



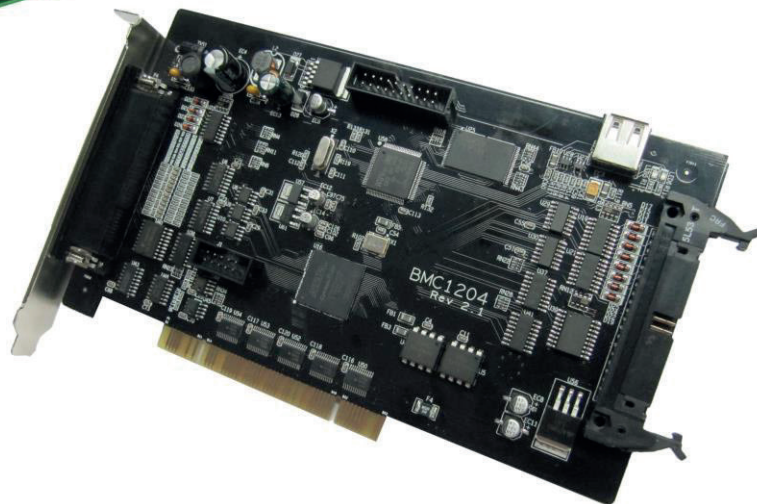
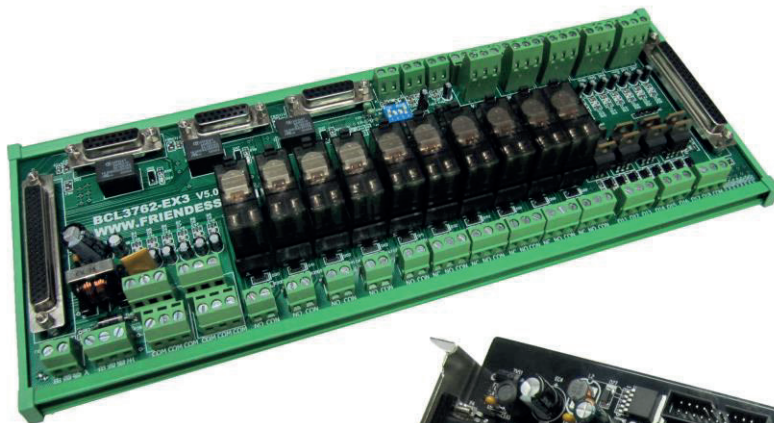
**РУКОВОДСТВО  
ПО ЭКСПЛУАТАЦИИ  
ЧПУ КОНТРОЛЛЕРА  
FSCUT 2000**



# FSCUT2000

## laser cutting control system

### User Manual



[www.fscut.com](http://www.fscut.com)

Ver 2.6



Thank you for using our products!

This Manual describes FSCUT2000 laser cutting control system in details, including system features, installation instructions etc. If you want to know more about CypCut laser cutting software that can improve the performance of height controller while using together, please refer to the help documents of the software. For any other information, please contact us directly.

Please read the Manual carefully before using the controller and relevant devices, so that you can make better use of it in future.

Along with continuous updating of product functions, there may be some differences between that you received and the Manual. We will apologize for any inconvenience.



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# Chapter 1 Product Introduction

## 1. Introduction

FSCUT2000 is a high-performance ring opening laser control system developed independently by Shanghai BoChu electronic technology co., LTD. It is widely used in metal and non-metal laser cutting area. Because of its outstanding performance in medium power fiber laser cutting area, it is favored by a large number of high quality customers.

When you buy the FSCUT2000 laser cutting control system, please read the Manual carefully before using the controller and relevant devices.

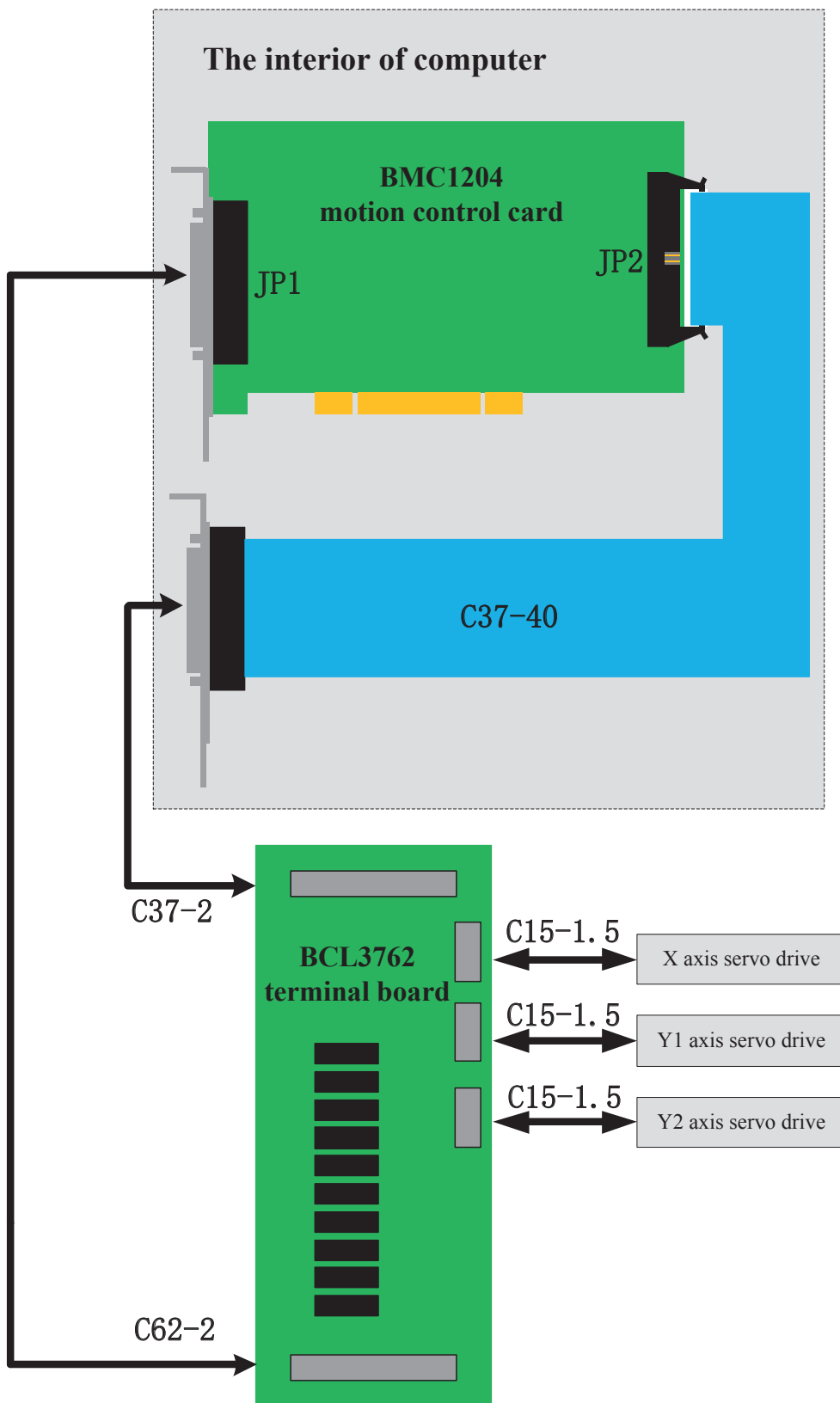
FSCUT2000 laser cutting control system is composed of standard accessories as shown below:

Name	Model	Number
<b>motion control card</b>	BMC1204	1
<b>terminal board</b>	BCL3762-V5.0	1
<b>Extension wire (with a guard sheet)</b>	C37-40	1
<b>37-pin cable (2metres)</b>	C37-2	1
<b>62-pin cable (2metres)</b>	C62-2	1
<b>Servo cable (1.5metres)</b>	C15-1.5	3
<b>Dongle</b>	Micro Dog	1
<b>laser cutting software</b>	CypCut	1

## 2 System Connection Diagram

BMC1204 card applies PCI interface whose external size is 213mm\*112mm. A control card has two sockets; JP1 is a DB62M socket and connect matched C62-02 cable to BCL3762 terminal board; JP2 is an external expansion caval socket and connect C40-37 expansion winding displacement (with catch) to back of computer case first, and then connect C37-02 cable to BCL3762 terminal board.

Connect the system is shown below:



Technical parameters

		4 axis with high-speed pulse output, maximum frequency 750kHz.
	<b>Motor</b>	3 axis with encoder feedback channel, four-frequency can be up to



<b>motion control</b>	<b>control signal</b>	8MHz.
		each axis with plus-minus limit ,origin signal,servo alarm signal.
		each axis with servo-enabled signal.
	<b>motion control performance</b>	control cycle 1ms.
		“S” speed-up&speed-down.
		velocity look-ahead, intelligent speed-up&speed-down.
		the speed limit of small circular arc .
<b>Laser control signal</b>	1 circuit PWM signal,choose 24V or 5V by dial switch.	
	2 circuits 0~10V analog signal .	
<b>I/O</b>	12 circuits general input interface.	
	18 circuits general output interface,10 circuits relay output, the other 8 circuits thyristor output.	
<b>work environment</b>	temperature:0~55℃	
	humidity:5%~90%,no condensation	
<b>Power Requirement</b>	24V,2A	

### 3. Control card installation

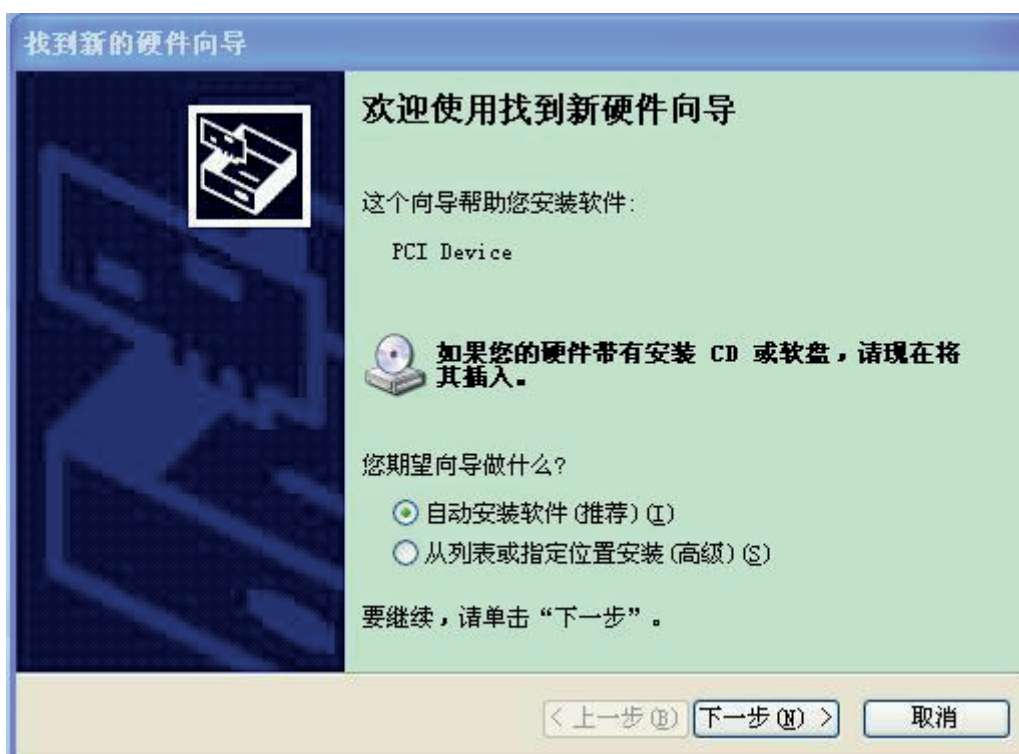
#### 3.1 Installation Steps



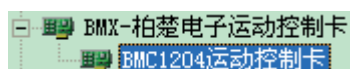
Please carefully handle them, and touch effective grounded metal parts before touching control card system or inserting/removing control card to prevent static electricity from damaging motion control card, and please wear electricity-proof gloves

- (1) Shut down computer, insert control card into PCI slot, and fix control card and catch screw of expansion winding displacement
- (2) Start the computer and “Found New Hardware Wizard” pops up; click “Cancel” button as shown below. If this window does not pop up, it means control card is not inserted correctly, so please repeat step one
- (3) Install CypCut software, simultaneously BMC 1204 card driver and softdog





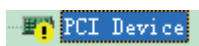
(4) Open the device manager to confirm the installation successfully. If the following icon appeared:



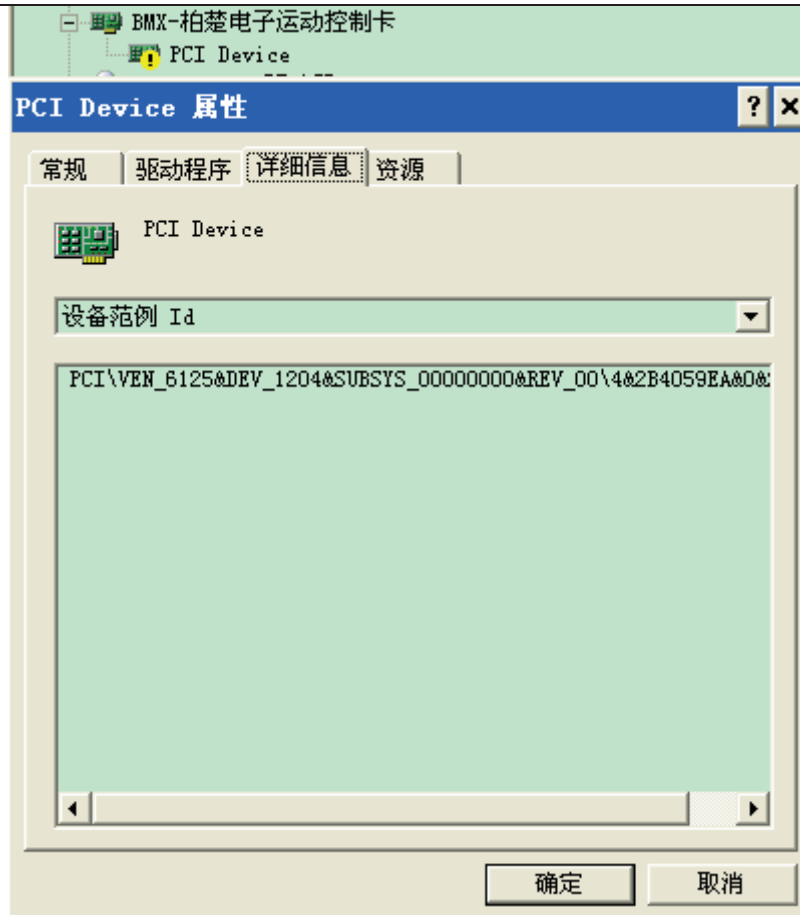
it show that the installation was successful.

### 3.2 Recovery processing

- (1) if starting the computer, “Found New Hardware Wizard” does not popup, or control card cannot be found in device manager, which means control card is not inserted correctly. Please replace PCI slot or computer, insert and fix control card then, and reinstall the software.
- (2) if there is yellow exclamation mark with the device, please double click



, open attribute page and select “details”.

