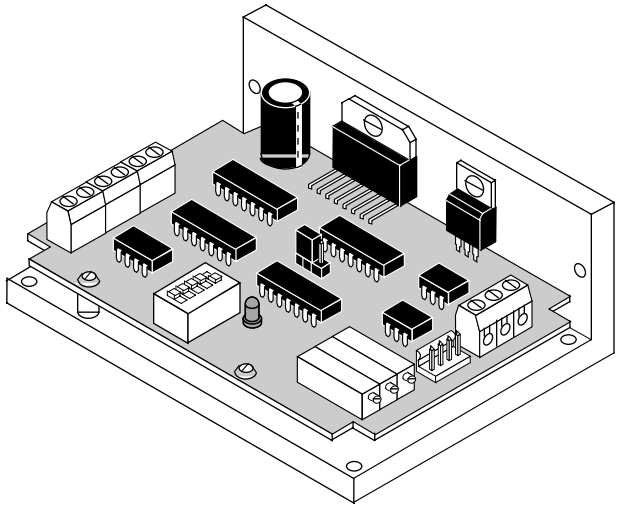
3/20/97

User's Manual

2035

2035 O

Step Motor Drivers



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Applied Motion Products

motors • drives • controls

Choosing a Power Supply

Voltage

Chopper drives 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 atleast five times that of the motor. Depending on how fast you want to run the motor, you may need even more voltage than that. More is better, the only upper limit being the maximum voltage rating of the drive itself: 35 volts. If you choose an unregulated power supply, do not exceed 24 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.

Current

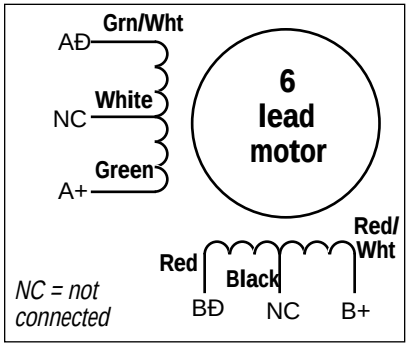
The maximum supply current you will need is the sum of the two phase currents. However, you will generally need a lot less than that, depending on the motor type, voltage speed and load conditions. That's because the 2035 and 2035 O use switching amplifiers, converting a high voltage and low current 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.

We recommend the following selection procedure:

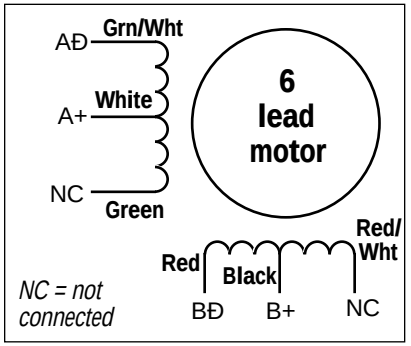
1. If you plan to use only a few drives, get a power supply with at least twice the rated phase current of the motor.

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 foldback. 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 "foldback" to a lower voltage. With many foldback schemes the voltage returns to normal only after the first motor step and is fine thereafter. In that sense, unregulated power supplies are better. They are also less expensive.

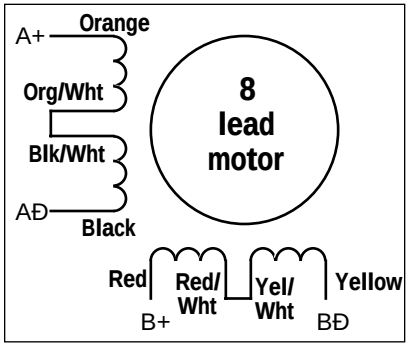


6 Leads Series Connected

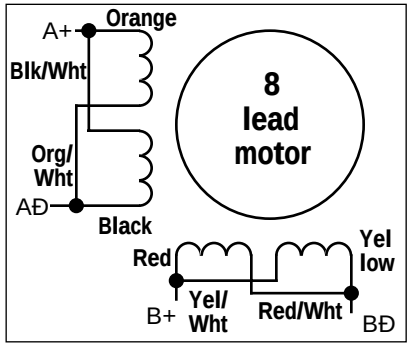


6 Leads Center Tap Connected

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



8 Leads Parallel Connected

Step Table
(full stepping)

