Radioberry @RPI-5

Radioberry

The radioberry is actual a radio card (raspberry pi hat), which can be plugged into a raspberry pi, forming a Software Defined Radio (SDR).

The radio card uses an Analog Devices AD9866 which is a 12-bit broadband modem mixed signal front end that has been repurposed as a direct down conversion (DDC) and direct up conversion (DUC) SDR transceiver covering 0-30 MHz

The radio card uses an Intell Cyclone 10LP FPGA, supporting the 10CL16 and 10CL25. The firmware will be loaded via the raspberry pi.

Power supply for the radio card is provided by the raspberry pi.

More info can be found at:

https://github.com/pa3gsb/Radioberry-2.x/wiki

Raspberry PI

The Radioberry started using the RPI-2 followed by the PI 3,4 and now the latest one the PI5!

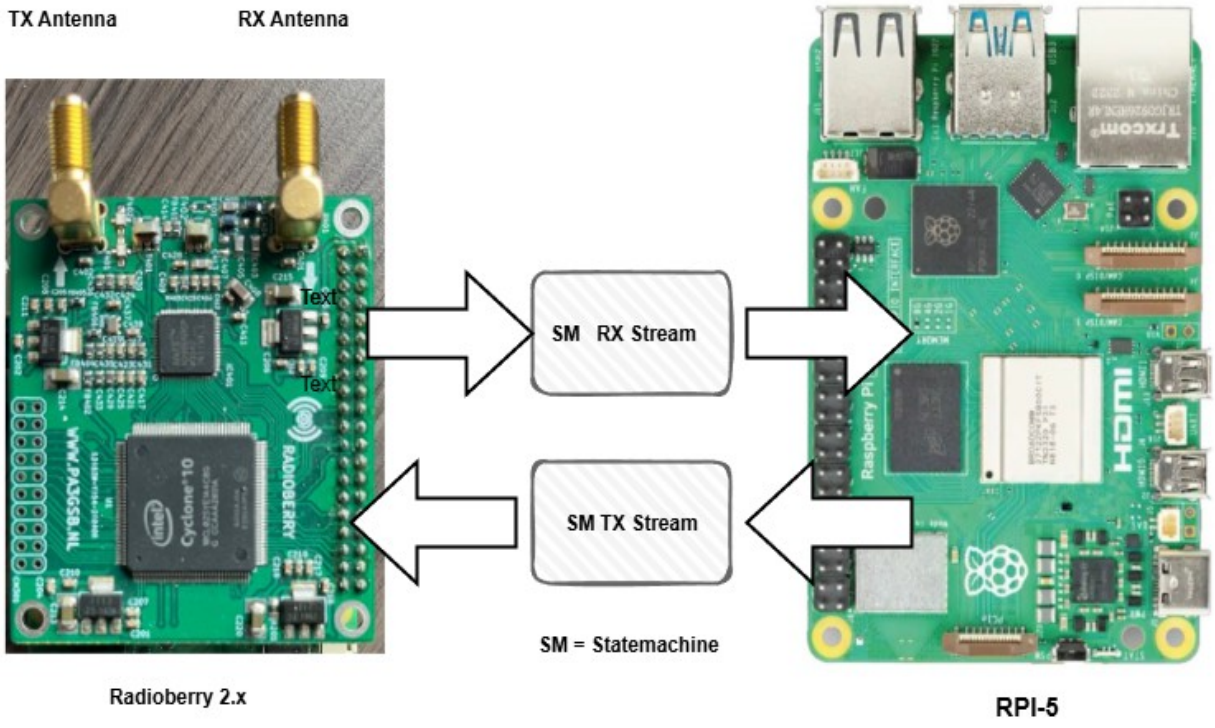
One major change of the Pi 5 is the IO handling, not longer executed by the BCM processor of the Pi but done by a RP1 chip (developed by the RasperryPi organisation) . The RP1 chip is doing the control of the IO, and transfers the data via PCIE to the main processor.

For every single byte transfer using the PCIE does cost a setup, transfer time. This makes the performance of a radioberry in combination with a gpio based mode in comparison to a rpi-4 not better. We were only able to use the radio with only 1 receiver channel with a 48K sampling rate. I decided to stop supporting this gpio option and like to present here the successor which uses state machines in the so called PIO mode.

