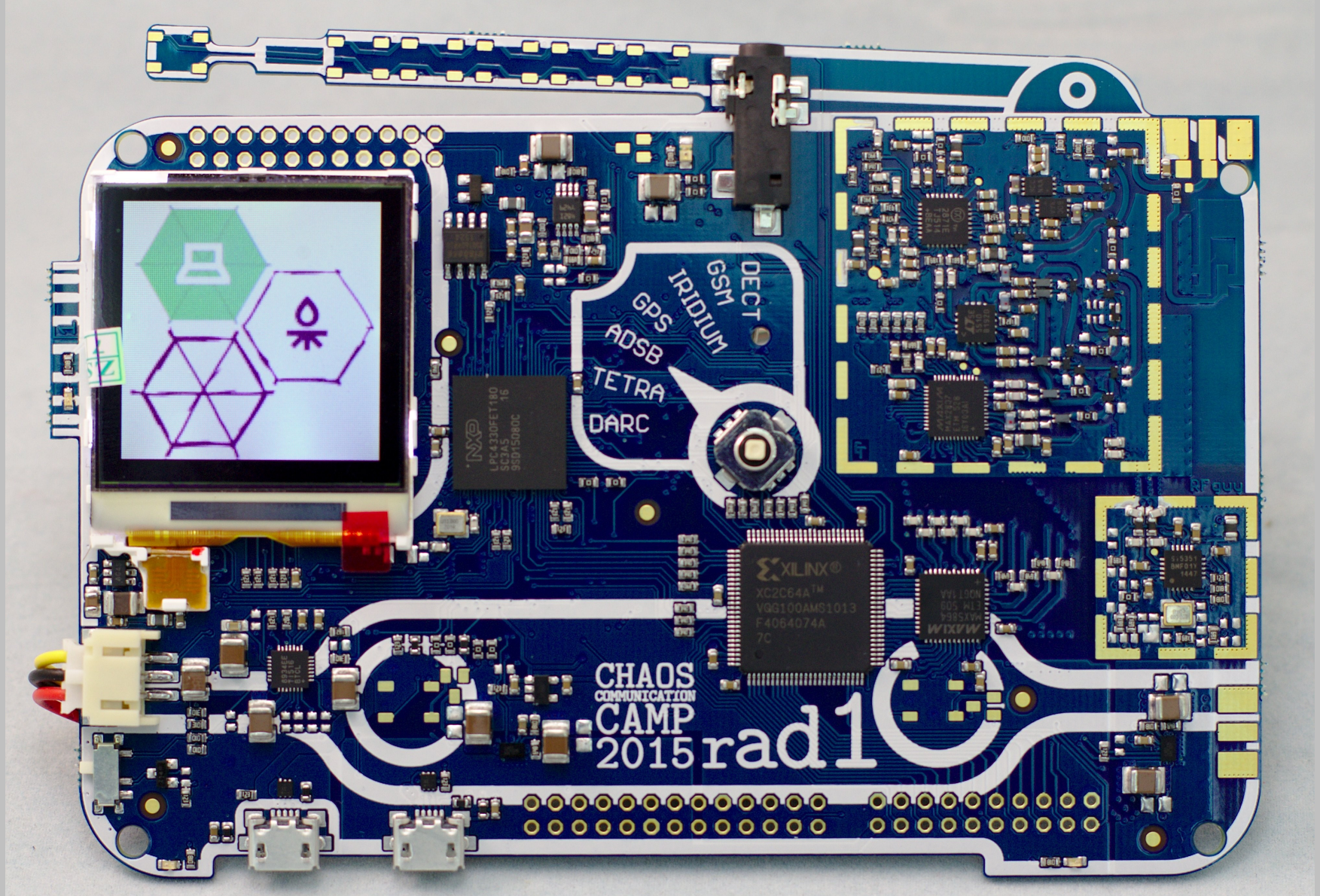
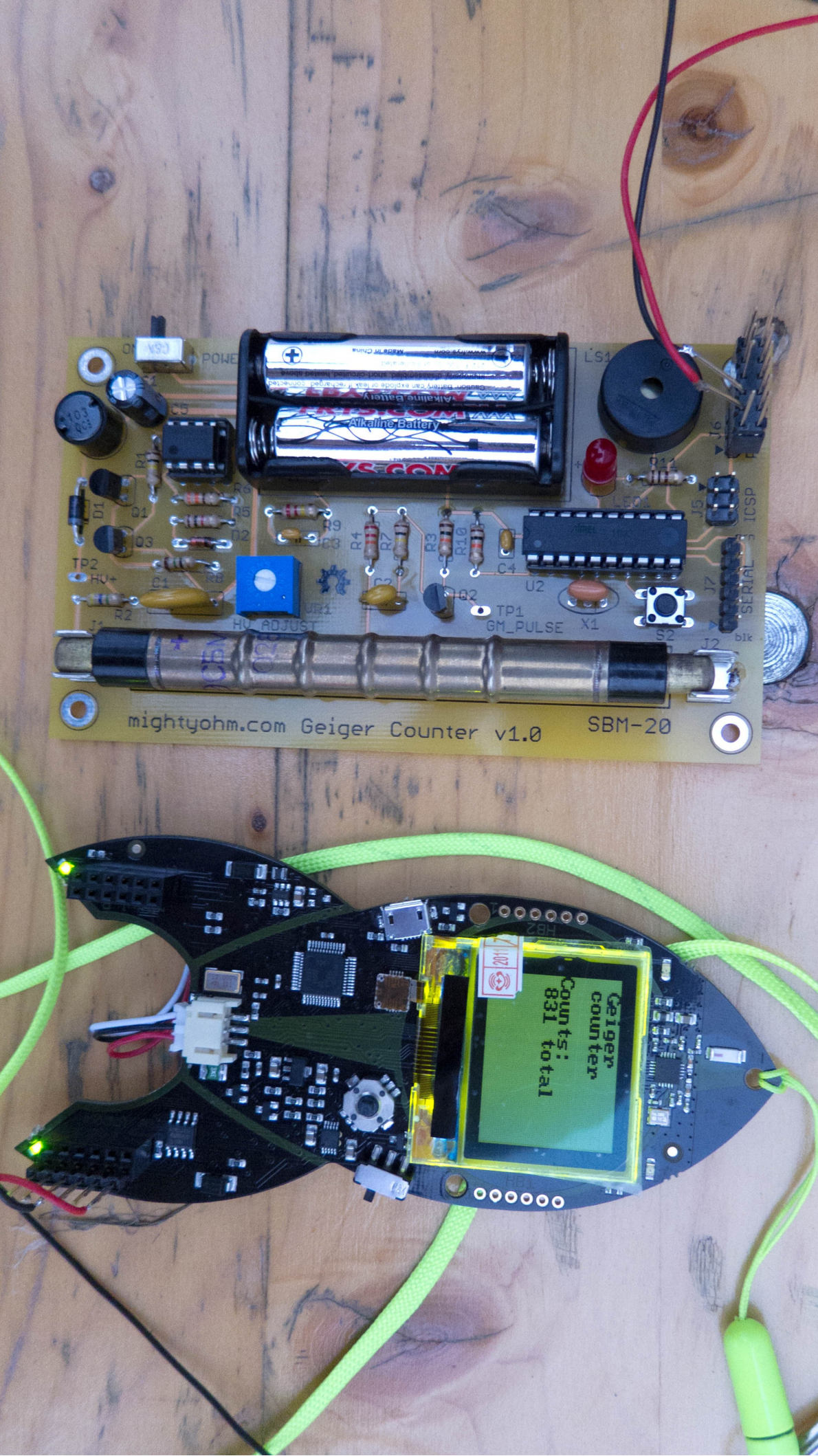

