DM422

Fully Digital Stepping Driver
User's Manual

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

Table of Contents

Introduction, Features and Applications 2
Specifications 3
Pin Assignment and Description 4
Control Signal Connector (P1) Interface 5
Connecting the Motor 6-7
Power Supply Selection 8
Selecting Microstep Resolution and Driver Output Current 9-10
Wiring Notes 11
Typical Connection. 11
Sequence Chart of Control Signals 11
Protection Functions 12
Frequently Asked Questions 13
Appendix 14

HELIX LINEAR TECHNOLOGIES

Introduction

The DM422 is a versatility fully digital stepping driver based on a DSP with advanced control algorithm. The DM422 is the next generation of digital stepping motor controls. It brings a unique level of system smoothness, providing optimum torque and nulls mid-range instability. Motor self-test and parameter auto-setup technology offers optimum responses with different motors and easy-to-use. The driven motors can run with much smaller noise, lower heating, smoother movement than most of the drivers in the markets. Its unique features make the DM422 an ideal solution for applications that require low-speed smoothness. Compared to the DM422C, the DM422 makes the motor run into higher speed and the user can configure the standstill current in the software. What's more, a pulse filter (smoother) has been built into the DM422.

Features

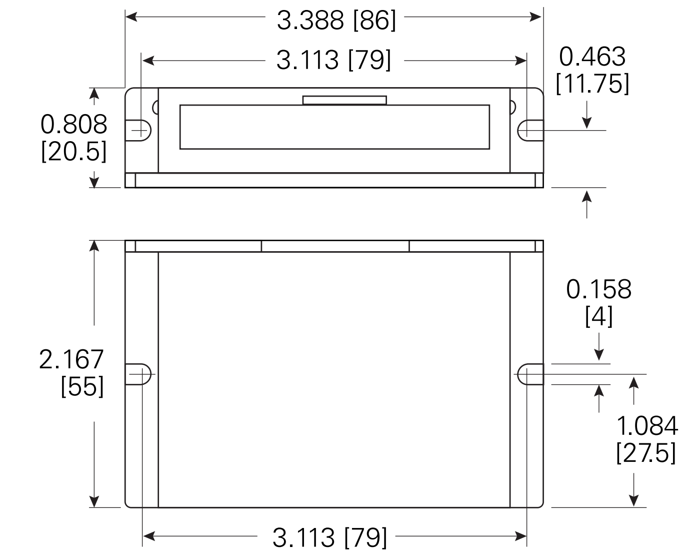
- Anti-Resonance, provides optimum torque and nulls mid-range instability
- Motor self-test and parameter auto-setup technology, offers optimum responses with different motors
- Multi-Stepping allows a low resolution step input to produce a higher microstep output for smooth system performance
- Microstep resolutions programmable, from full-step to 102,400 steps/rev
- Supply voltage up to +40 VDC
- Output current programmable, from 0.3A to 2.2A
- Pulse input frequency up to 75 KHz
- TTL compatible and optically isolated input
- Automatic idle-current reduction (Reduction rate can be software configured)
- Support PUL/DIR and CW/CCW modes
- Over-voltage, over-current, phase-error protections

Applications

Suitable for a wide range of stepping motors, from NEMA frame size 14 to 23. It can be used in various kinds of machines, such as laser cutters, laser markers, high precision X-Y tables, labeling machines, and so on. Its unique features make the DM422 an ideal solution for applications that require low-speed smoothness.

Electrical Specifications (T_j = 25°C/77°F)

Parameters	Min	Typical	Max	Unit
Output current	0.3	-	2.2 (1.6 RMS)	A
Supply voltage	+20	-	+40	VDC
Logic signal current	7	10	16	mA
Pulse input frequency	0	-	75	kHz
Isolation resistance	500			MΩ



Mechanical Specifications (unit: inch [mm])

Elimination of Heat

- Driver's reliable working temperature should be <70°C(158°F), and motor working temperature should be <80°C(176°F);
- It is recommended to use automatic idle-current mode, namely current automatically reduce to 60% when motor stops, so as to reduce driver heating and motor heating;
- It is recommended to mount the driver vertically to maximize heat sink area. Use forced cooling method to cool the system if necessary.

