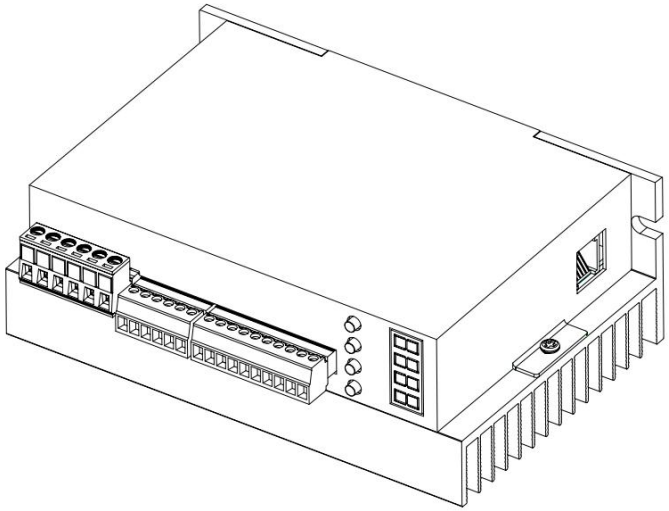
86 Closed-Loop Digital Step Driver

User Manual V202404.13

read this manual carefully before use to avoid damaging the drive



Focus on Step, Servo and Motion Control

catalogue

1. Introduction

86 The digital display closed-loop stepper driver employs advanced vector closed-loop control technology, effectively eliminating the step-loss issue inherent in traditional open-loop stepper motors. It significantly enhances the motor's rapid response and high-speed performance while reducing heat generation and vibration, thereby improving the equipment's operational speed and precision while lowering energy consumption. Additionally, the driver issues an alarm signal when the motor experiences continuous overload, ensuring reliability comparable to AC servo systems. The compatible motor mounting dimensions fully align with conventional (57/60) and 86 series stepper motors, enabling seamless upgrades from traditional open-loop stepper drive solutions. This design offers substantial cost advantages over AC servo systems.

This drive is suitable for a variety of small and medium-sized automation equipment and instruments, such as: wood carving machine, wire harness processing machine, laser cutting machine, high-speed plotter, small CNC machine tools, automation assembly equipment, etc. It is especially effective in the equipment which requires low noise, smooth operation and high speed response.

technical feature

- 32-bit motor control chip is used.
- The advanced vector closed-loop control technology is adopted;
- The LED digital display enables convenient parameter configuration and real-time monitoring of operational status.
- Static and dynamic currents can be set arbitrarily (within the 0～8.2A range);
- can drive (57/60) and 86 series hybrid closed-loop stepper motors;
- photoelectric isolation signal input/output;
- The frequency of impulse response is 200KHz.
- 16 universal subdivision options with maximum 256 subdivisions (51,200 pulses per revolution);
- Provide an electronic gear ratio (any subdivision value);
- It has overcurrent, overheat, overvoltage, phase loss and tracking error protection;
- The position control mode and the speed control mode are optional.
- There are two control modes in position mode (full closed loop and power angle closed loop).
- The open-loop function mode is integrated;

