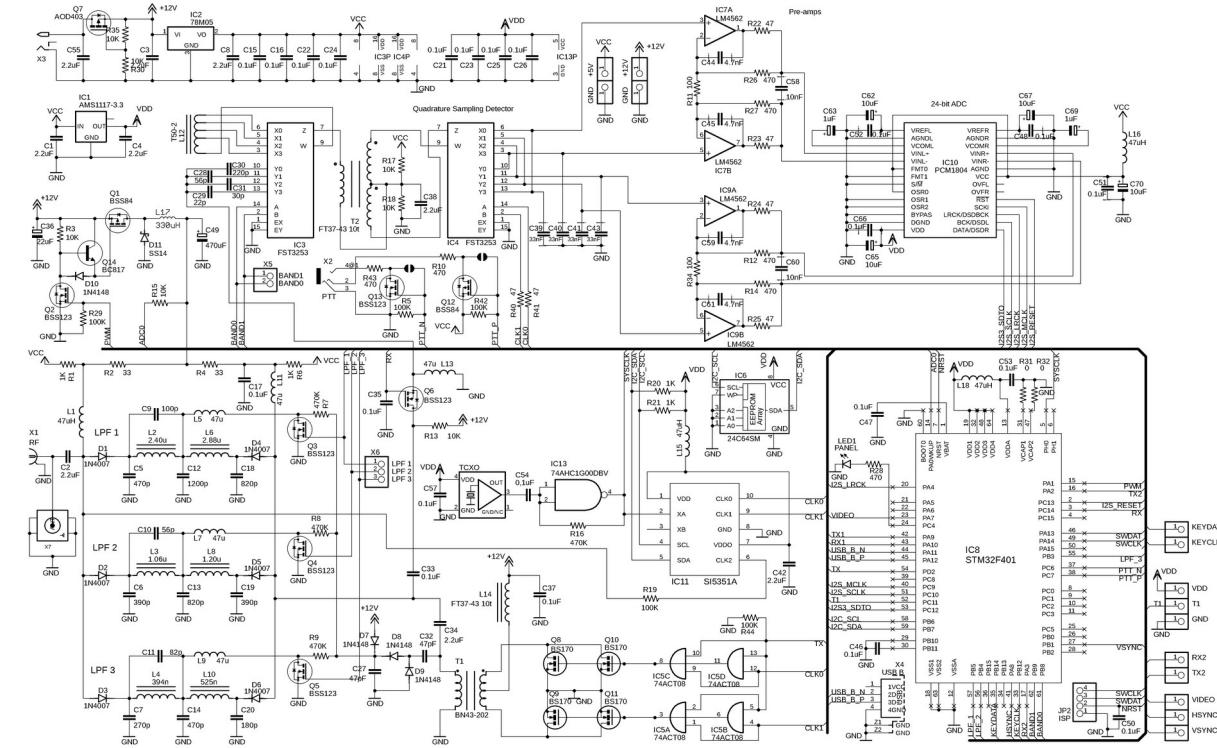# A Homebrew Digimode-Transceiver
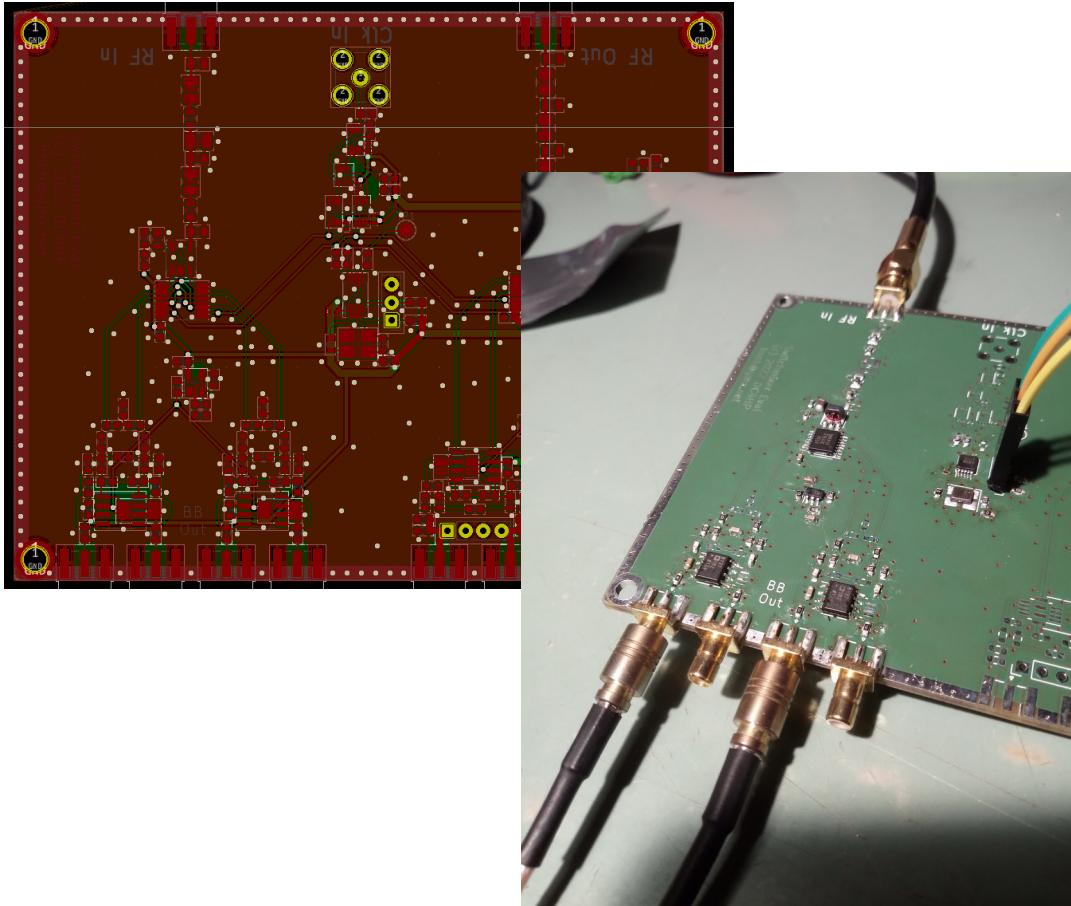
Henning Paul DC4HP
10.10.2023

Motivation

- Was pointed at QDX by fellow ham
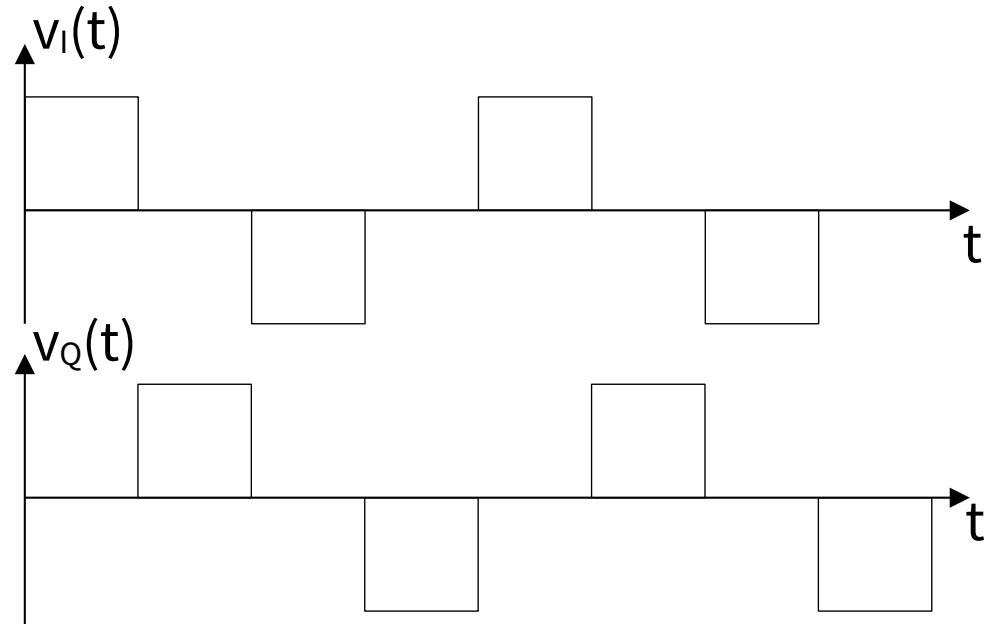
- Schematics available online

