Section 1 reference graphics

Here is a top view of the circuit board

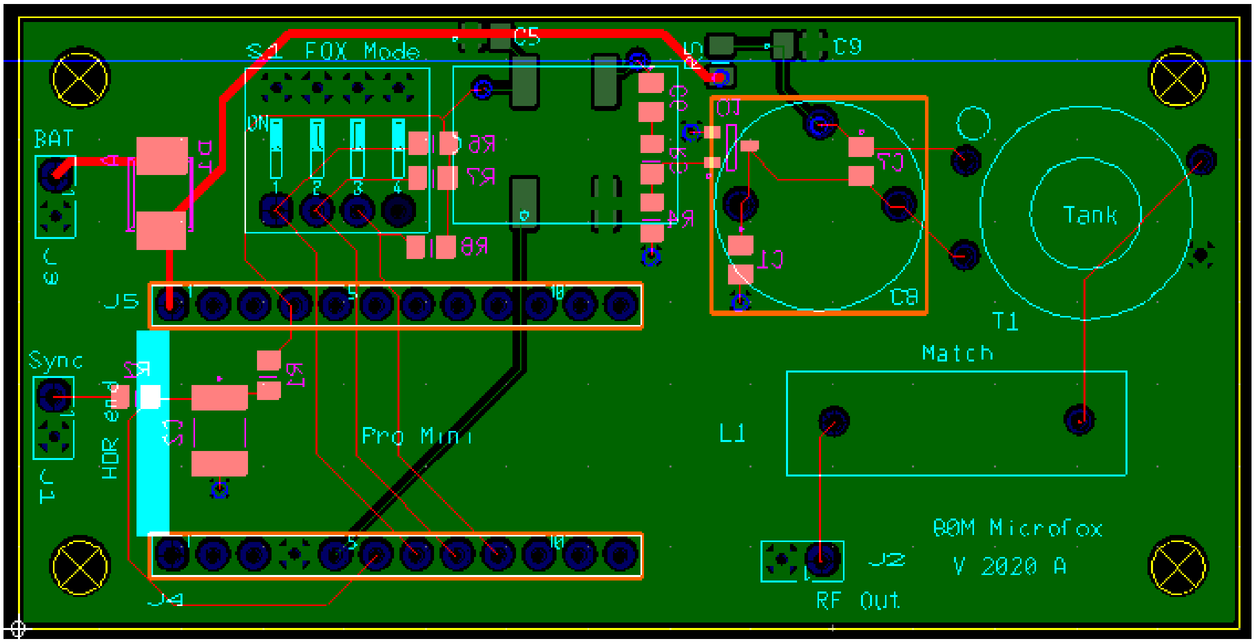


Figure 1 top view of circuit board

Bottom view of the board (looking down from the top in the cad program)

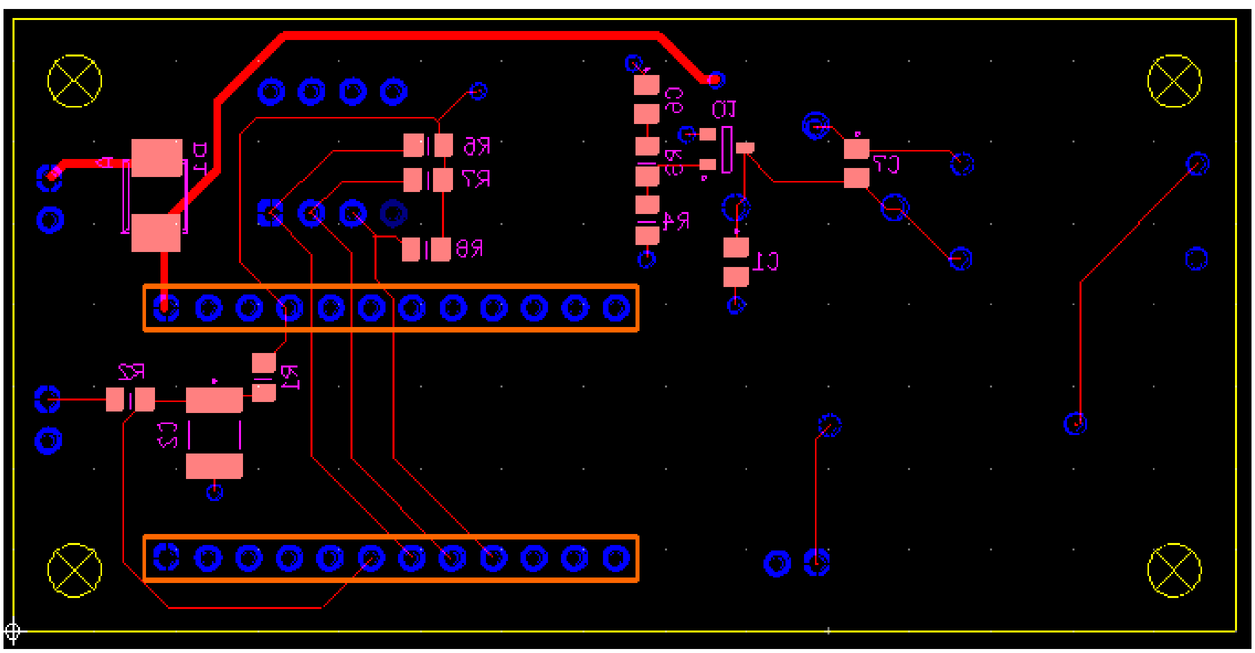


Figure 2 bottom view of the board looking down from the top

Photo of bottom of the board showing connection to tone output. This is a feature that was recently added to the software that can allow using the unit for a start timer or have audio for demo modes.