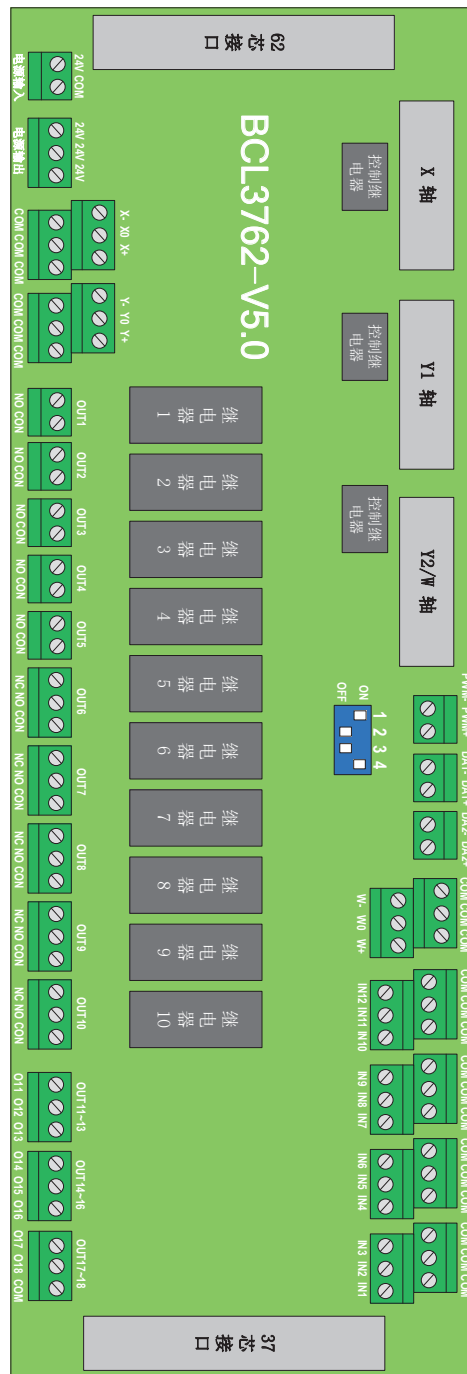


- (3) The first half of “device instance ID” is `PCI\VEN_6125&DEV_1204`, which means the computer correctly identifies motion control card and software installation may fail. Please reinstall Cypcut software. If it fails again, please contact with our technician
- (4) The first half of “device instance ID” is not `PCI\VEN_6125&DEV_1204`, which means the computer doesn't identify motion control card. Please shut down the computer, change the PCI slot, fix the control card again and reinstall the software.
- (5) If step three still fails, control card may be damaged, please contact with our technician.



## Chapter 2 Port Instructions

The configuration terminal board of BMC1204 is BCL3762-V5.0, as shown below:



BCL3762-V5.0 terminal board is installed by rail and also installed permanently. Its external size is 315mm\*107mm with DM62M and DB37M interface in two sides



corresponding to JP1 and JP2 of BMC1204. Use C62-2 cable to connect terminal board DB62 interface with JP1 port on the back of control card. JP2 interface is linked by C37-40 baffle wire and then is fixed on erection fixture of computer with bolts, and use C37-2 cable to connect it with DB37 socket on terminal board.

The three DB15M interfaces on the top left corner are servo control signals, from left to right are X axis, Y axis and W axis. When being used as longmen double-drive, W axis is Y2 axis. When being used as pipe cutting, W axis is rotation axis.

High-low terminals on bottom left are respectively plus-minus limit and origin signal of X axis and Y axis. High-low terminals on upper right are W axis of origin limit and general input interface. All the low terminals are break-over and are COM ground, namely 0 V.

The interface on bottom right is 18 circuits general output interface. There are 10 circuits relay output; the other 8 circuits are thyristor output. The first 5 ones of the 10 circuits relay output only have normally open contacts and the second 5 circuits have normally open contacts and normally closed contacts. The 8 circuits thyristor output is 24 V general cathode output.

The three 2--pin terminals right above are 1 circuit PWM and 2 circuits DA analog signal.

There is a 4-direction dial switch below the PWM and DA analog signal, its usage is shown below:

Switch P1 and P2 control the voltage of PWM

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

Switch P3 and P4 control the signal source of PWM

P3	P4	Implication
On	Off	PWM generated by PUL4- of the fourth axis
Off	On	PWM generated by independent PWM signal



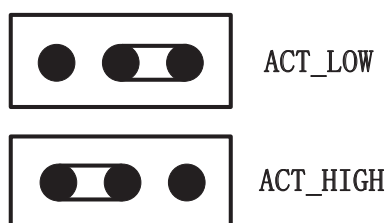
## Chapter 3 Wiring Instructions

### 1 Signal type

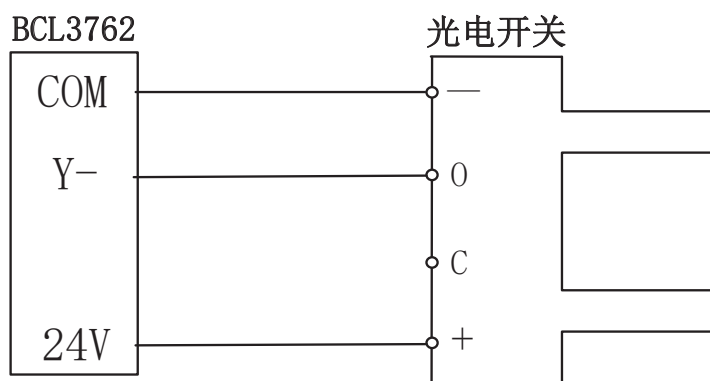
#### 1.1 Input signals

Input signals include: plus-minus limit, origin and general input. BMC1204 card input is active low level: support normally open and normally closed mode (modify polarity of input port through “platform configuration tool” of CypCut software). When the setting is normally open, input port and 0 V break-over are active; when the setting is normally closed, disconnection of 0 V is active.

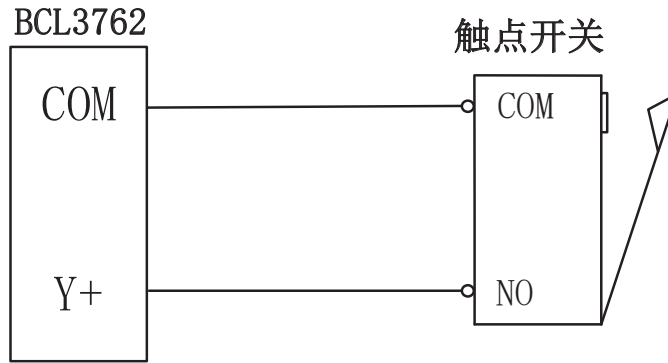
Input port polarity can be modified through hardware jumper. Now IN10, IN11 and IN12 input ports support this function. Jumper has two states, ACT\_LOW as shown in the figure, means low level is active (inputting 0V voltage is active); ACT\_HIGH as shown in the figure, means high level is active (inputting 24V voltage is active). Default state is ACT\_LOW.



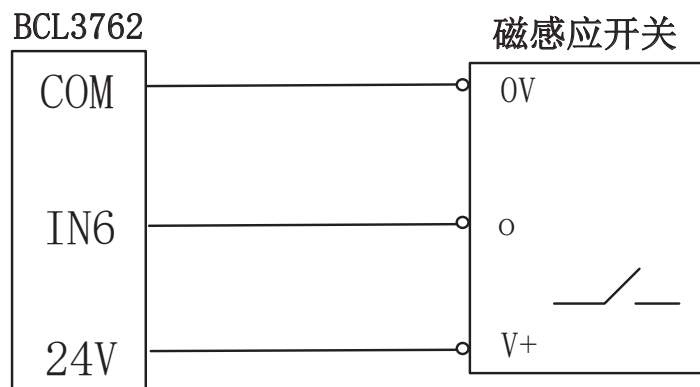
Typical connection of optoelectronic switch as below, which must use 24V switch of the NPN type.



Typical connection of contact switch is shown below:



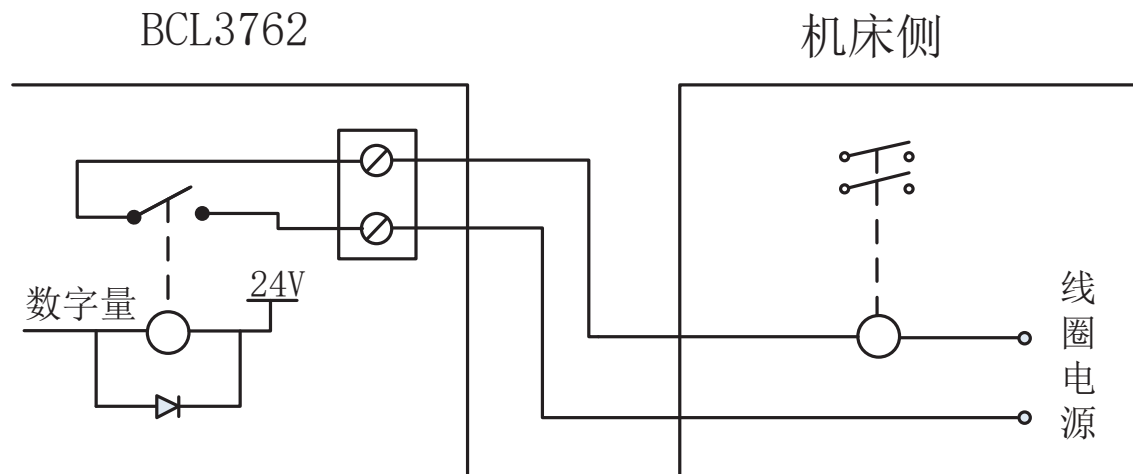
Typical connection of magnetic switch as below, which must use 24V switch of the NPN type.



### 1.2 Relay output signal

Load capacity of relay output contact on terminal board is: 240VAC/5A, 30VDC/10A. Controllable small power is 220 V alternating load. Please circumscribe contactor if connecting with big power load.

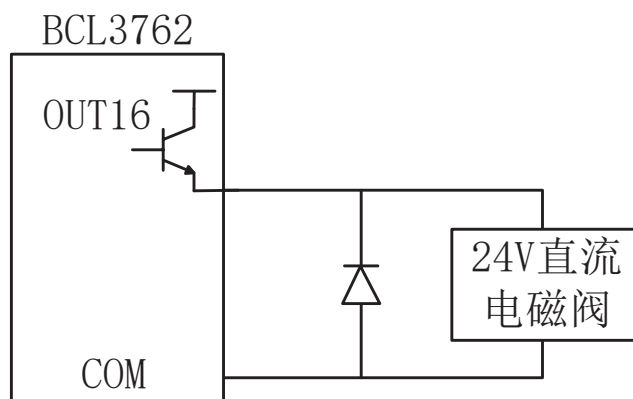
The connection of relay output and contactor is shown below:





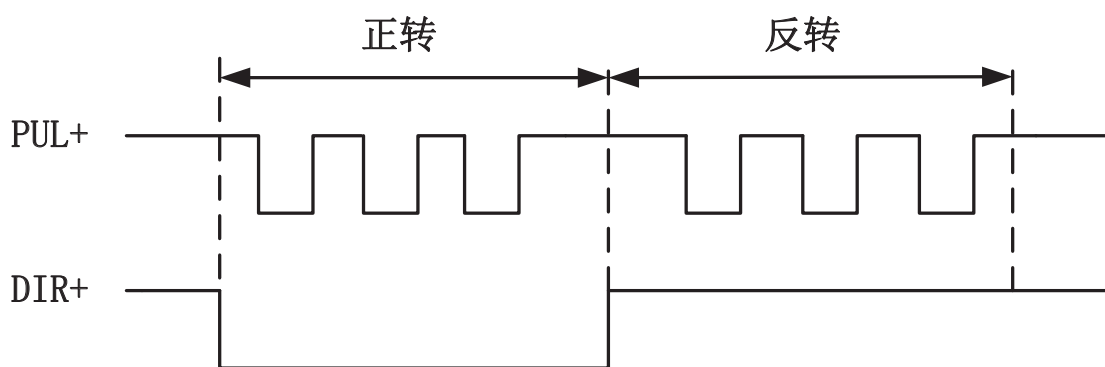
### 1.3 Thyristor output signal

There are OUT11~OUT18 thyristor emitter output on BCL3762-V5.0 terminal board and it can directly drive 24V direct current device. Each current supply capacity is 500mA, typical connection is shown below:

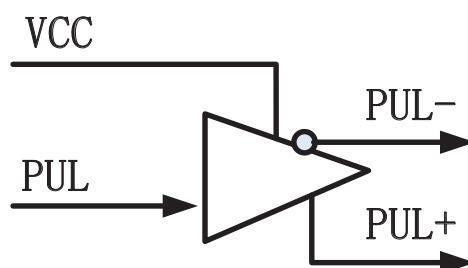


### 1.4 Differential output signal

Pulse command of control driver is “pulse+direction, negative logic”. The highest pulse frequency: 750 kHz. The pulse mode is shown below:



The output way of differential signal is shown below :





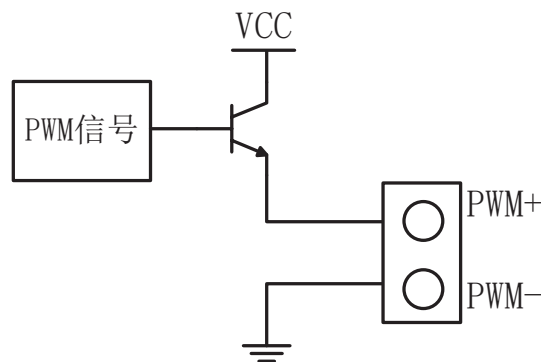
## 1.5 Analog output signal

There are 2 circuits 0~10V analog signal in the terminal board.

Range	0V~+10V
Maximum current load	50mA
Maximum capacitive load	350pF
Input impedance	100K $\Omega$
Maximum bipolar error	+/-50mV
Resolution ratio	10mV
Conversion speed	400us

## 1.6 PWM output signal

BCL3762 terminal board has 1 circuit PWM pulse width signal which can be used for controlling average power of fiber laser. PWM signal level is 5 V or 24 V for selection. Duty cycle is 0%~100% and the highest carrier frequency is 50 KHz. The output way of PWM signal is shown below:



We strongly recommend that users install PWM+ signal to a relay output port in series (PWM-enabled), then access laser, which can avoid laser light leakage in modulation mode. Please refer to 3.4.3 Fiber Laser Connection for more details. Furthermore, please adjust PWM signal level. Select 14 V or 5 V level through dial switch.

## 2 Terminal Instructions

### 2.1 External power source

External power source provide direct current 24 V for BCL3762 terminal board.

