EM1 Series

2-Phase Digital Stepper Drive

User Manual

For models of EM1-442,EM1-432,EM1-556,EM1-870

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Notice

Read this manual carefully before any assembling and using. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information regarding installation requirements.

- **Thank you for purchasing Leadshine EM1 series products**
- **Please read this manual carefully before operating**
- **Please keep this manual appropriately**

Record of Revisions

Manual Reversion	Data	Description of Release
V1.0	04/29/2024	Initial Release

Safety Precautions

Overall Notes

- Do not remove the housing with the drive powered on. Cables. Connectors and optional equipment.
- Please disconnect the power supply for at least 2 minutes and make sure the power indicator is off before wiring and checking. Even if the power is disconnected, voltage may remain inside the drive. Therefore, do not touch the power terminals while the power indicator is on.

- Please use the power supply specifications (number of phases.) that match the product. Voltage. Frequency. AC/DC).
- Be sure to connect the ground terminal of the driver (mounting surface) and motor to the ground pole.
- Do not damage or drag the cable, do not overstress the cable, do not hang heavy objects on the cable, or get caught in the cabinet door.
- Please do not disassemble the product yourself. Repair or modification.
- When the machine is connected to the machine and starts to operate make sure that the machine is ready for emergency stop.
- Do not touch the inside of the drive.

- The heat sink of the driver may be hot when the power is on or when the power is just cut off. The motor, etc. may be in a high temperature. Take safety measures such as installing a cover to prevent accidental touching by hands and parts (cables, etc.).
- Use double-insulated or reinforced insulation for control power.
- Do not use in places where water can be splashed. Corrosive environments. Do not use the product in the vicinity of flammable gases and combustible materials.
- Do not use damaged. Drivers and motors with missing parts.
- Please set up an emergency stop circuit externally to ensure that the power can be cut off and the operation can be stopped immediately in case of an abnormality.
- If the product is used under poor power conditions, install protection equipment (AC reactor, etc.) to ensure that the input power is supplied within the specified voltage variation range.
- Please use a noise filter to reduce the influence of electromagnetic interference.
- The driver and motor should be used in the specified combination.

Precautions for Storage and Transportation

- Please follow the Commands on the packaging for storage and do not overload the product.
- Please place this product in the following environment:
  - ➞No direct sunlight in the place.
  - ➞Ambient temperature does not exceed the product specification.
  - ➞Humidity does not exceed product specifications. Without condensation.
  - ➞No corrosive gases. Place of flammable gas.
  - ➞Dust. The place where there is less salt and metal powder.
  - ➞No water. Oil. The place where the splash of medicine, etc. occurs.
  - ➞Vibration or shock does not exceed product specifications.
  - ➞No equipment generating strong magnetic fields in the vicinity.

Precautions for Installation

- Please install the drive in a cabinet that provides fire protection. Electrical protection in the control cabinet.
- Please install the driver and motor in a position with sufficient weight resistance.
- Please install this product in the following environment:
  - ➞No direct sunlight in the place.
  - ➞Ambient temperature does not exceed the product specification.
  - ➞Humidity does not exceed product specifications. Without condensation.
  - ➞No corrosive gases. Place of flammable gas.
  - ➞Dust. Dust. The place where there is less salt and metal powder.
  - ➞No water. Oil. The place where the splash of medicine, etc. occurs.
  - ➞Vibration or shock does not exceed product specifications.
  - ➞No equipment generating strong magnetic fields in the vicinity.
- Do not block the air inlet and exhaust ports, and do not allow foreign objects to enter the drive and motor.
- Do not step on the product or place heavy objects on the drive.
- Please install the driver in the specified direction.
- Make sure to keep the specified intervals between the inner surfaces of the drive control cabinet and other machines.

Precautions for Wiring

- Do not pass the magnetic contactor in the wiring between the drive and the motor.
- Please connect the power terminal and motor terminal firmly.
- Keep a minimum distance of 10mm between the drive and the control cabinet or other equipment.
- Allow at least 30mm of wiring space above and below the driver.
- Signal cable. The encoder cable should be a twisted shielded cable with the shield grounded at both ends.
- The wiring length of the encoder is up to 20m.
- Reduce the frequency of power on/off as much as possible.

Precautions during operation

- To prevent accidents, perform a test run of the servo motor at no load (without the driver connected).
- When you install the machine and start operation, please set the user parameters in advance to match the machine.
- Positive limit (POT) during JOG operation and zero return operation. The signal of negative limit (NOT) is not valid.
- When using the motor on a vertical axis, please provide a safety device to avoid dropping the work-piece in case of alarm or over travel.
- When an alarm occurs, please reset it after investigating the cause and making sure it is safe.
- Do not use the brake of the holding motor for normal braking.

