

piHPSDR User's Manual

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Disclaimer. The manual has been written with the intention that it is useful. It is quite clear that it still contains errors, therefore it is stressed here that it comes without any warranty. The reader is hereby explicitly warned that through wrong use of an SDR program such as piHPSDR, it is possible to damage the radio hardware.

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The author:

Christoph van Wüllen (DL1YCF) has contributed a lot to piHPSDR in the last few years, this manual refers to the code in his github account

<https://github.com/dl1ycf/pihpsdr>

where the L^AT_EX „source code” of this manual, together with all figures in .png format, can be found in the `release/LatexManual` directory. At this moment this code has significant developed compared to the piHPSDR code in John Melton’s master repository, but there is still hope that both versions can be merged in the future, although this will be hard work.

If you think you can improve the manual, you are welcome. Simply fork the above repository and make a pull request, or (this is the recommended way) write an email to the author: `dl1ycf@darc.de`

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Chapter 1

Introduction

piHPSDR is a program that can operate with software defined radios (SDRs). As a graphical user interface, it uses the GTK-3 toolkit, while the actual signal processing is done by Warren Pratt's WDSP library. Thus, piHPSDR organizes the transfer of digitized radio frequency (RF) data between the radio hardware and the WDSP library, the transfer of audio data (either from a microphone or to a headphone), as well as the processing of user input (either by mouse/touch-screen, keyboard, or external "knobs and buttons"), and the graphical display of the RF data. piHPSDR is intended to run on different variants of Unix. It runs on all sorts of Linux systems, including a Raspberry Pi (hence the name piHPSDR), but equally well on Linux desktop or laptop computers, and on Apple Macintosh (Mac OSX) computers which have a Unix variant under the hood. The present author is not aware of piHPSDR running under the Windows operating system, although with environments such as MinGW, this should be possible.

Although piHPSDR can be operated entirely by using mouse and keyboard as input devices, many users prefer to have physical push-buttons and/or knobs or dials. To this end, piHPSDR can control push-buttons and rotary encoders connected to the GPIO (general purpose input/output) lines of a Raspberry Pi. At least two generations of such controllers have been put on the market by Apache labs, and I know of several projects where home-brewn controllers have successfully been made. As an alternative, MIDI devices can be used for user interaction. For desktop/laptop computers that do not have GPIO lines, MIDI offers an easy-to-use possibility of having push-buttons and dials that

control piHPSDR. Apart from homebrew projects in which a micro-controller such as an Arduino Micro controls the actual buttons/knobs and acts as a MIDI device to the computer to which it is connected via USB, there are low-cost so-called "DJ controllers" (DJ stands for disk jockey) from various brands which have successfully been used with piHPSDR. A third possibility to control piHPSDR is via a serial interface through CAT (computer aided transceiver) commands. The CAT model used by piHPSDR is based on the Kenwood TS-2000 command set with lots of PowerSDR extensions.

Using a touch-screen instead of a mouse offers the possibility to put the actual radio hardware together with a Raspberry Pi running piHPSDR and an assortment of buttons/knobs into a single enclosure. This way, one can build an SDR radio which can be operated like a conventional analog one.

The piHPSDR program has been written by John Melton G0ORX/N6LYT. It is free software that is licensed under the GNU (free software foundation) general public license. Many other radio amateurs have contributed to the code. A lot of extensions and improvements have been added by myself, therefore this document refers to the version of piHPSDR that can be found on my github account <https://github.com/dl1ycf/pihpsdr>.

Because piHPSDR can be used on many different types of computers, and because operating systems change rather quickly over time, I generally do not recommend to have a „binary release” with files that you can just copy to your computer and then it runs. Instead, my personal recommendation is to build piHPSDR and WDSP from the sources, only this procedure guarantees compatibility of the final program with your operating system. A manual of how to compile piHPSDR from the sources is available separately, see <https://github.com/dl1ycf/pihpsdr-compile-from-sources>, so this will not be covered in the present manual. This manual starts with the first invocation of a freshly compiled piHPSDR.

Within this manual, we shall use a typewriter font in red color if we refer to a text or a button within a menu or within the VFO bar. piHPSDR menus and commands are indicated through a typewriter font printed in blue. The author hopes that this improves readability. In some cases, if the name of a command or menu is written on the screen, you may find the same string both typed in red and blue in the description, depending on whether the text refers to the command in an abstract sense or to the string as it can be found on the screen. This may be confusing upon first reading, but I shall try to

follow the coloring convention as laid out here.

Chapter 2

Starting piHPSDR for the first time

Let us assume you have an SDR (say, an ANAN-7000 or a HermesLite-II) powered up and connected to an antenna, and you have piHPSDR installed on a computer (say, a Raspberry Pi or an Apple Macintosh), the first thing to do is to establish a proper connection between the computer and the radio. Although advocated at many places, I do highly recommend against a WiFi connection. WiFi routers often use optimizations where they hold back data packets for a given client for a while, to be able to send a collection of them in a burst. While this certainly optimizes the through-put because it minimizes clear-channel arbitration events, such jitters are disastrous in SDR operation. The safest way of connecting the radio and the computer is to have a managed switch with a built-in DHCP server, and to connect both the computer and the radio with a suitable cable to the switch. If the computer has both a RJ45 jack for an ethernet cable, and a WiFi interface, my personal recommendation is to use WiFi to connect the computer to the internet, and use a single direct cable plugged into the RJ45 jacks of the computer and of the radio. This is a little bit tricky since both the computer and the radio have to be set to a fixed IP address (e.g. computer: 192.168.1.50, radio: 192.168.1.51) with the same netmask. However, once this has been done, this is the safest connection with no perturbations from elsewhere.

If the piHPSDR program is started for the first time, it opens a window that looks like Fig. 2.1. Besides stating a version number and when piHPSDR was

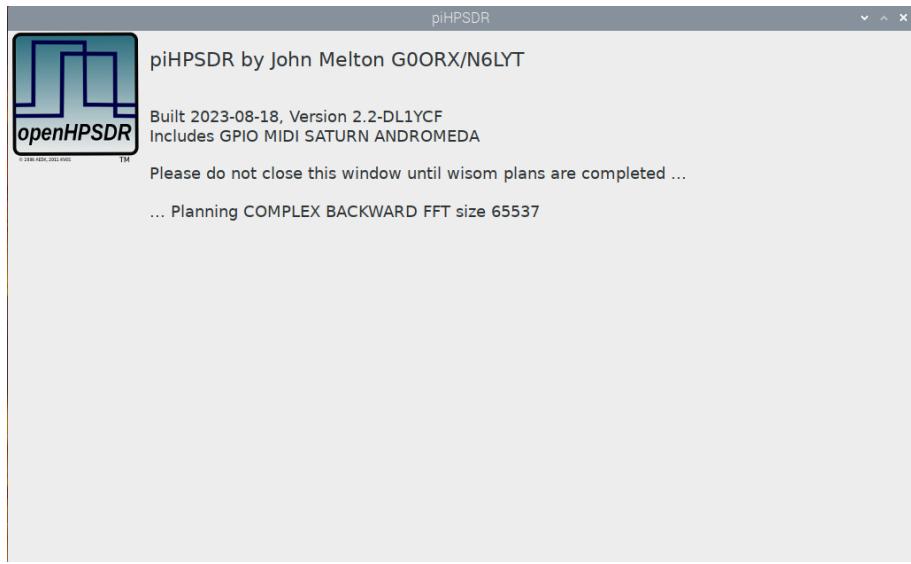


Fig. 2.1: piHPSDR screen while completing the *wisdom plans*.

built, a list of optional features (to be activated at compile time) is stated, in this case, GPIO, MIDI, SATURN, and ANDROMEDA. These options indicate that the program has GPIO support (this is only possible on Raspberry Pi or similar single board computers), that it has support for MIDI devices, that it can run natively on the compute module of the latest G2 (generation two) SDRs from Apache labs, and that it has support for Laurence Barker's ANDROMEDA controller. What is important here that you have to wait. This only applies to the very first time you start piHPSDR. On CPUs with a rather simple instruction set (like the ARM processor in the Raspberry Pi, or the Apple Silicon processor in recent Macintosh computers), this so-called *planning* step is quite fast. For example, on my Apple M2 Mac mini, this step only takes 6 seconds, and you have to wait for 34 seconds on a RaspberryPi 4. On the contrary, on CPUs with complex instruction sets, more planning is necessary: on my other Mac mini with a 3 GHz x86 processor, it takes 16 minutes! But note this has only to be done once, in subsequent starts of piHPSDR, the wisdom will simply be read from the file created during the *wisdom plans*. These plans contain, for a large number of dimensions, the fastest way how to perform FFTs (fast Fourier transformations) on the given CPU. When the wisdom is secured, piHPSDR tries to detect a radio on the network. If everything went well with the network connection, you then see

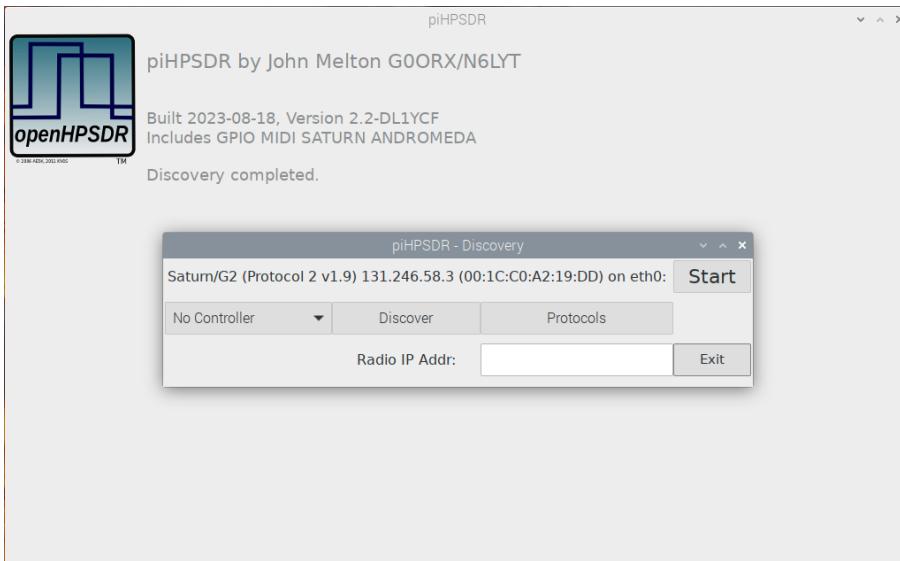


Fig. 2.2: A radio has been discovered. You are ready to start it.

a screen with a discovery menu (Fig. 2.2).

At this point, you can start the radio by clicking the **Start** button, but let us first explain the purpose of the other buttons! Easiest to explain is the **Exit** button, this will simply terminate the program. Most likely, you may want to go into the **Protocols** menu sooner or later. By default, piHPSDR tries to discover the presence of a radio using all protocols known to piHPSDR. However, if you know that your radio, for example, uses P2 (Protocol 2), then trying to discover a P1 (Protocol 1) radio is just a waste of time. So if you know which types of radio you want to connect to, you can enable (only) these in the **Protocols** menu. The available protocols are

Protocol 1 This is the "original" HPSDR protocol.

Protocol 2 This is the "new" HPSDR protocol.

Saturn XDMA This is used to talk to a Saturn FPGA through the internal XDMA interface. Only available if piHPSDR is compiled with the **SATURN** option.

USB OZY This is used to talk to a radio using the legacy USB OZY interface. Only available if piHPSDR is compiled with the

USB0ZY option.

SoapySDR This is used to talk to a radio through the SoapySDR library, for example to an AdalmPLUTO. Only available if piHPSDR is compiled with the **SOAPYSDR** option.

STEMlab This is used to connect to RedPitaya based SDRs through the WEB interface. Only available if piHPSDR is compiled with the **STEMLAB_DISCOVERY** option. Starting the radio using this protocol is a two-step process: first, the RedPitaya's WEB interface is located, and the **Start** button then starts the SDR app on the RedPitaya. Then, piHPSDR tries to connect to this SDR app and upon success offers a new **Start** button to start the radio. If the RedPitaya is exclusively used as a radio, it is recommended to auto-start the SDR app when the RedPitaya is powered up. In this case, the STEMlab protocol is not used, because the SDR app can be started through Protocol-2.

Autostart This is a very useful option. It indicates that if exactly one radio has been found, it is automatically started. So in normal operation, when starting piHPSDR subsequently, and all settings are still valid, the radio is started without user intervention. If this option is activated and one radio is present, you will not see this menu, so in order to make further changes here, you have to disconnect the radio from the ethernet cable, start piHPSDR until you see this menu, and reconnect the radio.

Sometimes piHPSDR needs to know the IP address of the radio. This is, for example, the case for the STEMlab discovery described above. In such a case the IP address in numerical form (xxx.xxx.xxx.xxx) can be entered in the box with the label **Radio IP Addr:**. If a legal IP address is contained in this box, protocol-1 and protocol-2 discoveries will also send to the IP address specified, in addition to the standard broadcast discovery packets which can only reach radios on the same network segment. With a known IP address, one can connect to radios which are not on the same subnet as the computer, in principle you can connect to any radio on the world provided it is on the internet. However, the original HPSDR standard states that a

broadcast packet must be used, so several radios won't reply. On the other hand, there are some radios such as a RedPitaya or a HermesLite-II which allow being discovered by such a routed packet.

The **Discover** button re-starts the discovery process. This is useful if the radio has been powered up too late and was not yet ready when piHPSDR was started. Simply press **Discover** to give another try.

The combo-box (pop-down menu) to the left of the **Discover** button lets you choose which type of GPIO controller you have attached to the computer. This menu is only available if piHPSDR has been compiled with the **GPIO** option, which is not the case on desktop/laptop computers. The menu lets you choose between

No Controller Choose this if no GPIO controller is wired to your Raspberry Pi. This is the default when you first start piHPSDR.

Controller1 Choose this if you have a "version 1" piHPSDR controller.

Controller2 V1 This option is valid for some early prototypes of the "version 2" controller with single encoders.

Controller2 V2 Choose this if you have a "version 2" piHPSDR controller with double encoders.

G2 Front Panel Choose this if you have an ANAN G2 radio with a built-in controller.

Attention. Be sure to choose a controller only if such a controller is actually connected to your Raspberry Pi. If you choose, for example, a controller which uses an I2C expander for the switches, but no I2C interface is present on your Raspberry Pi, the program may hang when trying to open the I2C connection.

All settings (protocols, controller, IP address) made in this menu are stored in the global (radio-independent) settings and are restored when piHPSDR is started the next time.

If all went well, a radio could be discovered and you hit the **Start** button, the radio is started, and if this succeeds, you see something like shown in Fig. 2.3.



Fig. 2.3: The radio with two RX. Sliders and Toolbar are not on display by default when using a controller.

The bottom of the window looks different (more controls) if you have chosen **No Controller** in the preceding menu. You see two receiver panels stacked vertically, both of them having a spectrum display and a waterfall area. At the top, just below the window title, you have the VFO bar which contains information on the frequencies of the two VFOs A and B, as well as lots of further information, to be explained later. At the top right, there are two buttons **Hide** and **Menu** which will be explained in the next chapter. To the left of these two buttons, there is the meter bar which by default is a digital S-meter. At this point, you have started piHPSDR successfully for the first time.

Chapter 3

Main window layout

3.1 One or two receivers

At the end of the previous chapter (Fig. 2.3), there were two receiver panels in the piHPSDR window, stacked vertically, and both including a spectrum scope (the green-coloured noise floor) and a waterfall. The waterfall area is completely black in the above picture since there was no RF signal. piHPSDR can be switched between having one or two receivers in the `Radio` menu. If there are two receivers (called RX1 and RX2), one of the two is the *active receiver*. If you look closely at the above picture, you will note that the spectrum scope of the lower (RX2) panel is shaded, while it is in bright colour for RX1. This indicates that RX1 is currently the active receiver. By simply clicking into the panel of the other (inactive) receiver, either with a mouse or on a touch screen, the formerly inactive receiver becomes active.

Many conventional rigs with two independent receivers discriminate between the *main* and the *sub* receiver. It is important that this is **not** the case for piHPSDR. In piHPDSR, both receivers are largely equivalent. For example, if you start transmitting in normal (non-split) mode, the TX frequency matches the frequency of the active receiver, no matter whether this is RX1 or RX2. Likewise, in split mode, the TX frequency matches the frequency of the non-active receiver. Most of the receiver-specific controls, for example adjusting the AF volume or the AGC gain, refer to the current active receiver. If piHPSDR runs with two receivers, RX1 is always controlled by VFO-A

while RX2 is controlled by VFO-B. The VFO settings not only include the frequency but also the current mode (e.g. LSB or CWU), the filter setting, the band and bandstack setting, whether RIT is enabled or not, and the RIT offset. So changing the RIT value only changes it for the active receiver. If you want to change the RIT value for RX2 while RX1 is the active receiver, you have to make RX2 active, change the RIT value and then make RX1 active again.

RX1 and RX2 are largely independent. They can receive on different bands. They can receive from different antennas provided the radio has two RF frontend with two analog-to-digital converter4s (ADC, as most modern radios do. In this case, one usually assigns the first ADC (ADC0) to RX1 and the second ADC (ADC1) to RX2. This can be done in the [RX](#) menu.

By default, if there are two receivers, they are vertically stacked, with RX1 in the upper part and RX2 in the lower part of the display. This can be changed in the [Screen](#) menu to horizontal stacking, where RX1 is in the left half and RX2 in the right half of the display. Changing the stacking trades vertical against horizontal resolution, of course.



Fig. 3.1: piHPSDR with a single RX and all controls (Zoom/Pan, Sliders, Toolbar) at the bottom.

Fig. 3.1 picture shows, for demonstration purpose, a piHPSDR window with

a single receiver. The RX panel only contains a spectrum scope with a white line and no waterfall (this can be changed in the [Display](#) menu). In addition, you see the toolbar with eight buttons at the lower edge of the window, and above it an area with sliders. Showing the sliders is the default (and necessary) if there is no GPIO or MIDI controller attached, since then these sliders are the only way to change, for example, the AF volume. If there is only one receiver, it is controlled by VFO-A. VFO-B then actually controls nothing (except the TX frequency in split mode), but the data stored in VFO-B can be quickly used, for example by copying VFO-B to VFO-A (the [A<B](#) command), or by swapping the two VFOs (the [A<>B](#) command).

3.2 Spectrum scope options

You have already seen two different spectrum scopes: in the first picture, the spectrum was a filled green area, while in the last picture, there only was a white line (this is similar to what you would see on a spectrum analyzer). This can be adjusted to your personal preference in the [Display](#) menu (see below). There are two options which you can enable or disable, such that there are four different outcomes. The first option is the „Filled” option which discriminates between a line spectrum and a spectrum which is filled below the line. In the picture below, the first and third example have no filling, while the second and fourth spectrum are filled:

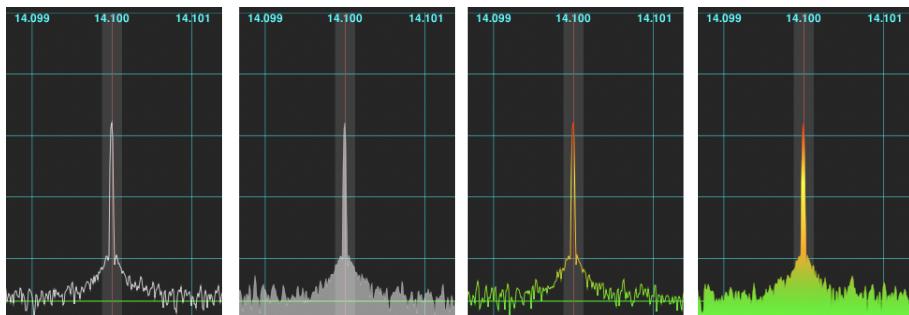


Fig. 3.2: Display options for the spectrum scope.

