

# FSCUT4000 Laser Cutting System User Manual





Shanghai Friendess Co., Ltd www.fscut.com Ver. 2.0



Thank you for choosing our products!

This manual gives a detailed introduction to the usage of FSCUT4000 laser cutting controller, including technical features and installation instructions etc. For CypCut laser cutting software operation, please refer to the CypCut user manual. For other matters you can contact us directly.

Operating personnel should read the manual in detail which will be helpful for a better use of the product.

Due to the continuous updating of product functions, the products you receive may differ from the statement in this manual in some respects. We apologize for any inconvenience it may cause.



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# **1. Product Description**

### 1.1 Brief Introduction

**FSCUT4000** is a high performance laser cutting system of close-loop control developed by Shanghai Friendess Company. It is widely used in metal and non-metal laser cutting application, has gained wide popularity among users at home and abroad.

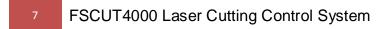
This manual served as installation and operation guide for FSCUT4000 system.

Item	Model	Qty.
Motion control card	BMC1214	1 pcs
I/O terminal board	BCL3724	1 pcs
62-pin cable (2m)	C62-2	1 pcs
Servo cable (1.5m)	C15-1.5	4 pcs
Control software	CypCut	1 pcs
Wireless handheld remote	WKB	1 pcs
NC panel (optional)	BCP5045	1 pcs

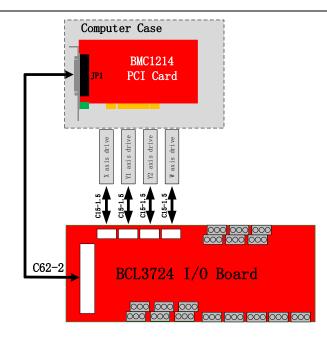
FSCUT4000 system hardware table:

# 1.2 Connection Diagram

BMC1214 card adopts PCI interface. Dimension: 155mm\*106mm. The socket (DB62M) on control card connects with BCL3724 I/O terminal by C62-2 cable. Wiring diagram shown below:







# 1.3 Technical Reference

		Analog output of 4 servo axis ports, -10V—+10V.
	Motor control	Encoder feedback channel of 4 servo axis ports, 10MHz.
	signal	Dedicated signal inputs of origin, positive/negative limit
		and servo alarm for each axis.
ltro]		Dedicated signal outputs of servo enable and alarm reset
Con		etc., for each axis.
Motion Control		Control cycle 1ms.
Moti		S-type acceleration and deceleration with filter.
<b>F</b> 4	Motion	Velocity look-ahead strategy, intelligent speed control at
	control	turning point.
	performance	Local curvature analysis and speed restriction at curves.
		Auto smooth corner.
Laser	control signal	1 PWM signal, DIP switch(24V/5V as options)
		3 analog output ports of 0~10V
		1 analog input port of 0~10V
I/	O function	12 common input ports.
		20 output: 6 relay outputs and 14 thyristor outputs.
Work environment		Temperature: 0-55 Celsius degree
		Humidity: 5% ~ 90% no condensation
Po	wer supply	24V, 2A
		•



## 1.4 Control Card Installation

### 1.4.1 Install steps



Please wear anti-static gloves to prevent possible electrostatic damage to the motion control card.

- (1) Power off computer, insert the control card into PCI socket, and fix the control card tightly;
- (2) After start up computer, "Add Hardware Wizard" pops out and click "Cancel" button, as shown below. If this dialog box does not appear, indicating the card is in poor connection, please repeat the first step.

Add Hardware	
	Welcome to the Add Hardware Wizard
	This wizard helps you install driver software to support older devices that do not support Plug-and-Play and which are not automatically recognized by Windows.
	You should only use this wizard if you are an advanced user or you have been directed here by technical support.
	If your hardware came with an installation CD, it is recommended that you click Cancel to close this wizard and use the manufacturer's CD to install this hardware.
	To continue, click Next.
	< Back Next > Cancel

- (3) Install CypCut software. The driver program will be installed by default option automatically.
- (4) Open windows device manager to confirm installation succeed. Below image

shows the installation is succeed.

BMX Motion Controller BMC1214 Motion Card



- 1.4.2 Troubleshoot
- (1) If "Find New Hardware" dialog box does not pop out after start up computer or control card does not shown in device manager, indicating that the control card is not in good connection with PCI socket. Please replace the PCI socket or change another computer, insert the control card tightly and reinstall software.
- (2) If the device has a yellow exclamation mark, double-click **PCI** Device to open its attributes page, and select "Detail Information" as shown below:

BMC1214 Motion Card Properties				
General Driver Details Resources				
BMC1214 Motion Card				
Property				
Hardware Ids 🔹				
Value				
Value           PCI\VEN_6125&DEV_1214&SUBSYS_0000000&REV_00           PCI\VEN_6125&DEV_1214&SUBSYS_0000000           PCI\VEN_6125&DEV_1214&REV_00           PCI\VEN_6125&DEV_1214           PCI\VEN_6125&DEV_1214&CC_FF0000           PCI\VEN_6125&DEV_1214&CC_FF0000           PCI\VEN_6125&DEV_1214&CC_FF0000				
OK Cancel				

- (3) If the first half of the 'device instance ID' attribute is displayed as
   PCIVEN\_6125&DEV\_1214<sup>2</sup> it means computer has correctly recognized the motion control card but software installation might be failed. Try install CypCut again, if installation still fails, please contact our technical support.
- (4) If the first half of 'device instance ID' attribute is not PCIVEN\_6125&DEV\_1214{, it



indicates computer doesn't recognize the control card. Power off computer and change PCI socket, install the card firmly and repeat installation again.

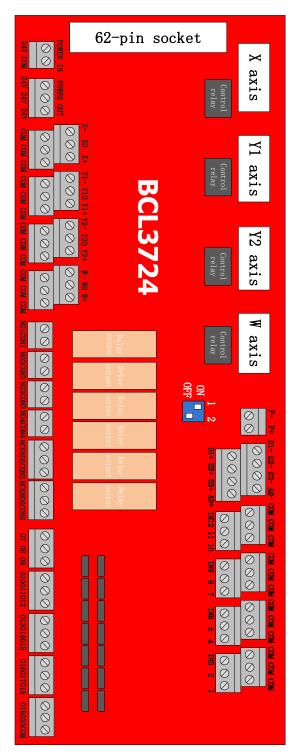
(5) If step (4) still fails, the control card might be damaged please contact our technicians.



# 2. BCL3724 Wiring Instruction

# 2.1 BCL3724 Description

BCL3724 diagram shown as below:





You can either use guide rail or fixed installation to install BCL3724 board, product dimension 315mm\*107mm. DB62M socket connected with JP1 interface of BMC1214 card by C62-2 cable.

4 sockets (DB15M) on top left are for servo control, from left to right is X, Y1, Y2 and W axis port.

The signal terminals on bottom left are positive/negative limit, origin inputs of X,

Y and W axes. All lower terminals are conducted, ground end of COM, 0V.

On bottom right are 20 common output terminals which are thyristor emitter output.

Thyristor output is 24V, common cathode.

Above are PWM signal and 4 DA analog signal terminals.

There is a DIP switch down below PWM:

Switch P1 and P2 to set PWM voltage

P1	P2	Description
On	Off	PWM voltage is 24V
Off	On	PWM voltage is 5V

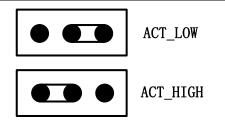
### 2.2 Signal Type

### 2.2.1 Input signal

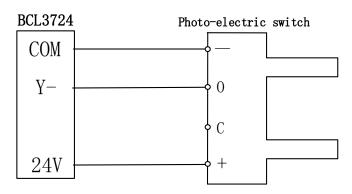
The input signals: positive/negative limit, origin, common input. All input terminals of BMC1214 are low-level active, support NO (normally-open) and NC (normally-close) input. When set input as normally-open, input signal active when conduct with 0V; when set input as normally-close, input signal active when disconnect with 0V.

The polarity of input can be changed by jump-wire, IN10, IN11, IN12 support jump-wire. There are 2 status of jump-wire, ACT\_LOW means low-level active (input 0V active); ACT\_HIGH means high-level active (input24V active). The default state is ACT\_LOW.

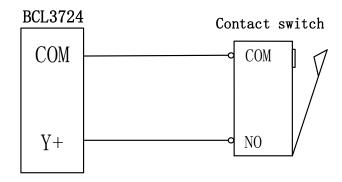




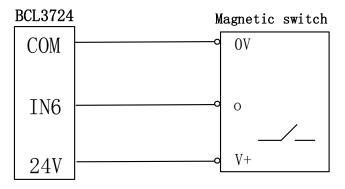
The typical wiring of photo-electric switch shown below, must use NPN 24V type switch.



The typical wiring of contact switch shown below.



The typical wiring of magnetic switch shown below, must use NPN 24V type switch.

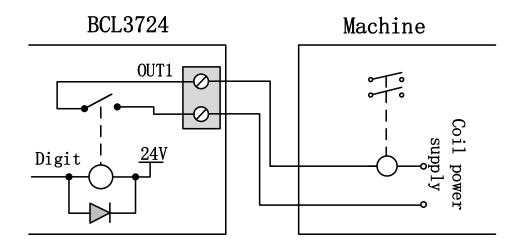




### 2.2.2 Relay output

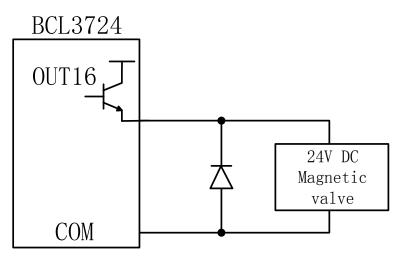
There are 6 relay output on BCL3724 terminal board which are OUT1-OUT6. OUT1-OUT4 only support normally open, OUT5-OUT6 have both NO and NC options. The maximum load of relay: DC 30V, 8A; AC 250V, 8A. Recommend to use load under 2A, the inductive load or high power load will reduce the service time of relay switch.

Wiring between relay output and contact shown below:



### 2.2.3 Thyristor output

There are 14 thyristor output on BCL3724 from OUT7-OUT20, which can drive 24V DC device directly, drive capacity is 500mA. Wiring diagram shown below:





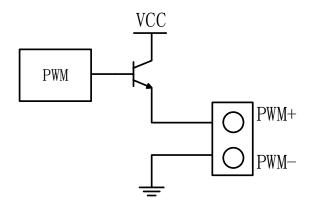
### 2.2.4 Analog output

3 analog output of 0-10V.

Output range	0V~+10V
Maximum output load	50mA
Maximum capacitive load	350pF
Input impedance	100ΚΩ
Maximum bipolar error	+/-50mV
Resolution	10mV
Conversion speed	400us

### 2.2.5 PWM output

There is one PWM port on BCL3724 for laser average power modulation. There are 5V and 24V for options. The duty cycle is adjustable from 0%~100%, the highest carrier frequency 50 KHz. The signal output shown below:



Set PWM signal level, 5V or 24V set by DIP switch.

## 2.3 I/O Specification

### 2.3.1 External power supply

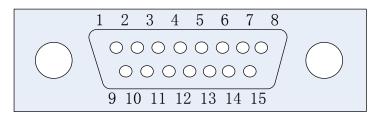
BCL3724 requires external 24V DC power supply. The 24V and COM connect with 24V and 0V of power supply.

