DR-38
STEP MOTOR DRIVER
USERS GUIDE

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Introduction

Congratulations on your purchase of an AMS model DR-38 Step Motor Driver. This product will provide years of reliable, accurate and cost-effective motion control. As with all AMS products, the DR-38 is backed by over 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 step motor 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-38 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-38** is a low cost, bipolar step motor driver designed to meet O.E.M. requirements for reliable, cost effective operation. The DR-38 operates in half step mode at speeds up to 20k SPS. It uses a single power supply input voltage, between 12 and 40 Vdc, to generate a drive current output of 4.0 amps per phase.

Features:

- *Low cost - small size*
- *Heat sinkable case*
- *Direction sensitive limit inputs, invert-able*
- *Speed sensing slow / fast decay selection*
- *12 to 40 Vdc power supply input*
- *4.0 amp output current (Peak)*
- *Output disable input*
- *Gentle power-up to reduce surge current*
- *Mating connectors included*

Out of the Box

The standard driver package includes:

1. A DR-38 driver.
2. One 6-pin motor/power connector (P3) that mates with J3 on the driver (AMS# 82-1812-06).
3. One signal cable (P2) that mates with J2 on the driver (AMS# BLC-15).
4. Three shunts for setting options.
5. One Users Manual (per shipment).

Required Accessories

1. Power supply-24 to 40Vdc.
2. A step pulse source with "low" going step pulses ranging from +5 to +24-volts (high) and 0 to 1-volt (low).
3. A step motor. A four wire, two-phase, bi-polar step motor is recommended. Six and eight wire motors can also be configured.

Recommended/Optional Accessories

4. Should additional cooling be required, a fan may be mounted to either draw or blow air across the heat-sink surface, depending on thermal conditions of the system.
5. Dual ammeter for more accurate current settings.
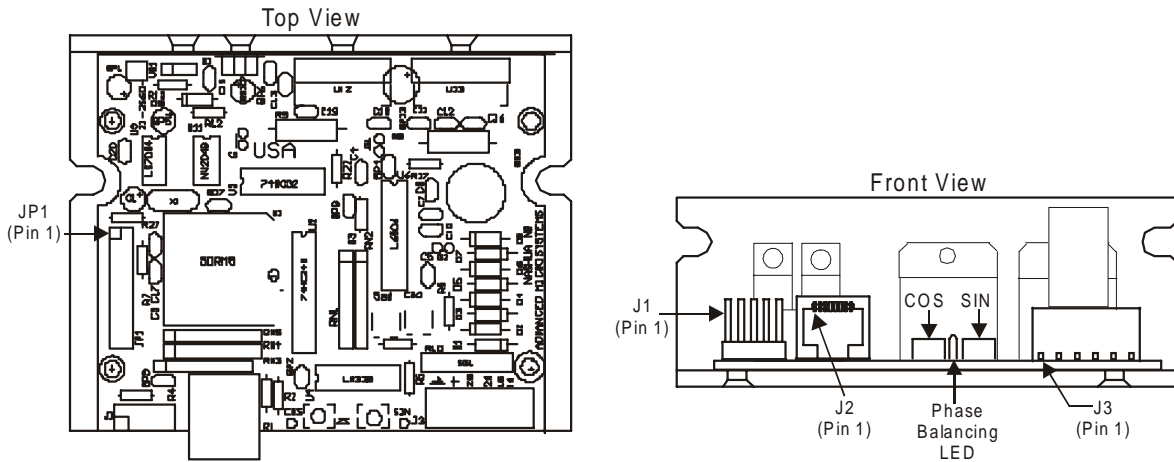
Power Supply Characteristics

For the best performance the power supply voltage should be as high as possible. It must be a minimum of two times the rated motor voltage; otherwise the motor will probably not function properly.

Be aware that exceeding the absolute maximum driver voltage rating (45Vdc) for even the shortest time will cause (non warranty) destruction to the driver. An unregulated 36-volt (at 120 Vac) power supply is preferred. Torroid transformer designs are the best, providing good, high-speed performance with adequate margin to withstand most "high" AC line conditions. If a regulated supply is used, it must be capable of withstanding any start-up surges. A switching regulated supply may not be suitable for use with this product. .