Then there is the „Gradient” option. Without this option, the spectrum is displayed in white colour. With the gradient option, the colour changes from green over yellow towards red depending on the signal strength (red colour

is reached for S9). The above picture demonstrates the four possible combinations, and in the [Display](#) menu, you can make your choice. This setting refers to both receivers when there are two. Note that the TX spectrum can be a filled one or a line spectrum, but that the gradient option does not apply.

3.3 Zoom and Pan



Fig. 3.3: The spectrum scope of Fig. 3.1 with a large Zoom value.

The width of the RX spectrum equals the sample rate of the receiver. This means that if you use, say, a sample rate of 96 kHz for a receiver, its spectrum will be 96 kHz wide, which may encompass a larger part of the spectrum than you are interested in. As a drawback, the part which is relevant to you may look a little bit compressed. This is where the [Zoom](#) command comes in. The zoom value can adopt integral values between 1 (no zoom) and 8. In the latter case, only 1/8 of the overall spectrum is displayed on the screen. In the picture below, you see that the RX scope is only 12 kHz wide (which is 1/8 of the RX sample rate, 96 kHz in our example). Note that what is displayed is in full resolution. Internally, a spectrum with 8 times the number of pixels of the screen width is created and only a part of it is displayed. The zoom

value can be changed using the **Zoom** slider (at the left edge below the RX panel).

When using a zoom value larger than one, this means that a spectrum with more pixels than the actual screen width is produced. One can select which part of that area is displayed on the screen with the **Pan** slider (below the RX panel at the right side). Normally (Zoom=1), the VFO dial frequency is exactly in the middle of the RX scope, and marked with a thin red line. On the picture above, the dial frequency (14.100 MHz) is found in the RX panel close to the left edge, and this has been done by moving the **Pan** slider.

3.4 The Hide button



Fig. 3.4: piHPSDR window with the Toolbar/Sliders/Zoom area „hidden”.

On small screens, space is scarce. This is particularly true for the vertical space if one uses two RX panels and both with a spectrum scope and a waterfall. In this case, it may be hard to actually watch the signals if the screen is small. This is where the **Hide** button comes in. Clicking on this button „hides” the toolbar and slider area:

The text on the button then changes to **Show**, and clicking this button again

will then return to the previous display.

3.5 Window areas

Look again at Fig. 3.1! Starting from the top, you see the title bar of the window. This bar is not visible in full screen mode, where the size of the piHPSDR window matches the display size. The title bar contains some basis information about the radio, e.g. its type, the protocol used, the IP and the hardware address of the radio. If you are really interested in this information, it is recommended to open the [About](#) menu.

Between the title bar and the RX spectrum scope, you see a small vertical area, most of which is taken by the VFO bar (containing the large frequency dials). At the rightmost end of this area, you see two buttons [Hide](#) (already discussed) and [Menu](#). Clicking on the latter button opens the main menu, which will be discussed in detail in the following chapters. The [Menu](#) button is really important, since it enables access to one of the menus used for configuring piHPSDR. Between the VFO bar and the [Hide](#)/[Menu](#) buttons, you see the meter area where you find the S-meter (during RX) and information about output power, SWR, etc. during TX.

Below the RX spectrum scope, you see the Zoom/Pan area with the Zoom and Pan sliders, as already discussed. This area can be „hidden” with the [Display](#) menu to save some vertical space. Below the Zoom/Pan sliders you see a larger Sliders area containing several sliders for adjusting AF volume, TX drive leve, RX AGC threshold, etc. Although the Sliders area can also be hidden via the [Display](#) menu, you should not do so unless you have a GPIO or MIDI controller which knobs that you can asssign to the slider functions. This is so since for normal operation, having access to the sliders is vital. Remember that for temporarily enlarging the space for the RX panel, there is the [Hide](#) button!

If you have a GPIO or MIDI console, and, say, assigned a knob there to control the AF volume, then turning the knob will auto-magically also move the AF slider if its on display (that is, if the sliders area is not hidden). If you turn a knob for which function there is slider on display, either because the slider area is hidden or because this function does not have a slider in that area, then a graphical slider will temporarily pop up in the middle of

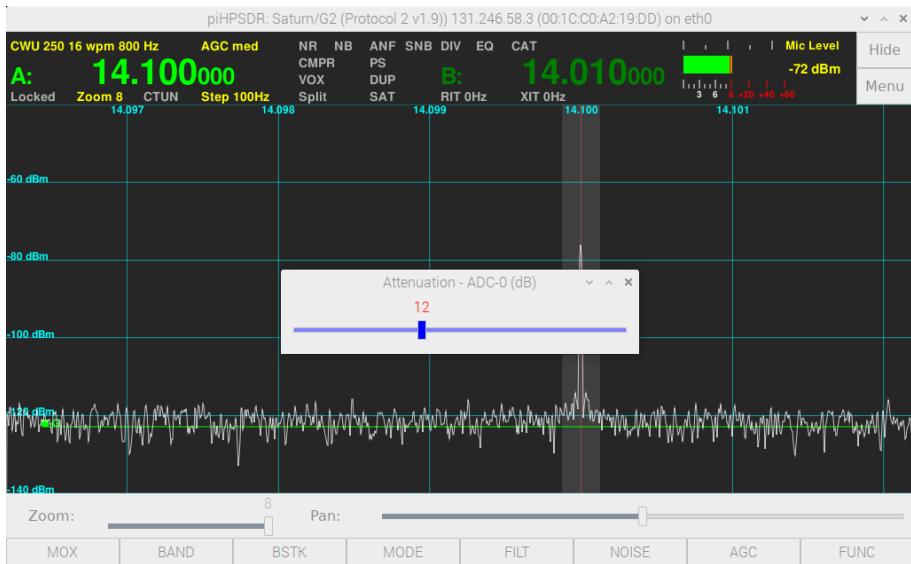


Fig. 3.5: A pop-up attenuation slider.

the window to inform you about the changes you have made. To give one example, a knob at a MIDI console has been assigned to the RF attenuator ([Atten](#) function, see Appendix A), which controls the step attenuator in the RF front-end (if there is one). As long as the sliders are on display, the [Att](#) slider in the right part of the slider area moves when turning the knob. But when the sliders are not displayed, then a slider image pops up on the middle of the screen, and the bar contained therein moves when turning the knob, and the numerical value is displayed as well (Fig. 3.5). Such a pop-up slider always occurs if a knob on the GPIO or MIDI console is turned and no slider associated with the value changing is on display.

3.6 Mouse clicks in the main window

The main window „accepts” mouse or touchscreen click events. Some of them come from the standard handlers of the GUI. It is clear, for example, that clicking the [Hide](#) or [Menu](#) buttons, as well as clicking one of the toolbar buttons, will activate the function associated with these buttons. Furthermore, the sliders (and the squelch enable/disable checkbox) in the sliders and Zoom/Pan are operated as usual. But there are additional functions

coded into piHPSDR:

If there are two receivers, a mouse click (press and release) into the panel of the non-active receiver makes it active. On the other hand, a mouse click in the panel of the active receiver changes the VFO frequency of that receiver to the value clicked on. This means, if you see a signal in the spectrum scope, click on that signal and your VFO will move (*jump*) to that signal. Note the VFO frequency will be rounded to the next multiple of the VFO step size when jumping by a mouse click or touch screen press.

The second option to change the VFO frequency of the active receiver is to click (and hold) into its panel, then drag the mouse to the left or to the right, and then release the button. This will shift the VFO frequency by the amount dragged, it makes no difference where the first click actually occurred, only the difference in horizontal position between click and release is used. You must drag at least three pixels so there is clear discrimination between a *VFO jump* (click then release) and a *VFO drag* (click, drag, and release) operation. Finally, the VFO frequency of the active receiver can be changed by the scroll wheel of the mouse, if there is any. Using the scroll wheel lets the VFO frequency move in multiples of the VFO step size, while mouse dragging can also be used for finer tuning.

Clicking into the VFO bar opens the **FREQ** (VFO) menu, for the VFO-A if clicked into the left half of the bar, and for VFO-B if clicked into the right half. This menu not only offers the possibility for direct frequency entry, but also lets you alter the RIT/XIT or VFO step size, or alter the Lock, Duplex, CTUN, or Split states. So a simple click in the VFO bar gets you quick access to often-used functions.

Clicking in the meter section (between the VFO bar and the Hide/Menu buttons) opens the **METER** menu, where you can change the meter properties (see below).

When operating with a mouse, there are usually two mouse buttons, the primary button (for right-handed mouses, this is usually the left button) and a secondary one. Secondary mouse clicks are difficult to apply with a touch-screen. Although there are touch-screen drivers which convert long presses to secondary clicks, they generate, for a long press, a primary click first and a secondary one later, so it is not possible to generate a single „secondary press” event. But for the benefit of mouse users, secondary mouse clicks are

handled in a special way:

A secondary click into the VFO bar will open the **BAND** menu, so a band change can be made with really few mouse clicks. Likewise, a secondary click into the panel of a receiver (no matter if it the active or the non-active one) will open the **RX** menu for that receiver. This can be used to change the settings of a non-active receiver without making it temporarily active. In the same way, a secondary click in the TX panel will open the **TX** menu.

3.7 VFO bar and status indicators



Fig. 3.6: The VFO bar

Fig. 3.6 shows the VFO bar layout in more detail. The example shown is a VFO bar whose width is 745 pixels and thus suitable for screens that are 1024 pixels wide (or more), since the meter area has a fixed width of 200 pixels, and the **Hide/Menu** buttons are 65 pixels wide. This layout is denoted **Large dials for 1024px windows**, as to the choice of VFO bar layouts, see the description of the **Screen** menu.

The large dials indicating the frequencies of VFO-A and VFO-B are easily recognized. The number to the left of the decimal point is the MHz part of the frequency, the three large digits to the right of the decimal point is the kHz part, and the last three (smaller) digits offer sub-kHz resolution. You may wonder why there is so much space to the left of the frequencies. This is so because with the advent of the QO-100 satellite, frequencies above 10 GHz can be used (with the transverter bands) and therefore eleven digits are needed!

Apart from the frequencies, you see a lot of text, most in light grey colour. As a general rule, a text in grey colour indicates a feature that is currently disabled, while features currently active are normally shown in yellow and sometimes in red.

At the top left corner of the VFO bar, the mode and filter of the currently

active receiver is displayed. In Fig. 3.6, the text is **USB Var1** which indicates that the mode is USB using the Var1 filter with variable width (see the **Filter** menu). For the CW (CWU and CWL) modes, the CW speed (in wpm) and the side tone frequency (in Hz) is stated as well.

Now we continue line by line, from left to right and find the string **AGC med** printed in yellow. This means that automatic gain control (AGC) is effective in the active receiver, and that the AGC time constant is intermediate. Possible values for the time constant are Long, Slow, Medium and Fast which can be selected in the **AGC** menu. Here one can also disable AGC, in this case the VFO bar shows **AGC off** in grey colour.

Continuing to the left, we see the noise reduction settings, all printed in grey (that is, they are not effective). This can be changed in the **Noise** menu. We have two different noise reduction capabilities **NR1** and **NR2**, these strings are printed in yellow instead of the grey **NR** if they are effective. There are also two different noise blankers **NB1** and **NB2**, the automatic notch filter **ANF** and the spectral noise blunker **SNB**. Besides enabling/disabling these functions, there are further parameters you can tweak in the **Noise** menu.

The next strings whether Diversity reception is enabled or disabled (**DIV**), or whether an equalizer is effective **EQ**. Since there is a separate equalizer for the RX and TX audio chain, the equalizer indicator, if it is effective, not only turns yellow but reads **RXEQ** while receiving and **TXEQ** while transmitting. This means, if only the TX equalizer is enabled, the indicator will show a grey **EQ** while receiving and a yellow **TXEQ** while transmitting.

The last indicator in the top row is **CAT** which indicates if the CAT module (see the **RIGCTL** menu) has accepted at least one connection. In total, piH-PSDR can be CAT-controlled simultaneously by five different sources, two of them using a serial line and three of them a TCP connection.

The indicators in the middle, between the VFO dials, are related to transmitting. **CMPR** indicates if a speech processor (compressor) is enabled, if so, it prints in yellow, followed by a number between 1 and 20 indicating the compression value in dB. **PS** indicates whether adaptive pre-distortion („PureSignal“) is enabled, PS settings can be made in the **PS** menu. **VOX** indicates whether VOX (voice control) is enabled. VOX means that if the microphone delivers an amplitude above a certain threshold, the radio is automatically put into TX mode. Enabling/Disabling VOX and setting the correct thresh-

old can be done in the **VOX** menu. Finally, **DUP** indicates whether duplex mode is active. In duplex mode, the receiver(s) continue to work during transmit. Duplex mode when using the same antenna for RX and TX is no fun: you not only hear your own signal with a delay (from the cross-talk at the TRX relay), but this cross-talk signal is usually so strong that it leads to „AGC pumping”, so your receiver is virtually deaf during the first second after TX/RX transition. For satellite operation, on the other hand, duplex mode is very convenient. Here you usually have two separate and well-decoupled antennas for RX and TX.

The bottom line of the VFO bar indicators are related to the VFO status. If the **Locked** string is red, it indicates that the VFO is locked and will not accept changes. There is a **LOCK** action which toggles the LOCK status and which can be assigned to a toolbar button or a push-button on a GPIO or MIDI console, but the Lock status can also be set/unset via the **FREQ** menu, accessibly by the main menu window, or just by clicking into the VFO bar.

The next indicator in the bottom line indicates the Zoom factor. If the Zoom factor is 1, the indicator is grey, otherwise it is yellow and also indicates the factor. Then there is a string **CTUN** which indicates whether the CTUN („click to tune”) mode is off or on (the string is yellow in the latter case). The step size of the VFO controlling the active receiver is displayed next, this string is always yellow.

The split status is displayed by the next indicator, which is red in split mode. If split mode is off, transmitting is done on the frequency and the mode of the active receiver (if there are two receivers), or on the frequency/mode of VFO-A (if there is only one receiver). If split mode is on, transmitting occurs on the frequency/mode of the non-active receiver (if there are 2) or on VFO-B (if there is only one receiver).

The next indicator shows the SAT (satellite) mode, which can be off (then the indicator reads **SAT** in grey), or which can be SAT or RSAT (then the indicator displays this string). Once SAT mode is engaged, the two VFOs are tied together such that any frequency change of one of the two VFOs also applies to the other VFO. This is the best way to do cross-band operation with, e.g. the QO-100 satellite which is at a fixed position. In RSAT mode, a frequency change of one of the VFOs is applied to the other VFO with an opposite sign (so if you move up VFO-A by 2 kHz, then VFO-B moves down by the same amount). This is what one needs for low-flying satellites which

have inverting transponders which offer some sort of Doppler correction.

Finally there are the **RIT** (receiver incremental tuning) and **XIT** (transmitter incremental tuning) indicators. If RIT is off, receiving occurs on the VFO dial frequency. If RIT is on, the indicator becomes yellow and also indicates the RIT offset, that is, the frequency offset used while receiving. RIT is used, for example, if during your CW QSO the frequency of the transmitter of your QSO partner drifts and you want to follow without altering the frequency of your own transmitted signal. The RIT indicator corresponds to the active receiver. If XIT is active, the indicator becomes yellow and shows the offset of the true TX frequency from the VFO dial frequency.

Finally, in the top right corner you see a symbol with a green and a red line that only occurs if one of the variable filters (**Var1** or **Var2**) have been selected. The green caret indicates the default filter edges, while the red one above denotes the current filter edges.

3.8 Meter section

Fig. 3.7 shows the different designs that exist for the meter. To the left (right) there are the digital (analog) meters, while the top panels show the meter during RX and the lower panels during TX.

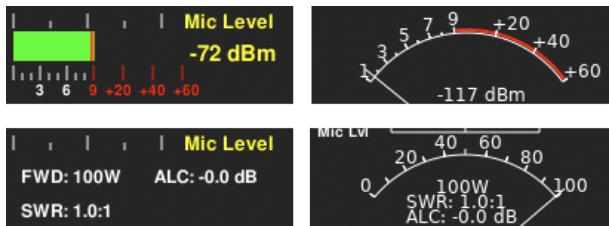


Fig. 3.7: Different designs for the meter.

The design can be switched between digital and analog in the **Meter** menu, which can be accessed quickly just by clicking into the meter area. During RX, an S-meter is shown together with the signal level in dBm. Note that -73 dBm corresponds to S9 for frequencies up to 30 MHz, while above 30 MHz, S9 corresponds to -93 dBm. Since the S meter is in steps of 6 dB, a signal level of S1 (below 30 MHz) corresponds to -121 dBm.

During TX, the output power is displayed, provided that the radio actually reports this power. The output power meter can be calibrated (see the **PA** menu). If the SWR exceeds a threshold for SWR warnings (the default is 1:3, but this can be changed in the **TX** menu), the SWR indicator turns red. If, in addition, SWR protection is enabled in the **TX** menu, the output drive will be reduced to zero if the SWR exceeds that threshold. Furthermore, the ALC (automatic level control) value of the transmitter is shown. Negative ALC values (at least in peak mode) indicate that the volume of the TX input audio could be increased to get full output power.

Further info on the meters (e.g. switching between „peak” and „average” reporting) is described in the **Meter** menu.

Chapter 4

The Main Menu: introduction

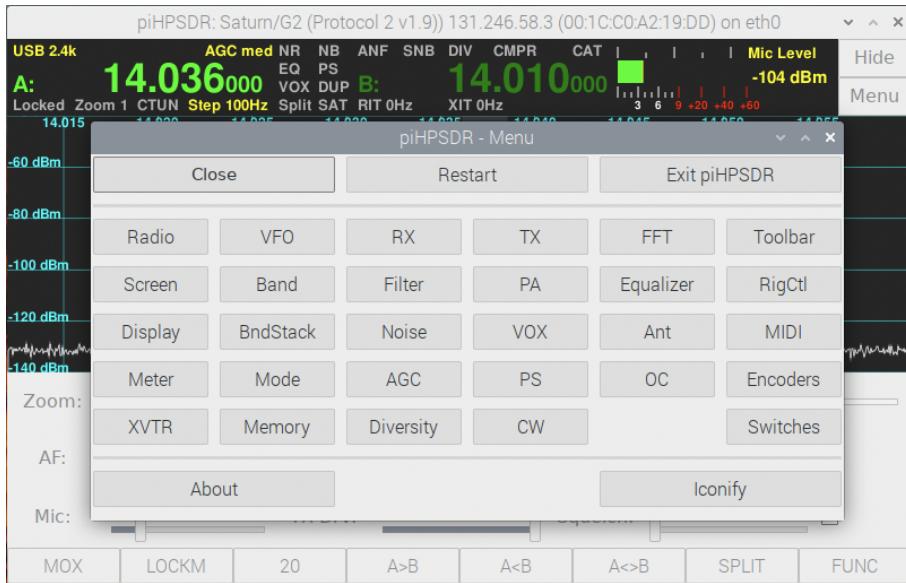


Fig. 4.1: The Main men, opened by the **Menu** button.

