



Manual

Modem Lab

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1. General

1.1. Welcome to Modem Lab

Modem Lab is an extremely efficient software product whose major function is to recognize modems in various fields of reconnaissance. Modems (as combinations of demodulator and decoder) are the central items in the automatic recognition process.

The analysts' knowledge and experience are employed to compile modems and modem lists for automatic recognition, i.e. the system is knowledge-based software.

The application provides functions like:

- Modem identification
- Demodulation and decoding of detected modems

These functions make it a powerful tool for a great variety of applications. Since this approach is based on profound knowledge, the application allows automatic identification and production of modems which are added to the system by the user. The close link between demodulator and decoder will minimize the identification error rate.

The software modules are neither platform nor operating system sensitive, i.e., they run on any commercial standard hardware (COTS) under any standard operating system (Windows® and Linux®). Since the modules do not depend on specific hardware, the use of new and more efficient hardware generations will increase the performance of the application by simple means.

The application can be adapted to new tasks in a quick and simple way. Some of the demodulators and decoders in new modems can be interchanged. This facility ensures that the system can be employed in varying scenarios. The adaptability of the application to future technology trends guarantees a maximum life cycle and a safe investment.

Note: Any requests and suggestions will be appreciated. We are happy to receive your information via the support contacts stated in chapter Support.

2. Overview

2.1. Software Modules

The software contains the following modules:

- APC (Automatic Production Channel)
- DANA (Digital ANalogue Audio Interface)
- Modem Lab(**Modem Laboratory**)

On the one hand, the perfect coordination between the software modules Modem Lab, APC and DANA increases the efficiency of the application. On the other hand, each of these modules will operate perfectly on its own.

DANA is used as a signal converter and provides the module APC with the signal data in the required form of digital IF.

The module **APC** handles the processing of signals, from the recognition of modems via the demodulation and decoding up to the permanent production of the message content. APC is a background process without user interface.

The module **Modem Lab** carries out the numerous tasks involved in display and user interaction. On the one hand, it provides graphic displays of the results supplied by the module APC; on the other hand, the user can edit parameters to control the operating mode of the APC.

2.1.1. DANA

The converter module **DANA** (Digital Analog Audio Interface) receives the existing input data from sound card or file and converts it into complex signal streams that can be processed by the APC. DANA features a graphical user interface which provides the option to edit various parameters. Among these parameters is the frequency, which is used to add an offset to adapt the center frequency of a signal delivered by an external receiver, or a signal file, to the reference frequency of a demodulator. For more information please refer to chapter Tools.

2.1.2. APC

The APC (Automatic Production Channel) module is the core of the application. This software module handles the complete signal processing operation in a technical sense. Its tasks are real-time identification, demodulation, and decoding of signals pre-processed by DANA. The results are sent to SDA for display.

The APC controls the following tasks:

- Energetic fine segmentation (signal detection and signal selection)
- Detection (modem identification)
- Demodulation and decoding (modem production)

The application works as a knowledge-based system, i.e. the software is capable of reliable recognition, demodulation and decoding of modems which have been included in the knowledge base (decoder list) of the system, using the experience of the analysts. The delivery contains a selection of demodulators and decoders as well as selected modems built-up from them. The user can edit the parameters of the demodulators, change demodulators, and setup additional modems from the existing demodulators and decoders. The decoder description language based on Python (pyDDL) offers the functionality to develop new decoders, which again can be combined with existing demodulators.

2.1.3. Modem Lab

The module Modem Lab(**Modem Laboratory**) contains the graphical user interface. The main functions of the Modem Lab are:

- Display and monitoring of the incoming signals
- Short time signal memories display
- Results display
- APC control
- Modem parameters configuration
- Display parameters configuration

For further details on the various Modem Lab functions and its operation, please see chapter Modem Lab Operating Modes.

2.2. Signal Sources

Signals can be provided to the application from different signal sources. Simplified, two categories of sources are available:

- Signals from sound cards (via DANA)
- Signals from files (via DANA)

In the next sections of this document, we provide an overview of all functions available. By design the modules can run on different computers and exchange the data via TCP/IP. Modem Lab, however, is delivered as a standalone system whose modules are setup to run on one single computer.

3. Basics

3.1. Software Start

Start the software or one of the additional tools either using the desktop icons or from the PROCITEC program group on the start menu:

Icon	Name	Description
	Modem Lab	Start the application including Modem Lab, DANA etc.
	DANA	Start DANA (Digital analog audio interface) for signal input

Table 1: Items in start menu

After starting the application, the Modem Lab will appear. You will see:

- a spectrum/sonagram display
- a result display
- the menu bar
- the toolbar
- two property sheets
- the status bar

Together with the Modem Lab, DANA will start. The APC is started in background without any GUI.

The left part of the window features two displays.

The spectrum / sonagram is a signal display showing the digital IF signal in two different presentations. The sonagram (top) shows the energy distribution of the signal in the frequency-time domain while the spectrum (bottom) indicates the spectral energy distribution of the most recent line at the bottom of the sonagram display.

The result display shows the modems currently stored in the knowledge base of the APC and the results of the automatic modem identification process.

The right-hand side of the window displays the following property sheets:

- In the upper part the parameters for APC control and parameter input for the APC modems are indicated. These parameter tabs include the demodulator parameters and the decoder selection.
- The lower part shows the parameters of the currently active display, like general display parameters, cursor parameters and display parameters.

The status bar of the Modem Lab is located at the bottom of the window. It indicates status messages, the time interval covered by the signal memory of the APC (SM = short-time memory) and the absolute receiver frequency of the input signal which corresponds to the complex frequency 0 (IF = intermediate frequency).

In the result display, you will first see the APC search. The color of the modem in the list varies depending on the state of recognition.

3.2. Modem Lab Operating Modes

The Modem Lab provides the option to supply signals from different sources. The following signal sources are available in the default installation:

- DANA
- Signal Memory

These modes can either be set on the menu <Extras><Mode> or the toolbar.

3.2.1. DANA

This is the application to stream signal recordings (files) or signals, which are connected to the input of the sound card. If you are using DANA as the signal source, the APC receives the signal data from DANA. For more information please refer to chapter Tools.

3.2.2. Signal Memory

The APC stores the input signal it receives in internal signal memory. The capacity is about 5 min (depending on the input sampling rate).

Signal memory also may be used as signal source for replaying the signal which was stored beforehand in the internal signal memory of the APC. This is helpful if you want to analyze short signal parts.

The Signal Memory settings are used to set the start and end time of the short-time memory. Activate the <Start> button to start over. To switch off continuous play, deselect the check box <Repeat replay> below the <End time> label.

3.2.3. Operation

In case you want to switch between signal-sources, please activate the stop symbol  in the toolbar. Select the new signal-source and activate the start symbol  in the toolbar.

If the button <Modem recognition>  is activated, the system automatically evaluates the modem with the best recognition results. Once the modem is found, production will start at the time the search was originally started. Production will then be faster than real time until all former signal data has been processed by the APC. Subsequently, the data is processed in real time again. The production will automatically stop and a new search started if the emission ends.

If <Production>  is selected, then the APC tries to produce results with the modem currently selected. The current modem is displayed above the control and modem parameters. Additionally, it is displayed in bold letters in the result display. In this mode no automatic recognition is carried out. We recommend this mode for modem development.

During automatic production, the stored control and modem parameters are used by the APC. If a signal is not recognized by the APC in automatic mode, either modify the parameters of the existing modem or create a new one.

To edit the modem parameters, first select manual mode and the modem to be edited. To do so, either use the modem list or double-click the respective modem in the result display.

Now select the <Demod> tab in the modem parameters form. Now you can edit the demodulator parameters e.g. the symbol rate or the shift of an FSK modem.

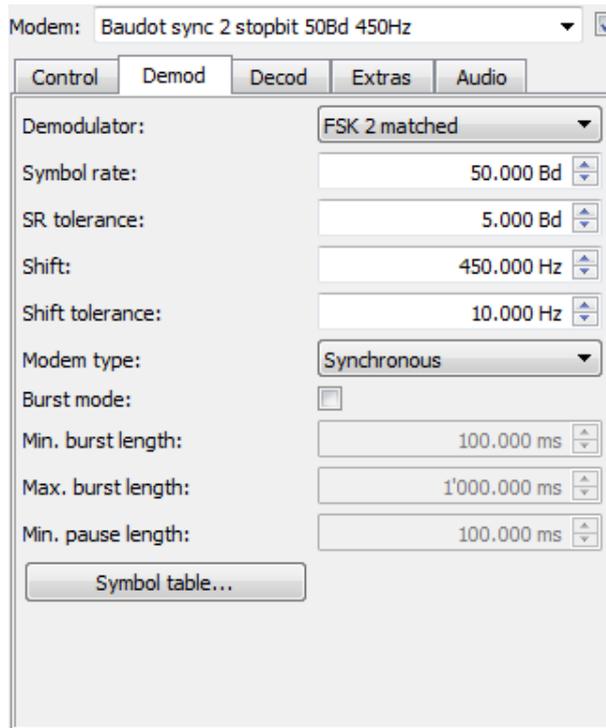


Figure 1: Demod Parameter Setting

To create a new modem, select the menu item **<Modem><New modem>**. Now change the demodulator type and enter the correct parameters.

If the demodulated signal has to be decoded, select a decoder on the **<Decod>** tab. Click on **<Decoder Name>**. A list of existing decoders will be displayed. Select the decoder and confirm by **<Ok>**. Now, the selected decoder will be used for decoding.

If there is no appropriate decoder, either modify an existing decoder or create a new one. For details see pyDDL manual.

3.2.4. Displays

There are different signal displays for the three main stages of the production process: The spectrum / sonogram display for the input signal, the bit display for the demodulator output, and the result display of all chosen modems. For each display there is an own parameterization window on the right hand side. For example, cursors can be added to the spectrum / sonogram via the **<Cursor>** tab.

3.3. File Menu

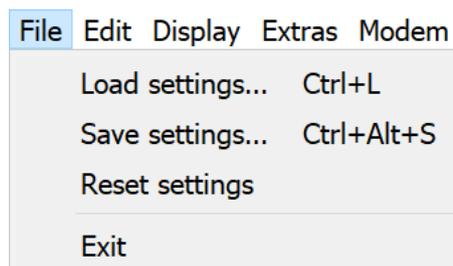


Figure 2: File Menu

Any changes in the GUI are automatically saved when you exit the application. This comprehends the following settings:

- Window position and window size of main window
- Show/hide property sheets
- Window positions and window sizes of the individual displays, if open
- All display parameters
- Window position and window size of the decoder editor as well as the last decoder edited, if open
- Modem list last in use
- Operation mode last in use
- Signal source definitions
- Positions of all tool bars

3.3.1. Load Settings...

Load previously saved settings from a file of your choice.

Before loading the settings, switch to <Production>.

3.3.2. Save Settings...

Save current settings to a file of your choice.

3.3.3. Reset Settings

On selection of this option the current settings are replaced with the default settings of the installation.

3.3.4. Exit

Exit Modem Lab.

3.4. Edit Menu



Figure 3: Edit Menu

Highlighted text blocks can be transferred to the clipboard of your computer and pasted in other positions in the text using the functions Copy and Paste.

3.5. Display Menu

This menu presents the various signal displays available in Modem Lab.

3.5.1. Spectrum/Sonagram

The spectrum/sonagram display shows the spectrum of signals over time. One important application is monitoring of the input signal. It displays both, the actual signal spectrum as well as the sequence of the most recent spectra in a waterfall display called sonagram.

The following figure shows an example of the spectrum/sonagram display.

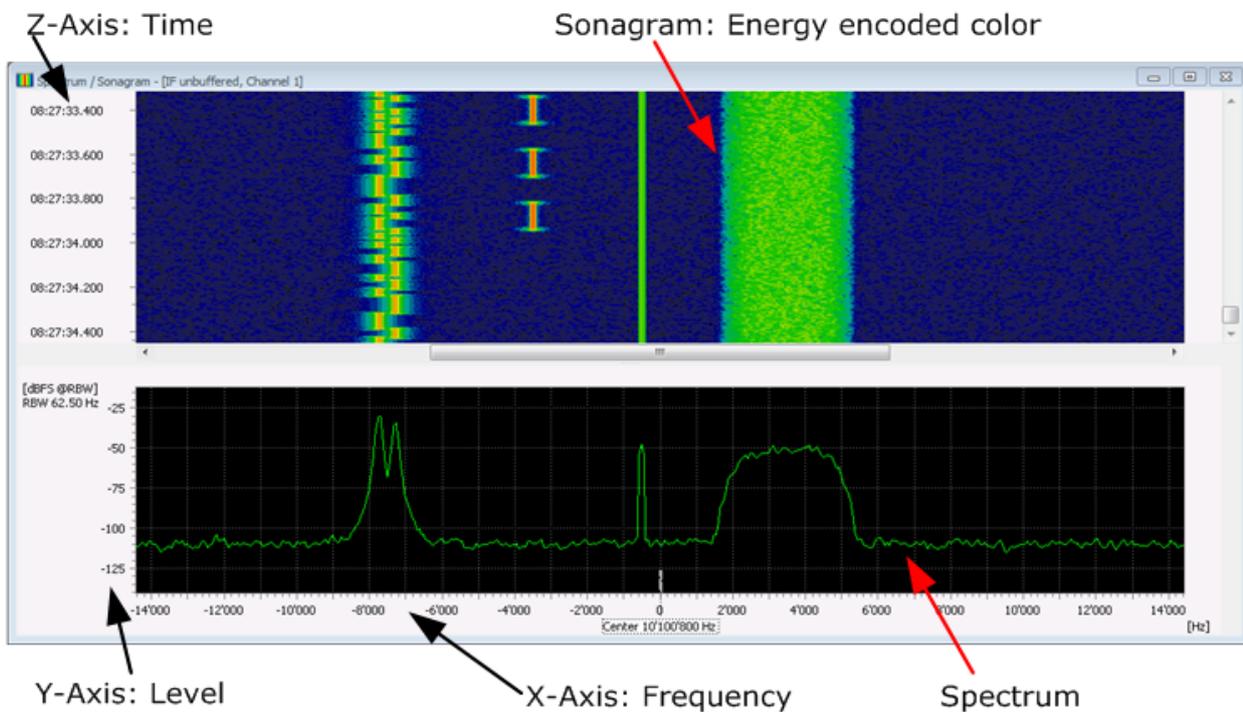


Figure 4: Spectrum/Sonagram

The spectrum/sonagram display is divided into two panels.

The upper panel shows the sonagram (spectrogram). Each horizontal line represents a certain time. The color represents the power on this frequency (from black to blue to green to red). The labels on the time axis (Z-Axis) show the recording period of the signal. Changes in the signal level in the course of time can be identified by changes in color.

In the lower panel of this display the spectrum (FFT) is shown.

X-Axis: Frequency 0 corresponds to the center frequency of the applied signal, e.g. the parameter **<signal frequency>** in DANA or a receiver frequency.

Y-Axis: Shows the logarithmic power, displayed in dBFS. This refers to the level of the signal. 0 dBFS represents full scale and -100 dB is 100 dB below full scale. 0 dBm is for 1 mW, -50 dBm means 50 dB below 1 mW, which equals 10^{-5} mW.

The spectrum/sonagram display provides an overview of the power distribution of the applied signal. The values and ranges of frequency, power level and time can be measured using cursor.

3.5.1.1. Power spectrum

The power spectrum (default) varies the displayed power level depending on the configured FFT length. With the next higher FFT length (factor 2), the spectra resolution is doubled and together with that also the bandwidth of one FFT bin is halved. Thus, also the measured power is halved. With the next smaller FFT length (factor 0.5) the measured power is doubled.

Measuring the power of a modulated signal requires accumulating the power over the signal's bandwidth. See chapter Power and SNR measurement.

The samplerate of a signal and the FFT length define the frequency resolution (also known as bin width, also known as RBW for resolution bandwidth):

$$\text{RBW} = \text{samplerate} / \text{FFT length}$$

The value below the Y-Axis label ([dBFS @ RBW] or [dBm @ RBW]) shows the current resolution bandwidth.

3.5.1.2. Power spectrum density

The unit commonly used for power density is "dB per Hz"; thus normalized to 1 Hz – independent of FFT length. However, the FFT length still defines the frequency resolution.

In a frequency band containing white noise only, the measured power density does not change with the FFT length. In a power spectrum the power level varies for different FFT lengths, which influences the frequency resolution (RBW).

For signals with a bandwidth smaller than the RBW, normalization makes no sense. Especially for unmodulated carriers, the power density cannot get measured, because the power is erroneously distributed over the RBW. A finer frequency resolution has to be applied by increasing the FFT length. Alternatively a power spectrum can be used in order to measure such signals.

In <Extras><PSD normalization> Power spectrum or power spectrum density (PSD) can be selected (see Figure 16).

To allow direct comparison of the resulting level with other software or other measurement devices, the parameter *normalization* bandwidth in the spectrum/sonogram display can be used. The measured power in the resolution bandwidth (RBW) is normalized to this normalization bandwidth. The default normalization bandwidth is 500 Hz.

Selection of <Extras><PSD normalization> is also available with context menu by pressing the right mouse button inside the spectrum/sonogram display. The menu then shows the item <Power Spectrum Density (PSD)> (see Figure 5).

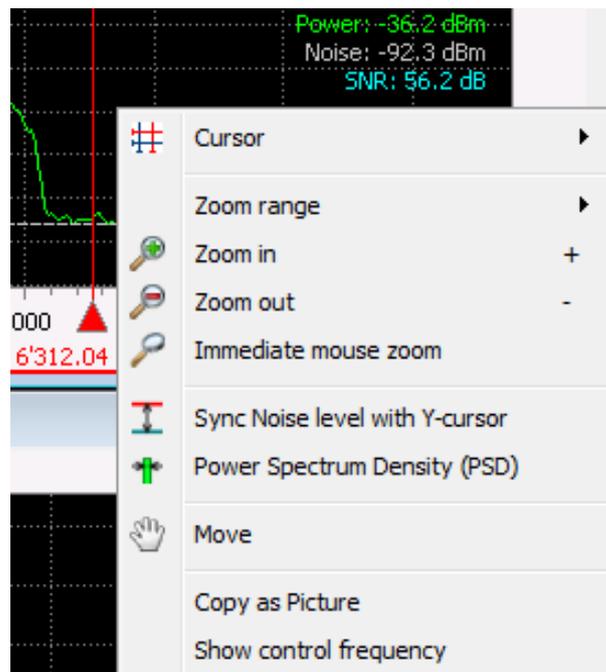


Figure 5: Spectrum/Sonagram - Context menu

The normalization bandwidth is only available in <Extras>.

3.5.1.3. Power in dBm

The levels are usually displayed without units in dB / dBFS, when no reference level is available with the signal data.

In case a receiver or in general a signal stream provides Modem Lab with a signal together with its reference power level as meta information, then spectrum/sonagram automatically displays the power level in "dBm". 0 dBm corresponds to 1 milliWatt power.

3.5.1.4. Power and SNR measurement

When spectrum/sonagram display is paused and the X-cursor are active, the upper right corner of the spectrum view shows the total power (total power: signal power S + noise power N), the noise power (N) and the signal to noise ratio SNR (S/N).

These values are calculated for the frequency band spanned by the X- cursor.

The calculation is performed based on the visible spectrum and thus is influenced by various parameters like <FFT length>, <windowing>, <exp. Averaging> and the spectrum display, e.g. <Average value Cur. 1/2>. Depending on these parameters, the measured values will vary by some dB. <Average value Cur. 1/2> is required for the measurement of short bursts.

The noise level is determined automatically and shown with a horizontal dashed grey line (see Figure 6). The level is calculated from the visible spectrum. It is important to have enough flat noise-only bands in the view. This can be controlled with the parameters <Center frequency> and <Frequency range>. The dashed grey line is for verification of the estimated noise level.

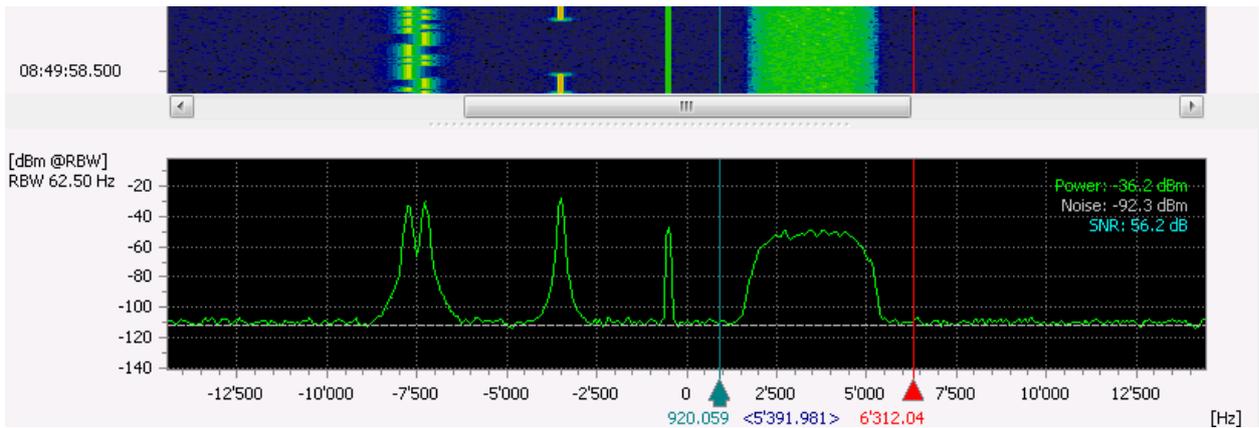


Figure 6: Spectrum/Sonogram with measurement values power, noise and SNR

Selecting the context menu item **<Sync Noise level with Y-cursor>** (see Figure 5), the Y-cursor are displayed at the currently estimated values for power and noise (red: power, green: noise) (see Figure 7). Modification of the X-cursor leads to a recalculation of the measured values and the Y-cursor also get updated. In case the Y-cursor get modified manually, e.g. for adjusting the noise floor, then the labels in the upper right corner are marked with a star to show that these are not the automatically determined values (see Figure 8).

Measurements functions for power and SNR are only available with the input signals “IF unbuffered” and “IF input”.

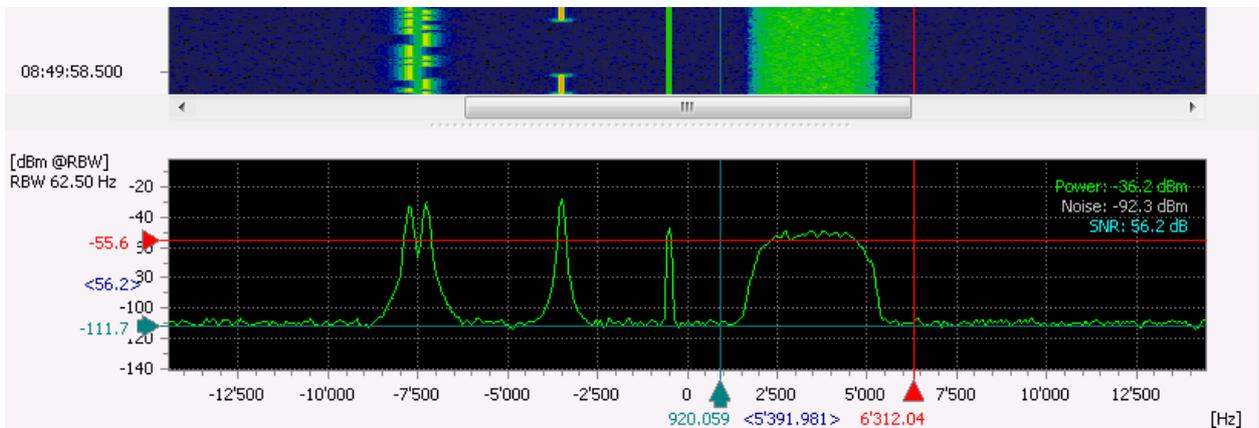


Figure 7: Spectrum/Sonogram with synchronized Y-cursor

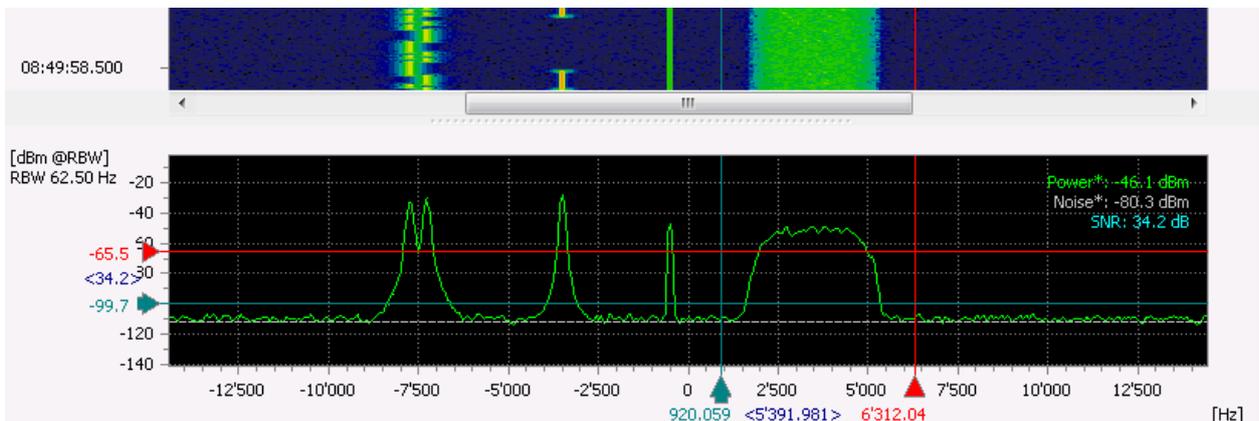


Figure 8: Spectrum/Sonogram with manually positioned Y-cursor

All spectral components between the X-cursor are used for calculation of “power”. This also includes regions which obviously contains just noise.

The APC uses knowledge of the modem to be produced and the unused regions’ power is not taken into account. Accordingly the SNR measurement in the APC is modem specific and the measured values will differ from the values in the spectrum/sonagram display.

Accurate SNR measurements are not possible for signals with smaller bandwidth than the RBW. Pure (unmodulated) carriers don’t use bandwidth, thus the SNR can only be specified for a given bandwidth.

The SNR is calculated using following simple formula:

$$\text{SNR} = (\text{Total Power} - N) / N = S / N$$

The value is then displayed in dB.

3.5.1.5. Spectrum/Sonagram-Specific Display Controls

The spectrum/sonagram display has various special features to simplify the navigation. To use the keyboard shortcuts, make sure the GUI focus is actually on the sonagram display (indicated by the blue title bar).

Scrollbars

The display window features a scrollbar each in frequency direction and in time direction (provided the signal exceeds the display section). In addition to the common drag functions, there are several keyboard shortcuts for scrollbar operations.

Zoom Functions

The sonagram software provides convenient zoom functions for quick navigation and analysis. The default zoom factor is 2, respectively its reciprocal in opposite direction. Custom zoom factors can be set on the display’s property sheet on <Extras><Relative Zoom Factor>.

