

Cherry Pi Calibration Guide

Calibrate the towers to the actual build surface

Carry out the following procedures, initially, with the heated bed cold and the nozzle cold, and clean i.e remove any bits of extruded plastic from the nozzle.

Set up five scripts in RepetierHost, to move the carriage to four specific measurement locations on your build surface and then save the resulting changes. Three locations are on a circle centred on the centre of your build surface immediately in front of each of the three towers. The fourth is the actual centre of your build surface. And each of the four locations is at height Z=0. The fifth script saves any changes and homes the carriages. It also lists the new values for the M666 variables.

In the version of Marlin installed on the Cherry Pi the M666 command allows you to change the following values and you can list them at any time with M666 L :-

Current Delta geometry values:

X (Endstop Adj): -2.25
Y (Endstop Adj): -2.60
Z (Endstop Adj): -2.20
P (Z-Probe Offset): X0.00 Y0.00 Z0.80
A (Tower A Position Correction): 0.00
B (Tower B Position Correction): 0.00
C (Tower C Position Correction): 0.00
I (Tower A Radius Correction): 0.00
J (Tower B Radius Correction): 0.00
K (Tower C Radius Correction): 0.00
R (Delta Radius): 121.20
D (Diagonal Rod Length): 231.99
H (Z-Height): 254.10

(The values shown are typical for a Cherry Pi but yours will probably differ slightly)

Let's call the three tower locations X, Y, and Z, and the centre C. Tower X is the front left tower, tower Y is the front right tower, tower Z is the rear tower. The script code for each is:

Script	Code
X (Script 1)	g0 f8000 x-77.94 y-45 z0
Y (Script 2)	g0 f8000 x77.94 y-45 z0
Z (Script 3)	g0 f8000 x0 y90 z0
C (Script 4)	g0 f8000 x0 y0 z0
(Script 5)	M500 G28 M666 L

(Decoded, g0 is a move to an absolute location, f8000 controls the speed of the move, and x, y, and z are followed by the corresponding coordinates in 3D

Cartesian space. The x and y coordinates are points on a circle 90mm from the build surface centre and directly in front of each of the three towers. Script 5 saves any new values to the EEPROM on your Arduino Mega 2560 using the M500 command, homes the carriages with the G28 command and then displays the current M666 values with M666 L)

Now run script 1 in RepetierHost (CTRL/ALT/1 or select Printer/Send Script 1 from the menu). The carriage should move down to a point in front of tower X. The proper height should be just above the print surface, with clearance space for a single sheet of paper to slide between the nozzle and the bed. Adjust the end-stop offset value for the X tower with M666 X if necessary, Use M666 L to show the current value of the X offset and then add to it (to close the gap between the nozzle and the bed) or subtract from it (to open the gap between the nozzle and the bed). Note that all end-stop offset values are negative so must be preceded with a minus sign E.G M666 X-2.55. Save the new value by running Script 5 (CTRL/ALT/5 or select Printer/Send Script 5 from the menu) then repeat the test by running script 1 again. Repeat until the paper slides between the print surface and the nozzle with only slight drag.

With tower X adjusted, move on to tower Y, and then to tower Z. When tower Z is adjusted, you should be able to go back and successfully repeat the test on tower X (and Y) without having to readjust.

Calibrate the printer to print flat

At this point, it is likely that if the firmware instructs the printer to move the carriage across the build surface, the nozzle tip will not stay true to the build surface. Even though the extruder will be at the calibrated correct Z height at each of the three tower locations, it will either be above or below the build surface at the centre of the build area. This is also corrected by adjusting the firmware using the M666 command.

Run script 4 (CTRL/ALT/4 or select Printer/Send Script 4 from the menu). The carriage should move straight down to the centre of the build surface. You will see one of three things. The extruder nozzle will be above the build surface, be at just the right height (using the paper test), or will hit the build surface.

The value in the firmware constant DELTA_RADIUS in Marlin controls the "flatness" of the movement of the carriage at a given Z height. If DELTA_RADIUS is too large, the extruder nozzle will track below the desired Z height inside the calibrated points X, Y, and Z. If DELTA_RADIUS is too small, the extruder will track above the desired Z height inside the calibrated points X, Y and Z.

The M666 variable to adjust is M666 R and must always be a decimal number i.e 253.0 for 253 (or whatever decimal is required E.G 253.3)

To lower the extruder nozzle

Increase DELTA_RADIUS by increasing the value of M666 R

To raise the extruder nozzle

Decrease DELTA_RADIUS by decreasing the value of M666 R

For your first cycle, if you are above the build surface, increase DELTA_RADIUS by (about) the same amount. If the extruder nozzle hits the build surface, decrease DELTA_RADIUS.

Next, repeat the X, Y and Z tower calibration process. Changing the DELTA_RADIUS changes the tower calibrations, so you must cycle through the process of adjusting the X, Y and Z scripts again. And when the X, Y and Z towers are set, test the centre C script.

You may have to repeat this a few times with smaller changes to DELTA_RADIUS, but eventually, the drag on a piece of paper should be the same at all four locations. Now the printer knows how to print flat at a given Z height.

Once all the above is correct you can set the nozzle height for printing by heating the nozzle to printing temperature (around 210 for PLA) and the bed to about 60. When the bed and nozzle are at the correct temperature send the C script, script 4 from RepetierHost to position the nozzle just above the centre of the build plate check the gap using the paper test described above. The nozzle (Z) height can be adjusted using M666 H. Increase the current value to bring the nozzle closer to the bed or decrease it to move the nozzle further away. Save the new values using script 5. It's a good idea to re-check the heights at the X, Y and Z script positions as well and re-adjust as necessary.

When you are happy that, at printing temperatures all is correct you can issue an M666 L command to list the M666 variables and then copy and paste them to a file for safe keeping. They can be re-entered using M666 at any time in the future to save having to do a full calibration should you need to re-load the Marlin firmware for any reason.

Calibrate the printer to print to correct dimensions.

At this point the printer probably prints, but the results are dimensionally wrong. Printing something 100mm long results in a printed object that is not exactly 100 mm long. This also, can be corrected in firmware using M666. Adjustments to DELTA_DIAGONAL_ROD in the firmware control the size of the printed object. The M666 command to achieve this is M666 D. This also needs to be a decimal value.

Download a simple calibration object from Thingiverse, slice it, and print it. By measuring the actual size of the object as printed and comparing it to the size in the design, the accuracy of the printer can be assessed and adjusted.

If the length of the object is wrong, adjust DELTA_DIAGONAL_ROD using M666 D

new M666 D value =

$(\text{measured length of printed calibration object} \times \text{old M666 D value}) / \text{actual length of calibration object}$

E.G calibration object is 50mm and current M666 D value is 231.99 and the printed object measures 49.34mm. The new value for M666 D would be :-

$(49.34 \times 231.99) / 50$ i.e M666 D228.9277

Send the new M666 D value and save with M500 and print and measure again. Repeat until the printed object measures correctly, the printer is printing accurately to size and is fully calibrated.

Happy printing!