The power supply must be capable of providing sufficient current to meet the surge demands during turn-on. The power output (Volt-Amps) is probably the most important parameter. When Vmm is lower, more amperage is required. At higher voltages the chopping efficiency will reduce current demand. Generally, at 36 volts, a 3 to 4 amp power supply will operate most motors. Smaller motors require less Volt-Amps. Note, frequently the best operation is obtained by using lower currents then the motor specification.
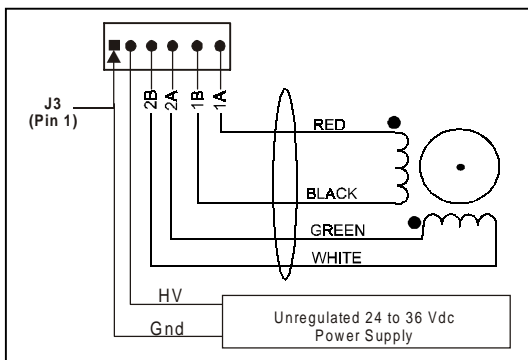
Quick Installation

The following procedure will provide minimal setup to move a motor and ensure that the unit is operational:

Top View

Front View

JP1 (Pin 1)

J1 (Pin 1)

J2 (Pin 1)

COS   SIN

Phase Balancing LED

J3 (Pin 1)

Preparation

Step 1. Inspect for any damage as a result from shipment and handling.

Step 2. Insure both current controls (COS and SIN) are in the full counterclockwise (zero current) position.

Step 3. Connect power and motor wires to the mating connector for J3, per the table and diagram below.

J3 Pin	Signal	Description
1	Gnd (-)	Minus side of DC power supply
2	Vmm (+24 to 40-volts)	Positive side of DC power supply
3	PH-2B	Motor coil 2+
4	PH-2A	Motor coil 2-
5	PH-1B	Motor coil 1+
6	PH-1A	Motor coil 1-

J3 (Pin 1)

2B 2A 1B 1A

RED
BLACK
GREEN
WHITE

HV
Gnd

Unregulated 24 to 36 Vdc Power Supply

Different motor manufactures use different nomenclature for winding designations. Coil 2 is connected between pins 3 and 4, and coil 1 between pins 5 and 6. These coils are separate and there must be no continuity between the two windings.

Note: driver outputs will be damaged if any PH output contacts Gnd or Vmm.

Setting the Current

The best method for setting the current is to use a dual ammeter circuit as described in the Addendum. Here, we will use the "meter-less" method.

The SIN and COS potentiometers each have ten equally spaced marks that can be used to set the output currents. The first mark, in the full CCW position, represents zero output current. Each incremental adjustment in the CW direction, adjusts the current approximately ¼ amp between 0 and 4 amps. Because most installations do not require the maximum torque, and motors usually have higher torque then the data sheets show, choose a lower current to start with; say ½ of the rated current.
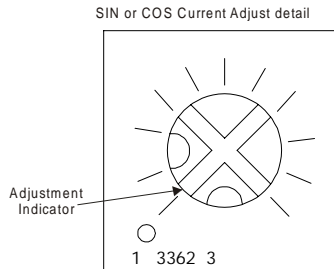
> **Step 4.** Turn the power on.
> **Step 5.** Carefully adjust the SIN potentiometer clockwise to the position corresponding to the desired current (see table below). At this point the phase balancing LED will be "off."
> **Step 6.** Adjust the COS potentiometer to an equal position.

The following table illustrates (approximate) current settings: Custom full-scale current range adjustments are also available (consult factory).

Adjustment Indicator	Current Value (Amps)
Full CCW	0
1	0.4
2	0.8
3	1.2
4	1.6
5	2.0
6	2.4
7	2.8
8	3.2
9	3.6
Full CW	4.0

SIN or COS Current Adjust detail

Adjustment Indicator

1 3362 3

Slight current imbalances will not affect performance significantly. Large imbalances can cause skipping steps and noisy operation or the symptoms of a stall condition.

> **Step 7**. Step it.
>   Apply step pulses from the pulse generator to verify motion.

If the motor refuses to turn, gradually increase or decrease current settings by rotating both trim pots equal amounts. Monitor motor heating with higher current settings. Heating is gradual depending on motor mass. The case should never exceed 100 degrees C.

