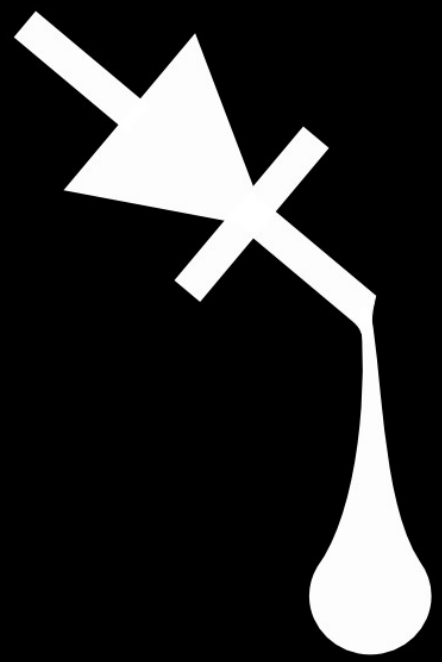
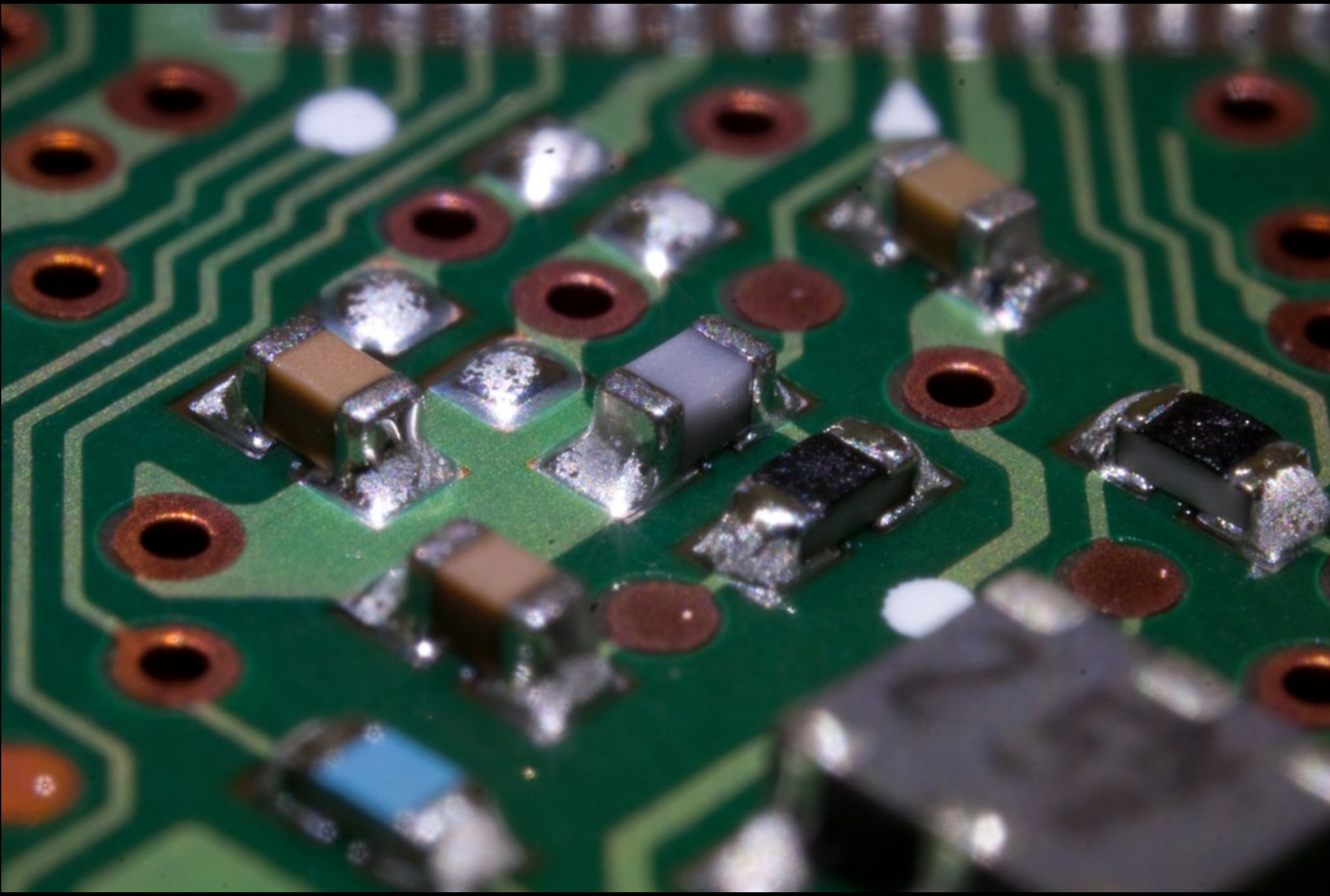
File -> Print -> Electronics



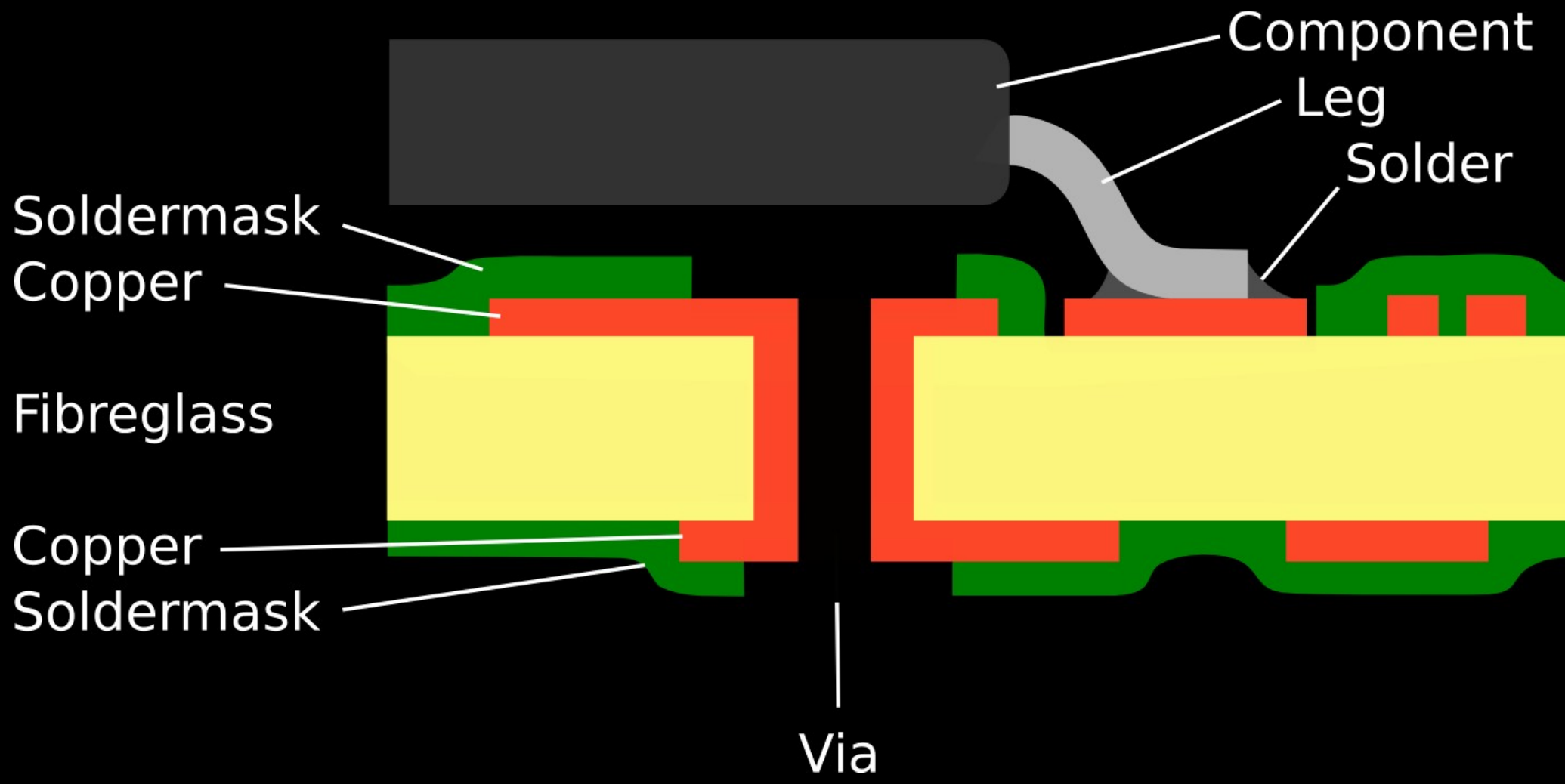
Printing circuit boards
without the tears

Jeff Gough

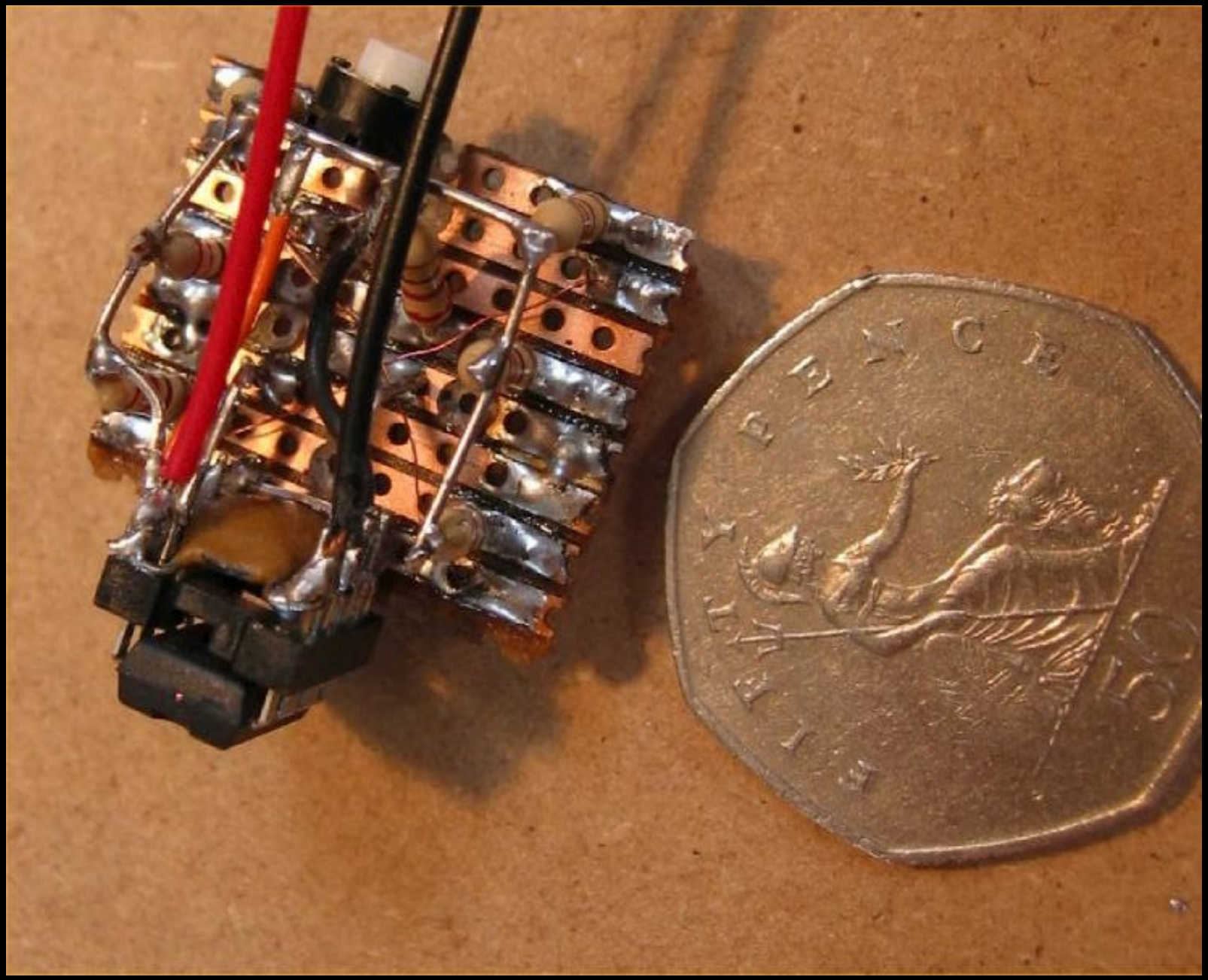
What is a PCB?

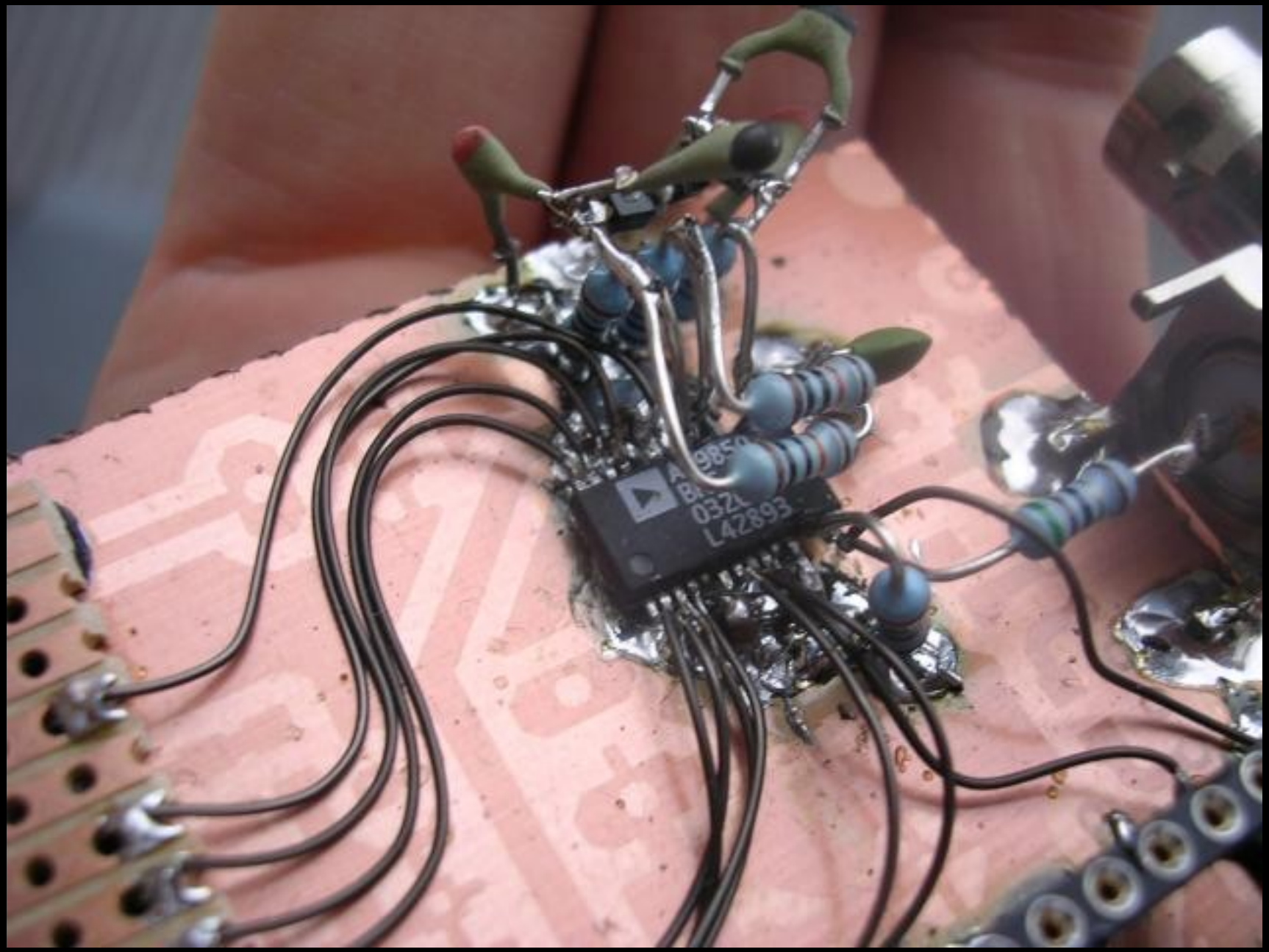


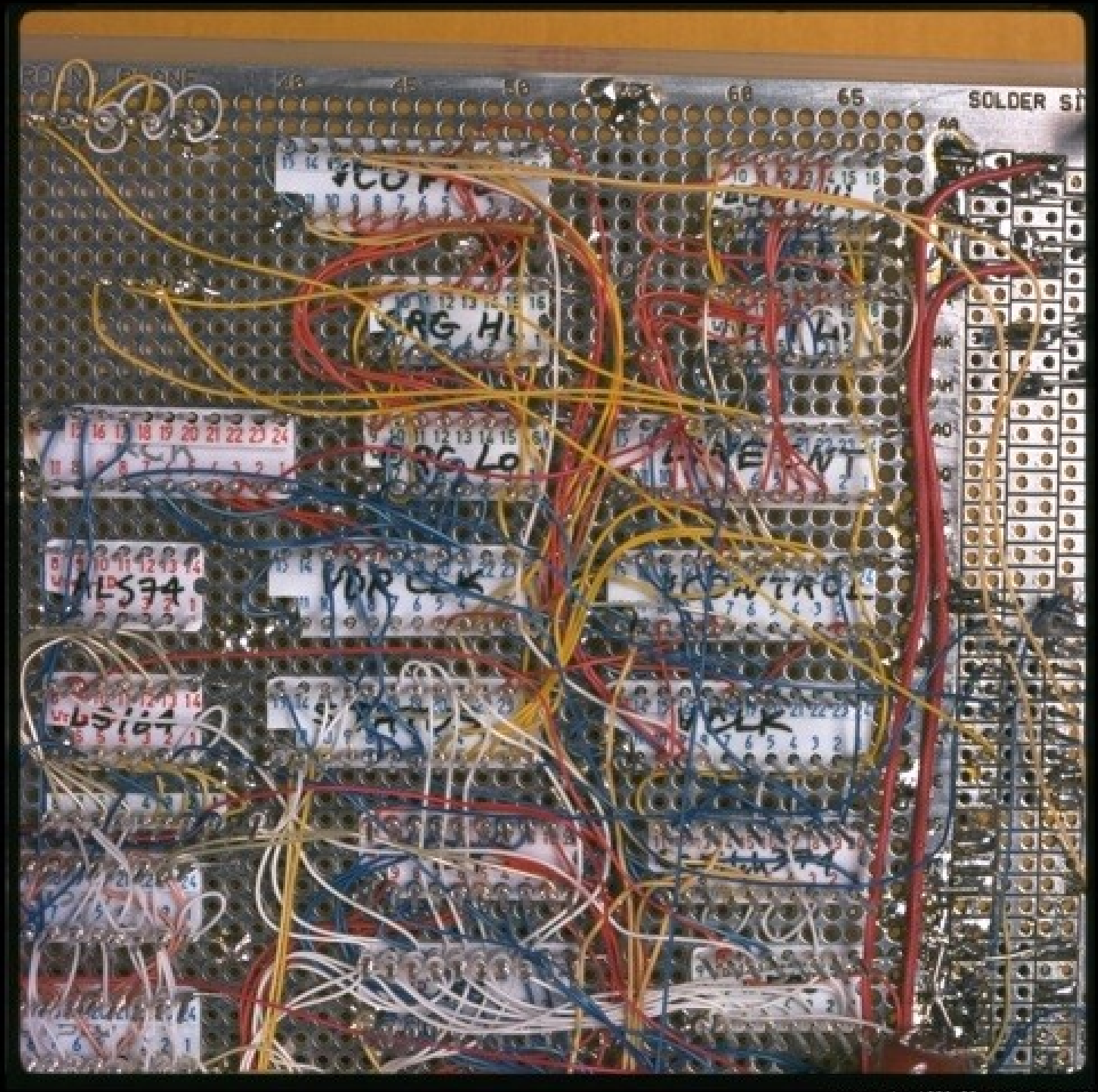
Elements


Component
Leg
Solder
Soldermask
Copper
Fibreglass
Copper
Soldermask
Via

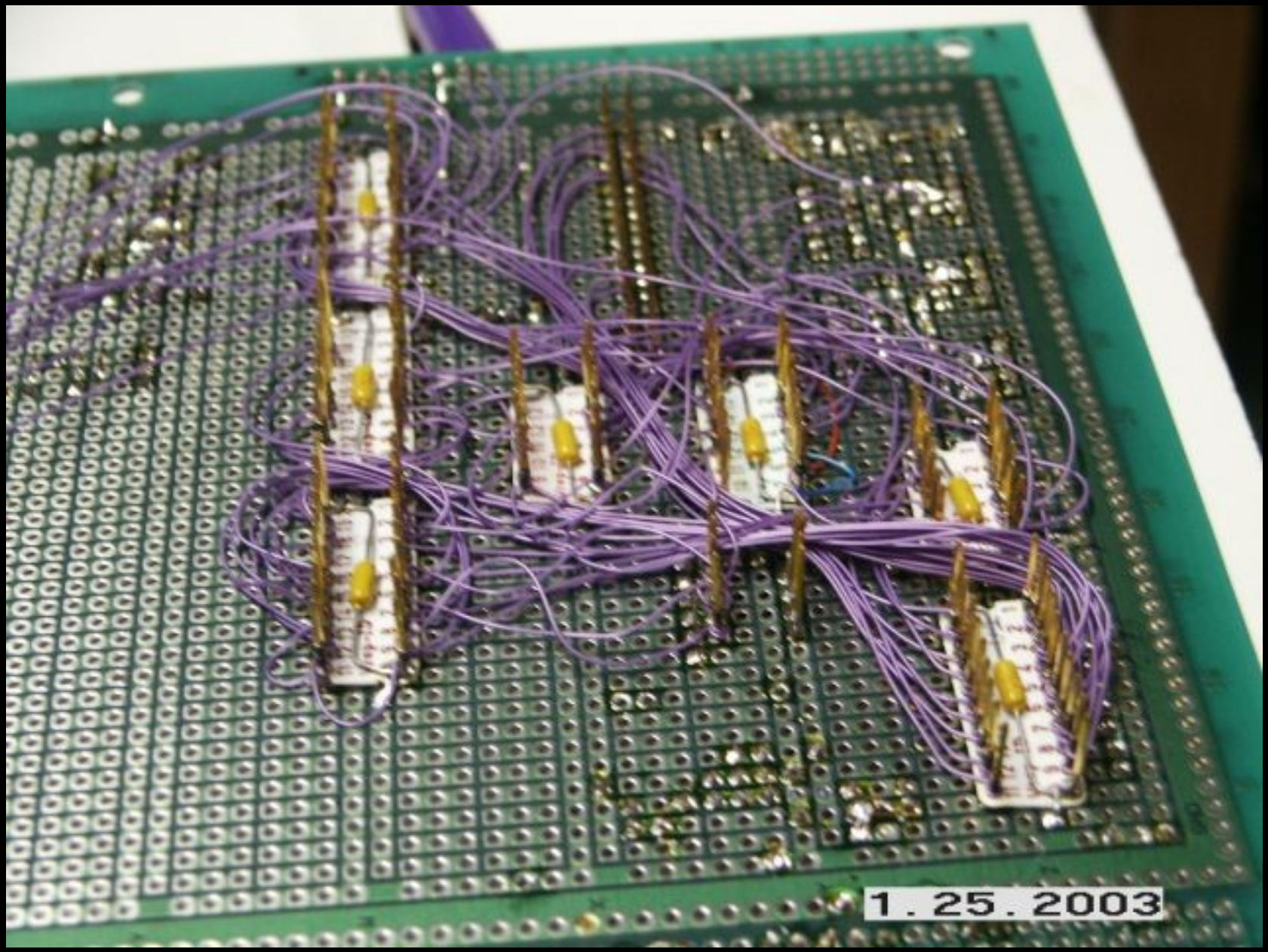
Why make your own PCB's?

