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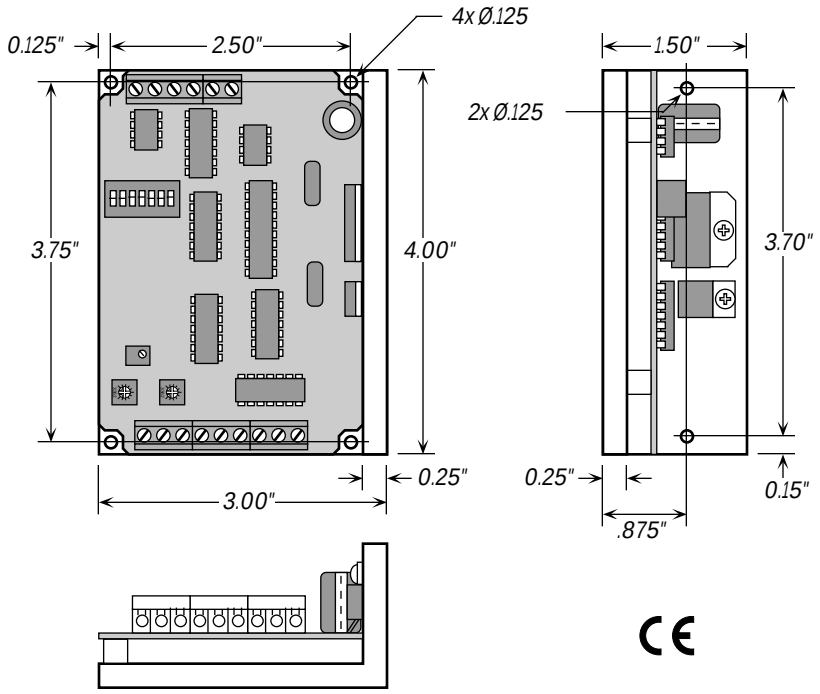
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Mechanical Outline

3/5/99
2035.ai
JK



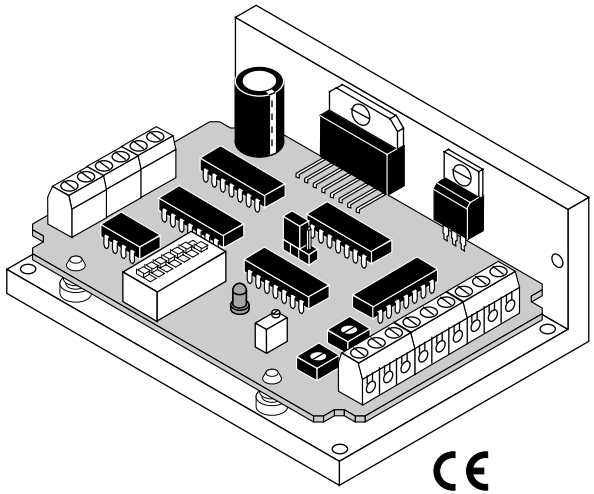
CE

User's Manual

2035

2035 O

Step Motor Drivers



CE

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Applied Motion Products, Inc.
404 Westridge Drive Watsonville, CA 95076
Tel (831) 761-6555 (800) 525-1609 Fax (831) 761-6544

REVISION E LEVEL

Applied Motion Products
motors • drives • controls

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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.

Is This the Right Manual?

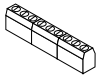
This manual is for 2035 and 2035 O drives of revision level E. Earlier drives had fewer features and different connections that revision E, so they require a different User's Manual.

If this is the manual that was shipped with your drive, it's almost certainly the right one. How can you tell for sure?

Hold the drive so that the words "Step Motor Driver" are at the bottom. On the right, you'll see a blue screw terminal connector. How many terminals does it have?


3 terminals - old 2035 or 2035 O. This is the wrong manual.


4 terminals - new 2035. This is the right manual.


9 terminals - new 2035 O. Right manual.

If this is the wrong manual, call the factory and request the "old" 2035 manual.

Technical Specifications

Amplifiers Dual, bipolar H-bridge, pulse width modulated switching at 20kHz. 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 (2035 O) 0 to 5000 steps per second. Linear acceleration and deceleration, individually adjustable from 5 to 900 msec.

Inputs Step, direction and enable, optically isolated, 5-24V logic. 2200 ohms input impedance. Motor steps when STEP input turns off. 10 µsec minimum low pulse. 50 µsec minimum set up time for direction signal. Step input is run/stop in oscillator mode. (0 =run, 1 = stop.)