### 2.3.2 Servo control port

The 4 servo ports on BCL3724 are DB15 sockets, signal pin description listed



below:



The signal pin description of C15-1.5 cable listed below:

	15-pin servo control interface						
Pin	Description	Pin	Description				
1	DA (-10~10V analog)	9	AGND (analog ground)				
2	0S (zero speed clamp)	10	0V (power supply ground)				
3	A+ (encoder A phase positive)	11	A- (encoder A phase negative)				
4	B+ (encoder B phase positive)	12	B- (encoder B phase negative)				
5	Z+ (encoder Z phase positive)	13	Z- (encoder Z phase negative)				
6	SON (servo enable)	14	ALM (alarm signal)				
7	CLR (alarm clear)	15	0V (power supply ground)				
8	24V (power supply)						

+24V, 0V: give 24V DC power supply to servo driver;

**SON:** servo-on output;

ALM: alarm input from servo;

**DA**, **AGND**: analog output for motor control;

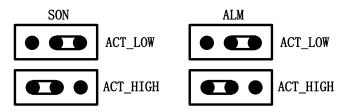
CLR: alarm reset;

**OS:** zero speed clamp signal;

```
A+, A-, B+, B-, Z+, Z-: Encoder 3-phase input signal, to check
```

encoder zero point.

The polarity of SON and ALM can be changed by jump-wire;



SON signal jump wire to ACT\_LOW, output is low-level active (output 0V active); Jump wire to ACT\_HIGH, output is high-level active (output 24V active); Default is ACT\_LOW.



ALM signal jump wire to ACT\_LOW, input is low-level active (input 0V active); Jump wire to ACT\_HIGH, input is high-level active (input 24V active); Default is ACT\_LOW.

### 2.3.3 Servo drive control signal

The wiring diagram with Panasonic, Yaskawa, Sanyo and Schneider provided here. For servo driver parameter setting you can take reference from ServoTools calculation. If you have any question please contact our technical support.

For other brand servo wiring please take notice of following items:

(1) Make sure the servo supports velocity control mode. For example, PanasonicA5 series servo must choose full-function type, cannot use pulse type;

(2) Check if SON signal is low-level active (SON is active when conducted with GND of 24V);

(3) Check if there is external emergency stop in servo I/O;

(4) Before trial run of driver, provide 24V power supply to IO terminal board, the24V power supply provided by BCL I/O board;

(5) If driver still can't run, check if the parameter 'positive/negative direction drive inhibit' in driver is disabled.



### Panasonic servo wiring diagram

FSCUT DB15 servo control

MINAS-A 50P

			1. 1	_			,
Signal	Pin	Shield	ling layer		Pin	Signal	
DA	1	<u> </u>	/		14	SPR/TRQR	
AGND	9			[	15	GND	
		, , ,					
A+	3	$-\frac{1}{1}$	1		21	OA+	
A–	11				22	OA-	
B+	4		i	$\frac{1}{1}$	48	OB+	
B-	12		i	i L	49	OB-	
Z+	5	<u>├                                    </u>	i	i l	23	0Z+	
Z-	13		t	†L	24	0Z-	J
		. ! !	I	i _			
24V	8	<u>├</u>	<u> </u>	+	7	COM+	
SON	6		I	<u> </u>	29	SRV-ON	
OV	10		I	<u>!</u> [	36	ALM-	
ALM	14		<u> </u>	<u> </u>	37	ALM+	
OV	15		1		41	COM-	
		۰ ۱ j	l l l l l l l l l l l l l l l l l l l	_			•
		N j	١j				
		<u> </u>	-+				
	L		!				

	Panasonic A5 reference setting					
Parameter	Description	Recommended value				
Pr0.01	Control mode	1				
Pr0.02	Real time auto tuning	0				
Pr0.04	Inertia ratio	You can calculate the inertia ratio by				
		Panasonic servo software				
Pr0.11	Encoder output pulse	Set by mechanism feature, the pulse equivalent				
	per motor revolution	should be among 1000-2000. For example, if				
		the linear distance is 10mm on machine load				
		per motor rotation, the pulse per revolution				
		should be 10000, and Pr0.11 set 2500.				
Pr1.01	1st gain of velocity	75.0Hz				
	loop					
Pr1.02	1st time constant of	9.0ms				
	velocity loop					
	integration					
P r1.04	1st time constant of	0.3ms				
	torque filter					
P r3.02	Input gain of speed	Set by maximum motor speed. If maximum				
	command	motor speed is 4000rpm, set 400 here.				



### Yaskawa servo wiring diagram

FSCUT DB15 servo control

## Yaskawa $\Sigma\,50\mathrm{P}$

Signal	Pin	Shielding layer	Pin	Signal
DA	1		5	V-REF
AGND	9		6	SG
A+	3		33	PAO
A-	11		34	/PAO
B+	4		35	PBO
B-	12		36	/PBO
Z+	5		19	PCO
Z-	13		20	/PCO
24V	8		47	+24 VIN
SON	6		40	/S-ON
OV	10		32	ALM-
ALM	14		31	ALM+
OV	15		1	SG
		Nj Nj		
		<u>~+</u>		

Yaskawa Sigma 5/7 reference setting				
Parameter	Description	Recommended value		
Pn000	Control mode	0000		
Pn100	Velocity loop gain	75.0Hz		
Pn101	Velocity loop integral constant	9 .00 MS		
Pn103	Inertia ratio	Set by calculation result of Yaskawa servo software SigmaWin. Or you can set by calculation result of ServoTools.		
Pn170	Adjustment-free	1400		
Pn212	Differential pulse output per motor revolution	Set by mechanism feature, the pulse equivalent should be among 1000-2000. For example, if the linear distance is 10mm per motor rotation, the pulse per revolution should be 10000, and Pr0.11 set 2500.		
Pn300	Input gain of speed command	0.01V/rated speed		



Pn401	Torque command filter	0.30 MS
	time constant	
Pn50A	Input signal	8100
Pn50B	Input signal	6548



# Sanyo R series wiring diagram

FSCUT DB15 servo control	nyo R2 50P	
Signal Pin Shielding layer		
Signal Pin Shielding layer	Pin	Signal
	21	V-REF
AGND 9	20	SG
A+ 3	3	A0+
	4	A0-
B+ 4	5	B0+
B- 12	6	B0-
Z+ 5	7	Z0+
Z- 13	8	Z0-
	49	OUT-PWR
	50	CONT-COM
SON 6	37	CONT1
0V 10	24	OUT-COM
ALM 14	46	OUT8

Sanyo R2 reference setting				
Parameter	Description	Recommended value		
SY09	Control mode	01		
Gr0.00	TUNMODE, tuning mode selection.	02		
Gr1.12	KVP, velocity loop proportional	75H z		
	gain			
Gr1.13	TVI, velocity loop integral time	9ms		
	constant			
Gr1.14	Inertia ratio	Input the value calculated by Sanyo		
		servo software, you can also		
		calculate by Friendess ServoTools.		
Gr8.29	VCGN, analog velocity command	Set by the maximum motor rpm. For		
	gain	example, if the maximum motor		
		speed is 4000rpm, set this parameter		
		as 4000.		
G r9.00	F-OT, forward over travel	00		
Gr9.01	R-OT, reverse over travel	00		
G r9.27	VLPCON, velocity loop	00		
G rB.13	Hold brake delay	00		



G rB.14	Release brake delay	00
G rC.04	Differential pulse output	Set by mechanism feature, the pulse
		equivalent should be among 1000-2000.
		For example, if the linear distance on
		machine load is 10mm per motor
		rotation, the pulse per revolution should
		be 10000, and Pr0.11 set 2500.



			8	0	
FSCUT	DB15 s	ervo	control	Schneider	Lexium 23D
	Signal	Pin	Shielding layer	Pin	Signal
	DA	1		42	V-REF
	AGND	9		44	GND
	A+	3		21	OA
	A-	11		22	/OA
	B+	4		25	OB
	B-	12		23	/0B
	Z+	5		50	OC
	Z-	13		24	/0C
	24V	8		11	COM+
	SON	6		9	SON
	OV	10		45	COM-
	ALM	14		28	D05+
	OV	15		27	D05-
			$\dot{-} \dot{-} \dot{-}$		

# Schneider Lexium 23D wiring diagram

Schneider 23D reference setting				
Parameter	Description	Recommended value		
P1-01	Control mode	0002		
P1-37	Inertia ratio	Input inertia ratio calculated by Schneider servo software, you can also use Friendess ServoTools to calculate the inertia ratio.		
P1-40	VCM, maximum command rotation speed	Set by maximum RPM of motor. For example, if the maximum RPM of motor is 4000rpm, set same value for this parameter.		
P1-46	ENCOUTRES, encoder output pulse per motor revolution	Set by mechanism feature, the pulse equivalent should be among 1000-2000. For example, if the linear distance is 10mm per motor rotation, the pulse per revolution should be 10000, and Pr0.11 set 2500.		
P2-04	KVP, velocity control gain	565rad/s		
P2-06	KVI, velocity integral compensation	108rad/s		



P 2-32	ATMODE, automatic	0
	adjustment	

#### 2.3.4 Origin and limit

X-: negative limit of X axis, dedicated input, low-level active;
XO: origin of X axis, dedicated input, low-level active;
X+: positive limit of X axis, dedicated input, low-level active;
COM: ground, the common end of above three signal ports.

Y1-: negative limit of Y1 axis, dedicated input, low-level active;
Y1O: origin of Y1 axis, dedicated input, low-level active;
Y1+: positive limit of Y1 axis, dedicated input, low-level active;
COM: ground, the common end of above three signal ports.

Y2-: negative limit of Y2 axis, dedicated input, low-level active;
Y2O: origin of Y2 axis, dedicated input, low-level active;
Y2+: positive limit of Y2 axis, dedicated input, low-level active;
COM: ground, the common end of above three signal ports.

W-: negative limit of W axis, dedicated input, low-level active;
WO: origin of W axis, dedicated input, low-level active;
W+: positive limit of W axis, dedicated input, low-level active;
COM: ground, the common end of above three signal ports.

You can change input polarity of origin and limit signals via machine config tool. See details in chapter 3 machine config.

#### 2.3.5 Common input

There are 12 common input IN1-IN12. You can assign common inputs as userdefined software button or alarm input. See details in chapter 3 machine config.

#### 2.3.6 Common output

There are 20 common output OUT1-OUT20. Common output can be assigned as user-defined signal output for laser, gas, indicator lamp controlling etc. See details in chapter 3 machine config.



