From bench to deployment
The HB9TV-1 linear transponder

using an Analog Devices ADALM-PLUTO

HAMRADIO 2025

HB9DUG Michel

June 27, 2025

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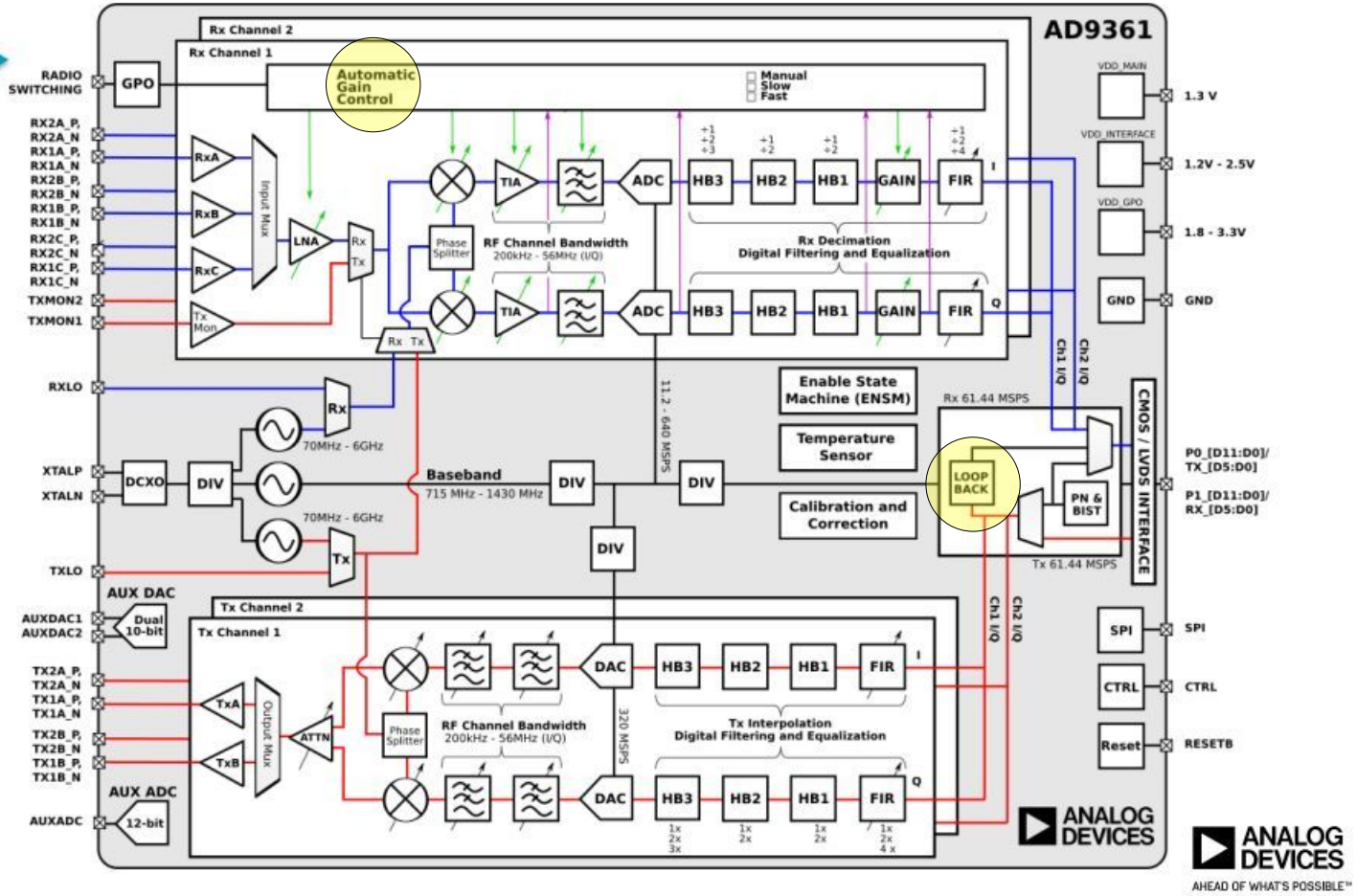
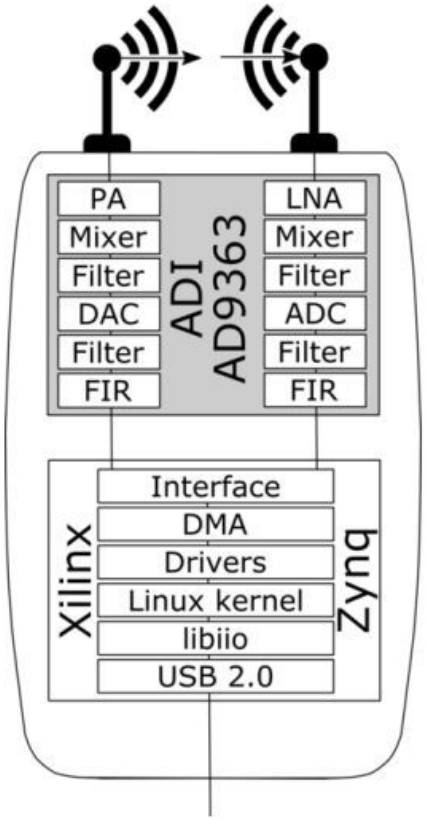
Project hardware

