

Installation and operation manual for COHIRADIA

Version 3

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This documentation is accompanied by a supporting video tutorial, also available at radiomuseum.org

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1 SYNOPSIS

COHIRADIA is an acronym for **CON**servation of **H**istorical **RA**diofrequency bands by **D**igital **A**rchiving.

The goal of the project is to give interested radio enthusiasts and collectors the opportunity to play back original radio signals that were recorded in the past, on historical radio receivers. These signals do not just represent a single station (which could be easily achieved just by modulating a carrier with a simple signal generator), but an entire frequency band with all the radio stations contained therein on the original carrier frequencies existing at the time of recording. The archive of the author contains more than 20 hours of recordings from the years 2006 - 2009 as well as new recordings starting from 2021 on long, medium and short wave up to 40 MHz. Until 2009 the antenna signals were recorded in analog form on a video recorder and digitized with a Software Defined Radio (SDR, STEMLAB125-14) from RedPitaya with 14 bit resolution in 2021. From 2021 on the author has made all records exclusively by direct digitalization with the SDR.

Any person who also possesses a STEMLAB125-14 can now play back the data after downloading them from radiomuseum.org. The small single-board computer can be purchased from several Internet platforms, currently for about 400 euros. The necessary hardware and software as well as all installation steps are described in this document. A first version of a reasonably user-friendly software for playback is available under Windows10 as well as an updated version of a combined program for playback and recording. The author has written the sources in Python and plans to publish them as an open source project on GITHUB in the near future. This would make it possible to port it to LINUX as well.

Detailed information in context to this manual can be found in the video tutorials included in the respective installation packages. The first two packages contain the simple player and the combined player/recorder. The functionality of the apps will be extended in future updates, but the basic installation procedure will remain the same. So, if you want to try COHIRADIA for the first time, it is always recommended to watch the basic tutorials

COHIRADIA_Installation_Guide_part1_playback.mp4

COHIRADIA_Installation_Guide_part2_recording.mp4

2 REQUIRED HARDWARE

(1) RedPitaya STEMLAB125-14 Starter Kit consisting of:

- STEMLAB125-14 Main board
- STEMLAB power supply
- LAN-cable
- SD-card with typ. 16GB and operating system pre-configured

(2) Optional: Case (acrylic or metal) for the main board

(3) AM-Radio with external connectros for ‚antenna‘ and ‚earth ground‘

(4) coaxial cable for coupling between the SMA output of the STEMLAB and an RF transformer (e.g. a 1:9 balun), optionally adapters from SMA to BNC are required, depending on the cable type used.

(5) PC with sufficient disk space for the data files.

(6) isolating RF transformer (e.g. a balun) with suitable turns ratio from the 50Ω output of the STEMLAB to the radio. Usually an impedance transformation 1:9 to 1:16 (turns ratio 1:3 or 1:4) works for typical tube devices. In principle any balun suitable for the frequency range can be used, if primary and secondary are completely isolated (no common ground !). The author uses in his video tutorial a pot core transformer with turns ratio 1:4 with an inductance of $64\mu\text{H}$ on the low impedance side and ca. 1 mH inductance on the high impedance side (radio receiver). The following transformers were successfully used by other RM members:

(a) toroid FT240/77, primary 10 turns , secondary 30 turns with a 0.5mm enameled copper wire. This was tested by Franz Wolf with an amplitude modulated signal generator RF1 from HEATHKIT and a CD player on a LOEWE Opta-Kantate, the result was rated by him as very satisfactory.

(b) Gerald Gauert reports successful playback from STEMLAB via a ferrite toroid, primary $65\mu\text{H}$, secondary 1.3mH. However, he reproduced on a *Stafurter Mikrohet* built in 1928, which has a loop antenna. So the coupling is done from the transformer to a second loop antenna for inductive coupling. Therefore, it is still unclear whether the transformer is optimal for this mode of operation.

Gerald Gauert also reports that in several old devices the antenna contributes significantly to the resonator capacitance and thus the mere coupling of the STEMLAB via a balun may cause unwanted damping and frequency shifts of the tuning circuit. Significant signal perturbations may also result. These findings could be confirmed by the autor with an *Atwaterkent10* from 1924. In such cases it is recommended to place a series of a 220pF capacitor and a $2.2\text{k}\Omega$ resistor between the balun output and the antenna input of the radio. This measure usually can fix the problem.