In general, variations in step motor current settings are not critical. The value that provides reliable operation (sufficient torque), without motor over heating, is probably best.

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

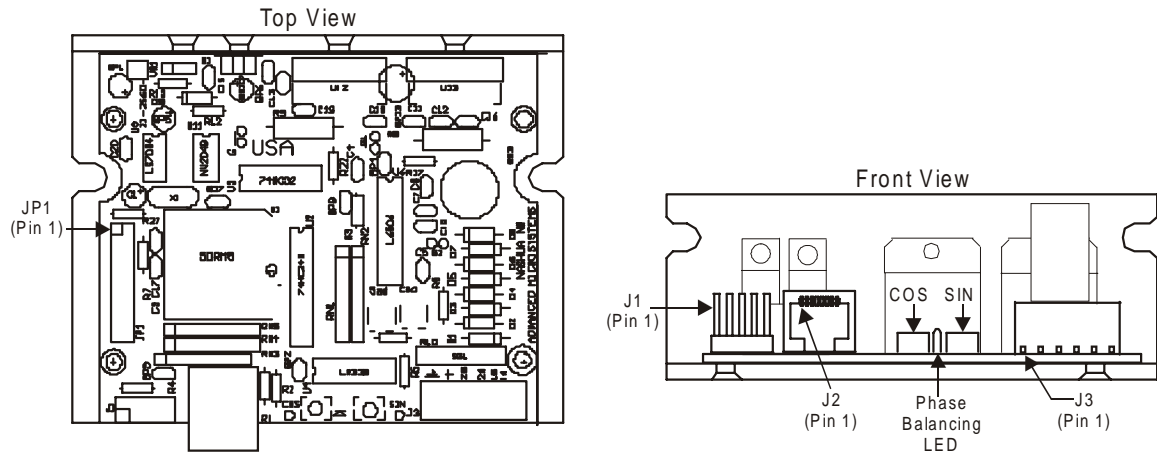> *Do not connect or disconnect the motor when power is "ON."*
>
> *The module case is tied to the logic common and power pins internally. Do not tie your power supply to ground at another location.*
>
> *The power supply voltage, including ripple and line voltage fluctuations must not exceed 45Vdc or be less than 12Vdc.*
>
> *Make sure the motor to be used is compatible with the drive.*
>
> **NEVER SHORT ANY MOTOR OUTPUT TO ANOTHER OUTPUT, GROUND or POWER SUPPLY.** *Permanent damage, not covered by warranty, will occur.*

Hardware Connections

Top View

Front View

Connector Description
   J1: Special Inputs
   J2: Step and Direction Input Connector
   JP1: Parameter Selection
   J3: Motor and Power Supply Connector

J1 and JP1 are both IDC connectors, capable of accepting suitable ribbon cable connections. JP1 has been designed primarily to accept shunts (jumpers).

Special Inputs (J1)

J1 is a 10-pin header that provides limit switch inputs, ground and a user defined +5 volt output. All inputs are 5 Vdc logic input, TTL/CMOS compatible. These signals connect DIRECTLY to the on-board microprocessor. It is highly recommended that external buffers be implemented to protect against inadvertent damage.

Caution: Exceeding the 5.5 volt maximum rating or below 0 volt minimum voltage will cause damage not covered by warranty.

Pin	Signal	Description
1	Vcc	+5 Vdc @ 100mA output (provided for user)
2	Lim A	Motion inhibited in CCW direction
3	Lim B	Motion inhibited in CW direction
4	Res.	
5	Res.	
6	Res.	
7	Res.	Reserved input
8	GND	Power common
9	Res.	Reserved input
10	Res.	Reserved input

Vcc
The DR-38 contains a 5-volt regulator circuit that operates from Vmm input. This output is rated for 100 mA and may be used for external applications. Increased heating will result for higher input voltages (Vmm). Additional cooling may be necessary.

Limit Inputs, A and B
These are direction sensitive inputs that can be used to prevent hardware damage or used as a "home" stop. Depending on system design, one input will prevent movement in the CCW direction, while the other will prevent movement in the CW direction. Asserting a low on both inputs will prevent movement in any direction.

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

When connecting from the J1 or J2 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 J1 or J2 modular connectors may suffer voltage drops if more than several milliamps of current is attempted over any significant cable length.

