Century Star HNC-180 series

HNC-180xp/T3

HNC-180xp/M3

HNC-180GCE

Connection Manual

V2.0

2015/05

Table of Contents

1 Precaution

1.1 Transportation and Storage


The product should be transported properly according to its weight.


The number of stacked products must not be more than what stipulated.


Do not climb up or stand on the product. Do not stack heavy things on it.


Dragging its cable to move or lift the product is not allowed.


Protect the front panel and screen from impact and cut.


Keep damp-proof while storing and transporting.


Let us know in time if the product has been stored overtime.

1.2 Inspection

- Check if the product is what the operator ordered.
- Check if there is damage of the product during the transportation.
- Comparing to the list, check if all the components are complete.
- Please contact us in time if the product type is wrong, lack of accessories or damaged during the transportation.

1.3 Installation and Wiring

Workers undertaking wiring or inspection must be qualified to do the jobs.

The NC device must be grounded reliably. The earth-resistance must be less than 4 ohm. Do not take the neutral as a ground. Otherwise, the system may not work normally and stably because of interference.

Installation and wiring shall be correct and firm to avoid wrong operation.

Any voltage at terminals must have its correct value and polarities (+, -) as mentioned in the manual. Otherwise, the short circuit or permanent damage to the machine may occur.

The surge-absorbed diode connected to NC device must be wired as shown in Figure 1-1 to prevent the damage to device.

It is absolutely not allowed to insert or pull out any plug or open the NC cabinet door with the power supply on.

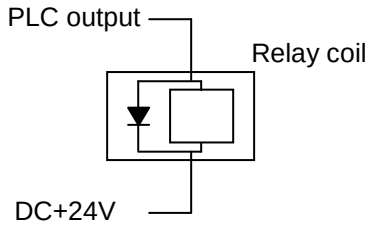


Figure 1-1 surge-absorbed diode

1.4 Operation and Maintenance

Personnel to operate and maintain the device must be competent for their work.

Before plugging in to get the main source, make sure that the main switch is off to avoid accidental start-up.

Do not refit the device.

Do not turn on and off the system frequently. The interval between on and off operations must be at least 3 minutes.

The operator's hands must be kept dry, clean and no greasy dirt during operation. It is suggested to keep the clear protection film on the panel.

Do not press the keys hard. It is not allowed to strike at the keyboard with wrench or other sharp-edged and hard articles.

Operators shall not leave the machine while operating the devices.

Power supply shall be turned off before checking, replacing or installing parts or elements.

When short-circuit or overload happens, do not turn on the power again unless checking and fixing the breakdown.

When alarm has happened, do not restart the device unless the accident is cleared off.

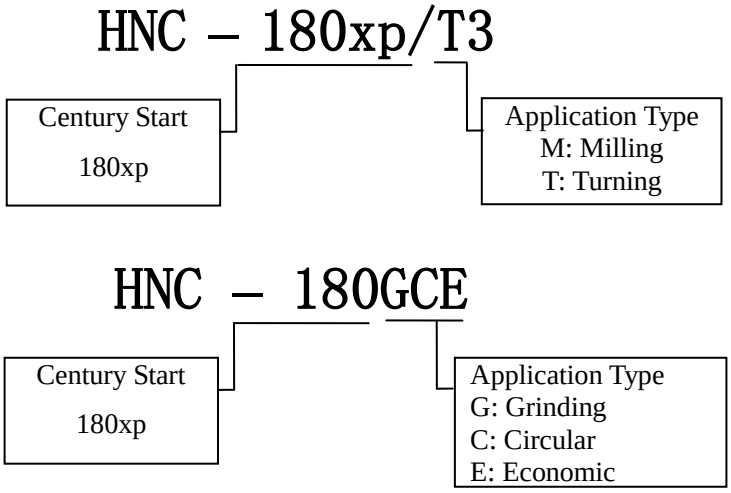
Do not install or operate the device if it is damaged or lack of parts and elements.

2 Installation

2.1 Connection

2.1.1 NC Device Type

Specification of NC device:



2.1.2 Total Connection Diagram

This section shows the total connection diagram of HNC-180.

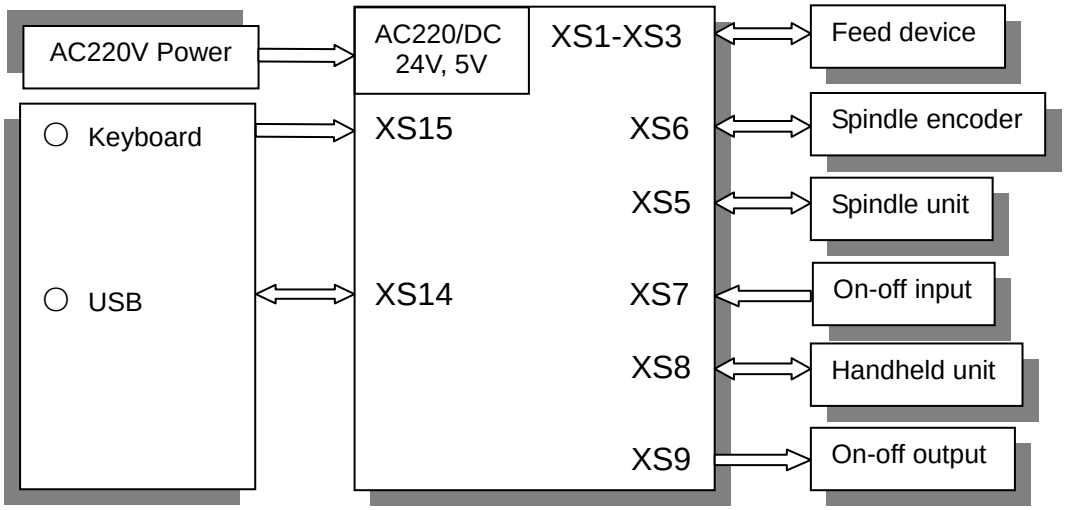


Figure 2-1 Total Connection Diagram

Note:

(1) Interfaces are all optional except that of power supply.

(2) As it is shown Figure 2-1, HNC-180 controls various types of feed units through XS1-XS3.

(3) The type of feed units can be same or not. Up to three feed axes can be connected.

2.2 Dimension

This section shows the interface of HNC-180.

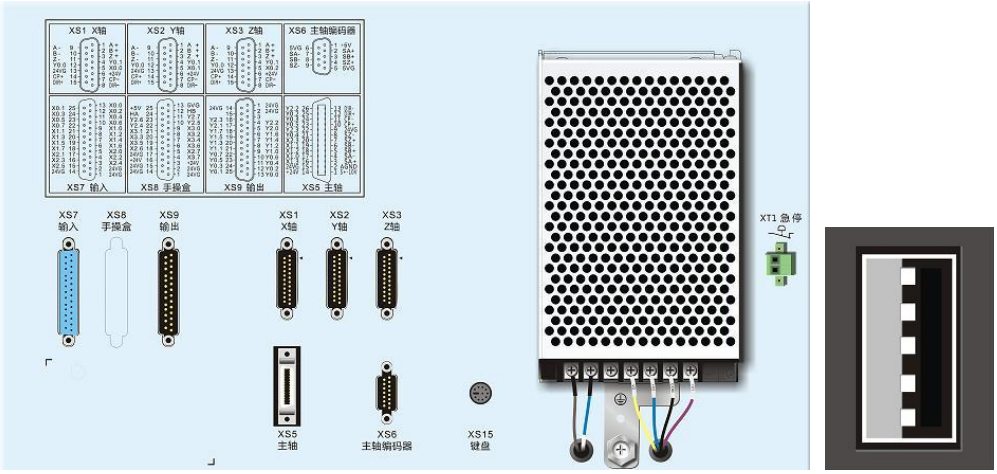


Figure 2-2 Interface of HNC-180

XS1, XS2, XS3: feed axis control interface

XS5: spindle control interface

XS6: spindle encoder interface

XS7: PLC input interface

XS8: handheld unit interface

XS9: PLC output interface

XS14: USB interface

XS15: keyboard interface

XT1: Emergency stop

2.3 Power Supply Connection

2.3.1 General Requirement

NC device: AC220V 50W, or DC24V/5V;

Cables: Shielded cables or twisted cables;

PLC power: If DC24V power supply is adopted, the power capability depends on PLC bits and the number of components with DC24V, such as relay, electromagnetic valve etc. It is noted that PLC power must be grounded with the signal of PLC interface of NC device. If DC24V power supply is required for brake on Axis Z and electromagnetic valve, it is better not to share the power with **PLC power** preventing the interference from the electromagnetic valve.

As it is shown in Figure 2-3, XS1, XS2, XS3 provides DC24V power supply to PLC on-off components of feed devices. XS6 provides DC5V power supply to spindle encoder. XS5 provides DC24V power supply to PLC on-off components of spindle unit. XS8 provides DC24V and DC5V power supply to PLC on-off components of handheld unit and manual pulse generator, respectively.

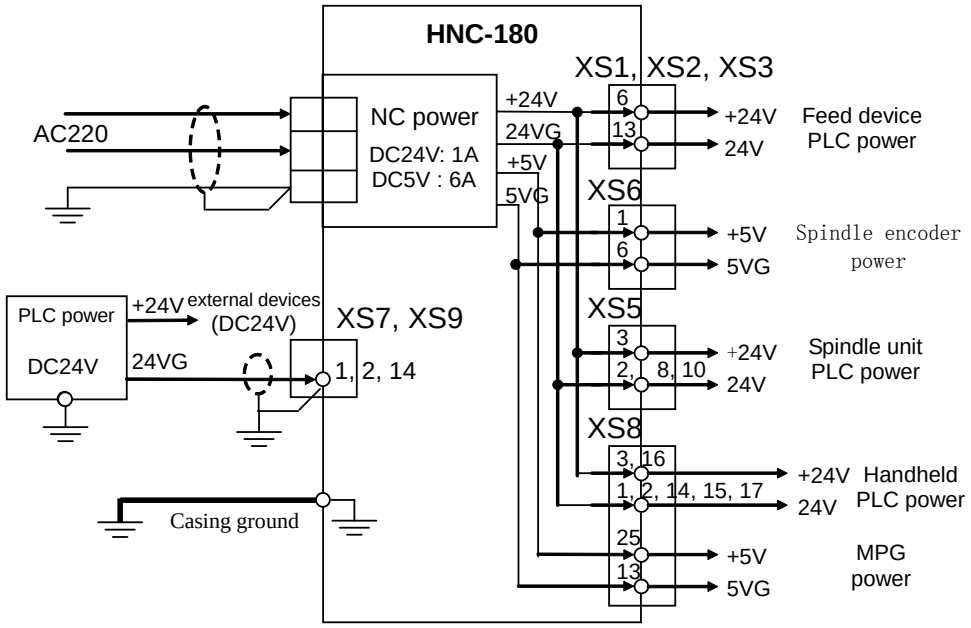


Figure 2-3 Power supply of HNC-180

The power of NC device is only 75W. Respectively, DC24V and DC5V provide 1A output and 6A output. It can only provide DC24V 1A and DC5V 1A to XS1, XS2, XS3, XS4, XS5, XS7. Please use additional power supply grounded with NC power, if the power of the mentioned interfaces of the connected devices is higher than NC power.

2.3.2 Grounding

- **Protective Grounding**

The ground wire of power supply is connected with PE interface of NC device. An additional copper ground wire at least 2.5 mm^2 shall be taken as the ground wire and connected with PE interface of NC unit, since the ground wire of the power cable is thin.

- **Signal Grounding**

As it is shown in Figure 2-3, the ground wire of external PLC power supply shall be connected with pin 1, 2, and 14 on XS7 and XS9. Otherwise, NC unit cannot control those components or receive signals by on-off outputs.

2.4 Installation Requirements for Cabinet

- The cabinet must prevent from dust, coolant and organic liquor.
- In the design of cabinet, the distance between the rare cover of CNC device and case should not be less than 20cm. Ensure that the temperature difference of case should not be higher than 10°C, when the temperature in the cabinet is climbing up.
- Install a fan in the cabinet to guarantee the ventilation.
- The display panel must install where the coolant cannot be sprayed.
- Try to reduce the external electric interference sending to CNC device as much as possible.

2.5 Design of Electromagnetic Compatibility

NC device shall be accorded with the requirement of electromagnetic compatibility in GB8832-1999.5 “The general-purpose technical conditions for NC system design”.

Electromagnetic Compatibility (EMC) refers to

- EMC level of electrical equipments shall not be higher than the permitted level in the expected working environment.
- The anti-interference ability of device shall be strong enough to ensure working normally in the expected working environment.

Based on the design of EMC, the following steps must be applied to ensure the product reliability:

- Keep away from the devices producing the interference.
- Use the isolated transformer for power supply.
- The components in the cabinets should be **installed and wired separately by the strong or weak power**.
- **The shield should be grounded** at the entrance into the cabinet.
- **The power cables and feedback cables** of drive motors and spindle drive motors are **directly connected to drive units**, skipped the terminals.
- Use **the shielded cables** for the signal wires, such as position feedback wires, command given wires, and communication wires. The cross section area of every single lead shall not be less than 0.2 mm^2. It is better to use the **double-twisted, double-shielded cables**.
- **Multi-core and twisted are all used** in the power lines of on-off terminal boards and encoder feedback shielded cables to improve the interference capability of components.
- The shell of components must be grounded reliability.

3 Interfaces

3.1 Connection to Drive Units

HNC-180 contains the axis control interface with pulse+direction, bidirectional pulse, or hermite pulse, and feedback interface to control the servo drive and step drive unit.

3.1.1 Interface Description of XS1, XS2, XS3

The pulse interface uses pulse signal and sends position command to control different kinds of step motor drive and servo drive with pulse interface. It is characterized as universal interfaces, strong anti-interference ability, and zero drift. However, the closed loop should be done in drive unit.

There are three pulse axis interfaces (XS1, XS2, and XS3) on HNC-180.

(1) Signal Definition

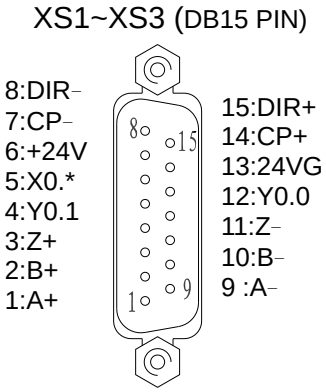


Figure 3-1 Interface of XS1~XS3

Table 3-1 Description of XS1~XS3

Signal	Description
A+, A-	feedback signal of encoder phase A
B+, B-	feedback signal of encoder phase B
Z+, Z-	feedback signal of encoder pulse Z
+24V, 24VG	Power output DC24V(it is to supply the power for I/O on servo.)
Y0.0	reset (logic Address:Y0.0)
Y0.1	enabled (logic Address:Y0.1)
X0.*	*: 0, 1, 2 stand for axis X, Y, and Z axis are ready respectively.
CP+, CP-	command pulse output (phase A)
DIR+, DIR-	command directional output (phase B)

(2) Technical Specification

- Maximum pulse frequency: 800KHZ
- 24V power supply: 200mA
- Encoder signal: RS422 level

(3) Equivalent circuit

- Pulse command output

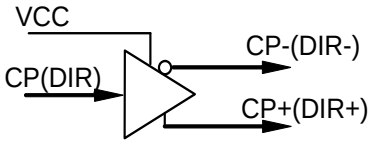


Figure 3-2 Pulse command output of equivalent circuit

- Encoder Input

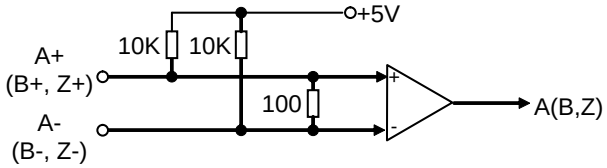


Figure 3-3 Encoder input of equivalent circuit

(4) Pulse type

The type of pulse output (pulse+direction, bidirectional direction, and alternating pulse) can be set by parameters. For more detailed information, please refer to Chapter 4.