By placing the handling in a state machine in the RP1 chip we are able to collect the radio IQ data and are able to use DMA to transfer the data to the driver which can be used by the firmware program of the radioberry. This all (should) result in a very low CPU use; all works is CPU offloaded. Using this pio mode option is outperforming all predecessors.

RPI-5 PIO mode

This diagram shows the radioberry dataflow. The PIO mode of the RP1 uses 2 Statemachines which transfers the data from and to the radioberry using DMA which helps to get the CPU utilization low.




```
File  Edit  Tabs  Help
top - 14:17:32 up  1:06,  2 users,  load average: 1.25, 1.22, 1.10
Tasks:   1 total,   0 running,   1 sleeping,   0 stopped,   0 zombie
%Cpu(s): 15.0 us,  1.3 sy,  0.0 ni, 83.6 id,  0.0 wa,  0.0 hi,  0.1 si,  0.0 st
MiB Mem :   4045.9 total,   2665.7 free,    796.7 used,    786.2 buff/cache
MiB Swap:    512.0 total,    512.0 free,      0.0 used.   3249.2 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
   1553 root      20   0  117568   1968   1568 S   2.3   0.0   0:53.35 radiobe+
```

Showing with a sample rate of 384K a CPU utilization below 3% for the radioberry firmware! Amazing

The following video does give some additonal information:

https://www.youtube.com/watch?v=v34ROMQqOaA

Software Stack

The required software is described at:

https://github.com/pa3gsb/Radioberry-2.x/wiki/Radioberry-Software-stack

So for the RPI-5 using the PIO mode the following software components are changed:

- Gateware; configuration / program running in the FPGA
  - https://github.com/softerhardware/Hermes-Lite2/tree/master/gateware/rtl/radioberry/pi-pio
- Driver; linux kernel program
  - https://github.com/pa3gsb/Radioberry-2.x/tree/master/SBC/rpi-5/device_driver/pio-mode/driver
- Firmware
  - https://github.com/pa3gsb/Radioberry-2.x/tree/master/SBC/rpi-5/device_driver/firmware

Image Release

The project started as indicated at page:

https://github.com/pa3gsb/Radioberry-2.x

stated the following:

Main purpose of the project:

- Building a HAM Radio
- Learning (from noob to guru)

With the idea in mind to build and install the software yourself.

This is for a lot of people a real burden... so in helping a release procedure was developed which makes the installation achievable for almost everyone! The forum is there https://groups.google.com/g/radioberry for helping each other to setup your radioberry radio.

For the setup you need to build your own linux image because we are using in the radioberry driver a rp1-pio driver which is still under construction. All the code is available and IT people should be able to pull it off but will take a considerable amount of work. Much code is under construction and quite vulnerable.

So I decided to make an image.

This is a **preconfigured SD-card image** for the **Radioberry** radio card on a **Raspberry Pi 5**. All included software is **open-source**; this download is a **service build** that saves you time on installation and configuration and **supports ongoing development** for this radio.

