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Full Digital Closed-Loop Two-Phase Stepper Driver User Manual

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Contents

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HBS57

Fully Digital Closed-Loop Stepper Driver

I. Product Introduction

1. Overview

The HBS57 is a new type of closed-loop stepper motor driver developed by our company based on over ten years of experience in stepper and servo research and development. It uses the latest dedicated motor control dual-core DSP chip and vector closed-loop control algorithm, which completely overcomes the problem of step loss in open-loop stepper motors. It also significantly improves the motor's high-speed performance, reduces motor heating, and minimizes motor vibration at high, medium, and low speeds, thereby enhancing machine processing speed and accuracy while reducing machine energy consumption. Additionally, when the motor is continuously overloaded, the driver will output an alarm signal, providing the same reliability as an AC servo system. Of course, the motor installation dimensions are fully compatible with traditional two-phase 42-57 series stepper motors, making it easy to upgrade traditional stepper drive solutions with minimal cost increase, only about 30-50% of the cost of traditional AC servo systems.

2. Technical Background and Features

Closed-loop stepper motor control, as a new type of stepper motor control technology, installs a high-precision optical incremental encoder on the rear shaft of the traditional two-phase stepper motor. Because the encoder has the characteristic of real-time rotor position feedback, the driver can monitor the motor shaft position in real-time, sampling the motor shaft position information 20,000 times per second. This allows the driver to compensate for displacement deviations in real-time, ensuring precise positioning. In contrast, traditional open-loop stepper motors, without encoder feedback for real-time rotor position information, can experience step loss when the load suddenly changes, leading to positioning errors and significant losses for users.

Closed-loop stepper systems are particularly suitable for low-rigidity load situations (such as belt and pulley systems). If using an AC servo system, they have a common problem of always needing to perform compensation actions. To achieve better rigidity, AC servo systems particularly prefer to work under high gain conditions, which can easily cause the AC servo motor to deviate from position during positioning, and the driver will overshoot in the opposite direction to correct the deviation. This phenomenon, known as hunting, is very common in systems where static friction is significantly higher than running friction. The solution is to reduce the gain, but the response speed and accuracy will be affected. The closed-loop stepper system can perfectly solve this problem. It uses the unique performance of the stepper motor to fix it in a predetermined position, reducing oscillation. This advantage is particularly suitable for fields such as nanotechnology, semiconductor manufacturing, vision systems, and inkjet printing, where low vibration is highly required.

The HBS57 uses a 1000p/r high-precision optical encoder. Unlike traditional internal microstepping stepper drivers, the system's high-performance dual-core digital signal processor (DSP) uses vector control and filtering technology to achieve smooth rotational control with the lowest harmonics.

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Under high load and high-speed conditions, the HBS57 still performs excellently, without step loss or positioning errors. Compared to ordinary stepper motors and drivers, the HBS57 can maintain high torque output for a long time. Under 100% load conditions, the stepper motor can continue to run without step loss. Unlike traditional open-loop stepper drivers, the HBS57 relies on its innovative current phase control technology to achieve continuous high torque operation under high-speed motion conditions. Because it can monitor the current positioning characteristics in real-time, the stepper motor can maintain high torque output even under 100% load.

Since the HBS57 driver can adjust the control current in real-time according to load changes, it can reduce heat generation and improve efficiency. Compared to open-loop stepper motors, heat generation is reduced by more than 50%, extending the life of the motor and bearings, improving product quality, and reducing maintenance rates.

