Isone Pro / Isone Pro *Surround*

Stereo / 5.1 surround binaural room simulator

User manual v1.0.1
December 2009

Contents

1. Description

Isone Pro is a Virtual Studio Technology (VST) plug in that allows real-time, zero-latency binaural room simulation over headphones. Isone Pro is best used with high-quality (full range) headphones having a flat frequency response.

Isone Pro is available in two separate editions:

- Isone Pro: simulation of a stereo loudspeaker setup at +30/-30 degrees azimuth;
- Isone Pro *Surround*: simulation of a 6-channel setup according to ITU specifications (including subwoofer).

2. Demo limitations

The demo versions of Isone Pro and Isone Pro *Surround* have the following limitations:

- Parameter display disabled, and
- A short noise burst is inserted in the output audio signal every 30 seconds.

The full versions of Isone Pro and Isone Pro *Surround* are available from www.jeroenbreebaart.com which does not have these limitations.

3. Installation

This plug in comes without installation program. The installation can be performed manually by the following two steps:

- Extract the file 'jb_isone_pro.dll' from the corresponding zip file, using an (un)zip program or using the build-in functionality from Microsoft Windows XP or Vista;
- Store the dll file in the directory where your host program stores all VST plugins. This directory depends on the host program. Please refer to the manual of your host program to determine the correct directory.

If you have used the demo version of this plug in (with the word 'demo' in the file name) and would like to install the full version, or if you have earlier beta versions, you are advised to delete all earlier versions of this plug in before installing newer versions.

4. Isone Pro overview

4.1 Headphone-based monitoring

With Isone pro, a virtual listening room can be experienced simply using high-quality headphones. Allowing for full control over loudspeaker cabinet type, loudspeaker distance, and room reverb time, the virtual listening room can be fully customized.

4.2 Head-related transfer functions (HRTFs)

A virtual listening room is typically created by simulating the acoustical transfer from all loudspeakers to both ears. These acoustical transfer properties are often referred to as Head Related Transfer Functions (HRTFs). Such HRTFs can be measured for each individual using specialized equipment. The measured transfer functions can subsequently be used as filters to simulate a virtual sound source over headphones (see this link for more background information).

HRTFs can be decomposed into two aspects:

1. Binaural cues, defined by differences between the left-ear HRTF and the right-ear HRTF. These cues comprise (1) inter-aural time differences (ITDs) resulting from the difference in path length from a source to both ears, and (2) inter-aural level differences (ILDs), resulting from the acoustical shadow effects of the head. The binaural cues predominantly determine the perceived *azimuth* (left-right) of a sound source and hence result from acoustical *cross-talk* between both ear signals.
2. Monaural cues, resulting from reflections in the pinna, shoulder and from the torso of the human body. These reflections result in specific peaks and troughs in the signal spectrum that depend on the *elevation* of the sound source.

When room reflections are present, the pair of transfer functions including the wall reflections for a certain sound source position to both ears is referred to as binaural room transfer function (BRTF). This is depicted in Figure 1.

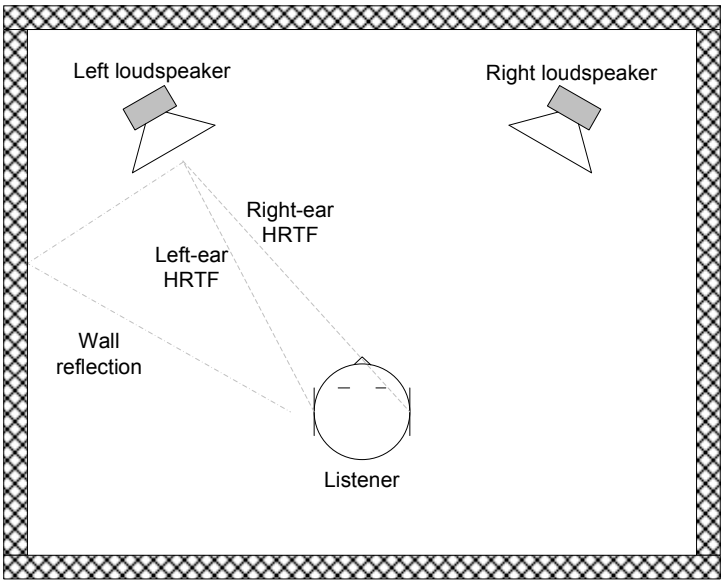


Figure 1 - Listening room with 2 loudspeakers. HRTFs for the left loudspeaker are indicated by dashed lines. A single wall reflection is indicated by the dash-dotted line.

