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CNC Controller Datasheet



1 Features

- 4-axis stepper motor control
- 2 general purpose 15 amp switched load outputs
- 12-36 VDC power supply
- Up to 15 amps output current.
- Plug compatible with standard Mean Well power supply
- Up to 6 amps drive current per motor.
- Up to 128 microstepping
- S-Curve acceleration and deceleration
- 25-Pin interface for I/O including
 - E-stop
 - Limit switches
 - RS-485 spindle control
 - PWM spindle control
 - Z-axis probing
- Protection features
 - Overcurrent protection
 - Reverse battery protection

- Over temperature shutdown
- Undervoltage lockout
- Isolated internal power supply
- Front panel 20x4 LCD text display
- Ethernet access for web based control
- 4 USB ports for:
 - Gamepad control
 - Wifi
 - Web camera
- Open-Source hardware and software
- Integrated with complete Open-Source design software

2 Applications

The Buildbotics CNC Controller is an ideal choice for new CNC controlled machinery (e.g. routers, plasma cutters, engravers, and 3D printers). It is designed for easy integration, ease of use, Open-Source hardware and software, performance, reliability.

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3 Description

The Buildbotics CNC Controller is built on Open-Source hardware and software.

3.1 Major hardware components

- Main board
 - isolated and non-isolated power supplies as required.
 - Stepper motor control for up to 4 axes.
 - 2 15A general purpose DC load switches..
 - RS-485 and direct spindle motor control
 - I/O for e-stop, fault indication, limit switches, general purpose switch contact control, and probing
- Raspberry PI
- Sleek enclosure including easy-to-use ports
 - Ethernet

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- 4 USB ports for direct attachment of keyboard, mouse, and joystick
- LCD Display
- Power supply jack (directly compatible with Mean Well GST280A desktop adapters)

3.2 Major Software Components

Standard Raspian Linux runs on the Raspberry PI. Buildbotics Open-Source software running on the Raspian OS provides the human interface for configuring the controller, and controlling motors and other peripherals. Human control can be provided via a built-in web server, or via a local joystick. G-code files are downloaded via the web interface and are then executed by the Buildbotics application.

The main board is controlled by an ATXMega192 microprocessor running the Buildbotics software. It provides smooth S-curve acceleration and sophisticated motion planning systems. The ATXmega192 receives G-code commands from the Raspberry PI and converts those commands to motor and I/O control as required

4 Parameters

The following table shows that recommended operating ranges for the Buildbotics controller. Values outside this range are likely to result in operating failures and could result in damage to the controller.

	Min	Typical	Max	Units
Electrical				
Power Supply Voltage (V _s)	12	24	36	VDC

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Input Current (I _s)			25	Amps
Motor Voltage (V _m)		V _s		VDC
Motor Current (Peak) (I _{mpk}		1.5	6	Amps
Load 1 Voltage (V ₁₁)		V _s		VDC
Load 2 Voltage (V ₁₂)		V _s		VDC
Load 1 Current (I ₁₁)			15	Amps
Load 2 Current (I ₁₂)			15	Amps
Maximum total output current			25	Amps
Maximum step rate			200,000	Steps/se
Microstepping	1	1/32	1/128	
Logic in lo(V _{IL})	0		.6	Volts
Logic in hi(V _{IH})	2		3.3	Volts
Logic out hi(V _{OH})	2.6	2.9	3.3	Volts
Logic out lo(V _{OL})		.4	.76	Volts
Analog Voltage (V _{AI})	0		3.3	Volts

5 Pin and port descriptions

All I/O pins and ports are accessible from the back panel of the enclosure as shown in the picture of the back panel.



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Ethernet

The Ethernet connector is the leftmost connector on the top row of the back panel. It is labeled ENet. Plug a standard RJ-45 Cat V or better Ethernet cable. The ethernet interface is compatible with either 10 or 100Base-T connections.

USB

The Buildbotics controller provides 4 USB2.0 ports which are located in the middle and rightmost positions on the top row. At present, any of these ports can accept a Logitech F310 or equivalent game controller.

Power Connector

The power connector is the rightmost connector on the bottom row. It provides the power source for the Buildbotics controller and its peripheral devices. It is a 6-pin Molex Minifit Junior connector. The bottom three pins (1, 2, and 3) provide the positive DC input voltage. The top three pins (4, 5, and 6) are ground. Pins 1, 2, and 3 are shorted together internally as are pins 4, 5, and 6. V_s is supplied through this connector. Valid voltages range from 12 to 36 volts DC. The Buildbotics controller is protected from reverse voltage connections. The Buildbotics Controller limits current into the power connector to no more than 25 amps.

The power connector is plug-compatible with Mean Well GST280AXX-C6P power supplies. It is compatible with Molex 39-0102060 connectors equipped with Molex 0039000077 16AWG female crimp pins.

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Load Connectors

The Buildbotics controller is equipped with two switched output connectors for supplying loads up to 15 amps each. (Note - the total current for the Buildbotics controller is 25 amps, so both switched outputs are not able to simultaneously supply 15 amps.) Labeled L1 and L2, these outputs are located next to the power connector in the second and third positions from the right on the bottom row.

