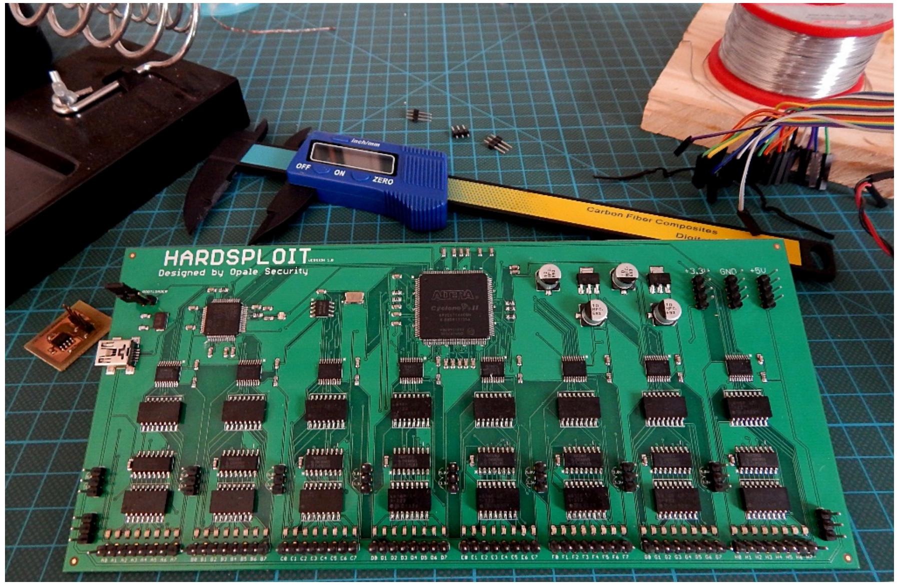
HARDSPLOIT

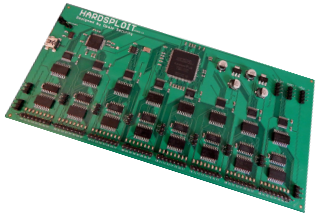
A Metasploit-like tool for hardware hacking

by OPALE security



OPALE security

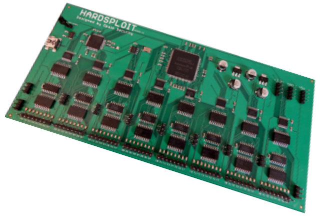
Who Are These Guys?



- Julien Moinard
  - Electronic engineer
  - Pentester
  - DIY enthusiast
- For Hardsploit
  - Hardware / VHDL

- Gwénolé Audic
  - Hardware hacking enthusiast
  - Pentester
  - Software developper
- For Hardsploit
  - Graphical interface / DB

The Fact



The gap between software & hardware security widen since the 2000s

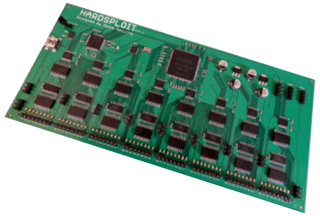
Golden age of software security (since 2000)

- Personal computers
- World Wide Web
- Online sales

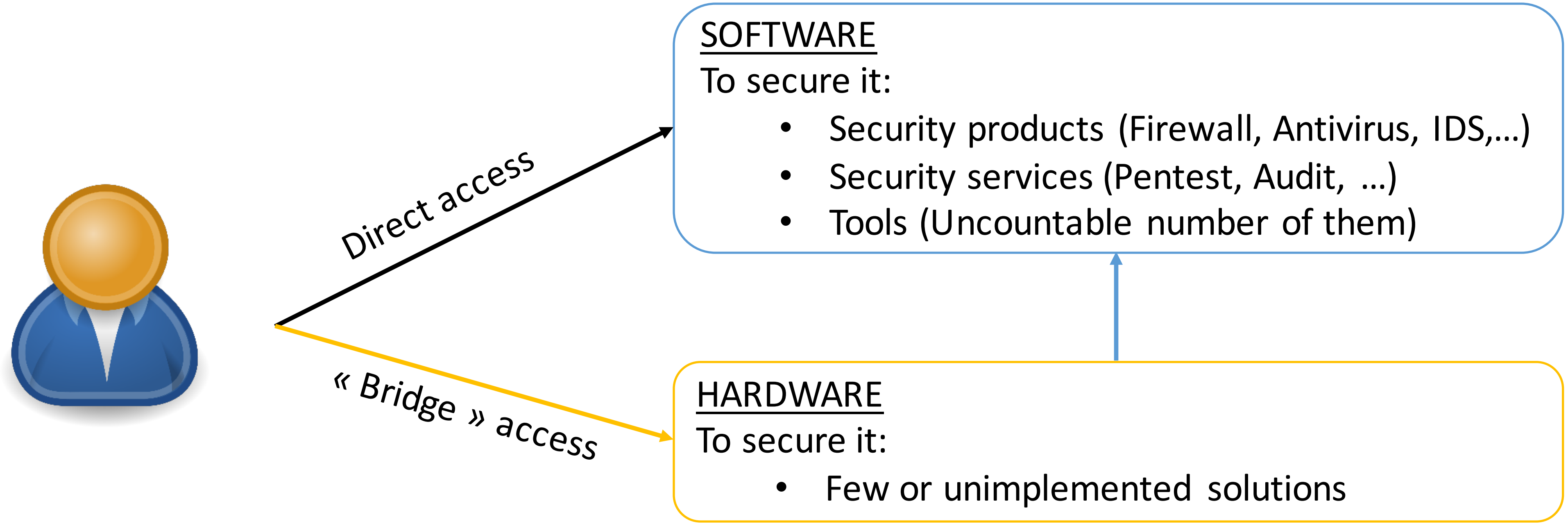
Golden age of hardware security (Now ?)

- « Internet Of Things »
- Connect everything (fridges to cars)
- Automation devices everywhere

Question



- Security speaking, is hardware the new software ?



SOFTWARE

To secure it:

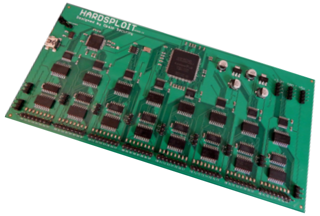
- Security products (Firewall, Antivirus, IDS,…)
- Security services (Pentest, Audit, …)
- Tools (Uncountable number of them)

HARDWARE

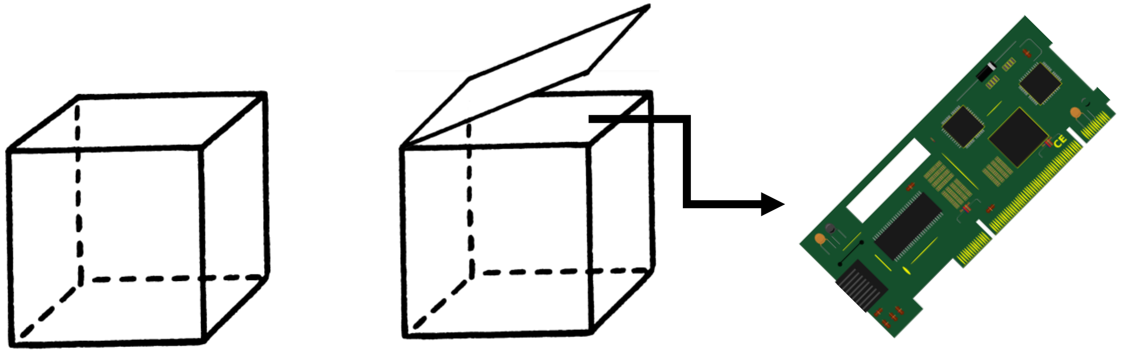
To secure it:

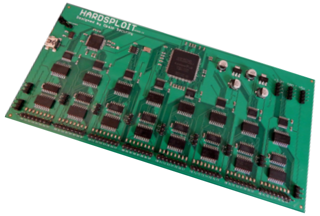
- Few or unimplemented solutions

Hardware Hacking Basic Procedure



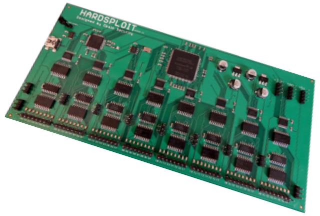
- 1/ Open it
- 2/ Fingerprint all the component (RTFD – Read The Fucking Datasheets)
- 3/ Use those that may contain data (Online / Offline analysis ?)
- 4/ Perform read | write operation on them
- 5/ Reverse engineering, find vulnerabilities and exploit them



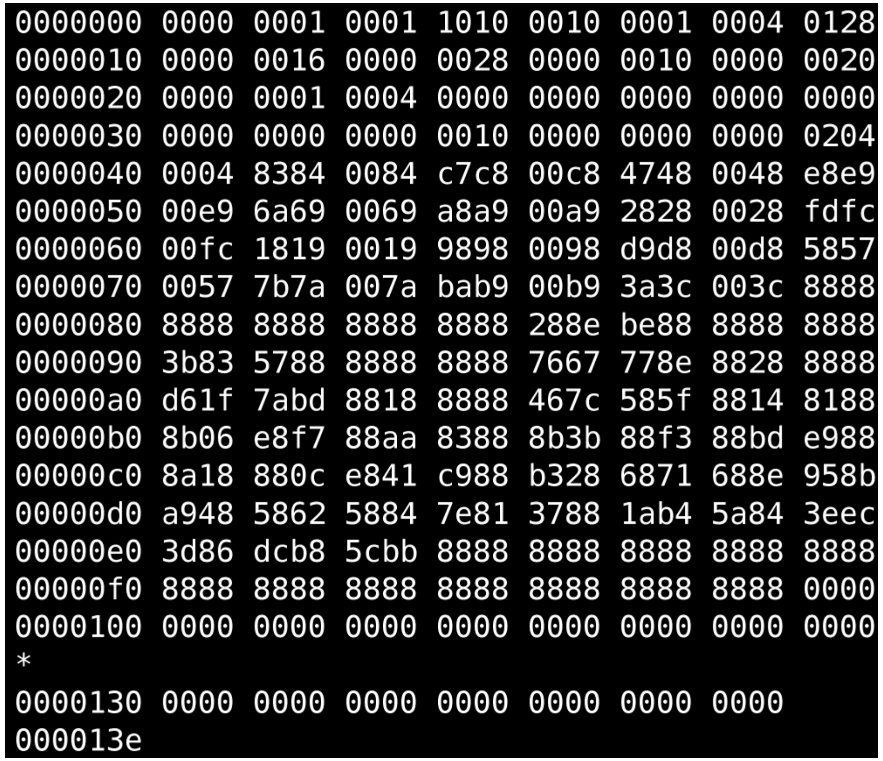


Global Purpose

Why ?

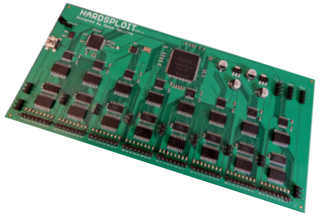


- Because chips contain interesting data
  - Passwords
  - File systems
  - Firmware
  - …

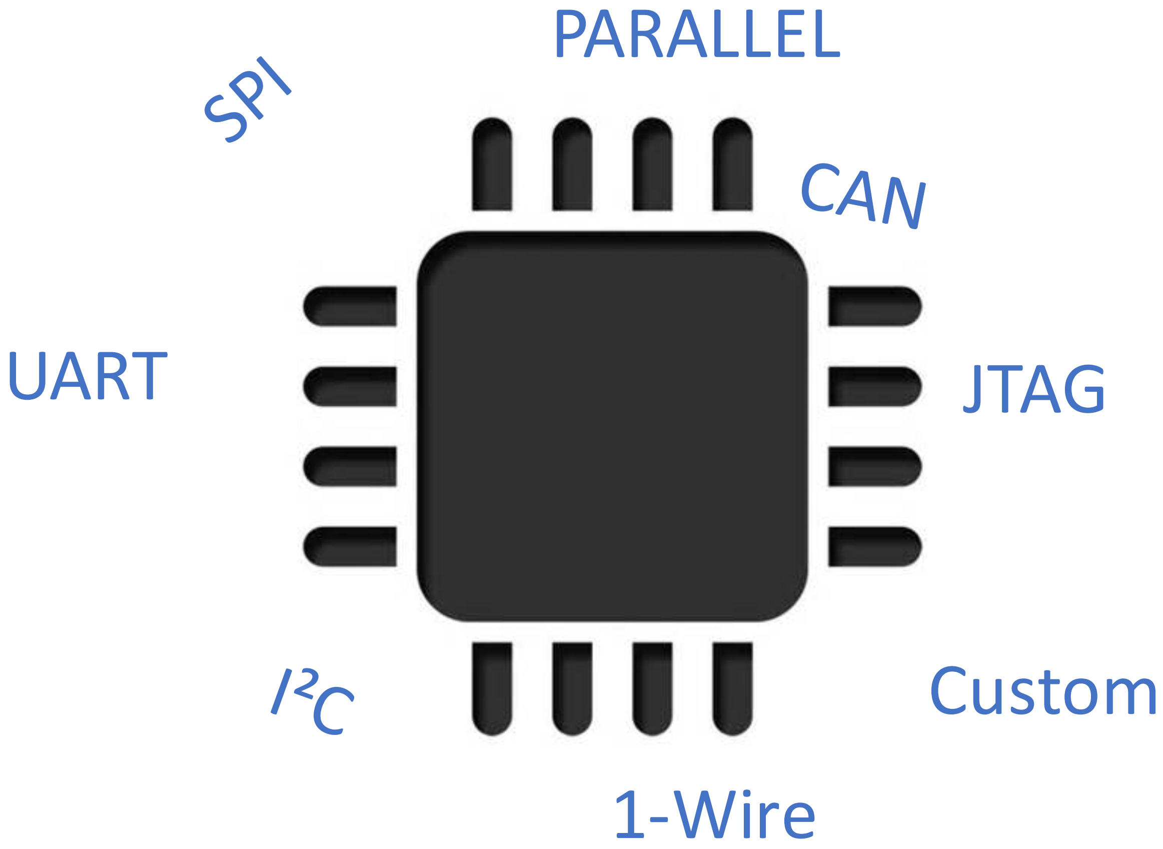


```
0000000 0000 0001 0001 1010 0010 0001 0004 0128
0000010 0000 0016 0000 0028 0000 0010 0000 0020
0000020 0000 0001 0004 0000 0000 0000 0000 0000
0000030 0000 0000 0000 0010 0000 0000 0000 0204
0000040 0004 8384 0084 c7c8 00c8 4748 0048 e8e9
0000050 00e9 6a69 0069 a8a9 00a9 2828 0028 fdfc
0000060 00fc 1819 0019 9898 0098 d9d8 00d8 5857
0000070 0057 7b7a 007a bab9 00b9 3a3c 003c 8888
0000080 8888 8888 8888 8888 288e be88 8888 8888
0000090 3b83 5788 8888 8888 7667 778e 8828 8888
00000a0 d61f 7abd 8818 8888 467c 585f 8814 8188
00000b0 8b06 e8f7 88aa 8388 8b3b 88f3 88bd e988
00000c0 8a18 880c e841 c988 b328 6871 688e 958b
00000d0 a948 5862 5884 7e81 3788 1ab4 5a84 3eec
00000e0 3d86 dcb8 5cbb 8888 8888 8888 8888 8888
00000f0 8888 8888 8888 8888 8888 8888 8888 0000
0000100 0000 0000 0000 0000 0000 0000 0000 0000
*
0000130 0000 0000 0000 0000 0000 0000 0000
000013e
```

How ?



