

BLDC Motor Controller Application Manual



- Installation and inspection of drives and motors
- Preliminary operation steps
- Introduction and adjustment method of driver control function
- Detection and maintenance
- Exception removal

This operating manual is suitable for the following user reference

- Installation or wiring personnel
- Debugger
- Maintenance personnel

Before using, please carefully read this manual. **The following must be observed** when you have not finished reading this manual;

- The installation environment must be free of water vapor, corrosive gases and flammable gases
- The connection of the power supply to the motor U, V and W is forbidden when wiring, and once the connection is wrong, the driver will be damaged.
- Please do not disassemble the driver, motor or change the wiring when energizing
- Before energizing, please make sure the emergency stop device is activated at any time
- Please do not touch the radiator to prevent burns when energizing

Caveat:

Driver is used for general industrial equipment, pay attention to the following:

- (1) In order to ensure correct operation, the operating instructions must be read before the installation, wiring and operation
- (2) Please do not modify the product.
- (3) When the use of this product in the following circumstances, should be taken the relevant measures for related operation, maintenance and management.

In this case, please contact us.

- ① For life-related medical equipment
 - ② For the equipment that may cause personal safety, such as a train or a lift
 - ③ For computer systems that may cause social impact
 - ④ For other equipment that impact on personal safety or public facilities.
- (4) For an environment that is susceptible to vibration, for example, on a vehicle, please contact us.
- (5) Failure to comply with the above requirements, resulting in direct or indirect loss, we will not bear the responsibility.

1. Overview

The BLDC driver is a high-performance, multi-functional, low-cost with Hall sensor DC brushless driver. By full digital design it has a flexible and diverse input control, high speed, low noise, perfect hardware and software protection, the driver can connect to computer through the serial communication interface which can achieve PID parameter speed, protection parameters, Motor parameters, acceleration and deceleration time and set some parameters. IO input status, analog input; alarm status and bus voltage can be monitored by this driver.

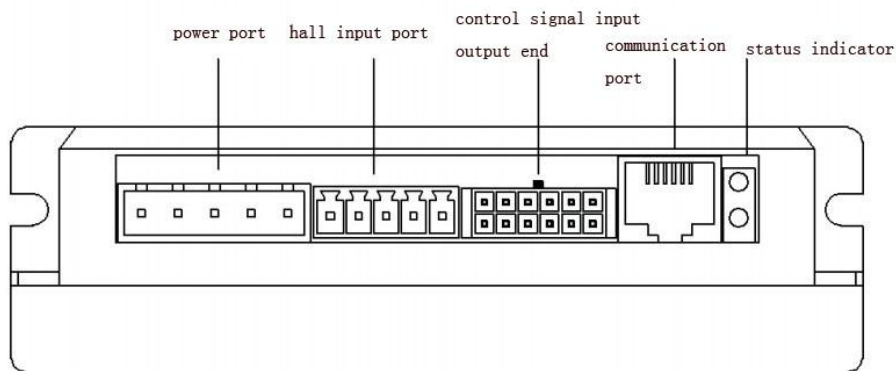
1.1 Driver parameter list

Input voltage	DC18-50V
Work current	<=10A
Motor hall type	240degree
Operating mode	Hall speed closed loop
Speed mode	0-5v analog input 0-100PWM input(PWM frequency scope 1KHz-20KHz) Internal given multi-sections of speeds 1, multi-sections of speeds 2,
Speed range	0-6000RPM
Protective function	<ul style="list-style-type: none">● Short circuit: When abnormal current is greater than 50A, short circuit protection is produced● Overcurrent: Overcurrent protection occurs when the current exceeds the operating current setting value and continues for a set time● Overvoltage: Overvoltage protection occurs when the voltage exceeds 55V● Under voltage: Under voltage protection when the voltage is below 55V● Hall anomaly: includes phase anomalies and abnormal values
Work environment	Occasion: non-corrosive, flammable, explosive, and conductive gas, liquid, dust Temperature:-10-55 ℃ (not frost) Humidity:<90%RH(not condensation) Altitude<1000m Vibration:<0.5G,10HZ-60HZ(not continuous operation) IP:IP21
Cooling method	Natural air cold
Dimensions	120*76*33(unit: mm)
Weight	250g

1.2 Features

- speed PID closed-loop control, low-speed high torque.
- Speed range, 0-6000RPM.
- The deceleration time can be set by software to achieve smooth and gentle operation.
- Driver itself loss is small, high efficiency, temperature rise is low, so the size is small and easy to install.
- A variety of speed control mode, which is set by the software.
- The enable direction and the polarity of the brake input signals can be set by software
- A variety of perfect protection.
- Built-in brake resistance and control circuit (optional), used to consume regenerative energy and prevent overvoltage.

