Analysis Suite go2signals

Manual

SOMO

Product Version v24.1.0

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PROCITEC®
HOUSE OF SIGNALS

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Contents

1. General

1.1. Welcome to SOMO

SOMO is an abbreviation for *Software Modulation Signal Generator*. Using SOMO, you can easily generate different types of modulation and their own parameters for each signal. The output of the results can be done via external interfaces (sound card, network) e.g. in go2DECODE. The results can be saved in a WAV file as well.

Features of SOMO

- Creation of various modulation schemes
- Variable modulation parameters
- Variable encoding modems
- Text input editor
- Generating short-time emissions (bursts)
- Multi-channel systems (with a maximum number of 100 channels)
- Frequency range up to 192 kHz
- HF Channel Simulation (multipath fading and noise)
- Variable pulse forming
- Spectrum/sonagram display
- Various text encodes with a scrambler which can be parameterized
- Unlimited combination of all preset signals (signal scenario)
- Option to save output as audio (WAV) or complex baseband-signal (WAV, 1Q12 or 1Q16)

SOMO Elements

SOMO provides a great variety of parameter options and functions. The current present description begins with the menu bar where existing functions can be accessed.

Next is a description of the toolbar, a more convenient option due to its quick access features. The toolbar provides frequently used standard functions such as loading or saving.

The Spectrum/Sonagram Display shows graphics of the generated signals in the time range or the spectrum range.

The Generator List is required for display and selection of the generators, the Property sheet is required for configuration.

2. Abstract

Start of SOMO

To start SOMO select <**Programs**><**Procitec**> in the Windows® program group of the start menu and then in the subfolder of the current release the entry SOMO. SOMO can either be started directly from within go2DECODE via the <**Extras**> menu or from the <**Start menu**> of the desktop.

Operation of SOMO

On program start, the screen will show the user interface displayed in Figure 1. The most recently used generator file will be loaded automatically. Initially it is "default.som" which contains two signals. The selected Morse signal has a center frequency of 12,500 Hz.

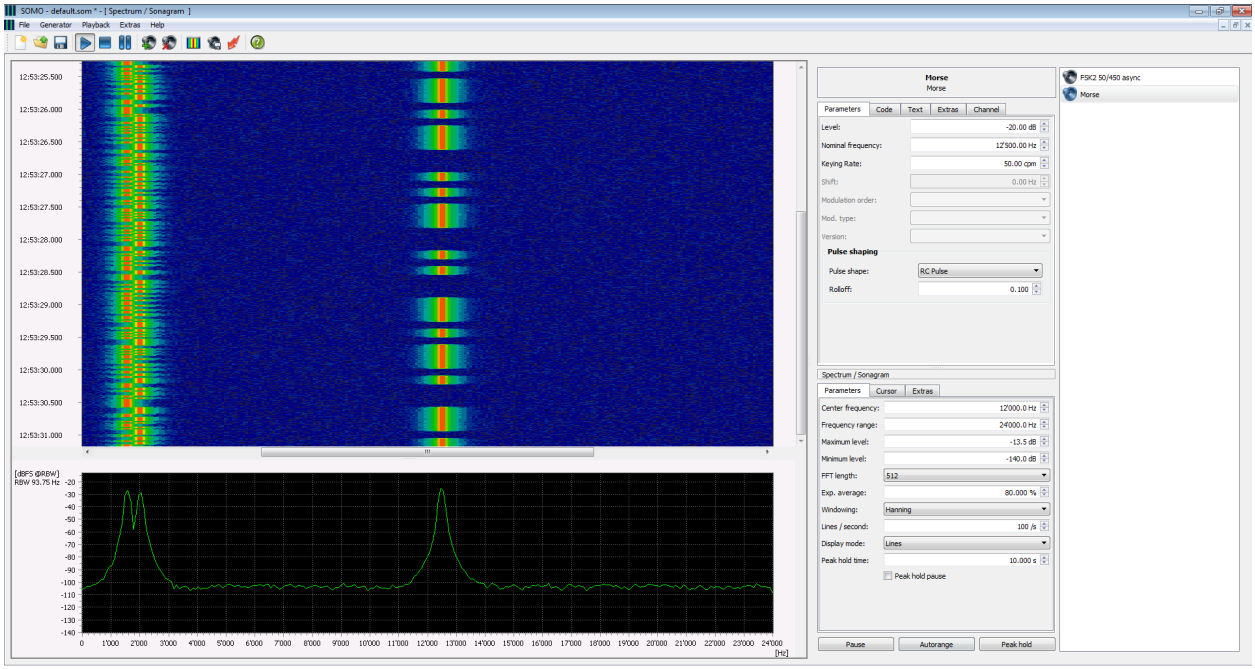


Figure 1: Signal Generation using SOMO

Click the start icon on the Toolbar to start playback. Otherwise, load a generator file using the menu <**File**><**Load generator file...**> or create a new generator file via the menu command <**File**><**New generator file**>.

To do so, select the desired signal type, e.g. Morse, in the <**Generator**> menu. This signal icon will appear in the Generator List. On pressing the Start icon on the toolbar, the spectrum/sonagram display will show graphics of the generated spectrum in the time range and the frequency range. Generate and play back one or several signals either individually or in combination.

To activate or deactivate the generator, double click the speaker icon or the speaker off icon .

Highlighted (selected) generators in this list can be edited via the property sheet at the top Figure 1. The spectrum/sonagram parameters can be edited in the display property sheet at the bottom.

SOMO will generate up to 100 signals of different modulation types with specific parameters for each signal. All activated signals are calculated and transmitted, or stopped and paused, using the icons on the Toolbar or the Menu Bar.

Once the generator file is complete, save the file via the menu command <**File**><**Save Generator File...**>. The <**Save As**> dialog box is displayed. The default directory for example generator files "*.som" is the folder " examples \somo" in the go2DECODE program directory.

User Interface SOMO

The output can be realized via external interfaces, or can be used for test purposes by feeding it back into in go2DECODE.

3. Control of SOMO

3.1. Menu Bar

SOMO provides a great variety of parameterizing options and functions. The present description starts with the Menu Bar where all existing functions are accessed. The menu bar is display in Figure 2.

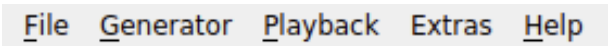


Figure 2: Menu Bar

3.1.1. File Menu

When selecting <**File**> the list in Figure 3 will be displayed.

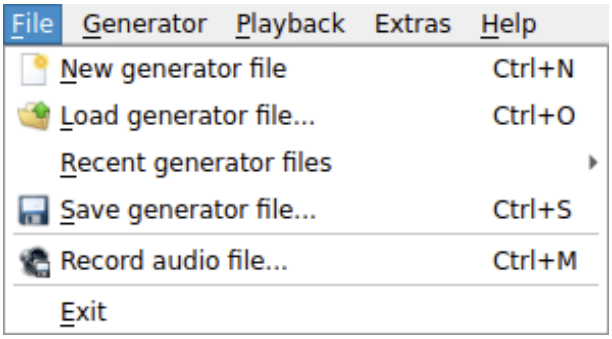


Figure 3: Menu File

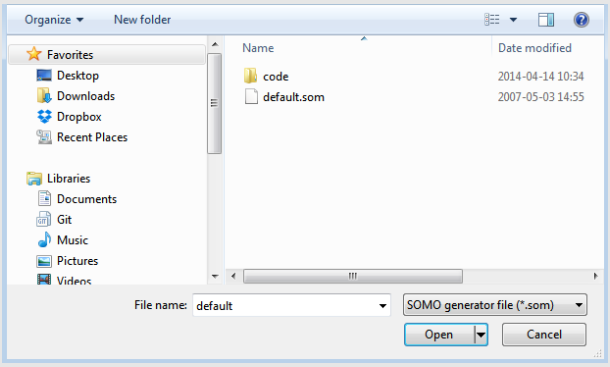
Menu Item	Function	Description
File	New generator file	Create a new, blank generator list. In general, the file type of the generator files is "*.som". New generators are added to the list by selecting a signal type on the Menu Generator
	Load generator file...	Load existing lists by means of this function. When activated, the box in Figure 4 will be displayed:  *Figure 4: Load generator file* It serves to select the directory and the generator list "*.som" file to be loaded.
	Save generator file...	Save the created generator list. A directory and a file name are suggested, either of which can be changed or edited, respectively.
	Record audio file...	Record and save generated signals as "*.wav" files. See chapter Record Audio File..
	Recent generator files	This menu contains a list of up to 9 recently used generator files in reverse chronological order. Activating submenu item on the file list opens the selected file.
	Exit	Exit the program

Table 1: File Menu Functions

3.1.2. Menu Generator

If <**Generator**> is selected, the list in Figure 5 will be displayed.

