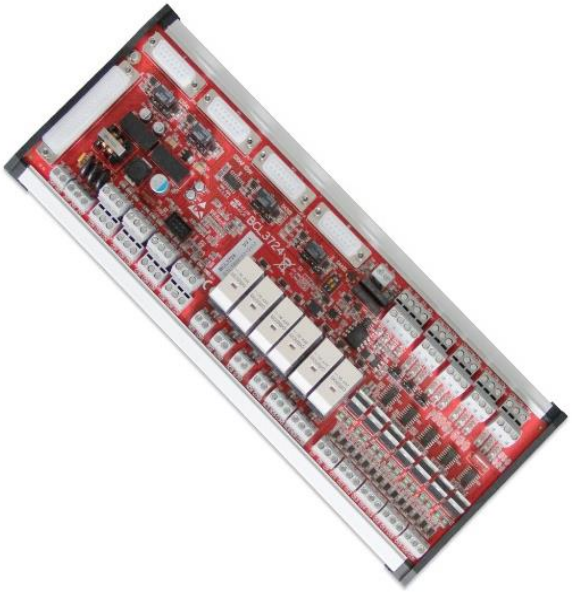
FSCUT4000 Laser Cutting System
User Manual



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.

Content

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.

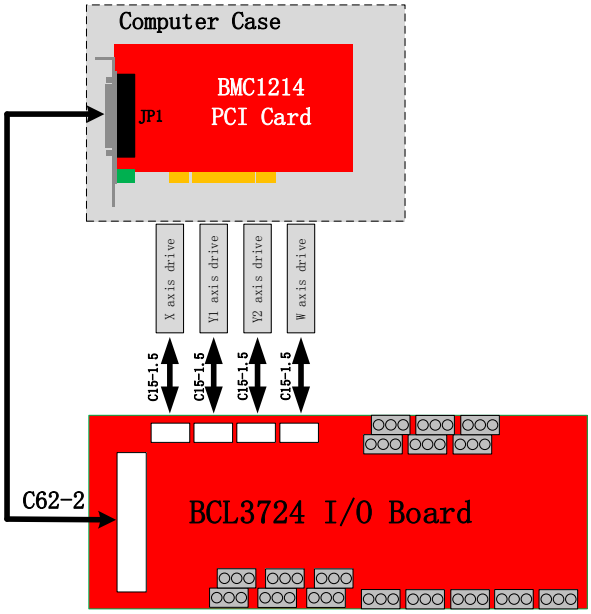
This manual served as installation and operation guide for FSCUT4000 system.

FSCUT4000 system hardware table:

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

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

Motion Control	**Motor control signal**	Analog output of 4 servo axis ports, -10V—+10V.
		Encoder feedback channel of 4 servo axis ports, 10MHz.
		Dedicated signal inputs of origin, positive/negative limit and servo alarm for each axis.
		Dedicated signal outputs of servo enable and alarm reset etc., for each axis.
	Motion control performance	Control cycle 1ms.
		S-type acceleration and deceleration with filter.
		Velocity look-ahead strategy, intelligent speed control at turning point.
		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
Power supply		24V，2A

1.4 Control Card Installation

1.4.1 Install steps

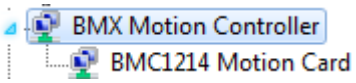
Caution	**Please wear anti-static gloves to prevent possible electrostatic damage to the motion control card.**

(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.

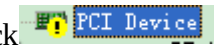
(3) Install CypCut software. The driver program will be installed by default option automatically.

(4) Open windows device manager to confirm installation succeed. Below image shows the installation is succeed.

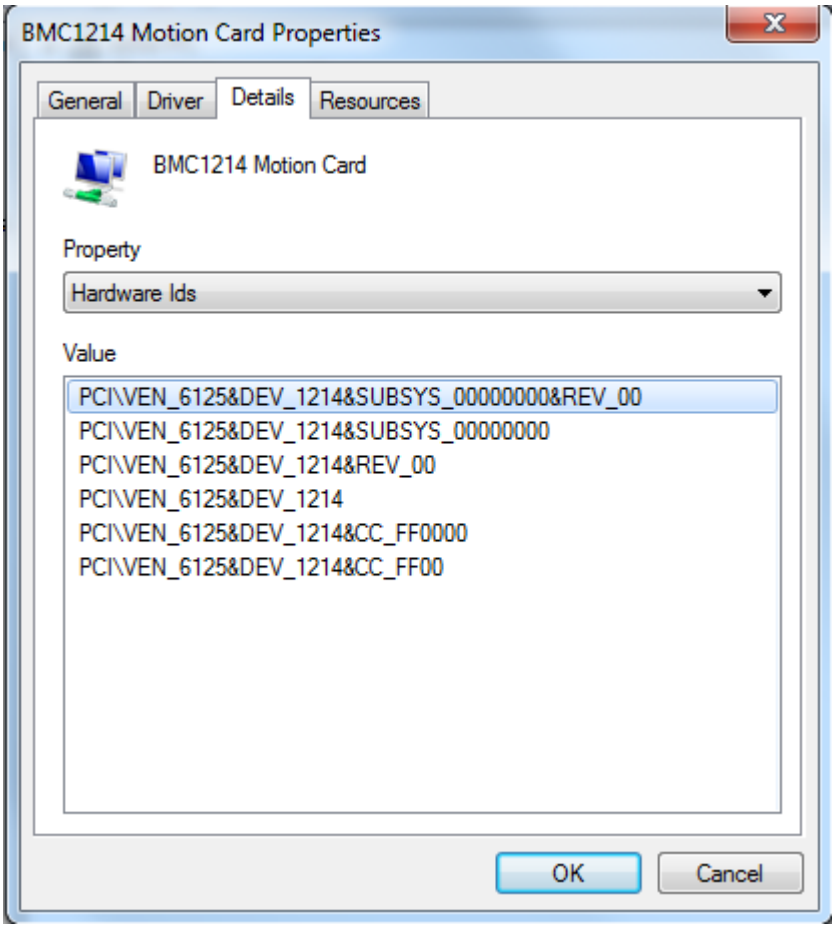


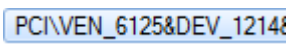
1.4.2 Troubleshoot

（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.

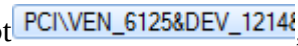
（2） If the device has a yellow exclamation mark, double-click 

to open its attributes page, and select "Detail Information" as shown below:



（3） If the first half of the ‘device instance ID’ attribute is displayed as 

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 

, it

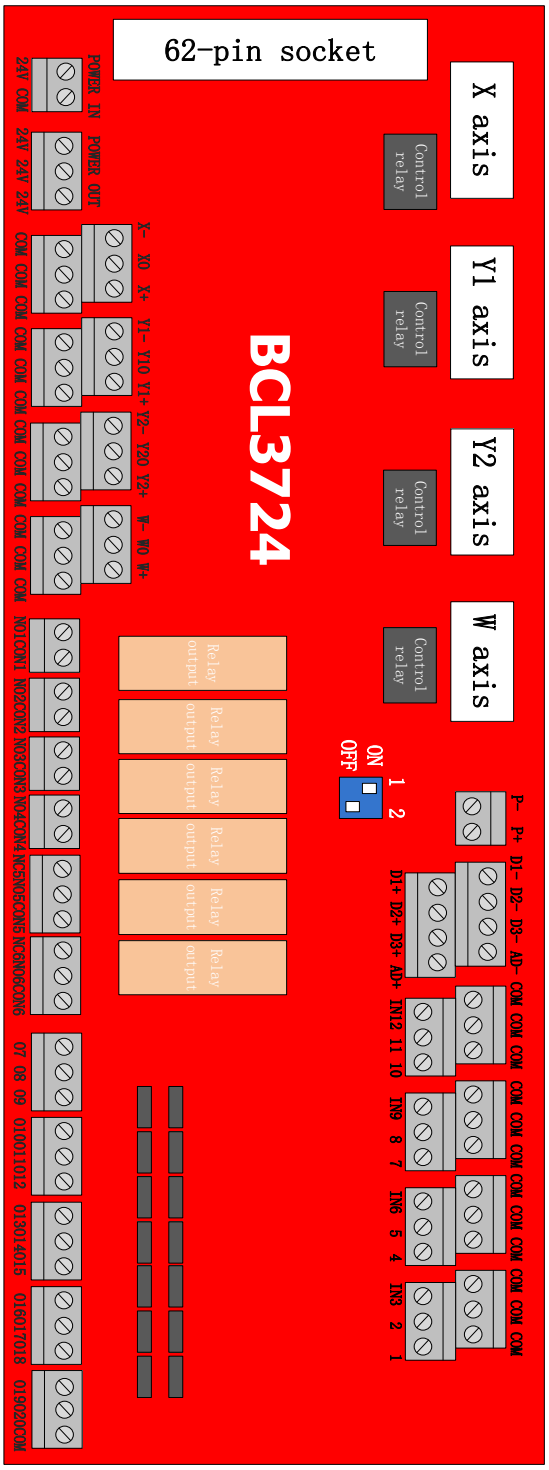
indicates computer doesn't recognize the control card. Power off computer and change PCI socket, install the card firmly and repeat installation again.

（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

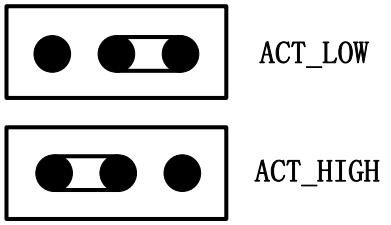
P1	P2	Description
On	Off	PWM voltage is 24V
Off	On	PWM voltage is 5V

2.2 Signal Type

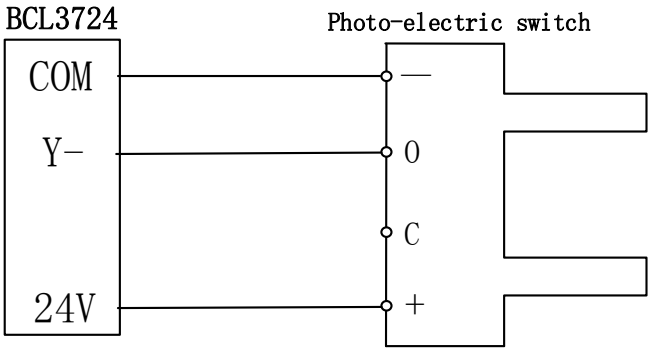
2.2.1 Input signal

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.

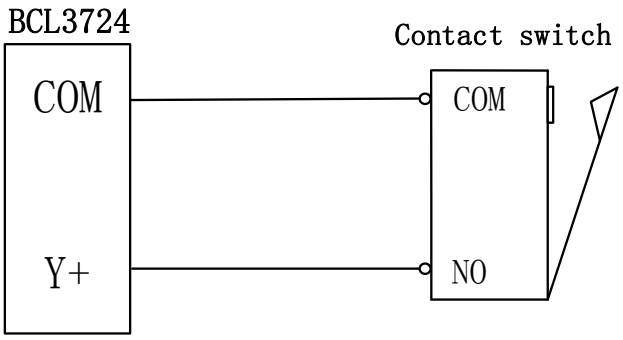
The polarity of input can be changed by jump-wire, IN10, IN11, IN12 support jump-wire. There are 2 status of jump-wire, ACT_LOW means low-level active (input 0V active); ACT_HIGH means high-level active (input24V active). The default state is ACT_LOW.



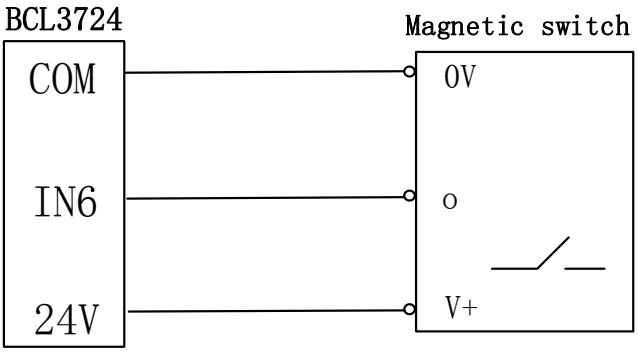
The typical wiring of photo-electric switch shown below, must use NPN 24V type switch.



The typical wiring of contact switch shown below.



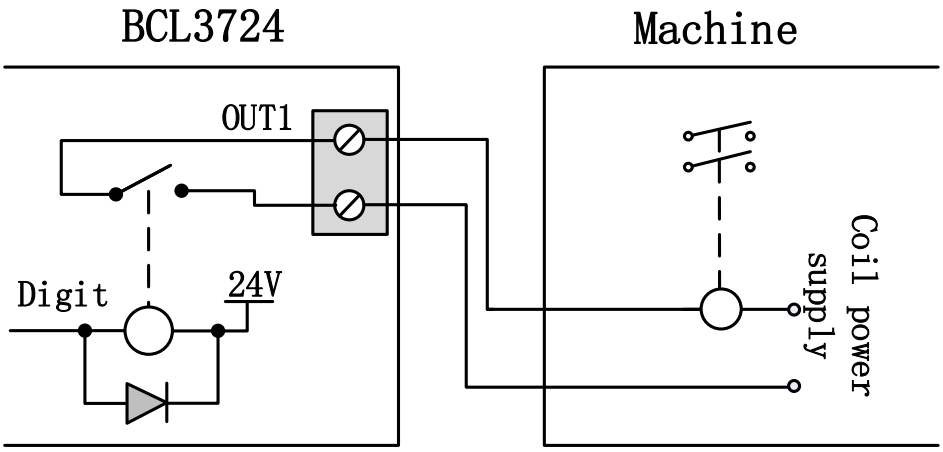
The typical wiring of magnetic switch shown below, must use NPN 24V type switch.



2.2.2 Relay output

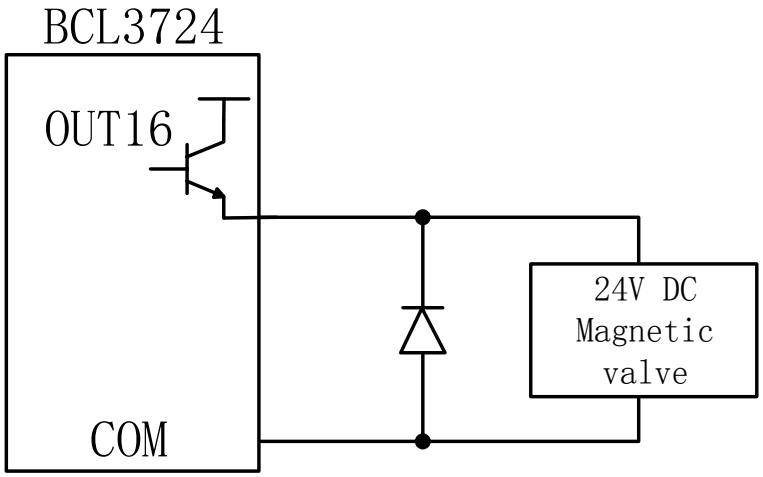
There are 6 relay output on BCL3724 terminal board which are OUT1-OUT6. OUT1-OUT4 only support normally open, OUT5-OUT6 have both NO and NC options. The maximum load of relay: DC 30V, 8A; AC 250V, 8A. Recommend to use load under 2A, the inductive load or high power load will reduce the service time of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



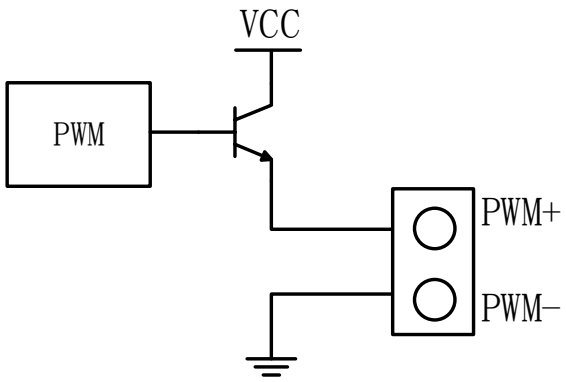
2.2.4 Analog output

3 analog output of 0-10V.