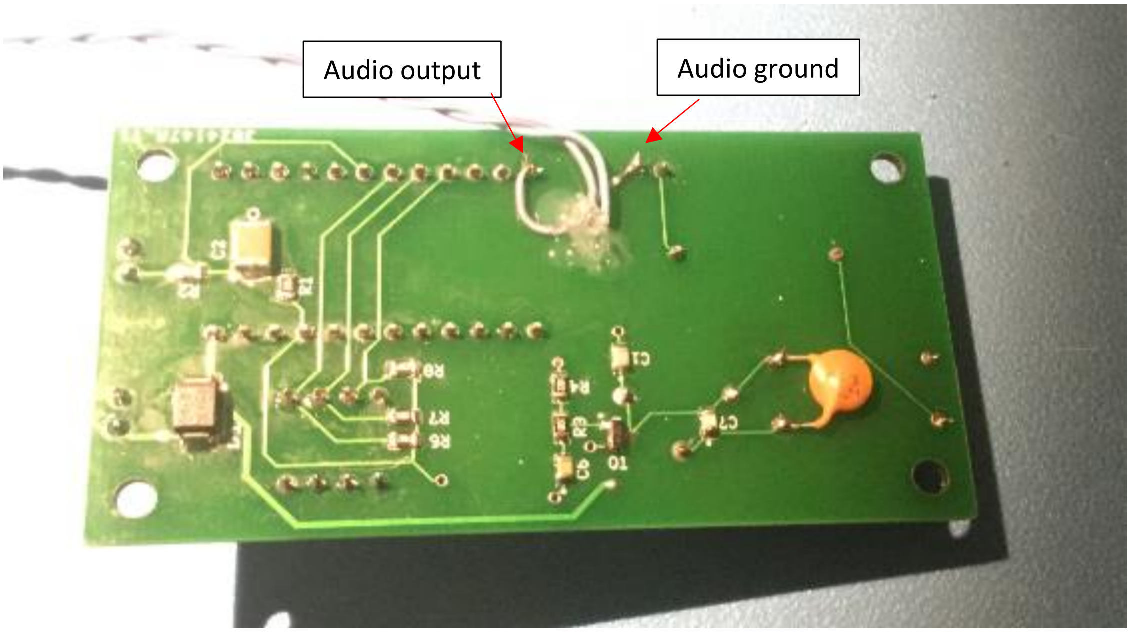


Figure 3 photo of bottom of board showing connections for audio output

Audio output comes from pin 9 of the pro-mini board This was a recently added software feature. Caution watch out for ESD damage. If an external amp is being used add a series resistance between this net and the audio jack (~1K) to help limit ESD current to a value that the on chip ESD diodes can handle. If driving a audio speaker direct watch out for ESD damage from charged cables.

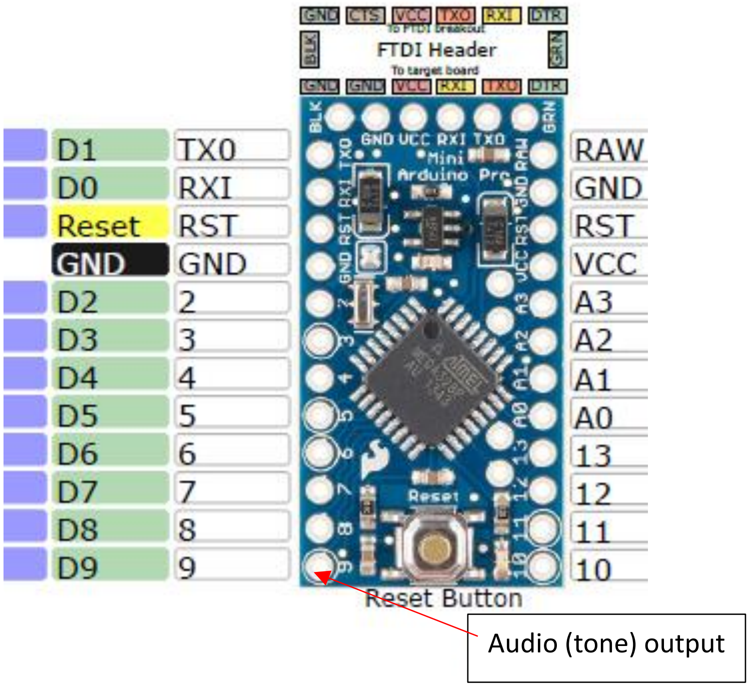


Figure 4 Audio output from pro mini

Section 2 general assembly notes

After building 5 units here are some things I have seen.

1 its best to install the oscillator (U2) first before installing anything else. This allows free access of the solder iron to all the pins. Then install the dip switch.

2. Install the board headers J4 and j5 next. They can then now be used as an alignment JIG for installing the header pins on the spark fun pro mini. The pro mini comes from spark fun without any headers installed. This will help get into the headers aligned straight up (referenced to the pro mini board).

3. After this you can install the balance of all other components in any order.

Some other notes there have been recent advances in the software that can allows the removal of some components. For example if you are using the dip switch there is no longer the need for using R6, R7 and R8 as the software has a compile switch that allows enabling internal chip pull ups. Yes, less parts!

This also includes R1 in the sync circuit.

An even reduction of parts is possible. The software allows setting the fox modes without the need of the dip switch. If you are using that option, then you don't need the dip switch at all. DIP0 tells the software to use the switch. There is a real possibility that the dip switch may disappear as that I/O could be used to support some cool future new features. Stay tuned.

Some notes about the case

I mounted my on off switch so that on is down. The rationale behind this is I think it will he harder to accidentally turn off the unit after synchronizing.

Base plate the following 3D printed base plate holds the board. It uses 4-40 inserts that are inserted using a soldering iron set to reduced temperature (~200 deg C).

