

# Installation

## FSCUT6000 User Manual

Shanghai Friendess Co., Ltd.

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

Ver 1.2



## Table of Contents

Table of Contents .....	2
1. Overview .....	4
1.1. Introduction .....	4
1.2. System Diagram .....	4
1.3. Product Details .....	5
2. Wiring Instruction .....	8
2.1. BMC2282 Installation .....	8
2.1.1. Dimension Diagram .....	10
2.1.2. Installation Diagram .....	10
2.1.3. Ethernet Terminal .....	12
2.1.4. PCIE Socket .....	12
2.2. HPL2720E Wiring .....	13
2.2.1. Interface Layout .....	15
2.2.2. J01 EtherCAT Input Terminal .....	15
2.2.3. J02 EtherCAT Output Terminal .....	15
2.2.4. J03 Power Input Terminal .....	15
2.2.5. J04 PWM Output Terminal .....	16
2.2.6. J05 DAOutput Terminal .....	16
2.2.7. J06 Common Output Interface .....	16
2.2.8. J07 Common Input Interface .....	17
2.3. BCS100E Wiring .....	18
2.3.1. Interface Layout .....	19
2.3.2. J01 Power Input Terminal .....	20
2.3.3. J02 Sensor Input Terminal .....	21
2.3.4. J03/04 EtherCAT IN/OUT Terminal .....	21
2.4. Cutter Wiring .....	22
2.4.1. ProCutter Wiring .....	22
2.5. Laser Wiring .....	23
2.5.1. IPG_ YLS German .....	23
2.5.2. IPG American .....	24
2.5.3. Raycus .....	25
2.5.4. Trumpf .....	26
3. Installation .....	27
3.1. Installation Steps .....	27
3.1.1. Step 1. Install BMC2282 Control Card .....	27
3.1.2. Step 2. Install BMC2282 Driver .....	27
3.1.3. Step 3. Connect Slave .....	28



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3.1.4. Step 4. Scan in CypConfig .....	28
3.1.5. Step 5 Use CypCutPro .....	28
4. Precautions .....	29
4.1. Wiring Precautions .....	29
4.1.1. Drag Chain Wiring .....	29
4.1.2. Machine Tool Wiring .....	31
4.1.3. Assembly Requirements .....	33
4.2. Troubleshooting .....	33
4.2.1. Device Manager cannot find PCIe devices .....	33
4.2.2. Device Manager cannot install driver .....	34
4.2.3. Bus Scan failed .....	34
4.2.4. Bus network alarm .....	35



# 1. Overview

## 1.1. Introduction

FSCUT6000 is CNC system for laser cutting and is very cost-effective. It is based on EtherCAT bus technology and capable of motion control, laser control, and cutting gas control. It is common used in sheet metal, kitchen ware, lamps and such industries. This user manual is only for installation guidance.

## 1.2. System Diagram

FSCUT6000 includes the EtherCAT BMC2282 Control Card, the bus IO board, and the bus height controller, among which the BMC2282 control card integrates the EtherCAT master protocol stack.

The network cable is led out from the network port of BMC2282 and connected to the BLT cutting head. The wiring diagram is shown in Figure 1.

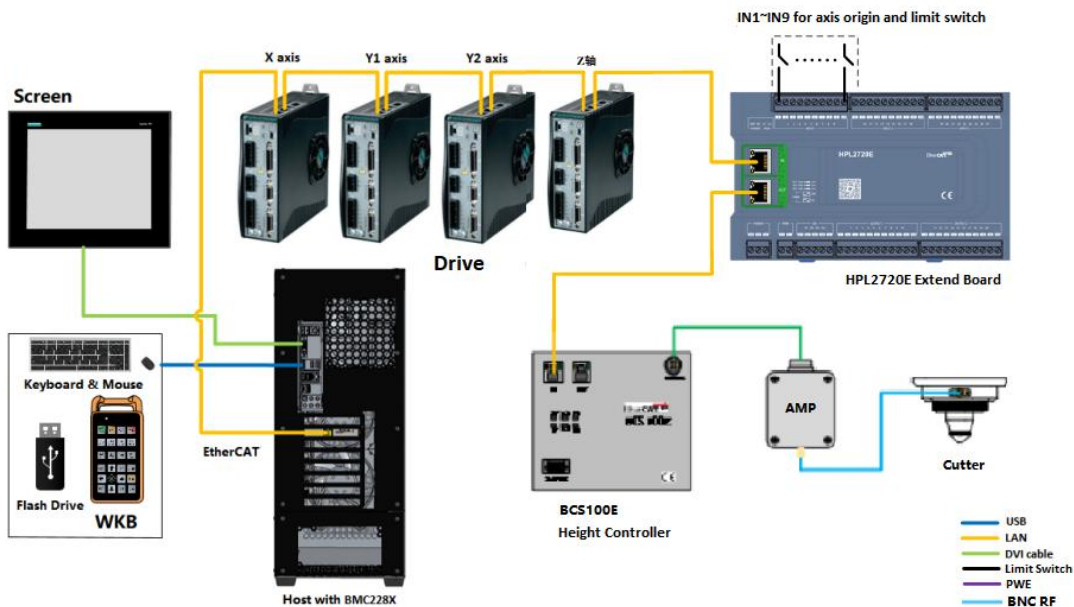


Figure 1 Wiring diagram of FSCUT6000 - BLT cutter



The wiring diagram of other cutting head is shown in Figure 2.

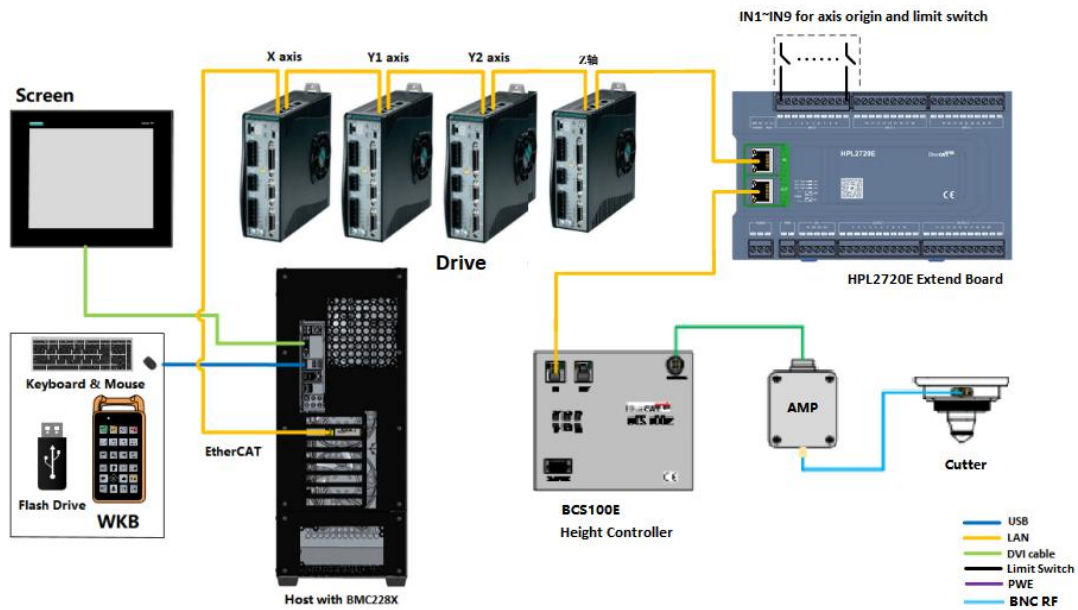


Figure 2 Wiring diagram of FSCUT6000 - other cutter

### 1.3. Product Details

FSCUT6000 EtherCAT CNC system includes BMC2282 Control Card, BCS100E terminal board or BCS210E height controller, HPL2720E, WKB V6 and related cables, etc.

FSCUT6000 packages contain hardwares and quantity that might be slightly different. Please consult Friendess customer support if any questions.



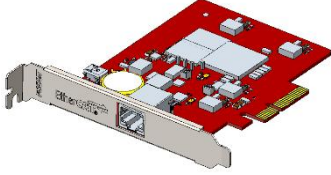





<p><b>BMC2282 Control Card</b> <b>(1)</b></p>	<p><b>BCS210E Motion Control</b> <b>(1)</b></p>	<p><b>HPL2720E Terminal Board</b> <b>(1)</b></p>
		
<p><b>WKB V6</b> <b>(1)</b></p>	<p><b>LAN-20X-PWE</b> <b>(1)</b></p>	<p><b>LAN Cables</b> <b>LAN-0 3X(3)</b> <b>LAN-1X (2)</b> <b>LAN-3X (1)</b></p>
		

Table 1-1 FSCUT6000-BLT cutter details



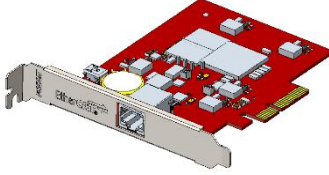







<p><b>BMC2282 Control Card</b> (1)</p>	<p><b>BCS100E Motion Control</b> (1)</p>	<p><b>HPL2720E Terminal Board</b> (1)</p>
		
<p><b>WKB V6</b> (1)</p>	<p><b>Amplifier</b> (1)</p>	<p><b>HC 4-core cable</b> (1)</p>
		
<p><b>LAN Cables</b> LAN-0 3X(4) LAN-1X (2) LAN-3X (1)</p>	<p><b>SPC RF cable</b> (2)</p>	
		

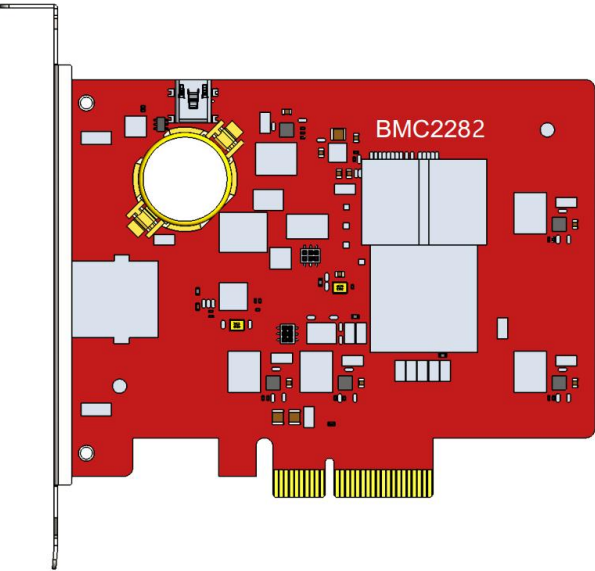
Table 1- 2 FSCUT6000-other cutter details



## 2. Wiring Instruction

### 2.1. BMC2282 Installation

BMC2282 Control Card is a motion control card based on the EtherCAT Its 1.0Ghz main chip provides excellent overall performance and has passed Friendess stringent testing standards.