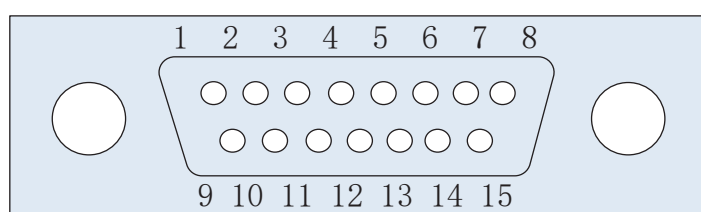




24 V and COM connect respectively 24 V and 0V output interface.

## 2.2 Servo control interface

The three servo control interfaces on BCL3762 are DB15 two-row bores, and pin definition as below:



There are two kinds of servo cables matching it:

The first one is C15-1.5 (produced before Oct.2013)

15-pin servo control interface					
Pin	Line color	Signal	Pin	Line color	Signal
1	purple	PUL+	9	Orange-black	PUL-
2	yellow	DIR+	10	red	DIR-
3	yellow-black	A+	11	Red-black	A-
4	blue	B+	12	green	B-
5	Blue-black	Z+	13	Green-black	Z-
6	black	SON	14	brown	ALM
7	Black-white	CLR	15	Brown-black	0V
8	orange	24V			

The other one is C15-2.5(produced after Oct.2013)

15-pin servo control interface					
Pin	Line color	Signal	Pin	Line color	Signal
1	yellow	PUL+	9	yellow-black	PUL-
2	blue	DIR+	10	Blue-black	DIR-
3	black	A+	11	Black-white	A-
4	orange	B+	12	Orange-black	B-
5	red	Z+	13	red-black	Z-
6	green	SON	14	purple	ALM
7	Green-black	CLR	15	Brown-black	0V
8	brown	24V			

+24V,0V:24V DC power supply for servo drive;

SON:servo on,the output of servo enable signal;



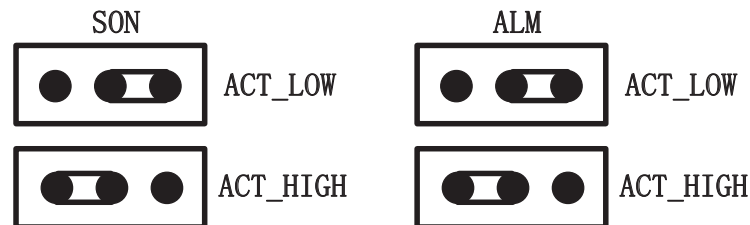
ALM:alarm,the input of servo alarm signal;

PUL+,PUL-:pulse(PULS),differential output signal;

DIR+,DIR-:direction(DIR),differential output signal;

A+,A-,B+,B-,Z+,Z-:three phase of encoder,input signal;

The SON and ALM signal can be modified through hardware jumper.



Jumper has two states, ACT\_LOW as shown in the figure, means low level is active (inputting 0V voltage is active); ACT\_HIGH as shown in the figure, means high level is active (inputting 24V voltage is active). Default state is ACT\_LOW.

Please see the figure below for connection of Panasonic, Yaskawa, Mitsubishi and Delta servo drivers

Please read below information when connecting driver of other brands:

(1) Please determine whether the type of servo driver SON signal you select with active low level (It is ON when connecting with 24V GND break-over)

(2) Determine servo driver parameters are: pulse signal type is "pulse + direction"

(3) Determine whether servo driver input terminal with external crash stopping signal input and the signal logic

(4) Before servo trial operation, provide 24 V power supply for terminal board, for servo needs 24 V power supply provided by terminal board

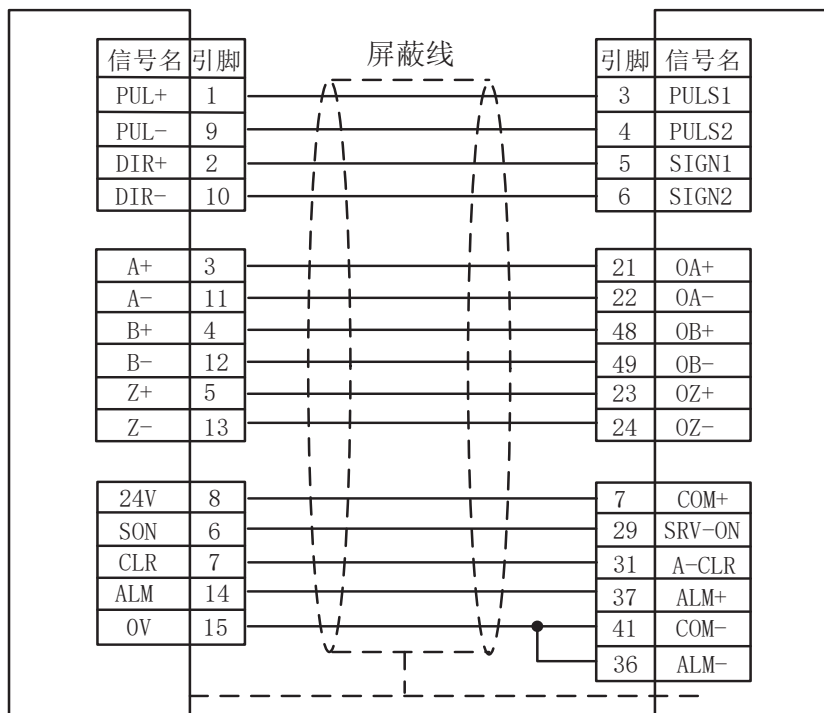
(5) if driver still cannot run, confirm that driver parameter is not using "positive & negative input inhibit"

(6) Connect shielding layer of signal line with servo driver case



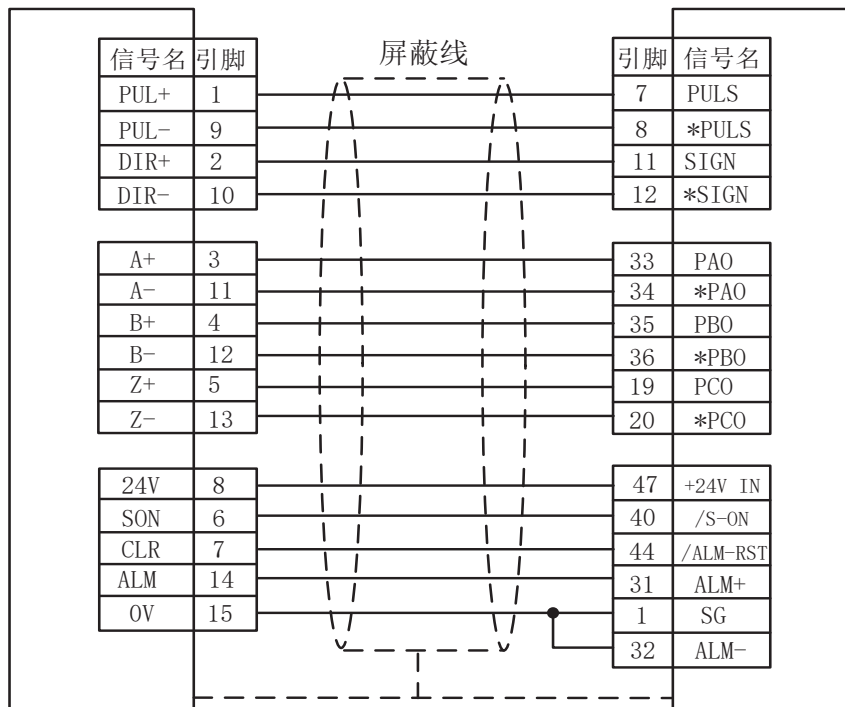
上海柏楚DB15伺服控制接口

松下MINAS-A伺服50P接口



上海柏楚DB15伺服控制接口

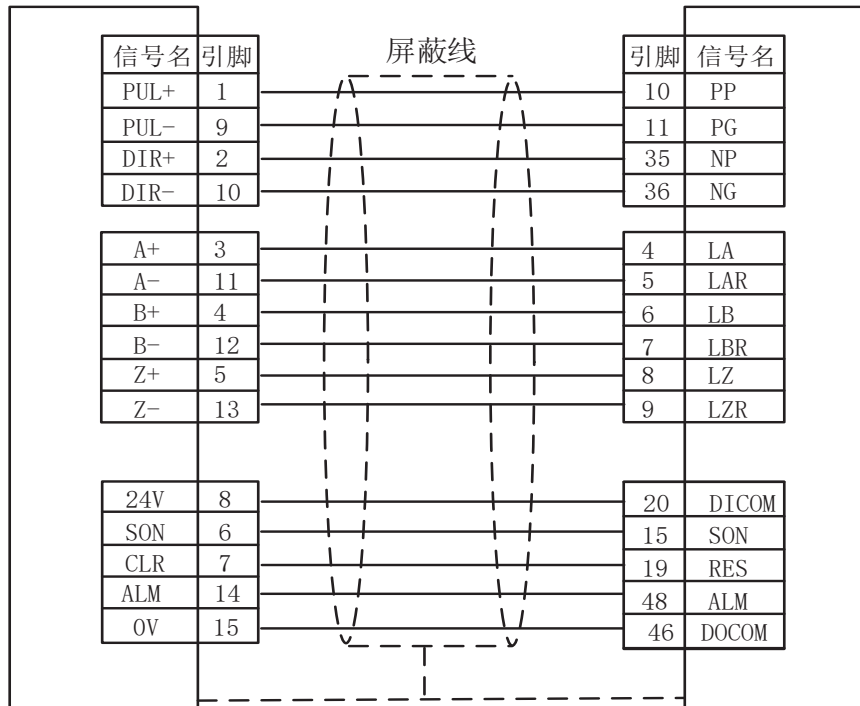
安川Σ-V伺服50P接口





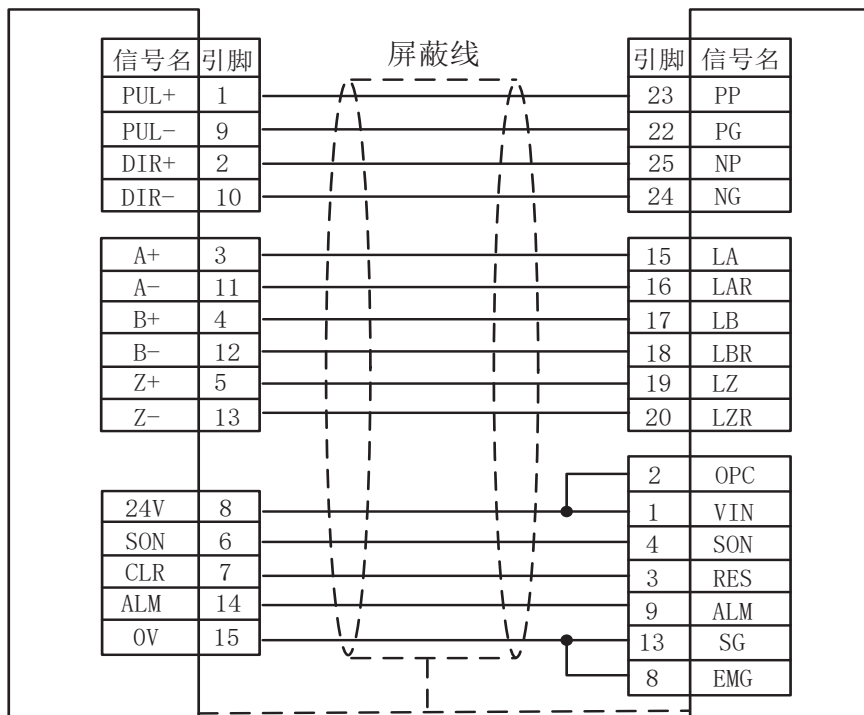
上海柏楚DB15伺服控制接口

三菱MR-J3-A伺服50P接口



上海柏楚DB15伺服控制接口

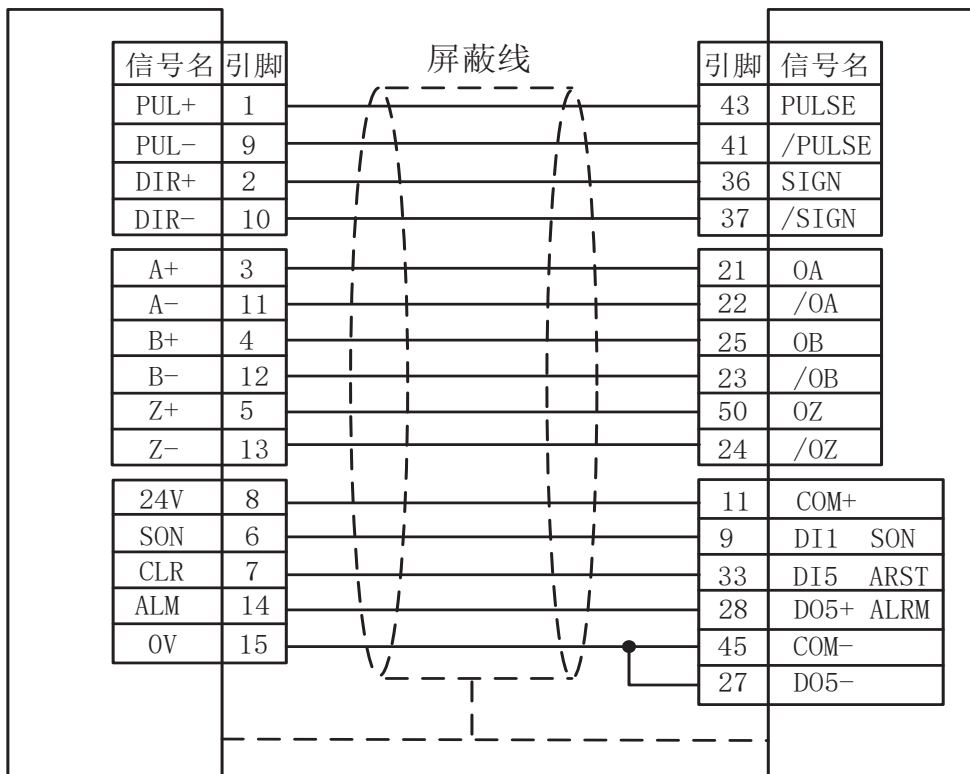
三菱MR-E-A伺服26P接口





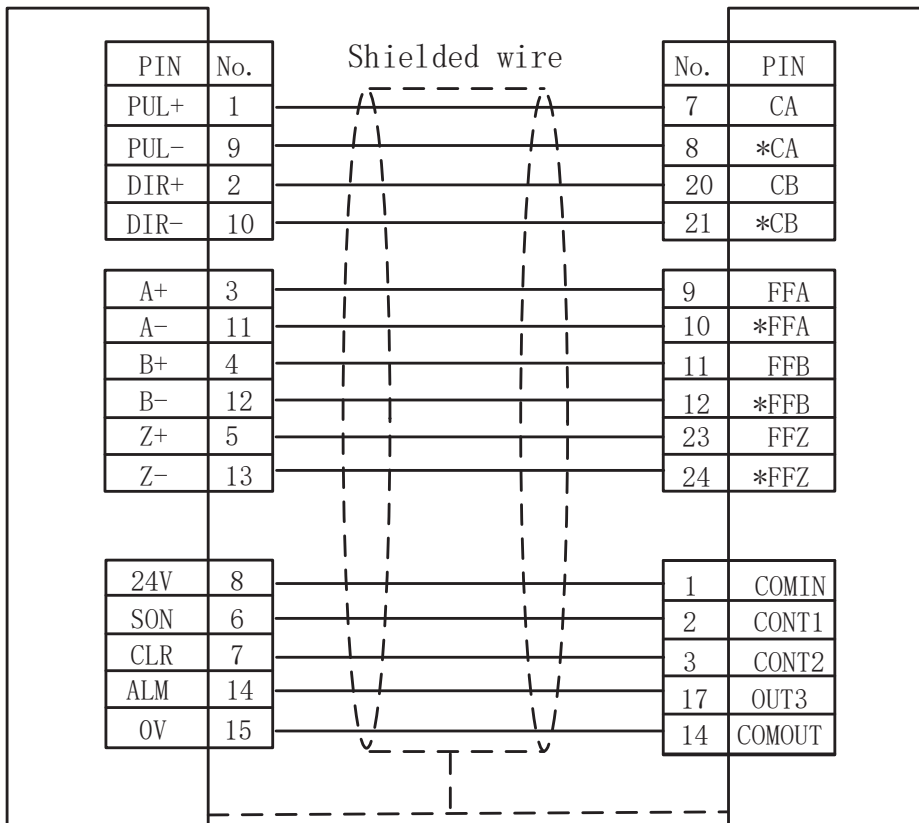
上海柏楚DB15伺服控制接口

台达ASD-A伺服50P接口



DB15 servo interface

Fuji-Shi A5 servo 26-pin interface





### 2.3 origin limit

X-: the limit of minus X direction, dedicated input signal and low level is active;

X0: the origin signal, dedicated input signal and low level is active;

X+: the limit of positive X direction, dedicated input signal and low level is active;

COM:GND,the general circuit of the above three signals;

Y-: the limit of minus X direction, dedicated input signal and low level is active;

Y0: the origin signal, dedicated input signal and low level is active;

Y+: the limit of positive X direction, dedicated input signal and low level is active;

COM:GND,the general circuit of the above three signals;

W-: the limit of minus X direction, dedicated input signal and low level is active;

W0: the origin signal, dedicated input signal and low level is active;

W+: the limit of positive X direction, dedicated input signal and low level is active;

COM:GND,the general circuit of the above three signals;

Configure or change these parameters through “platform configuration tool” coming with the CypCut software. Please refer to **chapter 4 platform configuration tool** for more details.