Table 3-2 Pulse Type

Pulse Type	CP	DIR
mode 1: pulse+direction pulse	pulse	direction
mode2: bidirectional pulse	positive pulse	negative pulse
mode3: hermite pulse	phase A	phase B

3.1.2 Connection to Stepper Motor Drive Unit

Up to three step motor drives can be connected to HNC-180 through XS1~XS3. Figure 3-4 shows the overall connection to step motor drive.

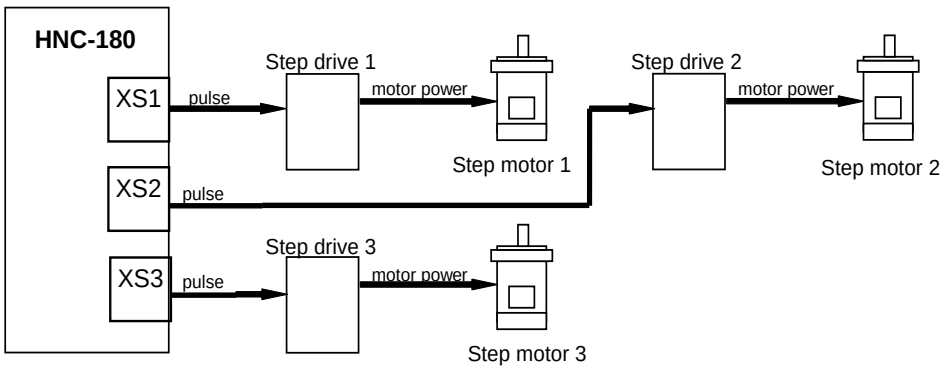


Figure 3-4 Overall connection to step motor drive

Figure 3-5 shows an example of the connection to SH-50806A (five phases mixed step motor).

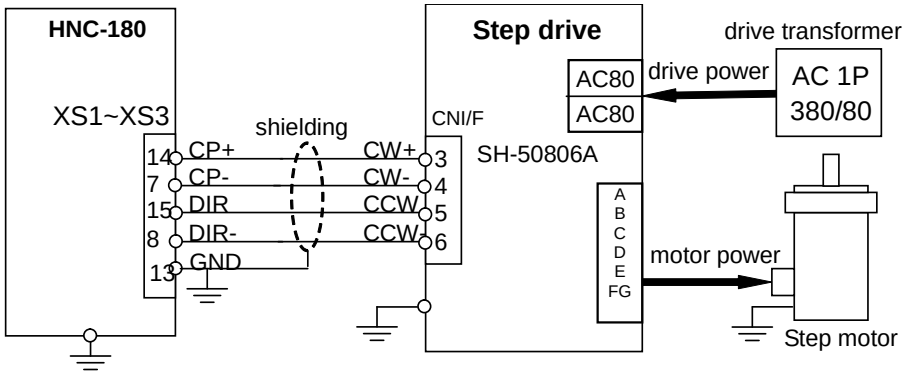


Figure 3-5 Connection to SH-50806A

The other types of step drive can be connected to HNC-180 through I/O. For the detailed connection, please refer to the relevant manual of drive. If DC24V is independent, it shall be grounded with I/O of DC power. A relay is required if I/O interfaces of step motor drives and NC unit are not matched (the type of NC PLC interface is NPN).

When using step motor, the operator can use the following table to set the parameters. For detailed information, please refer to Chapter 4 and Chapter 5.

Table 3-3 Parameters related to stepper motor

Parameter	Description	Value
Stepper motor type	45: with feedback; 46: without feedback	45/46
Shoot of Stepper Motor	Actual shoot of stepper motor	4, 6, 10…
Stepper motor	0: no; 1: yes	0, 1

3.1.3 Connection to Servo with Pulse Interface

Up to three servos can be connected to HNC-180 through pulse interface of XS1~XS3. Figure 3-6 is the overall connection between NC device and servo with pulse interface. Figure 3-7 and 3-8 are the two examples of connection to servo with pulse interface.

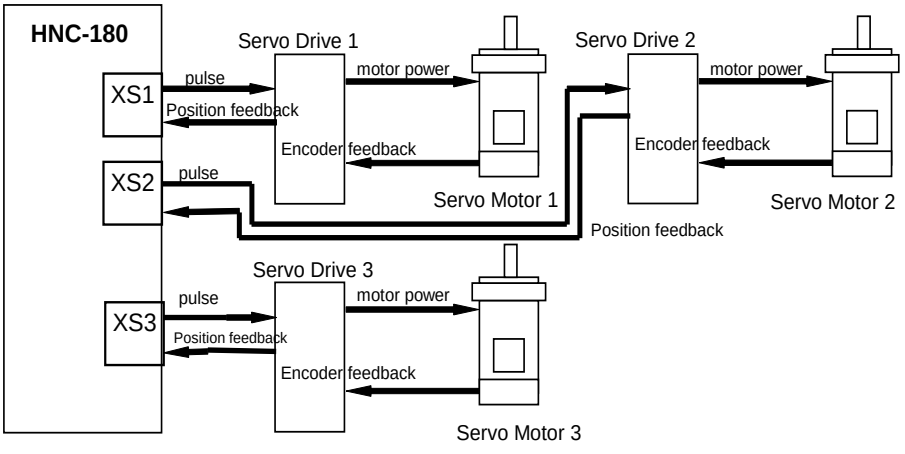


Figure 3-6 Overall connection between NC device and Servo with pulse interface

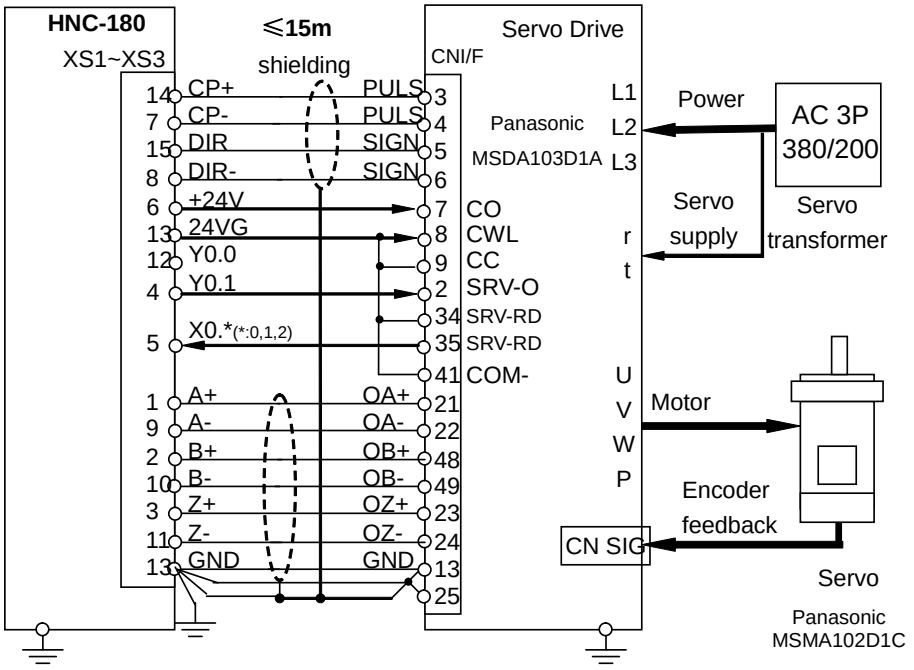


Figure 3-7 Connection to Panasonic MINAS A series

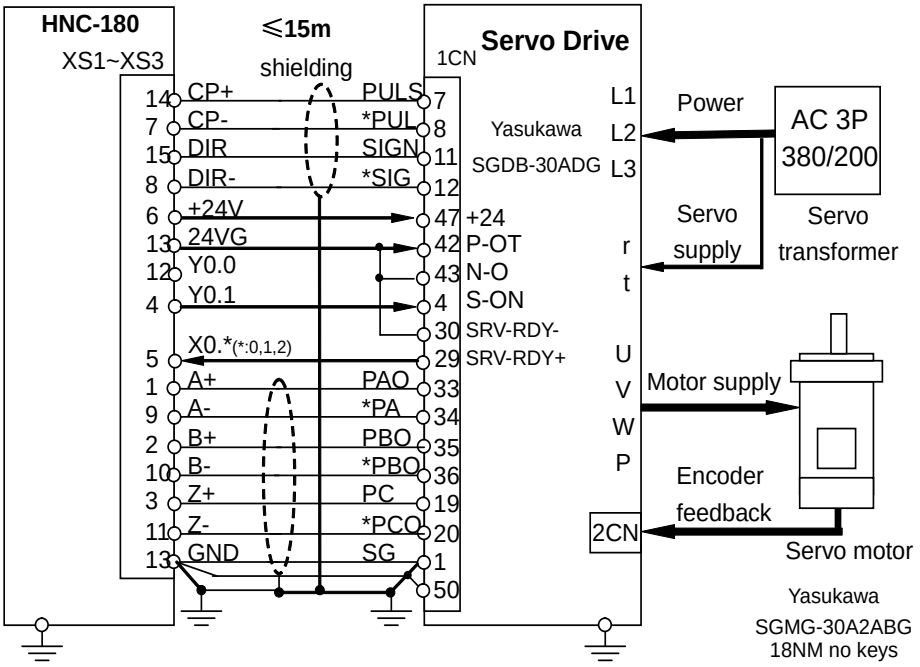


Figure 3-8 Connection to Yasukawa SGDB

The following list is the basic conceptions related to servo with pulse interface:

1. Position closed loop is constructed within servo driver rather than NC device.
2. Position feedback signals of pulse interfaces are only used for position monitoring, not for position closed loop.
3. To construct fully closed loop control, a servo driver with fully closed loop interface must be used.

4. Servo controller parameters should be set in servo driver. Please refer to the related manuals of the servo driver.

The following table is the list of parameters related to servo with pulse interface. For more detailed information, please refer to Chapter 4 and Chapter 5.

Table 3-4 List of parameters related to servo with pulse interface

- **Machine Parameters**

Parameter	Description	Value
Pulse output	0: unidirectional pulse, 1: bidirectional pulse, 2: Hermite pulse It shall be consistent with the setting of servo drive.	0/1/2 [10000] (default)

- **Servo Parameters**

Parameter	Description	Value
Servo type	45: with feedback 46: without feedback	45/46
Maximum Track Error	It is used in the alarm message--"too much track error" (unit: μm). If the value is 0, it means that this alarm function is deactivated. It is used according to the highest speed and the lag performance of servo loop. In general, the following formula is used: max.speed*(10000-position.loop.feedforward.coefficients*0.7)/proportion coefficients of velocity loop/3.	0~65535 [12000] (default)
Motor revolution	It refers to the number of pulses which NC can get from each revolution of the motor. It is usually set as pulses of position encoder of servo motor * 4.	0~65535 [10000] (default)
E-gear(NC) E-gear(Servo)	$\frac{E-gear(NC)}{E-gear(Servo)}=\frac{NC\,command}{Servo\,feedback}$	0~65535 [4:1] (default)
Stepper motor	0: no 1: stepper motor	0/1

- **Axis Parameters**

Parameter	Description	Value
Positioning tolerance	It refers to the maximum offset when setting C.S. (unit: μm). It depends on the motor size, the performance and load of drive unit. It is usually 10~50. If this parameter is too small, the system would be held. If it is too large, the machining precision would be affected. Generally, the bigger the machine, this value is larger. The worse the precision and transmission, the value is larger. If the stepper motor is used, this value can be set as integral times each step's pulses. If this value is less than backlash, the system would be held when the axis is moving backwards.	0~100 [20] (default)

3.2 Connection to Spindle device

Different kinds of spindle can be connected to HNC-180 by XS5 to implement CW rotation, CCW rotation, spindle orientation, speed regulation. Spindle encoder can also be connected by XS6 to implement threading of turning and grid tapping of milling.

3.2.1 Relevant Interfaces

3.2.1.1Spindle Interface XS5

As it is shown in Figure 3-9, XS5 includes the outputs of spindle speed analog voltage and PLC I/O.

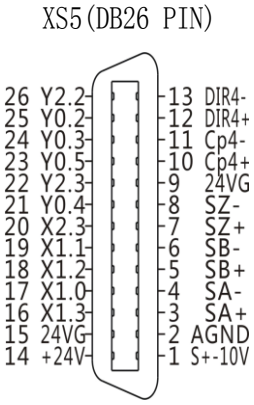


Figure 3-9 Interface of XS5

Table 3-5 Description of XS5

Signal	Description	
	Turning	Milling
+24V, 24VG	PLC power DC24V	PLC power DC24V
X1.0	Tool 1	Spindle orientation done
X1.1	Tool 2	Spindle speed arrived
X1.2	Tool 3	Zero spindle speed
X2.3	Spindle alarm	Spindle alarm
Y0.2	Spindle CW rotation	Spindle CW rotation
Y0.3	Spindle CCW rotation	Spindle CCW rotation
Y0.4	Spindle Mode Switch	Spindle Mode Switch
Y0.5	U6	Spindle orientation
Y2.2	Spindle Reset	Spindle Reset
Y2.3	Spindle Enabled	Spindle Enabled
A+, A-	Feedback signal of phase A	Feedback signal of phase A
B+, B-	Feedback signal of phase B	Feedback signal of phase B
Z+, Z-	Feedback signal of phase Z	Feedback signal of phase Z
CP+, CP-	Command pulse output (phase A)	Command pulse output (phase A)
DIR+, DIR-	Command pulse output (phase B)	Command pulse output (phase B)
AOUT	Spindle analog command: -10~+10V output	
GND	Analog output grounding	

The characteristics of interface:

- PLC I/O

This PLC I/O is connected to the same name of I/O on XS7 and XS9 in parallel. For more information, please refer to section 3.4.

- Spindle speed analog voltage output

  Voltage: -10V~+10V

  Load current: max. 10mA

The following table shows some I/O related to spindle gear control, which are on XS7 (PLC input) and XS9 (PLC output).

Table 3-6 I/O related to spindle gear control

Signal	Description		Interface	Pin
	Milling	Turning		
Inputs				
X1.0	Spindle orientation done	Tool 1	XS7	9
X1.1	Spindle speed arrived	Tool 2		21
X1.2	Spindle zero speed	Too 3		8
X1.3	Spindl ready	Tool 4		20
Outputs				
Y0.2	Spindle CW rotation	Spindle CW rotation	XS9	12
Y0.3	Spindle CCW rotation	Spindle CCW rotation		24
Y0.4	Spindle mode switch	Spindle mode switch		11
Y0.5	Spindle orientation	U6		23

3.2.1.2Spindle Encoder XS6

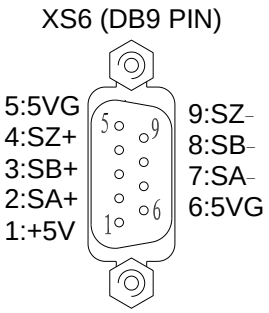


Figure 3-10 Interface of XS6

Table 3-7 Description of XS4

Signal	Description
SA+, SA-	Spindle encoder phase A signal
SB+, SB-	Spindle encoder phase B signal
SZ+, SZ-	Spindle encoder pulse Z signal
+5V, 5VG	Power DC5V

The characteristics of interface:

- Interface of spindle encoder

  Power: +5V, max. 200mA

  Encoder signal: RS422 level

3.2.2 Spindle Start and Spindle Stop

The spindle start and stop are controlled by PLC. Y0.2 and Y0.3 are to control spindle CW/CCW rotation and stop. In general, it is activated by connection. If Y0.2 is on, the operator can control the spindle CW rotation. If Y0.3 is on, the spindle CCW rotation can be controlled. If none of them is on, the spindle stops rotation.

