

# **User's Manual**

For

## **DM860H**

**Fully Digital Stepper Drive**

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Attention: Please read this manual carefully before using the drive!

## DM860H

### Digital two-phase stepper driver

#### 一、 Introduction

##### 1. Overview

DM860H It is the new digital stepping motor driver of the company. It adopts the latest 32-bit DSP digital processing technology. The driver control algorithm uses advanced variable current technology and advanced frequency conversion technology. The driver has low heat generation, small motor vibration and stable operation. Users can set any subdivision within 200~51200 and any current value within the rated current, which can meet the application needs of most occasions. Thanks to the built-in micro-segmentation technology, even in the case of low subdivision, high subdivision can be achieved, and the operation at low, medium and high speeds is smooth and the noise is extremely small. The parameter internal power-on auto-tuning function is integrated in the drive, which can automatically generate optimal operating parameters for different motors to maximize the performance of the motor.

##### 2. Features

- New 32-bit DSP technology
- Ultra low vibration noise
- Built-in high subdivision
- Parameter power-on auto-tuning function
- Variable current control makes the motor heat greatly reduced
- The current is automatically halved at rest
  
- for 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)
- The current setting is convenient, and can be selected between 2.1-7.2A
- The subdivision setting range is 200-51200
- With overvoltage, undervoltage, overcurrent protection

##### 3. Application field

**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.**

#### 二、 Electrical, mechanical and environmental indicators

##### 1. Electrical index

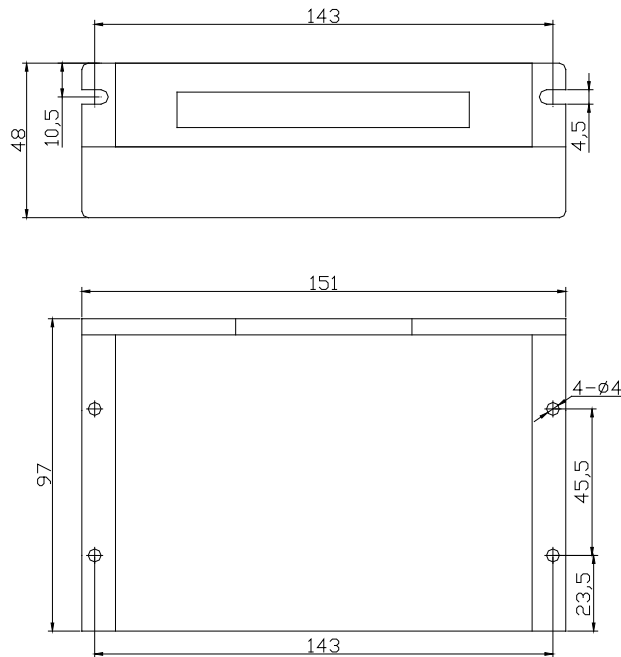
Description	DM860H			
	Min	Typical	Max	Unit
Output current [PK]	2.1	-	7.2	A
Input supply voltage	24	48	75	VAC
Control signal input current	6	10	16	mA
Control signal interface level	4.5	5	28	Vdc
Input signal minimum pulse width	1.5	-	-	us
Step pulse frequency	0	-	200	KHz
Insulation resistance	500			MΩ

Note: This driver power supply, AC and DC power supply are available, AC power supply range is 24~75VAC, DC power supply range is 24~100VDC, DC power supply has positive and negative power supply anti-reverse connection function.

## 2. Operating Environment and other Specifications

Cooling		Natural Cooling or Forced cooling
Operating environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	-5°C ~ +50°C
	Humidity	40 ~ 90%RH
	Vibration	5.9m/s <sup>2</sup> MAX
Storage Temperature		-20°C~80°C
weight		about 400 g

## 3. Mechanical Specifications (unit: mm [inch])



※Recommend use side mounting for better heat dissipation

## 4. Elimination of Heat

- 1) Driver's reliable working temperature should be <math><70^{\circ}\text{C}</math>(158°F), and motor working temperature should be <math><80^{\circ}\text{C}</math>(176°F);
- 2) It is recommended to use automatic idle-current mode, namely current automatically reduce to 50% when motor stops, so as to reduce driver heating and motor heating;
- 3) It is recommended to mount the driver vertically to maximize heat sink area. Use forced cooling method to cool the system if necessary.

