Contents

1 Preparation for Commissioning

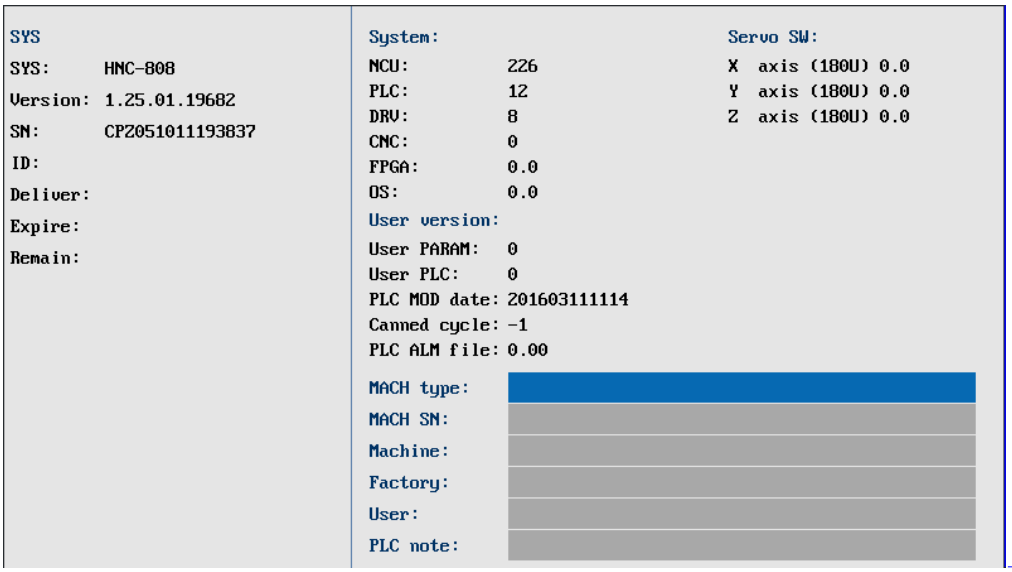
1.1 Verification and Recording

Please check the products based on the order list and packing list. Contact us immediately in case of any problems.

In order to facilitate future tracking and statistics, it is recommended that the commissioning personnel make a record according to the actual situation. For details, see "Appendix C - HNC-8 Commissioning Record

1.2 Version Information

Users may choose **Diagnosis** > **Version** (F10) to view the version information, which includes system information, user version, and servo software version information. See Figure 1.2.1.



批注 [z1]: 中文图

Figure 1.2.1 Version information

1.2.1 System Version

The system version displays the software and hardware version information of HNC-8. See

Figure 1.2.2.

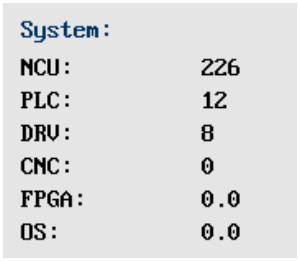


Figure 1.2.2 System information

- NCU: the kernel program of the system interpolator and interpreter.
- PLC: the PLC interpreter, editing, modification, and diagnosis programs of the system.
- DRV: the system driver program for the communications with the bus module.
- CNC: the user interface program for Human-Computer interaction.
- FPGA: the system hardware FPGA.

1.2.2 User Version

The user version displays the user file version information of HNC-8. See Figure 1.2.3.

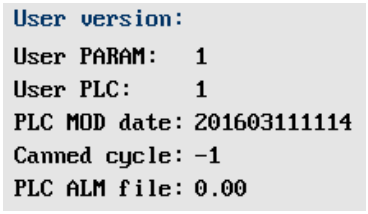


Figure 1.2.3 User version information

- User PARAM: displays the current system parameters' version defined by the user, which can be modified as required. This value corresponds to the user machine parameter [199].
- User PLC: displays the current ladder version number, which can be modified as required. This value corresponds to the user machine parameter [198].
- Canned cycle: displays the version number of the current canned cycle.
- PLC ALM file: displays the version number of the **PMESSAGE.TXT** alarm file. The version number can be added to the first line in the **PMESSAGE.TXT** file.

1.2.3 Servo Software Version

The servo software version displays the software version number of the servo driver on the bus. One servo driver corresponds to one servo driver version number. See Figure 1.2.4.

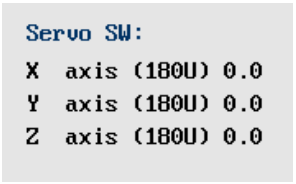


Figure 1.2.4 Servo version information

1.3 Software Upgrade, Parameters and PLC Backup/Import

HNC-8 software upgrade consists of program upgrade, parameter upgrade, PLC upgrade, and BTF upgrade.

Users need to back up PLC and parameters if parameter upgrade, PLC upgrade, or BTF upgrade is required. After the upgrade, the original system PLC and parameters will be replaced by the standard parameters and PLC.

1.3.1 Back up Parameters and PLC

Follow the instructions below to back up parameters and PLC:

1. Press **Set** > **PARAM** (F10) > **Rights** (F7) > **User level** > **Login** (F1) (See Figure 1.3.1).
2. Press **Back** (F10) > **FILE MA** (F6).
3. Select the type of files to back up as required, e.g. **PARAM**, **PLC file** (see Figure 1.3.2).
4. Press **Change** (F9), and select **USB** as the target disk driver.
5. Press **Change** (F9) to return to the **SYS** disk driver.
6. Press **Backup** (F5). See Figure 1.3.3.

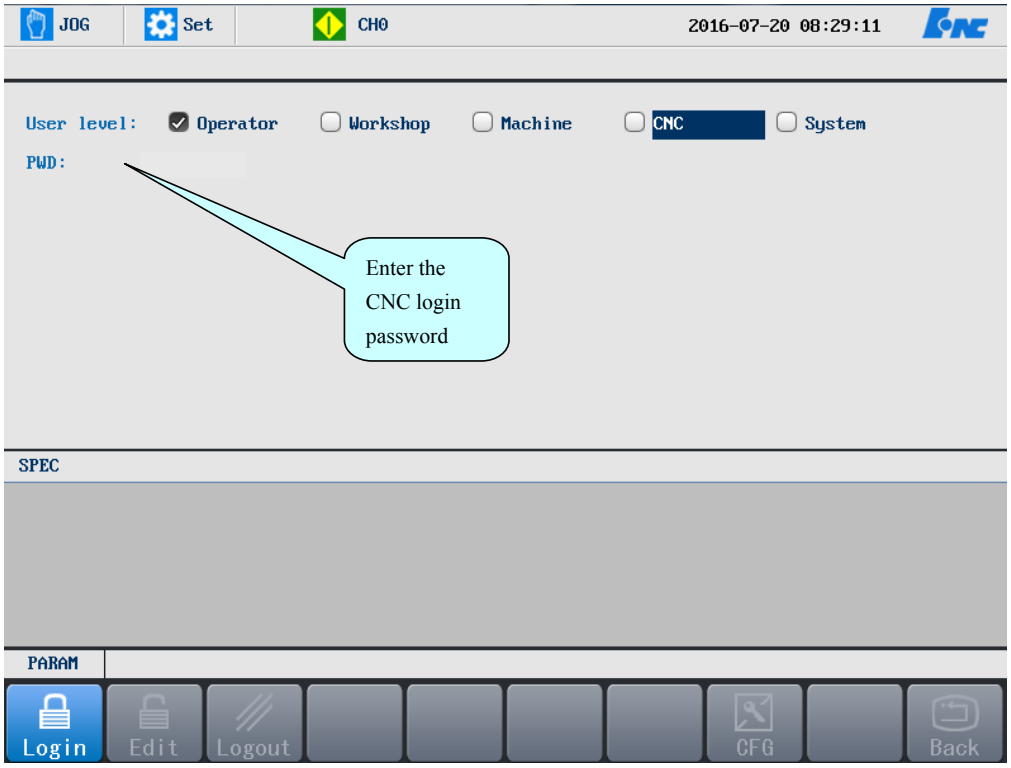


Figure 1.3.1 Login

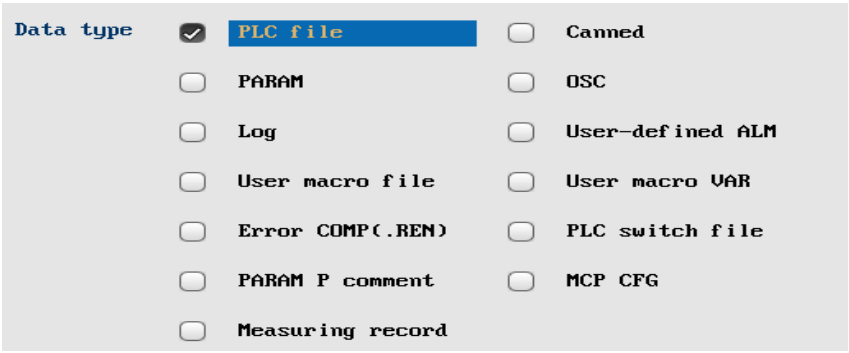


Figure 1.3.2 Select a file type to back up

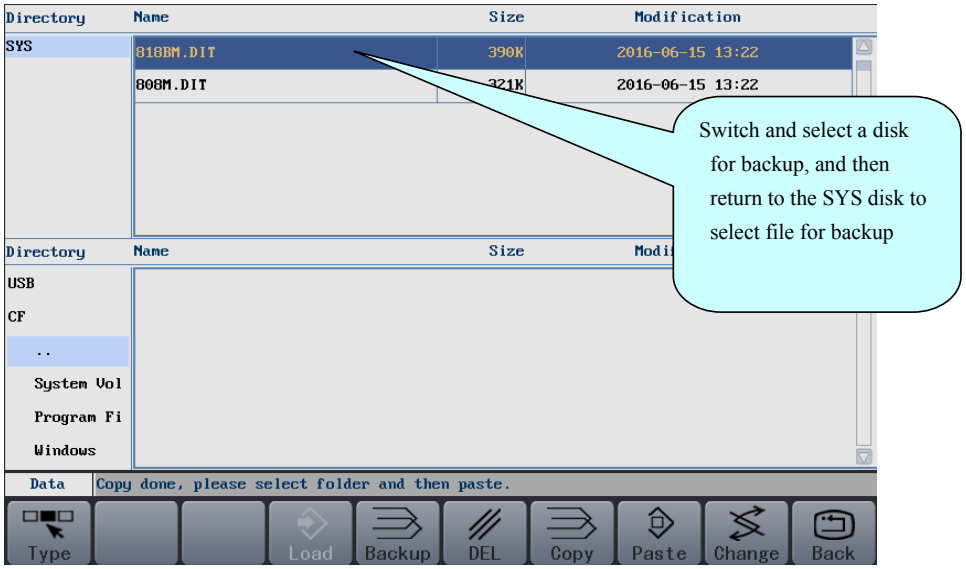
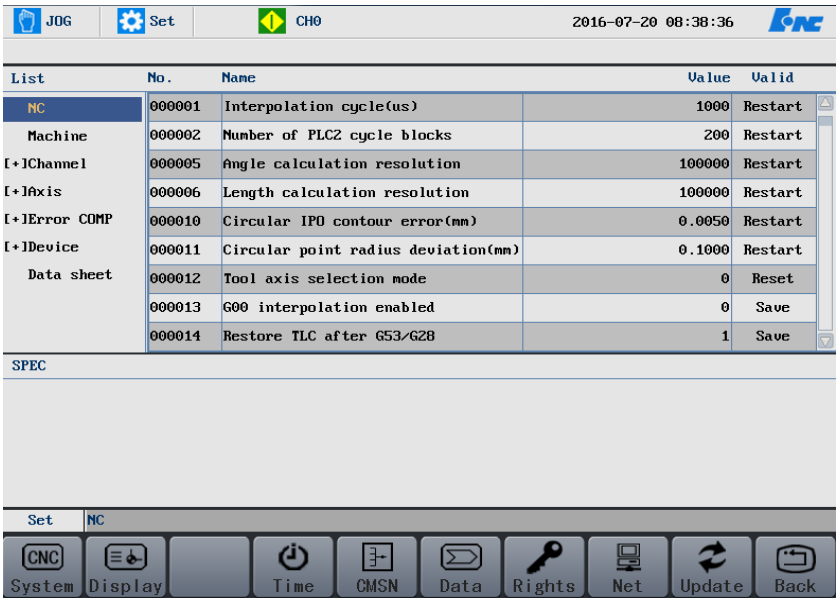


Figure 1.3.3 Switch window and select files

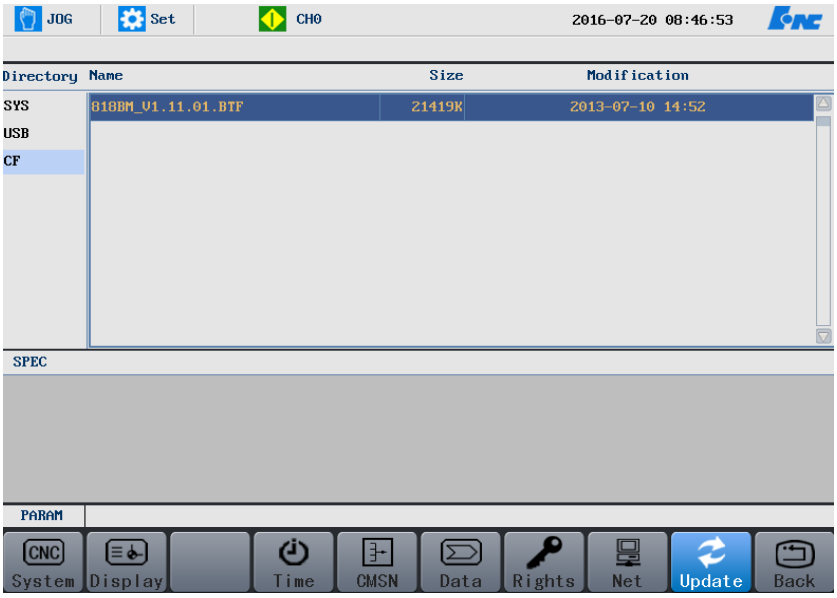
1.3.2 Software Update

Note: **For security reasons**, **it is recommended to disconnect the bus at the back of the system after PLC or parameter update**. **Otherwise**, **the machine may work improperly after rebooting as the standard PLC or parameters may be not compatible with the current machine**.

1. Press **Set** > **PARAM** (F10) > **SYS UPD**.

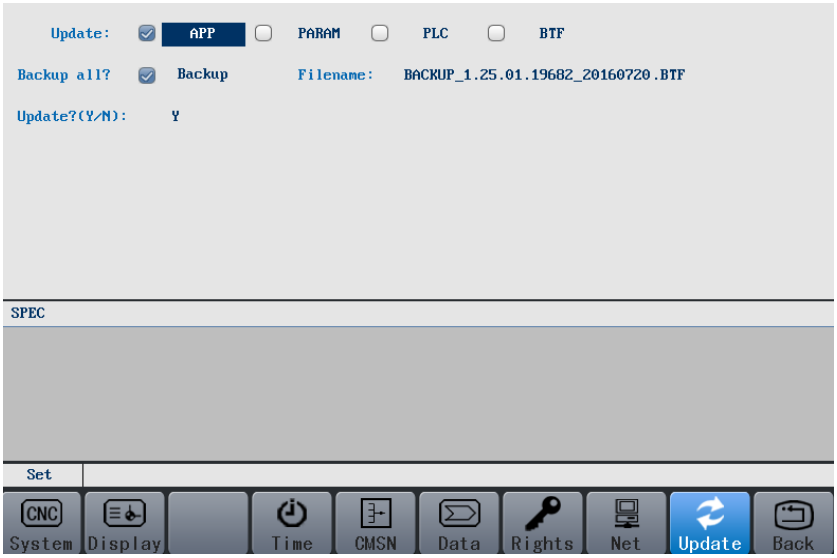


2. Select **USB**, find the BTF package to update, and press **Enter**.

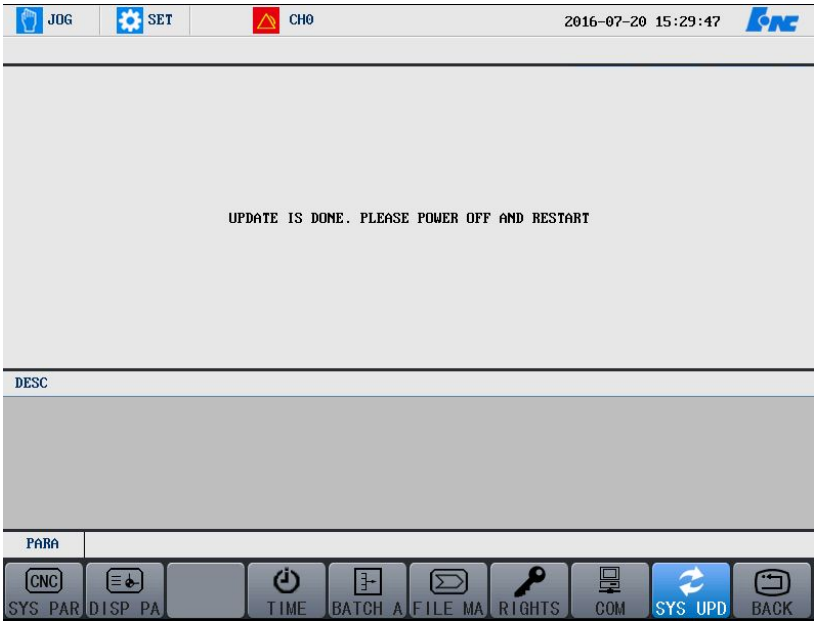


3. After entering into the update interface, users may choose to update the program, parameters, PLC or the entire BTF package as required. For example, if users need to update the BTF package, users may use the left and right key to select **APP**, **PARAM**,

PLC and press **Enter** to deselect these options (all options are selected by default), and then select **BTF** to update. See the figure below:



4. Press the down key to hover the cursor over "**Y**", and press **Enter** to start the update.
5. After the update is completed, cut off the power and restart the system. See the figure below:



6. After rebooting, if the BTF package or PLC is updated, users need to load the previous PLC to the system. If the BTF package or parameters are updated, users need to load the previous PLC to the system.

1.3.3 Load Parameters and PLC

Follow the instructions below to load parameters and PLC.

1. Press **Set** > **PARAM** (F10) > **Rights** (F7) > **User level** > **Login** (F1) (See Figure 1.3.1).
2. Press **Back** (F10) > **FILE MA** (F6).
3. Select the type of files to load as required, e.g. **PARAM**, **PLC file** (see Figure 1.3.2).
4. Press **Change** (F9), and select **USB** or **CF** as the source disk.
5. Use the "↑", "↓", "←", and "→" keys to select the files to load. See Figure 1.3.3.
6. Press **Load** (F4).

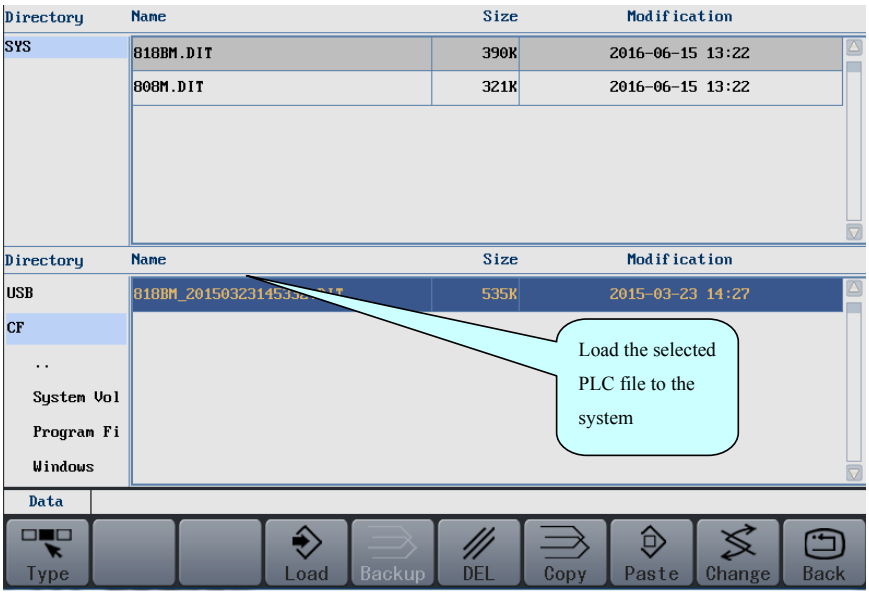
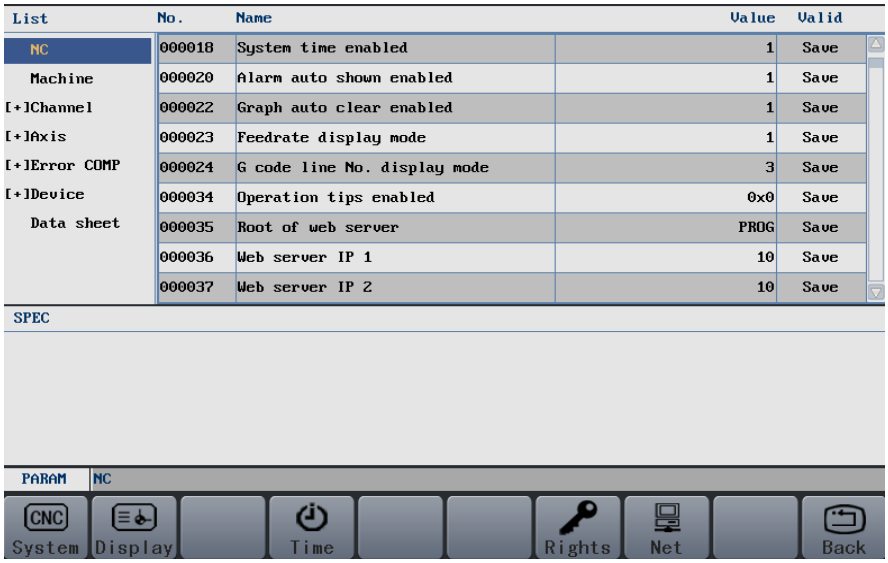


Figure 1.3.3 Back up PLC

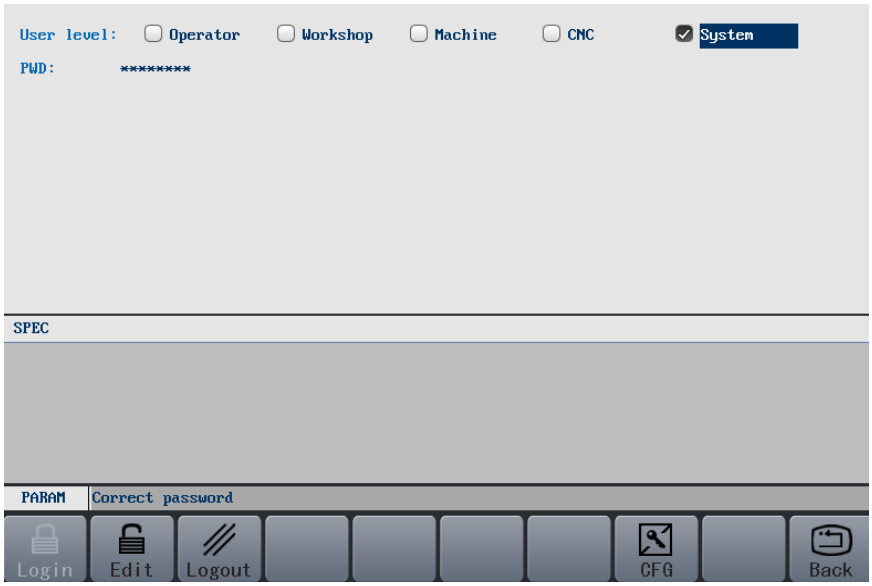
1.3.4 Batch Commissioning

HNC-8 system is configured with the standard batch commissioning features. This section describes the operation procedure of batch commissioning.

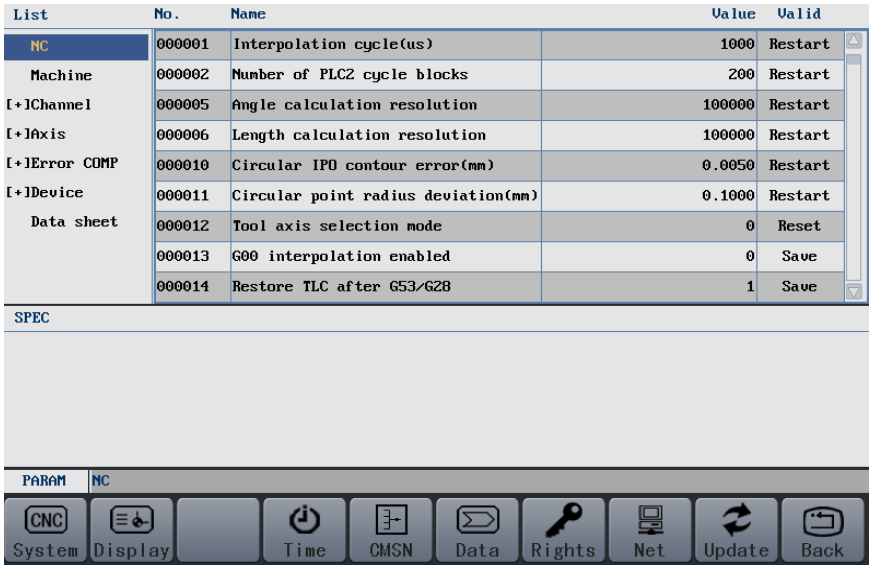
1. Enter the parameter interface.



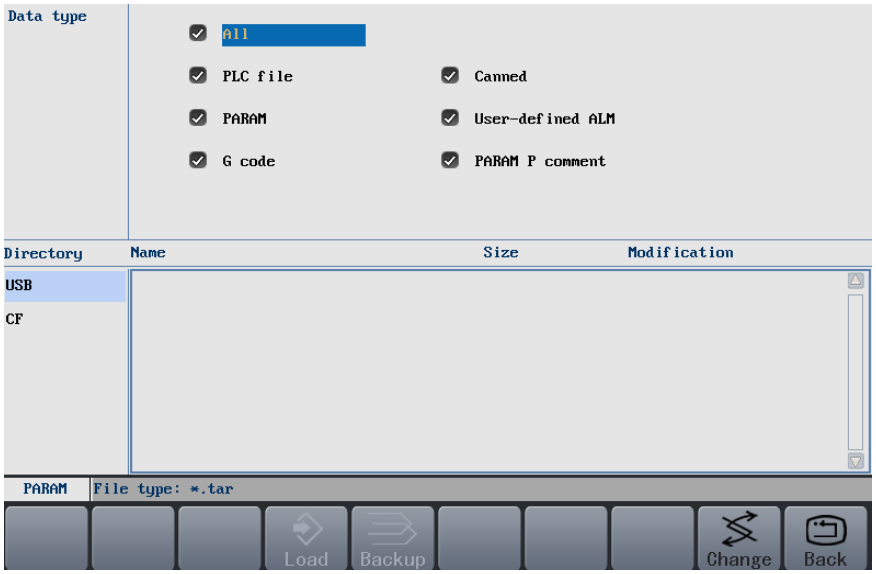
2. Press **Rights** to enter the rights management interface, select the **CNC** level, and enter the password (HIG). Press **Back** when the following screen appears:



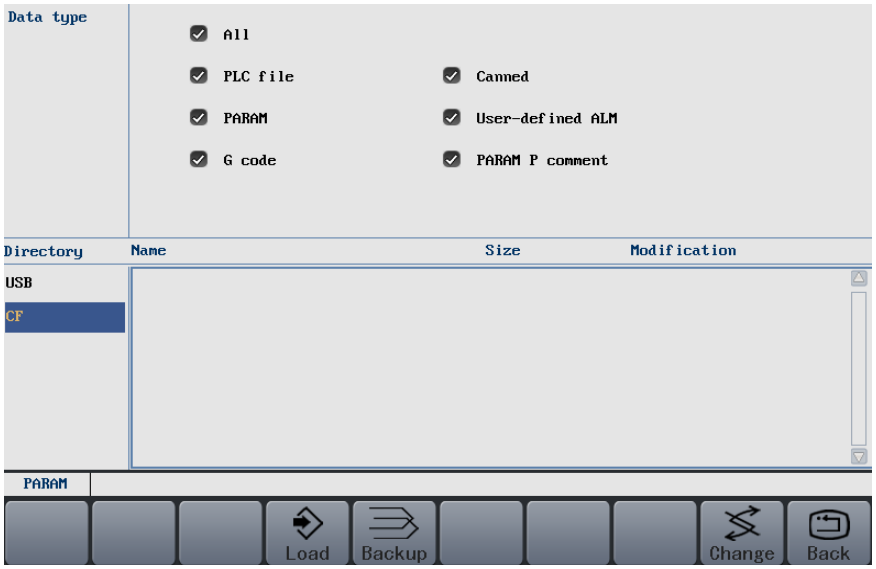
3. Press **CMSN** to enter the batch commissioning interface.



4. By default, the system will select all data types. Users may press **Enter** to cancel some data types.



5. Press **Change** to move the cursor to the lower left corner, use the Up and Down keys to move the cursor to the **USB** disk, and press the **Enter** key. After loading successfully, users may select to back up or load parameters.



6. This function is used to commission multiple machines. When a machine is commissioned to the best state, back up all parameters to the USB disk by referring to the steps above. Then insert the USB into a machine system that has not been commissioned, and load the backed up parameters from the USB to the system by referring to the steps above. The machine manufacturer can start testing the machine as the commissioning is completed.

Note: **To use the batch commissioning function**, **all electrical points and machine models of the commissioned machines must be the same**.

1.4 Offline Commissioning

It is recommended to conduct offline commissioning for drivers and motors before connection to prevent accidents, especially for large machine commissioning.

Follow the instructions below:

1. Place the drive or motor on a flat, secure location (e.g. ground).
2. Connect only the driver and the motor, set the driver to Internal Enable (for details, see "HSV-180UD AC Servo Driver User Manual"), and check the functioning.

   Note: For the absolute motor, if auto-rotation occurs upon power-on, then the motor requires returning to the reference point. For details, see "HSV-180UD AC Servo Driver

User Manual".

3. Connect the system to the driver, and connect the driver to the motor (For details, see "Hardware Connection User Manual"). See Figure 1.3. Restore the driver parameters to External Enable, and check if the network is normal by observing the driver LEDs or device interface parameters (for device interface parameters, see section 3.1). If some of the equipment are not displayed, users need to connect them one by one for troubleshooting.

Figure 1.3 Offline commissioning

Other tips for commissioning:

- Check if the U, V, W phase sequence of the power line is correct. For Golden Age's absolute motor, the phase sequence should be as U, W, and V. For Hua Da absolute motor, the phase sequence should be U, V, and W.
- Check if the CNC system can properly control the operation of the driver and motor, and if the working status of the driver and motor is stable and reaches the designed power.

4. Commission PLC, and check the emergency stop point. See section 6.4.

1.5 Power on Step-by-Step

Users should follow the step-by-step power on principle below in the pre-commissioning process to ensure the safety of the commissioning personnel and the machine, and to make it

easier to diagnose the problems encountered.

1. Power on the CNC system, and keep other components disconnected. Check the parameters and PLC, make sure the PLC is properly powered on, especially when brake exists on the gravity axis.
2. Power on the feed driver. Check if the device cable connections are correct, and if the driver is properly connected to the CNC system.
3. Power on the power unit (motor), and check
   - if the CNC system can properly control the motor
   - if the machine runs properly
   - If all limits are valid
4. Power on the spindle module, and check if the spindle speed is normal.
5. Power on the tool magazine module, and check if the tool change is proper.

1.6 Start-up Problems and Causes

This section describes the problems and causes after the HNC-8 system starts and goes to the Linux background.

1. Goes to the background with the information "Step 1/11: KernelInitErr".
   Cause: The system kernel failed to apply for memory.
   Solution: System memory troubleshooting
2. Goes to the background with the information "*Step 2/11: ReadCfgErr*".
   Cause: Read system configuration file **LNC32**.**CFG** error.
   Solution: Load the normal **LNC32.CFG f**ile.
3. Goes to the background with the information "*Step 3/11: NcguiErr*".
   Cause: No sufficient system memory. Failed to start the interface.
   Solution: System memory troubleshooting
4. Goes to the background with the information "*Step 3/11: BmpLoadErr*".
   Cause: No sufficient system memory. The initialization of the BMP module is abnormal.
   Solution: System memory troubleshooting
5. Goes to the background with the information "*Step 3/11: FontErr*"
   Cause: Failed to load the font library. There may be missing or damaged font library files.

Solution: Load the normal font library file.

6. Goes to the background with the information "*Step 4/11: ParmXmlLoadErr*".

   Cause: Failed to load the parameter configuration file **PARAM-CN.XML**.

   Solution: Reload the normal **PARM-CN.XML** file to the system.

Note: **Users may use the keyboard to input characters when the system goes to the background and the alarms above are reported**. **Because of the Linux system bugs**, **the input characters may not be displayed when the system goes to the Linux background for the first time**. **Users may manually start the CNC software when the power is kept on**, **and then the error information may be displayed after the system goes to the background again**.

The method to manually start the CNC software is as below:

- Input ***cd /h/lnc8*** on the **#** interface, and then press the **Enter** key.
- Input ***./n on*** the **#** interface, and then press the **Enter** key.

If the start interface is normal, **the exception information will be displayed in red on the interface**.

1. Display in red: 3-Interface initialization failure [2]

   Cause: The **BMP** file is damaged or missing.

   Solution: Replace the **BMP** file with a normal one.

2. Display in red: 4-Parameter initialization failure [2]

   Cause: The original file or the backup file is damaged (file verification failure), or the two files are inconsistent.

   Solutions:

   - Reboot the system and the alarm is cleared.
   - If the alarm is not cleared after the system reboots, enter the DT MGT interface, delete the backup file, and reboot the system again.
   - If the alarm cannot be cleared yet, users need to re-import a normal parameter file to the system.

3. Display in red: 5-Program manager initialization failure [-1]

   Cause: No sufficient system memory.

   Solution: System memory troubleshooting.

4. Display in red: 6-PLC initialization failure [-1]

   Cause: Failed to load the ladder file ***.DIT** to the system.

Solution: The ladder file is damaged.

5. Display in red: 7-Alarm module initialization failure [-2]

   Failed to open the syntax alarm file **SYTAX.ERR**.

   Solution: Import the normal **SYTAX.ERR** file to the system.

6. Display in red: 7-Alarm module initialization failure [-3]

   Cause: Failed to open the system alarm file SYS.ERR.

   Solution: Import the normal **SYS.ERR** file to the system.

7. Display in red: 8-Invalid data storage after last power failure. Please check the UPS power [0x0010].

   Cause: The data was not properly saved after the system is powered off.

   Solution: Make sure that the UPS is fully charged or change the abnormal UPS.

8. Display in red: 8-Data import module initialization failure [0x0001]

   Cause: The original system workpiece coordinate file **CAD.DAT** or the backup file is damaged (file verification failure), or the two data files are inconsistent.

   Solution: Restart the system to clear the alarm. If the alarm is not cleared after the system reboots, users need to reset the system workpiece coordinate, and then reboot the system.

9. Display in red: 8-Data import module initialization failure [0x0002]

   Cause: Failed to load the tool file DATA.DAT.

   Solution: Restart the system to clear the alarm; if the alarm is not cleared after the system reboots, users need to reset the tool data, and then reboot the system.

10. Display in red: 8-Data import module initialization failure [0x0004]

    Cause: Failed to load the Register B file **REG.DAT**.

    Solution: Restart the system to clear the alarm.

Note 1: **The different values in the items of 7**, **8**, **9**, **and10 represent different meanings**. **The values may be combined**.

Note 2: **The solutions to the items of 8**, **9**, **and 10 are similar to that in the item 2**. **Users may refer to item 2 for a problem solution**.

1. Display in red: 9-The gear ratio and encoder offset have not been set [0X0003].

   Cause: The axis' key parameters gear ratio and encoder offset have not been set. The value in the brackets indicates the mask of the axis with the problem.

Solution: Set the gear ratio and encoder offset parameters for the axis.

2. Display in red: 10-Motor position lost [0X0003]

   Cause: The difference between the motor position recorded when the power was off and the position when the motor is power on again exceeds the defined value. The value in the brackets indicates the mask of the axis with the problem.

   Solution: Press **Diagnosis** > **Help** to conduct troubleshooting.

3. Display in red: 11-GUI module initialization failure [3]

   Cause: Insufficient system memory. Failed to initialize the GUI related module.

   Solution: System memory troubleshooting.

2 Hardware Connection

HNC-8 CNC systems currently include HNC-8 A/B/C series. These systems use the NCUC bus interface, and need to be used with servo drivers and bus I/O modules.

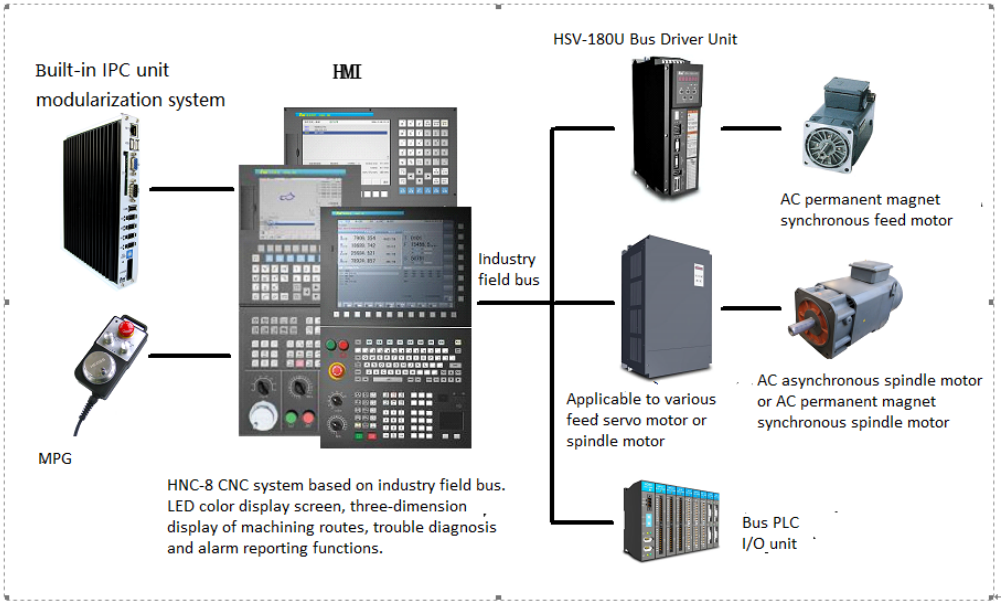


Figure 2 Wiring diagram for HNC-8 CNC system

2.1 Connection Requirements

HNC-8 CNC system require power supply with UPS function (HPW-145U). The HPW-145U power supply is used only for the communications equipment of the CNC system and Bus I/O unit. It cannot be used for the input or output panel of the Bus I/O unit. Otherwise, the system may not be able to start or the PLC signal may not be stable because of insufficient UPS power supply. For detailed information about the power supply of Bus I/O, see Section 2.5.

When the CNC system restarts after power off, different power-off intervals are required, depending on the machine electrical connection modes. If only the CNC system is power off, but the driver is still power on, users may power on the system again 5 seconds later. If the CNC system and the driver are power off simultaneously, users cannot power on the system again until the driver completes the electrical discharge. In this case, the power-off interval is the configured discharge time of the driver.

The discharge time for drivers are as below:

1. Low voltage driver (160U series 75 A or below): 15 s
2. High voltage driver

- 180U-075: 30 s
- 180U-100/150: 25 s
- 180U-200/300/450: 50

Compared with the traditional pulse interface systems, the bus architecture allows less interconnection cables and very convenient wiring for HNC-8 CNC systems.

The IPC unit is the core device for the bus connection, similar to the network server. This unit has an interface as shown in Figure 2.1.1.

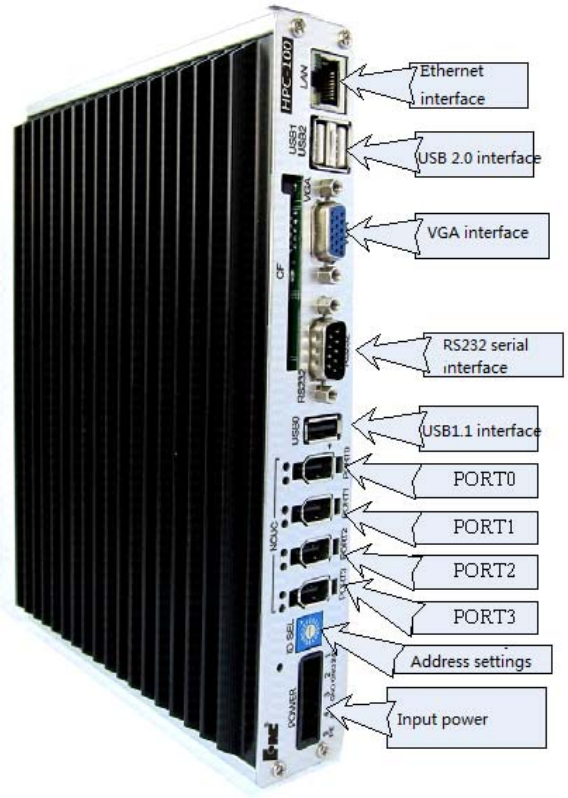


Figure 2.1.1 IPC unit interfaces

We provide users with a standard set of parameters and PLC. It is recommended to perform wiring accordance with the standard (see Figure 2.1.2) to ensure a very high commissioning efficiency.

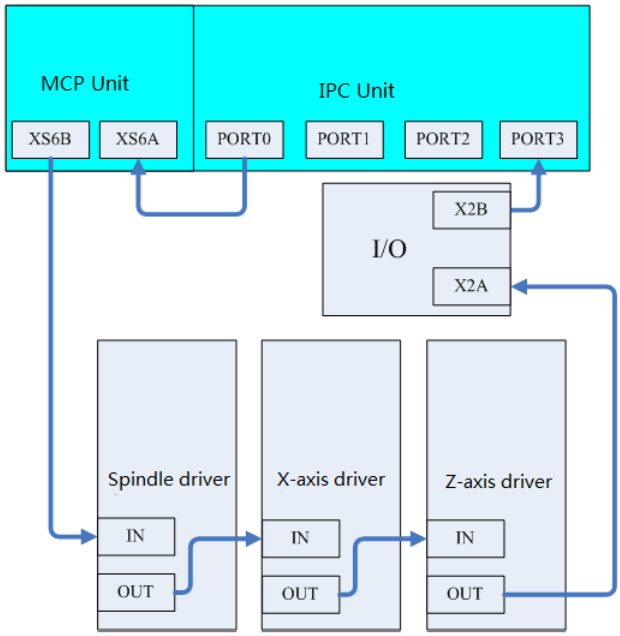


Figure 2.1.2 Wiring for turning machines

2.2 Typical Connection for Turning CNC System

The typical connection of HTC-8 CNC system with the Bus I/O unit and servo driver is as shown in Figure 2.2.1.

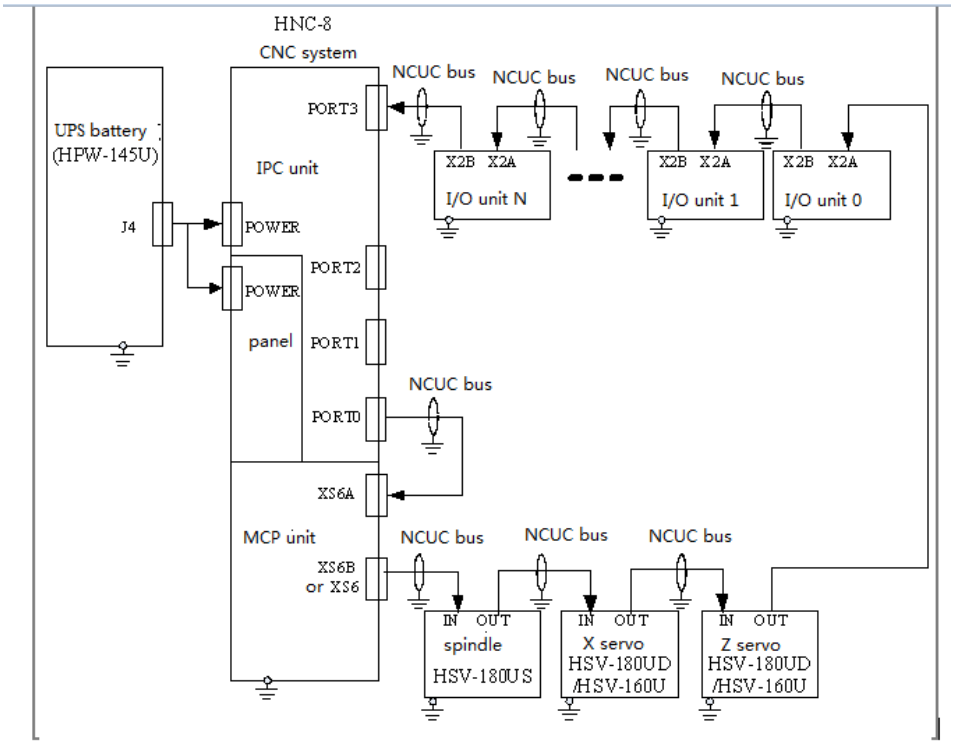


Figure 2.2.1 Typical connection of HTC-8 series with the Bus I/O unit and servo driver

2.3 Connection of Drivers

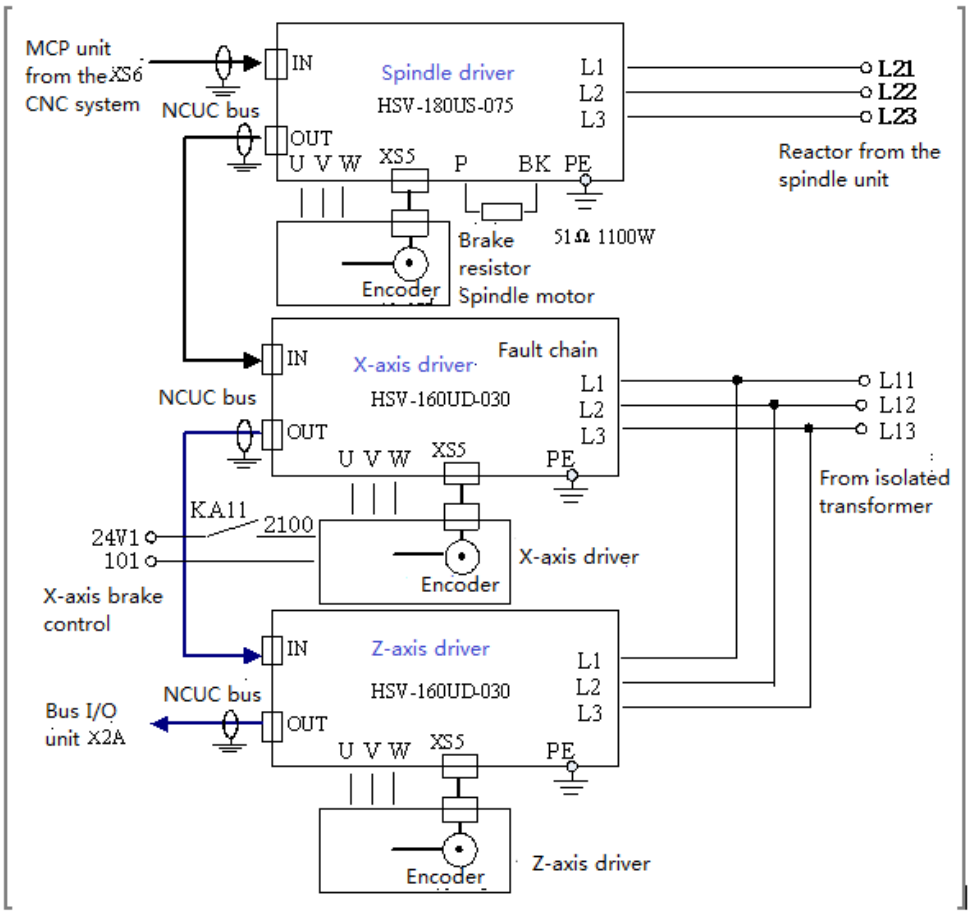


Figure 2.3.1 Connection of drivers

The cable connection of the NCUC bus is as shown in Figure 2.3.2.

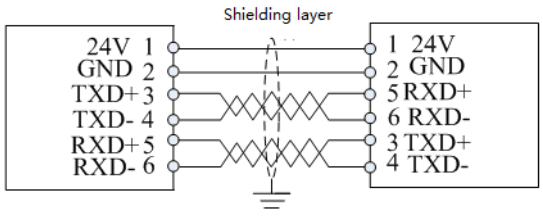


Figure 2.3.2 Cable connection of the NCUC bus

Note: **Users cannot use the UPS power supply during hardware connection**.

Users cannot use the UPS power to connect relay devices for the sake of convenience.

Otherwise, **a black screen may appear because of low voltage (24 volts)**.

2.4 Bus I/O Unit

Introduction to the Bus I/O unit:

1. A maximum of 16 I/O units can be expanded via the bus.
2. Different backplane sub-modules can be used to establish two kinds of I/O units. The HIO-1009 backplane sub-module provides a communication sub-module slot and eight functional sub-module slots. The corresponding established I/O unit is called HIO-1000A Bus I/O unit. The HIO-1006 backplane sub-module provides a communication sub-module slot and five functional sub-module slots. The corresponding established I/O unit is called HIO-1000B I/O Bus unit.
3. The functional sub-module includes digital input/output sub-modules, analog input/output sub-module, and axis control sub-module.
   - Digital input/output sub-module: provides 16-channel digital input or output signals.
   - Analog input/output sub-module: provides 4-channel A/D signals and 4-channel D/A signals.
   - Axis control sub-module: provides two axis control interfaces, including pulse command, analog command, and encoder feedback interface.
4. The digital input sub-module may use the NPN or PNP interface, while the output sub-module may use the NPN interface. Each digital has an indicator.

The name and model of each sub-module is as below:

Name		Model	Description
Backplane	9-slot backplane sub-module	HIO-1009	Provide one communication sub-module slot and eight functional sub-module slots
	6-slot backplane sub-module	HIO-1006	Provide one communication sub-module slot and five functional sub-module slots
Network	NCUC communication	HIO-1061	Mandatory (FireWire communication mode)

	sub-module (1394-6 FireWire)		Supported System: HNC-8 series
	NCUC communication sub-module (SC fiber interface)	HIO-1063	Mandatory (Optical communication mode) Supported System: HNC-8 series
Axis control	Incremental pulse axis control sub-module	HIO-1041	Optional. Each sub-module provides two axis control interfaces. Each interface includes: • Pulse commands • D/A analog voltage commands • Encoder feedback commands
	Absolute axis control sub-module	HIO-1042	Optional. Each sub-module provides two axis control interfaces.
Analog value	Analog input/output sub-module	HIO-1073	Optional. Each sub-module provides four-channel analog input and four analog output.
Digital value	NPN digital input sub-module	HIO-1011N	Optional. Each sub-module provides 16 NPN PLC digital input signal interface, valid for low level.
	PNP digital input sub-module	HIO-1011P	Optional. Each sub-module provides 16-channel PNP PLC digital input signal interface, valid for high level.
	NPN digital output sub-module	HIO-1021N	Optional. Each sub-module provides 16 NPN PLC digital output signal interface, valid for low level.

Table 2.4 Description of HIO-1000 sub-module models

The Bus I/O interface and the sub-module interfaces (HIO-1000A and HIO-1000B) are as shown in Figure 2.4.1 and Figure 2.4.2.

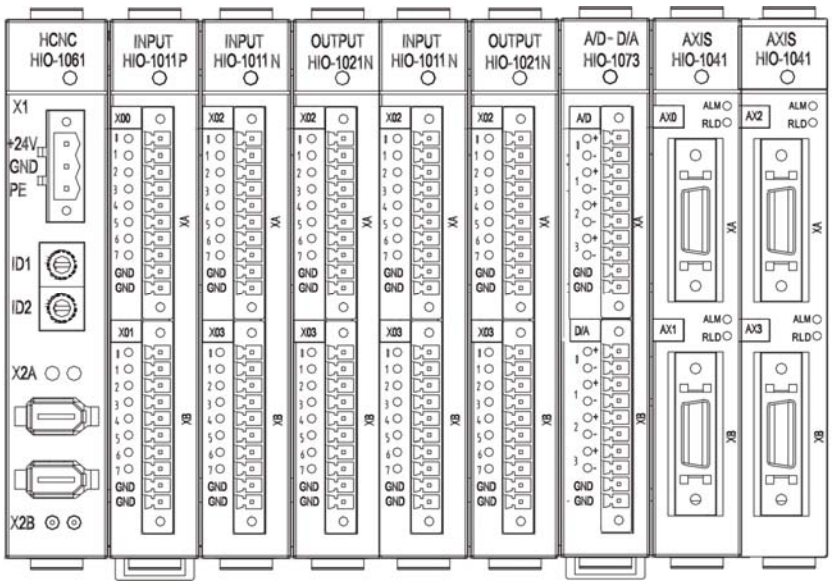


Figure 2.4.1 HIO-1000A I/O Bus interfaces

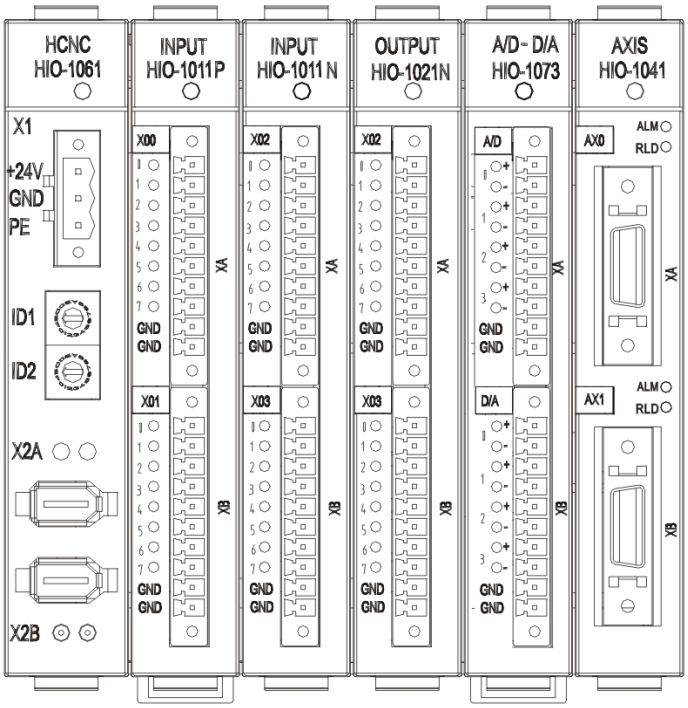


Figure 2.4.2 HIO-1000B Bus I/O interfaces

The electrical connection of HIO-1011 PNP input panel, HIO-1011NPN input panel, and HIO-1021NPN output panel on the Bus I/O is as shown in Figure 2.2.3.

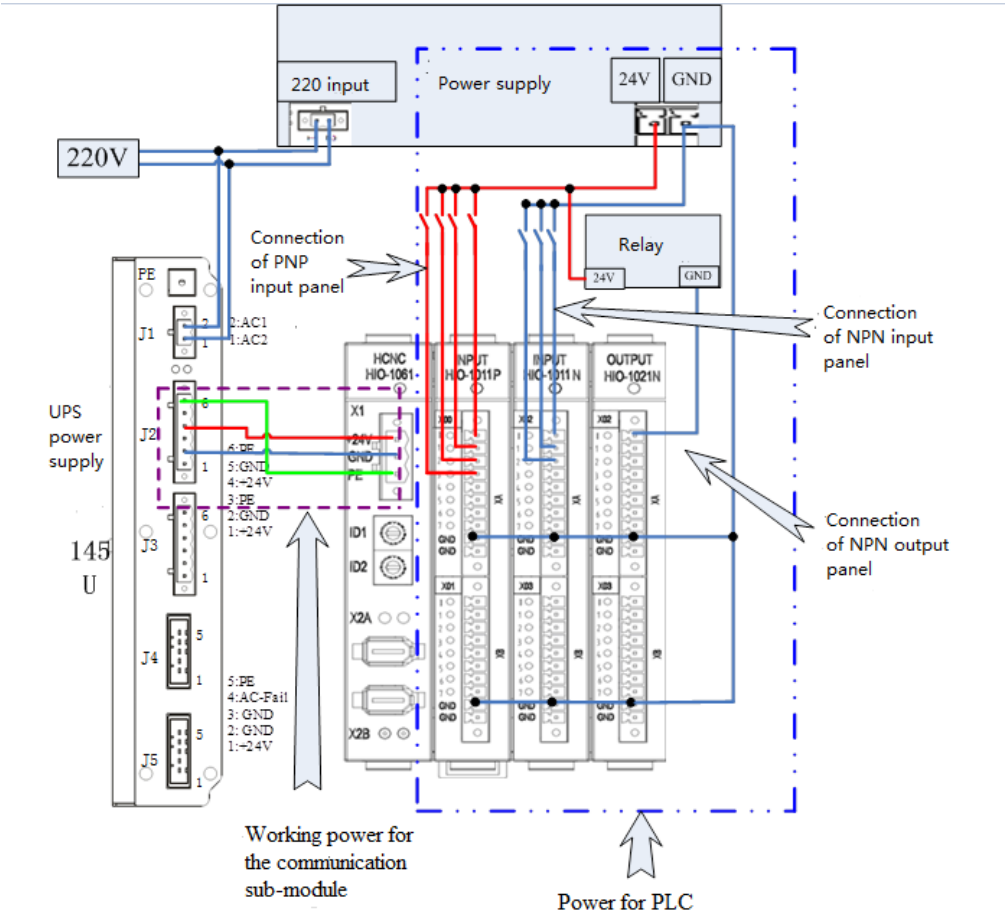
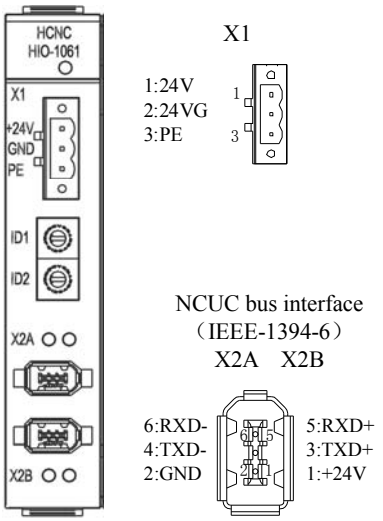


Figure 2.2.3 Bus I/O electrical connection diagram

2.4.1 Functions and Interfaces of Communication Sub-module

The communication sub-module (HIO-1061) is responsible for the communication (X2A, X2B interfaces) with the HNC-8 series CNC system, and provides the power input interface (X1 interface). The external output power should not be less than 50 W. The functions and interfaces are as shown in Figure 2.4.4.