H-mode mixer

- Gained interest in workings of quadratur H-mode mixer

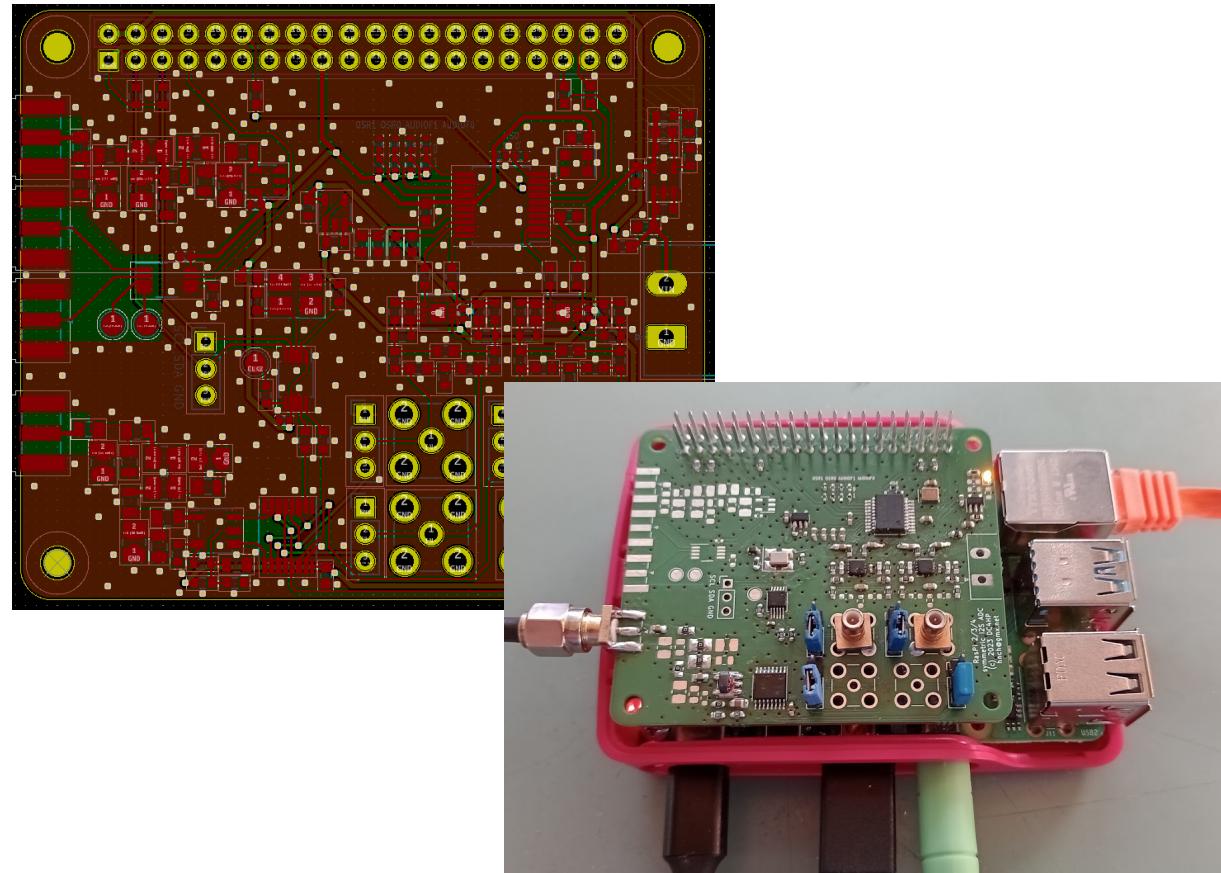- Layouted experimenter board to study it

H-mode mixer

- Mode of operation:

  - Received HF is switched onto I and Q receive path with alternating sign in a round-robin fashion
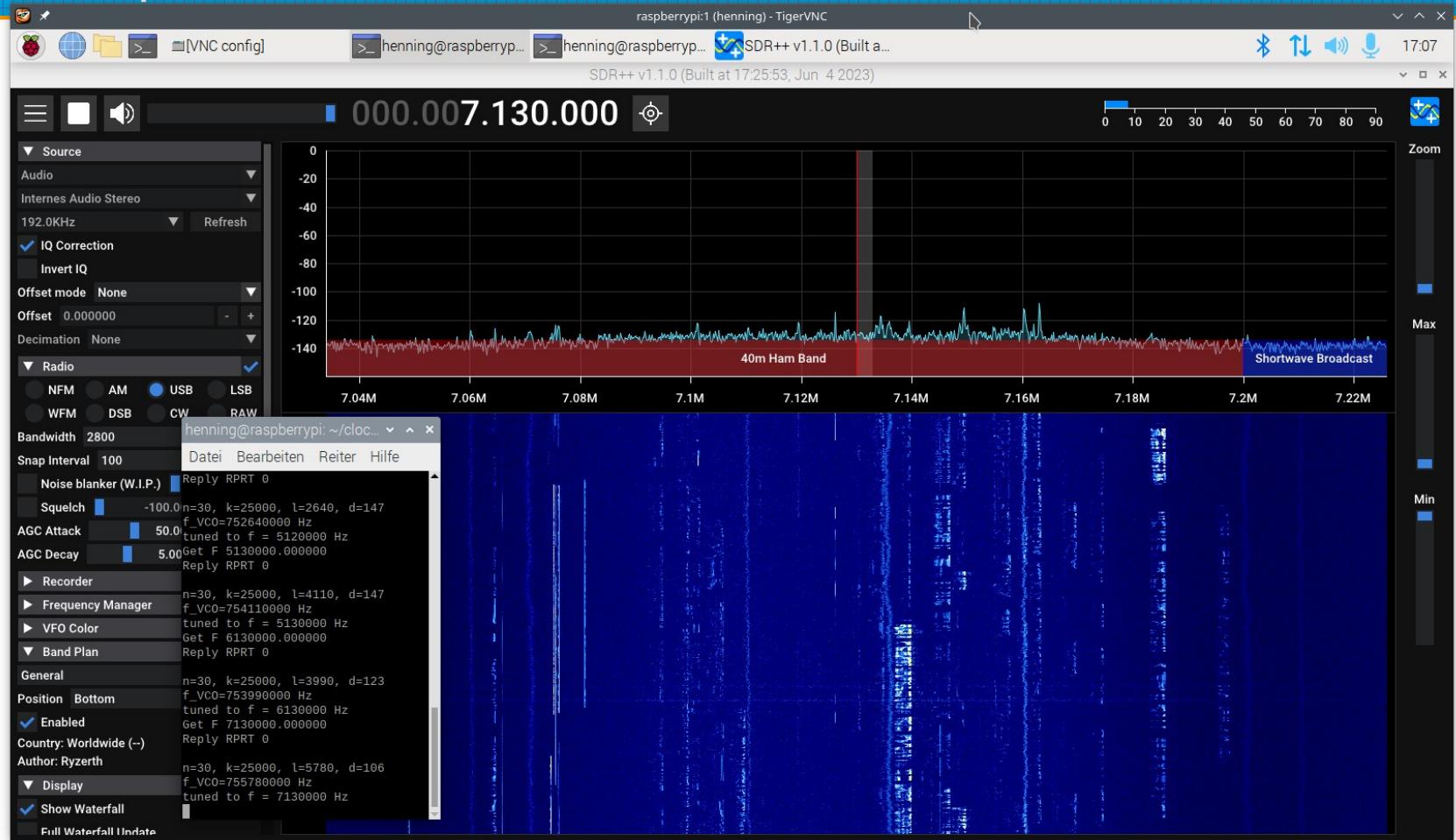
Raspberry Pi Hat

