User Manual

DM542 V3.0

Digital Stepper Drive

Revision 1.0

Leadshine Technology Co., Ltd.

Important 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.

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Record of Revisions

Revision	Date	Description of Release
1.0	Oct, 2017	Initial Release
3.0	Jan, 2019	Add Brake,etc.

Table of Contents

1. Introduction

The DM542 is a new digital stepper drive based on Leadshine's widely implemented DM stepper drives (10+ millions of units in field). While retaining features of simple design, easy setup, high precision and reliability, Leadshine has also upgraded it by adopting the latest stepper control technology and added additional advanced features for better torque (10-25%), quicker response time, control command smoothing, easy self-test, etc.

The DM542 is able to power 2 phase (1.8°) and 4 phase (0.9°) stepper motors smoothly with very low motor heating & noise. It can take 20-50VDC supply voltage and output 1.0 to 4.2A current. All the micro step and output current configurations can be easily done via built in DIP switches. Its control type (step & direction or CW/CCW) and command smooth filtering can also be configured via DIP switches. Therefore, the DM542 is an ideal choice for many applications requiring simple step & direction or CW/CCW control of NEMA 17, 23, and 24 stepper motors.

1.1 Features

- Step & direction (PUL/DIR) or CW/CCW (double pulse) control
- 20-50VDC supply voltage
- 200 KHz max pulse input frequency
- 16 micro-step resolutions of 200-25,600 via DIP switches or Leadshine ProTuner
- 8 output current settings of 1.0– 4.2A via DIP Switches
- Configurable control command smoothing for performance excellence
- Idle current reduction to 50% or 90% selection via SW4
- Convenient self-test for easy diagnosis
- Auto-tuning to match wide-range NEMA 17, 23, 24 stepper motors
- Anti-Resonance for optimal torque, extra smooth motion, low motor heating and noise
- Soft-start with no "jump" when powered on
- Optically isolated inputs with 5V or 24V
- Fault and Brake output
- Over-voltage, over-current and motor cable error protections
- CE certified and RoHS compliant

1.2 Applications

The DM542 stepper drive is designed to power 2 phase (1.8°) or 4-phase (0.9°) NEMA17, 23 and 24 hybrid stepper motors. It can be adopted in many industries (CNC machinery, electronics, medical, automation, packaging…) for applications such as CNC routers, mills, plasma, laser cutters, factory assembly lines, vending machines, etc. Its excellent performance, simple design, and easy setup features make DM542 ideal for many step & direction control type applications.

2. Specifications

2.1 Electrical Specifications

Parameters	Min	Typical	Max	Unit
Output Current	1.8	-	4.2 (3.0 RMS)	A
Supply Voltage	20	24 - 48	50	VDC
Logic signal current	7	10	16	mA
Pulse input frequency	0	-	200	kHz
Minimal pulse width	2.5	-	-	μS
Minimal direction setup	5.0	-	-	μS
Isolation resistance	500	-	-	MΩ

2.2 Environment

Cooling	Natural Cooling or Forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	0 － 65°C (32 - 149°F)
	Humidity	40 － 90%RH
	Operating Temperature	0 － 50°C (32 - 122°F)
	Vibration	10-50Hz / 0.15mm
Storage Temperature	-20°C － 65°C (-4°F - 149°F)	
Weight	Approx. 250g (8.8 oz)	