4.3 Parametric HRTF technology

Although the use of HRTFs has been shown to be very effective in numerous scientific publications, it also has well-documented shortcomings. For example, HRTFs vary from person to person as a result of differences in the head size, ear size, ear shape, and so on. Application of the wrong HRTFs results in significantly degraded sound source localization. It is therefore very important to match HRTFs to each individual listener for a convincing and accurate effect.

Isone Pro is the first VST plugin ever that provides such pseudo-personalized HRTFs. It provides means to adjust the HRTFs for each individual listener, by compensating for differences in the anthropometric properties of the head and ears (pinnae).

The head size has the strongest influence on the binaural cues – inter-aural time and level differences. Hence a mismatch in head size often results in a wrong azimuth, but can also result in an ill-defined sound source position, or an unnatural sound percept.

The ear size has the strongest influence on the elevation cues – peaks and throughs in the spectrum induced by reflections in the ear. Hence a mismatch in the ear size often results in a lack of externalization, or sources erroneously perceived from above.

4.4 Loudspeaker simulation

Besides HRTF adjustment, Isone Pro also allows to simulate a variety of virtual loudspeakers. Instead of simulating specific loudspeaker models, the approach taken in Isone Pro is to simulate characteristic, common attributes of loudspeakers instead of accurate simulation of specific models.

4.5 Room acoustic modeling

Simulation of the acoustic environment is essential for a compelling simulation of loudspeaker listening over headphones. Music or other audio content is almost never listened to in an anechoic environment, and those who have experienced audio playback in such anechoic rooms know that this results in a very unpleasant listening experience. Moreover, your audience will listen to the content you work on in the car, in the living room, or any other echoic environment and hence it is crucial that the audio producer or engineer can estimate the effect of a room on the content he or she is working on. Nevertheless, the room simulation module in Isone Pro can be switched on or off if desired.

5. Graphical User Interface (GUI)

The GUIs of Isone Pro and Isone Pro *Surround* are shown in Figure 2. The various GUI elements and their functions are listed in Table I.