The direction of some spindle rotation depends on the polarity (positive/negative) of spindle speed signal. In this case, Y0.2 (spindle CW signal) can be used as spindle enabled control, and the spindle CCW signal is not used.

Some spindle unit contains X1.1 (spindle speed arrived) and X1.2 (zero spindle speed), so that it can monitor the spindle rotation in PLC. For the turning machine, the spindle encoder is used to monitor the spindle rotation.

3.2.3 Spindle Speed Control

Analog output (AOUT) in XS5 is to control spindle revolution. The output range is -10V~+10V. Y0.2 and Y0.3 control the direction of spindle rotation.

3.2.4 Spindle Orientation Control

In the milling machine, spindle orientation function is implemented by the spindle drive units with spindle orientation function. Y0.5 is spindle orientation command, and X1.0 is the signal when spindle orientation is done.

3.2.5 Spindle Gear Control

Spindle gear can be controlled by PLC. Please refer to Table 3-6.

3.2.6 Connection to Spindle Encoder

The spindle encoder can be connected by XS5 to implement thread cutting, tapping etc. Two types of spindle encoder can be used: the difference TTL square-wave, and single-polar TTL square-wave.

Generally, the difference encoder is recommended to ensure the reliability during long-distance transmission and anti-interference ability. For the detailed connection, please refer to section 3.2.1.2.

The specification of spindle encoder:

- +5V power (within 200mA, use external power supply if it is higher than 200mA)
- TTL level output
- Difference o utputs: A, B, Z

3.2.7 Connection Example—Three-phase Asynchronous Motor

If the asynchronous motor without regulation device is taken as spindle motor, the spindle rotation (CW and CCW) and stop can be controlled by the outputs of NC device with the help of the relay and contact. As it is shown in Figure 3-11, KA3 and KM3 are to control the motor CW rotation. KA4 and KM4 are to control the motor CCW rotation. Spindle gear can be added to implement step speed regulation. An external spindle encoder can be used to implement thread cutting or grid tapping.

Note: The single-phase arc-extinguisher of contact is not shown in the figure.

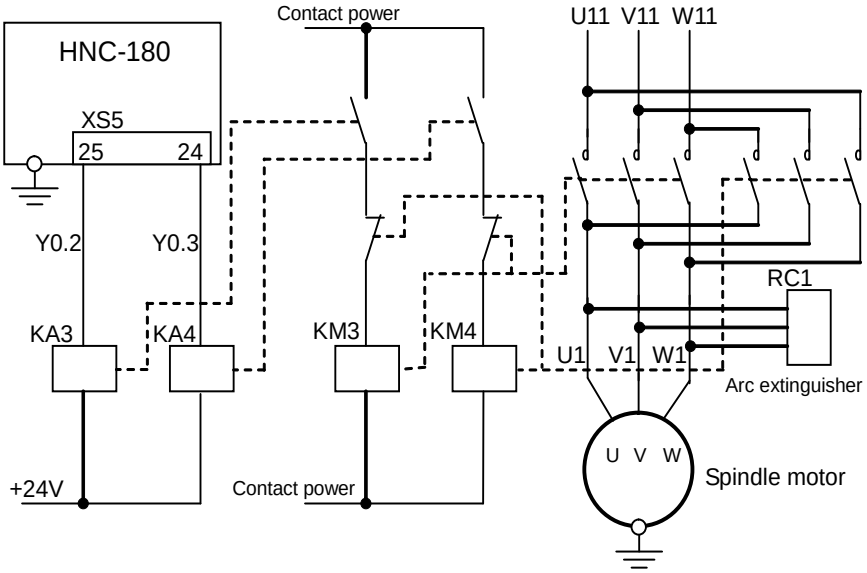


Figure 3-11 Connection example—Three-phase Asynchronous Motor

3.2.8 Connection Example—Spindle Drive

Generally, the servo drive includes AC frequency converter and spindle amplifier (characteristics: a broader speed regulation and the better low speed-torque). The signal of AOUT (-10~+10V) on XS5 can define the speed of spindle drive. Therefore, the non-step spindle regulation can be done within the reasonable range. Spindle rotation (CW and CCW), spindle stop, running status of spindle can be controlled by I/O. The connection is shown in Figure 3-12.

If AC frequency converter spindle is used, a mechanical gear should be used to be in the range of low speed-torque and speed regulation.

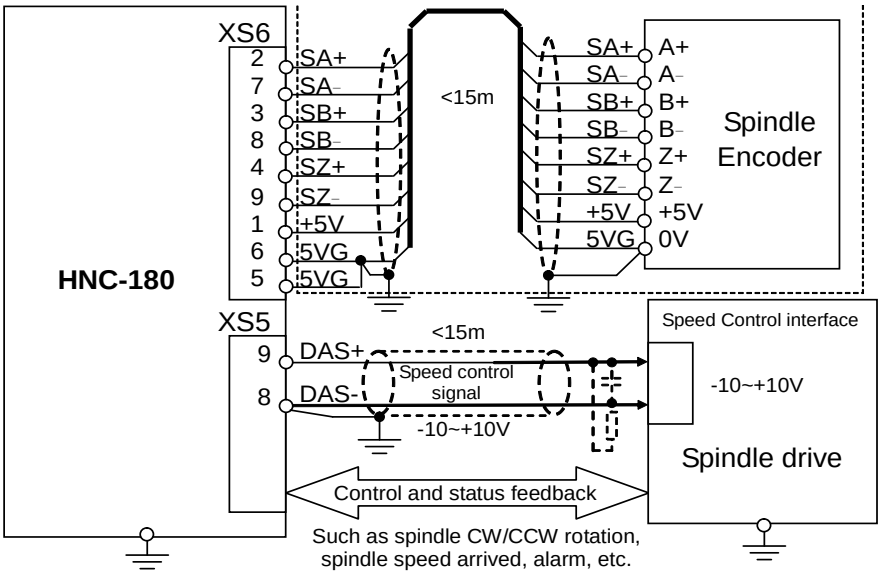


Figure 3-12 Connection to spindle drive (if there is not encoder, the contents in the dotted line is nothing)

As it is shown in Figure 3-12, spindle speed/position feedback is done by the external spindle encoder. Some spindle drive contains the similar motor speed/position output interface of encoder. Spindle speed/position feedback can be directly got from spindle drive, if the transmission ratio of spindles to spindle motors is 1:1 (Figure 3-13).

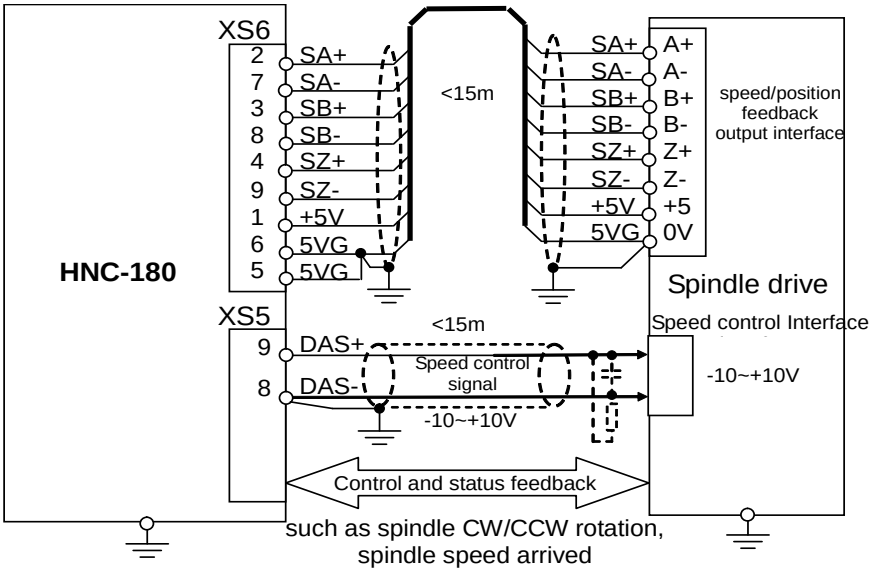


Figure 3-13 Connection to spindle drive with feedback output interface

3.2.9 Parameters related to Spindle device

The digital value relevant to spindle speed control signal takes two bytes, i.e. 16 bits, of PLC output Y[28] and Y[29] (Y[29] takes higher 8 bits). The relationship between output (digital value) and its relevant analogue voltage is shown below:

Table 3-8 Relationship between output and analog voltage

OUTPUT (HEXADECIMAL)	-0x7FFF~+0x7FFF (-32767~+32767)
AOUT	**-10V~+10V**

There are two kinds of parameter related to spindle device:

1. Spindle speed analog voltage
2. Spindle status feedback and control I/O

The above two functions are implemented by PLC program. For the detailed information, please refer to the definition of parameter P of HNC-180 in PLC program.

3.3 Connection to Handheld Unit

As it is shown in Figure 3-14, the handheld unit is equipped with the emergency stop button, pilot lamps, axis switch (OFF, X, Y, Z), magnification switch (X1, X10, X100), and the manual pulse generator. It is connected to XS8 of HNC-180.

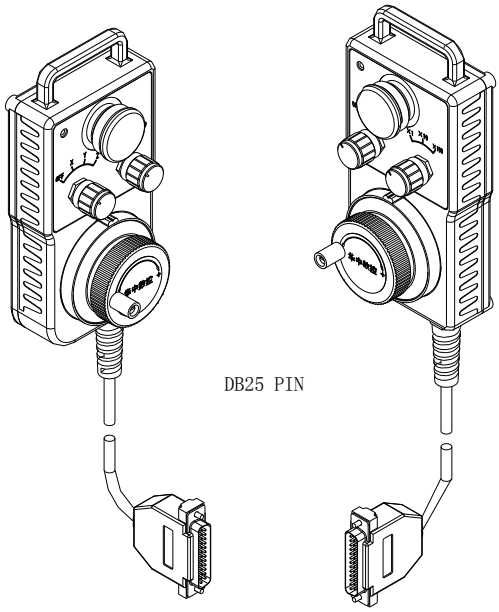


Figure 3-14 Interface of Handheld unit

3.3.1 Handheld Interface on HNC-180

Handheld unit is connected to HNC-180 by XS8 (DB25 pin).

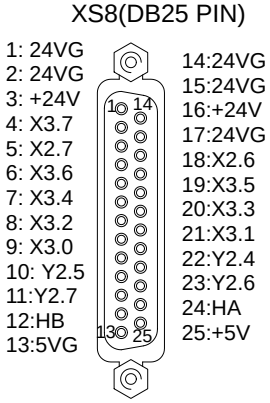


Figure 3-15 Interface of XS8

Table 3-9 Interface description of XS7

Signal	Description	
	Turning	Milling
+24V, 24VG	PLC power DC24V	PLC power DC24V
X2.6	2nd cycle start	2nd cycle start
X2.7	2nd feed hold	2nd feed hold
X3.0	Axis X selected	Axis X selected
X3.1	Undefined	Axis Y selected
X3.2	Axis Z selected	Axis Z selected
X3.3	Undefined	Undefined
X3.4	Ratio x1 on handheld unit	Ratio x1 on handheld unit
X3.5	Ratio x10 on handheld unit	Ratio x10 on handheld unit
X3.6	Ratio x100 on handheld unit	Ratio x100 on handheld unit
X3.7	2nd E-stop	2nd E-stop
Null	/	/
Y2.4	U4	U4
Y2.5	U5	U5
Y2.6	2nd cycle start pilot	2nd cycle start pilot
Y2.7	2nd feed hold pilot	2nd feed hold pilot
Null	/	/
HA	Phase A on handheld unit	Phase A on handheld unit
HB	Phase B on handheld unit	Phase B on handheld unit
+5V, 5VG	Handheld power DC5V	Handheld power DC5V

3.3.2 Connection to Standard Handheld Unit

The interface of standard handheld unit provided by our company is DB25 pin, which can be directly connected to XS8 on HNC-180 device.

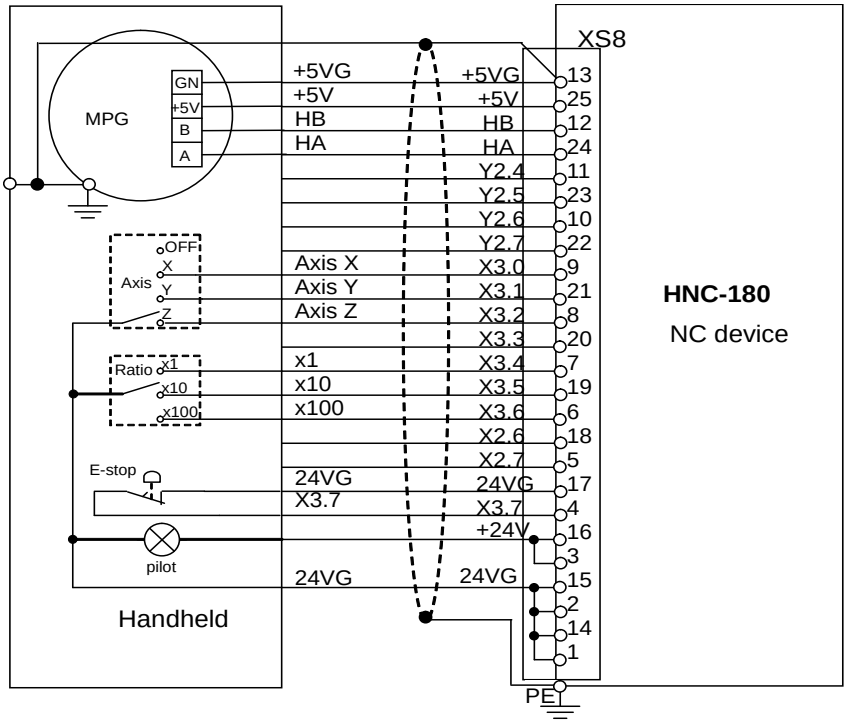


Figure 3-16 Connection to Standard Handheld Unit

3.3.3 Connection to Custom Handheld Unit

Please refer to standard handheld unit while designing I/O such as coordinate selection, ratio selection, and pilot lamps etc. Moreover, the handheld unit can also be in the form of external operation box or auxiliary control panel.

The type of I/O shall be NPN with DC24V. Please refer to section 3.4

The specification of MPG (Manual Pulse Generator) is DC5V, TTL level, phase-A output, and phase-B output.

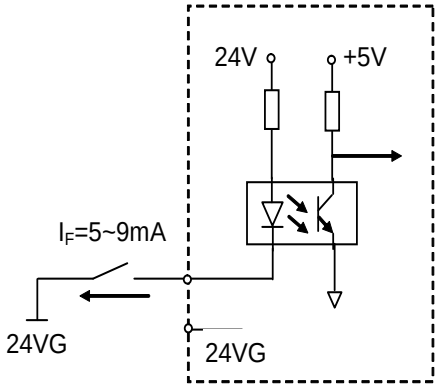
3.4 I/O on NC device

3.4.1 I/O Interface

There is 32/24 NPN I/O interface on HNC-180.

3.4.1.1Characteristic of input interface

(1) Equivalent circuit



24VG – common ground of NPN input

Figure 3-17 Equivalent circuit of Input interface

(2) Technical parameters

- The optically coupled technique is adopted. The highest isolated voltage is 2500VRMS (one minute).
- The supply voltage is 24V.
- Turn-on current I_F=5~9mA.
- Maximum leakage current≤0.1mA
- Filtering time is approximately 2msec.

Note: Any active I/O components (such as non-contact switch, Hall switch etc.) must be NPN type with DC24V.