2.3 Mechanical Specifications

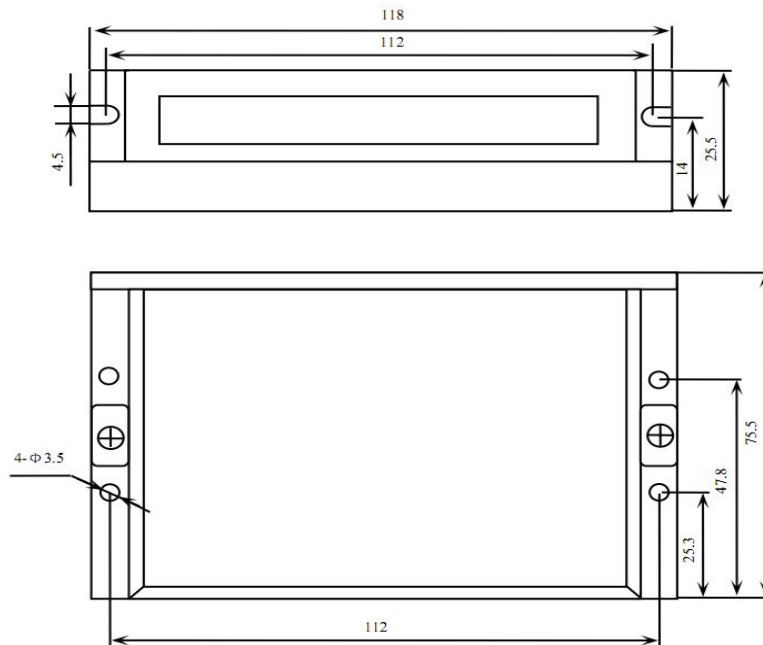(unit: mm [1inch=25.4mm])

Figure 1 Mechanical specifications
* Side mounting recommended for better heat dissipation

2.4 Elimination of Heat

- DM542's working temperature is less than 60℃ (140°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.

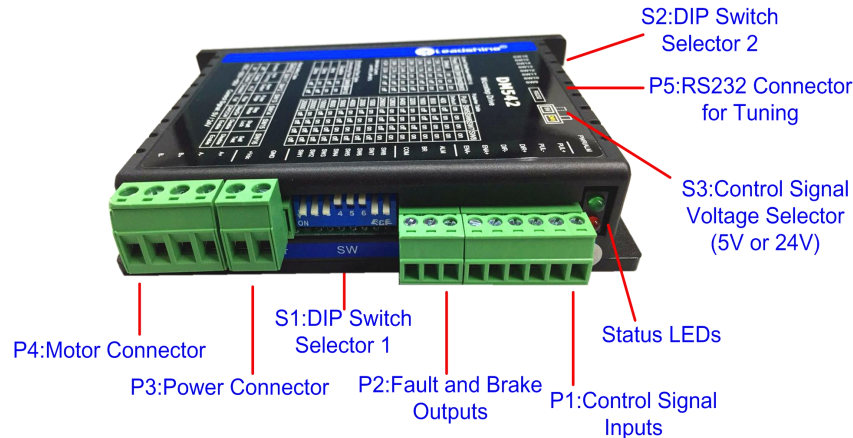# 3. Connection Pin Assignments and LED Indication

Figure 2 Connectors, DIP switches, and LED locations

The DM542 has four terminal block connectors P1, P2, P3 & P4 (see above picture), and two DIP switch selectors S1 & S2. P1 is for control signal connections, P2 is for fault output, P3 is for power connection, and P4 is for motor connection.

3.1 P1 - Control Signal Inputs Configurations

PIN	Details
PUL+	Pulse Connection: Required. **(1)** 5V / 24V, optically isolated, differential. **(2)** Maximum 200 KHz input frequency. **(3)** Pulse width of 2.5μs or longer. **(4)** In single pulse (step & direction) control mode, this input signal represents a pulse which is active at the rising or falling voltage edge (set by DIP switch SW13); in double pulse (CW/CCW) control mode, this input signal represents clockwise (CW) pulse which is active at both high voltage level and low voltage level.
PUL-	
DIR+	Direction Connection: Required. **(1)** 5V / 24V, optically isolated, differential. **(2)** Maximum 200 KHz input frequency. **(3)** Pulse width of 2.5μs or longer. **(4)** Minimal DIR signal setup time should be at least 5μs. **(5)** In single pulse (step & direction) control mode, this signal represents controls motion rotation direction; in double pulse (CW/CCW) control mode, this input signal controls counterclockwise (CCW) rotation direction and is active at both voltage high level and low level.
DIR-	
ENA+	Enable Connection: Optional. **(1)** Optically isolated, differential. **(2)** Disable the drive by 5V / 24V input connection; enable the drive by 0-0.5 VDC connection. **(3)** This connection is optional (defaulted to unconnected) with drive enabled. **(4)** By default, motor shaft is unlocked when drive disabled but can be configured to shaft locked by DIP switch SW15.
ENA-	

