

RichAuto—AutoNow F131 motion control system

User's manual

Applied in F131-3 axis linkages controller

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Thank you for choosing RichAuto products!

This manual helps you be familiar with the company's products, and get information about systems' components, configuration etc.

This manual contains detailed knowledge of the system characteristics, operating procedures, installation & commissioning, and safety precautions. Please read this manual carefully before using the system and machine, which will help you to use it better.

Cautions:

1. It's strictly prohibited in the strong interference and strong magnetic field environment. Operating ambient temperature: 0-70 °C; Environment humidity: 0-90% (non-condensing).
2. Insert U disk in the correct direction. Do not pull out or insert 50-pin signal transmission cable when system is powered on.
3. During the perform processing in U disk file, do not pull out the U disk to prevent the interruption of data transmission.
3. Strictly prohibited metal, dust, and other conductive substances drop into the handheld controller shell.
5. The machine casing shall be well grounded to ensure work safety and prevent interference.
6. Unauthorized removal is strictly prohibited, no internal user repairable parts.
7. For long time not using, please power off and keep it properly.
8. Be careful to prevent it from water, dust, fire when using.
9. Do not use the corrosive chemical solvents to clean the device.
10. Spindle motor bearing life and its speed is inversely proportional.
11. The tool bit is very sharp. Do not touch when it is running, in order to avoid injury; Do not use handkerchiefs, scarves to approach it to prevent embroiled damage.

Important statement:

The Company shall not be responsible for any loss caused by improper using or failure to comply with the rules of operation.

Beijing RichAuto S&T Co., Ltd owns final interpretation of this manual, we reserves the rights to revise all information in this manual, including data, technical details, etc.

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Foreword

System Introduction:

RichAuto-F131 motion control system for 3 axis linkage engraving machine is independently developed by Beijing RichAuto S&T Co., Ltd. It can be widely applied to machinery, advertisement, woodworking, mold engraving machines and soon in the industry machine control field.

RichAuto-F131 uses DSP as the core control system, High processing and operation speed which are the microcontroller, PLC systems can't match; Embedded structure, high degree of integration, strong stability, easy installation and operation; support U disk, removable storage card reader, and FTP transport protocol .Adapt USB Interface, high speed transfer, plug and play . Fully offline work.

Performance characteristics:

1. System standard configuration is X, Y, Z, three-axis motion control method.
2. Multiple I/O ports control. Standard equipped with I/O signal node which has 16 inputs and 8 output signals.
3. Support the standard G code, PLT format instructions; support domestic and international mainstream CAM software, such as: **Type3, Artcam, UG, Pro/E, MasterCAM, Cimatron, Ucamcam etc.**
4. Provide with power failed protection. System automatically save the current processing information in the moment of sudden power down (file name, current line number, work speed, spindle state);After powered up and returned HOME position, the system automatically prompts the user to restore the processing before power down which makes processing operations become more humanity.
5. Support breakpoint memory, select file line No. processing. Can save 8 different breakpoint processing information.
6. Multi-coordinate memory function. Provide 9 working coordinate system. The User can switch among the 9 coordinates, each coordinate system can save a process origin information.
7. Support adjusting spindle operating frequency (or spindle rotate speed). The spindle frequency is divided into 8 shifts. During processing, user can adjust shifts directly by keys without suspend processing.
8. Support adjust speed ratio during operation. To adjust the speed ratio so as to change the processing speed and travel speed, speed ratio values from 0.1-1. Increasing or decreasing 0.1 per time.
9. Simple manual operate mode. In manual mode, the system provides 3 kinds of move modes, including continuous, step (crawl), distance, become more simple and convenient.
10. Identifies M code, F code and other extended instructions, and it can also open a special code based on user's needs.
11. Built-in 512 M memory. Adapt USB communication port with high efficiency for file transfer. Can read files in U disk and card reader directly.
12. Unique handheld structure which can be hold with one hand. With LCD display and

- 24 keys operation keyboard, intuitive and flexible operation, no longer rely on the computer, completely offline operation.
13. Self-detection function. The system comes with I/O ports signal detection function, easy remote maintenance.
 14. Multiple languages display. Support English, Russian, France, Traditional Chinese and Simplified Chinese. Other language can be customized.
 15. System can automatically update itself, easily remote operation and maintenance.
 16. Supports FTP network file transfer function. If the U disk is damaged, files can be quickly transferred to the system through the network cable.

Product parameters:

Model No.	RichAuto-F131		
CPU	DSP	Power failure protection	Support
Built in memory	512MB	Breakpoint processing	8
Display screen	128*64 Monochrome LCD	External supply voltage	DC 24V
Communication port	U disk	Manual mode	Continuous, step, distance
Linkage axis	3 axis	Interpolate method	Straight line, arc, spline curve
Control signal	Differential signal	Soft / hard limit	Support
Driving system	Stepper / servo motor	Maximum pulse frequency	1MHz
Min. input unit	0.001mm	Password protection	Support
Languages	English, Simplified Chinese, Traditional Chinese, other languages can be customized		
Standard confi	Handle 1pc, data transmission cable 1 pc, I/O control board 1 pc		

Model List:

	No.	Name
AutoNow- 3 inches monochrome screen F1X series motion control system	F131	3 axis motion control system
	F135	Cylinder multi-spindle motion control system
	F141	4 axis motion control system

1 RichAuto-F131 system composition

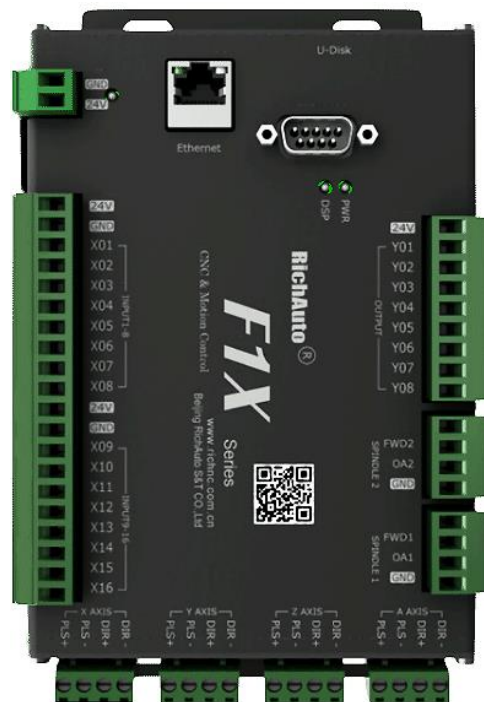
1.1 System composition

RichAuto-F131 motion control system contains the following parts: **Handheld controller** (Hereinafter called “handle”), **wiring board**, **data transmission cable**

RichAuto schematic diagram of system accessories



Handle



Wiring board



Data transmission cable



USB extension cable

1.2 Components description

1.2.1 Handle

As shown below, including 4 parts.

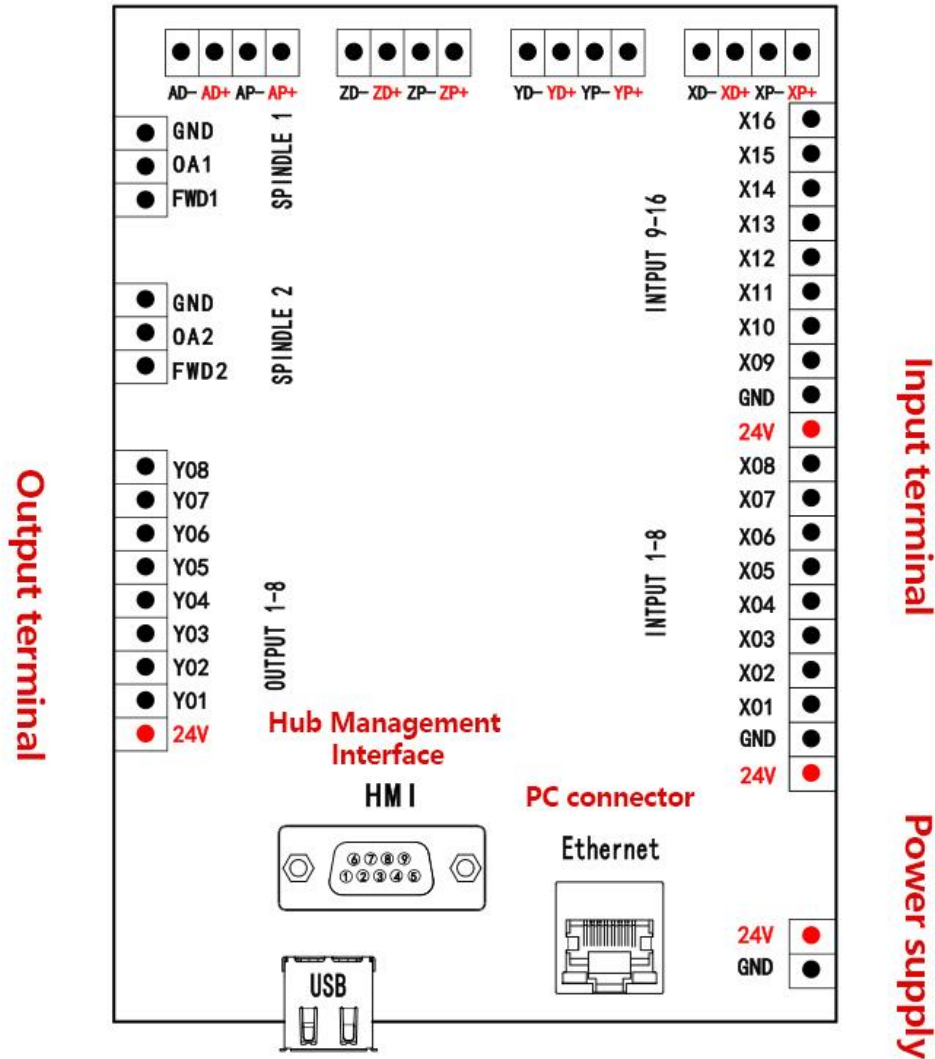


- 1) LCD screen: 128 * 64 resolution LCD screen, displays the machine motion, system settings and other information.
- 2) Key section: Contains 24 buttons for system parameter settings and machine movement control.
- 3) RichAuto LOGO
- 4) Data transmission cable: The handle communicates with the interface board through data transmission cable

1.2.2 Wiring board

The connection between handle and machine tool rely on the wiring board. As shown below:

Motor driver control output termianls



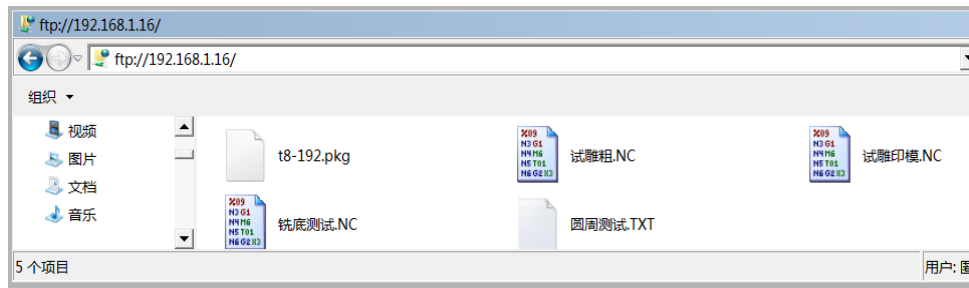
- 1) Data Transmission Cable: Signal given by the system is transmitted to the actuator through data transmission cable.
- 2) Output terminal: Including Spindle On/Off, Run lamp, Alarm lamp output signal ports etc.
- 3) Input terminal: Including HOME sensor, tool setter, driver alarm, hard limit, E-stop signal, foot pedal switch input signal ports.
- 4) Power supply terminal: DC 24V, 3A.

