CHC-1000L
Capacitive Height Controller
User Manual

V3.5

Foreword

Thanks for your trust in our products!

This manual provides a detailed introduction to the use of CHC-1000L capacitive height controller, including system feature, operation and installation guides.

Please read the user manual carefully before operating our controller and relative equipment.

Due to the constant updating of product functions, the products you receive may differ from the description in this manual in some aspects. We hereby apologize about that.

Contact Us

ShenZhen HongYuDa CNC Technology Co.,Ltd

Office/Workshop Add：6C/E4, TCL International E city, No.1001, ZhongShanYuan Road,Nanshan Zone, Shenzhen ,China.

TEL： +86-755-26625800

FAX： +86-755-26729960

Website： http://www.hydcnc.com

E-mail： hydcnc@126.com

Catalogue

Chapter 1 Product Introduction

1. Brief Description

CHC-1000L independent capacitive height controller (hereinafter referred as CHC-1000L) is a high-performance capacitive heightening device that adopts close-loop control method to control the laser cutting head's capacitive follower.

During laser cutting process, the distance between the nozzle and the workpiece surface is not constant due to the unsmooth workpiece and high-pressure gas injection when cutting, which has negative impact on the cutting performance and even damage the nozzle.

CHC-1000L height controller can keep distance between the nozzle and workpiece remain constant during fast laser cutting, so as to protect the nozzle from hitting workpiece and improve the cutting finishing. The capacitive sensor on the cutting head can detect the distance between nozzle and workpiece surface. It is sent to the regulator box for processing via preamplifier. Then the output signal is transmitted to the servo controller to control the Z axis.

By providing a unique Ethernet communication(TCP/IP protocol) interface, it can support many functions with CNC controller for laser cutting, such as automatic tracking of cutting height, segmented piercing, progressive piercing, edge seek, leapfrog, arbitrary setting of lift-up height of cutting head.

In terms of servo control, CHC-1000L adopts the double-closed-loop algorithm of speed and position, and its performance of running speed and precision is obviously better than that of similar products.

2. Performance Description

- Sampling rate: 1000 times per second.
- Static measurement accuracy: 0.001mm.
- Dynamic response accuracy: 0.05mm.
- Following range: 0-5mm.
- Maximum acceleration: 2G

- The upper limit of the following speed depends on the upper limit of the servo motor speed and the screw lead (10mm screw lead and 6000 RPM servo, can reach up to 1000mm/SEC)
- The signal will not decay with strong capacity of resisting when the length of signal transmission cable is up to 100m.
- Support network communications and U disk online update.
- Adapt to any cutting head and nozzle.
- Support alarm while hitting the board and beyond the edge.
- Support edge detection and automatically inspection.
- Automatic calibration process, with fast and easy operations.
- Support leapfrog and section piercing.
- Support oscilloscope functions to detect the capacitance and height changing in real time.

Comparison between Frog-100L and other height controller.

Specs	Other controller	CHC-1000L
Max moving speed	400mm/s	999mm/s
Max acceleration	0.4G	2G
Capacitance Mutation Restraint	5%	10%
Min Inflexibility Requirement	5Hz	2Hz
DA resolution	10 bit	12 bit
DA zero drift	16mv	3mv
DA response time	5ms	0.01ms
Positioning accuracy	0.05mm	0.01mm

Chapter 2 Wiring Description

2.1 System Components

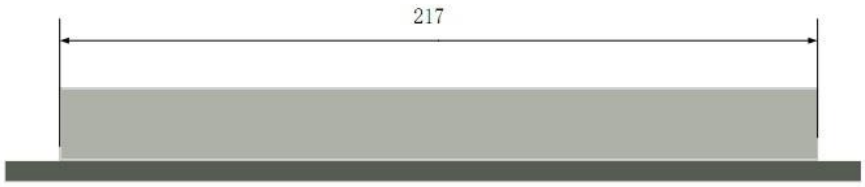
The capacitive height control system consists of CHC-1000L controller, preamplifier, and cables.

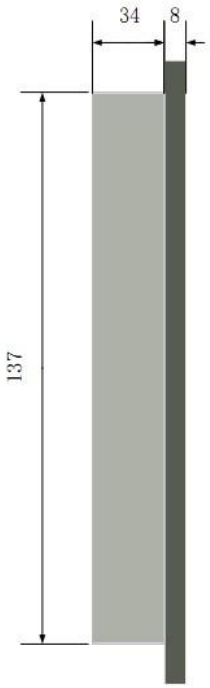
Component	Qty.	Standard Model No.	Optional
height controller host	1	CHC-1000L	
preamplifier	1	CHC-AMP	
RF cable	1	SPC-140 (140mm)	SPC-180 (180mm)
Sensor Cable	1	STC-5 (5 meters)/ STC-10 (10 meters)	STC-15 (15 meters)
Plug (male)	1	DB15(M)	
Plug (female)	1	DB15 (F)	
Paper instruction manual is no longer provided, please visit the company website to download the instruction manual. http://www.hydcnc.com/en/			

2.2 Installation Dimension

2.2.1 Host Controller

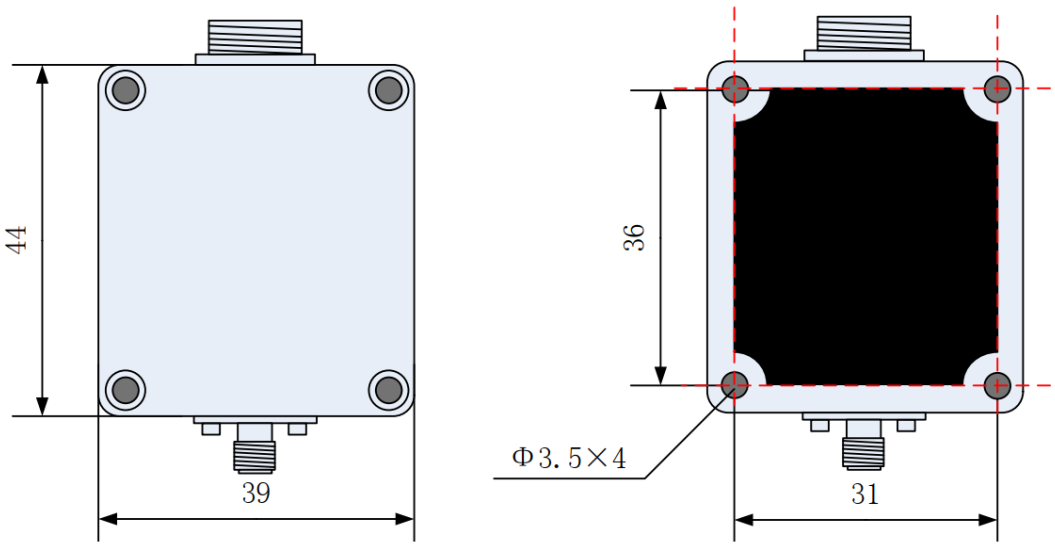
The dimension of host controller is shown below:





2.2.2 Preamplifier

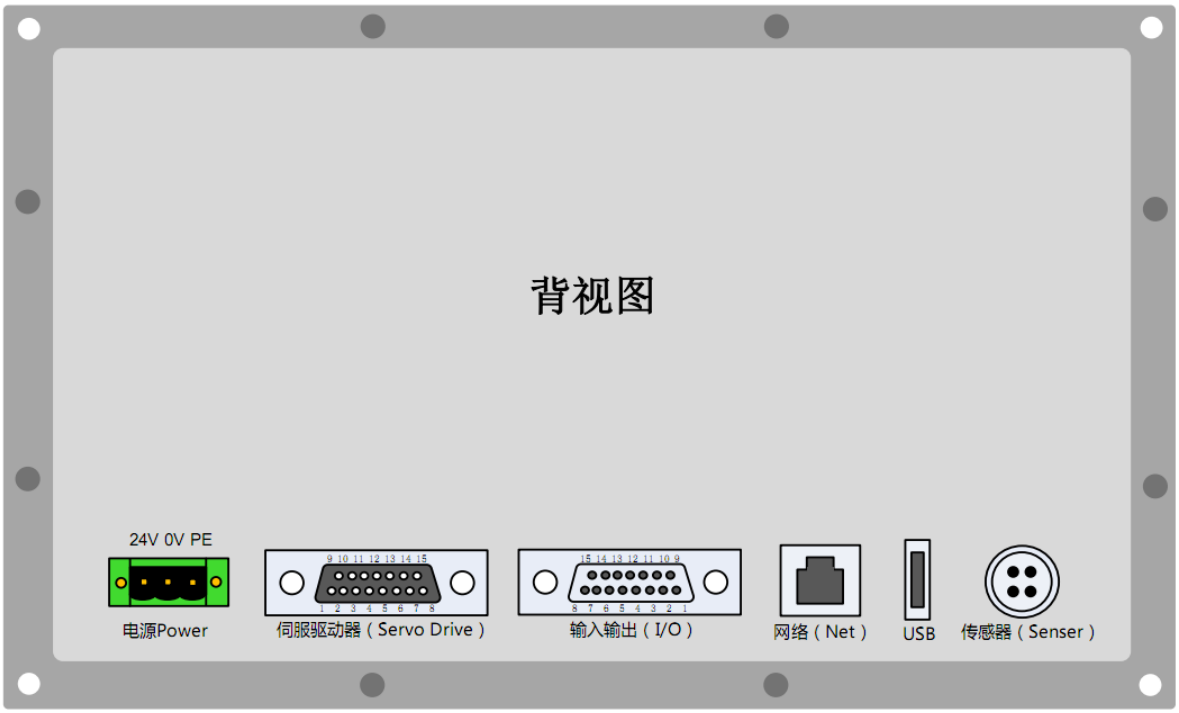
The dimension of preamplifier is shown below:



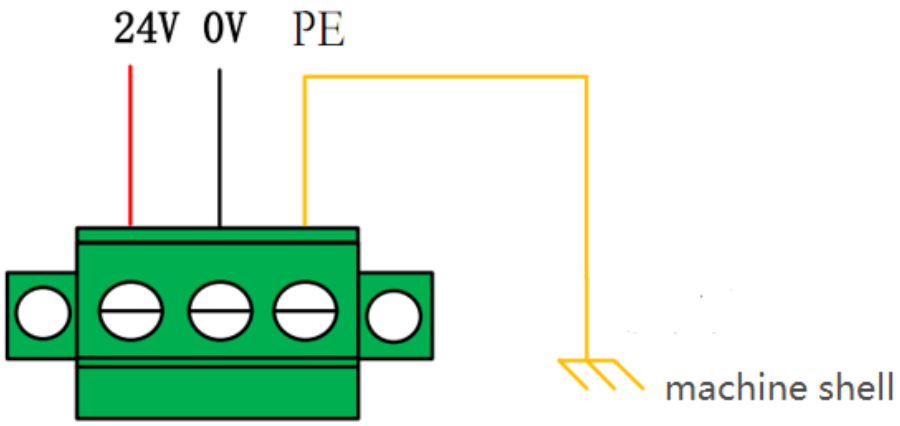
Sensor Mounting Dimension

2.3 Interface Description

2.3.1 Interface Layout

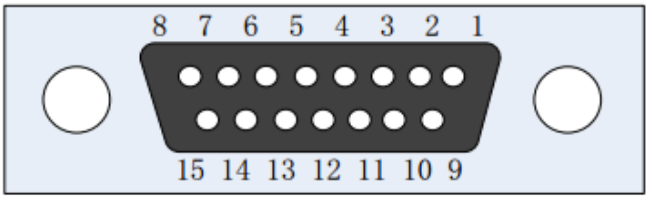


2.3.2 Power Interface



The machine shell is the negative pole of the capacitance. To ensure the stability of circuit measuring, the “PE” pin must be connected to the machine shell reliably (i.e. well conductive with machine shell). The preamplifier shell should be conductive with machine shell. The specific index is DC Resistance should be constantly less than 10 Ω， otherwise the actual following performance may not be good.