Output range	0V~+10V
Maximum output load	50mA
Maximum capacitive load	350pF
Input impedance	100KΩ
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

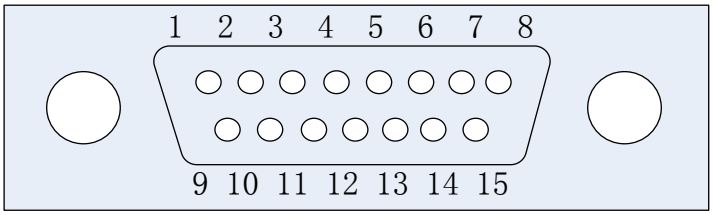
2.3.1 External power supply

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;

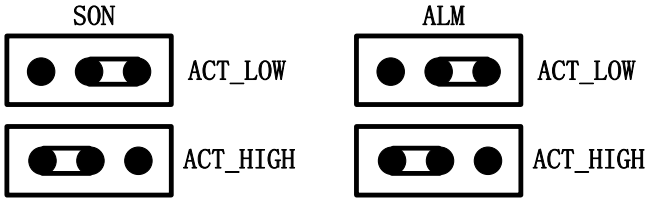
DA, AGND: analog output for motor control;

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, Panasonic A5 series servo must choose full-function type, cannot use pulse type;

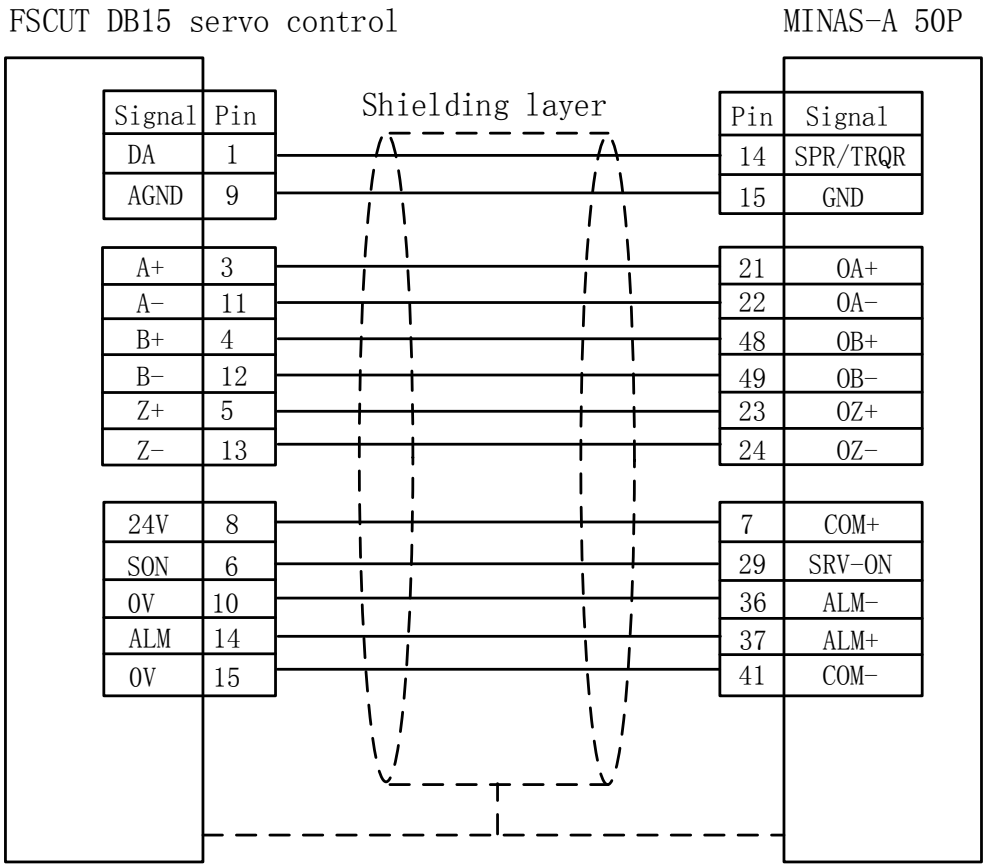
(2) Check if SON signal is low-level active (SON is active when conducted with GND of 24V);

(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, the 24V power supply provided by BCL I/O board;

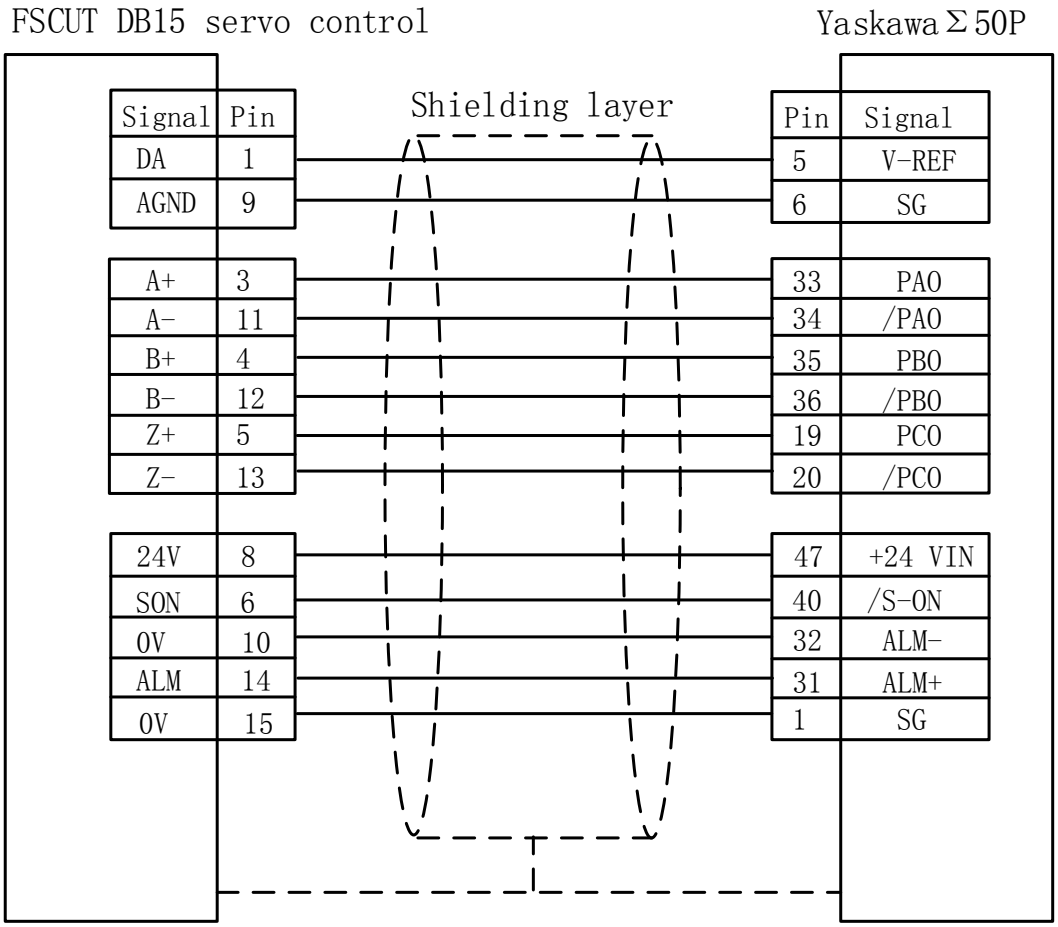
(5) If driver still can't run, check if the parameter 'positive/negative direction drive inhibit' in driver is disabled.

Panasonic servo wiring diagram



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 per motor revolution	Set by mechanism feature, the pulse equivalent 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 loop	75.0Hz
Pr1.02	1st time constant of velocity loop integration	9.0ms
P r1.04	1st time constant of torque filter	0.3ms
P r3.02	Input gain of speed command	Set by maximum motor speed. If maximum motor speed is 4000rpm, set 400 here.

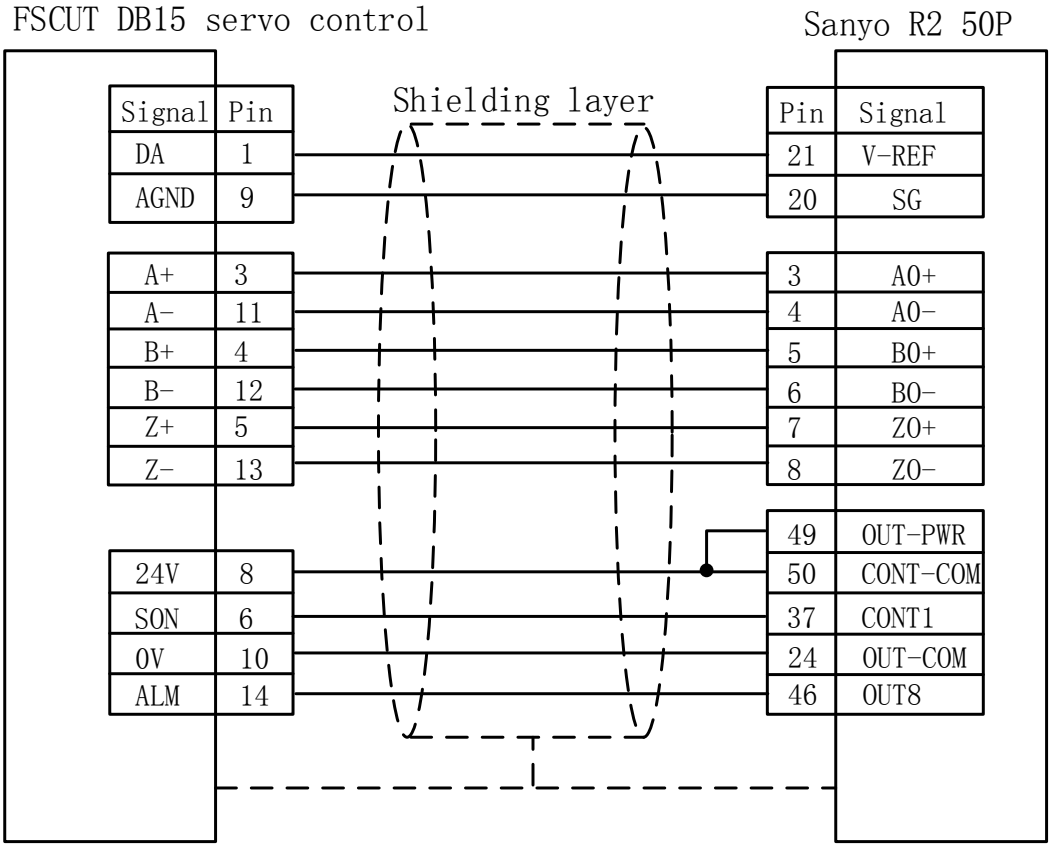
Yaskawa servo wiring diagram



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 time constant	0.30 MS
Pn50A	Input signal	8100
Pn50B	Input signal	6548

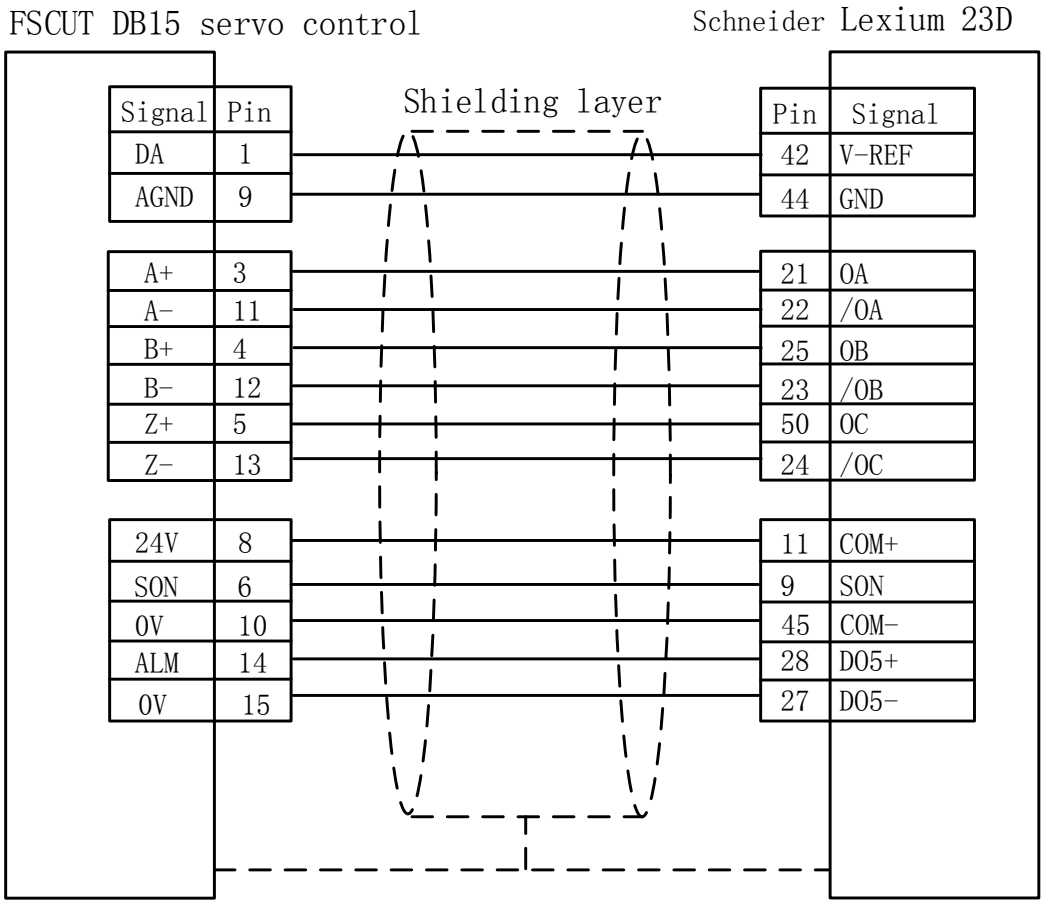
Sanyo R series wiring diagram



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 gain	75H z
Gr1.13	TVI, velocity loop integral time constant	9ms
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 gain	Set by the maximum motor rpm. For 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.

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 adjustment	0

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 user-defined 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.

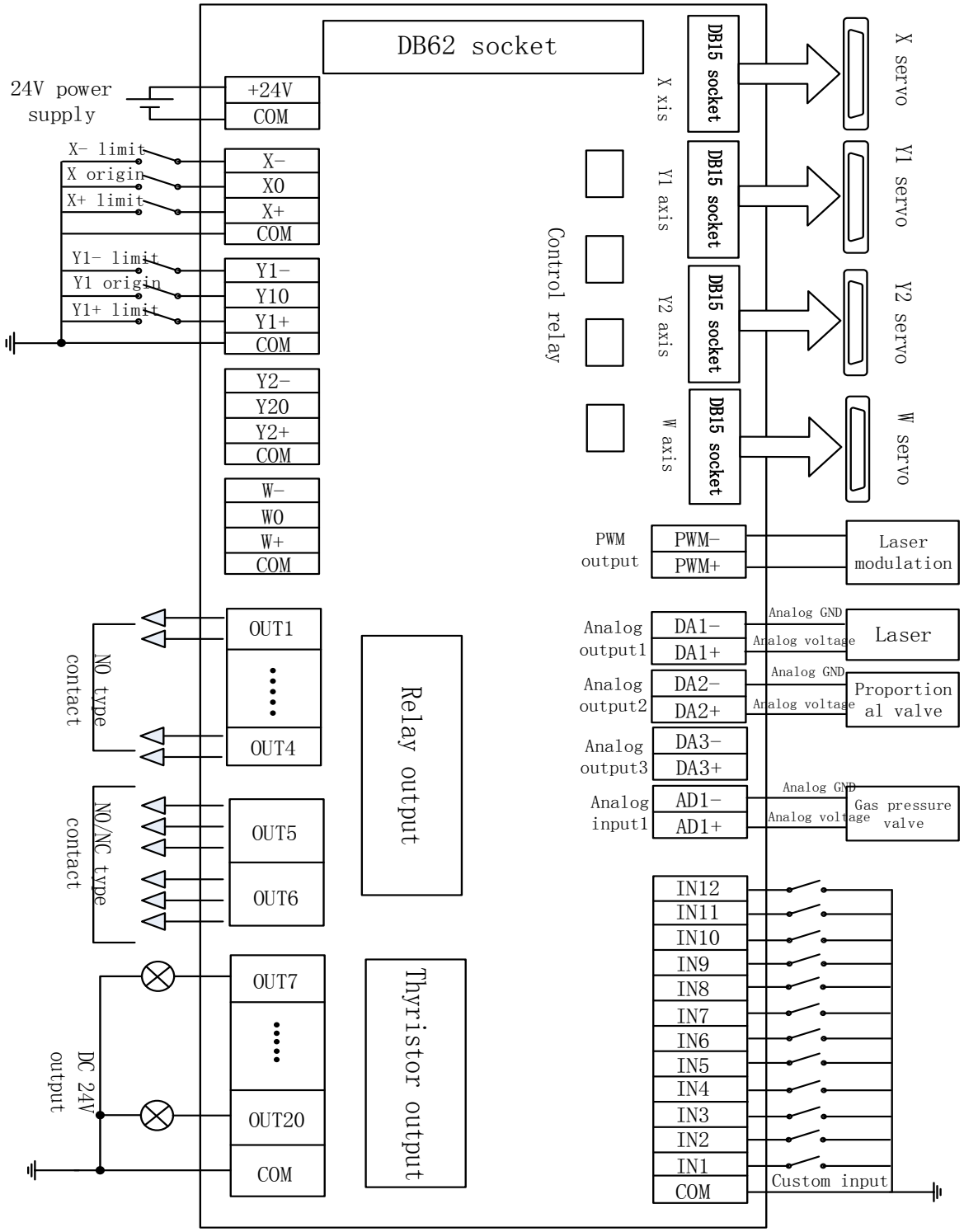
2.3.7 Analog output

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



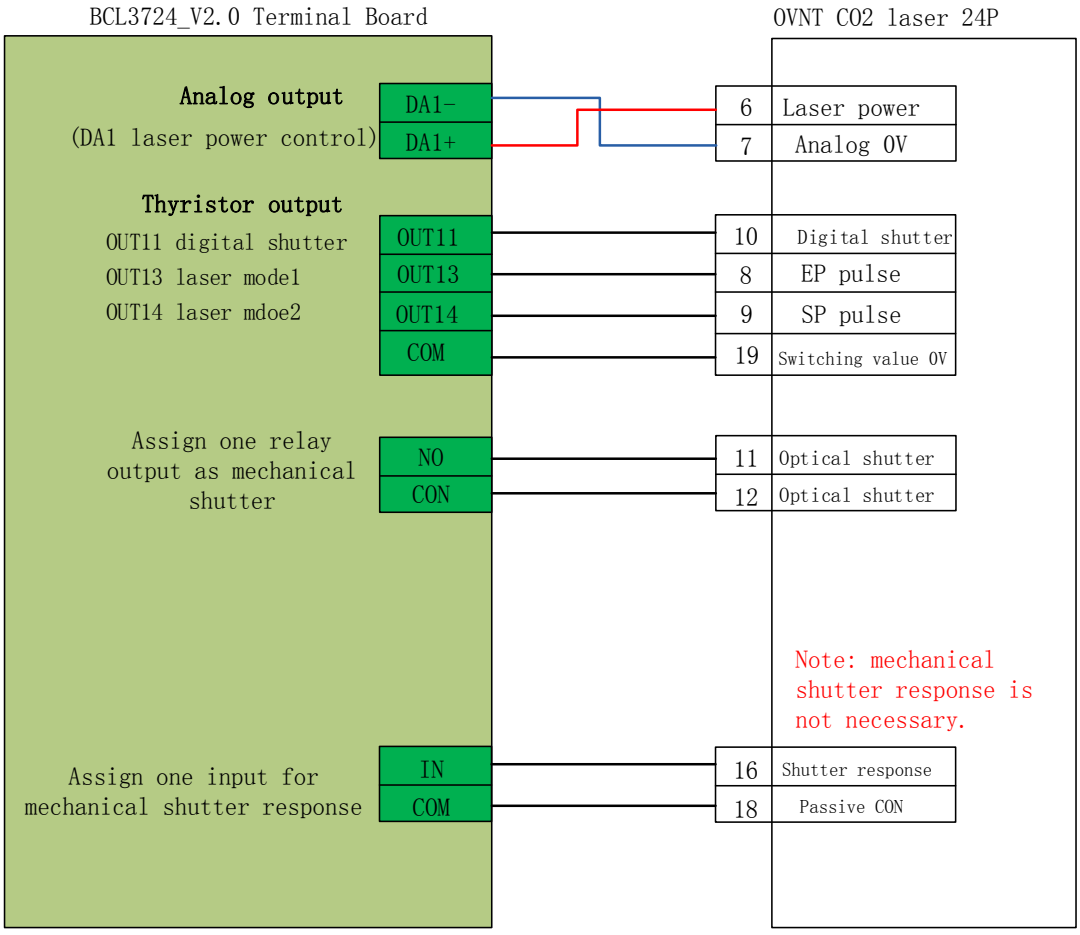
2.5 Laser Wiring Diagram

2.5.1 YAG laser

Assign an output for laser emission and connect with laser.

