



# Hardware Installation Manual

## For DM805-AI

### A Digital Stepper Drive With Analogue 0-5V Input

V1.0-150323

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## HEALTH AND SAFETY



Read this manual carefully before trying to install the stepper drive into your system. The person setup the stepper drive should have a better understanding on electronics and mechanics. Contact us if there is any question about the products or this manual.

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- Make sure the power supply voltage does not exceed the drive's input range. Double check the connections and make sure the power lead polarity is correct.
  - Disconnect the motor from the load if you are not sure the move direction. Adjust the axis in the middle before trying to run the motor.
- 



- Do NOT set high current on small stepper motor as this may damage the motor.
- Never disconnect the motor wires when the power is on.

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# 1. INTRODUCTION, FEATURES AND APPLICATIONS

## Introduction

Motion Control Products Ltd (MCP)'s digital stepper drive DM805-AI is a digital stepper drive with built-in oscillator, featured in supporting 0-5V analogue signal for speed controls. Using the latest digital control algorithm, it brings a unique level of system smoothness, providing optimum torque and nulls mid-range instability. The self-test and auto-configuration 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 on the markets.

The three built-in potentiometers are used to pre-set and adjust the velocity, acceleration and deceleration. In 0-5V speed mode, the motor speed is controllable and follows the analogue 0-5V input. In high/low speed mode, the motor speed is selected by digital input and adjusted by the high/low speed potentiometers. The user can run the motor with the least configuration and connection. In position mode, the DM805-AI digital stepper drive can be used as a traditional stepper drive. There is a 5V power supply output for customer's use.

## 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
- Command Source: 0-5V, built-in potentiometer and pulse
- Two preset velocity and adjust by built-in potentiometer
- Preset acceleration/deceleration and adjust by built-in potentiometer
- Velocity control mode via 0-5V and position control mode via pulse Built-in pulse generator nulls external motion controller
- Supply voltage up to +80 VDC
- Output current programmable, from 0.3A -5.0A (RMS)
- TTL compatible and optically isolated digital input
- Automatic current reduction
- Over-voltage, over-current, phase-error protections

## Applications

DM805-AI stepper drive is suitable for the application which needs to adjust the velocity via the potentiometer or analogue 0-5V command. It can work with the size NEMA 17/23/34 stepper motors to replace the brushless motor with gearbox, due to the nature of its high torque and less motor noise at low speed. It can be used in various kinds of machines, such as rotary heat exchange, conveyor belts, transport vehicle, laser cutters, laser markers, high precision X-Y tables, labeling machines and so on.

## 2. SPECIFICATIONS

### Electronic Specification $T_j = 25^{\circ}\text{C} / 77^{\circ}\text{F}$

Parameters	DM805-AI		
	Minimum	Typical	Maximum
Input voltage (VDC)	+ 18	+ 60	+80
Logic signal current (mA)	7	10	16
Pulse input frequency (kHz)	0	-	200
Isolation resistance (M $\Omega$ )	500	-	-

## Velocity Control

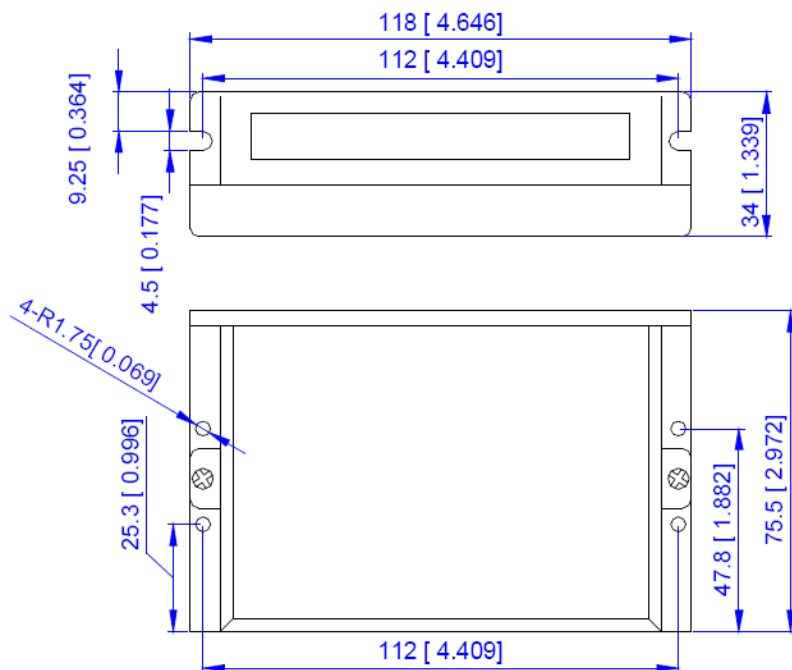
Item		Specification	Dead Band	Resolution	Min	Max
Analogue input	0-5V Speed Mode	0-5 V	10 mV	10 mV	0 Rev/s	25 $\pm$ 0.5 Rev/s
	External POT Mode		20 mV			
Accel / Decel / Ramp Potentiometer		0-25 turns	10 mV	10 mV	0.5 Rev/s <sup>2</sup>	250 $\pm$ 1 Rev/s <sup>2</sup>
Low-Speed Potentiometer		0-25 turns	10 mV	10 mV	0 Rev/s	5 $\pm$ 0.01 Rev/s
High-Speed Potentiometer		0-25 turns	10 mV	10 mV	0 Rev/s	25 $\pm$ 0.5 Rev/s



## Operating Environment

Cooling	Natural Cooling or Forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	0°C — 50°C (32°F — 122°F)
	Humidity	40%RH — 90%RH
	Operating Temperature	70°C (158°F) Max
	Vibration	5.9m/s <sup>2</sup> Max
Storage Temperature	-20°C — 65°C (-4°F — 149°F)	
Weight	Approx. 350g (12.34 oz)	