<b>BMC2282 EtherCAT Control Card</b>	
<b>Bus Protocol</b>	EtherCAT Master Protocol
<b>PCI Express</b>	PCI Express2.0 (Gen2)
<b>Power Supply</b>	Powered by PCIe motherboard, max 12V/1A, no hot plug
<b>Anti-interference Level</b>	ESD 3 (6kV contact, 8kV air), EFT 4 (4kV power supply, 2kV signal), Surge international 2 (2kV AC line, 1kV DC line)
<b>Dimension and Weight</b>	
<b>Dimension</b>	(L x W x H) 127.6mm x121.0mm x21.45mm
<b>Weight</b>	80g
<b>Feature</b>	
<b>Cooling</b>	Nature Cooling
<b>Operating Environment</b>	0~+60℃
<b>Storage temperature</b>	-20~+70℃
<b>Humidity</b>	0% to 90% (non-condensation)
<b>Certification</b>	CE



**Environment Requirement**

The waterproof and dustproof grade of the Control Card is IP00, unprotected. Please place the computer in a clean, dust-free environment.

Table 2-1 BMX2282 Technical Data



### 2.1.1. Dimension Diagram

BMC2282 Control Card dimension ( mm) is shown in Figure 3.

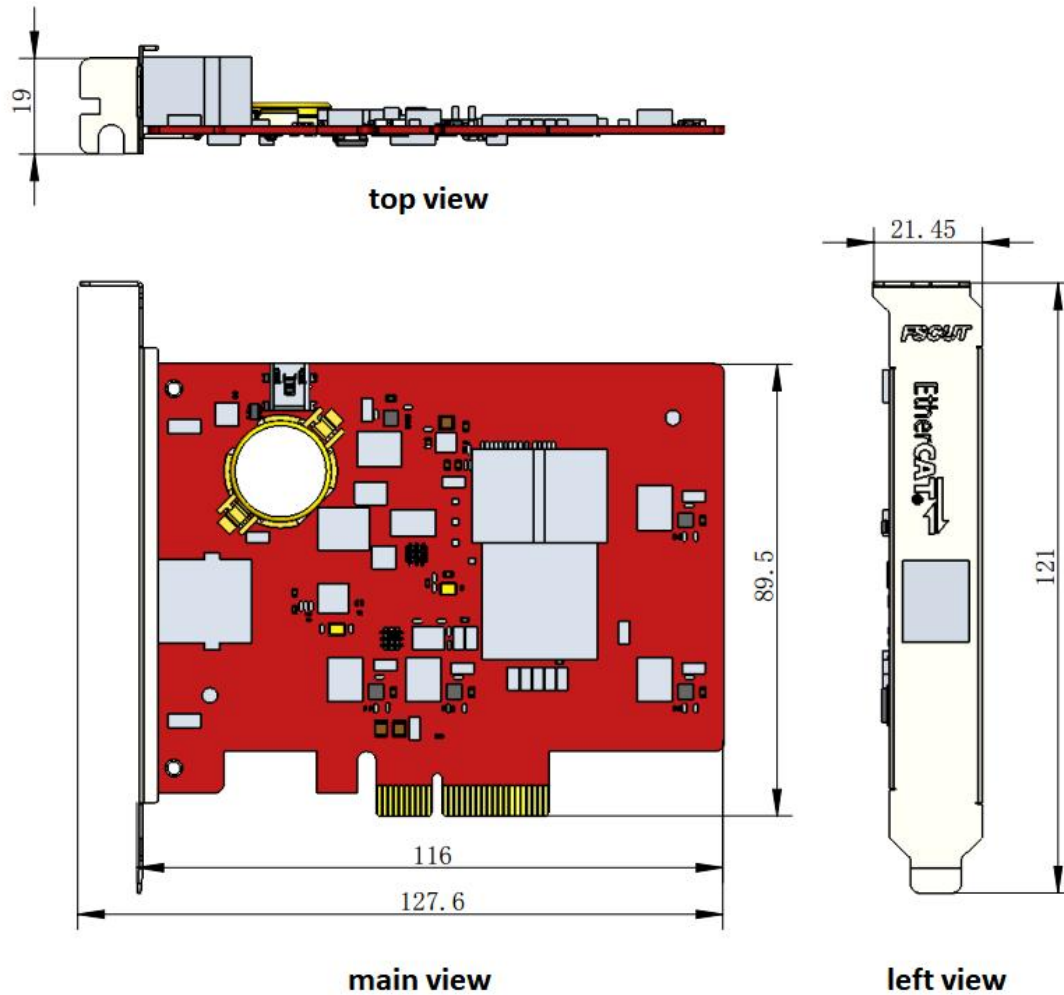


Figure 3 BMC2282 Dimension

### 2.1.2. Installation Diagram

Install BMC2282 in the socket of PCIE X4 and up with even force (refer to ②), and secure its blank screw (refer to ①). Be aware of the heat dissipation for BMC228X and keep it away from other cards as far away as possible. Refer to the diagram below.

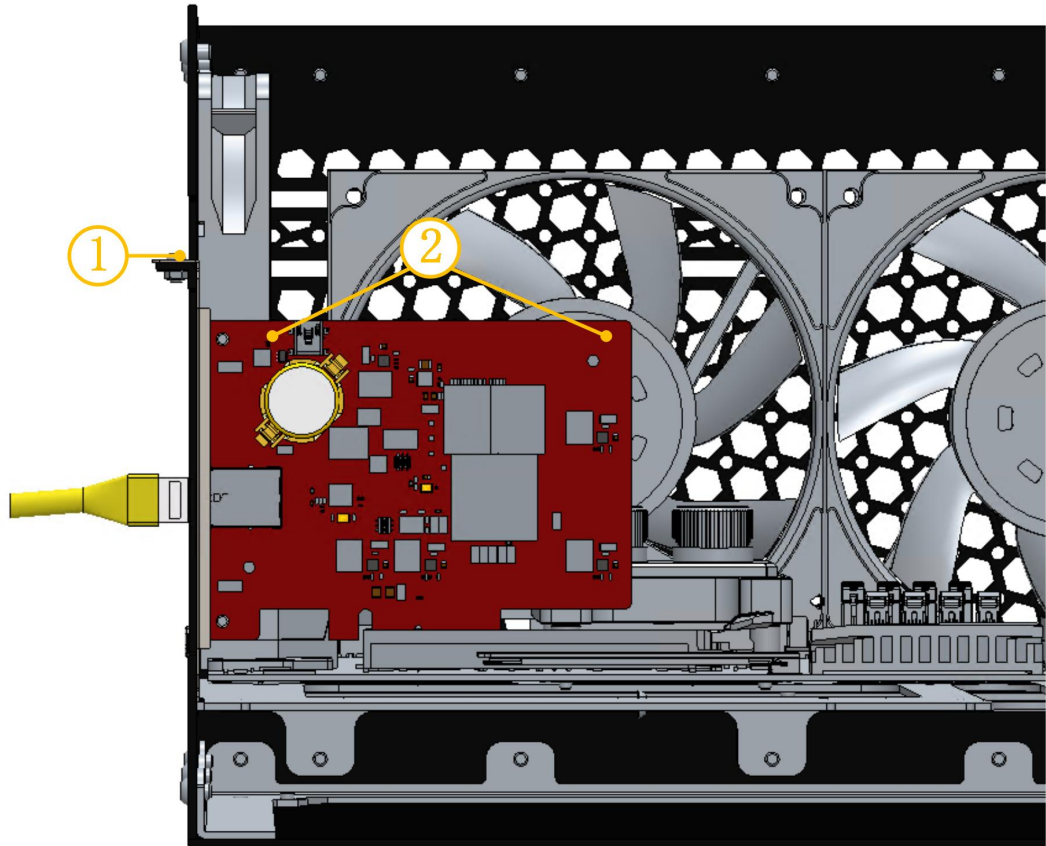


Figure 4 BMC2282 Control Card Installation

BMC228X installed is shown below.

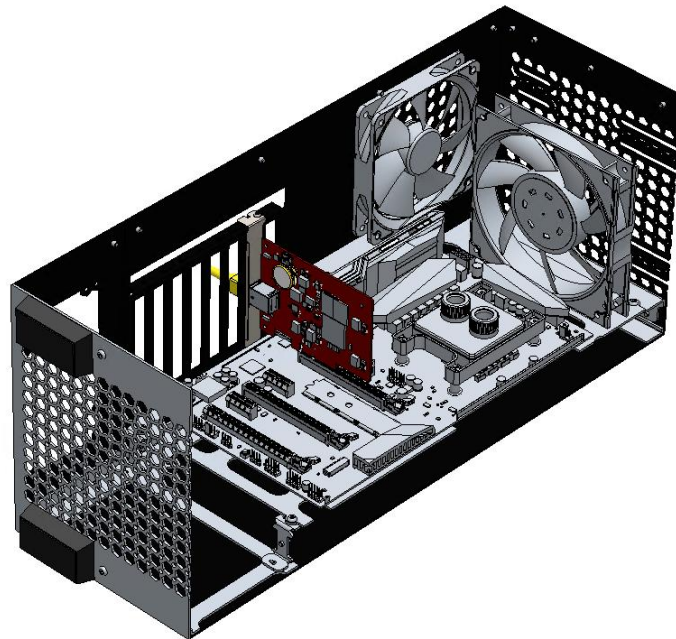
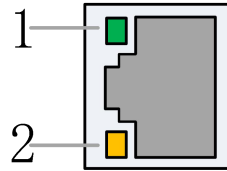


Figure 5 BMC2282 Control Card Installed



### 2.1.3. Ethernet Terminal

The standard socket of BMC2282 is RJ45 that can be used to connect EtherCAT slave devices(servo drives, BCS100E, HPL2720E, etc.)