### 2.4 general input

There are 12 circuits of general input with IN1~IN12. Configure 12 circuits of general input into various custom buttons or alarm input through “platform configuration tool” coming with the software. Please refer to **chapter 4 platform configuration tool** for more details.

### 2.5 general output

There are 10 circuits of general input with OUT1~OUT10. Configure 10 circuits of output into “laser”, “auxiliary gas” through “platform configuration tool” coming with the software. Please refer to **chapter 4 platform configuration tool** for more details.

When selecting BCL3762-V5.0 terminal board, besides 10 circuits relay output, there are also 8 circuits thyristor output interfaces which can directly drive 24V direct current device. Please refer to **chapter 4 platform configuration tool** for more



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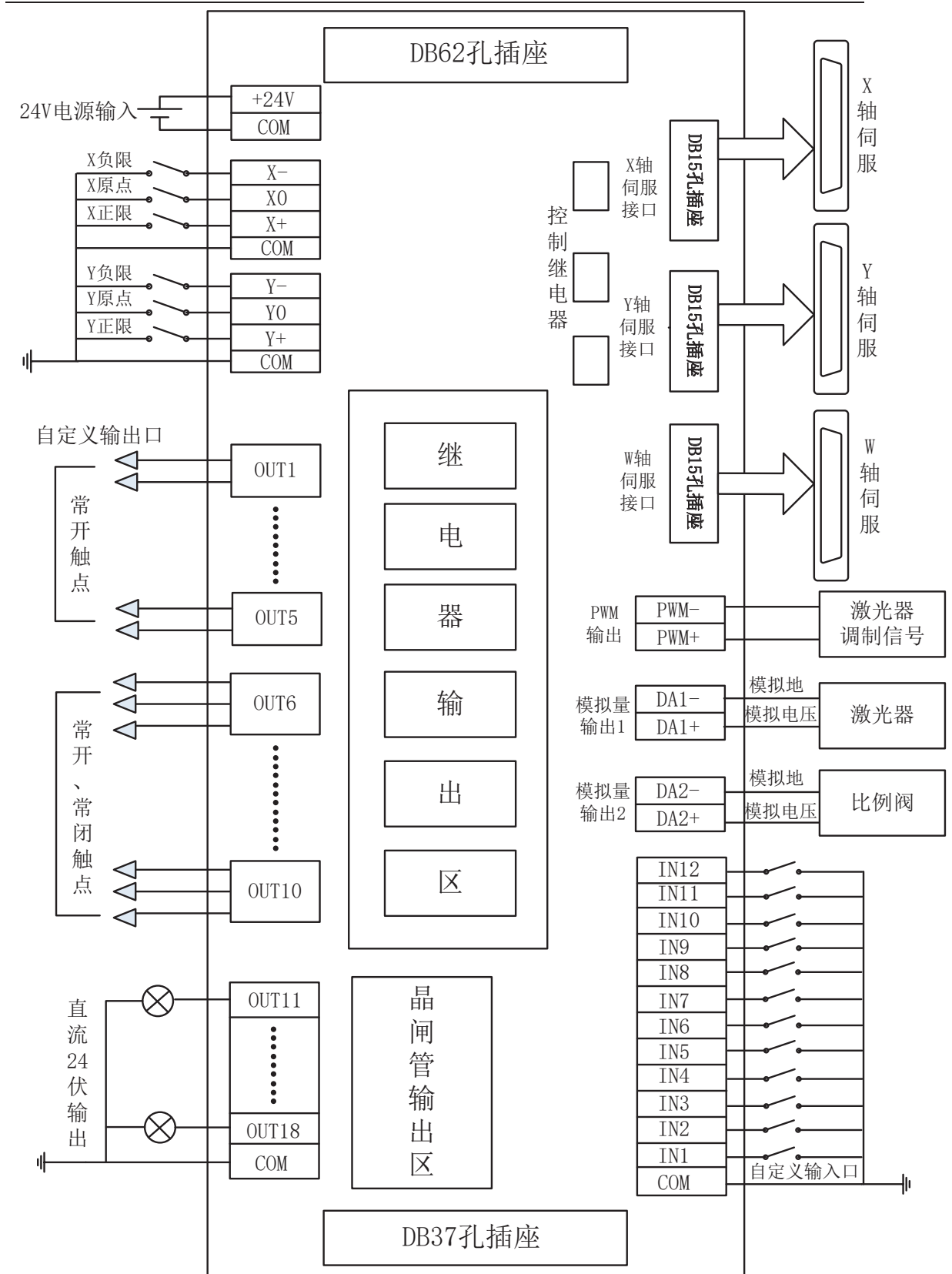
details.

DA1 and DA2 are 2 circuits 0~10V analog signal output. Users can configure these 2 circuits output into the control signal of “laser” and “auxiliary gas”.

## 2.6 PWM input

When configuration of the laser into “fiber laser” through “platform configuration tool” coming with the software., PWM output port will be activated and used for controlling fiber laser average power. If configuration is for other lasers, PWM interface will not output signal.

Connection Diagram







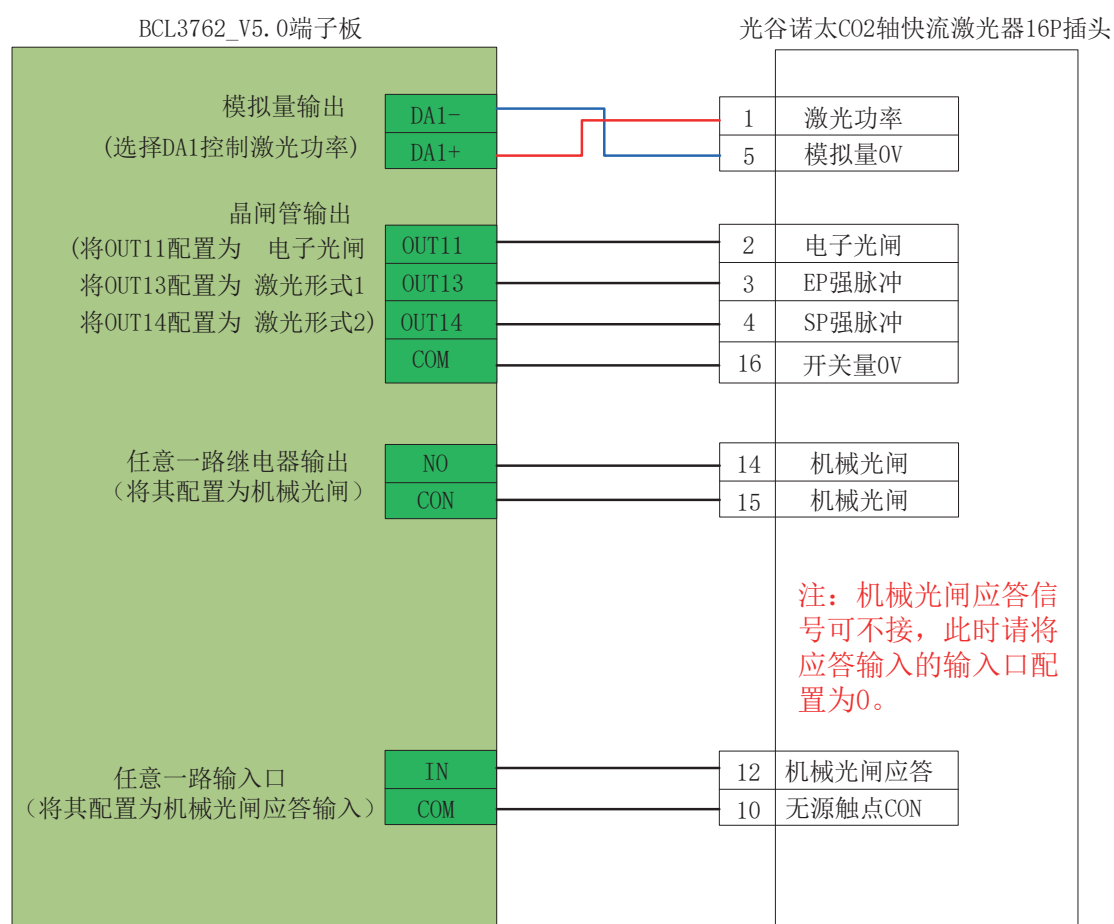
### 3 Laser connection

#### 3.1 YAG laser connection

Directly connect output port whose configuration is laser output signal to laser, which will not be covered here.

