Operator Manual

Digital and Mobile Receiver / Transceiver

RDR53 „sPocket“

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Konstruktion & Musterbau Burkhard Reuter Ziegelstraße 54 06862 Dessau-Roßlau
Tel. +49 034901/67275 www.Reuter-Elektronik.com

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1. Overview

The Reuter Digital Receiver "sPocket" (factory designation "RDR53") is a receiver for amplitude and frequency modulated signals in the range from 1 kHz to a maximum of 156 MHz (depending on the configuration). It operates on a new principle, Spectrum-Based Signal Processing (SBSP). It allows for an extremely selective filtering and low-noise demodulation with finely tunable parameters without the use of internal or external computers.

The sPocket's basic concept rests upon fully digital signal processing. The amplified and filtered antenna signal is digitized directly (DSR: Direct Sampling Receiver). There is no preceding frequency transformation ("mixing"), no adjustable frequency processing (PLL, VCO, DDS or similar) and no conventional filters (Quartz, Piezo, LC or similar). This results in an extremely linear phase response without additional phase noise or mixing interference, a prerequisite for clean, trouble-free and low-distortion demodulation.

The sPocket's frequency selection ("tuning") is purely computational without any change of frequencies within the device. There is only one free-swinging, very low-noise fixed frequency oscillator. A GPS-based measurement system determines all frequency deviations to within 1 Hz and corrects them without interfering with frequency generation.

The digitized reception signals are not processed through a processor by software (**no SDR**). The sPocket does not operate with a DSP, built-in PC or similar high-speed CPUs. However, PC accessories (monitor, keyboard, mouse ...) can be connected to the sPocket with restrictions. All signal processing occurs internally with a maximum of 167 MHz clock frequency in dedicated, parallel-working hardware ("FPGA"). It is programmable by a special firmware ("Configuration") and thus adjustable by updates.

The sPocket consists of the basic and the display unit. The display unit can be comprised of different devices. Usually, a standard tablet computer is employed. It is wirelessly connected to the basic unit via Wi-Fi. The display unit (hereafter referred to only as "tablet" or "display") has its own power supply (accumulator) and can be completely separated from the basic unit. It can thus be operated remote from the actual receiver (basic unit) and even remotely control it. The tablet can be docked to the basic unit in various configurations via a magnetic mount.

The basic unit contains all signal processing and a WiFi hotspot ("access point") for transferring the image and audio data to the display. The integrated electronics are completely arranged on a mainboard. Shielding of the various modules reduce mutual interference. The sPocket offers the possibility to install an extension board. This results in various device configurations, for example: Pure SW receiver, SW receiver with transmitter or SW plus FM receiver.

User guidance within the Reuter sPocket is provided by a modern user interface. The full HD display (1920 x 1200 pixels) displays a variety of elements that can be operated via touchscreen. To adjust set values (like tuning or volume), the basic unit possesses an additional rotary encoder ("scroll wheel"). An animated graphic on the user interface can replace the function of the scroll wheel during remote operation. Also, connection of a computer mouse is also possible. This allows fast and pixel-accurate settings.

The installation of a high-resolution display opens up possibilities that were not or only partially available with small mobile devices (like simultaneous spectrum and waterfall display). Digital signal processing enables high-accuracy data. As a result, the representations on the sPocket's display almost achieve measuring device quality.

The sPocket's spectrum-based signal processing (SBSP) performs four times faster than the well-known FFT (used within spectrum analyzers or SDR receivers with a PC). In addition, high priority was given to an artifact-free image display. Even with extreme settings, there is no flickering of the display (as often seen with very expensive measuring devices).

The sPocket is able to receive the entire LMK or FM range. There are various preselections with low or high pass filters below and above 10 MHz, bandpass filters from 50 to 71 MHz (6 m and 4 m) and 2 broadband but highly selective band filters (SAW) for 87.5 to 108 and 136 to 156 MHz. The selection of a single transmitter on the digital level occurs with phase-linear filters ("FIR filter"), or highly selectively utilizing the SBSP by using the spectral lines for demodulation.

The audio signals are converted into the analog domain by a 24 bit stereo DAC with an 81.92 kSpl/s sampling rate. 2 built-in miniature speakers allow for playback in quiet environments. The stereo headphone jack provides a high-quality audio signal for headphones or for forwarding to external amplifiers (like a stereo system).

The audio signal is also transmitted to the display (CD resolution with 2x 16 bit at 40.96 kS data rate). The signal can then be made audible via the built-in micro speakers with a limited level. Usually, the tablet also has a headphone jack. In addition to the remote operation of the basic unit, it is thus possible to monitor the received signals while the display is detached.

The tablet allows you to update the software of the sPocket by plugging in a conventional USB stick. The required files can be downloaded from any PC to this USB stick.

2. Safety precautions

Please always keep the following safety precautions in mind!

The device contains lithium-ion batteries (at least in the display unit). These batteries may only be operated under very specific conditions. In particular, complying to the upper operating temperature is relevant for safety. Never expose the device to temperatures higher than the maximum temperatures given in the specifications for the respective application!

If the device has been exposed to a higher than the permitted temperature under any conditions (for example accidents, fires, etc.), it must immediately be locked away in a fireproof and largely airtight container (like a safe, earthenware / concrete / metal container, etc.)! The device may only be removed from it after cooling to the permitted temperature!

Burning devices may only be extinguished with permissible methods (like powder or CO2 extinguishers)! Never use fire extinguishers with water-based extinguishing material (water or foam extinguishers).

Do not open the device. The unit contains no user-serviceable components for replacement (such as bulbs or fuses). The replacement of components, in particular batteries, may only be carried out by the manufacturer or persons authorized by him.

The device is intended for use indoors or outdoors without moisture. Do not expose it to moisture, never put liquid-filled containers on top of the unit. Do not allow frost, dew, condensation or rain reach the device! If moisture (like rainwater) came in contact or has accidentally entered the device, switch it off immediately! Send the device to the manufacturer for inspection!

Always provide a safe placement on a flat, straight and solid base of sufficient carrying capacity! Transport the device only in either solid boxes or crates (for example the shipping container), or transport it by firmly grasping the sides with both hands! The unit can cause an injury in case of a drop under its own weight!

Do not expose this equipment to mechanical stress caused by impact, pressure, vibration or shock which exceed that commonly used in the home with the use of electronic devices! The control elements and specifically the front window of the display are very sensitive to pressure or impact. Never press a control with a force beyond the extent necessary and never press the front screen more than is necessary to trigger the touch screen!

If you notice any damage to the device, stop the operation immediately! Send it in for repair to the supplier if necessary. Would you like to dispose the device due to damage or no more usability, send it back to the supplier or return it to your local waste collection center. Never dispose of the appliance elsewhere, such as household waste. It pollutes our environment!

Only use soft, lint-free and dry cloths to care for and clean the device! Be especially careful when cleaning the front screen of the display, as it is very sensitive to scratching. For stubborn dirt, do not use any solvents, but at most a slight moistening of the cleaning rag with distilled water! Make sure that no moisture reaches the inside of the device!

The device requires the connection of antennas. Please observe the relevant safety regulations when installing antennas! Particular attention must be paid to lightning and surge protection. If possible, hire a specialist company! If necessary, disconnect all antennas from the device when a thunderstorm approaches!

The device possesses a high-level headphone jack. Never set the volume too high!

3. First steps

After you have received the device and carefully read this operator manual (especially the above safety precautions!), you can now put it into operation.

3.1 Unpacking and first-time operation

Please unpack the device carefully and place it on a hard, flat surface. If you have just moved the device from a cooler to a warmer environment, please leave it switched off for a while to avoid any possible condensation moisture. By placing a hand on the top or bottom of the case, you can determine whether the device has approximately reached the ambient temperature.

Check the device's scope of delivery as indicated on the invoice and / or delivery note. At least one power supply cable for the basic unit and a plug-in power supply with cable for the tablet are always included. Ask for any missing cable immediately!

The display is covered with a protective film. Remove the protective film (there is usually a sticker to be found on one corner). Dispose of the protective foil in an environmentally friendly way!

On delivery, the sPocket is in the "Notebook closed" configuration. Meaning, the tablet is docked with the screen side to the base unit and folded down (as usual with notebooks). Flip the tablet up. Since the mounting has a suspension, the basic unit must be held in place (e.g. at the left-side connection sockets). The tablet can be opened up to a little over 90°. If opened too wide, it will be "top-heavy" and the sPocket will get unstable. In addition, the mounting has a limit at about 120° installation angle. Do not push the tablet with great force! Do not pull it away from the base unit. This will pull the tablet out of its mounting and separate it from the base unit.

Now connect the power supply cables. At least the basic unit must be connected to the supplied cable with "DC hollow socket" (2.5 mm pin diameter). The banana plugs on the other end should be connected to a suitable power source (e.g., 12 V laboratory or 13.8 V amateur radio power supply). Pay attention to the polarity (red = plus +, black = minus -). The basic unit operates with voltages from +9 V to +14.5 V with a maximum of 25 W power consumption. After connecting and switching on the power supply, the ring on the scroll wheel in the middle of the basic unit lights up and the device starts operating immediately.

The tablet can initially be operated with the built-in battery. If required, power can be supplied from external sources in two ways:

- By plug-in power supply. The sPocket comes with a box containing the power adapter supplied from the tablet manufacturer.
  A USB cable with USB-A (power supply side) and USB-C port (tablet side) is used as the connection cable. The USB-C port on the tablet is located on the left side approximately in the middle. USB-C is not polarized, the plug of the cable can be plugged in (also rotated by 180 °) in any manner. USB-A is polarized and can only be plugged into the power supply in one direction.

- By means of supply from the basic unit. The sPocket comes with a USB cable with micro-USB and USB-C plug. Insert the micro plug into the corresponding socket of the basic unit on the left side at the very back ("Charge" label on the front panel). **Always plug the micro USB plug into the base unit first, then the USB-C plug on the tablet!**

Switch the tablet on. The power button is the smaller button on the top left of the tablet. (The larger button to the right has no function on the sPocket). The button must be pressed for a few seconds. The tablet has successfully started as soon as the name of the manufacturer appears on the display. Release the power button immediately. Further pressing can put the tablet in an indeterminate operating condition!

The tablet uses a commercial computer operating system (MS Windows or a Linux / Android distribution). The OS takes some time to set up the WiFi connection and to start the user interface of the sPocket. Once it has appeared on the display, the data connection to the basic unit is established and the valid settings (in particular on the moving spectrum) appear in the display. This should be achieved in a matter of seconds, but may take longer if the wireless environment is poor (other strong stations, such as nearby Internet routers).

If no data transmission is detected or if the message "No WLAN connection" is displayed during operating attempts, the environment is too contaminated (many other WiFi transmitters in the vicinity). In this case, first try to use the external WiFi antenna (short, black "stub antenna" with SMA connection to the socket

with WiFi symbol next to USB micro).

The basic unit has an internal antenna, which is first switched on when starting. If no connection is possible, the basic unit automatically switches to the external antenna and then always back and forth in about 6 seconds. The tablet possesses only one internal antenna.

If after a waiting period of a maximum of one minute no connection has been established even with the external antenna, the sPocket must be placed into a less noisy environment. To reboot and attempting connection in a different environment, both units, the basic unit and the tablet, must be turned off and on again. If the connection is successful, the utilized WiFi channel can be adjusted in the 2.4 GHz band (see below in the further instructions). By default, the sPocket is set to channel 13. A (better) connection may be achieved on other channels (see "WiFi" dialog).

When docked, a stable connection is usually possible even under unfavorable conditions. The connection quality is displayed on the user interface of the tablet with the bar display "WiFi" in %. It should always be 100% and rarely fall short of it. Values below 100% cause data loss. These can be observed by a "frozen" screen (spectrum, waterfall, and S-meter do not move), suspension of the audio connection (if directed to the tablet), and alerts when making entry attempts.

The sPocket is now ready for operation. All settings of the device are made by tapping on the desired set value on the tablet ("touch operation") and adjusting the selected value by turning the scroll wheel. An "imitation" of the scroll wheel is located in the lower right of the display. Here, the scroll wheel function can be simulated by circular movement when touching the touchscreen.

Shutting the sPocket down is achieved in 2 steps:

Caution! Before switching off, any existing charging power supply must always be disconnected from the basic unit ("Charge" connection)!

1. Tapping the button "OFF" on the display and confirming the prompt by tapping "Shut down". The tablet computer now shuts down.

Caution! Never try to switch the tablet off by pressing the power button on the upper left corner of the tablet! This can result in unintended operation conditions! Always use the "OFF!" button within the user interface!

2. Switching of the power supply of the basic unit (Switching of the utilized power supply unit). This ceases the operation of the basic unit. The basic unit may continue to be supplied with internal power from the tablet (when docked) until it is completely shut down. This can be seen from the continuing glow of the scroll wheel’s ring and possibly continuing audio output. Always wait till the sPocket switched all units completely off.

Note: It is sometimes difficult to detect if the tablet computer is completely turned off (shutted down). Therefore, it should be docked when switching it off and should not receive a charging power supply. The switch-off status can then be recognized by both the ring lighting of the scroll wheel and the red LED on the top left of the tablet going out.

3.2 General information on operation

In order to receive any signal with the sPocket, you need an external antenna. Connect it to the SMA input socket. Usually, you can connect your antenna using one of the supplied adapter cables from SMA to the widely used BNC standard connector. Avoid mechanical stress to the socket! Observe the **permissible input level** of the sPocket!

The sPocket allows for easy connection of auxiliary antennas (input circuit very low or high impedance). However, the operation of such antennas (short wires, telescopic antenna, loop antenna ...) directly on the sPocket can cause interference. These are inevitably caused by the tablet computer, especially by the built-in display. The sPocket achieves full reception performance only by connecting a (ideally galvanically isolated) remote antenna via a 50 ohm cable.

Audio output of the received signals can be achieved in several ways:

- Loudspeaker in the basic unit. This is the usual operating mode (setting LSP to "internal" within the "Setup" dialog). The performance of the speakers is limited. When a high volume is desired, external

amplifiers with associated loudspeakers should be connected (e.g. by connection to a headphone jack).

- Headphone connection on the basic unit. This enables the highest quality audio output (24 bit resolution, low pass-through delay, low distortion factor, linear frequency response up to 15 kHz, high level possible).

- Loudspeaker of the tablet (setting LSP to "external" within the "Setup" dialog). The performance of these speakers is very limited. The audio output is achieved through the WiFi connection between the basic unit and the tablet. This causes delays and dropouts in the output if the connection is poor. Useful when the tablet is to be operated in detached mode (undocked).

- Headphone connection on the tablet. In general, high-quality playback can be achieved (16 bit resolution). However, restrictions due to the WiFi connection are present.

- Bluetooth connection. Can be enabled from the tablet or directly from the basic unit. Both depend on the development status of the software and the specifications of the tablet computer used.

Combinations are possible. However, the signal delay that always occurs between the basic unit and the tablet must always be taken into account.

If you want to use the GPS correction option for frequency adjustment (to increase the accuracy), connect the GPS antenna to the corresponding socket and locate the antenna in a place with good reception (e.g. in the window). By doing so, the GPS indicators within the user interface will show the process (wait a few minutes until the receiver locates satellites). In addition to the automatic frequency calibration, the indicators show the UTC time and the location.

Docking options

In addition to the standard operating "Notebook" mode (delivery status), the two parts of the sPocket can be used quite flexibly. To do this, the tablet must be disconnected from the basic unit. Proceed as follows:

- Double tap (tap twice at maximum one second apart) the "Touch Lock" button within the user interface. This blocks all reactions on the touchscreen. Only the button itself is released again after approx. 3 seconds. This state prevents an unwanted adjustment of the sPocket when you touch the tablet.

- Now pull the tablet out of the hinged mounting away from the basic unit. The basic unit is attached purely magnetically. After a short jerk it is released a few millimeters apart. Be careful not to press too hard on the display surface! If your fingers have poor grip (e.g. wet or greasy), touch the tablet as far as possible on the edges. Try to pull the tablet straight and vertically away from the basic unit.

- The detached tablet can now be operated independently of the basic unit. The possible distance without losing the WiFi connection depends on many factors. For distances over approx. 1 m, connect the external WiFi antenna of the basic unit and switch the sPocket to "external antenna" using the setting in the WiFi dialog.

- Double tapping on the activated "Touch Lock" again enables the operation. If you hold the tablet freely in your hands, make sure to hold it as far as possible at its edges to avoid unwanted touch inputs.

The tablet can be docked again in the usual direction and also in the opposite direction (display points upwards) (position the tablet to the centering mandrels of the mounting and then let the magnets pull it in). When the tablet is folded, the display points upwards and the sPocket can be operated completely flat. In this case, the scroll wheel is not accessible and operation can only be achieved with the help of the touch display. The speakers of the basic umit are then more or less ineffective.

A computer mouse can be connected to the tablet's micro USB port (above USB-C). An adapter from the usual USB-A standard to micro-USB may be necessary. The sPocket can be operated quickly and easily with the mouse. All settings that can usually be performed by a tap can now also be performed by a click. The other functions depend on the respective state of development of the software (e.g. extensions by pressing the right mouse button, emulation of the encoder using the mouse scroll wheel or the selection of spectral lines with pixel perfect accuracy).

Important information about the tablet

- Never connect devices other than the power pack or the USB cable to the basic unit as described above!
- Never connect the tablet to other devices with the exception of a standard computer mouse (micro USB connection, adapter may be required)!
- Never try to connect to the WiFi network of the sPocket with other devices!
- Never try to connect to the tablet's Bluetooth adapter with other devices!
- The internal battery may only be charged with the equipment supplied with the sPocket. Note the permissible ambient temperatures! If the tablet is operated and charged at the same time, it can heat up considerably! If the permissible temperature is exceeded, either stop operation or charging, or both.
- After undocking, the electrical contacts on the mounting of the tablet and the basic unit are freely accessible. Never connect anything to these contacts! Avoid touching these contacts with your fingers or other objects!
- The built-in magnets of the mounting both on the tablet (lower side of the housing) and on the basic unit (mounting bracket with centering pins) also attract all other magnetizable parts from the environment. Do not bring such parts near the brackets! Always check both mountings for cleanliness before docking the tablet! Carefully remove any adhering parts with your fingers or with soft, non-magnetizable tools (cloths, plastic pliers / tweezers, ...)!

Any other use of the tablet than exclusively for controlling the sPocket basic unit is not permitted. Damage to hardware and software that occurs, in particular influencing and changing the installed operating system, are excluded from the guarantee.

The only permitted connection of external devices (except a mouse) is to insert the supplied USB stick into the micro-USB socket of the tablet for the purpose of a software update. To do this, please follow the instructions in the manual carefully. If the stick was previously operated on other devices (e.g. a PC for storing new software for the sPocket), the risk of introducing malware ("viruses" or third-party operating systems) passes to the user of the PC!

3.3 Power supply

In addition to the need for two independent power supplies for the two components of the sPocket, there are also some conditions to consider. These result from the necessary interaction or the errors that can occur when one component is switched off and the other cannot therefore establish a connection.

The basic unit always requires an external power supply. However, when docked, the tablet can conduct electricity to the basic unit. This leads to undefined states when the tablet is switched on / going to switched on, but the basic unit has no power supply. Two possibilities have to be especially considered:

- The basic unit has no power supply, the tablet is switched on (operated from a battery or with the associated power supply). In this case, the basic unit draws power from the tablet, but it is **NOT** sufficient for stable operation. The power supply of the basic unit from the tablet is indicated by a red ring around the scroll wheel. The tablet will start, but will not find a functional basic unit (no displays, no operation possible).

- The sPocket runs normally and the supply to the basic unit is disconnected. In this case, the basic unit can (but does not have to) be switched to supply by the tablet (depending on the charge status and power supply of the tablet). The tablet then restarts and after re-establishing the WiFi connection, fully autonomous operation without external power supply may be possible (only from the tablet's battery). However, this constitutes a high and not guaranteed strain and is not a stable condition.

In general, the operation of the basic unit without a power supply is not possible and should therefore always be avoided. Various particularities must also be taken into account when supplying the tablet:

- If the external charging power supply (power supply or USB connection from the active basic unit) is established when the tablet is **switched off,** the tablet's battery is always charged. Charging continues even after the tablet is switched on (with reduced effect, since electricity is also used to operate the tablet).

- If the external power supply is only established when the tablet is already **switched on**, the tablet may only go into battery maintenance mode. In this case, the battery is not fully charged and / or switched back and forth between low recharging and operation. This can be observed from the reduced power consumption (operation of the basic unit on a power supply unit with power display and supply of the tablet via USB from the basic unit) and from the indicators within the user interface (constant change of the bar display of the battery charge: red from battery, green from external supply). The brightness of the display then changes constantly between the valid values for battery operation and power supply operation. (This can be adjusted by repeatedly adjusting the brightness controller in the respective switching phases.)

- When charging the tablet from the "Charge" connector of the basic unit, the connecting cable should always be connected to the sPocket (micro USB) **first** and **then** to the tablet (USB-C). If the USB connector is first plugged into the tablet, this may prevent charging from starting and the tablet may even lose charge (the basic unit then receives the battery charge from the tablet).

This conservation mode may not be ended even if the tablet is switched off, but remains on the external supply. To resume an active charge, the supply on the USB-C connection must be disconnected and reconnected after a few seconds. The tablet can then remain on the supply from the power supply or basic unit for as long as desired. When the battery is full, charging stops. The active charging process is indicated by the flashing of a small red LED on the top left of the display.

The tablet's battery capacity is limited. When fully discharged, the tablet switches itself off and can then only be laboriously restarted (first charging, then switch-on attempts until the tablet restarts). The lifetime of the battery and thus the tablet (battery usually cannot be replaced!) suffers from total discharge. Avoid the automatic switch off and leave the running tablet at the charging power source as often as possible.

On the other hand, the life of the battery is also reduced by constant full charging. Occasionally the battery should "work", meaning that the tablet should only be operated from the battery for a while or at least be disconnected from the power source (when not in use). If the tablet is connected to the charging port of the sPocket basic unit, this happens automatically when the power supply is switched off (but only if the tablet has been shut down properly beforehand using the "OFF" button on the user interface!). However, the tablet battery can be discharged via the cable. Therefore, always disconnect the cable before switching it off (pull out the USB-C plug).

4. Device description

4.1 Mechanics

The basic unit of the sPocket is located in a specially milled frame housing made of a light and high-strength aluminum-magnesium alloy. The lid and base are made of aluminum and screwed to the housing. The magnetic mounting of the display is also screwed to the frame housing. In addition to the built-in (not visible) magnets, it carries 2 centering pins for safe positioning of the display and some electrical contacts ("pogo pins") for contacting the docked display. All connection sockets are screwed onto the left side of the frame housing.

The loudspeakers are built into the top cover ("cover"). The main circuit board of the device is located inside the housing. It also carries the optical incremental encoder. Its shaft is provided with a stainless steel disc with a recessed grip ("scroll wheel") at the level of the cover. A translucent ring (LEDs on the main board) for sealing the scroll wheel is embedded in the cover. Sealing ring and scroll wheel do not tolerate great forces! Never press the ring and only as lightly as necessary to turn the wheel!

Caution! The sPocket is not **waterproof**! Spraying with liquids (for example, rain) or immersion or even submersion inevitably leads to ingress of the liquid. In such a case, the device must be taken out of operation immediately! The tablet, in particular, must be switched off and disconnected from the charging voltage immediately if liquid enters! Should an increase in temperature or even smoke and / or an open flame be detected (battery fire), the tablet must be immediately placed in a fire-proof container (e.g. metal bucket) and extinguished with permitted means (sand, for lithium-ion batteries suited fire extinguisher, never water or water-containing agents!). In case of doubt or if the fire spreads, immediately contact your nearest fire department!

4.2 Electronics

The motherboard and possibly an expansion board carry all electronic units of the sPocket. Both boards are connected to each other by pluggable HF cables (standard "U.FL") and an interface connector. The speakers are also connected via pluggable connectors. All connection sockets are soldered directly onto the main board.

The core of the sPocket’s electronics consists of a highly integrated FPGA (Field Programmable Gate Array). This circuit is programmed by special software (called "Configuration") to generate all the modules for basic signal processing. Those are:

- 32 bit microcontroller with 2 cores (user guidance / device control and display processor with hardware accelerator)
- Downconverter with filter for the ADC data
- Broadband spectrum analyzer (only for special versions)
- Narrow Band Spectrum Generation and Processing for Audio and Video (SBSP)
- Broadband FM demodulator with RDS decoder
- Time-based demodulators with filter (some only installed with optional equipment)
- Audio generation from spectrum data (back transformation into audible signal)
- Various modules such as interfaces (memory, I²C, I²S, ...) and clock generation.

Thus, the FPGA realizes all receiver functions by hardware. There is no processor, DSP or similar. The sPocket can therefore not run SDR software or other computer programs.

In addition to the FPGA, there are several other modules. The most important are:

- Analog signal processing (preamplifier and filter, switch, attenuator)
- Analog-to-digital converter (ADC, 2 or 4 16 bit units)
- Low-noise main clock oscillator
- Digital-to-analog converter (DAC, 2x 24 bit) for audio output, ADC for microphone signal
- 2 units of LPDDRAM memory (SBSP with 2.5 Hz resolution)
- Various DC / DC converters and linear regulators for the necessary operating voltages
- WLAN controller with memory and analog circuits
- GPS module

For extensions, the following modules are added to the expansion board:

- Microprocessor for transmitter control (transmitter)
- PWM amplifier for transmission power (transmitter)
- Digital RF signal generator (transmitter)
- GaN-FET Transmitter Class E / F (Transmitter)
- Preamp and filter for band III and extended 2 m band (FM)
- DAB + module
- Dual 14 bit DAC (exciter)
- Linear amplifier 100 mW (exciter).

4.3 Firmware

The firmware (internal operating software) of the sPocket is programmed into a non-volatile memory (Flash). Each time the sPocket is switched on, the firmware is loaded into the FPGA and configures it according to the necessary units. The configuration also contains the software of a microcontroller core generated in the FPGA for control tasks.

This software essentially determines the device functions. Because it is stored together with the FPGA configuration (which defines the possibilities of the hardware), it can be updated just like this and thus enable new device functions. New firmware (FPGA configuration + controller software) is loaded via the WiFi connection from the tablet.

An independent controller for WiFi functionality is built into the sPocket. It possesses its own memory and own software. This software can also be updated from the tablet. The WiFi controller sets up a WiFi access point in the 2.4 GHz WLAN range, into which controlling devices (the tablet) can log in.

A commercial operating system such as Windows, Linux or Android is hard coded into the tablet (flash memory). The OS is configured so that it can only establish and control the connection to the sPocket basic device. Applications other than those absolutely necessary for this are not active and cannot / may not be activated. After booting up, the OS starts a full-screen application software RDR53_xx.EXE (xx = software version number) and connects the tablet to the basic unit via WiFi. The application software controls the device via touch or mouse inputs and shows data on the display.

The following description applies to configurations from version V100 (device "sPocket") or V01 (WLAN) and RDR53_1 (tablet).

5. Operation

5.1 Connectors

The following operating and connection options are available for the sPocket.

Left side of the sPocket, sockets from left to right:

- Charging current output for tablet (micro USB)

Connect a USB cable to the tablet from here (usually USB-C on the tablet side). The tablet can then be charged with a voltage of 5 V and a maximum of 2 A current. Always connect the power source first (here: USB micro on the basic unit) and **then** the tablet!