- By using electronic buses



PARALLEL

SPI

CAN

UART

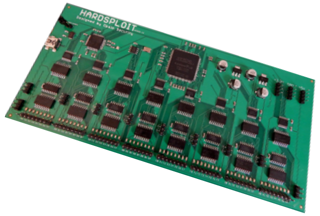
JTAG

I^2C

Custom

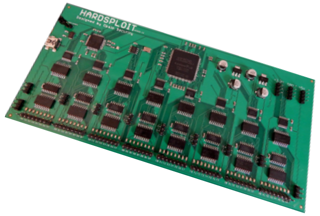
1-Wire

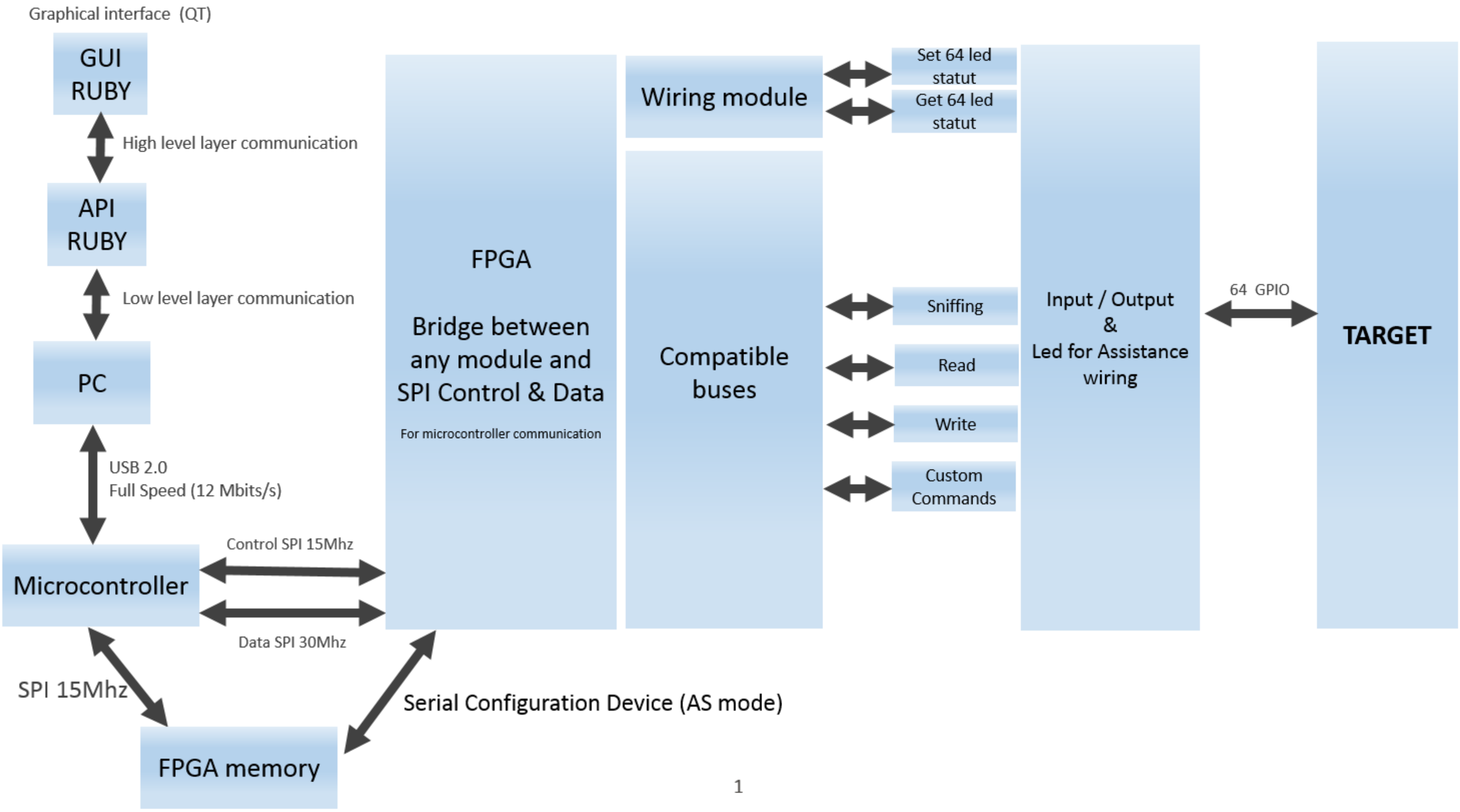
Quick Review



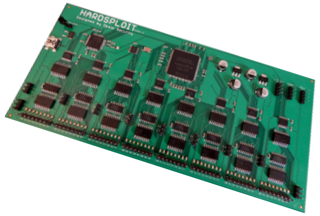
FUNCTIONALITIES	BUSPIRATE	JTAGULATOR	GOODFET	HARDSPLOIT
UART	○	Bus identification	✗	○
SPI	○	✗	○	○
PARALLEL	✗	✗	✗	○
I2C	○	✗	✗	○
JTAG / SWD	○	Bus identification	○	○
MODULARITY	Microcontroller	Microcontroller	Microcontroller	FPGA
EASE OF USE	Cmd line + datasheet	Command line	Command line	Official GUI / API / DB
I/O NUMBER	< 10	24	< 14	64 (plus power)
WIRING	TEXT (but MOSI = SDA ☺)	TEXT	TEXT	LED / TEXT

Hardsploit: Communication

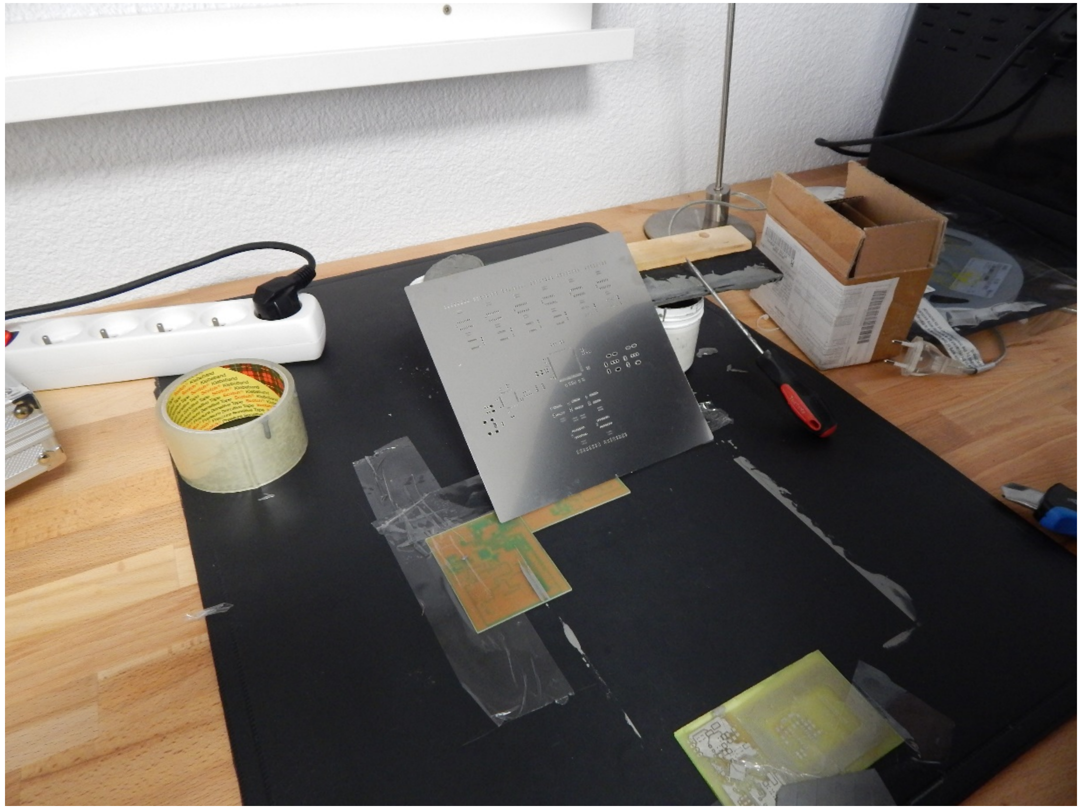


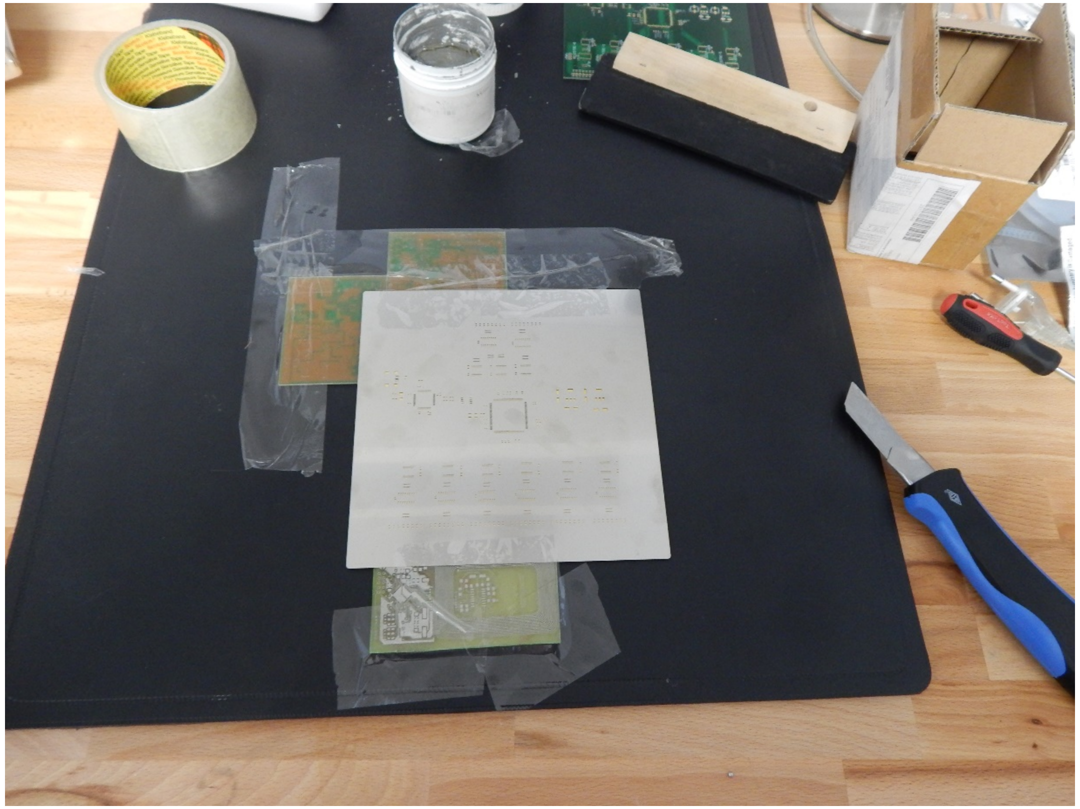


Prototype making



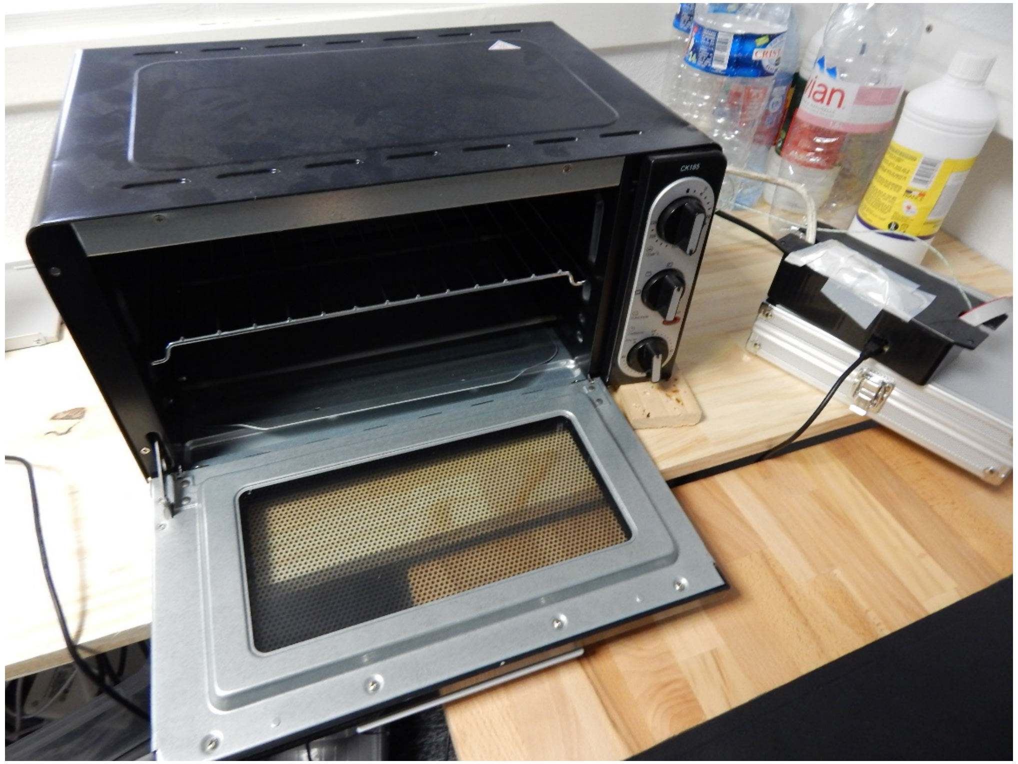
- Applying soldering past (low budget style)