Popup Menu

The spectrum/sonagram display provides a popup menu (right click) with a number of useful items:

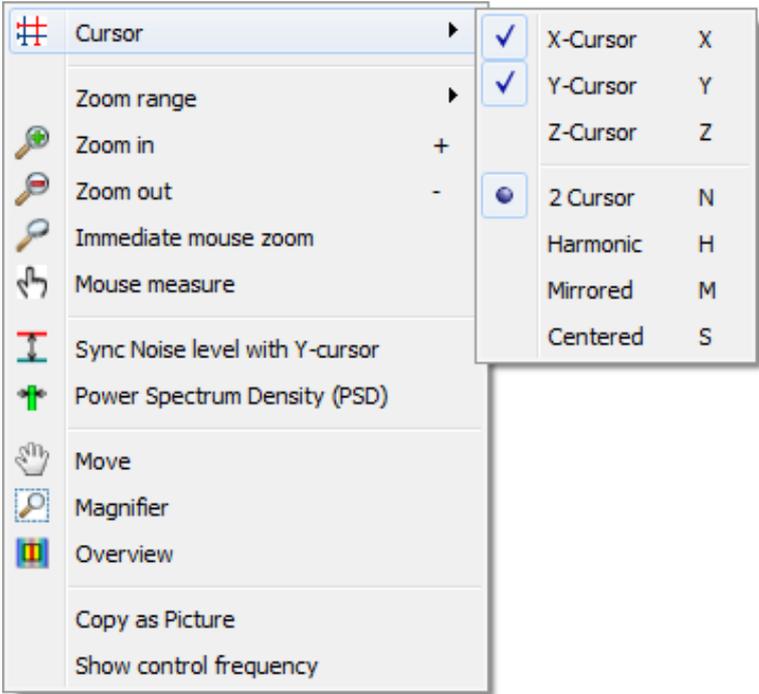


Figure 9: Spectrum/Sonagram - Popup Menu

Parameter	Function																					
<Cursor>	<p>Activate and deactivate X-, Y-, Z- and <Harmonic></p> <table border="1" data-bbox="780 383 1086 728"> <tr> <td><input type="checkbox"/></td> <td>X-Cursor</td> <td>X</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Y-Cursor</td> <td>Y</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Z-Cursor</td> <td>Z</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>2 Cursor mode</td> <td>N</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Harmonic</td> <td>H</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Mirrored</td> <td>M</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Centred</td> <td>S</td> </tr> </table> <p style="text-align: center;"><i>Figure 10: Cursor selection</i></p> <ul style="list-style-type: none"> • 2 Cursor mode 2 independent, moveable cursor will be displayed in the window. • Harmonic Several cursor are activated at equidistant intervals. In this mode, the first cursor will move all other cursor. The intervals are defined by grabbing and moving the second or any following cursor. The Harmonic function can only be applied in combination with X-cursor, Y-cursor or Z-cursor. It serves to measure repeating intervals. • Mirrored Several cursor are activated at equidistant intervals. Cursor 1 will be on one side and in the middle of the even-numbered equidistant cursor and the odd-numbered equidistant cursor is located on the other side. If you move one cursor (except Cursor 1) all other cursor besides Cursor 1 will move symmetrically. • Centered Several cursor are activated at equidistant intervals. In contrast to <Mirrored>, all cursor (except Cursor 1) and the cursor which is in the opposite of the first mirrored cursor are moving. 	<input type="checkbox"/>	X-Cursor	X	<input type="checkbox"/>	Y-Cursor	Y	<input type="checkbox"/>	Z-Cursor	Z	<input checked="" type="checkbox"/>	2 Cursor mode	N	<input type="checkbox"/>	Harmonic	H	<input type="checkbox"/>	Mirrored	M	<input type="checkbox"/>	Centred	S
<input type="checkbox"/>	X-Cursor	X																				
<input type="checkbox"/>	Y-Cursor	Y																				
<input type="checkbox"/>	Z-Cursor	Z																				
<input checked="" type="checkbox"/>	2 Cursor mode	N																				
<input type="checkbox"/>	Harmonic	H																				
<input type="checkbox"/>	Mirrored	M																				
<input type="checkbox"/>	Centred	S																				
<Zoom range>	<ul style="list-style-type: none"> • Max. frequency range. Zoom to maximum frequency range • Max. time range. Zoom to maximum time range (show entire buffer without scrollbar) • Max. frequency and time range <table border="1" data-bbox="743 1718 1125 1854"> <tr> <td>Max. frequency range</td> <td>F</td> </tr> <tr> <td>Max. time range</td> <td>T</td> </tr> <tr> <td>Max. frequency and time range</td> <td></td> </tr> </table> <p style="text-align: center;"><i>Figure 11: Maximize zoom range</i></p>	Max. frequency range	F	Max. time range	T	Max. frequency and time range																
Max. frequency range	F																					
Max. time range	T																					
Max. frequency and time range																						
<Zoom in>	<p>Enlarged view of the section delimited by the cursor. Repeat this process until the spectrum area displayed is satisfactory.</p>																					

Parameter	Function
<Zoom out>	Reduced view of the section delimited by the cursor. Repeat this process until the spectrum area displayed is satisfactory.
<Immediate mouse zoom>	Zoom in by clicking the mouse at the desired position (zoom out using the <Ctrl> key).
<Mouse measure>	Delivers X-, Y- and Z-values at the current mouse position in the sonagram in the X-, Y- and Z-cursor 1 boxes and displays them. If there is no valid Y-value the Y-cursor 1 is set to the smallest allowed value. This feature is only available if the sonagram is paused.
<Move>	The mouse pointer changes into a hand. Drag the displayed section in the desired direction by moving the mouse while keeping the left mouse button pressed.
<Sync Noise level with Y-cursor>	The Y-cursor are displayed at the currently estimated values for power and noise (red: power, green: noise). See chapter Power and SNR measurement.
<Power Spectrum Density (PSD)>	Switches between power spectrum and power spectrum density (PSD).
<Magnifier>	The mouse pointer changes into a magnifying glass superimposed on a rectangle. On mouse click, a separate window is opened showing the magnified contents of the sonagram display center. Select the section to magnify, either by drawing a rectangle before activating the magnifier function or simply clicking the position of interest in the sonagram display.
<Overview>	Opens a sonagram with an overview of the complete signal located in the buffer. In addition you see a rectangular mark around the section in the actual sonagram display.

Table 2: Spectrum/Sonagram Parameters - Popup Menu

3.5.1.6. Spectrogram/Sonagram Keyboard Shortcuts

The following keyboard shortcuts are available in the spectrum/sonagram display:

Parameter	Function
Mouse Wheel focus on sonagram	Move scrollbar in time direction
Mouse Wheel focus on spectrum	Move scrollbar in frequency direction
<Left Arrow>	Move scrollbar to lower frequencies. Additional <Ctrl> scrolls one page
<Right Arrow>	Move scrollbar to higher frequencies. Additional <Ctrl> scrolls one page
<Up Arrow>	Move time scrollbar one step towards the start. Additional <Ctrl> scrolls one page
<Down Arrow>	Move time scrollbar one step towards the end. Additional <Ctrl> scrolls one page

Parameter	Function
<Page Up>	Move time scrollbar one page towards the start. Additional <Ctrl> jumps directly to the start
<Page Down>	Move time scrollbar one page towards the end. Additional <Ctrl> jumps directly to the end
<Home>	Move time scrollbar directly to the start
<End>	Move time scrollbar directly to the end

Table 3: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Scroll functions

Parameter	Function
<Ctrl> + Mouse Wheel	Zoom in/out in time
<Ctrl> + Drag area with Mouse	Zoom into dragged area
<Shift> + Mouse Wheel	Zoom in/out in frequency
<Ctrl> + <Shift> + Mouse Wheel	Zoom in/out in time and frequency
<+> / <P>	Zoom in Graphical Zoom enlarges the visible frequency by factor ½ each time it is activated. If there is a drawn rectangle (by mouse) in the display window, it is zoomed into this section. After zooming, the rectangle, shown as a white dotted line, will disappear - as if clicked any position in the display window.
<-> / <M>	Zoom out The displayed frequency area is enlarged by factor 2

Table 4: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Zoom functions

Parameter	Function
	<i>Most Cursor shortcuts are toggle functions</i>
<X>	Activate and deactivate the (X) frequency-cursors
<Y>	Activate and deactivate the (Y) level-cursors
<Z>	Activate and deactivate the (Z) time-cursors
<N>	Switch to normal 2 cursor mode (no toggle function)
<H>	Activate and deactivate Harmonic cursor mode: <ul style="list-style-type: none"> • all harmonic cursors placed at one side • dragging cursor 1: moves all cursors - keeping distances • dragging cursor >= 2: Cursor 1 stays in place - all other stretch/move

Parameter	Function
<I>	Activate and deactivate mirrored cursor mode: <ul style="list-style-type: none"> • harmonic cursors placed on both sides of Cursor 1 • dragging Cursor 1: moves all cursors - keeping distances • dragging Cursor >= 2: Cursor 1 stays in place - all other stretch/move
<S>	Activate and deactivate centered cursor mode: <ul style="list-style-type: none"> • harmonic cursors placed on both sides of Cursor 1 • dragging Cursor 1: moves all cursors - keeping distances • dragging Cursor >= 2: cursors at opposite side stay in place - all other stretch/move

Table 5: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Cursors

Parameter	Function
<J>	Searches the spectrum for the maximum and displays the corresponding X/Y value as a tooltip. With active X-Cursors the search range can be restricted. The values are automatically inserted into the clipboard. The tooltip disappears as soon as the key is released.
<U>	Same as <J>, but searching for the minimum.
<L>	X-Cursor 1 and Y-Cursor 1 are moved to the next maximum of the spectrum curve towards lower frequencies, if X-Cursors are active. If <Peak-Hold> is activated, the maxima on the compressed curve are selected.
<R>	Same as <L>, but towards higher frequencies.

Table 6: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Minimum/Maximum

3.5.1.7. Spectrum/Sonagram Parameters Settings

As with all displays, the spectrum/sonagram’s parameters are edited on the property sheet, which features several tabs.

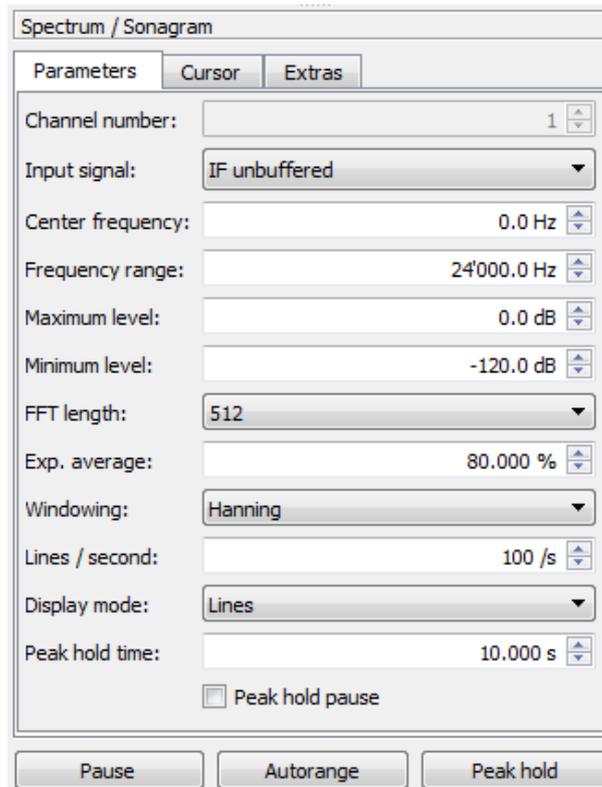


Figure 12: Spectrum/Sonagram - Parameters

To show the parameters of the spectrum/sonagram, select the <Parameters> tab. The following parameters are available:

Parameter	Function
<Channel Number>	There are signals that consist of several signal parts, e.g. the input signal channel in an MFSK2 modem. The channels of such signals are selected as the input signal by their channel number.
<Input signal>	Use this parameter to select the input signal of the display. If the automatic production is active, you can only select the input IF. While setting the parameters of the demodulator, it may occur that a previously selected input signal is no longer available. In this case, the selection <i>no signal</i> will be displayed.
<Center frequency>	The frequency section to be viewed is set in combination with the frequency range. The center frequency is the center of the section.
<Frequency range>	The frequency section to be viewed is set in combination with the center frequency. The frequency range is the range within the section. The zoom can thus be set manually.
<Maximum level>	Definition of the level range in the spectrum display. The maximum level is the upper end of the section.
<Minimum level>	Definition of the level range in the spectrum display. The minimum level is the lower end of the section.
<FFT length>	Number of values of frequency in which the signal is displayed. To obtain a higher resolution of the displayed frequency range, increase the FFT length.

Parameter	Function
<Exp. Average>	<p>The spectrum is displayed as an average of several spectra. The averaging can be set here.</p> <p>0%: No average</p> <p>- 80%: Low average</p> <p>80% - 99%: High average</p> <p>100%: No updating of the spectrum</p>
<Windowing>	<p>The FFT algorithm is used for the calculation of the spectrum. This algorithm, however, shows inaccuracies in the amplitude (attenuation) as well as in the bandwidth (expansion) of a signal due to the finite signal probe. These inaccuracies can be reduced using windowing:</p> <div data-bbox="660 763 1273 1198" data-label="Figure"> </div> <p style="text-align: center;"><i>Figure 13: Accuracies of windowing functions</i></p>
<Lines / second>	<p>Number of spectrums that can be calculated and displayed within one second. This parameter serves to set the time resolution for the sonagram, thus also setting the scroll speed.</p>
<Display mode>	<p>Use this parameter to set the type of the display: Line: the spectrum is displayed as a closed curve. Bar: the individual values are displayed as bars.</p>
<Peak hold time>	<p>When the time adjusted has elapsed, the peak hold (the red curve in the spectrum) will be reset to the current values. 0 means no reset.</p>
<Peak hold pause>	<p>This check box is used to freeze the continuous display after a period specified in the spin box <Peak hold time> (The button <Pause> is activated and locked). It can only be selected if the button <Peak hold> has been activated. This function will not stop the signal flow between the signal processing modules. To reactivate the continuous update of the display, press the button <Pause> again (toggle switch).</p>
<Pause>	<p>In Pause, the display is stopped (not the signal processing). Modification of the parameters is possible for a more detailed analysis of the current signal range.</p>
<Autorange>	<p>Automatic setting of the displayed range to view the total amplitude and frequency range. The mode autorange analyzes approx. 12 spectral lines. The display is adapted on every change of the range.</p>

Parameter	Function
<Peak hold>	By activating <Peak hold>, the maximum energies in the spectrum are recorded and displayed as a red curve.

Table 7: Spectrum/Sonagram - Parameters Tab

3.5.1.8. Spectrum/Sonagram Cursor Settings

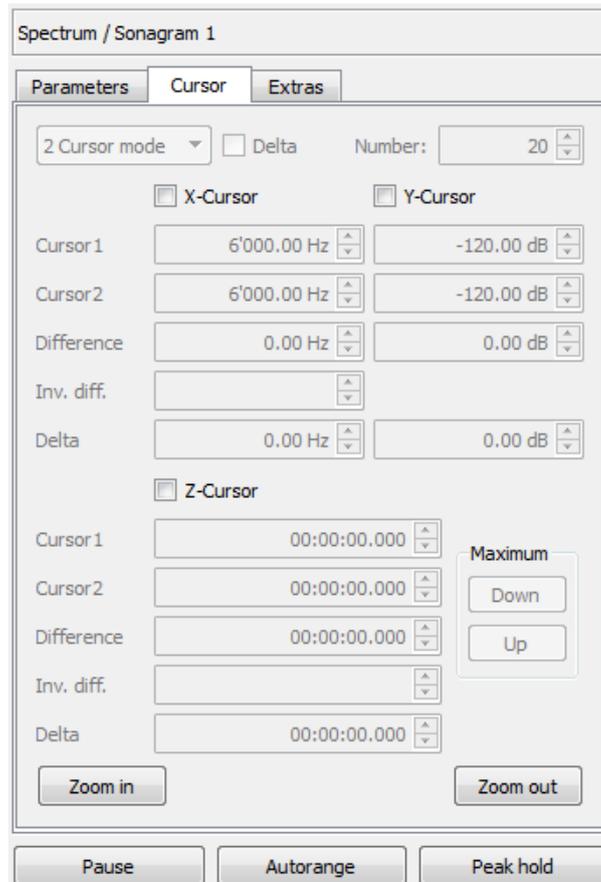


Figure 14: Spectrum/Sonagram - Cursor

The <Cursor> tab contains all functions related to cursor operations except for the <Zoom> buttons and the relative zoom factor setting. These are located on the <Extras> tab of the Spectrum/Sonagram Display.

Additionally, the spectrum/sonagram display features a popup menu and keyboard shortcuts. For details see chapter Spectrogram/Sonagram Keyboard Shortcuts.

Parameter	Function
Dropdown Menu Cursor mode	<ul style="list-style-type: none"> • 2 Cursor mode 2 independent, moveable cursor will be displayed in the window. • Harmonic Several cursor are activated at equidistant intervals. In this mode, the first cursor will move all other cursor. The intervals are defined by grabbing and moving the second or any following cursor. The Harmonic function can only be applied in combination with X-cursor, Y-cursor or Z-cursor. It serves to measure repeating intervals. • Mirrored Several cursor are activated at equidistant intervals. Cursor 1 will be on one side and in the middle of the even-numbered equidistant cursor and the odd-numbered equidistant cursor is located on the other side. If you move one cursor (except Cursor 1) all other cursor besides Cursor 1 will move symmetrically. • Centered Several cursor are activated at equidistant intervals. In contrast to <Mirrored>, all cursor (except Cursor 1) and the cursor which is in the opposite of the first mirrored cursor are moving.
<Delta>	The positions of Cursor 1 and Cursor 2 stay the same during changes of the cursor mode or the number of cursor, if this checkbox is not activated, otherwise the positions of the 2 outermost cursor are tried to keep fixed. This allows a convenient way to have multiple cursor at equidistant intervals in a specific area without the need to adapt the cursor. To cancel the additional cursor, select "2 Cursor" mode.
<Number>	Use this spin box to determine the number of cursor to be displayed in Harmonic mode.
<X-Cursor>	The cursor are activated/deactivated in X-direction. They are used to measure values of time.
<Y-Cursor>	The cursor are activated/deactivated in Y-direction. They are used to measure the values on the Y-Axis (which varies from display to display, i.e. phase, frequency etc.).
<Cursor 1>	Coordinates of the first X-, Y- and Z-cursor each
<Cursor 2>	Coordinates of the second X-, Y- and Z-cursor each
<Difference>	Difference between Cursor 1 and Cursor 2
<Inv. diff.>	Inverted difference is a helpful function for direct readout of symbol rate (determination of which is a major purpose of the Z-cursor) according to the formula $1 / [\text{value in box Difference}]$
<Delta>	Gap between the minimum and maximum cursor. In "2 Cursor" mode it is the same as Difference, in all other cases it is Difference times Number - 1.
<Z-Cursor>	The cursor are activated in Z-direction. They are used to measure values of time.
<Cursor 1>	Coordinates of the first X and Y Cursor each
<Cursor 2>	Coordinates of the second X and Y Cursor each
<Difference>	Difference between Cursor 1 and Cursor 2

Parameter	Function
<Inv. diff.>	Inverted difference is a helpful function for direct readout of symbol rate (determination of which is a major purpose of the Z-cursor) according to the formula $1 / [\text{value in box Difference}]$
<Delta>	Gap between the minimum and maximum cursor. In "2 Cursor" mode it is the same as Difference, in all other cases it is Difference times Number - 1.
<Down>	Sets X-cursor 1, Y-cursor 1 to the next visible maximum on the spectrum line against X-direction, if cursor are activated.
<Up>	Sets X-cursor 1, Y-cursor 1 to the next visible maximum on the spectrum line in X-direction, if cursor are activated.
<Zoom in>	With enabled cursor, the button <Zoom in> serves to graphically zoom into the area delimited by the cursor. With disabled cursor, the zoom enlarges the area by factor $\frac{1}{2}$ each time it is activated (X-direction only). Additionally, the user may draw a rectangle in the display window and zoom into this section graphically by means of the button <Zoom in>. If the display window has activated cursor, the zoom via rectangle will take priority. After zooming, the rectangle shown as a white dotted line will disappear. Otherwise, simply click any position in the display window to delete the rectangle.
<Zoom out>	Each time the button <Zoom out> is activated, the display area is enlarged by factor 2. With disabled cursor, the zoom is exclusively made in X-direction.
<Pause>	In Pause, the display is stopped (not the signal processing). Modification of the parameters is possible for a more detailed analysis of the current signal range.
<Autorange>	Automatic setting of the displayed range to view the total amplitude, frequency and phase range. The display is adapted on every change of the range. On pressing <Autorange> again, this process will be deactivated (toggle).
<Peak hold>	By activating <Peak hold>, the maximum energies in the spectrum are recorded and displayed as a red curve.

Table 8: Spectrum/Sonagram - Cursor Tab

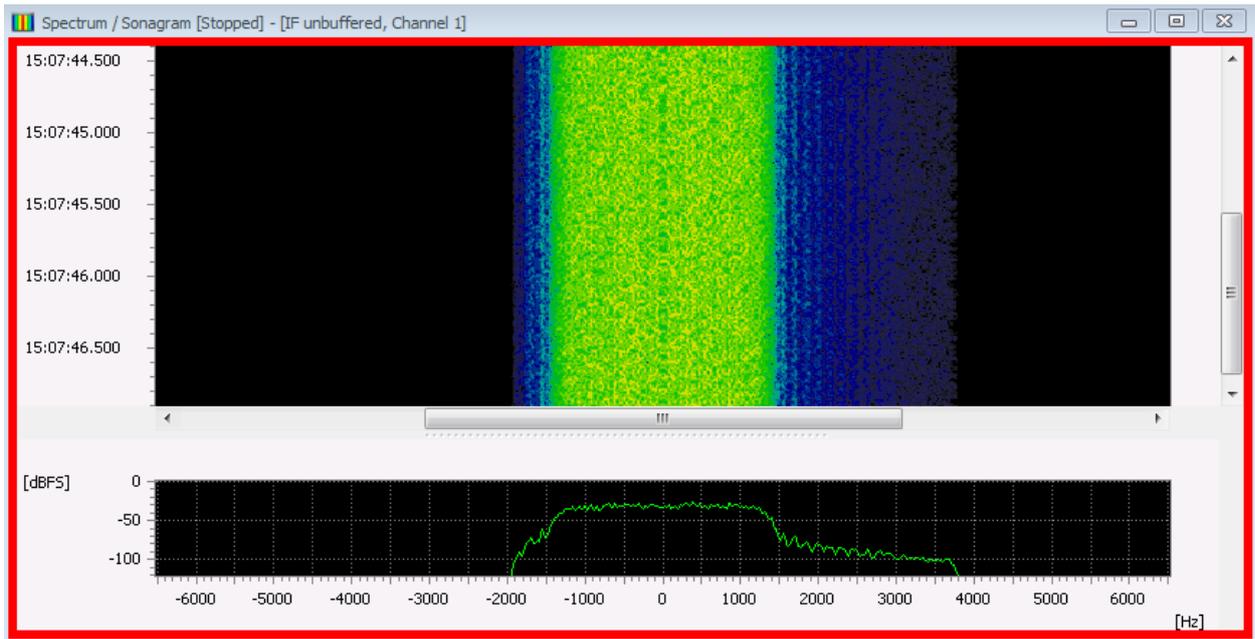


Figure 15: Spectrum/Sonagram - Display Paused

3.5.1.9. Spectrum/Sonagram Extras Settings

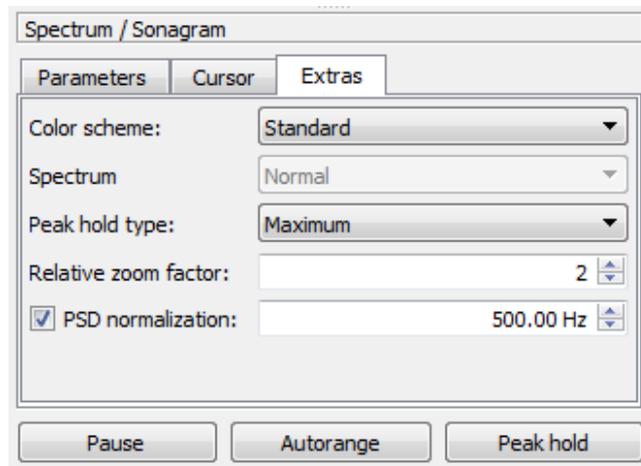


Figure 16: Spectrum/Sonagram - Extras

The <Extras> tab features additional options with regard to the display type. The dropdown list box <Color scheme> is used to select the color schemes for the displays.

Color Scheme	Foreground Color	Background Color
Standard	light	black
Inverse	dark	white
Monochrome	shades of grey	white

Table 9: Spectrum/Sonagram - Color Schemes

Additionally the <Extras> tab has a dropdown list Spectrum, which is inactive unless the Z-cursor are enabled. Specify whether you wish to display

Spectrum	Sector
Normal	exponential averaged spectrum
At Cursor	the spectrum exactly at the position of Cursor 1
Average value Cur.1/2	the averaged spectrum between the two cursor

Table 10: Spectrum/Sonagram - Spectra

The dropdown list <Peak hold type> offers the values:

- Maximum
- Minimum
- Average

With <Relative zoom factor> the favored relative zoom factor is set for zooming out and its reciprocal for zooming in. The default value in this spin box is "2".

The <PSD normalization> button is described in chapter Power spectrum.

3.5.2. Bit Display

Symbols are the output of a demodulation process. Every symbol can be viewed as a sequence of bits. The bit display shows symbols or bits.

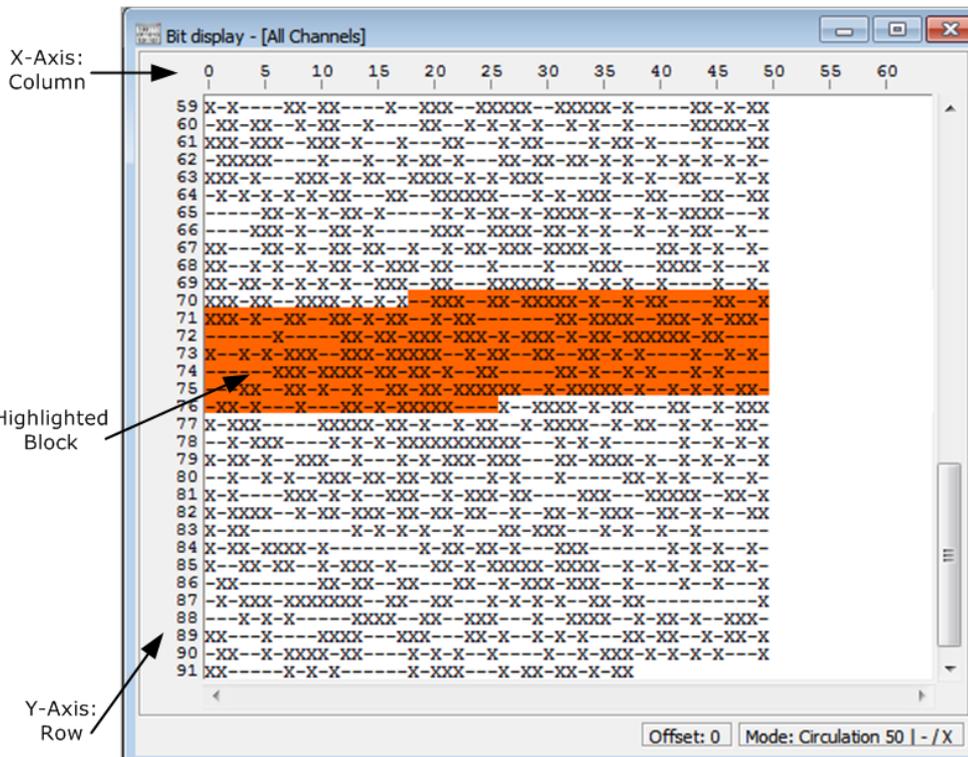


Figure 17: Bit Display

Column numbers for the bits or symbols are drawn on the X-Axis. The row numbers are drawn on the Y-Axis.

The bit display presents an overview of sequences of symbols and serves to analyze repeating bit patterns. Parts of the bit patterns can be highlighted. The highlighted part of the bit pattern or all bits saved in the bit display can be saved in a file.

Zoom in/out is possible by pressing <Ctrl> key and using the mouse wheel.

3.5.2.1. Bit Display Parameter Setting

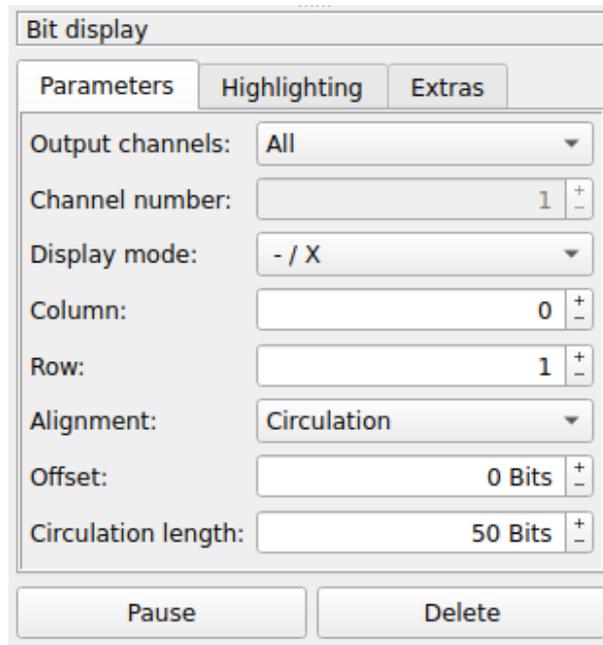


Figure 18: Bit Display - Parameters

Parameter	Function
<Output channels>	One symbol may consist of several channels, e.g. in an MFSK2 modem. This parameter serves to set the channels to be displayed: All: All channels of the symbol are displayed. Channel number: Symbols of a specified channel are displayed.
<Channel number>	Sets the channel of the symbols displayed. In a modem with one channel, there is only channel number 1.
<Display mode>	Use this parameter to set the mode in which the bits are displayed. If bits are displayed, the character left to the slash “/” stands for bit 0, and right to the slash “/” for bit 1. The bit ordering is always LSB first. For example, symbol 3 is serialized into bits 110. <ul style="list-style-type: none"> – / X Display the bits as “–” (value 0) and “X” (value 1) . / 1 Display the bits as “.” (value 0) and “1” (value 1) White / Black Display the bits white (value 0) and black (value 1) L / H Display the bits as “L” (value 0) and “H” (value 1) Symbols Display a symbol number (integer) instead of bits. The number of bits per symbol depends on the configured modulation.
<Column>	Sets the number of the column in which the bit pattern is displayed. The column is in the left end of the section to be viewed.
<Row>	Sets the number of the row in which the bit pattern is displayed. The row is in the upper end of the section to be viewed. This parameter cannot be modified unless the display type has been suspended using <Stop>  or <Pause>  .

Parameter	Function
<Alignment>	This parameter serves to select the mode which defines the length of a row: Circulation: The parameter Circulation defines the length of a row. Burst: The duration of a burst (in symbols) defines the length of a row. The mode Burst length should not be set unless there is a modem in which the burst mode has been activated.
<Offset>	Defines the number of the first bit from which the bit pattern is displayed.
<Circulation length>	Defines the number of bits required to draw a row. If the length is greater than the visible section, the invisible section can be displayed by means of the parameter Column. Columns which include only one bit number are called frames. Use this parameter to set the skew of the bit sequences to make the repeating bit patterns visible with frame. This parameter cannot be modified unless the row mode has been set to Circulation length.
<Pause>	The display is suspended in Pause and the parameters can be modified for a more detailed analysis of the bit pattern.
<Delete>	Clears the display

Table 11: Bit Display - Parameters Tab

3.5.2.2. Bit Display Highlighting Settings

The parameters of the highlight function can be displayed and modified by activating the <Highlighting> tab in enabled mode Pause.

Use the mouse for the highlighting operation:

- Move the mouse pointer to the start position of the block to be highlighted.
- Press the left mouse button.
- If the <Shift> key is held down during the selection, a block selection is created. If the block selection is already activated via the parameters, the block selection is deactivated again by pressing and releasing the <Shift> key.
- Drag the highlight to the end position of the block without releasing the left mouse button.
- After releasing the mouse button, the desired block has been defined.

