DR-4MPS MICROSTEPPING DRIVER USERS GUIDE

2 Townsend West
Nashua, NH 03063
www.stepcontrol.com

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Introduction

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

The DR-4MPS is a low cost, stand-alone microstepping driver that is designed to operate NEMA 23 frame size and smaller stepping motors. It was specifically developed for demanding O.E.M. applications that require precise positioning, simple integration and extended service life, all at a nominal cost.

Opto Isolator Option (Model DR-4MPS-O)

The opto-isolator option for AMS step drive products is a six channel PC board inserted between the step, direction and control originator and the power driver to provide full electrical isolation of all control signals. In addition to eliminating ground loops, the opto isolator board conditions and translates logic levels (user 5 to 30 volt) to the driver 5-volt TTL/CMOS logic. Input comparators withstand high voltage spikes and operate with very low drive currents.

Opto Isolator Features

- Full ground isolation for six signals
- High speed step and direction signals
- Isolated control lines (3) for microstepping mode
- Enable signal isolation
- Feedback isolation optional
- Inputs withstand over 30 volts
- Input threshold voltage based on power supply voltage

This Technical Reference Guide will assist you in optimizing the performance of your DR-4MPS 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-4MPS 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, 603-882-1447.

Thank You!
Your AMS Team

Product Overview

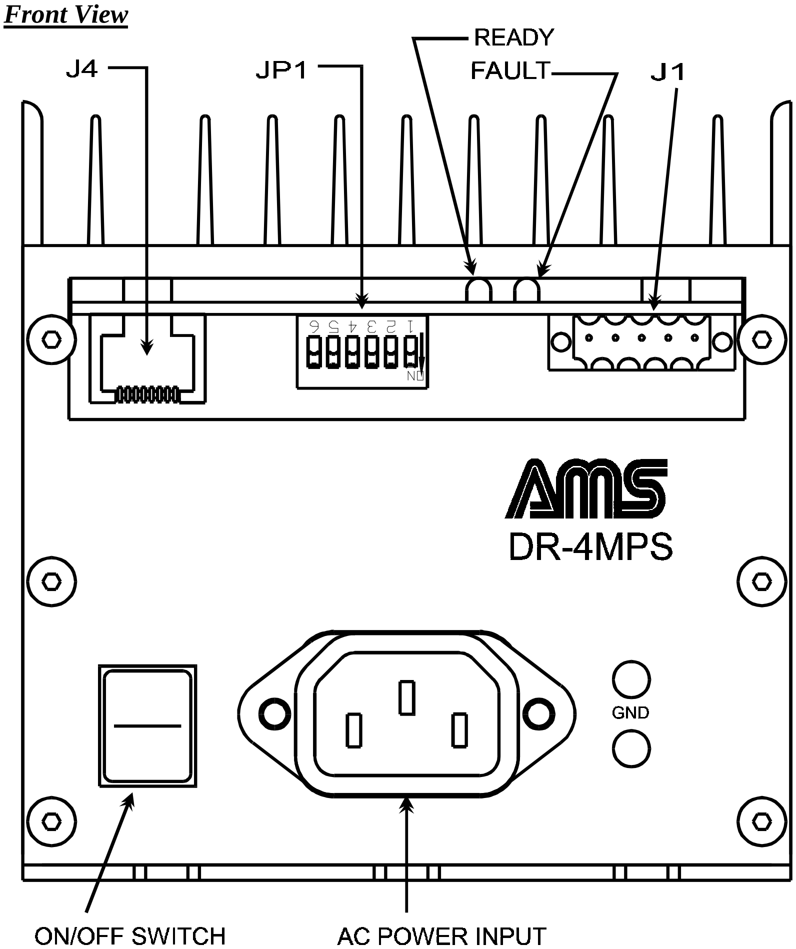
The **DR-4M** is a high performance, microstepping driver designed to meet O.E.M. requirements for reliable, cost effective operation. The **DR-4MPS** provides the next level of user integration with a built in 40 volt power supply. Both drivers offer eight resolution settings, from 1/2 step to 1/256 step. They are short circuit, over temperature and under voltage protected for extended service life.

