Rich Cattell's Marlin Branch delta calibration for newbies

Credits

Rich Cattell (and contributors) for making this version of auto calibration possible
Ira Nana, Minnow blog, and others in google groups

This is a work in progress so feel free to contact me with edits or corrections at dfruehwald@yahoo.com

Introduction

Automatic calibration can be a huge timesaver but it will not give you a perfectly calibrated printer. It gives you a good starting point with end stops set and flat movement across the print bed. Be prepared to have to make manual adjustments to dial in the dimensional accuracy you want.

I'm no expert, I'm just compiling what I've learned from setting up my delta printer, google groups, and lots of web surfing. This set of instructions is based on the current testing branch of Rich's code but should work with the Master branch also.

Before attempting an automatic calibration

- All printer settings in configuration.h need to be done
- All end stops must trigger correctly
- All motors must move in the correct direction
- G28 works as expected
- All diagonal rods are equal in length (or as close a possible)
- All towers are equidistant from each other (or as close as possible)
- All towers are perpendicular to build surface (Roofers square is flat against tower and bed)
- All towers equidistant from center of build plate (to maximize build area)
- Extruder calibrated (to print calibration object later)

Automatic Calibration

1. Run *M502* to reset all parameters to firmware defaults
2. Set your probe offset here with *M666 P<value>* if you don't know this value you can use zero and adjust z-height later with M206 or by tweaking the end stops with M666 X, Y, Z
3. Run *G30 A* to perform automatic calibration
4. Run *M500* to save the new parameters to nonvolatile memory
5. Run *M666 L* to list out all the new parameters
6. Copy the parameters and save them in case something goes wrong

At this point all of you parameters have been set such that the hot end will move parallel to the build plate but your prints most likely will still not be dimensionally accurate. If your probe offset was set correctly you should be able to print and have the first layer be close to the size set in your slicer settings.

Checking Z-height before print

Before doing a print I like to check the Z-height by moving the hot end to 1mm above the bed and stepping down to a piece of paper. Typical copy paper is around 0.1mm so at 9 of the 0.1mm steps the hot end should grab the paper. Measure your paper to be sure and adjust the steps based on the thickness of your paper. Check four spots (assuming 170mm bed):

- Tower A – G0 F8000 X-77.94 Y-45 Z1
- Tower B – G0 F8000 X77.94 Y-45 Z1
- Tower C – G0 F8000 X0 Y90 Z1
- Center – G0 F8000 X0 Y0 Z1

If all four spots grab the paper at the correct number of steps move onto to checking dimensional accuracy.

Adjusting Z-height

If your z-height is a bit off now is the time to adjust it. The two ways I know of to correct the z height are to use M206 Z or M666 X, Y, Z. M206 works great if all the A, B, C spots need the same adjustment value. M666 X, Y, Z lets you tweak each tower individually.

Take the difference in the number of steps that grabbed the paper at A, B, C and if all were the same (they should be after G30 A) you can issue M206 with a positive value to move the effector away from the bed or a negative value to move it closer. If they A, B, C points do not need the same correction than use M666 X, Y, Z to correct each tower individually. These numbers are always negative so decrease the number to move the effector away from the bed, increase it to move towards the bed.

Repeat until hot end is positioning correctly at the A, B, C positions. If after getting A, B, C right the center is still off you have a problem with Delta Radius.

Adjust delta radius using M666 R to fix the center z height. If your effector is higher in the center than the edge then increase this number, if it is lower at the center then decrease this number.

Use M500 to save the values to EEPROM (I also like to save the M666 L or M503 output somewhere in case it gets scrambled)

Repeat until all points are as close as you can get them. The idea is to have the effector moving as flat as possible across the entire bed.

Checking Dimensional Accuracy

1. Prepare your printer and print the calibration object
2. Measure the X, A, B, C/Y lengths (should be close to the same)
3. Measure the brim height (should be close to first layer height set in slicer)

If all the lengths are as expected and your brim is the height set in the slicer, congratulations you're done, if not read on.