DECT
GSM
IRIDIUM
GPS
ADSB
TETRA
DARC
XILINX
XC2C64A
VQG100AMS1013
F4064074A
7C
CHAOS
COMMUNICATION
CAMP
2015
rad1

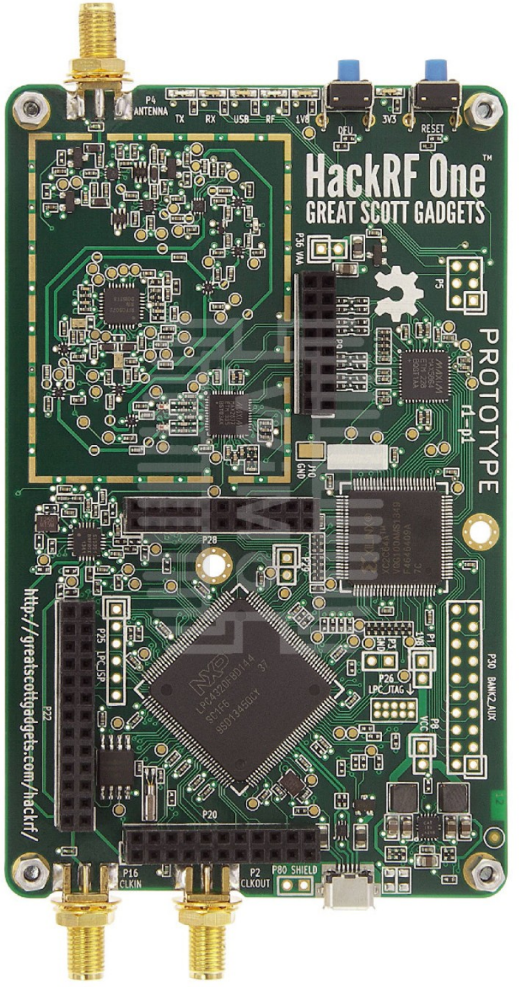

mightyohm.com Geiger Counter v1.0
SBM-20
HV ADJUST
GM_PULSE
SERIAL
ICSP
Alkaline Battery
Geiger counter
Counts:
831 total

Why an SDR?

- Have something useful way after camp
- Don't just put some sensor on it that next phone generation has by default
- Give an SDR to people who would not get one otherwise

Open Hardware: HackRF One

- Developed and produced by Michael Ossmann
- License: GPLv2 (Hard and software)
- Dual Core ARM Cortex M4 + M0
- 1 MHz – 6 GHz range
- 20 Msps maximum sample rate
- USB 2.0 port



Open Source

Firmware

- r0ketlib
  - Adapted code from previous project
  - Display, l0dables, fonts
- hackrf (firmware)
  - SDR support
  - Some initialization
  - CPLD flashing
- libopencm3
  - Hardware initialization & abstraction
- Portapack (archived version)
  - Basic embedded signal processing
- FatFS
  - Portable FAT implementation