- WiFi antenna (SMA)

The WiFi antenna is only required if the sPocket is to be operated with a detached display. The connection is also recommended for critical operations (very disturbed environment, software update with risk of unwanted cancellation, etc.). The sPocket also has an internal wireless antenna. However, it can only establish a connection at a very short distance (max a few meters). Often, the data rate is severely limited or there are many disconnections. The external antenna is automatically utilized by the sPocket or manuall by the operator (can be set within the WiFi dialog).

- GPS antenna (SMA)

The GPS antenna only needs to be connected if the frequency stabilization function is to be used or the position data is to be displayed. The sPocket possesses no internal GPS antenna, because it would have no reception due to the high shielding effect of the metal housing.

- Antenna input / output (SMA)

Connect the antenna for the needed frequency here. The sPocket comes with an adapter cable from SMA to the usual BNC standard.

- Morse key (3.5 mm stereo jack)

A morse key can be connected here (contact to ground). If the microphone used does not have a built-in PTT button or if an additional one is to be used (like a foot switch), then a PTT button can also be connected here with contact to ground. It is also possible to output the PTT signal and an RS-232 data telegram to control power output stages (both with 3.3 V CMOS level in positive logic). The assignment of the connections can be configured within the sPocket software.

- Microphone (3.5 mm stereo jack)

A microphone can be connected here. The tip is signal, the sleeve can be used as a PTT input (connect contact to ground). A 5 V bias voltage can be connected to the signal connector ("Microphone" dialog). It is also possible to output the PTT signal and an RS-232 data telegram to control power output stages (both with 3.3 V CMOS level in positive logic). The assignment of the ring connector can be configured within the sPocket software.

- Headphones (3.5mm stereo jack)

A stereo headphone can be connected here.

- Power supply input of the basic unit (hollow pin socket with 2.5 mm pin)

Connect the device with the associated connecting cable to a charging voltage in the range of 9 ... 14.5 V here. At the other end, the cable possesses banana plugs for conventional power supply units (for example laboratory or 13.8 V amateur radio power supply). The red plug is the positive pole. The sPocket can withstand overvoltage or incorrect polarity up to 25 V. **Above that, it will be damaged!**

5.2 Controls

The basic unit features the following control elements.

- Rotary encoder ("scroll wheel")

The rotary encoder enables the continuous adjustment of setting values. Each rotation will cause an advancement (clockwise rotation) or reversal (counterclockwise rotation) of the currently selected value. The colored ring is used to seal the scroll wheel and signals that the basic unit is ready for operation via the built-in LED

Note! In addition to the sockets, the rotary encoder is the main penetration point at the device for dust and / or liquids. Protect it especially against dirt and moisture. The ring and scroll wheel only tolerate low pressure. Never press on the ring and never with a force greater than just necessary to turn the wheel!

- Loudspeakers (top right and bottom)

The two speakers reproduce the received signal. They have low performance and a limited frequency range. In FM-W stereo mode, modest stereo playback is possible. Increasing the base width beyond the value 100 can be advantageous (see set value "Width").

The tablet has the following connection sockets and controls (arrangement can vary depending on the version, sockets from left to right).

- Headphone output: Connection of stereo headphones with 3.5 mm jack plug.

- Device defined: Do not use!

- USB micro: Connection of a standard USB computer mouse or an USB stick for software updates.

- USB-C: Charging port. Connect the charging unit here. Always connect and switch on the charging power source **first**, only **then** the tablet!

- Device defined: Do not use!

On the far right (at the bottom of the tablet) there are small speakers on both sides. These can be activated in the "Setup" dialog with the setting "external". The speakers are automatically switched off when headphones are plugged in.

The upper side of the tablet has the following controls:

- Large switch: Device-specific, do not operate!

- Small switch: Power button of the tablet. To switch the tablet on, press this button until the red LED at the top left of the display starts to light up, at the longest until an indicator appears on the screen (manufacturer logo).

Caution! Use this button only to switch the tablet on, never to switch it off! It can only be switched off by software using the corresponding button in the user interface!

Note: Attempts to switch off using the switch on button can cause the tablet to behave undefined (crash or untidy shutdown of the operating system). (This can also happen unintentionally due to software errors or the battery being idle.) In this case (the battery must be charged!) the tablet can be restarted normally after at least 1 minute with the power button. However, starting then takes significantly longer than usual! Unusual displays may appear on the screen before the sPocket user interface appears.

The magnetic docking function has the following elements.

- Rotatable mounting on the basic unit (top left).

The mounting is firmly screwed to the basic unit. It has 2 centering mandrels (only one visible in the picture) on which the display with the associated centering openings must be placed. In the middle of the mounting there are contact pins for contacting the display after docking. Magnets are embedded on the left and right. Together with the magnets of the display, they exert the necessary holding force for the display to fit securely in the mounting.

- Centering openings and contact sockets on the display.

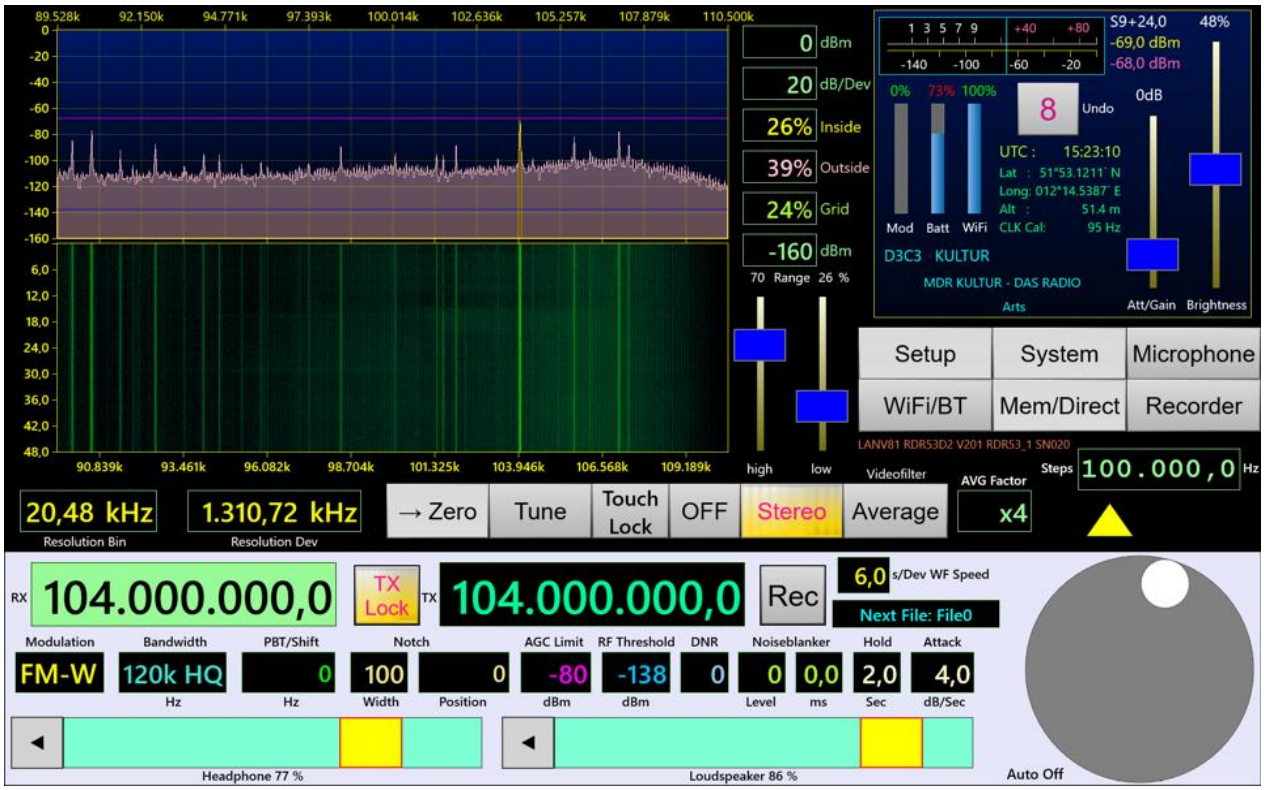
These fit exactly with the counterparts on the mounting of the basic unit. Magnets are also embedded in the display next to the contact sockets. To dock with the centering holes, the display must be held exactly over the centering pins of the mounting. From a distance of approx. 1 cm, the magnetic forces become noticeable and pull the display firmly into the mounting when approaching further. Undocking takes place in the opposite way by pulling the display away (exert traction as straight as possible away from the mounting!).

Caution! The magnets in the mounting and display attract all magnetizable parts from the environment! Always ensure that there are no adhering parts before docking the devices!

The main control element of the sPocket is the touch-sensitive screen ("touchscreen") with the graphic elements shown on the built-in LCD display. All adjustments are triggered by selecting ("tapping") a displayed graphic symbol. You can then change the selected value by turning the scroll wheel. In addition, some set values can be changed using "gestures" (certain touches on the touchscreen such as "swiping" with the finger in the horizontal or vertical direction). The selection of the set values and some adjustments can also be carried out with a computer mouse (connection to the USB micro port of the tablet).

The selection or activation of a value for inputs is signaled by highlighting the otherwise dark background of the value. In dialogs, the coloring is reversed: Not selected = light background, selected = dark background.

5.3 Set values



User interface of the sPocket. Below follows the meaning of the set values in the lower control panel.

- Frequency "RX" (light green highlighted as active set value)

Selecting the frequency display as the active input value (1x tap) allows the tuning of the reception frequency. Each locking step of the rotary encoder changes the frequency by the value of the set step size. Direct entry via a virtual numeric keypad ("Mem/Direct" dialog) is possible.

Settings can be made with an accuracy of 0.5 Hz. There are different setting limits, depending on the selected filters (see description in "Setup" dialog). Direct entries are rounded to the possible maximum or minimum value. Rotation of the scroll wheel at the region boundaries has no effect.

- Frequency "TX"

Frequency of the built-in transmitter. If no transmitter is installed in the sPocket, this value has no meaning. The TX frequency can always be adjusted independently of the RX frequency.

- "TX Lock" button

Activates a lock between RX and TX frequency. If the lock is active (button highlighted in yellow), the TX frequency is also automatically adjusted when the RX frequency is adjusted. If the lock is inactive, adjusting the RX has no effect on the transmission frequency.

- Button "Rec"

Starts the built-in audio recorder. The currently heard audio signal is saved as a WAVE file on the tablet. The tablet has approx. 20 Gbyte storage capacity. If the space is occupied, recording can no longer be started or an ongoing recording is canceled.

- Indicator "Next File: "

Displays the name of the file that will be created the next time a recording is started. The names are

numbered consecutively. During a recording in progress, the elapsed time since the start of the recording is shown here.

- WF speed in seconds per grid unit (s/Dev)

Operating speed of the waterfall diagram. High operating speeds require high computing power and can lead to delays in the display of other functions (spectrum, change of set values). The "Spectrum Display Rate" setting in the "Setup" dialog (see there) influences this setting value.

- Virtual scroll wheel

By rotating the touch screen with your finger or with the mouse pointer, the function of the encoder on the basic unit can be simulated. When the scroll wheel on the basic unit is turned, the virtual scroll wheel traces the corresponding movement on the display.

- Modulation

The type of acoustic playback of the received signal ("mode") is determined by the demodulators. They generate the audible signal from the spectra of the received signal ("SYNC" to "CW"), or from the signal itself (all other demodulators) according to the desired type of modulation. The following options are available.

Spectrum-based (values shown in light red):

· SYNC: Automatic detection of an amplitude-modulated double-sideband signal with carrier (A3E, AM radio stations).
The demodulator continuously determines the spectral line with the highest level within the audible range and interprets it as a carrier. The associated frequency is defined as the carrier frequency of the entire signal within the passband display; all other signals are viewed as sidebands and processed accordingly. Once a carrier is detected it is approximately 1.5 second "held", even if other signals reach temporarily higher values. Carrier frequency changes will be immediately "rejected" and resynchronized.

The demodulator "SYNC" also allows single-sideband demodulation of an A3E signal. If the set value "Modulation" is active, the label "SYNC Sideband" appears on the virtual button "-> Zero". Thus, the selection of the desired sideband is now possible: SLSB (left / lower side of the spectrum), SUSB (right / upper side) or SYNC (both sidebands). The values for bandwidth and shift are set accordingly. It should be noted that the carrier of the AM signal must always be present in the yellow (demodulated) listening area. Further manual adjustment of bandwidth and / or shift such that the carrier is no longer within the hearing range prevents demodulation.

· DSB: Double sideband signal with no carrier evaluation (A3E).
The channel processes all signals such as the carrier would be exactly on the center line of the audible spectrogram and generates the audio signals corresponding to the distance and level of the spectral lines from the center line.

· LSB: "Lower Side Band", lower sideband of a SSB signal (J3E):
The demodulator generates audio signals corresponding to the distance and level of the spectral lines from the center of the audible spectrogram to the left boundary line of the bandwidth.

· USB: "Upper Side Band", upper sideband of a SSB signal (J3E):
The demodulator generates audio signals corresponding to the distance and level of the spectral lines from the center of the audible spectrogram to the right boundary line of the bandwidth.

· EUSB: This is an extension of the USB demodulator (Extended Upper Side Band). This means that the entire spectrum can be used and not just the right half (if the frequency resolution is set accordingly). The maximum bandwidth limit + shift is set to 15 kHz audio frequency.

The importance of this demodulator is particularly given at very low frequencies (ELF) such as lightning observations, "Whistler" reception, submarine or radio observations of the Earth's magnetosphere. As a result, a frequency setting down to 0 Hz is possible. This mode produces a reproduction of the received EM waves with exactly the same audio frequency without any conversion or shift. As soon as the receive frequency is increased (the left edge spectrum larger than 0 Hz), a corresponding frequency conversion will happen so that the reception frequency at the left edge of the spectrum resembles an audio frequency of 0 Hz.

· SBCW: "Single Side Band + CW", automatic selection of the sidebands at 10 MHz:
The demodulator generates audio signals corresponding to the distance and level of the spectral lines from the center of the spectrogram to the left (receive frequency below 10 MHz) or to the right (receive frequency greater than or equal to 10 MHz) boundary line of the bandwidth. At the same time when operating as a SSB-transmitter (with expansion module) the emission of a keyed CW signal within the sideband is possible.

· CW: "Continuous Wave" Morse (A1A):
The demodulator produces an audio tone with the level of the spectral line directly on the spectrogram's centerline and a frequency that is adjustable via the "Shift" value (now "CW tone" / "Pitch").

Time-based demodulators (values shown in yellow):

· FM-N: Narrow Frequency Modulation (F3E):
The demodulator directly generates a frequency-demodulated signal from the ADC's signal with a maximum bandwidth of 20 kHz. Suitable for FM signals with a deviation up to ±7 kHz.

· FM-W: Wide Frequency Modulation, with optional stereo multiplex decoder (F3H):
The demodulator directly generates a frequency-demodulated signal from the ADC's signal with a maximum bandwidth of 300 kHz. Suitable for FM signals with a deviation up to ±80 kHz. With this demodulator,
A stereo decoder for FM radio signals can be activated using the "Stereo" button.

Note: The stereo decoder generates the left and right audio channel from the spectrum of the demodulated FM (MPX) signal. Therefore, in stereo no view of the RF signal in the narrow band spectrogram is possible. Instead, the MPX signal is presented in the spectrogram. If the sPocket is fitted with the broadband spectrum analyzer (optional equipment), the RF spectrum is also displayed when setting a resolution greater than 160 Hz / line.

· LSBQ / USBQ / DSBQ: Single sideband (LSB and USB) as well as double sideband (DSB without carrier).
Demodulators that are modeled after the operation of analog technology. Just like AM-E, they provide higher audio signal quality over their spectrum-based counterparts. However, they offer a lower functionality of the setting options such as lower selectivity, no notch filter and no DNR.

· DIGI: Special USB demodulator for receiving / transmitting RTTY, PSK, Weatherfax, SSTV and similar.
DIGI is a counterpart to CW and also possesses an adjustable signal pitch. This allows you to set the signal tones of the "Digi modes" to the frequencies required by the PC software. The pitch can also be set to negative values. This corresponds to a permutation of the sidebands (LSB receiving) and thus an inversion of the pitch or the bits in the decoding.

· AM-E: Double-sideband AM with carrier (A3E):
The demodulator directly generates an audio signal from the ADC's signal whose amplitude curve corresponds to the course of the envelope curve (peak amplitude, magnitude, envelope). With good reception, it allows a demodulation as in old tube / transistor radios with similar sound.

Compared to their spectrum-based counterparts, the time-based demodulators are distinguished above all by lower harmonic distortion, constant envelope delay in the pass band and significantly lower signal delay during reception (only a few ms compared to at least 100 ms for SBSP). This makes them especially suitable for signal output to the sound card of a PC. The output is sent to the two channels of the headphone jack as a separate I and Q signal. This enables the use of common SDR software for further processing. Especially in DSBQ mode with 12 kHz bandwidth, the signal is similar to that of simple receivers with direct mixers (but with much higher signal quality). The sPocket can thus be used as a high quality SDR.

These demodulators can also be used to receive normal SSB and CW signals. The IQ output to the headset then generates a "quasi-spatial" listening experience. The I and Q signals are assigned to the right and left headphones so that a location of the frequency position is possible. A signal in LSB is perceived as being on the left, a signal in USB as being on the right.

A double-tap on the "Demodulation" setting opens a menu for quick selection of the possible demodulators:

SYNC	DSB	LSB	USB	EUSB	SBCW	CW	Spec-based
AM-E	DSBQ	LSBQ	USBQ	DIGI	FM-N	FM-W	Time-based

- Bandwidth and shift ("PBT / Shift")

Bandwidth and shift can be adjusted in increments and limits that depend on the particular demodulator and the selected audio resolution (Setup). A fine-level adjustment in wide ranges is possible thanks to the spectrum based demodulators (filtering takes place "only" by selection of spectral lines). The time-based demodulators require an adjustable filter for each bandwidth and are therefore limited in the number of filter options.

If a time-based demodulator is selected, double-tapping the bandwidth setting opens a menu for selecting the possible values (example: FM-W with the "High-End FM" expansion option):

38k S	60k HQ	120k HQ	240k HQ				
50k S	60k S	140k S	300k HQ				Hz

Note: Depending on the modulation type, bandwidth and shift can only be adjusted as far as the selected sideband position permits. For example, no adjustment is possible for LSB where signals to the right of the center line of the spectrogram (in USB, the wrong sideband) could become audible.

In the operating mode "FM-W" (FM radio) there is a special designation after the bandwidth in kHz:

- "S": Sharp or steep-edged. These filters are designed for particularly high selectivity without considering possible distortions caused by the filter curve in the FM demodulator. Use these filters especially in the case of strong adjacent channel interference (strong other stations close to the selected station).

- "HQ": High Quality. These filters have a specially shaped filter curve ("bell shape"), which guarantees high-quality FM demodulation and maximum possible stereo channel separation. With good reception (sufficiently strong signal with little noise and no interference from neighboring transmitters), the sPocket achieves a sound quality that is significantly higher than the possible sound quality of other transmissions, like AM, DAB or the usual canned sound such as MP3 is (of course, depending on the quality of the signal emitted by the transmitter) with these filters.
Note: Depending on the development status of the software, the additional option "High-End FM" can be used to carry out a more extensive assessment of FM reception using additional tools such as a goniogram display (two-dimensional phase space of the stereo signals), an oscillogram of the LF signals in both channels or the use of one high-precision RF stereo measurement generator to check the reception path including the properties of the filter and demodulator.

- "Notch"

The notch filter is used to filter-out one narrow band signal within the passband for the suppression of interfering signals. The width of the filter and its position can be adjusted relative to the receive frequency. The notched-out frequency range is shown as a blue color column in the spectrum.

Caution! The notch filter requires the spectral data from the SBSP and therefore only works in the spectrum-based operating modes.

The relative position is converted into the absolute frequency in the passband and then stored. It remains when adjusting the receiver frequency, even if the filter area (relative position) falls outside the passband. In this case the setting of the position is limited to the maximum positive or negative value corresponding to the bandwidth. Due to storage of the absolute frequency, the setting can be automatically restored if the receiver is tuned so that the notch filter falls in the audible range again ("semi automatic" filter, tracking of relative position).

Auto Notch

The notch filter can be switched to fully automatic mode (and back to semi-automatic mode) by double-tapping the active display of the notch position. The word "Auto" appears followed by a set value. The value can be changed using the scroll wheel and determines the hold time (in tenths of a second) of the filter on a blanking signal found. This changes the "agility" of the filter when looking for interference signals. Short hold time = high agility results in a quick start of recognized interference carriers, but also the fast misinterpretation e.g. of AM modulation signals as interferers. Long hold time = low agility reduces the misinterpretation, but increases the time it takes to find interferences.

With FM stereo, the set value for the width ("Width") effects the setting of the stereo base width.

- Control limit ("AGC Limit") and hearing threshold ("RF Threshold")

2 horizontal marker lines are shown in the display of the spectrogram. Their content refers the values of the "RF Gain" (manual gain control) or "AGC Limit" (automatic gain control), and "RF Threshold".

The lower marker (blue) indicates the signal threshold above which a signal is audible. All signals whose level is less are inaudible.

The upper marker (purple) indicates the signal level that produces the maximum level of the audio signal. Signals above this marker are limited (or distorted). Internally, the Reuter sPocket operates with a 6 dB safety margin ("headroom"), so that in case of low clipping distortion does not occur immediately.

The marker can be moved by selecting its value. Direct input via the virtual numeric keypad is also possible.

Since the upper marker can be seen as the RF gain of the receiver (compared to analog receivers), it can be adjusted by manual operation, or as an Automatic Gain Control threshold. The mode is selectable in the Setup dialog. In automatic mode, the hold time used to set the marker position lower and the speed of the marker shifting downwards after the holding time (compares to "Decay" in an analog receiver) can be varied within wide limits. The movement upwards (= "Attack" / "Desensitization") always happens immediately upon detection of a higher level and the associated signals are processed only after the shift. The automatic mode thus prevents clipping.

Caution! The automatic control responds only to signals which are inside the passband (yellow lines in the spectrum)! Signals shown in light red, (that is outside the passband or within the notch filter) will not affect the marker position. However, since these signals are not processed, they can not cause clipping.

When manual control is selected the top marker describes by how many dBs a received signal on the marker line has to be amplified to reach 0 dB (full scale) of the audio signal. This "0 dB" audio level relation to the 0 dBm RF level is not an absolute value in dBm or dBµV because the audio signal is not generated in a well-defined impedance environment and amounts to far more than 1 mW (0 dB audio = about 5 Vpp at headphone and 10 Vpp at speaker output). The gain value of the upper marker is to be considered a relative value.

In automatic mode, this marker is moved by the Reuter sPocket itself. It automates the process of gain regulation. As a result, the AGC level is closely monitored and provides usable adjustments of the control parameters. The setting for the upper marker is a control limit (maximum gain) to prevent excessive gain. This limit can be set directly in dBm / dBµV as it relates to the received signal.

When using the FM demodulators, the markers work differently:

· FM-N: The signal for the narrow FM demodulator is used under the following scheme:

The lower marker receives the sum of all the audible signal spectral lines. It must be positioned above the visible signal spectra lines for its function. The upper marker determines gain / control limit. However, since FM is an amplitude suppression modulation scheme, the gain is not critical to the demodulation process. Only when there is too little gain (near the top marker, signal is very small) will the demodulation be aborted. The top marker can thus be used as a "noise gate" or "squelch". Set it so that unmodulated noise is not demodulated and the demodulation starts only at useful signals.

· FM-W: The signal for the wide FM demodulator is used prior to gain regulation.

The FM-W demodulator has a special algorithm for very high amplitude suppression and

therefore requires no control. The lower marker can be used for a "Mute" or "Squelch" function. The effect depends on whether the stereo decoder is on or off.

- Mono: There is an RF level dependent muting corresponding to the selected level for the hearing threshold.

- Stereo: There is a noise-dependent muting. For this, the signal-to-noise ratio of the pilot signal in the MPX signal is selectively measured. If it falls below about 24 dB, it will be muted. If it rises above about 30 dB, it will be switched to loud. The hearing threshold setting has only one on / off function (all values except "Off" turn the function on).

The muting of FM-W does not completely suppress the signal. It is only lowered by about 42 dB. Even when the receiver is muted, it can so be determined if reception is available.

Caution! Do not increase the volume so far that the muted signal is audible! As soon as the receiver engages, an accordingly high volume is available! This can lead to hearing damage when using headphones or connecting powerful amplifiers!

- Noise reduction ("DNR")

"DNR" stands for "Dynamic Noise Reduction", the noise reduction system of the sPocket.

A setting other than zero sets various algorithms with different levels of efficiency in operation. Values up to approx. 4 can be used for high-quality audio playback. At higher values, artifacts are noticeable depending on the signal content. Values of 10 or above are only useful for CW. The DNR can only operate together with the spectrum-based demodulators.

Caution! The setting of the noise reduction system has a major impact on audio quality! In addition to the planned reduction of noise the quality of usable signals is also affected. Only set the noise reduction system to values above 0 if necessary and try to find a setting that best suits your needs.

- Noise blanker

In addition to the dynamic noise reduction system "DNR" the "NB" (Noise Blanker) is available for impulse noise reduction. This system recognizes signal glitches (like discharge, ignition interferences, voltage spikes caused by switching, ...) by their typical fast signal rise and their broadband frequency spectra respond.

The noise blanker benefits from the spectrum-based operation of the sPocket. The signal evaluation takes place in the entire simultaneously received spectral range with approximately 164 kHz width.

If a glitch is detected, instead of the desired data signal, a special identification signal is forwarded to the audio module. This adds a replacement signal instead of the glitch in the generation of audio for speakers and headphones. There is no processing to decrease or mute the original (faulty) signals.

A replacement signal which is inserted in place of the faulty original signal can be calculated, because at the time of interference occurrence the complete spectrum of the useful signal is known. The last undisturbed spectrum contains all the signal components to continue the production of the currently active audio signal, including all frequencies and amplitudes. After the end of the interference pulse the signal generating proceeds with the calculation of the audio frequencies from the first click-free available spectrum again.

The substitute signal does contain all signal frequencies and their amplitudes at the beginning of the disturbance. This spectrum is put out statically for the duration of the disturbance. On the other hand a "normal" signal is a dynamic ever-changing spectrum. The replacement bridges the glitch thus; although this signal is a signal similar to the wanted signal, this similarity is reduced with the increased backup time. It is therefore all the more (annoying) audible, the longer the glitch. A particularly good replacement coverage results for in spectra with few, slowly changing signals (ideally sinusoidal tones such as CW, less dynamic music), and is not as so good for at speech or noise.

The noise blanker has two settings:

· Level: This value with a variable 0 to 15 defines the threshold level and the signal slew rate at which a signal is to be classified as a glitch.

· ms: Duration of inserting a substitute signal in place of the original signal.

The level value is a level setting of the noise blanker sensitivity. If the area around the two set values lights up red, this indicates a current interference / blanking. The higher the score, the more sensitive the blanker classifies signals as an interference. "0" is no blanking and at "15" already increased noise or a weak signal with a wideband modulation is defined as a disturbance.

The "ms" value specifies the duration in milliseconds, during which a replacement signal is inserted in place of a detected fault. It is limited to 9.9. At the latest, after 9.9 ms a spectrum from the received signal will be generated before re-inserting a replacement signal is possible ("not re-triggerable" noise blanker).

Follow these steps to set the best functionality as follows:

· Place a temporary blanking setting: Usual disturbances last approx. 0.2 - 0.5 ms.