2. Interface definition and connection diagram.

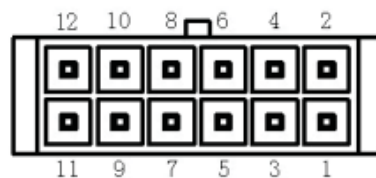


The position of each terminal on the panel

2.1 Control signal input and output terminal

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

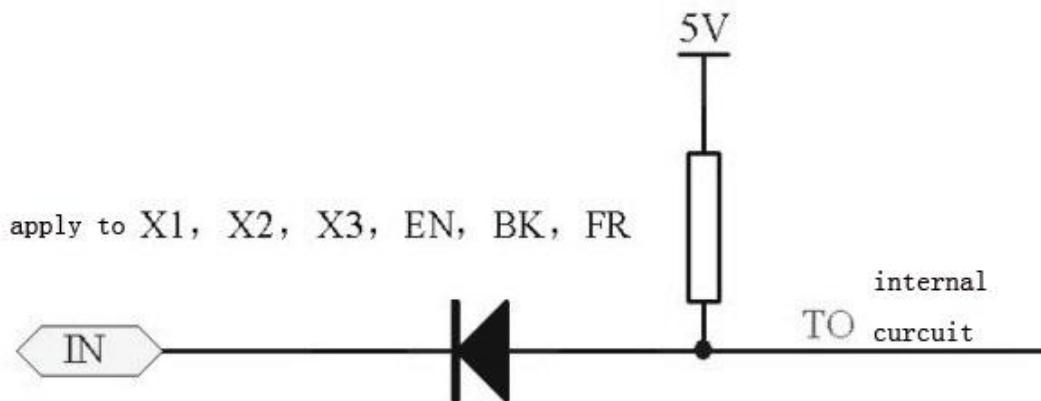


Pin arrangement and related name

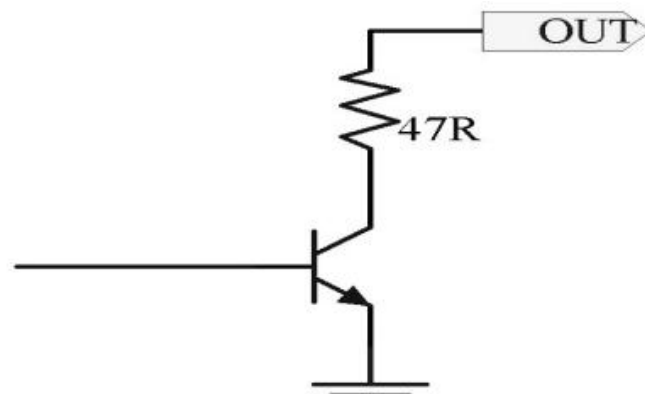
Terminal Pin	Pin Name	Definitions
1	GND	signal ground

2	ALM	alarm output (open drain),the current should be limited to 20mA
3	X1	multi-sections of speeds input 1
4	PG	hall signal exclusive OR output (open drain) ,the current should be limited to 20mA
5	X2	multi-sections of speeds input 2
6	5V	5V power output, the output power should be less than 20mA (internal for the linear power supply, excessive current will lead to overheating)
7	X3	multi-sections of speeds input 3
8	SV	analog signal input
9	FR	direction control signal
10	GND	signal ground
11	EN	enable signal, low level effective
12	BK	brake signal, high level brake, normally connected to GND

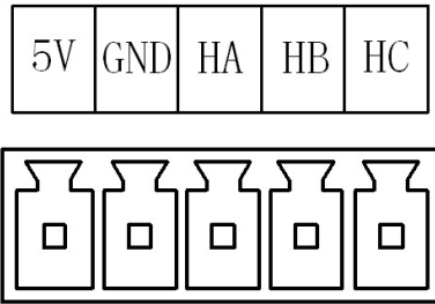
2.1.2 Pin X1, X2, X3, EN, BK, FR corresponding internal circuit