Software

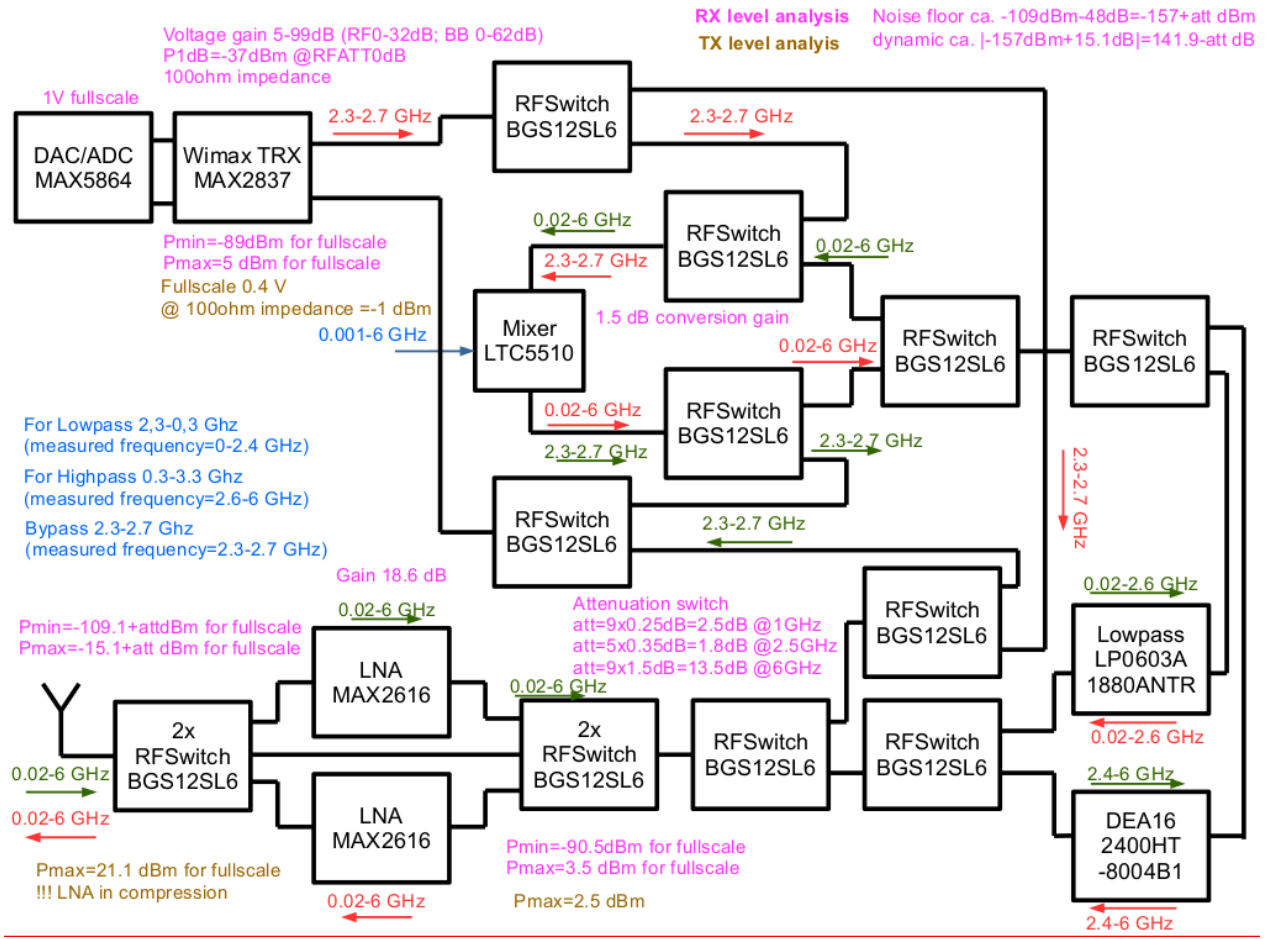
- GNURadio
  - Host based signal processing
- gr-osmosdr
  - GNURadio source/sink block
- libhackrf
  - Basic tools, debug functionality
- dfu-util
  - USB bootloader support

Sponsoring: Time and Quantity

- It took a lot of time to get the OK from some sponsors
- We initially communicated a goal of 3000 devices
- Got an estimate of 4500 visitors afterwards
  - Had to wait again for (much quicker) approval

Sponsoring: Design Changes

- Overall similar RF-Path to HackRF One
- Different mixer with external frequency generator to save cost
- Different RF-Switches
- Different LNAs
- Max 4 GHz design