- AD9361: 2 Rx + 2 Tx
- AD9364: 1 Rx + 1 Tx
- AD9363: 2 Rx + 2 Tx
- Major sections:
  - RF input/output paths
  - RF PLL/LO
  - Clock generation
  - ADC/DAC
  - Digital filters
  - Digital interface
  - Enable state machine
  - RX Gain (AGC)
  - TX Attenuation
  - Aux DAC/ADC and GPOs
  - Analog and Digital Correction/Calibration

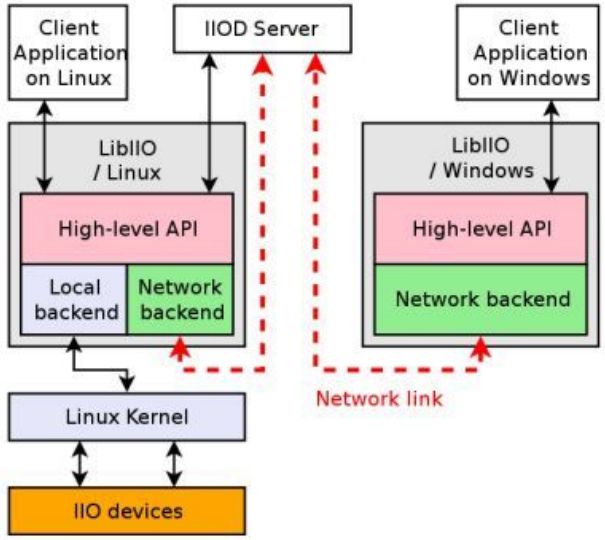


Project hardware



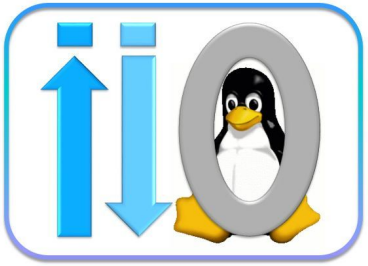
- Runs Linux inside the device
- Uses Linux's IIO framework to expose I/Q data and control
- Multi-Function USB Device
  - Native IIO over USB
  - Serial over USB
    - Kernel console
    - COMx, ttyACMx
  - Ethernet over USB (RNDIS)
  - Mass Storage
  - Device Firmware Update (DFU)
- USB Host
  - USB dongles

- Cross Platform
  - Windows
  - Linux
  - MAC
- Cross framework
  - Stacked libraries based on libiio



ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Project software



IIO
Linux kernel **I**ndustrial **I**nput / **O**utput frame framework

IIO - libiio
System library
Provides high-level C, C++, C# or Python programming interface to IIO
Cross Platform (Linux, Windows, MacOS X, BSD)
https://github.com/analogdevicesinc/libiio

IIO – libiio – Command line tools
iio_info, iio_attr, iio_readdev, iio_writedev et iio_reg
included with the libiio

pyadi-iio
Analog Devices python interfaces for hardware with IIO drivers
https://analogdevicesinc.github.io/pyadi-iio/guides/quick.html

PyADI-IIO
PYTHON FOR ADI INDUSTRIAL I/O DEVICES

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PySDR: A Guide to SDR and DSP using Python
https://pysdr.org/

Project software (Python)

Python program:

```
#
#  version 1.0   2021-12-20,  HB9DUG Michel
#
#  proto transponder DATV
#  input = 437 MHz
#  output = 1280 MHz
#  rf bandwidth = 2 MHz

import adi

# setup interface
sdr = adi.Pluto('ip:172.22.22.150')
sdr.sample_rate = 8.192e6

# Configure RX channel
sdr.rx_enabled_channels = [0]
sdr.rx_lo = 437000000
sdr.rx_rf_bandwidth = 2000000

# configure TX channel
sdr.tx_enabled_channels = [0]
sdr.tx_lo = 1280000000
sdr.tx_rf_bandwidth = 2000000
sdr.tx_cyclic_buffer = True
```

```
# Mute TX on power up
sdr.tx_hardwaregain_chan0 = -60

# Use RF loop back mode
sdr.loopback = 2

# AGC
sdr.gain_control_mode = 'slow_attack'

# TX on  (-60 to 0 dB)
sdr.tx_hardwaregain_chan0 = -10


while True:
    print(' ')
    stop = input('Return to Exit')
    sdr.tx_hardwaregain_chan0 = -60
    break
```

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Project software (IIO Command tools)