2.5.2 CO2 laser

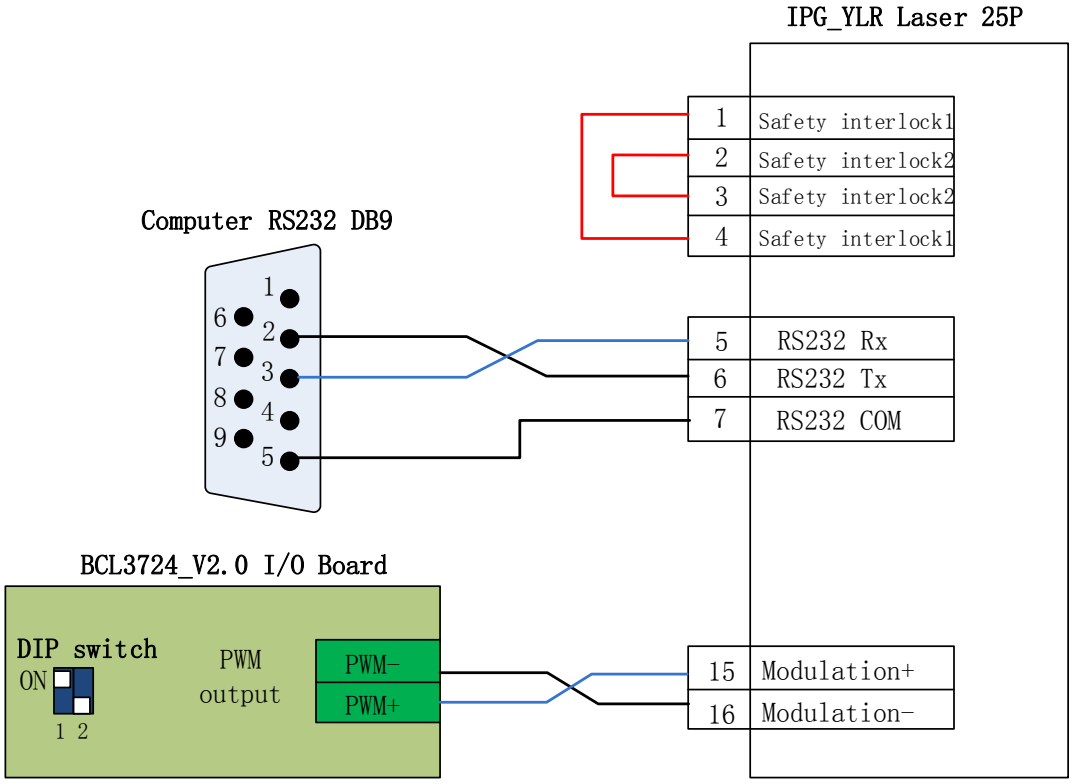
Here take example of NT-3200SM CO2 laser.



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.

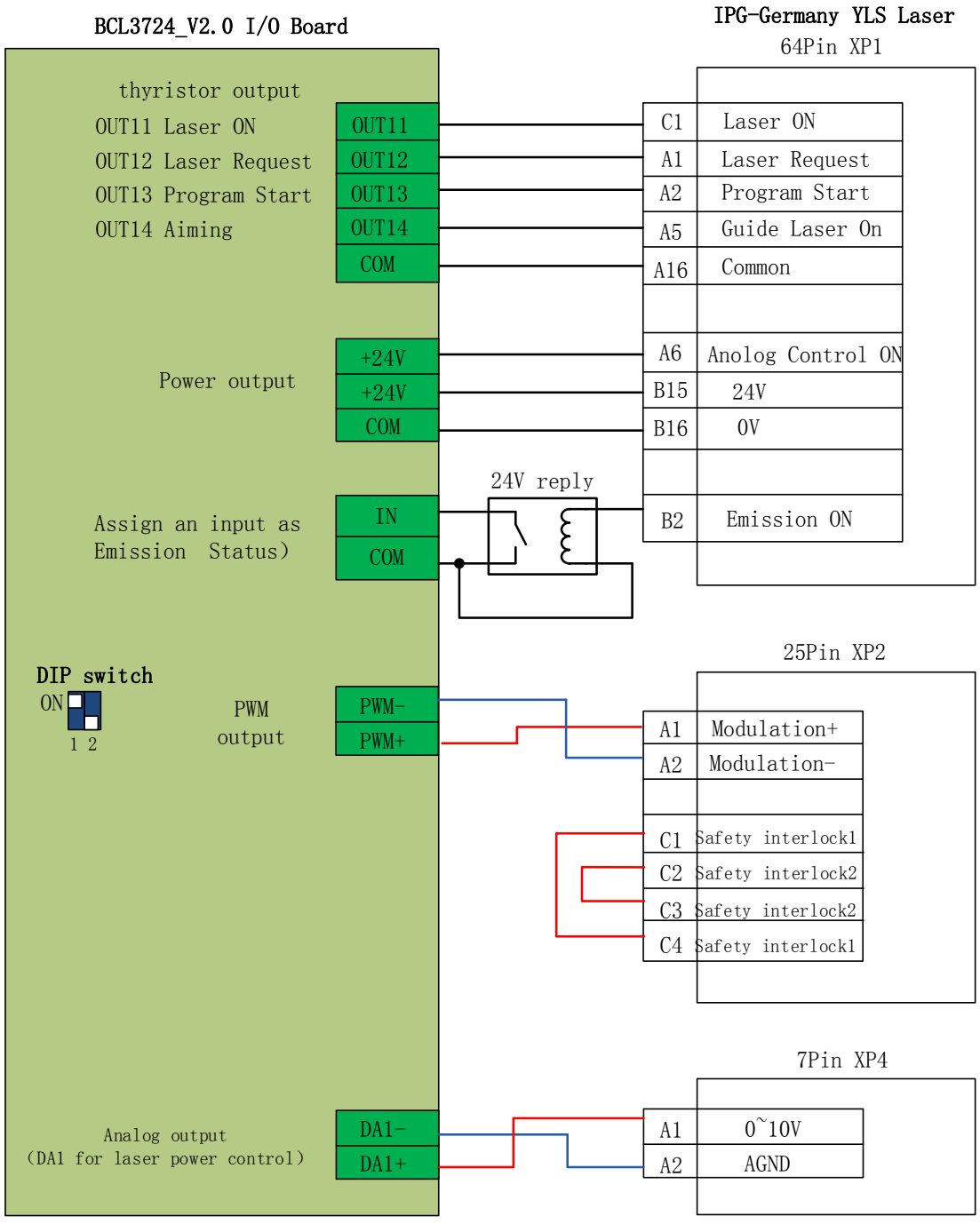
Recommend to use network communication for IPG-YLR series.

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

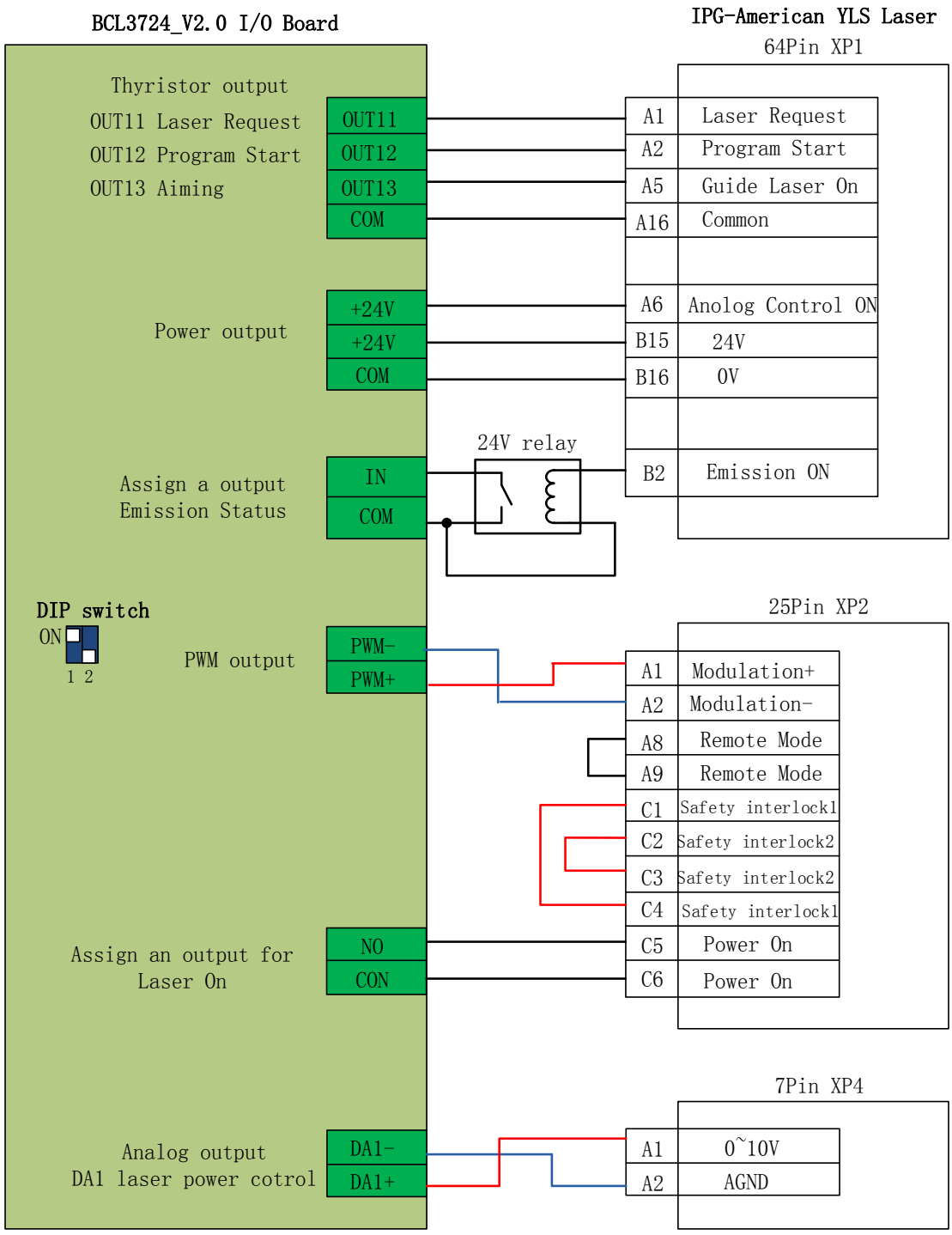


Note:

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

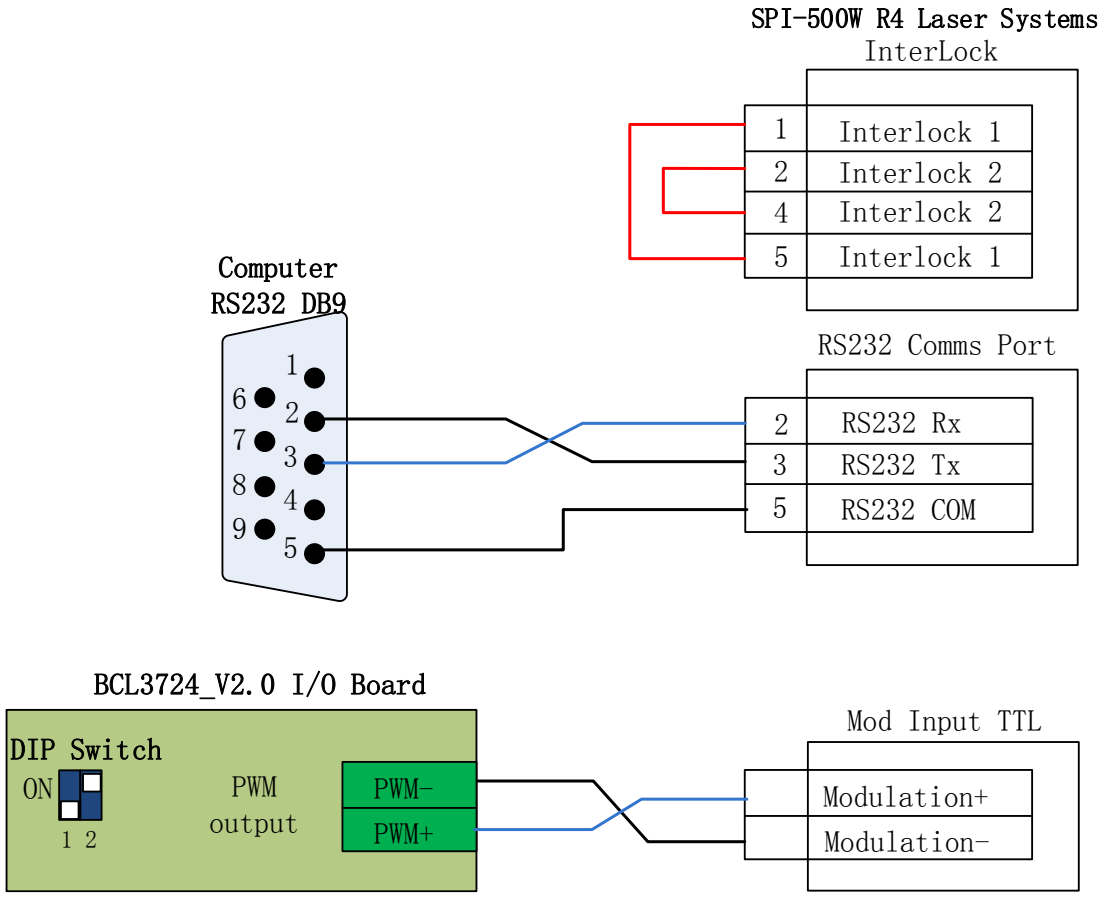


Note:

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

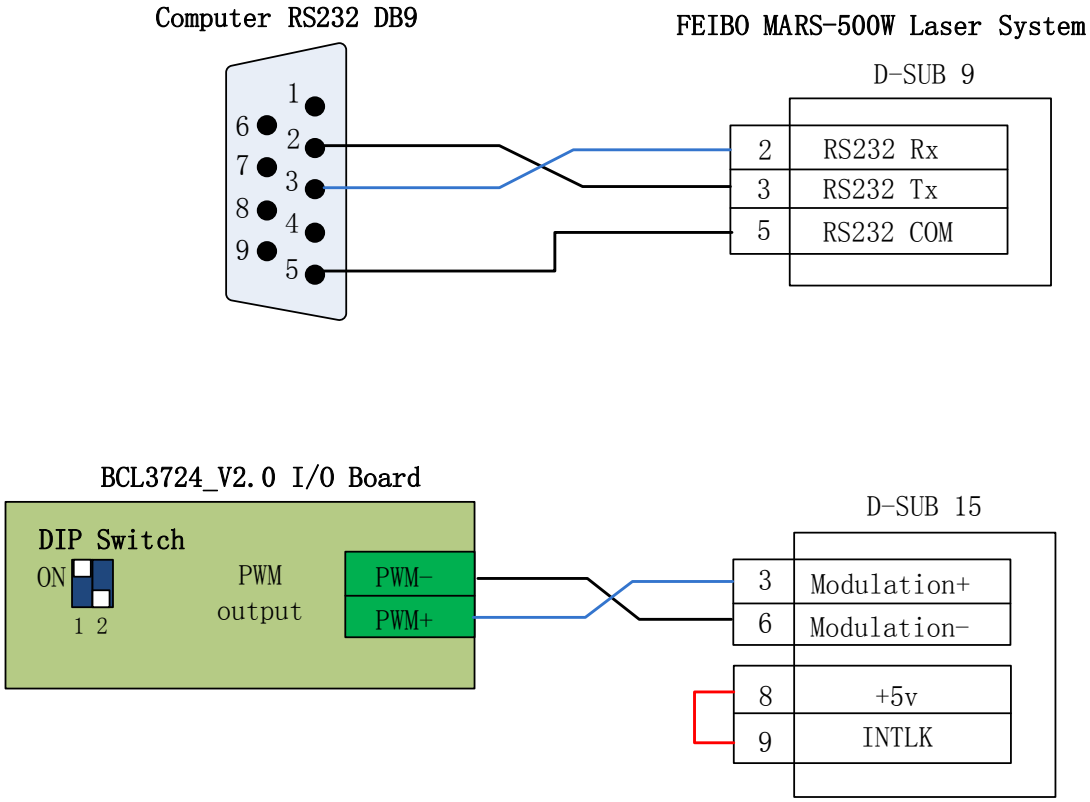


Note:

1. When use MODINPUTTTL 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).

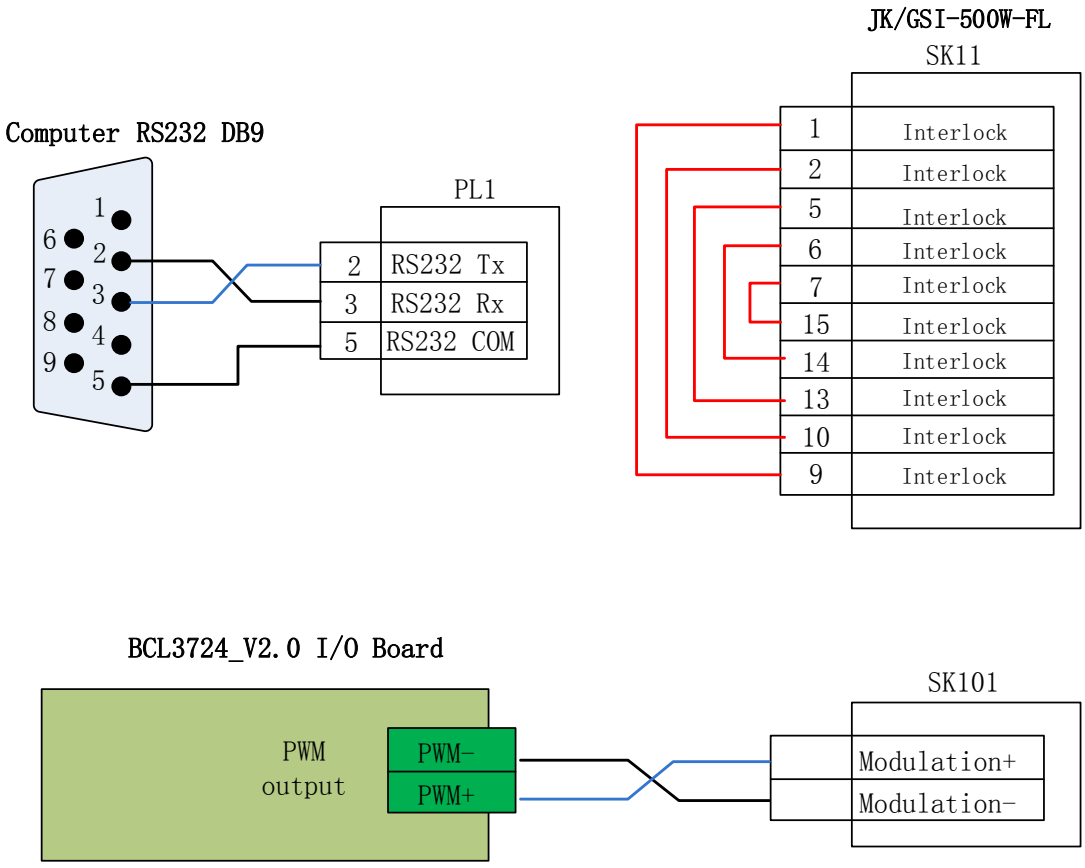
2.5.7 FEIBO MARS



Note:

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

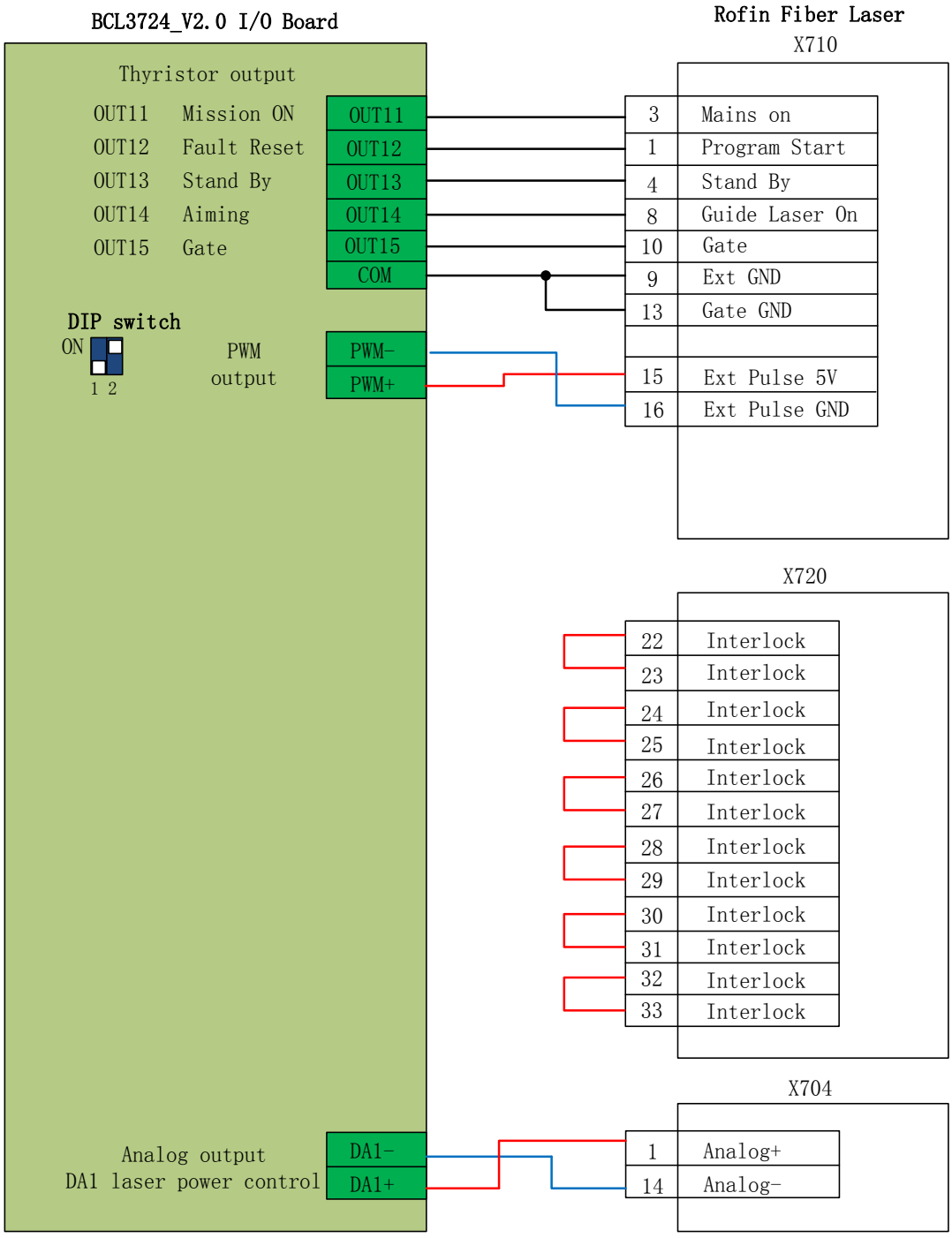
2.5.8 JK/GSI-FL



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).

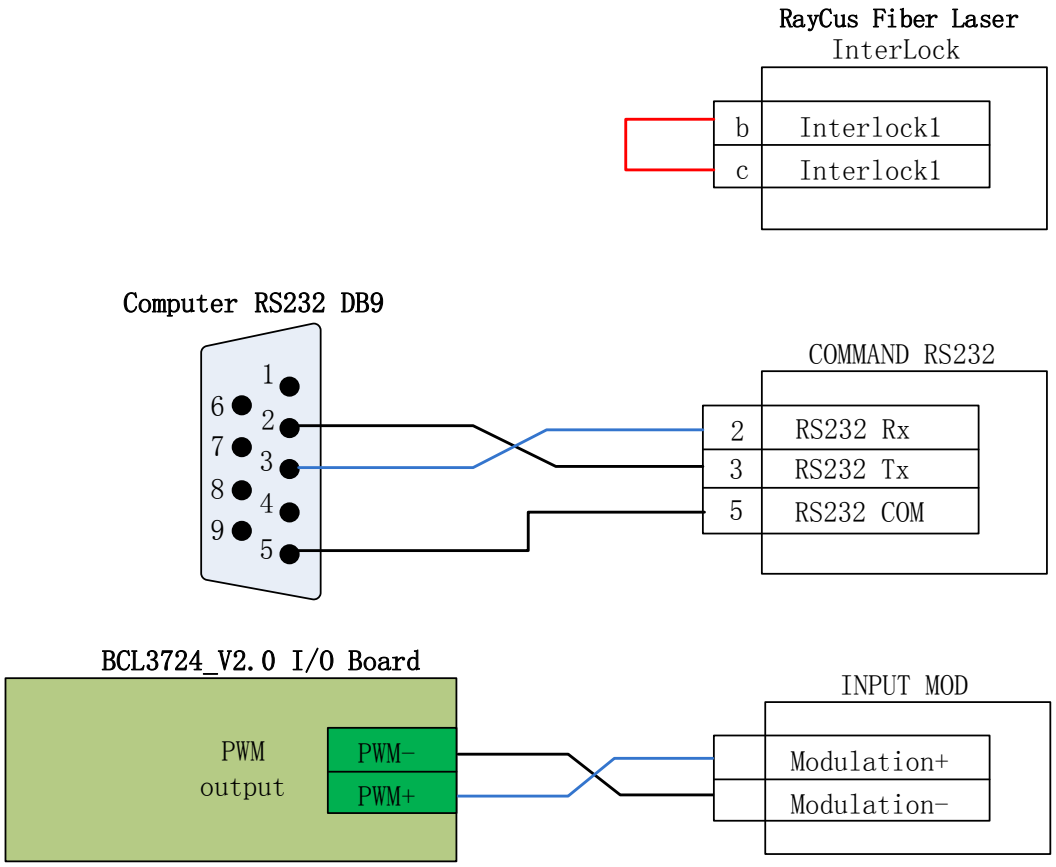
2.5.9 Rofin



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).

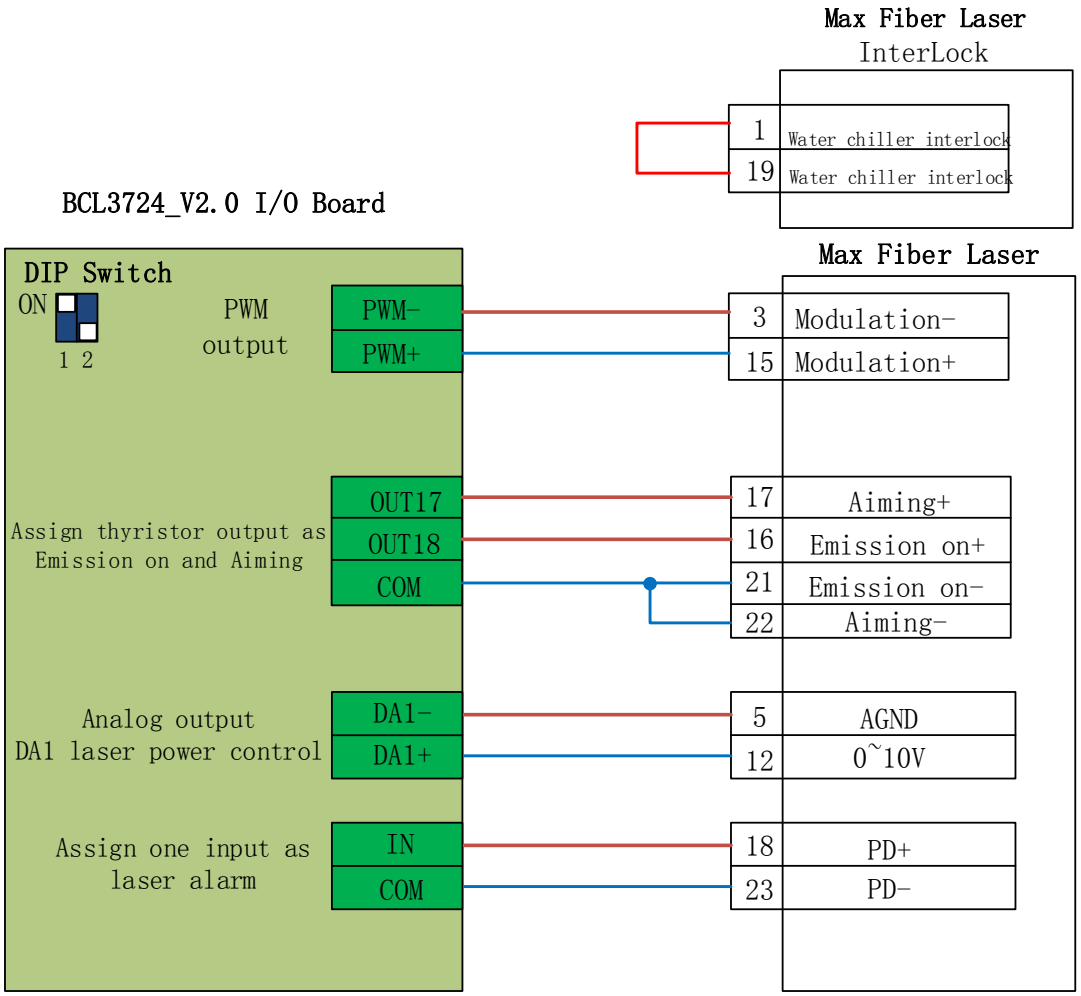
2.5.10 Raycus



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

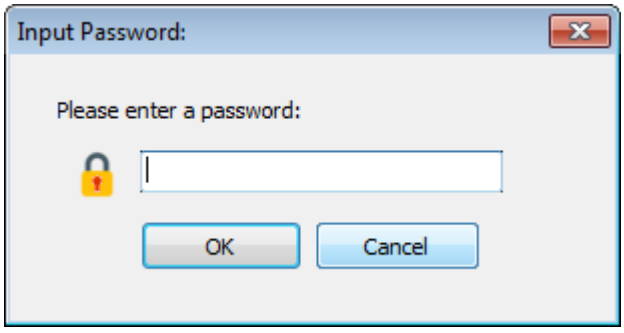
3.1 Installation and Operation

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.

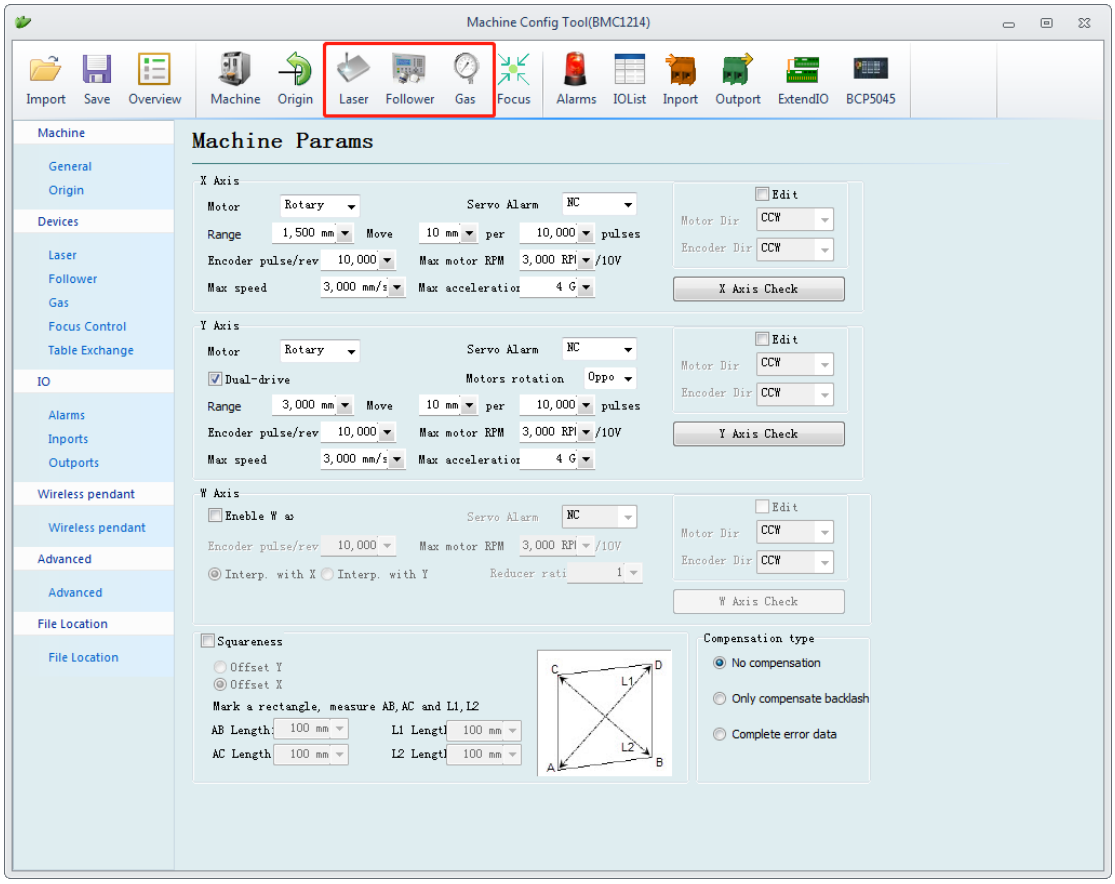


Initial password 61259023.

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.

