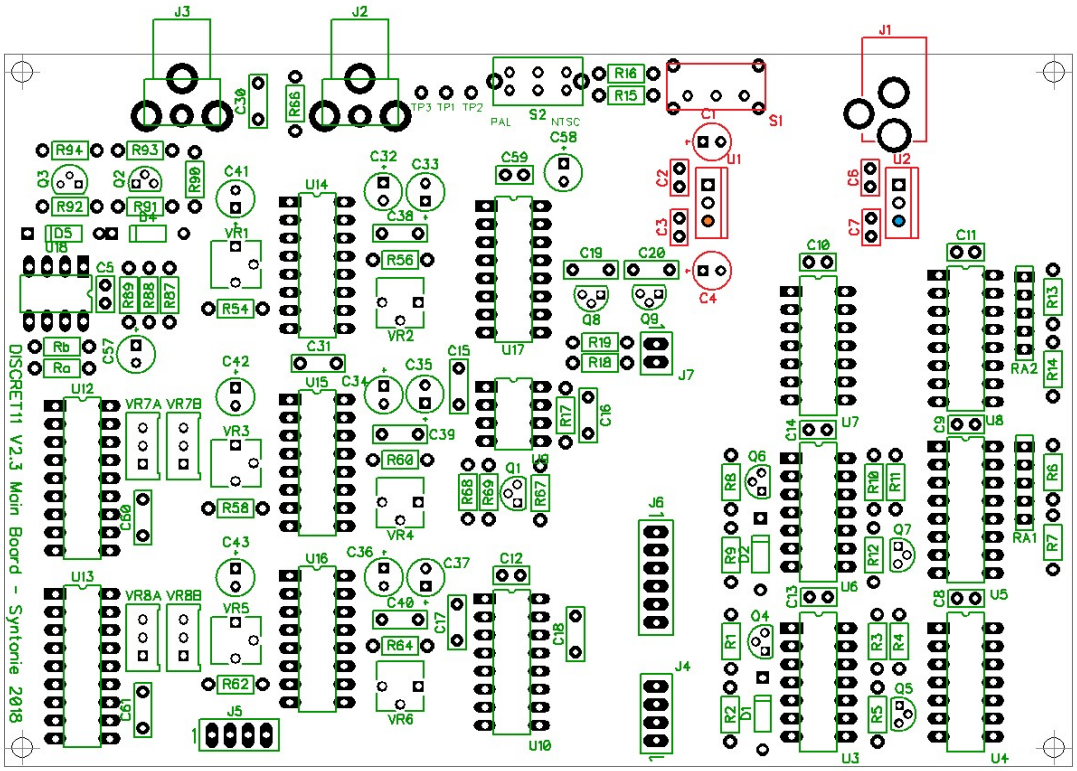
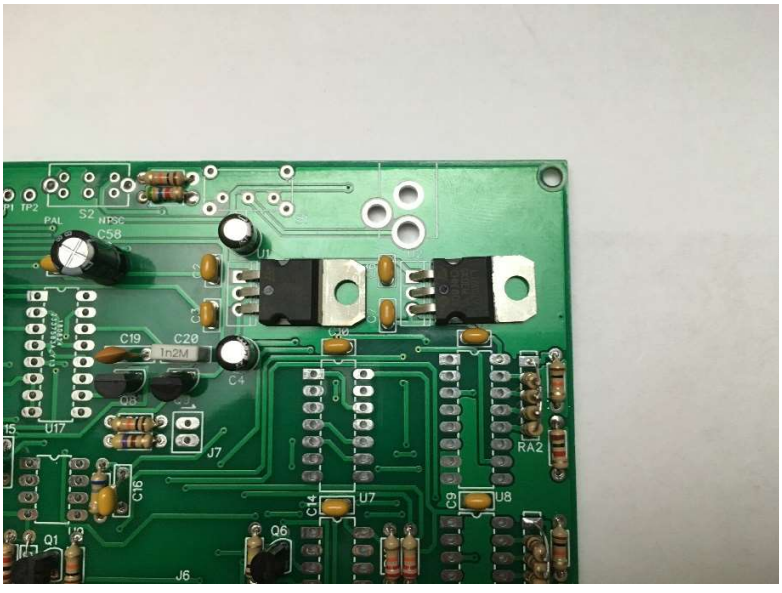
DISCRET11 V2.3 Build guide

A. Main Board

I. Power supply





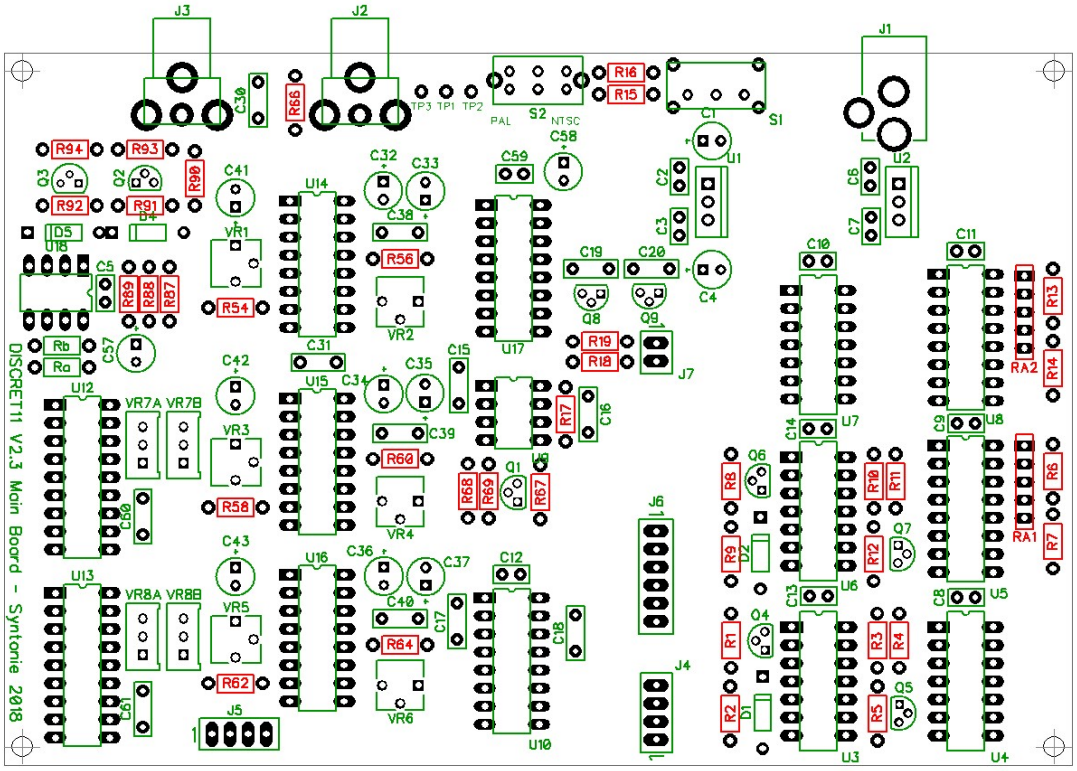
Place the following components :

- J1 : power connector
- S1 : SPDT switch
- C1, C4 : 10uF/16V
- C2, C3, C7, C8 : 100nF ceramic capacitors (marked 104)
- U1 : 7812
- U2: 7805

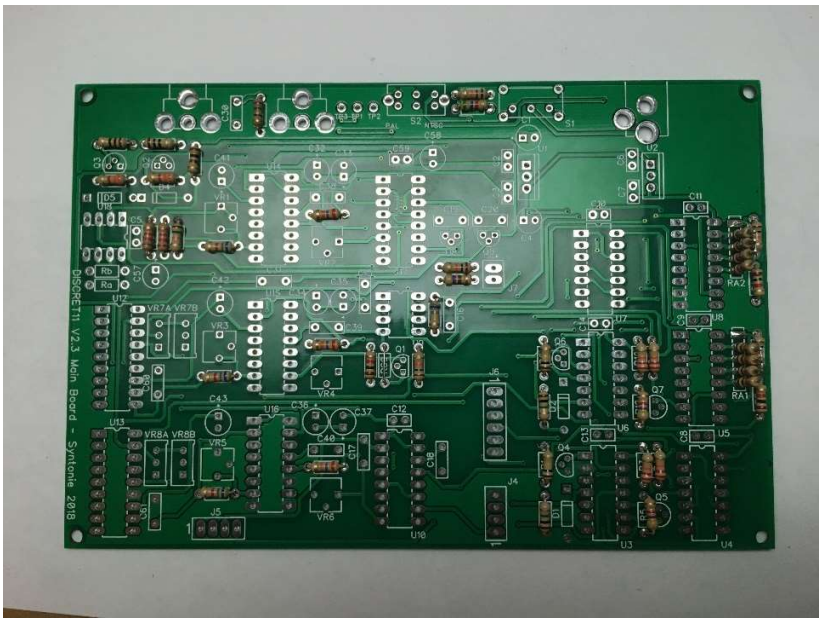
Electrolytic capacitors are polarized, mind the orientation.