2.3.3 Servo Drive Interface and Parameter Setting

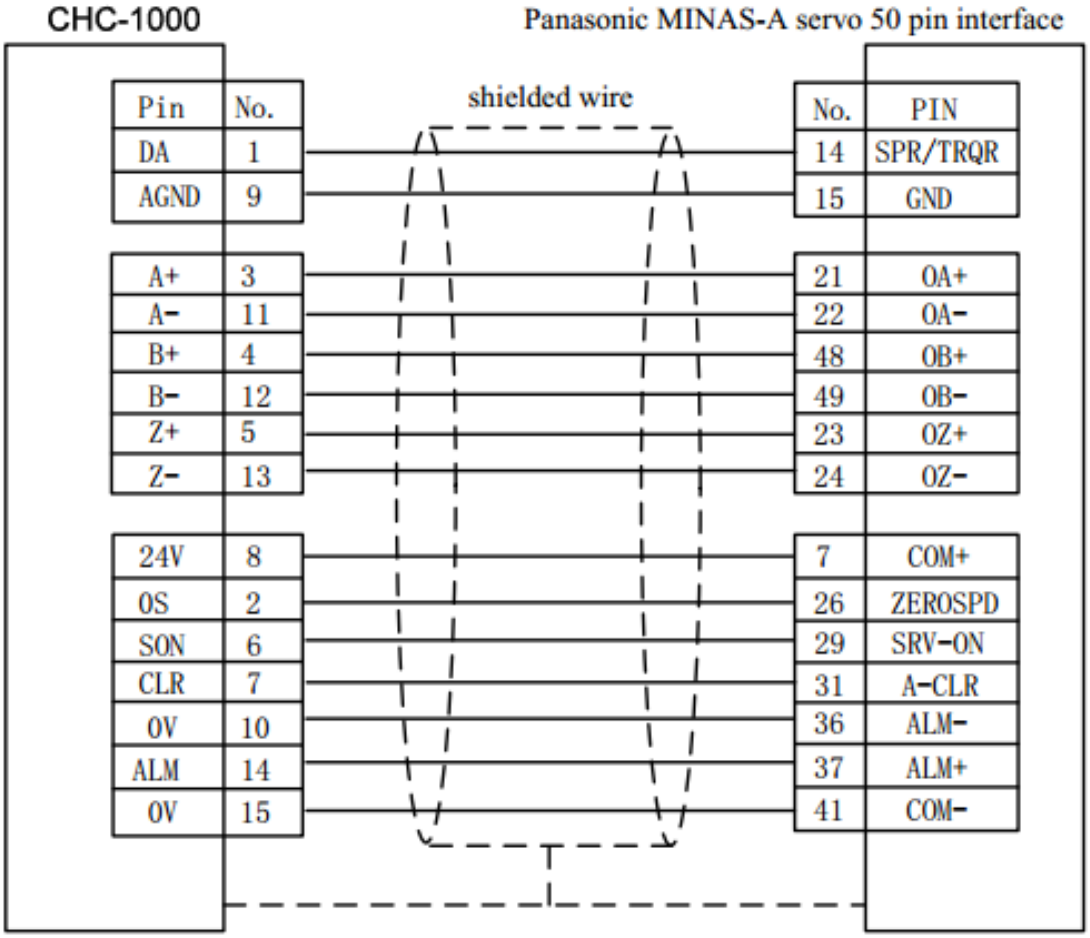


Pin	Color	Signal name
1	Yellow	DA (with an analog output of -10~10V)
2	Blue	0S (Zero speed clamp)
3	Black	A+ (Encoder A+)
4	Orange	B+ (Encoder B+)
5	Red	Z+ (Encoder Z+)
6	Green	SON (Servo on)
7	Green-black	CLR (Clear alarm)
8	Brown	24V (Power output)
9	Yellow-black	AGND (Analog ground)
10	Blue-black	0V (Power ground)
11	Black-white	(Encoder A-)
12	Orange-black	(Encoder B-)
13	Red-black	Z- (Encoder Z-)
14	Purple	ALM (Alarm signal)
15	Brown-black	0V (Power ground)

+24V/ 0V: Supply 24V DC power to servo drive;
DA/ AGND: Analog command signal, give speed signal to the drive;
0S: Zero Clamp, used to suppress the zero-shift of the servo;
SOM: Output the servo enable signal;
ALM: receive the alarm signal of the servo drive;
A+/A-/B+/B-/Z+/Z-: encoder three-phase, input signal;

Please note the followings when connecting the servo drive:
1. Firstly ensure that the servo drive supports speed mode. For example, the Panasonic A5 series servo shall be fully-functional, not pulsed mode.
2. CHC-1000L input and output port are low level active, so the selected servo shall be low level active also.
3. Check the servo motor is with brake or not. In case with brake, please connect the motor strictly in accordance with the wiring diagram and set the parameters related to the brake.
4.The shielded layer of control signal cable shall be connected to the housing of servo drive, and the servo drive should be well grounded.

Wiring diagram of Panasonic servo

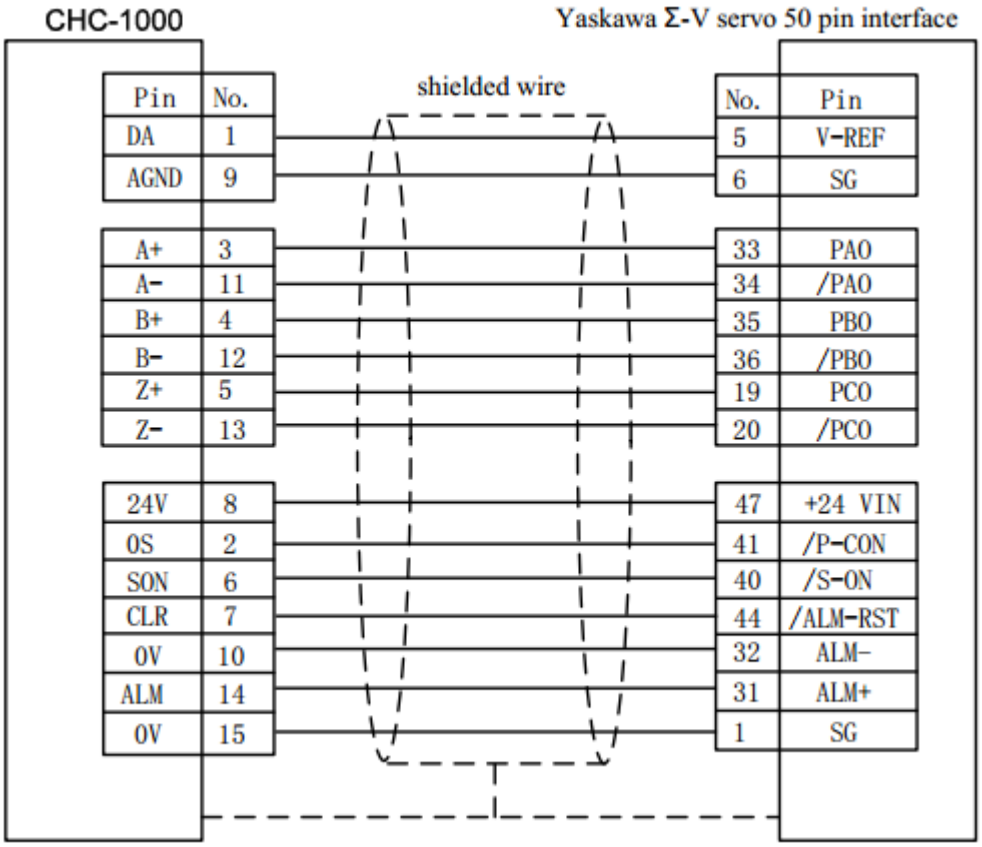


Corresponding to the wiring modes above, the servo parameters are set as follows:
Panasonic A5 series:

Parameter No.	Recommended value	Description
Pr001	1	Control mode: It must be set speed mode.
Pr002	3	Real-time automatic adjustment: The recommended setting is vertical axis mode.
Pr003	17	Servo rigidity, the recommended range is from Grade 14 to Grade 20.
Pr302	500	Input the gain of speed command.
Pr315	1	Enable zero speed clamp function.

Note: When using Panasonic A series servo, the height controller parameter setting: **mechanical parameter→servo type** is set to 0.

Yaskawa servo wiring

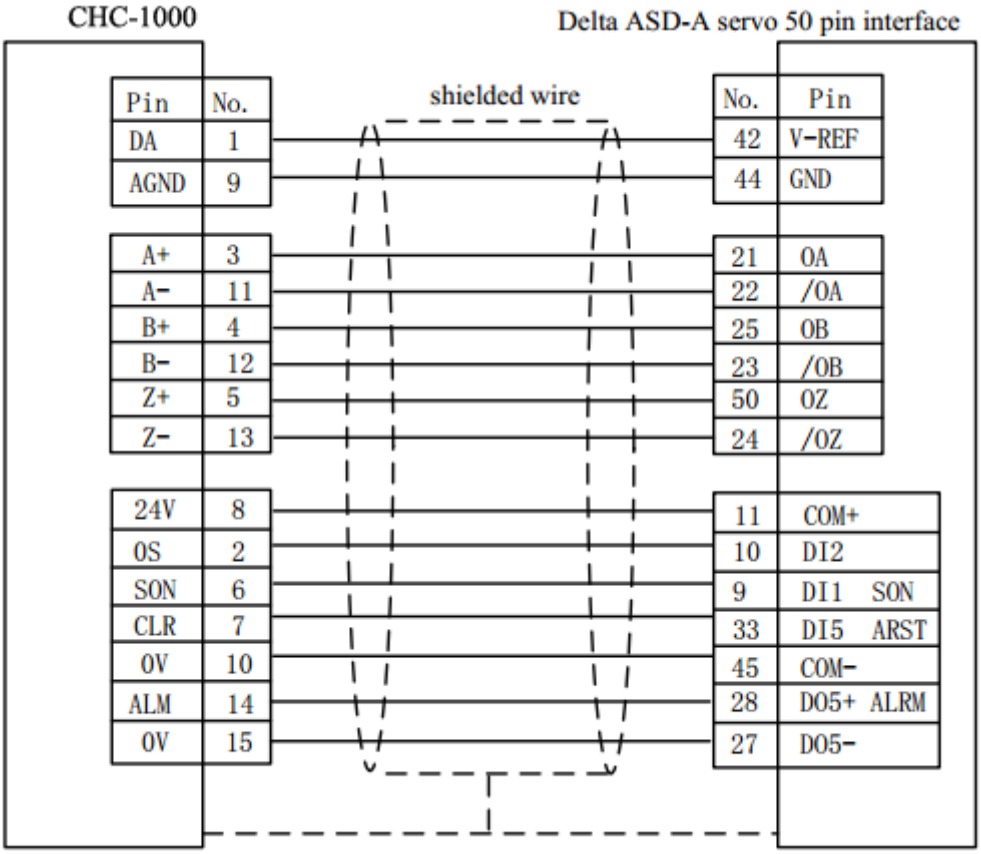


Yaskawa Σ-V Series Servo Drive Parameter Settings

Parameter	Value	Description
Pn000	00A0	Speed control mode with zero fixed function
Pn00B	-	Set to 0100 when using single-phase power
Pn212	2500	Number of pulses output by the encoder per revolution. The pulse parameter of corresponding CHC-1000L per revolution is 10000
Pn300	6.00	The speed gain of corresponding height controller is 500r/v/min
Pn501	10000	Zero fixed value
Pn50A	8100	Forward rotation is enable
Pn50B	6548	Reverse rotation is enable

Note: When using Yaskawa Σ series servo, the height controller mechanical parameter → servo type is set to 1.

