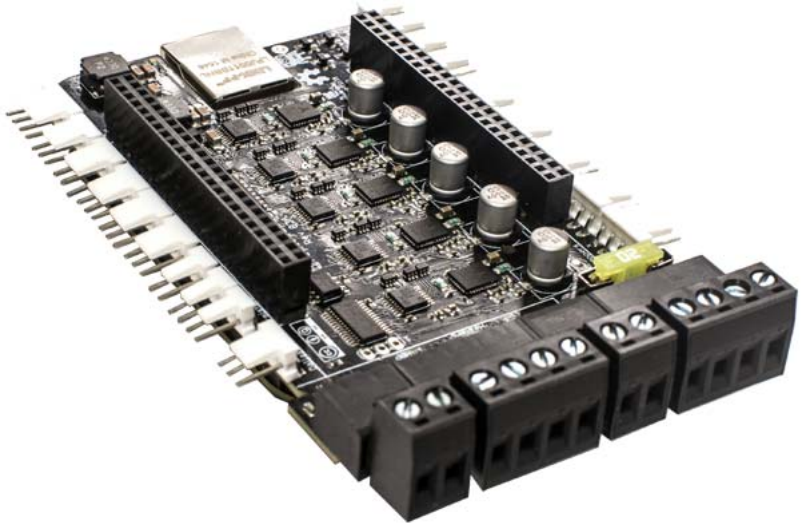
Replicape Rev B - 3D printer controller board

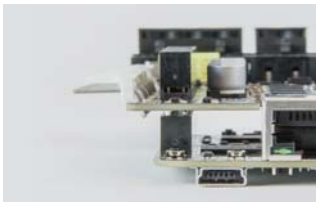
SKU 102991007



Description

Replicape is a high end 3D-printer electronics package in the form of a Cape that can be placed on a BeagleBone Black. This page is about the Major revision B. It has five high power and low noise stepper motors with cool running MosFets and it has been designed to fit in small spaces without active cooling and without the need for physical access to the board once installed. That means no potentiometers to trim or switches to flip.

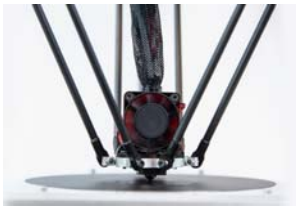
This page is about the hardware. It explains how to install the board and wire everything up. If you are looking for software that will run, have a look at the Kamikaze CNC image. There are other options as well, but that is the standard that will work for most people.



Blazing fast

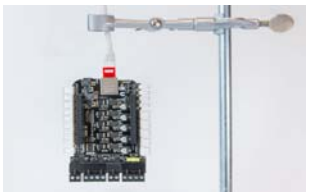
Replicape runs on BeagleBone Black, a 1GHz CPU with two additional 200 MHz PRUs.

What does that mean? It means you can have a huge delta while still running OctoPrint and Toggle.



Stealthy silent

By using the industry leading TMC 2100 stepper motor drivers, the sound leves are lowered to an incredibly low level. The stepper motor whining will not be the most prominent sound for your 3D-printer



Smart and connected

Replicape is a connected device, meaning it has access to the internet.

That is good, because it means it can run a web server giving instant access to all computers and smart phones in the network.