- After successful tests with a USB audio adapter I developed a hat for the Raspberry Pi using a 192kHz/24bit ADC
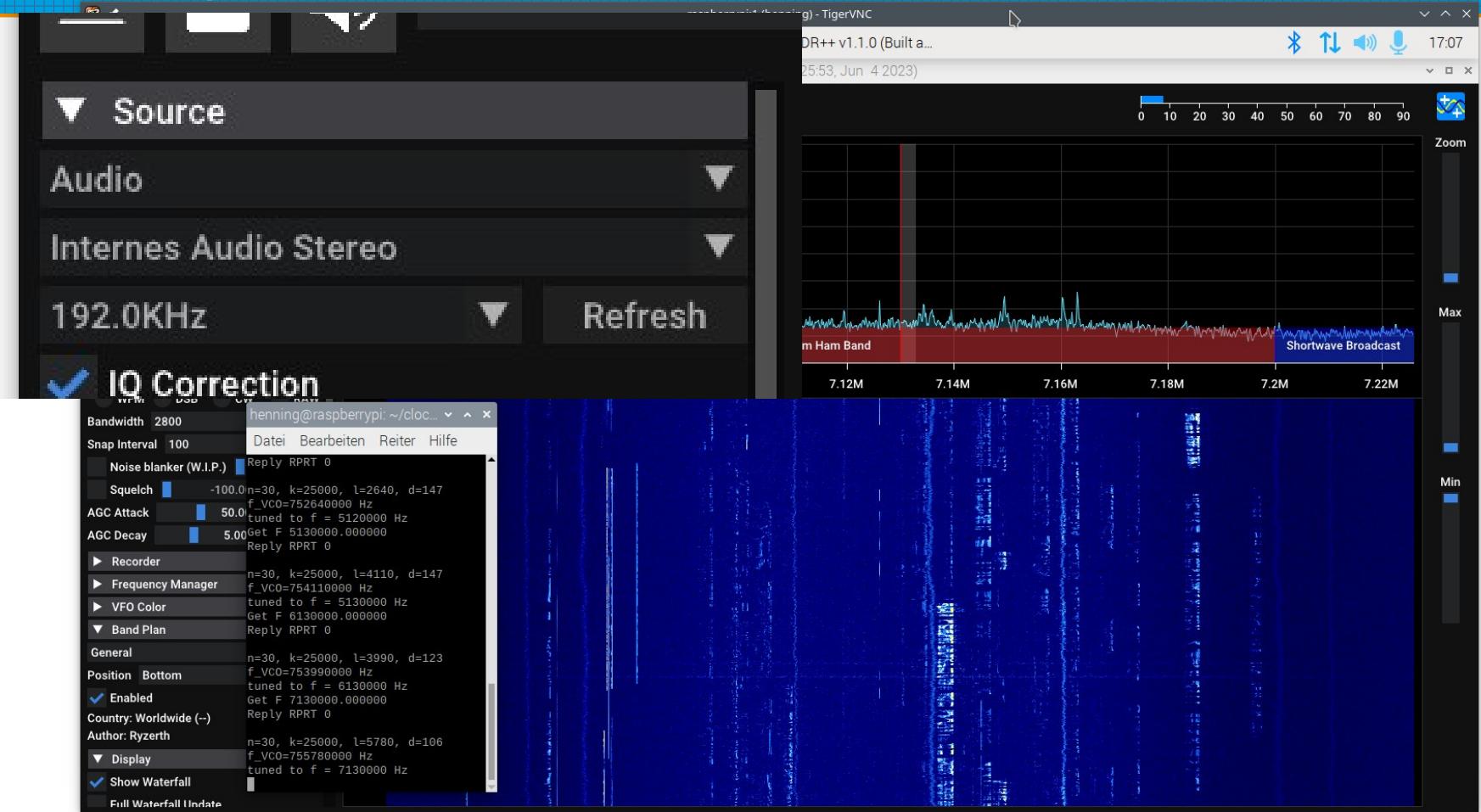
Receiver performance