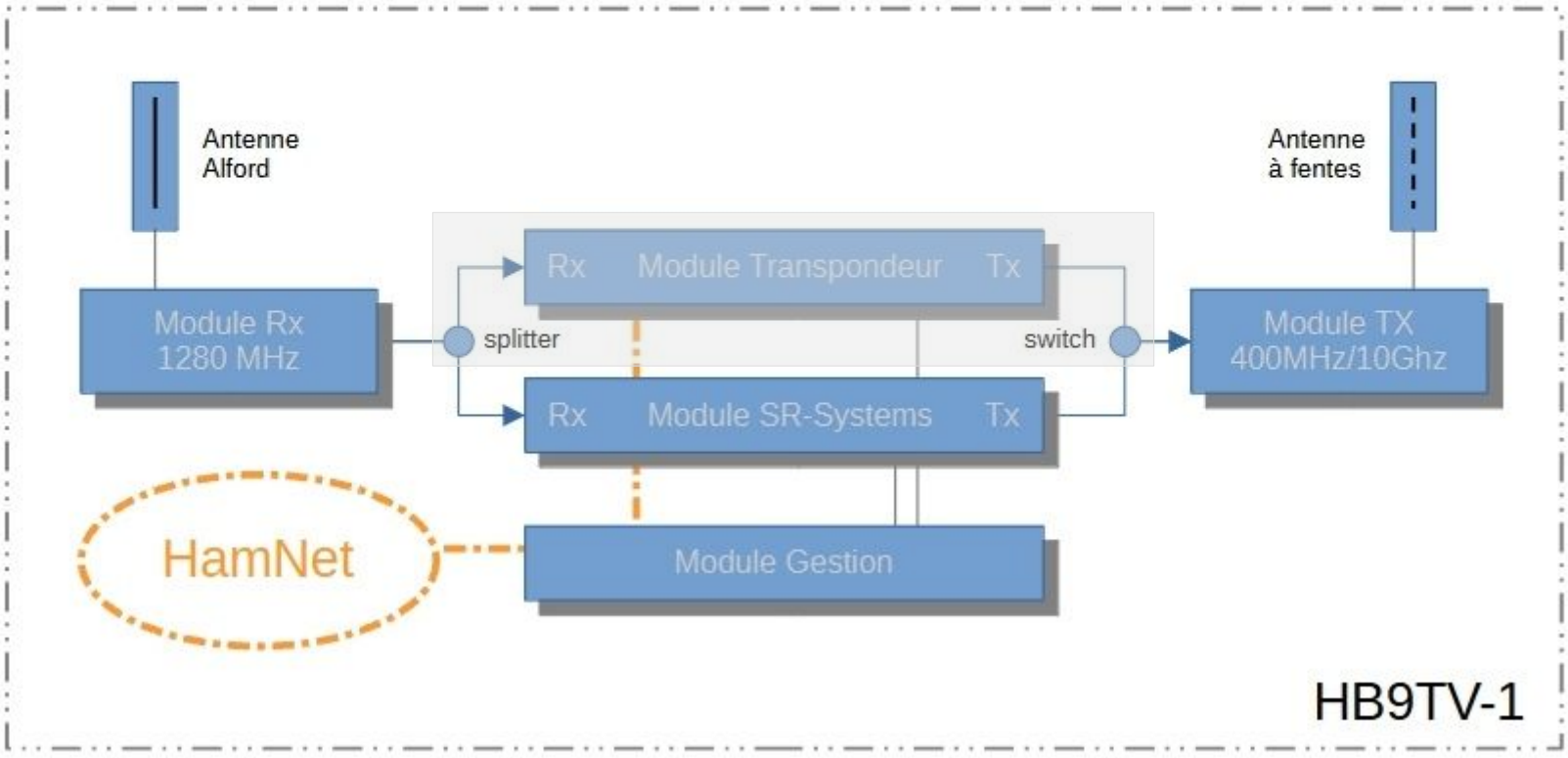
The goal : standalone Pluto using the mass storage drive support (USB Flash Drive)

Auto Run Support
runme[XX].sh

```
#
# version 1.0   2022-05-01
#
# HB9TV / HB9DUG
#
# proto transponder DATV
# input = 437 MHz
# output = 1280 MHz
# rf bandwidth = 2 MHz
# sample rate = 4096 MHz

# Configure sampla rate
iio_attr --uri "ip:192.168.2.1" -c ad9361-phy voltage0 sampling_frequency 4096000

# Configure RX channel
iio_attr --input-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 rf_port_select A_BALANCED
iio_attr --input-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 gain_control_mode slow_attack
iio_attr --input-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 rf_bandwidth 2000000
iio_attr --uri "ip:192.168.2.1" -c ad9361-phy altvoltage0 frequency 437000000

# configure TX channel
iio_attr --output-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 rf_port_select A
iio_attr --output-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 hardwaregain -10.000000
iio_attr --output-channel --uri "ip:192.168.2.1" -c ad9361-phy voltage0 rf_bandwidth 2000000
iio_attr --uri "ip:192.168.2.1" -c ad9361-phy altvoltage1 frequency 1280000000

while :
do
  echo "Press <CTRL+C> to exit."
  sleep 1
done
```