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

DIR=1 cw ↓ ↑ **DIR=0 ccw**

Step 3 is the Power Up State

Introduction

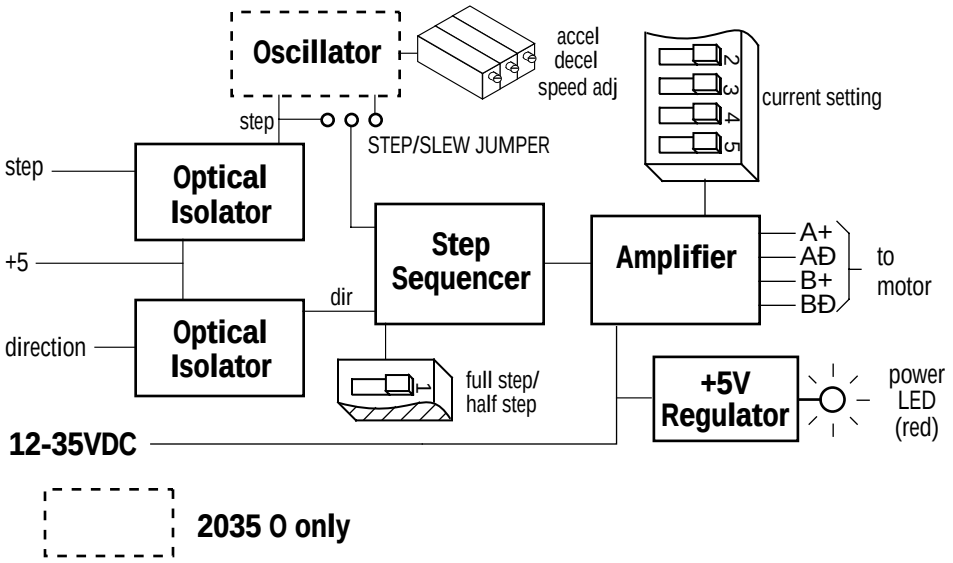
Thank you for selecting an Applied Motion Products motor control. We hope our dedication to performance, quality and economy will make your motion control project successful.

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 (408) 761–6544.

Features

- Drives sizes 14 through 23 step motors. Can also be used in some cases to drive size 34 motors.
- Pulse width modulation switching amplifiers
- Phase current from 0.125 to 2.0 amps (switch selectable, 16 settings)
- Step and direction inputs, optically isolated
- Full and half step (switch selectable)
- Automatic 50% idle current reduction
- Built in ramping pulse generator with adjustable speed, accel, decel (2035 O) 0 - 5000 Hz

Block Diagram



Technical Specifications

Amplifiers Dual, bipolar H-bridge, pulse width modulated switching at 20 kHz. 12-35 VDC input. 0.125 - 2.0 amps/phase output current, switch selectable in 0.125 A increments. 70 watts maximum output power. Automatic idle current reduction, reduces current to 50% of setting after one second.

Oscillator (O suffix) 0 to 5000 steps per second. Linear acceleration and deceleration, individually adjustable from 5 to 900 msec.

Inputs Step and direction, optically isolated, 5V logic. 5 mA/signal, sink requirement. Motor steps on rising edge of step line. 10 µsec minimum low pulse. 50 µsec minimum set up time for direction signal. Step input doubles as run/stop in oscillator mode. (0 = run, 1 = stop.)

Physical Mounted on 1/4 inch thick black anodized aluminum heat transfer chassis. 1.5 x 3.0 x 4.0 inches overall. Power on LED. See drawing on page 14 for more information. Maximum chassis temperature: 70° C. Weight: 9 ounces (250 g)

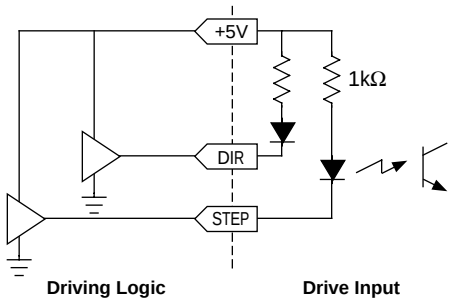
Connectors European style screw terminal blocks. Motor: 4 position. Signal Input: 3 position. DC Input: 2 position.

Connecting Logic

The 2035 and 2035 O drives contain 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.