3 INSTALLATION OF THE SERVER SOFTWARE ON THE STEMLAB125-14

Normally, an SD card with the operating system (Ubuntu) is included when purchasing a STEMLAB125-14. This card must be inserted into the SD card slot of the STEMLAB. If you don't have this SD card, you have to create one yourself, the instructions for writing the respective image to an empty SD-card as well as the a downloadable image file can be found at:

<https://redpitaya.readthedocs.io/en/latest/quickStart/SDcard/SDcard.html>.

Afterwards that you can connect the STEMLAB to the internet and call an installation script kindly created by Ueli Kurmann. The connection can be established either by Ethernet cable or by WLAN dongle via a common WLAN router. Then the following steps have to be taken:

- (1) Start a web browser (e.g. Mozilla Firefox) on the PC. On the web browser, enter `http://rp-#####.local` in the address field, where ##### stands for the MAC address (e.g. `rp-f03e17.local`). The MAC address is printed on the Ethernet connector of each STEMLAB.



- (2) Wait for the STEMLAB apps to be loaded in the web browser (this can take a while). The view should resemble the adjacent figure.



- (3) Afterwards click the icon „System“ and then open the App „Network Manager“ which allows for reading off the IP address assigned to the STEMLAB by the WLAN router.



- (4) Open a command line terminal in Windows and login to the STEMLAB per ssh with the IP-adress assigned by the WLAN router. Username and Password are ‚root‘ and ‚root‘, respectively (Port = port22). Typical command:

```
ssh root@###.###.###.###, Password: root
```

###.###.###.### is the IP-adress.

- (5) After the response of UBUNTU with a command line prompt, you should perform a system update with `apt update` and then a package installation with `apt upgrade`. This update is strongly recommended because otherwise the installation script by Ueli Kurmann may not run correctly. This step needs only be done once at the first startup.

- (6) Enter the following command in a single line after the command prompt:

```
curl --silent --cookie "SCHLUESSEL=1"  
https://cohiradia.radiomuseum.org/install.sh |bash
```

This will cause STEMLAB to run the installation script and create a directory with the necessary shell scripts, the server program, and the bit file for the FPGA. Now the system is ready for use in the context of COHIRADIA.

(7) After successful installation please shut down the STEMLAB properly with the command:

```
halt
```

When the terminal reports that the connection has been closed (this takes some time) and when the red flashing LED on the STEMLAB (th 'heartbeat') stops flashing the power supply can be disconnected.

Afterwards the system is ready for use in the context of COHIRADIA.

4 INSTALLATION OF THE APPS FOR PLAYBACK AND RECORDING OF RADIOFREQUENCY BAND DATA

So far there have been developed two major versions of software for the PC under Windows10, i.e.

,cohiradia_v1.1 '.zip

,cohiradia_v1.2 '.zip

Version 1.1 includes a simple player described in a previous manual (V2). This player served as a testing version during the early startup phase of COHIRADIA and the installation package still exists, but its development will be discontinued. This manual thus only refers to versions 1.2 and higher, which include software for playing and recording broadband data files. The software is called 'Cohiradia_RFcorder_v#.exe', where # stands for the current version number. The app allows the user to playback existing recordings but also to record own radiofrequency bands via an antenna after appropriately extending the hardware.

There is not yet a version available for LINUX, but the author plans to publish the underlying Code in the framework of an open source project on GitHub.

For installation please proceed as follows:

(1) Download the ZIP file, e.g. 'cohiradia_v1.2.zip' from radiomuseum.org and save it on the local PC.

(2) Unpack the file to a local directory (I call it ~\LOCAL). Here the following files should be created:

- The app Cohiradia_RFcorder_v1.1b.exe
- the corresponding videotutorial(s)
- the installation and operating manual (this document) as a pdf
- the Eagle files for the AD811 broadband amplifier module of the author
- pdf-files with schematic and layout of the AD811 board of the author

Additionally the desired AM wideband data files for playback, must be downloaded from radiomuseum.org and saved. A nice demo version is e.g. the 2006 MW recording 'RM2006clip_fcorr_i16_C_lo1100_r1250_c0.dat' It is recommended to save this file in the same directory ~\LOCAL as well, because then it can then be found most conveniently from within the playback app (default search path).

5 ASSEMBLY OF THE HARDWARE

5.1 PART A: PLAYBACK ONLY

(1) Disconnect the STEMLAB from the router and connect it directly to the LAN socket of the PC via the LAN cable. **)

(2) Connect SMA output jack 'OUT1' to the low impedance side of the RF isolation transformer/balun via a 50Ω coaxial cable.

(3) Connect the antenna input of the AM radio to the high-impedance side of the RF isolation transformer/balun.