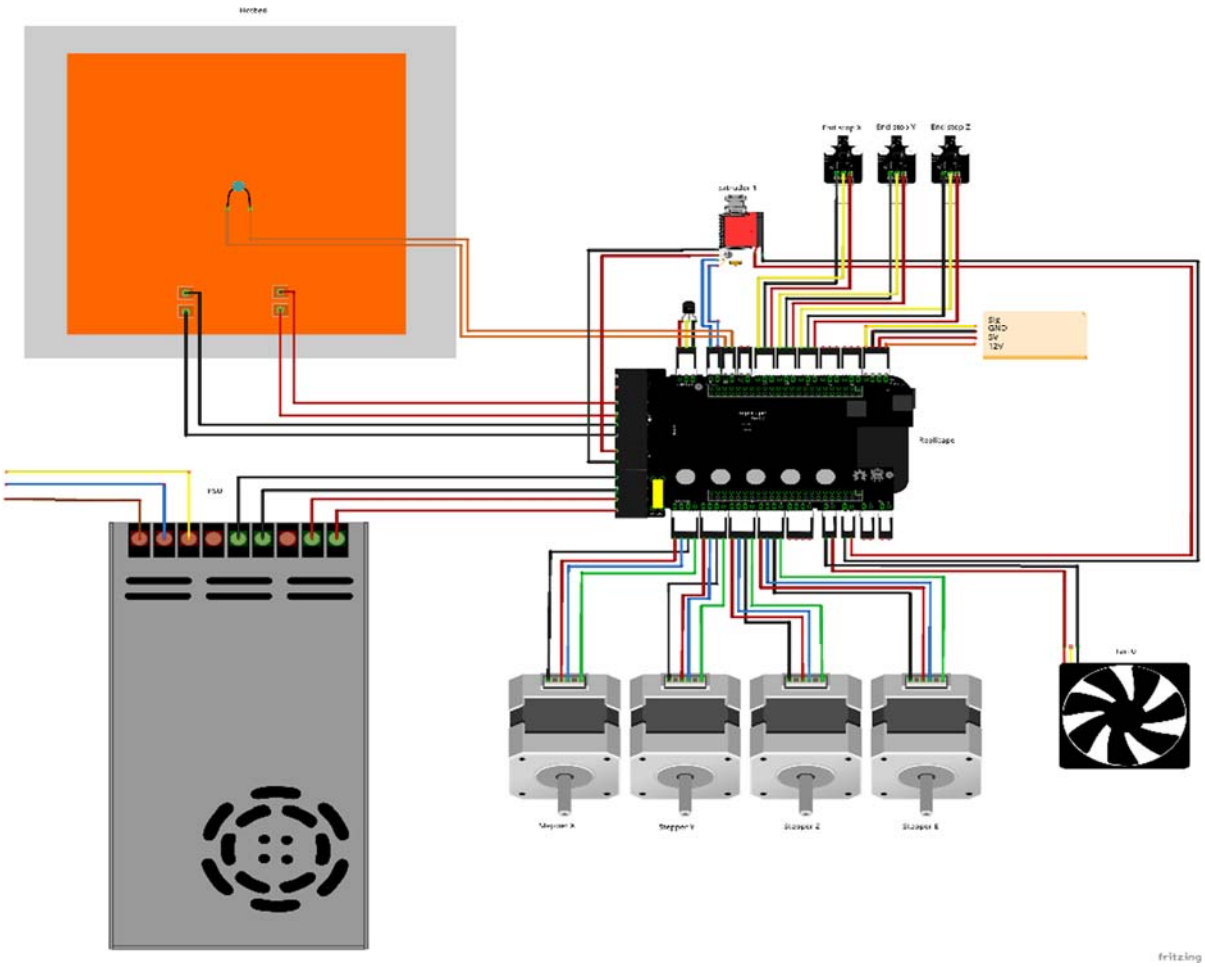
Mounting the Replicape on the BeagleBone.

As the name suggests, Replicape is a cape. Capes are one of the defining things about BeagleBone black/white/green, where the main development board acts as a base unit, and then accepts different add-on hardware through the two 48 pin headers, which in turn define some of the pin behaviors during Linux kernel startup. This is similar to"shields"on Arduino and"HAT"s on Raspberry Pi. Mounting the Replicape on BeagleBone should be pretty straight forward, just make sure the notch in the cape goes around the Ethernet connector so it makes a.. cape!