## Outline Dimensions



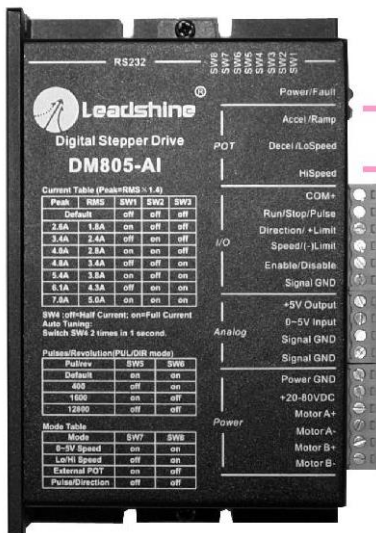
## Elimination of Heat

- Drive's reliable working temperature (heat sink) should be <70°C (158°F), and motor working temperature (surface) 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.

### 3. CONNECTORS AND PIN ASSIGNMENT

The DM805-AI has three connectors, connector for digital I/O signals connections, connector for analog 0-5V signal connections and connector for power and motor connections. The three parameters are used to preset or adjust the speed, acceleration and deceleration ramp. They have different functions in different modes. The green indicator turns on when the drive is powered on. When error happens, the red indicator flashes periodically to indicate the error type.



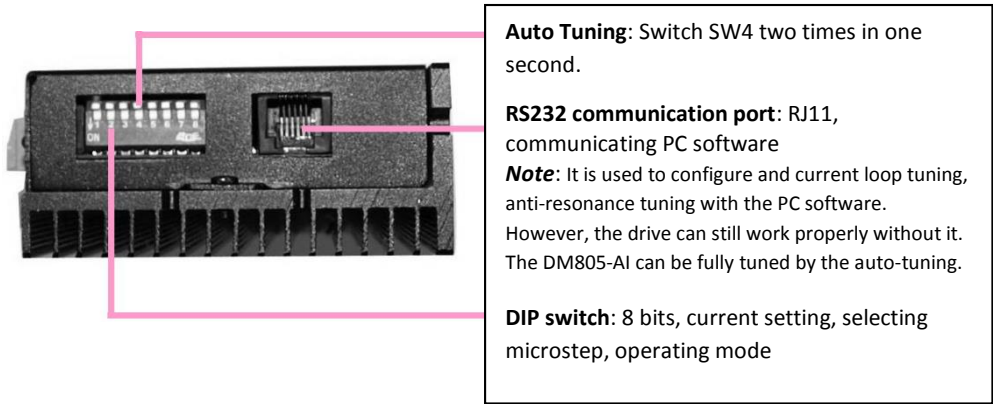
**Indicator in Green:** Power on, **In Red:** Faulty

**Potentiometers Adjusting Speed:** Acceleration and Deceleration

**Digital I/O Signal Connector:** 6-pin screw terminal, 3.81 mm space

**Analogue Signal Connector:** 6-pin screw terminal, 3.81 mm space

**Power Connector:** 6-pin screw terminal, 3.81 mm space



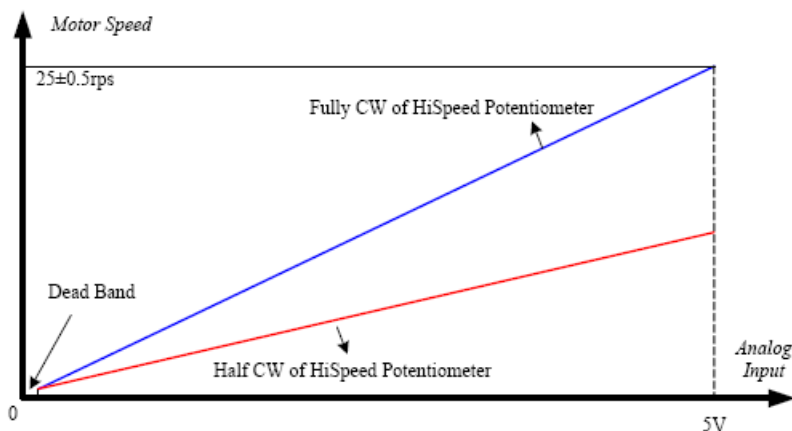
## 4. OPERATING MODE

Mode	SW7	SW8	Description
0~5V Speed	on	on	Analogue 0-5V Speed Mode
Lo/Hi Speed	off	on	Low and High Speed Mode
External POT	on	off	External Potentiometer Speed Mode
Pulse/Direction	off	off	Pulse and Direction Position Mode

### Analogue 0-5V Speed Mode

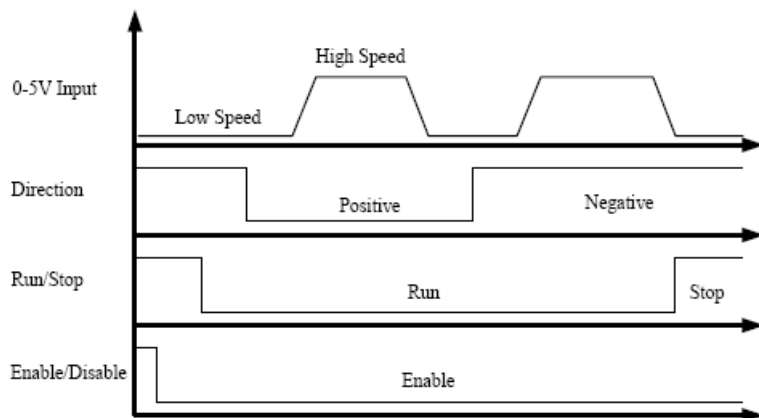
In this mode motor speed follows the analog 0-5V input voltage. Motor speed is also proportional to the HiSpeed potentiometer. Direction input controls the motor direction. The actual motor speed is calculated as follows:

$$Speed(RPS)= \quad 25\pm0.5(RPS) \quad \times \quad \frac{Analogue \; Input}{5V} \quad \times \quad \frac{Turns \; of \; HiSpeed \; Potentiometer}{25Turns}$$



