# *DR-4M MICROSTEPPING DRIVER USERS GUIDE*

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## *Table of Contents*

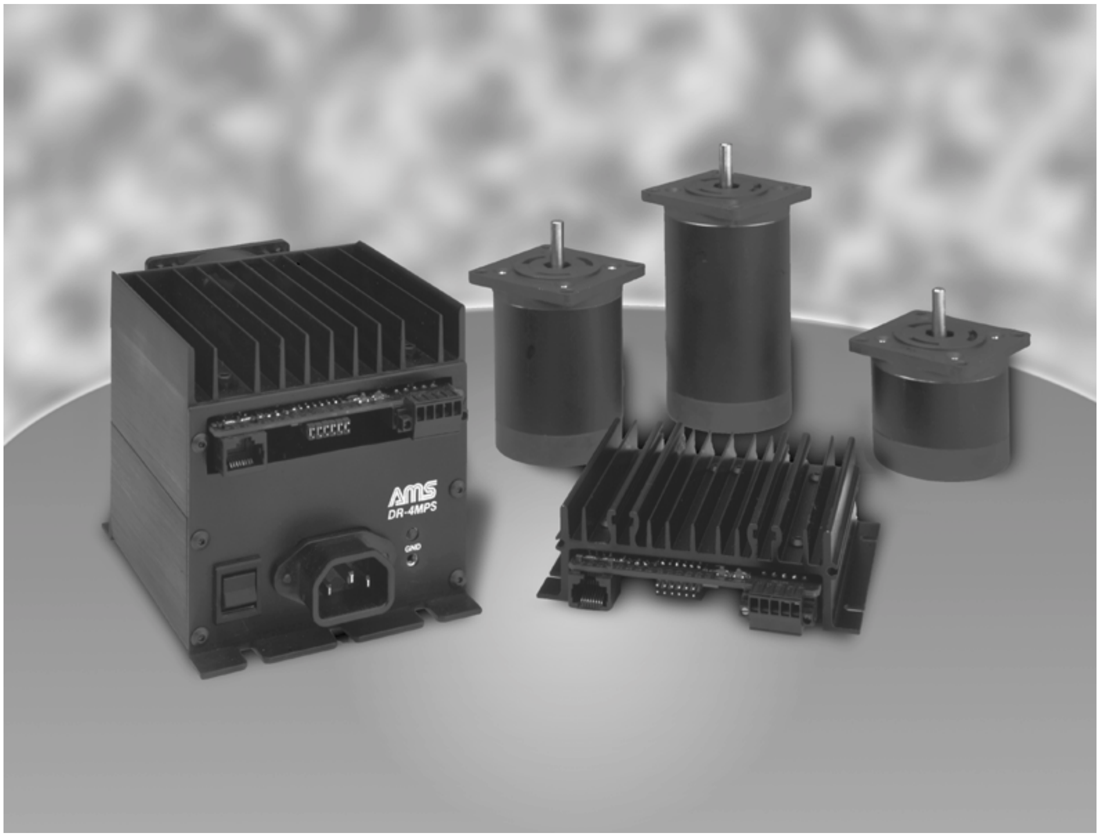
## Introduction

Congratulations on your purchase of an AMS model DR-4M Microstepping Driver. The DR-4M will provide years of reliable, accurate and cost-effective motion control. As with all AMS products, the DR-4M is backed by nearly two decades of manufacturing excellence and a commitment to quality and support that guarantees your satisfaction.

This Technical Reference Guide will assist you in optimizing the performance of your DR-4M driver. Its purpose is to provide access to information that will facilitate a reliable and trouble-free installation. We recommend that each section be reviewed prior to installation.

Although the DR-4M and supporting documentation were designed to simplify the installation and on-going operation of your equipment, we recognize that the integration of motion control often requires answers to many complex issues. Please feel free to take advantage of our technical expertise in this area by calling one of our support personnel to discuss your application at 603-882-1447.

Thank You!
Your AMS Team




## Product Overview

The DR-4M is a high performance, microstepping driver designed to meet O.E.M. requirements for reliable, cost effective operation. The DR-4MPS provides the next level of user integration with a built in 40 volt power supply.

Both drivers offer eight resolution settings, from 1/2 step to 1/256 step. They are short circuit, over temperature and under voltage protected for extended service life. Features include:

- ***Low cost - small size***
- ***Heatsinked enclosure***
- ***1 Mhz step clock***
- ***Step resolution to 50k steps/rev.***
- ***4 amp output current (Peak)***
- ***Auto current reduction/boost***
- ***Phase to phase/ground, over temp. and under voltage protected***
- ***Fault and diagnostic indicators***
- ***Mating connectors included***

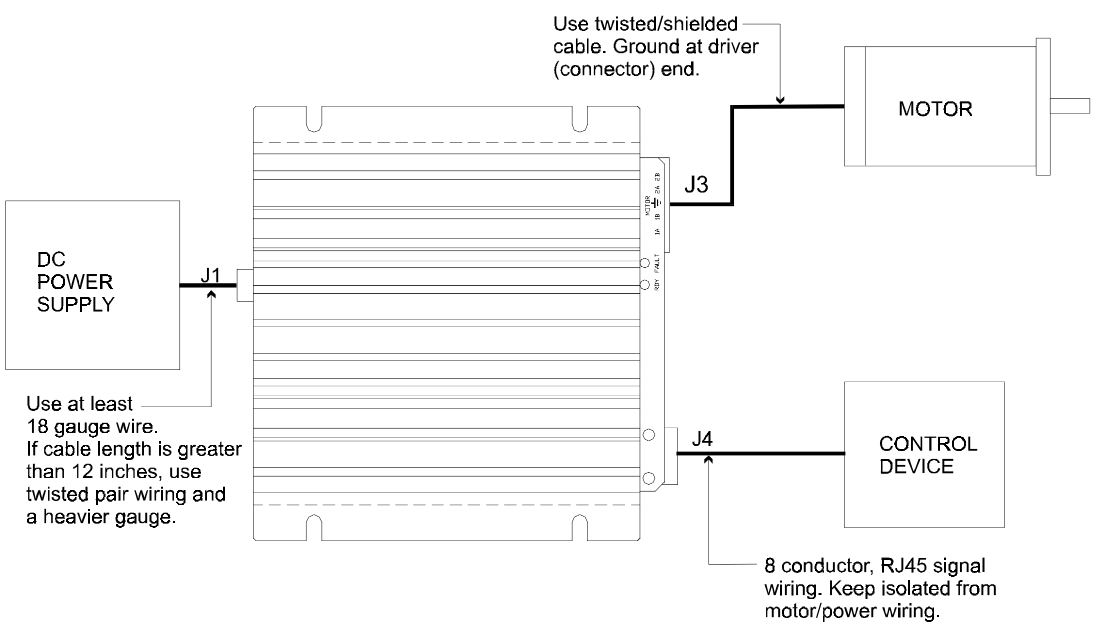
## Design Tips

EMI (electromagnetic interference or electrical noise) can be a major source of problems when integrating power drivers with microprocessor based devices. EMI is typically generated through ground loops and AC power line disturbances. External devices such as, relays, coils, solenoids, arc welders, motors, drivers, and other computer-based equipment are also sources of EMI.

