Filament scale – FULLY Read this before printing anything!

This folder should contain all the necessary files to replicate my filament scale with database (as shown in my video: https://www.youtube.com/watch?v=w4BVC18xrVI)

I know this document is long and might seem daunting, but there's really nothing special going on here. It's just a standard enclosure with a load cell stuck to it. If you've ever designed an enclosure for electronics before, you might even be able to redesign this thing from scratch.

BIG FAT WARNING: The CAD files are quite messy and will very likely require tweaking before they fit your needs. Different load cells have different mounting holes, and different ESP32's and buttons etc. might also cause problems. The bill of materials for the specific items I used are below.

1. Mechanical assembly

These models are quite rough. Since these took a long time to print, I couldn't iterate all that much. Oftentimes I also had to design without having the actual components at hand. Because I only printed them a few times, some mistakes are still in the designs (and I fixed them afterwards with my Dremel and hot glue gun).

You'll need to print 3 parts:

- The base
- The lid
- The holder shaft

This folder contains two versions of the base:

1.1 FS_Base

this is the first version that uses embedded M3 nuts to secure the lid to the base. I don't recommend this version, but I included it because it shows how to make this without heated inserts. This is the older version, which means that it might have some flaws that I fixed in the subsequent version (the one described below), BUT that newer version uses heated inserts instead of embedded nuts. The mounting holes for the load cell are spaced 10mm apart, for use with this load cell from Aliexpress: https://www.aliexpress.com/item/33046037411.html?spm=a2g0s.9042311.0.0.17674c4dvHD30m
You should probably check the mounting holes for the ESP too, since I'm not sure for what version I made those. The corresponding files for this version are:
- FS_Lid
- FS_Shaftsmall

The FS_ShaftSmall has mounting holes for the specific load cell mentioned above.

1.2 FS_Base_Insert

This is the most recent version, including some tweaks. The biggest difference is that this version uses heated inserts (the ones I used: https://www.aliexpress.com/item/4000460370347.html?spm=a2g0s.9042311.0.0.17674c4dvHD30m) instead of embedded nuts for mounting the lid and the ESP32. Another difference is that this version uses a different load cell: https://www.tinytronics.nl/shop/nl/sensoren/gewicht-druk-kracht/load-cell-5kg

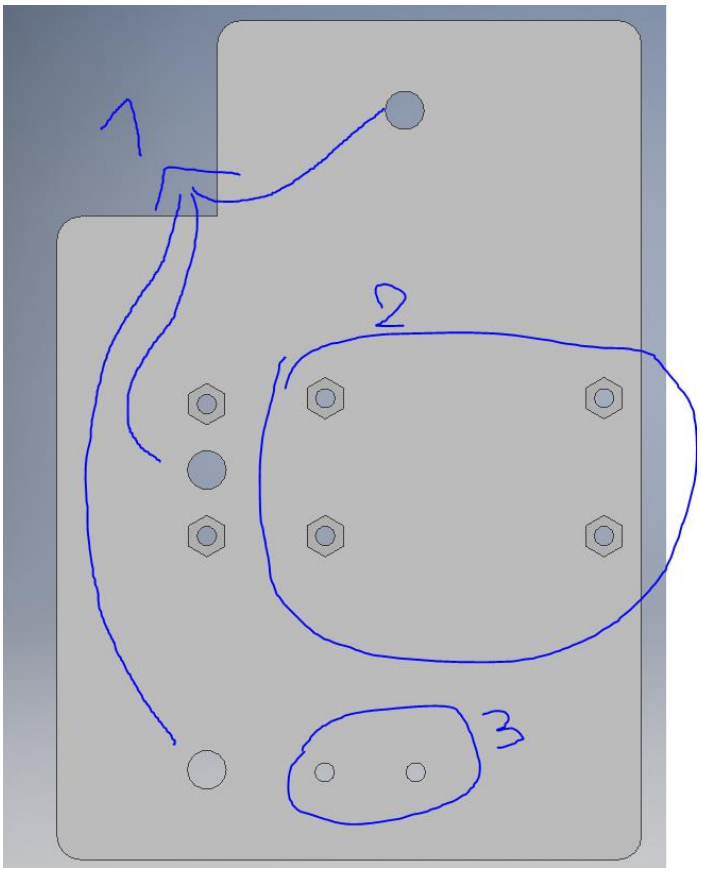
This one has different spacing on the mounting holes (and different size). Subsequently, this base also has a different version for the shaft and lid:

- FS_Lid_Insert
- FS_Shaft_Big

1.3 Mounting hole guide

(this is image shows the FS_Base (= old version), but the positions should be the same for the FS_Base_Insert)

