

DM542

**Digital two-phase stepper driver
instruction manual**

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[Please read this manual carefully before use to avoid damage to the driver]

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DM542 Digital two-phase stepper driver

1. Product introduction

1.1 Overview

DM542 is our company's new digital stepper motor driver, It uses the latest 32-bit DSP digital processing technology, The driver control algorithm adopts advanced variable current technology and advanced frequency conversion technology, The driver has low heat, small motor vibration and stable operation. Due to the use of built-in micro-segmentation technology, even under the condition of low-segmentation, the effect of high-segmentation can be achieved. The low, medium and high speed operation is very stable, and the noise is ultra-low. The driver integrates the parameter power-on auto-tuning function, which can automatically generate optimal operating parameters for different motors and maximize the performance of the motor.

1.2 Characteristics

- new 32-bit ARM technology
- ultra low vibration noise
- built-in high segmentation
- parameter power-on auto-tuning function
- variable current control greatly reduces motor heating
- the current is automatically halved at rest
- can drive 4,6,8 line two-phase stepper motor
- optically isolated differential signal input
- the impulse response frequency can reach up to 500KHz (factory default 200KHz)
- easy to set current, can choose between 0.1-4.2A
- the subdivision setting range is 400-25600
- Protection against overvoltage, undervoltage,

1.3 Application field

Be suitable for all kinds of small and medium-sized automation equipment and instruments, such as: engraving machine, marking machine, cutting machine, laser phototypesetting, plotter, CNC machine tool, automatic assembly equipment, etc. It is especially effective in applications where users expect small noise and high speed.

2. Electrical, mechanical and environmental indicators

2.1 Electrical index

Description	DM542
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	Minimum value	Typical value	Maximum value	Unit
Output current	0.1	-	4.2	A
Input supply voltage	24	36	50	VDC
Control signal input current	6	10	16	mA
Control signal interface level	4.5	5	28	Vdc
Input signal minimum pulse width	1.5	-	-	us
Step pulse frequency	0	-	200	KHz
Insulation resistance	100			MΩ

2.2. Use environment and parameters

cooling method		Natural cooling or forced air cooling
Use environment	occasion	Can not be placed next to other heat-generating equipment, to avoid dust, oil mist, corrosive gas, humidity and strong vibration, prohibiting flammable gas and conductive dust;
	temperature	-5℃ ~ +50℃
	humidity	40 ~ 90%RH
	vibration	5.9m/s2MAX
Storage temperature		-20℃~80℃
Use altitude		Below 1000 meters
Weight		About 280 g

2.3 Mechanical installation diagram

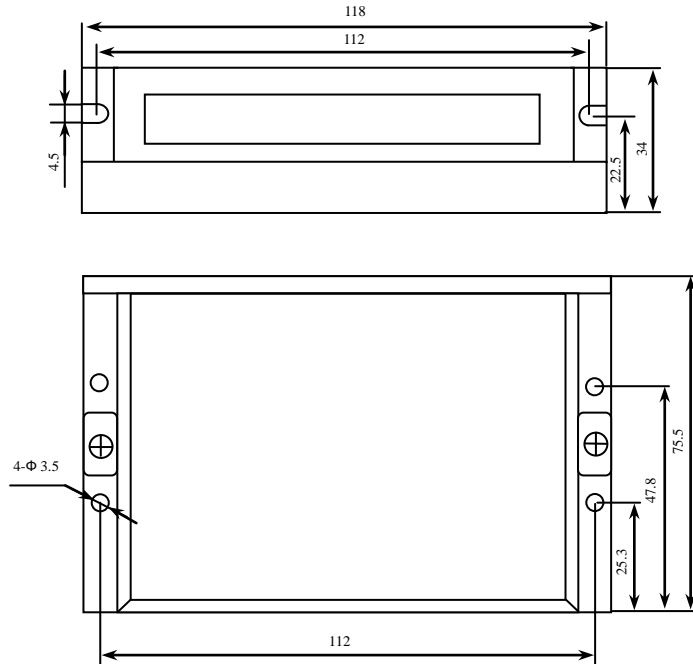


Figure 1 Installation dimensions (unit: mm)

※It is recommended to use side mounting for better heat dissipation. When designing the mounting dimensions, pay attention to the terminal size and wiring!