Table of Contents

1. Introduction

1.1 Product Introduction

EM1-542, EM1-556 and EM1-870 are a new generation of general-purpose pulsed two-phase stepper drives from Leadshine . The driver adopts the latest open-loop stepper drive control algorithm.

With more than 20 years of persistent pursuit, Leisai Intelligent has a more complete supply chain system and a more sound production guarantee. The whole series of EM1 has passed RoHS and CE certification, and the product quality is more reliable and assured.

1.2 Features

- Step & direction (PUL/DIR) control
- Input voltage 20-50VDC (recommended 24-48VDC)
- 500 KHz max pulse input frequency
- 15 microstep resolutions of 400-25000 via DIP switches
- Gain mode chose by dip switch: "high response mode" or "low vibration mode",
  high response mode:Faster start-stop response
  low vibration mode: less vibration noise
- 7 output current settings of 1.0-8.2A via DIP Switches
- Idle current reduction to 50% or 90% selection via SW4
- Auto-tuning to match wide-range NEMA 11, 17, 23 and 24 stepper motors
- Anti-Resonance for optimal torque, extra smooth motion, low motor heating and noise
- Optically isolated inputs with 5Vto 24V
- Fault output
- Over-voltage and over-current protections

1.3 Check Product

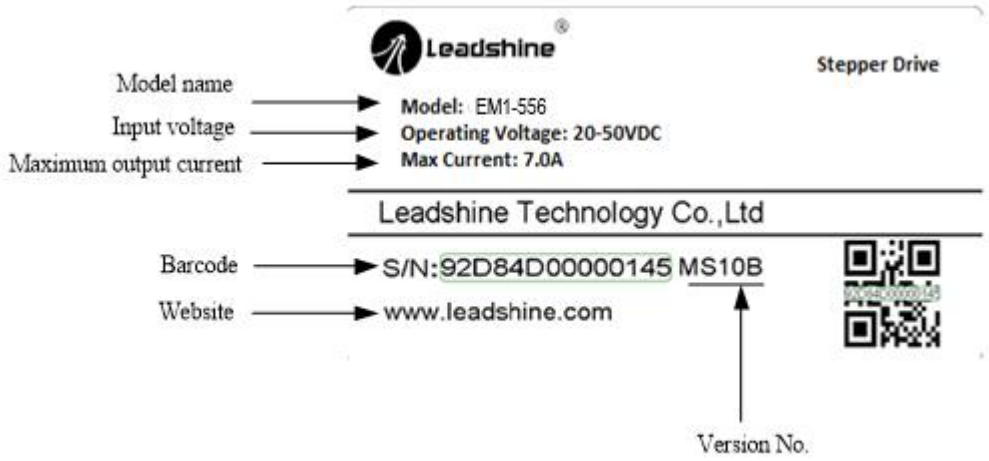
1.3.1 Arrival inspection

- Check whether the surface of the product is damaged or not during transportation.
- Check the nameplate models of the drive and motor are what you have ordered.
- Cheek if it is fully equipped with accessories. Accessories include power supply and motor output connector, control I/O signal connector.

CAUTION

- Neither the damaged nor missing accessories of stepper system are allowed to install.
- Contact Leadshine or local distributor if any failure was found.