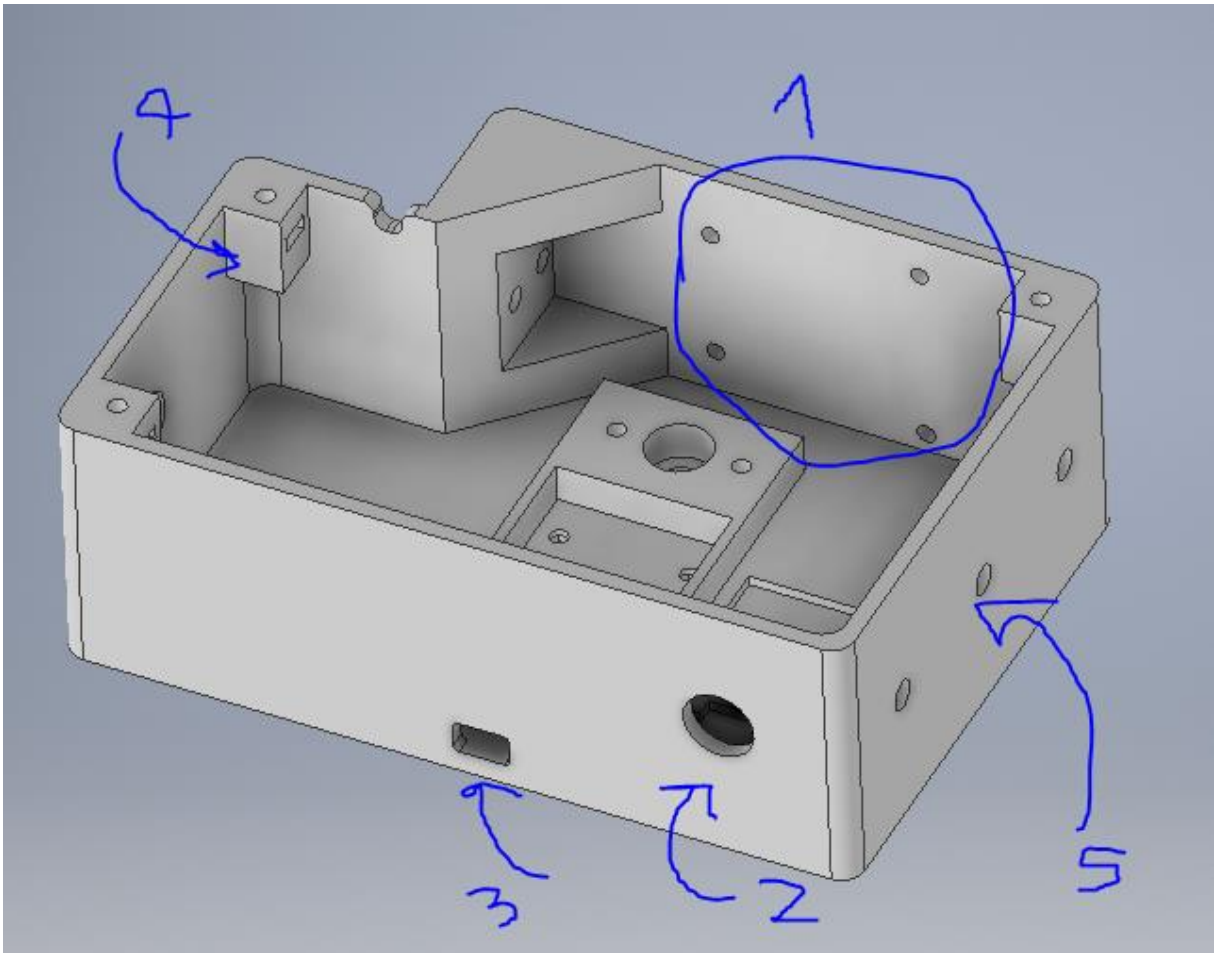
My apologies for the ugly screenshot. I might make a pretty technical drawing one day. But not today.



1) Mounting holes for attaching it to my custom 3D printer, these are useless for the Ender 3
2) Mounting holes for the ESP (on the FS_Base_Insert, these will be normal holes for a heated insert)

3) Holes for the load cell amplifier. On the FS_Base_insert, these are larger for a heated insert, BUT here the heated inserts don't work because the floor is too thin. That's a mistake on my part. I just hotglued the amplifier in place. Forgive me for sinning.

The remaining holes that I didn't indicate (the ones next to the ESP) are redundant; I had some ESP's without mounting holes so I used these mounting points to attach an extra piece that clamped the ESP in place.