***DR-4MPS Features*:**

- ***Low cost***
- ***Small size***
- ***Modular connectors for easy installation and removal***
- ***Heat-sinked with convenient cooling fan***
- ***Selectable step resolution to over 50,000 steps per revolution***
- ***4 amp output current (3 amp RMS)***
- ***40 volt power supply***
- ***Up to 1 Mhz step clock rate***
- ***Automatic current reduction and current boost mode***
- ***Protection against:***
  - ***Phase to phase short circuit***
  - ***Phase to ground short circuit***
  - ***Over temperature***
  - ***Under voltage***
- ***Fault indicators***
- ***Diagnostic indicators***

Assembly Drawing

Front View

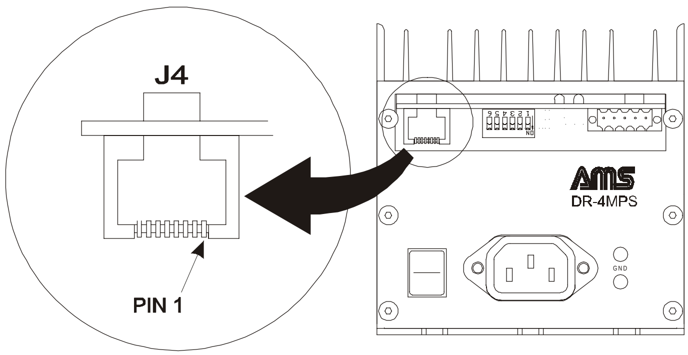


Connector Description
J4: Control Input Connector
JP1: Current Select Jumpers
J1: Motor Connector

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

Control Input (J4) Non-Isolated

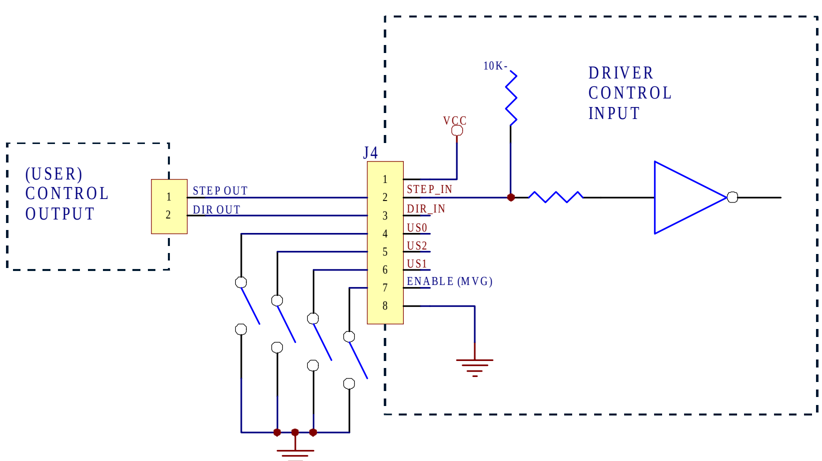
The essential input signals include a step pulse and direction control. Other inputs include three resolution select lines to permit remote select of microstep size (1/2 through 1/256). A miniature 8 contact RJ45 connector (similar to a phone plug) is provided for convenient interface of user control signals to the DR-4MPS.



