User's Manual

5560

## Step Motor Driver
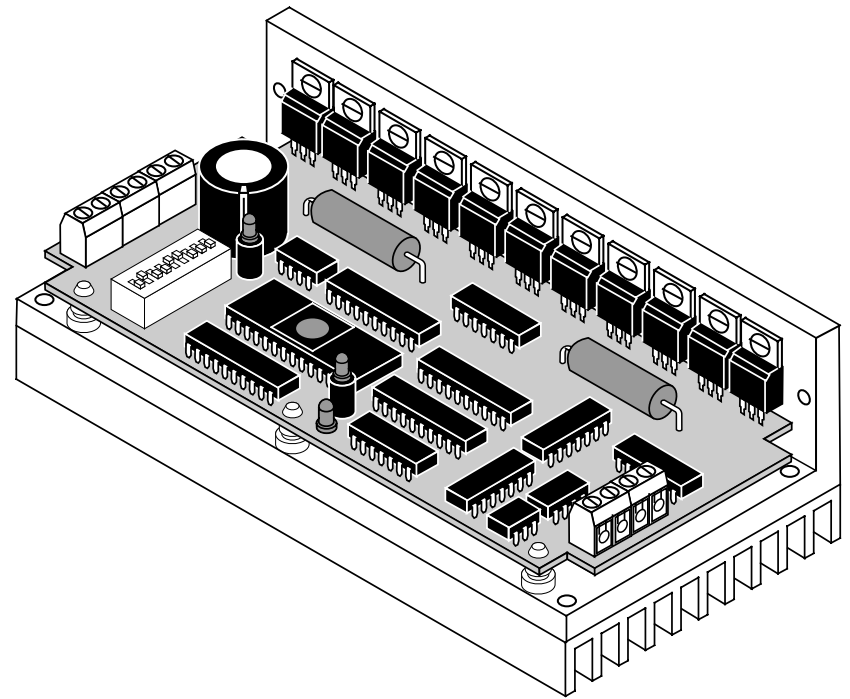
REVISION
LEVEL
E

Applied Motion Products

motors • drives • controls

Technical Specifications

Amplifiers Dual, MOSFET H-bridge, 3 state, pulse width modulated switching at 20 kHz. 24-60 VDC input. 1.0 - 5.5 amps/phase output current, switch selectable in 0.3 amp increments. 330 watts maximum output power. Overcurrent, overvoltage and overtemperature protection. Automatic idle current reduction (defeatable), reduces current to 50% of setting after one second.

Inputs Step, direction and enable, optically isolated, 5V logic. 5mA/signal, sink requirement. Motor steps on falling edge of step input. 1 µsec minimum pulse width, 250 kHz max step rate. 2 µsec minimum set up time for direction signal.

Microstepping 16 switch selectable resolutions. Steps per revolution with 1.8˚ motor: 200, 400, 800, 1000, 1600, 2000, 3200, 4000, 5000, 6400, 8000, 9000, 10000, 12000, 12700, 12800. Waveform: pure sine standard. Other waveforms available upon request. Other resolutions available upon request up to the sequencer limit of 12800 steps per revolution.

Physical Mounted on 1/4 inch thick black anodized aluminum heatsink/chassis.   2 x 3 x 6 inches overall. Power on and fault indicators. See drawing on page 14 for more information. Maximum chassis temperature: 70˚C.

Connectors European style screw terminal blocks.
Motor: 4 position
DC Input: 2 position
Signal Input: 4 position
Max. wire size: AWG 18

Fuse Wickman 5 amp time lag, TR-5 style. Order from Digikey (1-800-DIGIKEY) part number WK3063.