Tach Output (O suffix) Optically isolated. Uncommitted (open collector, open emitter) phototransistor, 24V max, 20 mA max. One pulse per step.

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 back cover for more information. Maximum chassis temperature: 70˚C. Weight: 9 ounces (250 g).
Ambient temp range (operating): 0 - 70˚C.

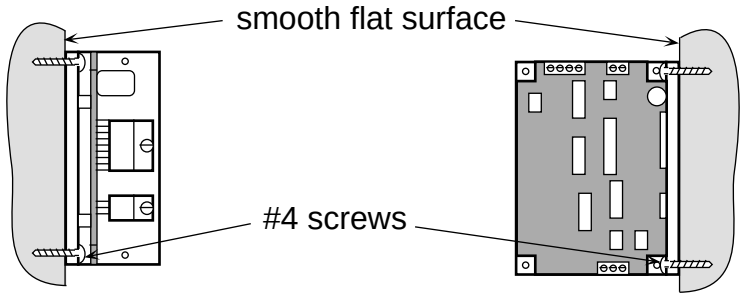
Connectors European style screw terminal blocks.
Power Supply: 2 position.
Motor: 4 position.
Signal Input: 4 position (2035), 9 position (2035 O)
Max wire size: AWG 16.

CE

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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 70˚C. Never put the drive where it can get wet or where metal particles can get on it.

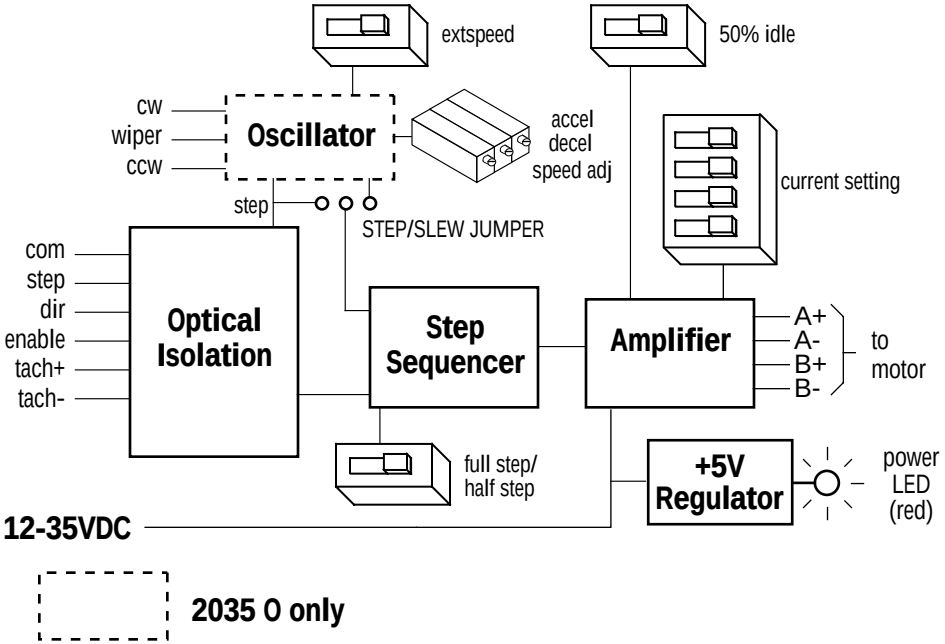
Recommended Motors

Motor Number	Size inches	Winding Connection	Max Torque oz-in	Current Amps
5014-842	1.38 x 1.38 x 1.57	4 lead	19	1.0
HT17-068	1.65 x 1.65 x 1.30	parallel	23	1.0
HT17-071	1.65 x 1.65 x 1.54	parallel	30	1.25
HT17-075	1.65 x 1.65 x 1.85	parallel	40	1.75
5023-127	2.22 x 2.22 x 2.25	4 leads	110	2.0
5023-149	2.22 x 2.22 x 3.25	parallel	140	2.0
HT23-393	2.22 x 2.22 x 1.54	parallel	75	1.4
HT23-396	2.22 x 2.22 x 2.13	parallel	175	1.4
HT23-399	2.22 x 2.22 x 2.99	parallel	260	1.4
5034-324	3.38 x 3.38 x 2.50	series	190	2.0

Features

- Drives sizes 14 through 23 step motors. Can also be used in some cases to drive size 34 motors. See page 14 for a list of recommended motors.
- Pulse width modulation switching amplifiers
- Phase current from 0.125 to 2.0 amps (switch selected, 16 settings)
- Step and direction and enable inputs, optically isolated, 5-24V.
- Inputs can be sourcing (PNP) or sinking (NPN) type
- Full and half step (switch selected)
- Automatic 50% idle current reduction (switch selected)
- Built in ramping pulse generator with adjustable speed, accel, decel (2035 O)
- 0 - 5000 Hz oscillator speed range (2035 O)
- Optically isolated Tach output for monitoring speed (2035 O)
- Speed can be set from on-board trimpot or external pot (2035 O)
- Compact size: 1.5 x 3 x 4 inches.