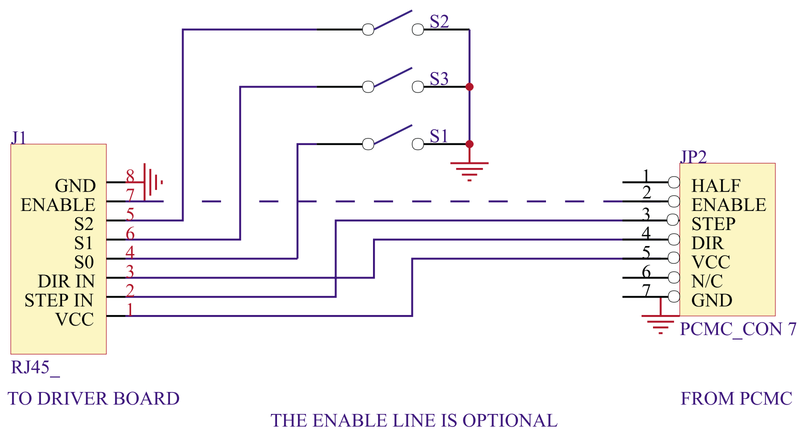
Pin	Signal	Description
1	Vcc	Vcc: +5Vdc output provided for user convenience permitting small loads up to 100 mA. **CAUTION: OUTPUT ONLY! VOLTAGE INPUT WILL CAUSE DAMAGE.**
2	Step In	Step (In): Step clock input. Each pulse causes the motor to step one microstep
3	Dir. In	Direction (In): Set the shaft direction for STEP input
4	US0 In	Microstep resolution select
5	US2 In	Microstep resolution select
6	US1 In	Microstep resolution select
7	Disable	Disable: Low input shuts off power drivers
8	Common	Ground: Connect to common (GND) of controller

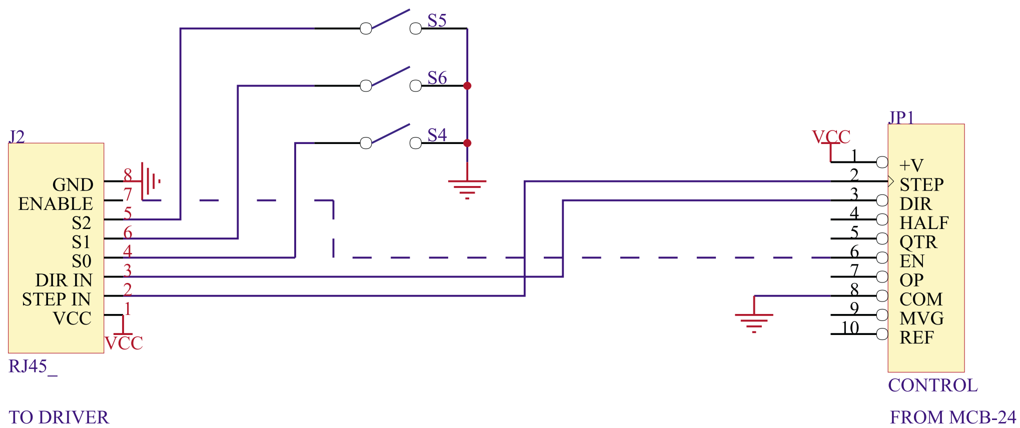
Inputs are TTL/CMOS compatible and are provided with current limiting circuitry capable of withstanding temporary over voltages. However, caution should be taken not to exceed accepted TTL/CMOS design guidelines as standard practice.

Control Input Connection Diagram



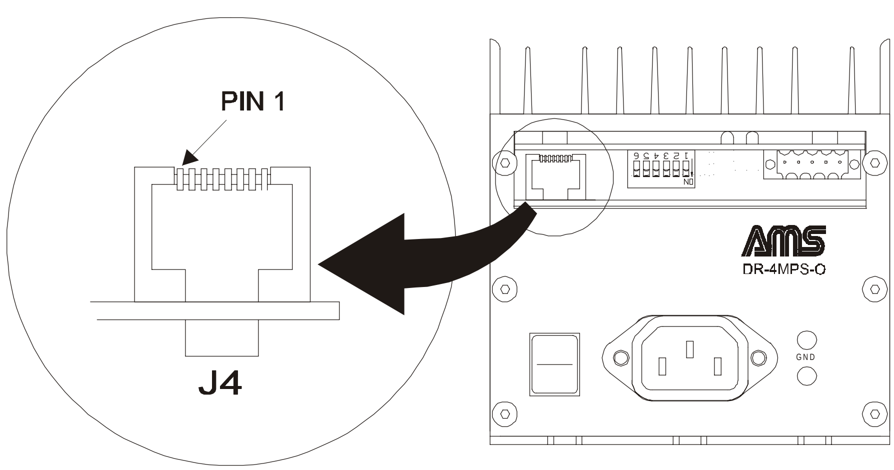
Control Input Connection Diagram (using AMS Control Boards)