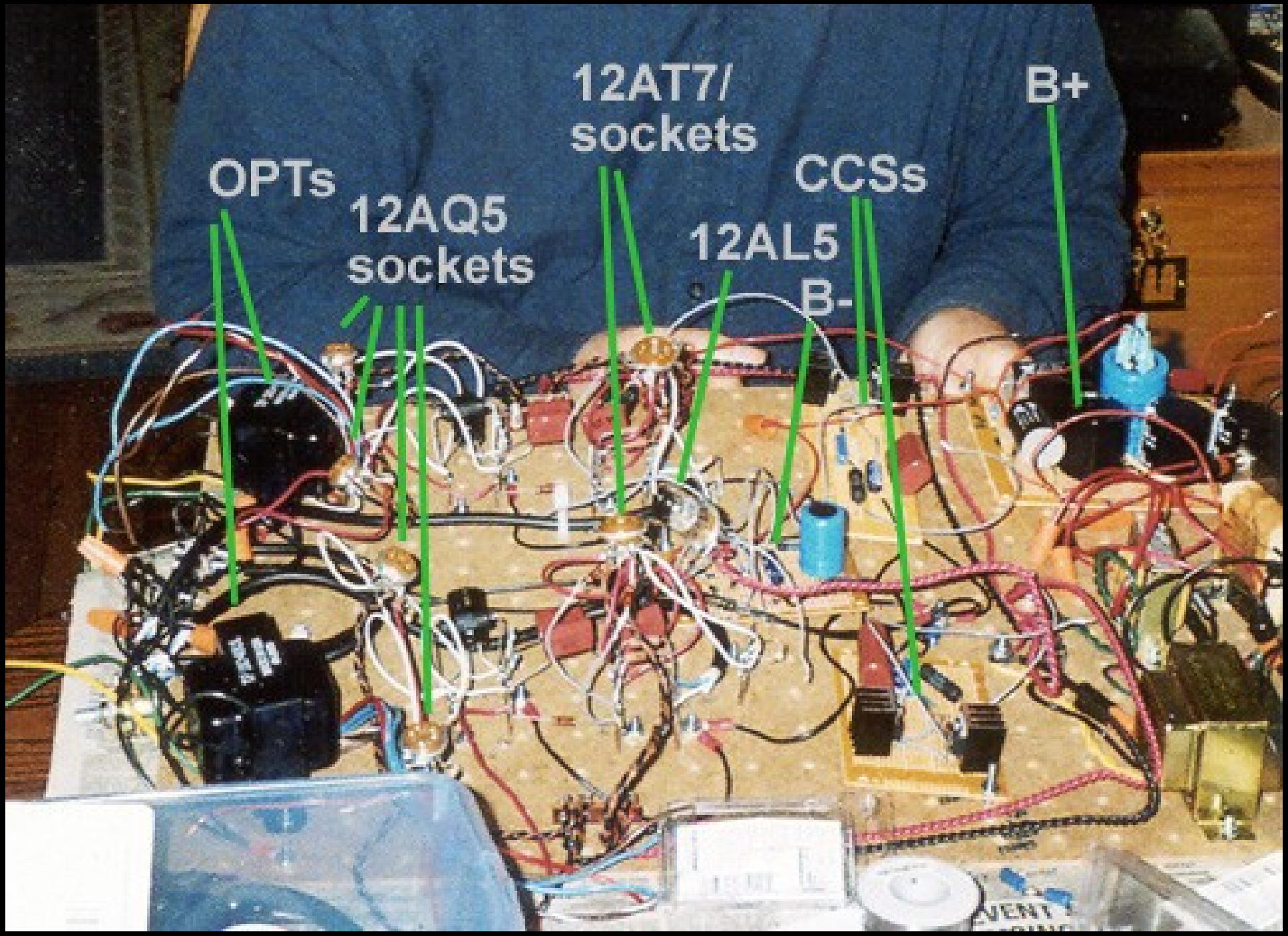

ELIZABETH II D·G·REG·F·D·
50

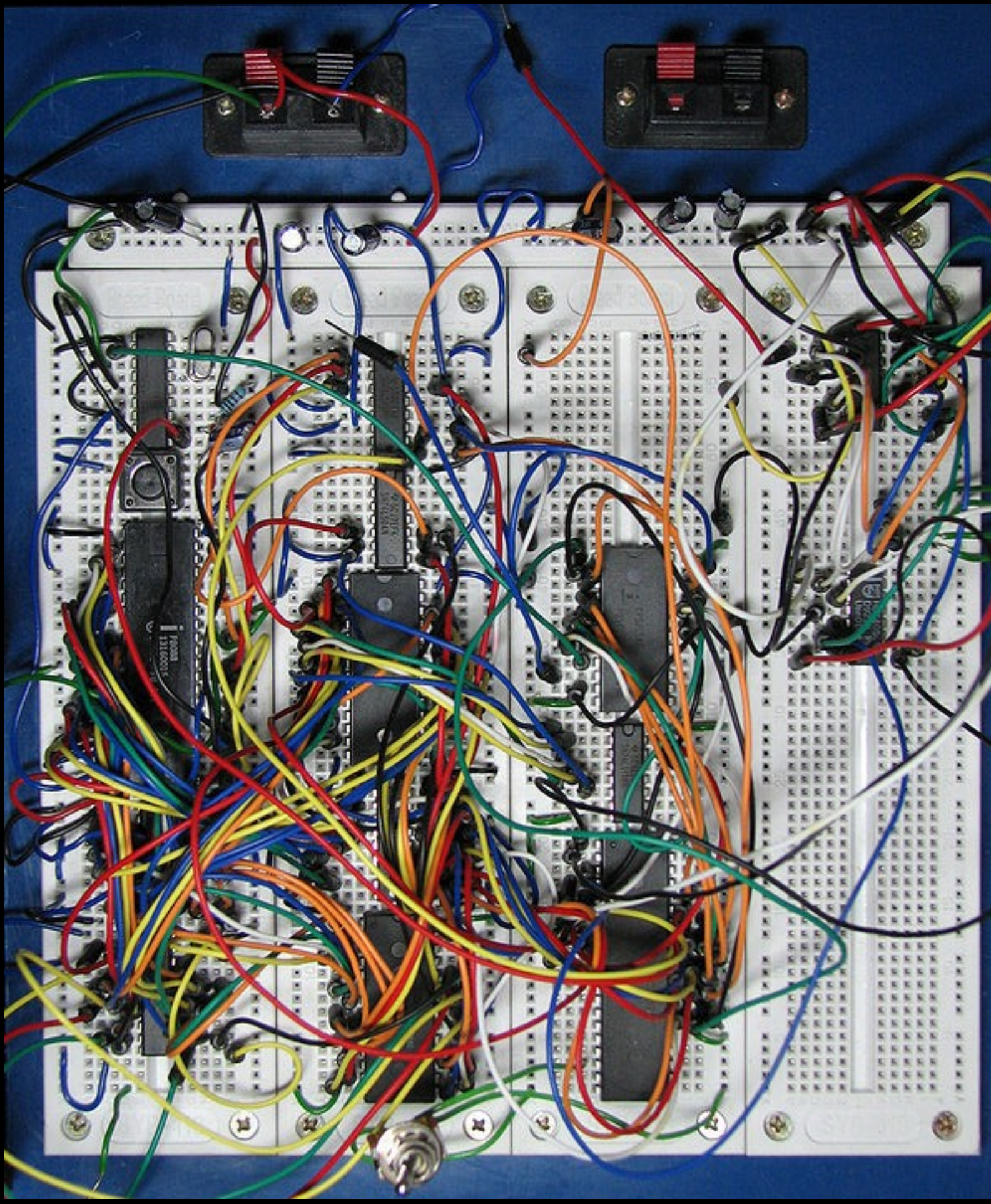

0321
L42893

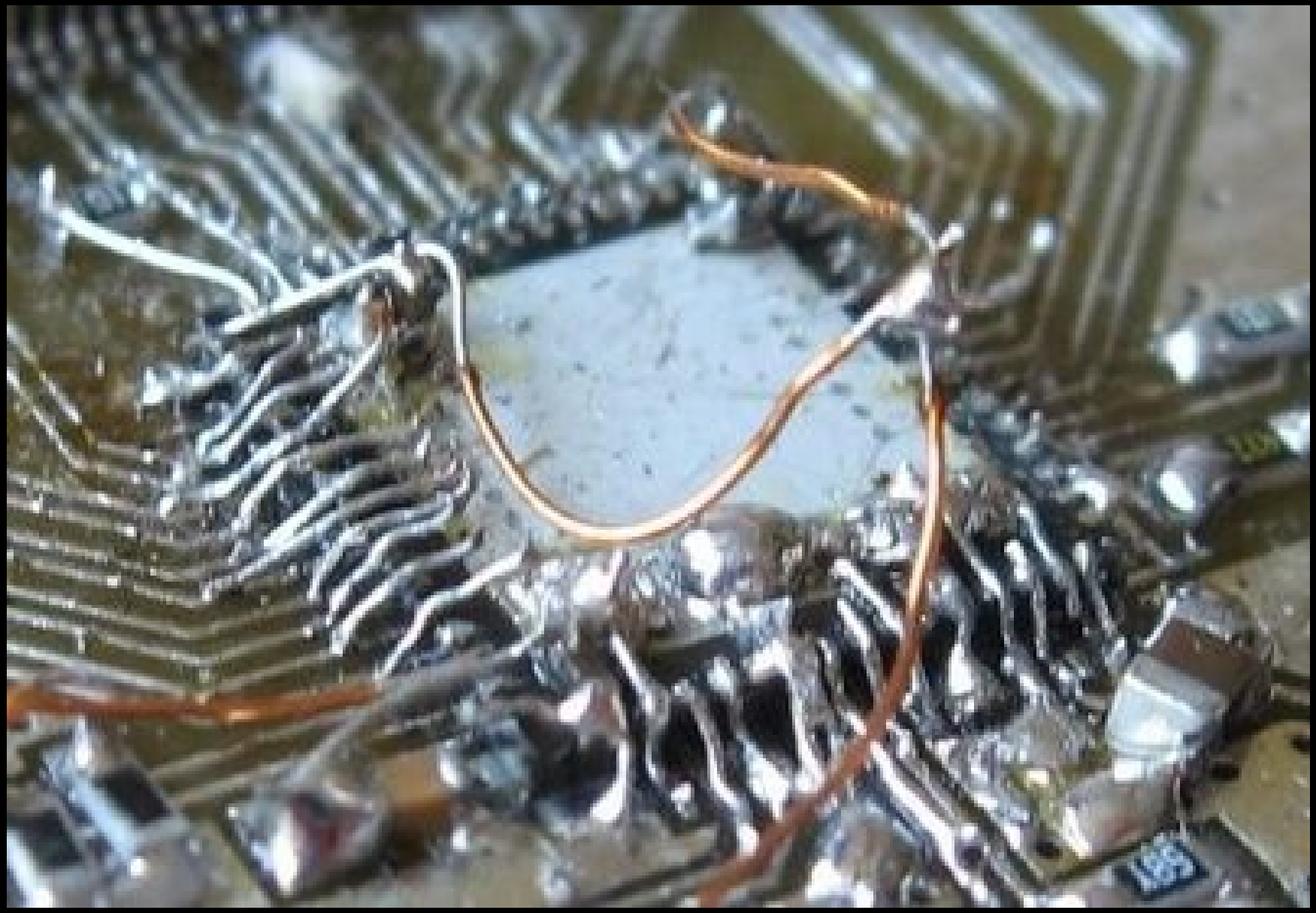


copyright 1986-98 philg@mit.edu


1.25.2003


OPTs
12AQ5
sockets
12AT7/
sockets
12AL5
B-
CCSs
B+





Prototyping electronics sucks

Why not use an Arduino?