⚠ **Notice** **Notes:** to avoid interference: (1) shield control signal wires; (2) don't tie PUL/DIR control signal cable and motor wires together;

3.2 P2 - Fault and Brake Output Connector

Pin	Details
ALM	Output Connection: Optional. **(1)** Maximum 30V/100mA output. **(2)** Sinking or sourcing. **(3)** The resistance between ALM and COM- is low impedance as default (configurable by DIP switch SW12), and will change to high when the drive goes into error protection. (4) Fault and Brake connection refer to chapter 4.2
BR	
COM-	

3.3 P3 - Power Connector

Pin	Details
GND	Connect to power supply ground connection.
+VDC	Connect to power supply positive connection. Suggest 24-48VDC power supply voltage

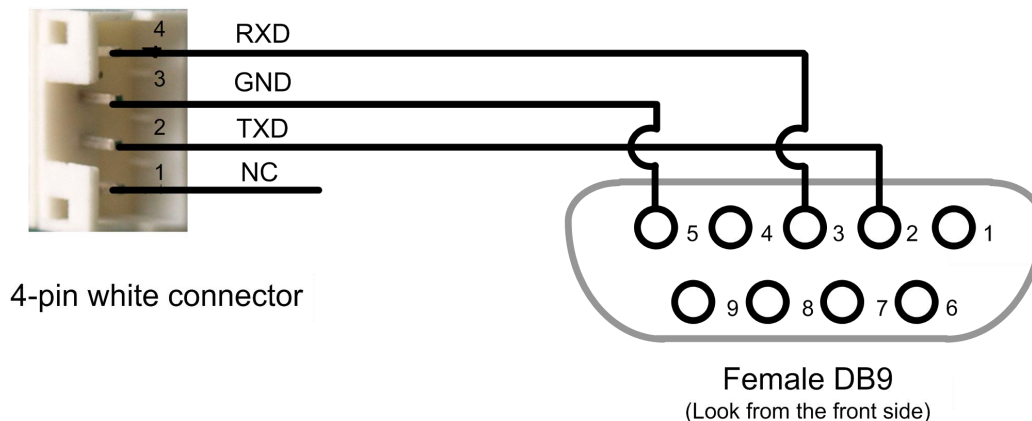⚠ **Warning** **Warning:** Don't plug/unplug P3 or any P1/P2/P4 terminal block to avoid drive damage or injury while powered on.

3.3 P4 - Motor Connector

PIN	Details
A+	Connect to motor A+ wire
A-	Connect to motor A- wire
B+	Connect to motor B+ wire
B-	Connect to motor B- wire

3.5 P5-RS232 Communication Connector for Tuning

4-pin white connector

Female DB9
(Look from the front side)

RS232 Connector			
Pin	Signal	Description	I/O
1	Reserved	-	-
2	TxD	RS232 transmit.	O
3	GND	Ground.	GND
4	RxD	RS232 receive.	I

3.6 Status LED Lights

There are two LED lights for DM542. The GREEN one is the power indicator which should be always on in normal circumstance. The RED one is a drive status indication light, which will be OFF while working normally but ON and flash 1-2 times in a 3-second period in the case of enabled over-voltage or over-current protection.

4. Control Signal and Fault Output

4.1 Control Signal Connection

The DM542 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.
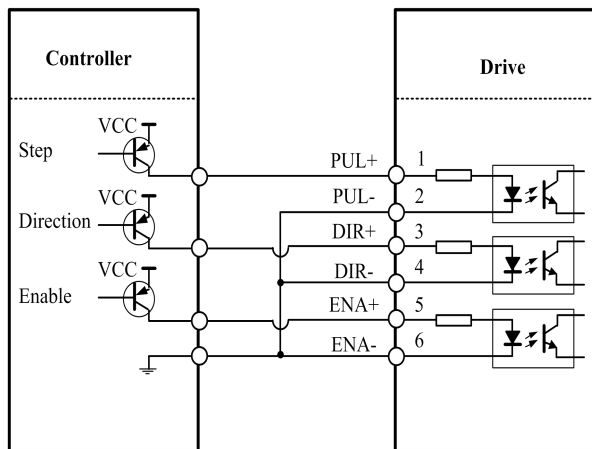