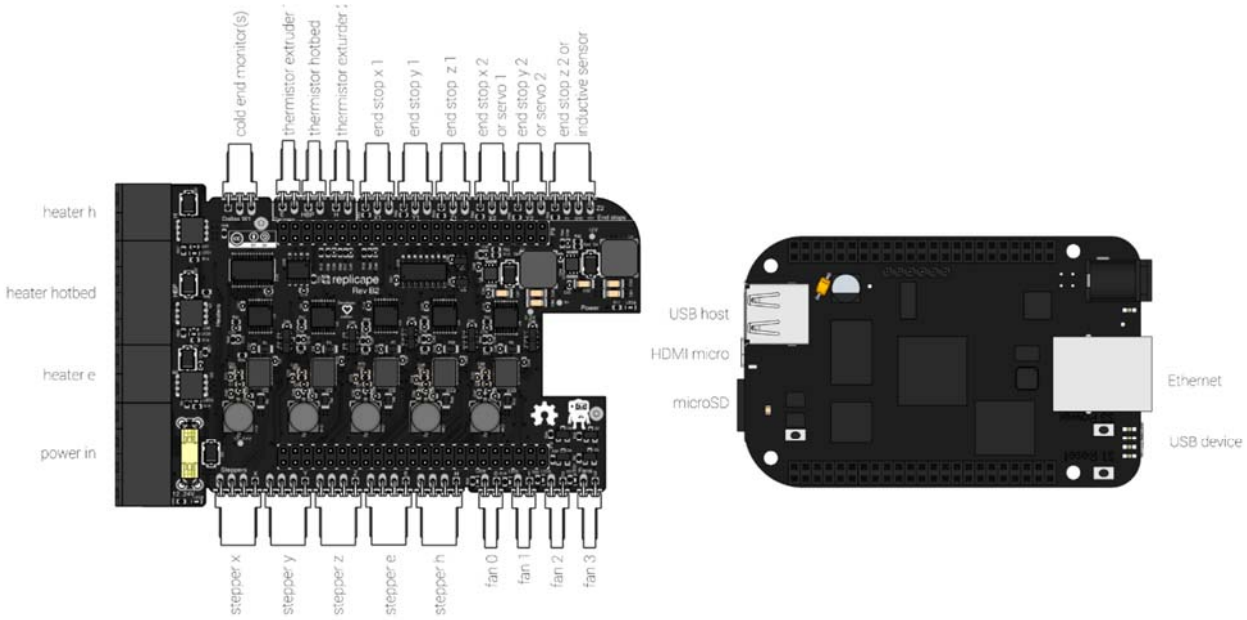
How to wire up the board

Fritzing example

The Fritzing board below shows the most basic setup for connecting the board.



Connector overview



Steppers

Bipolar and hybrid stepper motors are supported with these stepper motor drivers (SMD). Some smaller stepper motors are known to produce a high pitch noise and get very warm even with a low current setting. They will appear to work, but they may very well burn do to the large heat being produced.

With the board oriented as in the above image, the wires for the steppers are:

Rev B2: 1, 2, 3, 4 = OB1, OA1, OA2, OB2<- Not so standard

Rev B3: 1, 2, 3, 4 = OA2, OA1, OB1, OB2<- Pretty standard

Noise

The TMC2100 stepper drivers are designed to be very quiet. However, if the coil resistance on the steppers are too high, the current limit on the stepper drivers are never reached, and this makes the steppers give off a very high pitch sound. If you are experiencing high pitch noise, you might want to experiment with the"stealth mode"which will silence all steppers. This is micro stepping level 7 and 8. Stealth mode might make the steppers somewhat less powerful, but should work for most printers. To calculate if the current limit is reached or not, you can calculate the maximum coil resistance for a given input voltage. If the input voltage is 12V and you want to run your steppers on 1A current limit, the maximum coil resistance can be 12 ohm.

Heaters

The heater output on the Replicape have rugged connectors, with the heat bed having double connectors for redundancy (in case one wire comes loose) and for handling the power load. These are brand Molex connectors that have both screw terminals for easy fitting and slot in connectors for easy disassembly. All the heaters are controlled with PWM. The power MOSFETs controlling the output are AON6758 that are rated at 30V, 32A. For a 12V PSU, this means that the maximum power that can be used on the heated bed is 32 A x 12 V = 384 W. Please remember that there is a 20 A fuse preventing such a large power use on the heated bed. The 20 A fuse is installed to keep the traces on the PCB from over heating.

Thermistors

The thermistor inputs on Replicape have been designed for 100 K NTC thermistors. These are the typical type used for desktop 3D-printers. 10K thermistors can also be used, however the voltage divider setup makes the 100 K thermistors more ideal since the area of most change will be around 100 degrees. TODO: add charts for 10 K and 100 K thermistors showing their ideal temperature for most significant bit change.

Thermocouple

Thermocouple is not supported out of the box, but instead requires some extra care in order to work. Most importantly is to use a voltage divider on the signal so it is converted to a value that the analog input on the BeagleBone can handle: 1.8V. Secondly, the input needs to be sent in on AIN0..AIN3, which are pins P9_37...P9_40. Then, the analog input used needs to be enabled by a device tree overlay, ideally by editing the current DTO. That can be found here. Finally, the software needs to be hacked to make use of the new analog input and conversion.

https://en.wikipedia.org/wiki/Voltage_divider

https://github.com/eliasbakken/bb.org-overlays

Inductive sensors

Inductive sensors are typically mounted on the end stop marked Z2. If you have an NPN (sinking) sensor, you can mount it directly on there.

Typically

Brown: 12V (pin 4)

Blue: GND (Pin 2)

Black: Sig (Pin 1, square)

If you have a PNP (sourcing) type, you need to add a pull-down resistor externally between the signal and ground on the sensor. The value is not important, as long as it can comfortably pull a 4.7K resistor low. 1K should be fine.

DS18B20 temperature sensors

The connector marked Dallas W1 can be used for connecting temperature sensors of the type DS18B20. These are relatively low temperature sensors that can handle up to 125 degrees Celsius and are typically used for monitoring the cold end of the extruder which should never reach more than around 60 degrees when printing with PLA. The great thing about using a cold end monitor is that the temperature measurements can be used to regulate the fan on the extruder. That way, the noise level can be lowered further than when using the thermistor as a trigger for enabling the extruder fan.