(3) Typical application circuit

- Connecting to external passive switches or relay contacts;
  As it is shown in Figure 3-17, one contact of interface is connected with input, the other contact of interface is connected with 24VG.
- Connecting to external active switches
  The type of NPN output with DC24V shall be selected as the active switch. Please refer to the description of components, if necessary. The following figure is the connection of active input switch.

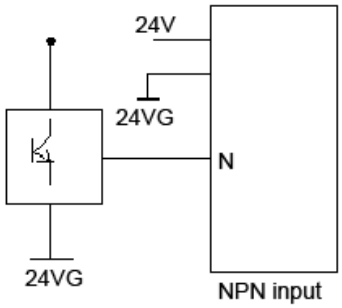


Figure 3-18 Connection of active input switch

3.4.1.2Pin of I/O input interface

PLC input interfaces are on XS7 (PLC input interface) and XS8 (handheld interface) of HNC-180. Some PLC input interfaces can also be connected with XS5 (spindle interface) or XS1~XS3 (feed axis interface) in parallel.

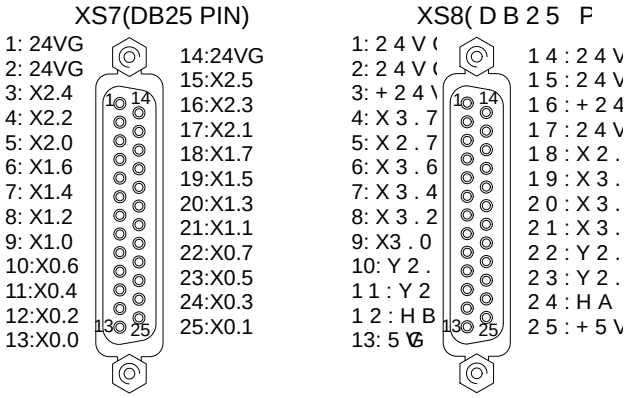


Figure 3-19 Interface of XS7 and XS8

Table 3-10 Inputs of XS7 and XS8

Signal	Description	
	Turning	Milling
+24V, 24VG	PLC power DC24V	PLC power DC24V
X0.0	Axis X Ready	Axis X Ready
X0.1	Tailstock forward Ready	Axis Y Ready
X0.2	Axis Z Ready	Axis Z Ready
X0.3	REF point on axis X	REF point on axis X
X0.4	Tailstock backward Ready	REF point on axis Y
X0.5	REF point on axis Z	REF point on axis Z
X0.6	Turret Locked	Tool Locked
X0.7	Chuck Locked	Tool Released
X1.0	Tool 1	Spindle orientation is done.
X1.1	Tool 2	Spindle speed is reached.
X1.2	Tool 3	Zero spindle speed
X1.3	Tool 4	Undefined
X1.4	Tool 5/Spindle gear 4	Spindle gear 4
X1.5	Tool 6/Spindle gear 3	Spindle gear 3
X1.6	Tool 7/Spindle gear 2	Spindle gear 2

X1.7	Tool 8/Spindle gear 1	Spindle gear 1
X2.0	Overtravel input	Overtravel input
X2.1	E-stop input	E-stop input
X2.2	External alarm	External alarm
X2.3	Spindle alarm	Spindle alarm
X2.4	Foot pedal switch	Undefined
X2.5	Operational door switch	Undefined
X2.6	2nd cycle start	2nd cycle start
X2.7	2nd feed hold	2nd feed hold
X3.0	Axis X selected	Axis X selected
X3.1	Undefined	Axis Y selected
X3.2	Axis Z selected	Axis Z selected
X3.3	Undefined	Undefined
X3.4	Ratio x1 on handheld unit	Ratio X1 on handheld unit
X3.5	Ratio x10 on handheld unit	Ratio X10 on handheld unit
X3.6	Ratio x100 on handheld unit	Ratio X100 on handheld unit
X3.7	2nd E-stop	2nd E-stop
Null	/	/

Note: X0.0 (Axis X Ready), X0.1 (Axis Y Ready), X0.2 (Axis Z Ready), X1.0 (Spindle orientation is done), X1.1 (Spindle speed reached), X1.2 (Zero spindle speed), and X2.3 (Spindle alarm) are parallel connection with the signals of feed axis interface and spindle interface. The operator can use one of them.

3.4.1.3Characteristic of output interface

(1) Equivalent circuit

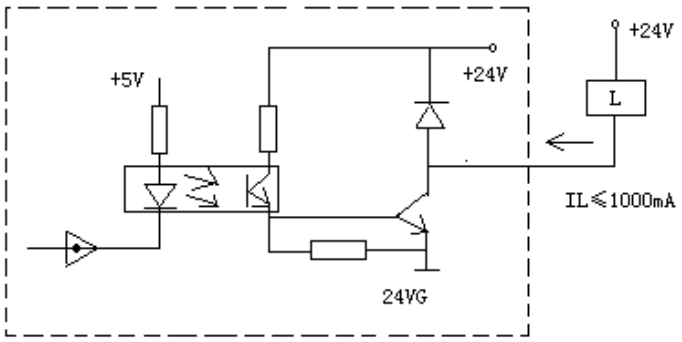


Figure 3-20 Equivalent circuit of output interface

(2) Technical parameters

- The optically coupled technique is adopted. The highest isolated voltage is 2500VRMS (one minute).
- The supply voltage is 24V.
- The maximum output current is 100mA.

(3) Typical application circuit

- To drive a LED

  A resistance about 10mA is required in series to control the current flowing through LED.

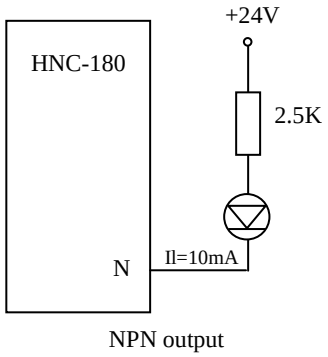


Figure 3-21 Output to drive LED

- To drive a filament pilot lamp

  A preheating resistance is required to reduce the current shock while turning the pilot on. The ohm value of the resistor should be large enough to keep the pilot dark when it is off.

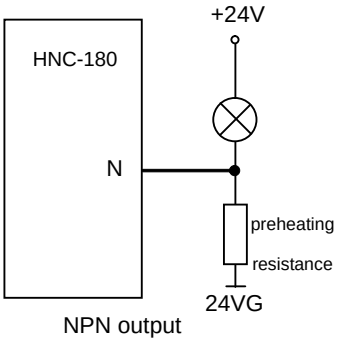


Figure 3-22 Output to drive a filament pilot lamp

- To drive an inductive load (such as relay)

  A flywheel diode shall be connected in parallel with the coil of the relay to protect the output circuit from interference (some relays have been equipped with flywheel diodes).

  Note: The voltage of coil shall be DC24V.

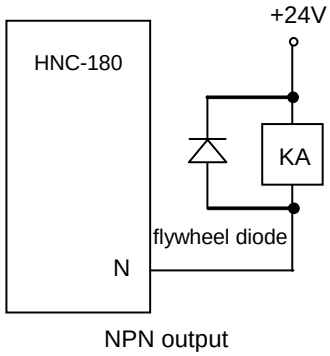


Figure 3-23 Output to drive an inductive load

3.4.1.4Pin of I/O output interface

PLC output interfaces are on XS9 (PLC output interface) and XS8 (handheld interface) of HNC-180. Some PLC output interfaces can also be connected with XS5 (spindle interface) or XS1~XS3 (feed axis interface) in parallel.

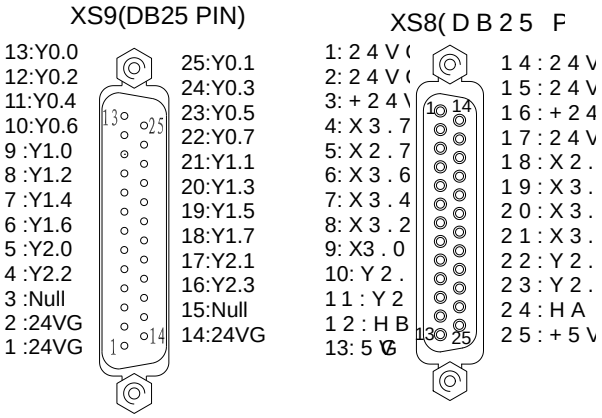


Figure 3-24 Interface of XS9 and XS8

Table 3-11 Outputs of XS9 and XS8

Signal	Description	
	Turning	Milling
24VG	PLC power DC24V	PLC power DC24V
Y0.0	Reset (clear the alarm)	Reset (clear the alarm)
Y0.1	Enabled	Enabled
Y0.2	Spindle CW rotation	Spindle CW rotation
Y0.3	Spindle CCW rotation	Spindle CCW rotation
Y0.4	Spindle brake	Spindle brake
Y0.5	U6	Spindle orientation
Y0.6	Chuck Locked	Tool Locked
Y0.7	Chuck Released	Tool Released
Y1.0	Turret CW	U7
Y1.1	Turret CCW	U8
Y1.2	Coolant	Coolant
Y1.3	Lubrication	Lubrication
Y1.4	Spindle gear 4	Spindle gear 4

Y1.5	Spindle gear 3	Spindle gear 3
Y1.6	Spindle gear 2	Spindle gear 2
Y1.7	Spindle gear 1	Spindle gear 1
Y2.0	U0/Tailstock forward	U0
Y2.1	U1/Tailstock backward	U1
Y2.2	Spindle Reset	Spindle Reset
Y2.3	Spindle Enabled	Spindle Enabled
Y2.4	U4	U4
Y2.5	U5	U5
Y2.6	2^{nd} cycle start pilot	2^{nd} cycle start pilot
Y2.7	2^{nd} feed hold pilot	2^{nd} feed hold pilot
null	/	/

Note: Y0.0 (Reset), Y0.1 (Enabled), Y0.2 (Spindle CW rotation), Y0.3 (Spindle CCW rotation), Y0.4 (Spindle brake), and Y0.5 (U6) are parallel connection with the signals of feed axis interface and spindle interface. The operator can use one of them.

3.4.2 Description of PLC Address

In the system program and PLC program, the on-off inputs from machine tool are defined as X. The on-off outputs to machine tool are defined as Y.

There are 8 bits (one byte) in each group of on-off inputs or outputs. For example, X0.0~X0.7 of XS6 on HNC-180 is in X[00]. (X0.0 takes the first bit of X[00], and X0.1 takes the second bit of X[00]…).

There are three kinds of PLC input/output:

1. I/O on PLC interface

   For HNC-180, there are 32 bits of inputs, and 24 bits of outputs. Every 8 bits is composed of a byte. The inputs are in X[00]~X[03], and the outputs are in Y[00]~Y[02].

2. Digital outputs relevant to spindle analogue voltage

   They are in Y[28] and Y[29].

   Note: The process of outputting the signal analog voltage command: PLC program calculates the digital outputs. Then, it is converted to analog voltage by internal D/A module.

   PLC program manages the digital outputs, which takes 16bits(two bytes) i.e. two groups of output signal.

   Thus, the spindle analog voltage is regarded as the output signal to handle.

3. The inputs to keys and the outputs to pilots on MCP (machine control panel). There are three rows of buttons on MCP and two ratio switches:

   - The first row (9 buttons): the inputs are in X[30] and 0 bits of X[31].

- The second row (10 buttons): the inputs are in 1~7th bit of X[33] and 0~2nd bit of X[32].
- The third row (9 buttons): the inputs are in 3~7th bit of X[32] and 0~3rd bit of Y[33].
- The two ratio switches contains 8 gears and 3 gears, respectively. The inputs are X[34] and X[35].

3.5 Design of E-Stop and Overtravel Released

There is an E-stop (emergency stop) input pin on both XS7 (PLC input interface) and XS8 (handheld unit). At least one E-stop button shall be connected in the following case.

- if there is an emergency, it is used to stop NC machine immediately or turn off the main supply of power devices (such as servo drivers).
- if there is an alarm message, E-stop button shall be pressed. Do not release E-stop button until the alarm message has been fixed.

There is no overtravel released button on the control panel of HNC-180. An external overtravel released button can be used to release the overtravel, if the overtravel limit switch is pressed (Figure 3-25). If the overtravel released button is not used, the overtravel is released after the resetting (Figure 3-26).

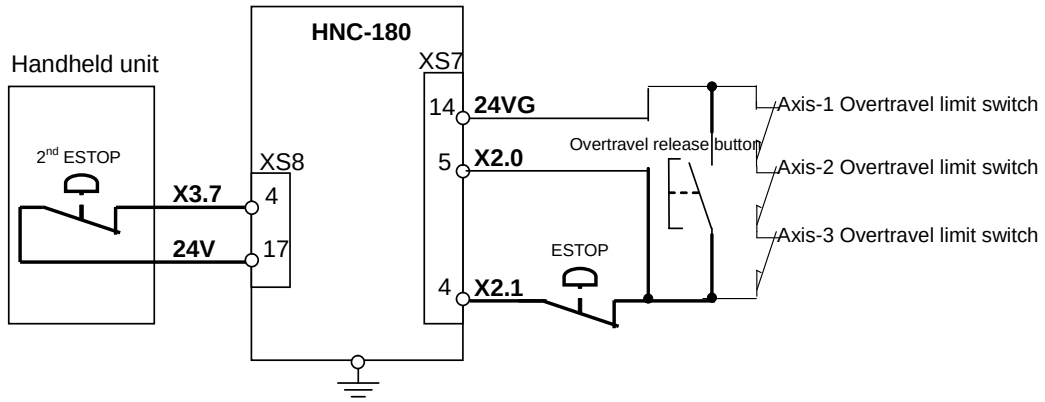


Figure 3-25 Recommended design of E-stop and Overtravel (with overtravel released button)

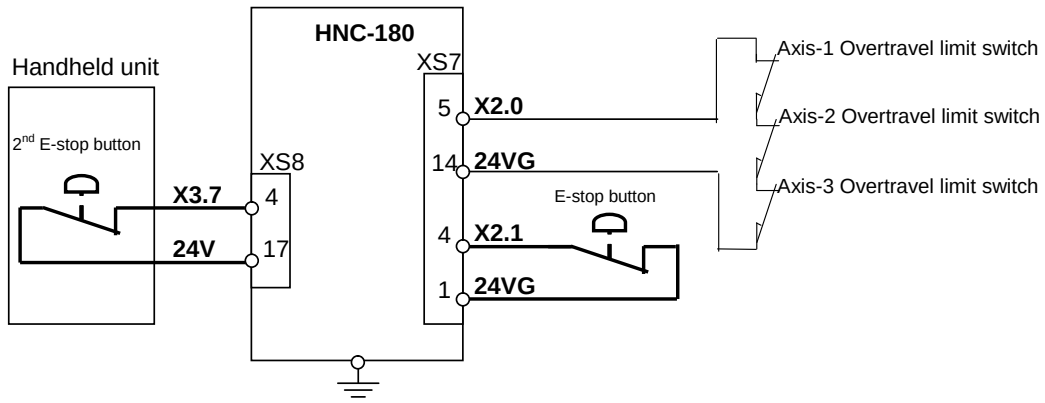


Figure 3-26 Recommended design of E-Stop and Overtravel (no overtravel released button)

The following table shows the input interface of E-stop.

Table 3-12 Input Interface of E-stop

Signal	Signal Description	Interface	Pin	Interface Description	Type
X2.1	E-stop input	XS7	17	PLC input	DB25 (male plug, female socket)
X3.7	2nd E-stop input	XS8	4	Handheld unit	DB25 (male plug, female socket)

More than one E-stop button can be used if necessary. The normally closed contacts of each emergency stop button are connected to input interface of NC device in series. Generally, E-stop buttons are released and its contacts are closed. While E-stop button is pressed, the contacts are open and E-Stop signal is sent to NC device. Then, the devices (such as feed motor, spindle motor, tool magazine/turret motor etc.) are stopped.