II. Electrical, Mechanical and Environmental Indicators

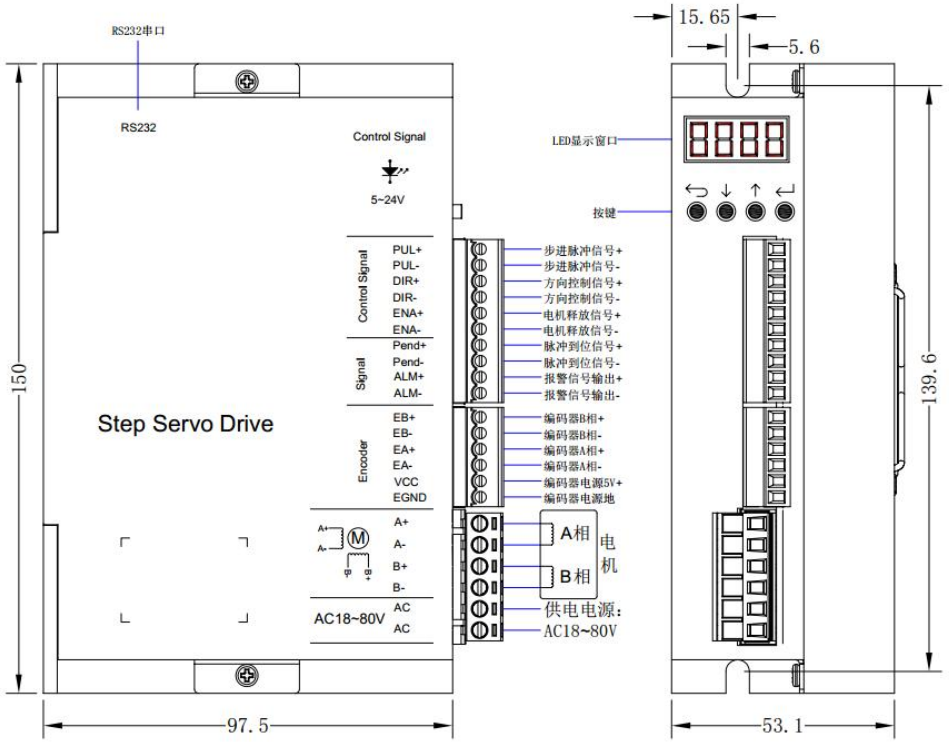
2.1 Electrical Specification

Parameter	Least value	Representative value	Crest value	Unit
Continuous output current	0	-	8.2	A
Input DC power voltage	+24	+48	+110	Vdc
Input power supply voltage (AC)	18	60	80	AC
Logic input current	7	10	20	mA
Impulse frequency	0	-	200	kHz
Insulation resistance	500			MΩ
Provide encoder current			50	mA

2.2 Environment and Parameters

Cooling-down method	The built-in cooling fan provides heat dissipation (if the radiator temperature exceeds 40°C, the fan will activate)	
Service environment	Usage scenarios	Avoid dust, oil mist, and corrosive gases
	temperature	-10℃～50℃
	Humidity	40～90%RH
	Shake	5.9 m/s² Max
Storage temperature	-20℃～+80℃	
Weight	560 grams	

2.3 Mechanical Installation Dimensions (mm)



Note: Keep the drive properly cooled

(1) The reliable working temperature of the drive is usually within 60℃, and the working temperature of the motor is within 80℃.

(2) When installing the drive, try to install it upright and sideways, away from heat source and not blocking the fan air duct. If necessary, install a cooling fan on the electrical cabinet to ensure the air convection inside and outside the cabinet and the drive operates within the reliable temperature range.

3. Introduction of Driver Port and Wiring

3.1 Port Definition and Lead Color Description

A. Motor and Power Input Ports

Terminal number	symbol	Name	Lead color explanation
1	A+	A-phase motor winding +	White
2	A−	A-phase motor winding-	Green
3	B+	B-phase motor winding +	Blue
4	B−	B-phase motor winding-	Black
5	AC/V+	Power input	AC18～80V/DC24～110V
6	AC/V−	Power input	

Note: Motor phase wires cannot be interchanged.

B. Encoder Signal Input Port

Terminal number	symbol	Name	Lead color explanation
1	EB+	Motor encoder B phase positive input	Yellow
2	EB−	Motor encoder B phase negative input	Green
3	EA+	Motor encoder A phase positive input	Black
4	EA−	Motor encoder A phase negative input	Blue
5	VCC	Encoder power supply +5V input	Red
6	EGND	Encoder power ground	White

C. Control Signal Port

Terminal number	symbol	Name	Explain
1	PUL+	Positive pulse input	The signal source can drive both +5V and 24V.
2	PUL−	Pulse negative input	
3	DIR+	Positive directional input	The signal source can drive both +5V and 24V.
4	DIR−	Negative input	
5	ENA+	Motor-enabled positive input	When the signal is valid, the motor is in a free state and not locked.
6	ENA−	Motor-enabled negative input	
7	Pend+	The arrival signal is now outputting.	After the motor is in position, the driver sends an output signal to the host computer.
8	Pend−	Signal output is at the right level	
9	ALM+	The alarm signal is being output.	The driver's fault protection system outputs signals to the host computer via P110 parameter settings for brake engagement control.
10	ALM−	Negative output of the alarm signal	

Note: When the driver fails, the ENA signal is active, and the driver will clear all faults.

