25/2.5 |
| GM7101-4SB61 | 3.7 | 23.6 | 10 | 1500 | 6000/9000 | 0.02 | 35 | HSV-180S-35/2.1 |
| GM7102-4SB61 | 3.0 | 19.1 | 8 | 1500 | 6000/9000 | 0.015 | 25 | HSV-180S-35/2.6 |
| GM7103-4SA61 | 3.7 | 35.3 | 10 | 1000 | 6000/9000 | | | HSV-180S-35/2.1 |
| GM7103-4SB61 | 5.5 | 35 | 13 | 1500 | 6000/9000 | 0.02 | 35 | HSV-180S-50/2.3 |
| GM7103-4SC61 | 7.5 | 35.8 | 18.8 | 2000 | 6000/9000 | | | HSV-180S-75/2.3 |
| GM7105-4SB61 | 7.5 | 47.8 | 18.8 | 1500 | 6000/8000 | 0.032 | 55 | HSV-180S-75/2.3 |
| **Motor Type** | **Rated Power Kw** | **Rated Torque Nm** | **Rated Current A** | **Rated Speed r/min** | **Maximum Speed * r/min** | **Rotating Inertia Kgm²** | **Weight Kg** | **Adaptive Spindle Drive** |
| GM7107-4SA61 | 6.3 | 60.2 | 19.4 | 1000 | 6000/8000 | 0.032 | 55 | HSV-180S-75/2.2 |
| GM7130-4SB61 | 5．5 | 35 | 13 | 1500 | 6000/8000 | 0.042 | 78 | HSV-180S-50/2.3 |
| GM7132-4SB61 | 7.5 | 47.8 | 18.8 | 1500 | 6000/8000 | 0.042 | 78 | HSV-180S-75/2.3 |

**Note:**

1. The specifications which are not covered in the above (such as power, rotary speed) can be designed according to customers' special requirements.

2. "*"means the specification not only related with the motor parameters, but also related with encoder parameters. It is special mentioned that if configured with encoder made in China or Japan, the maximum rotary speed is 6000 r/min; if configured with encoder made in Germany, the maximum rotary speed is 15000 r/min.

Table 3.5 Series GM7 AC servo spindle optic-electrical encoder socket (17 pin aviation socket)

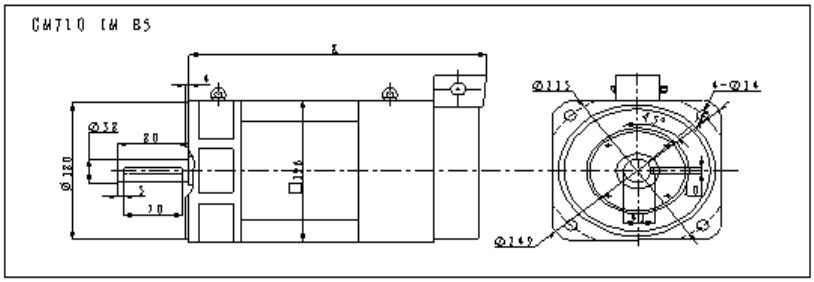
| Pin NO. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Signal | PE | A | A- | B | B- | none | none | none |

| 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|
| none | none | none | +5 V | 0 V | none | none | Z | Z- |

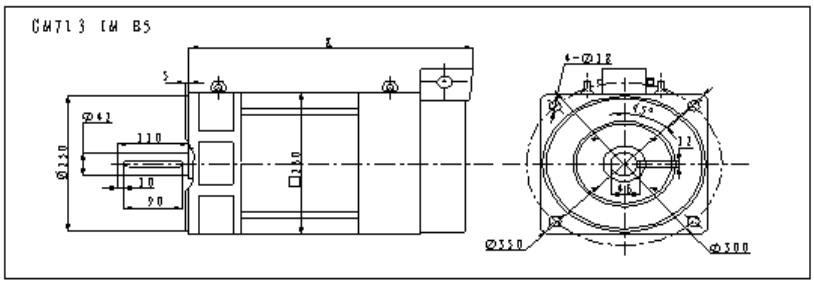
### 3.2.5 Installation Dimension of the Motor

The following figure shows the installation dimension of the series GM7 AC servo spindle motor.

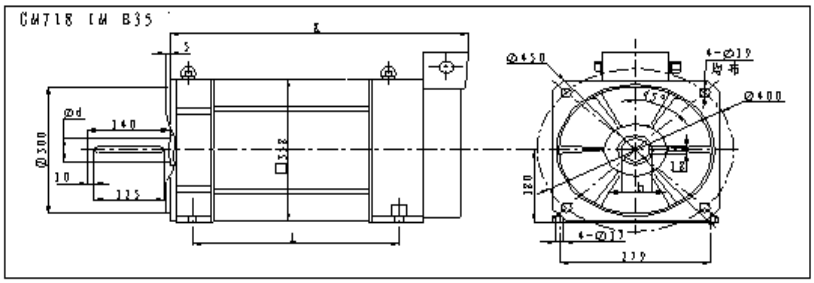
Figure 3-5 Installation dimension of series GM7 AC servo spindle motor



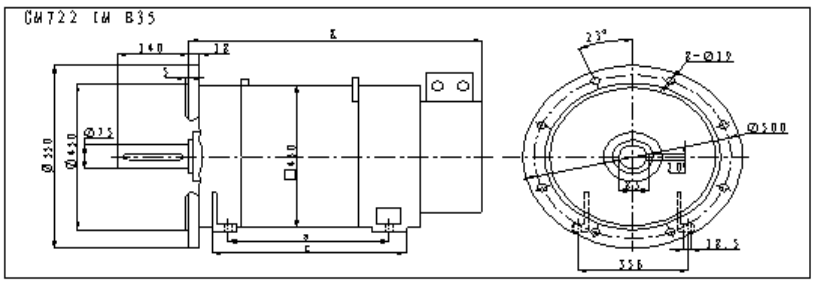

| Type | K |
|---|---|
| GM7100 | 360 |
| GM7101 | 405 |
| GM7102 | 360 |
| GM7103 | 405 |
| GM7105 | 500 |
| GM7107 | 500 |
| GM7109 | 540 |




| Type | K |
|---|---|
| GM7130 | 430 |
| GM7131 | 510 |
| GM7132 | 430 |
| GM7133 | 510 |
| GM7135 | 595 |
| GM7137 | 595 |




| Type | K | L | d | h |
|---|---|---|---|---|
| GM7181 | 730 | 325 | 60 | 64 |
| GM7183 | 765 | 360 | 60 | 64 |
| GM7185 | 835 | 430 | 60 | 64 |
| GM7187 | 925 | 520 | 65 | 69 |
| GM7189 | 975 | 570 | 65 | 69 |

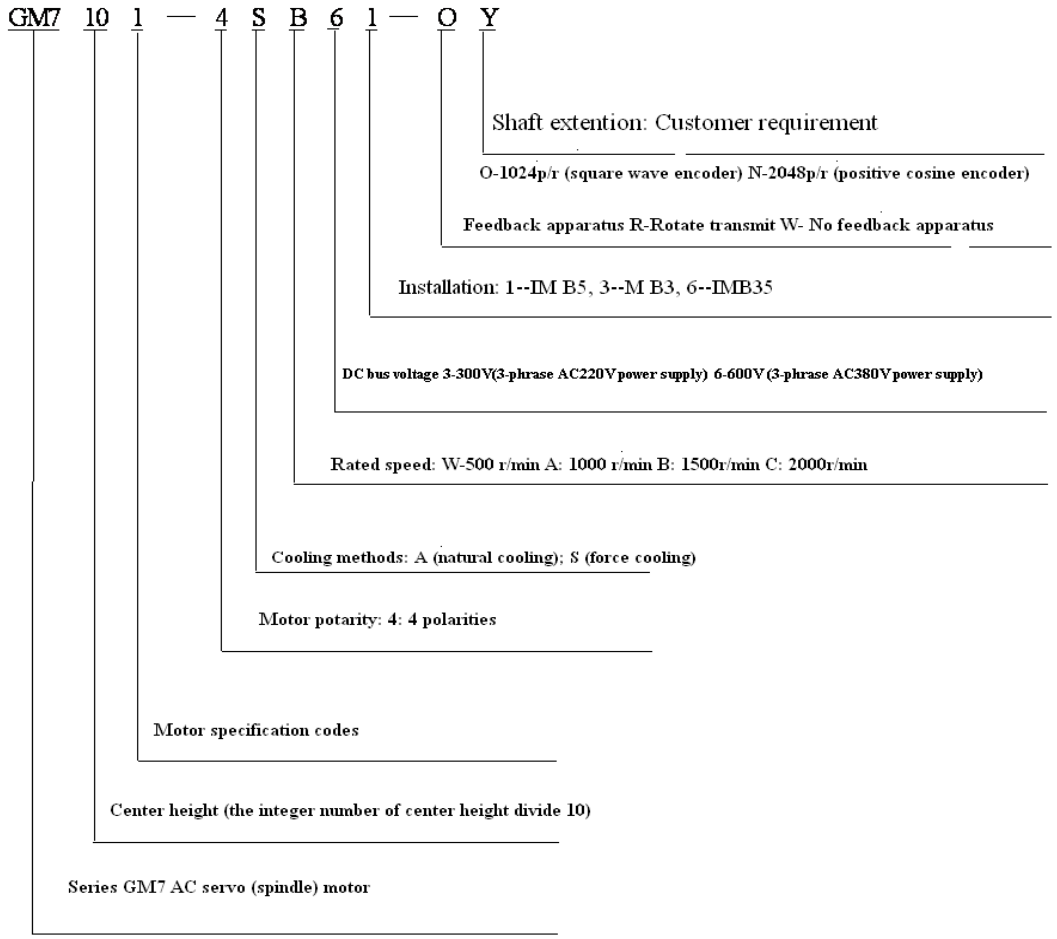



| Type | K | a | e |
|---|---|---|---|
| GM7221 | 960 | 445 | 540 |
| GM7223 | 960 | 445 | 540 |

### 3.2.6 Order Information

The following figure shows the order information of series GM7 AC servo spindle motor.

Figure 3-6 Order information of series GM7 AC servo spindle motor

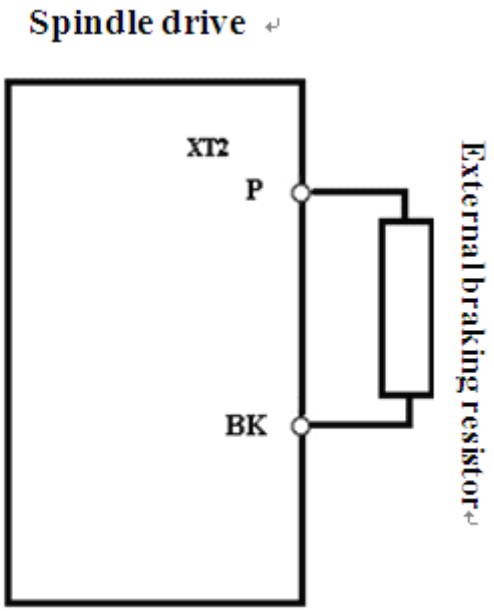



## 3.3 Specification of External Braking Resistor

The braking voltage of HSV-180S spindle drive is DC 700 V. For the maximum braking current, see Table 3-6. A 70 Ω/500 W braking resistor has been built in HSV-180S-025, 035, 050, 075 and a maximum of ten times overload is allowed (continuing for one second). An external braking resistor is required when the drive unit's load or inertia is big. The braking time is shorter when the load or inertia is bigger, and the resistance value is smaller and its power is bigger. However, the maximum braking current cannot exceed the drive's maximum braking current. Generally, the total braking power of the braking resistor is 10%

to 20% of the rated motor power. Connect **P** and **BK** terminals of the spindle drive with the external braking resistor if an external braking resistor is used. In this case, the internal resistor and the external resistor are serial connected. Table 3-6 shows the recommended external braking resistor.

Figure 3-7 Standard wiring diagram of the external braking resistor




The following table describes the recommended value of the external braking resistor of HSV-180S.

Table 3-6 Recommended value of the external braking resistor of HSV-180S spindle drive

| Specification | Maximum Braking Current (A) | External Braking Resistor (Recommended Value) |
|---|---|---|
| HSV-180S-025 | 15 | Use build-in braking resistor only |
| HSV-180S-035 | 20 | resistance: 68 Ω power: ≥ 500 W |
| HSV-180S-050 | 25 | resistance: 68 Ω power: ≥ 600 W |
| | | resistance: 56 Ω power: ≥ 1000 W |
| HSV-180S-075 | 40 | resistance: 30 Ω power: ≥ 1200 W |
| | | resistance: 27 Ω power: ≥ 1500 W |

## 3.4 Specification of Circuit Breaker, Input AC Reactor and Cable

Circuit breaker must be connected between the three-phrase AC power supply and power input terminals L1, L2, L3 on XT1 so as to cut off the power when the spindle drive motor is over currented or short circuited.

In order to cut off the input power immediately when the spindle drive unit breaks down, an electromagnetic contactor can be installed on the input side of the spindle drive to control the main circuit power on and off. But it must avoid frequently turning on and off the main circuit power in a short period of time through contactor (less than twice per minute).

In order to protect the rectifier components from damage caused by the high-current's impacting to the input power circuit, the power input side need to connect to an input AC reactor and increase its power factor. It can effectively eliminate the influence of high harmonics, prevent other equipment from damage caused by the voltage wave changes, and eliminate the unbalanced input current caused by phase voltage unbalanced.

In order to reduce the interference to other equipments and improve the anti-jamming capability of the spindle drive unit, the power input side can connect to an input filter.

For the wiring, see figure 3-8.

Figure 3-8 Standard wiring diagram of circuit breaker, contactor, input AC reactor and input filter

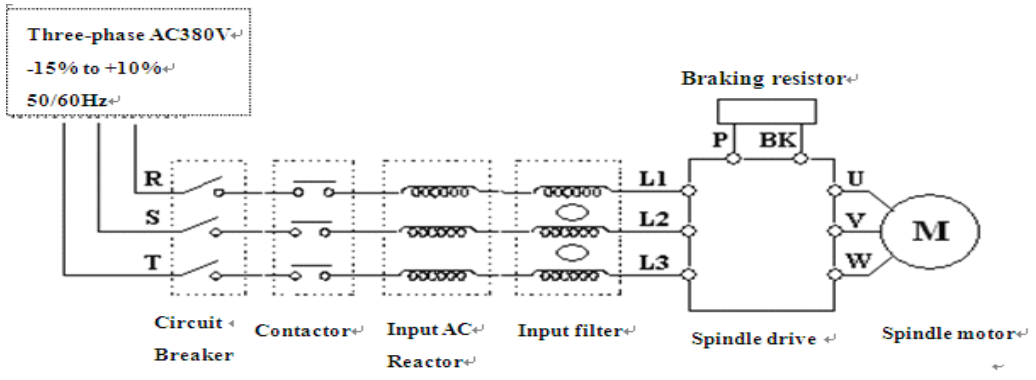



Figure 3-7 Recommended value of circuit breaker, contactor, input AC reactor

and cable

| **Type of drive motor** | **Power of Motor** (KW) | **Circuit Breaker** (A) | **Contactor** (A) | **Input AC reactor** | | **Main circuit cable** ($mm^2$) |
|---|---|---|---|---|---|---|
| | | | | **Current** (A) | **Inductance** (mH) | |
| HSV-180S-025 | 2.2 KW | 16 | 10 | 7 | 2.0 | 2.5 |
| HSV-180S-035 | 3.0 KW | 25 | 16 | 10 | 1.4 | 4 |
| | 3.7 KW | 25 | 16 | 15 | 0.93 | 4 |
| HSV-180S-050 | 5.5 KW | 32 | 25 | 15 | 0.93 | 4 |
| HSV-180S-075 | 7.5 KW | 40 | 32 | 20 | 0.7 | 4 |

# 4. Installation

## 4.1 Products Check

After receiving products, users must check the items as the following table.

| Item | Reference |
|---|---|
| Whether the product is damaged | Check the product appearance to make sure that the product is not damaged during transportation. |
| Whether the product type is in accordance with that in order | Check and make sure the type of the spindle drive unit and motor is in accordance with that in order |
| Whether the accessories are complete | Check the packing list and make sure that the accessory type and quantity is correct. |
| Whether the motor shaft can be easily turned by hand | Check and make sure that the motor shaft can be easily turned by hand, except motors with brakes. |

If there are any problems, contact directly with the applier or our company.

| Warning |
|---|
| 1. Do not install spindle drive which are damaged or with incomplete parts.<br>2. The spindle drive units must be matched with the compatible spindle motor.<br>3. Do not touch the spindle motor shaft directly, which can cause corrosive. |

## 4.2 Installation Environment

### 4.2.1 Environment Temperature

The working environment temperature is between 0℃ to 40℃. If the temperature over 40℃, de-rating required.

### 4.2.2 Humidity

Air relative humidity is equal or less than 90%. There is no condensation.

### 4.2.3 Altitude

Spindle drive units must be installed below 1000 m altitude. If over 1000 m altitude, de-rating required.

### 4.2.4 Vibration and Impulsion

Spindle drive is not load bearing and anti-collision. When installing and working, it must be free from oscillation and impact, and take measures to control the oscillation below 0.5 G (4.9 $m/S^2$).

### 4.2.5 Water

Spindle drive cannot be installed in the water spray or condensation location.

### 4.2.6 Air Pollution

The spindle drive must be free from air pollution. It must be installed in the electric cabinet which is resistant to corrosive and flammable gas, as well as prevent conductive object, mental dust, oil mist and liquid from entering to the interior of the equipment.

## 4.3 Installation of Spindle Drive

| Warning |
| --- |
| ● The spindle drive must be installed in the electric cabinet with fine protective function.<br>● The spindle drive must be installed in accordance with the specified direction and interval to ensure enough cooling.<br>● The spindle drive cannot be installed near combustibles that may cause fire hazard. |

### 4.3.1 Installation Methods

1. Installation Methods

There are three types of wall installation: directly installed without auxiliary devices, with auxiliary devices, and external heat sink installation. For their

installation diagrams, see Figure 4-1, Figure 4-2, and Figure 4-3. You can use any of the three methods, and install the servo drive vertically。

2. Installation Interval

For the installation interval of single spindle drive, see Figure 4-4 and Figure 4-5. For the installation interval of multiple spindle drive, see Figure 4-6.

During installation, leave enough intervals as possible to ensure a good heat emission.

3. Cooling

In the electric cabinet, there must be air blew through the radiator to prevent the ambient temperature of the spindle drive from overheating.

Figure 4-1 Wall installation diagram of HSV-180S-025,035,050,075 spindle drive (without auxiliary devices)

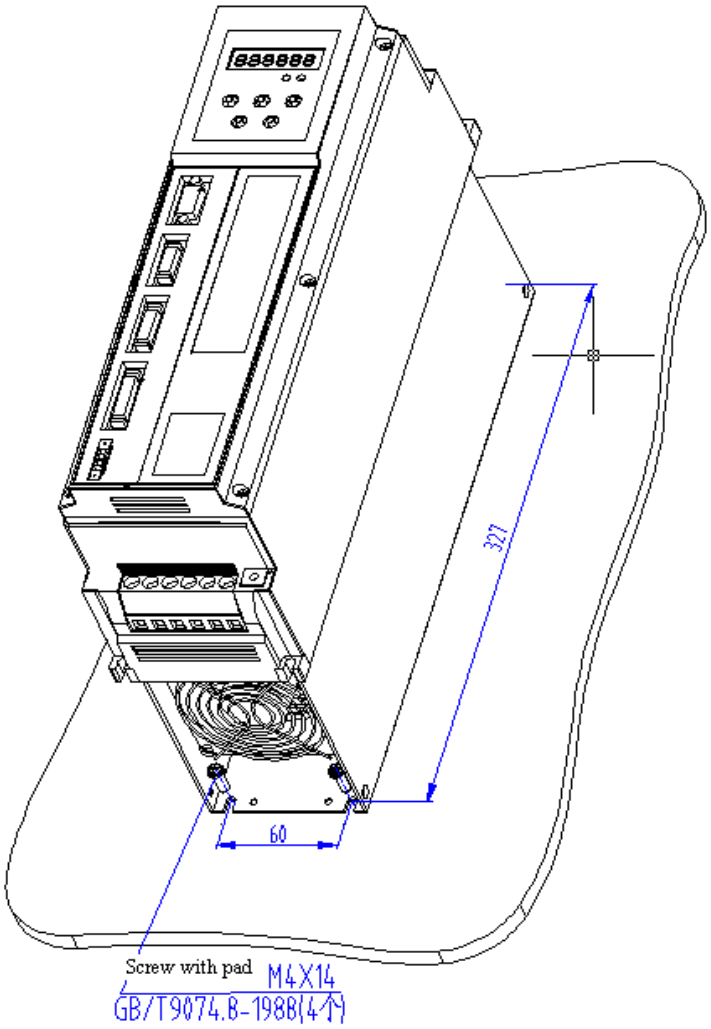


Figure 4-2 Wall installation diagram of HSV-180S-025, 035, 050, 075 spindle drive (with auxiliary devices)

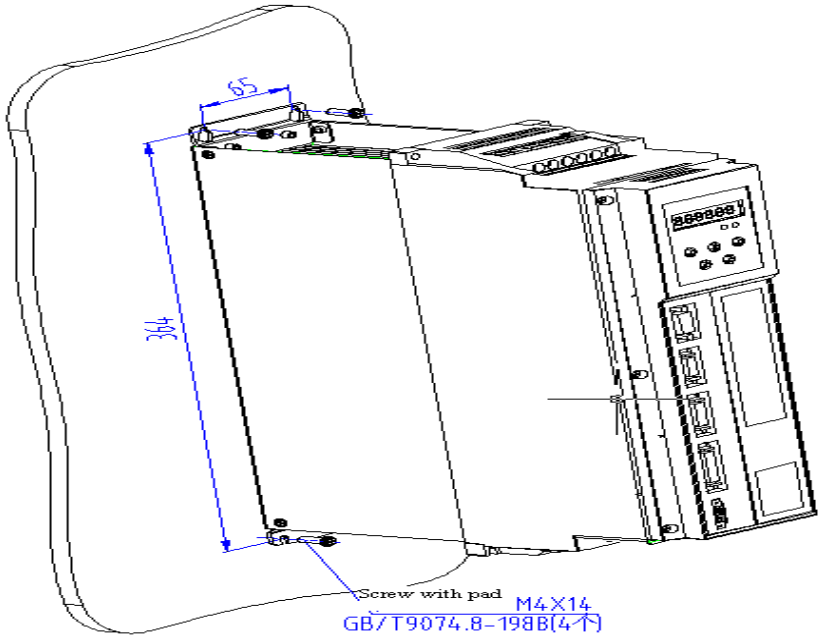



Figure 4-3 Wall installation diagram for external heat sink of HSV-180S-025, 035, 050, 075 spindle drive

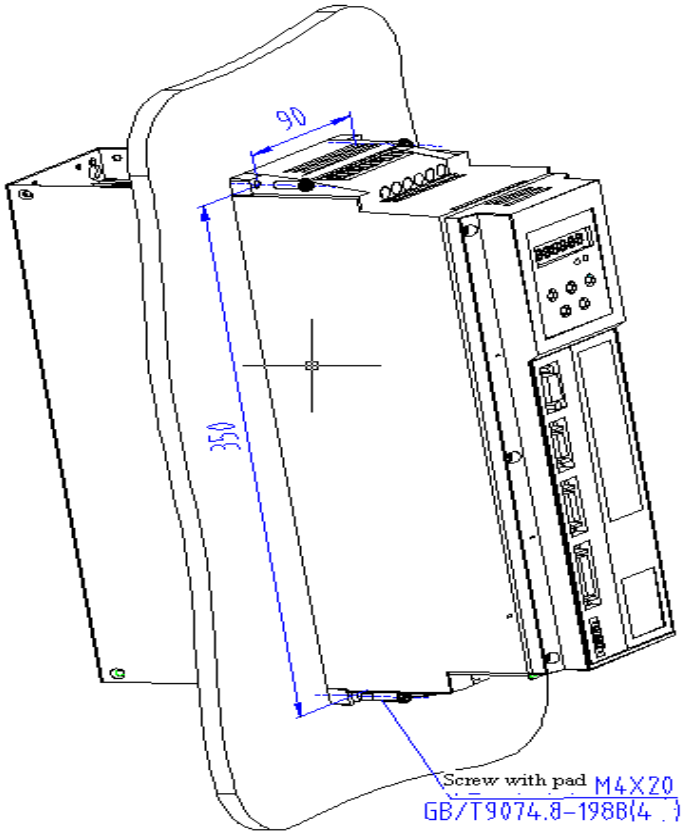


Figure 4-4 Installation interval of HSV-180S-025, 035, 050, 075 spindle drive (Wall installation)