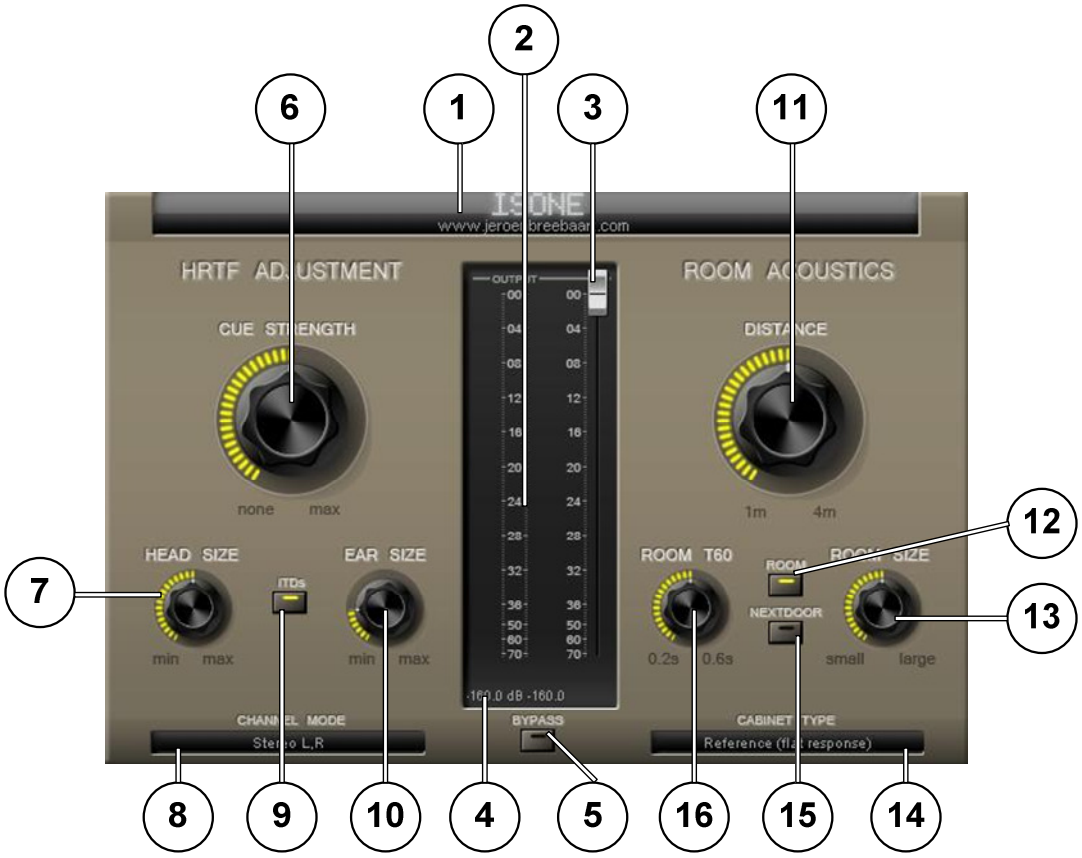


Figure 2 – Graphical User Interface of Isone Pro.

1	Parameter display	Displays parameter value of active GUI element
2	Output VU meter	Displays current output levels and peak level
3	Output trim knob	Changes the output level (in dB)
4	Output peak level display	Displays output peak level in dB during last 10 seconds. Can by reset by clicking on display
5	Bypass switch	Enables or disables internal bypass function of plugin
6	Cue strength knob	Changes the strength (effect size) of the HRTF elevation cues
7	Head size knob	Changes the HRTF head size *(only effective if ITD synthesis is enabled through switch 9)*
8	Channel mode menu	Allows to down-mix or solo the input channels
9	ITD switch	Allows to enable or disable synthesis of interaural time differences (ITDs)
10	Ear size knob	Changes the HRTF ear size *(only effective if cue strength knob 6 is set to non-zero values)*
11	Distance knob	Changes the simulated loudspeaker distance
12	Room switch	Enables or disables room acoustic simulation
13	Room size knob	Changes the simulated room size *(only effective if the room acoustic simulation is enabled through room switch 12)*
14	Cabinet type menu	Select a loudspeaker model
15	Next door switch	Enables or disables simulation of next-door listening
16	Room T60 knob	Allows to change the reverb time of the room simulation *(only effective if the room acoustic simulation is enabled through room switch 12)*

Table 1 – GUI elements and their functions.

6. Setting up and using Isone Pro

6.1 HRTF adjustment

(a) Recommended initial settings

The calibration of the HRTFs to each user's ears can be a somewhat tedious process, but fortunately is required only once if performed correctly. Here are some recommended settings that will work in most cases:

- Relatively small loudspeaker distance (about 1.5 meters)
- Room acoustic simulation enabled;
- Short reverb time (0.2 seconds or so);
- ITD switch enabled;
- Cue strength to relatively large values (90% or higher);
- Loudspeaker simulation disabled (flat response).

A dedicated preset '001 – HRTF calibration' is included to support this process.

(b) Selection of suitable audio material

The next step is to select suitable audio content to use during the adjustment process. It is recommended to use material that (1) you are very familiar with and (2) has a broad frequency spectrum. Suitable material comprises voice recordings, snare drums, etc. Use **mono** content, or stereo content with very limited stereo depth, and **little or no reverb**.

Do **not** use band-limited signals such as sinusoids, or instruments covering a narrow frequency range, and alike – the human hearing system cannot localize such signals accurately.

The best situation for the HRTF calibration is when you sit in front of an actual loudspeaker setup with loudspeakers at the correct positions (-30 and +30 degrees azimuth, 0 degrees elevation).

(c) Ear size adjustment

This is best performed by setting the channel mode to 'Mono L+R' (for Isone Pro) or 'Mono downmix on center' (Isone Pro *Surround*). Listen closely to the test material. Ask yourself the following questions:

- Where does the sound come from?
- Does it come from above, or more from the front?
- Does it sound natural, or do I perceive unnatural timbres or frequency notches?