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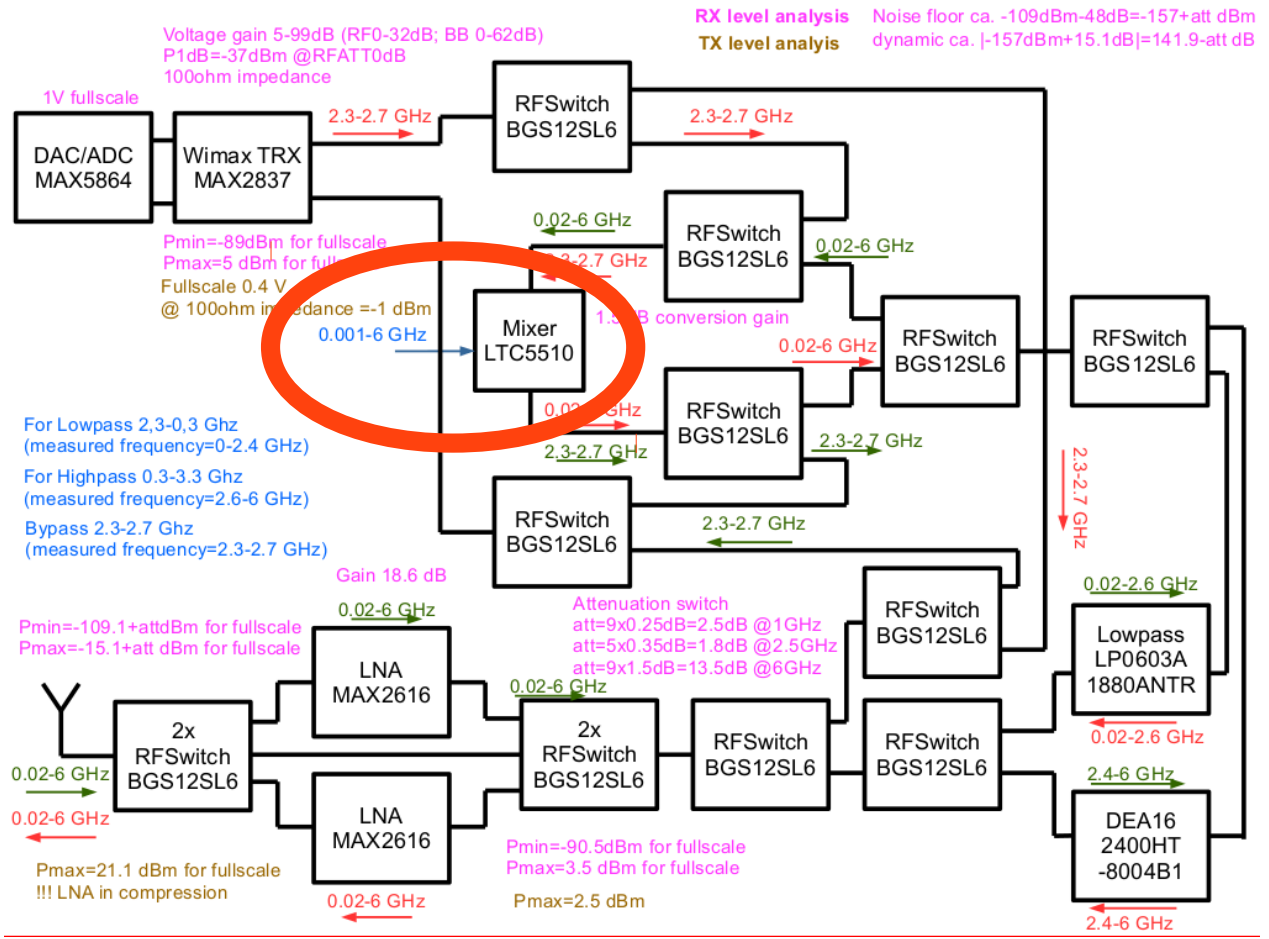
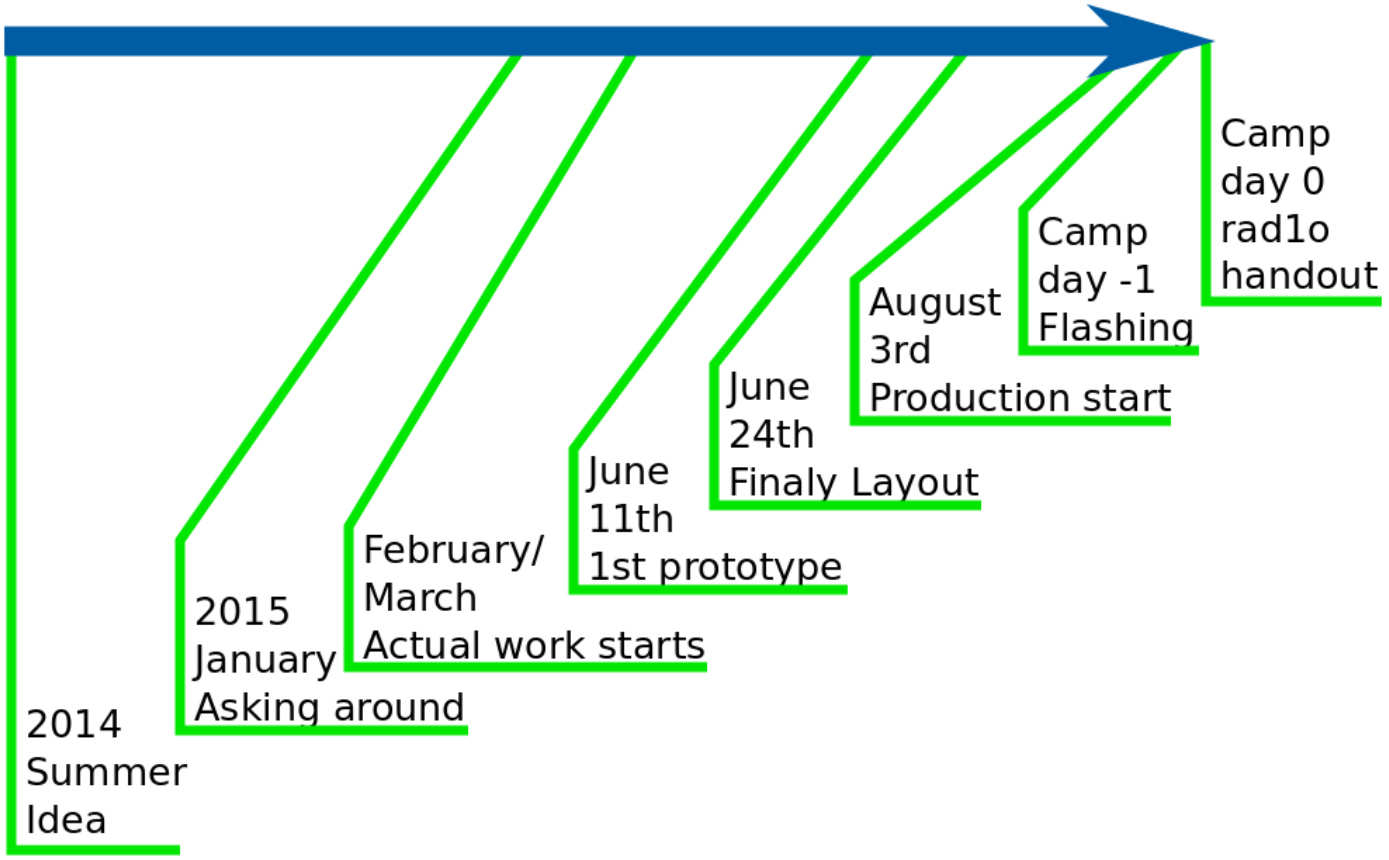
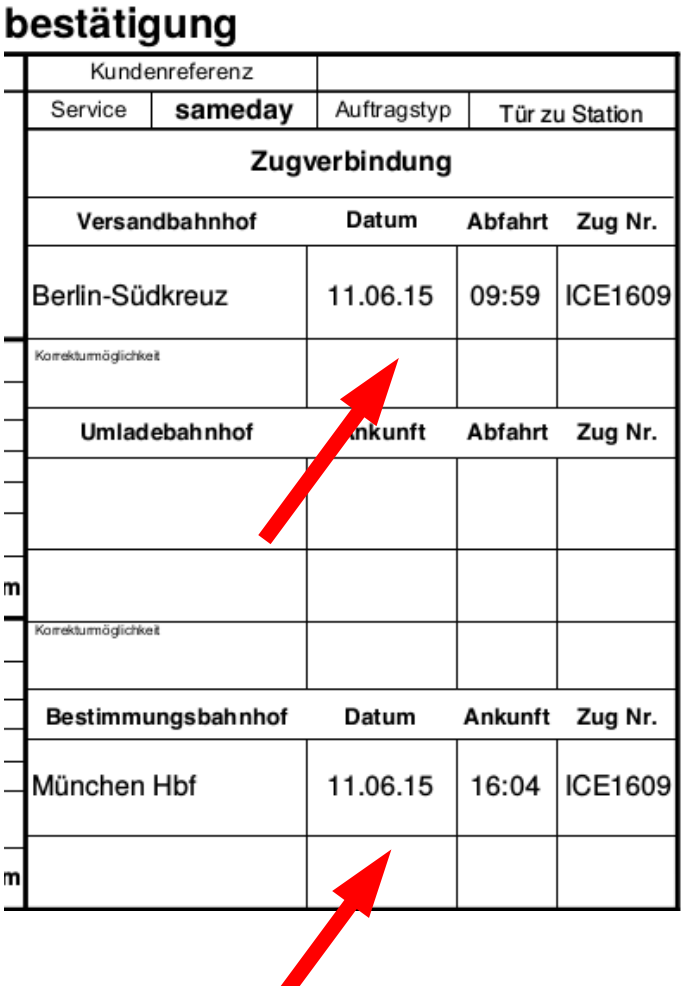


