ST4

SYNTHESIZER TRACKER

A PROJECT BY PIETER VAN DER MEER AND CHRISTIAN STUDACH

ORIGINAL CONCEPT AND DESIGN

VDM ST-1

A Synthesizer Concept by Christian Studach (Stu) for Tasty Chips Electronics

This is a first concept for a synthesizer, a hybrid sound device that could develop into a compact audio workstation. We aim to keep things simple and low budget, but to get the maximum done in a compact setup. This concept is split into sections for an easy understanding and also in order that it's possible to save some parts for a later state if they seem too ambitious for the moment.

VCO

These are the pipes! And probably the most complicated part of this concept. Many of the analog synths of first and second generation do provide standard waveforms such as sine, square, saw, triangle, which are often good enough for basic lead or bass sounds in combination with the common synthesizers signal path process (VCO → VCF → VCA). From the comeback of analog synths that appear on the market today, not many do have polyphonic abilities. Most of them do still have the basic waveforms and modulation through envelope generators and LFOs. During the last 20 years I've worked with a wide range of synthesizers from analog to digital and computer music softwares from sound trackers to modern software synthesizers and so I've learned about the pros and cons of these applications in daily musical use. Today we can look back on a history of electronic instruments development already, so it's time to reflect on what has been experienced so far and combine the aspects of different ways of sound generation to something new and leading: A hybrid portable synth machine for daily usage, that deserves to be called an instrument.

But let's get concrete!

So what could a 21st century synth pipe look like?
Let's keep it simple, but flexible and fun enough to not get bored.

- 4 oscillators, 2 analog, 2 digital (a simple / prototype version of the synth could also consist of just 2 oscillators, 1 analog, 1 digital)
- The 2 analog oscillators are monophonic and provide the basic waveforms, at least 2 of them (f.e. square and saw) just as they appear in conventional synthesizers
- The digital oscillators are polyphonic and contain some basic waveforms as well, but also a simple sampler section can be selected that opens a whole new universe of sounds
- 2 Detune knobs are there to detune the 2 oscillator pairs from each other in order to choose between a more clear or more rich sound. Rather than having a tune knob on the oscillators, which can be annoying, the detune knob between the oscillators can generate a fuller sound, without the musician being worried about being in tune with the rest of his setup.

The analog generators should provide the 'phat' part of the device, whilst the digital generators are the flexible, harmonic, more freaky and fun part. The strength of the synth is that these signals can be combined for further processing as described in the next parts. With a simple sampler on board, any possible waveform can be added to the sound and playing around with it should be a lot of fun.

Sampler section:
This is part of the digital VCO and forms the so called 'secret ingredient' of it. 2 samples can be recorded via internal mic (talking about a limited time of a 2 – 6 seconds here). There is a button to start and stop the recording. After being recorded the sample is available as an automatic loop like any other waveform is a loop too, just a bit longer. Now with 2 rotary switches the start and end point of this loop can be set. The sample could be 8-bit quality (even less could be fine) and its frequency rate can be changed by another knob for lofiness (bit crusher effect).

The VCO requires 2 potentiometers for detune and 4 of the 3-pole switches to select the waveform I think. The sampler section requires at least 2 times one button for recording and probably 3 rotary knobs.

MXR

This part is nothing but a simple audio mixer. It provides 4 potentiometers (1 for each oscillator) to adjust the amount of signal that goes into the VCF. These pots are followed by 3-pole bypass / mute switches to allow the signal to elude the Filter and go directly into the VCA, or to mute the oscillator entirely. Before the signal goes into the VCF there is another section of 3-pole switches to shunt each signal into one of the 3 filter types (lowpass, bandpass, highpass) for further processing. So 4 Potentiometers here with standard knobs and 8 of the 3-Pole switches would be necessary as well.

VCF
We've discussed this before and we're happy to have built the infamous Steiner Parker VCF in the past already. As we probably agree, it should be the weapon of choice here, or at least the base for further development, mainly because of 2 reasons: First, it's flexible, it provides 3 filter types and allows to use them in combination. Second, and that's the most important part, it just sounds fucking great! And I say that, because I've performed with this filter for many years and it has the ability to make the crowd go nuts in a live situation. Its design has been proofed many times and used in one of the greatest new analog synths that appeared on the market so far, the MiniBrute keyboard from Arturia. 2 Potentiometers, resonance (standard knob) and frequency with a big knob are required here. The filter also glues everything together, being 4 signals before, after the filter will only be one signal left for further processing.

VCA
ADSR what else? So 4 potentiometers for that. The VCA section should also have a switch to bounce from ADSR influence to note on (received e.g. via MIDI in). It could also have the note on influence on the sustain of the ADSR, then perhaps the switch is not needed. Further it would be very practical in regard of the prototype phase, but also for later testing on the final product, to have a trigger button, to simply trigger a sound without needing any MIDI controller or other complicated setup. The button could also serve as an extra live function to interfere the synth by hitting the button every now and then. If we target on that, it would be cool if the sound being triggered by the button could also be tuned by another potentiometer.

LFO
Should we have that too? Of course we should. On many synths I've tried I found the speed range of the LFO rather disappointing. Why does it not go faster than the hearable range? Talking about an FM possibility here. So this gives us another space to set a standard for sure. The range is limited within the range of the potentiometer of course, so an extra switch as it appears for instance in the Roland System 100M modular synthesizer would be a wonderful solution. So the ideal LFO section would look like this: 2 LFOs, because 1 is too obvious, but 2 of them make things sound interesting and more natural than techno. Still they could conveniently be constructed exactly the same way. Per LFO, one switch for the waveform selection, another switch for the speed range (slow, normal and ultra fast FM like), a potentiometer with big knob to adjust and play around with the LFO rate, finally 3 standard potentiometers to adjust the influence of the LFO (VCO, VCF, VCA) that means that all the corresponding sections would need to have the ability to be modified by voltage. For the VCO this means there should be a global tune for the LFO to take effect, the VCF has CV input for sure and the VCA would need that too. Adjusting the influence of the LFO inside the LFO section itself gives the most clear overview of what's going on, as it is rarely provided by other synths on the market.

KEY
This should describe how the sounds we construct are being triggered. As in every section before, here we have many possibilities as well. It's a matter of budget in the end, if we want to keep this ultra simple (MIDI in port) or provide a touch sensitive keyboard with breath control. In any case I think it's the last part to take care of, since we probably are going to start with just the MIDI in port anyway, which is fair enough for experiments, but also for a sound module if we aim for that. So I leave this bit for later. What would be great though, to keep things simple, is a button to trigger the sound as I mentioned before in the VCA paragraph.

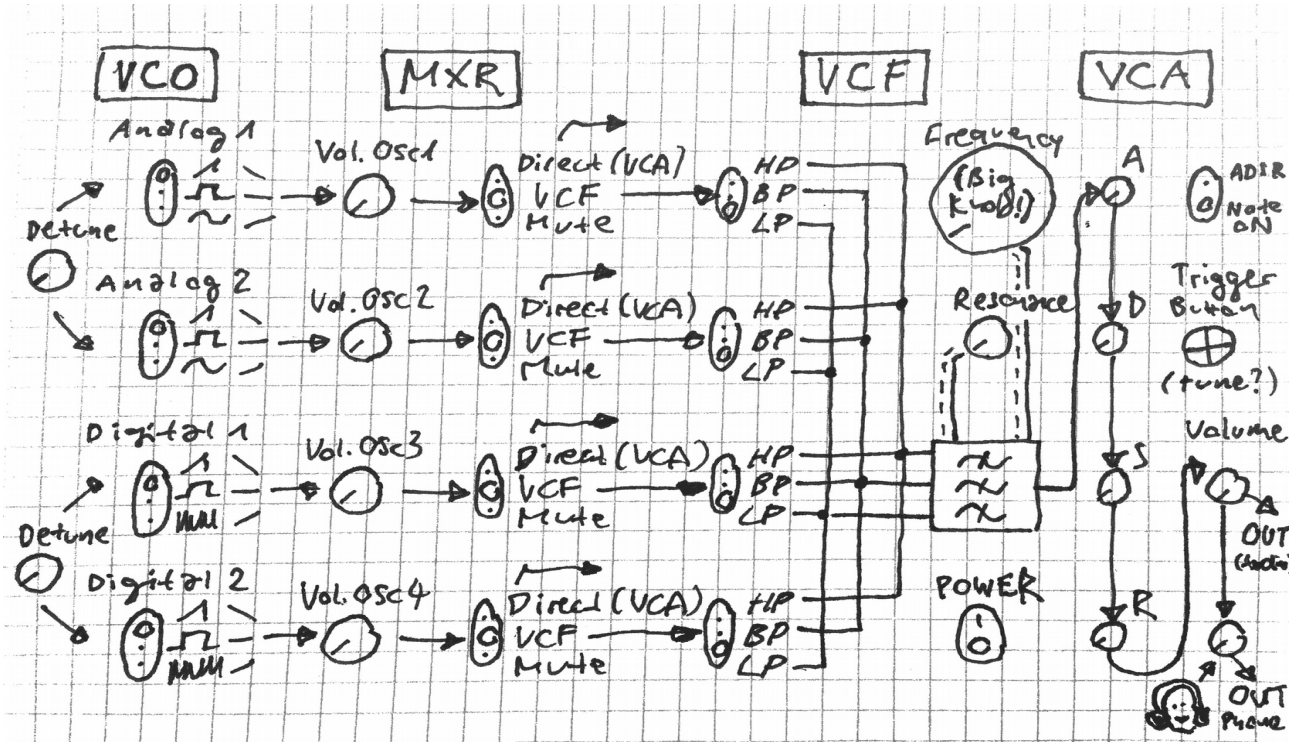
SQC
I think that's the interesting part where we should consider feasibility first, technical and budget wise. It definitely is another part where we can score some extra points. Here we could revolutionize the market by using the skills and experience from our demo scene / tracker music background. What if we can get a small display to work and develop a simple tracker interface for our synth instead of the boring 808-style LED step sequencer interface? I could imagine this would be a very powerful feature, maybe not for the first edition of the synth, but for future consideration. Perhaps a digitalization of the whole potentiometer section controlled by a tracker with an efficient 'arrow keys / enter button interface' as we know it from the classic tracker programs would drop an ultra efficient tool on todays market of analog synths. Also consider the possibility of programmable arpeggiators, portamentos and other effects when operating with a display.

Design and budget thoughts
On the next page you find a drawing of the synths signal path. This is just a sketch, I plan to replace it with a digital drawing soon, so we can mess around with it. In total we have the following parts on the budget.

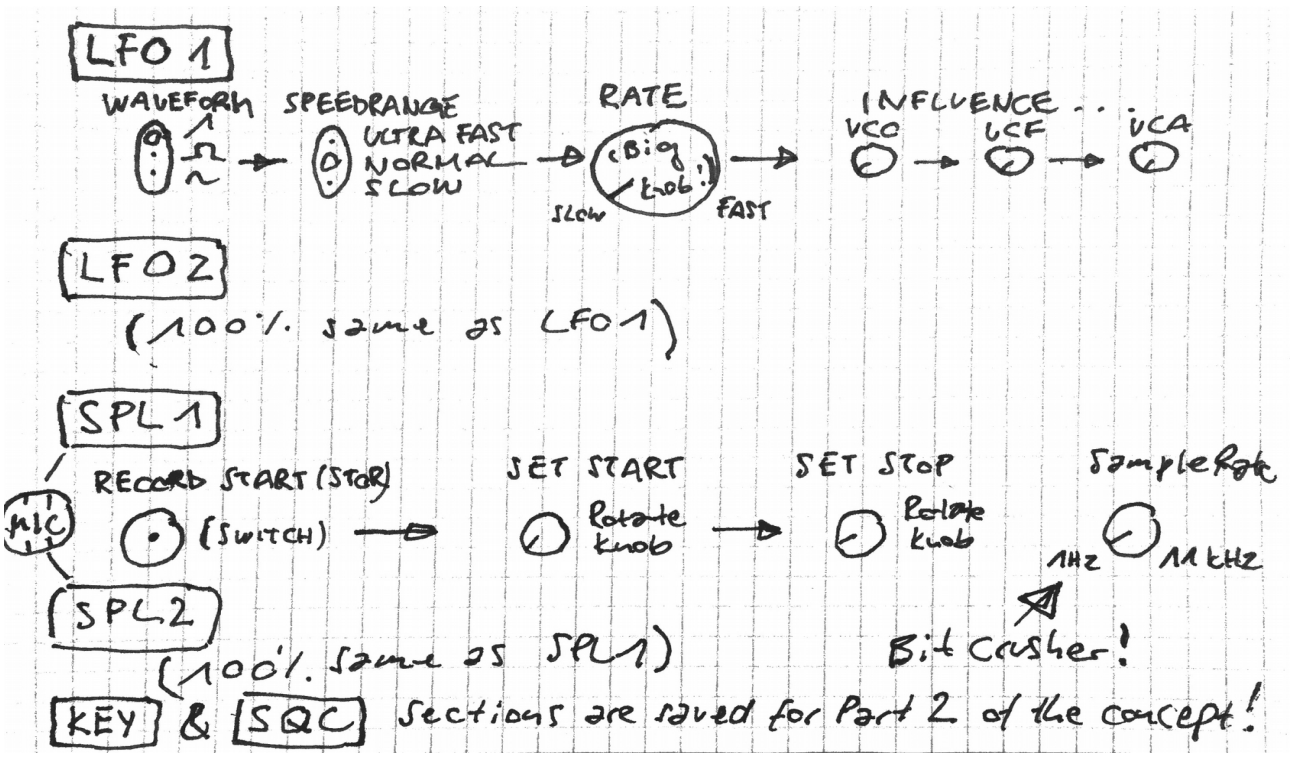
- 19 potentiometers with standard knobs (I'd go for something tiny like used in the recent Korgs)
- 3 potentiometers with big knobs for fine control (gives us a total of 22 potentiometers per device).
- 6 rotate knobs used for the sampler section (only if this is preferred to potentiometers)
- 16 times 3-pole switches (probably cheap), 2 times 2-pole switches and 3 push buttons
- 1 Microphone, nothing fancy here really, a good phone mic would do it I guess.