1) Mounting holes for the RFID reader
2) Mounting hole for either the button or the DC power jack; at the top there's a second similar hole to fit one of these too. For the ender 3, you'll want your power jack here (mark 2 on image) and the button on the top.
3) Hole for the ESP32 to connect to PC (this is important for calibrating the load cell). This hole is too small for most common ESP32's, for the one I had lying around it's sufficient. YOU'LL WANT TO CHECK THIS FOR YOUR ESP32.
4) Mounting for the lid. The FS_Base version has a slot to slide a nut in, but this doesn't always work too well. That's why you can also put a nut on the bottom of this little overhang (check the 3D file in case you don't understand)
5) Mounting holes for the ender 3.

You'll notice there are some recesses in the case floor. These indicate where the PCB's go (see BOM). Usually I just hot glue these in place (I should go to jail for that, I know).

1.4 Load cell

For mounting the load cell, I suggest putting some washers between the load cell and the case (same thing inbetween the load cell and the shaft).

1.5 How to print

This is fairly straight forward. The base is oriented with the lid facing up, like in the previous image. The lid itself is printed face down onto the buildplate. I used both a 0.4mm and a 0.6mm nozzle to print these. I generally recommend a bigger nozzle to get the print time low. Layer height is fine at standard settings for your nozzle (0.2mm and 0.32mm respectively), but of course smaller layer height will be stronger. The base needs supports under the embedded nuts for the ESP (for FS_Base), under the triangular braces next to the load cell mounting holes, underneath the lid mounting points (number 4 on previous image) BUT NOT INSIDE THE MOUNTING POINTS, OTHERWISE YOU CAN'T SLIDE IN A NUT. Make sure to use support blocker (Cura) on those. The holes on the walls should come out just fine without supports.

I highly recommend to print the embedded nut/heated insert features separately first to check tolerances. Also check if the mounting holes for the ESP and RFID match. Oh, and also check whether the ESP32 USB connector is still accessible once mounted, since you'll have to program it once it's installed to calibrate the load cell.

2. Electrical

I don't have a schematic, but the ESP code should mention the pin connection in the comments right next to the initialization code for each component. I used a buck converter to convert the 24V of my 3D printer to 3.3V. I used some Wago connectors to make a this into a 3.3V and ground rail, and connected everything using jumper wires. It should be relatively straight-forward.

3. Code

3.1 ESP32

I suggest you test all of your components separately with example code before uploading my code, and when doing so, use the same libraries as me. You might need to tweak several things that I can't even think of.

Also, the code folder contains 3 sketches, but these are supposed to be in one file, but multiple tabs (as can be seen right here in the video: https://youtu.be/w4BVC18xrVI?t=190). For some reason, I can't get the Arduino IDE to open these simultaneously, so you'll likely need to copy paste them in there yourself.

The ESP code requires some parameters to work for your setup. For one, you need to include your wifi ssid and password. You'll need to replace "your_ssid" and "your_password" with these respectively. Also, to establish a connection with the google sheets, you'll need to enter a key that

grants you access. This key is specific for your google sheets account, so you'll need to set that up first (see below). You'll need to replace "your_GAS" with this key.

For the OLED screen you might have to adjust some settings too to get it to work. Again, test this out using the same U8g2lib library I'm using.

You'll need to calibrate the load cell. This might vary for each load cell, even if they come from the same seller! Look up the word 'calibration' in the Arduino code (near the very bottom of the 'sheetstest' sketch). You'll need to change 3 values:

float zeroPoint

float knownW

float knownWAt

When you properly connect your load cell so that you can read its raw output (I used the basic example from the library), you'll want to note that value in these three cases:

1) When there's nothing on the load cell, except for the shaft of course. Enter this value into the variable zeroPoint.
2) Using a kitchen scale, measure the weight of one spool in grams. Enter this value into the variable knownW.
3) Now take that SAME SPOOL, and put it onto the spool holder. Note the output of the load cell. Enter it into the variable knownWAt.

For each of these, add some decimal zeroes to make sure that there's no rounding errors. For instance, if you measured 289446 for knownWAt, enter 289446.000 into the code. I know it's ugly, I'm sorry.

3.2 Google sheets code

You'll need to follow this tutorial to learn how to set up your sheets document so that it can accept external data: https://www.youtube.com/watch?v=oVgKkCO4CXQ You'll notice I used some of their code too.