Control Input (J4) Optically Isolated

The opto-isolator option for AMS step drive products is a six channel PC board inserted between the step, direction and control originator and the power driver to provide full electrical isolation of all control signals. In addition to eliminating ground loops, the opto isolator board conditions and translates logic levels (user 5 to 30 volt) to the driver 5-volt TTL/CMOS logic. Input comparators withstand high voltage spikes and operate with very low drive currents.



Pin	Signal	Description
1	VIP	Voltage input 8-24Vdc or 5Vdc regulated (special order)
2	Step In	Step (In): Step clock input. Each pulse causes the motor to step one microstep
3	Dir. In	Direction (In): Set the shaft direction for STEP input
4	US0 In	Microstep resolution select
5	US2 In	Microstep resolution select
6	US1 In	Microstep resolution select
7	Disable	Disable: Low input shuts off power drivers
8	Common	Ground: Connect to common (GND) of controller

Operation

The isolator consists of two independent circuits. The output circuit is powered by the 5 volts available from the power driver.

Because of the full isolation, the input circuitry power (VIP) must be supplied from a voltage common with the remote controller. The minimum power requirements can generally be met with the voltage available within the user system. VIP may be between 8 and 24 Vdc. VIP also determines the logic threshold voltage (Vth) for the inputs. This voltage is approximately ¼ of VIP.

Input Threshold Voltage Table (Vth)

VIP	Logic Threshold
5*	2.5 *
8	2
12	3
18	5
24	6

* Special order

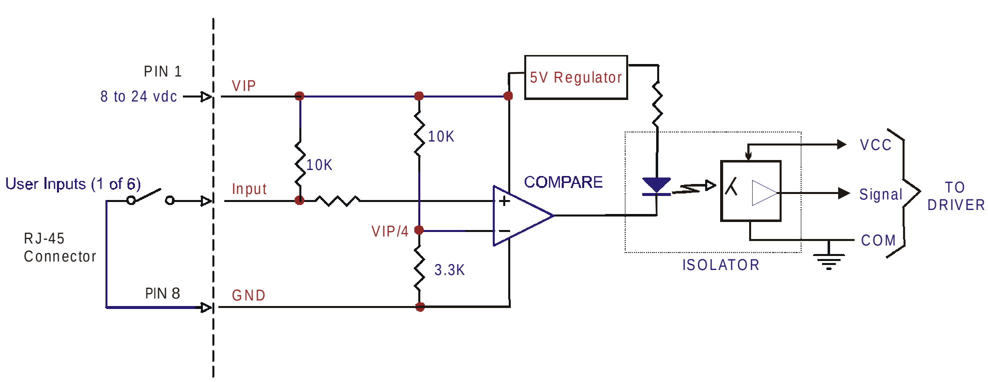
VIP can be either higher or lower than the logic voltage swing. The pull-up resistors on the inputs are to VIP; therefore the controller outputs may be open collector/drain capable of withstanding VIP.

For 5 volt designs please specify the 5 volt model. Here the integral regulator is bypassed, and the user must supply regulated +5 volts for VIP.

Speed

The digital step and direction signals are coupled through high-speed Opto-Isolators and will pass square waves in excess of 1 MHz. The other control inputs use standard speed isolators and will operate in excess of 75 KHz. (High speed options available on special order).

Block Diagram (One of Six Inputs)



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.	Programmable Control Using AMS' MCB-24* "H" Cmd.	"E" Cmd.
0	0	0	1/2	400	H3	E1
1	0	0	1/4	800	H2	E1
0	1	0	1/8	1,600	H3	E3
1	1	0	1/16	3,200	H2	E3
0	0	1	1/32	6,400	H1	E1
1	0	1	1/64	12,800	H0	E1
0	1	1	1/128	25,600	H1	E3
1	1	1	1/256	51,200	H0	E3

"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.