Signal	Description
24 V	DC 24 V power
24VG	DC 24 V power grounding
PE	Earth grounding

Signal	Description
24 V	DC 24 V power
GND	
TXD+	Data sending
TXD-	
RXD+	Data sending
RXD-	

Figure 2.4.4 Communication sub-module interfaces

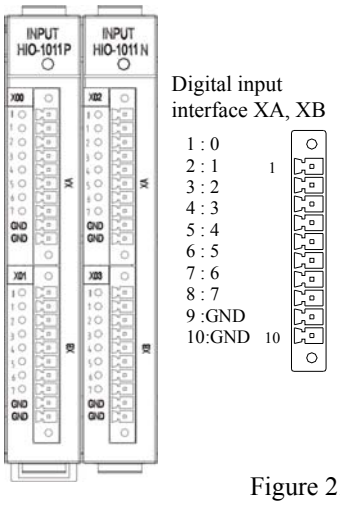
Note: **The power introduced by the communication sub-module is used as the working power for the Bus I/O unit**. **Different power supply should be used for the Bus I/O and the external circuits (e.g**. **PLC circuit, non-contact switch**, **travel switch**, **relays**, **etc**.**) related to the input/output sub-modules**. **The latter is also called as PLC power supply**. **See Figure 2.2.3**.

Note: **The GND terminal of the input/output sub-modules should be reliably connected to the power ground of the PLC circuit**.

2.4.2 Functions and Interfaces of Digital Input/Output Sub-modules

- Functions and interfaces of digital input sub-modules

Digital input sub-module consists of NPN (HIO-1011N) and PNP (HIO-1011P) models. The difference is: The NPN type is valid for low level while the PNP type is valid for high level (+ 24 V). Each digital input sub-module provides 16-channel digital signal input. The digital input interface XA, XB (gray) is defined as shown in Figure 2.4.5.



Digital input interface XA, XB

1 : 0
2 : 1
3 : 2
4 : 3
5 : 4
6 : 5
7 : 6
8 : 7
9 :GND
10:GND

Signal	Description	
	HIO-1011N XA, XB	HIO-1011P XA, XB
0-7	NPN input N0-N7 Valid for low level	PNP input P0-P7 Valid for high level
GND	DC24V grounding	

Figure 2.4.5 Digital input sub-module interfaces

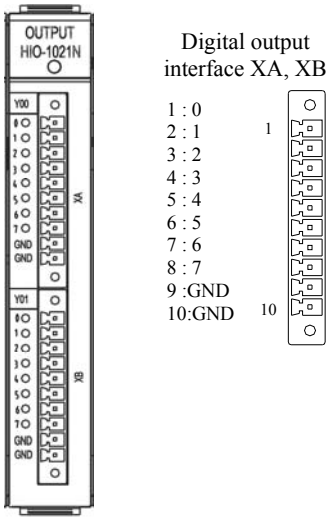
Note: The GND terminal of the input/output sub-modules should be reliably connected to the power ground of the PLC circuit.

As shown in the figure above, two input modules will find one IO_NET device. As the I/O box requires dongle functions, 10 groups of I/O input parameters must be set as a unit currently. See the figure below:

509014	Initial GP No. of output point	0	Restart
509015	No. of output point group	10	Restart

- Functions and interfaces of digital output sub-modules

The digital output sub-module (HIO-1021N) is the NPN model, valid for low level. Otherwise, the output is in the high impedance state. Each digital output sub-module provides 16-channel digital signal output. The digital output interfaces XA, XB (black) is defined as shown in Figure 2.4.6.



Signal	Description
0-7	NPN output O0-O7 Valid for low level
GND	DC24V grounding

Figure 2.4.6 Digital output sub-module interfaces

Note: The GND terminal should be reliably connected to the power ground of the PLC circuit.

As shown in the figure above, one output module will find one IO_NET device. As the I/O box requires dongle functions, 10 groups of I/O output parameters must be set as a unit currently. See the figure below:

509014	Initial GP No. of output point	0	Restart
509015	No. of output point group	10	Restart

2.4.3 Functions and Interfaces of Analog Input/Output Sub-Modules

The analog input/output (A/D-D/A) sub-module (HIO-1073) is used to output the A/D signal from the machine to the CNC system and the D/A signal from the CNC system to the machine. Each A/D-D/A sub-module provides four-channel 12-bit differential/single-terminal analog input and output. The A/D input interface is XA (green) and the D/A output interface is XB (orange). The interfaces are as shown in Figure 2.4.6.

If two input modules, one output module, and one AD/DA module are connected to one I/O box, then the system will find two IO_NET devices. The first IO_NET device has two input modules and one output module, while the second IO_NET device is the AD/DA module. As the I/O box requires dongle functions, 10 groups of input/output devices are required both for

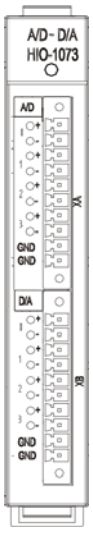
the first and second IO_NET device. See the figure below:

List	No.	Name	Value	Valid
Device4	509000	Device name	AX	Cure
Device5	509002	Device type	2002	Cure
Device6	509003	Device No. in same group	3	Cure
Device7	509010	Working mode	0	Restart
Device8	509011	Logical AX No.	0	Restart
Device9	509012	Encoder feedback negation mark	0	Restart
Device10	509013	Reserved	10	Restart
Device11	509014	Feedback POS cycle mode	0	Restart
Device12	509015	Feedbak POS cycle pulse	10	Restart

Device 9 in the first IO_NET device: two input and one output modules

Device2	510000	Device name	IO_NET	Cure
Device3	510002	Device type	2007	Cure
Device4	510003	Device No. in same group	1	Cure
Device5	510010	Reserved[0]	0	Restart
Device6	510011	Reserved[1]	0	Restart
Device7	510012	Initial GP No. of input point	10	Restart
Device8	510013	No. of input point group	10	Restart
Device9	510014	Initial GP No. of output point	10	Restart
Device10	510015	No. of output point group	10	Restart

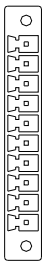
Device 10 in the second IO_NET device: AD/DA module parameters



A/D input interface

XA

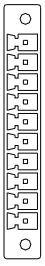
1: 0+
2: 0-
3: 1+
4: 1-
5: 2+
6: 2-
7: 3+
8: 3-
9: GND
10:GND



Signal	Description
0+, 0-	4-channel A/D input A/D0-A/D3 (Input range: -10 V to +10 V)
1+, 1-	
2+, 2-	
3+, 3-	
GND	Grounding

D/A output XB

1: 0+
2: 0-
3: 1+
4: 1-
5: 2+
6: 2-
7: 3+
8: 3-
9: GND
10:GND



Signal	Description
0+, 0-	4-channel D/A output D/A0-D/A3 (Output range: -10 V to +10 V)
1+, 1-	
2+, 2-	
3+, 3-	
GND	Grounding

Figure 2.2.6 Analog input/output sub-module interfaces

2.4.4 Functions and Interfaces of Axis Control Sub-Modules

The axis control sub-module (HIO-1041) provides 2-channel spindle analog interface and 2-channel pulse feed-axis interface. The axis control interfaces are XA and XB (26-core high-density). The interfaces are shown in Figure 2.4.7.

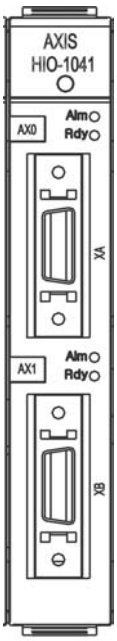
If the first 10 groups of devices (X/Y) are used for the input/output, then the initial group number of the second I/O device should start from 0 while the initial group number of the first I/O device should start from 10. See the figure below:

Device2	510000	Device name	IO_NET	Cure
Device3	510002	Device type	2007	Cure
Device4	510003	Device No. in same group	1	Cure
Device5	510010	Reserved[0]	0	Restart
Device6	510011	Reserved[1]	0	Restart
Device7	510012	Initial GP No. of input point	0	Restart
Device8	510013	No. of input point group	10	Restart
Device9	510014	Initial GP No. of output point	0	Restart
Device10	510015	No. of output point group	10	Restart

Device 10 in the second IO_NET device: two input and one output modules

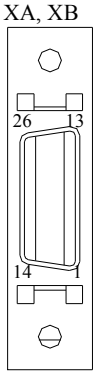
Device2	509000	Device name	IO_NET	Cure
Device3	509002	Device type	2007	Cure
Device4	509003	Device No. in same group	0	Cure
Device5	509010	Reserved[0]	0	Restart
Device6	509011	Reserved[1]	0	Restart
Device7	509012	Initial GP No. of input point	10	Restart
Device8	509013	No. of input point group	10	Restart
Device9	509014	Initial GP No. of output point	10	Restart
Device10	509015	No. of output point group	10	Restart

Device 9 in the first IO_NET device: axis control panel

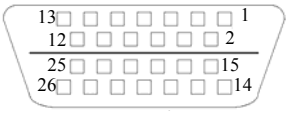


Axis control interface

XA, XB



26:NC	13:DIR-
25:5V	12:DIR+
24:5VG	11:CP-
23:NC	10:CP+
22:S-EN	9:24VG
21:S-MS	8:PZ-
20:NC	7:PZ+
19:NC	6:PB-
18:NC	5:PB+
17:NC	4:PA-
16:S-RDY	3:PA+
15:24VG	2:Vcmd1-
14:24V	1:Vcmd1+



Pin sequence (looking from the soldering lugs of the plug)

Signal	Description	Signal	Description
Vcmd1+, Vcmd1-	Analog output (-10 V to +10 V)	24VB	DC24V
PA+, PA-	Encoder A-phase feedback signal	S-RDY	Ready
PB+, PB-	Encoder B-phase feedback signal	S-MS	Switch mode
PZ+, PZ-	Encoder Z-phase feedback signal	S-EN	Enable
24 V, 24VG	DC24V power	5 V, 5VG	DC5V Power
CP+, CP-	Command pulse output (A phase)	NC	Blank
DIR1+, DIR1-	Command direction output (B phase)		

Figure 2.4.7 Axis control sub-module interfaces

3 Parameter Settings for Turning CNC System

3.1 Parameters

3.1.1 Parameter Numbers

The parameter numbers (IDs) for each type of parameters of HNC-8 CNC system is described in the table below:

Parameter Type	ID	Description
NC parameter	000000-009999	A total of 10000 IDs
Machine user parameters	010000-019999	A total of 10000 IDs
Channel Parameters	040000-049999	A total of 1000 IDs for each channel
Axis parameters	100000-199999	A total of 1000 IDs for each axis
Error compensation parameter	300000-399999	A total of 1000 IDs for each axis
Device interface parameters	500000-599999	A total of 1000 IDs for each device
Data table parameter	700000-799999	A total of 100000 IDs

- The NC parameters are the basic parameters of the CNC system, which are used to set interpolation cycle, operation resolution, etc.
- The machine user parameters are used to set the machine structure (e.g. turning machine or milling machine), channel count, etc.
- The channel parameters are used to set the parameters related to each channel. Channels are used to execute interpolation motion. Different channels can be used for different interpolation motions, and there is no interference between channels. Dual-channel means to perform two different kinds of interpolation motion at the same time.
- The axis parameters are used to set the parameters related to the logic axis in channels.
- The error compensation parameters are used to set the backlash and pitch error compensation related parameters (e.g. pitch error).

- The device interface parameters are used to set the parameters related to physical devices, e.g. axis, I/O.
- The data table parameters are used to set the data table related to error compensation and temperature.

3.1.2 Data Types of Parameters

The data types of HNC-8 CNC system parameters include:

- INT4: The parameter value must be an integer.
- BOOL: The parameter value must be **0** or **1**.
- REAL: The parameter value can be an integer or decimal.
- STRING: The parameter value is a string of one to seven characters.
- HEX 4: The parameter is input or displayed in the hexadecimal mode.
- ARRAY: The parameter is input or displayed in the array mode. The data is separated with a comma (,) or a period (.) symbol. The array value ranges from 0 to 127.

3.1.3 Parameter Access Level and Modification Permission

- For each level of parameters, users need to enter a password to log in, and then they may modify and save the parameters.
- In general, a user with higher permission may modify the parameters requiring relatively lower permission.
- Solid parameters (access level 5) cannot be modified by users. The parameters are automatically configured by the CNC system (factory-value).
- The table below describes the parameter access levels:

Parameter Access Level	Users	Symbol
1	Common users	ACCESS_USER
2	Machine manufacturer	ACCESS_MAC
3	CNC manufacturer	ACCESS_NC
4	Administrator	ACCESS_RD
5	Solid	ACCESS_VENDER

3.1.4 Parameter Validity Modes

The validity modes for HNC-8 CNC systems are as below:

- Valid after saving: valid after saving the parameter modification
- Valid immediately: valid immediately after the parameter modification (mainly for servo parameter modification)
- Valid after Reset: valid after saving the parameter modification and pressing the Reset key
- Valid after restarting: valid after saving the parameter modification and restarting the CNC system

3.2 Verify Device Parameters

3.2.1 Device Parameters

Users need to verify the device configuration parameters after the hardware connection is completed and the system is powered on for the first time. If the displayed parameter indicates that no corresponding device is found, users need to check the hardware connection.

Choose **Set** > **PARAM** (F10) > **SYS PAR** (F1) > **CFG** (F8) to check the connection.

Note: Users need to input the user password. For details, see Section 3.3.

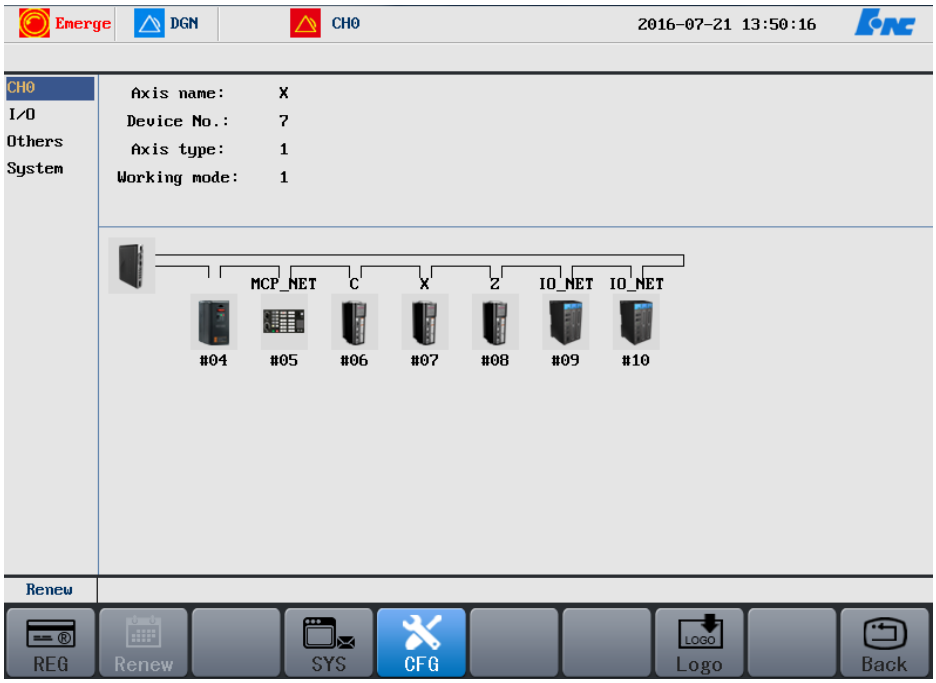


Figure 3.2.1 Device parameters

3.2.2 Axis Number and Device Number

The axis number refers to the logical axis number in the CNC system, and the device number refers to the number of physical devices on the bus. The sequence of the devices that are found may be different based on the bus wiring.

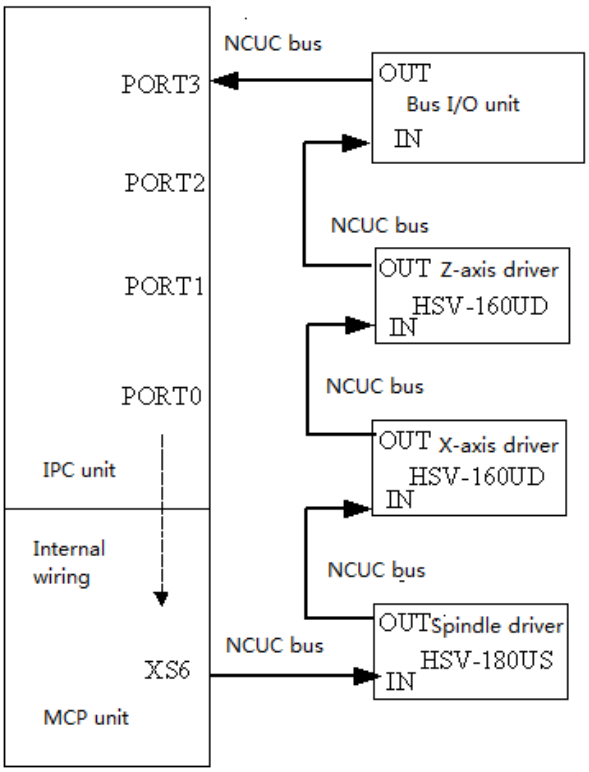
The device types supported by HNC-8 systems are as below:

Device Type	Device Name	Device Model	Connection Mode	Symbol
Reserved	RESERVE	1000	----	保留
Analog spindle	SP	1001	Local	
Local I/O module	IO_LOC	1007	Local	
Local control panel	MCP_LOC	1008	Local	
Manual pulse generator	MPG	1009	Local	
NC keyboard	NCKB	1010	Local	
Servo axis	AX	2002	Bus	
Bus I/O module	IO_NET	2007	Bus	
Bus I/O control panel	MCP_NET	2008	Bus	
PID control panel	PIDC	2012	Bus	
Encoder interface	ENC	2013	Bus	

If the bus connection of HNC-818B turning system is as shown in the figure below, then we

can see that:

- the MCP keyboard unit corresponds to the device number 5
- the spindle corresponds to the device number 6
- the axis X corresponds to the device number 7
- the axis Z corresponds to the device number 8
- the I/O unit corresponds to the device number 9



For a standard turning machine, the relationship between the axis number and the device number is as below:

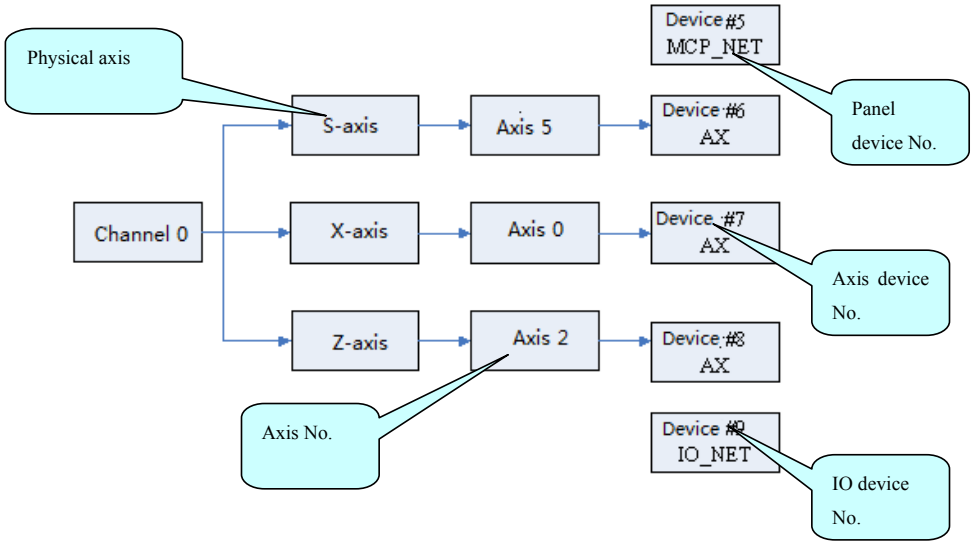


Figure 3.2.2 Relationship between axis No. and device No.

3.3 Parameter Setting Procedure

The operation procedure for parameter settings is as below:

1. Choose **Set** > **PARAM** (F10) > **Rights** (F7).
2. Use "←" or "→" to select a user level, press Login, enter the correct password, and then press Enter. If the symbol "√" is displayed next to the user, the user has successfully logged in. The system provides operation instructions on the interface. See Figure 3.3.1.
3. Press F10 to return to the previous window, and select **SYS PAR** (F1).
4. Use "↑" or "↓" to select a parameter type, and press **Enter** to expand the options. See Figure 3.3.2.
5. Use "→" to switch to the parameter window, and change the parameter value as required.
6. The system provides detailed description for each parameter. See Figure 3.3.3

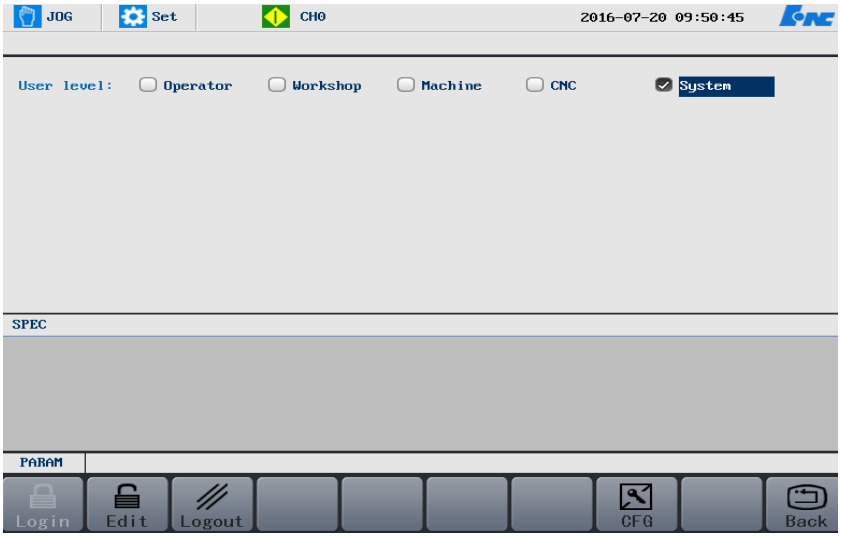
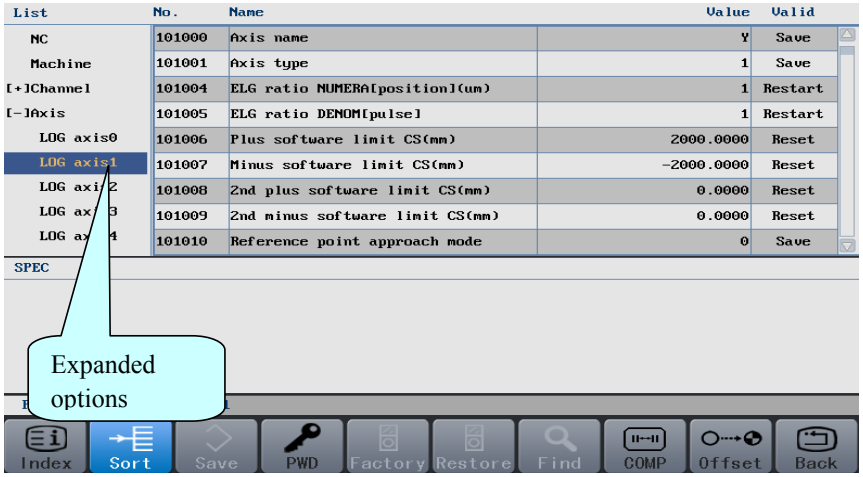


Figure 3.3.1 Login rights



3.3.2 Expanded options (second level)

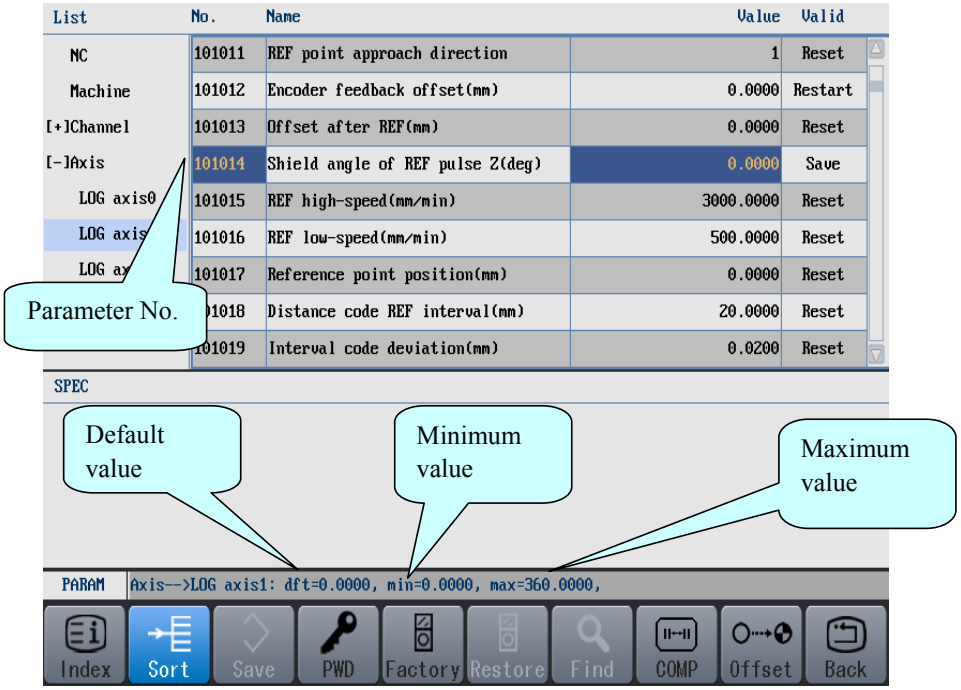
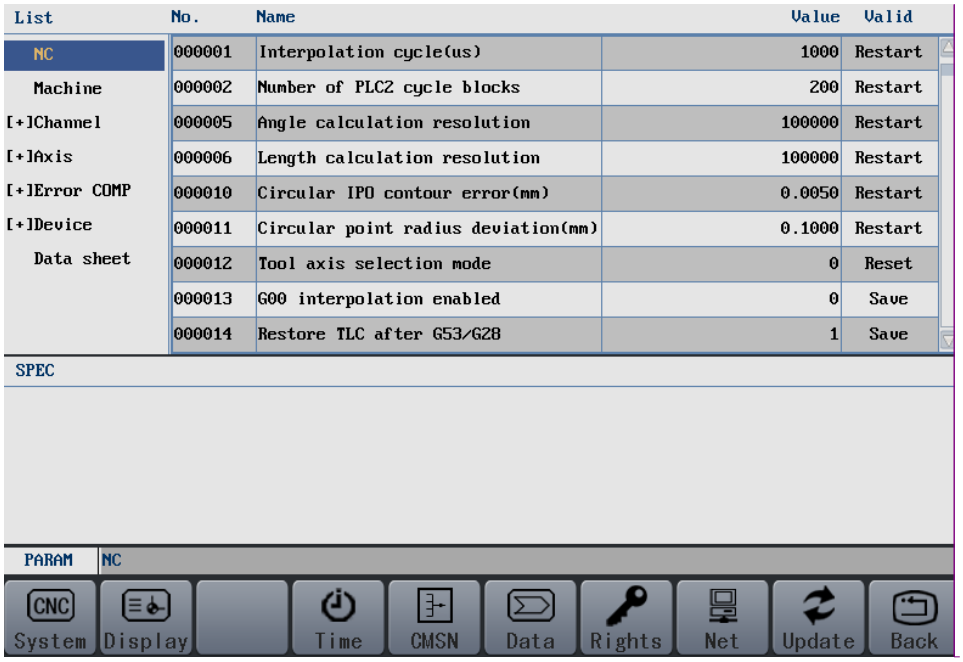


Figure 3.3.3 Value range

3.4 Parameter Settings for HNC-8 Turning System

3.4.1 Setting NC Parameters



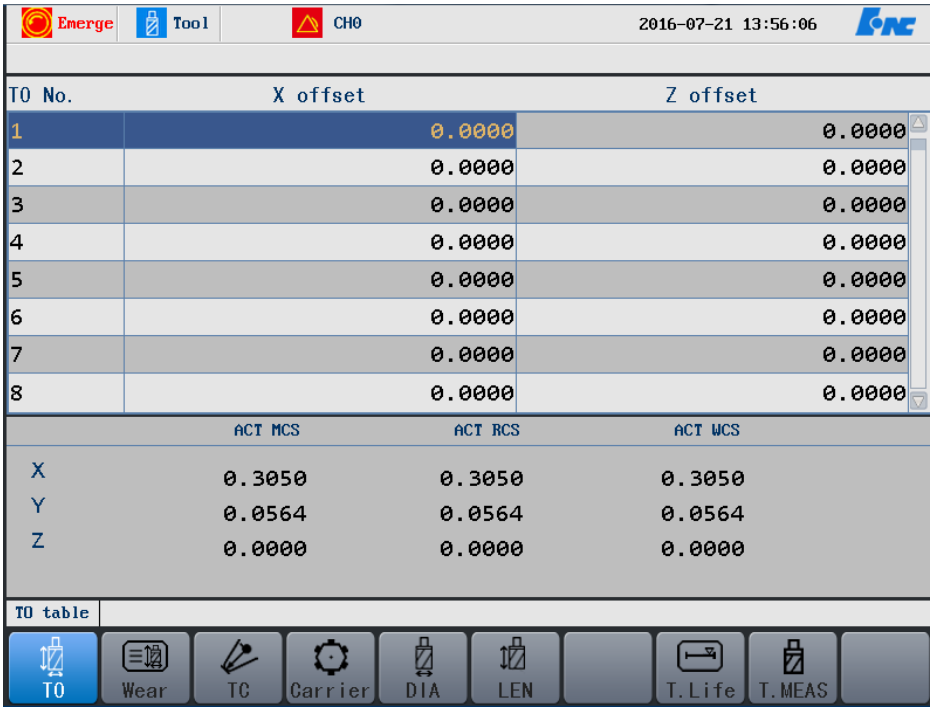
批注 [l2]: 图和实际内容对不上

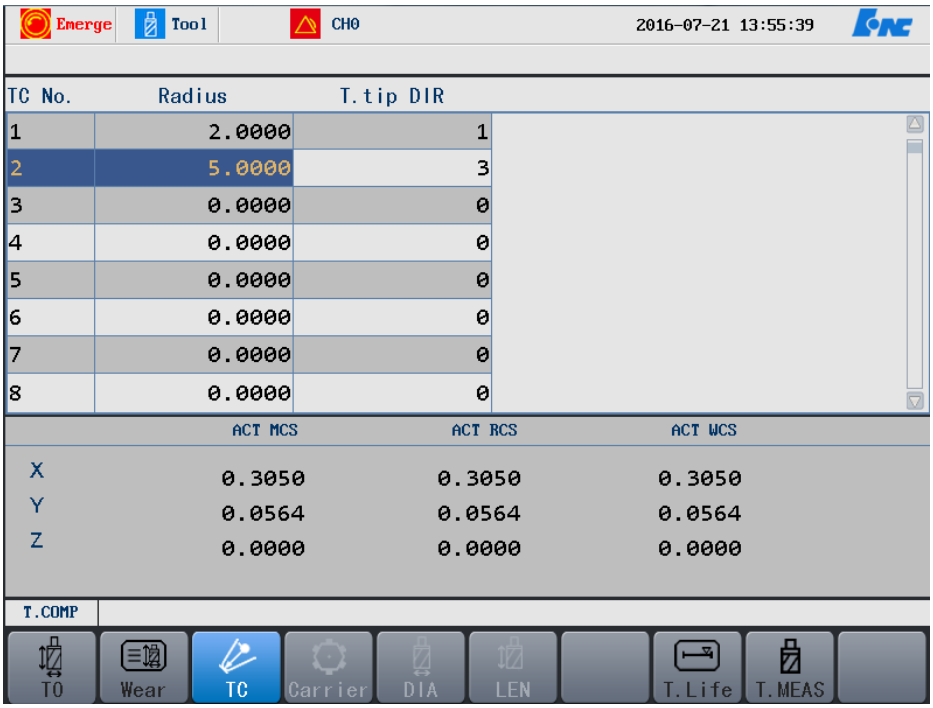
Figure 3.4.1 NC parameter settings

- PARM 000020: This parameter is used to set whether to automatically switch to the alarm window when an alarm is reported. The value **1** indicates to automatically switch to the alarm window.
- PARM 000022: This parameter is used to set whether to automatically clear the previous program movement route on the graph interface. The value **1** indicates to automatically clear the route.
- PARM 000023: This parameter is used to set the display mode of the feed speed on the human-machine interface. The value **0** indicates the actual speed while the value **1** indicates the command speed.
- PARM 000026: This parameter is used to set the decimal places of the position values displayed on the human-machine interface, including the machine coordinates, workpiece coordinates, the remaining feed, etc.

- PARM 000027: This parameter is used to set the decimal places of all speed values displayed on the human-machine interface, including the **F** feed speed.
- PARM 000034: This parameter is used to set whether to display the Restart message. The value **0** indicates to provide the message while the value **1** indicates not to provide the message.
- PARM 000060: This parameter is used to set how many tools (offset, wear, radius, tool nose direction) the system will save. This parameter must be greater than or equal to the count of **Tool Number** of all channels.

  Note 1: The channel parameter **Start Tool Numbe**r is used to set the start tool number of each channel.





Note 2: The channel parameter **Tool Number** is used to set the tool count of each channel. This parameter is used with the **Start Tool Number**. For example, if the **Start Tool Number** parameter of Channel 0 is set to **1** and **Tool Number** is set to **4,** and the **Start Tool Number** parameter of Channel 1 is set to **5** and **Tool Number** is set to **6**, then the data saved for Tool 1 to Tool 4 in the tool group corresponds to Channel 0 and the data saved for Tool 5 to Tool 10 corresponds to Channel 1.

- PARM 000061: This parameter is used to set the significant digits of tool offset and tool compensation number in the T commands. See the figure below:

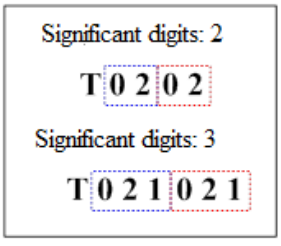


Figure 3.4.2 Significant digits of tool offset and tool compensation

- PARM 000063: This parameter is used to set the input mode of the tool wear value.

0: directly input value. 1: accumulative value. That is the input value plus the original wear value.

- PARM 000065: This parameter is used to set the display mode of the tool's coordinate value along the axis X.

  0: radius display 1: diameter display

3.4.2 Setting Motion-Axis Parameters

A turning machine usually has two motion axes: axis X and Z, as shown in Figure 3.2.2. In a standard HNC-8 system, the logical axis 0 maps the axis X, and the logical axis 2 maps the Z axis. Therefore, the parameter **040001 (Axis X No.)** is set to **0**, and the parameter **040003 (Axis Z No.)** is set to **2**. See Figure 3.4.3.

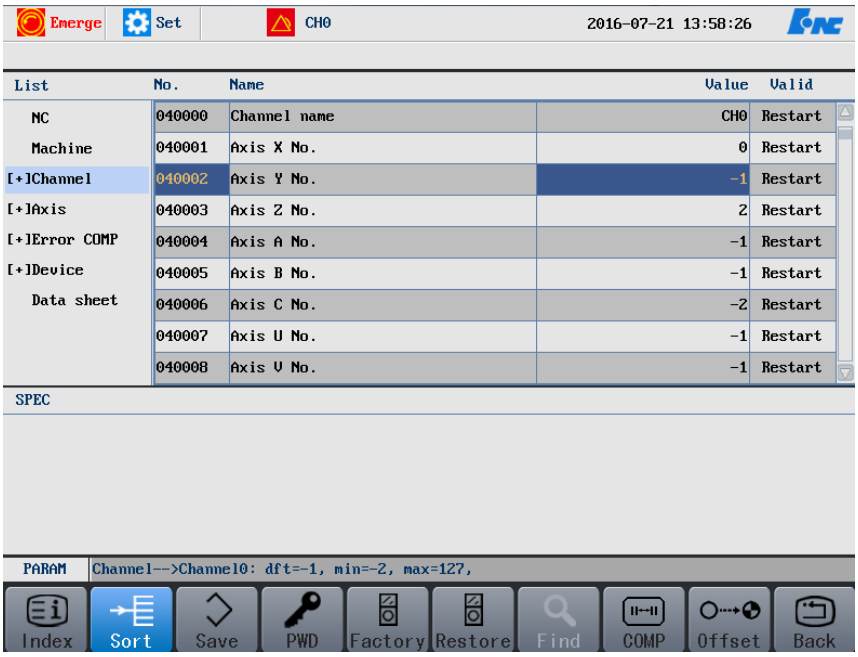


Figure 3.4.3 Channel parameter settings for two axes

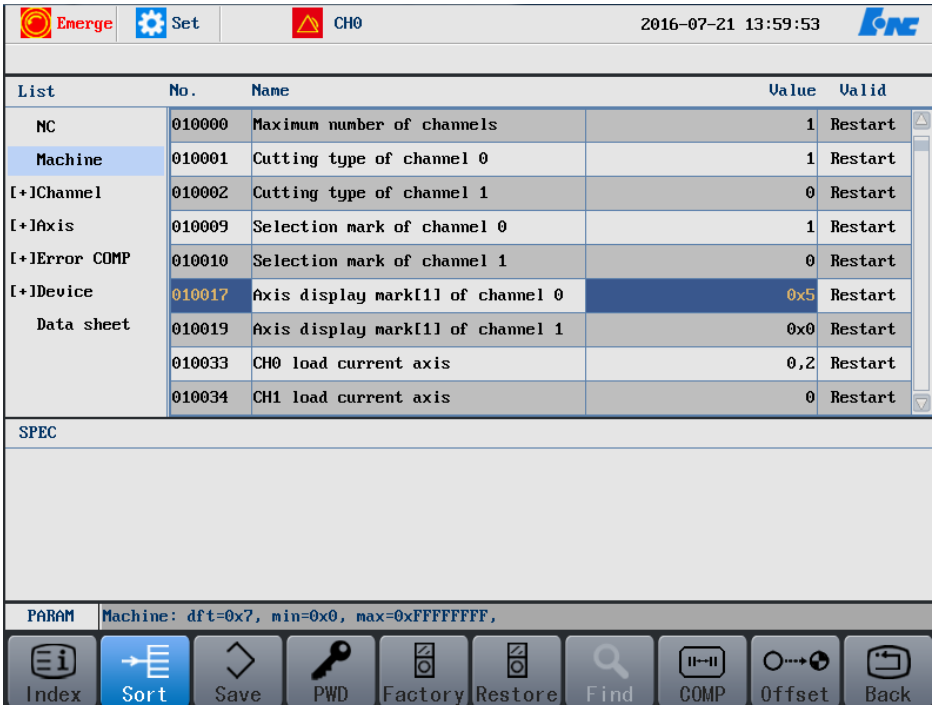


Figure 3.4.4 Machine user parameters for two axes

- PARM 010001: The **Cutting type of channel 1** parameter is used to set the system type for each channel.

  0: Milling system; **1**: Turning system.

  Set this parameter to **1** for the turning system. See Figure 3.4.
- PARM 010009: This group of parameters is used to set the selection mark for channels. The value **0** to **7** indicates the channel **0** to channel **7**. Set this parameter to **1** when configuring channel. This set of parameters are input and displayed in decimal values. A turning machine uses only one channel, and HNC-8 turning systems use channel 0, where the mark is **00000001**. This value is **1** when converted to the decimal value.
- PARM 010017: This parameter is used to set the axis display mark for channels. The value **0** to **3**1 indicates the axis **0** to axis **31**. The axis can be displayed on the CNC machine interface according to the actual demand. The set of parameters are input and displayed in hexadecimal values. A turning machine uses the axis **0** and axis **2**, where the mark is **00000101**. This value is **0x5** when converted to the hexadecimal value.

If you need to add an axis A and use the logical axis **3**, then the mark is **00001101**. This value is **0xd** when converted to the hexadecimal value.

- PARM 010033: This parameter is used to set the axis which load current will be displayed. This set of parameters are array parameters. The input axis number is separated with the comma (,) or period (.) symbol. A turning machine uses the logical axis 0 and axis 2. Set this parameter to **0, 2**.

  If you need to add an axis A and use the logical axis 3, set this parameter to **0, 2, 3**.
- PARM 010166: Set this parameter to the maximum duration allowed for the coordinate positioning after executing the rapid traverse command (G00). The unit is milliseconds (ms). If the axis rapid traverse speed is too fast, then set this parameter to a relatively greater value.
- PARM 010169: This parameter is used to set whether to conduct exact stop verification at the corner when executing the G64 command. When this parameter is set to 1, the CNC system will conduct exact stop verification in the G64 mode. In the G64 mode, if the feed length of two straight lines is less than or equal to **5** mm and the vector angle is less than or equal to **36º**, the CNC system will automatically use the arc mode. In this case, this parameter is invalid.
- PARM 010300-PARM 010499: User parameters, which can be input by users and correspond to the P variables in PLC. This parameter is read only in PLC. The figure below shows to call sub-programs based on the P parameters.

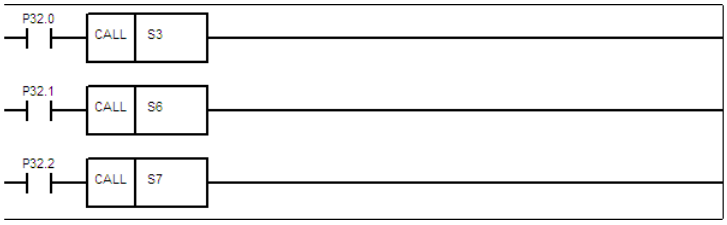


Figure 3.4.5 Call sub-programs based on the P parameters

- PARM 040032: This parameter is used to set the programming mode of the current channel. Users may use the diameter programming mode to write programs. In this case, a programming unit of change on the diameter corresponds to half unit amount of movement on the radial axis.

The value **0** indicates the radius programming mode while the value **1** indicates the diameter programming mode.

- PARM 040105: Set this parameter based on the thread machining speed and precision. If the value is too large, it may affect the thread precision; If the value is too small, the wait time for tool start may be too long.
- PARM 040014-PARM 040022: This parameter is used to set the programming name of the movement axis. For example, if the programming name of the axis X is set to **X**, then users may use **G01X10F1000** for G-code programming. If the programming name of the X axis is set to **X1**, then users need to use **G01X1=10F1000** for G-code programming.
- PARM 040070- PARM 040083: This parameter is used to set the machining parameters in the G64 small line mode.

  Note: For logical axis parameters, the parameter number **X** represents the logical axis number. If the logical axis is **0**, then **X** is **0**. See Figure 3.4.6.

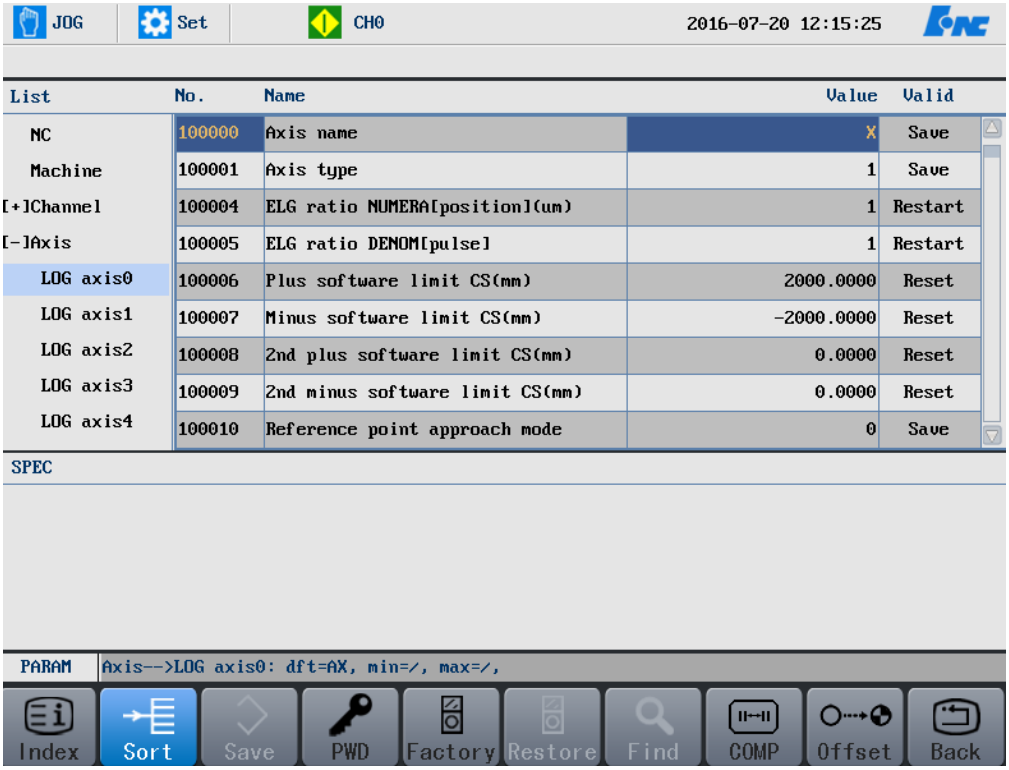


Figure 3.4.6 Coordinate parameters of axis 0

- PARM 10X000: This parameter is used to set the display name of the specified axis.

- PARM 10X001: This parameter is used to set the physical axis type of the machine. For common turning machines, set this parameter to **1** for the X and Z axes as both axes are linear axis.
- PARM 10X004: This parameter is used to set the movement distance of a machine axis per axis revolution. The unit for a linear axis is "um". For example, if the screw of the current axis X is 6 mm, then set this parameter to **6000**.
- PARM 10X005: This parameter is used to set the required pulse command number per axis revolution. For example, if the pulse number for the current motor per axis revolution is **131072**, and there is no reduction ratio, then this parameter is set to **131072**.
- PARM 10X006: This parameter is used to set the positive soft limit. If the tool exceeds this limit, an alarm will be reported. This parameter setting takes effect only after the machine returns to the reference point. For the absolute motor, this parameter setting takes effect immediately.
- PARM 10X007: This parameter is used to set the negative soft limit. If the tool exceeds this limit, an alarm will be reported. This parameter setting takes effect after the machine returns to the reference point. For the absolute motor, this parameter setting takes effect immediately.
- PARM 10X010: This parameter is used to set the mode of returning to the reference point mode. For the absolute motor, set it to **0**. For the incremental motor, set it to **2** or **3**. For distance code, set it to **5** or **6**.
- PARM 10X012: This parameter is used to set the encoder feedback offset for the absolute encoder motor. The absolute encoder will feed back a random position value when it is used for the first time. Users may set this parameter to the position value. The current position is the reference point position of the machine coordinate system.

  The method to calculate the encoder feedback offset is as below:

  1) View the **Motor POS** value as shown in Figure 3.4.7. The **Motor POS** here is the total pulse number that the servo motor reads from the motor encoder and feeds back to the system.

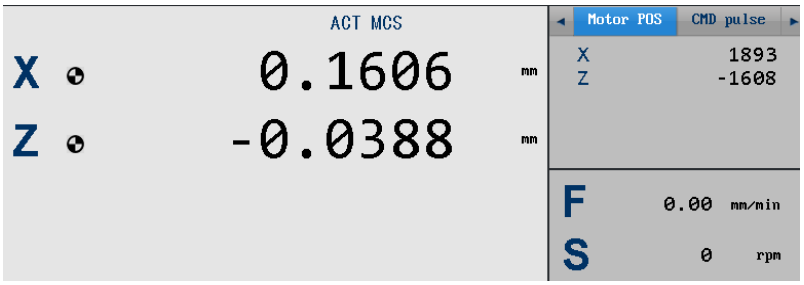


Figure 3.4.7 Motor position

2) Divide the total pulse number by the pulse number per axis revolution, and then multiply the value by the movement distance per axis revolution (or divide the value by the denominator [pulse] of the electronic gear ratio, and then multiply by the numerator [displacement] of the electronic gear ratio). The formula is as below:

Total pulse number/pulse number per axis revolution x *movement distance per axis revolution*

or

total pulse number/pulse number per axis revolution/denominator [pulse] of the electronic gear ratio x *numerator [displacement] of the electronic gear ratio*

As the unit of the electronic gear ratio's numerator is **um**, users need to convert it into **mm**, which means users need to divide it by **1000**.

For example, if

- the motor position is **266700000**
- the pulse per revolution is **131072**
- the screw lead is **4** mm
- set this position as the axis X reference point of the current machine

Then the encoder feedback offset is:

266700000/131072 x 4=8139.0381

- PARM 10X021: This parameter is used to set the coordinate value of the second reference point. Use the **G30 P2** command to return to this reference point. When the actual machine position is at the second reference point, F (*logical axis number* * 80) .8 is **1**. During tool change, users can use this register to determine whether the axis is at the second reference point. For example, the axis X is **F0.8**, and axis Z is **160.8**.
- PARM 10X025: This parameter is used to determine whether the current axis is within the

error range of the reference point. If the position difference between the actual machine position and the reference point is less than the value specified by this parameter, the axis is determined already at the reference point.

- PARM 10X031: This parameter is used to set the radius for the current rotation axis. The linear speed is converted into an angular speed with this parameter.

  Maximum speed of the rotation axis = maximum axis rotation speed x **2** x ***PI*** x *radius of the rotation axis (the value specified by this parameter)*

  When this parameter is set to **57.3**, the speed unit of the rotation axis is **360** mm/min.
- PARM 10X032: This parameter is used to set the axis' slow jog speed in the manual mode (JOG). If the axis is the rotation axis and the radius of the rotation axis is set to **57.3**, the speed unit here is **deg/min**, and the unit for the linear axis is **mm/min**.
- PARM 10X033: This parameter is used to set the axis' rapid jog speed in the manual mode (JOG). If the axis is the rotation axis and the radius of the rotation axis is set to **57.3**, the speed unit here is **deg/min**, and the unit for the linear axis is **mm/min**.
- PARM 10X034: This parameter is used to set the maximum rapid traverse speed (G00). This parameter is related to the machine motor speed, screw lead, and mechanical transmission ratio. For example, if the maximum motor speed is **2000** rpm, the screw lead is **4** mm, and the motor is directly connected to the screw, then the maximum rapid traverse speed is **8000** mm. If the axis is the rotation axis and the radius is set to **57.3**, then the speed unit here is **deg/min**, and that for the linear axis is mm/min. The maximum speed and rapid manual speed of the MPG is also determined by this parameter.
- PARM 10X035: This parameter is used to set the maximum speed for axis machining (G01, G02 ...). The maximum machining speed must be less than the maximum rapid traverse speed. If the axis is the rotation axis and the radius is set to **57.3**, then the speed unit here is **deg/min**, and that for the linear axis is **mm/min**.
- PARM 10X036: This parameter indicates the time from the speed **0** up to **1000** mm/min or from **1000** mm/min down to **0** during the rapid traverse movement of the linear axis.

  This parameter defines the axis rapid acceleration and deceleration speed. The greater the time constant of the rapid traverse acceleration and deceleration is, the more slowly the acceleration and deceleration speed is.

The table below describes the relationship between the time constant and rapid acceleration and deceleration speed:

Time constant	2 ms	8 ms	16 ms	32 ms	64 ms
Acceleration speed	1 g	0.2 g	0.1 g	0.05 g	0.02 g

For example, if the time constant is set to **4 ms**, the rapid traverse acceleration is calculated as follows:

1000 mm/60 s ≈ 16.667 mm/s

16.667/0.004 ≈ 4167 mm/s^2 ≈ 0.425 g (1 g=9.8 m/s^2)

- PARM 10X037: This parameter indicates the time from the acceleration speed **0** up to **1** m/s^2 or from **1** m/s^2 down to **0** during the rapid traverse movement (G00). This parameter defines the axis rapid jerk speed. The greater the time constant is, the more slowly the acceleration speed is.

  For example: if the rapid traverse acceleration is **0.2** g (i.e. 1.96 m/s^2), rapid traverse acceleration and deceleration jerk time constant is **8** ms, then the acceleration (jerk) is 1.96/0.008 = 245 m/s^3.

- PARM 10X038: This parameter indicates the time from the speed **0** up to **1000** mm/min or from **1000** mm/min down to **0** during the machining movement of the linear axis. This parameter defines the acceleration speed of the axis machining. The greater the time constant is, the more slowly the acceleration and deceleration speed is.

  This parameter is determined by the motor inertia and load inertia, and driver acceleration capability.

  The table below describes the relationship between the time constant and the machining acceleration and deceleration speed:

Time constant	2 ms	8 ms	16 ms	32 ms	64 ms
Acceleration speed	1 g	0.2 g	0.1 g	0.05 g	0.02 g

For example, if the time constant is set to **6** ms, the machining acceleration speed is calculated as follows:

$$1000 \text{ mm}/60 \text{ s} \approx 16.667 \text{ mm/s}$$

$$16.667/0.006 \approx 2778 \text{ mm/s}^2 \approx 0.283 \text{ g} \ (1 \text{ g}=9.8 \text{ m/s}^2)$$

- PARM 10X039: This parameter indicates the time from the acceleration speed **0** up to **1** m/s^2 or from **1** m/s^2 down to **0** during the axis machining (G01, G02). This parameter defines the axis machining jerk speed. The greater the time constant is, the more slowly the acceleration speed is. Suppose the machining acceleration speed is **0.05** g (0.49 m/s^2), and the time constant of the machining jerk acceleration and deceleration speed is set to **128** ms, then the jerk speed is: $0.49/0.128 \approx 3.8$ m/s^3.
- PARM 10X040: This parameter indicates the required time from the speed **0** to **1000** mm/min during thread machining. This parameter defines the acceleration speed of the thread machining. The greater the time constant is, the more slowly the acceleration speed is.
- PARM 10X041: This parameter indicates the required time from the speed **1000** mm/min to **0** during thread machining. This parameter defines the deceleration speed of the thread machining. The greater the time constant is, the more slowly the deceleration speed is.
- PARM 10X043: This parameter is used to set the distance that the axis moves when the MGP override ratio is set to X1 and one pulse is generated. When the parameter **010001** is set to **1** (turning machine) and the parameter **040032** is also set to **1** (enable radius programming), the manual pulse resolution corresponding to the axis X should be set to **0.5**.
- PARM 10X060: This parameter is used to set the allowed exact stop error for the axis rapid traverse positioning (G00). The value **0** indicates no limit on the current axis

positioning error. When the parameter value specified here is greater than **0**, an alarm will be reported if the machine coordinate of the current axis exceeds this value when the time specified by the parameter **010166** is reached.

- PARM 10X061: This parameter is used to set the maximum track error during axis movement. When the parameter **100090** is set to **0**, the track error is calculated by the servo drivers. The CNC system obtains the track error directly from the servo driver. When this parameter is set to **1**, the track error is calculated by the CNC system.
- PARM 10X067: This parameter is used to set the number of pulse per axis revolution received by the CNC system. For example, if the pulses per revolution of the motor is **131072**, the reduction ratio of the speed from the motor to the axis is 40:1, then set this parameter to **5242880= (131072 x 40)**.
- PARM 10X090: This parameter is used to set the calculation mode for the track error of the feed axis. When this parameter is set to **0**, the track error is calculated by the servo drivers. The CNC system obtains the track error directly from the servo driver. When this parameter is set to **100**, the track error is calculated by the CNC system. If the servo driver does not upload the track error, and this parameter value is set to 0, the CNC system will not display or monitor the feed axis' track error.
- PARM 10X197: The default value is **0**. When the configured motor encoder is an absolute encoder with battery box, set this parameter to the feedback pulse per motor revolution.

List	No.	Name	Value	Valid
[-]Device	507000	Device name	AX	Cure
Device0	507002	Device type	2002	Cure
Device1	507003	Device No. in same group	1	Cure
Device2	507010	Working mode	1	Restart
Device3	507011	Logical AX No.	0	Restart
Device4	507012	Encoder feedback negation mark	0	Restart
Device5	507013	Reserved	0	Restart
Device6	507014	Feedback POS cycle mode	0	Restart
Device7	507015	Feedbak POS cycle pulse	131072	Restart

Figure 3.4.8 Axis device interface parameter

- PARM 50X010: This parameter is used to set the default work mode of the servo axis in the bus network.
  - ✓ **1**: Incremental position mode

- ✓ **2**: Absolute position mode
- ✓ **3**: Speed mode

In Figure 3.1.2, the axis X corresponds to the device 7. Find the device 7 in the device interface parameters. See Figure 3.4.8. As it is the motion axis, and the motor is receiving incremental commands, set this parameter to **1**.

- PARM 50X011: This parameter is used to establish the mapping relationship between the servo axis device and logical axis. In Figure 3.1.2, the logical axis corresponding to the X axis is **0**. In the standard ladder graph of HNC-8 systems, the logical axis 2 corresponds to the axis Z.
- PARM 50X012: If this parameter is set to **0**, the encoder feedback is directly input into the CNC system. When this parameter is set to **1**, the inverse encoder feedback is input into the CNC system. When the feedback rotation speed is opposite to the actual rotation direction, set this parameter to **1**.
- PARM 50X014: Set this parameter to **0** for the linear feed axis or swing axis, and set the value to **1** for the rotation or spindle axis. This parameter is relevant to the parameter **50X015**.
- PARM 50X015: This parameter is used to set the loop pulse number when the feedback position loop is enabled. Generally, this parameter is set to the pulses per revolution.

3.4.3 Added a New Motion Axis

Add a new rotation axis A to a standard turning machine. The axis A uses the 17-bit absolute value motor with 1:180 reduction ratio, and the maximum motor speed is 3000 revolutions per minute. The axis A uses the logical axis 3, as shown in Figure 3.4.9.