### 2.3.7 Analog output

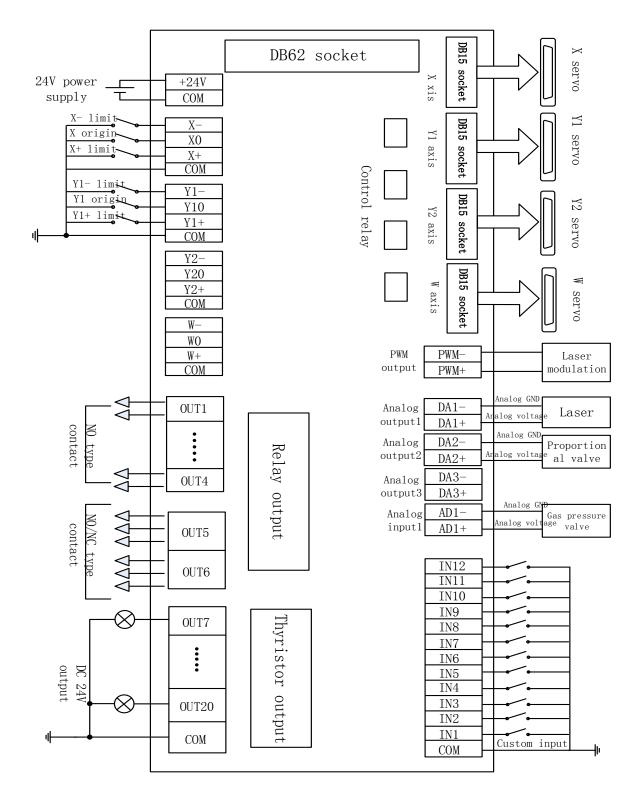
3 channels analog output of 0-10V, DA1, DA2 and DA3. Analog output can be assigned for laser peak power and gas valve control.

### 2.3.8 PWM output

For fiber laser configuration in CypCut machine config, PWM will be activated automatically for laser average power regulation. For other type laser, there is no signal output from PWM port.



# 2.4 Wiring Diagram





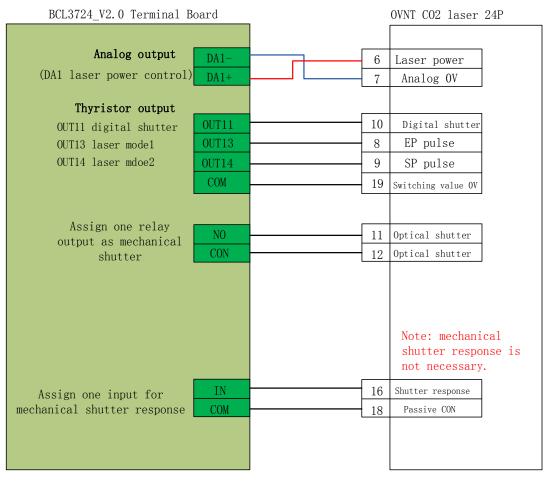
### 2.5 Laser Wiring Diagram

### 2.5.1 YAG laser

Assign an output for laser emission and connect with laser.

### 2.5.2 CO2 laser

#### Here take example of NT-3200SM CO2 laser.

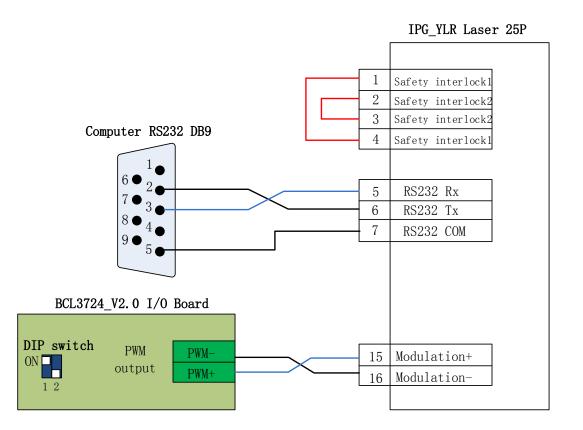


Note:

Some of CO2 laser also supports PWM control mode, wiring can take reference from Max laser.



2.5.3 IPG-YLR



It's recommended to use serial communication (RS232) or network communication under serial or Ethernet communication, CypCut can monitor laser status in real time and control laser of emission, aiming, peak power without DA analog output.

Recommend to use network communication for IPG-YLR series.

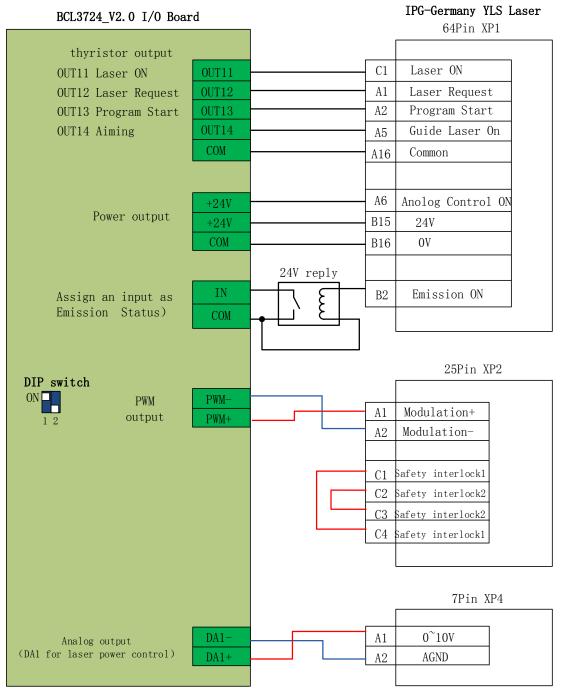
#### Note:

1. Remote start-up button is not necessary and not recommended for it might cause laser malfunction when laser is not well grounded.

2. Select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



### 2.5.4 IPG\_YLS Germany



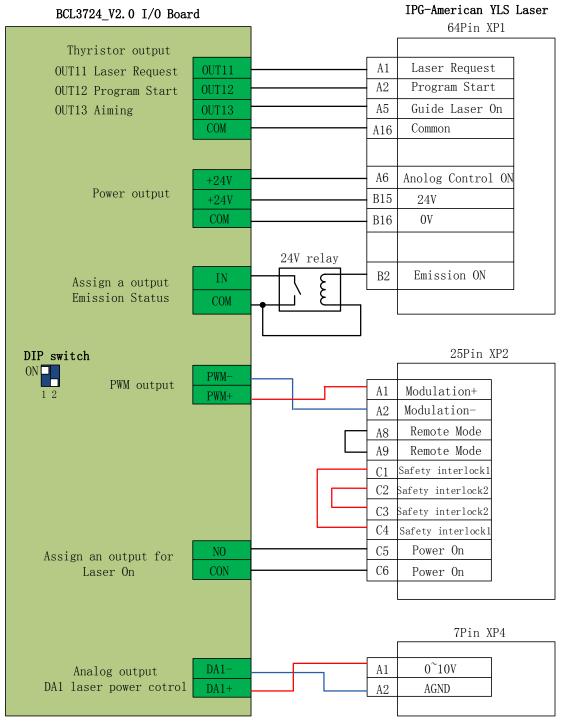
Note:

1. B2 'Emission ON' in XP1 interface is not necessary for CypCut, set 'Emission Status' as '0' in machine config, CypCut will not check laser emission status.

2. Select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



### 2.5.5 IPG\_YLS American



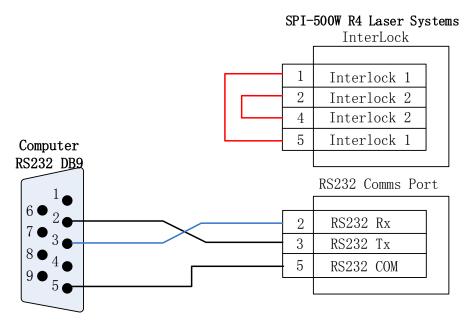
Note:

1. B2 'Emission ON' in XP1 interface is not necessary for CypCut, set 'Emission Status' as '0' in machine config, CypCut will not check laser emission status.

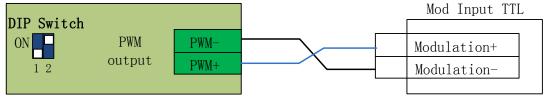
2. Select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



### 2.5.6 SPI-500W-R4



BCL3724\_V2.0 I/0 Board



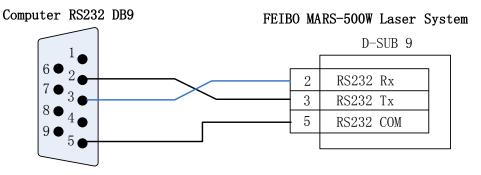
Note:

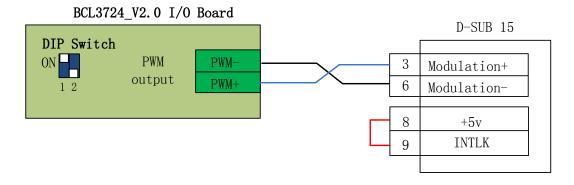
1. When use MODINPUTTL for laser modulation, select 5V for PWM (DIP switch: PIN1 OFF, PIN2 ON).

2. When use PIN1 of I/O interface for laser modulation, select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



### 2.5.7 FEIBO MARS



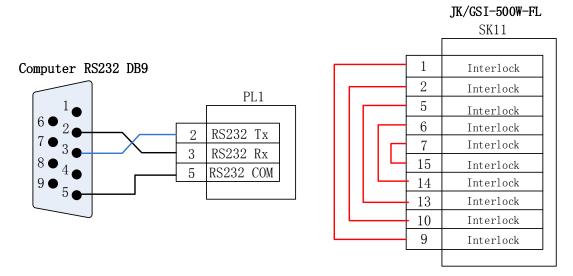


### Note:

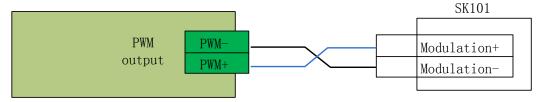
Select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



### 2.5.8 JK/GSI-FL



BCL3724\_V2.0 I/O Board



Note:

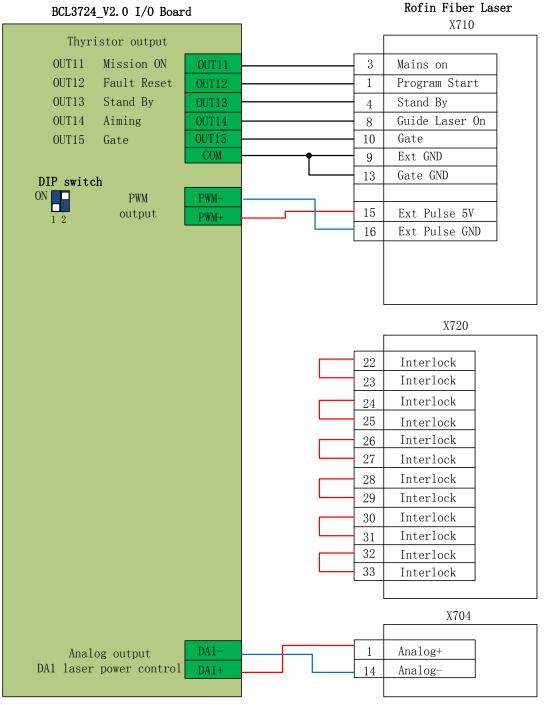
1. The interlock in SK11 interface

2. When use SK101 as modulation, select 5V for PWM (DIP switch: PIN1 OFF, PIN2 ON).

3. When use Pin-16 in PL5 as modulation, select 24V for PWM (DIP switch: PIN1 ON, PIN2 OFF).



#### 2.5.9 Rofin



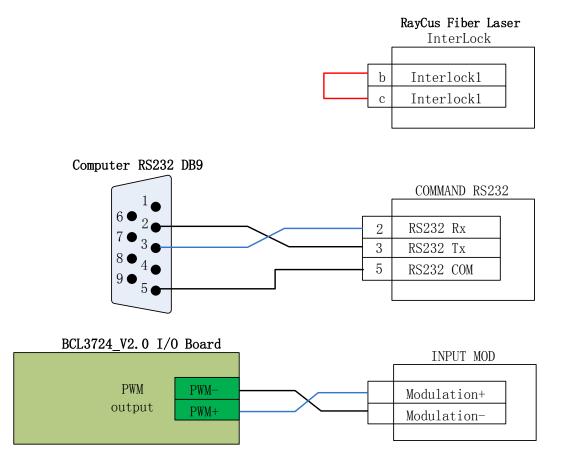
Note:

1. Take related reference for wiring of interlock in X720;

2. Select 5V for PWM ((DIP switch: PIN1 OFF, PIN2 ON; one of PIN3 or PIN4 ON and the other OFF).



### 2.5.10 Raycus



Note:

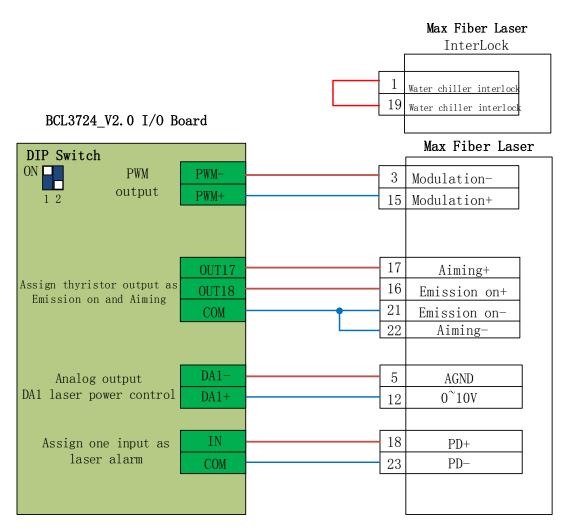
1. Raycus's latest products use 24V PWM, the old versions use 5V PWM. For latest Raycus laser, key switch turns to REM under serial communication, while for old versions key switch turns to ON position under serial communication. Laser PWM port will indicate its 24V or 5V control. No specific description indicates 5V PWM control.

2. 5V PWM control (DIP switch: PIN1 OFF, PIN2 ON).

3. 24V PWM control (DIP switch: PIN1 ON, PIN2 OFF).



2.5.11 Max



Note:

1. PD+/PD-(laser alarm output) connect to any input port in BCL3724 I/O board, then in 'machine config>alarm>custom alarm' setup the laser alarm (normally-open);

2. The ground end of aiming laser and laser emission can connect to any COM port in BCL3724 board.

3. 24V PWM control (DIP switch: PIN1 ON, PIN2 OFF; one of PIN3 and PIN4 is ON, the other is OFF).



# **3. Machine Config Tool**

## 3.1 Installation and Operation

CypCut default installation contains machine config program.

In Windows Start > All Programs > CypCut open machine config program ✓. 'CypCut laser cutting system' is software name which might be different of OEM version.

## 3.2 Password

You have to input password to start config tool.

Input Password:	×
Please enter a password:	
	1
🐱 !	1
OK Cancel	

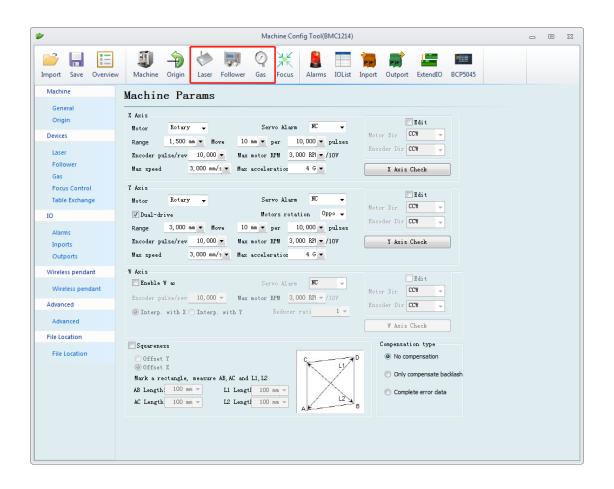
Initial password 61259023.

### Note:

All settings in machine config must setup by actual mechanism structure. Wrong settings will cause severe unknown problem! In machine config, all input are yellow color, and all output are green color.



## 3.3 User Interface



The first page open machine config is machine config overview. Click tab in top and left bar will open each parameter setup page for different machine module. For example, above three are entrance for laser, height control and gas system setting page. Click 'file location' will locate to folder of config data.

Click button in overview page will also open the parameter setting page of each module. Click 'Machine tool' will enter ' Machine' page.

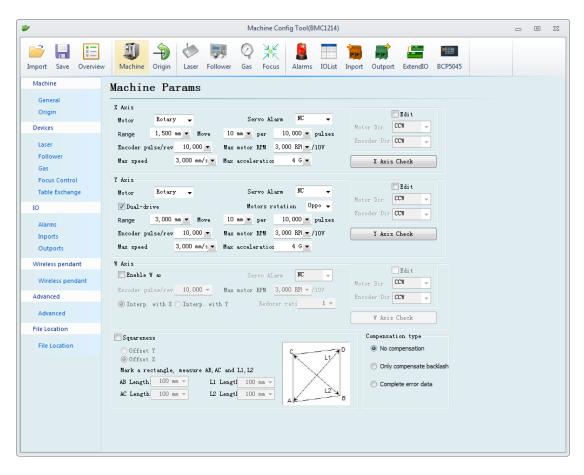
Click 'import' to finish machine config setting by existing file. Click 'save' save the setting.

#### Note:

- 1. Data folder contains all config files of CypCut.
- 2. Data backup is in CypCut > File > Backup.



## 3.4 Mechanism Config



Config mechanism structure, single drive Y axis or dual-drive Y axis, also config rotary axis.

**X axis range:** the maximum travel range under software limit protection function, also the width of white frame in CypCut drawing board.

**Y** axis range: the maximum travel range under software limit protection function, also the length of white frame in CypCut drawing board.

**Pulse equivalent:** pulse output per 1mm linear distance on machine load. You can calculate by ServoTools.

Servo alarm: set the triggered polarity of alarm signal is normally open or close.

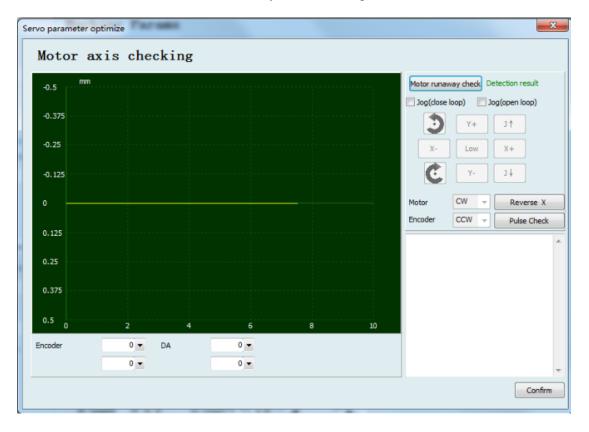
Max speed: maximum user speed and acceleration restricted by CypCut.

Pitch compensation: compensation method for mechanic error including backlash



and offset error data from interferometer.

Squareness: this is to offset the error when X and Y mechanic is not orthogonal.

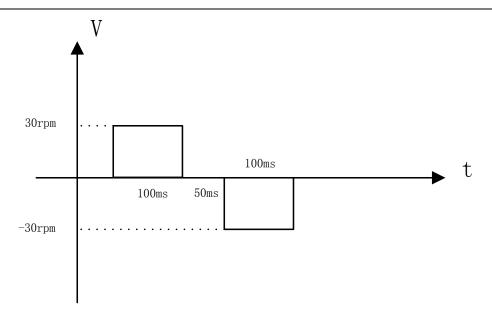


X/Y check: used for motor runaway risk checking.

**Motor runaway check:** to check if the motor rotation direction same with encoder feedback. For example: send voltage+ for motor rotation+. If encoder feedback pulses increase in positive value, it indicates motor rotation polarity same with encoder feedback. Otherwise, it cannot create a close loop control when motor rotation polarity different with encoder feedback, under this situation motor will never reach the target position and controller keep sending command signal, machine load will rush out, this scenario called 'motor runaway'. (Note: if doesn't pass motor runaway test, cannot open CypCut for machine spindle adjust).

The sequence of motor runaway check:





**Close-loop jog:** check the option and jog X axis, observe the motor rotation and encoder feedback polarity.

**Open-loop jog:** check the option controller only send analog output, doesn't compare with feedback. Dual-drive axis doesn't recommend this function.

Reverse X: if machine load direction not same with jog direction, click

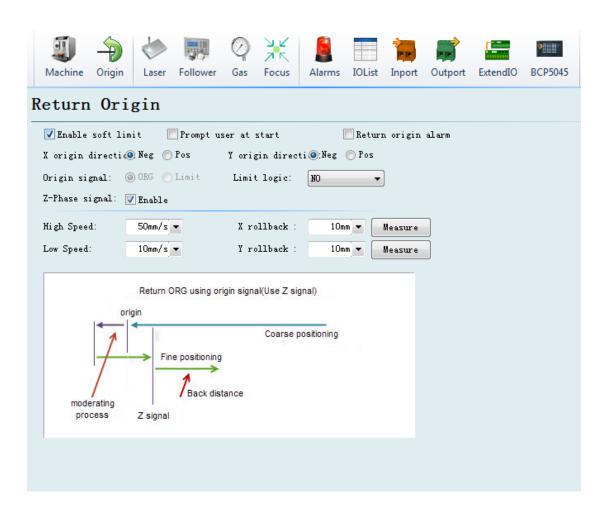
Reverse X

to reverse it and doesn't need to change setting in servo driver.

Pulse check: check if encoder feedback pulses match with controller command.



## 3.5 Return Origin Config



**Enable soft limit:** check this option, software limit function will force start all the time.

**Prompt user at start:** prompt message when open CypCut to inform user execute return origin operation.

**Origin direction:** select return origin direction needed. Return origin direction decides which coordinate quadrant system runs with. For example, return origin direction of X and Y are both in negative direction, system runs in first quadrant coordinate.

Origin signal: FSCUT4000 must use origin switch, cannot take limit as origin.

**ORG measure:** measure the installation distance between limit and origin switch. **Z-phase signal:** whether or not capture Z-phase signal results different return



origin process. The return origin process of each mode will display in picture. Dualdrive gantry synchronize function only available when capture Z-phase signal return origin.

Low speed: fine positioning speed, recommend to set 10mm/s.High speed: course positioning speed, recommend to set 50mm/s.Rollback: the distance motor rolls back after reach origin switch.Limit logic: the polarity of limit and origin signal active.

## 3.6 Laser Configuration

CypCut programmed standard configuration for YAG, CO2, IPG, Raycus, SPI and many other brand laser, select laser type and there are different parameter settings under each page.

er type:					
CO2	🔘 IPG	🔘 Max	🔘 Vall	ey Nuo	🔘 LianPing
🕤 SPI	🔘 CAS	🖱 Raycus	🔘 Rofin	n	🔘 Others
🔵 Mars	问 EO	🔘 Trumpf	🔘 nLi gl	ht	
aser Power:	1000₩ 👻				
- Mechanical shutter	: 11 🔻	Res	ponse input: 0	•	
Electronic Shutter:	1 -				
Laser Model 1:	13 🗸 🗸	Laser	Model 2: 14	•	
DA Select:	None	•			
DA Range:	🔘 0~5V	0~10V			
	1% 🔻				

## 3.6.1 CO2 laser configuration

Mechanic shutter: the output for mechanic shutter.