Block Diagram



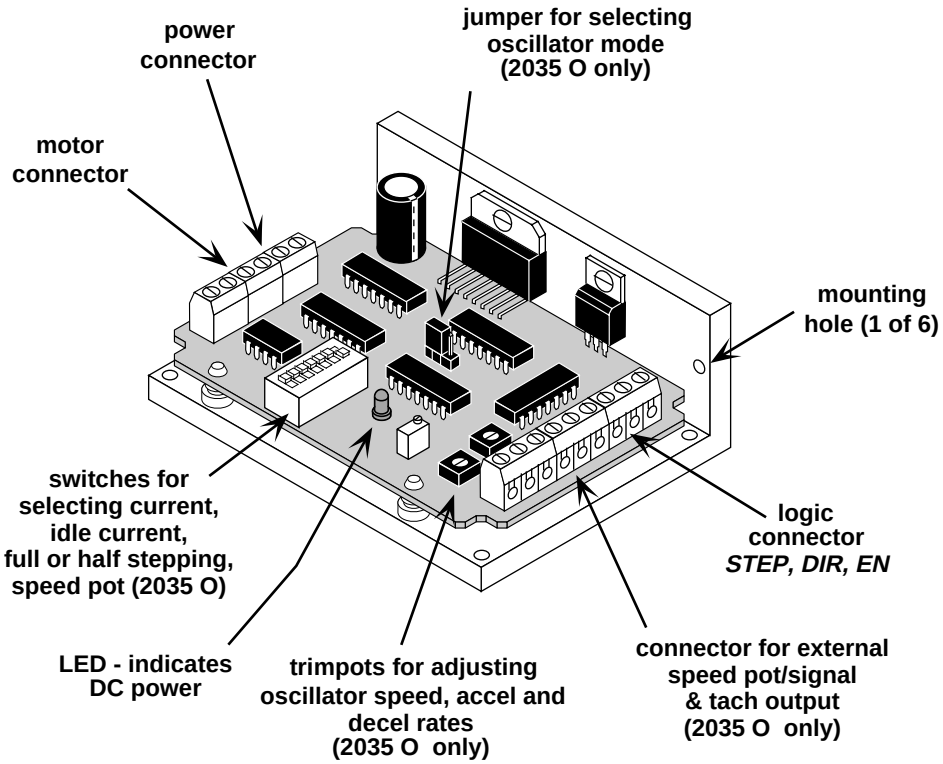
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Getting Started

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 to 24 volts DC, to activate the optoisolation circuits (if you are using an *O* drive and don't have 5 - 24V available, see page 12.)
- 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 (see page 14)
- 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.



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.

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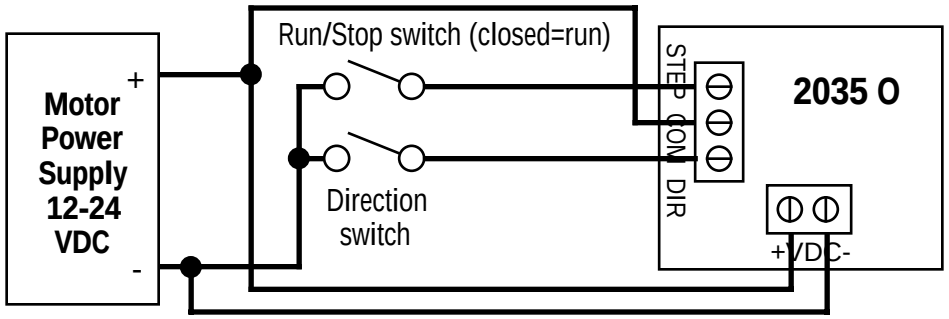
Using Mechanical Switches with 2035 O Drive

The 2035 O was designed to be used with active logic and for that reason has optically isolated inputs. To activate the optoisolators a small, but not insignificant amount of current at 5 to 24 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 - 24 volts.