1.3.2 Nameplate information



1.3.3 Part number

□ EM1 - □ 5 56 □ □ - □□□

Number of Axis	
blank	Single
2	Dual

Product Series	
EM	Digital Stepper

Series	
blank	Classic series
1	Pulse series

Control Mode	
blank	Pulse type
IO	IO type

Max. Input Voltage			
4	40V	5	50V
8	80V		

Peak Current Output			
22	2.2A	42	4.2A
56	5.6A	70	7A
82	8.2A		

Drive Version	
blank	Standard version
C	Economy version

Input Power	
blank	DC
AC	AC

Custom Code
XXX

2. Production Specifications

2.1 Electrical and Specifications

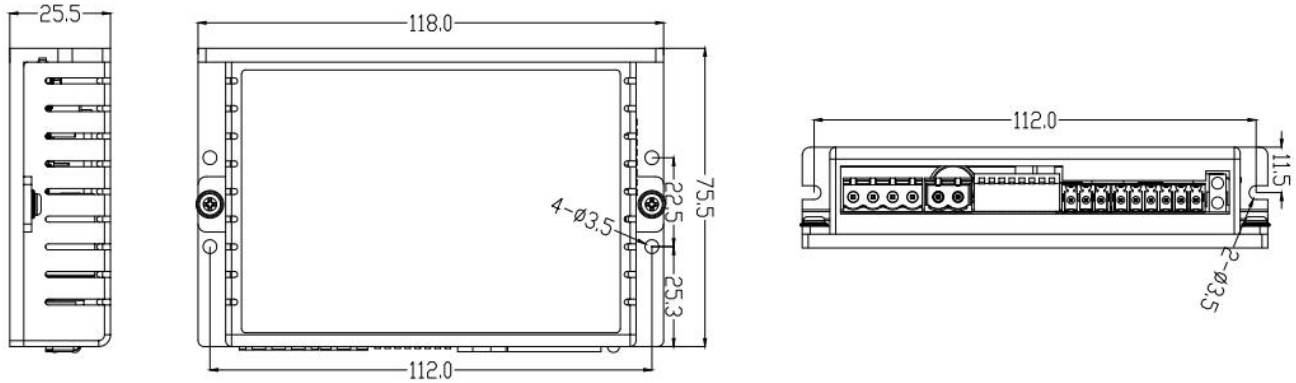
Drive Model	EM1-422	EM1-432	EM1-542	EM1-556	EM1-870	EM1-882AC
Dimension (L*W*H)	86*55.5*20.5		118*75.5*25.5	118*75.5*34		151*97*52
Matching Motors (Frame Size)	20/28/35/42	35/42	57	57/60	60/86	86
Input Voltage	20~36Vdc	20~36Vdc	24~50Vdc	24~50Vdc	24~80Vdc	20~70Vac 30~100Vdc
Max. Continuous Current Output	2.2A	3.2A	4.2A	5.6A	7.0A	8.2A
Pulse Voltage Input	5~24Vdc					
Max. Pulse Frequency	200kHz、500kHz Configurable					
Max. Current Output (Signal)	100mA（30Vdc Max. Voltage)					

2.2 Environment

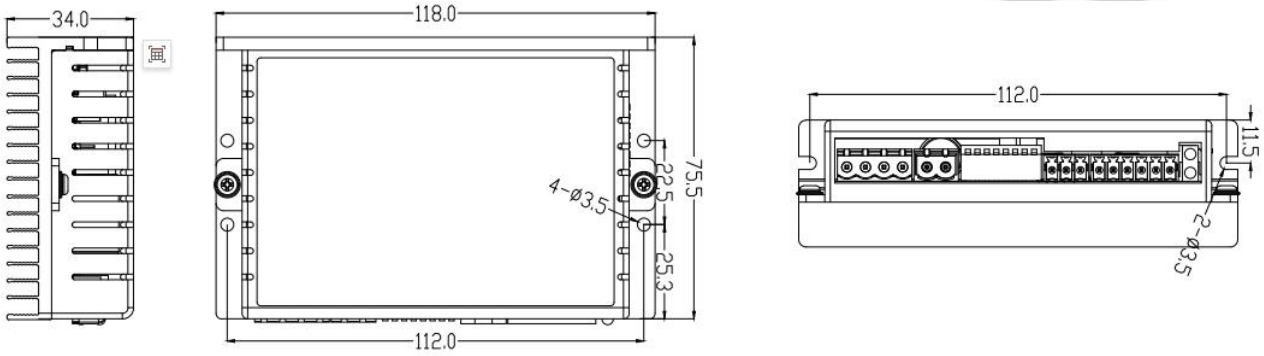
Cooling	Natural Cooling or Forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Humidity	40%RH－90%RH
	Operating Temperature	0°C － 40°C (32°F - 109°F)
	Vibration	10-50Hz / 0.15mm
Storage Temperature	-20°C － 65°C (-4°F - 149°F)	
Weight	Approx. 230g (0.51 lbs)	

2.3 Mechanical Specifications

(unit: mm [1inch=25.4mm])



- **Figure 1 EM1-542 Installation Dimension Drawing**



- **Figure 2:EM1-556,EM1-870 Installation Dimension Drawing**

2.4 Elimination of Heat

- EM1 reliable working temperature should be < 40°C (109°F)
- It is recommended to use automatic idle-current mode to reduce motor heating. That means set the SW4 pin of DIP switch at “OFF” position.
- It is recommended to mount the drive vertically to maximize heat sink area. Use forced cooling method to cool if necessary.

