Reverse Engineering

Linear DX

Wireless Security System

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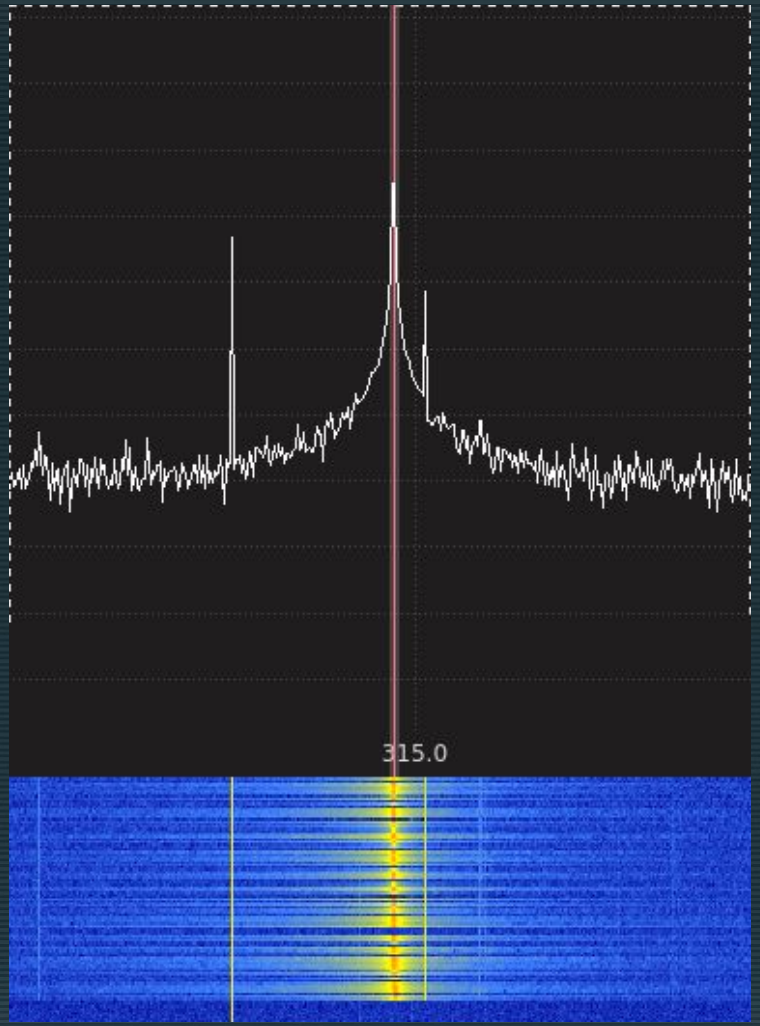
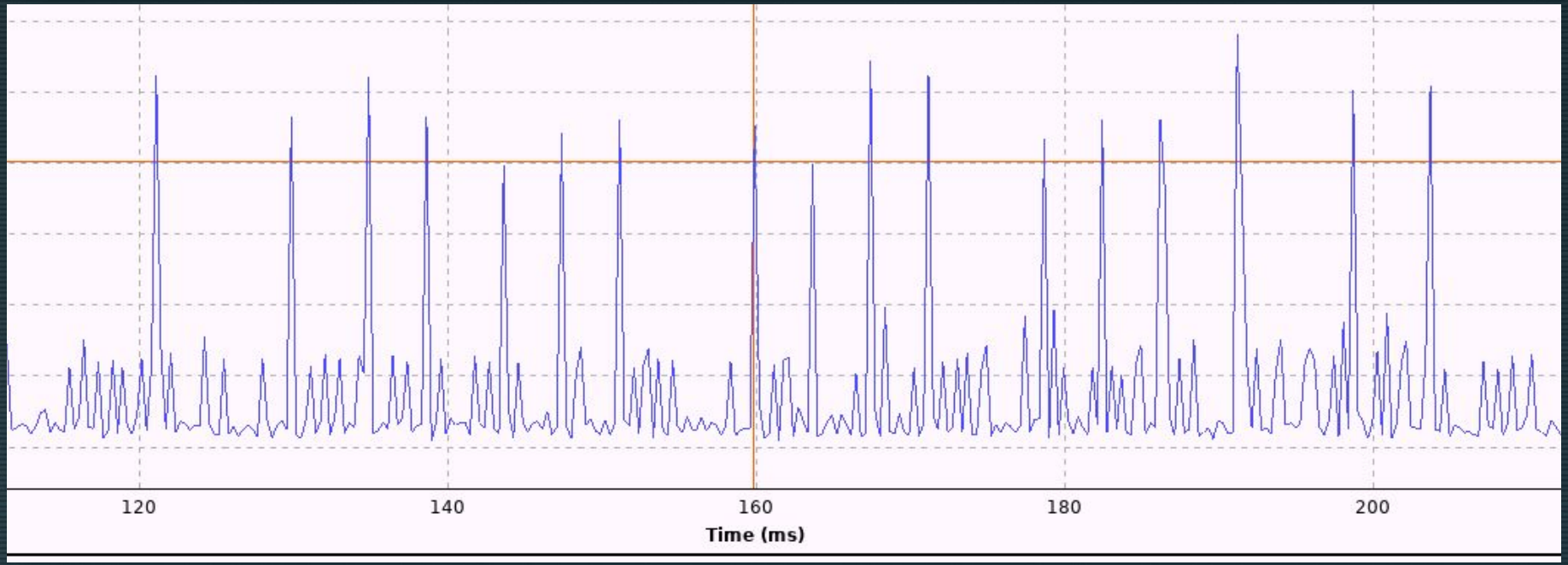
·Suite 200·
Background

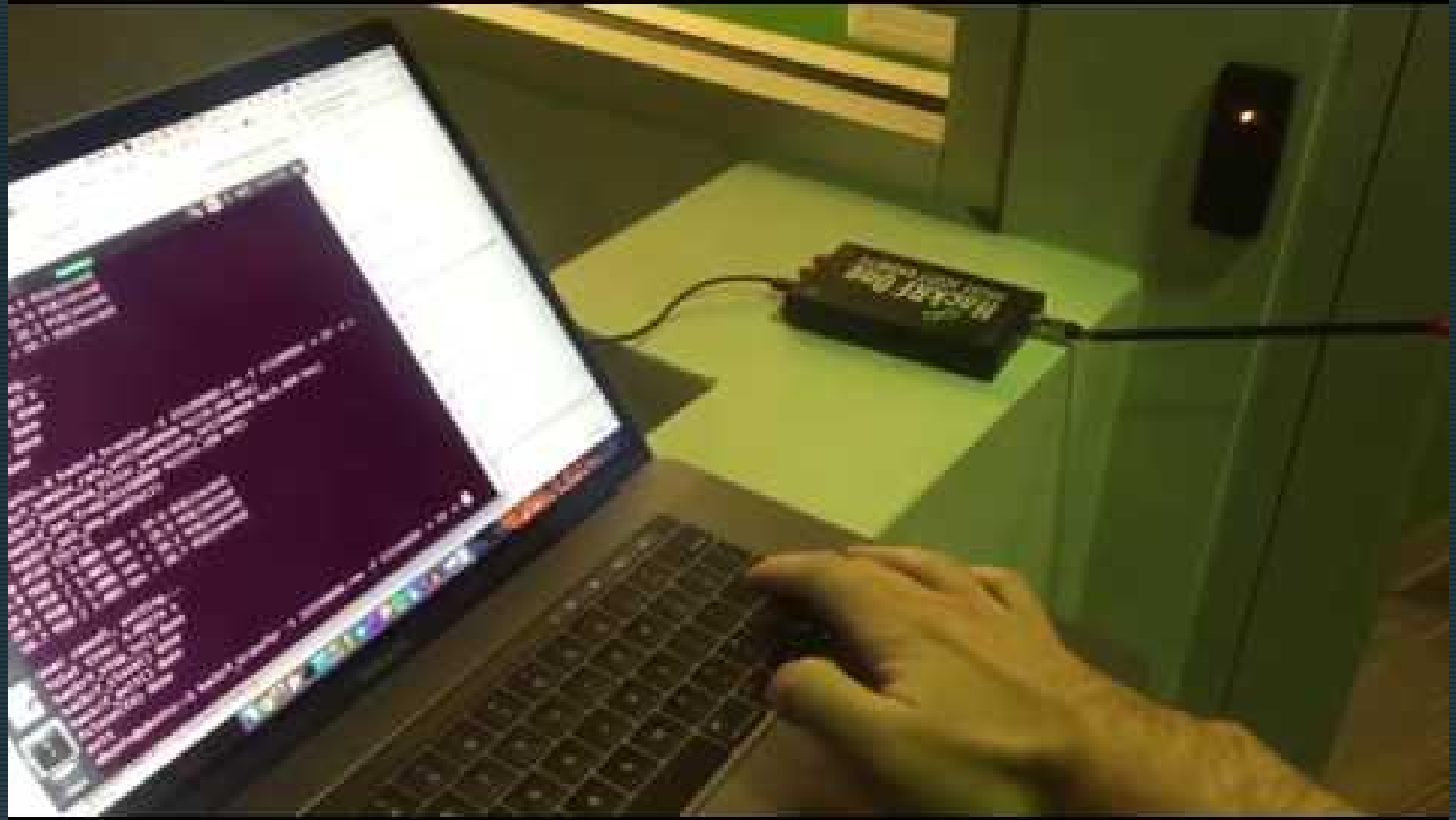
Lower Frequency In MHz	Upper Frequency In MHz
315.0	315.0

GQRX ->

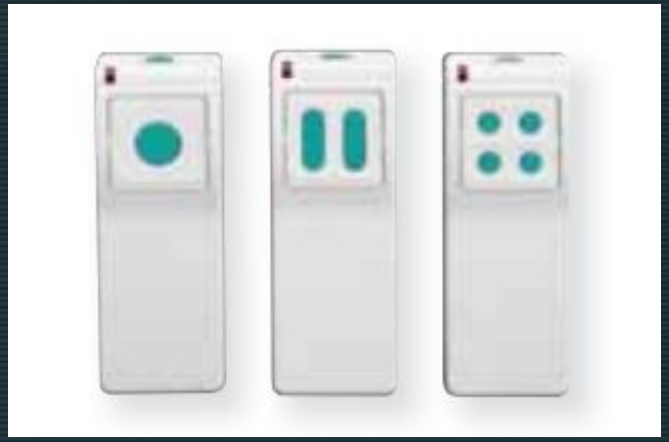


GRC time-domain






HACKERMAN

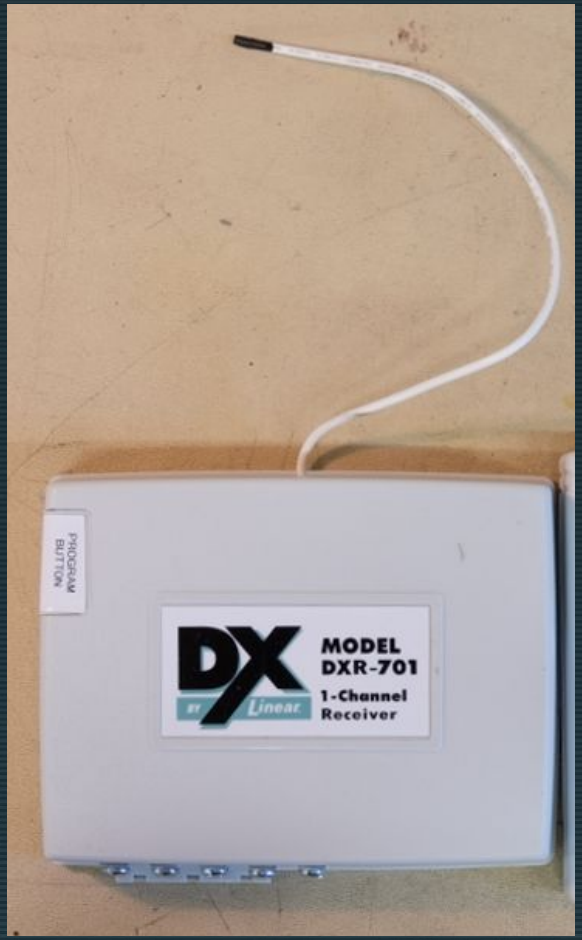



HELP


Linear SECURITY
READY
ARMED
TROUBLE

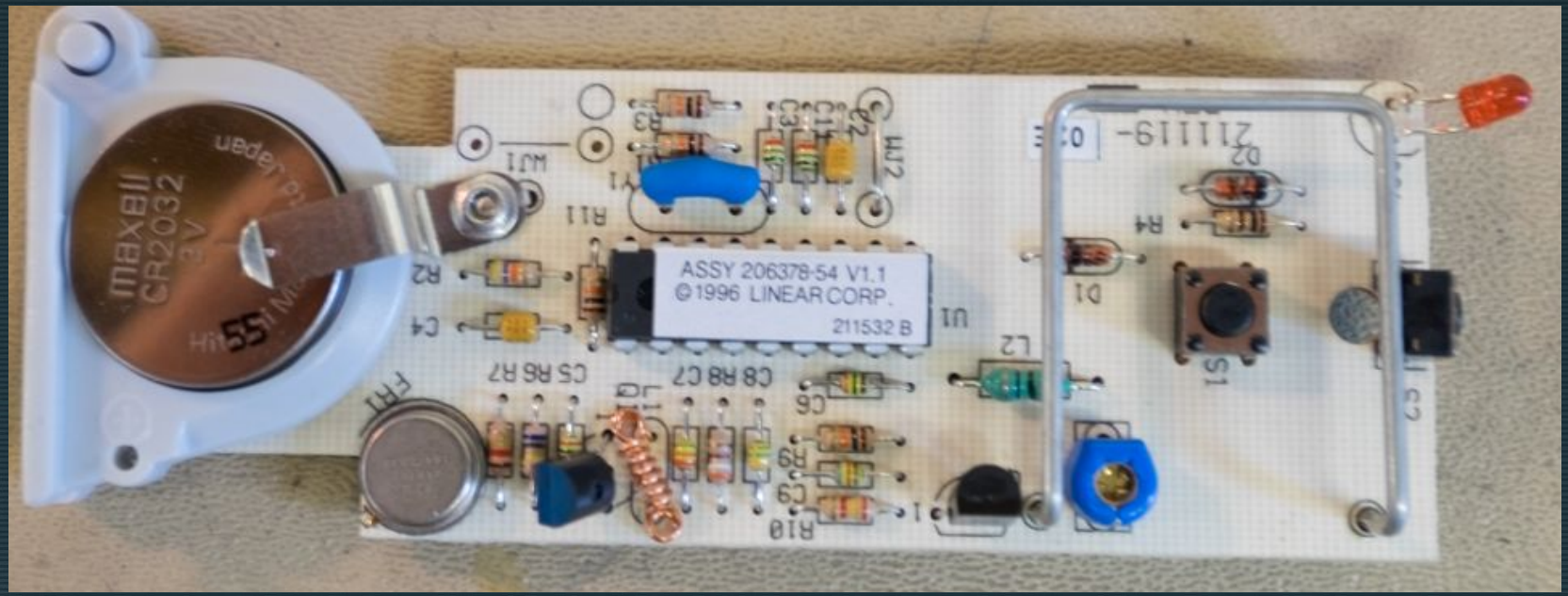

DX
MODEL
DX20-1040
8-CHANNEL
RECEIVER

DXR-701



The digital DX code format features over a million possible codes. The DX transmitters are precoded at the factory to unique codes, so no field coding is required. Receivers must be programmed to the transmitter's code before system testing and operation. Up to 32 transmitters can be programmed into the receiver's memory. The memory is retained, even without power.

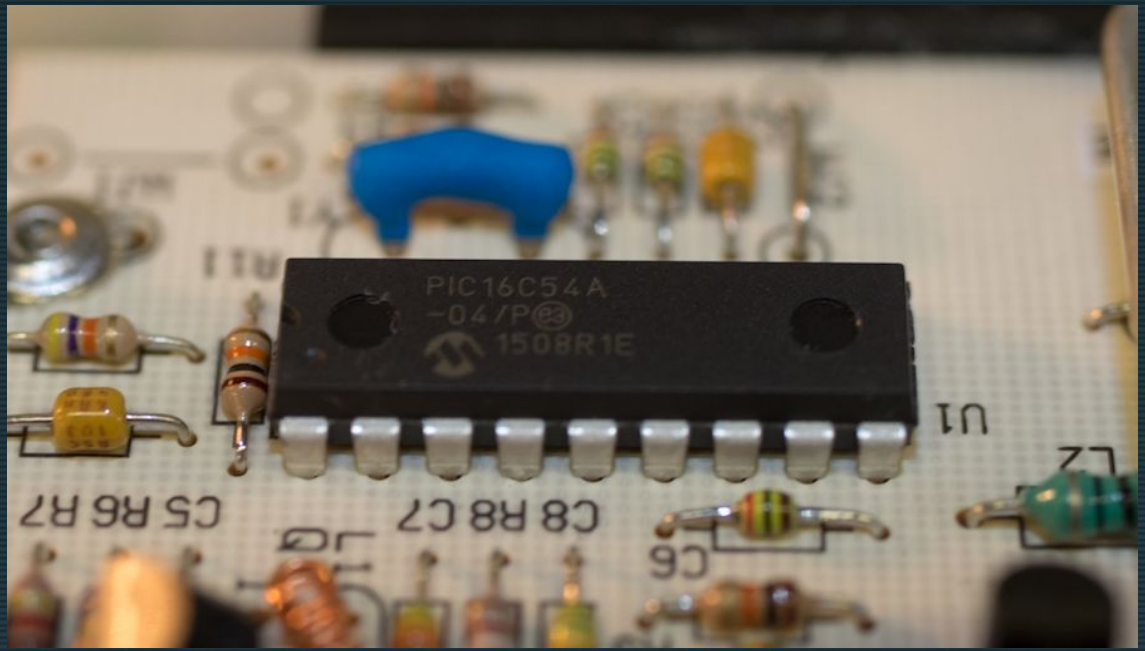
DXT-21


maxell
CR2032
3V
ASSY 206378-54 V1.1
©1996 LINEAR CORP.
211532 B

PIC16C54A

- RISC MCU
- 8-bit wide data path
- 12-bit wide instructions
- One-time-programmable
- 512b CMOS EPROM
- 25b RAM