Bend both regulators as shown on the picture. Plug a 15VDC center positive power supply 500mA, switch S1 to the left, and with a voltmeter, check the voltage at the output of both regulators (orange point should be around 12V, blue point around 5V).

II. Resistors



Place all the resistors according to the bill of material.

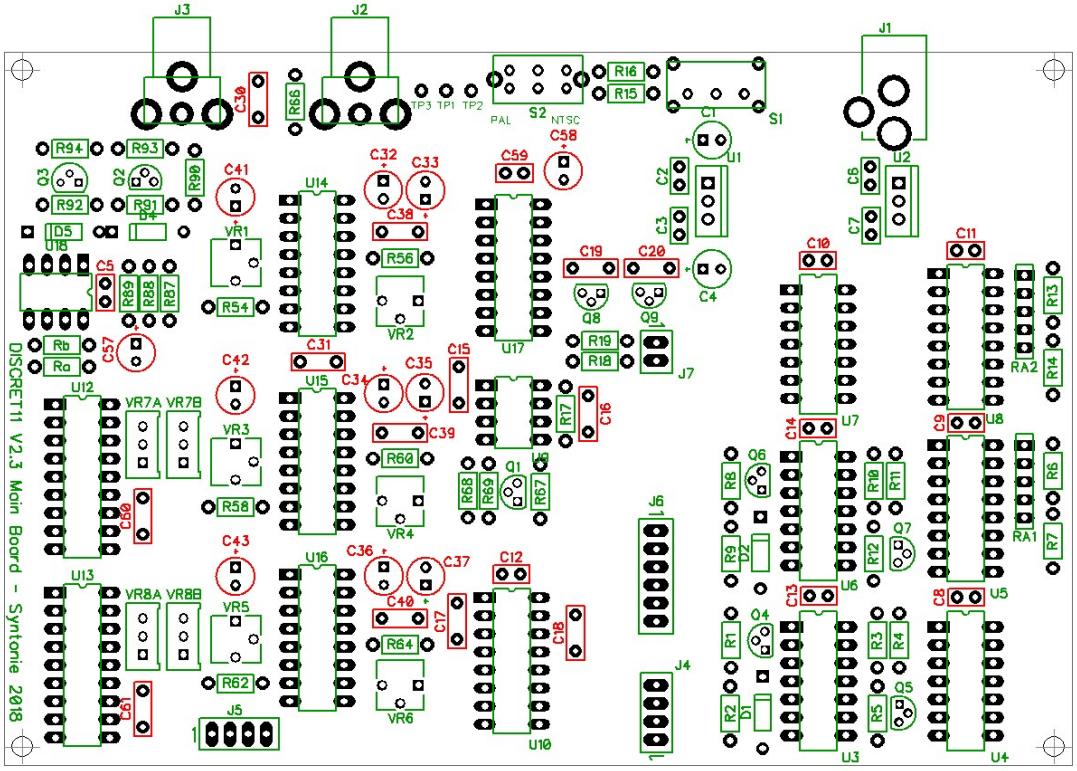


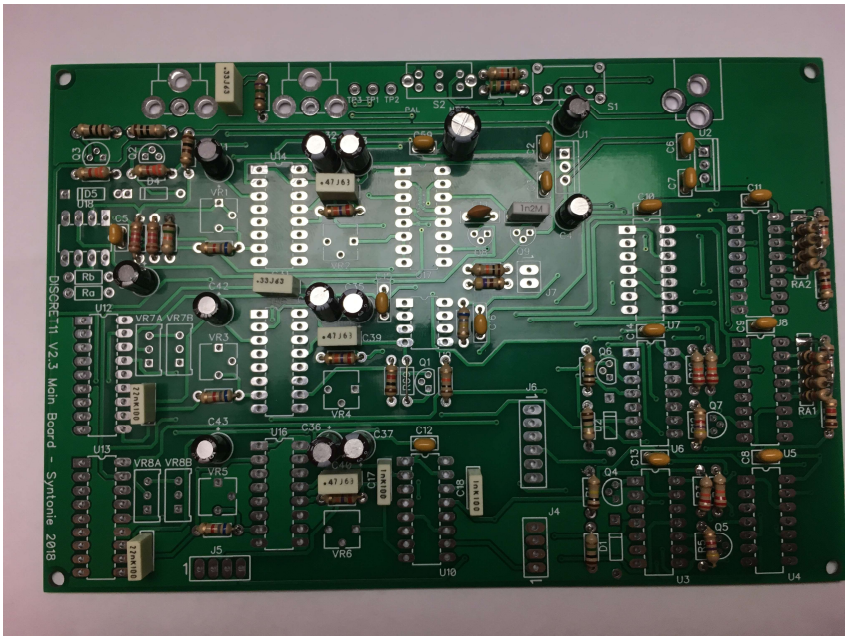
Note that on the picture, RA1 and RA2 are 4x 1K resistor, whereas kit include 2 resistors array (yellow component with 5 legs). Make the dot on the component match the square pad on the component footprint.

R69 is a resistor leg used as a jumper.

Ra and Rb are left empty on both pictures, however put 2x 10K to properly terminate the unused op amp in the LM6172 (U18).

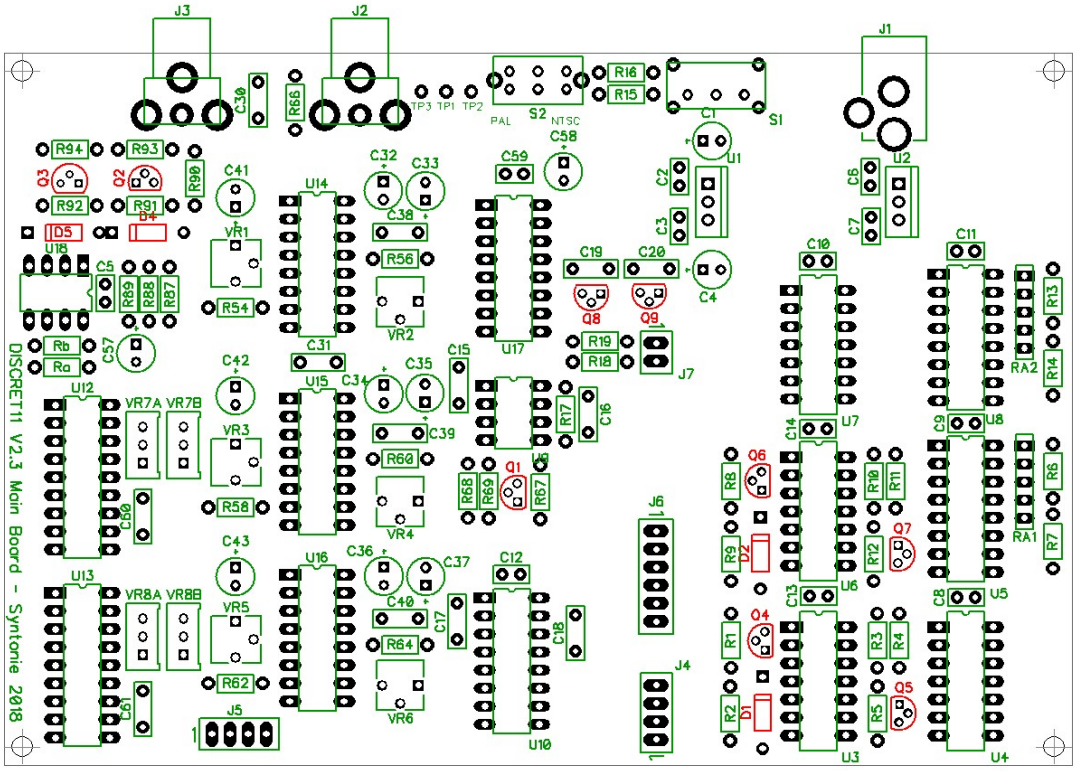
III. Capacitors

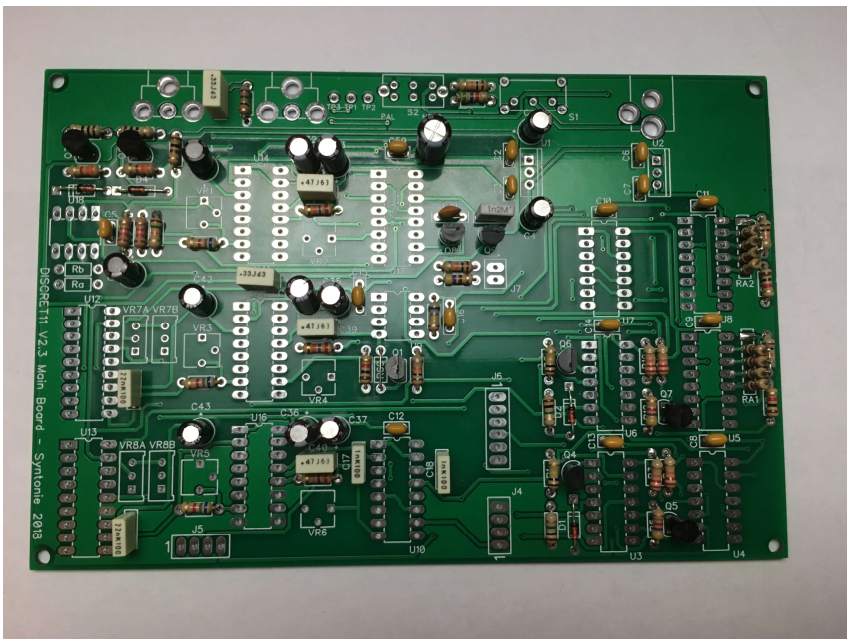




Place all the capacitors according to the bill of material. All the 100nF capacitors are ceramic (yellow body with 104 marking). Mind the orientation of electrolytic capacitors.