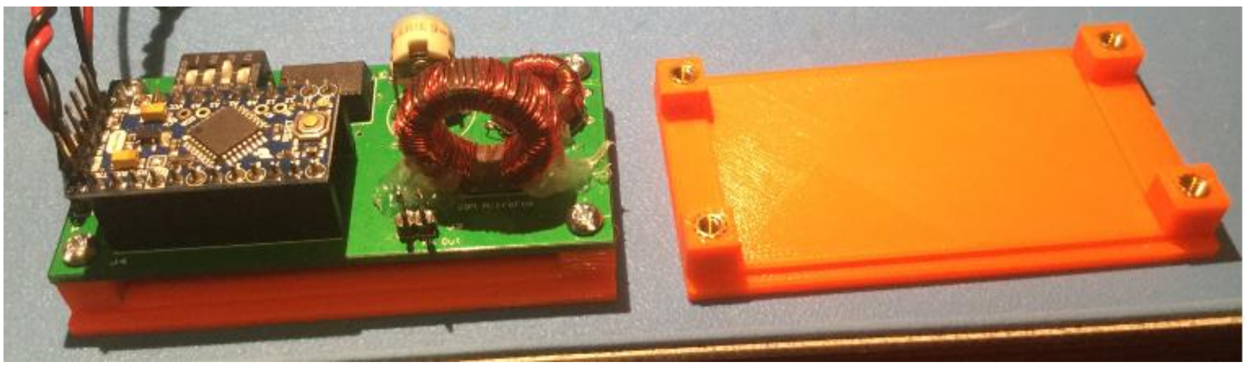


Figure 5 board and subplate

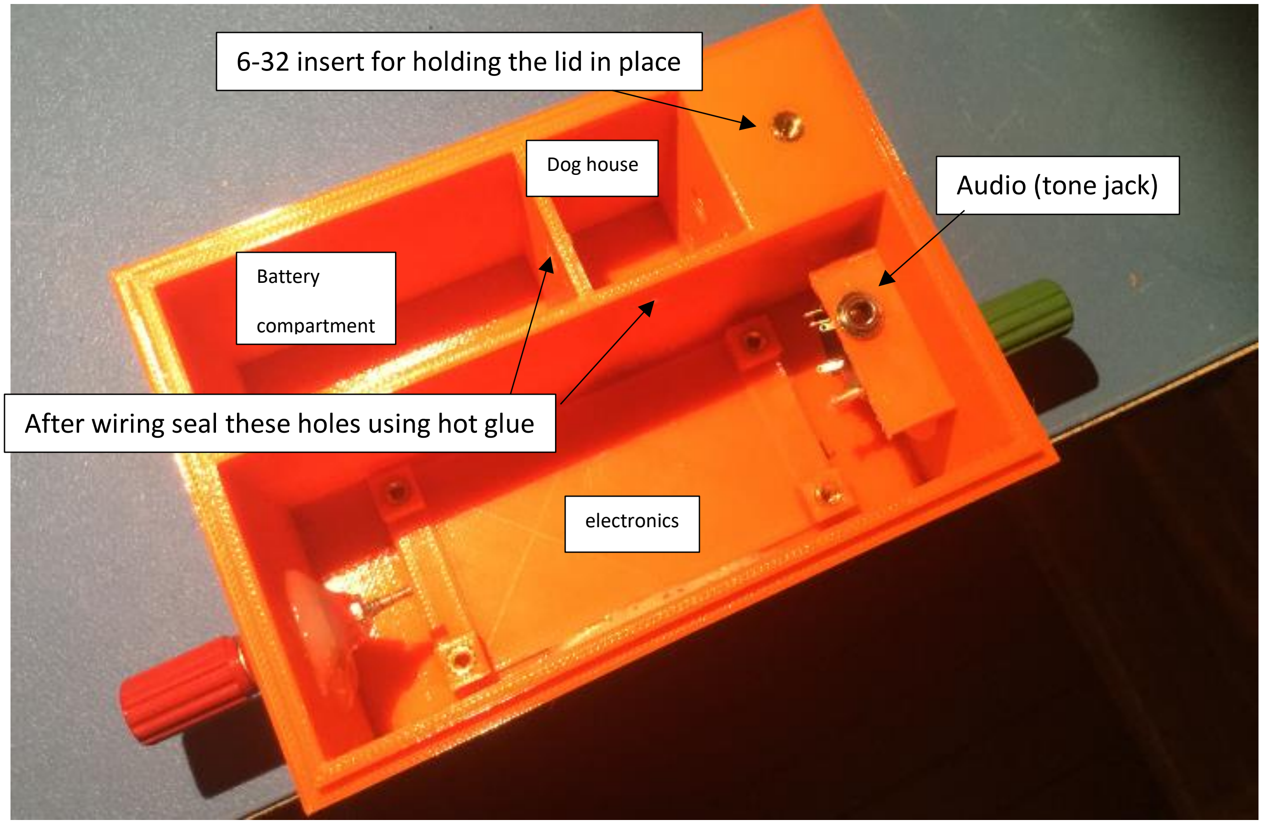
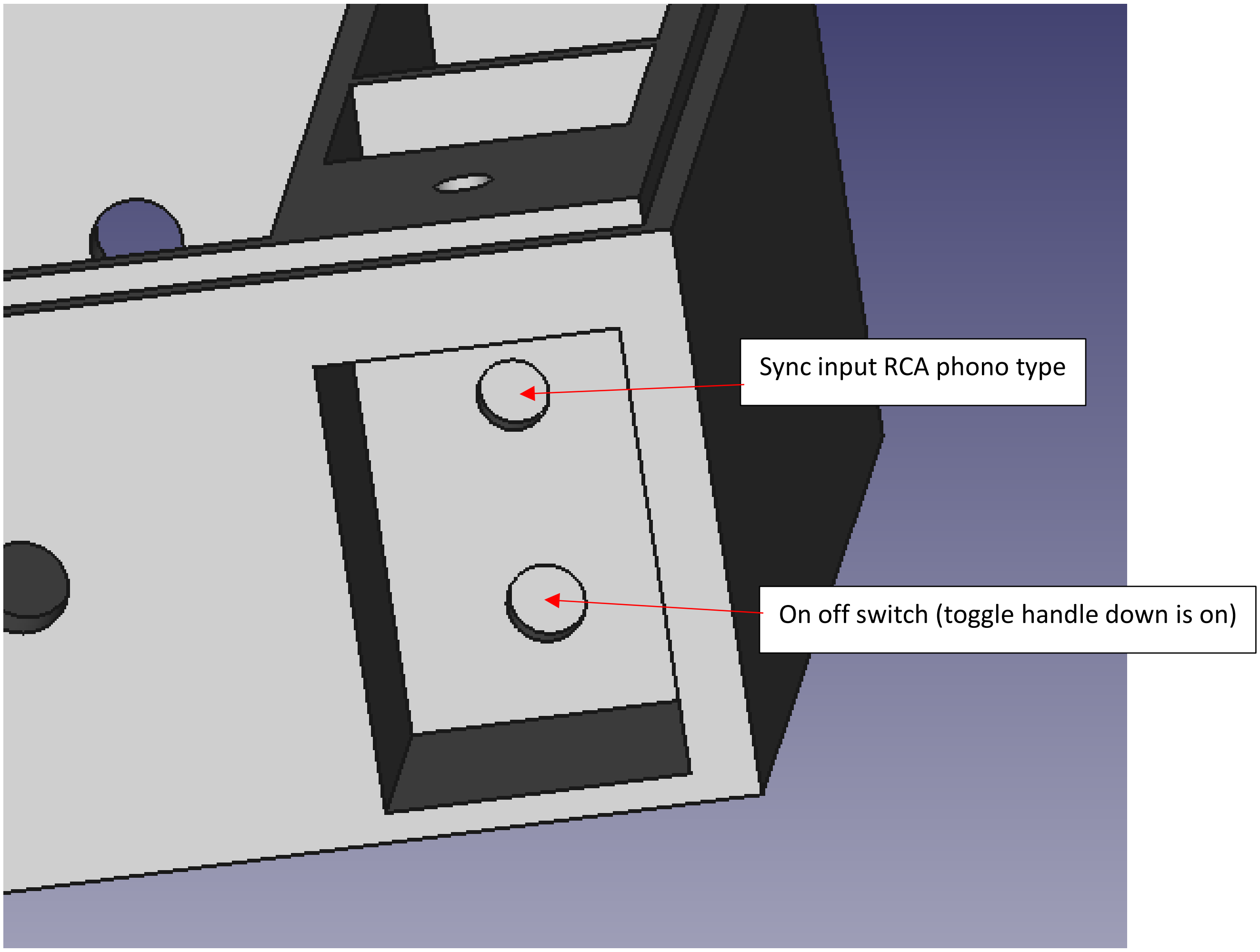