Timeline


2014
Summer
Idea
2015
January
Asking around
February/
March
Actual work starts
June
11th
1st prototype
June
24th
Finaly Layout
August
3rd
Production start
Camp
day -1
Flashing
Camp
day 0
rad1o
handout

Advice

- Start early, take risks early
  - SHA2016 team is already meeting
- Lead times of components and the PCB could have killed the project
- Had to resort to ultra fast shipping of prototypes to gain some days



bestätigung

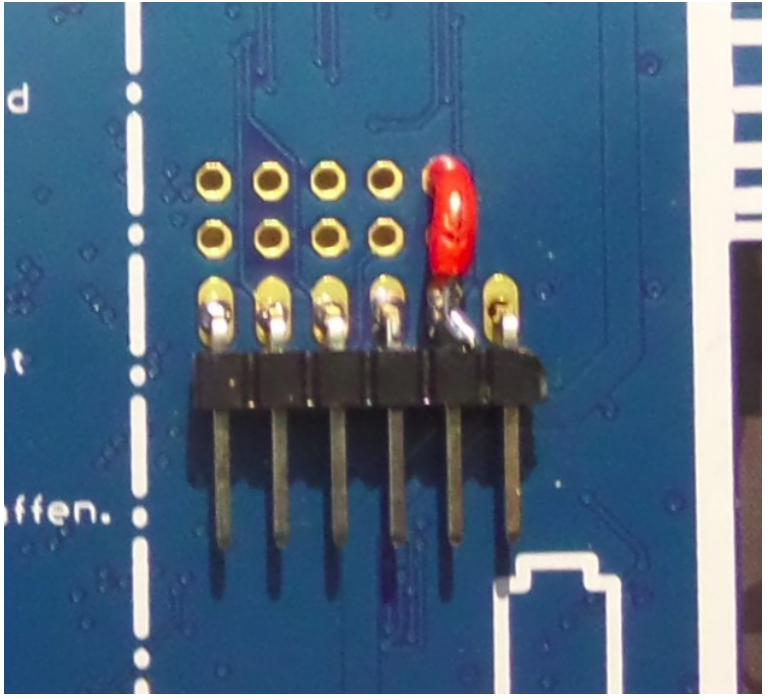
Kundenreferenz			
Service	**sameday**	Auftragstyp	Tür zu Station

Zugverbindung

Versandbahnhof	Datum	Abfahrt	Zug Nr.
Berlin-Südkreuz	11.06.15	09:59	ICE1609
Korrekturmöglichkeit			
Umladebahnhof		**Ankunft**	**Abfahrt**	**Zug Nr.**
Korrekturmöglichkeit			
Bestimmungsbahnhof	**Datum**	**Ankunft**	**Zug Nr.**
München Hbf	11.06.15	16:04	ICE1609

EAGLE vs. KiCad

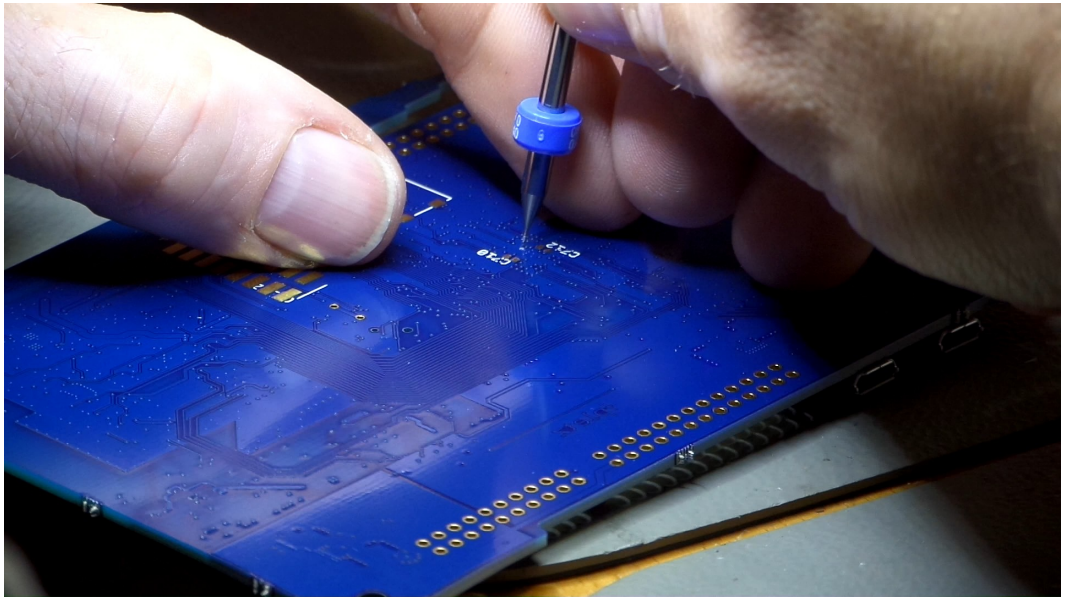
- HackRF One design is in KiCad
  - Most team members were familiar with EAGLE
- Made mistakes while copying the schematic...
- The ISP pin is missing a pull-up
  - May cause the rad1o to not boot
  - Apparently not an issue, but the pin is very touchy