L1 and L2 are 6-pin Amphenol Minitek male model 10127720-061LF connectors. Pins 1, 2, and 3 are shorted together and make up the top row, and are grounded. Pins 4, 5, and 6 are shorted together and make up the bottom row, and supply V_s when active.

L1 and L2 are plug compatible with Amphenol 10127716-06LF connectors equipped with Amphenol 10127718-001LF 20-30AWG crimp pins.

Motor Connectors

The Buildbotics controller is equipped with 4 motor drivers. The associated connectors are presented on the back panel. They are labeled X, Y, Z, and A; and are located in the seventh, sixth, fifth, and fourth positions (respectively) from the right on the bottom row.

Each of the motor connectors is a 4-Pin Amphenol Minitek Header (model 10127720-041LF) with male pins. The connectors are plug compatible with Amphenol FCI Model 10127716-04LF connectors equipped with Amphenol FVI Model 10127718-001LF female pins.

When facing the back panel, the pins are:

- Upper Left B+
- Lower Left B-
- Upper Right A-
- Lower Right A+

Each motor driver can drive up to 6 amps peak current.

I/O Connector

The I/O connector is labeled I/O and is located on the back panel in the leftmost position on the bottom row. It is a 25-pin D-SUB male connector. When facing the back panel, pin 1 appears in the upper left. The pins then count across the top row to pin 13 in the upper right. Pin 14 is in the lower left and then the pins continue to count to the lower right position with Pin 25 in the lower right position.



Pin	Name	I/O	Possible values	Description
1	Switch 1	0	V _{OL} , V _{OH}	Logic level load switch output
2	Switch 2	0	V _{OL} , V _{OH}	Logic level load switch output.
3	Min X	Ι	Open, short	Limit switch
4	Max X	Ι	Open, short	Limit switch
5	Min Y	Ι	Open, short	Limit switch
6	+3.3V	0	V _{3.3}	3.3 volt source, 26.1 ohms source impedance
7	Gnd			
8	Max Y	Ι	Open, short	Limit switch
9	Min Z	Ι	Open, short	Limit switch
10	Max Z	Ι	Open, short	Limit switch
11	Min A	Ι	Open, short	Limit switch
12	Max A	Ι	Open, short	Limit switch
13	RS485 A	I/O		Spindle control (negative side of rs485 differential pair)
14	RS485 B	I/O		Spindle control (positive side of rs485 differential pair)
15	Spin Enable	0	V _{OL} , V _{OH}	Spindle enable
16	Spin Dir	0	V _{OL} , V _{OH}	Spindle direction
17	Spin PWM	0	V _{OL} , V _{OH}	Spindle speed control (pulse width modulated signal alternating between V_{OL} and V_{OH})
18	Gnd			
19	Gnd			
20	+3.3V	Ο	V _{3.3}	
21	Fault	Ο	V _{OL} , V _{OH}	High (V _{OH}) signal indicates a fault.
22	Probe	Ι	V _{OL} , V _{OH}	Tool height probe

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23	EStop	Ι	V _{OL} , V _{OH}	Emergency stop switch
24	Analog	Ι	0-V _{3.3}	TBD
25	Gnd			
Shiel d	Gnd			

Limit Switches

The limit switch pins can be connected to either mechanical or optical limit switches. The min switches are used to indicate that the machine has reached the lowest numerical position and the max switches indicate the greatest numerical position.

Probe Switch

Applying V_{OL} to probe indicates that the Z axis probe has been reached. Not applying V_{OL} to probe indicates that the Z axis has not been reached.

EStop Switch

The estop pin is used to signal an emergency stop condition. Applying V_{OL} to estop indicates that an emergency stop has been requested. Not applying V_{OL} to estop indicates that an emergency stop has not been requested. Alternatively, the controller can be configured such that applying V_{OL} indicates that no emergency stop has been requested and not applying V_{OL} indicates that an emergency stop has been requested.

PWM Spindle

PWM spindle drivers are controlled via the *spin enable*, *spin dir* and *spin PWM* output pins. Both *spin enable* and *spin dir* output either logic high (V_{OH}) or logic low (V_{OL}). By default logic high indicates *spin enable* and logic low indicates spindle disable. Likewise, logic high on *spin dir* indicates clockwise rotation and logic low indicates counterclockwise rotation. However, both *spin enable* and *spin dir* may be inverted via the controller configuration.

spin PWM outputs a repeating pulse whose width is proportional to the desired spindle speed. The the base frequency, min & max speed and min & max pulse width may be set in the controller configuration.

RS485 Spindle

TODO





Load Switches

TODO, explain both the load switches themselves and the logic level outputs.

Fault Indication

 V_{OH} is applied to fault when a fault condition is detected. V_{OL} is applied to fault when no fault has been detected.

Dimensions



All dimensions are in milimeters

Top View

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Front View



Back View