Digital shutter: the output for digital shutter.

Response input: response input when open mechanic shutter.



**Laser form:** laser form can be set as continuous wave, gate pulse and high power pulse by mode 1 and mode 2 output.

**DA port:** there are three DA analog output, select one of them for laser power control.

**DA range:** set the analog voltage range.

Minimum power: the minimum laser power.

#### 3.6.2 IPG laser configuration

Laser type:				
© CO2	IPG	🔘 Max	🔘 Valley Nuo	问 LianPing
💿 SPI	💿 CAS	🔘 Raycus	💿 Rofin	💿 Others
🔘 Mars	🔘 E0	🔘 Trumpf	🔘 nLi ght	
		-Laser alarm	set	
Laser Power:	1000W 🔻	🔳 SI	hield laser alarm	🕅 Show laser alarm as way
PWM Enable +	0 🔫	PWM Enable -	0 🔻	
DA Select:	Mana			
DA Select:	None 👻			
	None ▼ O~5V ● 0~	10V		
DA Select: DA Range:		10V		
DA Range:	⊙ 0~5V ⊚ 0~	10V		
DA Range: IPG Configurati	⊙ 0~5V @ 0~		nv 🔿 YLS-Ame	erican i YLP Series
DA Range: IPG Configurati IPG Type:	⊙ 0~5V ⊚ 0~		, 0	erican 🔘 YLP Series
DA Range: IPG Configurati IPG Type:	0~5V 0 0~ on: 9 YLR/YLM e start button		control laser output	erican 🔘 YLP Series
DA Range: IPG Configurati IPG Type: Remote Start Outp	0~5V 0 0~ on: 9 YLR/YLM e start button	⊘ YLS-Germa ▼ I/O Laser of	control laser output	0
DA Range: IPG Configurati IPG Type: Remote Start Outp COM co	O 0~5V O 0~	<ul> <li>✓ YLS-Germa</li> <li>✓ I/O</li> <li>✓ Laser or</li> <li>✓ Use</li> </ul>	control laser output utput: 1 -	0
DA Range: IPG Configurati IPG Type: Remote Start Outp COM cc CO	© 0~5V @ 0~	<ul> <li>♥ YLS-Germa</li> <li>♥ I/O</li> <li>Laser oi</li> <li>♥ Use</li> <li>IP</li> </ul>	control laser output utput: 1 Network to communicate address 192.168.1.10	0
DA Range: IPG Configurati IPG Type: Remote Start Outp COM co co Ignore	© 0~5V @ 0~	<ul> <li>♥ YLS-Germa</li> <li>♥ I/O</li> <li>Laser oi</li> <li>♥ Use</li> <li>IP</li> </ul>	control laser output utput: 1 -	0

**PWM enable:** select a relay output in BCL3724 board as switch of PWM signal. Relay output can avoid laser leakage.

**DA output:** there are 3 DA ports of analog output, select one of them for laser power control. When use RS232 or network control doesn't require DA port.

#### **IPG Fiber Laser Configuration:**

#### **Remote start button:**

When key switch turns to remote control mode, you can startup laser by remote



button. If use remote start button, you need to setup the output port for the button. (Remote start up button is not recommended, for it's easy to cause laser malfunction).

#### **IPG remote control:**

When use IPG remote control, CypCut will monitor laser status in real time, then communicate and control laser emission, guide beam and peak current etc. When use remote control mode, doesn't require DA analog port.

IPG remote control supports serial and network communication, user can set IP or COM port as needed. When laser and BCS100 both select network communication with PC, take notice that the network segment of each IP cannot be same. For example, IP segment of BCS100 is 10.1.1.x while laser IP set 192.168.1.x. Recommend to use network communication which is more stable. If use serial communication, the shielding layer and outer shell of the connected device must be well grounded.

aser type:				
🔘 CO2	🔘 IPG	🔘 Max	🔘 Valley Nuo	🔘 LianPing
💿 SPI	🔘 CAS	🔘 Raycus	🔘 Rofin	💿 Others
Mars	🔘 E0	🔘 Trumpf	🔘 nLi ght	
Istor Power:	1000%			
Laser Power: PWM Enable +	1000₩ 💌	PWM Enable -	0 🗸	Shutter Enable 1
Laser Power: PWM Enable + DA Select:	1000₩ ▼ 0 ▼ None ▼	PWM Enable -	0 🗸	Shutter Enable 1 💌

#### 3.6.3 Feibo/Rofin/SPI/GSI/JK laser configuration

Feibo, Raycus and SPI laser are similar with IPG laser configuration, and support serial communication.

**Debug mode:** when enable this mode, CypCut log window will display the communication code with laser.



3.6.4 Configuration of other laser type

Laser type:					
🔘 CO2	🔘 IPG	🔘 Max	🔘 Valley Nuo	🔘 LianPing	
🔘 SPI	🔘 CAS	🔘 Raycus	🔘 Rofin	) Others	
🔘 Mars	🔘 E0	🔘 Trumpf	🔘 nLi ght		
Laser Power:	1000₩ 🔻				
PWM Enable +	3 👻	PWM Enable -	4	Shutter Enable 1	•
DA Select:	None 👻			Shutter Ready 0	•
					0ms 🖣

Shutter enable: output to open laser shutter.

## 3.7 BCS100 Configuration

## 3.7.1 Use BCS100 as height control unit

Foll	ower
BCS10	0 🔘 BCS100 Demo 🔘 IO
N	etwork Config:
	IP address: 10.1.1.188
	Test connection
	Set IP This computer installed 1 netcards: Network Card Name:本地连接 MAC : 34-97-F6-D9-0B-C5 MAC : 34-97-F6-D9-0B-C5
	IP : 10.1.255.49

Use BCS100 as height control unit, set IP address in machine config same in BCS100.

Details of setting IP address please check in BCS100 user manual P2.5.6.



### 3.7.2 Use external device as height control unit

Follower
----------

🔘 BCS	5100 🔘 BCS100 Dem	o (	) IO
	Port Configuration:		
	"0" means this port is n	ot in use, it ma	ay cause logical error if you set number to those ports.
	Start follow:	2 🚽	
	Lift/Stop follow:	0 🗸	
	Stop/Hold:	0 🗸	
	Jog up:	0 🗸	
	Jog down:	0 🗸	
	Jog down.	• •	
	Follow in place:	0 🗸	(Input)
	Follow in place:	O Low level	Migh level

CypCut supports I/O control mode for height controller of other brand. User can assign output with basic functions of lift, hold, up and down etc.

Start follow: output to start follow.

Lift/stop follow: output of stop follow and lift up.

Stop/hold: output of stop follow and hold still.

Jog up: output of jog Z axis up.

Jog down: output of jog Z axis down.

Follow in place: input signal of follow reached position.

Active level (follow in place input): active level of follow in place signal.

Note: If the port number set '0', means this port not in use. If this port not assigned to any signal, doesn't set any port number, otherwise it might cause error.



## 3.8 Gas System

				G DA	as Control Max P	regsur	e (Bar)			
Air(L):	6	-	]	DA1		<b>▼</b> + - 1	Valve	(L):		
Oxygen(L):	7	-		DA1			3	-	7	
Nitrogen(L)	: 8	-		DA1		<b>→</b>			Valv	re:
									5	-
Air(H):	0	-					Valve	CHC) :		
Oxygen(H):	0	-	]				0	<b>-</b>		
Nitrogen(H)	:0	-	]							
		© 0^9	-	oai vaive	e by setting th 10V	e same l	DA port.			
DA Voltage Control	Range: valve pov	or suj	5V ppl	<b>◎</b> 0~			-	off delay:	30s •	•
DA Voltage Control DA outpu Gas Alarm	Range: valve pov it O at ge	© 0~9 ver suj as off	5V ppl	⊚ 0~ Delay	107	alve	Valve-0	-	30s -	
DA Voltage Control DA outpu Gas Alarm	Range: valve pov it O at ge rm as need	© 0~9 ver suj as off	5V ppl		10V turn off va	alve	Valve-0	-	30s 1	
DA Voltage Control DA outpu Gas Alarm Config alar Air(L) ai	Range: valve pov it O at ge rm as need	off off off off	5V ppl		10V turn off va	alve	Valve-0	-	30s •	Ī
DA Voltage Control DA outpu Gas Alarm Config alau Air (L) ai Oxygen (L	Range: valve pov it O at ga rm as need larm:	© 0~5 ver suj as off ed. Any 0	5V ppl / gas d	O <sup>∼</sup> Delay hannel a	10V turn off va	alve affect of	Valve-o	nannel.	30s •	
DA Voltage Control DA outpu Gas Alarm Config alar Air (L) a Oxygen (L Nitrogen	Range: valve pov t O at ga rm as need larm: ) alarm: (L) alarm	© 0 <sup>~</sup> 5 yer suj as off ed. Any 0 0	5V ppl ✓ gas d ✓ NO ✓ NO ✓ NO	O <sup>*</sup> Del ay hannel a 1 • 1 •	10V turn off va	alve affect of	Valve-o	nannel. ▼ Alarm o	heck delay	Om s 💌
DA Voltage Control DA outpu Gas Alarm Config alar Air (L) ai Oxygen (L Nitrogen Air (H) ai	Range: valve pov it 0 at ga mm as need larm: ) alarm: (L) alarm larm:	© 0 <sup>~</sup> ts yer suy as off ed. Any 0 0 0	5V ppl / gas d ▼ NO ▼ NO	O <sup>*</sup> Del ay hannel a 1 • 1 •	10V turn off va alarm doesn't a Alarm (L):	alve affect of	Valve-o	nannel.	heck delay	
DA Voltage Control DA outpu Gas Alarm Config alar Air (L) ai Oxygen (L Nitrogen Air (H) ai	Range: valve pov t O at ga rm as need larm: ) alarm: (L) alarm	© 0 <sup>~</sup> ts yer sug as off ed. Any 0 0 0	5V ppl ✓ gas d ✓ NO ✓ NO ✓ NO	O <sup>*</sup> Delay hannel a • • • • • • • • • • • • • • • • • • •	10V turn off va	alve affect of	Valve-o	nannel. ▼ Alarm o	heck delay	Om s 💌

Valve (H/L): master valve of high pressure or low pressure gas channel.

Air: set output for air switch.

**Oxygen:** set output for oxygen switch.

Nitrogen: set output for nitrogen switch.

Gas alarm: to set alarm check for each gas channel or master valve.

There are 3 DA ports of analog signal can be assigned for gas pressure regulation.

## 3.9 Alarm Configuration



EM Stop: 0 - ONO NC	🦳 Manual reset all alarm 🦳 Force enable manual reset	
Safety mode: <mark>O</mark> NC - NC	Display warning while machine in operation:	
Max speed in safety mode: 500 ▼ mm/s	Custom input alarm: Alarm Input (Warnning Input ) 4 Bit Alarm	
Max laser power in safety mode: 1000 - W	🛉 Add 💻 Del	✓ Disable production
Allowed dual-drive error:	Alarm description     Port     Level     Time Filt       water temperature     0     0     NC     0       oil level     0     0     NC     0	ter 📝 Disable laser 📝 Disable Z follow 📝 Disable return orig
3 💌 mm	please enter <mark>0 </mark> ③ NO ─ NC O	✓ Disable Y jog

### 3.9.1 Warning message

Display the warning message of yellow color when machine is running. You can edit the warning message.