Label	Description	LED color	State	Description
1: Speed	Ethernet connection speed	Green	Off	10 Mbps
			Solid	100 Mbps
2: Link	Ethernet link status	Yellow	Off	No connection
			Flashes	Communicating
			Solid	Connected

Table 2-2 Description of RJ45 connection status

### 2.1.4. PCIE Socket

BMC2282 PCIE socket is X4 (Figure 6①)and can be used for X4, X8, X16. Its PCI Express Protocol standard is V2.0 (Gen2) and the motherboard requirements are as shown in Table 2-3.

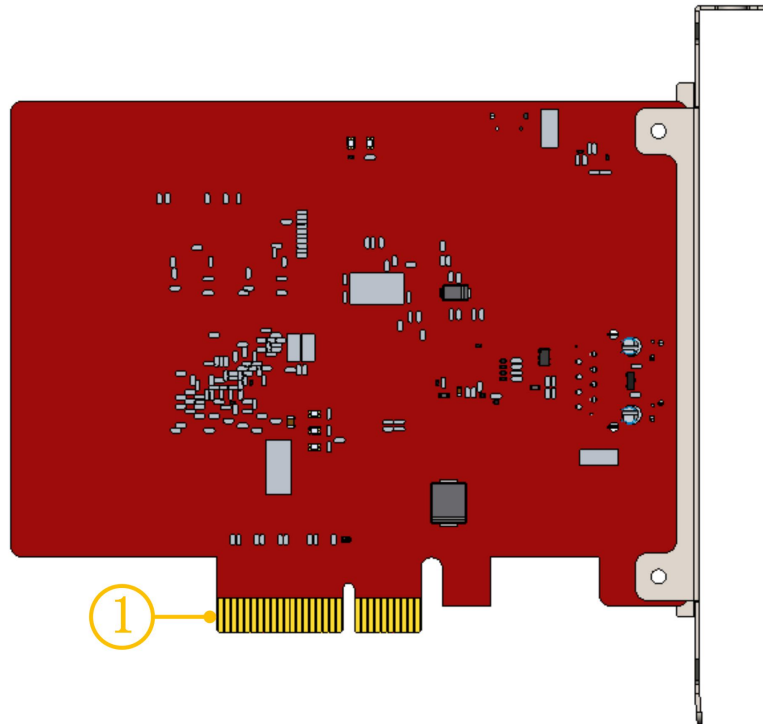


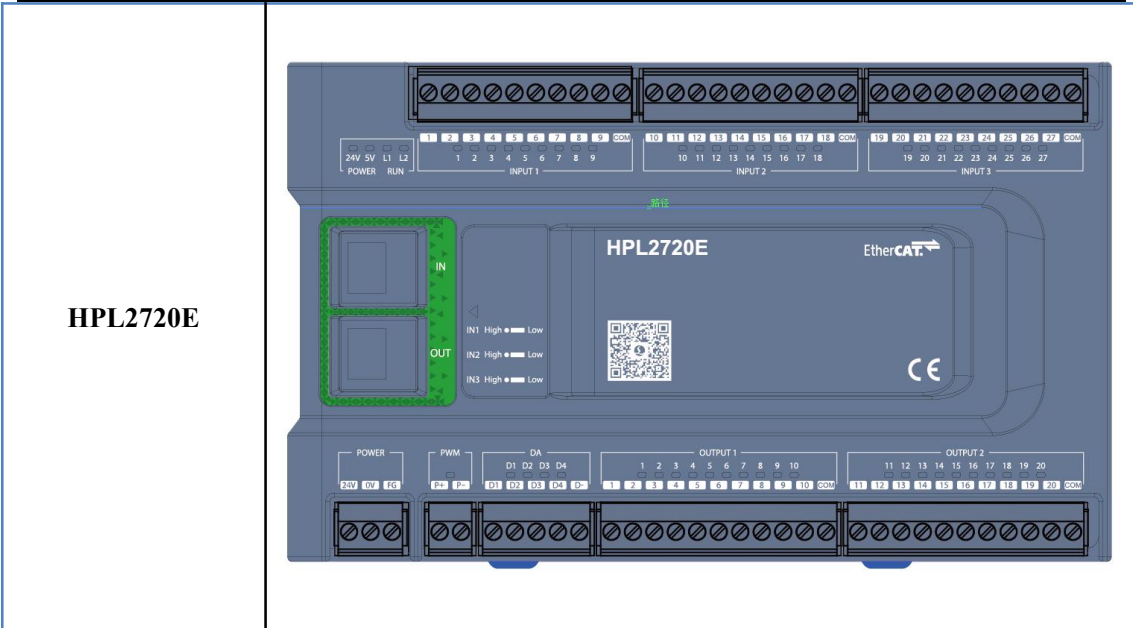
Figure 6 Gold Fingers

System	64-Bit Win7/10
CPU	Intel i3 8100 and up
Memory	4GB and up
PCIE Socket	X4 and up
PCI Express	PCI Express2.0 (Gen2) and up
Motherboard PCIE power supply	12V/1A and up

Table 2-3 Motherboard Requirements

## 2.2. HPL2720E Wiring

HPL2720E is an IO extend board based on the EtherCAT bus, which supports the peripheral resources required by the FSCUT6000 high-power cutting system, as shown in Table 2-4.



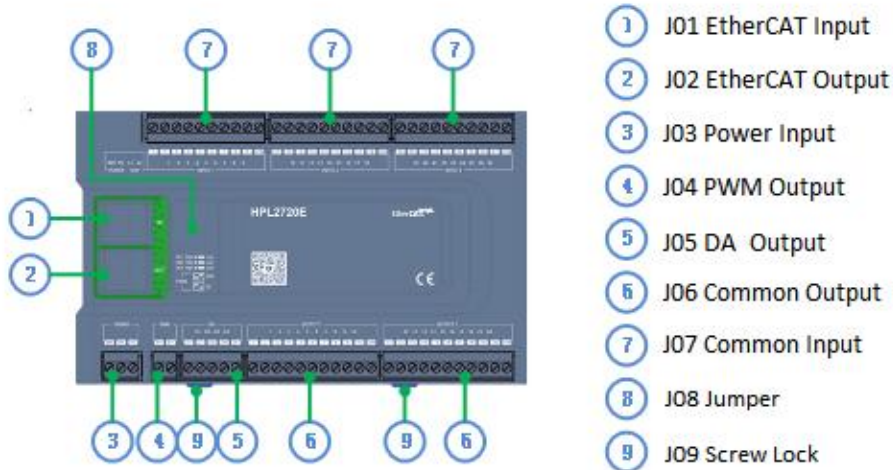
Module	Qty	Description	Note
Power Supply	/	24V DC/5A	
PWM	1	24V, $\pm 50\text{kHz}$ 0.3%	Max 50kHz,3%
DA	4	0-10V, 12bit, $\pm 20\text{mV}$	
Common Output	20	High level 24V output, $\leq 0.7\text{A}$ per channel The total current output $\leq 2.5\text{A}$	External relay recommended
Common Input	27	24V level, active low ( $<15.6\text{V}$ ); IN1~IN3 can be switched to active high ( $>5.8\text{V}$ )	
Working Environment	Temperature: $0\sim 60^{\circ}\text{C}$		
	Humidity: 10%~90% (no condensation)		
Dimension	195×118×45.2mm		
Weight	480g		

Table 2-4 HPL2720E Hardware Resources



### 2.2.1. Interface Layout

The interface layout of the HPL2720E terminals is shown in the figure below.



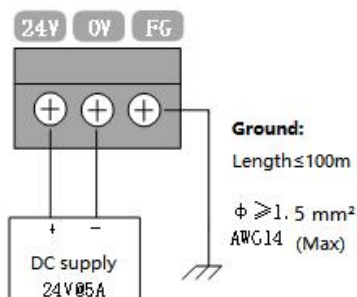
### 2.2.2. J01 EtherCAT Input Terminal

EtherCAT network cable input interface, standard RJ45 network cable;

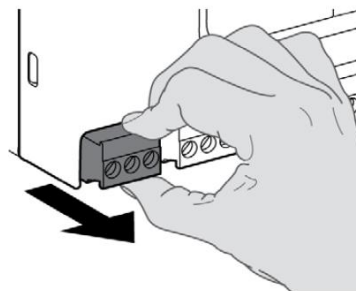
### 2.2.3. J02 EtherCAT Output Terminal

EtherCAT network cable output interface, standard RJ45 network cable;

### 2.2.4. J03 Power Input Terminal



How to remove power terminal block:



Notice

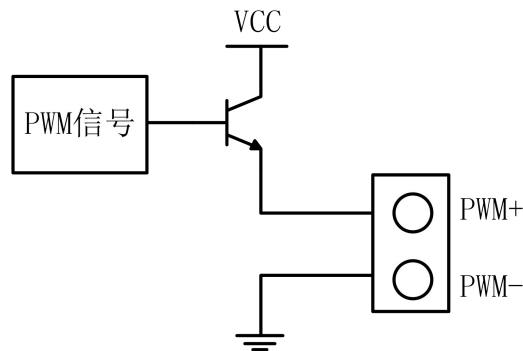
- 24V and 0V are respectively connected to the positive and negative poles of the DC 24V switching power supply; FG needs to be reliably connected to the ground, and the ground wire should be as short and thick as possible.
- All terminals are pluggable only, and disassembly is shown in the right figure above. There is no need to unplug the terminals for wiring.



### 2.2.5. J04 PWM Output Terminal

HPL2720E has a PWM pulse width modulation signal, which can be used to control the laser power. The PWM signal level is 24V. The duty cycle is continuously adjustable from 0% to 100%, and the max carrier frequency is 50KHz.

The signal output mode is shown in the figure below.



**Note: The P+ and P- signals have enabled solid-state relays inside, and no external relays are needed for isolation!**

### 2.2.6. J05 DAOutput Terminal

HPL2720E has 4 analog outputs of 0~10V. The four-way DA can be configured as the control signal of laser peak power and gas proportional valve in the "CypConfig" that comes with CypCutPro software.