- 5) Motor driver control terminals: Motor drivers control signal output ports

1.2.3 FTP Access Internal Storage Space

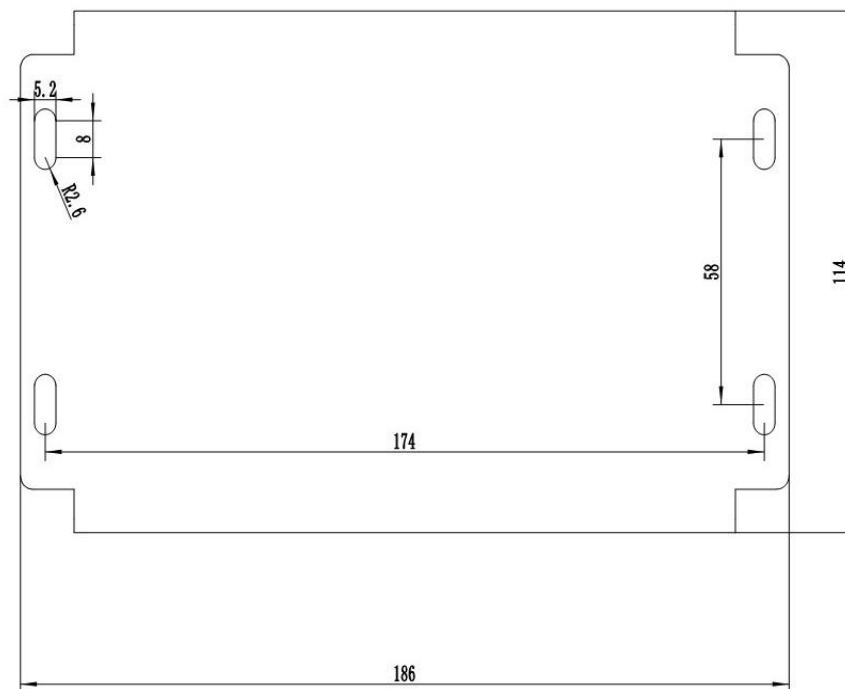
If the FTP server is setup on your PC, you can access the internal storage space of the system. To copy and paste the processing file through this method. The setting method is as shown below,

- 1) Enter the IP address (such as ftp://192.168.1.16) of the controller into the address bar of the Explorer, press Enter key;



- 2) User can upload, download, and rename the file after it entering into the controller inner space.

1.3 Wiring board installation dimensions



Scale 1:1 ,Unit mm

1.4 System startup methods


RichAuto-F131 3 axis motion control system has 2 starting methods:

- 1) **Normal starting:** Normal power on the system, after boot, it will enter into HOME TYPE interface and manual control interface.
- 2) **Emergency starting:** If normal starting cannot show any words or manual interface, emergency starting is required.



Power off the system first, then push “” and keep pressing, power on the controller

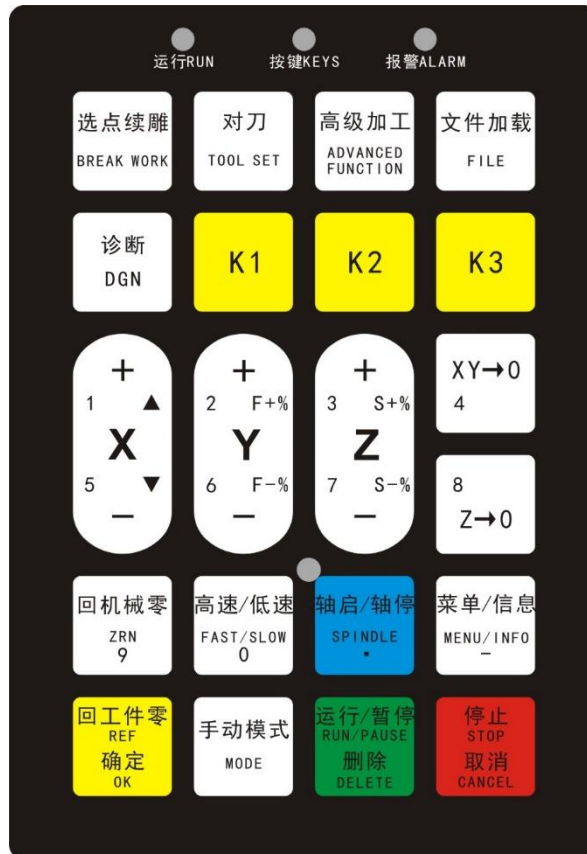


and waiting for 3-5 seconds. Release “”, it will get into “Emergency State”, at that time user could either set network-upgrade system or just normal restart the system without select any option.

2 Handheld controller buttons introduction

2.1 Buttons introduction

RichAuto-F131 handheld control system has defined 24 operation buttons, each one provides one or more functions in different working states:



Real photograph of pressing keys

2.2 Buttons Usage Methods

RichAuto-F131 provides 2 modes of button operations, including one-touch key & Combination keys.

- 1) **One-touch key:** Press 1 key on the handheld controller keypad is executing the single key operation.
- 2) **Combination keys:** Press 2 keys at the same time to achieve certain function is executing combination keys operation; The operation steps: press one **main function key** not release it, meanwhile press a second **auxiliary function key**, and then release the two buttons at the same time to realize the combination keys operation.


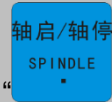
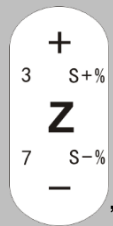

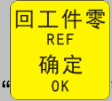



For instance, work coordinates switching combination keys are “” + “0-9 numeric



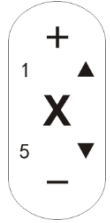
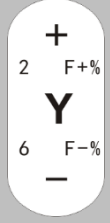
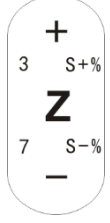
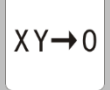
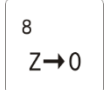





key". When operation, push the main function key "MENU/INFO" first, and then push auxiliary function key "0-9 numeric key" then, at last release both of them at the same time.










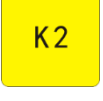

Common Used Combination Keys List

	Combination keys	Function
1	 "MENU/INFO" + "0-9" numeric key	Coordinate switching ("0" is mechanical coordinate, "1-9" is working coordinate).
2	 + 	Switching spindle shifts in manual mode
3	 + "0-9" numeric key	Breakpoint processing
4	 + 	Exit keyboard detection interface

Note: Users can also find the corresponding combination keys operation list at the back of the handle.

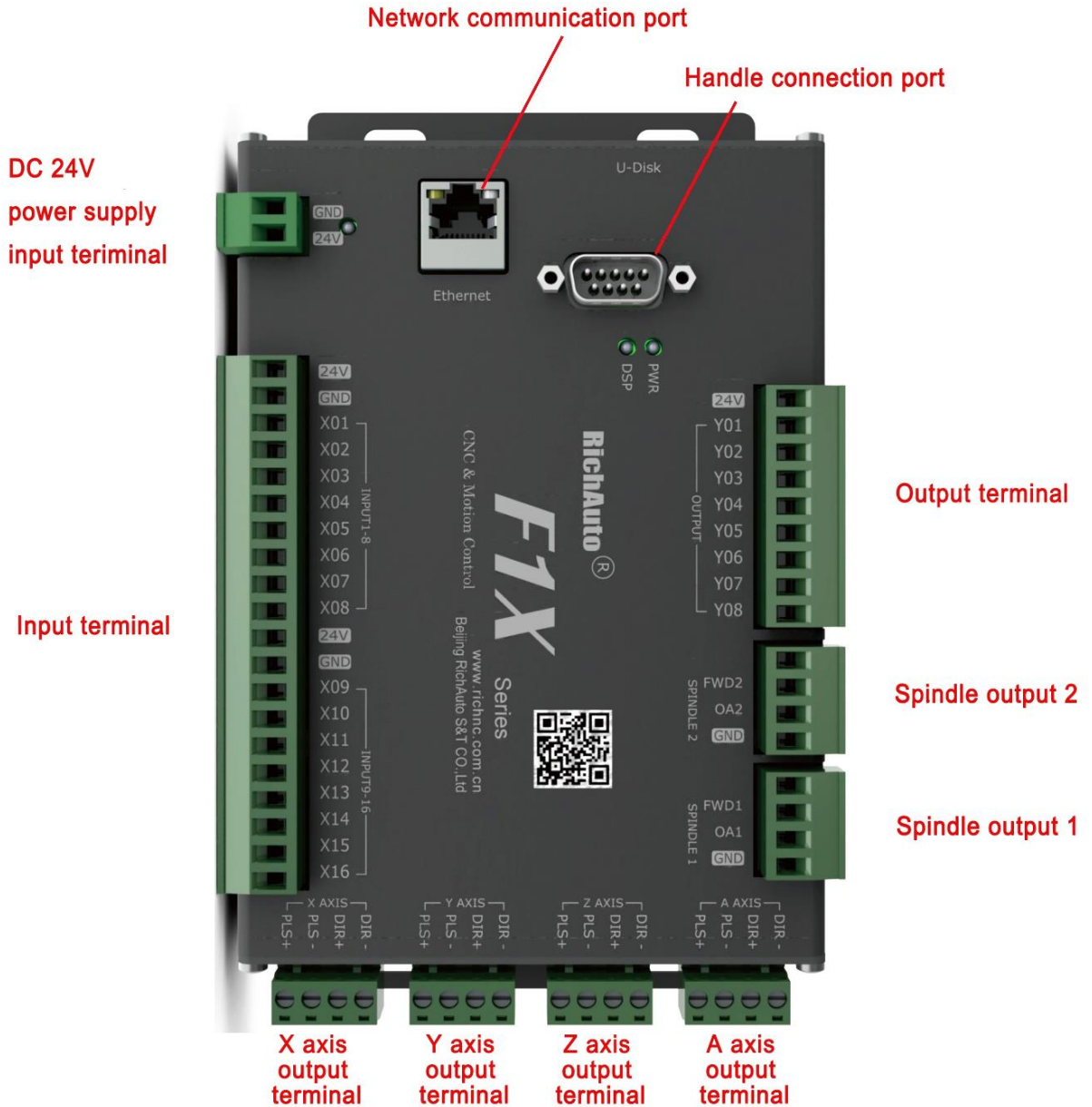
2.3 Buttons Function details

Name	Function
	X axis positive and negative movement, figure 1 and 5 input, Menu move up selection
	Y axis positive and negative movement, figure 2 and 6 input, work speed ratio increasing under AUTO mode
	Z axis positive and negative movement, figure 3 and 7 input, Spindle speed increasing under AUTO mode
	Figure 4 input. Set X axis and Y axis work origin
	Figure 8 input. Set Z axis work origin
	Start “resume work” combination function.
	Enable advanced processing function, such as array work, part work etc.
	Enable file loading function
	Checking input and output signals
	Enable tool setting function

	Figure 9 input, Return HOME operation in manual mode
	Parameters adjustment in MANU mode; Cancellation of various selections, inputs and operations in AUTO mode
	Figure 0 input, Manual speed High/Low switching, work/mechanical coordinates switching in AUTO mode
	Decimal point input, control spindle ON/OFF in MANU mode
	Enter into menu settings, minus input, view machining information during processing
	Return reference point(work origin); OK key of all selections, inputs and operation
	Manual motion states; Continuous, step, distance 3 modes switching in MANU mode
	RUN file or PAUSE the processing; DELETE the entered data; selections of different attributes in MENU
	System reserved function key
	System reserved function key
	System reserved function key

3 RichAuto Wiring board description

3.1 Wiring board terminal description



3.2 I/O description

Terminal	Name	Pin definition	Pin definition and parameters
DC24V	24V+	Input power supply+	Provide 24V operating voltage for the interface board after power up. Recommend to use DC 24V (current≥3A) current source
	24V-	Input power supply-	
X_AXIS	P+	X-axis pulse positive and differential signal	P + and P - are pulse differential pair signals. Using twisted pair can improve anti-jamming ability
	P-	X-axis pulse negative and differential Signal	
	D+	X-axis positive and differential signal	D + and D-are direction differential pair signals. Using twisted pair can improve anti-jamming ability
	D-	X-axis negative and differential Signal	
Y_AXIS	P+	Y-axis pulse positive and differential signal	P + and P - are pulse differential pair signals. Using twisted pair can improve anti-jamming ability
	P-	Y-axis pulse negative and differential Signal	
	D+	Y-axis positive and differential signal	D + and D-are direction differential pair signals. Using twisted pair can improve anti-jamming ability
	D-	Y-axis negative and differential Signal	
Z_AXIS	P+	Z-axis pulse positive and differential signal	P + and P - are pulse differential pair signals. Using twisted pair can improve anti-jamming ability
	P-	Z-axis pulse negative and differential Signal	
	D+	Z-axis positive and differential signal	D + and D-are direction differential pair signals. Using twisted pair can improve anti-jamming ability
	D-	Z-axis negative and	

		differential Signal	
C_AXIS	P+	C-axis pulse positive and differential signal	P + and P - are pulse differential pair signals. Using twisted pair can improve anti-jamming ability
	P-	C-axis pulse negative and differential Signal	
	D+	C-axis positive and differential signal	D + and D-are direction differential pair signals. Using twisted pair can improve anti-jamming ability
	D-	C-axis negative and differential signal	
Spindle1	FWD 1	Spindle forward signal	Support 0-10V analog quantity
	OA1	Analog output 1	
	GND	Ground signal	
Spindle2	FWD 2	Spindle forward signal	Support 0-10V analog quantity
	OA2	Analog output 2	
	GND	Ground signal	
OUTPUT SIGNAL	Y01	FDW/REV	No need to connect Y01 if the FWD and DCM is parallel connected
	Y02	Spindle speed 1	Logic low
	Y03	Spindle speed 2	Logic low
	Y03	Spindle speed 3	Logic low
	Y05	definable	Logic low
	Y06	definable	Logic low
	Y07	definable	Logic low
	Y08	definable	Logic low
	24V	Output DC 24V	Supply DC24V for indicators