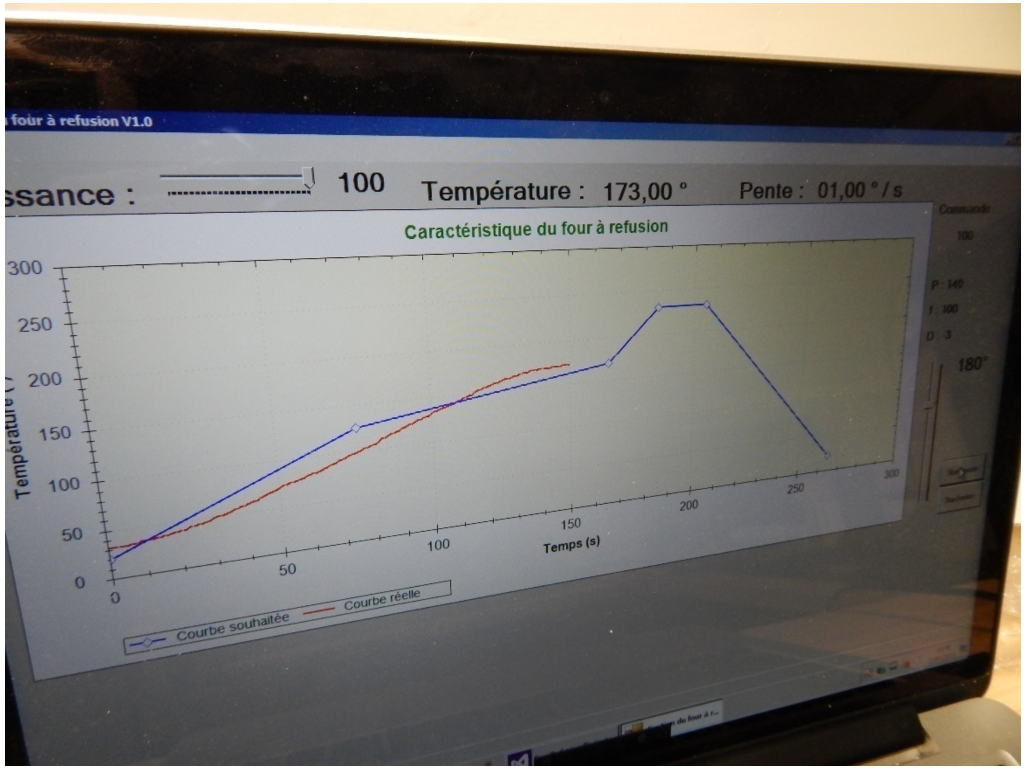




Prototype making

- Manual reflow oven (DIY style)

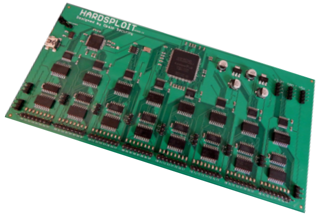


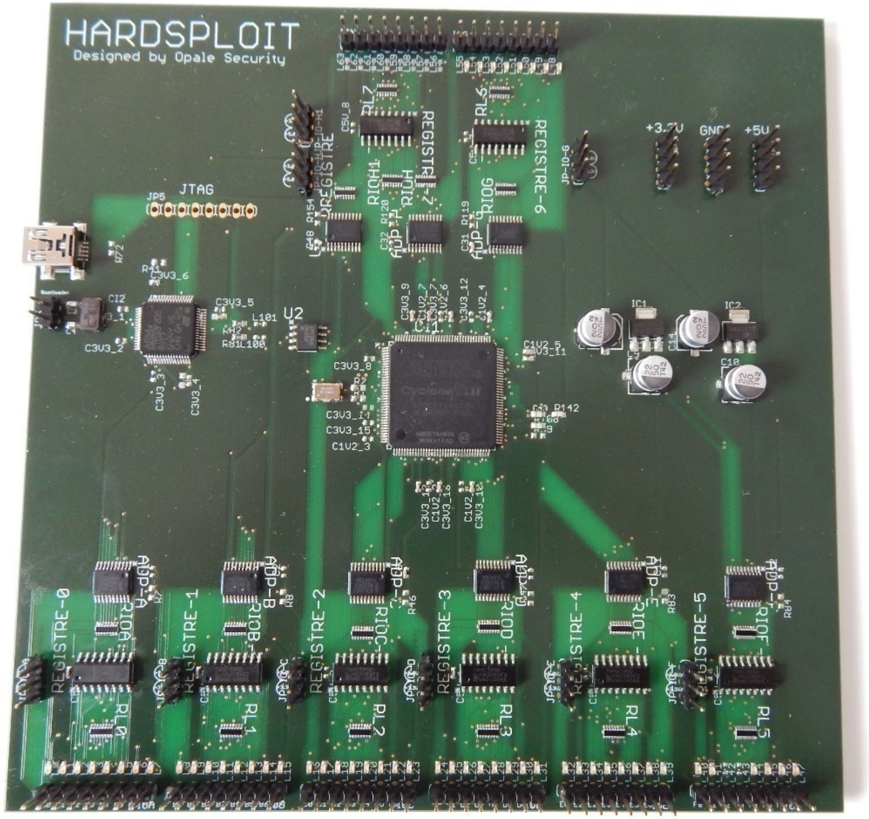


four à refusion V1.0

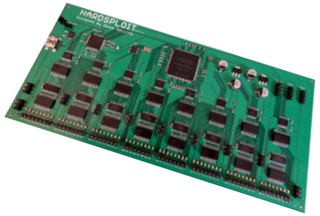
ssance : 100 Température : 173,00 ° Pente : 01,00 ° / s

Prototype V0.1 aka The Green Goblin

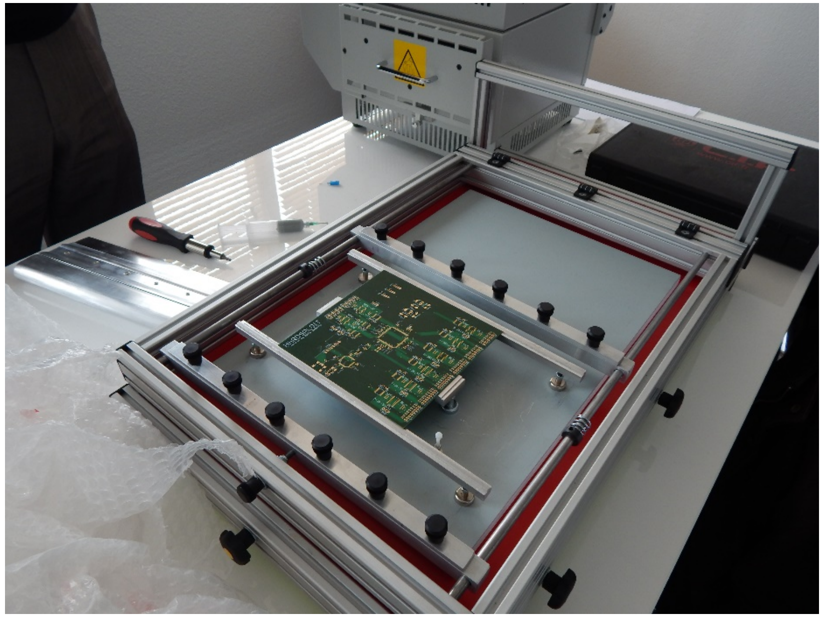


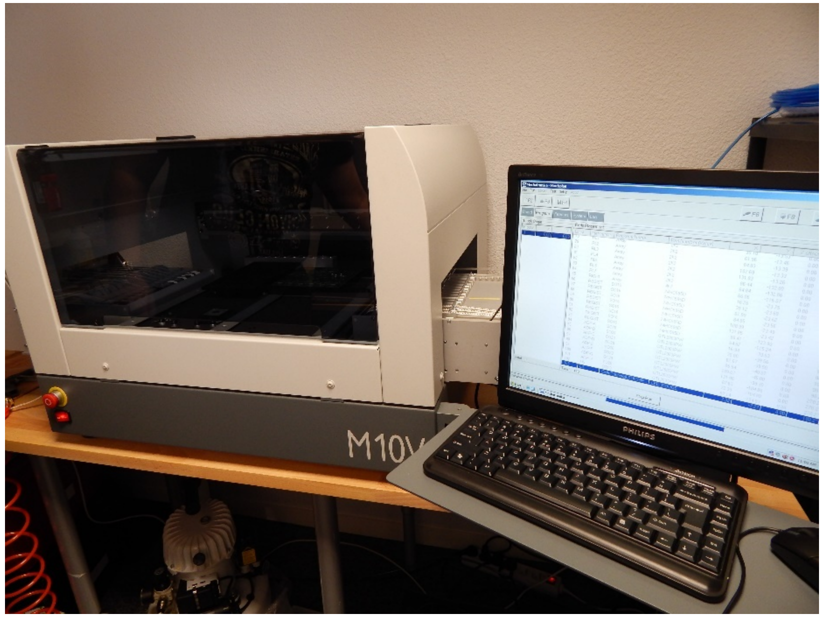


Prototype making (with a budget)

