BCS100 Fiber Laser Controller — User Manual

RSD-SUNMAX Series

SUNMAX LASER

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User Manual
(Fiber Laser Controller BCS100 — Instruction Manual)

English Edition Ver. 1.0

RSD SUNMAX LASER
RINSYUNDOU Co., Ltd.

Thank you for choosing our product.

This manual describes the BCS100 fiber laser controller in detail, including its system functions, operation, and installation. For details on the CypCut control software, refer to the CypOne J User Manual. For any other information, please contact us directly. Read this manual carefully before operating the controller and its related devices.

Because product functions are continuously updated, there may be some differences between the manual you receive and the actual product.

Contents

Chapter 1 Product Overview

1.1 Introduction

The BCS100 capacitive controller (hereinafter "BCS100") is a high-performance control unit that uses a closed-loop control method. The BCS100 features its own Ethernet communication (TCP/IP protocol) interface, and together with the CypCut software it easily provides many functions such as automatic

height tracking, segmented piercing, progressive piercing, edge seeking, leapfrog motion, and freely configurable lift-up height, greatly improving the success rate. In terms of servo control in particular, thanks to its dual closed-loop algorithm for speed and position, its execution speed and accuracy are clearly superior to other comparable products.

1.2 Performance Description

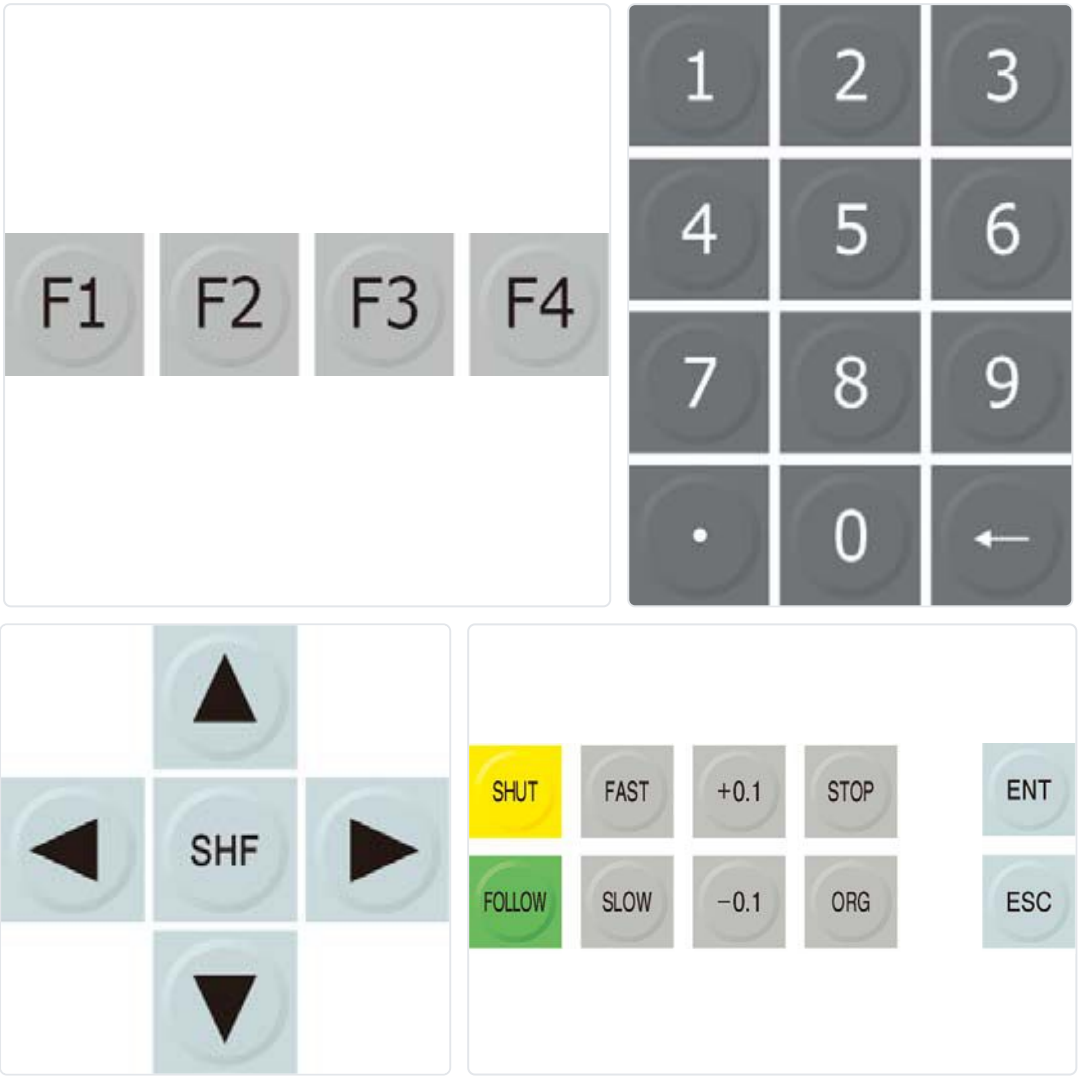
- Sampling rate: 1,000 times per second.
- Static measurement accuracy: 0.001 mm.
- Dynamic response accuracy: 0.05 mm.
- Following range: 0-25 mm.
- With a signal transmission cable up to 100 m long, the signal is not attenuated thanks to its high interference-resistant capacitance design.
- Supports network communication and online upgrade via USB flash drive (U disk).
- Compatible with cutting heads and nozzles.
- Supports alarms for hitting the board and crossing the edge.
- Supports edge detection and automatic inspection.
- Quick and simple operation with an automatic calibration process.
- Supports leapfrog motion and segmentation.
- Supports an oscilloscope function that detects capacitance in real time.

Comparison table of new and old products

Performance index	**BCS100 V2.0**	**BCS100 V3.0**
Maximum speed	400mm/s	999mm/s
Maximum acceleration	0.4G	2G
Capacitance disturbance suppression	5%	10%
Minimum rigidity requirement	5Hz	2Hz
D/A resolution	12 bit	16 bit
D/A zero drift	16mv	3mv
D/A response time	5ms	0.01ms
Positioning accuracy	±0.05mm	±0.01mm

Chapter 2 Operating Instructions

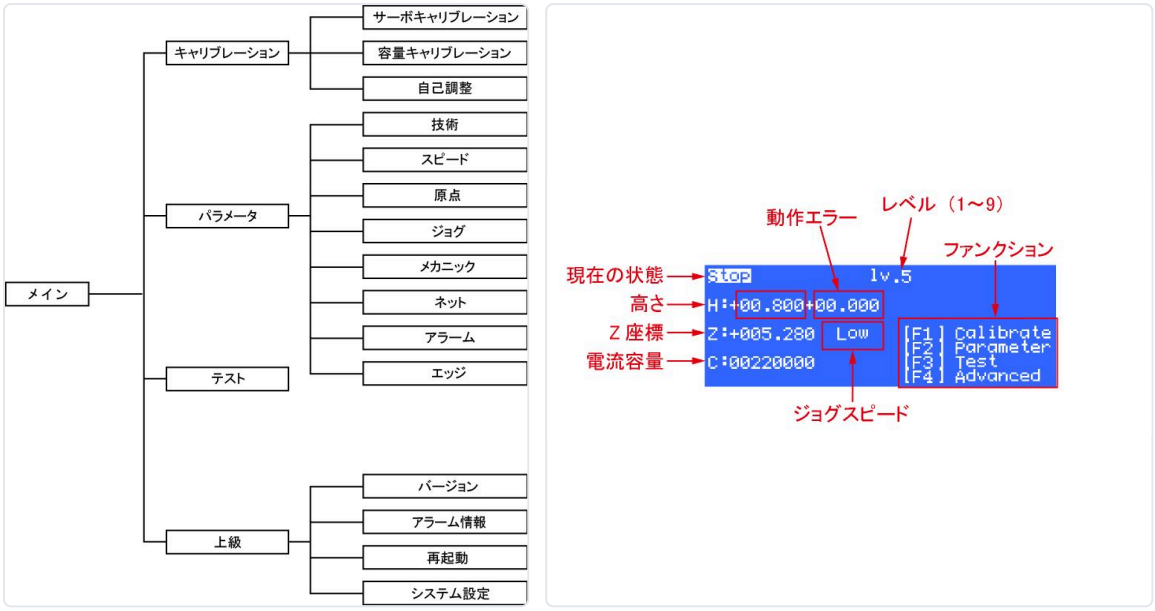
2.1 Key Description



Keyboard	Function
Function keys	Provide quick function settings on this interface.
Number keys Decimal point Backspace key	Used for numeric input, mainly for entering parameters.
Arrow keys	Used to move the cursor and to inch (jog) the follower. The <SHF> key switches the jog speed.
Control keys	<SHUT>: The cutting head automatically rises to the stop position; shuts down the follower. <FOLLOW>: Starts the follow function. <FAST><SLOW>: Adjust the follow gain level. <+0.1><-0.1>: Used to adjust the follow height. <STOP>: Immediately stops all motion. <ORG>: Immediately returns to the origin; accurate mechanical coordinates are obtained. <ENT>: Confirms the current operation. <ESC>: Cancels the operation and returns.

