Single Axis Stepper Motor Driver / Indexer
AISTEP1

Features:

- 3 A, 6 - 28V output rating per phase
- Simple STEP / DIR TTL opto-isolated inputs
- Full Step, Half Step, Quarter Step and Eighth Step Resolution (8X micro-stepping)
- Adjustable Motor Phase Current
- Overtemperature protection

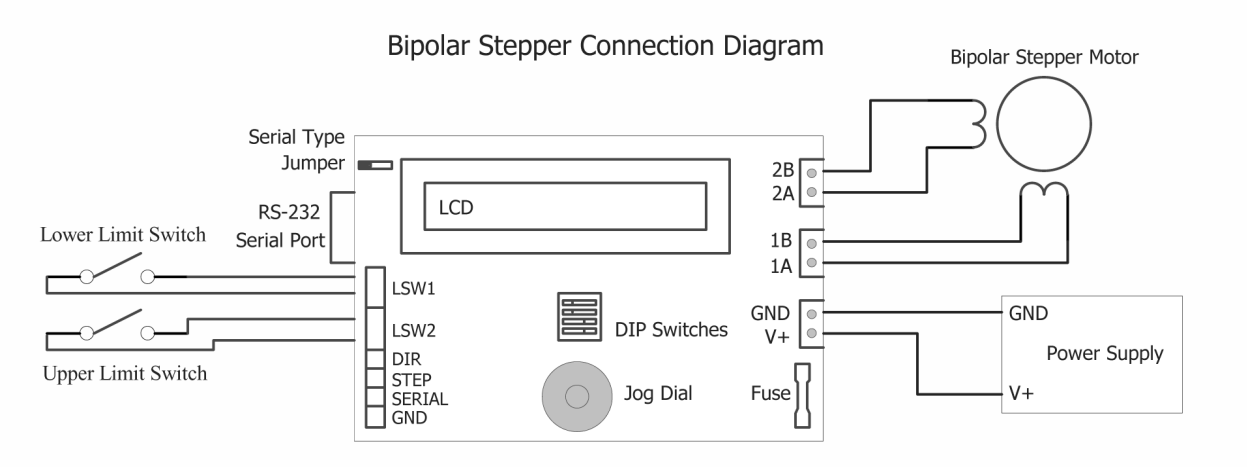


Figure 1 – Bipolar Stepper Motor Connections.

The Critical Velocity AISTEP is a powerful and versatile stepper motor position controller (indexer) capable of driving unipolar and bipolar stepper motors up to 3 amps per phase.

A full-featured menu-driven jog-dial interface allows stand-alone operation without a computer. In addition, a 100 position memory allows for quick recall of stored positions.

A serial interface provides control of the motor and controller configuration options.

The standard TTL STEP and DIRECTION interface allows for basic interaction while maintaining full control of maximum speed and acceleration of the motor.