The following design tips will help to prevent EMI from interfering with the system operation:

- Shield the driver and wiring by mounting it in its own metal enclosure as far away from noise sources as possible.
- Ground motor shields only at the driver end.
- Make sure that all power wiring (motor, AC, etc.) is away from the signal wiring (I/O, communications lines, etc.).
- Mechanical grounds should all be tied to Earth at a single point. Chassis and motor grounds should be tied to the frame and the frame to Earth.
- Ground all signal wiring to one point.
- Use solid-state relays or opto isolators whenever possible to isolate remote signals. Suppress all mechanical relays with capacitors or MOV’s.
- Use shielded, twisted pair cables for the motor, I/O and communications wiring.

***Block Diagram***



## *Installation*

The following installation procedure outlines the minimum steps required to make the DR-4M operational:

1. Connect a 28Vdc to 40Vdc power supply to the 2-pin connector (J1) on the rear of the DR-4M. Make sure pin 1 is connected to Vdc and pin 2 is ground. The power supply must be capable of providing 3 amperes. A typical power supply circuit is shown in the “Connecting Power Supply” section of this manual.

2. With the power “off” connect a motor to the 5 pin motor connector (J3) on the front of the DR-4M. Typical motor connection diagrams are shown in the “Stepping Motors” section of this manual. Be sure to insulate all motor leads and unused leads (6 lead motor) to prevent shorts to ground or to each other.

3. Set the appropriate Run and Hold current values using the dip switch (JP1) on the front of the DR-4M. Refer to the current setting table in the “Setting The Output Current (JP1) section of this manual. Be sure the Run current (output current) is set at a value that is consistent with the current rating of the motor.

4. Plug the 8 contact RJ45 connector and cable assembly (part# BLC-15) into the Control Input (J4) on the front of the DR-4M. Wire the other end to the appropriate control module. Refer to the “Control Input (J4) section of this manual for step and direction input connections and resolution settings. Note; a BLC-15 is supplied with each DR-4M.

5. Should the DR-4M require additional cooling, a fan (60mm) can be mounted on the heat-sink surface using the convenient channel slots that accommodate 6-32 hardware. A hole in the heat-sink surface provides access to a 2-pin fan connector located next to the J1 connector at the rear of the DR-4M. Refer to the “Assembly Drawing” section for information on the fan and mounting diagram. Wire the fan to either draw or blow air across the heat-sink surface, depending on thermal conditions of the system.

6. Adjust current and resolution settings as required. At least one Run current setting must be set “on” for the DR-4M to operate.

7. Apply power to the DR-4M. The Green LED should blink 3 or 4 times and turn off. If it does not, refer to the “Fault Protection” section of this manual for a description of the LED diagnostic conditions.

***“Do’s, Don’ts and Important Notes”***

***Do not connect or disconnect the motor when power is “ON.“***

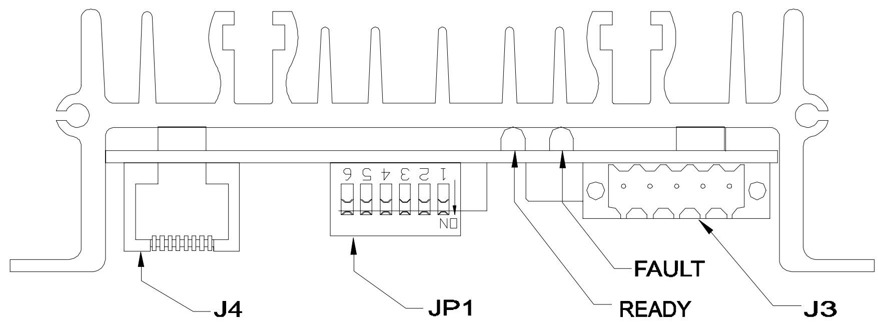
***The module case is tied to the logic common and power pins internally. Do not tie your power supply to ground at another location.***

***The power supply voltage, including ripple and line voltage fluctuations must not exceed 45Vdc or be less than 26Vdc.***

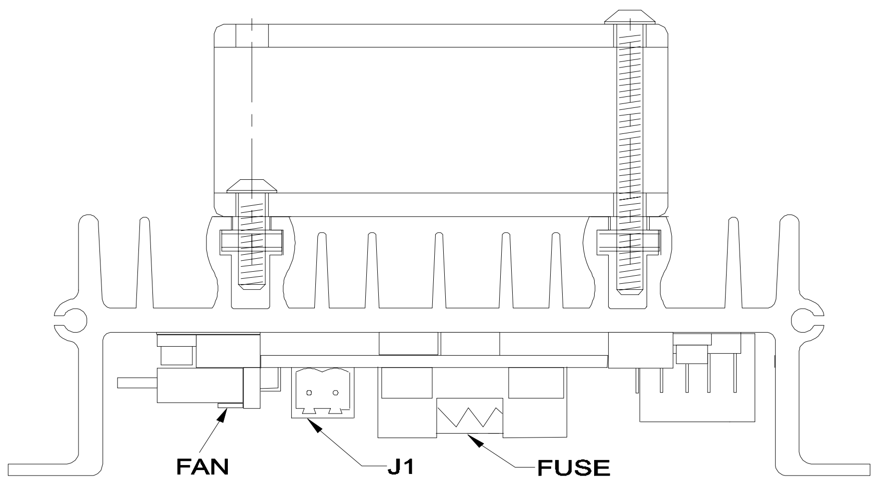
***Make sure the motor to be used is compatible with the drive.***

## DR-4M Assembly Drawing

### Front View




### Rear View with Optional Fan




***Connector Description***
J4: Control Input Connector
JP1: Current Select Switch
J3: Motor Connector
J1: Power Supply Connector
Fan: Optional Cooling Fan Connector

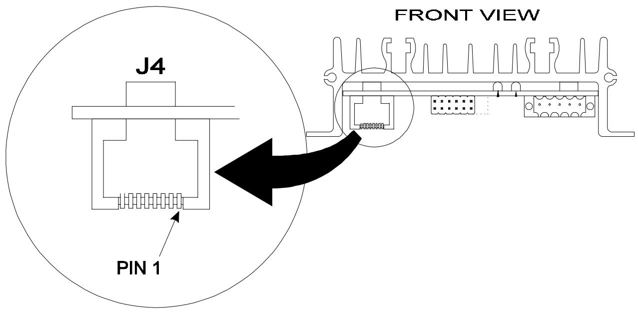
***LED Description (see Fault Protection Section)***
Ready (Green): Power-up and over temperature
Fault (Red): Over temperature, under voltage and short circuit

***Optional Cooling Fan***
Channel slots in the DR-4M extrusion provide a convenient way to mount a 60mm cooling fan, if required (see Mounting Dimensions in Specifications Section). This option is also available from AMS at time of order. Recommended fan specifications are 12Vdc/0.12A.