Rotate the ear size knob until the sound is perceived most natural, and coming most likely from the front. Wrong settings usually result in a sound perceived from above. Some people report that the adjustment process works best with their eyes closed.

(d) Head size adjustment

This works best by setting the channel mode to 'L only' or 'R only'. Listen closely to the test material. Ask yourself the following questions:

- Where does the sound come from?
- Do I hear a well-defined image, or is it spatially blurred or ambiguous?

Rotate the head size knob until the sound position is most defined and natural, and is perceived at 30 degrees azimuth.

(e) Cue strength adjustment

The cue strength knob modifies the strength of the HRTF elevation cues. If this knob is set to 0, no elevation cues will be inserted in the audio and the HRTFs will have a flat frequency response. Higher values will insert more (stronger) elevation cues. Depending on your own preferences, and the audio content, the cue strength can be adjusted as desired.

Note: If the cue strength is set to zero, the ear size setting will not have any effect!

(f) Inter-aural time differences (ITDs)

The ITD switch allows to enable or disable the synthesis of ITDs. Since ITDs occur in real life, the most natural effect will be obtained with ITDs enabled.

However, in some cases one may want to simulate inter-aural crosstalk without inter-aural delay influences, and hence the ITD synthesis can be switched off.

Note: If the ITD synthesis is disabled, the head size setting will not have any effect!

6.2 Room acoustics and channel modes

(a) Channel mode menu

This menu provides means to down-mix or solo the input channels, for example to verify mono compatibility of the audio mix at hand.

Isone Pro *Surround* supports a variety of additional features:

- 5.1 to 5.0 (no LFE): The LFE channel will be reproduced by the left and right front speakers, instead of the subwoofer
- ITU downmix: This setting creates a stereo down mix from 5.1 input according to the ITU specification

(b) Loudspeaker distance

This control allows one to modify the distance between listener and loudspeakers.

Note: The signal level will increase significantly for short distances!

(c) Reverb time and room size

These controls allow modification of the reverb time and room size of the listening room. For different audio material, different settings are often preferred.

(d) Room control

This switch allows to enable and disable the room acoustic simulation. When switched off, Isone Pro will emulate the perceived effect of listening to stereo loudspeakers in an anechoic room.

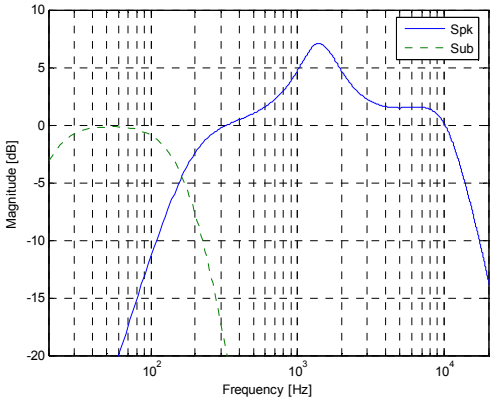
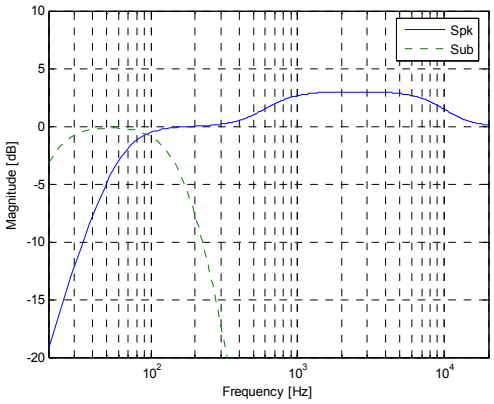
(e) Next door control