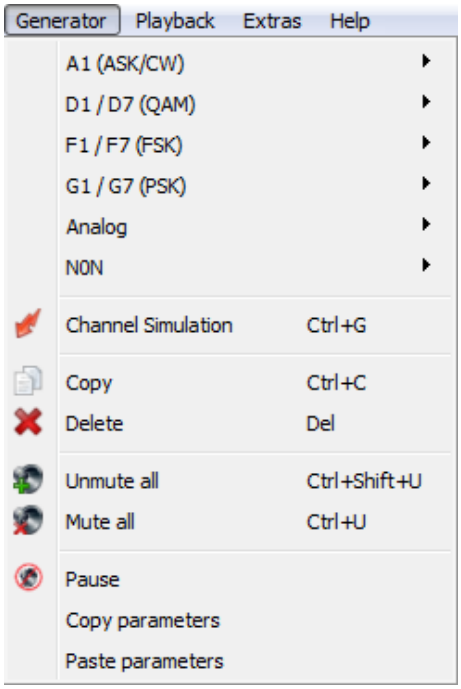


Figure 5: Menu Generator

Menu Item	Function	Description
Generator	A1 (ASK/CW) D1/D7 (QAM) F1/F7 (FSK) G1/G7 (PSK) Analog N0N	Allows selection of a signal type for which to generate a signal. E.g. <**Generator**><**A1 (ASK/CW)**><**Morse**> will generate a Morse signal. For all possible types of signals, see Table 8 in section Toolbar.
	Channel Simulation	Opens a dialog that allows to add white noise to the signals and to simulate a multipath propagation channel. See Channel Tab in Property Sheet.
	Copy	Copy the selected generator
	Delete	Remove the selected generator from the list
	Unmute all	Unmute (activate) all generators
	Mute all	Mute (pause) all generators
	Pause/Activate	This toggle switch serves to pause or activate the selected generator
	Copy parameters	Copy the parameters of the selected generator.
	Paste parameters	Paste the previously copied parameters into the selected generator

Table 2: Generator Menu Functions

3.1.3. Menu Playback

Figure 6 shows the menu which will be shown, when selecting <**Playback**>.

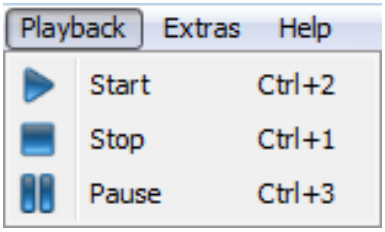


Figure 6: Menu Playback

Menu Item	Function	Description
Playback	Start	Play all activated signals from the generator list
	Stop	Stop playback
	Pause	Halt or restart playback

Table 3: Playback Menu Functions

3.1.4. Menu Extras

Selecting <**Extras**> open the menu displayed in Figure 7.

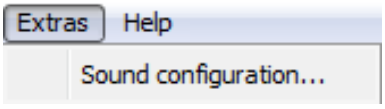


Figure 7: Menu Extras

Menu Item	Function	Description
Extras	Sound Configuration...	If your system features various sound cards (e.g. with different numbers of channels), use this item to select and configure the existing sound output devices.

Table 4: Extras Menu Functions

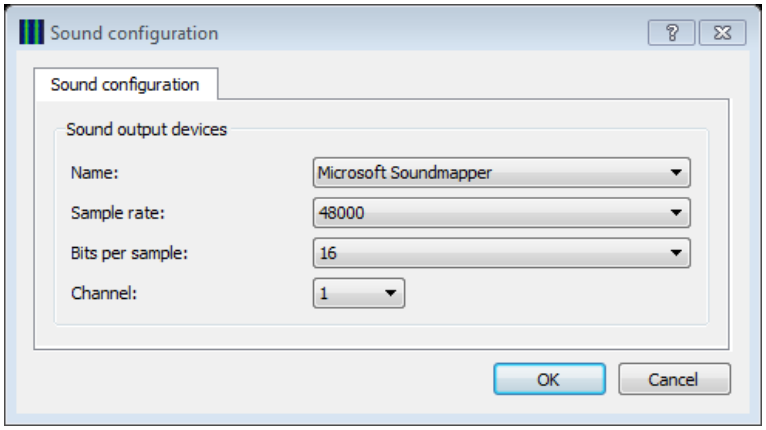


Figure 8: Menu extras sound configuration

In the dialog box displayed, select the desired sound device, enter the values for sample rate and bits per sample, and edit the number of channels.

3.1.5. Help Menu

When selecting <**Help**> the menu in Figure 9 will be shown.

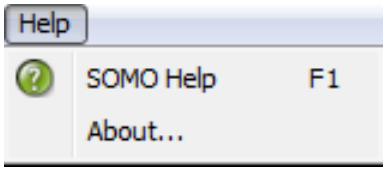


Figure 9: Menu Help

Menu Item	Function	Description
Help	SOMO Help	Open online Instruction Manual
	About...	Display information about SOMO

Table 5: Help Menu Functions

3.2. Toolbar

The toolbar displayed in Figure 10 features the following functions.

Figure 10: Toolbar

3.2.1. Functions

The toolbar displayed features the following functions:

Icon	Function
	New generator file
	Load generator file...
	Save generator file...
	Start
	Stop
	Pause
	Unmute all
	Mute all
	Sonagram and spectrum display
	Record audio file...
	Channel Simulation
	Online help

Table 6: Icons

The functions are identical with the functions of the menu items described in the paragraph Menu Bar.

The toolbar can be moved as desired by clicking the toolbar handle  ; the mouse pointer will then assume the shape  . Keep the mouse button pressed to move the bar.

3.2.2. Record Audio File...

On selection of the menu item <**Record audio file...**> the dialog box in Figure 11 will be displayed.

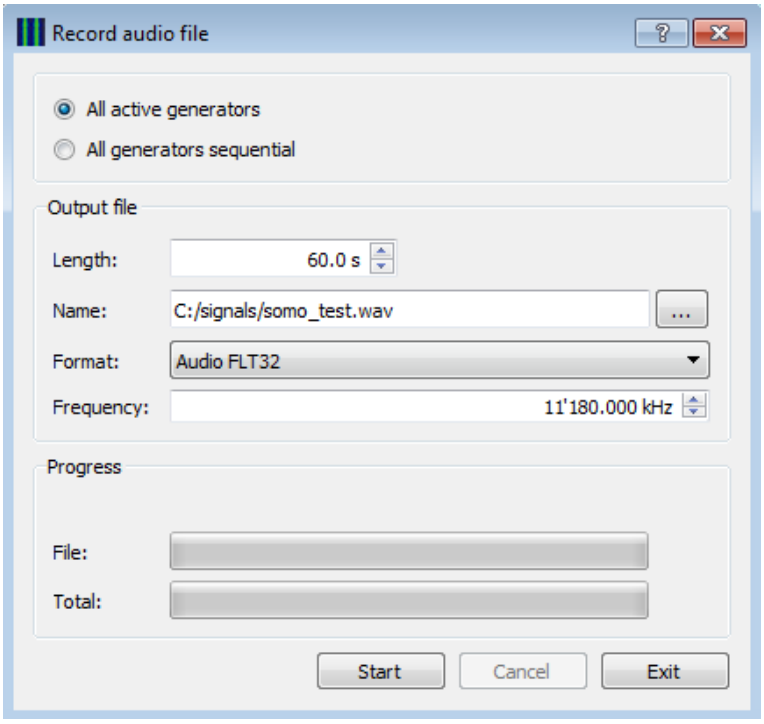


Figure 11: Record Audio File Dialog

Use this dialog to generate signals and save them in an audio file "*.wav". The spin box <**Length**> serves to enter the length of the signal to be recorded (minimum length 1.0 s, maximum length 1200 s). Only activated generators will be saved. If <**All generators sequential**> is enabled then the generators will not run parallel but a single file will be created for every generator.

The directory and the file name are defined in the box *Output file*. When the dialog opens, the previous output file name is displayed. Change this name to prevent this file from being overwritten. The progress of the recording process is displayed in the box *Progress*.

Audio-signals can be stored in a variety of formats, basic audio as well as complex baseband data. The data-format can be defined with the combo box <**Format**> in the box *Output file*. This is shown in Figure 12. It is also possible to define the format in <**Files of type**> within the selection dialog.

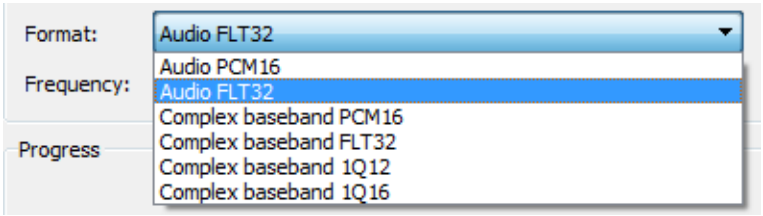


Figure 12: Audio Data-Format Selection

Data Format	Description
Audio PCM16 (*.wav)	The generated signal is stored without modification – as in-phase wave file in 16 Bit Integer format.
Audio FLT32 (*.wav)	The generated signal is stored without modification – as in-phase wave file in 32 Bit Float format.