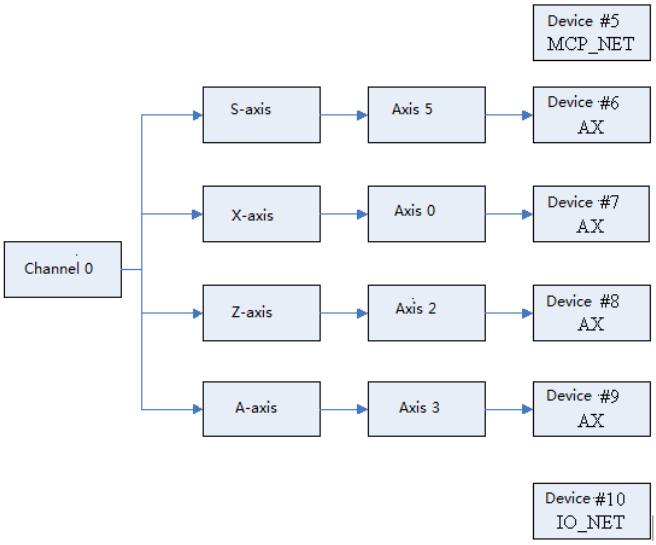


Figure 3.4.9 Turning machine with axis A

1. Set the channel parameters, as shown in Figure 3.4.10. Set the parameter **040004** to the logical axis number **3**.

List	No.	Name	Value	Valid
Machine	040000	Channel name	CH0	Restart
[+]Channel	040001	Axis X No.	0	Restart
[+]Axis	040002	Axis Y No.	-1	Restart
[+]Error COMP	040003	Axis Z No.	2	Restart
[+]Device	040004	Axis A No.	3	Restart
Data sheet	040005	Axis B No.	-1	Restart
	040006	Axis C No.	-2	Restart
	040007	Axis U No.	-1	Restart
	040008	Axis V No.	-1	Restart

Figure 3.4.10 Add axis A to the channel parameters

2. Set the machine user parameters, as shown in Figure 3.4.11. As the axis A is added and the logical axis 3 is used, set the parameter **010017** to **00001101**, which is **0xd** in the hexadecimal mode. Add the value **3** to the parameter **010033**.

List	No.	Name	Value	Valid
Machine	010000	Maximum number of channels	1	Restart
[+]Channel	010001	Cutting type of channel 0	1	Restart
[+]Axis	010002	Cutting type of channel 1	0	Restart
[+]Error COMP	010009	Selection mark of channel 0	1	Restart
[+]Device	010010	Selection mark of channel 1	0	Restart
Data sheet	010017	Axis display mark[1] of channel 0	0xD	Restart
	010019	Axis display mark[1] of channel 1	0x0	Restart
	010033	CH0 load current axis	0,2,3,5	Restart
	010034	CH1 load current axis	0	Restart

Figure 3.4.11 Add axis A to the machine user parameters

3. Set the device interface parameters, as shown in Figure 3.4.12.

List	No.	Name	Value	Valid
Device1	509000	Device name	AX	Cure
Device2	509002	Device type	2002	Cure
Device3	509003	Device No. in same group	3	Cure
Device4	509010	Working mode	1	Restart
Device5	509011	Logical AX No.	3	Restart
Device6	509012	Encoder feedback negation mark	0	Restart
Device7	509013	Reserved	0	Restart
Device8	509014	Feedback POS cycle mode	1	Restart
Device9	509015	Feedbak POS cycle pulse	131072	Restart

Figure 3.4.12 Device interface parameters of axis A

- Set the parameter **509010** to **1**, to send incremental commands.
- Set the parameter **509011** to the logical axis number **3**. See Figure 3.3.8.
- As it is the rotation axis with 360 degree's clearing function, set the parameter **509014** to **1**.
- As the axis A uses the 17-bit absolute motor with 1:180 reduction ratio, and the motor's pulse per revolution is **131072**, then the feedback position loop pulse is **23592960** (131072 *180). Set the parameter **509015** to **23592960**.
- As it is an absolute motor, set the encoder type to **3**, the absolute encoder.

4. Set the axis parameters. See Figure 3.4.13.

List	No.	Name	Value	Valid
[+]Channel	103000	Axis name	A	Save
[-]Axis	103001	Axis type	3	Save
LOG axis0	103004	ELG ratio NUMERA[position](um)	360000	Restart
LOG axis1	103005	ELG ratio DENOM[pulse]	23592960	Restart
LOG axis2	103006	Plus software limit CS(mm)	2000.0000	Reset
LOG axis3	103007	Minus software limit CS(mm)	-2000.0000	Reset
LOG axis4	103008	2nd plus software limit CS(mm)	2000.0000	Reset
LOG axis5	103009	2nd minus software limit CS(mm)	-2000.0000	Reset
LOG axis6	103010	Reference point approach mode	2	Save

Figure 3.4.13 Logical axis parameter settings for the axis A

- Set the parameter **103000** to **A** (axis A).
- Set the axis type parameter **103001** to **3** (rotation axis).
- Set the parameter 103004 to **360000** micro-degrees.
- As the axis A uses the 17-bit absolute value motor with 1:180 reduction ratio, and the motor's pulse per revolution is **131072**, then set the parameter **103005** to **23592960** (131072 *180).
- As the axis A uses the 17-bit absolute motor, set the parameter **103010** to **0**.
- Set the parameter **103012** based on the electronic gear ratio and motor position.
- Set the parameter **103031** to the default value of **57.3**.
- Since the maximum motor speed is **3000** revolutions per minute,

  the maximum speed of the axis A = the maximum motor speed x 2 x *PI* x *the radius of the rotation axis*/180 *reduction ra*tio

  3000*2*PI*57.3/180=3000*2*3.14*57.3/180=6000

  then the maximum value of **103034** (maximum rapid traverse speed) can be set to **6000**.
- After setting the maximum rapid traverse speed, set the parameters **103032** (slow jog speed), **103033** (fast jog speed), and **103035** (maximum machining speed) based on the actual situation.

  Note: The three speeds above cannot exceed the maximum rapid traverse speed.
- Set the rapid traverse speed and time constant for the machining acceleration and deceleration speed based on the actual situation.
- Set the parameter **103090** (encoder working mode).

  The 8th bit: the track error monitoring mode of the feed axis

  - ✓ 0: the track error is calculated by the servo driver. The CNC system obtains the track error directly from the servo driver.
  - ✓ 11: the track error is calculated by the CNC system based on the feedback of the encoder.

  If the servo driver does not upload the track error, and this parameter value is set to **0**, the CNC system will not display or monitor the feed axis' track error.

  The 12th bit: Whether to enable the opposite counting of the absolute encoder

  - ✓ 0: Disabled. The absolute encoder pulse count is valid only within a single counting range.
  - ✓ 1: Enabled. Increase the encoder counting range by recording the opposite rotation count of the absolute encoder.

  For linear axes with an overlong travel or linear axes/rotation axes with a large reduction ratio, users need to enable the opposite rotation counting of the encoder if

the absolute encoder is used. This is to avoid the loss of machine coordinate values caused by restarting after power off when the axis runs in the same direction for a long time.

For example, if the rotation axis is A (logic axis number 3, device 10), and use the 17-bit single-turn or 12-bit multi-turn absolute encoder with a 180:1 reduction ratio, it is recommended to conduct the following configuration to avoid the loss of machine coordinate values caused by restarting after power off when the axis runs in the same direction for a long time:

Set the axis parameter **103090** (encoder working mode) to **0x1100**.

Set the axis parameter **103094** (encoder counting bit) to **29**.

- Set the parameter **103060** (allowed positioning error) and 103061 (maximum track error). The faster the speed is, the greater the error. Users may view the interface track error on the interface.

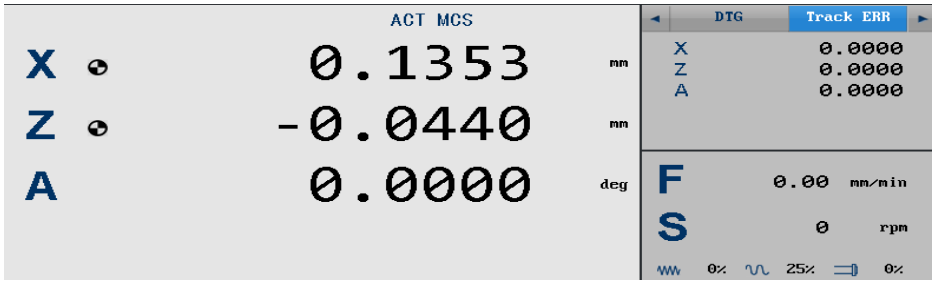
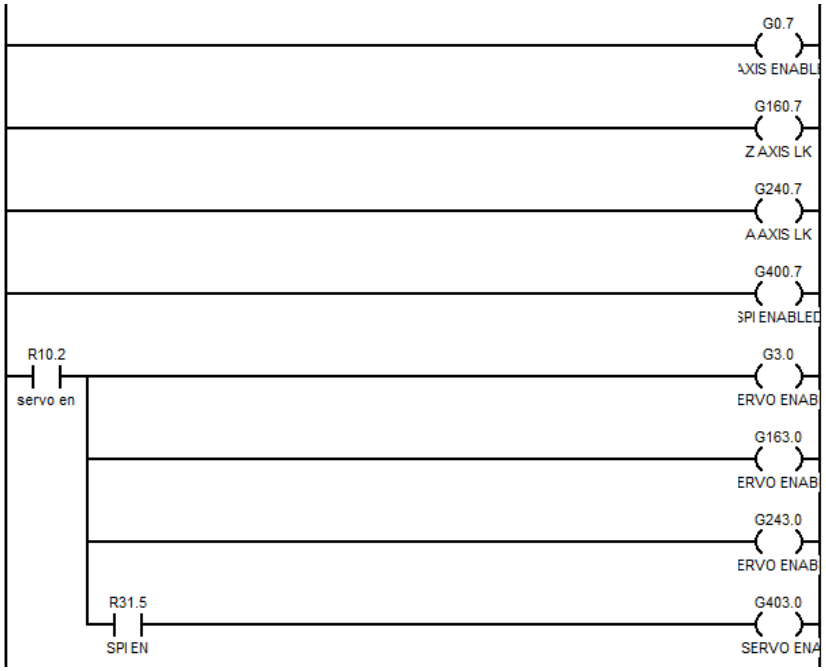
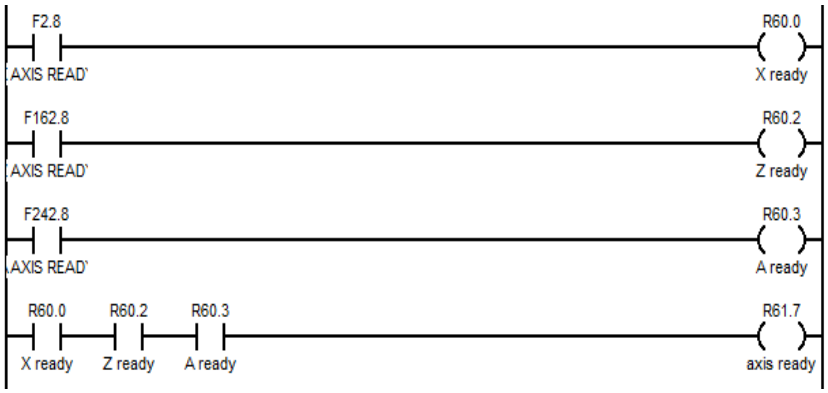


Figure 3.4.14 View track error

- Set the parameter **103067**: Axis pulses per revolution (pulses). As the axis uses the 17-bit absolute value motor with 1:180 reduction ratio, then
  axis pulse per revolution = motor pulse per revolution x *180 reduction ratio* = 23592960.
- Set the parameter **103094** (encoder counting bit). As this motor is a 17-bit single-turn and 12-bit multi-turn motor, set this parameter to **29**.
- Add the axis enable signal and manual registers to the PLC. See the figure below:



Add axis A enabled



Add axis A servo ready signal

Add axis A manual command signal

Restart the system after the settings.

3.4.4 Setting Spindle Axis Parameters

HNC-8 CNC system has two types of spindle: servo spindle and analog converter spindle. This section describes the 180US servo spindle. The configuration for the analog spindle is described in section 10.

Follow the instructions below to configure the servo spindle:

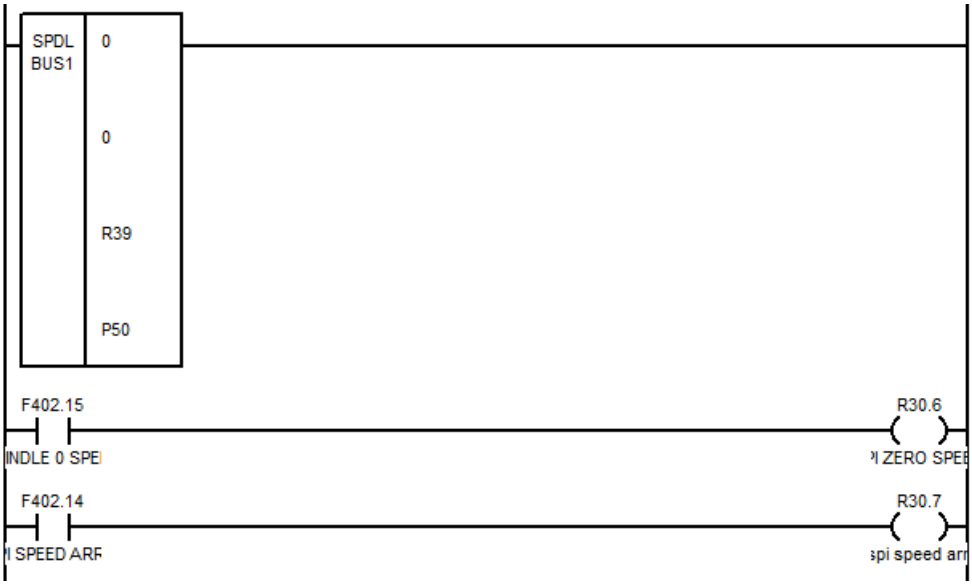
- Set the machine user parameters **010017**. If the logic axis number of the X is **0**, the logical axis number of Z is **2**, and the logical axis of the spindle is **5**, then set this parameter to **00100101**, which is **0x25** in the hexadecimal mode.

  Note: If the spindle is an analog spindle or it is not used for position control, then the spindle axis number may not be displayed. In this case, set this parameter to **00000101**, which is **0x05** in the hexadecimal mode.
- Add the value **5** to the machine user parameter **010033**.
- Set the channel parameter **040010**. The logical axis number in the standard turning machine parameters and PLC is **5**.
- Set the channel parameter **040027**. The value **0** indicates to display the actual speed,

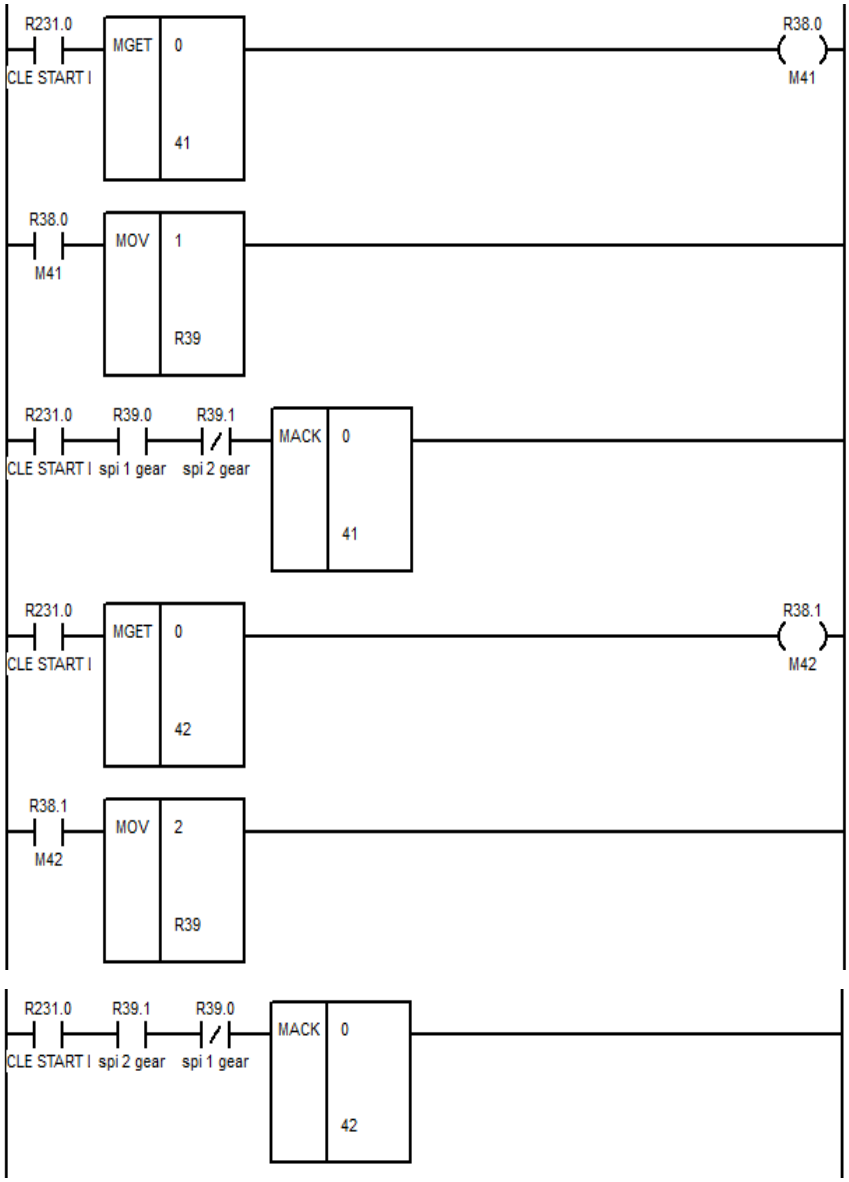
while the value **1** indicates to display the commanded speed.

- Set the channel parameter **040028**. Set it to the logical axis number of the spindle, which is **5** in the standard turning machine parameters. If there are two spindles, set the logical axis numbers of the two spindles, and separate them with a period symbol (.). If this parameter is not set, no spindle speed will be displayed.
- Set the parameter **105000** to **S** (axis display name).
- Set the parameter **105001** to **10**, which indicates the axis type is spindle.
- Set the parameter **105050** (default axis S rotation speed).
- Check the device parameters. If the device corresponding to the spindle is **6**, set the parameter **506010** to **3** (speed mode).
- Set the parameter **506011** to **5** as the specified logical axis number is **5** previously.
- Set the parameter **506014** to **1**.
- Set the parameter **506015**. Set this parameter based on the spindle feedback position cycle pulse number.
- Set the parameter **506016**. Set it to **3** for the absolute motor, and set it to **1** for the incremental motor.
- Add the enable signal and spindle control module to the PLC.

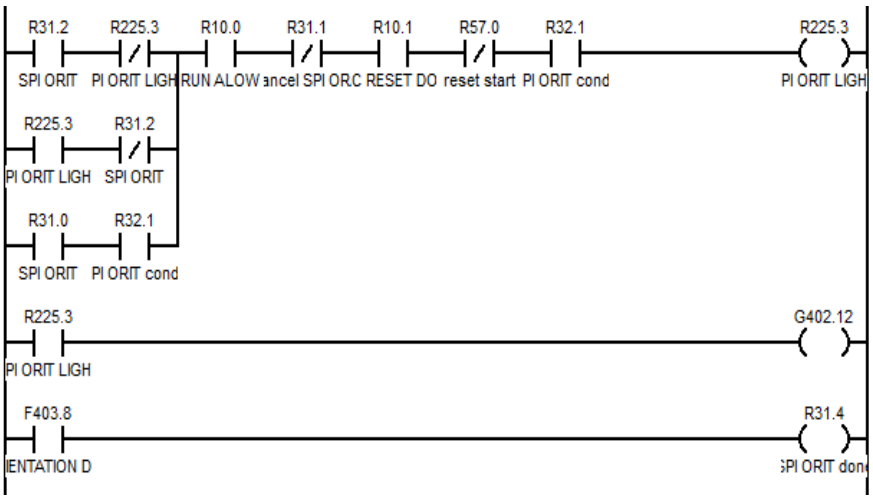
See the figure below:



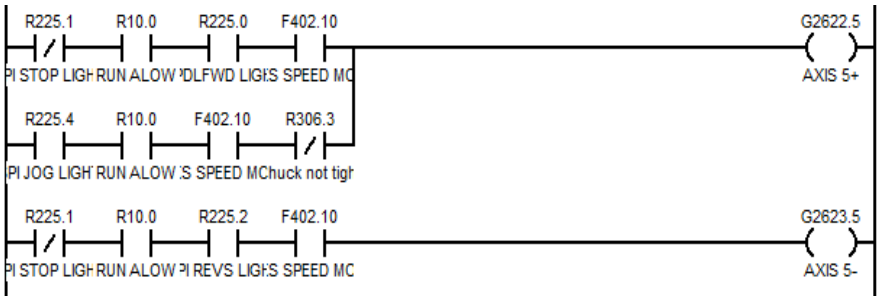
Spindle modules



Set spindle gear based on the M41 and M42 codes



Spindle orientation



Spindle motion

SPDLBUS1 can be used to set the spindle gear. The parameter description of SPDABUS1 is as below:

- Parameter 1: Channel number
- Parameter 2: Spindle number.
- Parameter 3: Gear register, starting from 1.
- Parameter 4: Control parameter. The specified parameter saves the maximum speed of the spindle motor, the initial speed, and other data

The values for the spindle control parameter (Parameter 4) include:

- The maximum motor speed.
- 1: The measured minimum speed at the first gear
- 2: The measured maximum speed at the first gear.
- 3: The current gear ratio numerator at the first gear.
- 4: The current gear ratio denominator at the first gear.
- 5: The measured minimum speed at the second gear
- 6: The measured maximum speed at the second gear.

- 7: The current gear ratio numerator at the second gear
- 8: The current gear ratio denominator at the second gear.

Set the gear register at R39 in the ladder graph above, to control parameter read from P50.

4 Servo Parameter Commissioning for Motion Axis

4.1 Technical Specifications for Drivers

Input power		Three-phase power supply AC220V, -15% to 10%, 50/60 Hz	
Control method		Position control, speed control, JOG control, internal speed control	
	Speed fluctuation ratio	< ±0.1 (load: 0% to 100%); < ±0.02 (power supply: -15% to +10%) The value corresponds to the rated speed.	
	Speed ratio	1:10000	
Position control		Input mode	Absolute position mode (The driver unit receives position from the system.)
		Electronic gear	$1 \leq \alpha/\beta \leq 32767$
Speed control		Input mode	Speed control mode (The driver unit receives speed commands from the system.)
		Acceleration and deceleration functions	Parameter settings: 1 to 32000 ms (0 to 1000 r/min or 1000 to 0 r/min)
Motor encoder type		Combined incremental encoder	Photoelectric encoder count: 1024 lines, 2000 lines, 2500 lines, 6000 lines
		Absolute encoder	ENDAT2.1/2.2 protocol encoder BISS protocol encoder HiperFACE protocol encoder TAMAGAWA protocol encoder
Monitoring function		Rotation speed, current position, position error, motor torque, motor current, command pulse frequency, operating status, etc.	

Protective function	Over speed, overvoltage of the main power supply, under-voltage, overcurrent, overload, encoder error, under-voltage of the control power supply, brake failure, communication failure, position error, etc.
Operation	6 LED digital tube, 5 buttons
Applicable load inertia	5 times less than the motor inertia

Models of 160U servo driver

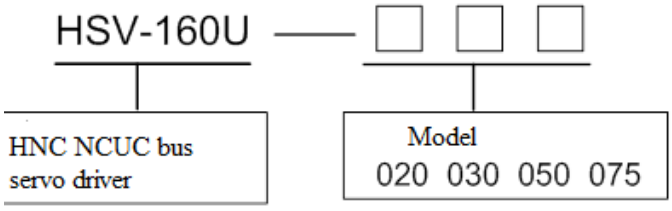


Table 4.1 Models of HSV-160U Series AC Servo Driver

Driver models	Continuous current (A/30 min) (valid value)	Short-time maximum current (A/1 min) (valid value)	Maximum applicable motor power (KW)
HSV-160U-020	6.9	10.4	1.5
HSV-160U-030	9.6	14.4	2.3
HSV-160U-050	16.8	25.2	3.8
HSV-160U-075	24.8	37.3	5.5

Models of 180UD servo driver

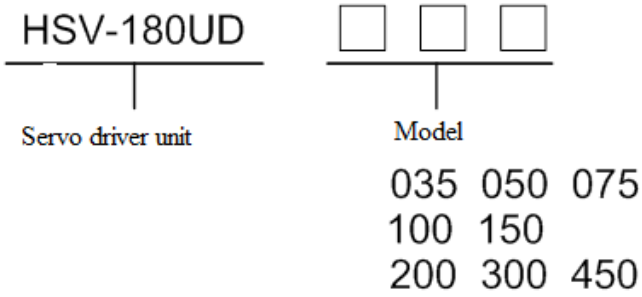


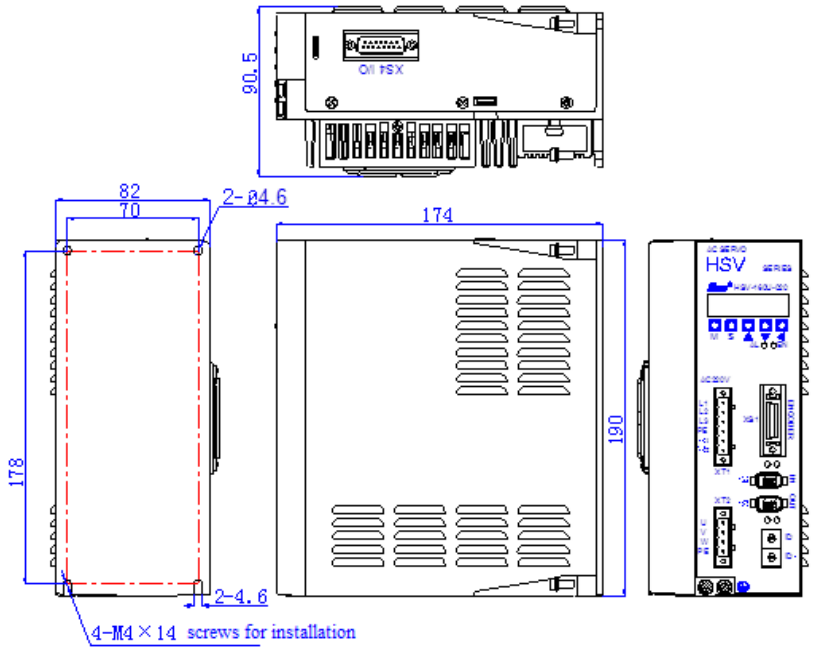
Table 4.2 Models of HSV-180UD Series AC Servo Driver

Driver models	Continuous current (valid value A)	Short-time maximum current (valid value A)
HSV-180UD-035	12.5	22
HSV-180UD-050	16.0	28
HSV-180UD-075	23.5	42
HSV-180UD-100	32.0	56
HSV-180UD-150	47.0	84
HSV-180UD-200	64.3	110
HSV-180UD-300	94.0	168
HSV-180UD-450	128.0	224

For details about the operation and display of servo drivers, see "HSV-160U AC Servo Driver User Manual" and "HSV-180UD AC Servo Driver User Manual."

4.2 Dimensions of Servo Derivers

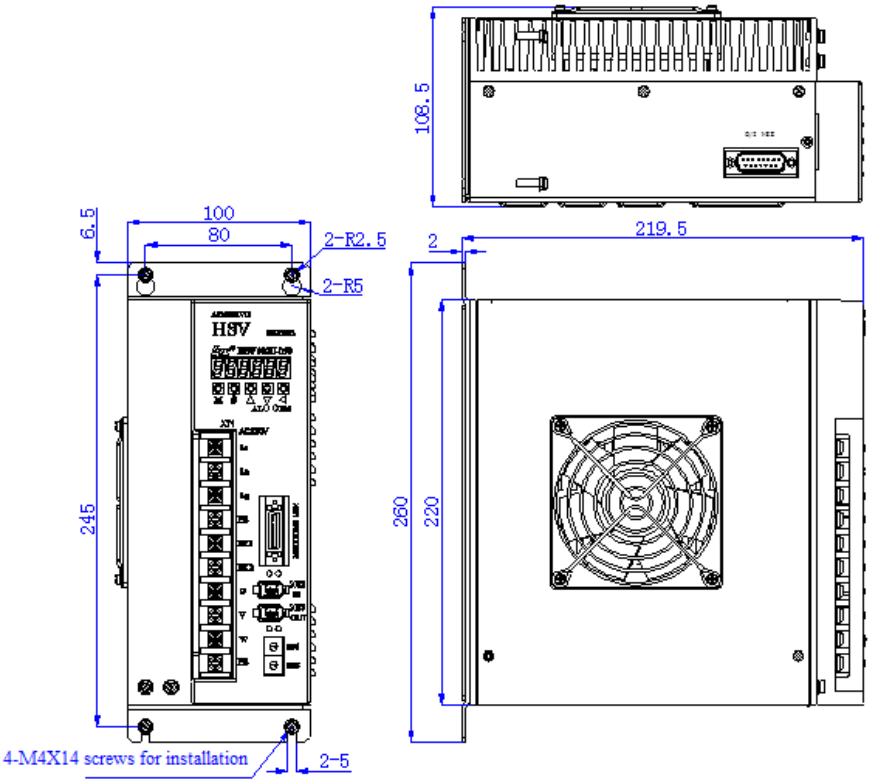
4.2.1 Dimensions of HSV-160U-020, 030 Servo Drivers



Dimensions of HSV-160U-020,030 servo drivers

(unit: mm)

4.2.2 Dimensions of HSV-160U-050,075 Servo Drivers



Dimensions of HSV-160U-050,075 servo drivers

(unit: mm)

4.3 Installation of Servo Drivers

Attention
● The servo driver must be installed in a protective electric cabinet. ● The servo driver must be installed in a specified direction, with specified space interval and good heat dissipation. ● The servo driver cannot be installed on or near combustibles to avoid fires.

4.3.1 Installation Methods

1. Installation Mode

Users can install the driver on a baseboard, perpendicular to the installation face. Figure 4.3.1 shows the installation diagram for HSV-160U-020, 030. Figure 4.3.2 shows the installation diagram for HSV-160U-050, 075.

2. Installation Interval

Figure 4.3.3 shows the installation interval for a single HSV-160U-020, 030 driver. Figure 4.3.4 shows the installation interval for a single HSV-160U-050, 075 driver. Figure 4.3.5 shows the installation interval for multiple HSV-160U-020, 030 drivers. Figure 4.3.4 shows the installation interval for multiple HSV-160U-050, 075 drivers. In the actual installation, a larger space interval is recommended to ensure good heat dissipation.

3. Heat Dissipation

Make sure that the wind from the cabinet blows to the heat dissipation component of the servo driver, so that the temperature surrounding the servo driver will not continue to rise.

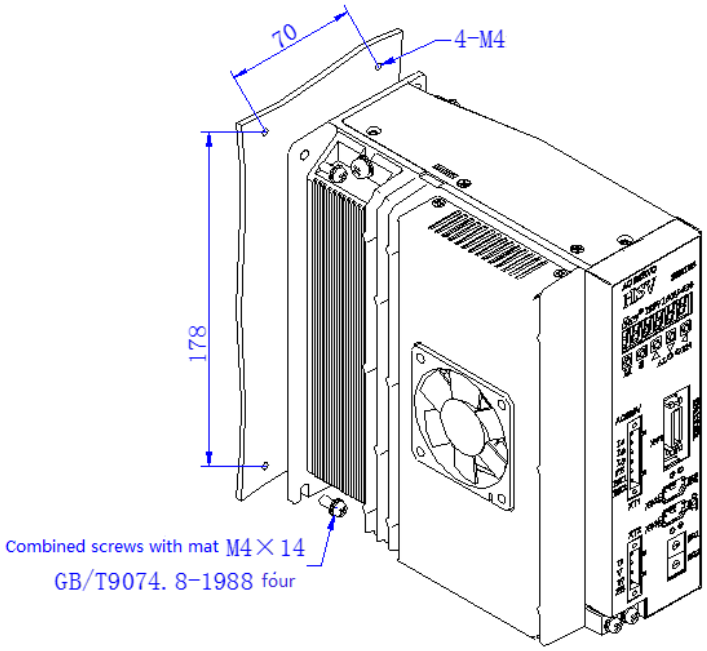


Figure 4.3.1 HSV-160U-020,030 installation diagram on a base board (Unit: mm)

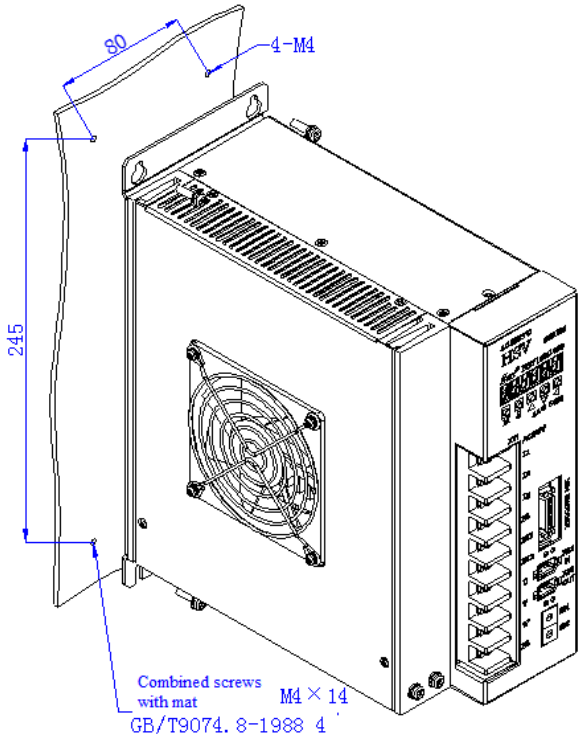


Figure 4.3.2 Installation diagram of HSV-160U-050,075 on a baseboard (Unit: mm)

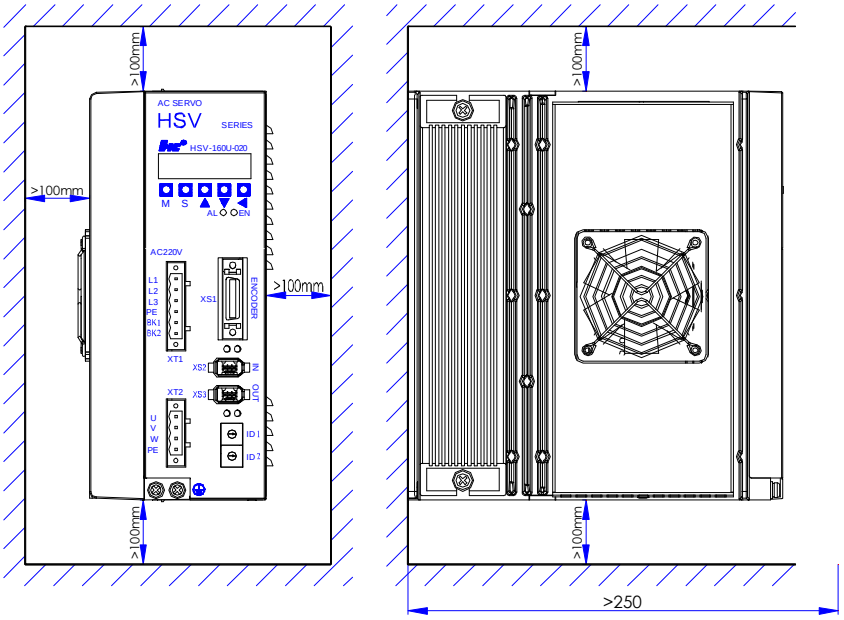


Figure 4.3.3 Installation interval for a single HSV-160U-020, 030 driver (unit: mm)

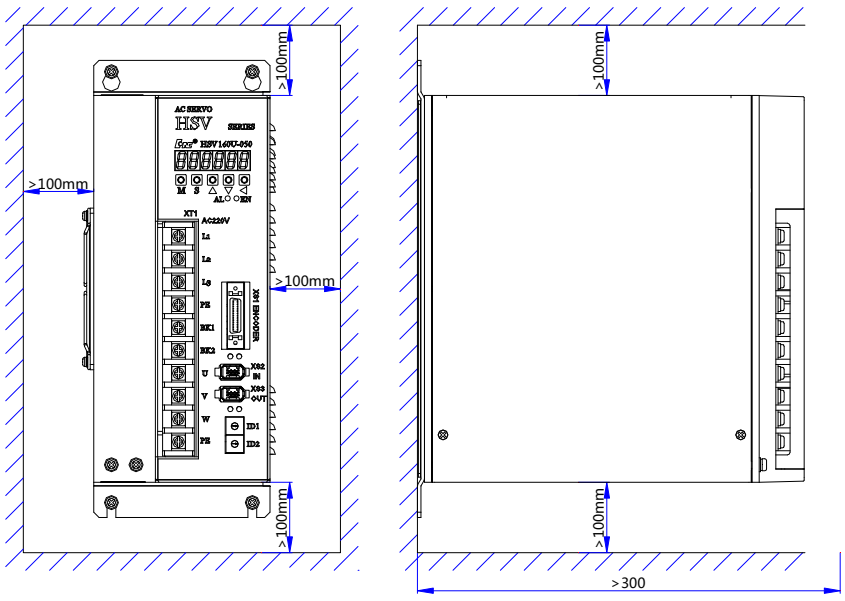


Figure 4.3.4 Installation interval for a single HSV-160U-050, 075 driver (unit: mm)

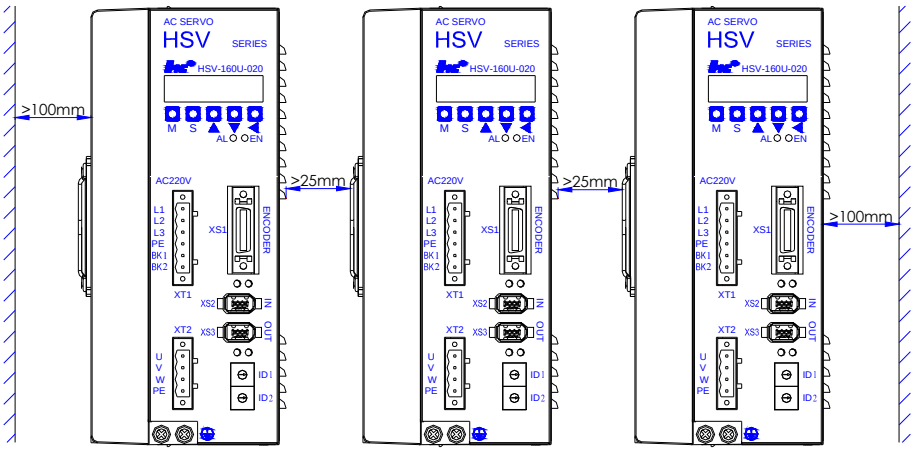


Figure 4.3.5 Installation interval for multiple HSV-160U-020, 030 drivers (unit: mm)

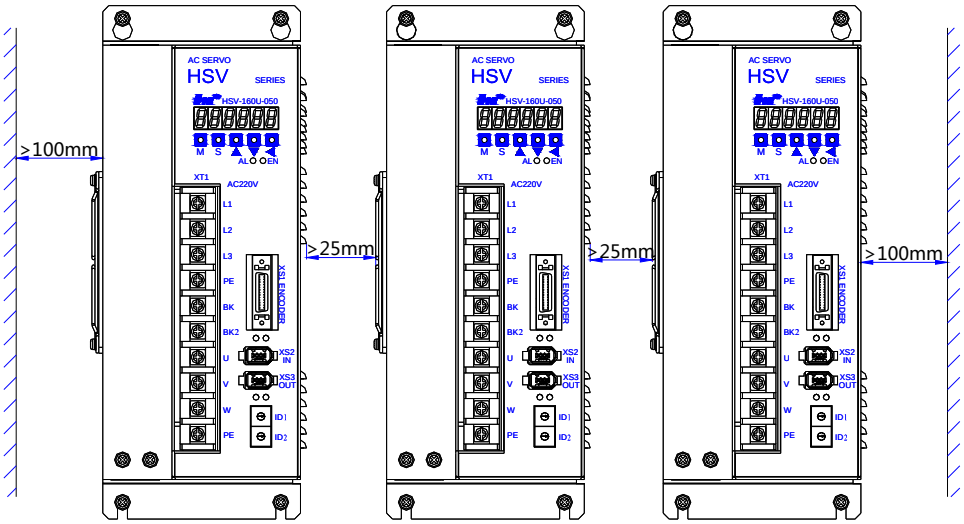


Figure 4.3.6 Installation interval for multiple HSV-160U-050, 075 drivers (unit: mm)

4.4 Servo Parameter Settings for Motion Axis

4.4.1 Modify Key 160U/180UD Servo Parameters on HNC-8 Software

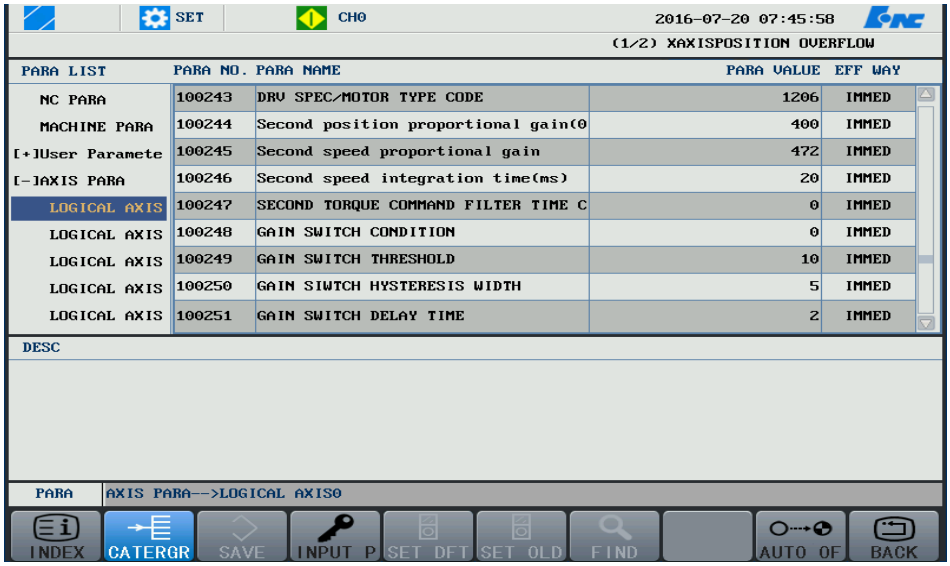
Users may directly modify the servo parameters in the HNC-8 system. When the logical axis number is set to **1**, a total of **88** servo parameters from **10X200** to **10X287** will be displayed after the axis moves. See the figure below:

Servo parameters in the CNC system

In these parameters, the parameters from **10X200** to **10X243** correspond to the servo PA parameters, while those from **10X244** to **10X287** correspond to the servo PB parameters.

Note: Within the parameter number, **X** indicates the logical axis number. For example, the parameter **102200** indicates the logical axis number is **2**.

Users need to set the motor code after powering the motor for the first time, and then input the code to the parameter 10X243 "DRV SPEC/MOTOR TYPE CODE". See the figure below:



Then set the parameter **10X224** and **10X225** based on the motor.

Power off and restart the motor after the settings above, the servo will automatically match the servo parameters based on the motor. Users can fine-tune the servo parameters according to the actual situation.

4.4.2 Parameters Related to Servo Motor

- Parameter settings for standard motors

For standard Hua Da servo motors, set PA-43 based on the description in the table below, and then users may proceed with the next parameter settings.

Common Hua Da servo motor code

Servo motor model	Rated Torque (Nm)	Rated Speed (rpm)	Rated Phase Current (A)	Motor Type Code	Compatible Drivers	Driver PA-43 Value
80ST-M01330LMBB	1.3	3000	2.8	0	HSV160U-20A	1100
110ST-M02420LMBB	2.4	2000	2.9	1		1101
110ST-M02515LMBB	2.5	1500	3.5	2		1102
80ST-M02430LMBB	2.4	3000	4.8	3	HSV160U-30A	1203
80ST-M03330LMBB	3.3	3000	6.2	4		1204
110ST-M03215LMBB	3.2	1500	4.5	5		1205
110ST-M05415LMBB	5.4	1500	6.5	6		1206
110ST-M04820LMBB	4.8	2000	6.0	7		1207
130ST-M03215LMBB	3.2	1500	4.5	8		1208
130ST-M04820LMBB	4.8	2000	6.2	9		1209
110ST-M06415LMBB	6.4	1500	8.0	10		1210
130ST-M05415LMBB	5.4	1500	7.0	11		1211
130ST-M06415LMBB	6.4	1500	8.0	12		1212
130ST-M09615LMBB	9.6	1500	11.5	13	HSV160U-50A	1313
130ST-M07220LMBB	7.2	2000	9.5	14		1314
130ST-M09620LMBB	9.6	2000	13.5	16		1316
130ST-M14615LMBB	14.3	1500	16.5	15	HSV160U-75A	1415
130ST-M14320LMBB	14.3	2000	17.0	17		1417

- Parameter settings for non-standard motors

If the motor code is not in the table above, users need to manually set motor-related parameters. Follow the instructions below

1. Confirm that the servo motor matches the specifications of the driver unit. That is: *rated current of the motor*/*the valid current of the driver motor* <= 1.5

   Note: The valid current of the driver indicates the valid value of the short-time maximum current of the driver. This value is displayed on the driver's label.
2. Confirm that the servo driver supports the servo motor's encoder.
3. Connect the driver's power lines L1, L2, L3, and connect the motor encoder line. (Note: Do not connect the U, V, W lines of the motor).

   Set the following parameters according to the driver model:

   PA-34: set it to **2003**

   PA-43: Set it according to the driver model

   HSV-160U-020: set it to **1102**

   HSV-160U-030: set it to **1205**

   HSV-160U-050: set it to 1310

   HSV-160U-075: set it to **1415**
4. Set the following parameters according to the motor model:

   PA-17: Maximum motor speed (unit: 1 r/min)

   PA-18: Overload torque current settings (Unit: percentage of rated current)

   PA-24: Servo motor's pole pairs

   PA-25: Servo motor's encoder type

   PA-26: Reference point error of the servo motor's encoder

   PA-27: Current proportional gain settings

   PA-28: Current integration time constant settings

   PB-42: Servo motor rated current (unit: 0.01 A)

   PB-43: Servo motor rated speed (unit: 1 r/min)
5. PA-34: Set it to **1230**, and save the parameters in the auxiliary menus; Cut off the power, connect the motor's power lines U, V, W, and then power on the servo again.

6. Connect the driver unit to the CNC system after confirmation

   Note: After the settings above are completed, users need to modify PA-2, PA-3, PA-27, PA-28 parameters based on the motor's running status for non-standard motors.

4.4.3 Parameters Related to Torque Control (Current Control)

PA-27: PI proportional gain in the current control mode

PA-28: PI integration time constant in the current control mode (0.1 ms)

PA-32: Output torque filter time constant (0.1 ms)

Parameter description: The parameters above are used to adjust the response in the current control mode.

PA-27: PI proportional gain in the current control mode

- Set the PI proportional gain in the current control mode.
- If large current noise appears during the motor operation, users may reduce the value accordingly.
- If the value is too small, the response will be delayed in the system. Users may set this value to a relatively larger value as long as the noise is not too big.

PA-28: PI integration time constant in the current control mode (0.1 ms)

- Set the PI integration time constant of current control.
- Set this parameter according to the electrical time constant of the motor.

Note: Generally, it is not recommended to modify the PA-27 or PA-28 parameters.

PA-32: Output torque filter time constant (0.1 ms)

- Set the torque command filter time constant.
- The larger the time constant is, the easier to eliminate the running noise of the motor, but the slower response of the control system.
- Users may set this value to a relatively smaller value as long as the noise is not too big.

4.4.4 Parameters Related to Speed Control Loop

PA -2: Set the proportional gain in the speed control mode PI.

PA-3: PI integration time constant in the speed control mode (0.1 ms)

PA-4: Speed feedback filter factor

PA-6: Acceleration time constant in the speed control mode (unit: ms/1000 r/min)

PA -38: Deceleration time constant in the speed control mode (unit: ms/1000 r/min)

Parameter description: The above parameters is used to adjust the speed response in the speed control mode.

PA-2: Speed PI proportional gain in the speed control mode (or directional mode)

- The larger the value is, the higher the gain and the greater the rigidness. Define the parameter value based on the spindle driver model and load values. In general, the bigger the load inertia, the larger the value.
- Users may set this parameter to a relatively larger value to increase the speed of response, under the condition of no oscillation cuased.

PA-3: PI integration time constant (0.1 ms) in the speed control mode (or directional mode)

- The smaller the value is, the faster the integration speed. Define the parameter value based on the spindle driver model and load values. In general, the bigger the load inertia, the larger the value.
- Users may set this parameter to a relatively smaller value under the condition of no oscillation cuased.

PA-4: Speed feedback filter factor

- Set speed feedback low filter to eliminate the speed feedback signal noise.
- The larger the value, the lower the end frequency, and the smaller the noise generated by the motor.If the load inertia is too large, users may decrease the value appropriately.If the value is too large, the response may become slow, which may cause oscillation.
- The smaller the value, the higher the end frequency, and the quicker the response.Users may decrease the value to obtain a quicker response.

PA - 6: Acceleration time constant in the speed control mode (unit: ms/1000 r/min)

PA-38: Deceleration time constant in the speed control mode (unit: ms/1000 r/min)

- PA-6 indicates the acceleration time of the motor from the speed **0** r/min to **1000** r/min; PA-38 indicates the deceleration time of the motor from the speed **1000** r/min to **0** r/min.
- The acceleration and deceleration is linear.
- The two parameters above are valid only for the speed control mode, but invalid for the position control mode.

4.4.5 Parameters Related to Position Control

PA-0: The proportional gain in the position control mode (unit: 0.1 Hz)

PA-1: The feedforward control gain in the position control mode.

PA-33: Position feedforward filter time constant

PA-13: Position command pulse division numerator

PA-14: Position command pulse division denominator

PA-35: Position command smooth filter time

Parameter description: The parameters above are used to adjust the position in the position control mode.

PA-0: Axis C position proportional gain in the position control position (unit: 0.1 Hz)

- Set axis C position proportional gain in the position control mode.
- The larger the value, the higher the gain, the greater the stiffness, and the smaller the position delay (position track error) under the same frequency command pulse condition. Howerver, if the value is too large, it may cause oscillation.
- Users may set this parameter to a relatively larger value to increase the position response, under the condition of no oscillation cuased.

PA-1: The feedforward control gain in the position control mode.

- Set the feedforward control gain in the position control mode.

- The larger the position feedforward gain is, the quicker the response of the control system, but the more unstable of the position control system, which may cause oscillation.
- When the system does not require very quick response, this parameter is usually set to **0**.

PA-33: Position feedforward filter time constant

- Set the filter time constant of the feedforward command.
- The smaller the time constant is, the quicker the response of the control system, but the more unstable of the control system, which may cause oscillation.

PA-13: Position command pulse division numerator

PA-14: Position command pulse division denominator

- Set the frequency division (electronic gear) of the position command pulse.
- (2) In the position control mode, it is easy to match with a variety of pulse source through the settings for the PA-13 and PA-14 parameters, to meet the control resolution requirements (ie angle/pulse).
- P×G=N×C

  P: Pulse number of input commands

  G: Electronic gear ratio $G = \frac{Position\ command\ pulse\ division\ numerator}{Position\ command\ pulse\ division\ numerator}$

  N: the number of motor rotation

  C: Motor encoder pulses per revolution
- [Example] If the input command pulse is **6000**, the servo motor rotation is **1**, and the motor encoder is an **2500**-line incremental optical encoder:

  $$G = \frac{N \times C}{P} = \frac{1 \times 2500 \times 4}{6000} = \frac{5}{3}$$

  Then set the parameter **PA-13** to **5** and **PA-14** to **3.**
- The recommended range of electronic gear ratio is $\frac{1}{50} \le G \le 50$.

PA-35: Position command smooth filter time

- Set the filter time constant of the position command.
- The larger the parameter value is, the more smooth the position command, but the slow response of the control system. This parameter is usually set to **0**.

5 Spindle Servo Parameter Settings

5.1 Technical Specifications of Drivers

Input power		**Specifications of 150 A and lower**: • Three-phase AC380V • -15% to +10%, 50/60 Hz **Specifications of 200 A and higher:** • Two-phase AC220V control power -15% to +10%, 50/60 Hz • Three-phase AC380V -15% to +10%, 50/60 Hz
Control mode	Speed control, C-axis position control, JOG control, internal speed control	
Constant power range	1:4	
Position control	C-axis position control function (receiving position pulse input command)	
Speed control	Input mode	Speed control (The driver unit receives speed commands from the system.)
	Acceleration and deceleration functions	Parameter setting: 0.1 s to 180 s (speed **0** to the maximum speed (PA-17) or the maximum speed to **0**)
Type of the first encoder	Incremental photoelectric encoder: 1024 lines, 2048 lines, 2500 lines Sin-cos incremental encoder: 256 lines Absolute encoder: EQN1325/EQN1313	
Type of the second encoder	Photoelectric encoder (TTL square wave) Sin-cos analog signal (1 Vpp)	

Monitoring function	Rotation speed, current position, command pulse accumulation, position error, motor torque, actual load current, rotor position, command pulse frequency, operating status, etc.
Protective function	Over speed, overvoltage of the main power supply, under-voltage, overcurrent, overload, encoder error, brake failure, communication failure, matching error between the driver and motor, etc.
Operation and display	6 LED digital tube, 5 buttons

Specifications of the spindle driver

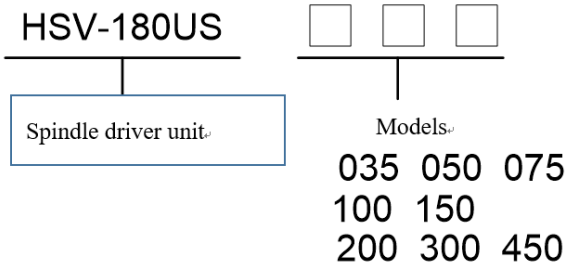


Table 5.1 Specifications of HSV-180US Series AC Spindle Driver

Model	Continuous current (valid value A)	Short-time maximum current (valid value A)
HSV-180US-035	16.8	22
HSV-180US-050	21.9	28
HSV-180US-075	31.4	42
HSV-180US-100	43.8	56
HSV-180US-150	62.8	84
HSV-180US-200	85.7	110
HSV-180US-300	125.0	168
HSV-180US-450	170.0	224

For details about the operation and display of the servo drivers, see "HSV-180US AC Spindle Servo Driver User Manual".

5.2 Spindle Driver Selection Guide

Users may follow the principles below to choose an AC spindle driver unit:

Generally, users may select the driver based on the condition (*maximum current*/*motor rated current* ≥ **1.6**) for the following scenarios:

- The inertia load is not large.
- The inertia load onto the spindle motor axis is three times less than the spindle motor's rotation inertia.
- The spindle motor does not always run at 6,000 rpm/min or higher.

- The requirements for the acceleration and deceleration time of start and stop is not very critical.
- The dynamic requirements is not very critical.

Generally, users may select the driver based on the condition (*maximum current/motor rated current* ≥ **2.4**) for the following scenarios:

- The inertia load is large.
- The inertia load onto the spindle motor axis is three times greater than or equal to the spindle motor's rotation inertia.
- The spindle motor always runs at 6,000 rpm/min or higher.
- The requirements for the acceleration and deceleration time of start and stop is very critical.
- The dynamic requirements (e.g. spindle rigid tapping) is very critical.

The relationship between the driver unit and motor is as shown in Table 5.2.