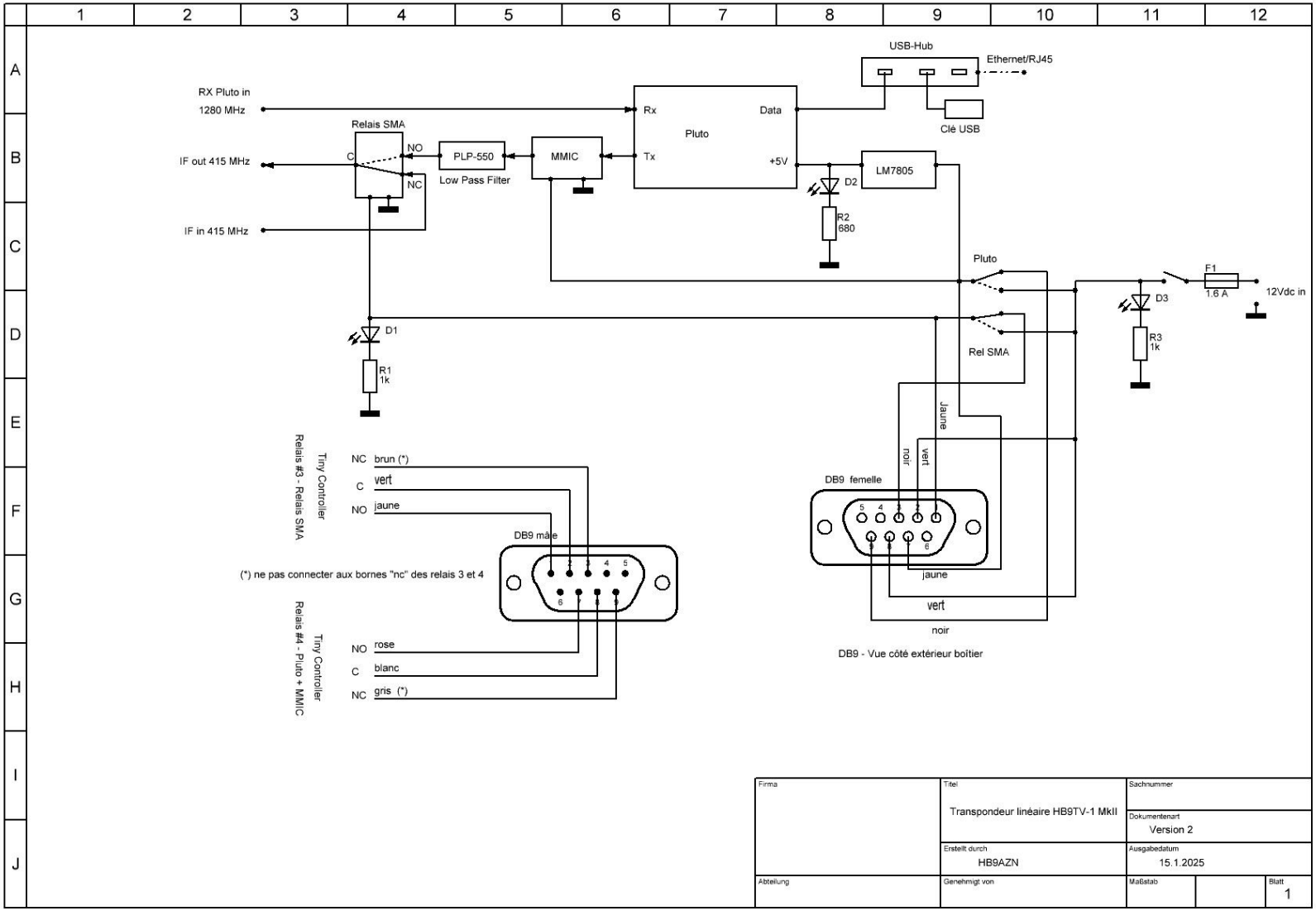
HB9TV-1 Deployment

The goal : to integrate a linear transponder module on the HB9TV-1 DATV Repeater



HB9TV-1 Deployment

The linear transponder module



Annexe 5

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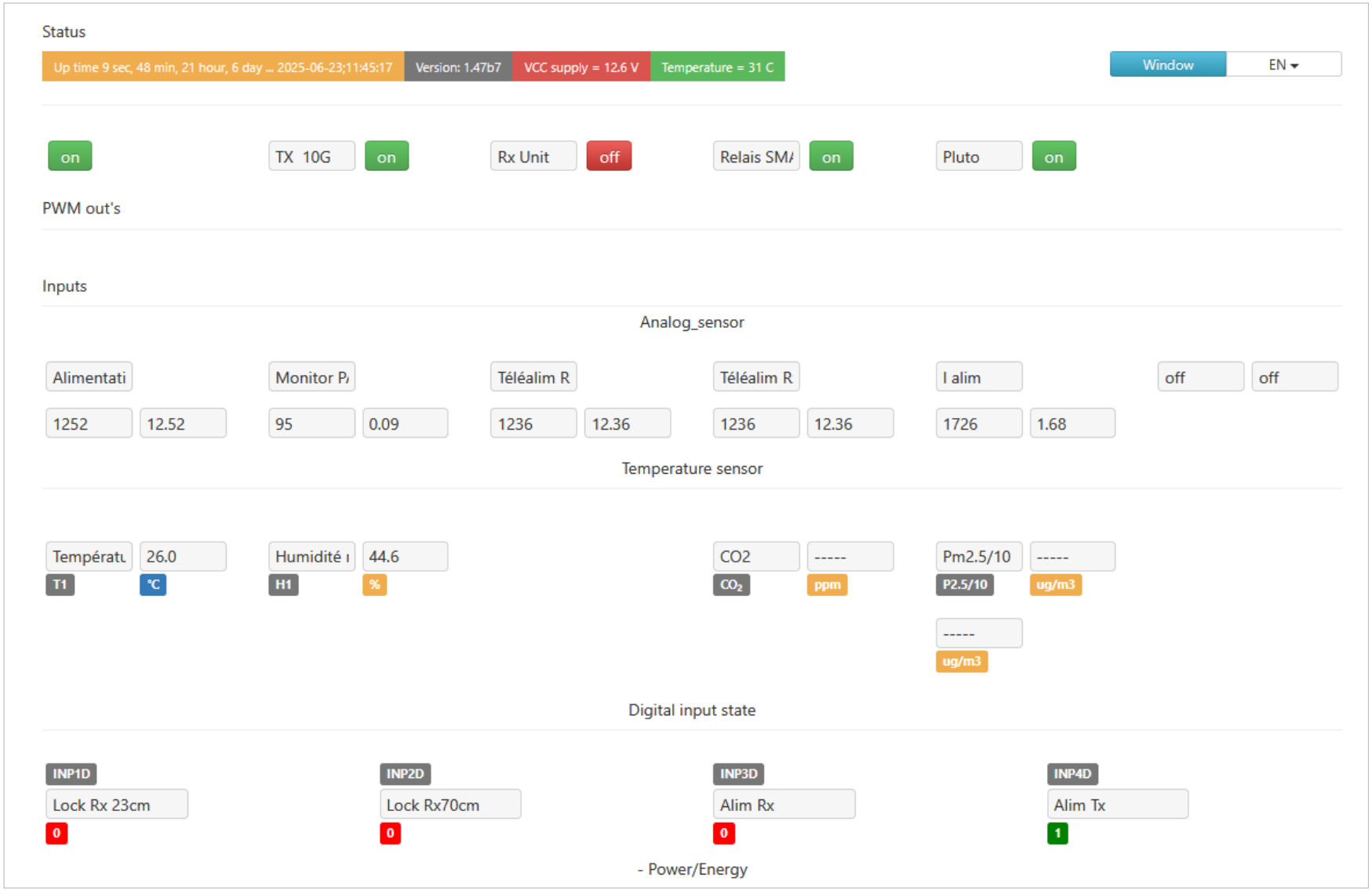
HB9TV-1 Deployment