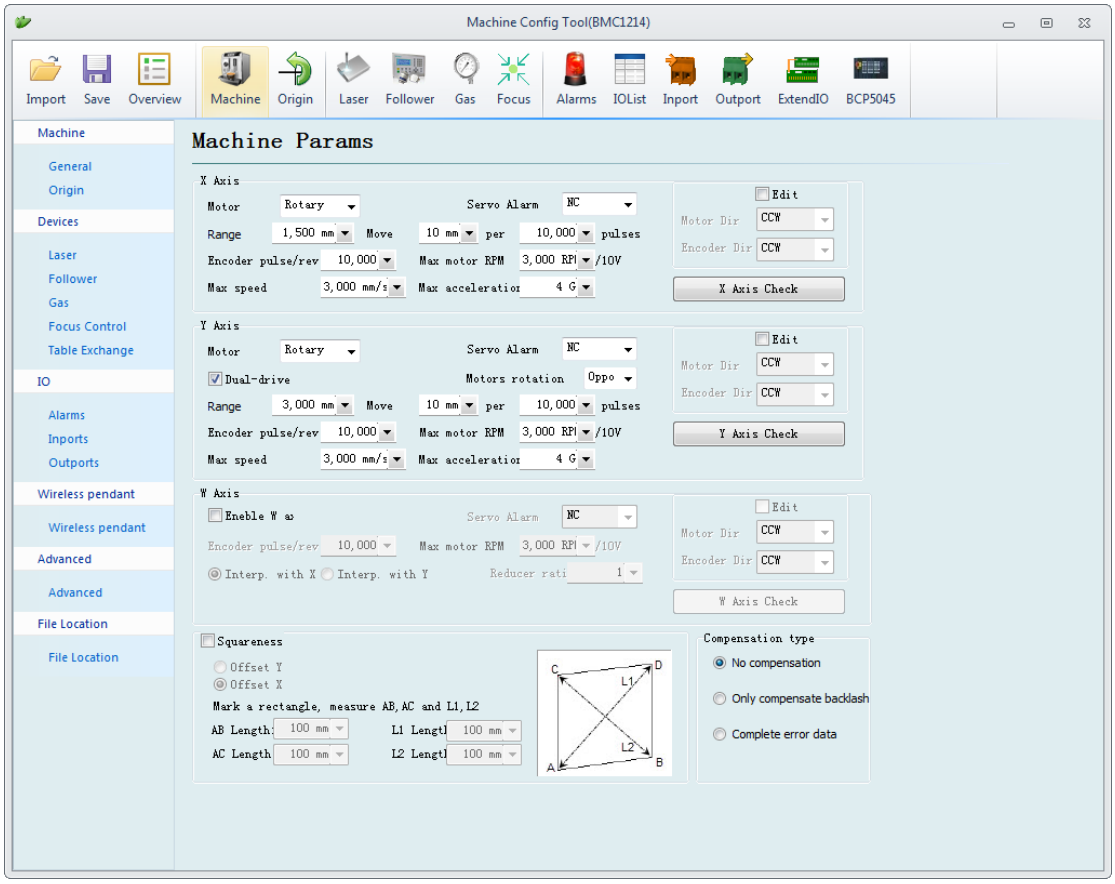
Click button in overview page will also open the parameter setting page of each module. Click 'Machine tool' will enter ' Machine' page.

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.

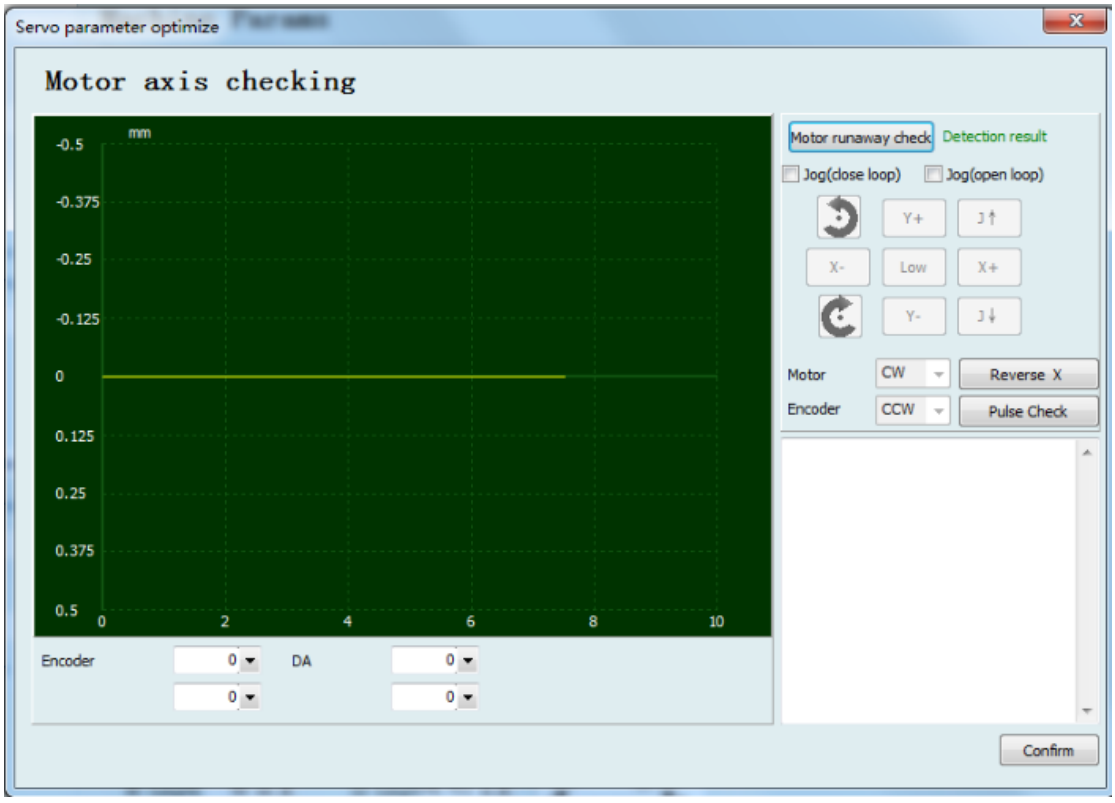
Max speed: maximum user speed and acceleration restricted by CypCut.

Pitch compensation: compensation method for mechanic error including backlash

and offset error data from interferometer.

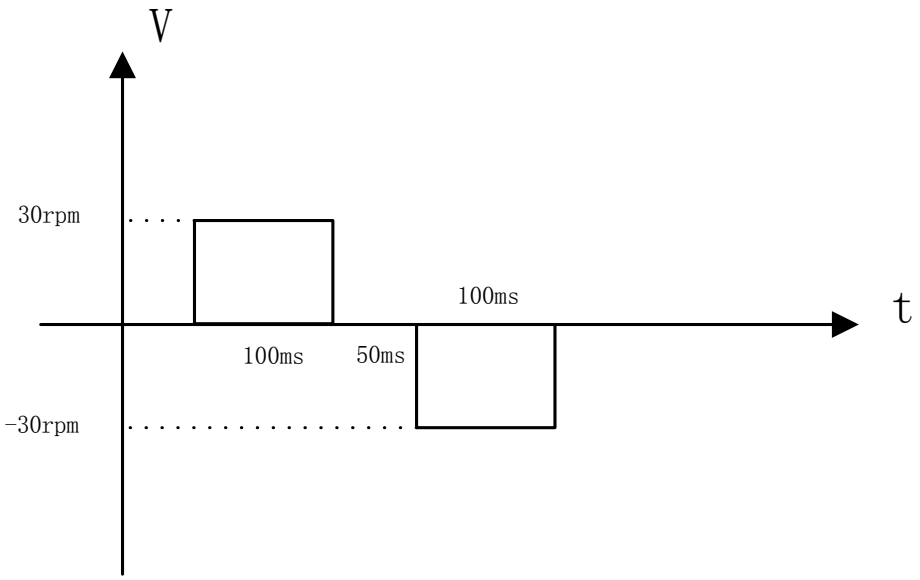
Squareness: this is to offset the error when X and Y mechanic is not orthogonal.

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:



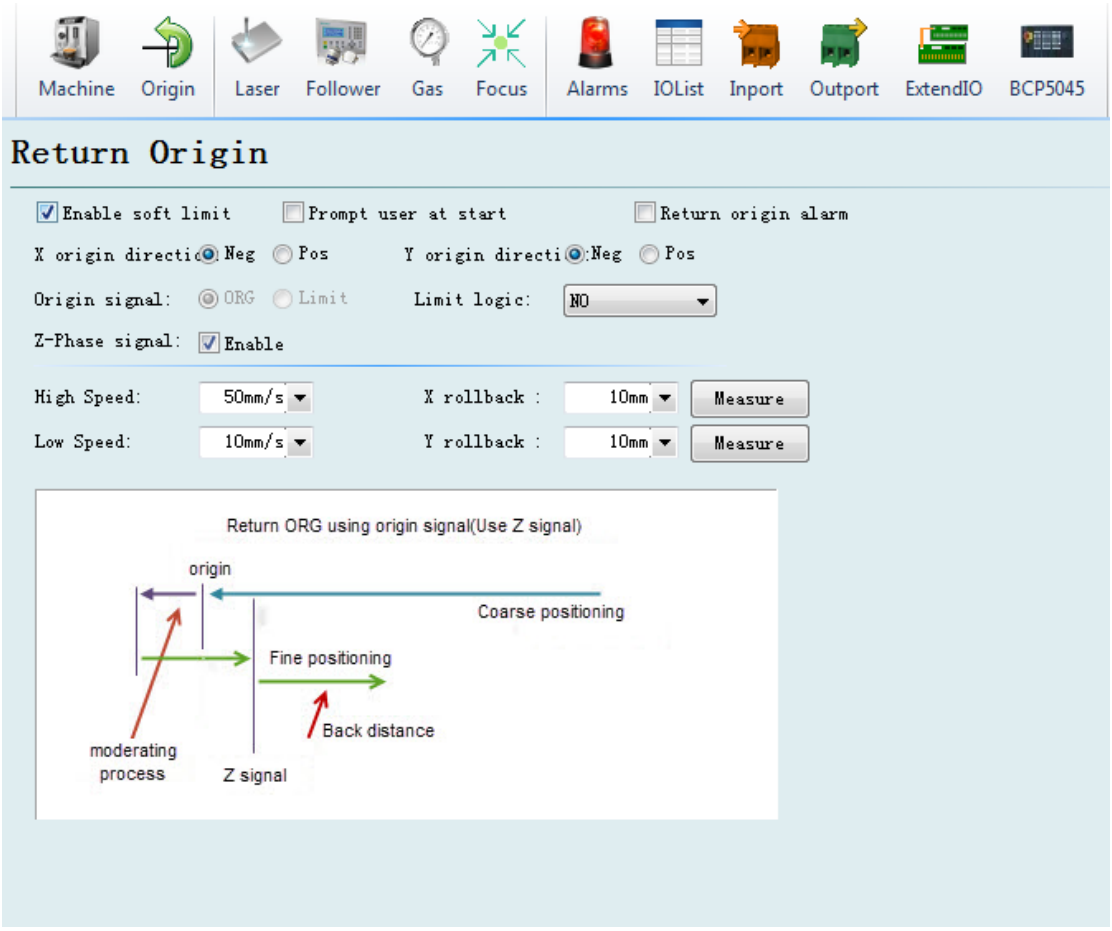
Close-loop jog: check the option and jog X axis, observe the motor rotation and encoder feedback polarity.

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. Dual-drive 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.

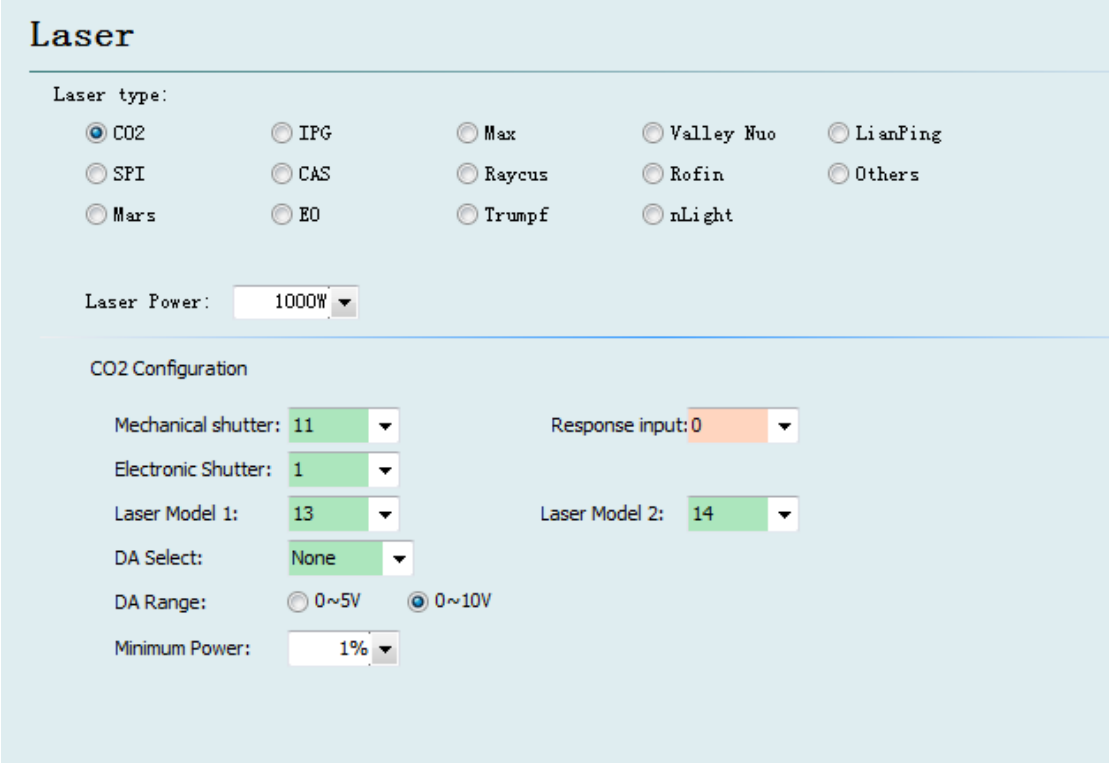
Rollback: the distance motor rolls back after reach origin switch.

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.

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.

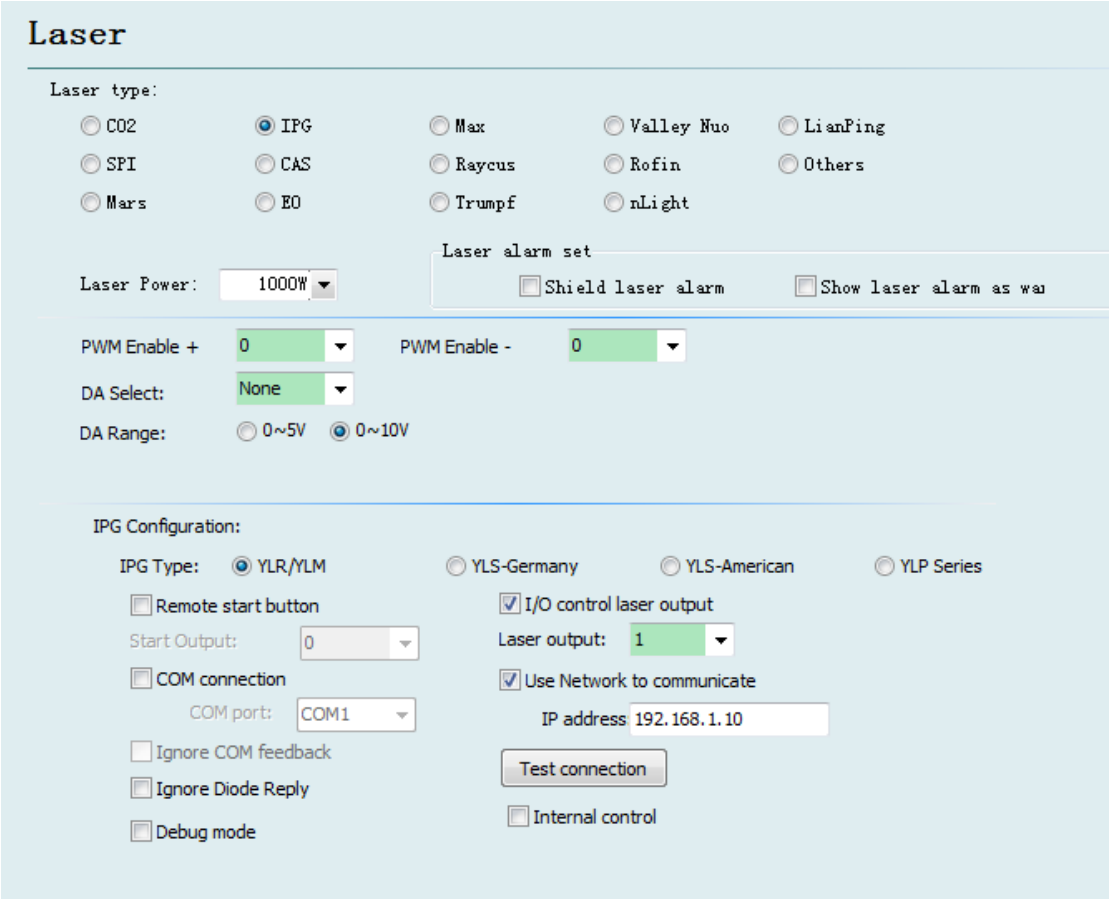
Laser form: laser form can be set as continuous wave, gate pulse and high power pulse by mode 1 and mode 2 output.

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



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

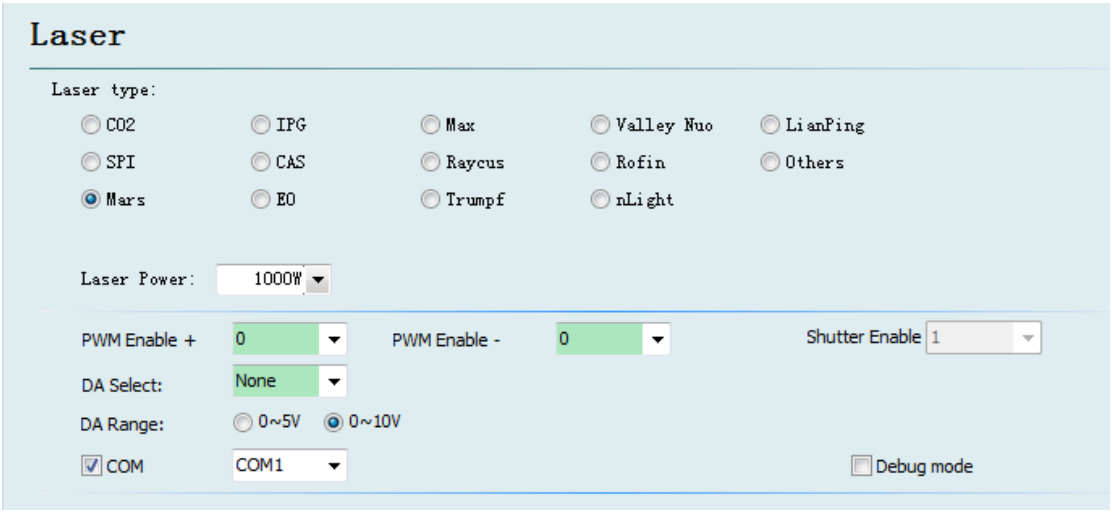
button. If use remote start button, you need to setup the output port for the button. (Remote start up button is not recommended, for it's easy to cause laser malfunction).