Figure 3 Connections to open-collector signals (Common-anode)
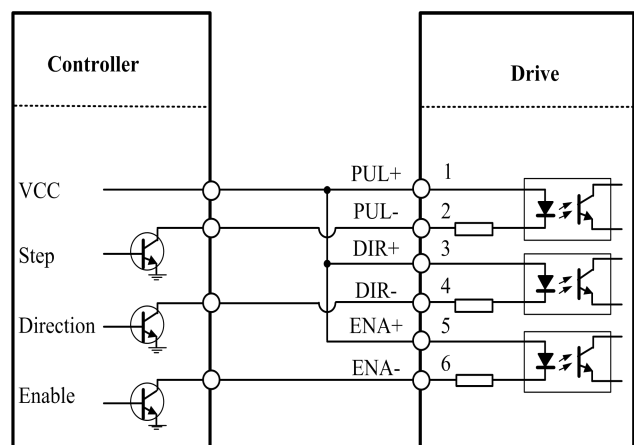
Figure 4 Connections to PNP signals (Common-cathode)

4.2 Fault and Brake output connection

- *Fault Output*

When over voltage or over current protection happens, DM542 red status LED light will blink and the impedance state between ALM and COM- 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.
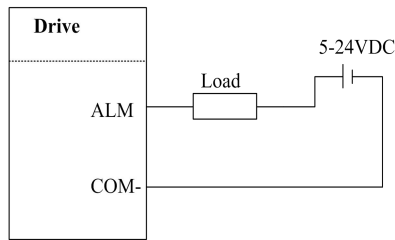
Figure 5 Sinking output   **Figure 6** Sourcing output
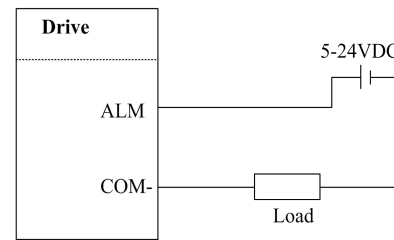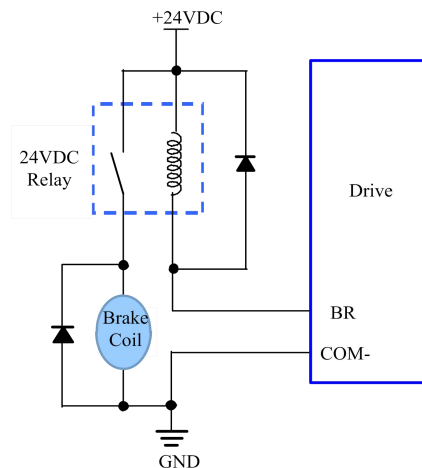
- *Brake Control*

It is recommended to connect a fly-wheel diode in parallel to a 24VDC relay and brake coil connection. Refer to the following figure for brake connection.

Figure 7 Brake Output Connection

5. Stepper Motor Connections

DM542 can drive 2-phase and 4-phase bipolar hybrid stepper motors with 4, 6, or 8 wires. Although setting the output current to 1.4 times of motor phase current will get maximum torque from the motor, at the same time motor heating will be also maximized. So, just configure the drive output current to a value which will get sufficient torque to reduce motor heating.