Wiring of Delta servo as follow



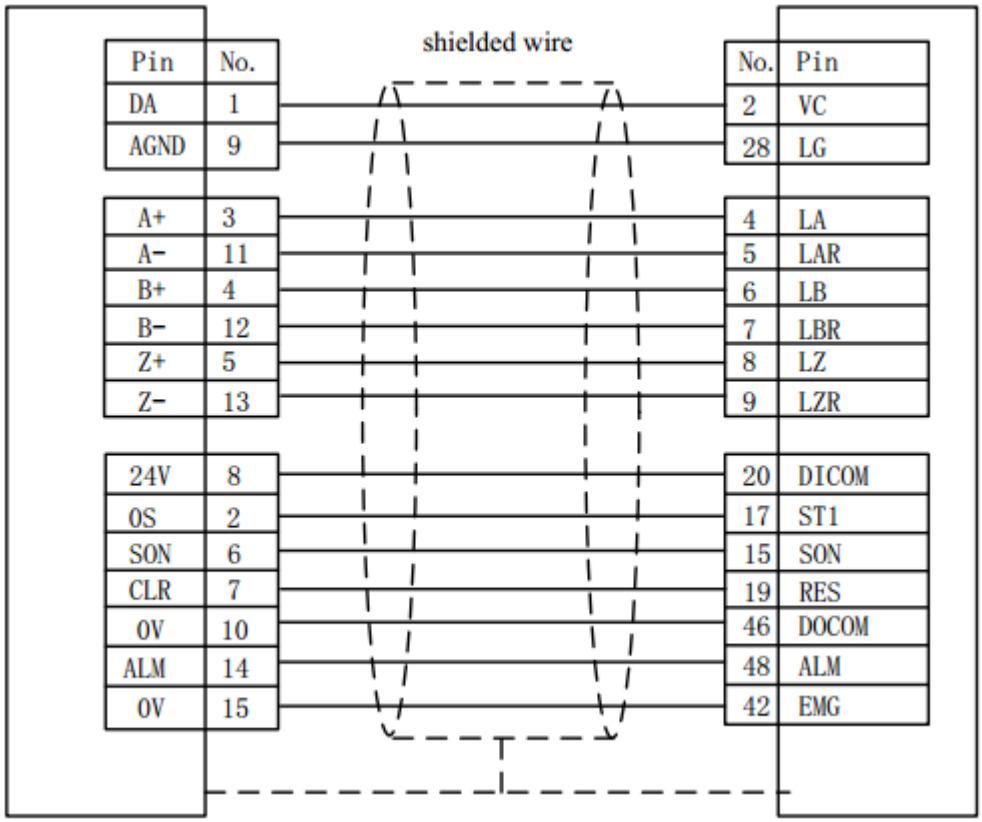
Delta servo setting as follow,

Delta ASD-A series:

Parameter No.	**Recommended value**	**Description**
P1-01	0002	Control mode: It must be set to speed control mode.
P1-38	2000	Set zero speed clamp value to the maximum.
P1-40	5000	The speed gain of corresponding height controller is 500 r/v/min.
P2-10	101	Set DI1 to SON, normally opened.
P2-11	105	Set DI2 to CLAMP, normally opened.
P2-12	114	Set speed command to external analog control.
P2-13	115	Set speed command to external analog control.
P2-14	102	Set DI5 to ARST, normally opened.
P2-22	007	Set DO5 to ALRM, normal close.

Wiring of Mitsubishi servo as follow,

CHC-1000 Mitsubishi MR-J30A servo

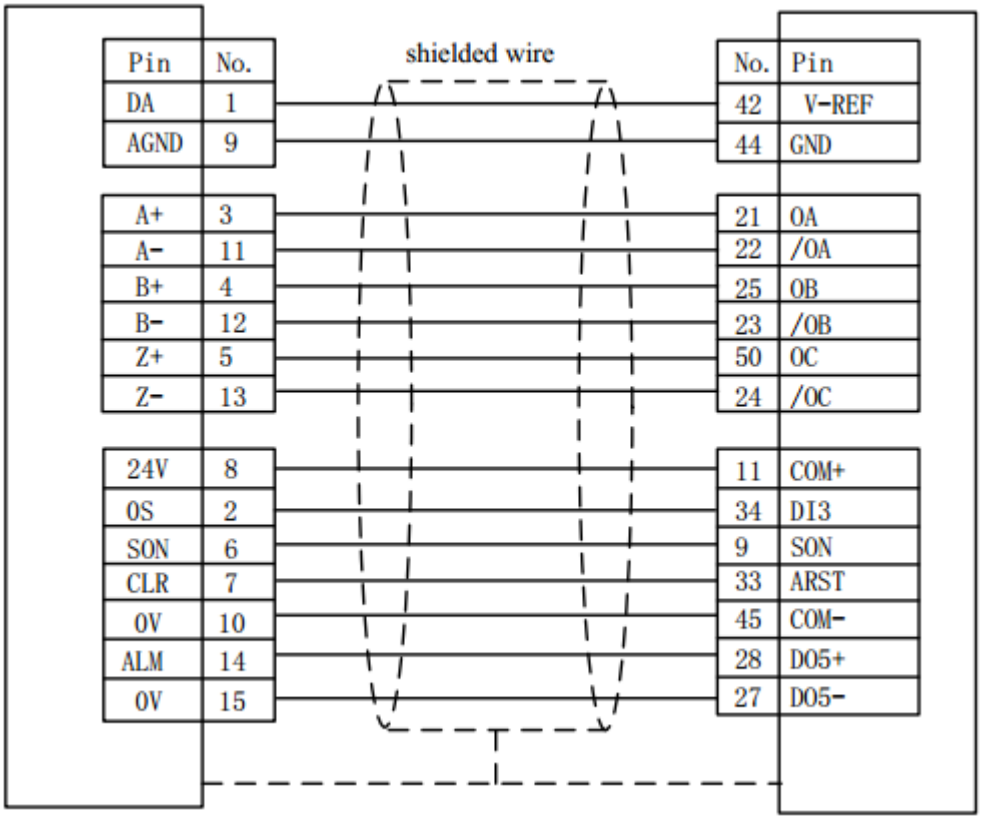


Mitsubishi MR-J30A series setting as follow,

Parameter No.	Recommnded value	Description
PA01	2	Control mode: Must be speed control mode
PA15	10000	Number of pulse output by the encoder per resolution.The number of pulses of corresponding CHC-1000 per resolution is 10,000.
PC12	5000	Speed gain. The speed gain of corresponding CHC-1000 is 500 r/v/min.
PC17	0	

Wiring of Schneider servo as follow,

CHC-1000 Schneider Lexium 23D

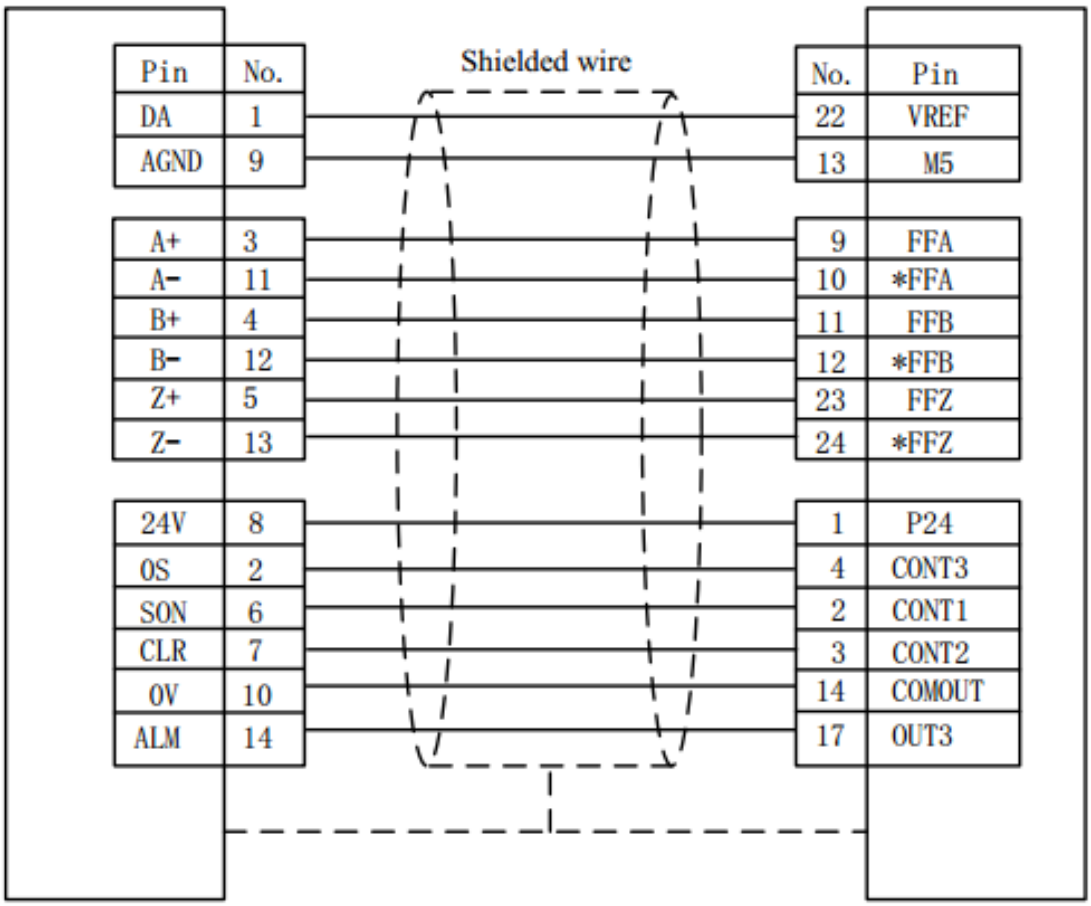


Schneider Lexium 23D servo setting as follow,

Parameter No.	Recommnded value	Description
P2-10	101	Servo IN1 function: SON
P2-11	0	Servo IN2 function: Not used
P2-13 to P2-17	0	Not use IN4 to IN8
P1-38	400	It's 40.0RPM, the zero compare value
P1-01	2	Must be speed control mode
P1-40	5000	Speed gain. The speed gain correspond CHC-1000 is 500 r/v/min
P1-46	2500	Number of pulse output by the encoder per resolution. The number of pulse of corresponding CHC-1000 per resolution is 10,000.

Wiring of Fuji ALPH A5 servo as follow,

CHC-1000 Fuji ALPH A5 servo

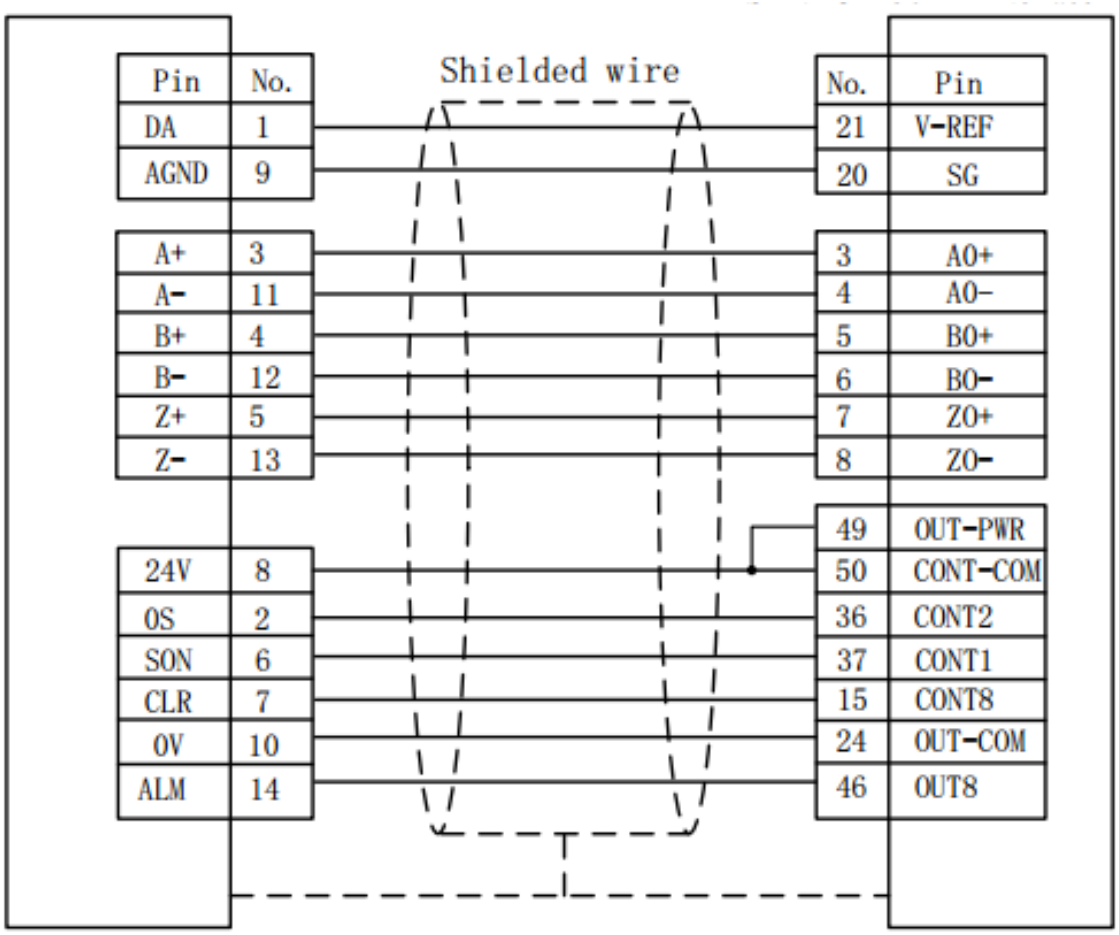


Fuji ALPH A5 servo setting as follow,

Parameter No.	Recommnded value	Description
PA-101	01	Control mode: Must be speed control mode
PA-108	2500	Number of pulse output by the encoder per resolution.The number of pulses of corresponding CHC-1000 per resolution is 10,000.
PA-115	17	Servo rigidity, the recommended range is from Grade 14 to Grade 20.
PA-303	02	Forward rotation is enabled.
PA-331	6.0	Speed gain. The speed gain of corresponding CHC-1000 is 500 r/v/min.