Signal Path

Here I show the signal path of the synth, this sketch can also be seen as a rough design idea.



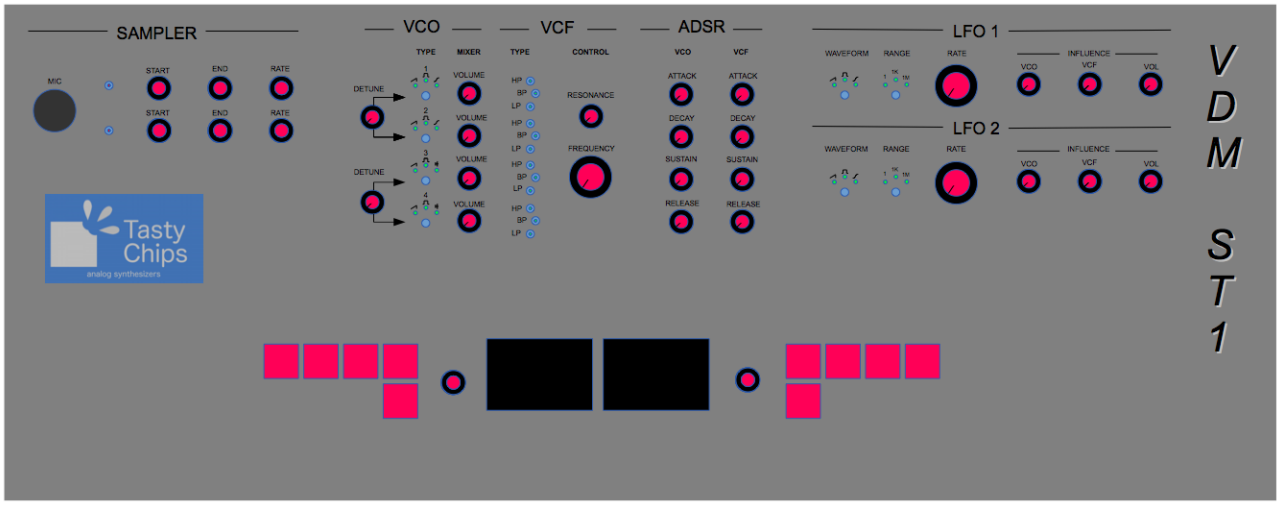
LFO and Sampler sections, probably underneath the synth section:



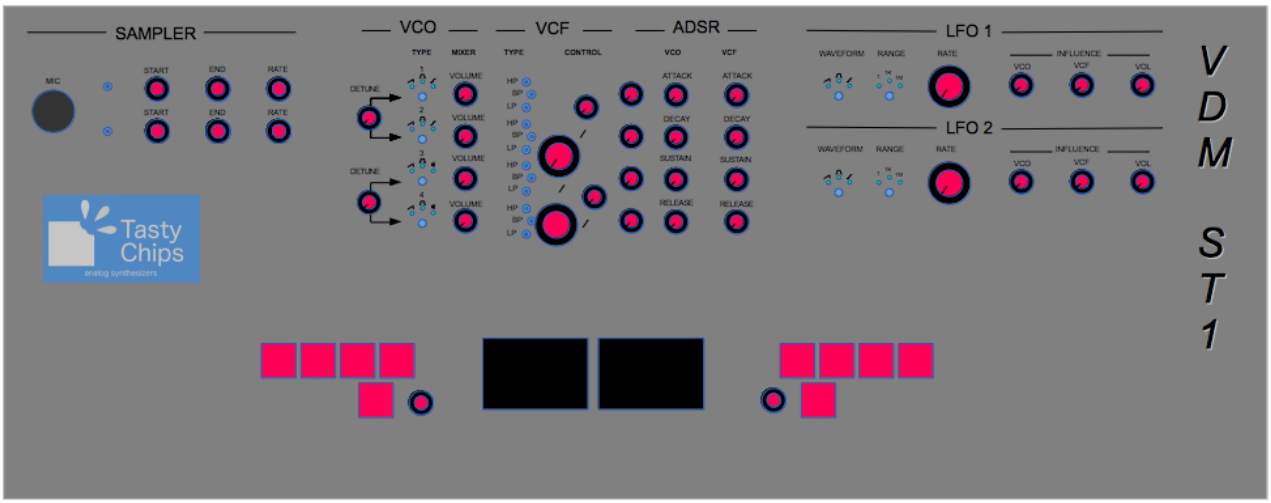
In the next version of this concept I will provide a proper in/out board suggestion as well as a digital sketch.

FIRST DEVELOPMENT STEPS

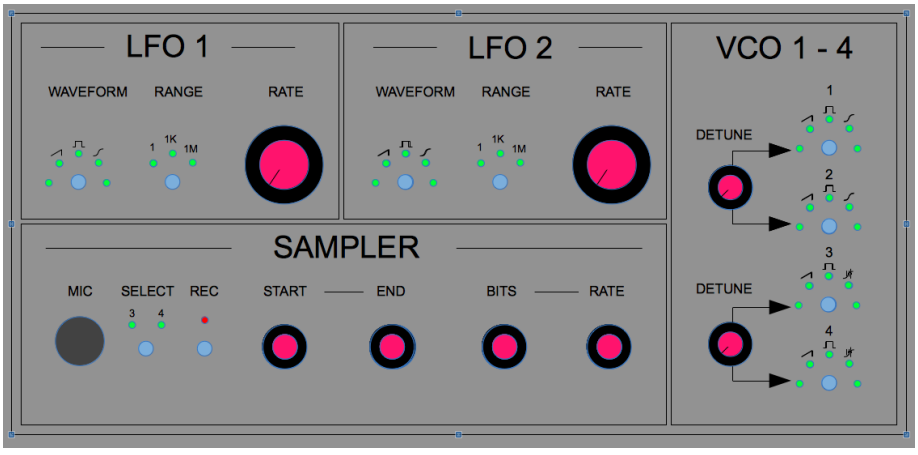
FIRST VERSION INTERFACE DESIGN



DELUXE VERSION INTERFACE DESIGN



SAMPLER / LFO 1 & 2 INTERFACE DESIGN



FIRST PARTLIST THOUGHTS (JUNE 2014)

Parts needed for the interface:

24 Potentiometer

8 Rotary Knobs

8 Tactile switch (no LED)

2 Tactile switch (with LED red)

12 Tactile switch (with LED green)

10 Keyboard style switch eventually, otherwise tactile switch (no LED)

24 LED

1 Mountable Mic

2 Displays

8 Knobs for the rotary switches

21 Knobs for the potentiometers (normal)

3 Knobs for the potentiometers (big)

REVISION A

34 Potentiometer

14 Rotary Knobs

18 Tactile switch (no LED)

0 Tactile switch (with LED red)

0 Tactile switch (with LED green)

10 Keyboard style switch eventually, otherwise tactile switch (no LED)

42 LED

1 Mountable Mic

2 Displays

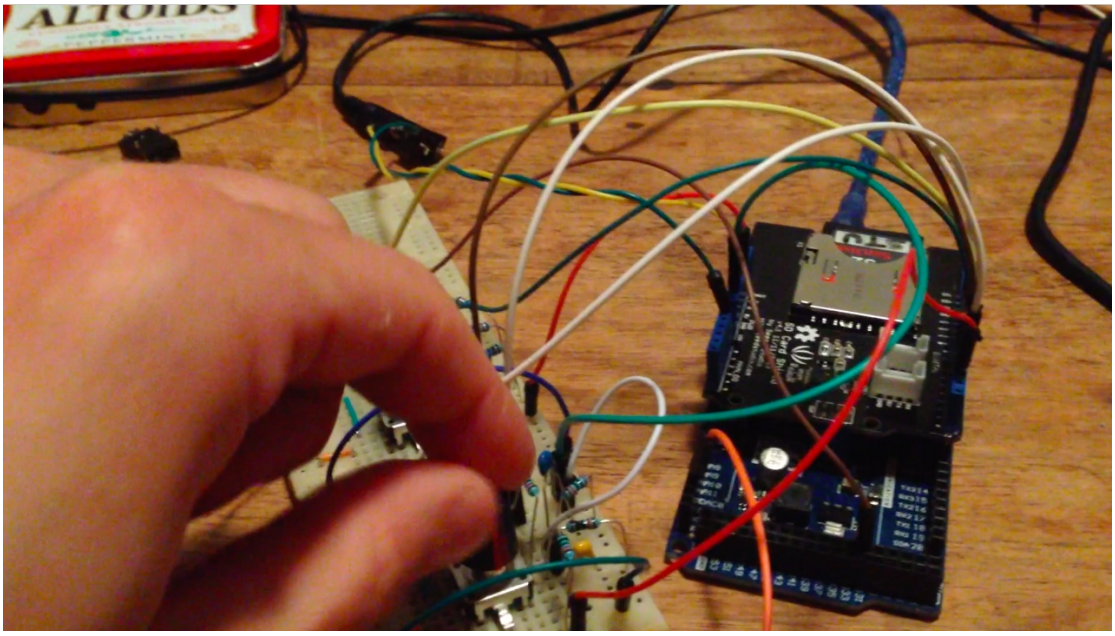
? Knobs for the rotary switches

? Knobs for the potentiometers (normal)

? Knobs for the potentiometers (big)

FIRST BREADBOARD (JUNE 2014)