## Signal Sequence

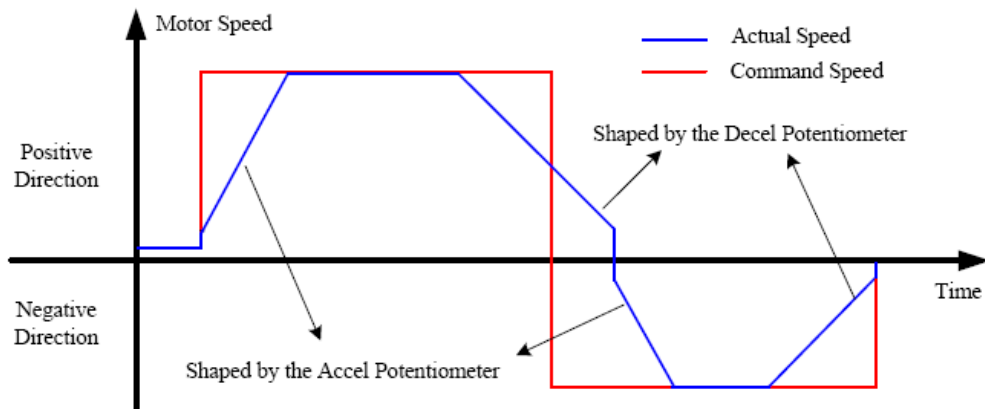
After power-up, the DM805-AI does not respond to the analog 0-5V input immediately. The Enable and Run signal should be activated prior to the analog 0-5V input. The drive is enabled when the Enable/Disable input is unconnected and the motor shaft has holding torque at that time. After Run signal is active, the motor speed follows the analog 0-5V input.



## Ramp Shaping

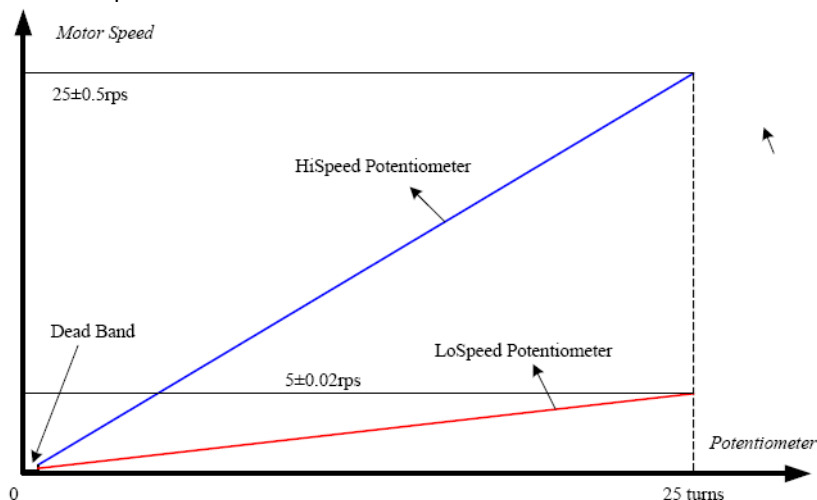
There are two potentiometers Accel and Decel for adjusting the acceleration ramp and deceleration ramp, respectively. When the input ramp exceeds the value set by the

potentiometer, the actual output ramp will be limited by the potentiometer value.



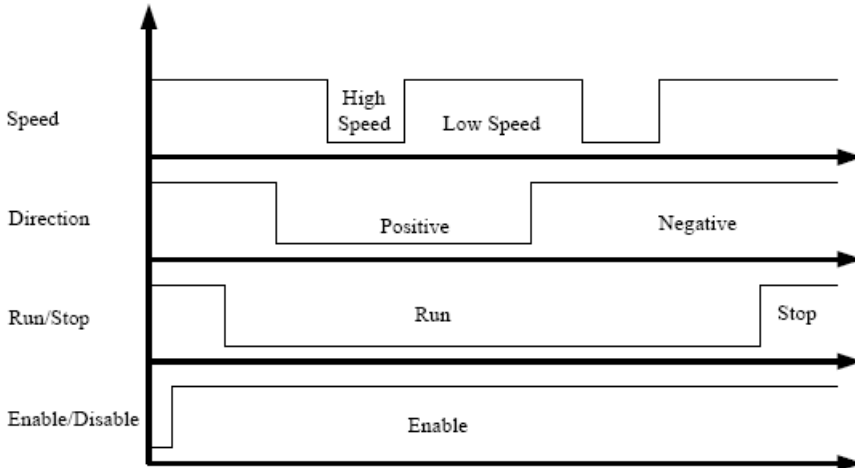
## Low/High Speed Mode

In low/high speed mode, motor speed is fixed to the value adjusted by the **LoSpeed** or **HiSpeed** Potentiometer, depending on the level of **Speed** input. When the **Speed** input is LOW level, the maximum motor speed adjusted by the LoSpeed potentiometer is 5rps. When the **Speed** input is HIGH level, the maximum motor speed adjusted by the **HiSpeed** is 25rps.