Wiring of SANYO servo as follow,

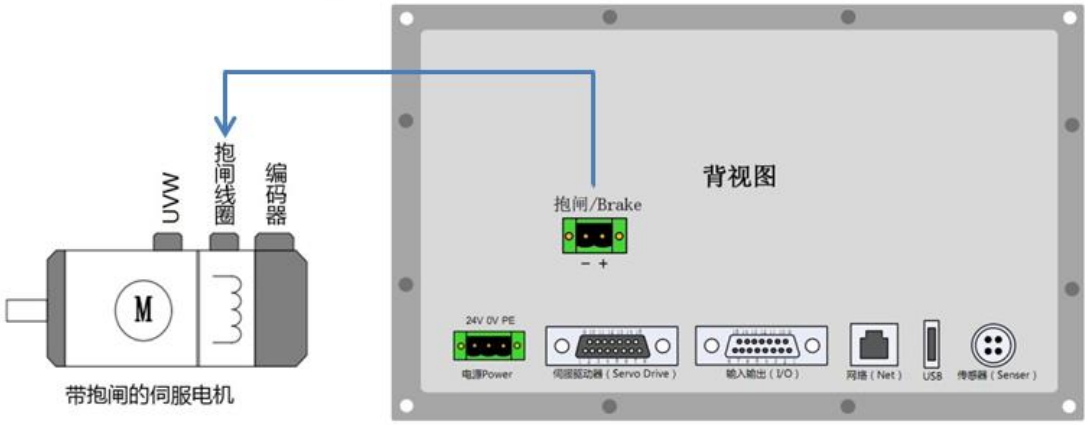
CHC-1000 SANYO R 50-Pin interface



SANYO Servo setting as follow,

Parameter No.	Recommnded value	Description
SY08	01	Control mode: Must be speed control mode
Gr0.00	00	Auto tune
Gr8.25	5000	Speed gain. The speed gain of corresponding CHC-1000 is 500 r/v/min.
Gr9.00	00	Motor rotate CW enable
Gr9.01	00	Motor rotate CCW enable
Gr9.26	00	Shut down servo gain switch
GrB.13	0	
GrB.14	0	
GrC.05	2500/8192	Number of pulse output by the encoder per resolution. The number of pulses of corresponding CHC-1000 per resolution is 10,000.

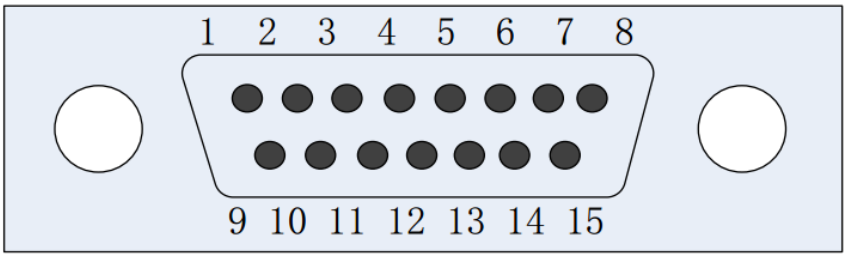
2.3.4 Brake Interface



In the version after August 2020 (hardware version V3.10), the brake port of the height controller can directly output 24V to drive the brake coil with a maximum current of 500mA. In order to distinguish it from the previous version, there will be a label on the back of the height controller, and you can directly connect the motor brake coil when using it.

When the height controller detects that there is no servo alarm and outputs the servo enable, it also outputs the brake release signal, that is, the brake interface outputs DC24V; when the enable is closed or the servo alarm is detected, the brake is disabled.

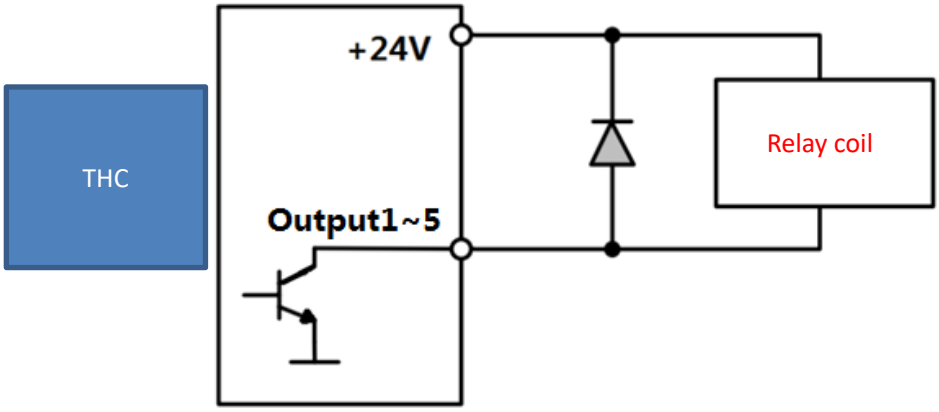
2.3.5 Description of Input and Output Interface



DB15 male (pin) input and output interface definition				
PIN	**Signal definition**		**PIN**	**Signal definition**
1	24V (Power output)		9	IN7(General input)
2	IN8(General input)		10	OUT5 (General Output)
3	OUT1 (Cutting in place)		11	OUT2 (Stay to position signal)
4	OUT3 (Alarm)		12	OUT4 (Punching in place)
5	IN1 (Cutting tracking)		13	IN2 (Move to aligning coordinate)
6	IN3 (Quick lift up)		14	IN4 (Stop)
7	IN5 (Upper limit)		15	IN6 (Lower limit)
8	0V (Power ground)			

Notes：

1. The output ports (OUT1~OUT5) are all open-drain outputs, which are connected to the power ground during output. Pay attention to the maximum output current of 200mA, and don't connect the wrong load to cause damage.



Wiring of output port control the relay

2. Input ports (IN1~IN8) are all active low level input, and the input is enabled when the input ports are connected with the power ground.

3. When the cutting head punches to place, OUT4 will output a desired signal with a width of 200ms. When the cutting lead follows to the cutting height, OUT1 will output continuous desired signal.

In/Out	Function Description
IN1 (Cutting tracking)	Input signal, active low. When the signal is low, the height controller will start to follow, and its function is same as the Follow function of the operation panel button; when the signal returns to the high level, the Follow function is closed. Note: By default, the height controller will automatically return to dock when the Follow is turned off. If manual operation is required, the Quick lift up signal (IN3) can be enabled in the mechanical parameter setting.
IN2 (Move to aligning coordinate)	Input signal, falling edge trigger. When the signal is low, the height controller will Move to aligning coordinate. The aligning coordinate can be set in the height controller process parameters, and the default is 20mm. The function of this input port is the same as pressing KEY [←]or[→] on the homepage. Note: If the current position is less than the set centering coordinate, the height controller will not execute this function.
IN3 (Quick lift up)	Input signal, falling edge trigger. When the signal is low, the height controller will return to the docking coordinates. The docking coordinates can be set in the height controller process parameters, and the default is 30mm.
IN4 (Stop)	Input signal, active low. When the signal is low, the height controller will stop the movement urgently.

IN5 (Upper limit)	Input signal, active low. Connect the upper limit switch, the Input logic (normally open or normally closed) can be set in the mechanical parameters of the height controller. When the upper limit triggers the height controller, it will stop moving up and give an alarm.
IN6 (Lower limit)	Input signal, active low. Connect the lower limit switch, and the Input logic (normally open or normally closed)can be set in the mechanical parameters of the height controller. When the lower limit triggers the height controller, it will stop moving down and give an alarm.
IN7 and IN8 (General input)	Input signal, active low. Spare input port.
OUT1 (Cutting in place)	Output signal, open-drain output, conduction with power ground during output, maximum current 200mA. Follow open, output when the height controller reaches the setting height, keep output when follow in position, close output when not in following position. The following height can be adjusted on the operation panel.
OUT2 （ Stay to position signal）	Output signal, open-drain output, conduction with power ground during output, maximum current 200mA. After the height controller turns off Follow, it will output after returning to the set docking coordinates, and turn off the output when it is not at the docking position. The docking coordinates can be set in the process parameters of the height controller, and the default is 30mm.
OUT3 （Alarm）	Output signal, open-drain output, conduction with power ground during output, maximum current 200mA. When the height controller detects the abnormality, it will output an alarm, such as upper and lower limit alarms, servo alarms, collision alarms, follow over deviations, abnormal capacitors, etc. will activate the output port to output alarms.
OUT4 (Punching in place)	Output signal, open-drain output, conduction with power ground during output, maximum current 200mA. After the height controller reaches the set piercing height, it outputs an effective signal lasting 200ms, and closes the output after 200ms. The height of the piercing can be set in the process parameters.
OUT5 (General Output)	Output signal, open-drain output, conduction with power ground during output, maximum current 200mA. Spare output port.

2.3.6 Sensor Interface

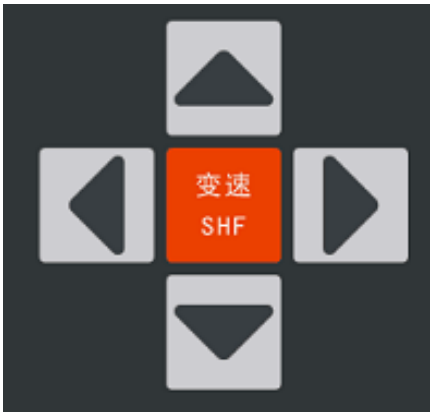
1:Connect with pin 1 of the cable
2:Connect with pin 2 of the cable
3:Connect with pin 3 of the cable
4:Connect with shield of the cable

4-pins signal cable of the sensor can be made with 3-pins shielded cable and 2 pcs of 4-pins aviation sockets. In case pin 1, 2, 3 are required to be connected together, pin 4 must be connected to shielded layer.