INPUT SIGNAL	X01	X Machine zero	Logic low, support external connection with mechanical, photoelectrical or proximity switch
	X02	Y Machine zero	Logic low, support external connection with mechanical, photoelectrical or proximity switch
	X03	Z Machine zero	Logic low, support external connection with mechanical, photoelectrical or proximity switch
	X03	C Machine zero	Logic low, support external connection with mechanical, photoelectrical or proximity switch, X03 is the tool setting signal terminal when it is three-axis.
	X05	Toolset signal	Logic low, support tool setting and instrument.
	X06	Driver alarm	Logic low
	X07	Hard limit	Logic low
	X08	E-stop	Logic low
	X09	Definable	Logic low
	X10	Definable	Logic low
	X11	Definable	Logic low
	X12	Definable	Logic low
	X13	Definable	Logic low
	X13	Definable	Logic low
	X15	Definable	Logic low
	X16	Definable	Logic low
	COM	Common	Providing Grounding Signals for Active Sensors
	24V	Sensor power output	Providing 24V voltage for Active Sensors

3.3 Hardware wiring

Installation Requirements: Switching mode power supply (24V, 3A), it's better to add a filter to prevent the electric field interference. If origin detecting switch is different power supply type, the special detecting switch power supply is needed. (Recommend 24V origin detecting switch).

The control connection of **RichAuto-F131** is realized by connecting the wiring board with the CNC machine.

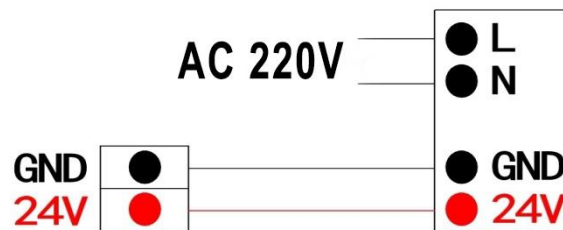
Input terminal: INPUT SIGNAL terminal; Main power supply terminal.

Output terminal: X, Y, Z, axis pulse signal output terminal; OUTPUT terminal.

Input terminals:

◆ Main power supply wiring

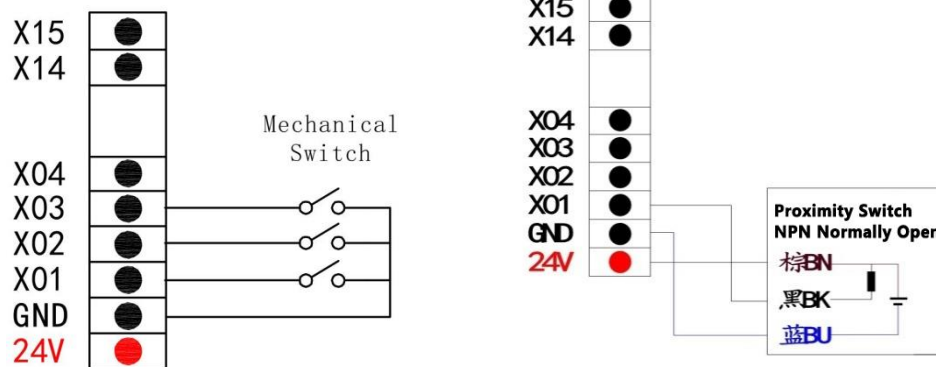
24V switching power supply



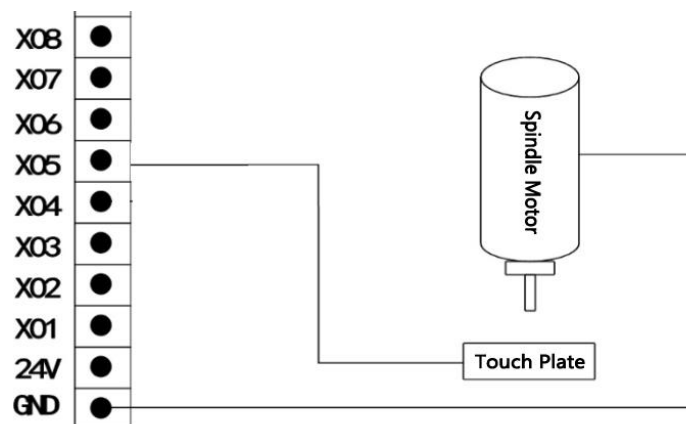
◆ INPUT SIGNAL WIRING

1) ZERO point(HOME): X, Y, Z axis wiring methods are the same

Mechanical Home switch wiring

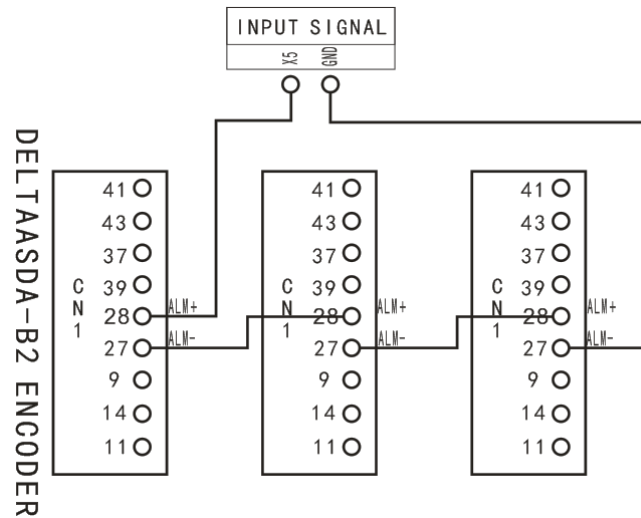


2) Tool setting: Simple constructed touch-off plate wiring

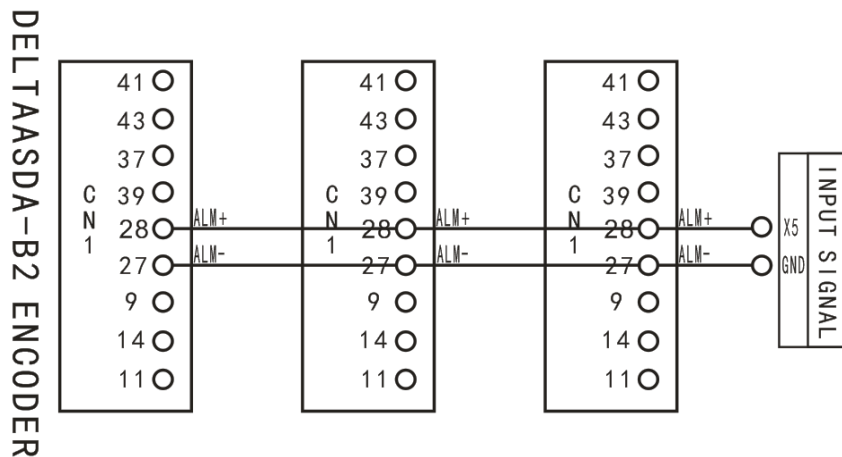


3) Alarm signal X5-X8: Default low level normally open. Take the driver alarm as example:

If the alarm signal is normally closed, wiring method is series connection. Meanwhile, revise the voltage level of X5.



If the alarm signal is normally open, the wiring method is parallel connection.

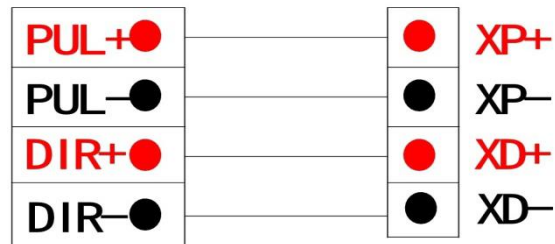


Output terminals:

- ◆ X axis pulse signal wiring (Y, and Z axis pulse signal wiring are the same)

Step drive:

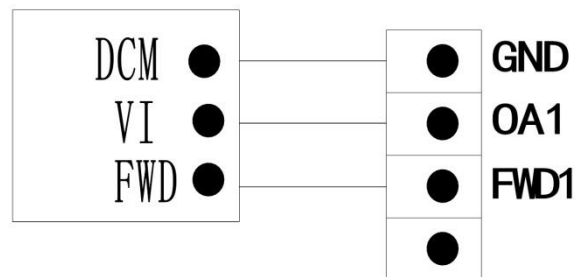
Stepper Driver Wiring Diagram



◆ OUTPUT SIGNAL: Spindle output

Analog output

Inverter




The machine tool and control system can be fully connected when the above connection are completed.

3.4 Commissioning of the machine and control system

- 1) Turn on the power, manually move each axis and confirm the motion direction. If the movement direction is opposite, user can change the motor phase sequence (A+,A- or B+,B-) or revise servo parameters (Refer to the servo driver user's manual).
- 2) According to the original location of the machine coordinates, user can enter into **Menu-Machine Setup-Home Setup- Home Dir** to reset it.



- 3) Press “”-Voltage Level (the top row stand for input voltage) to check whether the HOME switch is working normally or not (manually trigger the voltage level changes from L to H).

The machine is in good connection if all of the above work normal.

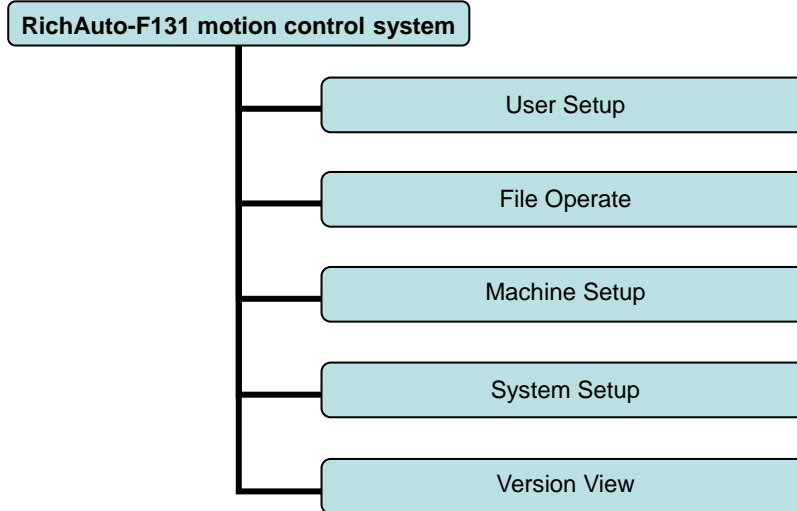
4 Menu Description

4.1 Menu category

RichAuto-F131 motion control system divides its menu according to menu function:

Five user interface, include: User Setup, File Operate, Machine Setup, System Setup, Version View.

- 1) User Setup: This menu is used to set processing parameters, G code attributes etc.
- 2) File Operate: Copy file from U disk to inner storage space and delete inner file.
- 3) Machine Setup: To set relative parameters about machine hardware.
- 4) System Setup: Change Chinese or English language, backup parameters and restore factory setting.
- 5) Version View: Users can view information about the system hardware and software etc.



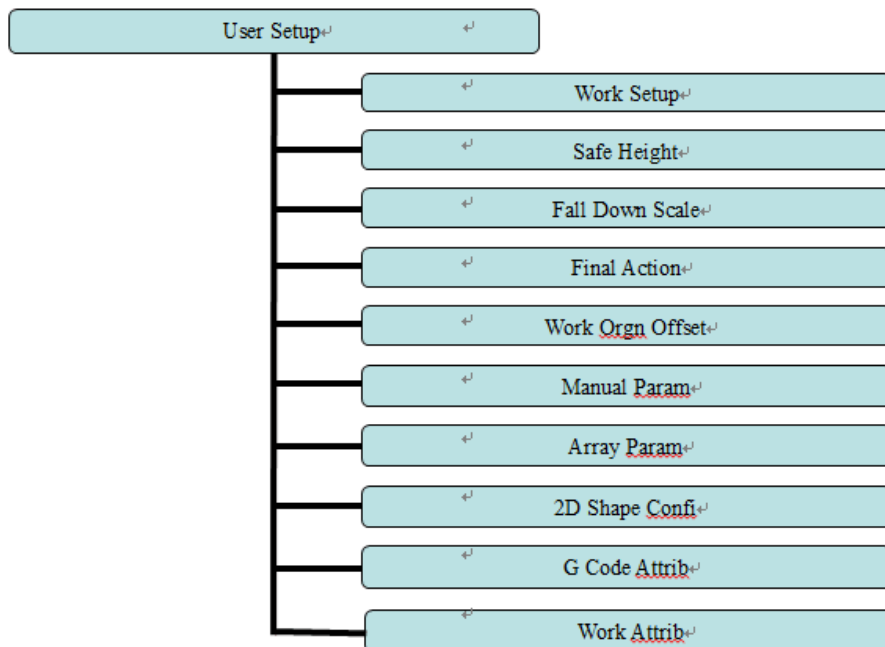
4.2 Menu details

4.2.1 User Setup

This menu is used to set processing parameters and G code reading attributes etc.