## Signal Sequence

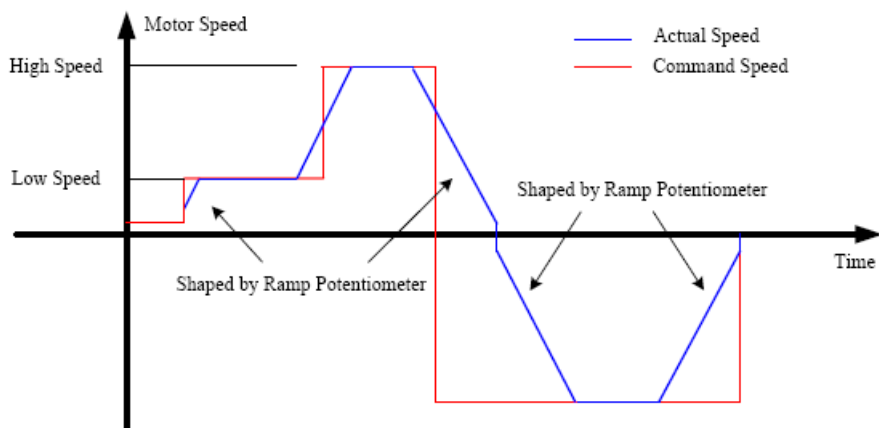
After powering up, the DM805-AI does not make the motor run immediately. The Enable and Run signal should be activated firstly. Drive is enabled when the Enable/Disable input is unconnected. After Run signal is activated, the Speed can be applied to the drive for low/high speed selection



## Ramp Shaping

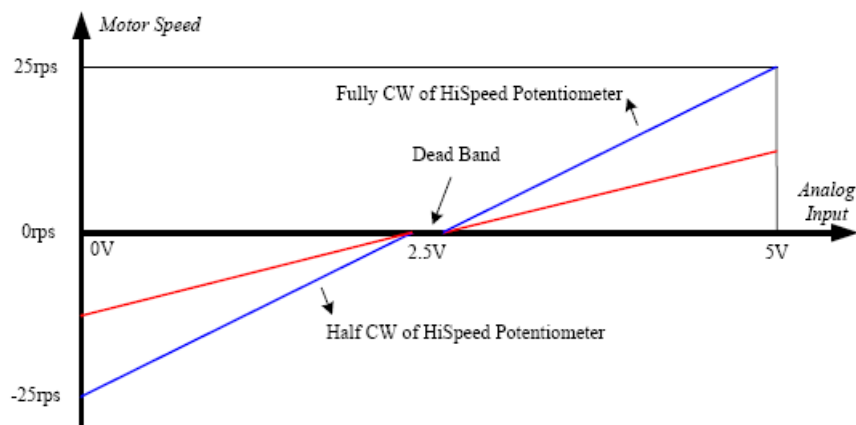
When motor speed switches between low and high or changes direction, the acceleration/deceleration ramp adjusted by the Ramp potentiometer will be inserted automatically for smooth motion.

**Note:** Do not adjust too small or too high Ramp. Otherwise the stepper motor may stall when switching between low and high speed.

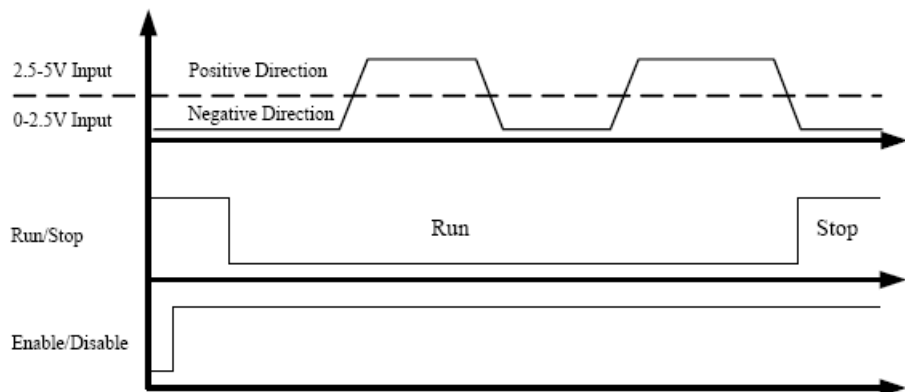


## External Potentiometer Mode

In this mode motor speed follows the analog 0-5V input voltage. Motor speed is also proportional to the HiSpeed potentiometer. When the analog input is 0-2.5V, the motor runs in negative direction. While the analog input is 2.5-5V, the motor runs in positive direction.

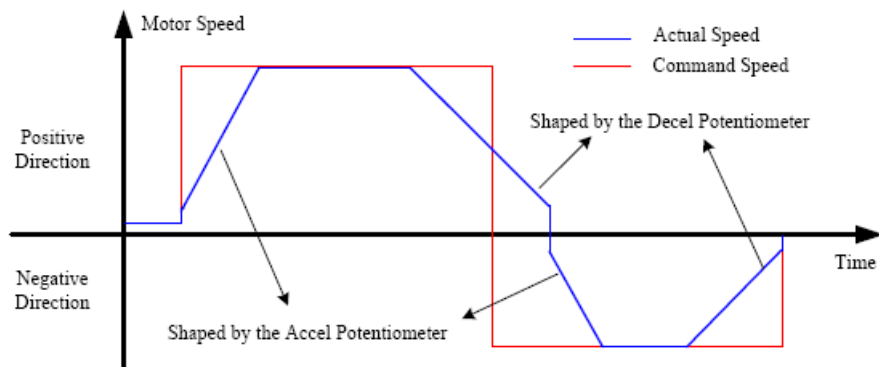


## Signal Sequence



## Ramp Shaping

There are two potentiometers Accel and Decel for adjusting the acceleration ramp and deceleration ramp, respectively. When the input ramp exceeds the value set by the potentiometer, the actual output ramp will be limited by the potentiometer value.