· Increase the level value from 0 to such an extent that the instantaneous received signal triggers the noise blanker. You can recognize this by the red lighted value and the audible replacement signals ("machine noise" at quick blanking).

· Now reduce the level value by a few steps, so that an undisturbed useful signal no longer triggers blanking.

Depending on the type and strength of impulse noise the duration may be adjusted. It should be as short as possible to just bypass the glitch. The level value may need to be changed slightly depending on the received signal, because of the many simultaneous signals in the total range of 164 kHz (like tuning the receiver to a heavily occupied broadcast band) can cause unwanted triggering of the blanker.

The noise blanker also protects the system from interference signals. If the blanking time is set correctly, after the glitch the full receiver sensitivity is immediately available again .

The FM demodulators can not generate substitute signals. Naturally, interference in FM mode has little effect on the signal quality. By using the system as an FM squelch unwanted noise can cause an increase in the squelch sensitivity. In this case use the AGC manual control or the lower marker ("threshold") for reducing audio noise.

- Slider parameters holding time and rate of increase ("Hold" and "Attack")

The automatic regulation of the sPocket (see description "Control Limit" / "AGC Limit") can increase the volume of the reception level so far that a signal at the control limit reaches full volume. As long as this limit is not reached (purple marker / displays in the S-meter are above the control limit) and the levels in the audible range are below the marker line, the automatic will continue to increase the volume. The speed with which this happens is adjustable with the value "Attack".

The increase ends when the signal level is reached (and always at the control limit). If the level falls, the regulation begins only after a waiting time with the further increase of the volume ("hanging" control). The waiting time can be set with the value "Hold".

When the automatic control (Setup) is switched off, "M" or "Man" for manual control is displayed in the values.

Note: The reception level within the listening area is measured in the SBSP modes for each yellow spectral line individually. The highest line is used. The control therefore moves to the top of the highest signal. Only with very unsteady signals (for example noise), a certain addition and averaging of several lines take place. In this case, the control does not go all the way to the highest peak. The same happens within the time-based operating modes, wherever the overall level within the listening area is evaluated broadband.

Note: The measured values of the control are also used for the display of the S meter (scale and yellow value). This means that a very narrow-band measurement in the SBSP operating modes takes place, in the time-based operating modes a broadband. This affects the display when measuring non-sinusoidal signals (especially with noise).

The setting of the 3 control parameters control limit, hold time and control speed has a great influence on the listening quality. Here are some tips:

- A suspension control is needed especially for the reception of SSB signals. Here, the hold time

should serve to bridge the speech pauses within a passage. For this purpose, holding times of one to several seconds should be selected. The control speed should be low (a few dB / s).
- With AM broadcast reception, the control responds to the carrier height. As long as no strong fading occurs, hold time and speed can be set to low values. With stronger fading the speed can be increased.
- The control speed can theoretically be set very high (max 99 dB/s). But do not succumb to the temptation to "rule out" any fading with a high control speed! Often, strong fading is also very selective. That means that the carrier varies differently than the modulation sidebands. If the control follows immediately and exactly to the carrier, the modulation is "tampered".
- **Important:** The control limit should not be far below the current reception level. In longer speech pauses (SSB) or when tuning, the control otherwise moves uncomfortably far into the noise. Compared to an analog device, the sPocket has an extremely high "gain". It is thus able (with a correspondingly low setting of the control limit) to even reproduce his own low intrinsic noise even at maximum volume. The control limit should therefore always be at least 10 - 15 dB above the noise line.
- As always: The best automatic is the one that you can switch off! For borderline reception, the control should be switched to "manual" (Setup). With the control limit (now called "Gain") you can now adjust the volume yourself.

- Headphone volume control ("Headphone")

Adjust the volume on the sPocket headphone connection. The yellow adjustment button can be moved back and forth with the finger or the mouse. If this setting is active (after tapping or clicking) the button turns red until another setting is selected. Tapping the field with the left arrow at the left end of the control immediately reduces the volume to zero.

- Adjustment for loudspeaker volume ("loudspeaker")

Adjust the volume for all speakers. The yellow adjustment button can be moved back and forth with the finger or the mouse. If this setting is active (after tapping or clicking) the button turns red until another setting is selected. Tapping the field with the left arrow at the left end of the control immediately reduces the volume to zero.

Note: The loudspeaker amplifier in the sPocket operates clocked as a D amplifier. The steep-edged signal is conducted relatively far into the device (up to the internal loudspeakers). As a result, slight intrinsic interferences are possible during reception with the highest sensitivity on various frequencies. Setting the loudspeaker volume to zero (or switching off the internal loudspeakers in the setup) switches the D-amplifier off and thus prevents possible interference.

Further settings of the user interface (area above the setting panel):

- Spectrum resolution ("Resolution Bin" and "Resolution Dev")

The central display element of the display is the representation of the spectrum ("spectrogram": Diagram representation of the spectrum, as well as "waterfall": Color-coded spectral values, sequentially arranged in time) of the received signals in a selectable frequency bandwidth. The width of a spectral line (called "Bin") corresponds to the set value "Bin resolution". The "Resolution unit" value shows the frequency range that is covered by a raster unit of the diagram. The total display width results from the number of bins or grid units displayed.

The Reuter sPocket transfers a 163.84 kHz wide frequency band from the time domain into the frequency domain thus generating the spectra. Resolutions down to 2.5 Hz/Bin are generated (corresponds to 65536 Bins for the entire spectrum). The width of the spectrum visible in the diagram is set by activating the set value for the width of a spectral line or the grid units.

("Broadband spectrum" optional equipment only): This option can also be used to set a viewing width greater than 164 kHz.

In the diagram there are 16 subunits with 64 lines each = 1204 lines in total. Accordingly, the total width of the display is 1024 Bin. The reception frequency usually always refers to the center of the spectrogram. The reception frequency is only shifted from the center if the spectrum has to be limited at the highest span (160 Hz/Bin), so that the full spectral range can always be displayed. The shift can be prevented by the "Spectrum Priority low" set value in the Setup. Then, invisible spectral components are hidden and the reception frequency remains in the middle of the diagram.

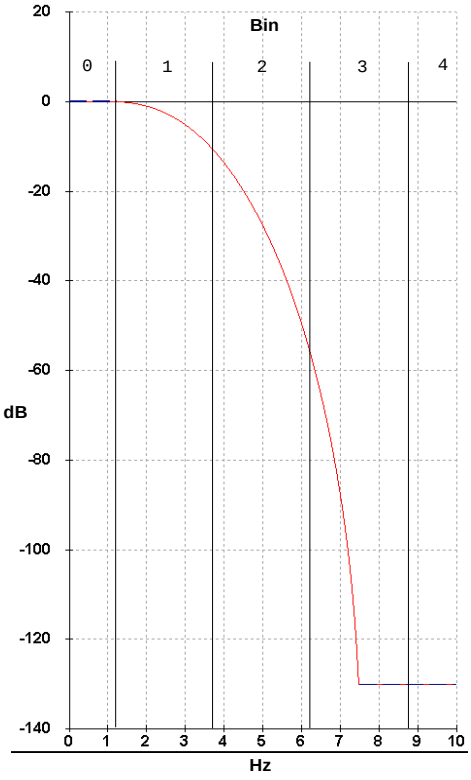
("Broadband spectrum" optional equipment only): In the case of a very wide field of view, which would require a display of negative frequencies on the left side or the display of spectral components outside the current frequency range, the reception frequency is always shifted from the center.

Any change in the spectrum width is made by doubling or halving the current resolution. The minimum width is given by the minimum possible width of the spectral lines (= highest possible resolution) of 10 Hz (optional equipment: down to 2.5 Hz). The greatest visible width results from the bandwidth of the entire spectral analysis of around 164 kHz (resolution 160 Hz/Bin).

With existing broadband analyzer (optional), the viewing width can be increased beyond the SBSP range. Again, a change occurs when doubling / halving the width. A minimum of 640 Hz/Bin is possible, a maximum of around 54.2 MHz can be displayed simultaneously. However, such a large area is limited to the respective receivable area by different prefilters.

Within a spectral line, the amplitude attenuation is less than 0.2 dB. The line width of -0.2 dB corresponds to the distance between the vertical display lines. Thus, despite frequency discretion, no signal can remain "invisible". If a signal is exactly "between" 2 lines, it is shown as two lines of equal size and with a maximum of 0.2 dB attenuation. There is almost no "picket fence effect" or similar artifacts as with the Fast Fourier Transform (FFT).

Outside of a spectral line, the attenuation increases rapidly and reaches 130 dB at the third line left and right from the selected frequency. This attenuation is maintained across all lines, there are no spurious resonances ("leakage") or similar artifacts of the FFT.



Filter curve of a spectral line width of 2.5 Hz

The lines of the graph of the spectrogram are always drawn so that its visible height exactly equals the value of the corresponding spectral component. There are no oblique lines drawn (intermediate values with estimated level). Each line is actually calculated and not interpolated from others further away.

The frame rate of the spectrogram is directly dependent of the selected resolution. The sPocket achieves this with 4x oversampling, so that the spectra are calculated in a time sequence that corresponds to 4x the frequency resolution.

Example:

Resolution 5 (Hz) = 160 Hz / sub-unit à spectrum display frame rate = 20 Hz (images / s = framerate). When switching to 2.5 Hz only 10 frames / s are achieved, when switching to 20 Hz, however, 40 frames / s.

The actually possible display frequency depends on the computing power of the tablet and the data rate of

the WiFi connection. The sPocket constantly transmits 80 spectra to the tablet, i.e. at lower rates from the SBSP, several of the same in a row. Higher rates are limited during the transmission. However, even powerful computers with 80 fps are usually overwhelmed and limit the frame rate or slow down other functions. In the Setup dialog, you can select the rate at which the tablet graphics should operate (full frame rate down to ¼ frame rate).

However, higher sampling rates of the spectrum are not limited internally in the sPocket (maximum 1280 spectra/s) and are fully utilized for further processing (audio generation or recording of maximum values, fast mean value filtering, etc.).

The maximum spectrum width of 163.84 kHz is the constant reception bandwidth of the sPocket. Any further signal processing (with the exception of FM broadband) takes place within this range. The width of the audible bandwidth inside this spectrum is determined by setting the demodulation filter bandwidth. How large the visible part of this spectrum is in the diagram is determined with the set value "Resolution".

- Button "→ ZERO"

The adjustment of frequencies and the corresponding steps can cause slightly offset settings. In this case, by tapping the "->ZERO" button, an update can be achieved as follows:

· Frequency values are always set to the nearest lower integer multiples of the corresponding step size, unless a range limitation is set.

· When the step size is adjusted, all the digits to the right of the least significant input point marked by the directional arrow are set to zero, or the lowest or highest possible value of the step size is set.

This function allows you to easily correct frequency values after changing the step size or automatic adjustment to the field boundaries.

Example (the "Hz" is not displayed):

Current frequency setting 1,124,550.0 (Hz), the corresponding current step size is set to 10.0 (Hz).

à New setting of step size to 1.000 (Hz). If the frequency is now adjusted, it is always tuned in 1000 Hz steps, e.g. in clockwise rotation: 1,125,550.0 ... 1,126,550.0 ... 1,127,550.0 and so on.

However, your intention in choosing the step size was probably the desire to tune the frequency to rounded thousands. You would now have to set such a "straight" frequency by direct input, would have to set it exactly before choosing the new step size, or again adjust the step size to initially 10 Hz (50 Hz, 150 Hz or 450 Hz would be more effective) and adjust it "smoothly".

This effort can be avoided by tapping the "->ZERO" button after adjusting the step size to 1,000 (Hz). The frequency is now automatically set to the next lower multiple of 1000 Hz, e.g. 1,124,000.0 (Hz).

The "zeroing out" of the lower digits also works with the frequency setting itself. It should be noted that it is always set to multiples of the currently valid grid value. If it is "crooked", the frequency is also set to a matching "crooked" value.

The → ZERO button can also set various other set values to zero (e.g. the position of the notch filter). With other values, the immediate setting to the minimum setting is possible (e.g. Hold or Attack). If → ZERO is tapped, the transmission frequency is only set to a multiple of the setting grid (behavior exactly like setting the reception frequency) if the lock to the RX frequency is not active. If the lock is active, the transmission frequency is set to the reception frequency immediately with → ZERO.

- Button "Tune"

This button switches the transmitter of the sPocket (if installed) to tune mode. For more information, see the description of the transmitter or exciter module. This button has no function on devices without a transmitter.

- Button "Touch Lock"

Locking and releasing the user interface. It is useful to lock the user interface if the touchscreen can be accidentally touched (e.g. when docking or undocking the basic unit). Pressing the button has a delay of approx. 3 s.

- Button "OFF"

Switch off button of the tablet. After tapping, a security question appears. In the event of an accidental tap, the shutdown process can be interrupted with "Escape". If you confirm "Shut Down!", the user interface is closed and the operating system shuts down in an orderly state. The tablet is only really switched off when the red LED on the top left of the display fades and the operating voltage of the sPocket basic unit has been switched off.

- Button "Stereo"

The sPocket possesses 2 audio channels that can operate independently within the 164 kHz SBSP reception bandwidth. Internally, channel 2 is programmed for phase-shifted reception of the same signal as channel 1. When "Stereo" is activated, both channels are output separately and thus create a surround effect. Without stereo, only channel 1 is output on both audio channels.

With FM-W, the two channels carry the left and right stereo signals (when turned on). All other time-based demodulators do not have a pronounced surround sound function. For DSBQ, L/USBQ and DIGI, the signal is instead output as an IQ signal. Thus, it is suitable for feeding it into the sound card of a PC, whereby the sPocket can serve as a high-quality SDR receiver. (However, the reception then deteriorates to "SDR level" by the inevitable interference of the PC.) In terms of hearing, the location of the sideband position (LSB = left, USB = right) is determined by the IQ output.

The effect of the "Stereo" function while using the SBSP modes is highly dependent on the settings. In certain settings, a good effect can be achieved. In addition to bandwidth and shift the exact tuning is primarily of importance. Even a small change in the reception frequency can change the effect, just as the change in the frequency position of the calibration (see the "System" dialog). Try different settings if necessary.

- Video filter

The "Video filter" button is used to activate a filter function in the image processing of the spectrum display. It can be switched between no filtering ("None"), mean value filtering ("Average"), maximum or minimum value filtering ("Max-Hold" or "Min-Hold") by continuously pressing the button.

- No filter: In case a high temporal resolution of the display is needed, the video filter should be switched off. The display will show a very highly dynamic image, with every change in the level (noise) displayed exactly as recorded.

- Average: Average of the spectral curves of multiple images. The displayed noise will be reduced as short-term maximum and minimum values do not appear in the display.

- Min / Max: The spectrum always displays the highest or lowest value measured since the last time the display was reset. Here all the detected values are recorded at full processing speed, even if this is above the frame rate (vertical period) of the display, so the actual maximum value might normally not be seen in the display. Setting for measurement and monitoring purposes.

The averaging factor of the average value filter or the reset rate of the minimum / maximum value filter can be changed via a set value that is visible to the right of the button when this filter is selected.

The holding time of the minimum and maximum values can also be set to "infinite". The unlimited measurement time allows the detection of transient signals (monitoring function), which are then displayed as long as desired.

Caution! Any change in the measurement period or the filter function leads immediately to a reset the display!

- Tuning grid ("Steps")

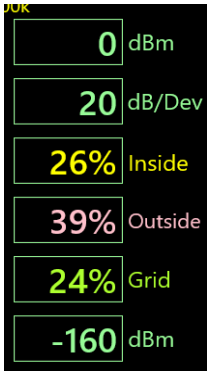
The step grid in which the reception and transmission frequency can be adjusted can be set using this value. To simplify the setting, you can set the point at which it changes up or down. This point is indicated by a yellow arrow pointing upwards below the step setting. The directional arrow (and thus the active least significant entry point) can be moved to the left and right by dragging on the touchscreen.

A quick selection of common step sizes is possible by double-tapping the set value.

1	100	4,5k	9k	12,5k	50k	500k
10	1k	5k	10k	25k	100k	Hz

The → ZERO button sets all digits to the right of the currently least significant digit (identified by the arrow) to zero. The marked position and all those to the left of it remain unchanged.

Set values to the right of the spectrograms:



Upper level limit of the spectrum

Scaling the spectrum per subunit

Brightness of the spectrum in the listening area

Brightness of the spectrum outside the listening area

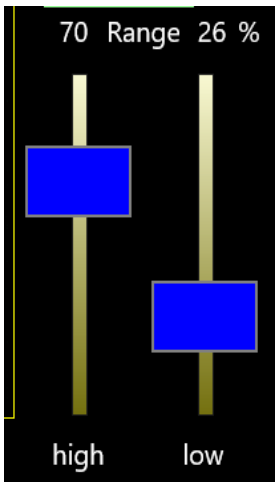
Brightness of the grid

Lower level limit of the spectrum

The vertical position of the spectrum can be adjusted by selecting and changing the value for the upper or the lower limit, the resolution via the value for the scaling per subunit. The unit of measurements can be switched in the Setup dialog between dBm and dBµV.

The brightness values determine the color saturation within the spectral display.

- Brightness setting of the waterfall diagram



The diagram for displaying the waterfall display has its own slider for setting the brightness values in the diagram. First, basic information about the display:

So-called "waterfall plots" are an important tool for recording and documenting signal changes over time. Thus, each recorded two-dimensional spectrograph will not be displayed with the frequency on the x-axis (horizontal) and the signal level on the y-axis (vertical), each new plot overwrites the old one immediately and irrevocably. Rather, the level meter will now be scaled to almost the depth level (z-direction). Since this third dimension in a graph is not possible or representable, the level is now coded in colors and the spectrum is written as a one-dimensional line in the diagram.

Imagine that you would grasp the usual spectrum display with your hands on the left and right. Turn it 90° around the horizontal axis with the "tips" towards you and now look at the edge of a thin "spectrum disk" from above which would make the peaks closer to them brighter and the more distant "valleys" darker.

These quasi rotated panes viewed from above are now drawn consecutively on the display, with the older panes sliding down one position and the edge of the newest pane being viewed appearing in the top line. The newest one is always drawn on top, the oldest slice disappears below the diagram. The effect corresponds to a visual impression of a waterfall, hence the name of this display. The "fall velocity" can be selected in different stages (see above, set value "WF speed in seconds per grid unit").

The view of the waterfall is heavily dependent on the "viewing depth" of the underlying level position in the diagram. The levels are displayed color and brightness coded. The color coding cannot be changed. Depending on the level position in the spectrum, the display is from "below" (lowest level in the spectrum) with blue over turquoise to green with increasing levels and further over yellow to red at the top (highest visible level).

The color coding alone is not sufficient for a sufficient contrast between the levels within the waterfall diagram. For this reason, the brightness of the color valid for the respective level is also coded. The brightness coding can be adjusted with the two sliders as follows:

- "**high**": This value specifies the percentage of the height of the spectrogram at which a color is displayed with the maximum possible brightness. Higher levels above the set value continue to be displayed at full brightness. Example: Setting 50%. A signal with a level exactly in the middle of the spectrogram (50% of the total height) is displayed with full brightness. All levels below are drawn darker, all levels above also with full brightness.

- "low": This value indicates at what percentage of the height in the spectrum a color with the lowest possible brightness (just visible) is shown. Levels below this signal level are not displayed (black). Example: Setting 25%. All signals below exactly one quarter of the diagram height are not displayed (black pixels in the waterfall). Signals above this are displayed with increasing brightness up to the setting "high" (full brightness).

The distance between the two settings (low can never be set above high) determines the range of levels from black to full brightness (hence the name "range" for the range of brightness coding). The contrast between different levels can be selected by a suitable setting. A large area results in slight differences in brightness between adjacent levels, but a wide overall range of brightness coding. A small area results in high contrast between adjacent levels, but no brightness coding outside the area. Extreme cases:

- "high" = 100%, "low" = 0%. In this case, all levels in the waterfall visible in the spectrogram are displayed and brightness-coded. Levels very far at the bottom (bluish color) are relatively dark and only a level directly at the top reaches full brightness.

- "high" = "low" + 1%. In this case, all levels below the two same values in the spectrogram are completely hidden (black). All levels above are immediately displayed with full brightness and only color-coded up to the top. In this setting, minute differences in level (1% of the spectrum height) can be displayed with full contrast between black and the assigned color.

Note: The specification in % of the level in the spectrum relativizes the actual level at the antenna input in dBm or dBµV. This results from the settings next to the spectrogram (level resolution and level position). Different settings of the level position always result in a color change of the display in the waterfall (except level below "low" → always black). This allows you to choose a preferred color representation.

For example, if you put the position of the spectrum display so that most of the levels are at the bottom, blue colors are predominantly drawn in the waterfall. If most of the levels are in the middle of the spectrogram, the waterfall is mainly drawn in green colors, etc.

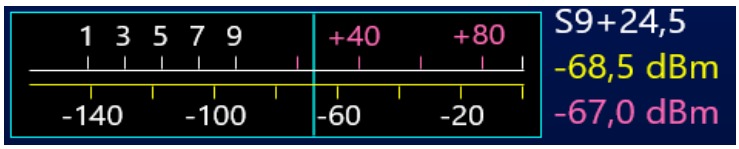
When shifting the level position in the spectrum (regardless of whether with the set values or by actually changing the level at the antenna input), it must be ensured that the levels desired for observation (e.g. the modulation of a radio transmitter) are as far as possible within the brightness-coded level range ("Range"). Otherwise they are either not shown at all (below "low") or only drawn with relatively low-contrast color coding (above "high").

Indicators and settings in the window at the top right of the user interface:

In the window on the top right there are mainly bar and text displays, as well as 2 adjustment controls.

- S-Meter

At the top of the window is an S-Meter, which mimics those from analog devices.



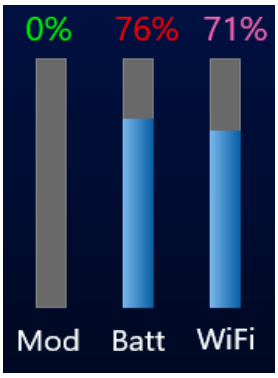
The instrument displays the current level in the audible frequency range on two scales (above S values with decimals and S9 + xdB or S0 -xdB, below dBm scaling) using a quick "pointer". To the right there are the smoothed averages (0.8 s) displayed as a digital value. The purple number value indicates the current position of the control / gain setting (upper horizontal line marker). The current unit of the numerical values is also displayed; they can be selected in the "Setup" dialog.

The measured values for the S-Meter can be derived directly from the spectrum. The video filtering is also regarded. Unfiltered values, average values or the currently accumulated maximum or minimum value are displayed.

When selecting a CW or SSB demodulator, however, it is always a "quasi-peak" reading. Each detected peak value is displayed for a short time, then the value slowly fades down to the current signal level.

Note: The blue-bordered field of the S-Meter lights up red when the ADC at the antenna input are overmodulated. Then the attenuator must be set higher and / or the antenna voltage reduced.

- Bar graphs



- Mod: Modulation of the microphone input in % of the full level. Values below the use of the limiter are shown in green, from the use of the limiter to full modulation in yellow and in the event of overmodulation in red. While the "tune" mode of the transmitter is active, the adjustable output level is displayed here.

- Batt: Display of the battery capacity reported by the OS. Red values indicate operation with discharging (decreasing capacity), green values when charging (increasing capacity).
Caution! The values are only valid when the sPocket is in full operation (basic unit on and WiFi connection established)! If the charging conditions are not defined (see "Battery management" → trickle charging), this display only shows very inaccurate values. So don't trust it too much! Only during the full charging process (green indicator and flashing red LED at the top left of the display), is it guaranteed that the battery capacity is always sufficient for operation. If the tablet is operated for a long time with a red display, it can switch off at any time and the operating system may crash (start only after full charge and with a very long operating time)!

- WiFi: Ratio of the data received from the basic unit via WiFi to the expected data. Purple indicator: Basic unit operates with external antenna, green display: Basic unit operates with an internal antenna. The indicator should always be 100% (all data fully received). If the indicator often drops below 100%, the antenna configuration must be changed (dialog "WiFi/BT") and / or the location of the sPocket must be changed (move the tablet to the basic unit or dock it completely, move the device out of the reach of other strong WiFi transmitters).

The indicator bar has another function (it is then colored red): When the audio connection from the sPocket to the tablet is switched on, it shows the fill level of the audio data buffer. Usually the buffer is always almost full. If data is missing due to dropouts in the WiFi connection, the audio continues to run smoothly

with the data from the buffer memory. Thus, the buffer empties itself (bar display drops). In the event of brief faults, the WLAN connection can often reload the missing data and the bar graph rises again. If this is not possible, data is taken from the memory until it is empty. Only then does audio playback stop. In this case, the buffer is first completely filled again before playback continues.

- Undo

The device constantly saves the last 28 operating steps that have been made. These settings can be recalled at any time (see description in Special features "Undo function").
Setting "0" always contains an unchangeable factory setting. It can be selected when the sPocket is in an undefined state, which can not be remedied by switching it off and on again (it always saves all settings and returns there when switched on).

- GPS indicators

If the GPS receiver is activated ("System" dialog), the GPS antenna is connected and enough satellites are received, the determined GPS data appears here. The data is updated in an irregular sequence, just as the display and other operating functions of the sPocket enable computing time for this (low priority of the GPS displays). The time therefore "lags" somewhat behind the actual one and should not be interpreted as "atom-precise".

The value "CLK Cal" indicates the currently measured deviation of the sPocket main oscillator from the GPS reference frequency. This value can be used for the automatic frequency correction (frequency calibration) of the sPocket. The frequency calibration system works as follows.

The GPS receiver uses the atomic clock time base in the satellites as a reference to generate a highly accurate time signal (so-called 1 PPS signal). This 1 second signal serves as a time base for measuring the frequency of the main oscillator in the sPocket. It has a maximum deviation of ± 12 ns (if at least 5 satellites can be received). The clock period of the sPocket oscillator is also around 12 ns. Thus, the maximum measurement error is 2 periods = 24 ns / second = 2.4*10-8 (0.024 ppm). This corresponds to a maximum measurement error of approximately 2 Hz with respect to the oscillator frequency. The average measurement error when reception is good (>= 10 satellites) is below 1 Hz.

The measured frequency deviation can be used to automatically calibrate the sPocket. For this purpose, the set value for manual entry of a calibration value must NOT be selected in the System dialog (see there). During auto calibration, the current calibration value is constantly calculated from the measured deviation and used for the correction of all frequency settings and displays. There is no direct intervention in the control of the oscillator. This maintains the high phase purity of the free running crystal oscillator.

The automatic calibration calculates the value internally to 0.5 Hz precisely and can adjust it by a maximum of one step each second. When the oscillator frequency changes (for example by temperature changes), the readjusting speed is thus max. 0.5 Hz / sec. If the oscillator frequency deviates too far from the nominal value (for example, in cold state after switching on or manually adjusting the calibration over larger ranges), it will take a long time for the system to readjust to a deviation <1 Hz.

- Attenuator / Amplifier ("Att/Gain")

This slide actuator enables the adjustment of the analog amplifier located in front of the ADC. A setting range from -6 dB (6 dB gain) to +25 dB (25 dB attenuation) is possible. Only one level of +14 dB can be set in DAB mode. The set value has a major influence on the basic reception parameters "sensitivity" and "controllability".

The sensitivity of the sPocket is determined by its own noise. Signals below the intrinsic noise can no longer be made visible and / or audible. The lower the set value, the lower the sPocket's inherent noise and the smaller signals can still be processed.