2.2 Function Hierarchy Chart

The function hierarchy of the BCS100 is as follows.



2.3 Main Interface

After the system is powered on, it automatically enters the <Main Interface>. Initialization completes as shown below.

The main interface display is as follows.

Current status

Displays the current motion state of the follow system. The motion states are:

- A. Stop: The Z axis is idle.
- B. Deceleration: After a stop command is received while in motion, there is a very short transition state for a low-speed stop. After coming to a complete stop, the state changes to "Stop."
- C. Moving: The Z axis is moving while lifting during processing.
- D. Follow: The follower follows the board while performing piercing and cutting operations.
- E. Origin: Returning to the Z-axis mechanical origin.
- F. Jogging: The Z axis is being jogged manually.
- G. Lift up: The process of stopping the follower and lifting it to the stop position.

Follow gain level

The follow gain level ranges from 1 to 30. The higher the level, the smaller the average error, the faster the following, and the stronger the slope-following capability. However, if the gain is too high, self-oscillation may occur. It is recommended to set this parameter using self-adjustment.

Follow height

Pressing the <+0.1> and <-0.1> buttons adjusts the actual height in 0.1 mm steps. The follow mode can be changed by pressing <SHUT> and <FOLLOW>. When <SHUT> is pressed, the axis automatically rises to the stop coordinate (by default the Z = 0 position; the stop coordinate is set by pressing <F2> to enter the parameter interface). In addition, in Ethernet control mode, the follow height is set by the CypCut software.

Dynamic error

In the follow state, this value reflects the real-time error during motion. Distance H between the follower and the plate surface: within the capacitance measuring range (calibration range), the distance between the follower and the plate surface is "follow height" + "dynamic error." Beyond the measuring range, "height setting" + "dynamic error" equals the calibration range.

Current Z-axis coordinate

After returning to the origin, a mechanical coordinate system is established on the Z axis. The coordinate increases as the axis moves.

Current capacitance value C

The system's sampling principle is to obtain the distance by measuring the capacitance between the follower and the plate. The closer the follower is to the plate, the larger the capacitance value. While the follower is touching the board, the capacitance becomes zero.

Z-axis jog speed

<L> indicates the low jog speed and <H> the high jog speed. The jog speed level can be switched by pressing the <SHF> button. Press the <↑> and <↓> buttons to jog.

2.3.1 Hidden Functions of the Main Interface

Keyboard	Function
<3>	Sets the follow parameters.
<4>	Displays the real-time error.
<5>	Real-time capacitance display.
<6>	Capacitance-distance curve.
<7>	Records the current capacitance.
<9>	Starts edge cutting.
<0>	Sets the current Z-axis coordinate to 0.

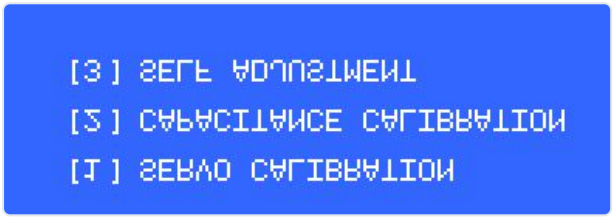
2.4 Calibration Interface

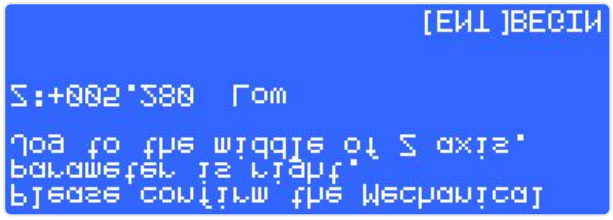
Press the <F1> key on the main interface to enter the <Calibration Interface>.

When installing and using the BCS100 for the first time, perform servo calibration first. Then return to the origin and perform capacitance calibration. Finally, perform self-adjustment. From the next time on, capacitance calibration alone is sufficient.

2.4.1 Servo Calibration

The purpose of servo calibration is to eliminate the zero drift of the servo motor. Press the <1> key to enter the <Servo Calibration> interface, shown below.



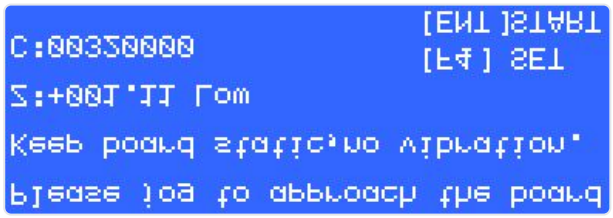


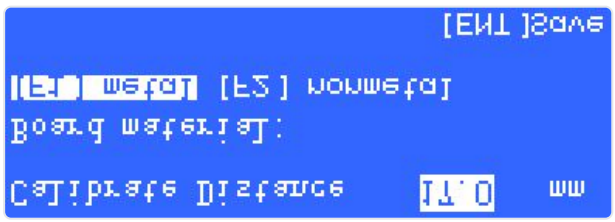
During servo calibration, the motor oscillates back and forth with a small amplitude. The motor must therefore first be jogged into the travel range, and it must not exceed the travel range while oscillating. Press <ENT> to start calibration.

After the calibration completes automatically, the system returns to the main interface.

2.4.2 Capacitance Calibration

The purpose of follower calibration is to measure the correspondence between capacitance and position between the follower and the board. Press <2> to enter the <Follower Calibration> interface (see figure below).





If no settings have been made previously, press <F4> to set the calibration parameters.

Parameter	Description
Calibration Distance	Capacitance data must be recorded within the calibration range; the default is 25 mm. If the Z-axis travel is too short, the user may reduce this value appropriately.
Board material	Sets the material of the object to be followed.

Press <ENT> to save the parameters and return to the previous interface. Before calibrating, first move the follower close to the board (at least 1 mm above the board) and keep the board free of vibration. Press <ENT> to start calibration.

The calibration process runs automatically and completes within 10 seconds. Pressing the <Stop> button forces the calibration to end. After calibration is complete, two criteria are evaluated, and each is graded on four levels: "excellent," "good," "not good," and "poor." The automatic calibration procedure is as follows:

1. The head descends slowly and checks whether it has touched the board.
2. After touching the board, the head rises 2 mm while its stability is checked.
3. The head descends slowly and checks whether it touches the board a second time.
4. If the board is touched, the head moves above the calibration range and the smoothness and capacitance characteristics are checked.

If any of these steps is not executed and an alarm occurs after calibration, hardware or connection problems should be suspected. A simple way to check for such a problem is as follows:

Touch the nozzle with a piece of metal and check whether the capacitance changes. If the change is small (around 200) or the capacitance is always 0, a hardware or connection problem is indicated.

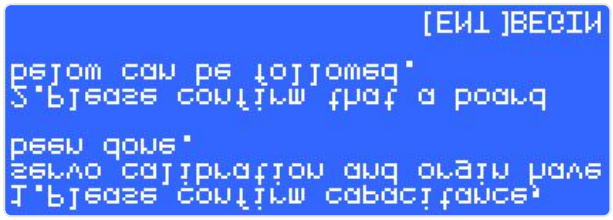
> **Caution:** For safety and to avoid static electricity, touching the nozzle by hand while the system is powered is not recommended.