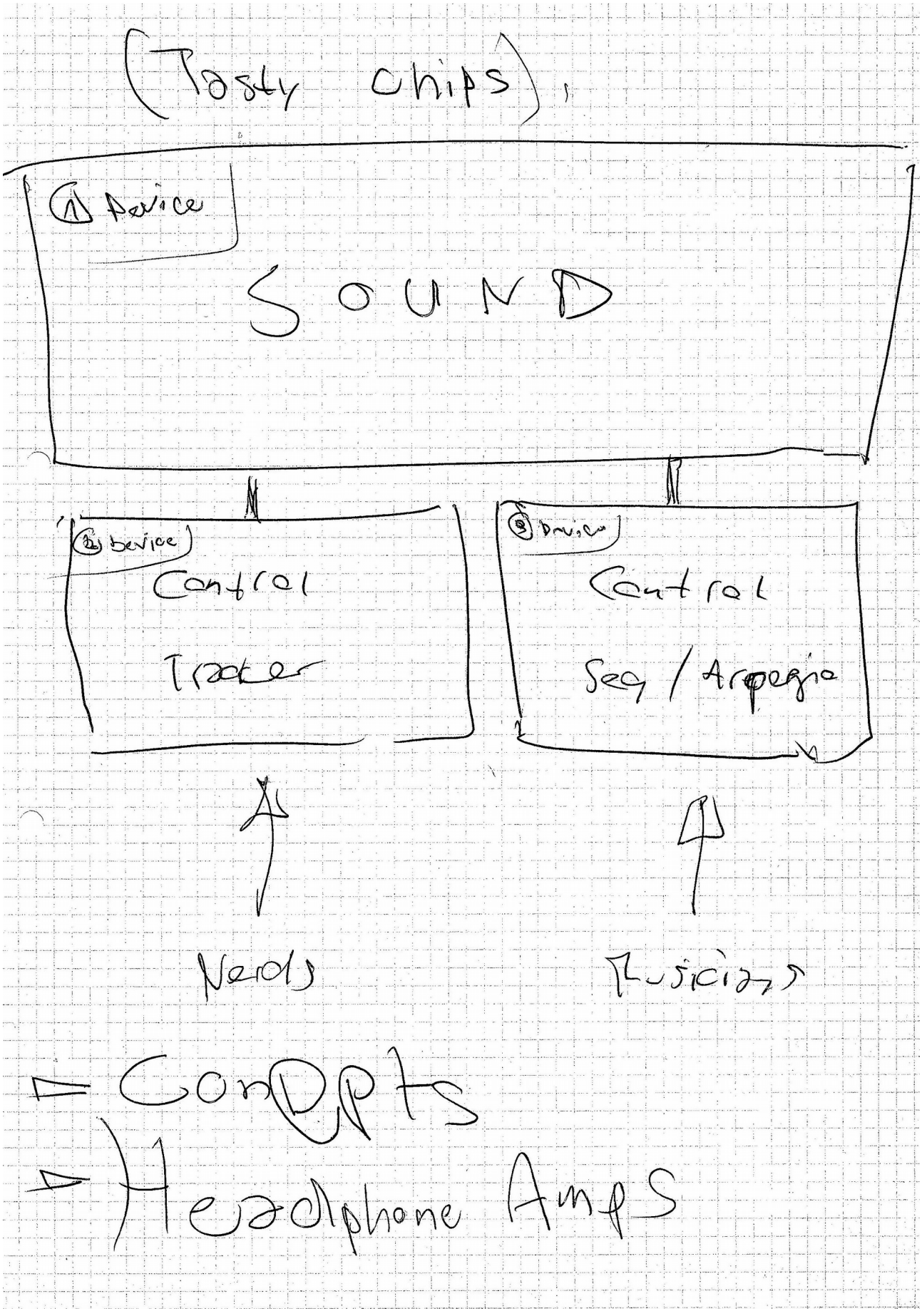
ARDUINO WITH SD CARD IMPLEMENTATION



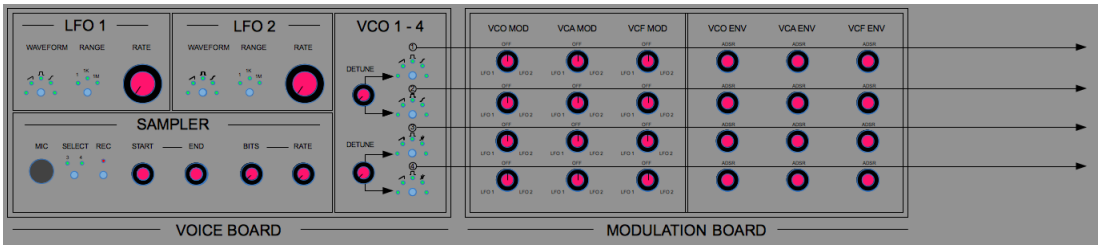
ST 4 DEVELOPMENT TEAM (2014 IN BASEL, SWITZERLAND)

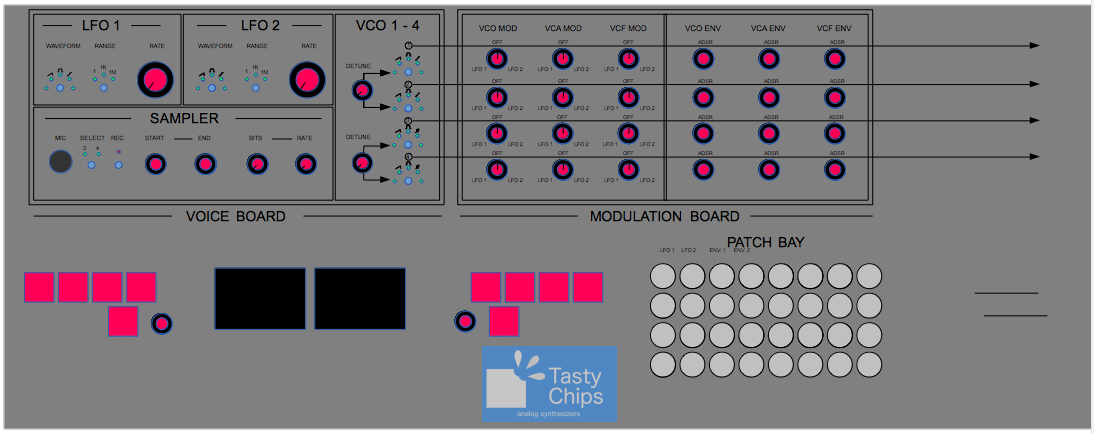
FIRST DESIGN REVISIONS

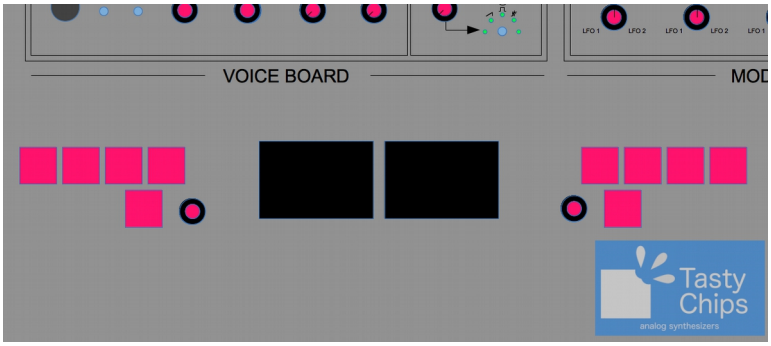
THE IDEA OF SPLITTING UP THE DEVICE IN A PRODUCT LINE



NEW IDEAS BASED ON THE FIRST EXPERIMENTS EXTEND THE CONCEPT

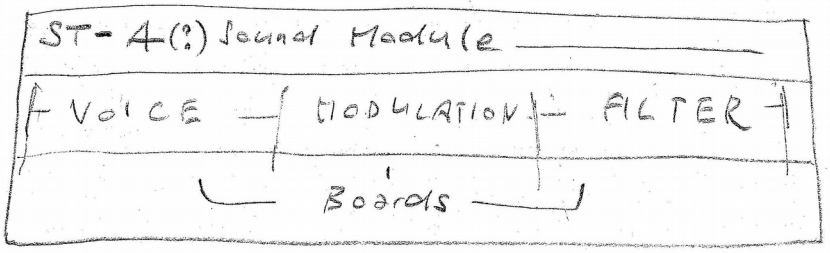






A NEW VERSION OF DESIGN HAS BEEN MADE AND PASSED ON TO PIETER
HERE ALSO THE NAME (ST4) IS MENTIONED FOR THE FIRST TIME

Pieter / Stk synth project Next Step Design (September 14)



Inputs:
- 1 MIDI - 5 Pol Din (PT)
- 1 Audio In - Mono Jack (PT)
- 1 USB or ST interface (PT)
  (for Data Transfer & Communication between ST Devices)

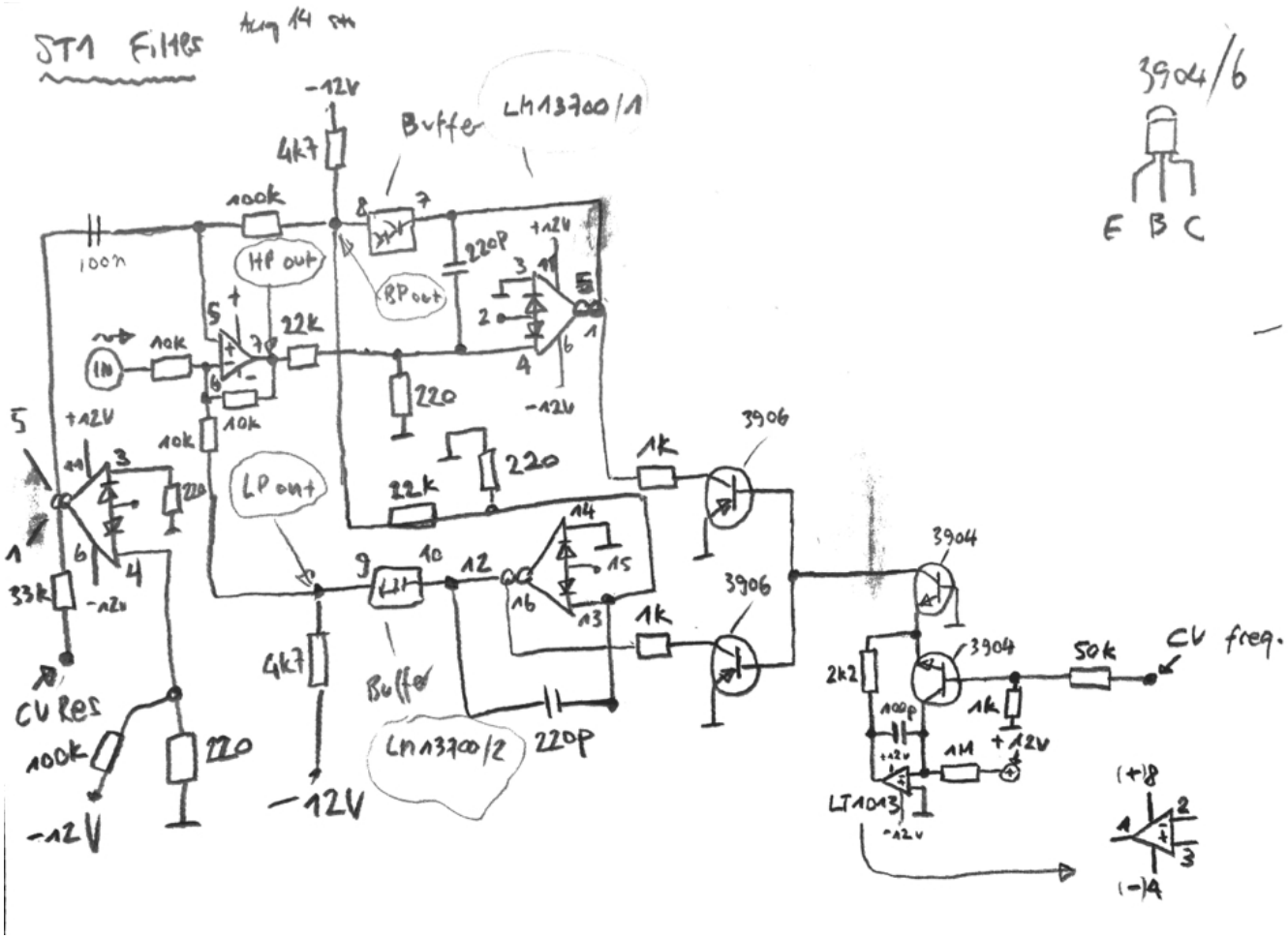
eventuell:
- 4 CV_1 Mono Jack for VCO (F)
- 4 CV_2 Mono Jack for VCF (F)
- 4 Gate Mono Jack for VCA (F)

Outputs:
- 4 Mono Jack for (PT) Separate Audio
- 2 Mono Jack for (PT) Mixed Stereo out