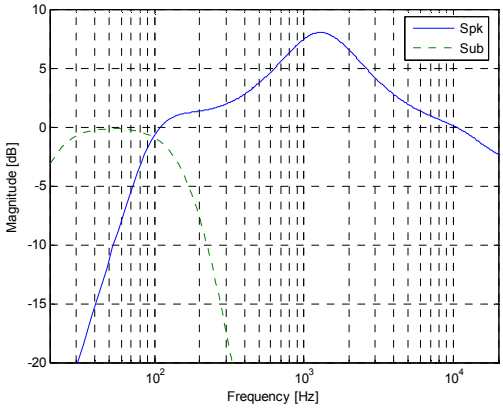
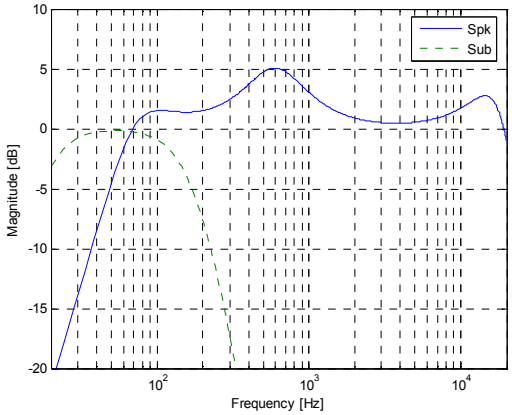
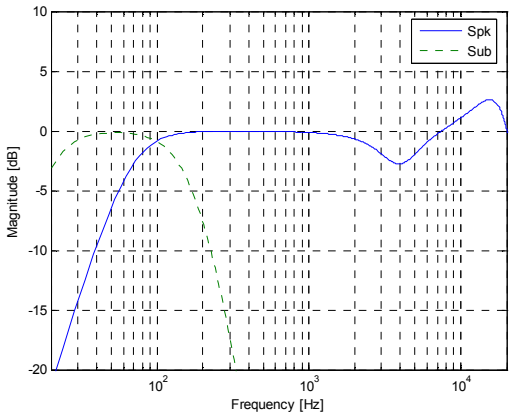
This switch simulates the complex filtering that occurs when listening in another room as the loudspeakers are placed.

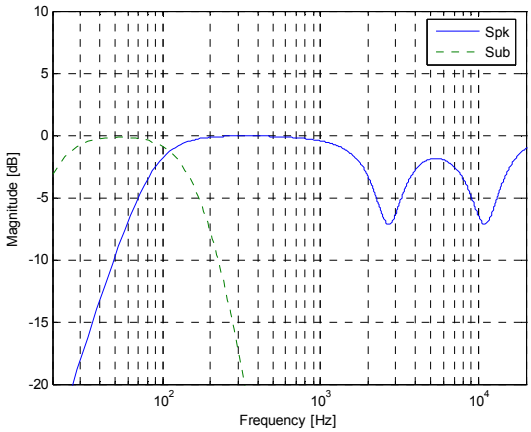
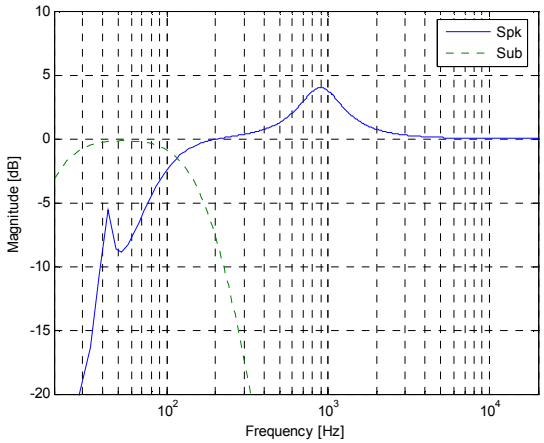
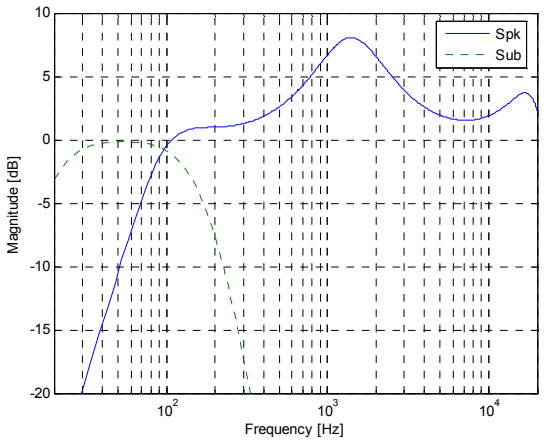
(f) Loudspeaker model menu