Remote management via HAMNET



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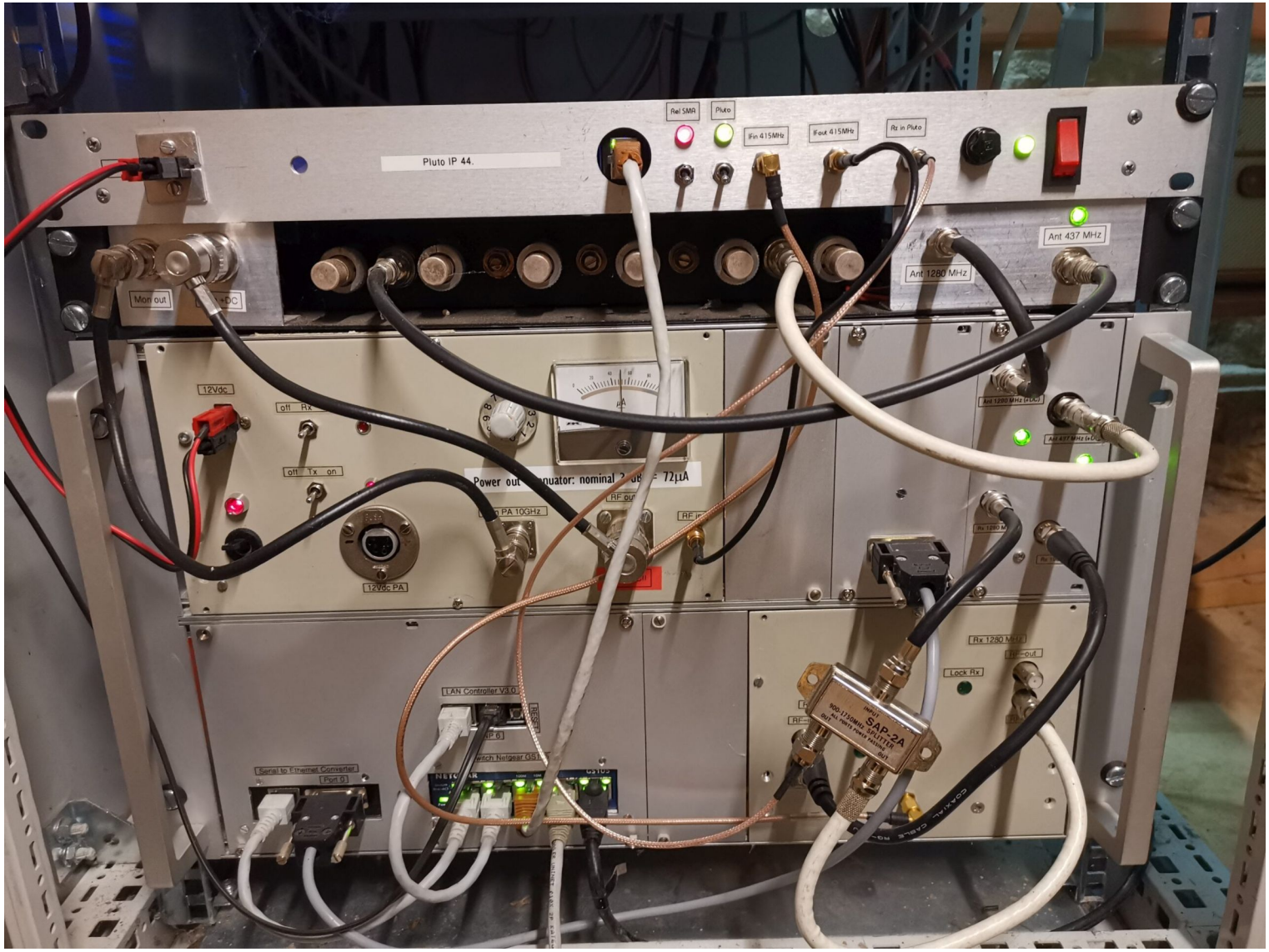
HB9TV-1 Deployment