Figure 6 subplate installed in case

The subplate was glued in place using gorilla glue. Note the audio jack that was installed for providing tone output from pin 9. The red banana if for the vertical wire and the green is used for the two counterpoise wires. Note use hot glue to seal the two through case holes to keep water out of the battery compartment and electronics compartment as it could get into the dog house form the sync connector.

Install controls

Here are the locations for the sync input and on / off switch

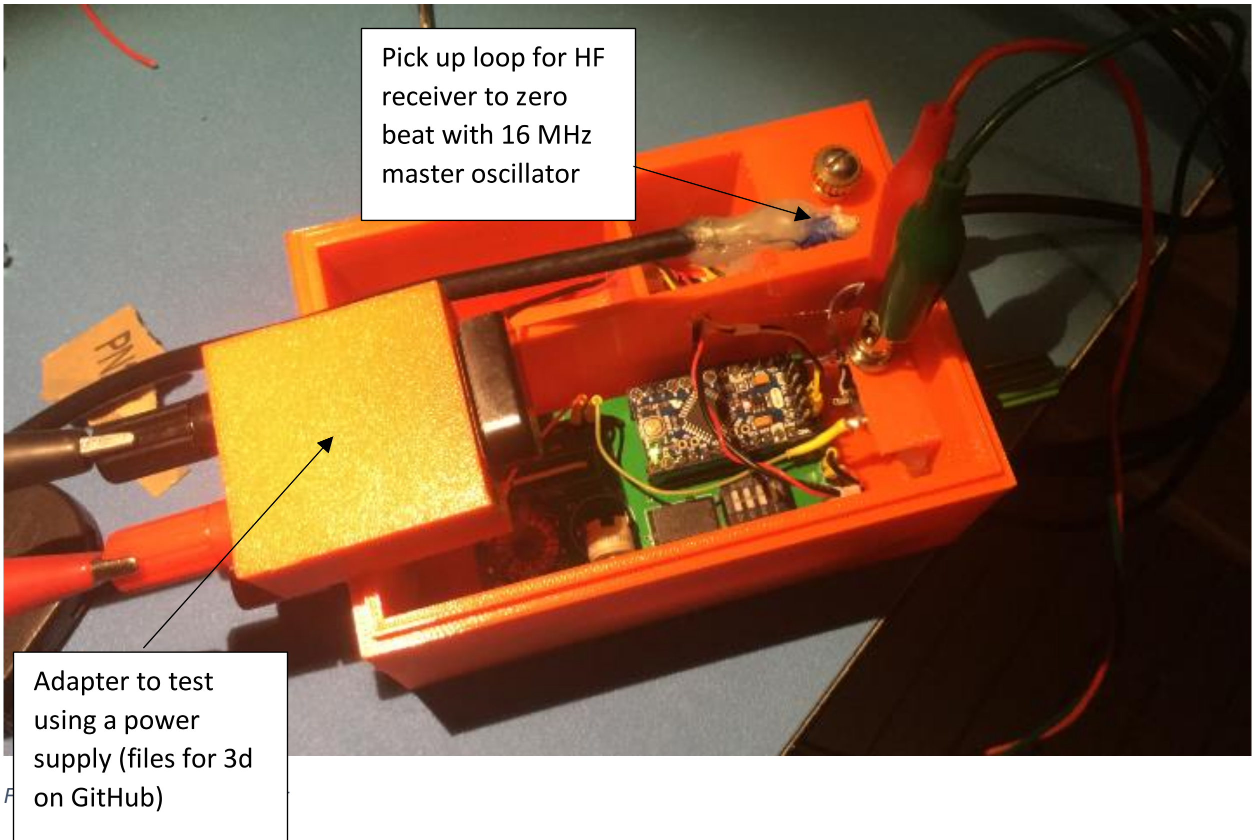


Calibration

There are frequency errors between the pro mini boards. The software allows setting a calibrate value to correct for the frequency offsets. If calibration is not the units will drift apart. I have observed tens of KHz differences in the 16 MHz master oscillator frequency.