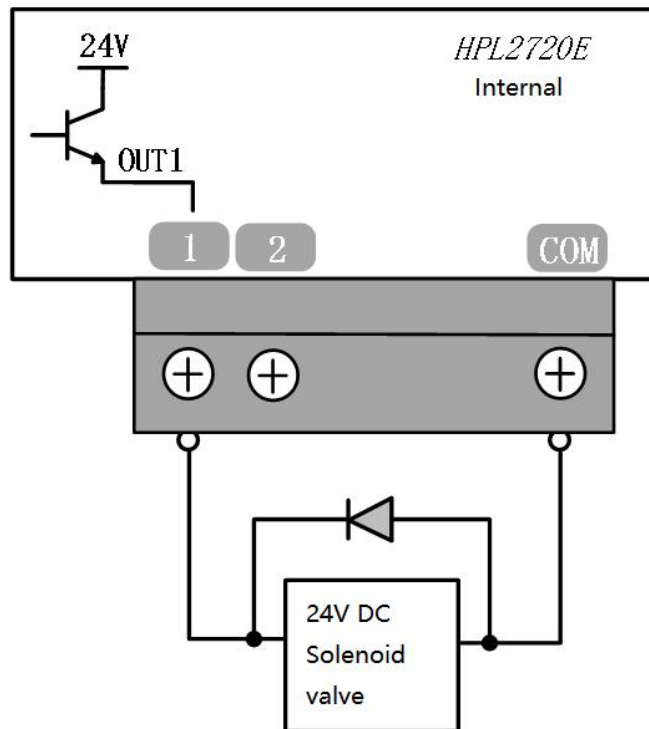
Output Signal	0~10V
Max Output	50mA
Max Error	+/-20mV
Resolution	2.7mV
Conversion	400us

Table 2-5 DA Output Parameter

### 2.2.7. J06 Common Output Interface

OUT1~OUT20, total 20 high-level 24V outputs. In the "CypConfig" that comes with CypCutPro, the output port can be configured as "height controller", "laser", "cutting head", "auxiliary gas", "alarm", "pallet changer" and other related controls interface.





**Note: Only DC loads can be connected, the output current of each channel must be  $\leq 0.7A$ , and the total current of the output port must be  $\leq 2.5A$ , otherwise the short circuit protection will be triggered.**

**If you need to connect to an AC load, please connect an external relay;**

### 2.2.8. J07 Common Input Interface

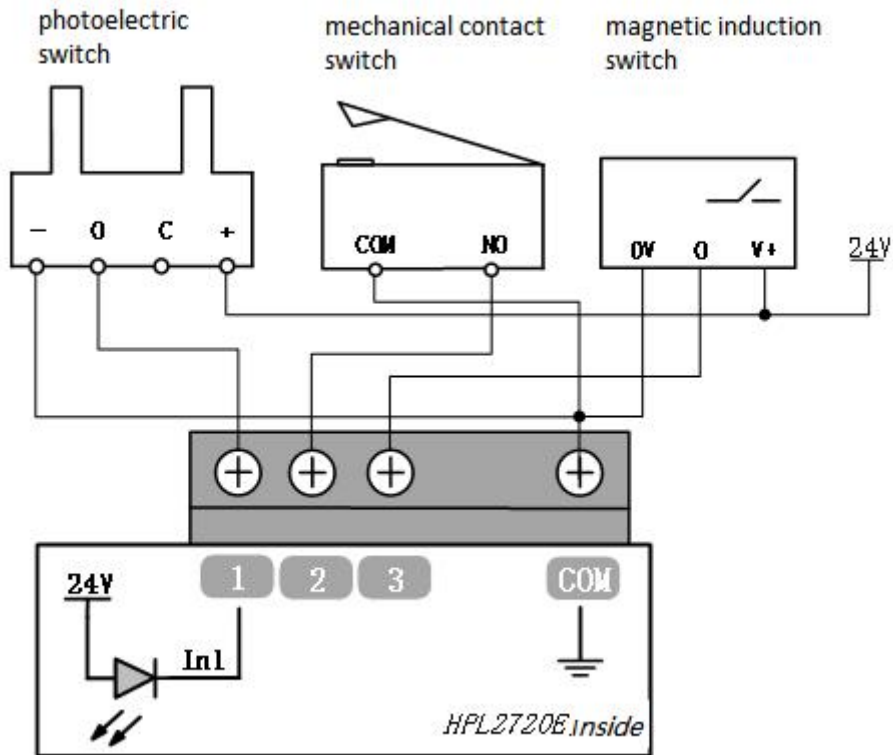
HPL2720E does not set a dedicated input, and each input port can be set as limit/origin signals.

The Normally Open and Normally Closed modes of the limit and origin signals can be set in the "CypConfig" that comes with CypCutPro. When it is set to NO, the input is valid when the input port is connected to 0V; when it is set to NC, the input is valid when it is disconnected from 0V.

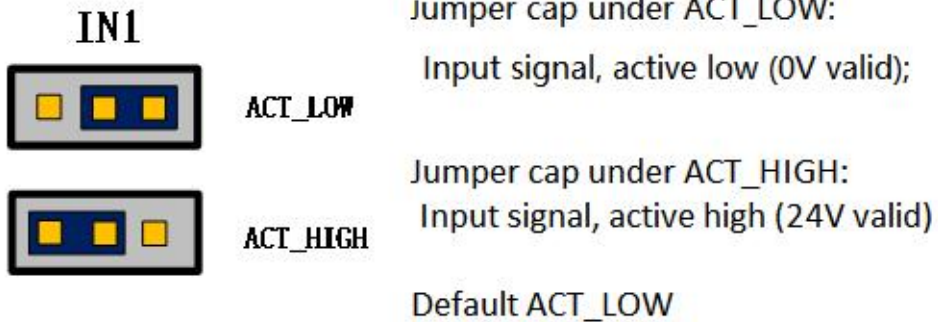
The typical connection of the photoelectric switch is shown in the figure below, and an NPN type 24V photoelectric switch must be used;

The typical connection of mechanical contact switch is shown in the figure below;

The typical connection of the magnetic input switch is shown in the figure below. An NPN 24V magnetic induction switch must be used.



Among them, IN1~IN3 can adjust the polarity of the effective level through hardware jumpers:



### 2.3. BCS100E Wiring

The BCS100E bus height controller uses the EtherCAT bus to control the laser cutting capacitive follower. It is a high-performance capacitive height controller.

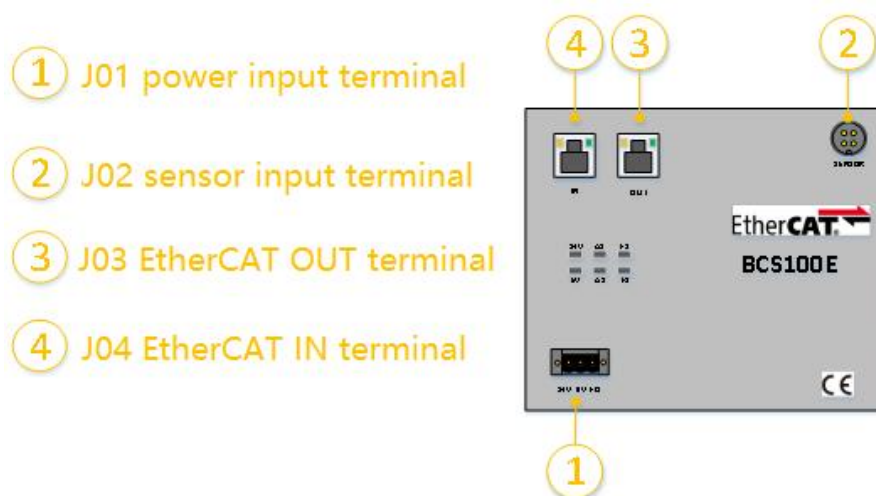


<b>BCS100E Height Controller</b>		
Module	Qty	Description
Power Supply	/	24V DC/1A
LAN port	2	EtherCAT slave network port, 100Mbps, left in and right out
Sensor interface	1	Capacitance detection control, height control range 0~25mm
Working Environment	Temperature: 0~60°C	
	Humidity: 10%~90% (no condensation)	
Dimension	136mm×123×34mm	
Weight	/	

Table 2-6 BCS100E Technical Data

### 2.3.1. Interface Layout

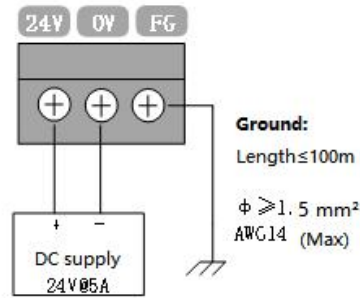
The interface layout of BCS100E is shown in the figure below.





### 2.3.2. J01 Power Input Terminal

The power terminal is connected to the positive and negative poles of the DC 24V switching power supply to supply power to the BCS100E controller. FG needs to be reliably connected to the ground, and the ground wire should be as short and thick as possible. The reliable grounding of the screen shell can not only improve the stability of the system, but also prevent the screen or interface from being damaged due to external static electricity or surge.



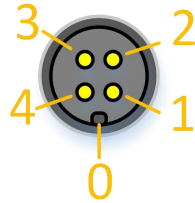
Pin	Note
FG	Shielding cover (internal short circuit with 0V)
0V	Power ground
24V	24V power positive

Table 2-7 J01 Power Input Terminal



### 2.3.3. J02 Sensor Input Terminal

J02 is the wiring port of the capacitive sensor. Through connecting four-core aviation plug-in wire, it is connected to Friendess AMP to monitor the real-time capacitance.



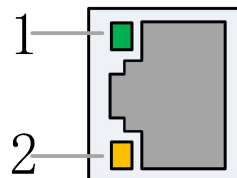
The signal definition table of the interface is as follows.

Label	Description
0	The mechanical fool-proofing of the terminal ensures that the signal transmission cable is connected correctly.
1	Power Supply
2	Sensor signal
3	Sensor signal ground
4	BCS100E processing circuit ground

Table 2-8 J02 sensor input terminal connection status

### 2.3.4. J03/04 EtherCAT IN/OUT Terminal

J04 is the EtherCAT LAN cable output interface, and J03 is the EtherCAT LAN cable input interface. Both are connected to standard RJ45 LAN cables for bus communication.