(4) Connect the power supply of the STEMLAB to the micro USB port for 'Power'. Alternatively, the STEMLAB can be powered directly from a USB port of the PC using a suitable micro USB cable.

For additional help see also the video tutorial.

**) According to the manufacturer, a WLAN connection can also be set up as an alternative to the LAN cable if a WLAN dongle has been purchased. However, the author has not yet tried out this option.

As a second alternative, the STEMLAB can probably remain connected to the WLAN router, but then the IP address assigned by the router would have to be used. This mode is probably rarely used in practice, since the radio receiver is probably not located right next to the router. Also this mode has not been tested by the author.

5.2 PART B: RECORDING

For recording one must couple the signal from an antenna to input 1 of the STEMLAB. However, since the dynamic range is 2 VSS and should be well utilized for low digitization noise, the antenna signal needs to be amplified before being passed to the STEMLAB. It is also recommended to connect a band filter in front of the wideband amplifier to suppress unnecessary signals as well as interferences and out of band noise.

Fig. 1 shows a setup used by the author. The antenna signal is first transformed via a balun (or rather an unun here) to approx. 50Ω . Then a passive bandpass filter is applied for the band to be recorded. For the dimensioning of such filters see e.g.

https://www.changpuak.ch/electronics/chebyshev_bandpass.php.

Next 2 amplifiers '1' and '2' with approx. 20dB each are cascaded, followed by a variable attenuator with 0 - 20dB. Depending on the available signal strength a third amplifier may be required. The overall gain should be chosen in such a way that the output signal does not exceed 1.6 Vpp, when monitored on an oscilloscope. 1.6Vpp are recommended for leaving some reserve to 2 Vpp because of signal fluctuations, e.g. due to fadings. When overdriving the amplifiers heavy intermodulation distortions are to be expected. The author uses a power splitter for splitting the output of the amplifier into a display unit (oscilloscope, RF voltmeter, level indicator...) and into the STEMLAB RF input jack.

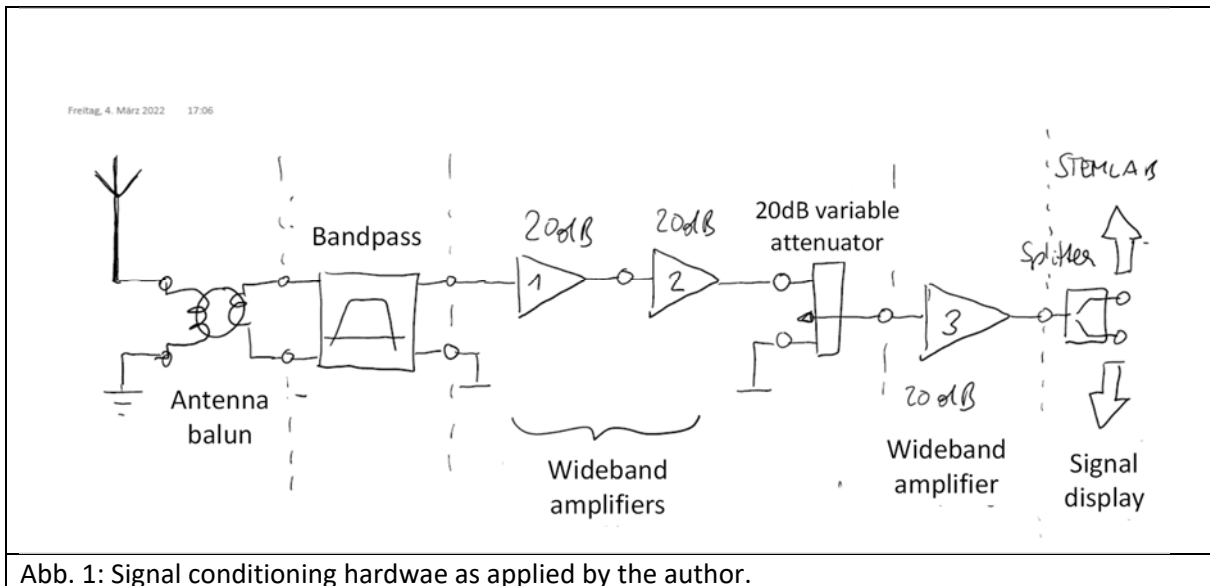


Abb. 1: Signal conditioning hardware as applied by the author.