Data Format	Description
Complex baseband PCM16 (*.wav)	The signal is converted to complex baseband and will be saved in 16 Bit integer format. The saved file is "stereo" with I/Q values in Left/Right channel. All go2DECODE applications will automatically recognize this format as complex baseband.
Complex baseband FLT32 (*.wav)	The signal is converted to complex baseband and will be saved in 32 Bit float format. The saved file is "stereo" with I/Q values in Left/Right channel. All go2DECODE applications will automatically recognize this format as complex baseband.
Complex baseband 1Q12 (*.q12)	The converted baseband signal is stored as 12 bit fixed-point number in little-endian Q1.10 format per sample without any file header. One I/Q pair occupies 24 bit – 3 bytes. With merely 12 bit the dynamic range is limited. The user has to set the modulator levels carefully to avoid over- and underflow in the saved file.
Complex baseband 1Q16 (*.q16)	The converted baseband signal is stored as 16 bit fixed-point number in little-endian Q1.14 format per sample without any header. One I/Q pair occupies 32 Bit – 4 bytes.

Table 7: Audio Recording Data Formats

When converting to complex baseband, the frequency 12.5 kHz of the generated signal is mixed to zero Hz and filtered, when using 48 kHz sound samplerate. For other samplerates, the frequency 1/4 of sound samplerate is mixed to zero Hz. This frequency should be considered as SOMO's band center. After conversion 86 % of the Nyquist bandwidth is usable.

You can use the field <**Frequency**> to define the (virtual) sender frequency for the file. When e.g. you load the file into DANA or the SonagramViewer this value will then be shown instead of SOMO's band center frequency.

Use the <**Start**> button to start the recording, the <**Cancel**> button to abort the recording, and the <**Exit**> button to close the dialog window.

3.2.3. Signal Types

The following signal types can be generated:

Signal Typ	Modulation
A1 (ASK/CW)	ASKn Morse
D1 / D7 (QAM)	QAMn ASKnPSKm
F1 / F7 (FSK)	NCPFSKn CPFSKn (G)MSK F7B/F7W TFM 3 TFM 5 DTFM

Signal Typ	Modulation
G1 / G7 (PSK)	PSKn A/B OFDM OQPSK
Analog	A3E A3E SC J3E LSB J3E USB F3E
N0N	Sine Rectangle Sawtooth Triangle File

Table 8: Signal Types

3.2.4. Channel Simulation

Use this function to simulate a propagation channel. When <**Channel Simulation**> is selected, the dialog in Figure 13 will be opened.

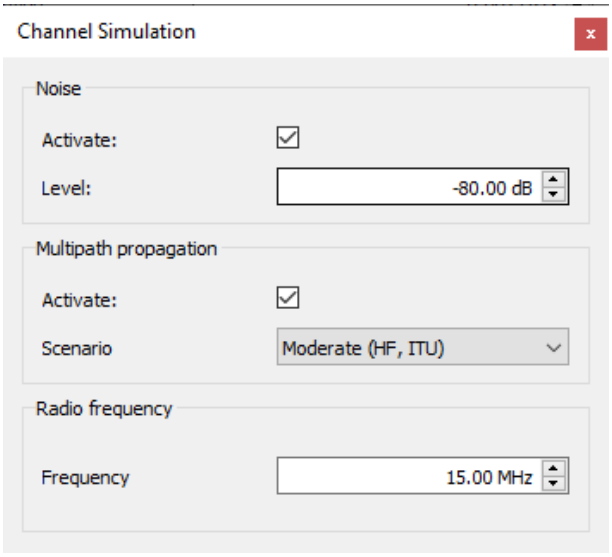


Figure 13: Channel Simulation

Noise

To superimpose the signals with white noise check <**Activate**>. The noise setting defined in this dialog is available regardless of the generators. The <**Level**> can be set within a range from -100.00 to 0.00 dB. The energy value stated applies to the energy of the total noise signal in the band and is not identical with the SNR of the signal.

Multipath propagation

The multipath propagation simulator supports the Watterson and the enhanced ITS (Institute for Telecommunication Sciences) model. To active the simulator for all generators, check <**Activate**>. With the pa-

rameter <**Scenario**> there is the possibility to specify a certain scenario to control the intensity of the disturbance. The settings specified in this dialog override the individual settings of each generator. You find more information about the channel simulator in Channel Tab in section Property Sheet.

Radio frequency

Here you can set the absolute transmitter frequency of the signal. This value is only a meta information and not visible in the spectrum/sonogram. It is used in other applications that receive the network stream provided by SOMO.

3.3. Spectrum/Sonagram Display

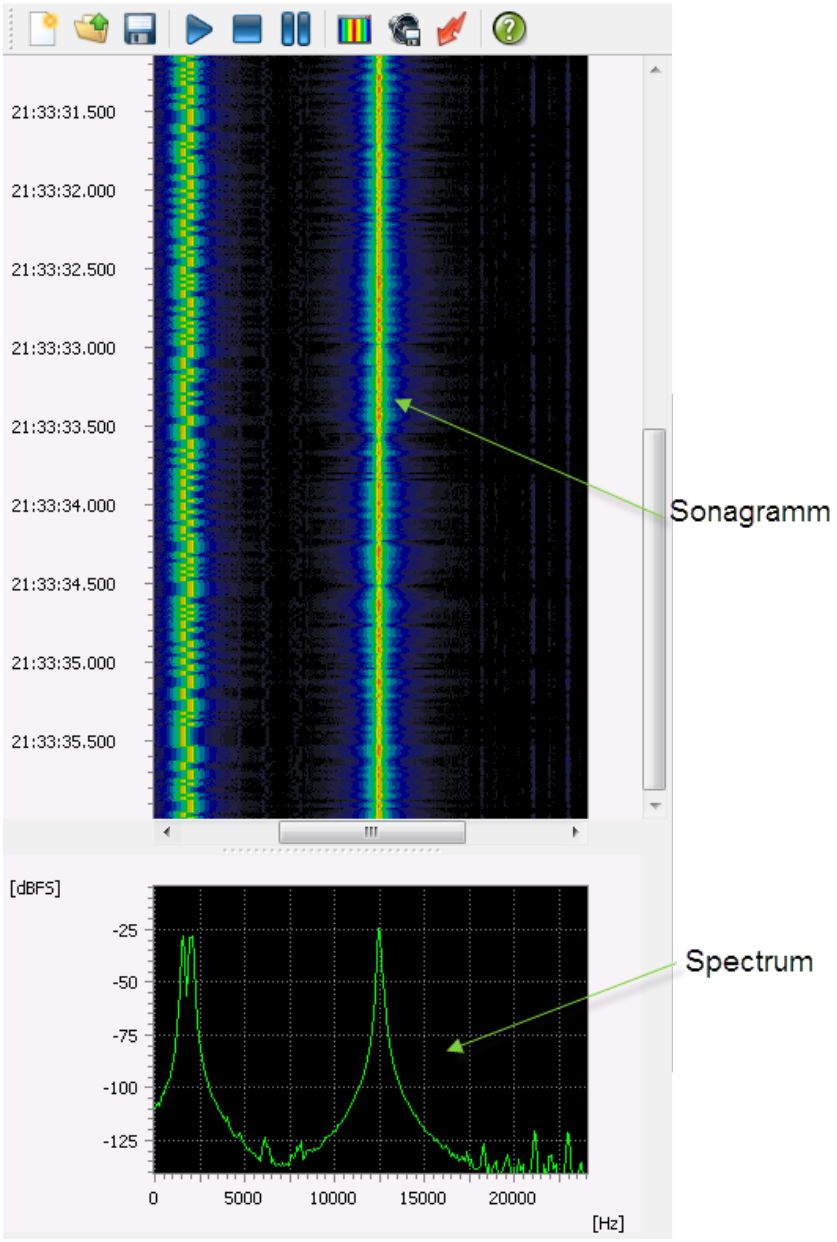


Figure 14: Spectrum/Sonagram Display in SOMO

The spectrum/sonagram display is activated via the Menu Bar or the Toolbar Toolbar and serves to display and verify the signals calculated by the generators. It is displayed in Figure 14. The display consists of two sections: The upper section displays the sonagram while the lower one depicts the spectrum of the signal. The displays are freely resizable using a splitter.

New data will not be depicted in the display until the output has been activated (mode <**Start**> and generator activated). Parameter modifications will have an immediate effect on the signal.

The current UTC time in hours, minutes, seconds and milliseconds is displayed to the left of the sonagram. The spectrum is indicated in dBFS above the frequency axis (in Hz). The display features a popup menu (right click) for convenient cursor and zoom operations, displayed in Figure 15 and Table 14.