Mechanical Outline

6x Ø.170

0.150" 2.45" 2.00"

5.70" 6.00" 5.70"

.720"
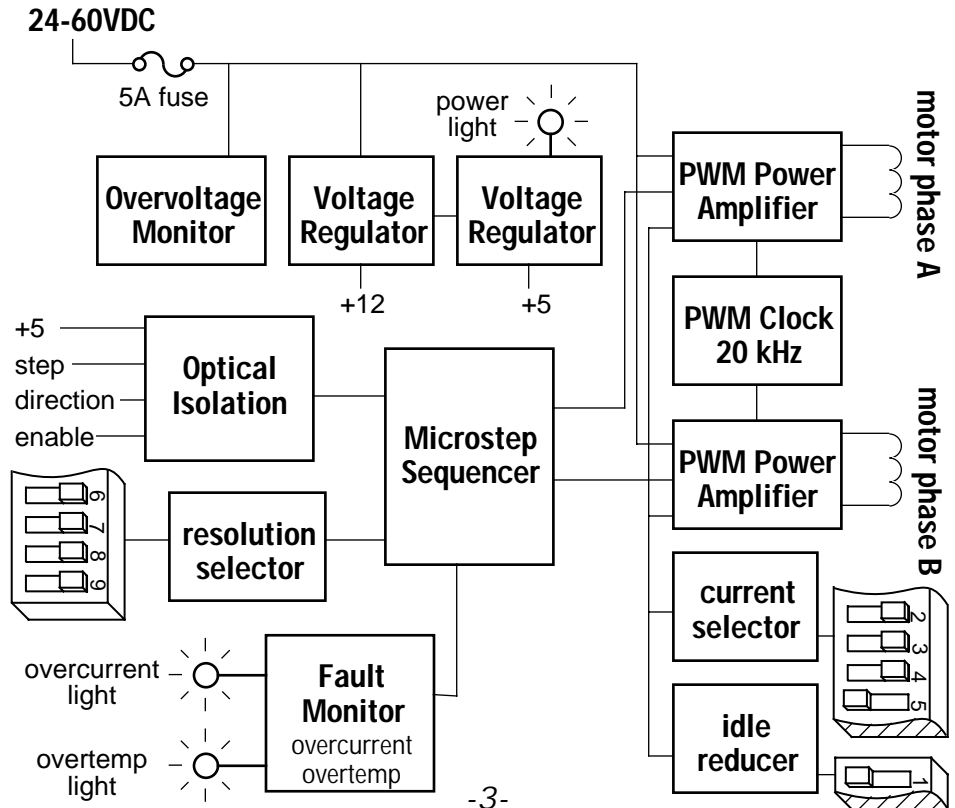
3.00" 0.25"

1.345" 0.15"
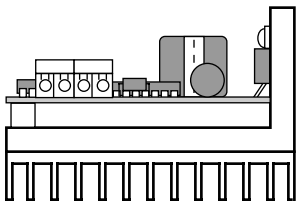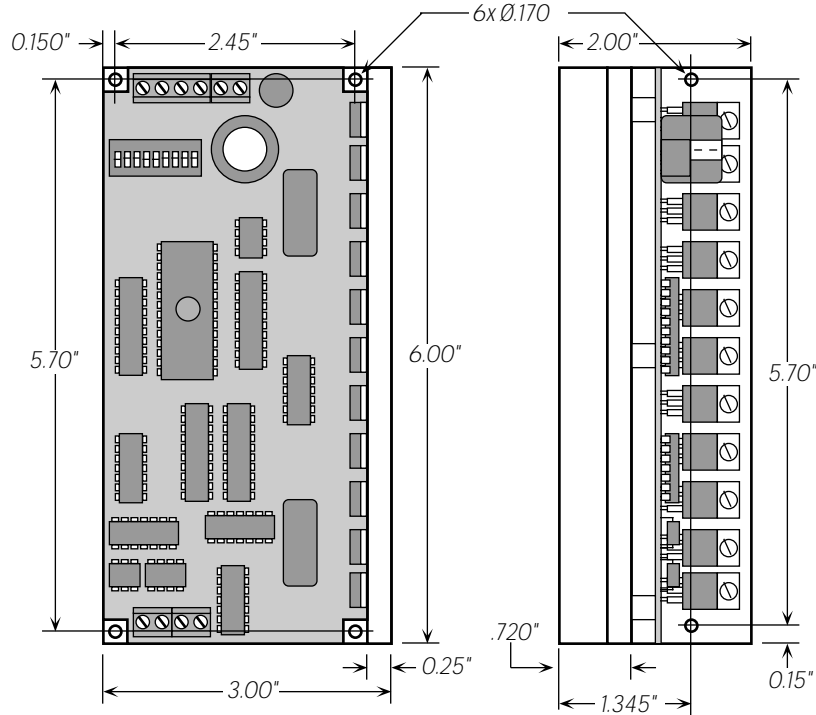
Introduction

Thank you for selecting an Applied Motion Products motor control. We hope our dedication to performance, quality and economy will make your motion control project successful. If there's anything we can do to improve our products or help you use them better, please call or fax. We'd like to hear from you. Our phone number is (800) 525-1609 or you can reach us by fax at (831) 761-6544.