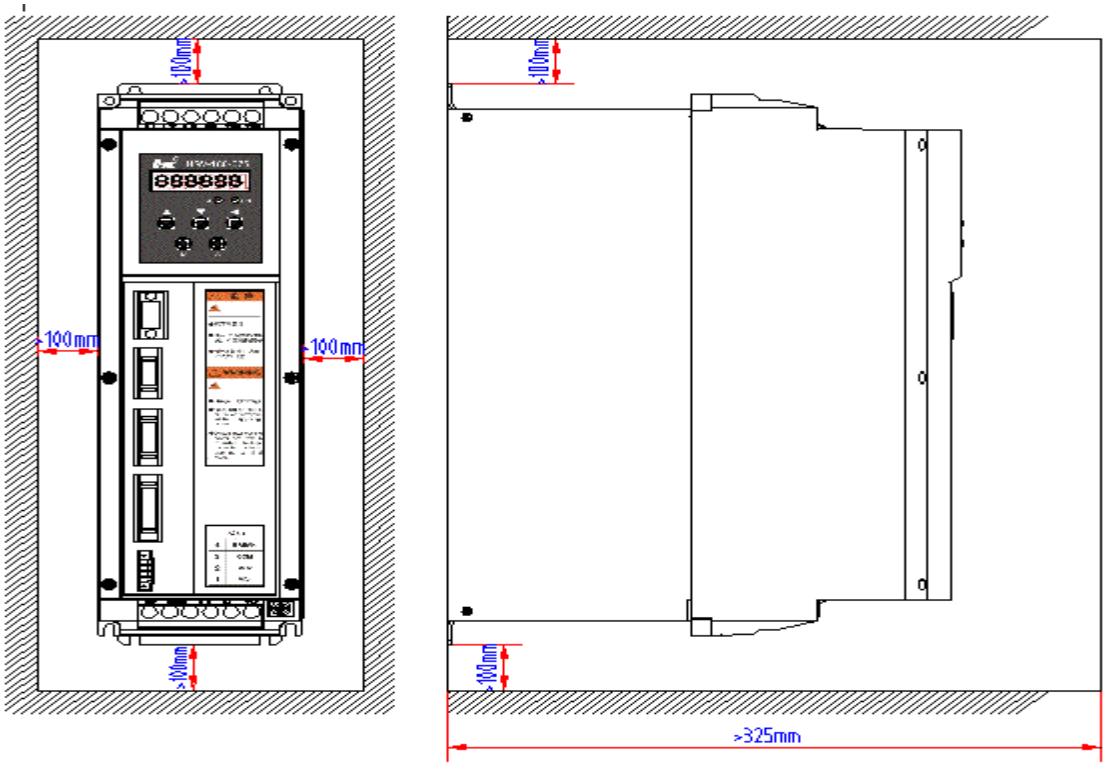



Figure 4-5 Installation interval of single spindle drive

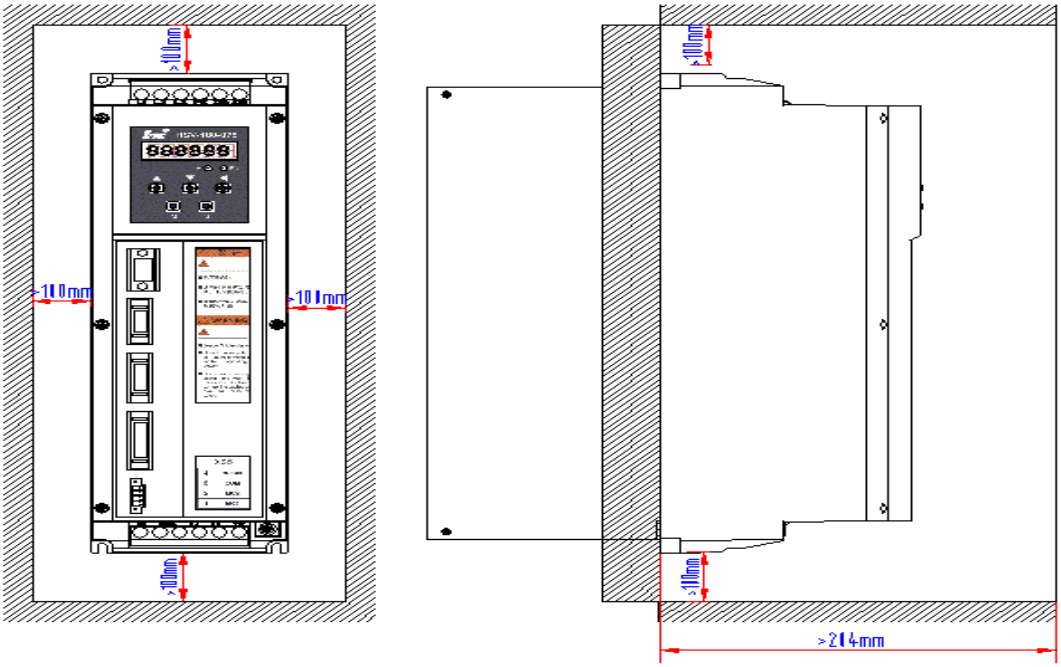
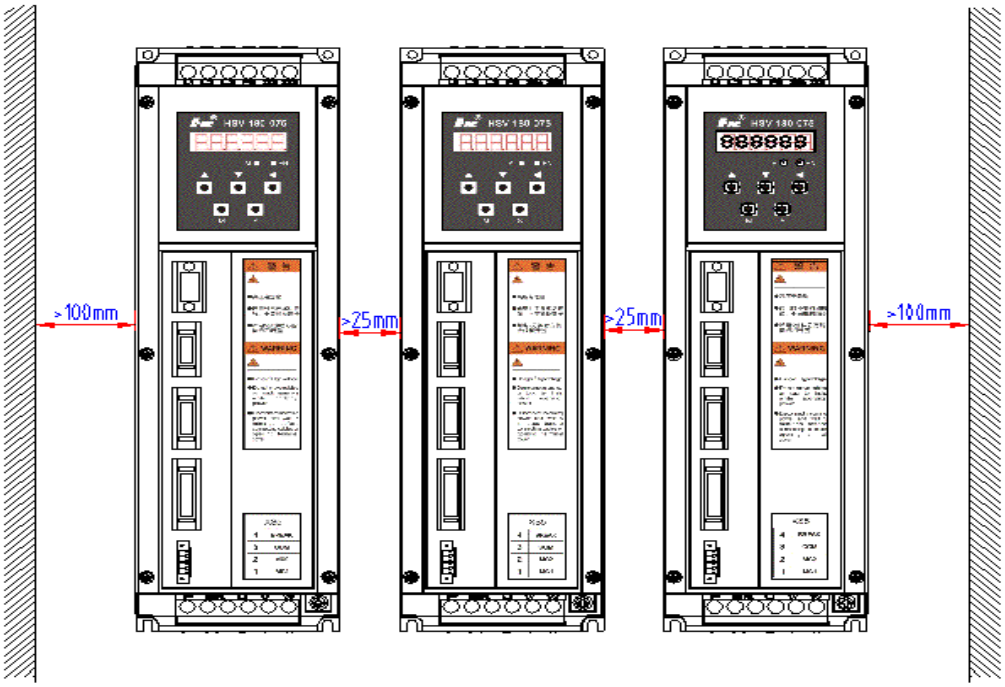


Figure 4-6 Installation intervals of multiple spindle drives




## 4.4 Installation of Spindle Motor

| Warning |
| --- |
| ● Do not knock the motor or encoder so as to prevent the motor from oscillation or impact.<br>● When carrying the motor, do not drag the motor shaft, leading-out wire or encoder.<br>● Do not overload motor shaft, otherwise the motor may be damaged.<br>● The motor must be firmly installed and prevent loosening. |

### 4.4.1 Installation Environment

1. Prevention

The spindle motor is not water-proof. When installing and operating, the motor must be guard against liquid spilling and prevent oil mist from entering the motor

through motor leads and motor shaft. If users need water-proof motor, make it clear when ordering.

2. Temperature and Humidity

The environmental temperature must be between 0 degree Celsius and 40 degree Celsius. Humidity cannot greater than 90% RH and there is no condensation.

After long-time operation, the motor will heat up. It is recommended that you use forced cooling or use derating motors if there is less space or the motor is closed to heating equipments

3. Oscillation

The motor must be free from oscillation, and take measures to control the oscillation below 0.5 G (4.9 $m/S^2$).

### 4.4.2 Installation Method

1. Installation Method

The GM7 series can be installed vertically and horizontally.

2. Installation Notes

- During installing and removing pulley, do not knock the motor or motor shaft to prevent damaging the encoder. Use the spiral drawing tools to install and remove the thermal expansion expansion-type coupling.
- Series GM7 motor cannot withstand the larger axial load and radial load. It is recommended that you use the flexible coupling to connect the load.
- When fixing the motor, use spring washer to tighten the bolts to prevent loosening

# 5. Wiring

| Warning |
| --- |
| ● Wiring and wiring inspection personnel must have required capabilities.<br>● Wiring and wiring inspection personnel must wait 5 minutes after power off for all wiring or wiring check to prevent from electronic shock. |
| **Caution** |
| ● Must be wiring in accordance with the terminal voltage and the polarity to prevent from equipment damage or personal injury.<br>● Spindle drive unit and spindle motor must be reliably grounded. |
| ● Do not directly hammer at the motor shaft when connect or disconnect its mechanic part to protect encoder from being damaged.<br>● Try to align the motor shaft to the optimum level to prevent from oscillation or bearing damage. |

## 5.1 Signals and Functions

### 5.1.1 Terminal Configuration

Figure 5-1 shows the interface configuration of HSV-180S. In the figure, XT1 and XT2 are the terminal blocks; XS1 is a DB9 socket; XS2, XS3, and XS4 are high-density sockets; XS5 is a wiring terminal.

Figure 5-1 Interface configuration of HSV-180S

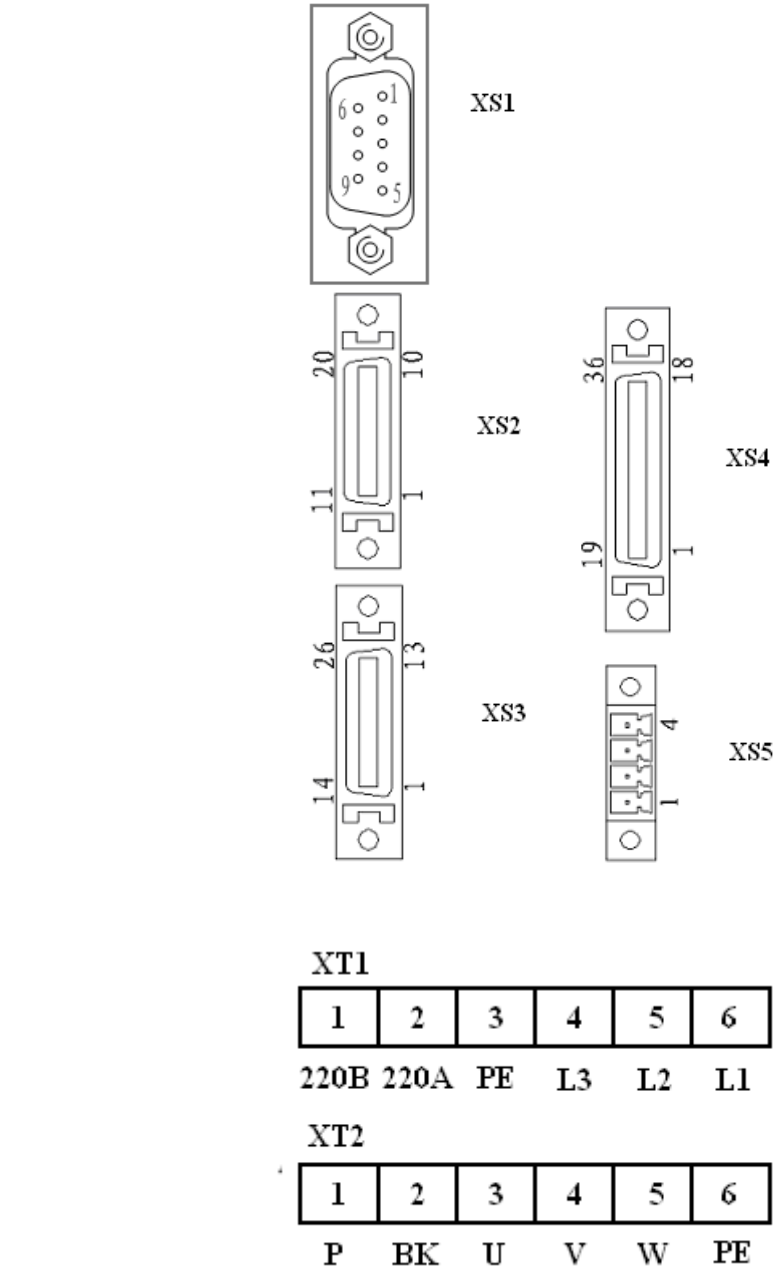



Figure 5-2 Soldering terminal of XS4 command input/output interface (looking from the soldering terminal)

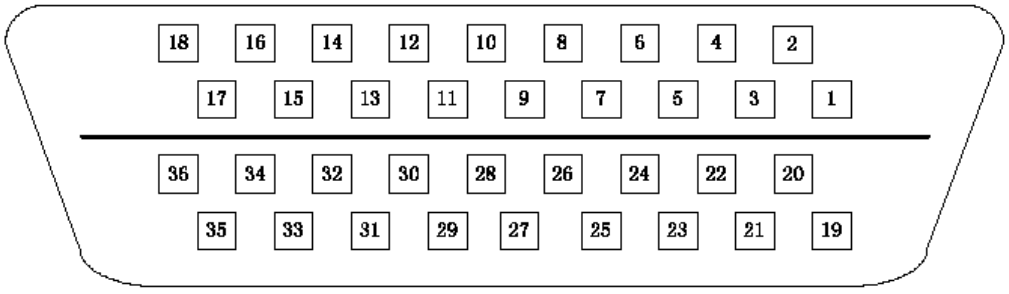


Figure 5-3 Plug of XS4 command input/output interface plug (looking from the plug)

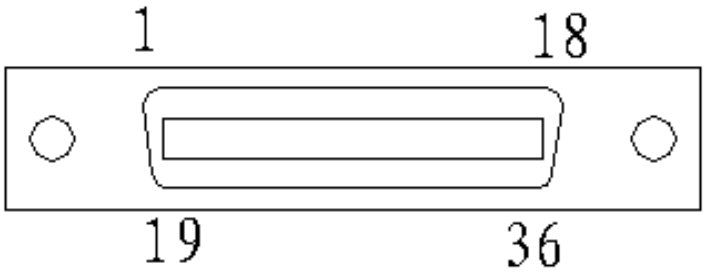
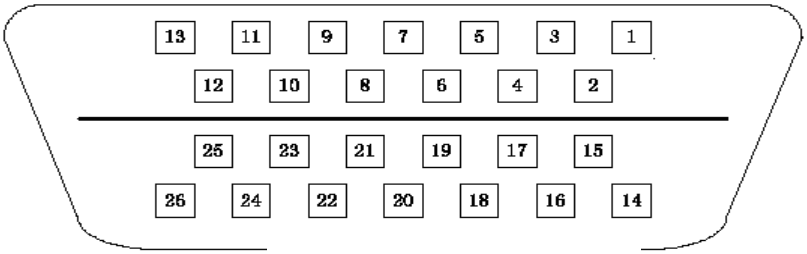
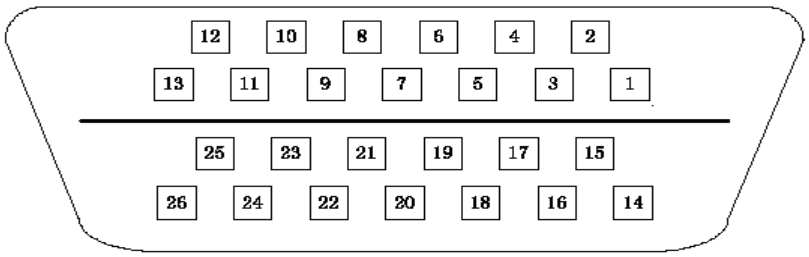



Figure 5-4 Soldering terminal of XS3 spindle motor optic-electrical encoder (looking from the soldering terminal)




AMP connection terminal




3M connection terminal

Figure 5-5 Plugs of XS3 spindle motor optic-electrical encoder (looking from the plug)

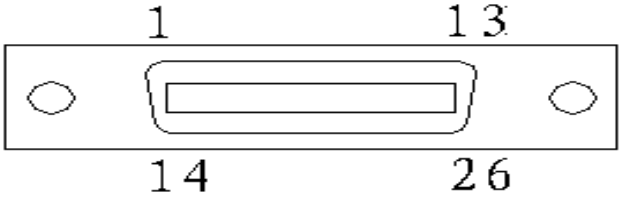



Figure 5-6 Soldering terminal of the XS2 spindle encoder (looking from the soldering terminal)

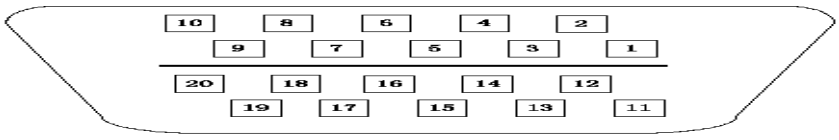
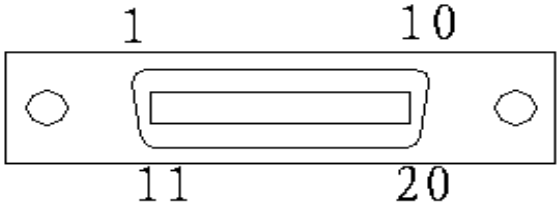



Figure 5-7 Plugs of XS2 spindle encoder (looking from the plug)




### 5.1.2 XT1 Power Input Terminal

| XT1 power input terminal of HSV-180S-025, 035, 050, 075 | | | |
|---|---|---|---|
| **NO.** | **Terminal Symbol** | **Signal** | **Function** |
| 1 | 220B | | Reserved |
| 2 | 220A | | |
| 3 | PE | Ground terminal | Ground terminal, and the ground resistance is less than 4 Ω. |
| 4 | L3 | Three-phrase main circuit power input terminal | Main circuit power supply input terminal<br>Three phrase AC 380 V/ 50 Hz<br>**Note**:<br>Do not connect to the output terminal U, V, W. |
| 5 | L2 | | |
| 6 | L1 | | |

### 5.1.3 XT2 Heavy Current Output Terminal

| HSV-180S-025, 035, 050, 075 XT2 heavy current output terminal | | | |
|---|---|---|---|
| **NO.** | **Terminal Symbol** | **Signal** | **Function** |

| | | | |
|---|---|---|---|
| 1 | P | Connection terminal for external braking resistor | ● Build-in 70 Ω/500 W braking resistors.<br>● If only use the braking resistor, the terminal P and BK must be disconnected to avoid short-circuit.<br>● If an external braking resistor is used, terminal P and BK must be connected to an external braking resistor.<br>**Note**:<br>Terminal P and BK cannot be shorted. Otherwise, the spindle drive may be damaged. |
| 2 | BK | | |
| 3 | U | Three-phrase output terminal of the spindle drive | It must be linked to the motor U, V, and W terminals correspondingly. |
| 4 | V | | |
| 5 | W | | |
| 6 | PE | Ground terminal | Ground terminal<br>Ground resistance is less than 4 Ω |
| | ⏚ | Ground terminal | Ground terminal<br>Ground resistance is less than 4 Ω<br>Spindle drive housing ground terminal |

### 5.1.4 XS1 RS232 Serial Interface

| NO. | Terminal Symbol | Signal | Function |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 2 | TX | Data transmission | It is connected to the serial data receiving interface (RX) of the controller or PC to achieve the serial communication. |
| 3 | RX | Data reception | It is connected to the serial data transmitting interface (TX) on the controller or PC to achieve the serial communication. |
| 5 | GNDD | Signal ground | Data signal ground |

### 5.1.5 XS4 COMMAND Input/output Interface

| NO. | Terminal Symbol | Signal | Function |
|---|---|---|---|
| 1 | EN | Spindle enable | Spindle enable input terminal<br>**EN ON**: Enable the spindle drive<br>**EN OFF**: The spindle drive stops working, and the motor is idle.<br>**Note**:<br>1: The motor must be static before the spindle drive switches from **EN ON** to **EN OFF**.<br>2: Input commands at least 50 ms after the spindle drive switches from the **EN OFF** to **EN ON**.<br>3: You can shield this function or you can keep the spindle drive in the state of **ON** by setting the control parameter **STA-6**. |
| 2 | ALM_RST | Alarm clear | Alarm clear input terminal |

<table>
<tr><td></td><td></td><td></td><td>ACL ON: Clear system alarm<br>ACL OFF: Keep system alarm</td></tr>
<tr><td>3</td><td>FWD</td><td>Spindle forward rotation</td><td>Spindle forward rotation input terminal<br>FWD ON: Spindle motor running forward<br>FWD OFF: Spindle motor stops running forward</td></tr>
<tr><td>4</td><td>REW</td><td>Spindle reverse rotation</td><td>Reverse rotation input terminal<br>REW ON: Spindle motor is running reverse.<br>REW OFF: Spindle motor stops running reverse.</td></tr>
<tr><td>5</td><td>INC_Sel1</td><td rowspan="2">Indexing incremental orientation angular ratio input selection</td><td rowspan="2">Input terminal for selecting indexing incremental orientation angular ratio<br><table><tr><td>INC_Sel1</td><td>INC_Sel2</td><td>ratio</td></tr><tr><td>ON</td><td>ON</td><td>4</td></tr><tr><td>OFF</td><td>ON</td><td>3</td></tr><tr><td>ON</td><td>OFF</td><td>2</td></tr><tr><td>OFF</td><td>OFF</td><td>1</td></tr></table></td></tr>
<tr><td>6</td><td>INC_Sel2</td></tr>
<tr><td>7</td><td>ZSP</td><td>Zero-speed reached input</td><td>Zero-speed reached input terminal<br>When the running speed is in the specified zero-speed range (by setting movement parameter PA-29), the zero-speed reached input is connected.</td></tr>
<tr><td>8</td><td>READY</td><td>Spindle output ready</td><td>Spindle ready output terminal<br>READY ON: indicates proper power supply, and no drive alarm. The</td></tr>
</table>

| | | | |
|---|---|---|---|
| | | | signal is connected.<br>**READY OFF**: indicates the main power is not switched on or a spindle drive alarm is reported. The signal is disconnected. |
| 9 | ALM | Spindle alarm output | Spindle alarm output terminal<br>**ALM ON:** indicates a spindle drive alarm is reported. The signal is connected.<br>**ALM OFF**: indicates no spindle drive alarm. The signal is disconnected. |
| 10 | SM | Speed feedback monitoring signal | Speed feedback monitor terminal<br>Speed feedback analog output |
| 11 | IM | Current monitoring signal | Current monitor terminal<br>Current analog output |
| 12 | AN+ | Analog output terminal | Speed analog command input<br>Input voltage range is between DC -10 to +10 or between 0 to +10 V |
| 13 | AN- | Reference terminal for analog input | Reference terminal for speed analog command input |
| 14 | CP+ | Command pulse PLUS input | Input terminal for external command pulse<br>Note:<br>1. You can set the pulse input mode by setting the movement parameter **PA--22**.<br>● Command pulse + characters |
| 15 | CP- | | |
| 16 | DIR+ | Command pulse SIGN input | |
| 17 | DIR- | | |

| | | | |
|---|---|---|---|
| | | | ● CCW/CW command pulse mode<br>● 2-phase command pulse mode |
| 32 | A+ | Spindle motor optic-electrical encoder A+ output | A-phase pulse monitor output (differential drive output)<br>Note:<br>1: Pulse output mode can be selected by setting the control parameter **STA-13.**<br>0: Spindle motor optic-electrical encoder A-phase pulse output<br>1: Spindle encoder A-phase pulse output |
| | | Spindle encoder A+ output | |
| 33 | A- | Spindle motor optic-electrical encoder A- output | |
| | | Spindle encoder A- output | |
| 18 | B+ | Spindle motor optic-electrical encoder B+ output | B-phase pulse monitor output (differential drive output)<br>NOTE:<br>1: Pulse output mode can be selected by setting the control parameter **STA-13**.<br>0: Spindle motor optic-electrical encoder B-phase pulse output<br>1: Spindle encoder B-phase pulse output |
| | | Spindle encoder B+ output | |
| 36 | B- | Spindle motor optic-electrical encoder B- output | |
| | | Spindle encoder B- output | |
| 35 | Z+ | Spindle motor optic-electrical encoder | Z-phase pulse monitor output (differential drive output)<br>NOTE: |

| | | | |
|---|---|---|---|
| | | Z+ output<br>Spindle encoder Z+ output | 1: Pulse output mode can be selected by setting the control parameter **STA-13**.<br>0: Spindle motor optic-electrical encoder Z-phase pulse output<br>1: Spindle encoder Z-phase pulse output |
| 34 | Z- | Spindle motor optic-electrical encoder Z- output<br>Spindle encoder Z- output | |
| 31 | ZPLS_OUT | Z-phase pulse open-collector output | Z-phase pulse open-collector output terminal<br>NOTE:<br>1: Pulse output mode can be selected by setting the control parameter **STA-13**.<br>0: Spindle motor optic-electrical encoder Z-phase pulse open-collector output<br>1: Spindle encoder Z-phase pulse open-collector output |
| 26 | Mode_SW | Control mode switch input/ Indexing incremental orientation input terminal | 1. Switch input terminal for control mode switching<br>● If the spindle runs under the external analog speed mode, the operating mode can be changed to the C-axis position control by this switch.<br>● The effectiveness can be tested by **STA－8** (STA-8: 0 indicates ineffective, 1 indicates effective)<br>● **Mode_SW ON**: Spindle is running under the position mode. |

| | | | |
|---|---|---|---|
| | | | ● **Mode_SW OFF**: Spindle is running under the external speed mode.<br>2. Input terminal for indexing incremental orientation<br>● In the orientation mode, **Mode_SW** is used to control the indexing incremental orientation.<br>● Each time the **Mode_SW** turned to ON, the spindle moves a preset angle along with the orientating direction.<br>● The angle is determined according to the value of **PA-40** as well as the terminal I**NC_Sel1** and **INC_Sel2**. |
| 25 | ORN | Spindle orientation ready input | Spindle orientation ready input terminal<br>**ORN ON**: indicates that spindle orientation is begin<br>**ORN OFF**: indicates that spindle orientation is cancelled |
| 29 | GET | Speed-reached output | Speed-reached output terminal<br>When the speed error is within or less than the preset speed error range (specified by movement parameter **PA-11**), the signal is connected. |
| 30 | ORN_FIN | Spindle orientation-finished output | Spindle orientation-finished output terminal<br>In the spindle orientation mode, when the error between the actual spindle position and the preset spindle orientation |

| | | | |
|---|---|---|---|
| | | | position (specified by movement parameter **PA-39**) is less than or equal to the preset spindle orientation-finished range (specified by the movement parameter **PA-37**), the signal is connected (**ORN_FIN ON**). When the spindle orientation is cancelled (**ORN** is switched to **OFF**), the signal is disconnected (**ORN_FIN OFF**). |
| 27,28 | GNDAM | Analog signal ground | Analog signal ground terminal |
| 23,24 | GNDDM | Digital signal ground | Digital signal ground terminal |
| 21,22 | Z | Z-phase pulse output | Z-pulse output to Siemens 801 system.<br>Note:<br>1: Pulse output mode can be specified by setting the control parameter **STA-13**.<br>0: Spindle motor optic-electrical encoder Z-phase pulse output<br>1: Spindle encoder Z-phase pulse open-collector output |
| 19,20 | COM | Common terminal | Public terminal of XS4 terminal switch-value input/output signal<br>**Note:**<br>COM signal must be connected with external DC 24V power GND signal of XS4 terminal switch-value input/output. Otherwise the spindle drive may work improperly. |