As wideband amplifier the author uses the low-noise video amplifier AD811, which can be used well up to 50 MHz. Alternatively one can use newer operational amplifiers with high gain bandwidth product or any other wideband RF amplifier with 50Ω input and output impedance. Care must be taken with amps with very high cutoff frequency (e.g. several 100 of MHz or even GHz) because they may introduce stability problems. Of course, good shielding between the stages and proper filtering of the supply lines via feedthrough capacitors should be taken care of. An Eagle layout for the AD811 board used by the author is available at radiomuseum.org as a part of the installation package.

6 PLAYBACK OF WIDEBAND RECORDINGS WITH THE RADIO RECEIVER

6.1 SETUP OF THE SOFTWARE COHIRADIA_RFCORDER FOR PLAYBACK/RECORDING

- (1) Connect the RP power supply to the mains, RP starts up, wait until the yellow LED stops flickering and the 'Heartbeat' (red) LED flashes regularly;
- (2) When using a direct Ethernet connection via the LAN cable, deactivate the WLAN to be on the safe side, otherwise connection errors between STEMLAB and PC may occur. This is not always the case, but unfortunately the problem appears very often with the author's system.
- (3) Start a web browser (e.g. Mozilla Firefox) on the PC. On the web browser, enter

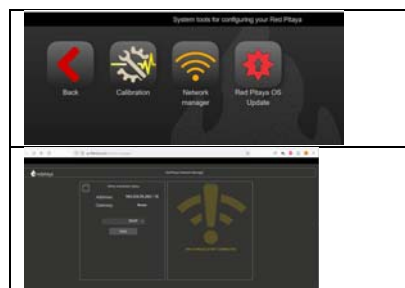
`http://rp-#####.local`

in the address field, where ##### stands for the MAC address (e.g. rp-f03e17.local). The MAC address is printed on the Ethernet connector of each STEMLAB.

- (4) Wait for the STEMLAB apps to load in the web browser (this can sometimes take a while). The view should be something like in the adjacent figure.



- (5) Then click the "System" icon, call up the "Network Manager" app there and read out the **STATIC** IP address there. This address should be different from the one assigned by the router in chapter 3 and is required for operation with the COHIRADIA app. Normally these addresses start with 169.254..... Should the app still show the address assigned by the router, enter a new STATIC address of your own choice. The fields 'Subnet mask' and 'DNS server' can be left empty.



- (6) Start the app Cohiradia_RFCorder_v1.1b.exe from the ~\LOCAL directory. The first time you do this, you will immediately be prompted to enter the correct IP address from step (5). Activating the button 'Set IP Address' allows to enter the IP address in the field above. Afterwards just press 'Save IP-Address'. The address remains stored for further calls in the configuration file 'config_SLsettings.txt'.

It may happen that the program is blocked by your virus scanner at the first call, then you have to authorize it as trustworthy.

6.2 OPERATION OF THE APP

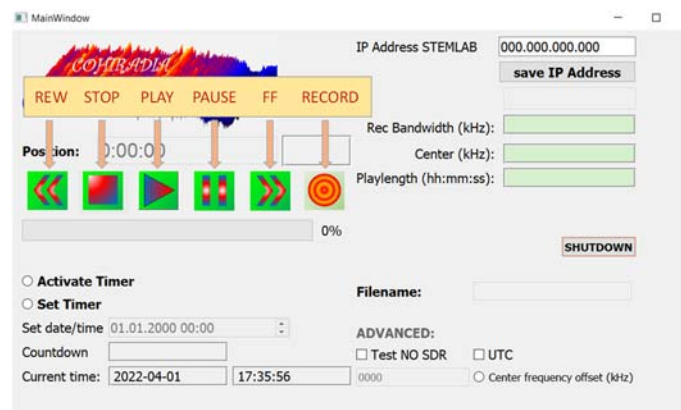
See also the related Video-Tutorials

COHIRADIA_Installation_Guide_part1_playback.mp4

COHIRADIA_Installation_Guide_part2_recording.mp4

6.2.1 Playback

The operation of the app should be intuitive in itself. When you press the 'Play' button, you are prompted to select a file. At the same time, some recording parameters like playing time, band center frequency and bandwidth are displayed in the right part of the window. The Play button starts the playback at the beginning of the recording. At the same time, the temporal position in the record is displayed in the time display window ('Position:'), located above the keypad. Now the radio signal is transmitted and the stations can be tuned in and listened to on the radio. Playback continues until the 'Stop' key is pressed. The playback can be paused any time by pressing 'Pause' and resumed by pressing 'Pause' again or, alternatively, the 'Play' button.