Table 5.2 Matching relationship between spindle drivers and motors

Driver model		HSV-180US-035		HSV-180US-050		HSV-180US-075	
Applicable motor power (kw)		3.7KW	5.5KW	5.5KW	7.5KW	7.5KW	11KW
Rated output current (A)		16.8		21.9		31.4	
Short-time maximum current (A)		22		28		42	
Circuit breaker (A)		25	32	32	40	40	63
Contactor (A)		18	25	25	32	32	40
Input AC reactor	**Current (A)**	10	15	15	20	20	30
	Inductance (mH)	1.4	0.93	0.93	0.7	0.7	0.47
Input filter (A)		10	15	15	20	20	30
Maximum brake current (A)		25		25		40	
Recommended braking resistor value	**Resistance (Ω)**	51Ω		51Ω		27Ω	
	Power (W)	1500W		1500W		2000W	

	Quantity	1		1		1	
Recommended value for the main circuit cable (mm^2)		4	4	4	4	4	10

Driver model		HSV-180US-100		HSV-180US-150		
Applicable motor power (kw)		11KW	15KW	18.5KW	22KW	
Rated output current (A)		43.8		62.8		
Short-time maximum current (A)		56		84		
Circuit breaker (A)		63	63	100	100	
Contactor (A)		40	50	63	80	
Input AC reactor	**Current (A)**	30	40	50	60	
	Inductance (mH)	0.47	0.35	0.28	0.24	
Input filter (A)		30	40	50	65	
Maximum brake current (A)		50		75		
Recommended braking resistor value	**Resistance (Ω)**	33Ω		27Ω		
	Power (W)	1500W		2000W		
	Quantity	2		2		
Recommended value for the main circuit cable (mm^2)		10	16	16	25	

Driver model	HSV-180US-200		HSV-180US-300	HSV-180US-450
Applicable motor power (kw)	30KW	37KW	51KW	75KW
Rated output current (A)	85.7		125	170

Short-time maximum current (A)		110		168	224
Circuit breaker (A)		125	160	200	400
Contactor (A)		95	115	150	250
Input AC reactor	**Current (A)**	80	90	150	250
	Inductance (mH)	0.17	0.16	0.095	0.056
Input filter (A)		80	100	150	250
Maximum brake current (A)		100		100	150
Recommended braking resistor value	**Resistance (Ω)**	30Ω		30Ω	30Ω
	Power (W)	2500W		2500W	2500W
	Quantity	3		4	6
Recommended value for the main circuit cable (mm^2)		35		70	120

5.3 Dimensions of Spindle Drivers

5.3.1 Dimensions of HSV-180US-035, 050, 075 Spindle Drivers

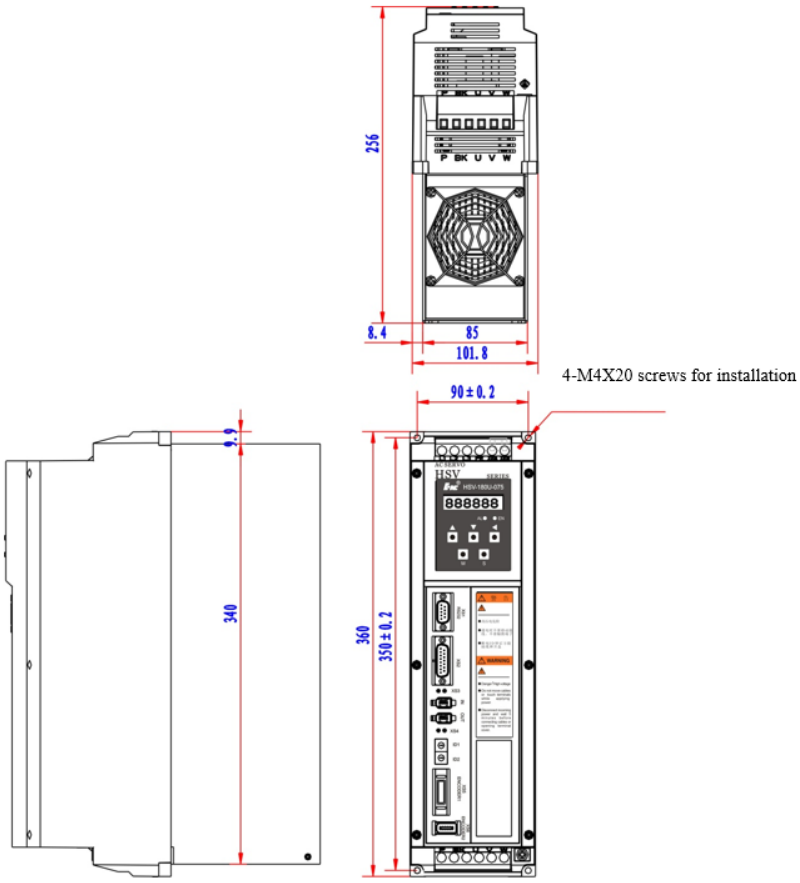


Figure 5.3.1 Dimensions of HSV-180US-035, 050, 075 Spindle Drivers

(Wall-through installation unit: mm)

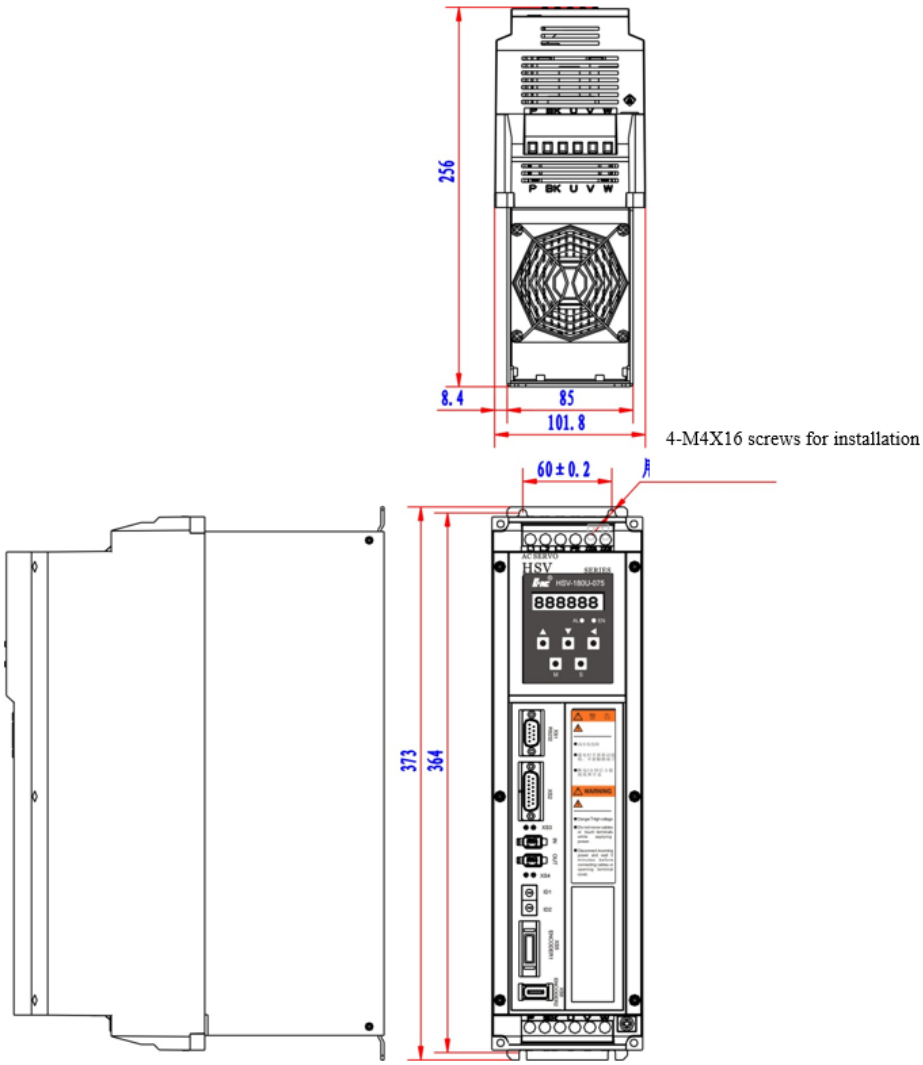


Figure 5.3.2 Dimensions of HSV-180US-035, 050, 075 Spindle Drivers (unit: mm)

5.3.2 Dimensions of HSV-180US-100, 150 Spindle Drivers

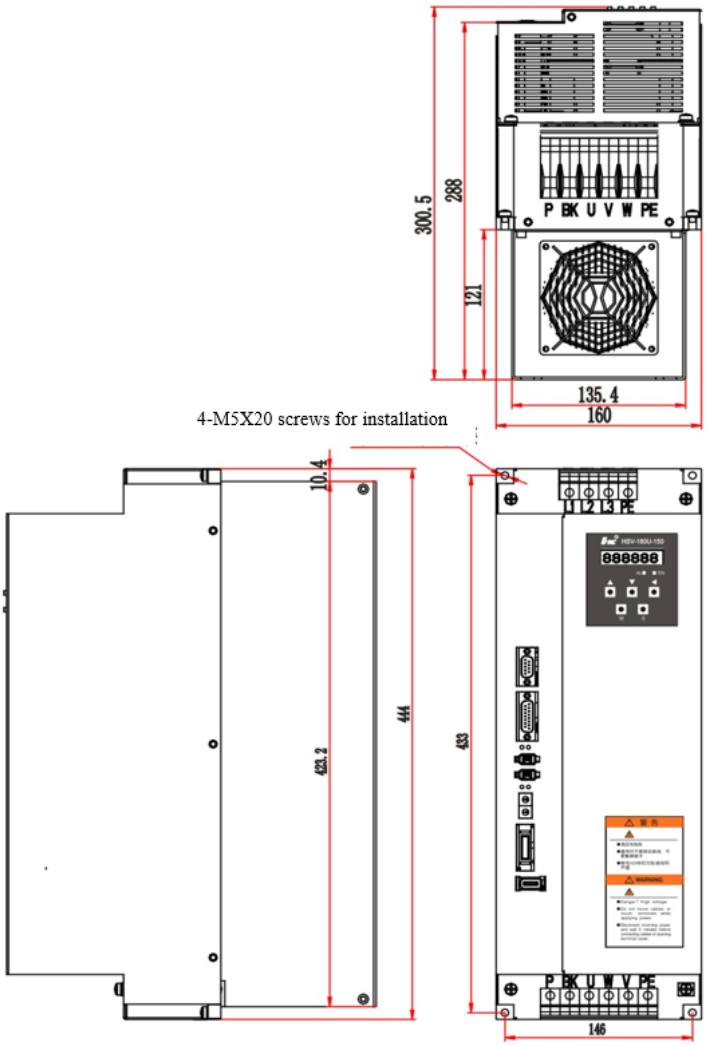


Figure 5.3.3 Dimensions of HSV-180US-100, 150 Spindle Drivers

(Wall-through installation unit: mm)

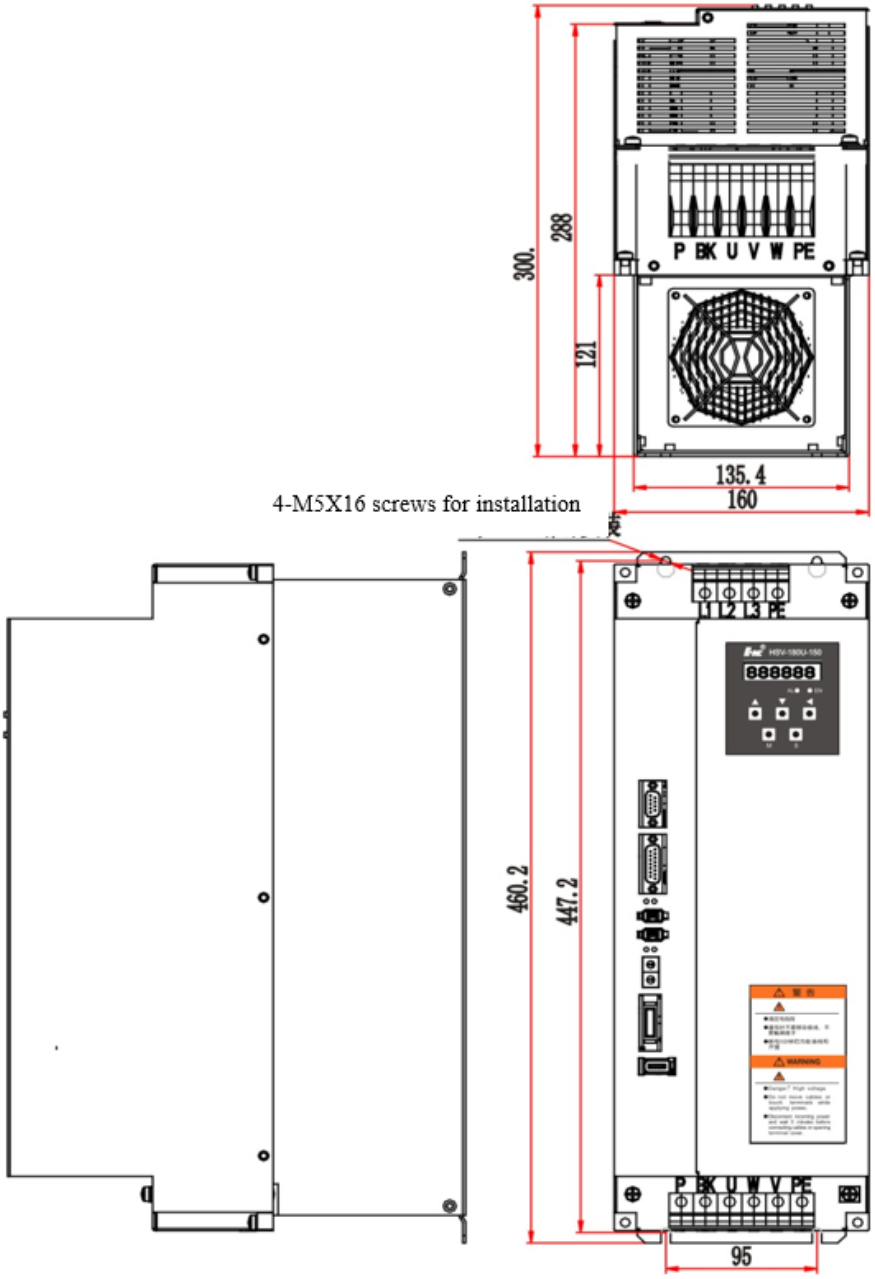


Figure 5.3.4 Dimensions of HSV-180US-100, 150 Spindle Drivers (unit: mm)

5.3.3 Dimensions of HSV-180US-200, 300, 450 Spindle Drivers

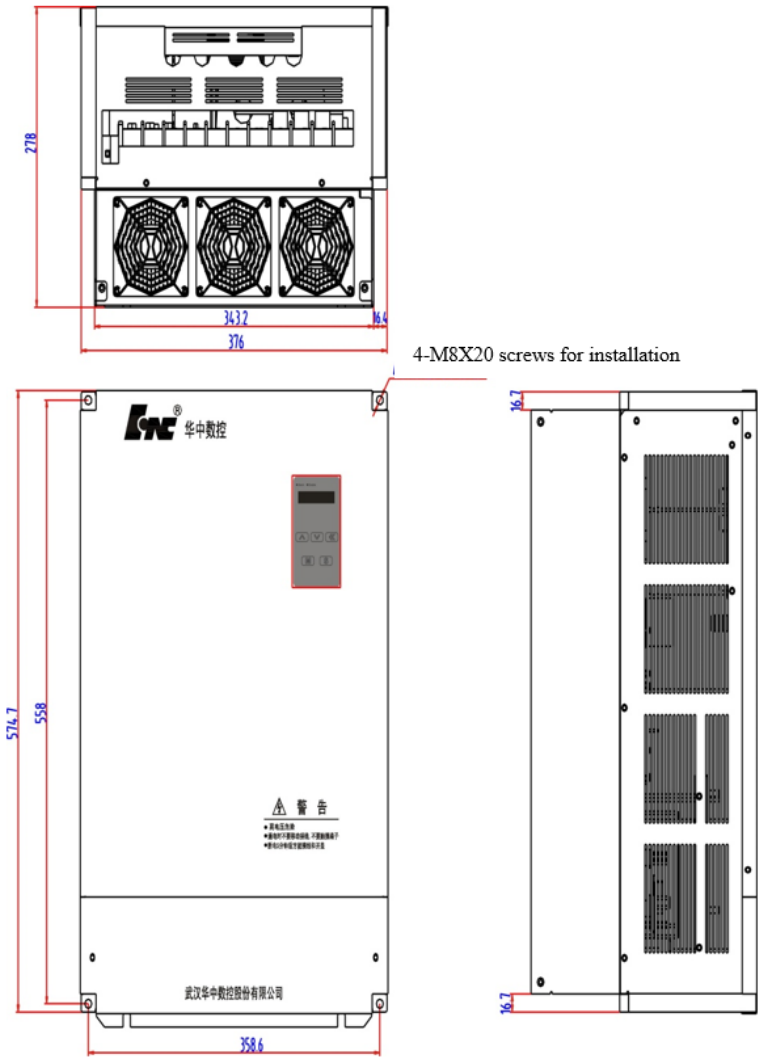


Figure 5.3.5 Dimensions of HSV-180US-200, 300, 450 Spindle Drivers

(Wall-through installation unit: mm)

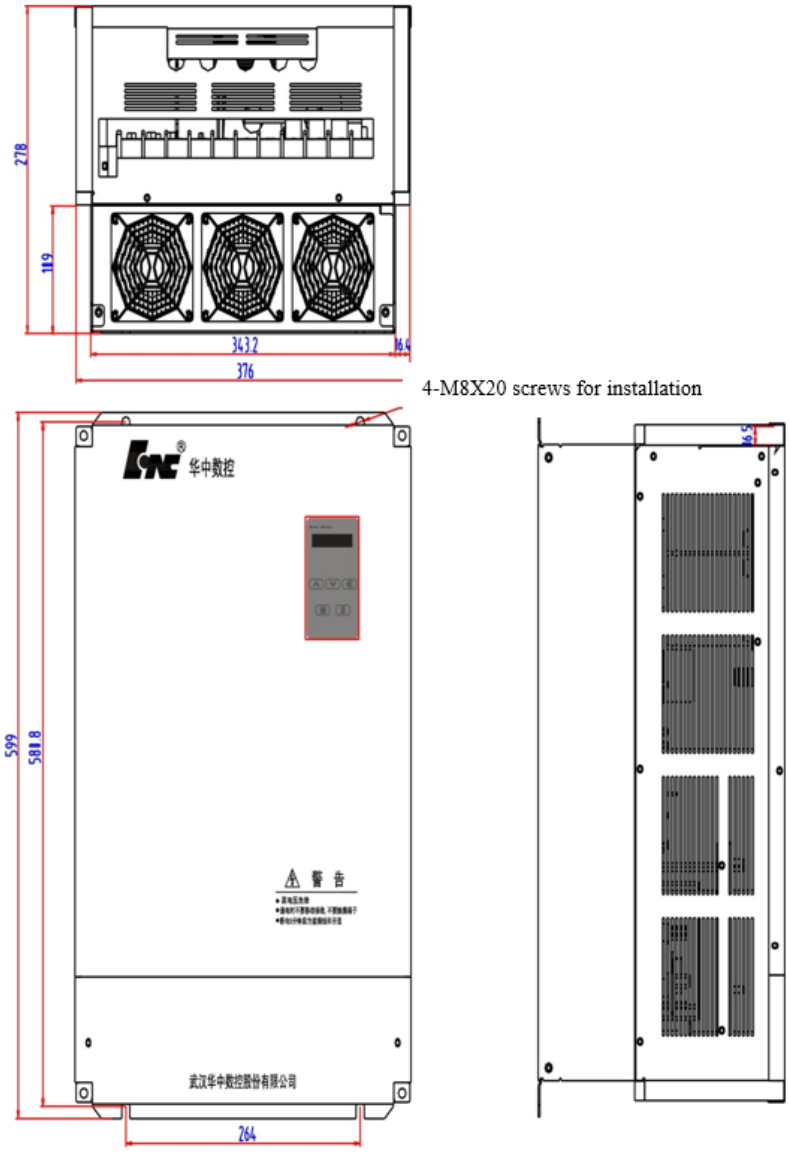


Figure 5.3.6 Dimensions of HSV-180US-200, 300, 450 Spindle Drivers (unit: mm)

5.4 Installation of Spindle Drivers

Attentions
● The servo driver must be installed in a protective electric cabinet. ● The servo driver must be installed in a specified direction, with

specified space interval and good heat dissipation.

- The servo driver cannot be installed on or near combustibles to avoid fires.

5.4.1 Installation Modes of HSV-180US-035, 050, 075 Spindle Drivers

1. Installation modes

   Installation modes of spindle drivers

   - Wall mounting without auxiliary devices, as shown in Figure 5.4.1
   - Wall mounting with auxiliary device, as shown in Figure 5.4.2
   - Wall-through mounting, as shown in Figure 5.4.3

   Users may choose one of the mode to install the driver, perpendicular to the installation face.

2. Installation space interval

   Figure 5.5.4 and 5.4.5 show the installation interval for a single spindle driver, and Figure 5.4.6 shows the installation interval for multiple spindle drivers. In the actual installation, a larger space interval is recommended to ensure good heat dissipation.

3. Heat dissipation

   Make sure that the wind from the cabinet blows to the heat dissipation component of the servo driver, so that the temperature surrounding the servo driver will not continue to rise.

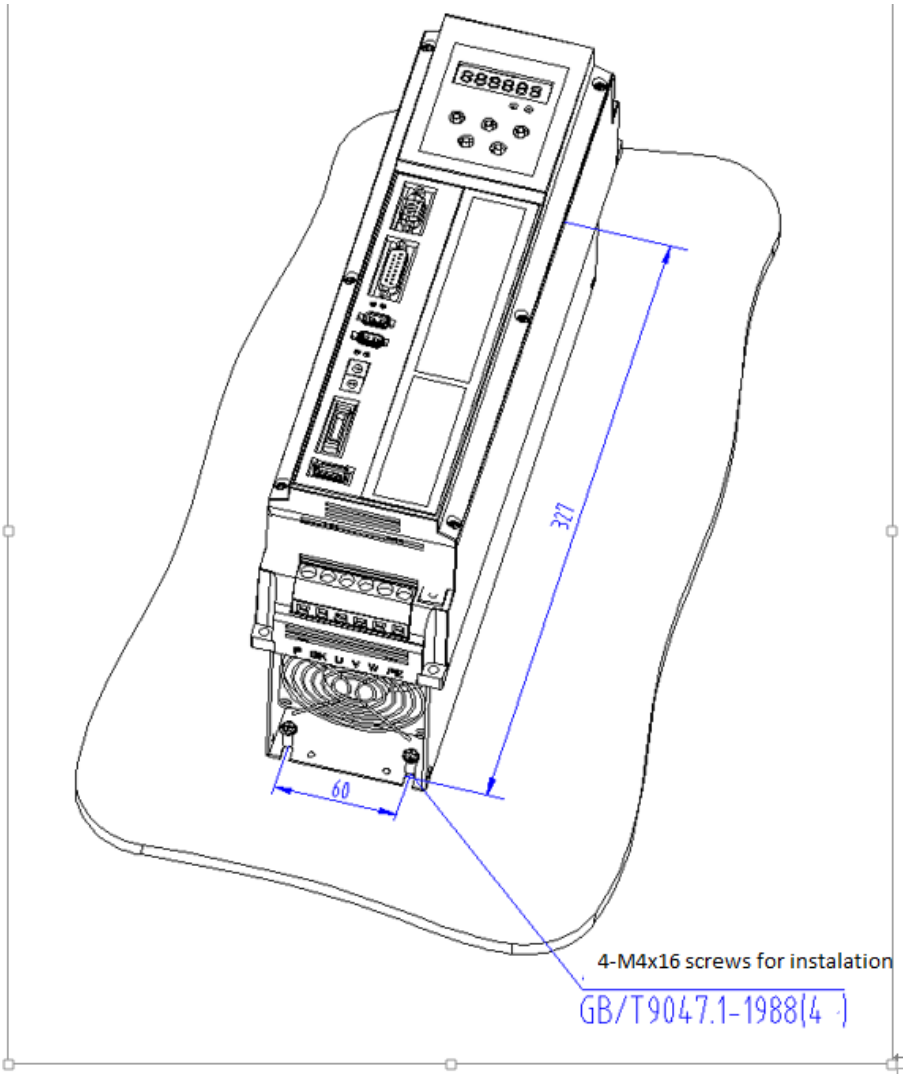


Figure 5.4.1 Wall mounted installation mode of HSV-180US-035, 050, 075 spindle drivers

(Without auxiliary device unit: mm)

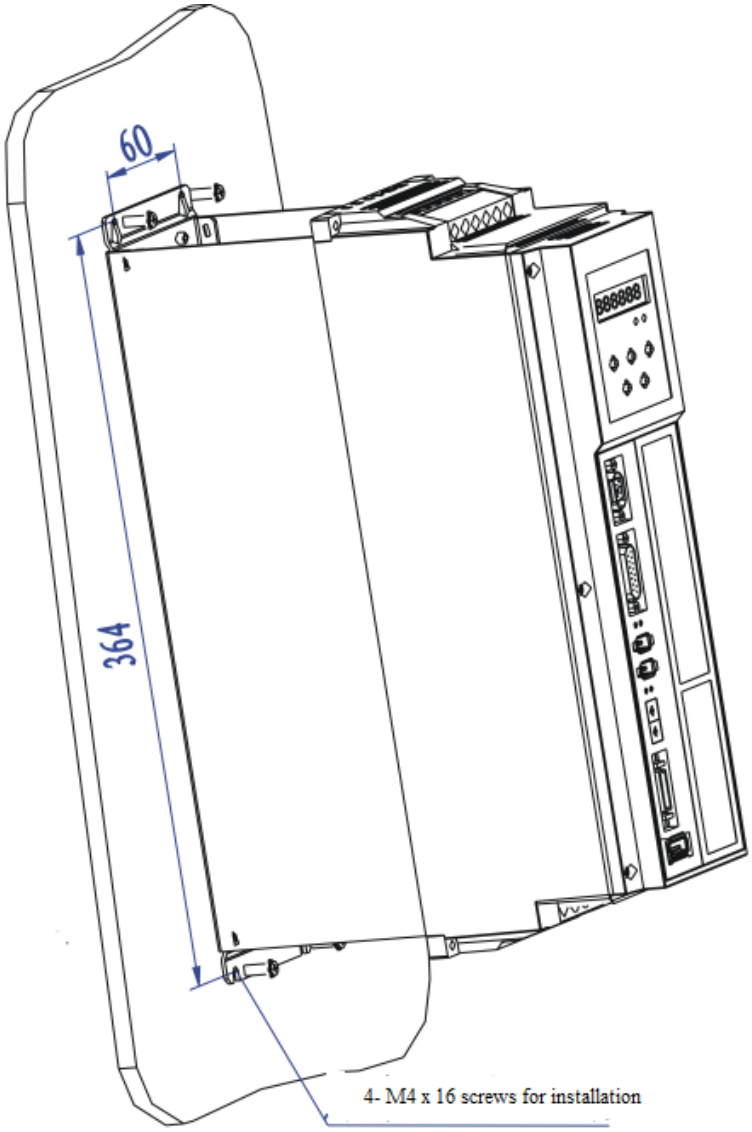


Figure 5.4.2 Wall mounted installation mode of HSV-180US-035, 050, 075 spindle drivers

(With auxiliary devices unit: mm)

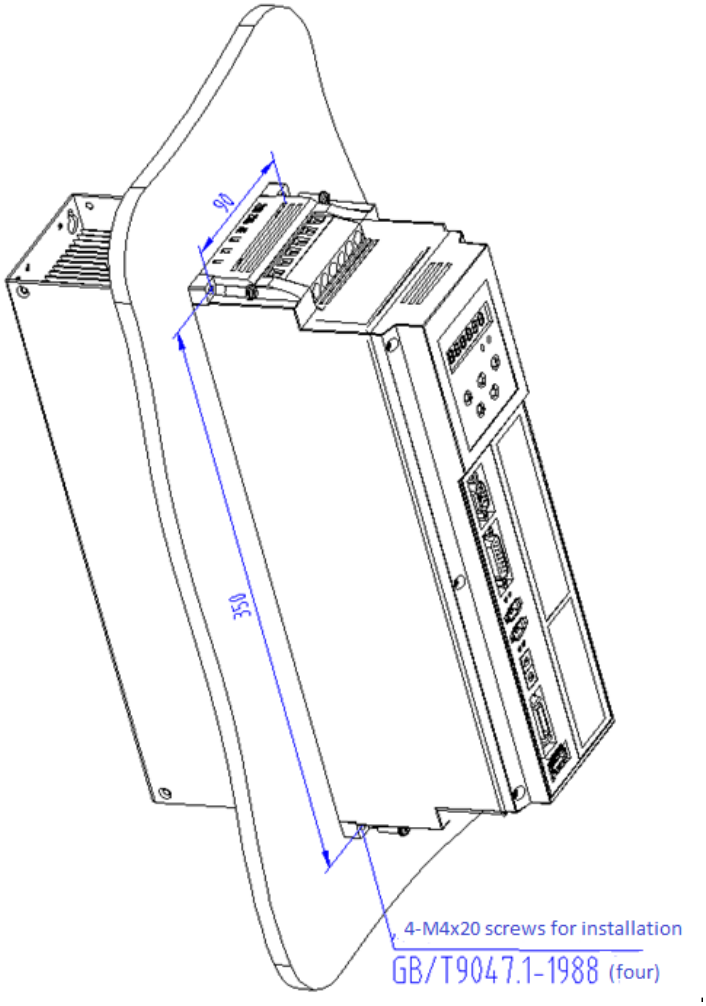


Figure 5.4.3 Wall-through mounting installation mode of HSV-180US-035, 050, 075 spindle drivers (unit: mm)

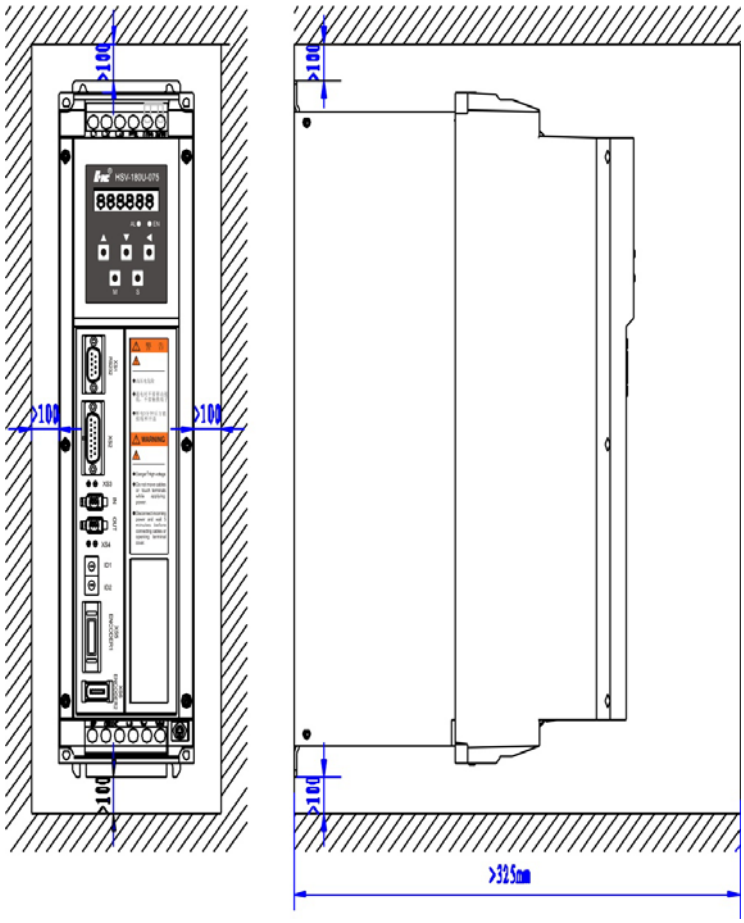


Figure 5.4.4 Installation space interval for a single HSV-180US-035, 050, 075 spindle driver

(Wall mounting installation unit: mm)

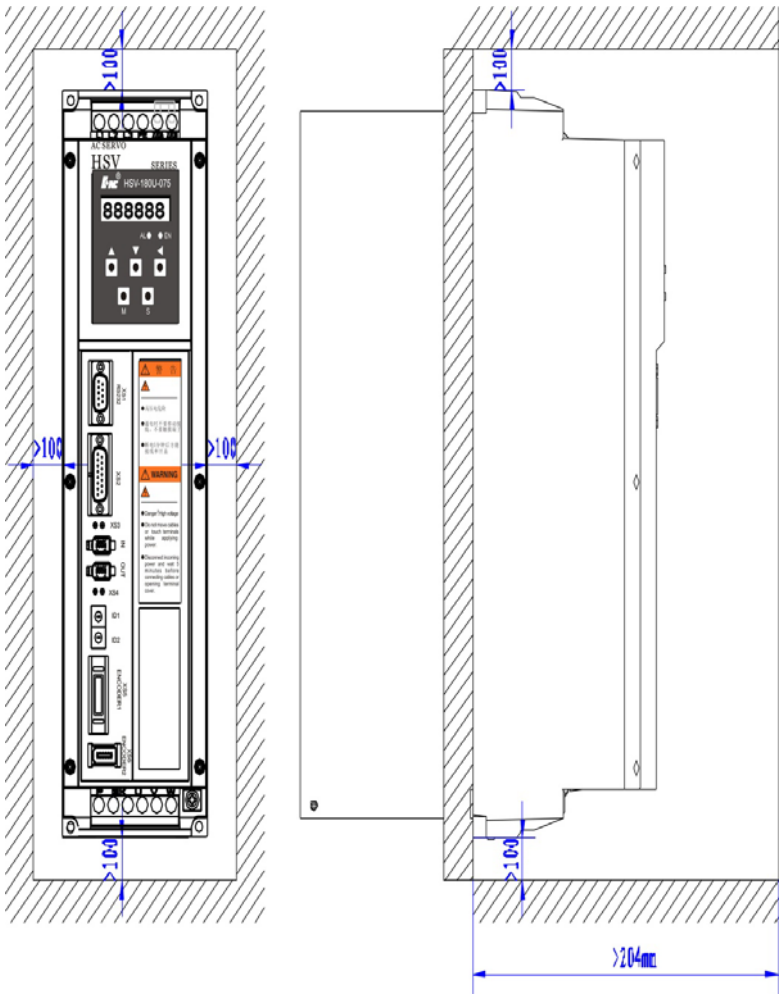


Figure 5.4.5 Installation space interval for a single HSV-180US-035, 050, 075 spindle driver

(Wall-through installation unit: mm)

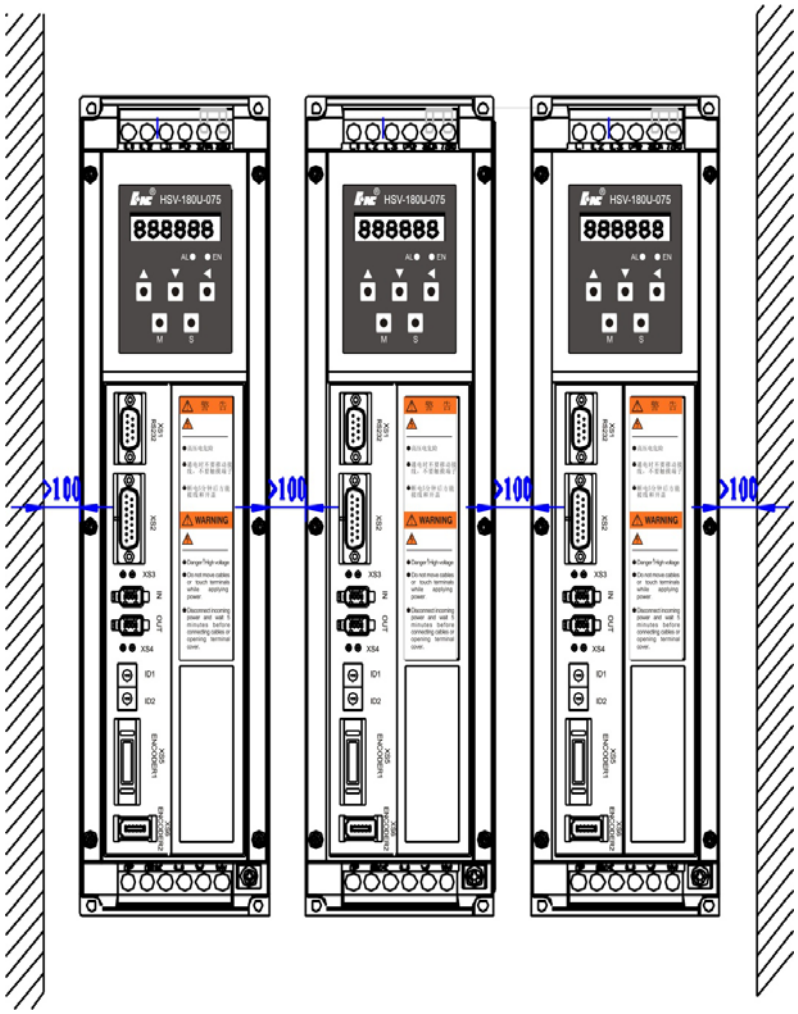


Figure 5.4.6 Installation space interval for HSV-180US-035, 050, 075 spindle drivers (unit: mm)

5.4.2 Installation Modes of HSV-180US-100, 150 Drivers

1. Installation modes

   Installation modes of spindle drivers:

   - Wall mounting (direct mounting with installation auxiliary device), as shown in Figure 5.4.7.
   - Wall-through mounting, as shown in Figure 5.4.8.

   Users may choose either of the modes to install the driver, perpendicular to the

installation face.

2. Installation space interval

   Figure 5.4.9 and 5.4.10 show the installation interval for a single spindle driver, and Figure 5.4.11 shows the installation interval for multiple spindle drivers. In the actual installation, a larger space interval is recommended to ensure good heat dissipation.

3. Heat dissipation

   Make sure that the wind from the cabinet blows to the heat dissipation component of the servo driver, so that the temperature surrounding the servo driver will not continue to rise.

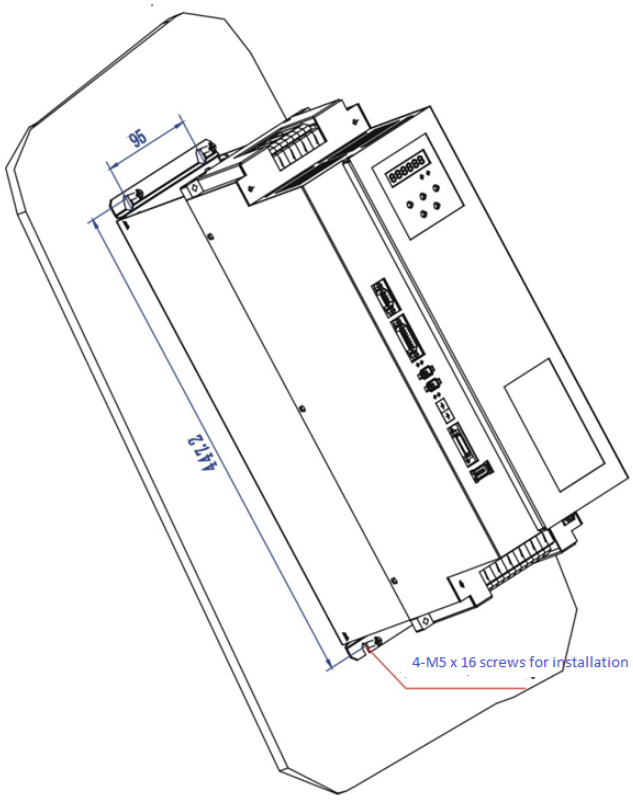


Figure 5.4.7 Wall mounting installation mode of HSV-180US-100, 150 spindle drivers (unit: mm)

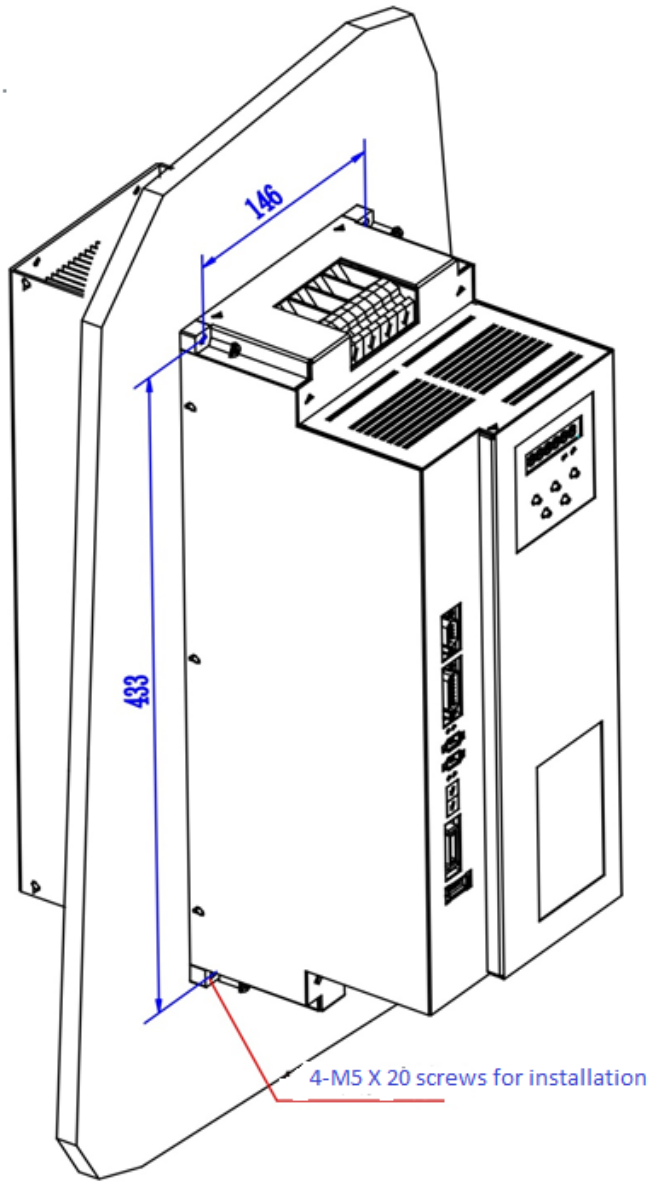


Figure 5.4.8 Wall-through mounting installation mode of HSV-180US-100, 150 spindle drivers (unit: mm)

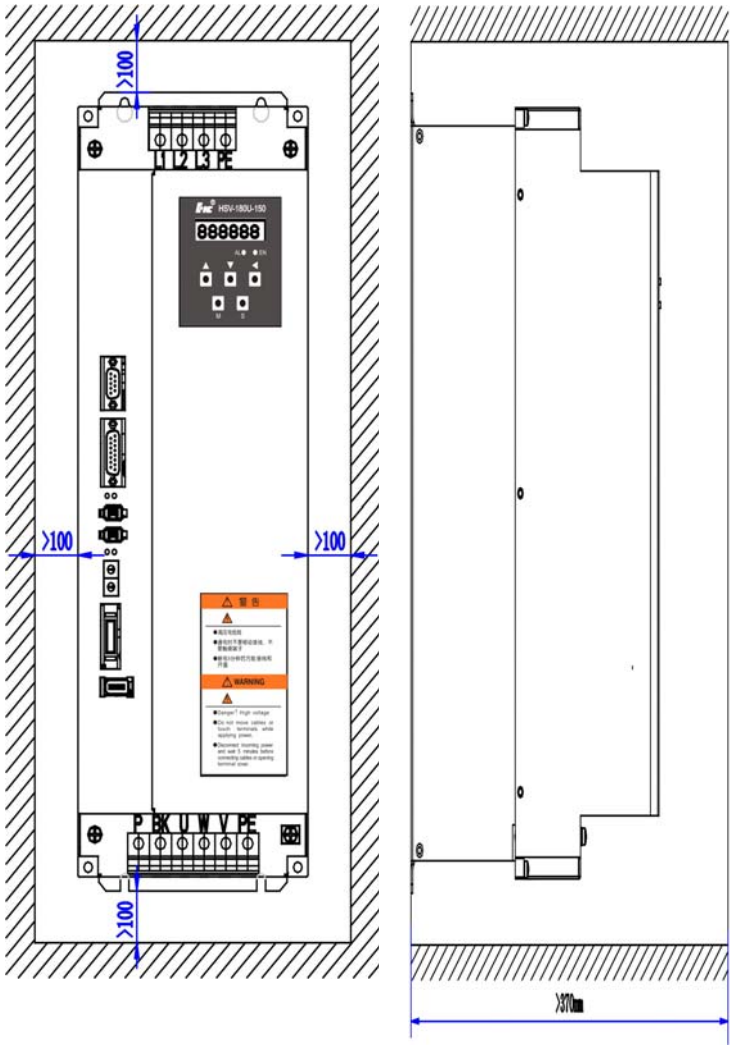


Figure 5.4.9 Installation space interval for a single HSV-180US-100, 150 spindle driver

(Wall mounting installation unit: mm)

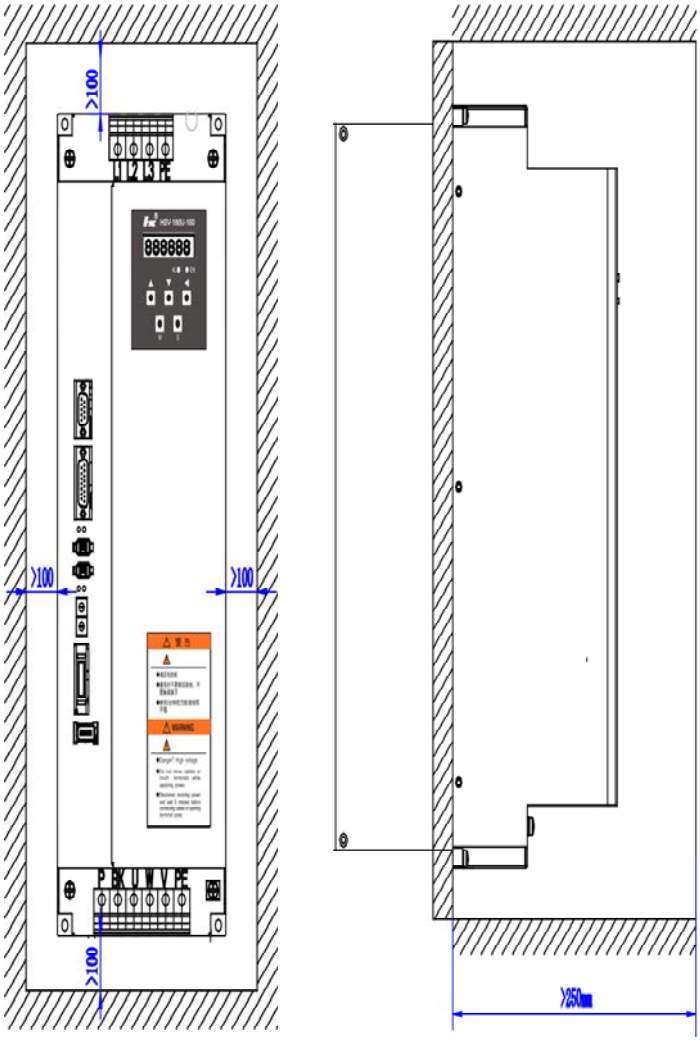


Figure 5.4.10 Installation space interval for a single HSV-180US-100, 150 spindle driver

(Wall-through installation unit: mm)

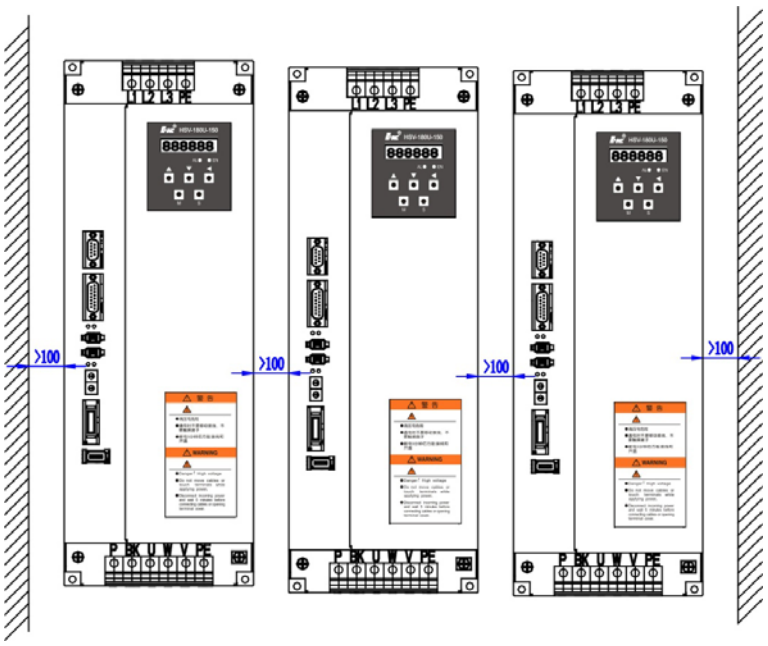


Figure 5.4.11 Installation space interval for HSV-180US-100, 150 spindle drivers (unit: mm)

5.4.3 Installation Modes of HSV-180US-200, 300, 450 Drivers

1. Installation modes

   There are two installation modes:

   - Wall mounting (direct mounting with installation auxiliary device), as shown in Figure 5.4.12.
   - Installation with heat dissipation externally placed, as shown in Figure 5.4.13.

   Users may choose either of the modes to install the driver, perpendicular to the installation face.

2. Installation space interval

   Figure 5.4.14 and 5.4.15 show the installation interval for a single spindle driver, and Figure 5.4.16 shows the installation interval for multiple spindle drivers. In the actual installation, a larger space interval is recommended to ensure good

heat dissipation.

3. Heat dissipation

   Make sure that the wind from the cabinet blows to the heat dissipation component of the servo driver, so that the temperature surrounding the servo driver will not continue to rise.

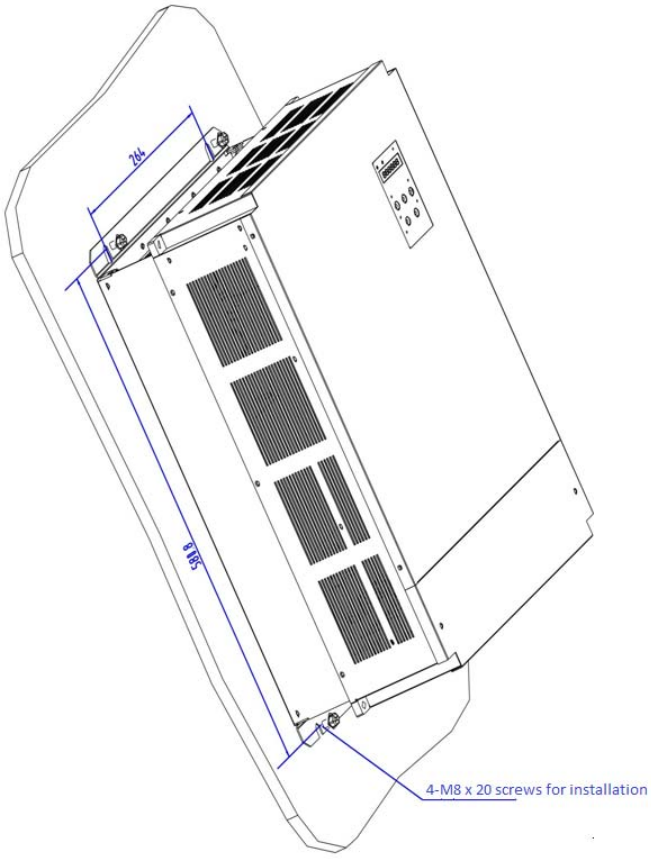


Figure 5.4.12 Wall mounting installation mode of HSV-180US-200, 300, 450 spindle drivers (unit: mm)

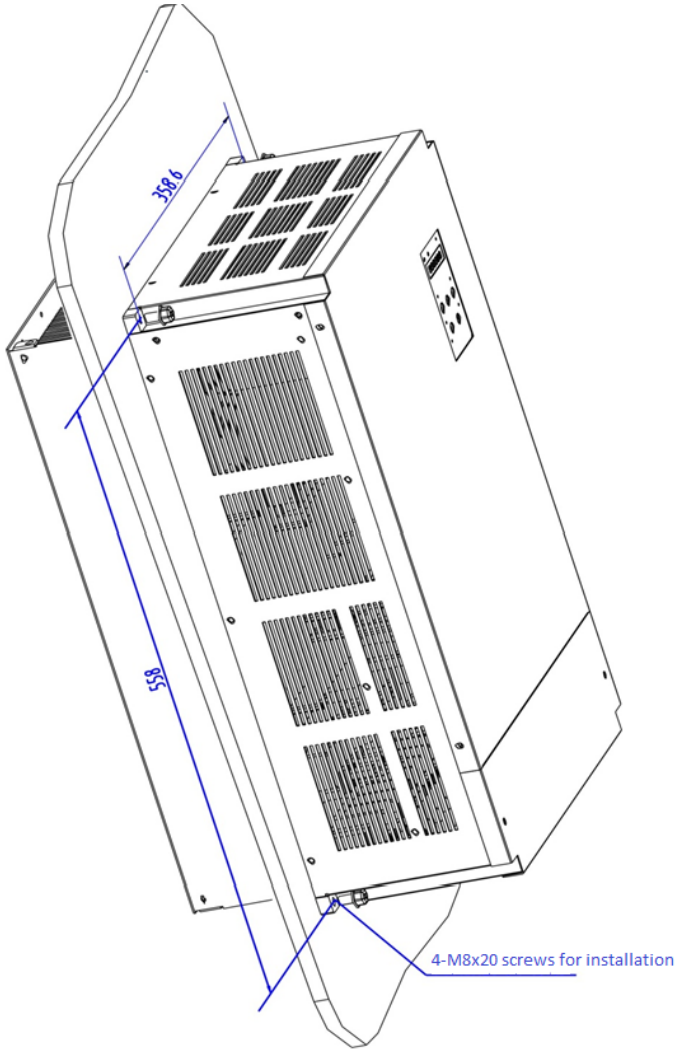


Figure 5.4.13 Wall-through mounting installation mode of HSV-180US-200, 300, 450 spindle drivers (unit: mm)

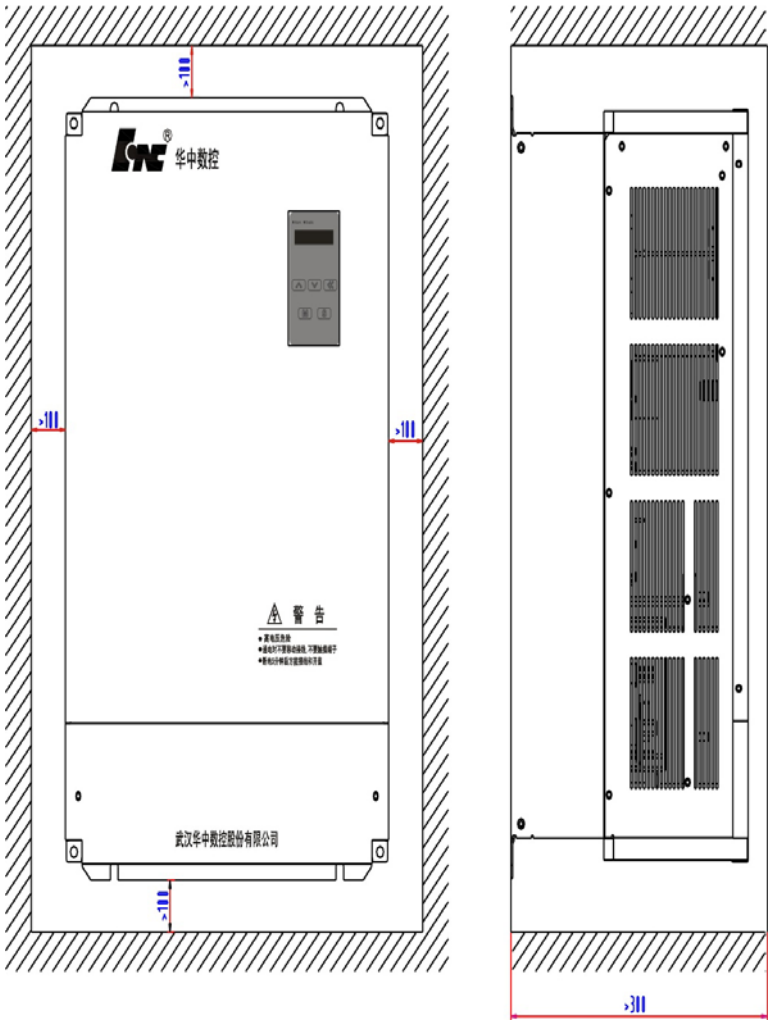


Figure 5.4.14 Installation space interval for a single HSV-180US-200, 300, 450 spindle driver

(Wall mounting installation unit: mm)

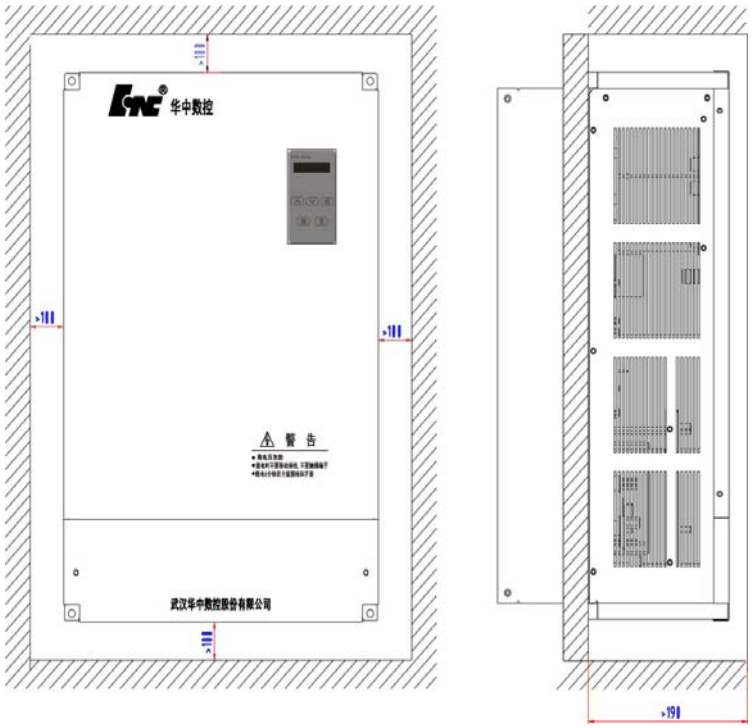


Figure 5.4.15 Installation space interval for a single HSV-180US-200, 300, 450 spindle driver

(Wall-through installation unit: mm)

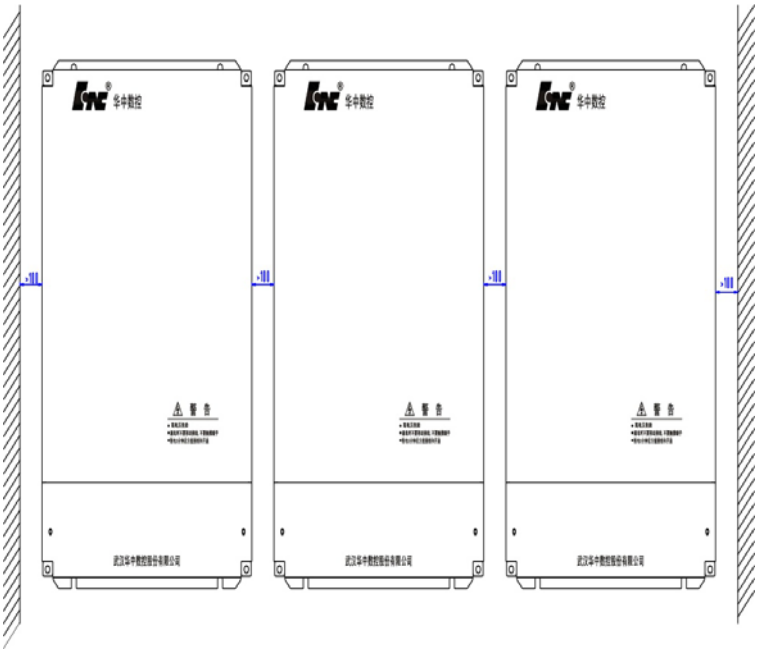


Figure 5.4.16 Installation space interval for HSV-180US-200, 300, 450 spindle drivers (unit: mm)

5.5 Key Spindle Servo Parameter Settings

5.5.1 Modify Key 180US Servo Parameters on HNC-8 Software

Users may directly modify the servo parameters in the HNC-8 CNC systems. when the logical axis number is set to **10**, a total of **60** servo parameters from **10X200** to **10X259** will be added to the coordinate axis parameters. See the figure below:

Servo parameters in the CNC system

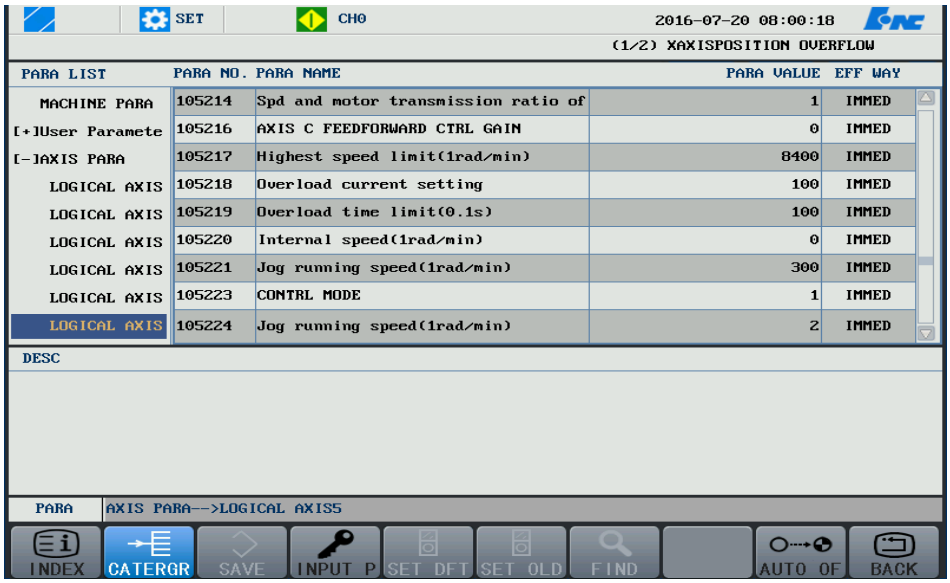
In these parameters, the parameters from 10X200 to 10X259 correspond to the servo PA parameters.