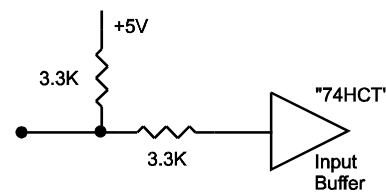
## Control Input (J4)

The essential input signals include a step pulse and direction control. Other inputs include three resolution select lines to permit remote select of microstep size (1/2 through 1/256).

A miniature 8 contact RJ45 connector (similar to a phone plug) is provided for convenient interface of user control signals to the DR-4M.




***Typical Input Circuit***



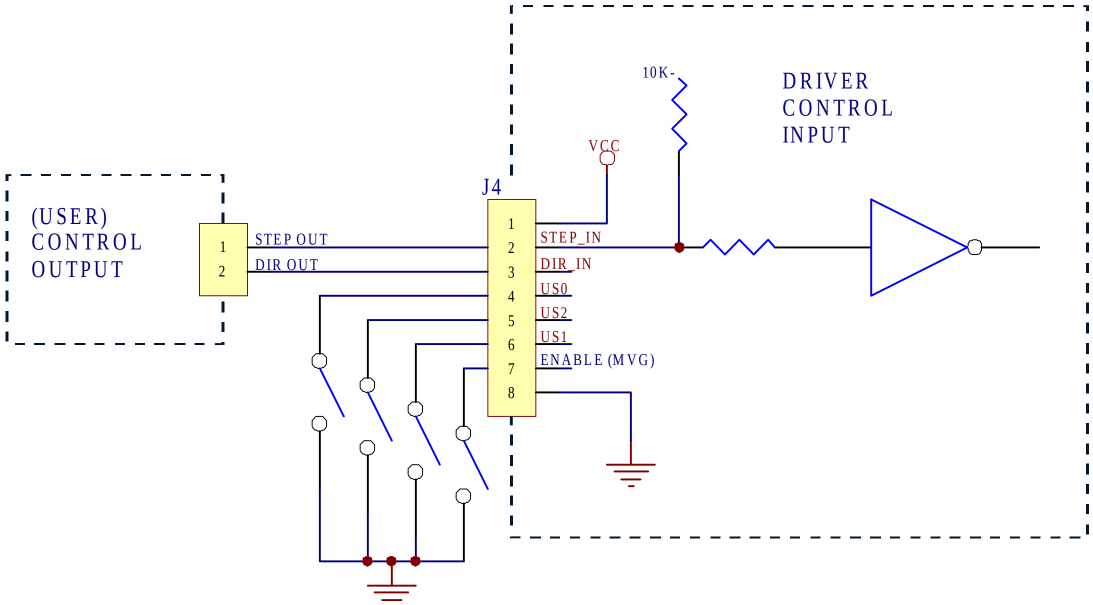

| Pin # | Description |
|---|---|
| 1 | VCC: +5Vdc output provided for user convenience permitting small loads up to 100 mA. |
| 2 | Step (In): Step clock input. Each pulse causes the motor to “step” one microstep. |
| 3 | Direction (In): Set the shaft direction for  STEP input. |
| 4,5,6 | Microstep resolution select |
| 7 | Disable: Low input shuts off power drivers. |
| 8 | Ground: Connect to common (GND) of controller. |

***Microstep Resolution Select Table***

The number of microsteps per step is selected by pins 4, 5 and 6 of connector J4. A 1 (one) may be an open circuit or a value between 2 volts and the maximum input. A 0 (zero) or low is ground or less than 0.7 volts.

| S0 (Pin 4) | S1 (Pin 6) | S2 (Pin 5) | Resolution | Steps/Rev. |
|---|---|---|---|---|
| 0 | 0 | 0 | 1/2 | 400 |
| 1 | 0 | 0 | 1/4 | 800 |
| 0 | 1 | 0 | 1/8 | 1,600 |
| 1 | 1 | 0 | 1/16 | 3,200 |
| 0 | 0 | 1 | 1/32 | 6,400 |
| 1 | 0 | 1 | 1/64 | 12,800 |
| 0 | 1 | 1 | 1/128 | 25,600 |
| 1 | 1 | 1 | 1/256 | 51,200 |

## Control Input Connection Diagram




***"Do's, Don'ts and Important Notes"***

| |
|---|
| ***When connecting the J4 cable assembly to your controller, Do make sure that the pin-out is correct, as color codes may not be consistent from one cable assembly to the next.*** <br><br> ***The wire size used with the J4 modular connectors may suffer voltage drops if more than several milliamps of current is attempted over any significant cable length.*** <br><br> ***Inputs are TTL/CMOS compatible and are provided with current limiting circuitry capable of withstanding temporary over voltages. However, caution should be taken not exceed accepted TTL/CMOS design guidelines as standard practice.*** |

## Stepping Motors

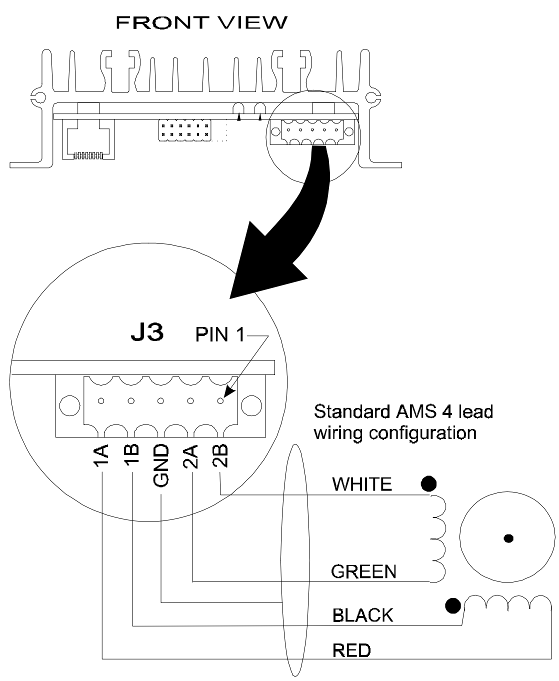
The DR-4M is a bi-polar, chopper driver that works with both bi-polar and uni-polar motors, i.e. 8, 4 and 6 lead motors. It is also possible to half a 6 lead center tapped motor with the DR-4M, however the performance may be compromised.

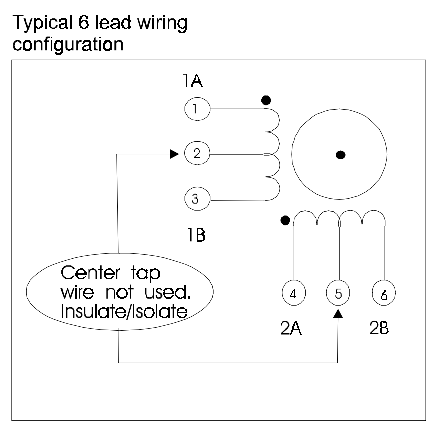
The DR-4M uses a constant chopping frequency and a varying duty cycle to sustain a given motor current. To avoid unstable chopping conditions and to provide a higher speed-performance ratio, a motor with a low winding inductance is preferred.