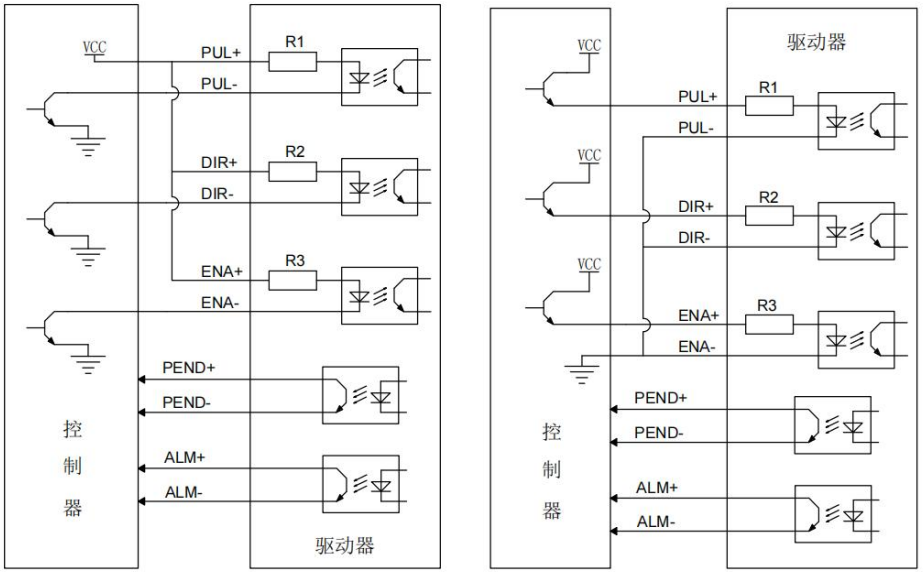
D. RS232 Communication Port

The driver connects to the PC using dedicated debugging software at a baud rate of 115200. A dedicated RJ11 interface cable is used, and pins 2, 3, and 5 can be connected during communication. The definitions are as follows:

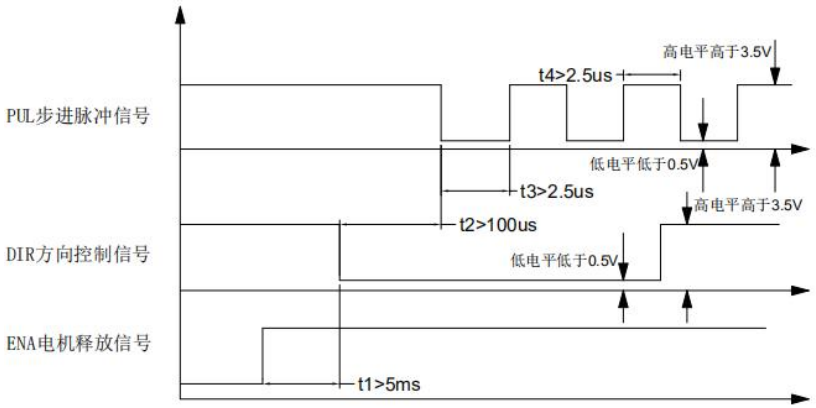
Terminal number	symbol	Name	Explain
1	+3.3V	3.3V power supply positive terminal	Reserve or skip
2	GND	GND signal ground	0V
3	RxD	RX data acceptance	
4	GND	GND signal ground	OV reservation may not be accepted
5	TxD	TX data transmission	
6	+5V	Positive terminal of the 5 V power supply	Reserve or skip

RS232 interface pin layout diagram

3.2 Control Signal Interface Circuit Diagram



3.3 Input Signal Waveform Timing Diagram



输入信号波形时序图

4. Parameter Settings

The control panel consists of 4-digit LED displays and 4 buttons.↩、↓、↑、↵ The components are designed to facilitate parameter setting and operational status monitoring.