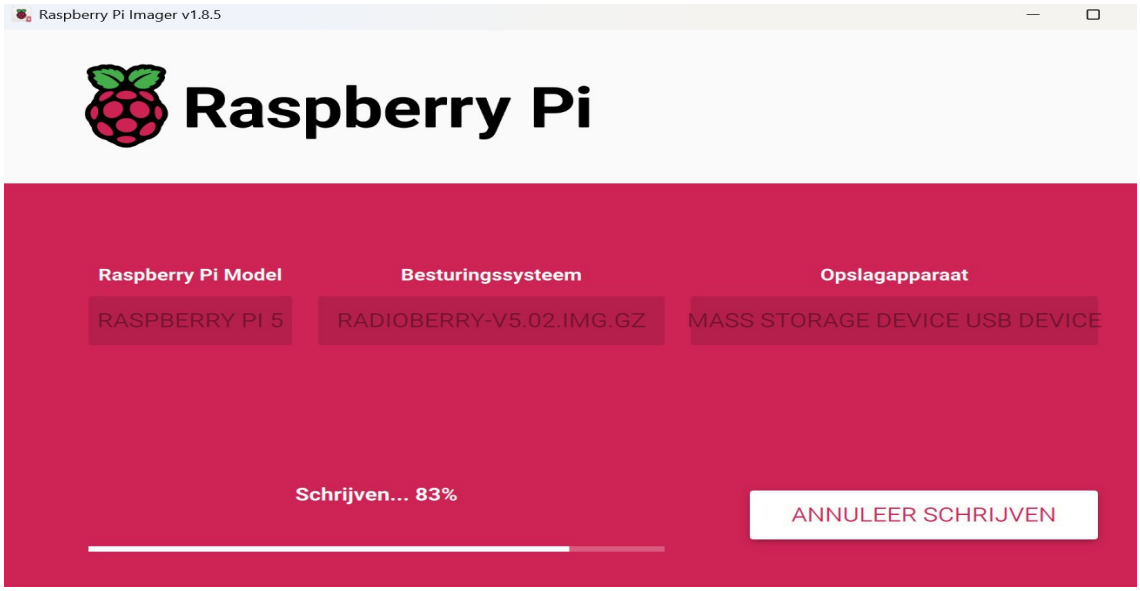
I will sell these images at https://gumroad.com/

The following link can be used:

https://pa3gsb.gumroad.com/l/radioberry

The acquired image can be installed to an SDCard using the imager tool:

Select use your own image and select the downloaded image.



With the image on the SDCard you can boot your raspberry pi and you should be able to operate your radio with the installed software.

Image content:

Raspberry Pi Linux User space version:

Distributor ID: Debian
Description: Debian GNU/Linux 13 (trixie)
Release: 13
Codename: trixie

Kernel version (Special version for Radioberry) :

6.12.55-v8-16k+

Radioberry software:

Gateware: 75.2

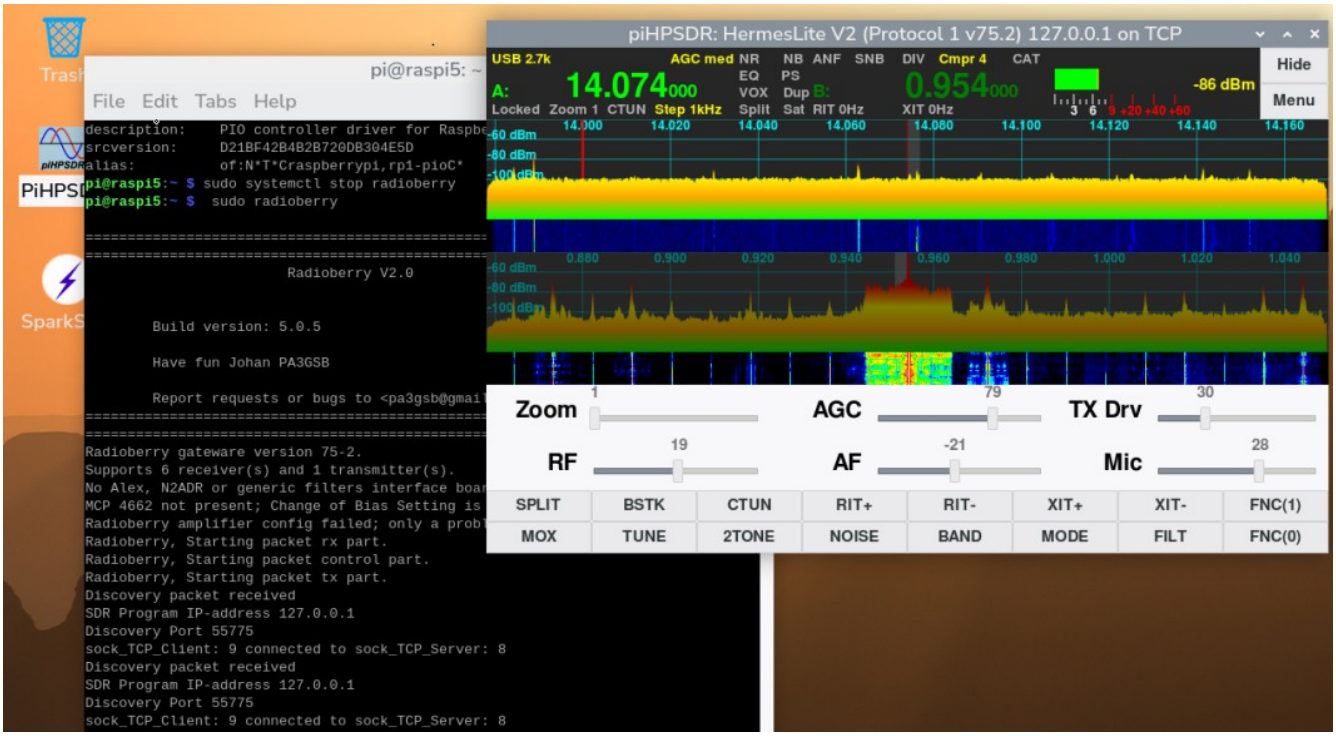
Kernel driver: 5.54

Firmware: 5.0.6

When your Radioberry uses the CL025 cyclone FPGA you are able to use 6 RX channels and 1 TX channel.

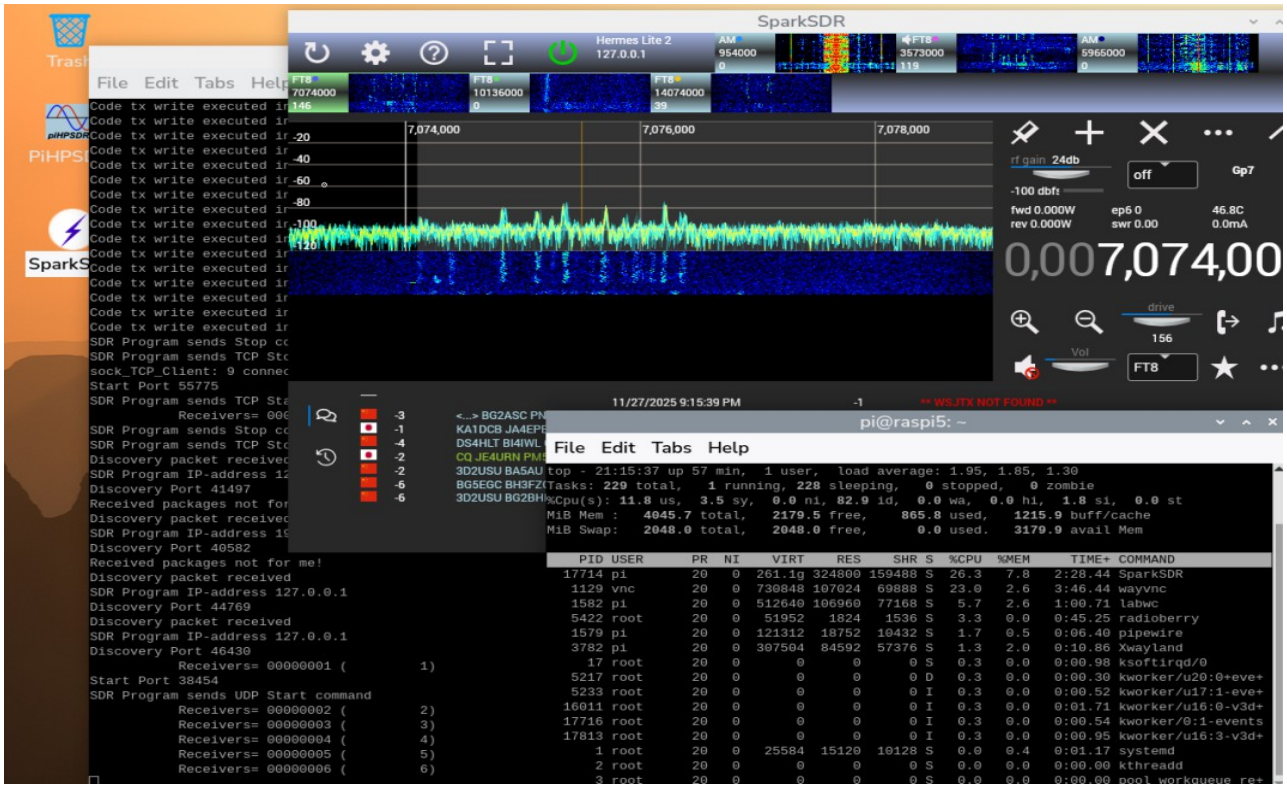
I installed 2 excellent SDR programs.