Features

- Drives NEMA sizes 14 through 42 step motors
- MOSFET pulse width modulation switching amplifiers (3 state)
- Phase current from 1.0 to 5.5 amps/phase (switch selectable, 16 settings)
- Step, direction and amplifier enable inputs, optically isolated
- Microstepping from full step through 1/ 64 (switch selectable, 16 settings)
- Overvoltage, overtemp and overcurrent (short circuit) protection
- Idle current reduction (50% or 0%, switch selectable)

Block Diagram

24-60VDC
5A fuse
power light
+12 +5
+5
step
direction
enable
Optical Isolation
Overvoltage Monitor
Voltage Regulator
Voltage Regulator
PWM Power Amplifier
PWM Clock 20 kHz
PWM Power Amplifier
Microstep Sequencer
resolution selector
current selector
idle reducer
overcurrent light
overtemp light
Fault Monitor
overcurrent overtemp
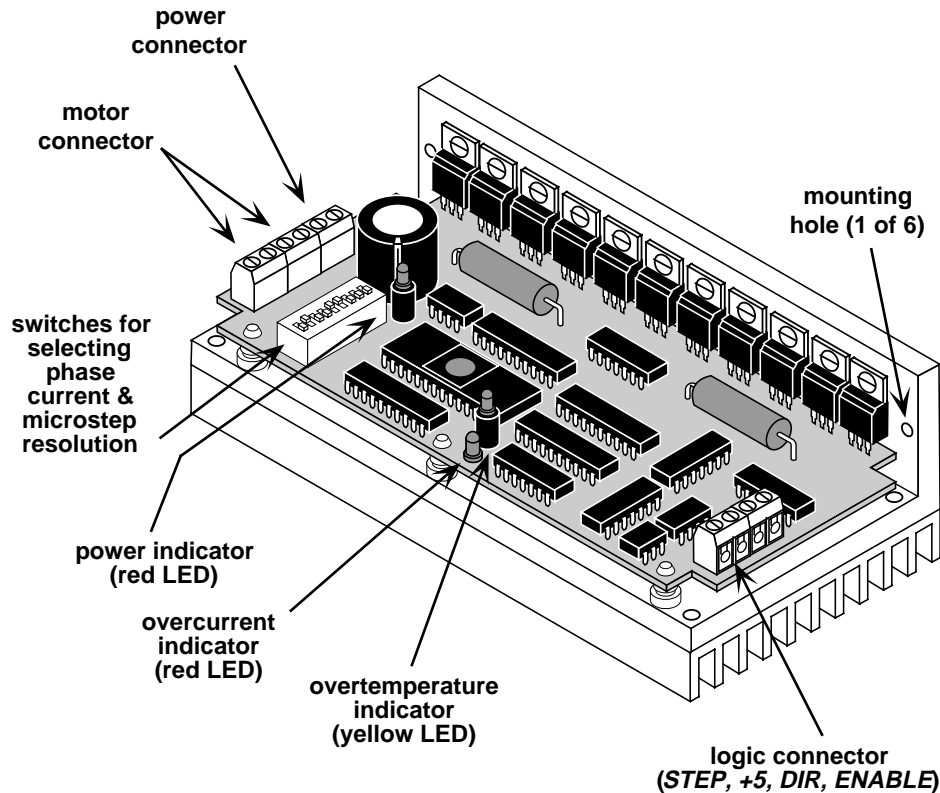motor phase A
motor phase B

Getting Started

To use your Applied Motion Products motor control, you will need the following:

- a 24-60 volt DC power supply for the motor. Please read the section entitled *Choosing a Power Supply* for help in choosing the right power supply.
- +5 volts DC, 15mA to activate the optoisolation circuits.
- a source of step pulses capable of sinking at least 5 mA
- if your application calls for bidirectional rotation, you'll also need a direction signal, capable of sinking 5 mA
- a compatible step motor
- a small flat blade screwdriver (1/8", 3/16" or 3 mm) for tightening the connectors