The meanings of the calibration results are as follows:

Item	Description
Stability	Reflects the static characteristics of the capacitance. If this rating is not ideal after calibration, the cause is board vibration or strong external interference.
Smoothness	Reflects the dynamic characteristics of the capacitance change during calibration.
Effective value	The difference in capacitance between the board at 0.5 mm and at infinity. A larger value means better precision and stability.

These two ratings must be at least "medium"; otherwise the system may not operate normally. Under relatively ideal conditions, both ratings should be "excellent" or "good."

Press <ENT> to save the calibration result, and the capacitance–distance curve is displayed. As shown below, a normal curve should be smooth.



If the curve is not smooth, the result is not ideal and recalibration is required. If the result remains unsatisfactory after repeated calibration, the hardware installation and system wiring should be re-examined. In addition, the calibrated curve can be displayed by pressing the <6> button on the main interface.

If calibration fails, the alarms are as follows:

Alarm	Description
Hit board over time	This alarm occurs when, during calibration, the cutting head descends but does not touch the board for a long time. How to check what happened: First, make sure the head is close to the board (about 5 mm) before calibration. Next, check that the hardware and connections are correct. Finally, try the calibration again. If the head does not move during calibration, the resolution of the analog voltage output may be insufficient; do not change the speed–voltage gain excessively.
Leave board overtime	Check whether the hardware and connections are correct.
Sample overtime	Calibrate again.
Always hit board	See the "Leave board overtime" alarm.
Capacity changes abnormally	Calibrate again. Before calibration, jog the head to about 1–5 mm from the board.

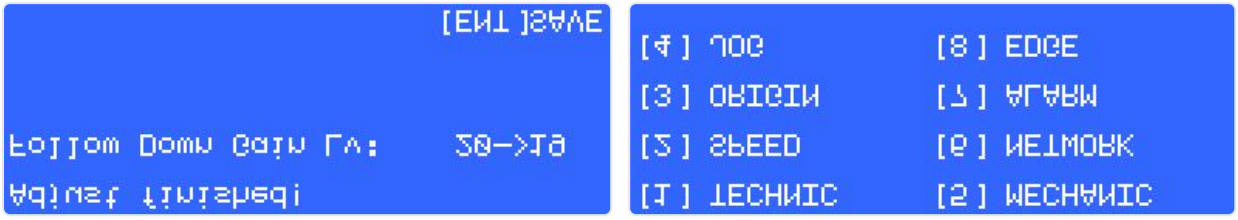
2.4.3 Self-Adjustment

Press <3> to enter the <Self-Adjustment> interface, as shown below.

Before adjusting, confirm the following:

- Servo calibration has been performed.
- Homing (origin return) has been completed.
- Capacitance calibration has been performed.
- There is a board beneath the follower head.

The adjustment process is repeated many times to optimize the internal parameters. The optimization result is shown below.



Press <ENT> to save the parameters. Their meanings are as follows:

Parameter	Description
Follow down gain Lv	The larger the value, the faster the response; if it is too large, heavy deceleration will result. This parameter can only be set by self-adjustment. The level parameter is also set after adjustment.

2.5 Parameter Interface

On the main interface, press <F2> to enter the <Parameter Interface>.

> **Caution:** When using the BCS100 for the first time, the above parameters must be set correctly. In particular, the "Mechanical parameters" must be set correctly; otherwise correct operation cannot be obtained.

2.5.1 Technical Parameters

Press <1> to enter the <Technical Parameters> interface. The first page is as follows:

The parameters are described below:

Parameter	Description
Z-Range	Sets the Z range. If the travel range is exceeded during movement, the axis stops immediately and a "Z out of range" alarm is issued.
Dock Position	Sets the target position of the follower after the program has been fully processed.
Mid Position	Sets a coordinate; press <←> and <→> on the main interface to move to that coordinate.
Punch height	Sets the gap between the follower and the board during the punching operation.

When the cursor selects the "positioning," "coordinate stop," or "Z-axis movement" parameters, an additional [F1] menu is displayed. Press [F1] to set the current parameter in jog mode.

Press <ENT> to go to the next page and continue setting the process parameters.

The second page is as follows:

These parameters are mainly used in I/O control mode. They have no effect in Ethernet control mode.

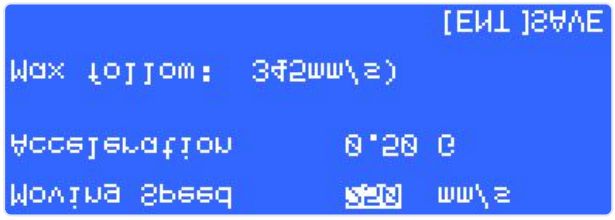
The parameters are described below:

Parameter	Description
IN1 following mode	When input port 1 is active, direct following mode is used.
Punching delay	Delay time during punching.
Progressive speed	Speed when progressively following down to the cutting height.

When the head descends to the punching position, output port 4 gives a 200 ms active signal. When it descends to the cutting height, output port 1 gives a continuously active signal.

2.5.2 Speed Parameters

Press <2> to enter the <Speed Parameters> interface, as shown below.



The parameters are described below:

Parameter	Description
Moving speed	Up/down movement speed of the follower. To improve efficiency and ensure stable system operation, it is recommended to run the servo motor close to its rated point.
Acceleration	Sets the acceleration for follower following and movement.
Max follow	Maximum following speed; depends on the acceleration and the nozzle type. This value increases as acceleration increases, and it is higher for capacitance-sensitive nozzles.

2.5.3 Origin Parameters

Press <3> to enter the <Origin Parameters> interface.

The parameters are described below:

Parameter	Description
Whether to origin after power-on	Sets whether to home automatically after power-on. Set this option to Yes after debugging is complete.
Whether to return to dock position	Sets whether to return to the configured dock position after homing is completed.
Origin speed	Sets the rapid movement speed for returning to the origin.
Return distance	Sets the return distance after the origin switch is touched. This position becomes coordinate zero.

2.5.4 Jog Parameters

Press <4> to enter the <Jog Parameters> interface.

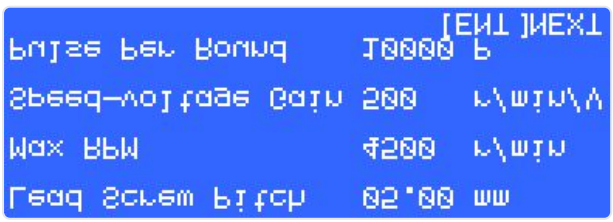
The parameters are described below:

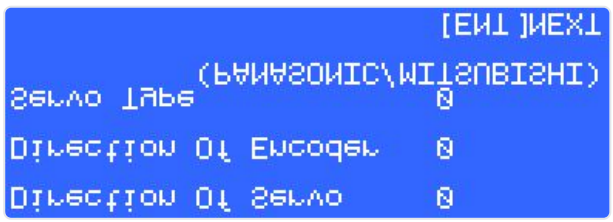
Parameter	Description
Jog speed low	Sets the speed of gear L during jog operation.
Jog speed high	Sets the speed of gear H during jog operation.
Software limit	Determines whether the soft limit is enabled during jogging. When enabled, the soft limit prevents jogging to negative coordinate positions or below that height, in order to avoid hitting the limit or the board during jog movement. The soft-limit protection function is effective only on the main interface.

Only the jog function on the <test> interface is open-loop controlled. If the encoder signal is abnormal, the jog function on the function test interface is not affected.