5.1 4-lead Motor Connection

Refer to figure 7 for how to connect a 4-wire stepper motor. Configure DM542 output current to one of the 8 available values through DIP switches SW 1-3 of the DIP switch selector 1 (figure 2).
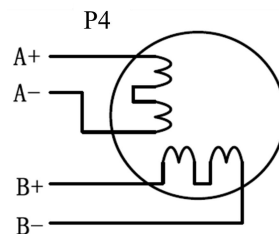
Figure 8 4-lead Motor Connection

5.2 6-lead Motor Connection

DM542 can power 6-lead stepper motors through half coil connection (half chopper) or full coil (full copper)

connection. The half coil connection only uses one half of the motor's windings and is usually selected in applications requiring high speed but lower torque. The full coil connection uses the full coil windings and is usually selected in high-torque required applications. Refer to figure 7 and 8 for those two connections.
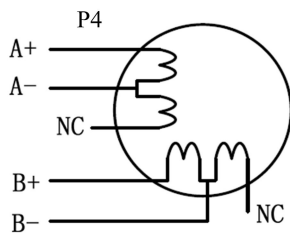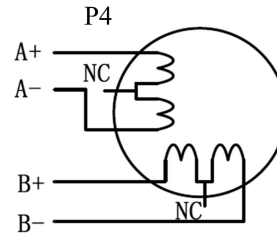

Figure 9 6-lead motor half coil connection

Figure 10 6-lead motor full coil connection

5.3 8-lead Motor Connection

DM542 can power 8-lead in series or parallel connection in series or parallel.

5.3.1 Series Connection

Series connected 8-lead stepper motors are typically implemented in applications which higher torque at lower speed movement is required. Because a stepper motors under series connection has the most inductance, the performance will start to degrade when the motor runs at higher speed. For this connection, it is suggested to set an DM542's output RMA current to no more than 70% of the stepper motor's phase current to prevent overheating. See the next figure for how to connect an 8-lead stepper motor for series connection.

Figure 11   8-lead motor series connection

5.3.2 Parallel Connection

Parallel connected 8-lead stepper motors are typically implemented in applications which higher torque at high speed movement is required. Compared with series connection, a parallel connected stepper motor has lower inductance and therefore have better torque performance at higher speed movement. Although setting the drive output current to 1.4 times of driven motor phase current will get the most torque, it is suggested to set an DM542's output current (peak of sinusoidal) to no more than 1.2 times the stepper motor's phase current to prevent overheating. Refer to the next figure for how to connect an 8-lead stepper motor for parallel connection.
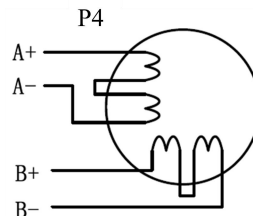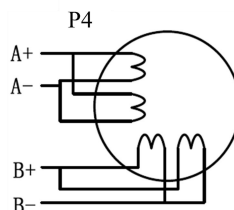

Figure 12   8-lead motor parallel connection

6. Power Supply Selection

DM542 is designed to power small and medium size stepping motors (frame sizes NEMA 23 to 24) made by Leadshine or other motor manufacturers. To get optimal performances, it is important to select proper power supply type, voltage, and supply output current. In general power supply voltage determines the high speed performance of a stepper motor, while drive output current determines the driven motor torque output. Higher supply voltage can increases motor speed torque performance, but at the same time result in more noise and motor heating. For low motor speed applications, it is suggested to use lower supply voltage power supplies.

6.1 Regulated or Unregulated Power Supply

Both regulated and unregulated power supplies can be used to power an DM542. Theoretically unregulated power supplies are preferred due to their ability to withstand back EMF current surge and faster response for current change. If you prefer to use a regulated power supply instead, it is suggested to choose one specially designed for stepper or servo controls such as one Leadshine RPS series power supply (http://www.leadshine.com/ProductSubType.aspx?subtype=regulated-switching-power-supplies). In the case when only general purpose switching power supplies are available, choose one with "OVERSIZED" current output rating (for example, using a 4A power supply for 3A stepper motor) to avoid current clamp. On the other hand, if unregulated supply is used, one may use a power supply of lower current rating than that of motor (typically 50%～70% of motor phase current). The reason is that the drive only draws current from an unregulated power supply during the ON duration of the PWM cycle, but not during the OFF duration.

6.2 Power Supply Sharing

Multiple DM542 drives can share the same power supply, if that power supply has enough capacity. To avoid cross interference, connect each DM542 DIRECTLY to that shared power supply separately instead of connecting those power connectors of drives in daisy-chain connection.