↵

Menu Structure of User Setup



↵

1) Work Setup:

WorkSpd: Processing program executes interpolation speed of instruction which includes G01, G02 and G03, system default is 3000 mm/minute.

FastSpd: Processing program execute movement speed of G00 instruction, system defaults 3000 mm/min.

SpdScale: Actual processing speed=Work Speed*Auto Scale. System defaults the auto scale doesn't affect the fast speed.

CycleCnt: System default is 1; user can modify it by themselves.

CycleIntvl: The repeat processing interval of the same work file. The system default is 0

2) Safety Height:

Z axis lifting height during processing. System defaults 40.000mm. If the other axis(X and Y axis) no need safe height, set 0.

3) Fall Down Scale:

FallType: ①Z only (It works when only the Z axis moves alone);

②Z move (It works as long as Z axis moves);

③Speed unlimited (It does not take effect when the tool is falling down).

FallHgt: System default is 5.000mm. Fall down scale takes effect when the Z spindle falls to the fall height.

FallSpd: The maximum speed of Z axis when falling down, Unit: mm/min

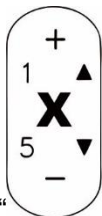
SafetyHgh: Z axis lifting height during processing. System default is 40.000mm.

FallLmt: ①All (The limit take effect as long as Z axis fall down during processing);

②First (The limit only take effect at first time falling down)

4) Final Action:

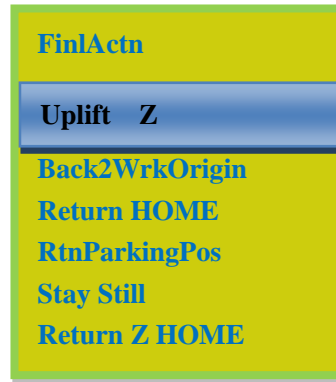
Stop position of axis: when the processing is finished. Including: pick up Z axis, back to work origin, back HOME, back position, none move. Set a special stop position:





Press " "move cursor to where user wants to modify, press "  " and input new

coordinate values one by one, then press "  "to save the changes. Press "  "to enter into system

Final Action list:



Press “” to move cursor to where user wants to modify, then press “” to save the change. Return to the upper menu.

5) Work Orgn Offset:

CurOriginOffset: External offset is also named as workpiece offset, it is used to record the temporary adjustment value of the current workpiece origin and only works in the current coordinate.

CmnOriginOffset: External offset is also named as Common origin offset, it is used to record the temporary adjustment values of all the workpiece origin and works in all of the workpiece coordinates.

6) Manual Param:

Manu Slow Spd: In low-speed motion mode, the speed value of the manual mobile machine's axis is executed.

Manu Fast Spd: In high-speed motion mode, the speed value of the manual mobile machine's axis is executed.

Grid & Dist: ①Manual distance (Set distance in manual), ②Low speed grid (Point distance of working in low-speed mode), ③High speed grid (Point distance of working in high speed).

Manu Type: ①Tradition (traditional Manual motion), ②Point movement (Manual motion of pointing).

7) Array Param:

XDirCnt: The array number along X axis

YDirCnt: The array number along Y axis.

Interval: System defaults 0, it means not wait.

X Space: The space along X axis (Unit: mm).


Y Space: The space along Y axis (Unit: mm).

Total Processing times= X count * Y count The default interval is 0 means not wait.

During processing, if user wants to change processing materials after completion of each processing, needs to set time interval as a negative number.

When the first time processing is completed, the screen prompt “Waiting for the next array processing...”, at this moment, user should press any key to start the next array processing, if user doesn’t press any key, the system will keep waiting.



Starting array work, press “”, the system prompts advanced processing list, then choose Array Work from the list.

8) 2D Shape Confi :

To set the parameters of two-dimensional graphics when processing DXF and PLT files.

Trvl Hgt: The travel height when run a 2D file, default 40mm.

Wrk Depth: The cutting depth of a 2D file which is calculated from the surface of the material, default 0mm.

Lift Spd: The tool lift speed when running a 2D file, default 3000mm/min.

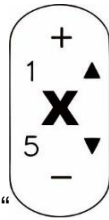
Fall Spd: The tool fall speed when running a 2D file, default 3000mm/min.


9) G Code Attrib:

Set special codes reading attribute in the G code file, to make changes according to the actual needs.

G Code Attrib	
I J K Mode	Reltv
F Code	Ignr F
S Code	Ignr S
T Code	Ignr T
Read G54	Ignr G54
Read G40	Ignr G40
Filter JD	Disabl
G83Space	0

PS: *Blue parts indicate system default attributes.*



Setting: Press “ ” move cursor to where needs to modify, press “  ” and

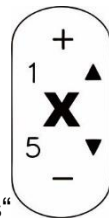



select, then press “ ” to save. Return to the upper menu.

10) Work Attrib

Set special settings which are required during processing, to make changes according to the actual needs.

Work Attrib	
QuryPara	Query
Preprco	Disabl
LiftFPus	None
StopFPus	None
PausAdju	All
FastScl	None
Copy&Wrk	Standa
StepAdjt	Contns
AutoLaser	Off



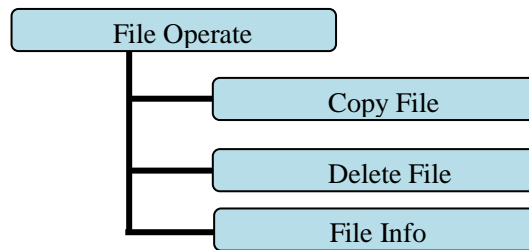
Setting: Press “ ” move cursor to where needs to modify, press “  ” and



select, then press “ ” to save. Return to the upper menu.

4.2.2 File Operate

Menu Structure of File Operate



Copy File:

Copy file from U disk to inner storage space.

Delete File:

Delete inner file that copy from U disk.

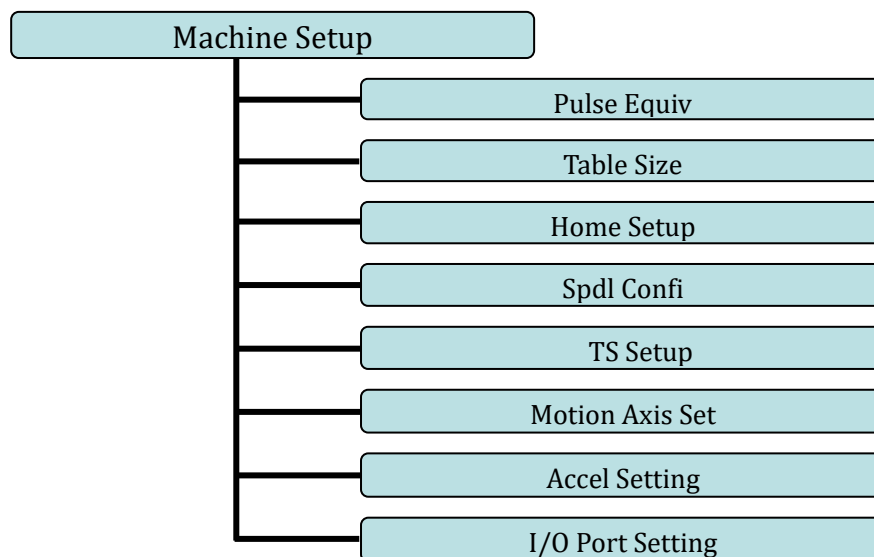
File Info:

It can calculate the total time of processing file and processing range.

4.2.3 Machine Setup

The manufacturer parameters which are under “Machine Setup” can be set by machine producers according to their equipment types. After setting, if the size and pulse equivalent of the machine tool remain unchanged, no modification is needed. Users are required to change the machine parameters under the technician’s guidance of the machine produce.

Menu Structure of Machine Setup



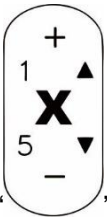

1) Pulse Equiv


Linear axis: The number of pulses required to send from the system when machine moves every 1mm. Unit: pulse / mm;


Rotating axis: The number of pulses required to send from the system when machine rotate every 1 degree. Unit: pulse / degree.

Calculation method please refer to PS1.1.2

Setting mode: Enter "**Pulse Equiv**", cursor is in the X axis pulse equivalent position,

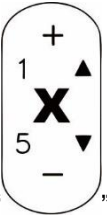

press "" to move cursor as required, press "" then, input a new value, and


press "" to save. To modify X, Y and Z axis value one by one in the same way,

press "" then save all changes and return to the "**Pulse Equiv**" menu.

2) Table size

RichAuto-F131 system makes the table size as the soft limit values, in order to prevent machine over travel. Machine size must be less than or equal to the actual size of machine table..

Setting: Enter "Table Size, press "" to move cursor as required, press ",

and input the new value, press "" to save the changes, To modify X, Y and Z axis

value one by one in the same way. Press "" Save all changes and go back to the "Table size" menu

3) Home Setup

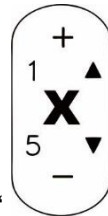
Home Speed: The movement speed of each axis when go mechanical origin (ZERO), the system default X, Y axis home speed: 3000 mm/minute, Z axis home speed: 1800

mm/minute.

Home Order: Motion sequence of each axis when executing return ZERO (return mechanical origin).

Including: Z-XY	Z-X-Y	Z-Y-X
XY only	Z only	None

Home Dir: Movement direction of each axis when return ZERO. The directions are depending on the real assembly position of HOME switches on the machine tool. If home switch is installed in the positive movement direction, then home direction should set as “**Pos**”, if it is installed in the negative movement direction, the home direction shall set as “**Neg**”



Setting mode: Enter “**Home Dir**”, press “ ”, move cursor as required,



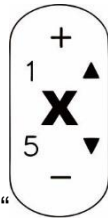
press “ ” to change home direction, then press “ ” to save the changes. Return to “**Home Dir**” menu.

Home Type: ①Query (System ask whether HOME or not after startup), ②All (All axis automatically go HOME position after system startup), ③Auto Z (Only Z axis go HOME position after startup the system), ④None (No axis go HOME after system startup).

4) Spdl Confi

Set all parameters of spindle, to modify as required

On Delay	4000
OffDelay	0
Spindle	On
Spdl Opt	Analog
Max Spd	24000
Min Spd	1000
SpdlFeed	500
SpdlLine	3



Setting method: Press “ ” to move cursor as required, press “ ” and select,



then press “ ” to finish modification. Return to upper menu.

5) TS Setup

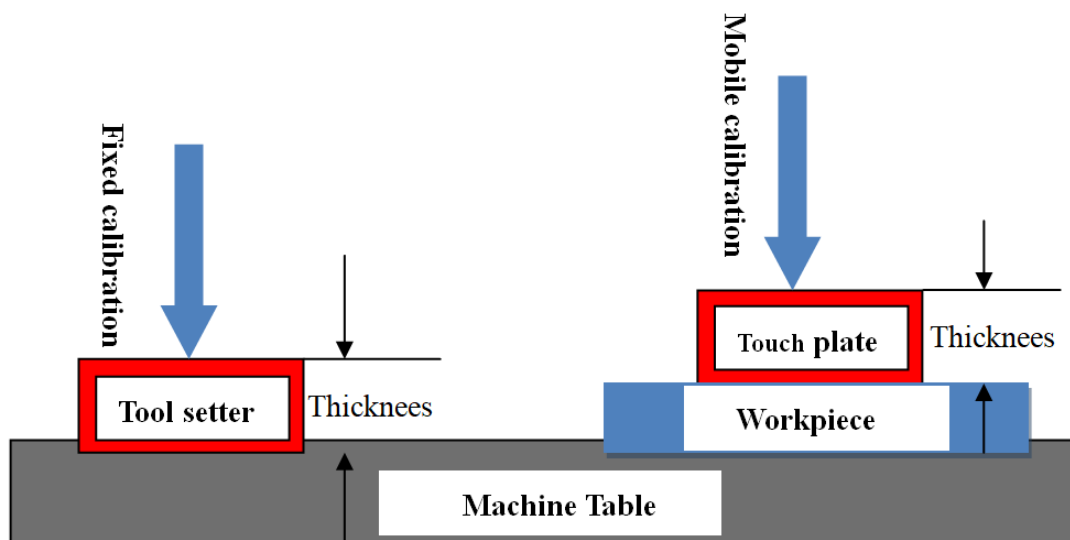
TS Param:

Set all parameters of tool setting, to modify as required.