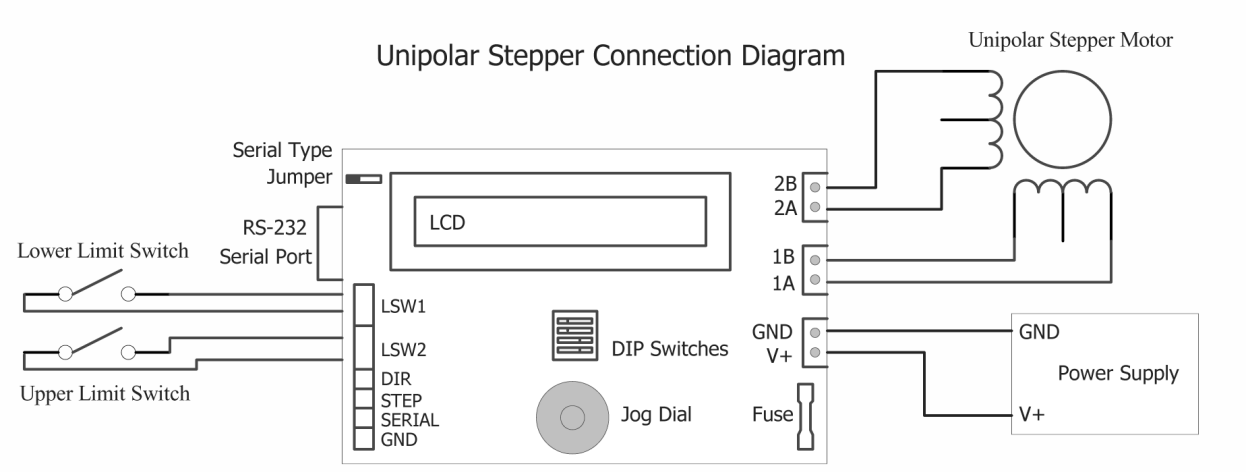


Figure 2 – Unipolar Stepper Motor Connections.

Absolute Maximum Ratings:

Parameter	Max	Units
Peak Output Current Per Phase	4	A
Input Voltage	28	V
Input Voltage Transient (t < 0.5 sec)	40	V

Warning – operating at or above the absolute maximum ratings may damage the controller or the equipment under control.

Operating Parameters:

Parameter	Min	Typical	Max	Units
Input Voltage	5.7	--	26	V
Input Voltage, Transient (t < 0.5 sec)	-2.0	--	40	V
Continuous Output Current Per Phase	--	--	3	A
Digital Logic Input Low Level (Opto-isolated)	0	--	2	V
Digital Logic Input High Level (Opto-isolated)	4	--	20	V
Digital Logic Input Current	--	3	20	mA
PWM Frequency	8	10	12	kHz
Step Rate	--	--	10000	Steps / sec
Quiescent Current Drain	20	35	40	mA
Temperature	-30	25	+50	°C

Signal Connector Pin-out:

Pin Label / No.	Function	Active H/L	Notes
LS1 (1, 2)	Normally open LOWER limit switch input	Default = Open Limit Hit = Closed	
LS2 (3, 4)	Normally open UPPER limit switch input	Default = Open Limit Hit = Closed	
DIR (5)	DIRECTION input	L = decreasing position H = increasing position	
ST (6)	STEP input	Steps on rising edge	
SR (7)	Serial input	RS-232 or Inverted TTL*	
GND (8)	Input Ground	--	Isolated from Stepper Controller Ground

* Depending on Serial Mode Jumper

Terminal Block Pin-out:

Pin Label	Function
V+	Power Supply Input
V-	Power Supply Ground
1A	Motor Phase 1 A
1B	Motor Phase 1 B
2A	Motor Phase 2 A
2B	Motor Phase 2 B

Board Configuration:

Stepper Driving Mode DIP Switch Settings:

Mode	Description	Steps / Cycle	Switch 1	Switch 2
Wave Drive	1 phase on at a time	4	OFF	OFF
Standard Drive	2 phases on at a time	4	ON	OFF
Half Stepping Drive	Half steps	8	OFF	ON
Micro Stepping Drive	Quarter Steps	16	ON	ON

Startup Mode DIP Switch Settings:

Mode	Startup	Power Down	Switch 3	Switch 4
Default	Current position starts at 0	--	OFF	OFF
Position Recall	Recalls position at power down. Assumes motor is at recalled position without moving.	Memorizes current position.	ON	OFF
Home at Startup	Motor steps decrease until lower limit switch is hit. This is the 0 position.	--	OFF	ON
Homed Position Recall	Motor steps decrease until lower limit switch is hit. This is the 0 position. Then move up until previous position at power-down is reached.	Memorizes current position.	ON	ON

Serial Mode Jumper Settings:

Mode	Description	JP5
RS-232 Serial	Standard serial port from PC's	Left 2 pins closed, Right 2 pins open
Inverted TTL	Inverted serial from MCU's	Left 2 pins open, Right 2 pins closed

Getting Started – Stand-Alone Operation

The Critical Velocity AI-STEP is simple to get up and running. Components needed for stand-alone operation:

- AISTEP controller board
- Bipolar stepper motor (less than 3 amps per phase)
- Variable voltage power supply

1) Connect the power supply, motor and controller board as indicated in figure 1 for a bipolar stepper motor or figure 2 for a unipolar stepper motor.