6.3 Selecting Supply Voltage

DM542's operating voltage is 20–50 VDC. Because of voltage increasing from potential power line voltage fluctuation and back EMF voltage generated during motor deceleration, it is suggested to use a 24-48 VDC power supply.

7. DIP Switch Configurations

Each DM542 has 3 DIP switch selectors. The first 8-bit is located on the side (DIP switch selector 1 in Figure 2) and used to configure settings of micro step resolution, output current, and motor standstill current as shown below:
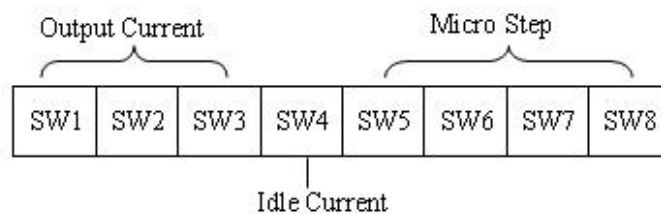
The second 8-bit DIP switch is located on the top (DIP switch selector 2 in figure 2), and used to configure settings of control command filtering time, motor auto-configuration, fault output impedance, pulse active edge, control mode,

lock shaft, and self-test as shown below:
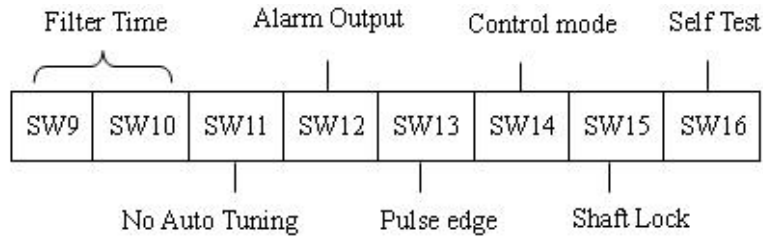
The Third switch is located on the top (DIP switch selector 3 in figure 2), used to configure the voltage of control signals. When the voltage of the control signal is 5V, the S3 is set to 5V; and when the voltage of control signal is 24V, the S3 is set to 24V, no need to connect a 2KΩ resistor.

7.1 Output Current Configuration　(SW1-3)

The DM542 has 8 micro step settings which can be configured through DIP switch SW1, SW2 and SW3.

For a given stepper motor, higher drive output current will make it output higher torque, but at the same time cause more heating for both the motor and drive. Therefore, output current is generally set to be such that the motor will not overheat for long time operation. Since parallel and serial connections of motor coils will significantly change resulting inductance and resistance, it is therefore important to set drive output current depending on motor phase current, motor leads and connection methods. Phase current rating supplied by motor manufacturer is important in selecting drive current; however the selection also depends on leads and connections.

The first three bits (SW1, 2, 3) of the DIP switch are used to set the dynamic current. Select a setting closest to your motor's required current.

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

* Users can use Leadshine ProTuner software to set output current, the minimum is 0.5A recommended

7.2 Idle Current Configuration　(SW4)

The SW4 of an DM542 is used to set output current percentage when motor is standstill. Idle current percentage will be set to 50% at OFF position, and 90% at ON position. When the driven stepper motor is idle (no movement) for 0.4 second, the output current of DM542 will be automatically reduced to the configured percentage.

7.3 Micro Step Configuration　(SW5-8)

Each DM542 has 16 micro step settings which can be configured through DIP switch SW5, SW6, SW7, and SW8. See the following table for detail.

Micro step	Pulses/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

* Users can use Leadshine ProTuner software to set a microstep in multiples of 200.

7.4 Filter Time Configuration (SW9-10)

DM542 has an advanced feature called control command smoothing to eliminate "noise" input pulse from the pulse generator (controller, PLC, etc.), and therefore improve motion smoothness and high-speed start frequency in many circumstances.

This is achieved through adding filtering time which is configured SW 9-10. See the following table for how to configure. In multi-axis applications make sure to set the Filter Time value of each DM542 to the same.