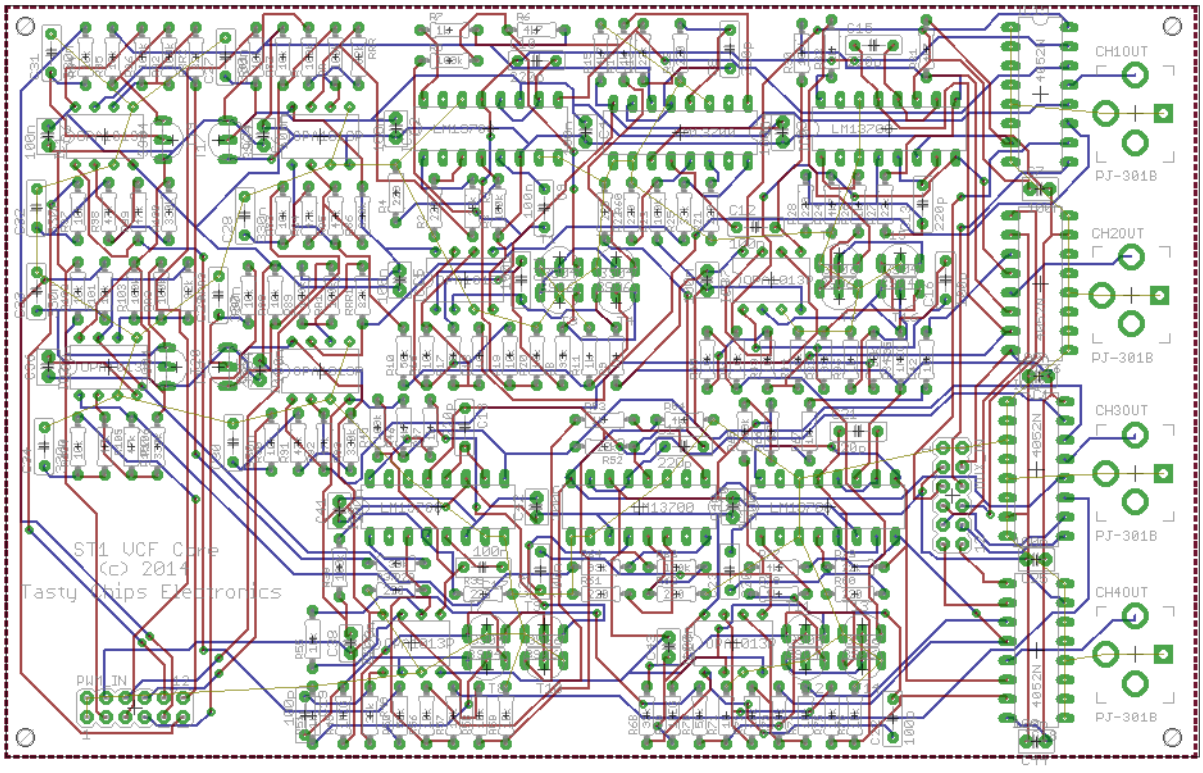
PT = Prototype
F = Final Version

ANALOG FILTER SCHEMATICS AND THE FIRST PCBs

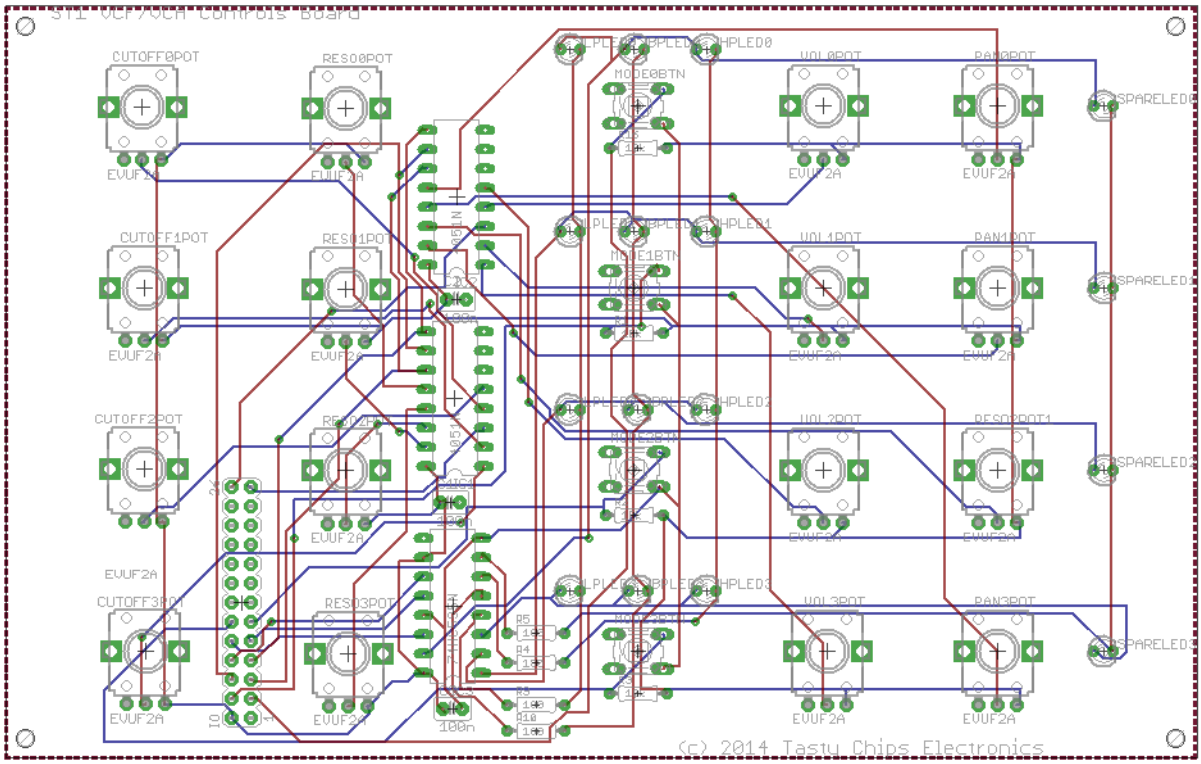
DRAWING THE SCHEMATICS OF PIETERS OWN FILTER DESIGN



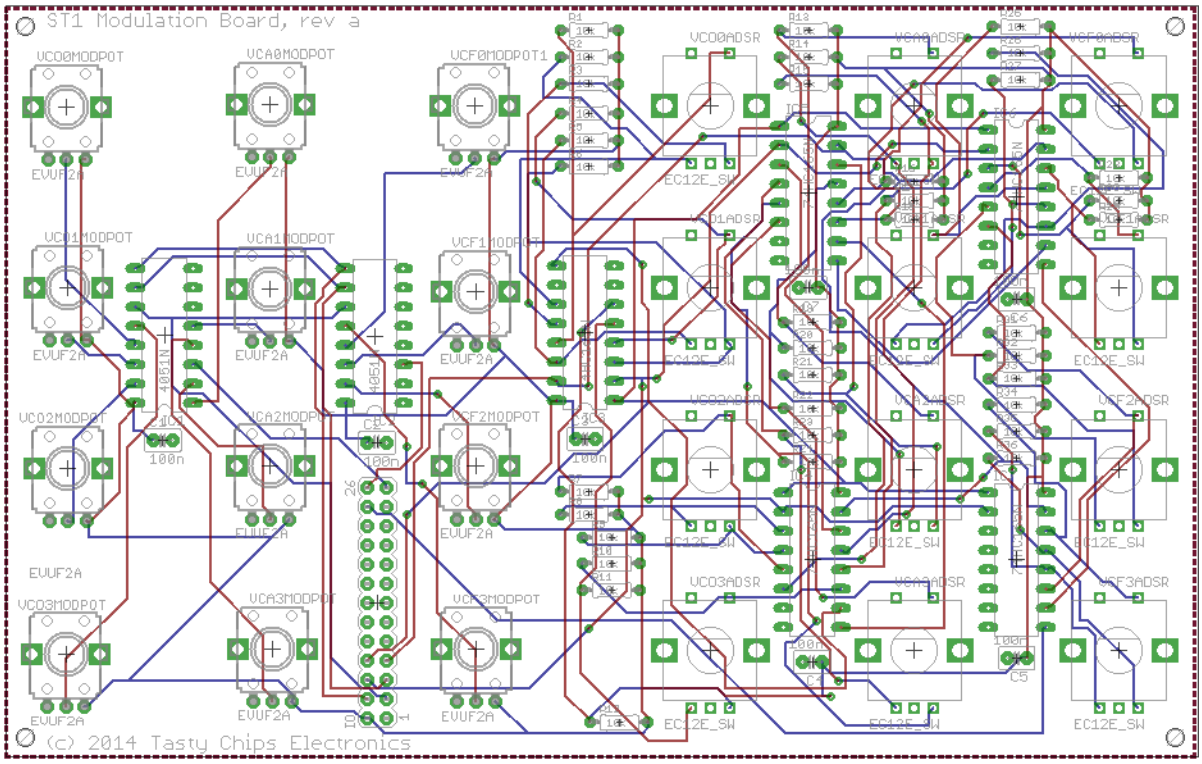
PCB OF THE FILTER CORE



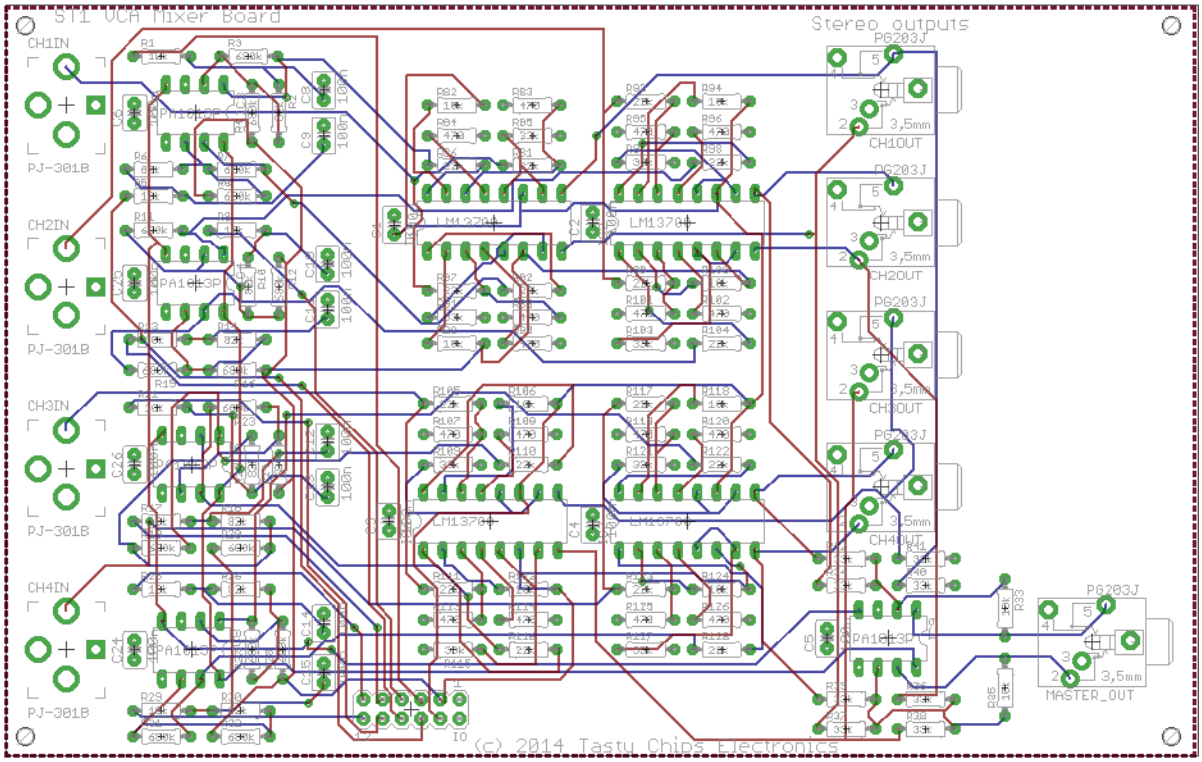
PCB OF THE VCF / VCA CONTROLS



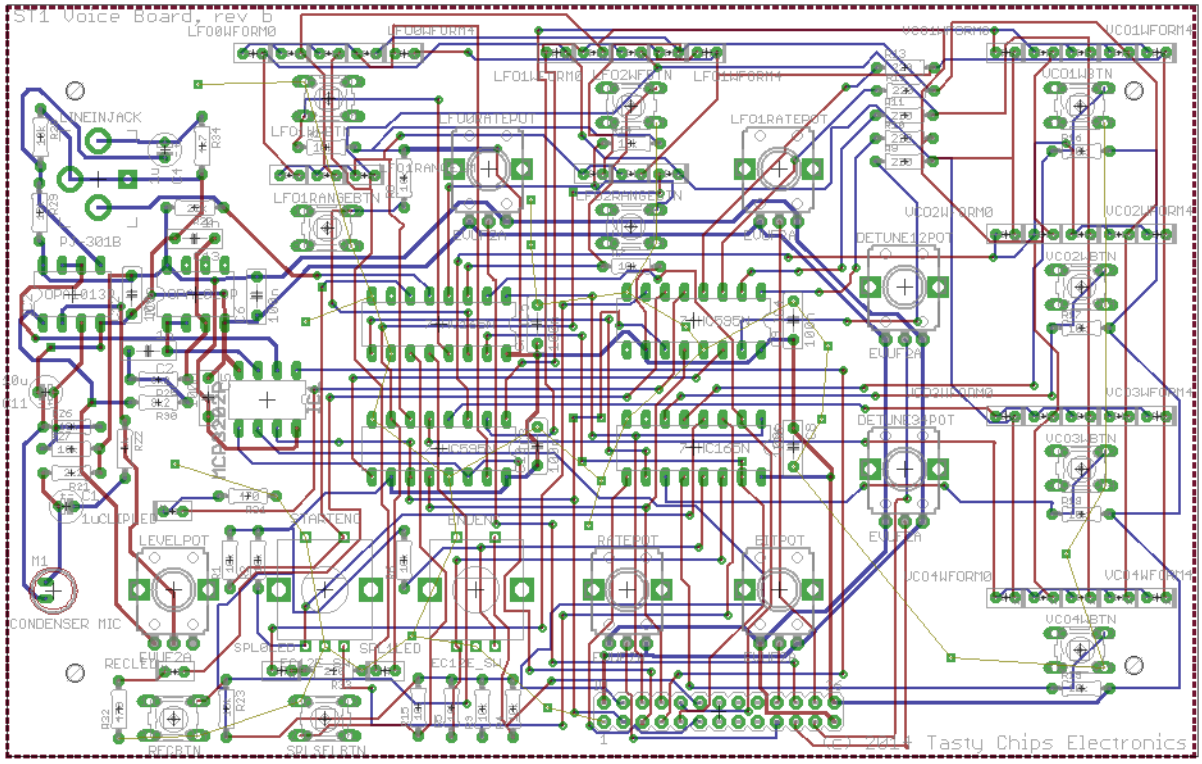