- Code Protected :(

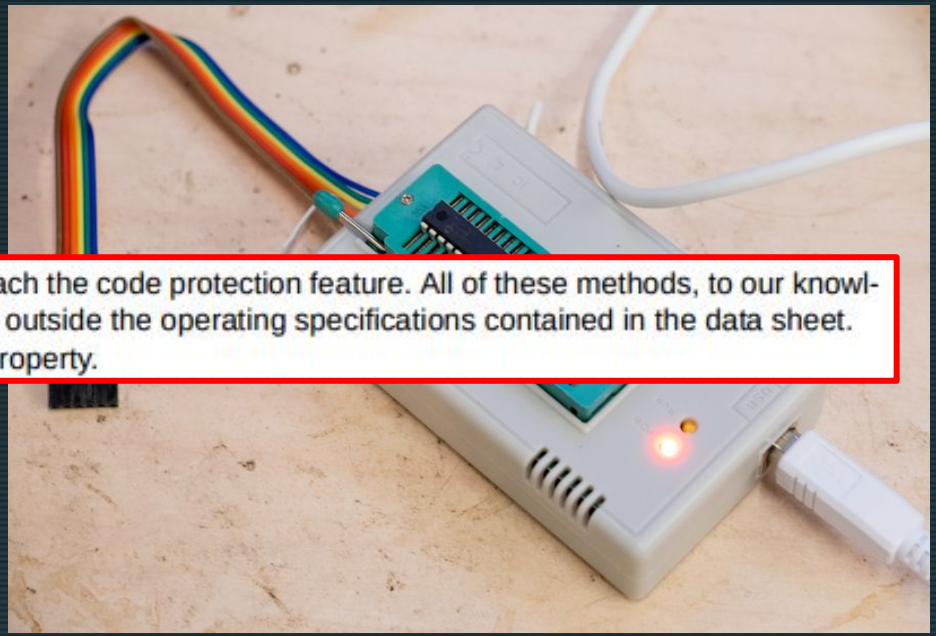


```
% hexdump -C 1503.bin.post
00000000  0b 0e 06 0a 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
00000010  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
00000040  0b 05 08 0a 09 0b 08 00  0f 0c 0d 02 08 0e 04 08  |................|
00000050  09 07 0e 0b 00 00 08 04  0f 05 03 00 09 07 02 02  |................|
00000060  0b 05 08 0a 09 09 05 02  0e 05 06 03 00 0e 0f 0c  |................|
00000070  0c 00 09 0c 0a 05 06 0a  04 00 0a 0a 04 0c 0f 00  |................|
00000080  0b 00 0f 00 0b 03 00 00  04 00 0b 06 00 00 01 00  |................|
00000090  0b 09 00 02 0c 03 00 01  03 05 07 02 08 04 09 06  |................|
000000a0  06 09 00 03 02 05 07 02  0b 05 0d 06 01 06 06 03  |................|
000000b0  00 04 0b 0f 00 00 00 04  0d 08 08 0c 04 0d 0f 0f  |................|
000000c0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
000001f0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0e  |................|
00000200
```

```
% hexdump -C 1507.bin.post
00000000  03 02 06 0a 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
00000010  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
00000040  0b 05 08 0a 09 0b 08 00  0f 0c 0d 02 08 0e 04 08  |................|
000000b0  00 04 0b 0f 00 00 00 04  0d 08 08 0c 04 0d 0f 0f  |................|
000000c0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
000001f0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0e  |................|
00000200
```

```
% hexdump -C 1510.bin.post
00000000  01 08 04 0a 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
00000010  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
00000040  0b 05 08 0a 09 0b 08 00  0f 0c 0d 02 08 0e 04 08  |................|
00000050  09 07 0e 0b 00 00 08 04  0f 05 03 00 09 07 02 02  |................|
00000060  0b 05 08 0a 09 09 05 02  0e 05 06 03 00 0e 0f 0c  |................|
00000070  0c 00 09 0c 0a 05 06 0a  04 00 0a 0a 04 0c 0f 00  |................|
00000080  0b 00 0f 00 0b 03 00 00  04 00 0b 06 00 00 01 00  |................|
00000090  0b 09 00 02 0c 03 00 01  03 05 07 02 08 04 09 06  |................|
000000a0  06 09 00 03 02 05 07 02  0b 05 0d 06 01 06 06 03  |................|
000000b0  00 04 0b 0f 00 00 00 04  0d 08 08 0c 04 0d 0f 0f  |................|
000000c0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0f  |................|
*
000001f0  0f 0f 0f 0f 0f 0f 0f 0f  0f 0f 0f 0f 0f 0f 0f 0e  |................|
00000200
```

MiniPro TL866

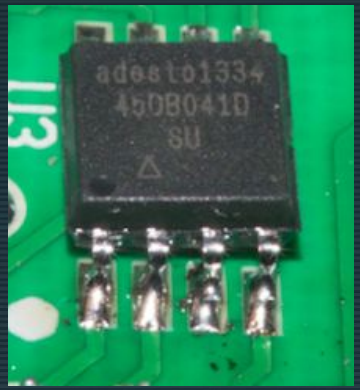


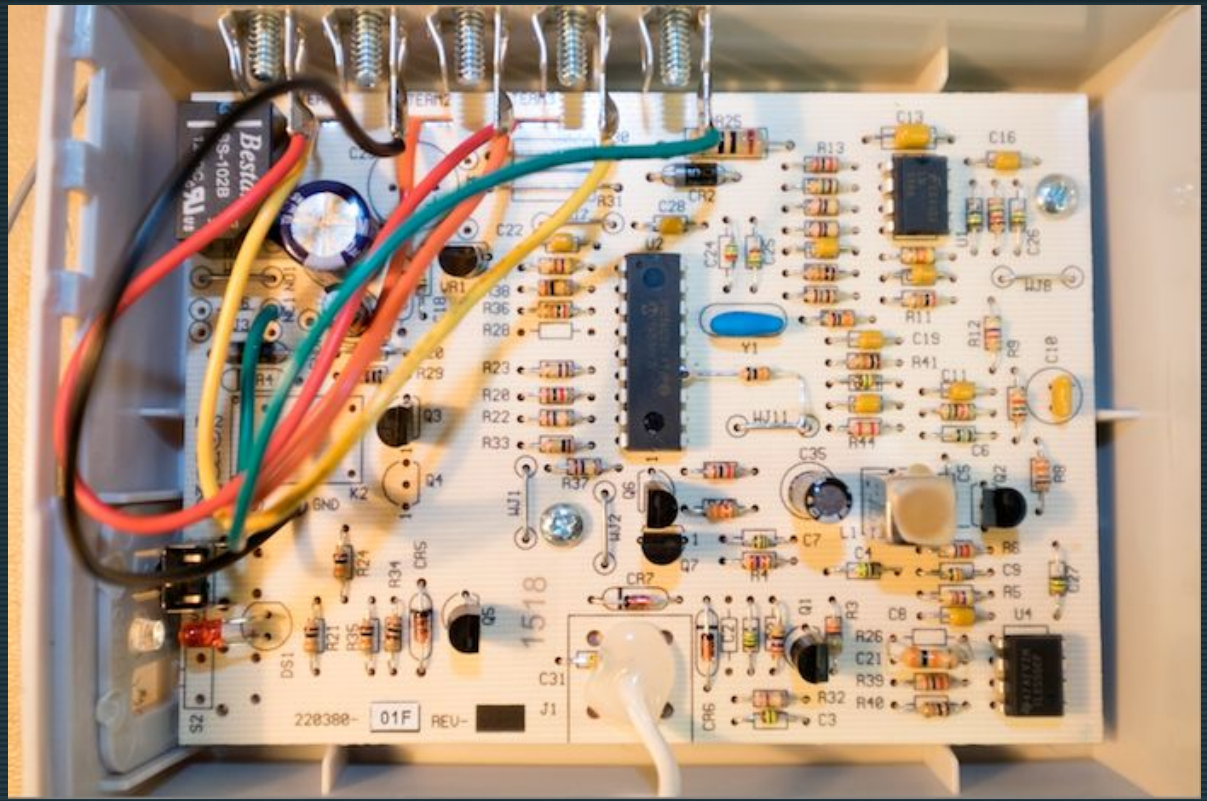
There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the PICmicro microcontroller in a manner outside the operating specifications contained in the data sheet. The person doing so may be engaged in theft of intellectual property.

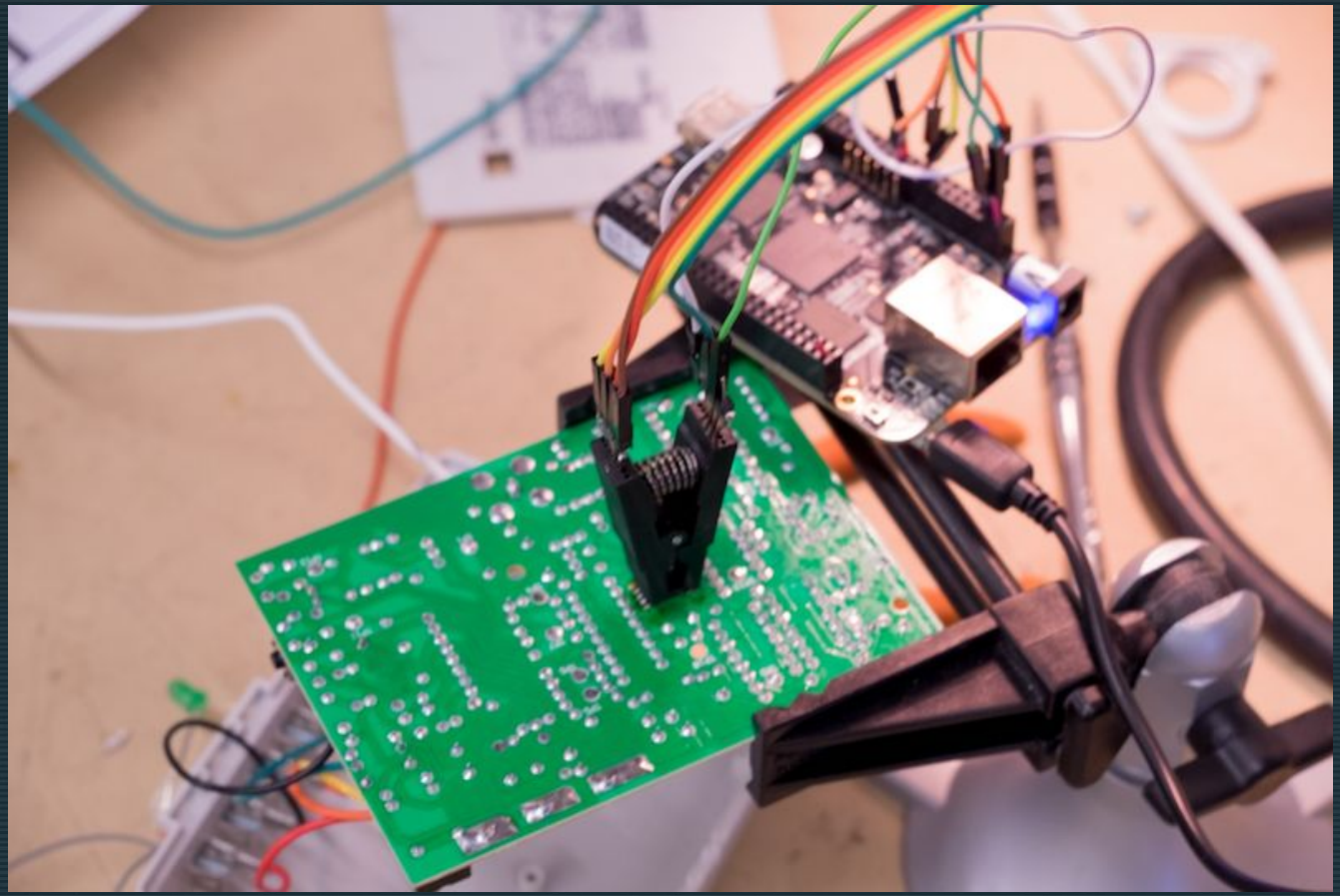
PIC16C56

- PIC16C54A += 512b EPROM
- Connected to 528k SPI flash
  - 264-byte pages

- Code Protected :(

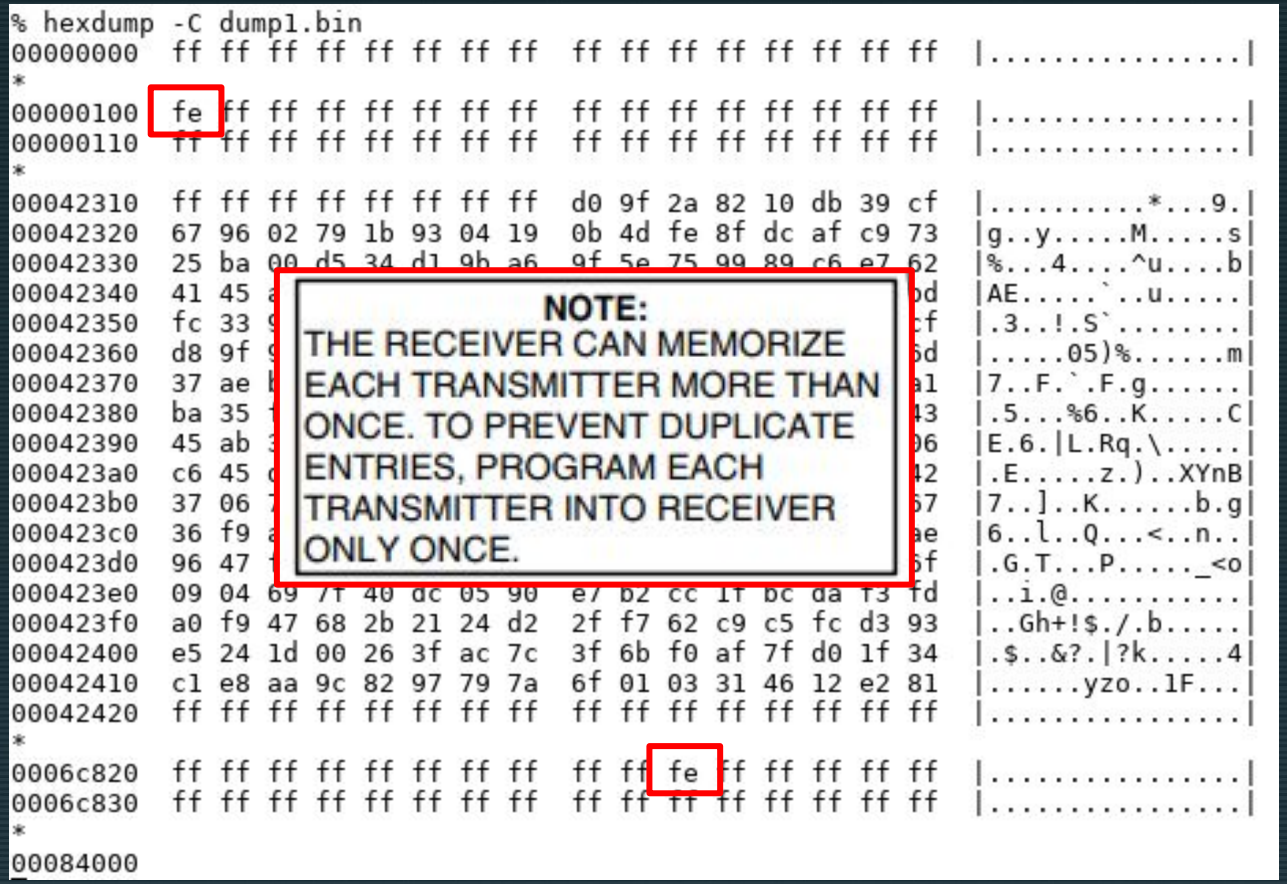






https://libreboot.org/docs/install/bbb_setup.html

```
% hexdump -C virgin.bin
00000000  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00042310  ff ff ff ff ff ff ff ff  d0 9f 2a 82 10 db 39 cf  |..........*...9.|
00042320  67 96 02 79 1b 93 04 19  0b 4d fe 8f dc af c9 73  |g..y.....M.....s|
00042330  25 ba 00 d5 34 d1 9b a6  9f 5e 75 99 89 c6 e7 62  |%...4....^u....b|
00042340  41 45 a1 f7 85 a7 8e 60  9c f0 75 09 f7 db 19 bd  |AE.....`..u.....|
00042350  fc 33 9a e1 21 f5 53 60  a2 01 19 08 c4 cf 9d cf  |.3..!.S`........|
00042360  d8 9f 9b 9b 13 30 35 29  25 8d c0 f2 b9 fd eb 6d  |.....05)%......m|
00042370  37 ae b7 46 e3 60 1e 46  8b 67 8b ea c1 1f d5 a1  |7..F.`.F.g......|
00042380  ba 35 f2 1d b7 25 36 bc  0e 4b 83 1b c4 ee 90 43  |.5...%6..K.....C|
00042390  45 ab 36 ff 7c 4c f2 52  71 d2 5c e5 e3 b7 c1 06  |E.6.|L.Rq.\......|
000423a0  c6 45 d6 a1 12 8f 14 7a  01 29 80 18 58 59 6e 42  |.E.....z.)..XYnB|
000423b0  37 06 7f 5d e6 85 4b fc  0c 8e aa 93 e9 62 94 67  |7..]..K......b.g|
000423c0  36 f9 a6 6c 87 d9 51 92  dc e1 3c b8 ee 6e 8c ae  |6..l..Q...<..n..|
000423d0  96 47 f7 54 19 a6 b2 50  bd e8 19 86 b7 5f 3c 6f  |.G.T...P....._<o|
000423e0  09 04 69 7f 40 dc 05 90  e7 b2 cc 1f bc da f3 fd  |..i.@...........|
000423f0  a0 f9 47 68 2b 21 24 d2  2f f7 62 c9 c5 fc d3 93  |..Gh+!$./.b.....|
00042400  e5 24 1d 00 26 3f ac 7c  3f 6b f0 af 7f d0 1f 34  |.$..&?.|?k.....4|
00042410  c1 e8 aa 9c 82 97 79 7a  6f 01 03 31 46 12 e2 81  |......yzo..1F...|
00042420  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00084000
```