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.

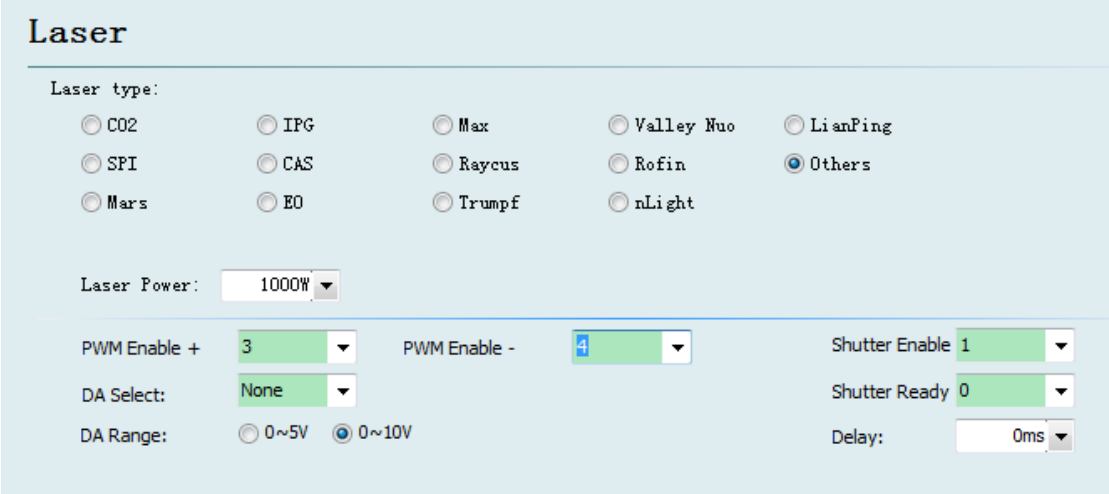
3.6.3 Feibo/Rofin/SPI/GSI/JK laser configuration



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.

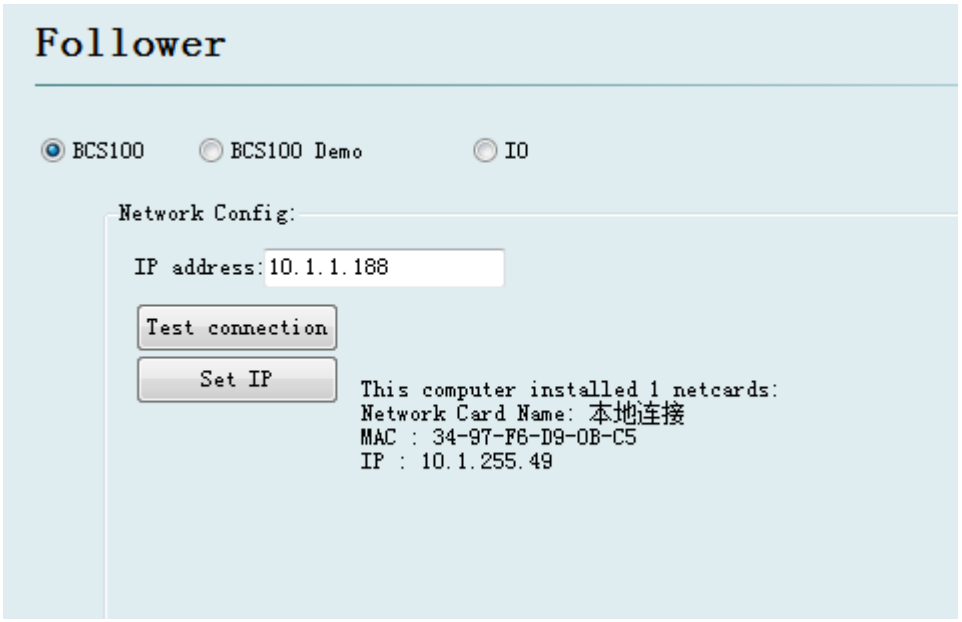
3.6.4 Configuration of other laser type



Shutter enable: output to open laser shutter.

3.7 BCS100 Configuration

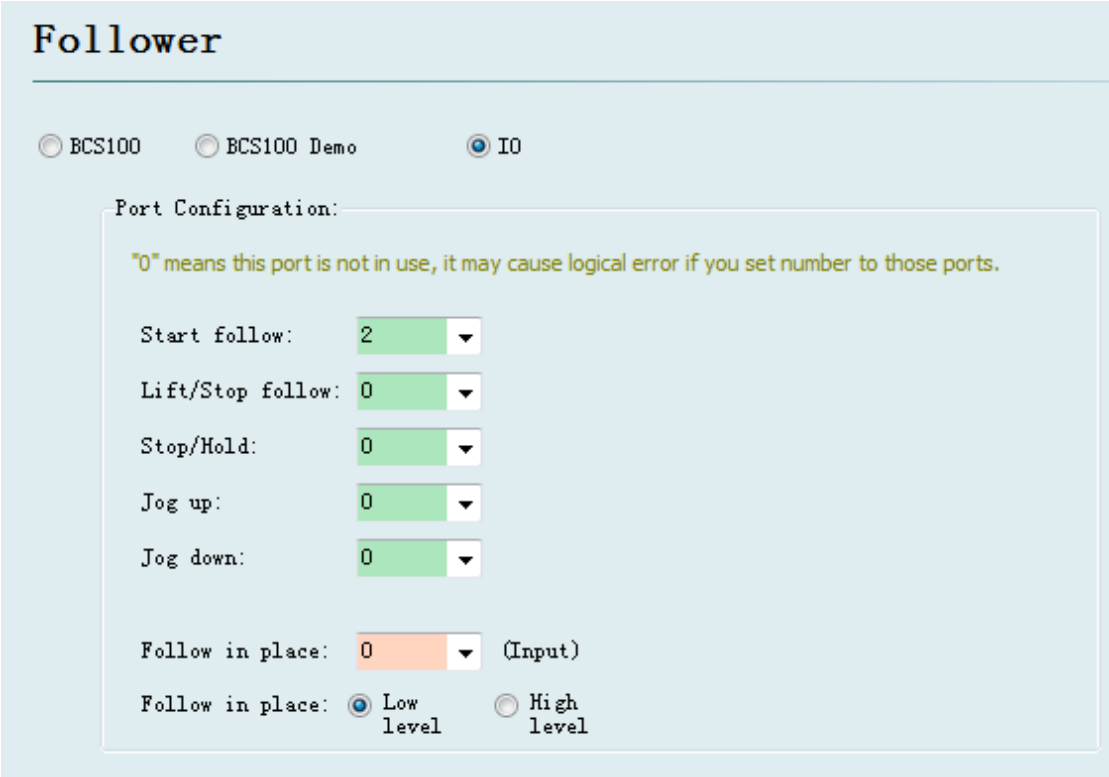
3.7.1 Use BCS100 as height control unit



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



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.

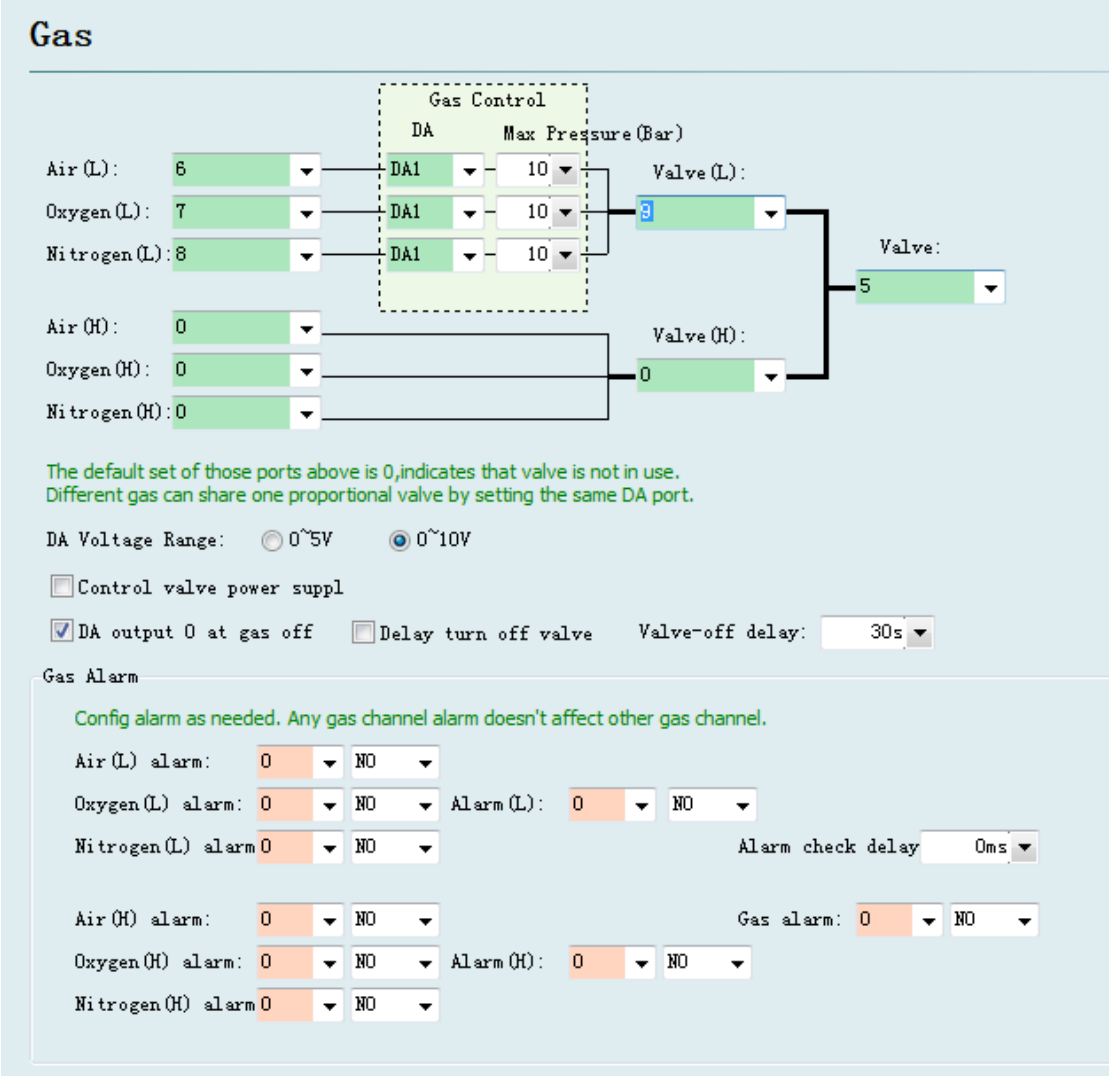
Jog down: output of jog Z axis down.

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



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

Air: set output for air switch.

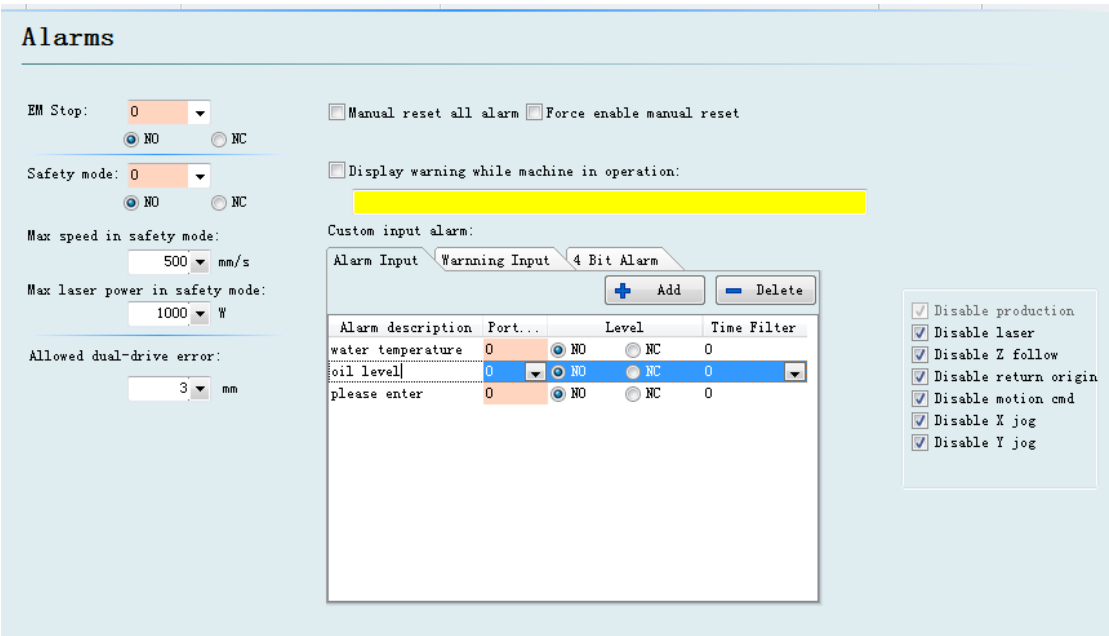
Oxygen: set output for oxygen switch.

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



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.

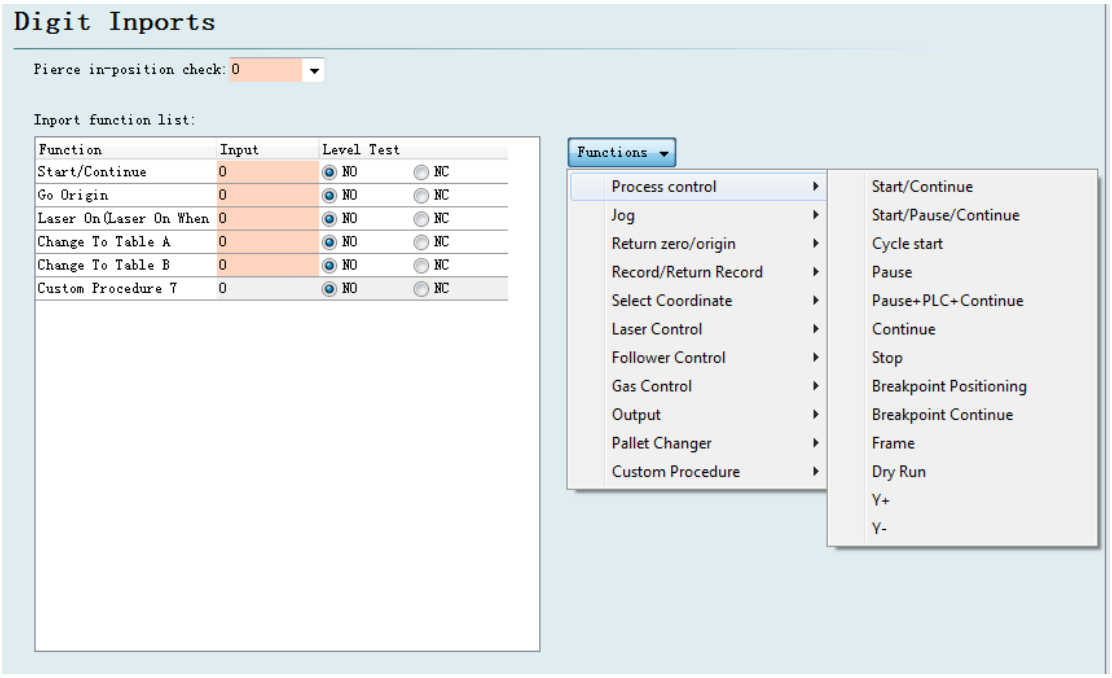
3.9.4 Custom alarm

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

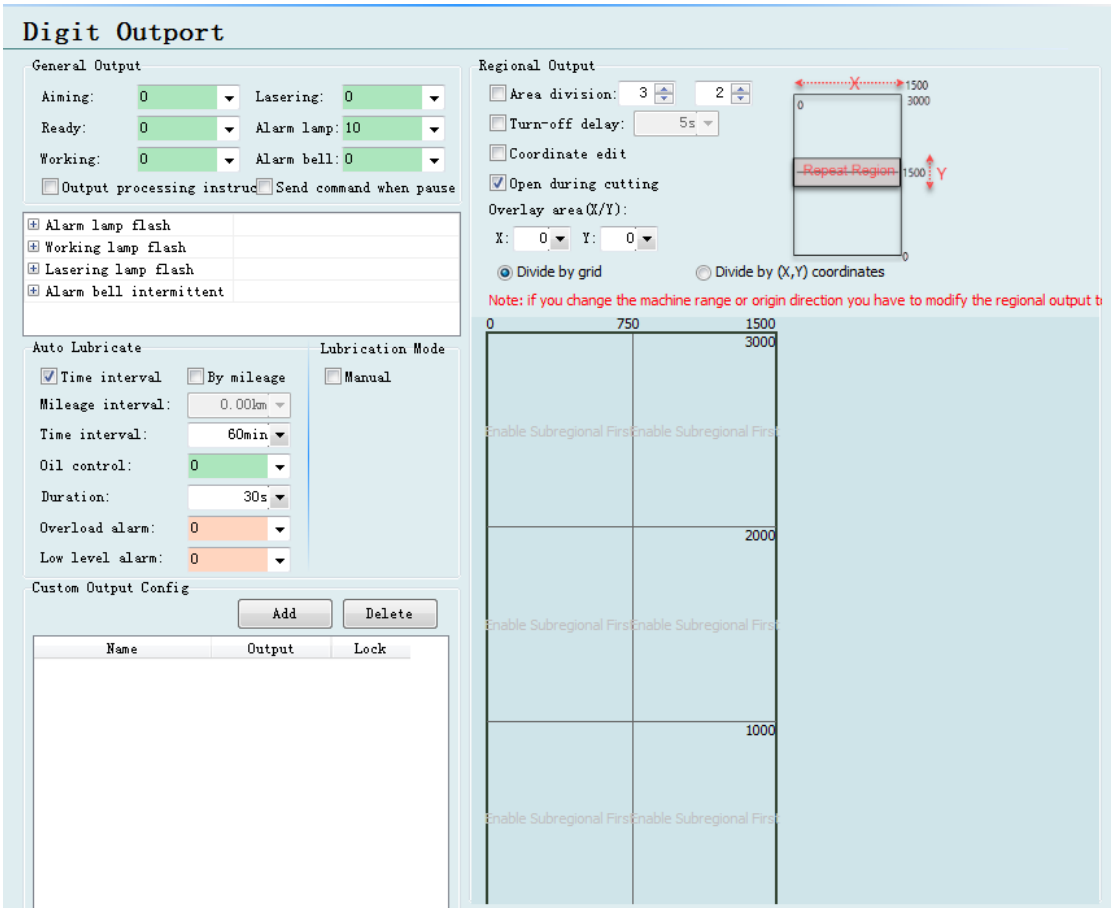
Maximum dual-drive position error allowed, the threshold to trigger alarm.