The HB9TV-1 rack and antennas



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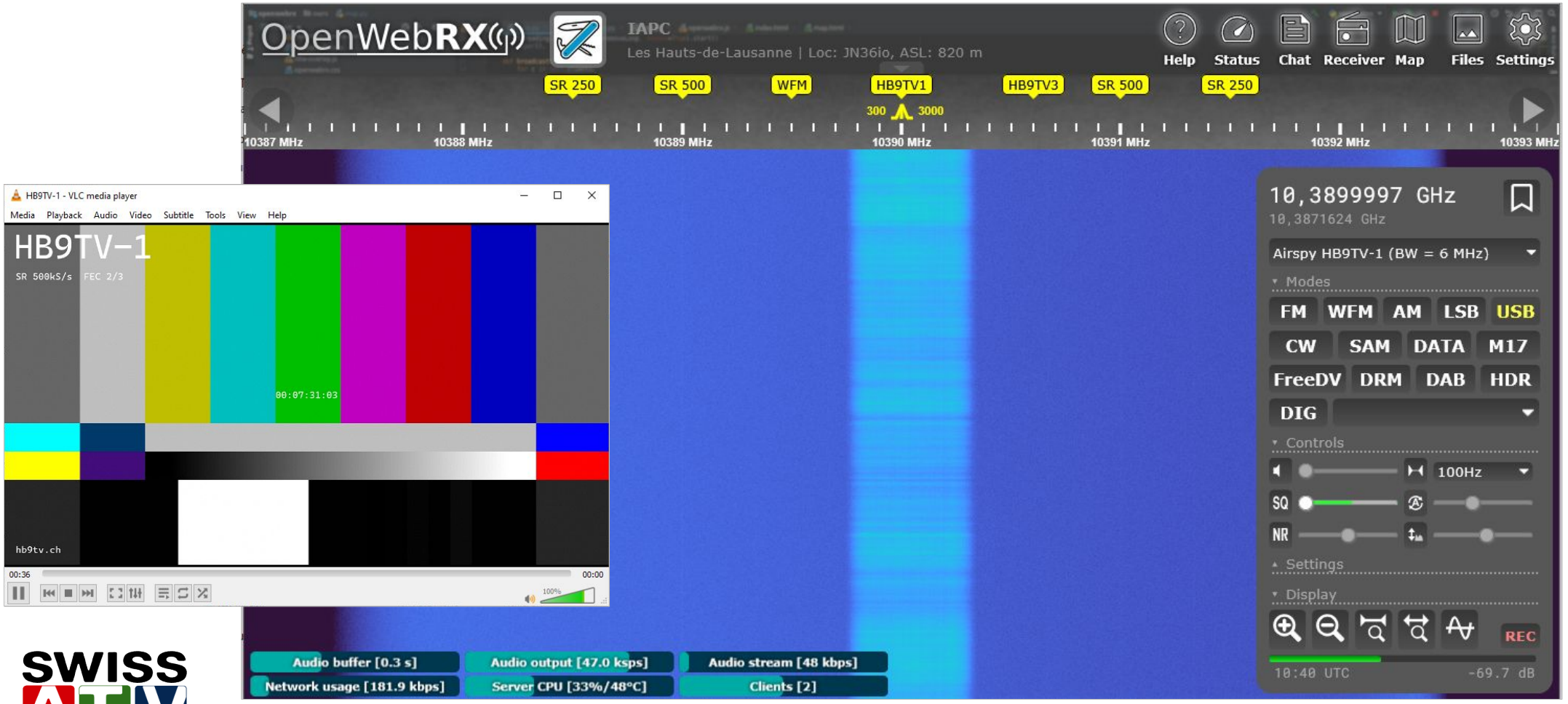
HB9TV-1 Deployment

The HB9TV-1 Spectrum Monitor http://sdr10ghz-fro.iapc.ch:2173/



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HB9TV-1 Deployment

The software

- based on a standalone Pluto
- Remote management via HAMNET
- using the PlutoDVB2 firmware from Evariste F5OEO (serveur MQTT Mosquito)
- at standby, the transponder should transmit a test card
  (thanks to the firmware's ability to stream a local TS file)

```
init_mire() {
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/frequency -m $tx_mire_freq)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/sr -m 500000)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/frame -m long)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/constel -m qpsk)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/fec -m 2/3)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/pilots -m 1)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/tssourcemode -m 1)
    $(mosquitto_pub -t $cmd_root/tx/dvbs2/tssourcefile -m /media/sda1/mire-hb9tv1-sr500-23-audio-600s.ts)
    $(mosquitto_pub -t $cmd_root/tx/gain -m $tx_xpdr_gain)
    echo "1: init mire done"
}
```

```
init_rx_channel() {
    $(mosquitto_pub -t $cmd_root/rx/frequency -m $rx_xpdr_freq)
    $(mosquitto_pub -t $cmd_root/rx/modegain -m slow_attack)
    iio_attr --input-channel --uri $sdr_ip -c ad9361-phy voltage0 rf_port_select A_BALANCED
    iio_attr --input-channel --uri $sdr_ip -c ad9361-phy voltage0 rf_bandwidth $rx_rf_bw
    echo "2: init rx channel done"
}
```

HB9TV-1 Deployment

The software

```
init_tx_channel () {
    $(mosquitto_pub -t $cmd_root/tx/frequency -m $tx_xpdr_freq)
    iio_attr --output-channel --uri $sdr_ip -c ad9361-phy voltage0 rf_port_select A
    iio_attr --output-channel --uri $sdr_ip -c ad9361-phy voltage0 rf_bandwidth $tx_rf_bw
    echo "3: init tx channel done"
}
```

```
waitlock() {
while :
do
    rssi_db=$(mosquitto_sub -t $dt_root/rx/rssi -C 1)
    echo $rssi_db

    rssi=$((${rssi_db%%'.'*}))
    sleep 0.5

    if [ $rssi -le $rx_level ]; then
      iio_attr --uri $sdr_ip -D ad9361-phy loopback 2 1>/dev/null # rf loopback mode rx -> tx
    else
      $(mosquitto_pub -t $cmd_root/tx/stream/mode -m dvbs2-ts)
    fi
done
}
```

```
trap exit_script SIGINT SIGTERM
init_mire
init_rx_channel
init_tx_channel

$(mosquitto_pub -t $cmd_root/tx/mute -m 0)

while :
do
waitlock
done
```