Label	Description	LED Color	State	Description
1: Speed	EtherCAT Bus Connection speed	Green	Off	10 Mbps
			Solid	100 Mbps
2: Link	EtherCAT Bus Link Status	Yellow	Off	No connection
			Flashes	Communicating
			Solid	Connected

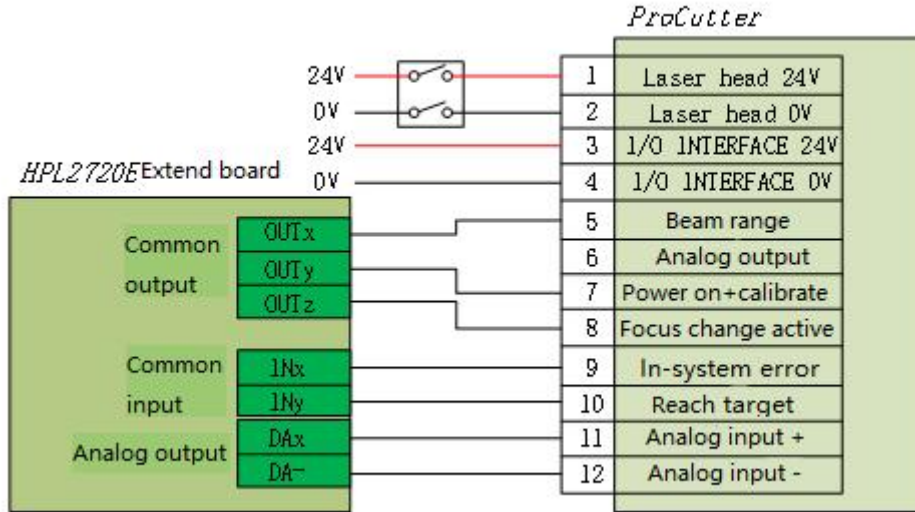
Table 2-9 RJ45 connection status



## 2.4. Cutter Wiring

### 2.4.1. ProCutter Wiring

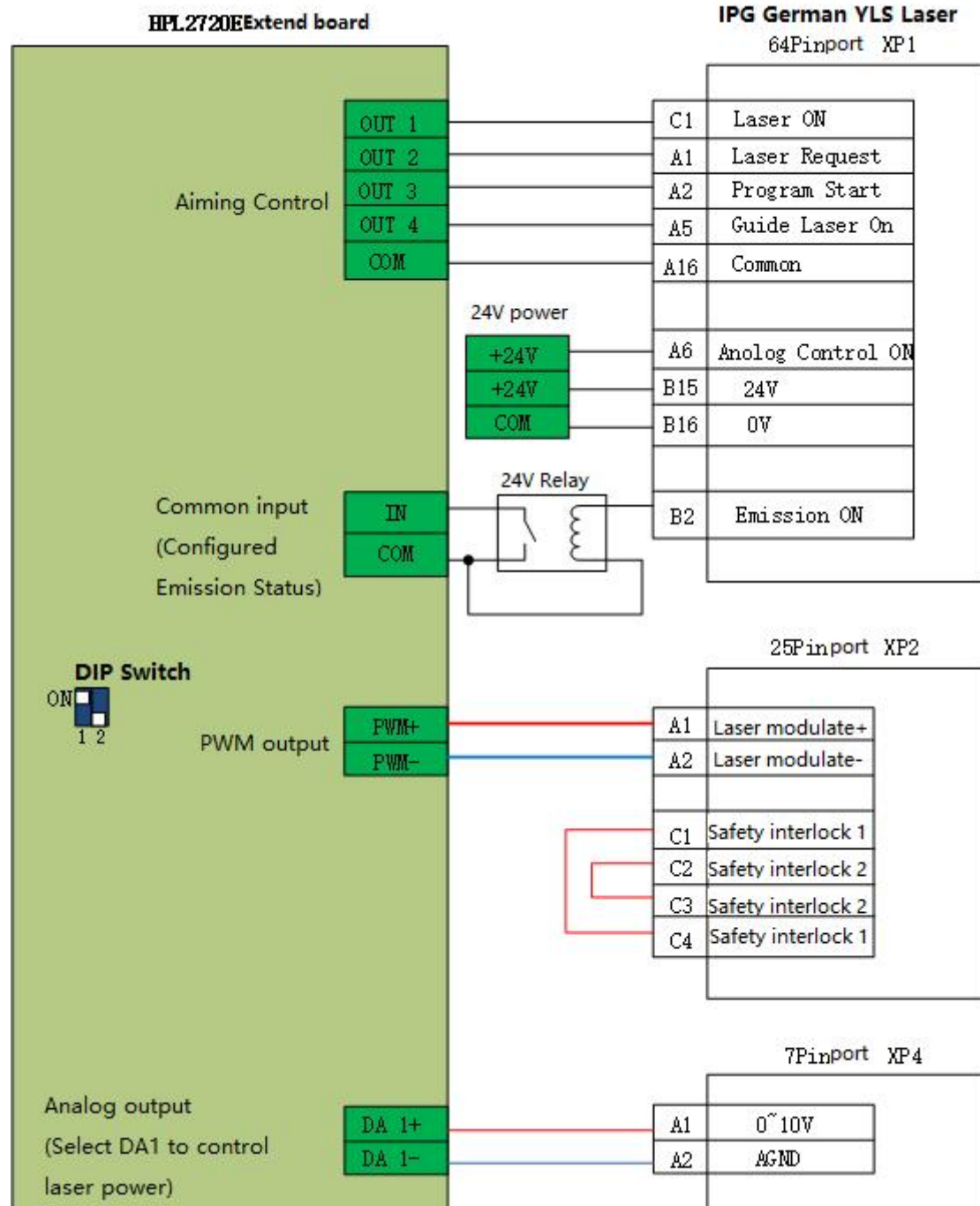
The connection of ProCutter cutting head is shown in the figure below.