2.5.5 Mechanical Parameters

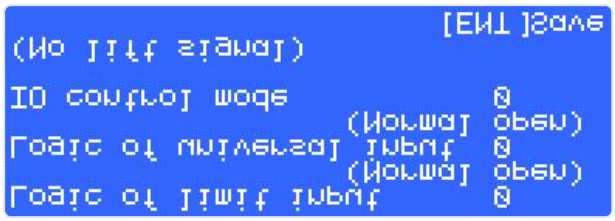
Press <5> to enter the <Mechanical Parameters> interface. Page 1 is displayed as follows:





Press <ENT> to display page 2:

Press <ENT> again to display page 3:

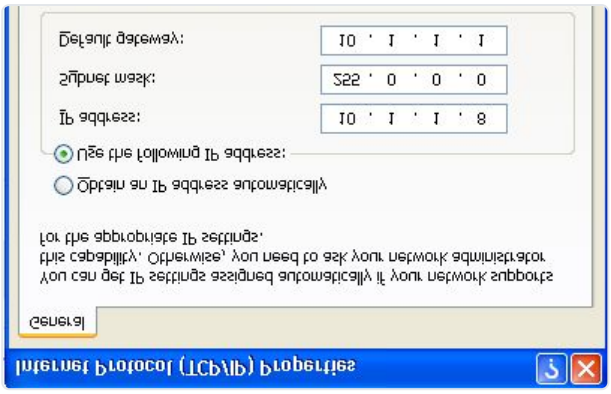


The parameters are described below:

Parameter	Description
Lead screw pitch	Set the travel of the transmission mechanism per screw lead (pitch). Theoretically, the larger the screw lead, the faster the Z-axis moves per revolution; a ball screw with a 5 mm lead is recommended.
Max RPM (rotate speed per minute)	Set the upper limit of the servo motor's allowable rotation speed according to the characteristics of the motor and load. In general it should not exceed 4,500 r/min.
Speed-voltage gain	Sets the actual rotation speed corresponding to each volt. The speed must match the driver parameters; the recommended value is 500 r/min per volt.
Pulses per round	Sets the number of pulses fed back per revolution by the servo motor encoder. This number must match the driver parameters.
Direction of servo	Sets the rotation direction of the servo.
Direction of encoder	Sets the pulse feedback direction of the encoder.
Servo type	0 represents Panasonic A5, Mitsubishi J3 series, Schneider Lexium23D, or Fuji A5 servos. 1 represents Yaskawa Σ-V or Delta ASDA series servos. 2 represents Teco JSDEP series servos. Different servos differ in the zero-speed clamp principle, the logic of the input and output signals, and the system control parameters.
Logic of limit input	Sets the logic of the limit input ports (IN5–6) (0: normally open / 1: normally closed).
Logic of General input	Sets the logic of the universal input ports (IN1–4) (0: normally open / 1: normally closed).
IO control mode	When set to 0, the follower moves down when IN1 becomes active, and stops following when IN1 becomes inactive. When set to 1, after IN1 becomes inactive, the follower moves up and becomes effective only after IN3 is activated. (Ignored when network communication is used.)

2.5.6 Network Settings

Press <6> to enter the <Network Settings> interface.



When using our CypCut laser cutting software, advanced functions such as lifting to any height, frog-leap moves, segmented piercing, and flying optical-path correction can easily be implemented over the network. For details, refer to the CypCut software manual. If you do not use the CypCut software, shut down the network; otherwise the startup process will be slow.

When using the network function, we recommend connecting the PC and the BCS100 directly with a crossover cable. The PC's IP address must be in the same network segment as the BCS100 (10.1.1.xxx, but it cannot be the same as the BCS100's address). The gateway must also be set within the same network segment, and its last number must be 1, for example 10.1.1.1.

> **Note:** If the computer is simultaneously connected to other network devices, such as an IPG fiber laser (network connection mode), each device must be set to a different network segment — for example, the devices can be set to 10.1.2.x and 192.168.1.x.2 respectively. After the network card's IP has been reset, disable the network card and enable it again so that the new IP settings take effect.

2.5.7 Alarm Settings

Press <7> to enter the <Alarm Settings> interface, shown below.

Parameter	Description
Max follow deviation	The maximum permissible follow error of the BCS100. After the cutting head is installed, if movement beyond the plate boundary or severe vibration of the board causes the follow error to exceed the set alarm value, the controller issues an "error too large" alarm.
Max follow delay	Sets the filter time for the follow-error alarm. The larger the value, the slower the response and the stronger the ability to reject interference.
Hit board delay	When the follower hits the board and the elapsed time reaches this limit, the follower automatically rises for protection and outputs an alarm signal.
Stop hit alarm enable	This parameter indicates whether the hit-board alarm is active while the follower is stopped. A value of 1 is safer. Setting it to 0 is convenient when the laser center needs to be aligned using adhesive tape, or when you want to keep the controller from constantly alarming on plastic film.
Limit alarm	When set to 1, the upper/lower limit alarm function is enabled: when the follower reaches the upper or lower limit, it automatically moves up and outputs an alarm signal. When set to 0, the alarm function is disabled.

2.5.8 Edge Settings

Press <8> to enter the <Edge Settings> interface, shown below.

Parameter	Description
Saturation speed	The maximum follow speed applied after the head cuts through, so that the head does not plunge too deep at saturation.
Cut in check	Checks whether H is lower than this parameter; when it is, the head starts following.
Cut out check	When the H position is checked to be greater than the cut-out value, the "cut out check" is performed and finally "cut out" is executed.
Cut out delay	Delay applied to the cut-out check.
Height	Through cut: sets the Z position to the follow position.

2.6 Test Interface

On the main interface, press <F3> to enter the <Function Test> interface.

Users can test the key states, the input/output ports, and whether the motor rotation direction is correct. After completing the installation for the first time, you must enter the switch-jog interface to determine whether the motor rotation direction and the encoder signal direction are correct.

If the motor rotation direction is incorrect, change the "Servo direction" parameter in "Machine parameters", and then run an open-loop jog to determine whether the encoder signal direction is correct. If a message appears indicating that the encoder direction is wrong, change the "Encoder direction" parameter in "Machine parameters".

The input and output ports of this interface are defined as follows.

Input port	Input port description	Output port	Output port description
IN1	Follow at cutting height	OUT1	Follow-in-place signal
IN2	Align coordinates	OUT2	Position-hold signal
IN3	Lift-up signal	OUT3	Alarm output signal
IN4	Stop signal	OUT4	Piercing signal
IN5	Negative limit	OUT5	Servo-off alarm (servo signal)
IN6	Positive limit	OUT6	Servo enable (servo signal)
IN7	Servo alarm (servo signal)	OUT7	Zero-speed clamp (servo signal)

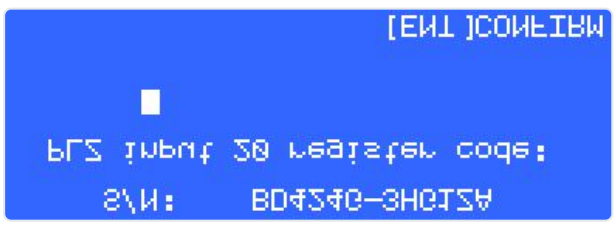
2.7 Advanced Settings Interface

On the main interface, press <F4> to enter the <Advanced Settings> interface.

2.7.1 Product Information

Press <1> to enter the <Product Information> interface.

Users can view the following information on this interface.



Information	Description
Version	For example, v3.0.3032 is the program version number. "2D" indicates that it is used for flat cutting; "3D" indicates that it is used for 3D machine cutting.
ID number	The globally unique serial number of the BCS100, e.g. 201111180100.
Expiration	The remaining service time of the BCS100 (e.g. 30 days, or unlimited).
Current Time	The current internal date of the BCS100.

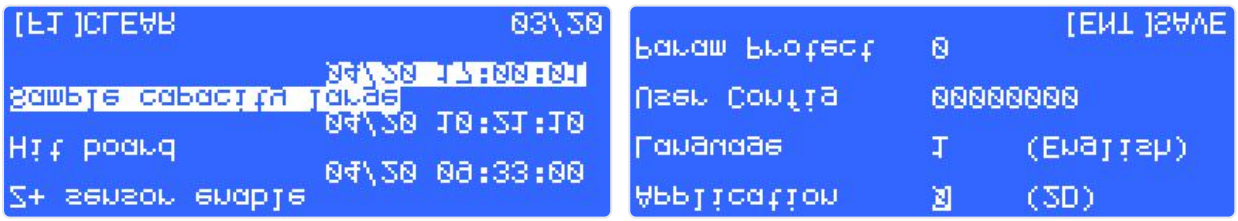
New versions of the program are released periodically. The update procedure is as follows.