Use the right mouse button to open a popup menu in the bit display. The popup menu serves to:

- Copy the highlighted block to the clipboard of the system.
- Save all symbols of the bit display to a file.
- Save the highlighted block to a file.

The individual items of the highlight option can be edited:

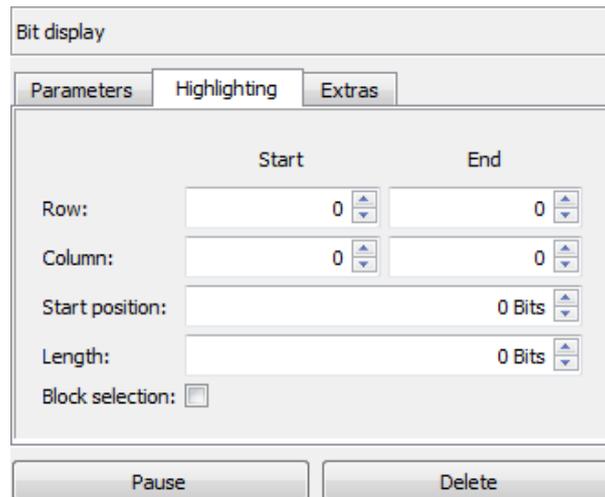


Figure 19: Bit Display - Highlighting

Parameter	Function
<Row>	Defines the start and the end of the row of the highlighted block.
<Column>	Defines the start and the end of the column of the highlighted block.
<Start position>	Defines the start of the selection in bits if block selection disabled.
<Length>	Defines the length of the selection in bits if block selection disabled.
<Block selection>	When deactivated, all bits are marked continuously from the start position. When the block selection is activated, a rectangular section (matching columns only) will be highlighted, i.e. the bits to the left of the start column and the bits to the right of the end column are not marked. Alternative switching with the <Shift> key while marking with the mouse. The switching of the block selection can influence the already marked area.
<Pause>	In <Pause> the display is stopped (not the signal processing). Changing the parameters is possible to analyze the bit pattern in more detail.
<Delete>	Clears the display and all bits stored in the bit representation.

Table 12: Bit Display - Highlight

3.5.2.3. Bit Display Extras Settings

The <Extras> tab serves to change the font size of the bit display and to include the bit display quality.

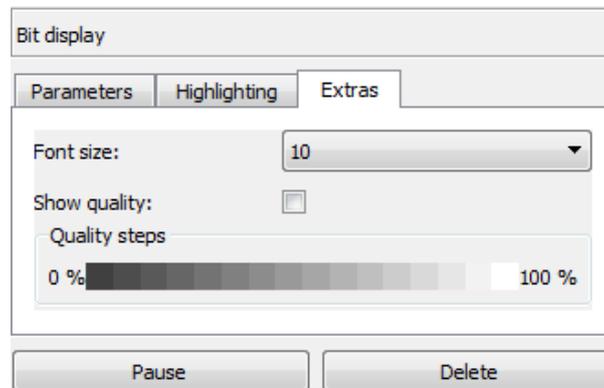


Figure 20: Bit Display - Extras

Parameter	Function
	Defines the size of a bit in the display. With small font sizes, more bits will be visible than with large font sizes. Identification of details will be harder with small font sizes.
<Show quality>	Highlights the quality of the individual bits in shades of gray. The lighter the color, the better the quality of the individual bit.

Table 13: Bit Display - Extras Tab

Copy picture to clipboard

In every display there is an entry “Copy as Picture” in the context menu. This will copy the complete display into the clipboard as an image. This can then be pasted into another application, e.g. MS Word®.

3.6. Extras Menu

This menu provides various control functions and settings.

3.6.1. Start

Start the signal processing mode of the APC. At the same time, the APC output is transferred to the Modem Lab.

3.6.2. Stop

Stop the signal processing mode of the APC.

3.6.3. Modem Recognition

Start the automatic signal processing mode of the APC. In addition, <Start> must be selected to produce some output. Once the automatic production mode has been started, the control and modem parameters can no longer be modified.

When the Modem recognition and start is enabled, then the search for a modem from the modem lists is started, i.e., the system searches for a modem that matches the signal. If a modem is found, production is started and output is produced from this modem as long as the signal is available.

3.6.4. Production

Start the manual production mode of the APC. The APC starts production with the selected modem.

3.6.5. Record demodulator output

Select this menu item to start recording the demodulator output (bit stream) during production. The created ".rec" file can later on be loaded into the Decoder Development Environment or the go2ANALYSE for further analysis of the bit stream.

3.6.6. Signal sources

This item is used to select one of the available signal sources. You can choose between DANA and Signal Memory.

3.6.7. Launch DANA

Launch DANA

Note: if DANA is running already nothing will happen.

3.6.8. Launch go2ANALYSE

Launch go2ANALYSE (Availability depends on the software version).

3.6.9. Launch Decoder Development

Launch external Decoder Development Environment for Python based decoders (Availability depends on the software version).

3.7. Modem Menu

The modem description (hereinafter referred to as "modem") provides the demodulator and decoder parameters of the modem. All demodulator and decoder parameters are saved in the modem file.

Note: the decoder itself is not part of the modem file.

The various rows in the modem list each represent one specific modem.

Each modem can be saved either individually in one file or in combination as a modem list.

3.7.1. New Modem

Add a new modem to the bottom of a modem list. A dialog will appear that shows a list of all the available modems in the installation folder. The modems are grouped (e.g. HF, VHF). You can choose which group is displayed. The group "User folder" shows all modems that were found in your user folder (including subfolders). Some of the listed modems will exhibit a short description. When you start typing in the upper text box the list will filtered. Wildcards are supported. Select one or several modems to load. If you click the button <New modem> then no modem file is actually loaded but a template is added to your list.

3.7.2. Load Modem from File

Load modems previously saved. A dialog window is displayed for selection of one or several modem files (.ver). The modems will be added to the bottom of the modem list.

3.7.3. Save Modem to File

Save the modem currently selected in the modem list. A dialog window is displayed to enter a file name for the modem. Although it is possible to save the modem file anywhere on your hard-disk it is recommended - and proposed - to save it in the common procitec/modems folder in your user folder. Then it will show up in the <New modem...> dialog.

3.7.4. Remove Modem

Remove the modem currently selected from the modem list.

3.8. Modem List Menu

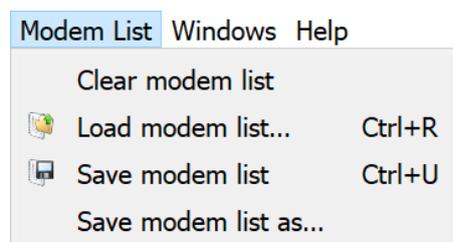


Figure 21: Modem List Menu

The modem list includes all modems currently available as well as various additional parameters. In detail, these are:

- Search strategy
- Signal search mode (frequency range or nominal frequency)
- Result threshold
- IF Saving mode
- Recording SNR

3.8.1. Clear Modem List

Create a new empty list. The current settings for nominal frequency respectively search range remain unchanged.

3.8.2. Load Modem List

Load one of the modem lists previously saved to a data medium. A dialog window is displayed for selection of a modem list. Once the loading process has been completed, the former modem list will be replaced by the new one.

Two types of modem lists are supported

- *.cmf: This type of modem list contains the complete definitions of the individual modems as well as command information.
- *.mlst: This type of modem list only contains a reference to the individual modems. These are then automatically loaded from the installation folder. If no suitable individual modem is found, then this modem is ignored.

In the installation directory, the folder 'procitec/common/x.y/modemlists' contains a number of predefined lists (mlst).

3.8.3. Save modem list

Save the current modem list. The list is always saved as type '.cmf'. The list contains all changes to the parameters of the individual modems.

3.8.4. Save Modem List as

Save the current modem list. A dialog window is displayed where the file name for the modem list can be entered

3.9. Windows Menu

Menu <Windows> serves to arrange the displays of Modem Lab more clearly and shows a list of all Modem Lab windows which are currently open. Selecting one of these windows will bring it to the foreground. These menu entries are user specific.

Persistent menu entries shown in upper half of menu <Windows> are explained below:

3.9.1. Position all

Arrange all signal and result display windows one below the other. Every window is displayed in the same size.

3.9.2. Position all and hide parameters

Arrange all signal/result display windows one below the other in equal size, and show or hide all property sheets (whichever applicable).

Use <Ctrl>+<Tab> to switch between display windows. Minimized windows will be restored if activated via the menu.

3.9.3. Split

Arrange Modem Lab windows both next to each other and below each other.

3.9.4. Cascade

Arrange the windows of the signal displays on top of each other.

3.9.5. Close all windows

Close all open Modem Lab windows.

3.9.6. Next Window

Places the focus on the next window or switches to it.

3.9.7. Previous Window

Places the focus on the previous window or switches to it.

3.9.8. Hide parameters

The property sheet currently displayed at the right is hidden and, vice versa, hidden property sheets are displayed.

3.9.9. Fullscreen

Switch the display to full screen modus (toggle function).

3.9.10. Remaining menu entries

Remaining menu entries are described in chapter Display Menu.

3.10. Help Menu

This menu provides detailed information about various subjects.

3.10.1. Help

Activate this item to display the present this Operating Manual.

3.10.2. List of Decoders

Opens a list of available decoders.

3.10.3. Decoder Data Sheets

Displays a detailed description of available decoders.

3.10.4. About

Displays a splash screen with version and copyright information.

3.11. Toolbar

The toolbar displays the major functions of the menu bar as icons. To activate the desired function, left click on the respective icon. Individual parts of the toolbar can be hidden or moved around.

The icons are listed in the order of their appearance on the toolbar:

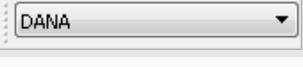
Icon	Function
	New modem
	Load modem from file
	Save modem to file
	Remove modem from modem list
	Open spectrum/sonagram
	Open bit display
	Open result display
	Drop-down list box featuring the available signal sources
	Start the signal processing of the APC. Modem Lab will now receive signal data
	Stop the signal processing of the APC. Modem Lab will not receive any further signal data
	Enable modem recognition mode
	Enable manual production mode
	Record demodulator output

Table 14: Modem Lab Toolbar Icons

3.12. Shortcuts

The following shortcuts are available for quick activation of frequently used functions:

Function	Shortcut
Load settings	<Ctrl>+<L>
Save settings	<Ctrl>+<Alt>+<S>
Copy	<Ctrl>+<C>
Paste	<Ctrl>+<V>
Spectrum / sonagram	<Ctrl>+<M>
Bit display	<Ctrl>+
Result Display	<Ctrl>+<T>
Start	<Ctrl>+<Return>
Stop	<Ctrl>+<Space Bar>
Load modem from file	<Ctrl>+<O>
Save modem to file	<Ctrl>+<S>
Load modem list	<Ctrl>+<R>
Save modem list	<Ctrl>+<U>
Position all	<F4>
Position all and show/hide parameters	<F8>
Show next window	<Ctrl>+<Right>
Show previous window	<Ctrl>+<Left>
Hide/show parameters	<F5>
Full screen	<F11>
Show instruction manual	<F1>

Table 15: Modem Lab Shortcuts

3.13. Modem Lab Window

To navigate in the main window of Modem Lab and to activate the functions, use one of the following three methods (depending on the current function):

- Keyboard shortcuts
- Left mouse button
- Popup menu via the right mouse button

You will find an overview of this subject in chapter Shortcuts. Use the keyboard to enter, edit or delete text.

When Modem Lab has been started using modem recognition, a search for the modem with the best result of all modems is carried out. Once the modem has been found, production starts from the time at which the search was started. This process will be faster than real time until the software has processed all existing signal data. Afterwards, the Modem Lab will again receive the data in real time.

When starting the program, the Modem Lab user interface is shown. The Modem Lab interface consists of four sections.

The left section contains all display windows currently open.

The right section features property sheets to view and edit the various parameters. Each sheet consists of several tabs.

- On the upper right is a sheet which serves to control the APC and to edit the parameters of the modems (demodulator selection and parameters, decoder selection, extras for modem parameter editing) . The modem currently active is displayed in a drop-down list box above these tabs.
- The display parameters on the lower right will vary with the active display window. To activate a display window on the left, left click the desired window and its parameters will be displayed on the lower right.
- Modems and displays are described in detail in the subsequent chapters.

There is a menu bar below the title bar of the program window, below the menu bar is a toolbar featuring frequently used items from the menu bar. In general, these are icons to open the displays and icons for control of the APC.

At the bottom of the user interface is a status bar. The left part of the status bar shows alert messages, errors or messages about the connection status to the APC.

The right part shows information about the status of the internal signal memory of the APC: the time range of the currently stored signal, its input (receiver) frequency and its samplingrate. A click with the left mouse button will enlarge or reduce the font size of the shown frequency. A click with the right mouse button displays a menu where the displayed frequency unit can be defined (default is Hz).

To the left a label indicates whether modem exclusion based on frequency information is enabled (default) or not. If enabled then modems will be excluded from search if their frequency range does not match the input signal. This applies only for recognition mode. In case of an input signal with unknown or false receiver frequency, e.g. the replay of a signal file without valid frequency information in DANA, this option should be disabled. A click with the left mouse button will toggle this option on or off. This setting is saved and restored when Modem Lab is started.

The section Frequency ranges explains how to edit these frequency ranges of a modem.

3.13.1. APC (Automatic Production Channel)

The task of the APC is the fully automated signal processing. This is achieved by detecting the signal and identifying the modem. The signal is then demodulated and decoded. Each of these steps can be controlled and modified by using the Automat control and the modem parameters (demodulator selection and parameter setting, decoder selection, extras for modem parameter setting). The results are controlled and displayed in the result display.

3.13.2. Result Display

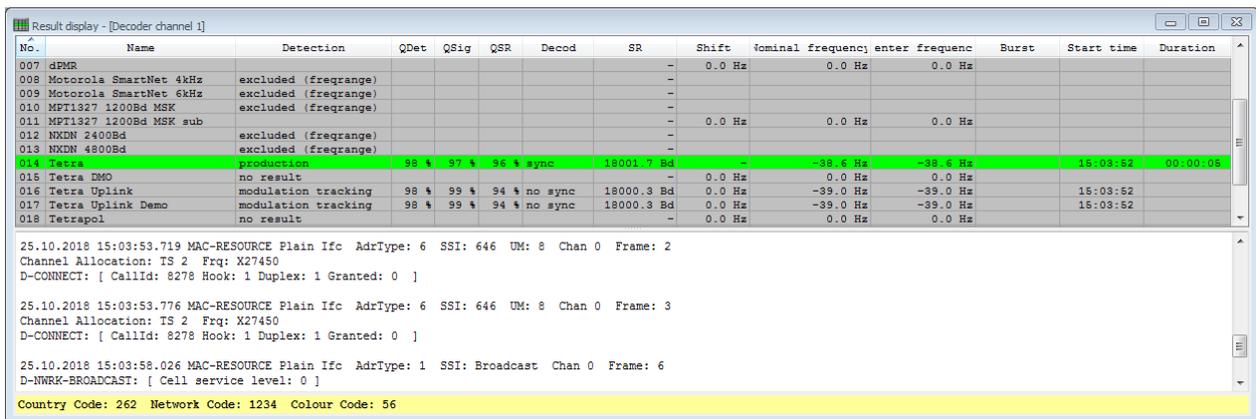


Figure 22: APC Result Display

The result display shows the search and production results of the APC. The display consists of 3 parts:

- **Modem table:** In the upper part of the display, you can see a table with intermediate results of demodulation and detection of all modems or that of a single active procedure (**marked bold**).
- **APC results:** In the lower area, the final results (messages from the APC, decoded text, runtime errors of the decoder) of search and production of the APC are displayed textually
- **Decoder status bar:** The status bar, highlighted in yellow at the bottom, shows important parameters, results and status of the active decoder live. The content depends on the decoder and can therefore be empty. Examples of the content are for example:
 - Network and country codes
 - currently active transmission type (e.g.: idle, data, voice, ...)
 - detected decoding modes (e.g. interleaving, scrambling, code rate, ...)

The status bar provides a fast overview of important and basic decoder results so that they do not have to be extracted manually from the sometimes quite extensive overall results.

Depending on the modem status, you will see the following APC messages in addition to the decoder result in the lower pane during production (apart from those that are self-explanatory like “search start” or “production start” etc.):

Message	Description
unidentified signal detected	Unknown signal detected - edit parameters
unidentified signal detected, closest [modem name]	Unknown signal detected with indication of closest possible modem - you may want to edit the parameters

Message	Description
unidentified signal detected, modulation similar [modem name]	Unknown signal detected with modulation similar to modem indicated - you may want to edit the parameters
modulation detected [modem name]	Modulation detected with indication of modem
modem detected [modem name]	The modem has been detected and production has started.

Table 16: Modem Lab Messages

To change the font size in the lower part of the window, see Result Display Extras Settings.

3.13.2.1. Parameter Setting

To view the parameters of the result display, do a right-click on the "Result Display Table Header" to open the context menu. All results except *No.* and *Name* are displayed by activating the various checkboxes.

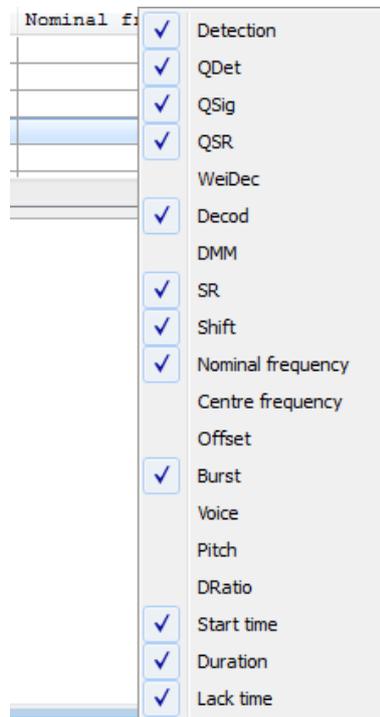


Figure 23: Modem Lab Selection of Result Production

The table lists the results in the upper part of the display together with their tasks:

Result Column	Function
No.	Modem number in the current list
Name	Name of modem

Result Column	Function
Detection	<p>Detection status of modem:</p> <p>No result: No statement on modem status possible</p> <p>Inactive: Modem is deactivated (either manually or automatically during search)</p> <p>Not detected: Modem has not been detected</p> <p>Waiting for decoder: Only modulation parameters has been detected, results from decoder are still pending</p> <p>Modulation: Modem has been detected on the basis of the modulation parameters</p> <p>Modem: Modem has been detected</p> <p>Signal lost: Modem was detected but is lost now</p> <p>Production: Modem is in production</p> <p>Modulation tracking: The modulation type has been detected, tracking parameters</p> <p>Modem tracking: The modem has been detected, tracking parameters</p> <p>Excluded (freqrange) Modem has been excluded due to receiver frequency</p> <p>Excluded (segmentation) Method excluded on the basis of segmentation results (e.g. spectrum does not fit)</p> <p>Excluded (bandwidth) Modem has been excluded due to inappropriate bandwidth</p> <p>Excluded (noprod) Modem does not support manual production (multi-modem)</p> <p>Excluded (nofreqsearch) Modem does not support automatic search within a frequency range</p> <p>Excluded (decod error) Modem has been excluded due to a decoder runtime error</p> <p>Excluded (demod error) Modem has been excluded due to a demodulator error (e.g. demodulator not available)</p> <p>Excluded (license) Modem has been excluded due to a missing license</p> <p>Excluded: Modem excluded due to wrong parameters</p>
QDet	Overall detection quality of modem (summation of various quality ratings)
QSig	Quality of signal based on symbol (hard) decisions
QSR	Quality of measured symbol rate
WeiDec	Weighting of decoder

Result Column	Function
Decod	<p>Status of decoder:</p> <p>No sync: Decoder not detected</p> <p>Identified: Decoder has detected modem characteristics in the data stream</p> <p>Accepted: Decoder has definitely identified the modem</p> <p>Sync: Decoder has found some modem characteristics but not identified it</p> <p>Error: Decoder runtime error</p>
DMM	This column indicates whether the demodulator has been modified by the decoder or not.
SR	Measured symbol rate (speed at which the signal is transmitted) or keying rate (number of characters per minute) for Morse modems
Shift	Measured shift (interval between the lowest and the highest frequency) of an FSK modem
Nominal frequency	Nominal frequency of the signal - relative to the center of the input signal
Center frequency	Center frequency of the signal - relative to the center of the input signal
Offset	Offset between nominal and center frequency
Burst	Length of burst (only if burst mode is enabled for this modem). Burst emissions are not continuous.
Voice	<p>Transmission mode in a speech modem:</p> <p>USB (One Side Band: Upper side band)</p> <p>LSB (One Side Band: Lower side band)</p> <p>DSB (Double Side Band, Amplitude modulation)</p> <p>FM (Frequency modulation)</p>
Pitch	Fundamental frequency of the perceived voice signal
DRatio	Scanning rate (dash-to-dot rate) of a Morse modem
Start Time	Time at which the modem was detected
Duration	Period during which the signal was detected
Lack Time	Time interval in which the signal was not detected

Table 17: Modem Lab Parameter Settings

3.13.2.2. Result Display Parameter Setting

To view the parameters of the result display, select the <Parameters> tab. All results except No. and Name are displayed by activating the various check boxes.

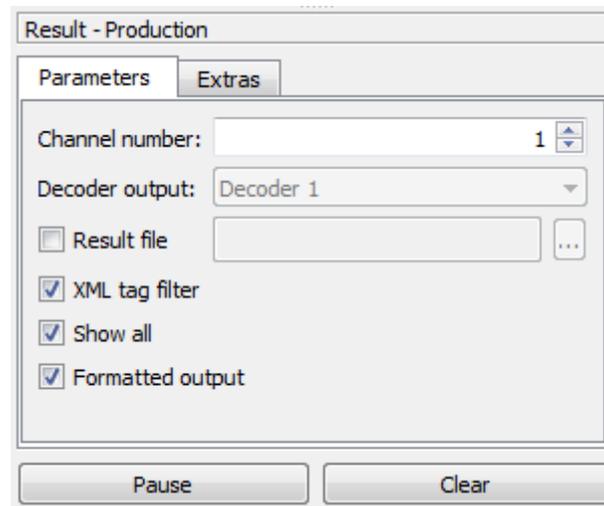


Figure 24: Result Display Parameters Settings

To edit the display parameters of the final results in the lower part of the display, select the <Parameters> tab. The following parameters are available:

Parameter	Function
Channel Number	This option serves to display the text of the respective decoder channels. Most modems only show output on channel 1. Some modems display additional results (e.g. LSB decoded results, CRC) on the other channels. A HEX output is sometimes available on channel 16.
Decoder Output	Toggle between Decoder 1 and 2 (default is decoder 1). This option is only effective if the demodulator used is F7B/F7W.
Result file	By activating this check box, the raw results of the output will be saved in a file. If no file has been specified, a file dialog will be displayed to select a base directory in which to save the results. A "results" directory is created in the base directory. The file "apcresult.xml" (required to view the result file formatted within a web browser) is copied to this directory.
XML tag filter	The plain XML result is displayed if this check box is not checked
Show all	Enable this check box to view additional messages in the lower result pane, like the modem closest to the unknown signal.
Formatted output	Select this check box to activate the formatted output. If not checked a considerable amount of additional information of the search results is displayed.
<Pause>	The display is halted in pause. Now edit the parameters for more detailed examination of the results.
<Clear>	Clears the buffer and the display of the final results

Table 18: Result Display Parameters Settings

3.13.2.3. Result Display Extras Settings

The font size of the text output (lower window of the result display) can be changed under the <Extras> tab. If the display focus is on the text output, the font size can also be changed using the following key combinations:

- by pressing <Ctrl> and using the mouse wheel
- by using the keyboard shortcut <Ctrl>+<+> or <Ctrl>+<->
- by using the keyboard shortcut <Ctrl>+<Up> or <Ctrl>+<Down>

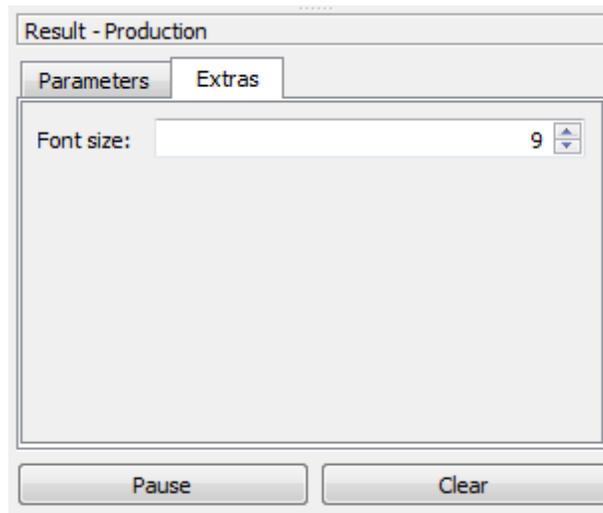


Figure 25: Result Display Extras Settings

3.13.2.4. Popup Menu Results Table

A popup menu is opened by a right-click in the results table. Various functions can be applied to the modem displayed in this table:

Parameter	Function
Use modem	The active modem (bold) is replaced by the selected modem
Save modem	Save the modem previously selected from the modem list to a data medium. Open a dialog window for input of a file name for this modem.
Remove modem	The selected modem is removed from the modem list.
Enable modem	Enable modem if it was disabled
Disable modem	Modem will be ignored during modem recognition
Add to multimodem	This allows to add the selected modem as a submodem to a multimodem. If there are any multimodems in the current modem list they will be listed here. The entry "New MultiModem" will automatically create a new multimodem and add the selected modem as a submodem. Note that the modem will be then removed from the list.

Table 19: Result Display Pop-Up Results Table

You may also use (activate) modems by double clicking the respective modem row in the table.

Another popup menu will open by a right-click in the result text window:

Parameter	Function
<Copy>	Copy highlighted result text to clipboard
<Select All>	Select complete result text

Table 20: Result Display Pop-Up Text Result

The contents of the result windows can also be selected using the mouse.

Note: The result window will stop scrolling if the scroll bar is touched. To re-enable scrolling move the scroll bar to the bottom.

3.14. APC Control Parameters

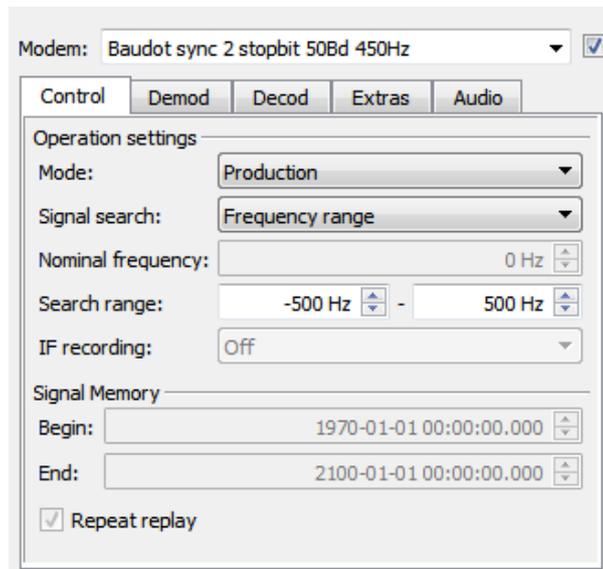


Figure 26: Modem Lab Control Parameter

3.14.1. Modem List

Apart from the result display, the modem list is the other way to display all modems.



Figure 27: Drop-down List Box Modem

It includes all modems that can be used in automatic production to identify the modem of a new signal. To show the modem list, activate the box Modem in the drop-down list.

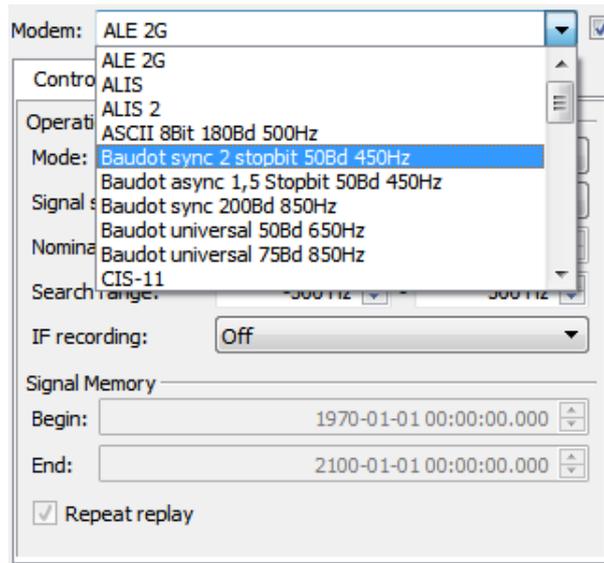


Figure 28: Drop-down List Box Modem with Modem List

Once the drop-down list is activated, a text cursor will appear so that the name of the active modem can be edited. On pressing the down control on the right, the drop-down list will open showing the list of modems. If the list includes a great number of modems, a scrollbar will appear on the right. Grab the slider of this scrollbar with your mouse cursor and slide downward to see the remaining part of the modem list. Click the desired modem to activate it. Use the cursor keys “Up” (↑) and “Down” (↓) to quickly move between modems.

Deactivating the check box to the right of the drop-down list box will deselect the modem from the APC modem list. Use this feature to exclude modems from the modem list in automatic production.

Tab	Task
<Control>	Modify the parameters controlling the automatic production. This will affect the entire modem list.
<Demod>	Select demodulator and edit the parameters of the active modem (not available during automatic search)
<Decod>	Decoder selection of the active modem
<Extras>	Edit additional parameters of the active modem

Table 21: Modem Lab Tabs

The functions of these tabs are explained below.