With the >> and << buttons you can fast forward and rewind. With single clicks, the software goes step by step (currently 5s per step). If you keep the buttons pressed after a doubleclick, the software will automatically fast forward/rewind as long as the button is pressed. If you want to jump to a certain position in the recording, you can pause the playback by pressing the 'pause' button and then enter the desired time in the 'Position:' window. Afterwards the entry must be confirmed by pressing the ENTER key, otherwise the value will not be accepted.

If you want to terminate the program, it is recommended to perform a shutdown of the STEMLAB beforehand. Since the STEMLAB125-14 runs a LINUX operating system, some experts recommend not just to disconnect the power supply, but to shut down in a controlled manner. According to many Internet reports, the file system of Pavel Demin is write-protected, and thus normally a brute-force power-down will not do any harm. However, under unfavorable conditions, damage to the file system could allegedly occur. Such events have been observed very rarely (has not happened to the author yet), but better safe than sorry. Therefore the author recommends to shutdown the LINUX by pressing the button 'SHUTDOWN' and to wait until the red 'Heartbeat'-LED on the STEMLAB stops blinking or the message about the successful logout is displayed as a popup message. After that you can exit the program via the closebox and unplug the power supply of the STEMLAB.

For special purposes there is a field 'Advanced' with 3 options in the lower right part of the app:

- (1) Checkbox with 'UTC'. Here you can change the timer and the displayed time to UTC, by default local time is used.
- (2) Checkbox 'Test NO SDR': If you activate this option, the software runs in a test mode, in which no STEMLAB needs to be connected. This mode is only used to try out if the app runs on the PC and if the basic functions run properly. In this mode there is no real playback, since no STEMLAB is connected.
- (3) Radio button 'Center frequency offset' : If you activate this button, you can set how much the playback center frequency is offset from the recording center frequency. This makes it possible to play a longwave recording e.g. in the medium frequency band. Example: You have a LW-recording with center frequency 180 kHz and set an offset of 1000kHz, then the band will be shifted up by 1000kHz. Stations originally located e.g. on 153 kHz will now be played back on 1153 kHz. This may be useful in special cases.

6.2.2 Recording:

If you want to record signals, you have to press the red 'Recording' button. Then you will be asked for the name of the file to be created. Then you are asked which band center frequency and which bandwidth you wish to apply. Theoretically the center frequency can be up to 60 MHz - bandwidth/2. For the bandwidth you can only select 6 preconfigured values from a menu, maximum 2.5 MHz, minimum 20 kHz. Finally, one is asked for the planned duration of the recording in minutes. This query was implemented for safety reasons, to prevent the disk memory from filling up uncontrollably. After specifying that value, the recording starts. If required, one could also pause the recording for a while with 'Pause' and continue with the 'Record' key. The recording can also be terminated prematurely with the 'Stop' key.

If you want to start a recording automatically at a certain time, you can activate the timer in the lower left area of the app. If you activate the radio button 'Set Timer', you can set the start time and the start date. After deactivating the radio button, the entry is retained. Caution: If you re-activate the button, the time is reset to the current time. If you then switch on the radio button 'Activate Timer', you will be asked again for the file name, bandwidth, center frequency and the planned duration of the recording. After accomplishing the inputs a countdown starts in the field 'Countdown' and after reaching the target time the recording starts.

Important: Before starting a recording, please check if there is enough space on the hard disk. Please note that the necessary storage space is calculated from bandwidth (Hz) * 4 * recording time (seconds). At 2.5 MHz this means $4 * 2.5 * 10^6 * 3600 = 3.6 * 10^{10} = 36$ GB per hour! For medium wave, 1.25 MHz bandwidth is sufficient, which results in 18 GB per hour.

LW recordings usually do not need more than 250 kHz bandwidth, the shortwave bands can be covered with 500 kHz up to the 22m band, above that you may need 1.25 MHz.

With 2.5 MHz bandwidth you could record e.g. 41m and 49m band at once, but this may not be recommendable in general because of the big 'gap' in between the bands. If not done for a very special purpose you certainly waste a lot of spectral space with a lot of relative 'emptiness'.

7 APPENDIX A: DATA FORMAT

7.1 WORKING PRINCIPLE OF THE SDR

The function of the SDR was roughly described by Pavel Demin on <http://pavel-demin.github.io/red-pitaya-notes/sdr-transceiver-wide/>. The system mixes down the original data into the baseband during recording, where the author always chooses about the band center frequency as local oscillator frequency LO, which corresponds to the band center frequency. For MW this is 1.1MHz. The downmixed data is then sampled at the sampling rate 'rate' and sent to the PC as 64bit COMPLEX numbers. The sampling rate determines the bandwidth of the broadcast band. Since sampling is complex, the bandwidth is exactly the sampling rate 'rate'. During playback the signal is mixed up again. Since you can choose LO, you can mix the signals to within the device specification (max 60 MHz) to any band. So you could also play LW data on a MW receiver. Typically one uses however the LO frequency, which was used with the recording.