Connect your logic circuitry to the signal connector as shown in the sketch at the right. Even though the drive provides it's own 5 volt logic power, you must supply 5 volts DC at 10 mA to activate the LEDs on the input side of the optoisolators.



Your logic must be capable of sinking at least 5 mA to control the drive. Most CMOS and open collector TTL devices are directly compatible with this drive. If you are using open collector outputs, no pull up resistor is necessary.

The driver will step on the positive going edge of the step pulse. Minimum pulse width is 10 µsec.

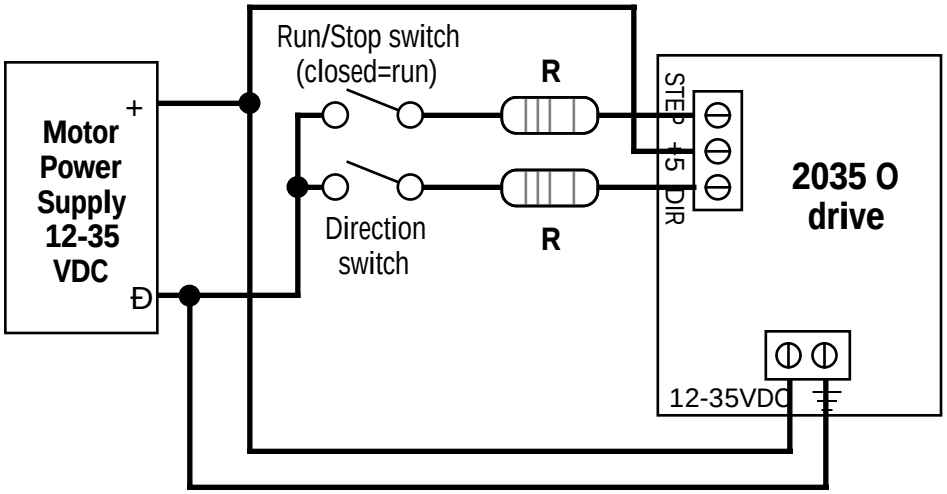


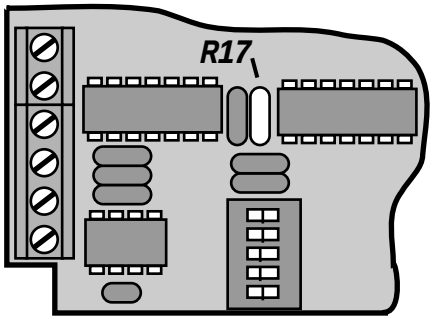
Table I: External Dropping Resistors					
Supply Voltage	**R Ohms**	**Supply Voltage**	**R Ohms**	**Supply Voltage**	**R Ohms**
12	1200	21	3000	30	4700
15	1800	24	3600	33	5100
18	2400	27	4200	35	5600

Idle Current Reduction

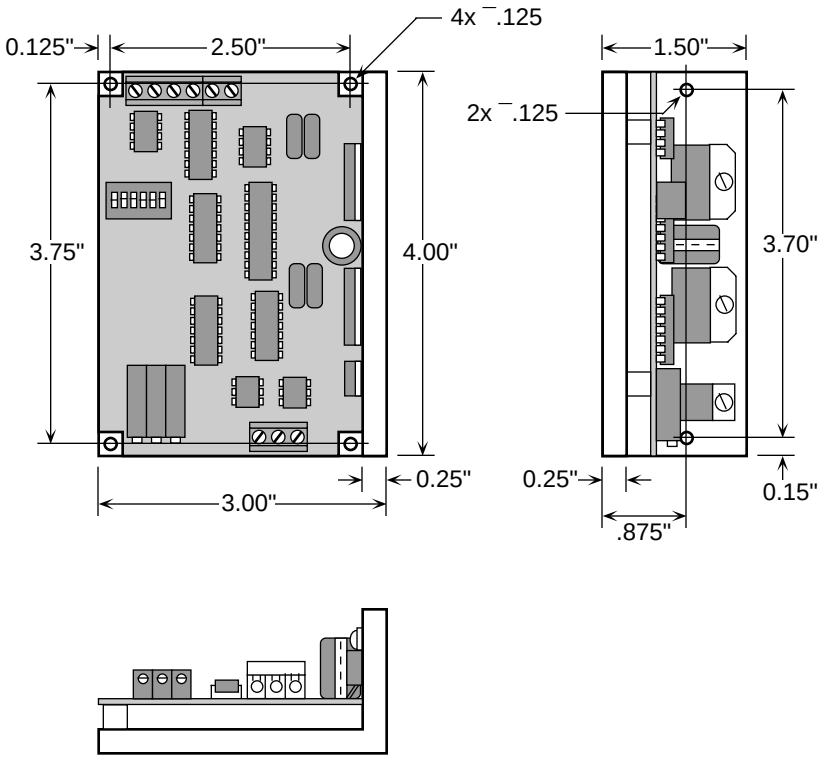
The 2035 and 2035 O drives include a feature that automatically reduces the motor current by 50% when the motor is not moving. This is known as idle current reduction.