3. Performance Parameters

- Utilizes a new 32-bit motor control dedicated dual-core DSP chip;
- Employs advanced vector current and speed and position closed-loop control algorithms;
- Static and dynamic current ratios can be set arbitrarily (within the range of 0---7A);
- Can drive the full range of 42-60 two-phase hybrid stepper servo motors;
- Motor is equipped with a 1000-line high-precision encoder as standard;
- Optocoupler isolated differential signal input;
- Pulse response frequency up to 300KHZ;
- 16 subdivision settings (400-51200), special subdivisions can be modified according to customer requirements;
- Features overcurrent, overvoltage, overspeed, overheating, and tracking error protection functions;
- Supports command control mode;
- Integrated RS232 communication function, and supports PC software debugging parameters;

4. Product Relative Advantages

Advantages over open-loop stepper motor drivers:

- Accurate positioning, the motor will not lose steps;
- Stable positioning, even if affected by external forces such as mechanical vibration or vertical positioning hold, it will automatically return to the original position;
- Uses 100% rated torque to drive the motor, while traditional open-loop stepper motors typically use only 50% rated torque to avoid step loss;
- The HBS57's control current is load-dependent, allowing the motor to run at high speeds, whereas traditional stepper motors use constant current regardless of load, thus greatly improving efficiency;
- Since there is no loss in motor torque output, the motor size is reduced by 1-2 levels compared to the original open-loop system, making the motor installation size smaller and reducing system costs;

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Advantages over AC servo motor drivers:

- No need to adjust gain (automatically adjusts gain according to load changes);

- Maintains stable position control, no vibration after positioning is completed;

- Can achieve rapid positioning, with steeper acceleration and deceleration curves, thereby improving processing efficiency;

- Excels in continuous operation during rapid short-stroke movements;

- Costs only 30%-50% of an AC servo system;

II. Electrical, Mechanical, and Environmental Specifications

1. Electrical Specifications

Parameter	**HBS57**			
	Minimum	**Typical**	**Maximum**	**Unit**
Continuous Output Current	0	-	7.0	A
Input Power Voltage	+16	+36	+70	VDC
Logic Input Current	7	10	20	mA
Encoder Current	-	-	50	mA
Pulse Frequency	0	-	300	kHz
Insulation Resistance	500	-	-	MΩ

2. Operating Environment and Parameters

Cooling Method	Natural cooling or additional heat sink	
Operating Environment	Usage Conditions	Avoid dust, oil mist, and corrosive gases as much as possible
	Temperature	0℃—50℃
	Humidity	40—90%RH
	Vibration	5.9 m/s^2 Max
Storage Temperature	-20℃—+80℃	
Weight	Approximately 285 grams	

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3. Mechanical Installation Dimensions (unit: mm)