The normally closed contacts of the positive/negative overtravel limit switches are connected to the overtravel loop of NC device in series. Generally, the overtravel limit switch is open. If the overtravel limit switch is pressed, the contacts are closed. Then, the overtravel loop of NC device is closed, and the alarm message is shown.

Same as E-stop alarm, NC device are stopped and the system shows the alarm message if there is an overtravel. To release the overtravel, the following steps can be done:

1) If there is no overtravel released button, press RESET key to reset the system.
2) If there is an overtravel released button, press this button. Then, press RESET key. Note: Do not release this button until NC device is released.
3) **Press the axis key with the correct direction** to release the overtravel limit switch.
4) Release the overtravel release button

4 Debugging

This chapter would introduce the steps for the first start-up:

- Preview of Operation
- Trial Operation
- PLC Debugging
- Machine Debugging

4.1 Checking before Operation

4.1.1 Inspection of Wiring

Make sure that all cables are connected correctly, especially:

- The polarity of damper diodes for relays and solenoid valves (please refer to Chapter 1).
- The phase sequence of strong current cables on motor.
- Position control cable and position feedback cable of feeding device and strong current cable on motor shall be connected to the corresponding interface as shown in Figure 5-1.

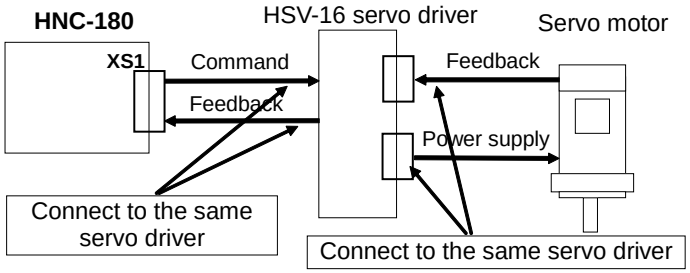


Figure 4-1 Connect to HSV-16, HSV-20D, Yaskawa or Matsushita servo with pulse interface

- Ensure that the type of analog speed command received by spindle unit is voltage, and check the wires to avoid damages to the related interfaces. The analog output of XS5 on NC device is -10V~+10V.
- Make sure that all grounding wires are reliable and correctly connected.
- Make sure that the emergency stop button and emergency stop circuit are effective. Pressing the emergency stop button down or cutting off the emergency stop circuit can cut out the power source of moving units such as feed driver, spindle drive unit etc. Please refer to Chapter 3.5 for the design of emergency stop circuit.

4.1.2 Power Inspection

- Make sure that the voltage and the polarity of each part of the circuit are correct, especially, the polarity of DC24V, and the circuit of power supply shall not be short circuit.
- Make sure that the specification of each part of the power supply in the circuit is correct.
- Make sure that the specification of each transformer in the circuit is correct, and the directions of I/O wires are connected in correct direction.

4.1.3 Device Inspection

- Make sure that each motor (spindle motor, feed motor) in the system is separated from mechanical transmission part, and reliably set down and fixed.
- Make sure that each power supply switch, especially the power supply switch of servo drive is off.

4.2 Trial Operation

4.2.1 Power On

Press E-stop button before the NC device is turned on or off.

Ensure the power of servo drive is off to prevent from the wrong action or malfunction due to the wrong setting of parameters, before doing the following steps:

1) Press E-stop button to ensure all the air switches in the system are open;
2) Turn the air switch of main power supply in the cabinet is on.
3) Turn the air switch or fuse with AC220V on, and ensure that the voltage of NC device is DC24V, and the power is DC5V.
4) Check the power supply of other parts.

4.2.2 Setting Parameters

After HNC-180 device is turned on, please **check the system parameters according to the hardware**. For detailed information, please refer to Chapter 4.

Note: Please set the servo parameters and internal parameters of servo according to servo manual, before the servo is powered on.

Do read the PLC programming manual and set PLC parameters according to the hardware configuration.

Attention: In PLC programming, the parameter shall not be set as 0, if one [P] parameter is taken as denominator(such as spindle speed transmission ratio denominator). Otherwise, the system would crash.

4.2.3 Inspection of External Status

Do the following inspections before the servo power is on:

- Check each feed drive unit and spindle drive unit, after the power is on.
- Check the required status reply signal, such as feed drive, spindle drive etc.

4.2.3.1PLC I/O Status

The operator can check the status of I/O signal (X, Y) by inspecting PLC status.

Moreover, the user can debug PLC program by inspecting the status of intermediate relay (R relay, not refer to actual relay in control cabinet), which is used for PLC programming.

To monitor PLC status, the operator can press DGN function key on MCP of NC device. For detailed information, please refer to the operation manual of HNC-180.

The value of X and Y is shown in binary. A group is composed of 8 bits, and each bit represents one bit of external on-off input or output signal. For example, X[00] includes 8 bits, which represents the inputs of X0.1~X0.7 from right to left, respectively, and X[01] represents the inputs of X1.0~X1.7 etc. Similarly, Y[00] represents the outputs of Y0.0~Y0.7, and Y[01] represents the outputs of Y1.0~Y1.7.

If the status of the connected input component varies (such as over-travel switch being pressed), the corresponding display of on-off numerical status would vary, from which the connection of the on-off I/O circuit can be checked.

4.2.3.2PLC I/O Address

PLC I/O addresses of HNC-180 device are defined as follows:
External on-off input signal: X[00]~X[03];
Input signal from button on panel: X[30]~X[45];
External on-off output signal: Y[00]~Y[02];
External on-off output signal: Y[28]~Y[29]; spindle speed control D/A;
Output signal from pilot on panel: Y[30]~Y[37].

4.2.4 Servo Power On

4.2.4.1Checking before Servo Power On

If any parameter has been modified, the operator shall turn the power supply of NC device off for 3 minutes, and turn it on again. Then, do the following steps:

- If the spindle encoder is used, the operator can rotate the axis of encoder to monitor the spindle speed and the spindle rotation, which can check the setting of spindle encoder.
- When the servo unit is connected to the control power supply, the position feedback control circuit is in the working mode. The operator can see the actual coordinate value including MCS (machine coordinate system), WCS (workpiece

coordinate system), and RCS (relative coordinate system) to check the actual position feedback of motor by press POS→ALL soft keys on NC device. For example, when the operator rotates the motor spindle (without brake) manually, the actual coordinate value on NC device would change. Then, the setting of axis parameters and the connection between servo and NC device can be checked.

Do not turn the servo on after manually rotating the motor.

4.2.4.2Turn Servo Power On

- Ensure the PLC control logic for the servo including power on, enabled, and disabled function and the circuit are correct.
- Turn on the circuit breaker of servo power supply.
- Ensure that the brake of motor is released. To check the brake, the operator can measure the power supply of brake control (DC24V), or hear the clatter when the brake is released at the instant of turning on the power supply.
- If handheld encoder is associated with the servo drive, this handheld unit can be used to directly control the motor operation and verify the correct connection of servo unit to the motor.
- Check the function of reference point return for each axis, once all feed axes are debugged.

For Stepper Motor Driver

- Ensure the type of pulse signal received by the stepper driver is the same as the setting of the pulse type in HNC-180.
- Ensure the correct number of beats of step motor is correct. Otherwise, the reference point would not be returned.
- Rotate the motor slowly and then quickly in jog or handheld mode. If there is abnormal sound or blocking during the motor rotation, please properly increase the value of jerk time for rapid traverse, jerk for rapid traverse, jerk time for machining, and jerk for machining.

For Servo Driver with Pulse Interface

- Ensure the type of pulse signal received by the servo driver is the same as the setting of the pulse type in HNC-180.
- Ensure the correctness of the motor revolution. It is usually feedback pulse from motor or servo * 4.

- Ensure the consistency of the variation of the feedback value during motor rotation with NC device command value. The operator can control the motor to move a short distance. Then, according to the variation of command value and feedback value, correct the sign of E-gear(NC) and E-gear(Servo), until the variation of the feedback value is same as that of the command value.
- Control the motor to move a short distance (such as 0.1mm), and check if the feedback value is same as the command value of the coordinate axis. If they are not same, the operator shall adjust the command multiple frequency of servo unit (usually there are two parameters: numerator and denominator of command multiple frequency) until the command value and the feedback values displayed on the screen of NC device are identical.

  Example: Given that NC device command value is 0.1mm, the feedback value is 0.05mm, and E-gear(NC):E-gear(Servo)=1:1. Then, the operator can adjust the parameters in three ways to get the same variation between the feedback value and the command value of NC device:

  1) Set the command multiple frequency of servo unit as 2.
  2) Set as twice as the feedback pulses of servo unit.
  3) Set the E-gear(NC) as 2.

  Thereafter, to fit with the variation of lead screw pitch and transmission ratio in the machine connection, only two parameters i.e. pulse1 and pulse2 in axis parameter is required to adjust. For more detailed information, please refer to chapter 4.

4.3 PLC Debugging

PLC function is offered in HNC-180. In aid of standard PLC applications with settings of related PMC user parameters, most NC turning machines and NC milling machines can be controlled. For the detailed information, please refer to HNC-180 PLC programming manual.

4.3.1 Main Elements of PLC Debugging

- Operate NC device to monitor on-off I/O status, and check PLC I/O points one by one for correct connection and logic relation against machine tool circuit diagram.
- Check the machine tool over-travel limit switch for correct operation.

4.3.2 Process of PLC Debugging

- Check each button on the operation panel, the on-off input signals, the system response and external logic circuit for correct operation. For instance, if the coolant button is pressed, then, the button lamp is on and AC contactor of coolant motor starts to work. If it is pressed once again, the lamp is turned off and AC contactor of coolant motor stops working.
- Return the reference point on each axis. Manually put the reference point response signal, and examine whether every coordinate axis can implement the reference point return with the correct operation or not.
- Connect the limit switch and the reference point return signal for every coordinate axis correctly, manually control the limit switch and reference point switch, and repeat the above two debugging steps to examine the effect of these switches.
- Check the correctness of the system alarm messages, the external alarm messages defined in PLC program, and the corresponding system action, when the on-off input alarm signal is inputted. For example, when the spindle alarm signal is valid, the spindle and the machining program would stop.

4.3.3 Methods for PLC Debugging

When PLC program cannot be executed in the expected procedure, the operator can follow the following steps to debug PLC:

- Check PLC input status (register X), if not, check the external circuit. For the command M, S, T, the operator can write a program including these commands, and then execute this program in AUTO (automatic) or SBL (single block) mode (PLC status cannot be monitor in MDI mode during the running) to monitor the

related registers during execution.

- Check PLC output status (register Y). If not, check the input condition or the corresponding setting of PLC user parameters.
- Check if the electronic switch or the relay directly controlled by the on-off output (register Y) can work. If not, check the connecting wire.
- Check if the contactor controlled by the relay or other switches (solenoid valve) can work. If not, check the connecting wire.
- Check the performance unit, including motor, hydraulic circuit, pneumatic circuit etc.

4.4 Machine Debugging

4.4.1 Emergency Stop and Limit

There are software limit in system. For the safety, it is suggested to use the hardware limit. The route limit switch is installed at the positive and negative direction of axes.

The parameters related to emergency stop and limit:

- PLC parameter 007078
  no detection of MCP emergency stop signal: check if the emergency stop is controlled by MCP emergency stop signal.
- PLC parameter 007079
  no detection of handheld emergency stop signal: check if the emergency stop is controlled by handheld emergency stop signal.
- PLC parameter 007075
  individual limit signal: check if there are individual limit switch to control hardware over-travel on each axis.
- PLC parameter 007081
  no detection of limit alarm signal: check if there are detection of limit alarm

If the limit switch is installed, please do ensure the over-travel limit switch is valid before machine debugging.

- Check the on-off I/O status of NC device, and press the over-travel limit switch on the machine to observe the change of the corresponding on-off input status, and check the correct connection of the over-travel limit switch.
- Move the axis slowly in jog or handheld mode to verify the validity of over-travel limit switch, the correctness of alarm message display, and the validity of over-travel released button (please refer to Chapter 3.5 for the operation of the over-travel released button).

4.4.2 Axis setting

The parameters related to axis are 100003~100036 and 200003~200036.

- Check the consistency of the direction and distance of machine with the corresponding commands from NC device. If not, the operator can modify the value and sign of Pulse1 and Pulse2 of axis parameters.
- Pulse1 and Pulse2 can be set according to the lead-screw and the transmission ratio to keep the consistency of the command value with the actual value of

machine. There are two ways (calculation, measurement) to set :

1) Calculation

   Given that HSV-16 is used, the transmission ratio is 2:5, the lead-screw is 6mm, and the revolution of motor encoder is 2500pulses. There are four subdivisions for servo driver and NC device, respectively. The motor revolution is 2500*4*4=40000p/r. The distance of tool movement is 6*1000*2/5=2400μm. Thus, Pulse1:Pulse2=2400:40000=3:50.

2) Measurement

$$\frac{pulse\,1(\mu m)}{pulse2} = \frac{\text{moving distance for each revolution}(\mu\text{m})}{\text{pulses for each revolution}}$$

   Please do the measurement more than once and try to increase the distance of measurement, because there is measurement error.

- According to the condition of mechanical transmission and the requirement of design, please set the rapid traverse speed, the maximum feedrate, the rapid traverse speed at REF, and the positioning speed at REF for each axis, correctly.

  Note:

  1) The rapid traverse speed is the maximum among these parameters.
  2) The setting of speed should not lead to the over-rated revolution of servo motor.
  3) The rapid traverse speed at REF shall be higher than the positioning speed at REF.

Set the characteristics of jerk for each axis according to the running status and mechanical transmission:

- The more the jerk time and jerk is, the acceleration/deceleration is slower, the less impact of machine motion is, the machining efficiency is lower. The less the jerk time and jerk is, the quicker the acceleration/deceleration is, the more impact of machine motion is, and the higher the machining efficiency is.
- The principle of setting acceleration and deceleration is that reducing the acceleration and deceleration time and jerk time on the premise of no alarm of drive unit, no stepper of motor and no obvious shock of machine motion to increase the response of coordinates and machining efficiency. If the acceleration and deceleration time or jerk time are set too small, it would lead to alarm of drive unit, out of step of motor, or machine vibration. the current of servo should not be too heavy during the start-up and the shut-down of the acceleration and deceleration. The recommended current is not more than 60% rated current of servo.

4.4.3 Reference point return setting

Mechanical reference point return switch can be installed, floating zero can also be set in the software. The mechanical reference point can be set in these two ways. The related parameters are as followed:

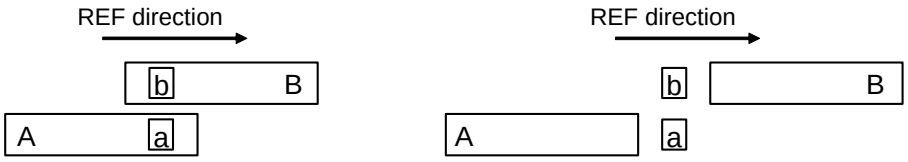
- PLC parameter 007017
  REF switch on machine: mechanical REF return mode or floating zero of REF return mode
- PLC parameter 007000
  Alarm when axis returns to REF point once powered: determine whether there is an alarm message about REF point return.
- PLC parameter 007084
  Detection of floating zero lost: check if the floating zero is lost.
- Axis parameter 100008~100012 and 200008~200012
  the direction, speed, and offset of mechanical REF return, etc

Note: Do check the validity of over-travel limit switch before the operation of reference point return.

- Check the validity of over-travel switch for the reference point return.
  Generally, the mechanical reference point is installed at the maximum travel. The valid travel of REF return block is more than 25mm to guarantee the enough deceleration distance and return the reference point precisely. The quicker the mechanical REF return is, the longer the REF switch is. Otherwise, there would be no enough deceleration distance to affect the accuracy of REF return, causing by the carriage moved by CNC acceleration and deceleration and machine inertia and passing REF block.
  1) Manually press the reference point switch during the movement of machine tool to check the validity of the reference point return process.
  2) Operate the machine tool and press the reference point switch by the reference point block to check the validity of the process of reference point return. The recommended speed of reference point return is under 1000mm/min.