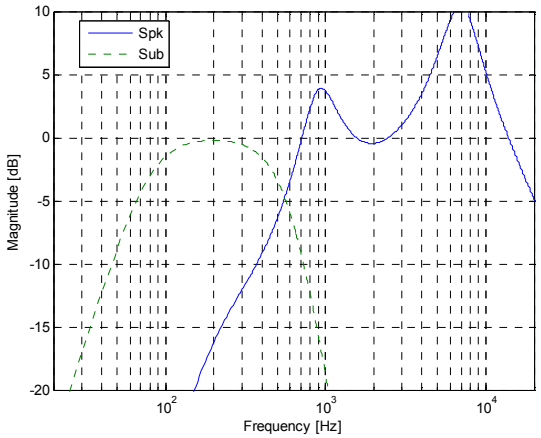
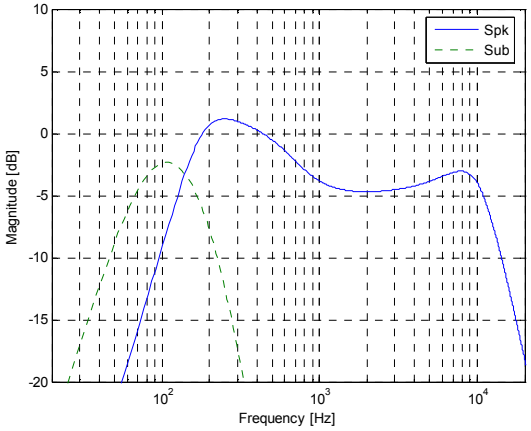
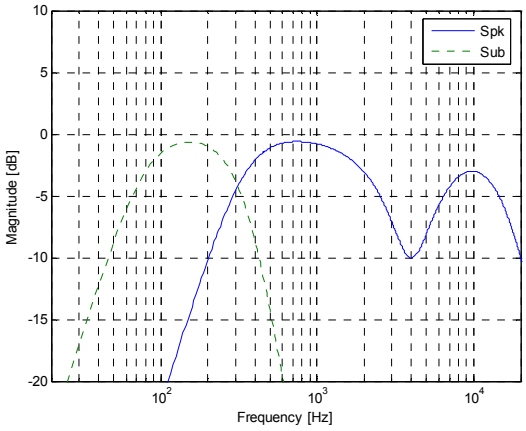
This menu provides a variety of loudspeaker models that can be selected. The following table describes the characteristics of the various loudspeaker models. Please note that

Isone Pro does not contain or employ measured characteristics of existing loudspeakers but instead relies on analytical/theoretical models of loudspeaker cabinets, including the size, volume, driver type, resonance frequencies, enclosure type, and so on.

0	Reference	Flat response from 10 Hz to 20000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 10-20000 Hz
1	Small band-limited speakers 	Frequency response 190 Hz to 11800 Hz +7 dB resonance at 1400 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 50-190 Hz <u>Sounds like:</u> *Auratone 5C* *Desktop PC speaker set* *AM radio* *Conventional TV set*
2	Near-field monitors A 	Frequency response 60 – 20000 Hz +3 dB resonance at 600 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *Acoustic Energy AE2* *ATC SCM20A* *Fostex NF1A* *Roister SNF-6*

3	Near-field monitors B 	Frequency response 82 – 20000 Hz +8 dB resonance at 1300 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *Avi Pro-9* *Avi NuNeutron*
4	Near-field monitors C 	Frequency response 55 – 18300 Hz +5 dB resonance at 600 Hz +3 dB resonance at 15000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *KRK V8* *Mackie HR824* *KSdigital ADM2*
5	Near-field monitors D 	Frequency response 68 – 19000 Hz -3 dB attenuation at 4000 Hz +2 dB resonance at 18000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *PMC LB-1*

6	Near-field monitors E 	Frequency response 71 – 20000 Hz -7 dB attenuation at 2700 Hz -7 dB attenuation at 11000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *Roland DS50A* *FAR DbW80*
7	Near-field monitors F 	Frequency response 78 – 20000 Hz +4 dB resonance at 900 Hz +9 dB resonance at 42 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *Tannoy reveal* *Westlake BBSM5*
8	Near-field monitors G 	Frequency response 79 – 19900 Hz +8 dB resonance at 1400 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 20-150 Hz <u>Sounds like:</u> *Yamaha NS10M* *SLS S8R*