7.2 FILE NAME CONVENTION

The author has defined a special standard notation for the file-name which automatically encodes the values for 'rate' and 'LO':

```
RECORDINGNAME_fcrr_i16_C_loxxxx_ryyyy_c0.dat
```

RECORDINGNAME is a string which can be chosen arbitrarily. Here no standard was defined yet. In the first file published in radiomuseum.org this name is `,RM2006clip``, as it represents a section of a record in the year 2006, for which there also exists a tune-through movie in radiomuseum.org.

The string `,_fcrr`` encodes the fact that the original recording was done on a video-tape in analogue manner which led to a relative shift of the carrier frequencies (here 3%). This shift was corrected after digitalization. Slight deviations from the original frequencies may, however, still exist (<1%).

The sequence `,_i16_C_lo1100_r1250_c0`` means:

`_i16_C`: data was stored as 2x16 bit COMPLEX,
`_lo1100`: the LO (band center) frequency was xxxx kHz
`_r1250`: the sampling rate and hence the bandwidth was yyyy kS/s (kHz)
`_c0`: no frequency offset correction has been used (this has always been chosen by the author, so it has no meaning and serves only as internal code for potential future extensions)

Example:

```
Filename = RM2006clip _i16_C_lo1100_r1250_c0.dat
```

`_lo1100`: the LO (band center) frequency was 1100 kHz (i.e. 1.1 MHz),

`_r1250`: the sampling rate and hence the bandwidth was 1250 kS/s (i.e. 1.25 MS/s)
`_c0`: no frequency offset correction

This name standard must be kept, because these parameters are automatically extracted from the file name by the playback program. If the respective strings are changed to invalid values, an error message will be displayed when loading the file.

7.3 DETAILS OF DATA FORMAT AND SIZE REDUCTION

The SDR on the RedPitaya STEMLAB125-14 reads the data by default as 64-bit COMPLEX samples with a sampling rate 'rate'. Each sampling value consists of two 32-bit words (float32), which represent the real and imaginary part of the data point. Since the STEMLAB125-14 has only 14 bit resolution, 2x 16bit per sample are sufficient to store the data. Otherwise the files would be unnecessarily twice as large. Therefore the data is compressed to 2x 16bit during recording and expanded again to 2x32bit during playback by the Python script before it is sent to the FPGA. The corresponding code modification was provided to the author by Pavel Demin and is described in the forum blog:

<https://forum.redpitaya.com/viewtopic.php?f=7&t=1030&hilit=medium+wave&start=20>

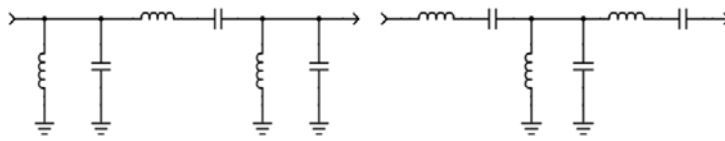
7.4 FILTERS

The following pages show the details of the bandpass filters built and used by the author. They are presented as screenshots which were produced with the filter-calculator on the webpage:

https://www.changpuak.ch/electronics/chebyshev_bandpass.php

The author always winds the coils himself and measures them with an LC meter. The values for the capacitors can mostly be set to the nearest available value of the E12 series without strong errors, only the coupling capacitors of the coupled resonators are somewhat more critical. A measurement of the transfer functions with a suitable measuring device is recommended in any case.

Medium wave, Chebyshev bandpass, shunt-type, 500 – 1700 kHz:



First element : shunt

First element : series

REQUIREMENTS

Center Freq. [MHz]
Bandwidth [MHz]
Passband Ripple [dB]
Impedance [Ω]
Order [1-19]
First Element

DESIGN DATA FOR YOUR BANDPASS

Chebyshev Bandpass Filter
www.changpuak.ch/electronics/chebyshev_bandpass.php
Version : 11. Jan 2014

Center Frequency : 1.1 MHz
Bandwidth : 1.2 MHz
Passband Ripple : 1 dB
System Impedance : 50 Ohm
Order of Filter : 4