  Note: The block of reference point shall be put within the certain distance. The recommended length is above 30mm of the valid travel distance. Otherwise, the block of reference point would be rushed over as the high speed of reference point return.

Note: There shall be a certain amount of overlap between the block for reference point and the nearby over-travel limit switch to ensure that the reference point return switch is not released, even if the over-travel limit switch is pressed. Thus, the reference point return can be done correctly, when the reference point switch just stops between the block of reference point and the pressed over-travel limit switch. Figure 5-2 shows the installation of REF switch and the over-travel limit switch. In the figure, “A” means the block of reference point, “B” means the block of nearby over-travel limit, “a” means the reference point switch, and “b” means the nearby over-travel limit switch.



(a) Correct Installation-overlap (b) Incorrect Installation-without overlap

Figure 4-2 Installation of REF switch and over-travel limit switch

- Check the effective travel range of each axis, and correctly set the positive software limits, the negative software limits in axis parameters (the software limit position is usually set between the two over-travel limit switches). Check the validity of software limit protection after the reference point is returned.

4.4.4 Spindle Function

- Check the direction and the speed of spindle rotation and set the related axis parameters (in general, they are the transmission ratio of spindle transmission part, the initial voltage/slope/the final voltage of D/A, the minimum speed, the maximum speed etc.), to reach the running requirement of spindle.
- Check other elements of PLC design, mainly including M, S and T commands, the safety interlock relations etc.

4.4.4.1Spindle D/A

The output voltage of interface AOUT of spindle D/A is -10V~+10V. Please set the type of speed command of spindle driver unit as the voltage to connect with NC device, as the speed command of some spindle driver unit can be in the form of both the voltage and current. Otherwise, the related interface of spindle unit would be destroyed.

- Ensure the related parameters of spindle D/A are correct.
  - Spindle parameter 007005
    Theoretical maximum spindle motor speed in DA10V: the maximum spindle analog voltage corresponding to motor revolution
  - Spindle parameter 007014
    Minimum spindle DA(0-10V): the initial spindle analog voltage
  - Spindle parameter 007015
    Threshold of spindle DA(0-10V): the threshold of spindle analog voltage
  - Spindle parameter 007026
    Spindle ±10V: the range of spindle analog voltage

  The voltage is 10V, when the spindle speed is the highest. For example, the voltage is 0V if it is S0. If there is voltage deviation, spindle parameter 007014 and 007015 can be set to adjust the voltage offset compensation (generally, it has been set in the production).

- Check the parameters of the spindle frequency converter drive or spindle servo drive.

- Turn off the power supply and disconnect the cable plug connecting the NC device with spindle frequency converter drive or spindle servo drive. Then, turn on the power supply again. When NC device is just turned on, the output voltage of spindle speed control signal AOUT (pin 1 and 2 of XS5) shall be around 9~10V. When the system has completed the start-up, it shall be 0V.

- Use the spindle speed control command (S command controlled by PLC program) to set the spindle speed. Check the voltage variation of speed control signal AOUT.

- Turn off the power supply and connect the cable plug connecting the NC device with spindle frequency converter drive or spindle servo drive. Then, turn on the power supply again. Use the spindle speed control command (S command controlled by PLC program) to set the spindle speed, and check the variation of spindle speed.

- Adjust the parameter setting of spindle frequency converter drive or spindle servo drive to optimize their performance.

4.4.4.2Spindle Encoder

Encoder must be installed, if threading is required. The related parameters of spindle with encoder are:

- Spindle parameter 007027
  Spindle encoder: spindle with/without encoder
- Spindle parameter 010012
  Spindle encoder revolution: the number of pulse per revolution of spindle sending from the encoder to NC unit
- Spindle parameter 001011
  Spindle encoder direction: the direction of spindle encoder

The related parameters of spindle without encoder are:

- Spindle parameter 007021
  Spindle zero speed fluctuation: spindle zero speed status
- Spindle parameter 007022
  Error between command revolution and actual revolution: the error tolerance between spindle command and actual revolution

4.4.4.3Spindle Brake

After M05 is executed, do set the proper spindle brake time to stop the spindle quickly and increase the machining efficiency. When the motor is used to brake, too much time consumed by brake would burn the motor out.

- Spindle parameter 007023
  spindle brake wait time: Interval time from receiving spindle stop command to outputting brake signal.
- Spindle parameter 007024
  spindle brake continued time: the time to brake spindle

Note: If the spindle is equipped with a brake, do release the brake unit before running the spindle.

4.4.4.4Spindle Gear

If the multi-speed motor is used to control machine, there are two gears of spindle:

- Spindle parameter 007030~007037
  Theoretical low speed and high speed of each gear: theoretical revolution range of spindle gear

- Spindle parameter 007038~007045
  Actual low speed and high speed: actual revolution range of spindle gear
- Spindle parameter 007046~007053
  Numerator and denominator of transmission ratio: deceleration ratio of spindle gear

When the programming revolution is different from the revolution detected by encoder, the spindle parameters can be set to keep consistent. The method of setting revolution is as followed: choose spindle 1st gear, input S in MDI to set parameters 007038~007045, monitor the spindle revolution, and input the checked values to parameters 007038~007045. The setting methods of rest gear are same.

4.4.4.5Knife Rest Debugging

System supports different kind of knife rest. For the detailed parameter settings, please refer to the machine's manual. If the knife rest is 4-8 station power knife rest, the cutter spacing signal is input directly, CW – tool selection, CCW – locked. The related parameters of running knife rest are:

- Knife rest and accessory parameters 007073
  Check knife rest arrived signal: detect the knife rest arrived signal
- Knife rest and accessories parameters 007018
  Knife rest locked ready signal: detect the knife rest locked ready signal
- Knife rest and accessories parameters 007008
  Maximum time of switching tool: the maximum time to switch tool
- Knife rest and accessories parameters 007009
  Time of knife rest CW delayed: the delayed time from knife rest CW stop to CCW locked start
- Knife rest and accessories parameters 007007
  Number of knife rest station: the number of knife rest station
- Knife rest and accessories parameters 007010
  Time of knife rest CCW locked: the time of knife rest CCW locked.

At the first time of switching tool, if the knife rest cannot rotate, it may be caused by the wrong connection of phase sequence of three-phase power of knife rest. It should press Reset key and cut off the power and check the wiring. If it is caused by the wrong connection of the phase sequence of three-phase power, the operator can switch two of three-phase power.

CCW locked time should be set properly. If the time is set too long, it would destroy motor. If the time is too short, the knife rest would not be locked. The way to check the lock of knife rest is: use the dial indicator to approach the knife rest, move the knife rest manually, the fluctuation of point of dial indicator should not be more than 0.01mm.

In the debugging, each tool position and the maximum tool switch should change tool once, monitor the validity of tool change and time parameters.

4.4.5 Machine Error Compensation

Please read section 4.3.6 Axis Compensation Parameters before setting the machine error. Machine tool error compensation mainly includes the backlash and the pitch error compensations, and these errors can be measured by the dial gauge, the block gauge or the laser interferometer.

4.4.5.1Backlash Error Compensation

For the small machine, the pitch error compensation is usually neglected, while the backlash is required to measure by using a dial gauge. The measurement is shown as below:

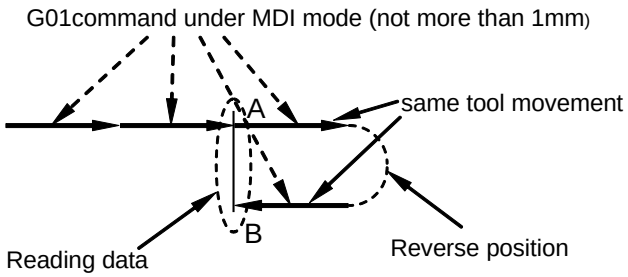


Figure 4-3 Measurement of Backlash

Backlash error compensation (μm) = |A – B|; in which “A” is the value read from the dial gauge at position A, and “B” is the value read from the dial gauge at position B.

Example: A=3mm, B=2.975mm, then,

Backlash error compensation=3-2.975=0.025mm=25μm

Note:

- Set the backlash error compensation to 0 before the measurement.
- Both backlash and pitch error compensation values can be measured by the laser interferometer.
- If the bi-directional pitch error compensation is used, then the backlash can be omitted, as it can be done through the bi-direction pitch error compensation.

4.4.5.2Pitch Error Compensation

There are two kinds of pitch error compensation: unidirectional, and bi-directional. The same offset for the positive and negative movement of feed axis is set in the unidirectional compensation, while the different offset for the positive and negative movement of feed axis is set in the bidirectional compensation. Generally, the unidirectional pitch error compensation is used. The measurement is shown as below:

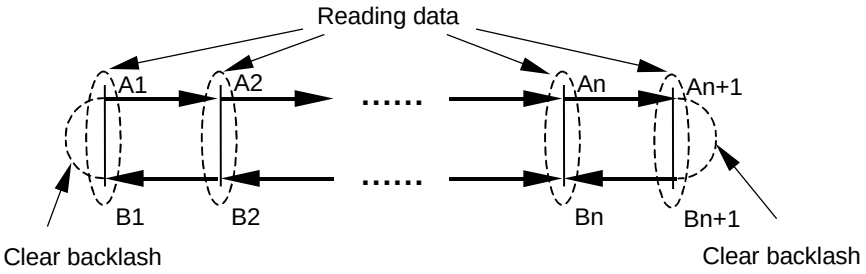


Figure 4-4 Measurement of Pitch Error

A_1~A_{n+1}: actual MCS position when the feed axis is moving in the positive direction;

B_1~B_{n+1}: actual MCS position when the feed axis is moving in the negative direction;

Offset(μm)=Programming coordinate value in MCS–Actual coordinate value in MCS;

Please refer to section 4.3.6 for the program of measuring the pitch error.

In general, the offset interval is about 50mm.

Please set the offset parameters as 0 before the measurement of compensation.

Take axis Y for example, the related parameters and data are given as follows:

REF point position: 0 (axis parameter);

REF direction: + (axis parameter);

Pitch comp point interval: 50mm (axis compensation parameter);

Travel distance: 400mm (machine data)

Then, the measuring points are -400, -350, -300, -250, -200, -150, -100, -50, 0, in which 0 is the reference point.

The actual value of measurement is as below:

- negative direction: -400.1, -350.08, -300.05, -250.06, -200.04, -150.02, -100.01, -50.005, 0;
- positive direction: -400.15, -350.12, -300.1, -250.1, -200.07, -150.06, -100.04, -50.05, 0.03;

Note: When the direction of reference point return is positive, the data at the negative side is measured first.

Therefore, the compensation parameters for axis Y shall be set as below:

- Unidirectional pitch error compensation

Parameter Name	Value	Description	
Backlash (μm)	30	Take -200 as the coordinate value	
Pitch compensation type	1	Unidirectional pitch error compensation	
Pitch compensation point	9		
Index of REF point	8		
Pitch comp point interval (μm)	50000	50mm	
Offset (μm) [0]	100	(-400)-(-400.10)	The data in the negative direction are used. The offset for the reference point is usually zero, as REF point is at the initial position.
Offset (μm) [1]	80	(-350)-(-350.08)	
Offset (μm) [2]	50	(-300)-(-300.05)	
Offset (μm) [3]	60	(-250)-(-250.06)	
Offset (μm) [4]	40	(-200)-(-200.04)	
Offset (μm) [5]	20	(-150)-(-150.02)	
Offset (μm) [6]	10	(-100)-(-100.01)	
Offset (μm) [7]	5	(-50)-(-50.005)	
Offset (μm) [8]	0	(0)-(0) (reference point)	

- Bidirectional pitch error compensation

Parameter Name	Value	Description	
Backlash (μm)	0	It is usually set as 0.	
Pitch compensation type	0	Bidirectional pitch error compensation	
Pitch compensation point	9		
Index of REF point	8		
Pitch comp point interval (μm)	50000	50mm	
Offset (μm) [0]	150	(-400)-(-400.15)	the data in the positive direction
Offset (μm) [1]	120	(-350)-(-350.12)	
Offset (μm) [2]	100	(-300)-(-300.10)	
Offset (μm) [3]	100	(-250)-(-250.10)	
Offset (μm) [4]	70	(-200)-(-200.07)	
Offset (μm) [5]	60	(-150)-(-150.06)	
Offset (μm) [6]	40	(-100)-(-100.04)	
Offset (μm) [7]	50	(-50)-(-50.05)	
Offset (μm) [8]	30	(0)-(-0.03) (reference point)	
Offset (μm) [9]	100	(-400)-(-400.10)	the data in the negative direction
Offset (μm) [10]	80	(-350)-(-350.08)	
Offset (μm) [11]	50	(-300)-(-300.05)	
Offset (μm) [12]	60	(-250)-(-250.06)	
Offset (μm) [13]	40	(-200)-(-200.04)	
Offset (μm) [14]	20	(-150)-(-150.02)	
Offset (μm) [15]	10	(-100)-(-100.01)	
Offset (μm) [16]	5	(-50)-(-50.005)	
Offset (μm) [17]	0	(0)-(0) (reference point)	

Note: When the laser interferometer is used to measure the pitch error, it is necessary to measure more than once. And the measurement software can automatically calculate the offset data based on the groups of measured data. In order to keep the precision of machine tool within specification, the offset data calculated in this way is usually different from the data from the manual calculation.

5 Fault Diagnosis

5.1 Fault and Solution

5.1.1 Abnormal Start-up

- No Display

Category	Reason	Solution	Reference
Wiring	incorrect power supply	Check power supply socket; Check power supply: AC24V or DC24V; Check wiring polarity;	Section 2.3
Adjustment	too bright or too dark	Adjust the knob on the back	
Hardware	mainboard error	Contact with us	

- System is crashed or restarted during the operation.

Category	Reason	Solution	Reference
Parameter	Incorrect setting of parameter	Check parameters in E-stop mode after restart; Check axis parameters, PMC user parameters; The parameter as denominator shall not be 0;	
Operation	Reading program from DNC or network	Wait for a moment; Stop the calling of the program;	
Software	System damaged	Reinstall the system.	
Wiring	Insufficient power supply	Check power supply socket; Check the voltage of power supply; Check the capacity of power supply; Check whether there is short circuit.	Section 2.3

5.1.2 E-Stop and Reset

- Unable to initiate reset signal

Category	Reason	Solution	Reference
Hardware	E-stop circuit is not closed	Check the normal closed contact of over-travel limit switch; Check the normal closed contact of E-stop button; If the handheld unit is not used or there is on E-stop button on the handheld unit, pin 4 and 17 of XS8 shall be short circuited.	Section 3.5

- Fail to reset

Category	Reason	Solution	Reference
Hardware	Requirement for reset is not reached, such as power supply of servo is not ready, spindle drive is not ready etc	Check the logical circuit; If HSV-20 servo is used, the reason is usually the power supply of servo drive is not ready; Check the power supply module; Check the wiring of power supply module; Check air switch of servo drive power supply.	Section 3.1

5.1.3 Abnormal Running of Servo

The interchange method is frequently used to verify the faulty of servo, which includes:

- Interchange the motors connected to the servo drives;
- Interchange the cables for servo drives;
- Interchange the interfaces of HNC-180 used for servo drives.

Please turn off the power supply first, if adding or removing the cables or the connectors is necessary to fix the problem. Please turn off the power supply for three minutes and restart the system, after the parameters are modified.

Ensure the signal ground of feed drive unit or spindle drive is reliably connected with the signal ground of NC device.