In these instances, the motor power supply can be used if it does not exceed 24 VDC. The recommended wiring diagram is shown below.

Check your wiring carefully before turning on the power supply!



Idle Current Reduction

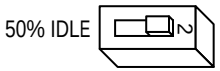
The 2035 and 2035 O drives include a feature that automatically reduces the motor current by 50% when the motor is not moving. This is known as idle current reduction.

For qualifying OEMs, we can change the amount of current reduction during the manufacturng process.

If you want full current all the time, move the switch away from the 50% IDLE label.



50% Idle Current



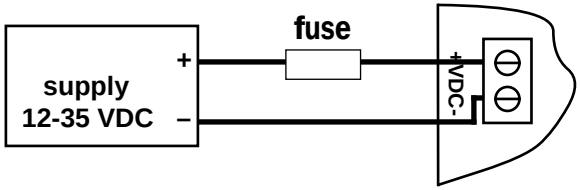
No Idle Current Reduction

Connecting the Power Supply

If you need information about choosing a power supply, please read *Choosing a Power Supply* on page 13 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 "**+VDC**". Connect power supply **–** to the drive terminal labeled "**-**". 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.

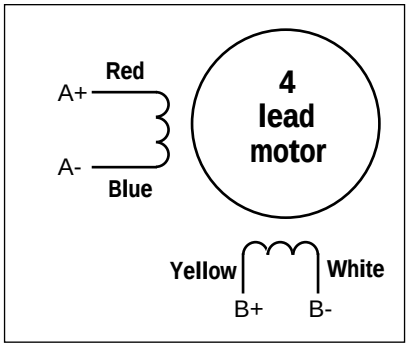


Connecting the Motor

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.

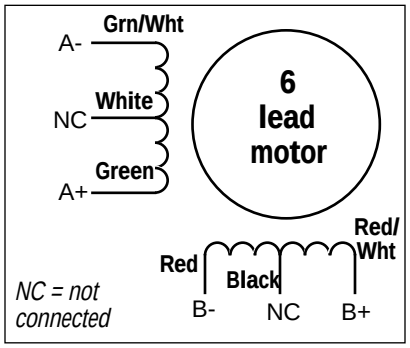
Four lead motors can only be connected one way. Please follow the sketch at the right.



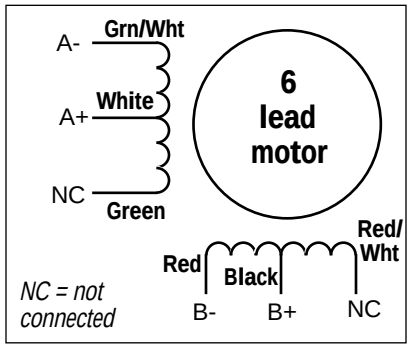
4 Leads

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

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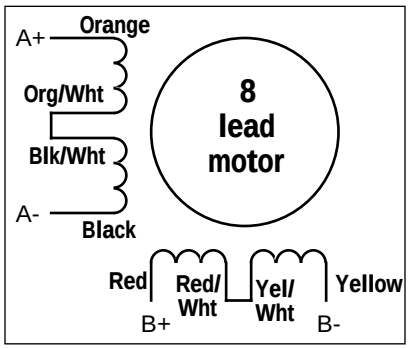


6 Leads Series Connected

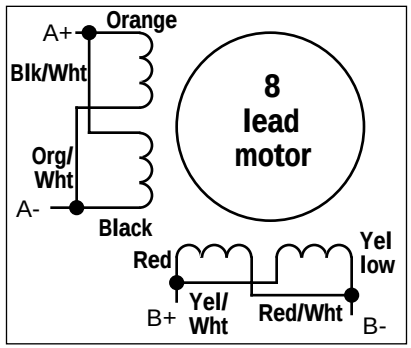


6 Leads Center Tap Connected

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

Using a Remote Speed Control Potentiometer

The 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.