PCB OF THE MODULATION BOARD



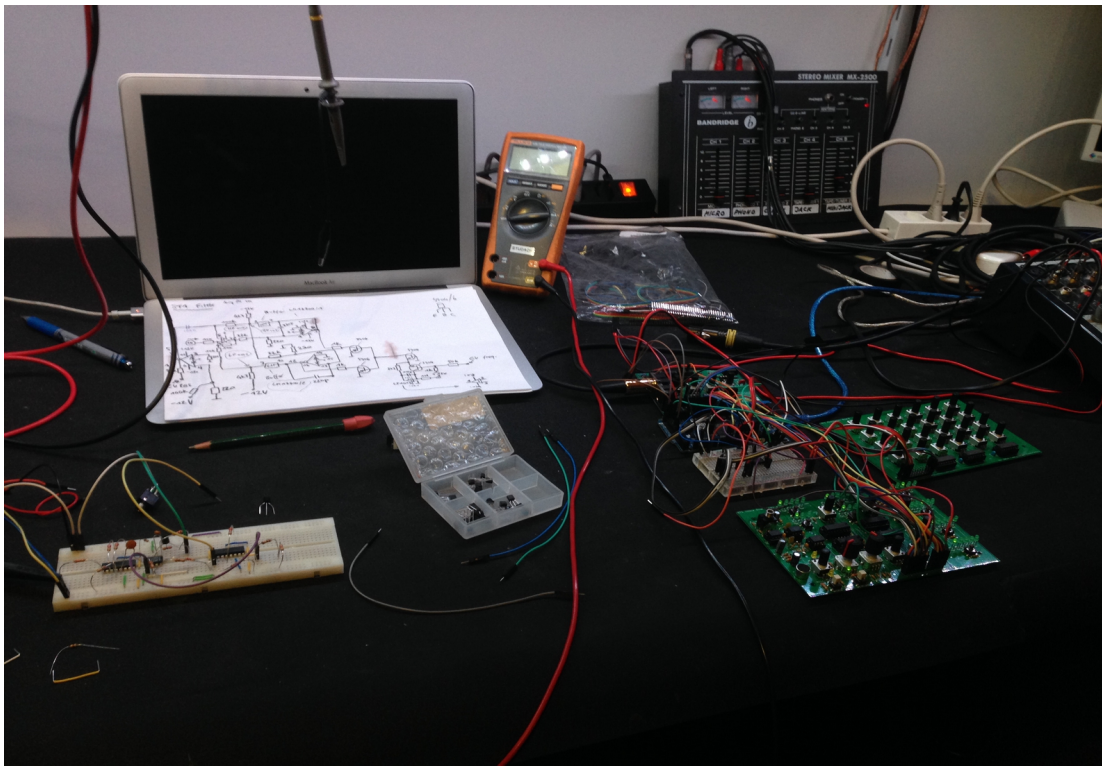
PCB OF THE VCA MIXER BOARD



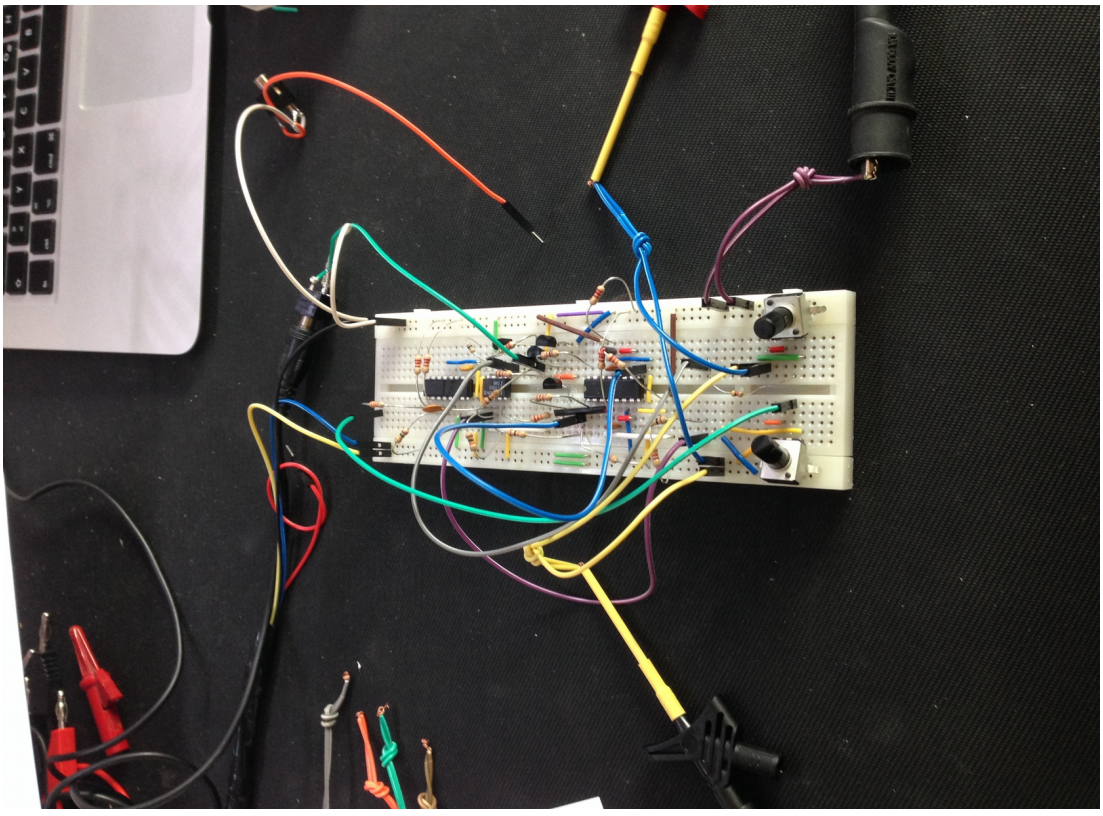
PCB OF THE VOICE BOARD



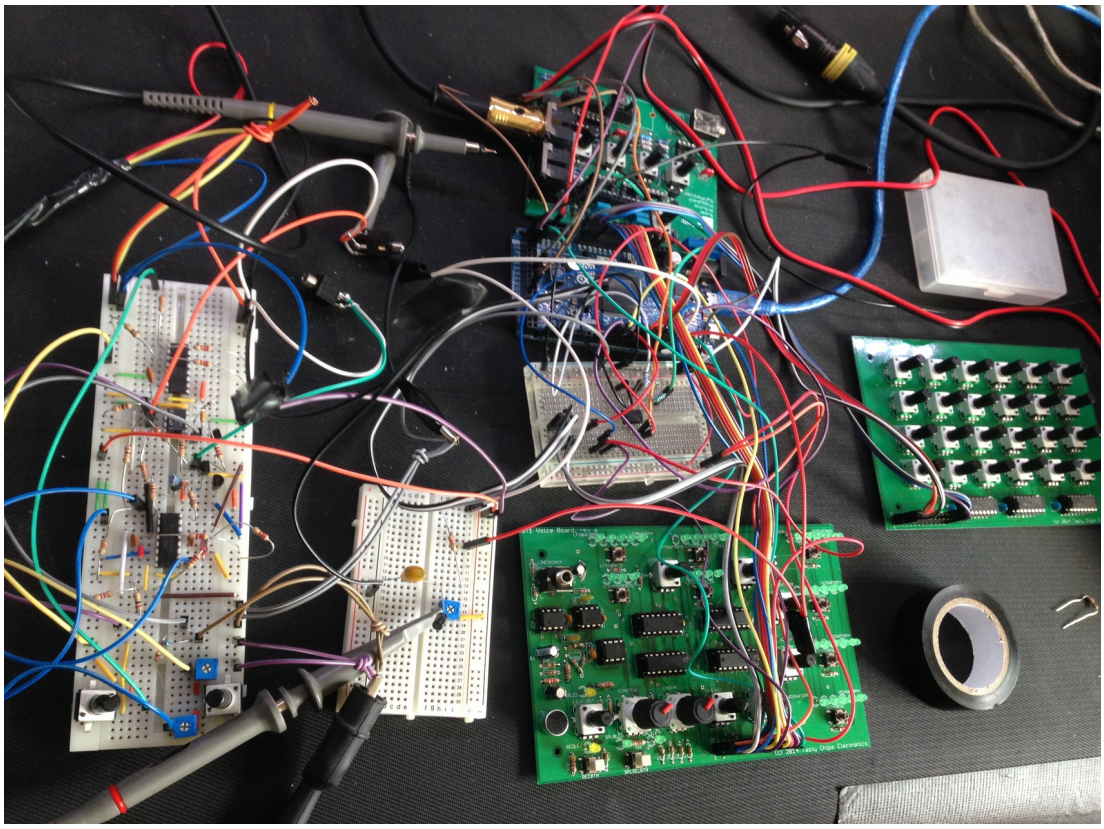
A FEW PCBs HAVE BEEN MADE ALREADY



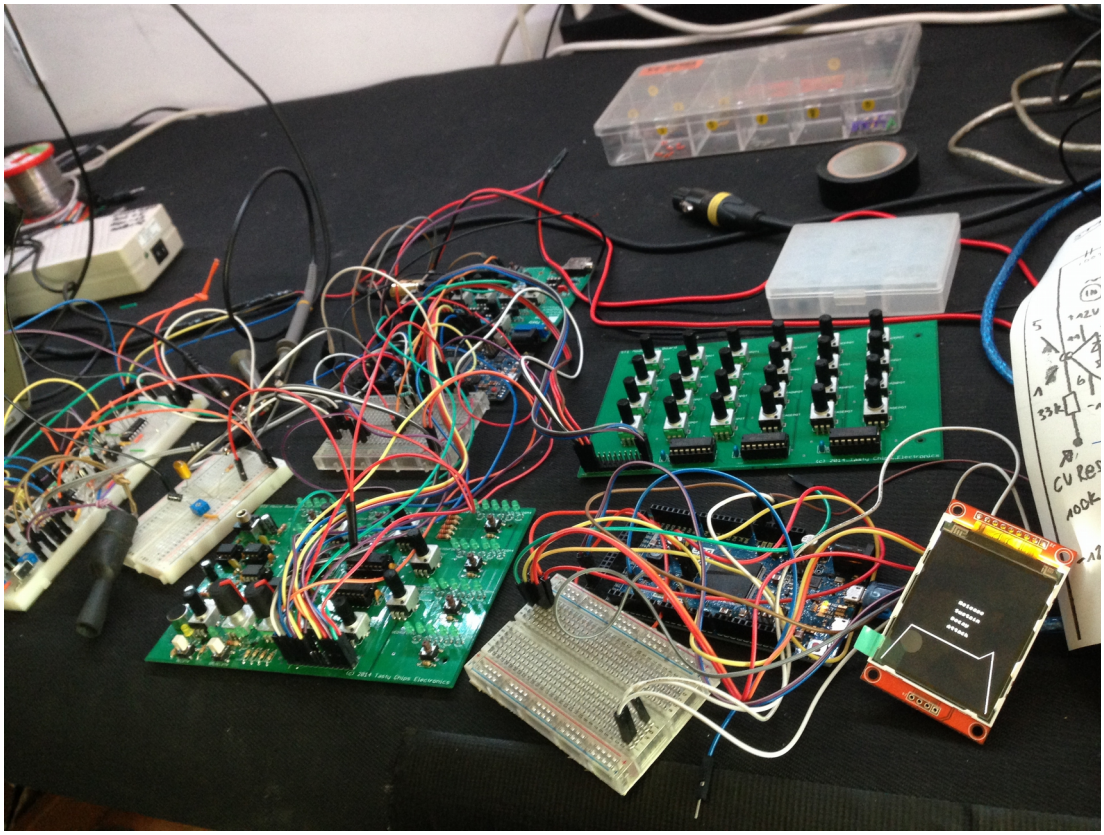
WHILST THE FILTER IS STILL ON A BREADBOARD



WHAT IS THAT A COLOR SPAGHETTI FACTORY?