### 5.1.6 XS3 ENCODER1 Spindle Motor Optic-electrical Input Interface

| NO. | Terminal | Signal | Function |
|---|---|---|---|

| | Symbol | | |
|---|---|---|---|
| 1 | A+ | Spindle motor optic-electrical encoder feedback A+ input | It is connected to the spindle motor optic-electrical encoder A+ phase. |
| 2 | A- | Spindle motor optic-electrical encoder feedback A- input | It is connected to the spindle motor optic-electrical encoder A- phase |
| 3 | B+ | Spindle motor optic-electrical encoder feedback B+ input | It is connected to the spindle motor optic-electrical encoder B+ phase. |
| 4 | B- | Spindle motor optic-electrical encoder feedback B- input | It is connected to the spindle motor optic-electrical encoder B- phase. |
| 5 | Z+ | Spindle motor optic-electrical encoder feedback Z+ input | It is connected to the spindle motor optic-electrical encoder Z+ phase. |
| 6 | Z- | Spindle motor optic-electrical encoder feedback Z- input | It is connected to the spindle motor optic-electrical encoder Z- phase. |
| 13 | OH1 | Motor overheating | Motor overheat detection Input terminal It is connect to the motor overheat detection sensor |
| 26 | OH2 | | |
| 14,15 | PE | Shield ground | It is connected to the motor housing |

| | | | |
|---|---|---|---|
| 16,17,<br>18,19 | +5V_ENC | Spindle motor optic-electrical encoder +5 V power output terminal | Connect the spindle motor optical-electrical encoder with 5 V power supply. If the cable is too long, use multiple wires to form serial connection. |
| 23,24,<br>25 | GNDPG | Spindle motor optic-electrical encoder +5 V power ground | |
| 20,21,<br>22 | +5V_MI | Spindle motor optic-electrical encoder +5 V feedback input terminal | Spindle motor optic-electrical encoder power feedback.<br>The spindle drive can automatically perform voltage compensation based on encoder feedback information. |

### 5.1.7 XS2 ENCODER2 Spindle Encoder Input Interface

| NO. | Terminal Symbol | Signal | Function |
|---|---|---|---|
| 19, 20 | +5VPI | Spindle encoder +5 V power feedback | It provides the function for spindle encoder power feedback. The spindle drive can make voltage compensation automatically according to the power feedback. |
| 7, 8 | +5VPO | Spindle encoder +5 V power input | A +5 V power is used in the spindle encoder. If the length of the cable is too long, you can connect two or more wires in parallel. |
| 9, 10 | GNDPP | Spindle encoder + 5 V power ground | |

| | | | |
|---|---|---|---|
| 1, 2 | PA- | Spindle encoder position feedback A- input | It is connected to the spindle encoder A- phase. |
| 11, 12 | PA+ | Spindle encoder position feedback A+ input | It is connected to the spindle encoder A+ phase. |
| 3, 4 | PB- | Spindle encoder position feedback B- input | It is connected to the spindle encoder B- phase. |
| 13, 14 | PB+ | Spindle encoder position feedback B+ input | It is connected to the spindle encoder B+ phase. |
| 5, 6 | PZ- | Spindle encoder position feedback Z- input | It is connected to the spindle encoder Z- phase. |
| 15, 16 | PZ+ | Spindle encoder position feedback Z+ input | It is connected to the spindle encoder Z+ phase. |
| 17, 18 | PE | Shield ground | It is connected to the housing. |

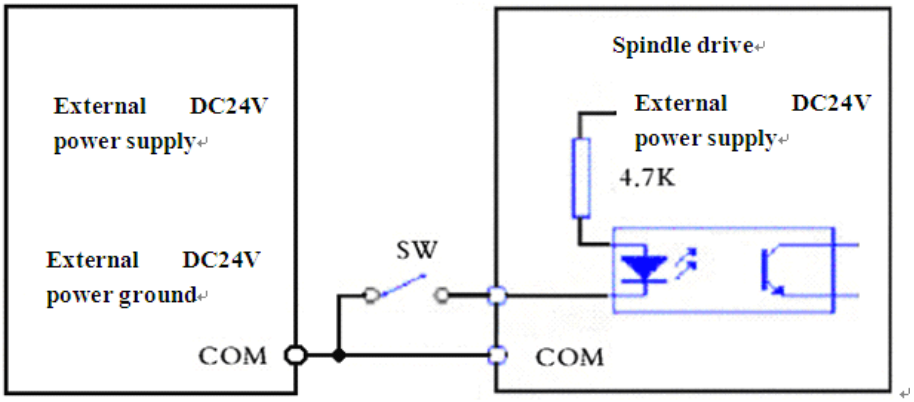
### 5.1.8 XS5 I/O Input/output Terminal

| NO. | Terminal Symbol | Signal | Function |
|---|---|---|---|
| 1 | MC1 | Failure chain | Failure chain output terminal<br>The relay is connected when the relay is in the Normal Open state and the spindle drive runs properly. The relay is disconnected if there is any spindle drive faults. |
| 2 | MC2 | | |
| 3 | COM | | Reserved |
| 4 | BREAK | | Reserved |

## 5.2 Interface Circuit

### 5.2.1 Switch-value Input Interface

Figure 5-8 Switch-value input interfaces of HSV-180S




**Note**:

1. The COM signal of the XS4 command input/output interface must be connected to the power ground of the external DC 24 V power supply. Otherwise, the spindle drive may work improperly.

2. Input mode: NPN. The input switch-value state is determined by the spindle drive. When the input of isolation optical coupler is conducted, the input switch -value state is **ON**. When the input of isolation optical coupler is turned off, the input switch-value state is **OFF**.

### 5.2.2 Switch-value Output Interface

Figure 5-9 a Relay connection diagram

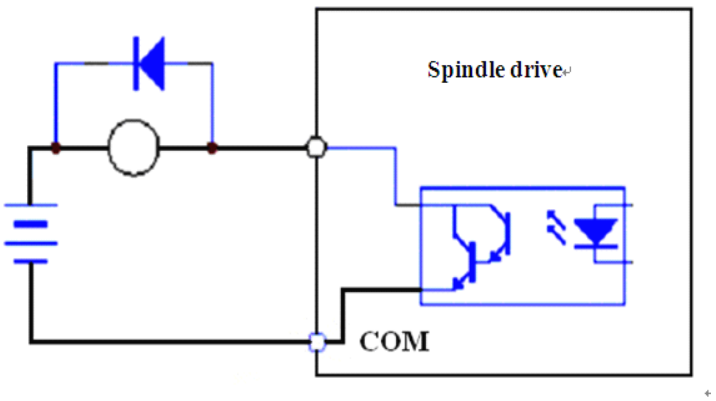
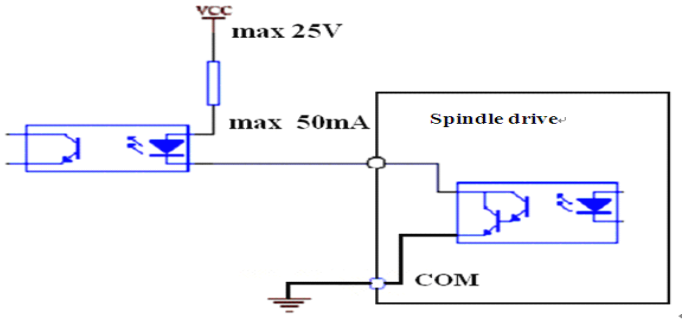



Figure 5-9 b Optical coupler connection




1. The Darlington transistor is served as the output transistor which needs to be connected to a relay or an optical coupler.
2. The external power supply is provided by users. Make sure that the polarity is not reversed. Otherwise, it may damage the spindle drive.
3. It provides open-collector output, with a maximum of 50 mA current and 25 V external power supply voltage. Therefore, the load of the switch-value output signal must meet the requirements. If the value exceeds the maximum value or the output terminal is directly connected to the power supply, it may damage the spindle drive.
4. If the load is an inductance load such as relay, it must be anti-parallel with the freewheeling diode (FWD) at both ends. The FWD cannot be reversed. Otherwise, it may damage the spindle drive.
5. The output transistor is Darlington Transistor. When it is conducted, the voltage drop between the collector and the emitter (Vce) is about 1 V, which cannot meet the requirement of the TTL low level. So it cannot be directly connected to the TTL.

**NOTE**:

- The output switch-value state is determined by the spindle drive. When the output of Darlington Transistor is connected, the output switch-value state is **ON**. When the output of Darlington Transistor is disconnected, the output switch-value state is **OFF**.
- The state of the spindle alarm output switch (ALM) is the exception. When the output of Darlington Transistor is connected, the state of ALM is **OFF**, otherwise, it is **ON**.

### 5.2.3 Pulse Command Input Interface

Figure 5-10 a Differential drive mode of the pulse input

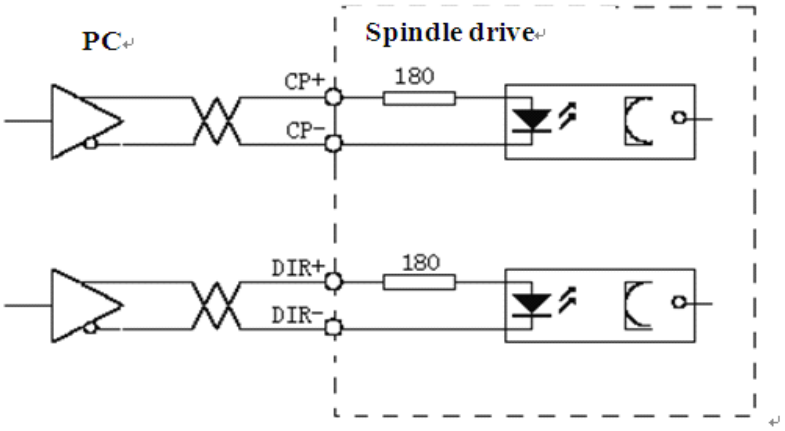
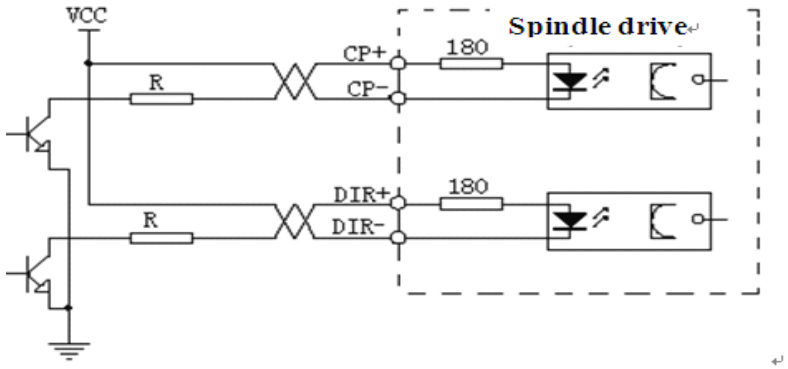



Figure 5-10b Single-ended drive mode of the pulse input




1. It is recommended that you use the differential drive mode to correctly receive the pulse command.
2. It is recommended that you use the differential drive mode (especially when the cable is too long) which uses AM26LS31, MC3487 drives or RS422 drives.
3. The single- ended drive mode can reduce the action frequency. You can determine the value of **R** according to a 10 to 15 mA drive current and a maximum of 25V external power supply voltage.

- Generally, if the value of **VCC** is **24 V**, the value of **R** is **1.3 K** to **2 K** (VCC = 24 V, R = 1.3 K to 2 K);
- If the value of **VCC** is **12 V**, the value of **R** is **510 Ω** to **820 Ω** (VCC = 12 V,

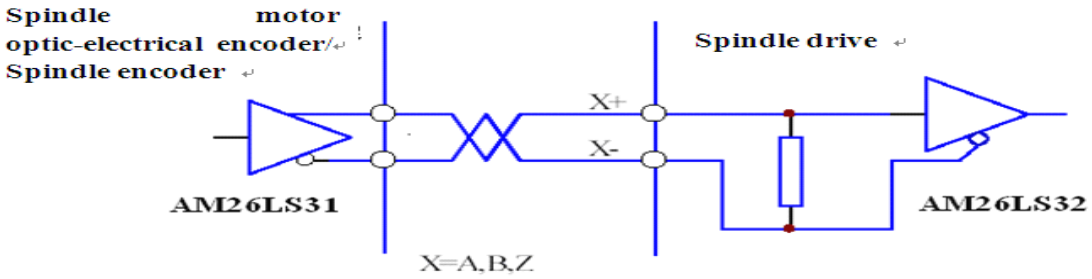
R = 510 Ω to 820 Ω);

- If the value of **VCC** is **5 V**, the value of R is **82 Ω** to **120 Ω** (VCC = 5 V, R = 82 Ω to 120 Ω).

4. In the single-ended mode, users provide the external power supply. Make sure that the polarity is not reversed. Otherwise, it may damage the spindle drive.

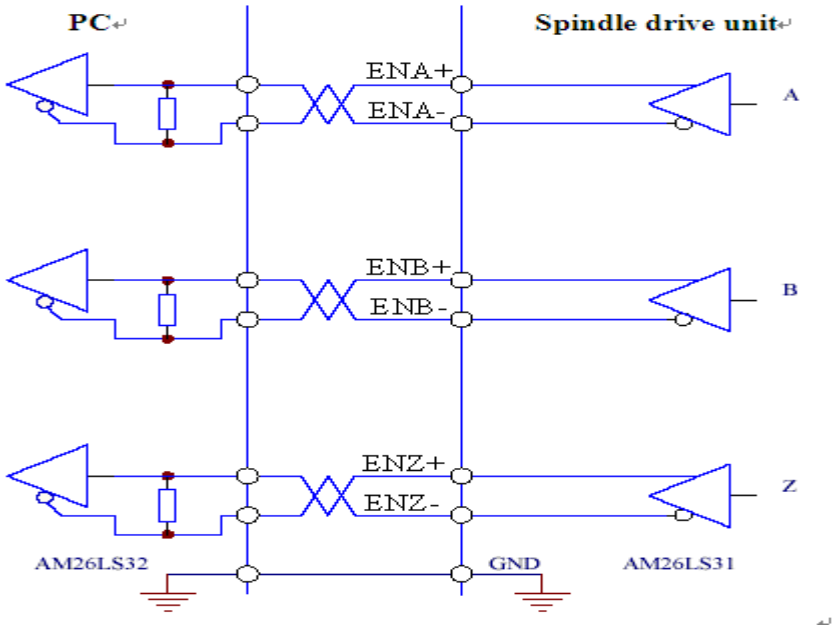
### 5.2.4 Spindle Motor optic-electrical Encoder/Spindle Encoder Input Interface

Figure 5-11 Spindle motor optic-electrical encoder/spindle encoder input interface



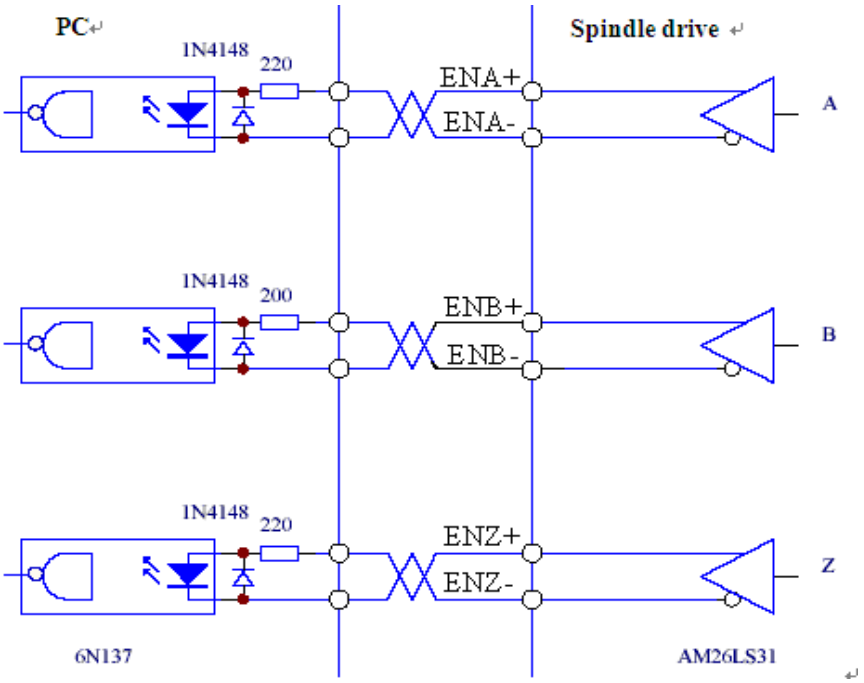

### 5.2.5 Spindle Motor optic-electrical encoder/Spindle Encoder Output Interface

Figure 5-12-a Spindle motor optic-electrical encoder/spindle encoder output interface




1. The encoder signal is outputted by the differential drive (AM26LS31).
2. The controller input terminal can adopt AM26LS32 receiver and must be connected to an approximate 330 Ω termination resistor.
3. The controller ground wire and the drive ground wire must be reliably connected.
4. The output must be non-isolated output.
5. The controller input terminal can also adopt an optical coupler receiver. However, the receiver must be a high-speed optical coupler, such as 6N137.

Figure 5-12 b Spindle motor optic-electrical encoder/spindle encoder output interface




## 5.2.6 Analog Command Input Interface

Figure 5-13 a Differential analog input interface

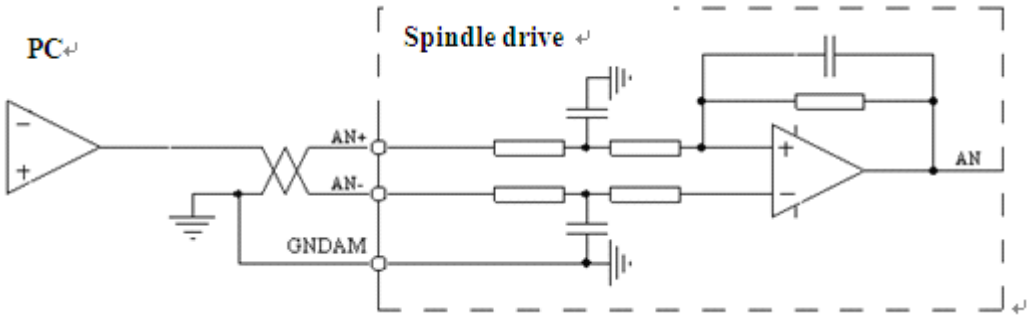



Figure5-13 b Single-ended analog input interface

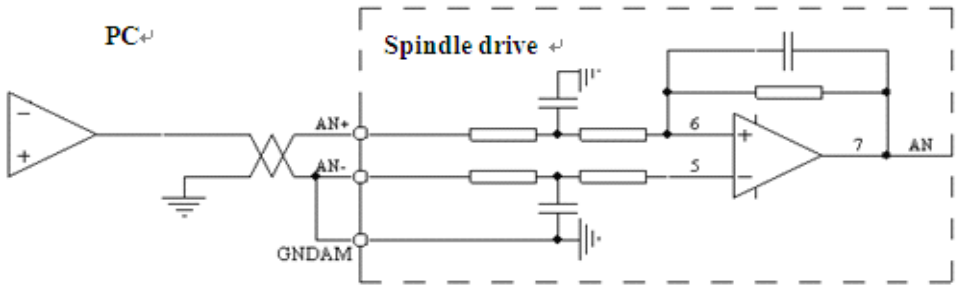



Figure 5-13 c Differential analog potentiometer input interface

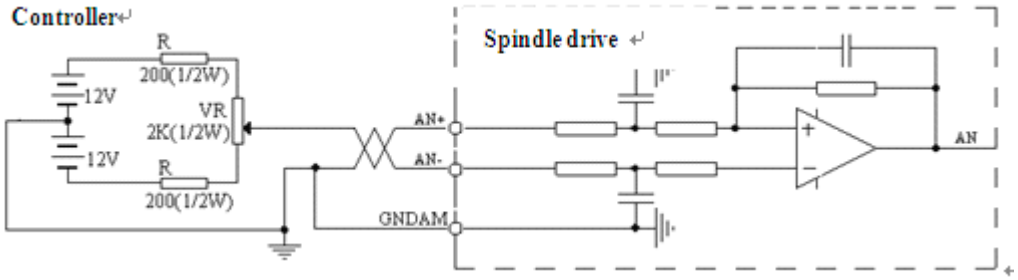
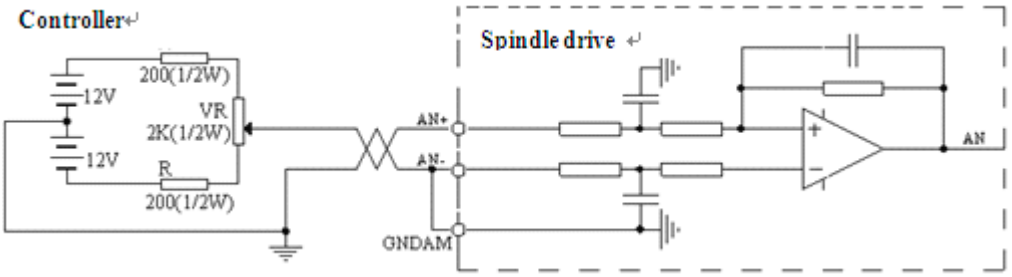



Figure 5-13 d Single-ended analog potentiometer input interface



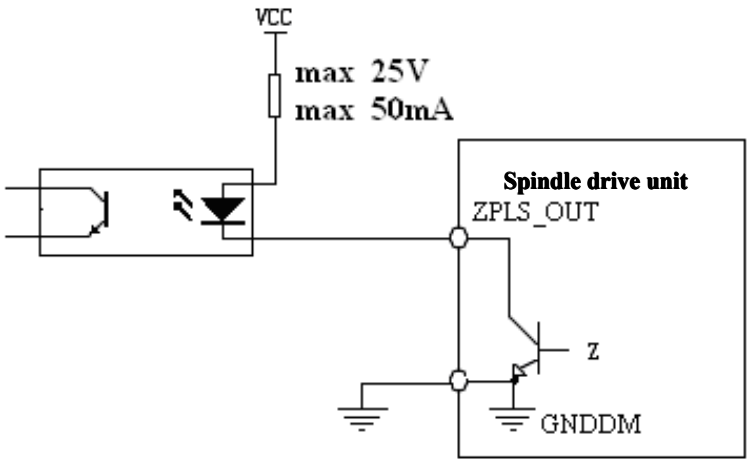

1. The analog input interface is differential. According to different connection methods, it has two forms connection, differential connection and single-ended connection. The range of input voltage is -10 V to +10 V.
2. In the differential connection, the analog ground wire is connected to the input reference terminal at the side of controller. Therefore, it needs three wires to connect the controller and drive unit (see Figure 5-13 a).
3. In the single-ended connection, the analog ground wire is connected to the input reference terminal at the side of the drive. Therefore, it needs two wires to connect the controller and the drive.(see Figure 5-13 b)
4. The differential connection is superior to the signal-ended connection for its good anti-common-mode interference characteristic.
5. The input voltage cannot exceed the range from -10 V to +10 V. Otherwise it may damage the spindle drive.
6. It is recommended that the shield cable be used to reduce the noise disturbance.
7. It is normal for the analog input interface has a zero bias which can be compensated by setting the movement parameter **PA-8**.

The analog interface is non-isolated.

### 5.2.7 Z-phase Pulse Open Collector Output Interface

1. It provides open-collector output, with a maximum of 50 mA current and 25 V external power supply voltage. Therefore, the load of the switch-value output signal must meet the requirements. If the value exceeds the maximum value or the output terminal is directly connected to the power supply, it may damage the spindle drive.
2. The external power supply is provided by the user. Make sure that the polarity is not reversed. Otherwise, it may damage the spindle drive.
3. Z-phase pulse signal is outputted by the open-collector. If there is Z-phase pulse signal, the signal is connected. Otherwise, the signal is disconnected.
4. The Z-phase pulse signal is usually very narrow. Therefore the PC must use a high-speed optical coupler receiver, such as 6N137.
5. The output must be non-isolated output (non-insulated).

Figure 5-14 Z-phase pulse open-collector output interface




## 5.3 Wiring

### 1. Power input terminal XT1, and heavy current power output terminal XT2

a. Diameter

The terminal diameters of P, BK, L3, L2, L1, U, V, W, PE on TX1, TX2 of HSV-180S-025, 035, 050, 075 ≥ 2.5 $mm^2$ (2.2 kw).

The terminal diameters of P, BK, L3, L2, L1, U, V, W, PE on TX1, TX2 of HSV-180S-025, 035, 050, 075 ≥ 4 $mm^2$ (3.0/3.7/5.5/7.5 kw).

b. Grounding

Grounding wire must be thick. The spindle drive and spindle motor must be connected to PE.