3.14.2. Control Settings

The control parameters serve to set the following areas of the APC.

- Automatic identification
- Duration of the production process
- Supervising of the production process
- Saving of signals

In addition to the direct input, the time parameters and the numerical values can be edited using the cursor keys “Up” (↑) or “Down” (↓) (corresponding to the up/down controls on the right of the spin box). This will change the digit on which the cursor is positioned. Position the cursor by means of the cursor keys “Right” (→) or “Left” (←).

Activate the <Control> tab to edit the parameters:

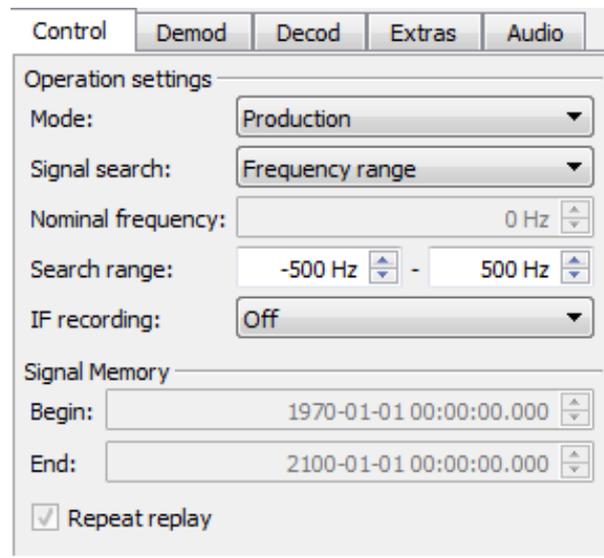


Figure 29: APC Control Parameters

3.14.2.1. Mode

Selection of the operating mode. You can select between:

- Modem Recognition (automatic mode)
- Production (manual mode)

3.14.2.2. Signal Search

- Frequency Range: The APC searches for signals in the defined search range and automatically determines the correct center frequency within the given range based on the results of the segmentation. Modems might be excluded on if their energy spectrum does not fit the current signal.
- Nominal frequency: Manual definition of the frequency offset of the signal. This is controlled on the <Extras> tab together with the modem-specific parameter Offset Nominal Frequency. There is only minimal center frequency correction carried out by each demodulator.

3.14.2.3. Nominal Frequency

Nominal frequency for every modem if <Nominal frequency> is used. Offset Nominal frequency on the <Extras> tab is added to this value for each modem.

3.14.2.4. Search Range

Modem types will be searched in the defined search range around the intermediate frequency ($f = 0$) if “Frequency Range” is used.

3.14.2.5. IF Recording

You can record the input signal by the APC. The recordings will be saved in the production memory on the hard-disk. The start of the recording can be dependent on different conditions.

- Off: Signal is not recorded.
- Detected modem: Recording is started on successful search when production starts
- Unknown Signal: Recording is started when no matching modem has been found, when a signal has been detected by the energy detector in the segmentation, and when this signal has at least the signal-noise ratio defined in Record SNR (see options menu)
- Signal detected: Recording is started as soon as some signal has been detected, and when the signal has at least the signal-to-noise ratio defined in Record SNR
- On: The complete signal is recorded.

Note: Please note that the recordings also depend on the begin and the end.

3.14.2.6. Signal Memory

These controls are only available when Signal Memory has been selected as signal source.

3.14.2.7. Begin

Time at which the recorded signal is read from the short-time memory.

3.14.2.8. End

Time at which the reading from the short-time memory is stopped.

3.14.2.9. Repeat Replay

You can have the recorded signal played repeatedly. To do so, select this check box.

The start and end times can be set both manually and by using the sonagram. First, activate the Z-cursor in the sonagram. Open the popup menu (right-click) in the sonagram (signal source must be set to Signal Memory), and use this menu to adopt the time position settings of the cursor as parameters for the start and end time of the short-time memory replay. On selecting <Begin> or <End>, only the start time or the end time will be set; otherwise, the entire time range will be set.

The parameter settings will take effect not only on all modems but also on all signal displays.

3.14.3. Demodulator Settings

The setting of the modem parameters directly affects the signal processing process. This way the characteristics of the modem can be modified. Transmission of a signal using high frequencies requires influencing (“modulating”) the signal to encode the transferred information in the signal. The basic high frequency (HF) signal is also called carrier. The APC has to reverse (“demodulate”) this influence to recover the information. The results of the demodulating process are symbols (one or several bits). Adjust the demodulation using the demodulation parameters. To do so, open the <Demod> tab.

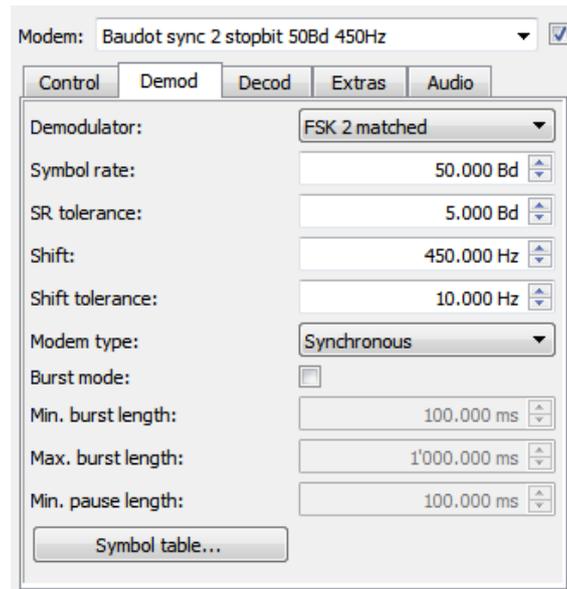


Figure 30: Tab Demod with Demodulator Drop-Down List

The Demodulator drop-down list box provides an extensive range of demodulator types. Select the appropriate demodulator type:

Demodulator Type	Demodulation of...
Voice	Speech signal
Morse	Morse signal
F1A	Morse over FSK
F7B/F7W	Four-channel frequency shift keyed and Morse signal
ASK 2, 4, 8	Amplitude shift keyed signal
FSK discr.	Frequency shift keyed signal
FSK 2 matched	Frequency shift keyed signal (shift is much bigger than symbol rate)
FSK	Frequency shift keyed signal (automatic demodulation strategy)
Multitone (MFSK)	Multi-tone frequency shift keyed signal
MC-FSK-2	Multi-channel frequency shift keyed signal
(G)MSK	(Gauss windowed) minimum shift keyed signal
TFM	Tamed frequency shift keyed signal
DPSK 2, 4, 8,16 A/B	Differential phase shift keyed signal

Demodulator Type	Demodulation of...
PSK 2, 4, 8,16 A/B	Absolute phase shift keyed signal
PSK data aided	Phase shift keyed signal, equalizer based on known training sequences/ symbols, which are parameterized by the decoder
MDPSK2, 4, 8, 16 A/B	Multi-channel differential phase shift keyed signal
MPSK2, 4, 8, 16 A/B	Multi-channel absolute phase shift keyed signal
OQPSK	Offset quadrature phase shift keyed signal
QAMn	Quadrature amplitude modulated signal (4x4 up to 16x16 constellation and generic user defined constellations)
OFDM	Orthogonal frequency division multiplexed signal
Chirp	with phase shift keying modulated chirp signal
MultiModem	Combination of several modems
Analogue Selcal	Distinct analog selcals (multitone)
Clover II	Clover II signal
Clover 2000	Clover 2000 signal
Clover 2500	Clover 2500 signal
Coquelet	Special filter demodulator for Coquelet signals
MT63	MT63 signal
Pactor II	Pactor II signal
Pactor III	Pactor III signal
Pactor 4	Pactor 4 signal
THROB / THROBX	THROB or THROBX signal

Table 22: Demodulator Types

Various parameters are available for every demodulator type. Some demodulators allow for changes in their symbol tables, i.e. modification of the symbol values produced by the demodulator in question.

In a symbol table with entries of 2 or more bits, these are specified LSB-first (least-significant-bits first). For example, the table entry "011" with 3 bits is assigned the symbol 6.

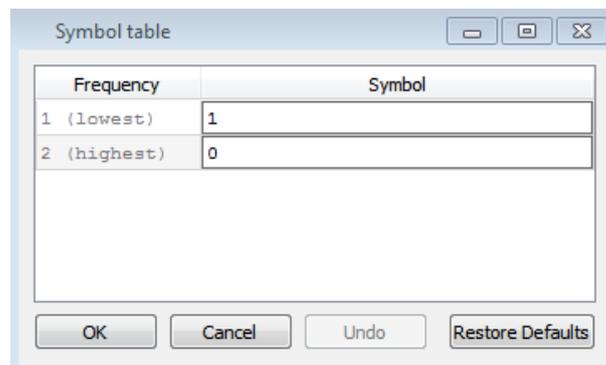


Figure 31: Demodulator Table of Symbols

3.14.4. Decoder Settings

The results of the demodulation process are symbols. These symbols can be decoded using an appropriate decoder. To do so, select the appropriate decoder from the list of decoders in the <Decod> tab. Additionally, decoders can be parametrized and edited.

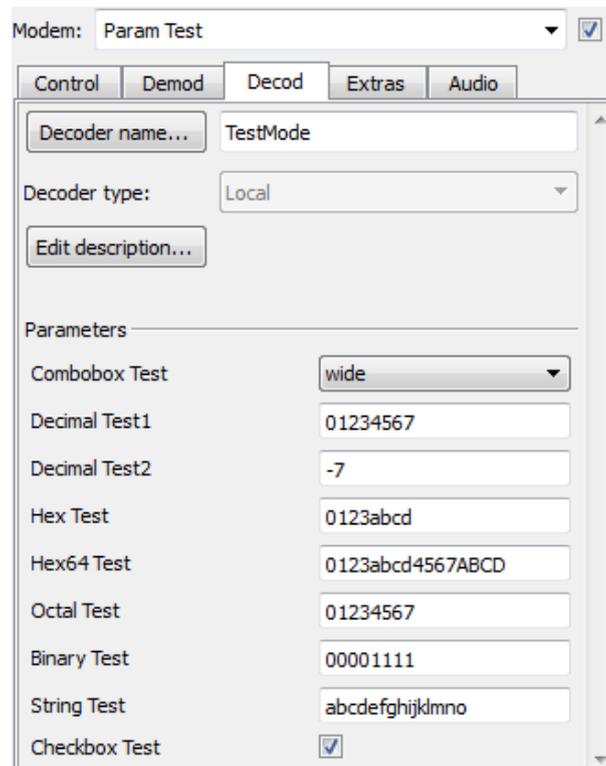


Figure 32: Parameters for Decoder Selection

The following table explains the parameters of the decoder selection.

3.14.4.1. Decoder Name

Specifies the name of the decoder in use. Press the button <Decoder name...> to open the dialog for selection of a decoder from the decoder list.

If the demodulator type is set to F7B/F7W then depending on the mode two decoders have to be set.

Note: Manual entries of the decoder name will cause the system to verify the existence of this decoder in the list of decoders. Please notice the decoder type.

3.14.4.2. Edit Description

If the source code of the selected decoder is available to the system then a click on this button will unpack the decoder and open its source code in the external Python decoder development based on Spyder. If no decoder name is given then it will just start Spyder.

3.14.4.3. Decoder List

If you press the button **<Decoder name...>**, the decoder list will be displayed. This list shows the names of all decoders known to the APC. Select the desired decoder via double click, or use the up/down keys on the keyboard to move in the list and press **<OK>** to confirm your selection. Activating the button **<No decoder>** will remove the decoder from the modem. To exit without a new selection, click **<Cancel>**. To update the list of local decoders click .

3.14.4.4. Parameters

Modem Lab provides the option to initialize a selection of decoder variables to user-defined values. The available parameters are displayed in the Parameters box. Depending on the decoder and modem implementation this makes it possible e.g. to select the alphabet or the desired submode etc.

These variables have to be defined in the decoder source code as well as in the modem (".ver") file. They can hold numerical and textual data. Data can even be selected using a combo box or a checkbox.

In the modem file the variables are stored in the **<DecoderParameters>** section. This section defines the variable name, its format and current value which are needed by the decoder as well as the definition of the graphical representation that is needed by the Modem Lab to display them. There are five classes of GUI elements possible:

- Combobox
- Textbox
- Checkbox
- List
- Matrix

The textboxes have each a format:

- dec
- bin
- oct
- hex
- string

Thus, it is possible to define the graphical representation of each decoder individually.

Parameters elements can be added, changed or removed by clicking **<Edit parameters...>**. In the there-upon upcoming XML editor one can see already defined decoder parameter elements in their XML representation. Using the toolbar, one can add templates of GUI elements, as shown above, to parameters list. The according XML template will be shown appended to already defined elements. After adjusting the templates and confirming by clicking on **<OK>**, freshly applied elements will appear in "Parameters" field. Clicking on **<Cancel>** will reject all changes.

The parameter elements List and Matrix can be set via XML to a fixed or a dynamic number of rows. With dynamic number of rows, the following key combination is used to add or to remove rows:

- **<Ctrl - Enter>** - add a row
- **<Ctrl - Delete>** - delete a row

To do this, the text cursor must be in the desired row.

In the examples folder of the installation you will find a decoder and a modem file which will exhibit the various possibilities.

In Figure 33 you can see parameter elements and their XML representation.

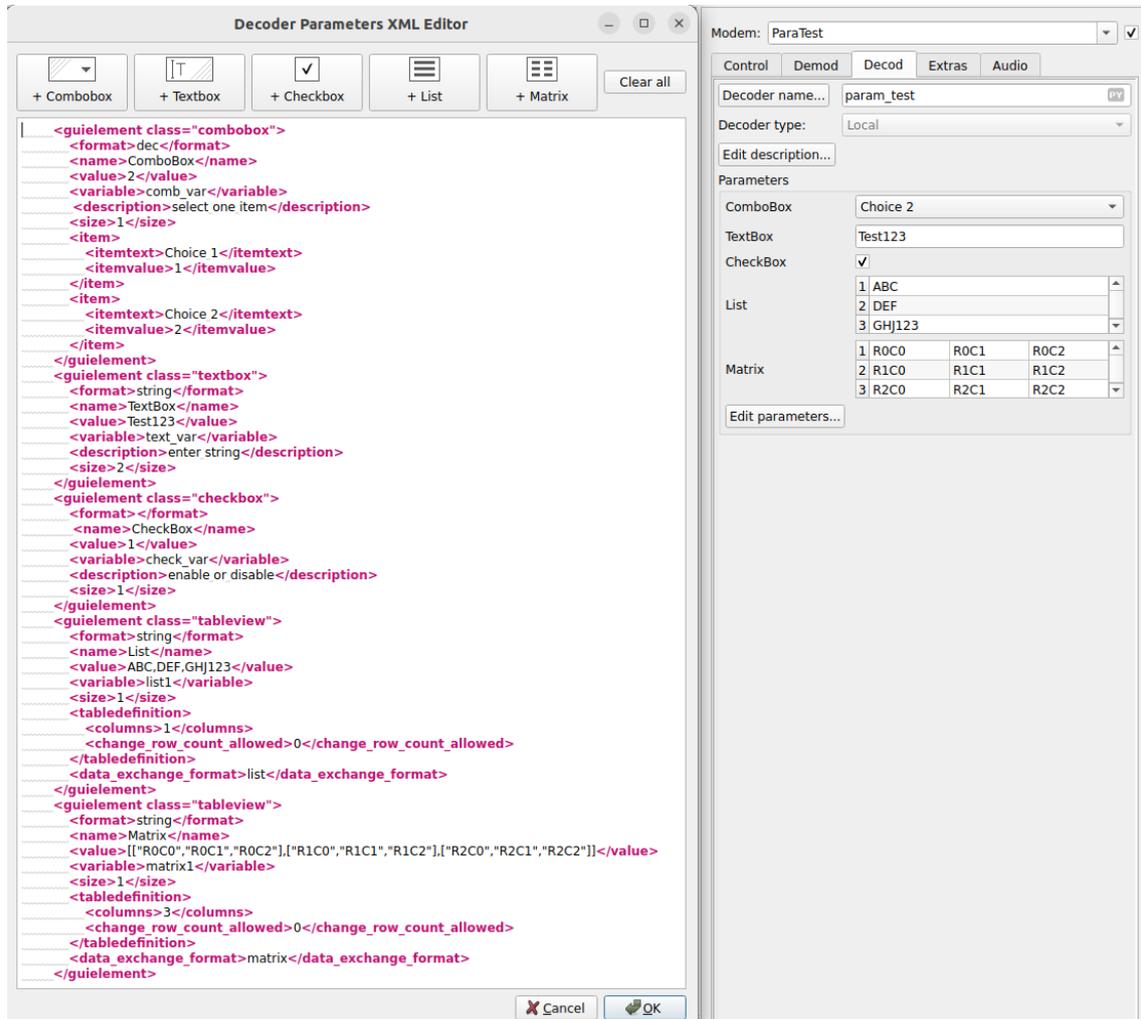


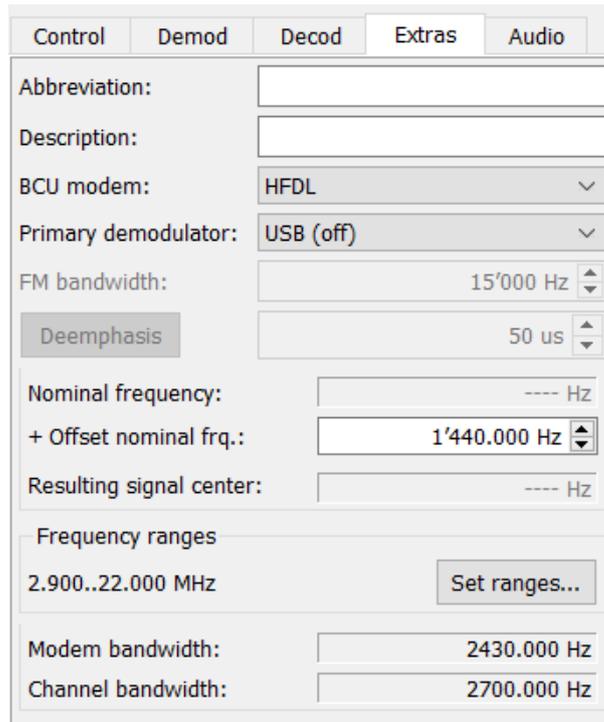
Figure 33: Decoder - Parameters - XML Editor

3.14.4.5. Protected Decoders

Specific decoders may be subject to license restrictions, i.e. they are protected and can only be run if the required license is installed. As no source code is available for these decoders, it is impossible to view or change them by using the decoder editor.

3.14.5. Extras Setting

The <Extras> tab features modem parameters that are impossible to assign to any demodulator or decoder parameters. The following table describes these general modem parameters:



The screenshot shows the 'Extras' tab of the 'Modem Parameter Setting' dialog. It contains several input fields and dropdown menus for configuring modem parameters. The 'BCU modem' is set to 'HFDL' and the 'Primary demodulator' is set to 'USB (off)'. The 'FM bandwidth' is 15'000 Hz and the 'Deemphasis' is 50 us. The 'Nominal frequency' is blank, '+ Offset nominal frq.:' is 1'440.000 Hz, and the 'Resulting signal center:' is blank. The 'Frequency ranges' section shows '2.900..22.000 MHz' with a 'Set ranges...' button. The 'Modem bandwidth' is 2430.000 Hz and the 'Channel bandwidth' is 2700.000 Hz.

Control	Demod	Decod	Extras	Audio
Abbreviation:			<input type="text"/>	
Description:			<input type="text"/>	
BCU modem:			HFDL	
Primary demodulator:			USB (off)	
FM bandwidth:			15'000 Hz	
Deemphasis			50 us	
Nominal frequency:			---- Hz	
+ Offset nominal frq.:			1'440.000 Hz	
Resulting signal center:			---- Hz	
Frequency ranges				
2.900..22.000 MHz				Set ranges...
Modem bandwidth:			2430.000 Hz	
Channel bandwidth:			2700.000 Hz	

Figure 34: Modem Parameter Setting Extras tab

3.14.5.1. Abbreviation

Defines the abbreviation of the modem. The maximum input is 5 characters.

3.14.5.2. Description

A short description of the modem. This description will be shown in the dialog which appears when "New Modem" is selected.

3.14.5.3. BCU modem

Stores the corresponding BCU (Broadband Classification Unit) modem in the APC modem. This information is used by other Procitec products in broadband classification so that the corresponding APC modem can be triggered if the BCU modem is successfully classified.

In the APC modem file, an ID is stored under the XML tag <MatchingBCUModem>, which is assigned to exactly one BCU modem. The assignment of the ID to the BCU modem name can be found in the file "bcumodemlist.xml" in the Modem Lab installation folder. To create your own assignments, it is possible to copy the XML file to the user directory under procitec/analysis-suite <version > and adapt it accordingly. After restarting Modem Lab, the modified list is loaded and can be selected in the <BCU modem> field.

3.14.5.4. Primary Demodulator

Type of primary demodulation (USB(off), LSB, AM, FM). The primary demodulation will be applied first before the actual demodulation starts.

3.14.5.5. FM Bandwidth

Assumed bandwidth when FM primary demodulation is selected (usually this is in the range of 12..15 kHz)

3.14.5.6. Deemphasis

Most FM systems use a system of emphasis where the higher frequencies are increased in amplitude before the modulation off the carrier. At the receiver, the higher frequencies must be deemphasized in order to recover the original baseband signal. This is done by activating <Deemphasis>.

You have to enter a value for the time constant used for de-emphasis. In most countries 50 μ s are used. In the US and South-Korea 75 μ s are common.

3.14.5.7. Nominal Frequency + Offset nominal frq.

An offset is used to adjust a deviation from the theoretical, nominal frequency for the current modem. The resulting frequency is used in the demodulator. This feature requires that the parameter Signal Search on the <Control> tab is set to Nominal frequency.

In case of an AM or a FM primary demodulation this parameter denotes the offset between the AM/FM carrier and the actual signal that contains the secondary modulation.

3.14.5.8. Resulting signal center

This shows the assumed center frequency depending on the Nominal frequency and Offset nominal frequency. The value depends on the demodulator setting. In case of a single channel signal, nominal and center frequency are usually identical. Well-known exceptions can be found in the literature or the decoder datasheets. In case of a multichannel signal, the nominal frequency is most of the times the frequency of the first (lowest frequency) channel.

3.14.5.9. Frequency ranges

This shows the overall frequency range (min..max) where this modem is active. The modem will be excluded from search in recognition mode if its frequency range does not match the input signal. When hovering over the label a tooltip will show all the defined frequency ranges. The button <Set ranges...> opens a dialog to define the frequency ranges.

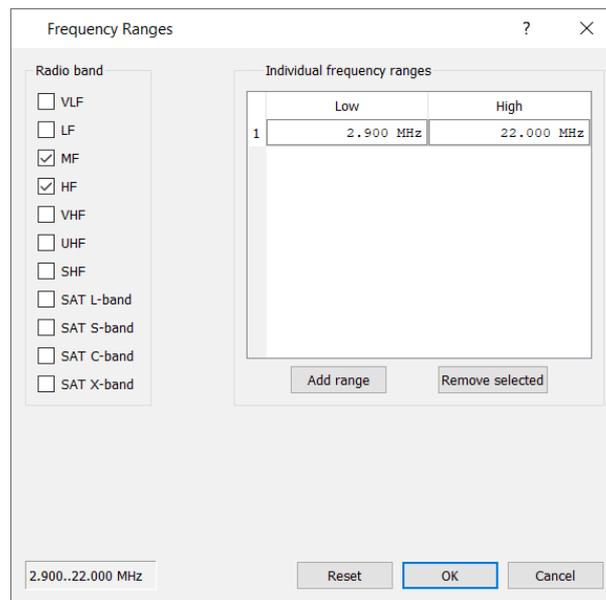


Figure 35: Frequency ranges dialog

On the left side of the dialog window is a list of possible radio bands where the modem is active. A radio band is a frequency range between two defined limits, e.g. 3..30 Mhz for HF. The definitions are according to ITU except the satellite (SAT) bands. A tooltip of every radio band checkbox indicates its frequency limits. More than one radio band can be selected if necessary.

If the limits of the set radio bands are too broad or if it is necessary to exclude some ranges then it is possible to define one or more individual frequency ranges in the table on the right side of the dialog. These individual ranges will overwrite the frequency settings of the defined radio bands.

In the lower left corner is the overall frequency range (min..max) shown where this modem is active and which is a summation of all set radiobands and/or individual frequency ranges. This range depends on the current settings and is updated if any changes are made.

- **<Reset>**: remove all defined frequency ranges and radio bands. Modem has then no frequency range restrictions.
- **<Cancel>**: discard all changes and close dialog.
- **<OK>**: accept all changes and close dialog.

If any of the parameter settings are invalid then the **<OK>** button is disabled and an error message is shown. As soon as the issue is resolved the **<OK>** button is reenabled.

3.14.5.10. Modem bandwidth

This field shows the bandwidth of the selected modem. The value is automatically calculated depending on the demodulator type and its current parameters. Primary modulation is taken into account. It is not possible to change the value but it is saved in the modem file.

3.14.5.11. Channel bandwidth

This field shows the minimum channel bandwidth that is required for proper demodulation and to allow symbol rate and frequency corrections. If the input signal has less bandwidth then this modem is automatically disabled. The value is automatically calculated depending on the demodulator type and its current parameters. It is not possible to change the value but it is saved in the modem file.

3.14.6. Control Frequencies

The various control frequencies for signal search (search range, center frequency, nominal frequency) which are described in chapter Control Settings can be visualized in the Spectrum/Sonagram display. This makes it necessary to check "Show control frequency" in the context menu. Dependent on the operating mode (modem recognition, production) and the strategy for signal search one or several white markers will appear in the display. These markers are coupled with the corresponding input fields, so that a movement of these markers with the mouse induces a change of the values in these fields and vice versa.

Note: The markers are only visible for the input signals "IF unbuffered" and "IF input". The markers in the spectrum display are always visible and cannot be moved with the mouse.

3.14.6.1. Frequency Range

If signal search is set to Frequency Range and the operating mode Modem Recognition (automatic mode) is selected then the frequency range in which the APC looks for signals is displayed as a hatched area in the Spectrum/Sonagram display. In addition, the center of the search range is indicated with another marker that exhibits the actual receiver frequency at the bottom.

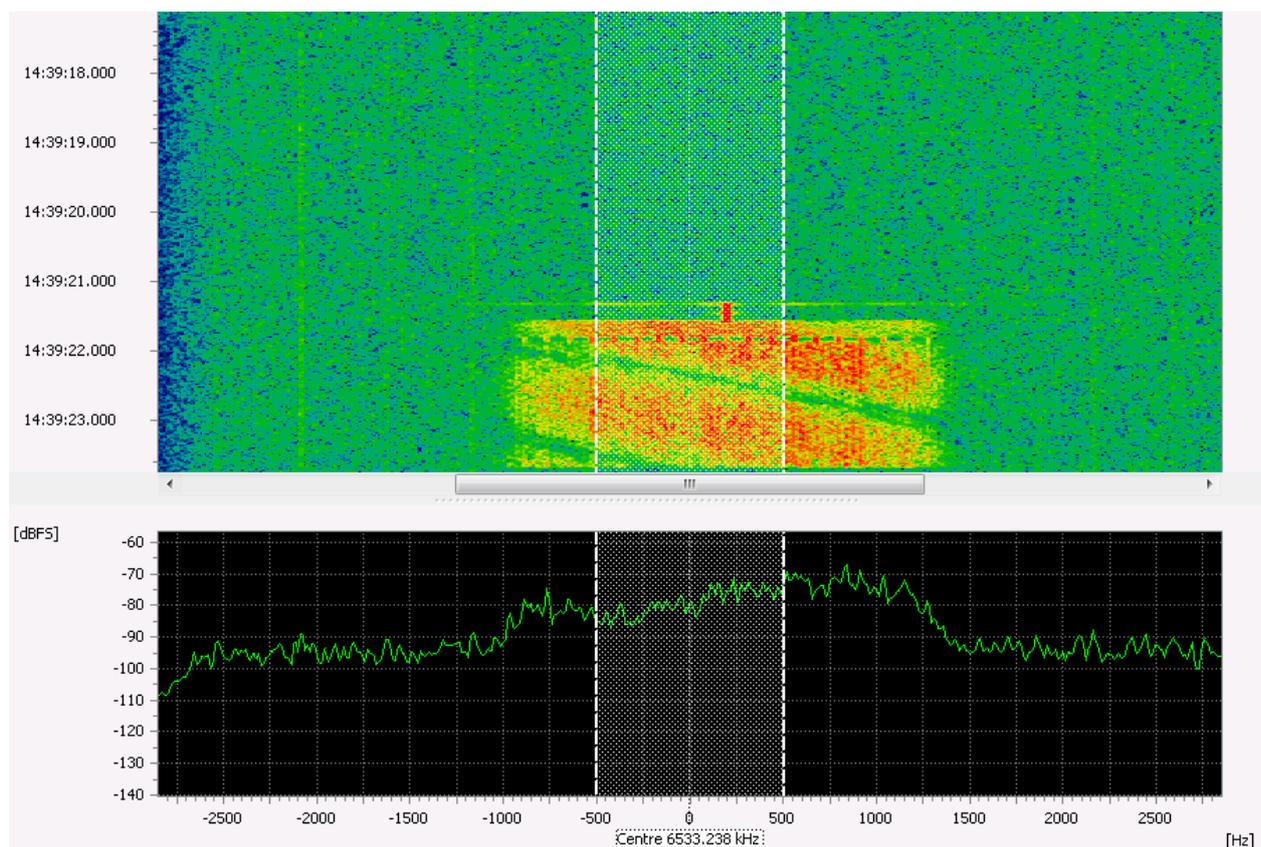


Figure 36: Spectrum/Sonagram with frequency search range and operating mode modem recognition

The search range can be moved with the mouse as a whole if it is "grabbed" in the center. But the upper and lower limit can be moved separately, too.