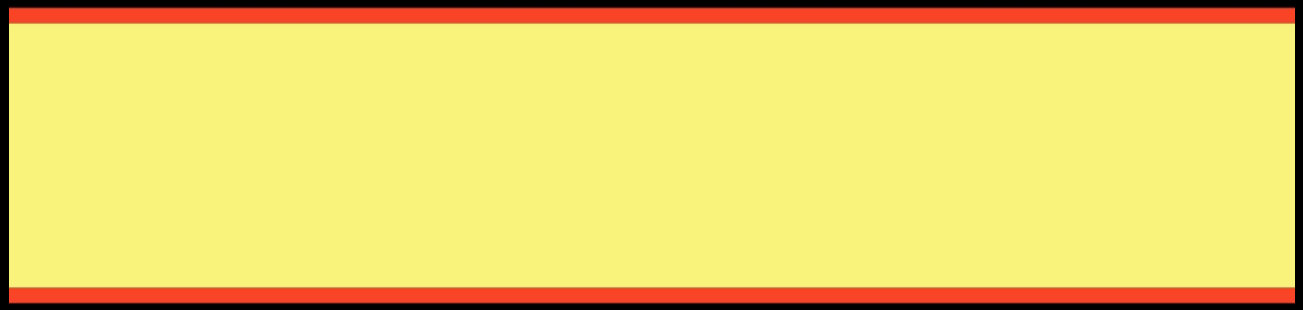
But I can get a PCB in 3 days for €50

Not fast enough

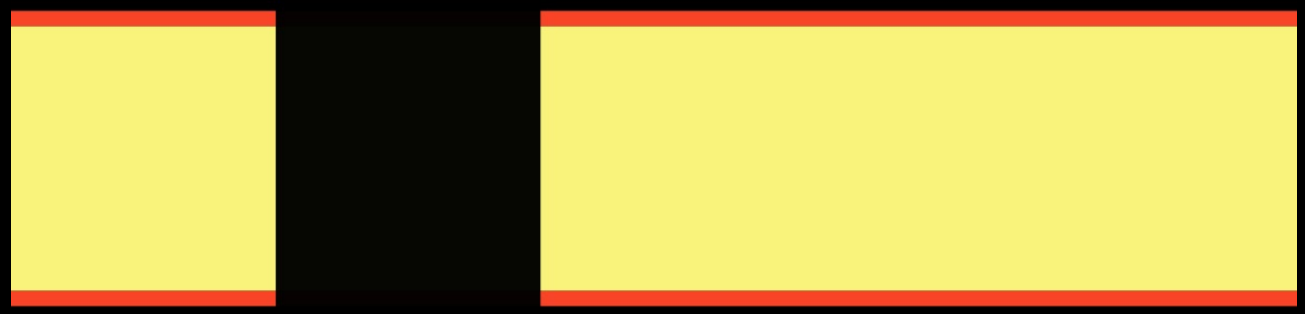
Not cheap enough

How PCB's are made industrially

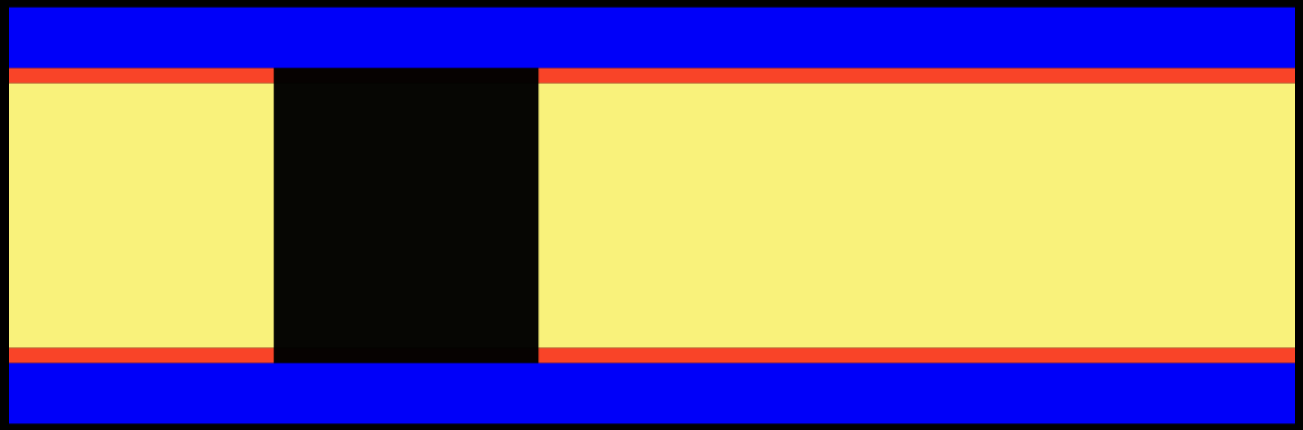
Start with laminate



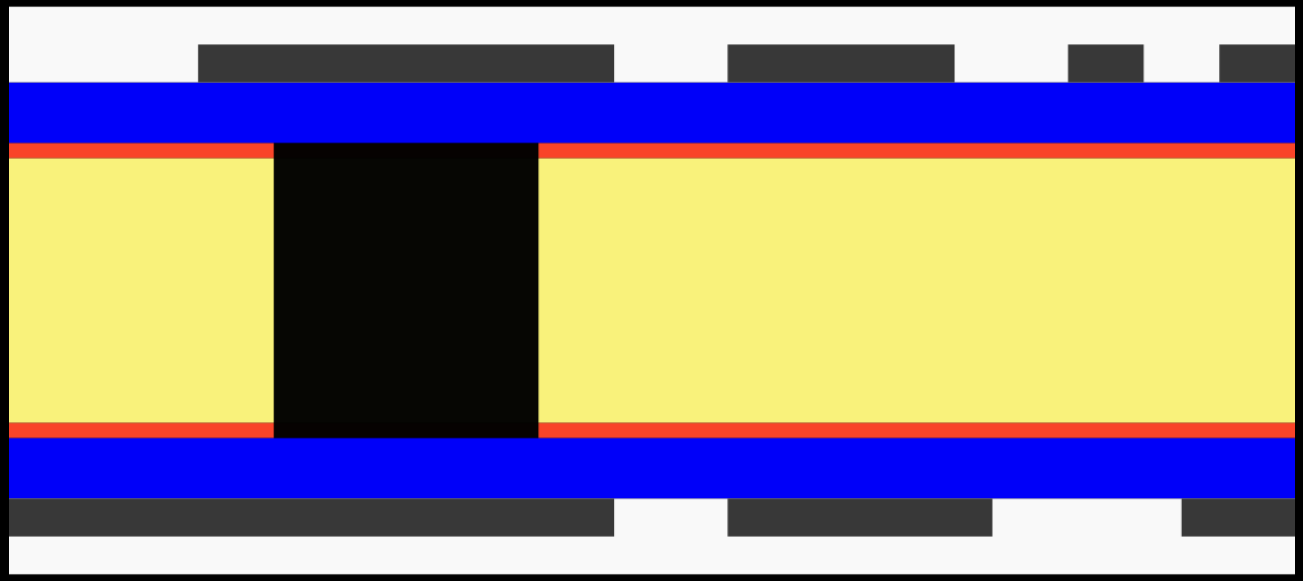
1. Drill



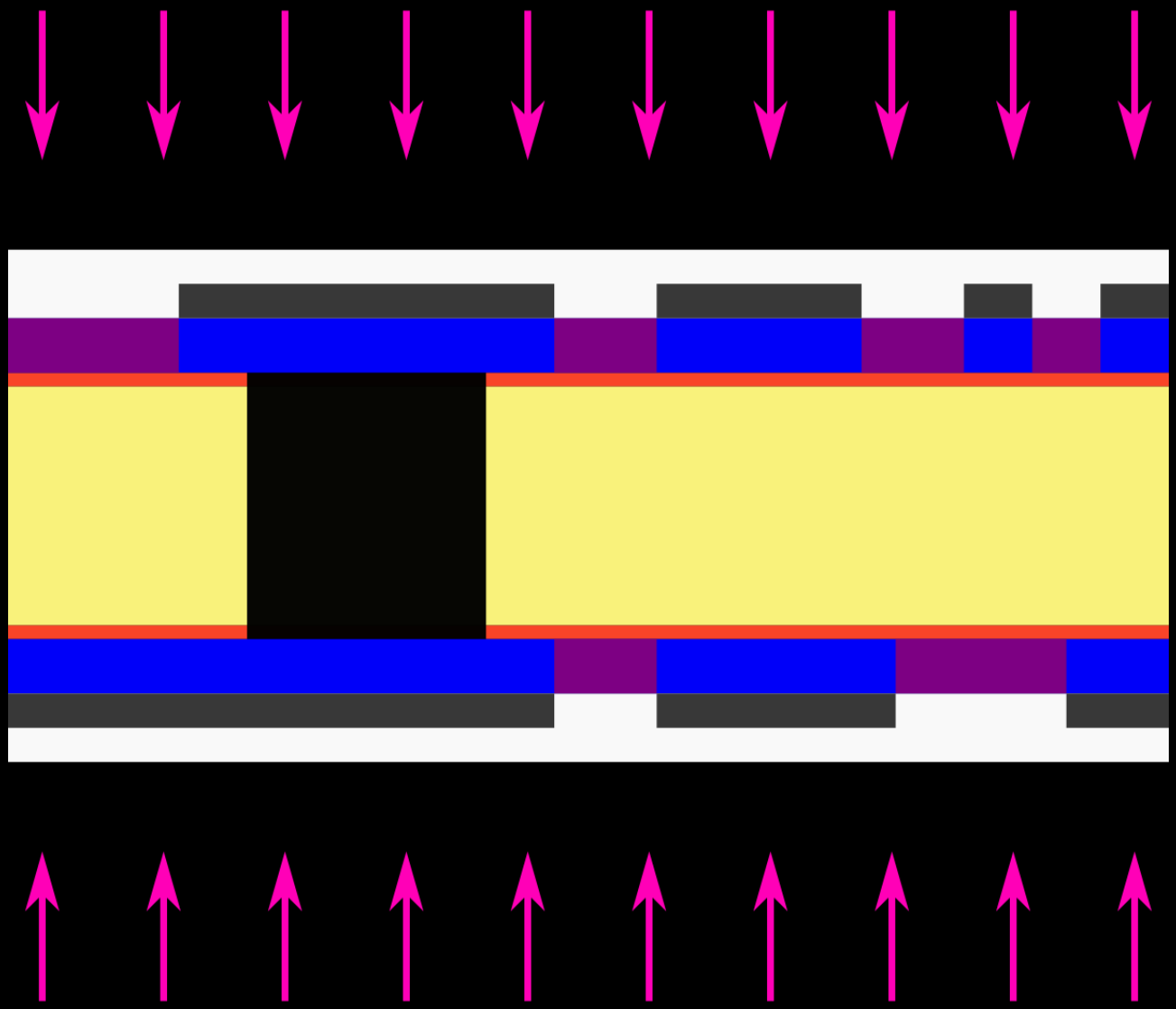
2. Deposit photoresist



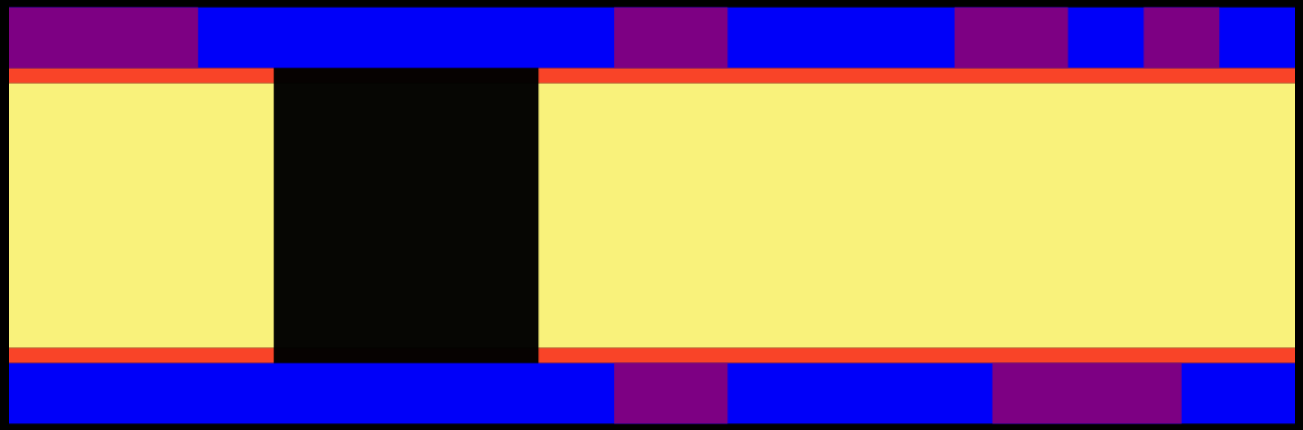
3. Mask



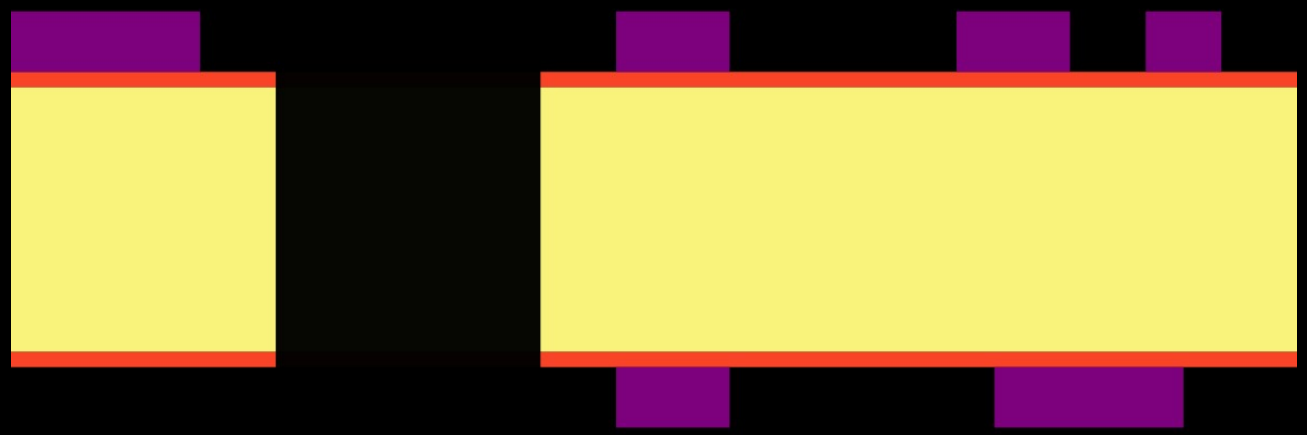
4. UV Expose



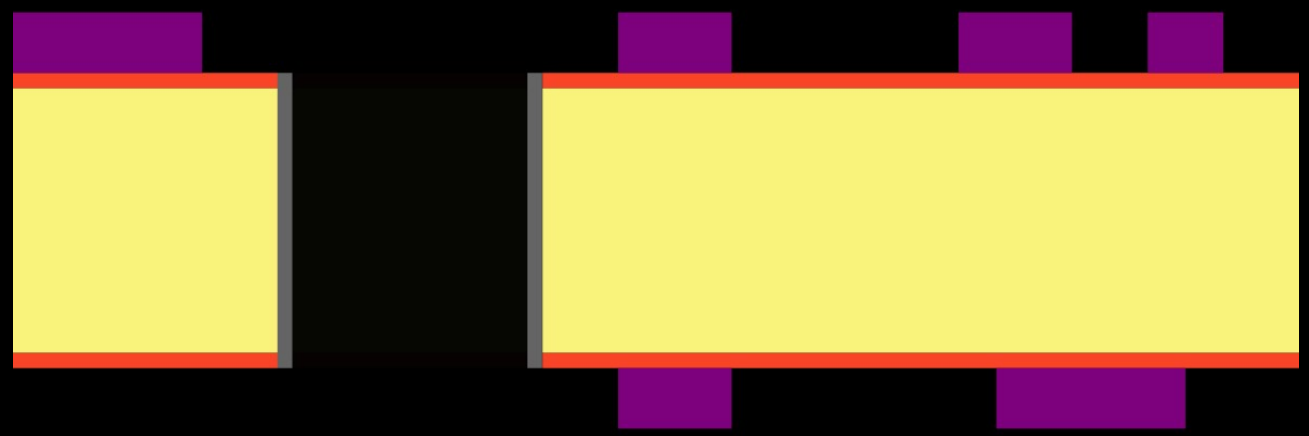
5. Exposed



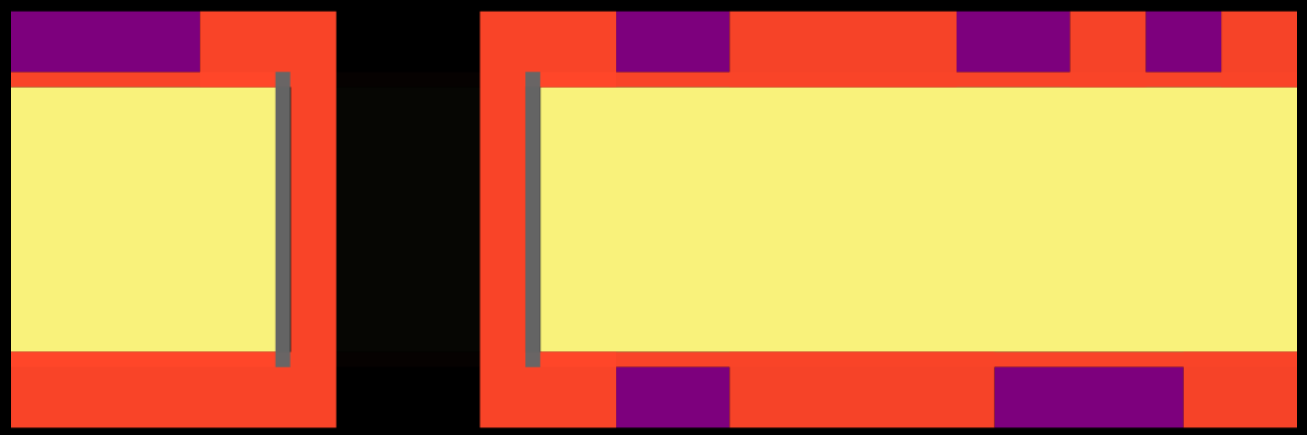
6. Develop



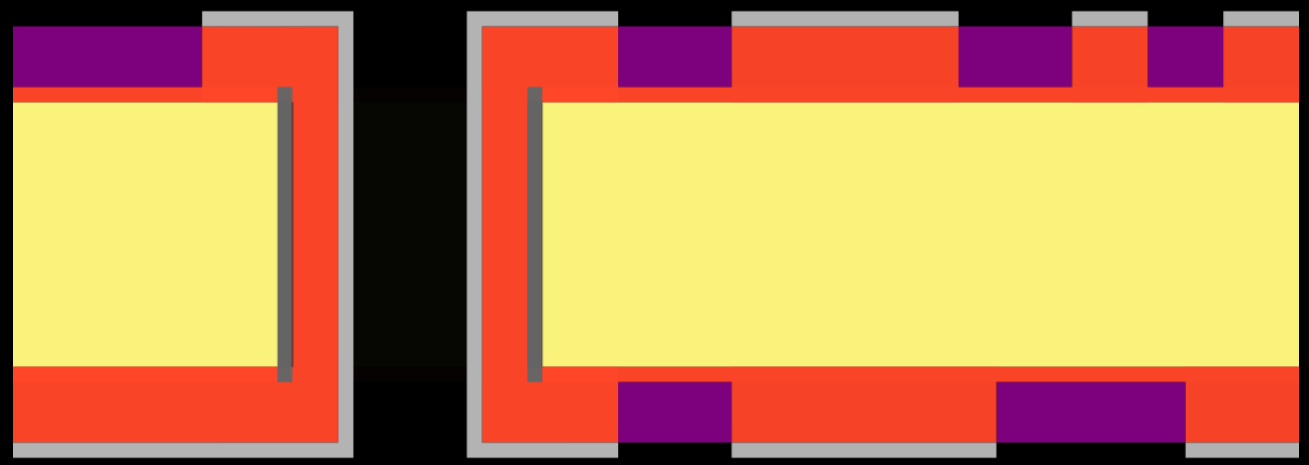
7. Hole wall activation



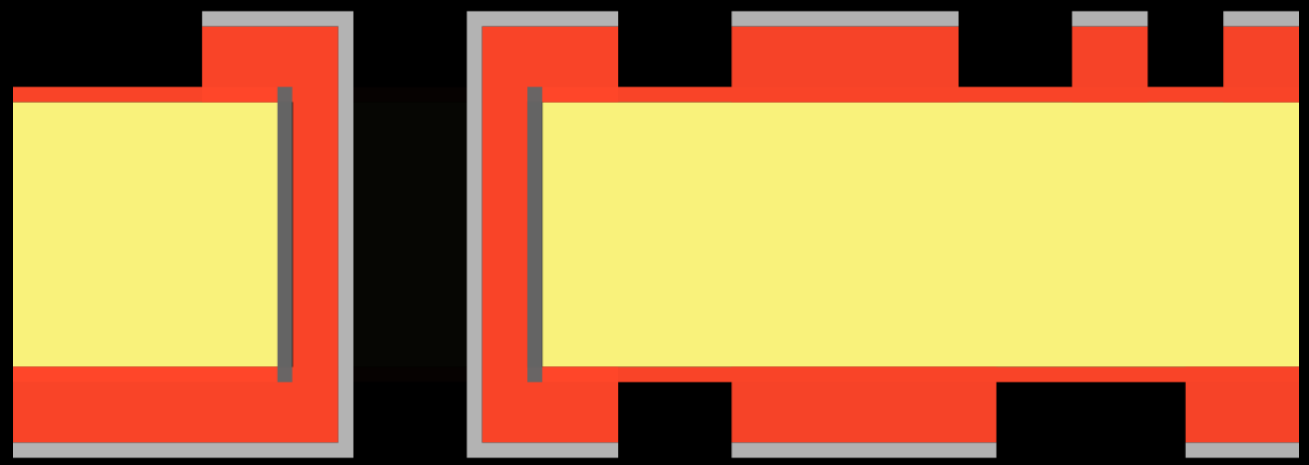
8. Electroplate copper



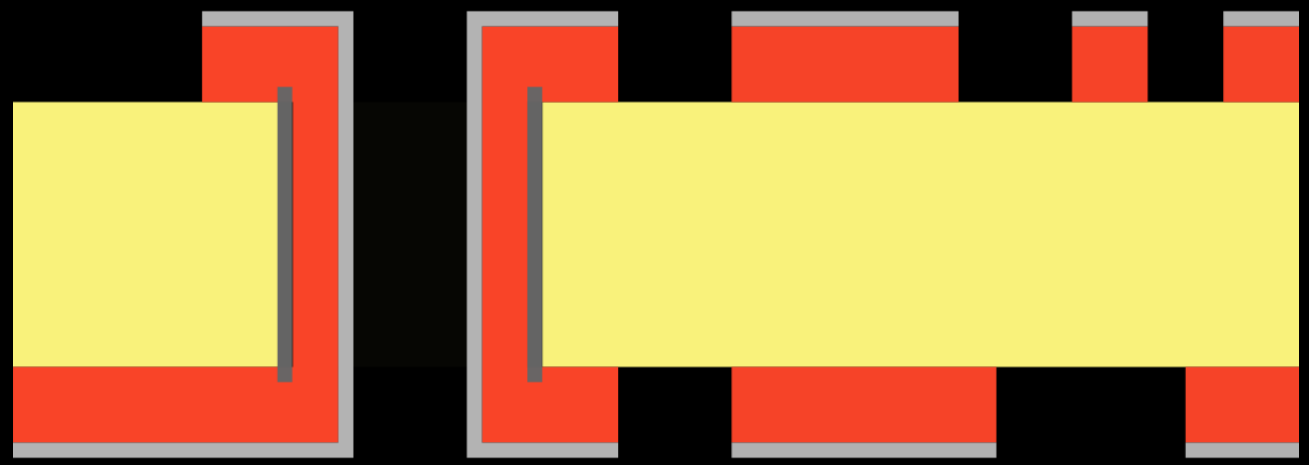
9. Electroplate tin



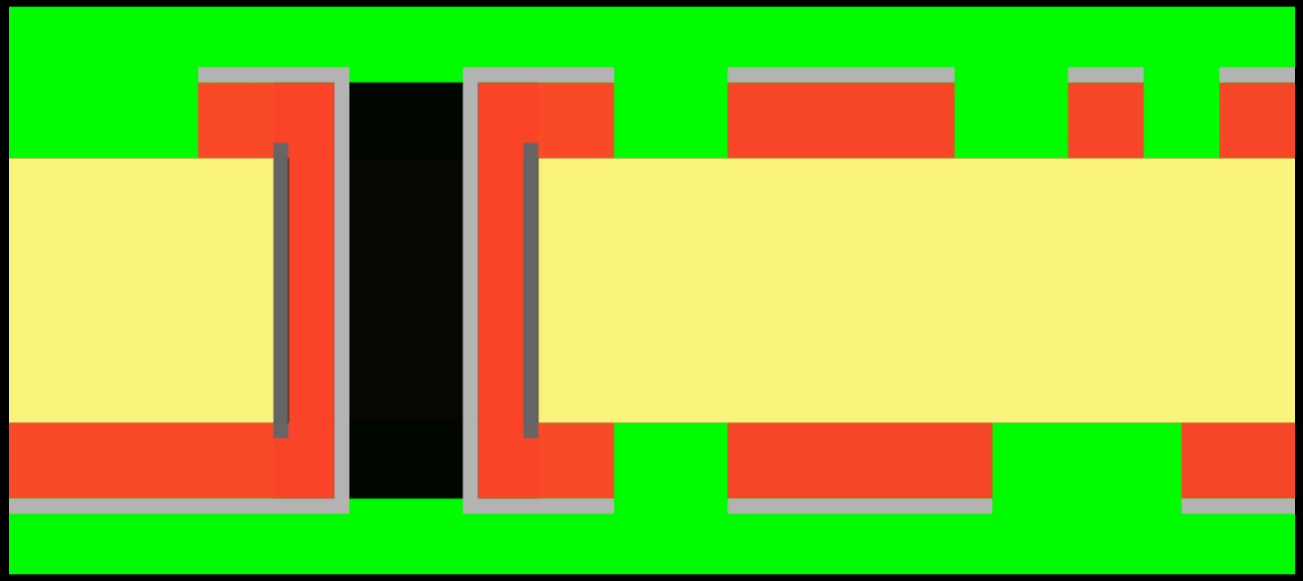
10. Strip photoresist



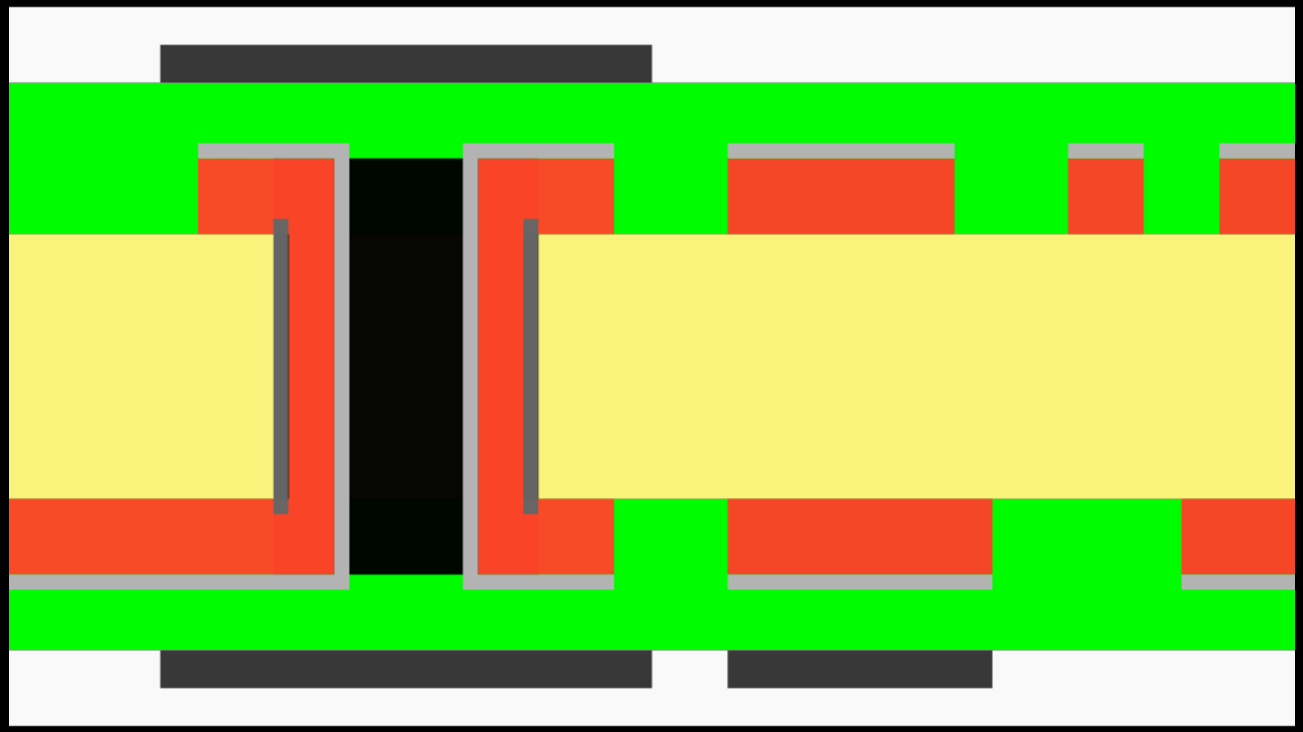
11. Etch copper



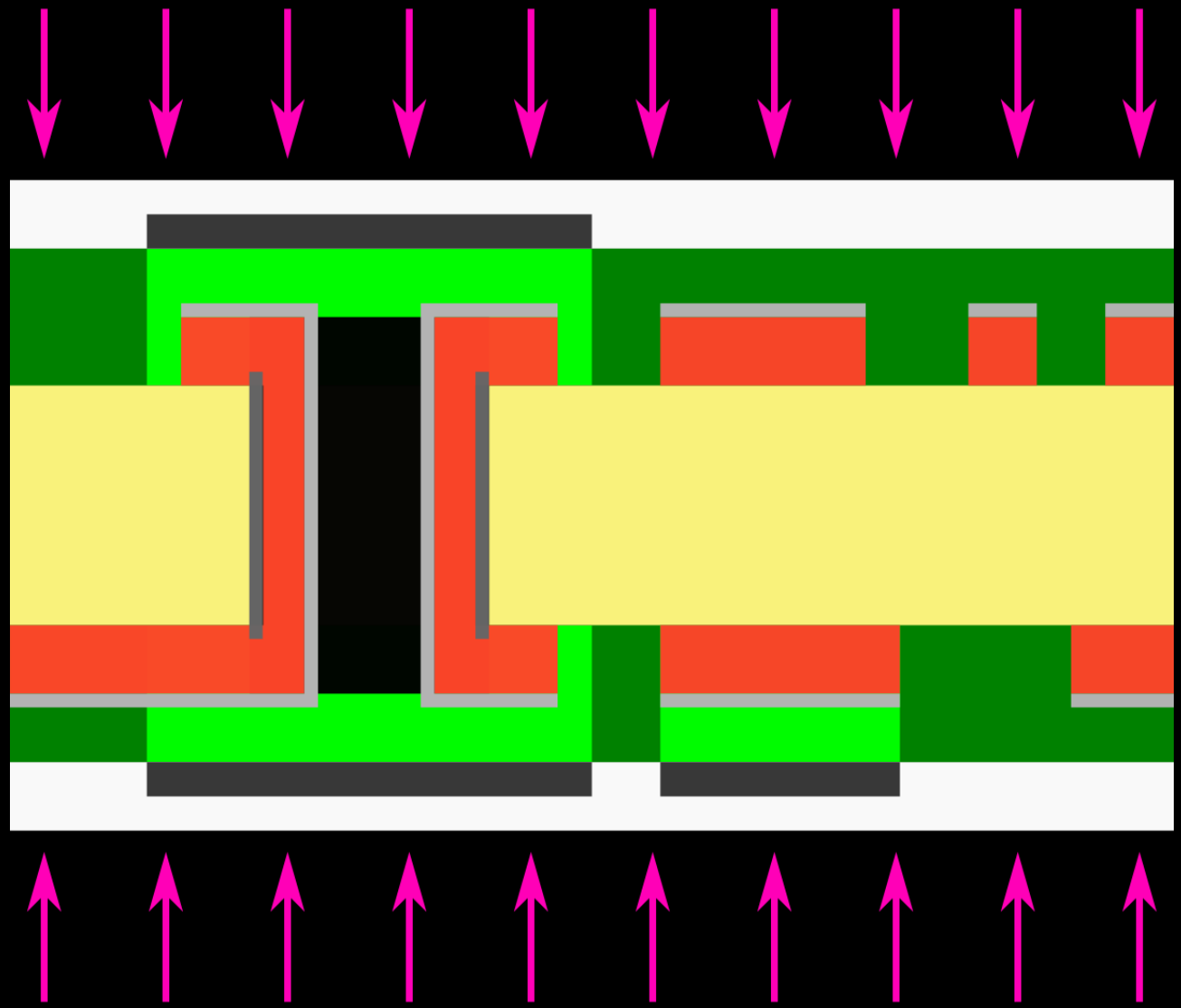
12. Deposit soldermask



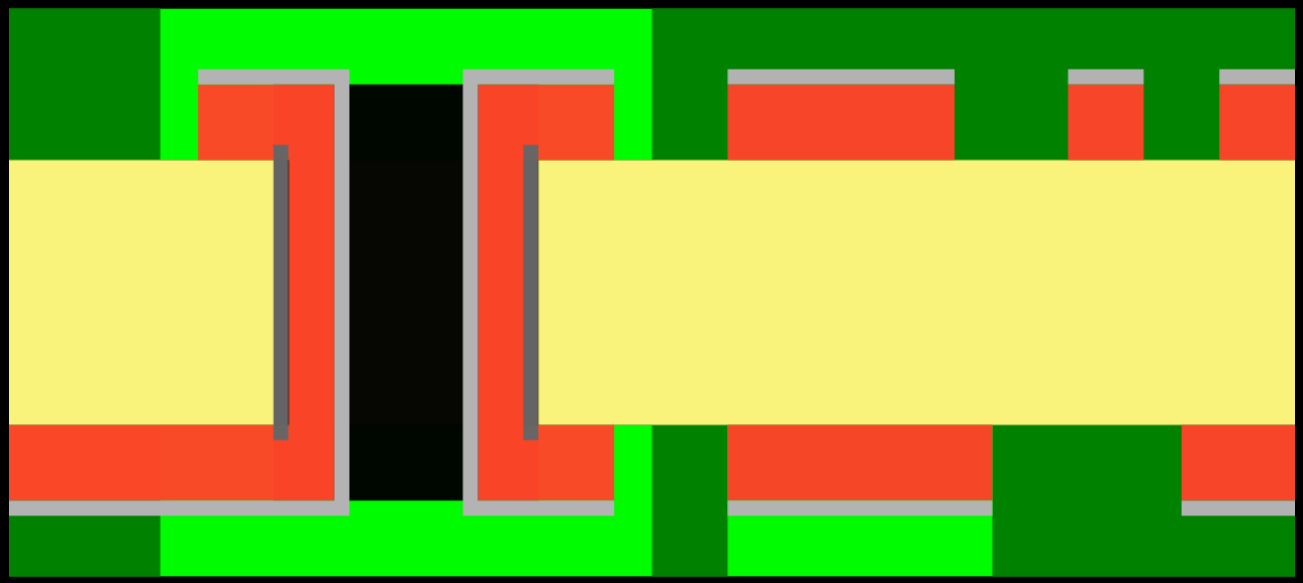
13. Mask



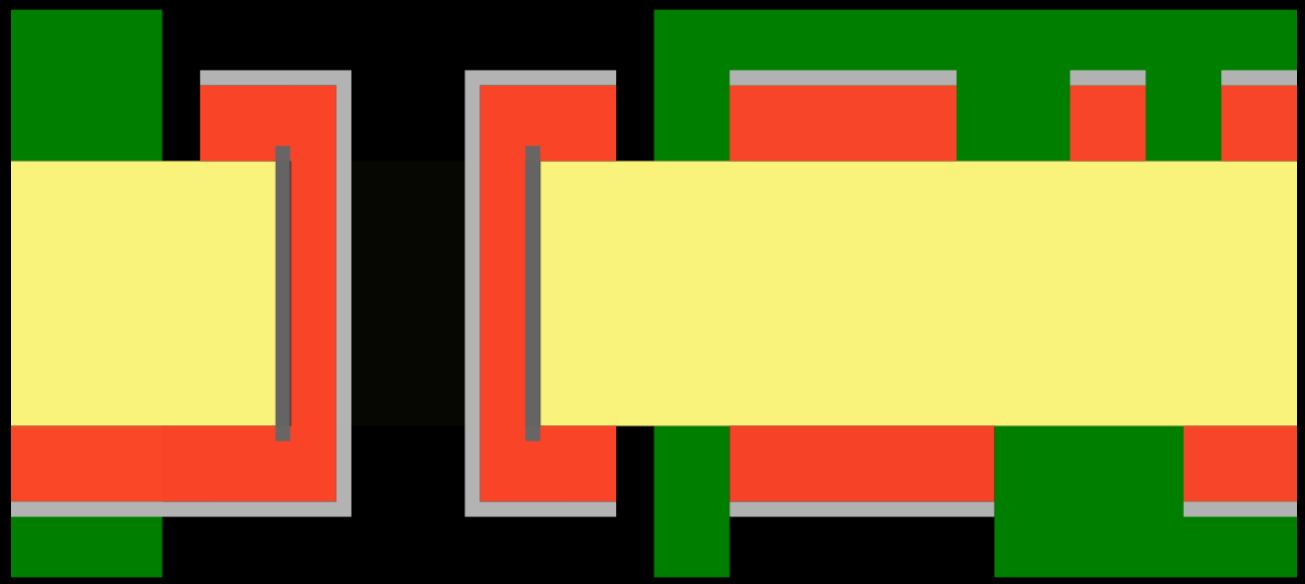
14. UV expose



15. Exposed



16. Develop

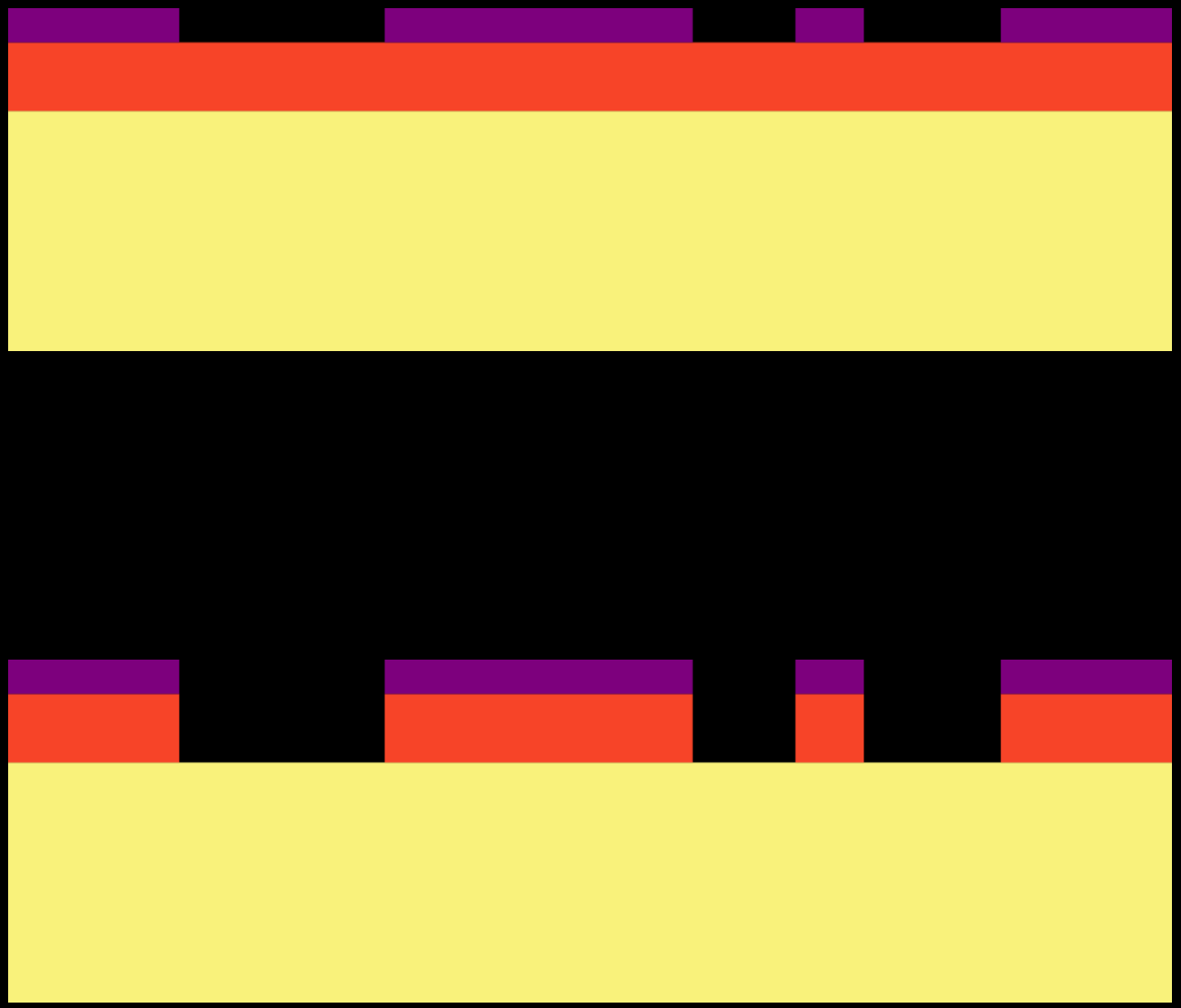


...and that's the abridged version

Where did those masks come from?

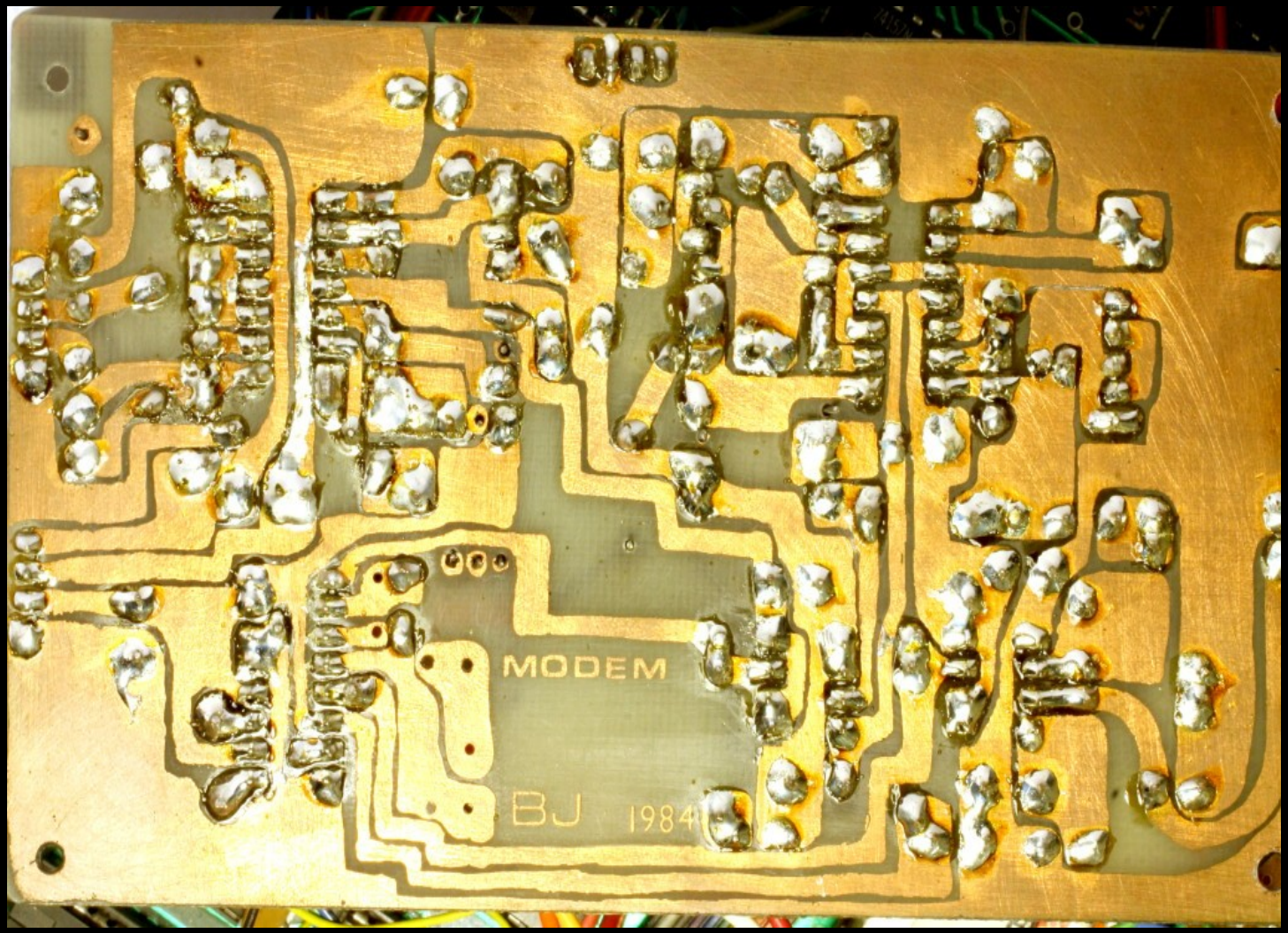
How it's done by hackers...