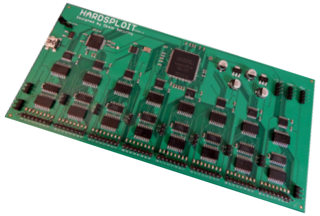


- The rebirth

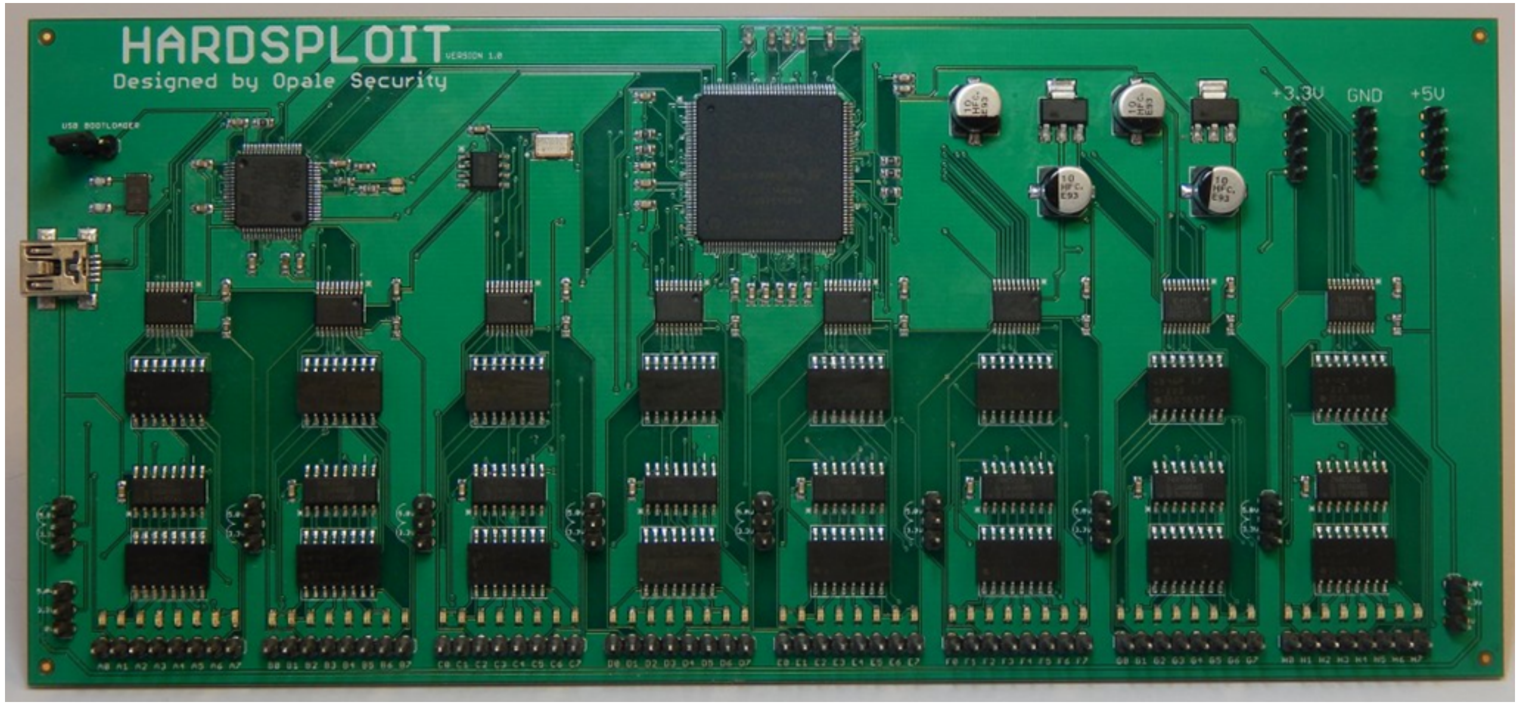




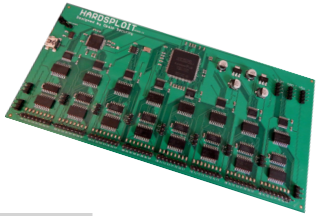
The board – Final version

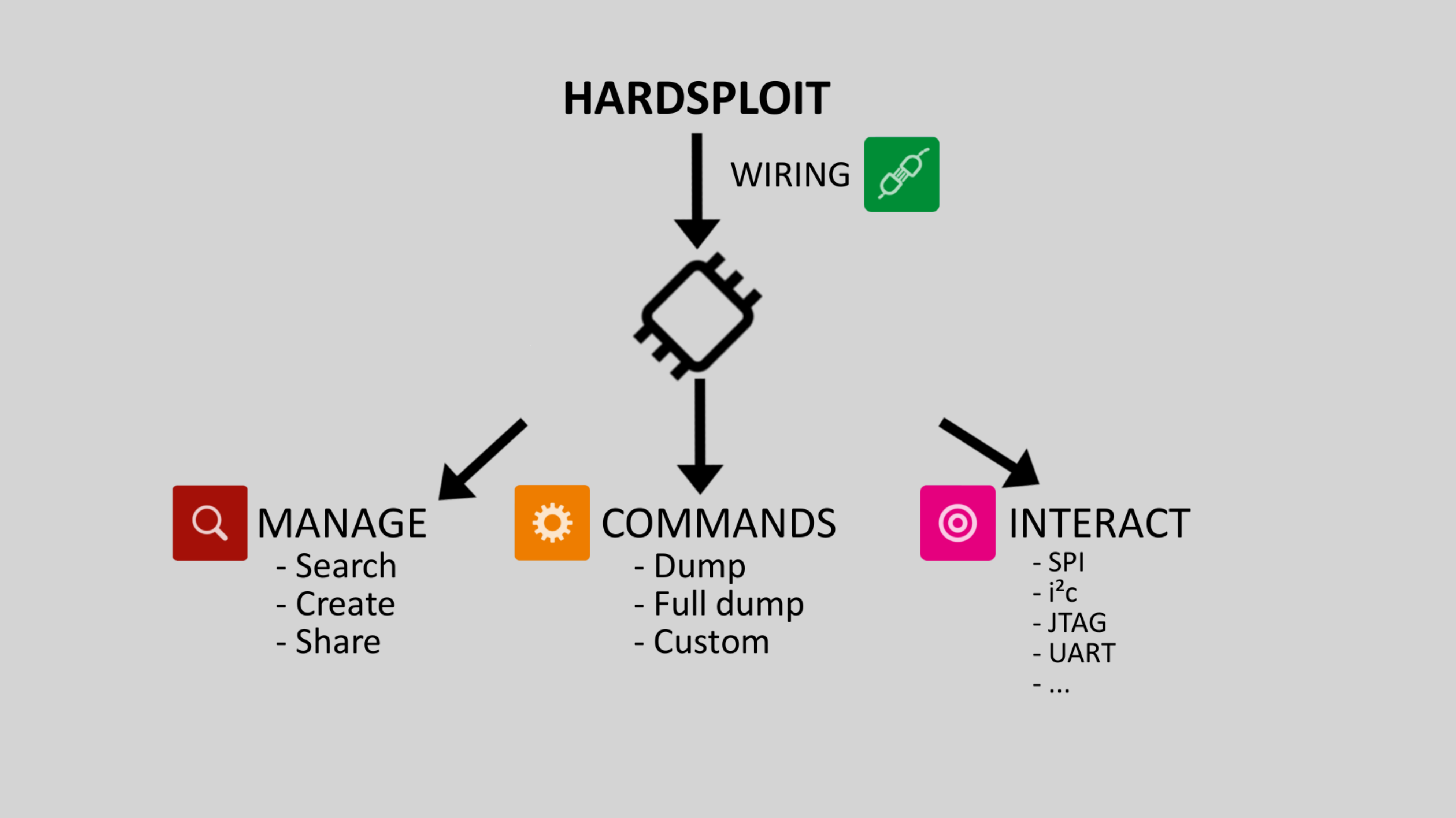


- 64 I/O channels
- Target voltage: 3.3 & 5V
- Use a Cyclone II FPGA
- USB 2.0
- 20cm x 9cm



Organization





HARDSPLOIT

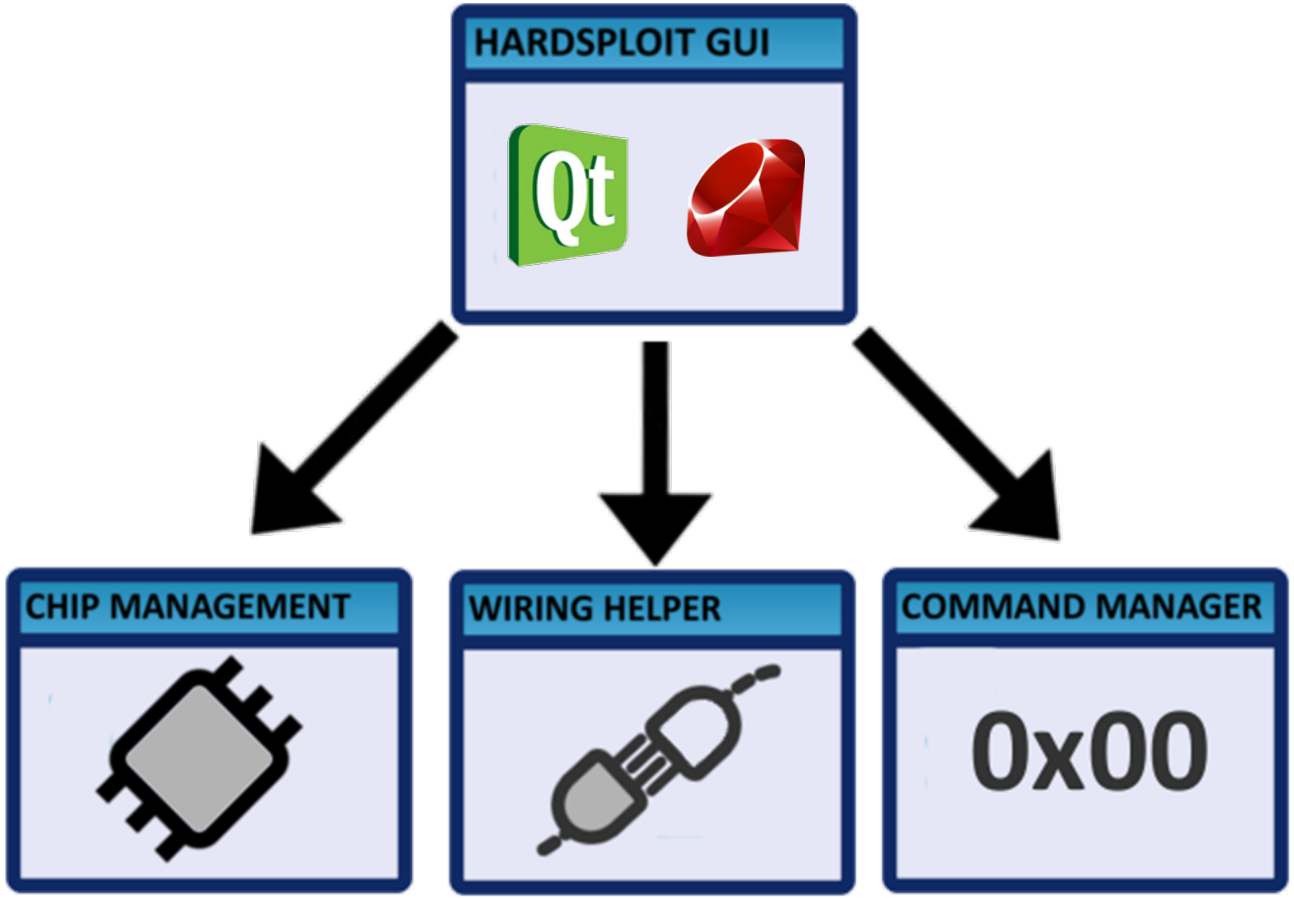
WIRING

MANAGE
- Search
- Create
- Share

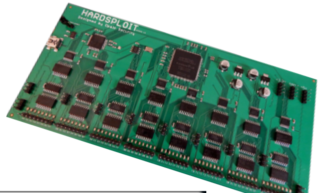
COMMANDS
- Dump
- Full dump
- Custom

INTERACT
- SPI
- i^2c
- JTAG
- UART
- ...

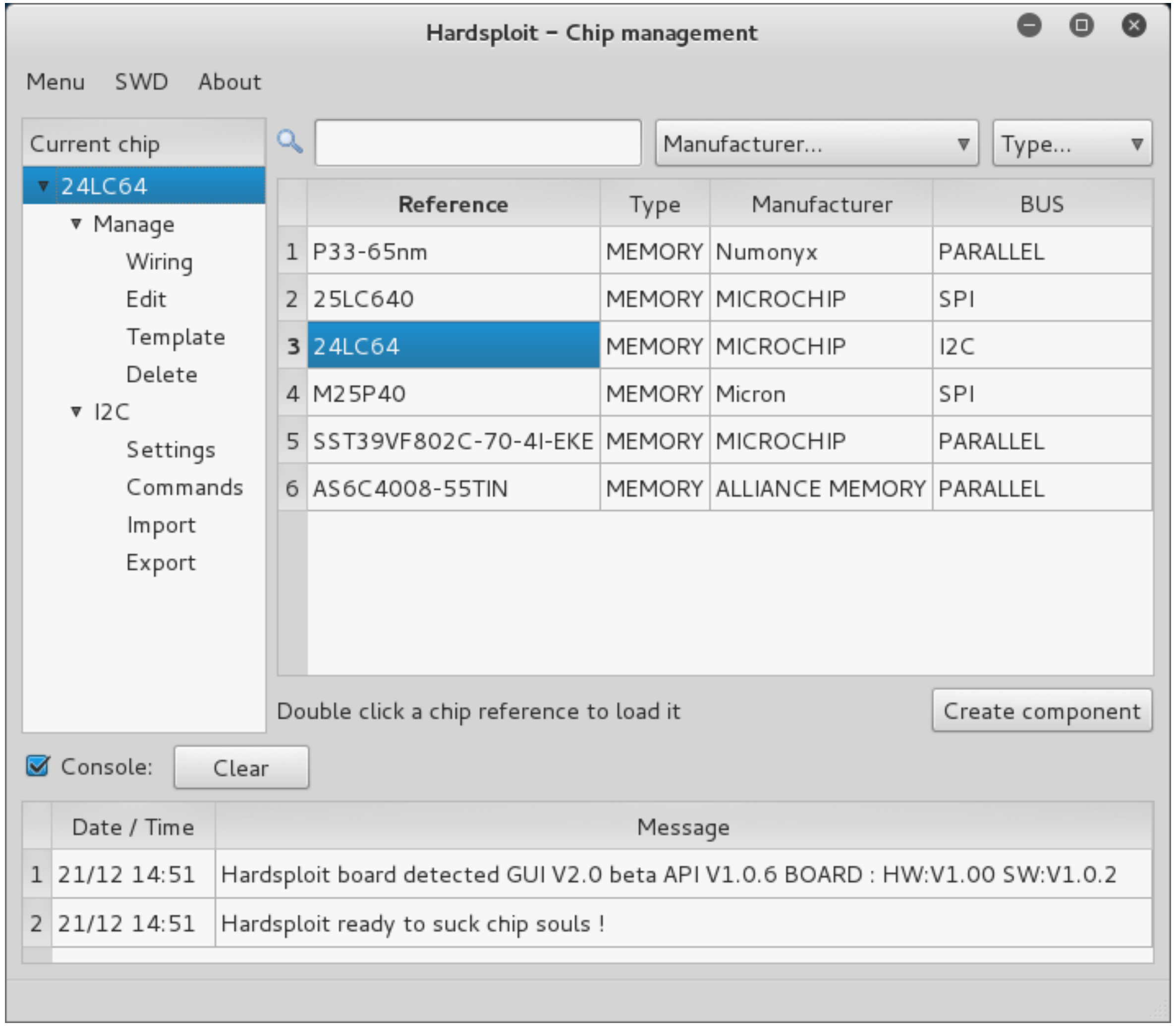
The Graphical Interface (W.I.P)



Chip module



- Search
- Create
- Modify
- Interact



Hardsploit – Chip management

Current chip

- 24LC64
  - Manage
    - Wiring
    - Edit
    - Template
    - Delete
  - I2C
    - Settings
    - Commands
    - Import
    - Export

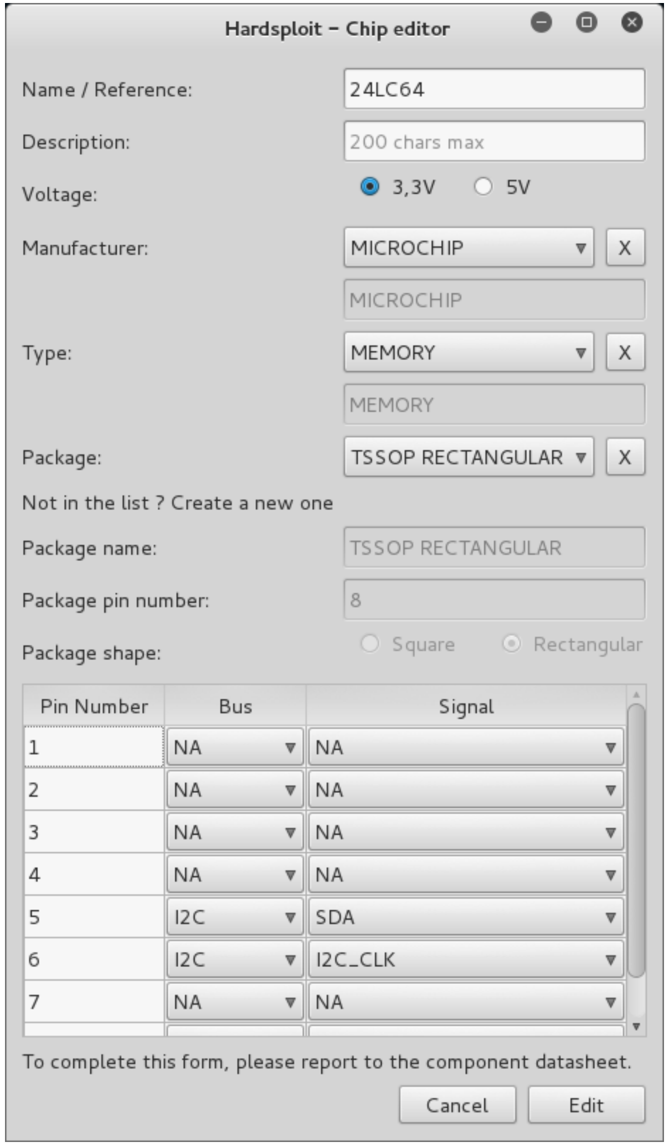
Search: (empty) | Manufacturer... ▾ | Type... ▾

	Reference	Type	Manufacturer	BUS
1	P33-65nm	MEMORY	Numonyx	PARALLEL
2	25LC640	MEMORY	MICROCHIP	SPI
3	24LC64	MEMORY	MICROCHIP	I2C
4	M25P40	MEMORY	Micron	SPI
5	SST39VF802C-70-4I-EKE	MEMORY	MICROCHIP	PARALLEL
6	AS6C4008-55TIN	MEMORY	ALLIANCE MEMORY	PARALLEL

Double click a chip reference to load it

☑ Console:

	Date / Time	Message
1	21/12 14:51	Hardsploit board detected GUI V2.0 beta API V1.0.6 BOARD : HW:V1.00 SW:V1.0.2
2	21/12 14:51	Hardsploit ready to suck chip souls !