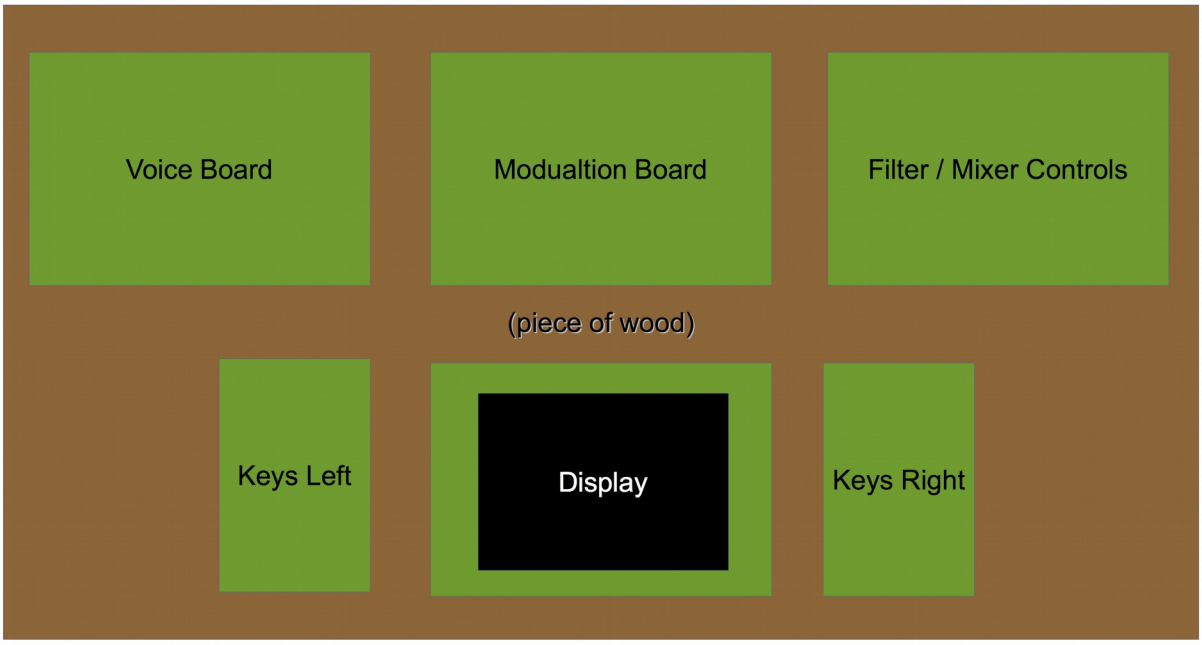
A TINY DISPLAY IS NOW WORKING TO TEST THE ADSR DISPLAY



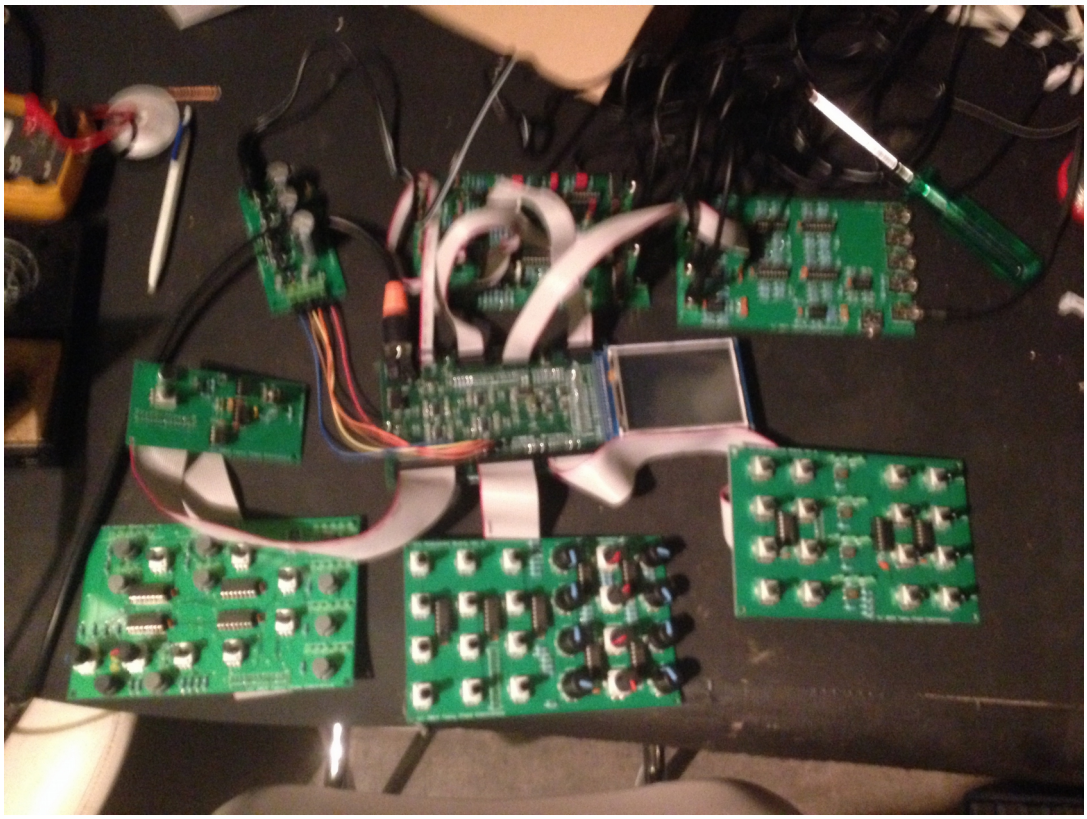
TIME TO BUILD THE PROTOTYPE

THE 'HOW TO ARRANGE THEM BOARDS' REQUIRES SOME RETHINKING

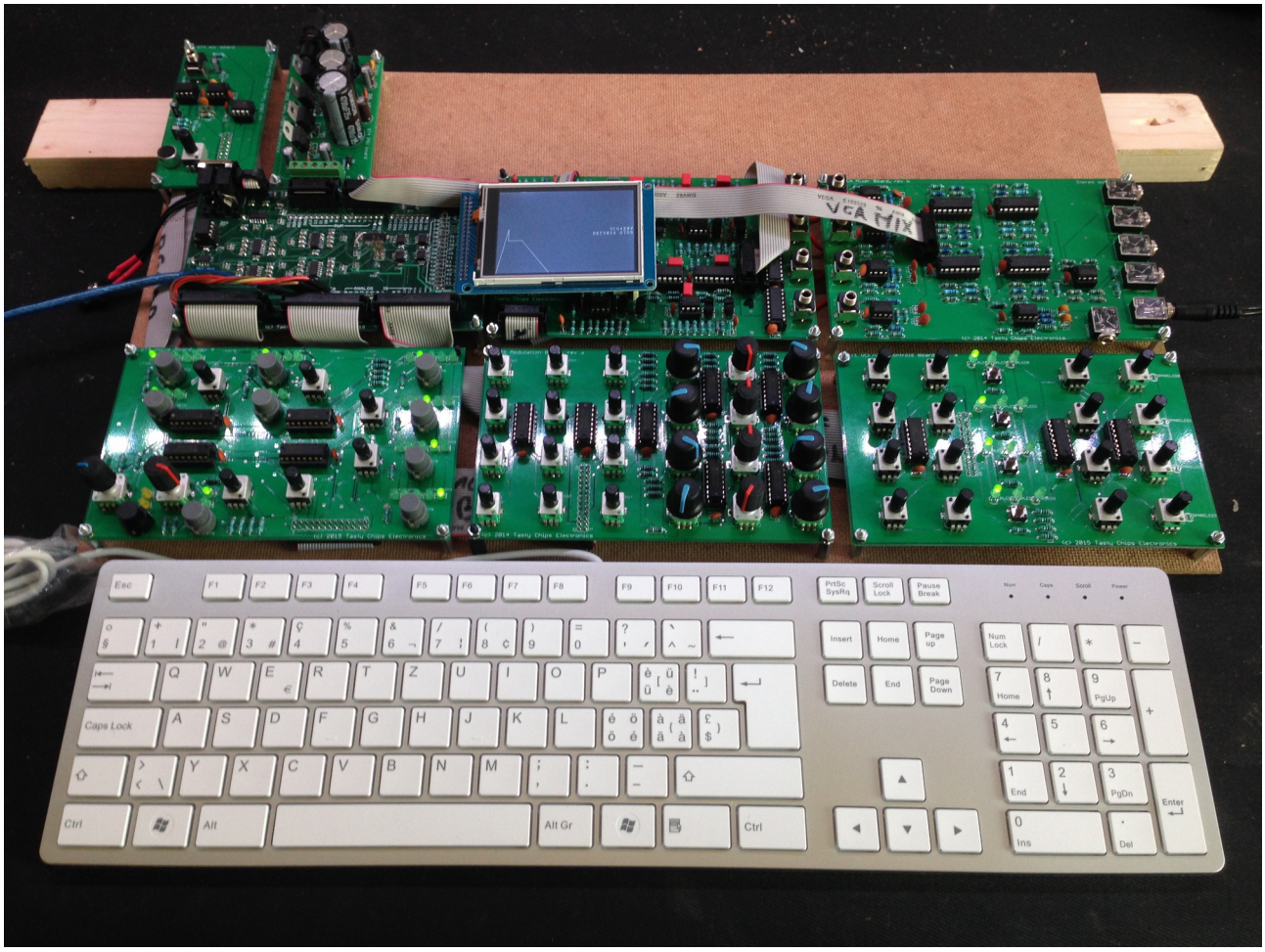
ST1 Prototype Interface



Filter Core ? / Other boards ? Where to place them? Maybe underneath?



VOILA NOW EVERTHING IS 'FIX' SCREWED DOWN TO A WOODEN BOARD

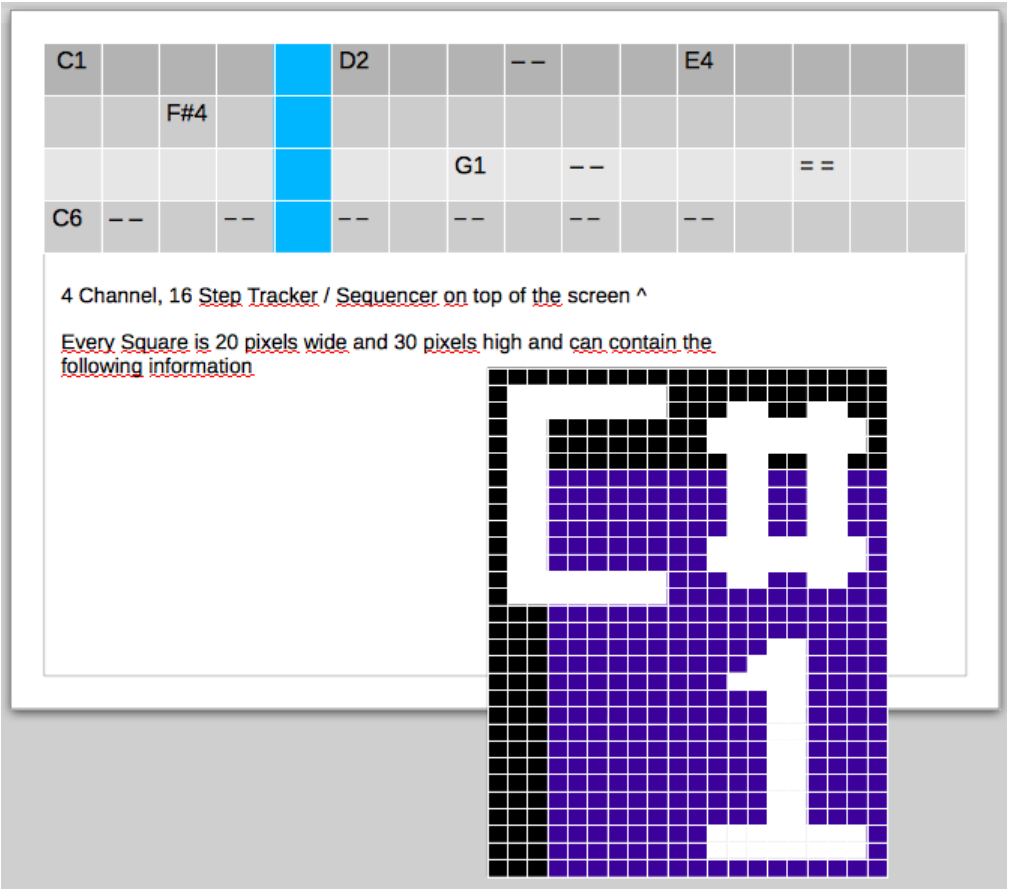


THE FAKE APPLE KEYBOARD WORKS LIKE A CHARM ON THE ARDUINO DUE

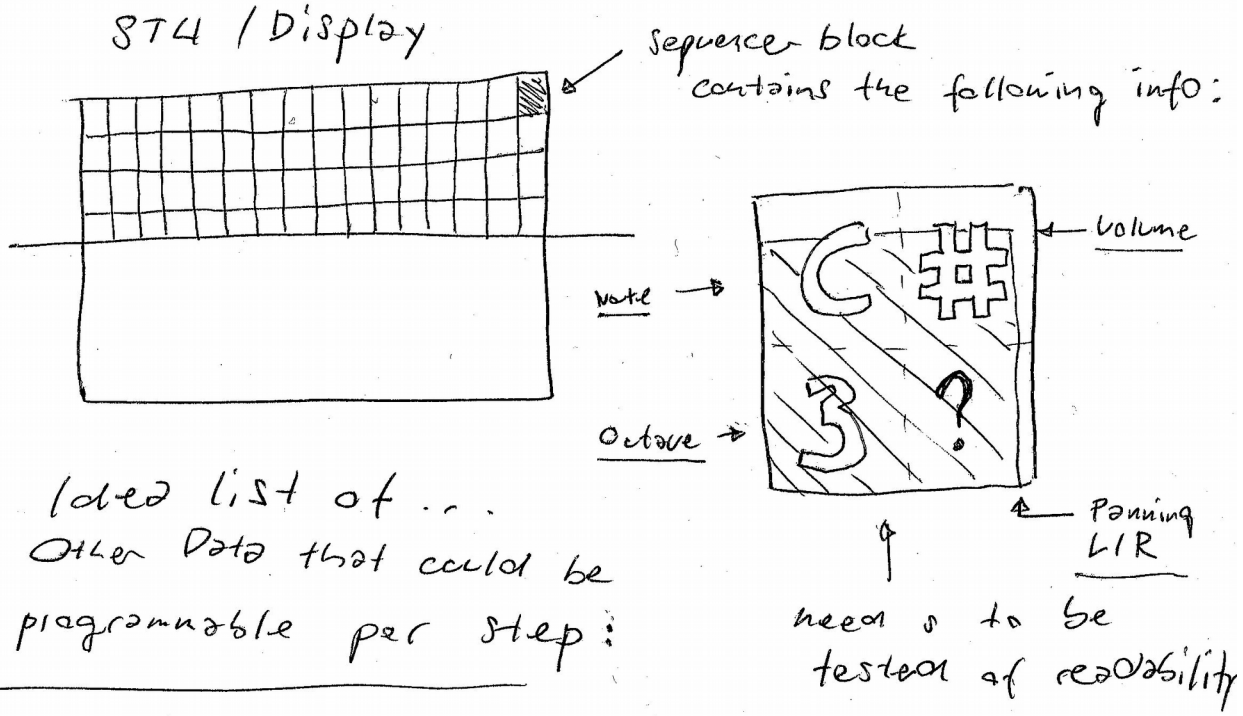
THE PROTOTYPE IS READY FOR FURTHER DEVELOPMENT!