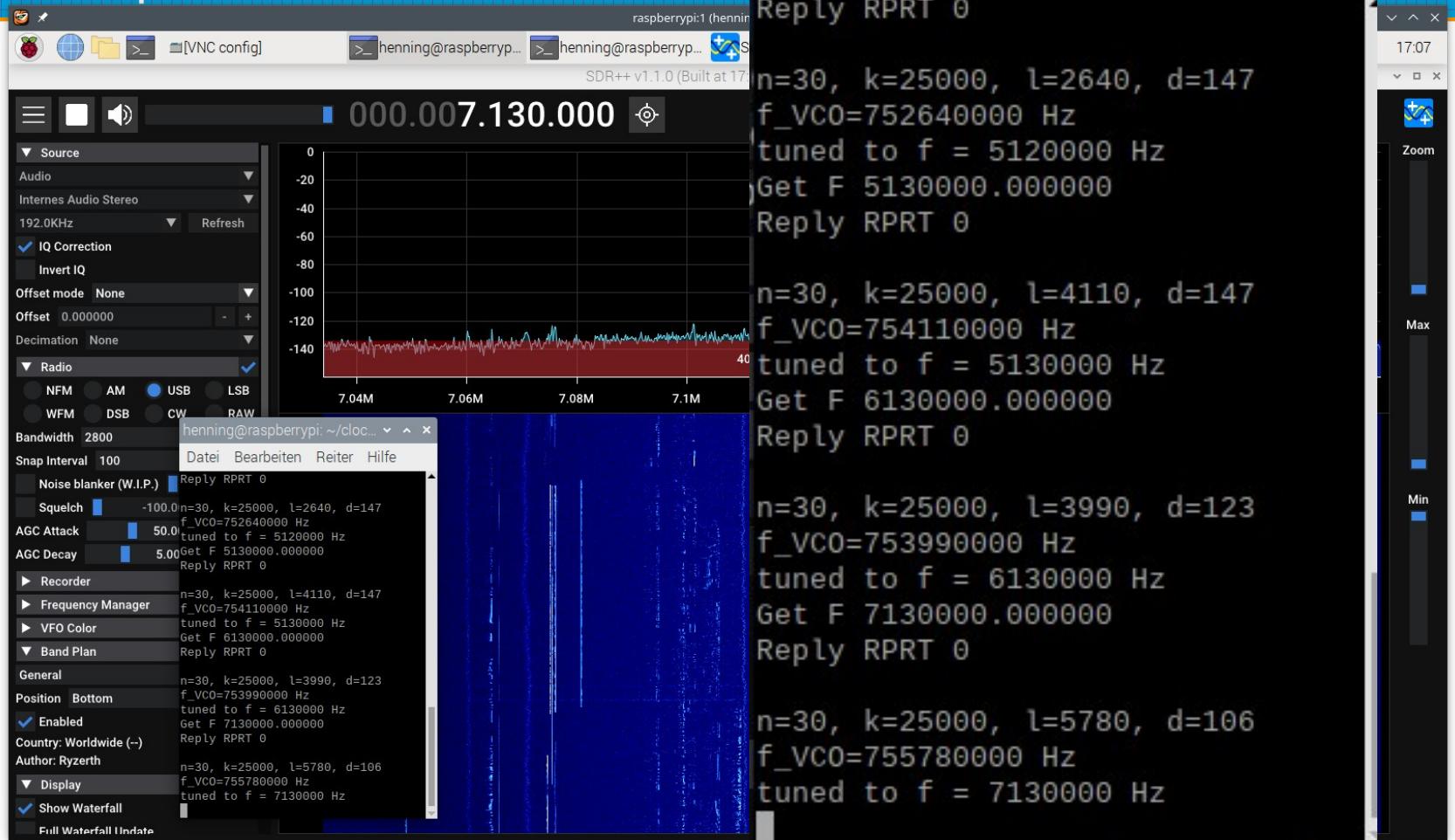- Fixed gain (20dB in ADC driver only)
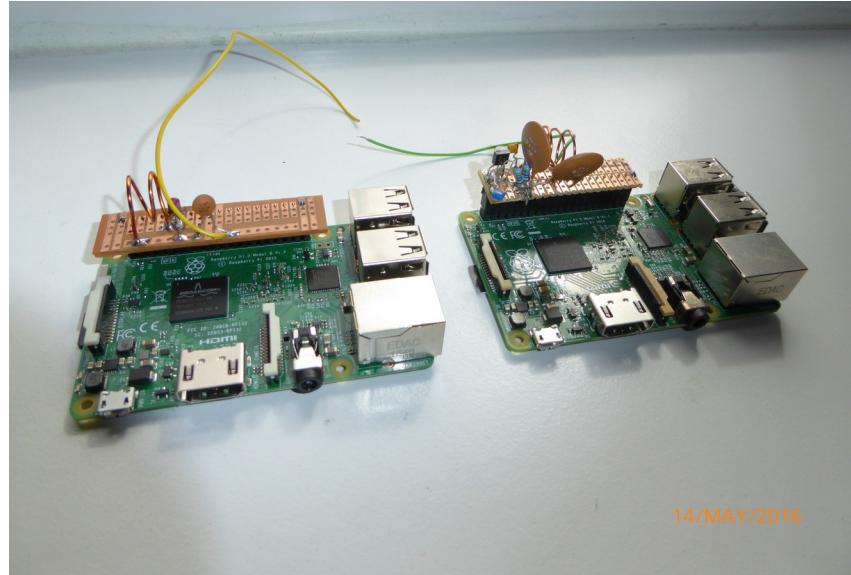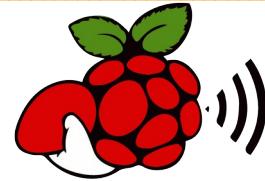
- No HF filtering

Receiver performance

Receiver performance

- Python script emulating rigctld to control Si5351A synth

Transmit signal generation

- rpitx by Evariste F5OEO
  (https://github.com/F5OEO/rpitx)

- Clock synthesizer of Raspberry Pi is abused to generate arbitrary clock signals on Pin 7

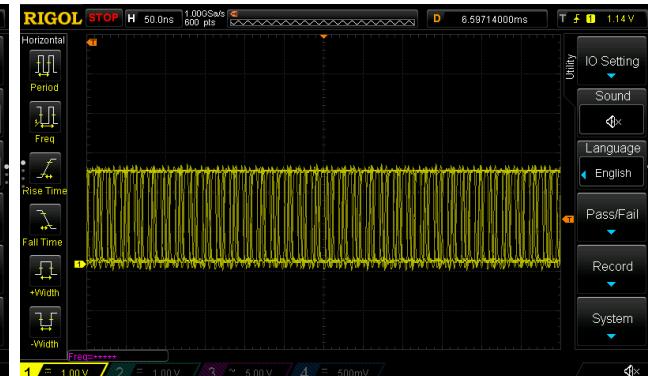- Originally only FM/FSK possible - but since RPi 2 also AM, SSB and OFDM
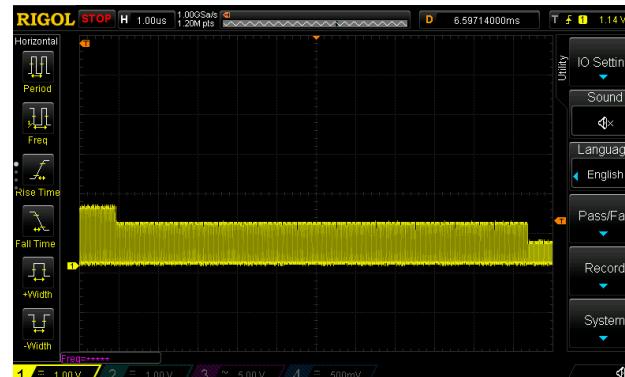

Photo: Gerald DL5BBN (TU Berlin), 2016

Transmit signal generation
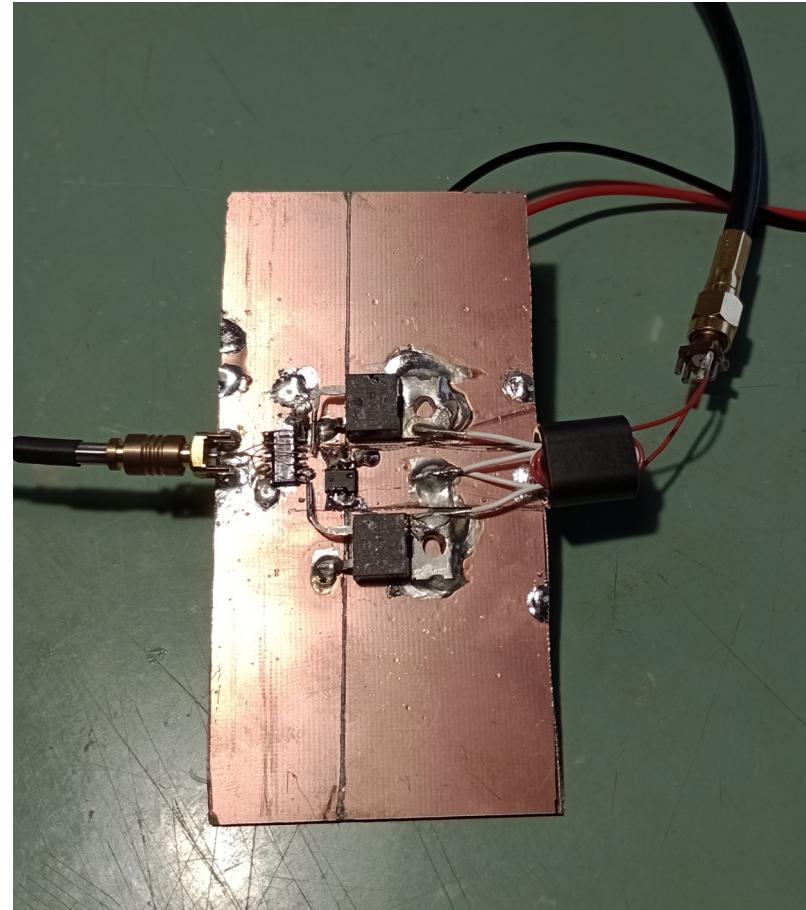
- rpitx wave forms