Key Function Description Table

Key	Function declaration
↩	Exit to cancel the operation; return to the previous page and end parameter input
↓	Used to adjust the data size of the current bit when flipping pages or changing values
↑	Shift operations for data bits when flipping pages or changing values
↵	Enter parameter modification mode and confirm the modification. Hold down for 3 seconds.

When powered on, the drive displays the current version number, followed by its status after 3 seconds (standby speed: 0; fault codes are shown when issues occur). In normal operation, the motor's RPM (revolutions per minute) is displayed in real time. When the motor reverses, the leftmost digit (the highest bit) on the digital tube flashes. Multiple fault alarms occur simultaneously, with corresponding fault codes flashing in rotation.

In standby mode, long press"↵"Press 3 seconds to enter P parameter setting mode, display the first parameter **P001**(subdivision selection), press"↓"、"↑Press to select the P parameter type you want to change. For example, to change a fractional value, press again while P001 is displayed.↵ Press the key to enter, and the digital display shows the current subdivision value. Long press"↵ Press and hold the key for 3 seconds to enter edit mode. The current fraction value will flash.↓"、"↑ Press the key to flip pages and select the desired sub-value. Hold down the key to continue.↵Press and hold for 3 seconds to confirm. The value stops flashing, and the subdivision change is complete. Press↩Press Return.

P001 subdivision parameters,**P002** motor running direction and **P003** motor type these three types of parameters drive the internal of the corresponding values, only through"↓"、"↑"Click the page to select the required value. The **P004** and **P005** parameters can be set to any value according to the needs of the device. When entering the corresponding setting interface, press"↑ Select the data bit to change (units, tens, hundreds, or thousands) and press"↓Adjust the data size of this position (0 to 9). Other P parameters are set through↓"、"↑Use the key to flip pages and select.

Note: After modifying the parameter, the display interface returns to the current P parameter number.

4.1 Parameter Function Description

The driver provides two sets of parameters for user operation, with the P0 set used to configure standard parameter values (e.g.

Parameters such as subdivision, lock motor current, and motor type are specified, while the P1 group parameters are used to configure the driver's performance parameters.

Parameter Function Table

Parameter	Name	Parameter range	Explain
P000	Controlling parameter	～	See Section 4.5 P000 for configuration instructions
P001	Subcategory selection	SEt ，2～256	See 4.4 Driver Subsection Settings for details
P002	Motor running direction	0、1	Motor direction switching
P003	Motor type	57、86	(57/60),86 Flange motors
P004	Location tolerance limit	1～9999	Encoder feedback value, default 4000. If it exceeds 9000, the value is (X-9000) * 1000 + 9000. Setting it to 0 disables position tolerance detection, which may cause loss of control in abnormal conditions.
P005	Percentage of the lock current	0～100%	The system defaults to 50
P006	Electronic gear frequency divider molecule		This value cannot be set to 0. The default is 1.
P007	Electronic gear frequency divider denominator		This value cannot be set to 0. The default is 1.
P020	Input pulse count (4 bits)	～	Displays the cumulative total of external input pulses, with the high and low bits shown separately.
P021	Input pulse count high 4 bits	～	
P100	Percentage of operating current	10～120%	**Default 100**
P101	Current loop proportional coefficient	1～1000	**Factory settings cannot be modified**
P102	Current loop integral coefficient	1～1000	**Factory settings cannot be modified**
P103	Current loop damping coefficient	1～1000	**Factory settings cannot be modified**
P104	Speed loop proportional coefficient	1～1000	**See Section 4.3 for details on driver rigidity adjustment.**
P105	Velocity loop integral coefficient	1～1000	**See Section 4.3 for details on driver rigidity adjustment.**
P106	Position loop ratio coefficient	1～1000	**See Section 4.3 for details on driver rigidity adjustment.**
P107	Speed loop feedforward coefficient	1～100	**See Section 4.3 for details on driver rigidity adjustment.**
P108	Internal driver enable	0、1	Default is 1. The motor is enabled when powered on.
P109	Speed loop damping coefficient	1～100	*
P110	Input and output level settings	0020	See 4.6 P110 Settings for details
P111	Positioning accuracy	1～50	Default value is 1, with a positioning error of ±1 pulse. The larger the value, the greater the positioning error. A larger value under heavy load can suppress resonance.
P112	Resonance coefficient	1～12	The default value is 6. For the same rigidity, the smaller the value, the shorter the positioning time and the more likely resonance occurs; the larger the value, the longer the positioning time and the less likely resonance occurs. You can modify it for special applications.
P200	Run mode selection	0、1、2、3	See Section 4.2 for details on the driver's operating mode.
P201	Speed setting	Default 60	RPM setting in I/O speed mode, unit: RPM
P202	Acceleration and deceleration time	100ms	Acceleration/deceleration time in I/O speed mode, in milliseconds
P203	Delay release of brake	Default 0	See 4.7 P203 Settings
P204	Alarm control mode	0、1、2	See 4.8 P204 Settings
P300	Current value in open-loop mode	4.8A	P200 is valid in the 3 open-loop mode
P301	After power-on, return to the initial position.	0	Set to 1 to return the motor to its initial position after power-on.
P304	Encoder type selection	1000	1000,2000,2500
P305	Overload time	160	Set to 0 to disable overload alarm (seconds)

