

# SKYSMotor

## BLS-510 BLDC drive Manual

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BLDC drive

**Thank you for using this product. This user's manual provides configuration, debugging, and control information for the BLDC driver. content include.**

- Installation and inspection of drivers and motors
- Trial operation steps
- Introduction to driver control functions and adjustment methods
- Inspection and maintenance
- Abnormalities

**This operation manual is suitable for the following users.**

- Installation or wiring staff
- Trial transfer personnel
- Maintenance or inspection personnel

**Please carefully read this manual to ensure that it is used correctly before using. Also, please keep it in a safe place for easy reference. The following must be observed when you have not read this manual:**

- The installation environment must be free of moisture, corrosive gas and flammable gas.
- Do not connect the power supply to the U, V, and W connectors of the motor when wiring, and the driver will be damaged when the connection is wrong.
- Do not disassemble the driver, motor, or change wiring while power is on.
- Before power on, please confirm whether the emergency stop device starts at any time.
- Do not touch the heat sink during power-on operation to avoid being hurt.

**Warning:**

**Drives are used for general industrial equipment. Pay attention to the following matters:**

- (1) In order to ensure correct operation, the operating instructions must be read thoroughly before installation, wiring, and operation.
- (2) Do not modify the product.

(3) When the product is used under the following conditions, relevant measures for operation, maintenance and management should be taken. In this case, please contact us.

① For life-related medical devices.

② For devices that may cause personal safety, such as trains or lifts.

③ for computer systems that may have social impact

④ For other equipment that has an impact on personal safety or on public facilities.

(4) For use in environments subject to vibrations, such as operation on vehicles, please consult us.

(5) If we do not perform the above-mentioned requirements and cause direct or indirect losses, our company will not bear the related responsibility.

If you still have problems in using, please consult our customer service technical support center.

## **1 Overview**

The BLDC driver is a high-performance, multi-functional, low-cost DC brushless driver with a Hall sensor. All-digital design makes it flexible and diverse input control mode, high speed ratio, low noise, perfect hardware and software protection functions, the driver can be connected to the computer through the serial communication interface, to achieve PID parameter adjustment, protection parameters, motor parameter, acceleration/deceleration time and other parameter settings and to be used for I/O input status, analog input, alarm status and bus voltage monitoring.