Hardsploit – Chip editor

Name / Reference:	24LC64
Description:	200 chars max
Voltage:	● 3,3V ○ 5V
Manufacturer:	MICROCHIP ▾ X MICROCHIP
Type:	MEMORY ▾ X MEMORY
Package:	TSSOP RECTANGULAR ▾ X

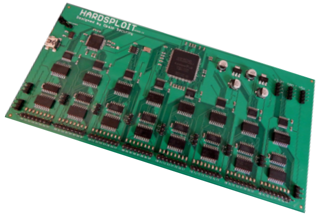
Not in the list ? Create a new one

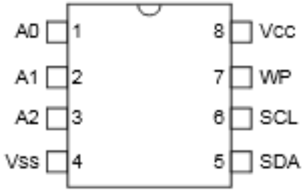
Package name:	TSSOP RECTANGULAR
Package pin number:	8
Package shape:	○ Square ● Rectangular

Pin Number	Bus	Signal
1	NA	NA
2	NA	NA
3	NA	NA
4	NA	NA
5	I2C	SDA
6	I2C	I2C_CLK
7	NA	NA

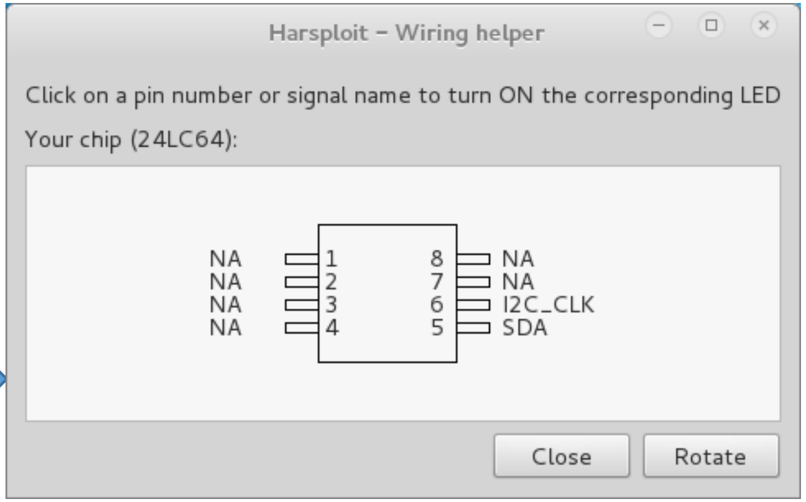
To complete this form, please report to the component datasheet.

Wiring module





Datasheet representation

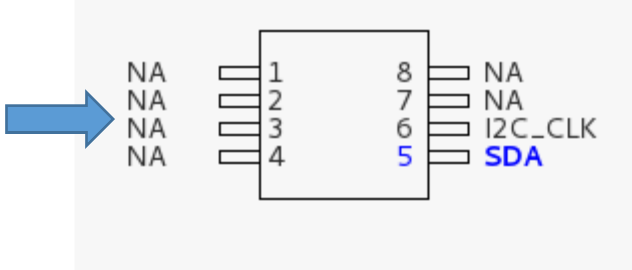


Harsploit – Wiring helper

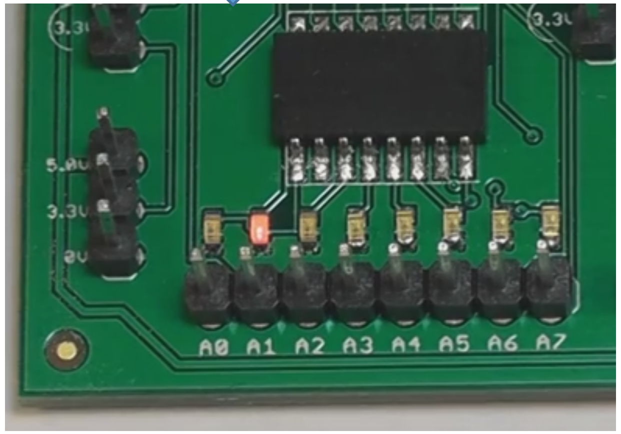
Click on a pin number or signal name to turn ON the corresponding LED

Your chip (24LC64):

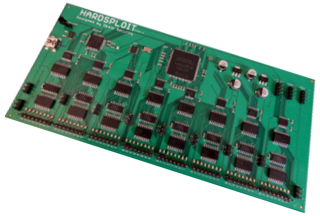
Hardsploit Wiring module representation

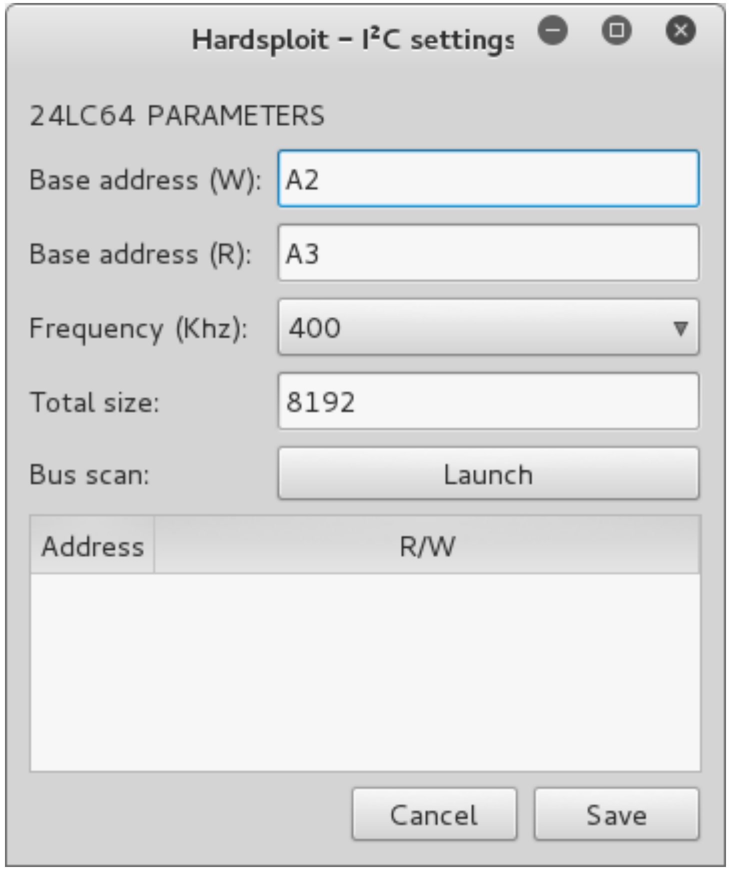


GUI <–> Board interaction



Settings module





Hardsploit – I²C settings

24LC64 PARAMETERS

Base address (W): A2

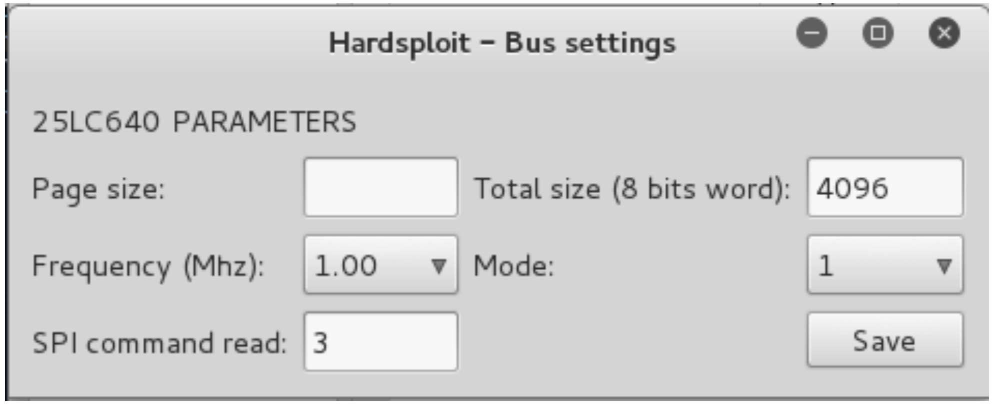
Base address (R): A3

Frequency (Khz): 400

Total size: 8192

Bus scan: Launch

Address	R/W



Hardsploit – Bus settings

25LC640 PARAMETERS

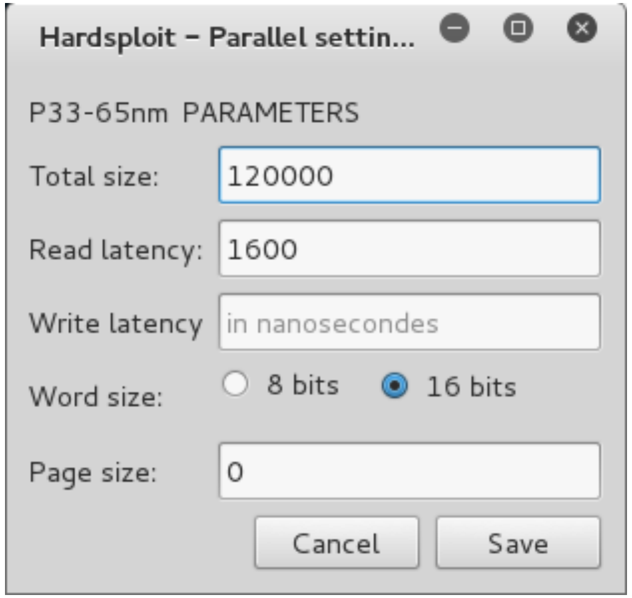
Page size:

Total size (8 bits word): 4096

Frequency (Mhz): 1.00

Mode: 1

SPI command read: 3



Hardsploit – Parallel settin...

P33-65nm PARAMETERS

Total size: 120000

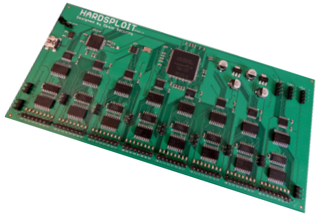
Read latency: 1600

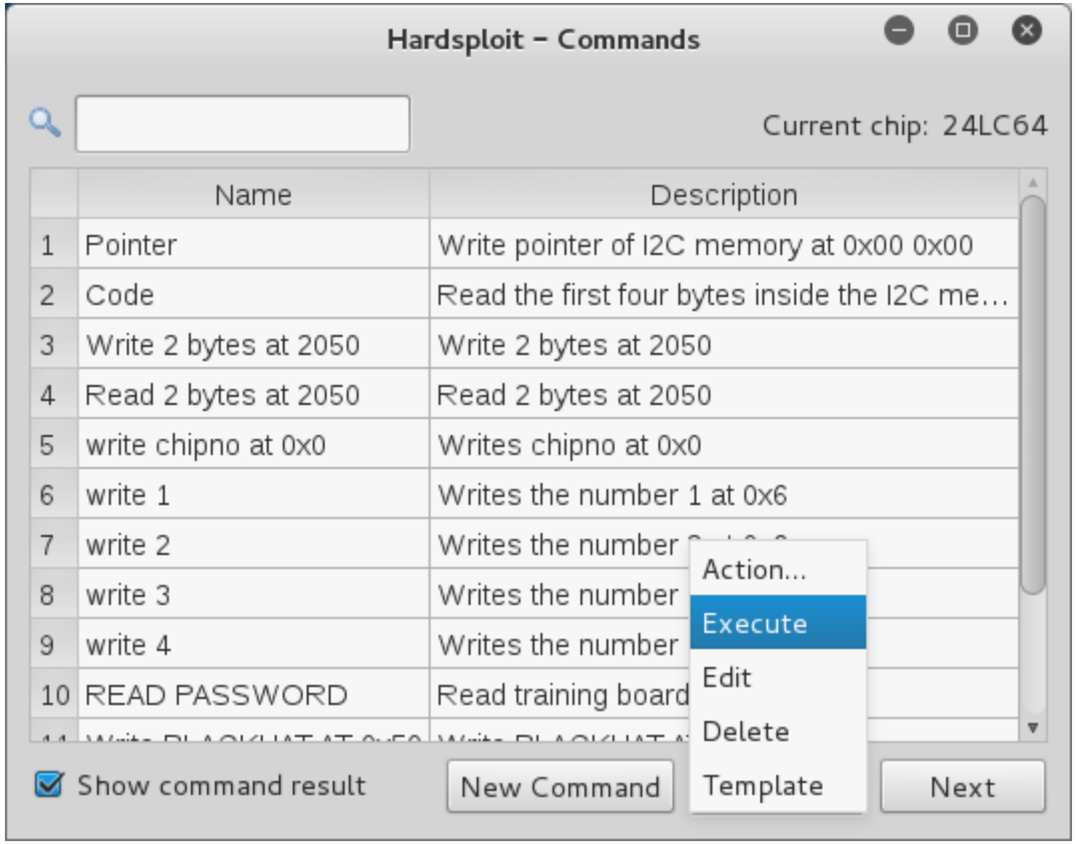
Write latency: in nanosecondes

Word size: ○ 8 bits ● 16 bits

Page size: 0

Command module

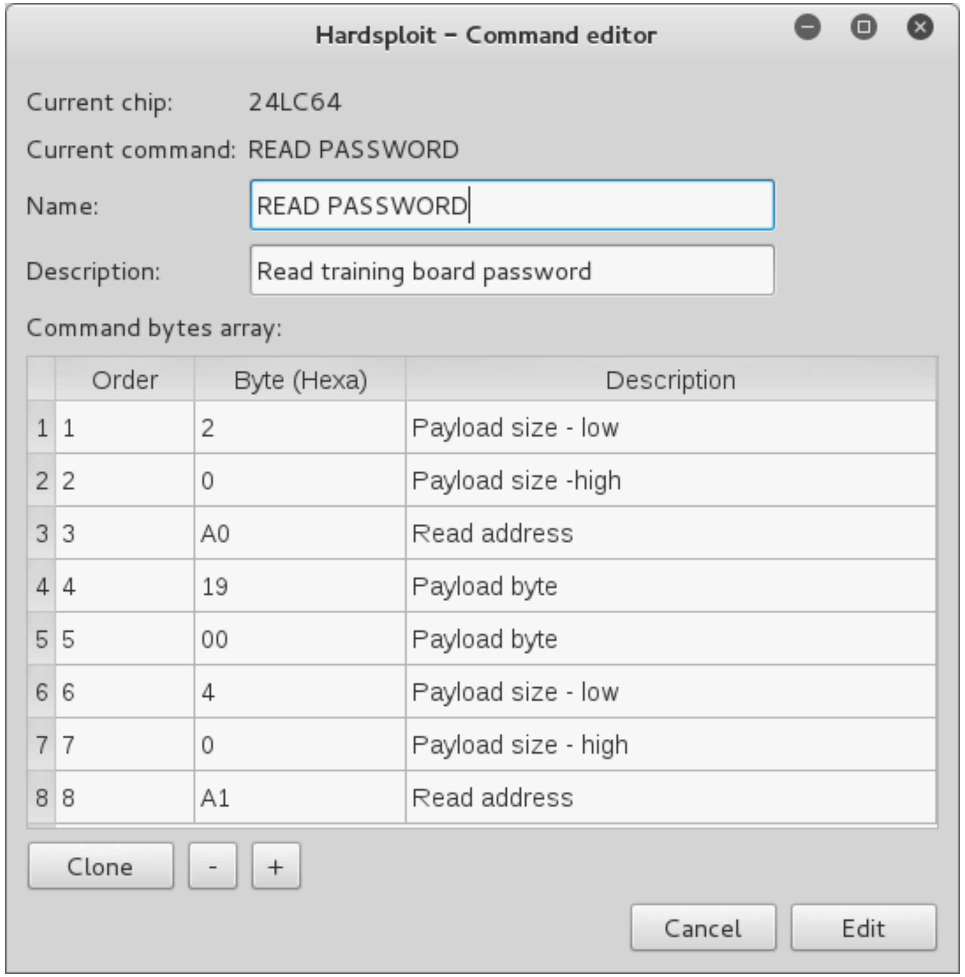




Current chip: 24LC64

	Name	Description
1	Pointer	Write pointer of I2C memory at 0x00 0x00
2	Code	Read the first four bytes inside the I2C me…
3	Write 2 bytes at 2050	Write 2 bytes at 2050
4	Read 2 bytes at 2050	Read 2 bytes at 2050
5	write chipno at 0x0	Writes chipno at 0x0
6	write 1	Writes the number 1 at 0x6
7	write 2	Writes the number
8	write 3	Writes the number
9	write 4	Writes the number
10	READ PASSWORD	Read training board
11	Write BLACKHAT AT 0x50	Write BLACKHAT A