Furthermore, it is possible to set the search range even if "Show control frequency" is not checked in the context menu. For this purpose, select an area with the mouse in the sonagram display (selection along time axis is irrelevant) and then select "Set frequency search range" from the context menu. It is required that the signal processing is stopped during this action.

If the operating mode is switched to Production then only a marker for the center frequency will be visible. Because in manual mode no segmentation and thus no frequency search is carried out.

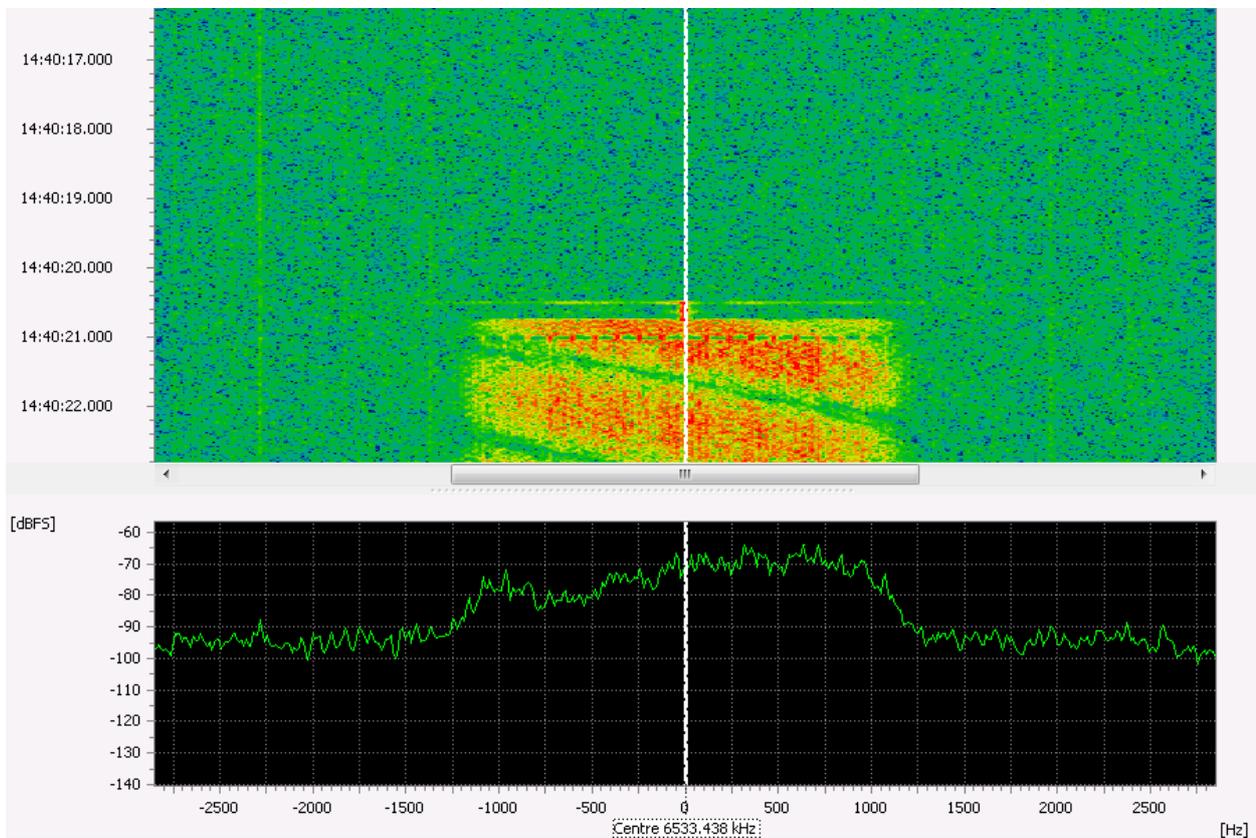


Figure 37: Spectrum/Sonogram with frequency search range and operating mode production

3.14.6.2. Nominal Frequency

If signal search is set to Nominal Frequency then the type of marker that is shown in the Spectrum/ Sonogram display changes whether signal processing is started or stopped.

If signal processing is running then only a single marker that indicates the global nominal frequency is visible. Again, the marker exhibits the actual receiver frequency at the bottom.

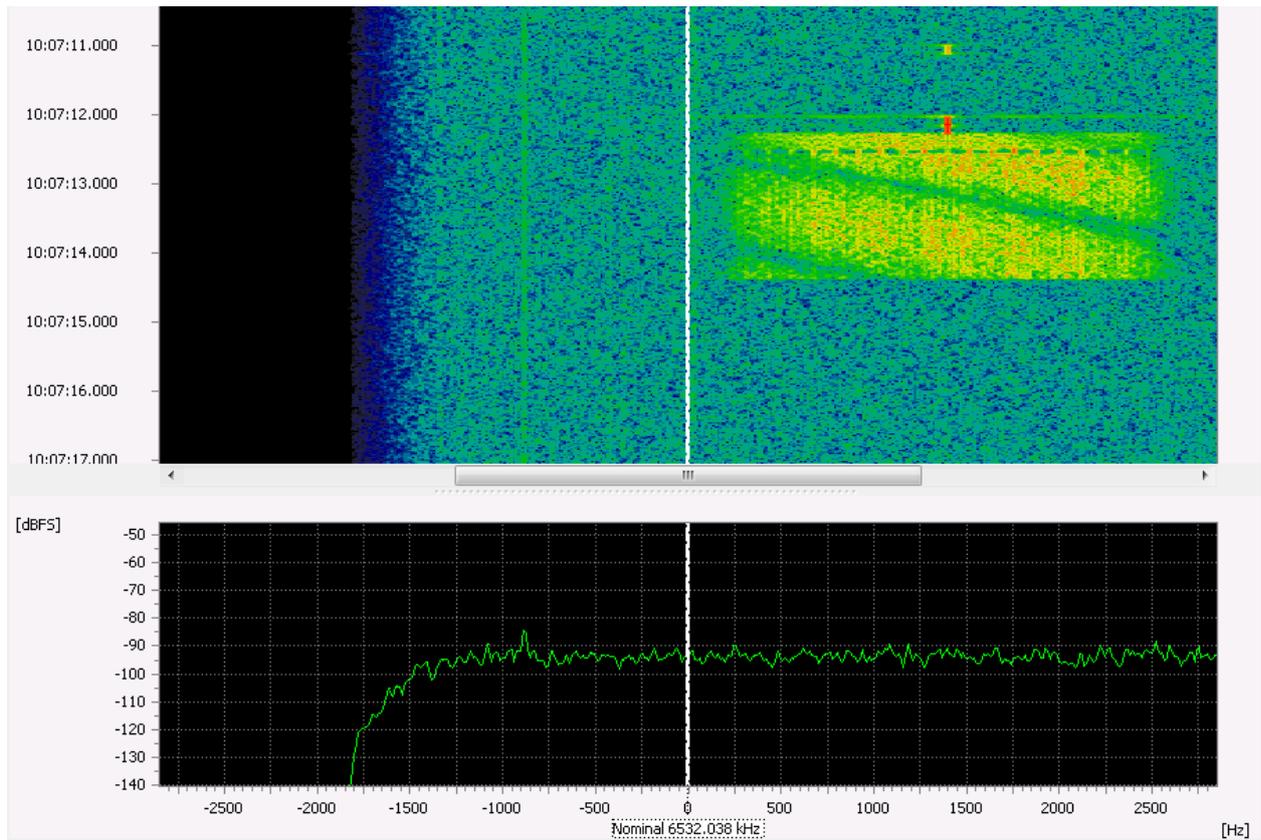


Figure 38: Spectrum/Sonogram with nominal frequency and operating mode modem recognition if signal processing is running

If signal processing is stopped then besides the global nominal frequency that is valid for all modems in the list another marker indicates the center frequency of the currently selected modem. In this case the offset nominal frequency specified in chapter Nominal Frequency + Offset nominal frq will be taken into account. To clarify which modem is actually selected its name will be shown in the sonogram display next to the marker.

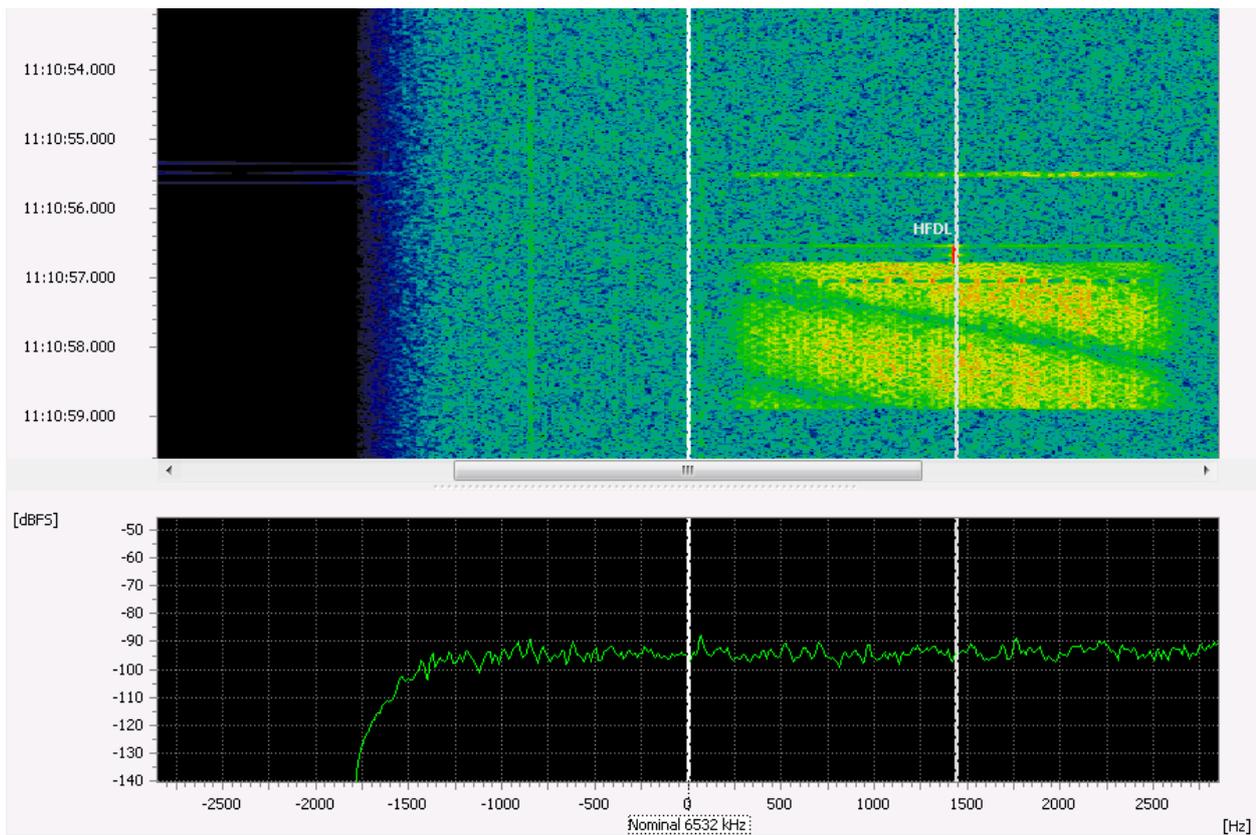


Figure 39: Spectrum/Sonogram with nominal frequency if signal processing is stopped and a single channel modem is selected

If the currently selected modem is a multichannel/multitone modem or one with a FSK demodulator then besides the center frequency all channels/tones will be marked with a single vertical line.

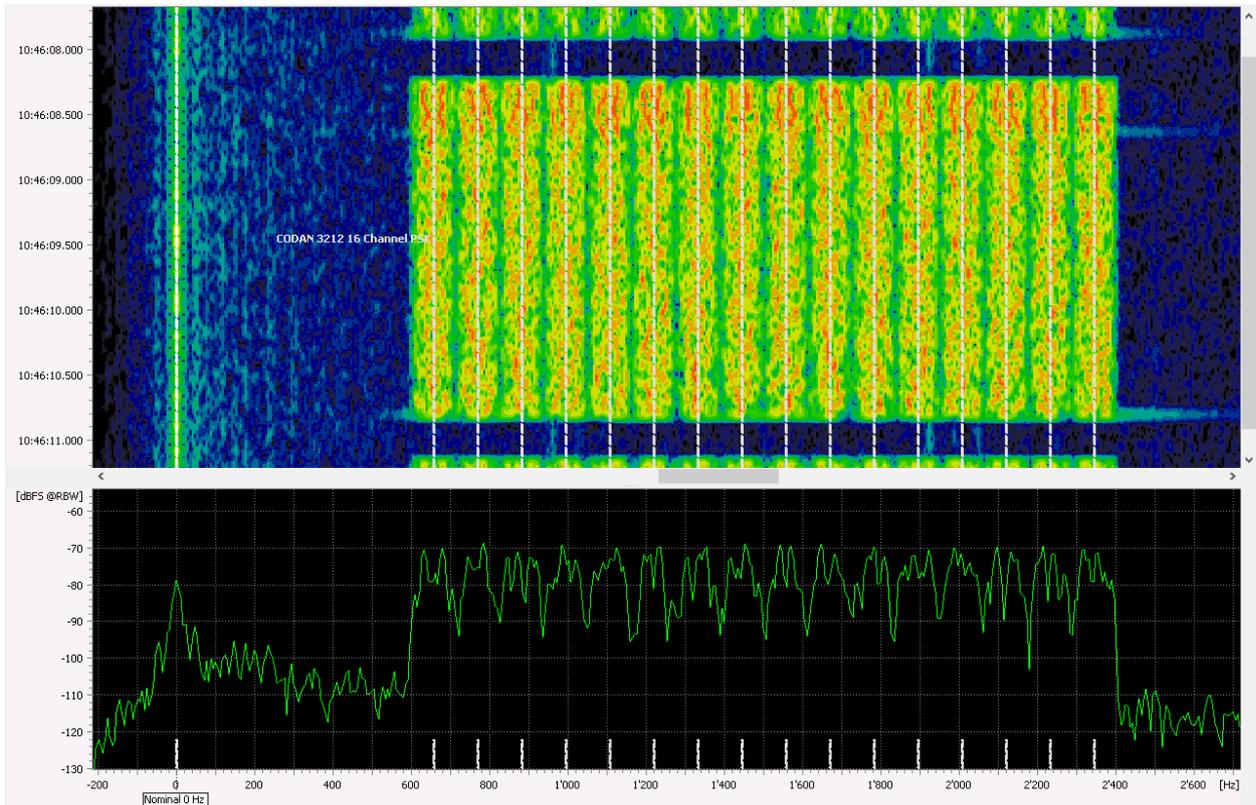


Figure 40: Spectrum/Sonogram with nominal frequency if signal processing is stopped and a multichannel modem is selected

3.15. Modem Lab Signal Displays

The signal displays have numerous different tasks depending on the operating condition of Modem Lab. When modem recognition is enabled, the displays serve to monitor the input signal and to verify the result. In production (either the APC has recognized a modem and switches from search to production mode or the manual production is enabled) all display functions are enabled, such as:

- Monitoring of the input signal
- Quantification of the signal and demodulation quality
- Identification of the modem parameters in the signal as well as in the demodulated bit stream

3.15.1. Displays and Signal Types Available

The following displays are available:

Display	Application
Spectrum / Sonogram	Monitoring of input signal, measuring of bandwidth, measuring of signal start or signal end, burst length measuring, measuring of the shift in FSK, etc.
Bit Display	Identification of frames, patterns, synchronous words, etc. of the demodulated signals

Display	Application
---------	-------------

Table 23: Display Types

3.16. Signal processing with the Modem Lab

Signal processing is done in several steps.

- Filtering
- Demodulation
- Decoding

Each step supplies temporary results (for example internal IF signals, demodulated bits, etc.) which can be selected as a signal to be displayed in order to verify the processing or to analyze the signal information. Each display is adjusted separately by means of the Input Signal parameters.

The following table explains the different input signals:

Input Signal	Description
IF unbuffered	Intermediate frequency before being stored into the short term memory as received from the signal source. Used to check the input signal.
IF input	Intermediate frequency at the input of the signal processing unit. Used to check the input signal. Signal times depend on the internal detection of the signal and identification of a modem in the APC.
Primary demod. AM/FM I	After AM/FM primary demodulation (only available if primary demodulation is selected)
IF reduced	Additional internal intermediate frequency. The bandwidth of the signal has been roughly adapted according to the selected symbol rate. Used to check the demodulator setting.
Symbols	Output of the demodulator

Table 24: Input Signal Parameters

The analysis of the intermediate signals after the individual process steps serves to check the demodulator. The availability of the input signals depends on the demodulator selected, as some demodulators will not calculate every signal.

4. Technical Reference

4.1. Demodulator Parameters

Various parameters are available for every demodulator type. Some demodulators allow for changes in their symbol tables, i.e. modification of the symbol values produced by the demodulator in question.

The following table provides a detailed description of the parameters:

Parameter	Function
<Adaptive equalizer>	These parameters serve to switch the transmission-channel equalization on and off. This compensates distortions that occur during transmission. LMS (Least Mean Squares) and for some demodulators "Instant Solver" are available.
<Audio in file>	Activate the recording of ".wav" files by means of these parameters. This requires saving the active IF. If this function records the signal, a ".wav" file is recorded simultaneously.
<BT>	This is the product of -3dB bandwidth and symbol duration, and is a specific characteristic of GMSK. Typical values are e.g. 0.25 for Tetrapol, 0.3 for GSM, and 0.5 for DECT.
<Burst mode>	This parameter serves to switch the burst mode on or off. The three parameters <Max. burst length>, <Min. burst length> and <Min. pause length> are only available in burst mode. Bursted signals only exist within a period defined by means of the burst length. Between such periods, they have a pause defined by means of the pause length.
<Channel distance>	Defines the distance between the individual channels
<Channel position type>	Choose between the lists items <i>Channel distance</i> and <i>Channel frequencies</i>
<Constellation...>	For the QAM demodulator it is hereby possible to define arbitrary custom constellations and symbol mappings. There is a separate document about the XML structure.
<Configure...>	Activates/deactivates the control of certain OFDM parameters with a XML description. Hereby, it is possible to parameterize the OFDM demodulator in a much more powerful way than the GUI allows. There is a separate document about the XML structure.
<Constellation>	Absolute/differential phase constellation for OFDM channels
<Distance F1 <-> F2>	Defines the distance between frequency 1 and frequency 2 of an F7B/F7W modem
<Distance F2 <-> F3>	Defines the distance between frequency 2 and frequency 3 of an F7B/F7W modem
<Distance F3 <-> F4>	Defines the distance between frequency 3 and frequency 4 of an F7B/F7W modem

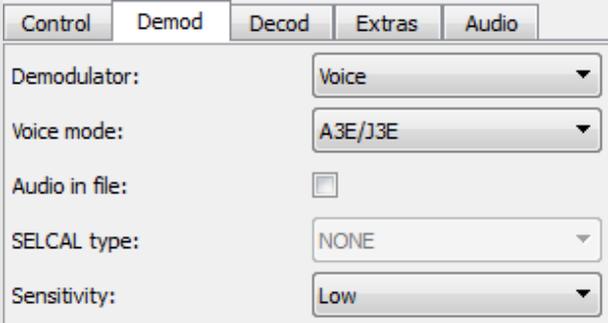
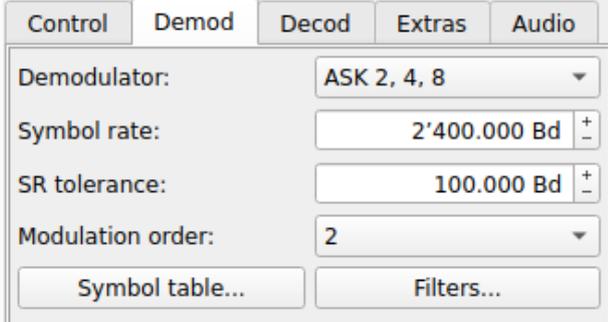
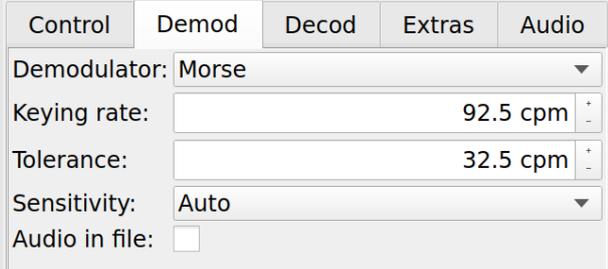
Parameter	Function
<Edit submodems...>	For Details see chapter MultiModem
<Equalizer filterlength>	The length of the equalization filter can be selected for the equalizer "Instant Solver". Higher values are more computationally intensive.
<Mode>	Mode of F7B/F7W, i.e. content of left and right channel (Data / Data, Data / Morse, Morse / Data, Morse / Morse, Data / -, - / Data, Morse / -, - / Morse, Data (interleaved))
<Filters...>	Invokes dialog to define individual window function and filter parameters
<Frequency table...>	Provided the selected list item in the drop-down list box Channel position type is <i>Channel frequencies</i> , activation of this button will display a table for input of the desired frequency for each channel. Using the button <Init> in this table, the frequency can be initialized at equidistant intervals based on the current entries in <i>Channel distance</i> and <i>No. of channels</i> . Manual editing is possible via double click on the respective cell. Subsequently, the various frequencies from this table will be used. The setting procedure for the parameter <i>Tone</i> position type is identical.
<Frequency tracking>	When using the equalizer "Instant Solver", the tracking of the carrier frequency can be switched off, as it is computationally intensive.
<Increment diff. phase>	Defines the increment of the differential phase in mode OFDM
<Keying rate>	Defines the keying rate (cpm) in a Morse modem. This is the number of characters produced per minute.
<Keying rate tolerance>	Defines the keying rate tolerance (cpm) in a Morse modem.
<Max. burst length>	Defines the maximum time the signal exists in burst mode (s). If the burst detection module cannot detect the burst end then the burst will be cut at the maximum length. A value of 0 s indicates there is no upper limit for burst length. In this case the measured burst length is omitted for the calculation of the demodulator quality.
<Min. burst length>	Defines the minimum time the signal exists in burst mode (s)
<Min. pause length>	Defines the minimum pause length between two signals in burst mode (s)
<Min. burst SNR>	Defines the minimum SNR at which a burst signal is detected A value of 0 dB will trigger an automatic internal setting of an optimal minimal SNR value in regard to the chosen demodulator type

Parameter	Function
<Modem type>	<p>Defines the mode of FSK demodulation, namely:</p> <ul style="list-style-type: none"> • Synchronous: If there are no or hardly no symbols that occur as single symbols but only as double, triple etc. ones, the symbol rate quality will deteriorate to 0 permanently to indicate that there is a demodulation with a multiple of the actual symbol rate • Asynchronous: Support of half start/stop bits • Asynchronous Baudot: Baudot encoding with arbitrary varying stop bit length • Multi SR: Multiple symbol rates. The symbol rate quality will not deteriorate if the demodulation is made with a multiple of the actual symbol rate
<Modulation order>	<p>Defines the number of potential bit counts of a symbol (2-order 1 bit, 4-order 2 bits, etc.). One bit is the lowest transmissible binary unit of information. It can have the values 0 and 1.</p>
<No. of channels>	<p>Defines the number of channels</p>
<SELCAL type>	<p>Defines the type of the SELCAL data</p>
<Sensitivity>	<p>Defines the voice sensitivity: Low (not sensitive) Medium (sensitive) High (very sensitive) For a well-balanced detection and misdetection ratio, we recommend to set this parameter to Medium by default.</p>
<Shift>	<p>The parameter Shift describes the frequency distance between two adjacent tones.</p>
<Shift tolerance>	<p>With this parameter the admissible inaccuracies in the shift (Hz) can be modified.</p> <hr/> <p>Note: the software may reduce the shift tolerance value entered to an appropriate value for the demodulator used. Furthermore please note that a tolerance value of 0 Hz will lead to a setting where shift measurement is not taken into consideration. Exception with <i>FSK-2 matched</i>: When using the demodulator <i>FSK-2 matched</i>, and provided the search is carried out with the <i>Automat</i>, <i>nominal frequency</i> or <i>search range</i>, note that the shift will, in addition to the demodulator measurement, be measured automatically if the tolerance value entered is greater than half the shift value or greater than $1.2 * \text{symbol rate}$. The measuring result is sent to the demodulator.</p> <hr/>
<Simultaneous tones>	<p>Displays the adjusted number of simultaneous tones in multitone demodulator</p>
<Symbol rate (Channel A/B)>	<p>Displays the symbol rate setting (Bd: symbols/second). The symbol rate is the transmission rate of the signal.</p>

Parameter	Function
<Symbol rate tolerance>	<p>With this parameter, change the admissible inaccuracies in the symbol rate.</p> <hr/> <p>Note: the software may reduce the symbol rate tolerance value entered to an appropriate value for the demodulator used. If very small tolerance values are set (<1 % of symbol rate) deviations from the nominal value will not cause a downgrading of the measurement.</p>
<Symbol table...>	<p>Serves to display and edit the symbol table. This parameter defines the bit number of the symbol. The physical limit condition for the bit number, which can be set in the right part of the symbol table, is specified in the left part of the symbol table. The bits are specified in LSB-first (least-significant-bit first) order.</p>
<Time delay...>	<p>Defines the time delay (phase offset) for every channel relative to the first channel</p>
<Tone distance>	<p>Defines the intervals between the individual tones (Hz)</p>
<Tone duration>	<p>Sets the preset duration of a tone in the multi-tone demodulator</p>
<Tone duration tolerance>	<p>Defines the admissible inaccuracies in the tone duration (ms).</p> <hr/> <p>Note: the software may reduce the shift tolerance value entered to an appropriate value for the demodulator used.</p>
<Tone position>	<p>Choose between the list items <i>Tone distance</i> and <i>Tone frequencies</i></p>
<Total no. of tones>	<p>Displays the adjusted total number of tones in multitone demodulator</p>
<Type>	<p>Select type MSK, GMSK (linear) and GMSK (non-linear). GMSK: for BT values less than 0.5 we recommend GMSK (non-linear).</p>
<Version>	<p>Displays the adjusted PSK version A or B. In PSK, the bit values are encoded by the shift between phase angles of the signal (the angles depend on the modulation order). In version B, the number of shifts is doubled. Version B allows for an easier recovery of the symbol rate from the signal.</p>
<Voice Mode>	<p>The voice mode specifies the modulation types to be detected by the speech modem. The software can search for single modulation types or combinations thereof.</p> <p>In the drop-down list box select from the following parameters:</p> <ul style="list-style-type: none"> A3E/J3E One and two side band A3E Two side band amplitude modulation with carrier J3E One side band modulation without carrier J3E/USB One side band: Upper side band J3E/LSB One side band: Lower side band F3E Frequency modulation <p>Once the software detects the voice modulation type to search, the result is indicated in the Result Display and recording is made provided the check box Audio in file is selected.</p> <p>Should the software detect any voice modulation types that do not correspond to the type to search for, the Result Display treats the respective modem as if nothing had been detected.</p>

Table 25: Demodulator Parameter Functions

The applied parameters of every demodulator are depicted in Demodulator Parameters.