TS Spd	4000
TS Thk	0
TS HIT	40
TS Type	Touch
TS Pos	InSite
TS Query	None

TS Position: ①Input Position (Mechanical coordinates of fixing tool setting, input the actual position).

②Manual Move (Manual selection when fixing tool setting).



Schematic diagram of tool setter & touch-off plate

C.A.D. Thickness (Unit: mm): The thickness should input actual value. If the input value is bigger than the actual thickness, Z axis may over cut; if smaller, Z axis tool bit can't reach workpiece surface. This parameter can only take effect when user uses auto

tool setting function.

Fall height after tool setting: After tool setting finished, the pickup height of Z axis, system default is 40.000 mm

6) Motion Axis Set

Motor Dir: Modify the direction of motor rotation.

Axis Disable: If the user's machine is a two-axis machine, the Z-axis can be forbidden here, then the screen will no longer display the Z-axis, and all Z-axis related parameters will no longer be meaningful.

Neg Spd Limit: Set the maximum speed in the negative direction of the machine tool, which limits all moving speed.

Pos Spd Limit: Set the maximum forward speed of the machine tool, which limits all moving speed

Circle Limit :

①Circle Limit (Maximum Processing Speed with Arc Instruction in Processing Program).

②Circle Diameter (diameter limited when arc instructions are available in the processing program)

7) Accel Setting

S acceleration: ①Linear (Linear acceleration mode); ②Curve (Curve acceleration mode).

Linear acceleration: System default: linear acceleration is 800 mm/s².

Curve acceleration: Curve acceleration is 1000mm/s², the proposed curve acceleration is 1-1.5 times of the linear acceleration value.

Jerk acceleration: It refers to growth rate of acceleration, that is acceleration's incensement per unit time, which can alleviate the adverse effects caused by sudden acceleration and deceleration of machine tools .

Start speed: Start speed of motion axis from stationary state. Not starting from 0, but starting directly from a certain speed, so it can shorten the overall processing time, but this speed shouldn't be too high. Too high, it will cause the motor losing steps, jitter and even whistle; Set too small, it will reduce the operating speed of the entire graph. If the inertia of the moving axis is large (heavy spindle), to set too small start speed will affect the motion speed of the whole graph. If the inertia of the moving axis is small (light spindle), the start

speed can be increased appropriately.

8) I/O Port Setting

Input Disable: Enable or disable the input port. User can disable X5-X8 if there is no signal on these ports. Prevent misoperation such as wiring error.

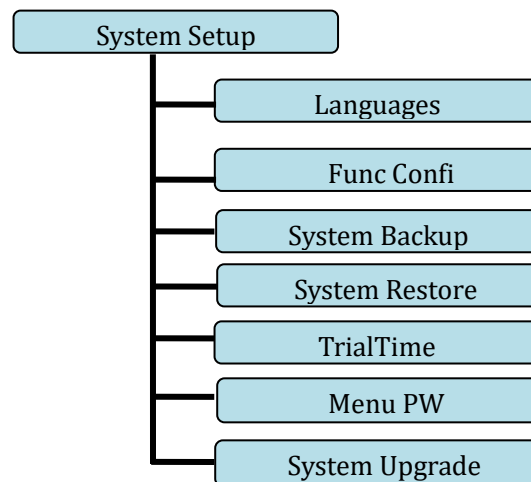
Input List: the functions list of the input ports, where users can view all the functions of the input ports.

Output Disable: To open or prohibit the output signal, if some ports of the interface board are not connected with any signal, you can choose to prohibit the signals of these corresponding ports to prevent misoperation such as wiring errors.

Output List: The functions list of the output ports, where users can view all the functions of the output ports.

4.2.4 System Setup

Menu structure of System Setup



1) Languages

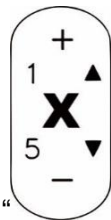
Change system display language, Chinese or English language.

2) Func Confi

Set whether the system retains a function or not, change it in accordance with the practical application. After the operation user has to restart the handheld controller.

Func Confi	
OrgQuery	Query
ClearSet	SameT
ClearPrt	Disabl
StopAct	None
OrgnAct	None
Brk Type	CrtLineStrt
SpdCtrl	DfltSpdCtrl

Blue parts indicate system default function



Setting: Press “ ” to move the cursor, Press “ ” and select the function in



needs, then press “ ” to save the change. Return to the upper menu.

3) System Backup

Backup the system parameters and function configuration and to save into U disk or inner storage. The backup file format is data.bak and config.bak.

Param Backup: To backup all of the parameters of the machine tool, default format is data.bak.

Func Backup: To backup the function configuration of the machine tool, default format is config.bak.

4) System Restore

Data Format: After data initial system parameters will restore to factory setting (Machine size, pulse equivalent etc.)

Internal Format: Wipe the internal files, it will not remove the system parameters after inner format.

Cache Initialize: The system needs wipe cache when it has been using for a long time or after the system upgrading, it will ask to reboot after “Wipe Cache” operation.

Func Restore: Restore the backup system parameters by choosing the “**config.bak**” file from the U disk or internal storage area.

Param Restore: Restore the backup system parameters by choosing the “**data.bak**” file from the U disk or internal storage area.

5) Trial Time


To be used to set the trail time of the controller, counting by day from the date of setting. User should send the origin 20 digits to us, then get new 20 digits from us and enter them into the controller, after that, the trail time will take effect.

6) Menu PW

Encrypt the system menu. User should contact the factory to reset it if wants to change the settings in MENU.

7) System Upgrade

If we added new functions, we will offer upgrade file which extension name is *******.PKG** format (File name is **rz-xxxx** or **q13-xxxx**). User could update the system through U disk..

Upgrade package format sample:  P1_1025(普通四轴雕刻[3寸单色屏][USB1]).pkg

4.2.5 Version View

Users can view information about the system hardware and software, including:

Version View	
Type:	F131
Update:	1.4975
HW No. :	F0039002
Axis:	3 Axis
192 .168 .1 .16	

- ✧ Type: for example 3 axis linkages system-F131, cylinder multi-spindle motion control system-F135.
- ✧ Update: means update package number, such as 1.4975
- ✧ HW No.: refers to hardware version number, such as F0020099
- ✧ Axis: 3 Axis stands for 3 axis carving
- ✧ 192.168.1.16 indicates the IP address of the current handle

5 Machine Operation

5.1 Return HOME

It will display “**all axis home**”, “**Z home only**”, “**none axis home**” after starting up the DSP handle. Returning Machine HOME can correct the coordinate system.

In some cases, such as after a normal power off, and then reboot to continue last operation, it is no need to go machine HOME, just choose “**none axis home**” to skip HOME operation. Because system automatically saves coordinate value when it exits normally.

5.2 Import processing file

Before processing, generally we should import files. **RichAuto-F131** system has 2 ways to import files: U disk file processing and inner file processing.

- 1) Directly import the processing file into U disk, and then run with the U disk inserting in the controller.
- 2) Copy the files to handle internal storage area via U disk, and then run the inner file without U disk.

5.3 Manual Processing Operation

Manual Processing Operation refers to move the machine tool by pressing the keypad. User can change the running speed and set the grid (step distance) in manual mode. System will enter Manual Operation state after returned home, and the screen displays,


Manual control interface:


Coordinate Number	1X	0.000	Idle	Operation Status Spindle Status Speed Mode Manual Motion Mode
	1Y	0.000	Idle	
	1Z	0.000	Idle	
Processing program	HORSE2.MMG	Cnti		

5.3.1 Manual speed switching and adjustment


1) Speed mode switching

There are 2 speed modes: Fast speed and Slow speed. We can switch speed mode by

pressing “” key. The speed mode status show on screen determines the actual


manual moving speed. If the current state is high-speed, press “”, the screen display will be changed from high-speed to low-speed. If the current state is low-speed,



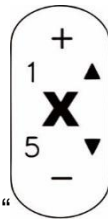
press “”, the screen display will be changed from low-speed to high-speed. The speed state on the screen determines the manual speed.

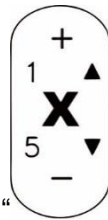
2) Speed adjusting



In manual mode, press “” enter into the current speed mode settings. For instance, suppose the current speed mode is SLOW, the screen displays:

Manu Low	
Set Dist	100.000
X Speed	1200.000
Y Speed	1200.000
Z Speed	1200.000
SlowGrid	0.100




The cursor is on “X speed”, Press “” to the one needs to be modified, and press



“” then input new value, and next press “” to confirm; Press “” to



exit the settings. If the input value is wrong, press “” to delete the last number and then input new numbers.


To ensure the accuracy of processing and debugging, the system introduces the concept of ‘grid’ which also called ‘minimum feed’. Precision can reach to 0.001mm. When user switch to “STEP” mode, and press the direction keys of X, Y, Z axis, machine will move by grid distance.

“Fast speed” mode setting is the same to “Slow speed” mode.

5.3.2 Manual processing mode

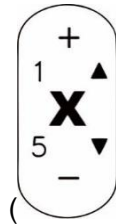
The system provides 3 manual movement modes: Continue, step, distance. User



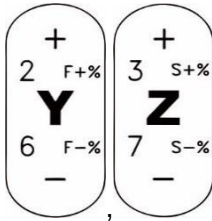
could press “” under manual mode to switch manual movement mode and view

the current movement mode through the screen bottom display status.

1) Continue (Continuous motion mode)



No specific data control, user could press motion direction key of each axis (

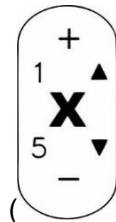


) the machine will move accordingly until the key is released. The motion speed is determined by current manual speed mode.

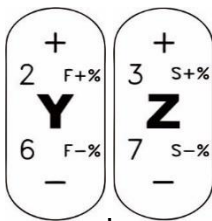
2) Step motion mode

In step mode, move 1 grid every half second. The grid distance is determined by the current speed mode. It is suitable for precise adjusting the cutter or fine adjusting the location of the mechanical coordinate.

3) Distance motion mode



It runs a certain distance according to the setting. Press motion direction keys (



), the machine will move accordingly.

Note: The movement will be carried out according to the current speed mode and the set distance, it is not affect by the 'grid', so it will not stop on grid point. To change



the distance value, triple press “

5.3.3 Manual testing input and output



Under the initial boot interface, pressing “

I/O Detection
IptCheck
OptCheck
Volt Lvl
KeyCheck

1) IptCheck(Manual test input ports)

1	2	3	4	5	6	7	8
L	L	L	L	L	L	L	L
1	2	3	4	5	6	7	8
L	L	L	L	L	L	L	L

From left to right are respectively represent: X HOME, Y HOME, Z HOME, tool setting, servo driver alarm, hard limit, emergency stop and foot switch. The port definitions will be a little different in individual custom system.

Manual trigger the corresponding signal, the corresponding signal **changed from L to H means the signal is in normal status**. If not, it is abnormal. User should check the corresponding switch, wiring and 50 pins cable. The screen will displays as follow.

1	2	3	4	5	6	7	8
H	H	H	L	L	L	L	L
1	2	3	4	5	6	7	8
L	L	L	L	L	L	L	L

To trigger X1 (X axis HOME switch), the corresponding letter changed, means X1 signal is normal, X2 to X8 detecting are in the same way.

Note: Do not confuse with “Voltage setup”.




2) OptCheck (Manual test input port)

1	2	3	4	5	6	7	8
L	L	L	L	L	L	L	L
1	2	3	4	5	6	7	8
L	L	L	L	L	L	L	L

In the bottom row, the former 4 numbers **0,1,2,3** corresponding to Spindle ON/OFF, Multi-speed 1, Multi-speed 2, Multi-speed 3.