Element 1 , Orientation : shunt
C = 5568.114 pF, L = 3759.644 nH
Element 2 , Orientation : series
C = 2965.746 pF, L = 7058.64 nH
Element 3 , Orientation : shunt
C = 7510 pF, L = 2787.501 nH
Element 4 , Orientation : series
C = 4000.052 pF, L = 5233.464 nH

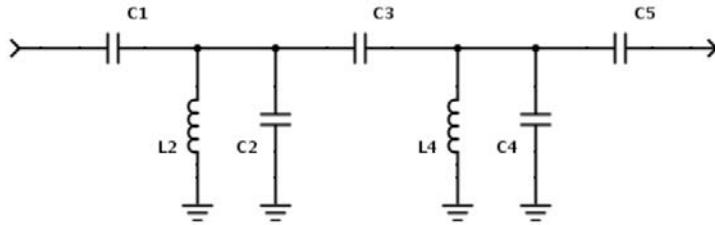
Appendix : Prototype G values

Combined filter for SW, 41m and 49m band, Coupled Resonators, 5.5 – 7.8 MHz:

Direct Coupled Resonator Bandpass Filter Designer

A fully experimental thing

L2,C2 form ,Resonator #1',
L4, C4 form ,Resonator #2'.
C1, C3 and C5 are the
,Coupling Capacitors'.



www.changpuak.ch/electronics/Direct-Coupled-Resonator-Bandpass.php

80%

REQUIREMENTS

Center Frequency [MHz]	<input type="text" value="6.65"/>
Bandwidth [MHz]	<input type="text" value="2.3"/> <input type="button" value="+"/> <input type="button" value="-"/>
Passband Ripple [dB]	<input type="text" value="3"/> (0...6)
Number of Resonators	<input type="text" value="2"/> <input type="button" value="+"/> <input type="button" value="-"/>
Impedance [Ω]	<input type="text" value="50"/>
Inductance	<input type="text" value="2000"/> <input type="text" value="nH"/> <input type="button" value="use my value"/>

► If the Ripple is 0 dB, a Butterworth Characteristic results. If larger : Chebyshev.

DESIGN DATA FOR YOUR BANDPASS

Direct Coupled Resonator Bandpass Filter Designer
<https://www.changpuak.ch/electronics/Direct-Coupled-Resonator-Bandpass.php>
Javascript Version : 11. February 2015

Design Data for a 2-Resonator Bandpass Filter.
Center Frequency : 6.650 MHz
Bandwidth : 2.300 MHz
Passband Ripple : 3 dB (Chebyshev Characteristic)
System Impedance : 50 Ohm

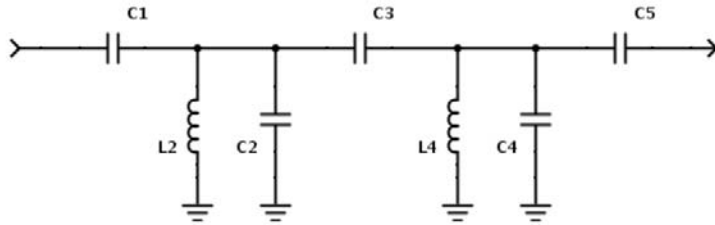
Coupling Capacitor : 123.98 pF
Resonator #1 C : 97.67 pF // L : 2.00 uH
Coupling Capacitor : 72.54 pF
Resonator #2 C : 97.67 pF // L : 2.00 uH
Coupling Capacitor : 123.98 pF

Filter for SW, 31m band, Coupled Resonators, 9.0 – 10.0 MHz:

Direct Coupled Resonator Bandpass Filter Designer

A fully experimental thing

L2,C2 form ,Resonator #1',
L4, C4 form ,Resonator #2'.
C1, C3 and C5 are the
,Coupling Capacitors'



www.changpuak.ch/electronics/Direct-Coupled-Resonator-Bandpass.php

REQUIREMENTS

Center Frequency [MHz]

Bandwidth [MHz]

Passband Ripple [dB] (0..6)

Number of Resonators

Impedance [Ω]

Inductance

► If the Ripple is 0 dB, a Butterworth Characteristic results. If larger : Chebyshev.