## Pulse/Direction Mode

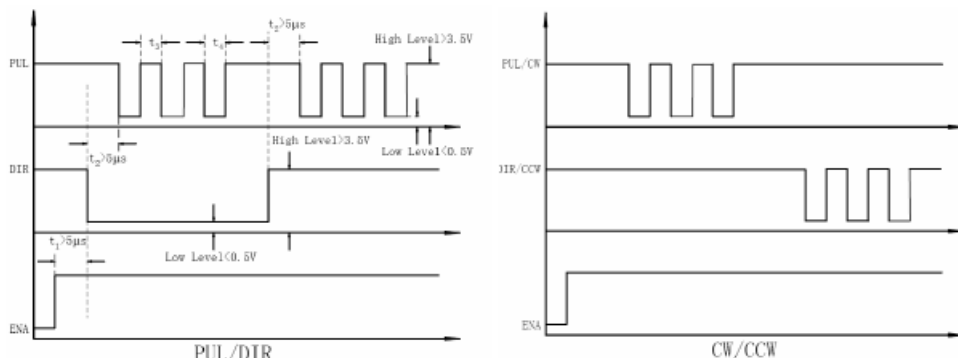
In this mode motor speed is proportional to the pulse input frequency and motor rotary angle is controlled by the pulse counts. The microstep can be selected by the DIP switch SW5 and SW6.



## 5. CONTROL SIGNAL REQUIREMENT

### Pulse/Direction Mode

DM805-AI can support Pulse/Direction and CW/CCW control signal modes. In order to avoid some fault operations and deviations, PUL, DIR and ENA should abide by some rules, shown as following diagram:



#### Remark:

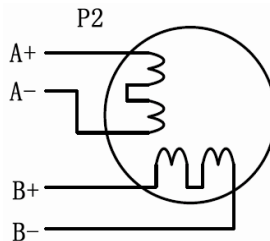
- ENA must be ahead of DIR by at least 5us. Usually, ENA+ and ENA- are NC (not connected).
- DIR must be ahead of PUL active edge by 5us to ensure correct direction;
- Pulse width not less than 2.5us;
- Low level width not less than 2.5us.

## 6. CONNECTING THE MOTOR

The DM805-AI stepper drive can drive any 2-phase and 4-phase hybrid stepper motors.

### 4-lead Motors Connections

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

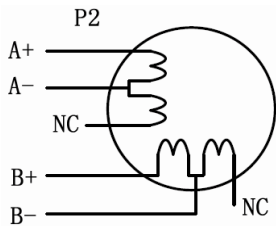


### 6-lead Motors Connections

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.

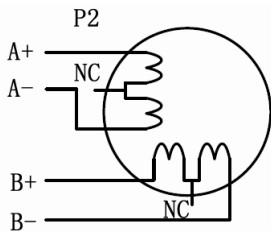
#### Half Coil Configurations

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 drive output current multiply the specified per phase (or unipolar) current rating by 1.4 to determine the peak output current.



Full Coil Configurations

The full coil configuration on a 6-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 issue.

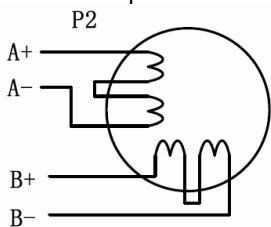


8-lead Motors Connections

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.

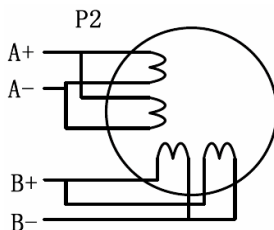
Series Connections

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 issue.



## 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.



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

## 7. POWER SUPPLY CONNECTION

The DM805-AI digital stepper drive can match small and medium size stepper motors (from NEMA frame size 14 to 34) supplied by Motion Control Products Ltd or other motor manufactures around the world. To achieve good performance, it is important to select the correct supply voltage and output current. Generally speaking, the supply voltage determines the high speed performance of the motor, whilst the output current determines the output torque of the motor (particularly at lower speed). Higher supply voltage will allow higher motor speeds to be achieved, at the price of more noise and heating. If the speed requirement is low, it is better to use a 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 power the drive. However, unregulated power supplies are preferred due to their ability to withstand current surge. If regulated power supplies (such as most switching supplies) are used, it is important to have large current output rating to avoid problems like current clamp, for example, using 4A supply for 3A motor-drive operation. On the other hand, with an unregulated supply, a power supply of lower current rating than that of the motor can be used (typically 50% - 70% of motor current). The reason is that the drive draws current from the power supply

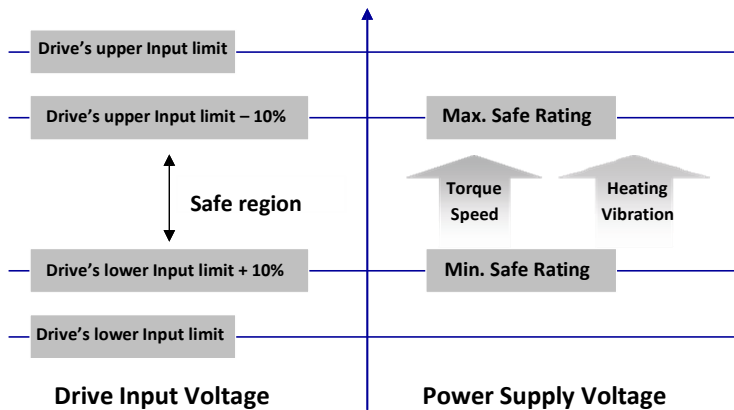
capacitor of the unregulated supply only during the ON duration of the PWM cycle, but not during the OFF duration. Therefore, the average current drawn from power supply is considerably less than motor current. For example, two 3A motors can be supplied by one power supply of 4A rating.

## Multiple Drives

We recommended in having multiple drives 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 of the drives. Instead, please connect them to power supply separately.

## Selecting Supply Voltage

The power MOSFETS inside the DM805-AI stepper drive can actually operate with wider voltage range than the input specification. 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, and it is suggested to use power supplies with theoretical output voltage of drive's minimum + 10% to drive's maximum – 10%, leaving room for power fluctuation and back-EMF.