Chapter 3 Operation Instruction

3.1 Keys Introduction

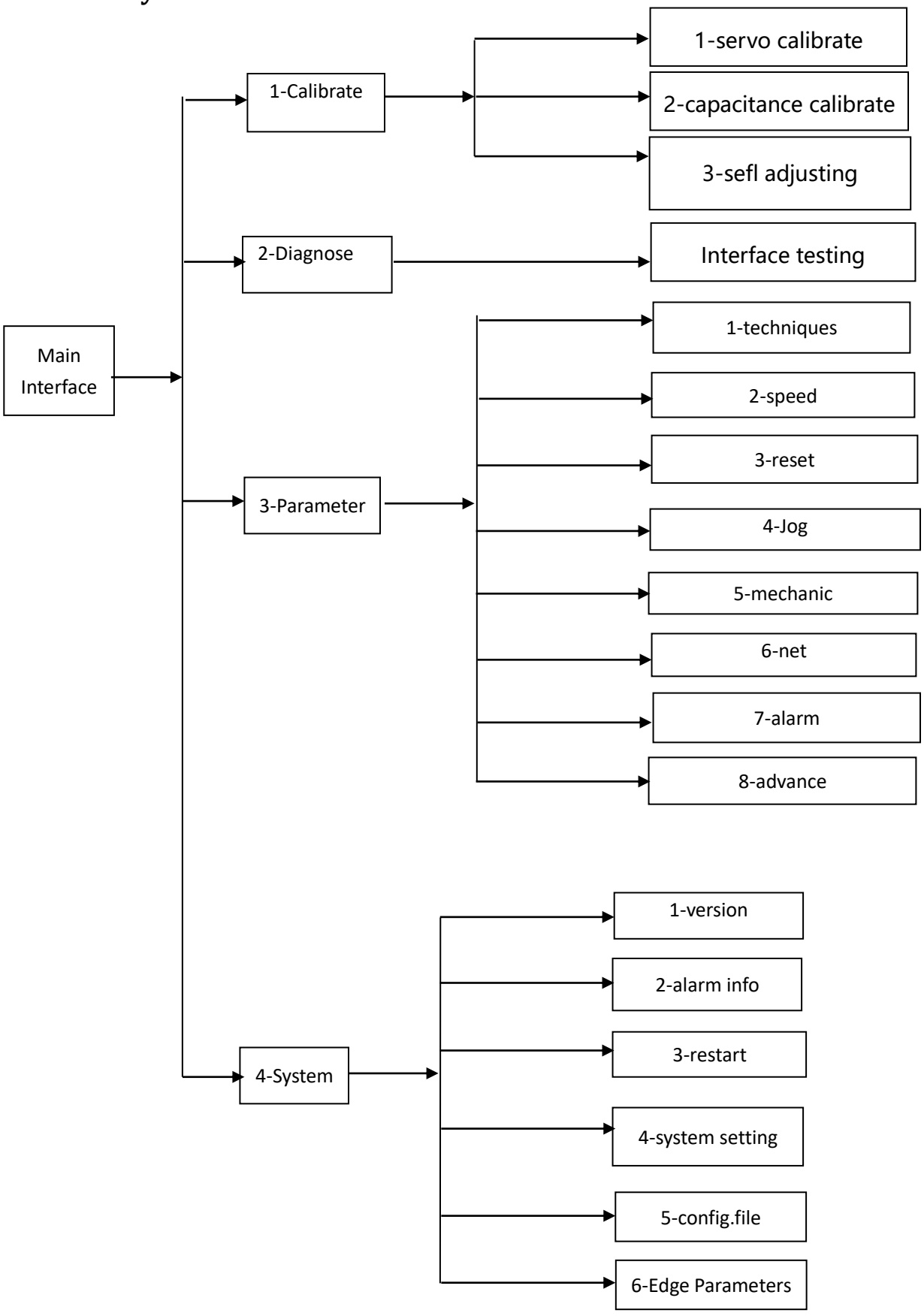
Digital keys and direction keys on operation panel



Function keys

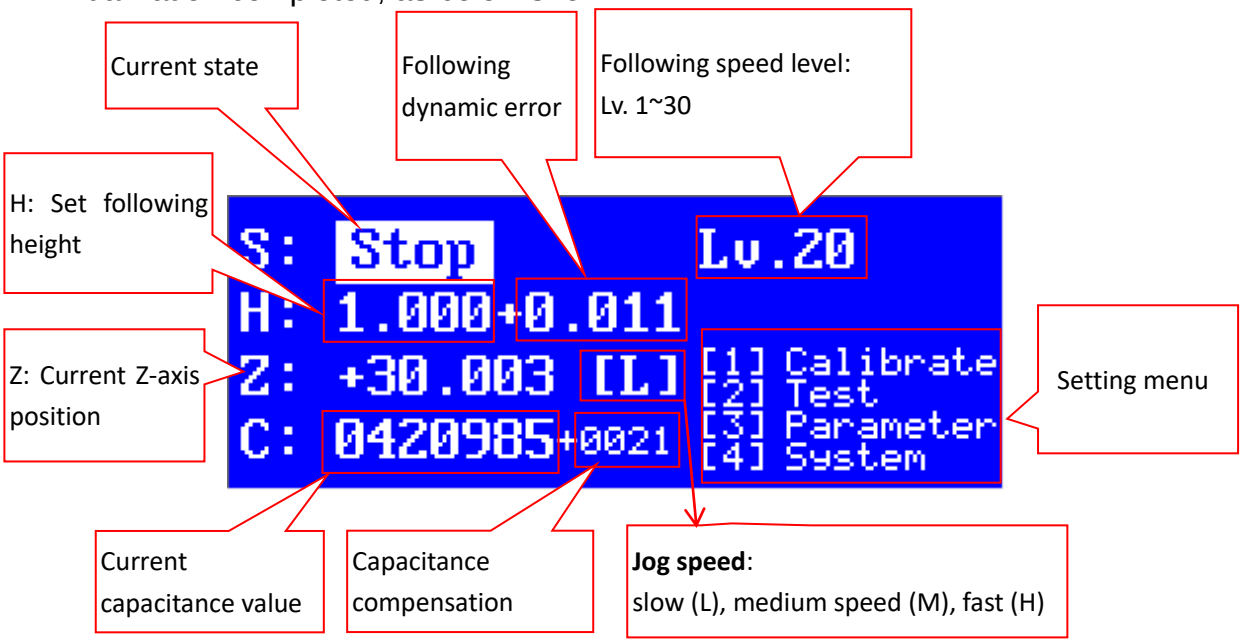
- SHUT: The cutting head will automatically rise to the stopping position while shutting the follower.
- FOLLOW: Start the following function.
- FAST/SLOW: Used for adjusting the following gain level.
- +0.1/-0.1: Used for adjusting the following height.
- STOP: Immediately stop all movements.
- HOME: origin position. Immediately go back to the origin and correct mechanical coordinates.
- SHF: arrow keys for switching cursor and inching follower, the SHF key can switch the jog speed.
- ENTER: confirm the current operation.
- ESC: cancel the operation and go back.

3.2 System Function Introduction



3.3 Main Interface

The system will enter [main interface] when the system is powered on and initialization completed, as below shown:



The display on the main interface include,
Current status: display the current motion state of the height controller. The motion states as follow,

A. Stopped: Z axis is in an idle state.
B. Decel: there will be a very short transition state for slow stop after receiving a stop instruction in motion state. It will change into Stop state after complete stop.
C. Moving: It is the movement of Z axis while lifting up during processing.
D. Follow: The follower follow the board while conduct pierce and cutting operations.
E. Origin: Go back to the mechanical origin of z axis.
F. Jogging: Manually jog z axis
G. Lift up: It is the process to shut the follower off, and lift it to the stop position.

Following Gain Level (Lv):

The scale of the following gain ranges from level 1~30, default level 16; the larger level, the minor average error is, the faster follow actions, and the stronger slope move ability is. But if gain is too high, there may be self-oscillation. It is suggested to set this parameter to self-adjusting.

Following Height:

The actual following height can be adjusted with a step of 0.1mm after pressing the button +0.1 or -0.1. The following mode can be changed through

SHUT and FOLLOW. After pressing SHUT, the axis will auto raise to the stopping coordinates (in case defaults to the Z-0, the stopping coordinates can be modified after pressing F2 to enter parameter interface. Additionally, in the Ethernet control mode, the following height is set by Cypcut software.

Dynamic Error:

In the following state, this value shows the real-time error during following movement.

Distance H between follower and the board surface:

Within the capacitance measurement range (calibration range), the distance between follower and the board surface is following height plus dynamic error. When exceeding the measuring range, set following height plus dynamic error is identically equal to the calibration range.

Current Z axis Coordinates:

After homing to origin, a mechanical coordinate system is established at Z-axis, the coordinate will increase when moving down.

Current Capacitance Value C:

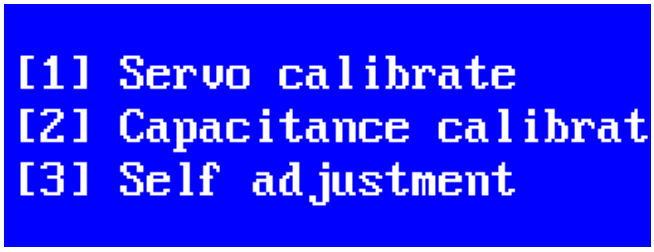
The principle of systematical sampling is to get the distance through measuring the capacitance between the follower and polar plate. The closer the follower is to the board, the larger the capacitance value is. The capacitance will change to zero while the follower hits the board.

Jog Speed of Z axis:

L represents low jog speed and the H represents high jog speed. The jog speed stalls can be switched through pressing the button SHF. Users can press the arrow button to jog.

3.4 Calibration Interface

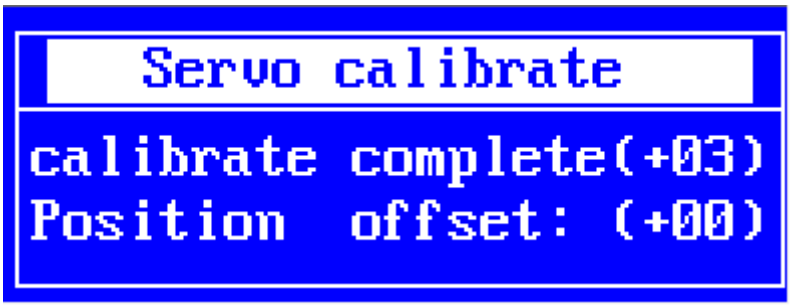
In the main interface, press key 1 to enter calibration interface, as below shown:



At the first time of installing and running the CHC-1000L, need to do servo calibration firstly. Then return origin, do capacitance calibration. At last, conduct self-adjusting. So that for the second time running, to do capacitance calibration is enough.

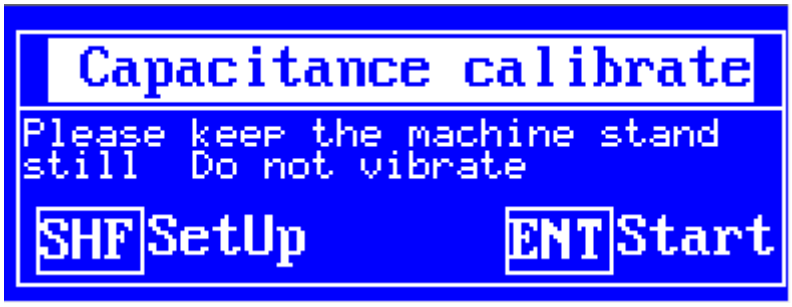
3.4.1 Servo Calibration

The purpose of servo calibration is to eliminate the zero drift of the servo motor. Press <1> to enter the “servo calibration” interface. Due to servo calibration, the electrical machine will oscillate back and forth in a small amplitude. Therefore, it is necessary to move to the middle of the stroke to prevent the concussion beyond the range of travel. Then press <ENT> to start the calibration. After the completion of automatic calibration, the system returns to the superior interface.