2.4. Strengthen heat dissipation

- 1) The reliable operating temperature of the driver is usually within 60 °C, and the motor operating temperature is within 80 °C;
- 2) It is recommended to use the automatic semi-flow mode when using the motor. When the motor stops, the current is automatically reduced by half to reduce the heat of the motor and the drive;
- 3) When installing the driver, please install it on the vertical side to make the heat dissipating teeth form a strong air convection; if necessary, install a fan near the driver to force heat dissipation to ensure the driver works within the reliable working temperature range.

3. Driver interface and wiring introduction

3.1 Interface description

1) Control signal interface





Name	Function
PUL+	Pulse signal: pulse rising edge is valid; PUL is 4.5~28Vdc at high level and 0~0.5V at low level. In order to respond reliably to pulse signals, the pulse width should be greater than 1.5 μs.
PUL-	
DIR+	Direction signal: high/low level signal, in order to ensure reliable commutation of the motor, the direction signal should be established before the pulse signal is at least 2μs. The initial running direction of the motor is related to the wiring of the motor. Interchanging any phase winding (such as A+, A-exchange) can change the direction of initial operation of the motor. DIR is 4.5~28Vdc at high level and 0~0.5V at low level.
DIR-	
ENA+	Enable signal: This input signal is used to enable or disable. When ENA+ is connected to 4.5~28Vdc, when ENA- is connected to low level (or internal optocoupler is turned on), the driver will cut off the current of each phase of the motor to make the motor free, and the stepping pulse will not be responded. When this function is not needed, the enable signal is left floating.
ENA-	

2) Power interface

Name	Function
DC-	DC power ground
DC+	DC power supply positive, power supply voltage range: DC 24~50Vdc, recommended 36Vdc operation.
A+, A-	Motor A phase coil interface.
B+, B-	Motor B phase coil interface.

3) Status indication

The green LED is the power indicator. When the driver is powered on, the LED is always on; when the driver is powered off, the LED is off. The red LED is a fault indicator. When a fault occurs, the indicator flashes in a cycle of 3 seconds. When the fault is cleared by the user, the red LED is always off. The number of flashes of the red LED in 3 seconds represents different fault information, as shown in the following table:

Serial number	Number of flashes	Red LED flashing waveform	Fault description
1	1		Overcurrent or phase-to-phase short circuit fault
2	2		Overvoltage fault
3	3		No definition
4	4		No definition

3.2. Control signal interface circuit

DM542 driver adopts a differential interface circuit which can be applied to differential signals, single-ended common cathode and single-ended common anode interfaces, built-in high-speed photocoupler, allowing to receive signals from long-line drivers, open collectors and PNP output circuits. In harsh environments, we recommend using long-line driver circuits, which have strong anti-interference ability. Now take the open collector and PNP output as an example, the interface circuit diagram is as follows:

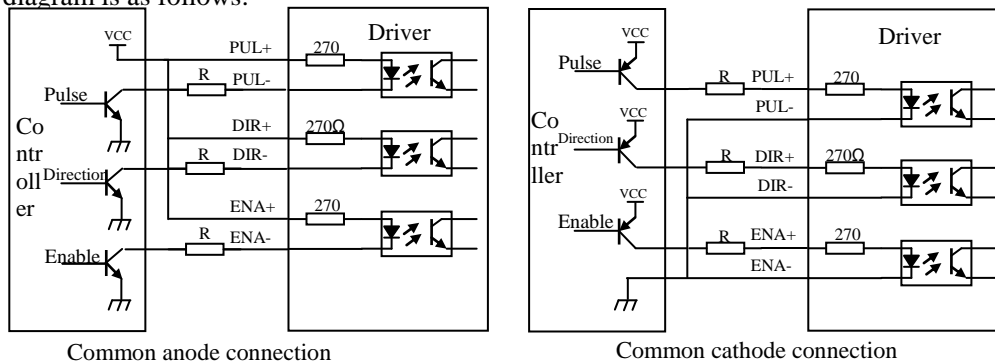


Figure 3 Input interface circuit

Note: When the VCC value is 4.5~28Vdc, R is shorted or not connected;