Note: Within the parameter number, **X** indicates the logical axis number. For example, the parameter **105200** indicates the logical axis number is **5**.

Users need to set the motor code after powering the motor for the first time, and then input the code to the parameter **10X259** "**DRV SPEC/MOTOR TYPE CODE**". See the figure below:

Then set the parameter **10X224** and **10X225** based on the motor.

Power off and restart the motor after the settings above, the servo will automatically match the servo parameters based on the motor. Users can fine-tune the servo parameters according to the actual situation.



5.5.2 Parameters Related to Asynchronous Spindle Motor

- Parameter settings for standard motors

For standard Golden Age asynchronous spindle motors, set PA-59 based on the description in the figure below, and then users may proceed with the next parameter settings.

Common asynchronous spindle motor code

Motor Code	Motor Model	Rated Power (KW)	Rated Torque (Nm)	Rated Current (A)	Compatible Drivers	PA-59
00	GM7101-4SB61	3.7	23.6	10	HSV-180US-035	0
01	GM7103-4SB61	5.5	35	13	HSV-180US-035	1
					HSV-180US-050	101
02	GM7105-4SB61	7.5	47.8	18.8	HSV-180US-050	102
					HSV-180US-075	202
03	GM7109-4SB61	11	70	25	HSV-180US-075	203
					HSV-180US-100	303
04	GM7133-4SB61	15	95.5	34	HSV-180US-100	304
					HSV-180US-150	404
05	GM7135-4SB61	18.5	117.8	42	HSV-180US-150	405
06	GM7137-4SB61	22	140.1	57		406

- Parameter settings for non-standard motors

For the asynchronous spindle motor or spindle of other manufacturers, users need to manually set the operating parameters. Follow the instructions below:

1. Confirm that the servo motor matches the specifications of the driver unit. See the spindle driver selection guide in this manual.
2. Confirm that the spindle driver supports the spindle motor's encoder.
3. Set the following parameters according to the motor label or user manual:

- **PA-41**: set it to **2003**.
- **PA-59**: Set it according to the driver model.

  HSV-180AS-035: set it to **1**.

  HSV-180AS-050: set it to **102**.

  HSV-180AS-075: set it to **203**.

  HSV-180AS-100: set it to **304**.

  HSV-180AS-150: set it to **405**.
- PA**-17**: Maximum motor speed (unit: 1 r/min).
- **PA-24**: Pole pairs of the IM motor.
- **PA-25**: Encoder type of the IM motor.
- **PA-33**: Flux current of the IM motor (unit: percentage of rated current)
- **PA-34**: Electrical time constant of the IM motor rotor (unit: 0.1 ms)
- **PA-35**: Rated speed of the IM motor (unit: 1 r/min)
- **PA-53**: Rated current of the IM motor (unit: 0.1 A)

4. **PA- 41**: Set it to **1230**, save the parameters in the auxiliary menus, and then power on the driver again.

5.5.3 Parameters Related to Torque Control (Current Control)

- **PA-1**: Output torque filter time (0.1 ms)
- **PA-27**: PI proportional gain in the current control mode
- **PA-28**: PI integration time in the current control mode (0.1 ms)

Parameter description: The parameters above are used to adjust the response in the current control mode.

PA-1: Output torque filter time constant (0.1 ms)

1. Set the torque command filter time.
2. The larger the time is, the easier to eliminate the running noise of the motor, but the slower response of the control system.
3. Users may set this value to a relatively smaller value as long as the noise is

not too big.

PA-27: PI proportional gain in the current control mode

1. Set the PI proportional gain in the current control mode.
2. Users may decrease the value accordingly if large noise appears during the motor operation.
3. If the value is too small, the response will be delayed in the system. Users may set this value to a relatively larger value as long as the noise is not too big.

PA- 28: PI integration time in the current control mode (0.1 ms)

1. Set the PI integration time in the current control mode.
2. Set this parameter according to the electrical time of the motor.

Note: Generally, it is not recommended to modify the PA-27 or PA-28 parameters.

5.5.4 Parameters Related to Speed Control

PA-2: PI proportional gain in the speed control mode (or directional mode)

PA-3: PI integration time (0.1 ms) in the speed control mode (or directional mode)

PA-4: Speed feedback filter factor

PA-5: Decceleration time (unit: 0.1 s/8000 r/min)

PA-6: Acceleration time (unit: 0.1 s/8000 r/min)

Parameter description: The parameters above are used to adjust the speed response in the speed control mode.

PA-2: PI proportional gain in the speed control mode (or directional mode)

1. The larger the value is, the higher the gain and the greater the rigidness. Users may define the parameter value based on the spindle driver model and load values.In general, the bigger the load inertia, the larger the value.
2. Users may set this parameter to a relatively larger value to increase the speed of response, under the condition of no oscillation cuased.

PA-3: PI integration time (0.1 ms) in the speed control mode (or directional mode)

1. The smaller the value is, the faster the integration speed. Define the

parameter value based on the spindle driver model and load values. In general, the bigger the load inertia, the larger the value.

2. Users may set this parameter to a relatively smaller value under the condition of no oscillation cuased.

PA-4: Speed feedback filter factor

1. Set the speed feedback low filter to eliminate the speed feedback signal noise.
2. The larger the value, the lower the end frequency, and the smaller the noise generated by the motor. If the load inertia is large, users may decrease the value appropriately. If the value is too large, the response may become slow, which may cause oscillation.
3. The smaller the value, the higher the end frequency, and the quicker the response. Users may decrease the value to obtain a quicker response.

PA-5: Decceleration time (unit: 0.1 s/8000 r/min)

PA-6: Acceleration time (unit: 0.1 s/8000 r/min)

1. PA-5 indicates the decceleration time of the motor from the speed 8000 r/min to 0 r/min; PA-6 indicates the acceleration time of the motor from the speed 0 r/min to 1000 r/min.
2. The acceleration and deceleration is linear.

5.5.5 Parameters Related to Position Control

PA-0: Axis C position proportional gain in the position control position (Unit: 0.1 Hz)

PA-16: Axis C feedforward control gain

PA-42: Axis C PI proportional gain in the position control mode

PA-43: Axis C Speed PI integration time in the position control mode (1 ms)

PA-49: Axis C gear ratio numerator

PA-50: Axis C gear ratio denominator

Parameter description: The parameters above are used to adjust the position and speed in the Axis C position control mode.

PA-0: Axis C position proportional gain in the position control position (Unit: 0.1 Hz)

1. Set the Axis C position proportional gain in the position control mode.
2. The larger the value, the higher the gain, the greater the rigidness, and the smaller the position delay (position track error) under the same frequency command pulse condition. Howerver, if the value is too large, it may cause oscillation.
3. Users may set this parameter to a relatively larger value to increase the position response, under the condition of no oscillation cuased.

PA-16: Axis C feedforward control gain

1. Set the Axis C feedforward control gain in the position control mode (PA-23=0).
2. The larger the position feedforward gain is, the quicker the response of the control system, but the more unstable of the position control system, which may cause oscillation.
3. This parameter is generally set to **0** when the system does not require very quick response.

PA-42: Axis C speed PI proportional gain in the position control mode.

1. Set the Axis C speed PI proportional gain in the position control mode.
2. The larger the value is, the higher the gain and the greater the rigidness. In general, the bigger the load inertia, the larger the value.
3. Users may set this parameter to a relatively smaller value under the condition of no oscillation cuased.

PA-43: Speed PI integration time in the Axis C position control mode (1 ms)

1. Set the Axis C speed PI intergation time in the position control mode.
2. The smaller the value is, the faster the integration speed. In general, the bigger the load inertia, the larger the value.
3. Users may set this parameter to a relatively smaller value under the

condition of no oscillation cuased.

5.5.6 Parameters Related to Spindle Orientation

PA-44: Position proportional gain in the spindle orientation mode (Unit: 0.1 Hz)

PA-38: Spindle orientation speed (unit: 1 r/min)

PA-39: Spindle orientation position (unit: pulse)

PA-13: Spindle and motor gear ratio numerator

PA-14: Spindle and motor gear ratio denominator

PA-47: Spindle encoder resolution (unit: pulse)

Parameter description: These parameters are used to set the functions related to spindle orientation.

PA-44: Position proportional gain in the spindle orientation mode (Unit: 0.1 Hz)

1. Set the position proportional gain in the spindle orientation mode.
2. The larger the value is, the higher the gain and the greater the spindle rigidness during orientation.
3. Users may set this parameter to a relatively smaller value under the condition of no jittering cuased.

PA-38: Spindle orientation speed (unit: 1 r/min)

Set the spindle motor speed during spindle orientation.

PA-39: Spindle orientation position (unit: pulse

1. Set the spindle orientation position. The motor or the number of pulses per revolution corresponds to 360 degrees.
2. This value is set based on the motor encoder or the zero pulse position of the spindle encoder.

PA-13: Spindle and motor gear ratio numerator

PA-14: Spindle and motor gear ratio denominator

1. Set the spindle and motor gear ratio.
2. Example:

   During operation, if the spindle rotates three times while the spindle motor

rotates five times, then PA-13 = **3**, PA-14 = **5**.

If the spindle rotates five times while the spindle motor rotates three times, then PA-13 = **5**, PA-14 = **3**.

PA-47: Spindle encoder resolution (unit: pulse)

1. Set the spindle encoder resolution to **4**.
2. PA-47 = *spindle encoder resolution* x **4**. If the spindle encoder resolution is 1200, then PA-47 is **4800** (1200 x 4 = 4800). If no spindle encoder is used, set it to **4096**.

6 PLC Commissioning

6.1 PLC Structure of HNC-8 Series

HNC-8 CNC system's PLC uses the loop scanning mode. The PLC will be initialized when powered on for the first time or reloaded into the system. After that, all input status will be sent to the input image register, and then the user program PLC1 and PLC2 will be sequentially called. When a loop scanning is completed, all the results are transferred to the output image register for controlling the actual output of the PLC. This process will be repeated. See Figure 6.1.

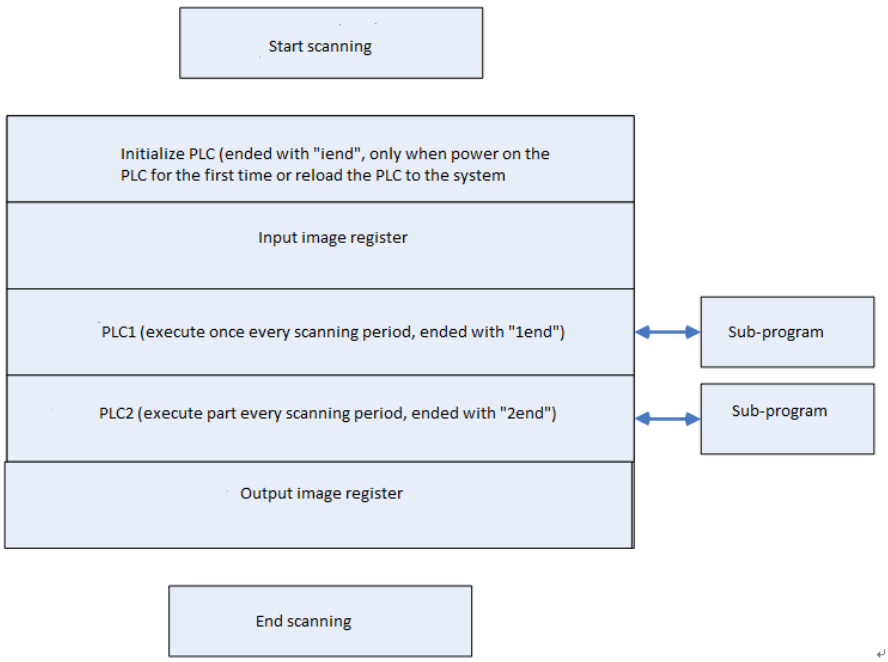


Figure 6.1 PLC Structure of HNC-8 Series

6.2 PLC Interface Signal Working Principles

PLC interface signals are responsible for the information exchange between PLC and NC. See Figure 6.2.

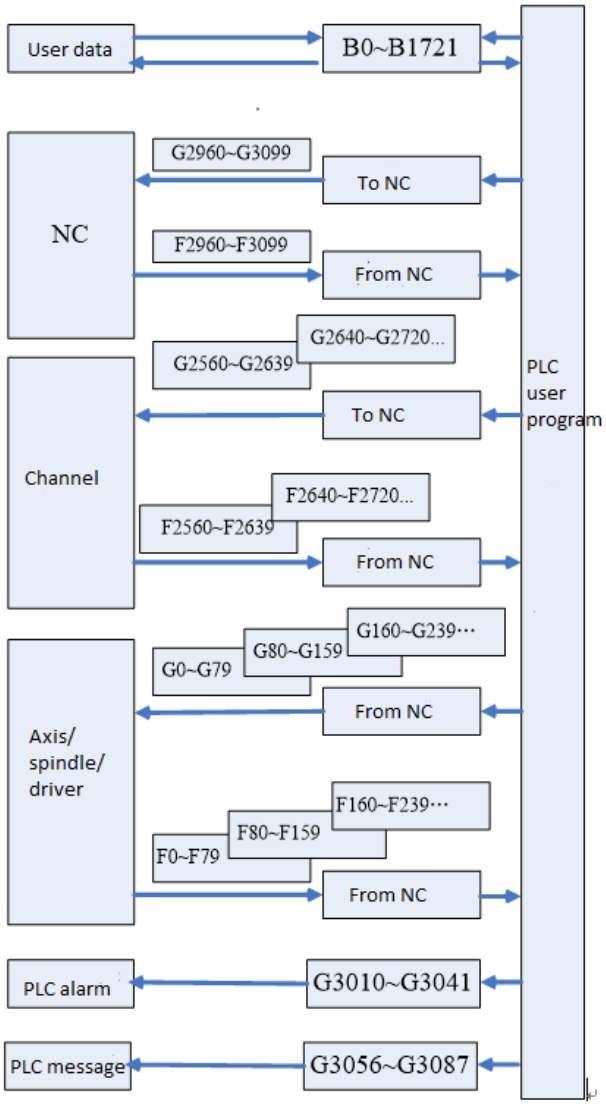
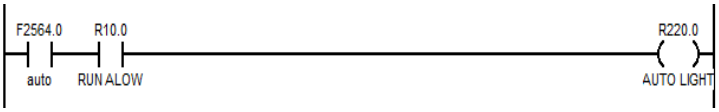


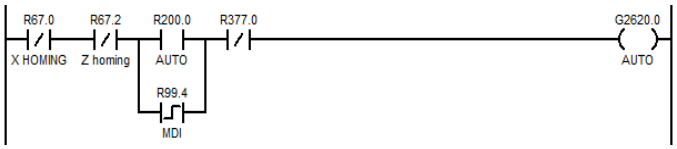
Figure 6.2 PLC interface signals

- The F register is a status register, which is used to transmit the CNC input signal from the CNC into PLC control module.

  The following figure shows that the system reads the F register, checks if it is in the automatic mode, and decides whether to enable the automatic light on the panel.



- The G register is a control register, which is used to output the CNC output signal from the control module to the PLC. The following figure shows how to set the automatic mode by setting the G register.



- The B register is a power-off saving register. The values in the register will be kept after the power is off. The power-off saving register can also be used as PLC parameters. Users can customize the usage of each parameter. The figure below shows that B0.0 is used to memorize the chuck status. Then the clamping/releasing status of the chuck can be automatically restored after power on again.

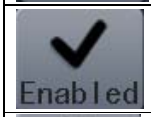
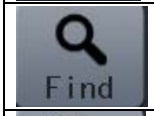
6.3 Ladder Graph Monitoring and Online Editing

The ladder graph monitoring and online editing are supported by the PLC editing function in the CNC system. It monitors the real-time status of each element in the ladder, and users can force modify the status of an element to achieve the commissioning purpose.

Press **DGN** > **LAD** to enter the ladder monitoring interface. See Figure 6.3.1.

Figure 6.3.1 Ladder graph monitoring interface

The table below describes each button and its sub menus on the interface.

	LAD DGN: to view variable values, and perform force operations on elements (second level sub-menus).
	Modify: to modify the settings for the elements (second level sub-menus).
	Disable: to disable the element (third level sub-menus).
	Enable: to enable the element (third level sub-menus).
	Undo: to cancel the operations of disabling of enabling the element (third level sub-menus).
	Find: to search elements (third level sub-menus).
	Prev: to find the previous elements upward from the current point (third level sub-menus).
	Next: to find the next elements downward from the current point (third level sub-menus).

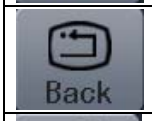
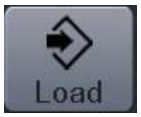
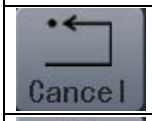
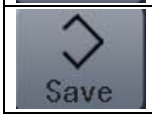
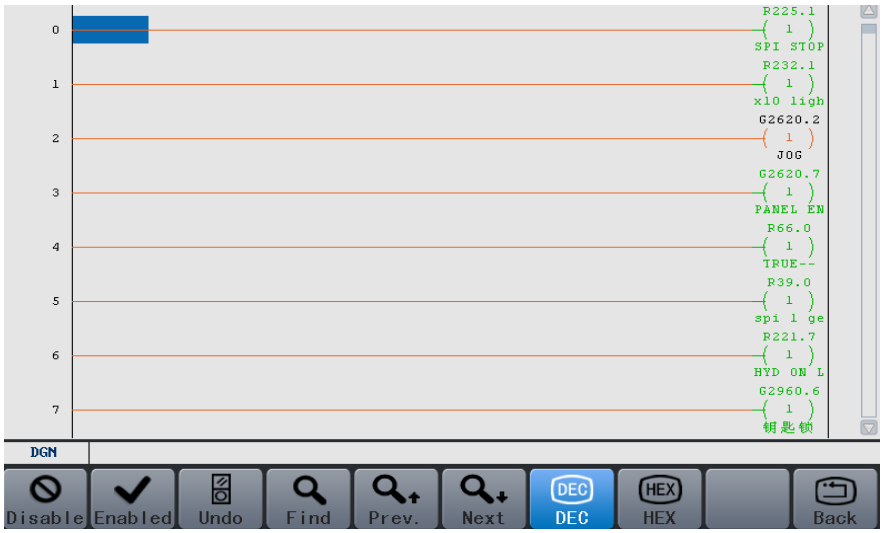
	DEC: The system displays the value in the "decimal" mode (third level sub-menus).
	HEX: The system displays the value in the "hexadecimal" mode (third level sub-menus).
	Back: to return to the second level sub-menus (third level sub-menus).
	Modify: to modify the settings for the elements (third level sub-menus).
	CMD: The command here refers to the common user operation commands, e.g. select lines, delete, copy, paste and other text editing commands (third level sub-menus).
	Load: to load the current ladder to the system. (third level sub-menus).
	Cancel: to cancel the editing on the ladder graph (third level sub-menus).
	Save: to save the editing on the ladder graph (third level sub-menus).

Table 6.3.1

6.3.1 Online Ladder Graph Diagnosis

Select the LAD DGN key to enter the ladder diagnostic interface, as shown in the figure below. Ladder diagnosis interface consists of Disable, Enable, Undo, DEC, HEX, and Back.



Press the **DGN** > **LAD** > **LAD DGN** to view the status and values of each register. Users may move the cursor up and down to view the information of each register. As shown in the figure above, if the element turns green, the element is connected or valid. Users may press **Disable**, **Enable**, or **Undo** and perform according operations on the elements. It is not recommended for non-commissioning personnel to perform such operations.

Button to disable elements. Hover the cursor over the element, and press this button to disable the element.

As shown in the figure below, hover the cursor over the element, and press this button. The element turns red, indicating that it is disabled and the output is stopped.

Note: This operation is valid only for the current line. As shown in the figure above, the disabling operation is valid only for the line of R2.0.

Button to enable elements. Hover the cursor over the element, and press this button to enable the element.

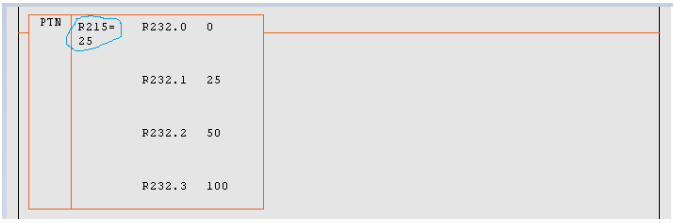
As shown in the figure below, hover the cursor over the element, and press this button. The element turns green, indicating that it is enabled. For example, hover the cursor over the X3.1 line, press this button, and the element turns green.

Note: This operation is valid only for the current line. As shown in the figure above, the enabling operation is valid only for the line of X3.1.

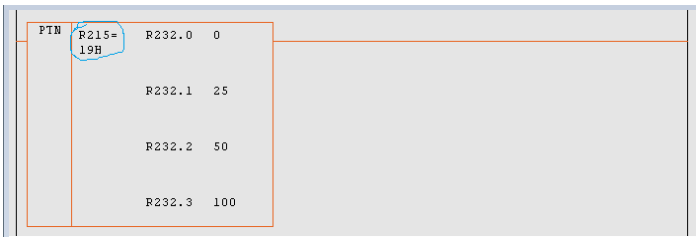
Button to undo the previous operation. Hover the cursor over the element, and press this button to cancel the operation of disabling or enabling the element. For example, press this button and the element turns to the previous color, which indicates the element function is restored.

By default, the value in the system is displayed in the decimal mode. Users may press the **HEX** button to display the value accordingly. The figures below shows the R215 register value of the PIN module in the decimal and hexadecimal modes:

Decimal display



Hexadecimal display



Button to back to the previous interface. Press this button to return to the ladder monitoring interface for other operations.

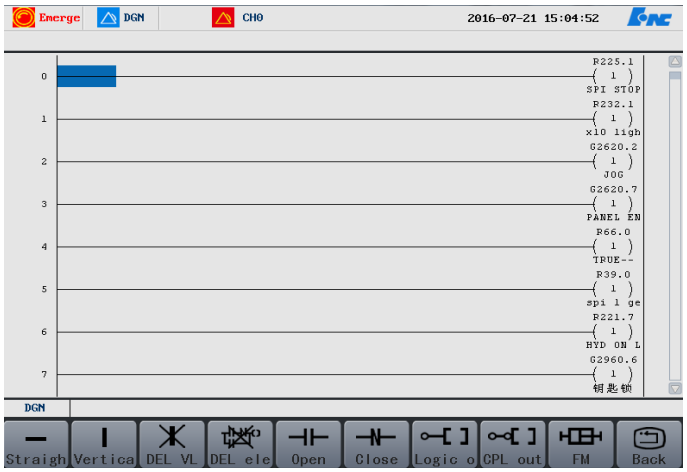
Press this button to enter the interface where users may search elements.

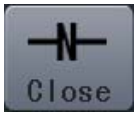
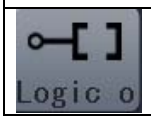
For example, input **P32.1**, and press the **Enter** key to find the first **P32.1**. Users may press **Prev.** to find P32.1 upwards from the current position.

In addition, users may press this **Next** button to find P32.1 downwards from the current position.

6.3.2 Editing

Users may press **Modify** to enter the third level sub-menu.

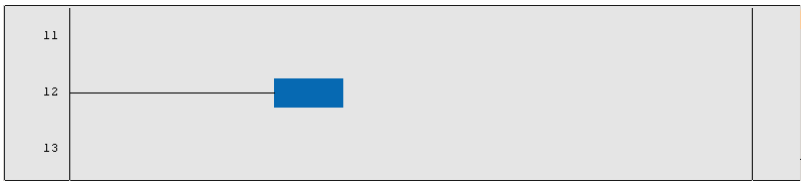


	Straight: to insert a straight line.
	Vertical: to insert a vertical line.
	DEL VL: to delete a vertical line.
	DEL ele: to delete an element.
	Open: to insert a normally open contact.
	Close: to insert a normally closed contact.
	Logic output: to insert output.

	CPL out: to insert CPL output.
	Functional module: to insert functions (Users may select elements based on the first character of the elements).

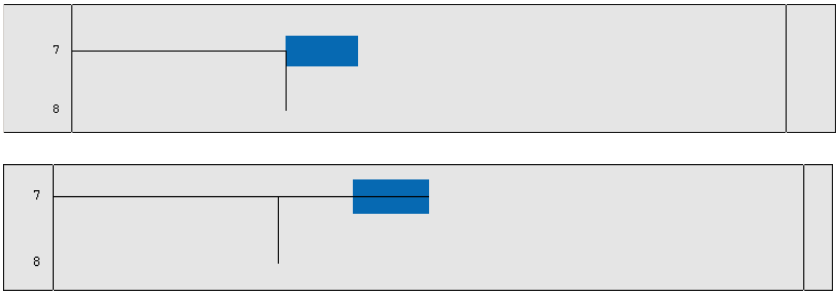
6.3.2.1 Insert a Straight Line.

Press the **Straight** button to insert a straight line into the ladder graph. See the figure below:



6.3.2.2 Insert a Vertical Line

Press the **Vertical** button to insert a vertical line on the right of the cursor. See the figure below:



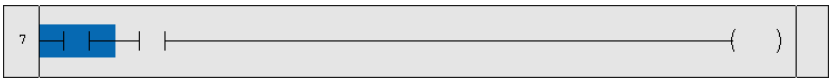
6.3.2.3 Delete a Vertical Line

Press the **DEL VL** button to remove the vertical line on the right of the cursor. See the figure below:

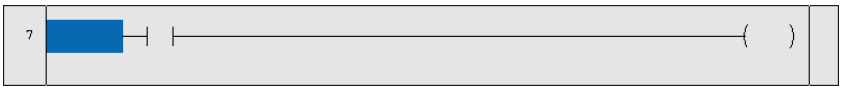
6.3.2.4 Delete Elements

Hover the cursor over the element you want to delete, and press this button to delete the element from the ladder graph.

Before deleting:

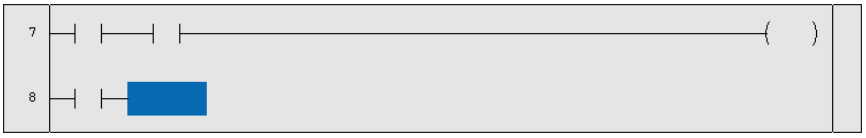


After deleting

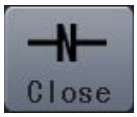


6.3.2.5 Open

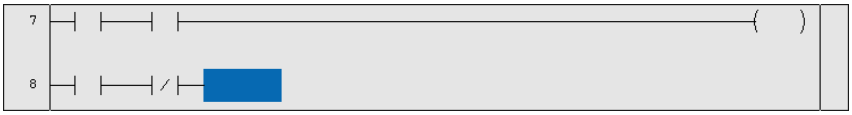
Move the cursor to the position where you want to insert a normally open contact, and press this button to insert it into the ladder graph. See the figure below:



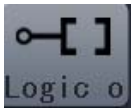
6.3.2.6 Close



Move the cursor to the position where you want to insert a normally open contact, and press this button to insert it into the ladder graph. See the figure below:

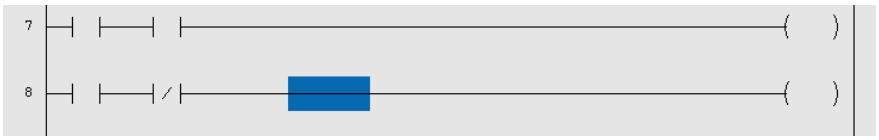


6.3.2.7 Logic Output

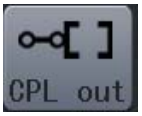


Hover the cursor to the position where you want to insert the logical output, and press this button to insert it into the ladder graph. See the figure below.

It should be noted that the logic output can be added prior to the specified position, but not behind the position. For detailed description, see the section related to programming in this manual.

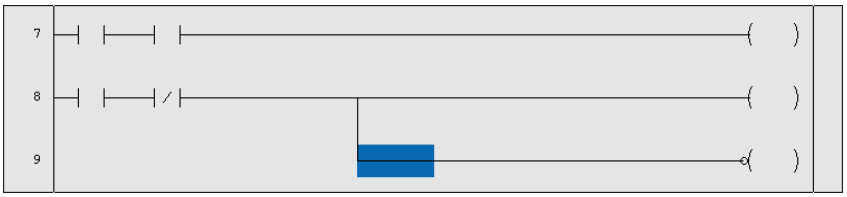


6.3.2.8 CPL Output



Move the cursor to the position where you want to insert the CPL output, and press this button to insert it into the ladder graph. See the figure below.

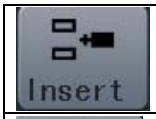
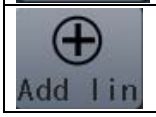
It should be noted that the CPL output can be added prior to the specified position, but not behind the position.



6.3.3 Command

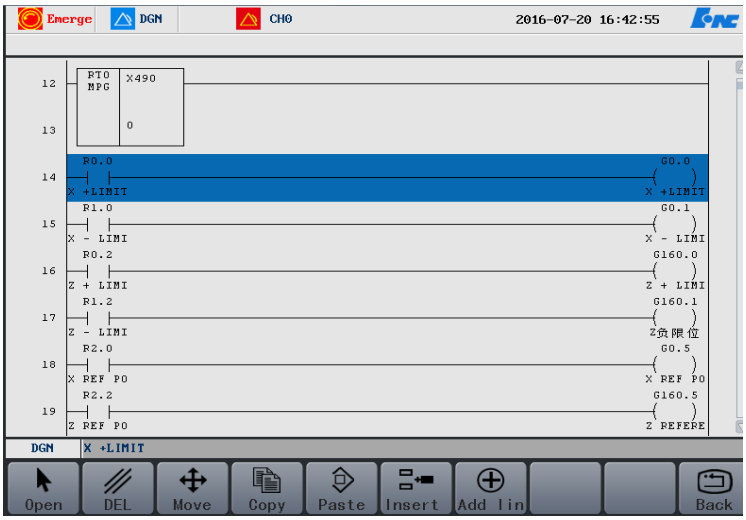
Command here refers to the common user operation commands, e.g. select line, delete, copy, paste and other text editing commands. Users may press the buttons and perform operations accordingly.

	Open: to select the line where the cursor is.
	DEL: to delete the line where the cursor is.
	Move: to move the selected element.
	Copy: to copy the selected element.
	Paste: to paste the selected element.

	Insert: to insert a line prior to the line where the cursor is.
	Add Line: to add a line behind the line where the cursor is.

6.3.3.1 Select

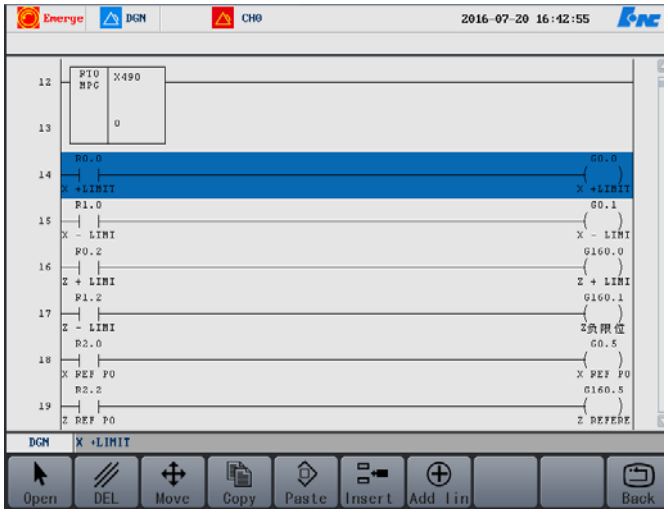
Hover the cursor over the line you want to select, and then press the **Open** key. The selected line turns blue. Press the **Open** key again to select the line next to the current line. See the figure below. Users may delete, move, or copy the selected line.



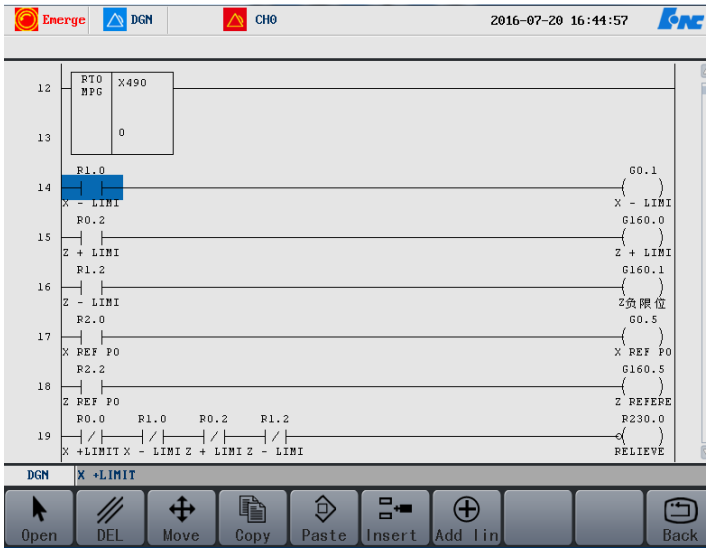
6.3.3.2 Delete

Press the **Open** key to select the line you want to delete. The line turns blue, and press the **DEL** key to delete the selected line. See the figure below:

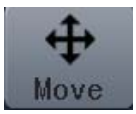
- Before deleting:



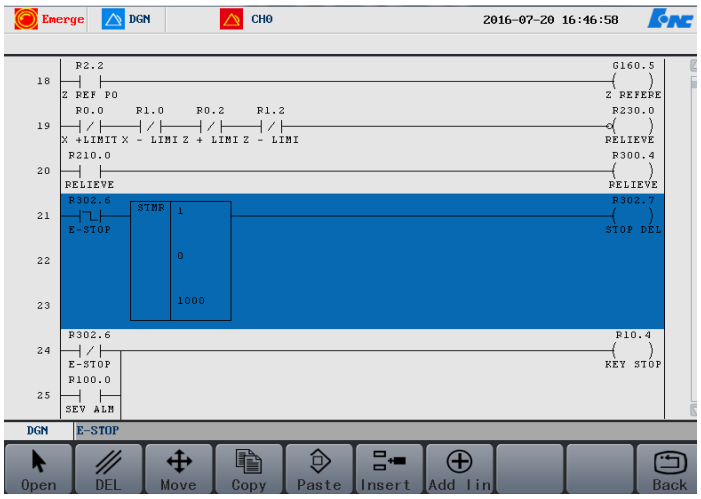
- After deleting



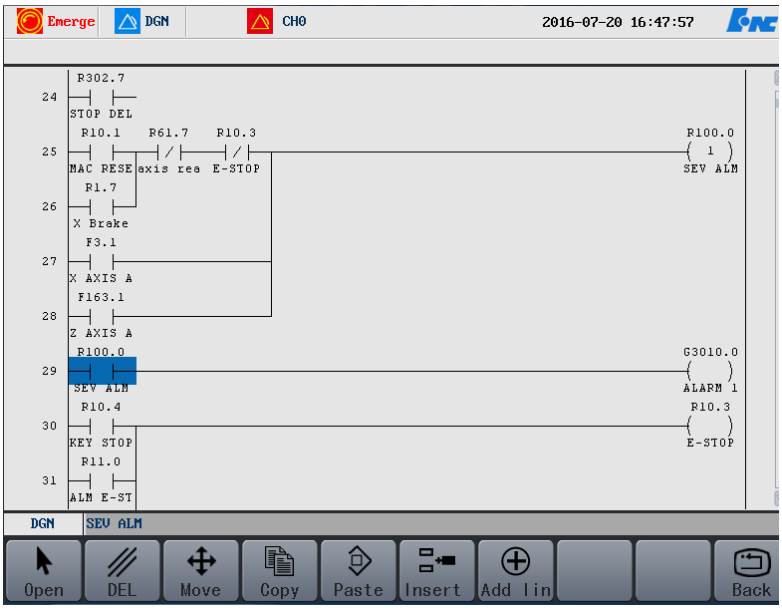
6.3.3.3 Move



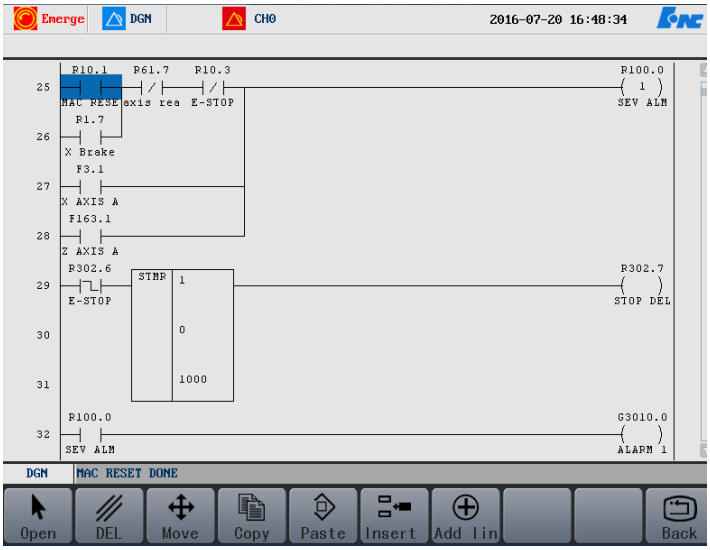
Press the **Open** key to select the line you want to move. The line turns blue, and press this key to move the line to a specific position. Here "Move" means "Cut".



After pressing the **Move** key, the selected line disappears.

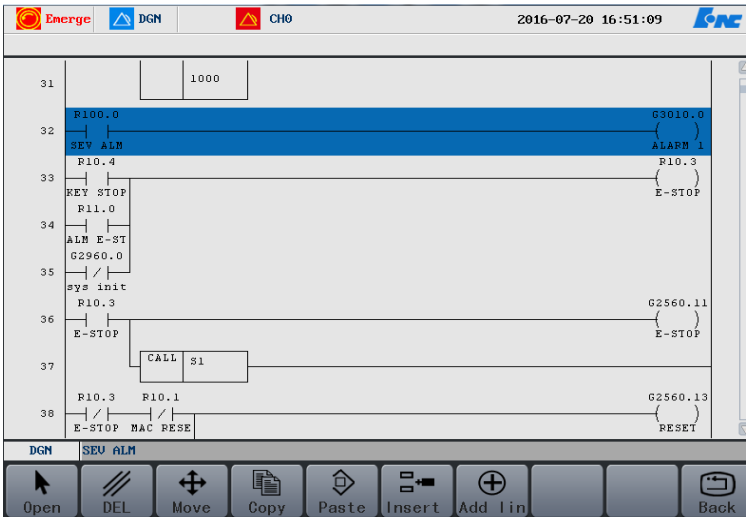


Move the cursor to the target line, and press the **Paste** key to move the line to the target position, as shown in the figure below:

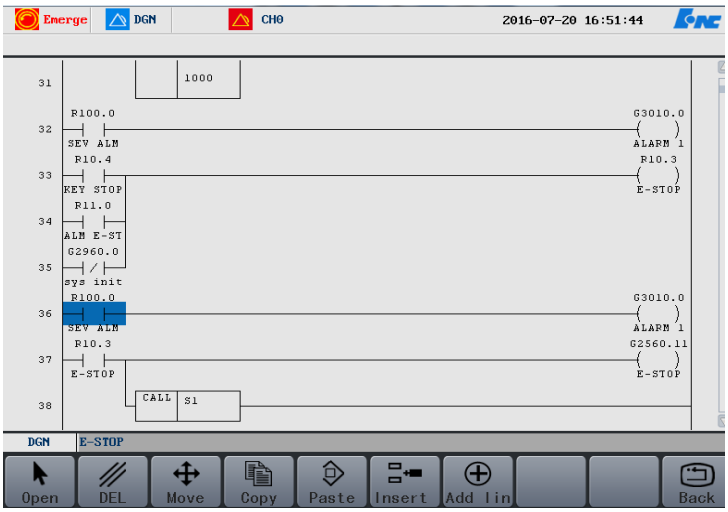


6.3.3.4 Copy

Move the cursor to the line which you want to copy, press the **Open** key, and then press the **Copy** key. See the figure below:



Move the cursor to the target line, and press the **Paste** key to paste the line to the target position. See the figure below:

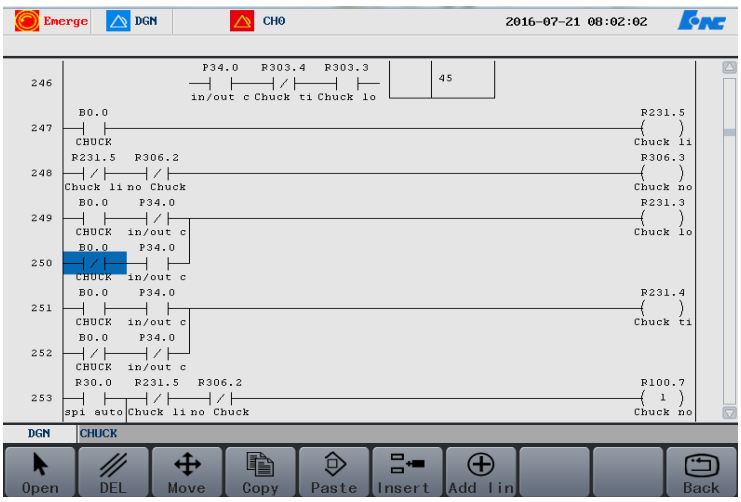


6.3.3.5 Insert a Line

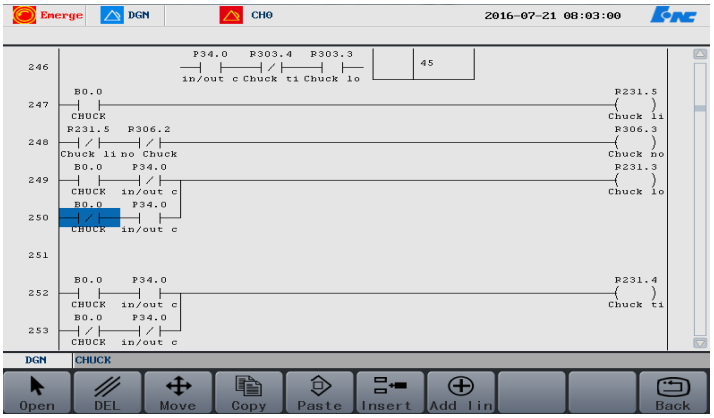
Move the cursor to the line behind which you want to insert, and press this key to insert the line. See the figure below.

It should be noted that the line is generally inserted upper the line where the cursor is.

- Before inserting



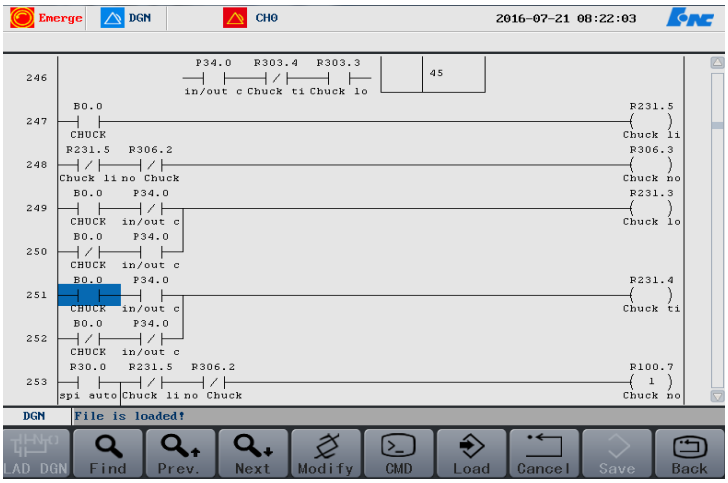
- After inserting



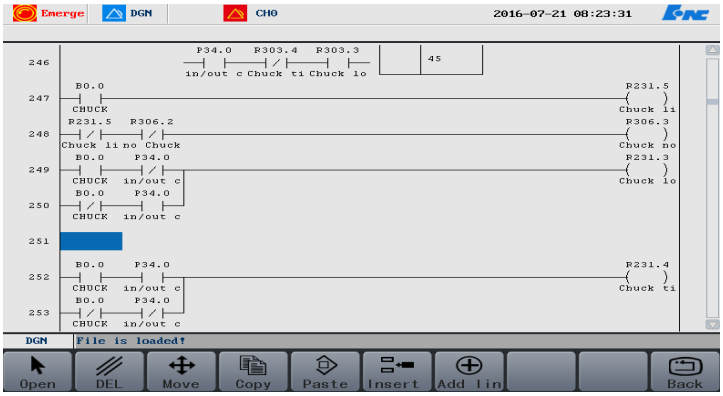
6.3.3.6 Add a Line

Difference from the **Insert** function, the **Add Line** function is used to add a line below the selected line. See the figure below:

- Before adding:



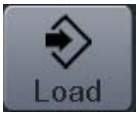
- After adding



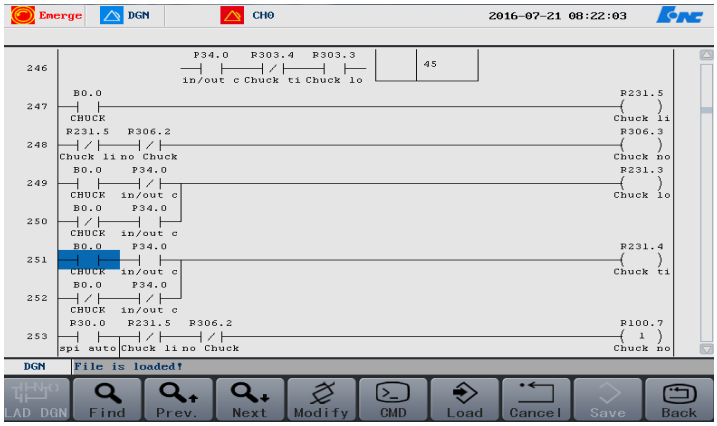
6.3.3.7 Back

Users may press the **Back** key to return to the previous interface for other operations.

6.3.4 Load

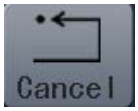


After the ladder graph is completed and verified, users may press the **Load** key to load it to the CNC system.

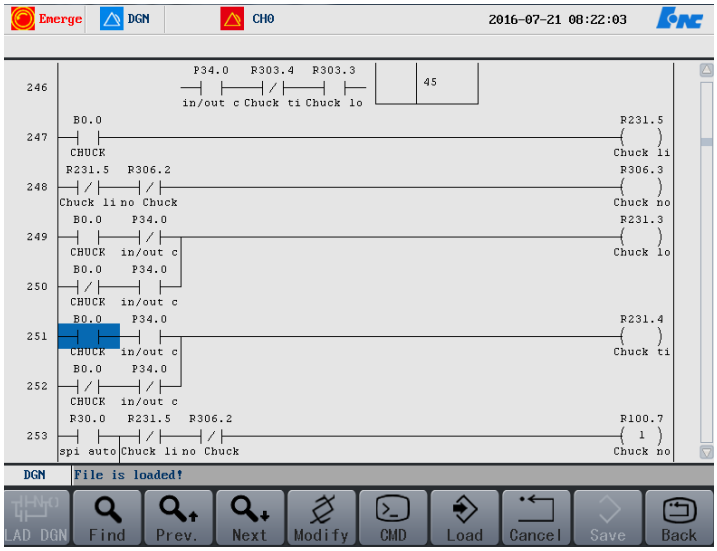


If the message "File is loaded" is displayed, the ladder graph is successfully loaded.

6.3.5 Cancel



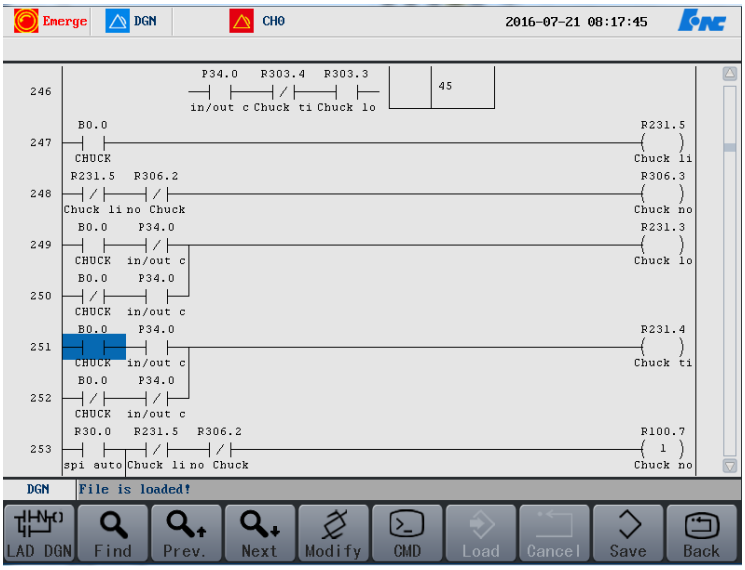
Users may press **Cancel** to cancel the editing on the ladder graph if they need to cancel the operation.



Note: This operation will discard all the editing from the time when you press the **Modify** button to the time when you press this button.

6.3.6 Save

After loading the ladder, user may press the **Save** key to save the editing on the ladder graph.



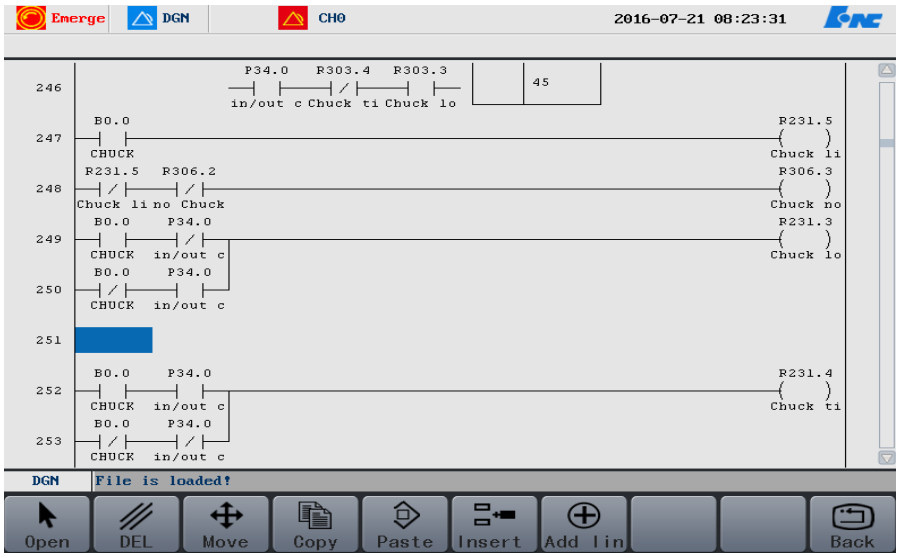
If the message "File is loaded" is displayed, the ladder graph is successfully saved.

6.3.7 Back

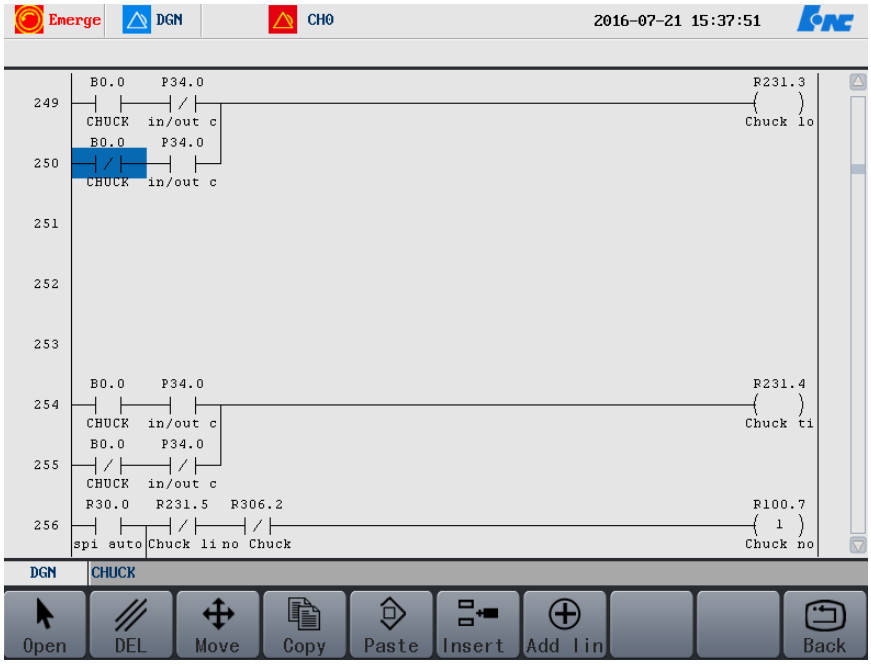
Users may press the **Back** key to return to the diagnosis interface.

6.3.8 Examples

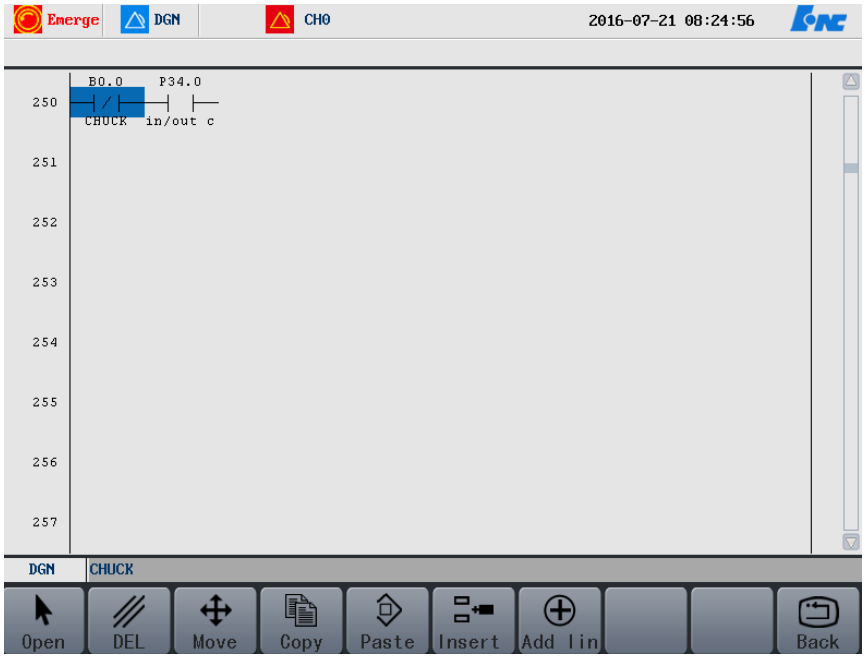
This section uses an example to describe how to edit the ladder graph, which may help users to quickly understand the ladder editing of HNC-8 CNC systems.



Press **DGN** > **LAD** > Modify, move the cursor to the line where users need to insert a line, press **CMD**, and press **Insert** to enter the interface as shown below:

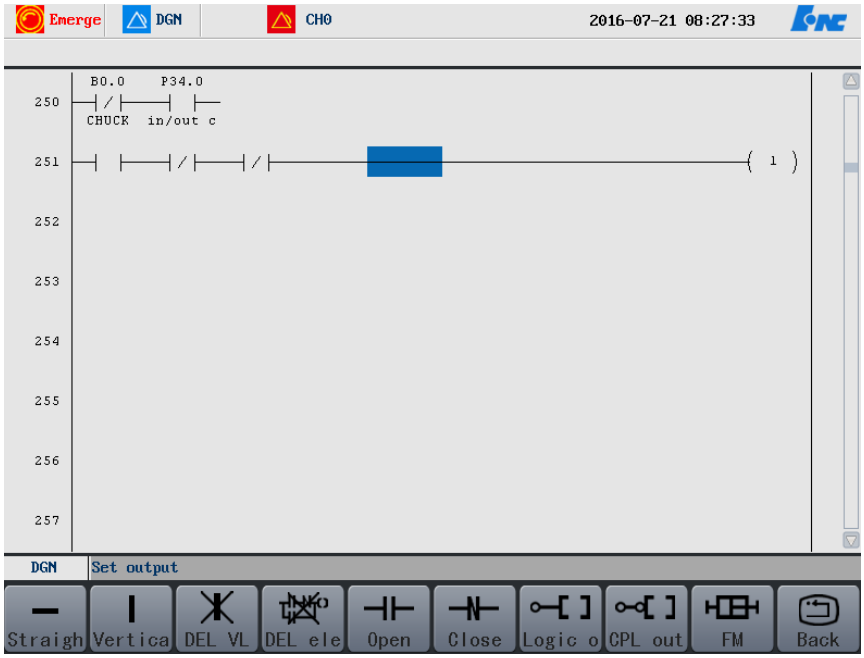


Press **Insert** for eight times as we need to insert eight lines.