2) Turn on the power supply, and adjust it to the nominal voltage required by the stepper motor.

3) The LCD should show:

Des:	0
Cur:	0

"Des" indicates Desired Position. "Cur" indicates the current position. The default mode is step mode, where turning the jog dial will move the stepper motor in the corresponding direction the appropriate number of steps.

- Turn the jog dial 1 click to the right. The motor should advance one step, and the screen should show:

Des:	1
Cur:	1

- Turning the dial in the opposite direction will move the stepper in the opposite direction. Turning the dial quickly will move the motor in larger steps.

  If 1 step at a time is too slow, you can change the number of steps the motor moves per click of the dial. To do this, push in and release the jog dial. This will bring up the menu. Rotate the dial to the right until "Config Jog Dial Step Size [5]" is selected. Push to select. Change this value to 10 (or the number of steps desired per click) and push in to save the setting. Now the motor will move 10 steps per click of the dial.

4) What if you wanted to save a certain position to memory and recall it later?

- Open the menu by pushing the dial, and select "Store Position to Memory [1]". Then dial in the memory slot to store it to. This can be from 0 – 99. Save it. Now move the motor to another position using the jog dial.

- You have the option to recall the stored position. Push the dial to open the menu, and select "Go to Stored Position [2]." Select the memory slot you saved the position to, and the motor should move to the position selected.

5) What if you wanted to quickly move the motor to certain positions without turning the dial so much?

- You can configure the jog dial to run in jog mode. To do this, enter the menu and select "Configure Jog Dial Mode [4]". The default setting is "Stp" for Step Mode. Change this to "Con" for Jog Mode.

  Now the LCD should show the current position, and the jog position indicator.

  Turn the dial one click to the right. The motor should start moving slowly. Turn it another click and the motor should move faster. Turn it in the opposite direction to reverse the motor's direction. This mode allows you to quickly find a position and stop.

6) You should be able to easily maneuver the motor and recall positions just using the jog dial and the LCD interface alone! There is no need to connect the controller to a computer for stand-alone operation.

- Feel free to configure other menu options to your liking, such as the motor's maximum speed and acceleration. Please see the "Menu Navigation" section of this manual for more information.

Getting Started – RS-232 Serial Operation

In addition to the requirements for stand-alone operation, a computer with an RS-232 serial port is required for RS-232 serial control.

The default connection speed is 9600 baud. Use the LCD interface to change to a different speed (see "Menu Navigation" for more information.)

The AISTEP recognizes commands in the following format:

C <Board ID> <Command>

Where
<Board ID> is the board's ID number (character "0" by default)
and <Command> is the command for the motor.

For testing, send the command using a terminal program such as Windows HyperTerminal.

1) Open Hyperterminal and create a new connection. Select the appropriate COM port (COM1, COM2) and configure as follows:

Bits per second:	9600
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

2) Once in the terminal session, type the character 'C'.

The LED should come on, indicating that it is in command receive mode.

Type the number 0 (which translates to ASCII value 48) to specify the board ID.

Now type 'S+250' followed by a period (.).

Thus, the complete command string should be:

C0S+250.

The motor should move 250 steps.

Try the following command:

C0S-500.

The motor should move 500 steps in the opposite direction.

You should be able to move the motor with serial commands alone. For other commands, please see "Serial Command Reference."

Getting Started – TTL Operation

The Critical Velocity AI-STEP can be controlled using simple TTL signals. To test this mode, a function generator is recommended to generate the STEP signals. Components needed for TTL operation:

- AISTEP controller board
- Bipolar stepper motor (less than 3 amps per phase)
- Variable voltage power supply
- Function generator to generate step signals

1) Connect the power supply, motor and controller board as indicated in figure 3. Connect the function generator to the STEP input pin of the AISTEP.