3.3. Control signal timing diagram

In order to avoid some malfunctions and deviations, PUL, DIR and ENA should meet certain requirements, as shown in the following figure:

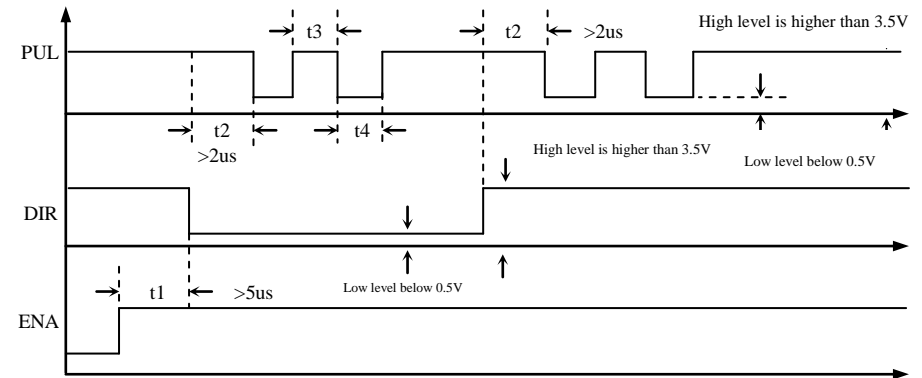


Figure 4 control signal timing diagram

Note:

- 1) t_1 : The ENA (enable signal) should be determined to be high by a DIR of at least 5 μs in advance. In general, it is recommended that ENA+ and ENA- be left floating.
- 2) t_2 : The DIR determines its state to be high or low at least 2 μs along the PUL fall.
- 3) t_3 : The pulse width is at least not less than 2 μs.
- 4) t_4 : The low level width is not less than 2μs.

3.4 Wiring requirements

1) In order to prevent the driver from being interfered, it is recommended to use shielded cables for the control signal and short-circuit the shielding layer with the ground wire. Except for special requirements, the shielding wire of the control signal cable should be grounded at one end: one end of the upper computer of the shielded wire is grounded, and the shielded wire One end of the driver is suspended. Only the same point is allowed to be grounded in the same machine. If it is not a real ground wire, the interference may be serious, and the shielding layer is not connected at this time.

2) The pulse and direction signal wires and the motor wires are not allowed to be wrapped side by side, preferably separated by at least 10cm, otherwise the motor noise will easily interfere with the pulse direction signal and cause the motor to be inaccurately positioned and the system to be unstable.

3) If one power supply supplies multiple drivers, parallel connection should be adopted at the power supply, and it is not allowed to connect to one driver first and then to the other in chain connection.

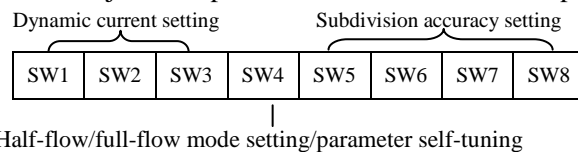
4) It is strictly forbidden to unplug and plug the strong current P2 terminal of the driver when the power is on. When the charged motor stops, there is still a large current flowing through the coil. Plugging and unplugging the P2 terminal will cause a huge momentary induced electromotive force and burn the driver.

5) It is strictly forbidden to connect the wire head to the terminal after tinning, otherwise the terminal may be damaged by overheating due to the increase of contact resistance.

6) The wire end of the wiring should not be exposed outside the terminal to prevent accidental short circuit and damage to the driver.