Two fundamental steps



Credit Flickr : anachrocomput

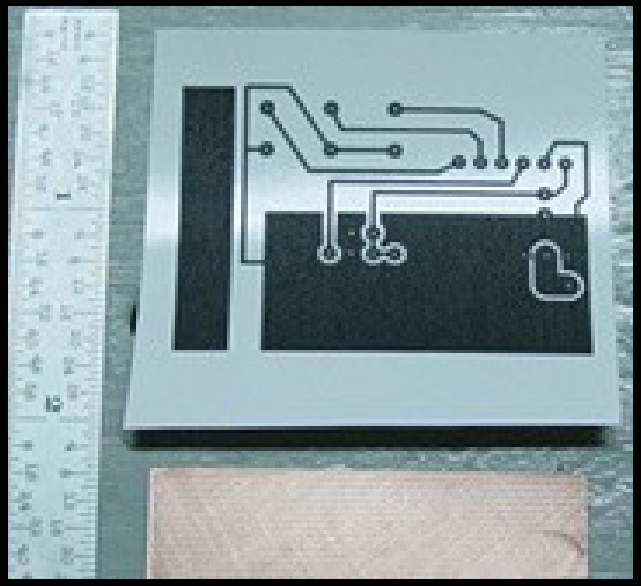
1. With a marker pen



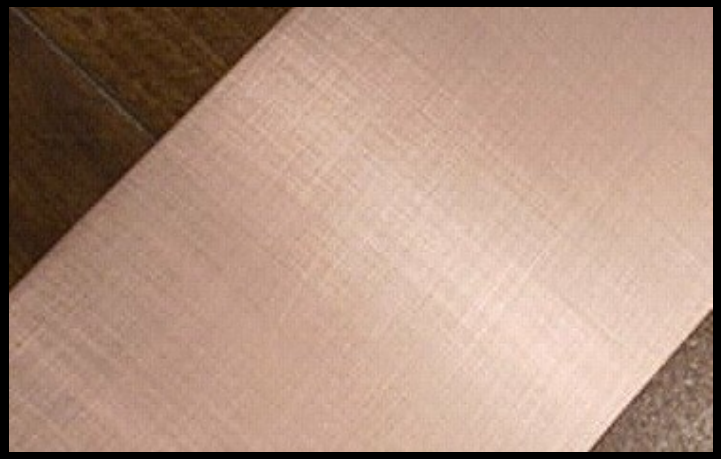
1. Draw

2. Etch

2. Toner Transfer



1. Laser print onto paper



2. Scrub copper

Image credit : http://www.5bears.com/pcb.htm

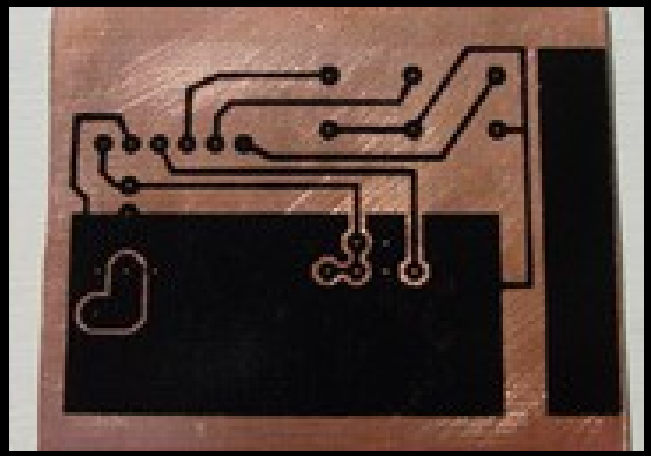
2. Toner Transfer

3. Iron to transfer image

4. Soak off paper

Image credit : http://www.5bears.com/pcb.htm

2. Toner Transfer

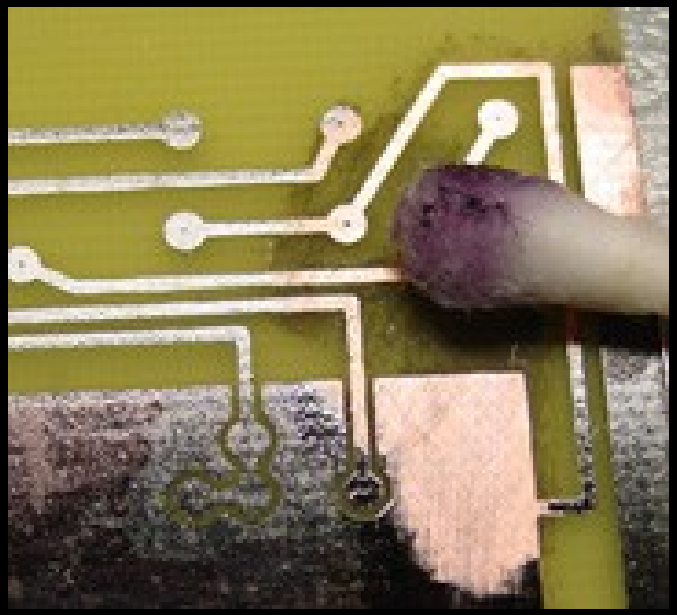


5. Clean off paper residue

6. Etch

Image credit : http://www.5bears.com/pcb.htm

2. Toner Transfer



7. Strip off toner

Image credit : http://www.5bears.com/pcb.htm

3. Photolithography

1. Produce artwork

2. Expose photoresist coated PCB to UV

3. Develop

4. Etch

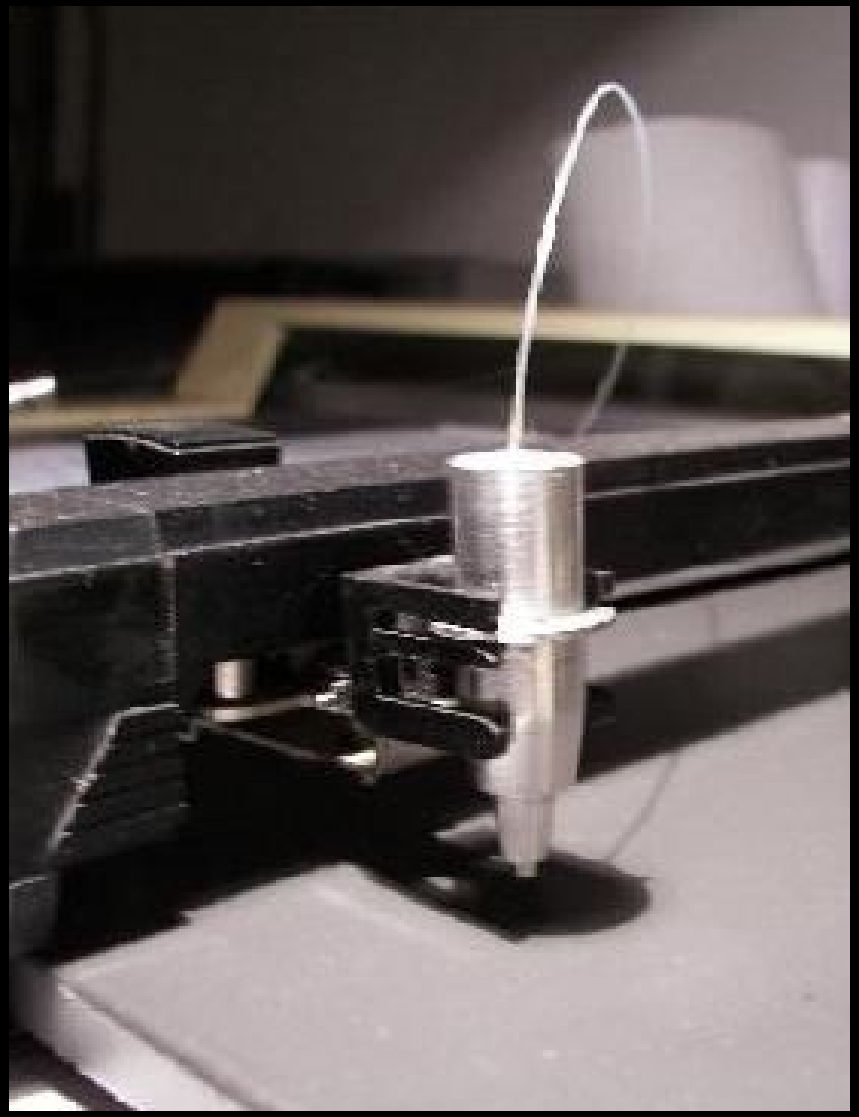
Image credit : http://www.electronics-lab.com

4. Isolation Milling

1. Mill

Image credit : http://www.brusselsprout.org

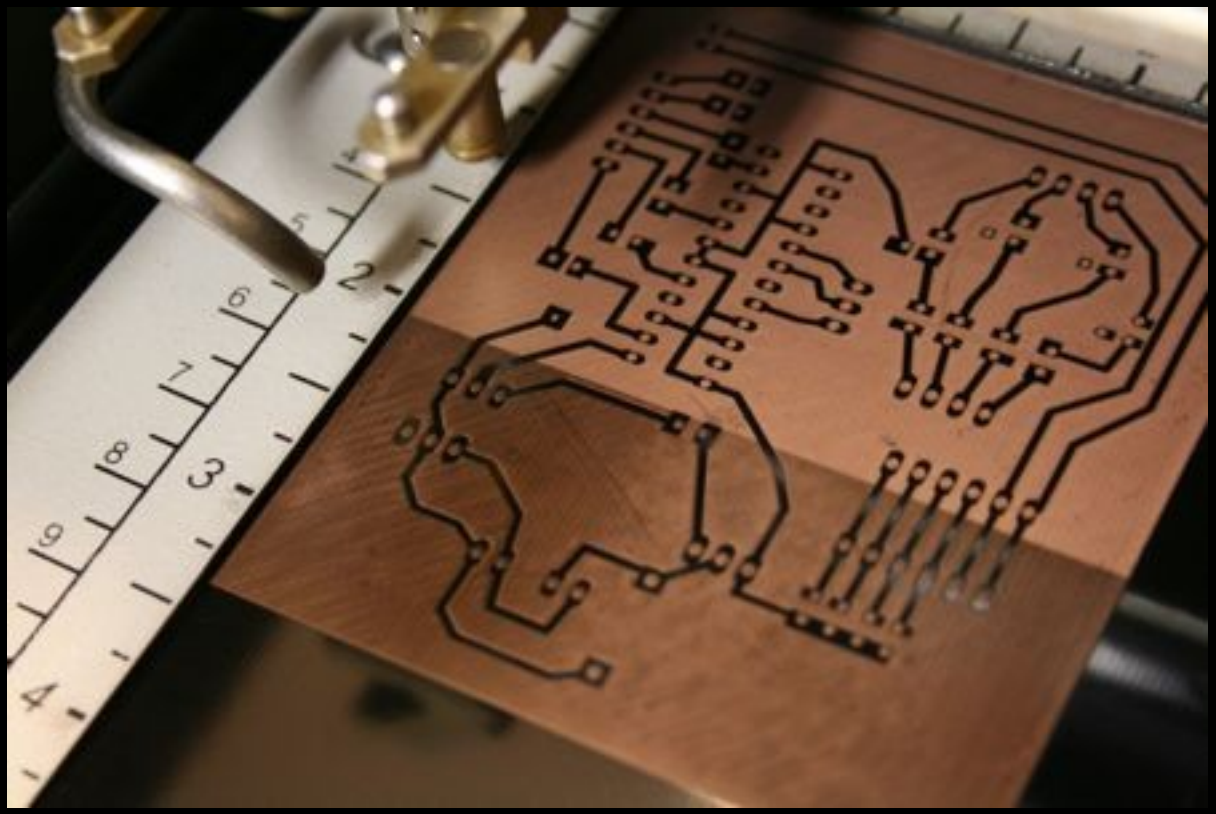
5. UV Photoplotting



1. Plot
2. Develop
3. Etch

Image credit : http://francois.dubrulle.pagesperso-orange.fr

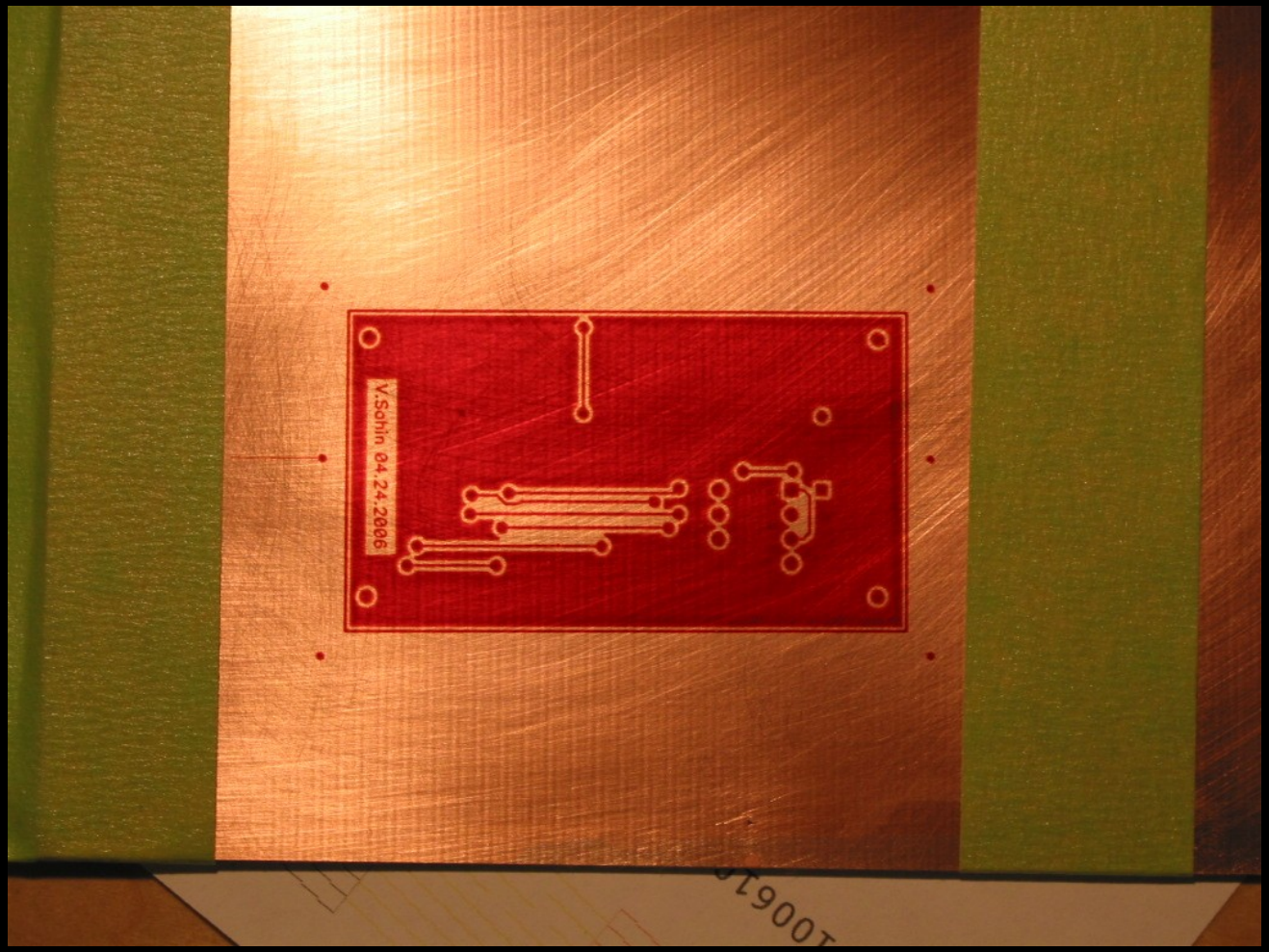
6. CO_2 Laser Engraving



1. Paint
2. Engrave
3. Clean
4. Etch

Image credit: http://hackaday.com/2008/06/20

7. Inkjet



1. Scrub
2. Print
3. Bake
4. Etch

Image credit : http://techref.massmind.org/

Ok, let's do better

Inkjetting Wax

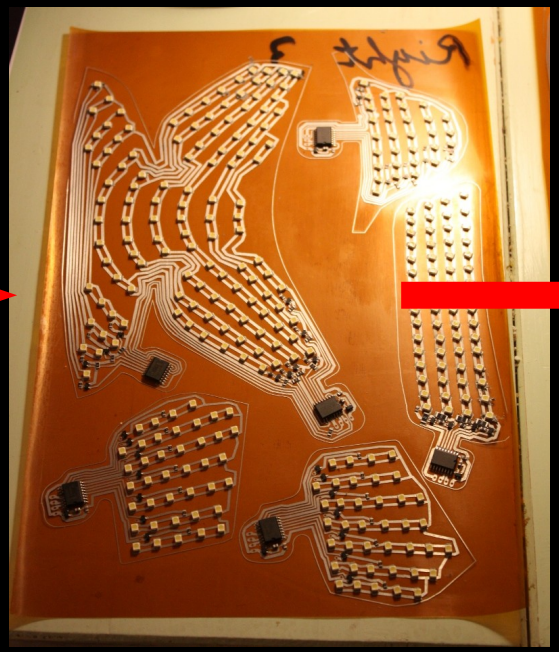
No spreading

Waterproof

No solids

Not reliant on magic ink formula

Proof of concept



Goal

Two steps: print, etch

< 0.2mm

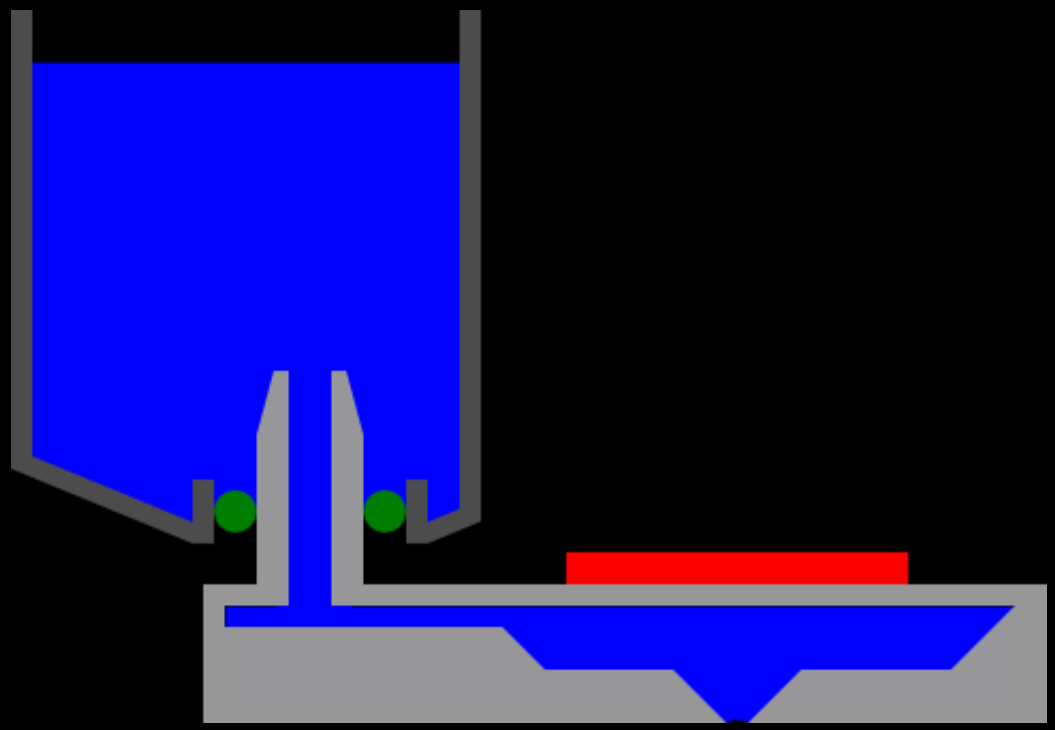
< 30 minutes

Double sided indexing

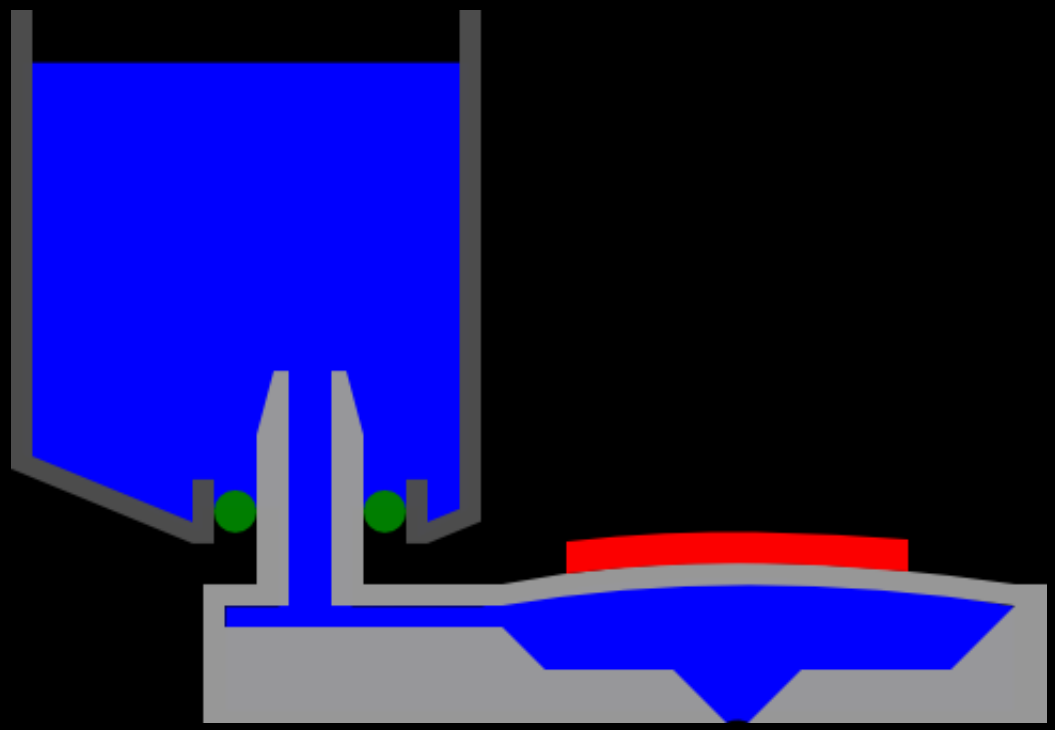
(but vias are an unknown)