***Drive Current***

The ideal current for a given motor is based on the specific characteristics of the motor and the requirements of the application. As a result, establishing the correct current is often determined empirically. Insufficient current will result in inadequate torque and under utilization of the motor. Excessive current can cause high-speed torque ripple, resulting in stalling or pole slippage, over heating of the motor and general inefficiency of the system. Current setting procedures are described in the next section; “Setting The Output Current (JP1).”

***Connecting a Stepping Motor (J3)***




| Pin # | Description | Function |
|---|---|---|
| 1, 2 | 2B, 2A | Phase 2 of the Stepping Motor is connected between Pin 1 and Pin 2. |
| 3 | Motor Gnd | Ground - useful for connecting motor shields. |
| 4, 5 | 1B, 1A | Phase 1 of the Stepping Motor is connected between Pin 4 and 5. |

***"Do's, Don'ts and Important Notes"***

***Do not connect or disconnect motor wires while power is supplied***

***When using a 6 lead motor be sure to insulate/isolate unused wires.***

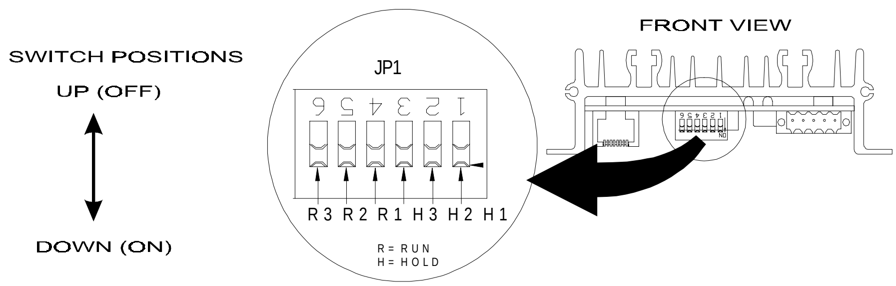
***The physical direction of the motor with respect to the direction input will depend on the connection of the motor windings. To reverse the direction of the motor with respect to the direction input, switch the wires on phase 1 or phase 2 of the outputs.***

## Setting the Output Current (JP1)

The DR-4M will automatically increase the current in the motor windings to one of seven Run current values, between .57 and 4.0 amps (in 14% increments), on receipt of a step pulse. Approximately two (2) seconds after the last positive edge of the step clock input the current will decrease to one of eight Hold current values. If the Hold current value is zero, the chopping will be disabled.

A dipswitch is used to program the Hold and Run currents. H1, H2 and H3 set the Hold (idle) current and R1, R2 and R3 set the RUN current. On power up the drivers are disabled. The Run current is maintained as long as the step pulse rate is above the "Settling" time.

When the stepping ceases a time-out is initiated. At the end of the two second time-out the current is changed to the Hold value. From this point on the Hold or Run values are used.




***Current/Jumper Settings***

| Hold Current | | | | Run Current | | | |
|---|---|---|---|---|---|---|---|
| Output Current (Amps) | Switch Setting H1 | Switch Setting H2 | Switch Setting H3 | Output Current (Amps) | Switch Setting R1 | Switch Setting R2 | Switch Setting R3 |
| 0 | Up | Up | Up | 0 | Do not set to 0 current* | | |
| 0.57 | Down | Up | Up | 0.57 | Down | Up | Up |
| 1.14 | Up | Down | Up | 1.14 | Up | Down | Up |
| 1.71 | Down | Down | Up | 1.71 | Down | Down | Up |
| 2.28 | Up | Up | Down | 2.28 | Up | Up | Down |
| 2.86 | Down | Up | Down | 2.86 | Down | Up | Down |
| 3.42 | Up | Down | Down | 3.42 | Up | Down | Down |
| 4.00 | Down | Down | Down | 4.00 | Down | Down | Down |

****Note: At least one Run Current switch must be "Down" or erratic and unpredictable behavior will occur on power-up.***

The actual motor current will vary based on a number of factors including motor characteristics, cable length and shielding. The Rule of Thumb is to set the output current one setting above the setting where reliable motion is achieved without excessive motor heating. **Refer to the Addendum; "About Step Motor Current" for more information.**

*"Do's, Don'ts and Important Notes"*

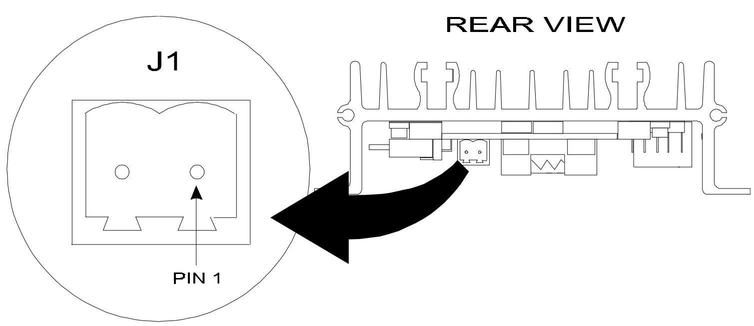
***Make sure that some non-zero value of Run current is set. The Hold current may be set between 0 and maximum (even higher than the Run value).***

***If step rates are below the time out value then Run and Hold should be set at the same values.***

***Using low power down values may cause a slight change in the motor resting position.***

## Connecting Power Supplies (J1)

The DR-4M can be operated from a single unregulated DC power supply. A 2 contact power connector (J1) is used to connect the DC power. The 5-volt logic supply is derived from an internal 5-volt regulator.

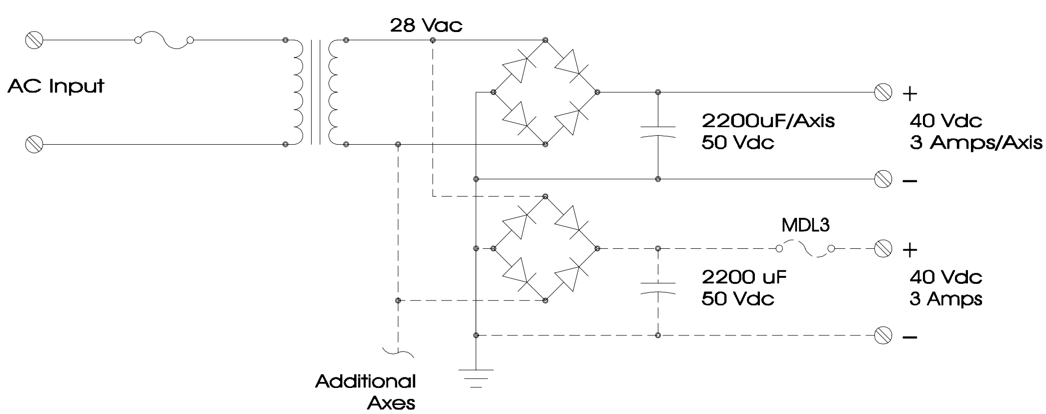



| Pin | Function |
|---|---|
| 1 | High Voltage |
| 2 | GND |

***Recommended Power Supply Circuit***

AMS recommends using an unregulated DC (or linear regulated) power supply. Switching power supplies are not recommended because of their inability to handle surge currents.