4. Current, subdivision DIP switch setting and parameter auto-tuning

DM542 driver adopts eight-position DIP switch to set the subdivision accuracy, dynamic current, static half current and realize the self-tuning of motor parameters and internal adjustment parameters. The detailed description is as follows:



4.1. Current setting

1) Working (dynamic) current setting

Output peak current	Output average current	SW1	SW2	SW3
1.00	0.71	on	on	on
1.46	1.04	off	on	on
1.92	1.36	on	off	on
2.37	1.69	off	off	on
2.84	2.03	on	on	off
3.32	2.36	off	on	off
3.76	2.69	on	off	off
4.20	3.00	off	off	off

2) Static (static) current setting

The quiescent current can be set with the SW4 dip switch, off means that the quiescent current is set to half of the dynamic current, and on means that the quiescent current is the same as the dynamic current. In general use, SW4 should be set to off, so that the heating of the motor and driver is reduced and the reliability is improved. After the pulse train stops, the current is automatically reduced to about half (60% of the actual value) for about 400ms, and the calorific value is reduced to 30% in theory.

4.2. Subdivision setting

Steps / rpm	SW5	SW6	SW7	SW8
400	off	on	on	on
800	on	off	on	on
1600	off	off	on	on
3200	on	on	off	on
6400	off	on	off	on
12800	on	off	off	on
25600	off	off	off	on
1000	on	on	on	off
2000	off	on	on	off
4000	on	off	on	off
5000	off	off	on	off
8000	on	on	off	off
10000	off	on	off	off
20000	on	off	off	off
25000	off	off	off	off

4.3 Parameter self-tuning function

If SW4 is toggled once within 1 second, the drive can automatically complete the auto-tuning of motor parameters and internal adjustment parameters; please perform auto-tuning once when the conditions of the motor, power supply voltage, etc. change, otherwise, the motor may not run normal. **Note that pulses cannot be input at this time, and the direction signal should not change.**

Implementation Methods 1) Switch SW4 from "on" to "off", and then switch from "off" to "on" within 1 second;

Implementation Methods 2) Switch SW4 from "off" to "on", and then switch from "on" back to "off" within 1 second.

5. Power supply selection

The power supply voltage can work normally between the specified ranges. The

DM542 driver is preferably powered by an unregulated DC power supply, or a transformer buck + bridge rectifier + capacitor filter. Note, however, that the peak voltage ripple after rectification should not exceed its specified maximum voltage. It is recommended that the user supply power with a DC voltage lower than the maximum voltage to prevent the grid from fluctuating beyond the operating range of the driver voltage.

If using a regulated switching power supply, be aware that the output current range of the switching power supply must be set to maximum.

Please note:

- 1) When wiring, pay attention to the positive and negative poles of the power supply.
- 2) It is best to use an unregulated power supply;
- 3) When using an unregulated power supply, the power supply current output capability should be greater than 60% of the driver set current;
- 4) When using a regulated switching power supply, the output current of the power supply should be greater than or equal to the operating current of the driver;
- 5) In order to reduce the cost, two or three drives can share one power supply, but the power supply should be large enough.

6. Motor matching

DM542 can be used to drive 4, 6, and 8-wire two-phase and four-phase hybrid stepper motors, and the step angle is 1.8 degrees and 0.9 degrees. When selecting a motor, it is mainly determined by the torque and rated current of the motor. The torque is mainly determined by the size of the motor. Large-sized motors have a larger torque; and the magnitude of the current is mainly related to the inductance. Small-inductance motors have good high-speed performance, but the current is larger.

6.1. Motor matching

1) Determine load torque, driver ratio operating speed range

$$T_{\text{motor}} = C (J\varepsilon + T_{\text{load}})$$

J: Moment of inertia of the load ε : Maximum angular acceleration of the load

C: Safety factor, recommended value 1.2-1.4

T load: maximum load torque, including effective load, friction, transmission efficiency and other resistance torque

2) What factors are determined by the motor output torque?