4.2 Drive Mode Settings

The P200 driver supports four operating modes, as follows:

Parameter	Parameter values	Parameter description (effective only after power-on)
P200	0	Full closed-loop mode (position mode), default
	1	I/O speed mode
	2	Angle of power closed loop mode (position mode)
	3	Open-loop stepping mode. The current value is set through the P300 parameter.

4.3 Drive Rigidity Adjustment

4.3.1 When P200=0, the Driver's Rigidity Parameters Are Adjusted as Follows in the Fully Closed-Loop Mode:

Parameter	Parameter name	Parameter declaration
P104	Speed loop proportional coefficient	The higher the value is, the higher the gain and the greater the rigidity.
P105	Velocity loop integral coefficient	The smaller the value is, the faster the integration speed is, the stronger the resistance to deviation is, the greater the rigidity is, and the smaller the value is, the more likely to cause overshoot.
P106	Position loop ratio coefficient	The smaller the value is, the higher the gain, the greater the rigidity and the faster the position tracking.
P107	Speed loop feedforward coefficient	The higher the value, the faster the tracking speed and the greater the rigidity, with a maximum of 100.

4.3.2 When P200 Equals 2, the Driver's Rigidity Parameters Are Adjusted as Follows Under the Power Angle Closed-Loop Mode:

Parameter	Parameter name	Parameter declaration
P104	Speed loop proportional coefficient	The default value is 10. The higher the value, the slower the position loop response and the weaker the rigidity.
P106	Position loop ratio coefficient	The default value is 25. The higher the value, the slower the position loop response and the weaker the rigidity.

4.4 Internal Driver Subdivision Settings (P001 Parameter Value) Driver Subdivision Table

Optional fraction	SEt,2,4,5,8,10,16,20,25,32,40,50,64,100,128,200,256

pay attention to：

1、The host computer calculates the pulse equivalent by multiplying the fractional value in the table by 200, yielding the subdivision value in units of pulses per revolution.

2、When the selected subdivision in P001 is **SEt**, the driver subdivision is defined by an electronic gear variable.

Electronic gears enable the definition of unit pulse commands for the driver, allowing the transmission system to move any distance. The pulse commands generated by the upper controller are independent of the transmission system's gear ratios, reduction ratios, or motor encoder line counts. This design allows seamless compatibility with various pulse sources to achieve optimal control resolution (angle/pulse). The calculation method is as follows:

Calculation formula:**P×G= N×C×4**

P: Number of input pulses

G: Electronic gear ratio:

G numerator / denominator

N: Number of rotations of the motor

C: The photoelectric encoder has a line-to-turn ratio of 1000.