TRACKER / SEQEUNCER DEVELOPMENT

THE TRACKER ACTUALLY IS A MIX OF RASTER TRACKER AND STEP SEQUENCER



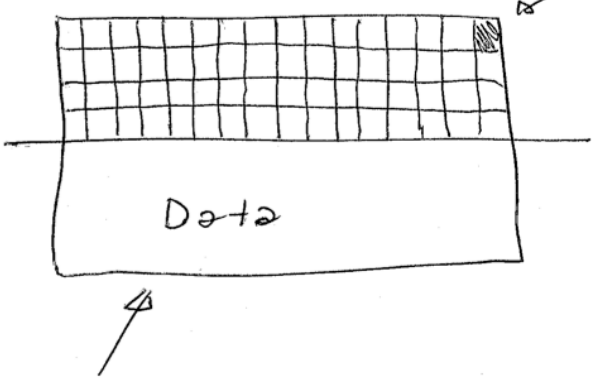
THIS REQUIRES SOME MORE SKETCHES TO COMMUNICATE THE IDEA



Idea list of ...
Other Data that could be
programmable per step:

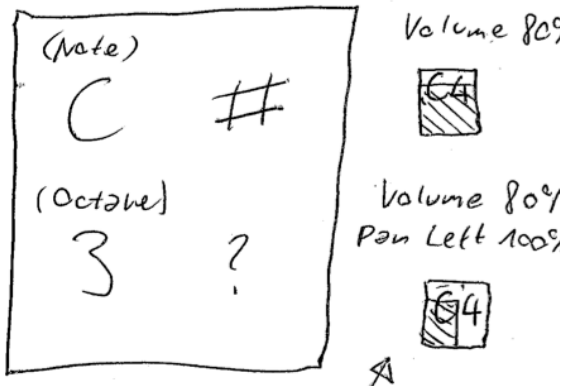
- Shuffle (Delayed triggering)
- Modulation (LFO Depth)
- Filter Value (Cutoff / Res.)
- ... ?

Option 1



Show information of selected block:

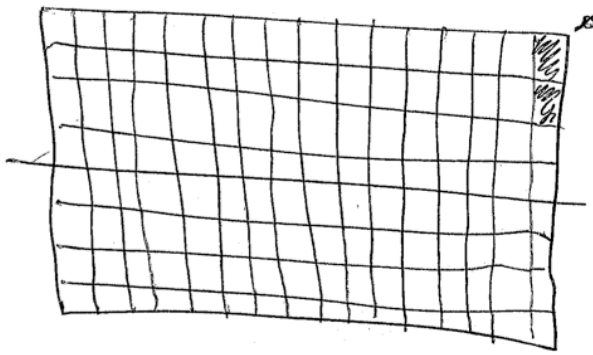
Sequencer Block:



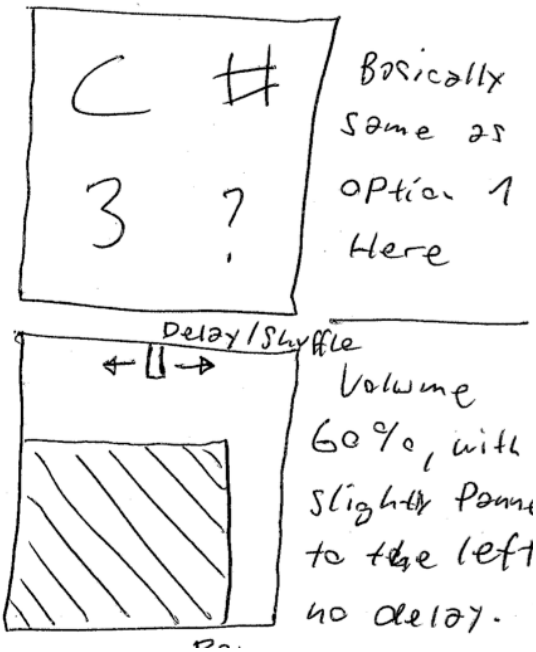
With this implemented, is it still readable???

if not, try option 2

Option 2



Sequencer Double Block



The basic idea is to work with Data AND colors to get the max out of a tiny screen.

PIETER IMPROVES THE SOFTWARE AGAIN AND AGAIN...

AT SOME POINT WE REALISE THAT THIS PROJECT IS SO DAMN AMBITIOUS!

:O

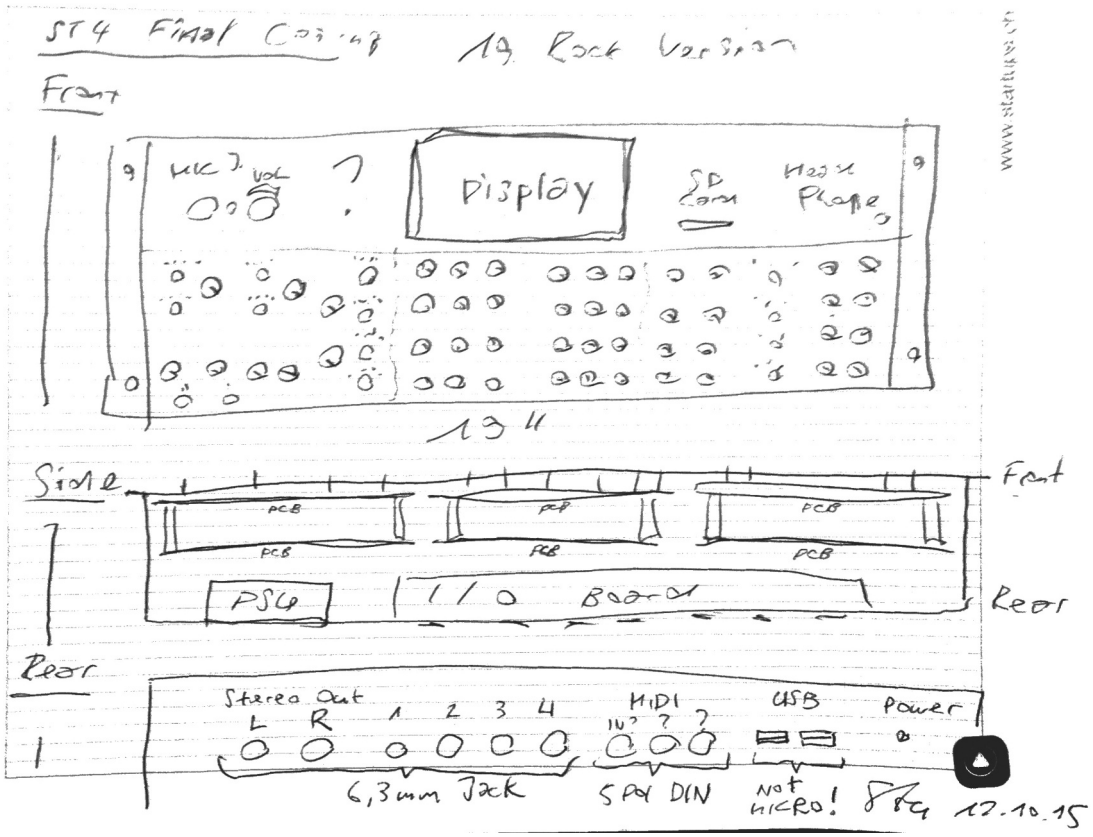
THERE ARE 2 OPTIONS NOW:

~~1) GIVE UP~~

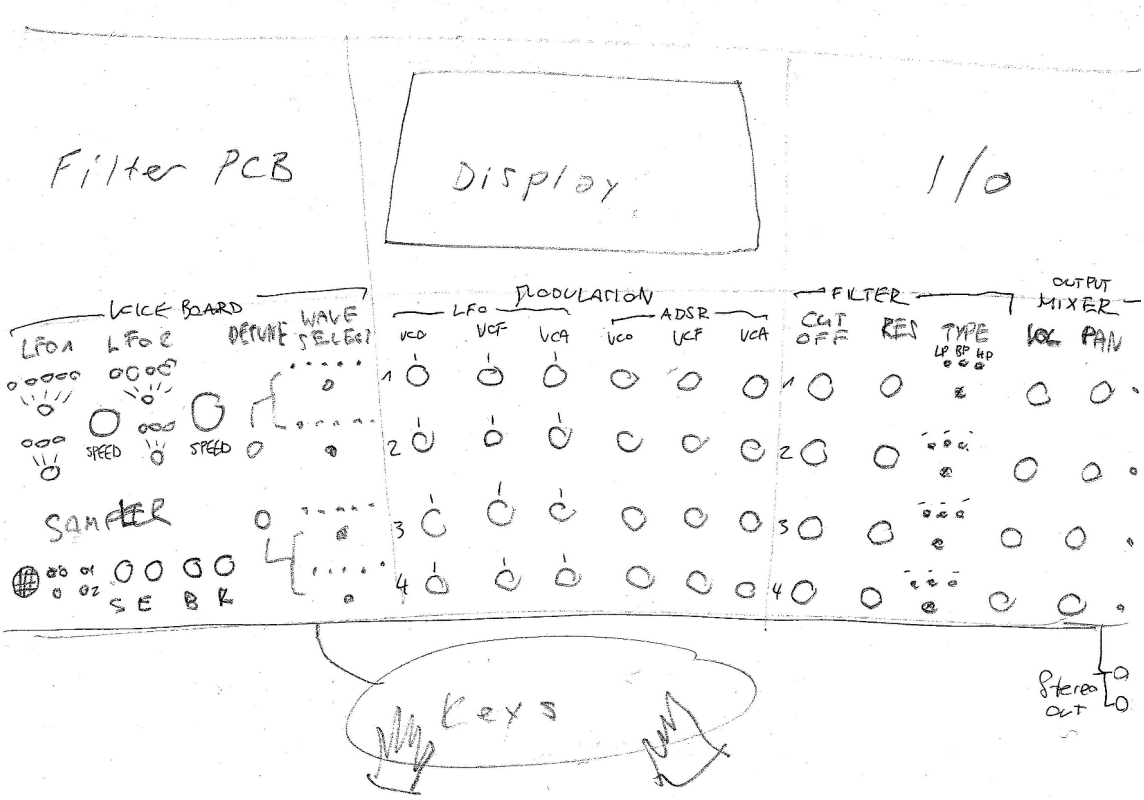
2) JUST..... FREAKING..... DO IT!!

FINAL CASING DESIGN

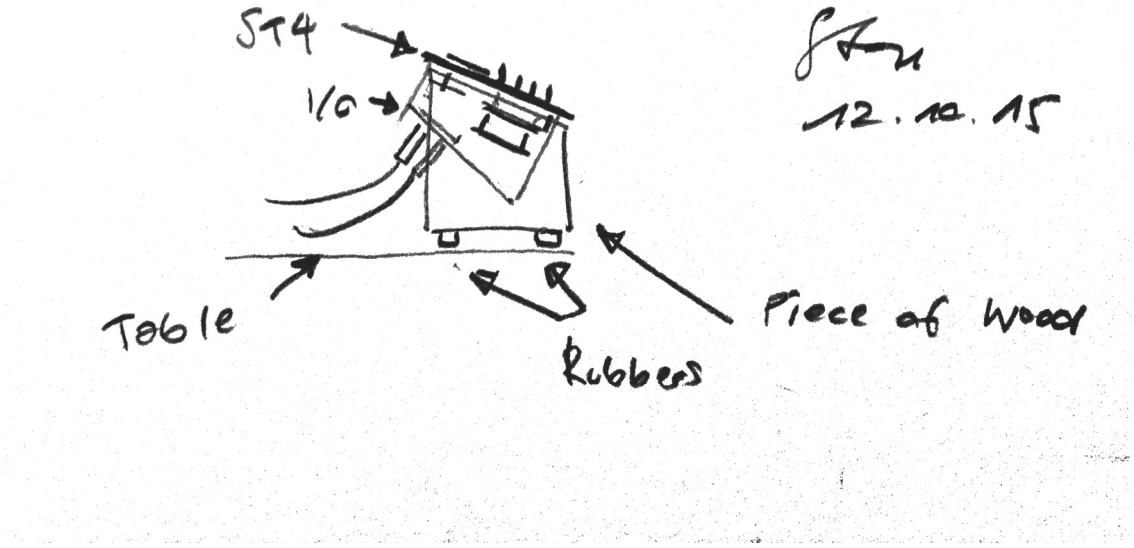
THE IDEA OF DOING A HYBRID CASING (19" AND DESKTOP COMPATIBLE)