- NBFM on 10m

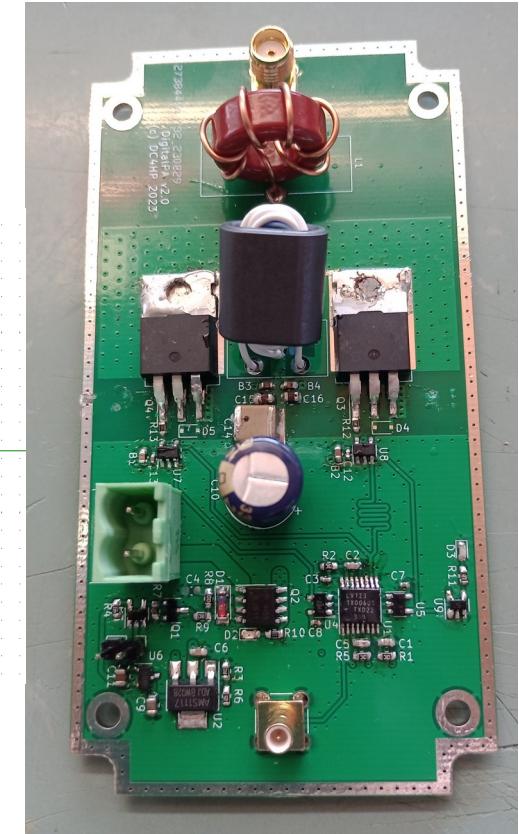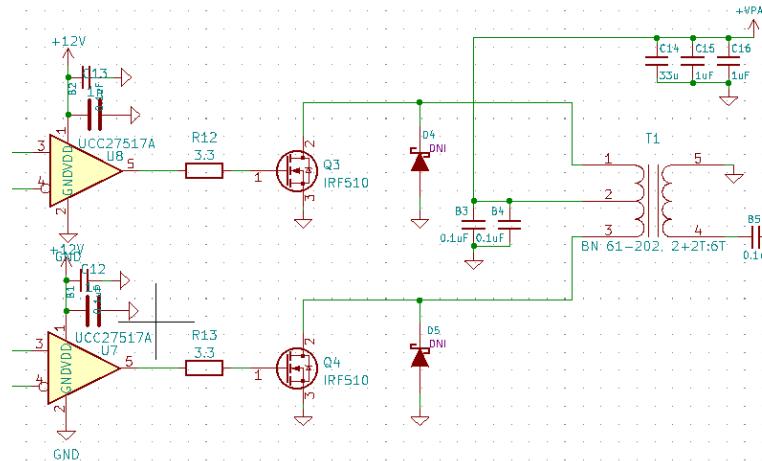- SSB on 10m:
  - Simultaneous FM and AM to create SSB

Power amplifier

- Output signal of Raspberry Pi is 3.3V logic level (at least for FSK):

- Option 1: Filter and feed into (linear) HF PA

- Option 2: Use digital (switching) PA

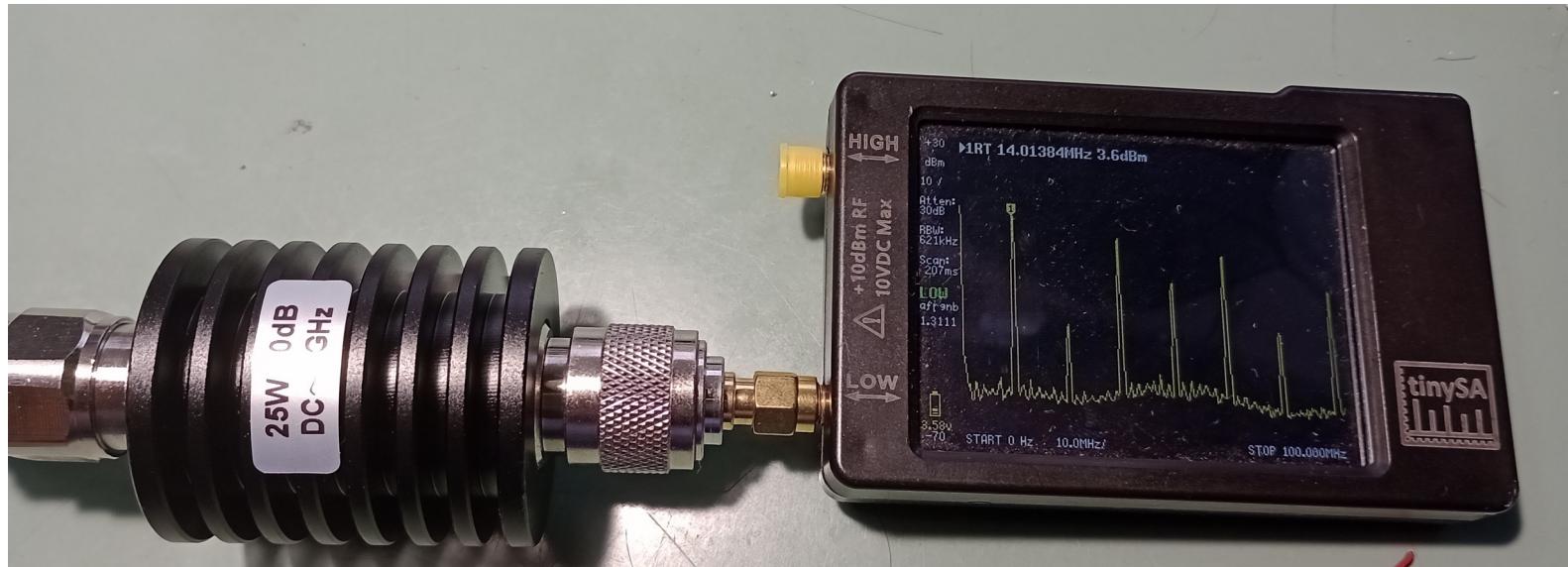- Experiments using circuit derived from QDX (but with stronger MOSFETs)

Power amplifier

- Final circuit:

  - 4A gate driver

  - High side PMOS to switch on PA

  - Under frequency lockout (500kHz) to avoid destruction of transistors by DC levels
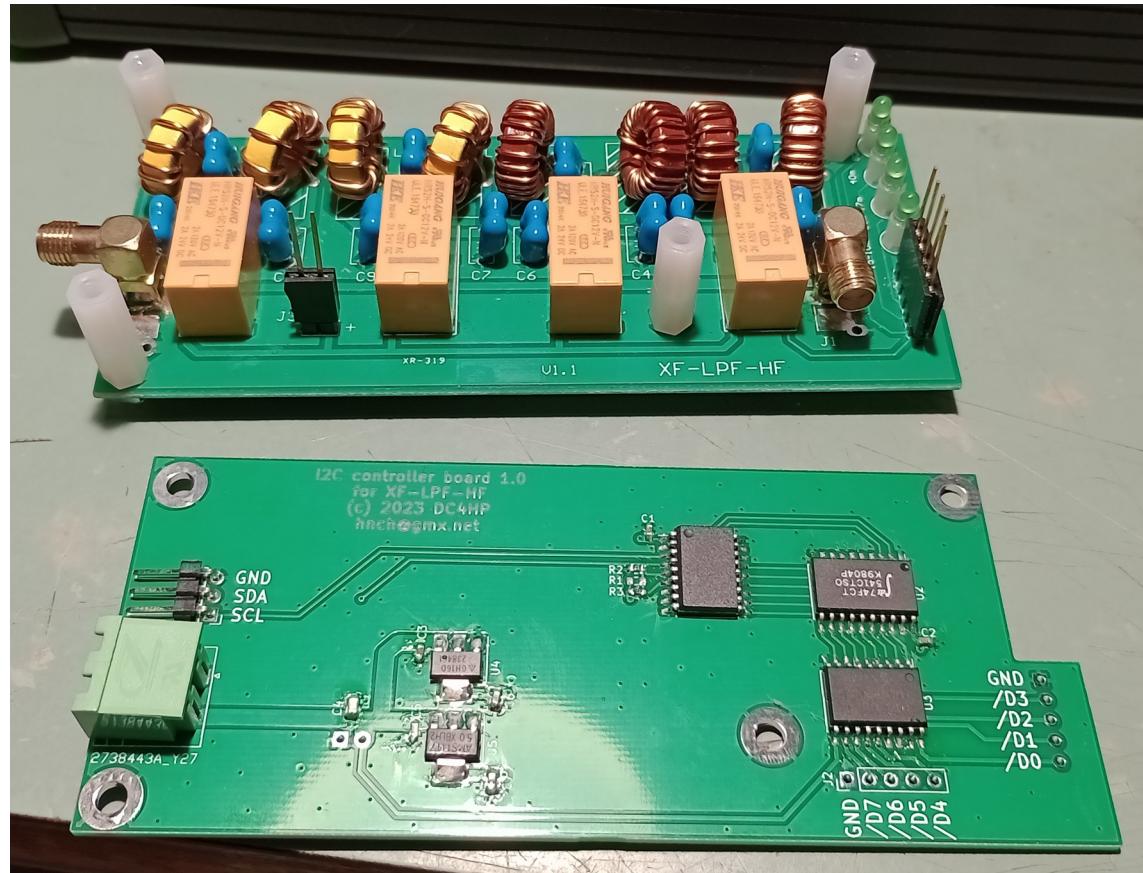
Power amplifier

- 43.6dBm (~22W) in the fundamental on 20m with 14V supply voltage (measured before low pass)
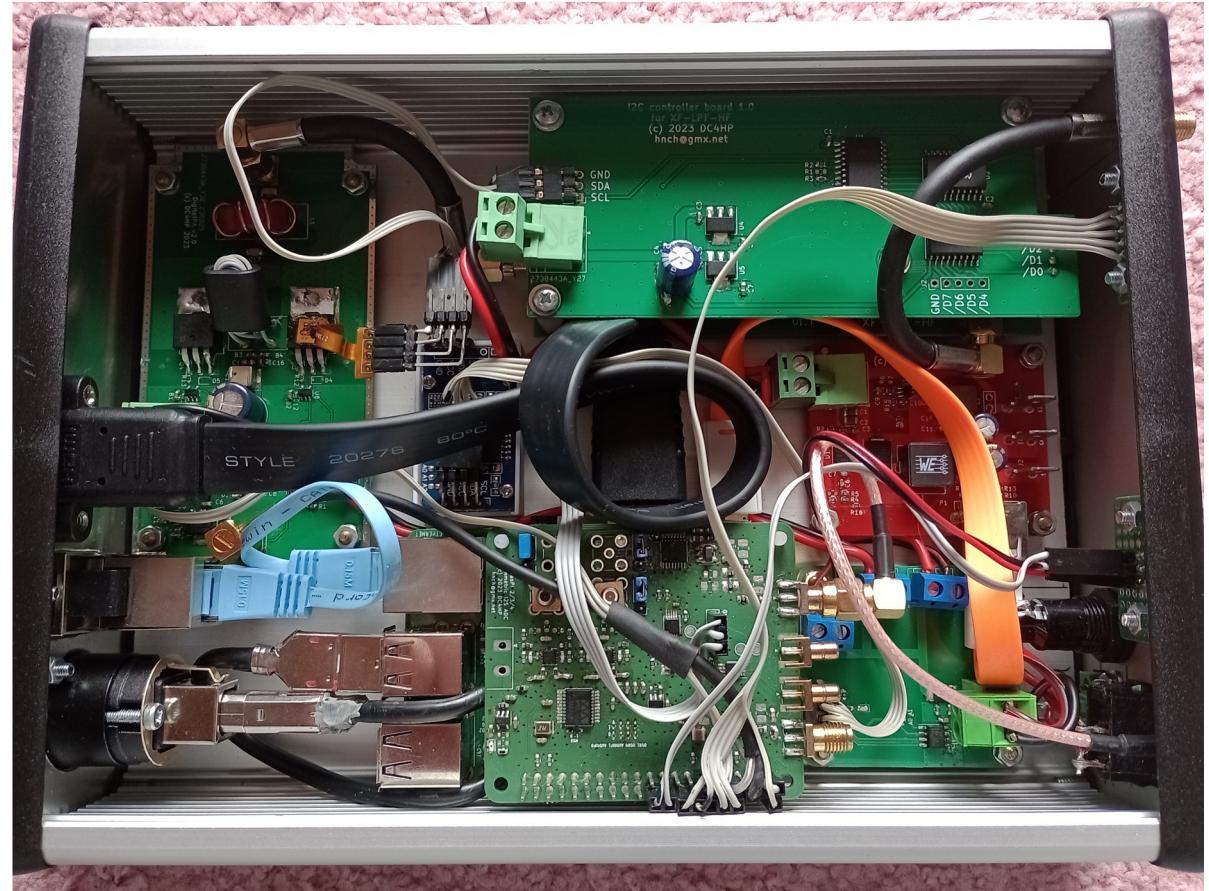
Power amplifier