The single rectifier/filter can be used for single axis configurations, or multiple axes, provided component values are scaled accordingly. Alternatively, individual axes can be supported by their own rectifier/filter.




If multiple drivers are used with one power supply, each drive should have separate power and ground wires that connect directly to the output capacitor of the power supply.

***"Do's, Don'ts and Important Notes"***

***Individual axes should be independently fused for fault isolation.***

***The power supply voltage, including ripple and line voltage fluctuations must not exceed the peak rating of 45Vdc or be less than 28Vdc.***

***Do not connect or disconnect motor wires while power is applied.***

***Wire size used to connect the power source to the driver should be at least 18 gauge. Heavier wire should be used for longer distances between the power supply and the driver.***

***The power supply output current needed is dependent on the supply voltage, motor selection and load.***

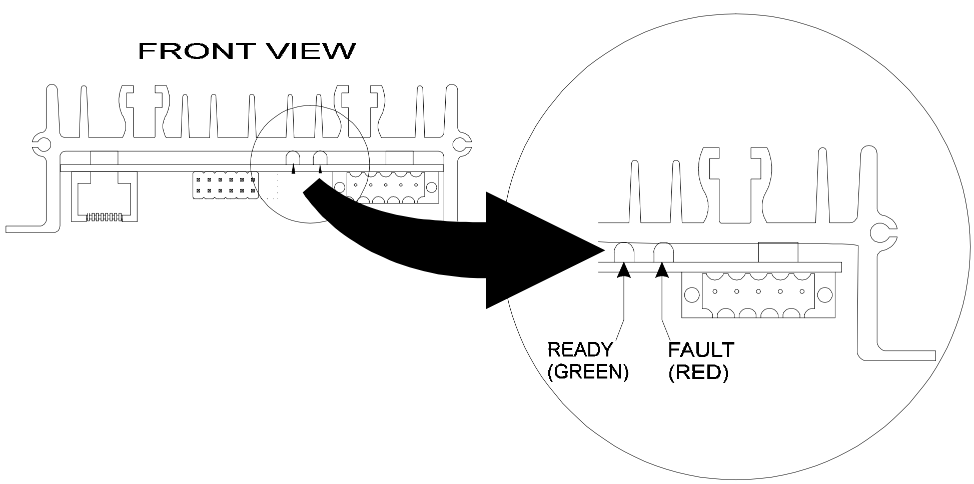
## Fault Protection

The DR-4M is internally protected against phase to phase and phase to ground short circuits, over temperature and under voltage.

The over temperature thermostat trips between 55°C and 65°C. The DR-4M is packaged in a specially designed heatsink to help avoid over temperature conditions. For maximum reliability it is recommended that an optional cooling fan be installed if system cooling is not present.

If the DC voltage to the driver drops below the minimum specification, the drivers output stage will be disabled. For added safety, the driver outputs will not automatically re-enable when the proper voltage and/or temperature condition is restored but rather requires the driver power to be cycled.

The short circuit protection consists of phase to phase*, phase to ground, and +40V to phase. If a phase short to ground fault is detected, the outputs will be disabled and cannot be re-enabled without resetting or powering down the driver.



***Diagnostic LED's***

Two LED'S (one Green and one Red) are provided to indicate operating conditions and status as follows:

1. Normal Power Up (reset): The Green LED will blink 3 or 4 times then remain on. If the flashing does not occur when the logic voltage is applied, something is malfunctioning.

2. During Stepping: The Green LED will be off when the motor is not on a full phase. The Red LED should normally be off.

***Faults***

A fault condition always involves the Red LED:

| Condition | Red LED | Green LED | Comment |
|---|---|---|---|
| Over temperature | On | Blink | Inhibits immediately, latch in 2 seconds. |
| Short to ground | Blink | Off | Latched; requires power cycle reset to clear. |
| Under voltage | On | Off | Inhibits immediately, latch in 2 seconds. |

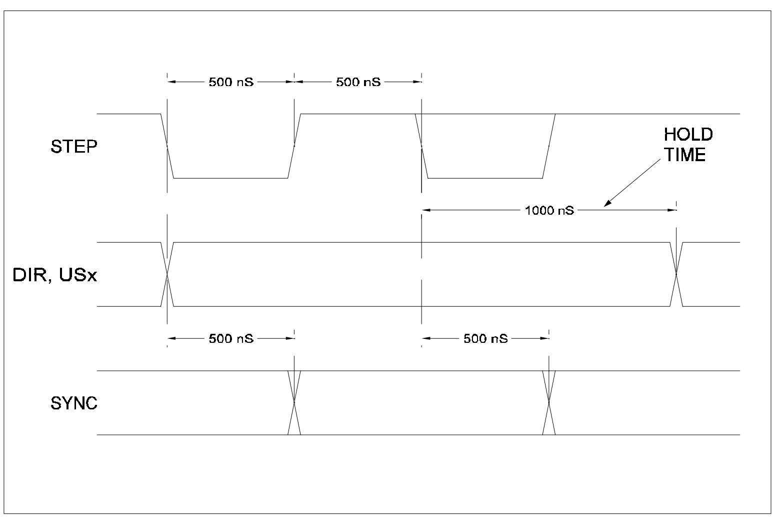
The on-board current regulation circuitry will regulate a phase-to-phase short. In this condition the motor may continue to run (on one phase only) and no LED fault indicator will appear. Symptoms of this condition are poor motor performance.

## Electrical Specifications

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Supply Voltage | 28 | | 40 | Vdc |
| Supply Current | | | 3 | Amp |
| Output Current/Phase (RMS) | | | 3 | Amp |
| Active Power Dissipation | | | 10 | W |
| Motor Chop Frequency | | 28 | | Khz |
| Quiescent Current | | 170 | | mAdc |
| Input Logic Current | | | 1.5 | mAdc |
| Input Logic High | 3.5 | | 5.0 | Vdc |
| Input Logic Low | | | 1.5 | Vdc |