The modulation capability of the sPocket determines the maximum possible level at the antenna input, which can still be processed by the ADCs without distortion. Higher levels produce an overload (S-Meter lights up red) with hard limitation of the signal peaks. This causes a lot of interference in the received signal and the desired useful signal may no longer be readable. Higher values of the adjusting controller allow higher values for the maximum modulation.

Note: The value for Att/Gain determines the absolute position of the receivable level range of the sPocket, not its size. The size of this area between self-noise (lower limit) and full modulation (upper limit) is a very important quality parameter, especially for directly digitizing receivers. However, it should not be confused with the specification of the "dynamic range" that is often used in other concepts, such as the receivers working with analog technology. The latter mostly refers to the assessment of generated intermodulation levels because there is no hard limitation like with "digital receivers".

The sPocket has a "usable dynamic range" of approx. 127 dB (D version with 4 ADC) between noise and limitation (while operating with usual settings in the long to short wave range). With 0 dB Att/Gain this corresponds to approx. -130 dBm self-noise and -3 dBm full modulation. Increasing Att/Gain to positive values shifts the range around this value to higher levels. Example: Setting +10 dB. The usable range is now between -120 dBm noise and +7 dBm full modulation. Setting towards negative values results in a corresponding shift of the range to smaller level values.

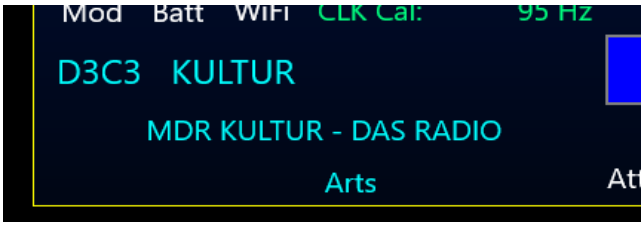
Note: Due to the properties of the necessary analog circuits before the ADCs, the shifting of noise and full level control does not follow the adjustment of Att/Gain very precisely. For example, the intrinsic noise decreases only slightly below 0 dB Att/Gain. On the other hand, large Att/Gain values increase the maximum possible level until the ADC is overmodulated, but there is also increasing distortion due to intermodulation, which can affect reception in a similar way to overmodulation.

The 0 dB setting of Att/Gain is in most cases the optimal setting for high sensitivity and high controllability. Only increase the value if there are very strong signals (large antennas) or when an overmodulation is often displayed in the S-Meter. Reduce the value only if very small signals "on the turf" have to be made audible without currently present strong signals.

- Brightness setting

This slider controls the brightness of the display backlight and the LED under the ring of the encoder. The lower the brightness, the lower the power consumption of the sPocket (especially the tablet).

- Text below the bar graphs



The light blue text below the bar and GPS indicators contains the information of the RDS signal of an FM radio transmitter (if receivable). Displayed are:

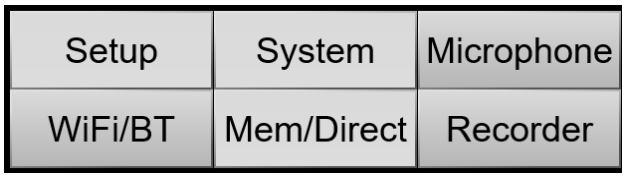
- PI: Program identification (4-digit hexadecimal identifier of the transmitter).
- PN: Program name (station name).
- TP: Indicates that this station is broadcasting traffic information.
- PT: Program text (continuous flow text with information about the station and / or program).
- PTY: Program type (designation of the type of program content mainly sent, e.g. news or rock music).

The sPocket's RDS decoder is programmed for maximum possible sensitivity (meaning the presentation of the RDS information) even under unfavorable reception conditions. It also allows individual bit errors in the data stream that can no longer be corrected later (RDS has an internal error correction that can correct many errors). Therefore, nonsensical characters or gaps can occasionally appear in the text ads. These errors continue to increase as the reception conditions deteriorate until reception ceases altogether.

Caution! The RDS decoder is only active when the stereo decoder is switched on (stereo button lights up yellow)!

6. Dialogs

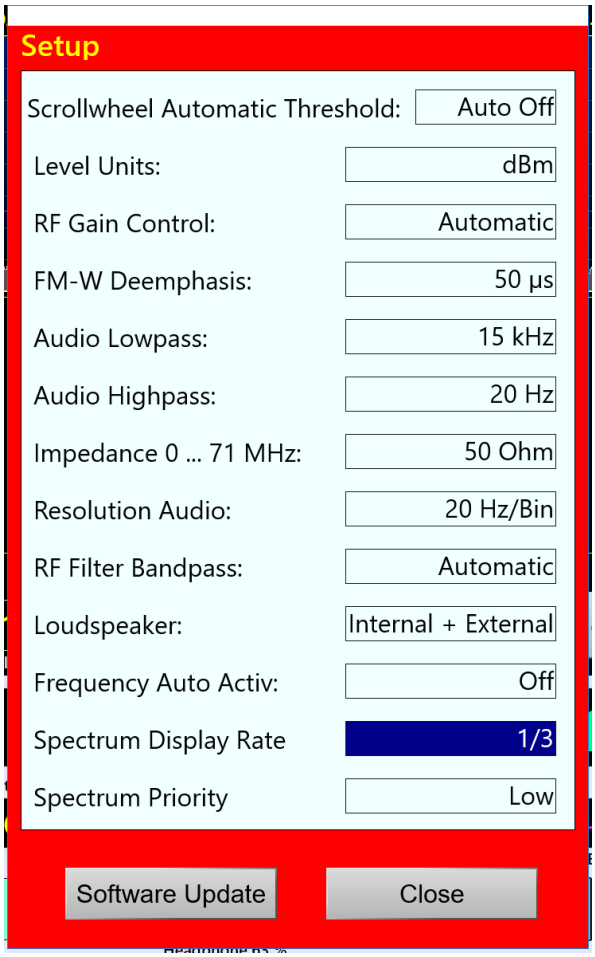
In addition to the permanently displayed user interface, different "windows" or "menus" are available, in which further additional options can be chosen. These temporary displays are called "dialogs" in the sPocket. The dialog is called up using the corresponding button below the display window for the S-meter and others.



Only one dialog can be open at a time within the user interface (exceptions: Software Update, Warning window and DAB window). The dialog windows always appear above the user interface and cover part of it. If the hidden area is to be made visible, the window can be moved by "touching" the upper bright area above the colored dialog content with the mouse or with a tap of the finger. Be careful not to move the dialog so far that it is barely or even no longer visible!

In contrast to the normal display, the values are shown in dialogs with dark lettering on a light background, and they are selected accordingly by inverse display with light letters on a dark background. Color highlighted values allow an adjustment via the encoder automatic (see description in "Setup dialog").

6.1 Setup dialog



Most basic settings of the device's functionality can be adjusted in the Setup dialog, their adjustment during normal operation is rarely necessary.

The individual values are as follows:

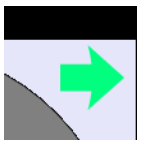
- Scrollwheel Automatic Threshold

A value from 0 ("Off") to 14 sets the rotational speed of the tuning knob and automatically forces the adjustment without the need of user intervention. 0 is OFF, "1" is the lowest speed (very slow rotation) and 14 the highest speed required to trigger the automatic mode.

The system monitors the movement of the scroll wheel and takes over its function, once a certain minimum number of pulses per second is detected. If this detection threshold is exceeded, the automatic system inserts virtual encoder pulses as sent by the keyboards operating system. These pulses cause exactly the same function (adjustment of a setting) as the operator would do using the scroll wheel. Tuning a frequency, for example, will have a flywheel effect.

The effect is a continuation of the adjustment process, even if the operator no longer turns the scroll wheel. It tries to automatically detect the rate of adjustment in accordance to the measured rotational speed of the wheel which is turned by the operator. Basically, only the rotary encoder has to be "pushed" with a few steps, after which the adjustment of the selected value automatically continues.

Once the automatic has taken over the adjustment of the scroll wheel from the operator, it signals this with a green arrow on the top right of the virtual scroll wheel:



The automatic encoder is active.

An arrow to the left signals the ongoing adjustment to lower values (scroll wheel was turned to the left), or an arrow to the right to higher values (scroll wheel was turned to the right).

At low values of the automatic setting (activation even at low rotation speeds) a small automatic adjustment speed is initially provided, with larger ones a higher one.

During the automatic adjustment, the operator can always increase the adjustment velocity by further rotation of the scroll wheel in the current direction. The automatic mode detects these pulses and correspondingly increases the speed up to a maximum specified by the device (depending on the set about 10 - 100 pulses per second).

If the operator moves the scroll wheel in the opposite direction, the automatic will be stopped immediately and the operator's adjustment in the opposite direction will be executed. Therefore, the last automatic pulse is reversed effectively.

The automatic mode is also stopped under the following circumstances:

- A value on the touchscreen is tapped.
- The final value of a set value is reached (not fully apparent, although some final values prevent adjustment beyond this, but the automatic remains active and must be terminated by the operator).
- The upper horizontal marker (manual gain control or automatic gain control) is moved at least one position up or the received signal exceeds the marker within the audible area. This is especially useful when tuning, as it switches off immediately when a strong signal enters the audible reception area (station search function).

The scroll wheel automatic mode is not available for all set values, but only for those with more than about 20 possible values. In dialogs, these values are highlighted in color.

There is a speed-dependent acceleration function when adjusting the frequency, which is also controlled by the encoder automatic. It increases the tuning step size with fast turning. The tuning acceleration effect is adjustable if no "Auto" is displayed before the set value within the dialog. (A value with "Auto" generates the automatic tuning.)

- Level Units

Scaling (y-axis) of the spectrum or waterfall chart and the S-Meter in dBm or dBµV.

- RF Gain Control

Adjustment of the the automatic control to "Auto" or "Manual".

- FM-W Deemphasis

The correction of the emphasis of FM radio stations. "Off" for linear demodulation (only suitable for measuring purposes), "50 µs" for the European standard, "75 µs" for the American standard.

- Audio Lowpass

The signals pass through a digital low pass filter for filtering unwanted higher-frequency components before audio playback. Here, the cutoff frequency of this filter can be adjusted. Thus, if necessary, a height reduction can be achieved, e.g. with strong noise in the signal.

- Audio Highpass

All signal processing in the sPocket is "DC-coupled", meaning there is no lower limit frequency (or it is equal to 0 Hz). Mismatches, low frequency deviations of the transmitter and receiver, interference, etc. could lead to the generation of DC voltage or low-frequency noise at the output. A digital high pass filter before D / A conversion prevents that from happening. Here, the cutoff frequency of this filter can be adjusted.

- Impedance 0 … 71 MHz

The antenna input's impedance can be switched for frequencies up to 71 MHz. In addition to the standard 50 ohm setting, "0 ohm" and "infinite" are possible. These values are to be regarded as idealized. In fact, they are very frequency dependent.

The 0 ohm setting results in a broadband low-impedance input ("current input"). It is suitable for connecting small auxiliary antennas, like loops. At higher frequencies, even short rod antennas (like telescopic antennas) can be operated advantageously in this setting. If a resistor is connected externally directly in front of the antenna connection, an input adaptation with this value can be achieved. An additional gain of 1000 ohm / resistor can be achieved. Example: External series resistor 100 Ohm: Gain is equal to 1000/100 = 20 dB.

The "infinite" setting achieves an input resistance of a few 10 kohm at very low frequencies. Due to internal parallel capacitances in the size of 100 pF, the impedance drops rapidly at higher frequencies. This setting is useful for short antennas (like telescopic antennas) at low frequencies. The gain is about 14 dB at low frequencies.

Note: The high-impedance antenna input can also be used as a measuring input (note the level!). Because the sPocket already has a high sensitivity below 1 kHz, this results in e.g. a high-quality audio spectrum analyzer (use demodulator "EUSB" and reception frequency 0.0 Hz).

- Resolution Audio

This setting affects the sound and adjustment options of the spectrum-based demodulators. It determines which spectral lines are made audible from the time-frequency conversion of the SBSP. 3 levels are possible:

- 10 Hz: Fine resolution with low ripples and distortion of audio generation. Spectrum update rate only 40 Hz, therefore large signal delay. Limited bandwidths of the demodulators (maximum audio frequency that can be generated is 5.1 kHz).

- 20 Hz: Medium resolution with low frequency ripple and normal harmonic distortion (SSB to SW). Spectrum update rate 80 Hz, moderate signal delay. Bandwidths of the demodulators corresponding to maximum audio frequency of 10.2 kHz.

- 40 Hz: Coarser resolution with higher ripples and fluctuating distortion of audio generation. Spectrum update rate 160 Hz, short passage delay of the signal. Extended bandwidths of the demodulators up to the maximum producible audio frequency 20.4 kHz.

The setting should be made according to existing requirements (like fast signal passage in CW or Digimodes), according to the desired setting options (maximum bandwidth, granularity of the bandwidth's

adjustment, shift, notch filter, etc.), as well as personal taste ("softness" or "clarity"of the audio playback).

- RF Filter Bandpass

Adjustment of the HF prefilter. With "Auto", the filters are automatically switched according to the reception frequency. That way, the tuning above the filter or band boundaries is possible. For example, a skip from 30 MHz to 50 MHz is performed as soon as it is tuned beyond 30 MHz.

Setting a fixed filter / band limits the frequency setting to that band. An exception is the transition at 10 MHz. Here, both the lower and the upper range can be selected, tuning is always allowed between minimum possible frequency (demodulator and spectrum display-dependent) and 30 MHz.

If a filter is selected that is outside the current reception frequency, it will be set to the lowest or highest filter frequency (depending on where the frequency currently is in relation to the filter).

- Loudspeaker

Switching the internal (basic unit) and / or external (tablet) speakers on or off.

- Frequency Auto Activ

The frequency setting can be activated automatically when another setting is active. The time until a jump from the currently active setting to the frequency set value is configured here. Each adjustment of the currently active setting restarts the timer. The jump to the frequency only takes place if no other operation has been carried out for the set time.

- Spectrum Display Rate

The sPocket's basic unit delivers spectrum and waterfall images at a rate of 80 images / second ("full rate"). This high number of images (also called frame rate) can only be drawn by very powerful graphics units (e.g. personal computers with special graphics cards and monitors) without losses. The tablet of the sPocket is not able to do this. The high frame rate also causes higher power consumption, more heating and restrictions in operation, because the drawing of the pictures consumes most of the available computing power. The frame rate of the spectra can therefore be reduced here. 1/2 rate is a good choice for a common PC used a display of the sPocket, 1/3 or 1/4 rate should be set for smaller computers like the corresponding tablet.

Note: Setting the frame rate affects the running speed of the waterfall diagram. This may have to be readjusted. It should also be noted that higher running speeds cause higher computing power with the described effects or restrictions.

- Spectrum Priority

Since the spectrum display in the two diagrams requires the most computing power (apart from internal processes of the operating system that cannot be influenced), it can be given a high (setting "high") or a low priority ("low") as required.

If the priority is high, the available computing power is used as much as possible for drawing the diagrams. The "movements" of the diagrams are therefore relatively fluid, rapid changes in the spectra can be easily recognized (depending on further settings such as spectrum resolution and spectra rate). As a result, the processing of the user operation can sometimes be delayed (e.g. activation of a new set value after tapping it). Encoder pulses can also be slowed down (reducing the adjustment speed of the set value when the scroll wheel is turned).

If the spectral displays have low priority, the drawing of the images lags behind the user guidance. User inputs or encoder pulses for settings are carried out as quickly as possible. This can occasionally lead to the omission of individual image drawings ("jerking" of the spectrum display, briefly stopping the waterfall).

Note: Such loss of spectrum drawings and / or delays or complete failure of individual operations can also occur with a poor WiFi connection. As soon as the WiFi bar graph drops below 100%, image data are missing and / or user input is lost.

Setting the spectra priority also results in some small changes in the display of the spectrum diagram. Especially with the resolution 160 Hz / bin (maximum possible viewing width without the "broadband spectrum" option), the visible spectrum is adjusted to the limits of the spectrum generation. This results

from the fact that the audible spectral range (yellow representation in the diagram) is not always in the middle of the entire visible spectral range (light red representation). At 160 Hz/Bin resolution, the SBSP can only calculate 1024 lines at the same time. This corresponds exactly to the width of the diagram. Therefore there are two ways of displaying the audible and visible spectrum:

- Low Priority: The audible spectral range is kept in the middle of the spectrogram (as with other resolutions). The set reception frequency is therefore always on the middle grid line of the diagram. Rare exceptions are possible (e.g. EUSB demodulator: Audible spectrum is always on the left edge of the diagram). The visible spectrum is shifted accordingly, so that parts of the image on the left edge of the diagram can be lost (hidden in black).

- High Priority: The visible spectrum is always drawn in full width of 1024 lines. No information provided by the SBSP is lost. For this, the audible spectral range is shown shifted from the center. The reception frequency is no longer exactly in the middle of the diagram, but somewhat offset depending on the demodulator and bandwidth. However, the grid lines and their labeling follow this offset, so that there is no restriction when reading the information.

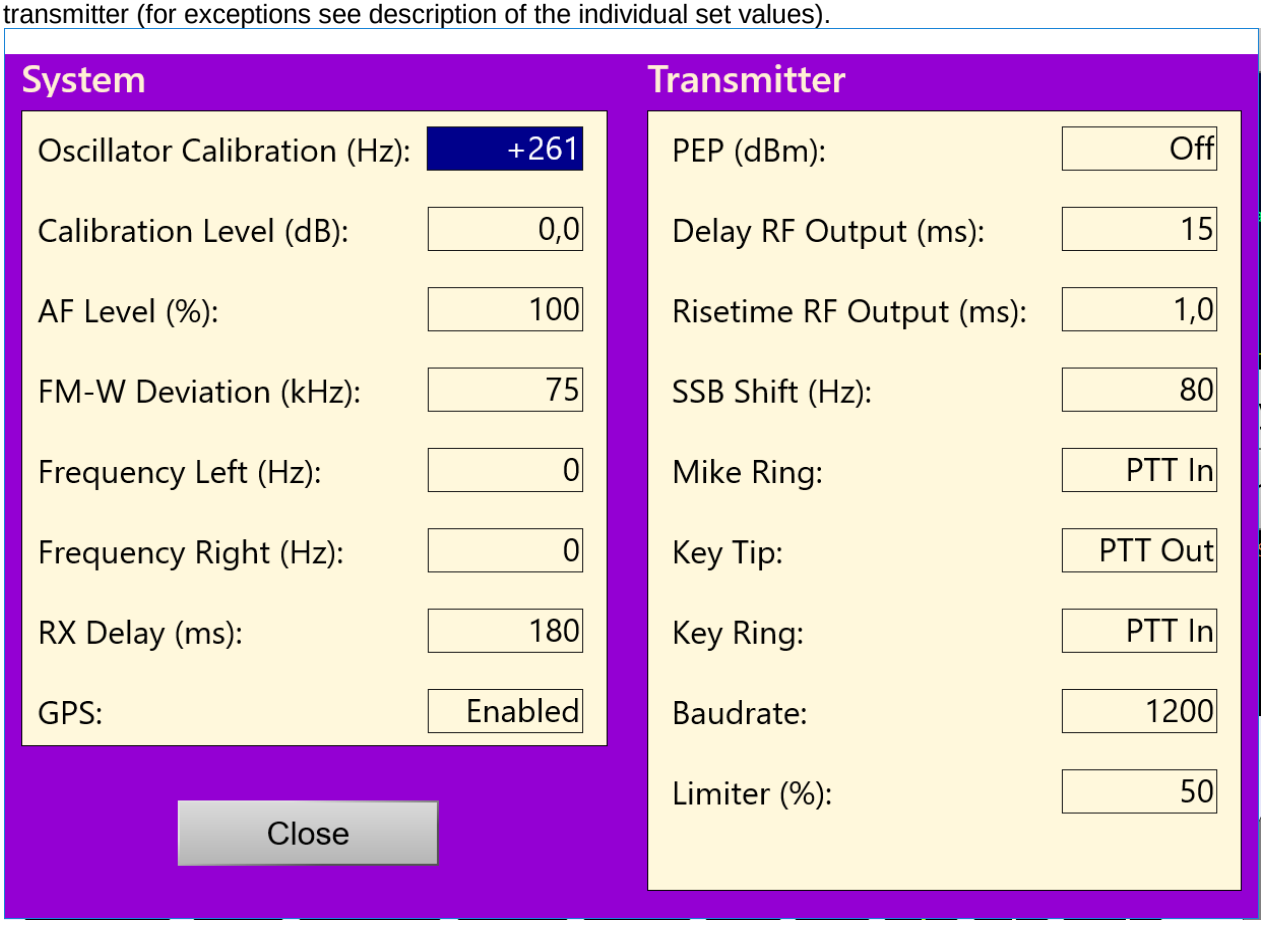
Note: The different display of the 160 Hz resolution depending on the spectrum priority has no influence on other properties such as demodulation of the filtering. It is only "cosmetic" in nature or takes into account various requirements such as maximum information requirements (always full spectrum visible) or operating habits (reception frequency always in the middle).

- Button "Software update"

This button starts another dialog via which the software of the sPocket can be updated. Further information can be found in the special section "Software Update".

6.2 System dialog

Similar to the Setup dialog, this dialog allows the adjustment of basic device functions. The settings for the transmitter are also accommodated within the System dialog. These have no meaning for devices without a transmitter (for exceptions see description of the individual set values).



The following settings are possible:

- Oscillator Calibration (Hz)

The main oscillator of the sPocket is a temperature compensated crystal oscillator (TCXO) without any influence by a control, PLL or similar. As a result, it achieves extremely low values for the phase noise (important for high RF sensitivity and audio signal quality). On the other hand, it always possesses a certain deviation from the nominal frequency. That is, the frequency setting has some error.

This error can be corrected in 2 ways:

- Manual calibration: When selecting the set value in the System dialog, the frequency deviation in Hz can be compensated by setting an opposite (compensating) value. This requires the awareness of the current deviation. The deviation may be obtained by e.g. observing a very frequency-accurate signal (beacon, measuring transmitter, ...) in the spectrum. The calibration then takes place on the exact center position in the spectrum or "beat zero" with a DSB or SSB demodulator.

- Automatic calibration by GPS: If the GPS receiver is active (see description of the GPS data above), the GPS receiver can determine the current deviation and enter the necessary correction value in the dialog. For this purpose, the set value must **NOT** be selected when the dialog is closed!

The distinction value selected / not selected decides whether the device works with manual or with GPS calibration. Of course, the latter is only successful with activated GPS.

- Calibration Level (dB)

An adjustment of this value causes a vertical shift of the display in all spectrograms by the set value and therefore also a change of level readings. Use it when you need to make an accurate level setting using an external reference. Permanently connected preamplifiers or attenuators with their associated values can be calibrated here so that the correct level is always displayed within the sPocket even despite preamplification / attenuation.

- AF Level (%)

If the test generator has been activated by setting calibration "+1995" or +2000 ", the amplitude of the test signals can be set here. For further information see section 10.2 and 11.2 "Special features".

- FM-Deviation (kHz)

When the test generator has been activated, the deviation of the frequency modulation can be set here. For further information see section 10.2 and 11.2 "Special features".

- Frequency Left (Hz)

When the test generator has been activated, the frequency of the first audio signal (normally used for left stereo channel) can be set here. For further information see section 10.2 and 11.2 "Special features".

- Frequency Right (Hz)

When the test generator has been activated, the frequency of the second audio signal (normally used for right stereo channel) can be set here. For further information see section 10.2 and 11.2 "Special features".

- **RX Delay (ms)**

As soon as the "PTT In" signal is switched on (can also be used by the RX as a mute signal), the receiver is switched to the lowest gain (corresponds to the "Hand" setting with -19.5 dB). After the signal has been switched off, the receiver is kept insensitive by the "RX delay" time (suppression of transients in the RX). After that time it is immediately put back on the defined maximum sensitivity ("Control limit" setting). Should the received signal now be stronger, the AGC is adjusted immediately.

Caution! The value "0 ms" has a special meaning in connection with the monitoring (see "Microphone" dialog). In this setting, there is no switching of the AGC to the lowest gain value. The self-received transmission signal is therefore just as audible as any other received signal. For this purpose, no additional sidetone will be displayed.

Note: The "RX Delay" is the relevant parameter for the time needed from switching off the transmitter up to full sensitivity of the receiver. This time may be minimal if the TX signal is outside the reception bandwidth.

However in case it is within (extreme: TX frequency = RX frequency), it will always be received itself depending on the RX / TX switch and the RX settings. It will therefore trigger the gain control (upward or downward). The gain control would increase gain after the delay-time and only with the defined gain control speed. However, it is time for the "RX Delay" once again been fully regulated. It will be increased after the RX Delay time automatically to the full value.

Note: The parameter "RX Delay" is in the CW operation of particular importance, especially on CW VOX (VOX = 10 ms). With each trigger of the transmitter, the following sequence is started: Signal TX-ON (PTT / Key / VOX) à Sequence time switch output à Start of rising edge HF à End of rising edge HF à Signal à Start of falling edge HF à End of falling edge HF à Signal TX-OFF (trigger delay RX) à RX delay à Setting of RX gain and falling signal PTT Out. By choosing a suitable RX delay, the operator can either choose to activate the RX as quickly as possible while accepting switching noises, or to minimize interference noise while accepting delays.

- GPS

Turn the GPS receiver on and off.

- PEP (dBm)

Setting the output power of the transmitter. Setting the transmitter output power above the value "Off" activates the transmitter of the sPocket. The minimum and maximum possible values depend on the type of transmitter installed and the transmission frequency (see technical data).

Caution! If a change of the output power is required when the transmission frequency changes, the reduction is carried out automatically. If a higher power could also be output on a newly set transmission frequency, there is **no** automatic increase!

- Delay RF Output (ms)

This value forms the basis of the built-in sequencer for operating the transmitter with an external PA. All switching processes start with the signal "PTT In" or "Key In" (simply called PTT without further identification). This signal can be taken from one of the jack socket connections (switch to ground) or generated internally by the "Tune" button or by a VOX. The TX-ON switching output (also configurable to connect the jack sockets) is activated immediately with PTT. The RF power is generated only after the time set here (allowing RX / TX switching of external PAs).

Example in the picture below: Switching time PTT à HF = 5 ms (Rising edge set to 1 ms, green PTT-Out, turquoise HF output on antenna socket):

- Risetime RF Output (ms)

Rise / fall time of the HF power after switching the transmitter on / off (see picture above with edge time = 1 ms). Increase or decrease of power are strictly linear with no overshooting of any kind. In AM modulation (carrier on / off) or at an emergency shutdown of the transmitter the edges can be reduced to zero and overshoots can occur.

- SSB Shift (Hz)

This value determines the position of the transmitted signal relative to the (suppressed) carrier in the SSB mode. The effect is exactly the same as the effect of setting "shift" at reception. In all other modes, SSB-Shift has no effect.

- Mike Ring, Key Tip, Key Ring

For the microphone jack, the middle contact ("Ring", right channel with stereo) can be assigned with different functions. The front contact ("Tip", left channel with stereo) always carries the microphone signal. The socket for the Morse key can be used to freely configure both contacts.

The individual contacts of the sockets can be assigned with the following signals.

- **PTT In**: The contact receives the PTT signal to turn on the transmitter. To accomplish this, the contact, which has a high internal resistance of 2.5 V, must be grounded by a switch or PTT switching output of other devices (< 0.4 V).
- **PTT Out**: The contact issues a signal to control additional devices. It is activated immediately on activation of a connection assigned with "PTT In" or with "KEY In" and deactivated only after its deactivation plus set value "RX Delay ms". This can be used to control an external PA.
- **KEY In**: The contact receives the signal from a single-pole morse key to turn on the transmitter. To accomplish this, the contact, which has a high resistance of 2.5 V, must be grounded by the key contact (< 0.4 V).
- **CAT Out:** The connector outputs a serial data word (standard "RS-232") for controlling external devices (like PA). The data rate of the signal can be changed via the set value "Baudrate".