% hexdump -C dump1.bin
00000000 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
00000100 fe ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
00000110 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
00042310 ff ff ff ff ff ff ff ff d0 9f 2a 82 10 db 39 cf |..........*...9.|
00042320 67 96 02 79 1b 93 04 19 0b 4d fe 8f dc af c9 73 |g..y.....M.....s|
00042330 25 ba 00 d5 34 d1 9b a6 9f 5e 75 99 89 c6 e7 62 |%...4....^u....b|
00042340 41 45 a |AE.....`..u.....|
00042350 fc 33 9 |.3..!.S`........|
00042360 d8 9f 9 |.....05)%......m|
00042370 37 ae b |7..F.`.F.g......|
00042380 ba 35 f |.5...%6..K.....C|
00042390 45 ab 3 |E.6.|L.Rq.\.....|
000423a0 c6 45 d |.E.....z.)..XYnB|
000423b0 37 06 7 |7..]..K......b.g|
000423c0 36 f9 a |6..l..Q...<..n..|
000423d0 96 47 1 |.G.T...P....._<o|
000423e0 09 04 69 7f 40 dc 05 90 e7 b2 cc 1f bc da f3 fd |..i.@...........|
000423f0 a0 f9 47 68 2b 21 24 d2 2f f7 62 c9 c5 fc d3 93 |..Gh+!$./.b.....|
00042400 e5 24 1d 00 26 3f ac 7c 3f 6b f0 af 7f d0 1f 34 |.$..&?.|?k.....4|
00042410 c1 e8 aa 9c 82 97 79 7a 6f 01 03 31 46 12 e2 81 |......yzo..1F...|
00042420 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
0006c820 ff ff ff ff ff ff ff ff ff ff fe ff ff ff ff ff |................|
0006c830 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
00084000
NOTE:
THE RECEIVER CAN MEMORIZE EACH TRANSMITTER MORE THAN ONCE. TO PREVENT DUPLICATE ENTRIES, PROGRAM EACH TRANSMITTER INTO RECEIVER ONLY ONCE.

```
% hexdump -C dump2.bin
00000000  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00000100  fd ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
00000110  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00042310  ff ff ff ff ff ff ff ff  d0 9f 2a 82 10 db 39 cf  |..........*...9.|
00042320  67 96 02 79 1b 93 04 19  0b 4d fe 8f dc af c9 73  |g..y.....M.....s|
00042330  25 ba 00 d5 34 d1 9b a6  9f 5e 75 99 89 c6 e7 62  |%...4....^u....b|
00042340  41 45 a1 f7 85 a7 8e 60  9c f0 75 09 f7 db 19 bd  |AE.....`..u.....|
00042350  fc 33 9a e1 21 f5 53 60  a2 01 19 08 c4 cf 9d cf  |.3..!.S`........|
00042360  d8 9f 9b 9b 13 30 35 29  25 8d c0 f2 b9 fd eb 6d  |.....05)%......m|
00042370  37 ae b7 46 e3 60 1e 46  8b 67 8b ea c1 1f d5 a1  |7..F.`.F.g......|
00042380  ba 35 f2 1d b7 25 36 bc  0e 4b 83 1b c4 ee 90 43  |.5...%6..K.....C|
00042390  45 ab 36 ff 7c 4c f2 52  71 d2 5c e5 e3 b7 c1 06  |E.6.|L.Rq.\.....|
000423a0  c6 45 d6 a1 12 8f 14 7a  01 29 80 18 58 59 6e 42  |.E.....z.)..XYnB|
000423b0  37 06 7f 5d e6 85 4b fc  0c 8e aa 93 e9 62 94 67  |7..]..K......b.g|
000423c0  36 f9 a6 6c 87 d9 51 92  dc e1 3c b8 ee 6e 8c ae  |6..l..Q...<..n..|
000423d0  96 47 f7 54 19 a6 b2 50  bd e8 19 86 b7 5f 3c 6f  |.G.T...P....._<o|
000423e0  09 04 69 7f 40 dc 05 90  e7 b2 cc 1f bc da f3 fd  |..i.@...........|
000423f0  a0 f9 47 68 2b 21 24 d2  2f f7 62 c9 c5 fc d3 93  |..Gh+!$./.b.....|
00042400  e5 24 1d 00 26 3f ac 7c  3f 6b f0 af 7f d0 1f 34  |.$..&?.|?k.....4|
00042410  c1 e8 aa 9c 82 97 79 7a  6f 01 03 31 46 12 e2 81  |......yzo..1F...|
00042420  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
0006c820  ff ff ff ff ff ff ff ff  ff ff fe ff ff ff ff ff  |................|
0006c830  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00084000
```

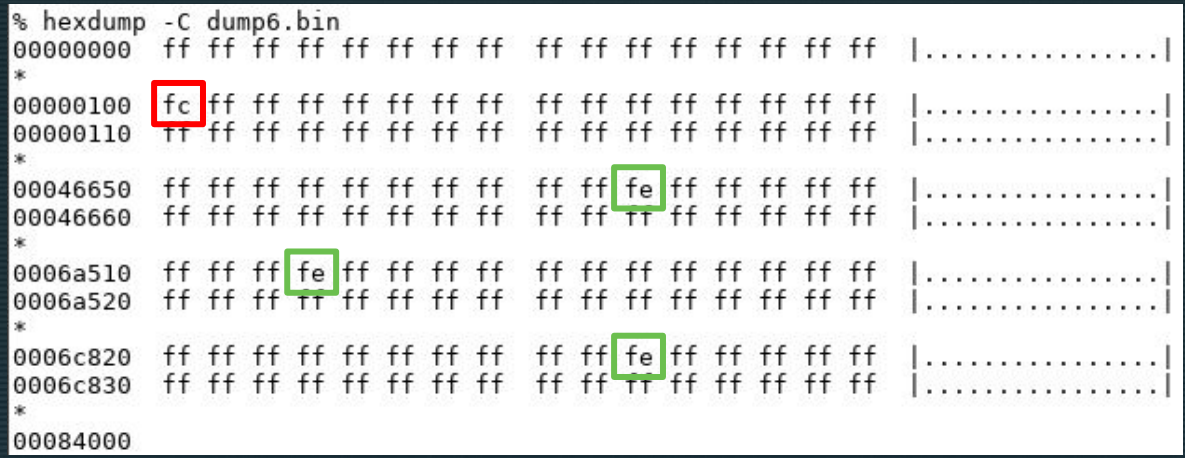
?!

```
% hexdump -C dump3.bin
00000000  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00084000
```


% hexdump -C dump4.bin
00000000 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
00000100 fe ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
00000110 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
0006c820 ff ff ff ff ff ff ff ff ff ff fe ff ff ff ff ff |................|
0006c830 ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff ff |................|
*
00084000

~StoredKeys ->

Cleared Low Bit
=
Programmed Key



```
% hexdump -C dump6.bin
00000000  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00000100  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
00000110  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00046650  ff ff ff ff ff ff ff ff  ff ff fe ff ff ff ff ff  |................|
00046660  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
0006a510  ff ff ff fe ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
0006a520  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
0006c820  ff ff ff ff ff ff ff ff  ff ff fe ff ff ff ff ff  |................|
0006c830  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00084000
```

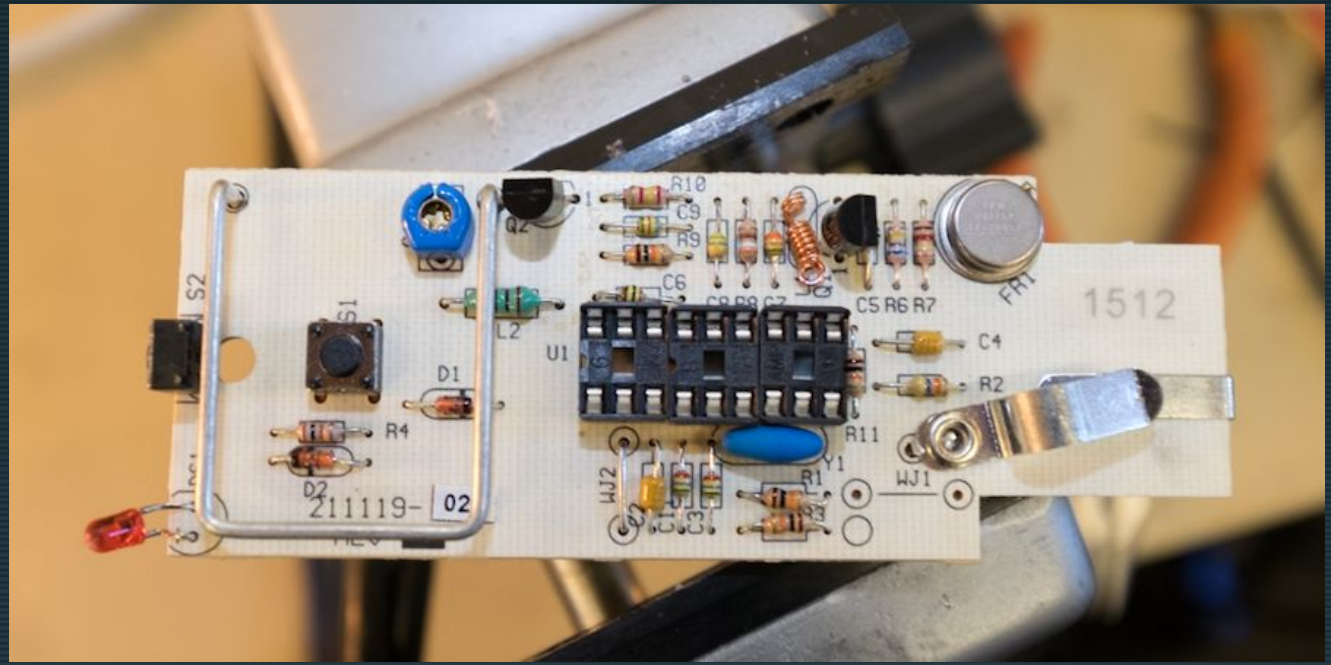
```
% hexdump -C virgin.bin
00000000  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00042310  ff ff ff ff ff ff ff ff  d0 9f 2a 82 10 db 39 cf  |..........*...9.|
00042320  67 96 02 79 1b 93 04 19  0b 4d fe 8f dc af c9 73  |g..y.....M.....s|
00042330  25 ba 00 d5 34 d1 9b a6  9f 5e 75 99 89 c6 e7 62  |%...4....^u....b|
00042340  41 45 a1 f7 85 a7 8e 60  9c f0 75 09 f7 db 19 bd  |AE.....`..u.....|
00042350  fc 33 9a e1 21 f5 53 60  a2 01 19 08 c4 cf 9d cf  |.3..!.S`........|
00042360  d8                                             6d  |.....05)%......m|
00042370  37                                             a1  |7..F.`.F.g......|
00042380  ba                                             43  |.5...%6..K.....C|
00042390  45                                             06  |E.6.|L.Rq.\.....|
000423a0  c6                                             42  |.E.....z.)..XYnB|
000423b0  37                                             67  |7..]..K......b.g|
000423c0  36                                             ae  |6..l..Q...<..n..|
000423d0  96 47 f7 54 19 a6 b2 50  bd e8 19 86 b7 5f 3c 6f  |.G.T...P....._<o|
000423e0  09 04 69 7f 40 dc 05 90  e7 b2 cc 1f bc da f3 fd  |..i.@...........|
000423f0  a0 f9 47 68 2b 21 24 d2  2f f7 62 c9 c5 fc d3 93  |..Gh+!$./.b.....|
00042400  e5 24 1d 00 26 3f ac 7c  3f 6b f0 af 7f d0 1f 34  |.$..&?.|?k.....4|
00042410  c1 e8 aa 9c 82 97 79 7a  6f 01 03 31 46 12 e2 81  |......yzo..1F...|
00042420  ff ff ff ff ff ff ff ff  ff ff ff ff ff ff ff ff  |................|
*
00084000
```

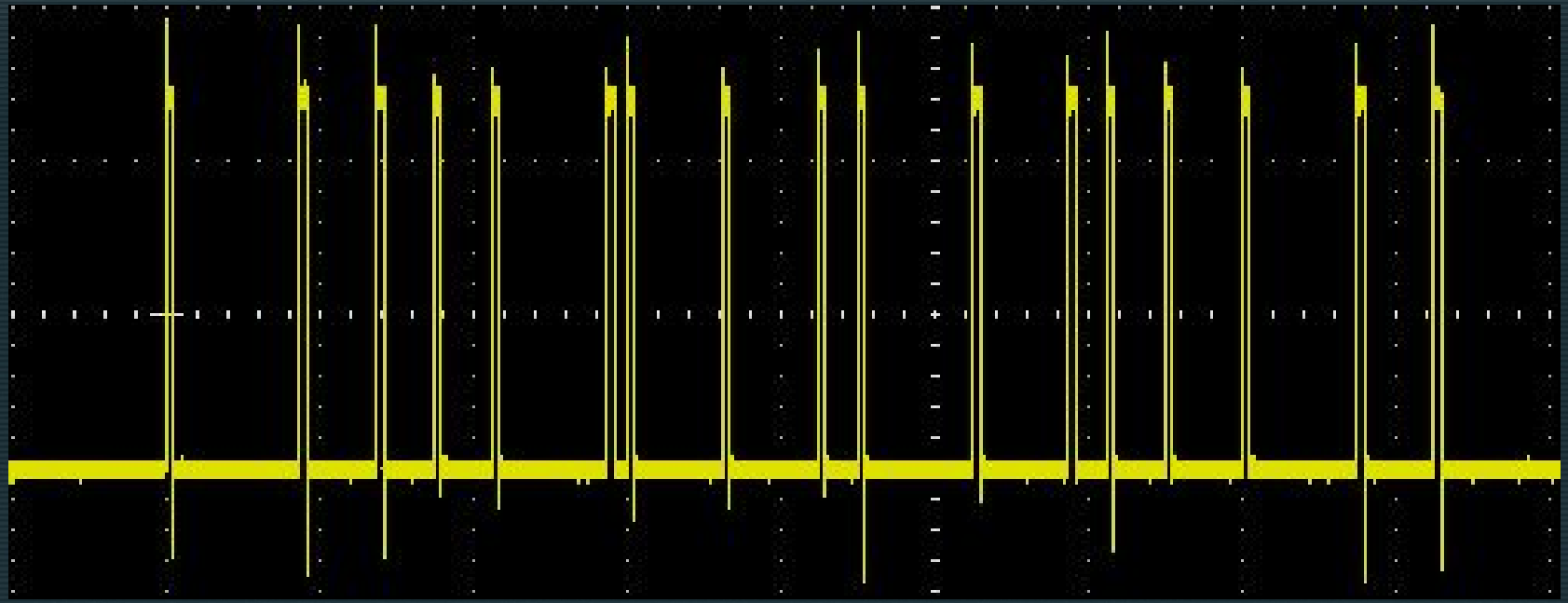
What we know so far

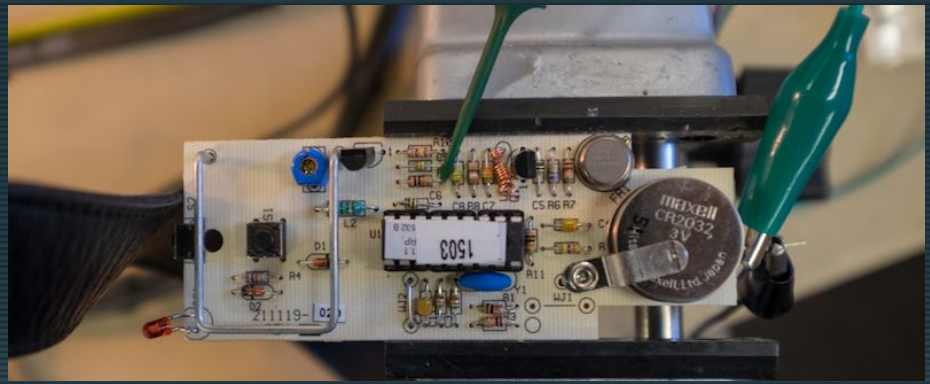
- Maps key -> address
- Key count is arbitrary
- Ships with dirty pages
- Incorrect clearing logic

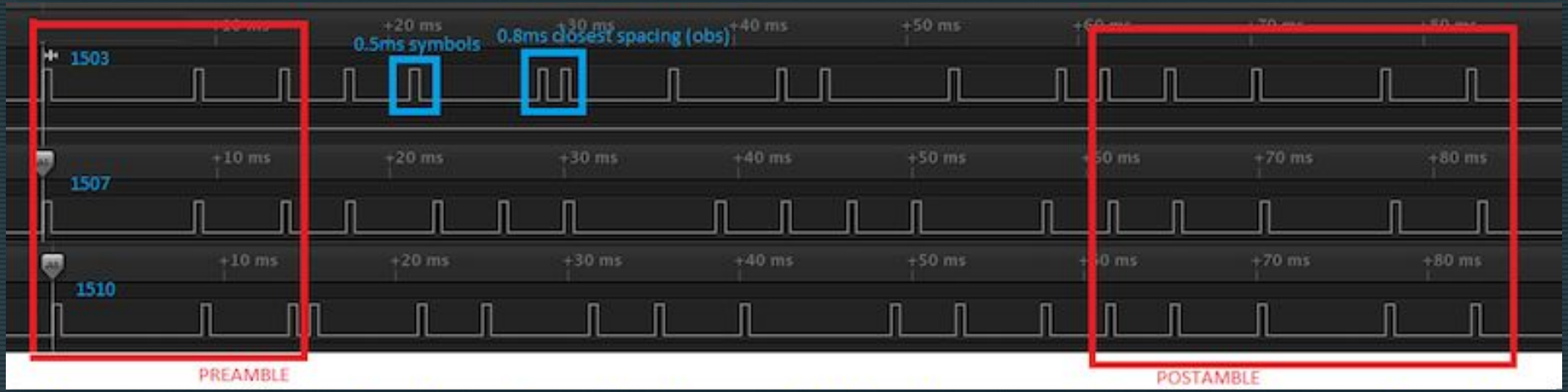
What we really want

- Mapping of address -> key
  - Brute force
  - Target the programmed key count
  - Target dirty pages


R10
C9
R9
Q2
C6
C5 R6 R7
FR1
1512
S2
S1
L2
U1
C4
D1
R2
R4
R11
Y1
WJ2
R1
WJ1
D2
211119-
02




1503
maxell
CR2032
3V
Z11119-


1503
1507
1510
+10 ms
+20 ms
+30 ms
+40 ms
+50 ms
+70 ms
+80 ms
0.5ms symbols
0.8ms closest spacing (obs)
PREAMBLE
POSTAMBLE

Scatter symbols across fixed timeline

3 in 9:

Scatter symbols across fixed timeline

3 in 9:

Scatter symbols across fixed timeline

3 in 9:

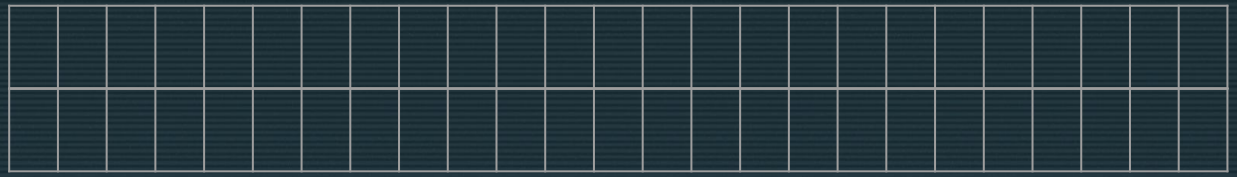
Scatter symbols across fixed timeline

3 in 9:

84 possible combinations

Scatter symbols across fixed timeline

11 across 50



Scatter symbols across fixed timeline

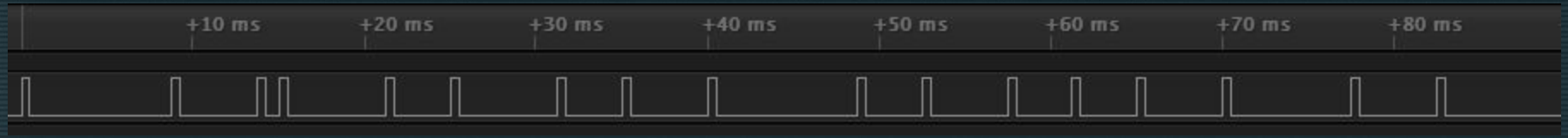
11 across 50

> 1,000,000,000 possibilities….