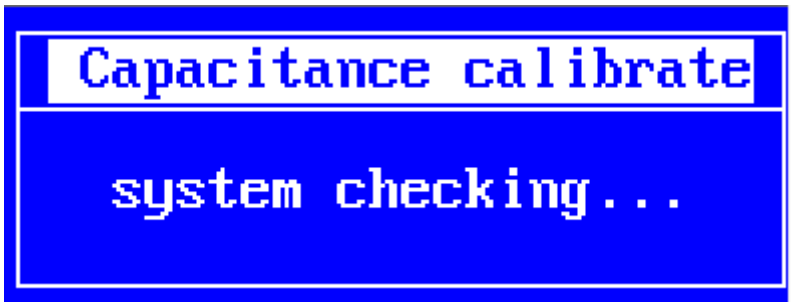


3.4.2 Floating Head Calibration

The purpose of floating head calibration is to measure the corresponding relationship between the capacitance and position between the floating head and the plate, then enter the floating head calibration interface by <2>, as shown below:

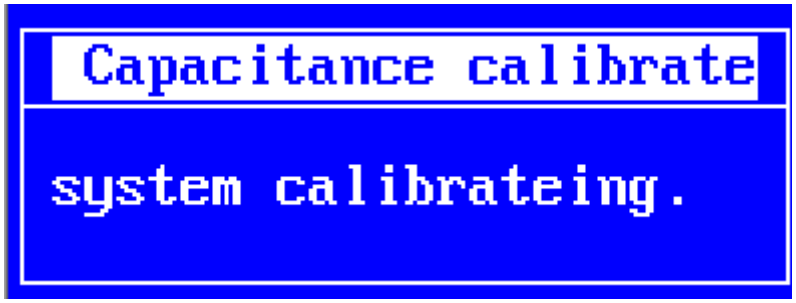


Before conducting calibration, aim the floating head close to the board surface (about 1~5mm away from the board surface), and keep the board surface still, then press <ENT> to start the calibration process, as shown below:

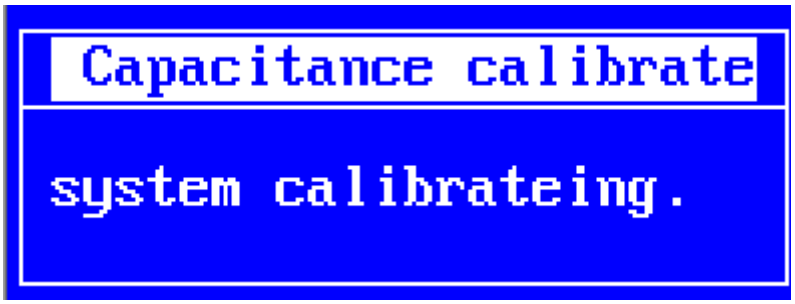


The calibration process will be completed automatically, which takes about 10 seconds. During the calibration process, users can press button STOP to end the calibration. When the calibration is completed, there are two indicators and each indicator has four levels: excellent, good, medium, poor. Briefly the floating head calibration process can be described as the following steps:

(1)The floating head moves slowly downward to detect the board surface.

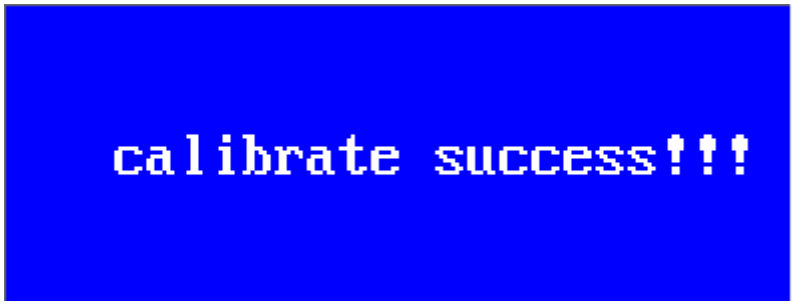


(2)After touching the board, move upward for a distance to detect the stability of the sensor.



(3) The floating head moves slowly downward to detect the board surface for the second time.

(4) After touching the board, move upward to the set calibration distance to detect the smoothness and characteristic curve of the sensor.



In case the above steps are not performed, or calibration process terminates abnormally, the hardware or cable maybe fault. There is a simple way to check whether the hardware or the connection is normal, that is, use a metal object slowly close to the nozzle, and observe whether the capacitance will change. If the capacitance gradually increased then turn 0 till the metal contact with the nozzle. It means the hardware and connection is normal and is able to be calibrated.

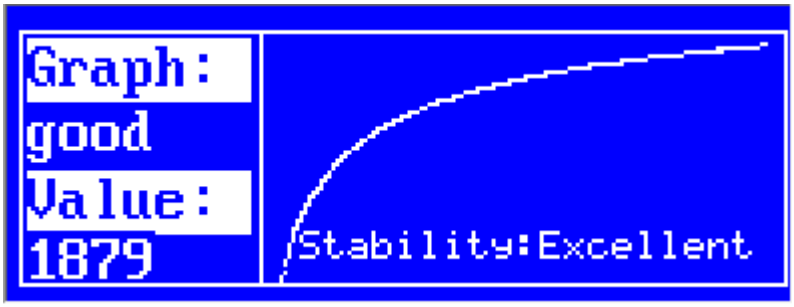
The Significance of the Calibration Result:

Stability: reflects the static characteristics of the capacitance. If not satisfied, it may be caused by the board vibration and strong external interference.

Smoothness: reflects the dynamic characteristics of capacitance changes during calibration.

The above two parameters should be calibrated to reach “medium” at least. Otherwise the system may not be used normally.

Effective Value: the transformation value of capacitance from 0.5mm to infinity. It reflects the measuring range of nozzle sensing. The larger measuring range, the better the tracking accuracy and stability. After saving the setting by <ENT>, the height-capacitance curve will be displayed.



In case the curve is not smooth and there are ups and downs or burrs, it indicates that the result is not ideal and need to conduct calibration again. If the results are still not ideal after repeated calibration, please check the hardware installation and connection of the system again. When pressing the button <6> on main interface to display the curve of floating head calibration, various alarms will appear if the calibration failed.

During floating head calibration, various alarms will appear in case of failures, as below listed:

Alarm	Description
Hit board over time	When calibrating, if cutting head moves down and check no board is hit in long time, there will be this alarm. How to check what happened? 1. Ensure the head is near the board before calibration< around 5mm>. 2, check if the hardware and connection are right. 3. Try calibration again. If head not move when calibrating, maybe the resolution ratio of analog voltage output is not enough. You should try to modify the speed voltage gain less.
Leave board overtime	Check if the hardware and connection are right
Sample overtime	Do calibration again
Always hit board	Refer to Leave board overtime alarm.
Capacity changes abnormally	Do calibration again. Take care of jog near the board at about 1—5mm before calibration.

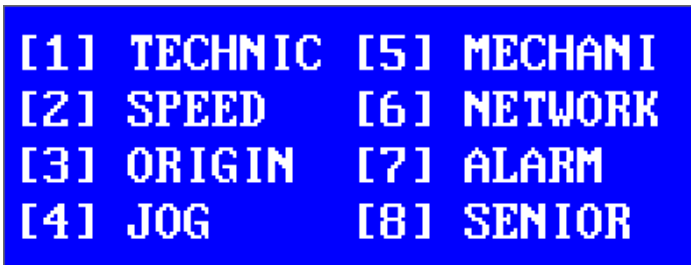
3.4.3 Self-adjustment

Automatic adjustment.

This function is not yet open, and it can be upgraded through software when it is open.

3.5 Parameter Interface

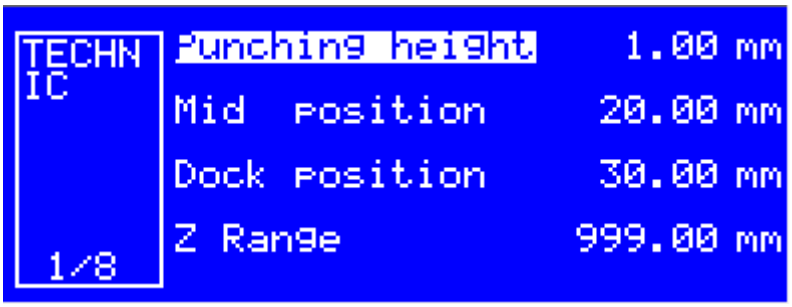
In main interface, press <3> to enter [parameter interface>, as shown below:

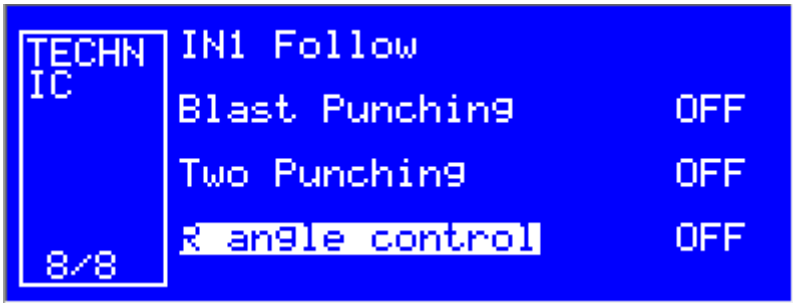


For the first time running the CHC-1000L, users need to set the above parameters correctly, especially the mechanical parameters. Otherwise the system will fail to work properly.

3.5.1 Technique Parameter

Press <1> to enter [technique parameter] interface. Page 1 is shown as below:





The definition of each parameter are shown as below:

Parameter	Definition
Piercing Height	Set the spacing distance between follower and the board during the piercing.
Mid Position	Set a coordinate, and move to the coordinate through pressing<←> and<→>on the main interface.
Dock Position	Set the target location of the follower after completely processing the program.
Z Range	Set Z rang. Immediately stop when exceeding the travel during running, and give an alarm of “Out of Z Rang”.

These parameters are mainly used in case where I/O control mode is employed. Under Ethernet control, these parameters will not take effect.

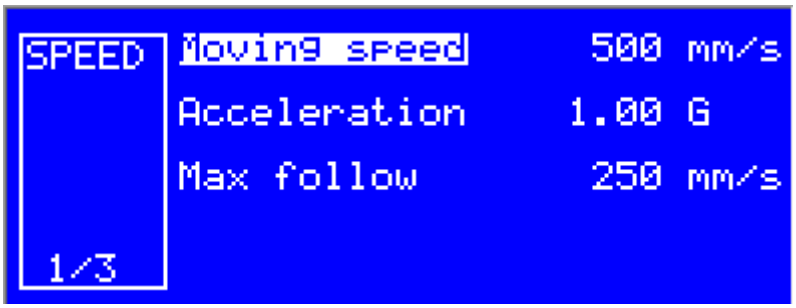
The definition of each parameter are shown as below:

Parameter	Definition
IN1 Following Mode	When input port 1 is effective, direct following mode is used, or piercing-delay-following.
Piercing Delay	Delay time during piercing.
Progressive Speed	Speed when progressively follow to the cutting height.

When dropping to the piercing position, output port 4 will give a 200ms of effective signal. When dropping to the cutting height, output port 1 will give a constant effective signal.

3.5.2 Speed Parameter

Press <2> to enter the interface of “speed parameters”, as shown below:

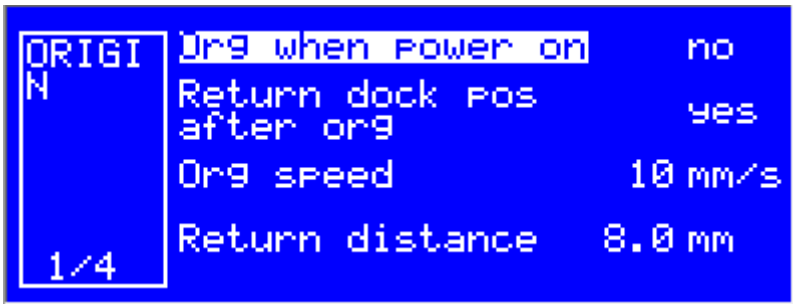


The definition of each parameter are shown as below:

Parameter	Definition
Moving Speed	Up/Down speed of follower, the suggested setting is that the servo motor should run close to rated point, so as to improve efficiency and ensure stable running of system.
Acceleration	Set the acceleration of follower for following and moving.
Max Follow	The max following speed, it depends on Acceleration and the type of nozzle. The value increases with the increasing Acceleration, and becomes higher with the higher capacity-sensitive nozzle.

3.5.3 Origin Parameter

Press <3> to enter the interface of <Origin parameters>, as shown below:

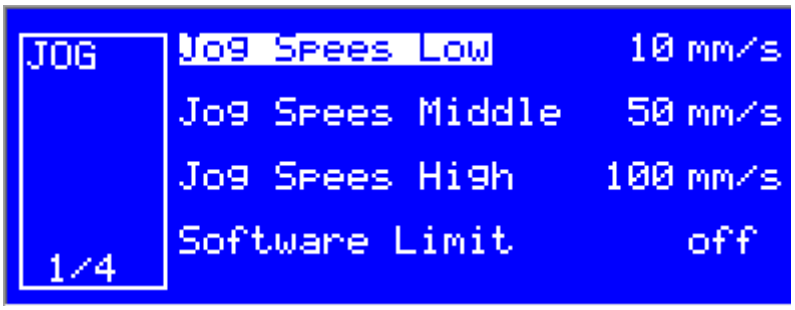


The definition of each parameter are shown as below:

Parameter	Definition
Org when power on	Set whether to auto reset after power on, and set the option to be Yes after debugging.
Return dock position after Org	Set whether to go back to the set dock position after completing reset.
Origin Speed	Set the fast movement speed to go back to the origin.
Return Distance	Set the return distance after touching the origin switch. This location is coordinate zero.