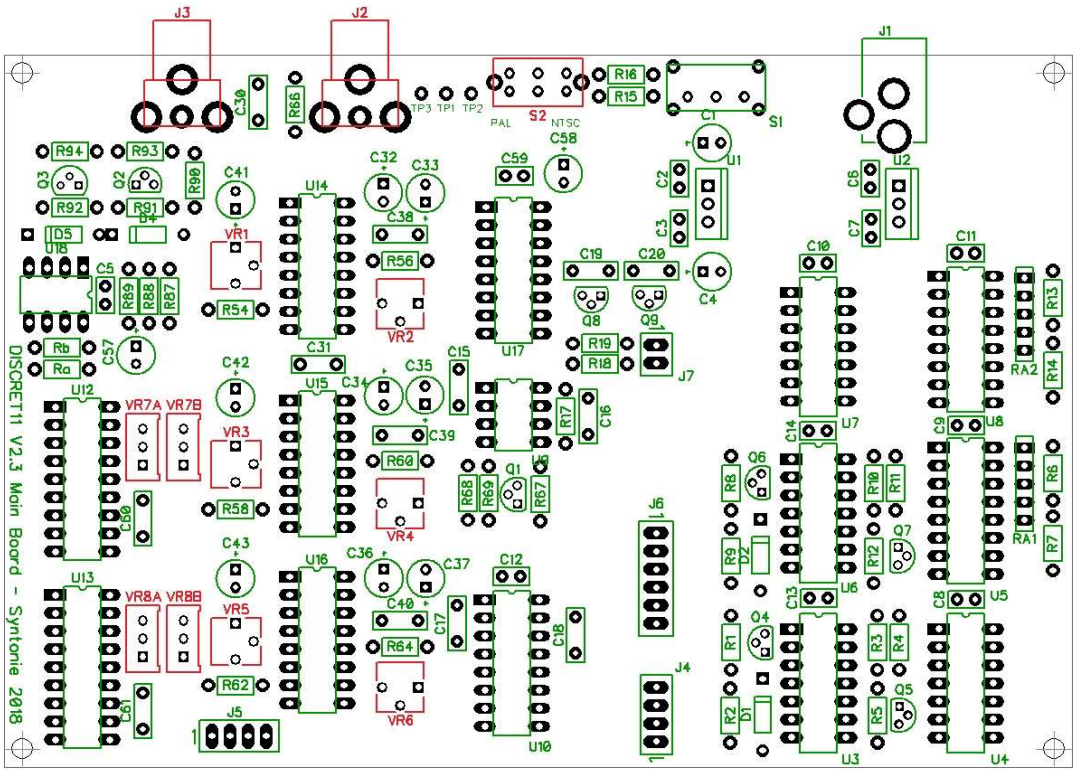
IV. Semiconductors

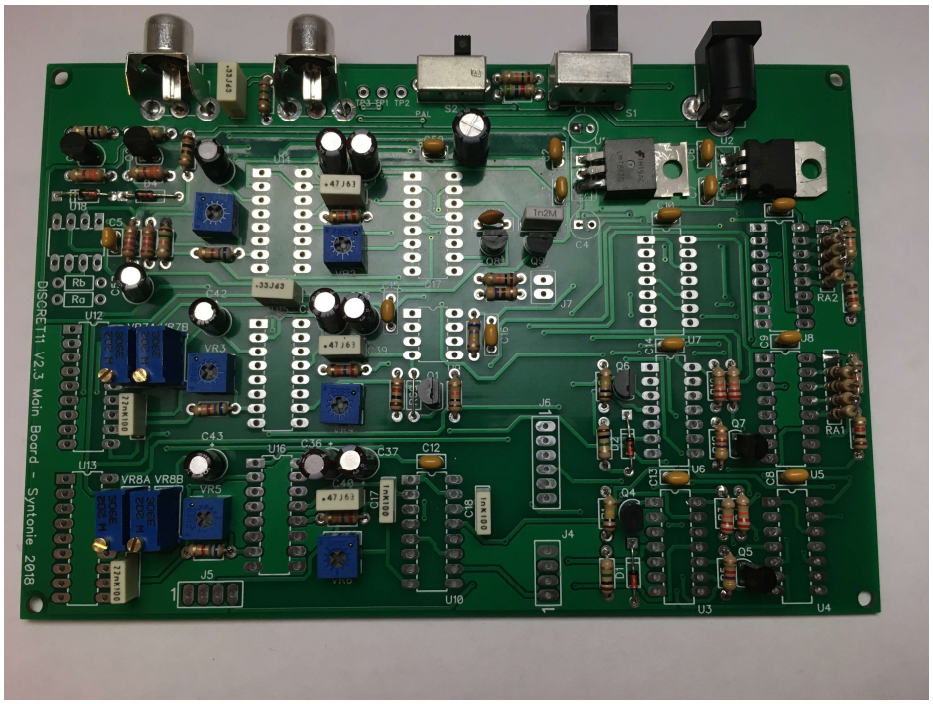




Place all the transistors and diodes according to the bill of material. Mind that Q3 is a 2N3906 whereas all other transistors are 2N3904. Diodes are polarized, be careful to orientation.

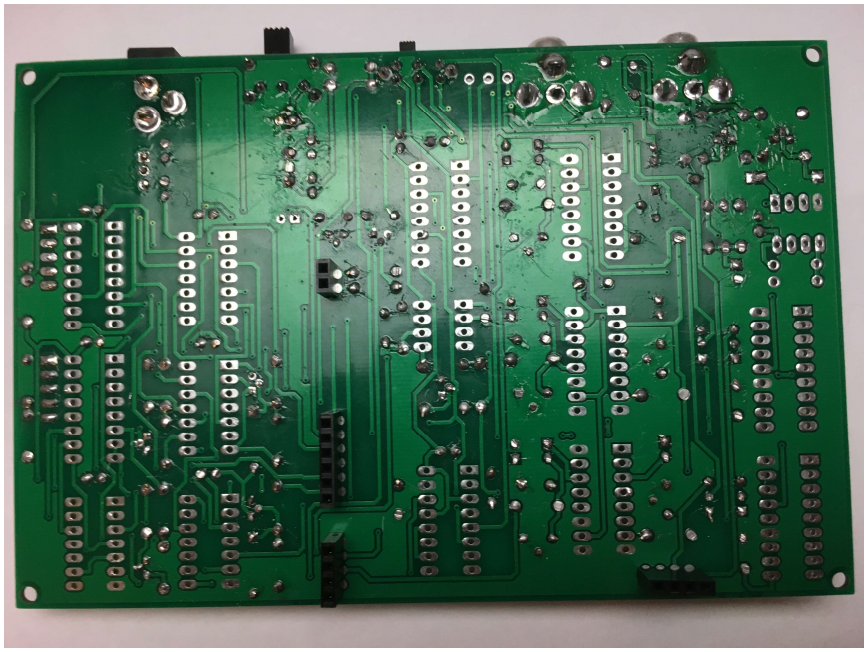
V. Hardware





Place both RCA connectors and the DPDT switch. Check the body of the trimmer potentiometer for their value, 502 is 5K, 203 is 20K and 202 is 2K. VR7A and VR8A are used to set delays for NTSC, VR7B and VR8B are used to set delays for PAL. So if you don't intend to use both standards, you do not need to put all 4 trimmers.