### ≡、Pin Assignment and Description

#### 1. Pin Assignment

##### 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 μ s.
PUL-	
DIR+	Direction signal: High/low level signal. To ensure reliable commutation of the motor, the direction signal should be established before the pulse signal is at least 2 μ s. 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 the initial running 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 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 terminal can be left floating.
ENA-	

##### 2) Connector Configurations

Name	function
AC	AC power supply AC input, AC 24~75VAC.
AC	AC power supply AC input, AC 24~75VAC.
A+, A-	Motor A phase coil interface.
B+, B-	Motor B phase coil interface.

#### 4) Status indication

The green LED is the power indicator. When the driver is powered on, the LED is always on. The LED goes out when the drive is powered 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:

No.	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

#### 2. Control signal interface circuit

The DM860H driver uses a differential interface circuit for differential signaling, single-ended common-cathode and single-ended common anode interfaces, and a built-in high-speed optocoupler that accepts signals from long-line drivers, open collectors, and PNP output circuits. In the harsh environment, we recommend long-line driver circuit, anti-interference ability. Now take the open collector and PNP output as an example. The interface circuit is as follows:

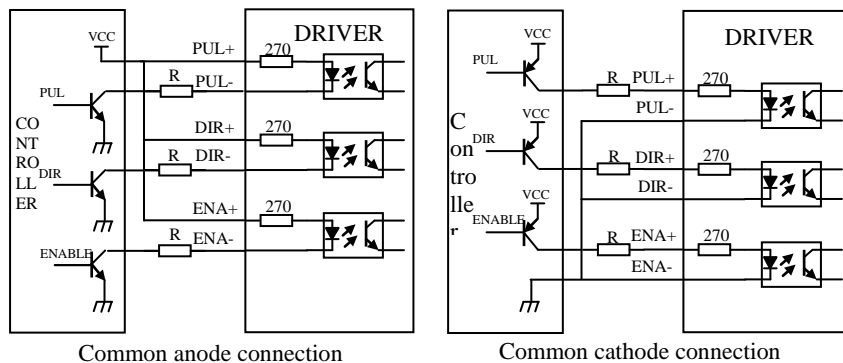


Figure 3 input interface circuit

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

#### 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:

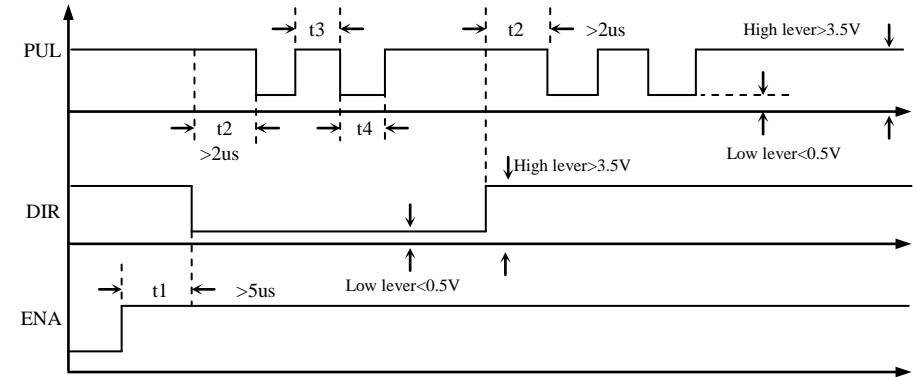


Figure 4 control signal timing diagram

Note:

- 1) t1: ENA (enable signal) should be DIR at least 5 μs in advance and determined to be high. In general, it is recommended that ENA+ and ENA- be left floating.
- 2) t2: DIR determines its state to be high or low at least 2 μs along the PUL falling edge.
- 3) t3: The pulse width is at least not less than 2 μs.
- 4) t4: The low level width is not less than 2 μs.

#### 4. Control signal mode setting

Pulse Trigger Edge and Single and Double Pulse Selection: The pulse rising edge or falling edge trigger is enabled by the PC software ProTuner software or STU debugger. It is also possible to set the single pulse mode or the double pulse mode. In dual pulse mode, the signal from the direction control must be held high or left floating.