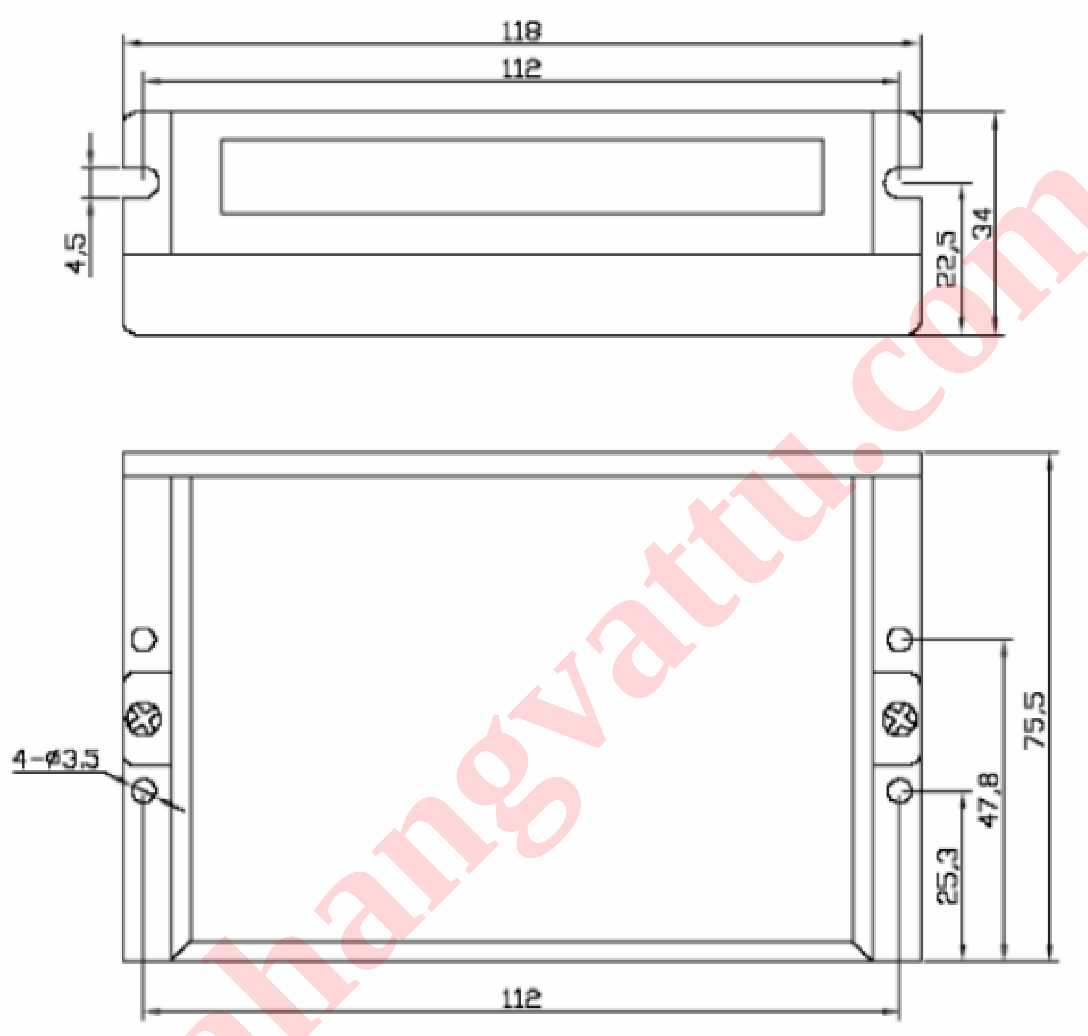

图 1. 安装尺寸图

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4. Enhanced Cooling Methods

1. The reliable operating temperature of the driver is usually within 60°C, and the motor operating temperature is within 80°C;
2. When installing the driver, please use an upright side installation to create strong air convection on the heat sink surface; if necessary, install a fan near the driver for forced cooling to ensure the driver operates within the reliable temperature range.

III. Driver Interface and Wiring Introduction

1. Interface Definitions

A. Motor and Power Input Port

Terminal No.	Symbol	Name	Wire Color Description
1	A＋	A-phase motor winding＋	Red
2	A－	A-phase motor winding－	Green
3	B＋	B-phase motor winding＋	Yellow
4	B－	B-phase motor winding－	Blue
5	+VDC	Power input positive	DC16-70V
6	GND	Power input negative	

Note: Motor wire phases cannot be interchanged.

B. Encoder Signal Input Port

Terminal No.	Symbol	Name	Wire Color Description
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 +5V input	Red
6	EGND	Encoder power ground	White

C. Control Signal Port

Terminal No.	Symbol	Name	Description
1	PU＋	Pulse positive input	Signal source +5V～24V universal, no need for additional resistor
2	PU－	Pulse negative input	
3	DR＋	Direction positive input	

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4	DR－	Direction negative input	Signal source +5V～24V universal, no need for additional resistor
5	ENA＋	Motor enable positive input	When this signal is active, the motor is in a free state, not locked
6	ENA－	Motor enable negative input	