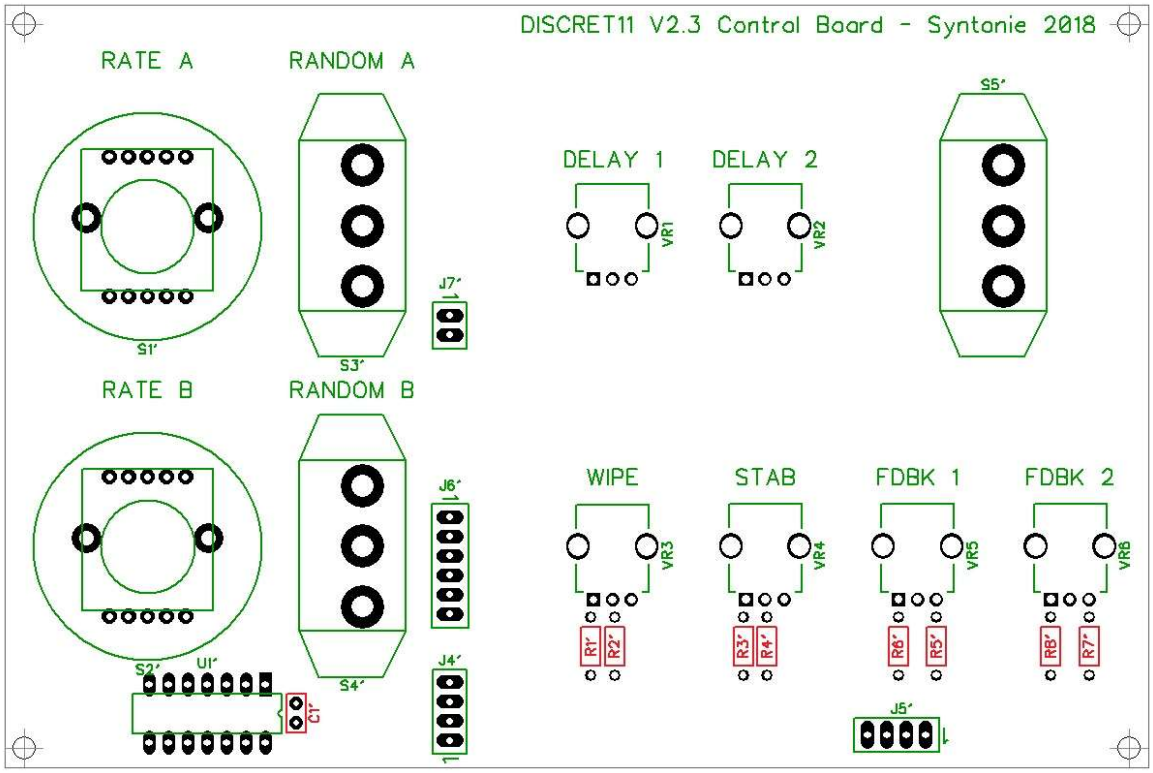
Now, solder all the board connectors (J4, J5, J6, J7). Note that the body of the connectors are on the solder side of the board, not on the component side.

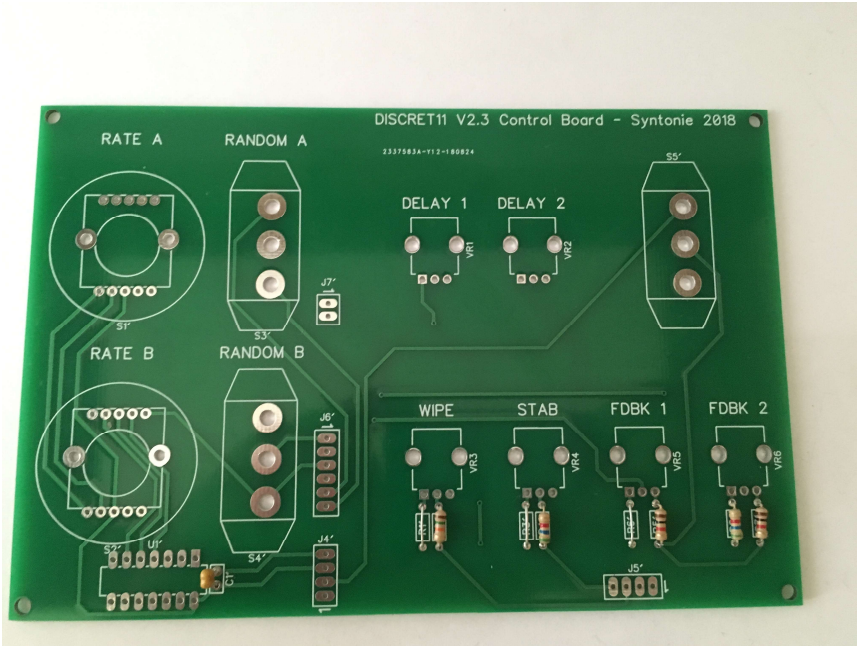


Mainboard is now almost complete. If you use socket for the IC, you can place and solder them, but don’t put the ICs in it yet.

B. Control board

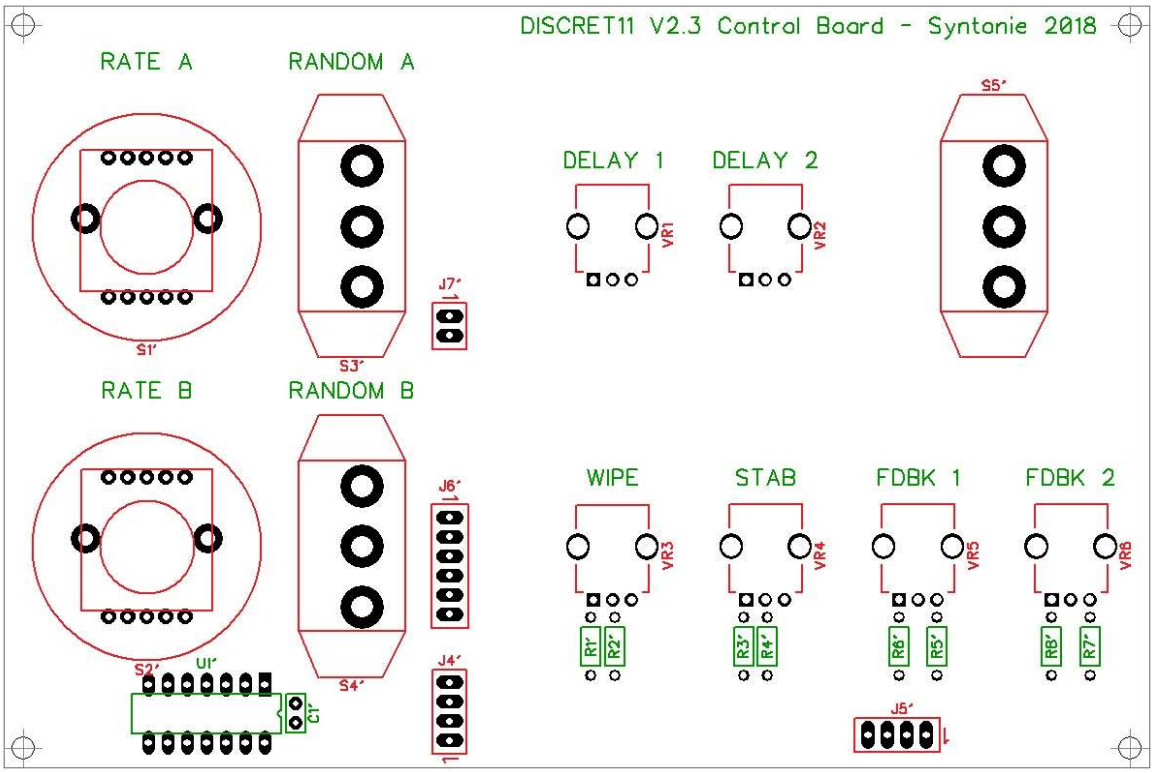
I. Passives

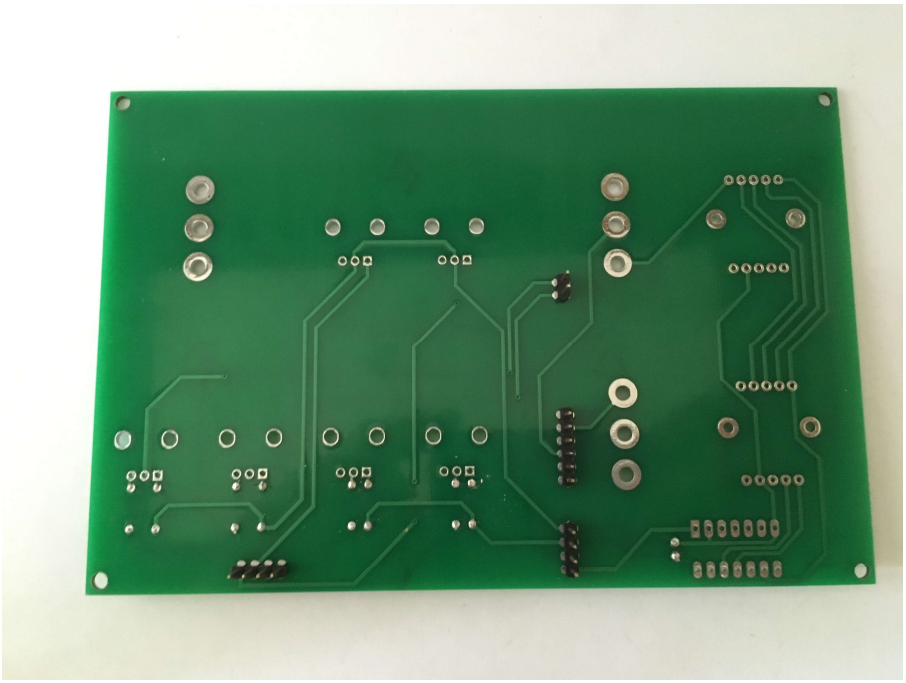




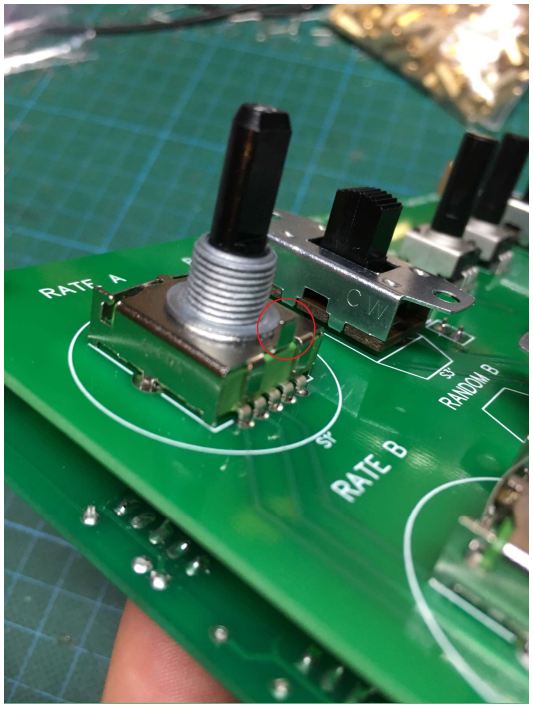
Place the 100nF capacitor (C1'), and all the resistors. Note that R1', R3' and R6' are resistors legs used as jumper.