Nerdkorea at Camp

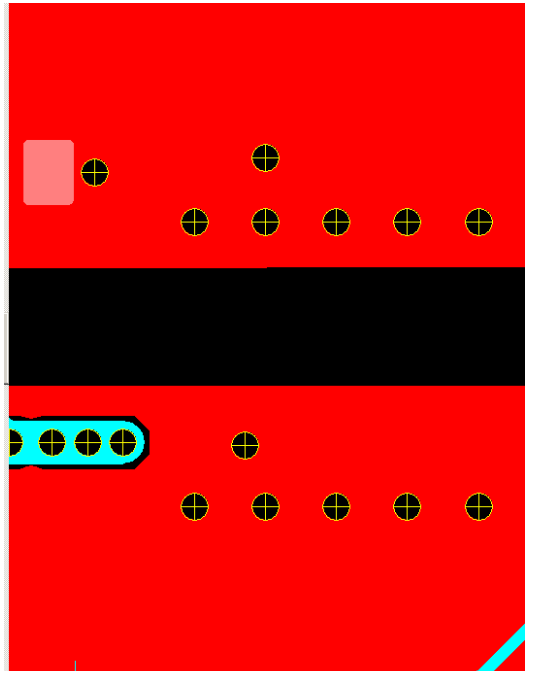
Prototype 1

- EAGLE symbol of the CPU had some pins swapped
  - Among them: VCC and GND
- We had to drill out a via with a 0.4 mm hole to disconnect a ball of the BGA
- All other pins were accessible through the pin headers

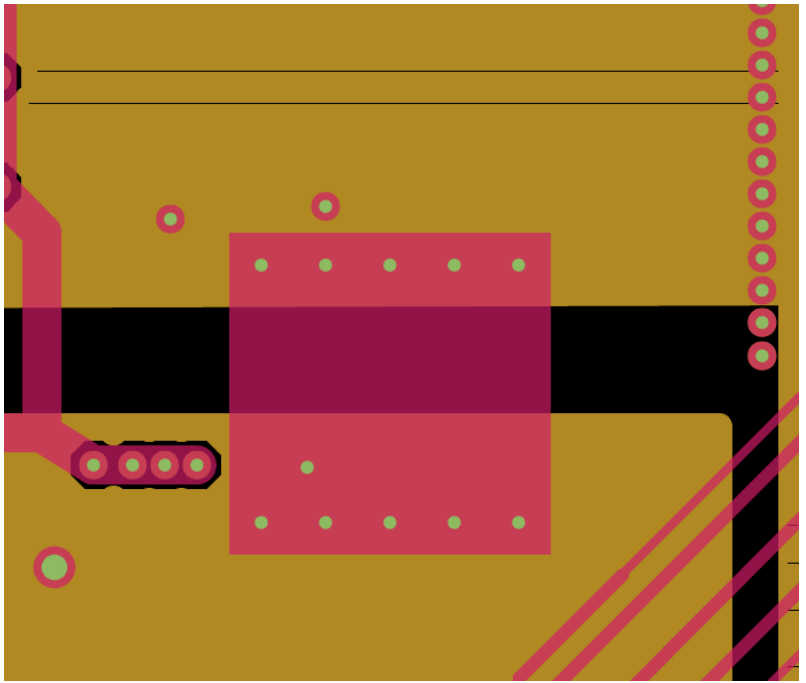


“Prototype” 2

- Make or break
  - Just for verification
- Ground plane #$%&



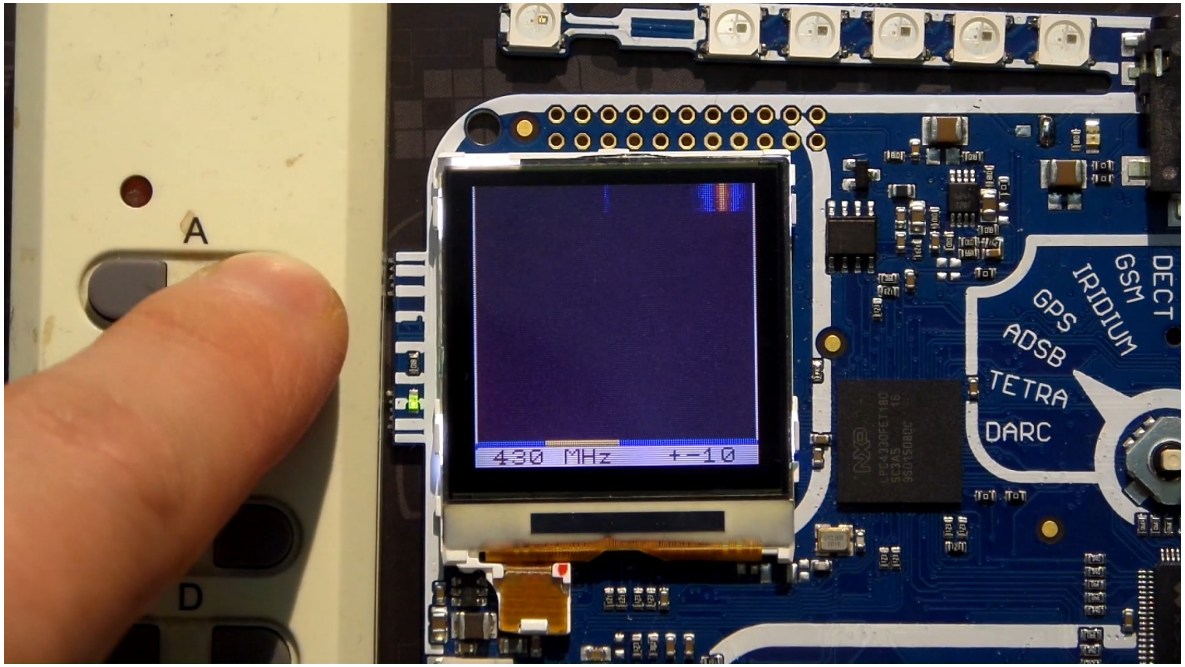
Prototype 2 PCB (DPF Viewer)