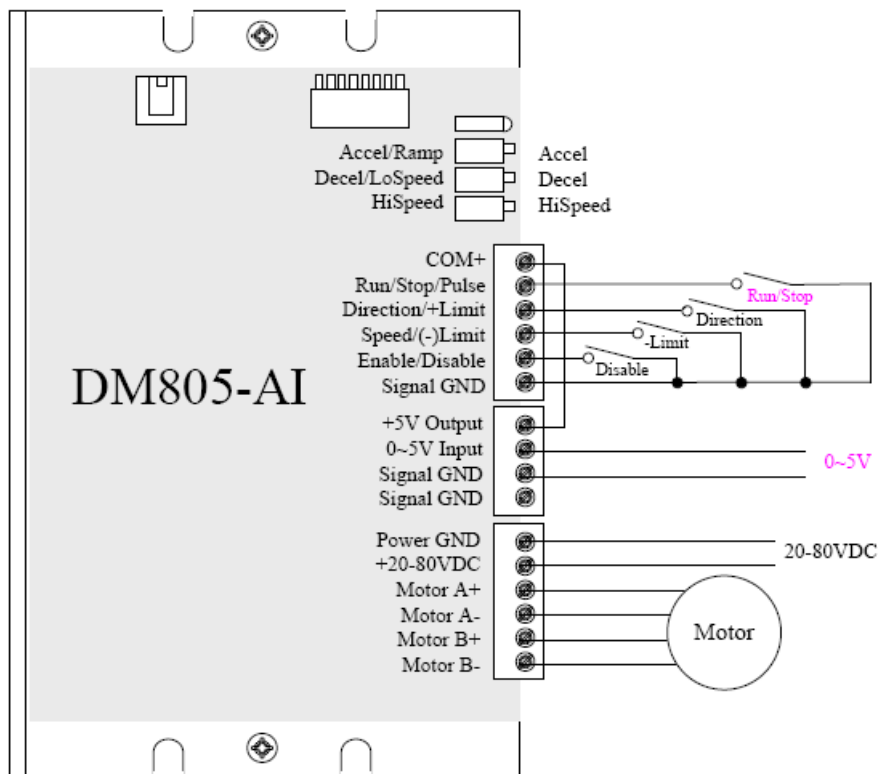


The recommended power supply voltage for DM805-AI is 24-72VDC:

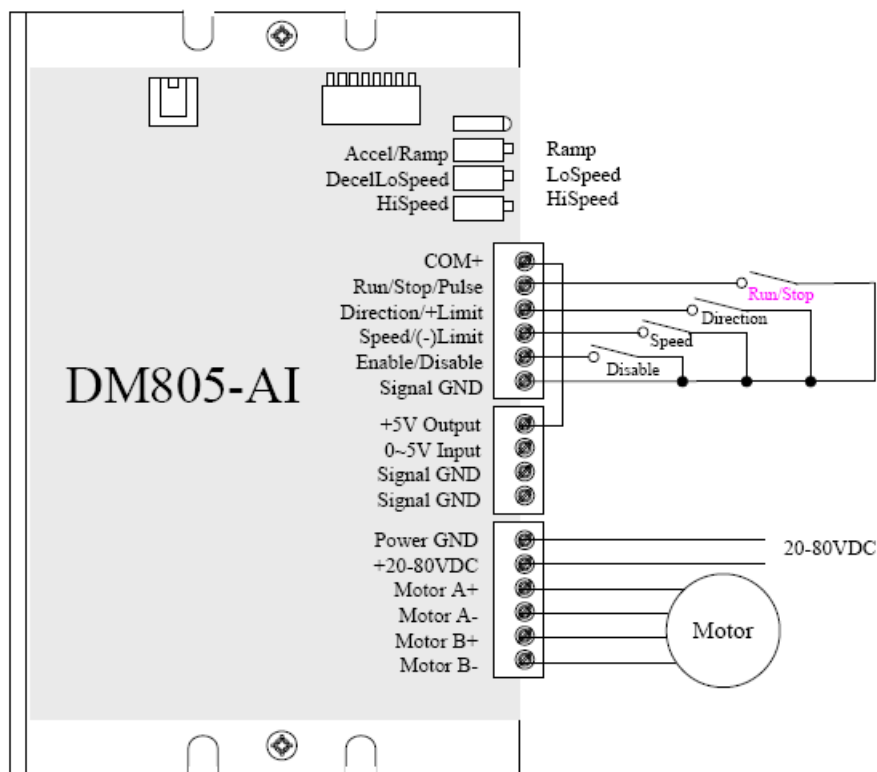
## 8. TYPICAL CONNECTION

### Analogue 0-5V Speed Mode

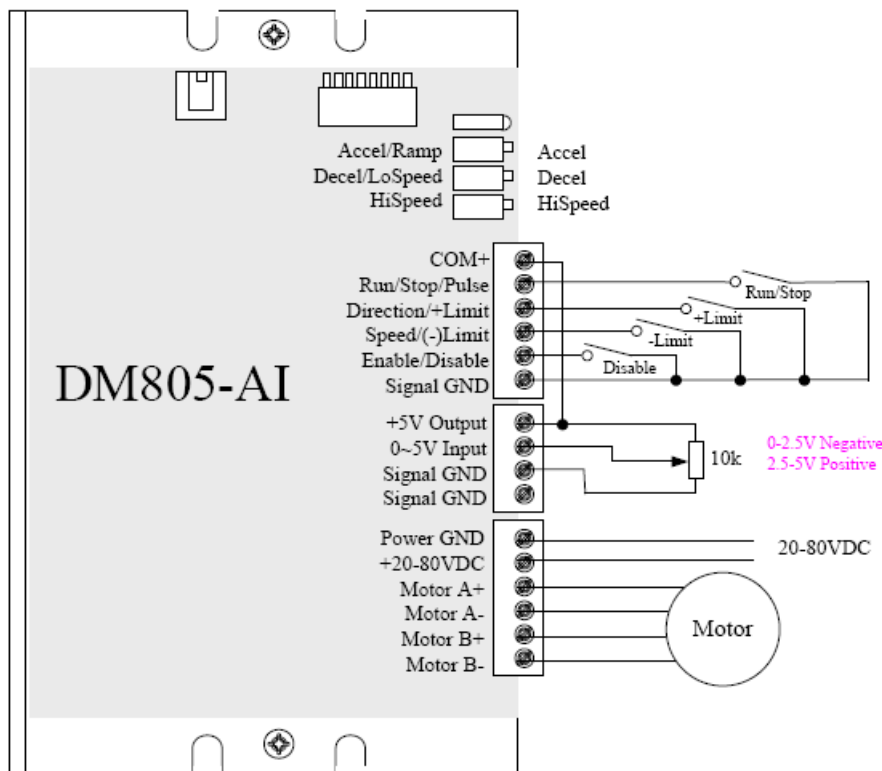
The 5V output of DM805-AI is connected to the COM+. The input signal is activated when it is short circuit to the signal GND. When the Limit switch is activated, the motor shaft will be free and the red indicator is on.



## Low/High Speed Mode



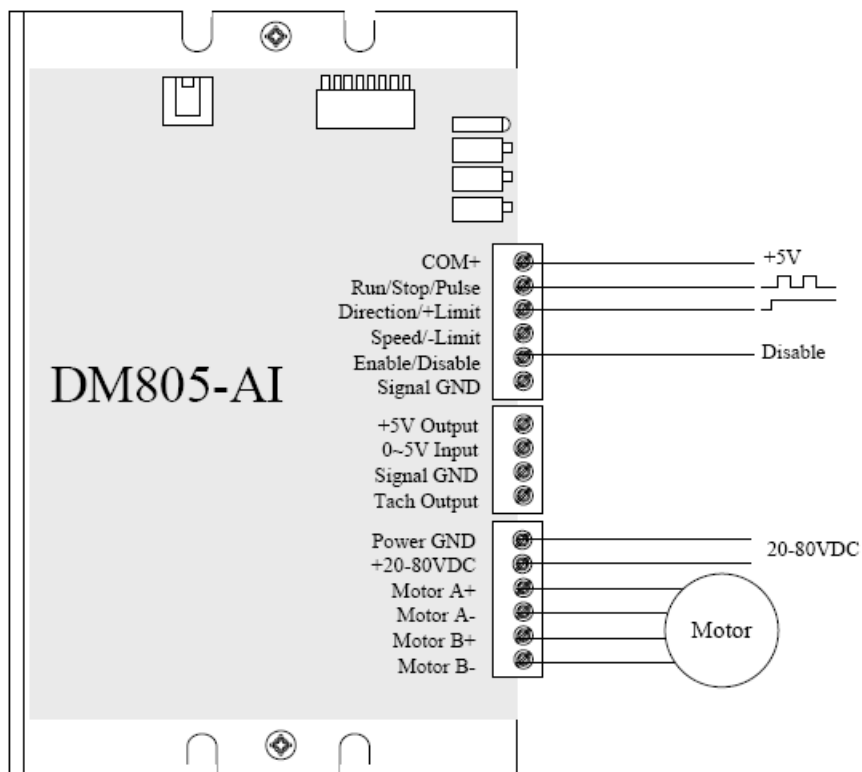
## External Potentiometer Mode





## Pulse/Direction Mode

A complete stepping system should include stepping motor, stepping drive, power supply and controller (pulse generator).

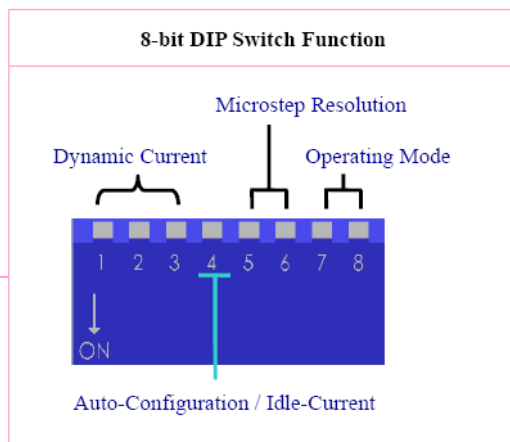
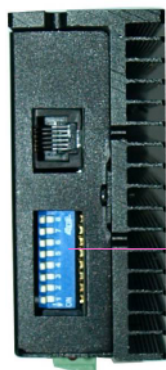


## 9. WIRING NOTES

- 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 a power supply serves several drives, separately connecting the drives is recommended instead of daisy-chaining.
- It is prohibited to pull and plug power connector while the drive is powered ON, because there is high current flowing through motor coils (even when motor is at standstill). Pulling or plugging power connector with power on will cause extremely high back-EMF voltage surge, which may damage the drive.

## 10. DRIVE CONFIGURATION

The DM805-AI stepper drive uses an 8-bit DIP switch to set operating mode, microstep resolution and motor operating current as follows. The dynamic current setting by SW1, SW2 and SW3 is active for all operating mode. The microstep resolution setting by SW5 and SW6 only takes effect in Pulse/Direction mode. SW4 is used to set the idle current and auto-configure the drive when it is first time installation.