☑ Show command result



Current chip: 24LC64

Current command: READ PASSWORD

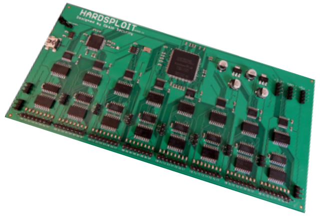
Name: READ PASSWORD

Description: Read training board password

Command bytes array:

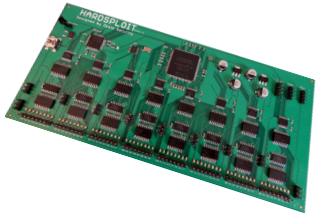
	Order	Byte (Hexa)	Description
1	1	2	Payload size - low
2	2	0	Payload size -high
3	3	A0	Read address
4	4	19	Payload byte
5	5	00	Payload byte
6	6	4	Payload size - low
7	7	0	Payload size - high
8	8	A1	Read address

The API



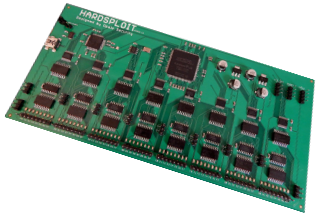
- Free to use API
- Create your own GUI
- Don’t use GUI at all
- Use it in your program
- …

Already available



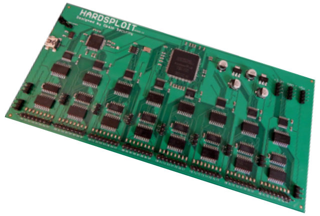
- Parallel non multiplexed memory dump
  - 32 bits for address
  - 8/16 bits for data
- Helping wiring
- I2C 100Khz 400Khz and 1 Mhz
  - Addresses scan
  - Read, write, automatic full and partial dump
- SPI mode 0,1,2,3 up to 25 Mhz
  - Read, write, automatic full and partial dump
- SWD interface (JTAG)
  - Dump and write firmware of most ARM CPU
- GPIO interact / bitbanging
  - Low speed < 500Hz read & write operations on 64 bits

More to come…

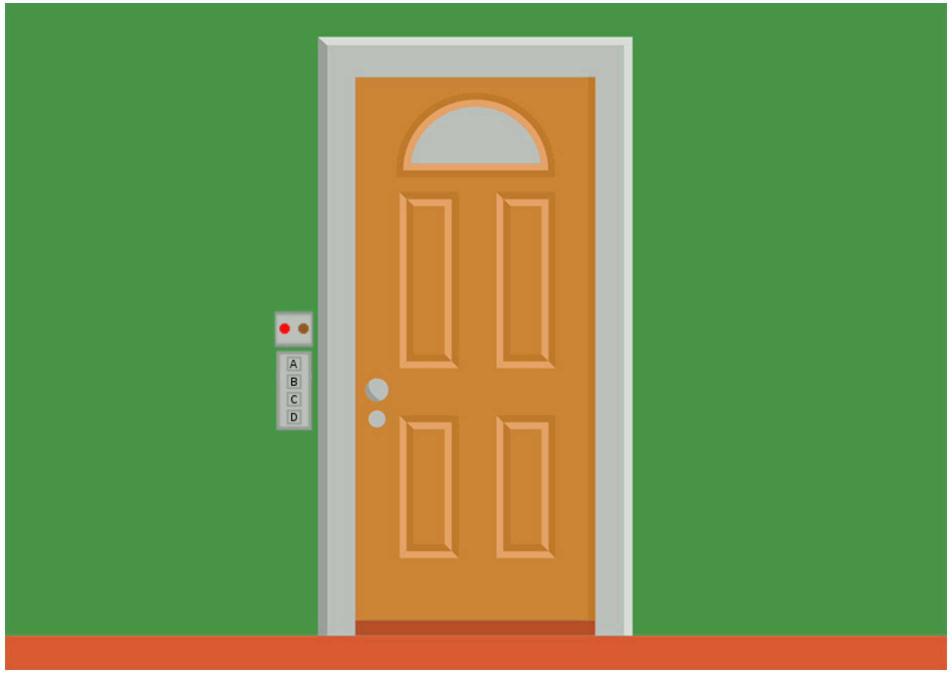


- Component & commands sharing platform
- TTL UART Module (RS232 and RS485 with level adapter)
- Parallel communication with multiplexed memory
- I2C sniffing (shot of 4000 bytes up to 1 Mhz)
- SPI sniffing (shot of 8000 bytes up to 25 Mhz in half / full duplex)
- RF Wireless transmission training platform (Nordic NRF24)
- Metasploit integration (module)
- JTAG pinout finder
- 1 Wire
- CanBUS (with level adapter)
- …

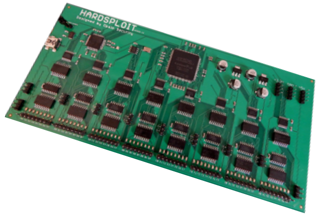
Concrete case

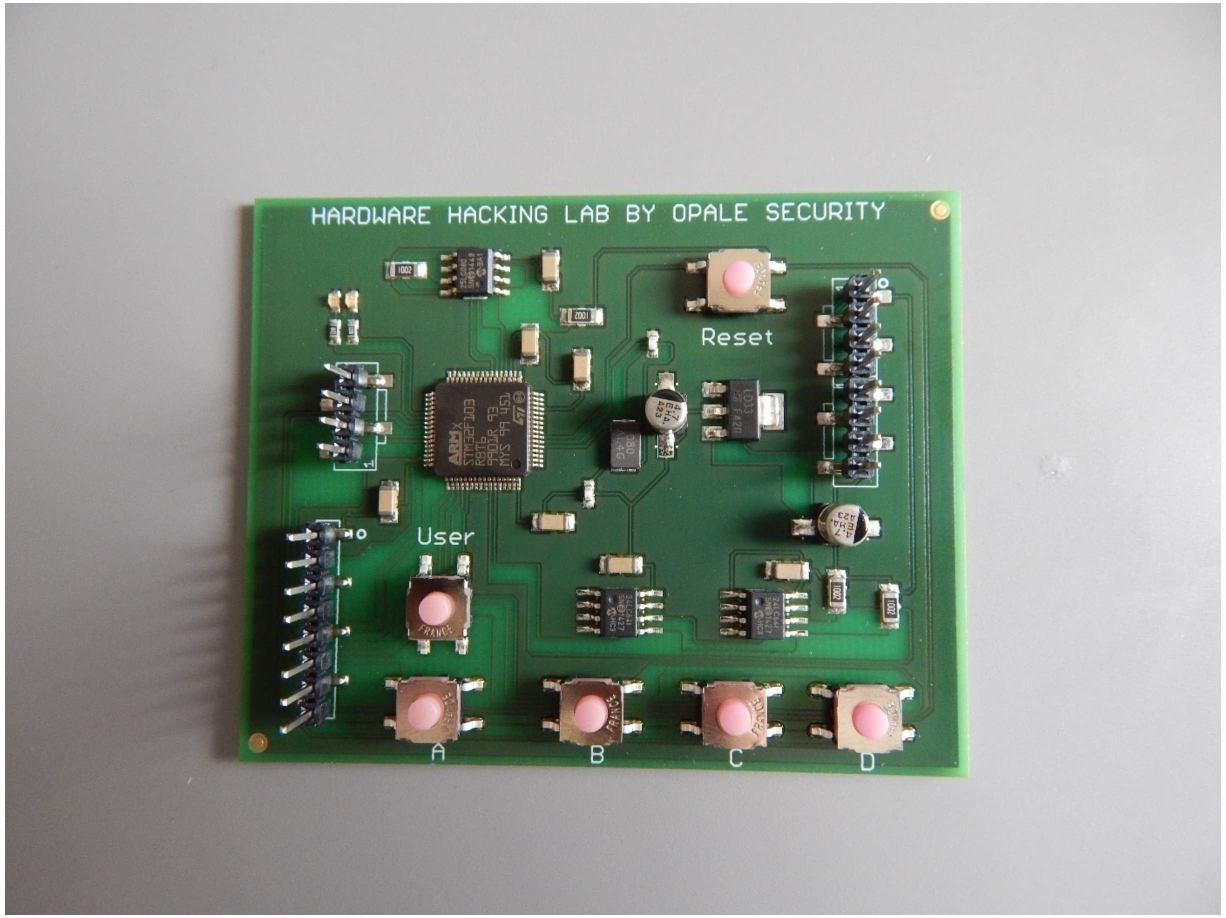


- An electronic lock system
- 4 characters pin code A – B – C – D
  - Good combinaison – Door opens, green L.E.D turn on
  - Wrong combinaison – Door closes, red L.E.D turn on