2.1.3 Pin PG, ALM corresponding internal circuit



2.2 Hall signal input

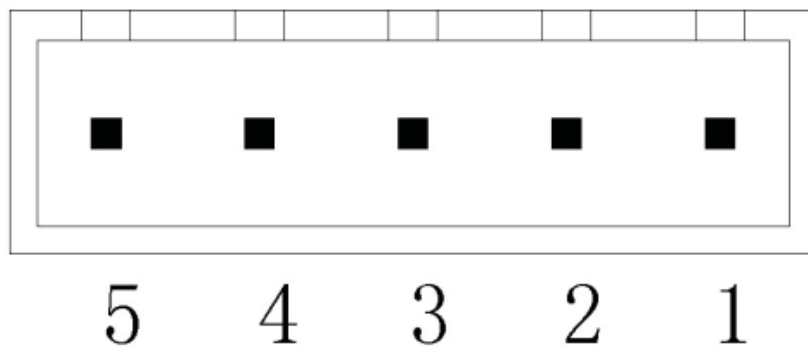


Pin arrangement and related name

Method of Connection:

5V-red (thin) GND-black (thin) HA –yellow (thin) HB-green (thin) HC-blue (thin)

2.3 Power Terminal

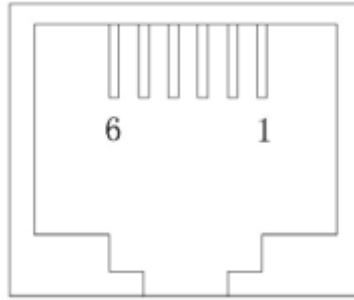


Power terminal pin arrangement

Terminal Pin Number	Pin Name	Definitions	Connect
1	GND	power supply input negative	24-
2	VDC	power supply input positive DC18-50V	24+
3	W	motor phase line	blue (thick)
4	V	motor phase line	green (thick)
5	U	motor phase line	yellow (thick)

2.4 Communication Port

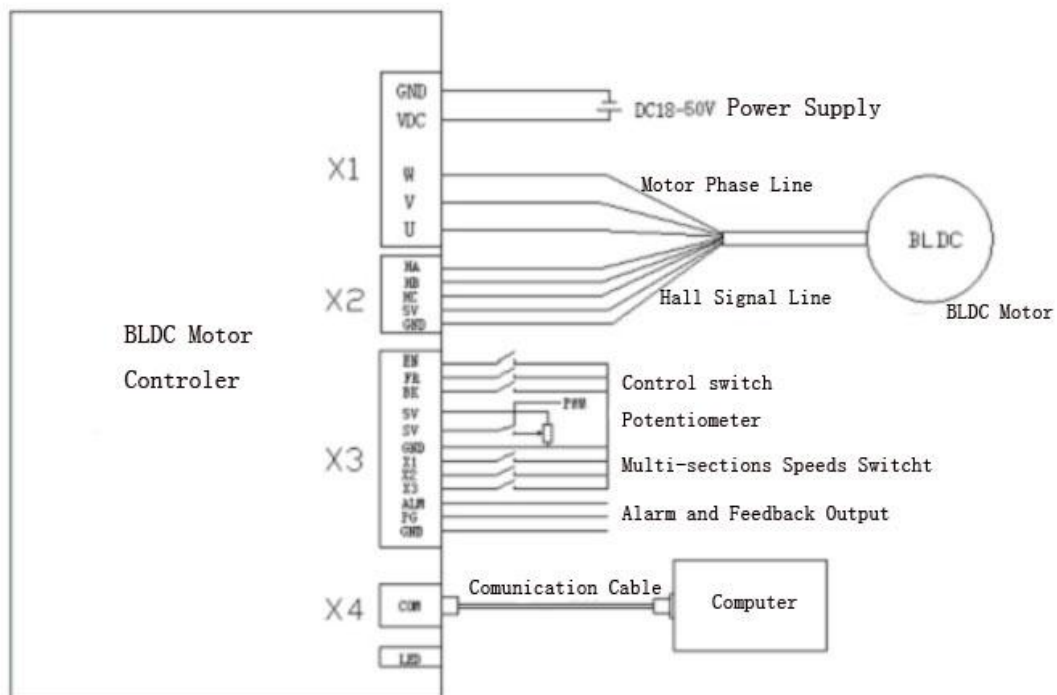
The driver is connected to the computer by serial communication, and the interface is RS232 level. The manufacturer must provide the dedicated cable to connect the computer. Physical interface using RJ12-6PIN telephone jack, the pin is arranged as shown below, the corresponding name of pin in the following table.