Adjusting Dimensional Accuracy

Need input on this section, have not gotten here on my printer yet.

1. *Use Tower Radius (I, J, K), fix objects A, B, C arm lengths to be as close to equal as possible*
2. *Use Diagonal Rod Length (D), fix all arm lengths for dimensional accuracy*
3. *Use Delta Radius (R), fix all Z heights to be similar*
4. *Use end stop offset to fix z to correct height not that all are similar*
5. *Recheck zero to be sure it's still good*

Note: Remind people to M500 to save also

Appendix A – OpenSCAD Calibration object

I suggest printing this with a skirt and a 2 to 3mm one layer brim. The skirt will allow the hot end to get the flow even prior to printing the actual object, the brim will give you something to measure the height of the first layer so you can match it to slicer settings.

```
length = 100;    //based on your printer and micrometer
width = 5;
height = 5;

module Asterisk(length, width, height)
{
      // rear tower
      cube([length, width, height], center=true);

      // front right tower
      rotate([0,0,60])
      {
            cube([length, width, height], center=true);
      }

      // front left tower
      rotate([0,0,-60])
      {
            cube([length, width, height], center=true);
      }

      // horizontal
      rotate([0,0,90])
      {
            cube([length, width, height], center=true);
      }

}

rotate([0,0,90])
{
      Asterisk(length,width,height);
}
```

Appendix B - G30 quick reference

G30 (without any parameters) - Probe bed a report current values
G30 Ax.xx - Full autocalibration (x.xx = optional value to specify required precision - if this is not specified the value in configuration.h will be used)
G30 E - Autocalibrate endstops (and then stop)
G30 R - Autocalibrate Delta Radius & Endstops (and then stop)
G30 D - Autocalibrate Diagional rod length (and then stop)
G30 Ix - Autocalibrate Tower position for Tower x (x= 1 for X tower, 2 for Y tower, 3 for Z tower) - This adjusts the A,B,C M666 values
G30 Tx - Autocalibrate Tower radius for Tower x (x= 1 for X tower, 2 for Y tower, 3 for Z tower) - This adjusts the I,J,K M666 values

Appendix C - M666 quick reference

L – List all values

M666 values as a formatted list with descriptions.

X, Y, Z – End stop adjustments

Always a negative value and specifies how far away to position the carriage after hitting the Max end stop. Make the value larger to move the carriage closer to the bed, smaller to move the carriage away from the bed.

P – Z-Probe Offset

Corrects for any difference in height between when your Z-Probe is at 0 versus the hot end being at 0. If your probe triggers before the hot end is at zero this will be a positive value. If your probe triggers at a value below zero (like some FSR's) the value will be negative.

A, B, C – Tower position correction

Adjust the tower position relative to the radial line from the center to the tower.

Positive value move the tower in the clockwise direction, negative values shift it counter-clockwise.

I, J, K – Tower radius correction

Adjust the tower position relative to the center of the build area. Starts at 0, negative numbers position the tower closer to the center, positive values position the tower away from the center.

If your test object's A, B, C arms do not match in length, use this value to adjust the length on that particular axis. Lowering this value will shorten the length, raising it will increase the length relative to that tower.

R – Delta radius

Adjust the effector Z height at the center relative to its Z height at the edge of the build area. If your effector is higher in the center than the edge than increase this number, if it is lower at the center than decrease this number.

D – Diagonal rod length

Adjusts the relative X/Y length of the printed object. If your calibration objects arm lengths are too short then decrease this number. If the measurements are too long then increase this number.

H – Z-height

Sets the maximum Z-Height when the effector is centered, use this to raise /lower the effector at the center. Increasing this number will lower the effector towards the bed, decreasing this number will raise the effector above the bed. This number needs to match up with your X, Y, Z end stop offsets such that at Z=0 the hot end is touching the bed.