Grounding resistance <4 Ω

c. Use cold pre-insulated terminals to connect terminals and make sure that the connection is firm.
d. Install the non-fuse circuit breaker to promptly cut off the external power when a spindle drive fault occurs.
e. It is recommended that the power is supplied after passing the input AC power reactor and input filter to improving the anti-jamming capability.
f. It is recommended that shield cable be used to prevent other electrical equipments from interference.

2. **Control signal XS4, feedback signal XS3 for spindle motor optic-electrical encoder, and spindle encoder feedback signal XS2**

a. Diameter

Shield cable is used (stranded shield cable is the best choice), and the cross-sectional area is greater than or equal to 0.12 $mm^2$ (AWG24-26). The shielded layer must be connected to the metal shell of the connection plug.

b. Cable length

The cable must be short. The length of the control signal cable XS4 is not greater than 10 meters, and the length of the feedback signal cable XS2, XS3 is no more than 40 meters.

c. Wiring

The wiring must be away from the electric power circuit to prevent interference.

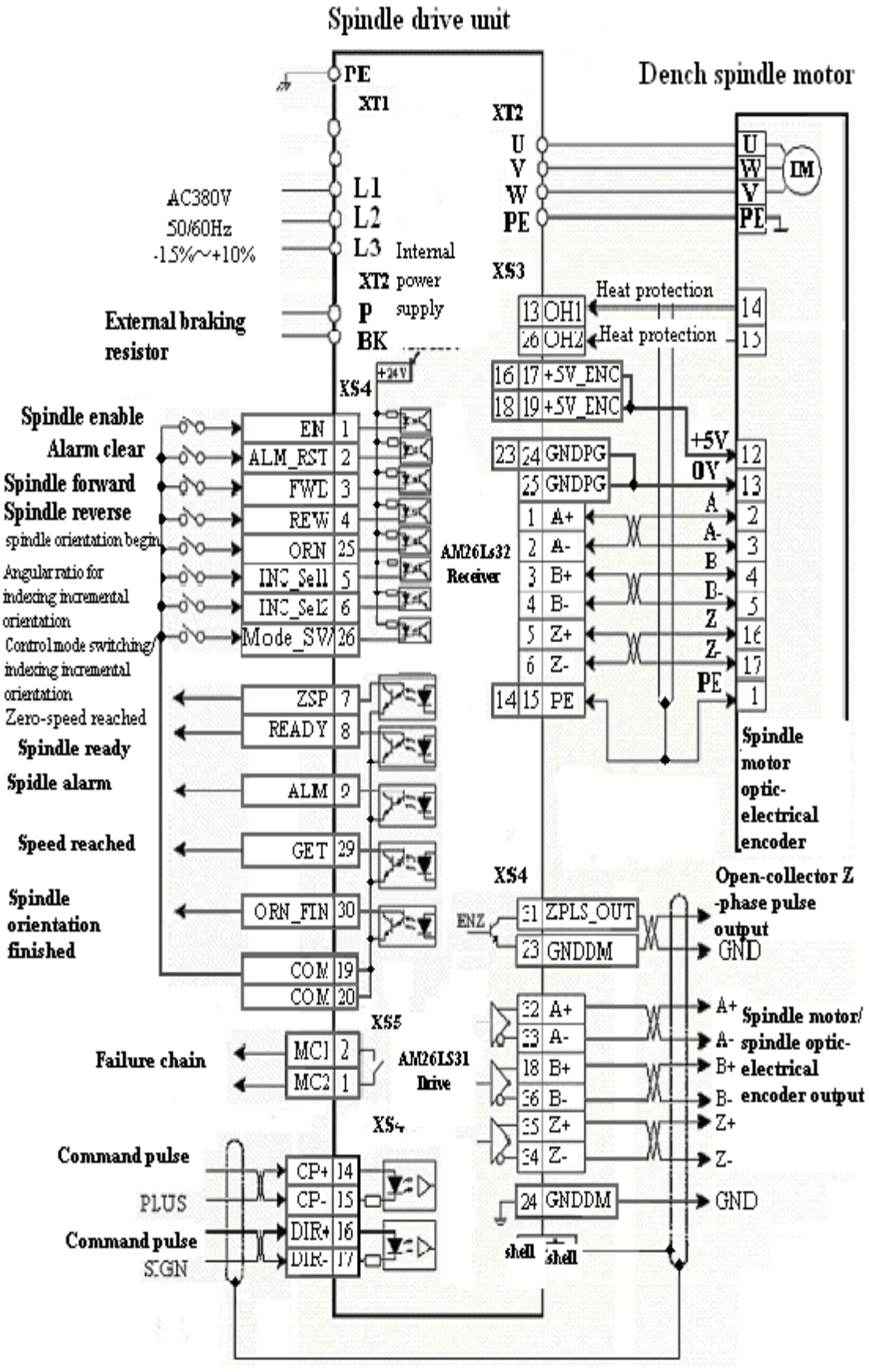
Install surge absorbers with inductive components (coils) of related circuits. Freewheeling diodes are antiparallel connected to the DC coils, and RC absorbed circuits are paralleling connected to the AC coils.

## 5.4 Standard Wiring

| Caution |
| --- |
| ● U, V, W on XT2 must be connected to the motor windings in corresponding order and cannot be reversed.<br>● Cables and wires must be fixed and cannot be near the radiator of the spindle drive or motor. Otherwise, the insulation properties may be reduced due to overheat.<br>● In the spindle drive, large-capacity of electrolytic capacitor exists, which leads to the remaining of high voltage even after power off. Therefore, do not touch the spindle drive or motor within five minutes after the power off.<br>● Terminals P, BK on XT2 are connected to the external braking resistor.<br>**Terminal P and BK cannot be shorted. Otherwise it will damage the spindle drive.**<br>● "Shell" in the wiring diagram refers to the mental shell of the wiring plug. The cable shield must be connected to the metal shell. First unravel the shield and avoid twisting together. Then loop part of the shield and cut off the rest. Last cover the looped shield with casing, and weld the exposed shield to the metal shell.<br>**Avoid too much solder to make sure the plug shield can be covered.**<br>● It will be better if you use a metal cable clip to form a 360-degree access and perform nearby grounded. |

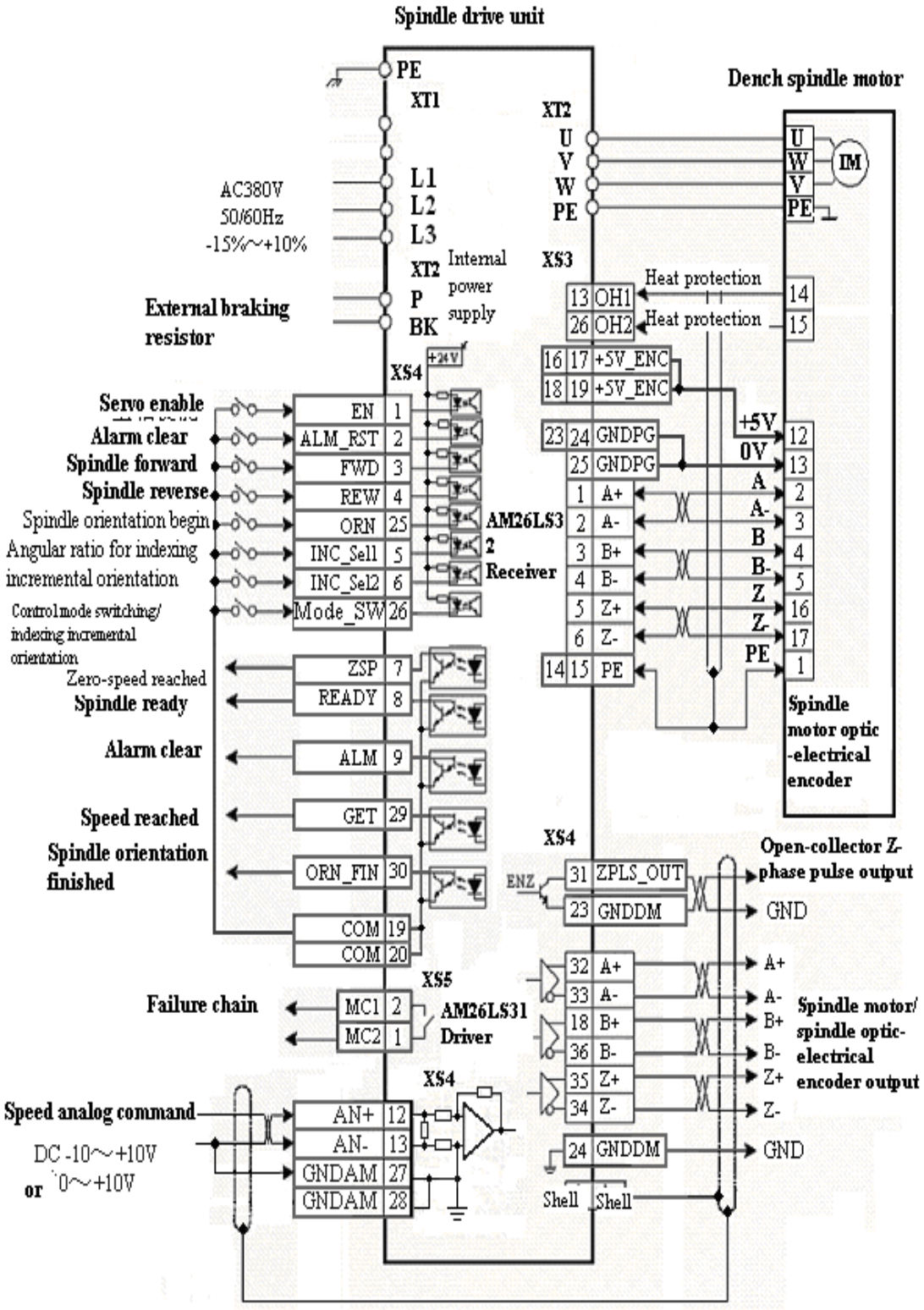
### 5.4.1 Standard Wiring for Position Control Mode (Pulse Interface)

Figure 5-15 Standard wiring for position control mode (pulse interface)


Spindle drive unit
Dench spindle motor
PE
XT1
XT2
U
V
W
PE
L1
L2
L3
AC380V
50/60Hz
-15%~+10%
Internal power supply
XT2
P
BK
External braking resistor
XS3
Heat protection
13 OH1
26 OH2
14
15
16 17 +5V_ENC
18 19 +5V_ENC
23 24 GNDPG
25 GNDPG
+5V
0V
XS4
+24V
Spindle enable
Alarm clear
Spindle forward
Spindle reverse
spindle orientation begin
Angular ratio for indexing incremental orientation
Control mode switching/ indexing incremental orientation
EN 1
ALM_RST 2
FWL 3
REW 4
ORN 25
INC_Sel1 5
INC_Sel2 6
Mode_SW 26
AM26LS32 Receiver
1 A+
2 A-
3 B+
4 B-
5 Z+
6 Z-
14 15 PE
12
13
2
3
4
5
16
17
1
Spindle motor optic-electrical encoder
Zero-speed reached
Spindle ready
Spidle alarm
Speed reached
Spindle orientation finished
ZSP 7
READY 8
ALM 9
GET 29
ORN_FIN 30
COM 19
COM 20
XS4
ENZ
31 ZPLS_OUT
23 GNDDM
Open-collector Z -phase pulse output
GND
22 A+
23 A-
18 B+
16 B-
15 Z+
14 Z-
A+
A-
B+
B-
Z+
Z-
Spindle motor/ spindle optic-electrical encoder output
24 GNDDM
GND
shell
shell
XS5
Failure chain
MC1 2
MC2 1
AM26LS31 Drive
XS4
Command pulse
PLUS
Command pulse
SIGN
CP+ 14
CP- 15
DIR+ 16
DIR- 17

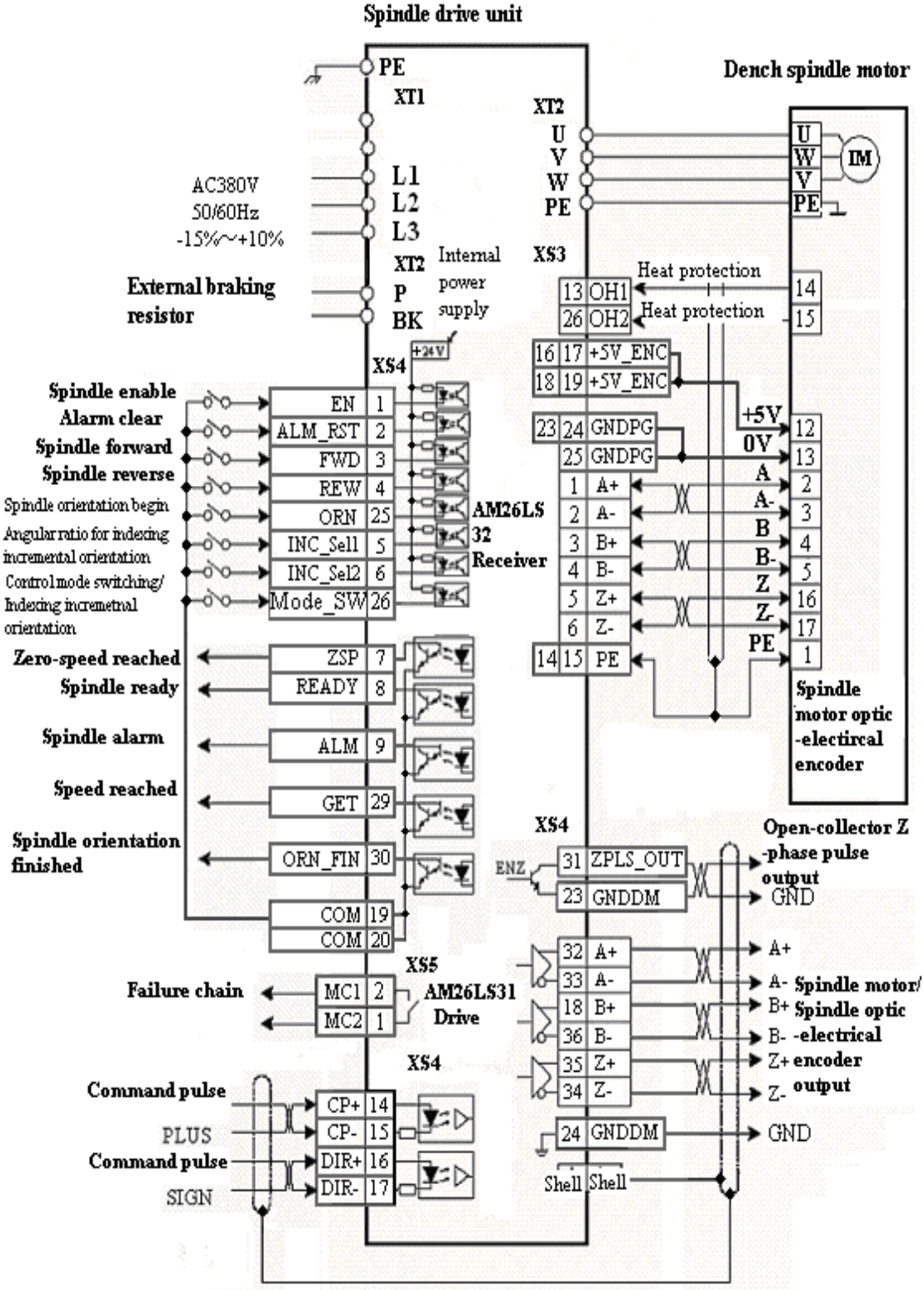
## 5.4.2 Standard Wiring for External Speed Control Mode (Analog Interface)

Figure 5-16 Standard wiring for external speed control mode (analog interface)



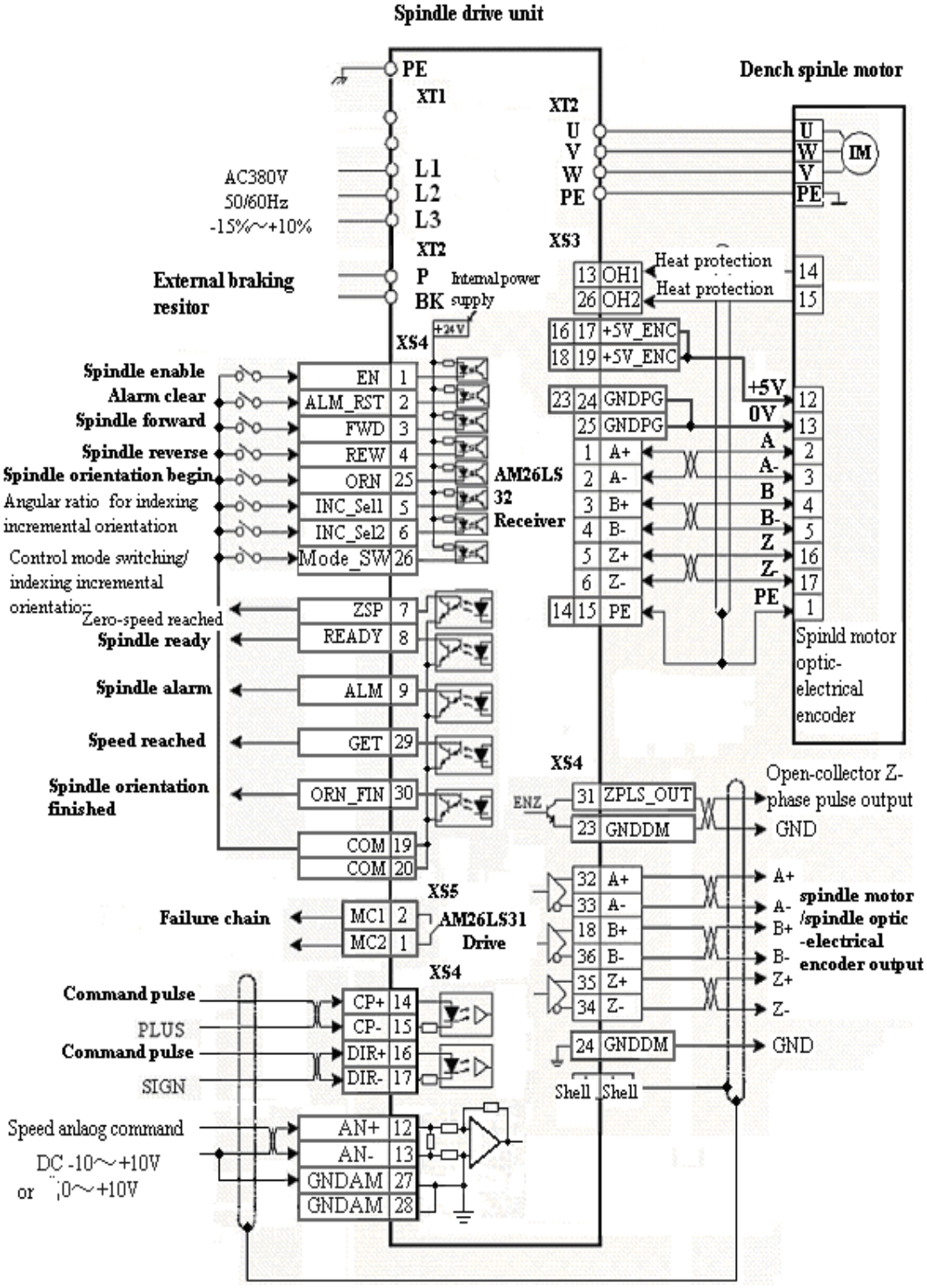

## 5.4.3 Standard Wiring for External Speed Control Mode (Pulse Interface)

Figure 5-17 Standard wiring for external speed control mode (pulse interface)



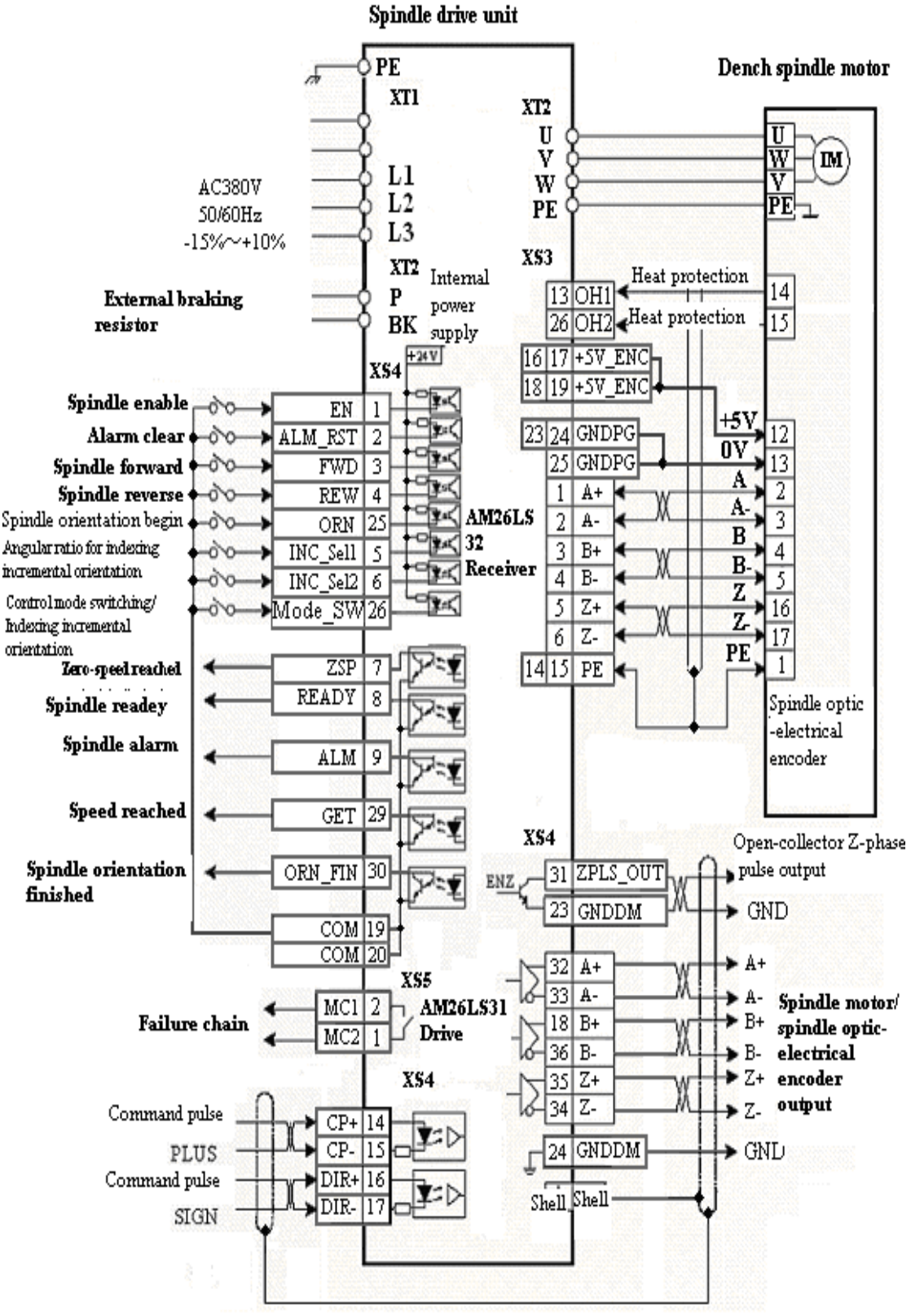

## 5.4.4 Standard Wiring for the Switching Between External Speed Control Mode (Analog Interface) and Speed Control Mode (Pulse Interface)

Figure 5-18 Standard wiring for the switching between external speed control mode (analog interface) and speed control mode (pulse interface)



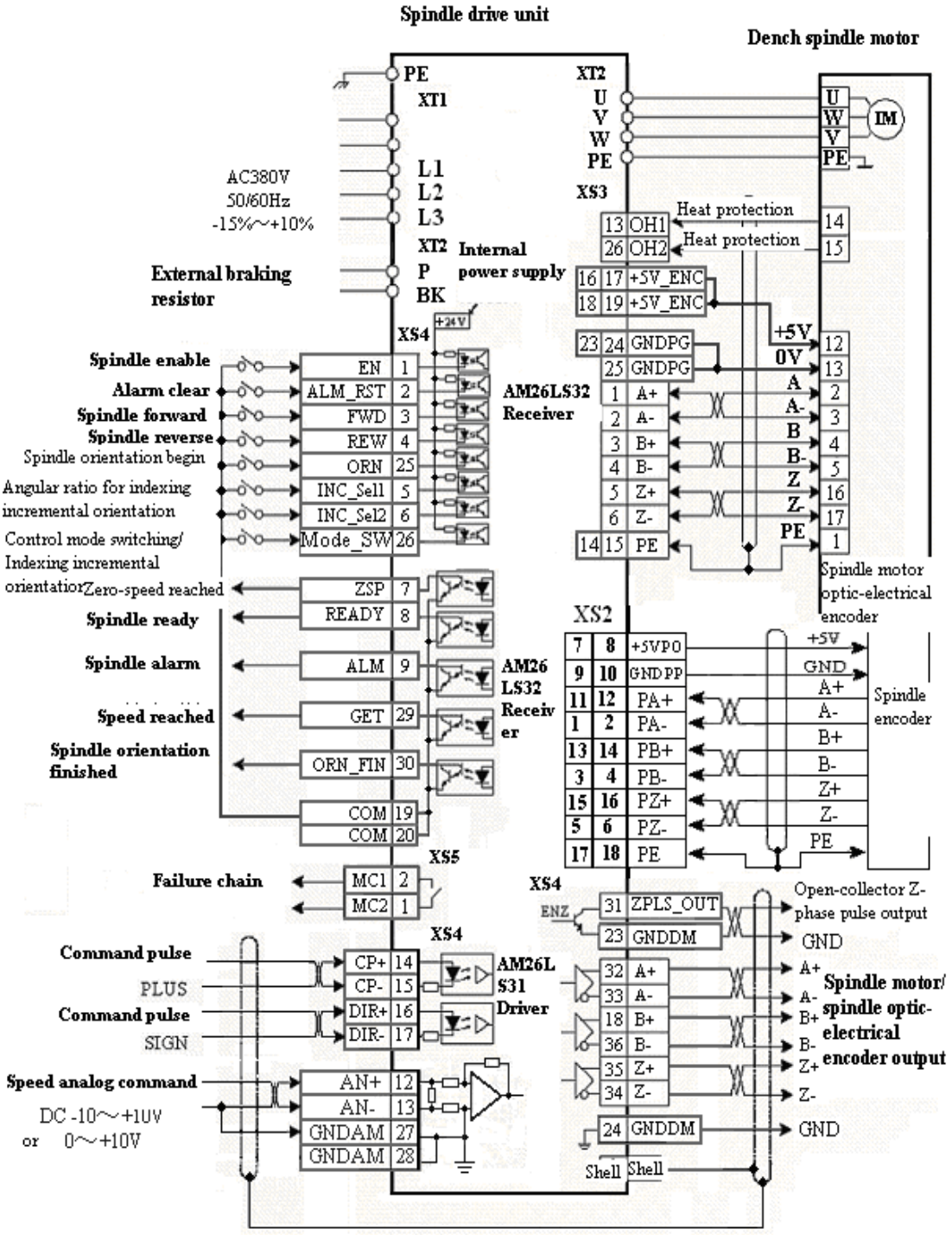

## 5.4.5 Standard Wiring For the Switching Between External Speed Control Mode (Pulse Interface) and Speed Control Mode (Analog Interface)

Figure 5-19 Standard wiring for the switching between external speed control mode (pulse interface) and speed control mode (analog interface)



## 5.4.6 Standard Wiring for Spindle Encoder

Figure 5-20 Standard wiring for spindle encoder

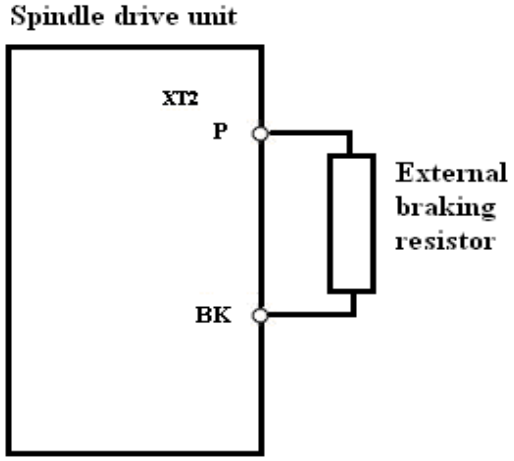



## 5.4.7 Wiring for External Braking Resistor

A 70 Ω/500 W braking resistor has been built in HSV-180S- 035, 050, 075, and a maximum of ten times overload is allowed (continuing for one second). An

external braking resistor is required when the drive unit's load or inertia is big. Connect **P** and **BK** terminals of the spindle drive with the external braking resistor if an external braking resistor is used. In this case, the internal resistor and the external resistor are serial connected. Figure 5-21 shows the standard connection of the external braking resistor.