I copy pasted the google sheets code into a text file in the code folder ("Google scripts code.txt"). You should be able to copy paste everything in there without any trouble once you used the tutorial above. However, the setup I made in the google sheets itself, I can export. For that reason, I copied my database to serve as an example for you guys. You should be able to copy paste the contents into your own sheets (or maybe even save as a copy?). Here's the link: https://docs.google.com/spreadsheets/d/1rK43gxUxIcJf6h-AjdytF1M80kL5fcfw8V61VSNi2tg/edit?usp=sharing

You'll need to set the time based trigger yourself. Follow this tutorial (the function you want to execute is LogData, this will also automatically make the weekly stats):

https://www.quora.com/How-can-I-periodically-run-a-Google-Script-on-a-Spreadsheet

Important usage notice: When you scan and upload a new filament to the database, you'll need to enter some stuff manually. Firstly, you'll have to copy the cells for the weight (column B) and the brand (column E) into the row that contains the new filament. You'll also have to give it a name, and

If you want, a recognizable color. Next, you'll have to add a new column into the 'logged data' sheet. You'll want to enter the name of the filament in the next empty column (make sure to match the name from the main page!). In order to get the right usage stats and line graph, you'll want to fill up the row you just made with its starting weight (which should be on the main page already) up until the row. You're basically telling the database that you've always had that spool, and that it has always been full.

You'll have to do a similar thing for the 'usage statistics' sheet. Make a new column at the end with the filament name at the top, and this time, fill it up with zeroes up until the last row. You're basically telling the database that you've always had this filament, but have never used it (0 usage).

The graphs will automatically detect that there's a new set of data. I have honestly no idea how they can change their range dynamically like that, since I never told them to do that, but they just worked from the get-go. Don't tell them though, they'll start slacking if you compliment them too much. Optionally, you can change the colours of the bar graph and line graph to match the colour of your filament. I couldn't find a way to do this automatically within the graph settings in google sheets, but I do know you can do it via scripting.

I know the above actions seem like a bother and that they hurt the usability, but take it from me, they don't. Once you understand what you need to do, you can literally do this in 30 seconds. Scan the spool, get the new entry, copy paste the brand and weight cells, make a name, copy that name, paste in both of the sheets and fill the columns. My record time is 18.38 seconds. I challenge you to do better. No, seriously, time yourself and tell me in the comments of my video what your time was.

4. Bill of materials

This BOM uses some local suppliers, but you might be able to find equivalents in your country, and definitely in China (Aliexpress).

- ESP32: https://www.tinytronics.nl/shop/nl/communicatie/bluetooth/esp32-wifi-en-bluetooth-board-cp2102
- Load cell: for the FS_Base (not recommended) I used: https://www.aliexpress.com/item/33046037411.html?spm=a2g0s.9042311.0.0.17674c4dvHD30m
  for the FS_Base_Insert I used: https://www.tinytronics.nl/shop/nl/sensoren/gewicht-druk-kracht/load-cell-5kg
- Load cell amplifier: https://www.tinytronics.nl/shop/nl/sensoren/gewicht-druk-kracht/load-cell-versterker-hx711
- RFID reader: https://www.tinytronics.nl/shop/nl/communicatie/rfid/rfid-kit-mfrc522-s50-mifare-met-kaart-en-key-tag
- RFID Stickers: https://www.aliexpress.com/item/32654646206.html?spm=a2g0s.9042311.0.0.17674c4dvHD30m
  When buying RFID stickers from somewhere else, make sure they match the ISO/IEC 14443 A/MIFARE standard of the reader.
- OLED screen: https://www.tinytronics.nl/shop/nl/display/oled/1.3-inch-oled-display-128*64-pixels-blauw-i2c

- 24V-3.3V buck converter: https://www.tinytronics.nl/shop/nl/spanning-converters/step-down/dc-dc-step-down-buck-converter-1.5a-3.3v-output
  None of these components draw that much current, so a smaller one might be sufficient too.
- 12mm push button: https://www.tinytronics.nl/shop/nl/componenten/schakelaars/zwarte-drukknop-12mm-reset-pbs-33b
- DC jack: Female for the case: https://www.tinytronics.nl/shop/nl/connectoren/jack-pluggen/dc-jack-plastic-5.5mm-female-mount
  Male for the external power supply: https://www.tinytronics.nl/shop/nl/connectoren/jack-pluggen/dc-jack-plastic-5.5mm-male
- Heated inserts:
  https://www.aliexpress.com/item/4000460370347.html?spm=a2g0s.9042311.0.0.17674c4dvHD30m
- Various M3, M4 and M5 nuts and bolts.

Let me know in the comments of my video if you have questions! I can't guarantee that I can fix them instantly, or that I can debug your code/design for you, but I might have forgotten some things in the document.