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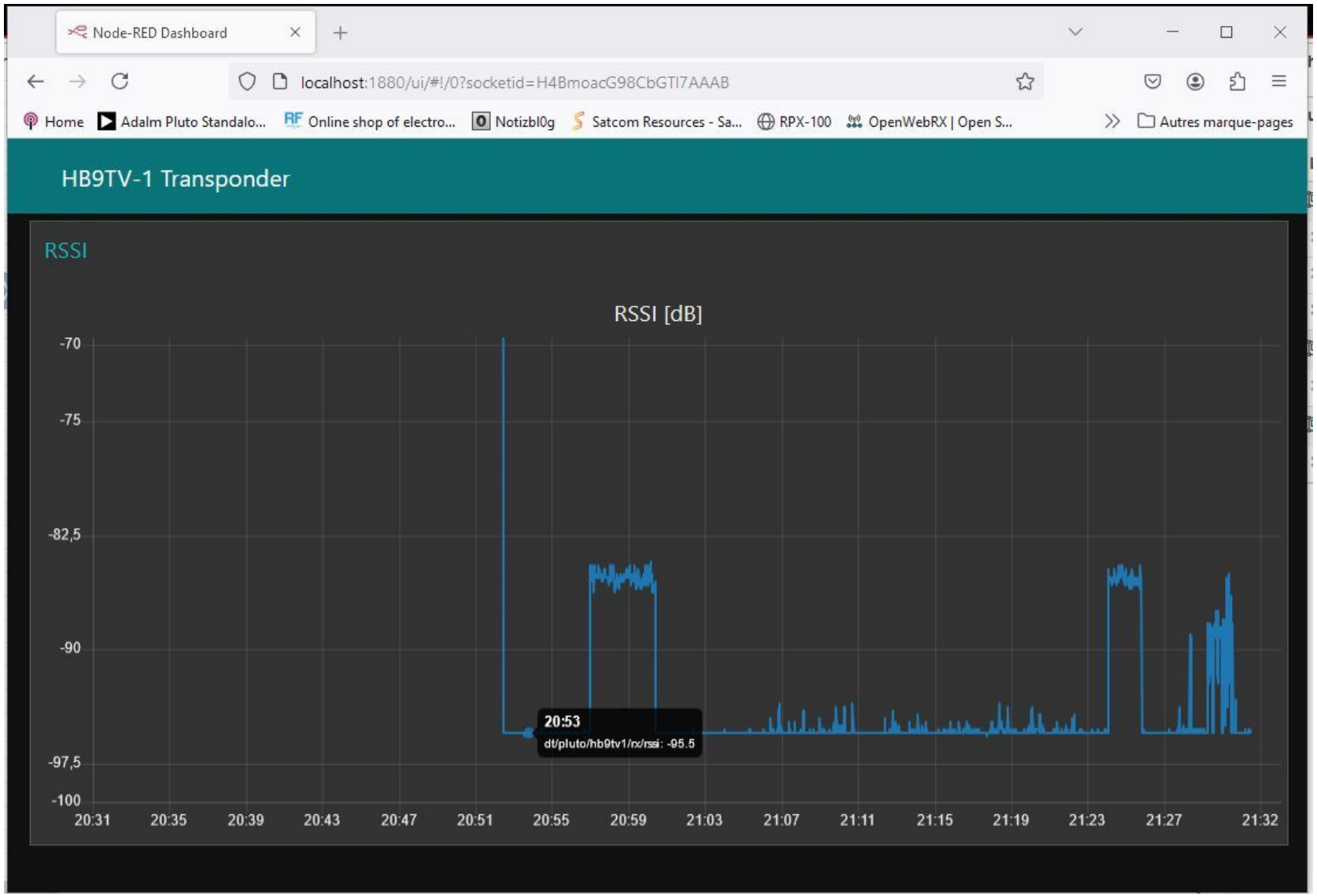
HB9TV-1 Deployment

MQTT + Node-RED = Monitoring tools



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HB9TV-1 Deployment

Testing

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HB9TV-1 Deployment

The measures

MESURES RELAIS LINÉAIRE HB9TV-1 ***mode DATV***

RX 10 GHz : parabole Fuba 80 cm, LNB 10'390 MHz LO 9'750 MHz, IF 640 MHz offset 200 Khz