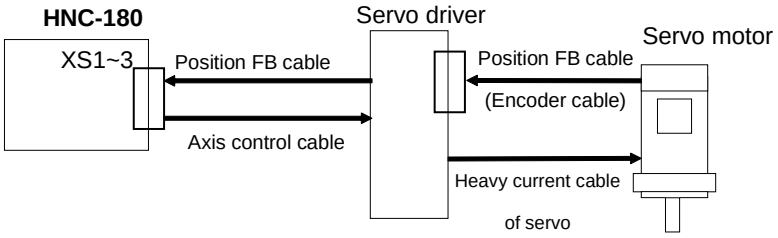


Figure 5-1 Connection between HNC-180 and Servo unit

- **There is an alarm message, once the power supply of servo drive is on.**

Category	Reason	Solution	Reference
Wiring	Error in phase order of servo motor strong current cable	Check the phase order of servo motor	Section 4.1.1
	Connection error in position feedback cable	Check the position feedback cable	
	Position feedback cable is not corresponding to motor strong current cable	Check the motor wiring	

- **Servo motor is dithering when it stops**

Category	Reason	Solution	Reference
Wiring	Error in the wiring of position feedback cable	Check the position feedback cable	Section 4.1.1
Motor	Abnormal running of motor encoder	Check servo motor and servo drive	
Parameters	Error in the parameter	Check the parameters related to gain adjustment of servo drive, and adjust them carefully. Proportion coefficients and integration time of speed loop can be reduced properly.	

- **Servo motor rotates slowly with zero drift.**

Category	Reason	Solution	Reference
Parameter	Error in parameter of servo drive	Servo drive is set to be controlled by the external command. Check the consistency between the internal control mode of servo drive and the actual condition. Example: For the drive with pulse interface, it is set as position control mode.	Operational manual of Servo drive
Parameters	Error in the servo parameters	Setting of servo type shall match with the actual condition	
Wiring	Weak connection of axis control cable between NC unit and Servo drive	Check the axis control cable (XS1, XS2, and XS3)	Section 4.1.1
Wiring	Interference to the axis control cable	Make coordinate axis control cables shielded with reliable grounding; Do not twist, if possible; Keep the strong current cables as far possible; Do not lay with them in parallel.	Section 3.5

- **Servo motor does not rotate.**

Category	Reason	Solution	Reference
Wiring	Disconnected control cable	Check the strong cable of motor; Check the control cable of axis;	Section 4.1.1
	No servo power supply	Check the power supply of servo;	
Parameters	Error in the parameter of servo drive	The internal parameter of servo drive shall be set as the external command control, i.e. controlled by NC device	
Parameters	Error in the servo parameter	Check if servo drive can correctly receive the enabled signal; Check the servo type of servo parameters in NC device;	
Parameters	Error in machine parameter	Check the consistency between the pulse type of NC unit and the setting of servo drive.	
Operation	Machine is locked	Press the machine locked button to release the locked status.	
Installation	Motor rotation blockage	Check if brake on motor is on; Check if mechanical load is too much.	

- **Motor can only rotate a short distance.**

Category	Reason	Solution	Reference
Wiring	Wrong connection between the position feedback cable and strong cable of motor	Check if the position feedback cable is corresponding to the motor strong current cable; Check the phase order of motor strong current cables; Check if the position feedback cable is disconnected.	Section 4.1.1
Parameters	Error in the servo parameter	Set the correct motor revolution; For the servo with pulse interface, E-gear(NC)/E-gear(Servo) shall be set correctly.	
Parameters	Error in the setting of motor pole pairs of servo drive	For GK motor, it is set as 3.	
Installation	Too much mechanical load	Check if the mechanical load is too much	

- **Motor jitters when rotating.**

Category	Reason	Solution	Reference
Wiring	No reliable grounding	Ground the whole system as required; Each unit or device shall be grounded reliably; Signal ground of drivers and NC device shall be reliably common grounded.	Section 3.6
	No reliable power supply of servo drive	Check the connection of servo drive power supply control circuit;	
	Interference	Position feedback cables and axis control cables must be shielded cables with reliably grounding; In the position feedback cable, the power supply wire and its ground wire shall be thicker. Two or three wires are connected in parallel; The length of axis control cables or position feedback cables shall be within 15m; The axis control cables and position feedback cables must be laid separately from the strong current cables; Do not twist axis control cable and position feedback cable, if possible.	
Wiring	Wrong connection of encoder cable and motor power supply cable	Check if the motor strong current cable is corresponding to the position feedback cable; Check the phase order of motor strong current cables; Check if the encoder cable is disconnected.	Section 4.1.1
	Disconnected position feedback cables	Check and repair the position feedback cables	

Parameters	Error in the parameter of servo drive	Check the parameters of servo drive, and run the motor by using servo internal command to verify the correctness of parameters. Then, connect to NC device.	Operational manual of Servo drive
		Check the parameters related to gain adjustment of servo drive, and adjust them carefully. Proportion coefficients and integration time of speed loop can be reduced properly.	
		Use GK servo motor, and set the pole pairs of motor as 3.	
Installation	Uneven mechanical load	Check the mechanical load	
Motor	Motor encoder broken	Repair or Replace the motor	

- **Motor is creeping**

Category	Reason	Solution	Reference
Wiring	No reliable motor grounding	Check motor strong current cables; Check the axis control cable	Section 3.6
Mechanics	Too much load	Check the servo power supply	
Parameters	Error in the parameters of servo drive	Check the parameters related to gain adjustment of servo drive, and adjust them carefully. Proportion coefficients and integration time of speed loop can be reduced properly.	Operational manual of Servo drive

- **Incorrect motor positioning and Accumulative Error**

Category	Reason	Solution	Reference
Wiring	No reliable motor grounding	Check the motor strong current cables; Check the axis control cable	Section 3.6
	No reliable position feedback cable	Use the shielded cable or twisted-pair double shielded cable with good quality; Use the thicker power supply wire for position feedback cable, such as take several wires connected in parallel; Shield layer of cable is grounded reliably; Add the magnetic rings on both sides of cable.	
Mechanics	Unreliable mechanical connection	Adjust the mechanical connection.	
Motor	Motor encoder broken	Replace the motor	

- **Weak torque output from motor axis**

Category	Reason	Solution	Reference
Wiring	No reliable motor grounding; being interfered	Check motor strong current cables; Check the position feedback cable; Check the axis control cable;	Section 3.6
Motor	Motor encoder broken	Replace the motor	

- **Driving axes slips down when starting**

Category	Reason	Solution	Reference
Mechanics	No balancing device; Invalid balancing unit	Add a balancing device; Check the balancing device;	
Wiring	Too early brake from the motor	Check if the connection of X0.2 (axis Z ready) is correct.	

- **Reference point return error**

Category	Reason	Solution	Reference
Parameters	It automatically stops when reference point is positioning.	Check if the parameter – stepper motor pulses – is set. Check the setting of the parameter – motor revolution. It shall be pulses from servo to NC unit*4.	

5.1.4 Abnormal Frequency Converter and Servo Spindle

- **Spindle overspeed and uncontrollable**

Category	Reason	Solution	Reference
Parameters	Error in the setting of spindle drive	Check the setting of spindle drive; Spindle drive should be controlled by the external command.	
Wiring	Interference	Speed control signal cables shall be shielded cables with reliable grounding; A resistance of 500-1000 ohms and ceramic plate capacitance of 1000p shall be connected to the spindle drive side of speed control signal cables in parallel.	Section 3.2 Section 3.6
Hardware	D/A circuit faulty	Repair or replace NC unit	

- Failed pitch machining

Category	Reason	Solution	Reference
Parameters	Error in the direction of spindle encoder	Check the consistency between the spindle encoder direction and the actual direction of spindle rotation.	

- Incorrect pitch machining

Category	Reason	Solution	Reference
Parameters	Error in the setting of spindle revolution	Check the spindle revolution	
Mechanics	Spindle encoder faulty	Replace spindle encoder. Turn the spindle manually and monitor the spindle speed to check whether the encoder is damaged.	
	Spindle encoder coupling faulty	Repair or replace	
Hardware	Not enough power of spindle encoder	Check the power supply of spindle encoder. If it is higher than the output capacity of XS9 of HNC-180, the independent power supply with DC5V for spindle encoder shall be used.	Section 3.2

5.1.5 Abnormal Running of I/O

Note: Each DC solenoid valve and brake must be connected to damper diode. Otherwise, the performance of DC24V power supply would be affected by the current shock when the solenoid valve is turned on. This would cause the random alarms from NC device or servo drive.

Each AC contactor and AC asynchronous motor such as cooling motor, hydraulic motor and AC asynchronous spindle motor controlled by contactors must be connected to RC arc damper. Otherwise, the performance of AC power supply would be affected and the interference would be produced by the current or voltage surge at the instant of turning on these devices. This would cause the random alarms from NC device or servo drive.

- **No input or output signal**

Category	Reason	Solution	Reference
Wiring	Signals without common grounding	DC24V power supply for external on-off I/O must have common ground with DC24V power supply for HNC-18i/18xp NC unit through XS6 and XS9.	Section 2.3

- **Unstable I/O**

Category	Reason	Solution	Reference
Wiring	Interference	It is recommended to use the independent shielded cables for connecting on-off input and output signals with reliable grounding, when separating HNC-180 device and strong current cabinet; The length of cable wire shall be within 15m; HNC-180 NC device shall be grounded reliably.	Section 3.6
Wiring	Abnormal power	Check the input/output voltage of HNC-180 NC unit	Section 2.3
Wiring	Too much interference from other devices sharing DC24V power supply with PLC	Check the anti-interference circuit of this kind of devices. For example, check the damper diodes in the band brake and the solenoid valve.	Section 2.3, Section 3.6.

5.2 Alarm Messages

Please stop running the machine and check the alarm messages to fix the problem, once there is abnormal running.

5.2.1 Check Alarm Messages

The operator press DGN function key and F3 soft key to check the alarm messages. When a fault occurs, CNC system will give an alarm message. For more detailed information, please refer to the operator's manual.

The alarm messages are categorized into the internal alarm and external alarm, in which the internal alarm is categorized into the programming error and the hardware error. In this manual, only the internal alarm messages related to hardware error would be described, which includes the error number and the alarm message. The external alarm messages are controlled by PLC. For detailed information, please refer to the operation manual of HNC-180 PLC.

The alarm message of common error would not be shown, once the problem is fixed. For the alarm message caused by E-stop, the alarm message would not be shown only if RESET button is pressed. Some alarm messages, such as the alarm caused by the setting of hardware parameters, would not be shown unless the system is restarted.

5.2.2 List of Alarm Messages

No.	Alarm Message	System status	Solution
01h	Initialization Error	Emergency stop	Set the axis parameters and servo parameters correctly.
02h	Parameter Error	Emergency stop	Set the parameters correctly.
05h	Position Lost	None	Move the axis
09h	Unknown Error	Emergency stop	Check the parameter, wiring and power supply, and turn on power supply again.
20h	Positive overtravel	No axis movement	Press the over-travel released button, move the axis to the negative direction.
21h	Negative overtravel	No axis movement	Press the over-travel released button, move the axis in the positive direction.
22h	Positive software limit	the overtravelled axis stops moving to the positive direction	Move the axis to the negative direction.
23h	Negative software limit	the overtravelled axis stops moving to the negative direction	Move the axis to the positive direction.
30h	Hardware Error	Emergency stop	Turn on the power again, after it has been off for three minutes.
38h	Abnormal feedback	Emergency stop	Check the position feedback cable of HNC-180 NC unit.
40h	Overspeed	Emergency stop	Check the axis control cable of servo drive. Set the value of maximum feedrate higher.
41h	Tracking error too much	Emergency stop	Check the mechanical load; Check the power supply of servo drive; Check the brake of servo; Check if the rapid traverse speed is higher than the rated motor rotation speed; Check the internal parameter of servo drive; Check the motor revolution; For servo, check E-gear(NC)/E-gear(Servo)
44h	No reference point return	Emergency stop	Check the reference point switch; Check the encoder feedback cable; Check the zero (Z, /Z) pulse of encoder;

6 Example of Typical Design

6.1 Overview

Applications of HNC-180 NC device to various NC machine tools may be different chiefly in two ways:

- Different feed axis
  It is specified in section 3.1.
- Different electrical design
  It would be described in this chapter.

6.2 Example of Design

6.2.1 Brief Introduction

- Machine: 2-coordinate parallel lathe, with 4-position automatic cutter saddle;
- Structure of control cabinet: strong current control cabinet + operation station
- Spindle: frequency converter + normal asynchronous motor

The following table shows the main components in the design of NC turning system.

Table 6-1 Main components in the design of NC turning system

No.	Name	Specification	Description	Notes
1	NC device	HNC-180xp/T3	Control system	HCNC
2	Handheld unit	HWL-1013-3	Manual control	HCNC
3	Control transformer	AC380/220V 250W /110V 150W / 24V 100W	Power supply for servo control, Power supply for switch	HCNC
			Power supply for heat exchanger and AC contactor	
			Power supply for spotlight	
4	Servo transformer	3P AC380/200V 2.5KW	Power supply servo supply module	HCNC
5	Switch power supply	AC220/DC24V 35W	I/O and intermediate relay	Ming Wei
6	Servo driver	HSV-160B^{+}-030	Axis X/Z motor drive	HCNC
7	Servo motor	130ST-M06025LFB(6NM)	Axis X feed motor	HCNC
8	Servo motor	130ST-M07720LFB(7.5NM)	Axis X feed motor	HCNC
9	Frequency converter	SJ300-075HF	Spindle frequency converter	Yaskawa

6.2.2 Overall Diagram

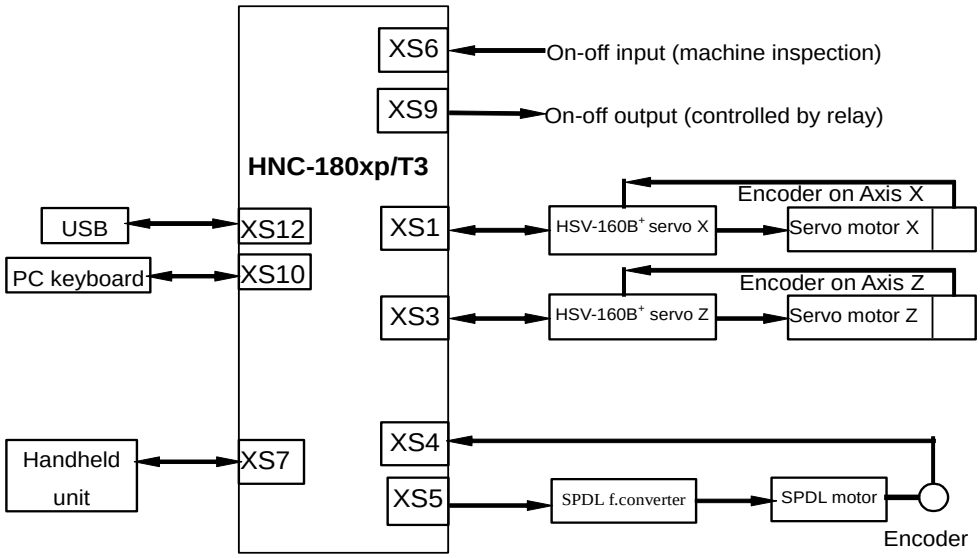


Figure 6-1 Overall Diagram of Typical Design of NC Milling System

6.2.3 I/O Specification

For detailed information, please refer to Chapter 3.

6.2.4 Circuit Diagram

The following section describes the main parts of the circuit diagram. As to the wire number, only those appeared in different pages are given.