Figure 5-21 Standard connection of the external braking resistor



# 6. Operation and Display

## 6.1 Overview

1. The drive unit panel consists of 6 LED digital displays, 5 buttons ↑, ↓, ←, M, S, and 2 light-emitting diodes.

- The 6 LED digital displays are used to display various statuses and set parameters.
- The red light-emitting diode is an alarming lamp (AL). When it is on, it means "drive unit alarm". The green light-emitting diode is an enable lamp (EN). When it is on, it means "spindle drive enable"
- The function of each button is as follows:

M: used for main menu mode switching

S: used for entering into the secondary menu, returning to the main menu mode, and input confirmation

↑: used for an increase in number and value, or moving to the next option

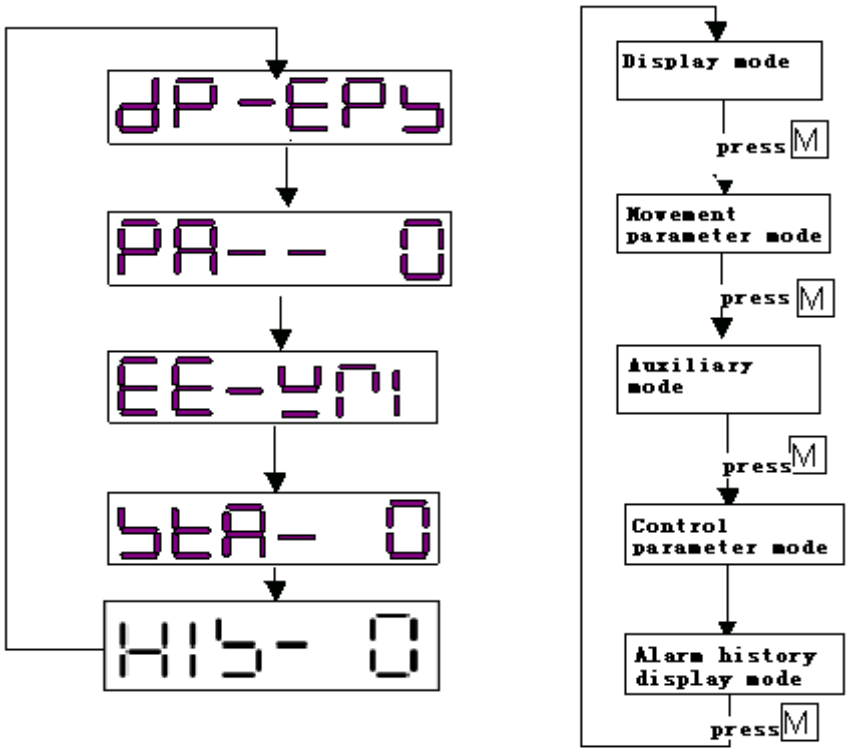
↓: used for a decrease in number and value, or moving back to the previous option

←: used for shifting

2. After the control power supply of the spindle drive is connected, the six LED digital displays on the panel all display "8", and change to "R O" a second later.

3. Users must operate based on the multi-level menus. The first-level menu is the main menu which includes five operation modes: display mode, movement parameter mode, auxiliary mode, control parameter mode, and alarm history display mode. Each operation mode contains a secondary menu. Figure 6.1 shows the operation on the main menu.

Figure 6-1 Main menu of series HSV-180S spindle drive unit




4. Press M to switch the operation mode on the main menu, Press S to enter the secondary menu of the mode. Secondary menu is the functional menu for each operation mode.

5. The 6-bit LED digital tube displays various status and data of the system. If the first bit of the digital tube displays A, and at the same time the red light-emitting diode is on, an alarm is generated. The follow-up bit of the digital tube displays the alarm code. After the process of fault diagnosis and troubleshooting, you can reset the system by the alarm reset mode under the auxiliary mode or cutting off the power and then re-power to the spindle drive. When the red light-emitting diode is off, the system is reset.

Figure 6.2 Alarm display


## 6.2 Operation in the Display Mode

1. On the main menu, select "DP-EPS", and press ↑ and ↓ to enter the secondary

menu for the display mode.

2. HSV-180S spindle drive contains 16 types of display modes (see table 6.1). Press ↑ and ↓ to select a display mode as required. The display status can only be viewed and cannot be modified or set. Press S to display the detailed status, then press S to return to the secondary menu, and then press S again to return to the main menu.

Figure 6-3 Secondary menu for the display mode

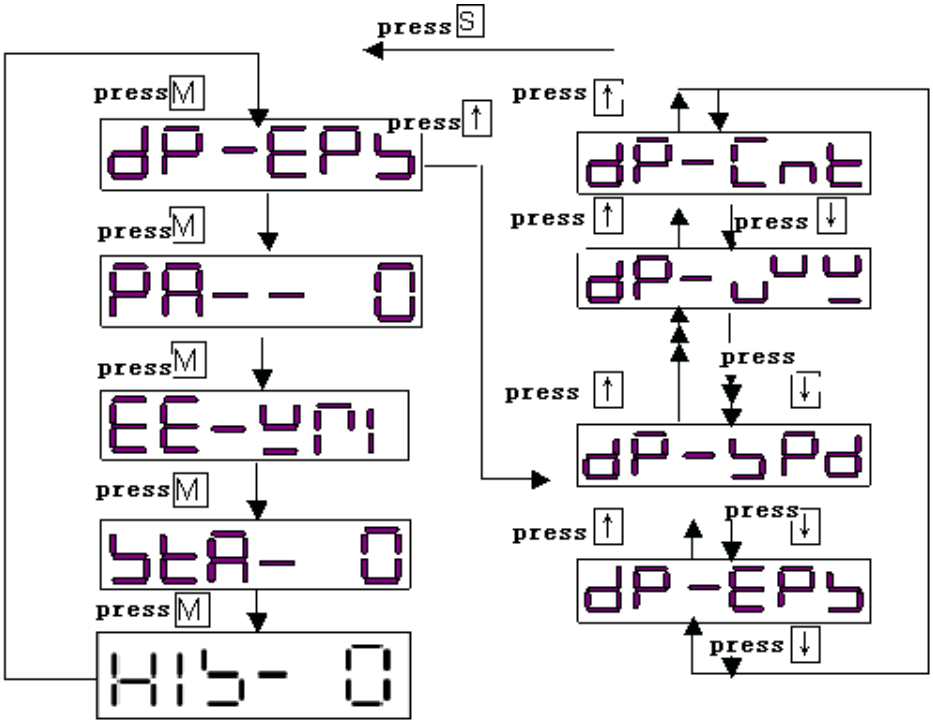



Table 6-1 Meaning of each symbol in the display mode

| NO. | Symbol | Description |
|---|---|---|
| 1 | DP-EPS | Display the speed tracking error (unit: 1 r/m) |
| 2 | DP-SPD | Display the actual speed (unit: 1 r/m) |
| 3 | DP-TRQ | Display the actual torque current (unit: digital. 32767 indicates the short-time maximum output current of the drive unit) |
| 4 | DP-IMF | Display the actual magnetic field current (unit: digital. 32767 indicates the short-time maximum output current of the drive unit) |
| 5 | DP-IMR | Display the magnetic field current command (unit: digital. 32767 indicates the short-time maximum output current of the drive unit) |
| 6 | DP-PFL | Display the low 16 bit of the actual position (unit: |

| | | |
|---|---|---|
| | | pulse) |
| 7 | DP-PFM | Display the high 16 bit of the actual position (unit: pulse) |
| 8 | DP-SPR | Display speed command (unit: 1 r / m) |
| 9 | DP-ALM | Display alarm status<br>(unit: digital. 32767 indicates the short-time maximum output current of the drive unit) |
| 10 | DP-PIN | Display switch-value input status<br>PIN.0: spindle drive enable<br>PIN.1: alarm status reset<br>PIN.2: CW control<br>PIN.3: CCW control<br>PIN.4: INC_Sel1<br>PIN.5: INC_Sel2<br>PIN.6: spindle orientation control<br>PIN.7: control mode switch |
| 11 | DP-IUF | Display the actual feedback value of the U-phase current (unit: digital, 32767 indicates the short-time maximum output current of the drive unit) |
| 12 | DP-POU | Display switch-value output status<br>POU.1: reserved<br>POU.2: system alarm indicator status<br>POU.3: zero-speed reached<br>POU.4: alarm output<br>POU.5: drive system ready<br>POU.6: reserved<br>POU.7: system enable indicator<br>POU.8: failure chain<br>POU.9: spindle orientation-finished<br>POU.10: speed reached |
| 13 | DP-IDS | Display the actual load current (unit: digital, 32767 indicates the short-time maximum output current of the servo drive) |
| 14 | DP-CNT | Display the control mode of the current spindle drive |
| 15 | DP-LAT | Display the number of the feedback pulse of the spindle motor optic-electrical encoder |
| 16 | DP-SPT | Display the number of feedback pulse of the spindle encoder |

Table 6-2 Meaning of the switch-value input status for DP-PIN

| Switch-value Input Status Display for | Switch-value Input Terminal | Meaning of Switch-value Input Terminal |
|---|---|---|

| DP-PIN | | |
|---|---|---|
| 1 | PIN.0 | Drive unit enable |
| 2 | PIN.1 | Alarm status reset |
| 4 | PIN.2 | CW control |
| 8 | PIN.3 | CCW control |
| 16 | PIN.4 | INC_Sel1 |
| 32 | PIN.5 | INC_Sel2 |
| 64 | PIN.6 | Spindle orientation control |
| 128 | PIN.7 | Control mode switch |

**NOTE**:

1. When the switch-value input terminal PIN.0 is effective, the drive is enabled. You can view the status of DP-PIN is 1.

2. When the switch-value input terminal PIN.0 and PIN.2 are effective, the drive is enabled. You can view the status of DP-PIN is 5 (1+4).

3. When the switch-value input terminal PIN.0 and PIN.6 are effective, the drive is enabled. You can view the status of DP-PIN is 65 (1+64).

Table 6-3 Meaning of the switch-value output status for DP-POU

| Switch-value Output Status Display for DP-POU | Switch-value Output Terminal | Meaning of Switch-value Output Terminal |
|---|---|---|
| 1 | POU.0 | Reserved |
| 2 | POU.1 | System alarm indicator |
| 4 | POU.2 | Zero-speed reached/ |
| 8 | POU.3 | Alarm output |
| 16 | POU.4 | System ready |
| 32 | POU.5 | Reserved |
| 64 | POU.6 | System enable indicator |
| 128 | POU.7 | Failure chain |
| 256 | POU.8 | Spindle orientation finished |
| 512 | POU.9 | Speed reached |

**Note**:

Refer to the switch-value output status for DP-POU in the process of spindle

orientation.

Table 6-4 Meaning of the switch-value output status for DP-POU in the process of spindle orientation

| | | **Switch-value Output Status Display for DP-POU** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Switch-value Output Terminal** | **Meaning of Switch-value Output Terminal** | 291 | 807 | 295 | 807 | 551 | 547 | 291 |
| Pou.0 | Reserved | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pou.1 | System alarm indicator | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pou.2 | Zero-speed reached | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| Pou.3 | Alarm output | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pou.4 | System ready | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pou.5 | Reserved | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pou.6 | System enable indicator | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pou.7 | Failure chain | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pou.8 | Spindle orientation finished | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| Pou.9 | Speed reached | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

1. Before spindle orientation is begin, POU.2, POU.3, POU.4, POU.6, POU.7, POU.9 is effective. (**0** indicates that the output status is effective and correspondingly outputs low-level voltage; 1 indicates that the output status is ineffective and outputs high-level voltage. Pay attention to the state of the alarm output switch-value. When a spindle drive alarm is reported, the state of alarm output switch-value is 1; when no alarm is reported, the state is 0. ) The state display for DP-POU is 291.
2. When the spindle orientation input signal from the PC is received, the spindle orientation begins. Before the spindle running speed get to the speed for spindle orientation, POU.3, POU.4, POU.6, POU.7 and POU.9 are ineffective. The status display for DP-POU is 807.
3. When the spindle runs at the spindle orientation speed, POU.2, POU.3, POU.4, POU.6, POU.7, and POU.9 are effective. The status display for DP-POU is 295.
4. When the Z-phase pulse occurs, the spindle begins to orient at the speed lower than the spindle orientation speed. In this case, POU.9 is ineffective,

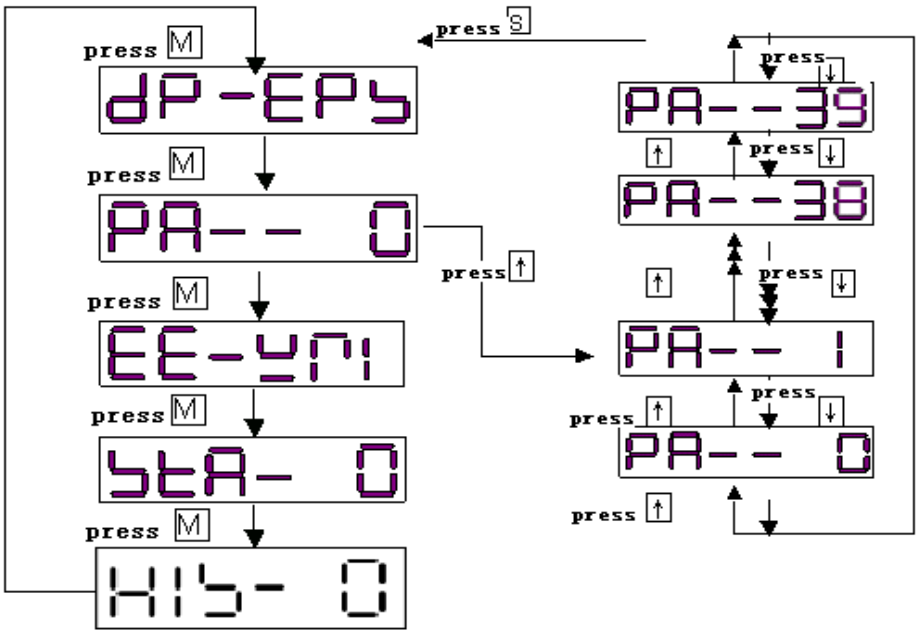
and the status display for DP-POU is 807.

5. When the spindle orientation position is not in the range of spindle orientation, the POU.8 is effective. The status display for DP-POU is 551.
6. When the spindle orientation is finished, the spindle stops at the required position of orientation and the POU.2 is effective. The status display for DP-POU is 547.
7. After the PC not sending out the spindle orientation signal, POU.2, POU.3, POU.4, POU.6, POU.7, and POU.9 are effective. The status display for DP-POU is 291.

## 6.3 Operation in the Movement Parameter Mode

1. On the main menu, select "PA--0", and press ↑and ↓ to enter the secondary menu for the movement parameter mode.
2. Series HSV-180S spindle drive contains 48 movement parameters (see Chapter 7 for specific meaning). Press ↑ and ↓ to select a required parameter. Press S to display the detailed parameters, and you can view, modify and set the parameter. After modifying or setting parameters, press S to return to the secondary menu, and then press S again to return to the main menu.
3. If the modified or changed parameters need to be saved, press M to switch to the "EE-WRI" mode, and then press S to save them to the EEPROM in the spindle drive. When the saving is finished, "FINISH" is displayed. Press M to re-select the movement parameter mode or other modes.

Figure 6-4 Secondary menu for the movement parameter mode



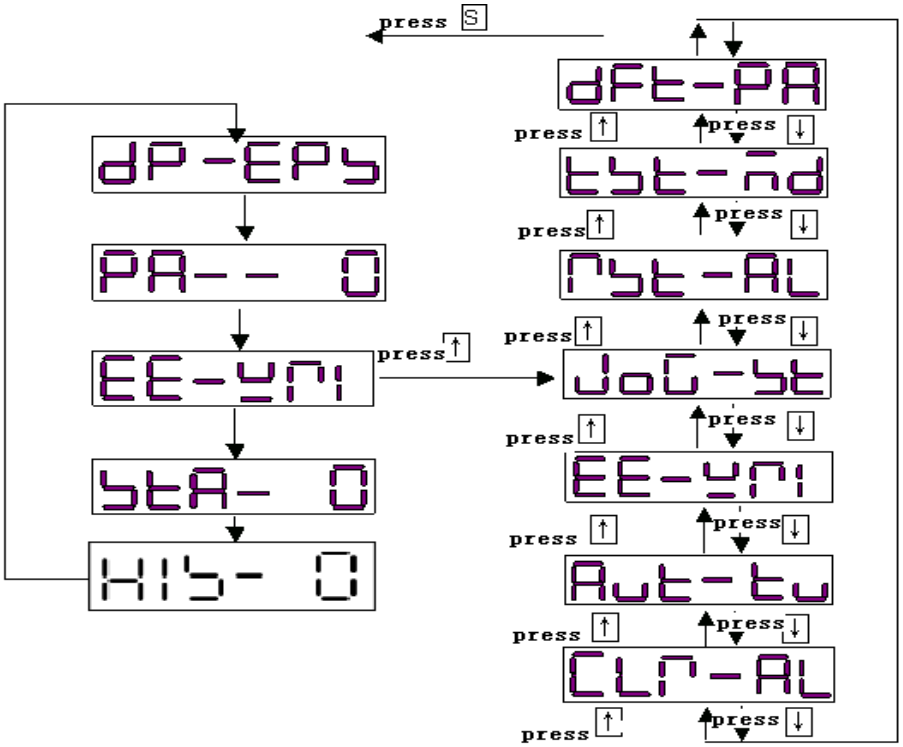

## 6.4 Operation in the Auxiliary Mode

1. On the main menu, select"**EE-WRI**", and press ↑and ↓ to enter the secondary menu for the auxiliary mode.
2. Series HSV-180S spindle drive contains 5 types of auxiliary modes (see Table 6-5). Press ↑and ↓ to select the required auxiliary mode, and press S to enter the detailed operation mode.

Table 6-5 Meaning of each symbol in the auxiliary mode

| No. | Symbol | Operation Mode | Description |
|---|---|---|---|
| 0 | EE-WRI | EEPROM mode | Saving the changed parameter to the internal EEPROM |
| 1 | JOG-- | JOG running | The drive unit and motor run in the JOG mode at the speed that has been specified. |
| 2 | RST-AL | Alarm resetting | Resetting spindle drive and clearing alarm |
| 3 | DFT-PA | Default settings restoration | Restoring the parameter setting to the original default setting |
| 4 | CLR-AL | Alarm history clearance | Clearing alarm history |
| 5 | AUT-TU | Reserved | |

Figure 6-5 Secondary menu for the auxiliary mode




1. **EEPROM mode**: This method is effective only during the parameter changes and settings. After changing or setting parameters, you can save the new parameter values by pressing S in this mode. When "**FINISH**" is displayed, the parameter change and setting is completed. Press M to switch to another mode, or press ↑ and ↓ to select other operations in the auxiliary mode.
2. **JOG mode**: This mode is effective only in JOG running. When the JOG speed parameter PA-21 is a non-zero value, on the main menu, press M to select the auxiliary mode, and press ↑ and ↓ to select the JOG running mode. "**JOG---**" is displayed through the digital display. Press S, "**R ---** "is displayed, which indicates that the system enters into the running state. Press and hold ↑, then the spindle drive and motor run at the speed specified by **PA-21**. Press ↓, then the motor run at the speed specified by **PA-21** in the opposite direction. Release the ↑ or ↓to stop the motor. Press S to return to the auxiliary mode. Press M to switch to another mode, or press ↑ and ↓ to

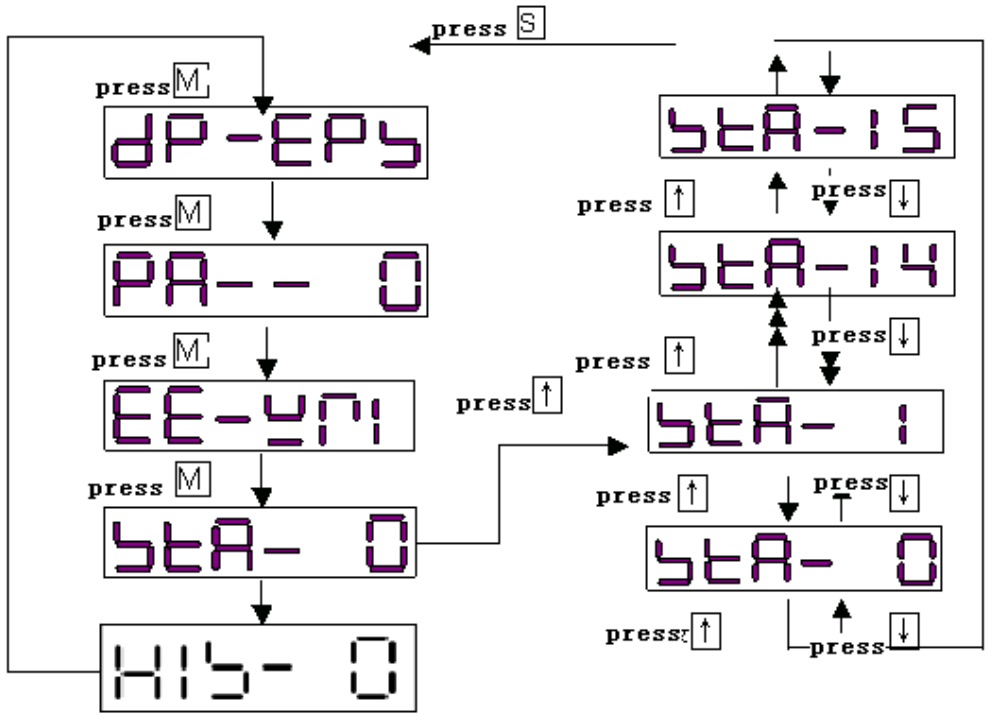
select other operations in the auxiliary mode.

3. **Alarm resetting mode**: When the spindle drive unit generates an alarm, press S to reset the system in this mode. If the fault is cleared, the spindle drive unit returns to normal. Press M to switch to another mode, or press ↑ and ↓ to select other operations in the auxiliary mode.
4. **Default restoration mode**: This mode is used to set the parameters to the default values. In this mode, press S to restore system parameters to default values. Press M to switch to another mode, or press ↑ and ↓ to select other operations in the auxiliary mode.
5. **Alarm history clearance mode**: This mode is used to clear alarm history records. In this mode, press S to clear the alarm history records. Press M to switch to another mode, or press ↑ and ↓ to select other operations in the auxiliary mode.

## 6.5 Operations in the Control Parameter Mode

1. On the main menu, select "**STA-0**", and press ↑and ↓ to enter the secondary menu for the control parameter mode.
2. Series HSV-180S spindle drive contains 16 types of control parameters (see Chapter 7 for specific meaning). Press ↑ and ↓ to select a required parameter. Press S to display the detailed parameters, and you can view, modify and set the parameter. After modifying or setting parameters, press S to return to the secondary menu, and then press S again to return to the main menu. Press M to switch to another mode, or press ↑ and ↓ to select other parameters in the control parameter mode.