For a given stepper motor and coil connection, the output torque has the following characteristics:

- The larger the actual motor current, the greater the output torque, but the more copper loss ($P=I^2R$) of the motor, the more heat the motor generates;

- The higher the power supply voltage of the driver, the higher the high-speed torque of the motor;
- It can be seen from the moment frequency characteristic diagram of the stepper motor that the high speed is smaller than the medium and low speed torque.

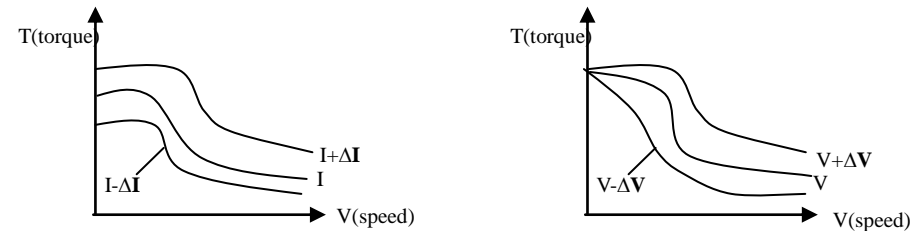


Figure 5 Moment frequency characteristic diagram

6.2 Motor wiring

For 6- and 8-wire stepper motors, the performance of the connected motors of different coils is quite different, as shown in the following figure:

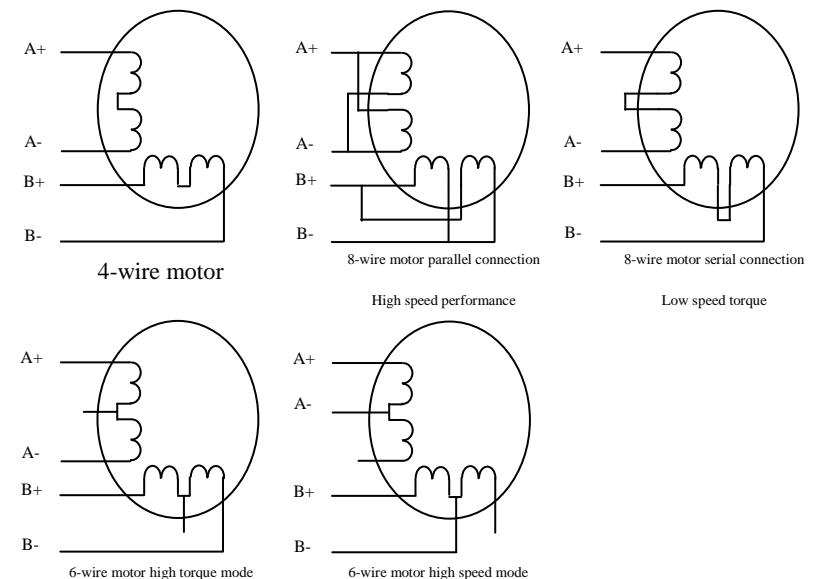


Figure 6 Motor wiring diagram

6.3 Input voltage and output current selection

1) Supply voltage setting

In general, the higher the supply voltage, the greater the torque at high motor speeds. The more you can avoid falling when you are at high speed. On the other hand, if the voltage is too high, it will cause overvoltage protection, and the motor will generate more heat and may even damage the driver. When operating at high voltages, the vibration of the motor at low speeds will be greater.

2) Set value of output current

For the same motor, the larger the current setting value, the larger the motor output torque, but the heat of the motor and the driver is also more serious when the current is large. The magnitude of the specific heat generation is not only related to the current set value, but also to the type of exercise and the dwell time. The following setting method uses the rated current value of the stepper motor as a reference, but the optimum value in practical applications should be adjusted based on this. In principle, if the temperature is very low ($<40^{\circ}\text{C}$), the current setting value can be appropriately increased to increase the motor output power (torque and high-speed response).