Operating Environment and other Specifications

Cooling	Natural Cooling or Forced cooling
Environment	Avoid dust, oil fog and corrosive gases
Ambient Temperature	0°-50° (32°-122°)
Humidity	40%RH – 90%RH
Operating Temperature	70°C (158°F) Max
Vibration	5.9m/s2 Max
Storage Temperature	-20°C – 65°C (-4°F – 149°F)
Weight	Approx. 100g (3.5274oz)

Pin Assignment and Description

The DM422 has two connectors, connector P1 for control signals connections, and connector P2 for power and motor connections. The following tables are brief descriptions of the two connectors. More detailed descriptions of the pins and related issues are presented in section 4, 5, 9.

Connector P1 Configurations

- **Pulse signal (PUL):** In single pulse (pulse/direction) mode, this input represents pulse signal, each rising or falling edge active (software configurable); 4-5V when PUL-HIGH, 0-0.5V when PUL-LOW. In double pulse mode (pulse/pulse), this input represents clockwise (CW) pulse, active both at high level and low level (software configurable). For reliable response, pulse width should be longer than 7.5μs. Series connect resistors for current-limiting when +12V or +24V used. The same as DIR and ENA signals.
- **DIR signal (DIR):** In single-pulse mode, this signal has low/high voltage levels, representing two directions of motor rotation; in double-pulse mode (software configurable), this signal is counter-clock (CCW) pulse, active both at high level and low level (software configurable). For reliable motion response, DIR signal should be ahead of PUL signal by 5μs at least. 4-5V when DIR-HIGH, 0-0.5V when DIR-LOW. Please note that rotation direction is also related to motor-driver wiring match. Exchanging the connection of two wires for a coil to the driver will reverse motion direction.
- **Opto-coupler (OPTO):** Opto-coupler power supply, and the typical voltage is +5V. Series connect resistors (at the PUL, DIR, ENA terminals) for current-limiting when 12V or +24V used.
- **Enable signal (ENA):** This signal is used for enabling/disabling driver. High level for enabling the driver and low level for disabling the driver. Usually left UNCONNECTED (ENABLED).

Selecting Active Pulse Edge and Control Signal Mode

The DM422 supports PUL/DIR and CW/CCW modes and pulse active at rising or falling edge. See more information about these settings in Section 13. Default setting is PUL/DIR mode and rising edge active.

Connector P2 Configurations

Pin Function	Details
+Vdc	Power supply, 20~40 VDC*
GND	Power Ground
A+, A-	Motor Phase A
B+, B-	Motor Phase B

* Including voltage fluctuation and EMF voltage.

Control Signal Connector (P1) Interface

The DM422 uses opto-couplers to increase noise immunity and interface flexibility. If the opto-couplers' supply voltage is higher than +5V, a current-limiting resistor needs to be connected at each command signal terminal to prevent overheating the opto-couplers. In the following figures, connections to open-collector and differential controller are illustrated.