RJ12 jack pin diagram

Terminal Pin Number	Pin Name	Definitions
1	NC	empty
2	TXD	MCU data sender
3	VCC	5V power supply
4	RXD	MCU data receiver
5	GND	ground
6	NC	empty

2.5 Typical wiring diagram

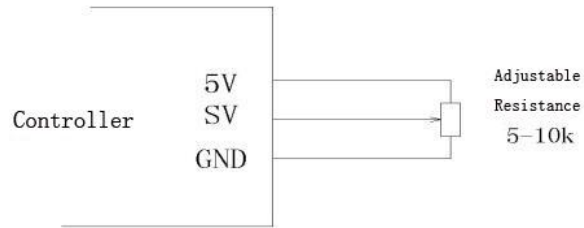


3. Control port function description

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 of this port as the speed reference. The following is the wiring diagram and description.

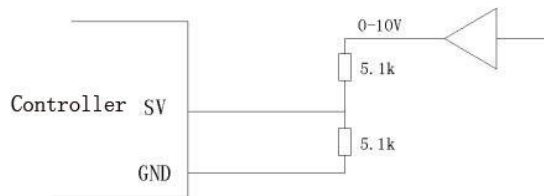
3.1.1 Adjustable resistance adjustment analog input



Adjustable resistance diagram

In the figure, the resistance of the adjustable resistor should be 5K-10K, when connect the divider resistance should distinguish the middle and end pin of the Variable Resistor. The wrong connection may cause 5V power short circuit and lead to damage the driver. When the voltage is connected or the voltage divider resistance is adjusted, if the driver power LED is dimmed or extinguished, the driver power should be disconnected immediately and re-confirms the resistor pins and then connect once again.

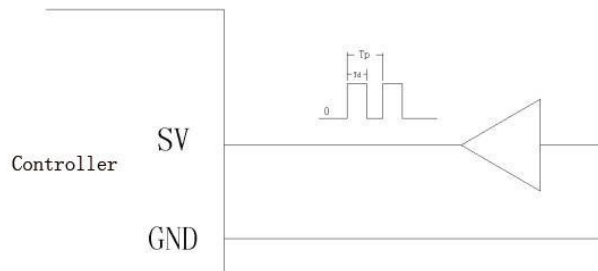
3.1.2 External 0-10V analog input



External 0-10V analog wiring diagram

When the SV connect the external analog input, it should be noted that the input analog voltage should be less than 5V; otherwise it may damage the internal circuit, higher than 5V should use divider resistance to divide voltage and ensure that the maximum voltage is less than 5V after divide voltage.

3.1.3 SV is used as the PWM input



PWM input wiring diagram

When the SV in the driver is used for the PWM input, the input is the switch value and should satisfy 5V level requirements. The PWM input signal duty cycle can be from 0 to 100%, the PWM frequency is 1 KHz-20 KHz, the low frequency show that the accuracy of PWM is higher. It is recommended that the PWM frequency be set at 2 kHz.

3.2 Forward and reverse direction control terminals

FR terminal is used to control the direction of the motor. When the FR terminal is switched at different levels, firstly it will decelerate to 0 e, and then accelerated from 0 to the given value in opposite direction. If the load inertia is big, it should be appropriate to increase the acceleration and deceleration time. Otherwise, there may cause excessive flow or excessive voltage when switching in the direction.

3.3 EN motor enable terminal

Start and stop of the motor can be controlled by switch EN pin. When the EN pin is connected to the GND, other operations will be allowed. If disconnected the motor will be in the free state, the other operation is disabled. When the motor fails, you can disconnect the EN pin, and then connect again to clear the fault.

3.4 BK brake control terminal

When the BK pin and the GND pin are disconnected, it will lead to the three phases short-circuit of the driver, the motor is in a braking state. When the BK pin and the GND pin are connected, the motor is out of braking state. If the motor speed is high or the load inertia is relatively large, the brake may impact the electrical and mechanical equipment. Except safety emergency stop, we should avoid such braking behavior. In order to reduce the action time, we should try to reduce the speed to a safe range before braking.

3.5 X1, X2, X3 multi segment control terminals

In the configuration software, you can set the multi segment speed mode by these input pins.