- Four-wire motor: The output current is set to be equal to or slightly smaller than the rated current of the motor;
- Six-wire motor high torque mode: the output current is set to 50% of the rated current of the motor unipolar connection;
- Six-wire motor high-speed mode: the output current is set to 100% of the rated current of the motor unipolar connection;
- Eight-wire motor series connection method: the output current can be set to 70% of the rated current of the motor unipolar connection;
- Eight-wire motor and connection method: The output current can be set to 140% of the rated current of the motor unipolar connection.

△Note: Please run the motor for 15-30 minutes after the current is set. If the motor temperature rise is too high ($>70^{\circ}\text{C}$), the current setting should be reduced. Therefore, it is generally the case that the current is set to a value that is warm but not hot when the motor is operated for a long period of time.

7. Typical wiring case

DM542 is equipped with motors in series and connected in parallel (if the rotation of the motor is different from the expected rotation, just exchange the positions of A+ and A-). The DM542 driver can drive four-wire, six-wire or eight-wire two-phase/four-phase motors. The following figure details the connection of 4-wire, 6-wire and 8-wire stepper motors:

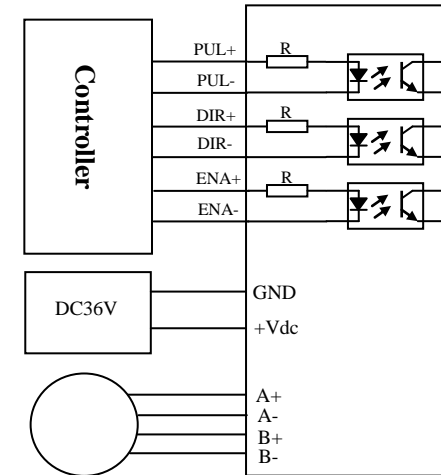


Figure 7 DM542 typical connection

Note:

- 1) The colors of different motors are different. Please refer to the motor data when using. For example, the colors of the 57 and 86 motors are different.
- 2) The phases are relative, but the windings of different phases cannot be connected to the terminals of the same phase of the driver (A+, A- are one phase, B+, B- are the other phases), 57HS22 motor lead definition, series and parallel connection method As shown below.

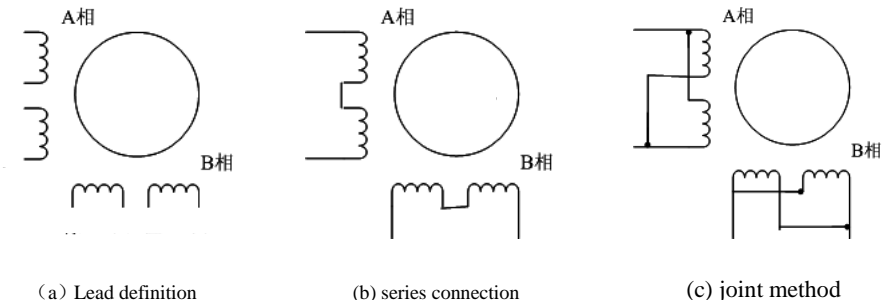


Figure 8 57 motor serial-parallel connection

3) DM542 driver can only drive two-phase hybrid stepper motors, but not three-phase and five-phase stepper motors.

4) The method of judging whether the stepper motor is connected in series or in parallel is correct: directly rotate the shaft of the motor by hand without connecting to the drive. If it can rotate easily and evenly, it means the wiring is correct. If there is greater resistance and Unevenness and a certain sound indicates that the wiring is wrong.

8. Protective function

1) Short circuit protection

When an interphase short circuit occurs or an internal overcurrent occurs in the driver, the red light of the driver flashes once and blinks repeatedly within 3 seconds. At this point, the fault must be discharged and the power-on reset should be resumed.

2) Overvoltage protection

DM542 when the input voltage is higher than 90V, the red light of the driver flashes twice, and it flashes repeatedly within 3 seconds. At this point, the fault must be discharged and the power-on reset should be resumed.