Select (JP1)

JP1 is a 20-pin header that implements special features. All inputs are 5 Vdc logic input; TTL/CMOS compatible.

Caution: Exceeding the 5.5-volt maximum rating will cause damage not covered by warranty.

Pin	Signal	Description	Pin	Signal	Description
1			2	Gnd	
3			4	Gnd	
5	N/C		6	Gnd	
7	H0	Auto Off*	8	Gnd	
9			10	Gnd	
11			12	Gnd	
13	S1	Fast Decay	14	Gnd	
15	S2	Slow Decay	16	Gnd	
17			18	Gnd	
19			20	TXD	

*Auto Off – (jumper installed) the motor current is automatically disabled when the motor is stopped.

Fast and Slow Decay
The Decay feature is of particular importance. There are two methods of switching a bipolar chopper drive. The slow decay provides smoother operation at slow speeds, reducing mechanical resonance affects, while a fast decay mode enhances torque at higher speeds.

In automatic mode, the controller senses and selects fast or slow decay based on the shaft speed.
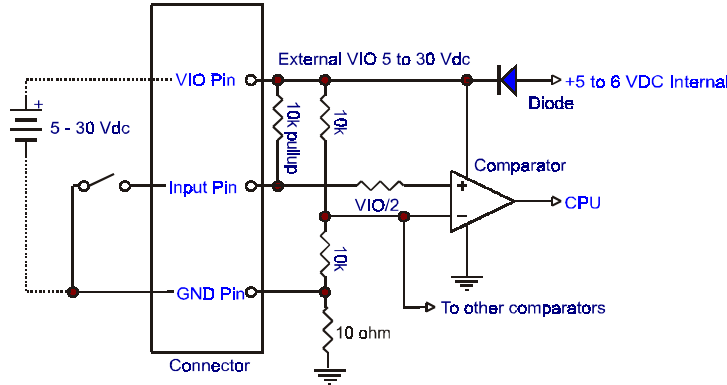
Jumpers Installed

S1	S2	Decay mode
No	No	Automatic (recommended)
Yes	No	Fast (best for higher speeds)
No	Yes	Slow (best for slow speed)

Some variation in winding current and heating will be observed, depending on the mode.

Control Input (J2)

J2 is a miniature, 8-contact (RJ45) connector (similar to a phone plug) provided for interface of user control signals to the DR-38. The essential input signals on J2 include a step pulse and direction control.

Typical Input Circuit

Pin #	Signal	Description	Color**
1	VIO	+5 to + 28 Vdc reference input	Blue
2	Step In*	Step clock or Encoder "A" input	Orange
3	Dir In*	Direction (In): or Encoder "B".	Black
4,5,6	N/C	Reserved- DO NOT CONNECT	
7	Disable In*	Low input shuts off power drivers.	Brown
8	COM	Common – 10 Ohm resistor to GND	Gray

Only these signals can withstand 28-volt high input.
**Actual colors may vary, as there is no "hard" standard for these cables.

The DR-38 can be ordered with an optional encoder input. This is not "encoder feedback" but can be used to implement a shuttle or tracking design, where the motor position can move proportionally to some remote quadrature encoder. This input can withstand 28 volts.

VIO (Optional Supply In)
This pin is used to define the threshold voltage for the Step pulse, Direction, and Enable inputs. Without an external supply, the logic threshold will be approximately 2.5 volts. If the logic signal input exceeds 5 volts, an external VIO supply should be used, however, the these three inputs will withstand in excess of 28 volts without damage. VIO output will measure about 4.5 volts.

Step /A (Input)
Each pulse applied causes a single step in the direction specified by the Direction Signal (pin 3). A low going pulse is preferred with a minimum width of 12 microseconds. Stepping occurs on the leading edge of the pulse.

Direction /B (Input)
This input specifies the shaft rotation direction on receipt of a step pulse. If the encoder input is ordered, encoder phase "B" is used here. This input can withstand 28-volts.

Disable (Input)
A low applied to this input disables stepping and reduces current to zero.