3.10 Common input



Click  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

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

3.11.3 Custom output

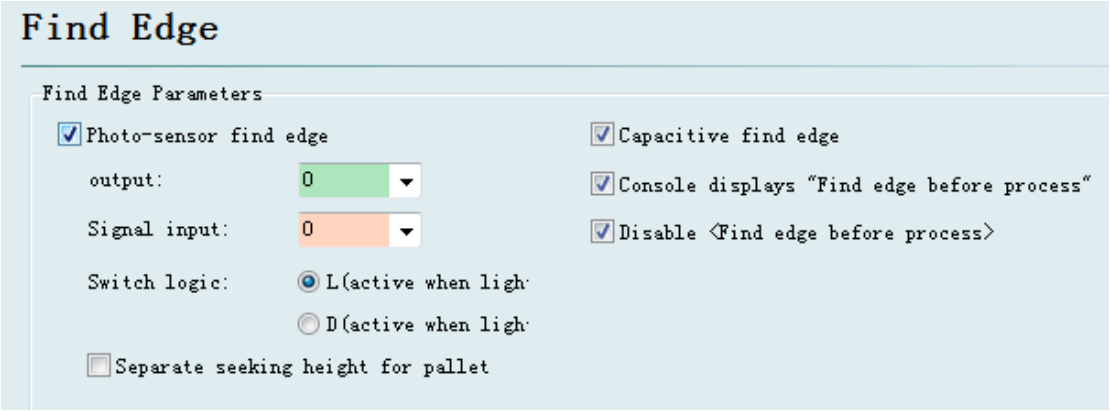
Assigned I/O will display software button under CypCut CNC tab. Custom I/O can select contact or self-lock control method.

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.

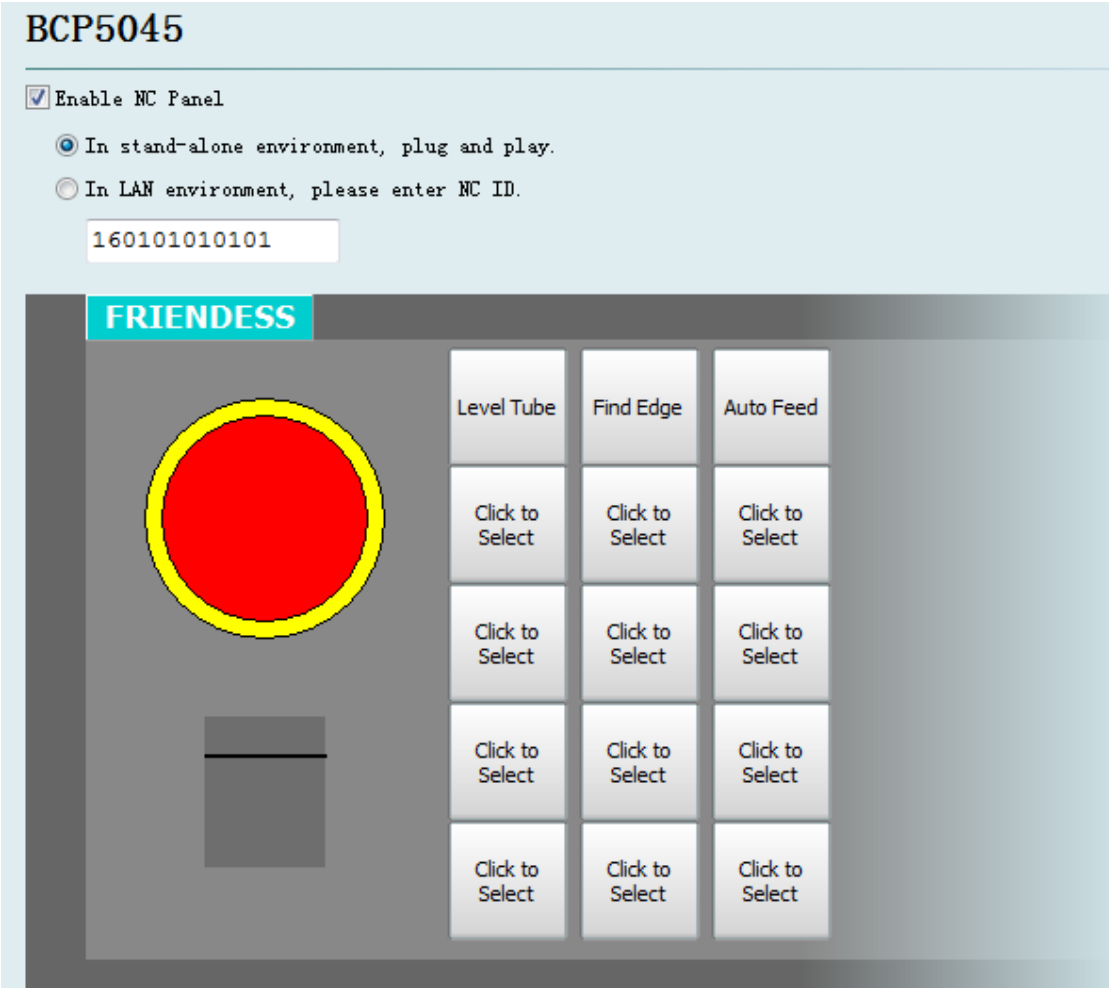
Turn-off delay: when laser head works from one region to another one, output of last region will turn off after preset delay.

3.12 Find Edge Setting



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

3.13 BCP5045 Panel



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

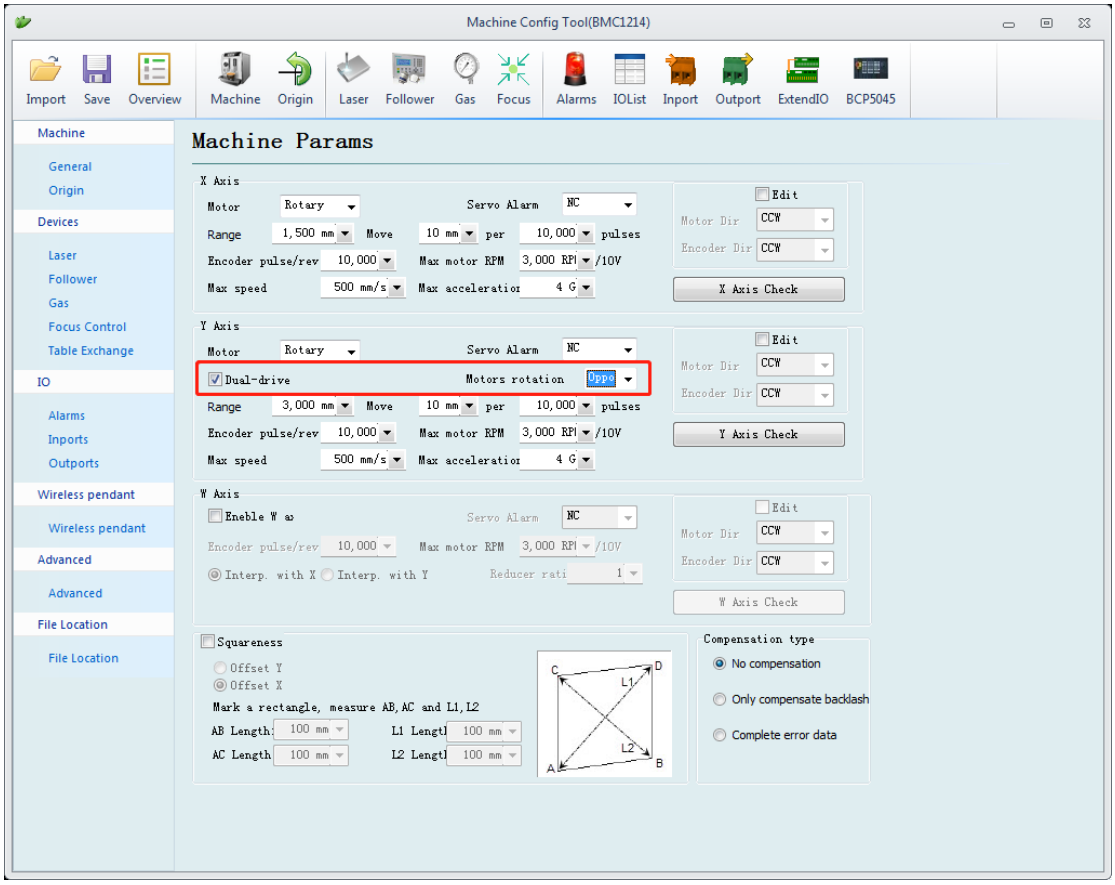
Connect BCL3724 I/O terminal board and BMC1214 control card by C62-pin cable, give 24V power supply to BCL3724 board. Make sure power supply in right wiring and no short circuit before power up.

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

4.2 Basic Machine Motion Config Checking

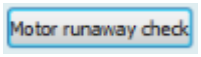
Motor runaway risk exists in close-loop control, you need to do some checking points before first-time running.

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).



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

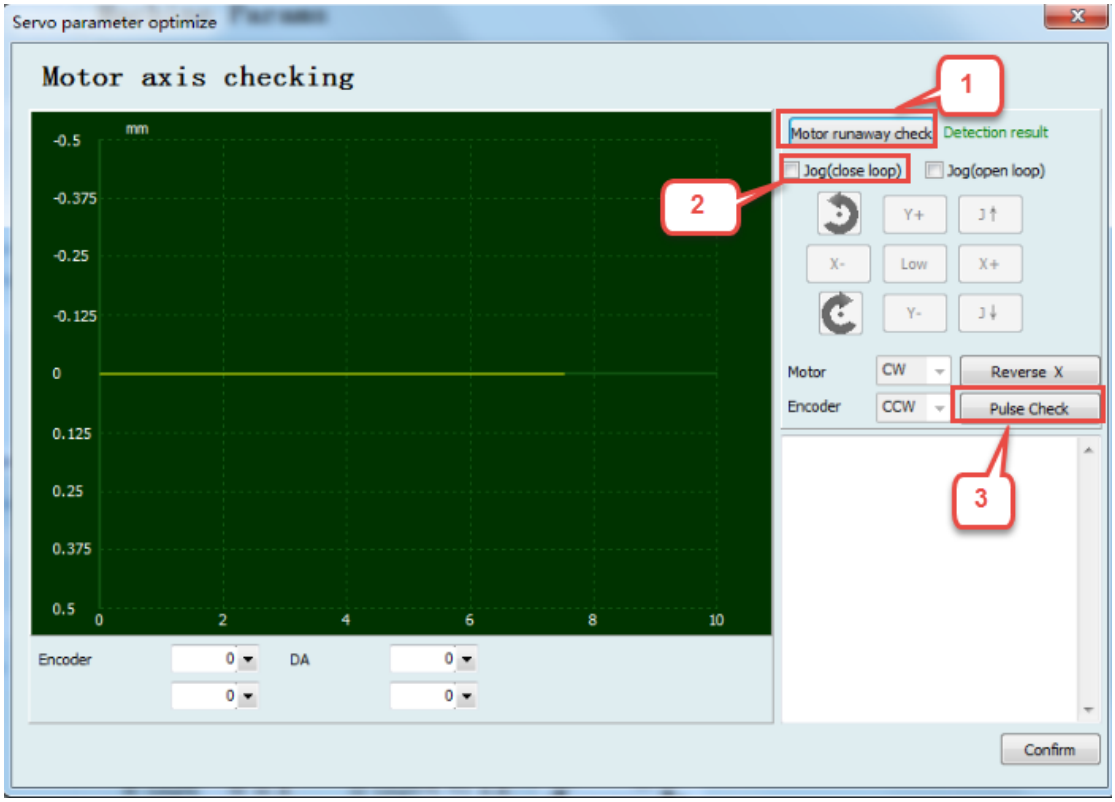
open ‘motor axis checking’ page.

1. Click 

to start motor runaway test.
2. Click 

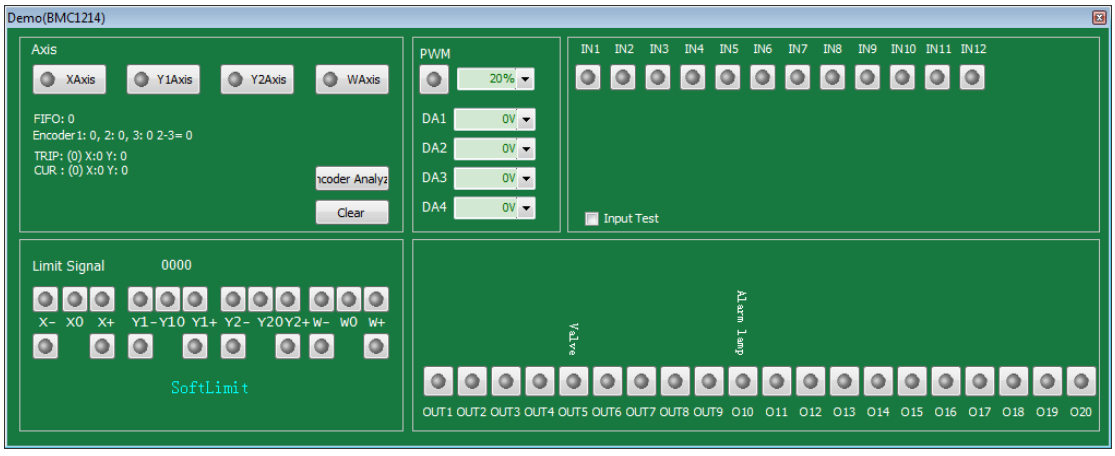
option, then jog motor in both directions, if motor motion direction not same with command direction in CypCut, click 

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

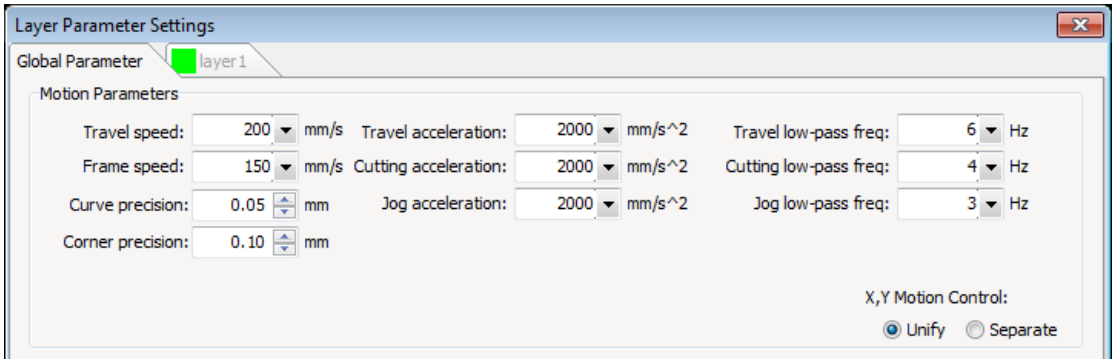
Startup computer and open CypCut software. Open File tab > Diagnosis > IO Monitor.



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:



Test single motor axis make sure pulse equivalent set right.

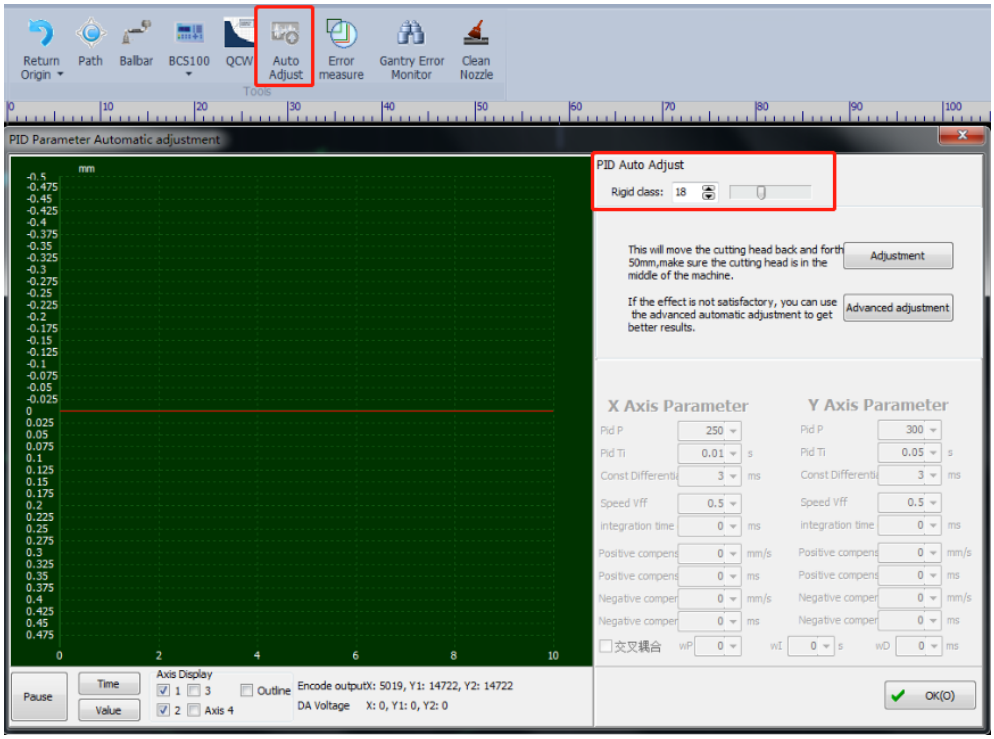
After all limit and origin signal tested to work normally, execute each motor axis return origin to build mechanical coordinate.