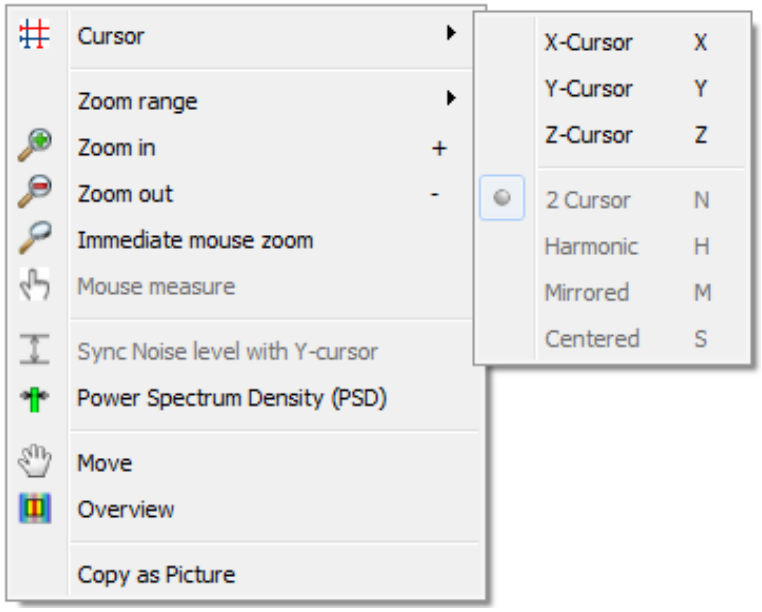
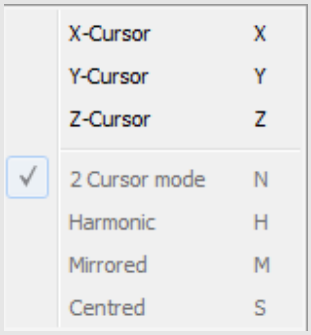
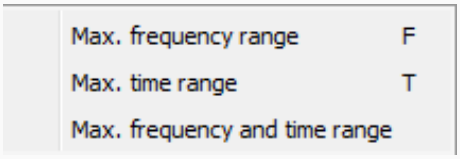


Figure 15: Spectrum/Sonagram Popup Menu

Parameter	Function
Cursor	Activate and deactivate X-, Y-, Z- and Harmonic cursors:  *Figure 16: Cursor selection*
Zoom Range	 *Figure 17: Maximize zoom range* 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.
Zoom in	Enlarged view of the section delimited by the cursors. Repeat this process until the spectrum area displayed is satisfactory.
Zoom out	Reduced view of the section delimited by the cursors. Repeat this process until the spectrum area displayed is satisfactory.

Parameter	Function
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.
Sync Noise level with Y-cursor	The Y-cursors are displayed at the currently estimated values for power and noise (red: power, green: noise). Modification of the X-cursors leads to a recalculation of the measured values and the Y-cursors 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. It can only be selected when the sonagram is paused.
Power Spectrum Density (PSD)	Switches between power spectrum and power spectrum density (PSD).
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.
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 9: Spectrum/Sonagram Popup Menu Parameters

The following keyboard shortcuts are available in the SOMO 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
<**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

Parameter	Function

Table 10: 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 11: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Zoom functions

Parameter	Function
	Most Cursor shortcuts are toggle functions
<**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: • 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
<**I**>	Activate and deactivate mirrored cursor mode: • 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

Parameter	Function
<**S**>	Activate and deactivate centered cursor mode: • 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 12: 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 13: Spectrum/Sonagram Display Control, Keyboard Shortcuts: Minimum/Maximum

3.4. Generator List

The generator list, displayed in Figure 18, shows all generators selected. The generator list provides the option to activate and deactivate the generators and to edit the generator names.

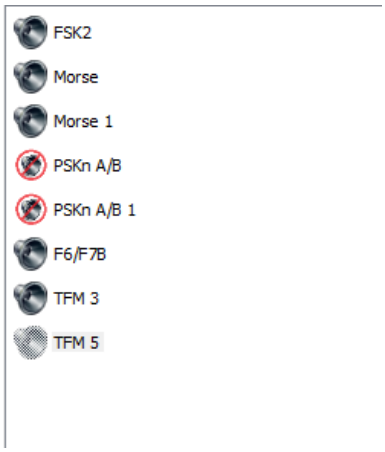


Figure 18: Generator List

To deactivate the generator, i.e. switching it to mute, double click the speaker icon  . To reactivate, double click the disabled speaker icon  .

All activated generators are created during playback (Start ). All generators can be activated or deactivated as desired during playback.

To change the name of a generator, select the generator in question. The name can be edited as desired by another click on the name, or by pressing the function key <**F2**>.

Selected generators are deleted via the menu <**Generator**><**Delete**> or using the shortcut <**Del**>, or its parameters can be set in the property sheet.

Additionally, the generator list features two popup menus with commands from the Menu Bar. Right-click the generator opens the left menu in Figure 19.

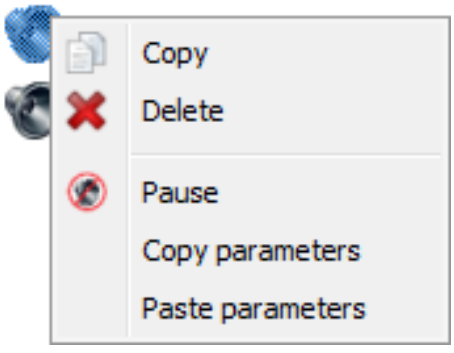


Figure 19: Popup Menu Generator

Right-click within the generator list pane opens the menu shown in Figure 20.

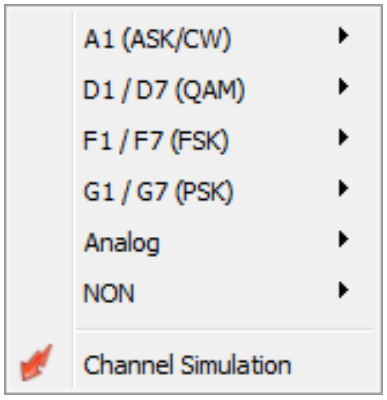


Figure 20: Popup Menu Generator list

3.5. Property Sheet

A very helpful feature to enter numerical values is the adjustability of every digit before and after the decimal point. Place the cursor after the digit to be changed and increase or reduce its value using the scroll wheel of your mouse, the up/down controls, or the arrow keys on the keyboard.

Note: The popup menu (right mouse button) in all spin boxes provides editor functions and display unit selection.

3.5.1. Parameters Tab

In the <**Parameters**> tab there is a difference between digital and analog generators. The parameters for digital generators are display in Figure 21. Figure 22 displays the parameters for analog generators.

Digital Generators

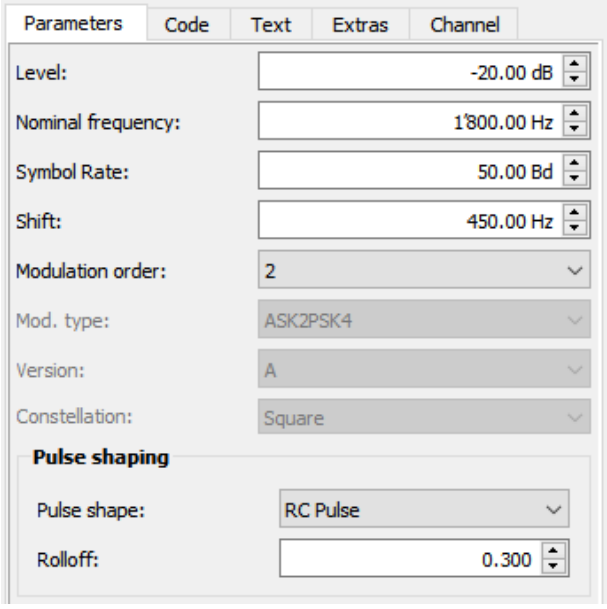


Figure 21: Parameters Tab (digital generators)

Parameter	Description and Input Options
<**Level**>	Output level of a signal in the range from -100 to 0 dB. 0 dB equals the maximum gain of the sound card. The total level of the output can be changed using the mixer (level setting of the operating system)
<**Nominal frequency**>	Center frequency of the signal. In case of a multichannel generator this represents the frequency of the first channel.
<**Symbol Rate**>	Symbol rate of the signal in the range from 0 – 19,200 Bd., or Keying rate in cpm (= characters per minute) with Morse signals
<**Shift**>	Only with FSK signals. Shift (distance between adjacent frequencies/tones) of the signal.
<**Modulation order**>	Modulation order of a symbol as a power of 2. Admissible values: 2, 4, 8, 16, 32, 64, 128, 256
<**Mod. Type**>	Different modulation variants of ASKnPSKm: ASK2PSK4 ASK2PSK8 ASK4PSK8 ASK4PSK16 ASK2PSK2
<**Version**>	PSK Version A or B. Only with PSKn signals
<**Constellation**>	Predefined known constellations, defining the mapping of the bit stream to the complex symbols (constellation points), which might reflect an absolute, differential or partial differential encoding. Choose *None* to specify your desired modulation order in <**Modulation order**> and symbol coding via the <**Code**> tab. Only available for QAM signals.
Pulse shaping	
<**Pulse shape**>	Pulse shape of the base band symbol: RC Puls , RC Spectrum, RRC Spectrum, Gaussian Puls, Chirp
<**Rolloff**>	Only available for pulse shapes *RC Puls, RC Spectrum* und *RRC Spectrum*. The roll-off changes the spectrum of the signal. The roll-off value is between 0.000 and 1.000.
BT	Only available for pulse shape Gaussian Pulse. Product of bandwidth B and symbol duration *T*. The value is between 0.100 and 1.000.
Shift	Only available for pulse shape *Chirp*. *Shift* describes the length of the chirp in frequency range. The end frequency of the chirp is *Nominal Frequency Shift*. If the value of *Shift* is positive, the result is an up-chirp. If it is negative, the chirp becomes a down-chirp.
Windowing	Only available for pulse shape *Chirp*. With *Windowing* it is possible to multiply the chirp with one of these window functions: *None, Tukey, Hanning* or *Blackman*.
Tukey parameter	Only available for pulse shape *Chirp* and Window *Tukey*. This parameter describes the ratio of Hanning section length to the entire window length. The value is between 0.00 and 1.00. If the value is 0.00, the window becomes a rectangle. If the value is 1.00, it becomes a Hanning window.