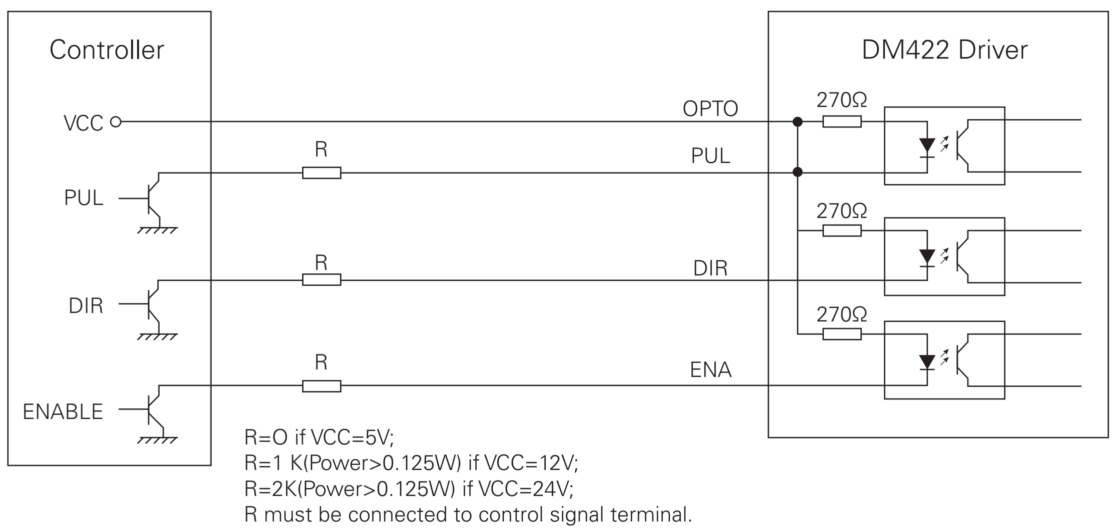


Figure 2: Connections to open-collector signal (common-anode)

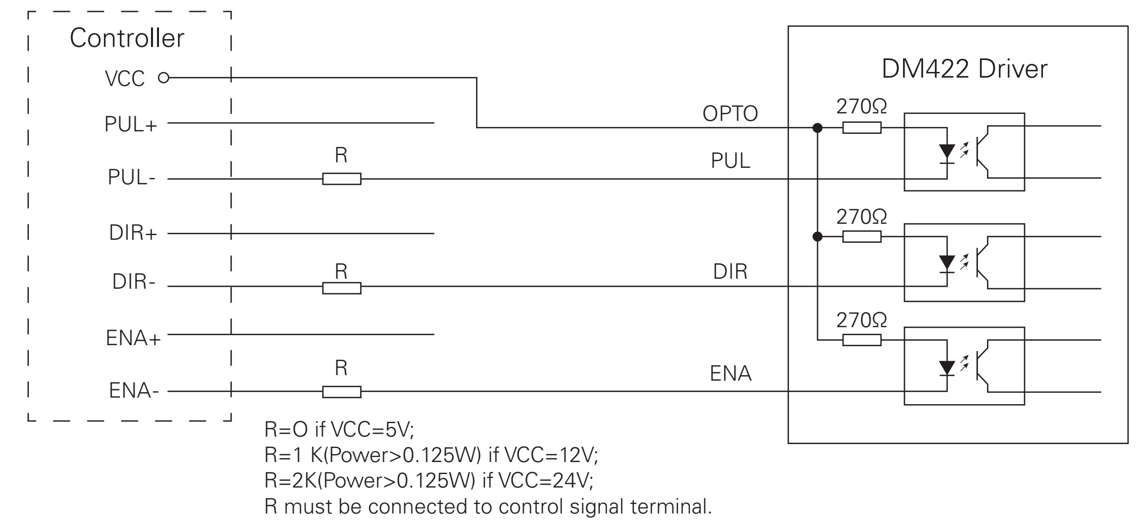


Figure 3: Connections to differential control signal

Connecting the Motor

The DM422 can drive any 2-phase and 4-phase hybrid stepping motors.

Connections to 4-lead Motors

4 lead motors are the least flexible but easiest to wire. Speed and torque will depend on winding inductance. In setting the driver output current, multiply the specified phase current by 1.4 to determine the peak output current.

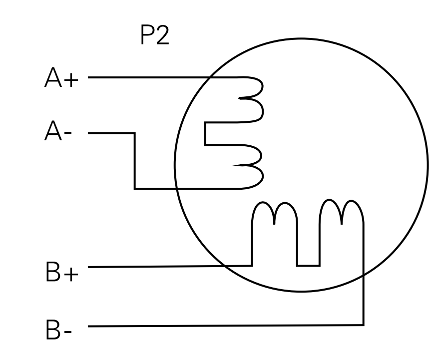


Figure 4: 4-lead Motor Connections

Connections to 6-lead Motors

Like 8 lead stepping motors, 6 lead motors have two configurations available for high speed or high torque operation. The higher speed configuration, or half coil, is so described because it uses one half of the motor's inductor windings. The higher torque configuration, or full coil, uses the full windings of the phases.

Half Coil Configurations

As previously stated, the half coil configuration uses 50% of the motor phase windings. This gives lower inductance, hence, lower torque output. Like the parallel connection of 8 lead motor, the torque output will be more stable at higher speeds.