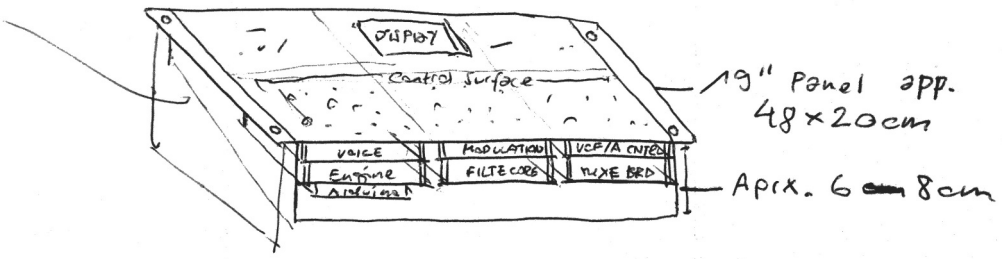
ON THE DESK THAT WOULD LOOK LIKE THIS



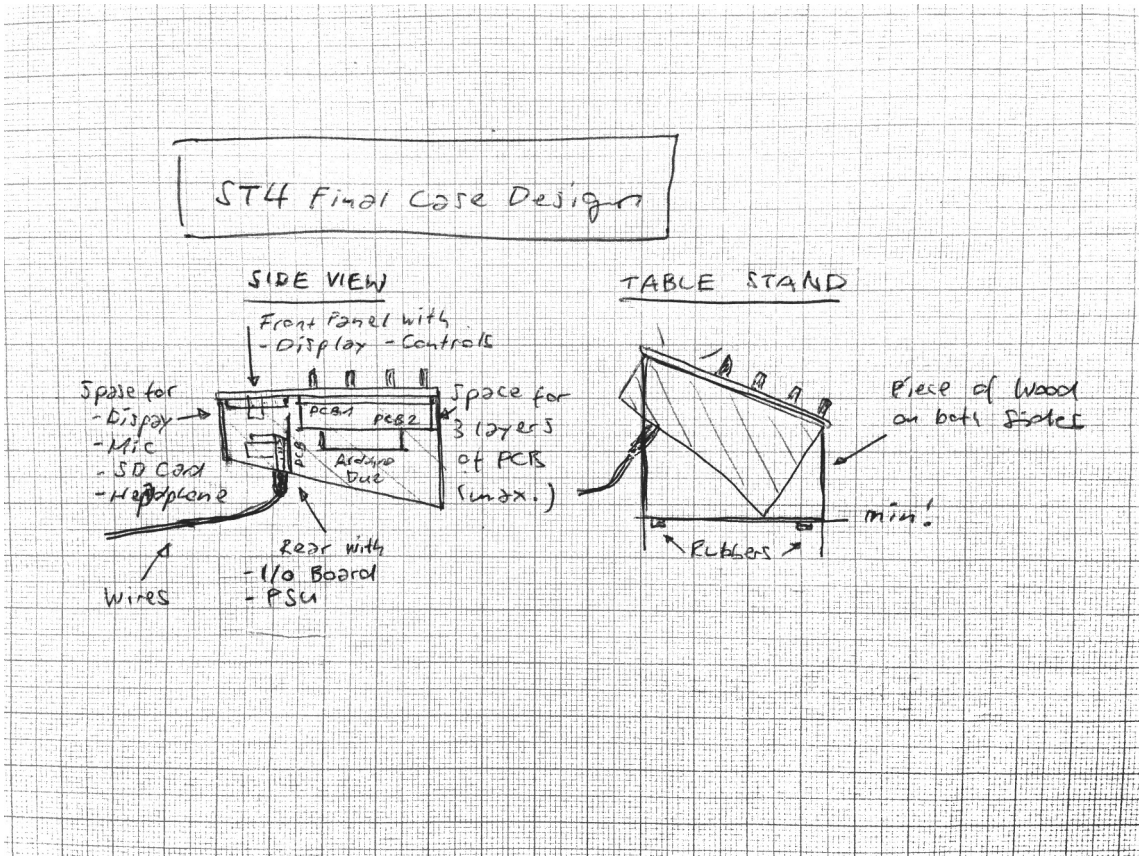
A SIDE VIEW EXPLAINING WHERE THE I/O BOARD IS PLACED



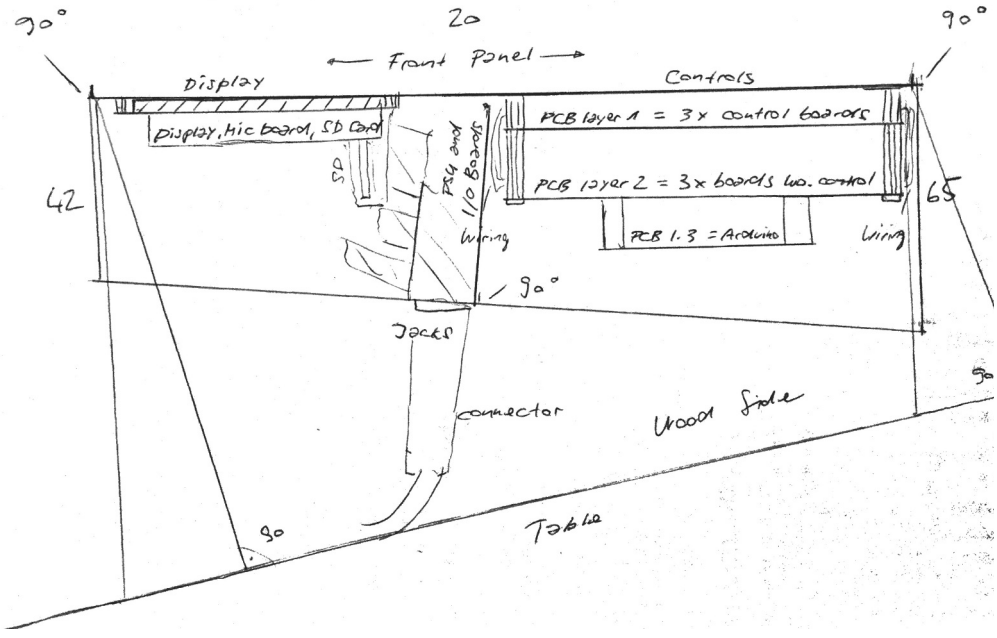
AND A FRONT VIEW EXPLAINING HOW THE PCBs ARE MULTILAYERED



SOME MORE SKETCHES



ST4 Final Case Design → View from left side



AND HERE IT IS!

~15kg of SYNTH POWER!

THE ST4 FITS WELL IN EVERY STUDIO

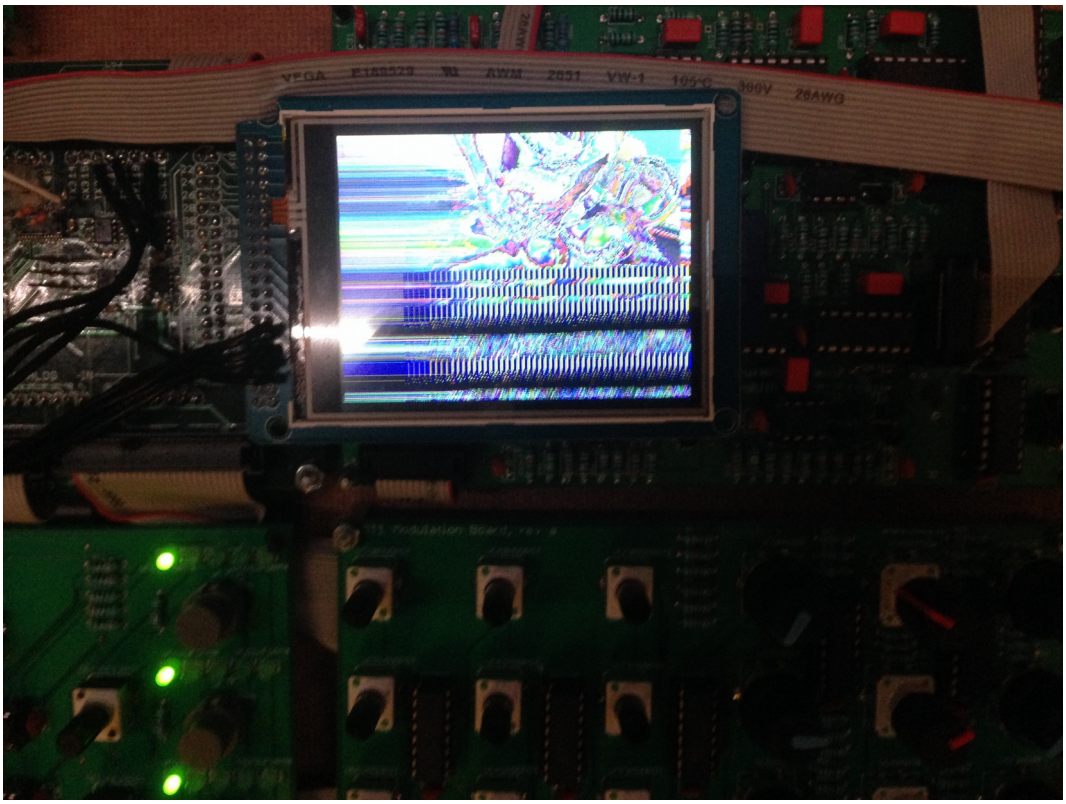
KICKSTARTER CAMPAIGN VIDEO PRODUCTION

STEFAN COMES OVER WITH SOME PROFESSIONAL VIDEO EQUIPMENT...

TO FILM STU DOING SOME LIVE TRACKING ON THE ST4

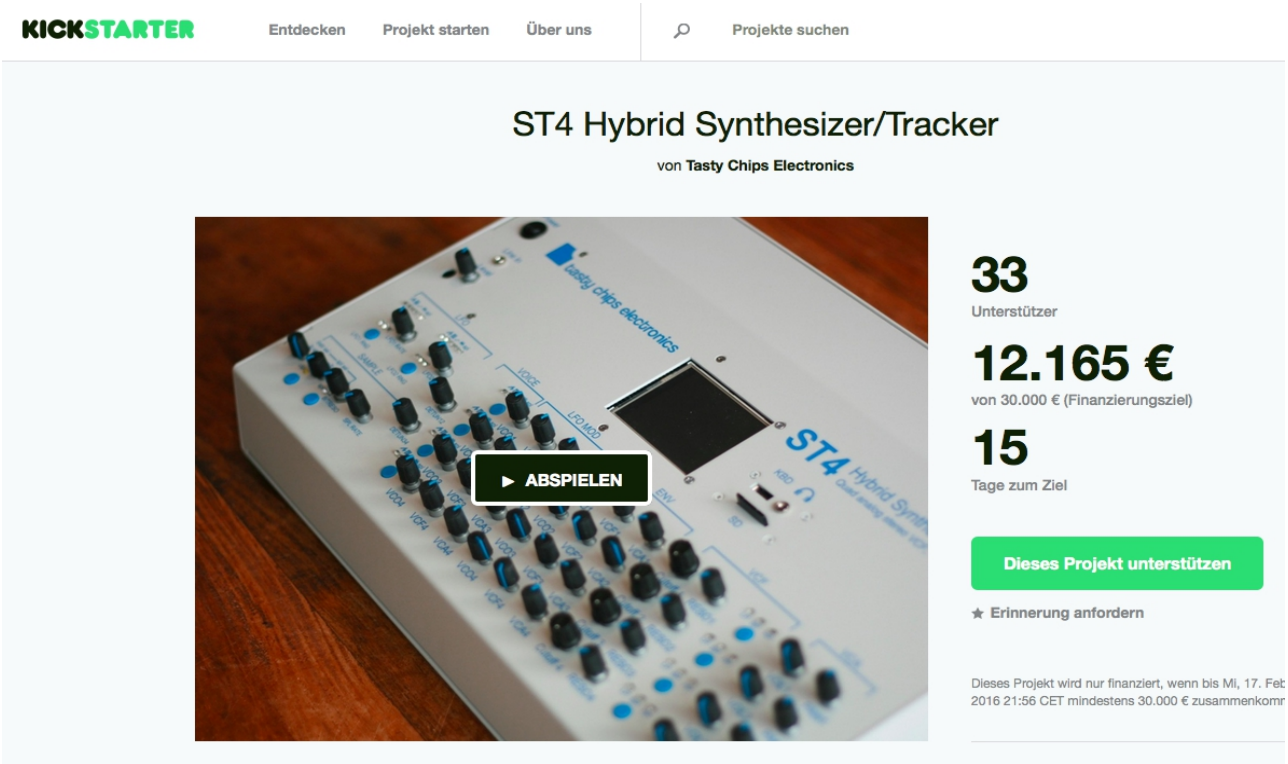
A MIDI KEYBOARD IS BEING INSTALLED TO DEMONTRATE THE ST4s MIDI SKILLS

IN THE MEANTIME WE TRIED TO WATCH SOME PR0N ON THE WOODEN BOARD =)



THEN THE FOOTAGE GETS PRODUCED FOR THE KICKSTARTER VIDEO

AND FINALLY PEOPLE CAN PURCHASE THE ST4 WORDWIDE!



THAT'S IT!

DOCUMENT VERSION 1

2016.02.02 by Christian Studach (stu@i2r.ch)