The wire size used with the J4 modular connectors may suffer voltage drops if more than several Milli amps of current is attempted over any significant cable length.

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-4MPS 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-4MPS, however the performance may be compromised.

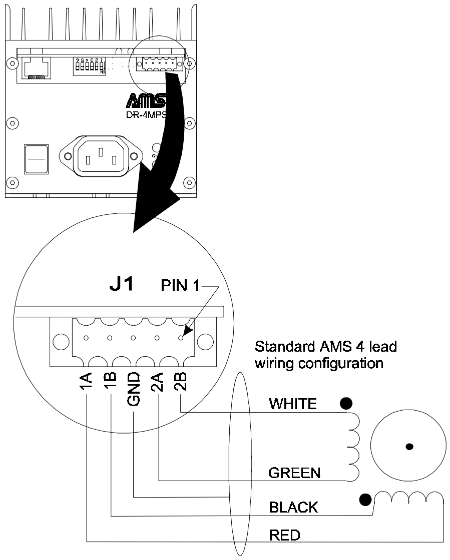
The DR-4MPS uses a constant chopping frequency and a varying duty cycle to sustain a given motor current. To avoid unstable chopping conditions and to provide a higher speed-performance ratio, a motor with a low winding inductance is preferred.

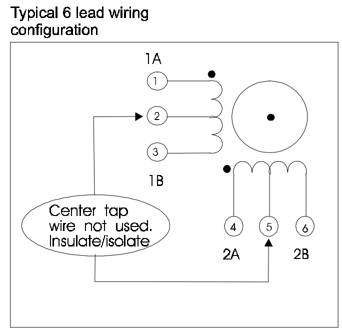
Drive Current

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 (J1)





Pin #	Description	Function
1, 2	2B, 2A	Phase A 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 B 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.

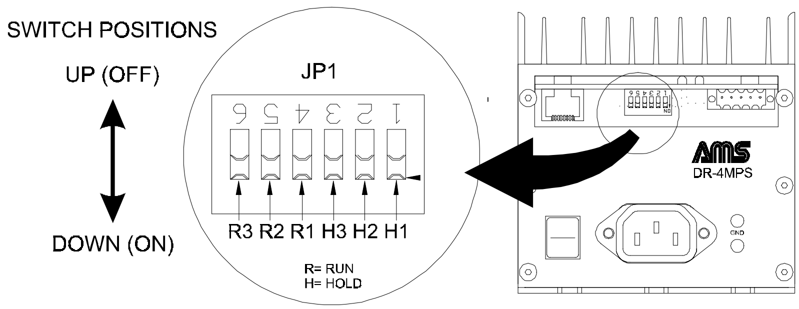
The physical direction of the motor with respect to the direction input will depend on the connection of the motor windings. To reverse the direction of the motor with respect to the direction input, switch the wires on phase 1 or phase 2 of the outputs.

Setting the Output Current (JP1)

The DR-4MPS 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.



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.