II. Hardware



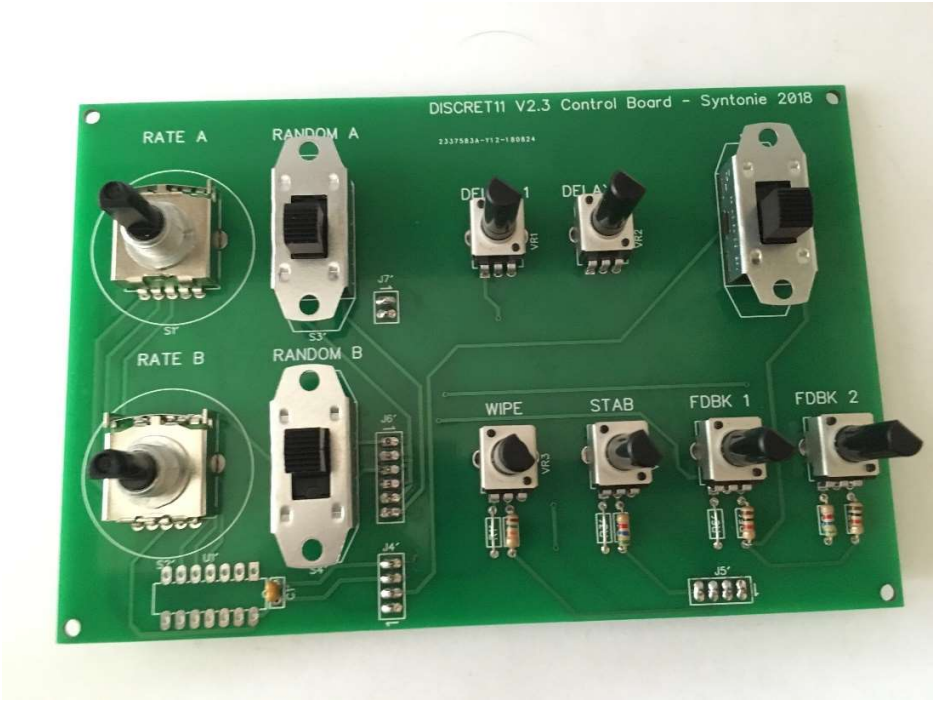


First, place the 4 connectors (J4', J5', J6', J7'). The pins of the connector should be on the solder side of the board.



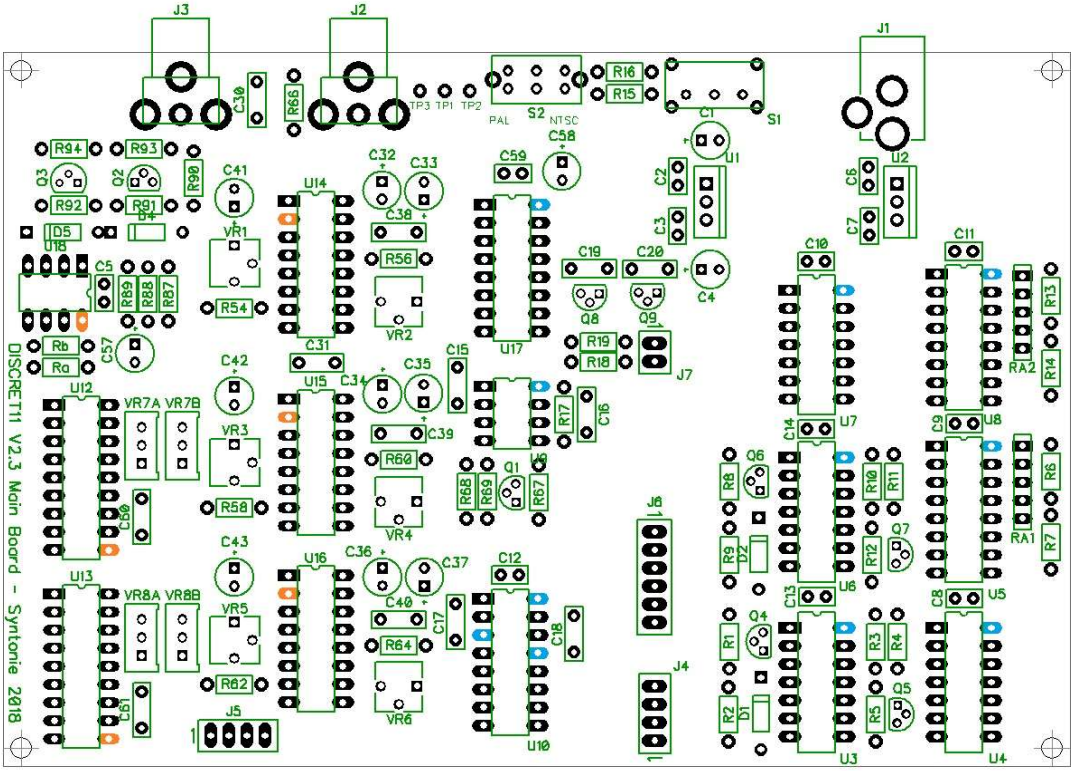
Before soldering the rotary switches, cut the small tabs using cutters, it will be better for the enclosure assembly later.

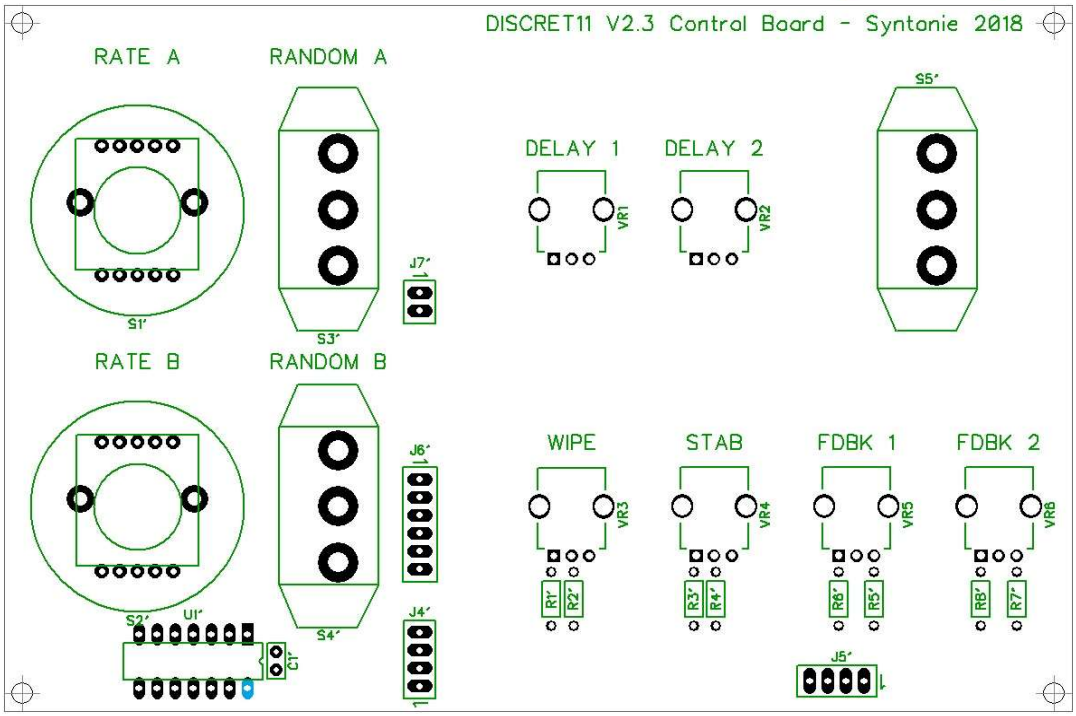
Then place the 2 rotary switches, the 3 SPDT slide switches and the 6 potentiometers.
The value of the potentiometer is marked on the bottom, 102 is 1K, 103 is 10K and 104 is 100K.