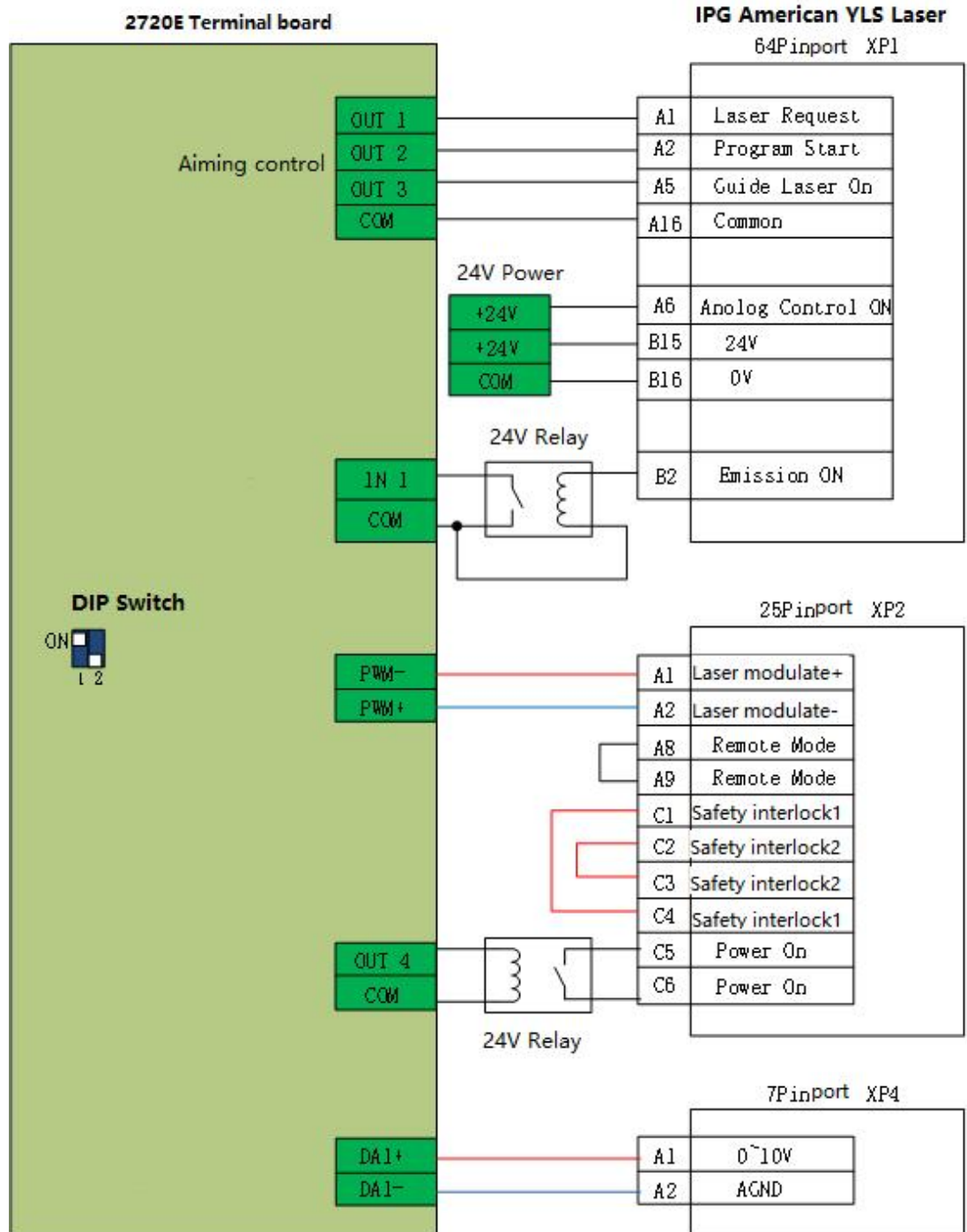
## 2.5. Laser Wiring

### 2.5.1. IPG\_YLS German





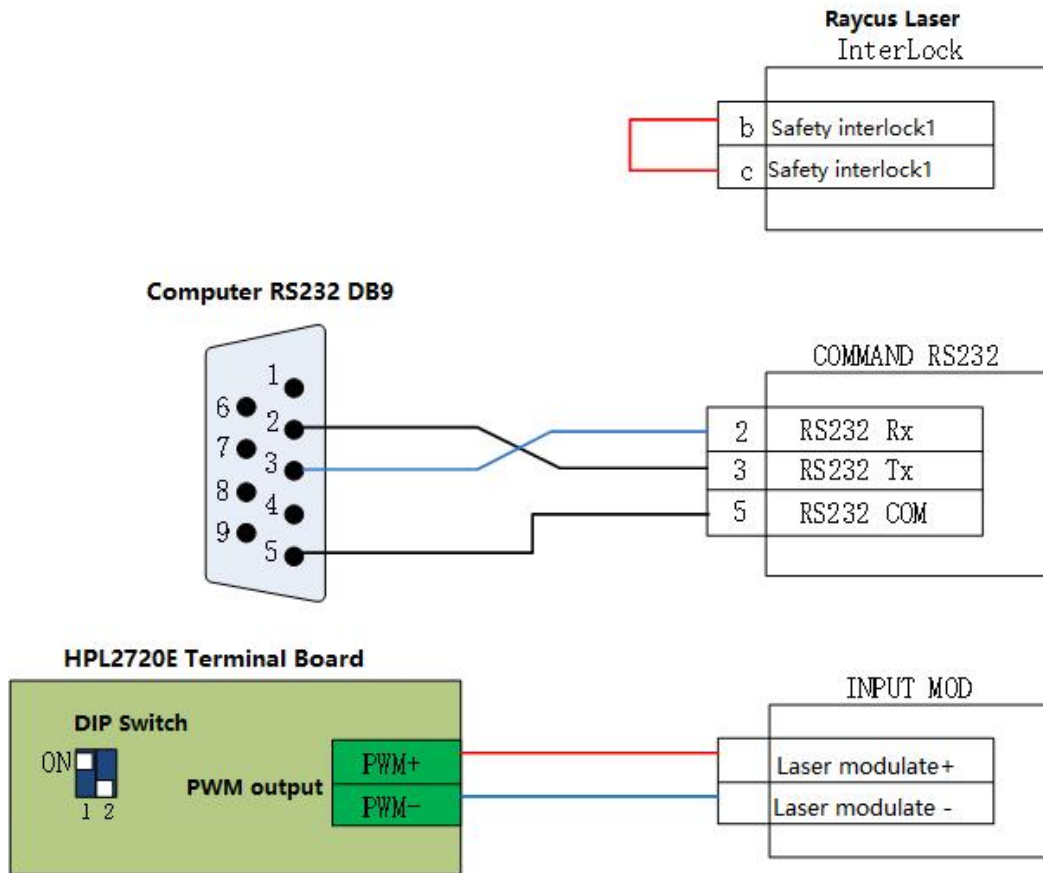
2.5.2. IPG American





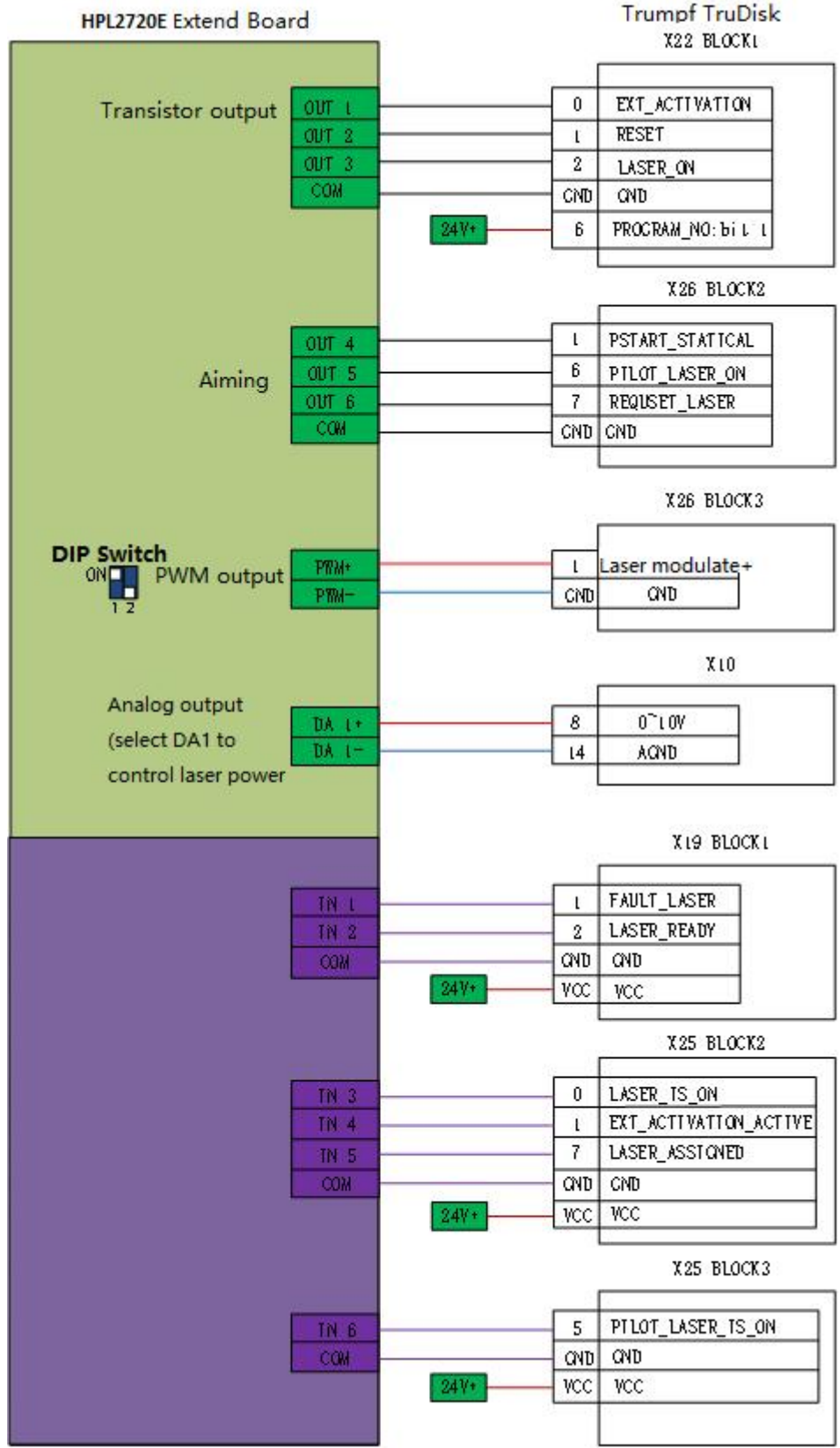


### 2.5.3. Raycus





### 2.5.4. Trumpf





## 3. Installation

### 3.1. Installation Steps

#### 3.1.1. Step 1. Install BMC2282 Control Card

- (1) Power off the host.
- (2) Open the host case, select a free PCIE slot, and use a screwdriver to remove its slat.
- (3) Insert BMC2282 into the slot. The installation is shown in 2.1.2.
- (4) Tighten the screws of the BMC2282 block with a screwdriver.
- (5) Cover the case, turn on the power of the host PC, and start the host.

#### 3.1.2. Step 2. Install BMC2282 Driver

2 ways to install BMC2282 driver.

Use CypCutPro to install the driver, check the driver when installing CypCutPro, as shown in Figure 7. The BMC2282 driver will be automatically installed.

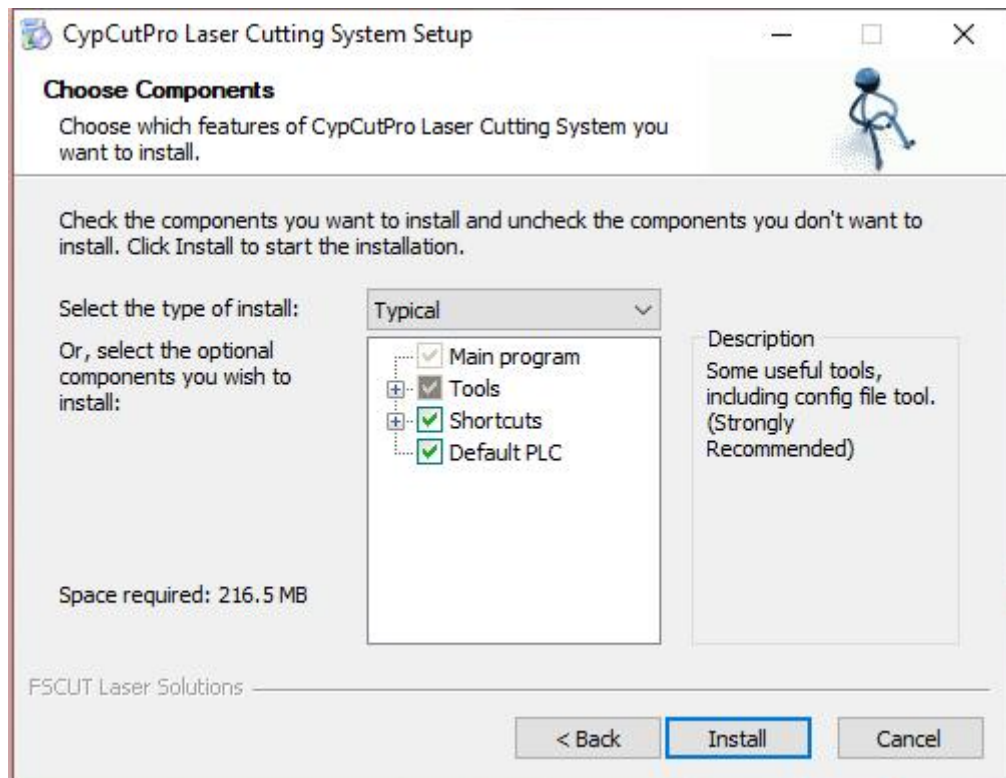


Figure 7 Check Driver Program

2. Open the "Device Manager", it will display "Other Devices" as shown in Figure 8, if its driver is not installed.

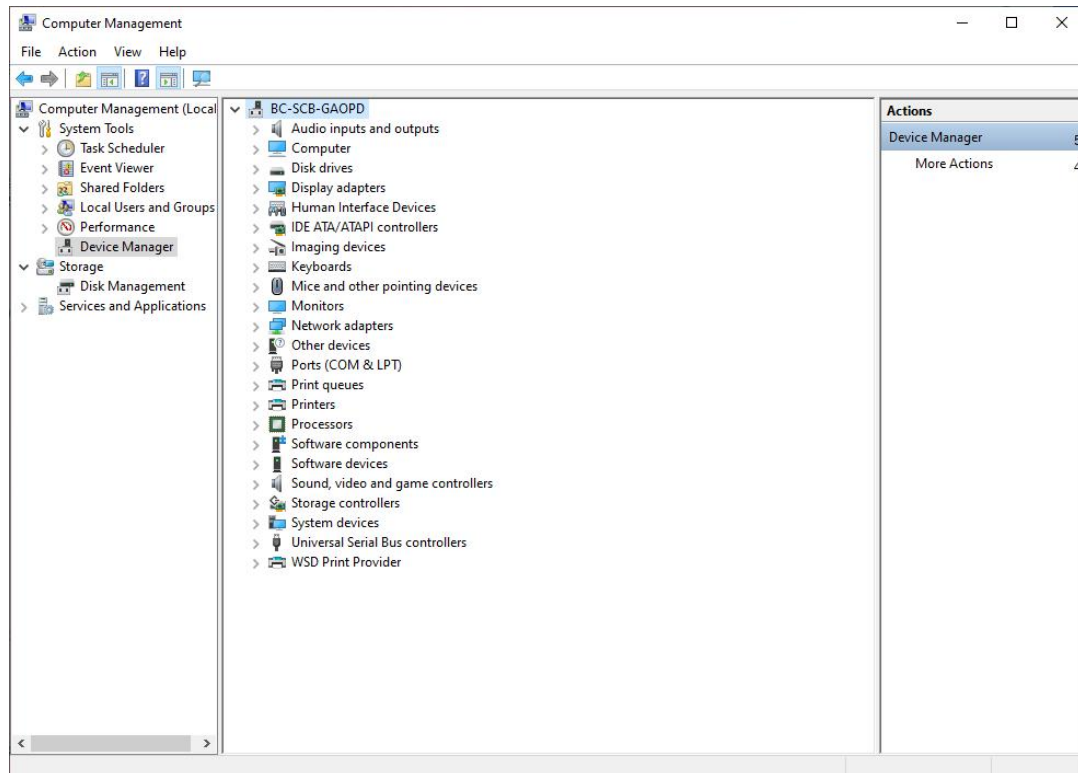


Figure 8 Unknown Device

Right click on "PCI FLASH Memory" and select "Update Driver Software".