For qualifying OEMs, we can change the amount of current reduction during the manufacturng process. This is accomplished by changing the value of resistor R17.

If you desire 100% current reduction (i.e. no motor current when idle), simply remove R17 by clipping off each end with wire cutters. If you want full current all the time, you can short out R17 by soldering a wire from one end to the other. ***However, soldering anywhere on the drive voids the warranty.*** The location of R17 is shown on the right.



Mechanical Outline

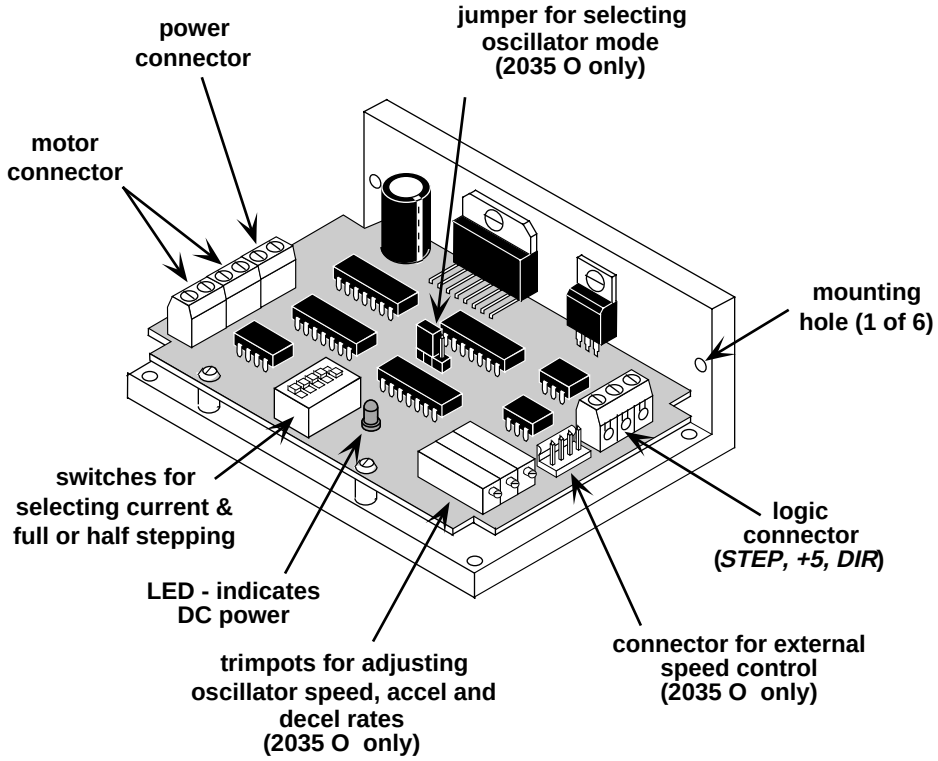


Getting Started

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

- a 12-35 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, 10mA to activate the optoisolation circuits (if you are using an *O* drive and don't have 5V available, see page 11.)
- 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 for tightening the connectors and adjusting the oscillator

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

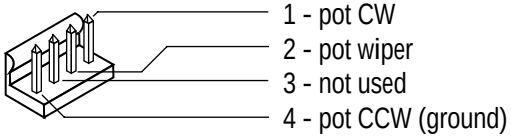


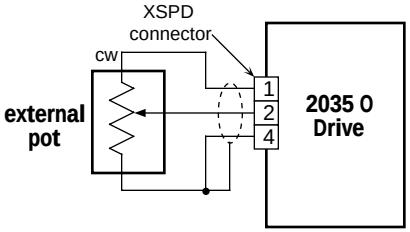
To install the external pot:

• locate the connector on the 2035 O labelled "XSPD." It can be found between the signal connector and the three blue potentiometers.
• remove the jumper from the XSPD connector. That disconnects the on board pot.
• prepare a cable with your pot on one end and the connector on the other end:

- ➤ the potentiometer wiper connects to pin 2
- ➤ the potentiometer CW terminal connects to pin 1
- ➤ the third pot terminal connects to pin 4
- ➤ the cable shield connects to the third pot terminal

With this arrangement, speed will increase as you turn the external pot clockwise. The frequency range will be 0 to 5000 steps per second.
The on board trimpots will still control acceleration and declerations times. Turning the pots clockwise makes the acceleration and deceleration faster (i.e. reduces the time to or from speed).





Using Mechanical Switches with 2035 O Drive

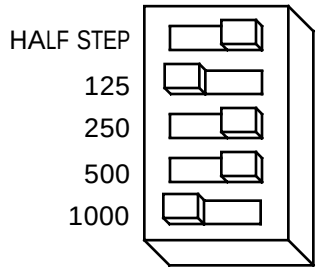
The 2035 O was designed to be used with active logic and for that reason are optically isolated. To activate the optoisolators a small, but not insignificant amount of current at +5 volts DC is required.

In some applications, step motors and drives are used with mechanical switches only and there is no readily available source of +5 volts.

In these instances, the 12-35 VDC motor power supply can be used with additional dropping resistors to power the opto LEDs. The recommended wiring diagram is shown on page 11. Table I lists the appropriate resistor value to use for a given power supply voltage. 1/4 watt or larger resistors should be used.

Please take care not to reverse the wiring, as damage to the LEDs will result rendering the drives inoperable. Check your wiring carefully before turning on the power supply!

Selecting Between Full and Half Step Operation



Locate the bank of tiny switches near the motor connector. The switch farthest from the edge of the circuit board is labeled *HALF STEP*. Sliding the switch toward the *HALF STEP* label sets the driver for that mode of operation. The opposite position is full step. When set to full step, the driver always uses "two phases on" mode to provide maximum motor torque.

Setting Phase Current

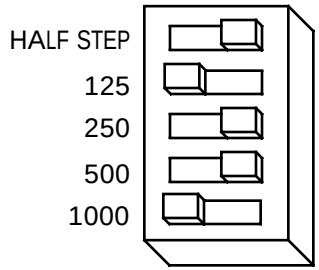
Before you turn on the power supply the first time, you need to set the driver for the proper motor phase current. The rated current is usually printed on the motor label.

The 2035 drive current is easy to set. If you wish, you can learn a simple formula for setting current and never need the manual 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 500 and 1000. Each switch controls the amount of current, in milliamperes (mA), that it's label indicates. There is always a base of current of 125 mA. To add to that, slide the appropriate switches toward their labels. You may need your small screwdriver for this.

Example



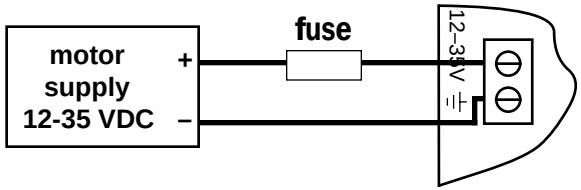
Suppose you want to set the driver for 1.25 amps per phase (1250 mA). You need the 125 mA base current plus another 1000 and 125 mA.
1250 = 125 + 1000 +125
Slide the 125 and 1000 mA switches toward the labels as shown in the figure.

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.

If you're power supply does not have a fuse on the output or some kind of short circuit current limiting feature you need to put a 3 amp slow blow fuse between the drive and power supply. Install the fuse on the **+** power supply lead.