#### 5. Wiring requirements

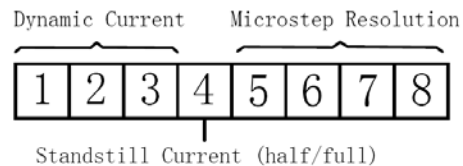
- 1) In order to prevent the driver from being disturbed, it is recommended to use the shielded cable

for the control signal, and the shield layer is shorted to the ground wire. Unless otherwise specified, the shielded cable of the control signal cable is grounded at one end: the upper end of the shielded cable is grounded at one end, and the shielded cable is driven. One end is suspended. Only the grounding at the same point is allowed in the same machine. If it is not a real grounding wire, the interference may be serious. At this time, the shielding layer is not connected.

- 2) The pulse and direction signal lines and the motor lines are not allowed to be bundled side by side, preferably separated by at least 10 cm. Otherwise, the motor noise easily interferes with the pulse direction signal, causing the motor to be inaccurately positioned, and the system is unstable.
- 3) If one power supply is used for multiple drives, parallel connections should be made at the power supply. It is not allowed to go to one chain and then to another chain.
- 4) It is forbidden to plug and unplug the driver's strong P2 terminal. When the charged motor stops, there is still a large current flowing through the coil. Pulling the P2 terminal will cause a huge moment to induce the electromotive force to burn the driver.
- 5) It is forbidden to add the tin wire to the terminal after adding the tin wire. Otherwise, the terminal may be damaged due to overheating of the contact resistance.
- 6) The wiring heads should not be exposed outside the terminals to prevent accidental short circuits and damage the drive.

#### 四、 Current, subdivision DIP switch setting and parameter auto-tuning

DM860H driver uses an eight-position dial switch to set subdivision accuracy, dynamic current, static half-flow, and auto-tuning of motor parameters and internal tuning parameters. The detailed description is as follows:



##### 1. Current Setting

##### 1) Dynamic Current Setting

Peak Current	RMS Current	SW1	SW2	SW3
Default[2.0A]		on	on	on
3.08A	2.57A	off	on	on
3.77A	3.14A	on	off	on
4.45A	3.71A	off	off	on
5.14A	4.28A	on	on	off
5.83A	4.86A	off	on	off
6.52A	5.43A	on	off	off
7.20A	6.00A	off	off	off

When SW1, SW2, and SW3 are set to off off, the required current can be set by PC software, the maximum value is 7.20A, and the resolution is 0.1A. If not set, the default current is 2.0A.

##### 2) Standstill Current Setting

SW4 is used for this purpose. OFF meaning that the standstill current is set to be half of the selected dynamic current, and ON meaning that standstill current is set to be the same as the selected dynamic current.

The current automatically reduced to 50% of the selected dynamic current one second after the last pulse. Theoretically, this will reduce motor heating to 36% (due to  $P=I^2 \cdot R$ ) of the original value. If the application needs a different standstill current, please contact Leadshine.

##### 2. Microstep Resolution Selection

Steps/rev.	SW5	SW6	SW7	SW8
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
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

When SW5, SW6, SW7, and SW8 are all on, the driver subdivision adopts the default internal subdivision number of the driver: the user sets the subdivision number through the PC software ProTuner or STU debugger, the minimum value is 1, the resolution is 1, The maximum value is 51200.

### 3. Parameter auto-tuning function

If SW4 toggles once within 1 second, the drive can automatically complete the self-tuning of the motor parameters and internal adjustment parameters. When the conditions such as motor and power supply voltage change, please perform a self-tuning. Otherwise, the motor may not run normal.

Note that the pulse cannot be input at this time, and the direction signal should not change.

Implementation method 1) SW4 is turned from off to off, and then dialed off to on within 1 second;

Implementation 2) SW4 is switched from off to on, and then dialed back to off in 1 second.

Note: This model has auto-tuning function for power-on parameters.

## 五、Power supply selection

The power supply voltage can work normally between the specified ranges. If the DM860H driver is powered by DC, it is better to use 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 drive 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.