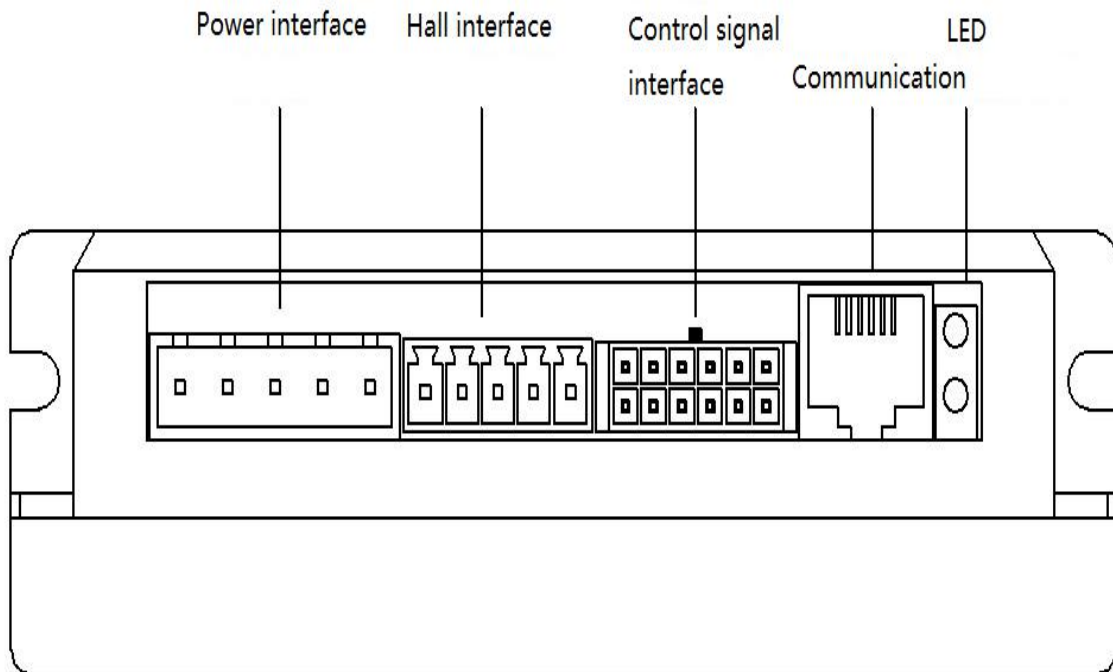
1.1 Driver Parameter List

Input Voltage	DC18V-50V
Working Current	<=10A
Motor Hall Type	60deg, 300deg, 120deg, 240deg
Operating mode	Hall speed closed loop
Speed mode	0-5V Analog input, 0-100% PWM input (PWM frequency range: 1KHz-20KHz) Internal given, Multi-speed 1, Multi-speed 2
Speed range	0—6000RPM
Protection	<ul style="list-style-type: none"> <li>● Short circuit: Short circuit protection occurs when the abnormal current is greater than 50A</li> <li>● Overcurrent: Overcurrent protection occurs when the current exceeds the operating current setting and continues for a set period of time</li> <li>● Overvoltage: Overvoltage protection occurs when the voltage exceeds 55V.</li> <li>● Undervoltage: Undervoltage protection occurs when the voltage is lower than 18V.</li> <li>● Hall anomaly: Including phase anomaly and value anomaly.</li> </ul>
Working environment	<p>Occasions: No corrosive, flammable, explosive and conductive gases, liquids and dust</p> <p>Temperature: -10-55°C (without frost)</p> <p>Humidity: less than 90% RH (non-condensing)</p> <p>Altitude: less than 1000m</p> <p>Vibration: less than 0.5G,10hz-60hz (discontinuous operation)</p> <p>Protection level: IP21</p>
Cooling method	Natural air cooling
Dimension	120*76*33 mm
Weight	250g

## 1.2 Features

- Speed PID closed-loop control, large torque at low speed.
- Wide speed range, 0-6000RPM.
- Running acceleration/deceleration time can be set by software to achieve smooth and soft operation.
- The driver has low loss, high efficiency and low temperature rise, so it is small in size and easy to install.
- Multiple speed control methods, set by software.
- Input signal polarity of the Enable, Direction and Brake can be set by software
- A variety of perfect protection features.
- Built-in braking resistor and control circuit (optional) for regenerating energy and preventing overvoltage.

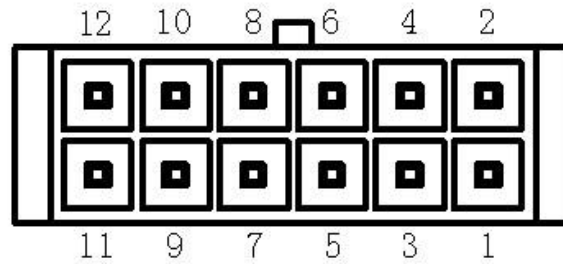
## 2 interface definition and connection diagram