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

> **When connecting from the J1 or J2 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 J1 or J2 modular connectors may suffer voltage drops if more than several milliamps of current is attempted over any significant cable length.**
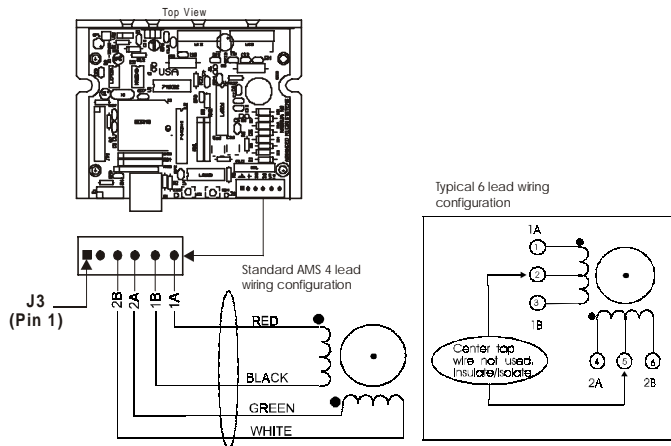
Motor Connection (J3)

The DR-38 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-38, however the performance may be compromised.

The DR-38 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.

Connecting a Stepping Motor (J3)

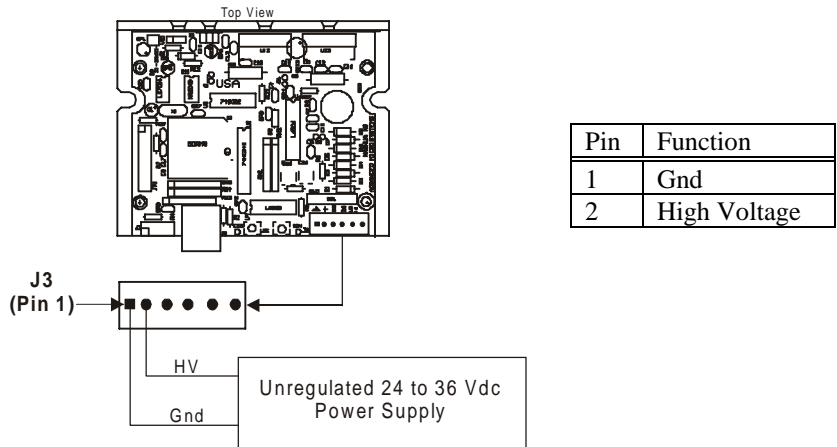| Pin #	Description	Function
3, 4	2B, 2A	Phase 2 of the stepping motor is connected between Pin 3 and Pin 4.
5, 6	1B, 1A	Phase 1 of the stepping motor is connected between Pin 5 and 6.

"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.**

Power Supply Connection (J3)

The DR-38 can be operated from a single unregulated DC power supply. The 5-volt logic supply is derived from an internal 5-volt regulator.

Pin	Function
1	Gnd
2	High Voltage

Recommended Power Supply Circuit

AMS recommends using an unregulated DC (or linear regulated) power supply between 24 and 36-volts (12-40 volt actual operating range). The current rating of the power supply should be sufficient to operate the DR-38, but not exceeding 6 amps. Switching power supplies are not recommended because of the 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 40Vdc or be less than 12Vdc.

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

Electrical Specifications

Parameter	Min	Typ	Max	Unit
Supply voltage	12	24	40	Vdc
Peak output current per phase	0		4.0	Amp
Buffered inputs (Step, Direction, Enable)	-0.5	2.5 (Thresh)	28	Volt
VIO external ref. for buffered inputs	None	5	28	Volt
Pull-up resistor (VIO) for buffered inputs				
Un-buffered logic inputs (high)	2.0		5.5	Volt
Un-buffered logic inputs (low)	-0.5		0.8	Volt
Pull-up resistor logic inputs (5V)		10k		
Input step rate	0		20,000	Steps/Sec
Step pulse width	12			Microseconds
Steps per revolution	400		400	1.8° Motor

Output Current Load	12Vdc	24Vdc	40Vdc	Unit
No load	.05	.05	.06	Amps (Imm)
2.0 amps (both phases on)	2.4	1.0	0.7	Amps (Imm)
4.0 amps (both phases on)	7.0 *	3.3	2.0	Amps (Imm)

*This parameter exceeds the maximum rating of the DR-38.

Thermal/Mechanical Specifications

Operating temperature…………………0 to +50° C

Storage temperature……………………-40 to +125° C

Size……………………………………..4.13" x 3.25" x 1.56"

Weight………………………………….12.8 oz.