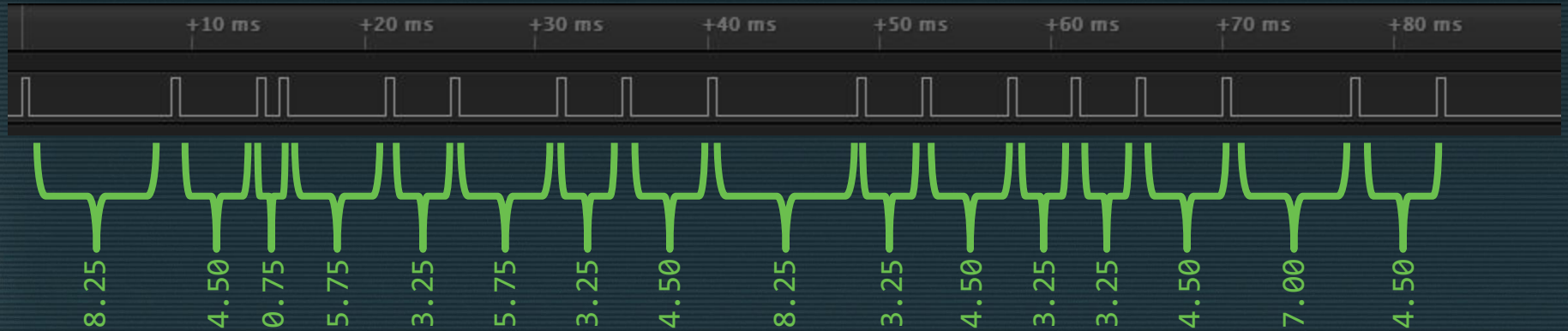
- 3 years to brute force…
- Key expansion?
  - Super small MCU...

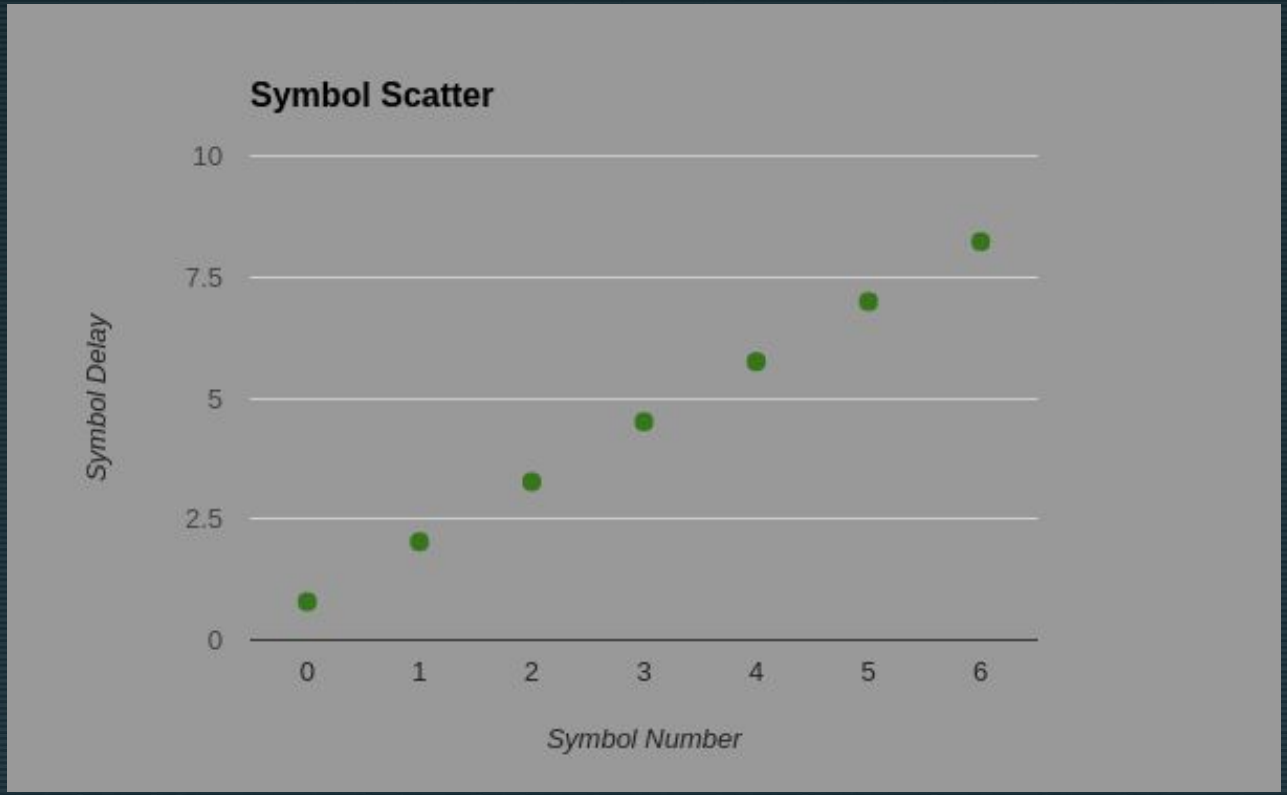
DX code format features over a million possible codes.

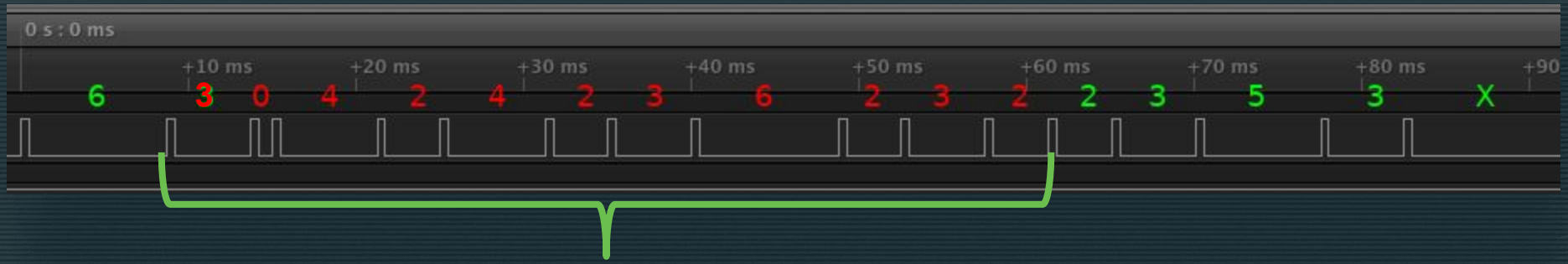
Dead space



Dead space

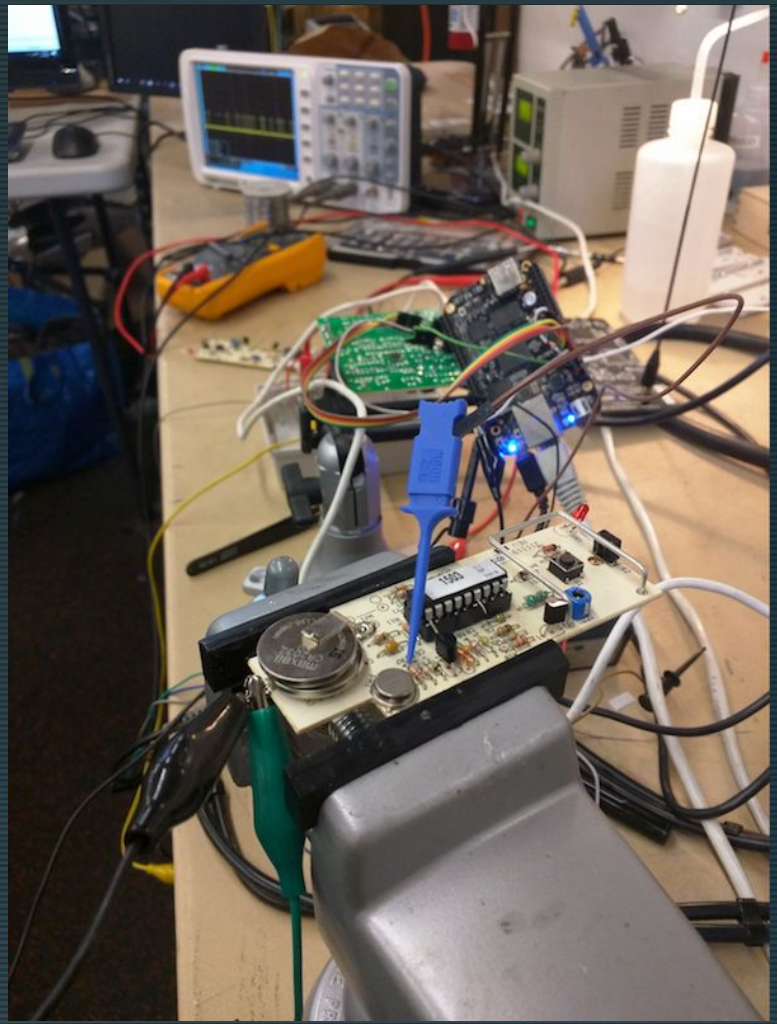

+10 ms
+20 ms
+30 ms
+40 ms
+50 ms
+60 ms
+70 ms
+80 ms
8.25
4.50
0.75
5.75
3.25
5.75
3.25
4.50
8.25
3.25
4.50
3.25
3.25
4.50
7.00
4.50


Symbol Scatter
10
7.5
5
2.5
0
Symbol Delay
0
1
2
3
4
5
6
Symbol Number

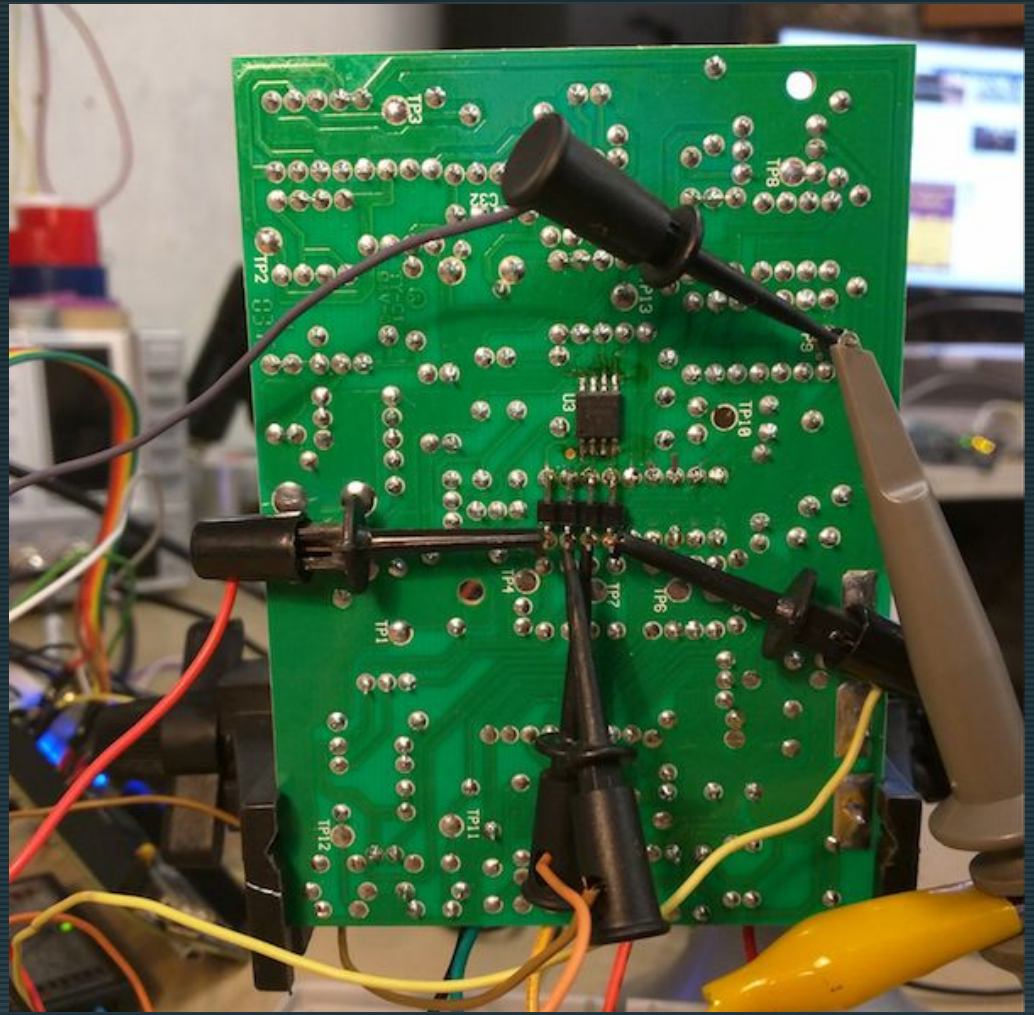


Index	Value
0	1.25
1	2.50
2	3.75
3	5.00
4	6.25
5	7.50
6	8.75

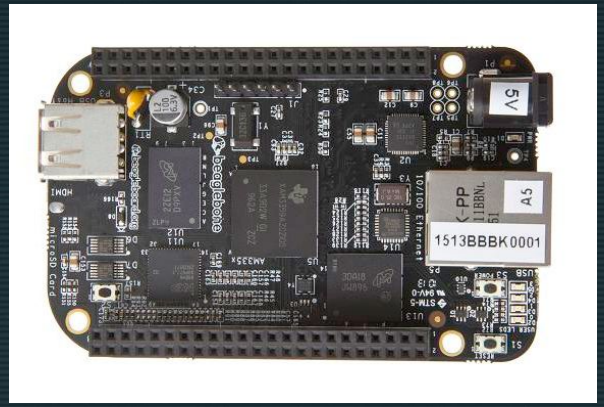
- 7 unique symbols += 1.25ms
- 11 dynamic, 6 static
- 112,295,183 potentially valid keys
- 130 days to brute force...




1503


TP3
TP8
C32
TP2
U3
TP10
TP4
TP7
TP6
TP1
TP11
TP12

Tooling & Automation



- Beaglebone PRU
  - Realtime RISC co-processor
  - Simple instruction set
  - (C compiler ITAR restricted…)
- Saleae Logic knockoff
  - Sniff SPI traffic in real time with sigrok-cli
- Python glue

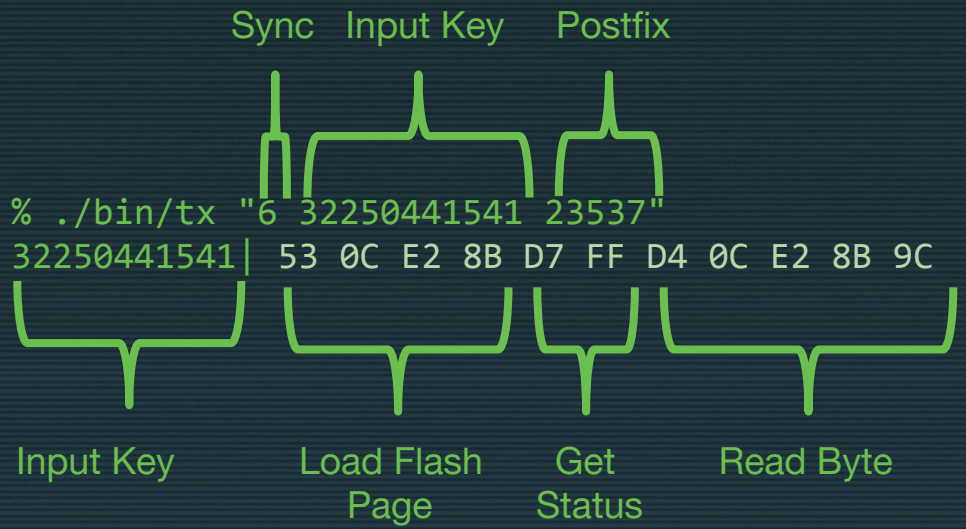
```
.macro DELAY_CNST(delaycnt)
    MOV DELAYCTR, ((delaycnt/2)-1)
LOOP:
    SUB DELAYCTR, DELAYCTR, 1
    QBNE LOOP, DELAYCTR, 0
.endm

.macro DOHIGH
    SET r30, r30, 14
.endm
.macro DOLOW
    CLR r30, r30, 14
.endm

.macro PULSE_CNST(duration)
    DOHIGH
    DELAY_CNST (duration-2)
    DOLOW
.endm

.macro BOARDRESET
    BOARDOFF
    DELAY_CNST 5*MS
    BOARDON
    DELAY_CNST 60*MS
.endm
```

Tooling & Automation



Fuzzing For Byte Selector Bits (4-symbol)

```
KEY          SPI_ADDR
3225044 1541 0c,e2,8b <-- start with real key
3225044 1550 X
3225044 1604 0c,e2,8c
3225044 1613 0c,e2,8d
3225044 1622 0c,e2,8e
3225044 1631 0c,e2,8f
3225044 1640 X
3225044 2036 X
...
3225044 2216 X
3225044 2225 X
3225044 2234 0c,e2,90
3225044 2243 0c,e2,91
3225044 2252 0c,e2,92
3225044 2261 0c,e2,93
```

- 256 byte selectors
- Consistent across all pages
- 256 valid, 715 tried
- Reduces search space by 65%

40,206,387 possible keys… (46 days)

Fuzzing For Page Selector Bits (6-symbol)

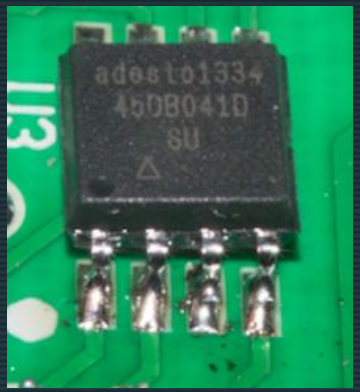
KEY	SPI_ADDR
3225044**1541**	0c,e2,8b <-- Start with real key
3225053**1541**	X
3225062**1541**	0c,e6,8b
3225116**1541**	X
3225125**1541**	0c,e8,8b
3225134**1541**	0c,ea,8b
3225143**1541**	0c,ec,8b
3225152**1541**	0c,ee,8b
3225161**1541**	X
322520	
322521	
3225224**1541**	0c,f2,8b
3225233**1541**	0c,f4,8b
3225242**1541**	0c,f6,8b
3225251**1541**	X

- 4001 valid page selectors
- 52374 tried
- Reduces search space by 92%

1,024,256 possible keys… (1 day)

DX code format features over a million possible codes.

u wot m8?