Table 14: Digital Generator Parameters

Analog Generators

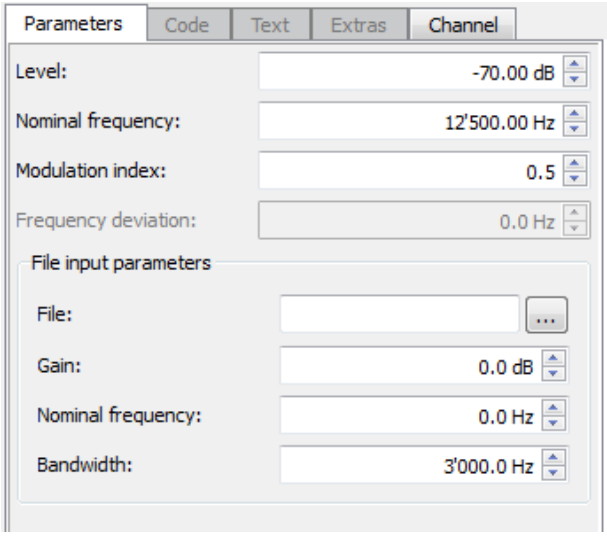


Figure 22: Parameters Tab (analog generators)

Parameter	Description and Input Options
<**Level**>	Output level of a signal in the range from -100 to 0 dB. 0 dB equals the maximum gain of the sound card. The total level of the output can be changed using the mixer (level setting of the operating system).
<**Nominal frequency**>	Center frequency of the signal.
<**Modulation index**>	Modulation index for AM modulation in the range of 0.1 through 2.0
<**Frequency deviation**>	Frequency deviation for FM modulation; range 1.0 up to value set in box Nominal Frequency
File input parameters	
<**File**>	Select file to be modulated or played back (WAV file)
<**Gain**>	Amplify the signal in the file selected in a range of 0 – 100 dB
<**Nominal Frequency**> / <**Bandwidth**>	These two parameters determine which frequency range of the selected file is to be used. After selecting the file, these parameters are first automatically set so that the entire frequency range of the file is selected. The <**Nominal Frequency**> parameter defines the lower frequency limit and the <**Bandwidth**> parameter the desired bandwidth. Both values are limited by the sampling rate of the input file. In case of a inphase input file the "Nominal Frequency" can be set between 0 and half of the sampling rate of the selected file. With a complex input file, the <**Nominal frequency**> parameter is limited downwards to the negative half sampling rate.

Table 15: Analog Generator Parameters

3.5.2. Code Tab

The <**Code**> tab, shown in Figure 23, displays all encoding settings. Every generator has its own text generator and modulates its encoding individually.

Depending on the currently selected generator, the <**Code**> tab is enabled or disabled. For all generators of type *analog* and *N0N* as well as the *Morse* generator the coding parameters are not available.

The order of the elements from top to bottom approximately follows the order in which their effect takes place in the processing chain. For example, <**Bit order (alphabet)**> appears before <**Startbit**> and <**Stopbit**>, because it doesn't affect the position of the start- and stopbit.

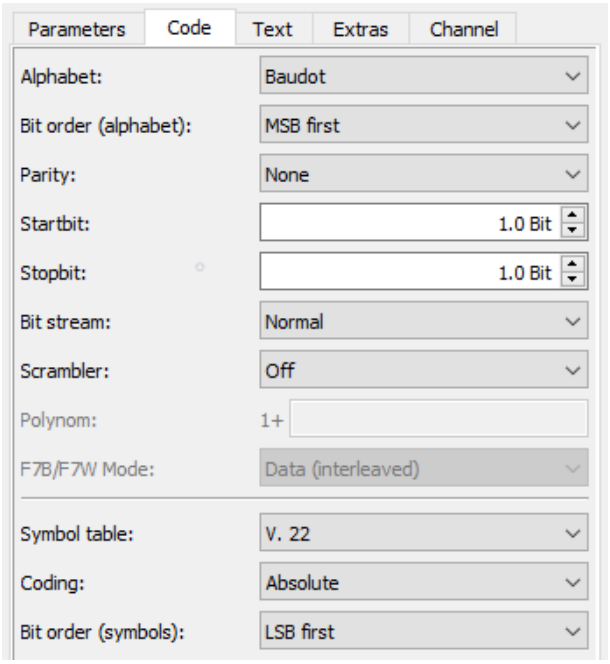


Figure 23: Code Tab

The following parameter setting options are available:

Parameter	Description and Input Options
<**Alphabet**>	Choose between the following alphabets, i.e. encoding types: Bit (I.e. no alphabet; input "0"/"1" or "x"/"-") ASCII 7 bit ASCII 8 bit Baudot HC ARQ ITA 2
<**Bit order (alphabet)**>	Order of the alphabet data bits (not available for alphabet *Bit*): LSB first MSB first
<**Parity**>	Selection of parity test, inserting of a parity bit, if required (not available for alphabet *Bit*: None Even Odd
<**Startbit**>	Insert start bit(s) into the bit stream: 0.0 to 10.0 bits (not available for alphabet *Bit*)
<**Stopbit**>	Insert stop bit(s) into the bit stream: 0.0 to 10.0 bits (not available for alphabet *Bit*)
<**Bit stream**>	Choose between inversion of the bit stream or no inversion
<**Scrambler**>	Activation of scrambler: Off V. 27 511er Test loop V. 22 V. 17,29,32,33 Polynomial input
<**Polynom**>	If the scrambler is in Input mode, any desired polynomial with a maximum length of n=128 can be entered: $x^{-k1} + ... + x^{-kn}$ The input of the exponents ki, separated by the character "+", will also be sufficient: Example: $x^{-5} + x^{-8}$ also can be obtained by the input of "5+8"
<**F7B/F7W Mode**>	Mode of the two channels with F7B/F7W: Data/Data Data/Morse Morse/Data
<**Symbol table**>	Various symbol tables: V. 17 Trellis V. 22 V. 26 V. 27 V. 29 V. 32 V. 32 Trellis V. 32bis Trellis V. 33 Trellis Gray
<**Coding**>	Choose between absolute and differential encoding
<**Bit order (symbols)**>	Order of the bits within each symbol: LSB first MSB first

Table 16: Code Tab Parameters

3.5.3. Text Tab

It depends on the generator type whether or not the parameters of the coding can be edited (for example with Figure 24 , allows for the definition of a text to be sent via the signal, unless any of the generators *Sine, Rectangle, Triangle, Saw tooth* or an *analog generator*) has been selected. If the code *Bit* has been chosen, the input should consist of "0" and "1", or of "x" and "-". Other characters will be ignored with this option.

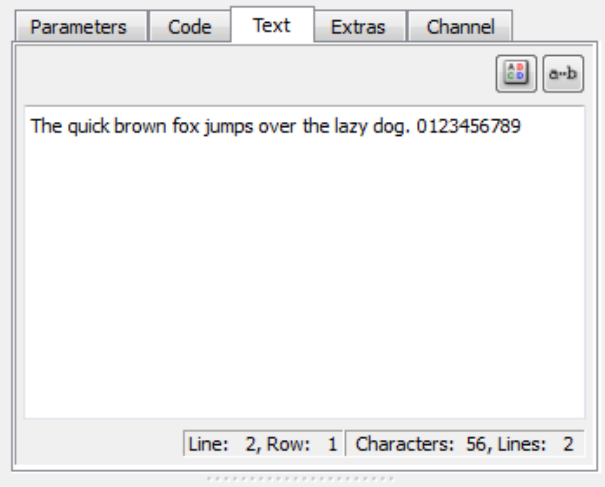


Figure 24: Text Tab

The <**Text**> tab resembles a text editor, i.e. various actions can be carried out using shortcuts. For example, the complete text can be highlighted using <**Select All**> in the popup menu and can then be deleted using the key <**Del**>.

To reinstall the default text, click the icon and acknowledge the alert message by pressing <**Yes**>.

The toggle button a-b serves to show/hide all nonprinting characters in the text. The panes at the bottom indicate the current cursor position (line, row) and the size of the text with number of characters and lines.