This configuration is also referred to as half chopper. In setting the driver output current multiply the specified per phase (or unipolar) current rating by 1.4 to determine the peak output current.

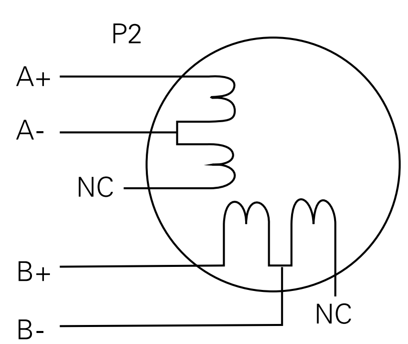


Figure 5: 6-lead motor half coil (higher speed) connections

Full Coil Configurations

The full coil configuration on a six lead motor should be used in applications where higher torque at lower speeds is desired. This configuration is also referred to as full copper.

In full coil mode, the motors should be run at only 70% of their rated current to prevent over heating.

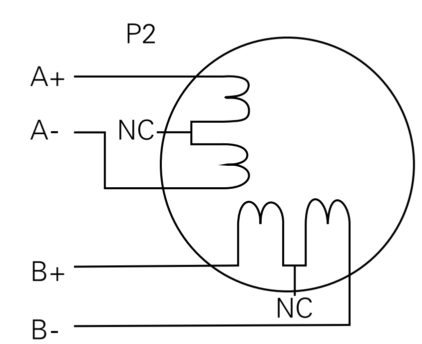


Figure 6: 6-lead motor full coil (higher torque) connections

Connections to 8-lead Motors

8 lead motors offer a high degree of flexibility to the system designer in that they may be connected in series or parallel, thus satisfying a wide range of applications.

Series Connections

A series motor configuration would typically be used in applications where a higher torque at lower speeds is required. Because this configuration has the most inductance, the performance will start to degrade at higher speeds. In series mode, the motors should also be run at only 70% of their rated current to prevent over heating.

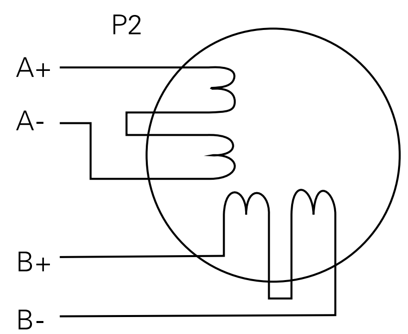


Figure 7: 8-lead motor series connections

Parallel Connections

An 8 lead motor in a parallel configuration offers a more stable, but lower torque at lower speeds. But because of the lower inductance, there will be higher torque at higher speeds. Multiply the per phase (or unipolar) current rating by 1.96, or the bipolar current rating by 1.4, to determine the peak output current.

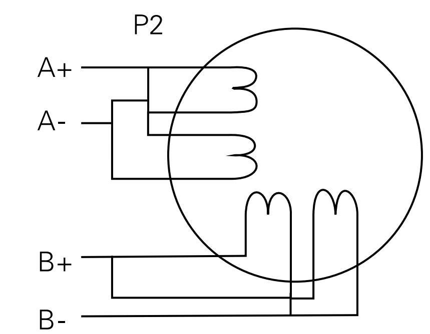


Figure 8: 8-lead motor parallel connections

NEVER disconnect or connect the motor while the power source is energized.

Power Supply Selection

The DM422 can match medium and small size stepping motors (from NEMA frame size 14 to 23) made by Helix Linear or other motor manufactures around the world. To achieve 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.

Regulated or Unregulated Power Supply

Both regulated and unregulated power supplies can be used to supply the driver. However, unregulated power supplies are preferred due to their ability to withstand current surge. If regulated power supplies (such as most switching supplies.) are indeed used, it is important to have large current output rating to avoid problems like current clamp, for example using 4ª supply for 3ª motor-driver operation. 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 current). The reason is that the driver draws current from the power supply capacitor of the unregulated supply only during the ON duration of the PWM cycle, but not during the OFF duration. Therefore, the average current withdrawn from power supply is considerably less than motor current. For example, two 3ª motors can be well supplied by one power supply of 4ª rating.