- Filtering using XF-LPF-HF from AliExpress

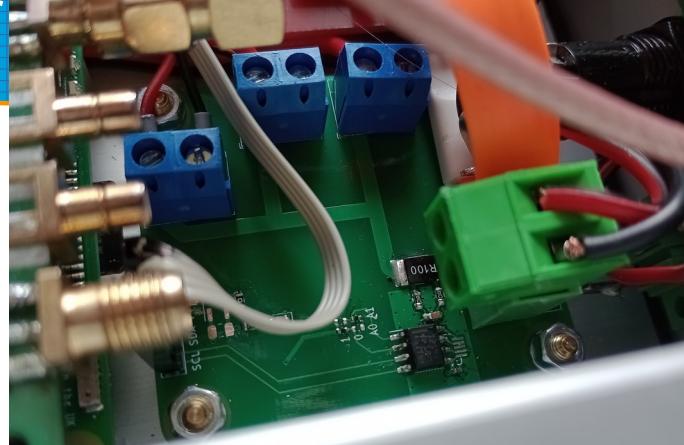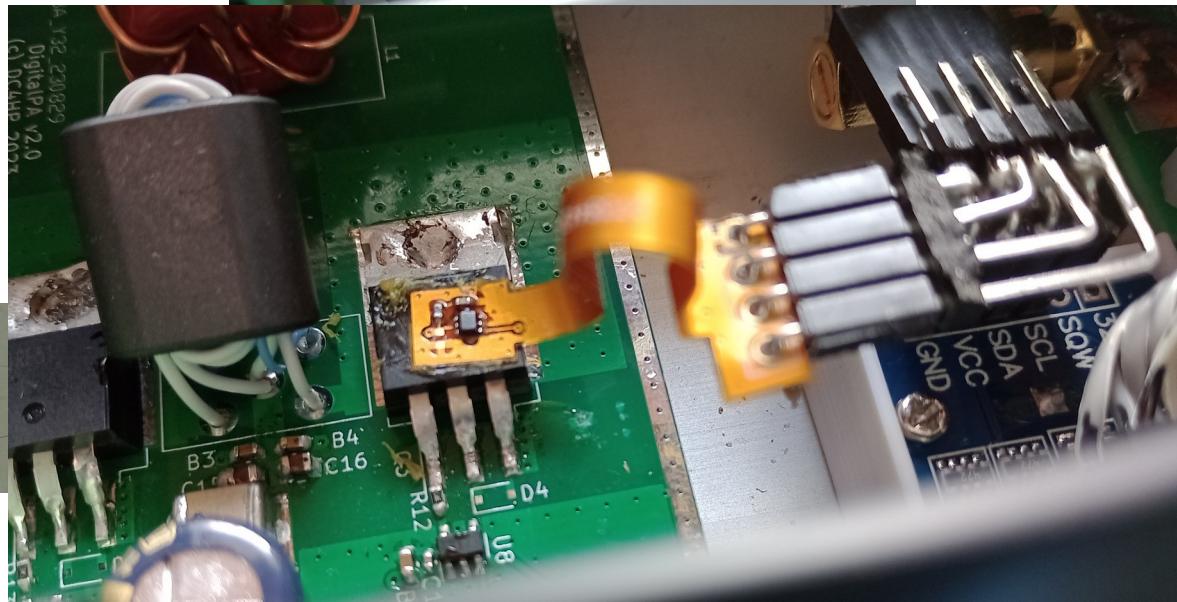- Controlled via I2C using self-designed controller board

Putting it all together

- LAN, USB and HDMI routed to front panel

- I2C RTC and serial port für GPS receiver

- 5V for RPi generated by self layouted DC/DC board

Putting it all together

- Measurement of input current and voltage using self-designed board

- Measurement of PA temperature using self-designed flex board

Putting it all together

- ATU-100 antenna tuner and Rx/Tx switch externally

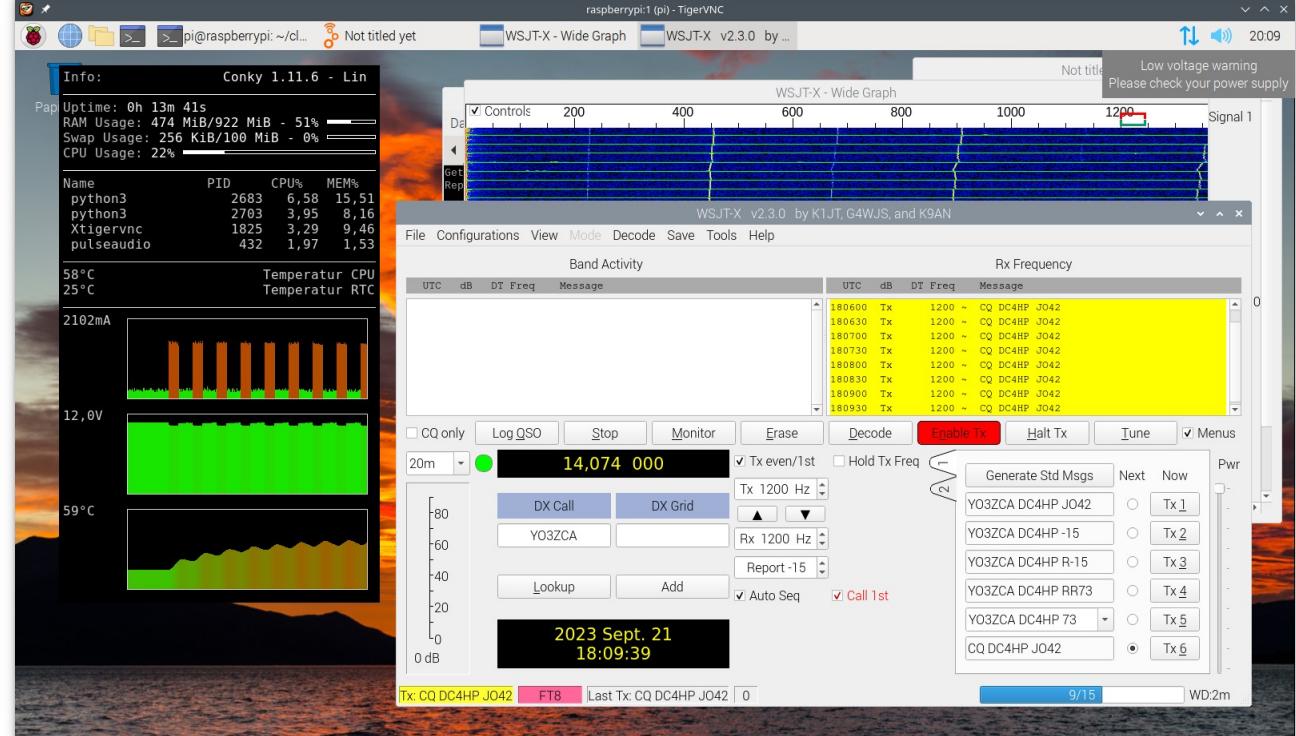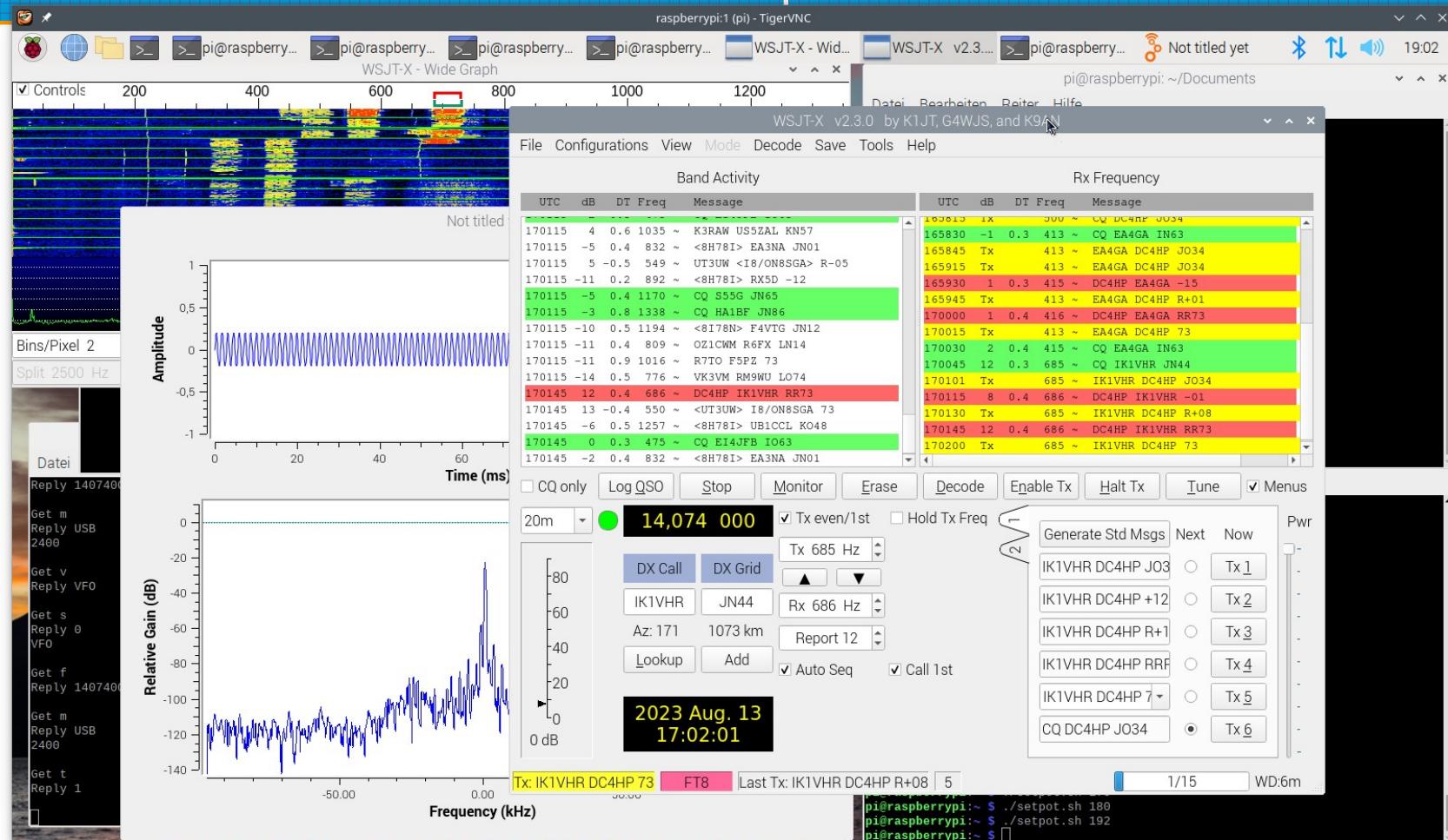- Supplied from SLA or LiFePo4 battery