Figure 6-6 Secondary menu for the control parameter mode




## 6.6 Operation in the Alarm History Display Mode Operation

1. On the main menu select "**HIS-0**", and press ↑and ↓ to enter the secondary menu for the alarm history display mode.
2. HSV-180S spindle drive saves the last ten alarm records. See Table 6-6. Press ↑ and ↓ to select a record of alarm status, and press S to display the detailed alarm information. For detailed meaning of alarm information, see Chapter 9 Fault Troubleshooting. If the servo drive does not have ten records of alarm status, then the alarm status "**-1**" is displayed. You can only view alarm information but cannot change or set alarm information. After viewing the alarm information, press S to return to the secondary menu. Press S **to** return to the main menu.

Figure 6-7 Secondary menu for the alarm history display mode

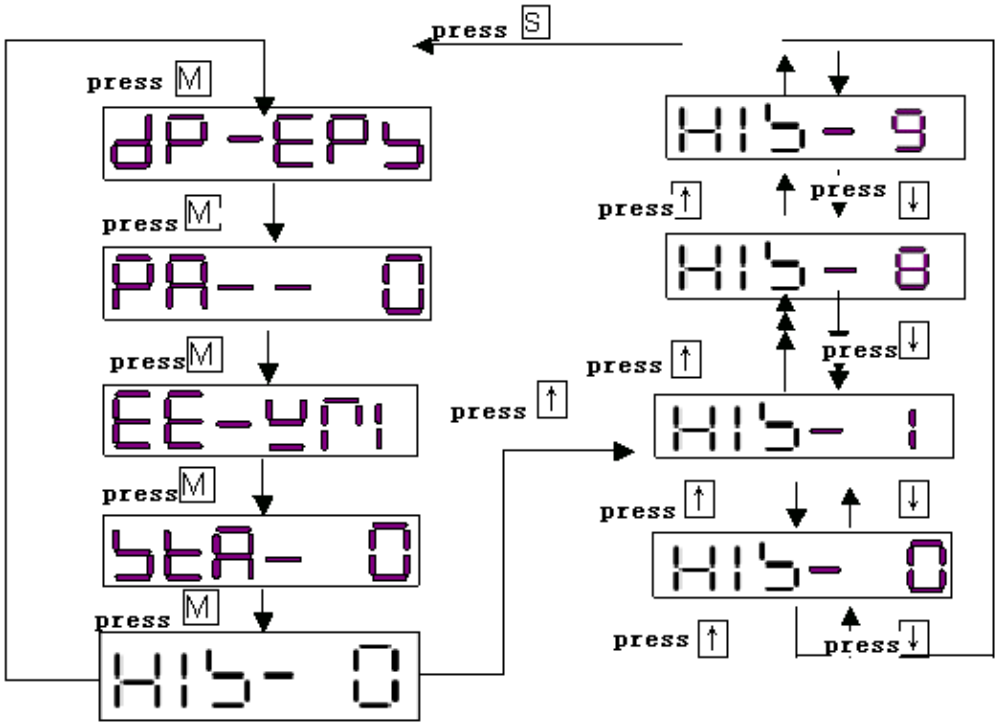



Table 6-6 Meaning of each symbol in the alarm history display mode

| | | |
|---|---|---|
| 1 | HIS-0 | The latest alarm status (the tenth alarm status) |
| 2 | HIS-1 | The ninth alarm status |
| 3 | HIS-2 | The eighth alarm status |
| 4 | HIS-3 | The seventh alarm status |
| 5 | HIS-4 | The sixth alarm status |
| 6 | HIS-5 | The fifth alarm status |
| 7 | HIS-6 | The fourth alarm status |
| 8 | HIS-7 | The third alarm status |
| 9 | HIS-8 | The second alarm status |
| 10 | HIS-9 | The first alarm status |

## 6.7 Movement Parameter Setting and Saving

| Caution |
|---|
| ● The movement parameter setting takes effect immediately after confirmation. Wrong settings may cause improper operation that leads to accidents.<br>● After changing a parameter, you can confirm the parameter change |

by pressing S only in the EE-WRI auxiliary mode.

1. On the main menu, press ↑ and ↓ to select a parameter number, and then press S to display the value of the parameter. Press ← to shift, and press ↑ and ↓ to change the parameter value.
2. When a parameter is modified, the right decimal point on the LED digital tube lights. Press ←, the modification position of the changed parameter moves to the left (left-cycle), and the corresponding decimal point on the LED digital tube light.
3. The parameter value increase or decrease 1 every time you press ↑ or ↓ respectively. The parameter value continuously increases or decreases if you press and hold ↑ or ↓ respectively
4. After the parameter modification is completed, Press S to return to the movement parameter mode menu. Press ↑ or ↓ to continue to modify other parameters.
5. After changing a movement parameter, you can save the parameter change by pressing S to return to the main menu and pressing M to select the auxiliary mode. Then press ↑ and ↓ to select "**EE-WRI**" and press S to save the changed parameter value to EEPROM. The panel displays FINISH, indicating that the parameter value is saved.
6. Press M to re-select the parameter mode or other modes.

## 6.8 Control Parameter Setting and Saving

**Caution**

- The control parameter setting cannot take effect immediately. The new parameter can be confirmed by pressing S only in the "EE-WRI" of auxiliary mode, and it takes effect after restarting the spindle drive.
- Wrong settings may cause improper operation that leads to accidents.

1. Select the control parameter mode on the main menu, press ↑ and ↓ to select a control parameter number, and then press S to display the value of the parameter. Press ↑ and ↓ to change the parameter value.
2. The parameter value increase or decrease 1 every time you press ↑ or ↓ respectively.
3. After the parameter modification is completed, press S to return to the control parameter mode menu. Press ↑ or ↓ to continue to modify other parameters.
4. The control parameter setting cannot take effect immediately. You can save the parameter change by pressing S to return to the main menu and pressing M to select the auxiliary mode. Then press ↑ and ↓ to select "**EE-WRI**", and then press S to save the changed parameter value to EEPROM. The wire control box displays **FINISH**, indicating that the parameter value is saved.
5. The changed control parameter takes effect as a default control parameter after restarting the spindle drive.

# 7. Parameter Setting

| Attention |
| --- |
| ● Personnel that set parameters must understand the meanings of the parameters. Wrong setting could result in damage to the equipment and injuries.<br>● It is recommended that parameter modification be performed under the condition that spindle motor run without load. |

## 7.1 Function Menu

Users can set various parameters for series HSV-180S spindle drive to adjust or set the performances and functions of the drive unit. This section describes the purpose and functions of these parameters. Understanding these parameters is essential for a best use and operation of the drive unit.

Series HSV-180S spindle drive parameters can be divided into two categories: movement parameter and control parameter (applicable to movement parameter mode and control parameter mode respectively). These parameters can be viewed, set and modified by keys or computer serial ports on the wire control box.

Table 7-1 Description of the two types of modes

| Mode | Group | Parameter No. | Description |
| --- | --- | --- | --- |
| Movement parameter mode | Motor parameter setting | 24, 25, 32 to 36 | Able to set parameters related to the spindle motor |
| | Position control | 0,12,16, 22 to 23 42,43,46 | Able to set position regulator gain, position command pulse input mode, and pulse frequency dividing/ frequency doubling- |
| | speed control | 2 to 9, 11, 17, 20 to 21, 22, 23, 29 to 30 | Able to set speed regulator, acceleration and deceleration time, speed input/output gain, modify zero drift, and rotary speed control.- |
| | Output torque adjustment- | 1,10,15, 18 to 19, 27 to 28 | Able to set the maximum output torque, overload torque, overload time and current regulator. |
| | Spindle | 13, 14, 37 to 39 | Able to set spindle orientation speed, |

| | | | |
|---|---|---|---|
| | orientation- | 40,41,44,45,47 | orientation position. |
| Control parameter mode | Function selection | 0 to 15 | Able to select user-defined input/ output signal and internal control function modes. |

## 7.2 Movement Parameter Mode

Series HSV-180S spindle drive can provide 47 movement parameters. For details about the movement parameters, see Table 7-2, and Table 7-3.

Table 7-2 a describes the movement parameters of the HSV-180S-050 spindle drive that configured with the Wuhan Dench GM7 spindle motor GM7103-4SB61, with a 7.5 KW rated power, 1500 rpm rated speed and 18.8 A rated current. The parameter with "*"need to be adjusted according to the actual operation.

Table 7-3 b describes the movement parameters of the HSV-180S-075 spindle drive that configured with the Wuhan Dench GM7 spindle motor GM7103-4SB61, with a 7.5 KW rated power, 1500 rpm rated speed and 18.8 A rated current. The parameter with "*"need to be adjusted according to the actual operation.

In the application control mode:

**P:** indicates position control (suitable for spindle position control and spindle orientation)

**S**: indicates speed control.

**Note**:

Do not modify the reserved parameters which may be applied by the internal system. Failure to follow this instruction could result in unexpected consequences.

Table 7-2 a Movement parameters of the HSV-180S-050 spindle drive configured with the Wuhan Dench GM7 spindle motor GM7103-4SB61

| No. | Parameter | Adaptive Control Mode | Value Range | Default Value | Unit |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 0 | Position control mode Position proportional gain | P | 10 to 9999 | 1000* | 0.01 Hz |
| 1 | Torque filter time constant | P, S | 0 to 499 | 10 | 0.1 ms |
| 2 | speed proportional gain 1 | S | 25 to 32767 | 4500* | |
| 3 | speed integral time constant 1 | S | 5 to 32767 | 40* | 1 ms |
| 4 | Speed feedback filter factor | P, S | 0 to 4 | 0 | |
| 5 | Deceleration time constant | S | 1 to 1800 | 40* | 0.1 s/maximum rotary speed (P17) |
| 6 | Acceleration time constant | S | 1 to 1800 | 40* | 0.1 s/maximum rotary speed (P17) |
| 7 | speed command input gain | S | 10 to 12000 | 6000* | 1 r/min/10 V |
| 8 | speed command zero drift compensation | S | -1023 to 1023 | 0 | |
| 9 | speed command gain adjusting | S | 80 to 120 | 100 | 1% |
| 10 | Current amplitude limit for maximum torque | P, S | 0 to 30000 | 25000 | **32767** indicates the short-time maximum current of the spindle drive |
| 11 | speed reached range | P, S | 0 to 32767 | 10 | 1 r/min |
| 12 | Test range for position tolerance | P | 1 to 32767 | 20000 | pulse |
| 13 | Speed ratio numerator of spindle to motor | P | 1 to 32767 | 1 | Applicable to orientation control only |
| 14 | Speed ratio denominator of spindle to motor | P | 1 to 32767 | 1 | Applicable to orientation control only |
| 15 | Current amplitude limit for the second torque | P, S | 10 to 32767 | 5000 | **32767** indicates the short-time maximum current of the spindle drive |
| 16 | Position feed forward gain | P | 0 to 100 | 0* | 1% |
| 17 | Maximum speed limit | P, S | 1000 to | 6500 | 1 r/min |

| | | | | | |
|---|---|---|---|---|---|
| | | | 16000 | | |
| 18 | Overload current setting | P, S | 10 to 32000 | 20000 | **32767** indicates the short-time maximum current of the spindle drive |
| 19 | Overload time setting of the system | P, S | 10 to 30000 | 600 | 0.1s |
| 20 | Internal speed | S | -8000 to 12000 | 0 | 1 r/min |
| 21 | JOG operation speed | P, S | 0 to 500 | 300 | 1 r/min |
| 22 | Command pulse input mode | P, S | 0 to 3 | 1* | |
| 23 | Selection of control mode | P, S | 0 to 3 | 1* | Select the control mode to the spindle drive<br>● 0: the C-axis position control mode that receive position pulse input command<br>● 1: the external speed control mode that receives the speed analog input command<br>● 2: the external speed control mode that receives the speed pulse input command<br>● 3: Internal speed control mode, and the internal speed command is set by the movement parameter **PA--20** |
| 24 | Magnetic logarithm of spindle motor | P, S | 1 to 4 | 2 | |
| 25 | Spindle motor encoder resolution | P, S | 0 to 3 | 0 | |
| 26 | reserved | | | 1 | |
| 27 | Current control proportional gain | P, S | 0 to 32767 | 2000 | |
| 28 | Current control | P, S | 1 to 127 | 10 | ms |

| | | | | | |
|---|---|---|---|---|---|
| | integral time | | | | |
| 29 | Zero-speed reached range | P, S | 0 to 300 | 10 | 1 r/min |
| 30 | Speed rate | S | 1 to 256 | 64 | 1/64 |
| 31 | Reserved | | | 4100 | |
| 32 | Weak magnetism adjusting coefficient | P, S | 50 to 150 | 80 | % |
| 33 | Flux current | P, S | 400 to 16383 | 6000 | **32767** indicates the short-time maximum current of the spindle drive |
| 34 | Time constant of spindle motor rotor electric | P, S | 50 to 4095 | 1500 | 0.1 ms |
| 35 | Rated speed of spindle motor | P, S | 100 to 3000 | 1500 | 1 r/min |
| 36 | The minimum flux current | P, S | 100 to 4095 | 600 | **32767** indicates the short-time maximum current of the spindle drive |
| 37 | The range for spindle orientation finished | P | 0 to 100 | 10 | Pulse |
| 38 | Spindle orientation speed | P | 40 to 600 | 400 | 1 r/min |
| 39 | Spindle orientation position | P | 0 to 32767 | 0 | Pulse |
| 40 | Incremental angle for indexing orientation | P | 0 to 32767 | 0 | ● Incremental angle for indexing orientation = **PA-40 x 360/ppr0/8 x** the angular ratio for indexing orientation<br>● If **SET-13** is set to **0**, the value of **ppr0** is multiplying the resolution of spindle motor optic-electrical encoder (**PA-25**) by **4**<br>● If **SET-13** is set to |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | **1**, the value of **ppr0** is multiplying the spindle encoder resolution by **4**<br>● The angular ratio for the indexing incremental orientation is determined by **INC_Sel1** and **INC_Sel2** |
| 41 | Speed ratio power of the spindle to motor | P | 0 to 4 | 0 | |
| 42 | Speed proportional gain 2 | P | 25 to 32767 | 4500* | |
| 43 | Speed integral time constant 2 | P | 5 to 32767 | 40* | 1 ms |
| 44 | Position proportional gain for orientation mode | P | 10 to 9999 | 1000* | 0.01 Hz |
| 45 | Flux current for orientation mode | P | 10 to 100 | 60 | 0 to 100% |
| 46 | Flux current for position control mode | P | 10 to 100 | 70 | 0 to 100% |
| 47 | Spindle encoder resolution multiplied by 4 | P, S | 0 to 32767 | 4096 | |

Table 7-3 b Movement parameters of the HSV-180S-075 spindle drive configured with the Wuhan Dench GM7 spindle motor GM7103-4SB61

| No. | Parameter | Adaptive Control Mode | Value range | Default value | Unit |
|---|---|---|---|---|---|
| 0 | Position control mode Speed proportional gain | P | 10 to 9999 | 1000* | 0.01 Hz |
| 1 | Torque filter time constant | P, S | 0 to 499 | 10 | 0.1 ms |
| 2 | Speed proportional gain 1 | S | 25 to 32767 | 4500* | |
| 3 | Speed integral time | S | 5 to | 40* | 1 ms |

| | | | | | |
|---|---|---|---|---|---|
| | constant 1 | | 32767 | | |
| 4 | Speed feedback filter factor | P, S | 0 to 4 | 0 | |
| 5 | Deceleration time constant | S | 1 to 1800 | 40* | 0.1 s/maximum rotary speed (P17) |
| 6 | Acceleration time constant | S | 1 to 1800 | 40* | 0.1 s/maximum rotary speed (P17) |
| 7 | Speed command input gain | S | 10 to 12000 | 6000* | 1 r/min/10 V |
| 8 | Speed command zero drift compensation | S | -1023 to 1023 | 0 | |
| 9 | Speed command gain adjusting | S | 80 to 120 | 100 | 1% |
| 10 | Current amplitude limit for maximum torque | P, S | 0 to 30000 | 25000 | **32767** indicates the short-time maximum current of the spindle drive |
| 11 | Speed reached range | P, S | 0 to 32767 | 10 | 1 r/min |
| 12 | Test range for position tolerance | P | 1 to 32767 | 20000 | pulse |
| 13 | Speed ratio numerator of spindle to motor | P | 1 to 32767 | 1 | Only applicable in orientation control |
| 14 | Speed ratio denominator of spindle to motor | P | 1 to 32767 | 1 | Only applicable in orientation control |
| 15 | Current amplitude limit for the second torque | P, S | 10 to 32767 | 5000 | **32767** indicates the short-time maximum current of the spindle drive |
| 16 | Position feed forward gain | P | 0 to 100 | 0* | 1% |
| 17 | Maximum speed limit | P, S | 1000 to 16000 | 6500 | 1 r/min |
| 18 | Overload current setting | P, S | 10 to 32000 | 20000 | **32767** indicates the short-time maximum current of the spindle drive |
| 19 | Overload time setting of the system | P, S | 10 to 30000 | 600 | 0.1s |
| 20 | Internal speed | S | -8000 | 0 | 1 r/min |

| | | | | | |
|---|---|---|---|---|---|
| | | | to 12000 | | |
| 21 | JOG operation speed | P, S | 0 to 500 | 300 | 1 r/min |
| 22 | Command pulse input mode | P, S | 0 to 3 | 1* | |
| 23 | Selection of control mode | P, S | 0 to 3 | 1* | Select the control mode to the spindle drive<br>● 0: the C-axis position control mode that receive position pulse input command<br>● 1: the external speed control mode that receives the speed analog input command<br>● 2: the external speed control mode that receives the speed pulse input command<br>● 3: Internal speed control mode, and the internal speed command is set by the movement parameter **PA--20** |
| 24 | Magnetic logarithm of spindle motor | P, S | 1 to 4 | 2 | |
| 25 | Spindle motor encoder optical -electrical resolution | P, S | 0 to 3 | 0 | |
| 26 | Reserved | | | 1 | |
| 27 | Current control proportional gain | P, S | 0 to 32767 | 2000 | |
| 28 | Current control integral time | P, S | 1 to 127 | 10 | ms |
| 29 | Zero-speed reached | P, S | 0 to 300 | 10 | 1 r/min |
| 30 | Speed rate | S | 1 to 256 | 64 | 1/64 |

| | | | | | |
|---|---|---|---|---|---|
| 31 | Reserved | | | 4100 | |
| 32 | Weak magnetism adjusting coefficient | P, S | 50 to 150 | 80 | % |
| 33 | Flux current | P, S | 400 to 16383 | 6000 | **32767** indicates the short-time maximum current of the spindle drive |
| 34 | Time constant of spindle motor rotor electric | P, S | 50 to 4095 | 1500 | 0.1 ms |
| 35 | Rated speed of spindle motor | P, S | 100 to 3000 | 1500 | 1r/min |
| 36 | The minimum flux current | P, S | 100 to 4095 | 600 | **32767** indicates the short-time maximum current of the spindle drive |
| 37 | The range for spindle orientation finished | P | 0 to 100 | 10 | pulse |
| 38 | Spindle orientation speed | P | 40 to 600 | 400 | 1 r/min |
| 39 | Spindle orientation position | P | 0 to 32767 | 0 | pulse |
| 40 | Incremental angle for indexing orientation | P | 0 to 32767 | 0 | ● The incremental angle for indexing orientation is **PA-40 x 360/ppr0/8 x** the angular ratio for indexing orientation<br>● If the **SET-13** is set to **0**, the value of **ppr0** is multiplying the resolution of spindle motor optic-electrical encoder by **4**<br>● If **SET-13** is set to **1**, the value of **ppr0** is multiplying the spindle encoder resolution by **4**<br>● The angular ratio for indexing incremental orientation is |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | determined by **INC_Sel1** and **INC_Sel2** |
| 41 | Speed ratio power of the spindle to motor | P | 0 to 4 | 0 | |
| 42 | Speed proportional gain 2 | P | 25 to 32767 | 4500* | |
| 43 | Speed integral time constant 2 | P | 5 to 32767 | 40* | 1 ms |
| 44 | Position proportional gain for orientation mode | P | 10 to 9999 | 1000* | 0.01 Hz |
| 45 | Flux current for orientation mode | P | 10 to 100 | 60 | 0 to 100% |
| 46 | Flux current for position control mode | P | 10 to 100 | 70 | 0 to 100% |
| 47 | Spindle encoder resolution multiplied by 4 | P, S | 0 to 32767 | 4096 | |

### 7.2.1 Parameters Related to Servo Motors

Table 7-6 Parameters related to spindle motors

| No. | Parameter | Function | Value Range |
|---|---|---|---|
| 24 | Magnetic logarithm of spindle motor | Set the parameter to the spindle motor magnetic logarithm.<br>● **1**: indicates one pair of spindle motor magnetic logarithm<br>● **2**: indicates two pairs of spindle motor magnetic logarithm<br>● **3**: indicates three pairs of spindle motor magnetic logarithm<br>● **4**: indicates four pairs of spindle motor magnetic logarithm | 1 to 4 |

| | | | |
|---|---|---|---|
| 25 | Spindle motor optic-electrical encoder resolution | Set the parameter to the encoder resolution of the spindle motor optic-electrical encoder:<br>● **0**: indicates that the encoder resolution is 1024 Pulse/r<br>● **1**: indicates that the encoder resolution is 2000 Pulse/r<br>● **2**: indicates that the encoder resolution is 2500 Pulse/r<br>● **3**: indicates that the encoder resolution is 1000 Pulse/r | 0 to 3 |
| 32 | Weak magnetism adjusting coefficient | Set the parameter to the weak magnetism adjusting coefficient. | 50% to 150% |
| 33 | Flux current value | 1. Set the parameter to the flux current value<br>2. **PA-33** = motor no-load current **x** $\sqrt{2}$ **x R x 32767/2000**<br>3. **R** is the resistance of the sample resistor of the spindle drive<br>● The resistance of the 25 A spindle drive is 94 Ω<br>● The resistance of the 35 A spindle drive is 68 Ω<br>● The resistance of the 50 A spindle drive is 47 Ω<br>● The resistance of the 75 A spindle drive is 33 Ω | 400 to 16383<br>**32767** indicates the short-time maximum current of the spindle drive |
| 34 | Time constant of spindle | 1. Set the time constant of the spindle motor rotor electric. | 50 to 4095 (unit: 0.1 |

| | | | |
|---|---|---|---|
| | motor rotor electric | 2. The time constant can be calculated according to the rotor inductance of the motor (self-inductance + leakage inductance) and rotor resistance.<br>3. The time constant is effective at any time. | ms) |
| 35 | Rated speed of spindle motor | Set the rated speed for the spindle motor when it is without load | 100 to 3000 (unit: 1 r/min) |
| 36 | The minimum flux current value | 1. Set the parameter to the minimum flux current value of the motor<br>2. The 0.1 times flux current value is the general method to set the parameter.<br>3. The value must less than the flux current value. | 100 to 4095<br>**32767** indicates the short-time maximum current of the spindle drive |

**Description of the parameter setting:**

Parameters related to spindle motors are effective under all control modes.

HSV-180S spindle drive adopts the indirect magnetic field orientation control mode which achieves the control for asynchronous motor. The key to the magnetic field orientation is the observation for flux, in other words, it is the calculation of slip angle frequency which is closely related to the motor parameter. Therefore, setting parameter correctly is the first and foremost.

**a. Technical data of Dench GM7105-4SB61-O spindle motor**

Table 7-7 Technical data of Dench GM7105-4SB61-O spindle motor

| Item | Value |
|---|---|
| Rated power | 7.5 KW |

| | |
|---|---|
| Rated current | 18.8 A |
| Rated voltage | 346 V |
| Rated speed | 1500 r/min |
| Magnetic logarithm | 2 |
| Encoder windings | 1024 |
| Rotary inertia | 0.032 Kg*m2 |
| Maximum speed | 8000 r/min |

### b. Parameter setting of the drive unit related to spindle motor

Table 7-8 Parameter setting related to spindle motor

| NO. | Parameter | Default value | Unit |
|---|---|---|---|
| PA--17 | Maximum speed limit of the motor | 8500 | 1 r/min |
| PA--24 | magnetic logarithm | 2 | |
| PA--25 | Spindle motor optic-electrical encoder resolution | 0 | |
| PA--32 | Weak magnetism adjusting coefficient | 80 | 1% |
| PA--33 | Flux current | 6000 | **32767** indicates the short-time maximum current of the spindle drive |
| PA--34 | Time constant of spindle motor rotor electric | 1500 | 0.1 ms |
| PA--35 | Rated speed | 1500 | 1 r/min |
| PA--36 | Minimum flux current limit | 600 | **32767** indicates the short-time maximum current of the spindle drive |

1. Generally, **PA-17** is set at the maximum speed + 500 r/min.
2. **PA--24**, **PA--25**, and **PA--35** must be filled in based on the technical data of the motor.
3. **PA--33** is the no-load current of the rated speed.

- For the 2.2 KW to 11 KW spindle motor, the no-load current is 40% to 60% of the rated current.
- For the 15 KW to 22 KW spindle motor, the no-load current is 30% to 40% of the rated current.
- The formula:

  **PA--33** = the no-load current of the motor **x** $\sqrt{2}$ **x R x 32767/2000**, or

  **PA--33** = (the no-load current of the motor/the short-time maximum current of the spindle drive) **x 32767**
- For the short-time maximum current, refer to Table 7-9.

Table 7-9 Short-time maximum current of the HSV-180S spindle drive

| Specification | Continuous Current (A) | Short-time Maximum Current (A) | Maximum Adaptive Motor Power(KW) |
|---|---|---|---|
| HSV-180S-025 | 10 | 15 | 2.2 KW |
| HSV-180S-035 | 14 | 21 | 3.7 KW |
| HSV-180S-050 | 20 | 30 | 5.5 KW |
| HSV-180S-075 | 28 | 43 | 7.5 KW |

**Note**:

- If **PA-33**(flux current) is set too large, it will cause saturation flux which could result in motor oscillation, and a larger fluctuation in rotary speed.
- If the value of excitation current is set too small, it will cause insufficiency of magnetic flux stimulation which will lead to a great drop of motor output torque loop.