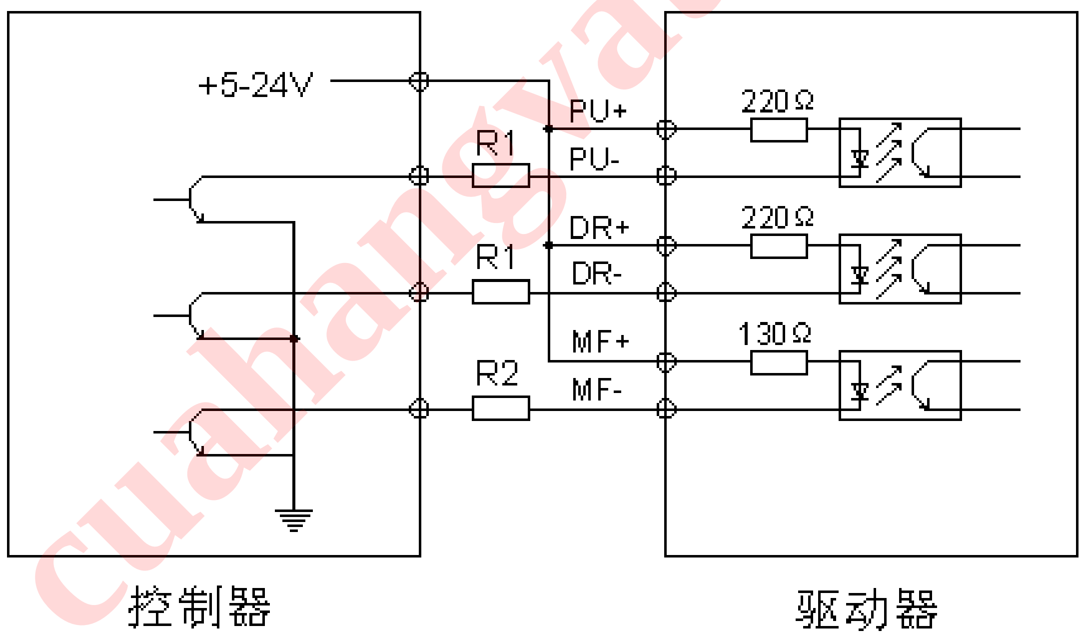
D. Output Signal Port

Terminal No.	Symbol	Name	Wire Color Description
1	ALM＋	Alarm signal positive output	Outputs signal to the host computer after driver fault protection
2	ALM－	Alarm signal negative output	

2. Control Signal Interface Circuit Diagram

The control signal input and output interface circuit diagram is shown in Figure 3.

(1) Common Anode Connection Method for Input Signals



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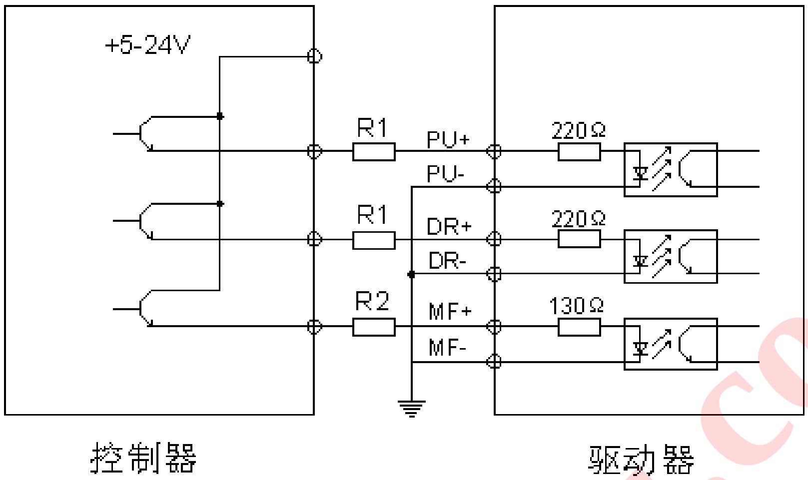
(2) Common Cathode Connection Method for Input Signals



(3) When using differential input, please wire according to the diagram below

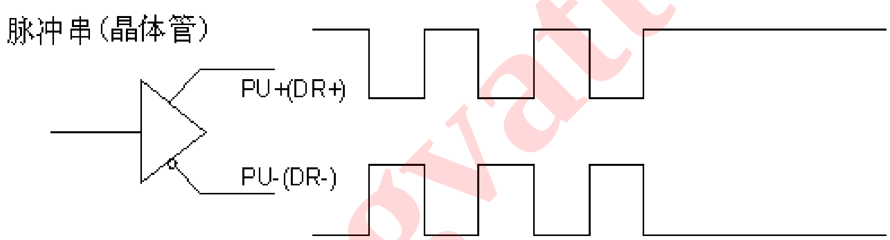


Figure 3(a) Differential Control Signal Interface Wiring Diagram

Note: The control signal level is compatible with 5V-24V. As long as the control signal input level is between 5-24V, there is no need to add external resistors R1 and R2.