For example: When the upper controller outputs an instruction pulse of 6000, the motor rotates one full turn.

$$G=\frac{N*C*4}{P}=\frac{1*1000*4}{6000}=\frac{2}{3}$$

Set parameter P006 to 2 and P007 to 3. The results above are derived through mathematical reduction, with the aim of selecting the least common denominator. The recommended range for the electronic gear ratio is:

$$\frac{1}{20}\le G\le 20$$

4.5 P000 Parameter Description

P000 is a control parameter with the default value "0000". The table below lists the functions corresponding to specific values.

P000	Function declaration
“1111”	Restore the driver to factory default settings
“0100”	The software turns on the drive fan.
“0101”	Display the motor's real-time speed (default when the driver is powered on)
“0102”	Real-time display of the DC bus voltage inside the drive
“0103”	Display the internal temperature of the drive in real time
“0104”	Display location error in real time
“0105”	Query the drive's production date
“0106”	View the drive's history of failures. The number 1 is the most recent failure.
“0200”	The drive enters self-test mode

Note: Set P000 to "0200" to enter self-test mode. The motor defaults to 60 rpm. ↓”、“↑The speed control knob allows adjustment between-300 to +300 rpm, with the digital display showing real-time motor speed.⮌Press to cancel test mode.

4.6 P110 Parameter Description

P110 is the input/output (IO) port level setting. The default parameter value is "0020", which is defined as follows:

Highest order	ENA enable level	0: External low-level enable; 1: External high-level enable
Second lowest	PUL level selection	0: Pulse + direction mode, triggered by the falling edge; 1: Pulse + direction mode, triggered by rising edge; 2: Double pulse mode, triggered by the falling edge; 3: Double pulse mode, triggered by the rising edge.
Second least significant bit	Pend signal	Default value: 2,control brake(normally closed output); 0: Run high resistance,set low resistance; 1: Run low resistance,set high resistance
Lowest order	ALM fault level	0 Normal high resistance, fault low resistance; 1: Normal low resistance, fault high resistance. When set to 1, ALM can also control the brake.

4.7 P203 Brake Delay Release Parameter Description

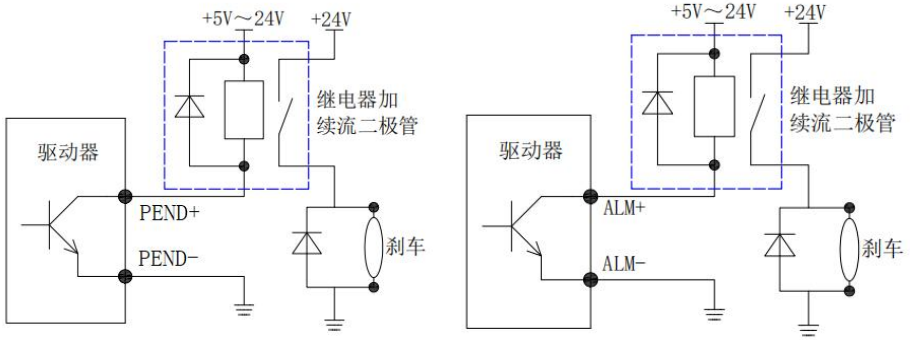
When the motor is connected to a brake, the brake signal is controlled by the Pend output pin by default. P203 controls the brake release delay time in milliseconds.

Parame-ter	Parameter val-ues	Parameter decl-aration
P203	0	The brake is released only after the driver's PWM wave output is normal and the motor is fully excited, responding to the external pulse signal and encoder feedback.
	200	The brake is released after the driver's PWM wave output is normal and the motor is fully excited, and the delay time is set to respond to the external pulse and encoder feedback.

Brake motor wiring method:

The brake coil generates significant surge currents during operation. Directly connecting it to the driver's output port may damage the optocoupler, requiring a relay for relay control. As both the brake coil and relay coil are inductive loads, a freewheeling diode (e.g., IN4007) is recommended. Note that the diode polarity must never be reversed.