2) Turn on the power supply, and adjust it to the voltage required by the stepper motor.

3) The LCD should show:

Des:	0
Cur:	0

4) Now turn on the function generator and set the frequency to approximately 5 Hz, square wave, 3 V_{pp}.

5) This signal should cause the motor to step in sync with the pulses produced by the function generator. To change directions, the DIR pin can be connected to a 5V source.

Please note that the input pins are isolated from the controller power supply, including ground. Do not connect the computer's ground wire to the ground wire of the power supply / motor controller.

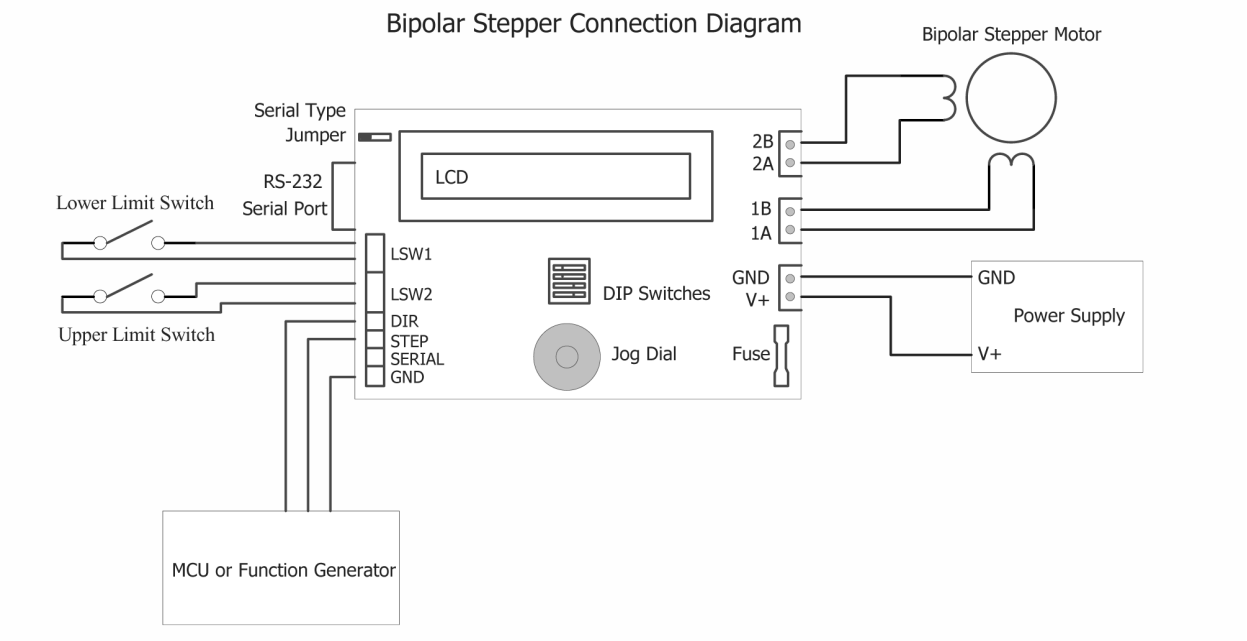


Figure 3 – TTL Input Connections.

Control Options:

The controller can accept inputs through the serial interface, the TTL STEP and DIR pins, and through the manual jog dial. All input pins are optically isolated to protect both the motor driver and the controlling system from voltage spikes, noise and incorrect wiring.

Serial Input:

RS-232: Any standard RS-232 serial port can be used to send commands to the controller. Ensure that the Serial Type Jumper is set for RS-232. The default connection parameters are:

Data bits: 8
Parity: None
Stop Bits: 1

To use another connection speed, refer to section "Menu Configuration Options."

Inverted TTL: This option allows for direct serial interface to microcontrollers. Ensure that the Serial Type Jumper is set for Inverted TTL. The default connection parameters are the same as for RS-232. Other connection speeds can be selected via the configuration menu.