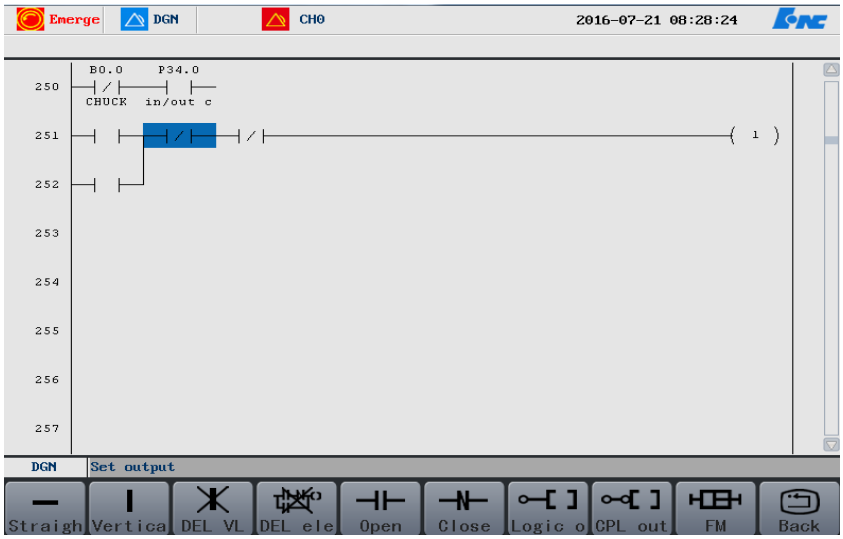


Move the cursor to the beginning of the first line. Press **Back**, and press **Modify** to start editing. Press **Open**. See the figure below:

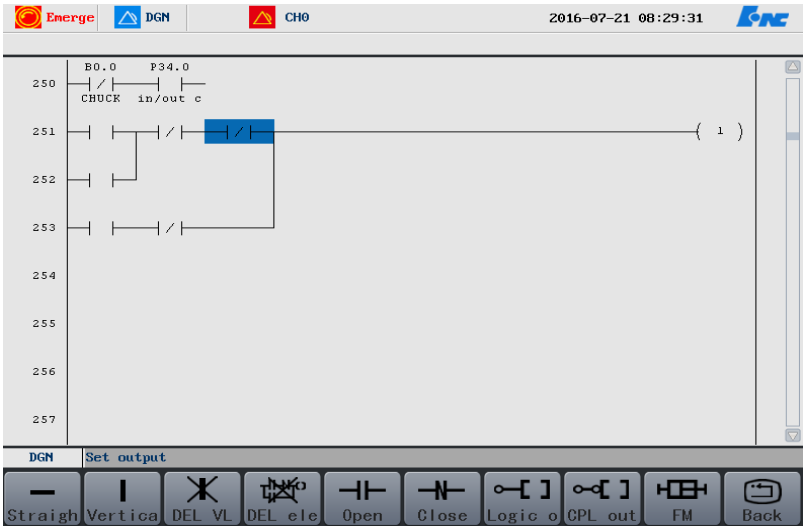
Add elements one by one as required. Press **Open** > **Close** > **FM** > - **Logic output** to display the interface as shown below:



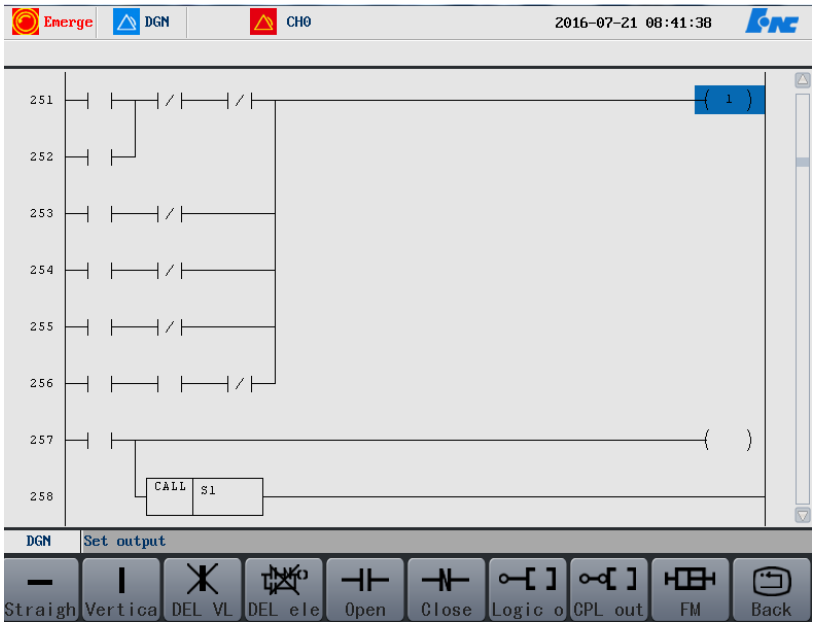
Move the cursor to the beginning of the second line, select **Open**, move the cursor to the beginning of the first line, and then press **Vertical**. See the figure below:



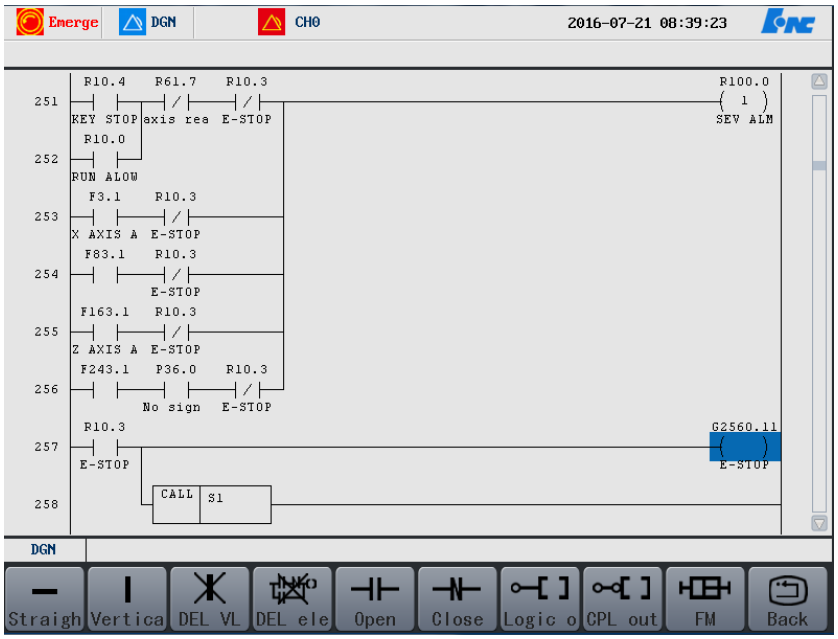
Move the cursor to the beginning of the third line, select **Open** > **Close** > **Straight**. Move the cursor to the second **Close** position in the first line, then move the cursor to the third space of the second line, and press **Vertical**.



Add other elements based on the operations above. See the figure below:



Then hover the cursor over the element, and press the "**Enter**" key to add the content to the definition register of the element.



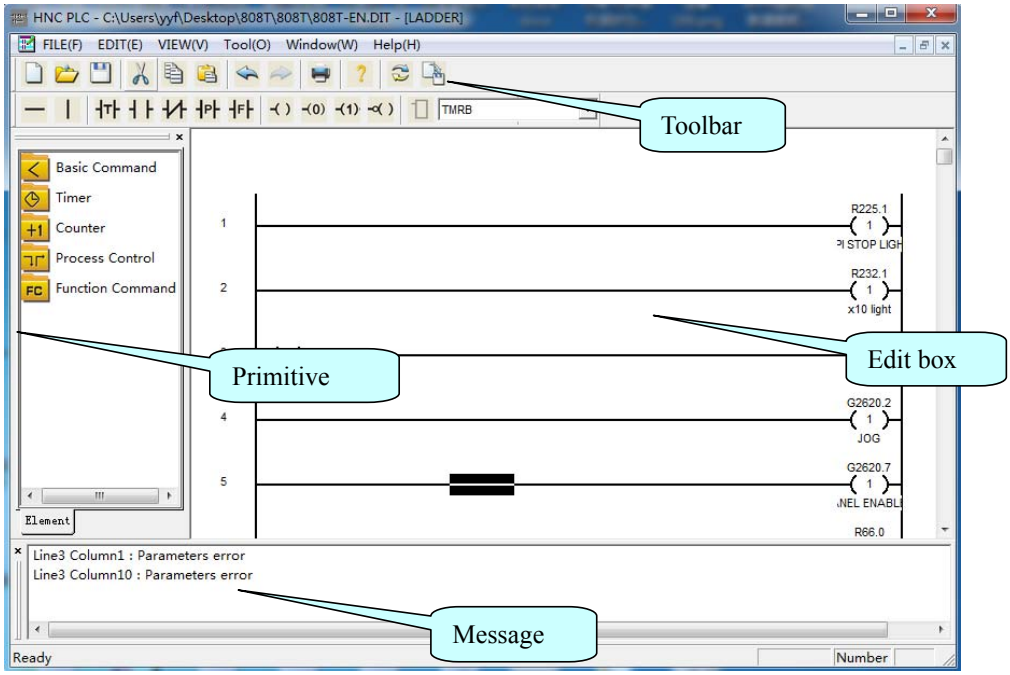
This way, eight lines are edited and completed.

6.4 PLC Functions

6.4.1 Interfaces of Ladder Graph

The ladder interface consists of the toolbar, primitive tree, edit box, and the message box.

The toolbar and primitive tree can be randomly placed based on user's requirements. This means users may place them on any side of the main window. Users can also make the toolbar "float" anywhere on the desktop.



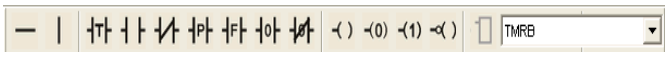
6.4.2 Toolbar

There are two toolbars on the ladder interface: operation toolbar and element toolbar.

1. The operation toolbar is used for easy operations, e.g. create files, zoom in and zoom out, undo, restore, etc.

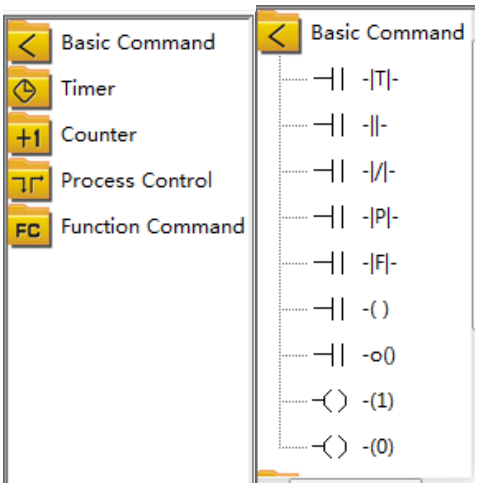
-  Press this button on the toolbar to undo the previous operation.
-  Press this button on the toolbar to restore the previous undone operation.
-  Press this button on the toolbar to convert the current ladder to the corresponding statement table. An error message box will be displayed if there are any errors in the ladder,
-  Press this button on the toolbar to convert the current ladder to the corresponding statement table and output the **plc.dit** file (ladder execution file). An error message box will be displayed if there are any errors in the ladder.

2. The primitive toolbar is used to rapidly add basic input/output units or select function modules.



6.4.3 Primitive Tree

The primitive tree is used to select function modules. Users may double-click the icon to expand or collapse the primitive tree, and then select the primitive icon you want to use from the primitive tree.

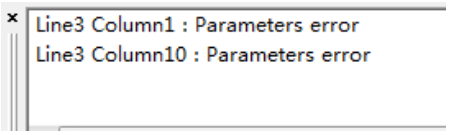


6.4.4 Edit Box

The Edit box is used to display and edit the ladder graph. The area between the left and right bold lines as shown in the figure below is the Edit box for the ladder. The current editing line number is displayed next to the left line, and the comment on the output status of the current line is displayed next to the right line.

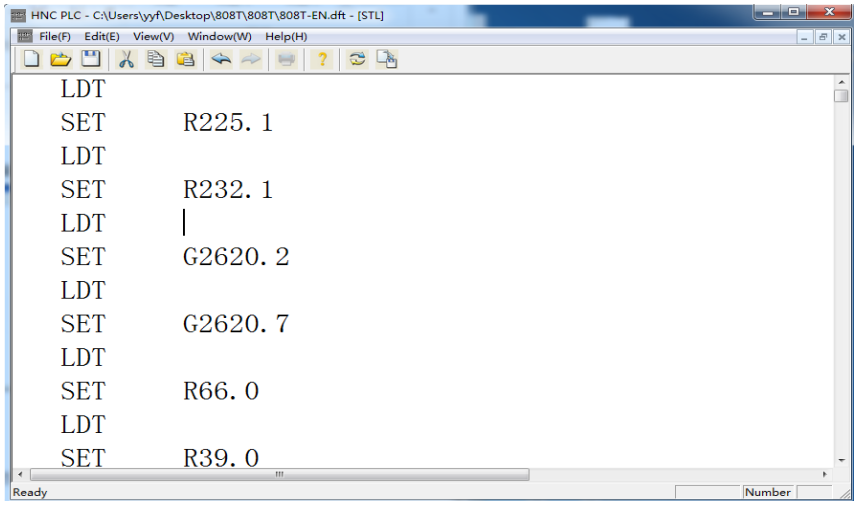
6.4.5 Message Box

The message box is used to display the conversion or output errors if there are any statement or identified syntax errors in the ladder when converting the ladder.



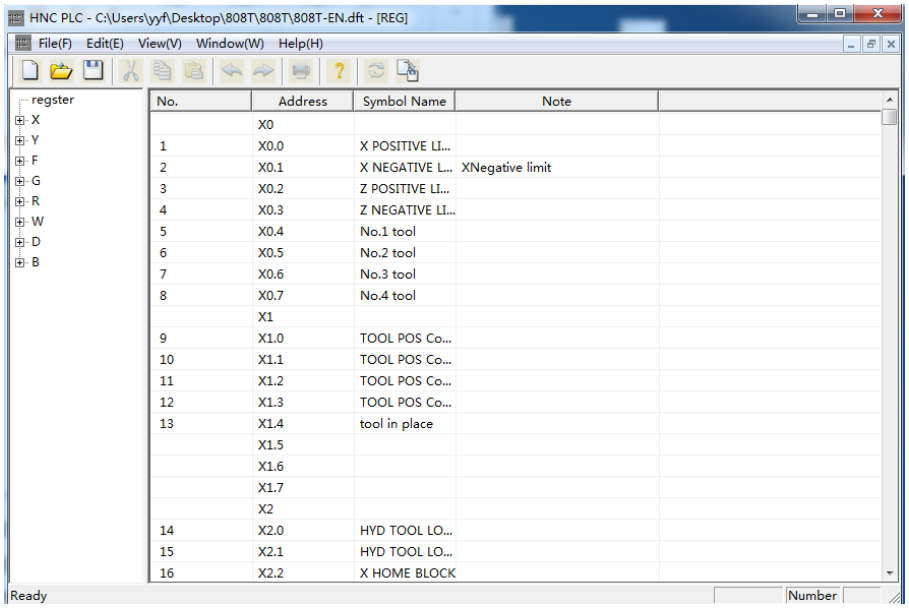
6.4.6 Statement Interface

The statement interface includes the toolbar and Edit window.



6.4.7 Symbol Table Interface

The symbol interface is used to define the symbol names and note of respective addresses.



The register selection pane is on the left and the register editing pane is on the right.

The register editing pane displays the number, address, symbol names and note.

- Number: displays the number of the current symbol name. This number is

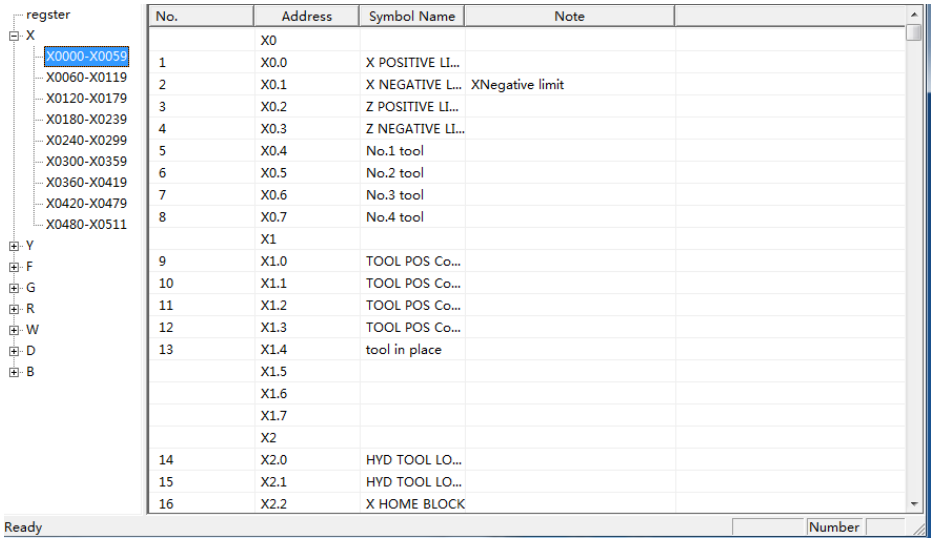
automatically generated.

- Address: the specified address.
- Symbol name: the symbol name corresponding to the specified address.
- Note: the note corresponding to the specified address.

6.4.8 Add a Symbol Table

This section uses X10.0 (axis X positive limit) as an example to describe the operation of adding a symbol table.

X10.0 exists in the X register. Select the **X** register from the register selection pane. Select **X000-X0049** as X10.0 exists in the group. Find **X10.0** under **Address**, click the corresponding cell under **Symbol Name** to display an editing box. Enter "X positive limit" and click the **Enter** key. After entering the symbol name, click the corresponding cell under **Note** for three times to display the editing box. Enter "X positive limit, valid for high level", and click the **Enter** key.

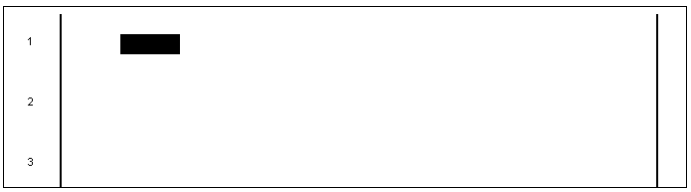


6.4.9 Insert a Primitive

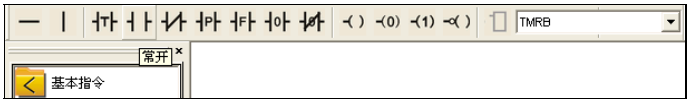
Insert primitives includes inserting basic primitives and function primitives.

- **Insert basic primitives**

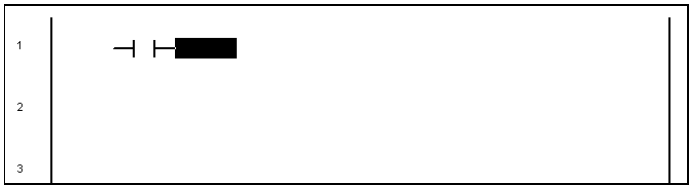
1. Select a position on the ladder graph to insert a primitive.



2. Click the basic primitive to add on the toolbar.

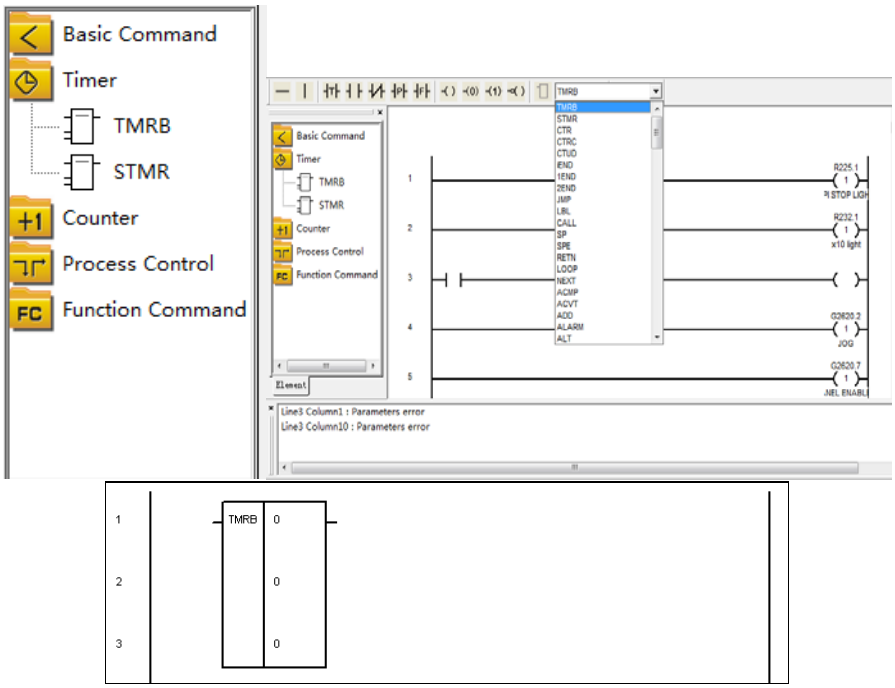


3. The basic primitive is added to the ladder.



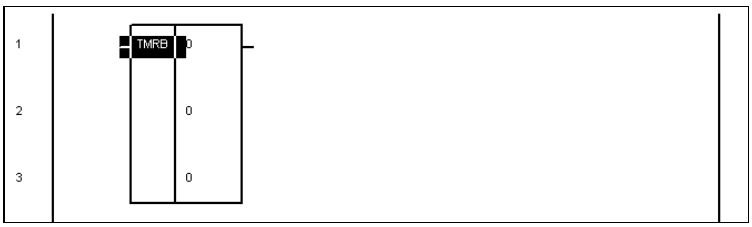
- **Insert function primitives**

1. Select the function primitive to insert. Users may select a primitive from the primitive tree or from the selection box of the toolbar.
2. Double-click the primitive on the ladder graph to add the function primitive.



6.4.10 Delete a Primitive

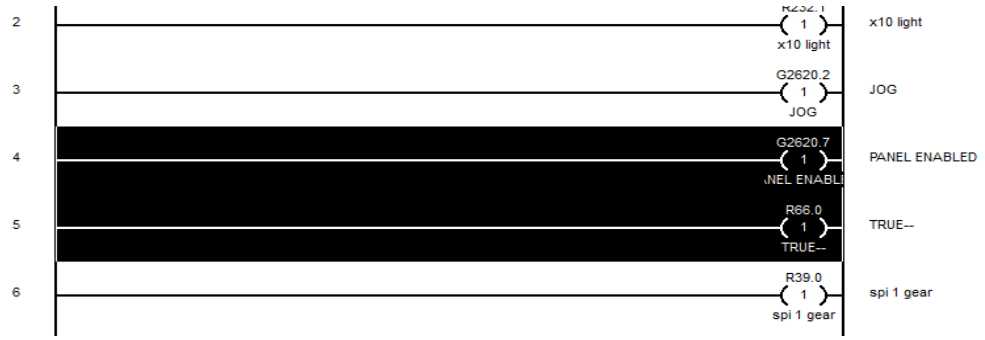
Select the primitive you want to delete from the ladder.



Press the **Delete** key to delete the selected element.

6.4.11 Delete Lines

Select the lines to delete. Users may select multiple lines by dragging the mouse.

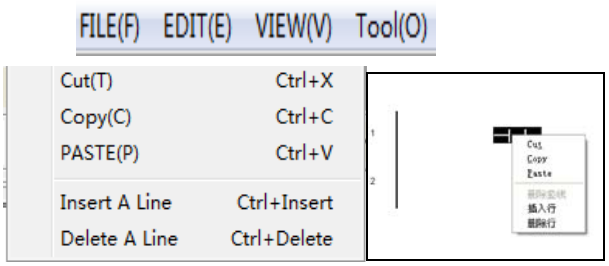


Press the **Delete** key to delete the selected lines.

6.4.12 Cut, Copy and Paste Elements

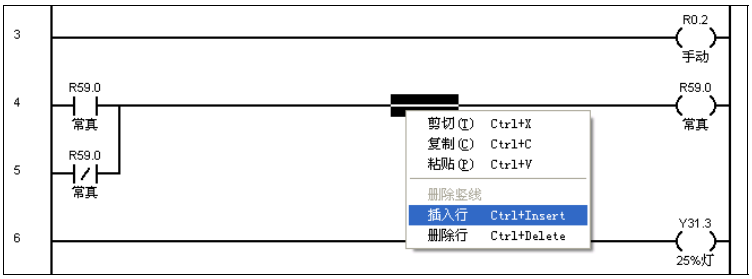
Before cutting or copying primitives, users need to select a primitive in the ladder graph.

Select **Cut** or **Copy** under the **EDIT** menu as required. Alternatively, users may right-click the element and select **Cut** or **Copy** as required. See the figures below:



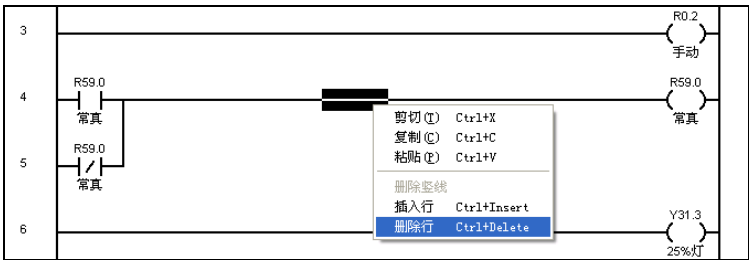
6.4.13 Insert a Line

Users may select a line, and then insert a line in front of it.



6.4.14 Delete a Line

Users may select a line in the ladder, and then delete it.



6.5 Power on System

Before machine debugging, users need to check whether each I/O point on the ladder is consistent with the electrical design of the machine. See Figure 6.4.1. If the emergency stop point of the machine is not X1.6, users need to modify the ladder.

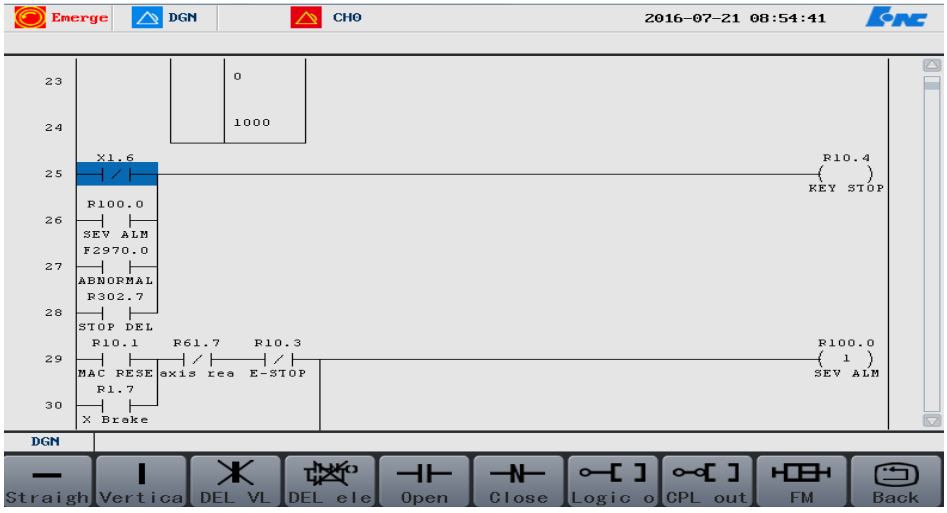


Figure 6.1 Emergency stop

6.6 PLC Commissioning Tips

This section describes two kinds of tips for PLC commissioning. For details about the PLC, see "HNC-8-PLC Commissioning Guide."

6.6.1 Step-by-Step Method

The most common PLC commissioning method is the step-by-step method.

- Description: Verify one by one until finally locate the point.

  Example: In the armless type ATC, the system alarm prompts users that the tool position is not arrived. Users may follow the operations below to find the point:

  1. Match the corresponding register based on the alarm. No.7 alarm corresponds to G3010.7.
  2. Search G3010.7 on the ladder interface. See Figure 6.6.1.
  3. Press **DGN** > **LAD** (F3) > **Find** (F2) > **G3010.7** > **Enter**.
  4. After the searching, the system will automatically go to the position where G3010.7 appears. Repeat the operation in the second step of searching for G3010.7 to find R101.2. The system will find two R101.2 points. One is in the 395 line within the sub-program SP3, which is cleared during reset. The other is in the 498 line, where the element is. See Figure 6.6.2.
  5. According to the conditions in the 498 line as shown in Figure 6.6.2, repeat the operations in the second step and continue to find R101.1.
  6. According to the information in the 497 line as shown in the figure 6.6.3, we can see that the disconnection signal of X2.3 is required for the tool to arrive the point.
  7. Find the final position, and you can start monitoring.

     Press **Back** (F10) > **LAD DGN** (F1).

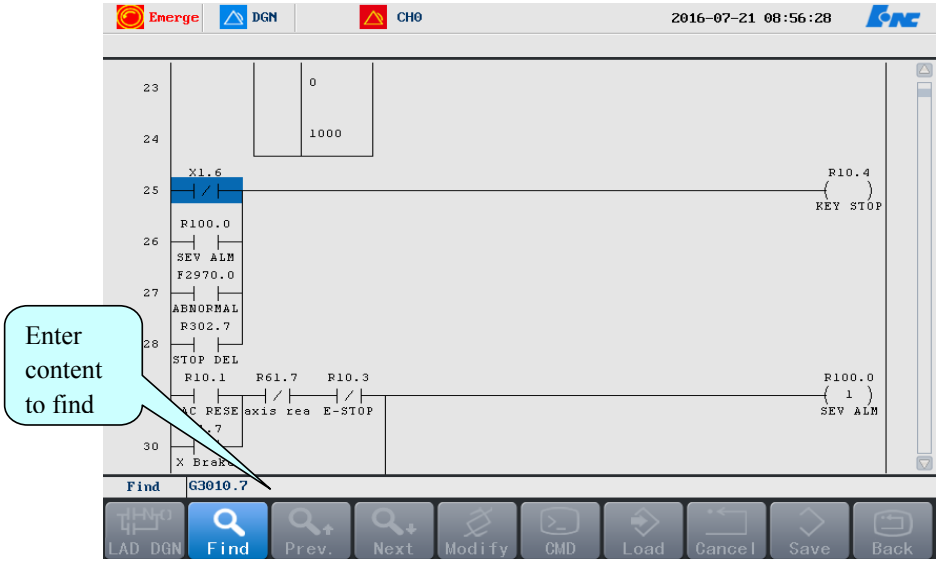


Figure 6.6.1 Find register in ladder

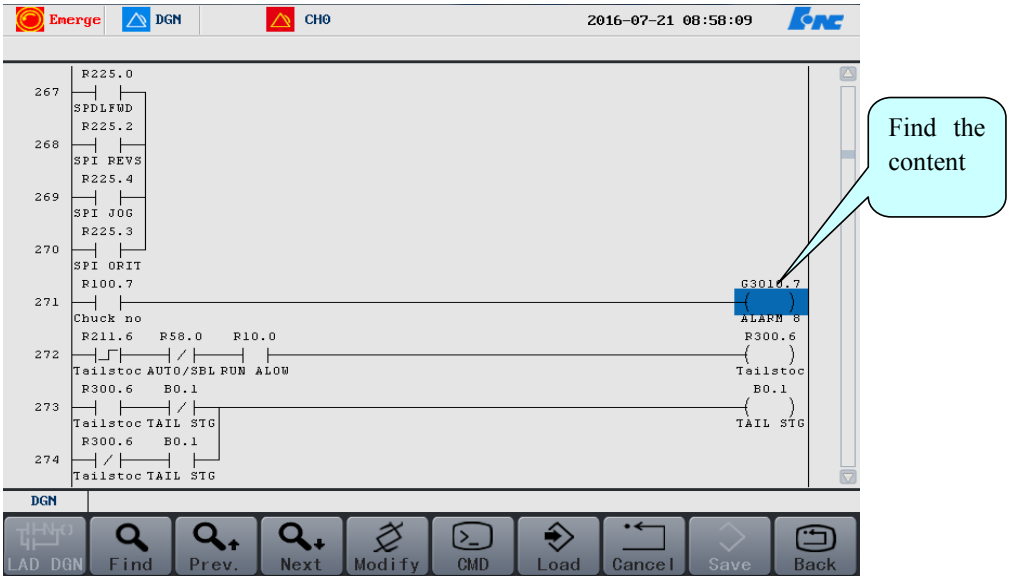


Figure 6.6.2 G3010.7 found

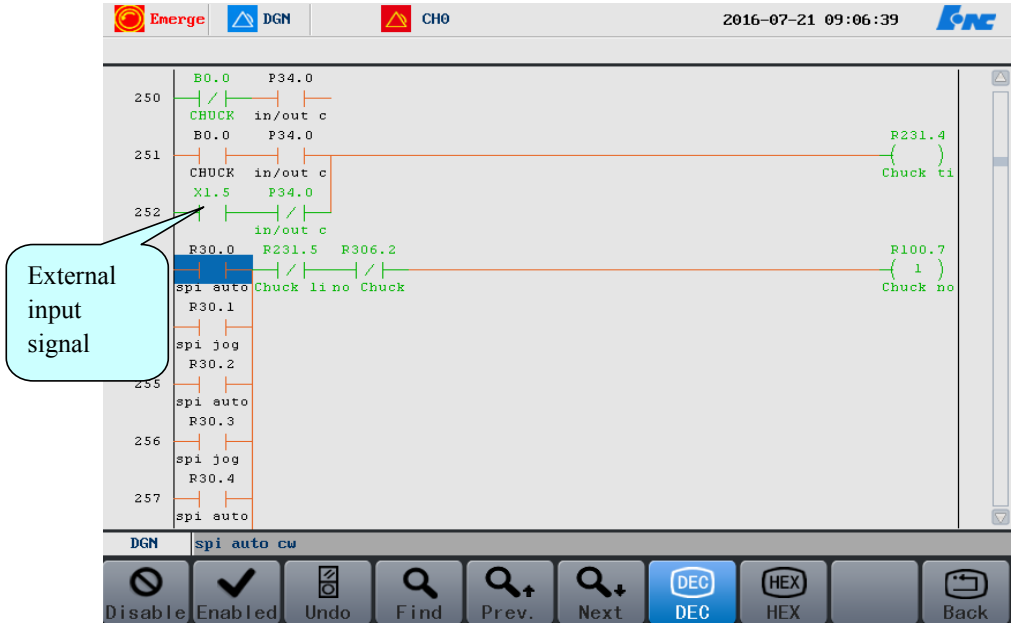


Figure 6.6.3 Locate the final point

6.6.2 Force Method

- Description: Use the force functions to verify each line of the ladder.

  The ladder of HNC-8 system provides three force functional buttons to facilitate the debugging, including Disable, Enable, and Undo.

  ✓ Disable: force disconnect the selected Open or Close element.

  ✓ Enable: force connect the selected Open or Close element.

  ✓ Undo: restore the element that is forced to disconnect or connect.

  The forcing function can be used for local verification. For example, users may use the "Enable" function to verify whether the ladder works based on the designed process, or use the "Disable" function to verify multiple conditions with the exclusive method.

  Example: Users may follow the operations below to commission the tool magazine of the robot-arm machining center, and verify if the arm inverse is valid.

  1. Find the code position of the tool arm inverse. See Figure 6.6.4.
  2. Select a line, e.g. ATCI in Figure 6.6.4, and then force enable all primitives that have been disconnected in this line.

3. As shown in Figure 6.6.5, force enable R102.0, R124.1 and X2.6.
4. Check if the output is valid.
5. Re-select a line ATC2, and repeat the operations from steps 2 to step 4.

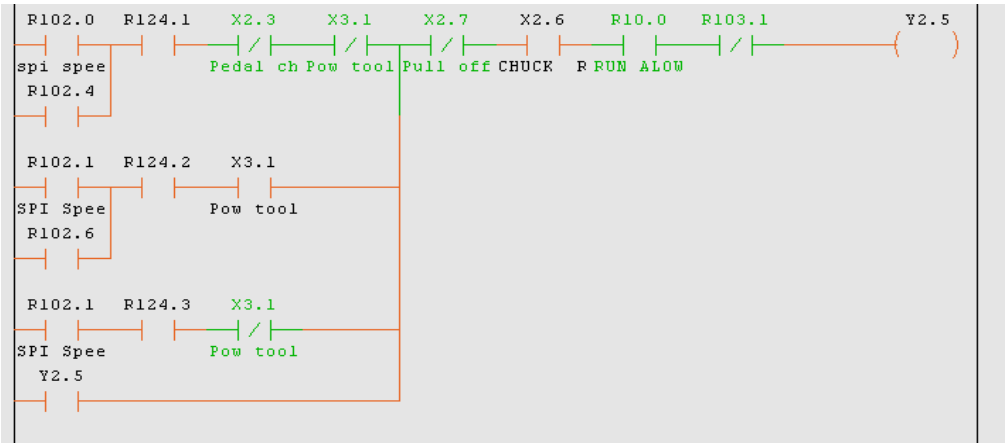


Figure 6.6.4 Tool arm inverse

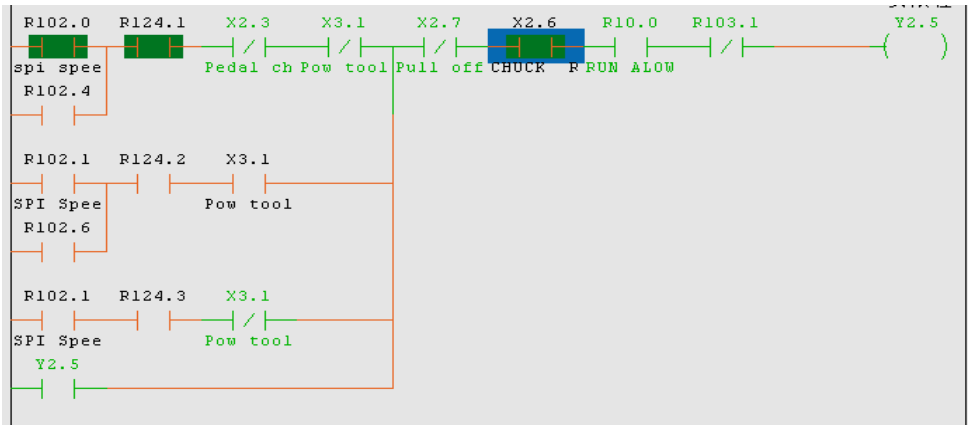


Figure 6.6.5 Force Enable

6.7 Common F Registers

- Axis status register 0 (F [axis number * 80])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Success to the reference	Reserved	Step 2 to the reference	Step 1 to the reference	Axis moving

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Confirm the 5th reference	Confirm the 4th reference	Confirm the 3rd reference	Confirm the 2nd reference

During axis movement: The value **1** indicates the axis is moving while **0** indicates the axis is not moving.

Step 1 to the reference: The first step to the reference point indicates that the axis has not encountered the Reference stop.

Step 2 to the reference: The second step to the reference point indicates that the axis has encountered the Reference stop and is finding the Z pulse.

Success to the reference: The value **1** indicates that the axis has returned to the reference point.

Confirm the 2nd reference: The value **1** indicates that the axis is at the second reference point.

Confirm the 3rd reference: The value **1** indicates that the axis is at the third reference point.

Confirm the 4th reference: The value **1** indicates that the axis is at the fourth reference point.

Confirm the 5th reference: The value **1** indicates that the axis is at the fifth reference point.

- Servo axis status register 0 (F [axis number * 80+2])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Spindle zero	Spindle speed arrived	Reserved	Reserved	Axis torque control	Axis speed control	Axis position control	Servo ready

Servo ready: When the servo has been enabled and no servo alarm is reported, the servo

will return the servo ready signal.

Axis position control: The value **1** indicates that the axis is in the position control mode.

Axis speed control: The value **1** indicates that the axis is in the speed control mode.

Axis torque control: The value **1** indicates that the axis is in the torque control mode.

Spindle speed arrived: The value **1** indicates that the spindle speed is reached.

Spindle zero: The value **1** indicates that the spindle is stopped.

- Axis servo status register 1 (F [axis number * 80+3])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Spindle orientation completed

Spindle orientation completed: The spindle starts orientation after the corresponding settings. The servo returns this signal after the spindle orientation is completed.

- Channel status register 0 (F [channel number * 80+2560])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Cycle start	Feed hold	MDI	Reserved	Reserved	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reset channel	Reserved	Reserved	Thread cutting	Reserved

MDI: The channel is in the MDI mode.

Feed hold: The channel is in the feed hold status.

Cycle start: The channel in the cycle start status.

Thread cutting: The channel is in the thread cutting status and the feed hold is not allowed.

Reset channel: After pressing Rest Channel or the reset button on the panel, the channel reset is valid until the channel reset answer is set.

- Channel status register 1 (F[2564])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	PMC	MPG	Reference	Incremental	Manual	Single block	Auto

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Auto: The channel is in the automatic mode.

Single block: The channel is in the single block mode.

Manual: The channel is in the manual mode.

Incremental: The channel is in the incremental mode.

Reference: The channel is in the mode of returning to the zero point.

MPG: The channel is in the MPG mode.

PMC: The channel is in the PMC mode.

Note: The register marked with "◆" is valid only when the setting panel is enabled and the channel is **0**.

6.8 Common G Registers

- Axis status register 0 (G [axis number * 80])

D7	D6	D5	D4	D3	D2	D1	D0
Enable axis	Lock axis	Reference stop	Reserved	Reserved	Reserved	Negative limit	Positive limit

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Release slave axis	Reserved	Reserved	Slave axis to reference

Positive limit: Set the value to **1** when the positive limit is encountered. An alarm will be reported by the system and positive movement is disabled.

Negative limit: Set the value to **1** when the negative limit is encountered. An alarm will be reported by the system and negative movement is disabled.

Reference stop: Set the parameter value to **1** when the machine encounters the Reference stop.

Lock axis: Lock the axis. When the value is set to **1**, the axis movement is not allowed, but the command position may be changed.

Enable axis: Signal to enable the axis.

Slave axis to reference: When this signal is **1**, the slave axis need to find the Z pulse and return to the reference point after the master axis returned to the reference point.

Release slave axis: When this value is set to **1**, the coupling of the slave axis is released and the slave axis can be separately moved.

- Axis control register 1 (G [axis number * 80+1])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Enable 2nd soft limit	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Enable 2nd soft limit: If the value is set to **1**, the axis soft limit is invalid and the second soft limit is valid.

- Axis servo control register 0 (G [axis number * 80+2])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Spindle orientation	Reserved	Reserved	Reserved	Reserved

Spindle orientation: When the value is set to **1**, the spindle starts orientation; when the value is set to **0**, the spindle stops orientation.

- Axis servo control register 1 (G [axis number * 80+3])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Enable servo

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Enable servo: In the bus system, this is used to enable the bus servo.

- Channel control register 0 (G [channel number * 80+2560])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Dry running	Cycle start	Feed hold	Reserved	Reserved	Reserved	Reserved

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reset	Reserved	E-stop	Reserved	Reset answer	Reserved

Feed hold: Set the channel to the feed hold mode.

Cycle start: Set the channel to the cycle start mode.

Dry running: Set the channel to the dry running mode.

Reset answer: When the channel reset is completed, set the reset answer.

E-stop: Set Emergency stop for the channel.

Reset: Reset the channel.

- Channel control register 1 (G [channel number * 80+2561])

D7	D6	D5	D4	D3	D2	D1	D0
Reserved	Reserved	Reserved	Reserved	Optional stop	Over block	Reserved	Enable servo

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Over block: Set the channel to the over-block status.

Optional stop: Set the channel to the Optional stop status.

- Current tool number register (G [channel number * 80+2563])

The current tool number is displayed on the interface.

- Feed rate register (G [channel number * 80+2564])

  Set the feed rate for the channel.

- Rapid traverse override register (G [channel number * 80+2565])

  Set the rapid traverse override for the channel.

- Spindle override register (G [channel number * 80+2566+ spindle number])

  Set the override for a spindle in the channel.

- Machining workpiece count register (G [channel number * 80+2579])

  The machining workpiece count is displayed on the interface.

- Channel control register 2 (G [2620])

D7	D6	D5	D4	D3	D2	D1	D0
Enable panel	PMC	MPG	Reference	Incremental	Manual	Single block	Auto

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Rapid traverse	Incremental override	

Auto: Set the channel to the automatic mode.

Single block: Set the channel to the single block mode.

Manual: Set the channel to the manual mode.

Incremental: Set the channel to the incremental mode.

Reference: Set the channel to the mode of returning to the reference point.

MPG: Set the channel to the MPG mode.

PMC: Set the channel to the PMC mode.

Enable panel: Set the value to **1** if users need to use all registers marked with "◆".

Incremental override: The incremental override uses two decimals.

- **00**: represents **x1**
- **01**: represents **x10**
- **10**: represents **x100**
- **11**: represents **x1000**

Rapid traverse: Set the movement mode of all axes in the channel 0 to the rapid traverse mode.

- Channel control register 3 (G [2621])

D7	D6	D5	D4	D3	D2	D1	D0
MPG 1 axis selection				MPG 0 axis selection			

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Enable MPG 1	MPG 1 override		MPG 0 override	

MPG 1 axis selection: Each axis uses four decimal places. The four digits represents the current axis. For example, the four digits **0000** represents the axis **X**; **0001** represents the axis Y; 0010 represents the axis Z.

MPG 1 override: Each override of the MPG uses two decimal places. The two digits represents the current override. For example:

- **00**: represents **x1**
- **01**: represents **x10**
- **10**: **represents x100**
- **11**: **represents x1000**.

Enable MPG 1: The MPG 1 can be used only when the MPG 1 is enabled.

- Axis positive movement control register (G [2622]) ◆

D7	D6	D5	D4	D3	D2	D1	D0
Axis 7+	Axis 6+	Axis 5+	Axis 4+	Axis 3+	Axis 2+	Axis 1+	Axis 0+

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Axis 8+

- Axis negative movement control register (G [2623]) ◆

D7	D6	D5	D4	D3	D2	D1	D0
Axis 7-	Axis 6-	Axis 5-	Axis 4-	Axis 3-	Axis 2-	Axis 1-	Axis 0-

D15	D14	D13	D12	D11	D10	D9	D8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Axis 8-

Users only need to set the movement control register when the system requires manual, incremental, zero, or spindle CW/CCW rotation operations. If users set the positive and negative movement simultaneously, the axis will not move. If users set the positive or negative movement in the manual mode, the axis will move accordingly. The axis will move a specific incremental distance if users set the valid period for axis positive/negative movement in the incremental mode. The axis will return to the reference point if users set the axis positive/negative movement in the reference mode (In the distance code zero mode, the axis positive/negative movement represents the direction for the feed axis to return to the reference point). If users set the positive or negative movement in the speed control mode, the axis will move accordingly.

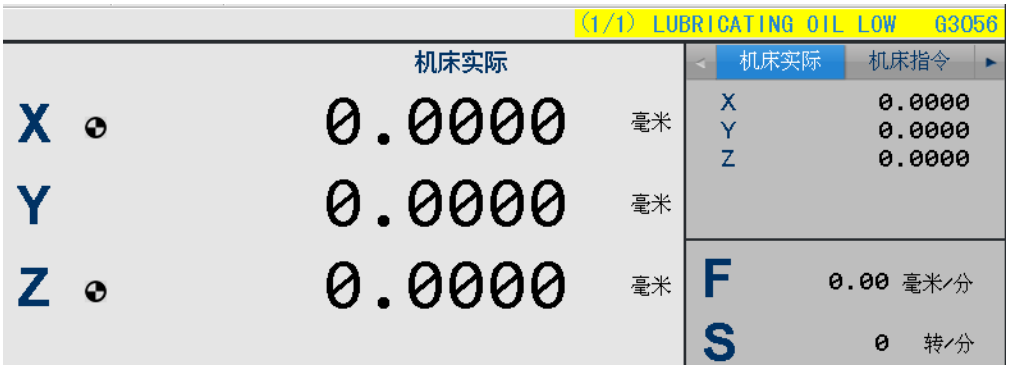
- Alarm registers (G [3010]-G [3042])

  Set PLC alarms. There is a total of **256** (16 * 16=256) alarm signals.

Note: The register marked with "◆" is valid only when the setting panel is enabled and the channel is 0.

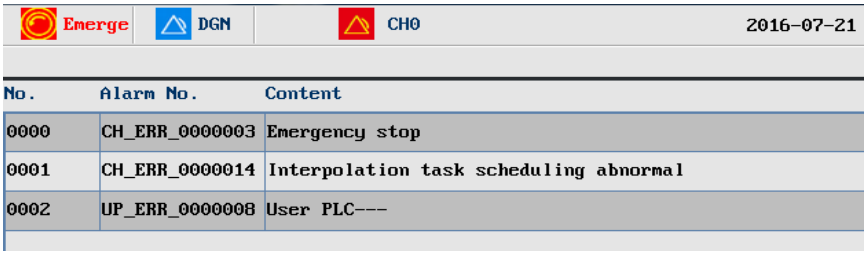
6.9 PLC Alarms/Message Creation and Usage

In HNC-8 CNC systems, users may create PLC alarms and messages. The PLC alarm and messages are written in the file suffixed with **TXT**.The PLC message only prompts users what problems exist, without affecting the normal machining. See the figure below:

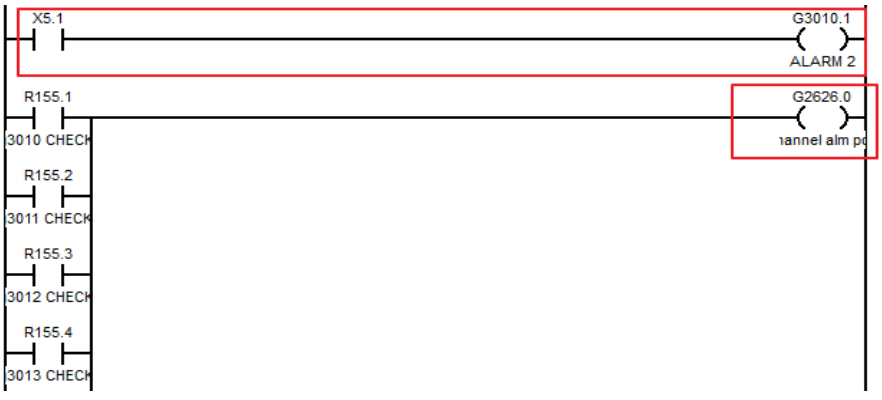


Users need to set **G2626.1** in the PLC for PLC message display. See the message of G3056.1 in the figure below:

The PLC alarms display what machine problems exist. The machine will stop automatic machining after a PLC alarm is reported, and change to the feed hold status until the alarm is cleared.



Users need to set **G2626.0** in the PLC to report PLC alarms. See the alarm of G3010.1 in the figure below:



The file name is **PMESSAGE.TXT**, and the path is **/h/lnc8 /plc/**. The format is *number* + *space* + *alarm information*. For example:

1 + *space* + *PLC alarm content 1*

2 + *space* + *PLC alarm content 2*

3 + *space* + *PLC alarm content 3*

…

…

256 + *space* + *PLC alarm content 256*

500 + *space* + *PLC message content 1*

501 + *space* + *PLC message content 2*

…

…

884 + *space* + *PLC message content 384*

The PLC alarm numbers start from **1** to **256**, and the PLC message numbers start from **500** to **884**.

In HNC-8 systems, the relationship between the alarm number and the G register is:

If *alarm number* -1 = a*16+b

Then: *alarm number* = G (3010 + a).b

For example: if the alarm number is **33**, 33-1=2*16+0, so the alarm number 33 corresponds to register G3012.0.

a = *alarm number*/16; b = *alarm number*/*the remainder*

In HNC-8 systems, the relationship between the message number and the G register is:

If *alarm number* -501 = a*16+b

Then: *alarm number* = G (3056 + a).b

For example: If the *alarm number* is 503, 503-501= 0*16 + 2, so the alarm number 503 corresponds to the register G3056.2.

a = *alarm number*/16; b = *alarm number/the remainde*r

The following text is a standard **PMESSAGE.TXT** file:

1: Axis is not ready. Please check the servo driver.

2: Tool number input error. Please check the tool number.

3: Tool change timeout. Please reset.

4: Position mode. Spindle rotation is not allowed.

5: Tool change is not arrived. Please perform "Manual tool change" and reset.

6: When the tool change is enabled and the indicator is lit, the spindle orientation is not allowed.

7: Spindle rotation is not allowed during spindle orientation.

8: Spindle rotation is not allowed when the chuck is not clamped.

9: The tool magazine is unlocked. Please manually lock the tool magazine.

10: The chuck cannot be released during spindle rotation.

501: High lubricant oil level.

502: Low lubricant oil level.

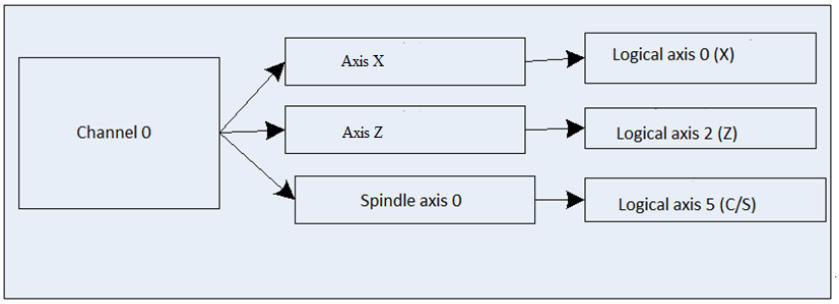
7 C/S Axis Change and Rigid Tapping

7.1 Parameter Settings for Axis C/S

1. Set the channel parameter "**Axis C No.**" to **-2**.
2. Modify the logical axis corresponding to the spindle. Set the display axis name to **C**, and modify this gear ratio and other parameters.
3. Add spindle to the axis display.
4. Use G code **STOC** to change the spindle to axis C, and use CTOS to change the axis C to the spindle. According to the axis number, users may check the operation mode of the spindle, or control the spindle operation in PLC. For example, change the axis 5 to the axis C/S.

G402.9	Change to the position control mode
G402.10	Change to the speed control mode
G402.11	Change to the torque control mode

For example: a turning machine with the structure as below:



1. Set the channel parameter "**Axis C No.**" to **-2**.

List	No.	Name	Value	Valid
NC	040000	Channel name	CH0	Restart
Machine	040001	Axis X No.	0	Restart
[+]Channel	040002	Axis Y No.	-1	Restart
[+]Axis	040003	Axis Z No.	2	Restart
[+]Error COMP	040004	Axis A No.	-1	Restart
[+]Device	040005	Axis B No.	-1	Restart
Data sheet	040006	Axis C No.	-2	Restart
	040007	Axis U No.	-1	Restart
	040008	Axis V No.	-1	Restart

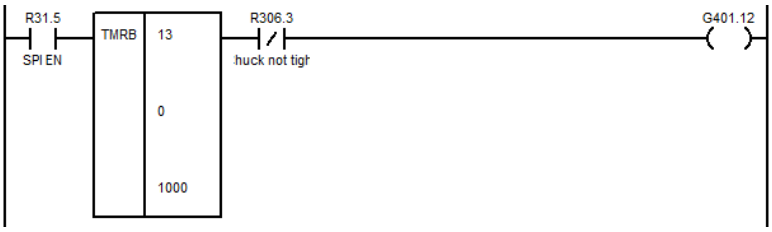
2. Modify the logical axis corresponding to the spindle. Set the display axis name to **C**, and modify this gear ratio and other parameters.

List	No.	Name	Value	Valid
Machine	105000	Axis name	C	Save
[+]Channel	105001	Axis type	10	Save
[-]Axis	105004	ELG ratio NUMERA[position](um)	5625	Restart
LOG axis0	105005	ELG ratio DENOM[pulse]	64	Restart
LOG axis1	105006	Plus software limit CS(mm)	2000.0000	Reset
LOG axis2	105007	Minus software limit CS(mm)	-2000.0000	Reset
LOG axis3	105008	2nd plus software limit CS(mm)	2000.0000	Reset
LOG axis4	105009	2nd minus software limit CS(mm)	-2000.0000	Reset
LOG axis5	105010	Reference point approach mode	0	Save

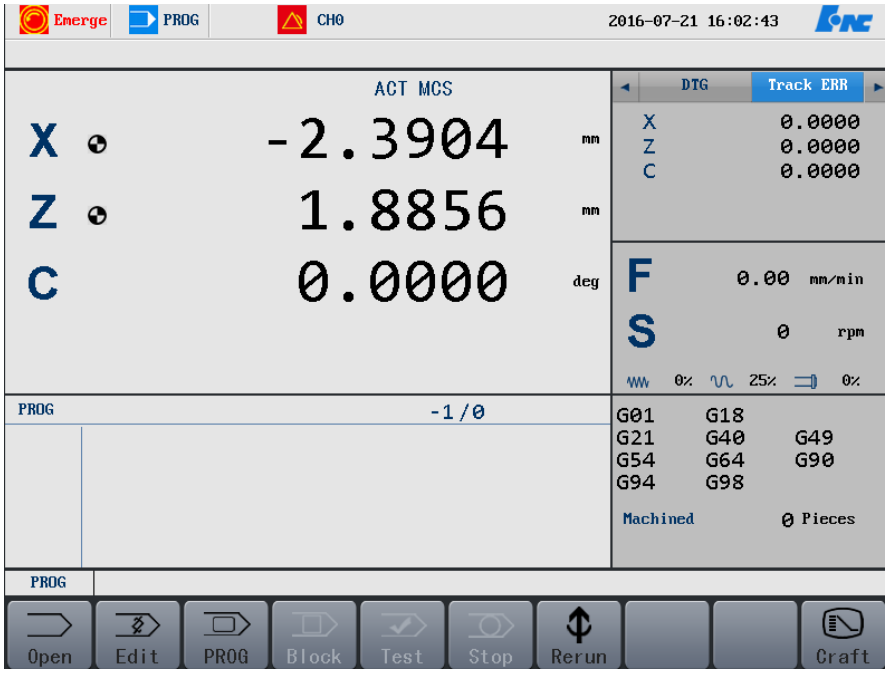
3. Add spindle to the axis display.

List	No.	Name	Value	Valid
NC	010000	Maximum number of channels	1	Restart
Machine	010001	Cutting type of channel 0	1	Restart
[+]Channel	010002	Cutting type of channel 1	0	Restart
[+]Axis	010009	Selection mark of channel 0	1	Restart
[+]Error COMP	010010	Selection mark of channel 1	0	Restart
[+]Device	010017	Axis display mark[1] of channel 0	0x25	Restart
Data sheet	010019	Axis display mark[1] of channel 1	0x0	Restart
	010033	CH0 load current axis	0,2,5	Restart
	010034	CH1 load current axis	0	Restart

4. Add the position mode ready signal for axis C mode change to the PLC.



5. Use G code STOC to change the spindle to axis C, and use CTOS to change the axis C to the spindle.



7.2 Use SSTT to View Waveform

The Servo Self-Test Tool (SSTT) can be used to diagnose synchronous error during rigid commissioning, and to increase the rigid tapping performance by modifying parameters.For detailed operation method, see SSTT User Manual.