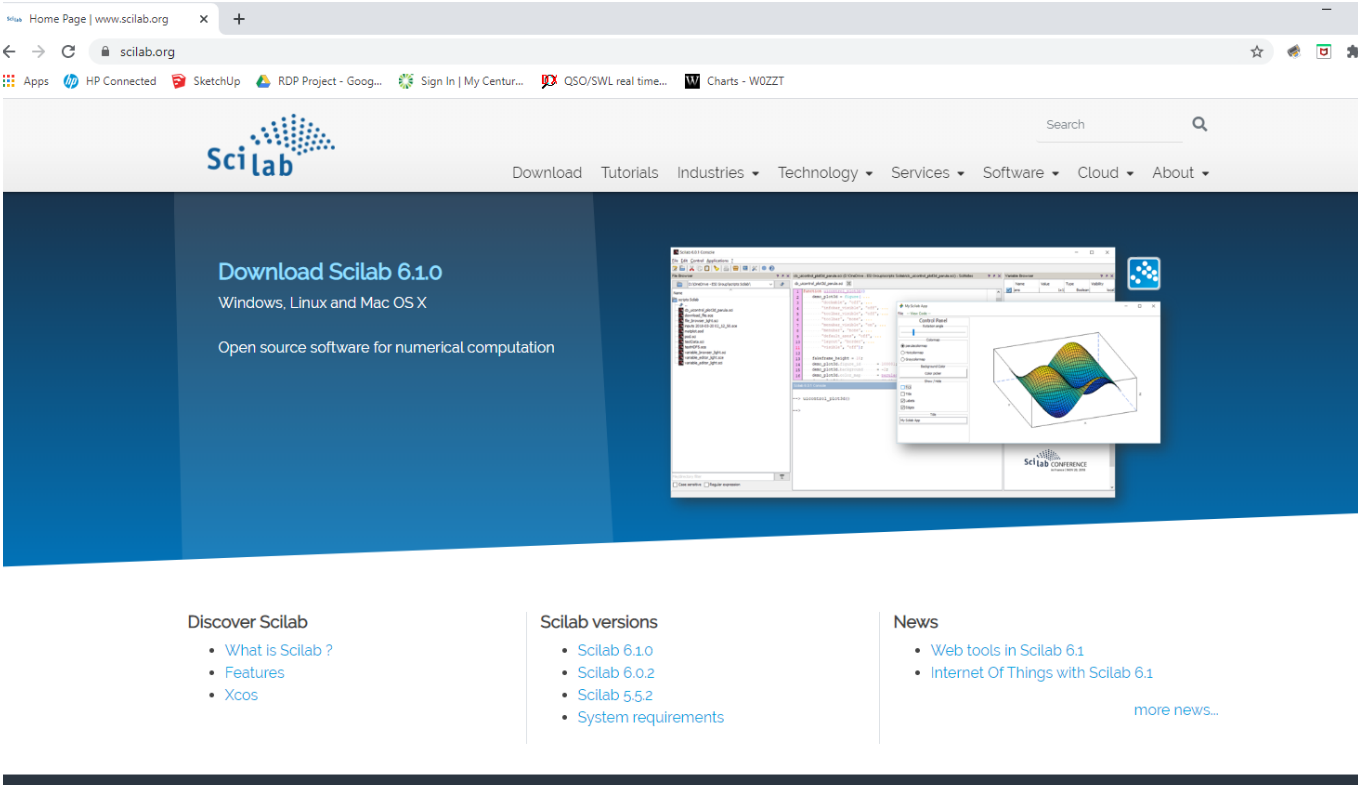
To calibrate (important to do after board is installed as I noticed that bending (putting the boar under stress) shifts the oscillator. Do the calibration after everything is mounted and wired in place.

Use a HF receiver and a small loop sensor and in CW mode zero beat the master oscillator and note its frequency on the radio.



After obtaining the frequency of the oscillator use the following script (or hand compute from the equations in the script. The script is written in SCILAB an open source version of MATLAB like scientific script software.

To down SCILAB go to https://www.scilab.org/



The calibration script starts below.

```
clc;
//
// Oscillator calibration calculator
//
// Enter measured frequency of Oscillator in MHz using CW receiver to zero beat
mprintf("enter frequency of the Oscillator in MHZ?\n");
FREQ = mscanf("%f");
FREQ_for_calc_IN_HZ = FREQ*1E6;
//
//
```

```
CALIBRATE = (FREQ_for_calc_IN_HZ/1024)-1;
//
// Now display it for printing a label
// Cut and paste output into notepad and print label
//
mprintf('Oscillator Frequency = %2.5f MHz \n',FREQ);
mprintf('Calibration = %1.3f  \n',CALIBRATE);
mprintf('Calibration = %d  \n',round(CALIBRATE));
mprintf('Use cal command cal<sp>%d to enter \n',round(CALIBRATE));
```

After running the script of hand computing use the cal command to enter the calibration data. Print a calibration tag and tape it inside the unit. I copy the output from the scrip into notepad and print them.

3D box parts

Here are the components that make up the 3D printed case

The following files are in the GETHUB for this project.

2. case_lid.stl the lid for the transmitter case.
3. bottom_half.stl the bottom main part of the case.
4. 80mbase.stl the sub chaassis that the PCB mounts on. Glue inside case.
5. audio_jack_holder.stl a bracket to hold optional audio jack for tone outputs.
6. 9vbattery_adaptor.stl a test adaptor for testbench testing with a powersupply.