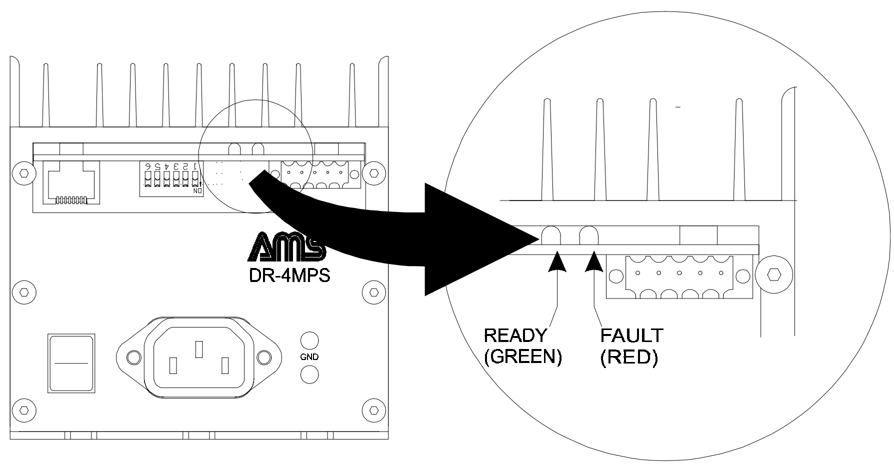
Fault Protection

The DR-4MPS 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-4MPS 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 +V 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 LEDS (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 temp.	On	Blink	Inhibits immediately, latch in 2 seconds.
Short outputs	Blink	Off	Latched; requires power cycle reset to clear.
Under voltage	On	Off	Inhibits immediately, latch in 2 seconds.

Specifications

Electrical

Parameter	Min	Typ	Max	Unit
Output Current/Phase (RMS)			3	Amp
Output Current/Phase (Peak)			4	Amp
Input Power			100	W
Motor Chop Frequency		28		Khz
Input Logic Current			1.5	mAdc
Input Logic High	3.5		5.0	Vdc
Input Logic Low			1.5	Vdc

Power Supply: 40V@80VA
Input Voltage: 100 to 125 VAC, 60 Hz or 200 to 250 VAC, 50Hz
Microsteps Per Full Step: 2, 4, 8, 16, 32, 64, 128, 256