Recommended Fuse: 3 Amp MDL

***Minimum Signal Timing***



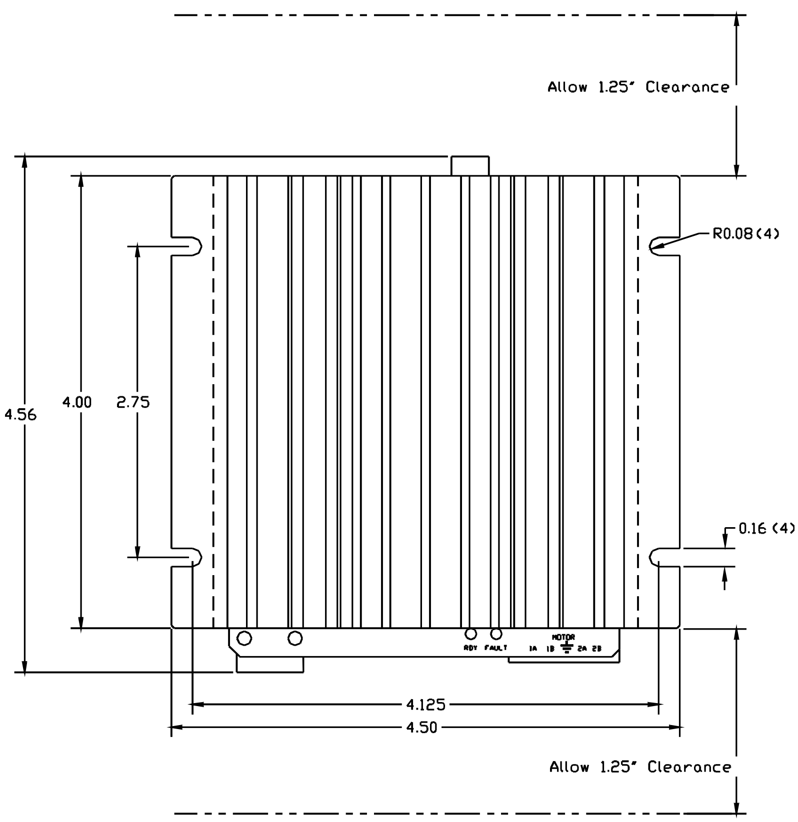
***Timing***

When the Step Clock Input goes high, the Direction and Microstep Select Inputs are latched. At this point, any changes to the inputs are disregarded until the next rising edge of the Step Clock Input. A step sequence is triggered with the positive going edge of the Step Clock Input. The Direction and Microstep Resolution Select Inputs are sampled within 1000nS of the step edge. The minimum pulse width for the Step Clock Input is 500nS. The typical execution time for a Direction or Microstep Select change is 1000nS.

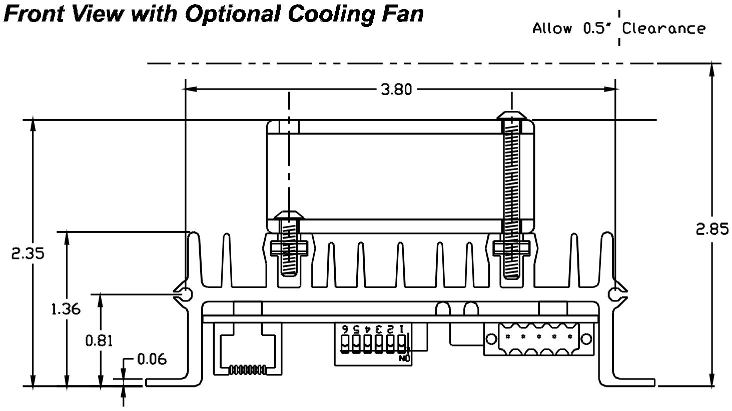
### *Thermal/Mechanical Specifications*

| | |
|---|---|
| Operating Temperature………………… | 0 to +50° C |
| Storage Temperature…………………… | -40 to +125° C |
| Size…………………………………….. | 4.56” x 4.5” x 1.4” |
| Weight………………………………….. | 12.8 oz. |

***Top View***




***Front View with Optional Cooling Fan***



## *Addendum*

## About Step Motor Current

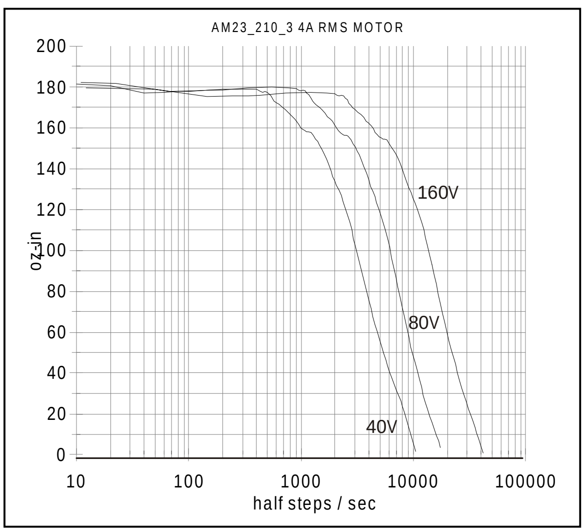
There is much confusion regarding the operation of step motors. Depending on your application, the step motor offers several advantages over servo motor designs, including lower cost and simplicity. The step (or stepper, or stepping) motor is a digital "synchronous" motor with a pre-designed number of "steps" per revolution. The most common motor has 200 full steps per revolution. Simple driver electronics can subdivide these steps into ½ step or more complex "microsteps."

***Step Motor Characteristics***

- The positional repeatability of each full or half step is very close to exact.
- While microsteps are repeatable, they tend to be somewhat non-linear.
- The torque is maximum at zero speed.
- The motor shaft RPM exactly correlates with the steps-per-second.
- Torque decreases with speed, eventually to zero or a "stall" condition.
- Resonance at certain speeds can cause undesired stalls or erratic operation.

There is little difference between today's step motor and the first generation of 60+ years ago. The magnetic materials and torque have been improved, yet it remains a simple, reliable workhorse of industrial motion control. Over time most improvements have been made to the drive and control electronics, i.e., microstep, solid-state components with higher voltage, current and switching speeds.

One insatiable hunger of a step motor is torque output at higher speeds. Winding inductance is the villain that limits speed. As the windings are switched on, the magnetic flux must be built up from current flow in the windings, producing mechanical torque. Higher step rates reduce the time available for flux to buildup and average current flow is reduced.




This reduced current results in reduced torque. The rate of current change depends on the voltage applied across it. High voltage applied across the coil will shorten the time constant.

Today's systems strive for low inductance motors and high voltage supplies. The above curves show the increased speed that might be obtained with higher supply voltages, up to 160Vdc. At standstill the average motor voltage is regulated to approximately 3Vdc.

A current sense circuit is used to switch off the current when it reaches the set value; hence the motor power is regulated. These "chopper" circuits operate at speeds above 20khz, well above hearing limits.

The following is an abstract from "Control of Stepping Motors, a Tutorial" (linked from www.stepcontrol.com) by Douglas W. Jones, University of Iowa Department of Computer Science. http://www.cs.uiowa.edu/~jones/step/index.html.

"Small stepping motors, such as those used for head positioning on floppy disk drives, are usually driven at a low DC voltage, and the current through the motor windings is usually limited by the internal resistance of the winding. High torque motors, on the other hand, are frequently built with very low resistance windings; when driven by any reasonable supply voltage, these motors typically require external current limiting circuitry.**"**

**"There is good reason to run a stepping motor at a supply voltage above that needed to push the maximum rated current through the motor windings.** Running a motor at **higher voltages** leads to a faster rise in the current through the windings when they are turned on, and this, in turn, leads to a **higher cutoff speed** for the motor and **higher torques** at speeds above the cutoff."