You will need:

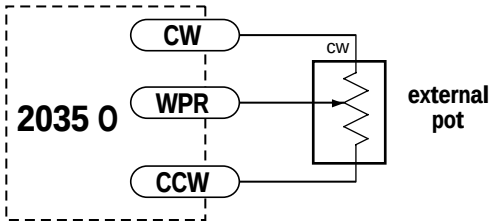
- a 10k to 100kΩ linear potentiometer. A multiturn type is recommended.
- a shielded, three wire cable

To install the external pot:

- move switch #1 toward the EXTSPEED label. That disconnects the on board pot.
- wire your pot to the 2035 O:

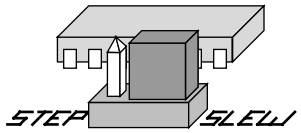
  ➤ the potentiometer wiper connects to the WPR terminal
  ➤ the potentiometer CW terminal connects to the CW terminal
  ➤ the third pot terminal connects to the CCW terminal
  ➤ the cable shield connects to the CCW terminal

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).



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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.

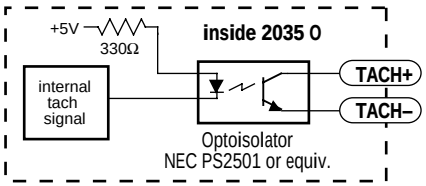
To change the slew speed, locate the trimpot labeled *SPEED*. By turning the brass screw you can raise or lower the speed within a range of 0 to 5000 steps per second. Turning the screw clockwise makes the motor run faster.

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 pot clockwise makes the motor accelerate or decelerate faster. ***The ACCEL and DECEL pots are single turn, so don't try to turn them too far.***

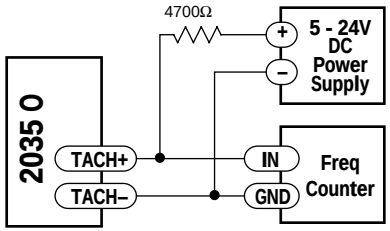
Tach Output

The Tach Out signal is provided for measuring the motor speed. It generates one pulse per motor step. The schematic diagram of the Tach Out optoisolation circuit is shown below.

Do not connect the Tach output to more than 24VDC.
The current into the Tach+ terminal must not exceed 20 mA.



Internal Tach Circuit

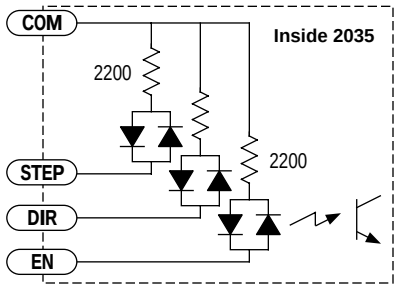


Connecting Tach Output to a Frequency Counter

Connecting Logic

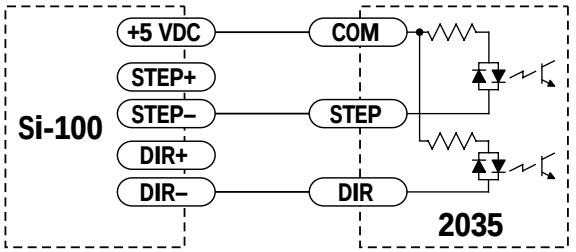
The 2035 and 2035 O drives contain optical isolation circuitry to prevent the electrical noise inherent in switching amplifiers from interfering with your circuits. Optical isolation is accomplished by powering the motor driver from a different supply than your circuits. There is no electrical connection 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 5-24 volts DC to activate the LEDs on the input side of the optoisolators. 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.

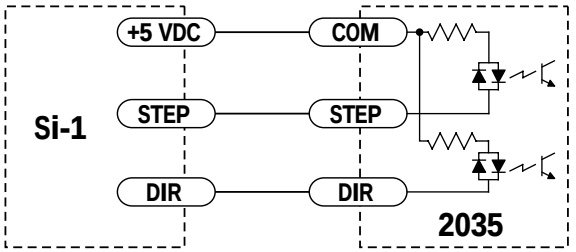


Most step motor indexers and PLCs can also connect directly to the 2035 and 2035 O drives.

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



Connecting the 2035 to an Applied Motion Si-100 Indexer
(leave Si-100 STEP+ and DIR+ outputs unconnected)

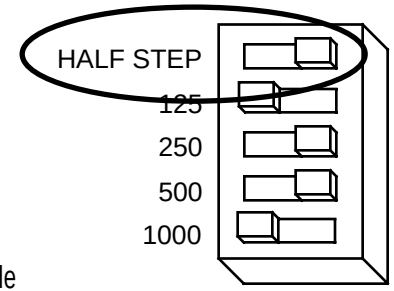


Connecting the 2035 to an Applied Motion Si-1 Indexer

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Selecting Between Full and Half Step Operation

Locate the bank of switches near the motor connector. One switch is labeled on the circuit board as *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

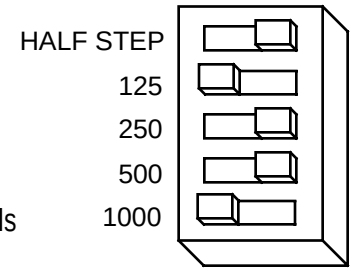
Locate the bank of tiny switches near the motor connector. Four of the switches have a value of current printed next to them, such as 500 and 1000. Each switch controls the amount of current, in milliamperes (mA), that it's label indicates. There is always a base of current of 125 mA. To add to that, 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.