3.5.4. Extras Tab

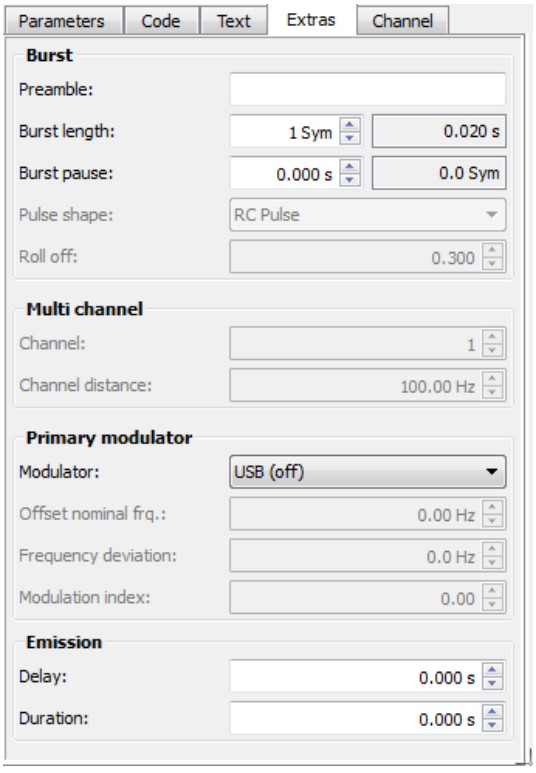


Figure 25: Extras Tab

The <**Extras**> tab is displayed in Figure 25 and allows the setting of several or all parameters, depending on the signal type:

Group Box	Parameter	Description
Burst	<**Preamble**>	Enter a bit combination at the beginning of a burst or at the beginning of the signal if burst mode is off. Use the following format: 01001...
	<**Burst length**>	Definition of the length of a burst (in symbols): 1 to 100,000 sym. The adjacent pane shows the equivalent in seconds. With multi-channel modems, please bear in mind that the number of symbols entered to determine the burst length will refer to all channels, i.e. with a number of channels of 10 and a desired burst length of 3 symbols (in time), enter a burst length of 10 x 3 = 30.
	<**Burst pause**>	Definition of the pause time between two 2 bursts (0 means burst mode Off): 0.000 to 3600.000 sec. The adjacent pane shows the equivalent in symbols.
	<**Pulse shape**>	Pulse shape of the burst with CPFSKn, (G)MPK, TFM signals: RC Pulse RC Spectrum RRC Spectrum
	<**Roll off**>	Roll-off for the pulse shape: 0.000 to 1.000
Multi-Channel	<**Channel**>	Number of channels: 1 to 100 (Maximum is limited by the totally available bandwidth)
	<**Channel distance**>	Distance between the individual channels in multi-channel mode.
Primary Modulator	<**Modulator**>	Choose the modulator desired: USB (off), LSB, AM, or FM
	<**Offset nominal frq.**>	Frequency offset of the primarily modulated signal relative to the parameter in box Nominal Frequency
	<**Frequency deviation**>	Frequency deviation for FM modulation; range 1.0 up to value set in the box Nominal Frequency
	<**Modulation index**>	Modulation index for AM modulation in the range of 0.1 through 2.0
Emission	<**Delay**>	Signal starts only after the parametrized time
	<**Duration**>	Maximum duration of emission (0 = infinite)

Table 17: Extras Tab Parameters

Selection of parameters depends on generator type.

Note: Analog generators, as well as generators of the types N0N or Morse, do not have any Extras parameters.

3.5.5. Channel Tab

The <**Channel**> tab is shown in Figure 26. This tab allows the simulation of a multipath propagation channel and periodic frequency shifts. The simulator supports the Watterson and the enhanced ITS (Institute for Telecommunication Sciences) model. Every generator has its own channel simulator with the settings set here. The individual generator settings are overridden with the setting of the global channel simulator from the toolbar, if it is activated there. The periodic frequency shifting is used for the simulation of a Doppler channel with moving transmitters and receivers or in general for simulation or tests of instabilities of the center frequency. These settings also apply per generator.

3.5.5.1. Multipath propagation

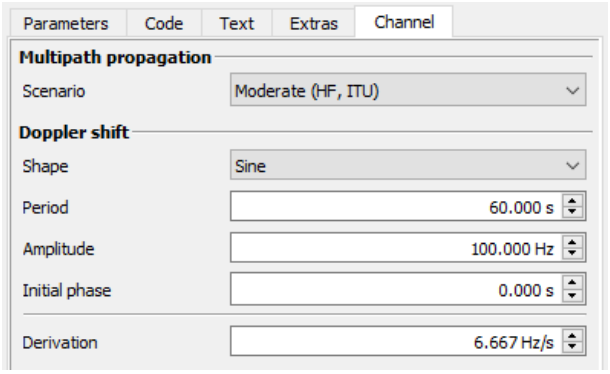


Figure 26: Channel Tab

Following table shows which scenarios are provided for the channel simulation. The scenarios marked with *ITU* are parameters settings, which are provided in the ITU Recommendation *ITU-R F. 1487* and *ITU-R F.520.2* . When selecting these scenarios, the Watterson model is used. The Watterson model is valid for bandwidths up to 12 kHz. When selecting scenarios marked with *ITS markiert*, the ITS Model is used. The ITS Model is valid for bandwidths up to 1 MHz The ITS scenarios use the same settings as the Watterson scenarios, but with some additional parameters.

Scenario	Description
None	No channel simulation
Flat1 (HF, ITU)	Propagation paths: 1 Doppler spread: 0,2 Hz
Flat2 (HF, ITU)	Propagation paths: 1 Doppler spread: 1,0 Hz
Good (HF, ITU)	Propagation paths: 2 Relative delay: 0,5 ms Doppler spread: 0,1 Hz
Moderate (HF, ITU)	Propagation paths: 2 Relative delay: 1 ms Doppler spread: 0 Hz
Poor (HF, ITU)	Propagation paths: 2 Relative delay: 2 ms Doppler spread: 1 Hz
Flutter (HF, ITU)	Propagation paths: 2 Relative delay: 0,5 Hz Doppler spread: 10 Hz

Scenario	Description
Good (HF, ITS)	ITU Parameter + additional Parameters
Moderate (HF, ITS)	ITU Parameter + additional Parameters
Poor (HF, ITS)	ITU Parameter + additional Parameters
Flutter (HF, ITS)	ITU Parameter + additional Parameters

Table 18: Parameters Tab Channel

3.5.5.2. Doppler shift

In Figure 27 the available periodic frequency responses are shown. These can be freely set in period duration, amplitude and initial phase, see Figure 26. The values chosen in the figure are extreme examples for a better visual visibility. The Z markers mark a period, while the X markers mark the maximum frequency deviation of the sine waveform.

- Period: 2 s
- Amplitude: 1.000 Hz
- Initial phase: 0 s

The amplitude indicates the maximum frequency deviation from the set center frequency. The difference between the largest and smallest frequency deviation is therefore twice the amplitude. In addition, the derivation of the frequency is specified in Hz/s, see Figure 26. For the triangular waveform, the magnitude of frequency derivation is meant. In the case of the sine wave, the magnitude of the frequency derivation during the zero crossing is meant.