Pihpsdr



Picture by JG1TWP Yado-san.

SparkSDR

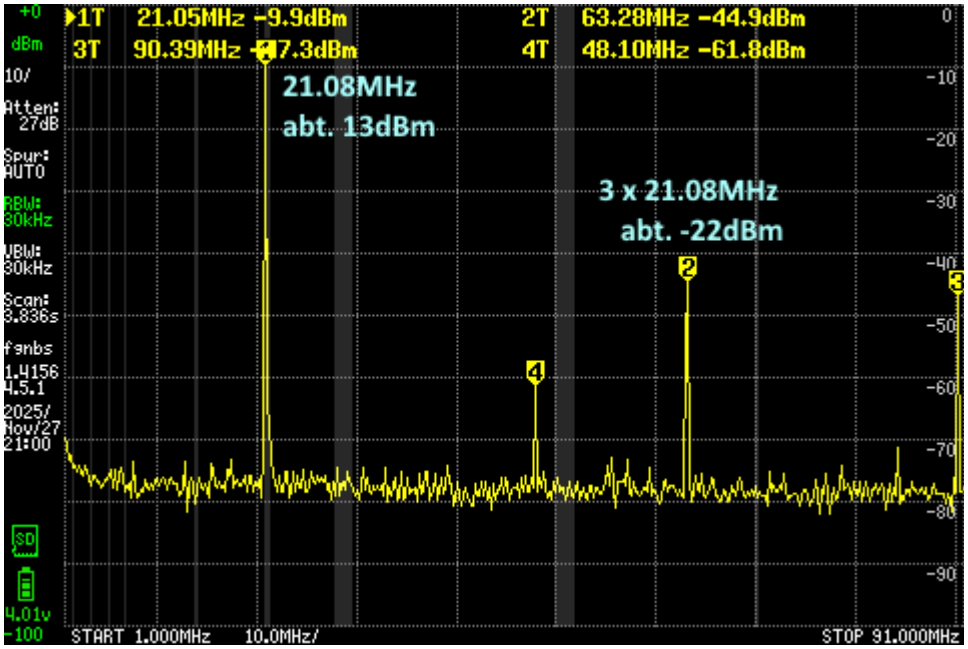


Picture by JG1TWP Yado-san.

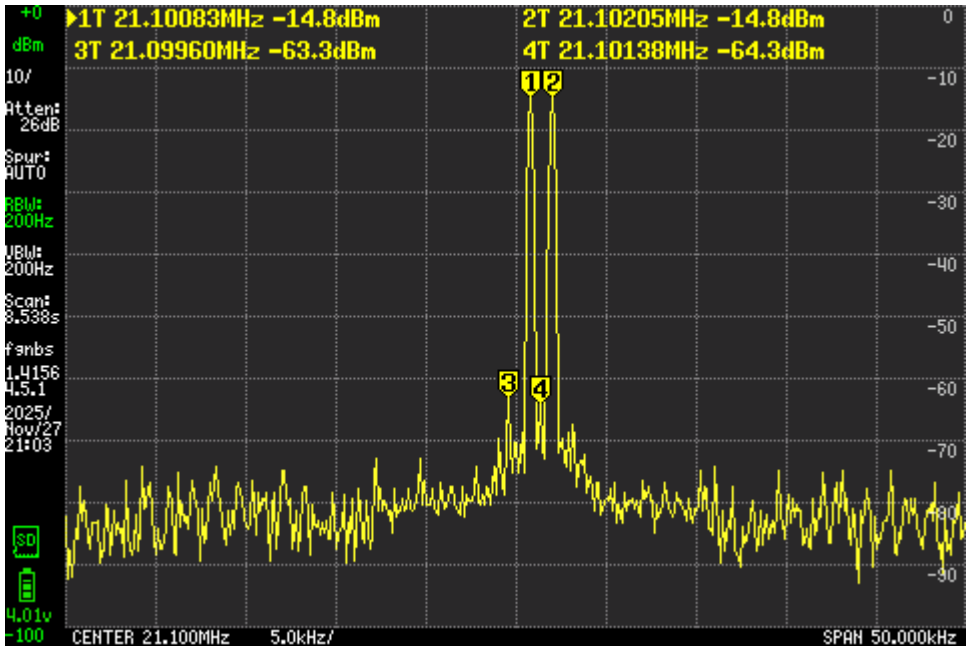
Here you see the SparkSdr running 6 channels at 96K sampling rate.