- 528k spi flash
- 512k addressable by remotes
- 1024k of key data...

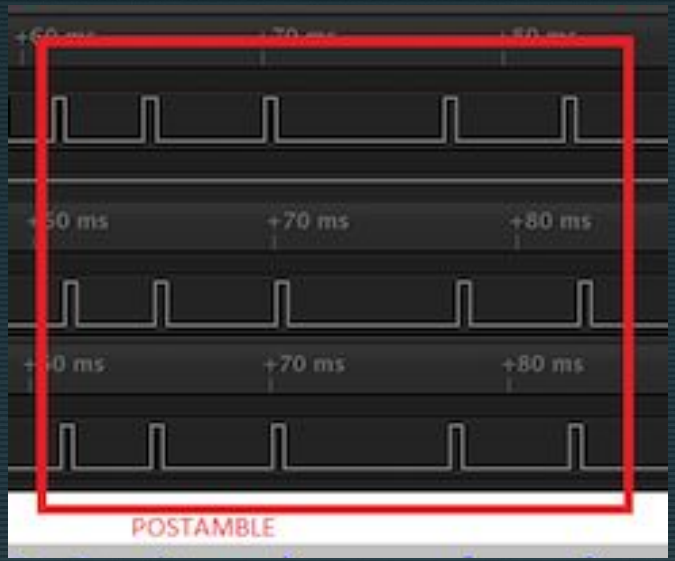
Duplicate Page Selectors!
03333333334 === 21333333334

> 1,000,000,000 (3 years) → 112,295,183 (113 days) → 40,206,387 (46 days) → 1,024,256 (1 day) → 512,128 (14 hours)

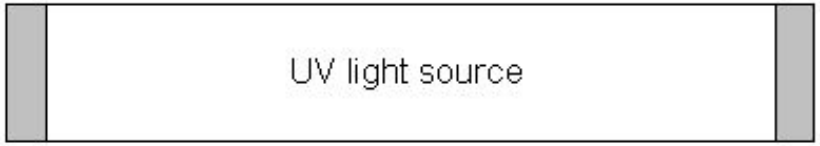
Arbitrary key = 7h on average.
With a single dirty page = 30 minutes.

Bonus: “multi-code” transmitters

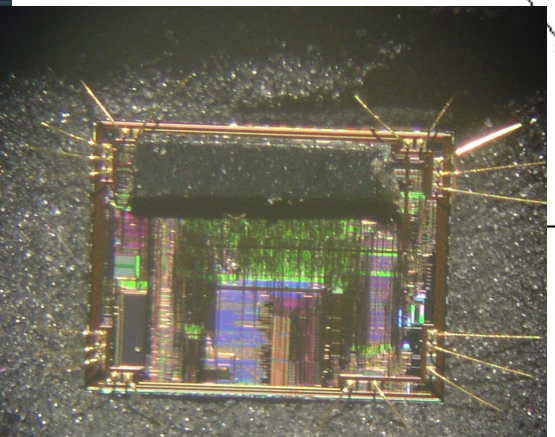
Channel	Postamble	Bit Mask
1	2353	0xFE (11111110)
2	6233	0x7F (01111111)
3	2533	0xFD (11111101)
?	3433	0xF7 (11110111)
?	5053	0xBF (10111111)
?	4153	0xEF (11101111)
?	3253	0xFB (11111011)
?	5233	0xDF (11011111)



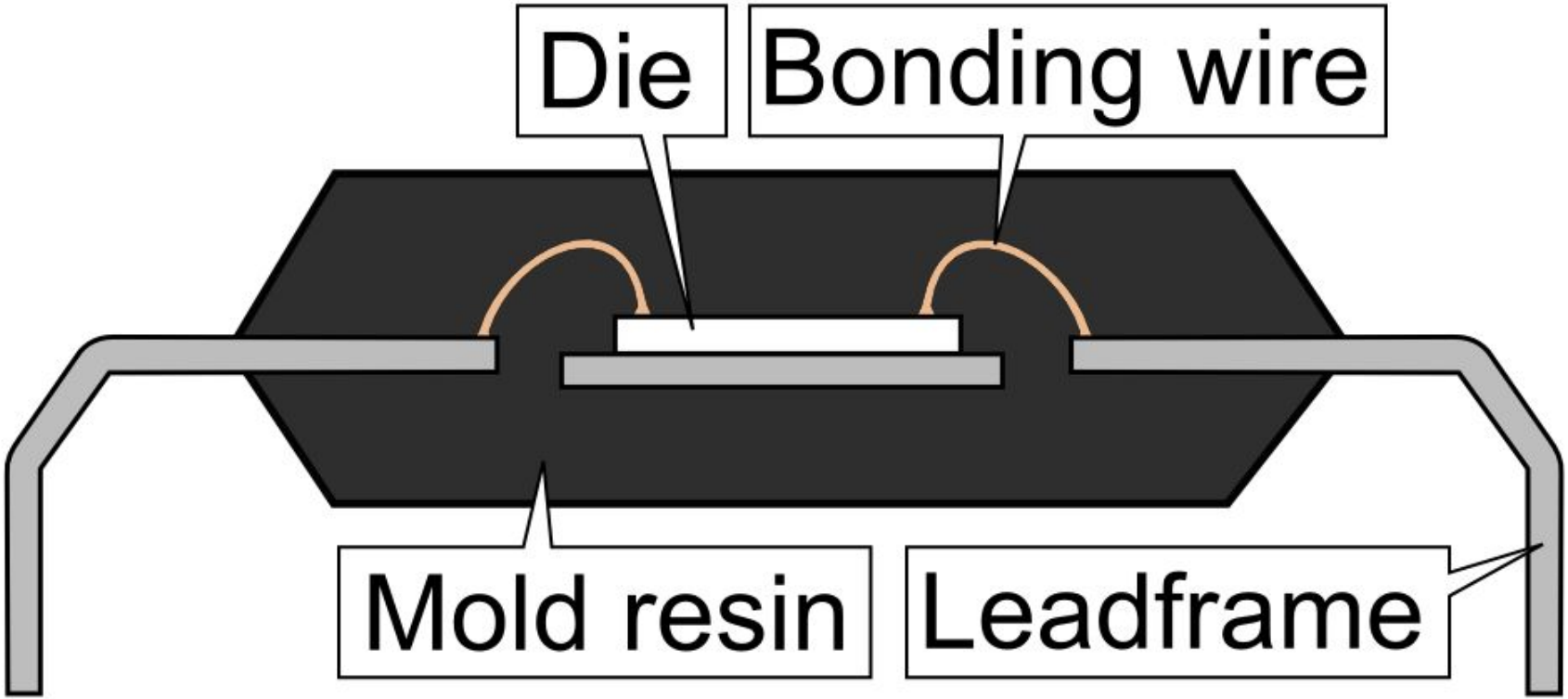
The Quest for Firmware



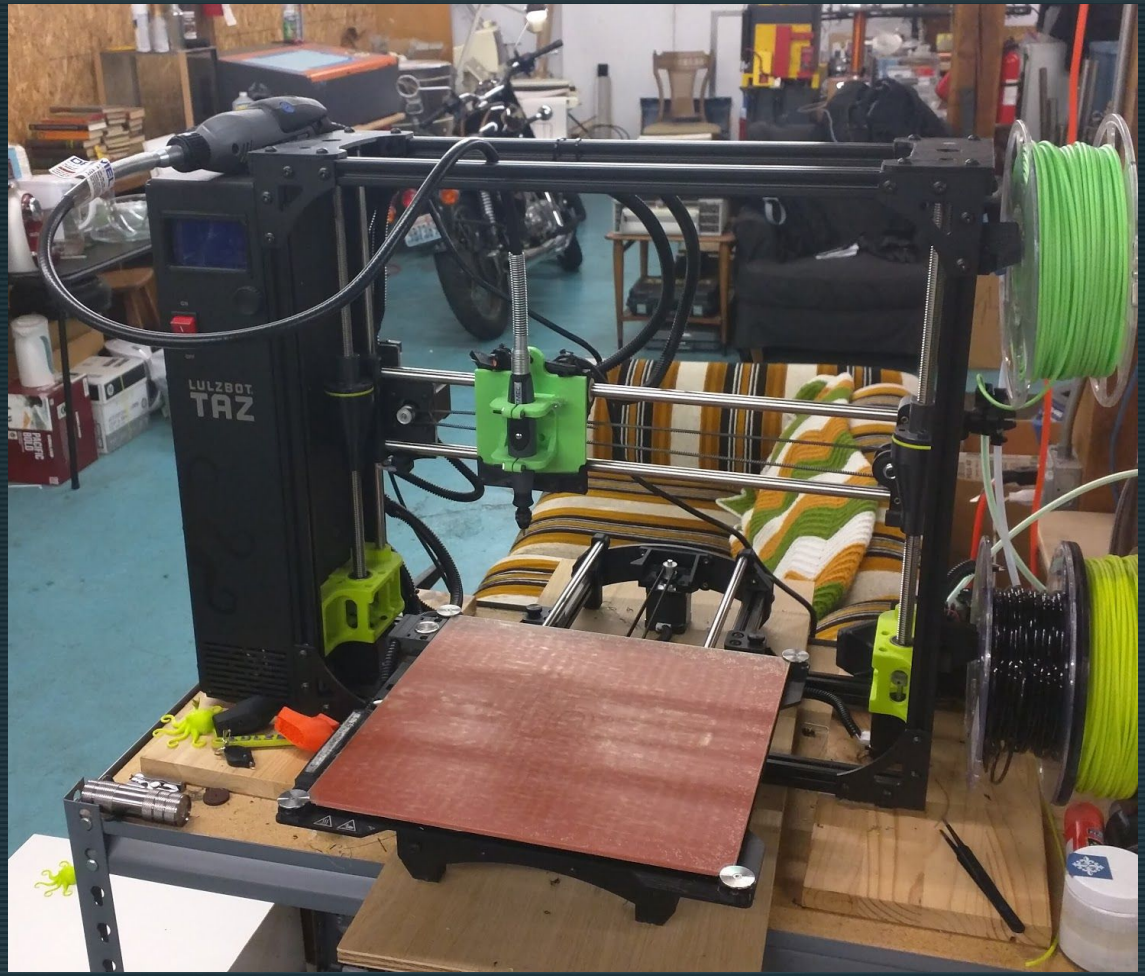
https://www.bunniestudios.com/blog/?page_id=40

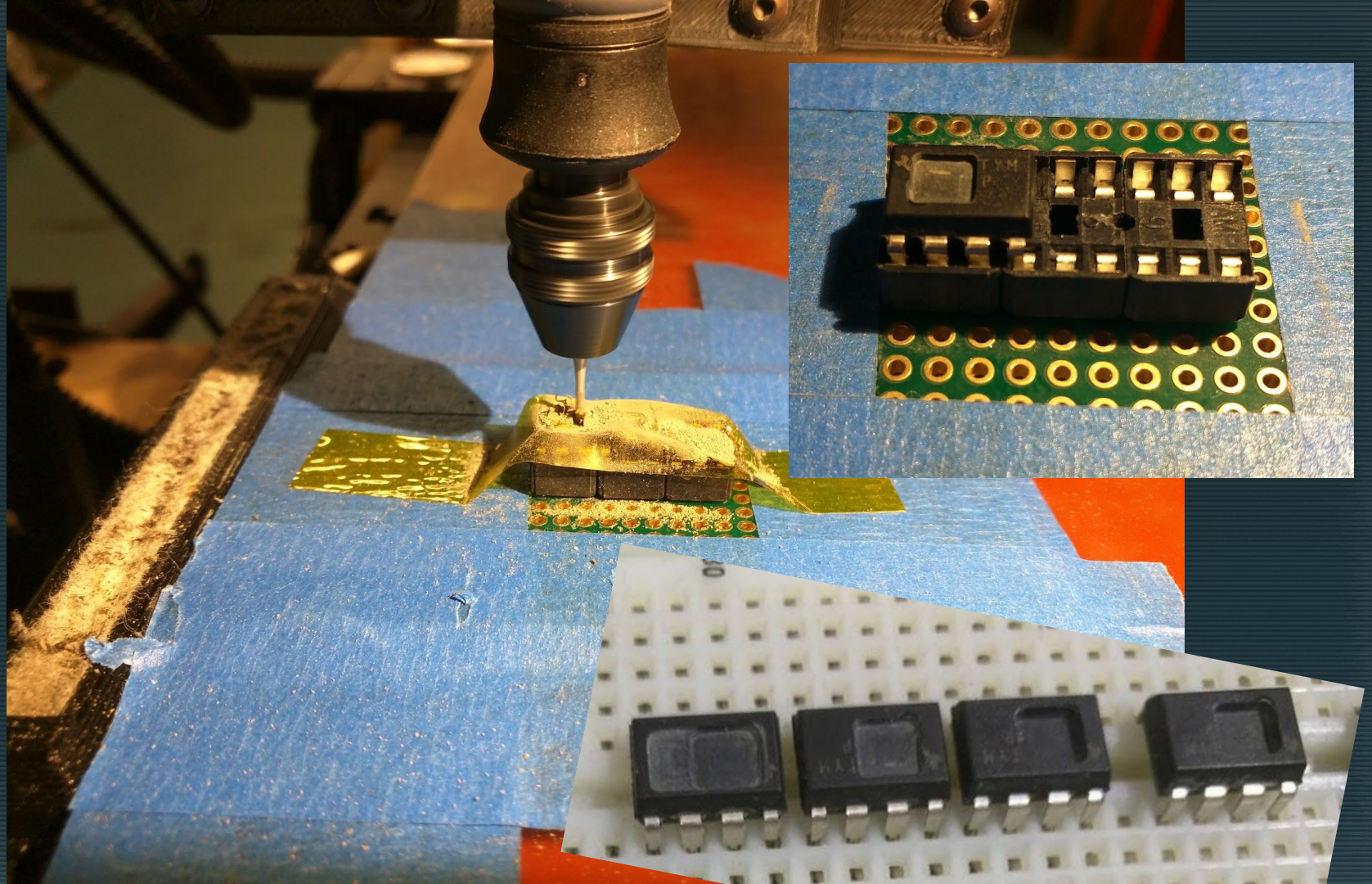


DIP



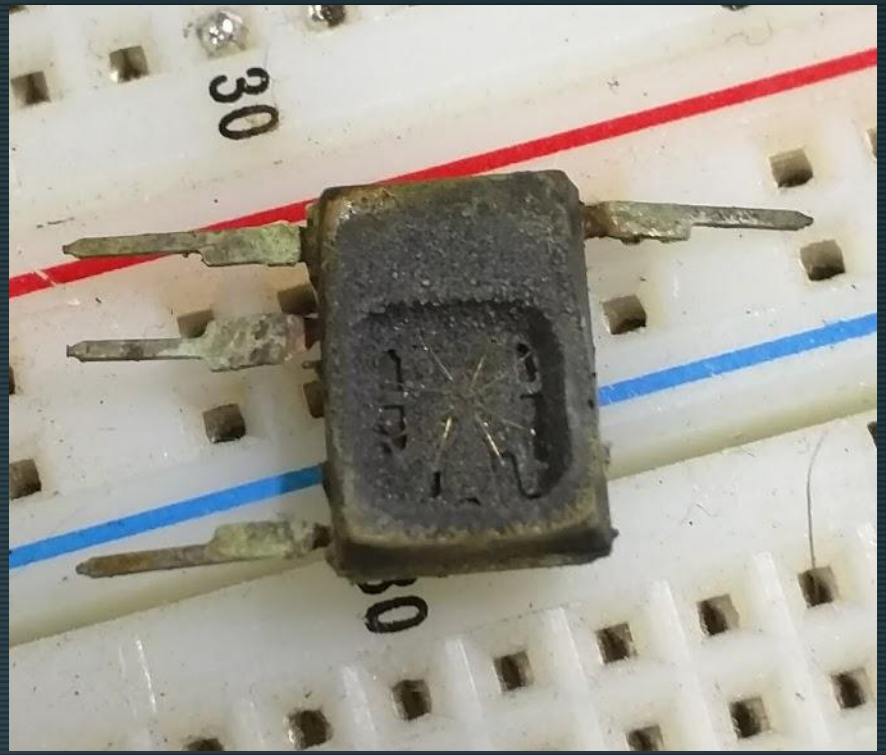
https://upload.wikimedia.org/wikipedia/commons/6/64/DIP_package_sideview.PNG