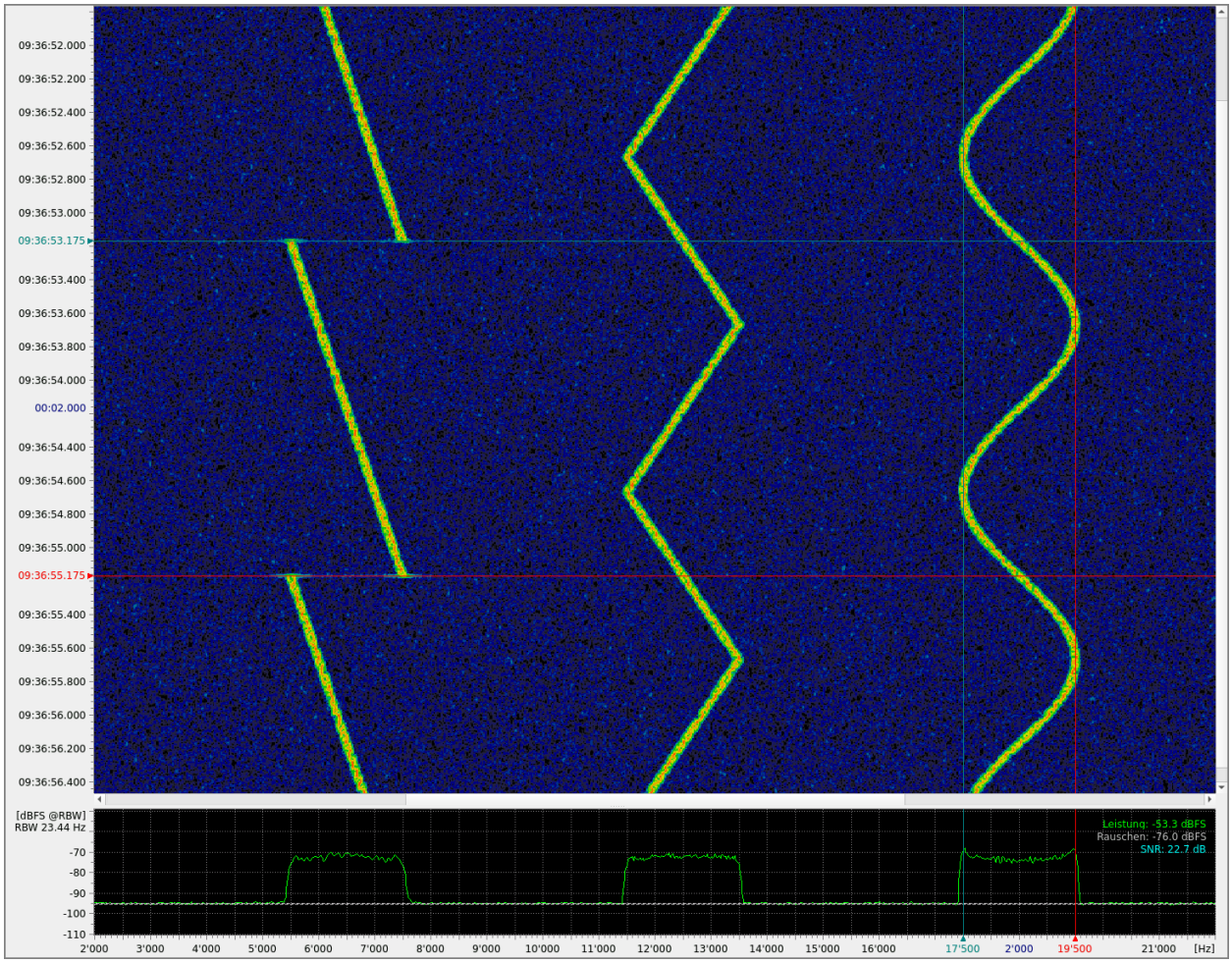


Figure 27: Periodic frequency shift: Linear, Triangle, Sine

In the following table, the shape of the frequency shift is given as a formula with

- P: Period
- T: Time
- A: Amplitude

Shape	Frequency within period in Hz	Frequency derivation in Hz/s
Linear	$A * (2 * \frac{t}{P} - 1)$	$2 * \frac{A}{P}$
Triangle	$A * \begin{cases} 4 * \frac{t}{P}, & 0 \leq \frac{t}{P} \leq \frac{1}{4} \\ 2 - 4 * \frac{t}{P}, & \frac{1}{4} < \frac{t}{P} \leq \frac{3}{4} \\ -4 + 4 * \frac{t}{P}, & \frac{3}{4} < \frac{t}{P} < 1 \end{cases}$	$4 * \frac{A}{P}$

Shape	Frequency within period in Hz	Frequency derivation in Hz/s
Sine	$A * \sin(2\pi * \frac{t}{P})$	$2\pi * \frac{A}{P}$

Table 19: Shape of frequency shift

In order to establish a relation between the frequency shift and the Doppler effect, the following model is assumed: An object, e.g. an airplane with transmitter, flies over the receiver on the ground with constant speed, direction and altitude. The frequency change at the moment of the overflight is then given by

$$\Delta F(t=0) = f * \frac{v^2}{c * h} \tag{3.1}$$

Model	Velocity v	Altitude h	Radio Frequency f	Frequency derivation $\Delta F(t=0)$
Plane 1	$800\frac{km}{h}$	10 km	1 GHz	$16.47\frac{Hz}{s}$
Plane 2	$800\frac{km}{h}$	1 km	1 GHz	$164.72\frac{Hz}{s}$
Satellite (ISS)	$28000\frac{km}{h}$	400 km	10 GHz	$5045\frac{Hz}{s}$

Table 20: Example values

In general, the frequency shift according to the above model can be given by the following equation. The moment of the flyover is at $t = 0$.

$$F(t) = f\sqrt{\frac{c\sqrt{h^2 + t^2v^2} + t * v^2}{c\sqrt{h^2 + t^2v^2} - t * v^2}} \tag{3.2}$$

3.5.6. Edit Parameters of the Spectrum/Sonagram display

To edit the parameters of the spectrum/sonagram display, use the corresponding property sheet. The parameters are distributed on several tabs.

The parameters of the spectrum/sonagram are displayed by activating the <**Parameter**> tab which provides the settings displayed in Figure 28.

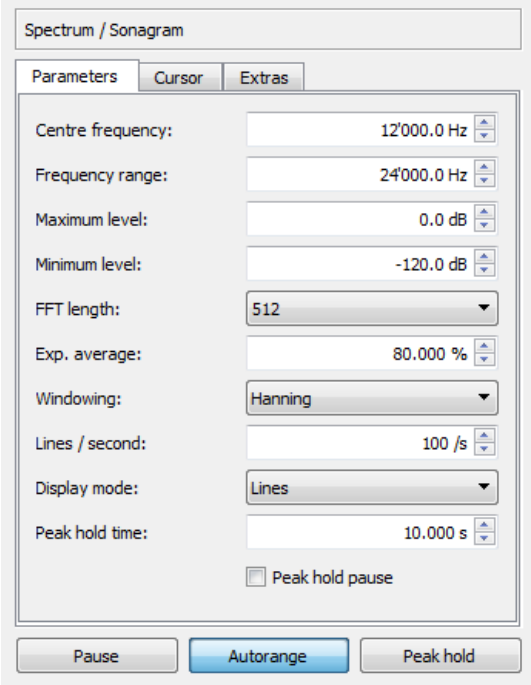


Figure 28: Parameters Tab

Parameter	Function
<**Centre frequency**>	Set the frequency section to view in combination with the frequency range. The center frequency is the center of the section.
<**Frequency range**>	Set the frequency section to view in combination with the center frequency. The frequency range is the range within the section. This setting allows for manual entry of a zoom level. Also, see the parameters <**Zoom in**> and <**Zoom out**> in Table 22 and Figure 30.
<**Maximum level**>	Define the level range in the spectrum display. The maximum level is the upper end of the section.
<**Minimum level**>	Define 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 will be displayed. Increase the FFT length to obtain a higher resolution of the displayed frequency range.
<**Exp. Average**>	The spectrum is displayed as an average of several spectrums. Changing the spectrum will result in a total view of the spectrum. 0 %: No average - 80 %: Low average 80 % - 99 %: High average 100 %: No updating of the spectrum

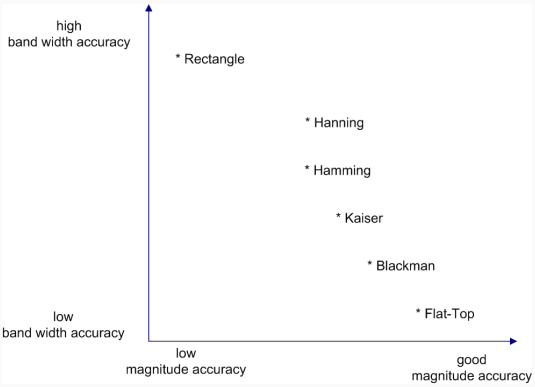
Parameter	Function
<**Windowing**>	The FFT algorithm serves to calculate the spectrum. This algorithm, however, shows inaccuracies in the amplitude (attenuation) as well as in the bandwidth (expansion) of a signal due to the finite signal probe. These inaccuracies can be reduced by means of windowing as shown in Figure 29:  *Figure 29: Windowing*
<**Lines / second**>	This is the number of spectrums that can be calculated and displayed within one second. The parameter defines the time resolution for the sonagram, i.e. also the scroll speed.
<**Display mode**>	In mode Line, the spectrum is displayed as a closed curve. In mode Beam, the single values are displayed as bars.
<**Peak hold time**>	When the time adjusted has elapsed, the peak hold (i.e. red curve in the spectrum) will be reset by setting on the current spectrum. 0 means no reset.
<**Peak hold pause**>	When the time adjusted in Peak Hold Time has elapsed, <**Pause**> is selected and the display is frozen. To re-activate the current display, <**Pause**> has to be selected again.
<**Pause**>	In <**Pause**>, the display is frozen (not the signal processing). Editing the parameters is possible for a more detailed analysis of the current signal range.
<**Autorange**>	Automatic setting of the displayed range in order to view the total amplitude and frequency range. <**Autorange**> analyzes approx. 12 spectral lines. The display is adapted on every change of the range. On pressing <**Autorange**> again, the process will be deactivated (toggle).
<**Peak hold**>	When activating <**Peak hold**>, the maximum energies in the spectrum will be recorded and displayed as a red curve.

Table 21: Parameters Tab Parameters

Cursor Functions of Displays

The cursor parameters are displayed by activating the <**Cursor**> tab. It is shown in Figure 30 . This tab enables to insert cursors into the display which serve to select or clarify specific sections of the display, or measure the signal data. The individual cursor positions are displayed and can be edited.