## 2.1 Control signal input and output

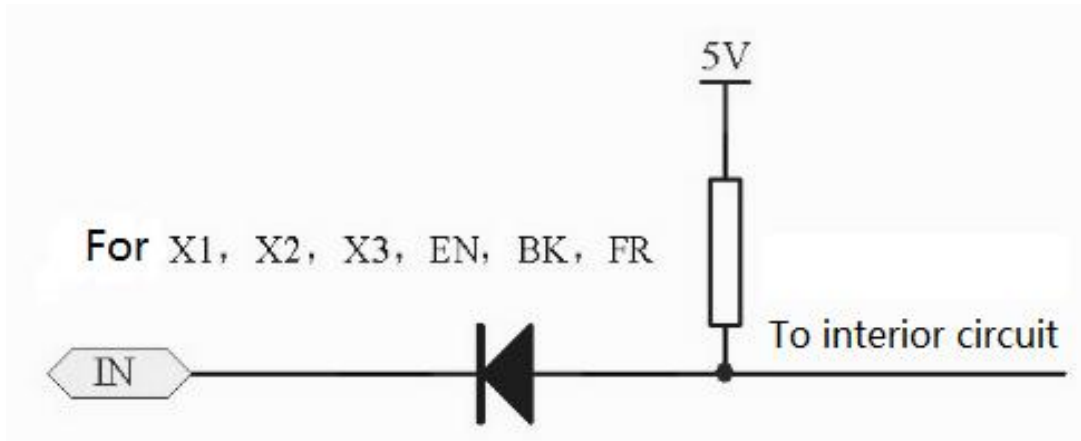
### 2.1.1 Pin List

BK	GND	SV	5V	PG	ALM
12	10	8	6	4	2
11	9	7	5	3	1
EN	FR	X1	X2	X3	GND

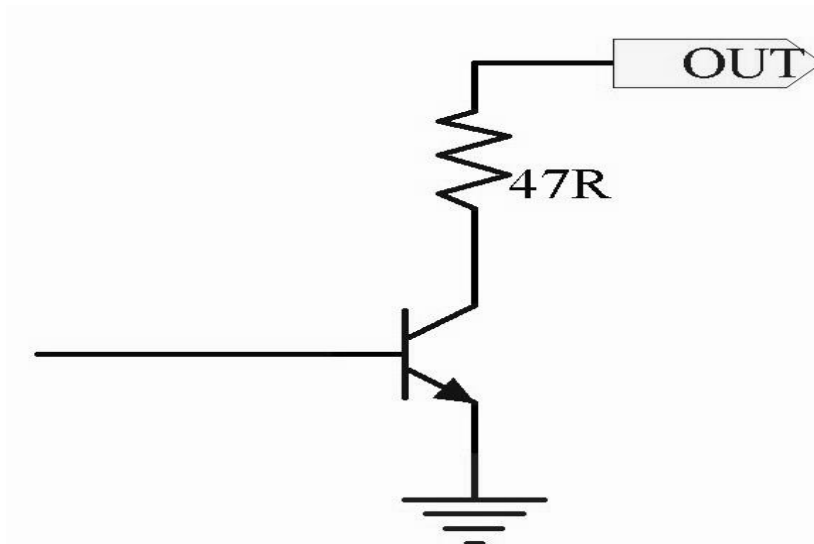


Pin	Name	Introduction
1	GND	Ground
2	ALM	Alarm
3	X1	multi-speed input 1
4	PG	Hall signal output
5	X2	multi-speed input 2
6	5V	5V power output
7	X3	multi-speed input 3
8	SV	Analog signal input
9	FR	Direction
10	GND	Ground
11	EN	ENA signal, active when it is low voltage
12	BK	Brake signal, active when it is high voltage, normally connected to ground

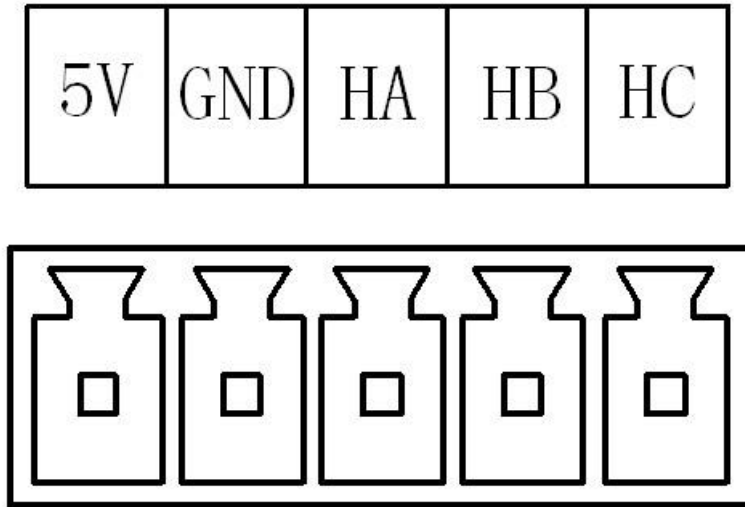
## 2.1.2 Internal Circuits for Pins X1, X2, X3, EN, BK, and FR



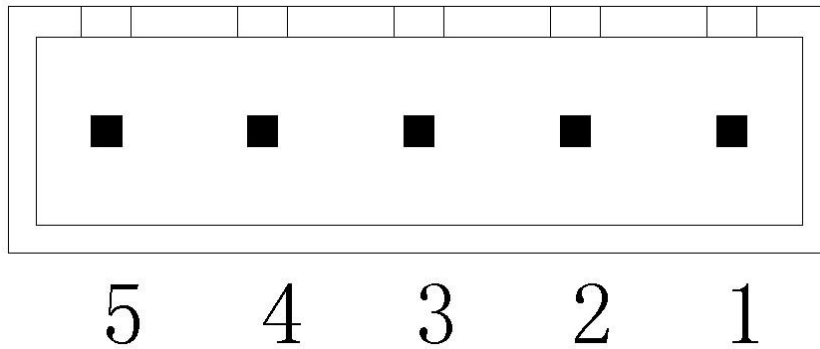
## 2.1.3 pin PG, ALM corresponding internal circuit