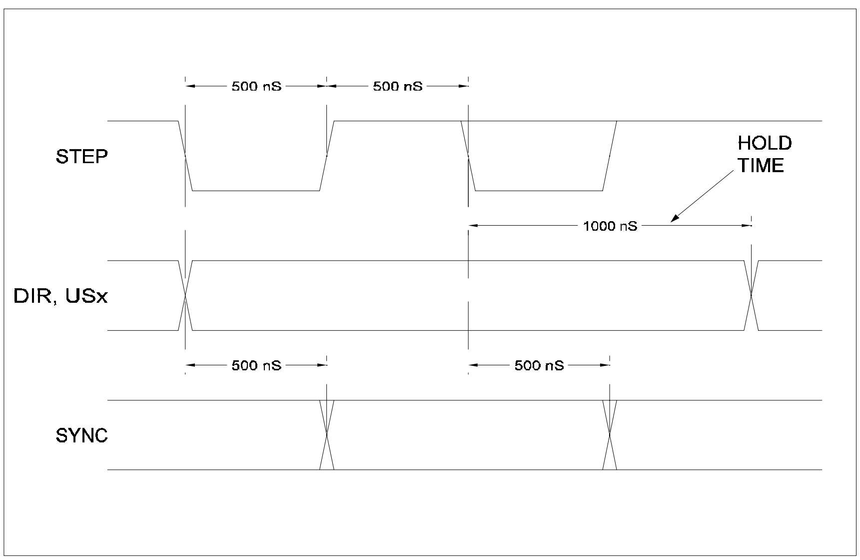
Thermal

Operating Temperature: 0 to +50° C
Storage Temperature: -40 to +125° C

Timing

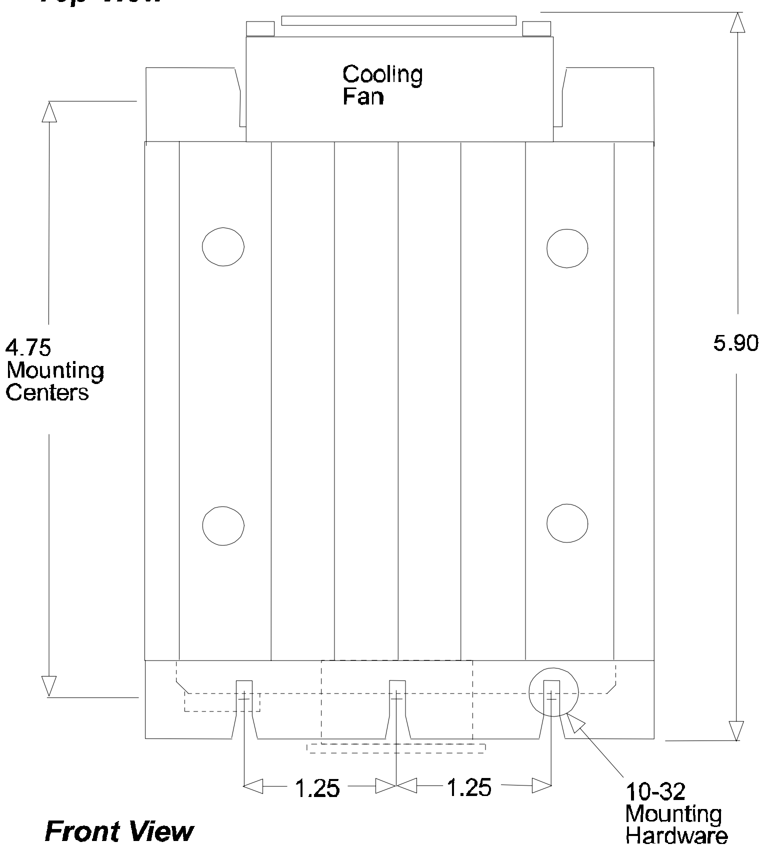
When the Step Clock Input goes high, the Direction and Microstep Select Inputs are latched. At this point, any changes to the inputs are disregarded until the next rising edge of the Step Clock Input. A step sequence is triggered with the positive going edge of the Step Clock Input. The Direction and 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.

Minimum Signal Timing

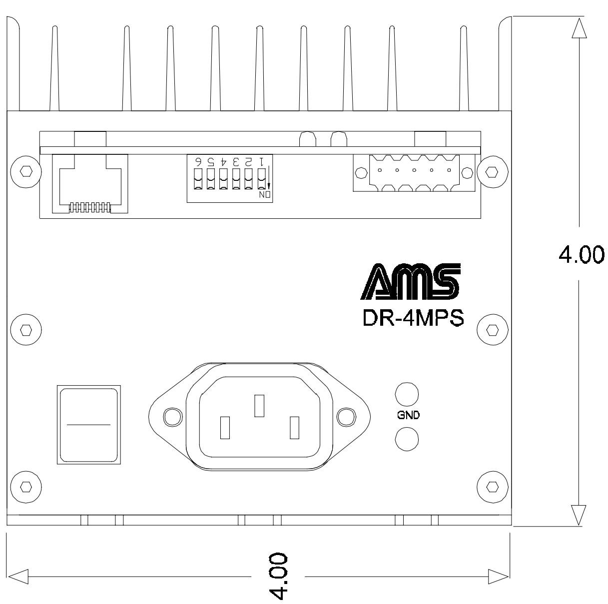


Mechanical Specifications
Size (inches): 4W x 5.9L x 4H
Weight: 3lb., 9oz.

Top View



Front View



Addendum

About Step Motor Current

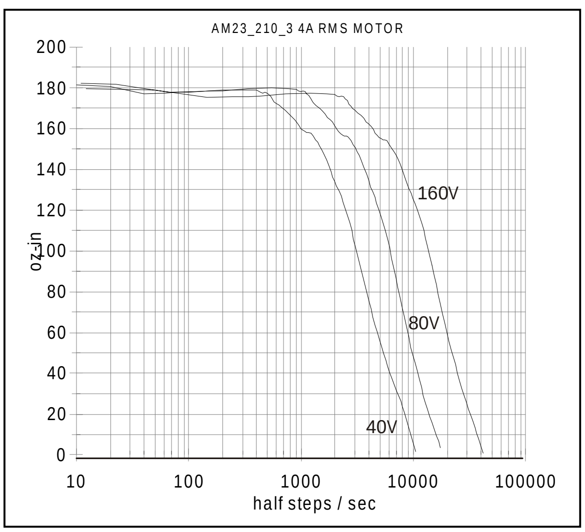
There is much confusion regarding the operation of step motors. Depending on your application, the step motor offers several advantages over servo motor designs, including lower cost and simplicity. The step (or stepper, or stepping) motor is a digital "synchronous" motor with a pre-designed number of "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

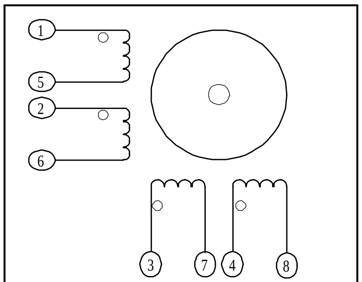
The rated current is specified based on the rated power input (watts) of a given motor.