Filter Time	SW9	SW10
0 ms (disabled)	ON	ON
6 ms	OFF	ON
12 ms	ON	OFF
25 ms (default)	OFF	OFF

⚠ Warning The Filter Time value must be set to the same for each DM542 in multi-axis applications

7.5 No Auto Tuning Configuration　(SW11)

DM542 can configure itself with the best match to the driven stepper motor for optimal performance. This feature may need to be disabled for some applications or when it is used to drive a specially designed stepper motor. To do that, set the DIP switch SW11 to ON position and the drive will be set to its default settings.

7.6 Alarm Output Configuration (SW12)

DIP switch SW12 is used to configure the impedance state of alarm output (fault output). At OFF position (default) the

resistance between ALM and COM- is set to low impedance in normal operation, and will change to high impedance when the drive goes into over-voltage or over-current protection. When SW12 is set to ON position, that resistance will be set to high impedance in normal condition and changed to low impedance under error protections.

7.7 Pulse Edge Configuration (SW13)

DIP switch SW13 is used to configure which voltage edge will activate a pulse signal. Set it to OFF position (default) means that a pulse is activated at voltage rising edge, and ON position means a pulse is activated at falling edge. Make sure this setting will match the pulse generator (controller, PLC, etc.)

7.8 Control Mode Configuration (SW14)

DIP switch SW14 is used to configure the control mode of DM542. By default it is set to OFF position for single pulse (step & direction, or pulse & direction) control. To change the control model to double pulse (CW/CCW) control type, set its position to OFF.

7.9 Shaft Lock Configuration (SW15)

Use DIP switch SW15 to set shaft lock mode when DM542 is disabled (read ENA+ and ENA- explanation of control connector for how to disable DM542). Set it to OFF position (default) for no motor shaft lock (free spin) when drive disabled. Set it to ON position for motor shaft lock.

7.10 Self-Test Configuration (SW16)

For test and system diagnosis purpose, EM42 is featured with Self-Test. Anytime DIP switch SW16 is switched to ON position, the drive will automatically rotate the driven stepper motor back and forth for one round in each direction. Set this switch position to OFF for normal operation.

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 DM542 drives, separately connecting the drives to the power supply is recommended instead of daisy-chaining.

● It is prohibited to pull and plug connector P4 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 P4 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 figure 11.
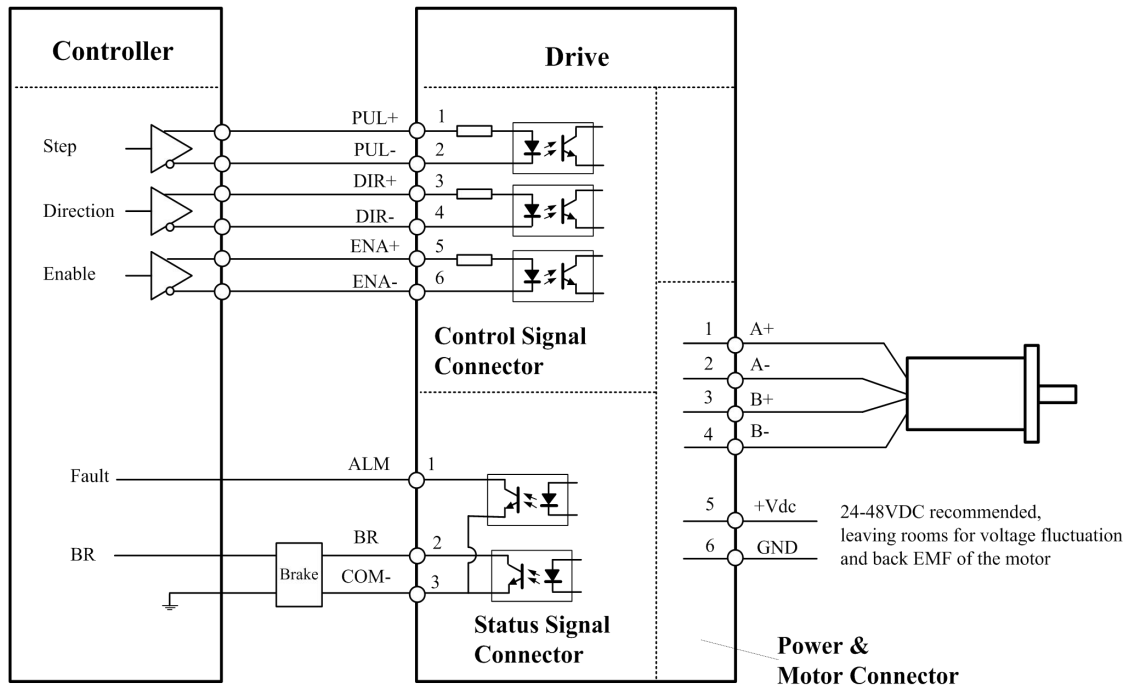
Figure 12 Typical connection