2.2 Hall signal input



2.3 Power Terminals

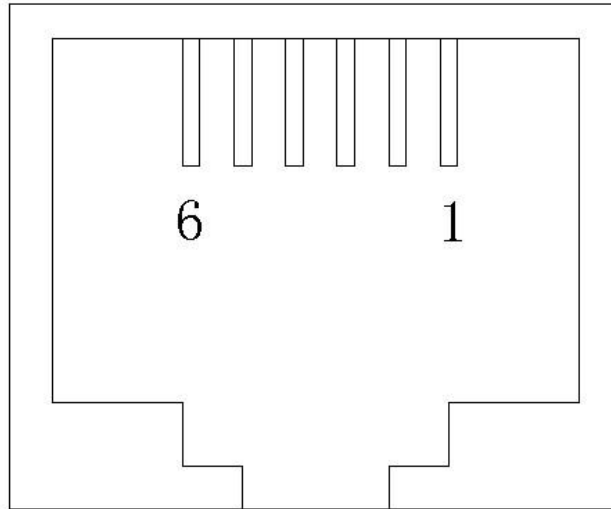


Pin	Name	Introduction
1	GND	Ground
2	VDC	Power input DC18-50V
3	W	Motor phase W
4	V	Motor phase V
5	U	Motor phase U



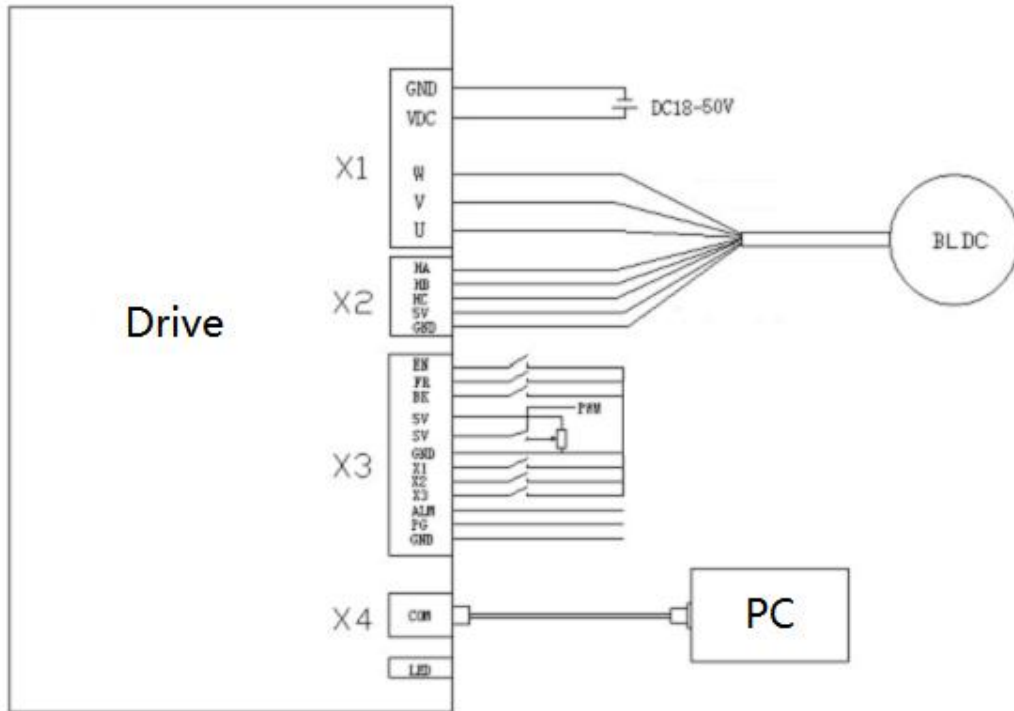
## 2.4 Communication Interface

The drive is connected to the computer using serial communications. The interface is RS232 level. It must be connected to the computer through a dedicated cable provided by the manufacturer. The physical interface uses an RJ12-6PIN telephone socket. The pinouts are as shown in the figure below. The pin number corresponding names are described in the following table.