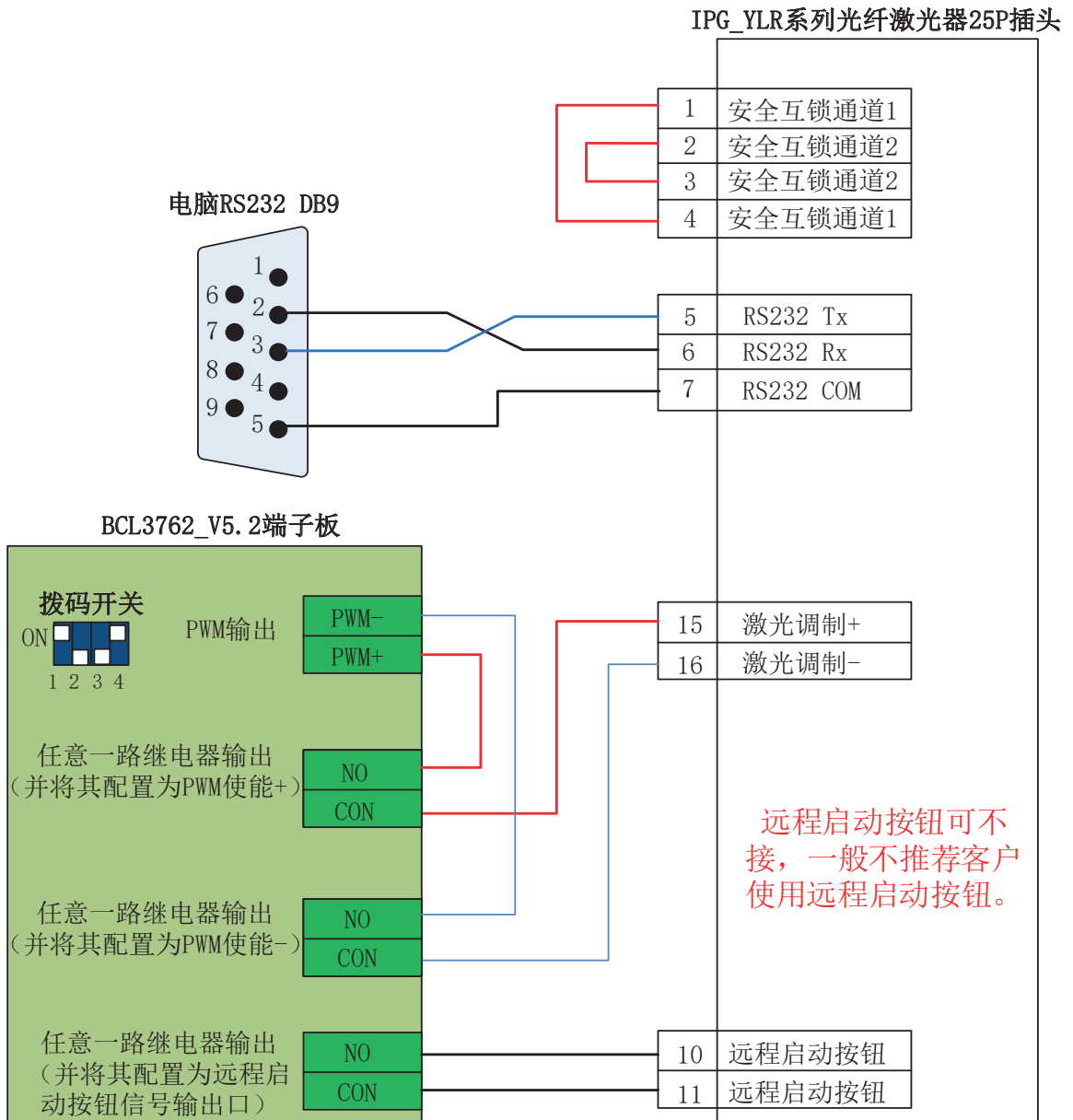
#### 3.2 CO2 laser connection

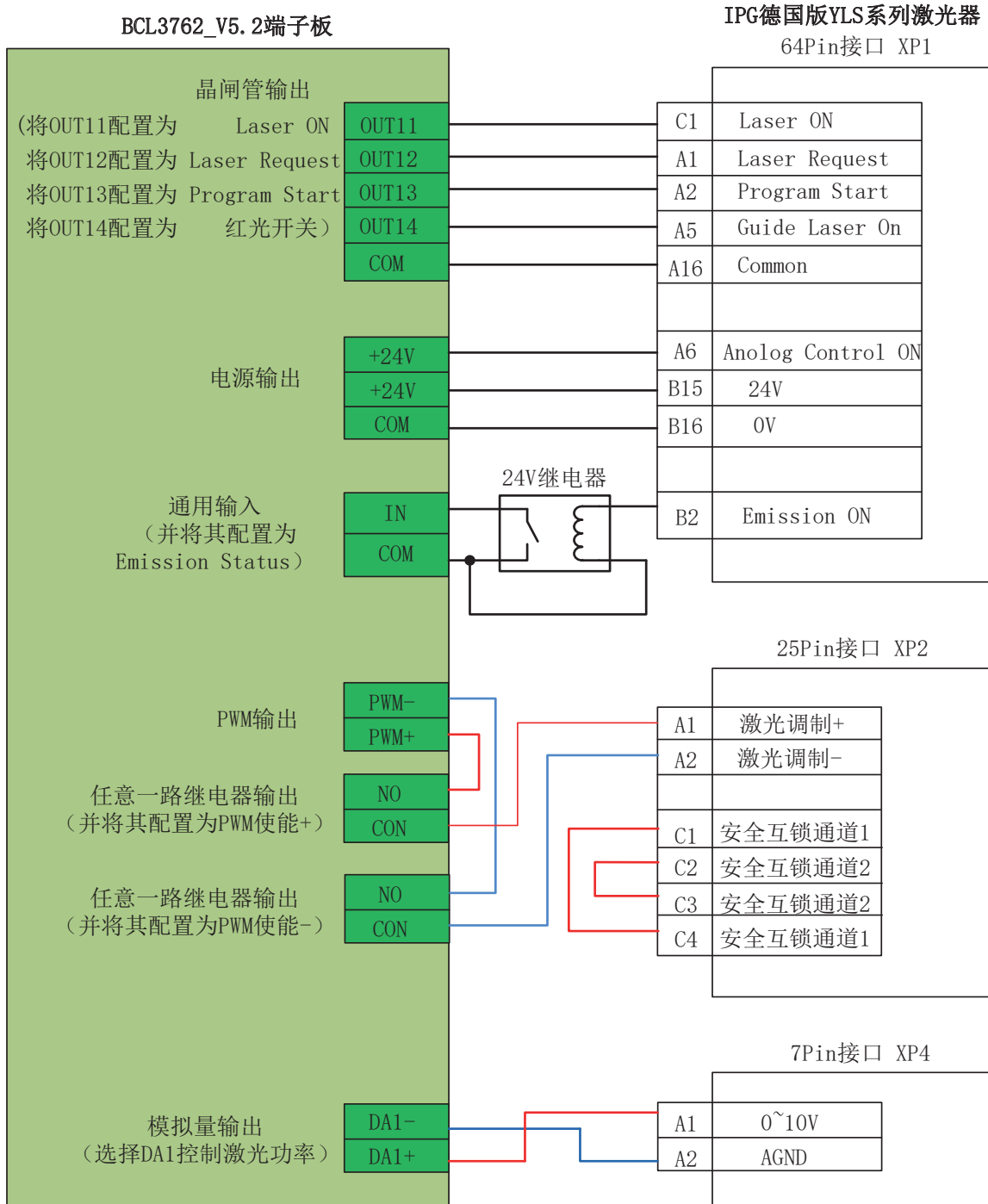
Here Nanjing Optical Valley Nuotai NT-2000SM CO2 FAF laser is included as an example, and lasers of other brands are similar

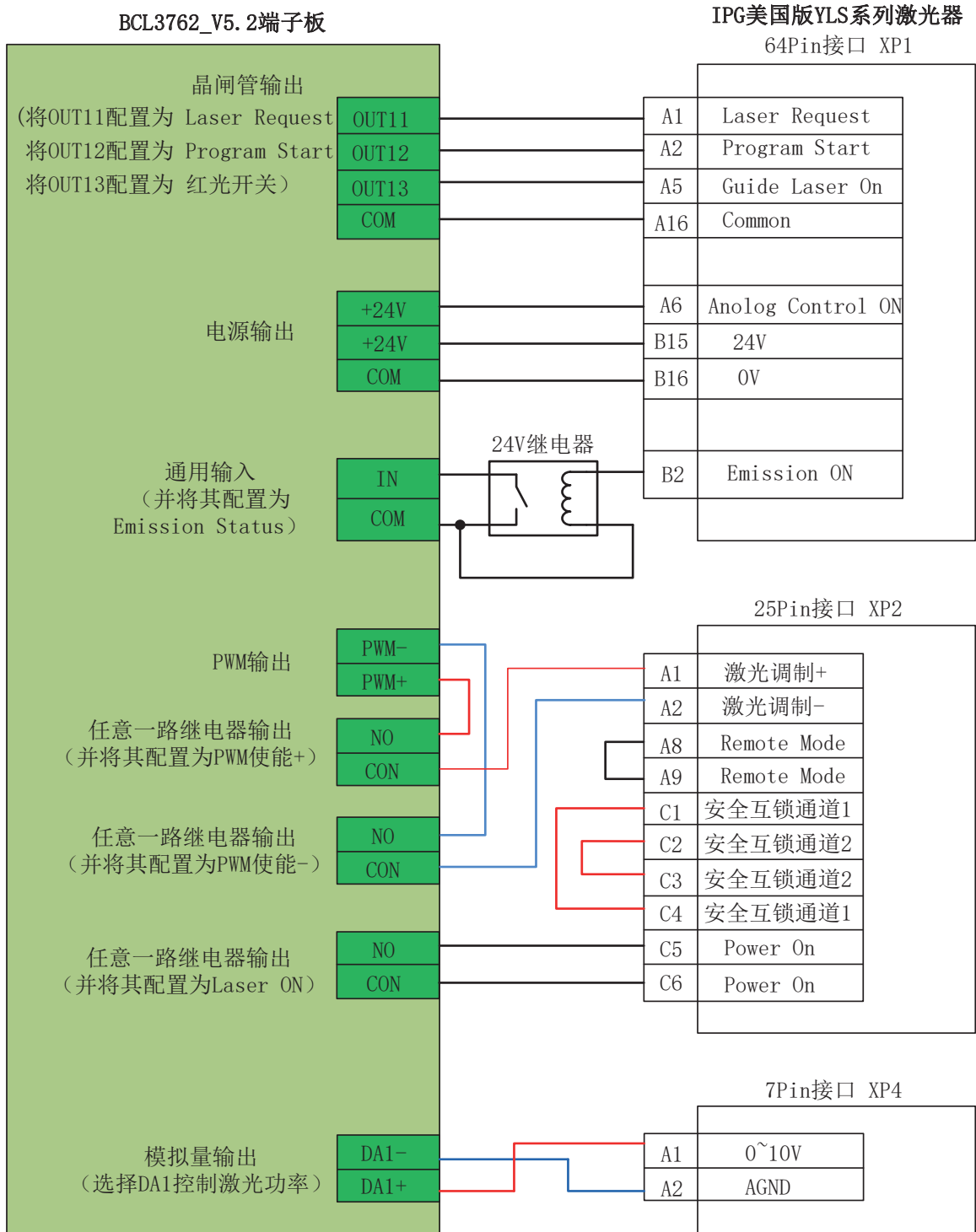


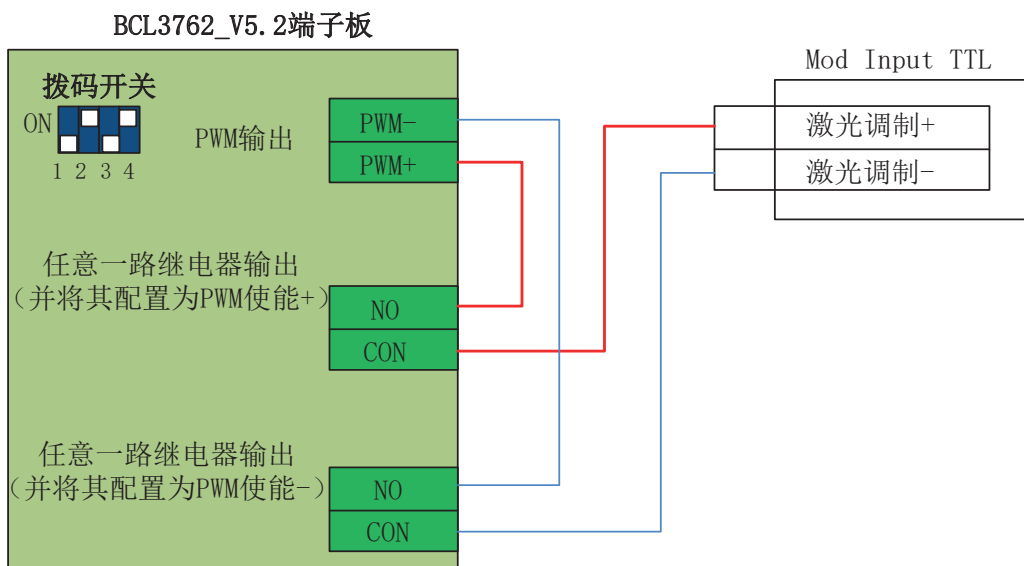
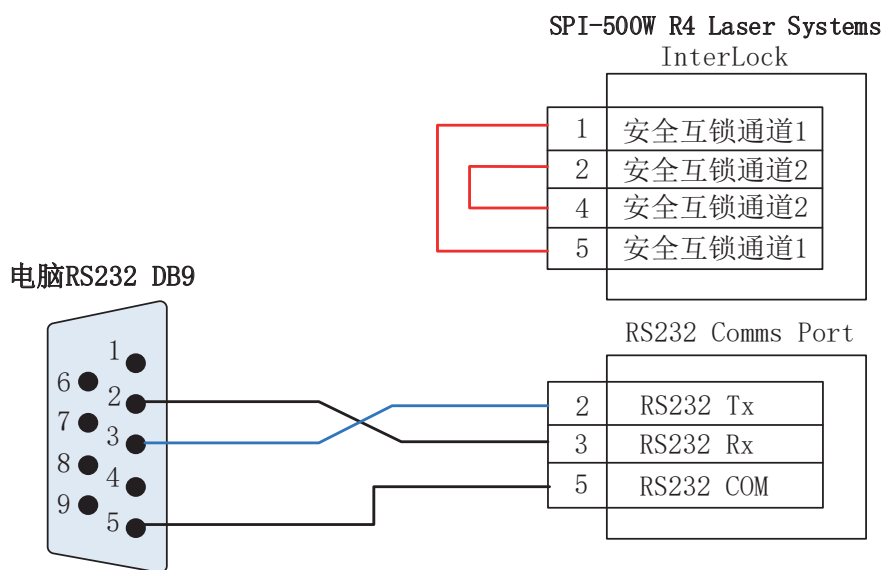
#### 3.3 Fiber laser connection

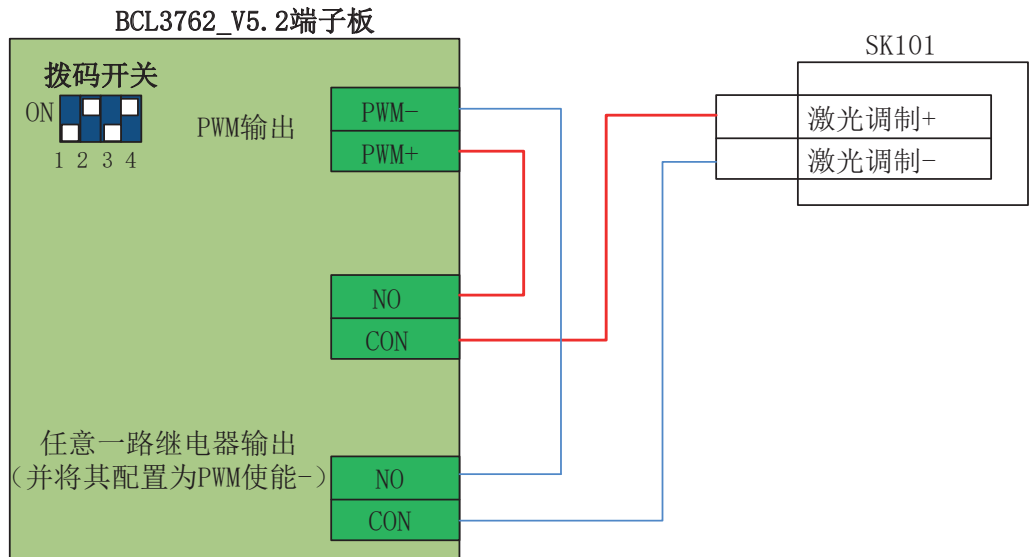
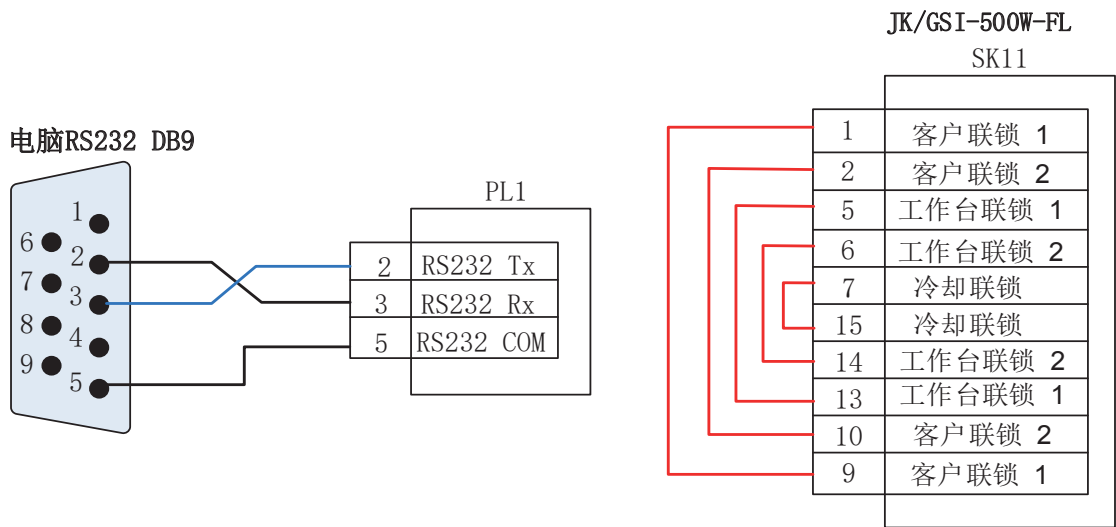
Here are some fiber lasers as examples, and lasers of other brands are similar.