Be careful that all the hardware components sit straight on the board, it will be easier for assembly enclosure later.
Now, the control board is almost complete, don't put U1' IC yet, you can however put the IC socket.

Now, connect both main board and control board using the 4 connectors. Power up the circuit using the 15V power supply and check that you have the right voltage at ICs pins.
Orange is 12V, blue is 5V.





If every voltage measured is correct, you can place all the ICs according to the BOM. Test the voltages at the output of the regulators, if it's still right, you can go to the calibration part. If not, check that every component is at the right spot, with the right orientation. Also check that everything is soldered well and that there is no short.

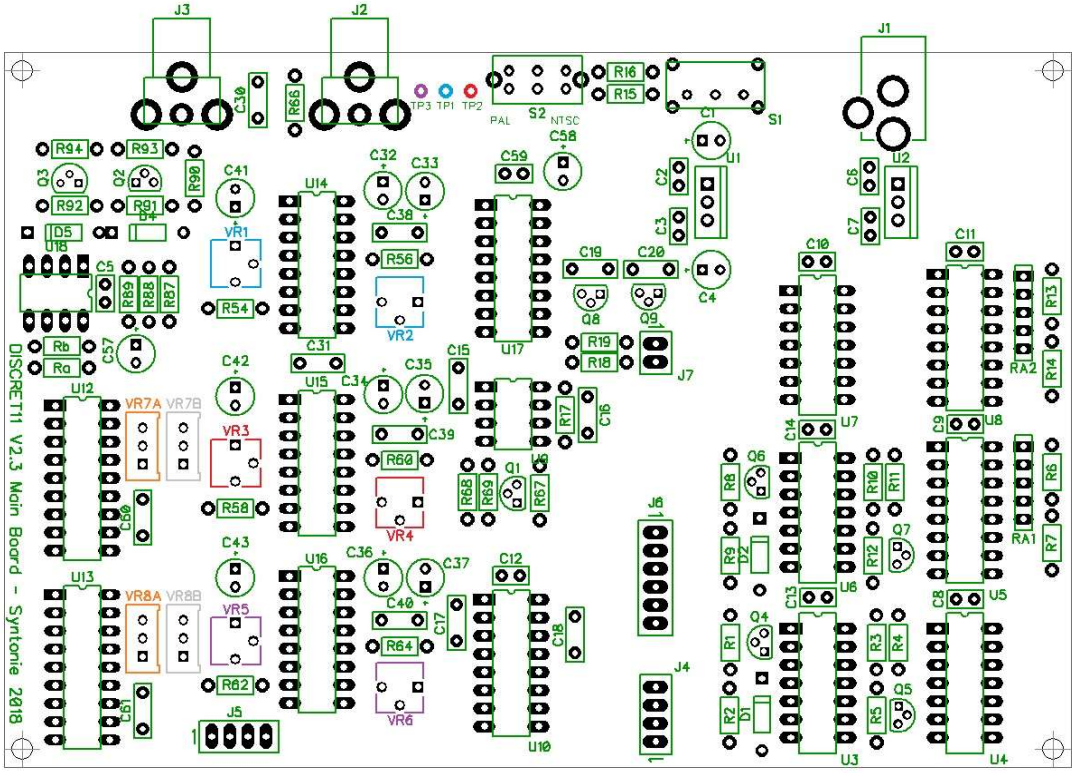
When powered up, U1 might get a bit hot, however you should be able to touch the heatsink without burning your finger. U12, U13, U14, U15 and U16 are powered by this regulator so they might get a bit hot too.

C. Calibration

For the calibration process, you'll need:

- a colour bar generator (or you can use a computer+HDMI/VGA to composite convertor)
- 2 channel oscilloscope (video trigger mode is a plus)
- flat and Philips screwdriver

Keep in mind that the delays chip make the video signal a bit dirty, so it's not possible to have a perfect color/brightness matching between the original, non-delayed, video signal and the 2 delayed signals, however we can get quite close.
Also, if you intend to use it mainly in PAL or in NTSC, best is to calibrate it for your standard, without worrying too much for the other one. I have a Sony Trinitron CRT that does both standards, and I really like the colors in NTSC, so I calibrate my unit so it suits both even though color/brightness matching isn't perfect, however it can get problematic when using a digital mixer (see II. Signal offset).
During all the calibration, be sure that all the potentiometer on the control board are at their minimum.

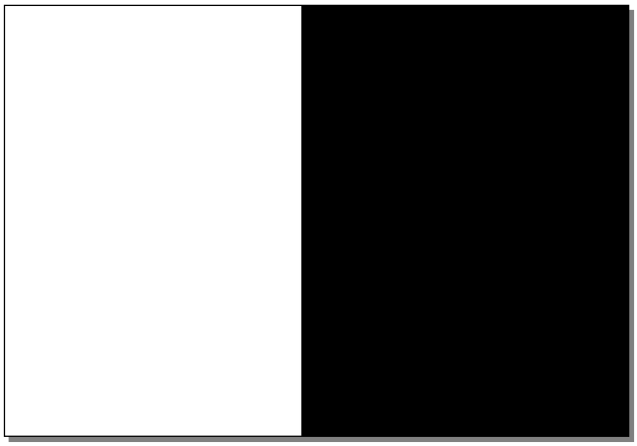


The 3 test points are located between J2 and S2:

- TP1 is the original, non-delayed signal, coming from pin 1 of U14
- TP2 is the signal delayed one time (by U12), coming from pin 1 of U15
- TP3 is the signal delayed two time (by U12 and U13), coming from pin 1 of U16
- Each of those chips has two trimmers, one for signal amplitude (on the left) and the other for signal offset (on the right)
- The 4 other trimmers (VR7x/VR8x) are used to set the delay of each chip, orange ones are for NTSC and grey one for PAL

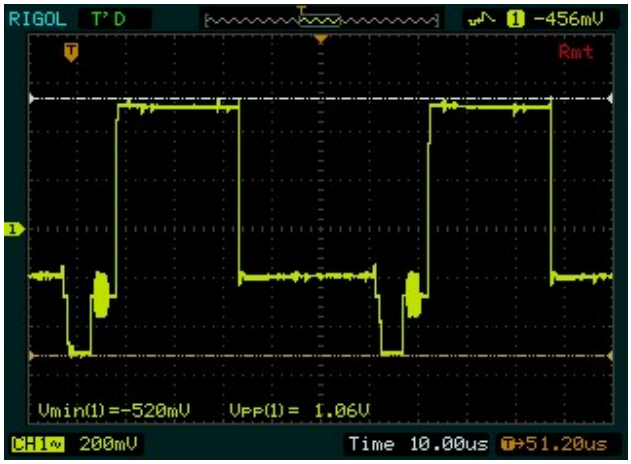
I. Signal amplitude

Power up the circuit and wait for a few minutes that it heats up. Plug the video source in J2 (input), and display an image that is half white/half black, so the amplitude of the content of the video signal goes from white level to black level.



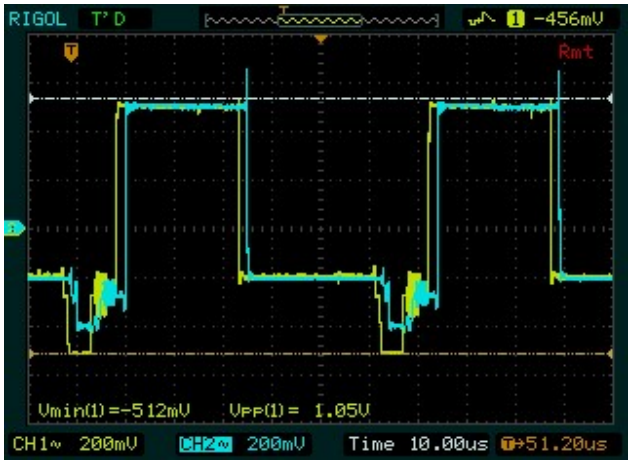
With your oscilloscope in AC mode, 200mV/div, 10/20us, check the signal at TP1. If you don't have anything displayed, set both VR1 and VR2 around their middle position. You can do that for VR3, VR4, VR5 and VR6 too.

If everything is working properly, you should now have a video signal displayed on the oscilloscope. If your oscilloscope got a trigger function, set it up so the signal stop to scrolls horizontally, it will be easier.



Using VR1, set the amplitude of the signal to 1Vpp (yellow signal on the oscilloscope).

With the other channel of the oscilloscope, check the signal at TP2.
Using VR3, set the signal at TP2 (blue trace) so it has the same amplitude as the signal at TP1 (yellow trace), don't worry about the sync signal, it gets deteriorated by the delay but will be replaced by the original sync signal later.



Keep one probe of the oscilloscope on TP1 and put the other one on TP3.
Using VR5, set the signal at TP3 so it has the same amplitude as the signal at TP1.

You'll notice that after one delay, the signal is already getting some spikes at the transient, making it a bit hard to get a good measurement, even more after the second delay.