The sketch below shows where to find the important connection and adjustment points. Please examine it now.

power connector

motor connector

switches for selecting phase current & microstep resolution

power indicator (red LED)

overcurrent indicator (red LED)

overtemperature indicator (yellow LED)

mounting hole (1 of 6)

logic connector (*STEP, +5, DIR, ENABLE*)

Choosing a Power Supply

We recommend using an Applied Motion Products power supply with this drive. Two models are available: the PS430 (30 volts DC at 4 amps) and the PS1050 (50 volts DC at 10 amps). The PS430 can also provide 500 mA of well regulated 5 volt power for your logic circuits. If you do not choose an A.M.P. supply, please follow the recommendations below.

Voltage

Chopper drives like the 5560 work by switching the voltage to the motor terminals on and off while monitoring current to achieve a precise level of phase current. To do this efficiently and silently, you'll want to have a power supply with a *voltage rating at least five times that of the motor.* Depending on how fast you want to run the motor, you may need even more voltage than that. If you choose an unregulated power supply, do not exceed 40 volts. This is because unregulated supplies are rated at full load current. At lesser loads, like when the motor's not moving, the actual voltage can be up to 1.4 times the rated voltage. For smooth, quiet operation, a lower voltage is better.

Current

The maximum supply current you could ever need is the sum of the two phase currents. However, you will generally need a lot less than that, depending on the motor type, voltage speed and load conditions. That's because the 5560 uses switching amplifiers, converting a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current you'll need from the power supply. A motor running from a 48 volt supply can be expected to draw only half the supply current that it would with a 24 volt supply.

We recommend the following selection procedure:

1. If you plan to use only a few drives, get a power supply with at least twice the rated phase current of the motor.

2. If you are designing for mass production and must minimize cost, get one power supply with more than twice the rated current of the motor. Install the motor in the application and monitor the current coming out of the power supply and into the drive at various motor loads. This will tell you how much current you really need so you can design in a lower cost power supply. If you plan to use a regulated power supply you may encounter a problem with current fold back. When you first power up your drive, the full current of both motor phases will be drawn for a few milliseconds while the stator field is being established. After that the amplifiers start chopping and much less current is drawn from the power supply. If your power supply thinks this initial surge is a short circuit it may "fold back" to a lower voltage. Because of that, unregulated power supplies are better. They are also less expensive.

Fault Protection

The 5560 provides protection against excessive power supply voltage, reversed power supply polarity, motor short circuits and excessive drive temperature. Under normal operation, you should see one red light, the power light.

If you see no lights either the fuse is blown or you do not have power applied to the drive. If the fuse blows either the + and - leads to the power supply are reversed or the power supply voltage exceeded 62 VDC. If the power supply is on and the power indicator is not, the fuse on the 5560 drive has blown. First check to see that the wires connecting the power supply to the drive are not reversed. If they are not reversed, measure the power supply voltage. You should use an oscilloscope for this, because short spikes may not show up on a simple voltmeter. Such spikes can be damaging to the 5560 and will trigger the overvoltage protection resulting in a blown fuse.

If you see two red lights the 5560 has detected an overcurrent condition and shut down the amplifiers. The first thing you should do is switch the power supply off. Check the motor wiring carefully. Make sure that the connections to the drive are secure and that any unused motor leads are insulated from the drive and power supply and from each other. Check the motor leads for shorts between phases or shorts to ground.

If you see one red light and one yellow light the 5560 has overheated. This means you need more air flow around the drive or additional heat sinking.

Mounting the Drive

You can mount your drive on the wide or the narrow side of the chassis. If you mount the drive on the wide side, use #6 screws through the four corner holes. For narrow side mounting applications, you can use #6 screws in the two side holes.

wide side
mounting holes

narrow side
mounting holes
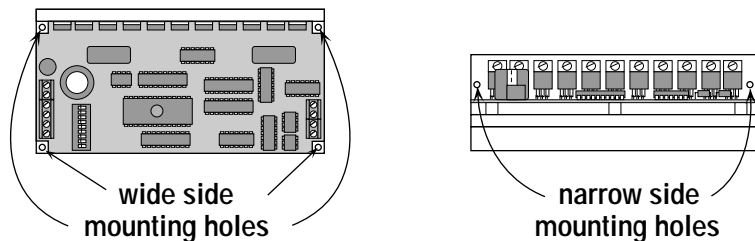
The amplifiers in the 5560 generate heat. To operate the drive continuously at maximum power you may need additional heat sinking or forced air cooling. Never use your drive in a space where there is no air flow or where other devices cause the surrounding air to be more than 70˚C. Never put the drive where it can get wet or where metal particles can get on it.