TTL STEP and DIRECTION inputs:

To cause the motor to move a step, a pulse to the STEP input pin will cause the motor's desired position to increment or decrement, depending on the state of the DIR pin.

A logic HIGH on the DIR pin increments the desired position counter, while a logic LOW on the DIR pin decrements the position counter.

The position counter is changed on the rising edge of the STEP input pin.

Manual Operation through the Jog Dial:

The controller can also be operated through the manual jog dial and LCD interface.

The dial can be used to move the motor one step at a time (Step Mode) or to rotate the motor automatically at several speeds (Continuous Rotation Mode). Please see "Menu Navigation" for a description of how to change these modes. The default mode is Step Mode.

Step Mode:

Turn the jog dial clockwise or counterclockwise to move the stepper motor step by step. Turning the dial quickly will yield larger steps. The number of steps the controller takes per click of the jog dial is configurable through the menu. The default configuration is 1 step, so each click of the dial will move the motor 1 step. Please see "Menu Navigation" for more information.

The LCD displays Desired Position and Current Position.

Jog Mode:

In Jog Mode, the dial can cause the motor to step at varying speeds depending on how far clockwise or counterclockwise the dial is turned. There are 9 speeds, but the maximum speed is limited by the user's setting accessible through the menu system.

The LCD displays a bar graph indicating the position of the dial. The motor will stop rotating once the dial is brought back to the center position.

Step Modes:

The controller provides 4 step modes, selectable via the DIP switch bank. The default setting is the Wave Drive mode.

Wave Drive:	A single phase is active at any given time. All steps are full steps and land on the motor's natural positions. Since only a single phase is powered at a time, power consumption is reduced, but torque is also reduced.
Standard Drive:	Both phases are active at any given time. All steps are full steps and land between the motor's natural positions. Higher torque is available at the expense of twice the current consumption.
Half-Stepping Drive:	Both the natural steps and the intermediate steps are used, resulting in twice the number of steps per revolution. For example, a motor with 200 native steps per revolution can achieve 400 steps per revolution in this mode.
Micro-stepping 4X:	Micro-stepping achieves four times the number of natural steps per revolution using PWM phase current control. A 200 natural step motor would take 800 steps to complete a revolution. Operating in this mode may allow the motor to run quieter and with higher precision.

Power Modes:

Low Power Idle:	The controller has automatic idle power reduction. If the motor has not moved for 0.3 seconds, it enters a low power mode, where the hold current is reduced by 50%. As soon as the motor receives a command, full power is restored. This mode is valid in Wave Drive, Standard and Half Step modes.
Motor Sleep:	Motor sleep mode shuts off power to the motor when it is in a natural step position. This mode is specifically requested through the serial port. If the motor is in Standard or Micro-stepping mode, or in between natural step positions in Half Stepping mode, motor power will not be shut down in order to preserve position integrity.

Limit Switches:

The controller comes with two limit switch inputs: a lower and an upper limit switch. The limit switch inputs are connected directly to the controller logic and should only be used with normally open mechanical switches. When a limit switch is hit, the motor immediately stops moving in that direction. Any additional commands to continue to moving against the limit switch are ignored.

Startup Modes:

There are four possible modes that determine the behavior of the controller at startup.

Default:	This mode starts the motor position at 0. There is no initial motor movement unless a command is sent.
Position Recall:	Recalls the position at power down at startup. For example, if the controller was turned off at position 245, the position counter will start up at 245. There is no initial motor movement. This mode is useful in situations where the motor is used to position a light load, such as a mirror or a lens, and has no tendency to move when power is removed. Thus, at power up, the controller can assume that the motor has not moved and the previous position is still valid.
Home at Startup:	Moves motor towards the lower limit switch and resets the position counter to 0 when the switch is hit. The lower limit switch must be installed for this mode to work properly.
Homed Pos Recall:	Moves motor towards the lower limit switch and resets the position counter to 0 when the switch is hit. It then moves the motor to the previously recorded position at power-down. This automatic homing mode ensures that the motor is accurately positioned at startup. The lower limit switch must be installed for this mode to work properly.