Production PCB (gerbv)

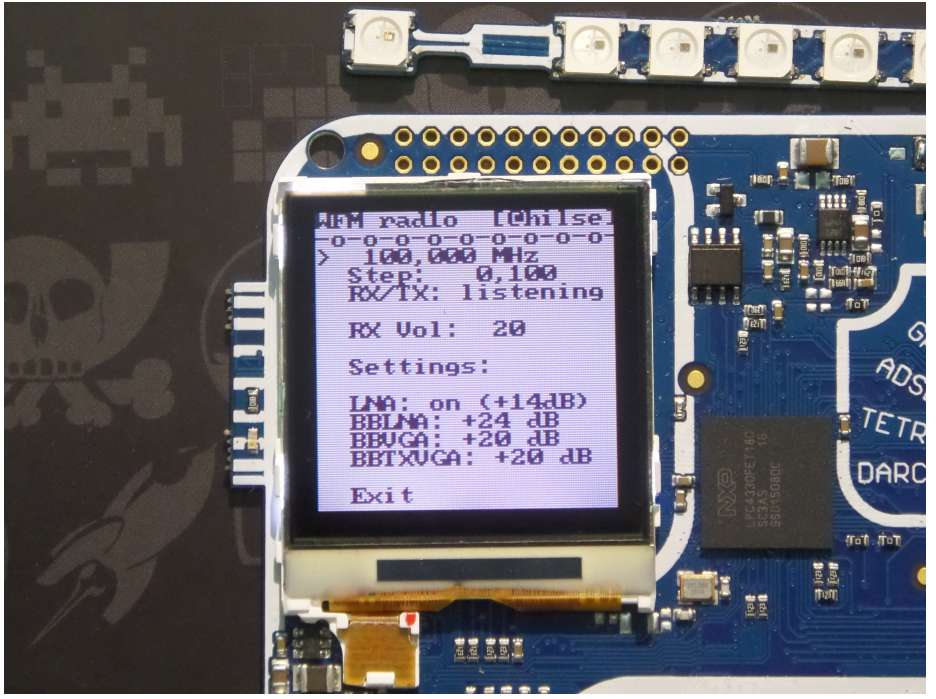
Application: rfapp

- scope
  - Shows an RF waterfall
  - Selectable frequency
  - Selectable timescale
  - Bandwidth: 2 MHz



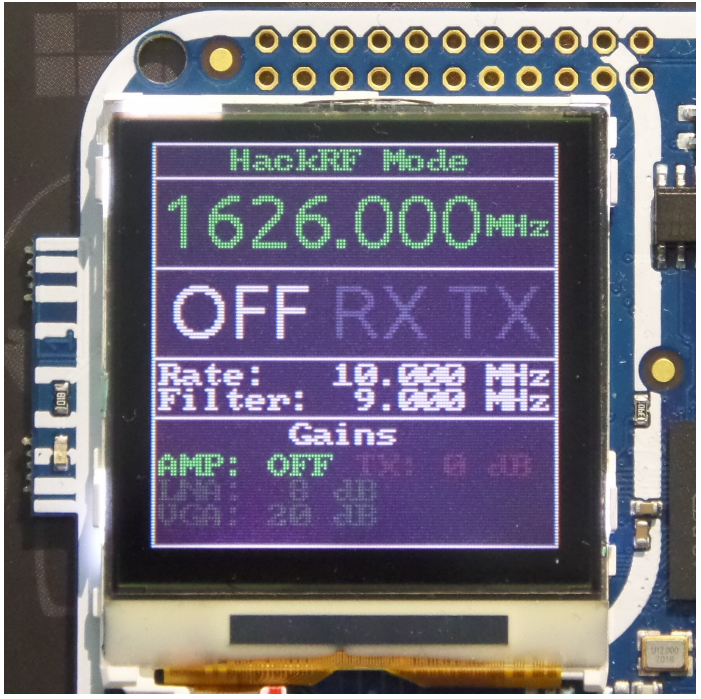
Application: rfapp

- FM Receiver / Transmitter
  - Wideband FM
  - Push to talk
  - Thanks to @hilse



Application: HackRF App

- Status display for different HackRF mode settings
- Choose HKRF-APP in the bootloader