4. The value of **PA-34** (time constant of spindle motor rotor electric) can be specified based on the rotor inductance of the motor (self-inductance + leakage inductance) and rotor resistance.
   - For the 2.2 KW to 11 KW spindle motor, the time constant is from 1300 to 1800.
   - For the 15 KW to 30 KW spindle motor, the time constant is from 3000 to 4000.

**Note**:

- If **PA-34** is set too large or too small, it will cause a greater deviation of the magnetic field oriented angle, which may cause a great drop of motor output torque loop.
- PA**-36** (minimum flux current limit) is set for preventing the insufficiency of magnetic flux stimulation when the motor running at a high-speed. Generally **PA-36** is set to **0.1** times of the value of **PA-33** (flux current) or smaller.

### 7.2.2 Parameters Related to Movement Control

Table 7-10 Parameters related to movement control

| NO. | Parameter | Function | Value Range |
|---|---|---|---|
| 0 | Position control mode Speed proportional gain | 1. Set the parameters to the proportional gain of the position loop regulator under the position control mode<br>2. The greater of the parameter value, the greater of the gain and the rigidity, and the smaller of the position lag value at the same frequency of the command pulse.<br>Note: the value is too large may cause oscillation or overshooting.<br>3. The parameter value is determined according to the type of spindle drive and operating load. | 10 to 9999 unit: 0.01 1/S |
| 12 | Test range for position tolerance | 1. Set the parameters to the test range for C- axis position tolerance.<br>2. Under the C-axis control mode, when the value for the position tolerance is over the parameter value, the tolerance alarm is generated. | 1 to 32767 pulse |
| 16 | | 1. Set parameters to the position feed forward gain. | 0 to 100 |

| | | | |
|---|---|---|---|
| | Position feed forward gain | 2. When the parameter is set to **100%**, the position lag value is **0** at any frequency of the command pulse.<br>3. The high-speed response is improved as the feed forward gain of the position loop increased. This can cause instability and oscillation.<br>4. If the fast response is not required, the parameter can be set to **0**. | |
| 22 | Command pulse input mode | 1. Set parameters to the command pulse mode<br>2. Set parameters to one of the 3 types of input mode.<br>● 0: indicates two-phase positive pulse input<br>● 1: indicates pulse + direction<br>● 2: indicates CCW pulse/CW pulse<br>3. CCW is defined as forward for the spindle rotating counterclockwise (looking from the axial direction).<br>4. CW is defined as reverse for the spindle rotating clockwise (looking from the axial direction). | 0 to 3 |
| 23 | Selection of control mode | 1. This parameter is used to select control mode for the spindle drive.<br>● **0**: indicates the C-axis position control mode, receiving the position pulse input command.<br>● **1**: indicates the external speed control mode, receiving speed analog input command.<br>● **2**: indicates the external speed control mode, receiving speed pulse input command.<br>● **3**: indicates the internal speed control mode. | 0 to 3 |

| | | | |
|---|---|---|---|
| | | The internal speed command is set by movement parameter **PA-20**. | |
| 42 | Speed proportional gain 2 | 1. Set parameters to the proportional gain for speed regulator under the position control mode.<br>2. Gain and rigidity will be enhanced as the parameter value increases. This parameter is determined by the actual spindle drive system type and the load. Generally, load inertia grows as the value increases.<br>3. It is recommended that the value be larger if no oscillation exists. | 25 to 32767 |
| 43 | Speed integral time constant 2 | 1. Set this parameter to the speed regulator integration time constant.<br>2. Integration speeds up as the value decreases. This parameter is determined by the actual spindle drive system type and the load. Generally, load inertia grows as the value increases.<br>3. It is recommended that the value be smaller if no oscillation exists. | 5 to 32767 |
| 46 | Flux current for position control mode | 1. Set parameters to the flux current value under position control mode. The parameter is specified by **PA-33** and **PA-46**, and the flux current value is **PA-33 x PA-46**. | 10 to 100% |

Parameters setting in the position control mode (PA-23 is set to **0**):

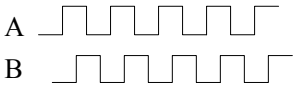
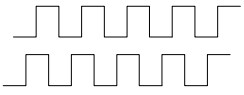
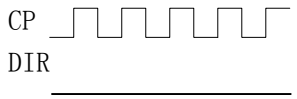
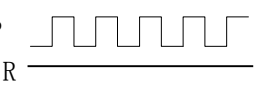
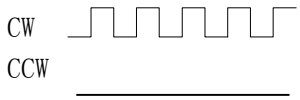
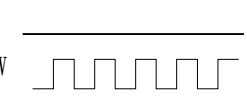
1. The position loop feature is adjusted by setting **PA-0**.
2. The speed loop feature is adjusted by setting **PA-42** and **PA-43**.
3. The current loop feature is adjusted by setting **PA-27** and **PA-28**.
4. The value of flux current is calculated by multiply **PA-33** by **PA-46**. There is

an example, if the value of PA-33 is 6000 and PA-46 is 70, flux current value = 6000 x 70% = 4200

**Note**:

In the position control mode, the spindle drive can receive three types of pulse command. You can select one of the three commands by setting the movement parameter **PA-22** (indicating the command pulse input mode).

Table 7-11 Command pulse

| Signal Input Pin | Pulse | | Command Pulse Input Mode (movement parameter PA-22) Setting |
|---|---|---|---|
| | Forward | Reverse | |
| CP<br>XS4-14<br>XS4-15<br>DIR<br>XS4-16<br>XS4-17 |  |  | 0 (positive pulse) |
| |  |  | 1 (pulse + direction) |
| |  |  | 2 (CW+CCW)<br>(CW+CCW) |

## 7.2.3 Parameters Related to Speed Control Mode

Table 7.12 Parameters related to speed control mode

| NO. | Parameter | Function | Value Range |
|---|---|---|---|
| 2 | Speed proportional gain 1 | 1.Set parameters to the proportional gain for the speed regulator.<br>2.Gain and rigidity will be enhanced as the parameter value increases. This parameter is determined by the actual spindle drive system type and the load. Generally, load inertia grows as the value increases.<br>3.It is recommended that the value be larger if no oscillation exists. | 25 to 32767 |
| 3 | Speed integral time constant 1 | 1.Set this parameter to the speed regulator integration time constant.<br>2.Integration speeds up as the value decreases. This parameter is determined by the actual spindle drive | 5 to 32767 mS |

| | | | |
|---|---|---|---|
| | | system type and the load. Generally, load inertia grows as the value increases.<br>3.It is recommended that the value be smaller if no oscillation exists. | |
| 4 | Speed feedback filter factor | 1.Set this parameter to the features of low-pass filter for speed feedback.<br>2.Noise produced by motors and cut-off frequency decreases as the value increases. If the load inertia is large, decrease the value to prevent from slow response or oscillation.<br>3.The cut-off frequency increases and speed feedback response becomes faster as the value decreases. If high speed feedback response required, decrease the value. | 0 to 4 |
| 5 | Deceleration time constant | 1. The value indicates the time required for motor slow down from the maximum speed to 0r/min.<br>2. Deceleration features linearity. | 0.1S to 180S |
| 6 | Acceleration time constant | 1. The value indicates time required for motor speed up from 0 r/min to the maximum speed.<br>2. Acceleration features linearity. | 0.1S to 180S |
| 7 | Analogue speed command input gain | 1.Set this parameter to the relationship between voltage and rotary speed under analogue speed command mode.<br>2.The value is the speed corresponding to the + 10 V voltage ( unit: 1 r/min)<br>3.The valve is effective under the external speed control mode. | 0 to 12000 |
| 8 | Speed command zero drift compensation | 1. In the speed control mode, this parameter is used to adjust zero drift input by external analogue speed command. The method of adjustment is as follows:<br>● Perform short-connection between the analogue control input terminal and grounding wire for signal.<br>● Set this parameter to the value that stops the operation of the motor. | -1023 to 1023 |
| 9 | Speed command gain adjusting factor | 1. In the speed control mode, this parameter is used to adjust the amplification factor of PA--7.<br>2. The value is effective under the external speed control mode. | 80% to 120% |
| 11 | speed reached | 1. Set parameters to speed reached. | 0 to 32767 |

| | | | |
|---|---|---|---|
| | range | 2. In the non-position control mode, if the motor speed tracking error is less than the value, the switch signal for speed reached is connected, otherwise it is disconnected.<br>3. In the position control mode, this parameter is ineffective.<br>4. The parameter value has no relation to the rotary direction. | r/min |
| 17 | Maximum speed limit | 1. Set parameter to the maximum speed limit.<br>2. The parameter value has no relation to the rotary direction. | 0 to 16000(unit: 1 r/min) |
| 20 | Internal speed | 1. Set parameters to the internal speed.<br>2. In the internal control mode, select the internal speed as the speed command. | -8000 to 12000 (unit: 1 r/min) |
| 21 | FOG operating speed | 1. Set this parameter to the speed in the JOG mode. | 0 to 500(unit: 1 r/min) |
| 22 | Command pulse input mode | 1. Set parameters to the command pulse input mode.<br>2. Select one of the 3 types of input mode by setting the parameter.<br>● 0: indicates two-phase positive pulse input<br>● 1: indicates pulse + direction<br>● 2: indicates CCW pulse/CW pulse<br>3. CCW is defined as forward for the spindle rotating counterclockwise as looking from the axial direction.<br>4. CW is defined as reverse for the spindle rotating clockwise as looking from the axial direction. | 0 to 3 |
| 23 | Selection of control mode | 1. This parameter is used to select the control mode for spindle drive.<br>● **0**: indicates the C-axis position control mode, receiving the position pulse input command.<br>● **1**: indicates the external speed control mode, receiving speed analog input command.<br>● **2**: indicates the external speed control mode, receiving speed pulse input command.<br>● **3**: indicates the internal speed control mode. The internal speed command is set by movement parameter **PA-20**. | 0 to 3 |
| 29 | Zero-speed reached range | 1.Set parameters to the zero-speed reached range.<br>2. In the non-position control mode, if the motor speed is less than the value of this parameter, the switch signal for zero-speed output is connected. Otherwise, it is disconnected.<br>3. In the position control mode, this parameter is | 0 to 300 (unit: 1 r/min) |

| | | | |
|---|---|---|---|
| | | ineffective.<br>4.The parameter value has no relation to the rotary direction. | |

Parameter setting in the speed control mode (**PA-23** is set to **1**, **2** or **3**):

1. Speed loop feature is adjusted by setting **PA-2** and **PA-3**.
2. Current feature is adjusted by setting **PA-27** and **PA-28**.
3. Flux current value is determined by setting **PA-33**.
4. When **PA-23** is set to **1**, it can receive the internal analog command with the voltage amplitude no more than 10 V (-10 V to +10 V or 0 to +10 V).
5. When **PA-23** is set to **2**, it can receive three types of external pulse commands (positive pulse, pulse + direction, positive and negative pulse). For the command pulse mode, see Table 7-11.
6. When **PA-23** is set to **3**, in the internal control mode, the spindle drive running at the speed specified by **PA-20** (without the external command).

### 7.2.4 Parameters Related to Output Torque Regulation

Table 7-13 Regulating parameters

| NO. | Parameter | Function | Value range |
|---|---|---|---|
| 1 | Torque filter time constant | 1. Set parameters to the filter time constant for the torque command.<br>2. The responding speed becomes slower as the value increases, which may cause instability and oscillation.<br>3. The parameter is generally set to **10** if a slow response is not needed. | 0 to 499<br>Indicates the range is 0~49.9 ms |
| 10 | Current amplitude limit for maximum torque | 1. Set parameters to the current amplitude limit for maximum torque.<br>PA-10 = $\sqrt{I_e^2 - I_{null}^2}$ x $\sqrt{2}$ x 2 x R x 32767/2000<br>$I_e$: indicates the rated current of the motor<br>$I_{null}$: indicates the no-load current of the motor<br>R indicates the resistance of the spindle drive sample resistor. For the specific resistance, refer to the parameter setting related to spindle motor **PA-33** in | 0 to 30000<br>**32767** indicates the short-time maximum current of the spindle drive unit |

| | | | |
|---|---|---|---|
| | | Table 7-6.<br>The value is effective at any time. | |
| 15 | Current amplitude limit for second torque | 1. Set parameters to the current amplitude limit for the second torque.<br>2. **PA-15** = *the second current limit* x $\sqrt{2}$ x R x 32767/2000, PA-15 ≤ (PA-10)/4,<br>R indicates the resistance of the spindle drive sample resistor<br>For the specific resistance, refer to the parameter setting related to spindle motor **PA-33** in Table 7-6.<br>The value is effective at any time. | 10 to 32767<br>**32767** indicates the short-time maximum current of the spindle drive |
| 18 | Overload current setting | 1. Set parameters to the overload current of spindle motor.<br>2. The value is equals to 1.5 x *the rated current* x $\sqrt{2}$ x R x 32767/2000<br>R indicates the resistance of the spindle drive unit sample resistor<br>For the specific resistors, refer to the parameter setting related to spindle motor **PA-33** in Table 7-6.<br>The value is effective at any time. | 10 to 32000<br>**32767** indicates the short-time maximum current of the spindle drive |
| 19 | Overload time | 1. Set this parameter to the allowable overloading time of the system.<br>2. The value indicates the overloading time per time unit (unit: 0.1s). For example, if the value is **200**, the allowable overloading time is **20s**.<br>3. The value is effective at any time. | 10 to 30000 |
| 27 | Current control proportional gain | 1. Set this parameter to the proportional gain of current loop.<br>2. Decrease the value to decrease the loud noise of current during motor operation.<br>3. However, a small value will decrease the feedback response. | 0 to 32767 |
| 28 | Current control integration time | 1. Set this parameter to the integration time of current loop.<br>2. Increase the value to decrease the loud noise of current during motor operation.<br>3. A big value will decrease the feedback response. | 1 to 127 |

**Description of parameters setting**:

1. Parameters related to the output torque are effective in any control mode.

2. The setting for **PA-10**:
   - The maximum current amplitude limit value for output torque is between 1.5 to 2 times of the rated current of the motor.
   - The formula is as follow:

     PA-10 = $\sqrt{I_e^2 - I_{null}^2}$ x $\sqrt{2}$ x 2 x R x 32767/2000
   - And a more simple formula: PA-10 = (1.5 to 2 x rated current of the motor/short-time maximum current of the spindle drive) x 32767.
   - For the short-time maximum current value, see Table 7-14.
   - Take the Dench GM7105-4SB61-O spindle motor as an example, $I_e$ (rated current) is 18.8 A, the maximum current amplitude limit value is between 1.5 to 2 times of $I_e$, therefore, PA-10 = (2 x 18.8/43) x 32767≈28652, and the value range of PA-10 is from 25000 to 26000.
3. The setting for PA-18:
   - The overload current value usually is 1.5 times of the rated current of the motor.
   - The formula is as follow:

     **PA-18 = 1.5 x rated current x $\sqrt{2}$ x R x 32767/2000**
   - And a more simple formula: **PA-18 = (1.5 x rated current of the motor/short-time maximum current of the spindle drive) x 32767**.
   - For the short-time maximum current value, see Table 7-14.
   - Take the Dench GM7 105-4SB61-O spindle motor as an example, the rated current is 18.8 A, the overload current value is 1.5 times of the rated current. Therefore, PA-18 = (1.5 x 18.8/43) x 32767≈21489, the value range of PA-18 is from 20000 to 22000.

Table 7-14 Short-time maximum current of the HSV-180S spindle drive

| Type | Continuous Current (A) | Short-time Maximum Current (A) | Maximum Adaptive Motor Power (KW) |
|---|---|---|---|
| HSV-180S-025 | 10 | 15 | 2.2 KW |
| HSV-180S-035 | 14 | 21 | 3.7 KW |

| | | | |
|---|---|---|---|
| HSV-180S-050 | 20 | 30 | 5.5 KW |
| HSV-180S-075 | 28 | 43 | 7.5 KW |

### 7.2.5 Parameters Related to the Oriented Control

Table 7-15 Oriented Parameters

| NO. | Parameter | Function | Value Range |
|---|---|---|---|
| 13 | Speed ratio numerator of spindle to motor | 1. Set parameters to the speed ratio of spindle to motor.<br>2. **PA-13** is the numerator and **PA--14** is the denominator of the speed ratio. During operation, if the spindle makes three turns per time and the spindle motor makes five, the value of **PA-13** is **5** and **PA-14** is **3**. | 1 to 32767 |
| 14 | Speed ratio denominator of spindle to motor | | 1 to 32767 |
| 37 | Spindle orientation finished range | 1. Set parameters to the minimum position error range in the spindle orientation finished.<br>2. When the position error is smaller than the value, the orientation-finished output switch (**ORN_FIN**) is connected. | 0 to 100 Pulse |
| 38 | Spindle orientation speed | 1. Set parameters to the spindle orientation speed. | 40 to 600(1 r/min) |
| 39 | Spindle orientation position | 1. Set parameters to the spindle orientation speed.<br>2. The value is set by taking the zero pulse position of the motor encoder or spindle encoder as a reference. | 0 to 4095 Pulse |
| 40 | Incremental angle for indexing orientation | Set parameters to the incremental angle for indexing orientation | 0 to 32767 |

**Parameters setting in the orientation mode**:

1. The position loop feature is adjusted by setting **PA-44**.
2. The speed loop feature is adjusted by setting **PA-42** and **PA-43**.
3. The current loop feature is adjusted by setting **PA-27** and **PA-28**.
4. The flux current value is specified by multiplying **PA-33** by **PA-45**. For example, if PA-33 is 6000 and PA-45 is 60, the flux current value = 6000 x 60% = 3600.

## A. Spindle Orientation

### 1. Spindle motor optic-electrical encoder orientation

- In the spindle motor optic-electrical encoder orientation mode, connect the encoder to the input interface XS3 for feedback.
- Set **PA-13** (indicates speed ratio numerator of spindle to motor) to **1** and **PA-14** (indicates speed ratio denominator) to **1**, set **PA-25** (indicates the resolution of optic-electrical encoder) to **0** (indicates that the resolution is **1024**).
- According to the actual requirement, set **PA-37**, **PA-38**, and **PA-39**, in this case the range for spindle orientation position is from 0 to 4096.
- Set the control parameter **STA-13** to **0**, and spindle optic-electrical encoder is used for position feedback, in this case, the command input/output interface XS4 outputs the position of the spindle optic-electrical encoder.
- Set the control parameter **STA-15** to **0**, spindle motor optic-electrical encoder is used for orientation, and according to the actual requirement, set **STA-14** (indicates the spindle orientation direction).
- The spindle motor optic-electrical encoder orientation is applicable in the condition of the speed ratio of spindle to motor is **1**:**1**.

## B. Spindle encoder orientation

- In the spindle encoder orientation mode, connect the spindle optic-electrical encoder to the input interface XS3 for feedback, and connect spindle encoder to the interface XS2 for feedback.
- Set the movement parameter PA-25 (indicates the spindle motor optic-electrical encoder resolution) to 0 (indicates that the resolution is 1024), and set PA-47 according to the actual used spindle encoder.
- According to the actual requirement, set **PA-37**, **PA-38**, and **PA-39**, in this case, the range for spindle orientation position is from **0** to the value of **PA-47**.
- Set the control parameter **STA-13** to **1**, and the command interface uses spindle encoder to feedback position. In this case, the interface XS4 outputs

the position of the spindle optic-electrical encoder.

- Set **STA-15** to **1** (indicates spindle encoder orientation), and set **STA-14** (spindle orientation direction) according to the actual requirement.

**Note**:

- To prevent interference, the interface XS2 adopts AM26LS32 differential receiver to receive differential input signal. The spindle encoder adopts the differential drive output mode with the AM26LS31, MC3487 or similar RS422 line drive.
- Connect the spindle encoder to a +5V power supply.
- The spindle motor optic-electrical encoder orientation is not applicable in the condition of the speed ratio of spindle to motor is **1**:**1**.

**C. Zero switch Orientation**

- In the zero switch orientation mode, connect A, B-phase of spindle motor optic-electrical encoder to the interface XS3 for feedback, disconnect the Z-phase of spindle motor optic-electrical encoder, and connect the Z-phase of zero switch to the XS3.
- Set **PA-13** (indicates speed ratio numerator of spindle to motor) to **1** and **PA-14** (indicates speed ratio denominator) to **1**, set **PA-25** (indicates the spindle optic-electrical encoder resolution) to **0** (indicates that the resolution is **1024**).
- According to the actual requirement, set **PA-37**, **PA-38**, and **PA-39**, in this case, the range for spindle orientation position is from **0** to **4096 x n** (n indicates the speed ratio of spindle to motor).
- Set the control parameter **STA-13** to **0**, and the command interface uses spindle motor optic-electrical encoder to feedback. In this case, the interface XS4 outputs the position of the spindle optic-electrical encoder.
- Set **STA-15** to **0** for spindle motor optic-electrical encoder orientation, and according to the actual requirement, set **STA-14** (indicating the spindle orientation direction).
- Zero switch orientation is applicable in the condition of the speed ratio of

spindle to motor is **1**:**1**.

**Note**:

- To prevent interference, the drive interface XS3 uses AM26LS32 differential receiver to receive differential input signal.
- The zero switching adopts the differential drive output mode with the AM26LS31, MC3487 or similar RS422 line drive.
- Connect the zero switch to a +5 V power supply.

**2. Indexing incremental orientation**

**a) Indexing incremental orientation for spindle motor optic-electrical encoder**

- The wiring is the same as that in the spindle motor optic-electrical encoder orientation mode and the zero switch orientation mode.
- The angular ratio for indexing incremental orientation is determined by the fifth pin **INC_Sel1** and the sixth pin **INC_Sel2** on the XS4.
- Set movement parameter **PA-40** (indicates the incremental angle for indexing orientation), and set **STA-13** to **0**, at this time, the value of **ppr0** is multiplying the set resolution of spindle motor optic-electrical encoder by **4**.
- The formula for the incremental:

  The incremental angle = **PA-40** x **360/ppr0/8 x** the angular ratio for indexing incremental orientation.

  For example: If PA-40 is 2048, INC_Sel1 and INC_Sel2 are effective (INC_Sel1 and INC_Sel2 is connected), incremental angle = 2048 x 360/4096/8 x 4 = 90.
- When the spindle motor optic-electrical encoder orientation and the zero switch orientation are finished, make **ORN** (spindle orientation begin) and **Mode_SW** (the input terminal for indexing incremental orientation) effective until a indexing incremental orientation is finished, in this case, **ORN_FIN** (spindle orientation finished output) is ineffective, and the spindle motor rotates a incremental angle along with the spindle orientation direction.

  For example, if PA--40 is 2048, and INC_Sel1 and INC_Sel2 set to ON, the

spindle motor turns 90 degrees. After the incremental orientation is finished, ORN_FIN (spindle orientation finish output) is effective.

- If a further indexing incremental orientation is required, make **Mode_SW** ineffective, a moment later, make it effective, the spindle motor rotates to another incremental angle.
- If a further incremental fixed angular orientation is not required, make **Mode_SW** ineffective. The control process is similar to that of spindle orientation.

Note:

- Indexing incremental orientation for spindle motor optic-electrical encoder must be performed after the spindle motor optic-electrical encoder orientation or the zero switch orientation is finished.
- The input switch **Mode_SW** is a dual-purpose terminal. In the orientation mode, when the **ORN** is effective, it is an input terminal for indexing incremental orientation. In the non-orientation mode, when the **ORN** is ineffective, it is a switch input terminal for control mode switching.

**b) Indexing Incremental orientation for spindle encoder**

- The wiring is the same as that in the spindle encoder orientation mode.
- The angular ratio for indexing incremental orientation is determined by the fifth pin **INC_Sel1** and the sixth pin **INC_Sel2** on XS4.
- Set the movement parameter **PA—40** (incremental angle), and set control parameter **STA-13** to **1**, at this time, the value of **ppr0** is the value of **PA-47**.
- The formula for the incremental angle is as follow:

  The incremental angle = **PA--40** x **360/ppr0/8** x the angular ratio for indexing incremental orientation.

  For example, if PA-40 = 2400, PA-47 = 4800, INC_Sel1 and INC_Sel2 are effective (INC_Sel1 and INC_Sel2 is connected), the incremental angle = 2400 x 360/4800/8 x 4 = 90
- When the spindle encoder orientation is finished, make **ORN** (spindle orientation begin) effective until a indexing incremental orientation is

finished, and then make **Mode_SW** (the input terminal for indexing incremental orientation) effective, in this case, **ORN_FIN** (spindle orientation finish output) is ineffective, and the spindle motor rotates a incremental angle along with the spindle orientation direction.

For example, if PA-40 is 2400, PA-47 = 4800, and INC_Sel1 and INC_Sel2 are set to ON, the spindle motor turns 90 degrees. After the indexing incremental orientation is finished, ORN_FIN (spindle orientation-finished output) is effective.

- If a further indexing incremental orientation is required, make **Mode_SW** ineffective, a moment later; make it effective, the spindle motor rotates to another incremental angle.
- If a further incremental fixed angular orientation is not required, make **Mode_SW** ineffective. The control process is similar to that of spindle orientation.

**Note**:

- Indexing incremental orientation for spindle encoder is based on the spindle encoder orientation, and it must be performed after the spindle encoder orientation is finished.
- The input switch **Mode_SW** is a dual-purpose terminal. In the orientation mode, when **ORN** (spindle orientation begins) is effective, it is an input terminal for indexing incremental orientation. In the non-orientation mode, when the **ORN** is ineffective, it is a switch input terminal for control mode switching.