9	PC desktop speakers 	Frequency response 600 – 14000 Hz +15 dB resonance at 900 Hz +25 dB resonance at 7000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 80-600 Hz
10	Portable music player 	Frequency response 142 – 9000 Hz -5 dB attenuation at 700 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 80-150 Hz
11	Flatpanel TV 	Frequency response 350 – 13000 Hz -10 dB attenuation at 4000 Hz Subwoofer (*Isone Pro Surround only*): Frequency response 80-350 Hz

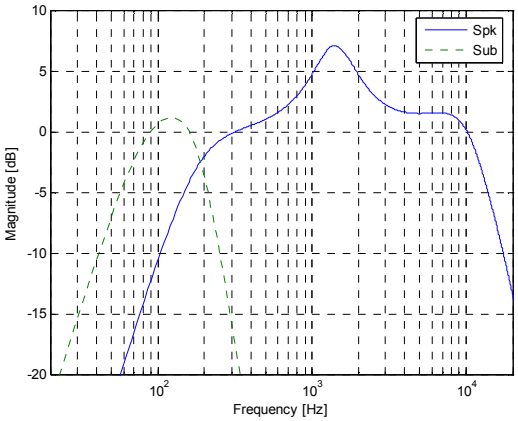
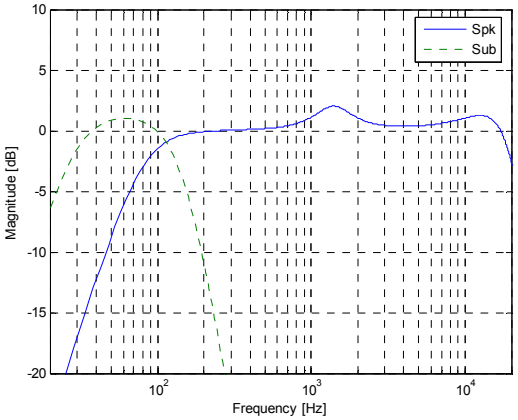
12	Sub / sat (low-end) 	*Isone Pro Surround only!* Frequency response 180 – 10000 Hz +7 dB gain at 1400 Hz Subwoofer: Frequency response 80-180 Hz
13	Sub / sat (high-end) 	*Isone Pro Surround only!* Frequency response 80 – 20000 Hz +2 dB gain at 1400 Hz Subwoofer: Frequency response 30-150 Hz

Table 2 – Loudspeaker model characteristics.

7. Advanced mouse control

The various GUI elements can be controlled by left-mouse mouse clicks (switches) or left-mouse drags (knobs and sliders). The following key combinations apply that modify the behavior of GUI elements:

- Control: Set the control in its default value;
- Shift: Decrease the sensitivity of the control;
- Alt (applied on rotary knobs): Jump to clicked position;

8. Disclaimers

VST is a trademark of Steinberg Media Technologies GmbH.

Isone Pro does not include nor employ actual measured impulse responses from human heads, listening rooms or loudspeaker models. All internal processing is based on analytical/theoretical models of human heads, listening rooms and loudspeaker cabinets.

All loudspeaker brands, types and trademarks mentioned in this document are property of their respective owners and are only used as example to characterize certain properties or classes of properties, without incorporation of measured responses of these products.

9. Specifications

Property	Supported values
Supported input/output formats	Stereo output Mono or stereo input (Isone Pro) 6-channel input (Isone Pro *Surround*)
Plug in delay (latency)	0 samples
Supported bit depths	32 bit float 64 bit float
Number of parameters	13
Supported sample rates	44.1 kHz – 384 kHz
VST version	2.4
Number of presets	50

10. Known issues

- None

11. Change log

Version 1.0.1

- Extension towards surround sound capabilities in separate plugin;
- Improved HRTF models;
- Bug fix during initialization in some hosts;
- Improved room model and loudspeaker-room interaction model;
- Lower level of early reflections to result in a cleaner sound;
- Bug fix for presets selection in some hosts;
- Larger ITD range to cover greater variety in head size.

Version 1.0.0

- Initial version.