Now we have a series of chapters that discuss all the piHPDSR menus. Many menus can be opened by a button click (or a push-button on an external controller), e.g. hitting the **MODE**, **FILT**, or **NOISE** button on the toolbar you have seen in the last picture. You already know that the VFO and Meter menus can be opened by clicking into the VFO or meter section at the top of the window. When operating with a mouse, a secondary click in the RX

or TX panadapter opens the RX or TX menu. But there is one place from which *all* piHPSDR menus are at hand, and this is the "Main Menu". It can be opened by clicking into the **Menu** button at the top right corner of the piHPSDR window, the outcome is shown in Fig. 4.1.

Some remarks have to be made about menus in general. Since piHPSDR is optimized for working with small screens, only one menu can be open at a time. If a menu is open and one tries to open another one, the first menu will be destroyed (closed) and the new one will be opened. For example, if you hit the **FILT** button in the toolbar when starting from Fig. 4.1, the main menu closes and the **Filter** menu opens. If you try to open a menu that is already open, then the menu will be closed. So, starting from Fig. 4.1 hitting the **Menu** button again will close the menu. Likewise, when the Filter menu has been opened, either via the Main Menu or with the **FILT** button, then hitting this button again will close the **Filter** menu.

While the menus are looking quite diverse, some effort has been invested to keep some things consistent throughout. For example, at the top left corner of the menu you usually find the "Close" button which closes the menu. The close button is somewhat emphasised (slightly larger letters, and a thin border) so you will always quickly find it. Of course, it is possible to close a menu by deleting the menu window (on RaspberryPi, this is the small cross at the left of the title bar) but this is neither necessary nor recommended.

There are some commands available here that do not directly affect the radio operation, so these commands are found in the top and bottom line of the Main Menu. We first mention the **Restart** button in the middle of the top line. This restarts the radio protocol. While not needed under normal circumstances, it may happen (especially with beta releases of radio FPGA firmware) that the data exchange between piHPSDR and the radio gets out-of-sync. I observed such problems with early versions of the P2 firmware for Orion2 boards and that is the reason the **Restart** button is there, since this made a quick recovery possible without losing the QSO. At the bottom right, there is the **Iconify** button which „minimizes“ the piHPSDR window. Normally, if needed, one can do so by standard methods of the operating system in the title bar of the piHPSDR window. If piHPSDR, however, runs in full-screen mode (this is the case on very small touch screens), then the **Iconify** button to make the piHPSDR window temporarily disappear without breaking the connection to the radio, do some work with the operating

system, and get the piHPSDR window back. Note in earlier versions of piHPSDR this function was associated with the "Hide" button in the top right corner of the main window. Then, there are two menus ([Exit](#) and [About](#)) which are described in due course and which one can open by clicking either [Exit piHPDSR](#) or [About](#) in the main menu.

The other buttons, between the two horizontal separator lines, give access to piHPSDR control and fine tuning. They are organized in six columns, namely radio related menus (first column), VFO related menus (second column), RX and TX related menus (third and fourth column), menus affecting both RX and TX (fifth column) and, finally, menus for adjusting how you can control piHPSDR (sixth column), either via Toolbar, MIDI, or GPIO encoders or switches. „**Encoders**” are knobs which you can turn, and which can be used to change AF volume or TX output power. „**Switches**” are push-buttons which can be used to trigger a function such as transmitting a carrier for tuning, toggle between RX and TX, open a menu, and so forth.

4.1 The Exit Menu

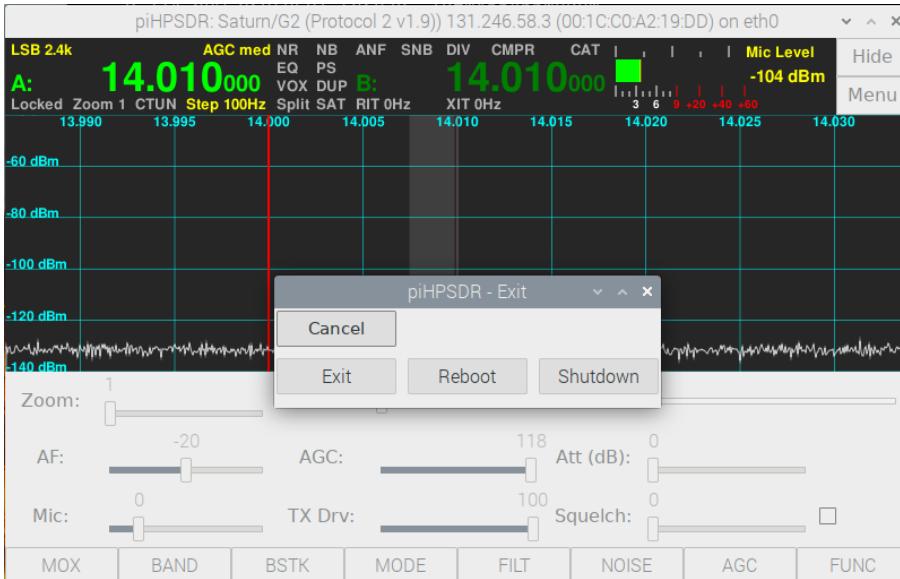


Fig. 4.2: The [Exit](#) menu.

Via the **Exit** menu, you can leave the piHPSDR program. When leaving the program, the radio protocol is stopped and all the settings are written to a preferences file. This file is located in the piHPSDR directory and takes the name `xx-xx-xx-xx-xx-xx.progs`, where the xx encode the MAC address for the radio. So the preferences for different radios (if you have more than one) are stored in different files. To leave the program, just click the "Exit" button in this menu. If you decide you want to continue, you can leave the **Exit** menu by clicking the "Cancel" button. This is the button which closes the menu and has the same position and look as the "Close" buttons in all the other menus.

If piHPSDR runs with administrator privileges, you can even leave the program and either re-boot or switch off the computer via the "Reboot" and "Shutdown" buttons. This makes sense for setups where a Raspberry Pi running piHPSDR, a small SDR radio, a touch-screen and several encoders and switches are built into a single common enclosure. On the other hand, when running piHPSDR on desktop or laptop computers, clicking "Reboot" or "Shutdown" both leave the piHPSDR program but no re-boot or shutdown takes place, due to missing administrator privileges.

4.2 The About Menu

The about menu gives you some information about piHPSDR, first the original author and an (incomplete) list of persons who contributed to the code, and then a statement which version of piHPSDR is working here, and when it has been compiled. Here you also find the version number of the WDSP library which is the „engine” running under the hood, and which does nearly all of the signal processing. Finally, there is some data on the radio, namely the device type and version numbers, and which protocol is running. For diagnostic purposes, you also see the MAC address of the radio, its IP address and the IP address of the computer running piHPSDR. The MAC address is of interest since the radio-specific preferences are stored in a file whose name is derived from the radio’s MAC address.

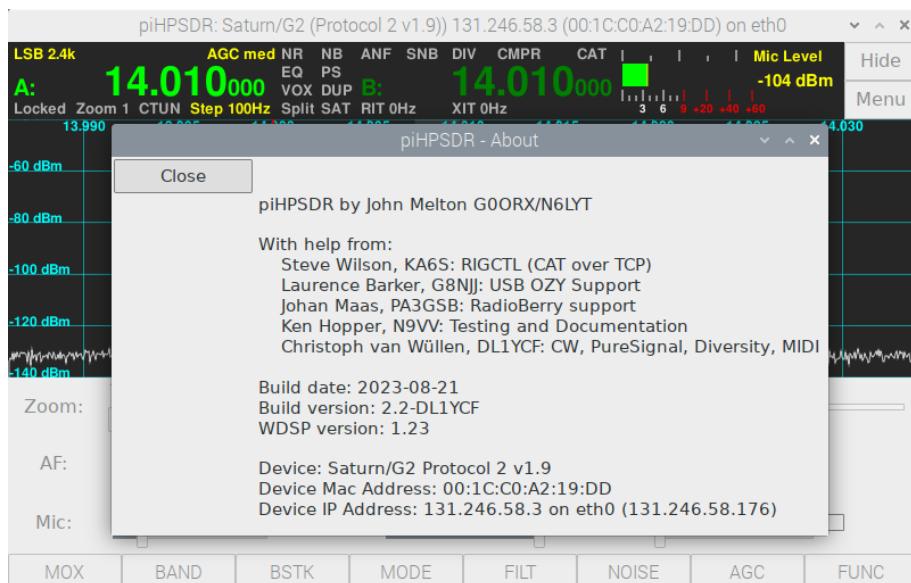


Fig. 4.3: The [About](#) menu.

Chapter 5

The Main Menu: Radio-related menus

5.1 The Radio Menu

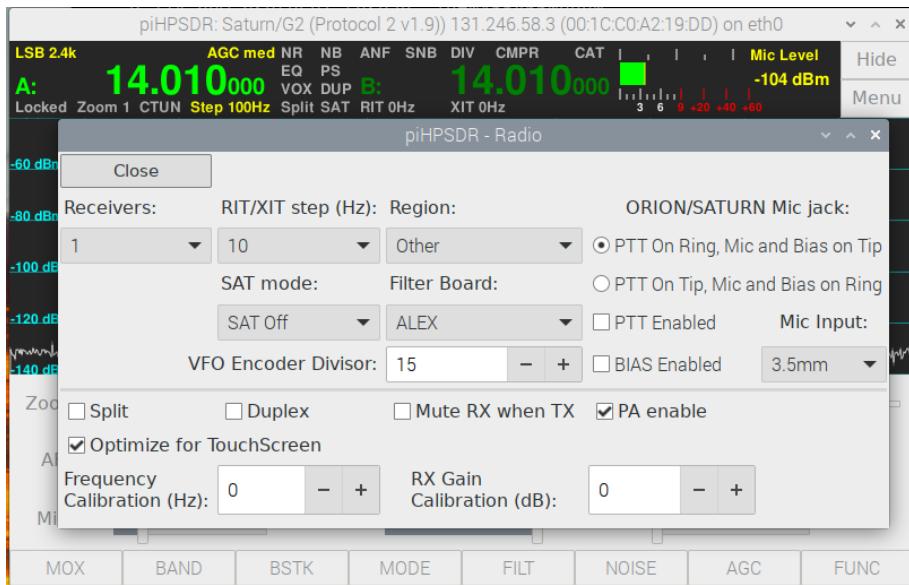


Fig. 5.1: The [Radio](#) menu.

The [Radio](#) menu lets you make settings which affect the general setting, and

the hardware of the radio. The following figure (Fig. 5.1) shows the menu as it opens on an Anan G2 radio. Note this menu looks slightly different for different radios and protocols, this will be discussed at the end of the section. First, we go through all the elements we see in Fig. 5.1, they will be colored red in the following list.

Receivers: In the pop-down menu (GTK combo-box) below this string, you can select the number of receivers that are running (well, you can choose between 1 and 2). When the number of receivers change, the radio communication will shortly be stopped and then resumed, so do not be surprised if the spectrum scope freezes for a second or so.

RIT/XIT step: In the pop-down menu you can choose among three (1 Hz, 10 Hz, 100 Hz) step sizes for RIT and XIT. For example, if the RIT step is 10 Hz, then you can change the RIT offset in steps of 10 Hz with the RIT+ or RIT- buttons in the toolbar or on the GPIO/MIDI controller.

Region: Although not obvious, this selects settings for the 60m band. Possible choices are "Other", "US", "UK" and "WRC15". The US and UK choices implement the channel structure of the 60m band according to the regulations valid in these countries. "WRC15" gives you a small (15 kHz wide) 60m band according to the WRC15 (World Radio Conference 2015) document, which is now implemented in many countries. With "Other" you have a large 60m band from 5250 o 5450 kHz, but it is most likely not legal for you to operate in this entire range.

Orion/Saturn Mic jack: This part of the menu is not shown for pre-Orion boards. The Orion, Orion2, and Saturn boards can switch the connections of the TRS microphone jack in software (hardware jumpers had to be used previously). While the ring of the TRS plug is always connected to ground, the microphone and PTT connections are on the ring an tip and you can choose which one is on the ring and which one on the tip. You can then separately enable the PTT function of the jack, and select whether a bias (DC offset) is applied to the mic connection (this is necessary for condensor microphones and detrimental if a dynamic mirophone is connected without a blocking capacitor).

Mic Input: This is only shown for Saturn boards. These radios have two jacks for connecting a microphone, either a 3.5mm TRS jack in the front panel, or an XLR connection in the back panel. The pop-down menu lets

you choose between these two options.

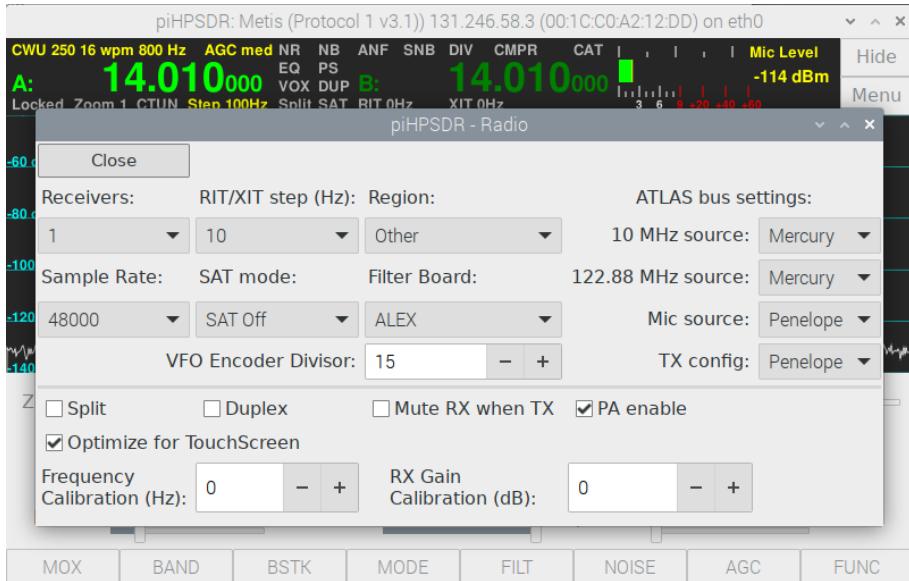


Fig. 5.2: The [Radio](#) menu for a legacy HPSDR board.

5.2 The Screen Menu

5.3 The Display Menu

5.4 The Meter menu

5.5 The XVTR (Transverter) Menu

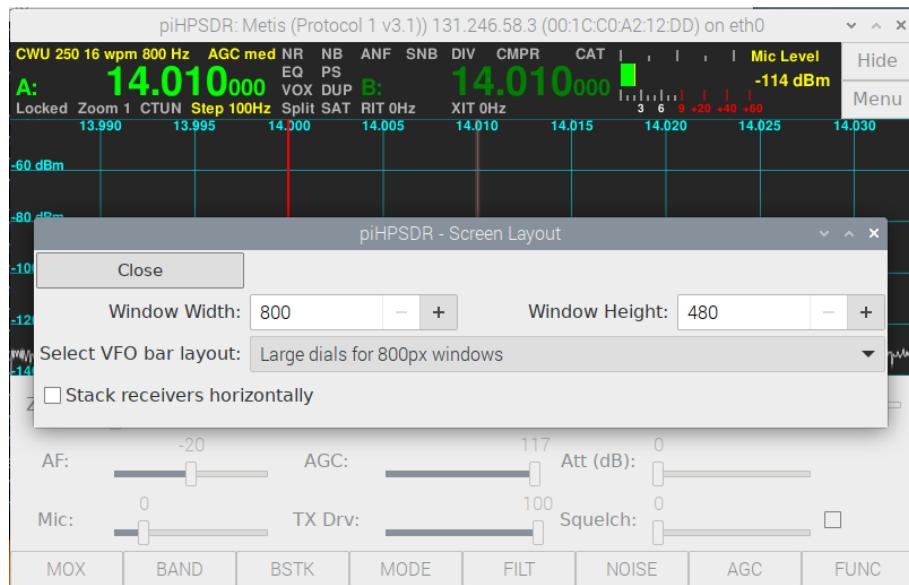


Fig. 5.3: The [Screen](#) menu.

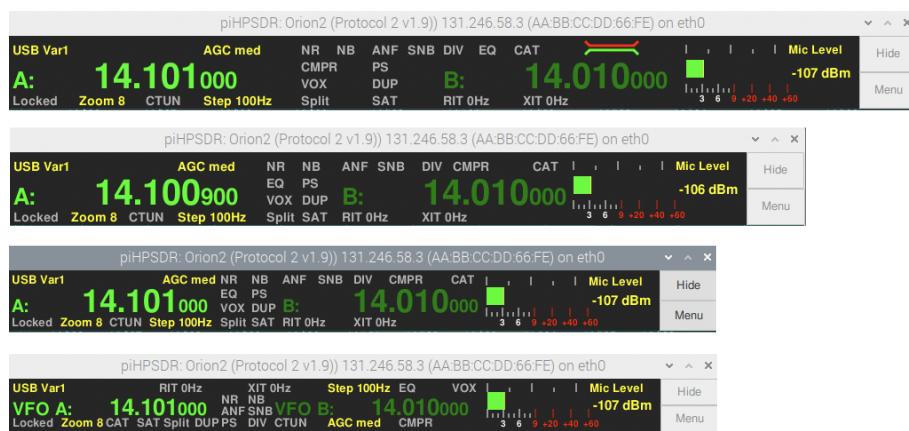


Fig. 5.4: Four choices for the VFO bar built into piHPSDR.

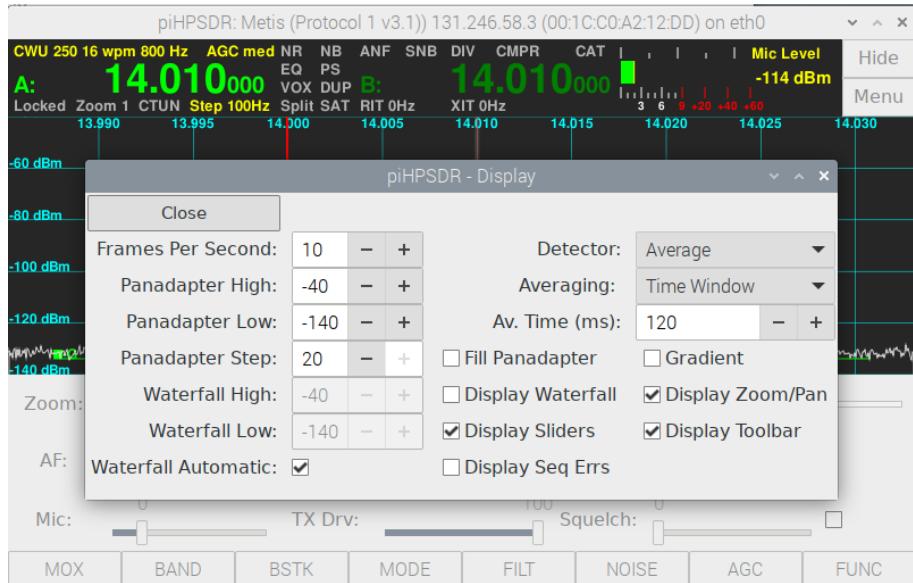
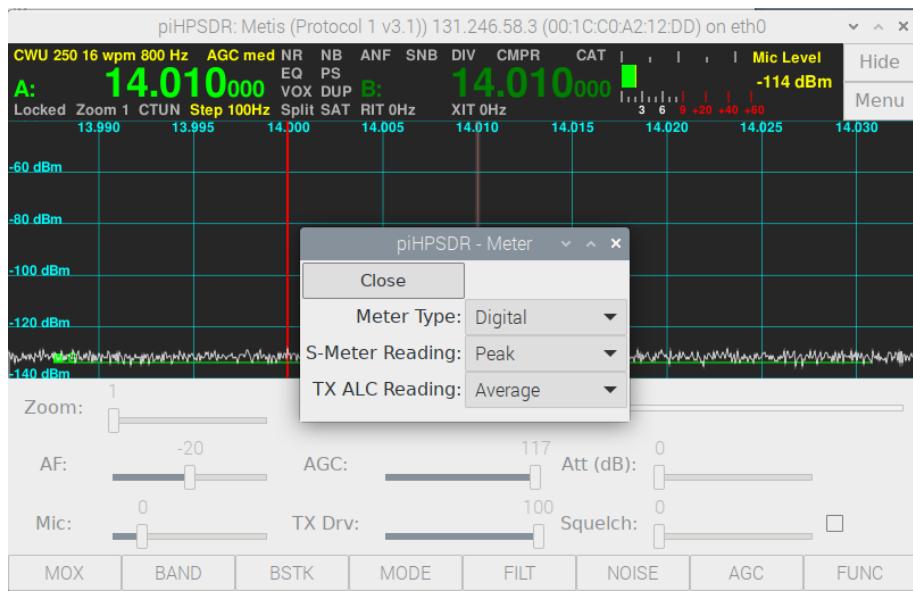
Fig. 5.5: The *Display* menu.Fig. 5.6: The *Meter* menu.