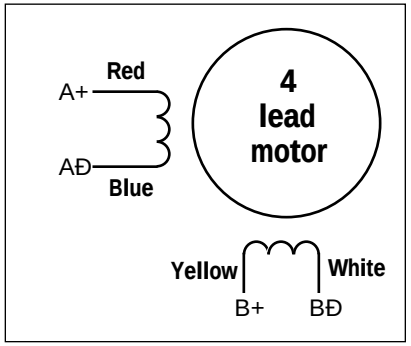
Connect the motor power supply **+** terminal to the driver terminal labeled "**12–35VDC**". Connect power supply **–** to the drive terminal labeled with the ground symbol: ⏚ . Use no smaller than 20 gauge wire. **Be careful not to reverse the wires.** Reverse connection will destroy your driver, void your warranty and generally wreck your day.



Connecting the Motor

Warning: 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.



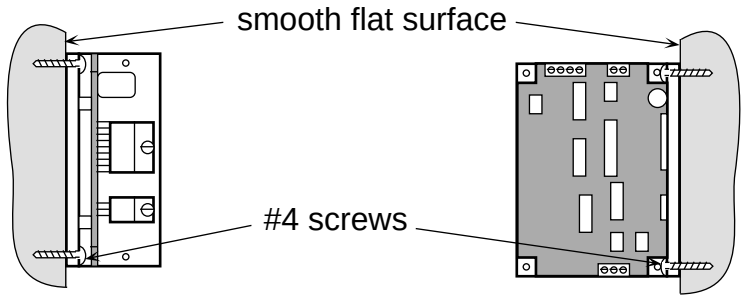
4 Leads

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

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 #4 screws through the four corner holes. For narrow side mounting applications, you can use #4 screws in the two side holes.



wide side mount **narrow side mount**

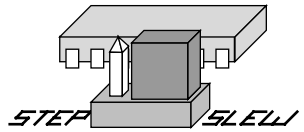
The amplifiers in the drive generate heat. Unless you are running at 1 amp or below, you may need a heat sink. To operate the drive continuously at maximum power you must properly mount it on a heat sinking surface with a thermal constant of no more than 4 °C/watt. Applied Motion Products can provide a compatible heat sink. Often, the metal chassis or enclosure of your system will work as an effective heat sink.

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 50 °C. Never put the drive where it can get wet or where metal particles can get on it.

Current Setting Table

.125 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.125 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.25 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.25 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.375 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.375 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.5 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.5 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.625 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.625 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.75 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.75 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
.875 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1.875 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
1 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5
2 **AMPS/PHASE**	CURRENT BASE = 125mA	125	250	500	1000	2	3	4	5

Using the Oscillator



Drives with an O suffix are equipped with internal pulse generators that you can use to drive the motor. To set the drive to oscillator mode, simply find the jumper located near the center of the printed circuit board and move it to the SLEW setting. The figure at the right shows the proper setting of the jumper.

The oscillator is activated by driving the *STEP* input low. The frequency of step pulses will increase linearly, accelerating the motor until it reaches a preset speed. The motor will remain at this speed until the *STEP* input is driven high. The step pulse frequency then decreases linearly, decelerating the motor and load to rest.

To change the slew speed, locate the trimpot labeled *SPEED*. By turning the brass screw you can raise or lower the speed within a range of 0 to 5000 steps per second. Turning the screw clockwise makes the motor run faster.

The acceleration and deceleration rates can also be adjusted using the trimpots labeled *ACCEL* and *DECEL*. The range of accel and decel time is 5 to 900 milliseconds. Turning the screw clockwise makes the motor accelerate of decelerate faster.

You can check the exact speed by connecting a high impedance device (like an oscilloscope or frequency counter) to the middle pin of the STEP/SLEW header.

Do not leave any external device permanently connected to the STEP/SLEW header or erratic operation may result due to electrical noise. The middle pin of the STEP/SLEW header connects to some very sensitive, high speed digital circuitry.

Using a Remote Speed Control Potentiometer

The latest revision of model 2035 O step motor driver includes an analog signal input connector that can be used to control the oscillator speed externally. Normally, an on board potentiometer controls the speed. To determine if your 2035 O is the correct revision: look for either a four pin header labeled "XSPD" near the three blue trimpots or the name on the PC board 1000-050 followed by a letter B. You will need:

- a 100kΩ linear potentiometer. A multiturn type is recommended.
- a four pin female connector compatible with .025 inch square pins on .100"centers. AMP type MTA-100 is one type that works well
- a shielded, three wire cable