There are two kinds of multi segment mode respectively, mode 1 and mode 2, mode 1 is the decoding mode, and mode 2 is bit selection mode.

3.5.1 Multi segment speed mode1

X1, X2, X3, and GND disconnected or connected, which can be combined into 8 different states. Different speeds are achieved by switching different states. When switching between different speeds, the motor will runs according to the acceleration and deceleration set parameters.

X1-GND	X2-GND	X3-GND	Speed Segment	Value
connect	connect	connect	Speed Segment 0	User can set
connect	connect	Disconnect	Speed Segment 1	User can set
connect	Disconnect	connect	Speed Segment 2	User can set
connect	Disconnect	Disconnect	Speed Segment 3	User can set
Disconnect	connect	Disconnect	Speed Segment 4	User can set
Disconnect	connect	Disconnect	Speed Segment 5	User can set
Disconnect	Disconnect	connect	Speed Segment 6	User can set
Disconnect	Disconnect	Disconnect	Speed Segment 7	User can set

Multi-segment mode 1 X1, X2, X3 corresponding to different speed segment

3.5.1 Multi-segment mode 2

Multi-speed mode 2 is the bit selection mode, X1, X2, X3 corresponds to different speeds.

When X1 is connected to GND, speed segment 0 is set

When X2 is connected to GND, speed segment 1 is set

When X3 is connected to GND, speed segment 2 is set

When X1, X2, X3 have two or all connected to GND, the priority is arranged from high to low X1> X2> X3>. If the X1 and X2 are connected at the same time, the running speed segment 0.X2 X3 is connected at the same time, the running speed segment 1.When X1, X2, X3 are disconnect, run speed segment 3 set the speed.

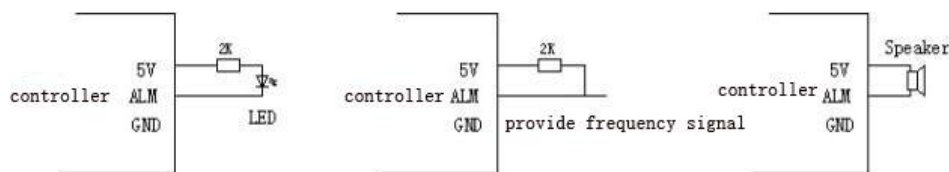
When switching between different speeds, the motor will runs according to the acceleration and deceleration set parameters.

X1-GND	X2-GND	X3-GND	Speed Segment	Value
connect	X	X	Speed Segment 0	User can set
Disconnect	connect	X	Speed Segment 1	User can set
Disconnect	Disconnect	connect	Speed Segment 2	User can set
Disconnect	Disconnect	Disconnect	Speed Segment 3	User can set

Multi-segment mode 1 X1, X2, X3 corresponding to different speed segment

3.6 ALM alarm output terminal

ALM signal output is triode open drain output. When the driver occurs, short circuit, overcurrent, hall signal error, overvoltage, under voltage and other abnormalities, the ALM pin outputs low level. Its absorption current should be less than 50mA; the alarm output circuit is shown as follows.



(1) LED indicator output

(2) digital signal output

(3) buzzer output

3.7 PG hall signal output pin is used to feedback motor speed pulse signal, PG signal pin is also open drain output; A 2K-10K resistor should be added between 5V and PG as pull-up resistor.

During an electrical cycle, the PG signal pin outputs 3 pulses.

A mechanical cycle = electrical cycle * pole pairs

For two pairs of pole PG will generate 6 pulses per a mechanical circle, and four poles are 12 pulses. When the motor rotates, the relation between the output frequency of the PG signal and motor speed is as follows

Motor speed (RPM) = 20 * PG signal frequency / motor pole pairs

3.8 PWR/ALM indicator light

There are two LED lights in the driver, red and green respectively, red is ALM error type indicator light, green as power indicator light. After power on, green light is on in normal condition. If the green light is off, please check the power supply. The red light indicates different states by varying the number of flashes. it is shown as the following table.

LED lights state	Indicate
Always bright	External or software disabled
Every second, flashing once	Short circuit protection
Every second, continuous flash 2 times	Hall value exception
Every second, continuous flash 3 times	Hall phase abnormality

Every second, continuous flash 4 times	Overcurrent
Every second, continuous flash 5 times	Bus voltage is too low
Every second, continuous flash 6 times	Bus voltage is too high

4. Instructions



Safety tips: before the connection you should understand connection diagram firstly. the motor and the load should be disconnected in order to avoid the wrong wiring generate vibration and other causes of damage to the motor and load.