Fig. 5.7: The [XVTR](#) (transverter) menu.

Chapter 6

The Main Menu: VFO-related menus

6.1 The VFO menu

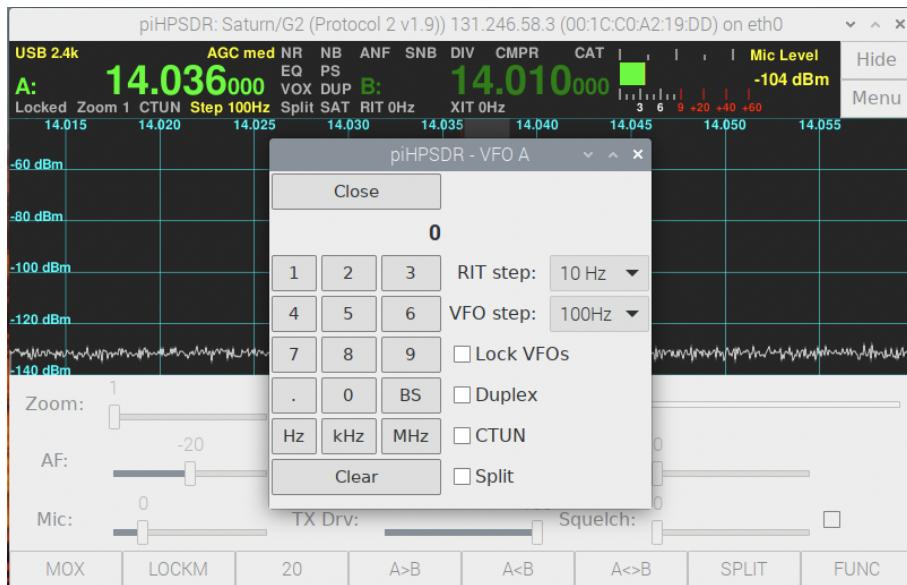


Fig. 6.1: The VFO menu.

6.2 The Band menu

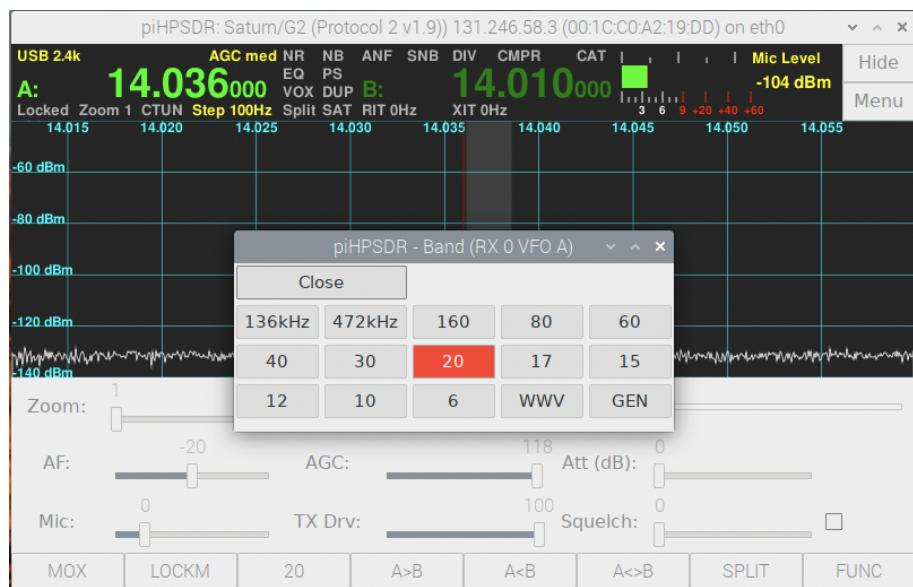


Fig. 6.2: The [Band](#) menu.

6.3 The BndStack (Bandstack) menu

6.4 The Mode menu

6.5 The Memory menu

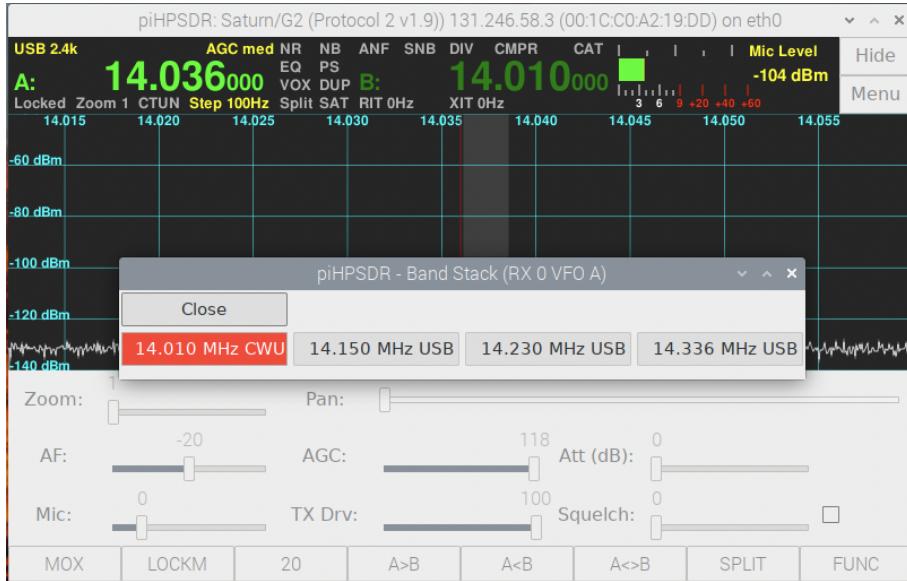


Fig. 6.3: The [BndStack](#) (Bandstack) menu.

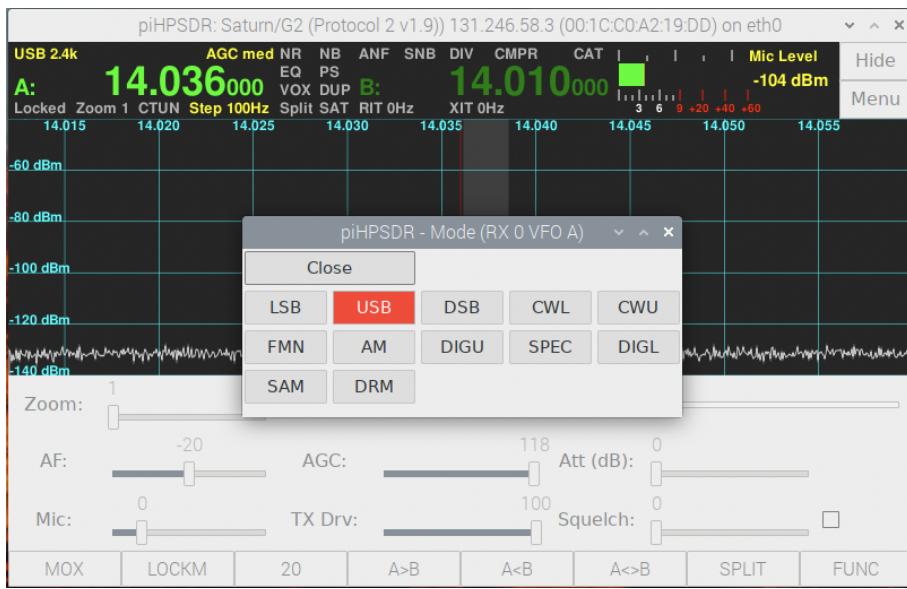


Fig. 6.4: The [Mode](#) menu.

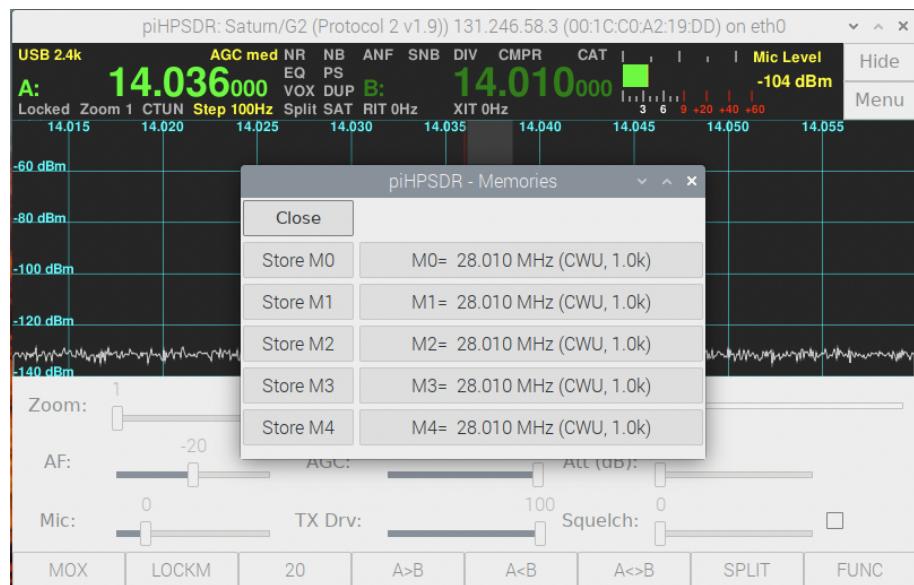


Fig. 6.5: The [Memory](#) menu.

Chapter 7

The Main Menu: RX-related menus

7.1 The RX Menu

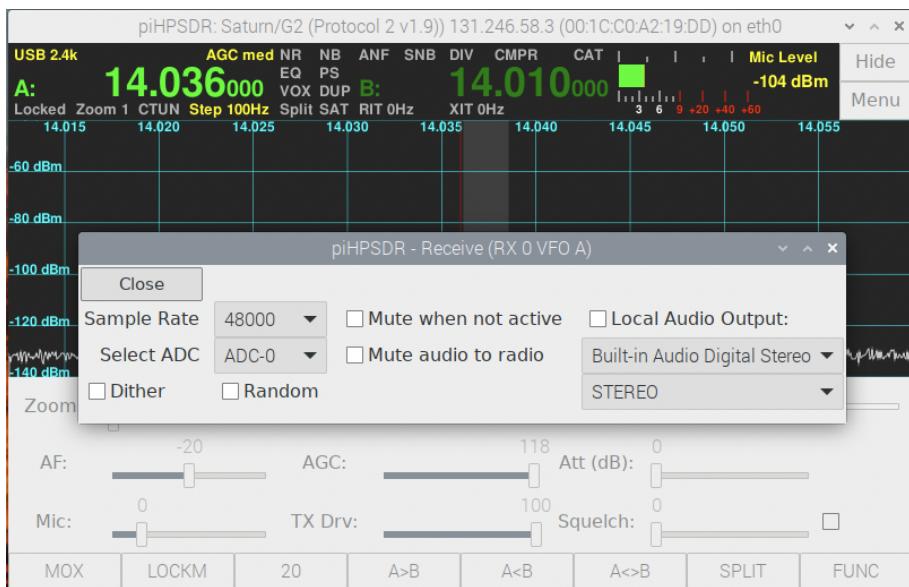


Fig. 7.1: The RX menu.

7.2 The Filter menu

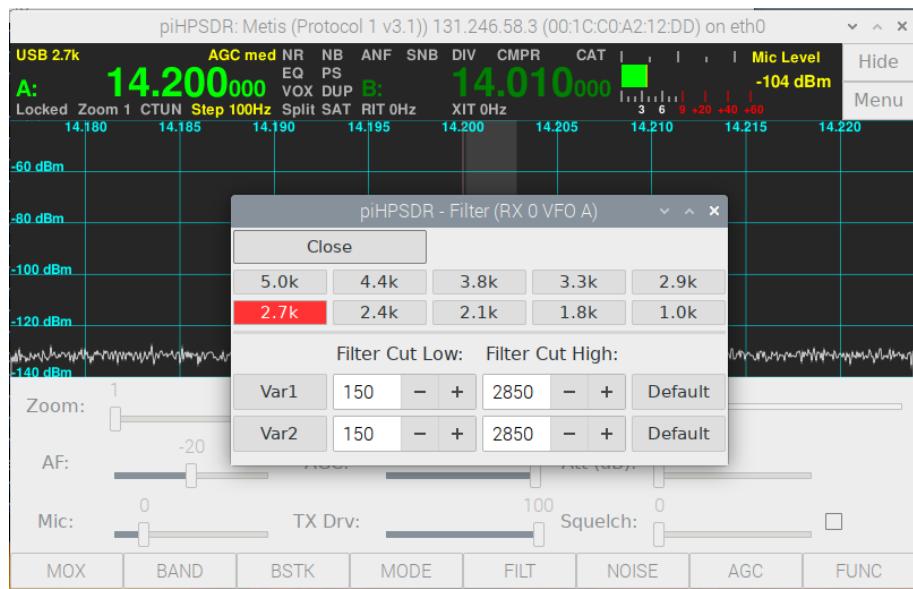


Fig. 7.2: The [Filter](#) menu (single side band modes).

7.3 The Noise Menu

7.4 The AGC Menu

7.5 The Diversity Menu

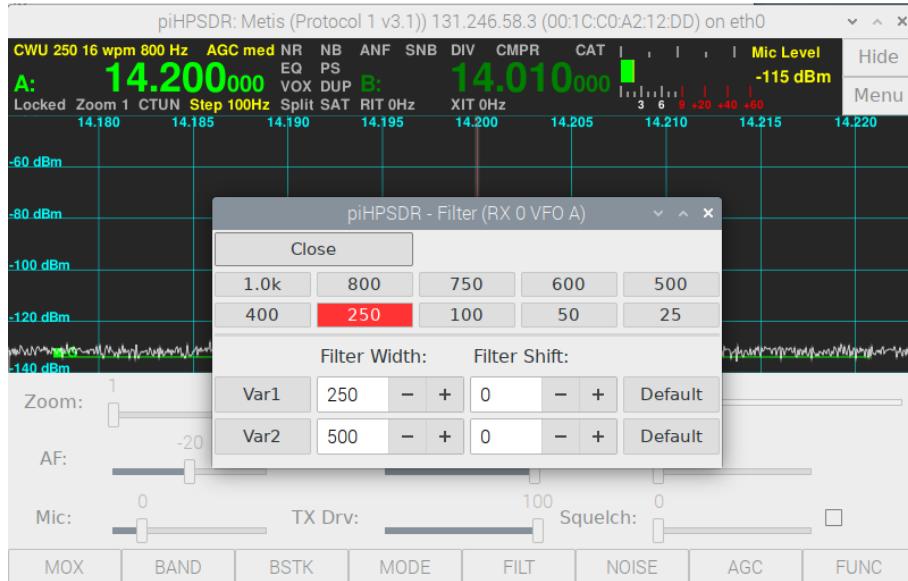


Fig. 7.3: The [Filter](#) menu (CW, AM, etc.).

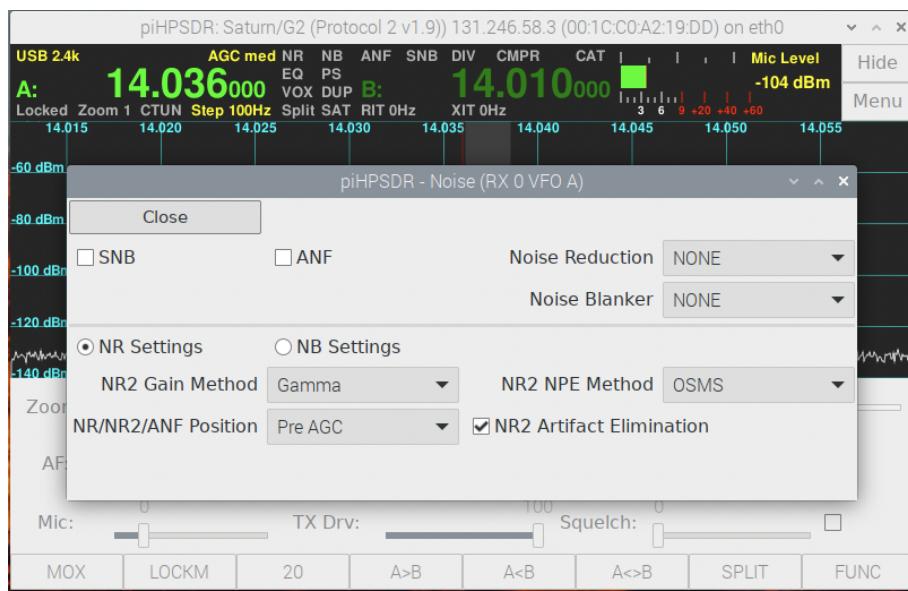


Fig. 7.4: The [Noise](#) menu (with NR settings).

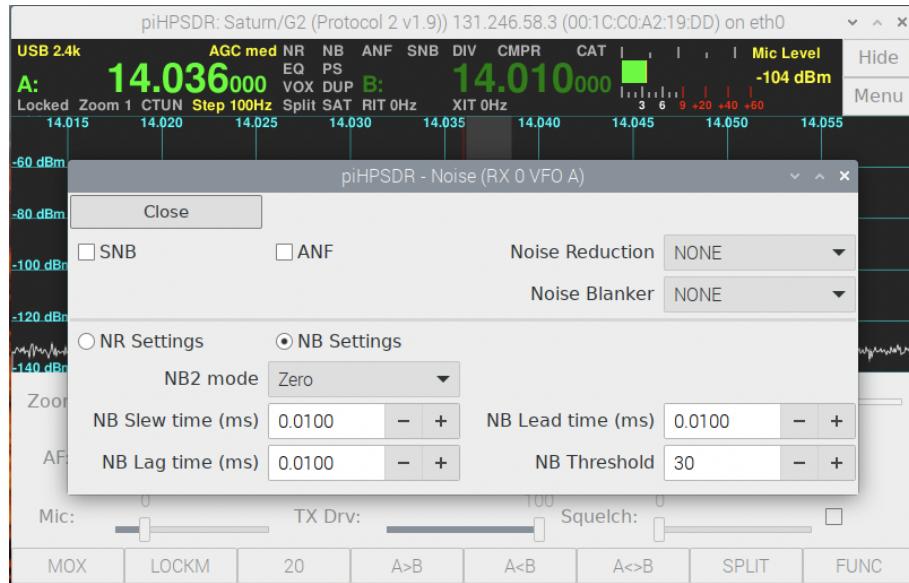


Fig. 7.5: The [Noise](#) menu (with NB settings).