3. Control Signal Timing Diagram

To avoid some malfunctions and deviations, PUL, DIR, and ENA should meet certain requirements, as shown in Figure 4:

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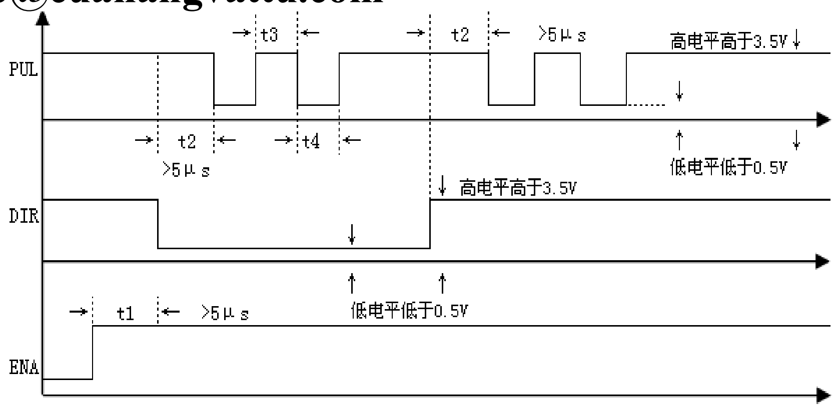

Figure 4 Timing Diagram

Notes:

1. **t1**: ENA (enable signal) should be set high at least 5μs before DIR. Generally, it is recommended to leave ENA+ and ENA- floating.
2. **t2**: DIR should be set high or low at least 5μs before the falling edge of PUL.
3. **t3**: Pulse width should be at least 2.5μs.
4. **t4**: Low-level width should be at least 2.5μs.

4. Control Signal Mode Settings

Pulse trigger edge and single/double pulse selection: Set the pulse rising edge or falling edge trigger to be effective through PC software or handheld debugger; you can also set single pulse mode, double pulse mode, quadrature pulse mode, and internal command mode, as well as parameters such as half current ratio and full current ratio.

IV. DIP Switch Settings

The HBS57 driver uses a six-position DIP switch to set subdivisions and other functions, detailed as follows:

1. Subdivision Settings

Steps/Rev	SW1	SW2	SW3	SW4
400	on	on	on	on
800	off	on	on	on
1600	on	off	on	on
3200	off	off	on	on
6400	on	on	off	on
12800	off	on	off	on
25600	on	off	off	on
51200	off	off	off	on
1000	on	on	on	off

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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
40000	off	off	off	off

2. Motor Model Selection

Motor Model or Rated Current	SW6
57HS20	off
57HS30	on

3. Motor Rotation Direction

Motor Rotation Direction	SW5
Clockwise	off
Counterclockwise	on

In addition to the above subdivision settings via DIP switches, we can also provide drivers with special subdivisions according to specific customer requirements.

V. Power Supply Selection

The power supply voltage can operate normally between DC16V-70V. The HBS57 driver is best powered by a non-regulated DC power supply, and it can also be powered directly by a transformer step-down. Ensure that the ripple peak voltage after rectification does not exceed 70V. It is recommended to use a 24V-48V DC switching power supply to avoid power grid fluctuations exceeding the driver's voltage operating range.

- If using a regulated switching power supply, ensure that the output current range of the switching power supply is set to the maximum.

Please note:

1. Be careful not to mix up the power input and motor phase wires when wiring;
2. It is best to use a non-regulated power supply;
3. When using a non-regulated power supply, the power current output capability should be greater than 60% of the driver's set current;
4. When using a regulated switching power supply, the power output current should be greater than or equal to the driver's operating current;
5. To reduce costs, two or three drivers can share one power supply, but ensure that the power supply has sufficient power.

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