We recommend using solid-state relays, which eliminate the need for freewheeling diodes. Key advantages include: rapid response, diode-free operation, and silent switching. Refer to the wiring diagram below for relay connections.



4.8 P204 Parameter Description

The default control mode setting for the P204 driver alarm is 0, as follows:

Parameter	Parameter val-ues	Parameter decl-aration
P204	0	By default, the driver turns off PWM output after an alarm, and the motor is not controlled.
	1	After the alarm, the motor is controlled by PWM with constant current output. After 3 seconds, the current starts to decrease gradually, and the PWM output stops. This prevents the workpiece from colliding with the equipment due to inertia during the alarm.
	2	After the drive alarm, the system outputs PWM control motor with constant current. After 3 seconds, the system clears the fault and restarts. After clearing the fault twice, the system will not restart if the fault persists.

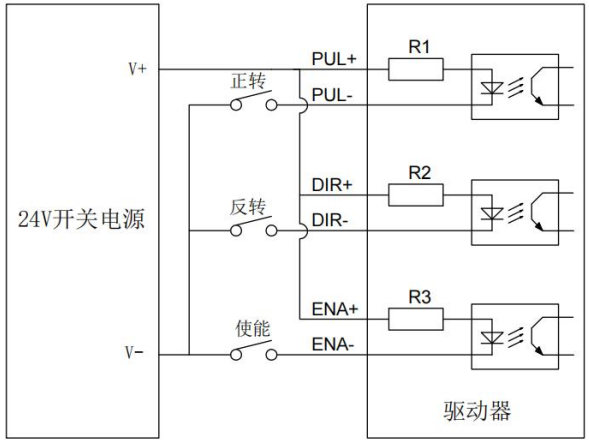
Note: When the overcurrent alarm is set, no PWM output is generated for any value.

When P204 is set to 1, the system triggers a non-zero alarm, and the driver delays motor release to prevent workpiece impact due to inertia.

4.9 I/O Speed Mode

When P200 is set to "1", the drive operates in I/O speed mode. P201 and P202 are valid in speed mode. P201 sets the motor speed (rpm). P202 sets the acceleration and deceleration time in milliseconds. The control method and wiring method are as follows:

Impulse /PUL	Direction /DIR	Content
0	0	The motor has stopped runn-ing.
0	1	The motor operates at the speed set by P201, with direction switching controlled by PUL/DIR (P002 allows direction adjustment).
1	0	
1	1	The motor has stopped runn-ing.



V. Driver Alarm Codes

When a drive fails, the corresponding fault code flashes. If multiple alarms occur, they will be displayed in rotation. You can view historical faults by setting parameters in P000. You can also access this information through the external ENA interface.

Clear the current fault.

List of Alarm Codes

Alarm code	Alarm name	Alert content
Er 01	Excess current	The motor current is too high (due to an internal short circuit in the driver or a short circuit in the motor wires)
Er 02	Exceed the speed limit	The motor speed exceeds the maximum limit (5000 rpm)
Er 03	Location deviation	The positional deviation exceeds the P004 set value. Possible causes: 1、 The phase of the encoder wire and the power line is wrong. 2、 The acceleration time is too short, and the speed is too high, causing the motor to fail to respond in time. 3、 Motor torque is small and the load is not moved (stall).
Er 04	Drive overheating	The drive temperature exceeds the protection threshold (maximum 80°C)
Er 05	DC overvoltage	The main circuit input voltage exceeds the maximum limit
Er 06	EPROM wrong	EPROM read/write error
Er 07	Overload alarm	Motor stall (failure to reach set position for prolonged duration)
Er 08	Motor connection fault	Motor wiring error or broken wire (phase loss)

VI. Product Warranty Terms

1、 Guarantee Period

Our company provides a 2-year warranty on products from the date of self-delivery, and offers free repair services during the warranty period.

2、 Not Covered by Warranty

- Improper wiring, such as connecting power cords to motor terminals or plugging/unplugging while powered on
- Unauthorized modification of internal components
- Use beyond electrical and environmental requirements
- The environmental heat dissipation is too poor.