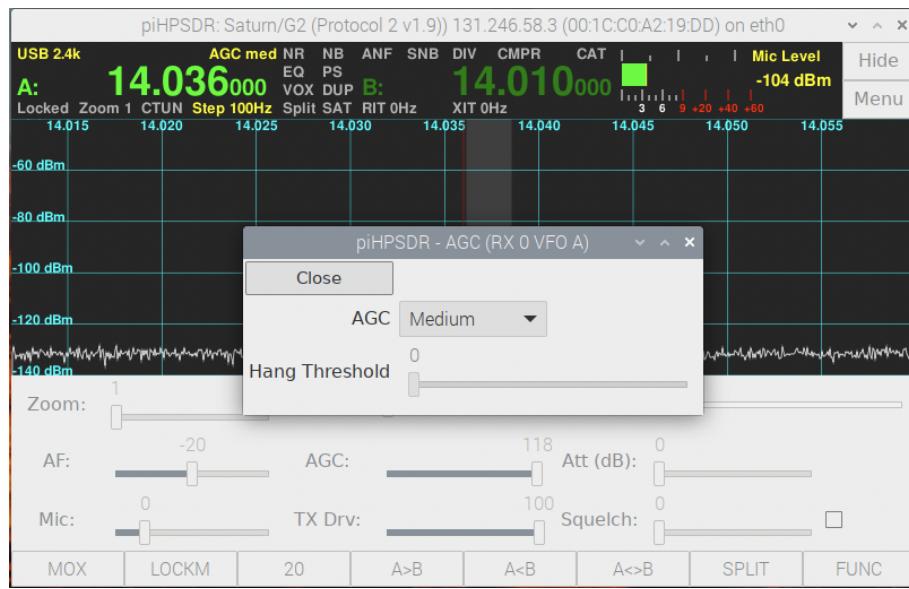


Fig. 7.6: The [AGC](#) menu.

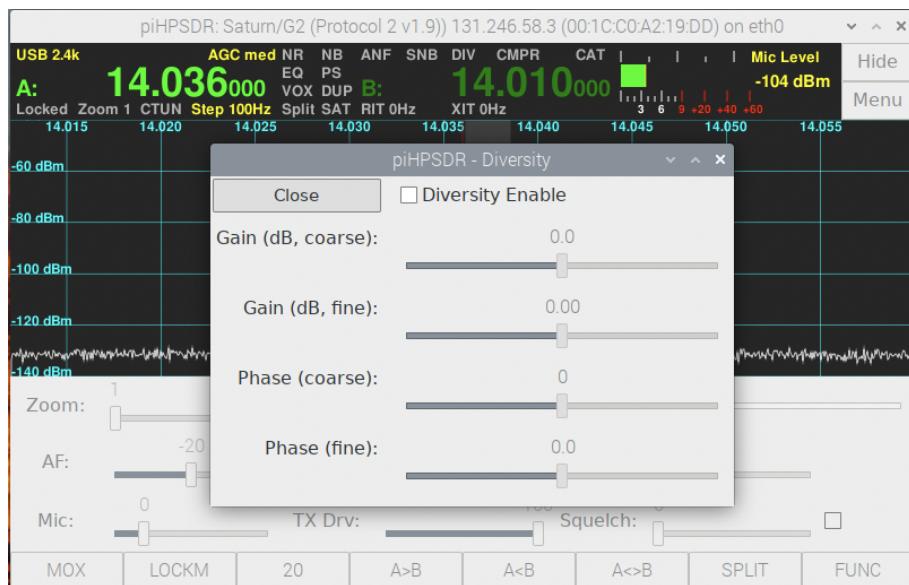


Fig. 7.7: The [Diversity](#) menu.

Chapter 8

The Main Menu: TX-related menus

8.1 The TX Menu

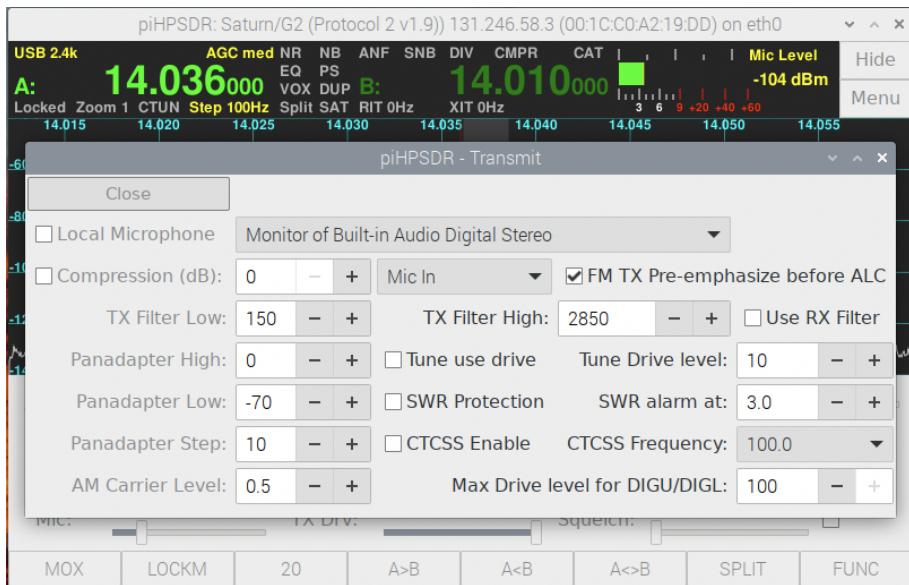
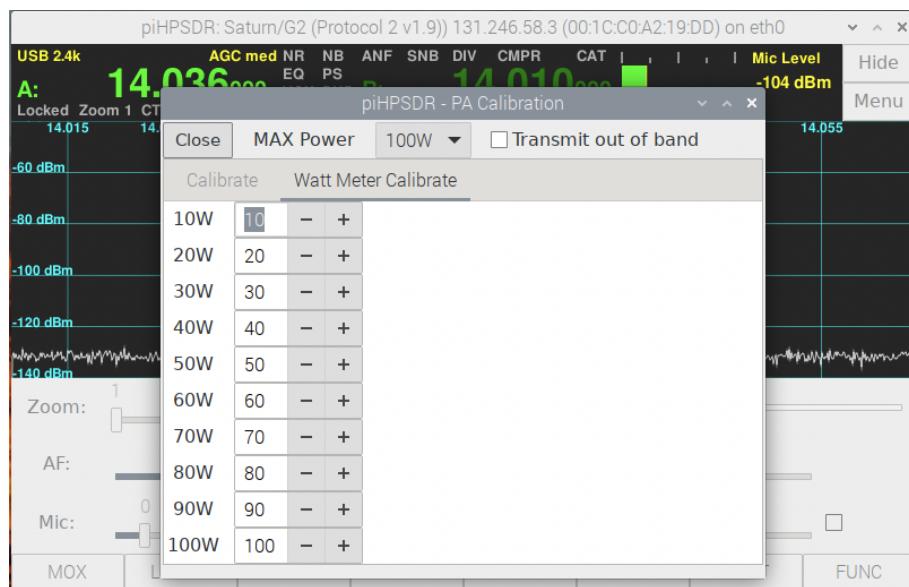
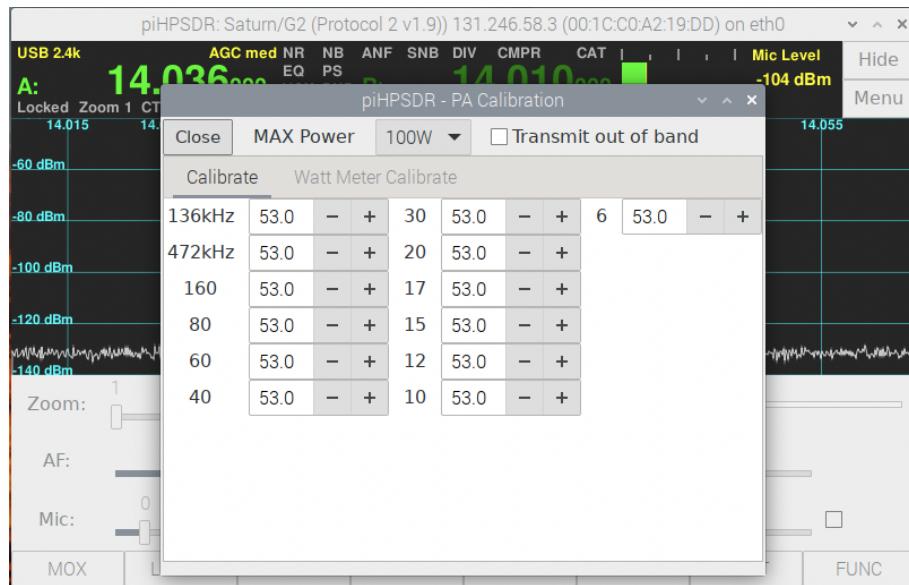
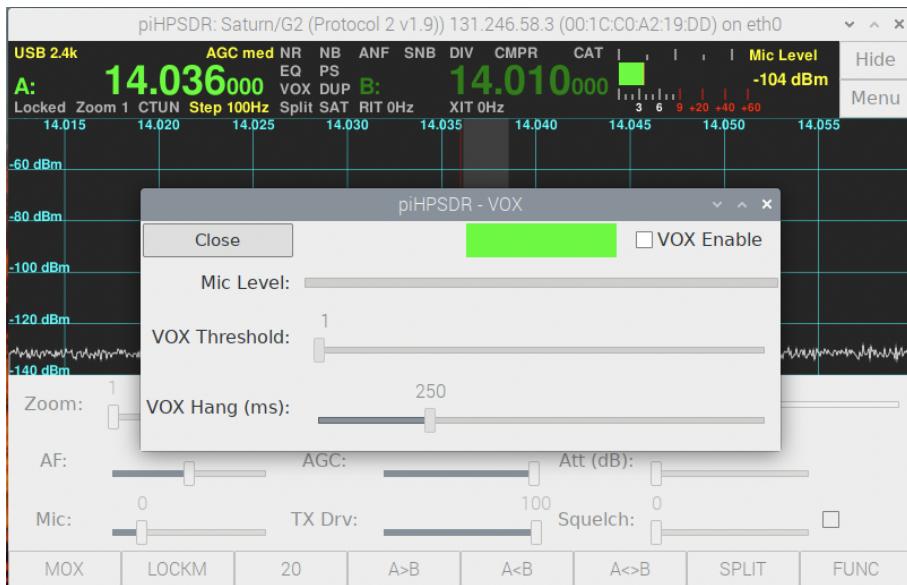


Fig. 8.1: The TX menu.

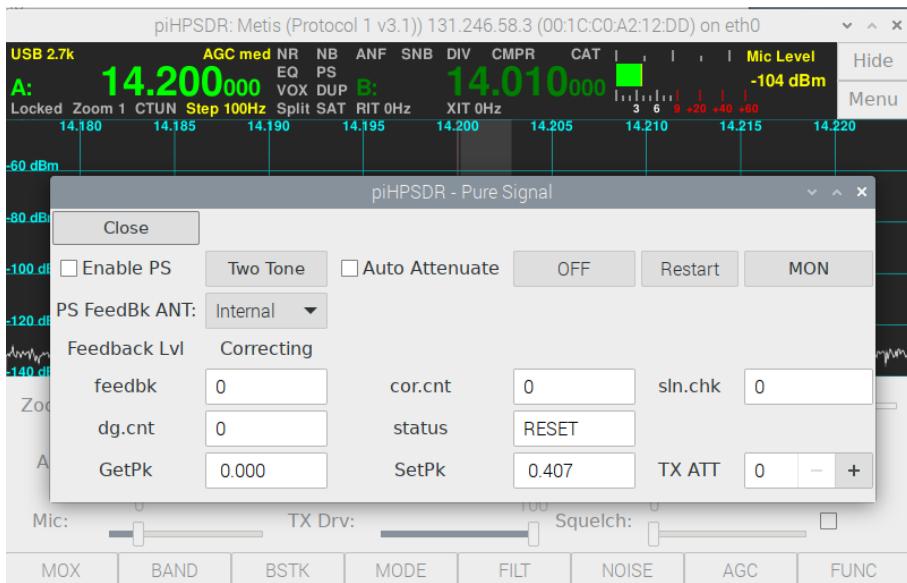
8.2 The PA Menu

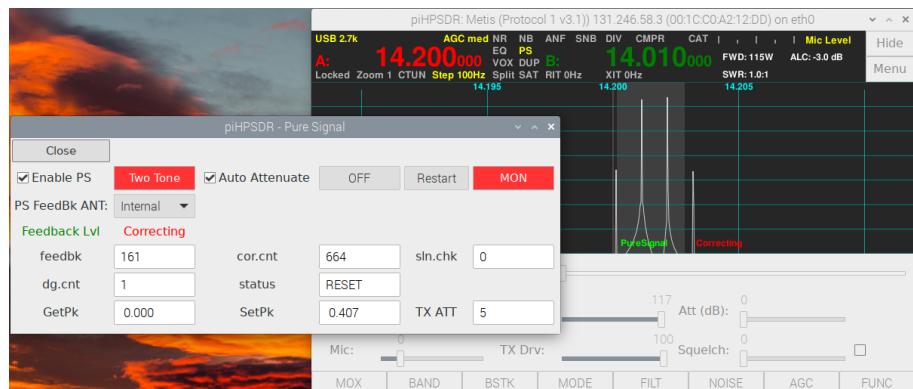
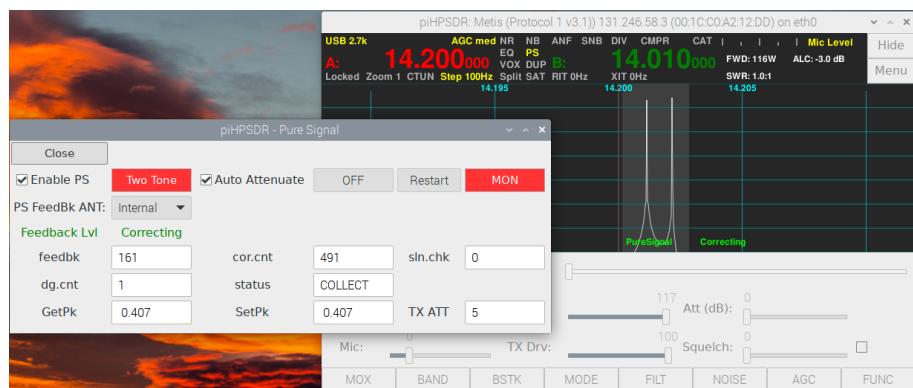
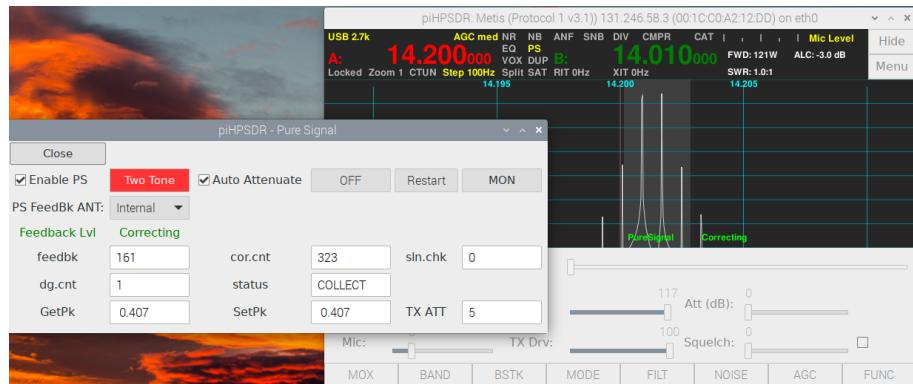