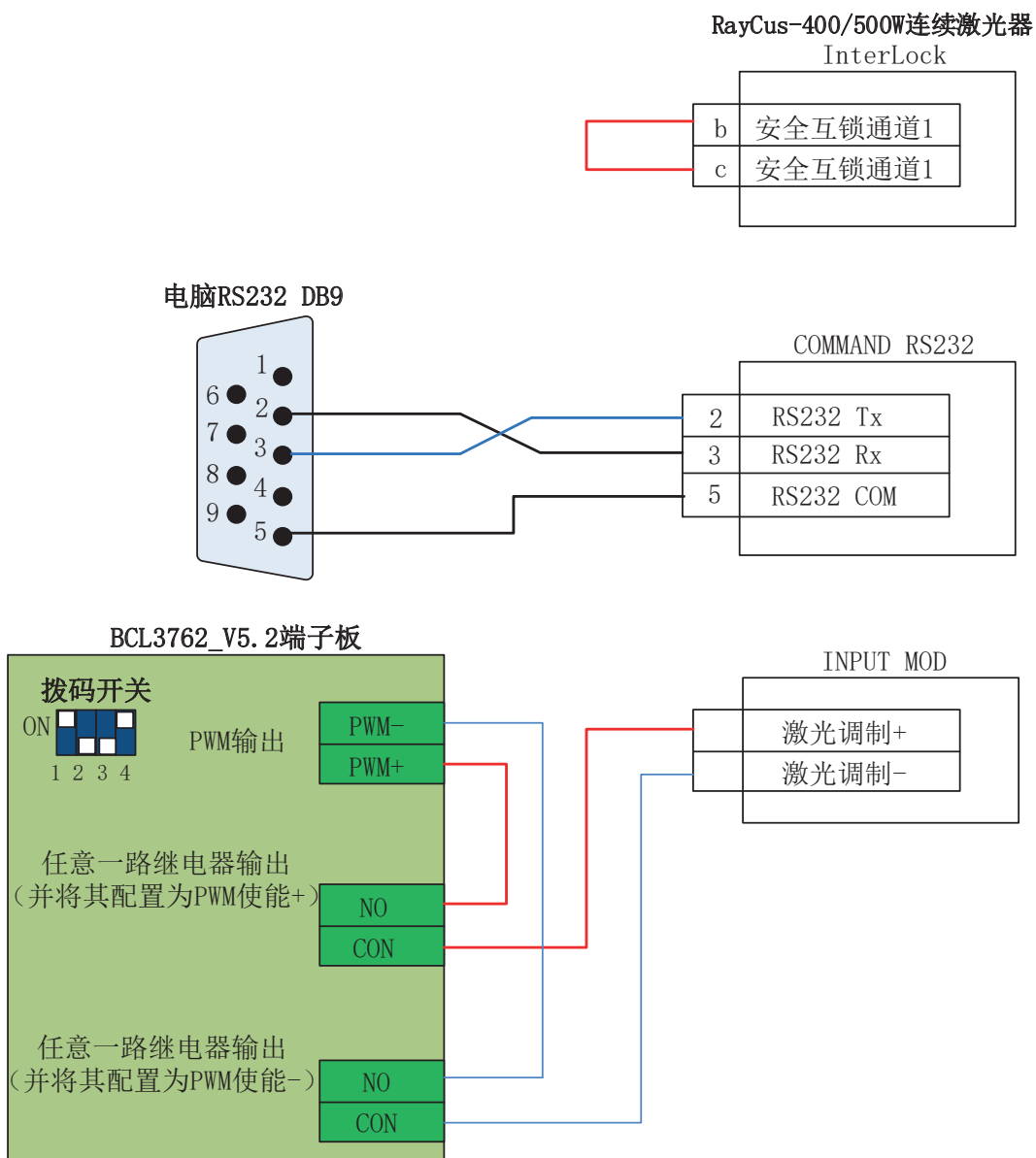


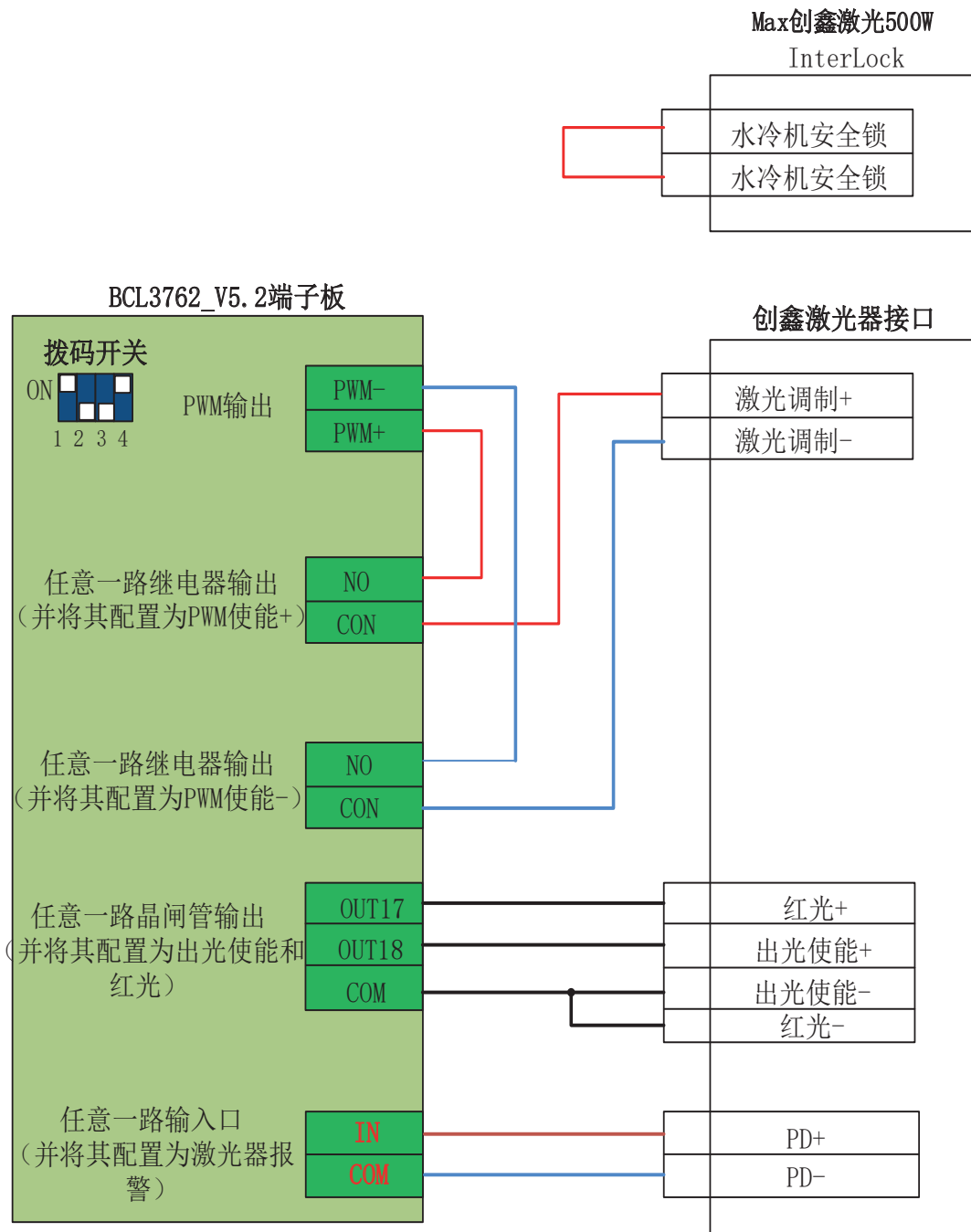












When the laser used supports remote control, such as serial interface or Ethernet, we strongly recommend that you connect remote control port (serial interface or Ethernet) and start the function. After starting remote control, CypCut software will monitor in real time laser and can operate laser by communication. Therefore, when you connect serial port, there is no need to connect analog quantity interface to control laser peak power.

**Notes:** Don't connect remote start button, especially when there is no good ground with laser, we don't recommend users connect remote start button, for it is





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easy to make laser breakdown.

#### **3.4 Points of serial connection for attention**


Considering from system stability, we suggest using network for communication of PC and laser. If using serial connection communication, please pay attention that case serial port connects and shielding layer must be ground connection.



## Chapter 4 Platform Configuration Tool

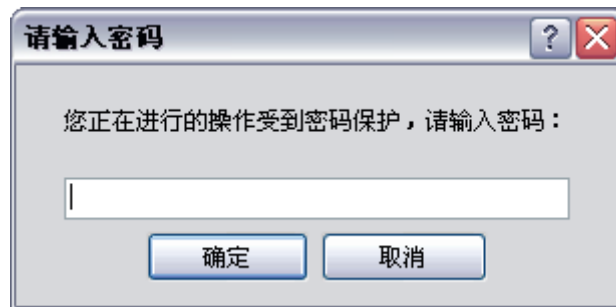
### 1 Installation and operation

When you install CypCut software, your default selection is platform configuration tool.

Click “start”- “all programs”- “CypCut software for laser cutting”- “platform configuration tool” (the icon is ) to operate platform configuration tool software. “CypCut software for laser cutting” in the path is name of software. Different customers have different software names.

### 2 Password Input

Before operate platform configuration tool, password box will appear as shown below:



Input correct password and click “OK”, and you can start platform configuration.

**Notes: users should do parameter configuration based on actual configuration of cutting platform and wrong configuration may lead to unpredictable consequence!**



## 3 User interface



Main interface of platform configuration tool is information overview; the left and the upper convenient buttons are for entering various parameters setting page; blue selected box as shown in the figure above is convenient button for controlling laser, and adjusting auxiliary gas. Click left “configuration files” button to locate Data file.

Double click information overview to enter into parameters setting page for current information, such as: double click “mechanical structure” to enter machine tool setting page.

Click “Open” button to open existing configuration files; Clicking “save” button is to save information.

**Notes: Data files include various configuration information of CypCut software.**



## 4 Mechanical structure configuration

### 机械结构

**X 轴配置：**

单边驱动     双边驱动

X轴行程范围：

X轴每运动  毫米对应  个脉冲

**Y 轴配置：**

单边驱动     双边驱动

Y轴行程范围：

Y轴每运动  毫米对应  个脉冲

**W 轴配置** 第三轴可作为旋转轴，使得设备同时具有平面切割和圆管切割的能力。

W与X轴形成插补关系     W与Y轴形成插补关系

圆管转动一圈对应  个脉冲

**速度限制：**

平面切割最大速度：     平面最大加速度：

圆管切割最大速度：     圆管最大加速度：

**螺距补偿：**

不补偿     仅补偿反向间隙     完整丝杆螺距补偿

**垂直度矫正**

空走一个正方形，输入边长和测量偏差。

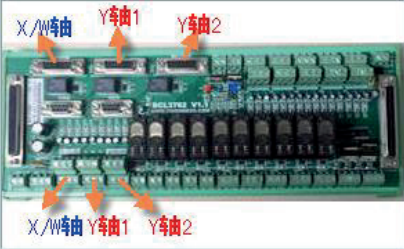
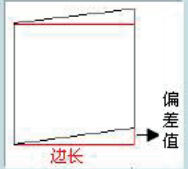
使能垂直度矫正

以Y轴为基准矫正X轴

以X轴为基准矫正Y轴

正方形边长：

偏差值：

Select drive mode for X axis and Y axis (single drive or double drive) based on mechanical structure and then configure information of rotation axis.

X axis range: width of rectangle on CypCut painting interface. After start soft limit protection, max range for X axis.

Y axis range: height of rectangle on CypCut painting interface. After start soft limit protection, max range for Y axis.

Pulse equivalent: pulse count sent for 1 mm motion. Count automatically by actual motion distance and pulse count, and millimeter value can be set as four digits after the decimal point.  $\text{Pulse equivalent} = \text{pulse count} / \text{millimeter value}$ .

Rate limitation: limit max speed and acceleration for CypCut software.

Pitch Compensation: error compensation for lead screw.

Verticality correction: when installation of X axis and Y axis is not 90°, the deviation can be eliminated through “Verticality correction”.



## 5 Back to the origin configuration

**回原点**

X轴回原点方向： 负向  正向      Y轴回原点方向： 负向  正向

回原点采样信号： 原点  限位      行程开关逻辑：

使用Z相信号： 使用Z相信号

粗定位速度：      回退距离：

精定位速度：

**使用限位开关回原点（不使用Z相信号）**

限位      粗定位过程      回原点过程

减速过程      返回距离      精定位过程

Origin direction: Different type can select different back to origin direction. Back to origin direction determines quadrant tool coordinate is in. For example, if X axis and Y axis select negative back to the origin, tool motion is in the first quadrant.

Sampled signal for back to origin: if users select limitation signal, origin switch can be replaced by limitation switch in the process of back to origin to realize coarse positioning.

Z direction signal: whether to use Z direction signal and sampled signal determines specific process of back to origin. The system will show a whole process on an image based on different back to origin way.

Coarse positioning speed: approach the origin fast and 10mm/s is recommended.

Fine positioning speed: approach the origin fast and 50mm/s is recommended.

Rollback distance: a distance for back in the motions of back to origin can ensure distance of mechanical origin.

## 6 Laser configuration

CypCut provides lasers for YAG, CO<sub>2</sub>, IPG, Raycus, and SPI and other fibers, and different fiber types correspond to different parameters.



## 6.1 YAG laser configuration

**激光器**

激光器类型：

YAG
  CO2
  IPG 光纤
  SPI光纤
  Raycus光纤
  GSI/JK光纤
  创鑫光纤
  Meiman

---

YAG激光器配置

激光输出口：

Laser output port: output port for setup switch laser.

## 6.2 CO2 laser configuration

**激光器**

激光器类型：

YAG
  CO2
  IPG 光纤
  SPI光纤
  Raycus光纤
  GSI/JK光纤
  创鑫光纤
  Meiman

---

CO2激光器配置

机械光闸：
                   应答输入：

电子光闸：

激光形式1：
                   激光形式2：

DA端口选择： 不使用
                    DA1
                    DA2

DA电压范围： 0~5V
                    0~10V

最小功率：

Mechanical shutter: output port for controlling mechanical shutter.

Electric shutter: output port for controlling electric shutter.

Response input: output port for response signal after mechanical shutter.

Laser form: set laser form as continuous wave, gate pulse and strong pulse through laser form 1 and laser form 2.

DA port: 1204 card provides 2 circuits of analog quantity and any circuit can control laser output power.

DA voltage range: analog quantity range for controlling pulse power.

Minimum power: minimum for pulse power.

## 6.3 IPG laser configuration



### 激光器

激光器类型：

YAG  CO2  IPG 光纤  SPI光纤  Raycus光纤  GSI/JK光纤  创鑫光纤  Meiman

PWM信号使能 +  PWM信号使能 -

DA端口选择： 不使用  DA1  DA2  BCS100-DA1  BCS100-DA2

DA电压范围： 0~5V  0~10V

IPG激光器配置：

IPG型号： YLR系列(400/500W)  YLS系列-德国版  YLS系列-美国版

使用远程启动按钮  
Start信号输出口：

使用串口控制IPG激光器  使用网络与IPG激光器通讯  
选择串口： IP地址：

忽略串口返回状态

PWM-enabled signal: select a relay output port as PWM-enabled switch, which can avoid laser leakage or wrong trigger under modulation mode.

DA port selection: 1204 card provides 2 circuits of analog quantity. Any circuit can control laser peak power. Don't use this port when using serial port or remote control.

IPG fiber laser configuration:

Remote start button:

After IPG fiber laser key switch selects remote control mode, start laser through remote start button. After selecting this function, signal output port is set corresponding to remote start button. (This function is not recommended, for it is easy to cause laser breakdown).

IPG remote control:

After starting IPG remote control, CypCut software will monitor laser in real time and operate laser through communication. Motions, such as Emission, Guide beam, Current, etc, are realized. After selecting this option, DA port will be not available.

IPG remote control provides serial port and network, so users can set serial port or network IP address based on actual condition. If communication of PC, laser and BCS 100 applies network communication, please don't repeat segment. For example, if heightening machine segment is 10.1.1.x, laser can set as 192.168.1.x. For system stability, network is recommended. If using serial port communication, case and shielding layer of serial port connector must be ground connection

If using beam provided by IPG laser, beam port of "Programmable Output/Input" cannot be set.



## 6.4 Raycus/SPI/GSI/JK laser configuration

**激光器**

激光器类型：

YAG  CO2  IPG 光纤  SPI 光纤  Raycus 光纤  GSI/JK 光纤  创鑫 光纤  Meiman

PWM信号使能 +  PWM信号使能 -

DA端口选择： 不使用  DA1  DA2  BCS100-DA1  BCS100-DA2

DA电压范围： 0~5V  0~10V

使用串口通讯  波特率：  调试模式

Except remote control, Raycus and SPI fiber laser as well as IPG fiber laser configuration supports serial port communication.