Caution! The signals "PTT Out" and "CAT Out" are 2.5 V CMOS level with approx. 700 ohm internal resistance! Especially the signal "PTT Out" is not a switching contact, open collector or similar with active "low" level! For use in common low-active interconnections, the signal must be converted by means of an external amplifier (transistor or IC)!

- Baudrate

Data rate of the CAT Out signal for controlling external devices. The generation of an RS-232 signal to control other devices is software-dependent (optional activation). By default, this signal is inactive (2.5V "high" level).

- Limiter (%)

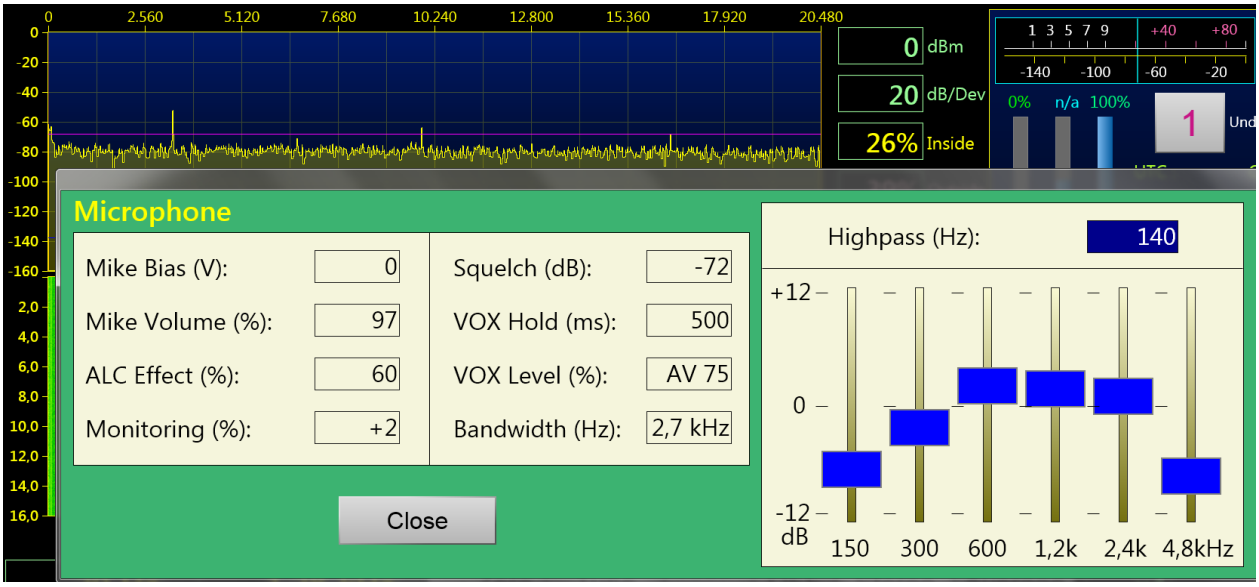
The transmitter's modulator has a distortion-free limiter. This set value can be changed in steps of 25%, 50% and 100%. The value indicates from which level of the modulation (left bar in the S-Meter window) the modulation is limited. At the same time, the full output power is generated from the beginning of the limitation. Effectively, at 25% this means an additional amplification of the modulation voltage by a factor of 4 (12 dB), at 50% by a factor of 2 (6 dB). These are the values by which the dynamic range of the modulation is compressed.

The limitation use and thus the full modulation is shown in the modulation bar with yellow text.

The use of the limiter / dynamic compressor allows a higher modulation of the modulator and thus a higher average output power in SSB operation. At the same time, distortions and overmodulations ("splatter") are effectively avoided. The limiter operates without distortion between the use of the limit (yellow modulation values) and overmodulating the microphone input (red modulation values). In conjunction with the ALC of the microphone amplifier in low levels (only to prevent overmodulation) an optimal modulation quality can thus be achieved.

6.3 Microphone dialog

When opening the Microphone dialog, the spectrum display is switched to the display of the signals at the microphone input (audio spectrum analyzer).



The parameters have the following meanings:

- Mike Bias (V): 5 V can be selected as a bias for active microphones.

- Mike Volume (%): Volume adjustment of the microphone.

- ALC Effect (%): The microphone amplifier has an automatic gain control (ALC). It reduces the gain at high levels to avoid clipping. The effect of the regulation can be adjusted here.

- Monitoring (%): When transmitting, the receiver is switched to minimum sensitivity so that the transmission signal is normally not audible. If the sidetone is set to values not equal to 0, the modulation signal of the transmitter becomes audible. In CW, a sound is generated, which corresponds to the setting "CW tone" in the user interface. Negative values of the sidetone settings, create a phase shift of 180 ° in order to dampen any feedback which can occur.

Note: If no RX Delay is set (see above "System" dialog), there is no reduction in receiver sensitivity. Thus even the received broadcast signal is audible (if in range) and there is no side tone generated!

Note: In mode "SBCW" (combined SSB / CW) mode, when pressing the PTT key the SSB sidetone (microphone signal) will be generated; when keying with the Morse key the appropriate sideband tone ("L Freq" according to System dialog). Even if a double tone signal is sent into the sideband ("Freq L" and "Freq R" not equal to 0), only" Freq L " will be generated as a sidetone. In case "Freq L '= 0, then no sidetone will be generated, but a short-pulse (DC impulse).

- Squelch (dB): The microphone is switched off below the squelch threshold. Only levels above this threshold generate modulation signals.

- VOX Hold (ms): Hold time of the VOX (voice-controlled transmitter activation). If VOX is activated (value> "Off"), the transmitter is accessed as soon as the degree of modulation exceeds the value "VOX Level". The transmitter is switched off if the modulation level was below the VOX level for at least the set time.

Caution! The VOX can be switched off directly in the user interface when the "Stereo" button is switched on. This allows a quick deactivation in case of noise (like a telephone call).

- **VOX Level (%):** The VOX threshold can be set as a percentage of full scale. The full level control itself can be adjusted with the microphone level and is indicated by the modulation bar display in the user interface. The VOX activates the transmitter when the modulation bar reaches the set threshold.

Setting a value with "AV" before the percentage will activate an anti-VOX circuit. This always sets the

internal threshold to 99 % when a received signal in the demodulation range (yellow spectrum area) reaches the AGC threshold (setting "Gain Limit"). In the case of receiving a stronger signal the VOX is "deaf" and can only be enabled by a very high microphone level (full scale modulation). If the signal falls below the AGC gain limit (channel free), the VOX works with the set sensitivity.

Note: By selecting the AGC threshold and thus the point at which HF regulation begins, the allowable reception level can influence the threshold of the VOX. If one drives the system gain as high as into the noise, the anti-VOX is almost always active. The higher the AGC threshold, the stronger the signals that may be present in the channel without activating the anti-VOX.

The anti-VOX does not respond when the VOX turned on the transmitter. During the transmission period, the VOX tests microphone signals always to the set level. Only when the sPocket goes back to reception, the anti-VOX monitors the signals in the reception band again and is able to "deaf" the VOX.

In split mode (TX frequency not equal to RX frequency), the anti-VOX can only monitor signals on the RX frequency. Strong signals on a frequency outside the RX band (on the shifted TX frequency) have no effect on the anti-VOX.

- Bandwidth (Hz): Bandwidth of the transmission signal. In FM it represents the cutoff frequency for the modulating signal. Selectable in different levels depending on the operating mode.

Caution! The transmission bandwidth extends for AM and DSB of both sidebands. The highest modulation frequency which will be transmitted is only **half the size** as the set bandwidth range. In case of SSB the transmit bandwidth corresponds to the transmitted **LF-bandwidth**. For CW, the bandwidth setting has **no effect**. For FM, the transmission bandwidth corresponds to a value that results from the set **bandwidth and hub** (see "System" dialog) according to the theory of frequency modulation.

Caution! In an SSB mode, the position of the bandwidth within the LF spectrum is determined by the "SSB Shift" setting within the System dialog! The lowest transmitted frequency therefore results from the value of the SSB shift, the highest LF frequency of SSB Shift + bandwidth. This corresponds exactly to the conditions when receiving an SSB signal. If the value for the SSB shift is set too low, the transmission signal will reach the wrong sideband due to the edge steepness of the filter (approx. 150 Hz for 60 dB attenuation)! At least 100 Hz should be chosen as a shift, so that no strong signal is generated in the wrong sideband.

- **Highpass (Hz)** Highpass filter to block DC voltage and attenuation of very low modulation frequencies. Can be adjusted in different levels. The high pass filter can be set to "Off". The microphone signal is then passed to the modulator inside the transmitter module without any influence. The bandwidth is about 80 Hz - 10 kHz. The bandwidth of the transmitted signal is then only determined by the transmitter filter ("Bandwidth (Hz)" setting).

Note: By bypassing the filter ("Off" level), the transmitted LF bandwidth can be extended slightly downwards. The signal then contains quite low frequencies of a broad-band and frequency linear modulation, for example in the AM or FM mode. For normal voice transmission in SSB radio mode, however, the high pass filter should always be switched on (prevention of low-frequency transmissions in the wrong sideband). The equalizer can then be used to set the frequency response for good speech intelligibility.

- **Equalizer** Slider to influence frequency response. A multi-channel tone control network ("Equalizer") is installed in the microphone circuit. The appropriate frequency range's level can be raised or lowered with the sliders. The bandwidth of each range is designed so that adjacent frequencies can be influenced with a maximum of 3 dB.

Extreme example: All settings to maximum. Then, for any frequency other than the lowest and the highest, an increase of +18 dB is possible (+12 dB boost on their own, plus each of the adjacent frequencies +3 dB). The lowest and the highest channel will have +15 dB boost.

Caution! The equalizer is located behind the ALC in terms of signal flow! An amplification (increase) of the modulation signal can therefore not be compensated by the ALC and can cause overmodulating of the modulator with a hard limitation (distortion) of the signal. In this case unwanted spurious emissions rise over the allowed values of the transmitter! Adjust the settings of the equalizer in the positive range (increase) very carefully!

Note: The settings of the equalizer can be heard via the sidetone, or via the spectrum during opened Microphone dialog. The sidetone does **not represent the bandwidth limitation** according to the

Microphone dialog! The exact transmission signal can only be monitored by self-reception when the setting "RX Delay" in the System dialog is set to 0.

Operation of the test generator

A test generator for the transmitter can be activated within the System dialog. The test generator is installed in the transmitter's modulator. It is activated as soon as a frequency setting of a test signal greater than 0 is present.

The test generator is especially useful to test and calibrate the transmitter. The generated signals have a very high quality (distortion level well below 0.01% THD, SNR > 100 dB) and do not intermodulate with another. While using the SSB modes, the transmitter's intermodulation can be measured with two-tone modulation.

- "AF Level (%)" : Level of the test generator. It affects both frequencies equally. The full output of the modulator is achieved with 100% level, regardless of whether both or only one test signals are activated.

  Note: The various filters in the transmitter have a certain amount of ripple in the passband (0.3 dB). At 100% level, it may come to clipping at certain frequencies. Then decrease the level setting by a few percent points.

- "FM Deviation (kHz)": In case FM modulation is selected (set value "Demodulator" in the user interface), the hub can be set here. The value is for a modulation level of 100%. Depending of the demodulator (FM narrow or wide) both modulation types are stored separately and always used for the modulation of the transmitter. The usual hub settings are 2.5 kHz for FM-N and 75 kHz for FM-W.

- "Frequency Left" and "Frequency Right": Independent frequency settings of the test generator. If set to "0" for both frequencies, the test generator is turned off. The frequencies are added in the transmitter's modulator. If both are active, each signal will be used with only 50% level to avoid clipping. The frequencies can be set in 10 Hz increments up to 1 kHz and above (up to max. 15 kHz) in 100 Hz steps.

Note: The terms "Left" and "Right" have no meaning for the transmitter.

Note: The test generator is not affected by filter settings for the microphone channel. In the FM modes the chosen bandwidth serves as upper limit.

Mode "SBCW"

Besides being able to generate a test signal with the tuning operation ("Tune" button), the test generator has an additional task:

- Generate a sideband signal by pressing the morse key.

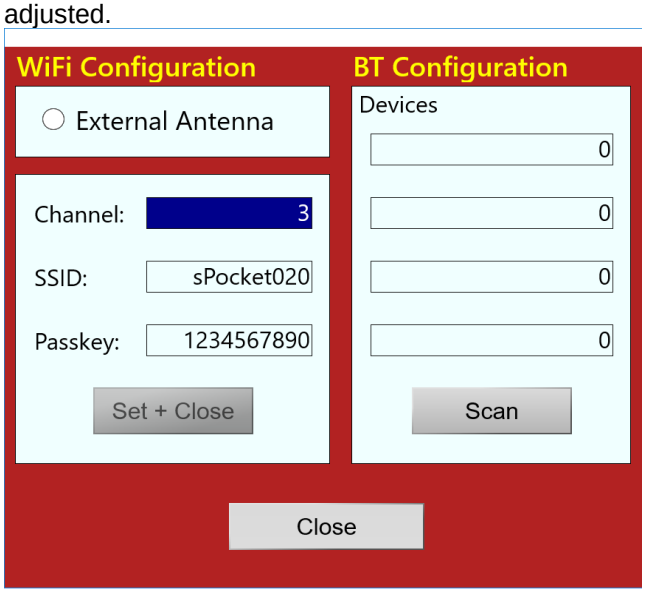
By pressing the PTT in mode "SBCW" normal SSB operation is established (automatic switching of the sidebands at / above 10 MHz). However, with (sole or additional) actuation of the morse key, an audio frequency within the sideband is generated whose level corresponds to the frequency setting of the test generator. The modulation level can be influenced via the level setting of the test generator. It is also possible to activate both frequencies and to generate a two-tone signal within the SSB sideband.

Caution! The generated signal is not subject to the bandwidth limit of the transmission bandwidth (setting "Bandwidth" in the Microphone dialog)! Don't select a frequency setting that is outside of your desired SSB transmit bandwidth!

Caution! If at least one frequency setting of the test generator is greater than 0, the generator signal is also output in tuning mode ("Tune" button) instead of the carrier frequency. **In AM mode the AM carrier will be immediately turned on to full level and will use the generator's signal only as a modulation signal!**

6.4 WiFi/BT dialog

In this dialog, various settings for affecting the network controller of the basic unit and tablet can be adjusted.



The set values have the following meaning:

- External Antenna The basic unit of the sPocket has an internal antenna and a connection socket for an external antenna. Usually the internal antenna is used. You can switch to an external antenna by tapping the set value. Tapping again switches back, etc.

Caution! Before switching to the external antenna, it must be connected to the socket! If no WiFi connection is established after the switchover (also possible when switching to the internal antenna and the tablet is too far away from the basic unit or if the WiFi environment is disturbed), no further operation is possible. Also no manually switching the antenna again!

Note: If the basic unit cannot establish a WiFi connection for more than approx. 6 s, it automatically switches the antenna configuration again. In addition to the set value in the WiFi dialog, the switching status can also be recognized by the text color of the WiFi bar in the user interface (if there is a connection).

- Channel: Radio channel in the 2.4 GHz band on which the sPocket builds its network. The channel can be selected in the European range between 1 and 13. Choose a channel that is used as little as possible by other nearby access points (like wireless routers) and is not disturbed (for example by microwave ovens). The beginning of the band channels 1 -3 and the band end channels 11 - 13 are usually favorable.

- SSID: The name of the generated WiFi network. This always consists of the word "sPocket" and the attached 3-digit serial number.

- Passkey: Password (BSSID) for access to the network. The sPocket WiFi network uses "WPA / WPA2-PSK" encryption. To be able to log in to the network, a client must transmit a password and a network name. The sPocket's password always consists of 10 digits.

Note: Depending on the software development status, the SSID and passkey can be fixed or changed.

- **"Set + Close" button** If one of the 3 network parameters has been changed, the change must be activated in the basic unit and tablet by pressing this button. During the reset of the network, there is no connection between the tablet and the basic unit and therefore no further operation of the sPocket is possible. If the new configuration is successfully established, the sPocket will continue to run as normal. If not, the sPocket tries to connect to the old configuration again. In this case, the new set values have not been accepted and must be changed to valid values and a new attempt started.

Note: Only change the values if absolutely necessary (e.g. switching to a less occupied WiFi channel). Check whether the switchover has really taken place when a connection is established again. The sPocket may still be running with the old values!

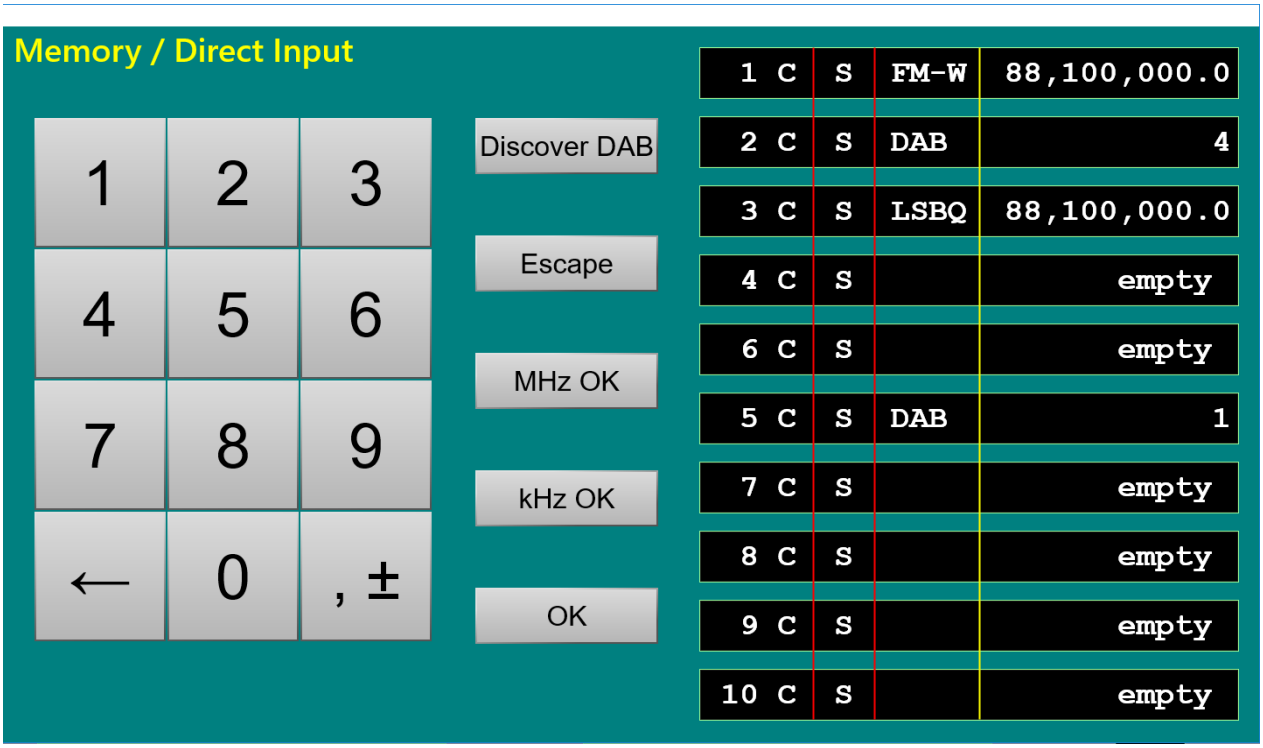
- **Devices** After a scan of the Bluetooth networks in the area, the devices found are entered here.

- **"Scan" button** Detection of Bluetooth devices in the area with which a connection can be established.

Note: The Bluetooth functionality of the sPocket, meaning the devices that can be used to establish a connection and what data transfers can be made, depend on the hardware (tablet) and the level of development of the software. Further information can be found in the section "Special features → Bluetooth".

6.5 Memory dialog

The "Mem/Direct" dialog ("Memory" for short) is used to enter values directly and to manage the memory slots. Direct entry of a value using the virtual numeric keypad always takes place via the set value that is active when the dialog is opened. Almost all values on the user interface allow direct entry. Caution! Some values are not visible after opening the dialog (but the dialog can be moved as described above)!



The right side always shows 10 memory slots as an extract of the freely available 199 slots. This extract window can be scrolled up and down by turning the scroll wheel. The order of the storage locations depends on the set value of the user interface that is active when the dialog is opened:

- RX or TX frequency are active: The list is sorted by frequencies.
- All other values: The list is sorted by slot number (as in the picture above).

Tapping a slot name (demodulator + frequency) closes the dialog and immediately configures the sPocket with the data from that slot.

The slot entries in the memory dialog are separated by a yellow line between the demodulator name and the frequency. If a slot is selected by tapping on the frequency (larger field), the complete device setting is set to the values of the memory. All settings of the sPocket including "minor things" such as volume and brightness or the socket assignment of the microphone and key are restored exactly as they were when you saved this slot.

If, on the other hand, you tap on the demodulator name (smaller field), only the frequency, the demodulator and the bandwidth (possibly with dependent parameters such as shift and notch filter ...) are set according to the memory. All other parameters such as volume or display brightness are retained as they are currently set.

If you tap on the "S" in a line, the current setting of the device is immediately written to the appropriate slot. There is no further warning or consultation! The change of the memory slot is indicated by a violet color. A memory slot always contains all settings that can be changed by the operator, including entries in dialogs, the position of the setting controls, etc.

If you touch "C" or the memory slot number, the data of the memory slot will be completely deleted. Again, without further warning! A deleted slot is "empty" and selecting it has no effect, the current setting of the device is not changed.

Discover DAB button: When the button is pressed, a complete DAB search is started (only devices with built-in FM module).

Escape button: The dialog is closed without any direct input being made.

MHz OK and kHz OK buttons: Direct entries are now recognized as the corresponding power of ten, whereby a maximum of one decimal place can be entered. Especially useful for direct frequency input.

Example:

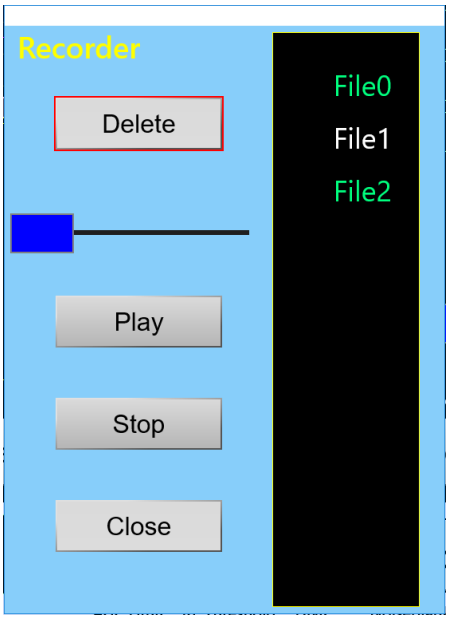
Input sequence "1 → 0 →, → 1 → MHz OK" with direct frequency input results in an adoption of the frequency 10.100.000.0 MHz into the frequency setting. It should be noted that entries that are too large or too small are limited to valid values, or a change to the relevant area takes place (pre-filter automatic mode).

The "←" button deletes the last digit entered or the comma.

OK button: Acceptance of direct input without further scaling. If no direct input has been made (e.g. only the memory slots have been used), the dialog will be closed without any further changes, just as with Escape.

6.6 Recorder dialog

This dialog is used to display and edit the files recorded with the "Rec" button.



On the right side of the dialog, a list of 11 files out of 256 possible files for recordings appears. The list can be scrolled up and down with the rotary encoder. The file names simply consist of the word "File" plus their number in the list. After the number, the file size in the memory is displayed. Free spaces in the list are marked with "empty". Entries are selected by tapping and then displayed in white.

A double tap on the Delete button deletes the selected file. There is no further security question!

"Play" button starts playback of a file. The progress is indicated by the blue controller above the button.

Tapping the "Stop" button cancels the playback process.

As usual in all dialogs, the Close button closes the window.

Note: The files can only be listened to via the "external" speakers, which are built into the tablet. They may have to be switched on first within the Setup dialog.

7. Special features

All device settings and functions described so far are more or less often required for the intended use of the sPocket. However, some functions are rarely or never necessary. These are described below.

The variety of possible settings and operating modes of the sPocket may lead to incomprehensible settings. Switching the device off and on again does not help in this case: All device settings are saved; after switching on, the sPocket is in exactly the same operating state as when it was switched off.

There are several possibilities to set the device to a known operating state:

- The "Undo" function.
- The initialization of a start-up status, called the "Factory setting".
- The complete deletion of almost all software in the device and the re-saving of other (new) software ("Software Update").

7.1 Undo function

Use this function if you have performed only a few operations that have led to an unsatisfactory or confusing setting state of the device. You can return the setting state of the device to one of the last maximum of 28 operating states. Please note the current status of the undo storage ("Undo Level"), which is always displayed on the "Undo" button in the user interface:

The device is currently in state "4".

Now try to define a certain number of operating steps that you think you want to undo. Subtract this number from the displayed undo state, calculating a possible "underflow" to 0 or negative values as a count back to the highest possible value of 28:

Example: Current state 4, desired return of the device setting by 5 operating steps:

4 - 5 = -1 à (0 equals 28) à 28 - 1 = 27.

Tap on the button. A dialog with a setting option for the undo value opens. Set it to the desired undo state ("27" in the example). Close the dialog by tapping the "OK" button. The device is set to the state that existed when the undo state "27" was last seen in the display (i.e. before 5 operating steps).

Note: The undo value is always counted when buttons are pressed (the state of the device is saved again). At any time, you can completely store the device setting by tapping any non-active setting. Remember or write down the displayed undo state if you think you possibly want to reverse the next device setting.

Note: At switch-on the setting of the device is restored to the level displayed when switching it off. If you memorize / note down the value displayed immediately after switching on, you can access this switch-on state until it overflows (i.e. the automatic reuse of this storage space after 28 operating steps).

7.2 Factory setting

Position 0 of the undo function always refers to a non-erasable basic setting (factory setting). When it is called up, the device is set to a basic state with defined set values (such as frequency 81.92 kHz, demodulator SYNC, shift 0, etc.).

Note: You can also use the manually allocated memory slots (see "Memory" dialog) to load defined settings that you have stored yourself in a specific slot. These memory slots are not changed by the undo function or the factory setting.

7.3 Software Update

The sPocket allows its functionality to be changed using the software ("firmware") programmed in the basic unit and the software for the tablet (user interface). Both can be updated at any time.

The firmware creates not only in the usual sense the "software", say specified programs of microprocessors, but also the configuration files used in programmable logic devices ("FPGA" = Field Programmable Logic Array à free matrix of programmable Logic units), thus the existence of complete units such as processors and interfaces within the device (so-called "soft cores").

The user interface (software in the tablet) essentially determines the appearance and the options for user guidance. It has no influence on the actual device properties and the reception / transmission options of the sPocket. No signal processing takes place in the tablet (no "SDR"), with the exception of the transmission of the audio signal to the loudspeaker / headphone jack.

Note: An independent network controller with its own firmware ("WLAN driver") is located in the basic unit. In certain cases, the WLAN driver must also be reloaded and is then explicitly provided with the new firmware of the sPocket and the new software of the tablet.