Choosing a printhead

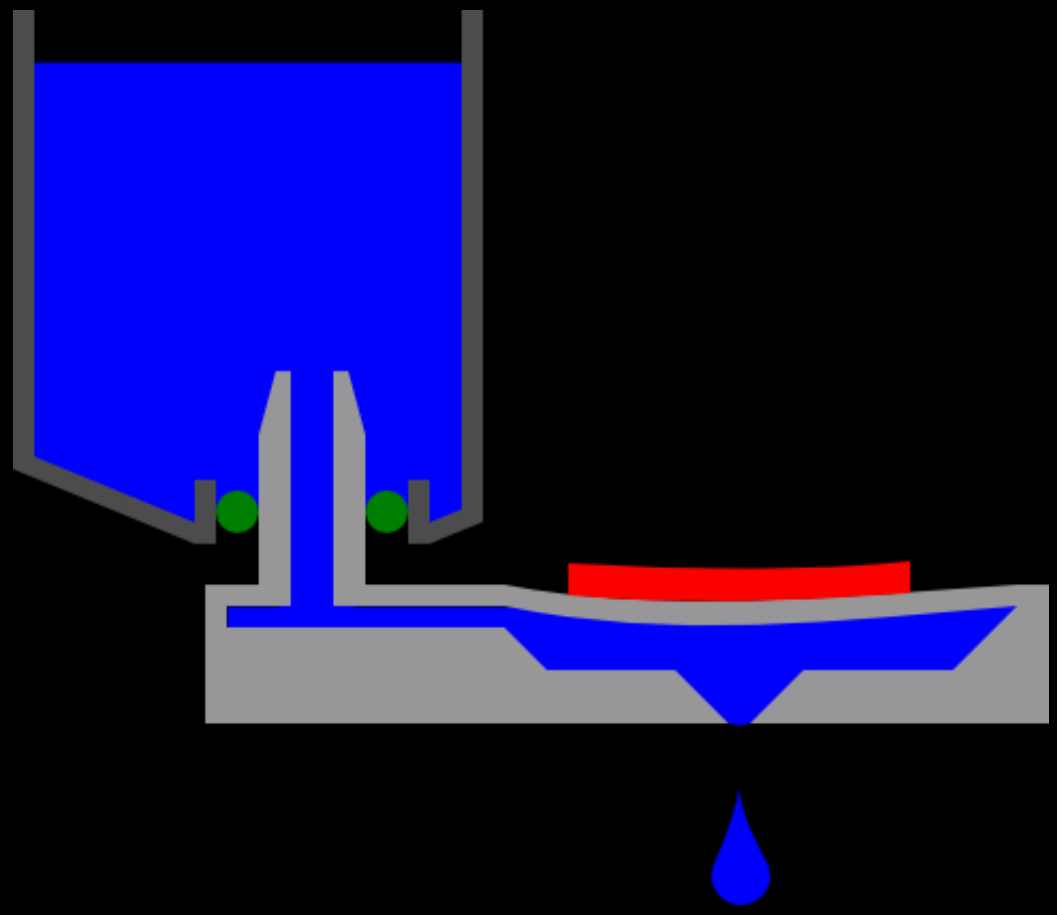
Piezo Inkjet



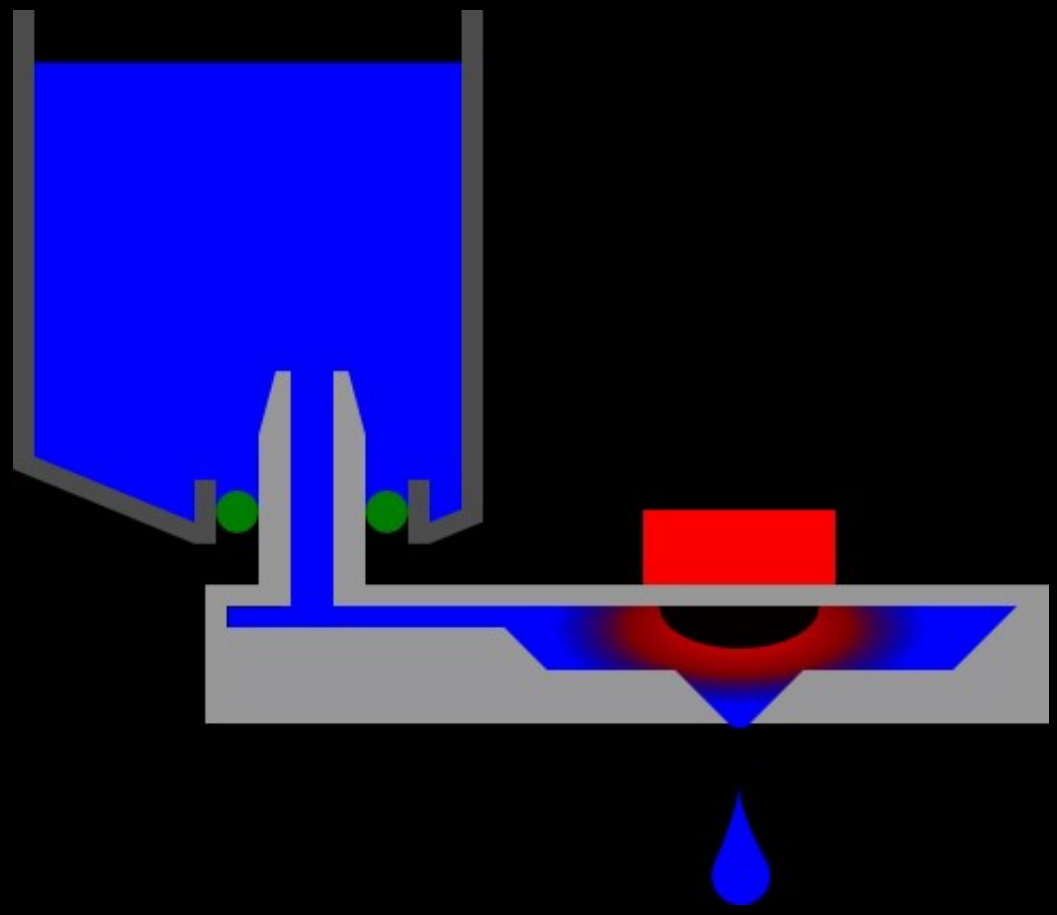
Piezo Inkjet



Piezo Inkjet



Thermal Inkjet



Epson Stylus S21

4pl drops (19um)

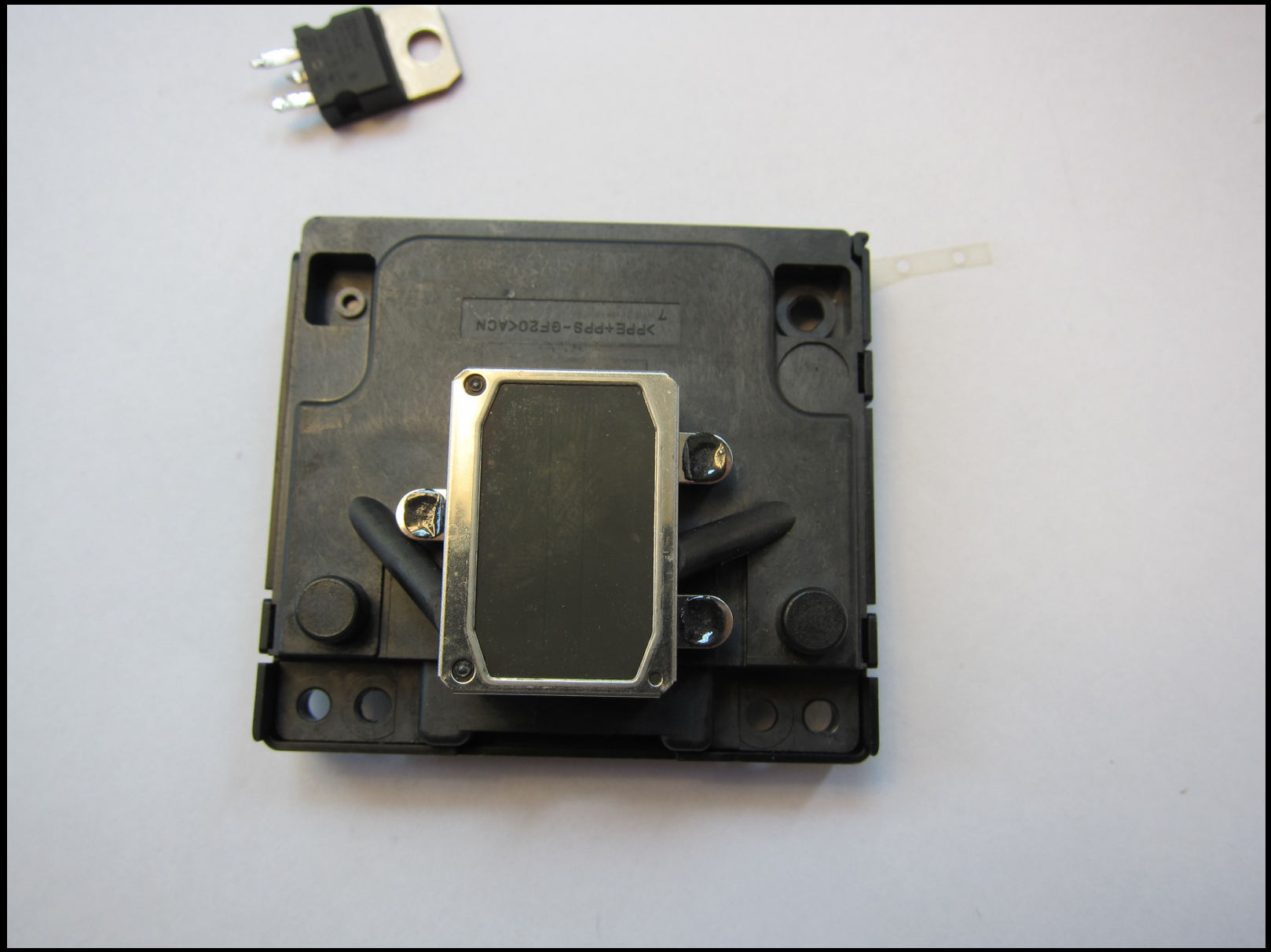
30 nozzles C, M, Y,

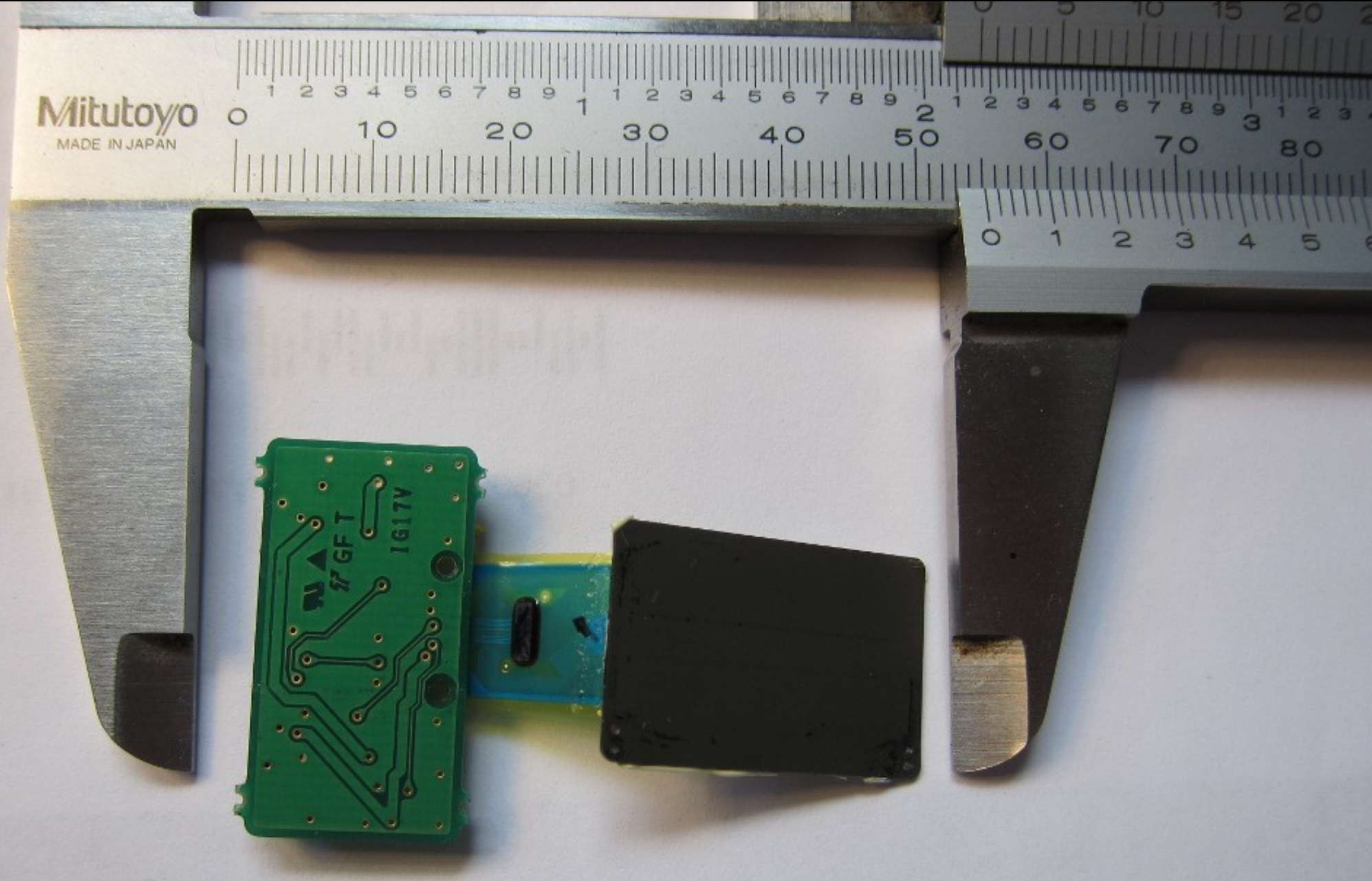
90 nozzles K

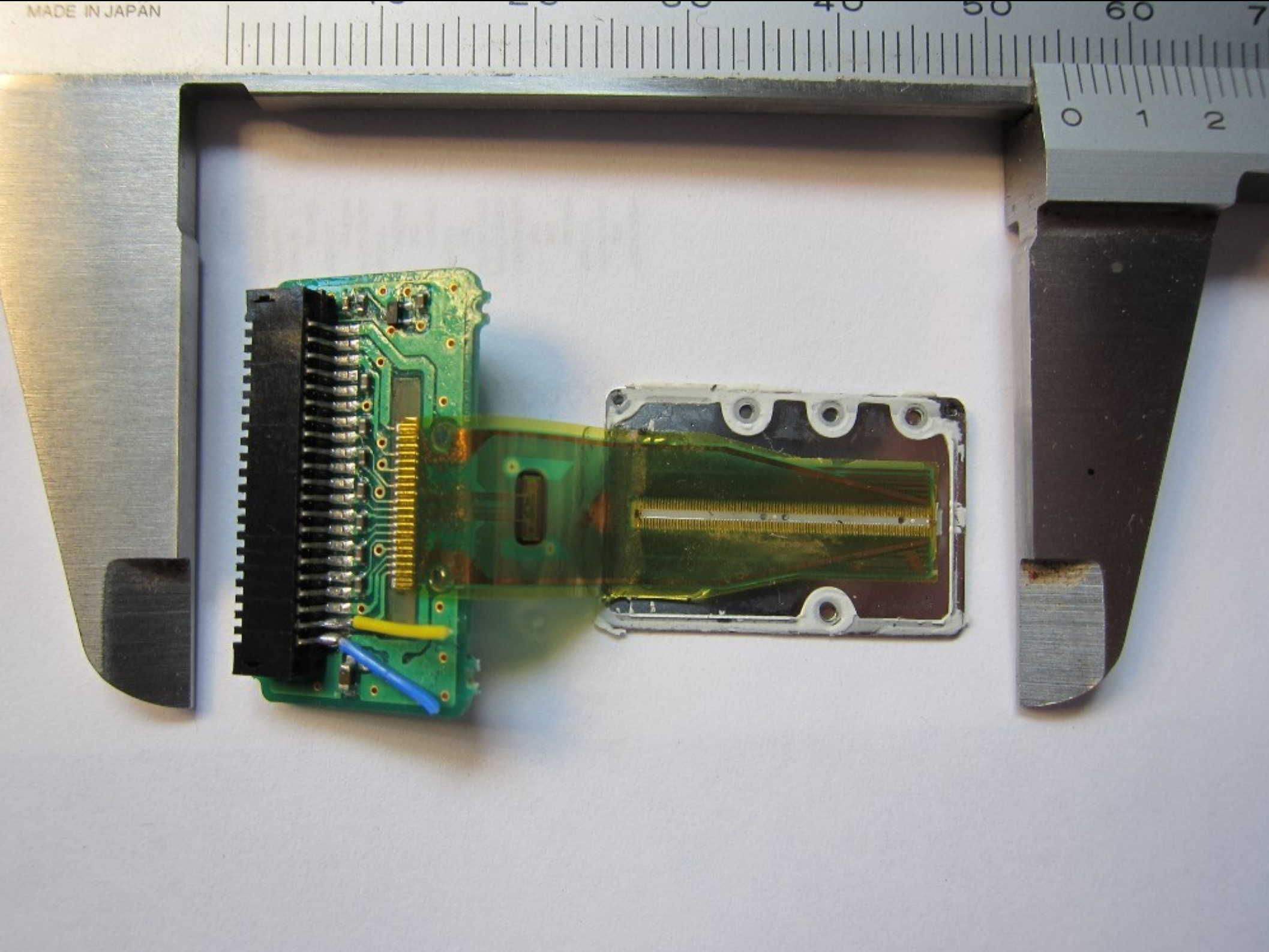
€40 !