Demodulator	Additional Settings
Voice (Speech)	 <p style="text-align: center;"><i>Figure 41: Voice Parameters</i></p>
ASK 2, 4, 8 (Amplitude Shift Keying, 2, 4, 8-order amplitude shift keying)	 <p style="text-align: center;"><i>Figure 42: ASK Parameters</i></p>
Morse	 <p style="text-align: center;"><i>Figure 43: Morse Parameters</i></p>

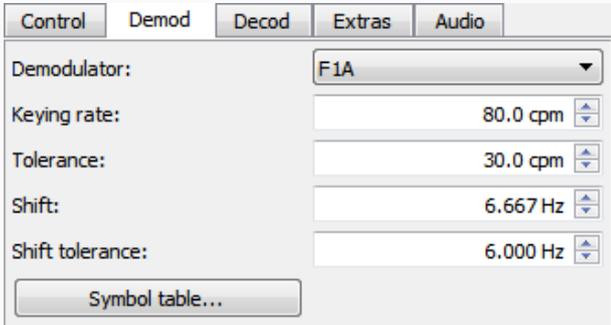
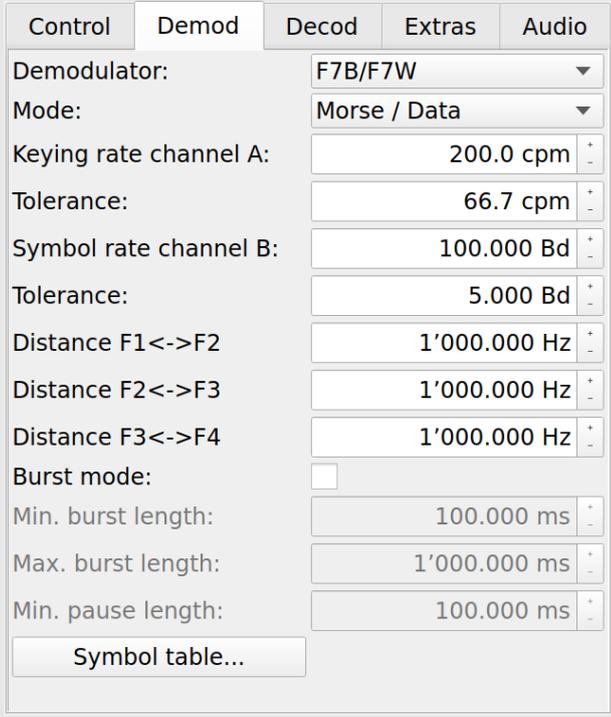
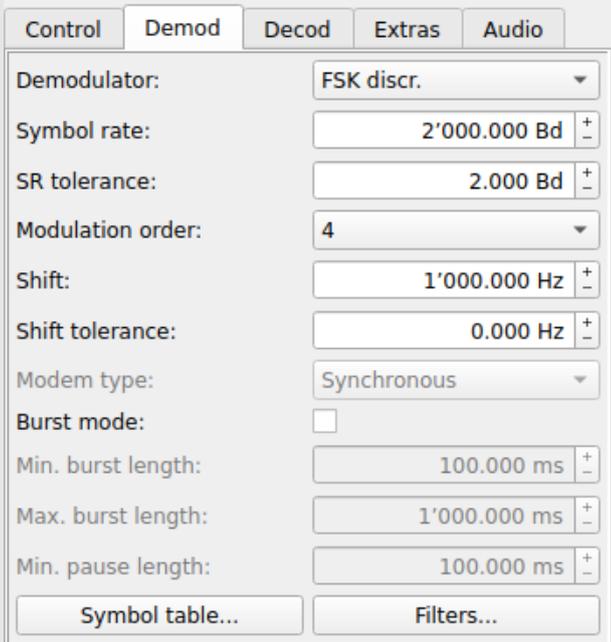
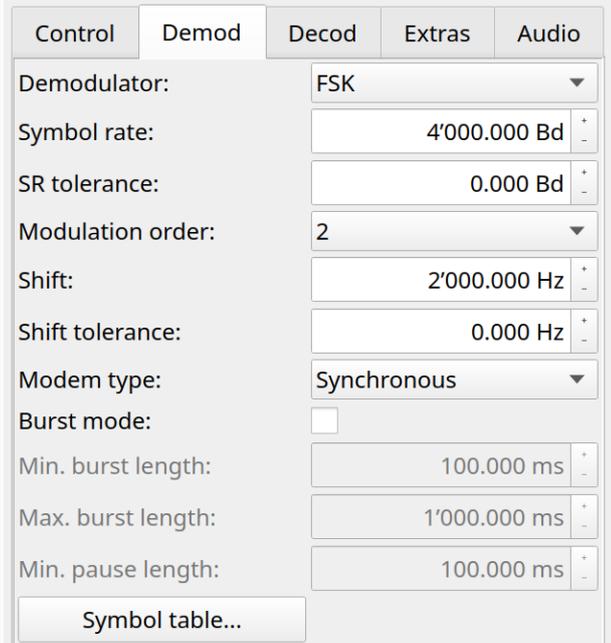
Demodulator	Additional Settings
F1A	 <p>The screenshot shows the 'F1A Parameters' dialog box with the following settings:</p> <ul style="list-style-type: none"> Control: Control Demod: Demod Decod: Decod Extras: Extras Audio: Audio Demodulator: F1A Keying rate: 80.0 cpm Tolerance: 30.0 cpm Shift: 6.667 Hz Shift tolerance: 6.000 Hz Symbol table... button
F7B/F7W	 <p>The screenshot shows the 'F7B/F7W Parameters' dialog box with the following settings:</p> <ul style="list-style-type: none"> Control: Control Demod: Demod Decod: Decod Extras: Extras Audio: Audio Demodulator: F7B/F7W Mode: Morse / Data Keying rate channel A: 200.0 cpm Tolerance: 66.7 cpm Symbol rate channel B: 100.000 Bd Tolerance: 5.000 Bd Distance F1<->F2: 1'000.000 Hz Distance F2<->F3: 1'000.000 Hz Distance F3<->F4: 1'000.000 Hz Burst mode: <input type="checkbox"/> Min. burst length: 100.000 ms Max. burst length: 1'000.000 ms Min. pause length: 100.000 ms Symbol table... button

Figure 44: F1A Parameters

Figure 45: F7B/F7W Parameters

Demodulator	Additional Settings						
<p>FSK-2 matched (2-order Frequency Shift Keying with matched filter demodulator, modulation index > 1)</p>	<div style="border: 1px solid #ccc; padding: 5px;"> <div style="border-bottom: 1px solid #ccc; margin-bottom: 5px;"> Control Demod Decod Extras Audio </div> <p>Demodulator: FSK 2 matched ▼</p> <p>Symbol rate: 13.333 Bd ▲▼</p> <p>SR tolerance: 0.050 Bd ▲▼</p> <p>Shift: 6.667 Hz ▲▼</p> <p>Shift tolerance: 6.000 Hz ▲▼</p> <p>Modem type: Synchronous ▼</p> <p>Burst mode: <input type="checkbox"/></p> <p>Min. burst length: 100.000 ms ▲▼</p> <p>Max. burst length: 1'000.000 ms ▲▼</p> <p>Min. pause length: 100.000 ms ▲▼</p> <p style="text-align: center; margin-top: 5px;">Symbol table...</p> </div> <p style="text-align: center; margin-top: 10px;"><i>Figure 46: FSK-2 matched Parameters</i></p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <div style="border-bottom: 1px solid #ccc; margin-bottom: 5px;"> Symbol table - □ ✖ </div> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr style="border-bottom: 1px solid #ccc;"> <th style="padding: 2px 5px;">Frequency</th> <th style="padding: 2px 5px;">Symbol</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px 5px;">1 (lowest)</td> <td style="padding: 2px 5px;">1</td> </tr> <tr> <td style="padding: 2px 5px;">2 (highest)</td> <td style="padding: 2px 5px;">0</td> </tr> </tbody> </table> <div style="margin-top: 5px; text-align: center;"> OK Cancel Undo Restore Defaults </div> </div> <p style="text-align: center; margin-top: 10px;"><i>Figure 47: Frequency to Symbol Conversion Table Parameters</i></p> <hr style="border: 0.5px solid #ccc; margin-top: 10px;"/> <p>Note: Similar tables are available with all FSK modems.</p>	Frequency	Symbol	1 (lowest)	1	2 (highest)	0
Frequency	Symbol						
1 (lowest)	1						
2 (highest)	0						

Demodulator	Additional Settings
<p>FSK discr. (2, 4, 8-order Frequency Shift Keying, with FM demodulation and discriminator, modulation index 0.2 ... 10)</p>	 <p style="text-align: center;"><i>Figure 48: FSK discr. Parameters</i></p> <hr/> <p>Note: the parameter Shift describes the frequency distance between two adjacent tones. With modulation index > 1 the demodulator “Multitone (MFSK)” or “FSK-2 matched” should be used.</p>
<p>FSK (automatically selects “FSK-2 matched” or “FSK discr.” demodulator depending on symbol rate, frequency shift, and modulation order)</p>	 <p style="text-align: center;"><i>Figure 49: FSK Parameters</i></p>

Demodulator

Multitone (MFSK)

Additional Settings

Control Demod Decod Extras Audio

Demodulator: Multitone (MFSK) ▾

Tone duration: 100.000 ms ±

Tone duration tolerance: 20.000 ms ±

Total no. of tones: 2 ±

Simultaneous tones: 1 ±

Tone position type: Equidistant frequencies ▾

Tone distance: 20.000 Hz ±

Burst mode:

Min. burst length: 100.000 ms ±

Max. burst length: 1'000.000 ms ±

Min. pause length: 100.000 ms ±

Frequency table...

Figure 50: Multitone (MFSK) Parameters

Frequency table

Tone	Frequency
1	0.000
2	0.000

OK Cancel Init Undo

Figure 51: Frequency Table for Multitone Modems

Note: Similar tables are available with all multitone modems..

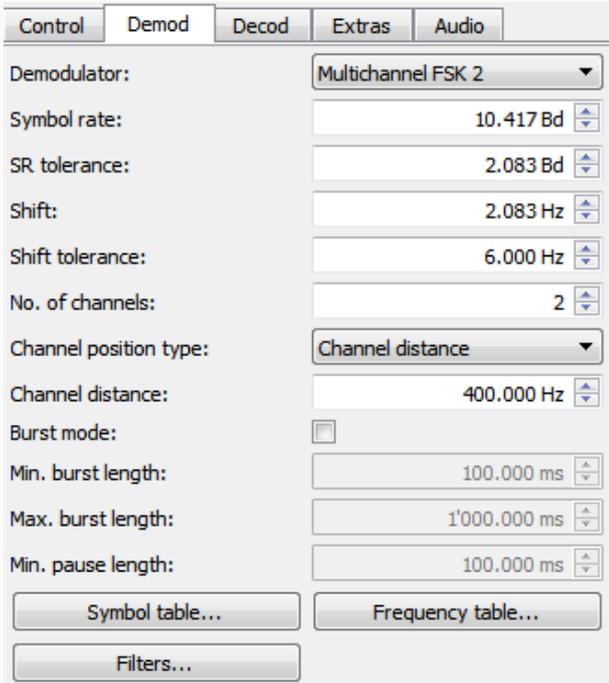
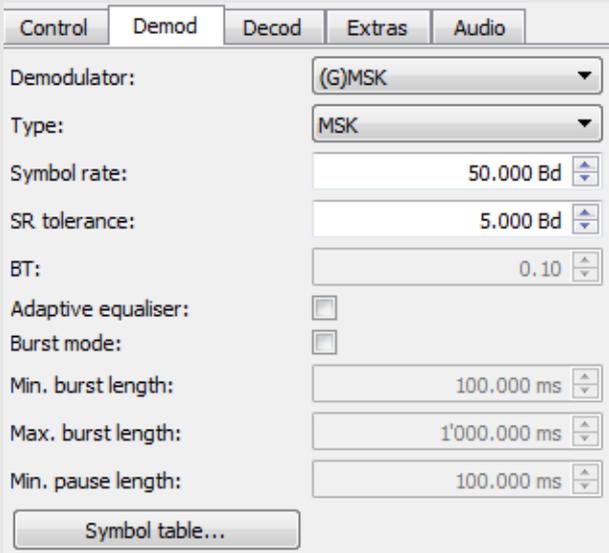
Demodulator	Additional Settings
<p>MC-FSK-2</p>	 <p>The screenshot shows the 'Additional Settings' for the 'MC-FSK-2' demodulator. It features a tabbed interface with 'Control', 'Demod', 'Decod', 'Extras', and 'Audio' tabs. The 'Demod' tab is active. Parameters include: Demodulator (Multichannel FSK 2), Symbol rate (10.417 Bd), SR tolerance (2.083 Bd), Shift (2.083 Hz), Shift tolerance (6.000 Hz), No. of channels (2), Channel position type (Channel distance), Channel distance (400.000 Hz), Burst mode (unchecked), Min. burst length (100.000 ms), Max. burst length (1'000.000 ms), and Min. pause length (100.000 ms). There are buttons for 'Symbol table...', 'Frequency table...', and 'Filters...'.</p>
<p>(G)MSK ((Gauss Windowed) Minimum Shift Keying, bivalent frequency shift keying with minimum shift, modulation index = 0.5)</p>	 <p>The screenshot shows the 'Additional Settings' for the '(G)MSK' demodulator. It features a tabbed interface with 'Control', 'Demod', 'Decod', 'Extras', and 'Audio' tabs. The 'Demod' tab is active. Parameters include: Demodulator ((G)MSK), Type (MSK), Symbol rate (50.000 Bd), SR tolerance (5.000 Bd), BT (0.10), Adaptive equaliser (unchecked), Burst mode (unchecked), Min. burst length (100.000 ms), Max. burst length (1'000.000 ms), and Min. pause length (100.000 ms). There is a 'Symbol table...' button.</p>

Figure 52: MC-FSK-2 Parameters

Figure 53: (G)MSK Parameters

Demodulator	Additional Settings																																			
TFM	<div style="border: 1px solid #ccc; padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Control</th> <th style="text-align: left;">Demod</th> <th style="text-align: left;">Decod</th> <th style="text-align: left;">Extras</th> <th style="text-align: left;">Audio</th> </tr> </thead> <tbody> <tr> <td>Demodulator:</td> <td colspan="4">TFM ▼</td> </tr> <tr> <td>TFM Mode:</td> <td colspan="4">TFM 3 ▼</td> </tr> <tr> <td>Symbol rate:</td> <td colspan="4">1'200.000 Bd + -</td> </tr> <tr> <td>SR tolerance:</td> <td colspan="4">1.000 Bd + -</td> </tr> <tr> <td>Adaptive equaliser:</td> <td colspan="4"><input type="checkbox"/></td> </tr> <tr> <td colspan="5" style="text-align: center;"> <div style="border: 1px solid #ccc; padding: 2px 10px; display: inline-block;">Symbol table...</div> </td> </tr> </tbody> </table> <p style="text-align: center; margin-top: 10px;"><i>Figure 54: TFM Parameters</i></p> </div>	Control	Demod	Decod	Extras	Audio	Demodulator:	TFM ▼				TFM Mode:	TFM 3 ▼				Symbol rate:	1'200.000 Bd + -				SR tolerance:	1.000 Bd + -				Adaptive equaliser:	<input type="checkbox"/>				<div style="border: 1px solid #ccc; padding: 2px 10px; display: inline-block;">Symbol table...</div>				
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Adaptive equaliser:	<input type="checkbox"/>																																			
<div style="border: 1px solid #ccc; padding: 2px 10px; display: inline-block;">Symbol table...</div>																																				

Demodulator

DPSK 2, 4, 8, 16 A/B
(Differential Phase Shift Keying)

Additional Settings

Control Demod Decod Extras Audio

Demodulator: DPSK 2,4,8,16 A/B

Symbol rate: 1'000.000 Bd

SR tolerance: 0.000 Bd

Modulation order: 2

Version: A

Adaptive equaliser: LMS

Equaliser filter length: —

Frequency tracking:

Burst mode:

Min. burst length: 100.000 ms

Max. burst length: 1'000.000 ms

Min. pause length: 100.000 ms

Min. burst SNR: 0 dB

Symbol table... Filters...

Figure 55: DPSK 2,4,8,16 A/B Parameters

Symbol table

Phase for Version A	Phase for Version B	Symbol
0	-90	0
180	90	1

OK Cancel Undo Restore Defaults

Figure 56: Phase to Symbol Conversion Table

Note: Similar tables are available with all PSK modems.

Filters

Channel Frequency/Magnitude Median

Channel

Length: 16 Sym

Window: Blackman Harris

Enable second filter

Bandwidth: 175.0 Hz 0.0 Hz

Pulse Shape: RRC - Root Raised Cosine None

Roll-Off: 0.6 0.0

Use Defaults Restore Defaults

Close

Figure 57: PSK Channel Filter Parameters

Note: This dialog is available with all PSK demodulators and with some FSK demodulators. Here you can override the predefined parameters for the channel filters. Only expert users should alter these settings.

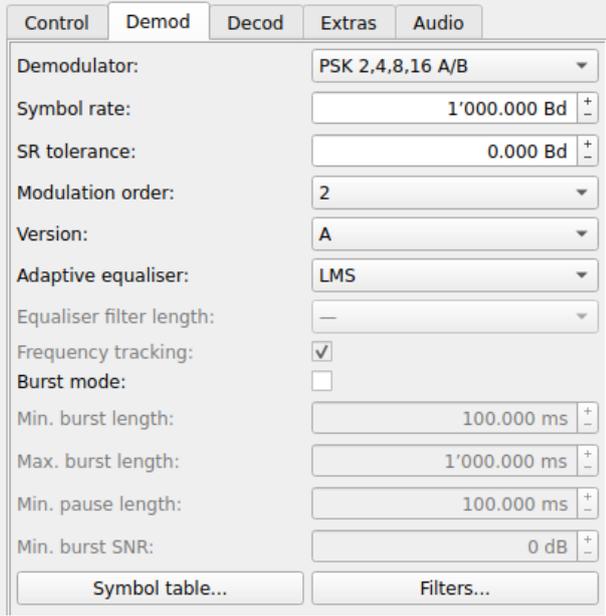
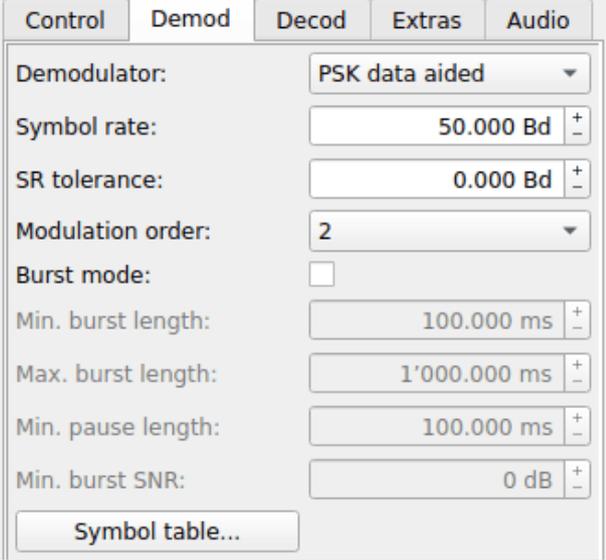
Demodulator	Additional Settings
PSK 2, 4, 8, 16 A/B (Phase Shift Keying, absolute phase shift keying)	 <p>The screenshot shows the 'Demod' tab of the settings interface. The 'Demodulator' dropdown is set to 'PSK 2,4,8,16 A/B'. Other parameters include Symbol rate (1'000.000 Bd), SR tolerance (0.000 Bd), Modulation order (2), Version (A), Adaptive equaliser (LMS), and various burst and SNR settings.</p>
PSK data aided	 <p>The screenshot shows the 'Demod' tab of the settings interface. The 'Demodulator' dropdown is set to 'PSK data aided'. Other parameters include Symbol rate (50.000 Bd), SR tolerance (0.000 Bd), Modulation order (2), and various burst and SNR settings.</p>

Figure 58: PSK 2,4,8,16 A/B Parameters

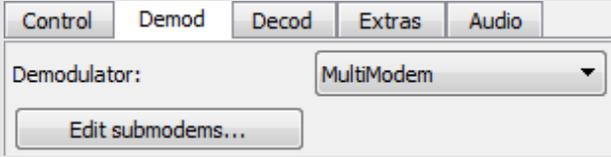
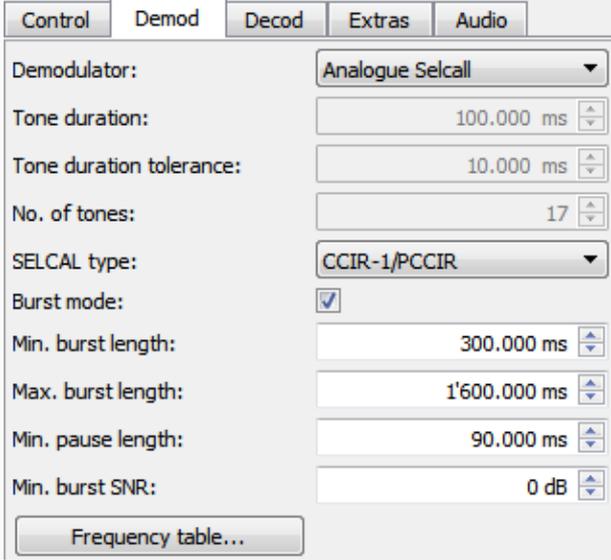
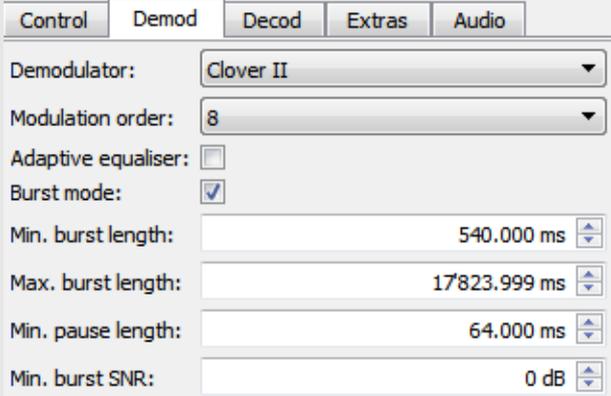
Figure 59: PSK data aided Parameters

Demodulator	Additional Settings																																																																																															
<p>MDPSK 2, 4, 8, 16 A/B (Multi-DPSK, 2-, 4-, 8- or 16-order multi-channel differential phase shift keying, 2 - 100 channels)</p>	<div style="border: 1px solid #ccc; padding: 5px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; border-bottom: 1px solid #ccc;">Control</td> <td style="text-align: center; border-bottom: 1px solid #ccc;">Demod</td> <td style="text-align: center; border-bottom: 1px solid #ccc;">Decod</td> <td style="text-align: center; border-bottom: 1px solid #ccc;">Extras</td> <td style="text-align: center; border-bottom: 1px solid #ccc;">Audio</td> </tr> <tr> <td style="padding: 5px;">Demodulator:</td> <td colspan="4" style="padding: 5px;">MDPSK 2,4,8,16 A/B ▾</td> </tr> <tr> <td style="padding: 5px;">Symbol rate:</td> <td colspan="4" style="padding: 5px;">1'000.000 Bd + -</td> </tr> <tr> <td style="padding: 5px;">SR tolerance:</td> <td colspan="4" style="padding: 5px;">10.000 Bd + -</td> </tr> <tr> <td style="padding: 5px;">Modulation order:</td> <td colspan="4" style="padding: 5px;">2 ▾</td> </tr> <tr> <td style="padding: 5px;">Version:</td> <td colspan="4" style="padding: 5px;">A ▾</td> </tr> <tr> <td style="padding: 5px;">No. of channels:</td> <td colspan="4" style="padding: 5px;">1 + -</td> </tr> <tr> <td style="padding: 5px;">Channel position type:</td> <td colspan="4" style="padding: 5px;">Channel distance ▾</td> </tr> <tr> <td style="padding: 5px;">Channel distance:</td> <td colspan="4" style="padding: 5px;">100.000 Hz + -</td> </tr> <tr> <td style="padding: 5px;">Adaptive equaliser:</td> <td colspan="4" style="padding: 5px;">LMS ▾</td> </tr> <tr> <td style="padding: 5px;">Equaliser filter length:</td> <td colspan="4" style="padding: 5px;">— ▾</td> </tr> <tr> <td style="padding: 5px;">Frequency tracking:</td> <td colspan="4" style="padding: 5px;"><input checked="" type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">Burst mode:</td> <td colspan="4" style="padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">Min. burst length:</td> <td colspan="4" style="padding: 5px;">100.000 ms + -</td> </tr> <tr> <td style="padding: 5px;">Max. burst length:</td> <td colspan="4" style="padding: 5px;">1'000.000 ms + -</td> </tr> <tr> <td style="padding: 5px;">Min. pause length:</td> <td colspan="4" style="padding: 5px;">100.000 ms + -</td> </tr> <tr> <td style="padding: 5px;">Min. burst SNR:</td> <td colspan="4" style="padding: 5px;">0 dB + -</td> </tr> <tr> <td style="padding: 5px;"></td> <td colspan="2" style="padding: 5px; text-align: center;">Symbol table...</td> <td colspan="2" style="padding: 5px; text-align: center;">Frequency table...</td> </tr> <tr> <td style="padding: 5px;"></td> <td colspan="2" style="padding: 5px; text-align: center;">Time delay..</td> <td colspan="2" style="padding: 5px; text-align: center;">Filters...</td> </tr> </table> <p style="text-align: center; margin-top: 10px;"><i>Figure 60: MDSPK 2,4,8,16 A/B Parameters</i></p> </div>	Control	Demod	Decod	Extras	Audio	Demodulator:	MDPSK 2,4,8,16 A/B ▾				Symbol rate:	1'000.000 Bd + -				SR tolerance:	10.000 Bd + -				Modulation order:	2 ▾				Version:	A ▾				No. of channels:	1 + -				Channel position type:	Channel distance ▾				Channel distance:	100.000 Hz + -				Adaptive equaliser:	LMS ▾				Equaliser filter length:	— ▾				Frequency tracking:	<input checked="" type="checkbox"/>				Burst mode:	<input type="checkbox"/>				Min. burst length:	100.000 ms + -				Max. burst length:	1'000.000 ms + -				Min. pause length:	100.000 ms + -				Min. burst SNR:	0 dB + -					Symbol table...		Frequency table...			Time delay..		Filters...	
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<p>MPSK 2, 4, 8, 16 A/B (Multi-PSK, 2-, 4-, 8- or 16-order multi-channel absolute phase shift keying)</p>	<div style="border: 1px solid #ccc; padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse; background-color: #f0f0f0;"> <thead> <tr style="background-color: #e0e0e0;"> <th style="padding: 2px;">Control</th> <th style="padding: 2px;">Demod</th> <th style="padding: 2px;">Decod</th> <th style="padding: 2px;">Extras</th> <th style="padding: 2px;">Audio</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">Demodulator:</td> <td colspan="4" style="padding: 2px;">MPSK 2,4,8,16 A/B ▼</td> </tr> <tr> <td style="padding: 2px;">Symbol rate:</td> <td colspan="4" style="padding: 2px;">1'000.000 Bd + -</td> </tr> <tr> <td style="padding: 2px;">SR tolerance:</td> <td colspan="4" style="padding: 2px;">10.000 Bd + -</td> </tr> <tr> <td style="padding: 2px;">Modulation order:</td> <td colspan="4" style="padding: 2px;">2 ▼</td> </tr> <tr> <td style="padding: 2px;">Version:</td> <td colspan="4" style="padding: 2px;">A ▼</td> </tr> <tr> <td style="padding: 2px;">No. of channels:</td> <td colspan="4" style="padding: 2px;">1 + -</td> </tr> <tr> <td style="padding: 2px;">Channel position type:</td> <td colspan="4" style="padding: 2px;">Channel distance ▼</td> </tr> <tr> <td style="padding: 2px;">Channel distance:</td> <td colspan="4" style="padding: 2px;">100.000 Hz + -</td> </tr> <tr> <td style="padding: 2px;">Adaptive equaliser:</td> <td colspan="4" style="padding: 2px;">LMS ▼</td> </tr> <tr> <td style="padding: 2px;">Equaliser filter length:</td> <td colspan="4" style="padding: 2px;">— ▼</td> </tr> <tr> <td style="padding: 2px;">Frequency tracking:</td> <td colspan="4" style="padding: 2px;"><input checked="" type="checkbox"/></td> </tr> <tr> <td style="padding: 2px;">Burst mode:</td> <td colspan="4" style="padding: 2px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 2px;">Min. burst length:</td> <td colspan="4" style="padding: 2px;">100.000 ms + -</td> </tr> <tr> <td style="padding: 2px;">Max. burst length:</td> <td colspan="4" style="padding: 2px;">1'000.000 ms + -</td> </tr> <tr> <td style="padding: 2px;">Min. pause length:</td> <td colspan="4" style="padding: 2px;">100.000 ms + -</td> </tr> <tr> <td style="padding: 2px;">Min. burst SNR:</td> <td colspan="4" style="padding: 2px;">0 dB + -</td> </tr> <tr> <td colspan="2" style="padding: 2px; text-align: center;">Symbol table...</td> <td colspan="3" style="padding: 2px; text-align: center;">Frequency table...</td> </tr> <tr> <td colspan="2" style="padding: 2px; text-align: center;">Time delay...</td> <td colspan="3" style="padding: 2px; text-align: center;">Filters...</td> </tr> </tbody> </table> <p style="text-align: center; margin-top: 5px;"><i>Figure 61: MPSK 2,4,8,16 A/B Parameters</i></p> </div>	Control	Demod	Decod	Extras	Audio	Demodulator:	MPSK 2,4,8,16 A/B ▼				Symbol rate:	1'000.000 Bd + -				SR tolerance:	10.000 Bd + -				Modulation order:	2 ▼				Version:	A ▼				No. of channels:	1 + -				Channel position type:	Channel distance ▼				Channel distance:	100.000 Hz + -				Adaptive equaliser:	LMS ▼				Equaliser filter length:	— ▼				Frequency tracking:	<input checked="" type="checkbox"/>				Burst mode:	<input type="checkbox"/>				Min. burst length:	100.000 ms + -				Max. burst length:	1'000.000 ms + -				Min. pause length:	100.000 ms + -				Min. burst SNR:	0 dB + -				Symbol table...		Frequency table...			Time delay...		Filters...		
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<p>OQPSK (Offset Quadrature Phase Shift Keying)</p>	<div style="border: 1px solid #ccc; padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse; background-color: #f0f0f0;"> <thead> <tr style="background-color: #e0e0e0;"> <th style="padding: 2px;">Control</th> <th style="padding: 2px;">Demod</th> <th style="padding: 2px;">Decod</th> <th style="padding: 2px;">Extras</th> <th style="padding: 2px;">Audio</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">Demodulator:</td> <td colspan="4" style="padding: 2px;">OQPSK ▼</td> </tr> <tr> <td style="padding: 2px;">Symbol rate:</td> <td colspan="4" style="padding: 2px;">10.000 Bd ▲ ▼</td> </tr> <tr> <td style="padding: 2px;">SR tolerance:</td> <td colspan="4" style="padding: 2px;">0.050 Bd ▲ ▼</td> </tr> <tr> <td style="padding: 2px;">Burst mode:</td> <td colspan="4" style="padding: 2px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 2px;">Min. burst length:</td> <td colspan="4" style="padding: 2px;">100.000 ms ▲ ▼</td> </tr> <tr> <td style="padding: 2px;">Max. burst length:</td> <td colspan="4" style="padding: 2px;">1'000.000 ms ▲ ▼</td> </tr> <tr> <td style="padding: 2px;">Min. pause length:</td> <td colspan="4" style="padding: 2px;">100.000 ms ▲ ▼</td> </tr> <tr> <td colspan="5" style="padding: 2px; text-align: center;">Filters...</td> </tr> </tbody> </table> <p style="text-align: center; margin-top: 5px;"><i>Figure 62: OQPSK Parameters</i></p> </div>	Control	Demod	Decod	Extras	Audio	Demodulator:	OQPSK ▼				Symbol rate:	10.000 Bd ▲ ▼				SR tolerance:	0.050 Bd ▲ ▼				Burst mode:	<input type="checkbox"/>				Min. burst length:	100.000 ms ▲ ▼				Max. burst length:	1'000.000 ms ▲ ▼				Min. pause length:	100.000 ms ▲ ▼				Filters...																																																						
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Demodulator	Additional Settings																																																																																															
<p>QAM n (Quadrature Amplitude Modulation, square and any user-defined constellations)</p>	<div data-bbox="719 443 1326 1227" style="border: 1px solid gray; padding: 5px;"> <table border="1"> <thead> <tr> <th>Control</th> <th>Demod</th> <th>Decod</th> <th>Extras</th> <th>Audio</th> </tr> </thead> <tbody> <tr> <td>Demodulator:</td> <td colspan="4">QAMn</td> </tr> <tr> <td>Symbol rate:</td> <td colspan="4">1'000.000 Bd</td> </tr> <tr> <td>SR tolerance:</td> <td colspan="4">0.000 Bd</td> </tr> <tr> <td>Modulation order:</td> <td colspan="4">16</td> </tr> <tr> <td>No. of channels:</td> <td colspan="4">1</td> </tr> <tr> <td>Channel position type:</td> <td colspan="4">Channel distance</td> </tr> <tr> <td>Channel distance:</td> <td colspan="4">100.000 Hz</td> </tr> <tr> <td>Adaptive equaliser:</td> <td colspan="4">LMS</td> </tr> <tr> <td>Equaliser filter length:</td> <td colspan="4">-</td> </tr> <tr> <td>Frequency tracking:</td> <td colspan="4"><input checked="" type="checkbox"/></td> </tr> <tr> <td>Burst mode:</td> <td colspan="4"><input type="checkbox"/></td> </tr> <tr> <td>Min. burst length:</td> <td colspan="4">100.000 ms</td> </tr> <tr> <td>Max. burst length:</td> <td colspan="4">1'000.000 ms</td> </tr> <tr> <td>Min. pause length:</td> <td colspan="4">100.000 ms</td> </tr> <tr> <td>Min. burst SNR:</td> <td colspan="4">0 dB</td> </tr> <tr> <td colspan="2">Constellation...</td> <td colspan="3"><input type="checkbox"/> Own configuration</td> </tr> <tr> <td colspan="2">Frequency table...</td> <td colspan="3">Time delay...</td> </tr> <tr> <td colspan="2">Filters...</td> <td colspan="3"></td> </tr> </tbody> </table> <p style="text-align: center;"><i>Figure 63: QAM n Parameters Parameters</i></p> <p>Note: Any user-defined constellations can be demodulated via the "Configure..." button and using an XML description. Some sample constellations are available via the XML editor, which opens when pressing the button. The XML format is described in a separate document.</p> </div>	Control	Demod	Decod	Extras	Audio	Demodulator:	QAMn				Symbol rate:	1'000.000 Bd				SR tolerance:	0.000 Bd				Modulation order:	16				No. of channels:	1				Channel position type:	Channel distance				Channel distance:	100.000 Hz				Adaptive equaliser:	LMS				Equaliser filter length:	-				Frequency tracking:	<input checked="" type="checkbox"/>				Burst mode:	<input type="checkbox"/>				Min. burst length:	100.000 ms				Max. burst length:	1'000.000 ms				Min. pause length:	100.000 ms				Min. burst SNR:	0 dB				Constellation...		<input type="checkbox"/> Own configuration			Frequency table...		Time delay...			Filters...				
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Filters...																																																																																																