The software

- Python / GNU Radio under Linux on the Raspberry Pi

- GNU Radio Flowgraph for Rx:

  - Capture from I2S ADC; LPF at 2.9kHz; Output to virtual sound card

- GNU Radio Flowgraph for Tx:

  - Capture from virtual sound card; SSB modulation; Output to rpitx-Block

    (https://github.com/jmfriedt/gr-rpitx)

- Python script emulated rigctld

  - Controls Rx mixer's Si5351A via I2C

  - Parametrizes Tx flow graph via ZMQ
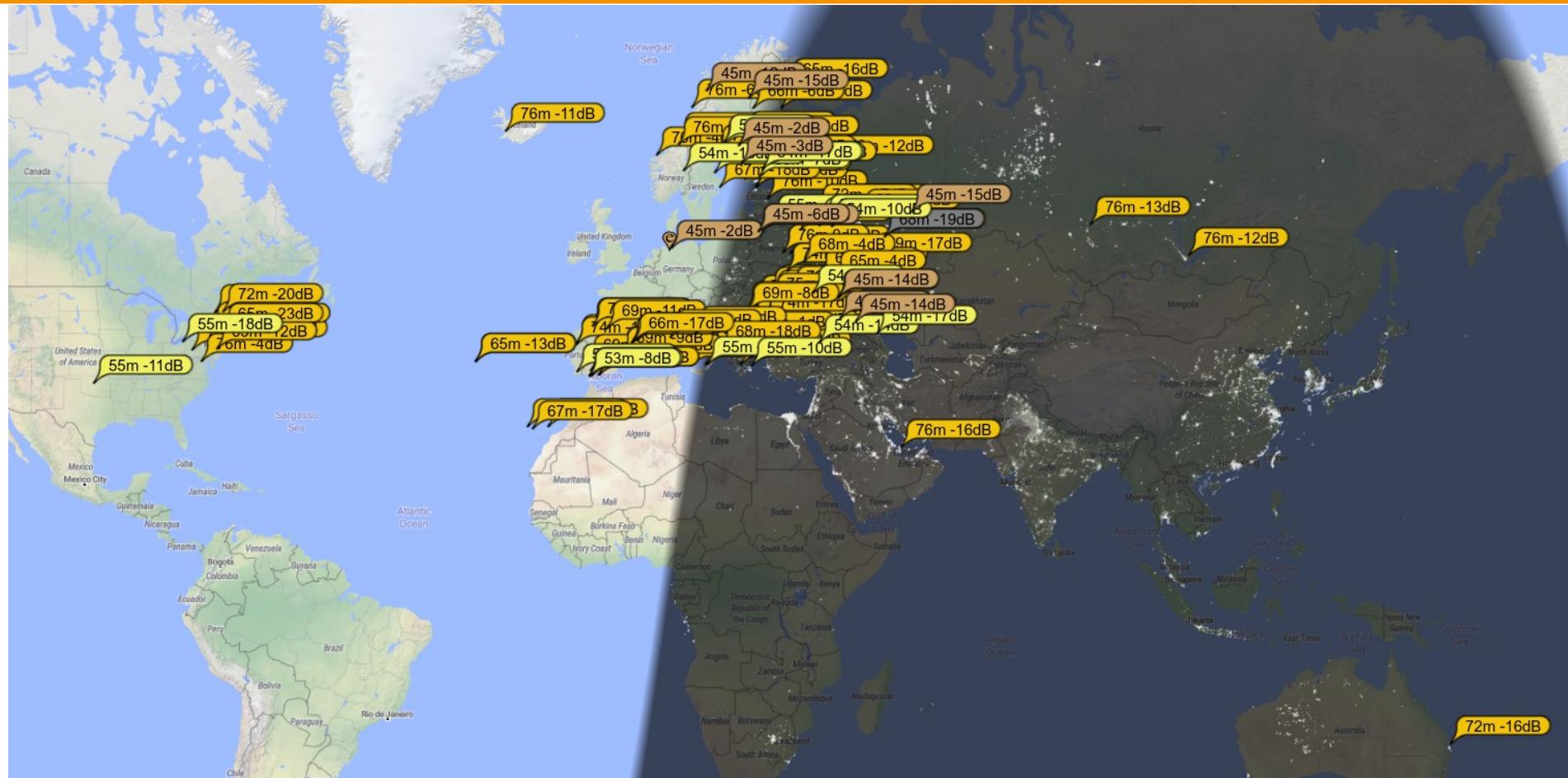
  - Controls output LPF via I2C

The software

- Current, voltage and temperature sensors available via standard Linux sensors API → use any tool you like for display

Impressions from the practical use

Impressions from the practical use

Thank you very much!