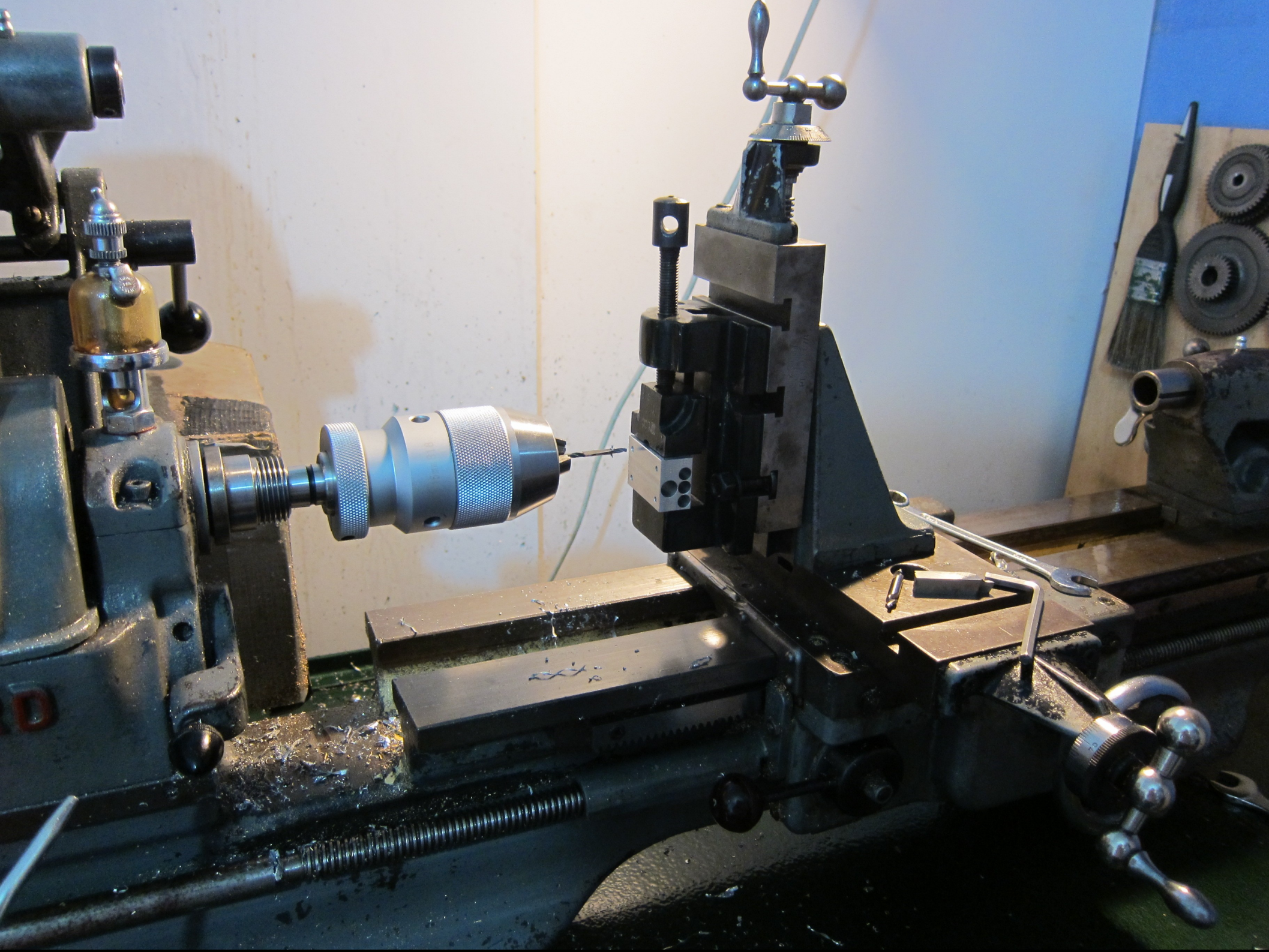
Its printhead

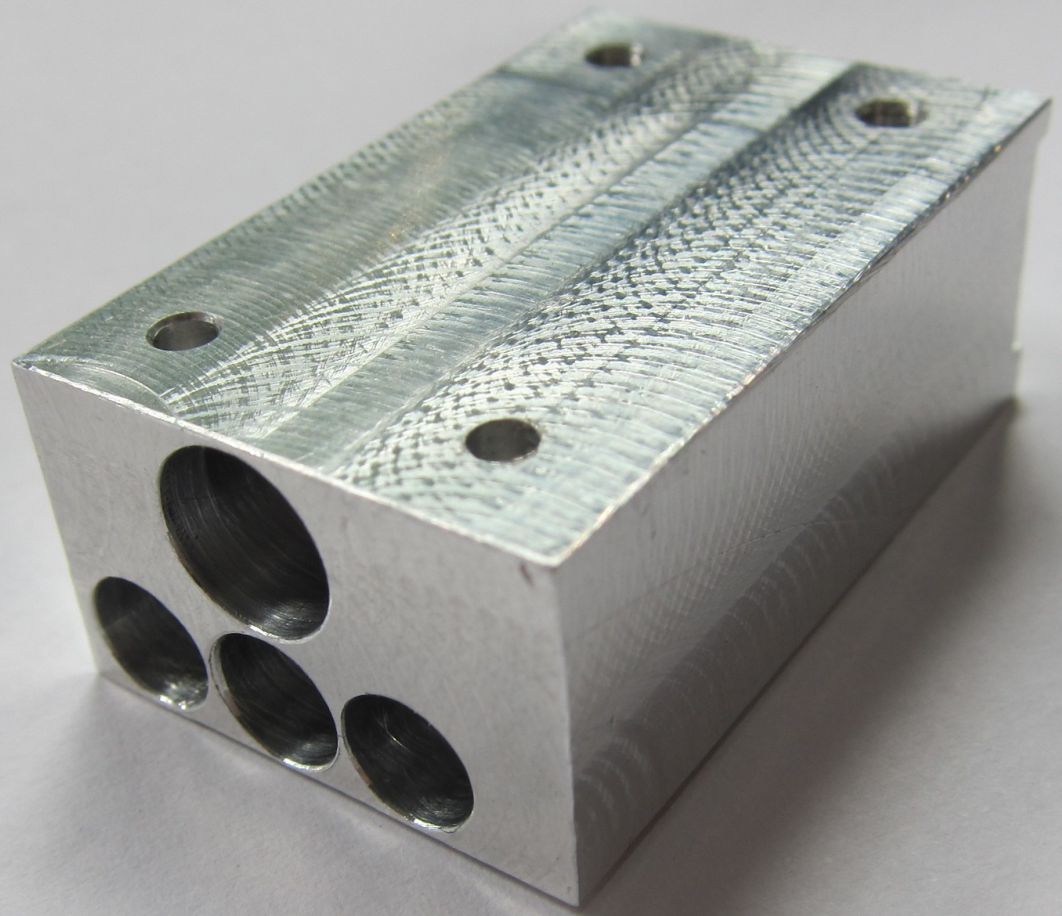
Its printhead

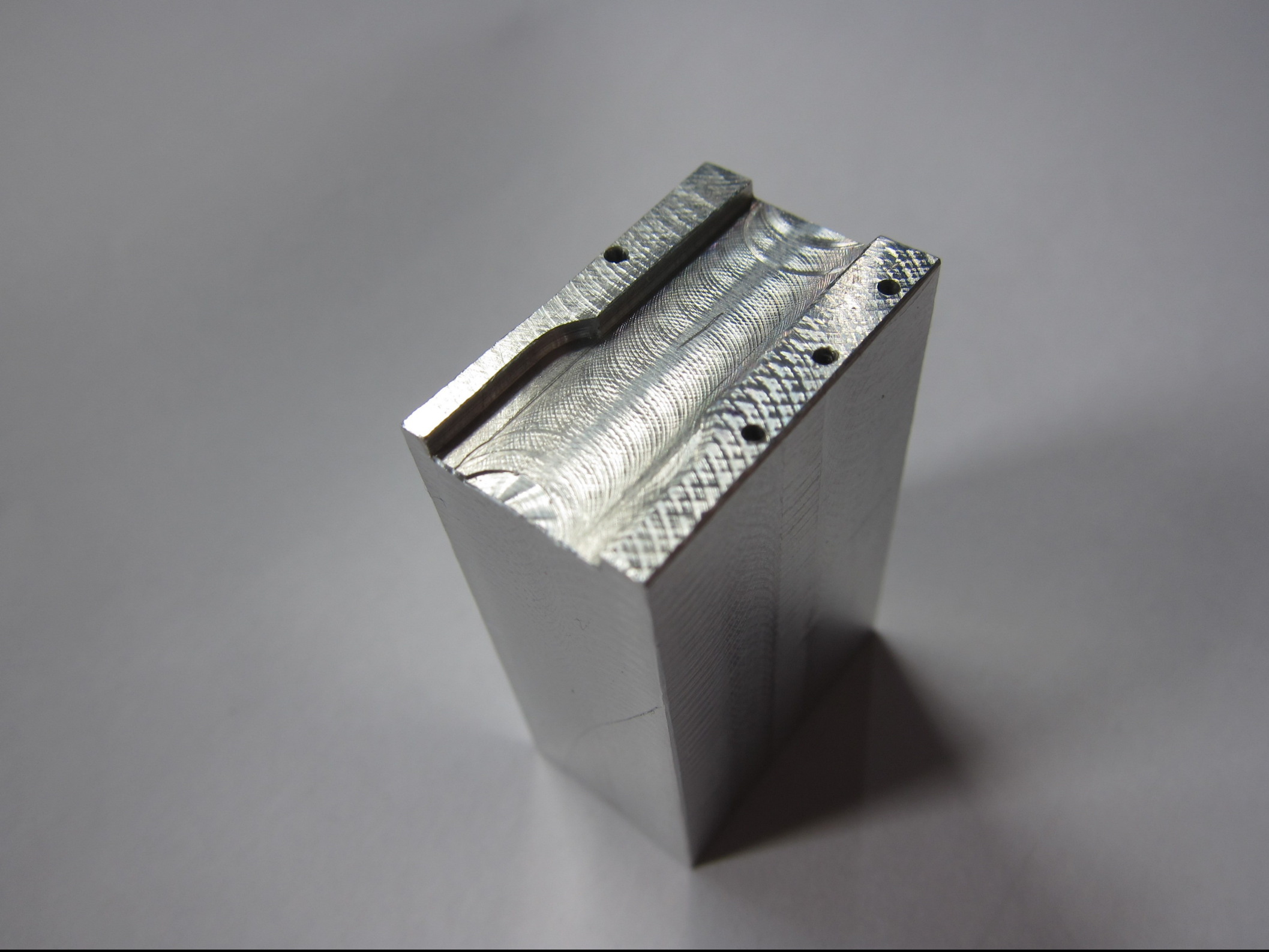


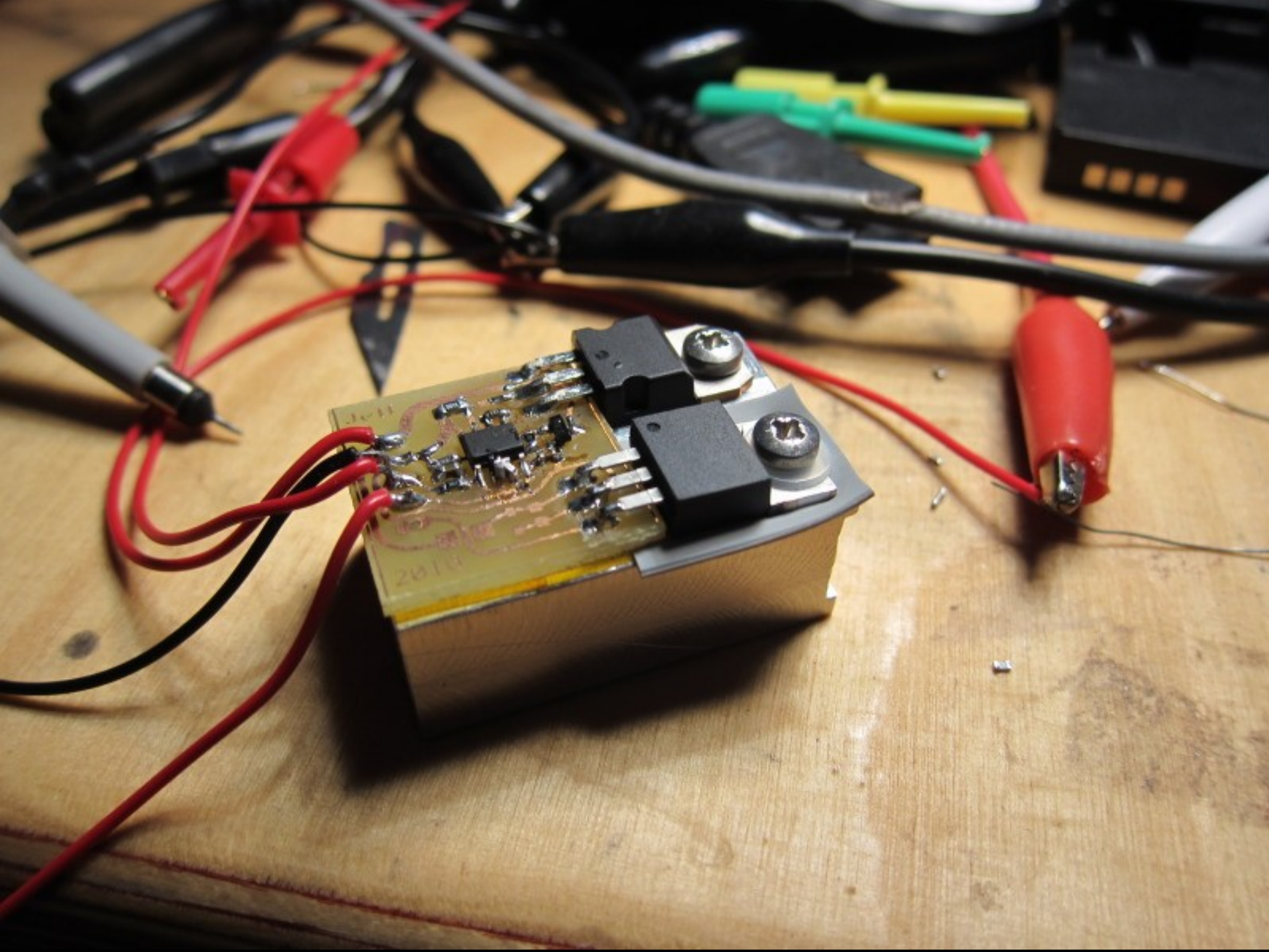

Mitutoyo
MADE IN JAPAN
GF T
1G17V

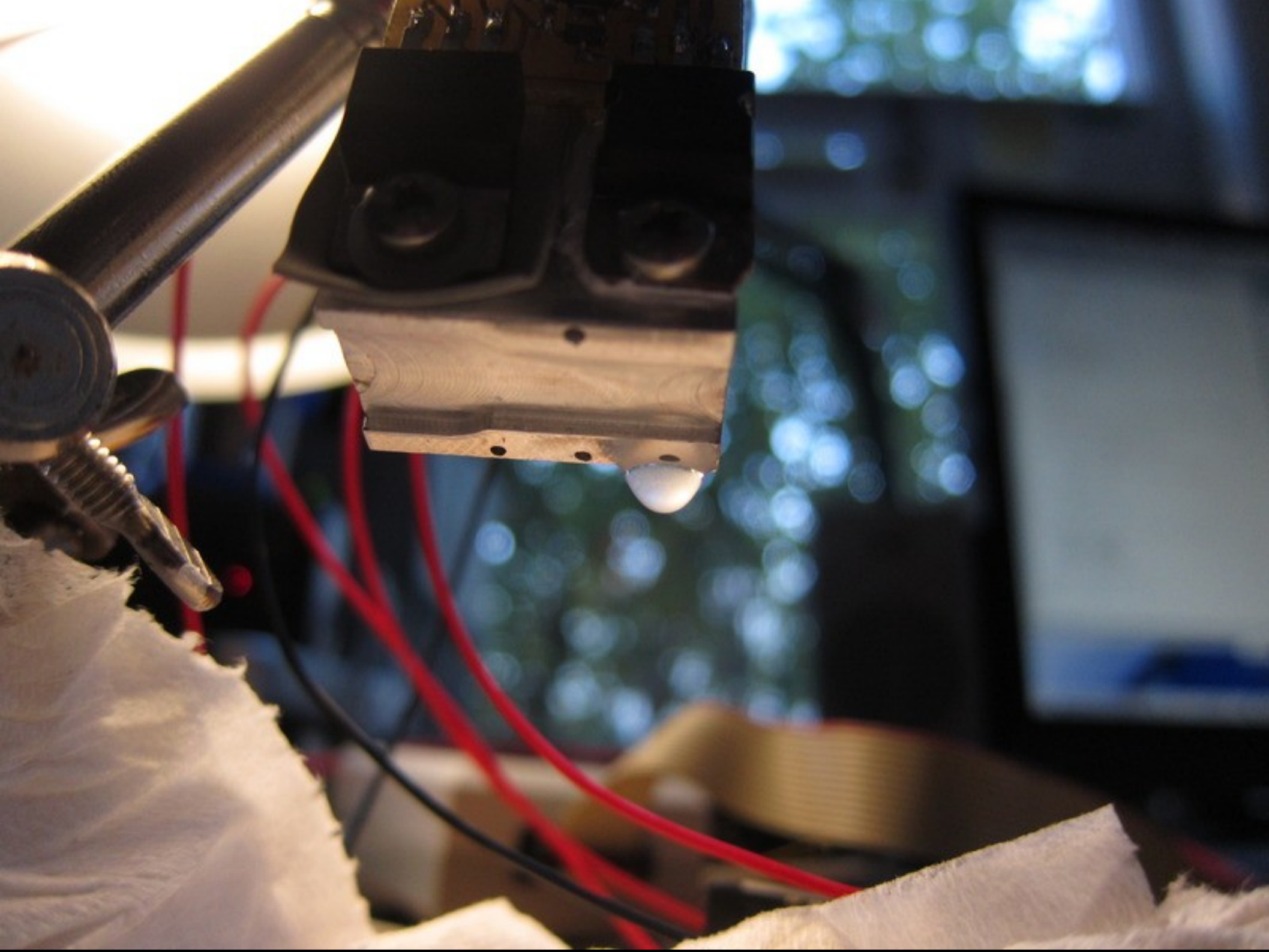

MADE IN JAPAN
40
50
60
0
1
2



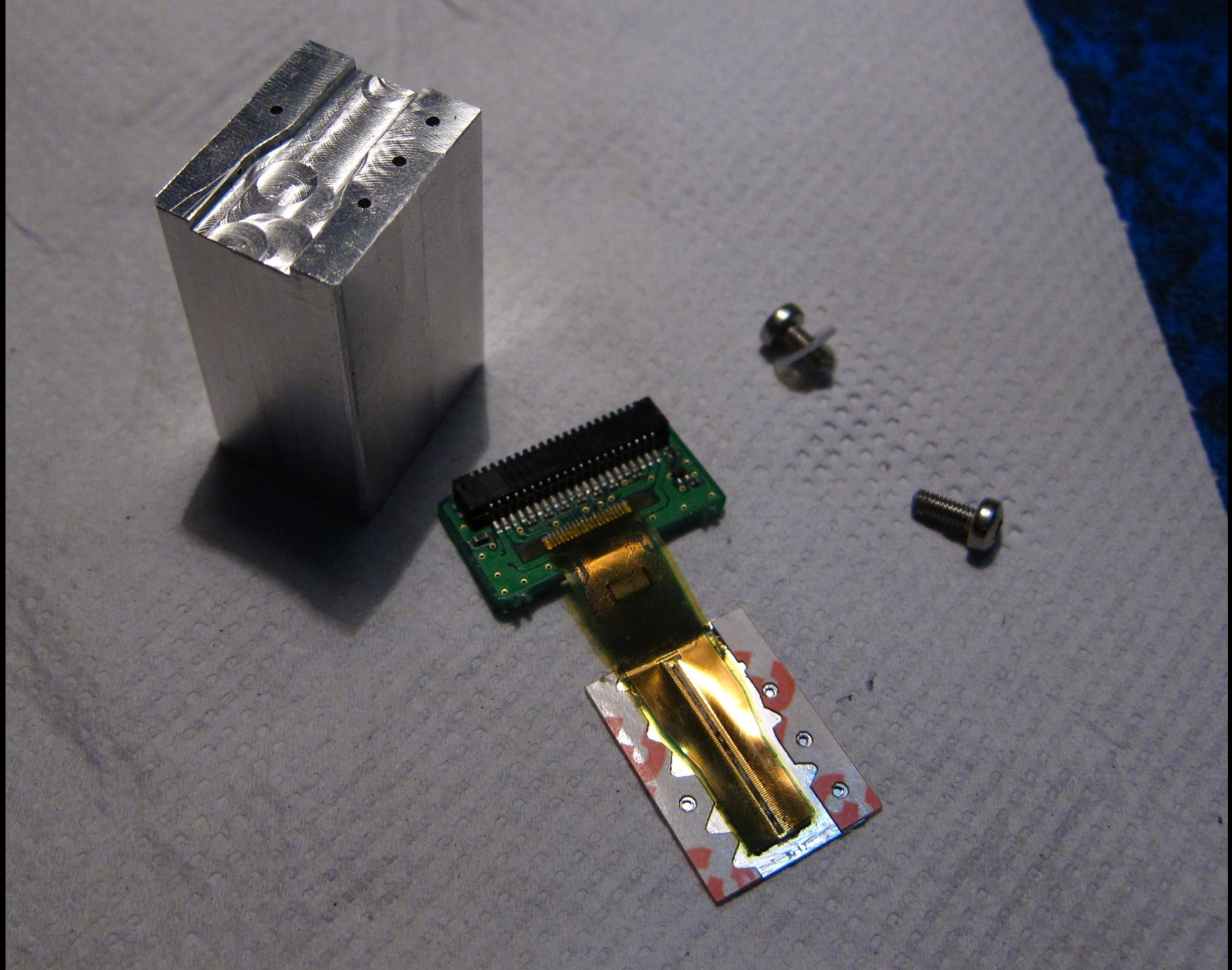


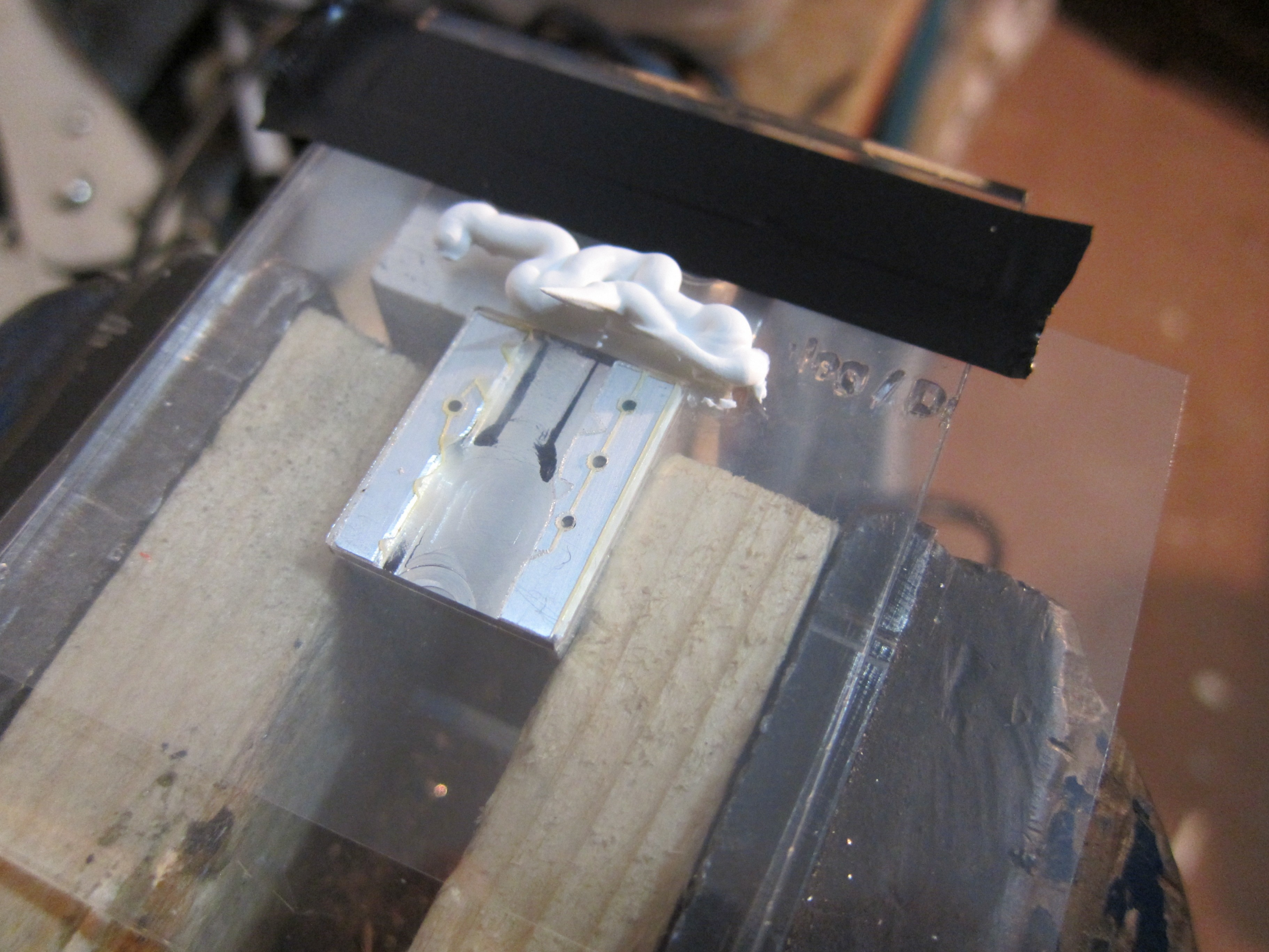


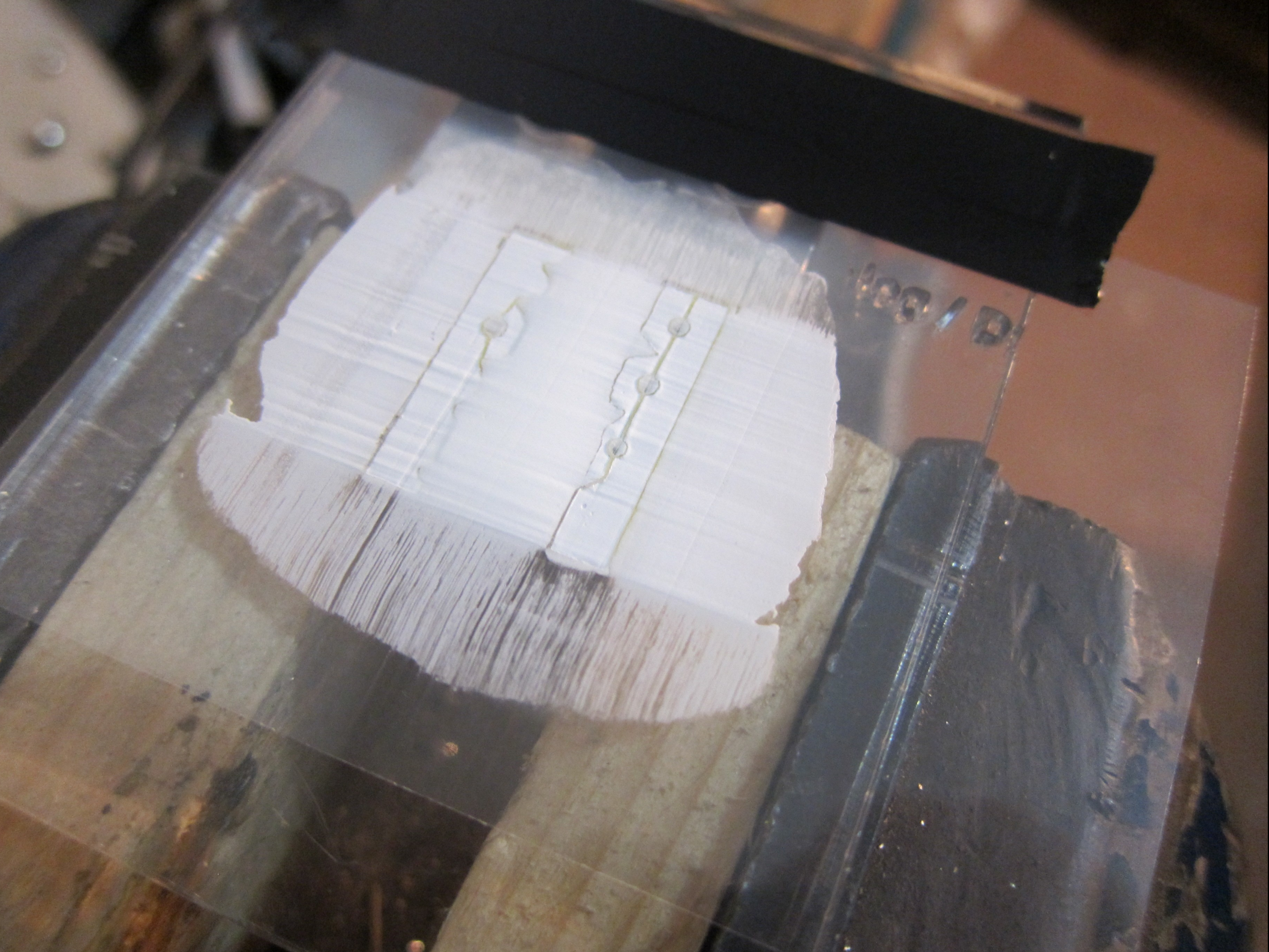


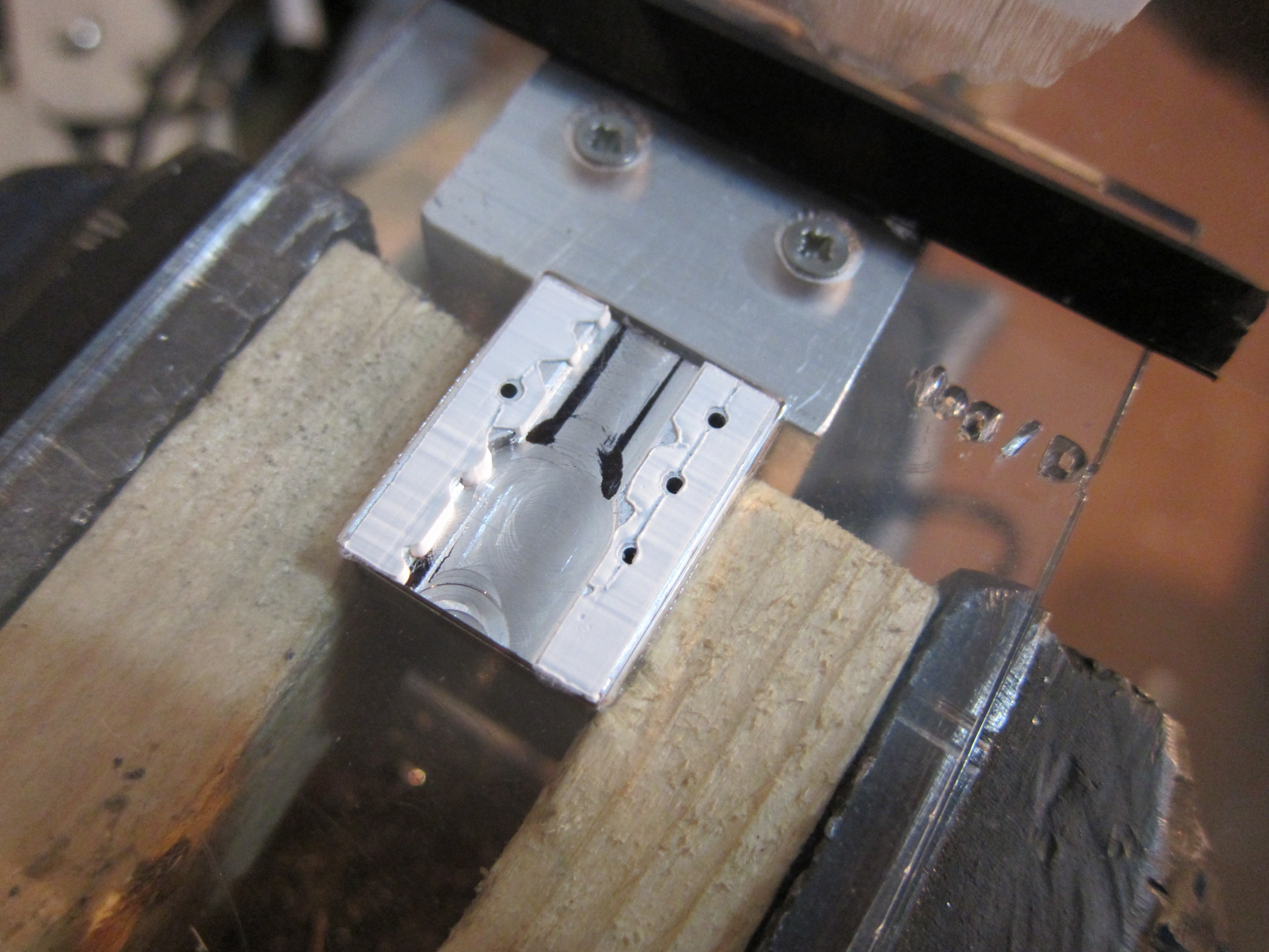


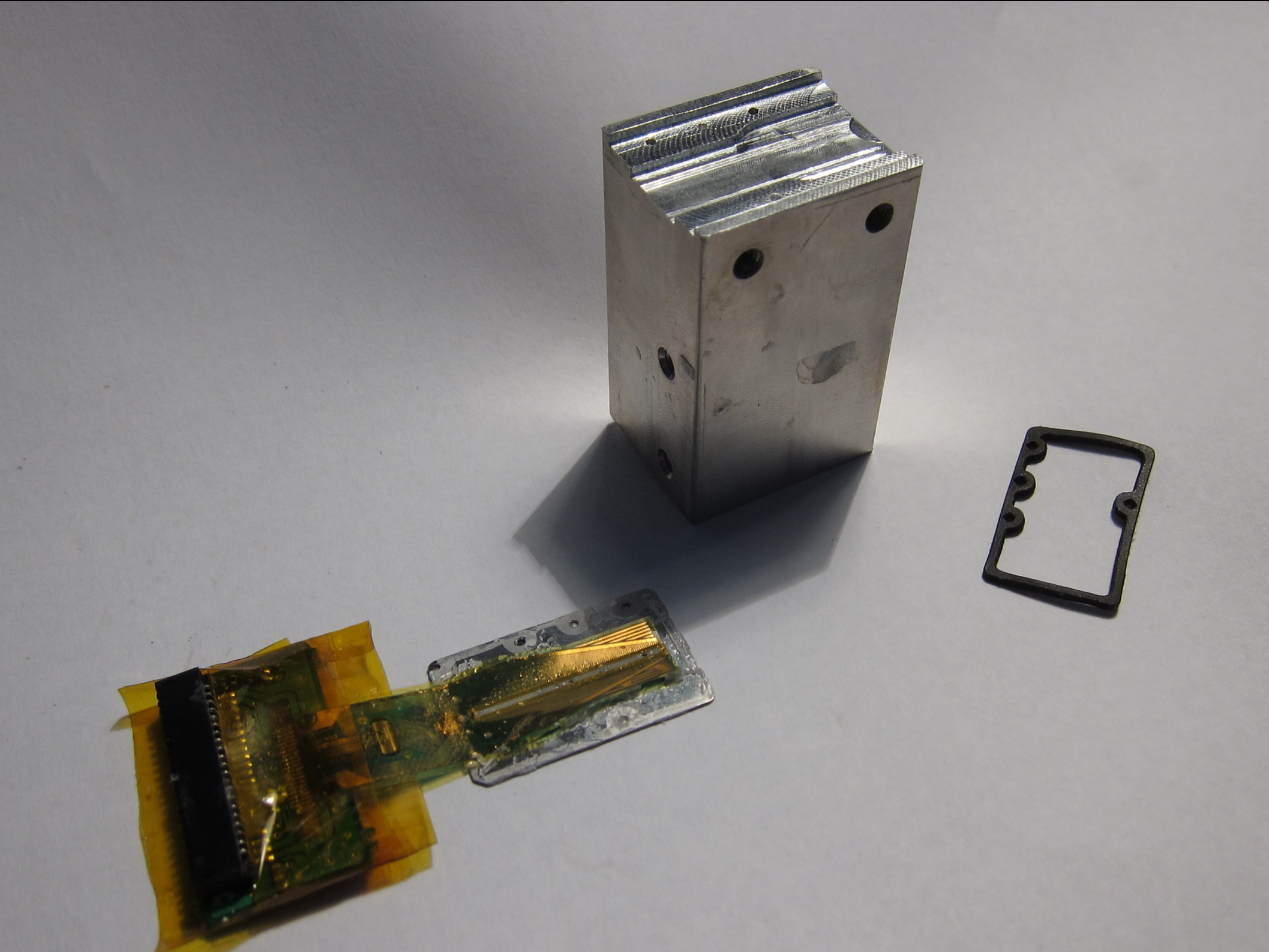
3M
3M
3M
3M
3M
3M
3M
3M
3M

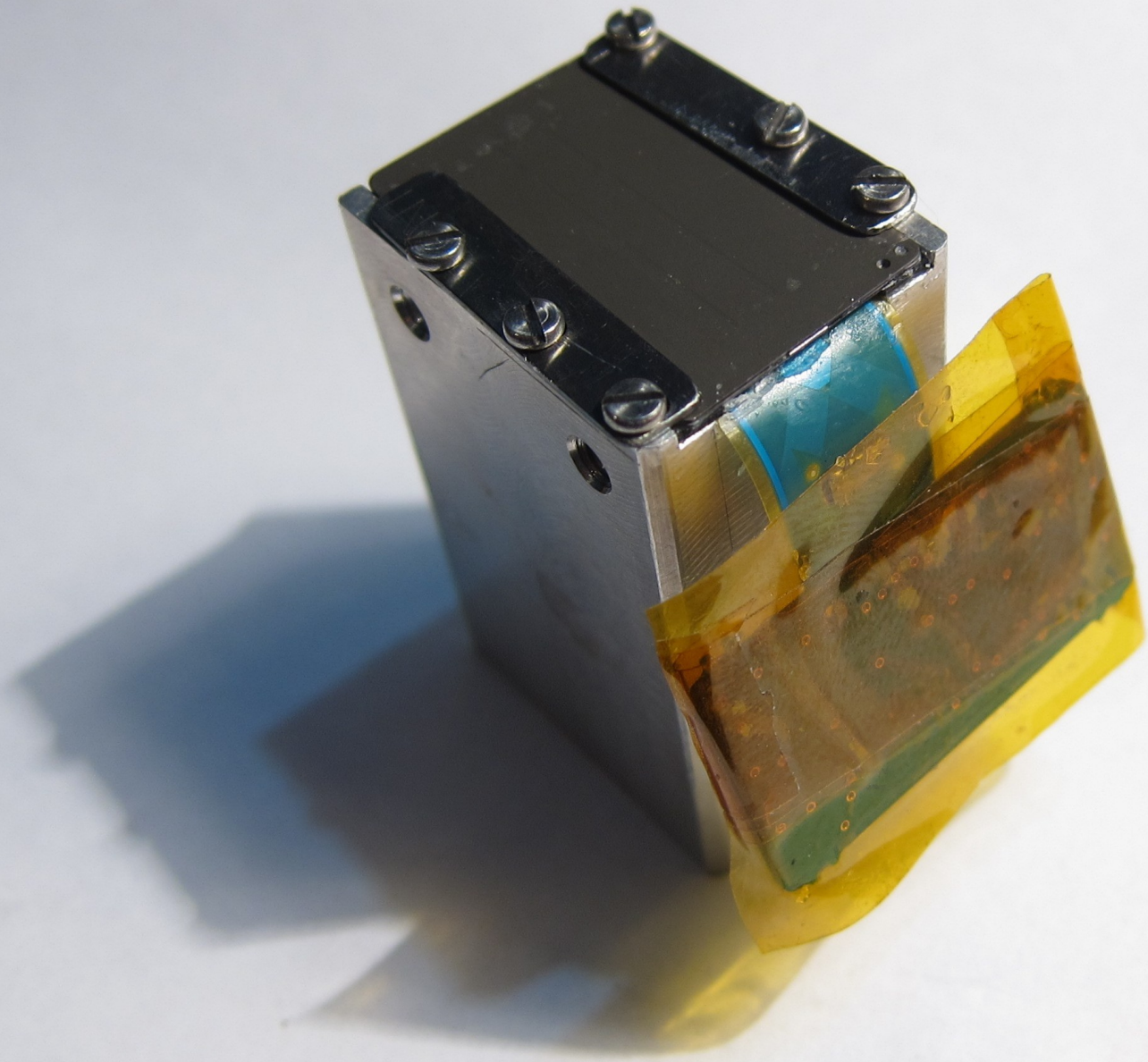












Previous reversing attempts

- Volkan Sahin
- POSAM

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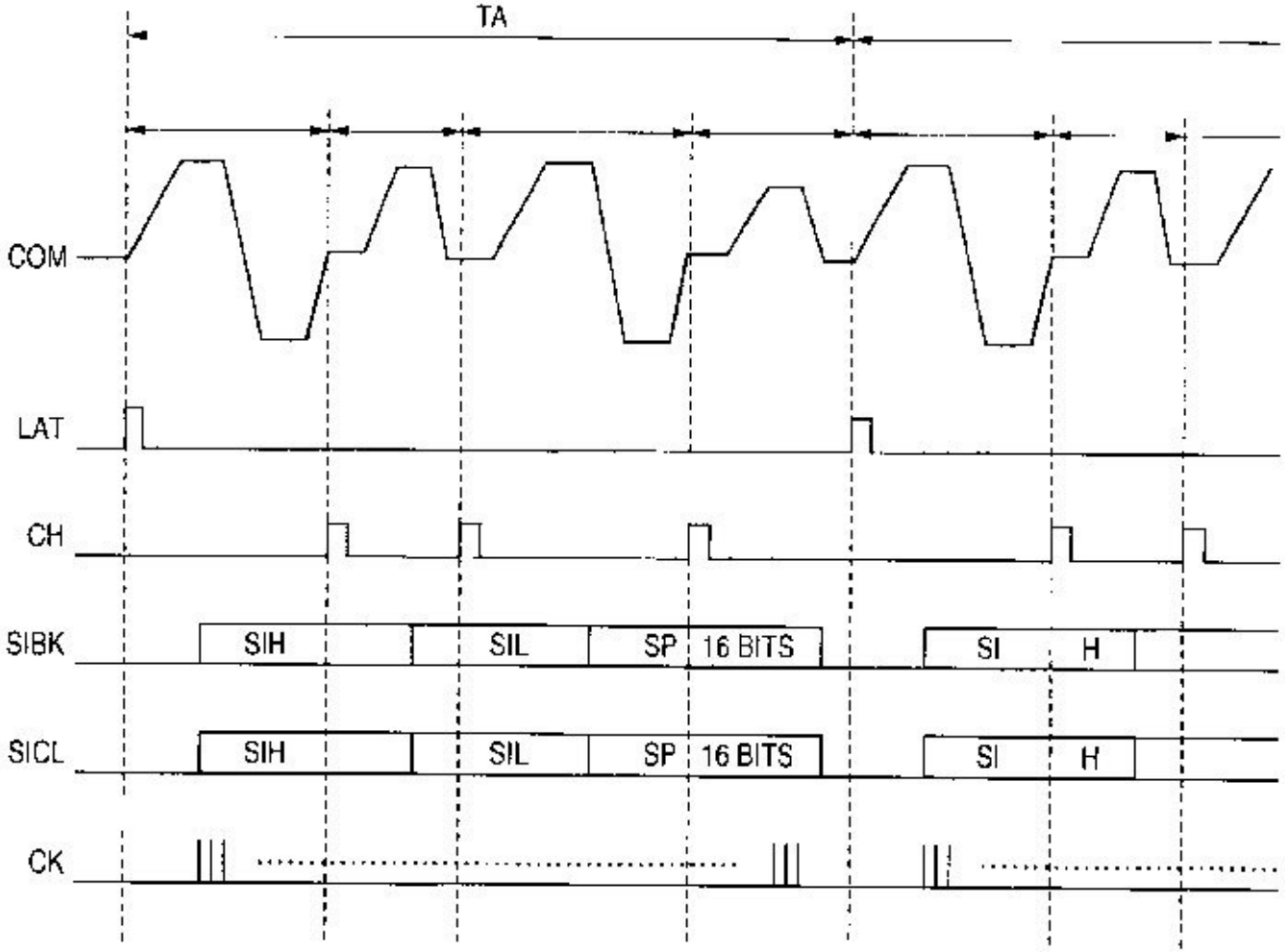
FIG. 5


TA
COM
LAT
CH
SIBK
SIH