## 7 Heightening machine configuration

### 7.1 Use BCS100 network heightening machine

**调高器**

使用BCS100网络调高器

网络配置：

IP地址：

If using network heightening machine matched by the company (BCS100), please set IP address which should be as the same as the network address in the BCS 100 parameters.





## 7.2 Not use BCS100 network heightening machine

**调高器**

使用BCS100网络调高器

端口配置：  
以下端口“0”表示不使用。如果没有该信号请不要填写，否则可能导致逻辑错误。

开始跟随： 2

上抬/结束跟随： 0

停止/Hold： 0

点动上升： 0

点动下降： 0

跟随到位信号： 0 (输入)

到位信号电平： 低电平  高电平

CypCut also supports input/output to control heightening machine of other brands. Users can set it by themselves. Rise (close following) and stop (Hold). Output port for raise and decline and input port for following signal.

Start following: open the input port for following.

Raise/finish following: set (close following) output port for raise.

Stop/ Hold: Stop output port for Z axis motion.

Click to raise: manually control input port for Z axis raise.

Click to decline: manually control input port for Z axis decline.

Follow signal: collect input port for following.

Signal level: set effective mode for controlling level.

**Notes: if port is “0”, it means it is not available. If there is no this signal, please don't set randomly, or it may cause logical error!**

## 8 Auxiliary gas configuration

**辅助气体**

总控制阀： 5

空气开关： 0

氧气开关： 0

氮气开关： 0

开气延时： 0ms

使用高压阀、低压阀调节气压 (非连续)

使用比例阀调节气压 (0-10V连续)

DA1

DA2

BCS100-DA1

BCS100-DA2

Master control valve: set output port for auxiliary gas.

Air switch: set output port for air selection.

Oxygen switch: set output port for oxygen selection.

Nitrogen switch: set output port for nitrogen selection.



When users select BCS100 heightening machine, use any of 2 circuits of analog quantity provided by BCS100 to control proportional valve to adjust air pressure of auxiliary gas, and also select 2 circuits of analog quantity 1204 card to regulate air of auxiliary gas.

If selecting “use high-pressure valve, low-pressure valve to regulate air”, users can set input port and name of high-pressure valve and low-pressure valve.

使用高压阀、低压阀调节气压 (非连续)  
 使用比例阀调节气压 (0-10V连续)

低压阀配置：

名称	输出口
穿孔气阀	6

添加  
删除

高压阀配置：

名称	输出口
切割气阀	7

添加  
删除

默认气阀： 6

## 9 Alarm configuration

### 报警配置

伺服报警：  
 无效  常开  常闭

双驱轴位置偏差过大报警  
 允许偏差  脉冲  
 持续时间  毫秒  
 最大偏差  脉冲

急停按钮：  
 输入口：  
 无效  常开  常闭

自定义输入报警：

报警描述	端口号	电平检测		
气压报警	3	<input type="radio"/> 无效	<input checked="" type="radio"/> 常开	<input type="radio"/> 常闭
激光头碰撞报警	4	<input type="radio"/> 无效	<input checked="" type="radio"/> 常开	<input type="radio"/> 常闭

添加  
删除



### 9.1 Servo alarm

Inactive: not handle servo driver alarm.

Normally open: servo alarm signal is normally open and only alarm signal of a few drivers is normally open.

Normally closed: servo alarm signal is normally closed and the alarm signal of most of drivers is normally closed.

### 9.2 Encoder alarm

If X axis or Y axis in platform structure uses double drive, please set error alarm parameters of double shaft drive. If bilateral error reaches certain value (allowable deviation) and lasts some time (duration), the system will appear “ big deviation alarm of double shaft drive ” . If deviation value reaches instantly allowable maximum deviation value (maximum deviation), the system will immediately produce alarm.

### 9.3 Emergent stop button

Configure input port for emergent stop button, and here emergent stop is an input signal. If input port is active, emergent stop alarm will be produced.

### 9.4 Customized input alarm

Users can add other types of alarm in “customized input alarm” and input alarm name in alarm description. Select port number and level detection type corresponding to alarm. general customized alarms include lack-voltage alarm, excessive temperature alarm, laser head collision alarm, etc.

**Notes: all the alarm states will be automatically eliminated within 2 seconds after alarm signal elimination.**



## 10 general input

通用输入

功能	输入口	电平检测
开始/继续加工	1	<input type="radio"/> 无效 <input checked="" type="radio"/> 常开 <input type="radio"/> 常闭
停止	2	<input type="radio"/> 无效 <input checked="" type="radio"/> 常开 <input type="radio"/> 常闭

添加  
删除

Click “add” button, add   in input port configuration list. Users can select input port function name from drop-down list and corresponding input port, and don't repeat using input port which has been set.

Name	Instruction
Start/continue processing	Press the button:start processing; loosen the button:continue processing;
Laser contact	Press the button:open the laser; loosen the button:close the laser;
Open/close laser (self-locking)	Press the button:open the laser;press again:close the laser; loosen the button:no action;

## 11 general output

通用输出

红光：0  
加工指示：0  
报警指示：10  
出光指示：0  
除尘开关：0

分区域输出  
 使能分区域输出：3 行 2 列  
 请注意：修改行程范围或原点方向之后一定要重新设置分区域输出！

A 区域 → 输出1 点击选择

B 区域 → 输出3 点击选择

输出4 点击选择



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### 11.1 Output port configuration

Red Beam: set output port for beam switch.

Processing indication: after port configuration, corresponding indicator light will blink when processing.

Alarm indication: after port configuration, corresponding indicator light will blink during alarm.

Light indication: after port configuration, corresponding indicator light will blink during lightening.

### 11.2 Regional output

Regional output is mainly used for dust removal with machine. When laser starts, cutting head moves to area A (as shown in figure above), and corresponding “output port 1” of the area will open; if trace moves from area A to area B, “output port 1” will be closed immediately, and “output port 3” will open immediately.



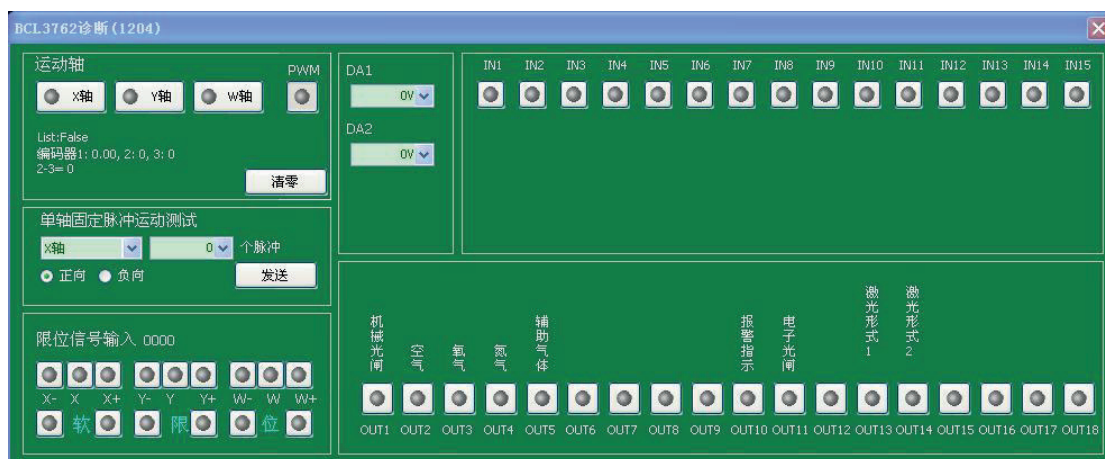
## Chapter 5 Electrical System Debugging

### 1. Power supply test

Connect C62-2 and C37-2 cables with terminal block and control card, and provide 24V power for terminal block. Before turn on system power, please confirm whether power connection is correct and whether positive and negative power is short circuit.

### 2. All the hardware signal test

Start computer and CypCut software. Click “file” in menu → “interrogation windows” .



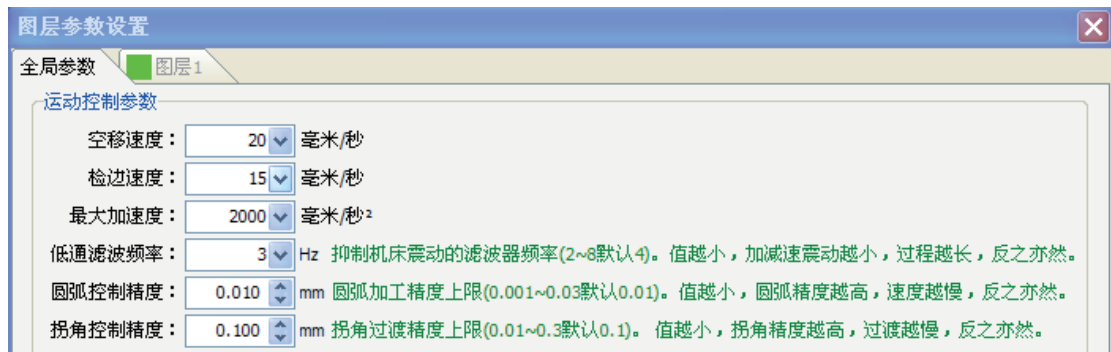
Please check in sequence positive/negative/origin switch of each axis, input signal, output signal, DA signal, PWM signal and servo-enabled signal.

For machines of double shaft drive, reset count value of encoders of two axes through **【reset】** button.

### 3. Basic motion test

First, set servo driver parameters as conservative values. Set the parameters of Cypcut as conservative values.

Parameter setting as shown below:



Maximum acceleration:2000mm/s<sup>2</sup>

Low-pass filter frequency:3Hz

Double-drive machines cannot connect with coupling and should try running. Direction of rotation and lead screw installing direction of electrical machines must be confirmed, and then install gate of the machine.

Use uniaxial to fix pulse movement test, and test whether the system pulse is set correctly.

#### 4. Cypcut basic functional test

Use control panel on the right of CypCut software to click manually, rise and fall floating head, switch gas, switch shutter, switch beam, laser fixed fire, and change fixed fire power. Confirm the system can control laser, heightening machine, gas, etc normally.



## Chapter 6 Movement Effect Debugging

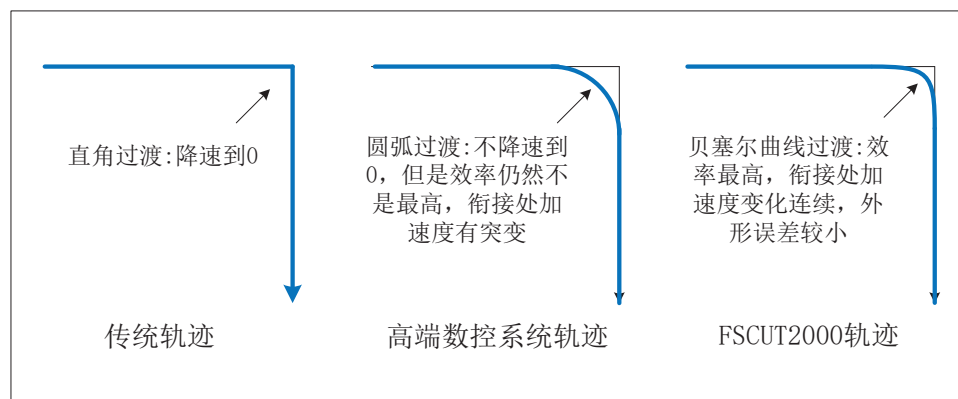
### 1. Debugging purposes

Confirm all the functions of the system are normal, start debugging and optimize movement effect. The purposes are: to debug several parameters of the system and to make machine tool cut with high speed and high precision based on safety.

### 2. FSCUT2000 motion control feature and function

#### 2.1 Turning smoothing

In order to meet high speed machining requirement, we apply Bezier curve transition method that is more efficient than arc transition method to handle speed of two adjacent motion vectors at turning. Transition curve precision will change with machining precision and graph outline. The handling of turning motion is similar to track drift of formula car, which can make machine reach the highest efficient turning within the range of performance, thus avoiding turning burning in hot working.



#### 2.2 Circular interpolation in high speed and high precision

During curve interpolation, consider fully load balancing of each axis. Automatically calculate speed, accelerated speed, and accelerated acceleration in each time of arc acceleration and deceleration based on target precision to perform circular interpolation at full speed.





传统方法:以轨迹上速度、加速度的矢量合成为控制目标。当圆弧曲率半径较小,目标速度较大时,没有考虑到轴的频繁换向以及三角函数形加减速的影响,导致X、Y轴分量力矩的急剧变化,从而使得加工精度下降

FSCUT2000:以X、Y轴上单轴的速度、加速度、加加速度为控制目标。均衡X、Y轴的负载,使得运动的升降速更平滑更高效。提高小圆加工的速度和精度

### 2.3 Bezier curve, NURBS curve direct interpolation

Directly perform arbitrary C3 continuous parameter circular interpolation and realize complex contour machining with higher speed and higher precision.

传统方法:把曲线拆分成多条微线段或圆弧段处理,丧失了很多原图的信息。加工速度和精度都有所限制。

FSCUT2000:充分考虑原图的1, 2, 3阶导数及图形特性。直接对任意C3连续曲线插补。实现更高速高精度的加工

### 2.4 Curvature optimization function

Handle micro-segment, PLT graph with curve smoothing, interpolation, matching, etc, and convert to C3 continuous curve machining.

传统方法:无优化

高端数控系统:单一的AKIMA或B样条插值方法

FSCUT2000:曲率优化功能是一个综合方法。会根据原图进行分析、综合。选择采用曲线平滑或者曲线拟合,以及采用Bezier曲线还是NURBS曲线。尤其擅长处理变形严重的PLT图形。



## 2.5 Smooth S acceleration and deceleration

Trapezoid acceleration and deceleration: sudden change with acceleration.

Traditional S acceleration and deceleration: acceleration trapezoid.

FSCUT2000 S acceleration and deceleration: acceleration N order derivative continuity.

## 3. Estimation of system load condition

Light-load: general ratio of inertias  $< 150\%$ , such as gear rack structure with reducer (reduction ratio is large enough).

Medium-load: general ratio of inertias  $150\% \sim 300\%$ , such as lead screw with reducer.

Heavy-load: general ratio of inertias  $> 300\%$ , such as lead screw without reducer.

## 4. Approximate extent of estimation

name	default	Light-load	Medium-load	Heavy-load
maximum acceleration(mm/s <sup>2</sup> )	2000	5000~8000	3000~5000	2000~3000
Low pass filter frequency	4	5~8	4~6	2~4
Circular control precision (mm)	0.01			
Turning control precision (mm)	0.1			

name of parameter	Meaning of parameter
maximum acceleration(mm/s <sup>2</sup> )	maximum acceleration of X axis and Y axis (achieve minimum)
Low pass filter frequency	System dynamic behavior. The more frequency, the bigger mechanical vibration, and bigger acceleration and deceleration as well as turning, and vice versa. We suggest setting it bigger without obvious mechanical vibration and shock.



Circular control precision (mm)	Bigger setting, faster circular and lower precision, and vice versa. This is not real precision.
Turning control precision (mm)	Bigger setting, faster turning and lower precision, and vice versa.

## 5. Servo debugging experience

### 5.1 basic requirement

The servo parameter debugging of this section is one of the available debug methods, and can be a model for new learners and reference for practitioners.