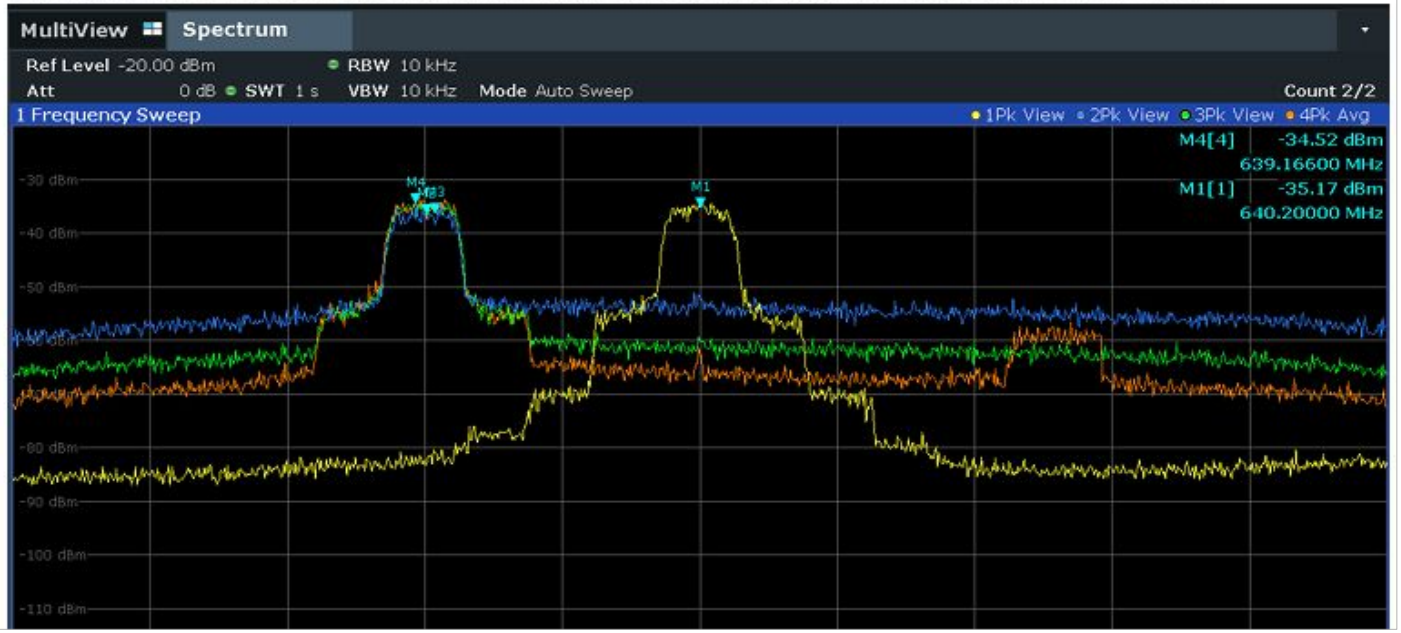
TX 1280 MHz : OBS, DATV-Easy 3.08, PLUTO et PA (nominal max 36 dBm), antenne panneau 15 dB

Mesures de la sortie du relais en fonction de la puissance entrée, ouverture > 9dBm

couleur Ces glissem	Vidéo	Frequence entrée relais	Fréquence sortie relais	IF LNB + offset	SR	**Sortie Relais dBm**	**Sortie LNB dBm**	MER RX dB
Jaune	Mire centrale	na	10390.000	640.200	250	**na**	-35.17	20.0
Bleue	TX HB9IAM	1279.00	10389.000	639.200	250	**10.0**	**-36.44**	17.0
Verte	TX HB9IAM	1279.00	10389.000	639.200	250	**20.0**	**-36.70**	21.0
Orange	TX HB9IAM	1279.00	10389.000	639.200	250	**25.0**	**-36.70**	22.0

note : Une puissance du TX > 23 dBm augmente les épaules et l'intermodulation par saturation

L'AGC est très efficace, la puissance de sortie ne varie pas pour une entrée de 10 à 30 dBm !



Thanks to Pierre HB9IAM for his detailed report on the linear transponder measurements, available here : https://hb9tv.ch/lhistoire/hb9tv-1-transpondeur/

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References

HB9TV powered by arald

HB9TV-1 Transpondeur

Suite au prototype de transpondeur linéaire construit et tester début 2022 (voir articles dans **HBradio 1/2022** , **CQ-TV 275** et présentation au **Forum DATV / HAMRADIO 2022**) , l'équipe de **HB9TV** a décidé d'installer cette technologie sur le relais DATV HB9TV-1.

Un module transpondeur linéaire a été construit intégrant un Adalm-Pluto avec un interface Hub USB/Ethernet équipé d'une carte SD permettant de stocker des fichiers (mire, programmes, etc.). La connexion Ethernet par le Hamnet permet la gestion du Pluto à distance. Le module intègre encore un ampli 400 MHz et un filtre sur sa sortie émission.

Grâce à la conception modulaire du relais existant HB9TV-1, les chaînes réception et émission sont utilisées telles quelles. En entrée, un splitter 3dB fournit le signal au relais «standard» et au transpondeur ; en sortie, un relais commute le signal d'émission en provenance soit du relais «standard» soit du transpondeur.

HB9TV powered by arald

HB9DUG / 2024-12-01

https://hb9tv.ch/lhistoire/hb9tv-1-transpondeur/

https://hb9tv.ch/

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Home | Les paramètres | L'histoire

1ère mondiale?

Un mode transpondeur linéaire a été installé sur le relais DATV HB9TV-1

Les détails


Le bassin lémanique

HB9TV-1

HB9TV-2

Après la mise en route du relais HB9 IBC-1 de la Barillette, il était tentant de réaliser un pont entre le

HB9TV-3

A l'été 2004, la chance nous sourit. Un OM nous signale du matériel à

HB9TV powered by arald

ARALD

L'idée d'un relais ATV pour le bassin lémanique germa en juillet 1993. En novembre 1993, Un projet prend forme et le consortium ARALD – Amateur Radio ATV La Dôle est fondé...

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Thank you for your attention !