The correct installation and connection procedures are described as follows:

(1) Connect the various control signal lines on the X3, and the drive enable signal EN is the necessary. The driver is enable when the EN signal is low. Before the computer software configures the drive, it should be high level

(2) Connect the phase line of the motor and the hall signal line. Ensure the connection is correct. The wrong wiring may cause the motor to vibrate or turn off, abnormal alarm and so on.

(3) Connect the driver and the computer with communication cables; try to avoid the hot plug communication cable.

(4) Connection power. Pay attention to the positive and negative direction of the power supply.

(5) Open the computer, install and run the configuration software BLDC_2, and then set the hall sequence and number of pole-pairs. Set input mode to internal given, click configures to enter a certain speed. The typical value is set to 300RPM. After the settings are complete, click "save EEPROM". When enable the EN signal, the motor will work at the set value. If an exception occurs, please disconnected the EN signal and checks the connection again. About exception Please refer to"FAQ".

(6) After proper hardware connection and software configuration, the motor should be stable and low noise. In no-load case, low value and small fluctuations current should be observed by the software. Otherwise, please check the connection and configuration again.

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

5. FAQ (Frequently Asked Questions)

1. Phenomenon: after EN enable, the motor is out of control to run away.

Solution: first check if the hall signal line and the motor phase line have been connects correctly. If correct, try to change the Hall sequence. For example, if the current setting is 60 degrees, change to 300 degrees. If 120 degrees, then change to 240 degrees.

2. Phenomenon: after EN enables, the motor vibration or does not work, after a few seconds it occurs over-current protection.

Solution: This situation is caused generally by hall signal line or motor phase line error. If the phase sequence of the motor and the hall signal are unknown, we can fix the motor line connection, and then adjust the order of the three hall lines. By try again and again, you will find the correct corresponding phase sequence.

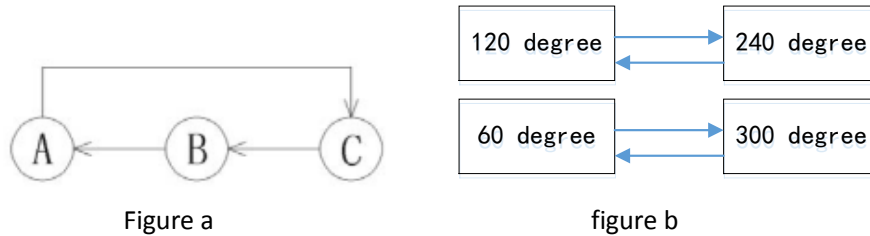
3. Phenomenon: after EN enable, the hall signal appears error alarm when the motor rotates an angle.

Solutions: make sure that the hall signal line is connected reliably, if it is reliable, the hall sequence is changed in the configuration software, change to 120 degrees if the current setting is 60 degrees or 300 degrees. if 120 or 240 degrees, change to 60 degrees. If you have the same

phenomenon as the problem 1 and 2 after the change, the troubleshooting will be carried out according to the corresponding solution.

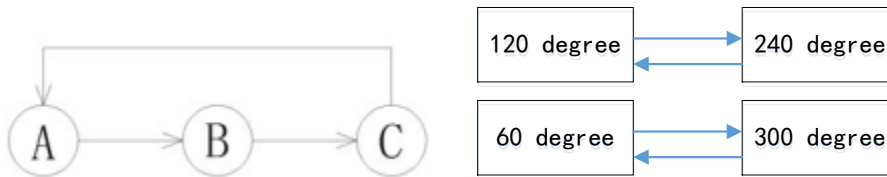
4. Phenomenon: motor likes to works normally. But the temperature is higher than at normal case. When disconnect the EN and GND pins, it occurs the power supply protection.

Solution: Left shift the hall signal line according to the following figure a. And then change the hall sequence as following figure b.



5. Phenomenon: motor works well but it contains large vibration. The motor temperature rise is slightly higher than at normal case. When reverse the FR signal, it occurs protection phenomenon.

Solution: Left shift the hall signal line according to the following figure a. And then change the hall sequence as following figure b.



6. Installation Dimensions