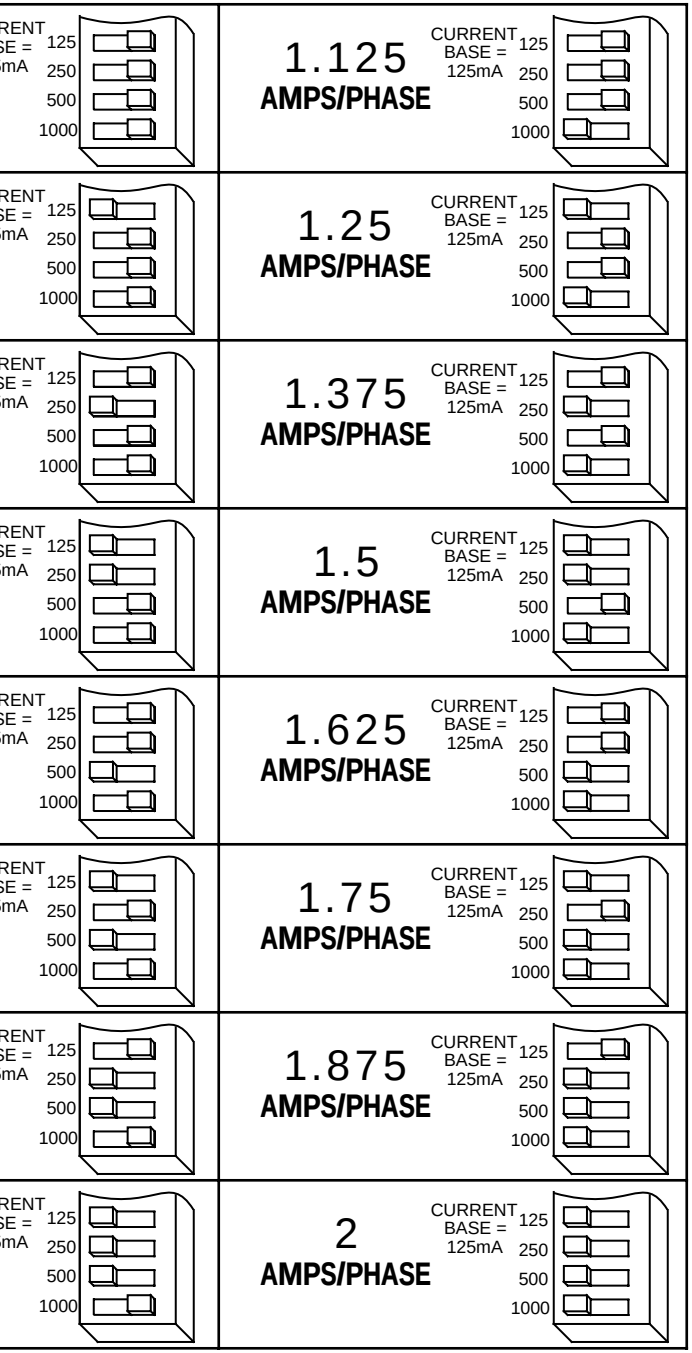
1250 = 125 + 1000 +125

Slide the 125 and 1000 mA switches toward the labels as shown in the figure.



Current Setting Table

.125 **AMPS/PHASE**	1.125 **AMPS/PHASE**
.25 **AMPS/PHASE**	1.25 **AMPS/PHASE**
.375 **AMPS/PHASE**	1.375 **AMPS/PHASE**
.5 **AMPS/PHASE**	1.5 **AMPS/PHASE**
.625 **AMPS/PHASE**	1.625 **AMPS/PHASE**
.75 **AMPS/PHASE**	1.75 **AMPS/PHASE**
.875 **AMPS/PHASE**	1.875 **AMPS/PHASE**
1 **AMPS/PHASE**	2 **AMPS/PHASE**



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