Connecting the Power Supply

If you need information about choosing a power supply, please read *Choosing a Power Supply* located in the back of this manual.

Connect the motor power supply **+** terminal to the driver terminal labeled "**+V**". Connect power supply **–** to the drive terminal labeled "**V–**." Use 18 gauge wire. **Be careful not to reverse the wires.**

DC Power Supply

5560 Drive
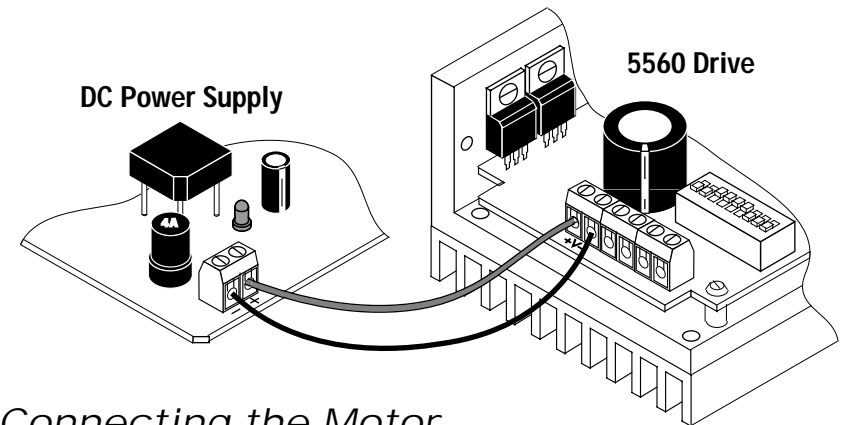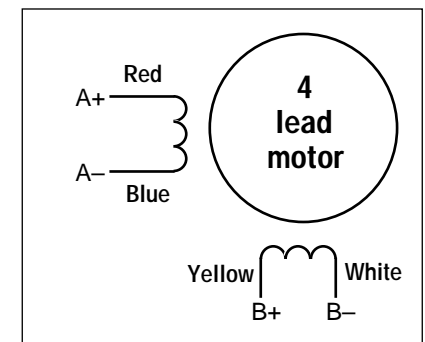
Connecting the Motor

When connecting the motor to the driver, be sure that the motor power supply is off. Secure any unused motor leads so that they can't short out to anything. Never disconnect the motor while the drive is powered up. Never connect motor leads to ground or to a power supply!
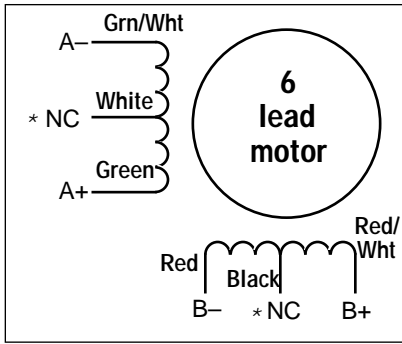
You must now decide how to connect your motor to the drive. The lead colors shown are for Applied Motion Products motors.