3.5.4 Jog Parameter

Press <4> to enter the interface of <jog parameters>, as shown below:



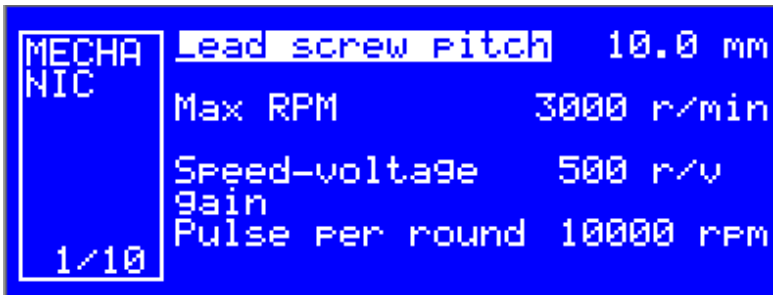
The definition of each parameter are shown as below:

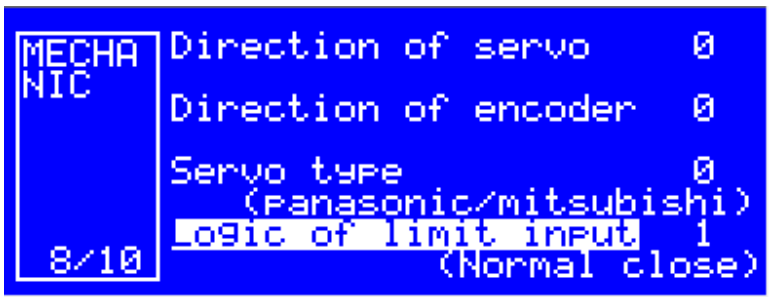
Parameter	Definition
Jog speed low	Set the speed L of Gear during jog movement.
Jog speed medium	Set the speed M of Gear during jog movement.
Jog speed high	Set the speed H of Gear during jog movement.
Soft Limit Protect	Determine whether or not to enable the soft limit while setting jog. If used, the soft limit should not jog to the position of negative coordinate or below the following height, so as to avoid hitting the limit or board during jog movement. Soft limit protection function only becomes effective on the main interface.

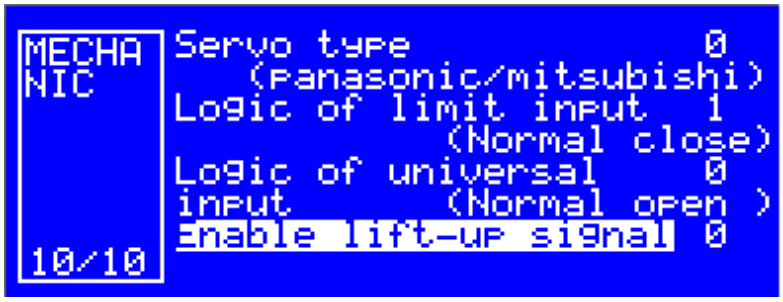
Only the jog function on the interface of<test>is open-loop controlled. The jog function on the functional testing interface will not be affected when encoder signal is abnormal.

3.5.5 Mechanical Parameter

Press <5> to enter the interface of <mechanical parameters>, and Page 1 is as shown below:





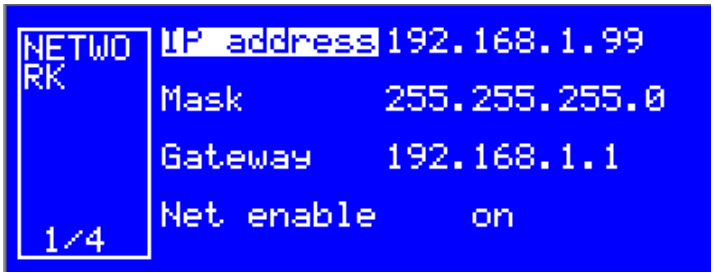


The definition of each parameter are shown as below:

Parameter	Definition
Lead Screw Pitch	Set the travel of transmission mechanism per revolution, such as screw pitch (lead). In theory, the greater the screw lead, the faster the running of Z-axis, and it is recommended to use the ball screw with a lead of 5~10mm.
Max RPM (rotate speed per minute)	Set the allowable upper limit of rotational speed of servo motor according to the characteristics of motor and load. Generally, it does not exceed 4500 rev/min.
Speed-voltage Gain	Set the actual rotational speed corresponding to each volt. The speed should be consistent with the parameters in the driver, and the recommended value is 500 rev / min corresponding to each volt.
Pulses per Round	Set the number of pulses fed back by the encoder of servo motor per revolution. The number should be consistent with the parameters in the drive.
Direction of Servo	Set the rotation direction of servo.
Direction of Encoder	Set the direction of pulse feedback of encoder.
Servo Type	**0** represents the servo of Panasonic A5, Mitsubishi J3 series, Schneider Lexium23D or Fuji A5. **1** represents the servo of Yaskawa Σ-V or Delta ASDA series. **2** represents the servo of Teco JSDEP series. The principles of zero-speed clamp, logic of input and output signals and system control parameters are different when the servos are different.
Logic of Limit Input	Set the logic of limit input port (IN5~6) (0: normally opened / 1: normally closed).
Logic of General Input	Set the logic of universal input port (IN1~4) (0: normally opened/ 1: normally closed)
IO Control Mode	If it is set to be 0, the follower will move down when IN1 is enabled, while the follower will shut when IN1 is disabled. If it is set to be 1, after IN1 become disabled, the follower can move up only after setting IN3 to be enabled. (The parameter is ignored when using network communication)

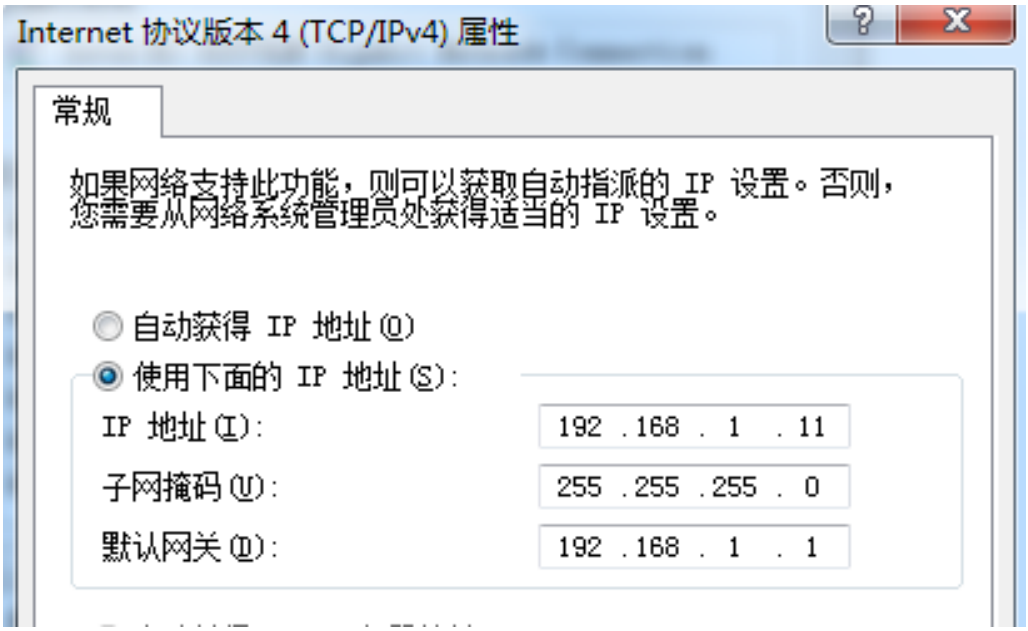
3.5.6 Network Parameter

Press to enter the interface of <network settings>, as shown below:



When using the network function, it is recommended to directly connect the PC and CHC-1000L by crossed wire. IP address of PC should be in the same network segment with CHC-1000L (192.168.1.xxx, which cannot be the same as CHC-1000L). The gateway should also be set in the network segment, and the last number is 1, such as 192.168.1.1

As shown below:



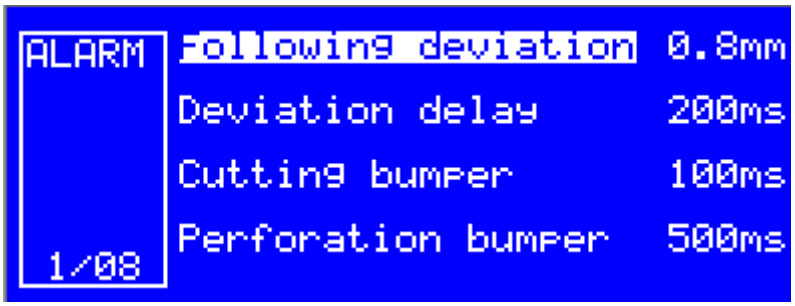
Note:

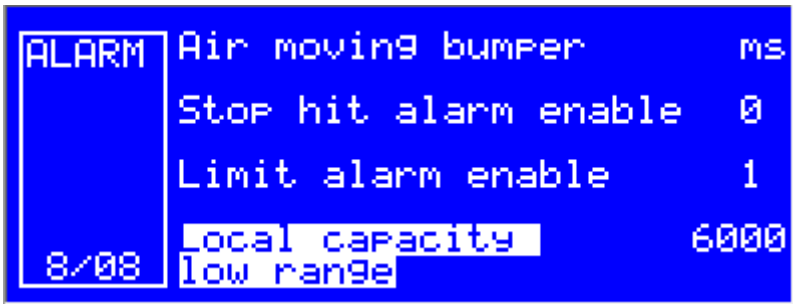
1. When the PC is connected to other network concurrently, such as IPG fiber laser (network connection mode), and each equipment should be set in different network segments. For example, the equipment can be respectively set to be 10.1.2.x and 192.168.1.x.

2. After the IP of network card is reset, please disable-enable the network card again, so as to make the IP settings of the network card to take effect.

3.5.7 Alarm Parameter

Press <7> to enter the interface of <alarm settings>, as shown below:

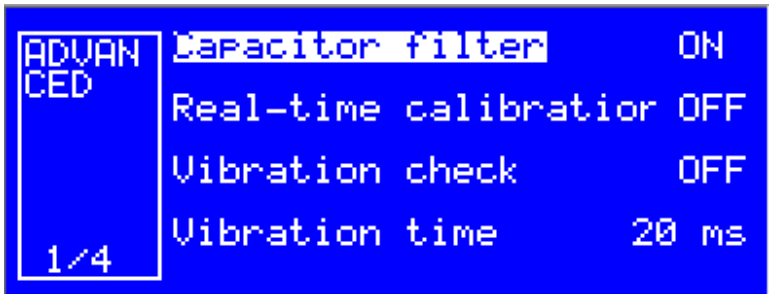




Parameter	Definition
Max Follow Deviation	It is the max. Allowable following error of CHC-1000L. After the cutting head is in place, the controller will give an alarm for too large following error if the following error exceeds the set alarm value due to the movement beyond the plate boundary or severe vibrations of board.
Max Follow Delay	Set the filter time of following error alarm. The greater the value, the slower the response and the stronger the ability to filter out interference.
Hit Board Delay	When the follower hits the board and the duration reaches the time limit, the follower will automatically move up for protection and output alarm signal.
Stop Hit Alarm Enable	This parameter indicates if hit board alarm is active when the follower is in stop state. It is safer when the value equals 1. And when you need to adjust the center of laser by stick adhesive tape, or when you do not want the controller always alarm in no plastic film, it is convenient to set it to 0.
Limit Alarm	When it is set to be 1, upper and lower limit alarm function will be started. The follower will automatically move up when encountering upper/lower limit and then give an alarm signal. When it is set to be 0, alarm function is disabled.
Capacitance Decrease Range	When the current capacitance is less than the calibrated value, the highest capacitance minus this value will trigger an alarm.