The version numbers of the currently available software are always displayed below the switch field for the dialogs:

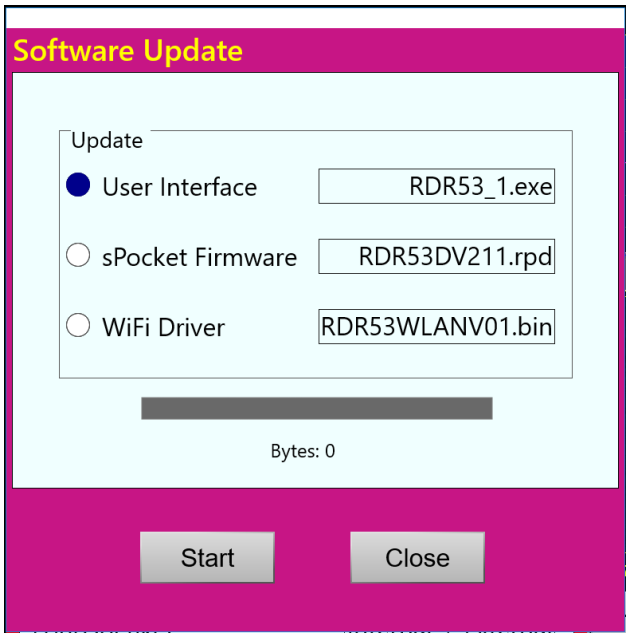
Meaning in the example picture above: (W)**LAN** driver **V81** in device **RDR53** (sPocket) type **D2** with firmware **V201** and user interface **RDR53_3**, **S**erial **N**umber **020.**

New software is downloaded by copying the necessary files from a USB stick that has to be plugged into the micro-USB port of the tablet. Such a stick, loaded with the latest software at delivery, is always included with the sPocket. If it is no longer available, a compatible type must be used: At least 64 kByte storage capacity, formatted on NTFS (Windows file system), connection type USB micro.

The new software must be copied onto this stick. This is usually accomplished by downloading the software from a website and copying the files to the stick using a Windows-compatible personal computer. Old files on the stick must be overwritten. If the stick contains several files suitable for uploading to the sPocket (e.g. an older and a newer version), it is not clear which file will ultimately be used.

Software Upload

To download the software from the stick to the units of the sPocket, the "Software Update" dialog must be opened via the "Setup" dialog:



3 different units of the sPocket can be updated with new software:

- "User Interface": The software of the tablet with the visible user interface (*.exe)

- "sPocket Firmware": The FPGA of the sPocket basic unit with its configuration file (*.rpd).

- "WiFi Driver": The software of the network processor in the basic unit (*.bin).

Updating can be done in any order (unless there is a special instruction when the files are made available!). The desired software part is selected by tapping an entry in the dialog. The operating system then reads the file from the USB stick if a suitable one is found on it. If there are several, the first findable one with the appropriate file extension is used. Pressing the "Start" button starts processing the file. Depending on the file, this process takes different times. The status display (progress bar and count of the transferred bytes) signals the progress. Processing ends with a message about the success or failure of the update.

If the update is successful, there may be further information on the progress, e.g. the request to switch off and restart the sPocket (after updating the user interface). If other software parts are also to be loaded (e.g. firmware of the basic unit), this can be done beforehand (provided no order was specified when the files were made available!). However, this depends on the state of the WiFi connection between the tablet and the basic unit. If the connection is still stable or is re-established after the update (wait maybe 10 s, assessment through WiFi bar display and movement of the spectrogram), you can continue with the upload of other files. Otherwise, a shutdown and restart is necessary first.

If the update is canceled with an error message, the entire process must be repeated. If the WiFi connection remains stable, it is sufficient to close and reopen the update dialog and select the file(s) again. Otherwise, everything must first be switched off and restarted. This is especially the case after a failed update of the WiFi driver, but also mostly after a firmware update has been canceled.

Updates are canceled mainly because of an unreliable WiFi connection. If data is lost, it is always aborted for security reasons. Otherwise, incorrectly loaded software could prevent the operation of the sPocket forever (can only be restarted by the manufacturer). For safety reasons, there is never any erasable software in the basic unit. After the device has been aborted and restarted, a version display may appear in which older versions than the previously installed or new ones are displayed. In this case, the security files that are permanently burned in upon delivery are active.

Please note the following to avoid aborts during the software update:

- Dock the tablet to the basic unit beforehand.
- Set it to use the internal antenna.
- Connect the external WiFi antenna.
- Use a WiFi channel that shows no interference during normal operation.
- Pay attention to a stable power supply of the basic unit.

- Connect the tablet to a charging power source (capacity indicator must be green).
- Do not start an update if the tablet is supplied with battery power (purple display) and the capacity is below 70%.

7.4 DAB reception

The sPocket is equipped with an independent receiver module, which allows the reception of DAB / DAB + broadcasts. No signal processing of the sPocket is used in the process, only the audio output and the operation via the sPocket hardware. Accordingly, almost all functions of the sPocket are disabled, whether spectrum-based or time-based. DAB is a feature largely independent of the sPocket and only integrated to the extent that its functionality is compatible with the sPocket hardware and software.

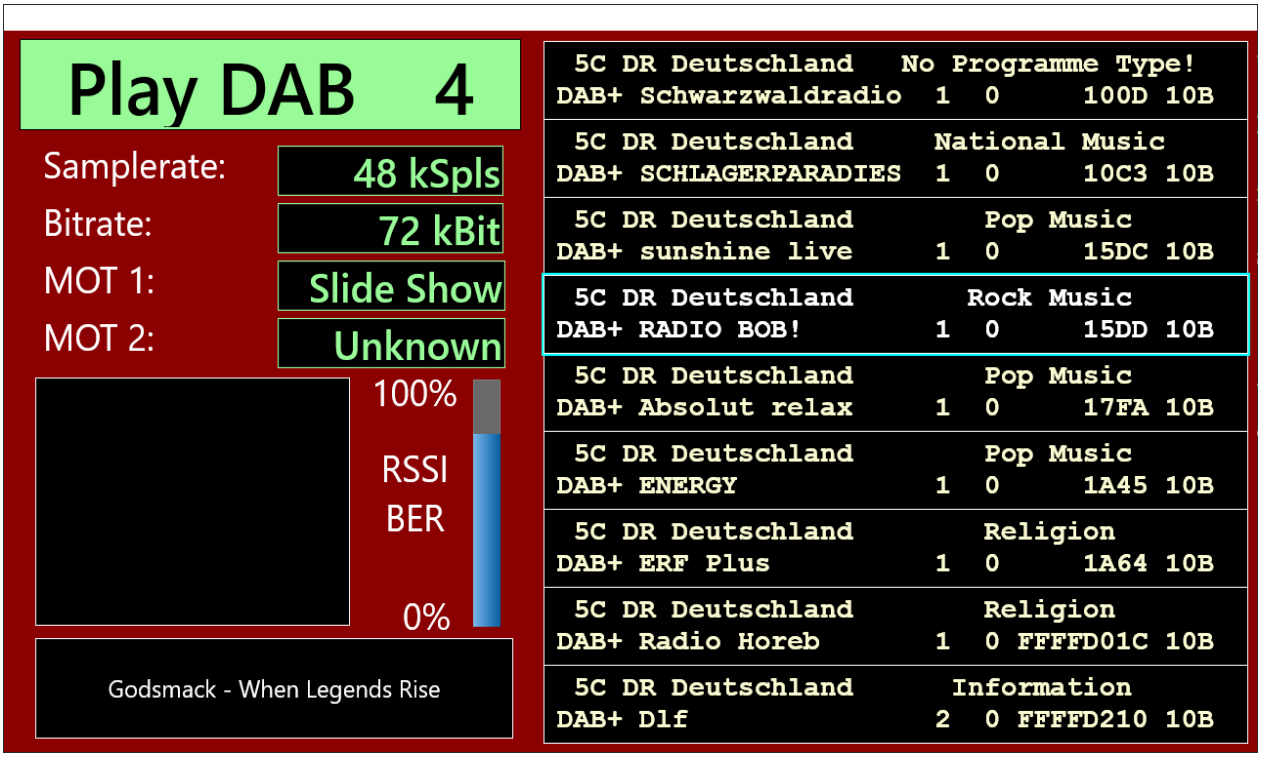
Note: In particular, DAB represents an impairment of the rights to free reception of radio signals because decoding the transmitted data requires the submission of license fees. As a hardware manufacturer, we see this very critically. In addition, the receipt of such programs is only possible with a disproportionate amount of hardware and software, which excludes almost every interested individual user from their own reception options (purchase and use of external devices always necessary). In this sense, from our point of view, **DAB is not a "radio"!** We only support it peripherally because "it's there".

The DAB module is located on the FM extension board behind the first prefilter / preamplifier in the signal path. It thus benefits from the low input noise of the sPocket and allows good reception. However, the prerequisite is always the **connection of a suitable antenna**. A simple telescopic antenna or the like usually only allows the reception of a few transmitters.

DAB or DAB + are digital modulation types. The information is transmitted in the form of bits which are coded, compressed, interleaved and modulated in a variety of ways. The reception of such transmission types differs fundamentally from, for example, AM or FM transmissions. The sPocket has thus (unfortunately) no influence on the quality of the received broadcasts (except in the LF range, which is designed with 24 bit / 81.92 kHz with very high quality in mind).

To receive a DAB (+) station, follow these steps:

- Switch the reception range in the Setup dialog (value "Filter bandpass") to 174 - 240 MHz. Alternatively, you can tune the frequency from 156 MHz to higher values (filter on automatic), or select a slot in the Memory dialog with a saved DAB program, or tap the "Search DAB" button in the Memory dialog.
- The following appears in the DAB dialog: "Search DAB...". You can not receive DAB stations "just like that" indiscriminately. The receiver module first has to compile all sorts of program data. For this purpose, it searches the entire frequency range (band III) for active stations and their program content (transmitted data streams).
- The result is a list of receivable stations and their program content. The display shows the number of receivable programs. If the list contains at least one program, the first program in the list is selected for reception. Otherwise, the message "DAB Failed!" appears.
- No station frequency is displayed, only the program number in the list. There is no frequency tuning. Only the program list can be scrolled with the wheel. A maximum of 256 programs are possible. If the number is lower, the corresponding places in the list will be empty.
- A program can be selected by tapping the list entry. The list entry is then surrounded by a light blue frame. To the left of the list are some more information about the selected program.



The program of a station is not always audible. For this 2 further requirements must be met:

- The program must transmit an audio stream. Programs with pure data services are not audible.
- The reception quality must be sufficient to be able to demodulate, decode and decompress the program ("RSI/BER" indicator bar at least 1/3 blue).

Especially the last case can cause unpredictable dropouts, fragmentations or total failure of the program due to fluctuating reception conditions. Borderline conditions result in peculiar distortions similar to the audio "quality" of mobile phones in poor connection. Therefore, ensure stable reception with a good antenna and by locating the sPocket in a low-noise environment.

The 2-line entries in the program list contain various information. These are (order from upper left row to lower right row):

- Channel number from 5A to 13F.
- Name of the ensemble (the "multiplex", the summary of various programs on a station).
- Program type (same name as RDS program type on FM).
- Service type: DAB, DAB+, DATA or DMB. Only DAB and DAB+ are receivable.
- Program name.
- Service component number.
- Service component ID.
- Service ID.
- Ensemble ID.

To the left of the list, the following information is available, each updated for the selected program:

- Sample rate of the audio signal: 24, 32 or 48 kHz.
- Bit rate of the compressed data stream: The higher the value, the lower the compression factor / higher the audio quality.
- Quality of the data stream from 0 - 100%: The display is based on an internal calculation of the bit error rate. 100% quality = no errors, 0% = no data decodable. Values of less than approx. 60% result in dropouts in the audio signal. Below about 30%, nothing is audible.
- MOT 1 / 2: Type of multimedia data sent. Possible are: Sl(ide) Show (SLS), BWS, TPEG, EPG, DGPS, TMC, Java, DMB, Push(Data), Journal(ine) or unknown.

To evaluate the MOT data, additional decoders are required. Depending on the software version or type and equipment of the sPocket, these can be supplied or additionally installed. Depending on the MOT data type, the decoded data appear in the black window to the left of the program list (e.g. as a picture or as text).

Below the MOT window, the program text of the selected program is displayed, if available (transmitted).

As long as the sPocket is operated in DAB mode, the other functions are blocked. However, these can be opened and operated via the area with the buttons for the dialogs. In particular, the termination of DAB reception is possible by entering a frequency outside of DAB, selecting a memory slot or switching the RF filter to another area.

Note: When a DAB program is called from another frequency range, a new DAB scan only starts if no scan has been performed since the device was switched on. Otherwise, after initializing the DAB module (about 2 s waiting time), the program with the stored list number is chosen immediately. If the sorting has changed in the meantime (for example, because the device can now receive other stations), the program is not correct. Afterwards, perform a new DAB scan manually (button in the Memory dialog).

7.5 Activation of additional features

Certain additional features such as broadband spectrum, FM filter or increasing the spectrum resolution can be activated regardless of the software installed or updated later when purchasing. To activate one or more options (subject to a charge), a specific code must be entered in the frequency entry of the Memory dialog. This code only ever applies to a specific device with its permanently burned-in serial number. This means that the activation is permanently linked to this device and can never be deleted (except from the manufacturer).

The code must be entered as a direct RX frequency entry with a comma before the last digit and confirmed with "MHz OK". If it fits the device and has been unlocked by the manufacturer, an "OK" message appears. After switching the sPocket off and on again, the corresponding option(s) can be used.

8. Specifications

Frequency range (version C/D 1):	0 - 30 MHz, 50 - 71 MHz
Frequency range (version C/D 2/4):	0 - 30 MHz, 50 - 71 MHz, 87.0 MHz - 110.0 MHz, 130 - 156 MHz, 174 – 240 MHz (only DAB reception)
Frequency adjustment:	Rotary encoder with increments of 0.5 Hz to 999.999.5 Hz, direct input via virtual keyboard, via touchscreen
Frequency deviation internal oscillator:	<± 5 ppm min after 10 min, internal manual calibration
at active GPS with at least 7 satellites:	<± 0.024 ppm in the set status
Input impedance:	50 ohm, 0 - 71 MHz can be switched to zero or high impedance
max. processable input level	<= 71 MHz: -3 dBm, with attenuator: up to +22 dBm
max. processable input level	> 71 MHz: -27 dBm, with attenuator: up to -2 dBm
Level of inaccuracy:	<= ± 3 dB
Inherent noise (MDS) <= 71 MHz:	<= -163 dBm/Hz
Inherent noise (MDS) >= 87.5 MHz <136 MHz:	<= -170 dBm/Hz
Inherent noise (MDS) >= 136 MHz:	<= -167 dBm/Hz
Intermodulation distortion <= 71 MHz:	IMA3 >= 82 dBc, 2x -12 dBm at 10 MHz
Intermodulation distortion > 71 MHz:	IMA3 >= 66 dBc, 2x -34 dBm at 100 MHz
(each approx. 2 dB below ADC limitation, ATT/GAIN = 0 dB)	
Filter bandwidth (SBSP):	10 Hz - 20.4 kHz depending on settings
Filter bandwidth (time-based):	125 Hz - 20 kHz depending on settings
Stereo crosstalk:	>= 80 dB, 0 ... 15 kHz, bandwidth 300 kHz HQ
Audio output:	Headphone: Stereo DAC 24 bit, max. 1.5 Vrms on 32 ohm speakers: D amplifier, max. 2x 0.7 W to 8 ohm
Memory slots:	28 for undo function, 199 freely assignable
Display:	TFT 10.1" (25.6 cm) 1920 x 1200 pixels
Connectors:	SMA socket for receiving antenna, SMA socket for GPS antenna, SMA socket for WLAN antenna, 3.5 mm stereo jack sockets for headphones, microphone and morse key, hollow pin 2.5 mm pin for charging current
Power supply:	7.5 - 14.5 V / max 25 W
Size (width / height / depth):	260 mm / 177 mm / 28 mm
Weight:	max. approximately 2.0 kg, depending on the version / equipment
Operating conditions:	0 ... +35 °C ambient temperature, <= 99% rel. non-condensing humidity, IP 40, pollution class 2
Compliance:	CE according to DIN EN 55013, EN 55020, EN 60065 (Consumer electronics and related equipment), RoHS / WEEE Directive, ear-Reg. 27676700

All specifications are subject to change during the course of technical development!

9. Brief introduction to SBSP

The SBSP "Spectrum Based Signal Processing" is a novel principle in the processing of radio signals. This principle has long been known in measurement tech as well as commercial, military and space applications and is used for various applications, for example:

- Spectrum analyzers
- Digital telecommunications networks
- Sonar equipment
- Radio astronomy
- Broadband radio monitoring

Furthermore, is also used in the private sector in the form of SDRs "Software Defined Receiver". In this case, a PC attachment receives the RF signals and, where appropriate, converts them into digital signals and forwards them to a PC, or feeds the analog signals into the sound card of the PC. Software running on the PC then takes over the function of the receiver by "simulating" the usual analogue processing stages as a program sequence on one (or more) powerful processors.

All these "SDR" applications share the following characteristics (with rare exceptions):

- Using the FFT algorithm to transform the time-based data ("oscillogram") into frequency-based data ("spectrogram").
- Use of spectrograms only for measurements and visual representations.
- No use of the spectrograms to directly process the modulated information (filtering, demodulation, audio generation).

The latter does not apply to special modulation processes (e.g., digital voice transmission in telecommunication networks) which have been developed specifically for the use of the FFT algorithm.

All other common "analogue" modulation types like AM, SSB or FM are not processed spectrum-based. The reasons for this are, among others:

- High effort for simultaneous application in measurement / image display and signal processing.
- Missing software (programs to imitate the analog principles are freely available, proprietary software development for SBSP is complicated, time-consuming and expensive).
- **The FFT algorithm is NOT SUITED for good results.**

Since the FFT is otherwise used everywhere, the last statement should be briefly clarified. "FFT" is a binary calculation rule ("algorithm") optimized for the digital execution in clocked systems ("processor"), which performs the mathematical process of the Fourier transformation of a signal of specific length (duration). The execution of this "analogue" transformation (consisting of a theoretically infinite variety of signal states) based on discrete (finite amount) digital samples of the signal (the samples from the ADC) leads to significant limitations in the achievable results.

This is similar(!) to the well-known Nyquist theorem: A signal can only be uniquely (re)produced if its bandwidth is less than half the sampling frequency. For the FFT one could say: It is only possible to calculate a unique spectrum from a certain number of samples whose resolution reaches at most the reciprocal of the signal duration (number of samples times sampling period). For example, to get a spectrum with a resolution of 1 Hz (the distance of the spectral lines, i.e. the smallest possible separability of two frequencies), a signal duration of at least 1 s is necessary. Or in other words: At 1 Hz resolution, you can only get a unique spectrum once per second.

In addition, there are further limitations (disturbing artifacts) such as side resonances ("Leakage") or level errors of the spectral lines ("picket fence effect"). All this makes the FFT unusable for direct signal processing of analogue modulations. Experiments have shown that for a usable signal quality resolutions of the spectra of at least 10 Hz are required. Experienced ears can hear even 1 Hz difference at higher frequencies. On the other hand, (apparently) continuous tone generation requires a spectral rate of at least 50 S/s (spectra per second). That compares most fittingly with image processing. There, too, the eye sees individual images only at about 50 Hz as a continuous movement.

In order to be able to use the advantages of SBSP nevertheless, another algorithm than the FFT must be used. The sPocket uses a scalable time-frequency transformation that works 4 times faster than the FFT. In the example, error-free spectra with 1 Hz resolution could be generated from a signal duration of 0.25 s. Or 10 Hz resolution with 40 S/s, 20 Hz with 80 S/s etc. This roughly corresponds to the requirements for a

sufficient signal quality.

Thus, this algorithm can be used for signal processing (filtering, demodulation) in devices that do not require Hi-Fi audio quality (hand-held radios, amateur radios, simple AM radio receivers, etc.). It offers enormous advantages in terms of selectivity and flexibility (fine-tuned and far-reaching parameter adjustability and easy implementation of additional functions such as notch and noise filters).

However, it is not (yet) applicable for direct signal processing of FM-modulated signals. This would require much higher spectral rates with much higher resolution. An issue for the future. The sPocket's filtering and FM demodulation is therefore carried out conventionally in the time domain on the basis of individual samples.

However, the SBSP can also be used advantageously in the stereo decoder and in the RDS decoder. Here, the most popular use case is the processing of narrowband signals without high data rates (with the exception of the difference signal).

Stereo decoder

The task of the stereo decoder is actually not decoding, but a demodulation. The difference signal present in the MPX signal in the form of a two-sideband modulation with suppressed carrier at 38 kHz must be demodulated and offset with the sum signal. This then results in the left and right audio channels.

The main problem is the absence of the carrier (called "subcarrier") for AM demodulation of the difference signal. Instead, the so-called pilot tone is contained in the MPX signal (always clearly visible in the sPocket's MPX spectrogram). Its frequency is exactly half of that of the necessary subcarrier and its phase (time of zero crossings) corresponds exactly to that of the necessary subcarrier. This can therefore be generated ("regenerated") from the pilot tone.

The exact regeneration of the subcarrier in terms of frequency, phase and amplitude is essential for the accuracy of the difference signal's demodulation and thus the quality of the L / R stereo signal. (Of course, the exactness of the demodulation and the difference signal itself, too. The latter is strongly dependent on the filter and FM demodulator.)

All current regeneration methods produce more or less strong errors of the 3 parameters. They mainly result from having to work on different frequencies (19 kHz → 38 kHz, mixing to 0 Hz) and using different filters (bandpass, lowpass). These introduce deviating phase and amplitude responses. A digitally operating system can avoid some of these errors. Above all, they are constant and predictable and therefore can be stably corrected by compensations.

The sPocket's SBSP operation allows differential signal demodulation without any artificial regeneration of a carrier signal. Only the original pilot tone is required. The pilot tone can advantageously be taken out of the SBSP in extremely narrow band and with very low noise. It represents "only" a single spectral line that should be used. Everything else around it is simply omitted (numerical selection principle instead of filter specifications).

Furthermore, the "spectral line" pilot tone is no longer a specific frequency, but a so-called IQ signal (mathematical signal in the form of complex numbers) with the target frequency 0 Hz. Also, the difference signal can be taken from the SBSP so that its center is around 0 Hz. (In contrast to real signals, IQ signals can represent negative frequencies, so the lower sideband is negative, the upper positive is around zero.) Thus, both signals match without subcarrier generation and are already demodulated. Only the phase synchronization remains, which is performed as a simple phase shift of the differential signal depending on the phase of the pilot tone.

The amplitudes also match exactly due to the relative level accuracy of the SBSP of the sPocket (± 0.1 dB) and to the sum signal. A correction of the absolute values can be carried out easily and stably. This makes channel separations over 80 dB achievable. Incidentally, at this point, the base width adjustment is made. Only the level of the difference signal is changed from 0 to 200%.

RDS decoder

The RDS decoder operates similar to the stereo decoder in its first stages. Again, a demodulation ("mix") with a non-existent subcarrier is necessary again, this time at 52 kHz. As with the stereo decoder, the spectral line of the pilot tone is used immediately and the RDS sidebands are taken from the SBSP in the correct frequency, phase and amplitude. The subsequent stages correspond to the usual decoding of the

RDS data with error correction.

The sPocket's RDS decoder allows one wrong bit per block. This enables a fast response of the decoder (DX operation). However, occasionally erroneous characters appear at a too low signal-to-noise ratio.

A disadvantage of the SBSP in conjunction with the RDS decoder is the necessity of the pilot tone in the MPX spectrum. RDS signals from stations that do not transmit a pilot tone (i.e. that only transmit in mono) can not be demodulated. However, these are very rare cases.

10. Exciter

The sPocket can be equipped with a customizable signal generator ("Exciter"). It is located on the circuit board of the FM / DAB receiver in the basic unit.

10.1 Overview

The Exciter consists of a digital sine generator according to the DDS (Direct Digital Synthesis) principle, a quadrature modulator and a DAC for converting the digital values into an analogue output voltage. It can generate all modulations (except DAB) that can be received by the sPocket in broadband and high quality. The modulation can occur by an internal test generator or by the microphone signal. Sampling with the manual button is also possible (CW operation). In conjunction with an external power amplifier, the exciter can be used as a transmitter.

10.2 Technical data

Frequency range:	0.1 MHz – 156 MHz
Output power max. (at 50 ohms, PEP):	+20 dBm ± 1 dB @ 0.1 - 20 MHz almost linearly falling to +12 dBm @ 120 MHz +12 dBm ± 2 dB @ 120 - 156 MHz
VSWR (at 50 ohm real):	<= 1.5
Upper / secondary wave attenuation to 50 MHz:	>= 60 dB
Upper / secondary wave attenuation from 50 MHz:	>= 60 dB
Intermodulation third and higher order: (fmod 1.0 kHz + 1.5 kHz, @ 7.1 MHz @ 5 W PEP)	>= 60 dB (PEP)
Modulation types:	AM, DSB, SSB, CW, FM-N, FM-W
Modulation bandwidth:	1.8 ... 9.6 kHz depending on the operating mode
Rise / fall time RF signal (SSB / CW / FM):	0.1 ... 9.9 ms selectable
Delay PTT / Key à RF Out:	2 ... 255 ms selectable
OFF PTT / Key à RF Out:	< 1 ms + release time
PTT muting delay / Key off à RX:	0 ... 630 ms selectable
Shift TX / RX frequency:	Freely adjustable TX frequency
VOX holding time:	OFF, 10 ms, 250 ms, 500 ms ... 2500 ms
Squelch / Anti-VOX:	From -82, ... -34 dB adjustable
ALC:	0 (off) ... 100% action set
Limiter / compressor:	100% (off), 50%, 25% modulation

Special features:

- CW keying possible with VOX (setting 10 ms)
- Combined SSB / CW (SBCW) with the possibility of sending CW in SSB sideband
- Adjustable FM hub
- Two-tone test generator with adjustable frequency and level
- Internal transmitting / receiving switchover with time sequencer for external PA
- Equalizer and adjustable sidetone for microphone channel
- Dynamic compressor / distortion-free limiter

10.3 Operation

The exciter can only be operated with the user interface beginning from version 400.

The exciter can be switched on via PTT, Key, tune or VOX if its transmission frequency is within the permissible frequency range. The PTT, key and VOX signals are generated via connected switches or the VOX function. The Tune signal can only be generated using the virtual button of the same name if the active set value within the user interface is the RX or TX frequency.

Tuning mode "Tune"

The tuning function is triggered by pressing the "Tune" button. The exciter is then switched on with 0% modulation and minimum power. It generates a CW carrier at the set frequency.

Caution! If the test generator is activated (a test tone with a frequency greater than 0 is set), a carrier with ¼ of the power set in the "System" dialog is generated in AM mode! In modes without generating a carrier, a signal will be created with the test frequencies as modulating frequencies.

The "Mod" bar graph now serves to set the transmission power (or the degree of modulation when the test generator is active). The transmit power can be varied; the modulation display shows the set value from 0% (minimum possible power) to 100% (according to power setting in the System dialog). As long as the tuning function is active, no other setting can be selected (except switching between RX and TX frequency). Pressing the Tune button again ends the tuning function and the device returns to normal operation.

Via the callable dialogues (see section 6. "Dialogs") the exciter and the microphone input are can be configured within wide limits. In normal transceiver operation with alternating RX and TX phases, the transmitter is switched on either by the signal "PTT In" or "Key In" (switch on a connection of the jacks "Mike" or "Key"). In addition, the transmission mode can be triggered by a VOX (automatic switching, which is controlled by the level at the microphone input).