## 六、Motor matching

The DM860H can be used to drive 4, 6 and 8 wire two-phase, four-phase hybrid stepping motors with a step angle of 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. The large-sized motor has a large torque; the current is mainly related to the inductance, and the small-inductance motor has a high-speed performance, but the current is large.

### 1. Motor

#### 1) Determine load torque, drive ratio operating speed range

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

J: moment of inertia of the load  $\varepsilon$ : 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 stepping motor that the high speed is smaller than the medium and low speed torque.

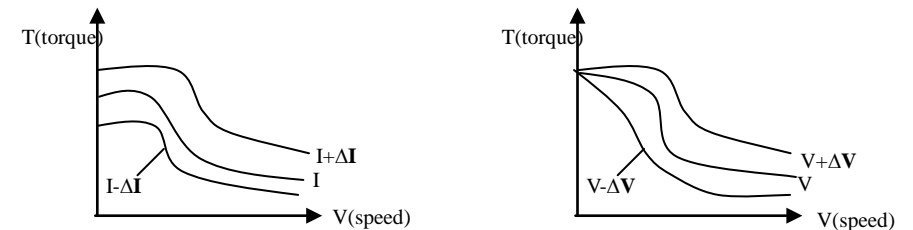
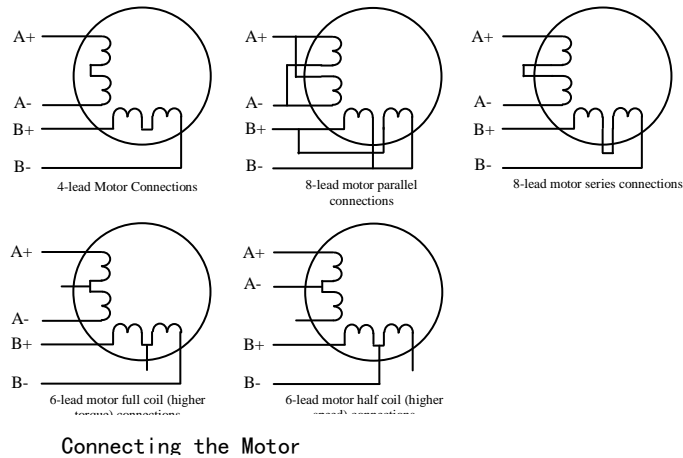


Figure 5 moment frequency characteristic diagram

### 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:



### 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 at high speeds. 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.

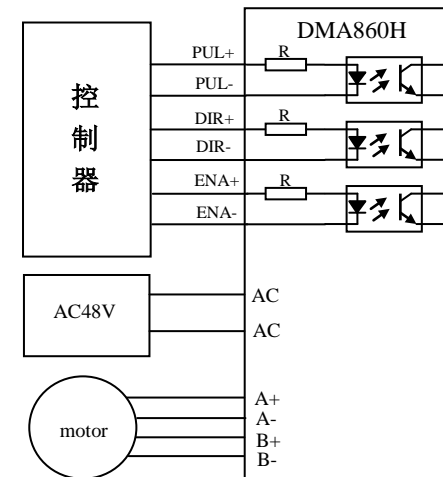
#### 2) Output current setting

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 specific heat generation is related not only 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 stepping 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: 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.

The DM860H driver can drive four-, six- or eight-wire two-phase/four-phase motors. The following figure details the connection of 4-wire, 6-wire, 8-wire stepper motors:



note:

- 1) The colors of different motors are different. When using the motor, the motor data is correct. For example, the color of the 57 and 86 motor wires is different.
- 2) The phase is relative, but the windings of different phases cannot be connected to the terminals of the same phase of the driver (A+, A- is one phase, B+, B- is another phase),
- 3) The DM860H driver can only drive two-phase hybrid stepping motors and cannot drive three-phase and five-phase stepping motors.

4) Method of judging whether the stepping motor is connected in series or in the correct connection method: directly rotate the shaft of the motor by hand without connecting the driver. If it can be easily and evenly rotated, the wiring is correct, if the resistance is large and Uneven and accompanied by a certain sound to explain the wiring error.

## 八、 Protective function

### 1) Short circuit protection

When a phase-to-phase 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

When the input voltage is higher than ACVAC of DM860H, 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 drive 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 drive 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 up. Reversing the positive and negative poles will cause the fuse in the drive to burn out!