3. Connection Pin Assignments and LED Indication

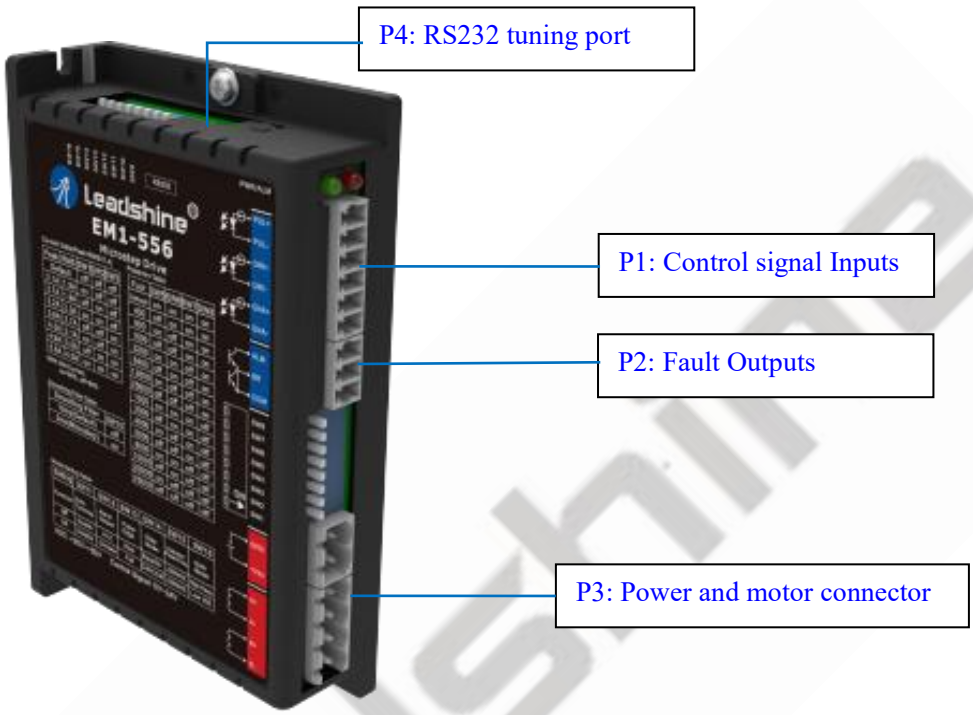


Figure 3 Connectors, DIP switches, and LED locations

The EM1 has three connector blocks P1&P2&P3 (see above picture). P1 is for control signals connections, and P2 is for output signals connections, P3 is for power and motor connections. The following tables are brief descriptions of the three connectors. P4 is for modifying parameters More detailed descriptions are as below.

3.1 P1 - Control Connector

PIN	Details
PUL+	Pulse and Direction Connection: **(1)** The pulse signal supports 5~24V compatible, when connected to a 24V pulse signal input,there is no need to connect a resistor, and falling edgeis effective the factory default **(2)** Maximum 500 KHz input frequency **(3)** The width of PUL signal is at least 2.5μs, duty cycle is recommended 50% **(4)** DIR signal requires advance PUL signal minimum 5 μs in single pulse mode
PUL-	
DIR+	
DIR-	
ENA+	Enable Connection: (default no connection) **(1)** supports 5~24V compatible **(2)** When ENA+ connected to 5V, ENA- connected to GND, the motor is in power-off no response for pulse input **(3)** ENA signal requires advance DIR signal minimum 5μs in single pulse mode **(4)** Enable time to be at least 200ms
ENA-	

Notes:

(1) Shield cables are required for P1;

(2) Don't tie P1/P2 cables and P3 cables together.

3.2 P2 - Fault Output Connector

Pin	Details
ALM+	**(1)** Maximum 30V/100mA output **(2)** Sinking or sourcing **(3)** The resistance between ALM+ and ALM- is low impedance as default, and will change to high when the drive goes into error protection. **(4)** Fault connection refer to chapter 4.2
ALM-	

3.3 P3 - Motor and Power Supply Connector

Pin Function	Details
GND	Power supply ground connection.
+Vdc	Power supply positive connection. Suggest 24-48VDC power supply voltage
A+, A-	Motor Phase A connections. Connect motor A+ wire to A+ Pin; motor A- wire to A-
B+, B-	Motor Phase B connections. Connect motor B+ wire to B+ Pin; motor B- wire to B-

Warning: Don't plug or unplug the P1 & P2&P3 terminal block to avoid drive damage or injury when EM1 is powered on.

3.4 P4 - RS232 Tuning Port

The P4 connector in Figure 3 is a RS232 communication port for PC connection. Refer to the following pin definitions.

It is just used to modify parameter, not for equipment control because neither precision nor stability is sufficient. If you need a field bus drive, please choose a Leadshine RS485 or EtherCAT type drives

The interface definition is as follows:

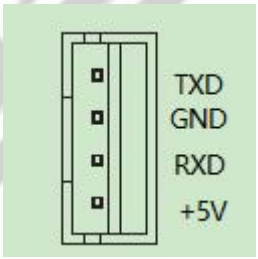


Figure 4 RS232 tuning port

3.5 LED Light Indication

There are two LED lights for EM1. The GREEN one is the power indicator which will be always on generally. The RED one is a protection indicator which will flash 1-2 times in a 3-second period, when protection enabled for a EM1. Different number of flashes indicates different protection type (read section 11 for detail).

4. Control Signal and Output Signal

4.1 Control Signal Connection

The EM1 can accept differential or single-ended control signals (pulse, direction, and enable) in open-collector or PNP connection through the P1 connector (figure 2). It is recommend to add an EMI line filter between the power supply and the drive to increase noise immunity for the drive in interference environments.