Caution! In contrast to conventional designs, the sPocket enables the transmission frequency to be adjusted at any time within a very large tuning range (even while a program is currently running). Always make sure that the broadcasts are in a permissible range in accordance with the applicable regulations!

The fact that the exciter can be freely tuned at any time simplifies its use as a signal generator for measurement purposes. The "Tune" button can be used as a permanent switch (modulation / test signals must be selected beforehand). During transmission, you can switch between reception and transmission frequency and both can be tuned independently of each other.

12. Tips and tricks

Below are some hints and more in-depth descriptions for using the sPocket.

12.1 CW operation

In CW operation, the sPocket offers a number of setting options. The different variants and associated functions of the sPocket will be explained in more detail below.

Basic information

The sPocket offers three independent demodulators for receiving (and for devices with exciter also transmitting) morse codes, hereinafter simply called "CW operation":

- "CW": Spectrum-based directly at the set frequency with adjustable pitch (CW shift).
- "SBCW": Spectrum-based as adjustable tone in the sideband (LSB < 10 MHz, USB from 10 MHz).
- "DIGI": Time-based with adjustable storage at the set frequency.

Each of the demodulators has its own characteristics. They will be explained in more detail below. Fundamentally, the properties of the respective signal processing also apply:

- Spectrum-based: Fine tuning of bandwidth and its shift, extremely high selectivity, auxiliary tools such as notch filters, noise reduction, noise blanker and mute / squelch available, higher signal throughput time, low signal distortion possible.
- Time-based: Few levels for bandwidth available, moderate selectivity, sometimes coarser frequency settings, no helper tools, very low signal turnaround time, very low signal distortion.

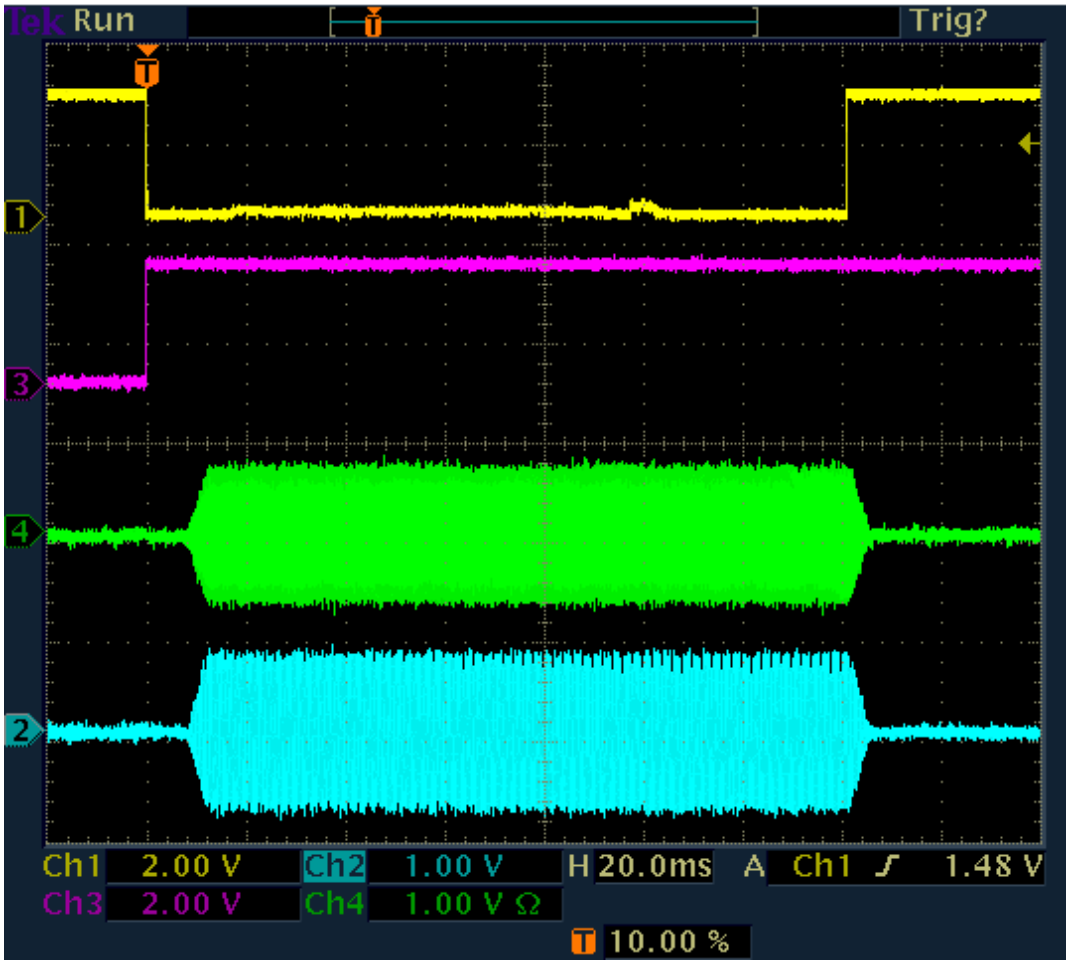
Just these properties can decide the choice of demodulator, for example, if a low signal propagation time is required (DIGI) or a high selection against adjacent channel interference (CW / SBCW).

CW operation at the sPocket is always carried out with a single-pole morse key. It must be connected to a freely configurable connection of one of the KEY or MIKE sockets to the ground of the socket (see also "System" dialog). An internal keyer does not exist. The selected connector must be assigned the signal "KEY In" in the TX dialog. If an external PA is connected, a connector should also be assigned the signal "PTT Out" and connected to the PTT input of the PA (**Attention!** A level converter is usually necessary!). Thus, the internal timing can be used as described below.

Time behaviour of the signal generation

The generation of clean signals with well defined and not (noticeably) fluctuating delay times is essential for efficient CW operation. The picture below shows the basic procedure when generating a single CW pulse. The assignment of the signals to the oscillograms applies from top to bottom as follows:

- PTT In (yellow): The signal at the input, generated by the contact of the morse key (low-active).
- PTT Out (red): The PTT output signal for controlling the PA (high-active).
- RF Out (green): The high frequency signal generated at the antenna output.
- Audio Out (blue): The audio output to headphones and speakers.



A CW pulse

The generation of a CW pulse (dot or dash) starts when the key is pressed (yellow line goes from high to low). At the same time, the PTT signal is activated for an external PA (red line from l to h). At the same time, the receiver (RX) of the sPocket will also be muted.

The generation of the RF pulse (green) starts after the time "Delay RF ms" has elapsed (System dialog, set to 10 ms in the picture). At the same time, an audio signal is generated (sidetone, blue) if the sidetone is activated in the Microphone dialog. Both signals are increased from 0 to the defined levels in a linear "ramp" (rising edge) (setting in System dialog, value "Risetime RF", here set to 4 ms). The signals are generated as long as the key is pressed.

After releasing the key and a short debouncing time (about 0.5 ms), the signal generation ends. The levels are again reduced to 0 in a linear ramp.

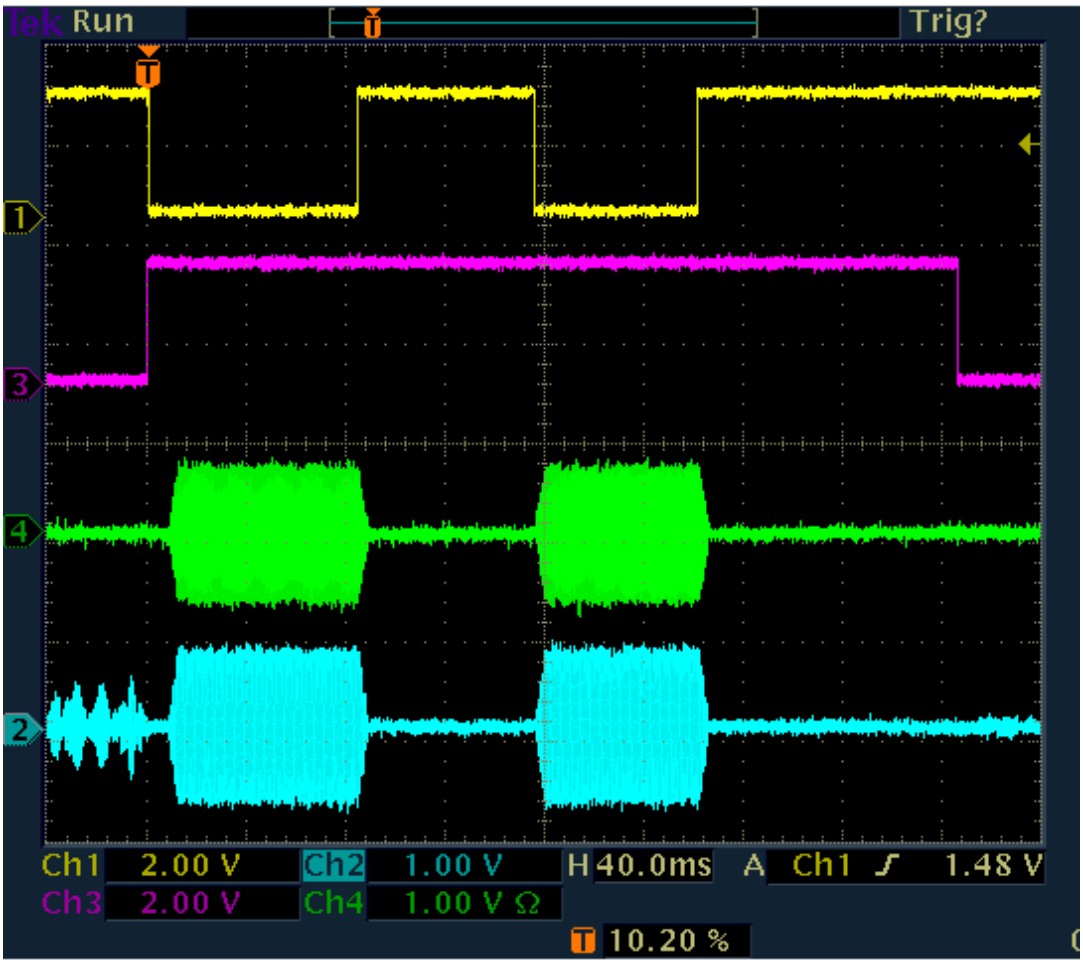
The PTT Out signal remains active for a while, at least until the end of the signal edge (key on h + debouncing time + signal edge duration).

It is still active in the example (end not visible). The additional time corresponds to the setting "RX Delay ms" in the System dialog. For this time span, the receiver is also kept muted. The meaning behind this is the suppression of audible remnants of the own transmission signal due to the signal propagation times and the transient effects of spectrum and control.

When PTT Out goes low again (inactive), the PA is turned off and the RX is re-engaged. If the RX Delay time is set long enough, the RX will not receive any signal and the control will return to the level at the time of muting (or possibly higher, if higher reception levels occurred in the meantime). This means that the RX has full sensitivity immediately after switching off the PA (or switching the antenna relay).

CW character sequence with RX Delay ("semi-BK")

Usually, not just a single dot or dash is sent, but a more or less continuous sequence (complete letters and words).



Sequence of CW pulses without "intermittent listening" (RX Delay> character pitch)

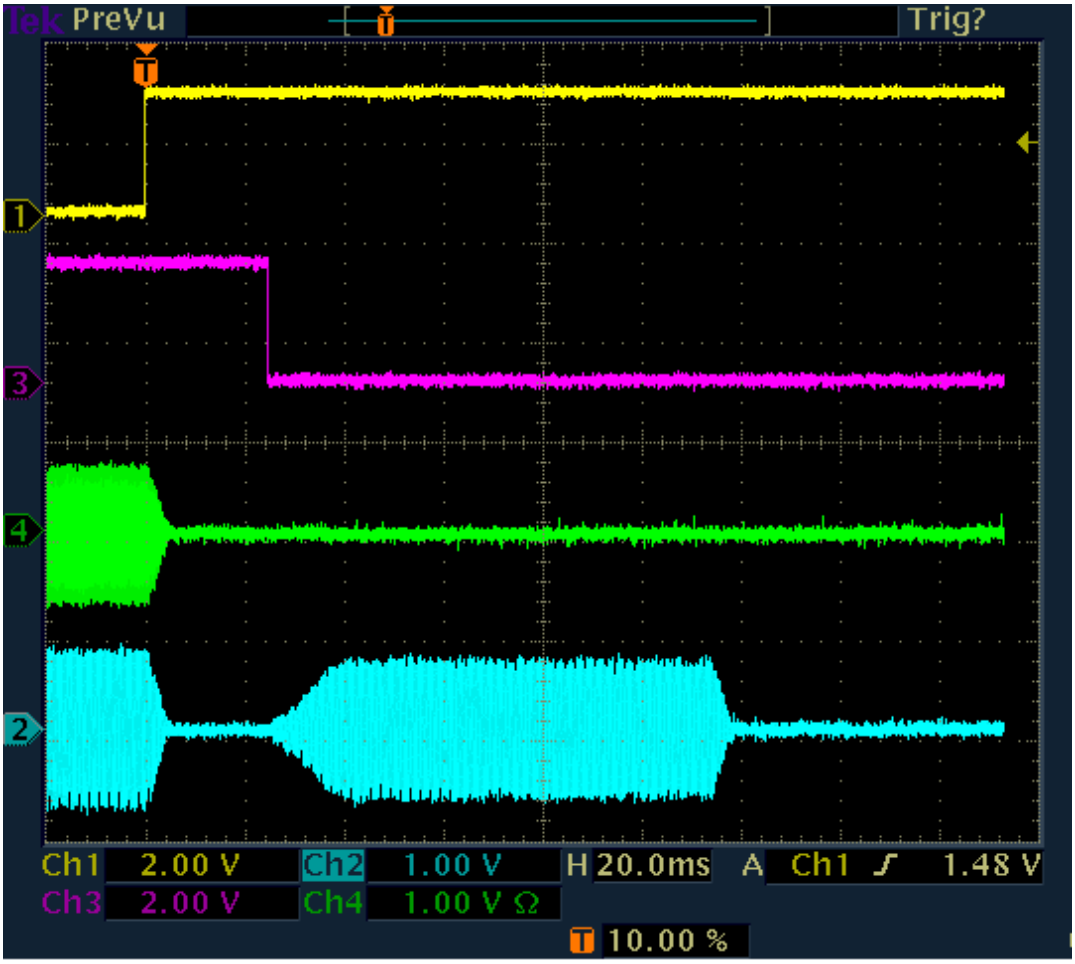
Whereas: As long as PTT Out is active, the signal is generated immediately with KEY In. There is no time lag "Delay RF" between key and signal generation. Thus, the RF pulses (and the sidetone when active) follow exactly the keystrokes.

Only when PTT Out has dropped and then / again a keystroke occurs, the RF delay is again "integrated". It follows: **Compared to the keystroke, the first impulse is always shortened by the time "Delay RF"! All the following impulses are exactly correct.** If the first impulse is also to be largely accurate, the Delay RF must be set very small (at least 0.1 ms are possible).

Caution! The delay time "Delay RF" between PTT Out and the onset of high frequency generation protects the PA (transfer relay). It must not be too short (please note the PA's specifications)!

Throughout the complete character sequence, the PA stays switched on and the RX mutes as long as no pause is greater than the "RX Delay" time.

If the RX Delay time is set very low, the PA shuts off between the characters and the RX is engaged. Depending on the other settings, a more or less long reception of your own transmission takes place. The onset of reception and the duration of self-reception are mainly dependent on the cycle time of the selected demodulator including the filter.



Self reception of the broadcast with a short RX Delay

In the example, RX Delay is set to 20 ms (1 raster unit). 20 ms after the end of the pulse edge PTT Out drops and the RX becomes active again. It reproduces the self-received transmission signal stored in the signal path. Playback ends after the signal propagation time of self-receipt through the entire receiver block.

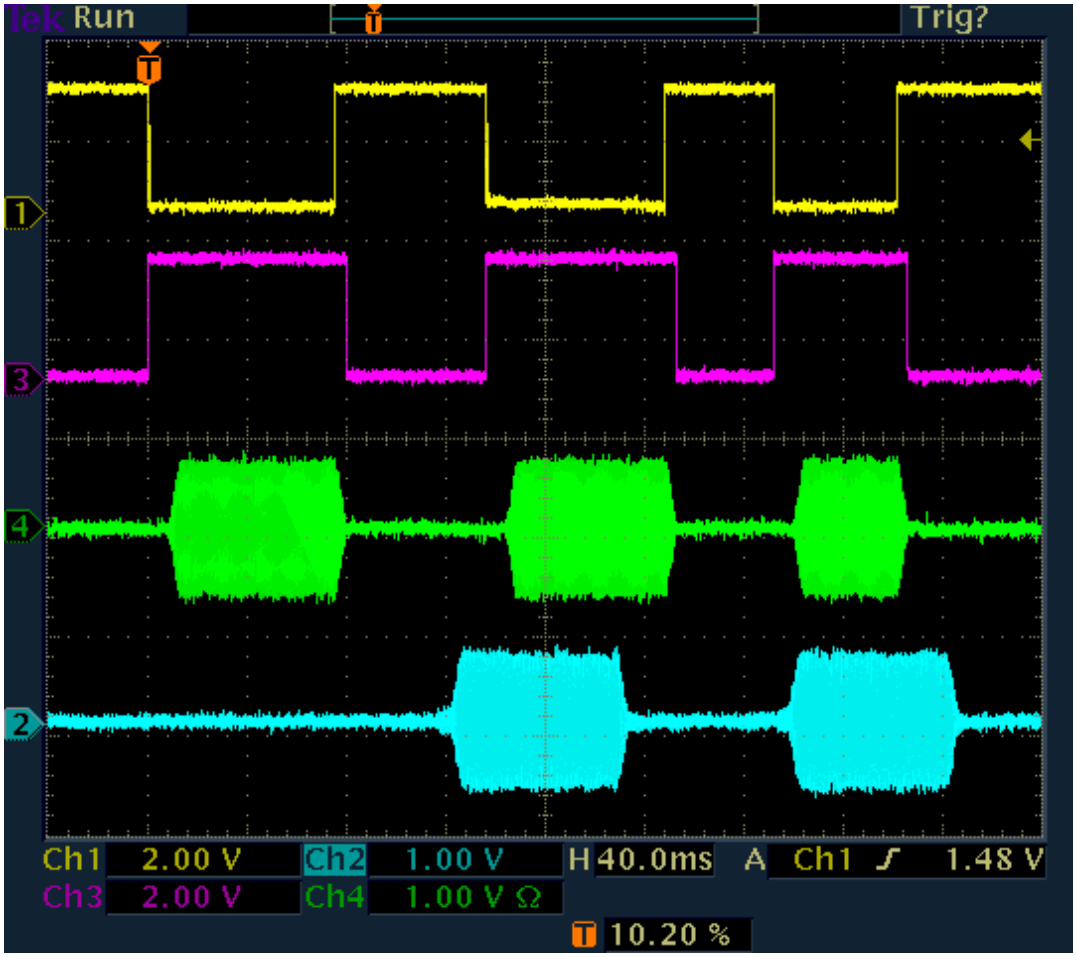
In the example, the propagation time is about 115 ms (end of RF transmission until the end of playback of the RX). This is a typical value for the spectrum-based demodulators when setting the audio resolution (Setup dialog) to 20 Hz. At 40 Hz, the time is reduced, at 10 Hz it is longer.

The self reception possibly conceals received signals. Particularly disturbing is that it also sets the control on the value of the self-reception level. This is usually higher (corresponding to the blocking attenuation of the TX / RX switching) than weak received signals. Depending on the control setting (speed), the receiver therefore takes a while to again possess full sensitivity for weak received signals.

You should always set the RX Delay to at least as long as the self reception passes through the RX block, so in the case shown to 120 ms. Then no own signal (disturbing) is audible or drives the RX to low sensitivity by modulation of the control.

CW character sequence without RX Delay ("full-BK")

In the extreme case RX Delay = 0, the sPocket never mutes the receiver. It remains active during the entire duration of the transmission (PTT Out to high level). Thus, a self reception of the transmission is always present. It also does not start until after the end of the broadcast. Instead, the RX always returns a complete picture of what happened at the antenna connector (own signal attenuated). The signal propagation time within the RX is of course retained and thus determines the meaningfulness of this operating state.

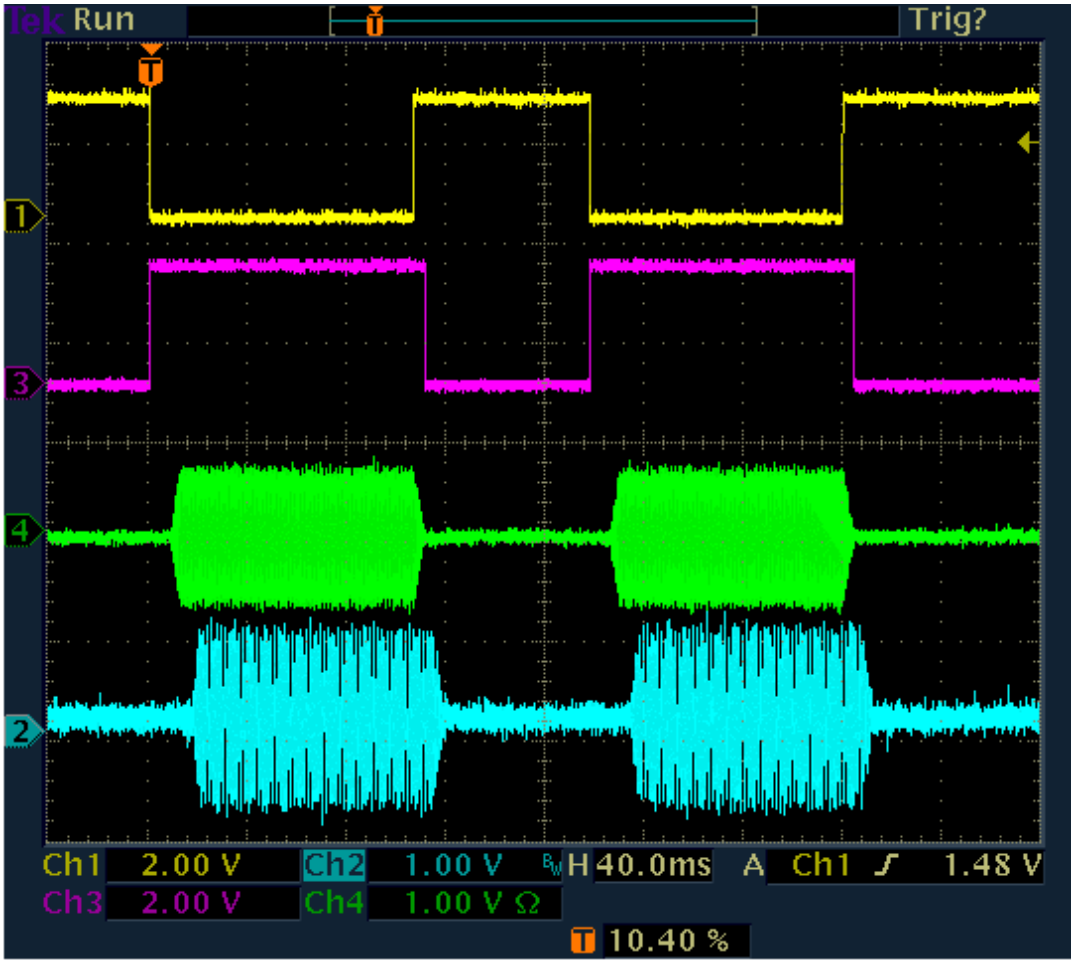


Full-BK for spectrum-based demodulators

Because the RX is always active, no sidetone (if set) is generated. So you only hear the (delayed) own transmission and the received signals, if strong enough (control always adjusts to the level of self reception). In the picture above, the RX cycle time is in turn approx. 115 ms.

Caution! At full-BK, all characters are always shortened by the time "Delay RF".

The picture below shows the full-BK operation with time-based demodulator (DIGI). Here the signal propagation times are much shorter. They depend on the filter bandwidth. It is 500 Hz in the example, resulting in a propagation time of approx. 7.5 ms. When increasing or decreasing the bandwidth, it decreases or increases approximately reciprocally (at 250 Hz for about 15 ms, etc.).



Full-BK for time-based demodulators

In the case of full-BK with DIGI, setting the control to the self reception level may be annoying. If the other received signals are much weaker, they are barely audible. You should choose semi-BK with very low RX Delay (and sidetone) in this case. The RX is then indeed disabled during the transmission and shortly thereafter, but immediately after a (very short) RX Delay fully sensitive again.

Comparison of demodulators suitable for CW

CW:

- Functionality according to the pictures for operation with spectrum-based demodulator.
- Pitch on reception and sidetone on transmission directly result from the set value "CW Pitch".
- The transmission frequency always equals the set TX frequency.
- Throughput time is longer, depends on audio resolution (Setup dialog).
- Extremely narrow and steep-edged bandwidths down to 10 Hz can be realized.
- DNR, NB and notch filter available.
- "Absolutely noiseless" reception by setting the demodulator threshold between noise and received signal possible.
- Temporary (as long as settings are not changed) CW-Shift independent monitoring tone possible if keying with input "PTT-In" instead of "KEY-In" and setting the desired tone for "Freq L" in the Setup dialog.

SBCW:

- Functionality according to the pictures for operation with spectrum-based demodulator.
- Pitch on reception results from storing the received signal towards the center of the display ("SSB mode").
- Sidetone during transmission results from the "Freq L" setting in the System dialog.
- The transmission frequency always equals the TX frequency ± Freq L (thus in the lower or upper SSB sideband).
- A two-tone signal can be sent (Freq L **and** Freq R > 0).
- Throughput time is longer and depends on audio resolution (Setup dialog).
- Bandwidths according to the set SSB bandwidth.

- DNR, NB and notch filter available.
- "Absolutely noise-free" reception possible by setting the demodulator threshold between noise and signal (if no SSB signal is present).

DIGI:

- Functionality according to the pictures for operation with time-based demodulator.
- Pitch on reception directly results from the set value "CW Pitch".
- Sidetone during transmission results from the "Freq L" setting in the System dialog.
- Transmitting frequency equals the TX frequency plus Freq L minus the CW pitch.
- A two-tone signal can be sent (Freq L **and** Freq R > 0).
- Pass-through time is short and depends on bandwidth.

The frequency of the transmitted signal with DIGI depends, among other things, on both the CW Pitch and the selected audio test frequency (similar to SBCW). In order to transmit exactly on the set TX frequency, the CW pitch and Freq L must be exactly the same. CW Pitch (change of the receive pitch) or Freq L (change of the sidetone pitch) can be used as "XIT" for exact pitch tuning to the frequency of the QSO partner.

Sidetone

While transmitting, the sPocket allows the playback of a sidetone through the audio outputs next to operating the RX (full-BK only with RX Delay = 0). The sidetone is set in the Microphone dialog (value "Monitoring" = volume of the sidetone in %). When the dialog is opened and when transmitting in a mode other than CW (or SBCW or DIGI with activation of the "KEY In" input), the microphone signal is always audible.

The CW sidetone is heard only when the morse key is pressed (regardless of the status of the transmitter). To do this, the value "Monitoring" in the Microphone dialog must not be set to 0 **and** the RX Delay in the TX dialog must be greater than 0 (otherwise RX is always received during transmission).