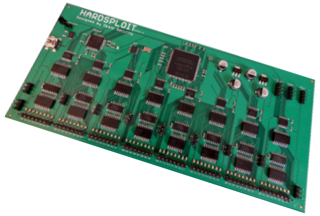


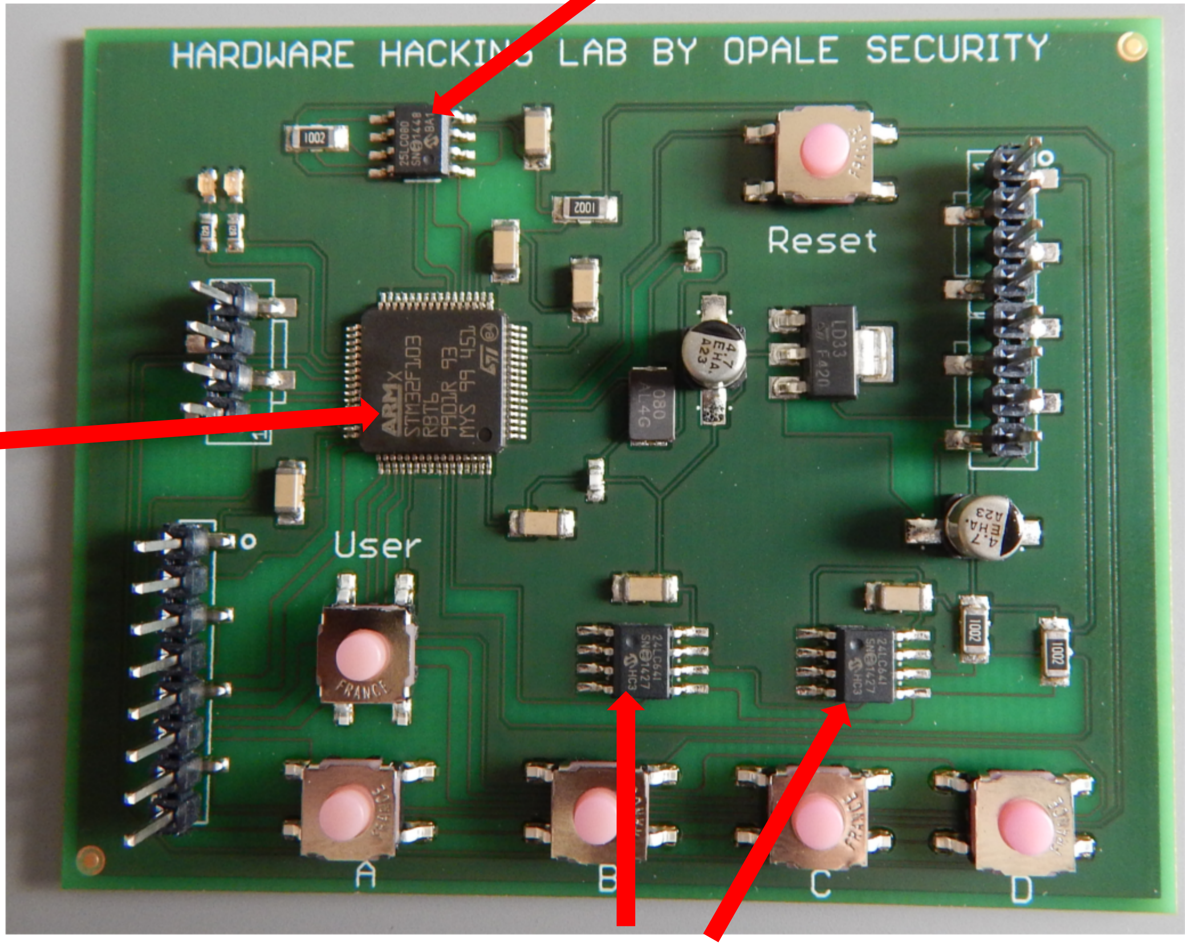
1/ Open it





2/ Fingerprint

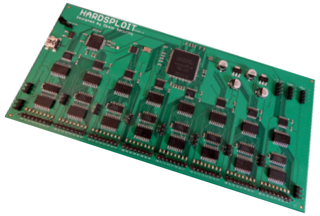




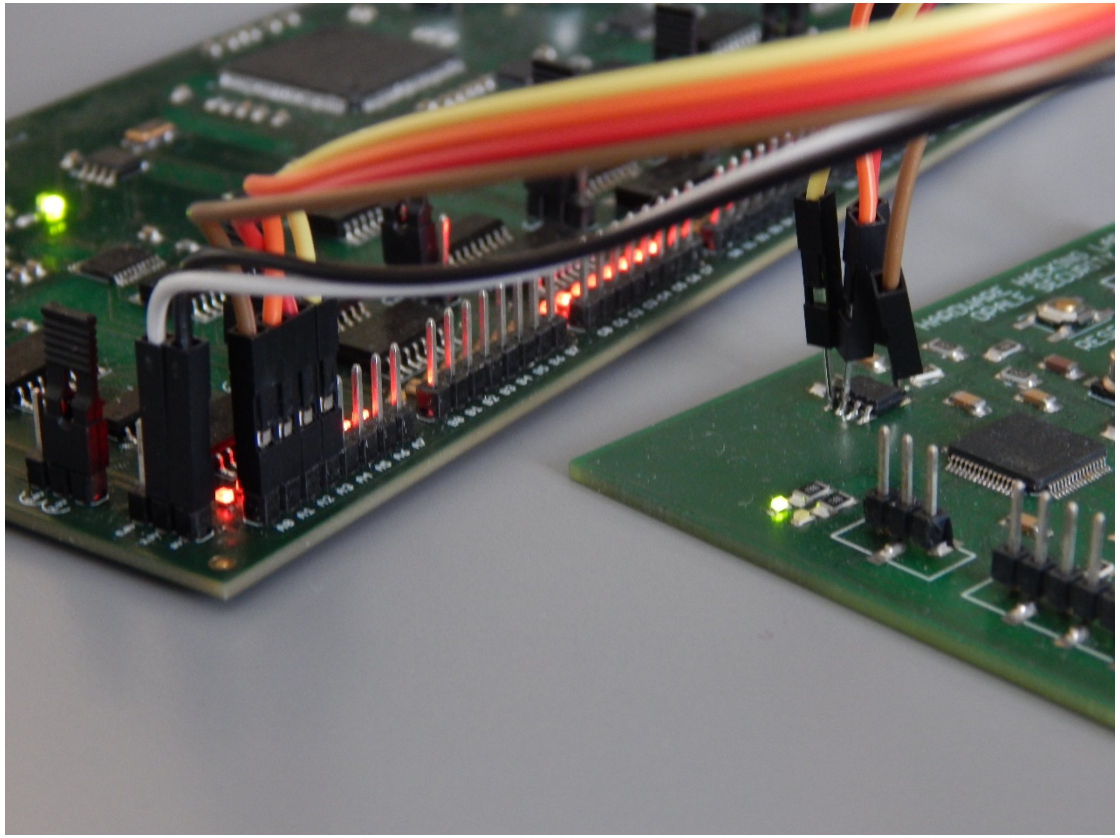
SPI MEMORY 25LC08

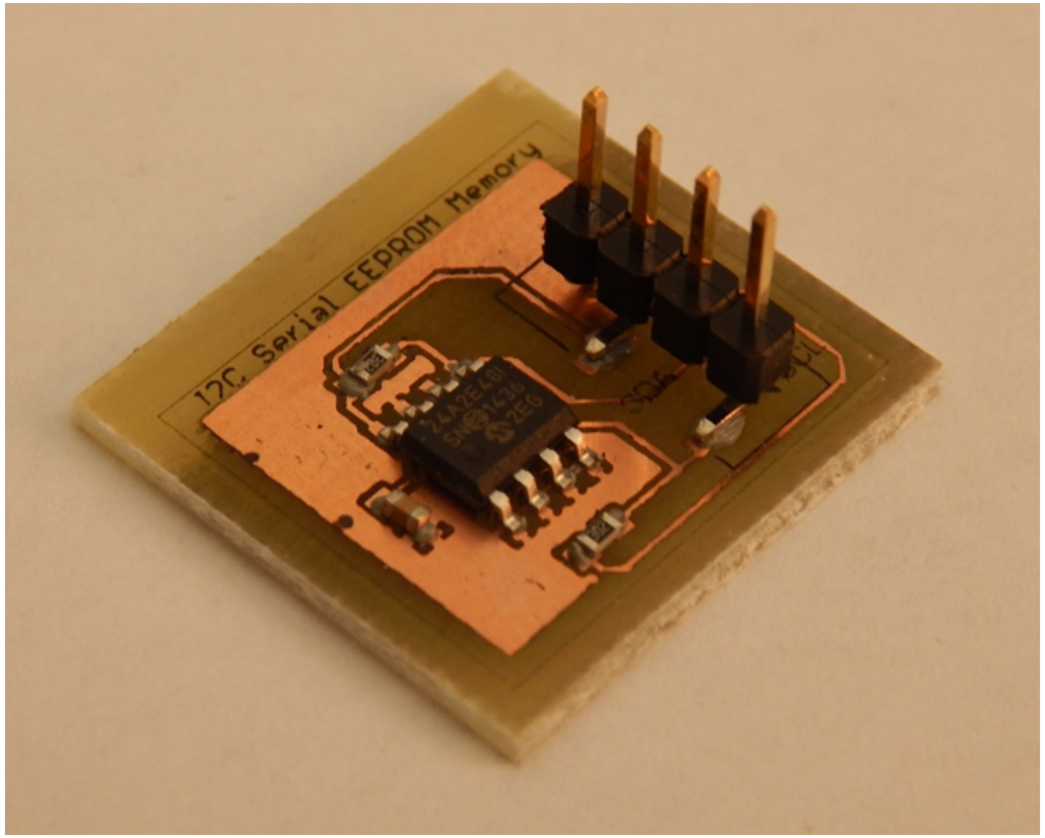
STM32F103RBT6

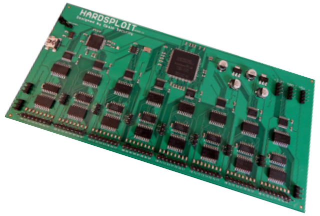
I2C MEMORIES 24LC64



Online / Offline analysis ?



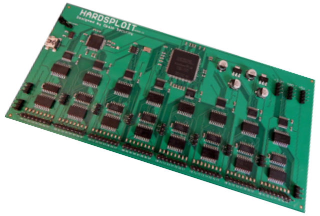




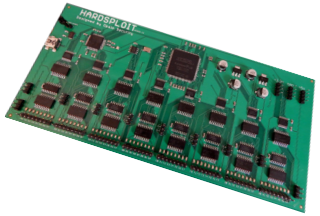
Scenario

- Open Hardsploit to create the component
- Connect the component to Hardsploit
- Enter and save the component settings
- Dump the content of the memories
- Change the door password by using commands
- Try the new password on the lock system

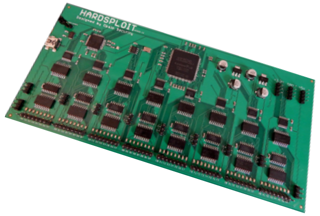
Read | Write operation



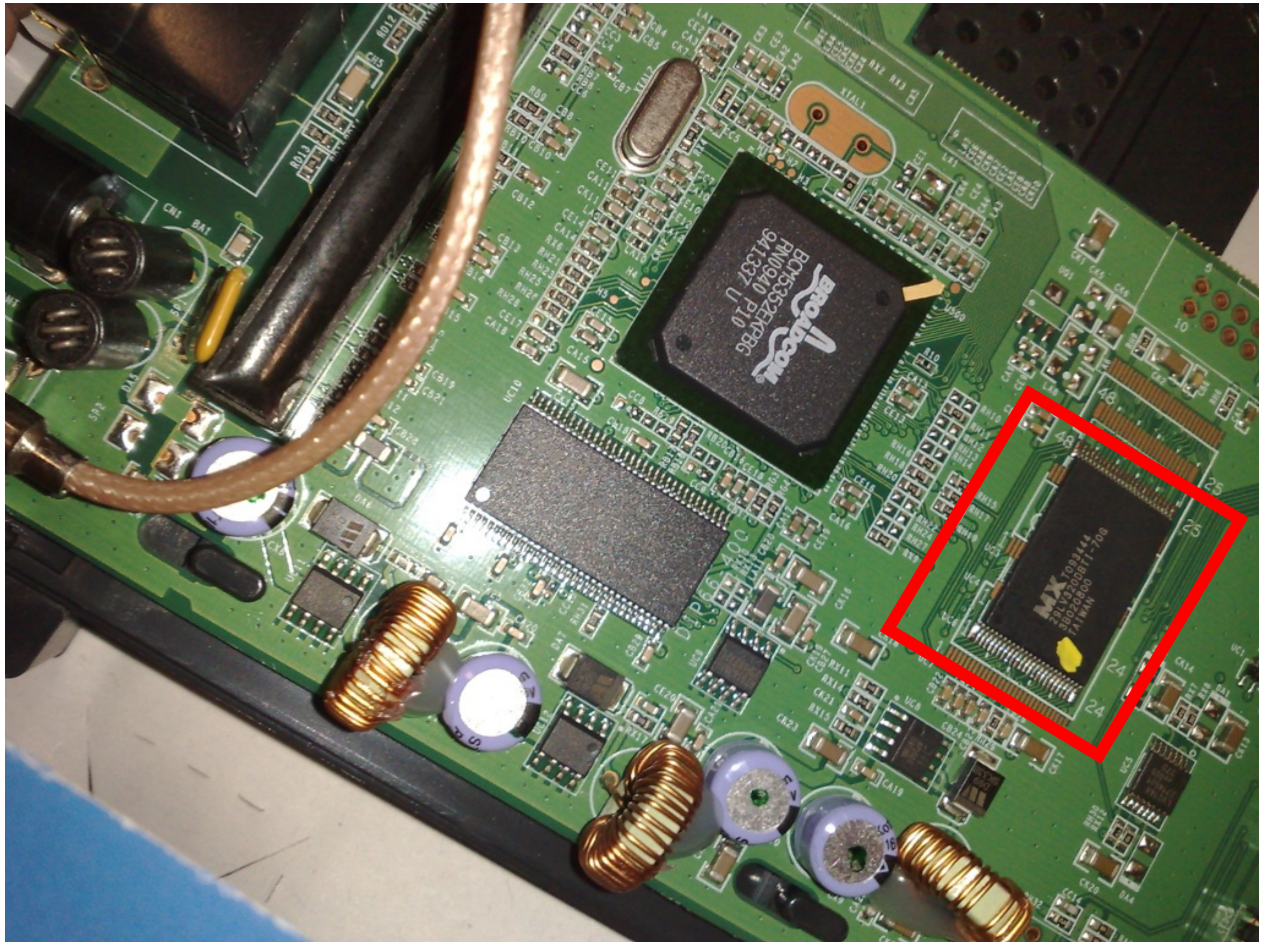
- Time for a live demo ?