Pin	Name	Introduction
1	NC	-
2	TXD	MCU txd
3	VCC	5V power
4	RXD	MCU rev
5	GND	Ground
6	NC	-

### 2.5 Typical wiring diagram

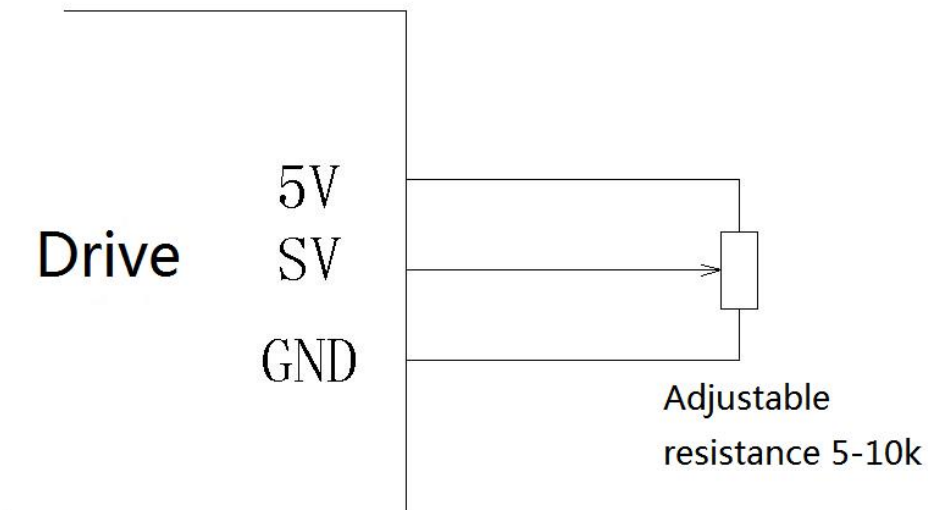


## 3 Control port function description

### 3.1 Analog/PWM Input Terminal SV

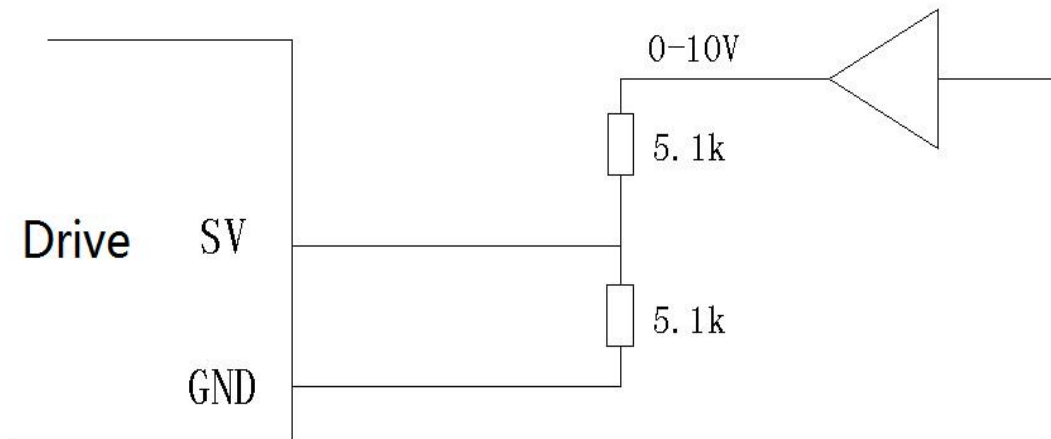
SV is used for analog input or PWM input. When the input of BLDC\_2 software is set to “analog input” or “PWM input” mode, the input value of this port is used as the given value of speed. Below is the wiring diagram and description.

#### 3.1.1 Adjustable Resistance Adjust Analog Input



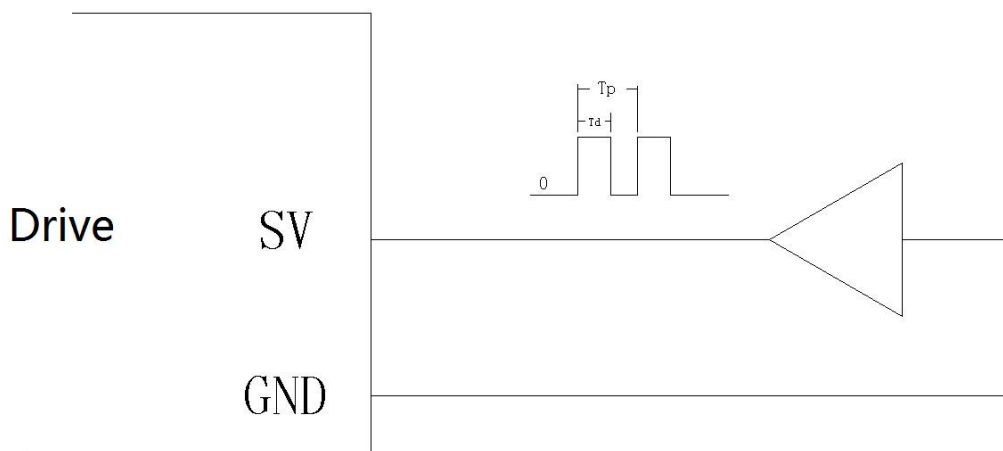
The resistance value of the adjustable resistor in the figure should be before 5K-10K. When connecting the voltage divider resistor, the two ends of the resistor and the center tap must be confirmed before reconnecting. The wrong connection may cause the 5V power supply to be short-circuited and cause the driver to be damaged. If, after connecting, or when adjusting the voltage divider resistance, the driver power LED is dimmed or extinguished, immediately disconnect the driver power and reconnect after verifying the resistance pin.