"Microstepping, where the control system positions the motor rotor between half steps, also requires external current limiting circuitry. For example, to position the rotor 1/4 of the way from one step to another, it might be necessary to run one motor winding at full current while the other is run at approximately 1/3 of that current."

***Motor Choice***

The discussion here relates to bipolar chopper motors. Internally, standard motors have 4 windings, resulting in a total of 8 wire leads. Motor manufacturers supply various configurations:

| Leads | Application Connection | Comment |
|---|---|---|
| 8 | Bipolar (series or parallel), unipolar | All 8 leads are available. External interconnect can be cumbersome and untidy. |
| 6 | Unipolar or bipolar series | Can be used with 50% copper reduced torque but increased speed possible. |
| 4 | Bipolar series or bipolar parallel | Series: higher torque but reduced speed capability. Parallel: higher speed with lowered torque. |
| 5 | Unipolar only | Not suitable for bipolar drives. See AMS model CCB-25 with programmable phase sequencing. |

***Determining the Current Value***

Question: What is the right current value?
Answer: The minimum value to operate reliably.

As the step motor current is reduced below the rated current, the torque output is reduced and eventually the motor will stall. The ideal current setting minimizes heating of motor and electronics, increases reliability, and reduces power supply requirements. Motors run more quietly and resonance effects can be reduced. One drawback from low current operation is that some microstep size linearity may be reduced, but full or half step accuracy is not adversely affected.

***AMPS and Wire Count and Power***

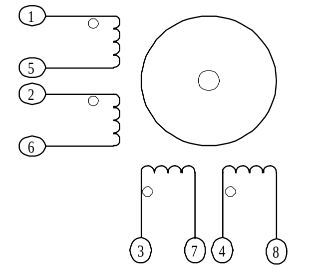
The rated current is specified based on the rated power input (watts) of a given motor.

A. Basic 8 Wire Motor

While never actually used as 8 individual coils, virtually all permanent magnet motors have 4 internal coils. All common configurations can be constructed from the 8 wire motor.

Let us assume that each winding of the 8 wire motor has the following specifications:

Current = 2 amps
Resistance =1.0 ohm
Voltage= 2.0 volts
Inductance = 4.4 mH



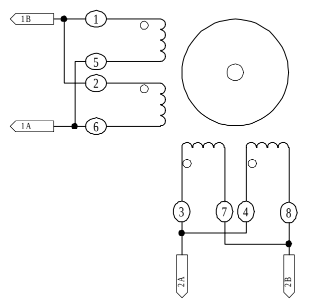
**A Basic 8 Wire Motor**

The power per winding is:

$I^2R$ or 2 x 2 x 1= 4 watts,
x 4 coils = 16 watts total for this motor.

These values correspond closely with a NEMA size 23, 4 wire motor designs.

These following examples will configure the basic 8 wire motor into four real life connections:



**4 Wire Parallel**

4 Wire Parallel

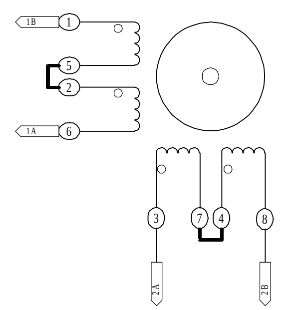
The high-speed model implements parallel coil connection. Two coils connected in parallel result in the following for each of the two phases:

Parallel Resistance= 0.5 ohms
Parallel Inductance= 2.2 mH
Current= 4 amps (2 volts)
Watts per phase=8 (x 2 phases) = 16 watts total

B. 4 Wire Series

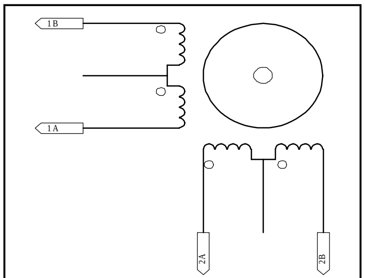
Changing to a series design, we have two pairs of two coils connected in series. Each has:

Series Resistance= 2 ohms
Inductance= 17.5 mH
The rated current is now 2 amps (4 Volts)
Watts per phase=8 (x 2 phases) = 16 watts total



**4 Wire Series**

Note that the series inductance is FOUR times the parallel design. Inductance limits the obtainable speed, since the time constant limits the amount of flux (hence torque) when step-to-step time is short.




**6 Wire Motor**

C: Adapting Available 6 Wire Motors

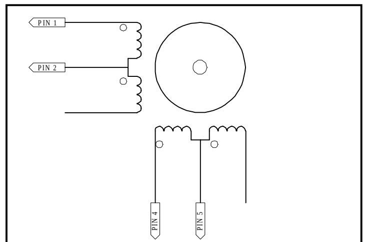
A 6 wire motor is equivalent to the 4 wire series motor.

Series Resistance= 2 ohms
Inductance= 17.5 mH
Rated current= 2 amps (4 volts)

In practice the two coil ends are connected, while no connection is made to the center tap.

Half Copper or 50% Winding

The maximum speed can be increased by using ½ the coil. To do this, connect the driver between the center tap and one end of the winding.




**6 Wire, Half Copper**

The tradeoff is a loss of torque. The RMS current is the manufacturer's unipolar amperage rating with the same wattage per phase.

Often a 6 wire design is being upgraded or the size, features, availability or cost dictate the 6 wire motor. Some characteristics can make the motor impossible to use. Many motors are rated at voltages in excess of 5 volts. This means that 10 volts is necessary in the series (100% copper) configuration.

Aside from having excessive inductance, proper chopper operation dictates operation from voltage sources much higher than the motor rating. The minimum recommended value for VMM (DC supply) is 2 times the winding rating (the higher the better, until excessive heating occurs or insulation breakdown).

The RMS current rating for series operation is:

The manufacturer's unipolar amperage rating divided by 1.414. The lower current will reduce the average voltage slightly (about 7 volts).

***Summary***

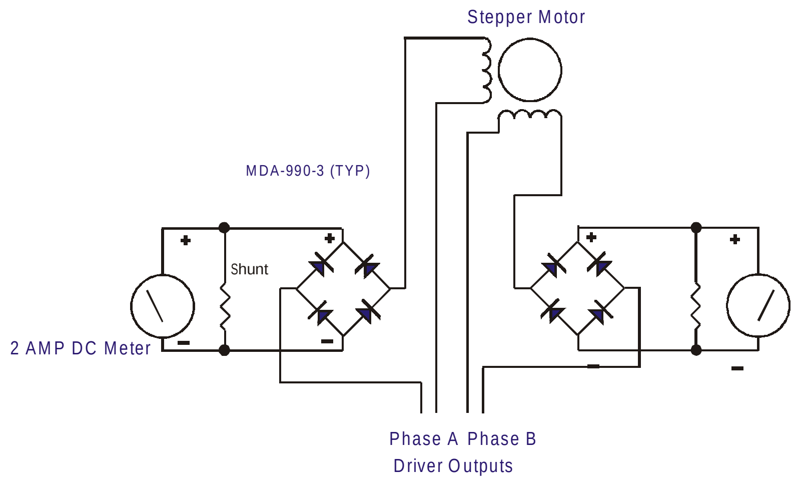
| # Leads | Winding Connection | Per Phase Bipolar Current | |
|---|---|---|---|
| | | Full Step (Total) | Microstep RMS (Peak) |
| 4 wire | Parallel | 4.0A (8.0A) | 4.0A (5.66A) |
| 4 wire | Series | 2A (4.0A) | 2.0A (2.8A) |
| 6 wire | Unipolar | 4A per phase | NA |
| 6 wire | Series | 2.8A (5.6A) | 2.8A (4A) |
| 6 wire | 50% Copper | 4A (8A) | 4A (1.7A) |

- Peak Current= One phase on and the other phase off.
- Peak Current =1.414 times RMS.
- RMS= Current per phase with both phases driven on (full step).
- RMS Microstep (or full step)= Both phases operating at equal currents.
- RMS = .707 times peak current.
- Total = Entire motor current.