Single-ended connection method:

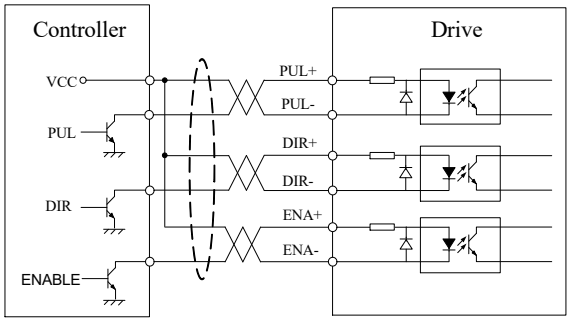


Figure 5 Connections to open-collector signal (common-anode)

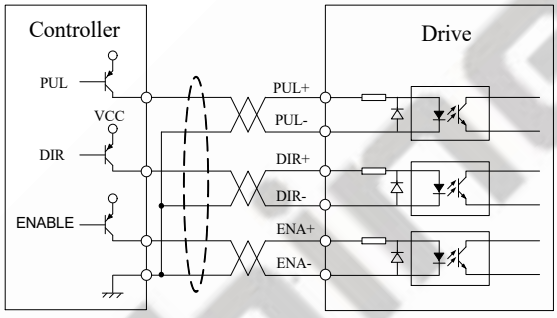
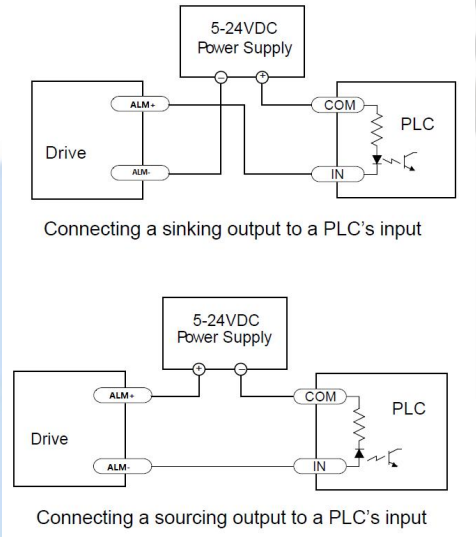


Figure 6 Connections to PNP signal (common-cathode)

Notes:
(1) ENA signal is no-connected as default;
(2) Control signal amplitude is 24 V as default.When connect to a 24V pulse signal, there is no need to string resistor, and the factory default is effective on the falling edge.

4.2 Fault Output Connection

When over voltage or over current protection happens, EM1 red status LED light will blink and the impedance state between ALM+ and ALM- will change (from low to high or high to low depending on configuration) and can thus be detected. Fault output connection is optional, and it can be connected either in sinking or sourcing.



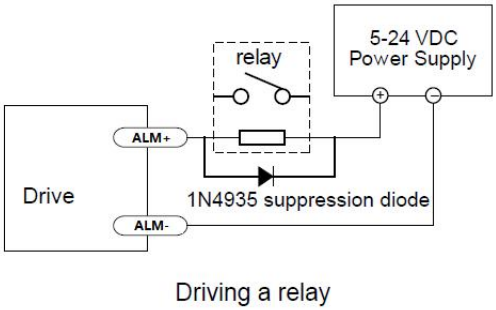


Figure 7 output signal connection

4.3 Wiring method of motor with brake

Relay wiring refers to the pictures below. Because the coil of brake and relay are sensitive load, it is recommended to add a diode, the diode model can choose ordinary rectifier diode (such as: IN4007). In addition, diode polarity must not be connected in reverse.
We also suggest customers to use solid state relay, in this condiction there is no need to add a diode. Solid state

relay advantages: fast response speed, no need to add diode, through and break without sound; recommended to use "Kaiser" KS 1-10DD model solid state relay.