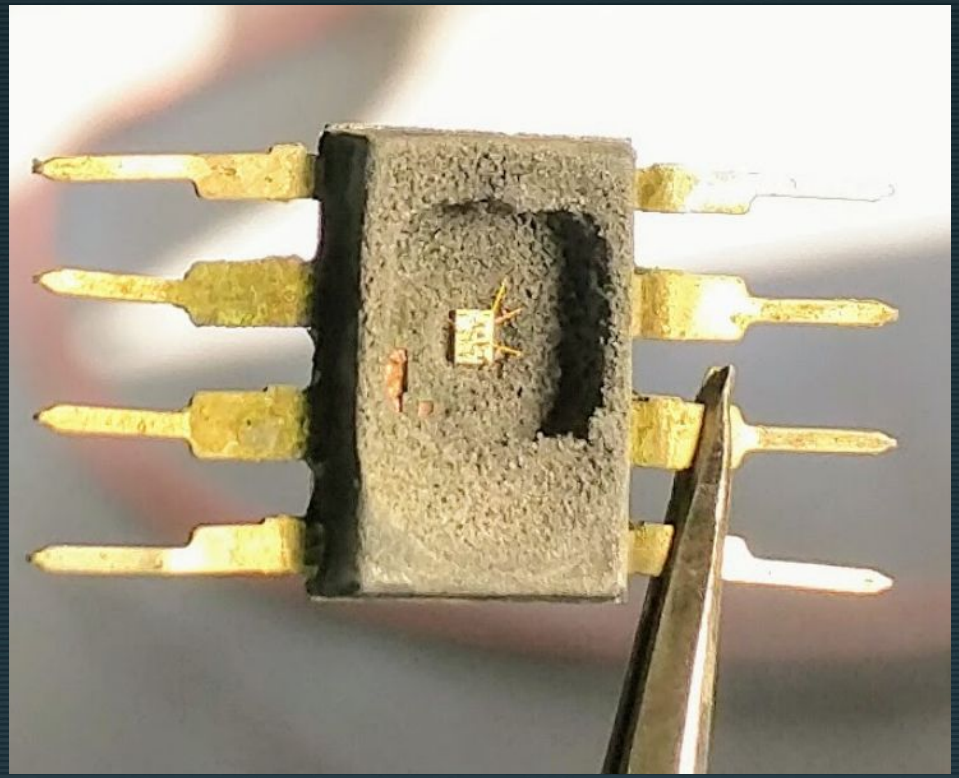

LULZBOT
TAZ

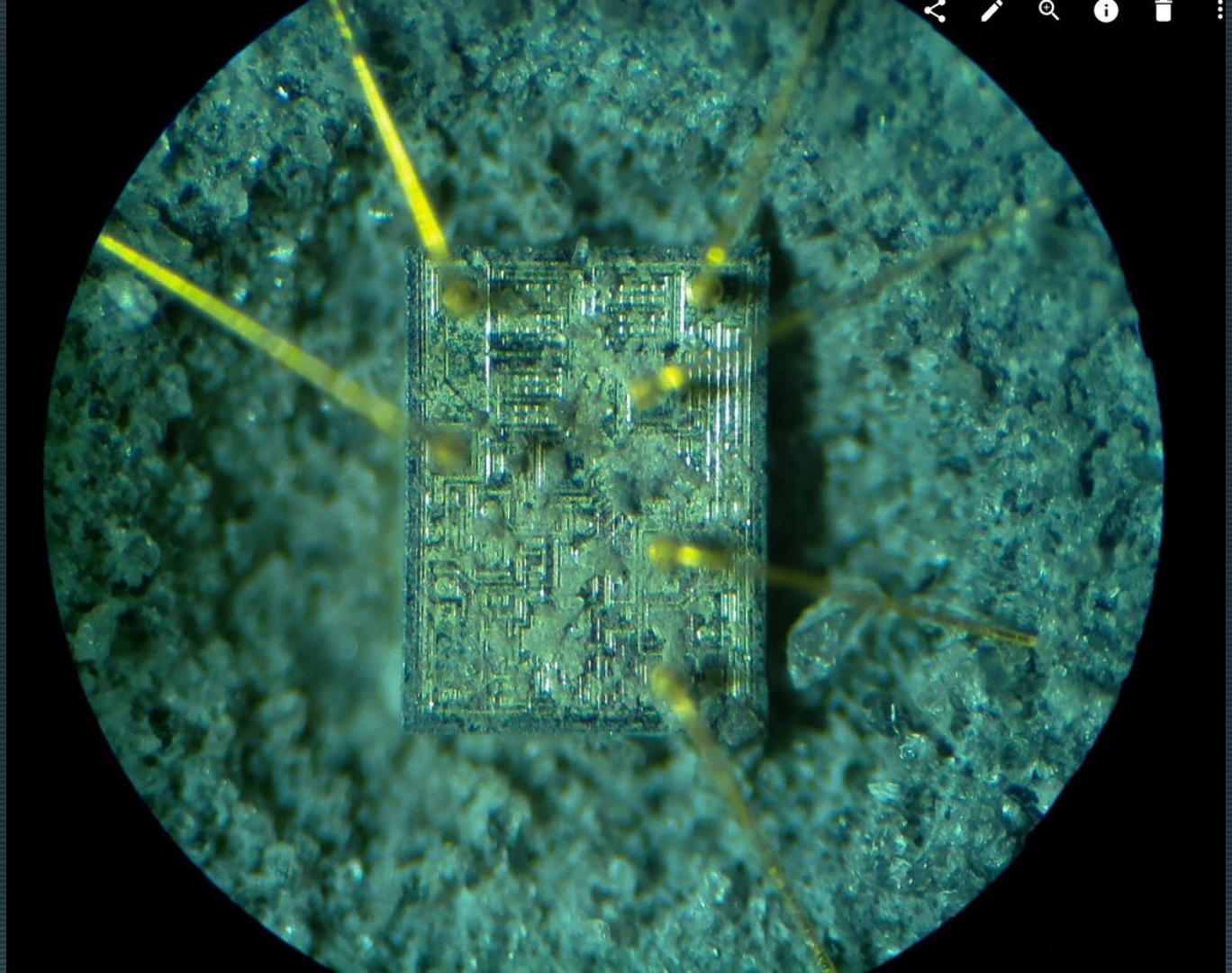


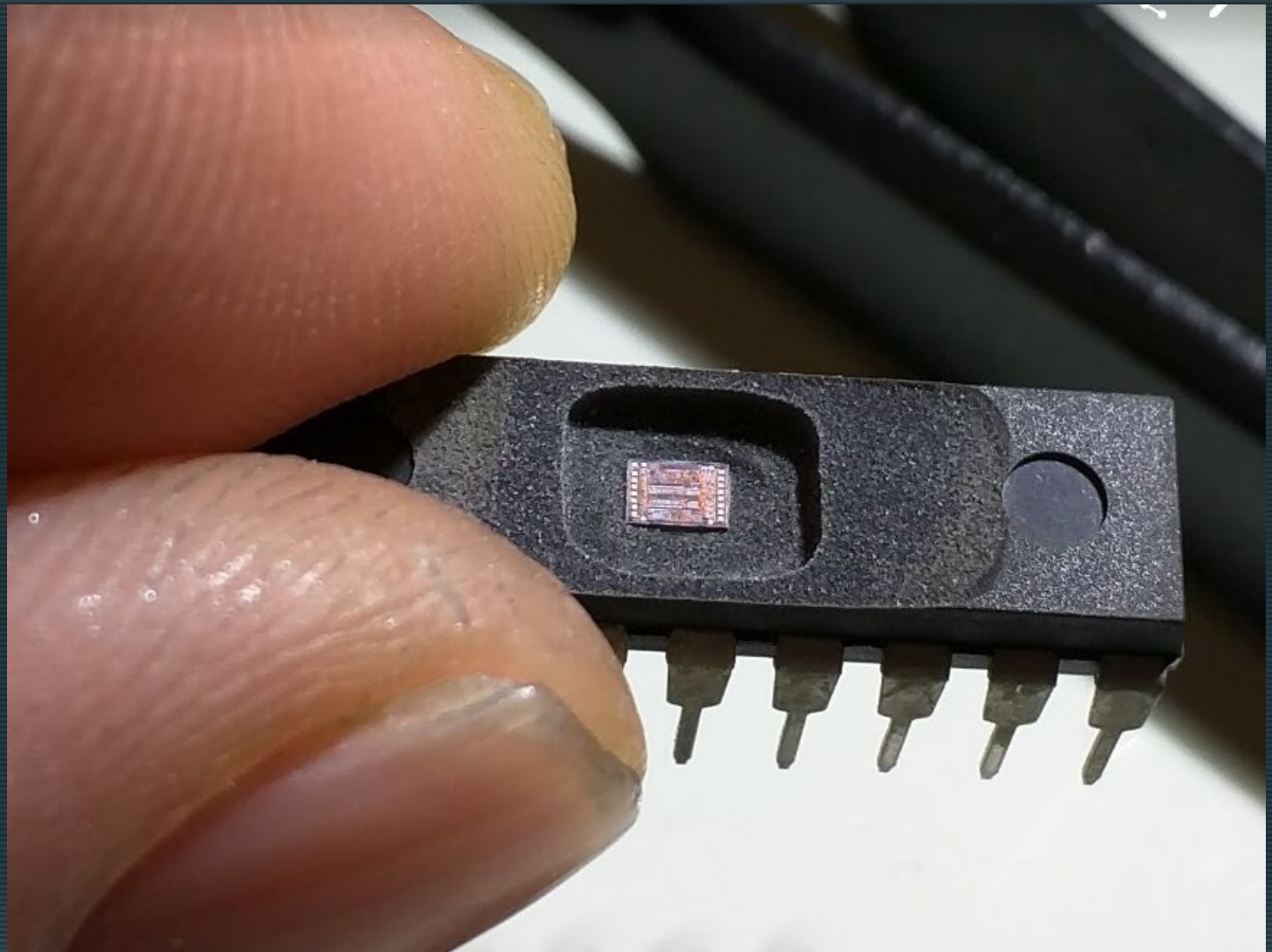
sciencecompany.com

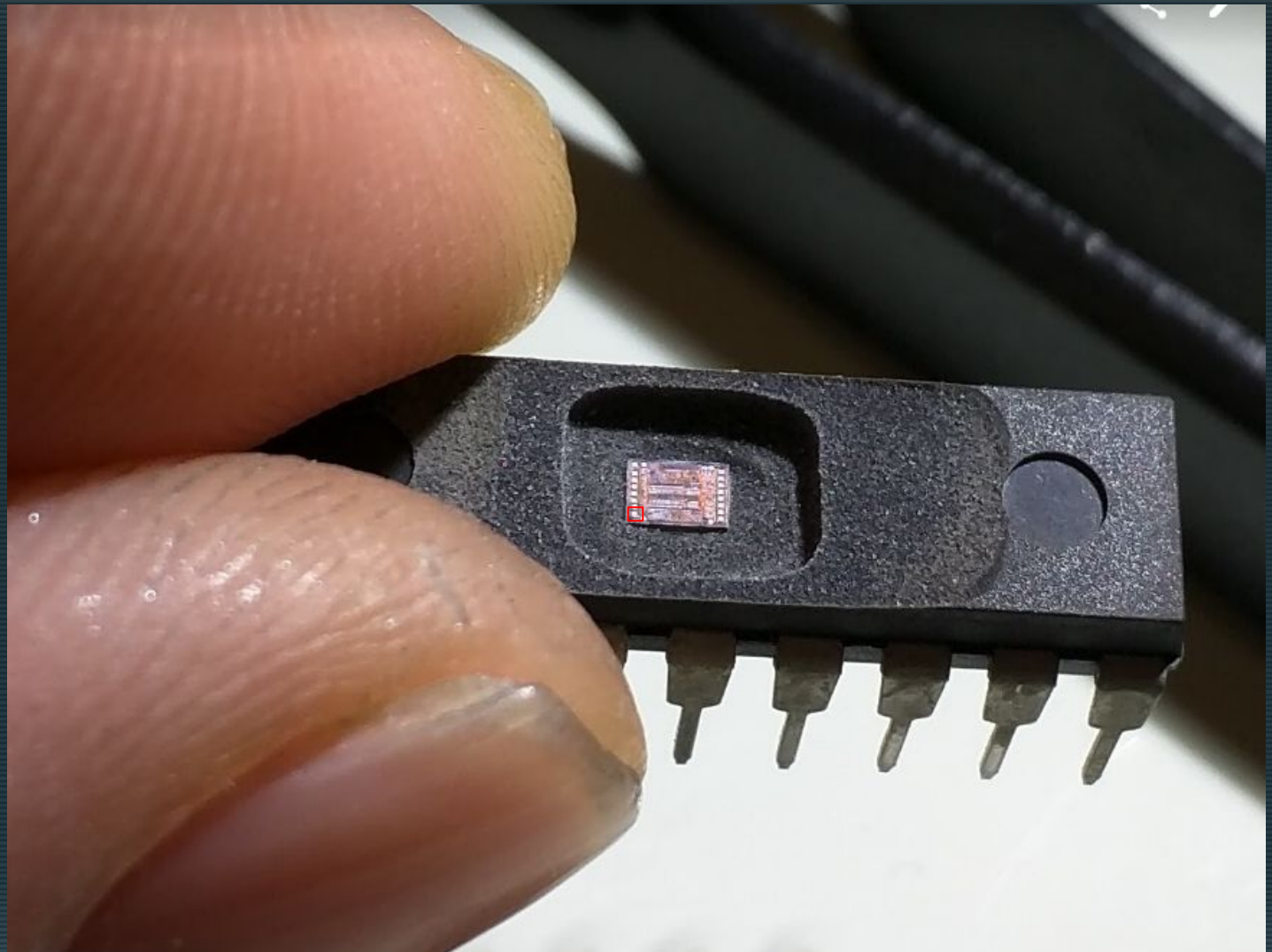

Thermo


30

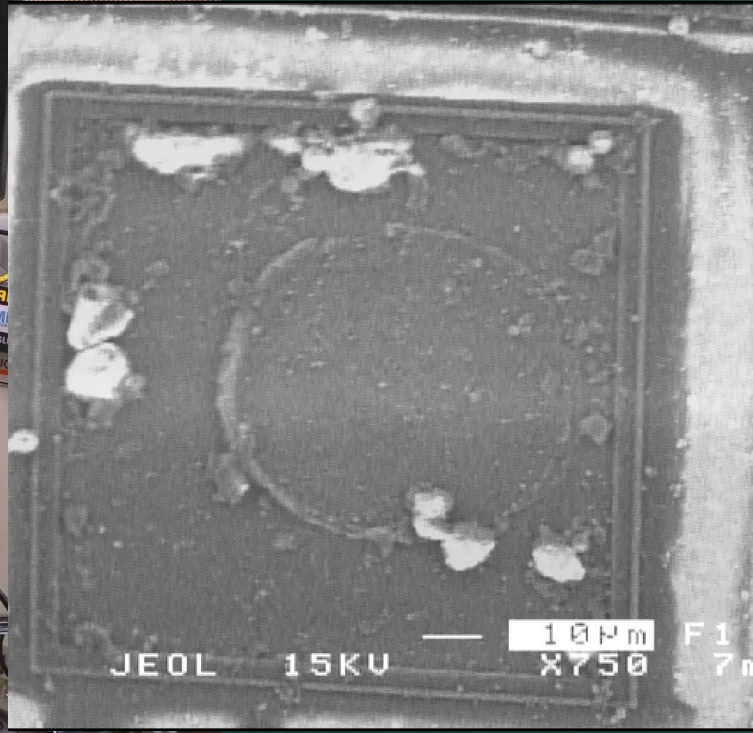


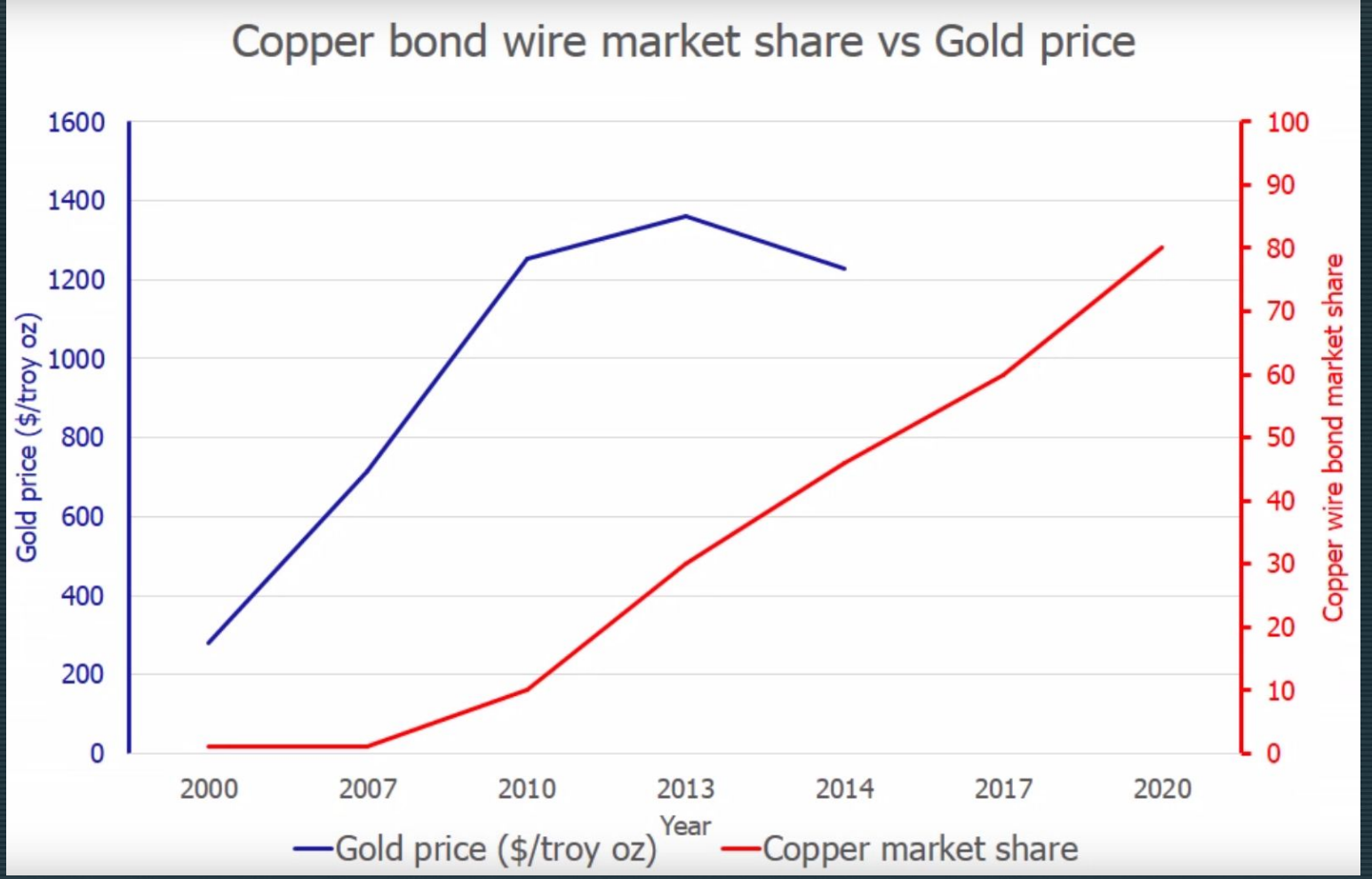







THIS MACHINE DOES SCIENCE
Thermo
JSM-6320F SCANNING


JEOL 15KV
X750



Source: JIACO Instruments

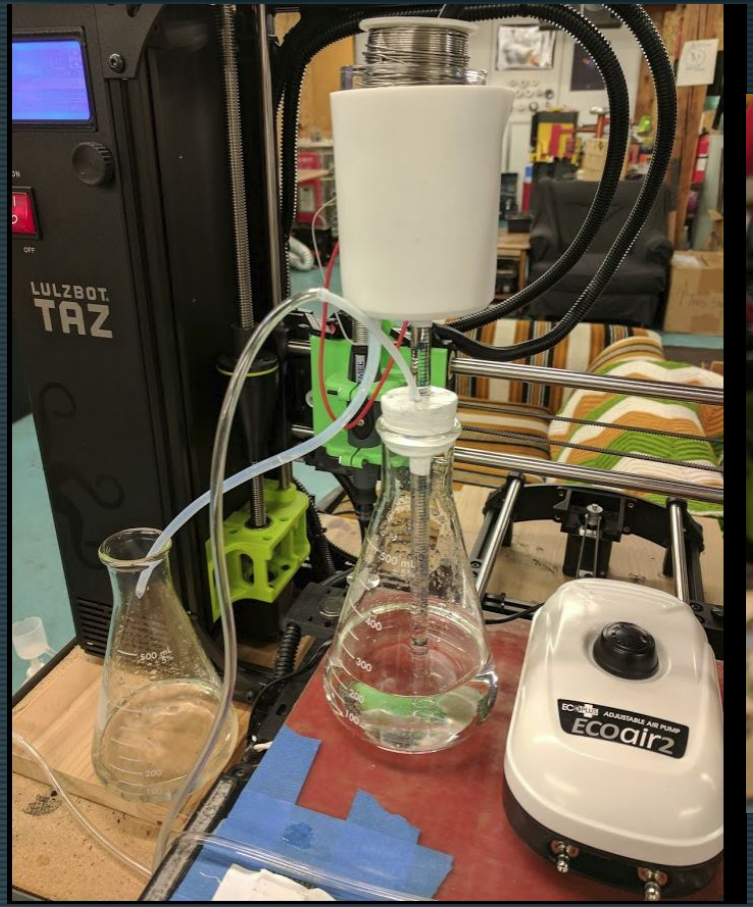
Credit: NileRed

The supplier responded regarding the nitric acid and does not feel comfortable shipping direct. They stated that the company appears to be more security software based as opposed to materials type research. Due to the dangerous nature of the product, they are prohibiting the sell of this material to that location.

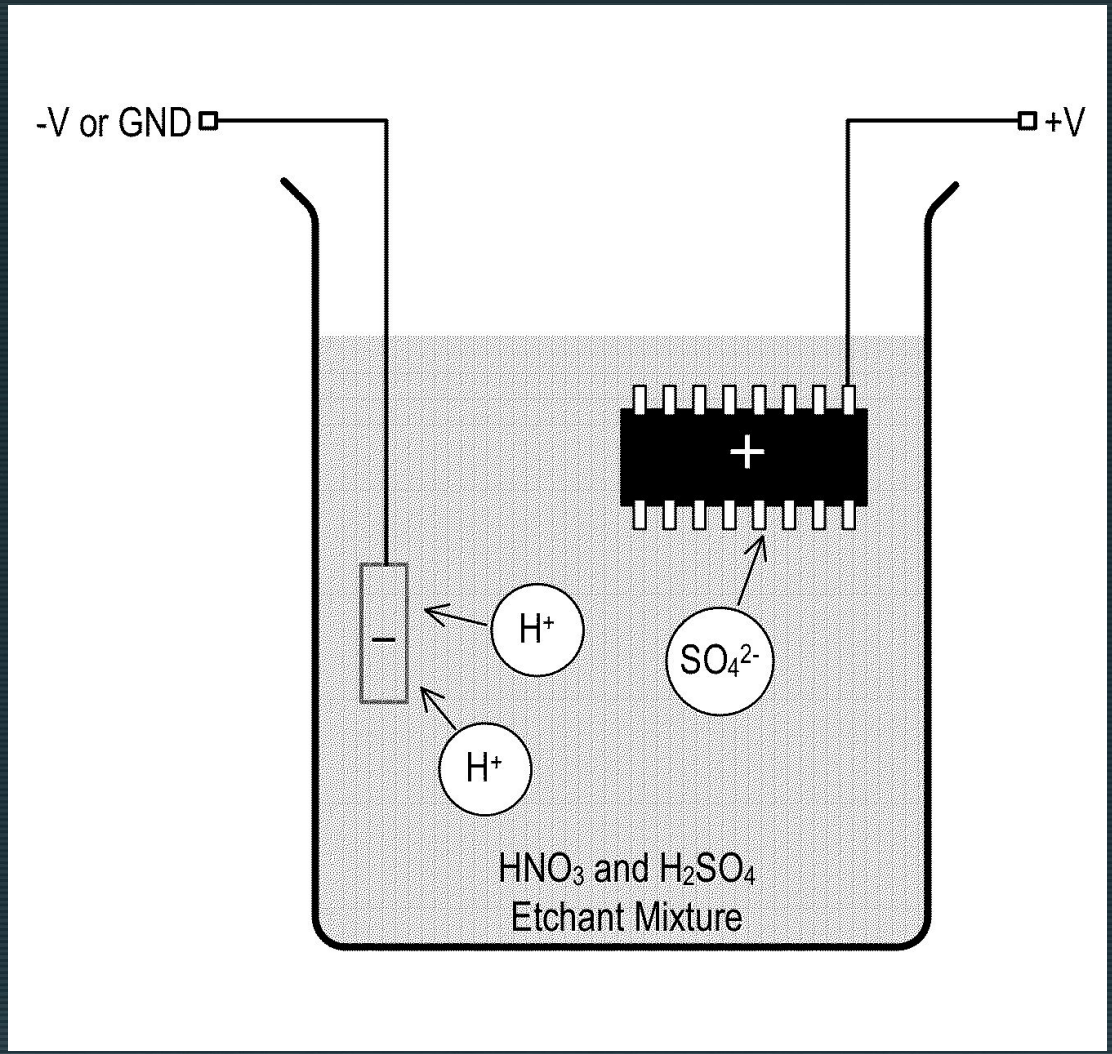