Figure 9 Click "Update Driver"

Select CypCutPro and find the default location of driver files: C:\Program Files (x86)\Friendess\CypCutPro\Drivers, then click Next.

The driver installation is complete, if "BMC2282 DMA" is displayed.

### 3.1.3. Step 3. Connect Slave

Use CAT5E or above standard network cable ( Friendess network cable recommended) to connect the slave the wiring diagrams of BLT series cutting head and other cutting heads are shown in section 1.2.

### 3.1.4. Step 4. Scan in CypConfig

Open "CypConfig" and click "BUS Scan"->"Start". The system will scan the connected slave information.

### 3.1.5. Step 5 Use CypCutPro

After setting the parameters in the "CypConfig", open CypCutPro, import the graphics, and set the process parameters, then it can be processed See the CypCutPro manual for details.

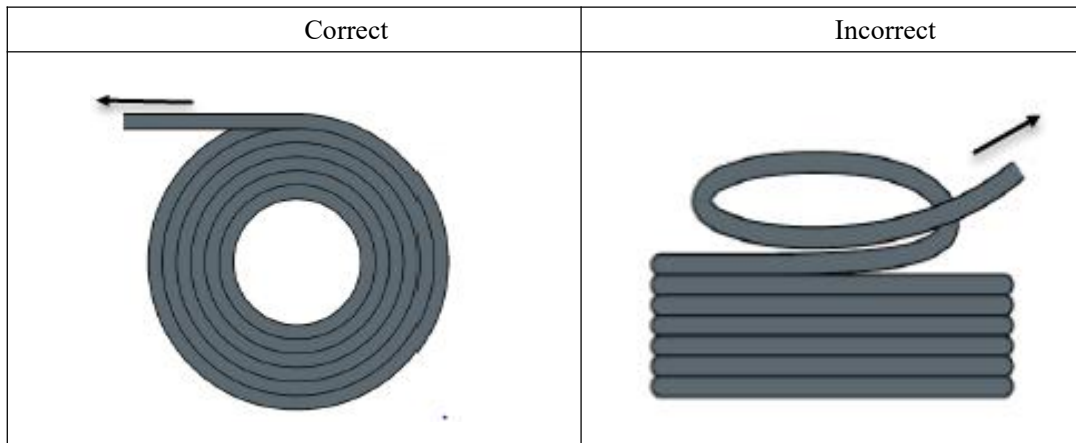


## 4. Precautions

### 4.1. Wiring Precautions

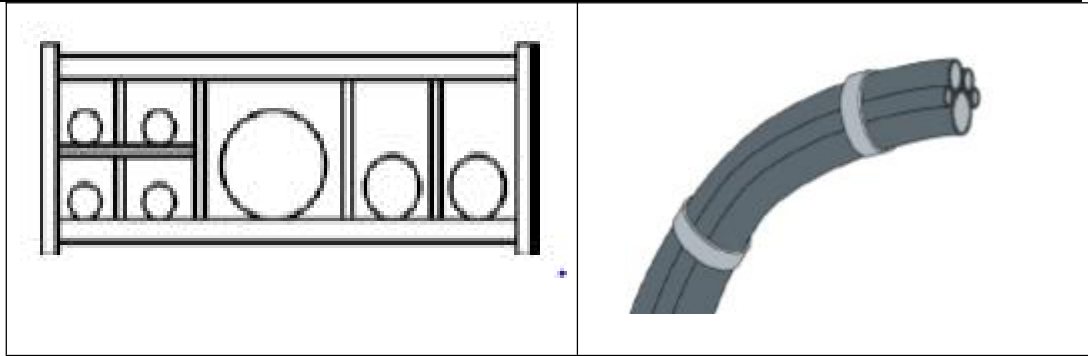
#### 4.1.1. Drag Chain Wiring

- When releasing the 4-pin cable from the coil, it is necessary to prevent the cable from twisting (the cable must be released along the tangential direction) and the cable must be laid straight. This work should be done before laying the cables, to give the cables time for stress relief. Because the manufacturing process cannot completely guarantee that the cable is straight and free of distortion, the printed logo on the surface of the cable rotates in a tiny spiral.



- Cables are not allowed to be twisted when installed in a closed space, and twisting during installation may cause damage to the core wire stranding. This effect is gradually strengthened during the operation of the cable, resulting in back-twisting, which eventually leads to the breakage of the core wire and failure.
- The cables must be laid loosely next to each other in the drag chain support. Spacers should be used to separate the cables as much as possible. The space between the cable and the spacer, separator and the cable adjacent to it, shall be at least 10% of the diameter.

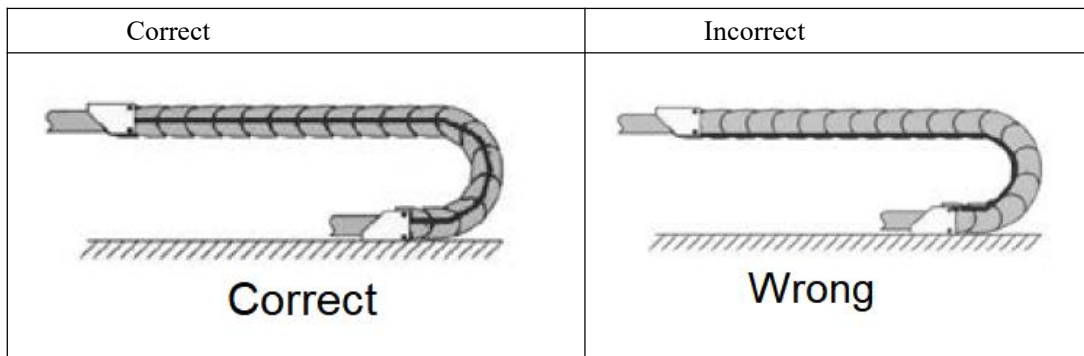




4. The cables should be installed according to the weight and size of the cables. The larger diameter and heavier cables should be placed outside; the smaller diameter and lighter cables should be placed inside. The cables can also be placed from the inside to the outside descendingly by size. Do not place one cable on top of another without using a spacer.
5. For vertically suspended drag chains, keep more free space for the vertical support, because the cables will be stretched during operation. After a short run, it is necessary to check that the cables run along the center area and adjust them if necessary.
6. For self-supporting drag chain, cables are fastened to moving and fixed points. Suitable cable supports from the supplier are required. Cable ties have very limited applicability when operating at high accelerations. So you should not bundle multiple cables together. Cables should not be fixed or tied to any moving parts of the drag chain. The gap between the fixed point and the bending area should be wide enough.

**self-supporting****sliding**

7. It is recommended to fix the cable on the moving point for sliding drag chains. A small cable protection zone is required at the fixing point. (Refer to the instructions from the drag chain supplier)
8. Please ensure that the cable runs along the center area with the desired bending radius. Do not apply tension to the cable (do not pull it too tightly), otherwise the friction inside the drag chain will cause the cable sheath to wear; do not let the cable be too loose in the drag chain, otherwise it will easily cause abrasion of the cable and the inner wall of the drag chain, or tangled with other cables.



9. If the cable does not run smoothly, check whether it is twisted along the longitudinal axis during operation. The cable should slowly rotate at a certain fixed point until it runs freely.
  
10. Given the size of cables and drag chains, their length characteristics vary considerably. During the first few hours, the cable naturally elongated. For drag chains, it takes more hours for this to happen. Such a large discrepancy can be remedied by regularly checking the cable installation locations. It is recommended to do regular inspections, every three months for the first year and at every maintenance thereafter. This includes checking that the cables are completely free to move within the intended bending radius and making adjustments if necessary.

#### 4.1.2. Machine Tool Wiring

##### 1. Power Supply (Power) Wiring

###### (1) Strong Electricity

- Strict separation of strong and weak electricity

Select the appropriate diameter for the power cable according to the power. The table below is the cable diameter and its corresponding power.

Cable Spec(mm <sup>2</sup> )	Cross Section(mm <sup>2</sup> )	25°C Copper Wire Ampacity (A)	Single-phase 220v load power (W)	Three-phase 380v load power (W)
1.5	1.38	15	3300	9476.8
2.5	1.78	25	5500	13163.2
4	2.25	32	7040	16848.8
6	2.85	45	9900	23693.6
10	7*1.35	60	13200	31591.2
16	7*1.7	80	17600	42121.6
25	7*2.14	110	24200	57917.6

- Add auxiliary devices such as short-circuit protectors and filters for strong electricity.



(2) Weak Electricity (DC24V for example)

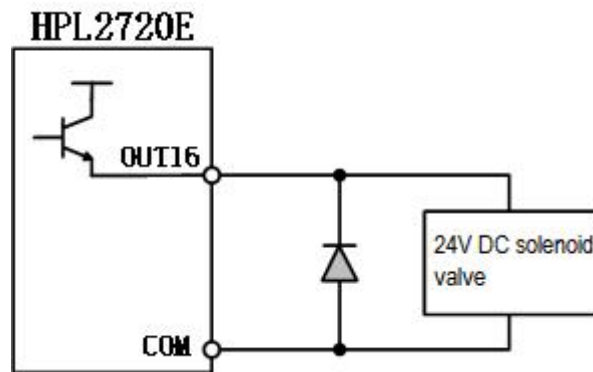
- Distinguish the positive and negative wires of the power supply in color, e.g., the red wire is connected to the positive pole, and the blue wire is connected to the negative pole
- Loads with relatively large interference (e.g. servos and solenoid valves) are powered separately from the controller.