The number 4 and 5 are respective to alarm lamp, run lamp. The port definitions will be

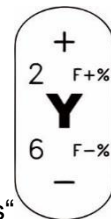
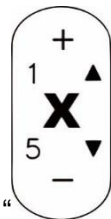
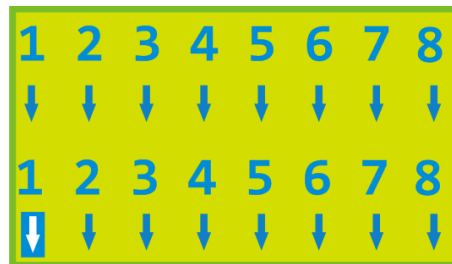
a little different in individual custom system.

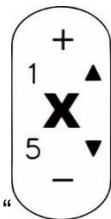
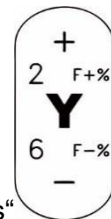

Manually control the corresponding output port by pressing “” to change the corresponding letter to H. For example, press “” to highlight number 0 position to start the spindle, then press “” to change the corresponding letter to L, it means to stop the spindle.

3) Volt Lvl (Voltage Setup)



Used to set the input, output signal port normally open or normally closed port state, system defines “↓” as normal open; “↑” as normal closed.

Including 2 rows of arrows:



Setting: Press “” move to left or right in the row. Press “” can jump up and down. Move the cursor to arrow which needs flip, and press “” to flip the arrow. Return to the upper menu.

4) Key Check

Detect the keys are valid or not. Press every button, the screen will highlight it if the key is valid, if not valid will not highlight. Use combination keys “” + “” to exit.




5.3.4 Manual switching coordinate system

Including **machine coordinate system** and **work coordinate system**.

Machine coordinate system is a fixed position, the origin point of machine coordinate is always a fixed position relative to the machine; its coordinate value is called mechanical values, the origin of coordinate is the origin of the machine or called reference point. So, at any time, a point in space can be uniquely determined by a mechanical coordinate system. Because of reference point is the calculation basis of machine coordinates movement, all of those operations such as power on the machine or abnormal release and so on have to return to the reference point which is refers to return machine ZERO.

Work coordinate system used more greatly than other coordinates system in processing. Usually, in processing, we describe a processing position is always relative to a certain point on the workpiece, whereas the workpiece on the machine tool's position relative to the mechanical origin is often change, so it is necessary to introduce a set of more convenient coordinate system during processing, that is work coordinate system. The origin of work coordinate system is a fixed point relative to the workpiece, but it is floating relative to the machine coordinate origin.

RichAuto-F131 provides 1 machine coordinate system and 9 work coordinate

systems. Press “” + “” can switch the machine coordinate system and work coordinate system; press “” + “Number button 1-9” can switch among different work coordinate systems.

Schematic diagram of coordinate system

<table border="1"> <tr><td>AX</td><td>0.000</td><td>MAUN</td></tr> <tr><td>AY</td><td>0.000</td><td>S 2</td></tr> <tr><td>AZ</td><td>0.000</td><td>L SP</td></tr> <tr><td colspan="3">Continous</td></tr> </table> <p>Machine coordinate system</p>	AX	0.000	MAUN	AY	0.000	S 2	AZ	0.000	L SP	Continous			<table border="1"> <tr><td>1X</td><td>0.000</td><td>MAUN</td></tr> <tr><td>1Y</td><td>0.000</td><td>S 2</td></tr> <tr><td>1Z</td><td>0.000</td><td>L SP</td></tr> <tr><td colspan="3">Continous</td></tr> </table> <p>Work coordinate system1</p>	1X	0.000	MAUN	1Y	0.000	S 2	1Z	0.000	L SP	Continous		
AX	0.000	MAUN																							
AY	0.000	S 2																							
AZ	0.000	L SP																							
Continous																									
1X	0.000	MAUN																							
1Y	0.000	S 2																							
1Z	0.000	L SP																							
Continous																									
<table border="1"> <tr><td>2X</td><td>0.000</td><td>MAUN</td></tr> <tr><td>2Y</td><td>0.000</td><td>S 2</td></tr> <tr><td>2Z</td><td>0.000</td><td>L SP</td></tr> <tr><td colspan="3">Continous</td></tr> </table> <p>Work coordinate system2</p>	2X	0.000	MAUN	2Y	0.000	S 2	2Z	0.000	L SP	Continous			<p>...</p> <table border="1"> <tr><td>8X</td><td>0.000</td><td>MAUN</td></tr> <tr><td>8Y</td><td>0.000</td><td>S 2</td></tr> <tr><td>8Z</td><td>0.000</td><td>L SP</td></tr> <tr><td colspan="3">Continous</td></tr> </table> <p>Work coordinate system8</p>	8X	0.000	MAUN	8Y	0.000	S 2	8Z	0.000	L SP	Continous		
2X	0.000	MAUN																							
2Y	0.000	S 2																							
2Z	0.000	L SP																							
Continous																									
8X	0.000	MAUN																							
8Y	0.000	S 2																							
8Z	0.000	L SP																							
Continous																									

Note: The system cannot set workpiece origin under machine coordinate system. User should switch to work coordinate first, and then set workpiece origin.

5.4 Auto processing operation

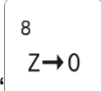
Auto processing refers to the system runs according to the instruction of the file in U disk or inner storage space, it also called “file processing”. Before auto processing, user must set the machine tool parameters and all of the system parameters correctly. Auto processing steps could refer to the following text.


5.4.1 Set workpiece origin

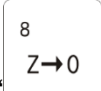
The origin coordinates of X, Y and Z axis in the processing program is workpiece origin. Before processing, we should pay attention to this position as well as the real position. Operation is as follow:

Move X, Y and Z to the position which will start to process the file on workpiece.


Afterwards, press zero clearing “” zero clearing can set the workpiece origin of X,

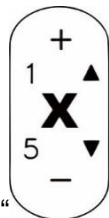
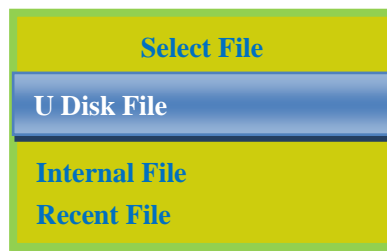
Y axis. Press zero clearing “” can set the origin of Z axis. It should be noted that if


user have already used the automatically tool setting function which single key is “”

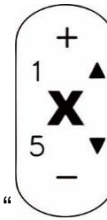
will no need to press “”.

5.4.2 Choose processing file

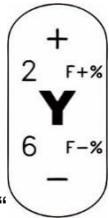
After determined the workpiece origin, press “” will appears a dialog:



Press “” to enter into the list, the



screen will display three file name, choose the file by pressing “ ”. Press



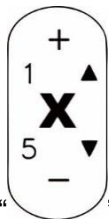
“ ”to open the next page. Press “ ” to exit.

5.4.3 Set processing parameters



After choosing the processing file please press “ ”,enter into processing parameters setting, it includes work speed, travel speed (or Fast speed) ,speed scale(speed ratio),fall down speed(or Z down ratio)

Set Work Param	
WorkSpd	1100.000
FastSpd	1200.000
SpdScale	0.8
FallSpd	600.000



Press “ ” to move cursor to select different settings., press “ ” to set the



value (next value setting is in the same way), then press “ ” to save, the system will check the processing codes and start to run when the reviewing is completed.




The system code checking is auto mode, user can press “ ” to skip the checking and start to run immediately.

System will remember the checking only when the previous checking is a complete and correct checking. So that the system won't check the same code again next time.

During processing, the screen scrolling display real-time processing speed, operation

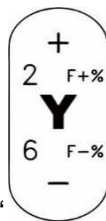
time and current line number. Press "  " to display all processing information.

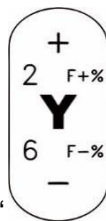
Press "  " again to return to the coordinate display interface.

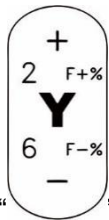
5.5 Operations during processing

5.5.1 Speed ratio & spindle grade Adjusting

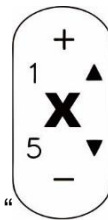
1) Adjust speed ratio



During processing, press "  " can directly change speed ratio, each push on



"  ", the speed ratio will increase or decrease 0.1, each push on "  " the speed

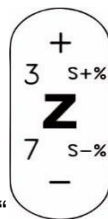


ratio will increase or decrease 0.01 Speed ratio: max 1.0, min 0.01; the displayed speed will change because of the speed ratio, but not affect the display of work time .

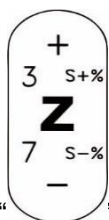
current speed= work speed * ratio

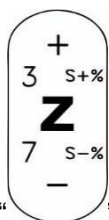
2) Adjust spindle shift

If user has set multi-step speed, the DSP handle can change the multi-step speed



during AUTO processing. Press "  " to change spindle speed. Each push on



"  " will go up or drop 1 shift in the range of S1 to S8.

5.5.2 Pause & adjust position



Press “DELETE” pause processing. The right upwards of screen will change from “MAUN” to “PAUZ” and machine paused processing except the rotating of spindle. Shown below,

1X	7.000	PAUS
1Y	8.000	S2
1Z	-2.000	H SP
User will start		

At this moment, the user is allowed to adjust the position of X, Y, Z axis. The system default motion mode is STEP. So that user can fine adjust each axis distance. Machine moves one low or high speed grid distance in every step.



When the adjustment is finished, press “DELETE” again, screen shows below,

1X	7.000	PAUS
1Y	8.000	S2
1Z	-2.000	H SP
Restore Position?		



The system asks the user whether save the modified position. Press “OK”/



“DELETE” the system will start processing in modified position, press “CANCEL”, system will go back to the previous position where before modifying.

5.6 Find Breakpoint Processing & Power Failure Protection

Find Breakpoint processing is a function developed to meet the special requirements of customers in operation. Find Breakpoint processing mainly includes: Find Breakpoint,


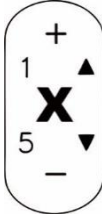



Break List, Part Work, PwrFlrProtect. Press “BREAK WORK” to start advanced processing, screen shown as below:

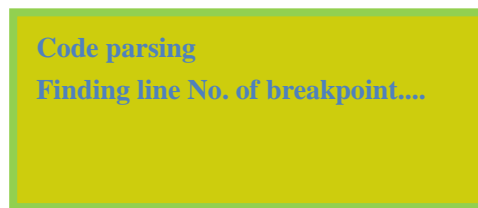


5.6.1 Find Breakpoint

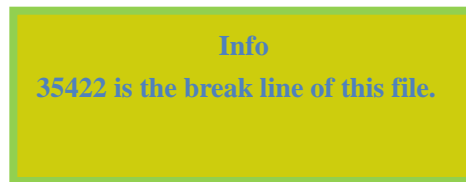
If the tool broken unexpected in the process and no breakpoint is saved, stop processing and replace with a new tool. If the original workpiece was not destroyed, manually move X and Y to the position in front of the breaking place,

press “” to start advanced processing, then press “” to move cursor to Find Breakpoint,

Press “” to booting and pre-reading the code, the system will prompt as below:



Press “” to start processing, press “” the screen displays the current position line number.

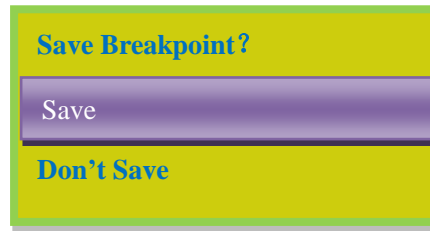


Note: Using this function user has to ensure the work coordinate the same as it was before.

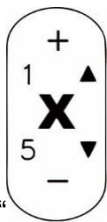
5.6.2 Break List



If user presses “**停止 STOP 取消 CANCEL**” during process of processing, the screen shows below:



If we want to save breakpoint, press “**回工件零 REF 确定 OK**”, the screen displays break list (totally 8),

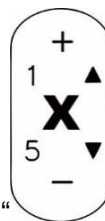


press “**回工件零 REF 确定 OK**” to choose the save position and then press “**回工件零 REF 确定 OK**” to save, system auto REF. If we want to continue processing from the breakpoint, we can choose the



combination button “**运行/暂停 RUN/PAUSE 删除 DELETED**” + “1-8”. First press “**运行/暂停 RUN/PAUSE 删除 DELETED**” and not release it, at the same time press number button (1-8), then release together, the system will start processing from the breakpoint.