3.1.2 External 0-10V Analog Input



When the SV is connected to an external analog input, it should be noted that the input analog voltage should be less than 5V, otherwise it may damage the internal circuit. When it is higher than 5V, the voltage divider resistor should be used to ensure that the maximum voltage after the voltage division is less than 5V.

3.1.3 SV Used as PWM Input



When the SV in the driver is used for PWM input, the input quantity is the switch quantity and should be full of 5V level requirement. This PWM is a true PWM input, not a PWM filtered analog input. The duty

cycle of the PWM input signal can be any value from 0 to 100%, the PWM frequency should be between 1KHz and 20KHz, and the frequency deviation is low, the PWM precision is high. It is recommended to set the PWM frequency to 2KHz.

### **3.2 FR positive direction control terminal**

The FR terminals are used to control the motor rotation direction. When the FR terminal switches between different levels, it will decelerate to 0 according to the acceleration/deceleration time set value, then switch the direction and then increase from 0 to the given value. If the load inertia of the motor dragging is large, the acceleration/deceleration time should be appropriately increased, and there should be no over-current or over-voltage in the direction switching.

### **3.3 EN motor enable terminal**

The ON and OFF of the EN pin and GND can control the running and stopping of the motor. Only when the EN pin is connected to the GND, other operations can be allowed. If the EN pin is disconnected, the motor is in the free state and other operations are disabled.

When the motor fails, the EN pin can be disconnected first and then turned on to clear the fault.

### **3.4 BK brake control terminal**

When the BK pin is disconnected from the GND pin, the driver short-circuits the three phases and the motor is in braking state. When the BK pin is connected to the GND pin, the motor is released from the braking state. If the motor is at a high speed or the load inertia is relatively large, the brake will have an impact on the electrical and mechanical devices, causing great damage. In addition to safe emergency braking, such braking behavior should be avoided. To reduce the operating time, try to reduce the speed to a safer range and brake again.

### **3.5 X1, X2, X3 multi-speed control terminals**

Multi-speed input mode can be set in the configuration software

There are two types of multi-speed modes, namely mode 1 and mode 2, mode 1 is a decoding mode, and mode 2 is a bit selection mode.

#### **3.5.1 Multi-speed mode 1**

The disconnection or conduction of X1, X2, X3 and GND can be combined into 8 different states corresponding to 8 different speeds. Different speeds are achieved by switching between different states.

Different speed transitions are performed according to the set acceleration/deceleration time.

X1--GND	X2--GND	X3--GND	Speed section	Value
Closed	Closed	Closed	Speed section 0	User-defined
Closed	Closed	Open	Speed section 1	User-defined
Closed	Open	Closed	Speed section 2	User-defined
Closed	Open	Open	Speed section 3	User-defined
Open	Closed	Open	Speed section 4	User-defined
Open	Closed	Open	Speed section 5	User-defined
Open	Open	Closed	Speed section 6	User-defined
Open	Open	Open	Speed section 7	User-defined

### 3.5.1 Multi-speed mode 2

The multi-speed mode 2 is a position selection mode, that is, X1, X2, and X3 each correspond to a speed.

When X1 is closed, run the speed set by speed segment 0,

When X2 is closed, the speed set by speed segment 1 is set.

When X3 is closed, the speed set by speed segment 2 is set,

When two or all of X1, X2, and X3 are closed, the priority is ranked from high to low as X1>X2>X3. If X1 and X2 are closed at the same time, the speed segment 0 is run. When X2 and X3 are closed at the same time, the speed segment 1 is run.