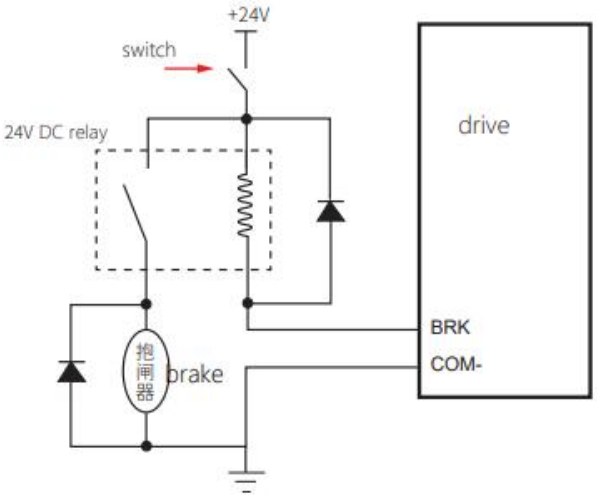


Figure 8 Ordinary relay connect the motor with brake

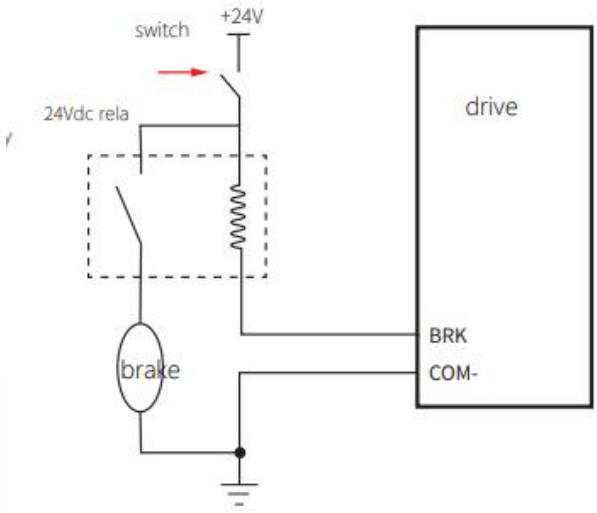


Figure 9 Solid state relay connect the motor with brake

5 Motor Connection

The EM1 can drive 2-phase and 4-pahse bipolar hybrid stepper motors.

The 4 lead motors are the least flexible and easy to connect. The output current from drive that is multiply the specified phase current by 1.4 to determine the peak output current.

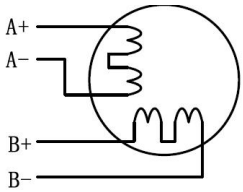


Figure 10 4-lead Motor Connections

6. Power Supply Selection

The EM1 can power medium and large size stepping motors (frame size from NEMA 11 to 24). To get good driving performances, it is important to select supply voltage and output current properly. Generally speaking, supply voltage determines the high speed performance of the motor, while output current determines the output torque of the driven motor (particularly at lower speed). Higher supply voltage will allow higher motor speed to be achieved, at the price of more noise and heating. If the motion speed requirement is low, it's better to use lower supply voltage to decrease noise, heating and improve reliability.

6.1Power Supply Sharing

Multiple EM1 drives can share one power supply to reduce cost, if that power supply has enough power capacity. To avoid cross interference, connect each stepper drive directly to the shared power supply separately. To avoid cross interference, DO NOT daisy-chain connect the power supply input pins of the drivers. Instead connect them to power supply separately.

6.2 Selecting Supply Voltage

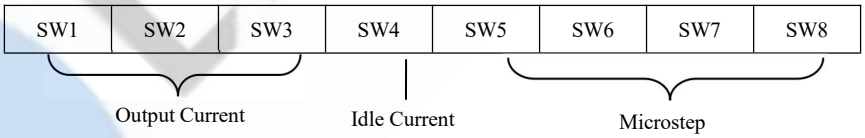
The EM1 is designed to operate within 20- 80VDC voltage input. When selecting a power supply, besides voltage from the power supply power line voltage fluctuation and back EMF voltage generated during motor deceleration needs also to be taken into account. Please make sure leaving enough room for power line voltage fluctuation and back-EMF voltage charge back.

Higher supply voltage can increase motor torque at higher speeds, thus helpful for avoiding losing steps. However, higher voltage may cause bigger motor vibration at lower speed, and it may also cause over-voltage protection or even drive damage. Therefore, it is suggested to choose only sufficiently high supply voltage for intended applications.

7. DIP Switch Configurations

The EM1 has two sets of DIP switches. The first set is used to configure settings of micro step resolution, output current, motor standstill current and smoothing time as shown below. The second set can be used to set filter time, double pulse mode, limit pulse frequency 500 kHz (default 200 kHz), etc

7.1 Dip switches 1



1） driver output current setting （DIP Switches SW1~SW3）

■ DM1-542

SW1	SW2	SW3	Drive current Peak （A）	Drive current RMS（A）
OFF	OFF	OFF	1.0（default）	0.7
ON	OFF	OFF	1.5	1.1
OFF	ON	OFF	1.9	1.4
ON	ON	OFF	3.4	1.7
OFF	OFF	ON	2.8	2.0
ON	OFF	ON	3.3	2.4
OFF	ON	ON	3.8	2.7
ON	ON	ON	4.2	3.0

■ DM1-556

SW1	SW2	SW3	Drive current Peak (A)	Drive current RMS (A)
OFF	OFF	OFF	1.8 (default)	1.3
ON	OFF	OFF	2.1	1.5
OFF	ON	OFF	2.7	1.9
ON	ON	OFF	3.2	2.3
OFF	OFF	ON	3.8	2.7
ON	OFF	ON	4.3	3.1
OFF	ON	ON	4.9	3.5
ON	ON	ON	5.6	4.0

■ DM1-870

SW1	SW2	SW3	Drive current Peak (A)	Drive current RMS (A)
OFF	OFF	OFF	1.4 (default)	1.0
ON	OFF	OFF	2.6	1.8
OFF	ON	OFF	3.4	2.4
ON	ON	OFF	4.0	2.8
OFF	OFF	ON	4.8	3.4
ON	OFF	ON	5.4	3.8
OFF	ON	ON	6.1	4.3
ON	ON	ON	7.0	5.0

Note:
When SW1~3 are OFF, the driving current can be set by the debugging software.