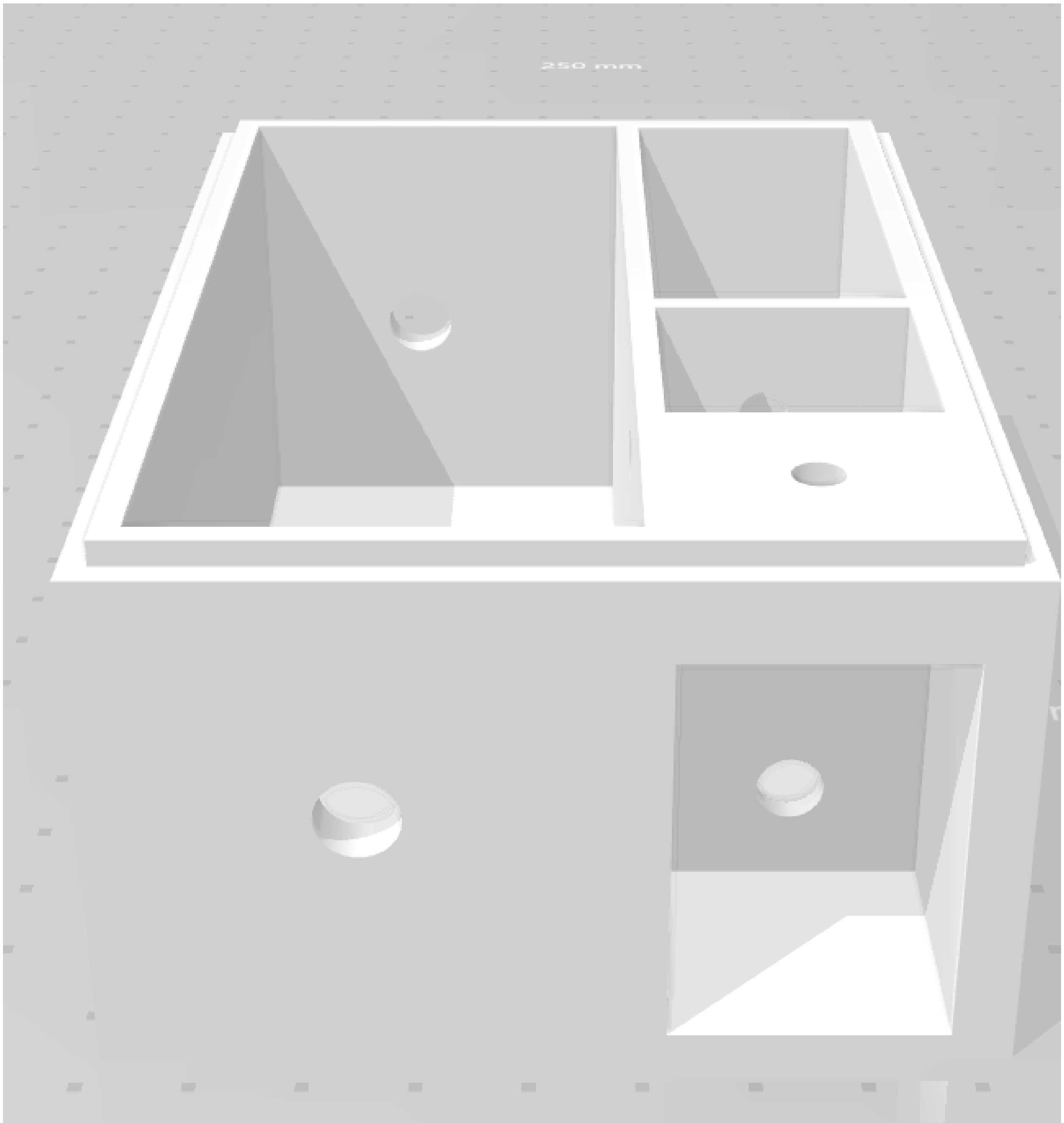


Figure 8the main case

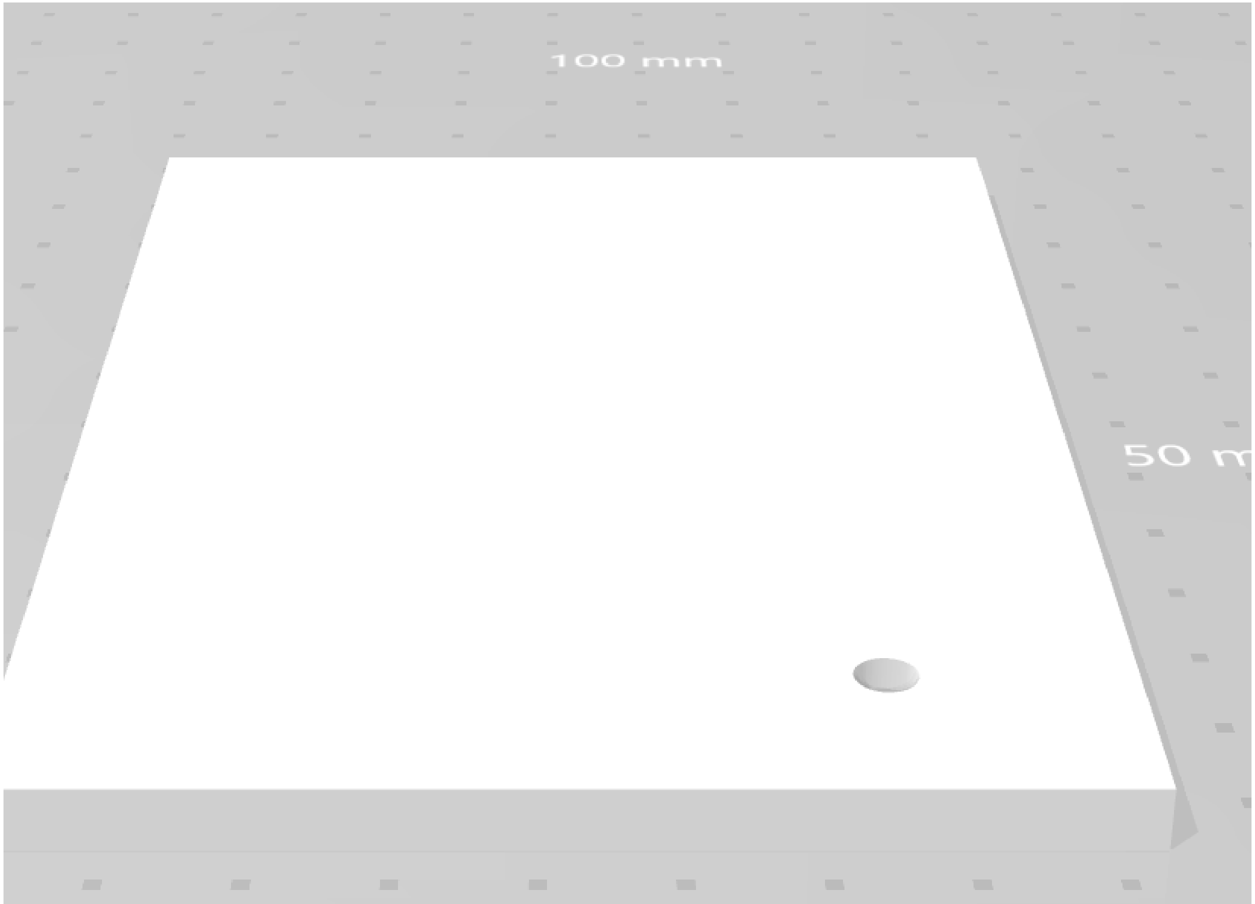


Figure 9the case lid

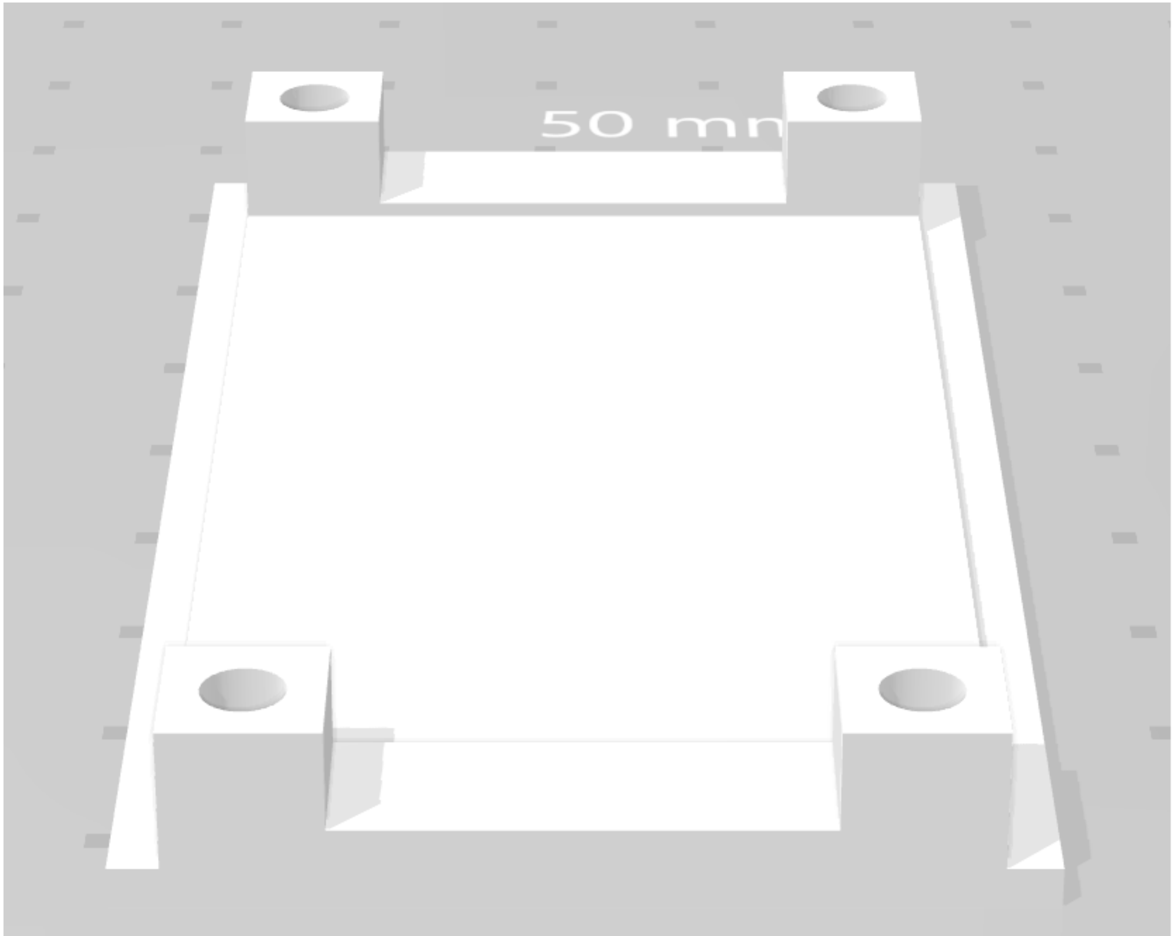