When X1, X2, and X3 are off, the speed set in speed segment 3 is run.

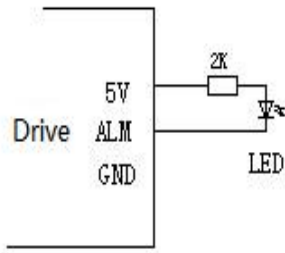
After switching, different speed transitions are performed according to the set acceleration/deceleration time.

X1--GND	X2--GND	X3--GND	Speed section	Value
Closed	X	X	Speed section 0	User-defined
Open	Closed	X	Speed section 1	User-defined
Open	Open	Closed	Speed section 2	User-defined
Open	Open	Open	Speed section 3	User-defined

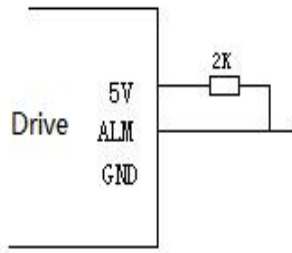
### 3.6 ALM alarm output terminal

The ALM signal output is a transistor open-drain output. When the driver occurs, short-circuit, over-current, Hall signal error, over-voltage, under-voltage and other abnormalities, the ALM outputs a

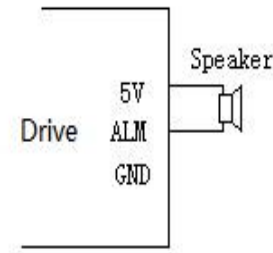
low level. The absorption current should be less than 50mA, the alarm output circuit has the following:



(1) LED output



(2) Digital signal output



(3) Buzzer output

### 3.7 PG Hall signal output terminal

The PG signal is used to provide the motor speed pulse signal. The PG signal is an open-drain output. A 2K-10K resistor should be added between 5V and PG for the pull-up resistor.

One pulse of the motor will output 3 pulses at the PG signal end.

**Mechanical cycle = electrical cycle \* pole pairs**

One revolution of the motor for two pairs of poles will produce six pulses, and four pairs of poles will have 12 pulses.

The relation between the frequency and the rotation speed output at the PG terminal when the motor rotates is as follows.

$$\text{Motor speed (RPM)} = 20 \times \text{PG signal frequency} / \text{number of motor pole pairs}$$

### 3.8 PWR/ALM indicator

There are two LED indicators on the drive, red and green, red is the ALM error type indicator, and green is the power indicator. Normally, the green light is on after the power is turned on. If the green light is off, check whether the power is normal.

The red indicator light can indicate different statuses with different flash times. As shown in the table below.

LED Flash Frequency	Indication
Stay on	Externalor software disable
Flash once every 2 seconds	Short-circuit Protection
Flash twice every seconds	Hall value anomaly
Flash 3 times every seconds	Hall phase abnormality
Flash 4 times every seconds	Overcurrent
Flash 5 times every seconds	Bus voltage is too low
Flash 6 times every seconds	Bus voltage is too high

## 4 Operation



**Safety Tips:** Before connecting, you should understand the connection diagram. When you use it for the first time or are not familiar with the device, you should disconnect the motor from the load to avoid damage to the motor and the load caused by incorrect wiring.

(1) Connect the various control signal lines on the X3. The drive enable signal EN is necessary. The drive can drive the motor only if the EN signal is low (the switch of the EN signal pair in the figure is closed). It should be high before the computer software configures the driver, that is, the switch corresponding to the EN signal is turned off.

(2) Connect the motor's phase line and Hall signal line. When connecting, confirm the phase line of the motor and the definition of the Hall signal line. Then, according to the definition, it is correctly connected with the terminal on the driver. Incorrect wiring may cause vibration or flying of the motor during power-on commissioning, abnormal alarms, etc.

(3) Use a dedicated communication cable to connect the driver to the computer. Try to avoid unplugging and plugging in the communication cable several times after power-on to prevent damage to the interface chip due to unequal ground potential or static electricity.

(4) Connect the power supply. Pay attention to the positive and negative direction of the power supply. After reverse connection, the power indicator of the driver is off, and the power should be disconnected as soon as possible. Otherwise, the power supply itself and the driver are damaged.

(5) Turn on the computer, install and run the configuration software BLDC\_2, and configure the software to set the pole timing and pole pair number of the drive adapter motor. Set the input mode to internal reference. Click “Config” to input a certain speed. The recommended setting is 300RPM for trial operation. Click “Save EEPROM” after setting. Then the external enable control signal EN is closed, the driver is in the start-up state, and the motor rotates to the set value. If there is an abnormality, disconnect the enable signal and recheck whether the connection is correct. For the description of abnormal conditions, please refer to the “FAQ”.