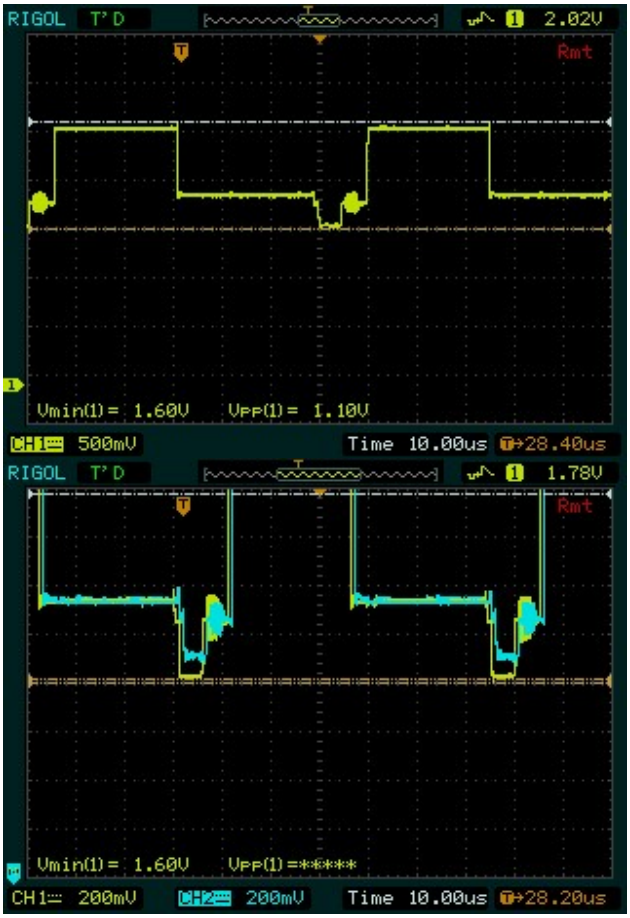
II. Signal offset

Now, we'll calibrate the offset of the signals. The decoder documentation (where the original circuit comes from) states that the sync tip should sit at 1.4V, it works pretty well in PAL, however in NTSC, it seems a bit too low, it's better around 1.6V. Even more if you use a digital video mixer, as they can be quite picky with the voltage offset it seems. I tested with the following mixers:

- Videonics MX-1 PAL: works great when set up at 1.4V, above makes the image b/w and glitchy
- AVE-5 PAL: works great when set up at 1.4V, above makes the image b/w and glitch.
- AVE-5 NTSC: works great when set up at 1.6V, seems to work even when the signal is lower.

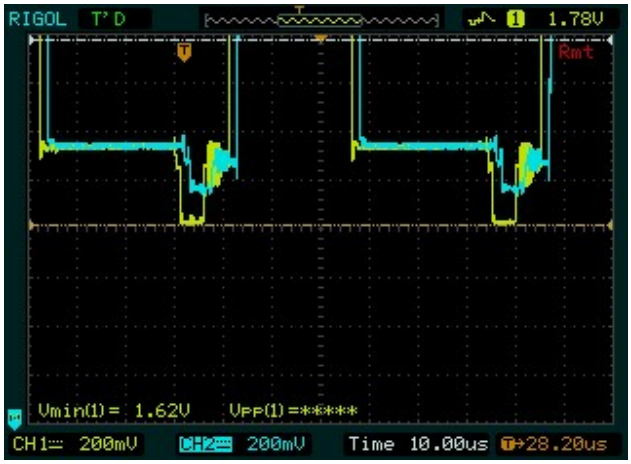
So depending on your format, aim for 1.4V for PAL or 1.6V for NTSC.

Use the same video source as before (half white/half black). Put both channel of your oscilloscope in DC mode, put the first probe on TP1.



Adjust VR2 until the sync tip is at the right level (here 1.6V).

Then using the other probe, check TP2. Adjust VR4 until the black level of TP2 signal (blue trace) is aligned with the black level of TP1 signal (yellow trace). Note that we're not aligning the signals according to the sync tip but to the black level.



Repeat the same process with TP3 and VR6.

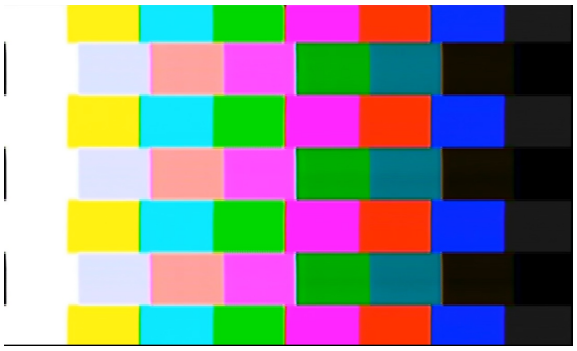
Now that black level is set up, you should have something stable displayed.

You can fine tune by checking the b&w signal on a monitor, turn Rate A switch to the 6th position and leave Rate B on the first position, turn VR4 so the black part matches between delayed and non-delayed line and then adjust VR3 until the white part matches. You can repeat with Rate A: 1st, Rate B: 6th, VR5/VR6.

III. Signal Delay

For this calibration, best is to use a monitor with a color bar as video source. Set Rate A switch to the 6th positon and Rate B switch at the 1st.
Set S2 switch to the standard you intend to use:

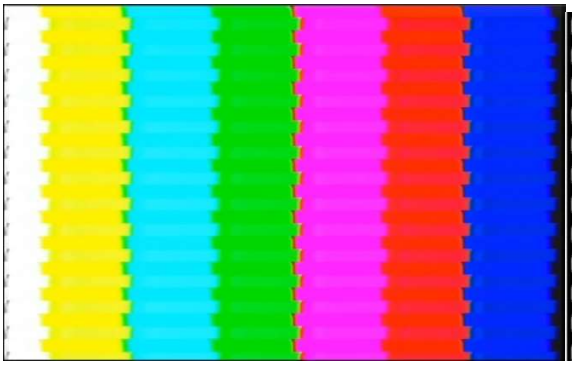
- If NTSC, we will use VR7A and VR8A
- If PAL, we will use VR7B and VR8B

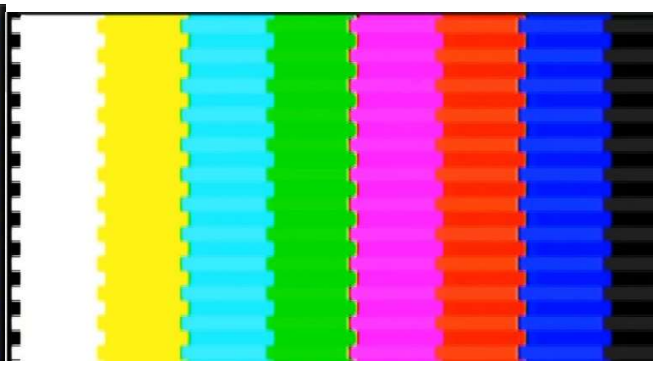


Now, your monitor should display the original signal (which have the right colors) and the delayed signal (which should have wrong colors unless you're lucky).

If your turn VR7x, the colors of the delayed signal will start to change. Turn it clockwise until your hear some clicks (which mean you reached the end of the potentiometer).

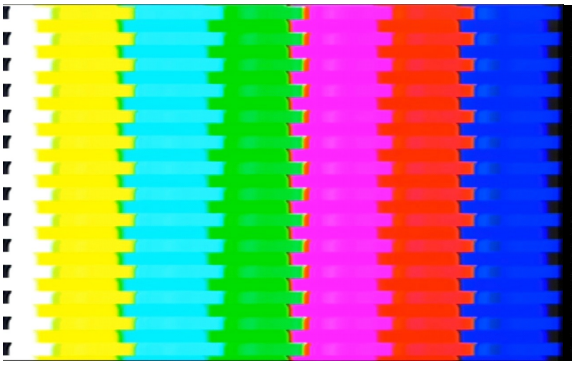
And then turn it counter-clockwise until the color of the delayed signal match the color of the original one. You'll notice that there is two or three position where the colors looks right, however keep in mind that the more the signal is delayed, the more it gets damaged. So best is to set it up to minimum delay once the right colors are reached. And also VR1' and VR2' on the control board can be used to have longer delay (that's why you should keep them at minimum when doing this calibration).