Multiple Drivers

It is recommended to have multiple drivers to share one power supply to reduce cost, if the supply has enough capacity. To avoid cross interference, DO NOT daisy-chain the power supply input pins of the drivers. Instead, please connect them to power supply separately.

Selecting Supply Voltage

The power MOSFETs inside the DM422 can actually operate within +20 ~ +40VDC, including power input fluctuation and back EMF voltage generated by motor coils during motor shaft deceleration. 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 driver damage. Therefore, it is suggested to choose only sufficiently high supply voltage for intended applications, and it is suggested to use power supplies with theoretical output voltage of +20 ~ +36VDC, leaving room for power fluctuation and back-EMF.

Selecting Microstep Resolution and Driver Output Current

Microstep resolutions and output current are programmable, the former can be set from full-step to 102,400 steps/rev and the latter can be set from 0.3ª to 2.2ª. See more information about Microstep and Output Current Setting in Section 13.

However, when it's not in software configured mode, this driver uses a 6-bit DIP switch to set microstep resolution, and motor operating current, as shown below:

Microstep Resolution Selection

When it's not in software configured mode, microstep resolution is set by SW5, 6 of the DIP switch as shown in the following table:

Microstep	Steps/rev. (for 1.8° motor)	SW5	SW6
1 to 512	Default/Software configured	ON	ON
8	1600	OFF	ON
16	3200	ON	OFF
32	6400	OFF	OFF

Current Settings

For a given motor, higher driver current will make the motor to output more torque, but at the same time causes more heating in the motor and driver. 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 driver output current depending on motor phase current, motor leads and connection methods. Phase current rating supplied by motor manufacturer is important in selecting driver current, however the selection also depends on leads and connections.

When it's not in software configured mode, 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.

Dynamic current setting

Peak Current	RMS Current	SW1	SW2	SW3
Default/Software configured (0.3 to 2.2A)		ON	ON	ON
0.5A	0.35 A	OFF	ON	ON
0.7A	0.50 A	ON	OFF	ON
1.0A	0.71 A	OFF	OFF	ON
1.3A	0.92 A	ON	ON	OFF
1.6A	1.13 A	OFF	ON	OFF
1.9A	1.34 A	ON	OFF	OFF
2.2A	1.56 A	OFF	OFF	OFF

Note: Due to motor inductance, the actual current in the coil may be smaller than the dynamic current setting, particularly under high speed condition.

Standstill current setting

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

By default, the current automatically reduced to 60% of the selected dynamic current two second after the last pulse. Theoretically, this will reduce motor heating to 36% (due to P=I2*R) of the original value. **Reduction rate and idle time can be configured in the PC software ProTuner**. See more information in section 13.

Wiring Notes

- In order to improve anti-interference performance of the driver, 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 a power supply serves several drivers, separately connecting the drivers is recommended instead of daisy-chaining.
- It is prohibited to pull and plug connector P2 while the driver 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 driver.

Typical Connection

A complete stepping system should include stepping motor, stepping driver, power supply and controller (pulse generator). A typical connection is shown as figure 9.