Dimensional Drawing
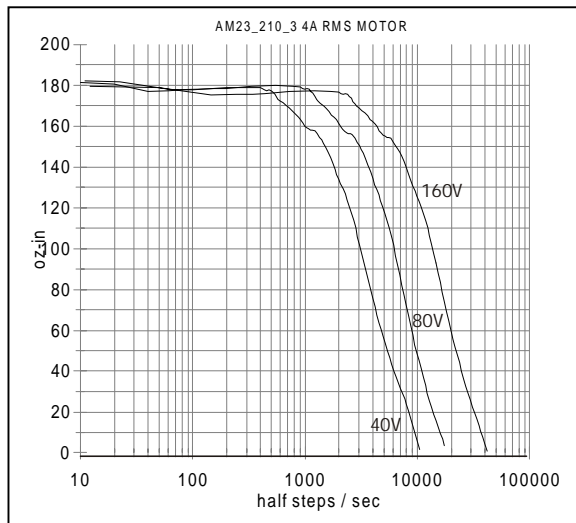
Addendum

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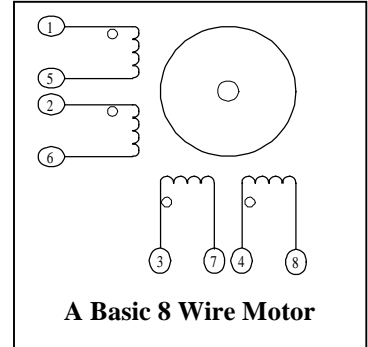
Let us assume that each winding of the 8-wire motor has the following specifications:

    Current = 1 amps
    Resistance = 4.0 ohm
    Voltage= 4.0 volts
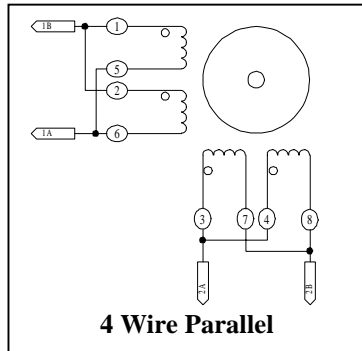   Inductance = 4.4 mH

The power per winding is:
  I^2R or 1 x 1 x 4= 4 watts,
  x 4 coils = 16 watts total for this motor.

A Basic 8 Wire 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:
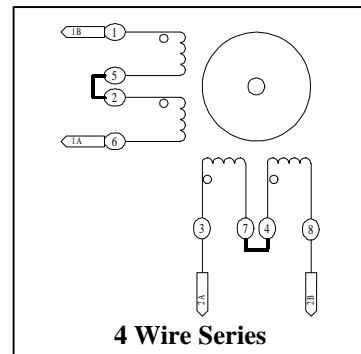
    Parallel Resistance= 2 ohms
    Parallel Inductance= 2.2 mH
    Current = 2 amps @4 volts or 8 VA
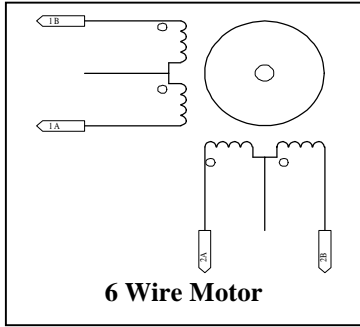   Watts per phase= 8VA (x 2 phases) = 16 watts total

B. 4 Wire Series
Changing to a series design, we have two pairs of two coils connected in series. Each has:

    Series Resistance= 8 ohms
    Inductance= 17.5 mH
    The rated current is now 1 amp (8 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 a 4-wire series motor.

    Series Resistance= 4 ohms

    Inductance= 17.5 mH

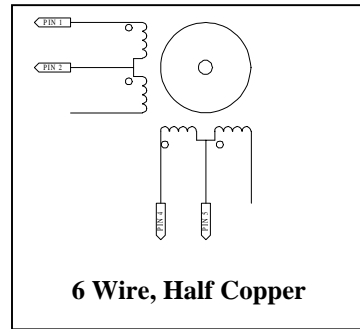   Rated current= 1 amp (8 volts)

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.