The sidetone is generated in the sPocket by bypassing (almost) all signal processing units. It has no noticeable delay to the direct transmission signal. But it also suffers the shortening of the first CW pulse by the RF Delay when switching on the transmitter. The edge shaping corresponds to that of the RF transmission signal. In doing so, it produces an exact (temporal) replica of what the receiver of his own broadcast hears.

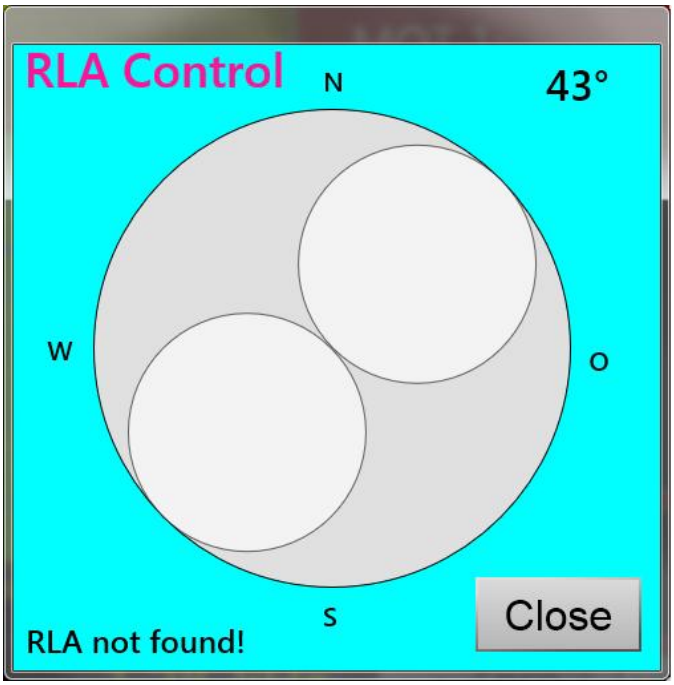
The frequency of the sidetone depends on different settings. It largely corresponds to the frequency that a receiver of the program hears with the same setting of the RX (i.e. exactly the same frequency setting / CW Pitch, etc.) or the frequency that is heard even during reception. The setting can also be adapted to your own habits or frequency inaccuracies (use of the test signal "Freq L" in the System dialog as a correction value).

13. Extensions and Updates

13.1 Controlling the antenna RLA4

The cross loop antenna RLA4 possesses an electronic directional diagram rotation option. A manually operated rotary encoder is installed on the associated control unit for setting the receiving direction. It can also be controlled via a WiFi connection. To do this, the control unit logs into a WiFi router and receives its control commands via it.

The access point of the sPocket can also take over the function of the WiFi router (depending on firmware or activation of this option). In this case the RLA4 can be controlled directly from the sPocket. For this purpose, an additional button "RLA" is provided within the middle button bar in the user interface. When you press the button, the following dialog opens.



The two white circles schematically show the "eight" -shaped directional diagram of the RLA4. Similar to the virtual scroll wheel on the user interface, they can be rotated on the touchscreen using a circular pulling motion. The current direction is displayed in the top right, as it is transmitted to the control unit and is also displayed there. The status of the RLA4 is displayed at the bottom left (connection available or not).

13.2 Power pack

The sPocket requires an external power supply. Under normal conditions, a suitable power supply unit is usually employed for this. However, an independent power supply is required for mobile operation. A commercially available power pack can be used for this, as one is used to recharge smartphones or tablets via a USB connection.

The power pack usually only outputs a voltage of 5 V, which is not sufficient to operate the sPocket. However, modern devices support different modes with increased output. These are usually referred to as "Fast Charge" or "Quick Charge" in different versions. A power pack is required for the sPocket that can output 12 V at an USB-A socket with min. 1.0 A.

In order to be able to switch the output voltage from 5 V to 12 V, the connected device must carry out a certain switching sequence of the data connections. Only if those conditions are met, 12 V will be output by the power pack. The sPocket has no USB power supply input (only output to the tablet, never connect a source here!) and therefore no switching option. That is why there is a suitable switch for the power pack. It has to be connected to the power pack and after switching "12 V", provides this voltage for the sPocket on a USB-A socket. A cable with an USB-A plug and a hollow pin plug for the power supply socket of the sPocket is used for the connection.

Caution! Always establish the connection to the sPocket when it is switched off (switch to "OFF")! Only switch to "12 V" **afterwards**.

It is also possible to switch on 5 V in order to be able to supply other devices with this voltage. However, the sPocket does NOT operate with this voltage! Only operate it with 12 V!

It is not possible to recharge the power pack during operation. To do this, the switch must be powered down and then disconnected from the power pack. There is a USB-C socket on the power pack that serves as a charging input. Any standard 5 V power supply can be connected here (e.g. the one supplied with the tablet). Some power packs also support fast or quick charge. This means that they can request an increased charging voltage from suitable power supplies and then charge them faster than with 5 V.

If the tablet is also to be recharged when the sPocket is operated from the power pack (connection of the tablet to the charging port of the basic unit), the power pack must deliver an increased current. In this case, devices with min. 1.67 A power supply required. Devices with a lower current yield may work, but a possible self-shutdown is possible at any time. In this case, reload the tablet from other sources if necessary (e.g. your own power pack).

A 10,000 mAh power pack allows approx. 4 hours of operation with normal settings of the sPocket. A fully charged tablet with little brightness, low spectrum rate and without audio output allows for about as much. The remaining charge of the tablet is displayed in the sPocket user interface, that of the power pack with usually 3 or 4 LEDs.

13.3 Software Update to Version 3

The version 3 update for the sPocket contains the following files:

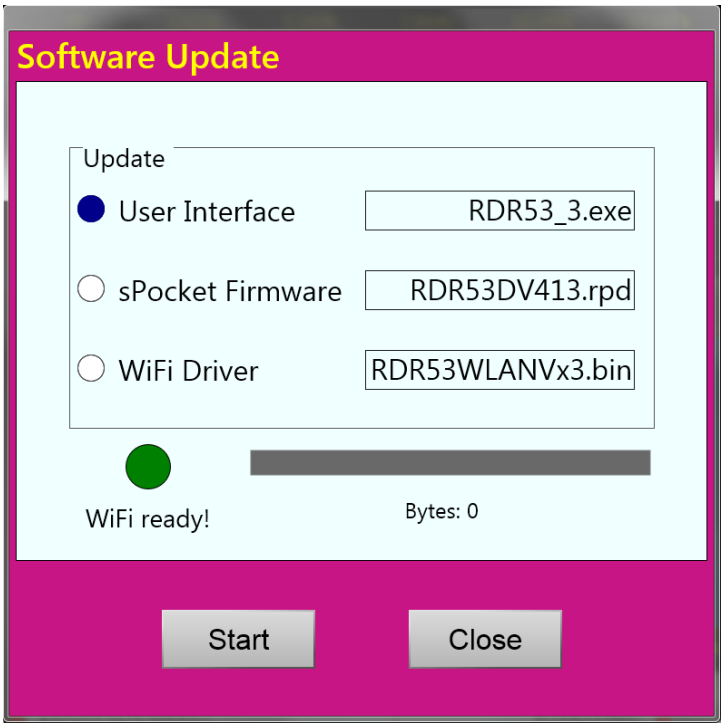
- RDR53_3.EXE: User interface for the tablet. This file contains the user interface visible on the display. It is installed on the tablet of the sPocket by selecting the "User Interface" option in the "Software Update" dialog after calling up the "Setup" dialog.

- RDR53DV213 or 413.RPD: This file contains the configuration of the sPocket. It must be installed by selecting the "sPocket Firmware" option in the "Software Update" dialog after calling up the "Setup" dialog.

- RDRWLANVx3.BIN: This file contains the driver for the sPocket's WiFi module. It must be installed by selecting the "WiFi Driver" option in the "Software Update" dialog after calling up the "Setup" dialog.

The individual files are installed as described in Section 7.3 "Software Update". The following procedure is recommended:

1. Update User Interface. When prompted to restart, switch the device off completely (press the "OFF" button on the user interface and confirm with "Shut down!"; Disconnect the possibly existing charging power supply for the tablet from the "Charge" output at the tablet (USB-C); Switch off the power supply for the basic unit, wait approx. 10 s until everything is completely switched off). Then switch on again: Supply the basic unit with power, switch on the tablet with the button at the top left (red LED in the display below the button must light up or the manufacturer logo must appear), possibly connect the charging current to the USB-C socket at the tablet, wait until the user interface is active . Tap Setup and then Update. The update dialog of the new version 53_3 contains a check of the reliability of the WiFi connection for the following updates (firmware and WiFi driver). These updates can and must only be carried out if there is an uninterrupted connection between the tablet and the basic unit (bar graph "WLAN" min. 95% for at least 10 s without sinking below).

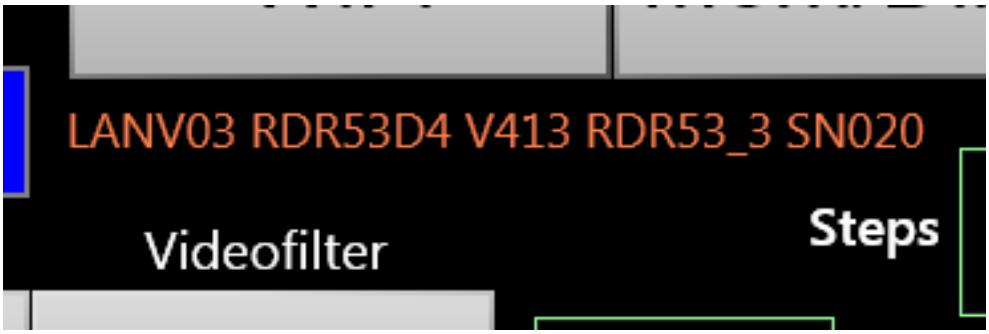


2. If "WiFi ready!" is displayed, transfer the firmware. After completion, wait until the WiFi connection is re-established ("WiFi ready!") and / or a prompt about the required restart appears. In the event of error messages (e.g. "Timeout"), the update can be repeated immediately **if the WiFi**

connection is established ("WiFi ready!"). Otherwise switch off completely, restart and repeat "Update Firmware" until it has been carried out successfully. Do not restart after successful update.

3. If "WiFi ready!" is displayed, perform Update WiFi Driver. Switch off the device completely as described under point 1 and then restart again. In the event of errors, repeat Update WiFi as described under point 2 until success is signaled.

After the updates, the new software should be displayed in the info line under the dialog buttons as follows:



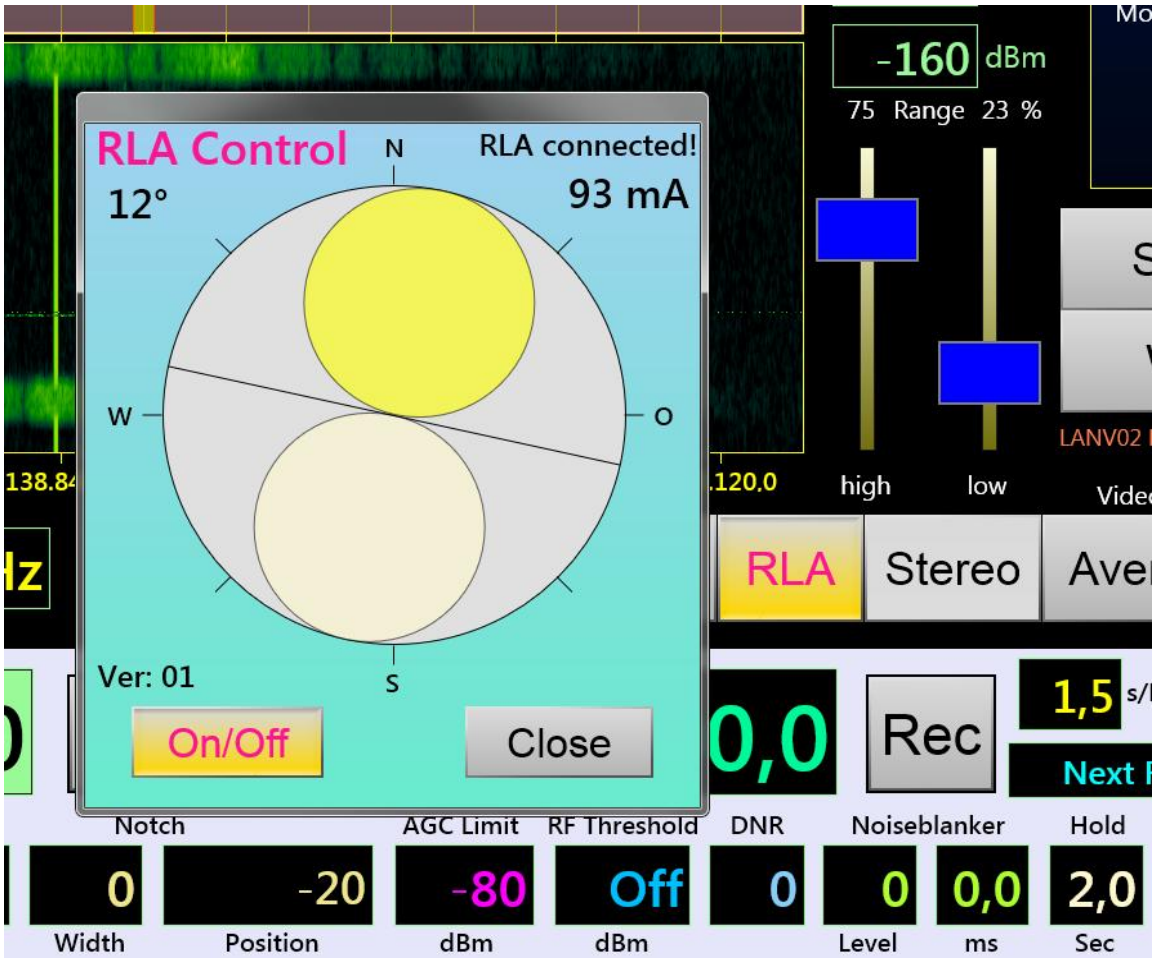
"LANV83" can also be displayed for the LAN version (the first digit is switched between 0 and 8 with each update). The versions for RDR53 are displayed depending on the version of the device as "C" or "D" (17 bit or 18 bit ADC) and "1", "2", or "4" (up to 71 MHz, with FM and 2 m, with exciter). RDR53_3 is the user interface. The serial number "SN" depending on the serial number of the device.

The version 3 update contains the following changes compared to the original software:

- Activation of the DAB slide show (device versions 2 and 4 only). The slide show images are displayed in the window provided on the DAB user interface. The download of the images can be tracked via the progress bar below the image window.

By double-clicking / clicking on the picture, it can be enlarged approx. 1.5 times or normalized again.

- Complete implementation of remote control of one or more RLA4 antennas.



The control unit of an RLA4 can log into the access point of the sPocket (see description of control unit "RSW3"). Logging in is only possible if the serial number of the control unit is specified in the System dialog (new setting "RSW3 S/N"). As soon as the control unit has successfully logged in, the "RLA" button is displayed as active (yellow). When opening the "RLA" dialog, the text "RLA connected!" appears in the top right (otherwise: "RLA not found!").

The antenna can be switched on or off using the "On/Off" button. The status is also displayed via the current measured value at the top right. With this display, interruptions or short circuits can also be found in the antenna cable. It is also switched on automatically as soon as the reception direction is turned. To do this, tap on one of the two "receiving lobes" (shown simply as circles) and pull the receiving direction with your finger to the desired position. The direction display at the top left shows the current position in sync with the display of the control unit.

As soon as the antenna diagram is tapped, the RLA can be operated. This is indicated by the now yellow circles (otherwise white). The circle on the right is shown darker, the degree display refers to it from 0° (north) to 180° (south). The current setting position of the sPocket (e.g. frequency, bandwidth ...) also remains active on the user interface. If the RLA dialog is to remain open (the window can be dragged by tapping the upper, thickened frame), but the receiver is to be operated normally again, the active set value of the user interface (or any other one) must be tapped again. The return of the active operation from the RLA to the sPocket is indicated by the deactivation (white) of the reception diagram.

Dragging the receiving direction with your finger (or the mouse pointer when connecting a computer mouse) only allows a relatively rough positioning. The antenna also does not react to large shifts at will because the transfer of data from the control unit to the antenna via the coax cable takes some time (only 125 bit/s data rate). This results in delayed and jerky movements during quick operations. The diagram always shows the actual position reported by the antenna, not the currently selected target position with the finger.

An exact and sensitive setting is possible with the scroll wheel of the sPocket. As soon as the RLA control is active (yellow circles), the movements of the scroll wheel are used exactly for switching through one level

of the antenna position. This corresponds to the operation as with the control unit's rotary encoder of the antenna (its operation is also shown by rotating the directional diagram and updating the degree display on the sPocket). Please note that a position step does not exactly correspond to a 1° change in direction, but approx. 0.776° (the RLA4 has 232 steps for 180° rotation). However, the indication of decimal places is omitted in the degree display. The actual positioning of the reception direction is far less precise than 1° (non-linear control of the amplifiers in the antenna, mechanical inaccuracies, influence of the installation site, etc.).

Fine adjustment is useful and important when using the zero point of the directional diagram to hide signals from a certain direction. The zero point is represented in the diagram by the line between the circles. It is very sharp and, with precise positioning, allows suppression of 40 dB or more (depending on the frequency, design / version and mounting position of the antenna).

- Activation of the mouse wheel.

If a computer mouse is connected to the tablet's micro USB port, a mouse wheel ("scroll wheel"), if present on the mouse, can now be used just like the scroll wheel of the sPocket. Each click of the mouse wheel is translated into a step of the sPocket scroll wheel. For less frequent settings (e.g. switching the range of view of the spectrum), operation is greatly accelerated because you do not have to use the scroll wheel every time or move the virtual scroll wheel on the screen with the mouse.

The mouse wheels on common computer mice are often of poor quality (unstable) and often produce wrong steps. Extensive settings (e.g. frequency setting over larger areas) are tedious and you should continue to use the scroll wheel of the sPocket. With frequent use of the mouse wheel, it is advisable to purchase a high-quality version, such as that used for e.g. on trackballs for machine control or for design tasks (drawing).

- Bluetooth functionality is omitted.

The Bluetooth functionality of the sPocket basic unit and the tablet have proven to be insufficient for the transmission of real-time audio data. Both devices only possess a single 2.4 GHz transceiver respectively. This frequency is largely used for the data transfer between the devices.

There is the technical possibility of a so-called WiFi / Bluetooth coexistence even with only one transceiver, but due to the necessary switching between the applications, it is not able to transmit sufficient amounts of data for both applications at the same time. Simple controls or non-real-time data exchange (e.g. transfer of files, images, websites, etc.) are possible by alternately using the transceiver with both applications. However, video or audio data streams that have to be transmitted in real time without interruption are only ever possible with one application.

With the sPocket, this is the WiFi application that is always necessary to transmit the moving spectral images and audio data from the basic unit to the tablet. Since a simultaneous transmission via Bluetooth e.g. to BT speakers or similar is not possible, the Bluetooth functionality has been completely removed from the WiFi dialog. The theoretically possible coupling to BT devices for the purpose of remote control or data exchange (e.g. transmission of the recorded WAV files) is also possible via WiFi and is therefore unnecessary.

Note: Version 3 of the user interface can be operated entirely by mouse and can therefore also be used on any PC with a Windows operating system (from V 7) (similar to a "normal" SDR program for PC-only receivers). In order to exit the operating software without automatically switching off the computer, a version with an additional "OK" button within the Off dialog (RDR53_3PC.EXE) was created. It should be noted, however, that the software is designed primarily for operation via touchscreen and on small screens, as well as with low-performance computers (tablets). Therefore, the features that are common in normal Windows programs, such as scalable font sizes, windows or spectrum diagrams, are missing. The program window is always 1920 x 1200 pixels and requires the corresponding size and resolution of the PC monitor (min. Full HD, more is better). The software also does not carry out any independent signal processing (e.g. no own calculation of the spectra, therefore no arbitrary scaling / diagram size / independent windows etc.). All data and operating options are dictated by the sPocket basic unit. Nevertheless, when using a powerful PC, effective operation and, above all, a very high speed of the spectral display can be achieved (set "Full Rate" in the Setup dialog). Due to the data transmission exclusively via WiFi, the complete remote control of the sPocket including audio transmission up to Internet remote control is also possible using a suitable PC / software.

13.4 Tablet Upgrade (Software Version 4)

The display and touch operation of the sPocket are implemented using a PC-compatible tablet computer. The performance of the tablet has a great influence on the display speed of the displays (especially spectrum and waterfall displays) and on the stability of the WiFi connection between the tablet and the basic unit. In the course of the further development of the RDR technology, all sPocket are delivered with the latest available tablets.

For devices from serial number 030, more powerful tablets are used. These are mechanically compatible (same size and magnetic holder on the basic unit). There are a few small differences for the electrical connections:

- The micro-USB connection for the tablet's data connections (USB stick for software updates, connection of a computer mouse) has been converted to the more modern USB-C variant. A simple adapter from Micro-USB (socket) to USB-C (plug) is therefore required to connect older peripheral devices.

- The new tablets have a quick charge mode for charging the internal battery. The fast charger works with a voltage of 12 V on the USB-C charging port (as opposed to 5 V on the older tablets). It is therefore necessary to switch the charging output on the basic unit (micro USB) from 5 V to 12 V. All devices from S / N 030 contain this conversion ex works. Older devices must be converted by us if the new tablets are to be charged via the basic unit. The power supply units supplied with the tablet provide the correct voltage and can always be used for charging.

Caution! **Always use only the power supply unit supplied with the tablet! The use of a 12 V power supply for a 5 V tablet will destroy it!**

Note: Basic units converted to 12 V (from S/N 030 or older units after a tablet upgrade) can only charge a connected tablet if the basic unit is also supplied with 12 V ± 0.2 V! The basic unit can also work with smaller or larger voltages, but the charger cannot.

Caution! **Never connect devices other than the associated tablet to converted basic units (from S/N 030 or older devices after a tablet upgrade) to the charging socket! Other devices (older tablets or general computer peripheral devices) will inevitably be destroyed when connected!**

With the conversion of the sPocket to new tablets (from S/N 030 or older devices after tablet upgrade) new software version 4 is installed on the devices. This corresponds to version 3 with the following changes:

- Support of higher WiFi data rates for better stability of the connection.
- Bugfix for non-functional noise blanker NB.
- Support of the latest antennas RLA4G and RFA1 as well as the associated control units RSW3 and RSW4 (operation via WiFi directly on the tablet possible).

13.5 Software Version 5

The version 5 update for the sPocket contains the following files:

- RDR53_5.EXE: User interface for tablet. This file contains the user interface visible on the display. It is installed on the tablet of the sPocket by selecting the "User Interface" option in the "Software Update" dialog after calling up the "Setup" dialog.

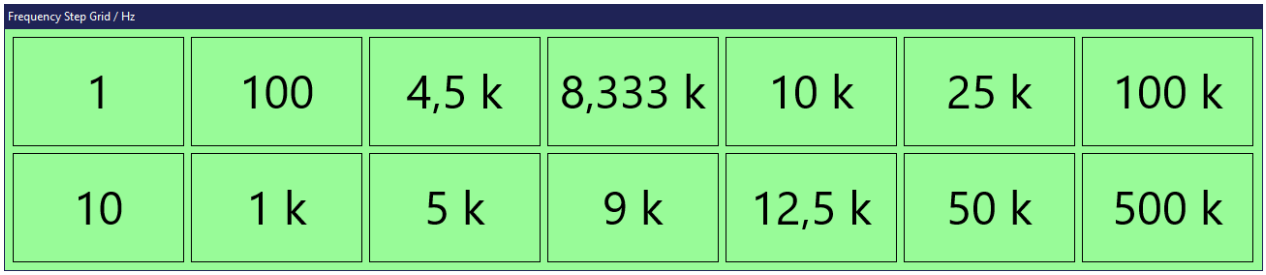
- RDR53DV215 or 415.RPD: This file contains the configuration of the sPocket. It must be installed by selecting the "sPocket Firmware" option in the "Software Update" dialog after calling up the "Setup" dialog.

- RDRWLANVx4.BIN: This file contains the driver for the sPocket's WiFi module. It must be installed by selecting the "WiFi Driver" item in the "Software Update" dialog after calling up the "Setup" dialog (only if it has not already been updated to software version 4).

The individual files are installed as described in Section 7.3 "Software Update" or under Section 13.3.

Version 5 contains the following enhancements:

- Inclusion of the tuning step size (grid) 8.333 kHz into the step size menu (double click on the setting "Steps").

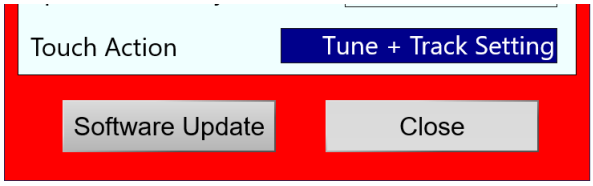


This step size is "real" 8 1/3 kHz. This means that the periodic fraction 1/3 is taken into account, there is no cut off of the 0.3333 .... Hz digits. In the case of continuous tuning, this would otherwise lead to the totaling up of the missing positions and thus to an increase in the tuning error.

Note: A step size broken down to 1/3 cannot normally be set by changing the "Steps" setting on the user interface. This can only be achieved by making a selection in the menu. However, after selecting 8.333 kHz, each digit of the step size can be changed. With this, for example, a step size of 333.3 Hz period or similar can be set. When changing the 0.1 Hz digit, however, only the setting 0 or 5 is possible! The consideration of the 3 period is then lost (always "smooth" adjustment to 0.0 Hz or 0.5 Hz).

- Tuning by tapping a spectral line in the spectrum or waterfall.

The Setup dialog contains a new set value "Touch Action":



This value can be used to define various actions that are to be carried out when the touchscreen is touched in the area of the spectrum or waterfall diagram. The following options are available.

· No Action

Touching it has no effect.

· Track Frequency

Touching the touchscreen and dragging it to the left or right always changes the reception frequency. The adjustment is always made with the set step size. Each time you drag a distance of 4 pixels on the screen, a step is performed.

Note: If the step size and the visible spectrum resolution are adapted to each other according to 4 spectral lines / step (do some calculations), the tapped point of the spectrum follows the dragging movement exactly (as if it were "stuck" to the finger / stylus).

· Track Setting

As above, but the set value currently selected as active is "pulled" (changed upwards or downwards).

· Tune + Track Frequency

When you tap on a point in the spectrum / waterfall, the point you tapped is immediately set as the reception frequency. Tuning is performed within the grid of the tuning increment. After tapping, the frequency can be pulled.

· Tune + Track Setting

As before, except that the currently active set value is changed when dragging after tuning has been performed.

When using these functions, it should be noted that a touchscreen always has a few pixels inaccuracy. If

you tap with your finger, this inaccuracy increases by the area of the finger recognized by the screen. It is therefore recommended to use a suitable touch pen (also known as "stylus" or "digitizer" pen). The fundamental deviation of the touchscreen from the visible screen is largely constant. With a little practice / experience you will quickly know how far from the visible (desired) point you have to tap in order to hit it exactly.

With the combination of "Tune + Track Setting" and selection of the spectrum resolution as the active set value, precise tuning over large frequency ranges (e.g. entire VHF band) can be quickly achieved (max. 2x tap) after a little practice:

- Set a relatively coarse resolution (large viewing width).
- Tap on the desired spectral line (tuning close to the desired frequency).
- Without letting go, pull to the left ("zoom in").
- Let go and then tap again with a high resolution (usually precise tuning immediately if the transmitter is in the grid).
- Before releasing, zoom out to the right again to a large viewing width.