### **3.9.2** Emergency stop button

When this signal port active will trigger emergency stop alarm.

### 3.9.3 Safety mode

Safety mode used for machine maintenance mode, under which machine speed and laser power will all be restricted to preset safety range.

## 3.9.4 Custom alarm

User can assign any input port as alarm, edit alarm description and active level of signal port, and select allowed machine actions in alarm status.

### 3.9.5 Allowed dual-drive error

Maximum dual-drive position error allowed, the threshold to trigger alarm.



# 3.10 Common input

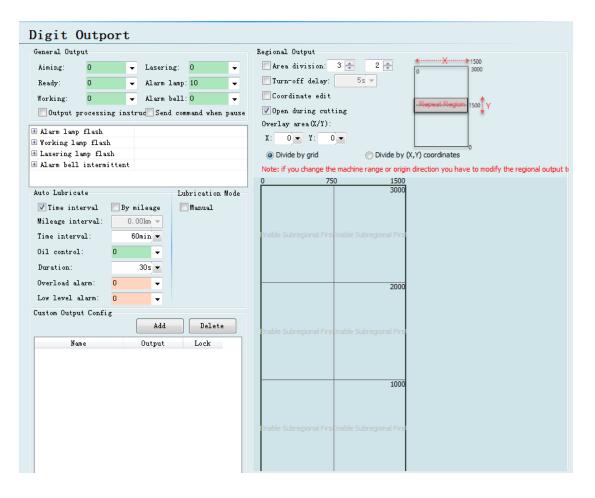
erce in-position chec	ik: U	-				
port function list:						
unction	Input	Level Te		Functions 👻		
tart/Continue	0	O NO	O NC	Process control	•	Start/Continue
o Origin aser On(Laser On When	0	NO	O NC	Jog	•	Start/Pause/Continue
aser On Laser On When nange To Table A	0	<ul> <li>NO</li> <li>NO</li> </ul>		Return zero/origin		Cycle start
nange To Table B	0	NO NO	NC NC	-		
istom Procedure 7	0	O NO	O NC	Record/Return Record		Pause
			0	Select Coordinate		Pause+PLC+Continue
				Laser Control	•	Continue
				Follower Control	•	Stop
				Gas Control	•	Breakpoint Positioning
				Output	•	Breakpoint Continue
				Pallet Changer	•	Frame
				Custom Procedure	•	Dry Run
				Custom roccusic		Y+
					_	Y-

Click Functions 
button and select controlled function and active level of input

signal.



## 3.11 Common output



### 3.11.1 Output configuration

Aiming: output to control guide laser.

Lasering: system will send an output signal for indicator lamp when laser in emission.

**Working:** system will send an output signal for indicator lamp when laser in production.

Alarm lamp: system will send an output signal for alarm lamp when alarm triggered.

Alarm bell: system will send an output signal for alarm bell when alarm triggered.

Ready: after machine axes returned origin, system will send an output.

### 3.11.2 Auto lubricate

After this I/O is assigned for auto lubrication, CypCut will start time/running

51



length counting and turn on/off lubrication when reach preset time/mileage interval.

## 3.11.3 Custom output

Assigned I/O will display software button under CypCut CNC tab. Custom I/O can select contact or self-lock control method.

### 3.11.4 Regional output

Regional output used for automatic dust extracting. When machine in production, laser head works in region A, output in region A will active and turn on dust extractor. When laser head works from region A to region B, output 12 turns off and output 15 turns on.

**Turn-off delay:** when laser head works from one region to another one, output of last region will turn off after preset delay.

## 3.12 Find Edge Setting

Find Edge		
Find Edge Parameters		
📝 Photo-sensor find	edge	🔽 Capacitive find edge
output:	0 🗸	✓Console displays "Find edge before process"
Signal input:	0 🗸	📝 Disable (Find edge before process)
Switch logic:	◎ L(active when ligh <sup>.</sup>	
	🔘 D(active when ligh <sup>.</sup>	
🔲 Separate seekir	ng height for pallet	

CypCut supports find workpiece edge by capacitance sensing and photo-electric sensor. Photo-electric sensor must be Omron E3Z-L61 model. Capacitance sensing realized by BCS100 height controller.



## 3.13 BCP5045 Panel

BCP5045				
📝 Enable NC Panel				
In stand-alone environment, plu				
○ In LAN environment, please enter	r NC ID.			
160101010101				
FRIENDESS				
	Level Tube	Find Edge	Auto Feed	
	Click to Select	Click to Select	Click to Select	
	Click to Select	Click to Select	Click to Select	
	Click to Select	Click to Select	Click to Select	
	Click to Select	Click to Select	Click to Select	

Enable BCP5045 panel in this page. In stand-alone environment, CypCut will connect to BCO5405 Mac address. In LAN environment, input ID of BCP5045. There are 12 custom buttons which can be assigned for machine function like PLC control or pallet control.



# 4. Electrical System Adjustment

## 4.1 Power Supply Checking

Connect BCL3724 I/O terminal board and BMC1214 control card by C62-pin cable, give 24V power supply to BCL3724 board. Make sure power supply in right wiring and no short circuit before power up.

Note: Do not hot plug BMC1214 card and C62-pin cable!

## 4.2 Basic Machine Motion Config Checking

Motor runaway risk exists in close-loop control, you need to do some checking points before first-time running.

First, confirm some basic settings in 'machine config tool' in below image: motor type, servo alarm signal polarity, pulse equivalent, encoder feedback, input gain of speed command, for dual-Y drive structure you also need to confirm rotation direction of master motor and slave motor in case of mechanic twisting (Take notice that servo drive parameters should be same settings for dual-Y axes).

55 FSCUT4000 Laser Cutting Control System



	Machine Config Tool(BMC1214)	- • 2
mport Save Overview	Image: Second system       Image: Second system <td< th=""><th></th></td<>	
Machine	Machine Params	
General	X Axis	
Origin	Motor Rotary - Servo Alarm NC - Edit	
Devices	Range 1,500 mm v Move 10 mm v per 10,000 v pulses	
Laser	Encoder pulse/rev 10,000 v Max motor RPM 3,000 RPI v /10V	
Follower	Max speed 500 mm/s V Max acceleration 4 G V X Axis Check	
Gas		
Focus Control	Y Axis Edit	
Table Exchange	Motor Rotary V Servo Alarm NC V Motor Dir CCW V	
IO	✓ Dual-drive Motors rotation Dppe ▼ Encoder Dir CCW	
Alarms	Range 3,000 mm V Move 10 mm V per 10,000 V pulses	
Inports	Encoder pulse/rev 10,000 Max motor RPM 3,000 RPI - /10V Y Axis Check	
Outports	Max speed 500 mm/s 💌 Max acceleration 4 G 💌	
Wireless pendant	W Axis	
Wireless pendant	Eneble W av Servo Alarm NC - Edit	
Advanced	Encoder pulse/rev 10,000 v Max motor RPM 3,000 RPI v /10V	
Advanced	◎ Interp. with X ◯ Interp. with Y Reducer rati	
Advanced	W Axis Check	
File Location		
File Location	Squareness Compensation type	
	Offset Y     C     Offset X     C	
	Mark a rectangle, measure AB, AC and L1, L2	
	AB Length: 100 mm v L1 Lengt 100 mm v O Complete error data	
	AC Length 100 mm V L2 Lengt 100 mm V L2 B	
	Ap-	

Second, check motor direction and feedback pulse direction from encoder. Click

X Axis Check

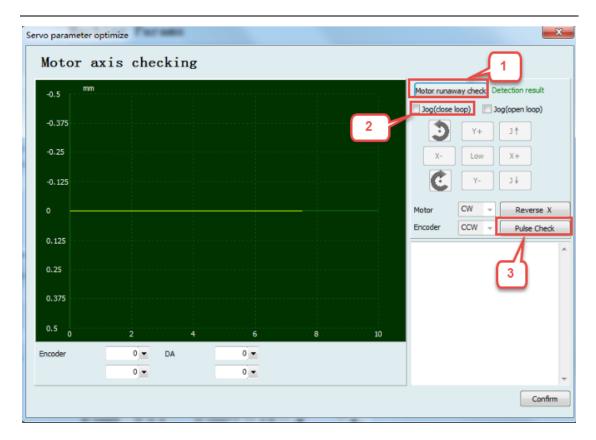
open 'motor axis checking' page.

- 1. Click Motor runaway check to start motor runaway test.
- 2. Click option, then jog motor in both directions, if motor motion

direction not same with command direction in CypCut, click Reverse X to reverse it.

3. Pulse check. This is to ensure encoder feedback pulses and input gain of speed command set right.

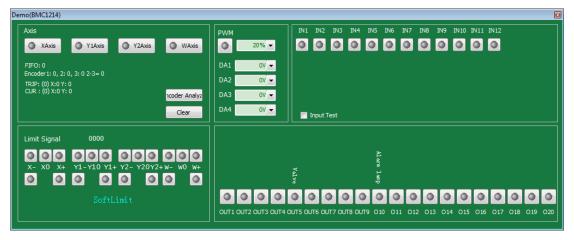




## 4.3 Hardware Signal Checking

Startup computer and open CypCut software. Open File tab > Diagnosis > IO

Monitor.



Check each signal one by one: positive limit/negative limit/origin switch of each motor axis, DA signal, PWM signal, servo enable signal and all other input and output signal.



## 4.4 Basic Motion Test

First, set conservative PID value in servo driver. And set conservative value of motion control parameter in CypCut. In CypCut 'Layer' > 'Global Parameter' shown as below:

Layer Parameter Settin	gs							
Global Parameter	layer 1							
Motion Parameters								
Travel speed:	200 👻	mm/s	Travel acceleration:	2000	mm/s^2	Travel low-pass freq:	6 🔻 Ha	z
Frame speed:	150 👻	mm/s	Cutting acceleration:	2000	mm/s^2	Cutting low-pass freq:	4 💌 Ha	z
Curve precision:	0.05 🌲	mm	Jog acceleration:	2000	mm/s^2	Jog low-pass freq:	3 🔻 Ha	z
Corner precision:	0.10 🌲	mm						
						· · · · · · · · · · · · · · · · · · ·	otion Control: Unify 🔘 Sepa	irate

Test single motor axis make sure pulse equivalent set right.

After all limit and origin signal tested to work normally, execute each motor axis return origin to build mechanical coordinate.

## 4.5 CypCut Basic Function Test

On CypCut control panel(right side on screen), click direction button to jog control axes, lift up/down Z axis, turn on/off gas blow, open/close aiming laser, change laser burst power etc. to test each part function well. Confirm system can control laser, BCS100 height controller, gas and other devices function well.