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

6 Wire, Half Copper

voltages in excess of 10 volts. This means that 20 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 voltage rating. The minimum recommended value for Vmm (DC supply) is 3 times the winding rating (the higher the better, until excessive heating occurs or insulation breakdown).

Summary

# Leads	Winding Connection	Per Phase Bipolar Current	
		Full Step (Total)	Micro step (Peak)
4 wire	Parallel	2.0A (4.0A)	2.8A
4 wire	Series	1A (2.0A)	1.4
6 wire	Unipolar	1.4A per phase	NA
6 wire	Series	1A (2.8A)	1.4A
6 wire	50% Copper	1.4A (8A)	2

- 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.

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.

More voltage applied to the motor equals more watts into the motor, resulting in additional heating. Motor heating can accumulate at continuous high stepping speeds, load torque and supply voltages of over 40 volts. Methods of reducing heating include motor heat sinking and short duty cycle (with a reduced holding current).

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.

Full and Half Step Operating Current

The DR-38 can sequence winding currents to produce two different resolutions.

Resolution	Advantages	Disadvantages	Current Setup
Full Step	Highest torque	More resonance's, noisy operation, large steps can be jumpy.	100%
Half Step	High torque	Less resonance and noise, smoother operation.	100%

Motor output torque is proportional to the current settings. Many applications do not require full current for reliable operation. You should use lower currents (if possible) for quieter operation with less resonance.

Current Setup for DR-38

The DR-38 incorporates two DMOS full-bridge power driver I.C.'s rated at 4 amps each. The chopper drive circuitry operates at approximately 20 Khz. Current sense resistors are used to regulate the current in each of the two windings. This feedback attempts to maintain a constant motor winding current, compensating for variations of power supply voltage, motor resistance, motor step rate, etc.

The basic setup technique involves the following steps:

1. Insert a current meter in series with one winding (the second winding is optional). Most AC amp-meters are designed to measure 60 Hz current and will produce reading errors in these 20 Khz + frequency-switching circuits, therefore, a separate bridge rectifier circuit is necessary.

2. Set both SIN and COS potentiometers to a safe, low (CCW) position, especially when using low current motors.

3. The output drive electronics must be set for peak current. The following conditions must be noted:
   A. The drive outputs must be enabled, without any current reduction (100% holding).
   B. The step controller must command equal currents for both winding.
   C. Each product may have slight variations in their design.

The specific procedure to set both phases to 100% on the DR-38 uses the following setup for all current adjustment methods:
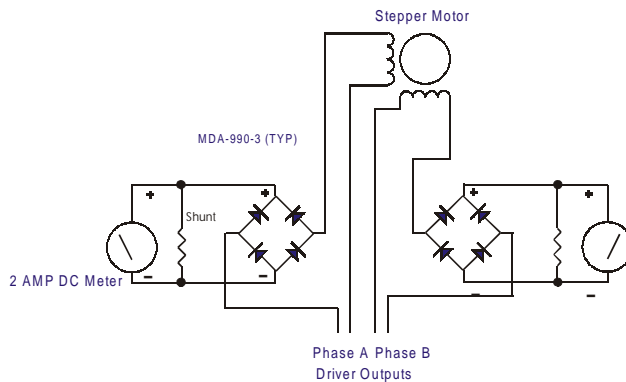
Setup
Remove any jumpers or connections from JP1 and J1. On power-up, both phases will be commanded to 100% current and adjustments may be made. The DR-38 will be in half step mode and can be stepped (any stepping can cause the current to vary from being equal).

Dual Meter Setup for Current Calibration (Best Method)
Using two meters is the best method because both phases can be observed at once. One can see the currents change, relative to one another, when stepping at a slow speed.

The following is the basic setup and diagram for two-phase current measurement:
1. The Amp meter can be digital or (preferably) analog.
2. The bridge rectifier must be rated above the maximum expected voltage and current.
3. A small capacitor (filter) may be needed across the meter.
4. Two meters will indicate proper operation.
5. Additional meter protection circuitry may be desired (not shown).

Single Meter Method

Here only one of the Amp meter circuits is used. After power is applied, (both windings at 100%) the metered phase is adjusted to the desired current. Next, the unmeasured phase is adjusted until the balance LED just changes ON/OFF. At this point both phases are equal.

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