1. Prepare a USB flash drive and format it as FAT/FAT32 (NTFS format is not supported).
2. Copy the upgrade file(s) to the root directory of the USB drive. Do not rename the files. (For BCS100 V2.0 there are two files, <BCS.AFM> and <BCS.FFM>; for BCS100 V3.0 there is only one file, named <BCV3.AFM>.)
3. Insert the USB drive into the USB interface of the BCS100.
4. Restart the BCS100. (Method 1: turn the power off and on again. Method 2: use the restart function.)
5. Wait until the upgrade progress bar reaches 100% and the buzzer sounds.
6. Remove the USB drive and check the software version.

When the service time of the BCS100 expires, alarm information (service time expired) is displayed on the main interface and key functions cannot be used. The user can press [F1] to register, enter the <Registration Interface>, and continue using the height controller after entering the correct registration code.

2.7.2 Alarm Information

Press <2> to enter the <Alarm Information> interface.



On this interface, previous alarm events are displayed in a list. The system can record up to 20 alarm events. The alarm list can be cleared by pressing <F1>. For the meaning of each alarm, refer to Chapter 5.

2.7.3 Restart

Press <3> to restart the BCS controller. This operation is equivalent to powering the system off and then on again. When upgrading the program, the user can first insert the USB disk into the BCS and then use the restart function to complete the upgrade, which saves the trouble of powering the system off and on.

2.7.4 System Settings

Press <4> and enter the password 61259023 to access the <System Settings> interface.

Parameter	Description
Application	0: flat cutting application. 1: 3D cutting application.
Language	0: Chinese version. 1: English version.
User configuration	Special customization functions.
Parameter protect	0: parameters are not encrypted. 1: parameters are encrypted; a password must be entered to change the parameters. Password: 11111111.

2.7.5 Configuration File

Press <5> and the following is displayed.

The functions of the configuration file are as follows:

- Copy all parameters of a specified machine to machines of the same type.
- Create the BCS100 startup logo.
- Back up the BCS100 parameters.

> **Caution:**
>
> - Use a USB disk formatted as FAT/FAT32.
> - The configuration file format is xxx.CFG. When importing a file from the USB disk, make sure there is only one CFG file, and save it in the root directory of the disk.
> - Files are exported to the USB disk under the name EXPORT.CFG. If a file named EXPORT.CFG already exists on the USB disk before exporting, it will be overwritten.

2.8 Oscilloscope

The oscilloscope function is one of the unique features of the BCS100. After pressing <5> on the main interface, you can enter the <Capacitance Oscilloscope> interface. The principle of the oscilloscope is to display the capacitance value C in real time. The maximum (MAX), minimum (MIN), difference between MAX and MIN (DIF), and average (AVE) of the measured capacitance are also displayed, as shown below.

Keep the cutting head and the board fixed and observe the change in capacitance. The larger the DIF value, the greater the interference and the more unstable the capacitance.

Users can judge the level of interference by referring to the following values.

DIF value	Interference level
0–10	None
10–20	Very small
20–30	Small
30–50	Medium
Over 50	Large

Chapter 3 Installation Instructions

3.1 Introduction to the Accessories

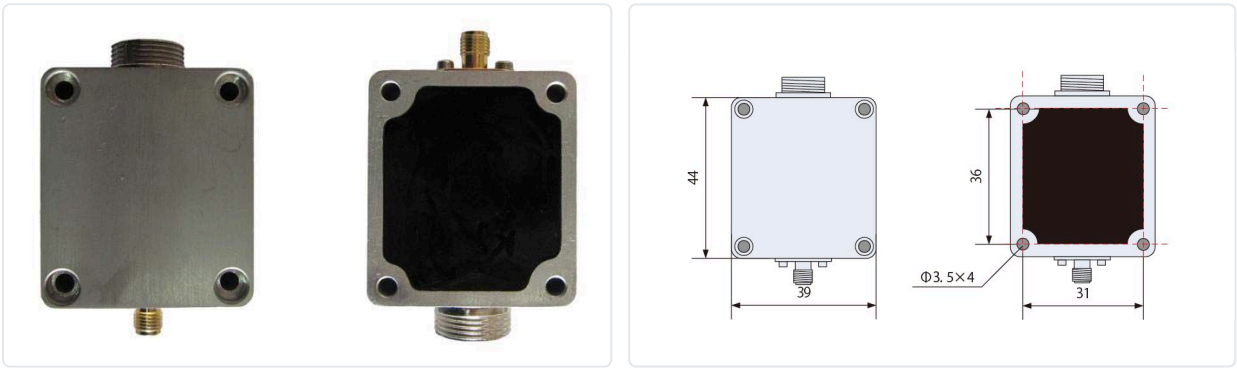
The capacitance control system consists of the BCS100 controller, a preamplifier, a laser cutting head, and cables, as shown below.

Accessory name	Quantity	Standard type	Optional type
Master controller	1	BCS100	
Preamplifier	1	BCL_AMP	
Heat-stable cable	1	SPC-140 (140mm)	SPC-180 (180mm)
Sensor signal cable	1	HC-15 (15m)	HC-15 (20m)
Servo drive cable	1	C15-2.5 (2.5m)	C15-1.5 (1.5m), C15-4 (4m)
DB15 plug (pin)	1	DB15M	
DB15 plug (socket)	1	DB15F	
Manual	1		

3.2 Installation Dimensions (Unit: mm)

3.2.1 Preamplifier

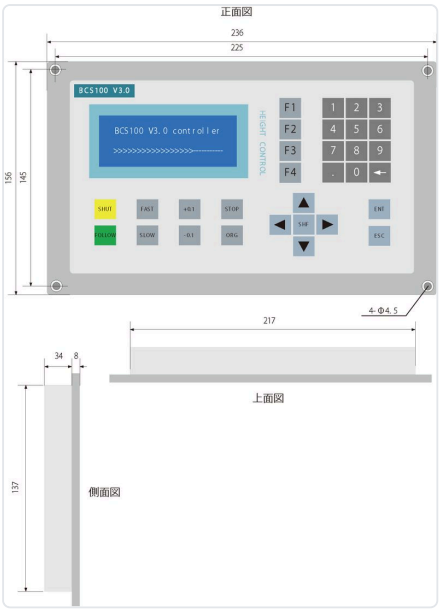
The appearance and installation dimensions of the preamplifier are shown below.



Amplifier appearance / Amplifier installation drawing

3.2.2 Master Controller

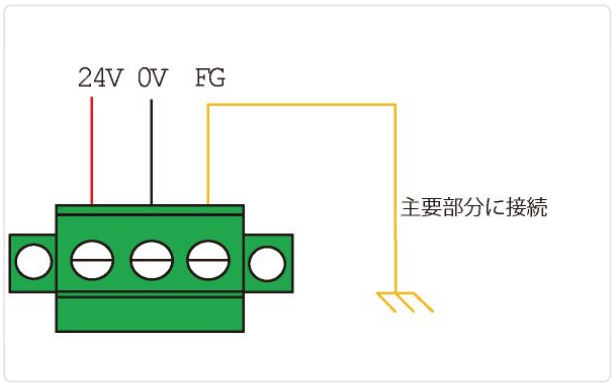
The appearance and installation dimensions of the master controller are shown below.



3.3 Wiring Procedure

3.3.1 Interface Layout

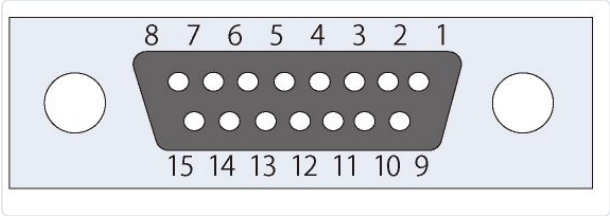
The detailed interface layout of the BCS100 wiring terminals is shown below.