Figure 10the sub base for mounting the board

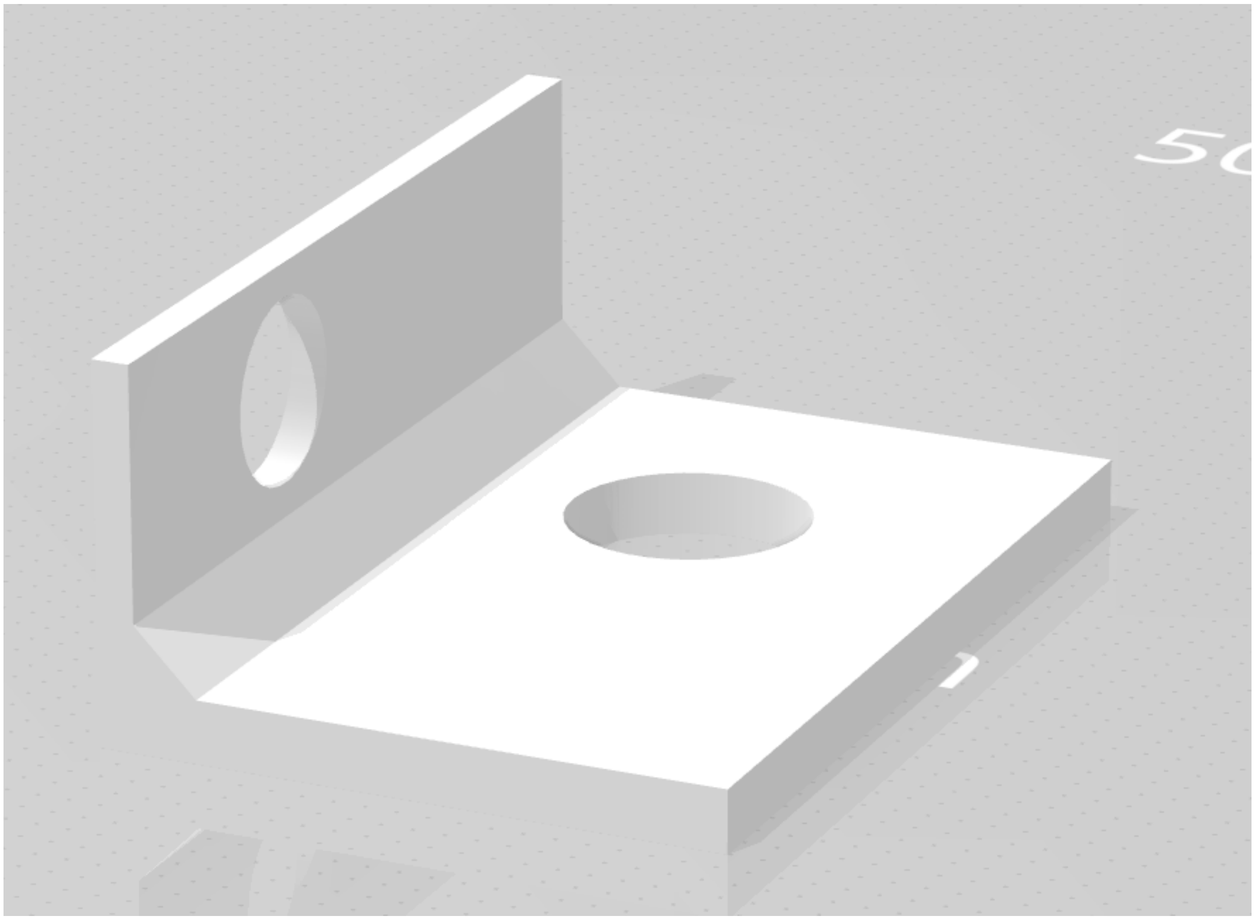


Figure 11 Audio jack holder

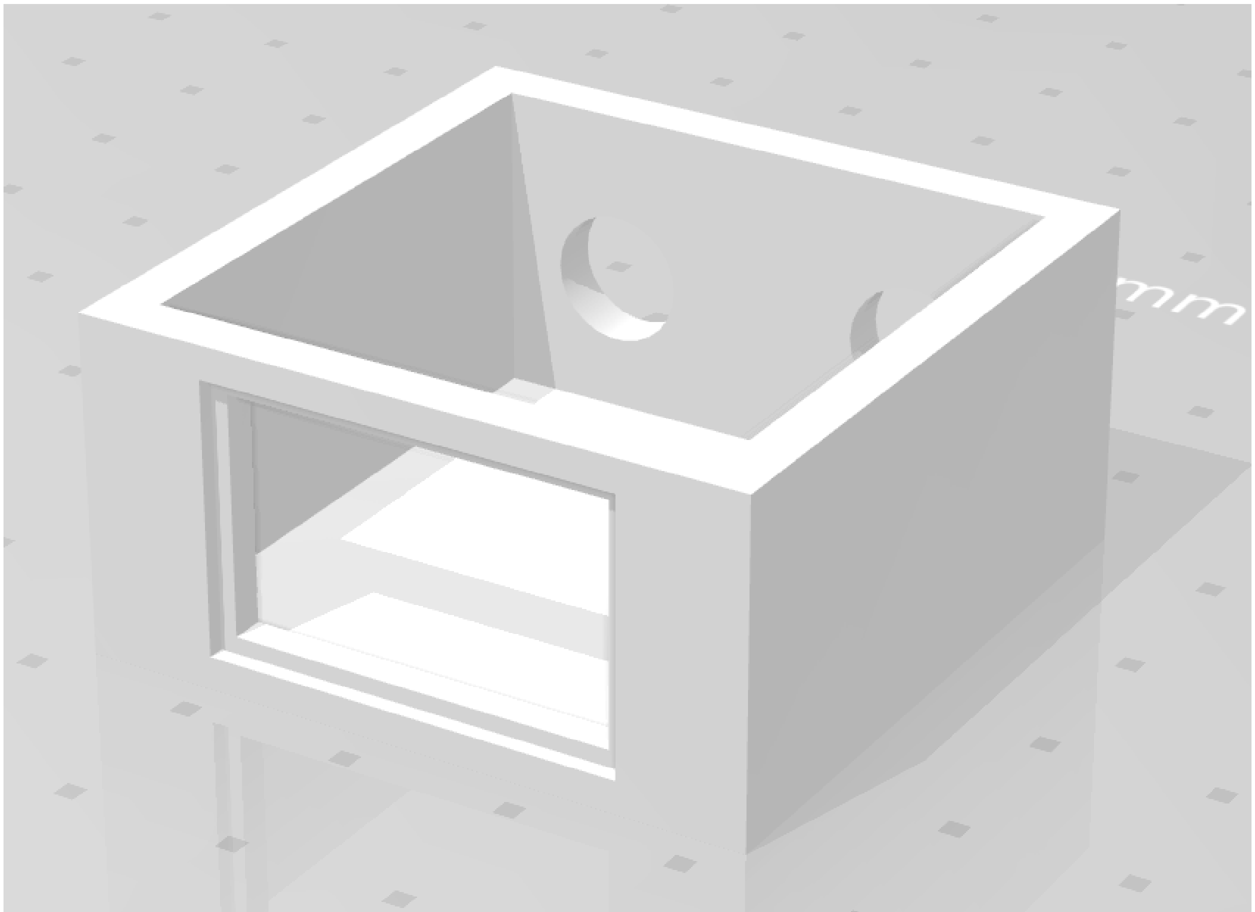


Figure 12test jig for testing without batteries

Note for the test jig the battery connector was harvested from expired 9-volt batteries.