Documentation Red Pitaya

# Introduction and Goal (Alexander Schmid)

The Red Pitaya STEMlab 125-10 is a “Multifunction Lab Instrument”.

More concretely, it is a single-board computer consisting of a dual-core ARM Cortex-A9 MPCore CPU, a Xilinx Zynq 7010 FPGA, a number of digital IO pins and four coaxial RF I/Os (two inputs and two outputs).

The Red Pitaya runs a custom Ubuntu-based operating system with an nginx-based web server. This allows the user to connect to the Red Pitaya over a local network and, via a web-browser, interact with a number of included applications. Among these applications are an oscilloscope, signal generator, logic analyzer and others.

The included logic analyzer supports reading data from the Red Pitaya’s digital I/O-pins and decoding the I2C, SPI and UART protocols. This limited number of supported protocols has proven to be insufficient.

The goal of this project is to support the analyzing of additional protocols with the Red Pitaya, especially the CAN protocol.

Because the included logic analyzer application is closed-source, this will necessitate building a new logic analyzer application from scratch.

# Important/helpful links to get start or to deal with problems

Information about rp.h : [https://github.com/RedPitaya/RedPitaya/blob/master/api/include/redpitaya/rp.h#L145](https://github.com/RedPitaya/RedPitaya/blob/master/api/include/redpitaya/rp.h" \l "L145)

Examples of RF Input Output: [https://redpitaya.readthedocs.io/en/latest/appsFeatures/examples/genRF-exm1.html#code-c](https://redpitaya.readthedocs.io/en/latest/appsFeatures/examples/genRF-exm1.html" \l "code-c)

Information about IOs: <https://redpitaya.readthedocs.io/en/latest/developerGuide/125-14/fastIO.html>

Specs of the Redpitaya: <https://www.redpitaya.com/f146/specifications>

Sampling rates, etc: [https://redpitaya.readthedocs.io/en/latest/appsFeatures/examples/acqRF-samp-and-dec.html#s-rate-and-dec](https://redpitaya.readthedocs.io/en/latest/appsFeatures/examples/acqRF-samp-and-dec.html" \l "s-rate-and-dec)

Ringbuffer stuff: <https://github.com/RedPitaya/RedPitaya/issues/100>

# Procedure Initial Start

# Initial setup

Insert the provided SD-card into the Red Pitaya. Connect the provided Micro-USB power supply to the Red Pitaya.

If you are working from home: Connect the provided Ethernet cable to the Red Pitaya and to your WiFi router. Go to the URL printed on the sticker on the Red Pitaya’s ethernet port, i.e. „rp-fxxxxx.local/“. If you get the Red Pitaya’s web interface, congratulations, you are connected.

If not, you may need to go into the settings of your WiFi router, check the Red Pitaya’s local IP address and type that into your router.

If you are working in the lab: Connect the Ethernet cable to the Red Pitaya and directly into your computer.

Follow the directions here to get a connection to the Red Pitaya: <https://redpitaya.readthedocs.io/en/latest/quickStart/connect/connect.html>.

Once you are connected, you can plug the WiFi dongle into the Red Pitaya and connect to the TI\_Roboter network via the web interface. The password is „ITRobot!“. Now, you can access the Red Pitaya via WiFi if your PC or phone is connected to the same WiFi network.

To then do software development via the Red Pitaya, connect via SSH. On linux, simply run „ssh root@<either your Red Pitaya’s URL or IP here>“. On Windows, use Putty get an SSH connection. The password is also „root“.

The Windows Explorer and most Linux file managers support browsing files via SSH or more precisely SFTP or FISH. Simply google the instructions for more convenient file access.

# Recurrent work

## Building App

The source for the main app can be found in the „RPOSC-LogicAnalyser“ folder of the project.

A web app for the Red Pitaya consists of several components. Among these are the backend code written in C++, contained in the src-Folder.

The backend code is compiled into a shared object file loaded by the webserver.

This build is performed via the Makefile contained in the root folder of the app. To perform the build, run „make INSTALL\_DIR=/opt/redpitaya“.

The current implementation of the RPOSC-LogicAnalyser app has two additional dependencies that must be installed for the backend to successfully compile. These are „libsigrokdecode2“ and „libsigrokdecode-dev“, both for the armhf architecture.

These should already be installed on the provided SD-Cards.

If you decide to wipe the sd-cards, simply install them via apt if your Red Pitaya has an internet connection or install them via dpkg from the libsigrokdecode\_packages folder of the project.

The frontend consists of the index.html file and the js and css folders, containing the Javascript and CSS code respectively.

While a simple frontend for the Red Pitaya that simply consists of hand-written HTML, Javascript and CSS does not need to be built, our UI is built with Vue.js version 3.