For example: You want to start processing from the breakpoint 1, then you should

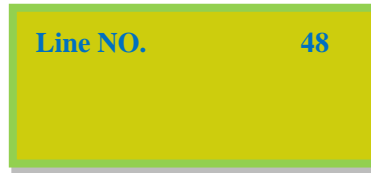


use the combination button “**运行/暂停 RUN/PAUSE 删除 DELETED**” + “**1**”, system will restore processing from breakpoint 1. Take the “1nTest.cnc” as example, it has 6705 lines of G code, The screen shows below,






Press “” for reviewing, afterwards it shows the break line number:




Press “” prompts the processing information list, user can modify according



to real needs, then press “”, the system will restore running at that point. If user




needs to go backwards from the breakpoint, press “”, the screen shows as below:



← **The total line number of file code**

Enter the new line number that needs to be getting back towards.




Input the line number which need to be go back to, and then press “”, the screen shows as below



Press “” prompts the processing information list, user can modify according



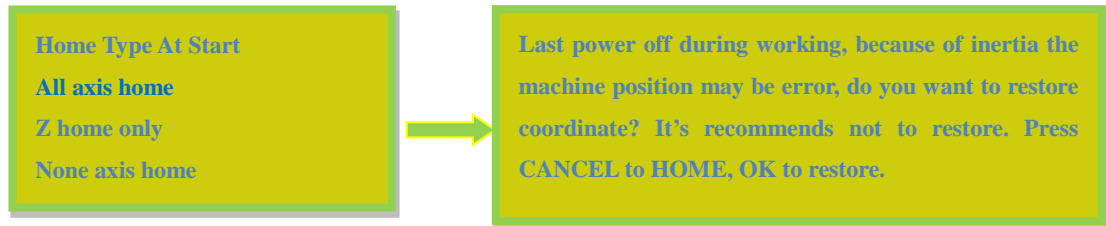
to real needs, then press “”, the system will start to process from the new line. The machine must go HOME before saving a break point or processing.

5.6.3 Part Work

Line Selection Processing is that the user can choose the G code line number to start and end processing, so that it can react subsection processing.

5.6.4 PwrFlrProtect

When there is a sudden power shut down during processing, system will save current coordinate and parameters, while power restart, process continue. Before that, system must have go back to machine **HOME**. Shown as below



Press "REF" to continue unfinished processing, it will display stop line No, and the



line number can be chosen. Press "CANCEL" cancel the power failure protection. **If user wants to go backwards from the power failure position, the operation method is the same way to "Breakpoint processing".**

5.7 Advanced Work

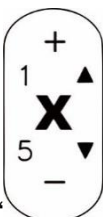

Advanced processing is designed for some special requests in operation, it contains: Array Work ,Scale Work, Mill Plane ,Auto Plane , Calc Border. The shortcut key

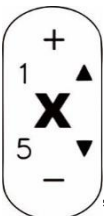
is "ADVANCED FUNCTION" shown below,


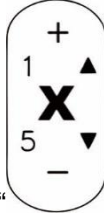


5.7.1 Array Work

Steps as below:

- 1) Press “” to move cursor to the Array work, press “” to enter, then press

“” to select different files list.

- 2) Press “” to enter file list, then press “” move the cursor to choose object file.

- 3) Set processing parameters, also can modify the array parameters in this step, or you can go to “AUTO PRO SETUP”, choose “Work Array” and modify the array parameters. The rest steps are similar to the normal processing. System will start to work according to the user’s setting.

- 4) In the processing of array work, you can view real time row number, volume number


etc. by pressing “”.

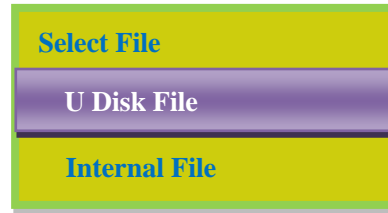
Note: Set interval value into a negative value if users want a manual control during array processing.

5.7.2 Scale Work

If the actual processing requires different sizes of the same file, user can use “scale work”, and enter a zoom in/out ratio.



Steps: Press “” to get into “Scale work”.



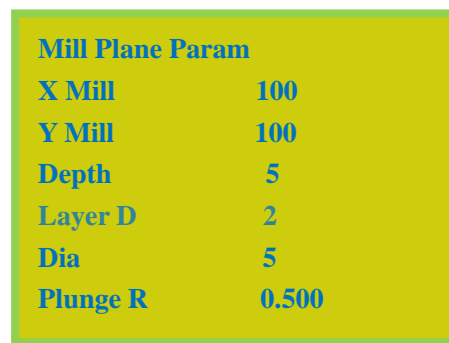
Choose desired processing file and input correct parameters:

Scale Work		
X	Scale	1
Y	Scale	1
Z	Scale	1

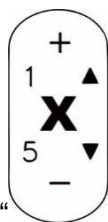
5.7.3 Mill Plane

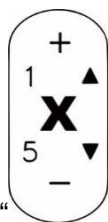
Include two types: Rectangle mill and circular mill.

✓ **Rectangle Mill**




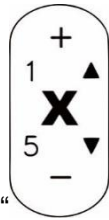
Mill Plane Param	
X Mill	100
Y Mill	100
Depth	5
Layer D	2
Dia	5
Plunge R	0.500




1) Press “” to move cursor to choose the mill type.



2) Press “” to enter the scan mill set, it includes: Scan type, Width, Height, Diameter, Depth, Z Step, T Ratio.



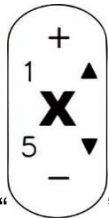
- 3) Press “ ” to move cursor on the option which need modify, press “  ” to choose mill type(X Scan or Y Scan), also press this button to modify the parameters.



Press “ ” after modified all the parameters to save them.

✓ **Circular Mill**

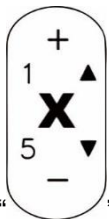
Mill Plane Param	
Mill RAD	100
Depth	5
Layer D	2
Dia	5
Plunge R	0.500




- 1) Press “ ” to move cursor to choose the mill type.



- 2) Press “ ” to enter the scan mill set, it includes: Scan type, Width, Height, Diameter, Depth, Z Step, T Ratio.



- 3) Press “ ” to move cursor on the option which need modify, press “  ” to

choose scan type, also press this button to modify the parameters. Press “  ” after modified all the parameters to save them.

5.7.4 Auto Center

Auto Center is to determine the central of the connection between two points which is used to find the central point of the workpiece embryo.

The specific steps of Auto Centre are as follows (X axis)



Press “ ” to enter into the interface of “Auto Center”, select MidPntAxis.



1) Manually move the tool to one side of the workpiece, press “ ” to record the first point , after recording success the screen display as below.

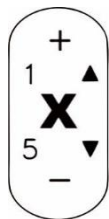


2) Then manually move the tool to the other side of the workpiece, press “ ” to record the second point , after recording success the screen display as below.
 The operation of Y axis and Z axis is same of X axis.

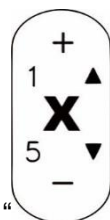


5.7.5 Calc Border

Calculate bound means user can check the size of processing, So as to avoid unnecessary waste of materials and processing errors. Steps as below:

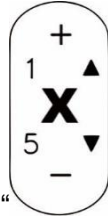
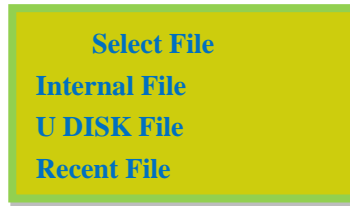


1) Press” ” to move the cursor to Calculate bound ,press “ ” to enter,



then press “ ”to select file list, Press “ ”get into the file list





- 2) Press “ ” to choose file. Press “ ”, system start to read the file, after reading the file, the system will calculate the area.

Appendix 1. Pulse equivalent calculation

PS 1.1 Stepper motor drive

PS1.1.1 Linear axis

Unit: Pul/mm

Formula = pulses per revolution / distance per revolution

Numerator:

Pulses per revolution formula: (360 °/stepper angle* Driver subdivision)

(Some stepper drivers mark pulse number directly).

Denominator:

Distance/revolution formula:

- ▶ Screw drive = screw pitch*mechanical transmission ratio(reduction ratio)
- ▶ Rack (straight) drive = rack module*gear teeth number*π*mechanical transmission ratio (reduction ratio)
- ▶ Rack (helical) drive = rack module*gear teeth number*π*mechanical transmission ratio(reduction ratio)/cos (helical angle)
- ▶ Pulley & belt drive = π*pulley diameter*mechanical transmission ratio(reduction ratio)

✓ **Screw drive:**



$$\text{pulse} = \frac{360^\circ \text{Stepper angle} * \text{Driver subdivision}}{\text{Screw pitch} * \text{transmission ratio}}$$

Pulse/rev	SW5	SW6	SW7	SW8	MSTEP	SW5	SW6	SW7	SW8
400	ON	ON	ON	ON	2	ON	ON	ON	ON
800	OFF	ON	ON	ON	4	ON	OFF	ON	ON
1600	ON	OFF	ON	ON	8	ON	ON	OFF	ON
3200	OFF	OFF	ON	ON	16	ON	OFF	OFF	ON
6400	ON	ON	OFF	ON	32	ON	ON	ON	OFF
12800	OFF	ON	OFF	ON	64	ON	OFF	ON	OFF
25600	ON	OFF	OFF	ON	128	ON	ON	OFF	OFF
51200	OFF	OFF	OFF	ON	256	ON	OFF	OFF	OFF
1000	ON	ON	ON	OFF	5	OFF	ON	ON	ON
2000	OFF	ON	ON	OFF	10	OFF	OFF	ON	ON
4000	ON	OFF	ON	OFF	25	OFF	ON	OFF	ON
5000	OFF	OFF	ON	OFF	50	OFF	OFF	OFF	ON
8000	ON	ON	OFF	OFF	125	OFF	ON	ON	OFF
10000	OFF	ON	OFF	OFF	250	OFF	OFF	ON	OFF
20000	ON	OFF	OFF	OFF	DISABLE	OFF	ON	OFF	OFF
40000	OFF	OFF	OFF	OFF	DISABLE	OFF	OFF	OFF	OFF



E.g.1: Driver nameplate1

E.g.2:Driver nameplate2

Motor nameplate/ stepper angle=1.8°

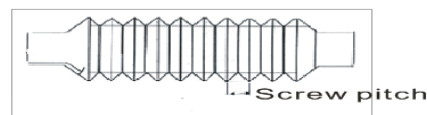
Explain: Stepper angle is the data of motor, means the angle of motor rotating for a single step. Driver subdivision is set in the driver.

In E.g.1, Pulse/rev is Pulses per revolution of stepper motor, so that the user only needs to select a relative value according to the actual dial code. For example: If user choose 3200 Pulse/rev, indicates $(360^\circ/\text{stepper angle}) \times \text{Driver subdivision} = 3200$.

In E.g.2, the MSTEP means subdivision number. So, if the stepper angle is 1.8°, selected subdivision is 16, then $(360^\circ/\text{stepper angle}) \times \text{subdivision} = (360^\circ/1.8) \times 16 = 3200$.

The use should use correct computational method according to the actual marks of stepper motor driver nameplate.

Screw pitch (above picture): The distance that the nut moves when the ball screw makes one rotation.



Transmission ratio: The reduction rate or angular velocity ratio of the front drive sprocket to the end driven wheel.

✓ **Rack drive:**

▶ **Straight teeth:**



$$\text{pulse} = \frac{360^\circ}{\text{Stepper angle}} \times \text{Driver subdivision} \\ \text{rack module} \times \text{gear teeth number} \times \pi \times \text{transmission ratio}$$

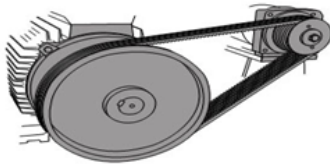
► Helical teeth:



$$\text{pulse} = \frac{\frac{360^\circ}{\text{Stepper angle}} \times \text{Driver subdivision} \times \cos(\text{helical angle})}{\text{rack module} \times \text{gear teeth number} \times \pi \times \text{transmission ratio}}$$

Explain: Rack module and gear teeth number are both the parameters of the rack. Rack module * gear teeth number * pi is the pitch circle circumference of the rack.

✓ **Pulley&belt drive:**



$$\text{pulse} = \frac{\frac{360^\circ}{\text{Stepper angle}} \times \text{Driver subdivision}}{\pi d \times \text{transmission ratio}}$$

d: Pulley diameter

PS1.1.2 Linear axis pulse equivalent computing method

For example: the stepper motor driver dialed code is 1600 pulse/rev.