First, debuggers should be familiar with servo and can use professional servo software to debug servo. Panasonic servo comes with PANATERM testing software and Yaskawa servo comes with SigmaWin+ testing software. This can simplify debugging.

### 5.2 Panasonic servo debugging experience

STEP1: 【time feed forward constant gain】 parameter (Pr1.10) setting is 0%.

STEP2: open 【gain adjustment】 interface in PANATERM software. Open 【real time automatic adjustment】 function of target axis. Notes, if it is double shaft drive, all the servo parameters should be modified and parameters of two axes should be handled at the same to start movement.

STEP3: rigidity is set as conservative value. For example, it can be set as level 11 first. Then click to move this high-speed axis with Cypcut software. Observe whether axis is with abnormal sound and vibration, etc. Raise rigidity slowly. When the axis is with abnormal sound or vibration, level 1~2 should be declined to guarantee system stability. The final level should not be more than level 20.

STEP4: Close 【real time automatic adjustment】 .

STEP5: after rigidity of X axis and Y axis is tested, set rigidity level as the same level to guarantee response of two axes are the same. The smaller rigidity is standard. For example, X axis is level 19 and Y axis is level 16. Finally, set X axis and Y axis as level 16 and then remember to close 【real time automatic adjustment】 and save parameters.



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### 5.3 Yaskawa servo debugging experience

Yaskawa servo debugging is similar with the Panasonic. However, there is difference. The difference is that:

- Yaskawa servo double shaft drive cannot open advanced automatic tuning function and cannot calculate ratio of inertias.
- If you don't understand, we suggest closing Pn140 model tracking function.
- If you don't understand, we suggest closing Pn170 adjustment free function.
- If it is single shaft drive, we suggest advanced automatic tuning to optimize parameters.
- Yaskawa servo does not introduce rigidity and can set position loop gain, speed loop gain and speed loop integral based on Panasonic servo rigidity. The table is as below, and you should pay attention to unit and decimal point.



刚性	第 1 增益				第 2 增益				A4 系 刚性设定 (参考) *1
	Pr1.00	Pr1.01	Pr1.02	Pr1.04*2	Pr1.05	Pr1.06	Pr1.07	Pr1.09*2	
	位置环增益 [0.1/s]	速度环增益 [0.1Hz]	速度环积分时间常数 [0.1ms]	转矩滤波器 [0.01ms]	位置环增益 [0.1/s]	速度环增益 [0.1Hz]	速度环积分时间常数 [0.1ms]	转矩滤波器 [0.01ms]	
0	20	15	3700	1500	25	15	10000	1500	—
1	25	20	2800	1100	30	20	10000	1100	—
2	30	25	2200	900	40	25	10000	900	—
3	40	30	1900	800	45	30	10000	800	—
4	45	35	1600	600	55	35	10000	600	—
5	55	45	1200	500	70	45	10000	500	—
6	75	60	900	400	95	60	10000	400	—
7	95	75	700	300	120	75	10000	300	—
8	115	90	600	300	140	90	10000	300	0
9	140	110	500	200	175	110	10000	200	—
10	175	140	400	200	220	140	10000	200	—
11	320	180	310	126	380	180	10000	126	1
12	390	220	250	103	460	220	10000	103	2
13	480	270	210	84	570	270	10000	84	3
14	630	350	160	65	730	350	10000	65	4
15	720	400	140	57	840	400	10000	57	5
16	900	500	120	45	1050	500	10000	45	6
17	1080	600	110	38	1260	600	10000	38	7
18	1350	750	90	30	1570	750	10000	30	8
19	1620	900	80	25	1880	900	10000	25	9
20	2060	1150	70	20	2410	1150	10000	20	10
21	2510	1400	60	16	2930	1400	10000	16	11
22	3050	1700	50	13	3560	1700	10000	13	12
23	3770	2100	40	11	4400	2100	10000	11	13
24	4490	2500	40	9	5240	2500	10000	9	14
25	5000	2800	35	8	5900	2800	10000	8	—
26	5600	3100	30	7	6500	3100	10000	7	15
27	6100	3400	30	7	7100	3400	10000	7	—
28	6600	3700	25	6	7700	3700	10000	6	—
29	7200	4000	25	6	8400	4000	10000	6	—
30	8100	4500	20	5	9400	4500	10000	5	—
31	9000	5000	20	5	10500	5000	10000	5	—

#### 5.4 DELTA servo debugging experience

Delta servo debugging is similar with the Panasonic. The reference method is shown as follow :

- The parameter P2-00 KPP is the equal of the position loop gain of Panasonic. Though its unit is rad/s, it's same as 1/s actually. Such as the P2-00 KPP = 90, it's same as 900 of the position loop gain of Panasonic, because of the 10 times difference of their units.
- P2-02 FPG: the feed-forward setting is 0.

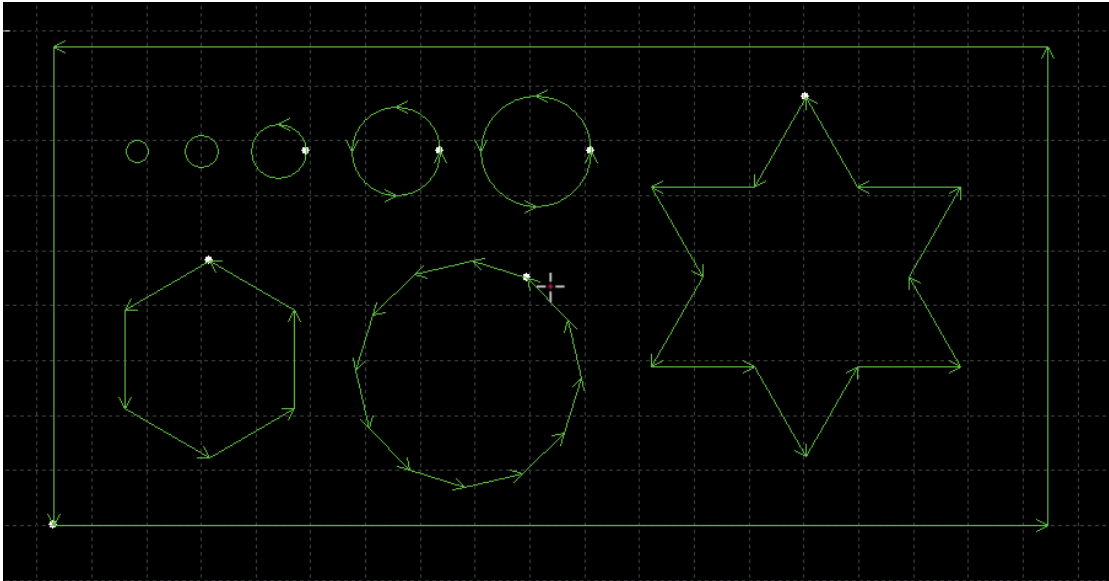


## 6. Parameter setting steps

### 6.1 Cut master drawing

Before parameter setting, cut a master drawing. We suggest turning down laser power and marking in steel plate. Observe precision of marking path.

Cutting master drawing includes small circle of various sizes, regular hexagon, regular dodecagon, star, rectangle, etc, for example as shown below:



### 6.2 Debug max acceleration and low pass filter frequency

First, set max acceleration and low pass filter frequency as estimated.

Set max acceleration, including:

- Servo output instant moment cannot be more than 120%
- Mechanical structure will not have deformation, vibration or non-linear effects with this acceleration. general lead screw acceleration is not more than 0.5G. Gear rack is not more than 0.9 G

Low pass filter frequency setting:

- When cutting rectangle, there will be no wave after turning

Based on experience, system shock= acceleration\*low pass filter frequency.

When setting, turn up and turning down acceleration and frequency. Don't turn up one value and turn down value. For example, acceleration is 8000 while low pass filter frequency is 3Hz. Set based on experience group below. Or when acceleration is determined, adjust low pass filter frequency in the range of two levels.

level	1	2	3	4	5	6	7	8	9
-------	---	---	---	---	---	---	---	---	---



maximum acceleration	1000	2000	3000	4000	5000	6000	7000	8000	9000
Low pass filter frequency	2	3	4	5	5.5	6	6.5	7	7.5

### 6.3 Debug circular precision and turning precision

If you don't satisfy circular precision, turn down circular precision parameter and at this time the processing of circular will be slow.

If you don't satisfy turning precision, turn down turning precision parameter and at this time turning will be slow. In order to avoid turning burning, we suggest turning up parameters during cutting carbon steel.



## Chapter 7 General Problems

### 1. How to debug flying cutting

In order to use flying cutting, the conditions below must be met:

- Cypcut version must be greater than 6.3.497, we suggest version 6.3.502 and above
- Need encoder of X axis and Y axis to feedback signal
- The system instructs that pulse equivalent and encoder feedback pulse equivalent of the axis must be the same. For example, each 1000 pulse moves 1 mm of X axis, so pulse feedback from encoder also needs to be 1000

### 2. Pulse equivalent setting skill

The system defines that pulse equivalent is the pulse count sent after 1mm movement.

The maximum pulse frequency of BMC1204 motion control card is 750 K, so the highest moving speed designed by the system is 1000mm/s, pulse equivalent of each axis should not be more than  $750K/1000 = 750$  Pulse/mm.

Besides, we suggest setting bigger pulse equivalent if allowed, and pulse sequence is more continuous. In high-speed laser cutting, don't set pulse equivalent below 200 Pulse/mm.

If convenient, set pulse equivalent of X axis and Y axis as the same, which is helpful to reduce stage error and to improve precision.

### 3. "Motion control card initialization fails" pops up when open Cypcut

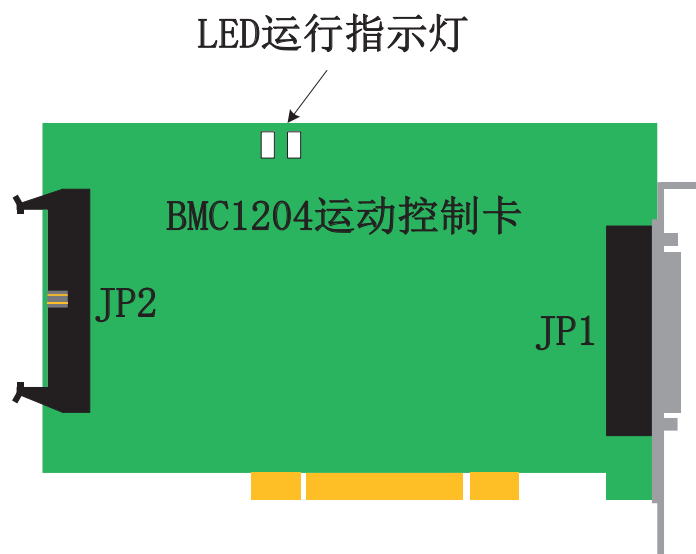
A. "desktop" of computer → "my computer" and right click → "attributes" → "device manager". Click "operation" → "Scan for hardware changes". See whether there is motion control card, as shown below:



If BMC1204 motion control card can be found in device manager, please try reopening Cypcut software

B. Observe that 2 small lights on top of BMC1204 is blinking. The position of lights is shown as below:





Status	Meaning	Solution
1 blink 1 blink	running normally	normal
1 blink 2 blink	not available	-
1 blink 3 blink	unsupported USB	replace USB flash disk to upgrade
1 blink 4 blink	FPGA BOOT data transmission error	use USB flash disk to upgrade
1 blink 5 blink	FPGA BOOT initialization error	use USB flash disk to upgrade
1 blink 6 blink	FPGA BOOT unable to complete	use USB flash disk to upgrade
2 blink 3 blink	ARM upgrade failed	use USB flash disk to upgrade
2 blink 4 blink	file system formatting error	back to repair

C. If LED is one flash and one flash (alternately flashes), BMC 1204 card is normal. Maybe PCI slot is bad contact. We suggest reinserting board card or replacing PCI slot after computer switches off.

#### 4. How to use USB flash disk to upgrade BMC1204

After Cypcut upgrades new functions, sometimes firmwares of BMC 1204 card will be upgraded. In the case of interference, static, etc, firmwares of control card may be lost. Using USB flash disk to upgrade is a fast and effective way. The steps as below:

STEP1: find a USB flash disk, formatting is FAT/FAT32.

STEP2: under Cypcut installation directory (default: C:/ ProgramFiles /Friendess /Cypcut), there is a drivers directory. Copy BMC.AFM and BMC.FFM to USB flash disk.

STEP3: unplug USB flash disk and turn off PC. Open rear cover of PC, insert USB flash disk into USB slot of BMC1204 card, and then turn on PC. At this time, BMC1204 card will upgrade automatically, in which LED will not blink. After



upgrade, the two LED will blink at the same time. It takes less than one minute to upgrade.

STEP4: unplug USB flash disk and turn off PC. Turn on PC .Please don' t restart computer directly.

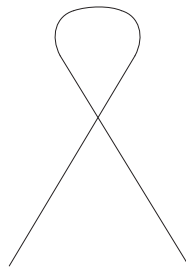
STEP5: after start PC, observe that whether LED is one flash and one flash (alternately flashes). If it is, it means upgrade is successful.

### 5. Slow graphics processing

In Cypcut, use node mode to observe this graphic. If nodes are too many and graphics consist of many micro-segments, please perform curve smoothing on graphics and then process them.

### 6. Turning burning

- If machine allows, improve low pass filter frequency and reduce time of acceleration and deceleration
- Properly increase turning precise parameters, and make high-speed smooth transition in sharp corner with Bezier curve
- Modify the mapping way,processing the circle overcut by the example as shown below.



- Modify power curve, lower laser power when lowering speed.

### 7. Laser not emitting light

#### A. Platform configuration

- ① determine correct laser (IPG large power has German version and American version)
- ② determine whether COM port is selected and is set with port number, or DA port and voltage range is selected correctly
- ③ PWM-enabled is in correct configuration

#### B. Measure output

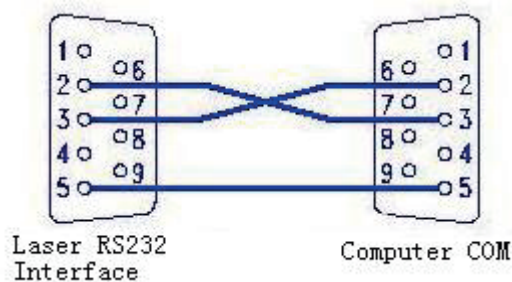
- ① in the interrogation window (file—interrogation window), corresponding DA and PWM is simulated to perform variable output. Use respectively multimeter to test whether DA of terminal block and PWM voltage have output and changes (PWM has output only when the light is bright). And then test whether DZ and PWM of laser have pressure drop;



- ② if pressure drop is obvious, please replace wire rod and do test again;
- ③ if there is no change, or there is incorrect change, please contact with our technician;

#### C. Connection

- ① Test whether connection of PWM, DA and serial port line is correct and break-over ;
- ② Serial port line RS232 is 2—3, 3—2, 5—5! 5 is earth wire, so good ground connection must be guaranteed;
- ③ Positive and negative of PWM and DA line must be connected correctly, and test break-over and whether they are disturbed seriously;



#### D. Laser

- ① Use the matching software coming with laser to do self-checking and to check light change, and to judge whether laser is working normally.
- ② if using serial port communication, don't open cutting software and communication software coming with laser: serial port can only be used by one program at the same time!
- ③ if there is no corresponding option for new laser, please contact with our technician.



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