DESIGN DATA FOR YOUR BANDPASS

Direct Coupled Resonator Bandpass Filter Designer
https://www.changpuak.ch/electronics/Direct-Coupled-Resonator-Bandpass.php
Javascript Version : 11. February 2015

Design Data for a 2-Resonator Bandpass Filter.
Center Frequency : 9.500 MHz
Bandwidth : 1.000 MHz
Passband Ripple : 2 dB (Chebyshev Characteristic)
System Impedance : 50 Ohm

Coupling Capacitor : 47.35 pF
Resonator #1 C : 96.23 pF // L : 1.80 uH
Coupling Capacitor : 13.28 pF
Resonator #2 C : 96.23 pF // L : 1.80 uH
Coupling Capacitor : 47.35 pF

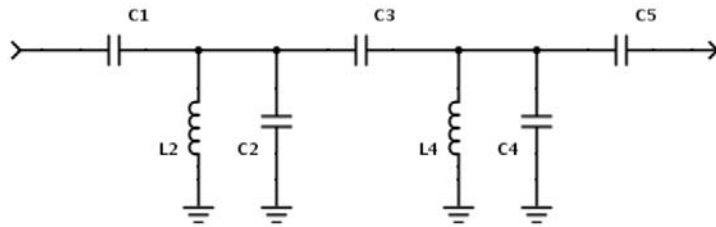
Please verify by simulation that attenuation above passband is sufficient.
Negative capacitances indicate an unhappy inductance.

Filter for SW, 20m band, Coupled Resonators, 15.2 – 15.8 MHz:

Direct Coupled Resonator Bandpass Filter Designer

A fully experimental thing

L2,C2 form ,Resonator #1',
L4, C4 form ,Resonator #2'.
C1, C3 and C5 are the
,Coupling Capacitors'.



changpuak.ch/electronics/Direct-Coupled-Resonator-Bandp 70%

REQUIREMENTS

Center Frequency [MHz]	<input type="text" value="15.5"/>
Bandwidth [MHz]	<input type="text" value="1"/> <input type="button" value="+"/> <input type="button" value="-"/>
Passband Ripple [dB]	<input type="text" value="1"/> (0..6)
Number of Resonators	<input type="text" value="2"/> <input type="button" value="+"/> <input type="button" value="-"/>
Impedance [Ω]	<input type="text" value="50"/>
Inductance	<input type="text" value="500"/> <input type="text" value="nH"/> <input type="button" value="use my value"/>

► If the Ripple is 0 dB, a Butterworth Characteristic results. If larger : Chebyshev.

DESIGN DATA FOR YOUR BANDPASS

Direct Coupled Resonator Bandpass Filter Designer
https://www.changpuak.ch/electronics/Direct-Coupled-Resonator-Bandpass.php
Javascript Version : 11. February 2015

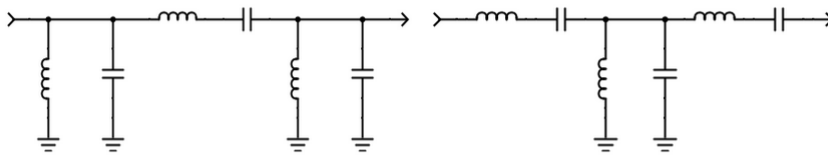
Design Data for a 2-Resonator Bandpass Filter.
Center Frequency : 15.500 MHz
Bandwidth : 1.000 MHz
Passband Ripple : 1 dB (Chebyshev Characteristic)
System Impedance : 50 Ohm

Coupling Capacitor : 39.85 pF
Resonator #1 C : 160.31 pF // L : 500.00 nH
Coupling Capacitor : 12.15 pF
Resonator #2 C : 160.31 pF // L : 500.00 nH
Coupling Capacitor : 39.85 pF

LW-Filter, Chebyshev - bandpass, series-Type, 135 – 315 kHz:

www.changpuak.ch/electronics/chebyshev_bandpass.php

Chebyshev Bandpass Filter Designer



First element : shunt

First element : series

REQUIREMENTS

Center Freq. [MHz]

Bandwidth [MHz]

Passband Ripple [dB]

Impedance [Ω]

Order [1-19]

First Element

DESIGN DATA FOR YOUR BANDPASS

Chebyshev Bandpass Filter
www.changpuak.ch/electronics/chebyshev_bandpass.php
Version : 11. Jan 2014

Center Frequency : 0.225 MHz
Bandwidth : 0.18 MHz
Passband Ripple : 1 dB
System Impedance : 50 Ohm
Order of Filter : 3

Element 1 , Orientation : series
C = 5592.652 pF, L = 89465.876 nH
Element 2 , Orientation : shunt
C = 17579.247 pF, L = 28462.626 nH
Element 3 , Orientation : series
C = 5592.652 pF, L = 89465.876 nH

Appendix : Prototype G values
G[1] : 2.0236704484434225
G[2] : 0.9940829987374997

The values of the capacitors can be set to 18nF and 5.6 nF, respectively, without problems