Demodulator	Additional Settings
<p>OFDM (Orthogonal Frequency Division Multiplexed signal)</p>	<div style="border: 1px solid #ccc; padding: 10px; margin: 10px auto; width: 80%;"> <div style="display: flex; justify-content: space-between; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> Control Demod Decod Extras Audio </div> <p>Demodulator: OFDM</p> <p>Symbol rate: 33.333 Bd + -</p> <p>No. of channels: 45 + -</p> <p>Channel distance: 62.500 Hz + -</p> <p>Constellation: PSK-2A</p> <p>Burst mode: <input type="checkbox"/></p> <p>Min. burst length: 100.000 ms + -</p> <p>Max. burst length: 1'000.000 ms + -</p> <p>Min. pause length: 100.000 ms + -</p> <p>Min. burst SNR: 0 dB + -</p> <p>Increment diff. phase: 0.000° + -</p> <p style="text-align: center;">Configure... <input type="checkbox"/> Use configuration</p> </div> <p style="text-align: center; margin-top: 10px;"><i>Figure 64: OFDM Parameters</i></p> <hr style="border: 0.5px solid #ccc;"/> <p>Note: An XML editor has been added so that the parameters of the OFDM demodulator can be edited. XML files created with the PROCITEC Signal Analyzer Tool can be imported.</p> <div style="border: 1px solid #ccc; padding: 10px; margin: 10px auto; width: 80%;"> <p>Constellation: PSK-2A</p> <p>Burst mode: PSK-4A</p> <p>Min. burst length: PSK-8A</p> <p>Max. burst length: PSK-2B</p> <p>Min. pause length: PSK-4B</p> <p>Min. burst SNR: PSK-8B</p> <p>Increment diff. phase: DPSK-2A</p> <p style="text-align: center;">Configure...</p> </div> <p style="text-align: center; margin-top: 10px;"><i>Figure 65: OFDM Constellations</i></p>

<p>Demodulator</p> <p>MultiModem Continuous production across multiple (sub)modems</p>	<p>Additional Settings</p>  <p style="text-align: center;"><i>Figure 66: MultiModem</i></p>
<p>Analogue Selcall</p>	 <p style="text-align: center;"><i>Figure 67: Analogue Selcall Parameters</i></p>
<p>Clover II</p>	 <p style="text-align: center;"><i>Figure 68: Clover II Parameters</i></p>

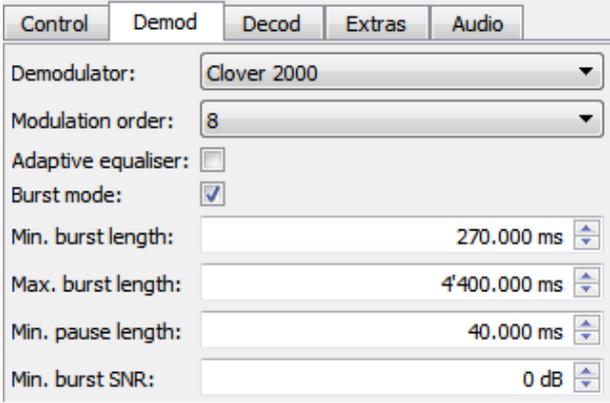
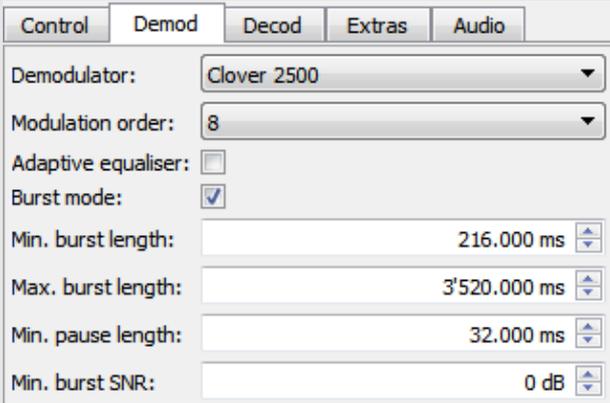
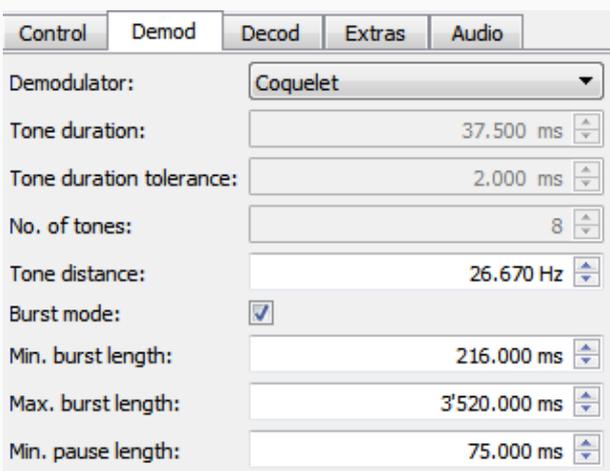
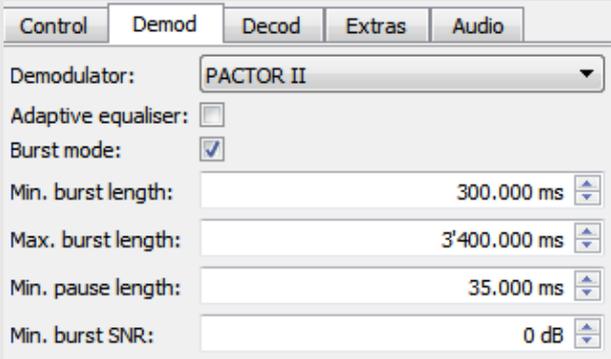
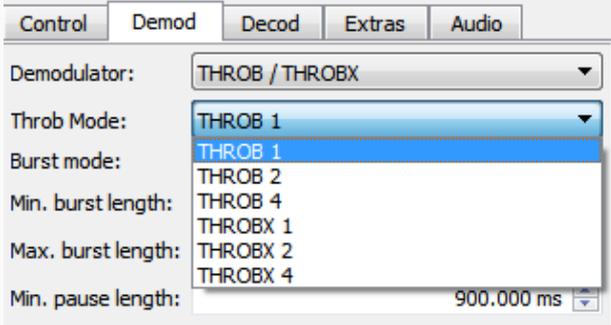
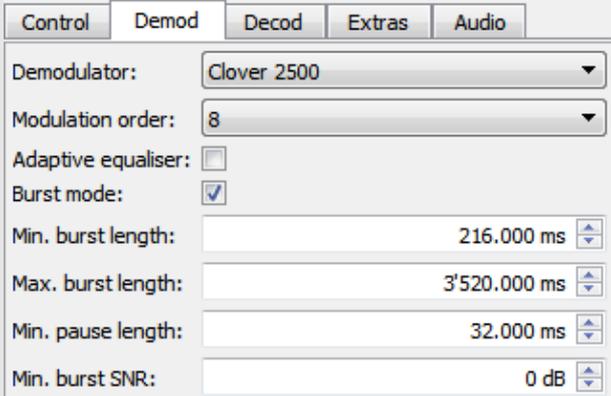
Demodulator	Additional Settings
Clover 2000	 <p>The screenshot shows the 'Demod' tab of the Clover 2000 settings. The 'Demodulator' is set to 'Clover 2000' and 'Modulation order' is set to '8'. 'Adaptive equaliser' is unchecked, and 'Burst mode' is checked. The 'Min. burst length' is 270.000 ms, 'Max. burst length' is 4'400.000 ms, 'Min. pause length' is 40.000 ms, and 'Min. burst SNR' is 0 dB.</p>
Clover 2500	 <p>The screenshot shows the 'Demod' tab of the Clover 2500 settings. The 'Demodulator' is set to 'Clover 2500' and 'Modulation order' is set to '8'. 'Adaptive equaliser' is unchecked, and 'Burst mode' is checked. The 'Min. burst length' is 216.000 ms, 'Max. burst length' is 3'520.000 ms, 'Min. pause length' is 32.000 ms, and 'Min. burst SNR' is 0 dB.</p>
Coquelet (Special filter demodulator for Coquelet signals)	 <p>The screenshot shows the 'Demod' tab of the Coquelet settings. The 'Demodulator' is set to 'Coquelet'. 'Tone duration' is 37.500 ms, 'Tone duration tolerance' is 2.000 ms, and 'No. of tones' is 8. 'Tone distance' is 26.670 Hz. 'Burst mode' is checked. The 'Min. burst length' is 216.000 ms, 'Max. burst length' is 3'520.000 ms, and 'Min. pause length' is 75.000 ms.</p>

Figure 69: Clover 2000 Parameters

Figure 70: Clover 2500 Parameters

Figure 71: Coquelet Parameters

<p>Demodulator</p> <p>Pactor II/III</p>	<p>Additional Settings</p>  <p>Figure 72: Pactor II/III Parameters</p>
<p>THROB / THROBX</p>	 <p>Figure 73: THROB / THROBX Parameters</p>
<p>MT63</p>	 <p>Figure 74: MT63 Parameters</p>

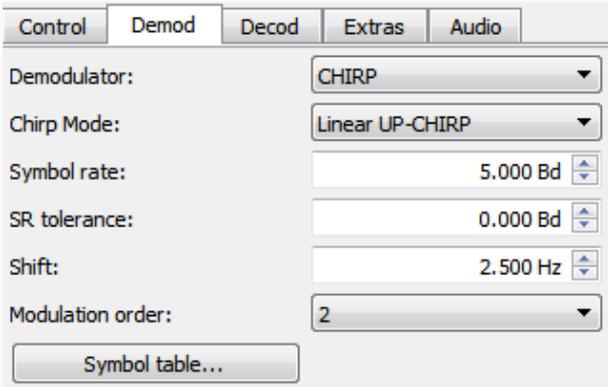
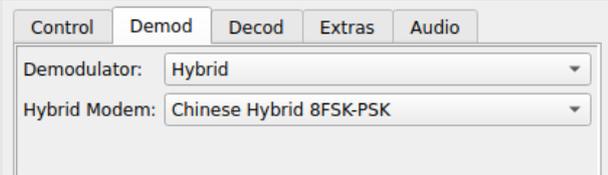
Demodulator	Additional Settings
<p>Chirp (with phase shift keying modulated chirp signal)</p>	 <p>The screenshot shows a dialog box with tabs: Control, Demod, Decod, Extras, Audio. The 'Demod' tab is active. It contains the following settings:</p> <ul style="list-style-type: none"> Demodulator: CHIRP Chirp Mode: Linear UP-CHIRP Symbol rate: 5.000 Bd SR tolerance: 0.000 Bd Shift: 2.500 Hz Modulation order: 2 Symbol table... button
<p>Hybrid Modems with some submodi</p>	 <p>The screenshot shows a dialog box with tabs: Control, Demod, Decod, Extras, Audio. The 'Demod' tab is active. It contains the following settings:</p> <ul style="list-style-type: none"> Demodulator: Hybrid Hybrid Modem: Chinese Hybrid 8FSK-PSK

Figure 75: Chirp Parameters

Figure 76: Hybrid Parameters

Table 26: Demodulator Settings

4.1.1. MultiModem

The demodulator type *MultiModem* allows the continuous production across multiple (sub)modems. In general, when the APC notices that the emission of a modem ends then it will stop the production and start a new search. A subsequent emission might then be detected and a new production is started. However, in some cases it is preferable to have a continuous production even if the emission switches to a different mode. E.g. Pactor modems usually start in Pactor I mode (FSK) and then later switch to a multichannel PSK (Pactor II or Pactor III).

A multimodem is a bundle of several submodems. Each submodem is a complete modem with a demodulator and a decoder. Whenever the APC notices the emission end for one of the submodems it will start an internal search for one of the other submodems. If the (internal) search is successful the production will continue with the new submodem. From the outside the production appears to be continuous. Only if the (internal) search fails then the production is ended and a normal search starts.

The only parameters of a multimodem are a list of submodems. When the button <Edit submodems...> is clicked a dialog appears.

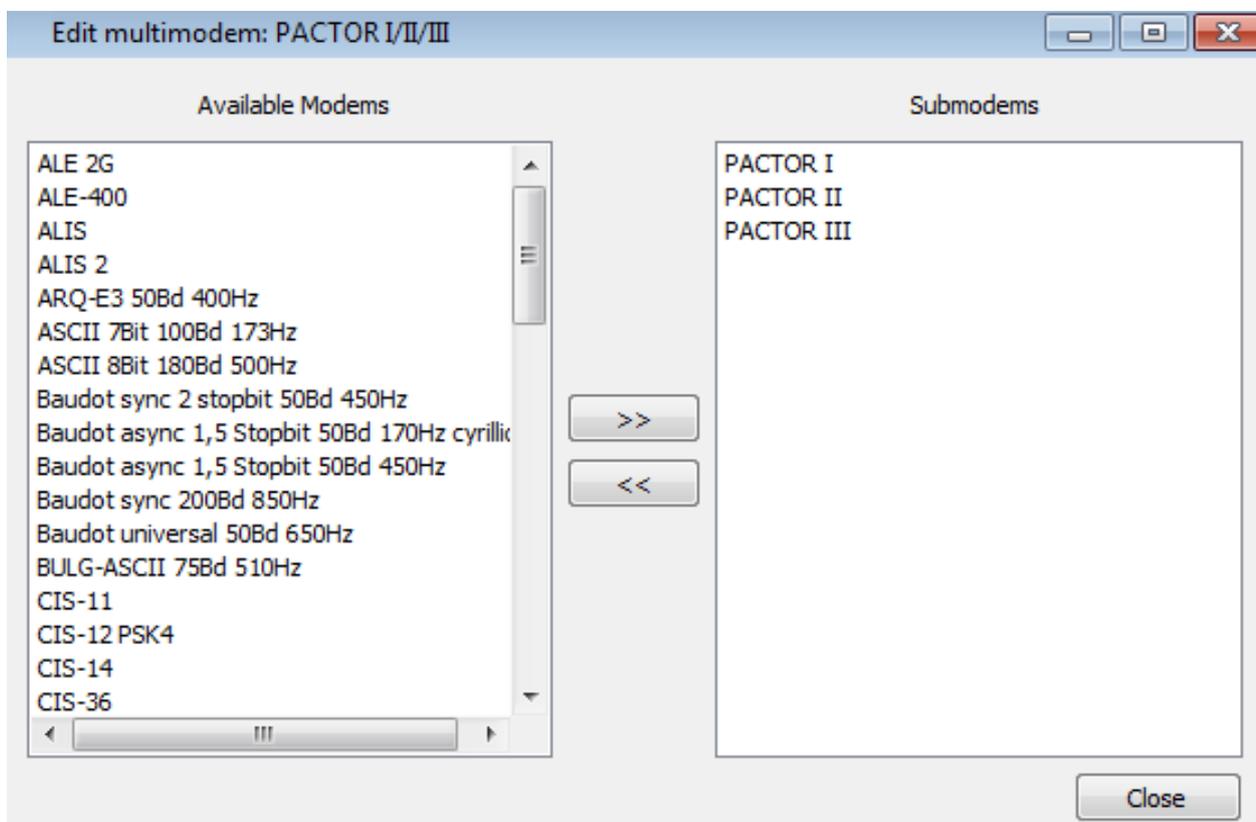


Figure 77: Dialog Edit MultiModem

On the left in Figure 77 is a list of all modems that are currently loaded (multimodems excluded). On the right is a list of the current submodems. A submodem can now be easily added by selecting one of the modems from the left list and clicking the <>> button in the center. The modem will then be removed from the normal modem list and added as submodem to the multimodem. To remove a submodem just select it on the right side and click the <<< button. The submodem will then be again a part of the normal list and its parameters can be edited.

For the creation of a MultiModem the following workflow is recommended:

1. Analyse the signal manually and determine which modems are actually needed for every part of the emission. Adjust the demodulator settings and decoder accordingly.
2. Create a normal modem list with all of these modems.
3. Start the automatic production. Several production results – one for every modem found in the emission - should be shown. The production results should cover the complete emission.
4. Create a MultiModem and add all of the above modems as submodems.
5. Start again an automatic production. Now only one production result that covers the complete emission should be shown. The content of the production result should be identical to the results when a normal modem list was applied.

Warning: A multimodem is automatically deactivated when in manual production mode.

4.1.2. External modems as plugins

The APC has a plugin mechanism for external modems. This demodulator-interface can be used to integrate demodulators which have been developed by the customer and which he does not want to distribute. It is a C-interface that allows integrating a complete modem - demodulator plus decoder - as an external library (DLL/shared lib) into the APC. It is also possible that the external library only demodulates and then a pyDDL decoder is applied. The comprehensive API allows the integration of the external modem into the automatic recognition process of the APC.

The usage of a C-interface does not impose any restrictions on the programming language that is actually used for the plugin. It can be written in C, C++, Java, Python etc. The plugin can even be just a thin proxy for a hardware modem - local or remote.

A detailed description of the C-interface and C++ example code is available on request. For more information please contact service@procitec.com.

4.2. List of Decoders

See separate document for a list of supported and delivered decoders. In addition, there is a separate document with a short description of every decoder (datasheet).

5. FAQ

5.1. Decoders

5.1.1. Adjusting the Polarity

If decoding is not possible as the decoder cannot automatically detect the polarity of the signal, then we recommend changing the primary demodulator from USB (off) to LSB.

5.2. Miscellaneous

5.2.1. Disable tool tips

Open the “modem-lab.conf” file in the user folder and set the value of ShowToolTips to 0.

5.2.2. Change language of GUI

To do this, it is necessary to create the file “prolang.cfg” in the user folder and then modify it with a text editor. Valid entries are “de” for German and “en” for English. Modem Lab must be restarted after the change.

5.2.3. Location license file

The license file “default.maw” is stored and searched for in the user folder.

(.../<user>/procitec/analysis-suite <version>)

Alternatively, it can be stored in the installation folder.

5.2.4. Drag-and-Drop

Modems and modem lists can be added via drag-and-drop to Modem Lab. This also applies to signal recordings (e.g. WAV files) in DANA. It is possible to select multiple files at the same time.

5.2.5. Modem Lab runs very slowly or seems to stuck

If Modem Lab is parameterized with a very long modem list and / or fed with a broadband input signal, it takes a long time until the automatic detection is finished. Modem Lab seems to stuck, but it continues to run in the background. It is recommended not to use a broadband input signal, but to use only the necessary narrowband input signal. Furthermore, the modem list should be limited to possible modems.

5.2.6. Modem is not found or decoded

There are several possible reasons:

- Nominal frequency or search range is not set correctly
- Signal quality is too bad
- The modem is not included in the modem list, not selected or not active
- The mode is set to production: only the selected modem is active. Other modems in the list are ignored.

5.2.7. Installed modems

The displayed modems in the result display are not all installed or existing modems and doesn't represent the complete modem database. Modems can be added via **<Modem><New Modem>**.

5.2.8. Result location

Results produced are stored by Modem Lab in the user folder under

`".../<user>/procitec/analysis-suite <version>/mem_prod"`

in addition to the output in the user interface.

5.2.9. File extensions

- `".ver"` – Single Modem
- `".cmf"` – List of modems (complete modem definitions)
- `".mlst"` – List of modems (only modem references)
- `"._dec.pkg"` – pyDDL decoder package
- `"._dec.py"` – pyDDL Decoder Python source file
- `".wav"` – signal file, real or complex
- `".para"` – signal parameters for wav files (like receive frequency)

5.2.10. Compressed signal files

If signal files have been lossy compressed (e.g. mp3), important signal information (e.g. phase) which are necessary for demodulation are usually lost. This difference is not acoustically audible but prevents decoding for most modems. Only simple modems, e.g. morse, are rather uncritical in this regard. Signal files, even after reconversion of mp3 or similar, are therefore mostly unusable.

5.2.11. Real and complex signals

A complex signal consists of 2 real channels (I and Q components). The spectrum of a complex signal generally differs at positive and negative frequencies. Real signals are single-channel. Since the spectrum of a real signal is symmetric around 0 Hz, the redundant negative frequencies are usually not displayed in spectrum representations.

In DANA, files with 2 channels are played by default as a real signal and only the first channel is used. In order to play the file in as a complex signal, you have to right-click on the path of the corresponding file in the file list and set the mode to IQ. The signal must be selected and played at the same time.

5.2.12. Spinbox features

The values of all spinboxes can be changed using the mouse wheel. The digit marked by the cursor changes. Furthermore, the unit can be changed by right-clicking on the spinbox and previously entered values are displayed again.

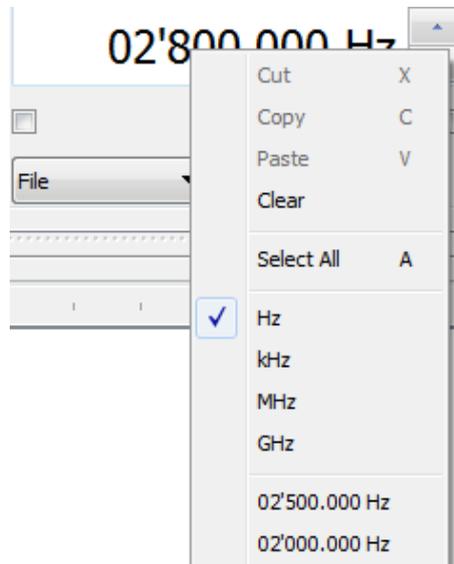


Figure 78: Spinbox menu

5.2.13. Changing the font size

The font size can be adjusted for high-resolution monitors as follows:

- By setting the parameter “--font-size <XX>” at startup via the command line. The font size is only changed for the current call.
- As a permanent entry in the file “modem-lab.conf” in the user directory. The key `<add key="GlobalFontSize" value="XX"/>` under the entry `<appSettings>` has to be updated or created.

6. Tools

6.1. DANA

6.1.1. Welcome to DANA

DANA is an abbreviation for *Digital Analog Audio Interface*. DANA converts analog signals into complex IF signals and provides these complex signals as a TCP/IP signal server to the APC. The process is shown in Figure 79.

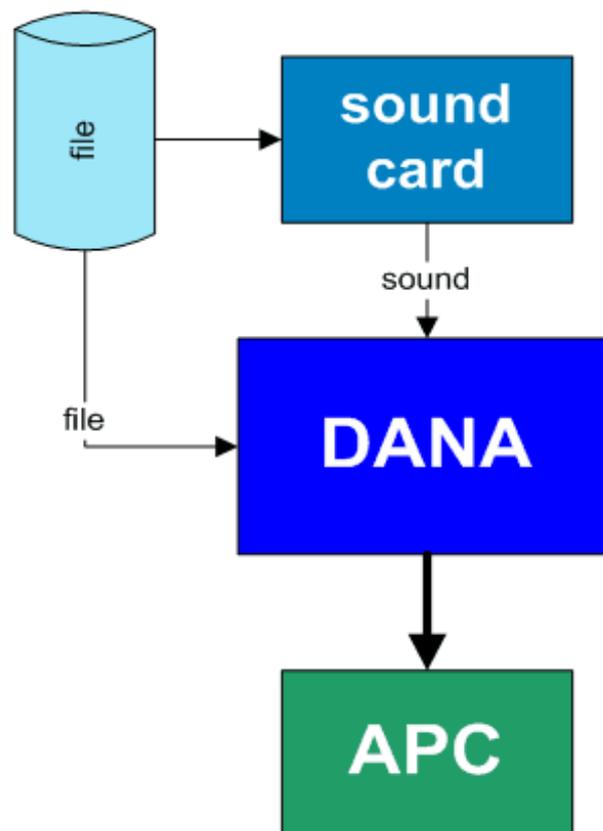


Figure 79: DANA Functions

Two kinds of sources are available:

- **Sound:** Analog signals from the sound card with a sampling rate of 48 kHz or 96 kHz (online), e.g. signals generated and played back using the signal generator SOMO, or WAV files (playing mode *Sound*) played by means of any media player.
- **File:** Signal recordings (e.g. WAV files) can also be played back directly using DANA. The APC has to be ready (indicated by the green dot on the status bar). In contrast to other players, no audible sound output is available.

The input signal is converted into a digital intermediate frequency (IF). The input-signal can be shifted by an offset (mixed) and it can be filtered. To add a filter, the center frequency and the bandwidth (start/end frequency) has to be entered.

To enable the decoder to process the signal correctly, the frequency of this signal must fit, i.e. the processing result mainly depends on the input in the spin box <Frequency>. The frequency of most of the signals will fit when the center of the output signal is in zero position.

File Types

The following file formats are supported:

- WAV: PCM 8/16/24/32 bit integer, PCM 32 bit float (IEEE 754), A-law, μ -law
- Blackbird TCI CAP: 16/32 bit integer, complex/real
- MetadataRaw: 8/16/32 bit integer, 32 bit float (IEEE 754), complex/real, big endian/little endian
- MEDAV DAT/DAZ: 8/16/32 bit integer, 32 bit float (IEEE 754), complex/real
- BLUE (Midas BLUE aka BLUE 1.0 and Platinum BLUE aka BLUE 2.0): 8/16/32 bit integer, 32/64 bit float (IEEE 754), big endian/little endian
- SigMF: 8/16/32 bit integer, 32/64 bit float (IEEE 754), complex/real, big endian/little endian
- SignalHoundIQFile (signal recording from Spike application): 16 bit integer, complex

When using the standard WAV format, 1-channel (mono) WAV files are interpreted as real-valued signals (i.e., *Audio*), 2-channel WAV files (stereo) are interpreted per default also as real-valued signals. The interpretation of a 2-channel WAV file as either *I/Q* or *Audio* can be manually overridden through the context menu in the file list. If a 2-channel file is interpreted as *Audio*, only the first channel (the left channel) is used.

Spectrum Display

The spectrum of the input signal is displayed with adjusted filter range.

The individual menus and windows of DANA are explained on the following pages. The appearance of the DANA screen depends on the selection of the setting *Sound* or *File*. In the setting *File*, a play list with the corresponding functions and parameters will be displayed in addition.

6.1.2. Control from user interface

DANA user interface

The user interface of DANA can be seen in Figure 80.