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16 BITS
SI
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SIH
SIL
SP
16 BITS
SI
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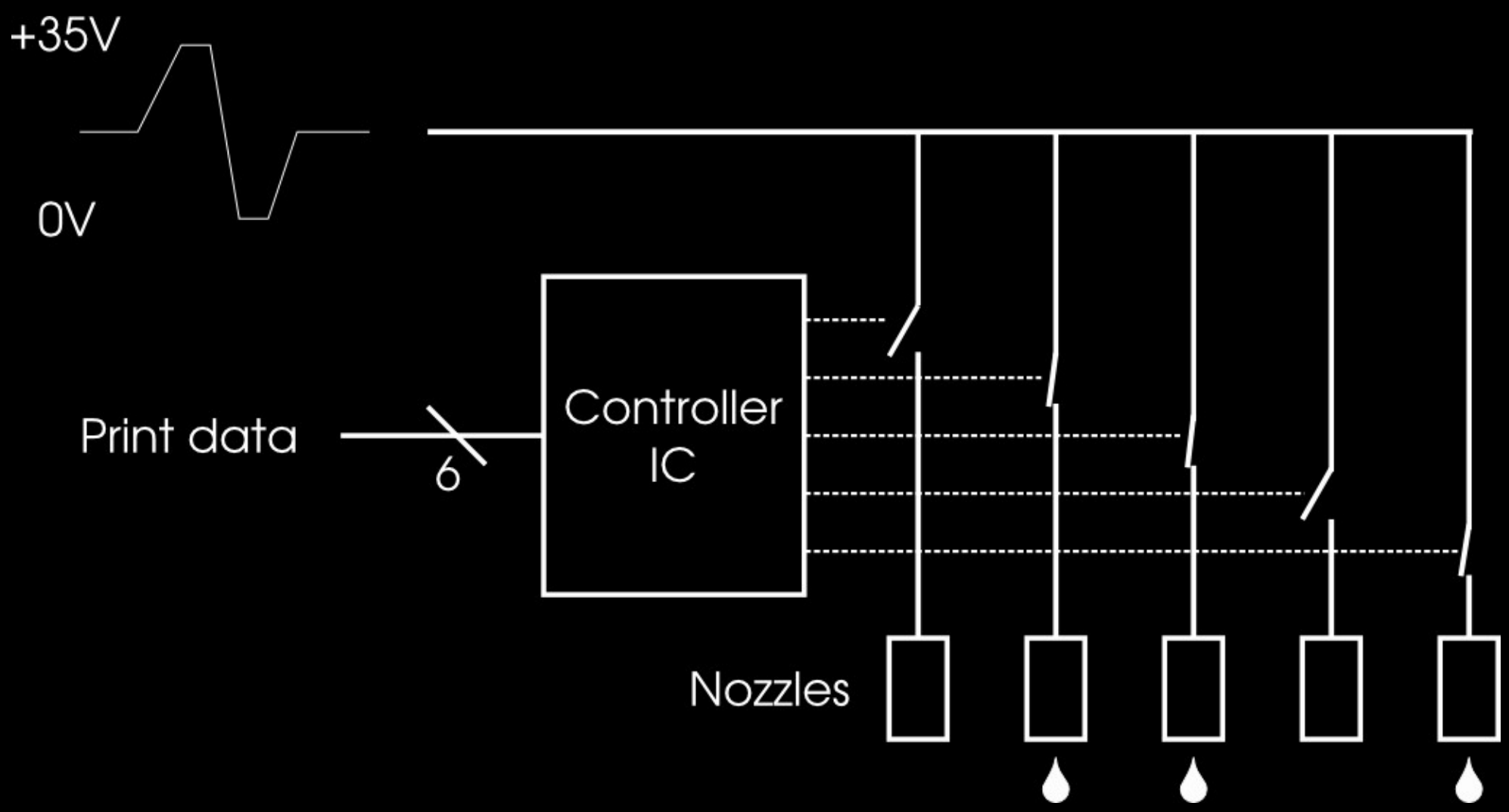
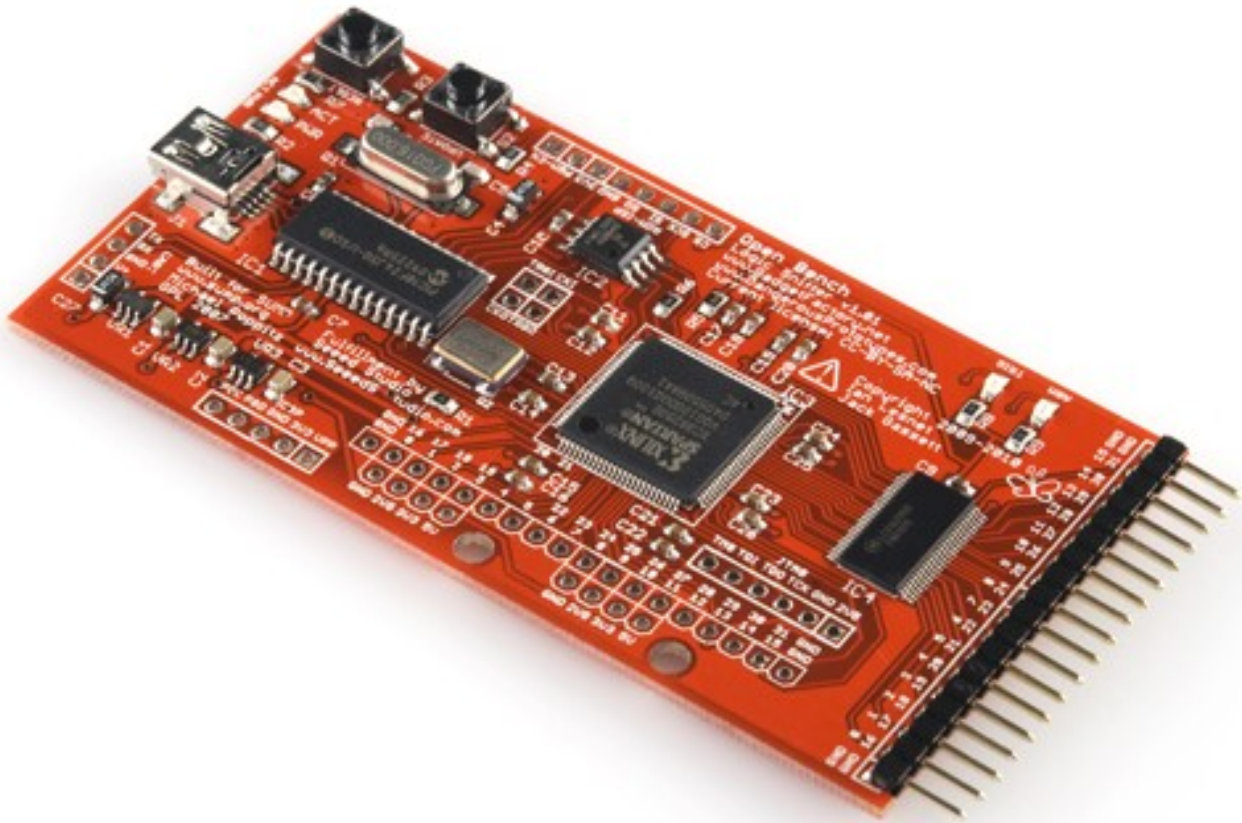
CK

Controlling the printhead





25.38
TENMA

Applications Places System jeff Fri Jul 9, 4:39:15 PM

Logic Analyzer Client

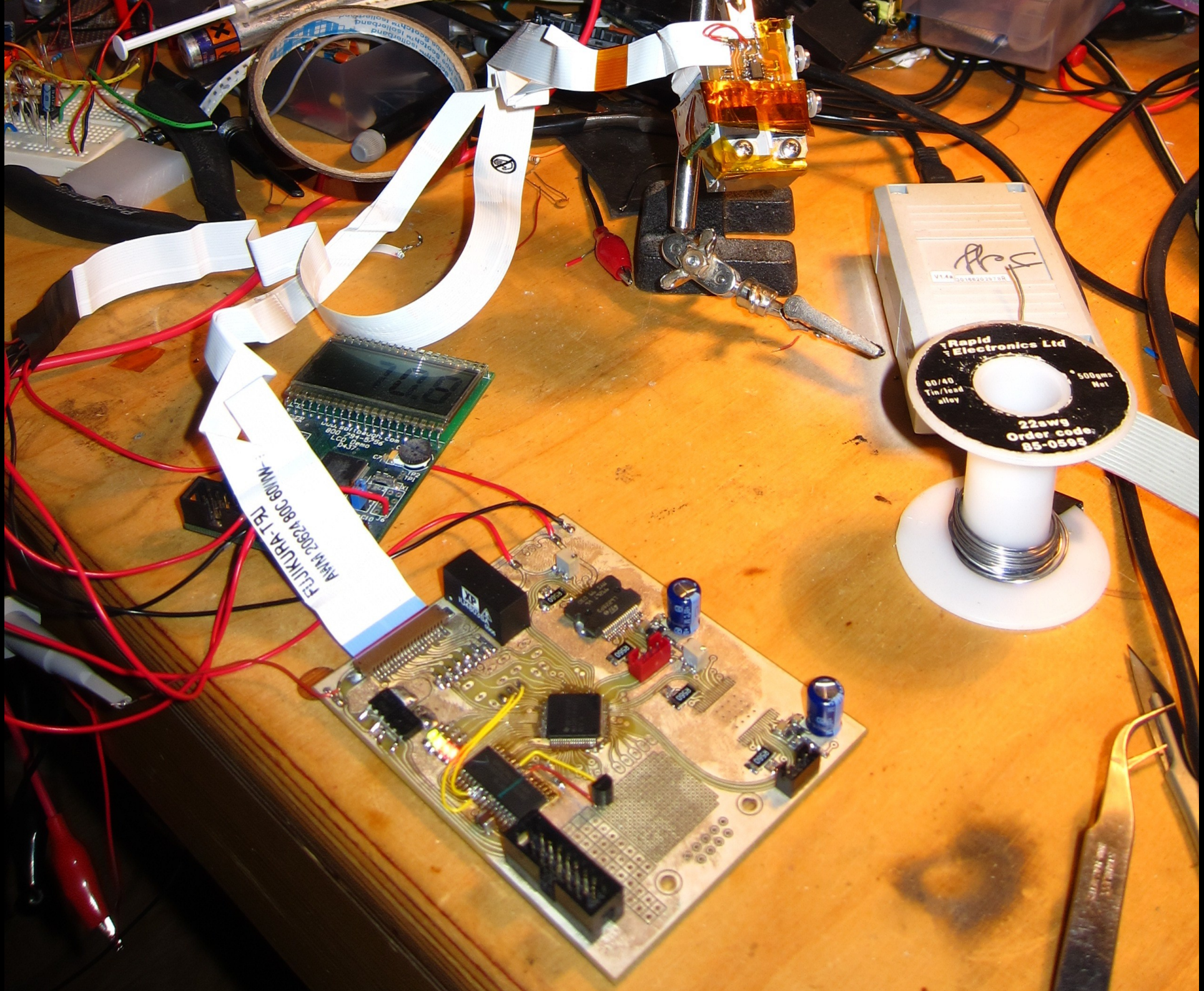
File Project Device Diagram Tools Help

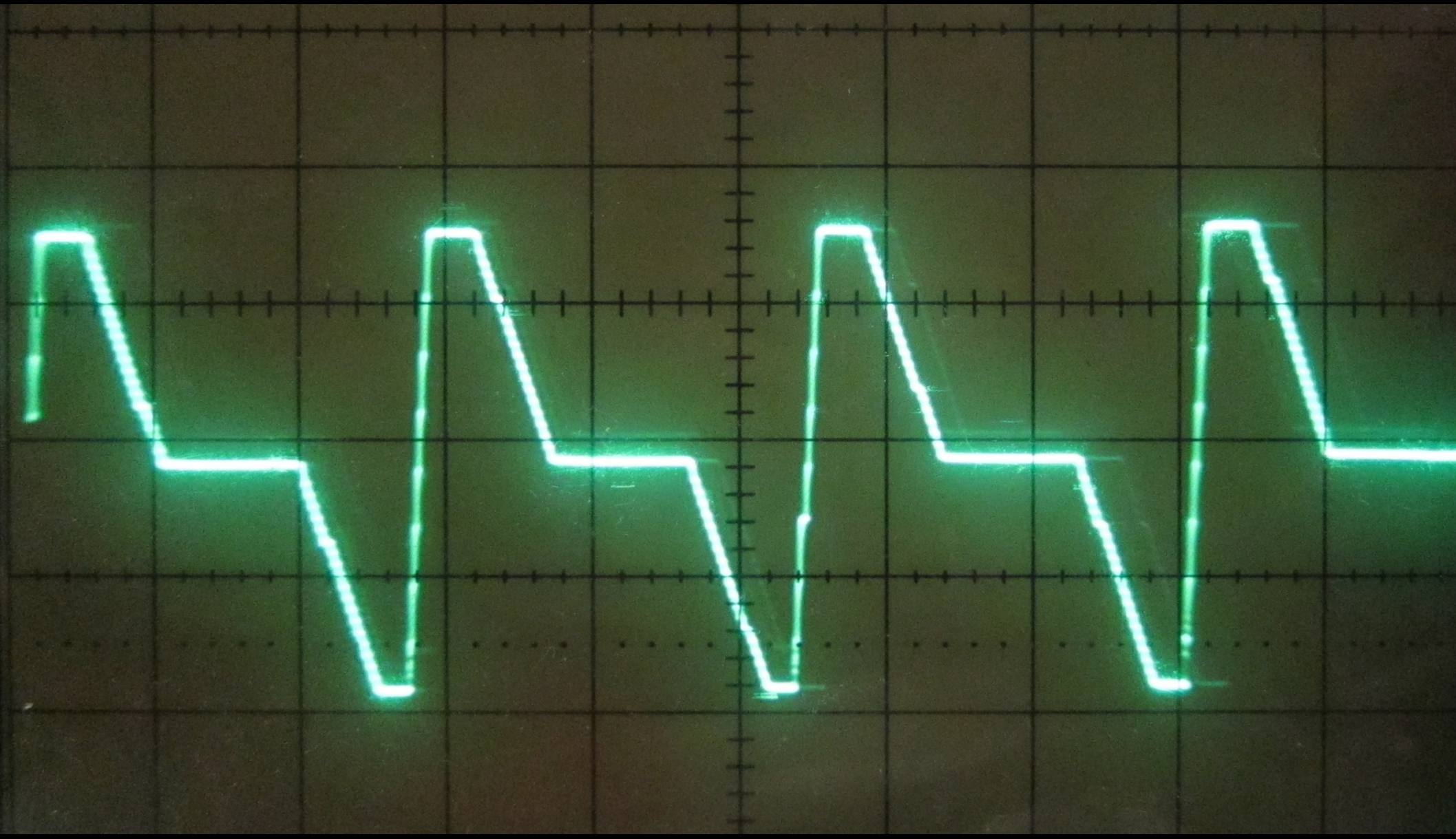
Page 1 of 1

-0.0022168 sec | -0.00221 sec | -0.0022032 sec | -0.0021964 sec | -0.0021896 sec | -0.0021828 sec | -0.002

Channel 10 | Time -2192.120µs

jeff@chisel:~ | Logic Analyzer Client


FUJITSU
A4/A 20824 80C 60W
Rapid Electronics Ltd
60/40 Tin/lead alloy
500gms Net
22swg
Order code:
85-0595