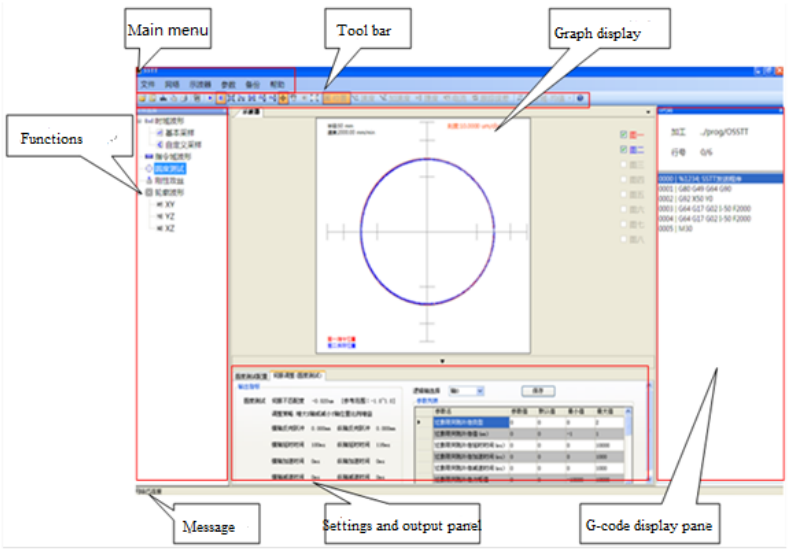
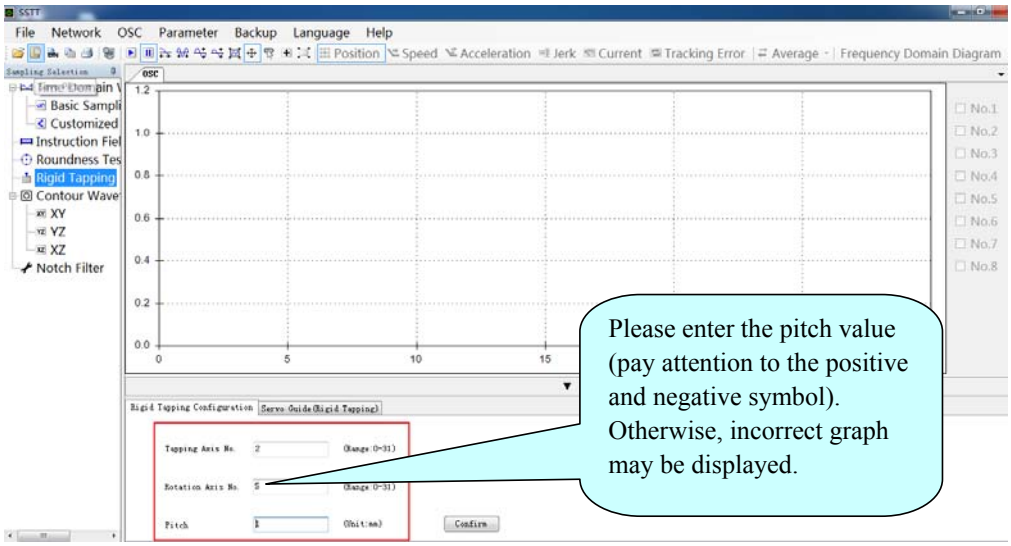


Figure 7.2.1 SSTT main interface

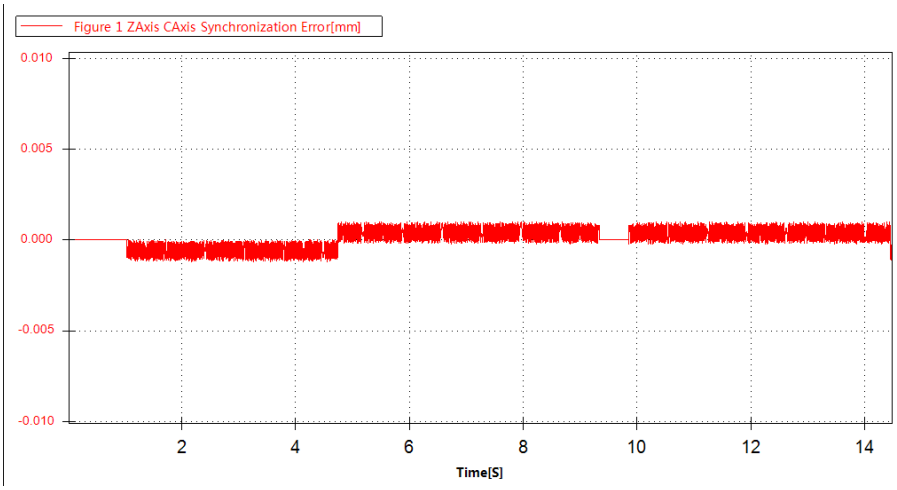
Follow the instructions below to obtain the rigid tapping synchronization error:

1. Click the ↔ button to connect SSTT to the CNC system.

2. Click the Rigid Tapping button to display the sampling settings interface.



3. Set the tapping axis number to **2**, rotation axis to **5**, pitch to **1**, and click Confirm after settings.
4. Click to start sampling (make sure that the CNC system is running the rigid tapping program at this time), and obtain the synchronous error of rigid tapping.



7.3 Modify Parameters

Before rigid tapping, users need to define the spindle speed "S", call the canned cycle G84, and perform rigid tapping at the axis C rotation speed of "S". The feed speed of the axis Z is calculated based on the axis C rotation speed "S". The parameters affecting the rigidness of rigid tapping are described as below:

Axis C parameters (No. 5 logical axis)

1. Parameter No. 105038: machining acceleration/deceleration time

   This parameter is in milliseconds. It specifies the time for the axis C to accelerate from **0** radian/min to **1000** radian/min or decelerate from **1000** radian/min to **0** radian/min.

   Since 1 radian = 180/π degrees ≈ 57.296 degrees, and it is 360 degrees per motor revolution, then in the machine without spindle speed reduction ratio, this parameter specifies the time for the spindle to accelerate from **0** r/min to **159** (57.296 * 1000/360 ≈ 159) rev/min.

Since the standard spindle motor configured for HNC-8 systems takes 300 milliseconds to accelerate from **0** to **3000** rev/min, it is recommended to set this parameter to **19**. However, as the motor is not stable enough with the limited value, the value should be slightly larger. It is recommended to set this parameter to **32** for the rigid tapping.

2. Parameter No. 105039: Machining acceleration and deceleration jerk time.

   This parameter is in milliseconds. It specified the time for the speed to accelerate from **0** to **1** radian/s^2 or decelerate from **1** radian/s^2 to **0**. This default parameter value is **16**. Users may set it to a greater value to achieve better rigid tapping performance.

The parameters affecting rigid tapping performance are as below:

Axis C driver parameters

1. Parameter No. 105200: Proportional gain in the position control mode

   Functions and settings:

   - Set the axis C proportional gain in the position control mode.
   - The larger the value is, the higher the gain, the greater the rigidness, and the smaller the position delay under the same frequency command pulse condition. Howerver, if the value is too large, it may cause oscillation.
   - Define the parameter value based on the spindle driver model and load values.

2. Parameter No. 105242: Speed proportional gain in the position control mode

   Functions and settings:

   - Set the axis C proportional gain in the speed control mode.
   - The larger the value is, the higher the gain and the greater the rigidness. Define the parameter value based on the spindle driver model and load values. In general, the bigger the load inertia, the larger the value.
   - Users may set this parameter to a relatively larger value under the condition of no oscillation cuased.

Axis Z driver parameters

1. Parameter No. 102200: Position proportional gain

   Functions and settings: the same as the axis C parameter 105200.

2. Parameter No. 102202: speed proportional gain

   Functions and settings: the same as the axis C parameter 105242.

3. Parameter No. 102232: torque command filter time constant.

   Functions and settings:

   After increasing the speed proportional gain (102202), users may appropriately increase this parameter value to eliminate the vibration if any machine vibration is

caused.

7.4 Rigid Tapping Adjustment for HNC-8 Systems

In the case of no machine vibration, users may increase the axis Z driver parameters' (**102200** and **102202**) value. If vibration is caused, users may eliminate the vibration by modifying the parameter **102232**. Adjust the rigidness of the axis Z to the most, and adjust the parameters of the axis C to match those of axis Z. If the axis C cannot reach the status of axis Z, then users may slightly adjust the axis Z parameters to match the axis C, and adjust the synchronization errors to the minimum.

1. Position proportional gain adjustment (synchronization error)

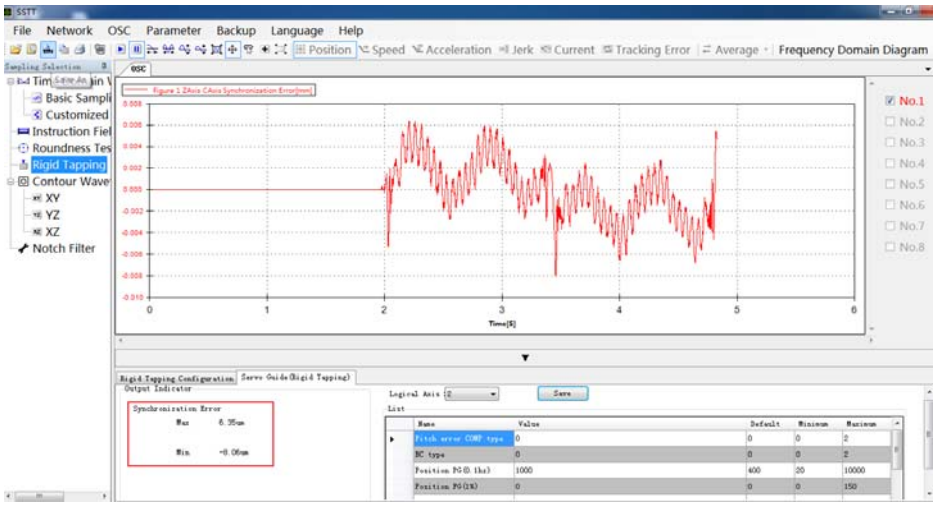
   The larger the position proportional gain, the smaller the track error. During rigid tapping, the synchronization error is derived from:

   Formula 1: *Synchronization error = axis Z actual position – axis C actual position* * (*pitch*/360)

   It is easy to see that the synchronization error is minimized when the difference between the actual position of the axis Z and the command position of the axis C (track error) satisfies the following formula:

   Formula 2: *Axis Z track error = axis C track error*/ 360 * *pitch*

   According to the formula above, adjust the position proportional gain parameters of the axis Z and axis C to achieve a minimum synchronization error. See the figure below:



Because the feedback value of the machine spindle is the inverse value, the pitch of M3 is **0.5**, the waveform as shown in the figure can be verified according to the formula 1. This synchronization error is caused because the axis C is faster than the axis Z. Users may reduce the synchronization error by increasing the axis Z position proportional gain.

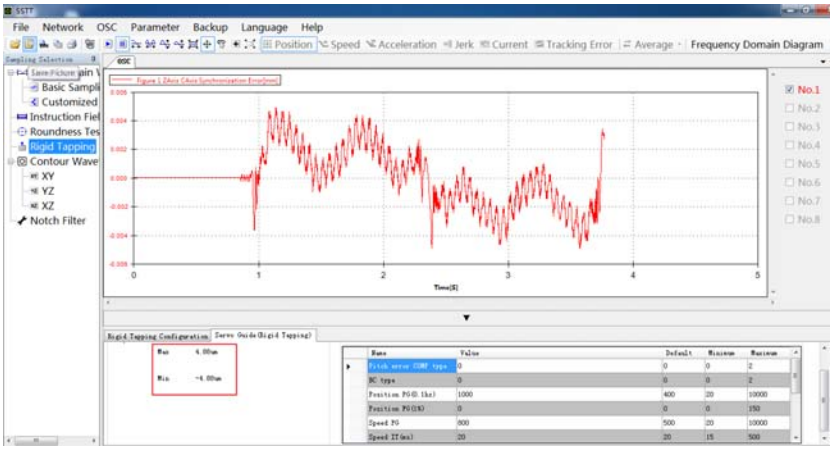
During rigid tapping, this parameter value of the axis Z and axis C should be the same or very close to each other.

2. Adjust speed proportional gain

The larger the value is, the higher the gain and the greater the rigidness. Users may define the parameter value based on the servo driver model and load values. In general, the bigger the load inertia, the larger the value. Users may set this parameter to a relatively larger value under the condition of no oscillation caused.

The sine waves in Figures 1 and 2 are from the axis Z motor, which is related to the pole pair number of the motor. The motor generates the number of sine waves as the pole pairs per revolution. Users may reduce the amplitude of the sine wave by increasing the speed proportional gain.

The figure below shows the wave after increasing the speed proportional gain:



3. Rigid tapping Adjustment

- **Axis Z**

  Increase the axis Z position proportional gain and speed proportional gain to adjust the axis Z to a relatively rigid status. During the adjustment, set the position proportional gain of the axis Z to about **800**. If no vibration occurs, then increase the speed proportional gain

gradually. If vibration occurs, properly increase the value of torque command filter time constant to eliminate vibrations (generally the value cannot exceed **5**). If the vibration cannot be eliminated, properly decrease the speed proportional gain of the axis Z. After the vibration is eliminated, gradually increase the position proportional gain of the axis Z to about **1200**. If vibration occurs, properly decrease the position proportional gain of the axis Z until the vibration is eliminated.

- **Axis C**

After the axis Z settings are completed, set the axis C position proportional gain to the same value as that of the Z axis. Properly increase the speed proportional gain of the axis C to the same as that of the Z axis. If whistle or vibration occurs, decrease the axis C speed proportional gain value.

- **Adjusting overshoot**

Configure the parameters according to the steps above. During the high-speed (s3000) rigid tapping dry-running test, if the axis C overshooting occurs, users need to modify the system parameters of acceleration and deceleration time. Properly increasing the axis C deceleration time can significantly reduce the overshooting. It is recommended to set this value to **32** based on the standard spindle motor of HNC-8 system.

8 PMC Axis Settings

8.1 Introduction to PMC Axis

PMC axes are servo axes, which are not controlled by the CNC, but by PMC-related signals. PMC axis motion requires three elements in the PMC: motion mode, motion displacement, and speed. HNC-8 system has standard commands (**AXISMVTO**, **AXISMOVE**) for PMC axis. The PMC axis must be set with an unused channel which must be set to the PMC mode. During programming, users only need to use this command, and do not need to set the value or conduct buffering for the three elements in the ladder.

8.2 Parameter Settings for PMC Axes

Follow the instructions below to conduct PMC axis parameter settings:

1. Set the parameter **010050** to the total number of PMC axes.
2. Set the parameter **010051** to the logical axis number of the current channel.
3. Set the logical axis number specified by the parameter **010051** in an unused channel.
4. Select the logical axis number specified by the parameter **010051**, and set the value of No. **100** parameter (PMC and coupling axis type) to **0** (PMC axis).
5. Enable the logical axis specified by the parameter **010051** in the PLC.
6. Use the **AXISMVTO** module in the PLC to move No. 6 axis to an absolute position, or use the **AXISMOVE** module to move No. 6 axis to a relative position.

8.3 PMC Axis Registers

- Axis mode control (G [axis number * 80+60]): Request to switch the axis control mode to PMC axis mode when the axis control mode is set to **3**.

Exit the PMC axis mode when the axis control mode is set to **-1**.

- Axis mode status (F [axis number * 80+70]): The PMC axis mode is valid when the axis mode status is set to **3**. This axis will no longer accept the G-code commands, and only accept the **AXISMOVE** (relative movement) and **AXISMVTO** (absolute movement) commands of the ladder.
- PMC axis override (G [Axis No.*80+61]): PMC axis override, which is used to control the PMC axis speed.
- PMC axis stop (G [Axis No.*80+62]): During PMC axis movement, the PMC axis movement will be stopped if this setting is valid.
- PMC axis idle (F [axis number * 80+1].0): During PMC axis movement, this setting is invalid. When the PMC axis stops, this setting is valid, and the PMC axis is idle to accept new PMC axis movement commands.

8.4 Examples of PMC Axes

If one turning machine has a servo magazine, which is controlled by the PMC axis. See Figure 8.3.1.

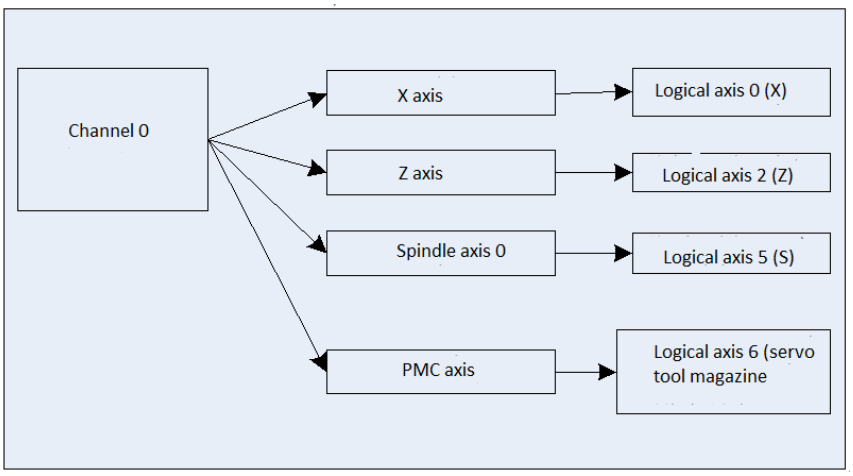


Figure 8.3.1 Turning machine with PMC axes

1. As only one servo magazine needs PMC axis, set the parameter **010050** to **1**. See Figure 8.3.2.

List	No.	Name	Value	Valid
NC	010050	No. of PMC & coupled slave axes	1	Restart
Machine	010051	PMC & coupled slave axes No.[0]	-1	Restart
[+]Channel	010052	PMC & coupled slave axes No.[1]	-1	Restart
[+]Axis	010053	PMC & coupled slave axes No.[2]	-1	Restart
[+]Error COMP	010054	PMC & coupled slave axes No.[3]	-1	Restart
[+]Device	010055	PMC & coupled slave axes No.[4]	-1	Restart
Data sheet	010056	PMC & coupled slave axes No.[5]	-1	Restart
	010057	PMC & coupled slave axes No.[6]	-1	Restart
	010058	PMC & coupled slave axes No.[7]	-1	Restart

Figure 8.3.2 Set PMC axis count

2. Set the parameter **010051** to **6**.

List	No.	Name	Value	Valid
NC	010050	No. of PMC & coupled slave axes	1	Restart
Machine	010051	PMC & coupled slave axes No.[0]	6	Restart
[+]Channel	010052	PMC & coupled slave axes No.[1]	-1	Restart
[+]Axis	010053	PMC & coupled slave axes No.[2]	-1	Restart
[+]Error COMP	010054	PMC & coupled slave axes No.[3]	-1	Restart
[+]Device	010055	PMC & coupled slave axes No.[4]	-1	Restart
Data sheet	010056	PMC & coupled slave axes No.[5]	-1	Restart
	010057	PMC & coupled slave axes No.[6]	-1	Restart
	010058	PMC & coupled slave axes No.[7]	-1	Restart

Figure 8.3.2 Set PMC axis number

3. Because axis X, axis Z, and spindle axis are in in channel 0, set the parameter **040006** in channel 0 to **6**.

List	No.	Name	Value	Valid
NC	040000	Channel name	CH0	Restart
Machine	040001	Axis X No.	0	Restart
[+]Channel	040002	Axis Y No.	-1	Restart
[+]Axis	040003	Axis Z No.	2	Restart
[+]Error COMP	040004	Axis A No.	-1	Restart
[+]Device	040005	Axis B No.	-1	Restart
Data sheet	040006	Axis C No.	6	Restart
	040007	Axis U No.	-1	Restart
	040008	Axis V No.	-1	Restart

Figure 8.3.3 Set logic axis 6 in channel 0

4. Set parameters (e.g. axis type and gear ratio) for axis 6 based on the parameters of the rotation axis.

List	No.	Name	Value	Valid
[+]Channel	106000	Axis name	P1	Save
[-]Axis	106001	Axis type	3	Save
LOG axis0	106004	ELG ratio NUMERA[position](um)	360000	Restart
LOG axis1	106005	ELG ratio DENOM[pulse]	131072	Restart
LOG axis2	106006	Plus software limit CS(mm)	2000.0000	Reset
LOG axis3	106007	Minus software limit CS(mm)	-2000.0000	Reset
LOG axis4	106008	2nd plus software limit CS(mm)	2000.0000	Reset
LOG axis5	106009	2nd minus software limit CS(mm)	-2000.0000	Reset
LOG axis6	106010	Reference point approach mode	2	Save

Figure 8.3.3 Set servo axis parameters

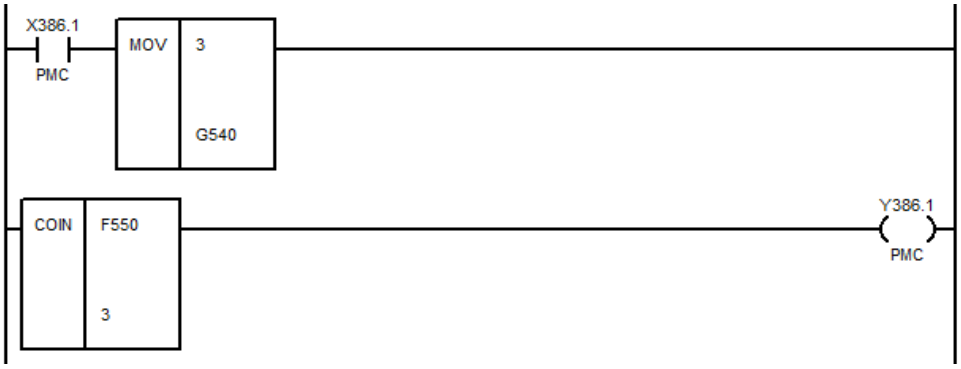
5. Select logical axis 6 from the coordinate parameters, and modify the parameter value of **106100** to **0**.

List	No.	Name	Value	Valid
[+]Channel	106087	Axis overload threshold	0	Save
[-]Axis	106090	Encoder working mode	0x100	Restart
LOG axis0	106094	Encoder counter digits	29	Restart
LOG axis1	106100	Axis motion control mode	0	Reset
LOG axis2	106101	Following axis 1 No.	-1	Reset
LOG axis3	106102	Following axis 2 No.	-1	Reset
LOG axis4	106103	Following axis 3 No.	-1	Reset
LOG axis5	106104	Following axis 4 No.	-1	Reset
LOG axis6	106105	Following axis 5 No.	-1	Reset

Figure 8.3.4 Set logical axis 6 for PMC axis

6. Switch PMC axis modes

   Before using the PMC axis function, users need to switch the axis control mode to the PMC axis mode. In the PMC axis mode, the system does not receive the commands sent in the manual or automatic mode. The system only receives motion commands sent by the PLC module.



When X386.1 (PMC axis request) is valid, set G (480+60) to **3**, which indicates to request for switching the axis 0 to the PMC mode. Then check if F550 is equal to **3**.

If F550 is equal to 3, the axis 0 has been switched to the PMC axis mode, and Y386.1 is lit.

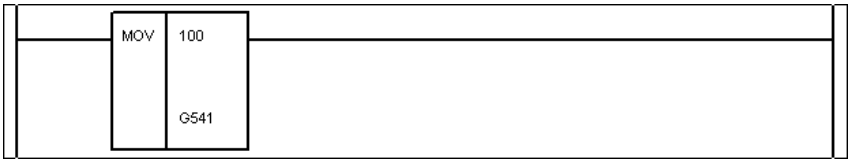
7. PMC axis speed

   PMC axis speed is the maximum feed rate of the axis parameters.

106035	MAX feedrate(mm/min)	6000.0000	Reset

8. PMC axis override

   During PMC movement, user may control the PMC movement speed through PMC axis override. The following figure shows to set the PMC axis override to 100:



9. PMC axis stop

   During PMC axis movement, make this setting of G[axis number *80+62].0 valid to stop the PMC axis movement. The following example shows to press the button X386.3 to stop the PMC axis movement.

10. PMC axis relative movement

    When the control mode is switched to the PMC axis mode, users may use the PLC module to control the PMC axis movement.

    The PLC module AXISMOVE is the relative movement module of the PMC axis. This module has two parameters:

    Parameter 1: Axis number.

    Parameter 2: Axis movement (unit: 1/1000 mm or 1/1000 degrees).

If **P50** is set to **10000**, the PLC axis will move 10 mm in the positive direction when X386.5 is valid.

Note 1: As long as X386.5 is valid for a period, the PMC axis will move 10 mm, without requiring X386.5 valid during the whole movement.

Note 2: The PMC axis will not receive any other move commands until the previous command execution is completed. The PMC axis idle (F [axis number * 80+1].0) can be used to verify if the PMC axis movement is completed.

11. PMC axis absolute movement

When the axis control mode is switched to the PMC axis mode, users may use the PLC module to control the PMC axis movement.

The PLC module AXISMVTO is the absolute movement module of the PMC axis. This module has two parameters:

Parameter 1: Axis number.

Parameter 2: Axis movement position (unit: 1/1000 mm or 1/1000 degrees).

If P51 is set to **20000**, the PLC axis will move 20 mm when X386.5 is valid.

9 Backlash and Pitch Error Compensation

9.1 Parameter Settings for Backlash Compensation

1. Check if the value of the axis parameters 10x130 and 10x131 is 0.

By setting the parameter 10x130, the system may conduct smooth processing of comprehensive error compensation for the current axis, to prevent impact that is caused by sudden compensation value change on the machine. If the comprehensive error compensation value change of two adjacent interpolation cycles is greater than the maximum value specified by this parameter, the system will display a corresponding message. The program continues to run. The comprehensive error

compensation value change is limited to the maximum value of this parameter. If this parameter value is **0**, the backlash cannot be compensated.

The maximum displacement error compensation of the current axis can be set through the parameter 10x131. If the comprehensive error compensation value for the current axis is greater than the maximum value of this parameter, the system will display a corresponding message. The program continues to run. If the value is **0**, the backlash cannot be compensated.

The following is the default value of the parameter.

101130	MAX error COMP rate(mm/deg)	0.0100	Reset
101131	MAX error COMP(mm/deg)	1.0000	Reset

2. Set the error compensation axis parameter **30x000** to **1**.

   Measure the backlash for the axis requires compensation, and set the measured value for the error compensation axis parameter **30x001**.

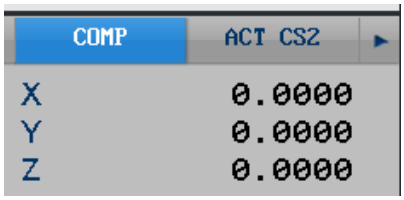
3. Set the parameter **30x002**. When the backlash is large, users may disperse the backlash compensation into multiple interpolation cycles by setting this parameter. This may prevent the impact that is caused by the compensation on the axis during axis inverse.

   If this parameter value is greater than zero, then the backlash compensation will be completed within N interpolation cycles.

   $$N = backlash\ compensation\ value / backlash\ compensation\ rate$$

   If the backlash compensation rate is greater than the backlash compensation value, or is set to zero, the compensation will be completed within one interpolation cycle.

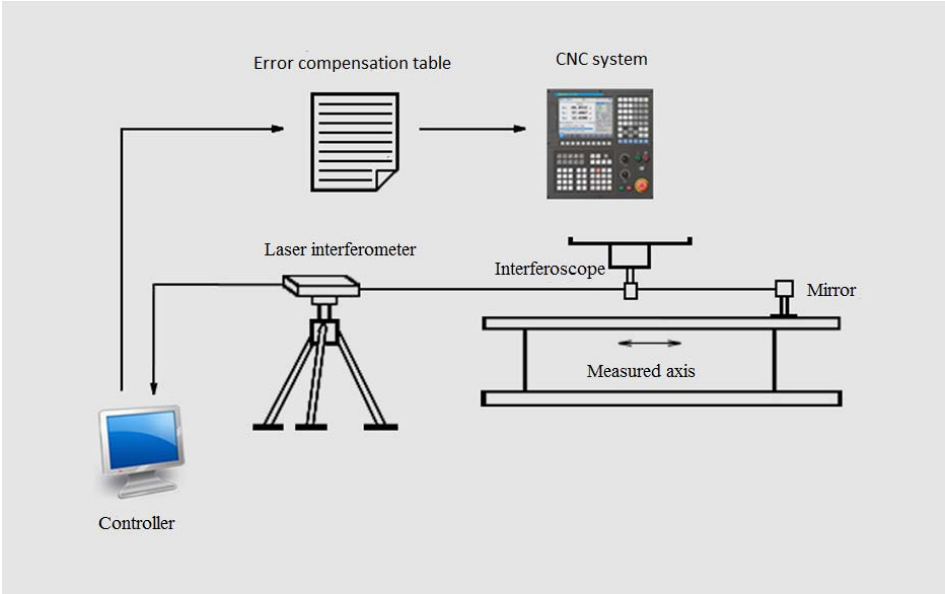
   Measure the backlash again, and check if the axis compensation value changes on the interface. If there is any change, the compensation takes effect. The figure below shows the compensation value display interface:



Note: The character "X" within the axis number represents the specific axis number. For example, the axis X of a turning machine is **0**, the axis Z is **2**, and the spindle axis is **5**.

9.2 Pitch Error Compensation Settings

In the semi-closed CNC machining systems, the machining positioning accuracy is affected by the precision of the ball screw in a large degree. The ball screw has its own manufacturing error; In addition, the precision of the ball screw will be reduced after being used for a long time. Therefore, users need to verify the CNC machine periodically, and conduct proper pitch error compensation for the CNC system to improve the precision of the CNC machining. Laser interferometer is widely used to measure and compensate the pitch error in the CNC machines. HNC-8 software may write the error compensation value measured by the laser interferometer into the error compensation parameter table, and then conduct compensation accordingly. See the figure below:



After measuring the pitch error compensation value with a laser interferometer, perform the following operations:

Check if the value of the axis parameters **10x130** and **10x131** is **0**. If the value is **0**, the pith error compensation is invalid.

Set the error compensation axis parameter **30x020**. This parameter is used to enable or disable the pitch error compensation function of the current axis.

- 0: to disable the pitch error compensation function
- 1: to enable the pitch error compensation function, unidirectional compensation
- 2: to enable the pitch error compensation function, bidirectional compensation
- Set the error compensation axis parameter **30x021**. This parameter is used to set the starting point of the compensation, and should be set to the coordinate value of the machine coordinate system. When the pitch error is measured along the negative axis, this parameter should be set to the coordinate value of the end measurement point (the left measurement point).

For example, if the axis X returns to the reference point in the positive direction, the positive software limit is **2** mm and the negative soft limit is **-602** mm, the pitch error measurement starts from the position **0** mm along the negative axis X, to the end point **-600** mm, then the starting point of the axis X pitch error compensation should be set to **-600** mm.

For example, if the axis Y returns to the reference point in the negative direction, the positive software limit is **510** mm and the negative soft limit is **-10** mm, the pitch error measurement starts from the position **20** mm along the positive Y axis, to the end point **500** mm, then the starting point of the axis Y pitch error compensation should be set to **20** mm.

1. Set the axis error compensation parameter **30x022**. This parameter is used to set the sampling compensation count within the specified compensation movement. The compensation value for each sampling point are stored on the pitch error compensation table in the specified location. Therefore, the count of the sampling compensation points will determine the length of the pitch error compensation table. Assuming that the count of the sampling compensation points is *n*, then the pitch error compensation table length is *n* for the unidirectional compensation and *2n* for the bidirectional compensation. If the count of the compensation points is set to **0**, the pitch error compensation is invalid.
2. Set the error compensation axis parameter **30x023**. This parameter is used to set the distance between two adjacent sampling compensation points within the specified compensation movement. The pitch error compensation will be invalid if the compensation point interval is set to **0** after specifying the start point of the compensation and the compensation point count,

   The end point coordinate of compensation is calculated as follows:

   $$\textit{End point coordinate} = \textit{start point coordinate} + (\textit{compensation points} - 1) \times \textit{compensation interval}$$

   For example, if the compensation start point coordinate is **-25.0** mm, compensation points are **30**, compensation interval is **25.0** mm, then the

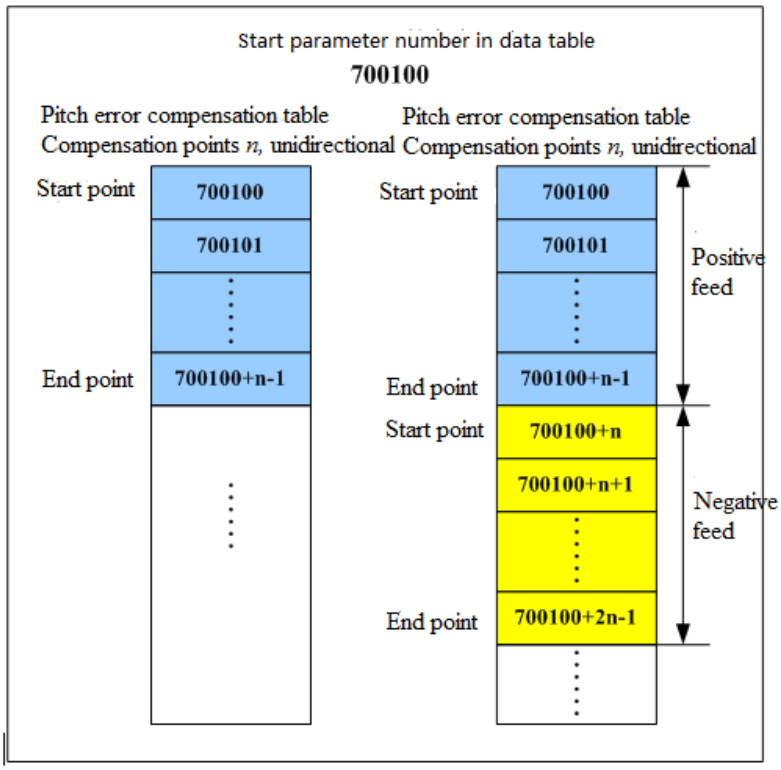
compensation movement is **725.0** mm, and the compensation end coordinate is **700.0** mm.

3. Set the error compensation axis parameter **30x024**. If the value is **0**, the compensation function is disabled. If the value is **1**, the compensation function is enabled. When the compensation is disabled, the compensation value of the start point will be set as the compensation value of the current position if the feed command position of the compensation axis is less than the coordinate value of the start point. The compensation value of the end point will be set as the current position compensation value if the feed command position of the compensation axis is greater than the coordinate value of the start point. When the compensation is enabled, the command position coordinate that exceeds the compensation travel range will be automatically floated to the compensation travel range during the query of pitch error compensation table. In this case, the compensation end point is the compensation start point. This compensation function is mainly used for the compensation of the rotation axis. For the rotation axis with 360-degrees movement range, users may set the compensation start point to **0** degree and the end point to **360** degrees during compensation.
4. Set the error compensation axis parameter **30x025**. The pitch error compensation value multiplied by this parameter value is output to the compensation axis. Therefore, the actual compensation value can be adjusted through this parameter. If this parameter is set to **0**, no pitch error compensation value will be output.
5. Set the error compensation axis parameter **0x026**. This parameter is used to set the start parameter number of the pitch error compensation table in the data table parameters. The pitch error compensation table is used to save compensation values of sampling compensation points. These compensation values can be obtained by pre-defining the machine pitch error.

compensation value = command machine coordinate value – actual machine coordinate value

After setting the start parameter number, the storage position for the pitch error compensation table in the data table parameters is defined. The compensation sequence number starts with this parameter number, and the address is based on the coordinate order (in ascending order) of the sampling coordinate points. For directional pitch compensation, input the positive pitch compensation, and then input the negative pitch compensation.

The length of the pitch error compensation table depends on the compensation type (unidirectional or bidirectional) and compensation point count. The defined start parameter number for the pitch error compensation table cannot conflict with an existing one, and the memory range cannot exceed the data table parameter range.



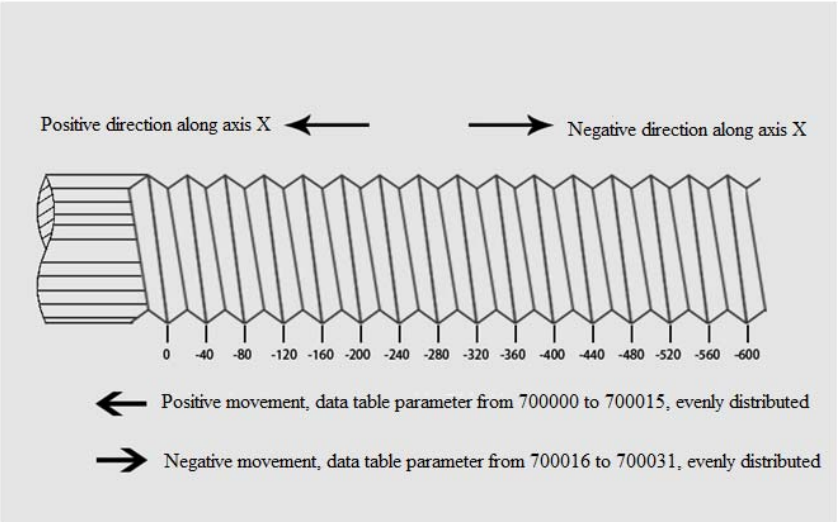
Note: Within the parameter number, the character "X" represents the axis number. For example, the axis X of a turning machine is **0**, the axis Z is **2**, and the spindle axis is **5**.

Take the X axis of a turning machine as example:

If:

- the compensation axis is axis A
- the axis returns to the reference point in the positive direction
- the positive soft limit is 2 mm
- the negative soft limit is -602 mm
- directional pitch compensation is required, from 0 to 600, a total of 16 points

See the figure below:



Then set the related parameter as below:

- Pitch error COMP type: **2** (bidirectional compensation)
- Start point of PE COMP: **-600.0** mm
- Pitch error COMP point: **16**
- PE COMP point interval: **40.0** mm
- Pitch error module COMP enable: **0** (disabled)
- Pitch error module COMP override: **1.0**
- 1st PARAM No. of PE COMP table: **700000**

List	No.	Name	Value	Valid
NC	300016	1st PARAM No. of TE slope table	700000	Reset
Machine	300017	TE COMP rate(mm/deg)	0.0100	Reset
[+]Channel	300020	Pitch error COMP type	2	Reset
[+]Axis	300021	Start point of PE COMP(mm/deg)	-600.0000	Reset
[-]Error COMP	300022	Pitch error COMP point	16	Reset
COMP AX0	300023	PE COMP point interval(mm/deg)	40.0000	Reset
COMP AX1	300024	Pitch error modulo COMP enabled	0	Reset
COMP AX2	300025	Pitch error COMP override	1.0000	Reset
COMP AX3	300026	1st PARAM No. of PE COMP table	700000	Reset

Confirm the sampling compensation points:

Based on the settings above, the compensation travel is 600 mm, and the coordinate values (in ascending order) of compensation points are:

-600, -560, -520, -480, -440, -400, -360, -320, -280, -240,

-200, -160, -120, -80, -40, 0

The pitch error compensation parameter numbers for axis X are:

- Start parameter number for the positive compensation table: 700000
- End parameter number for the positive compensation table: 700015
- Start parameter number for the negative compensation table: 700016
- End parameter number for the negative compensation table: 700031

10 Configuration for Analog Spindle

This section describes the analog spindle settings based on the I/O connection method.

10.1 Configuration with D/A Panel

Only the D/A panel is connected to output analog voltage and control the frequency spindle without feedback. See Figure 10.1.1.

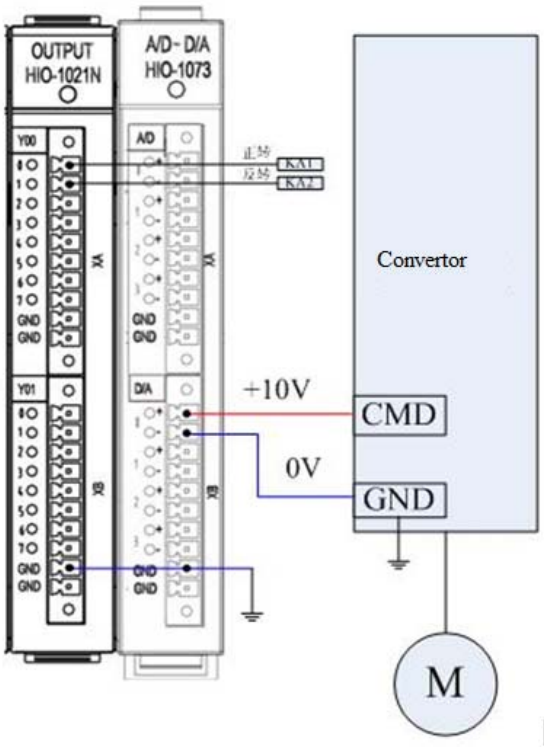


Figure 10.1.1 D/A board output analog voltage to control the frequency spindle

As shown in Figure 10.1.2, the input panel, output panel, and A/D-D/A panel are connected to the I/O device.

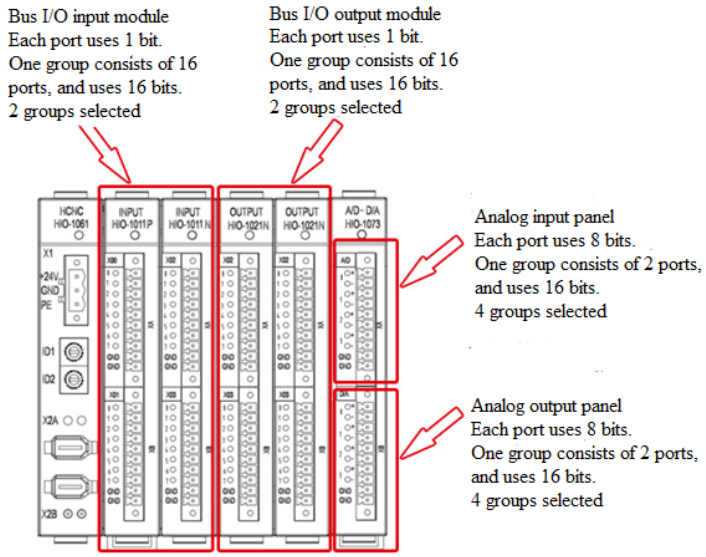


Figure 10.1.2 I/O connected with D/A board

Then two I/O devices are sequentially identified in the interface parameters. The first is the bus I/O module, and the second one is the analog input/output module. The device number is 9 and 10 respectively. See Figure 10.1.3.

List	No.	Name	Value	Valid
Device3	509000	Device name	IO_NET	Cure
Device4	509002	Device type	2007	Cure
Device5	509003	Device No. in same group	0	Cure
Device6	509010	Reserved[0]	0	Restart
Device7	509011	Reserved[1]	0	Restart
Device8	509012	Initial GP No. of input point	0	Restart
Device9	509013	No. of input point group	10	Restart
Device10	509014	Initial GP No. of output point	0	Restart
Device11	509015	No. of output point group	10	Restart

Figure 10.1.3 Device Interface Parameters identify two I/O devices

10.1.1 Configure Parameters for the I/O Module

The following two parameters must be set for the bus I/O module:

1. Set the parameter **509012** to **0**, which means to start with Group 0.
2. Set the parameter **509013** to **10**.

3. Set the parameter **509014** to **0**, which means to start with Group 0.
4. Set the parameter **509015** to **10**, which means 10 groups of input points.

List	No.	Name	Value	Valid
Device3	510000	Device name	IO_NET	Cure
Device4	510002	Device type	2007	Cure
Device5	510003	Device No. in same group	1	Cure
Device6	510010	Reserved[0]	0	Restart
Device7	510011	Reserved[1]	0	Restart
Device8	510012	Initial GP No. of input point	10	Restart
Device9	510013	No. of input point group	10	Restart
Device10	510014	Initial GP No. of output point	10	Restart
Device11	510015	No. of output point group	10	Restart

Figure 10.1.4 Configuration for I/O module

10.1.2 Configure Parameters for the Analog Input/Output Module

The following two parameters must be set for the analog input/output module:

1. Set the parameter **510012** (**Initial GP No. of input point**) to **10**. The start group number of input points should not conflict with that of the I/O module. For example, if the bus I/O module uses Group 0 to 10, then this parameter can be set to **10**, which means to start with Group 10.

   Note: This start group number should not conflict with the input group number of other devices.
2. Set the parameter **510013** (**No. of input point group**) to **10**, which means 10 groups.
3. Set the parameter **510014** (**Initial GP No. of output point**) to **10**. This start group number of output points should not conflict with that of the I/O module. For example, if the bus I/O module uses Group 0 to 10, then this parameter can be set to 10, which means to start with Group 10.

   Note: This start group number should not conflict with the output group number of other devices.
4. Set the parameter **510015** (**No. of output point group**) to **10**, which means 10 groups.

See Figure 10.1.4.

List	No.	Name	Value	Valid
Device3	510000	Device name	IO_NET	Cure
Device4	510002	Device type	2007	Cure
Device5	510003	Device No. in same group	1	Cure
Device6	510010	Reserved[0]	0	Restart
Device7	510011	Reserved[1]	0	Restart
Device8	510012	Initial GP No. of input point	10	Restart
Device9	510013	No. of input point group	10	Restart
Device10	510014	Initial GP No. of output point	10	Restart
Device11	510015	No. of output point group	10	Restart

Figure 10.1.5 Analog input/output module configuration

10.1.3 Configure Parameters for Device 4

The parameters must be configured for the device 4 are as follows:

1. Set the parameter **504010** (**Working mode**) to **3**, which means the analog spindle working mode.
2. Set the parameter **504011** (**Logical AX No.**) to define the mapping relationship between the analog spindle device and logical axis.
3. Set the parameter 504013 (**Spindle DA output type**) to define the spindle DA output type.
   - **0**: Output voltage 0 to 10 V, with no difference between spindle clockwise rotation and counter clockwise rotation.
   - **1**: Output voltage -10 to 10 V, with difference between the spindle clockwise rotation and counter clockwise rotation.
     Users may select the output analog voltage type based on the actual situation.
4. Set the parameter **504017** (**Spindle DA output device No.**). This parameter is set to the device number of the I/O module. For example, if the I/O module is on device 9, then set this parameter to **9**.
5. Set the parameter **504019** (**Spindle DA output port No.**). One DA output port uses two groups of Y register (16-bit output). After defining the I/O device number corresponding to the spindle DA output, this parameter can be used to locate the position of the DA output Y register. This means the offset of the start group corresponding to the I/O device output point. As shown in the figure above, there is a digital output sub-module (HIO-1021N) on the I/O module, and

the analog output uses group 0 (pin 1 and pin 2) of the analog input/output panel, then the offset of DA output Y register's position to the I/O device output start point is 2. If group 1 of the input/output panel is used, this offset is set to **3**.

6. Set the parameter **504014** (**Spidle DA output zero shift**). When there is zero drift for the spindle DA output voltage, users may set this parameter to calibrate the output voltage. The actual output voltage of the port is minus by this parameter value. The unit is **mv**. If the DA output port voltage measured by a multimeter in the case of no spindle speed is **0.2** V (the value under normal circumstances should be close to **0** V), to calibrate the output voltage, set this parameter to **200**.

List	No.	Name	Value	Valid
Device3	504000	Device name	SP	Cure
Device4	504002	Device type	1001	Cure
Device5	504003	Device No. in same group	0	Cure
Device6	504010	Working mode	3	Restart
Device7	504011	Logical AX No.	5	Restart
Device8	504012	Encoder feedback negation mark	0	Restart
Device9	504013	Spindle DA output type	0	Restart
Device10	504014	Spindle DA output zero shift(mv)	200	Restart
Device11	504015	Feedbak POS cycle pulse	4096	Restart

List	No.	Name	Value	Valid
Device3	504016	Spindle ENC feedback device No.	-1	Restart
Device4	504017	Spindle DA output device No.	9	Restart
Device5	504018	Spindle ENC FBK interface No.	0	Restart
Device6	504019	Spindle DA output port No.	0	Restart

Figure 10.1.6 Analog spindle SP device settings

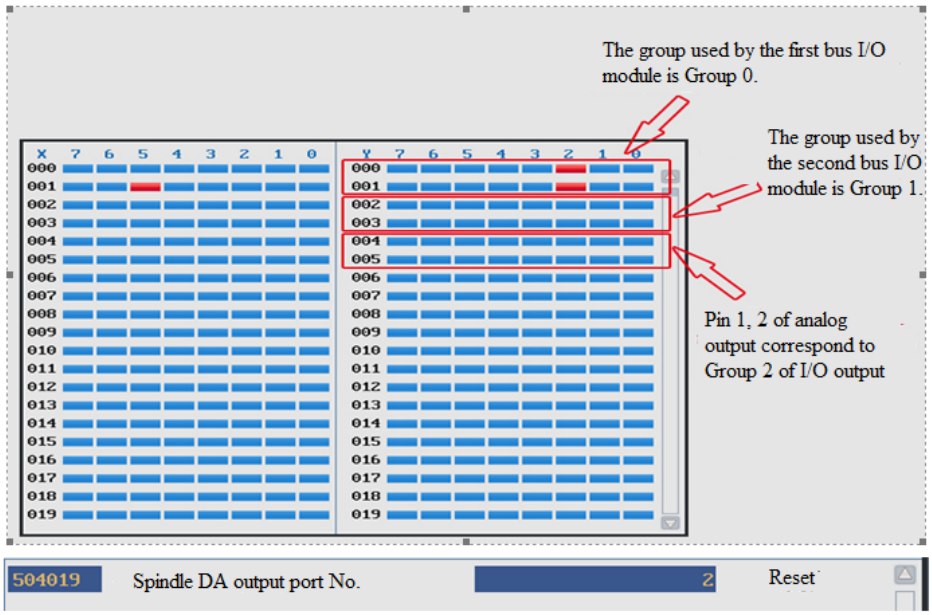


Figure 10.1.7 Settings for spindle DA output port number

10.2 Configuration with Axis Control Panel

Use the axis control panel to output analog and receive encoder's feedback, as shown in Figure 10.2.1.

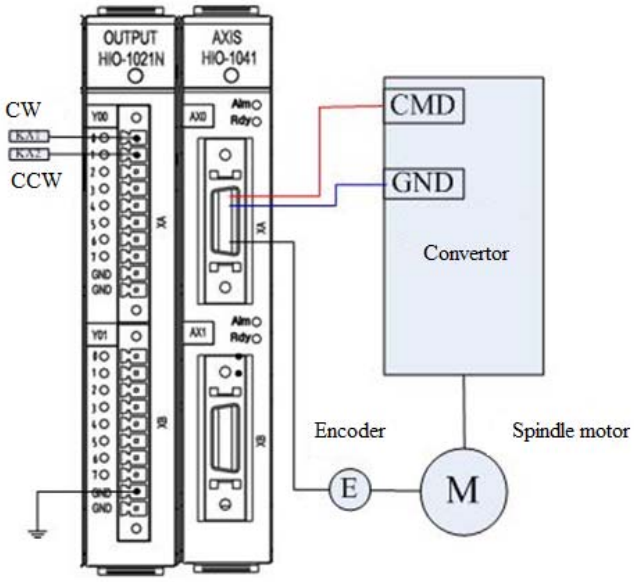


Figure 10.2.1 Axis control panel outputs analog and receives feedback

Only the D/A panel is connected to output analog voltage and control the frequency spindle. See Figure 10.2.2.

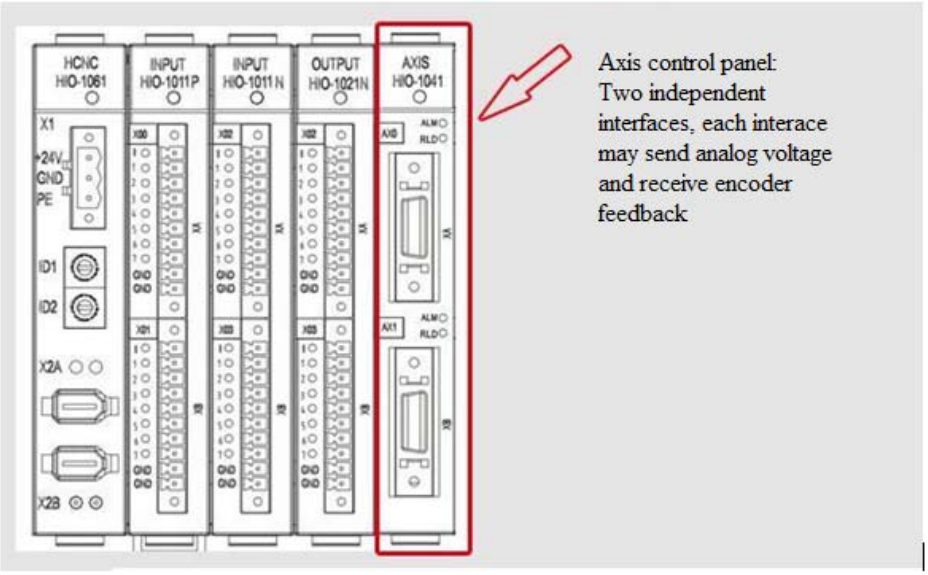


Figure 10.2.2 I/O connected with axis control panel

Two I/O devices are identified in the device parameters. The first one is the axis control panel and the second one is the I/O module.

List	No.	Name	Value	Valid
Device4	511000	Device name	IO_NET	Cure
Device5	511002	Device type	2007	Cure
Device6	511003	Device No. in same group	1	Cure
Device7	511010	Reserved[0]	0	Restart
Device8	511011	Reserved[1]	-1	Restart
Device9	511012	Initial GP No. of input point	0	Restart
Device10	511013	No. of input point group	0	Restart
Device11	511014	Initial GP No. of output point	0	Restart
Device12	511015	No. of output point group	0	Restart

Figure 10.2.3 Two I/O_NET devices on the axis control panel

10.2.1 Configure Parameters for the Axis Control Panel

List	No.	Name	Value	Valid
Device4	511000	Device name	IO_NET	Cure
Device5	511002	Device type	2007	Cure
Device6	511003	Device No. in same group	1	Cure
Device7	511010	Reserved[0]	0	Restart
Device8	511011	Reserved[1]	-1	Restart
Device9	511012	Initial GP No. of input point	10	Restart
Device10	511013	No. of input point group	10	Restart
Device11	511014	Initial GP No. of output point	10	Restart
Device12	511015	No. of output point group	10	Restart

List	No.	Name	Value	Valid
Device4	511016	Encoder A type	1	Restart
Device5	511017	Encoder A revolution	4096	Restart
Device6	511018	Encoder B type	0	Restart
Device7	511019	Encoder B revolution	0	Restart
Device8				
Device9				
Device10				
Device11				
Device12				

Configure parameters for the ais control panel

The parameters need to be configured for the spindle axis control panel in the analog voltage command mode are as below:

- Start group number of output point

  For example, if the bus I/O module uses Group 0 to 10, then this parameter can be set to **10**, which means to start with Group 10.

  Note: This start group number should not conflict with the output group number of other devices.

- Encoder A/B Type

  This parameter is used to specify the type of encoder A/B.

  0 or **1**: incremental encoder

  3: absolute encoder

- Encoder A/B revolution

When the type of encoder A/B is incremental encoder, this parameter should be set to the pulse number per revolution of encoder A/B.

(When using interface A of the encoder feedback panel, set the encoder A's type and the pulses per revolution of encoder A. When using the interface B of the encoder feedback panel, set the encoder B's type and the pulses per revolution of encoder B.)

10.2.2 Configure Parameters for Device 4

1. Spindle DA output type

   0: Output voltage 0 to 10 V, with no difference between the spindle clockwise rotation and counter clockwise rotation.

   1: Output voltage -10 to 10 V, with difference between the spindle clockwise rotation and counter clockwise rotation.

   Users may select the output analog voltage type based on the actual situation.

2. Feedback position cycle pulses

   This parameter is used to set the feedback cycle pulses of the spindle encoder. Generally, this parameter is set to the spindle pulses per revolution. For example, if the spindle motor is an incremental motor with **1204** lines, then this parameter is se to **4096** (1024*4=4096).

3. Spindle encoder feedback device number

   This parameter is set to the device number of the encoder module. For example, if the encoder feedback module is in device 11, then set this parameter to **11**.

4. Spindle DA output device number

   This parameter is set to the device number of the I/O module. For example, if the I/O module is on device 12, then set this parameter to **12**.

5. Spindle encoder feedback interface number

   An encoder interface consists of two encoder feedback ports. This parameter is used to set the port number used by the current analog spindle.

   0: encoder feedback port A

1: encoder feedback port B

6. Spindle DA output port number

   One DA output port uses two groups of Y register (16-bit output). After defining the I/O device number corresponding to the spindle DA output, this parameter can be used to locate the position of the DA output Y register. This means the offset of the start group corresponding to the I/O device output point.

   As shown in the figure above, there is a digital output sub-module (HIO-1021N) on the I/O module, and the analog output uses group 0 of the analog voltage command spindle control panel (analog voltage emitted by pin 1 and pin 2 of the interface), then the offset of DA output Y register's position to the I/O device output start point is **2**.