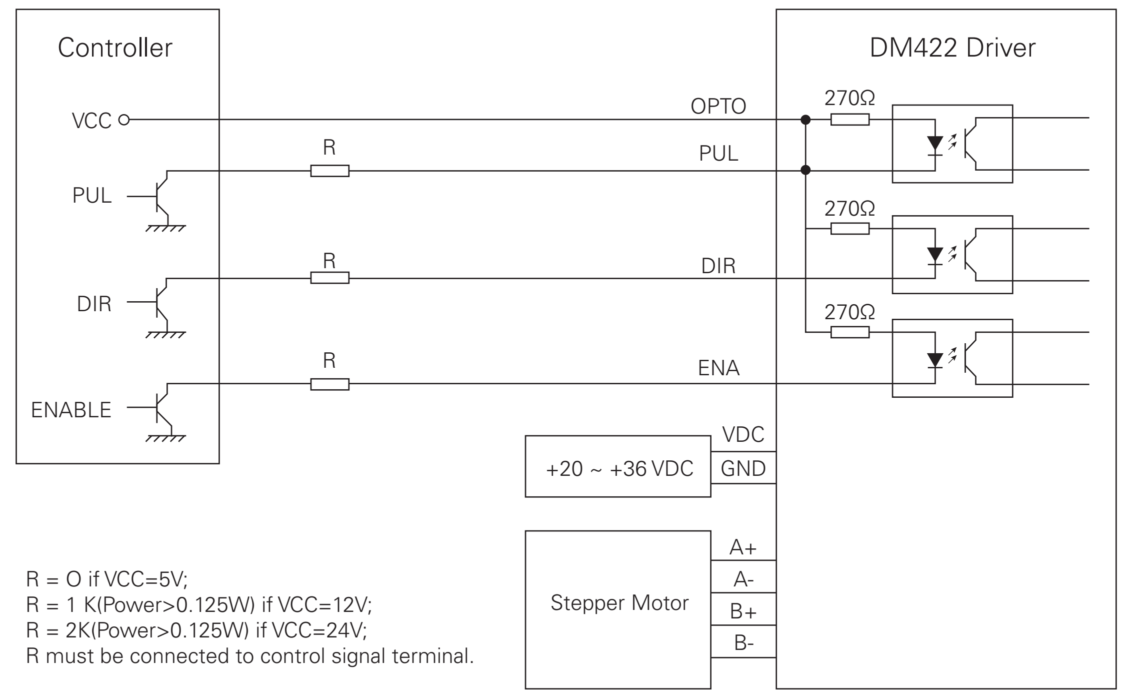


Figure 9: Typical connection

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 10: Sequence chart of control signals

- **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.
- **t2:** DIR must be ahead of PUL effective edge by 5μs to ensure correct direction;
- **t3:** Pulse width not less than 7.5μs;
- **t4:** Low level width not less than 7.5μs.

To improve reliability, the driver incorporates some built-in protection functions. The DM422 uses one RED LED to indicate what protection has been activated. The periodic time of RED is 3 s (seconds), and how many times the RED turns on indicates what protection has been activated. Because only one protection can be displayed by RED LED, so the driver will decide what error to display according to their priorities. See the following Protection Indications table for displaying priorities.

Over-current Protection

Over-current protection will be activated when continuous current exceeds the limit or in case of short circuit between motor coils or between motor coil and ground, and RED LED will turn on once within each periodic time (3 s).

Over-voltage Protection

When power supply voltage exceeds 48±2 VDC, protection will be activated and RED LED will turn on twice within each periodic time (3s).

Phase Error Protection

Motor power lines wrong & not connected will activate this protection. RED LED will turn on four times within each periodic time (3s).

Attention: When above protections are active, the motor shaft will be free or the LED will turn red. Reset the driver by repowering it to make it function properly after removing above problems. Since there is no protection against power leads (+,-) reversal, it is critical to make sure that power supply leads correctly connected to driver. Otherwise, the driver will be damaged instantly.

Protection Indications

Priority	Time(s) of ON	Sequence wave of RED LED	Description
1st	1		Over-current protection
2nd	2		Over-voltage protection
3rd	4		Phase error protection

Frequently Asked Questions

In the event that your driver dœsn'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 driver is disabled
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 rotates in the wrong direction	• Motor phases may be connected in reverse

Problem Symptoms and Possible Causes

Symptoms	Possible Problems
The driver in fault	• DIP switch current setting is wrong • Something wrong with motor coil
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 driver heating	• Inadequate heat sinking / cooling • Automatic current reduction not being utilized • Current is set too high

Twelve Month Limited Warranty

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

Exclusions

The above warranty dœs 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, a returned material authorization number (RMA) must be obtained from customer service at e-mail: sales@helixlinear.com before returning product for service. Customer shall prepay shipping charges for products returned to Helix Linear for warranty service, and Helix Linear shall pay for return of products to customer.

Warranty Limitations

Helix Linear makes no other warranty, either expressed or implied, with respect to the product. Helix Linear specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not allow limitations on how long and implied warranty lasts, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the 12-month duration of this written warranty.

Shipping Failed Product

If your product fail during the warranty period, e-mail customer service at sales@helixlinear.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. Send failed product to:

Helix Linear Technologies, Inc. 23200 Commerce Park Road Beachwood, Ohio 44122