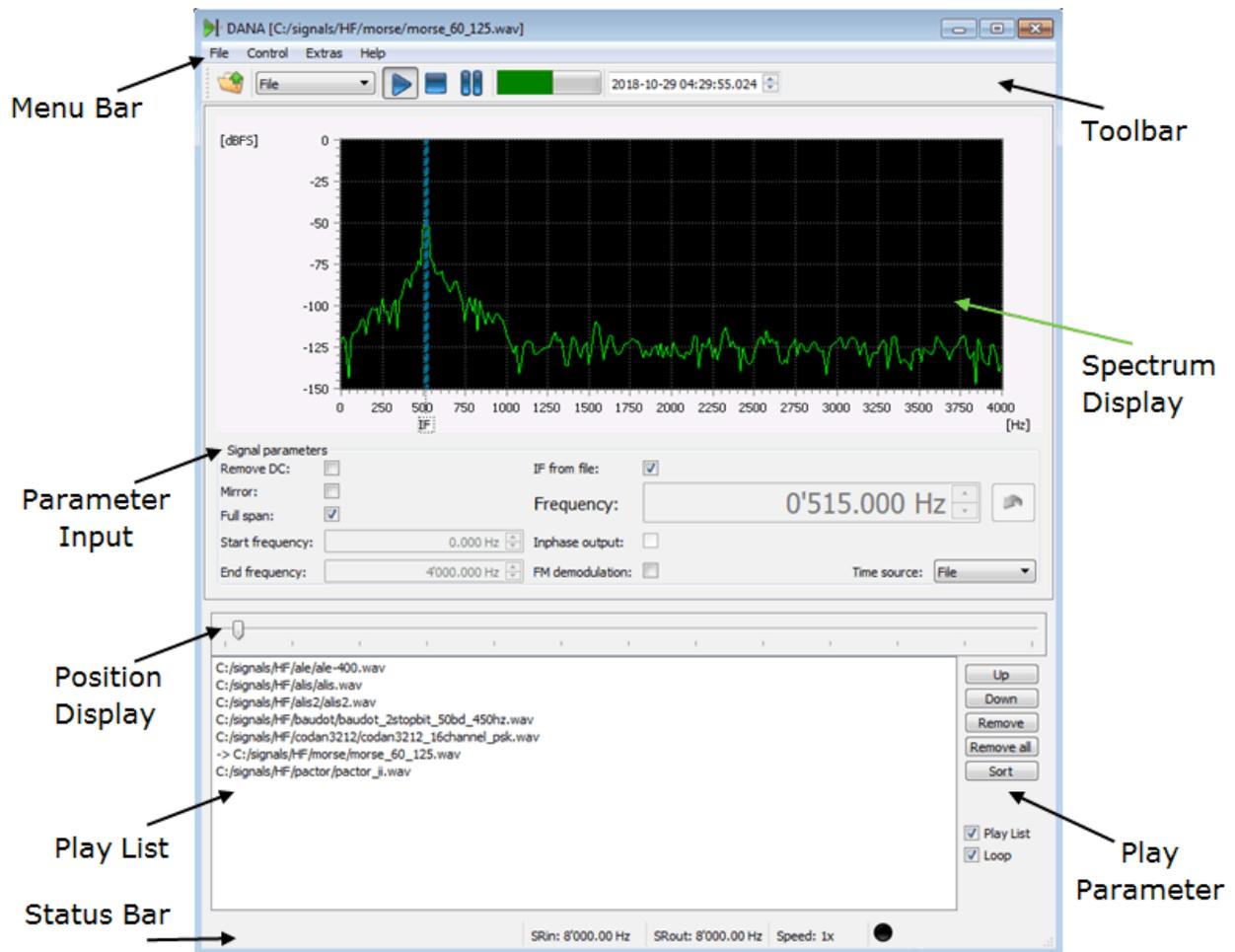


Figure 80: DANA User Interface

Start of DANA

In Modem Lab DANA is started automatically. In addition, it is possible to start it by hand in Modem Lab with the help of the <Extras> menu. It is also possible to start DANA from the <Startmenü> of your desktop.

6.1.2.1. Menu Bar

The menu bar of DANA is displayed in Figure 81.

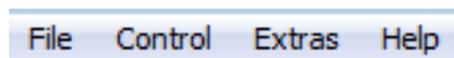


Figure 81: DANA Menu Bar

6.1.2.1.1. Menu File

If <File> is selected, the list shown in Figure 82 will be opened.

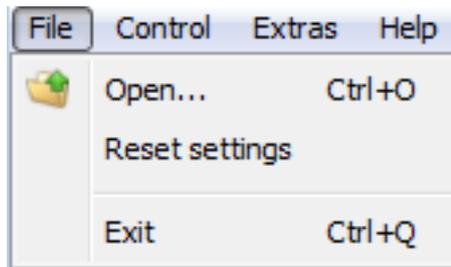


Figure 82: DANA Menu File

Menu Item	Function
Open...	Load selected WAV files into the play list. These are only visible if the source is <i>File</i> . Simultaneous selection and loading of several files is possible.
Reset Settings	All settings will be reset to their factory settings. The play list will not be modified.
Exit	The application will close. The settings and the play list will be stored.

Table 27: DANA File Functions

6.1.2.1.2. Menüpunkt Control

The menu <Control> is shown in Figure 83.

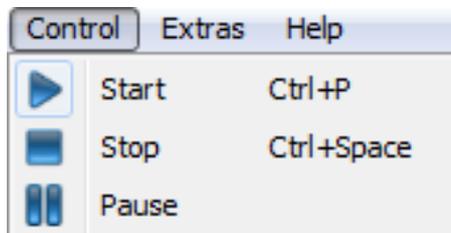


Figure 83: DANA Menu Control

Menu Item	Function
 Start	Start playback. APC receives signal data.
 Stop	Stop playback. APC no longer receives any signal data.
 Pause	With DANA in mode <Start>, playback will be halted; DANA in mode <Pause>, playback will be restarted.

Table 28: DANA Control Functions

6.1.2.1.3. Menu Extras

When <Extras> is selected, the list in Figure 84 will be opened.

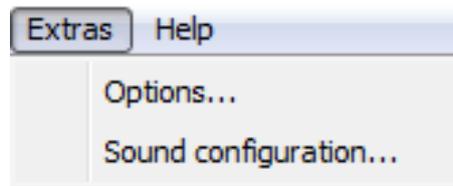


Figure 84: DANA Menu Extras

Options...

<Options...> controls the handling of files or signals, respectively. It consists, as shown in Figure 85, of two group boxes.

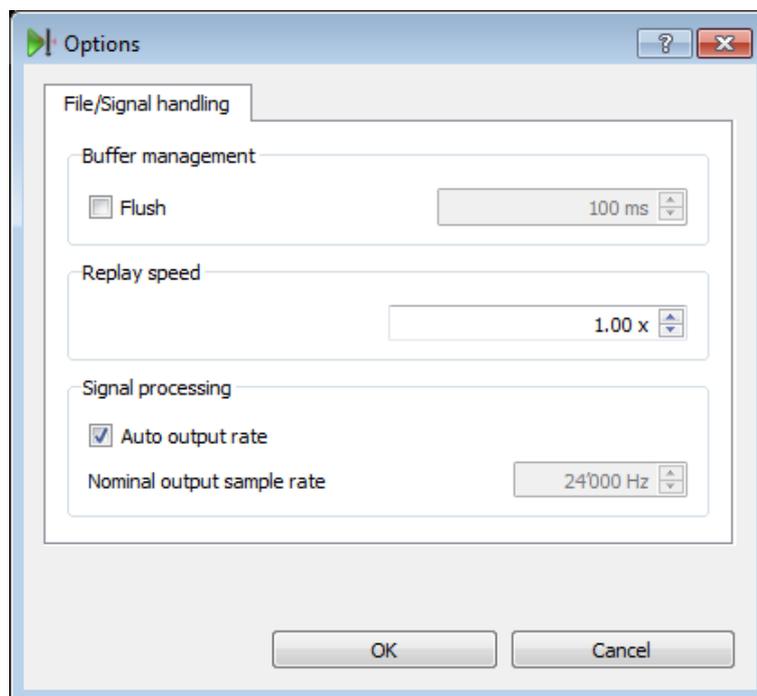


Figure 85: DANA Options Menu

If the checkbox <Flush> in group box *Buffer management* is enabled then DANA will send some noise for a specific time after playing back a file with deactivated loop function. This is done in order to flush the internal APC buffers. This option is helpful if the signal ends jointly with the input file. At signal end if the flush is deactivated or at the end of the flush, the internal APC buffers are additionally emptied via a signal end (EoS) signaled by DANA.

The replay speed while playing from file can be set in the spin box <Replay speed>. A replay slower than real time (factor < 1) is advisable for input signal with a very high sampling rate or to analyze very short burst signals. Replaying faster than real time is helpful for the fast production of long signal recordings or for modems with a very small symbol rate. It is to be noted that the APC has an internal limit for the production which is regulated by the license.

When the checkbox <Auto output rate> in the group box *Signal Processing* is activated, DANA will use the input sampling rate for the output. Otherwise DANA will select a value close to the one specified in the spin box <Nominal output sample rate> and resample the input signal.

Sound Configuration...

If the system features various sound cards (e.g. with different numbers of channels), this item can be used to select and configure the existing sound input devices.

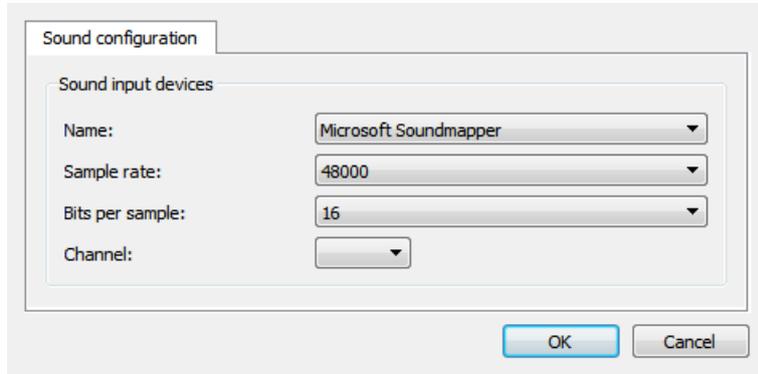


Figure 86: DANA Sound Configuration Menu

In the in Figure 86 displayed dialog box, the desired device can be selected with <Name>.To configure the input device, <Sample rate>, <Bits per sample> und <Channel> can be used.

Note: This menu entry might not be accessible if no actual recording device is plugged in (e.g. a microphone).

6.1.2.1.4. Menu Help

The <Help> menu can be seen in Figure 87.

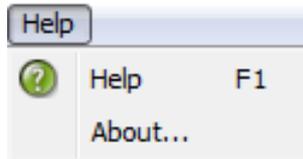


Figure 87: DANA Menu Help

Menu item	Function
Help	Opens the online help.
About...	Displays information about DANA.

Table 29: DANA Help Functions

6.1.2.2. Toolbar

The toolbar of DANA is displayed in Figure 88.



Figure 88: DANA Toolbar

6.1.2.2.1. Signal Source

With the combo box in Figure 89 it is possible to define the signal source in DANA.

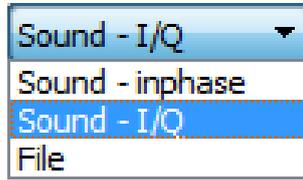


Figure 89: DANA Signal Source

Signal Source	Description
Sound - inphase	The signal is received from the current recording source of the system, e.g. Windows® Media Player or a receiver’s audio output. This is an online signal source, i.e. the playback is in real-time and if the APC is not able to process the input signal fast enough then it will drop it.
Sound - I/Q	Similar to <i>Sound – inphase</i> , but stereo input signal is interpreted as quadrature I/Q signal. One important application is to connect the I/Q output of another program through a virtual audio cable with DANA.
File	Load files containing signal recordings: The file is played directly via DANA. Usually this is an offline signal source, i.e. if the APC is not able to process the input signal fast enough then DANA will have to wait. Playback is in real-time if not specified otherwise on the command line. Note: This entry might not be accessible if no actual recording device is plugged in (e.g. a microphone).

Table 30: DANA Auswahlmöglichkeiten Signalquelle

6.1.2.2.2. Control Icons

The Control Icons  Start,  Stop and  Pause will be explained in Table 28.

6.1.2.2.3. Gain Display

The bar graph shows the input signal level.

Bar Graph	Description
 Green	all right
 Red	over modulated. If the display is red (over modulated) and <i>Sound</i> input is selected, then the volume of the soundcard output has to be reduced, until the gain display turns green (please refer to the documentation of your operating system for details).

Table 31: DANA Gain Display

6.1.2.3. Spectrum Display and Conversion Parameter Setting

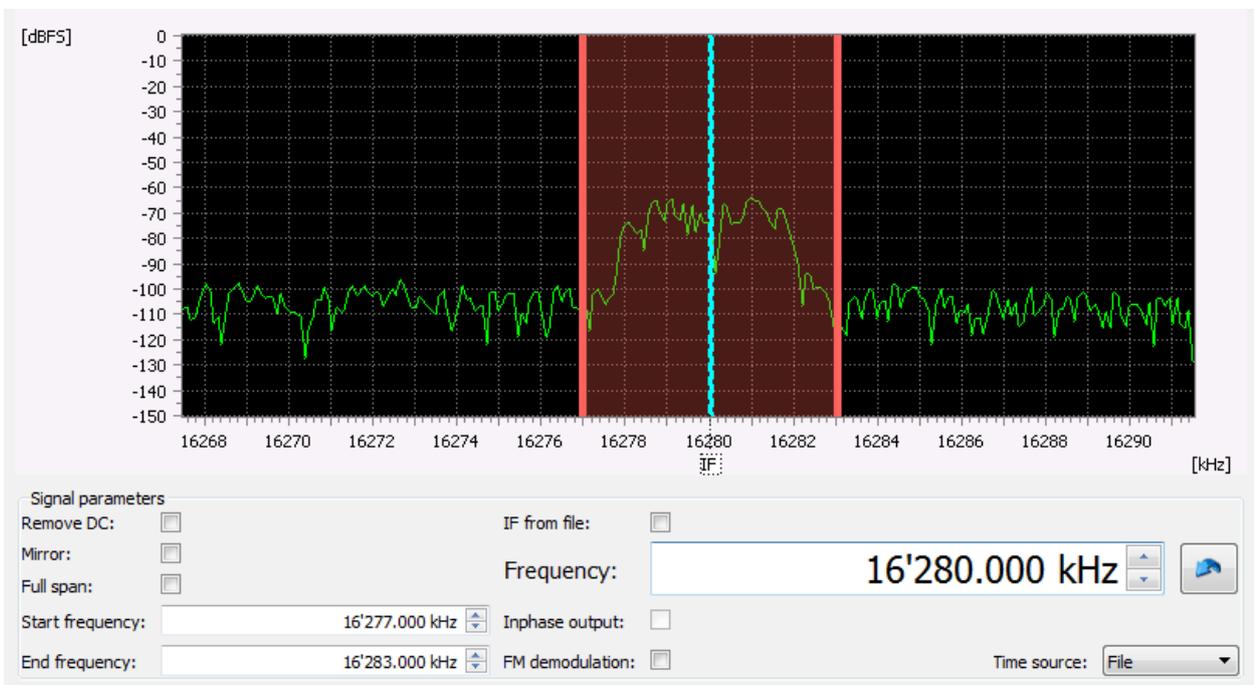


Figure 90: DANA Input signal with band-pass filter enabled

In this window, the spectrum (green) of the input signal is displayed (in dBFS) above the frequency axis (in Hz). Additionally, the band-pass filter (red) for the signal is displayed. The blue line indicates the selected center frequency for the IF of the input signal. If **<IF from File>** is not activated, as is the case in the figure above, the center frequency can be changed in the **<Frequency>** box or directly by moving the blue indication line with the mouse.

Figure 90 shows an example of an input signal with a band-pass filter from 16.277 kHz to 16.283 kHz. Start and end frequency of the band-pass filter can be changed in the corresponding spin boxes or directly by moving one of the red lines in the spectrum with the mouse.

The following shows how the conversion can be parameterized.

Input Filter Settings

In Figure 91, the existing settings for the input filtering are shown.

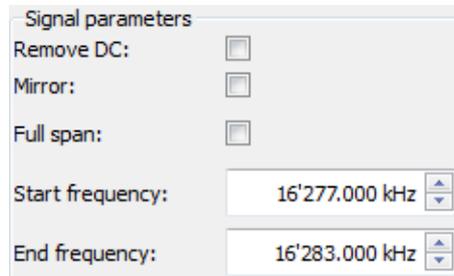


Figure 91: DANA Input Filter

Parameter	Description and Input Options
<Remove DC>	Removes the DC bias in the input signal. This option is particularly relevant for signals from the sound card.
<Mirror>	If signals are in reverse position (LSB, USB), the mirror mode can be activated to turn these signals to the correct position.
<Full Span>	This option deactivates the band-pass filter. The input signal is not filtered.
<Start frequency>	Defines the lower frequency for the band-pass filter. The value displayed refers to the input signal.
<End frequency>	Defines the upper frequency for the band-pass filter. The value displayed refers to the input signal.

Table 32: DANA Parameter Input Filter

Output Signal

In Figure 92 sind Einstellungen für das Ausgangssignal dargestellt.

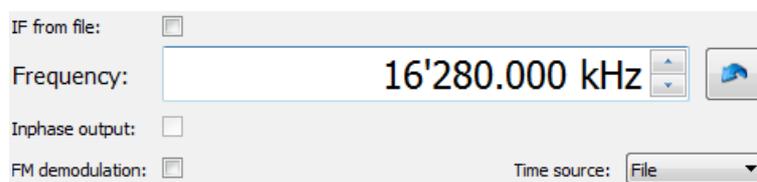


Figure 92: DANA Output Signal

Parameter	Description and Input Options
<IF from file>	The relative mixer frequency (IF) by which the input signal will be shifted is retrieved automatically from the audio file if available. WAV files created by PROCITEC applications will store this mixer frequency in the file itself. It is also possible to create a text file with the identical name as the signal recording file but with the extension “*.para” and the content “IFFrequency xxx.x”. Replace xxx.x with the desired mixer frequency. If the “*.para” file is found, it will have priority over the value stored in the WAV file itself. The “*.para” file can also be created from the context menu. See chapter Play List.

Parameter	Description and Input Options
<Frequency>	The frequency entered defines the absolute frequency position in the input signal which is shifted to zero in the output signal. The spin box allows direct input in Hz, kHz, MHz or GHz. For more options, the context menu has to be opened. If the icon  is clicked then the relative mixer frequency (IF) is reset to zero.
<Inphase output>	Enforce output of an inphase (real) signal (in contrast to a complex signal which is used as default). This will set IF automatically to zero. The checkbox is only enabled if input signal is real and the checkbox <Full span> is enabled. Should be enabled if input signal is from a receiver's FM discriminator output and demodulator should work only with the inphase part (e.g. 4-ASK).
<FM demodulation>	The output signal will be the frequency demodulated (after band-pass filter and frequency mixing). A squelch is automatically applied to suppress noise. It is recommended to apply a band-pass filter. (Can be combined with option <Inphase output> if necessary.)
<Time source> File	The original creation time stored in the audio file or if not available the latest modification date is used (available in file mode only). DANA will act as an offline signal source for the APC.
<Time source> System clock	The current system clock of the computer, which is stored in the audio file, is used. If the checkbox <Play List> is activated, all files will be processed as files belonging to one emission (available in File mode only). DANA will act as an online signal source for the APC.

Table 33: DANA Parameter Output Signal

6.1.2.4. Play List

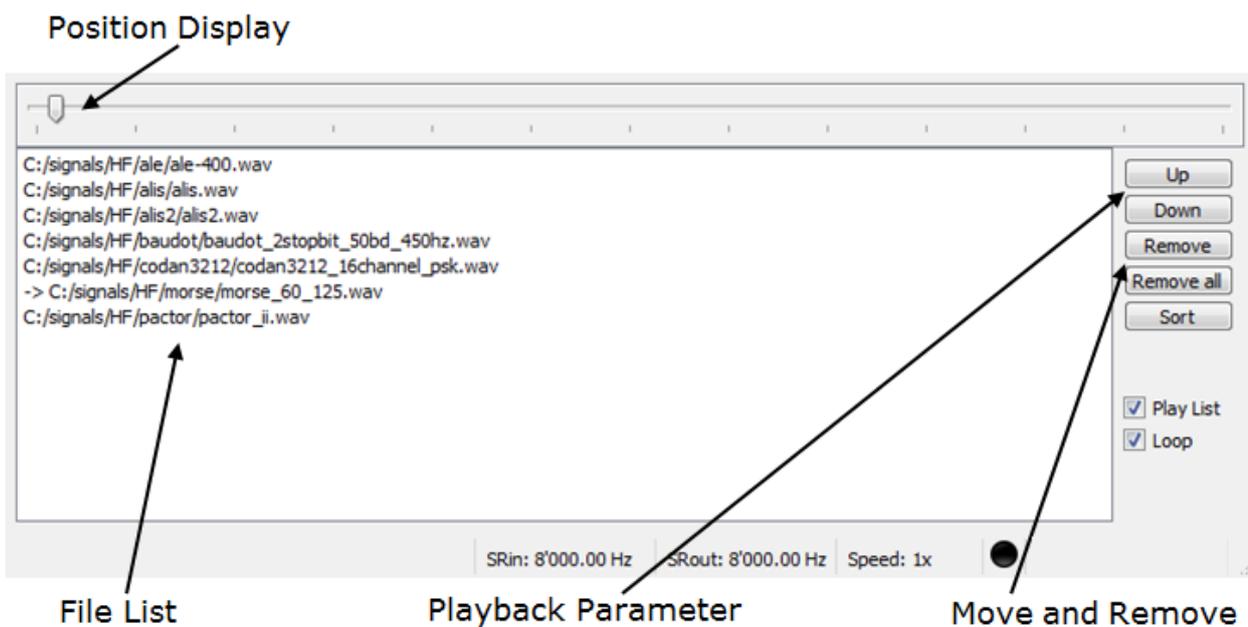


Figure 93: DANA Play List

File List

DANA shows the list of loaded files. The current replay file is marked in the play list with an arrow on the left side in front of the filename.

Note: The play list is available in *File* mode only.

When a file in the list is double clicked, then this file will be made active and replayed. The files can not be played until the APC is ready. There is also a context menu available which entries depend on the file:

Status	Description
● Green dot	Sink connected
● Black dot	Sink not connected

Table 34: DANA APC-Status

Context Menu

There is also a context menu available, which entries depend on the file:

Function	Description
Remove	Remove file from list (use <Ctrl> or <Shift> to select several files).
Save IF	Save the currently parameterized frequency in a text file in the same folder where the signal recording file resides. This file will have the identical name as the signal recording file but with the extension “*.para”. The stored frequency will be automatically loaded if <IF from file> is enabled. Menu entry only available for the active signal recording file.
Set receiver frequency (RF)	Opens a dialog for setting the receiver frequency and saves it in a text file with the extension “*.txt” parallel to the signal recording file. See also Set IQ mode .
Set IQ mode	In case the input file is replayed as audio file but contains indeed IQ (complex) data then select this entry. A text file will be created in the same folder where the signal recording file resides. This file will have the identical name as the signal recording file but with the extension “*.txt”. There will be the info stored that the file has IQ data. DANA will automatically reload the information from this file in the future. WAV files containing IQ data created by go2signals applications are automatically correctly recognized. Menu entry only available for the active signal recording file.
Set audio mode	Undo above action and treat input file as normal audio input. This Menu entry is only available for the active signal recording file.

Table 35: DANA Context Menu

Add and Remove Files

Files are loaded using <File><Open> or via the toolbar by clicking the icon . In either case, the dialog box shown in Figure 94 will be opened.

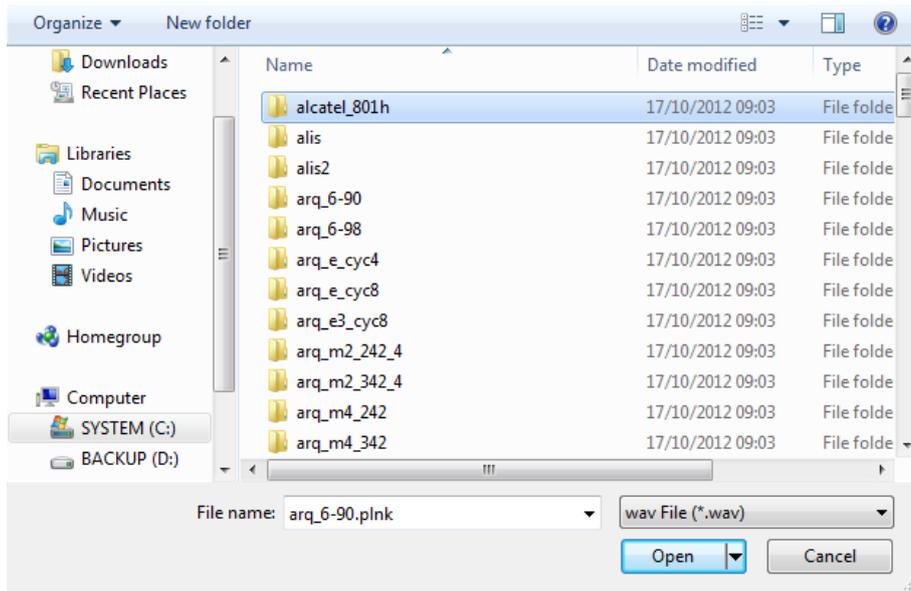


Figure 94: DANA Add or Remove Files

In this dialog window, first the file type and then one or more files have to be selected. New files are added to the existing play list. Drag’n and drop of files from the File Explorer is supported, too.

Files selected with the mouse (use <Ctrl> oder <Shift> key to select several entries) can be moved or removed using the buttons to the right of the play list (see Figure 93):

Button	Function
<Up>	Move selected files upward by one position
<Down>	Move selected files downward by one position
<Remove>	Remove the selected files from the play list
<Remove all>	Remove all files from the play list
<Sort>	Alphabetical sorting of the playlist based on the file path

Table 36: DANA Buttons Play List

Play Files

Playback can be started either via double clicking the desired file in the list or by activating <Start>. The currently replayed file is indicated by an arrow on the left side.

The different play modes are selected by checking the checkboxes <Play List> and/or <Loop>.

Button	Function
<Play List>	The list is played once from the file marked
<Loop>	The file or the files are played repeatedly

Table 37: DANA File Play Modes

Position Display

The progress bar shows how much of the currently active file has been played. By moving the slider, it is possible to directly jump to a location. Alternatively, the current file time can be entered in the input field can be changed at the top right (not available if input signal is from soundcard or time source is set to system).

Note: The input field is inactive if *Sound* is the input source or system time is set as the time source.

Status Bar



Figure 95: DANA Status Bar

The status bar (see Figure 95) displays following information.

Panel	Content
SRin	Input sampling rate
SRout	Output sampling rate
Speed	Replay speed (if this field is greyed out then replay is in real time, e.g. if replay is from soundcard)
APC Status	● = Sink connected ● = Sink not connected

Table 38: DANA Status Bar Panels

A click with the mouse on the panels *SRout* or *Speed*, respectively, will open the options menu directly.

6.1.3. Control from command line

It is possible to control a running instance of DANA completely from the command line. It is possible to start/stop the replay, add files, change input parameters, etc.

To get a complete list of existing options type "Dana /help" on the command line.

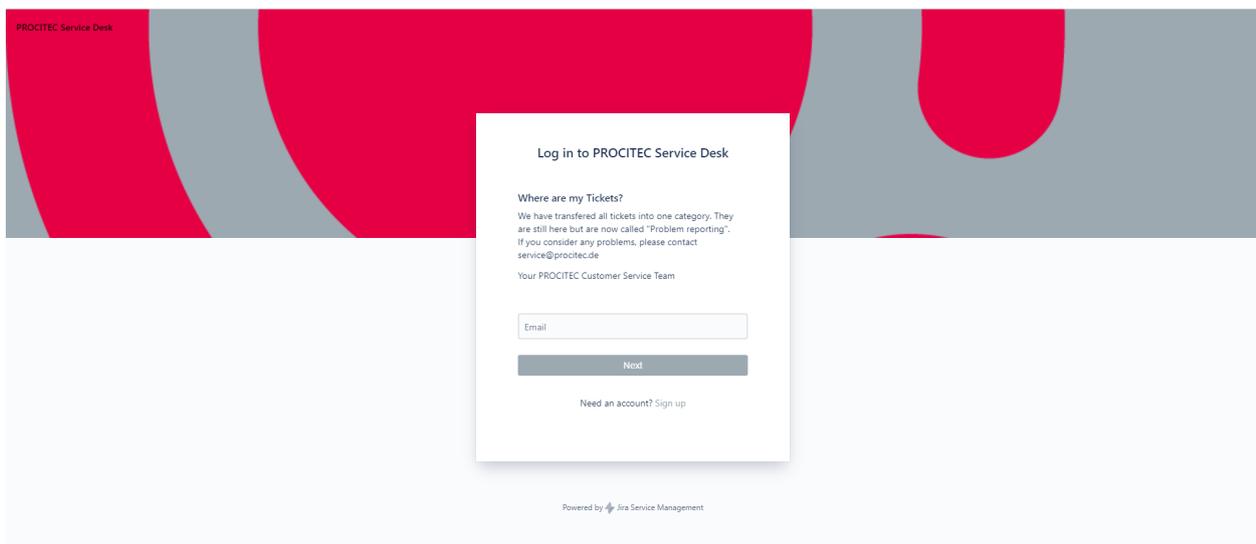
A. Support

Requests and suggestions?

All requests or suggestions regarding our go2signals product-range are very much appreciated; we would be delighted to hear from you.

Any questions? We are happy to assist you!

If you have any further questions, please do not hesitate to contact our Support Team for rapid assistance – just raise a service request at: <http://servicedesk.procitec.com>.



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