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



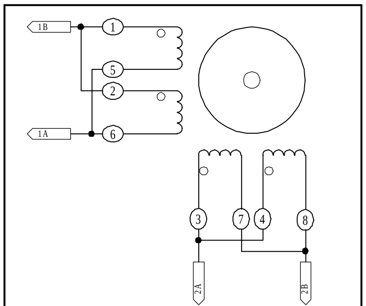
A Basic 8 Wire Motor

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:

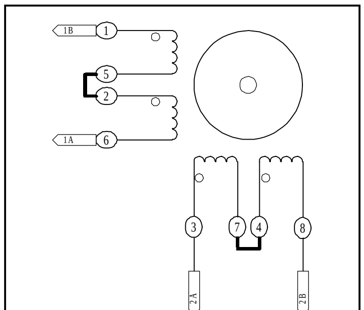
Parallel Resistance= 0.5 ohms
Parallel Inductance= 2.2 mH
Current= 4 amps (2 volts)
Watts per phase=8 (x 2 phases) = 16 watts total

B. 4 Wire Series

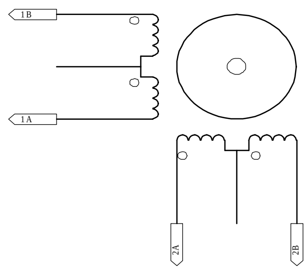
Changing to a series design, we have two pairs of two coils connected in series. Each has:

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

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.



4 Wire Series



6 Wire Motor

C: Adapting Available 6 Wire Motors

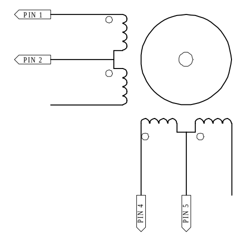
A 6 wire motor is equivalent to the 4 wire series motor.

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

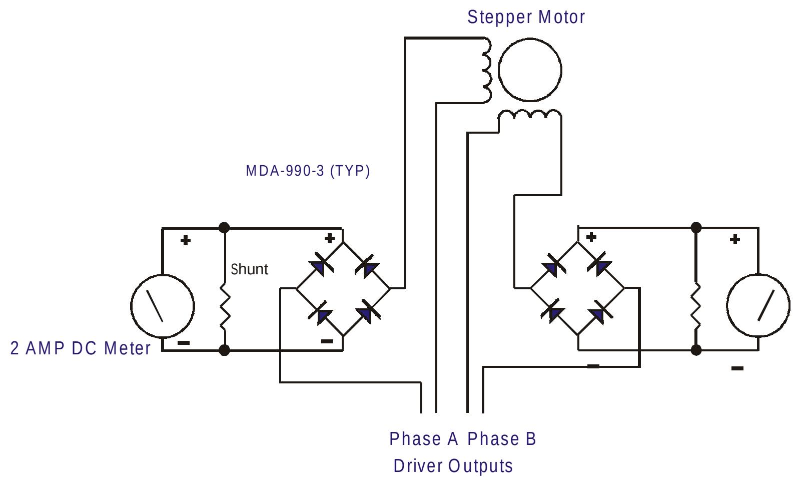
# Leads	Winding Connection	Per Phase Bipolar Current	
		Full Step (Total)	Microstep RMS (Peak)
4 wire	Parallel	4.0A (8.0A)	4.0A (5.66A)
4 wire	Series	2A (4.0A)	2.0A (2.8A)
6 wire	Unipolar	4A per phase	NA
6 wire	Series	2.8A (5.6A)	2.8A (4A)
6 wire	50% Copper	4A (8A)	4A (1.7A)

- 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.