Please see "Startup Mode DIP Switch Configuraiton" to select the appropriate mode.

Maximum Speed Configuration:

The AISTEP can be configured to limit the motor's maximum speed. This prevents loss of tracking when the motor cannot keep up with the pulse train being fed to it.

To configure the motor's maximum step speed to match your application, use either the LCD interface or the serial interface to configure the speed parameter.

The speed is set in Steps per Second. The minimum value for this parameter is 5 steps per second, and the maximum value is 12,500 steps per second.

Acceleration Configuration:

The AISTEP can be configured to gradually accelerate and decelerate the motor to its maximum speed when traveling. The default configuration is acceleration from ¼ of the maximum configured speed to full speed in 100 steps. The acceleration parameter is a number from 0 – 100, which indicates the factor applied to 100 steps. A value of 2 indicates the acceleration / deceleration should occur over 200 steps. A value of 5 indicates an acceleration ramp over 500 steps.

To configure the controller's acceleration to match your application, use either the LCD interface or the serial interface to configure the acceleration ramp parameter.

To disable the acceleration / deceleration ramp, set the parameter to 0.

Memory Operations:

The AISTEP has 100 memory locations that can be used to store position values. Use the LCD Interface to store the current position to a particular memory location or go to a previously stored location. You can also use it to view previously stored locations. Please see the "Menu Navigation" section for more details.

The same functions can be accessed through the serial port as well. Please see the Serial Command Reference section for memory operation commands.

LCD Backlight Timer:

The LCD backlight is enabled by default. To conserve power, the LCD backlight can be configured to shut off after a period of inactivity – from 5 – 120 seconds. To disable the timer, set the backlight timer to 0 seconds.

The timer is disabled if any menu is activated.

Serial Connection Speed Configuration:

The serial port supports 2400, 4800 and 9600 bits per second operation. This option is configurable through the menu. Please see "Menu Navigation" for more information.

Board ID Number Configuration:

The default Board ID Number is ASCII character '0' or number 48. To change the number that the board responds to, use the menu to select a value from 0 – 255. Use of a unique Board ID Number allows multiple AISTEP controllers to be connected to the same serial line.

To connect multiple boards to the same serial port, a repeater may be necessary due to the load placed on the line by the internal opto-isolators.

Motor and Power Supply Selection:

When choosing a stepper motor, ensure that it has an operating voltage between 6 and 26 volts, and a current of 3 or less amps. The power supply voltage should match the motor voltage rating. Supplying the controller with a higher voltage than the motor can handle may result in overheating and damage to the motor and the controller. The current draw per phase of the motor should not exceed 3 amps.

Menu Navigation:

To enter the main menu, push and release the jog dial. The Main menu will come up. To select an option, push and release the jog dial again. Turn the dial left or right to select between menu items. The menu structure is described as follows:

[Main Menu]

[1] Store Position to Memory
- Stores the current position to a memory location. Select a memory slot to store the position to. (0 – 99)

[2] Go to Stored Position
- Moves the motor to a previously stored position. Select a memory slot to load the position from. (0 – 99)

[3] View Stored Positions
- Views the stored positions at all memory locations. Turning the jog dial selects the memory location to view. Push the jog dial to exit.

[4] Configure Jog Dial Mode
- Select between Step Mode and Jog Mode (Continuous Rotation). See "Manual Operation" for a description of these modes.

[5] Configure Jog Dial Step Size
- Enter the number of steps to advance per detent of the jog dial in Step Mode.

[6] Configure System Parameters (Opens Configuration Menu)

1. Idle Power Save Mode
   - On/Off: When set to ON, the motor current will be dropped to ½ of its full level after an idle period.