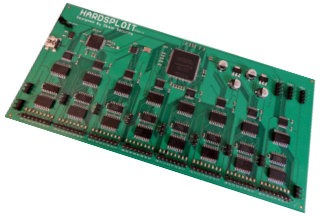
Parallel bus memory

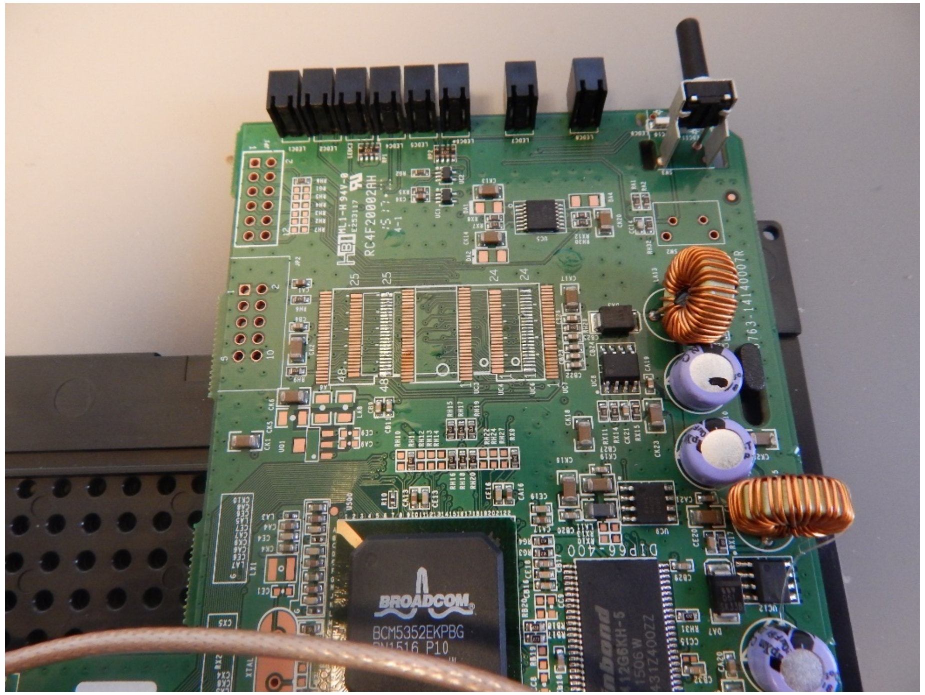


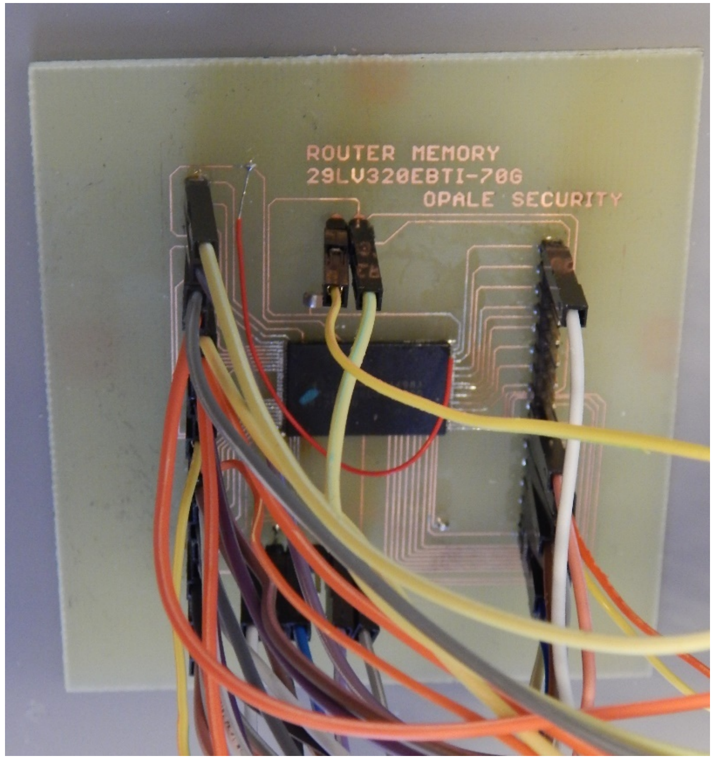
1/ Fingerprint

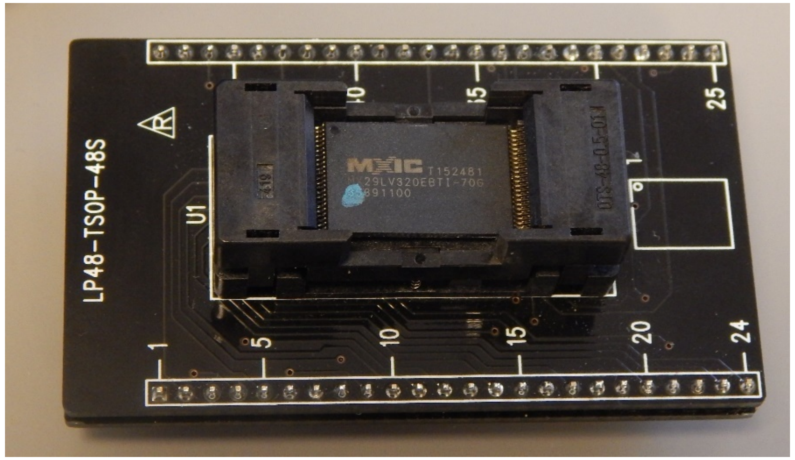


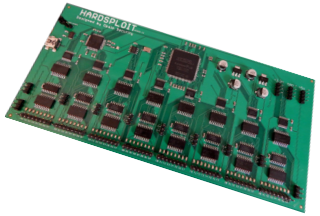
2/ Offline analysis



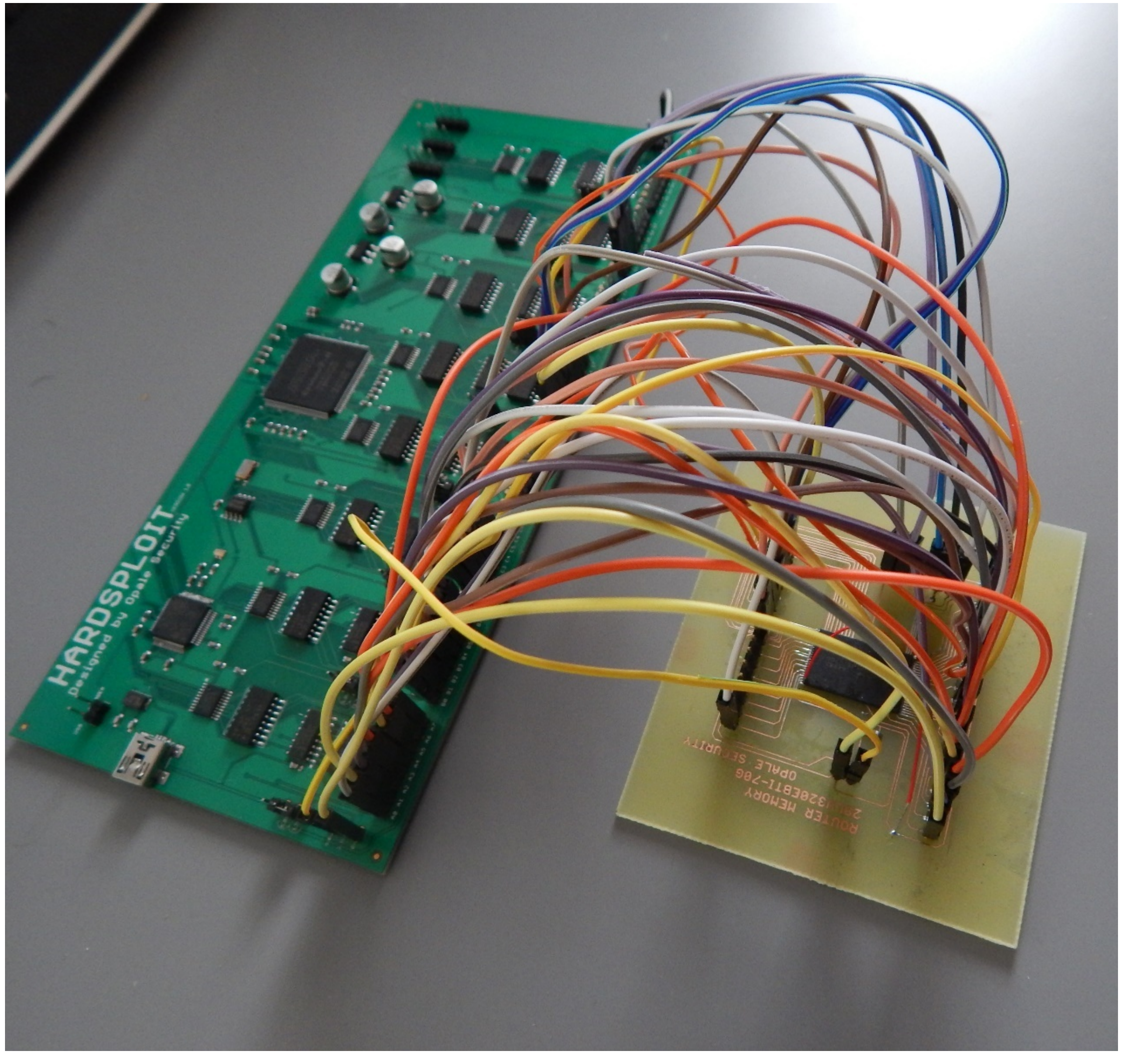


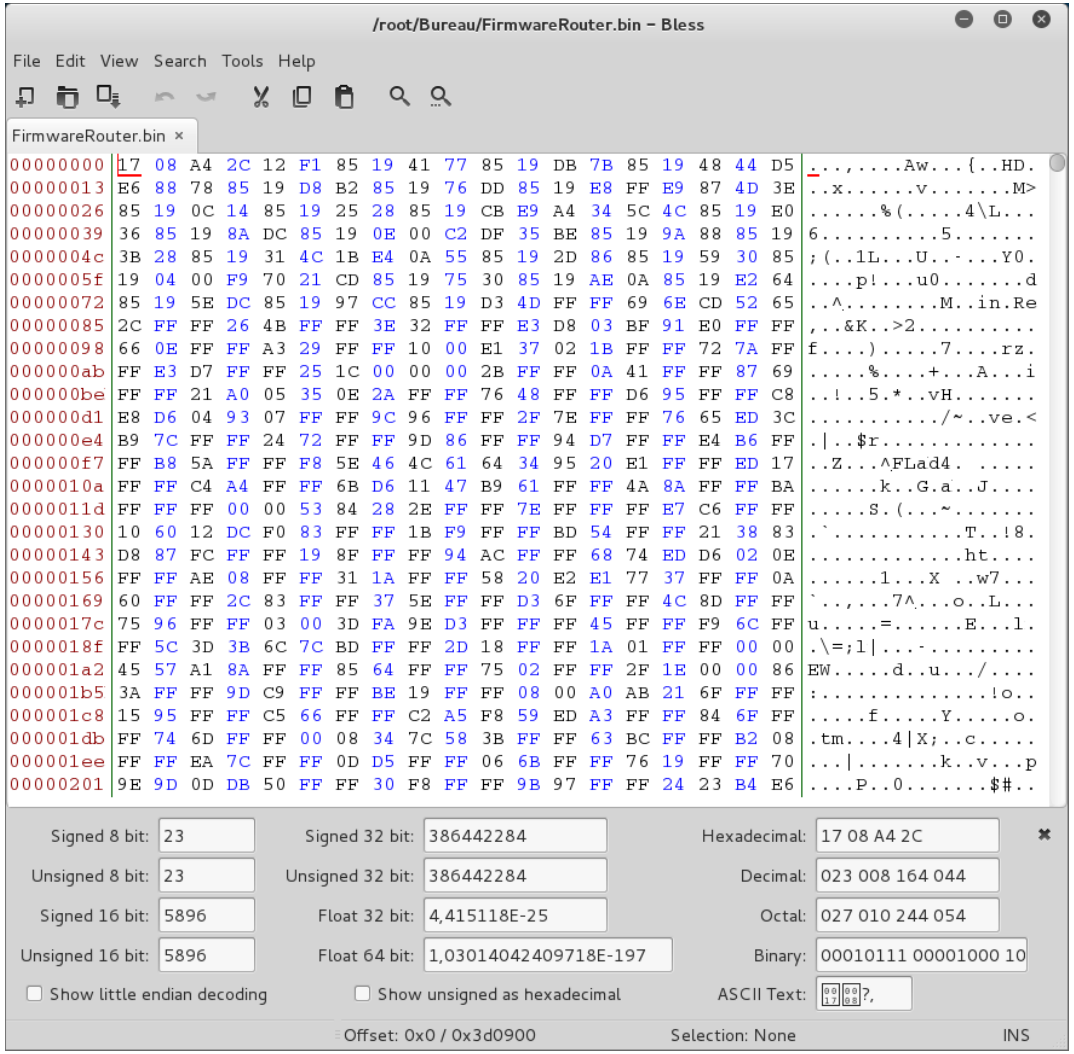






3/ Ready to dump the content




/root/Bureau/FirmwareRouter.bin – Bless
File Edit View Search Tools Help
FirmwareRouter.bin ×

```
00000000 17 08 A4 2C 12 F1 85 19 41 77 85 19 DB 7B 85 19 48 44 D5 ...,....Aw...{..HD.
00000013 E6 88 78 85 19 D8 B2 85 19 76 DD 85 19 E8 FF E9 87 4D 3E ..x......v.......M>
00000026 85 19 0C 14 85 19 25 28 85 19 CB E9 A4 34 5C 4C 85 19 E0 ......%(.....4\L...
00000039 36 85 19 8A DC 85 19 0E 00 C2 DF 35 BE 85 19 9A 88 85 19 6..........5.......
0000004c 3B 28 85 19 31 4C 1B E4 0A 55 85 19 2D 86 85 19 59 30 85 ;(..1L...U..-...Y0.
0000005f 19 04 00 F9 70 21 CD 85 19 75 30 85 19 AE 0A 85 19 E2 64 ....p!...u0.......d
00000072 85 19 5E DC 85 19 97 CC 85 19 D3 4D FF FF 69 6E CD 52 65 ..^.........M..in.Re
00000085 2C FF FF 26 4B FF FF 3E 32 FF FF E3 D8 03 BF 91 E0 FF FF ,..&K..>2..........
00000098 66 0E FF FF A3 29 FF FF 10 00 E1 37 02 1B FF FF 72 7A FF f....).....7....rz.
000000ab FF E3 D7 FF FF 25 1C 00 00 00 2B FF FF 0A 41 FF FF 87 69 .....%....+...A...i
000000be FF FF 21 A0 05 35 0E 2A FF FF 76 48 FF FF D6 95 FF FF C8 ..!..5.*..vH.......
000000d1 E8 D6 04 93 07 FF FF 9C 96 FF FF 2F 7E FF FF 76 65 ED 3C .........../~..ve.<
000000e4 B9 7C FF FF 24 72 FF FF 9D 86 FF FF 94 D7 FF FF E4 B6 FF .|..$r.............
000000f7 FF B8 5A FF FF F8 5E 46 4C 61 64 34 95 20 E1 FF FF ED 17 ..Z...^FLad4. .....
0000010a FF FF C4 A4 FF FF 6B D6 11 47 B9 61 FF FF 4A 8A FF FF BA ......k..G.a..J....
0000011d FF FF FF 00 00 53 84 28 2E FF FF 7E FF FF FF E7 C6 FF FF .....S.(...~.......
00000130 10 60 12 DC F0 83 FF FF 1B F9 FF FF BD 54 FF FF 21 38 83 .`..........T..!8.
00000143 D8 87 FC FF FF 19 8F FF FF 94 AC FF FF 68 74 ED D6 02 0E .............ht....
00000156 FF FF AE 08 FF FF 31 1A FF FF 58 20 E2 E1 77 37 FF FF 0A ......1...X ..w7...
00000169 60 FF FF 2C 83 FF FF 37 5E FF FF D3 6F FF FF 4C 8D FF FF `..,...7^...o..L...
0000017c 75 96 FF FF 03 00 3D FA 9E D3 FF FF FF 45 FF FF F9 6C FF u.....=......E...l.
0000018f FF 5C 3D 3B 6C 7C BD FF FF 2D 18 FF FF 1A 01 FF FF 00 00 .\=;l|...-.........
000001a2 45 57 A1 8A FF FF 85 64 FF FF 75 02 FF FF 2F 1E 00 00 86 EW.....d..u.../....
000001b5 3A FF FF 9D C9 FF FF BE 19 FF FF 08 00 A0 AB 21 6F FF FF :...............!o..
000001c8 15 95 FF FF C5 66 FF FF C2 A5 F8 59 ED A3 FF FF 84 6F FF .....f.....Y.....o.
000001db FF 74 6D FF FF 00 08 34 7C 58 3B FF FF 63 BC FF FF B2 08 .tm....4|X;..c.....
000001ee FF FF EA 7C FF FF 0D D5 FF FF 06 6B FF FF 76 19 FF FF 70 ...|.......k..v...p
00000201 9E 9D 0D DB 50 FF FF 30 F8 FF FF 9B 97 FF FF 24 23 B4 E6 ....P..0.......$#..
```

Signed 8 bit: 23
Unsigned 8 bit: 23
Signed 16 bit: 5896
Unsigned 16 bit: 5896

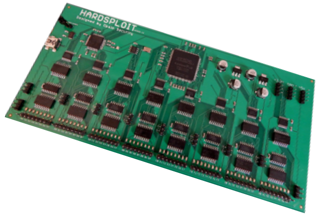
Signed 32 bit: 386442284
Unsigned 32 bit: 386442284
Float 32 bit: 4,415118E-25
Float 64 bit: 1,03014042409718E-197

Hexadecimal: 17 08 A4 2C
Decimal: 023 008 164 044
Octal: 027 010 244 054
Binary: 00010111 00001000 10
ASCII Text: ?,

☐ Show little endian decoding
☐ Show unsigned as hexadecimal

Offset: 0x0 / 0x3d0900   Selection: None   INS

Thank you !



- To learn more about Hardsploit and follow the development:

hardsploit.io