## 4.6 Position-Loop PID Self Adjustment

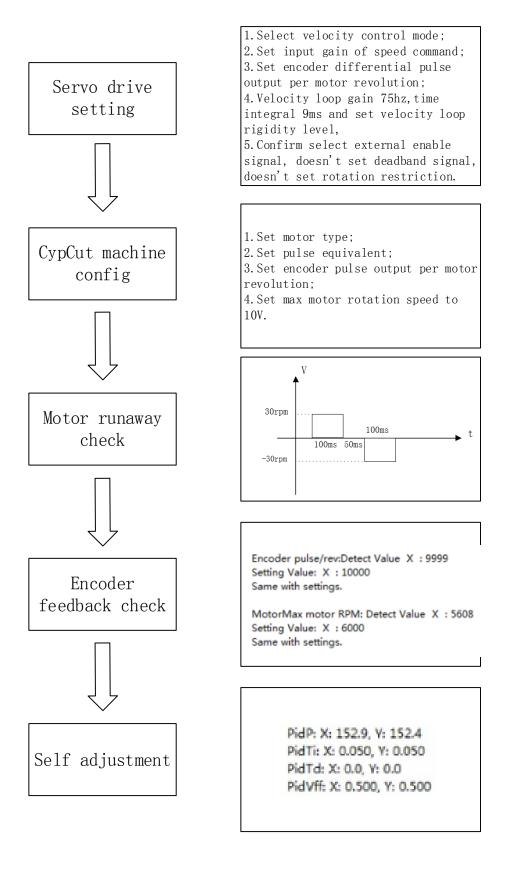
In CNC tab > Auto adjust, to adjust position-loop PID parameter.



		Tr	Adjust measure	Monitor	Nozzle							
	10	20	30	40	50	60			80	90		100
) Param	eter Automatic	adjustment										×
-0.5	mm						PID Auto Adjust					
-0.475							Rigid class: 18			-		
-0.425												
-0.4												_
-0.35 -0.325							This will mov 50mm,make			ck and forth Adj	justment	
-0.3							middle of th					_
-0.25							If the effect	t is not satis	factory, yo	ou can use Advance	ad adjustma	
-0.2							the advance better result	eu automau	c adjustme	ent to get	eu aujusune	
-0.15							better resu	<b></b>				
-0.1												
-0.075												
-0.025							X Axis Pa	ramete	er 👘	Y Axis Pa	ramete	r
0.025							Pid P	250 -		Pid P	300 -	
0.025 0.05 0.075							Pid P	250 -	5	Pid P	300 -	s
0.025 0.05 0.075 0.1 0.125									s			s ms
0.025 0.05 0.075 0.1 0.125 0.15 0.175							Pid Ti	0.01 - 3 -		Pid Ti	0.05 -	
0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225							Pid Ti [ Const Differenti Speed Vff [	0.01 v 3 v 0.5 v	ms	Pid Ti Const Differenti Speed Vff	0.05 v 3 v 0.5 v	ms
0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225 0.25							Pid Ti	0.01 - 3 -		Pid Ti	0.05 -	
0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225 0.25 0.275 0.275 0.3							Pid Ti [ Const Differenti Speed Vff [	0.01 v 3 v 0.5 v	ms ms	Pid Ti Const Differenti Speed Vff	0.05 v 3 v 0.5 v	ms
0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225 0.225 0.25 0.275 0.325 0.325 0.35							Pid Ti Const Differenti Speed Vff integration time	0.01 v 3 v 0.5 v	ms ms	Pid Ti Const Differenti Speed Vff integration time	0.05 - 3 - 0.5 - 0 -	ms ms
0.025 0.05 0.075 0.12 0.125 0.15 0.25 0.25 0.25 0.25 0.275 0.3 0.325 0.375 0.3							Pid Ti Const Differenti Speed Vff Integration time	0.01 v 3 v 0.5 v 0 v 0 v	ms ms mm/s	Pid Ti Const Differenti Speed Vff Const Differenti Speed Vff Positive compens	0.05	ms ms mm/s
0.025 0.05 0.15 0.125 0.15 0.25 0.25 0.25 0.25 0.25 0.325 0.325 0.325 0.325 0.375 0.425							Pid Ti Const Differenti Speed Vff Integration time Positive compens Positive compens	0.01 ¥ 3 ¥ 0.5 ¥ 0 ¥ 0 ¥	ms ms mm/s ms	Pid Ti Const Differenti Speed Vff integration time Positive compens Positive compens	0.05 ~ 3 ~ 0.5 ~ 0 ~ 0 ~	ms ms mm/s ms
0.025 0.05 0.075 0.1 0.125 0.25 0.25 0.275 0.3 0.325 0.375 0.375 0.4 0.425			4 6		8		Pid Ti Const Differenti Speed Vff Integration time Positive compens Negative compens Negative comper	0.01 ~ 3 ~ 0.5 ~ 0 ~ 0 ~ 0 ~	ms ms mm/s ms mm/s	Pid Ti Const Differenti Speed Vff integration time Positive compens Negative compens	0.05 ~ 3 ~ 0.5 ~ 0 ~ 0 ~ 0 ~ 0 ~	ms ms ms mm/s ms



# 5. Adjustment Steps





# 6. Common Problems in Close-Loop control

## 6.1 Motor Runaway Error

Error source: system doesn't receive feedback pulse or receive abnormal pulses from encoder.

Checking points:

- Check the wiring, make sure servo enable signal, speed command signal and encoder signal are wired with correct signal pin;
- (2) Check servo driver parameter: if set external enable, do not set deadband(neutral zone), and set zero offset value properly;
- (3) Check PID parameters in velocity loop and current loop, servo rigid level cannot be too low.

## 6.2 Encoder and Speed Check Failed

Error source: in Pulse Check process, program detected received encoder pulses and maximum speed doesn't match with preset value.

Checking points:

- If test results remain same error value in repeated testing, check servo driver parameter if command speed gain and feedback pulses match the setting in CypCut machine config;
- (2) If test results are different error value in repeated testing, encoder signal might be disturbed. Check in electrical cabinet if separate the wiring of strong current from weak current.

## 6.3 Position Error Too Large

Error source: the feedback position different with command position. Checking points:



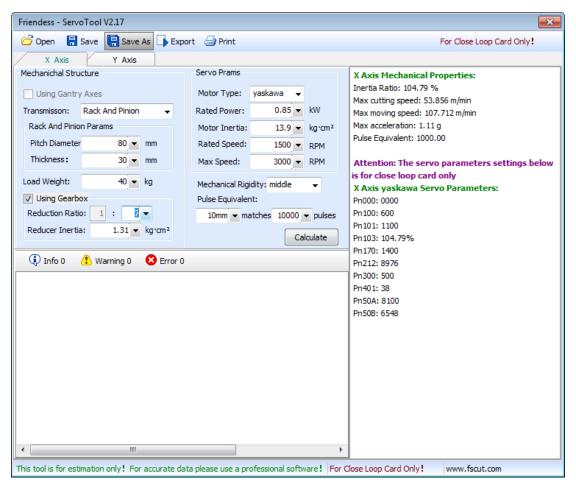
- Open CypCut machine config, and execute Motor runaway check make sure the checking passed;
- (2) If this error came after increasing acceleration in CypCut, might be caused by motor torque being restricted. Driver settings restrict motor torque or motor itself is of low torque type;
- (3) If this error came after increasing speed in CypCut, motor speed might be limited. Servo parameter might limit motor speed, or exceed motor maximum speed;
- (4) If this type error always exist when setting acceleration and speed from high to low level, it indicates servo system is of low rigid. Mechanic or driver inner loop is low rigid.



# 7. Optimize Machine Motion Performance

# 7.1 Calculate Inertia Ratio and Preview Machine Performance Features

The inertia ratio is a crucial indicator of machine performance features. You can calculate inertia ratio of each motion axis of machine by ServoTools. Download link is http://downloads.fscut.com/. ServoTools interface shown below:



When inertia ratio is smaller than 200% machine runs in light load can reach high speed cutting.

When the inertia ratio is between 200% to 300% machine runs in medium load, cutting precision is declined compared with light load in high speed, cutting speed and low-pass frequency should be lower.



When inertia ratio is between 300% to 500% machine runs in heavy load and cannot reach high speed cutting.

When inertia ratio is larger than 500% indicating serious defect in machine design, servo system cannot complete adjustment in short time.

You can calculate a rough value of machine maximum cutting speed, travel speed, and acceleration by ServoTools. The calculation results can be set in CypCut > Global Parameter > Motion Control parameter. Experienced users can calculate more accurate inertia ratio by servo tuning tool.

Note: The servo parameters calculated by ServoTools only for FSCUT system of close-loop control card. Open loop control card should set servo parameter by position loop control mode.

## 7.2 Motion Control Parameter Adjustment

#### 7.2.1 Motion control parameter description

Speed, acceleration, low-pass filter frequency, corner and curve precision in FSCUT4000 system are available for users to adjust, other parameters related with motion control are optimized automatically. Parameter description listed below:

Name	Description
Travel Speed	The maximum travel speed. You can calculate by ServoTools and
	input calculated value directly.
Travel	The maximum travel acceleration. You can calculate by
Acceleration	ServoTools and input calculated value directly.
Cutting	The maximum cutting acceleration which directly influences
Acceleration	speed in cutting curve or corner path. You need to observe the
	torque curve in servo tuning tool to adjust acceleration in cutting.
Low-Pass	The filter frequency to suppress machine vibration. Suppression
Frequency	works stronger under smaller low-pass frequency value.
Curve Precision	Curve cutting precision. Smaller value works higher curve control
	precision and lower speed.
Corner Precision	The precision of NURBS curve fitting corner path. Smaller value
	works more pointed corner cutting but also slow the speed.

#### 7.2.2 Adjust cutting acceleration

Jog axis at high speed, 500mm/s for example, make sure axis move enough

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distance to reach the pre-set speed.

Monitor the torque curve in servo tool when jog control the axis, increase the cutting acceleration if peak torque is under 80% of rated value, lower the cutting acceleration if peak torque is below 80% of rated value.

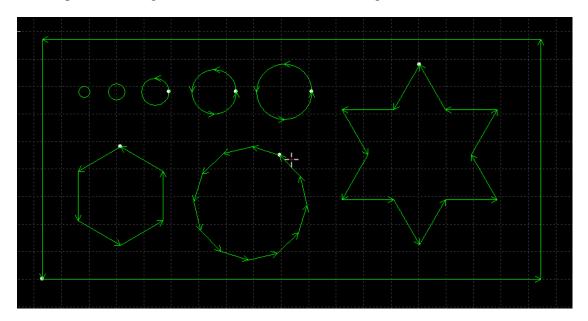
Adjust the acceleration until peak torque reaches to 80% of rated value when jog the axis in high speed. The acceleration lead screw structure can bear is usually under 0.5G. For rack gear structure is under 2G.

#### 7.2.3 Adjust travel acceleration

You can calculate maximum travel acceleration by ServoTools. Or directly set a value 1.5~2 times larger than cutting acceleration. When machine running without load, motor peak torque should be under 150% of the rated value, and there should be no mechanism deformation or vibration under this acceleration. The acceleration lead screw structure can bear usually is under 0.5G. For rack gear structure is below 2G.

#### 7.2.4 Adjust low pass filter frequency

You can adjust low-pass filter frequency (LPF) by cutting a part. Lower laser power and make a marking cut on workpiece. Observe the quality of marking contour. The marking graphic could be small circles in different sizes, hexagon, dodecagon, star shape and rectangle etc. As shown in the below image:



Setup low pass filter frequency as high as possible as long as not reducing



marking contour precision. The standard of contour precision should be no waving at corner position in cutting star, rectangular or polygon etc. You can setup by experiential value in below table. Setup the cutting acceleration then adjust LPF 2 levels around. The cutting acceleration has to match with LPF, you cannot setup one of them too larger than the other one.