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.


Return Origin
Path
Ballbar
BCS100
QCW
Auto Adjust
Error measure
Gantry Error Monitor
Clean Nozzle
Tools
PID Parameter Automatic adjustment
mm
PID Auto Adjust
Rigid class: 18
This will move the cutting head back and forth 50mm,make sure the cutting head is in the middle of the machine.
Adjustment
If the effect is not satisfactory, you can use the advanced automatic adjustment to get better results.
Advanced adjustment
X Axis Parameter
Y Axis Parameter
Pause
Time
Value
Axis Display
Outline
Encode outputX: 5019, Y1: 14722, Y2: 14722
DA Voltage X: 0, Y1: 0, Y2: 0
OK(O)

5. Adjustment Steps

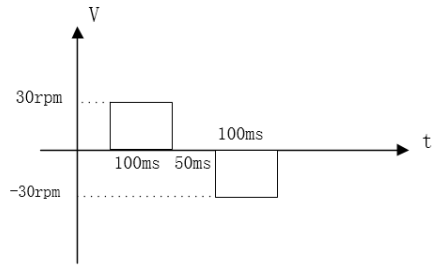
Servo drive setting

1. Select velocity control mode;
2. Set input gain of speed command;
3. Set encoder differential pulse output per motor revolution;
4. Velocity loop gain 75hz, time integral 9ms and set velocity loop rigidity level,
5. Confirm select external enable signal, doesn't set deadband signal, doesn't set rotation restriction.

CypCut machine config

1. Set motor type;
2. Set pulse equivalent;
3. Set encoder pulse output per motor revolution;
4. Set max motor rotation speed to 10V.

Motor runaway check



Encoder feedback check

Encoder pulse/rev:Detect Value X : 9999
Setting Value: X : 10000
Same with settings.

MotorMax motor RPM: Detect Value X : 5608
Setting Value: X : 6000
Same with settings.

Self adjustment

PidP: X: 152.9, Y: 152.4
PidTi: X: 0.050, Y: 0.050
PidTd: X: 0.0, Y: 0.0
PidVff: X: 0.500, Y: 0.500

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.

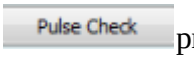
Checking points:

（1） 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 

process, program detected received encoder pulses and maximum speed doesn't match with preset value.

Checking points:

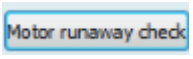
（1） If test results remain same error value in repeated testing, check servo driver parameter if command speed gain and feedback pulses match the setting in CypCut machine config;

（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:

（1） Open CypCut machine config, and execute 

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;

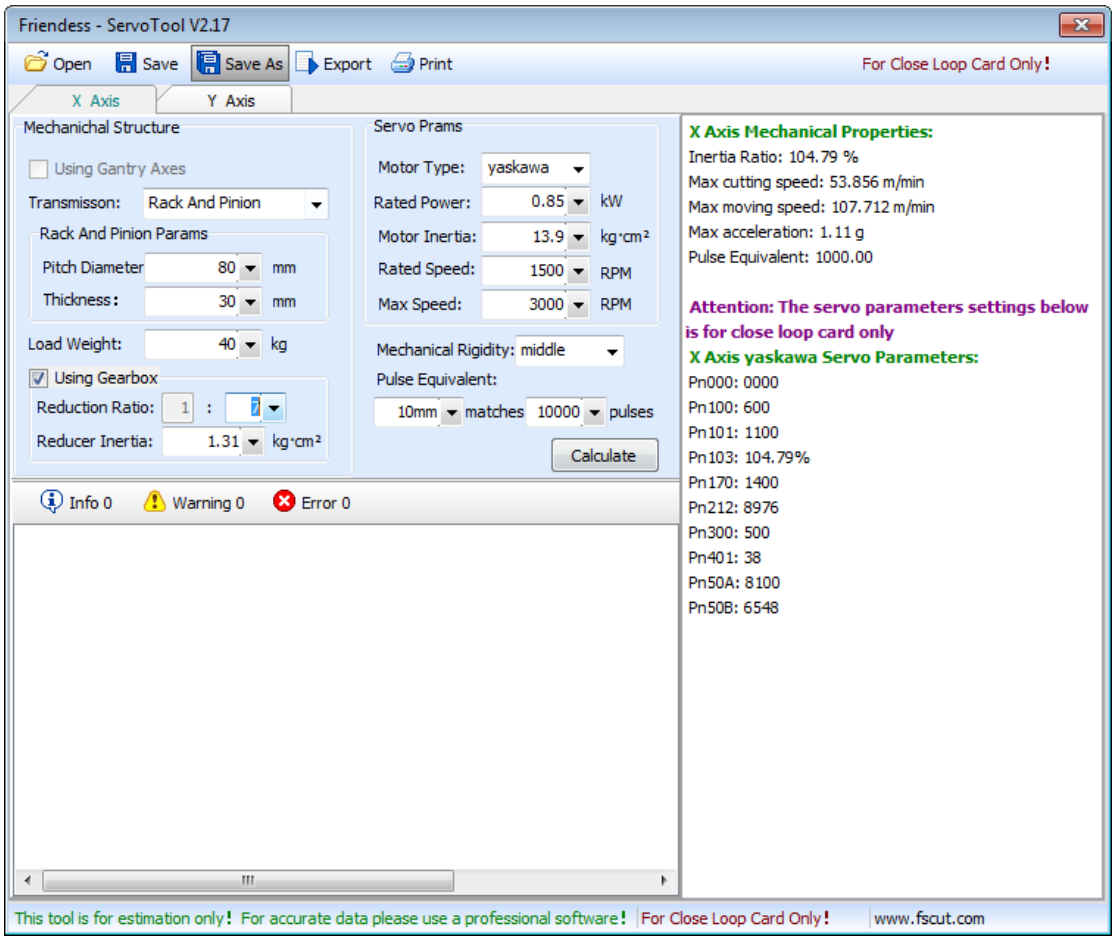
（3） If this error came after increasing speed in CypCut, motor speed might be limited. Servo parameter might limit motor speed, or exceed motor maximum speed;

（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 Acceleration	The maximum travel acceleration. You can calculate by ServoTools and input calculated value directly.
Cutting Acceleration	The maximum cutting acceleration which directly influences 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 Frequency	The filter frequency to suppress machine vibration. Suppression 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

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.

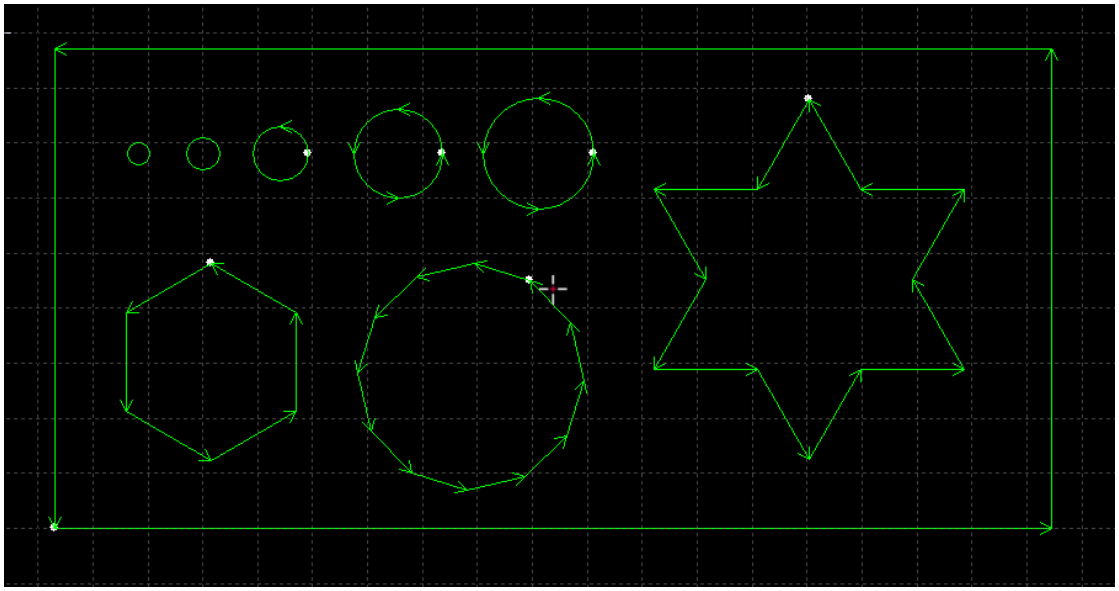
Adjust the acceleration until peak torque reaches to 80% of rated value when jog the axis in high speed. The acceleration lead screw structure can bear is usually under 0.5G. For rack gear structure is under 2G.

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.

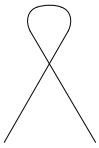
8. FAQ

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

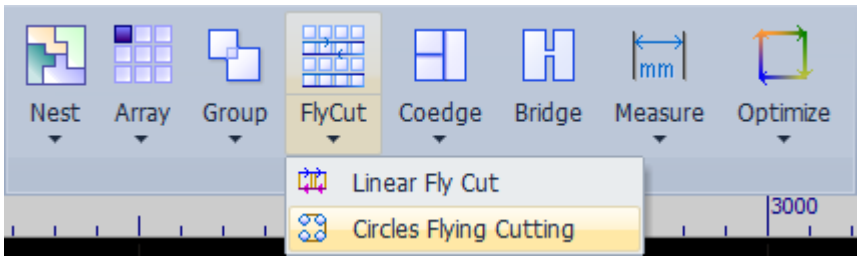
- Check laser status with laser software, test laser emission for trouble shooting.
- When use serial communication, it's not allowed to use multiple software to communicate with laser at same time.
- If serial communication failed, use debug mode to check command and laser response.

9. Appendix

9.1 Fly Cut Operation Guide

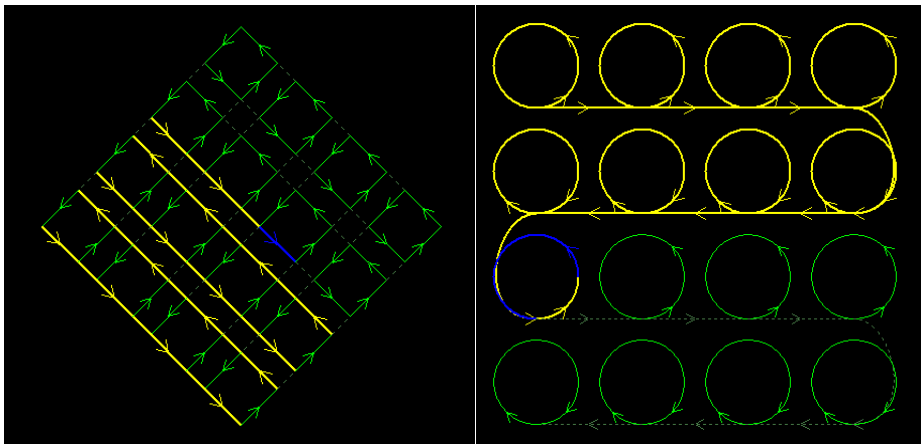
9.1.1 Function

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.

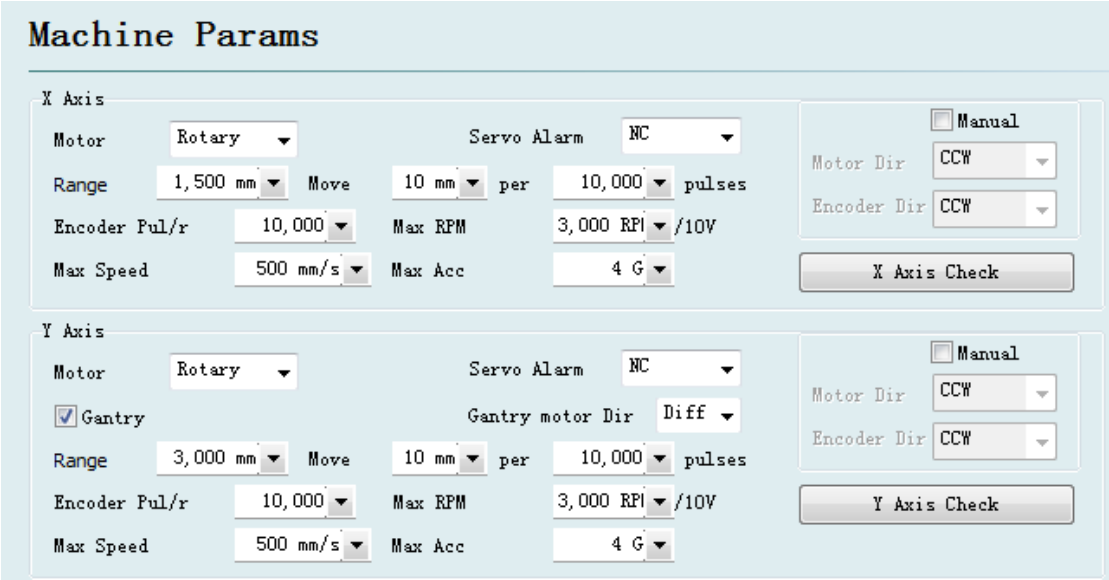
Set return origin direction of X/Y axis by machine design. Return origin direction results in which coordinate quadrant machine runs with. If return origin towards negative direction, then machine runs in positive range of coordinate. If return origin direction towards positive direction, then machine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



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.

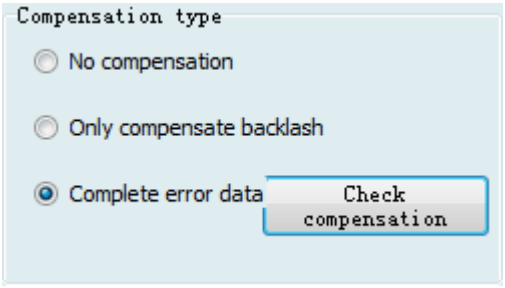
Stop time: the minimum stop duration for Renishaw is 2 seconds.

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

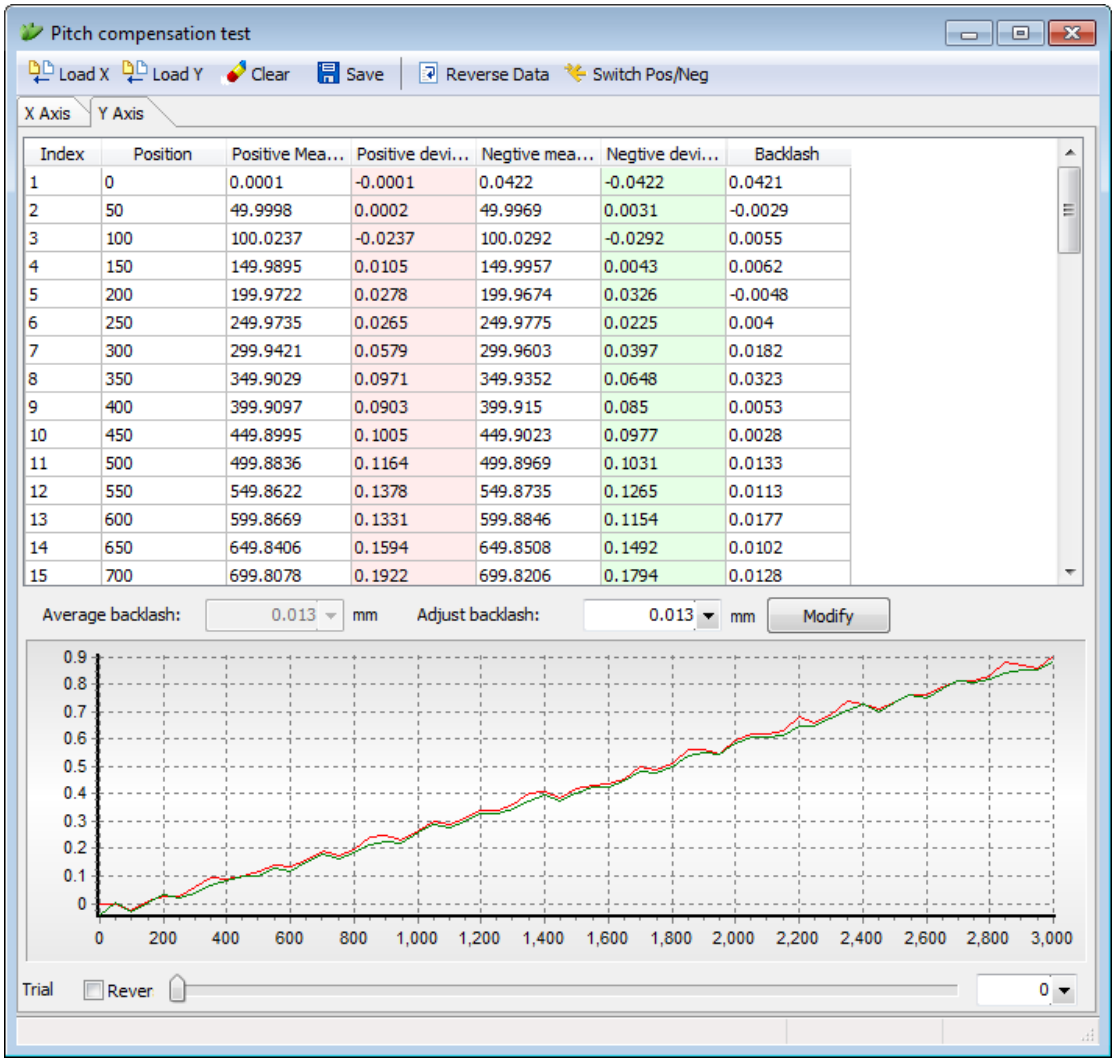
The measurement data file can be imported in CypCut. CypCut can read measurement file generated by Renishaw, API, Agilent, OptoDyne interferometer software. If the measurement file of interferometer you are using cannot read by CypCut, please contact our technical support. Below is where to import measurement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

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



Click 

will open below window.



Click Load X to import measurement file of X axis, click Load Y 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.

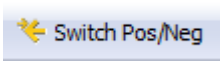
9.2.7 FAQ

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 

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.