***Set-up for Current Calibration***

The following is the basic setup and diagram for 2 phase current measurement:

A. The Amp meter can be digital or (preferably) analog.
B. The bridge rectifier must be rated above the maximum expected voltage and current.
C. A small capacitor (filter) may be needed across the meter.
D. A single meter circuit can be used, but two meters will indicate proper operation.
E. Additional meter protection circuitry may be desired (not shown).




***Current Set-up Techniques***

There are several basic methods used in establishing the initial motor current settings. The method used depends on the product model.

The following is a matrix of AMS products with adjustable current and the recommended (initial) current set-up techniques:

| **Model** | **Type** | **Adjustment** | **Method (See Below)** |
|---|---|---|---|
| MAX-410/420 | Microstep | Programmable | A1 |
| CMAX-410/810 | Microstep | Programmable | A1 |
| SAX/DAX | Full/Half Step | Programmable | A2 |
| CCB-26 | Microstep | Single Potentiometer | B |
| DCB-241 | Half Step | Single Potentiometer | B |
| DCB-261 | Microstep | Single Potentiometer | B |
| DR-4M/PS | Microstep | DIP Switch | B |
| CDR-4/8MPS | Microstep | DIP Switch | B |
| DCB-264 | Microstep | Dual Potentiometer | C |
| DCB-612 | Microstep | Dual Potentiometer | C |
| ALL | | | D |

****************** WARNING **********************

**LIVE CONNECTING/DISCONNECTING MOTORS WILL CAUSE DAMAGE THAT IS NOT COVERED BY WARRANTY.**

General Procedure for all Methods

Assume a 2 amp bipolar motor (4 wire, parallel connection). The RMS value is 2 amps per phase, thus the peak (only one phase on) is 1.414 x 2 (amps), or 2.8 amps. Before proceeding, make sure the power is off and let any residual power supply capacitors discharge whenever motor circuits are connected or disconnected.

1. Adjust the output current to zero, either by pot adjustment, or serial command (depending on the product model/features).
2. Connect an amp meter(s) and motor as shown above.
3. Apply power.
4. Enable drive (method depends on model. See “E” command). The enable should eliminate “hold” reduction.
5. Increase the current setting until some amperage reading is obtained. Do not exceed the RMS current rating (2 amps in this example).
6. Adjust the “run” current. This is done at standstill. Methods for adjusting the current vary depending on the product model, as follows:

Method A: Programmable Current

AMS “programmable current” products have a digitally controlled potentiometer that is used for both hold and run current settings. The range is between 0 and 100 representing 0% and 100% of the full-scale drive current. Two “Y” command parameters control the hold and run values. For this procedure, set both values the same, i.e., “Y 40 40.” Generally the preferred method is use of the peak value (one phase maximum) for micro step models and RMS (both phases on) for full/half step models such as the SAX or DAX.

1. Microstep Models with Programmable Current:
    - 1A. Set the resolution mode to “fixed” resolution (H 0).
    - 1B. Single-step until a maximum current on one phase is reached.
    - 1C. Use the “Y” command to obtain the desired current.

2. Full/Half Step Models with Programmable Current:
    - 2A. Single-step until equal currents on both phases is reached.
    - 2B. Use the “Y” command to obtain the desired current.

Fine tune using the Empirical Method (D) as required.

Method B: Peak Current, Single Potentiometer Models

The single turn potentiometer’s position is proportional to the full current rating of the product. If necessary the driver is stepped until one phase is maximum and the other is at zero current (¼ step resolution is convenient).

1. Adjust the “run” current to the peak value, which is 2.8 amps in this example. Fine tune using the Empirical Method (D) as required.

Method C: RMS Current for Dual Potentiometer Models

The two motor windings are adjusted separately in these microstep designs. There is one Sine (SIN) and one Cosine (COS) control. The preferred method is to enable both outputs to produce equal currents (RMS), and then adjust both potentiometers to equate the values.

1. Adjust both potentiometers to minimum (CCW). After applying power, the “E 3” command presets the digital phase data to equal values corresponding to the RMS value. One potentiometer (either one) is then increased to the desired RMS current.
2. A comparing LED is provided that changes state when both current settings are equal. Once one phase current is set, the other potentiometer can be “tweaked” until the LED changes to the opposite, on or off, condition. Both meters will affirm equal currents.

Fine tune using the Empirical Method (D) as required.

Method D: Empirical Method, Minimum Current

The "empirical" method is the best approach for "final-tuning" the system and can/should be used for all AMS products. This technique is generally used for "final tuning" complete system configurations. When the best values are determined they can be used in future production, providing tolerances are sufficiently close. Once the system is assembled in its final form and the motion commands are sent to the motor:

1. Reduce the current by CCW rotation of the potentiometer(s) (by equal increments in dual potentiometer models, or by using the "Y" command available in programmable units).
2. Reduce the current setting until operation becomes erratic or undesirable.
3. Increase the current gradually until reliable operation is obtained, then increase the current equally by 10 to 20%.

For dual potentiometer models, both potentiometers must be adjusted by equal amounts. Note that the "E3" command must be issued if the motor has been stepped to a non-RMS position. Periodically use the "E3" sequence to balance the two (SIN/COS) currents.

In any of these adjustments, monitor motor temperature and insure that excessive heating does not occur. Larger motors require more time for temperature to stabilize. When a low hold current and short run cycle is used, heating effects are reduced.

***HEAT: The Primary Enemy of Motor Damage***

Advanced Micro Systems driver designs limit winding current to an adjustable value. Higher speeds are achieved from higher voltage DC supplies. In general, the only cause of motor damage is from excessive heating. Most step motors can withstand 100 degrees C.

A chopper drive regulates the motor current. Generally the "run" current is set at zero speed. If a hold mode is available the current will "set-back" when the motor is not moving. The voltage supplying the motor should be three or more times the rated motor voltage. If the supply were equal to the motor voltage, chopping would not function and performance would be very poor.

With higher voltages the regulation limits power and, hence heating. As the motor is rotated faster the chopper uses the available voltage to overcome a "back EMF" effect that takes place, thereby retaining more shaft torque.