Four lead motors can only be connected one way. Please follow the sketch at the right.
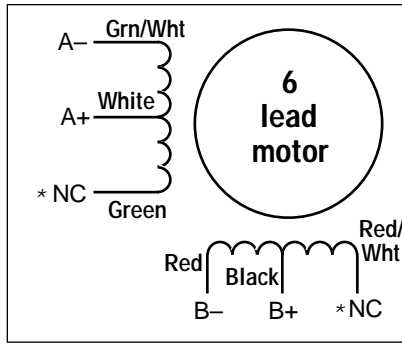
Six lead motors can be connected in series or center tap. In series mode, motors produce more torque at low speeds, but cannot run as fast as in the center tap configuration. In series operation, the motor should be operated at 30% less than the rated current to prevent overheating. Winding diagrams for both connection methods are shown on the next page.
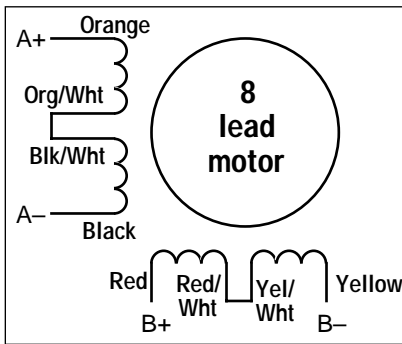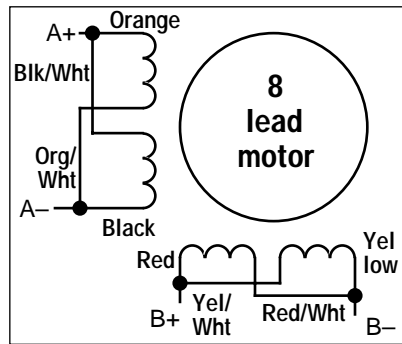

A+ Red

A– Blue

4 lead motor

Yellow B+ White B–

4 Leads

6 Lead Motor Diagrams

6 Leads Series Connected

A− Grn/Wht
* NC White
A+ Green

6 lead motor

Red Black Red/Wht
B− * NC B+

6 Leads Center Tap Connected

A− Grn/Wht
A+ White
* NC Green

6 lead motor

Red Black Red/Wht
B− B+ * NC

* NC = not connected to anything.

Eight lead motors can also be connected in two ways: series and parallel. As with six lead motors, series operation gives you more torque at low speeds and less torque at high speeds. In series operation, the motor should be operated at 30% less than the rated current to prevent over heating. The wiring diagrams for eight lead motors are shown below.

8 Leads Series Connected

A+ Orange
Org/Wht
Blk/Wht
A− Black

8 lead motor

Red Red/Wht Yel/Wht Yellow
B+ B−

8 Leads Parallel Connected

A+ Orange
Blk/Wht
Org/Wht
A− Black

8 lead motor

Red Yellow
Yel/Wht Red/Wht
B+ B−

Step Table
(full stepping)

Step	A+	A-	B+	B-
0	+	−	+	−
1	−	+	+	−
2	−	+	−	+
3	+	−	−	+
4	+	−	+	−

DIR=0 (0V) CW

DIR=1 (5V) CCW

Step 3 is the Power Up State

Selecting Microstep Resolution

200 STEPS/REV (FULL)	STEP MODE	**5000 STEPS/REV (1/25)**	STEP MODE
400 STEPS/REV (HALF)	STEP MODE	**6400 STEPS/REV (1/32)**	STEP MODE
800 STEPS/REV (1/4)	STEP MODE	**8000 STEPS/REV (1/40)**	STEP MODE
1000 STEPS/REV (1/5)	STEP MODE	**9000 STEPS/REV (1/45)**	STEP MODE
1600 STEPS/REV (1/8)	STEP MODE	**10000 STEPS/REV (1/50)**	STEP MODE
2000 STEPS/REV (1/10)	STEP MODE	**12000 STEPS/REV (1/60)**	STEP MODE
3200 STEPS/REV (1/16)	STEP MODE	**12700 STEPS/REV (1/63.5)**	STEP MODE
4000 STEPS/REV (1/20)	STEP MODE	**12800 STEPS/REV (1/64)**	STEP MODE

Idle Current Reduction

Your drive is equipped with a feature that automatically reduces the motor current by 50% anytime the motor is not moving. This reduces drive heating by about 50% and lowers motor heating by 75%. This feature can be disabled if desired so that full current is maintained at all times. This is useful when a high holding torque is required. To minimize motor and drive heating we highly recommend that you enable the idle current reduction feature unless your application strictly forbids it. Idle current reduction is enabled by sliding switch #2 toward the *50% IDLE* label, as shown in the sketch below. Sliding the switch away from the *50% IDLE* label disables the reduction feature.