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:
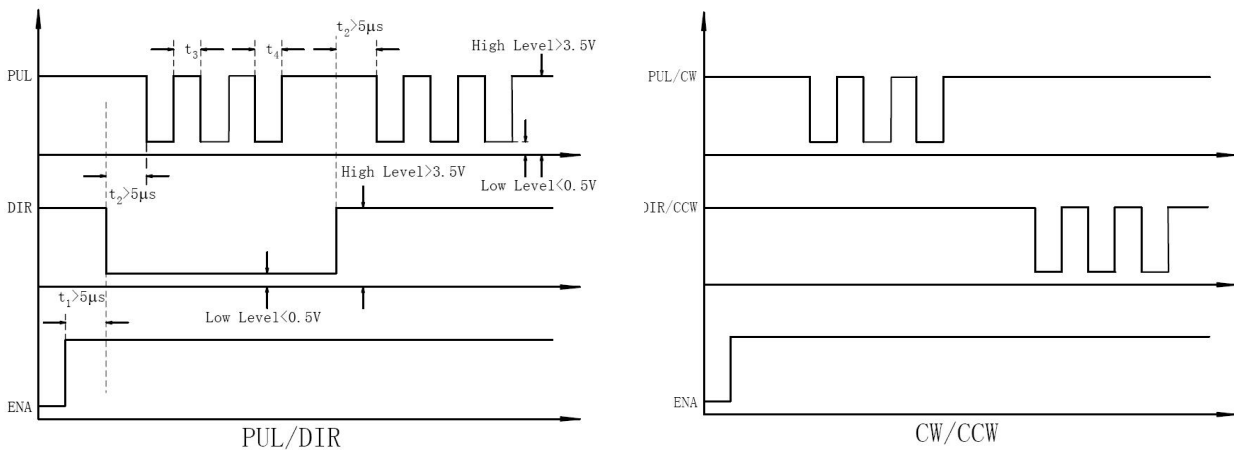
Figure 13   Sequence chart of control signals

Remark:

a) t1: ENA must be ahead of DIR by at least 5μs. Usually, ENA+ and ENA- are NC (not connected). See "Connector P1 Configurations" for more information.

b) t2: DIR must be ahead of PUL effective edge by 5μs to ensure correct direction;

c) t3: Pulse width not less than 2.5μs;

d) t4: Low level width not less than 2.5μs.

11. Protection Functions

DM542 incorporates are built with over-voltage and over-current error protections. When it is under error protection, the red LED light will blink for one or two times in a period of 3 seconds. If fault output connection is connected, the impedance mode between ALM+ and ALM- will be changed (See "Fault Output Configuration" section for detail).
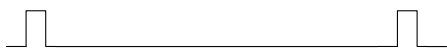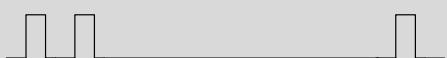
Priority	Time(s) of Blink	Sequence wave of red LED	Description
1st	1		Over-current protection activated when peak current exceeds the limit.
2nd	2		Over-voltage protection activated when drive working voltage is greater than 60VDC
3rd	4		Motor cable error protection activated when the motor cable wiring is incorrect

Figure 14   Error Protections

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
	Pulse/revolution 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.

14. Contact Us

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        86-755-2641-7674   (Asia, Australia, Africa)

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        support@leadshineusa.com   (Support)