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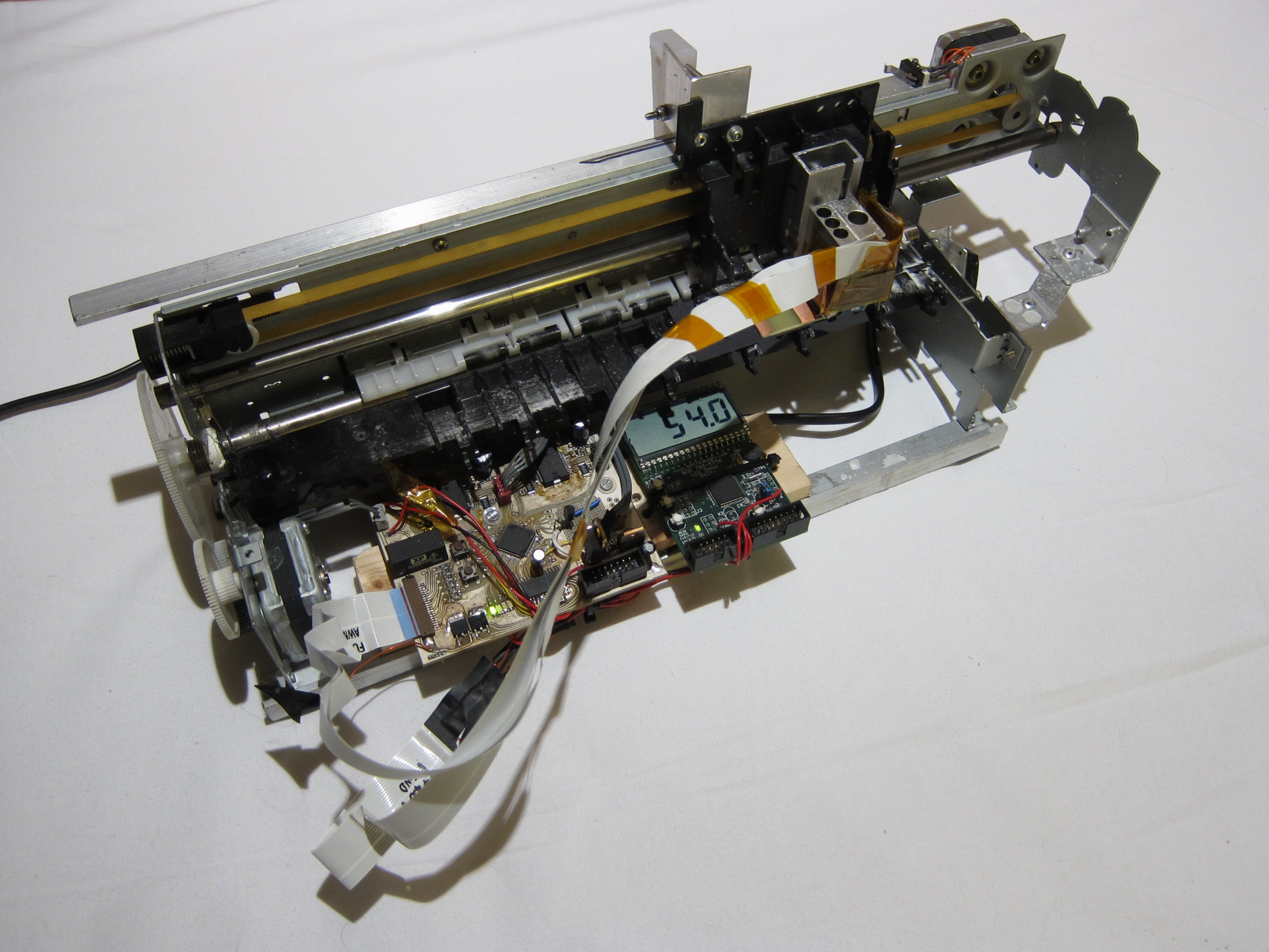
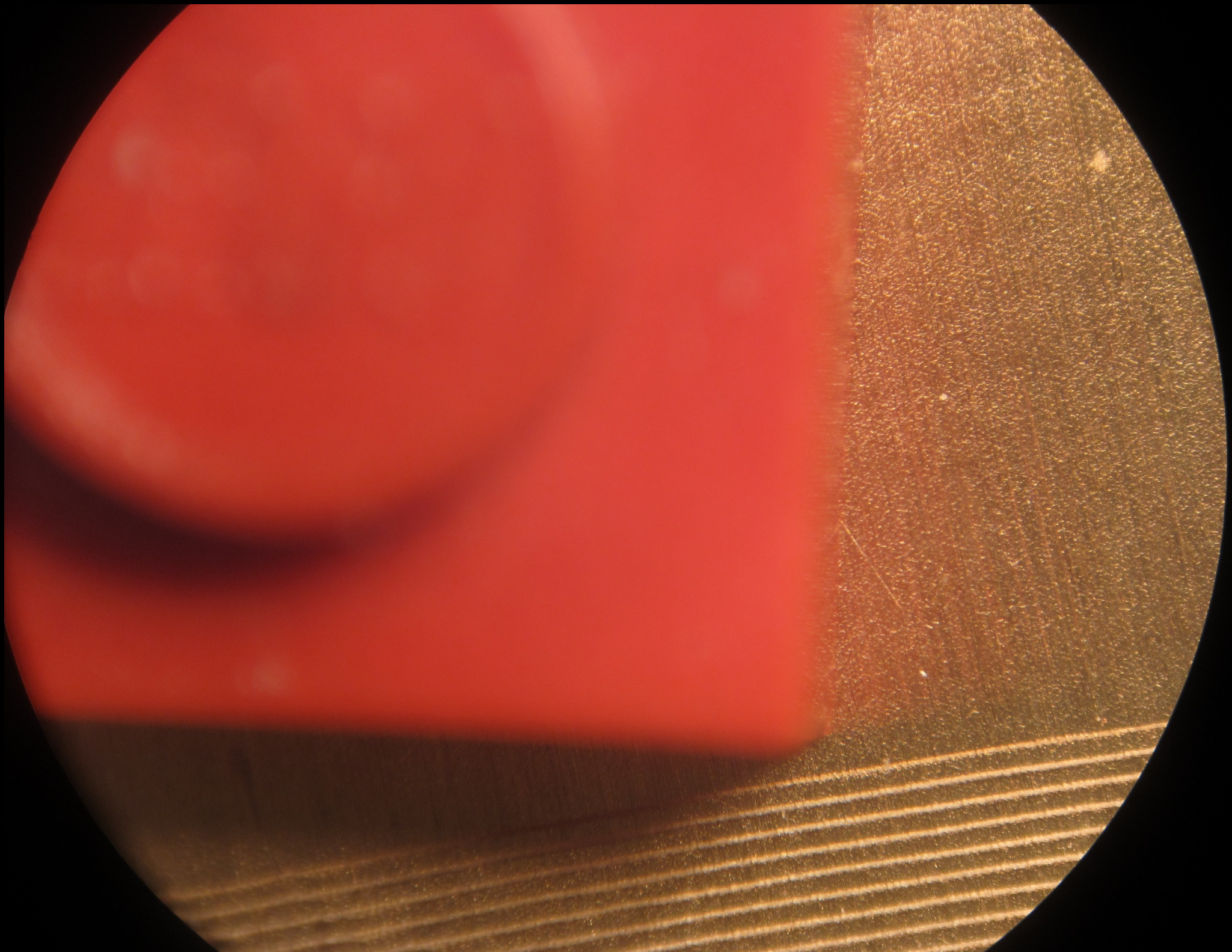
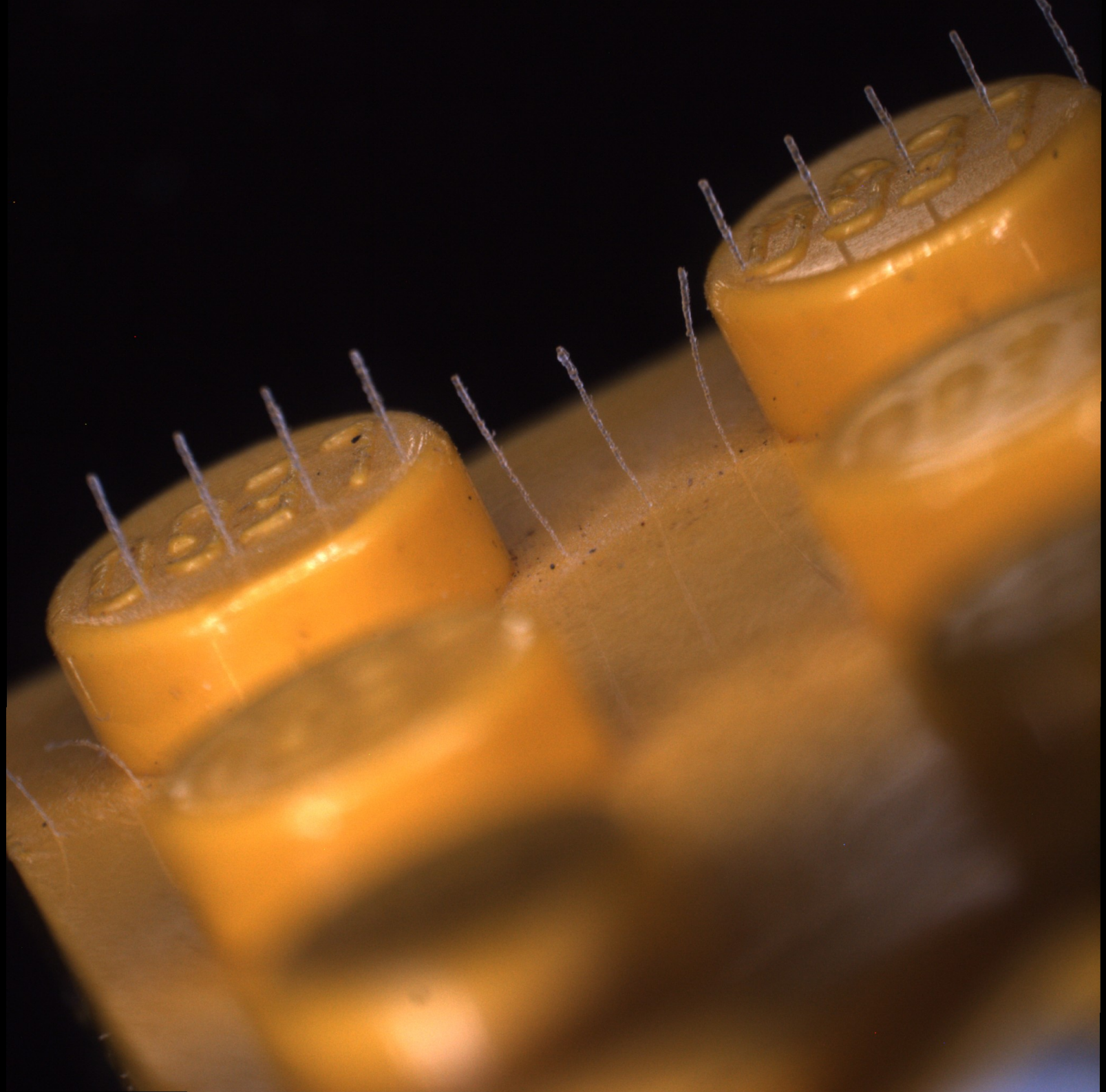
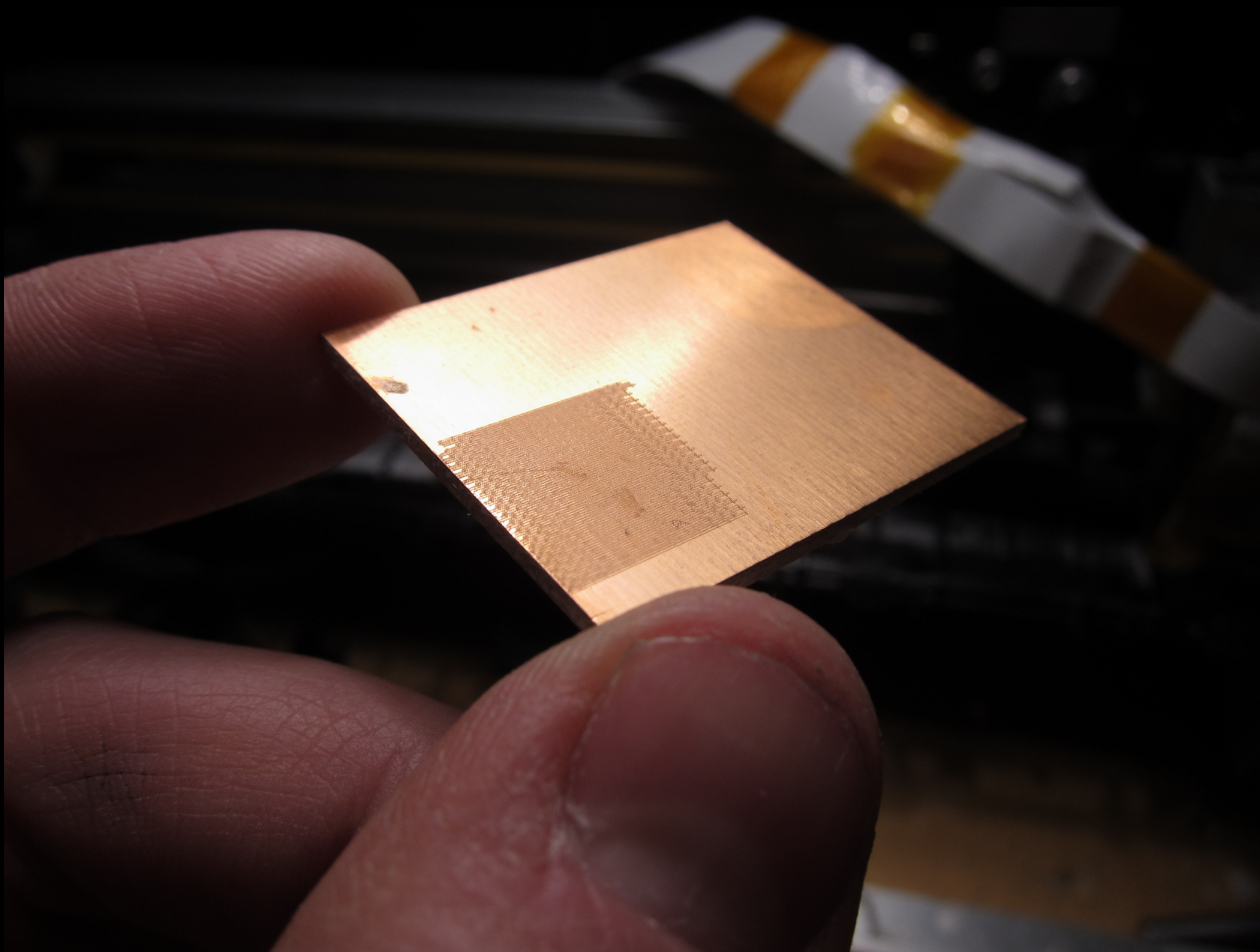

54.0

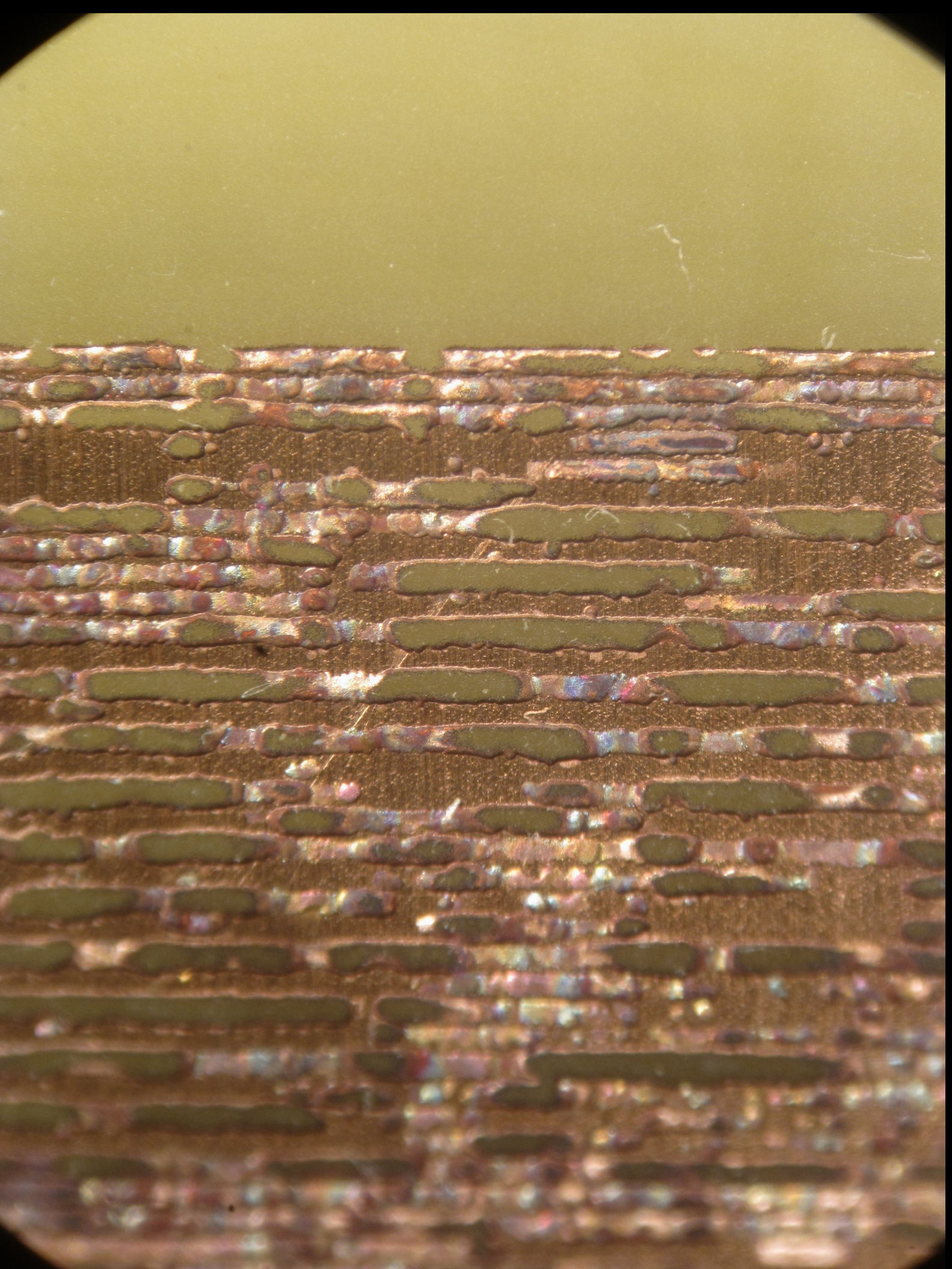
Enough of this crap, what have you printed?!

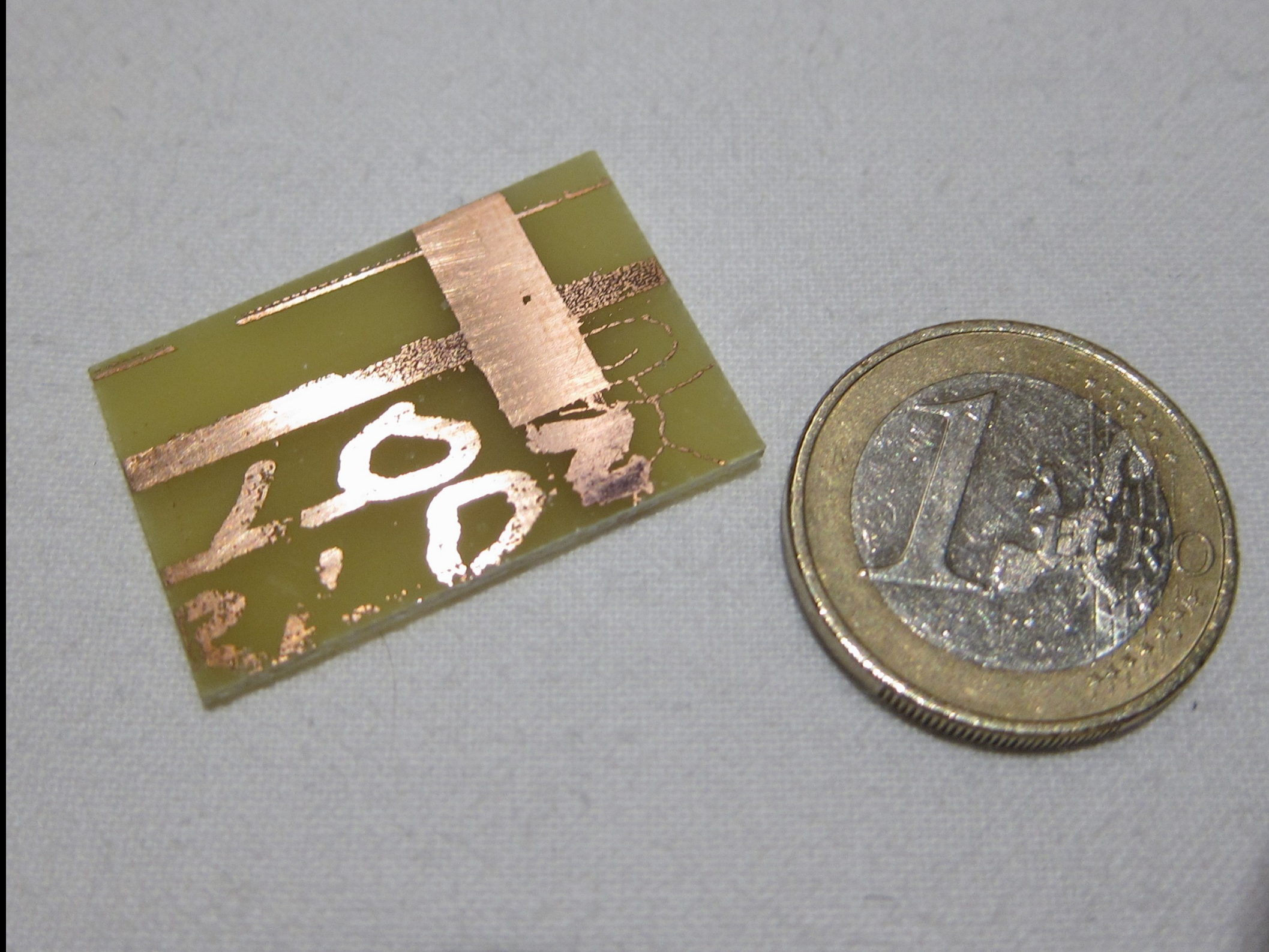
LEGO



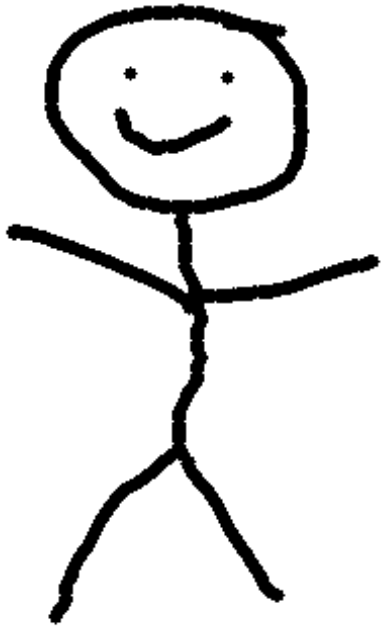







1.82
2.4
1
EURO

HELLO WORLD



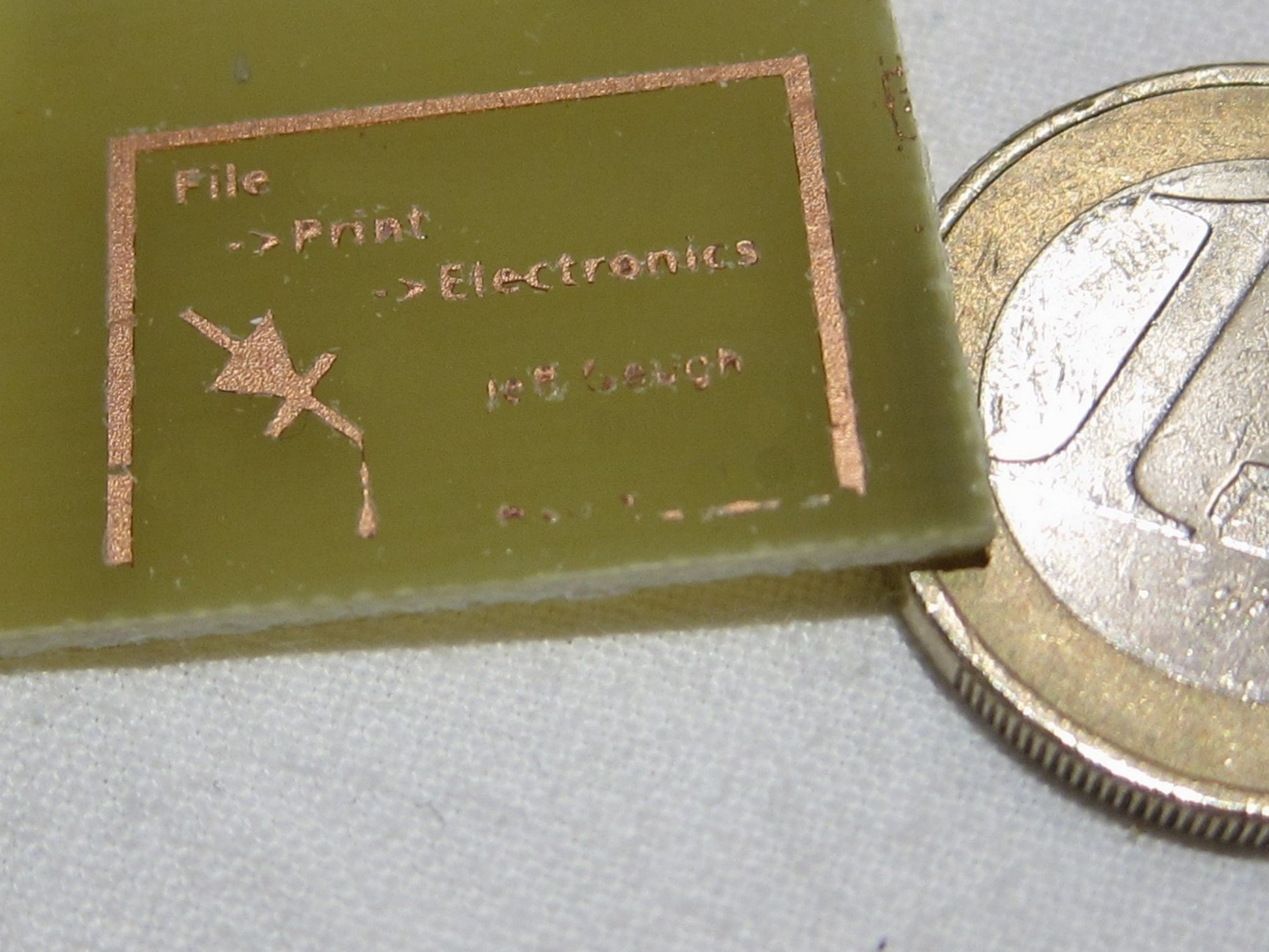
?

HELLO
WORLD

HELLO
WORLD

HELLO
WORLD

HELLO
WORLD


File
->Print
->Electronics

and next...

Better priming of nozzles

Finish reversing the printhead interface

Cleaning pulses / squeegee

Strobe photography to optimise drive pulses

3D

Generic, open inkjet research tool!

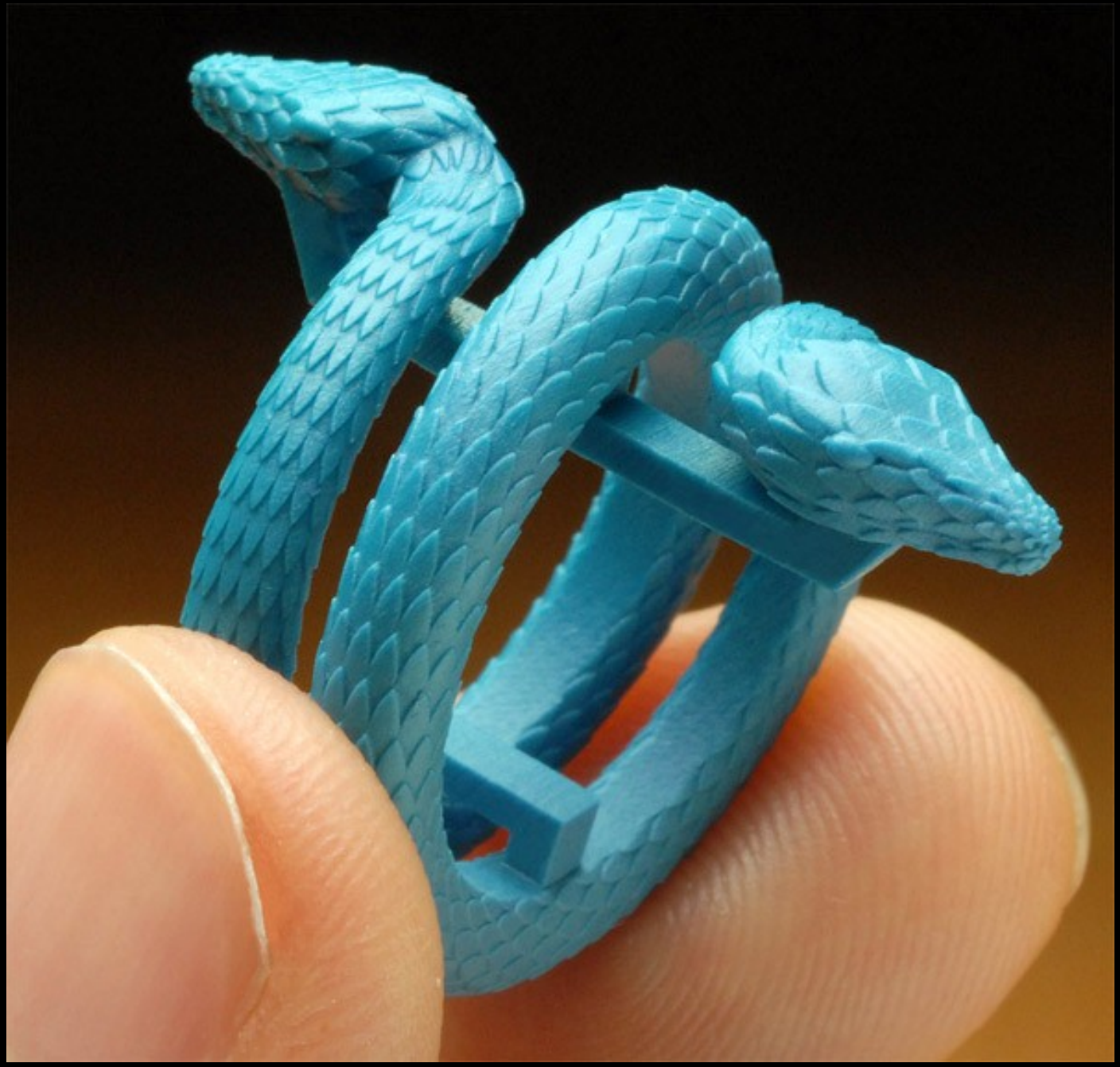


Image credit : http://www.protojewel.com

WE COME
IN PEACE