Idle Current Reduction Selected

No Current Reduction

Microstepping

Most step motor drives offer a choice between full step and half step resolutions. In full step mode, both motor phases are used all the time. Half stepping divides each step into two smaller steps by alternating between both phases on and one phase on. Microstepping drives like the 5560 precisely control the amount of current in each phase at each step position as a means of electronically subdividing the steps even further. The 5560 offers a choice of full and half step as well as 14 other step resolutions. The highest setting divides each full step into 64 microsteps, providing 12,800 steps per revolution when using a 1.8° motor. In addition to providing precise positioning and smooth motion, microstep drives can be used for motion conversion between different units. The 12,700 step/rev setting is provided as a means of converting motion from metric to english. (There are 12.7 mm in a half inch.) Other settings provide step angles that are decimal degrees (12,000 steps/rev makes the motor take 0.030˚ steps.) Some settings are used with lead screws. When the drive is set to 2000 steps/rev and used with a 5 pitch lead screw, you get .0001 inches/step. Other resolutions are also possible. We can provide an alternate ROM that will allow settings such as 1° or 2° per step.

Connecting Logic

The 5560 contains optical isolation circuitry to prevent the electrical noise inherent in switching amplifiers from interfering with your circuits. Optical isolation is accomplished by powering the motor driver from a different supply than your circuits. There is no electrical connection between the two: signal communication is achieved by infrared light. When your circuit turns on or turns off an infrared LED (built into the drive) it signals a logic state to the phototransistors that are wired to the brains of the drive.

A schematic diagram of the input circuit is shown below.

You must supply 5 volts DC to activate the LEDs on the input side of the optoisolators. The maximum current draw is 15 mA.

Your controlling logic must be capable of sinking at least 5 mA to control each drive input. Most CMOS and open collector TTL devices are directly compatible with this drive. Logic low, or 0, for a given input occurs when that input is pulled to less than 0.8 volts DC. In this state the LED is conducting current. Logic high, or 1, occurs when the input is greater then 4 volts or open.
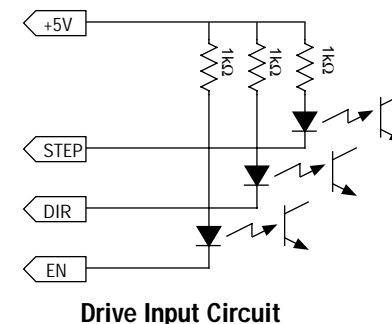
Drive Input Circuit

STEP tells the driver when to move the motor one step. The drive steps on the falling edge of the pulse. The minimum pulse width is 1 microsecond.

DIRECTION signals which way the motor should turn. See the step table on page 6 for details. The *DIRECTION* signal should be changed at least 2 microseconds before a step pulse is sent. **If you change the state of the direction input and send a step pulse at the same instant the motor may take a step in the wrong direction.**

ENABLE allows the user to turn off the current to the motor by setting this signal to logic 0. The logic circuitry continues to operate, so the drive "remembers" the step position even when the amplifiers are disabled. However, the motor may move slightly when the current is removed depending on the exact motor and load characteristics. **If you have no need to disable the amplifiers, you don't need to connect anything to the *ENABLE* input.**

Setting Phase Current

Before you turn on the power supply the first time, you need to set the driver for the proper motor phase current. The rated current is usually printed on the motor label. The current you set on the 5560 is the peak current, not RMS.

The 5560 drive current is easy to set. If you wish, you can learn a simple formula for setting current and never need the current table again. Or you can skip to the table on the next page, find the current setting you want, and set the DIP switches according to the picture.
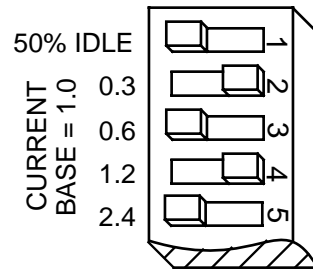
Current Setting Formula

Locate the bank of tiny switches near the motor connector. Four of the switches have a value of current printed next to them, such as 0.3 and 1.2. Each switch controls the amount of current, in amperes (A), that its label indicates. There is always a base of current of 1.0 A. To add to that, slide the appropriate switches toward their labels. You may need your small screwdriver for this.

Example

Suppose you want to set the driver for 4 amps per phase. You need the 1 A base current plus another 2.4 and 0.6 A.

4.0 = 1.0 + 2.4 + 0.6

Slide the 1.2 and 0.6 A switches toward the labels as shown in the figure.

Current Setting Table