Electrochemical

Plasma

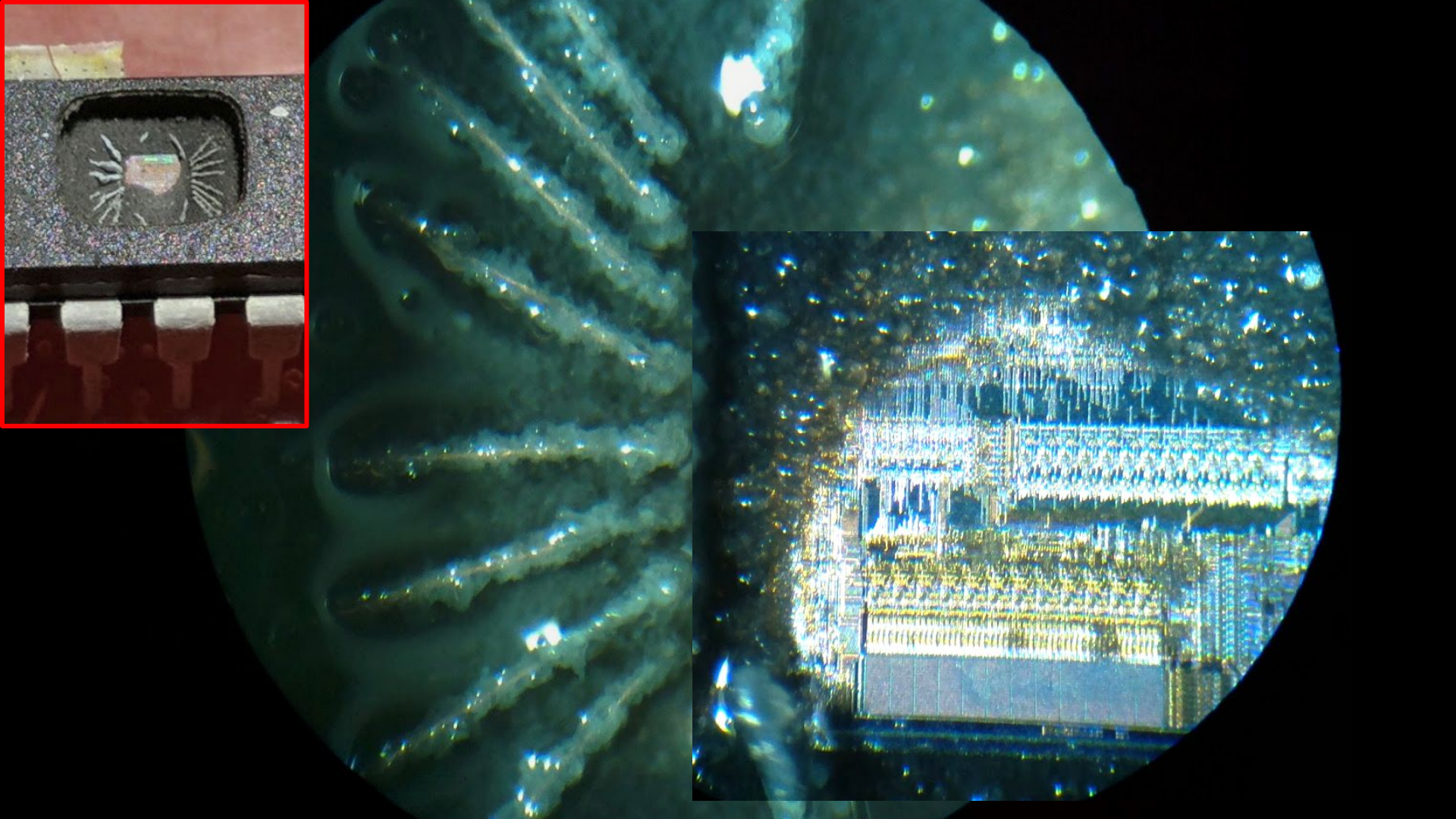
YOLO


LULZBOT
TAZ
ADJUSTABLE AIR PUMP
Ecoair2


500 mL
400
300
200
VWR
MODEL 320
STIR
HEAT



US9543173B2




Vorsicht: Überdruck möglich
Caution: Internal Pressure Possible
SIGMA-ALDRICH
84392-500ML
Lot # BCBT4509
Nitric acid
purum p.a., fuming, packed in coated, shock- and leak-protected glass bottle, ≥99% (T)
NO GHS SYMBOL
Nur durch qualifiziertes Personal im Abzug öffnen.
Doit être ouvert uniquement sous une hotte aspirante par une personne qualifiée.
To be opened by qualified staff in fume

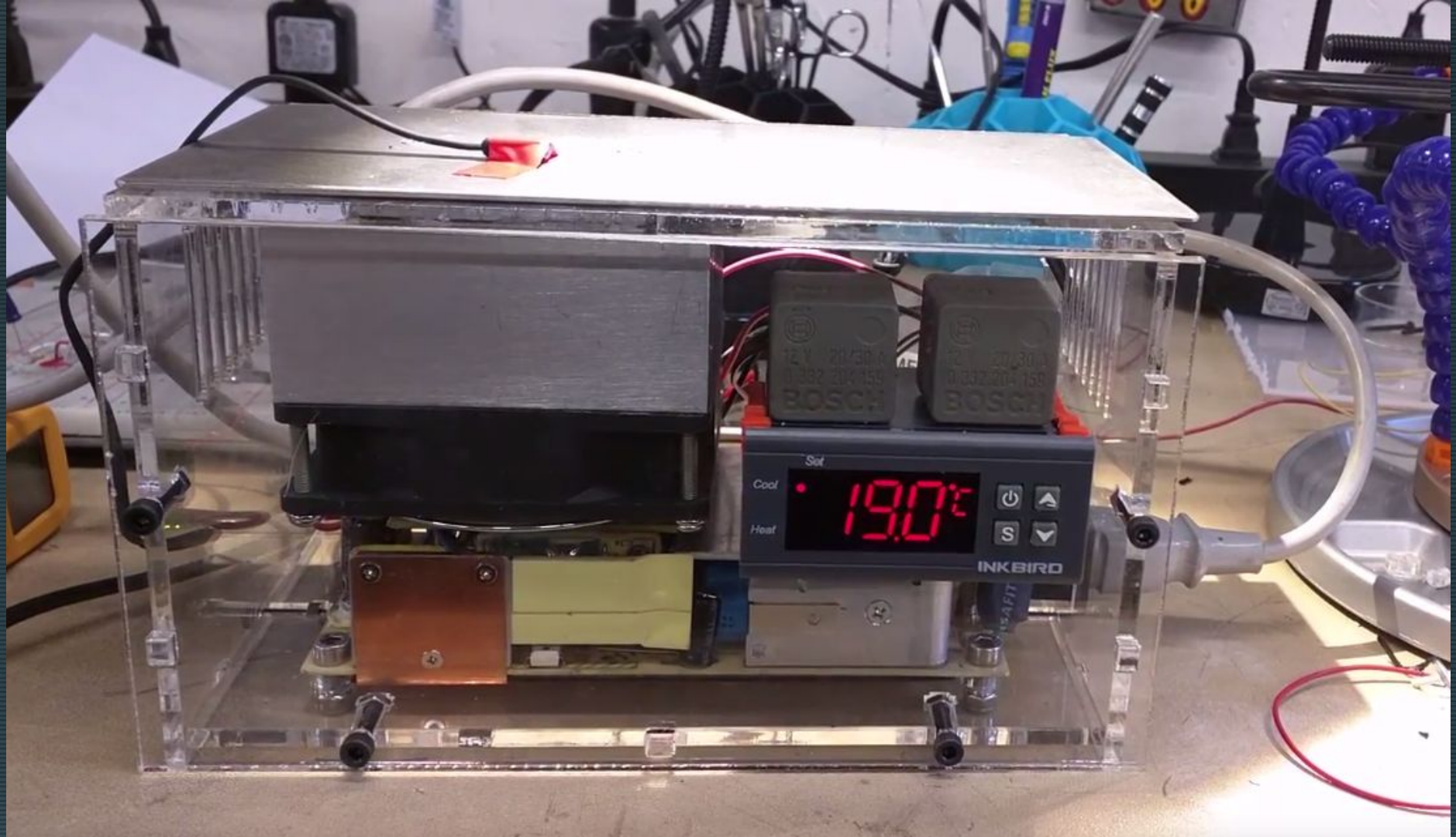
Credit: NileRed

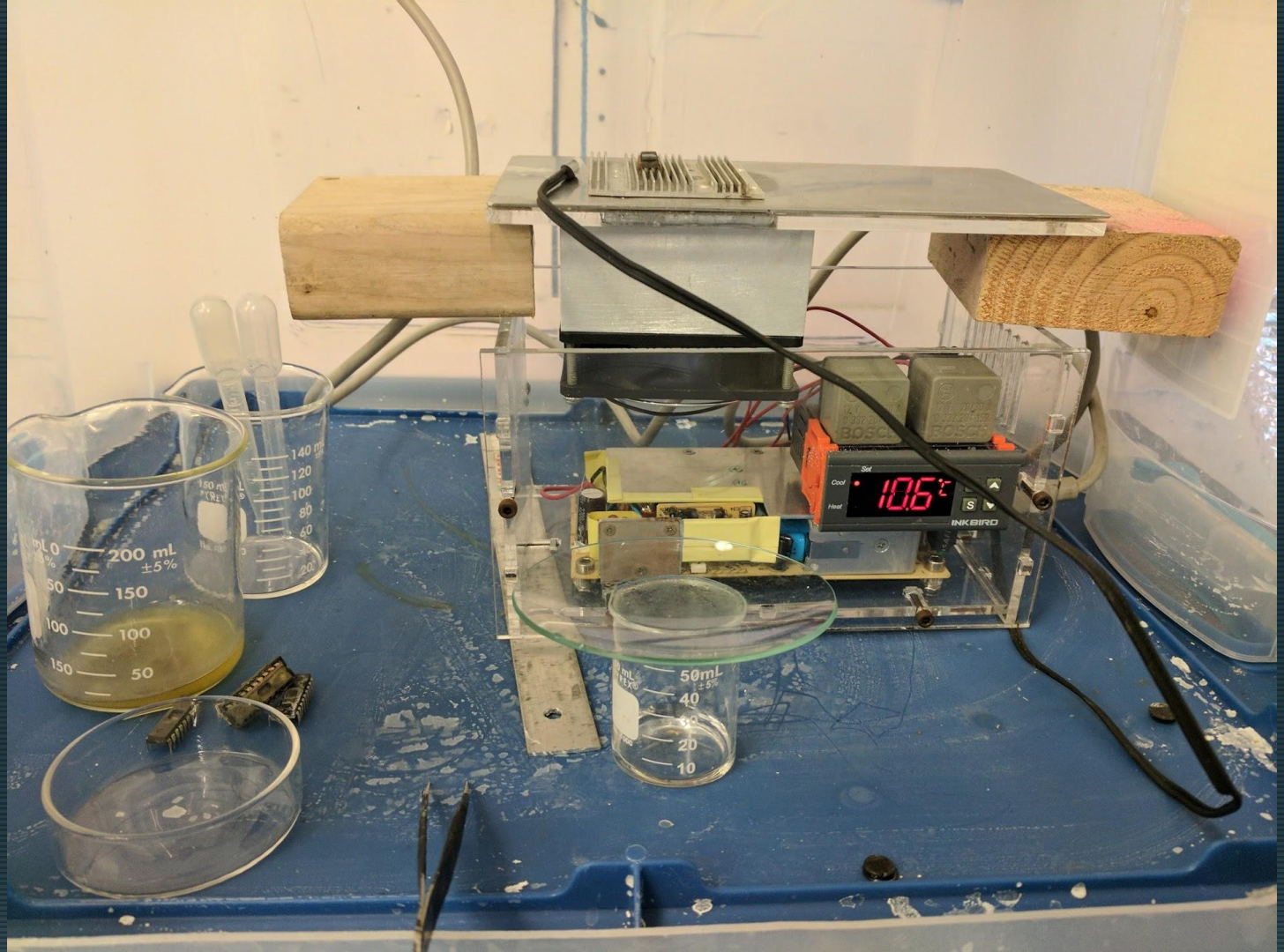

Destroys Stumps!
Spectracide
STUMP REMOVER
GRANULES
Accelerates Decomposition!
Will Not Harm Surrounding Vegetation
Easy To Pour