7. Zero drift correction of spindle DA output

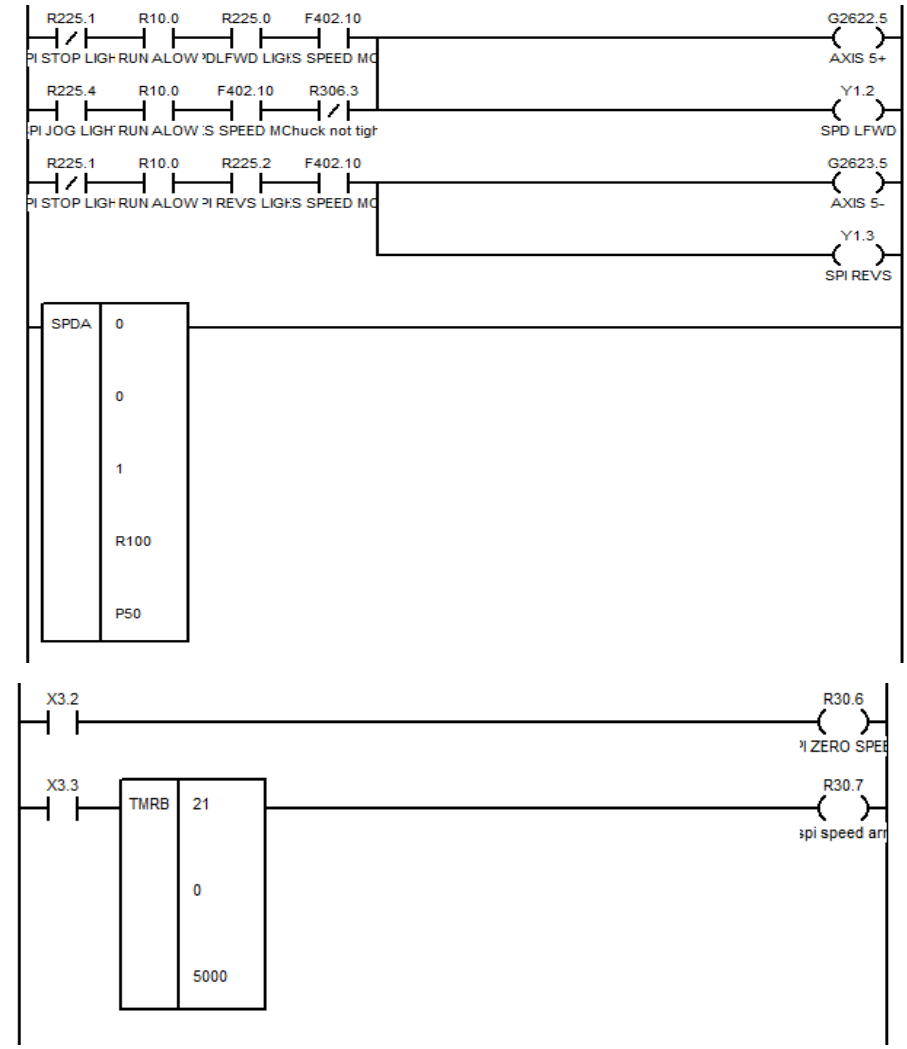
   Set the parameter **504014**. When there is zero drift for the spindle DA output voltage, users may set this parameter to calibrate the output voltage. The actual output voltage of the port is minus by this parameter value. The unit is **mv**. If the DA output port voltage measured by a multimeter in the case of no spindle speed is **0.2** V (the value under normal circumstances should be close to 0 V), to calibrate the output voltage, set this parameter to **200**.

Figure 10.2.4 Settings for spindle DA output port number

10.3 Add SPDA to the Ladder

1. Change SPDLBUS1 to SPDA.
2. Add the Y-axis output of for the spindle CW and CCW rotation.
3. Change the spindle zero speed and spindle speed reached signal to the X input signal.

See the PLC as shown in the figure below:



Analog spindle PLC modification

11 Design Examples of CNC Turning System

HNC-8 CNC system can be applicable to various CNC turning machines, with the following two main kinds of difference:

1. The logical relationship between the digital input and output, that is, the PLC programing, is different.
   For details, see PLC Programming Manual
2. The definition and electrical design of digital input/output are different
   This chapter mainly describes the difference from this aspect.

The digital input/output is usually divided into two categories: the digital input/output connected to the internal cabinet and connected to the machine. The cabinet commissioning and electro-mechanical joint commissioning are generally separated.

11.1 System Introduction

Tool machine: Two-coordinate turning machine, linear axes X and Z

Structure of control cabinet: strong current control cabinet + overhead bin

Spindle: spindle driver

The main components of a typical CNC system are as shown in Table 11.1.

Table 11.1 Main components of a typical CNC system

No.	Name	Model	Main Application	Remarks
1	CNC system	HNC-818B-T	System Control	HNC
2	MPG	HWL-1002	MPG control	HNC
3	Servo Transformer	3P AC380/220 V 2.5 KW	Power supply for the server power module	HNC
4	Control transformer	AC380/220 V, 300 W /110 V, 250 W	Power supply for server control and switches	HNC

No.	Name	Model	Main Application	Remarks
		/24 V, 100 W	Power supply for heat exchanger and AC contactor	
			Power supply for light	
5	Bus I/O Unit	HIO-1061	NCUC communication sub-module	HNC
		HIO-1006	Backplane sub-module (6 slots)	
		HIO-1011N	PLC input sub-module: two modules and a total of 32 channels	
		HIO-1021N	PLC output sub-module: two modules and a total of 32 channels	
6	Switch power supply	HPW-145U	Power supply for the CNC device and bus I/O unit	HNC
7	Switch power supply	AC220/DC24V 50 W	Digital value and intermediate relay	MEAN WELL
8	Switch power supply	AC220/DC24V 100 W	Lifting shaft brake and solenoid valve	MEAN WELL
9	Server Driver	HSV-160UD-030	X/Z-axis motor driver	HNC
10	Spindle driver	HSV-180US-075	Spindle motor driver	HNC
11	Servo motor	130ST-M07220LMBB (with brake)	X-axis feed motor (Tamagawa absolute encoder)	Hua Da Motor
12	Servo motor	130ST-M07220LMBB	Z-axis feed motor (Tamagawa absolute encoder)	Hua Da Motor
13	Spindle motor	GM71054SB61-H	AC servo spindle motor	Golden

No.	Name	Model	Main Application	Remarks
				Motor
14	Reactor	AC380V 5.5 kVA	Driver power line isolation (1 unit)	HNC

11.2 Overall Diagram

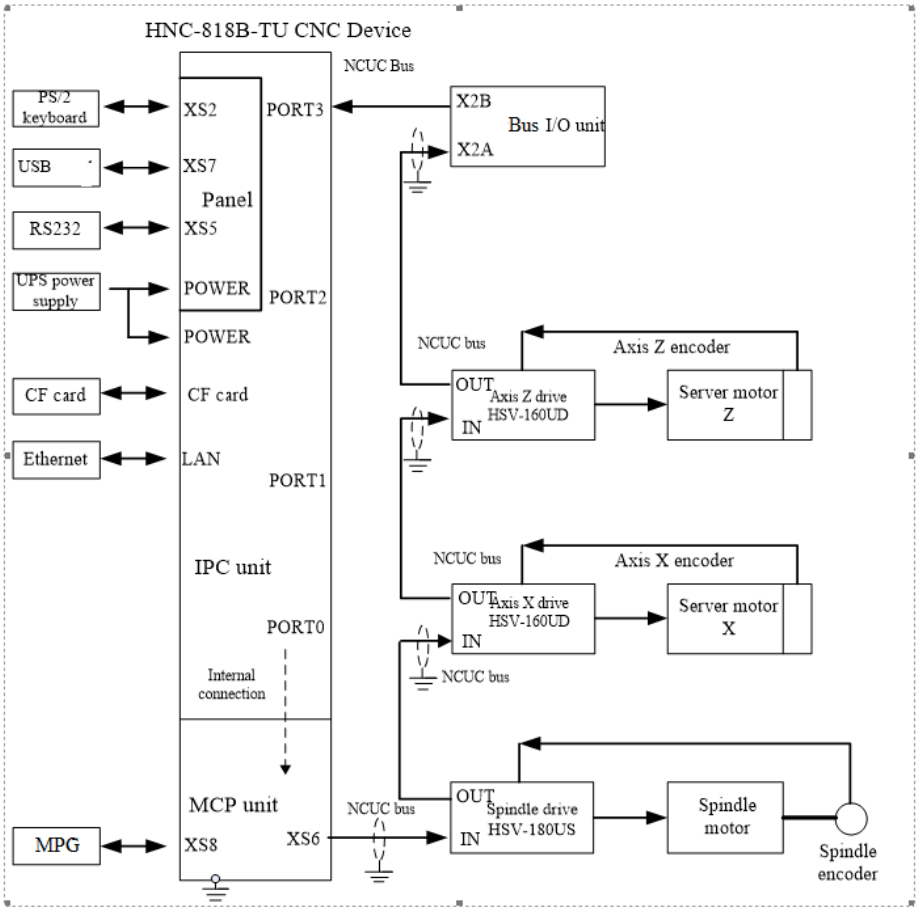


Figure 11.2 Overall diagram of typical CNC system

11.3 Definition of Digital Input/Output

For HNC-8 system, the hand-held unit interface provides a small number of I/O

signals, and the rest of I/O signals are provided by the Bus I/O unit. This application case requires two input sub-modules (HIO-1011N) and output sub-modules (HIO-1021N) of HIO-1000 series. The detailed definitions are as shown in the following table:

XS8 (DB25/F pinhole) MPG interface

Pin Number	Signal Name	Definition
13	5 V ground	Manual Pulse Generator (MPG) + 5 V power GND
25	+5 V	MPG + 5 V power
12	HB	MPG Phase B
24	HA	MPG Phase A
11	O3	Undefined
23	O2	Undefined
10	O1	MPG working indicator, valid for low level
22	O0	Undefined
9	I0	Select the axis X on the MGP, valid for normally open and closed points
21	I1	Select the axis Z on the MGP, valid for normally open and closed points
8	I2	Undefined
20	I3	Undefined
7	I4	Select the incremental override X1 on the MGP, valid for normally open and closed points
19	I5	Select the incremental override X10 on the MGP, valid for normally open and closed points
6	I6	Select the incremental override X100 on the MGP, valid for normally open and close points
4, 18	I7	MPG emergency stop button
5	Blank	
3, 16	+24V	DC24V power supply for MPG digital

Pin Number	Signal Name	Definition
1, 2, 14, 15, 17	24 V ground	input/output

- Input interface (bus I/O unit input sub-module HIO-1011N):

X00:

Pin Number	Signal Definition	Signal Definition
0	X0.0	Axis X positive over-travel limit, valid for the normally open and closed points
1	X0.1	Axis X negative over-travel limit, valid for the normally open and closed points
2	X0.2	Axis Z positive over-travel limit, valid for the normally open and closed points
3	X0.3	Axis Z negative over-travel limit, valid for the normally open and closed points
4	X0.4	Tool position 1 of four-position turret
5	X0.5	Tool position 2 of four-position turret
6	X0.6	Tool position 3 of four-position turret
7	X0.7	Tool position 4 of four-position turret
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

X01:

Pin Number	Signal Name	Signal Definition
0	X1.0	Eight-position turret, hydraulic turret and power turret code point
1	X1.1	Eight-position turret, hydraulic turret and power turret code point
2	X1.2	Eight-position turret, hydraulic turret and power

Pin Number	Signal Name	Signal Definition
		turret code point
3	X1.3	Eight-position turret, hydraulic turret and power turret code point
4	X1.4	Tool position signal of eight-position turret
5	X1.5	Reserved
6	X1.6	Reserved
7	X1.7	Reserved
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

X02:

Pin Number	Signal Name	Signal Definition
0	X2.0	Signal of hydraulic turret clamped
1	X2.1	Tool position signal of hydraulic turret
2	X2.2	Reserved
3	X2.3	Pedal chuck
4	X2.4	Emergency stop button
5	X2.5	Reserved
6	X2.6	Chuck released
7	X2.7	Chuck clamped
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

X03:

Pin Number	Signal Name	Signal Definition
0	X3.0	Dividing signal of power turret
1	X3.1	Locking signal of power turret
2	X3.2	Reserved

Pin Number	Signal Name	Signal Definition
3	X3.3	Reserved
4	X3.4	Reserved
5	X3.5	Reserved
6	X3.6	Reserved
7	X3.7	Reserved
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

- Output interface (bus I/O unit output sub-module HIO-1021N):

Y00:

Pin Number	Signal Name	Signal Definition
0	Y0.0	Hydraulic output
1	Y0.1	Over-travel released
2	Y0.2	Chuck released
3	Y0.3	Chuck clamped
4	Y0.4	Tailstock released
5	Y0.5	Tailstock clamped
6	Y0.6	Lubrication
7	Y0.7	Cool down
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

Y01:

Pin Number	Signal Name	Signal Definition
0	Y1.0	Clockwise rotation of turret
1	Y1.1	Counter clockwise rotation of turret
2	Y1.2	Turret clamped
3	Y1.3	Turret released

Pin Number	Signal Name	Signal Definition
4	Y1.4	Working indicator
5	Y1.5	Reserved
6	Y1.6	Axis X brake
7	Y1.7	Reserved
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

Y02:

Pin Number	Signal Name	Signal Definition
0	Y2.0	Clockwise rotation of chip removal motor
1	Y2.1	Counter clockwise rotation of chip removal
2	Y2.2	Reserved
3	Y2.3	Reserved
4	Y2.4	Reserved
5	Y2.5	Reserved
6	Y2.6	Reserved
7	Y2.7	Reserved
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

Y03:

Pin Number	Signal Name	Signal Definition
0	Y3.0	Select Mode 0 for power turret
1	Y3.1	Select Mode 1 for power turret
2	Y3.2	Select Mode 2 for power turret
3	Y3.3	Select Tool 0 of power turret
4	Y3.4	Select Tool 1 of power turret
5	Y3.5	Select Tool 2 of power turret

Pin Number	Signal Name	Signal Definition
6	Y3.6	Select Tool 3 of power turret
7	Y3.7	Parity check
GND	24 V GND	External DC 24 V power GND
GND	24 V GND	External DC 24 V power GND

11.4 Electrical Schematic Diagram

This section describes the main parts of the electrical schematic diagram. Cable numbers are provided only for the cables that appears in different pages.

11.4.1 Power Supply

In this design, the AC24V power supply for the light, DC24V power supply for the solenoid valve with high working current, and DC24V power supply for the digital output (e.g. relay and server control signal, etc.) are independent and isolated by a low filter.

The anti-interference ceramic rings and high-voltage ceramic capacitors on the input terminal of the main power line and transformers are not shown in the diagram. As shown in Figure 11.4.1.

In Figure 11.4.1, QF0-QF4 are three-phase air switches. QF5-QF11 are single-phase air switches. KM1-KM4 are three-phase AC contactors. RC0-RC3 are three-phase RC absorbers (arc extinguisher). RC4-RC12 are single-phase RC absorber (arc extinguisher). KA1-KA4 are DC24V relays. V1, V2, V3 and VZ are freewheeling diode. YV1, YV2, YV3 and YVZ are solenoid valves and Axis X motor brake.

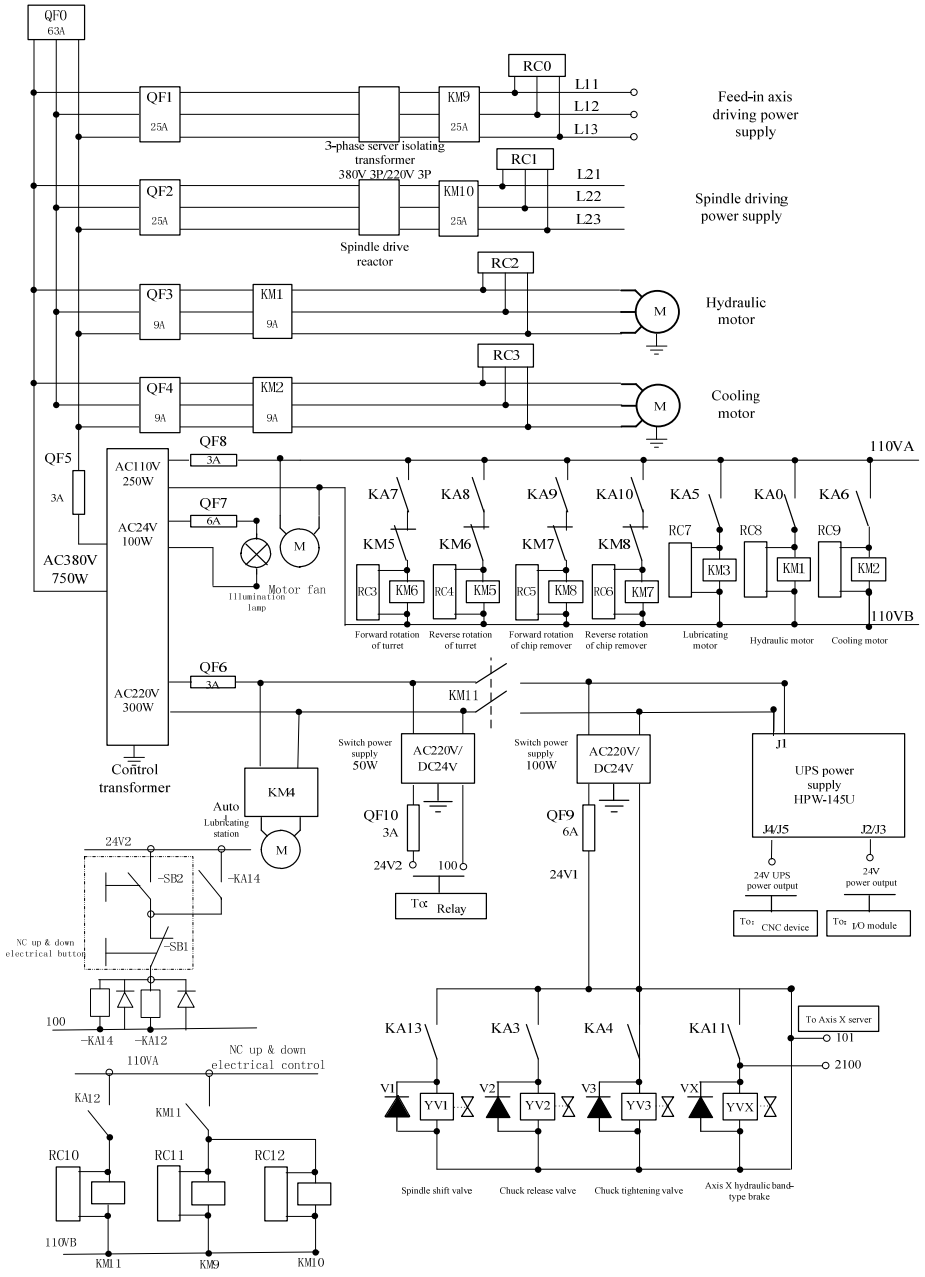


Figure 11.4.1 Electrical schematic diagram of typical CNC system: power supply

11.4.2 Relay and Digital Input/Output

The relay is mainly controlled by the digital output; the digital input mainly refers to the status and alarm information about the feed driver device, the spindle driver device and other machine and electrical parts. Figure 11.4.2 shows the relay section of electrical schematic diagram of typical CNC system. The digital input and output connection are as shown in Figure 11.4.3 and Figure 11.4.4 respectively.

The digital input/output for two-axis turning machine requires two input sub-modules HIO-1011N and two output sub-modules HIO-1021N in the bus I/O unit.

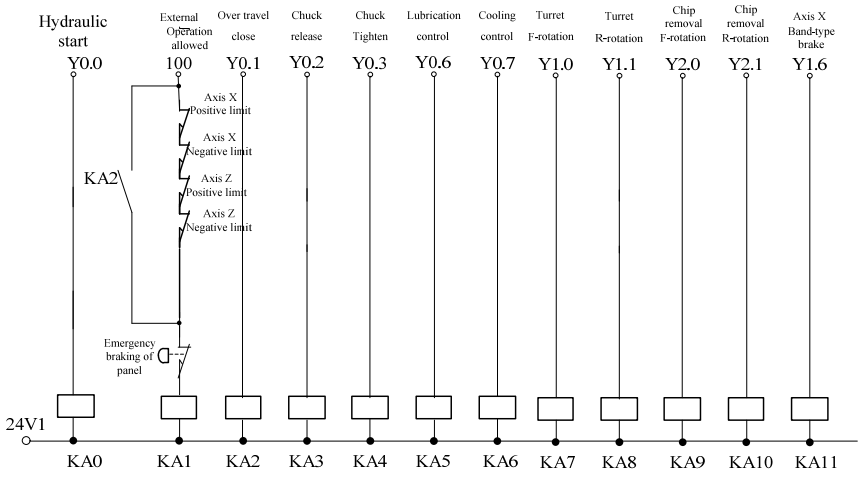


Figure 11.4.2 Electrical schematic diagram of typical CNC system: relay section

"100" is the Ground of DC24V 50W switch power supply in Figure 11.4.1.

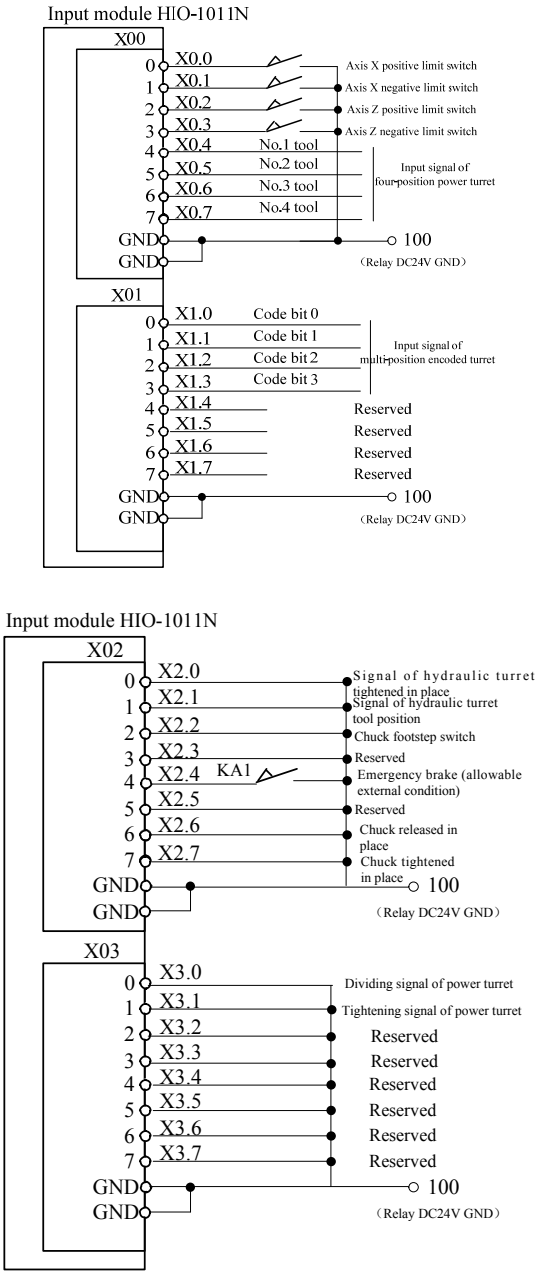


Figure 11.4.3 Electrical schematic diagram of typical CNC system: NPN input module

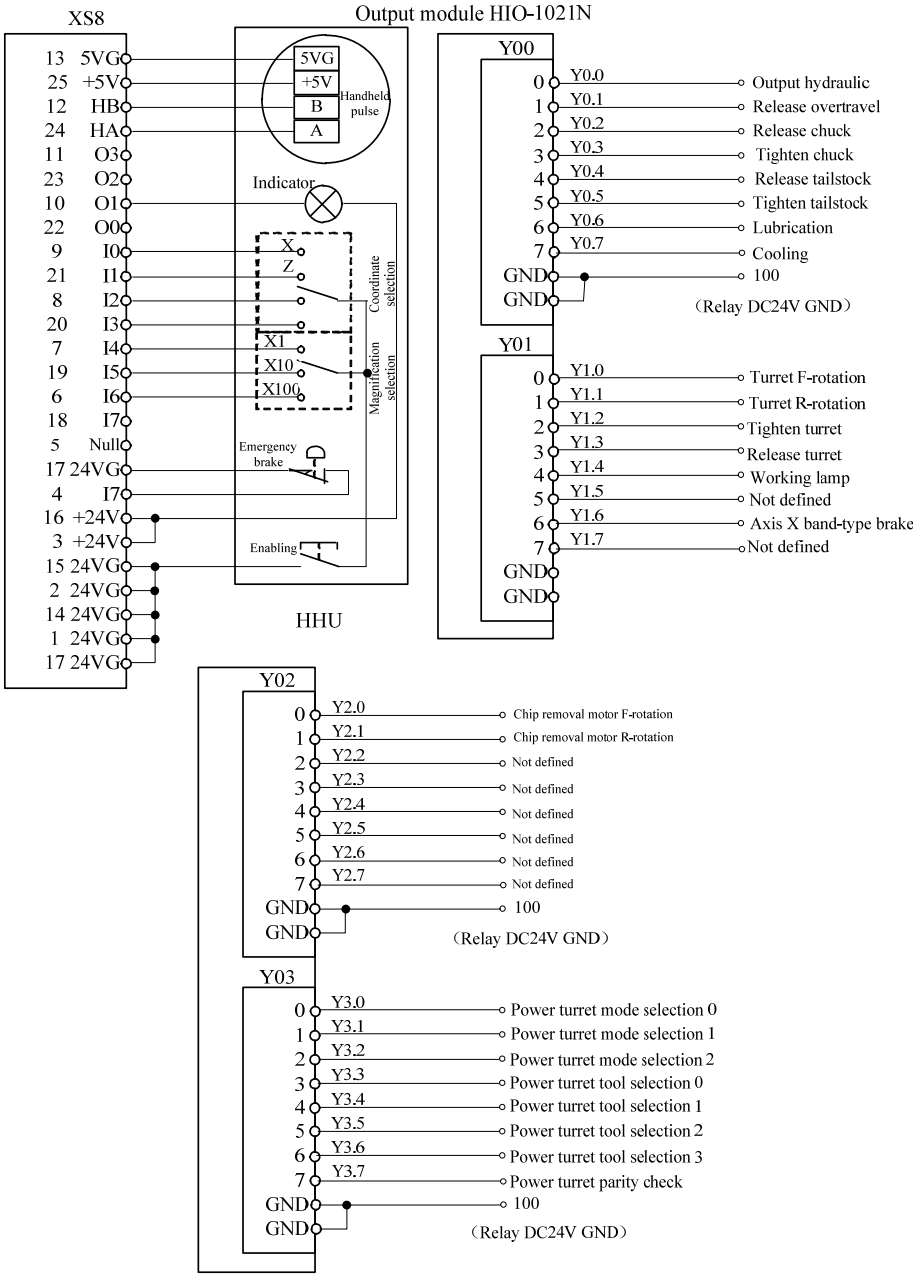


Figure 11.4.4 Electrical schematic diagram of typical CNC system: digital input/output

11.5 Parameter Settings for HNC-8 Turning System

P parameters used in the standard ladder diagram are as follows:

- P0-P7: Spidle override 50, 60, 70, 80, 90, 100, 110, 120
- P8-P28: Feed rate including 0, 1, 2, 4, 6, 8, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100, 105, 110, 120
- P29: Cooling for 10 seconds
- P30: Cooling for 3600 seconds
- P31: (1: Panel hand wheel 2: External hand wheel)
- P32: Select Turret

  1: four-position turret

  2: eight-position turret

  4: hydraulic turret

  8: server turret
- P33: The maximum number of tool position of hydraulic turret (default 12)
- P34: Internal and external chuck 0: internal 1: external
- P35:

  0: without the second spindle

  1: with the second spindle (valid for 818B Turning Center)
- P36

  0: with the signal of chuck clamped

  1: without the signal of chuck clamped
- P37:

  0: hydraulic chuck

  1: non-hydraulic chuck
- P39: Inspection time of spindle fluctuation (unit: MS)
- P50: **8000** the maximum spindle rotation speed
- P51: **0**, the minimum spindle rotation speed at gear 1
- P52: **8000**, the maximum spindle rotation speed at gear 1
- P53: **1**, numerator of gear ratio at gear 1

- P54: **1**, denominator of gear ratio at gear 1
- P55: **0**, the minimum spindle rotation speed at gear 2
- P56: **8000**, the maximum spindle rotation speed at gear 2
- P57: **1**, Numerator of gear ratio at gear 2
- P58: **1**, Denominator of gear ratio at gear 2

11.6 Parameters Description

11.6.1 Key Axis Parameters

Parameter Number	Parameter Name	Parameter Description
#10X001	Type of axis	1: linear axis
#10X004	ELG ratio NUMERA [position] (um)	The movement distance of the machine axis per motor revolution. For example, the machine moves 10 mm per motor revolution, then it is **10000**.
#10X005	ELG ratio DENOM [pulse]	The required pulse command number per motor revolution. For example, it is **131072** for the 17-bit absolute motor.
#10X067	Pulses per axis revolution.	The required pulse command number per motor revolution. For example, it is **131072** for the 17-bit absolute motor.

Note: The character "X" within the axis number represents the specific axis number. For example, the X axis of a turning machine is **0**, and the Z axis is **2**.

11.6.2 Spindle Parameters

Parameter Number	Parameter Name	Parameter Description
#105001	Type of axis	10: Spindle
#105004	ELG ratio NUMERA [position] (um)	The movement distance of the machine axis per motor revolution. For the spindle with the shift of C/S axis, it is 360 degrees per motor revolution. The value is set to **360000**.
#105005	ELG ratio DENOM [pulse]	The required pulse command number per motor revolution. The parameter is set to **4096** for the motor with 4096 lines.
#105067	Pulses per axis	The required pulse command number per motor revolution.

Parameter Number	Parameter Name	Parameter Description
	revolution.	The parameter is set to **4096** for the motor with 4096 lines.
#040028	Customized spindle display	It is used to set the spindle corresponding to which logic axis will be displayed on the interface.

11.6.3 Device Parameters

The sever parameters of HNC-8 system can be modified both on the driver and the system.

Choose **Set** > **PARA** (F10) > **SYS PARA** (F1) > **DEVICE PARA**, and press the Enter key.

Parameter Number	Parameter Name	Parameter Description
#50X010	Operating mode	This parameter is used to set the default work mode of the servo axis in the bus network. • **1**: Incremental position mode • **2**: Absolute position mode • **3**: Speed mode Set it to **3** for the spindle; set it to **2** for the axis X/Z absolute motor; set it to **1** for the incremental motor
#50X011	Logic axis number	This parameter is used to establish the mapping relationship between the servo axis device and logical axis. • **5**: for the spindle • **0**: for axis X • **2**: for axis Z
#50X014	Enable feedback position cycle	Set it to **1** for the spindle. Set it to **0** for the motion axis.
#50X015	Feedback position cycle pulses	This parameter is used to set the loop pulse number when the feedback position cycle is enabled. Generally, this parameter

Parameter Number	Parameter Name	Parameter Description
		is set to the pulses per revolution. For example, it is **131072** for the 17-bit absolute motor.
#50X016	Encoder Type	This parameter is used to specify the encoder type of the servo axis and the feedback mode of Z-pulse signal. • **0** or **1**: increment encoder with Z pulse signal feedback • **2**: Incremental linear grating with distance-coded Z pulse feedback signal. • **3**: absolute encoder without Z pulse signal feedback.

Note: The character "X" within the parameter number represents the specific device number. For example, the axis X of a turning machine is **6**, and the axis Z is **8**.

11.6.4 Axis Speed Parameters

Parameter Number	Parameter Name	Parameter Description
#040030	Default channel feed speed	The CNC system will use the default feed speed specified by this parameter to execute the program when the feed speed is not set by the programming in the channel.
#040031	Default dry running speed	When the CNC switches to the dry running, the machine will apply the feed speed set by this parameter to execute the program.
#10X015	High speed to the reference point	The rapid traverse speed before pressing the reference key when returning to the reference point. The unit is mm/minute for the movement axis.
#10X016	Low speed to the reference point	The deceleration speed before pressing the reference key when returning to the reference point. The unit is mm/minute for the movement axis.

Parameter Number	Parameter Name	Parameter Description
#10X032	Slow jog speed	This parameter is used to set the axis movement speed in the JOG mode. The unit is mm/minute for the movement axis.
#10X033	Fast jog speed	This parameter is used to set the axis rapid traverse speed in the JOG mode.
#10X034	Maximum rapid traverse speed	The maximum speed of G00 rapid traverse (no machining) when the rapid traverse speed is the maximum. The unit is mm/minute for the movement axis.
#10X035	Maximum machining speed	The maximum machining speed allowed when the CNC system executes the machining command (G01, G02, etc.)
#10X031	Converted radius of rotation axis	When the parameter value is **57.3**, the speed unit of the rotation axis is degree/min.

Note: The character "X" within the axis number represents the specific axis number. For example, the axis X of a turning machine is **0**, the axis Z is **2**, and the spindle axis is **5**.

11.6.5 Reference Parameters

Parameter Number	Parameter Name	Parameter Description
#10X010	Mode of returning to the reference point	Mode of returning to the reference point is divided into the following types for HNC-8 CNC system. **0: Absolute coding** The position value can be obtained immediately and provided to the CNC system once the encoder is powered on. When the CNC system power is off, the current machine position will be kept. Therefore, the system does not need to move the machine axis to locate the reference point and the machine can immediately run. **2:** + -

Parameter Number	Parameter Name	Parameter Description
		Return to the reference point from the current position in the specific direction and at the high speed. After pressing the Reference key, inversely move to the reference point at the low speed until the system detects the first Z pulse signal, and continue to move for a distance specified by the parameter **100013**. This way, the returning to the reference point is completed. **3:** + - + Return to the reference point from the current position in the specific direction and at the high speed. After pressing the Reference key, inversely move to the reference point at the low speed until the system detects the first Z pulse signal, and continue to move for a distance specified by the parameter **100013**. This way, the returning to the reference point is completed. **Distance code reference mode 1** When the CNC system is equipped with distance-coded grating, the machine may find the reference point and set up the coordinate system only after moving a very short distance. When the grating feedback and the direction of returning to the reference point is the same, set this option to **4**. **Distance code reference mode 2** When the CNC system is equipped with distance-code grating, the machine may find the reference point and set up the coordinate system only after moving a very short distance. When the grating feedback and the direction of returning to the reference point is the same, set this option to **5**.
#10X011	Direction of returning to the	This parameter is used to set the initial movement direction to the reference point searched by the coordinate system after sending the

Parameter Number	Parameter Name	Parameter Description
	reference point	command of returning to the reference point. **-1**: negative direction **1**: positive direction **0**: distance code returning to the reference point
#10X012	Encoder feedback offset	This parameter is used to set the encoder feedback offset for the absolute encoder motor. The absolute encoder will feed back a random position value when it is used for the first time. Users may set this parameter to the position value. The current position is the reference point position of the machine coordinate system.
#10X013	Offset after returning to the reference point	While returning to the reference point, after the system detects the Z pulse, it may not be used as the reference point. The system continues to move a distance specified by this offset and then sets the point as the reference point. The default value is **0**. Normally this parameter is one quarter of screw pitch.
#10X014	Shielding angle of Z pulse returning to the reference point	When using an incremental position to measure the machine of the feedback system back to the reference point, the machine movement distance of one motor revolution may exist between two times of returning to the reference point, as position offset exists at the reference point switch. When the Z pulse signal is too close to the reference point, users may set a mask angle to neglect the Z pulse before and after the signal of reference point, but to detect the next Z pulse signal so as to solve the inconsistency in the two times of returning to the reference point. Users may view the Z pulse offset displayed to set this parameter. If the screw lead is **10** and Z pulse offset value is **9.8** after returning to the reference point, it may have impact on returning to the reference point. Users may set it to

Parameter Number	Parameter Name	Parameter Description
		180, which means the screw will rotate an additional half revolution and then the Z pulse offset will be **4.8**.
#10X017	Coordinate values of reference point	This parameter is used for the distance code returning to the reference point. It may not be at the same position after each returning as the distance code returns to the closet reference point each time. There will be a feedback position value after the first returning to the reference point. Users may set this point as the machine zero point and set this value as the parameter value. The current position is the zero point position of the machine coordinate system.
#10X018	Distance-code reference point interval	This parameter represents the interval of two adjacent reference points in the incremental measuring system with distance-code reference point.
#10X019	Interval Code Offset	This parameter represents the offset interval of reference points in the incremental measurement system with the distance-code reference point.
#10X020	Maximum movement distance searching for Z pulse	It is used to set the distance for searching for Z pulse of the reference point. This distance is usually within one screw lead.

Note: The character "X" within the axis number represents the specific axis number. For example, the axis X of a turning machine is **0**, the axis Z is **2**, and the spindle axis is **5**.

11.6.6 Other Parameters

Parameter Number	Parameter Name	Parameter Description
#010017	Display axes for turning machine	Set it to **0x25** as the display axes for a standard turning machine are 0, 2 and 5. If there is no axis C, set this parameter to **0x05**.
#040001	Axis X number	Set the axis number for the X feed axis in the current channel. Set this parameter to **0** for a standard turning machine.
#040003	Axis Z number	Set the axis number for the Y feed axis in the current channel. Set this parameter to **2** for a standard turning machine.
#040006	Axis C number	Set the axis number for the C rotation axis in the current channel. Set this parameter to **2** for a turning machine which spindle axis has C-axis functions.
#505018	Encoding type of band switch	**0**: the band switch uses Code 8421 **1**: the band switch uses the isolation code

Appendix A- MCP Input/Output of HNC-8 Systems

- 818A turning machine panel

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
X480	Automatic	Single block	Manual	Incremental	Return to reference point	Clamp and release chuck	Internal chuck External chuck	Dry running
X481	Over-block	Optional stop	MST lock	Machine lock	Tailstock clamp and release	Hydraulic enable	Feed hold	Manual tool change
X482		-X		x1	x10	x100	x1000	Working light
X483	Protective door	-Z	Fast feed	+Z	Spindle jog	Cool down	Lubricating	Spindle upshift
X484	Chip removal and clockwise rotation	Chip removal and counter clockwise rotation		+X		Spindle clockwise rotation	Spindle stop	Spindle CCW rotation
X485	Spindle downshift		Over-travel released					
X486	Rapid traverse override				Cycle start	Feed hold		

X487	Spindle override					
X488	MPG emergency stop, MPG axes selection, and MPG magnification					
X489	Feed rate					
X490	MPG incremental pulses per cycle					
X491						

- 818B turning machine panel

	0	1	2	3	4	5	6	7
X480	Automatic	Single block	Manual	Incremental	Return to reference point	Clamp and release chuck	Clamp and release tailstock	Dry running
X481	Over-block	Optional stop	MST lock	Machine lock	Center rest	Tailstock connection	Feed hold II	Manual tool change
X482				0%	25%	Spindle CW rotation	Spindle stop	Spindle CCW rotation
X483	Working light	+C	-Y		50%	100%	Spindle jog	Spindle upshift
X484	Spindle downshift	Protective door	-X	Fast feed	+X	F1	F2	Cool down
X485	Lubricating	Hydraulic enable	Automatic power-off		+Y	-C	F3	F4
X486	Chip removal and clockwise rotation	Chip removal stop	Chip removal and counter clockwise rotation	Over-travel released	Cycle start	Feed hold		
X487	Spindle override							
X488	MPG emergency stop, MPG axes selection, and MPG magnification							
X489	Feed rate							
X490	MPG incremental pulses per cycle							
X491								

- 818C turning machine panel

	0	1	2	3	4	5	6	7
X480	Automatic	Return to reference point	Manual	Incremental	Over-travel released	Single block	Dry running	Over-block
X481	Optional stop	Machine lock	0%	25%	50%	100%	Working light	Spindle CW rotation
X482	Spindle orientation	X	A	7	-JOG	Spindle stop	Cool down	Y
X483	B	8	Fast feed	Spindle CCW rotation	Spindle jog	Z	C	9
X484	+JOG							
X485								
X486					Cycle start	Feed hold		
X487	Feed rate							
X488	MPG emergency stop, MPG axes selection, and MPG magnification							
X489	Spindle override							
X490	MPG incremental pulses per cycle							
X491								

Appendix B HNC-8 Central F-G Register List

Axis status word:

Each axis is configured with 80 status words. Each word has 16 bytes. The first line represents 0 to 7 bit, the second line represents 8-15 bit. When using the axis status word, users need to add the logic axis number offset.

[F0.0] Axis moving: The value **1** indicates the axis is moving while **0** indicates the axis is not moving.

[F0.1] First step to the reference point: The value **1** indicates that the axis has not reached the reference stop. The value **0** indicates that the axis has reached the reference stop.

[F0.2] Second step to reference point: The value **1** indicates searching for the Z pulse; otherwise, the value is **0**.

[F0.3] Failed to return to reference point: The value **1** indicates that the axis has not returned to the reference point. The value **0** indicates that the axis has returned to the reference point.

[F0.4] Succeeded in returning to reference point: The value **1** indicates that the axis has returned to the reference point. The value **0** indicates that the axis has not returned to the reference point.

[F0.5] The slave axis is returning to the reference point.

[F0.6] The slave axis reference verification is completed.

[F0.7] The following status of the slave axis has been released.

[F0.8] First reference point confirmation: The value **1** indicates that the axis is at the first reference point. The value **0** indicates that the axis is not at the first reference point.

[F0.9] Second reference point confirmation: The value **1** indicates that the axis is at the second reference point. The value **0** indicates that the axis is not at the second reference point.

[F0.10] Third reference point confirmation: The value **1** indicates that the axis is at the third reference point. The value **0** indicates that the axis is not at the third reference point.

[F0.11] Fourth reference point confirmation: The value **1** indicates that the axis is at the fourth reference point. The value **0** indicates that the axis is not at the fourth reference point.

[F0.13] The axis parameters take effect.

[F0.14] The axis has been locked.

[F0.15] The axis has been repositioned.

[F1.0] The value **1** indicates that the PMC control function is enabled. The value 0 indicates that the PMC control function is disabled.

[F1.1] The feed spindle mode. The value **1** for indicates the position mode and the value **0** indicates the speed mode.

[F1.5] The feed spindle orientation is completed.

[F1.6] The feed spindle is at the zero speed.

[1.7] The spindle speed is reached.

[F1.13] Unlock the indexing axis. The value **1** indicates that the system notifies PLC to unlock the indexing axis.

[F1.14] The indexing axis is at the indexing position.

[F1.15] Lock the indexing axis. The value 1 indicates that the system notifies PLC to lock the indexing axis.

[F2.0] The value **1** indicates to capture one Z-pulse signal of returning to the reference point. Otherwise, the value is **0**.

[F2.3] Capture the second encoder Z pulse, mainly for the distance code scale returning to the reference point.

[F2.6] Capture Zero for the spindle. The value **1** indicates that the spindle rotates and captures the first Z pulse. For CS switching, set this option to **1**.

[F2.7] Servo parameter switching status. 0: The default parameter value. **1**: changed to the second set of servo parameters.

[F2.8] The value **1** indicates that the bus servo is ready. Otherwise, the value is **0**.

[F2.9] The value **1** indicates that the servo is in the position control mode. Otherwise, the value is **0**.

[F2.10] The value **1** indicates that the servo is in the position speed control mode. Otherwise, the value is **0**.

[F2.11] The value **1** indicates that the servo is in the torque control mode. Otherwise, the value is **0**.

[F2.14] The value **1** indicates that the spindle speed is reached. Otherwise, the value is **0**.

[F2.15] Spindle at zero speed: The value **1** indicates that the Spidle is stopped. Otherwise, the

value is **0**.

[F3.0] The value **1** indicates the servo is normal.

[F3.1] The value **1** indicates a servo alarm is reported.

[F3.2] The value **1** indicates that a servo message is displayed.

[3.8] Spindle orientation completed: The spindle starts orientation after the corresponding settings. The servo returns a signal after the spindle orientation is completed. In this case, the value is **1**. Otherwise, the value is **0**.

[F4] The number of the channel which the axis belongs to.

[F5] The number of slave axes.

[F [6/7]] The real-time output command increment, the motor coordinate.

[F [8/9]] Real-time output command position, the motor coordinates.

[F [12/13]] The output command pulse position (unit: pulse).

[F [16/17]] The output command pulse increment (unit: pulse).

[F [18/19]] The output command torque.

[F [20/21]] No. 1 encoder feedback actual position (unit: meter).

[F [24/25]] No. 2 encoder feedback actual position (unit: meter).

[F [28/29]] The machine command position (unit: meter).

[F [32/33]] The machine actual position (unit: meter).

[F [36/37]] Axis alarm.

[F36.2] Reach the positive limit stop.

[F36.3] Reach the negative limit stop.

[F36.4] The actual speed exceeds the speed limit.

[F36.6] Over speed.

[F36.7] Over acceleration speed.

[F36.8] Failed to find the Z pulse.

[F36.9] Disconnected.

[F36.10] Not return to the reference point.

[F36.11] The synchronous position exceeds the limit.

[F0.12] Failed to verify the slave axis zero point.

[F36.13] The synchronous speed exceeds the limit.

[F37.0] Exceeded the positive travel limit.

[F37.2] Exceeded the negative travel limit.

[F37.3] The acceleration speed does not match and the maximum speed.

[F [38/39]] Axis message.

[F38.0] Exceeded the maximum compensation rate.

[F38.1] Exceeded the maximum compensation value.

[F38.2] The offset parameter of the reference point is too small.

[F38.4] The soft limit value is too large.

[F38.5] The second soft limit value is too large.

[F38.6] The cycle digits of the absolute encoder are invalid.

[F38.7] Position overflow.

[F38.8] The target point is outside the positive limit.

[F38.9] The target point is outside the negative limit.

[F38.10] The Z pulse mask angle need to be modified.

[F38.11] The reference point position need to be modified.

[F38.12] The track error is too large.

[F [70]] Axis current mode.

Axis control word

[G0.0] Axis positive limit

[G0.1] Axis negative limit.

[G0.2] Disable axis positive movement.

[G0.3] Disable axis negative movement.

[G0.4] Start returning to the reference point.

[G0.5] Set Reference stop.

[G0.6] Set axis lock.

[G0.7] Enable the axis.

[G0.11] Release the Follow function of the slave axis.

[G0.15] Reset a single-axis.

[G1.0] Enable PMC axis absolute movement.

[G1.1] Enable PMC axis relative movement.

[G1.2] Enable the second soft limit.

[G1.3] Enable the extended soft limit.

[G1.5] Feed spindle orientation.

[G1.6] The feed spindle rotates clockwise.

[G1.7] The feed spindle rotates counter clockwise.

[G1.12] The response of PLC to switch the spindle to C/S.

[G1.14] The response of PLC to the signal of unlocking the indexing axis.

[G1.15] The response of PLC to the signal of locking the indexing axis.

[G2.0] Capture the zero pulse.

[G2.1] Wait for the zero pulse.

[G2.2] Disable the function of finding zero pulse.

[G2.3] Capture the zero pulse of the second encoder.

[F2.8] Switch servo parameters. 0: Default parameters. 1: Switch to the second set of parameters.

[G2.9] Change to the position control mode

[G2.10] Change to the speed control mode.

[G2.11] Change to the torque control mode.

[G2.12] Spindle orientation begins.

[G3.0] Enable Servo.

[G3.1] Reset the servo to clear the servo alarm.

[G4] Axis jog mark. This mark is valid during axis manual, returning to the reference point, and Spidle rotation.

[G5] Axis increment mark. This mark is valid during incremental movement.

[G [6/7]] Jog speed, 0: stop; 1: manual speed; 2: rapid traverse speed; >2: customized speed.

[G8] Incremental override

[G9] MPG override

[G [10/11]] MPG pulse count.

[F [12/13]] Axis feedback position (unit: pulse).

[G [16/17]] Axis feedback position 2 (unit: pulse).

[G [20/21]] Axis feedback increment (unit: pulse).

[G [22/23]] Axis feedback increment 2 (unit: pulse).

[G [24/25]] Axis feedback torque current.

[G [26/27]] Axis feedback track error (unit: pulse).

[G [28/29]] The counter value of encoder 1.

[G [32/33]] The counter value of encoder 2.

[G [36/37]] Real-time compensation value.

[G [38/39]] Sampling time stamp.

[G[48/49]] PMC axis absolute movement position.

[G [52/53]] PMC axis incremental movement amount.

[G [56/57]] Servo alarm number.

[G [58/59]] Servo message number.

[G60] Axis control mode switching.

[G61] PMC axis override value.

[G62.0] PMC axis stops.

[G62.1] The MPG breakpoint values are cleared.

Channel status word

[F2560.0 - F2560.3] Acquisition mode.

- 0: Reset mode
- 1: Auto mode
- 2: Manual mode
- 3: Incremental mode
- 4: MPG mode
- 5: Homing mode
- 6: PMC Mode
- 7: Single block mode
- 8: MDI mode

[F2560.4] Feed hold: The channel is in the feed hold status.

[F2560.5] Cycle start: The channel is in the cycle start status.

[F2560.7] The user movement is executed.

[F2560.9] Thread cutting: The channel is in the thread cutting status and the feed hold is not allowed.

[F2560.12] Reset channel: After pressing Reset Channel or the Reset button on the panel, the channel reset is valid until the channel reset answer is set.

[F2560.13] The channel is being reset.

[F2560.14] There is axis the channel returning to the Zero point and finding the Z pulse. Switching mode is not allowed.

[F2561.0] The program is selected and positioned by an interpreter.

[F2561.1] The program starts, and positioning is controlled by the channel.

[F2561.2] The program is completed, and positioning is controlled by the channel.

[F2561.3] Break-off instruction (e.g. G28/G31) is completed.

[F2561.4] The break off instruction is skipped.

[F2561.5] Wait for the instruction to be completed.

[F2561.6] The program re-runs the Reset command.

[F2561.7 Any Line request.

[F2561.8] The channel loads the breakpoint.

[F2562.8] Tool selection.

[F2562.9] Tool offset [T contains the offset number].

[F2562.10] PLC index command.

[F2562.11] Spindle constant linear velocity.

[F2569] Tool offset number.

[F [2570/2571] The first S instruction (unit: 0.001 rev/min).

[F[2572/2573] The second S instruction (unit: 0.001 rev/min)

[F[2574/2575] The third S instruction (unit: 0.001 rev/min)

[F[2576/2577] The fourth S instruction (unit: 0.001 rev/min)

[F2578] The G31 code that is currently waiting for signals.

[F [2581/2589]] The nine axis numbers in the channel.

[F [2590/2593]] The four spindle axis numbers in the channel.

[F [2594/2595]] The syntax error alarm number.

[F [2596/2599]] The channel alarm number.

[F [2600/2603]] The channel message number.

[F [2604/2607] User output.

[F [2608/2615]] M code (up to eight) running in the channel.

[F2616] T code running in the channel.

Channel control word

[G2560.4] Feed hold: Set the channel to Feed hold.

[G2560.5] Cycle start: Set the channel to Cycle start.

[G2560.6] Dry running: Set the channel to the Dry Running status.

[G2560.9] Reset answer: When the channel reset is completed, set the reset answer.

[G2560.11] Emergency stop: Set Emergency stop for the channel.

[G2560.12] Clear channel cache.

[G2560.13] Reset: Reset the channel.

[G2560.14] Restore channel data.

[G2560.15] Save channel data.

[G2561.0] Enable the interpreter.

[G2561.1] The program re-runs step 2.

[G2561.2] Over-block: Set the channel to the over-block status.

[G2561.3] Optional stop: Set the channel to the Optional stop status.

[G2561.4] Reset the interpreter.

[G2561.5] Re-run the program.

[F2561.6] The program runs from any line.

[G2561.7] Restore the interpreter data.

[G2561.8] Save the interpreter data.

[G2561.10] User motion control.

[G2561.11] Externally break off.

[G2561.12] Enable the MPG break off function.

[G2561.13] Program modification tag.

[G2562.10] Check spindle speed.

[G2562.11] Channel MST lock.

[G2562.12] No spindle in the channel. No need to check if the speed is reached.

[G2562.13] Spindle speed reached:

[G2620.0] Auto: Set the channel to the automatic mode.

[G2620.1] Single block: Set the channel to the single block mode.

[G2620.2] Manual: Set the channel to the manual mode.

[G2620.3] Increment: Set the channel to the incremental mode.

[G2620.4] Return to the reference point: Set the channel to the mode of returning to the zero point.

[G2620.5] MPG: Set the channel to the MPG mode.

[G2620.6] PMC: Set the channel to the PMC mode.

[G2620.7] Enable panel: Set the value to 1 if users need to use all registers marked with ◆.

[G2620.8-G2620.9] Incremental override: The incremental override uses two decimals.

- 00 represents x1
- 01 represents x10
- 10 represents x100
- 11 represents x1000

[G2620.10] Rapid traverse: Set the movement mode of all axes in the channel 0 to the rapid traverse mode.

[G2621.0-2621.7] MPG axis selection: Each axis has four decimal places. The four digits represents the current axis. For example, the 4 digits 0000 represents the axis X; 0001 represents the axis Y; 0010 represents the axis Z.

[G2621.8-G2621.11] MPG override: Each override has two decimal places. The two digits represents the current override. For example:

- 00 represents x1
- 01 represents x10
- 10 represents x100
- 11 represents x1000

[G2621.12] Enable MPG 1: The MPG 1 can be used only when the MPG 1 is enabled.

[G2622]-[G2623] Users only need to set the movement control register when the system requires manual, incremental, returning to the reference point, or spindle CW/CCW rotation operations. If users set the positive and negative movement simultaneously, the axis will not move.

If users set the positive or negative movement in the manual mode, the axis will move accordingly. The axis will move a specific distance if users set the valid period for axis positive/negative movement in the incremental mode. The axis will return to the reference point if users set the axis positive/negative movement in the reference mode (In the distance code reference mode, the axis positive/negative movement represents the direction for the feed axis to return to the reference point). If users set the positive or negative movement in the

speed control mode, the axis will move accordingly.

[G2626.0] Channel alarm. The value **1** indicates the channel alarm is enabled.

[G2626.1] Channel message. The value **1** indicates the channel message function is enabled.

[G2562.10] Spindle fluctuation detection. The value **1** indicates to start the spindle fluctuation detection.

[G2563] Tool number displayed in the channel.

[G2564] Feed rate in the channel.

[G2565] Rapid traverse override in the channel.

[G [2566/2569] Override of four spindles in the channel.

[G [2570/2571]] Spindle 1 output commands. The override and gear ratio have been calculated. The analog spindle here outputs the DA value.

[G [2572/2573]] Spindle 2 output commands.

[G [2574/2575]] Spindle 3 output commands.

[G [2576/2577]] Spindle 4 output commands.

[G2578.0] Workpiece coordinate system control.

[G2578.1] Imaginary axis coordinate system control.

[G2578.8] The tool coordinate system controls initialization.

[G2578.9] The tool coordinate system controls operation.

[G2578.0] workpiece coordinate system control.

[G2579] Workpiece count.

[G2580] Internal disable mask.

[G2581] External disable mask.

[G2582] G31 code number when the measurement is broken off.

[G [2608/2615]] Response to eight M codes in the channel.

[F2616] Response to the T code in the channel.

[G [2628/2629]] Spindle 1 output command rotation speed. Check the spindle fluctuation based on the difference between this command rotation speed and the actual rotation speed.

[G [2630/2631]] Spindle 2 output command rotation speed.

[G[2632/2633]] Spindle 3 output command rotation speed.

[G [2634/2635]] Spindle 4 output command rotation speed.

[F2961] Axis shielding status word:

[F2978] System activity channel number.

[G2961] Channel shielding request word.

[G2978] System activity channel request.

[G2960.0] First release emergency stop. Set it to **1** after the first release emergency stop.

[G2960.6] Program lock. Set it to **1** to edit the program.

Appendix C HNC-8 Commissioning Record

- **Equipment**

Machine type: ( ) Vertical machining center ( ) Horizontal machining center

( ) Milling machine ( ) Turning machine

( ) Slant bed turning machine ( ) Others

CNC system: ( ) 818A ( ) 818B ( ) 848C ( ) Special

- **Drivers and motors**

Servo drivers: ( ) FireWire ( ) Optical fiber

Gravity-axis motor: ( ) With brake ( ) Without brake

Spindle motor: ( ) Frequency conversion ( ) Asynchronous ( ) Synchronous

- **Auxiliary equipment**

Input: ( ) PNP ( ) NPN

Output: ( ) PNP ( ) NPN

UPS power supply: ( ) Yes ( ) No

Grating: ( ) Yes ( ) No

Tool magazine: ( ) Armless ( ) Manipulator ( ) Others

Turret type: ( ) Hydraulic turret ( ) Servo turret ( ) Electric holder

- **Machine**

Cabinet wiring: ( ) Clean and orderly ( ) Disorganized ( ) Potential problems

- **Material**

Electrical schematic: ( ) Yes ( ) No

Connection Description: ( ) Yes ( ) No

- **Axis X**

Driver model		Technical specifications for drivers	(unit: Ampere)
Motor manufacturers		Motor Specifications	(unit: N*m)
Motor Type	( ) Linear motor ( ) Torque motor ( ) Common motor		
Encoder Type	( ) Relative ( ) Absolute		

Parameter ID	Parameter Description	Parameter Value
100001	Axis type	
100004	Electronic gear ratio numerator	
100005	Electronic gear ration denominator	
100006	Positive soft limit coordinate	
100007	Negative soft limit coordinate	
100012	Encoder feedback offset	
100034	Maximum rapid traverse	
100035	Maximum processing speed	
100036	Rapid traverse acceleration/deceleration time constant	
100037	Machining acceleration and deceleration jerk time constant	
100038	Machining acceleration and deceleration time constant	

100039	Machining acceleration and deceleration jerk time constant	

- **Axis Z**

Driver model		Driver technical specifications	(unit: Ampere)
Motor manufacturers		Motor Specifications	(unit: N*m)
Motor Type	( ) Linear motor ( ) Torque motor ( ) Common motor		
Encoder Type	( ) Relative ( ) Absolute		

Parameter ID	**Parameter Description**	**Parameter Value**
101001	Axis type	
101004	Electronic gear ratio numerator	
101005	Electronic gear ration denominator	
101006	Positive soft limit coordinate	
101007	Negative soft limit coordinate	
101012	Encoder feedback offset	
101034	Maximum rapid traverse	
101035	Maximum processing speed	
101036	Rapid traverse acceleration/deceleration time constant	
101037	Machining acceleration and	

	deceleration jerk time constant	
101038	Machining acceleration and deceleration time constant	
101039	Machining acceleration and deceleration jerk time constant	

- **Spindle**

Driver model		Driver technical specifications	(unit: Ampere)
Motor manufacturers		Motor Specifications	(unit: N*m)
Motor Type	( ) Linear motor ( ) Torque motor ( ) Common motor		
Encoder Type	( ) Relative ( ) Absolute		

Parameter ID	**Parameter Description**	**Parameter Value**
102001	Axis type	
102004	Electronic gear ratio numerator	
102005	Electronic gear ration denominator	
102006	Positive soft limit coordinate	
102007	Negative soft limit coordinate	
102012	Encoder feedback offset	
102034	Maximum rapid traverse	
102035	Maximum processing speed	

102036	Rapid traverse acceleration/deceleration time constant	
102037	Machining acceleration and deceleration jerk time constant	
102038	Machining acceleration and deceleration time constant	
102039	Machining acceleration and deceleration jerk time constant	