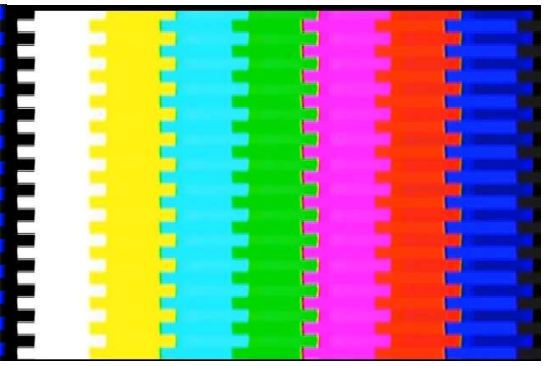




Result in NTSC when calibrated Result in PAL when calibrated

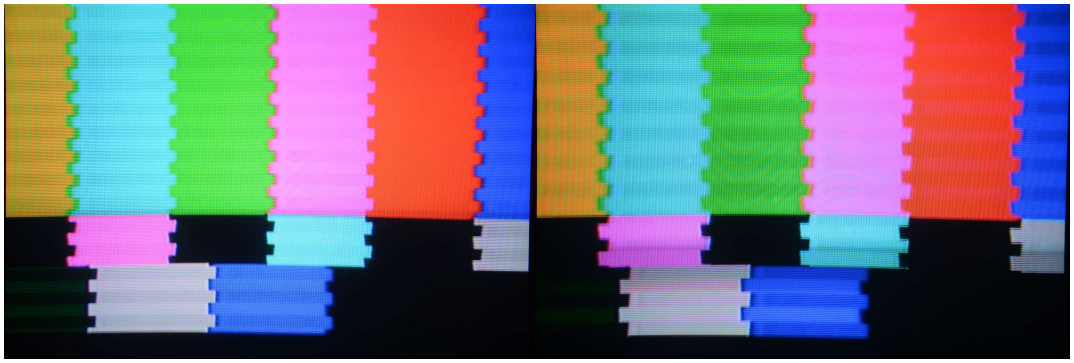
Now, put the Rate A switch to the 1st position and the Rate B switch to the 6th position. Adjust VR8x as done with the previous trimmer. Once the trimmer set, you can move VR5 a bit to make the brightness match a bit more.

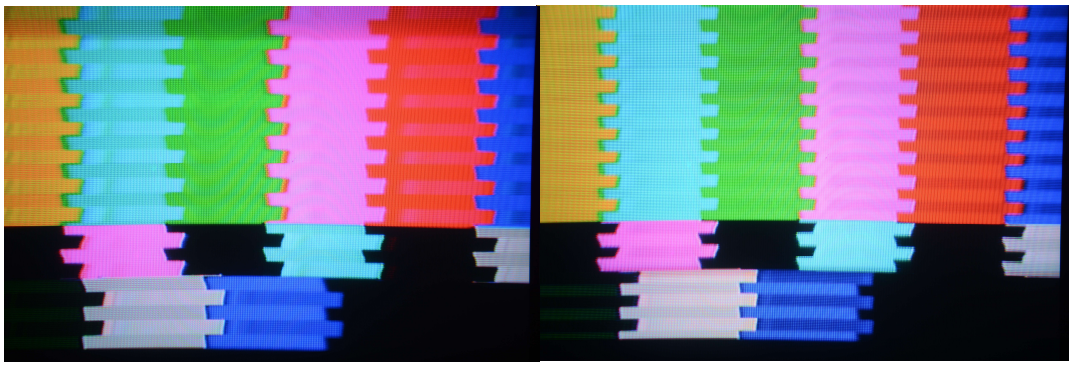




Result in NTSC when calibrated Result in PAL when calibrated

As you can see, color/brightness matching isn't perfect but this is good enough. These captures were made with an Easycap USB capture card, here are the result with the same settings on a CRT screen:





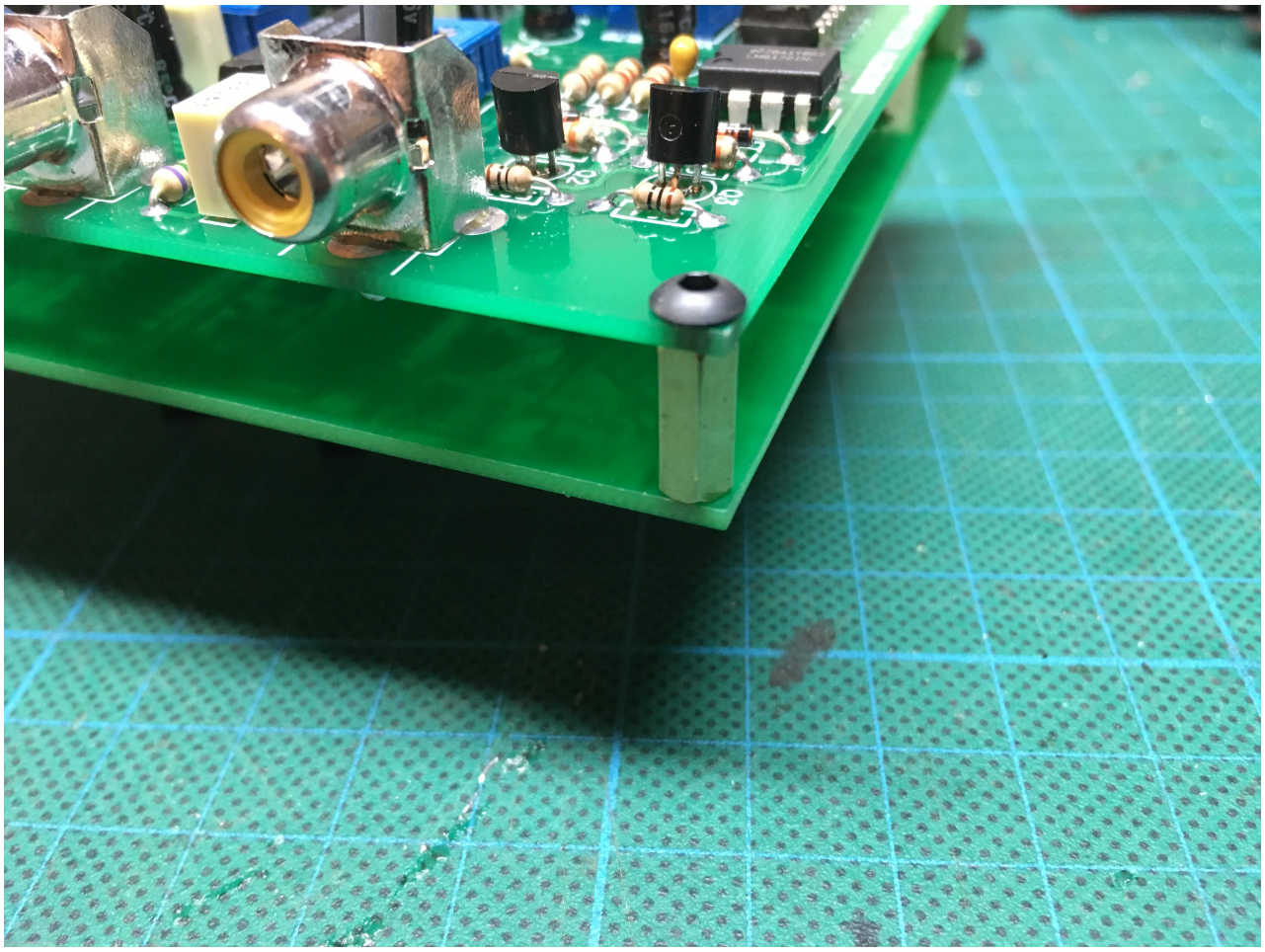
NTSC PAL

The difference in color/brightness is more noticeable on the CRT.

It seems that the delay is affected by heat, so best is to wait a bit after power up so it warms up and then calibrate the delay times.

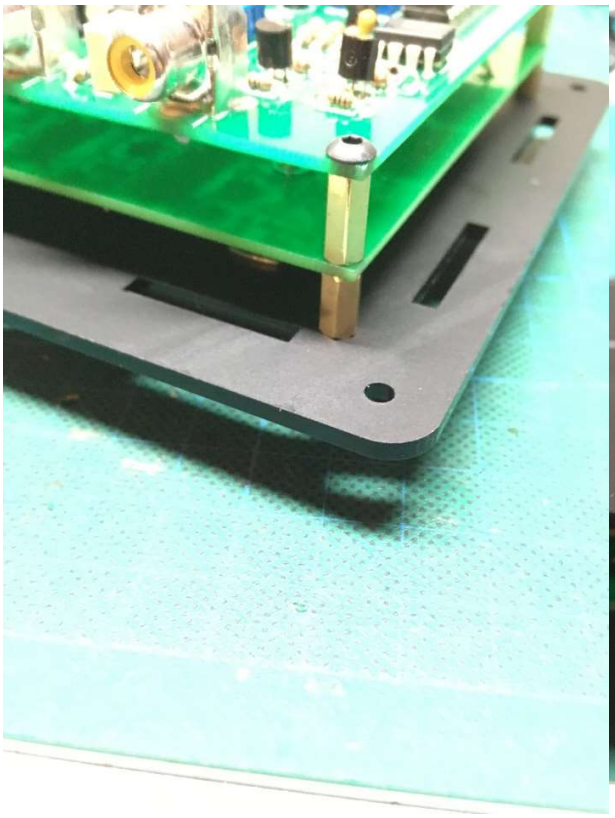
D. Enclosure assembly

First, use the 11mm FF spacers and attach them between the 2 boards using 6mm M3 screws (screws go on the main board side). There are 4x 8mm M3 screws, keep them for the rubber feet at the end.



Then add the 9mm spacers (the ones with a thread) on the control board side.

Add the top part of the enclosure, and secure it to the boards using 6mm M3 screws.



Now, add the two long side of the enclosure, attach the 45mm FF spacers using 6mm M3 screws. Add the 2 short side and the bottom of the enclosure. Attach the rubber feet using 8mm M3 screws.