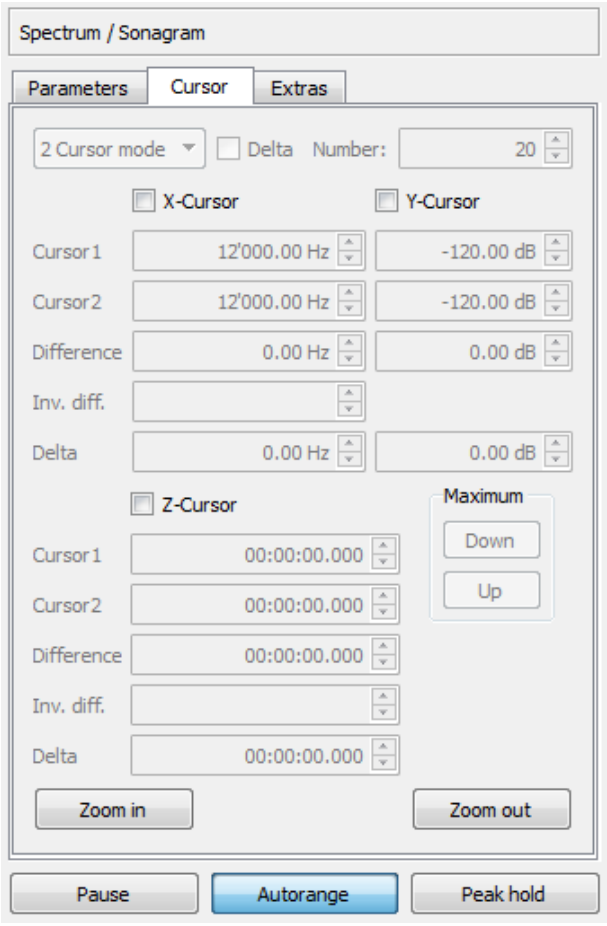


Figure 30: Cursor Tab

Parameter	Function
Drop-down Menu Cursor mode	*2 Cursor mode* independent, moveable cursors will be displayed in the window. *Harmonic* Several cursors are activated at equidistant intervals. In this mode, the first cursor will move all other cursors. The intervals are defined by grabbing and moving the second or any following cursor. The *Harmonic* mode can only be applied in combination with X-cursors, Y-cursors or Z-cursors. It serves to measure repeating intervals. *Mirrored* Several cursors 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 cursors besides cursor 1 will move symmetrically. *Centred* Several cursors are activated at equidistant intervals. In contrast to *Mirrored*, all cursors (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 cursors, if this checkbox is not activated, otherwise the positions of the 2 outermost cursors are tried to keep fixed. This allows a convenient way to have multiple cursors at equidistant intervals in a specific area without the need to adapt the cursors. To cancel the additional cursors, select *2 Cursor mode*.
<**Number**>	Use this spin box to determine the number of cursors to be displayed in *Harmonic* mode.
<**X-Cursor**>	The cursors are activated/deactivated in X-direction. They are used to measure values of time.
<**Y-Cursor**>	The cursors are activated/deactivated in Y-direction and 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 function for direct readout of symbol rate (determination of which is a major purpose of the Z-cursors) according to the formula 1 / [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 cursors 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
<**Inv. Diff.**>	Inverted difference is a function for direct readout of symbol rate (determination of which is a major purpose of the Z-cursors) according to the formula 1 / [value in box Difference]

Parameter	Function
<**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-Cursor1, Y-Cursor1 to the next visible maximum on the spectrum line against X-direction, if cursors are activated.
<**Up**>	Sets X-Cursor1, Y-Cursor1 to the next visible maximum on the spectrum line in X-direction, if cursors are activated.
<**Zoom in**>	With enabled cursors, the button <**Zoom in**> serves to raphically zoom into the area de-limited by the cursors. With disabled cursors, the zoom enlarges the area by factor 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 cursors, 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 cursors, 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. This mode analyzes approx. 12 vectors. 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 dis-played as a red curve.

Table 22: Cursor Tab Parameters

Tab Extras

The <**Extras**> tab features additional options with regard to the display type and is displayed in Figure 31.

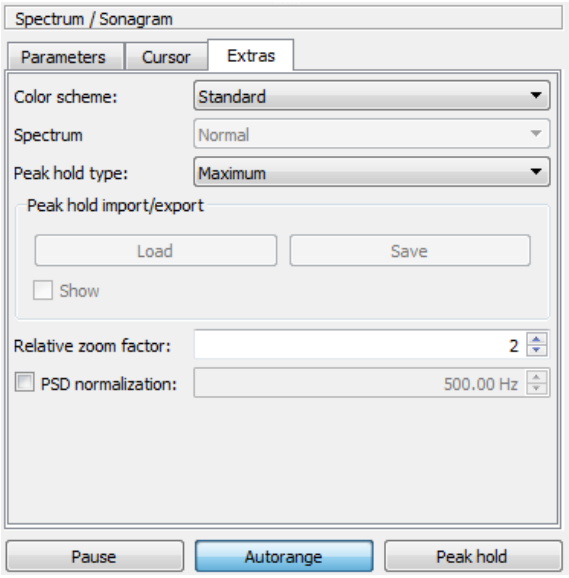


Figure 31: Extras Tab

The list box <**Color scheme**> serves to select the color schemes for the displays:

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

Table 23: Display Color Schemes

Further, the <**Extras**> tab has a drop-down menu <**Spectrum**>, which is inactive unless the Z-cursors are enabled. Specify whether you wish to display:

Spectrum	Description
Normal	The spectrum usually averaged exponentially
At Cursor 1	The spectrum exactly at the position of Cursor 1
Average value Cur. 1/2	The spectrum averaged between the two cursors

Table 24: Display Spectrum

The group box <**Peak-Hold import/export**> permits to save and load peak hold curves for accurate comparison. The two functions are inactive unless the buttons <**Pause**> and <**Peak hold**> are selected.

The curves are stored in "*.csv" format (*Comma Separated Value*), which is editable in Microsoft® Excel or a suitable editor such as e.g. Microsoft® WordPad. When loading a saved curve, it is inserted in the spectrum display as a yellow line.

The checkbox <**Show**> is not active unless a curve has been loaded. Please make sure to display the inserted curve using the original FFT length or an adjacent FFT length.

In the <**Relative Zoom Faktor**> group box, enter the desired relative zoom factor for zooming out and its inverse for zooming in. By default, this spin box is preset to 2.

Switching between power spectrum and power density spectrum (PSD, Power Spectral Density) is done with the <**PSD normalization**> check box.

3.6. Shortcuts

Function	Shortcut
Start online help	<F1>
Rename	<F2>
Show /hide parameters	<F5>
Stop	<Ctrl> + <1>
Start	<Ctrl> + <2>
Pause	<Ctrl> + <3>
Select all	<Ctrl> + <A>
Copy	<Ctrl> + <C>
Delete selected generator	<Del>
Jamming	<Ctrl> + <J>
Load generator file	<Ctrl> + <L>
Record audio file	<Ctrl> + <M>
New generator file	<Ctrl> + <N>
Save generator file	<Ctrl> + <S>
Paste	<Ctrl> + <V>
Record audio file	<Ctrl> + <W>
Cut	<Ctrl> + <X>
Undo	<Ctrl> + <Z>
Unmute all	<Ctrl> + <Shift> + <U>
Mute all	<Ctrl> + <U>
Channel Simulation	<Ctrl> + <G>

Table 25: Shortcuts

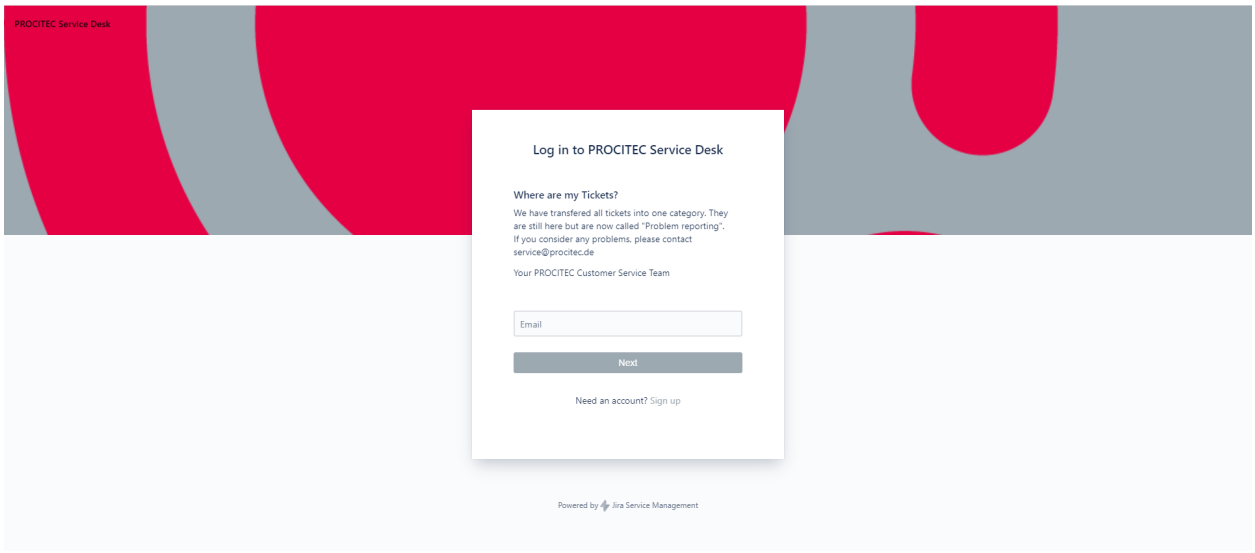
A. Support

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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