(6) After the correct hardware connection and software configuration, the motor should be stable in rotation and low in noise. In no-load operation, the monitoring current in the software is small and the variation is small. Otherwise, reconfirm whether the connection is correct and the configuration is correct.

(7) Switch the motor rotation direction by changing the FR pin signal.

## **5 frequently asked questions**

1. Phenomenon: After EN is enabled, the motor is not controlled to fly.

Solution: First confirm the Hall signal line, the connection with the motor phase line is correct, change the Hall timing in the configuration software is correct, if the current setting is 60 degrees will be changed to 300 degrees, for 120 degrees is changed to 240 degrees.

2. Phenomenon: After EN is enabled, the motor vibrates, or does not move, and over-current protection occurs after a few seconds.

Solution: This situation is generally a Hall signal line or motor phase line connection error. If the motor phase sequence and the Hall signal sequence are unknown, then the trial-and-conquer method can be used, that is, keeping the motor phase lines connected and fixed, and then adjusting the sequence of the three Hall lines to always find a group of normal operation or fly-over conditions. In the case of a flyover, the Hall phase sequence can be changed in the configuration software as described in Question 1.

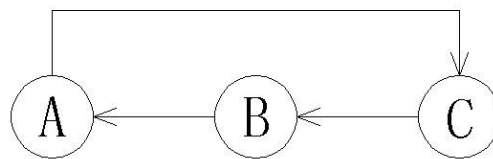
3. Phenomenon: After EN enable, Hall signal error alarm appears after the motor rotates by one angle.

Solution: First make sure the Hall signal line is connected reliably. If it is reliable, change the Hall timing in the configuration software. If the current setting is 60 degrees or 300 degrees, change it to 120 degrees. If it is 120 degrees or 240 degrees, change it to 60. degree. After the change, if you encounter the same phenomenon as the problem 1 and the problem 2, perform the troubleshooting according to the corresponding solution.



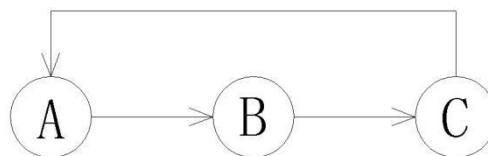
4. Phenomenon: normal operation on the surface of the motor, the temperature rise of the motor is slightly higher than the operating temperature of the correct wiring mode. When the EN pin is disconnected from the ground, the power supply is protected.

Solution: Rotate the Hall signal to the left by one bit, that is, the Hall signal B is connected to the Hall signal A, the Hall signal C is connected to the Hall signal B, and the Hall signal A is connected to the Hall signal C. Then the computer is used. Or, the keyboard changes the Hall timing by 180 degrees. For example, if the current is 120 degrees, it is changed to 240 degrees. If it is 240 degrees, it is changed to 120 degrees. If it is 60 degrees, it is changed to 300 degrees. If it is 300 degrees, it is changed to 60 degrees.



5. Phenomenon: The motor runs normally and the vibration is great. The motor temperature rise is higher than the correct wiring temperature. When the FR (reverse signal) signal changes, the protection phenomenon occurs.

Solution: Rotate the Hall signal to the right by one, that is, the Hall signal B is connected to the Hall signal C, the Hall signal C is connected to the Hall signal A, and the Hall signal A is connected to the Hall signal B. Then the computer is used. Or the keyboard changes the Hall timing by 180 degrees. For example, if it is currently 120 degrees, it is changed to 240 degrees. If it is 240 degrees, it is changed to 120 degrees. If it is 60 degrees, it is changed to 300 degrees. If it is 300 degrees, it is changed to 60 degrees.



6. Phenomenon: When the motor is switched between forward and reverse, the actual commutation time is longer than the set acceleration/deceleration time.

Solution: The acceleration and deceleration time set by the software is the commutation time is greater than the acceleration and deceleration time is the motor speed from 0 to 3,000 rev / min time, such as setting the motor deceleration time is 1 second, when the motor deceleration from 6000 rev / min At 0, it takes 2 seconds. The other case is that the characteristics of the drive PID setting are relatively soft, the given speed reaches 0, and the actual speed has not reached 0, and it takes a certain period of time to reach 0. You can speed up the speed response by increasing the values of VP and VI.

6 installation size