3) Motor open circuit protection

When the motor is open or not connected, the driver flashes red 4 times and flashes repeatedly within 3 seconds. At this point, the fault must be discharged and the power-on reset should be resumed.

△ Note: Since the driver does not have the reverse polarity protection function of the power supply, please confirm the correct connection between the positive and negative terminals of the power supply before powering on. Reversing the positive and negative poles will cause the fuse in the drive to burn out!

9. common problem

9.1 Common problems and treatment methods in the application

Phenomenon	Possible problem	Solution
Motor does not turn	Power light is not lit	Check the power supply circuit, normal power supply
	Motor shaft is powerful	The pulse signal is weak and the signal current is increased to 7-16mA.
	Subdivision is too small	Selective segmentation
	Current setting is too small or not	Selective current

	Driver is protected	Power on again
	Enable signal is low	This signal is pulled high or not
	Does not respond to control signals	Not powered
Motor steering error	Motor line is wrong	Any two wires of the same phase of the exchange motor (for example, A+, A-exchange wiring positions)
	The motor line has an open circuit	Check and pick up
Alarm indicator is on	Motor line is wrong	Check wiring
	Voltage is too high or too low	Check the power supply
	Motor or drive damage	Replace the motor or drive
Inaccurate location	Signal interference	Eliminate interference
	The shield is not connected or not connected well	Reliable grounding
	The motor line has an open circuit	Check and pick up
	Subdivision error	Set the subdivision
	Small current	Increase current
Stall when the motor accelerates	Acceleration time is too short	Accelerated acceleration time
	Motor torque is too small	Select a large torque motor
	Low voltage or too small current	Appropriately increase the voltage or current

1) What is a stepper motor and a stepper driver?

Stepper motor is a special motor specially designed for precise control of speed and position. Its rotation is operated step by step at a fixed angle (called "step angle"), so it is called stepper motor. Its characteristic is that there is no accumulated error, every pulse signal sent from the controller is received, and the motor runs at a fixed angle under the drive of the driver, so it is widely used in various open-loop control.

The stepper driver is a power amplifier that can operate the stepper motor. It can convert the pulse signal sent by the controller into the power signal of the stepping motor. The speed of the motor is proportional to the pulse frequency, so the control pulse frequency can be precisely adjusted. Speed, the number of control pulses can be accurately positioned.

2) What is the breakdown of the driver? What is the relationship between the speed of the stepper motor and the pulse frequency?

The stepper motor is determined by its own unique structure. The factory is marked with the “inherent step angle of the motor” (such as 0.9 °/1.8 °, which means that the angle of the half step work is 0.9 ° for each step, and 1.8 ° for the whole step.). However, in many precision control and occasions, the angle of the whole step is too large, affecting the control precision, and the vibration is too large. Therefore, it is required to complete the inherent step angle of a motor in many steps. This is called a subdivision drive and can realize this function. The electronic device is called a subdivision driver.

$$V = \frac{P \cdot \theta_e}{360 \cdot m}$$

V: Motor speed (r/s) P: Pulse frequency (Hz)

θ_e : Inherent step angle of the motor

m: Subdivision number (1 for the whole step and 2 for the half step)

3) What are the advantages of subdividing drivers?

- By reducing the step angle that each step has passed, the step uniformity is improved, so that the control accuracy can be improved.
 - Motor vibration can be greatly reduced, low frequency oscillation is an inherent characteristic of stepper motor, and subdivision is the best way to eliminate it.
 - It can effectively reduce torque ripple and increase output torque.
- These advantages are generally recognized by users and bring them benefits, so it is recommended that you use subdivision drivers.

4) Why does my motor only work in one direction?

- The direction signal may be too weak or the wiring polarity is wrong.
- The pulse mode does not match, the signal is pulse/direction, the driver must be set to this mode; if the signal is CW/CCW (double pulse mode), the driver must also be in this mode, otherwise the motor will only run in one direction.