Switches as end stops

All the end stops have 4.7K (47K on Rev B3) pull-up resistors on the signal lines. Therefore, the best way to connect switches is between the signal and ground pins on the connectors. If the switches have can be connected as normally closed (NC), that is preferable since it will act as a pressed in switch if a cable has been destroyed or removed.

The signals on the end stops as as follows:

pin 1, square, signal (yellow wire in Fritzing diagram above)

pin 2, round, GND (black wire in Fritzing diagram above)

pin 3, round, VCC (red wire in Fritzing diagram above)(5V)**Connectors**

Replicape comes with Molex screw terminals for the heaters, hot bed and power input. Most stepper motors comes with the 4 pin Molex 2.54 mm (0.1") female connector attached. Fans and end stops sometimes comes with the right connector, but not always, it depends on the manufacturer. The white 2, 3 and 4 pin connectors on Replicape used for thermistors, end stops and steppers are the MTA-100 series from TE connectivity.

Power

Replicape is powered through a single 12 to 24 V power supply. This powers the BeagleBone as well, through a 5V step down converter. It also supplies 12V for fans and the inductive sensor. If the USB device connector is used, no power is drawn through the connector.

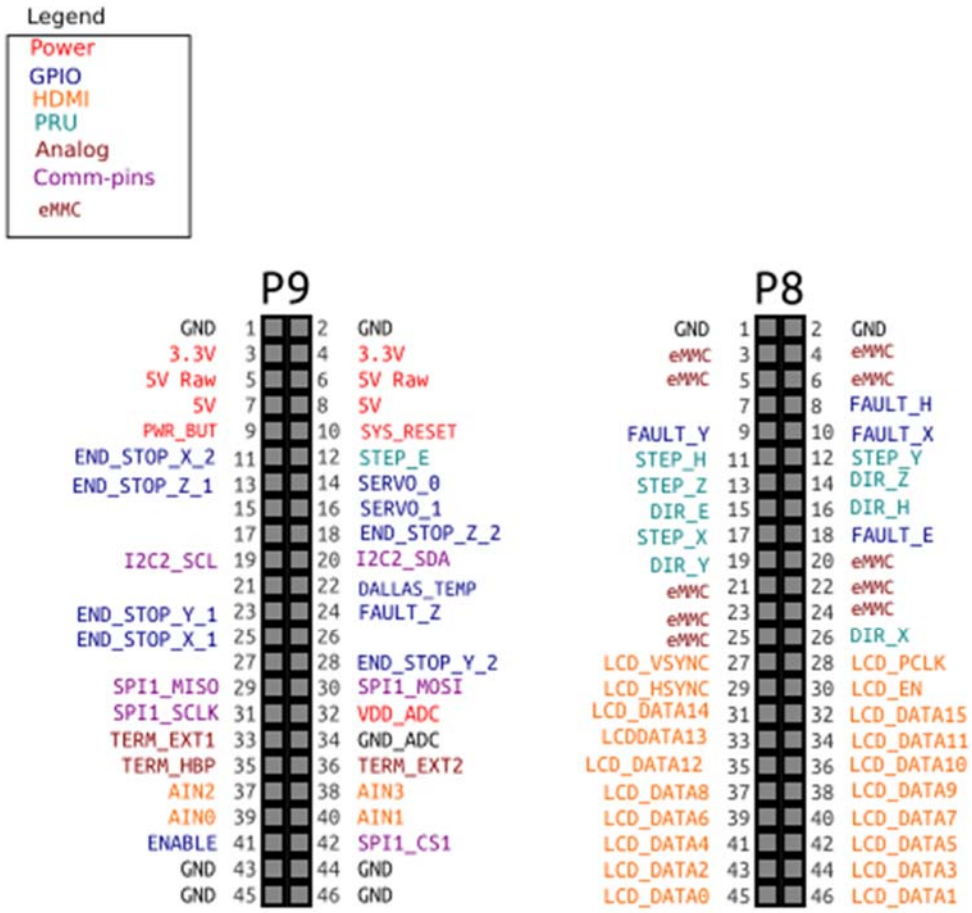
Note that if you do not power the Replicape, the BBB will not be able to properly communicate with it, and you will get an error such as

kamikaze redeem[675]: Error accessing 0x70: Check your I2C address

Hardware details

Pins on the BeagleBone used by replicape

Below is a diagram of the pins that have been used on the BeagleBone.



Technical Details

Weight	G.W 60g
Battery	Exclude

Part List

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