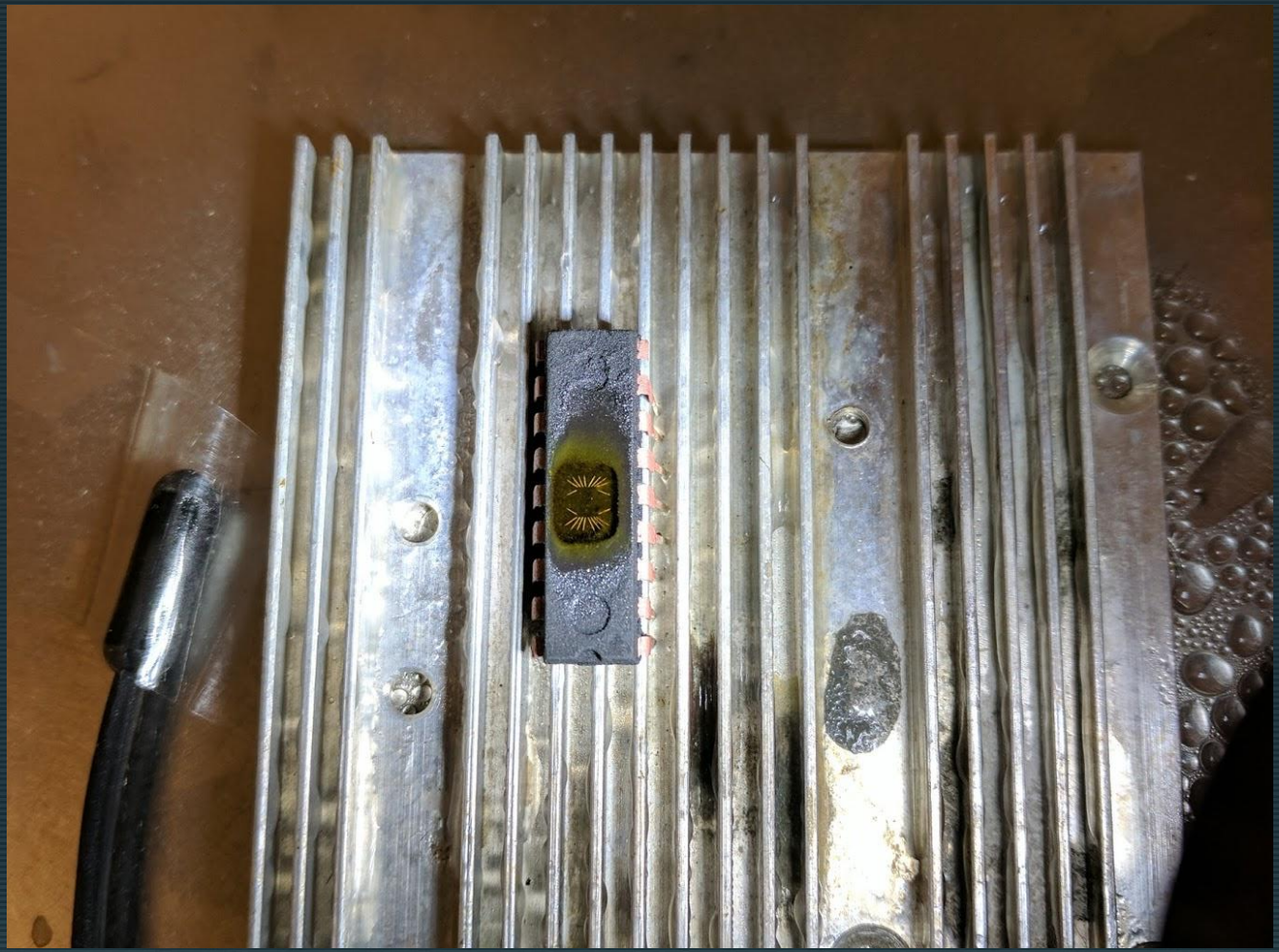
+

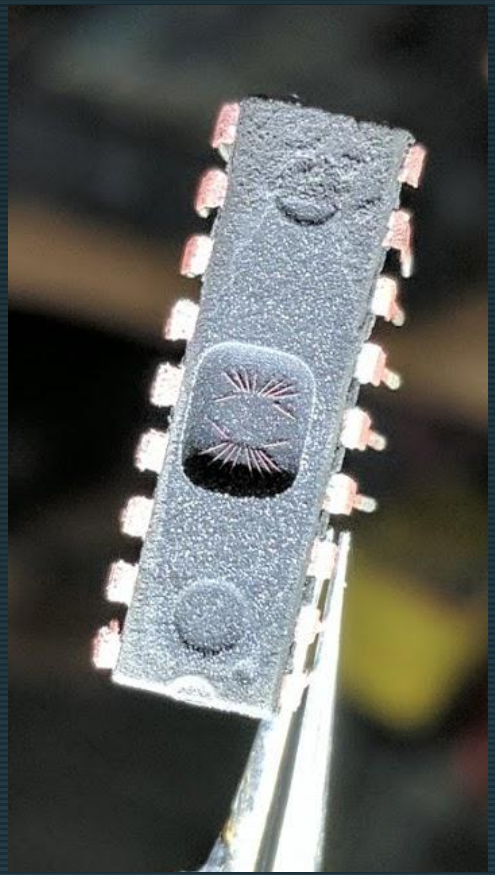

ROOTO
PROFESSIONAL
DRAIN OPENER
OPENS
DISSOLVES
DANGER -- POISON

+

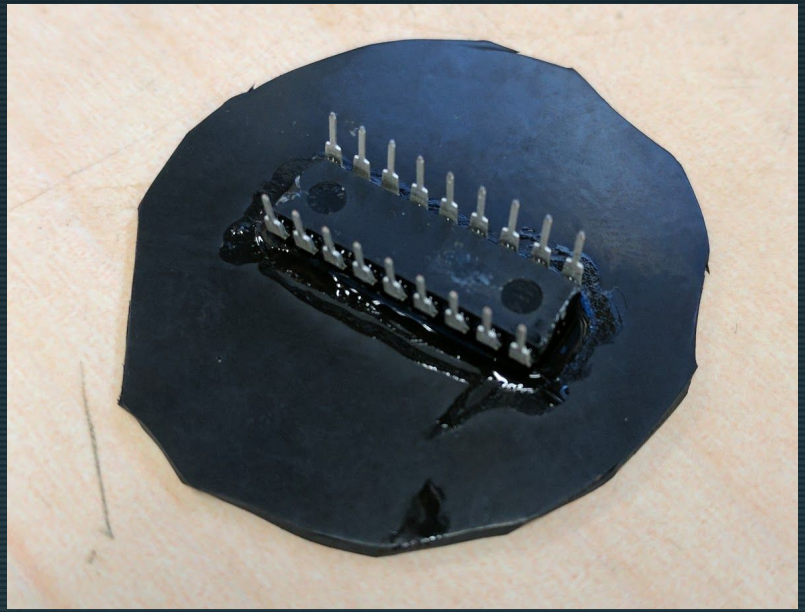

Set
Cool
Heat
19.0°C
S
INKBIRD
BOSCH
BOSCH

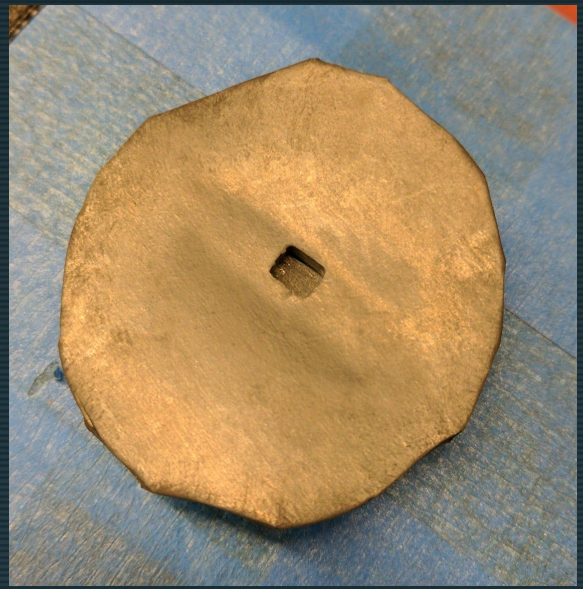

200 mL ±5%
150
100
50
140
120
100
80
60
50mL
40
20
10
Set
Cool
Heat
10.6°C
S
INKBIRD
BOSCH

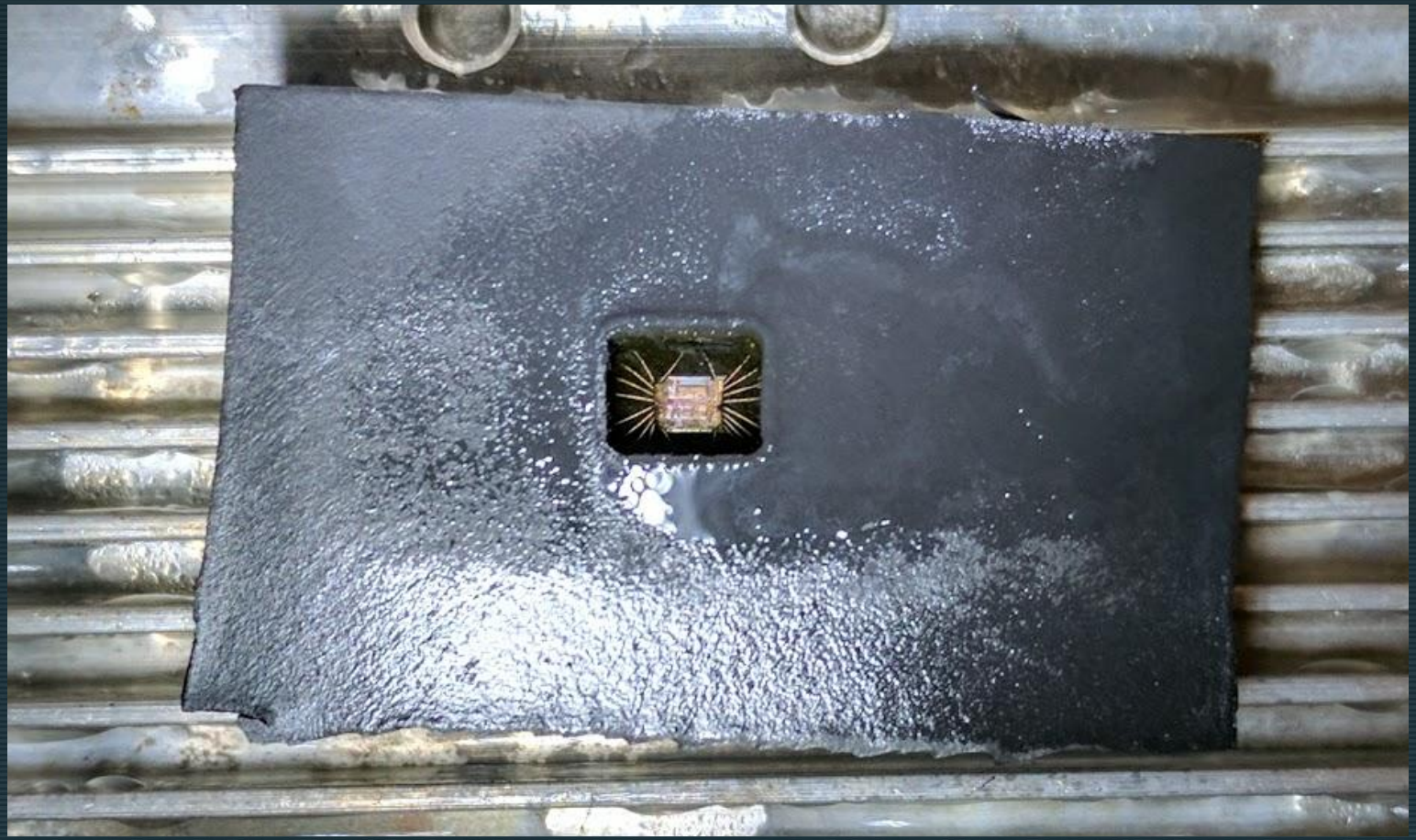


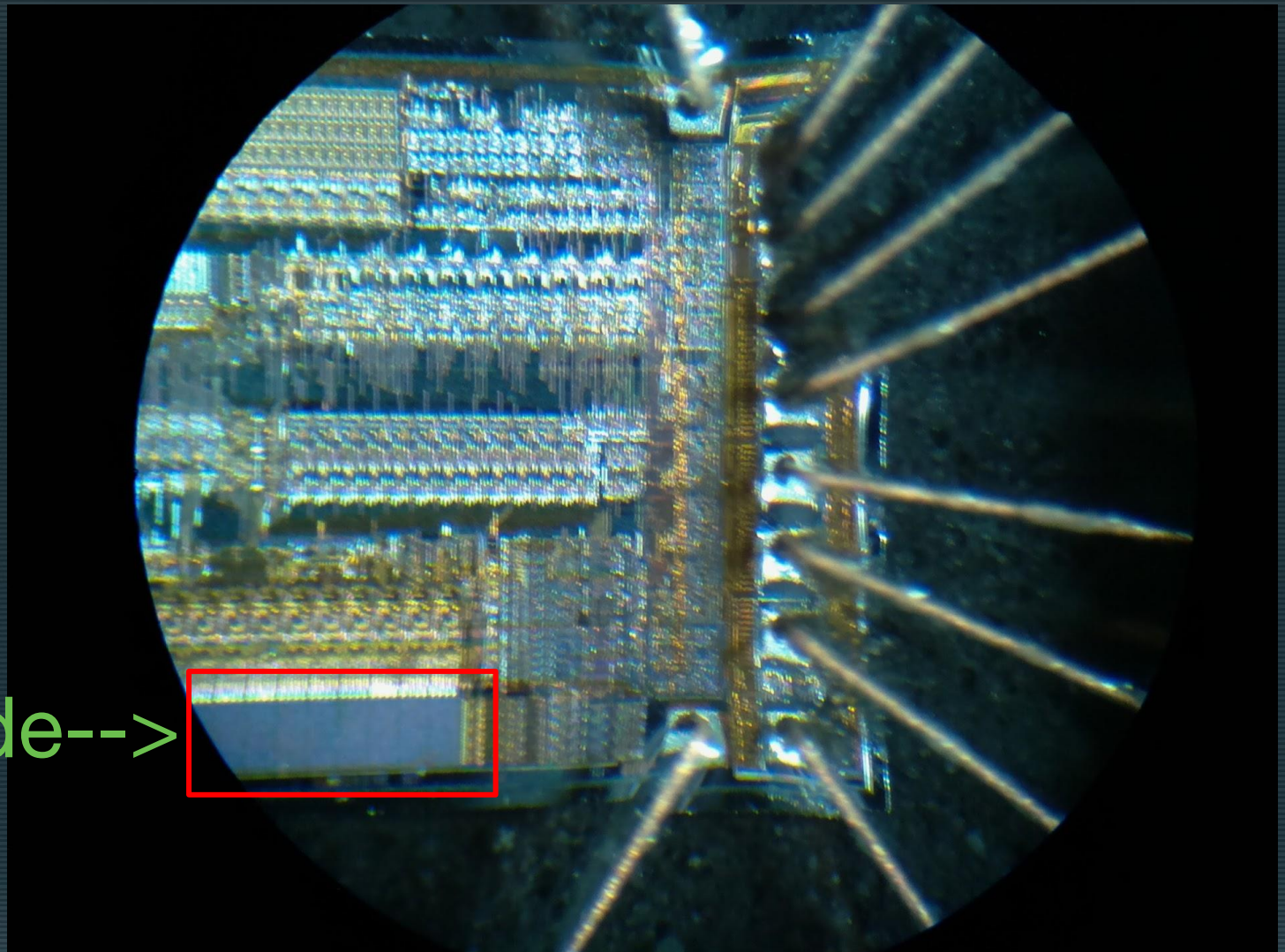


Viton Gasket

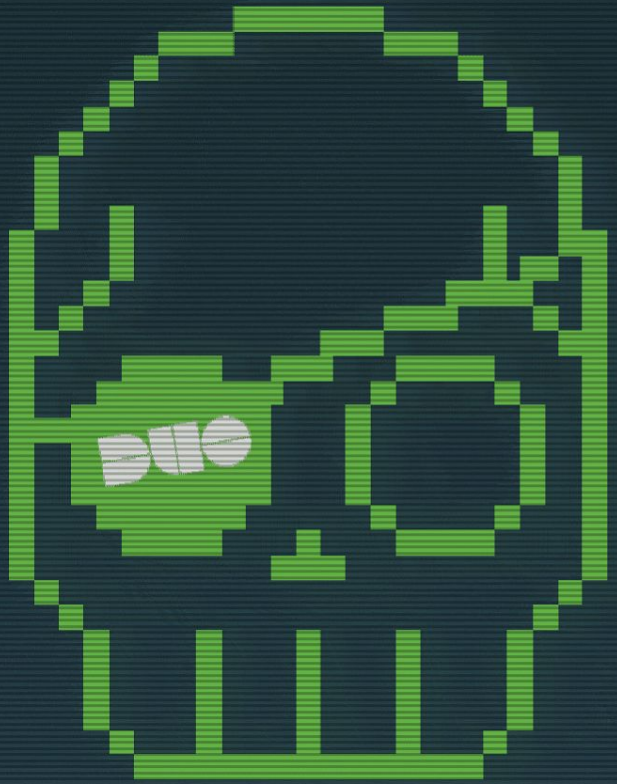







Code-->

Questions?



@sirus
mdavidov@duo.com
github.com/sirusdv/linear_dx
duo.sc/lineardx