A Vue.js project consists of several components in the form of .vue-files. These contain HTML, Javascript and CSS.

To compile the .vue-files into HTML, Javascript and CSS, npm version 6.14.11 is used. The provided virtual machine already contains a working npm installation.

The UI-code is contained in the logic-analyzer-webui-dev folder. To build it, open a terminal in that folder and run „npm install“ once. Then run „npm run build“. This creates a folder called „dist“, which contains the compiled UI. Copy that folder into the RPOSC-LogicAnalyser folder and you have the complete project which can be copied to the Red Pitaya.

Each Red Pitaya web app also loads a specific FPGA-image. The path to that FPGA-file is specified in the FPGA.conf file. More on that in chapter „Current State and Future Directions“.

To summarize:

Initial setup, done one time:

If the project is not on the Red Pitaya yet, copy the RPOSC-LogicAnalyser folder to the Red Pitaya under the path *„*/opt/redpitaya/www/apps*“.* If not already installed, install libsigrokdecode2 and libsigrokdecode-dev on the Red Pitaya.

Install npm on your PC or start the provided VM on your PC, go to the logic-analyzer-webui-dev folder and run „npm install“.

To build, done each time changes are made:

If changes were made to the backend, go to the RPOSC-LogicAnalyser folder on the Red Pitaya, run „make clean“ and „make INSTALL\_DIR=/opt/redpitaya“.

If changes were made to the frontend, go to the logic-analyzer-webui-dev folder on your pc, run „npm run build“, then copy the newly created dist folder to the Red Pitaya under „/opt/redpitaya/www/apps/RPOSC-LogicAnalyser“, merge and overwrite if prompted.

# Known issues and workaround

## The included applications on the Red Pitaya do not start, the progress ring simply keeps spinning

If the browser’s javascript console shows „Uncaught ReferenceError: AnalyticsCore is not defined“, you most likely have an ad-blocker enabled in your browser. The included applications will not work with an ad-blocker. Simply disable it for your Red Pitaya’s URL and reload the page.

## Filesystem is read-only

Call `rw` inside of the RP console to make writeable

## Call the Redpitaya webserver fails within Windows

## SSH connection breaks

Simple restart should work. We don’t know why it happens but maybe it’s a temperature problem.

## Acquiring data never stops

If you call the “rp\_App\_Init()” to initialize the Webapp, replace it with “rp\_Init()”. Until now we didn’t notice any different behavior, only the acquiring process stops correctly.

To stop the acquiring process, its needed to push the FPGA image again via “cat /opt/redpitaya/fpga/fpga\_0.94.bit > /dev/xdevcfg”.

## ws.app is null when starting up the Webapp

The name of the application (in the app.js) must be the same as the name of the folder

## Cannot read fpga file

Maybe you modified the fpga.conf of your project in windows, than everytime you open the file in nano, the file gets parsed from “DOT format” and somehow the path gets corrupted. Just copy a file from a working project or build up the file from scratch, but do it in Linux.

# Our VPN solution for „home office“

1. Build and configure a wireguard server
2. Build certificates for every client.
3. Install wireguard client software on your pc
4. Wireguard doesn’t work on the redpitaya directly therefore we did a little workaround
   1. Install wireguard on a raspberry or similar (following link should contain tutorial)
      1. https://www.sigmdel.ca/michel/ha/wireguard/wireguard\_02\_en.html
   2. Configure and connect the raspi
   3. Activate vnc server on the Raspberry
   4. Connect the redpitaya via lan to the raspberry
   5. You should now be able to control the raspi via vncViewer
      1. It is very important to use (real vncViewer) other clients didn’t work in our tests (https://www.realvnc.com/de/connect/download/viewer/)
   6. And on the raspi the Redpitaya should be available
   7. Finally build autostart (build in wireguard service)
      1. https://www.sigmdel.ca/michel/ha/wireguard/wireguard\_02\_en.html

4.1 Install (Ubuntu/Mint/Arch/Manjaro):

* `sudo apt install wireguard` (Ubuntu/Mint)
* `sudo pacman -s wireguard-tools` (Arch/Manjaro)
* Save .conf file to /etc/wireguard
* To start VPN: `wg-quick up <nameofconf>`
* To stop VPN: `wg-quick down <nameofconf>`
* If error `resolvconf: command not found` run `sudo ln -s /usr/bin/resolvectl /usr/local/bin/resolvconf`
* `sudo wg show all` shows the current connection

4.2 Install (Windows)

* Install: https://download.wireguard.com/windows-client/wireguard-installer.exe
* Run and import config file

# Current State and Future Directions