Transmit

TUNE, drive100, PA-Cal.=40.5

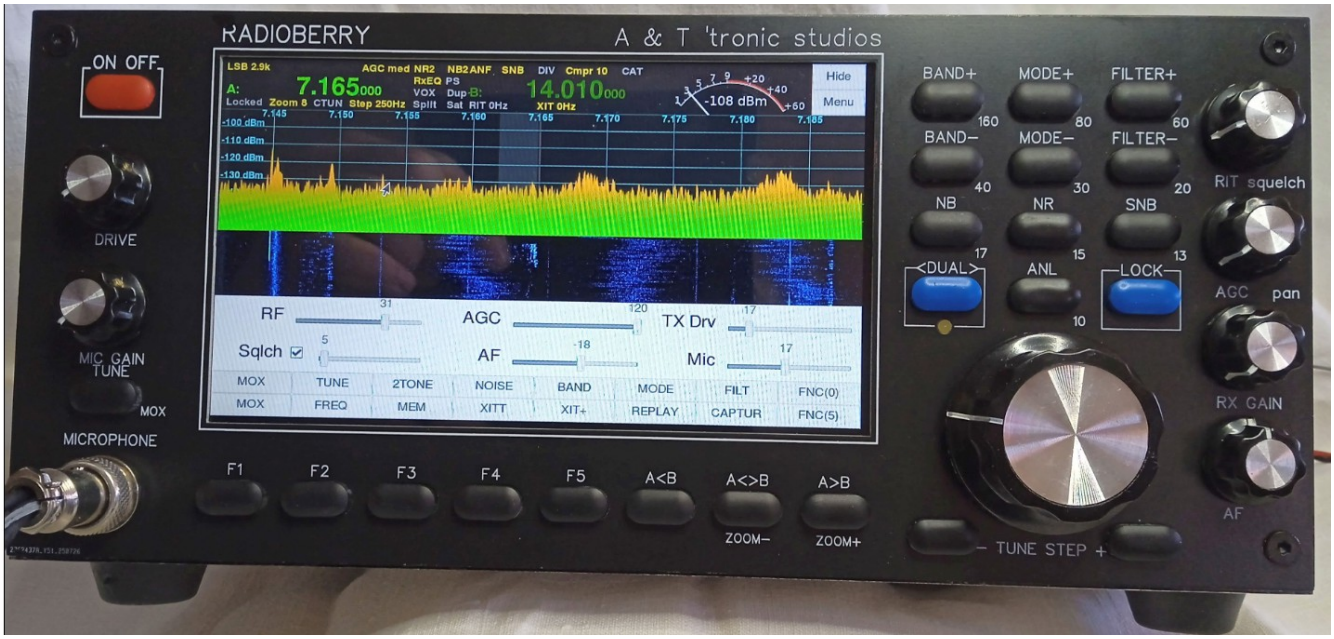


2TONE, drive100, PA-Cal.=40.5



Pictures by JG1TWP Yado-san.

It is all about doing experiments, the Radioberry is not a ready to use transceiver, additonal components are required to make for instance a standalone version. This radio is created by Italian radio amateurs Carlo and Paolo.



They describe this at http://tarozzi.net/radioberry/

There are of course many other setup possibilities. If you like to share your setup please use the forum https://groups.google.com/g/radioberry .

Hope this image for the radioberry and the other information does hopefully show enough information about the Radioberry and the possibilities to make an easy start by using this image and maybe a start of new developments, as said please share your endeavors!

Special thanks to Yado-san (JG1TWP) for your invaluable help and support.

Enjoy and 73's

Johan

PA3GSB