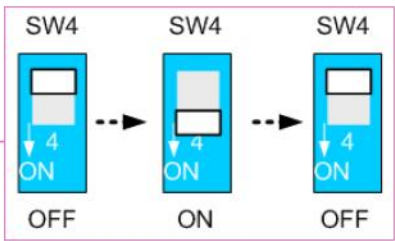
## Auto Configuration by SW4

To get the optimized performance, switch SW4 two times in one second to identify the motor parameter after power-up if it is the first time installation. The motor parameter is identified and the drive’s current loop parameters are calculated automatically when SW4 is activated. The motor shaft will have a little vibration during auto-configuration. If the user changes the motor or the power supply, don’t forget to activate SW4 once again.

Sometimes the result of the auto-configuration is not good. This will happen to the stepper motor with large inductance or resistance. The user needs to tune the current loop parameter manually. Please refer to the software manual of the DM805-AI.



**Auto configuration:**  
**Switch SW4 two times in one second.**



## Selecting Operating Mode

Mode	SW7	SW8	Description
0~5V Speed	on	on	Analogue 0-5V Speed Mode
Lo/Hi Speed	off	on	Low and High Speed Mode
External POT	on	off	External Potentiometer Speed Mode
Pulse/Direction	off	off	Pulse and Direction Position Mode

**Note:** Turn off the power supply before changing operating mode.

## Microstep Resolution Selection

In Pulse/Direction mode, microstep resolution is selected by SW4 and SW5. The stepper motor moves one step when one pulse is applied to the stepper drive. If microstep is 1, the step angle is a full step which is 1.8 degree for 2-phase stepper motor and 1.2 degree for 3-phase stepper motor. Microstep can be taken as the divisions of one full step. For example, stepper motor moves half of the full step when the microstep is 2. For 2-phase stepper motor and drive, we have the following formula to calculate the microstep resolution, or pulse counts of one motor shaft revolution:

$$\text{Microstep Resolution} = 200 \times \text{Microstep}$$

The motor speed can be calculated as follows:

$$\text{Motor Speed (RPS)} = \frac{\text{Pulse Input Frequency}}{\text{Microstep Resolution}}$$

When selecting the drive's microstep resolution for the system:

- Consider the MAX speed needed, MAX input frequency of driver and MAX output frequency of the controller.
- 1600 pulses/revolution (8 Microstep) is suitable for most application.
- >1600 pulses/revolution only increase smoothness but not resolution.
- For digital driver, Microstep resolution is not important.

## Current Settings

### Dynamic current setting

For a given motor, higher drive current will make the motor to output more torque, but at the same time causes more heating in 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.

## Idle current setting

When there is no pulse applied to the DM805-AI and the time exceeds the idle-time which can be configured via the PC based software, the drive goes into idle status. SW4 is used to set the idle-current, OFF meaning that the motor coil current is automatic reduced, and ON meaning that current is 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  $P=I^2 \cdot R$ ) of the original value. If the user wants to change the idle time and current reduction rate, please consult the DM805-AI's software manual.

# 11. PROTECTION FUNCTIONS

To improve reliability, the DM805-AI stepper drive incorporates some built-in protection functions. The drive uses one red LED to indicate what protection has been activated. The periodic time of red is 3 OR 5s (seconds), and how many times the red LED blinks indicates what protection has been activated. Because only one protection can be displayed by red LED, the drive 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, the RED LED will turn on once within each periodic time (3s).

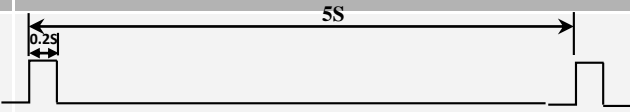
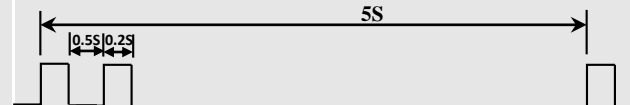
## Over-voltage Protection

When power supply voltage exceeds the limit, protection will be activated and RED LED will blink twice within each periodic time.

**Note:** When the above protections are active, the motor shaft can turn freely or the LED will turn red. Reset the drive by powering down and repower, this will remove the above problems. Since there is no protection against power leads ( + / - ) reversal, it is critical to

make sure that power supply leads are correctly connected to the drive. Otherwise, the drive will be damaged instantly.

### Protection Indications

Priority	Time(s) of Blink	Sequence wave of red LED	Description
1st	1		Over-current protection
2nd	2		Over-voltage protection

## 12. FREQUENTLY ASKED QUESTIONS

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 mistakes 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
	Motor coil problems/motor problem
Erratic motor motion	Control signal is too weak
	Control signal is interfered
	Wrong motor connection
	Motor coil problems
	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 utilised
	Current is set too high

# APPENDIX

## Twelve Month Limited Warranty

Motion Control Products Ltd. warrants its products against defects in materials and workmanship for a period of 12 months from the shipping date. During the warranty period, Motion Control Products will either, at its option, repair or replace products which are proved to be defective.

### Exclusions

The above warranty shall not apply to defects resulting from: improper or inadequate handling by the customer; improper or inadequate customer wiring; unauthorised modification or misuse; or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

## Shipping Failed Product & Obtaining Warranty Service

If your product should fail during the warranty and want to obtain warranty service, a RMA (returned material authorisation number) request form must be filled in on our website <http://www.motioncontrolproducts.com/pages/returns.php> before returning the product for service. Please include a written description of the problem along with contact name and address. Customer shall prepay shipping charges returned to Motion Control Products for warranty service, and Motion Control Products shall pay for return of products to the customer, providing the fault is not customer caused. Send the failed product to your distributor for your area or to **Motion Control Products Limited**, 11-15 Francis Avenue, Bournemouth, Dorset BH11 8NX, UK. Also enclose information regarding the circumstances prior to the product failure. For full terms and conditions of Warranty and Returns Policy, please refer to our website <http://www.motioncontrolproducts.com/pages/returns.php>

## Warranty Limitations

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