8.3 The VOX Menu

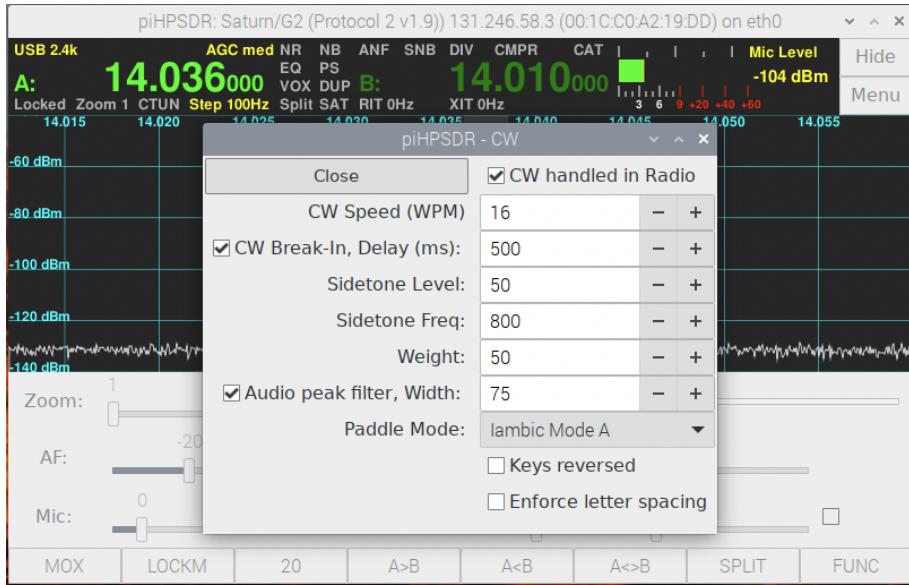


8.4 The PS (PureSignal) Menu





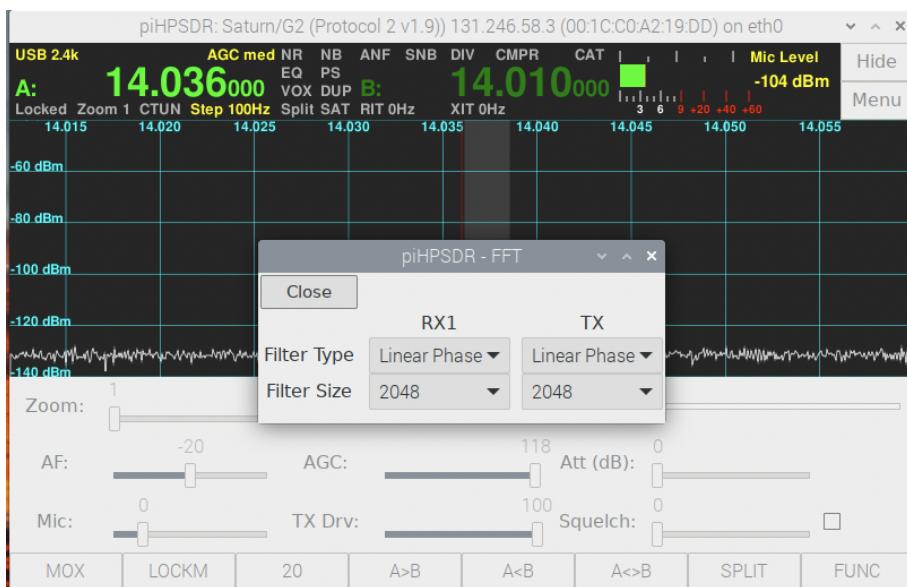
8.5 The CW Menu



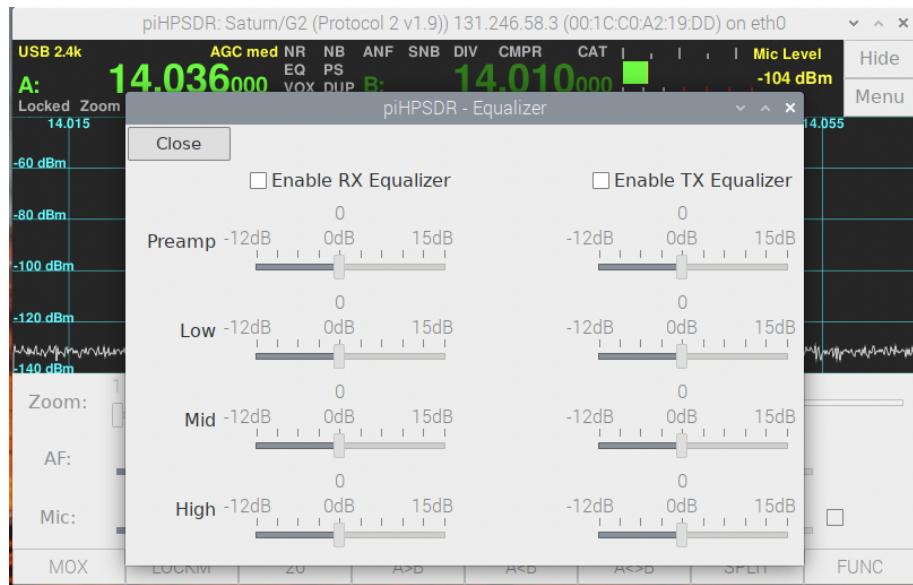
Chapter 9

The Main Menu: menus for RX and TX

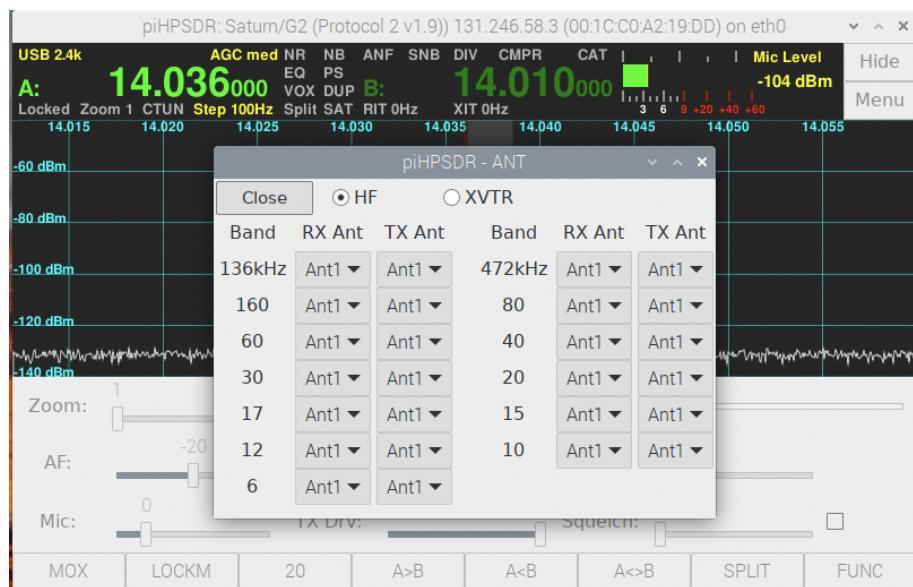
9.1 The FFT (Signal Processing) Menu



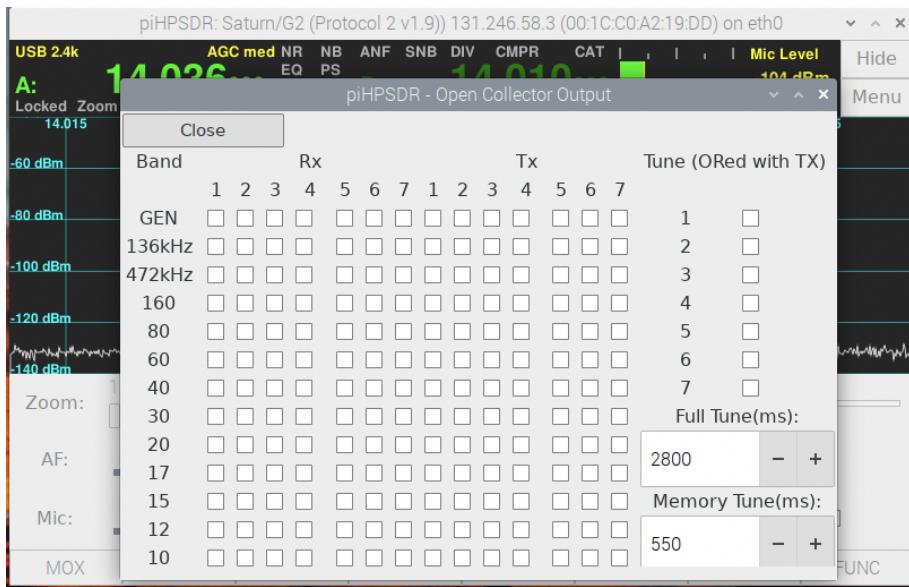
9.2 The Equalizer Menu



9.3 The Ant (Antenna) Menu



9.4 The OC (OpenCollector) Menu



Chapter 10

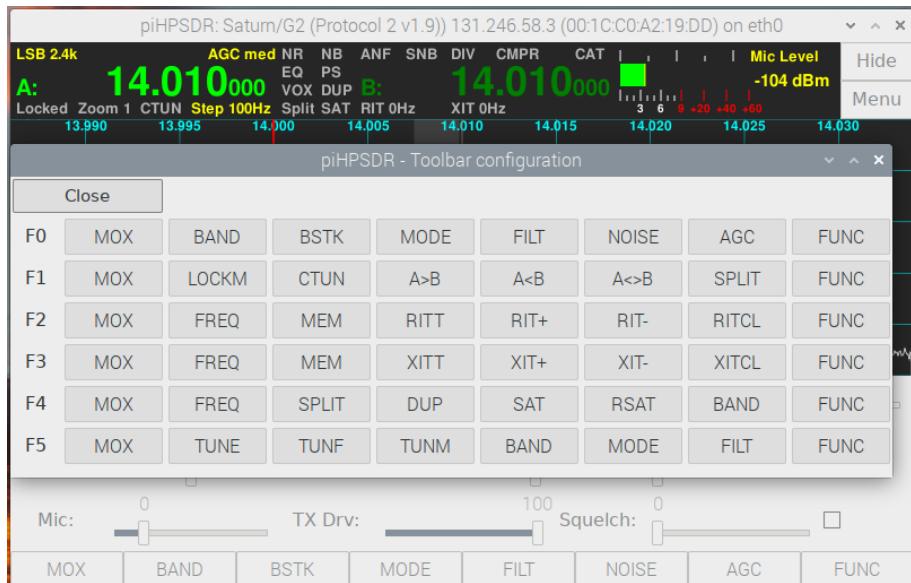
The Main Menu: controlling piHPSDR

In this chapter, the customization of the toolbar (at the bottom of the piHPSDR window), as well as how to configure GPIO and MIDI controllers, is described. Furthermore, in this chapter we discuss the RIGCTL menu which allows controlling piHPSDR by some external program such as a logbook or contest program, via standardized CAT commands that can be sent to piHPSDR either over a serial line or via TCP.

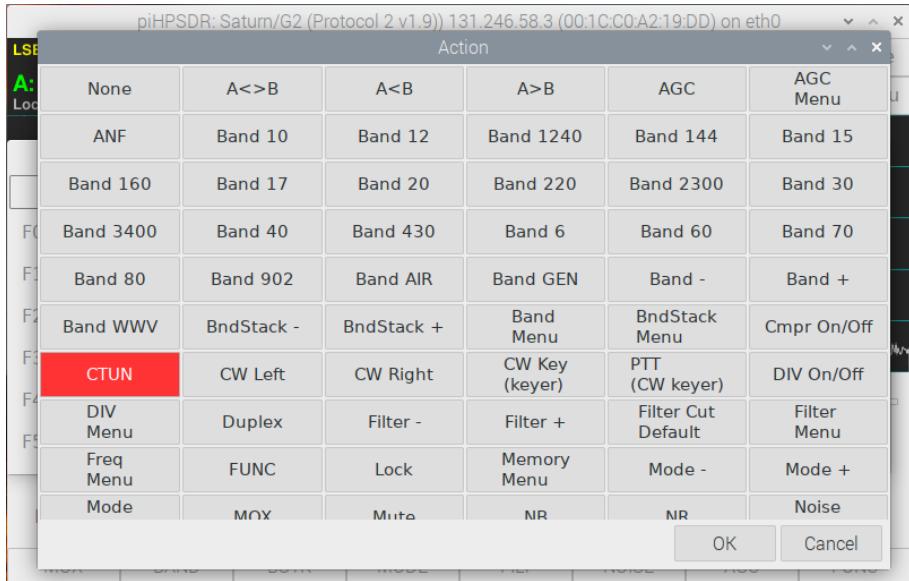
Note for Controller1 owners: The eight switches (push-buttons) of the controller, that are positioned below the screen, are bound to the eight toolbar buttons on the screen. Therefore, there is no "Switches" menu for this controller, and the switches are implicitly configured via the Toolbar menu.

10.1 The Toolbar Menu

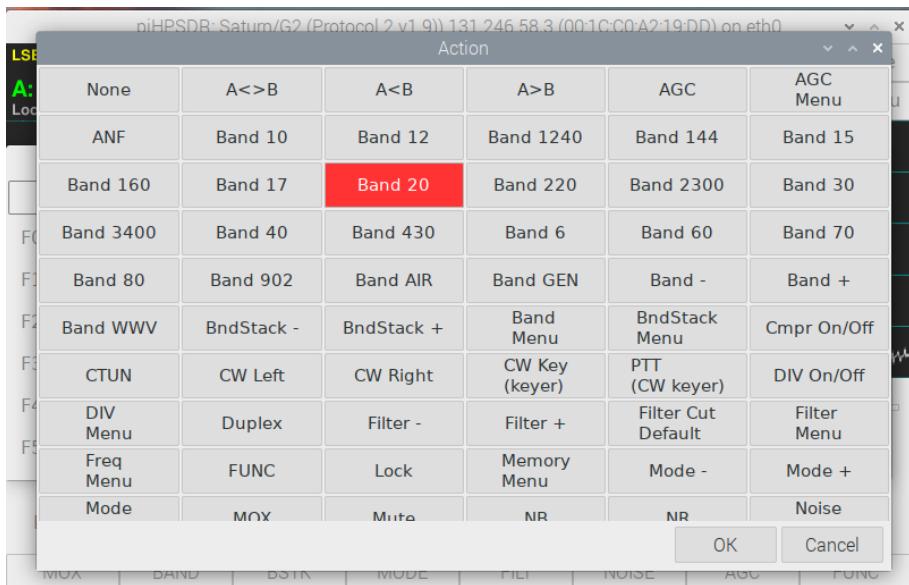
We start with the "Toolbar" menu, that can be found at the top of the rightmost column in the main menu. The toolbar consists of eight buttons that can be assigned to a set of eight functions. There are six such sets, and pressing the FUNC button cycles through these six sets. If you click the Toolbar button, a menu pops up and you see the following:



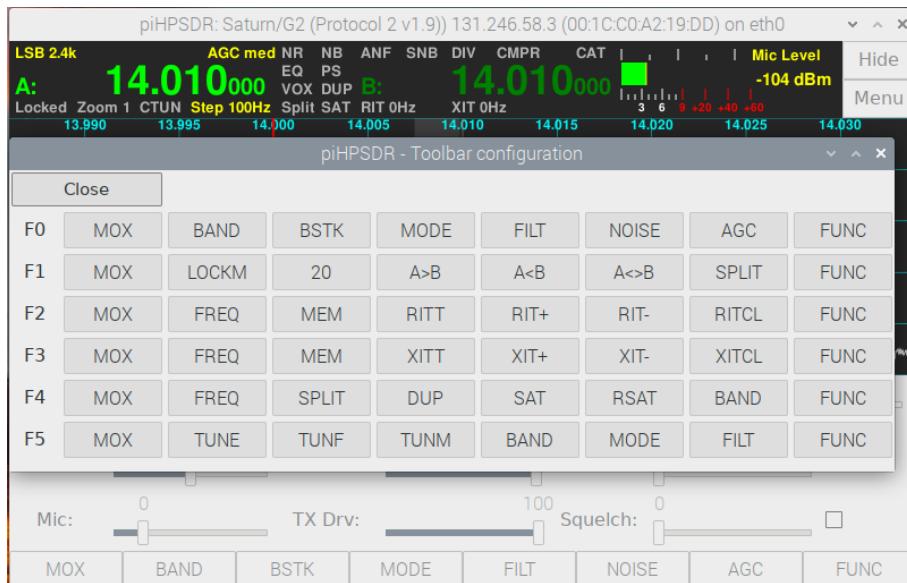
The six lines denoted F0 through F5 indicate the six different sets. If you look closely, you will discover that the set F0 is the one that is currently active, since the labels in this line exactly match the labels in the toolbar. In this menu, the possible actions (that can be bound to a button) are written with the short text (see Appendix A), since this is the text that is printed on the toolbar buttons. If one now clicks (just an example) the CTUN button in the line F1, an „action dialog” pops up that looks as follows:



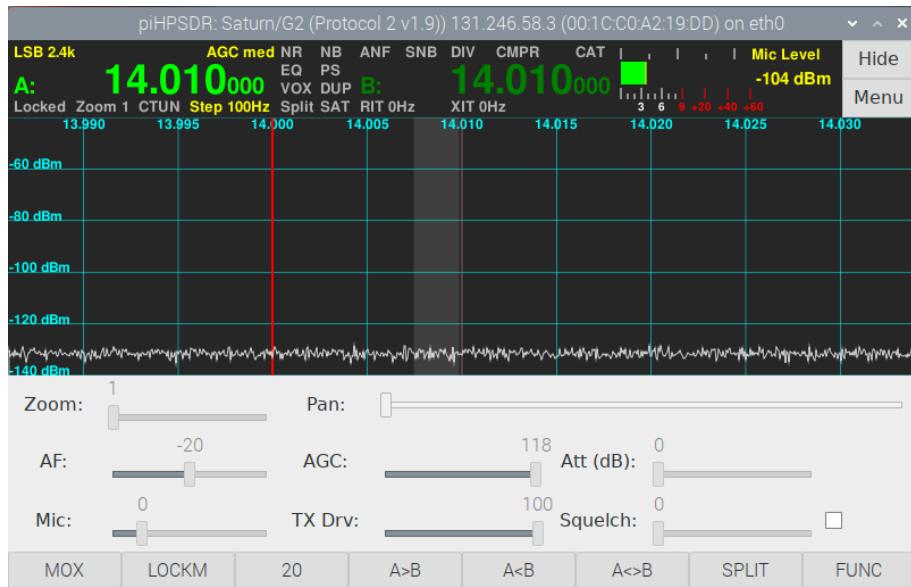
The current action selected (CTUN) is high-lighted. Lists of possible actions can be rather long, so it might be necessary that you have to scroll up or down in such an action dialog until you have found what you were looking for. Now (again just an example) the button Band 20 has been clicked in the action dialog, such that it gets high-lighted:



If one now closes the action dialog by clicking the OK button, the third button in the F1 line of the toolbar menu has changed, it now gives the short text (20) of the action, which will switch the active receiver to the 20m band (see the explanation of all the actions in Appendix A).

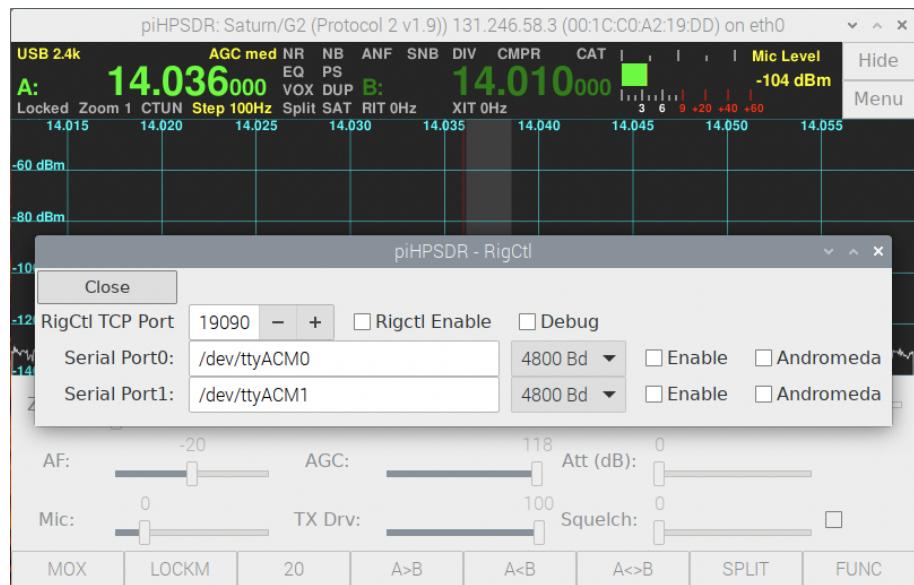


You also see that the toolbar has not changed, because we have just changed the F1 set, while currently the F0 set is active. If one now, however, clicks the FUNC button at the bottom right one advances to the F1 set and the toolbar labels are updated:

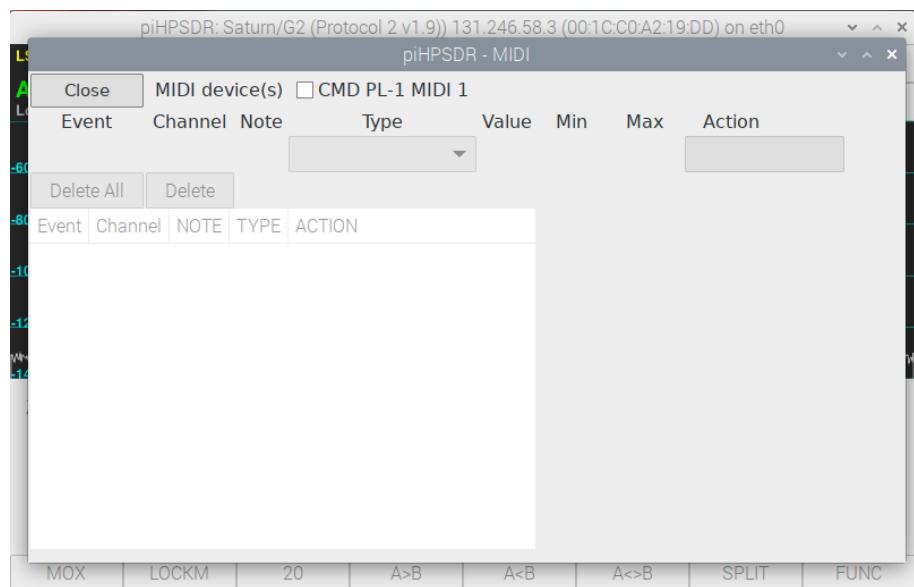


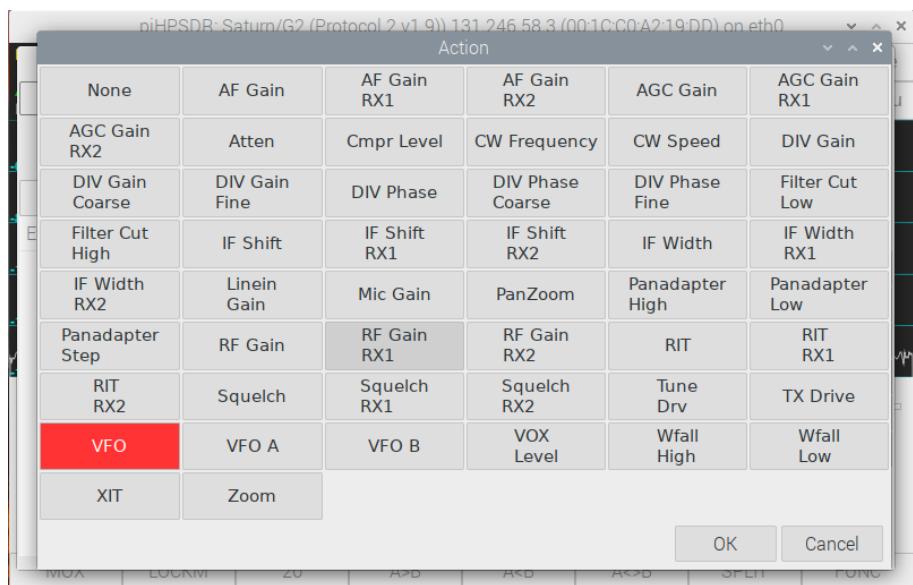
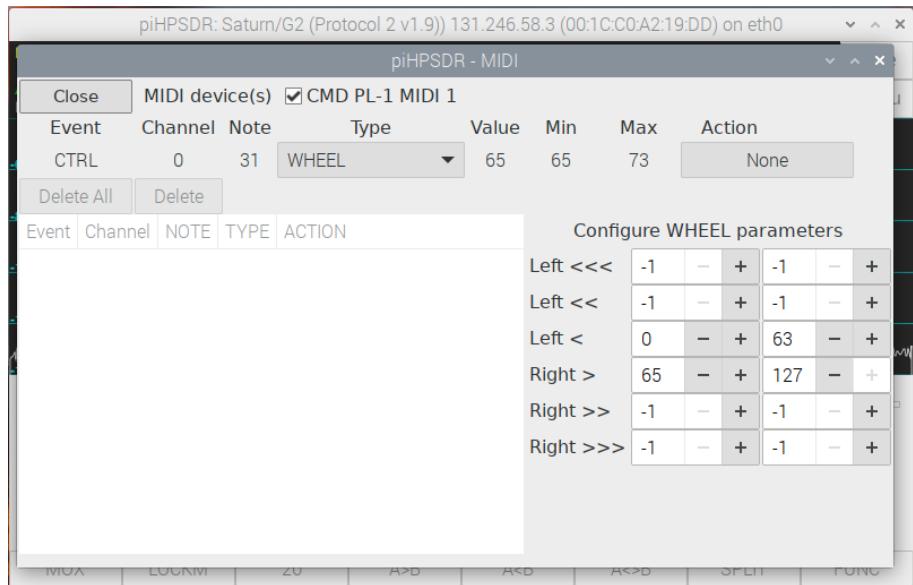
Note that it is not possible to change the assignment of the rightmost button of the toolbar, it will always be assigned to FUNC, since if one has no access to this function, one no longer cycle through the sets.