2. Grounding

- **The ground wiring adopts the standard two-color, yellow and green, wires.**
- It is recommended to use multi-point grounding, for some high-frequency signals (PWM, pulse, encoder, capacitance, etc.) in the laser cutting machines.
- The machine tool uses galvanized grounding screws and a special grounding wire for grounding. The resistance between the grounded metal body and the main grounding point should be  $\leq 0.1\Omega$ .

3. Signal (Control)

- Signal wire color, e.g. black.
- Choose the signal wire according to the power.
- DC 24V solenoid valve is recommended. Add absorption circuits at both ends of the solenoid valve, that is, connect a freewheeling diode in parallel at both ends of the solenoid valve (pay attention to the direction, withstand current, and withstand voltage), as shown in the figure below.



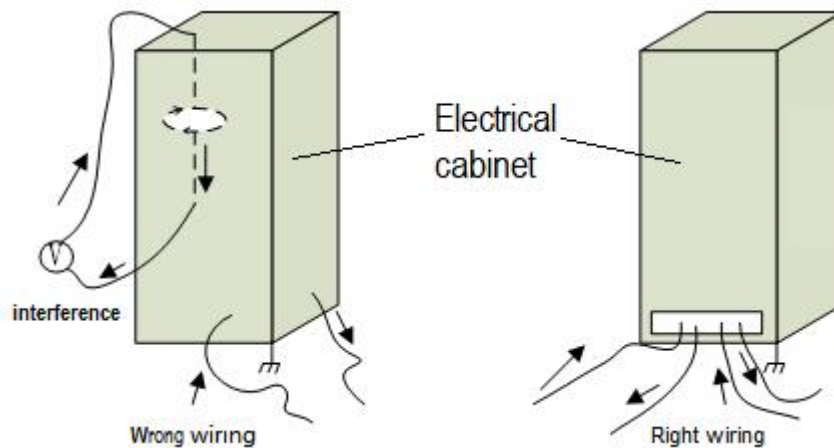
- It is recommended that the digital signal (PWM) shielding layer be grounded at both ends, and the analog signal (DA) shielding layer be grounded at one end. Single-ended grounding can avoid low-frequency current noise on the shielding layer; double-ended grounding can effectively eliminate high-frequency interference. If the transmission cable is very long, it is recommended to ground at multiple points to ensure that the shielding layer is at the same potential.
- The resistance from the cutting head connected to the amplifier to the shell of the machine tool is  $\leq 1\Omega$ , and the resistance to the grounding point of the electrical cabinet is  $\leq 6\Omega$ .





#### 4. Notes

- Each cable is marked clearly and accurately.
- Cables are in parallel and not crossed, and the harnesses should be straight and leveled.
- If using the cables from Friendess, choose the appropriate cable according to the layout space, and do not pile up and circle it.
- All wiring must be firm to prevent sparking.
- Wiring should avoid loops and antenna effects. The current loop composed of signal source---transmission line---load is equivalent to a magnetic field antenna. As shown in the figure below, the wrong connection is on the left, and the correct connection is on the right.



#### 4.1.3. Assembly Requirements

	<b>Handle with care. Please wear anti-static gloves or touch a grounded metal object to prevent static electricity from damaging the motion control card before touching the control card circuit or inserting/pulling the control card.</b>
	<b>Except for the USB interface, plugging and unplugging with power is prohibited for other interfaces, which may cause internal components damaged.</b>
	<b>Handle with care. Do not press the card. Pressing might cause the card to bend and its function damaged.</b>

#### 4.2. Troubleshooting

##### 4.2.1. Device Manager cannot find PCIe devices

If the device manager cannot find any PCIe devices:

1. Check the status of the indicators on BMC2282. The positions of the power indicator and system status indicator are shown in Figure 14

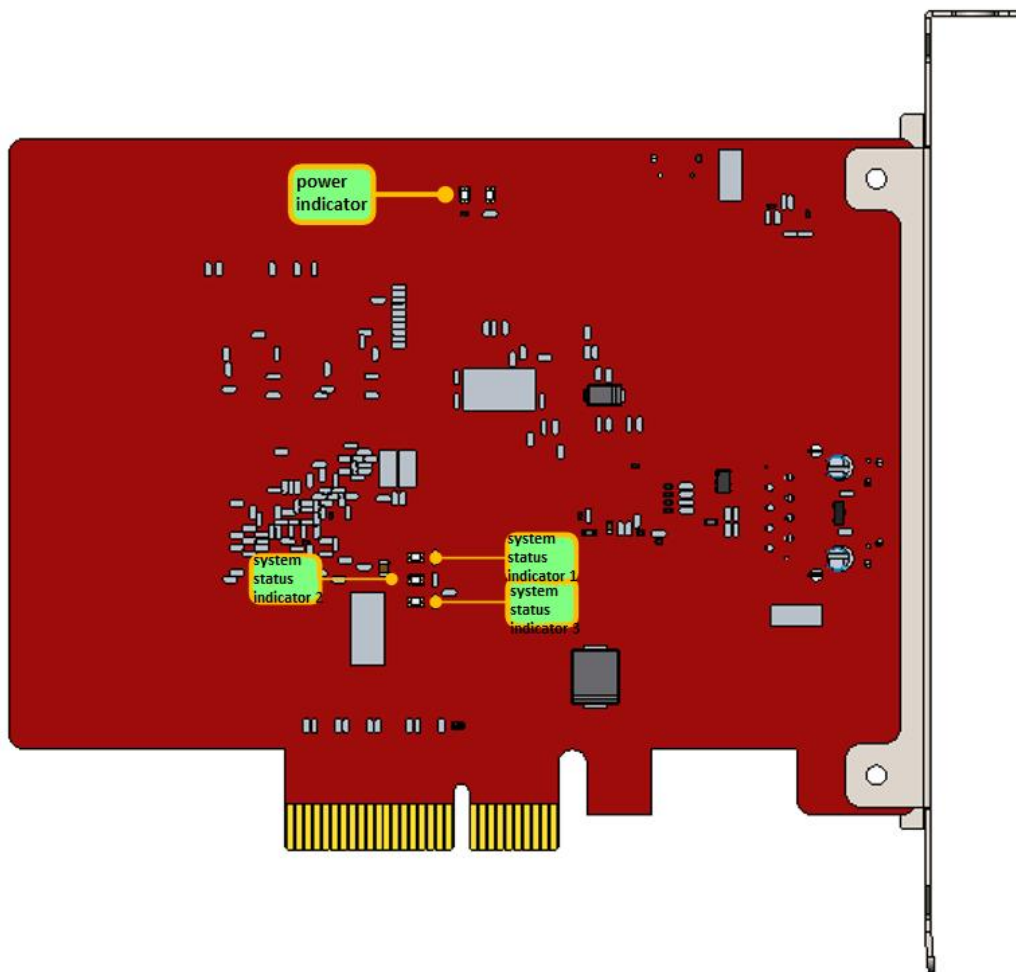


Figure 14 BMC2282 Indicators

If it is not in the OP state, the power indicator is always on, both the system status indicator 1 and the system status indicator 2 flash at 1 Hz at the same time, and the system status indicator 3 is always on.

If it is in the OP state, the power indicator is always on, the system status indicator 1 and system status indicator 2 flash alternately at 1 Hz, and the system status indicator 3 is always on.

If the BMC2282 status indicator is abnormal, change the card and try again.

2. If the BMC2282 status indicator is normal, change a card slot or host computer to scan again
3. If the PCIe device still cannot be found, contact our customer service.

#### 4.2.2. Device Manager cannot install driver

If PCIe devices are in the device manager, but the BMC2282 driver is not recognized:

1. Please manually install the driver again according to section 3.1.2.
2. If the driver is still not installed, change a card slot or install the driver on the host.
3. If the driver is still not installed, contact our customer service.

#### 4.2.3. Bus Scan failed

If the ConfigTool failed to scan the slaves:



1. Check whether the EtherCAT bus servo and slaves are powered on.
2. Check whether the network cable installed securely.
3. Check whether the slave device is supported. If not, contact customer service. If yes, change the slave device and scan again.
4. If still failed, contact customer service

#### 4.2.4. Bus network alarm

##### Common Bus Network Alarms and Solutions

Alarm	Reason	Solution
Bus network alarm, the network cable is not connected 0x9811002D	The slave device is not powered on or the network port is connected incorrectly	Check the power supply of the slave device and the wiring of the network port
Watchdog timeout alarm	Communication between CypCutPro and BMC2282 timed out	If it is automatically released, it can be ignored; if it occurs during processing, record the operation steps and give feedback to our customer service.
Bus network alarm, network mismatch 0x9811001E	The network cable between the EtherCAT network port of the computer and the slave is loose or the power supply of the slave is disconnected	<ol style="list-style-type: none"> <li>1. Check the wiring of the EtherCAT network port</li> <li>2. Sort out the wiring and check for interference</li> <li>3. Check the power supply of the slave</li> </ol>
Bus network alarm frame lost 0x98110025	EtherCAT network communication data frame loss	<ol style="list-style-type: none"> <li>1. Check the wiring of the EtherCAT network port</li> <li>2. Sort out the wiring and check for interference</li> <li>3. Check the power supply of the slave</li> </ol>
Bus network alarm, the slave is not in OP state	The Nth slave is abnormal, the network cable between the N-1 slave and the Nth slave is loose or interfered	<ol style="list-style-type: none"> <li>1. Check the wiring of the EtherCAT network port</li> <li>2. Sort out the wiring and check for interference</li> <li>3. Check the power supply of the slave</li> </ol>
Bus network alarm, network timeout 0x98110010	EtherCAT network communication data frames are lost continuously	<ol style="list-style-type: none"> <li>1. Check the wiring of the EtherCAT network port</li> <li>2. Sort out the wiring and check for interference</li> <li>3. Check the power supply of the slave</li> </ol>

Table 2-1 Master card bus alarm and solution