2)Idle Current Configuration

SW4 is used to set motor idle current percentage. At OFF position it means the standstill current is set to be 50% of the

selected output current. At ON position it means standstill current is set to be 90%.

The current automatically reduced to 50% of the selected dynamic current 0.4 second after the last pulse.

3) Microstep Resolution Configurations

Microstep resolution is set by SW5, 6, 7, 8 of the DIP switches as shown in the following table. Note: “default” means the parameters can be set by Leadshine software.

Microstep	Steps/rev.(for 1.8°motor)	SW5	SW6	SW7	SW8
1	200 (default)	ON	ON	ON	ON
2	400	OFF	ON	ON	ON
4	800	ON	OFF	ON	ON
8	1600	OFF	OFF	ON	ON
16	3200	ON	ON	OFF	ON
32	6400	OFF	ON	OFF	ON
64	12800	ON	OFF	OFF	ON
128	25600	OFF	OFF	OFF	ON
5	1000	ON	ON	ON	OFF
10	2000	OFF	ON	ON	OFF
20	4000	ON	OFF	ON	OFF
25	5000	OFF	OFF	ON	OFF
40	8000	ON	ON	OFF	OFF
50	10000	OFF	ON	OFF	OFF
100	20000	ON	OFF	OFF	OFF
125	25000	OFF	OFF	OFF	OFF

7.2 DIP Switch 2

1） Micro-segmentation / Filter setting

SW9	SW10	illustrate
ON	ON	Micro-segmentation（default）
OFF	ON	Filtering time 6ms
ON	OFF	Filtering time 12ms
OFF	OFF	Filter command settings（default 25ms）

2）other switch function settings（SW11~16）

7.3 Automatic Motor Matching & Self Configuration

When powered on a EM1 will automatically configure itself with the best settings to match the driven stepper motor for optimal performance. No action is needed.

8. Wiring Notes

- In order to improve anti-interference performance of the drive, it is recommended to use twisted pair shield cable.
- To prevent noise incurred in PUL/DIR signal, pulse/direction signal wires and motor wires should not be tied up together. It is better to separate them by at least 10 cm, otherwise the disturbing signals generated by motor will easily disturb pulse direction signals, causing motor position error, system instability and other failures.
- If only one power supply serves multiple EM1 drives, separately connecting the drives to the power supply is recommended instead of daisy-chaining.
- It is prohibited to pull and plug connector P2 while the drive is powered ON, because there is high current flowing through motor coils (even when motor is at standstill). Pulling or plugging connector P2 with power on will cause extremely high back-EMF voltage surge, which may damage the drive.

9. Typical Connection

A complete stepping system should include stepping motor, stepping drive, power supply and controller (pulse generator). A typical connection is shown as below.

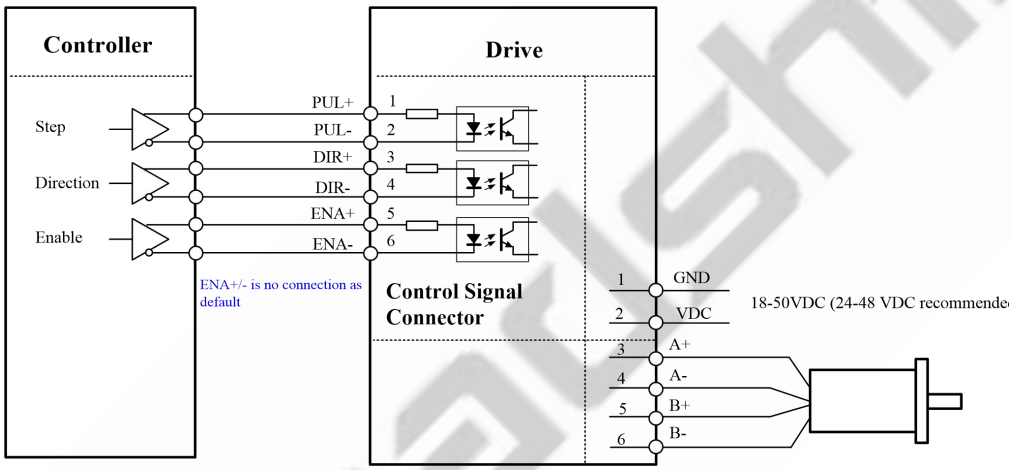


Figure 11 Typical Connections

10. Sequence Chart of Control Signals

In order to avoid some fault operations and deviations, PUL, DIR and ENA should abide by some rules, shown as following diagram:

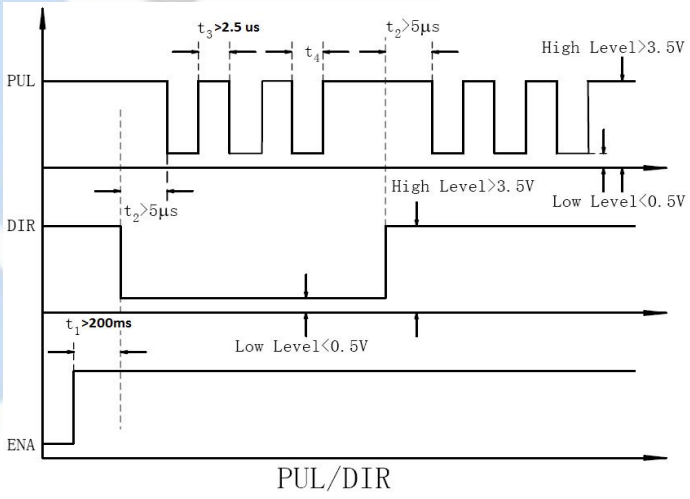
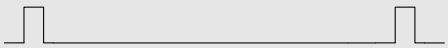
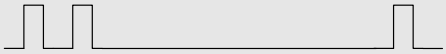


Figure 12 Sequence chart of control signals

note:
t1: ENA must be ahead of DIR by at least 200ms. Usually, ENA+ and ENA- are NC (not connected). See "Connector P1 Configurations" for more information.
t2: DIR must be ahead of PUL effective edge by 5 s to ensure correct direction;
t3: Pulse width not less than 2.5 s;
t4: Low level width not less than 2.5 s;
Duty cycle of Pulse signal is recommend 50%.

11. Protection Functions

To improve reliability, the drive incorporates some built-in protections features.

Priority	Time(s) of Blink	Sequence wave of red LED	Description
1st	1		Over-current protection activated when peak current exceeds the limit.
2nd	2		Over-voltage protection activated when drive working voltage is greater than 60VDC
3nd	3		Reserved.

When above protections are active, the motor shaft will be free or the red LED blinks. Reset the drive by repowering it to make it function properly after removing above problems.

12. Troubleshooting

In the event that your drive doesn't operate properly, the first step is to identify whether the problem is electrical or mechanical in nature. The next step is to isolate the system component that is causing the problem. As part of this process you may have to disconnect the individual components that make up your system and verify that they operate independently. It is important to document each step in the troubleshooting process. You may need this documentation to refer back to at a later date, and these details will greatly assist our Technical Support staff in determining the problem should you need assistance.
Many of the problems that affect motion control systems can be traced to electrical noise, controller software errors, or mistake in wiring.
Problem Symptoms and Possible Causes

Symptoms	Possible Problems
Motor is not rotating	No power
	Microstep resolution setting is wrong
	DIP switch current setting is wrong
	Fault condition exists
	The drive is disabled
Motor rotates in the wrong direction	Motor phases may be connected in reverse
The drive in fault	DIP switch current setting is wrong
	Something wrong with motor coil
Erratic motor motion	Control signal is too weak
	Control signal is interfered
	Wrong motor connection
	Something wrong with motor coil
	Current setting is too small, losing steps
Motor stalls during acceleration	Current setting is too small
	Motor is undersized for the application
	Acceleration is set too high
	Power supply voltage too low
Excessive motor and drive heating	Inadequate heat sinking / cooling
	Automatic current reduction function not being utilized
	Current is set too high

13. Warranty

Twelve Month Warranty

Leadshine Technology Co., Ltd. warrants its products against defects in materials and workmanship for a period of 12 months from shipment out of factory. During the warranty period, Leadshine will either, at its option, repair or replace products which proved to be defective.

Exclusions

The above warranty does not extend to any product damaged by reasons of improper or inadequate handlings by customer, improper or inadequate customer wirings, unauthorized modification or misuse, or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

Obtaining Warranty Service

To obtain warranty service, please contact your seller to obtain a returned material authorization number (RMA) before returning product for service.

Shipping Failed Products

If your product fail during the warranty period, please contact your seller for how and where to ship the failed product for warranty or repair services first, you can also e-mail customer service at tech@leadshine.com to obtain a returned material authorization number (RMA) before returning product for service. Please include a written description of the problem along with contact name and address.