10.2 The RigCtl (Rig control, or CAT) Menu

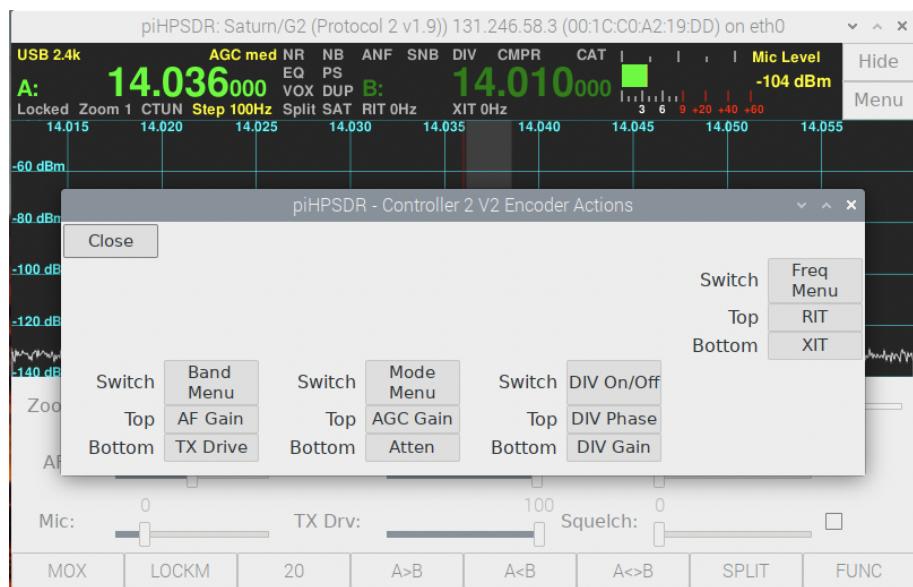
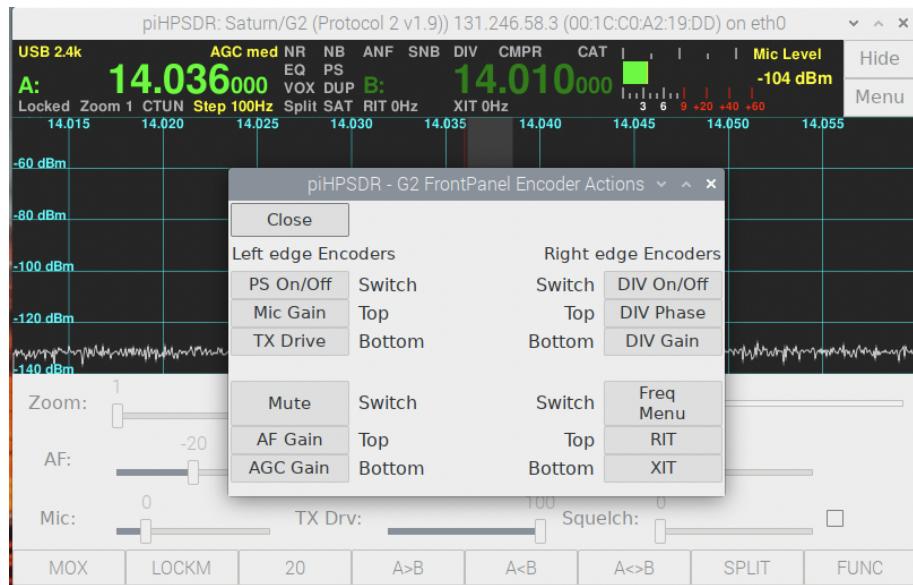


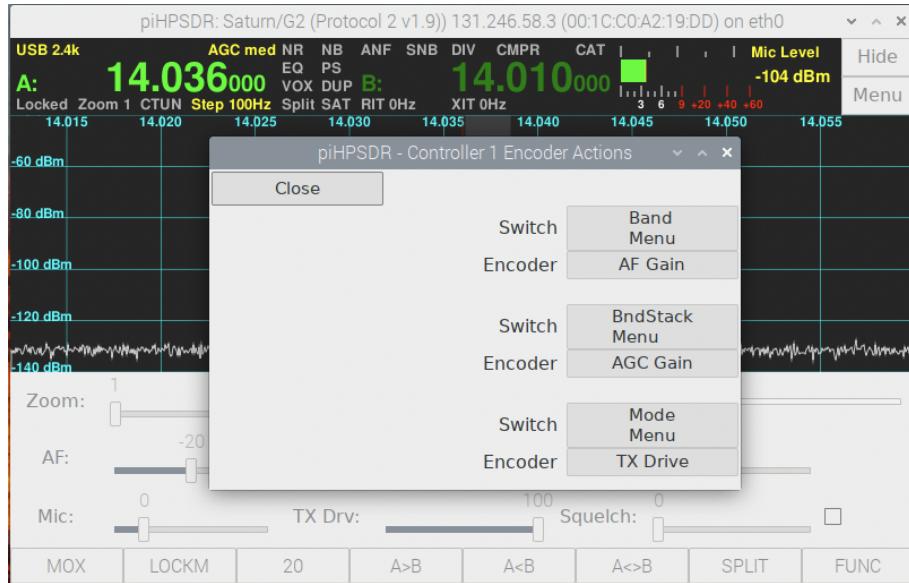
10.3 The MIDI Menu



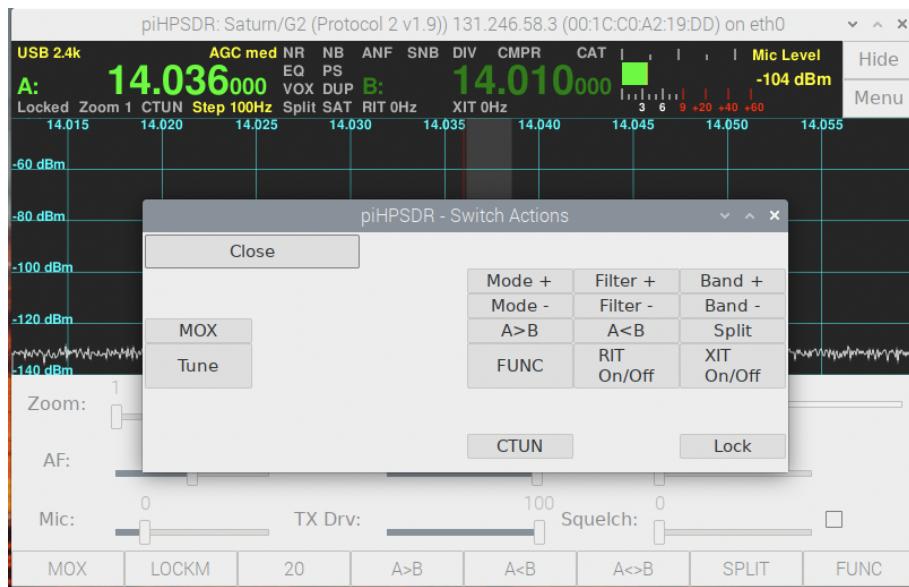


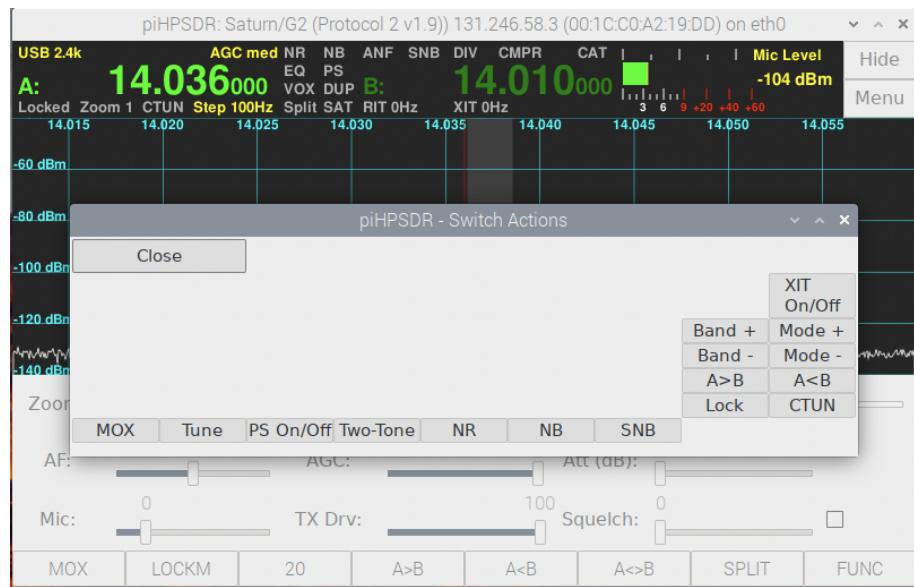
10.4 The Encoders Menu





10.5 The Switches Menu





Appendix A

List of piHPSDR „Actions”

In this chapter, we give a list of „actions” implemented in the piHPSDR program. These actions can be assigned to toolbar buttons on the screen, or pushbuttons/encoders of a GPIO-connected or MIDI controller. Not all actions can be assigned to all control elements. Changing the AF volume, for example, can only be assigned to a knob which you can turn, while switching RIT on/off can only be assigned to a button that you can push. For each action in the following table, there is a long and a short string assigned. The long string will be used when there is enough space, while the short string is used for small buttons and to store actions in preference files (therefore the short strings never contain a blank character or a line break). Then, for each action we give the type of control element allowed for this action as a combination of the letters B, P, E, which stand for

- B ”Button”: A button in the toolbar, or a push-button or switch on a GPIO or MIDI connected console
- P ”Potentiometer”: A potentiometer or a slider on a MIDI connected console
- E ”Encoder”: A rotary encoder on a GPIO or MIDI connected console

The main difference between a ”potentiometer” and an ”encoder” is, that the former has a min and max position, while an encoder can be turned in either direction without stopping. This means that a potentiometer reports a value between min and max, while an encoder reports an increment,

that is, whether it has been turned clock wise or counter clock wise. The existing GPIO consoles do not have potentiometers (most likely because of the lack of analog inputs), but many MIDI consoles do have, and Arduino-based MIDI controllers might have it because there analog inputs to read out potentiometers are available.

To give an example, controlling the TX drive can be done both with a slider and with an encoder. While for a slider/potentiometer, the values from min to max are simply mapped to the TX drive values from 0 to 100, the signals from an encoder will just increase or decrease the value until one of a limits has been reached.

In the following, the actions are alphabetically sorted by their long name, with the "empty" action listed first.

NONE	NONE	BPE
This is an action which does nothing. It can be assigned to buttons or encoders that are often accidentally operated. Some MIDI consoles, for example, report a button press event if the VFO knob is touched, and this we want to ignore.		

A<>B	A<>B	B
Swap VFOs A and B. This will not only swap the frequencies, but also all other settings associated with that VFO, such as mode, filter, CTUN, and RIT settings.		

A<B	A<B	B
Copy VFO B to VFO A.		

A>B	A>B	B
Copy VFO A to VFO B.		

AF Gain	AFGAIN	PE
Change the AF gain (headphone volume) of the active receiver.		

AF Gain RX1	AFGAIN1	PE
Change the AF gain (headphone volume) of the RX1 receiver.		

AF Gain RX2	AFGAIN2	PE
Change the AF gain (headphone volume) of the RX2 receiver.		

AGC Menu	AGC	B
Opens the AGC menu.		

ANF	ANF	B
Toggles the state (on/off) of the automatic notch filter for the active receiver.		

Atten	ATTEN	PE
Changes the value (0-31 dB) of the step attenuator of the active receiver. This function is only available for radios that have such an attenuator.		

Band 10	10	B
Change band of the active receiver to the 10m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 12	12	B
Change band of the active receiver to the 12m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 1240	1240	B
Change band of the active receiver to the 1240 MHz (23 cm) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 144	144	B
Change band of the active receiver to the 144 MHz (2m) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 15	15	B
Change band of the active receiver to the 15m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 160	160	B
Change band of the active receiver to the 160m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 17	17	B
Change band of the active receiver to the 15m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 20	20	B
Change band of the active receiver to the 15m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 220	220	B
Change band of the active receiver to the 220 MHz (1.25 m) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 2300	2300	B
Change band of the active receiver to the 2300MHz (13 cm) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 30	30	B
Change band of the active receiver to the 30m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 3400	3400	B
Change band of the active receiver to the 3400 Mhz (9 cm) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 40	40	B
Change band of the active receiver to the 40m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 430	430	B
Change band of the active receiver to the 430 MHz (70 cm) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 6	6	B
Change band of the active receiver to the 6m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 60	60	B
Change band of the active receiver to the 60m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 70	70	B
Change band of the active receiver to the 70 MHz (4m) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 80	80	B
Change band of the active receiver to the 80m band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band 902	902	B
Change band of the active receiver to the 902 MHz (33 cm) band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band AIR	AIR	B
Change band of the active receiver to the 108 MHz band, used for aircraft communication. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band GEN	GEN	B
Change band of the active receiver to the current bandstack entry of the "general" band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

Band -	BND-	B
Change band of the active receiver to the next lower band in the list of bands. If already at the lowest band, switch to the highest band (including transverter bands which have been defined) whose frequency is with the radio's frequency range.		

Band +	BND+	B
Change band of the active receiver to the next higher band in the list of bands (including transverter bands that have been defined). If already at the highest band, switch to the lowest band whose frequency is with the radio's frequency range.		

Band WWV	WWV	B
Change band of the active receiver to the current bandstack entry of the WWV band. If already on that band, move to the next bandstack entry. This action is a no-op if the frequency of the band falls outside the frequency range of the radio.		

BndStack -	BSTK-	B
Cycle backward through the bandstack entries of the active receiver.		

BndStack +	BSTK+	B
Cycle forward through the bandstack entries of the active receiver.		

Band Menu	BAND	B
Open the BAND menu.		

BndStack MENU	BSTK	B
Open the BANDSTACK menu.		

Cmpr On/Off	COMP	B
Toggle the state (on/off) of the compressor used in the TX audio input.		

Cmpr Level	COMPVAL	PE
Change the value of the compressor (0-20 dB) used in the TX audio input. The compressor is automaticall switched on (off) if the "new" value of the compressor is larger then (equal to) zero.		

CTUN	CTUN	B
Toggle the state (on/off) of the CTUN state of the active receiver. CTUN stands for "click to tune". In CTUN mode, you can move the RX frequency over the whole spectrum scope, whose center then remains at a fixed frequency.		

CW Frequency	CWFREQ	PE
Change the CW side tone frequency in the range 300-1000 Hz. This also changes the BFO frequency upon receive.		

CW Left	CWL	B
This action indicates the closure/opening of the left paddle of a CW key. It is usually assigned to a GPIO line or a MIDI controller to which a Morse paddle is attached, and works with the iambic keyer that is built into piHPSDR. This keyer is only active if CW is <i>not</i> handled in the radio (see CW menu).		

CW Right	CWR	B
This action indicates the closure/opening of the right paddle of a CW key. It is usually assigned to a GPIO line or a MIDI controller to which a Morse paddle is attached, and works with the iambic keyer that is built into piHPSDR. This keyer is only active if CW is <i>not</i> handled in the radio (see CW menu).		

CW Speed	CWSPE	PE
Change the CW side tone frequency in the range 1-60 wpm. This affect the built-in iambic keyer or the keyer inside the radio, depending on whether CW is handled in the radio or not (see CW menu).		

CW Key (keyer)	CWKy	B
Straight key key-down or key-up event. Usually assigned to a GPIO line of MIDI controller to which a straight key or an external keyer is attached. Note that this action does not automatically switch to TX, so it must be used together with either manual RX/TX switching, or with the "PTT (CW Keyer)" action.		

PTT (keyer)	CWKyPTT	B
This very similar to the PTT action (see below) with the exception that CW handling in the radio is temporarily disabled (thus, CW handling in piH-PSDR is enabled). This allows to have, e.g. a paddle attached to the radio while a contest logging program „talks” to piHPSDR.		

DIV On/Off	DIVT	B
Toggles (enabled/disabled) DIVERSITY reception.		

DIV Gain	DIVG	E
Adjust DIVERSITY gain. One tick of the encoder increments or decrements the gain by an amount of 0.5		

DIV Gain Coarse	DIVGC	E
Adjust DIVERSITY gain (coarse adjustment). One tick of the encoder increments or decrements the gain by an amount of 2.5		

DIV Gain Fine	DIVGF	E
Adjust DIVERSITY gain (fine adjustment). One tick of the encoder increments of decrements the gain by an amount of 0.1. Since adjusting the DIVERSITY gain (or phase) is sometimes difficult, assigning one encoder to a coarse and another encoder to a fine adjustment may help in locating the „sweet spot”.		
DIV Phase	DIVP	E
Adjust DIVERSITY phase (fine adjustment). One tick of the encoder increments of decrements the gain by an amount of 0.5		
DIV Phase Coarse	DIVPC	E
Adjust DIVERSITY gain (coarse adjustment). One tick of the encoder increments of decrements the gain by an amount of 2.5		
DIV Phase Fine	DIVPF	E
Adjust DIVERSITY gain (coarse adjustment). One tick of the encoder increments of decrements the gain by an amount of 20.1		
DIV Menu	DIV	B
Open the DIVERSITY menu.		
Duplex	DUP	B
Toggle (on/off) DUPLEX status. IN the DUPLEX mode, the receivers continue to work during TX, and the RX panels are not removed during TX. Instead, a separate TX window opens during transmitting. Generally, DUPLEX only make sense when using different and well decoupled RX and TX antennas.		
Filter -	FL-	B
Cycle forward (!) through the list of filters for the current mode of the active receiver. Normally, this means switching to a narrower filter (hence the name FILTER -). When reaching the last filter in the list, further cycling switches to the first (widest) filter.		