## 7.3 Control Parameter Mode

Series HSV-180S spindle drive unit provides 16 control parameters, see Table 7-12. For the parameter operation, setting, modifying and saving, see 6.7 Control Parameter Operation, and 6.8 Control Parameter Modifying and Saving.

Table 7-16 Control Parameters

| NO. | Parameter | Function | Description |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 0 | STA-0 | Reserved | |
| 1 | STA-1 | This parameter is used to specify the direction of position command pulse or the inversion of speed command input. | **0**: Normal direction<br>**1**: Opposite direction of position command pulse or speed command. |
| 2 | STA-2 | This parameter is used to specify whether feedback break-off alarm is allowed. | **0**: Allow<br>**1**: Not allow |
| 3 | STA-3 | This parameter is used to specify whether system overspeed alarm is allowed. | **0**: Allow<br>**1**: Not allow |
| 4 | STA-4 | This parameter is used to specify whether position over-tolerance alarm is allowed. | **0**: Allow<br>**1**: Not allow |
| 5 | STA-5 | This parameter is used to specify whether system overload alarm is allowed. | **0**: Allow<br>**1**: Not allow |
| 6 | STA-6 | This parameter is used to specify whether the internal SVR-ON control start is allowed. | **1:** Allow<br>**0:** External enable |
| 7 | STA-7 | This parameter is used to specify whether system main power undervoltage alarm is allowed. | **1**: Not allow<br>**0**: Allow |
| 8 | STA-8 | This parameter is used to specify whether control mode switching is allowed. | **1**: Allow<br>**0:** Not allow |
| 9 | STA-9 | Reserved | |
| 10 | STA-10 | Reserved | |
| 11 | STA-11 | This parameter is used to specify whether spindle encoder A, B phase exchange is allowed. | **1**: Allow<br>**0:** Not allow |
| 12 | STA-12 | This parameter is used to specify whether motor overheat alarm is allowed. | **1**: Not allow<br>**0**: Allow |
| 13 | STA-13 | Command interface uses spindle encoder or spindle motor optic-electrical encoder to feedback. | **1**: Spindle encoder feedback<br>**0**: Spindle motor optic-electrical encoder feedback |
| 14 | STA-14 | This parameter is used to set the spindle orientation rotary | **1**: Reverse orientation (CW)<br>**0**: Forward orientation (CCW) |

| | | | |
|---|---|---|---|
| | | direction. | |
| 15 | STA-15 | This parameter is used to set the spindle encoder orientation or spindle motor optic-electrical encoder orientation | **1**: Spindle encoder orientation<br>**0**: Spindle motor optic-electrical encoder orientation |

# 8. Operation and Modification

| Caution |
| --- |
| ● The spindle drive and motor must be reliably grounded, and PE terminal must be connected with the grounded terminal of the equipment reliably.<br>● The power can be connected only after the wiring is correct.<br>● Emergency stop circuit must be provided to make sure the power could be stopped at once in case of emergency.<br>● If a drive alarm is reported, make sure the alarm is cleared and the spindle enable input signal (EN) is ineffective before restarting the drive unit.<br>● After the spindle drive and motor are power off, do not touch the spindle drive within 5 minutes to avoid electronic shock.<br>● Be cautious to prevent burning as the temperature may get higher after the spindle drive and motor running for a period of time. |

## 8.1 Power Connection

1. Power On Sequence

- Connect the main circuit power (three-phase AC 380 V) and external DC 24 V power supply. The digital tube of the spindle drive is light, spindle alarm (ALM) is disconnected, and the failure chain relay normally-open contact on interface XS5 closed. If an alarm is reported, power the spindle drive off and check the trouble.
- After 1 second, the spindle enable signal (EN) is received. If the spindle drive have no faults and the spindle enabling function is effective, the motor is activated and in the state for running. If an alarm is reported and the spindle enabling function is ineffective, the motor is idle. At this time, power off the main circuit power and check the trouble.

- In the external speed running mode (analog interface), the PC outputs the spindle forward (FWD) or spindle reverse (REW) control signal to spindle drive. And operate PC to send analog command to spindle drive. The motor runs according to the command.
- In the position running mode (pulse interface) or the external speed running mode (pulse interface), the PC sends pulse commands to the spindle drive. The motor runs according to the command.
- For the details, see the sequential diagram for power connection and alarm.

Figure 8-1 Sequential diagram for power connection (analog command)

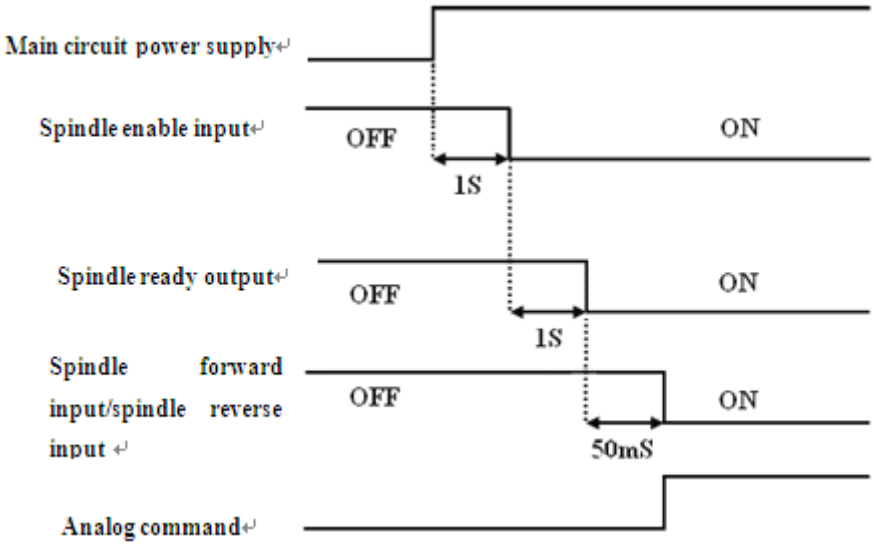



Figure 8-2 Sequential diagram for power connection (pulse command)

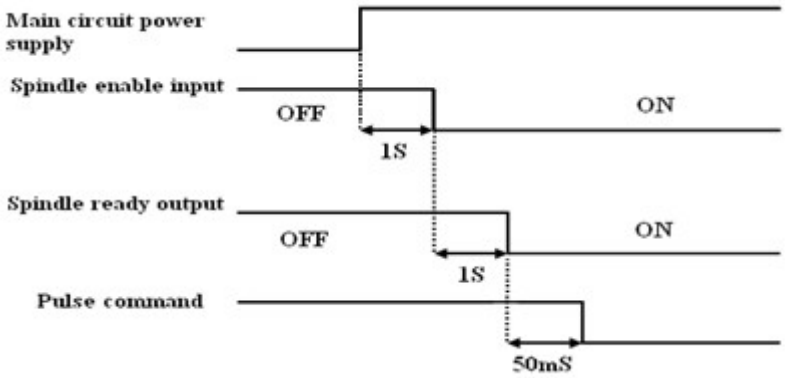
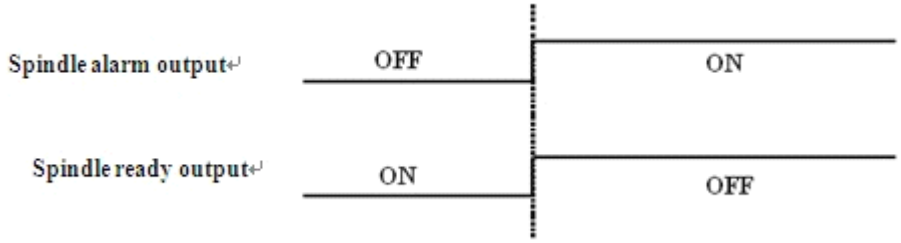



Figure 8-3 Sequential diagram for alarming




**Note:**

When a spindle drive alarm is reported, cut off the external control circuit power immediately based on the spindle alarm output signal (ALM) or the failure chain input/output terminal XS5.

2. Power Off Sequence

- Disconnect the main circuit power (three-phase AC 380 V) of the spindle drive. If the spindle enable signal (EN) keep outputting "ON" signal, **A-1** (indicates main power low-voltage) is displayed, the green enable light (EN) on the drive unit panel is off, and the red alarm light (AL) is on (indicates alarm).
- After disconnect the main circuit power, the internal capacitor storage energy of the spindle drive could not be released immediately. Do not connect nor disconnect wire within five minutes.
- Avoid frequently turning on and off the main circuit power in a short period of time, which may damage the soft-start circuit.

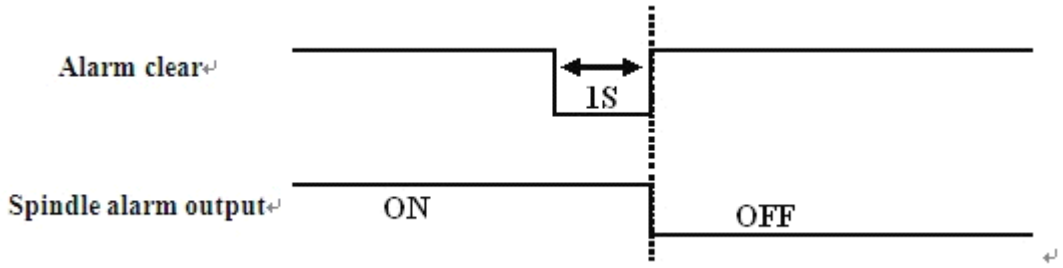
3. Alarm Clear

There are three methods to clear the alarm:

- Turn off the power (three-phase main power), after the fault source is cleared; repower the spindle drive to clear the alarm. (Some alarm can only be cleared by this method).
- Do not turns off the power, after the fault source is cleared, and enter the auxiliary mode to reset the internal alarm to clear the alarm. After the alarm is reset, the red alarm light is off (indicating the alarm is cleared), the spindle alarm (ALM) output is disconnected and the failure chain relay normally-open contact on the input/output terminal XS5 is connected.
- Do not turns off the power, after the fault source is cleared, reset the external

alarm to clear the alarm via the alarm clear input signal (ALM_RST), see Figure 8-4. After the alarm is reset, the red alarm light is off (indicates the alarm is cleared), the spindle alarm (ALM) output is disconnected and the failure chain relay normally-open contact on the input/output terminal XS5 is connected.

Figure 8-4 Sequential diagram for external alarm clear




## 8.2 Checking Before Running

After the installation and connection is completed, check the following items before power on:

1. Whether the strong power terminal (XT1) is correct and reliable? Whether the input voltage is correct? Whether the power lines or motor lines is short circuited or grounded.
2. Whether the encoder cable connection is correct?
3. Whether the control signal terminal connection is correct? Whether the polarity and size are proper?
4. Whether the spindle drive and motor are fixed firmly?
5. Whether the motor shaft is not connected to over-loading?

## 8.3 Trial Operation

### 8.3.1 JOG Running Mode

For wiring, see Figure 5-15 and Figure 5-16 in Chapter 5

1. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.

2. Set JOG running speed: Press M to select movement parameter mode. Press ↑ or ↓ to select the movement parameter **PA-21** (specifying JOG running speed), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to a non-zero value (unit: 1 r/min). Press S to return to the movement parameter mode.
3. Set the internal enable: Press M to select movement parameter mode. Press ↑ or ↓ to select the movement parameter **STA-6**(indicates the state for enable), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **1** (internal enable is allowed). Press S to return to the movement parameter mode. Save the parameter and disconnect the main circuit power (three-phase AC 380 V).
4. Connect the main circuit power (three-phase AC 380 V) of the spindle drive. If there are no alarms or abnormal situation, the green enable lamp (EN) is light, which indicates the drive is working properly. The motor is activated and in the zero speed state.
5. In the auxiliary mode, press ↑ or ↓ to select the JOG mode, and **JOG--** is displayed through the digital cube. Press S to enter into the JOG mode. **RUN--** is displayed through the digital cube. Press and hold ↑, the servo motor runs at the JOG speed. Release ↑, and then the motor stops and enters the zero-speed state. Press and hold ↓, the motor runs at the JOG speed in the opposite direction. Release ↓, and then the motor stops and enters the zero-speed state. The JOG speed is specified by the movement parameter **PA-21** (unit: 1 r/min).

### 8.3.2 Internal Speed Running Mode

1. For wiring, refer to Figure 5-15 and Figure 5-16 in Chapter 5
2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of spindle drive is on. If an alarm is reported, check the connection.
3. Set the internal enable: Press M to select control parameter mode. Press ↑ or ↓

to select the control parameter **STA-6** (indicates the state for spindle drive enable), and press S to enter the parameter setting mode, press ⇑ or ⇓ to set the parameter to **1** (internal enable is allowed). Press S to return to the control parameter mode.

4. Set the movement parameter **PA-23** to **3** (indicating the internal speed control mode) and set the movement parameter **PA-20** to **0** at first (indicates that the internal speed is 0 rpm).

5. Save the parameter settings to EEPROM.

6. Turn off the power, wait for 30 minutes, and then connect the power again.

7. If there are no alarms or abnormal situation, the green enable lamp (EN) is light, which indicates the spindle drive is operating normal. The motor is activated and in the zero speed state.

8. Set the movement parameter **PA-20** (internal speed). Press S to enter the parameter setting mode, press ⇑ or ⇓ to set the parameter to the running speed of the motor (unit: 1 r/min). Press S to confirm, and then the motor will run at the specified speed.

### 8.3.3 Position Running Mode (Pulse Interface)

1. For wiring, see Figure 5-15 in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ⇑ or ⇓ to select the control parameter **STA-6** (indicates the state for spindle drive enable), and press S to enter the parameter setting mode, press ⇑ or ⇓ to set the parameter to **0** (indicates that external enabling function is allowed). Press S to return to the control parameter mode.

4. Set the movement parameter **PA-23** to **0** (indicates the position running mode) and according to the controller signal output mode to set the movement parameter **PA-22** (indicates the command pulse input mode).

5. Save the parameter settings to EEPROM.

6. Turn off the power, wait for 30 minutes, and then connect the power again.

7. Verify no alarm or abnormal condition is reported. The green enable lamp (EN) is on, which indicates the spindle drive is working properly. The motor is activated and in the zero speed state.

8. PC sends pulse command to the 14,15,16,17 pins on the command input/output interface XS4. The motor runs according to the command.

### 8.3.4 External Speed Running Mode (Analog interface)

1. For wiring, see Figure 5-16 in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-6** (indicates that external enabling function is allowed), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.

4. Set the control parameter **PA-23** to **1** (indicates the speed running mode). According to the actual requirement, set the movement parameter **PA-7** (indicates the speed command input gain) and **PA-8** (indicates the speed command zero drift compensation).

5. Save the parameter settings to EEPROM.

6. Turn off the power, wait for 30 minutes, and then connect the power again.

7. If there are no alarms or abnormal situation, the green enable light (EN) is on which indicates the spindle drive working properly. The motor is activated and in the zero speed state.

8. Use PC outputs forward or reverse control signal to the third pin (FWD) and the forth pin (REW) and outputs analog signal to the 27, 28, 12, 13 pin (GNDAM, AN+, AN-) on the command input/output interface XS4. The motor rotate forward or reverse.

### 8.3.5 External Speed Running Mode (Impulse interface)

1. For wiring, see Figure 5-17 in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the drive unit; and then the display of drive unit is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-6** (indicates the state for servo enable), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.

4. Set the control parameter **PA-23** to **2** (indicates the speed running mode). According to the controller output signal mode, set the movement parameter **PA-22** (indicates the command pulse input mode).

5. Save the parameter settings to EEPROM.

6. Turn off the power, wait for 30 minutes, and then connect the power again.

7. If there are no alarms or abnormal situation, the green enable light (EN) is on, which indicates the spindle drive is working properly. The motor is activated and in the zero speed state.

8. The PC sends pulse command to the 14,15,16,17 pins on the command input/output interface XS4. The motor runs according to the command.

### 8.3.6 Spindle Orientation

1. For wiring, see Figure 5-16, Figure 5-17 Standard wiring diagram for external speed control mode or Figure 5-18, Figure 5-19 Standard wiring diagram for the switching between external speed control mode and position control mode or Figure 5.20 Standard wiring diagram for spindle encoder in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-6** (indicates the state for enabling), and

press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.

4. Set the control parameter **PA-23** to **1** or **2** (indicates the speed running mode).

5. According to the actual operation, set the movement parameter **PA-37**, **PA-38**, **PA-39**, **PA-47**.

6. According to the actual operation, set the control parameter **SET-13**, **SET-14**, **SET-15**.

7. Save the parameter settings to EEPROM.

8. Turn off the power, wait for 30 minutes, and then connect the power again.

9. If there are no alarms or abnormal situation, the green enable light (EN) is on which indicates the spindle drive is working properly. The motor is activated and in the zero speed state.

10. Output the control signal for spindle orientation begins to the 25 pin (ORN) on the XS4 command input/output interface. The spindle motor orientate at the preset spindle orientation speed. When the deviation between the actual position and preset orientation position is equal or less than the preset range for spindle orientation finished, the 30 pin (ORN_FIN) on the XS4 outputs signal for spindle orientation finished. When the output signal is absent, the state of spindle orientation is finished.

### 8.3.7 Spindle Indexing Incremental Orientation

1. For wiring, see Figure 5-16, Figure 5-17 Standard wiring diagram for external speed control mode or Figure 5-18, Figure 5-19 Standard wiring diagram for switching between external speed control mode and position control mode or Figure 5-20 Wiring diagram for spindle encoder in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-6** (indicates the state for enabling), and

press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.

4. Set the control parameter **PA-23** to **1** or **2** (indicates the control mode selection).

5. According to the actual operation, set the movement parameter **PA-37**, **PA-38**, **PA-39**, **PA-40**, **PA-47**.

6. According to the actual operation, set the control parameter **SET-13**, **SET-14**, **SET-15**.

7. Save the parameter settings to EEPROM.

8. Turn off the power, wait for 30 minutes, and then connect the power again.

9. If there are no alarms or abnormal situation, the green enable light (EN) is on, which indicates the spindle drive working properly. The motor is activated and in the zero speed state.

10. Output the control signal for the indexing incremental orientation ratio to the 19 PIN (INC_Sel1) and the 21 PIN (INC_Sel2) to determine the ratio. Output the control signal for spindle orientation begins to the 25 pin on XS4. The spindle motor orientates at the preset spindle orientation speed. When the deviation between the actual position and the preset orientation position is equal or less than the preset range for spindle orientation finished, the 30 pin (ORN_FIN) on the XS4 outputs signal for spindle orientation finished.

11. Output the control signal for indexing incremental orientation to the 26 pin (Mode_SW) on the XS4 and the indexing incremental orientation is begin. When the orientation is finished, the 30 pin (ORN_FIN) on XS4 outputs spindle orientation finished signal. When the control signal for orientation begin (ORN) is absent, the state of spindle indexing incremental orientation is finished.

### 8.3.8 Switching Between External Speed Running Mode (Analog Interface) and Position Running Mode

1. For wiring, see Figure 5-18 in Chapter 5.

2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive.

The display of the spindle drive is on. If an alarm is reported, check the connection.

3. Set the external enable: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-6** (indicates the state for enable), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.

4. Set the control mode switching: Press M to select control parameter mode. Press ↑ or ↓ to select the control parameter **SAT-8** (indicates control mode switching), and press S to enter the parameter setting mode, press ↑ or ↓ to set the parameter to **1** (control mode switching is allowed). Press S to return to the control parameter mode.

5. Set the movement parameter **PA-23** to **1** (indicating speed running mode). According to the actual requirement, set the movement parameter **PA-7**, **PA-8**, and **PA-22**.

6. According to the controller output signal mode, set movement parameter **PA-22** (indicates the command pulse input mode).

7. Save the parameter settings to EEPROM.

8. Turn off the power, wait for 30 minutes, and then connect the power again.

9. If there are no alarms or abnormal situation, the green enable light (EN) is on, which indicates the spindle drive is working properly. The motor is activated and in the zero speed state.

10. Switching between external speed running mode (analog interface) and position running mode is controlled by the 26 pin (Mode_SW) on interface XS4 (indicating the switch input for control mode switching). When the **Mode_SW** is **OFF**, the spindle runs under the analog speed mode. Use PC to output forward or reverse control signal to the third pin (FWD)and the forth pin(REW) on XS4 and output analogue signal to the 27, 28, 12, 13 pin (GNDAM, AN+, AN-)on XS4. The motor rotates forward or reverse. When the **Mode_SW** is **ON**, the spindle runs under the position running mode. Operate PC outputs pulse command to the 14, 15, 16, 17 pin (CP+, CP-, DIR+, DIR-) on the XS4 interface. The motor runs

according to the command.

### 8.3.9 Switching Between External Speed Running Mode (Pulse Interface) and Position Running Mode (Pulse Interface)

1. For wiring, see Figure 5-19 in Chapter 5.
2. Connect the main circuit power (three-phase AC 380 V) of the spindle drive; and then the display of the spindle drive is on. If an alarm is reported, check the connection.
3. Set the external enable: Press M to select control parameter mode. Press ⇑ or ⇓ to select the control parameter **SAT-6** (indicates the state for enable), and press S to enter the parameter setting mode, press ⇑ or ⇓ to set the parameter to **0** (external enable is allowed). Press S to return to the control parameter mode.
4. Set the control mode switching: Press M to select control parameter mode. Press ⇑ or ⇓ to select the control parameter **SAT-8** (indicates control mode switching), and press S to enter the parameter setting mode, press ⇑ or ⇓ to set the parameter to **1** (control mode switching is allowed). Press S to return to the control parameter mode.
5. Set the movement parameter **PA-23** to **1** (indicates speed running mode).
6. Based on the PC output pulse command mode, set the movement parameter **PA-22** (indicates the command pulse input mode)
7. Save the parameter settings to EEPROM.
8. Turn off the power, wait for 30 minutes, and then connect the power again.
9. If there are no alarms or abnormal situation, the green enable light (EN) is on, which indicates the spindle drive is working properly. The motor is activated and in the zero speed state.
10. Switching between external speed running mode (analog interface) and position running mode is controlled by the 26 pin (Mode_SW) on interface XS4 (indicates the switch input for control mode switching). When the **Mode_SW** is **OFF**, the spindle runs under the external speed mode. Use PC to output pulse command to the14, 15, 16, 17 pin (CP+, CP-, DIR+, DIR-) on XS4. The motor runs according to the command. When the **Mode_SW** is **ON**, the spindle runs

under the position running mode. Use PC to output pulse command to the 14, 15, 16, 17 pin (CP+, CP-, DIR+, DIR-) on the interface XS4. The motor runs according to the command.

# 9. Fault Troubleshooting

| Caution |
| --- |
| ● Maintenance personnel must have related knowledge and abilities.<br>● Do not touch the spindle drive or motor within five minutes after power-off to prevent electric shock or burns.<br>● If a spindle drive alarm is reported, do not use the spindle drive only after the alarm is cleared based on the alarm code.<br>● Before the alarm reset, make sure that the EN signal is ineffective to prevent accidents caused by a sudden start. |

## 9.1 Protection and Fault Identification

1. Series HSV-18S of spindle drive provides 16 different protection functions and fault identification. If one protection function is activated, alarm information can be displayed through the digital tube on the spindle drive panel, the spindle alarm output (ALM) is connected, and the failure chain relay normally-open contact on the input/output terminal XS5 is disconnected.
2. It is required to connect the alarm output (ALM) or XS5 terminal to the PC. When the protection function of the spindle drive is activated, the PC can promptly take emergency measures.
3. After the fault source is cleared, you can turn off three-phase main power, and then the repower the spindle drive to clear the alarm, or enter the auxiliary mode to reset the internal alarm to clear the alarm, or reset the external alarm to clear the alarm via the alarm clear input signal (ALM_RST).
4. The protection function with "*" cannot be cleared by resetting the external or internal alarm. It can only be cleared by cutting off the power, and then repower the spindle drive after the fault source is cleared.

Table 9-1 Alarm information

| No. | Alarm Type | Description | |
| --- | --- | --- | --- |
| 1 | A-1 | Under-voltage | The three-phase main voltage is less than |

| | | | |
|---|---|---|---|
| | | supply | AC 200 V |
| 2 | A-2 | Over-voltage supply | The three -phase main voltage equal or is greater than AC 560 V |
| *3 | A-3 | Inverter fault | An inverter power part fault occurs. |
| 4 | A-4 | Brake fault | Overworking of the brake circuit that causes the fault |
| 5 | A-5 | Spindle drive overheat | The radiator temperature exceeds the specified maximum temperature. |
| 6 | A-6 | Spindle motor overheat | The spindle motor temperature exceeds the specified maximum temperature. |
| 7 | A-7 | Feedback line disconnection | The spindle motor encoder feedback line is disconnected. |
| 8 | A-8 | Orientation fault | The spindle orientation is unfinished. |
| 9 | A-10 | Over current fault | The winding current of the spindle motor is too large. |
| 10 | A-11 | Spindle motor over-speed | The speed of the spindle motor exceeds the specified maximum speed. |
| 11 | A-12 | Overlarge speed deviation | The value of speed steady-state error exceeds 25% of the specified speed. |
| 12 | A-13 | System overload | The spindle motor load exceeds the specified maximum over current. |
| *13 | A-14 | System parameter error | The parameters saved in EEPROM are incorrect. |
| *14 | A-15 | Control panel circuit fault | A control panel element or soldering fault occurs. |
| *15 | A-16 | DSP fault | A control program execution fault occurs, |

**Version history of HSV-180S spindle drive**:

1. Series HSV-180S spindle drive User's Manual V1.0 2010.1

a. Applicable to HSV-180S-025, 035, 050, 075 spindle drive

b. Software version V 3.5

2. Series HSV-180S spindle drive User's Manual V2.0 2010.11

a. Applicable to HSV-180S-025, 035, 050, 075 spindle drive.

b. Software version V 3.5

c. Remove the control power AC220 V; modify the wiring diagram, sequential diagram and the corresponding description.