3.3.2 Power Interface Description

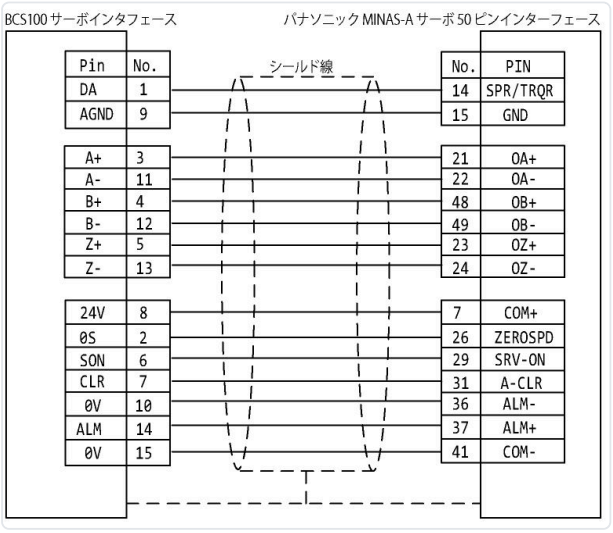
The machine casing serves as the negative pole of the measured capacitance. To ensure stable operation of the measurement circuit, the FG pin of the power interface must be securely connected to the machine casing (that is, it must be in good electrical continuity with the machine casing), and the preamplifier casing must also be in good continuity with the machine casing. The specific criterion is that the DC impedance must always be less than 10 Ω; otherwise, proper height-following performance may not be achieved.

3.3.3 Servo Connection and Settings



Pin	Color	Signal Name
1	Yellow	DA (analog output, -10 to 10 V)
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)

Wiring diagram for the Panasonic servo

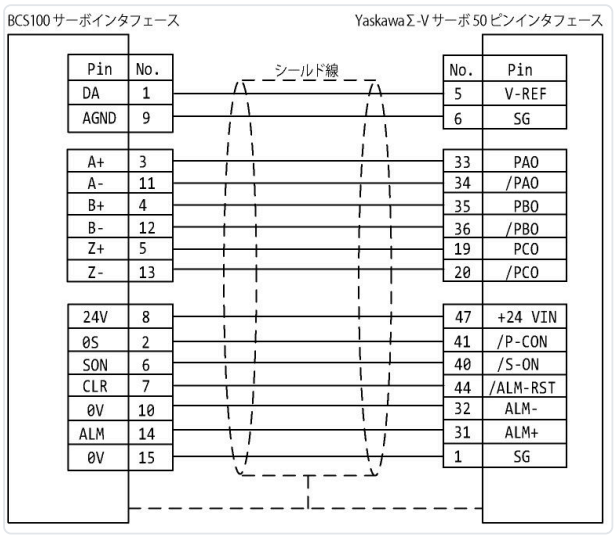


For the wiring mode shown above, set the servo parameters as follows.

Panasonic A5 series:

Parameter No.	Recommended Value	Description
Pr001	1	Control mode: must be set to speed mode.
Pr002	3	Real-time auto-tuning: vertical-axis mode is recommended.
Pr003	17	Servo stiffness; the recommended range is 14 to 20.
Pr302	500	Speed command input gain.
Pr315	1	Enables the zero-speed clamp function.

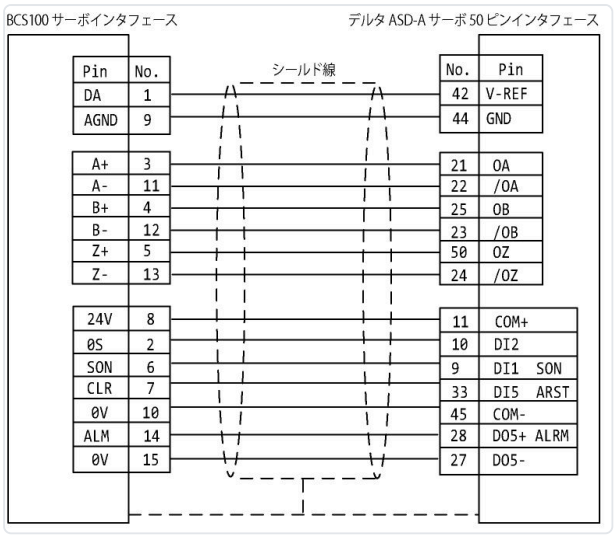
Wiring diagram for the Yaskawa servo



Yaskawa Σ-V series:

Parameter No.	Recommended Value	Description
Pn000	00A0	Speed control with the zero-position clamp function.
Pn00B	-	Set to 0100 when using a single-phase power supply.
Pn212	2500	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution parameter is 10,000.
Pn300	6.00	The corresponding height controller speed gain is 500 r/v/min.
Pn501	10000	Zero clamp value.
Pn50A	8100	Enables forward rotation.
Pn50B	6548	Enables reverse rotation.

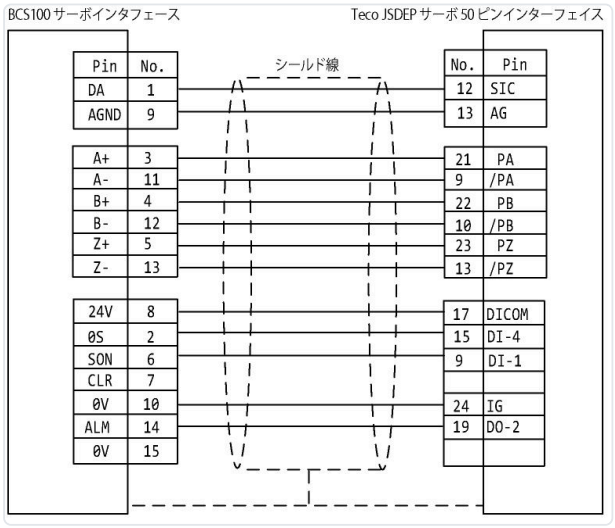
Wiring diagram for the Delta servo



Delta ASD-A series:

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

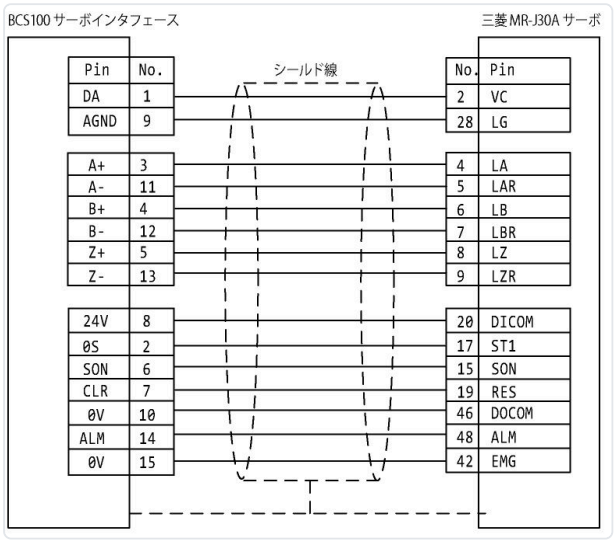
Wiring diagram for the Teco servo



Teco JSDEP series:

Parameter No.	Recommended Value	Description
Cn001	1	Control mode: must be set to speed control mode.
Cn002.2	1	Automatic gain (note: this is the second digit of parameter Cn002).
Cn005	2500	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution parameter is 10,000.
Cn026	4	Stiffness. Level 4 is the default.
Sn216	4000	Speed gain. The corresponding BCS100 speed gain is 400.

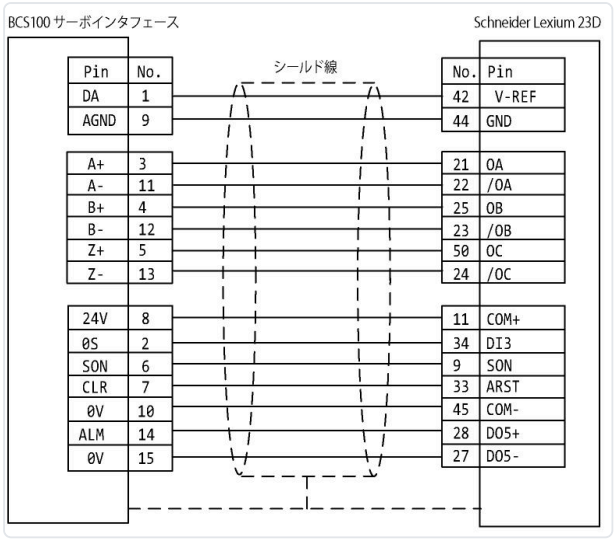
Wiring diagram for the Mitsubishi MR-J30A servo



Mitsubishi MR-J30A series:

Parameter No.	Recommended Value	Description
PA01	2	Control mode: must be set to speed control mode.
PA15	10000	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution parameter is 10,000.
PA12	5000	Speed gain. The corresponding BCS100 speed gain is 500 r/v/min.
PA17	0	

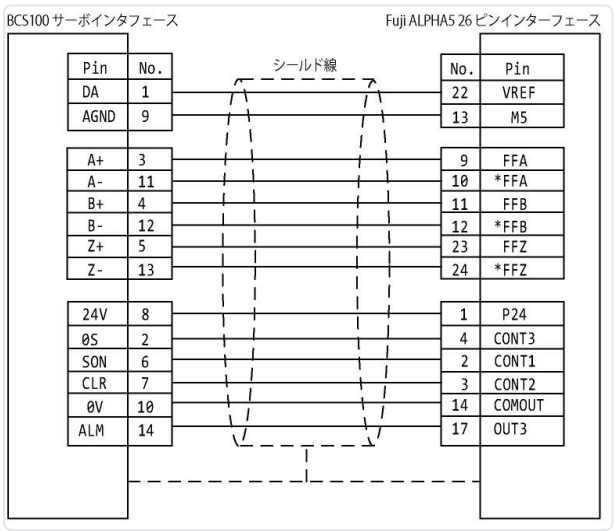
Wiring diagram for the Schneider Lexium 23D



Schneider Lexium 23D:

Parameter No.	Recommended Value	Description
P2-10	101	Servo input IN1 function: SON
P2-11	0	Servo input IN2 function: not used
P2-12	5	Servo input IN2 function: Z clamp
P2-13 to P2-17	0	Servo input IN4–IN8 functions: not used
P1-38	400	40.0 RPM, zero comparison value
P1-01	2	Control mode: must be set to speed control mode.
P1-40	5000	Speed gain. The corresponding BCS100 speed gain is 500 r/v/min.
P1-46	2500	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution parameter is 10,000.

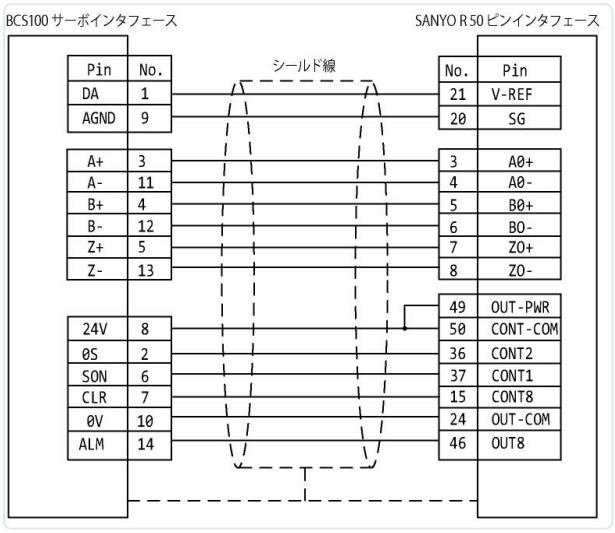
Wiring diagram for the Fuji ALPHA5 servo



Fuji ALPHA5 series:

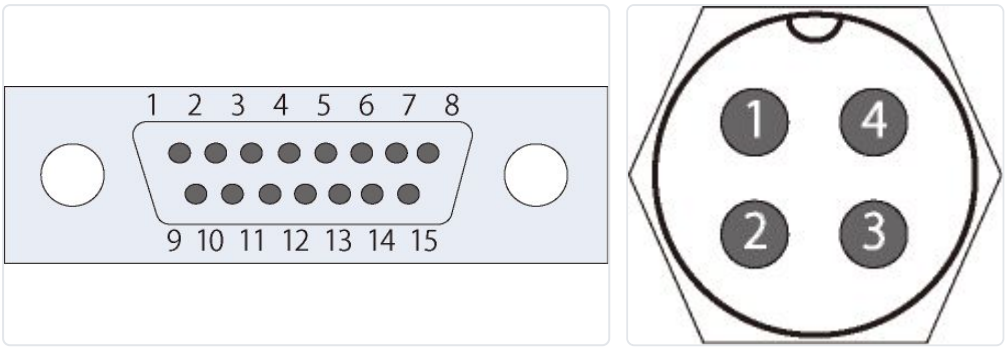
Parameter No.	Recommended Value	Description
PA-101	01	Control mode: must be set to speed control mode.
PA-108	2500	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution parameter is 10,000.
PA-115	17	Servo rigidity; the recommended range is grade 14 to grade 20.
PA-303	02	Enables forward rotation.
PA-331	6.0	The corresponding height controller speed gain is 500 r/v/min.

Wiring diagram for the SANYO R servo



Parameter No.	Recommended Value	Description
SY08	01	Speed control mode
Gr0.00	00	Auto-tuning
Gr8.25	5000	Speed gain. The corresponding BCS100 speed gain is 500 r/v/min.
Gr9.00	00	Motor CW rotation enable
Gr9.01	00	Motor CCW rotation enable
Gr9.26	00	Disable the servo gain switch
GrB9.13	0	
GrB9.14	0	
GrC.05	2500/8192	Number of encoder output pulses per revolution. The corresponding BCS100 pulses-per-revolution value is 10,000.

3.3.4 Input and Output Interface Description



15-pin male input/output interface

Pin	Signal Definition	Pin	Signal Definition
1	24V (power output)	9	IN7 (general input)
2	IN8 (general input)	10	IN9 (general input)
3	OUT1 (cutting in place)	11	OUT2 (fixed as in-position signal)
4	OUT3 (alarm)	12	OUT4 (punching)
5	IN1 (cutting follow)	13	IN2 (move to alignment coordinates)
6	IN3 (quick lift-up)	14	IN4 (stop)
7	IN5 (upper limit)	15	IN6 (lower limit)
8	0V (power ground)		

Note:

1. The output ports (OUT1–OUT4) are all open-drain outputs referenced to the output power ground.
2. The input ports (IN1–IN9) are all active-low inputs; an input is enabled when the port is connected to the power ground.
3. When the cutting head has punched into position, OUT4 outputs the desired signal with a width of 200 ms. While the cutting head is following at the cutting height, OUT1 outputs a continuous desired signal.

3.3.5 Sensor Interface Description

- 1: Connect to pin 1 of the cable.
- 2: Connect to pin 2 of the cable.
- 3: Connect to pin 3 of the cable.
- 4: Connect to the cable shield.

The sensor's 4-pin signal transmission cable can be made from a 3-core shielded cable and two 4-pin air plugs. Pins 1, 2, and 3 must each be connected through, and pin 4 must be connected to the shielding

layer during manufacture.

3.4 Debugging Procedure

After installation, the user should debug the controller as follows:

1. Set the servo parameters. For details, refer to "Servo Parameters" in Chapter 5.
2. After powering on and completing initialization, enter the parameter interface and set the "machine parameters."
3. Return to the <main interface> and check whether the travel switches are working. For optoelectronic switches, when the upper limit is blocked with a shade, the interface displays "Upper limit enabled"; when the lower limit is blocked, it displays "Lower limit enabled."
4. Enter the <test interface> and perform an open-loop jog to check whether the motor rotation direction is correct. If the direction is wrong, change the servo direction parameter. If the encoder signal is reversed (machine parameter), change the encoder direction parameter.
5. Enter the <calibration interface> and perform "servo calibration" to remove the servo zero drift.
6. Manually return to the origin, then turn on the power-on reset function in the <reset parameters> interface.
7. Enter the follower's <calibration interface> and perform "capacitance calibration."
8. After completing the above steps, change other parameters as needed.

Chapter 4 Alarm Handling and FAQ

4.1 System Alarm Analysis

4.1.1 Z+ / Z- limit enable

When the system detects that the Z+ / Z- limit input is enabled, an alarm occurs. The possible reasons are as follows:

- The Z+ / Z- sensor detects something.
- The Z+ / Z- sensor has failed, or it has been in use for a long time and there is oil contamination and dust on its surface.
- The "limit logic" parameter can be set to normally open or normally closed.
- The wiring is incorrect.

4.1.2 Out of Z range

When the Z axis moves beyond the travel range set in the system parameters, an alarm is raised. If the alarm is a false alarm — that is, the system has returned to the origin and the encoder feedback is correct — check the range parameter.