Level	1	2	3	4	5	6	7	8	9	10
Cutting Acceleration (G)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1	1.5	2
LPF (HZ)	2	3	4	5	5.5	6	6	6	7	8

#### 7.2.5 Curve precision and corner precision

It's recommended to use the default value. If it's really needed, you can fine tune the value a little bit around the default value.

If curve cutting precision doesn't reach requirement, you can lower the value, meanwhile cutting speed at curve also be reduced. Speed reduction is more obvious under smaller precision value. If corner cutting precision is not satisfied, you can lower the value, meanwhile cutting speed at corner also be reduced. Sharpe corner will turn to round corner under a large precision value.



# 8. FAQ

## 8.1 Cutting is Slow or Jamming

- In CypCut, open 'node mode' to view the drawing, if graphic contour made of a lot nodes, please optimize and smooth the graphic before cutting.
- Check the cutting parameter setting see if there is improper setting of time delay, or mixed time unit set 200ms to 200s for example.
- If Z axis jamming in lifting actions, check the BCS100 firmware version. If it's BCS100 V2.0, make sure firmware update to V802 and later version.
- If it takes a long time for laser to start emission, check the serial communication of laser.

## 8.2 Corner Over Burned

- Raise the low pass filter frequency to reduce the acceleration and deceleration time at corner.
- Raise the corner precision in global parameter to smooth the corner path.
- Modify the drawing, for example, change the corner path like below image.



- In layer parameter setting window, open speed-power regulating curve function, lower the laser power at low speed position.
- Apply cooling point technique at corner position to cool off the heated zone then resume cutting.

## 8.3 Laser No Emission

- 1. Check Laser Setting in Machine Config
- Check the laser type selection, for example, IPG YLS American version is



different with Germany version.

- If use serial or Ethernet communication, check in PC if select correct communication port.
- If use analog signal to control laser peak power, check if select right DA port.
- Check if PWM and 'Laser on' signal select right I/O port.
- 2. Check PWM and DA Output Signal
- In CypCut > File > Diagnosis > Card Monitor input different DA and PWM value, then measure the voltage output at DA and PWM port in BCL3724 I/O terminal board.
- If measured voltage is under pre-set value or no voltage output at all, try change another PWM or DA port then measure output voltage again.
- If it's confirmed hardware error, please contact technical support.

## 3. Check the Wiring

- Check the wiring of PWM, DA, serial cable and other signal wiring with laser control.
- Serial cable must have shielding layer and pin 2, 3 are crossed.
- 4. Check Laser Status
- Check laser status with laser software, test laser emission for trouble shooting.
- When use serial communication, it's not allowed to use multiple software to communicate with laser at same time.
- If serial communication failed, use debug mode to check command and laser response.



# 9. Appendix

## 9.1 Fly Cut Operation Guide

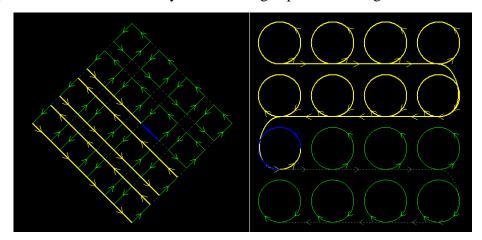
## 9.1.1 Function

There are new functions for CypCut later than V6.3.495: 'fly cut' also named 'scan line cut' in CypCut. This function applied in thin sheet cutting, used to cut arrayed parts of standard shape in high speed to improve production efficiency. Function entry shown as below.



### 9.1.2 Function description

Linear Fly Cut: select the rectangular array and create fly cut path. The fly cut path will be along same direction and laser head will not lift traveling between cut paths, meanwhile machine always maintain high speed in cutting.



Circular Fly Cut: select arrayed circles and create fly cut path. The cutting will follow continuous path, laser head will not lift traveling between cut paths, meanwhile machine always maintain high speed in cutting.



## 9.2 Pitch Error Compensation

#### 9.2.1 Pitch error compensation description

The mechanical error in ball screw and gear rack is an absolute existence, so the actual mechanic character is different with its nominal character. For application of high precision, it requires to measure mechanical error by measuring instrument like interferometer, then offset measured data via cutting control system to reduce mechanical error.

CypCut laser cutting software designed complete compensation functions to create required machine actions for measuring device capturing data and offset error measurement data from interferometers of Renishaw, API, Agilent, OptoDyne etc. You can also set backlash error compensation directly if there is no interferometer measured data.

#### 9.2.2 Mechanical origin

Before measure mechanical error must return axes to mechanical origin to build correct coordinate. CypCut takes origin point as reference to offset pitch error data. If the origin position is different before and after pitch error measuring, then pitch error offset cannot serve its purpose to reduce error even work in opposite effect.

Use 'Z phase' signal to improve return origin precision. FSCUT4000 system provides encoder feedback channel for each motor axis to ensure control precision.

Set return origin direction of X/Y axis by machine design. Return origin direction results in which coordinate quadrant machine runs with. If return origin towards negative direction, then machine runs in positive range of coordinate. If return origin direction towards positive direction, then machine runs in negative range of coordinate.

You can repeat return origin and measure origin precision by interferometer. The error of each origin should be no more than 5µm.

#### 9.2.3 Measure pulse equivalent

The theoretical pulse equivalent is different with actual value due to mechanical



error. Precise pulse equivalent can be measured by interferometer.

aomin	e Param	IS			
{ Axis					Manual
Motor	Rotary 👻		Servo Alarm	NC	Motor Dir CCW -
Range	1,500 mm 🔻	Move 10 mm	💌 per 🔢 10,0	000 <b>y</b> pul	Ises
Encoder Pu	1/r 10,0	000 🔽 - Max RP	M 3,000	RPI 🔻 /10V	Encoder Dir CCW
Max Speed	500	mm/s 💌 Max Ac	c ·	4 G 🔻	X Axis Check
Axis Motor	Rotary 👻		Servo Alarm	NC	Manual
📝 Gantry			Gantry motor D	ir Diff	▼
Range	3,000 mm 💌	Move 10 mm	💌 per 10,0	000 <b>-</b> pul	Encoder Dir CCW -
	1/m 10.0	000 💌 Max RP	м 3,000	RPI 🔻 /10V	Y Axis Check
Encoder Pu					

## 9.2.4 Mechanic error measure

In CypCut > CNC > Path function is to setup and create motion path for interferometer to capture and record measurement data. Machine runs and pauses in preset distance and time interval, meanwhile interferometer measures and records the actual position at each pausing point. After measurement complete will generate a data table of comparison between theoretical position and actual position.

Most interferometers in market, take Renishaw for example, has to setup travel range, travel interval and time duration at each stop, like stop 1 sec every 30mm. Interferometer capturing data or not is decided by the interval distance and stop duration. First you have to setup several parameters:

**Range:** the range to be measured, usually a little smaller than maximum machine travel range.

**Interval:** by theory, shorter measure interval will get more precise offset result. Shorter measure interval will come with more stop points to be measured also take more time for a whole measurement process. Recommended interval is 10mm~100mm.

Stop time: the minimum stop duration for Renishaw is 2 seconds.





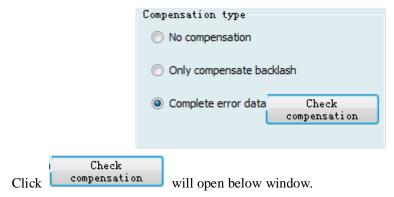
Make sure the zero point of interferometer and machine origin in same position. Check in CypCut machine config, pitch compensation function

should be disabled while still in measuring process.

## 9.2.5 Import measurement data to CypCut

The measurement data file can be imported in CypCut. CypCut can read measurement file generated by Renishaw, API, Agilent, OptoDyne interferometer software. If the measurement file of interferometer you are using cannot read by CypCut, please contact our technical support. Below is where to import measurement file:

Open CypCut machine config, in Machine > Pitch Compensation > Interferometer.





Axis	IX Load Y	Viear 📊	Save 🛛 🐼 Rev	verse Data 🛛 🔆 S	witch Pos/Neg				
Index	Position	Positive Mea	Positive devi	Negtive mea	Negtive devi	Backlash			
1	0	0.0001	-0.0001	0.0422	-0.0422	0.0421			
2	50	49.9998	0.0002	49.9969	0.0031	-0.0029			=
3	100	100.0237	-0.0237	100.0292	-0.0292	0.0055			
4	150	149.9895	0.0105	149.9957	0.0043	0.0062			
5	200	199.9722	0.0278	199.9674	0.0326	-0.0048			
5	250	249.9735	0.0265	249.9775	0.0225	0.004			
7	300	299.9421	0.0579	299.9603	0.0397	0.0182			
3	350	349.9029	0.0971	349.9352	0.0648	0.0323			
Э	400	399.9097	0.0903	399.915	0.085	0.0053			
10	450	449.8995	0.1005	449.9023	0.0977	0.0028			
11	500	499.8836	0.1164	499.8969	0.1031	0.0133			
12	550	549.8622	0.1378	549.8735	0.1265	0.0113			
13	600	599.8669	0.1331	599.8846	0.1154	0.0177			
14	650	649.8406	0.1594	649.8508	0.1492	0.0102			
15	700	699.8078	0.1922	699.8206	0.1794	0.0128			-
Averag 0.9 - 0.8 -	je backlash:	0.013 -	mm Adjust l	oacklash:	0.013 -	mm Modify		<u></u>	2
0.7									
0.6	<b>.</b>								
0.5	<b>.</b>		÷						
0.4	<b>!</b>		÷		+				
0.3	<b>.</b>			<del>,</del>					
0.2 -	•		· · · · · ·						
0.1	····-	-	÷						
0 -									
	0 200	400 600 8	00 1,000 1,	200 1,400 1,	600 1.800 2	.000 2,200 2,	400 2,600	2,800	3,000
			.,,						
rial 🗏	Reven								0 👻

Click to import measurement file of X axis, click to import measurement file of Y axis. Imported file will be shown in data table and graph.

If the coordinate polarity in data table is different with return origin direction, then compensation invalid.

#### 9.2.6 The operation steps of pitch error compensation

- 1. Execute 'return origin' via CypCut;
- 2. Setup the parameter in Interferometer software;
- 3. Setup travel path in CypCut > CNC > Path;
- 4. Execute measurement program for interferometer to capture data;
- 5. Import measurement file to CypCut machine config;
- 6. Execute 'return origin' via CypCut;
- 7. Execute measurement program via interferometer again to check compensation result.



#### 9.2.7 FAQ

1. Pitch error doesn't change after compensation

You need to execute return origin after import compensation file to let

compensation data take effect.

If the pulse equivalent is too small, for example, less than 200 pulses per 1mm, the compensation file doesn't work.

## 2. Backlash larger after compensation

If backlash gap became larger or even doubled, position error data might be offset

in wrong direction. Click Switch Pos/Neg to switch over positive and negative data group.

This happened most likely when polarity of interferometer measure range and machine travel range not same.

### 3. Data curves are symmetrical

If the data curves of positive and negative direction are symmetrical in opposite direction, the polarity symbol of one of the data groups is wrong. This is rare situation, you can manually reverse the polarity symbol of positive or negative position error data group, then import file again. Or contact technical support.