6.2.4.1Connection to Power Supply

There is no solenoid valve in the system. Only one power supply with DC24V 35W is used. A low pass filter is used at the lead-in wire of switch power supply to separate from the power supply of servo(AC220V)

In Figure 7-2, QF1~QF5 are 3φ air switches. QF6~QF8 are 1φ air switches. KM1~KM3 are 3φ AC contactors. RC1 and RC2 are 3φ RC absorbers (arc damper). RC3~RC5 are 1φ RC absorbers (arc damper). KA1~KA3 are DC24V relays.

Note: The magnetic rings and the high voltage ceramic plate capacitors at the main power lead-in wire and the transformer input side are not shown in this figure.

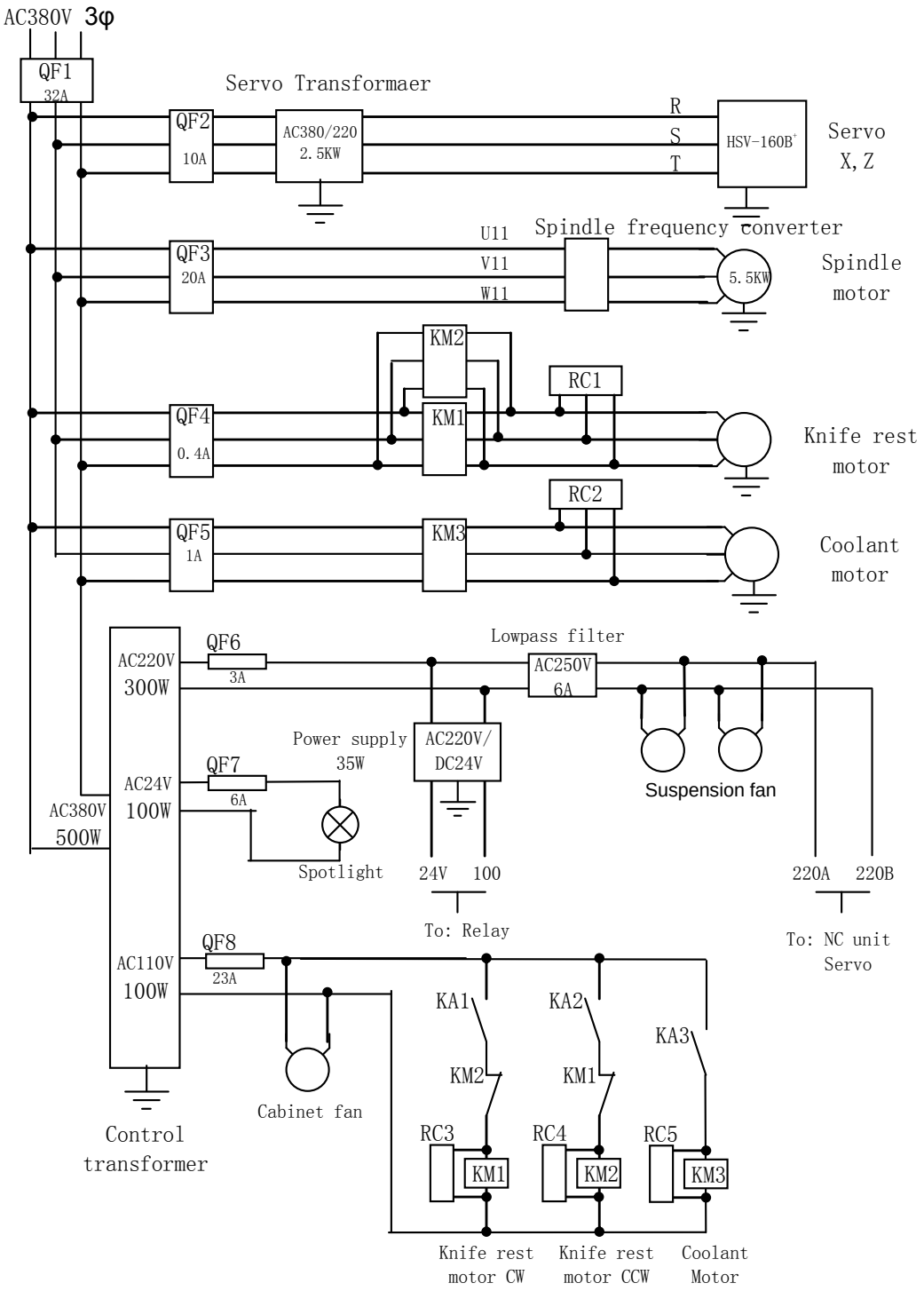


Figure 6-2 Circuit diagram of typical turning system – power supply

6.2.4.2Connection to Relay and I/O

Relay is controlled by the on-off output signals, and the on-off input signals mainly refer to the status and alarm messages of feed unit, spindle unit, machine tool electric part etc.

As it is shown in Figure 7-3, KA1~KA3 are intermediate relays.

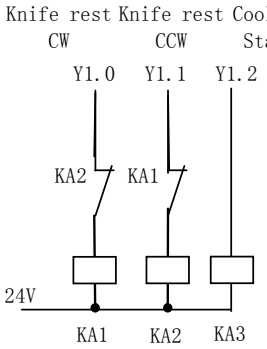


Figure 6-3 Circuit diagram of typical turning system – Relay

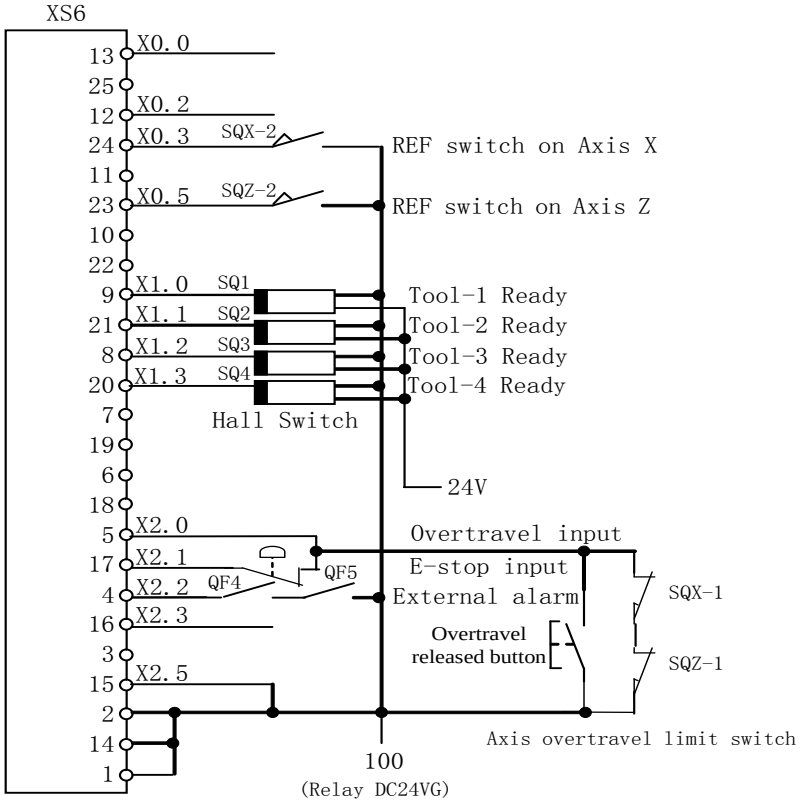


Figure 6-4 Circuit diagram of typical turning system – I/O 1

As it is shown in Figure 6-4, X0.0~X0.2, X1.1, X1.2, and X2.3 are from XS1~XS3 (feed axis interface), and XS5 (spindle interface). If there is no related alarm input signals, then the corresponding input signals shall be connected to DC24VG. “100”

and “24V” in the graph is the output of DC24V 35W switching power supply.

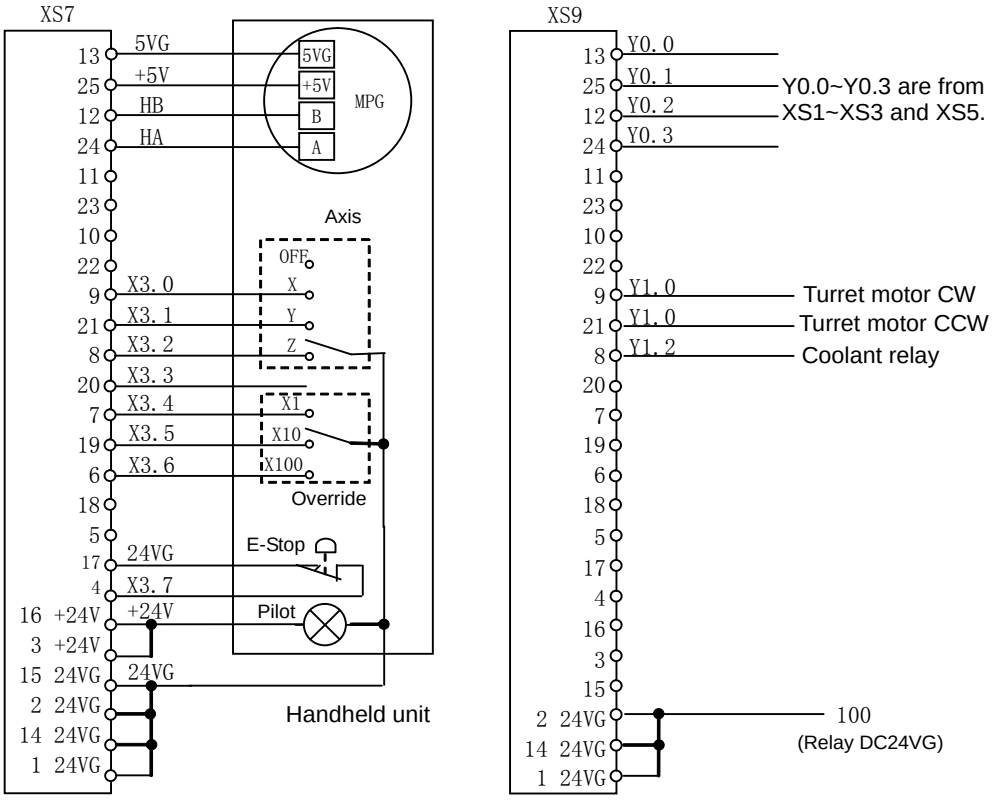


Figure 6-5 Circuit diagram of typical milling system – I/O 2

6.2.4.3Connection to Spindle

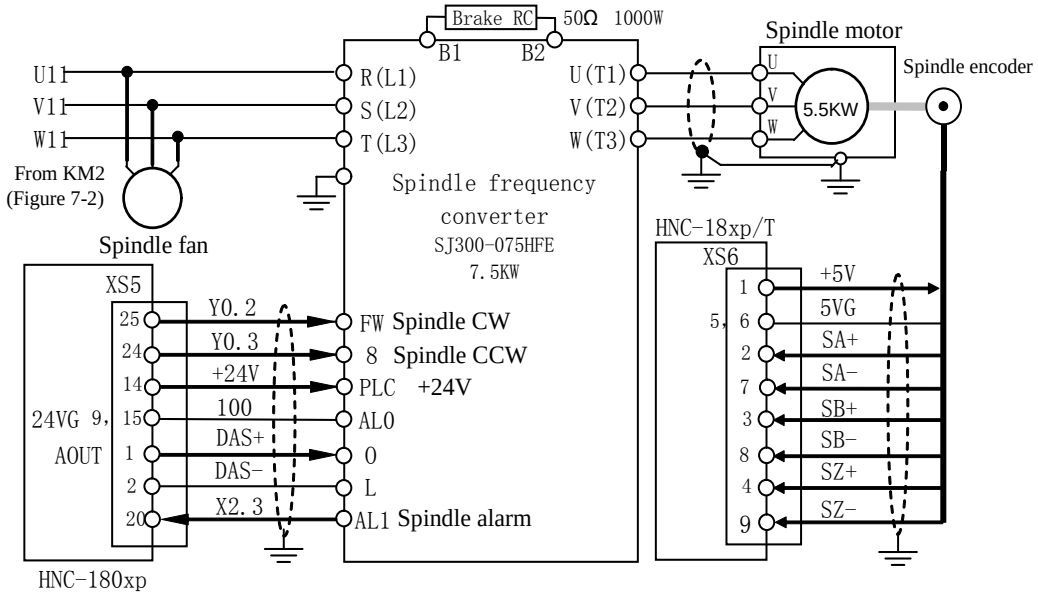


Figure 6-6 Circuit diagram of typical turning system – Spindle

6.2.4.4Connection to Servo Drive Unit

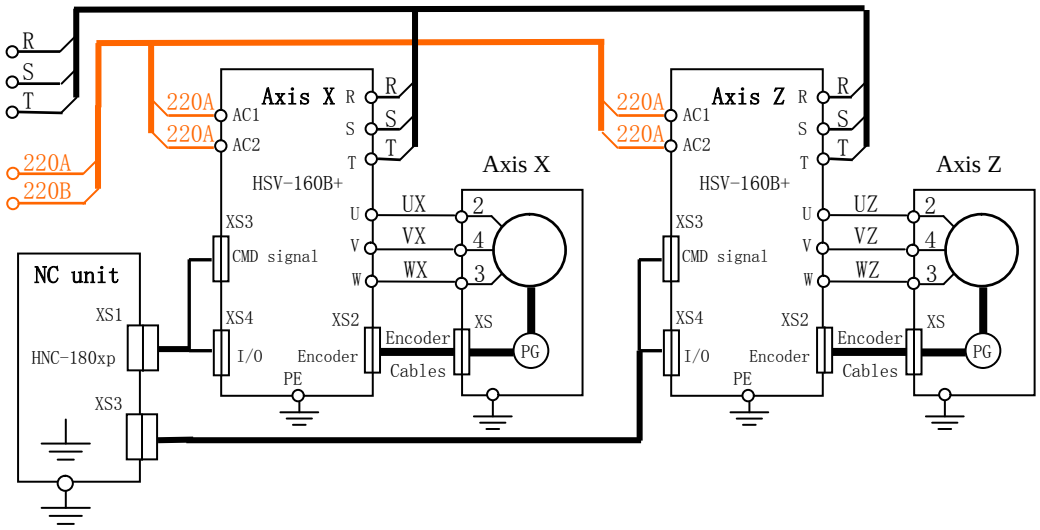


Figure 6-7 Circuit diagram of typical turning system – Servo Drive Unit

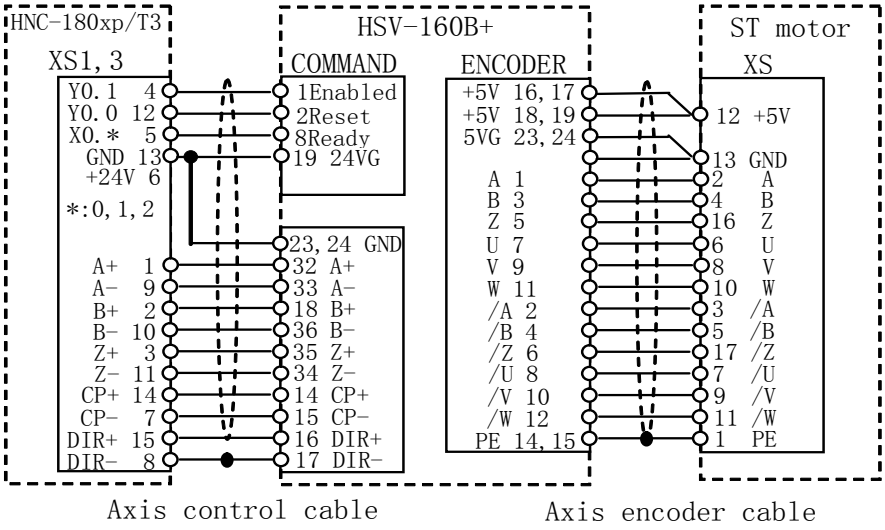


Figure 6-8 Circuit diagram of typical turning system – Servo drive cable