➤ **Screw drive**

screw pitch=5mm, pulse equivalent= $\frac{1600}{5} = 320$

➤ **Rack drive**

rack module:1.25, gear teeth number:23, π :3.131592653, transmission ratio:1/5(0.2)

helical angle:19°31'32" ($\approx 19.52833333^\circ$)

Straight Arack

Pulse equivalent= $\frac{1600}{1.25 \times 23 \times 3.131592653 \times 0.2} = 88.573$

Helical rack

$$\text{Pulse equivalent} = \frac{1600}{1.25 \times 23 \times 3.131592653 \times 0.2 \div \cos(19^\circ 31' 32'')}^\circ$$

$$= \frac{1600 \times \cos(19.52833333)}{1.25 \times 23 \times 3.131592653 \times 0.2} = 83.378$$

NOTES: $1.25 \times 23 \times 3.131592653 \times 0.2 = 18.0631577605$

$$\cos(19.52833333) = 0.93237630503668681677372930102306$$

$$1.25 \times 23 \times 3.131592653 \times 0.2 \div \cos(19.52833333) = 19.1666969915 \approx 19.1667$$

PS1.1.3 Rotary axis (pul/ °)

Formula = pulses per revolution / angles per revolution (360°)



$$\text{pulse} = \frac{360^\circ}{\text{Stepper angle}} \times \text{Driver subdivision}$$

$$= \frac{360^\circ \times \text{transmission ratio}}{360^\circ}$$

PS1.1.4 Rotary axis pulse equivalent computing

E.g.: pulse/rev=1600, transmission ratio = 1/40

$$\text{Pulse equivalent} = \frac{1600}{360 \times 1/30} = 177.778 \text{ (result retains up to 3 decimal places)}$$

PS 1.2 Servo driver

The pulse equivalent factory value X, Y and Z on the handle are all 400, which can be used as a constant or change a new value to set the electronic gear ratio on the servo motor driver. It can be reduction of a fraction.

Electronic gear ratio molecules that represent the resolution of the encoder are found in the servo drive specification.

Denominator of electronic gear ratio:

Linear axis

- ✓ Screw drive: pulse equivalent * screw pitch * mechanical transmission ratio
- ✓ Straight rack: pulse equivalent * rack module * gear teeth number * π * mechanical transmission ratio
- ✓ Helical rack: pulse equivalent * rack module * gear teeth number * π * mechanical

Transmission ratio/cos (helical angle)

- ✓ Pulley & belt drive: pulse equivalent $\pi \times \text{pulley diameter} \times \text{mechanical transmission ratio}$

Rotation axis

- ✓ pulse equivalent $\times 360^\circ \times \text{mechanical transmission ratio}$

Appendix 2. Common problems and troubleshooting

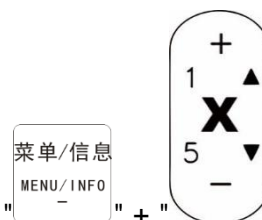
PS2.1 Solutions for screen display faults


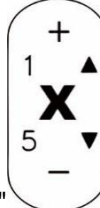
After powered on the "Screen flicker or automatically restart"


- 1) Switching mode power supply is insufficient. Check power supply if there are problems, and change high-quality power supply to solve the problems.
- 2) The local power grid unstable. Check local grid voltage stability or use the regulator filter device.
- 3) The power chip of the handle is ageing. This phenomenon also appears when the handle is powered through the USB cable to the computer. Please return back the handle to our company.
- 4) Temporary solution. Using standard 5V mobile phone charger, supply power through the USB cable to handle. Duplicate power supply for temporary emergency use.

Failed to set work piece origin during normal operation process

- 1) It is under the mechanical coordinate system. Check if the main interface displays AX



AY AZ, AA, if yes, should press "  " + "  " switching to work coordinate

system. Then it can set work origin. Press "  + "  " is for going to mechanical coordinate system where cannot set work origin in there.

- 2) The buttons are broken. Press "  " and check whether the buttons are normal or not.

Assertion error

Assertion error (occurred during the processing or after starting) is generally a software problem. User can boot the controller by entering "emergency state", or re-upgrade it. If can't be solved either, user should send back it for repairing.

Unable to read U flash disk or read error occurs

- 1) Processing by U-disk, screen shows "there is no item in this option". Format U-disk to FAT32, change allocation unit to the default configuration size. Then re-import processing files, it will read normally.
- 2) U flash disk capacity is too large (16G, 32G or 64G etc.). Recommend replace U disks such as 2G ,4G, 8G.
- 3) There is something wrong with USB communicate port or U-disk interface is broken, change a new USB port or U-disk.
- 4) There is no any reaction while insert into the U-disk. Change a genuine brand of U-disk, such as SanDisk, FOUNDER U-disk etc.
- 5) If the U-disk interface is weak connection, user can copy files into inner memory space of the controller for temporary solution.
- 6) Program contains non-standard G codes, or some illegal characters. The system does not recognize them and interrupt handling. Recommend using professional simulation software to review the program whether there is an illegal character. Delete all illegal characters.

PS2.2 FAQ in practical operation

After the machining, the cutting size doesn't match the actual size in processing file

- 1) Pulse equivalent is wrong. Please contact the engraving machine manufacturer to get the correct values and modify them.
- 2) User has selected the wrong tool bit which is not the same as it set in process file.
- 3) Check if there is any problem with the path processing file.

The screen displays "exceed limit" during processing

- 1) The machine hasn't returned ZERO, lead the system is unable to confirm the actual position. Solution is to go machine ZERO.
- 2) The reserved processing range is small than the actual file size after user set work piece origin. Confirm the actual file size and then set a correct working origin.
- 3) Set wrong working origin in the process of creating processing file path. Check the file path, and then generate the correct one.

Hard limit triggering

- 1) If the machine has connected with hard limit, the hard limit switch maybe damaged or the voltage setup status on X6 is wrong.
- 2) System has not connected with hard limit signal: Confirm whether connect other signal wire to hard limit X6 port, if not, check voltage setup normal or not. If normal, user could go to "MACHINE SETUP"- "Input Conf" and DISABLE X6 port, then go to "SYSTEM SETUP"- "wipe cache". If still can't solve this problem, user can upgrade the system.

Z axis (spindle) fall down abnormally (too fast) and cause Z feed amount too much during processing

- 1) Z axis working speed exceed the fastest speed cause Z axis loses its steps when moving up. " MACHINESETUP " - " Max Spd Limit ",set the safe speed.
- 2) The coupling is loosen or transmission mechanism slipping. Re-adjustment the

connecting parts.


- 3) The signal wire connected between the interface board and the motor driver has got interference. Adjust the circuit.
- 4) Processing file error. Check processing file, try to download the correct processing file to U disk or handle internal.
- 5) There is something wrong (plug loosen or wire damaged or wire diameter is too slimy) with the lines connecting Z axis motor and motor driver. Replace the lines.

Repeating the same processing file after returning back to the machine ZERO, Z axis cutting depths are not as same as each other

- 1) Machining table is uneven or processing object not firmly fixed, re-milling the machine table to adjust the flatness.
- 2) Z-axis origin detection switch repeat positioning accuracy error, causing Z axis homing error each time. Replace a high-quality detection switch.
- 3) Too much interference in the Z-axis homing process to form a false Z origin. Re-adjust the wiring.

The machine cannot stop after returning ZERO, and cause spindle hit the machine body



Double press “” to check input signal (Origin detection switch signal). To do self-test. Detect whether the signal is triggered or disconnected.

- 1) The origin detection switch is broken. Replace a new one.
- 2) The distance of the origin detection switch detection sheet beyond the detection range(This problem is common occurs in optoelectronic and proximity switches) of the switch, adjust the position of the test piece.
- 3) The origin detection switch to the interface board wiring aging or loosening. Check the connections again.
- 4) The interface board is broken. Return back to us to repair.

- 5) 50-pin data cable is broken. Replace it with a new data cable.

The machine uniform moves to the reverse direction when backing to the machine

ZERO

- 1) The origin detection switch types do not match with the definition of the corresponding voltage level. Modify the voltage level in the controller. (Normally open type corresponds to a level defined the direction of the arrow down, normally closed type corresponds to the level defined arrow up).
- 2) The origin detection switch is broken. Replace a new one.
- 3) The origin detection switch connects interface board not well. Refresh the cable to confirm the wiring is correct.
- 4) Too much interference, resulting in the illusion of the detection switch has been triggered. Recalibrated the whole circuit.
- 5) The interface board is broken. Depot Repair.
- 6) 50-pin data cable is broken. Replace the data cable.

Abnormally running when processing or the actual file is different from theoretical file

- 1) The system program disorder.
- 2) Too much external interference lead the controller cannot work normally. Re-adjust overall circuit. (The wires of weak current and strong current should be separately binding, the inverter and other components should be separated connected each GND of themselves).
- 3) There is something wrong while converting the file format and the program appears illegal characters or system unrecognized codes. Recommended to use third party simulation software to review the program paths.

Start automatic tool setting, the tool does not stop after touching C.A.D (Tool sensor).

- 1) The cutter signal cable connects X4 maybe broken circuit.
- 2) The "GND" signal port on the interface board hasn't been connected with spindle housing or poor connection.
- 3) Go to "MACHINE SETUP"- "Input Confi" to confirm if X4 is enabled.

Coordinate value changes on screen, but the machine does not move

- 1) If it is one axis not moving, it maybe wiring problem. Change another normal terminal to this axis wiring terminal, if it moves properly indicating the rear parts of motor driver have no problem. Check if there is something wrong with interface board or 50-pin cable. If it is still not moving, it is necessary to detect the corresponding drive and motor.
- 2) If all axes are not moving, firstly, check if there are problems in the 50-pin cable and interface board,; secondly, if the interface board and 50-pin cable are normal, then user should check the power supply of the motor drivers.
- 3) If debugged all above parts, but the machine still not move, then the mechanical parts should be checked.

It is normal to the move from one position to another position, but when return from that position to the original position is not normal

Mechanical assembly problem, guide screw may be not installed well.

Motor moving direction is wrong

- 1) Exchange A+&A- or B+&B- cable of the stepper motor
- 2) Change motor direction mask (not recommend)

The machine vibrates when moves in arc or two-axis linkage movement

- 1) Check whether the machine is placed horizontally
- 2) Check if the coupling units loose or not.
- 3) Increasing the "start speed", avoid the resonance point.

PS2.3 Electrical components and wiring problem

A single axis or multi axis can only in one direction after machine power on

- 1) There is something wrong with the connecting between the interface board and motor driver common anode end, check the connection.
- 2) Interface board is broken. Replace the interface board.
- 3) The motor driver is broken. Replace the driver.
- 4) Measure the direction voltage of that axis with a multimeter. Check if the direction is correct.

One axis motor does not move after handle power up

- 1) Pulse cable and direction cable connect oppositely, adjust connection sequence..
- 2) 5V common anode end of the motor driver disconnected, check the connection.
- 3) The motor driver is broken (Performance as the motor moves when push it by hand), change a new one.
- 4) The interface chip of the interface board is broken, no pulse signal output.
- 5) Switch this terminal with another normal terminal to check interface board abnormal or driver abnormal.

Screen is not bright after power up, but connect the handle to computer with USB cable the screen displays normally

- 1) The DC24V voltage of the handle is not available. Check if the DC24V power supply voltage output is normal or not. If normal, please check if the cable from the power supply to the interface board is virtual connection.
- 2) The 50-pin cable is broken or 50 pin connecting plug hasn't connected well.

Screen is not bright neither after power up nor connect to computer by USB cable

- 1) This phenomenon may due to the handle shocked by external force or fall on the ground, causing the crystal processor broken. Return back to repair.
- 2) Users connect high voltage power supply to the interface board and cause the handle

and interface board broken. Return back to repair.

The screen display “Spindle on”, actually the spindle off; the screen display “Spindle off”, actually the spindle on

- 1) Line fault. Spindle on signal and COM port is short circuit. Check circuit line.
- 2) The output level definition reversed. Go to the “voltage setup” and modify the output level definition (modify the left first arrow direction in the second row).

The handle screen doesn’t light up and shows nothing after power on

- 1) The power supply voltage is too large or the + and – short circuit burned the chip. Return to us for repairing.
- 2) The power supply damaged, change a new one.
- 3) 50-pin cable is broken, replace it.
- 4) 50-pin socket broken, send back to us for repairing.


System always alarm after the alarm signal has been connected

Change the input level on X4 (normally open, wiring in parallel; normally closed, wiring in series).

Press “spindle on” button, but spindle does not start

- 1) Check wiring, if normal, check if the inverter has alarm, if the inverter is normal and its setting is correct, and then check if the spindle motor damaged or not.
- 2) Check if 50-pin cable is loose. Confirm the settings of inverter refer to its manual to debug one by one.



- 3) Check interface board. Press “” to start spindle, use multimeter to measure Y1 and GND to see whether conducting, if not, interface board or 50-pin cable is broken. To replace a new one for trouble clearing one by one.