Filter +	FL+	B
Cycle backward (!) through the list of filters for the current mode of the active receiver. Normally, this means switching to a wider filter (hence the name FILTER +). When reaching the first filter in the list, further cycling switches to the last filter which is the variable Var2 filter.		

Filter Cut Low	FCUTL	E
Adjust the low-cut of the current filter. Note that the notion of „low” edge of the filter refers to audio frequencies for the single side band modes LSB, CWL, DIGL. This action is a no-op unless the current filter is one of the two variable filters Var1 or Var2.		

Filter Cut High	FCUTL	E
Adjust the high-cut of the current filter. Note that the notion of „high” edge of the filter refers to audio frequencies for the single side band modes LSB, CWL, DIGL. This action is a no-op unless the current filter is one of the two variable filters Var1 or Var2.		

Filter Cut Default	FCUTDEF	B
Reset the low and high cut of the current filter to the default values. This action is a no-op unless the current filter is one of the two variable filters Var1 or Var2.		

Filter Menu	FILT	B
This opens the Filter menu.		

VFO Menu	FREQ	B
This opens the FREQ (VFO) menu.		

FUNC	FUNC	B
Cycle through the six toolbar sets. For the piHPSDR GPIO controller V1, where the eight switches follow the toolbar buttons, this also affects the function of the switches. Note that this action is <i>always</i> connected with the right-most toolbar button.		

IF Shift	IFSHFT	E
This command is effective only if one of the variable filters Var1 or Var2 is currently used in the active receiver, and shifts the filter, that is, it affects the low and high cut in the same way.		

IF Shift RX1	IFSHFT1	E
This command is effective only if one of the variable filters Var1 or Var2 is currently used in VFO-A, and shifts the filter, that is, it affects the low and high cut in the same way.		

IF Shift RX2	IFSHFT2	E
This command is effective only if one of the variable filters Var1 or Var2 is currently used in VFO-B, and shifts the filter, that is, it affects the low and high cut in the same way.		

IF Width	IFWIDTH	E
This command is effective only if one of the variable filters Var1 or Var2 is currently used in the active receiver, and changes the filter width, that is, it affects the low and high cut in an opposite way.		

IF Width RX1	IFWIDTH1	E
This command is effective only if one of the variable filters Var1 or Var2 is currently used in VFO-A, and changes the filter width, that is, it affects the low and high cut in an opposite way.		

actionIF Width RX2IFWIDTH2EThis command is effective only if one of the variable filters Var1 or Var2 is currently used in VFO-B, and changes the filter width, that is, it affects the low and high cut in an opposite way.

Linein Gain	LIGAIN	PE
Change the line-in gain of the radio. If the radio does not have a line-in input, this control has no effect.		

Lock	LOCK	B
Lock the VFOs. A locked VFO will not accept VFO frequency steps in either direction, and cannot be moved by dragging with the mouse. Band changes etc. are still possible, though. The command is intended to guard against accidentally moving the VFO dial.		

Memory Menu	MEM	B
Open the MEM (Memory) menu.		

Mic Gain	MICGAIN	PE
Change the mic gain (from -12 to 50 dB). The amplification of the microphone audio data is done in software, and applies to the TX audio input samples wherever they come from. (See the discussion of local microphones in the TX menu.)		

Mode -	MD-	B
Cycle backwards through the list of modes for the active receiver. When the first mode (LSB) has been reached, jump to the last one (DRM). Note that when changing the mode, the current filter, noise reduction, equalizer, VFO step size, and TX compressor settings are stored for the old mode, and the settings last used with the new mode are restored. This allows to quickly switch between SSB and CW, or between SSB and digi modes, without re-adjusting these settings.		

Mode +	MD+	B
Cycle forward through the list of modes for the active receiver. When the last mode (DRM) has been reached, jump to the first one (LSB). Note that when changing the mode, the current filter, noise reduction, equalizer, VFO step size, and TX compressor settings are stored for the old mode, and the settings last used with the new mode are restored. This allows to quickly switch between SSB and CW, or between SSB and digi modes, without re-adjusting these settings.		

Mode Menu	MODE	B
Open the Mode menu.		

MOX	MOX	B
Toggle between TX and RX. Unlike the PTT action, which puts the radio into TX when pressed and into RX when released, this button toggles the PTT state when pressed.		

Mute	MUTE	B
Toggles the „mute” state of the active receiver. If a receiver is muted, it produces zero-amplitude audio output.		

NB	NB	B
Cycles through the noise blanker states (NB off/NB1/NB2).		

NR	NR	B
Cycles through the noise reduction states (NR off/NR1/NR2).		

Noise Menu	NOISE	B
Opens the NOISE menu.		

NumPad 0	0	B
Used for direct frequency entry. This is the same as hitting the corresponding button „0” in the VFO (VFO) menu.		

NumPad 1	1	B
Used for direct frequency entry. This is the same as hitting the corresponding button „1” in the VFO menu.		

NumPad 2	2	B
Used for direct frequency entry. This is the same as hitting the corresponding button „2” in the VFO menu.		

NumPad 3	3	B
Used for direct frequency entry. This is the same as hitting the corresponding button „3” in the VFO menu.		

NumPad 4	4	B
Used for direct frequency entry. This is the same as hitting the corresponding button „4” in the VFO menu.		

NumPad 5	5	B
Used for direct frequency entry. This is the same as hitting the corresponding button „5” in the VFO menu.		

NumPad 6	6	B
Used for direct frequency entry. This is the same as hitting the corresponding button „6” in the VFO menu.		

NumPad 7	7	B
Used for direct frequency entry. This is the same as hitting the corresponding button „7” in the VFO menu.		

NumPad 8	8	B
(Used for direct frequency entry. This is the same as hitting the corresponding button „8” in the VFO menu.)		

NumPad 9	9	B
Used for direct frequency entry. This is the same as hitting the corresponding button „9” in the VFO menu.		

NumPad BS	BS	B
Used for direct frequency entry (BS = backstep). This is the same as hitting the corresponding button in the VFO menu. It cancels the last-entered digit.		

NumPad CL	CL	B
Used for direct frequency entry (CL = clear). This is the same as hitting the corresponding button in the VFO menu. It cancels all entered digits so far.		

NumPad Dec	DEC	B
Used for direct frequency entry (DEC = decimal point). This is the same as hitting the corresponding button in the VFO menu.		

NumPad kHz	KHZ	B
Used for direct frequency entry. This is the same as hitting the corresponding button in the VFO menu. The VFO frequency is changed to the value entered so far, multiplied with 1,000. For example, to go to 7.040 MHz, one can enter the sequence „7”, „0”, „4”, „0”, „,KHZ”.		

NumPad MHz	MHZ	B
Used for direct frequency entry. This is the same as hitting the corresponding button in the VFO menu. The VFO frequency is changed to the value entered so far, multiplied with 1,000,000. For example, to go to 7.040 MHz, one can enter the sequence „7”, „DEC”, „0”, „4”, „,MHZ”.		

NumPad Enter	EN	B
Used for direct frequency entry. This is the same as hitting the corresponding button in the VFO menu. The VFO frequency is changed to the value entered so far. For example, to go to 7.040 MHz, one can enter the sequence „7“, „,0“, „,4“, „,0“, „,0“, „,0“. This is rarely used but offers Hz-resolution for the direct frequency entry.		

PanZoom	PAN	E
Change the Pan value. This control is only effective when the Zoom value is larger than 1.		

Pan-	PAN-	B
Decrease the PAN value by 100. This control is only effective when the Zoom value is larger than 1.		

Pan+	PAN+	B
Increase the PAN value by 100. This control is only effective when the Zoom value is larger than 1.		

Panadapter High	PANH	PE
Change the dBm value (from -60 to +20) at the top of the spectrum scope of the active receiver. Values outside this range can be set in the DISPLAY menu.		

Panadapter Low	PANL	PE
Change the dBm value (from -160 to -60) at the bottom of the spectrum scope of the active receiver. Values outside this range can be set in the DISPLAY menu.		

Panadapter Step	PANS	PE
Change the step size (from 5 to 30) of the panadapter of the active receiver. This is the spacing of the thin horizontal lines in the spectrum scope.		

Preamp On/Off	PRE	B
Toggle the preamp of the active receiver. Although the preamp switching is part of the HPSDR protocol, this has no effect in current radio models since the preamp is hard-wired „on”.		

PS On/Off	PST	B
Toggle (on/off) adaptive predistortion (PureSignal).		

PS Menu	PS	B
Open the PS (PureSignal) menu.		

PTT	PTT	B
Put the radio into TX mode when the button is pressed, and go back to RX when the button is released. This is one of the few actions where a button release event is significant. When attaching, say, the PTT contact of a microphone to a GPIO line for this purpose, take care of proper debouncing, since piHPSDR is not good at debouncing switches where both the press and release events are significant.		

RF Gain	RFGAIN	PE
Set the gain of the RF front end of the active receiver. Only effective for radios that have such a gain control. Most HPSDR radios do not have RF gain, they have a step attenuator in the RF front end instead. Small SDR radios using the AD9866 chip (HermesLite, RadioBerry) and radios connected via the SoapySDR library usually do have an RF gain control.		

RF Gain RX1	RFGAIN1	PE
Set the gain of the RF front end of RX1. Only effective for radios that have such a gain control. Most HPSDR radios do not have RF gain, they have a step attenuator in the RF front end instead. Small SDR radios using the AD9866 chip (HermesLite, RadioBerry) and radios connected via the SoapySDR library usually do have an RF gain control.		

RF Gain RX2	RFGAIN2	PE
Set the gain of the RF front end of RX2. Only effective for radios that have such a gain control. Most HPSDR radios do not have RF gain, they have a step attenuator in the RF front end instead. Small SDR radios using the AD9866 chip (HermesLite, RadioBerry) and radios connected via the SoapySDR library usually do have an RF gain control.		

RIT	RIT	E
Change the RIT value of the active receiver in the range -9999 to 9999 Hz. If a zero value is set, RIT is automatically disabled, if a non-zero value is set, RIT is enabled.		

RIT Clear	RITCL	B
Set the RIT value of the active receiver to zero. As a side effect, RIT is disabled for the active receiver		

RIT On/Off	RITT	B
Toggle RIT (enabled/disabled) for the active receiver. Note the RIT value is not changed, so you can temporarily disable RIT, and then enable it with the same offset (RIT value) used before.		

RIT -	RIT-	B
Decrement the RIT value of the active receiver by the RIT step size, in the range -9999 to 9999 Hz. If a value of zero is reached, RIT is automatically disabled, and if a nonzero value is reached, RIT is automatically enabled. Note that this action belongs to the few ones for which a button release event has an effect. If you press and hold RIT- (either on the toolbar, or on a GPIO or MIDI console), there is an auto-repeat such that the action will be repeated every 250 msec until the RIT- button is released.		

RIT +	RIT+	B
Increment the RIT value of the active receiver by the RIT step size, in the range -9999 to 9999 Hz. If a value of zero is reached, RIT is automatically disabled, and if a nonzero value is reached, RIT is automatically enabled. Note that this action belongs to the few ones for which a button release event has an effect. If you press and hold RIT+ (either on the toolbar, or on a GPIO or MIDI console), there is an auto-repeat such that the action will be repeated every 250 msec until the RIT+ button is released.		

RIT RX1	RIT1	E
Change the RIT value of RX1 in the range -9999 to 9999 Hz. If a zero value is set, RIT is automatically disabled, if a non-zero value is set, RIT is enabled.		

RIT RX2	RIT2	E
Change the RIT value of RX2 in the range -9999 to 9999 Hz. If a zero value is set, RIT is automatically disabled, if a non-zero value is set, RIT is enabled.		

RIT Step	RITST	B
Cycle through the possible values (1 Hz, 10 Hz, 100 Hz) of the RIT step.		

RSAT	RSAT	B
If the SAT mode is either Off or SAT, change it to RSAT. If the SAT mode is RSAT, change it to Off. In RSAT mode all VFO frequency <i>changes</i> applied to one of the two VFOs will be applied to the other VFO with the sign reversed.		

SAT	SAT	B
If the SAT mode is either Off or RSAT, change it to SAT. If the SAT mode is SAT, change it to Off. In SAT mode all VFO frequency <i>changes</i> applied to one of the two VFOs will be applied to the other VFO as well.		

SNB	SNB	B
Toggle (enable/disable) the spectral noise blower for the active receiver.		

Split	SPLIT	B
Toggle (on/off) the split status of the radio.		

Squelch	SQUELCH	PE
Change the squelch threshold value of the active receiver. Squelch is automatically enabled (disabled) if the resulting value is non-zero (zero).		

Squelch RX1	SQUELCH1	PE
Change the squelch threshold value of RX1. Squelch is automatically enabled (disabled) if the resulting value is non-zero (zero).		

Squelch RX2	SQUELCH2	PE
Change the squelch threshold value of RX2. Squelch is automatically enabled (disabled) if the resulting value is non-zero (zero).		

Swap RX	SWAPRX	B
Make the inactive receiver the active one. This action is only effective if piHPDSR is running two receivers.		

Tune	TUNE	B
Toggle (on/off) TUNE. If selected in the OC menu, an OC output will become active (low). This can then be used to start an external automatic tuner.		

Tune Drv	TUNDRV	E
Change the drive level (0-100) used for TUNEing. This is equivalent to changing the "Tune drive level" spin button in the TX menu and to check the "Tune use drive" box.		

Tune Full	TUNF	B
Set the "full tune" flag and clear the "memory tune" flag. If an OC output is assigned to the TUNE state, it will be cleared (go high again) 2800 msec after starting TUNE (this time can also be adjusted in the OC menu).		

Tune Mem	TUNM	B
Set the "memory tune" flag and clear the "full tune" flag. If an OC output is assigned to the TUNE state, it will be cleared (go high again) 550 msec after starting TUNE (this time can also be adjusted in the OC menu).		

TX Drive	TXDRV	PE
Set the TX drive level (0-100).		

Two-Tone	2TONE	B
Toggle (on/off) the two-tone state of the transmitter. If the two-tone state is engaged, the radio will go TX and emit a two-tone signal.		

VFO	VFO	E
This is the VFO frequency control of the active receiver.		

VFO A	VFOA	E
This is the VFO frequency control of VFO-A.		

VFO B	VFOB	E
This is the VFO frequency control of VFO-B.		

VOX On/Off	VOX	B
Toggle (on/off) vox status. If vox is enabled, you can automatically key the transmitter by talking into the microphone, without the need to press a PTT button. See the VOX menu.		

VOX Level	VOXLEV	E
Change the VOX level threshold. If you operate vox, and the radio does not go TX while talking into the microphone, decrease the VOX threshold. If the radio goes TX simply because the neighbour's hound starts barking, increase the VOX threshold.		

Wfall High	WFALLH	E
Change the "high" level (-100 dBm ... 0 dBm) of the waterfalls. Signal levels between low and high are colour coded from black to yellow, while signals above "high" are yellow and signals below "low" are black. This value has no effect if the automatic waterfall coloring is chosen ("waterfall automatic"), which is usually preferable.		

Wfall Low	WFALLL	E
Change the "low" level (-150 dBm ... -50 dBm) of the waterfalls. Signal levels between low and high are colour coded from black to yellow, while signals above "high" are yellow and signals below "low" are black. This value has no effect if the automatic waterfall coloring is chosen ("waterfall automatic"), which is usually preferable.		

XIT	XIT	E
Change the XIT value of the transceiver in the range -9999 to 9999 Hz. If a zero value is set, XIT is automatically disabled, if a non-zero value is set, XIT is enabled.		

XIT Clear	XITCL	B
Set the XIT value of the transmitter to zero. As a side effect, XIT is disabled.		

XIT On/Off	XITT	B
Toggle XIT (enabled/disabled) for the transceiver. Note the XIT value is not changed, so you can temporarily disable XIT, and then enable it with the same offset (XIT value) used before.		

XIT -	XIT-	B
Decrement the XIT value of the transmitter by the RIT (!) step size, in the range -9999 to 9999 Hz. If a value of zero is reached, XIT is automatically disabled, and if a nonzero value is reached, XIT is automatically enabled. Note that this action belongs to the few ones for which a button release event has an effect. If you press and hold XIT- (either on the toolbar, or on a GPIO or MIDI console), there is an auto-repeat such that the action will be repeated every 250 msec until the XIT- button is released.		

XIT +	XIT+	B
Increment the XIT value of the transmitter by the RIT (!) step size, in the range -9999 to 9999 Hz. If a value of zero is reached, XIT is automatically disabled, and if a nonzero value is reached, XIT is automatically enabled. Note that this action belongs to the few ones for which a button release event has an effect. If you press and hold XIT+ (either on the toolbar, or on a GPIO or MIDI console), there is an auto-repeat such that the action will be repeated every 250 msec until the XIT+ button is released.		

Zoom	ZOOM	PE
Change the ZOOM value (1...8) of the active receiver.		

Zoom -	ZOOM-	B
Decrease the ZOOM value of the active receiver by one. If the ZOOM value was already 1, this is a no-op.		

Zoom -	ZOOM-	B
Increase the ZOOM value of the active receiver by one. If the ZOOM value was already 8, this is a no-op.		

Appendix B

piHPSDR keyboard bindings

Appendix C

piHPSDR CAT commands

The CAT model of piHPSDR largely follows that for other SDR programs. It is based upon the Kenwood TS-2000 CAT command set, which can easily be found on the internet (see the Appendix of the Kenwood TS-2000 instruction manual) and will not be reproduced here for copyright reasons. So if you want to connect a logbook or contest logging program to piHPSDR, you will normally tell this program that it has to control a Kenwood TS-2000.

In the SDR community, there exist a heavily extended TS-2000 CAT command set known as the „PowerSDR CAT command set”, the original source is probably

[https://www.flexradio.com/documentation/
powersdr-cat-command-reference-guide/](https://www.flexradio.com/documentation/powersdr-cat-command-reference-guide/)

Many (but probably not all) of the commands listed there are implemented in piHPSDR, because it seems that there exist SDR controllers which communicate over the serial line. In recent years, such an open-source controller, the ANDROMEDA controller, has been developed by Laurence Barker G8NJJ, see

https://github.com/laurencebarker/Andromeda_front_panel

This controller uses some additional CAT commands to communicate with the radio, and these commands have also been implemented into the RIGCTL module of piHPSDR by Rick Koch N1GP (thanks Rick). These are the ZZZD and ZZZU commands for moving the VFO frequency down/up, and

the ZZZP and ZZZE commands for sending information about push-buttons and encoders, and a ZZZS command which contains information on the ANDROMEDA version. Furthermore, if "Andromeda" is selected in the RIGCTL menu, piHPSDR will constantly *send* status information to the ANDROMEDA controller using a ZZZI command. Status information is sent if something changes (active receiver, diversity status, PTT status, TUNE mode, PS status, CTUN mode, RIT and XIT status, and LOCK status), such that the ANDROMEDA controller can update the corresponding LEDs.