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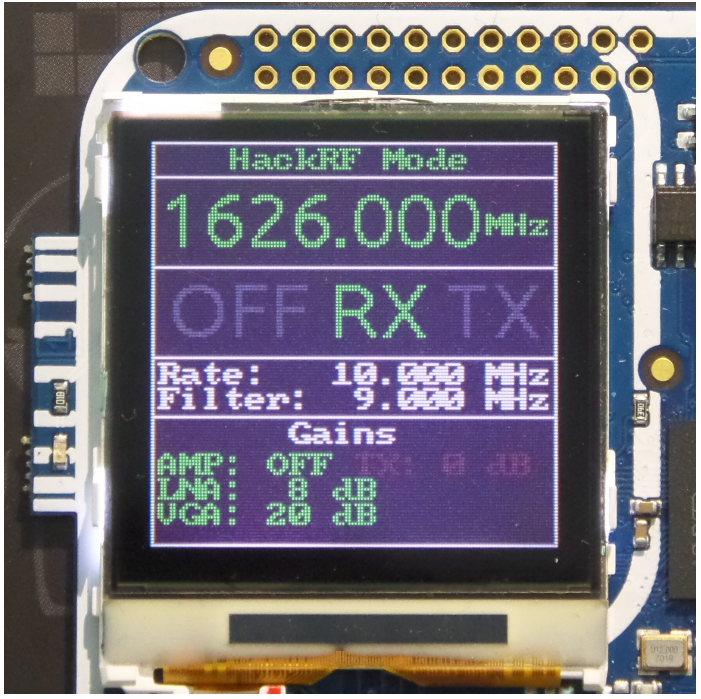

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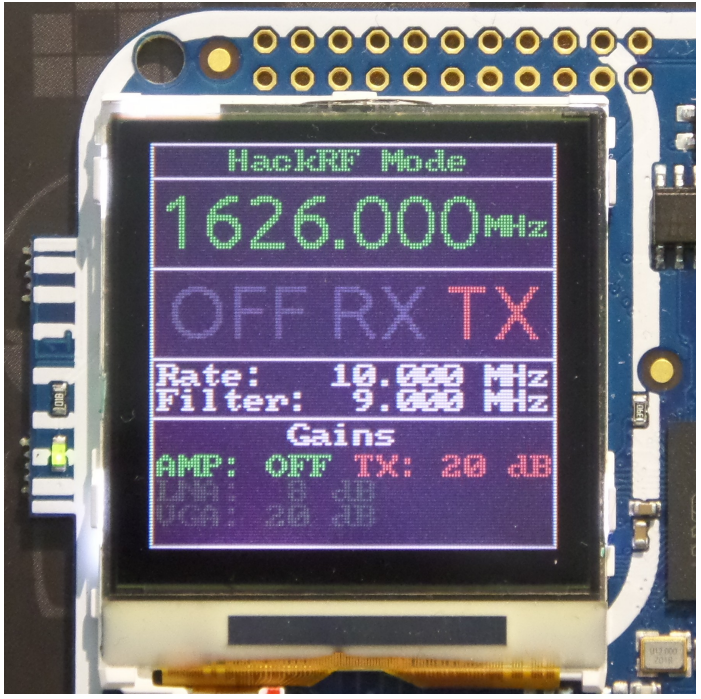
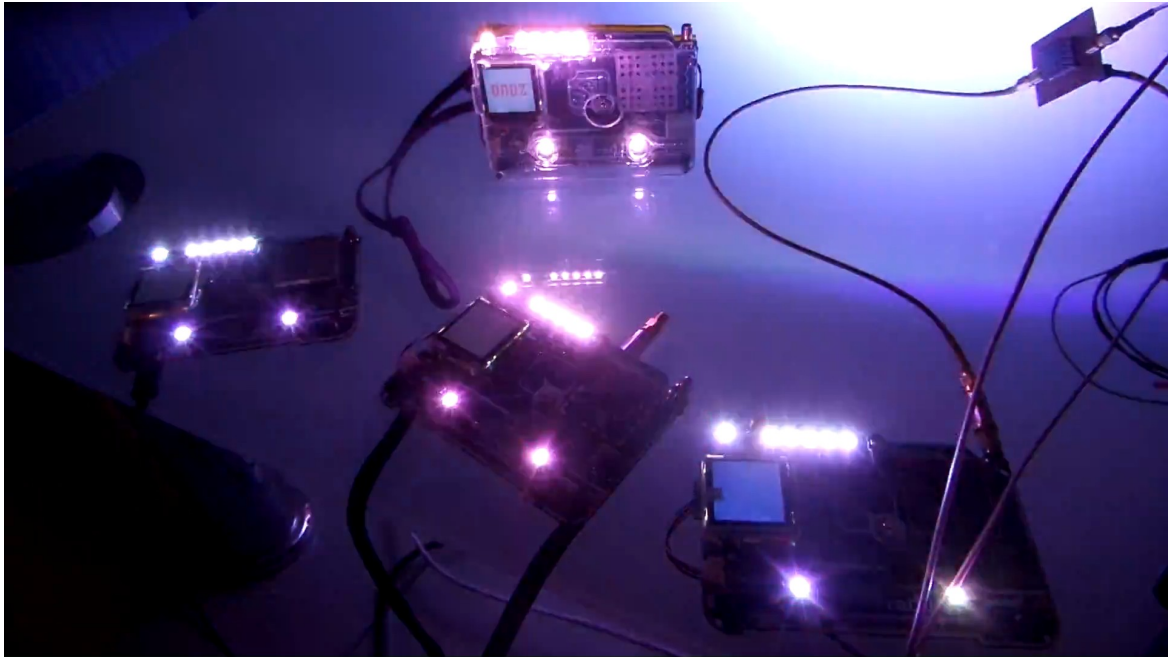


l0ungel1cht

- Takes DMX data and transmits commands to other rad1os
- Using rflib from @hilse: Moves SDR processing to M0 core



Demo: Remote Controlled Power Socket

Possible Standalone Applications for the rad1o

- No WiFi jammers please :)
- RF replay device
- Self made home automation
- Passive indoor localization
- Simple “video” streaming
- USB filter
- USB debugging

- Very good general SDR introduction:
  http://greatscottgadgets.com/sdr

- Mailing list: rad1o@lists.muc.ccc.de
- GitHub: https://github.com/rad1o/
- Wiki: https://rad1o.badge.events.ccc.de
- twitter: @rad1obadge

Thanks to all people involved in the project

- https://media.ccc.de/v/camp2015-6884-the_rad1o
- https://media.ccc.de/v/dg56-Hands-on_Rad1o
- https://media.ccc.de/v/32c3-7153-rad1o