2. Configure Maximum Speed
   - Enter the maximum number of steps per second the motor can take.

3. Configure Acceleration
   - Enter the acceleration constant.

4. Configure LCD Backlight Timer
   - Enter the number of seconds after which the backlight automatically shuts off. Enter 0 to disable automatic shut off. (default)

5. Configure Serial Connection Speed
   - Select between 2400, 4800 and 9600 bits per second for serial communications.

6. Configure Board ID Number
   - Select the ID Number the board will respond to in Serial Mode. The default is ASCII character '0' or decimal number 48.

7. Exit Configuration Menu
   - Returns to the Main Menu.

[7] Exit Main Menu

Serial Command Reference:

The motor controller accepts configuration and motion commands through the serial port. Each command is first preceded with a sync character 'C', followed by the number of the controller and the command. The default is ASCII '0'. The following illustrates the command set. Note that spaces are added for clarity only – actual commands should not have any spaces. The end of the command is followed by a period.

Motion Commands:

`C 0 S + 1000 .`	Move stepper motor 1000 steps in the positive direction.
`C 0 S – 250 .`	Move stepper motor 250 steps in the negative direction.
`C 0 A + 300 .`	Move stepper motor to absolute position 300.
`C 0 A - 100 .`	Move stepper motor to absolute position -100.
`C 0 A + 0 .`	Move stepper motor to absolute position 0.
`C 0 A 0 .`	Move stepper motor to absolute position 0.
`C 0 L .`	Move stepper motor in the negative direction until the lower limit switch is hit, then stop.
`C 0 H .`	Move stepper motor in the positive direction until the upper limit switch is hit, then stop.
`C 0 R .`	Reset current position counter to 0 without moving motor.

Memory Commands:

`C 0 G 12 .`	Move stepper motor to position specified in memory location 12.
`C 0 M 230 @ 1 .`	Store 230 to memory location 1.
`C 0 P @ 1 .`	Store current position to memory location 1.

Configuration Commands:

`C 0 C A 5 .`	Configure acceleration parameter to 5.
`C 0 C S 200 .`	Configure maximum speed parameter to 200.

Power Commands:

`C 0 Z .`	Shut off power to motor. (only valid when motor is at a full step.)
`C 0 C L .`	Put motor in power save mode (reduces current consumption by 50%) *

Application Notes:

PWM controllers switch currents at high frequencies to vary the average power to the load. This switching can cause undesirable RF interference. To minimize such interference, it is recommended to twist the input V+ and Ground wire pair together, the 1A and 1B wires together, and the 2A and 2B wires together.

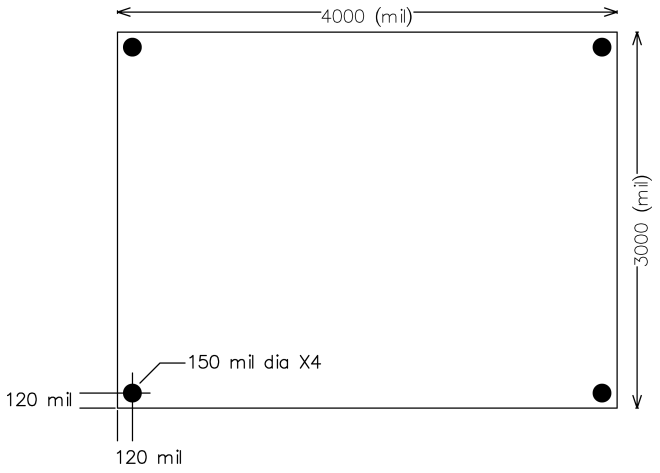
The Motor Idle Power Save Mode should be used whenever possible to reduce power consumption when the motor is idle. This will reduce heating of the motor and increase service life.

There is an on-board 10 Amp blade type fuse. Only replace with a fuse of the same current rating.

In general, motor torque decreases as the step rate increases. Configure the maximum motor speed setting to prevent loss of position integrity from excessive step rates. Use the acceleration / deceleration feature to ramp up the speed of the stepper motor. This ensures that the motor will not slip due to a heavy load.

The controller should have adequate ventilation to permit proper cooling. If necessary, a fan can be used to provide additional cooling.

Mechanical Specifications:



30-Day Limited Warranty:

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