3.5.8 Advance Parameter

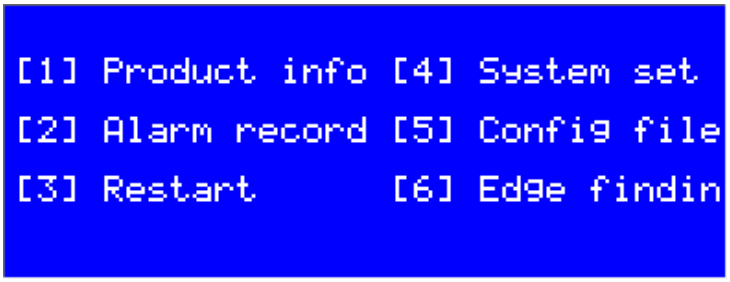
Press <8> to enter the interface of <advance parameter>, as shown below:



- **Capacitance Filter:** Whether the signal filter function of the capacitance sensor is on or off. Default ON.
- **Real-time Calibration:** When the capacitance detected by the sensor drifts due to the external conditions change (such as temperature), the height controller will start auto-adjustment. The condition is: after the following off, the height regulator is lifted back to the dock coordinate and the distance between the dock position and the board surface is greater than the effective range distance of the capacitor. (More than 30mm).
- **Vibration Suppression:** during the processing of thin board or tube, vibration of the board will occur very frequently due to the gas blowing when processing over the edge of the board or the area without support. This function can suppress the vibration caused by cutting the board of weak rigidity with cutting gas, so as to reduce the raised grain on the surface.
- **Suppression Time:** This can be set according to the actual cutting environment. The default is 20ms.

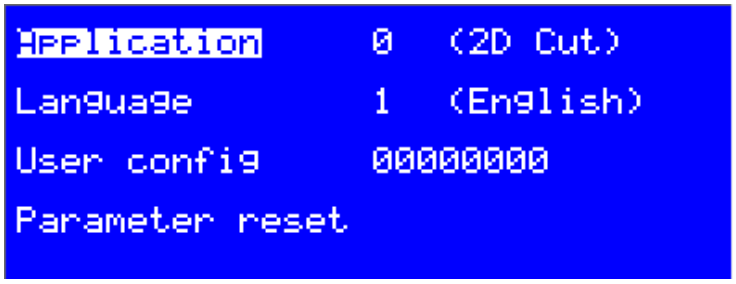
3.6 System Parameter

Access system parameters can view version information, time Settings, encryption and decryption Settings and other operations require password entry, the default password is: 23041550



System Information Interface

Version Information Interface



System Setting Interface

Application Setting

3.7 Oscilloscope

Oscilloscope function is one of the features of CHC-1000L.

Users can enter the interface of <capacitance oscilloscope> after pressing <5> on the homepage. The principle of the oscilloscope is to display capacitance value C in real time. It also displays the maximum value (MAX), minimum (Min), difference between the Max and Min (DIF) and average value (AVE) of the measured capacitance. As below shown:

Please monitor the changes of capacitance while keeping the cutting head and board stationary. The bigger DIF value is, the bigger the interference is, or the more unstable the capacitance is.

User can determine the interference size in reference with the values below:

DIF Value	Interference Level
0--10	None
10--20	Very little
20--30	Little
30--50	Average
>50	Large

Chapter 4 Debugging and Alarm Description

4.1 Debugging Steps

After installation, it needs to debug the controller as following steps:

1. Set servo parameters. Please refer to related Chapter of servo parameter settings for details.

2. When power on and the initialization completed, enter the parameter interface and set Mechanical parameters.

3. Go back to Test Interface to check whether the travel switch is enabled. If it is an optoelectronics switch, the interface will display Upper Limit is enabled when blocking the upper limit with shade. It will display Lower Limit is enabled when blocking the lower limit.

4. Enter Test interface to conduct open-loop jog, and check whether the rotation direction of motor is right. If the direction is wrong, please change the servo direction parameters. And then conduct the open-loop jog again, please change the encoder direction parameters if the encoder signal is inverse (Mechanical parameters).

5. Enter Calibration interface, and conduct Servo calibration to eliminate the zero shift of servo.

6. Return to the origin manually, and turn on the power-on reset function on the interface of Reset parameters.

7. Enter Calibration interface and do capacitance calibration for the follower.

8. Modify other parameters as required after completing the steps above.

4.2 Alarm and Analysis

Alarm	Description	Analysis
Upper/Lower Limit Valid	This alarm is generated when the system detects that the upper/lower limit of the Z-axis photoelectric switch or the contact sensor is effective.	· Check whether the wiring is correct; · Check whether “input logic “parameters are set correctly. Limit signal could be set to normally open or close; · Upper/Lower limit sensor detect object and output valid level signal; · Upper/Lower limit sensor damaged, or there is oil contamination or powder on the surface due to long-time working;
Out of Z Range	This alarm is generated when Z axis moves beyond its travel range.	In case of mistaken alarm, firstly try to reset the coordinate and confirm whether the travel parameters are set correctly and whether the feedbacks of the encoder is normal;
Servo Alarm	This alarm is released when system detect No.14 input ALM is enabled, which reflects the servo alarm status.	The high/low level logic of the alarm is different among different servos, so the servo-type parameters should be set correctly. · Servo type parameter setting is not correct; · Wiring is not correct; · Electrical system disturbs the wires; · The servo alarm;
Encoder Abnormal	This alarm is released when the system keeps in stop status and the encoder feedback value changed.	· The axis vibrates by external force; · Wiring disconnected, and zero-clamp signal null and void; · Servo rigidity is poor; · Encoder wire is interfered. Check whether the shielded wire is connected ground. Its better add magnet ring.

Encoder No Response	When the system try to move and send out speed command as voltage, but the encoder feedback value does not change at all, this alarm displays.	· Wiring connection is poor, the analog signal is not delivered to the servo, or the zero-clamp signal is in effect always, or feedbacks signal of encoder is not correctly connected to the height controller. · Servo type is incorrect. Servo shall have speed control mode, not pulse-mode. · Incorrect setting of servo parameters. Haven't switched to speed mode.
Encoder Deviation Large	When the system detects that the difference between the feedback position and the target position is too large, the alarm will be generated.	· Encoder is going in opposite direction. The position loop of the system doesn't form negative feedback. Need to modify the parameter. · Encoder feedback is abnormal due to interference of wiring. · The mechanical Z axis is stuck and the system instant torque increase, but the actual position fail to follow the destination position.
Capacity Turn 0	When the system failed to measure the capacitance correctly, this value becomes 0.	· The floating nozzle touched the board below. · There is water entering the cutting head. · The local capacity of cutting head is large which is out of measuring range of preamplifier. · The preamplifier was broken. · Wiring connection in not fixed between preamplifier and the cutting head. · Inside the cutting head, the positive of capacity (nozzle) is short circuit with the negative of capacity (cutting head housing)
Local Capacity Low	When the system detects that the local capacitance reduce beyond a certain range, the alarm will be generated.	· Connection or some part is replaced or removed, or the random changes in the characteristics of the simulated components. By this time, just need to re-calibrate. · The laser scatters on the nozzle, and raise the heating and temperature drift. · Gas blowing causes the gap between the positive (nozzle) and negative (cutting head housing) to change. · Poor contact between the connection of nozzle and the preamplifier. · The parameter of calibration range is low. In 2D mode 15mm is suggested and 10mm is suggested in 3D mode. · Connection between preamplifier and nozzle is not fixed. · Plasma cloud impacts the preamplifier. During the

		processing of stainless steel (especially with film), the following height should be large than 0.5mm, and add the blowing gas pressure.
Capacity Abnormally Large	When the system detects that the capacitance exceeds the maximum value calibrated, the alarm will be generated.	· The floating nozzle touched the board below. · There is water entering the cutting head. · The laser scatters on the nozzle, and raise the heating and temperature drift. · Inside the cutting head, the positive of capacity (nozzle) is short circuit with the negative of capacity (cutting head housing)
Follow Deviation Large	When following, the system detects the height (distance between nozzle and the board) suddenly becomes abnormal, the alarm will be generated.	· The meaning of two parameters with excessive following errors was described in details in Chapter 3, Section 3.5.7 The reason includes: · The cutting range is beyond that of the board. No object can be followed under the floating head. · The board shakes.
Expiration of Time	The service time of system setting is expired.	· Contact the supplier for solution.
Battery Lost Lock	If the user is not registered, this alarm will appear when the battery of the controller is removed.	· Users need to register to remove the alarm.
Jog near to board	When users jog towards the board around, the system detects the distance is too close then generate this alarm.	· None

4.3 FAQ

4.3.1 Obvious shake and mechanical shock in following movement.

- Amplifier casing or controller FG pin are poorly connected to the machine casing.

Machine casing is the negative electrode of the measured capacitor. When the conductivity of amplifier casing and machine casing is poor, the AC impedance between the positive and negative electrodes of the capacitor is large. Thus, the load of measured circuit varies, which may lead to larger measurement error. If good mechanical connection cannot be achieved, users can add a heavy wire (copper material is better) between amplifier metal casing to reduce AC impedance. The AC impedance of single-point connection is greater than that of good mechanical connection. It is required to make AC impedance less than 10 Ω。

- Servo rigidity is too large.

  Mechanical shock and obvious vibration may be caused during the movement due to over-large servo rigidity. For example, it is suggested that the servo rigidity of Panasonic MINAS A5 series should not be above Level 19.

- Following speed is too large.

  Vibration may be caused during the movement due to over-large following speed level. Level 3 to 7 is suggested.

- Poor Follower Calibration

  When the data stability and smoothness of capacitance and position stored in CHC-1000L is poor, vibration will be caused during the following movement. Please do follower capacitance calibration again, until the stability and smoothness becomes excellent or good.

- In case there is a heavy interference at site, users can appropriately reduce the parameter of “servo gain” coefficient.

4.3.2 The follower always hits the board during the following movement.

- Too small calibration range or too large Z-axis speed.

  The smaller the calibration range, the smaller the deceleration distance of following movement. If Z-axis speed is too large and it is not reduced to 0 when the follower flows to place, overshoot will be unavoidable. The greater the Z-axis speed is, the greater the overshoot is. When Z-axis speed is greater than 100mm/s, it is recommended to set the calibration range to be 15mm. When

Z-axis speed is greater than 250mm/s, it is suggested to set the range to be 20~25mm.

- Capacitance Calibration
  The follower will hit the board when there is a large deviation between the capacitance stored in CHC-1000L and actual measured capacitance. For example, the nozzle temperature heats a lot or the connection is not stable. Users need to firstly find the reason, and then calibrate again after solving the problem.

- The locking nut of ceramic part is not fixed.
  The locking nut of ceramic part is not fixed tightly, which may lead to instable detecting capacitance. The detected index is the change of blowing capacitance should be less than 50.

4.3.3 Large deviation between the following height and the height actually set.

- Incorrect parameter setting
  The lead distance of screw pitch does not match the actual lead distance, and the speed gain parameter of regulator does not match the set value of the drive.

- Calibration problem
  The above problem will occur when the floating head capacitance calibration is not done again after the nozzle is replaced.

- The laser scatters on the nozzle then leads to the abnormal heating of nozzle, or the blowing leads to a large change in capacitance, which will change the capacitance of the cutting head.

4.3.4 Lift-up Height Abnormal

- When the life-up height is getting lower and lower during processing, users need to check whether there is mechanical slippage or abnormal mechanical connections.

4.3.5 Follower moves up without contacting the board during calibration.

- Please check the followed material is set to “metal” or “non-metal”.

4.3.6 Display initialization failed when start up.

- Abnormal power supply or other reasons may cause CHC-1000L power cannot load the master control program. Download the latest program to update can solve this problem.

4.3.7 Failed to upgrade the USB or USB drive could not be found.

Upgrade method: hold down the backspace key < ⟵ > for 6 seconds around and then enter system upgrade interface, and then insert the USB.

- Ensure the upgraded file (CHC_app.bin) is saved under the root directory of the USB drive.
- Format the USB drive into FAT32 format.