4.1.3 Z- limit continue enable

When the system is returning to the origin, it moves back while the Z sensor is enabled; if it cannot leave the Z sensor's active area, an alarm occurs. Check whether the sensor is damaged.

4.1.4 Z+ limit continue enable

When the system returns to the origin, it moves back along the positive axis; if it enters the Z+ sensor's active area, an alarm occurs. Check whether the alignment coordinate or dock coordinate is too large.

4.1.5 Servo Alarm

When the system detects that input No. 14 (ALM), which reflects the servo alarm state, is enabled, an alarm is shown on the screen. The reasons for a servo alarm are as follows:

- The servo itself is in alarm.
- The "Servo Type" parameter is not set correctly.
- The wiring is incorrect.
- The electrical system is interfering with the wires.

4.1.6 Abnormal Encoder Operation

When the system is at a standstill but the encoder feedback value changes, this alarm occurs. The reasons leading to this alarm are as follows:

- The axis vibrates due to an external force.
- The wiring is wrong and the zero-speed signal is invalid.
- The servo rigidity is very low.
- The encoder wires are subject to interference. Shielding is required and must be connected to ground; it is better to add a wire ring.

4.1.7 Encoder Not Responding

The system tries to move and sends the speed command as a voltage, but the encoder feedback value does not change at all, and an alarm occurs. The reasons are as follows:

- Wiring error.
- The servo type is wrong. The servo must be in speed control mode.
- The servo parameters are not set correctly; the servo must be switched to speed control mode.

4.1.8 Encoder Deviation

When the difference between the target position and the feedback position is too large, an alarm occurs. It reflects that the servo cannot correctly follow the speed command. The reasons are as follows:

- The encoder feedback direction is wrong. The related parameter must be changed.

- A wiring error or interference corrupts the encoder feedback.
- The mechanism is stuck, so the actual position cannot follow the target position.

4.1.9 Capacity is 0

If the system cannot detect the capacitance of the nozzle, the capacitance value is displayed as 0 on the screen. An alarm may occur in the following situations:

- The nozzle touches the plate below.
- There is water on the cutting head.
- The local capacitance of the cutting head is large and outside the preamplifier's detection range.
- The preamplifier is broken.
- The connection is not secure.
- Inside the cutting head, the capacitance positive (nozzle) is short-circuited to the capacitance negative (machine shell).

4.1.10 Error Caused by Local Capacitance

When the local capacitance has changed, an alarm occurs. The reasons are as follows:

- The connection or some part has been changed or moved. Perform the calibration again.
- The laser heats the nozzle, and the temperature becomes very high for a short time.
- A person's hand must not remain on the nozzle.
- Gas blowing causes the distance between the anode (nozzle) and the cathode (machine shell) to change.
- The connection is not secure.
- A low calibration-range parameter may also lead to this alarm. 15 mm is recommended in 2D mode and 10 mm in 3D mode.
- One of the reasons is the cutting flame; when the plate material is stainless steel, electrons affect the capacitance sensor.
- If there is plastic film on the steel surface, remove the film first. Check whether the machine is correctly connected to ground. The follow height must be greater than 0.5 mm. Increase the blowing pressure.

4.1.11 About Deviation

When the system's H height (the distance between the nozzle and the plate) changes greatly within a short time, an alarm occurs. The related parameters are explained in Section 2.5.5. The reasons for the alarm are as follows:

- The cut runs off the plate, and there is nothing below to follow.
- The plate is vibrating strongly.

4.1.12 Error Caused by Sample Capacitance

If the sampled capacitance is larger than the maximum capacitance obtained during calibration, an alarm occurs. The reasons are as follows:

- The nozzle is touching the plate below.
- There is water on the cutting head.
- The connection is not secure.
- Inside the cutting head, the capacitance positive (nozzle) is short-circuited to the capacitance negative (machine shell).

4.1.13 Expired

The usage period of this system has expired.

4.1.14 Battery Lock

If the battery of an unregistered controller is removed, an alarm occurs. The user can clear the alarm by registering the controller.

4.1.15 Vibration Near the Board

If the follower oscillates while running near the plate, an alarm occurs.

4.2 FAQ

4.2.1 Noticeable Vibration and Mechanical Shock During Following Motion

- The FG pin of the amplifier casing or the controller is not connected to the machine casing.

The machine casing is the negative electrode of the measured capacitor. If the conductivity between the amplifier casing and the machine casing is poor, the AC impedance between the positive and negative electrodes of the capacitor is large. As a result, the load on the measuring circuit fluctuates and the measurement error may become large. If a good mechanical connection cannot be obtained, a wide wire (copper is preferable) can be added between the amplifier metal casing and the machine casing to reduce the AC impedance. The AC impedance of a single-point connection is larger than that of a good mechanical connection. The AC impedance should be kept at 10 ohms or less.

Servo stiffness is too high

Excessive servo stiffness can cause mechanical shock or noticeable vibration during motion. For example, the servo stiffness of the Panasonic MINAS A5 series must not exceed level 19.

Follow speed is too fast

If the follow speed is too high, vibration may occur during travel. Levels 3–7 are recommended.

Poor follower calibration

If the stability and smoothness of the capacitance and position data stored in the BCS100 are poor, vibration will occur during the follow motion. Recalibrate the follower's capacitance until the stability and smoothness are excellent.

If there is strong interference in the field, the user can appropriately reduce the "servo gain coefficient" parameter.

4.2.2 The Follower Keeps Hitting the Board While Following

Calibration range is too small, or Z-axis speed is too high

The smaller the calibration range, the shorter the deceleration distance of the follow motion. If the Z-axis speed is too high and does not decrease to 0 when the follower reaches position, overshoot is unavoidable. The higher the Z-axis speed, the greater the overshoot. If the Z-axis speed is greater than 100 mm/s, setting the calibration range to 15 mm is recommended. If the Z-axis speed is greater than 250 mm/s, setting the calibration range to 20–25 mm is recommended.

Servo stiffness is too low

If the servo stiffness is too low, the servo response may lag behind the controller's control signal, causing the follower to collide with the plate. For example, for the Panasonic MINAS A5 series, a stiffness of level 13 or below is recommended.

Capacitance calibration

The follower will hit the plate if there is a large deviation between the capacitance stored in the BCS100 and the actually measured capacitance — for example, when the nozzle temperature has risen significantly or a connection is unstable. The user must first find the cause, resolve the problem, and then recalibrate the capacitance.

No preheating

Preheat the amplifier for 2–5 minutes, and operate the BCS100 controller only after the amplifier's sampling capacitance has stabilized.

The lock nut of the ceramic part is not securely tightened

If the lock nut of the ceramic part is not securely tightened, the detected capacitance may become unstable.

4.2.3 The Follow Height Differs from the Actual Height

No preheating

Preheat the preamplifier for 2–5 minutes before operating the BCS100 controller. The preamplifier's sampling capacitance can change with temperature. Preheat the amplifier for 2–5 minutes, and operate

the BCS100 controller only after the amplifier's sampling capacitance has stabilized.

Calibration problem

This phenomenon often occurs when the follower's capacitance is not recalibrated after replacing the nozzle. If laser spatter onto the nozzle or the assist gas blow is abnormal, the cutting head's capacitance changes and the nozzle temperature rises abnormally (above 100°C). With intelligent calibration, the follower does not touch the plate, and the actual height ends up higher than the set height.

Exit the intelligent check option before performing calibration.

4.2.4 The Follower Cannot Move to the Correct Height

If the follower does not move up, or the lift height is incorrect, the user should first observe and determine whether the Z-axis coordinate is normal. If the Z-axis coordinate is unclear, first return to the origin, press "FOLLOW" and "SHUT" repeatedly, then follow the plate and check whether the Z-axis coordinate is consistent. If the Z-axis coordinate keeps decreasing, there may be a problem with the system's position feedback. The reason is that the servo motor, or the ball screw and coupling, is slipping, causing a coordinate offset.

4.2.5 "Verification error, ARM upgrade failed" During Upgrade

The upgrade file may be infected with a computer virus.

4.2.6 The Follower Rises Without Touching the Board During Calibration

Check that the follow material is set to "Metal" or "Non-metal".