PSP Xenon

Full Band Precision Limiter

rev. 1.5.2

Acknowledgements

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Algorithm overview

Thank you for your purchase of the PSP Xenon!

PSP Xenon is a full band, dual-stage limiter featuring an integrated Leveler, advanced K-System metering and psychoacoustically optimized wordlength reduction. PSP Xenon offers 64-bit double floating-point precision processing throughout its entire signal path, and can operate at sample rates up to 192kHz.

Once you experience for yourself the pristine, transparent response and intuitive design of this plug-in, we believe it will become your "go to" limiter for mastering and other critical audio applications.

PSP Xenon's Approach to Limiting

PSP Xenon's limiter section consists of two processing stages. The first section applies the initial gain reduction while allowing the transients to exceed the ceiling level (fixed at 0dBFS). The longer the Attack time, the more transients will exceed the ceiling level. This stage uses multiple Infinite Impulse Response (IIR) higher-order filters for intelligent adaptive envelope extraction to ensure low aliasing and intermodulation distortion. This section uses only a small amount of lookahead.

The transients which pass through the first stage are then subject to processing by the second stage of PSP Xenon's limiter section. This stage provides fail-safe (brick wall) limiting by using lookahead processing in conjunction with sophisticated Finite Impulse Response (FIR) based envelope detectors. By using FIR-based filters for the second stage, this guarantees that every single transient will be detected and caught. This two-stage operation results in much greater control over how the transients are affected than in traditional single-stage limiters.

Finally, the limiter envelope detector can be oversampled to automatically prevent intersample peaks introduced by the reconstruction filter at the digital-to-analog converter. This way an engineer will not need to lower the output level of the entire signal anymore—PSP Xenon's envelope detector does it automatically whenever required. The result - greater loudness at reduced distortion.

The Integrated Leveler

PSP Xenon also includes an integrated Leveler which compensates for volume changes in the program that occur over longer periods of time. To understand how the Leveler functions, you need to be aware that the average level and loudness of a given audio signal cannot be increased infinitely for a given release time. There is a threshold, dependent on the specific audio material you are limiting, above which increasing the limiter input gain will not result in greater perceived loudness. Instead, the limiter will start to pump heavily whenever it recovers from moments of deep gain reduction. In this situation, there is nothing gained by increasing the input level above that threshold level.

However, sometimes program material consists of dynamically louder and quieter parts. If the limiting parameters were set for the quiet passages, when the louder parts occur the artifacts mentioned previously will become very apparent. PSP Xenon Leveler applies a relatively constant, slow-changing gain reduction to loud passages before the limiting is applied. This is particularly useful for loudness maximization applications, in which the goal is to make each part of the song sound as loud as possible. For traditional limiting of short peaks without clipping, the *leveler* can be turned off (*leveler knob* all the way up) thereby preserving the original macrodynamics of the program.

Metering in PSP Xenon

By default, PSP Xenon shows the peak level of the input and output signal as well as the gain reduction applied. The peak meters have a falloff time of 8dB/sec. To allow for consistent loudness control, we built the K-System mastering metering system into PSP Xenon. The K-System metering measures both average RMS and peak levels. Three different K-System scales (K-12, K-14, K-20) are available. The scales differ by the amount of headroom and were carefully chosen to help engineers produce masters having consistent loudness and a crest factor optimized for the specific audio being mastered. K-12 is designed for mastering audio for broadcasting purposes, K-14 is intended for typical CD production, and K-20 is optimized for movie production.

K-System metering is not only a metering system. It is the first integrated metering and monitoring system. To achieve the goal of standardizing studio loudness levels it includes guidelines for calibrating speakers levels using a pink noise generator and an SPL meter. To facilitate this, PSP Xenon includes a band-limited pink noise generator which produces pink noise at the RMS level appropriate for the given K-System scale, thereby making speaker calibration much easier and faster.

Explaining every detail of the K-System metering and monitoring system is beyond the scope of this manual. For further information please visit the site of the designer of the K-System, Bob Katz, at his Digital Domain site: http://www.digido.com.

Metering a digital sample's value is often not the safest way to measure peak audio level. The reconstruction filter in the end-listener's digital-to-analog converter might create inter-sample peaks that exceed the analog level corresponding to 0dBFS. This overshoot and ringing is known as Gibb's Effect. Many cheap analog circuits don't have enough headroom to handle such levels and get non-linear. As a result of the nonlinearity distortion is introduced. For this reason, PSP Xenon includes an oversampled (reconstruction) metering option. In this mode the meters attempt to estimate the actual level emitted from the converter, allowing the engineer to lower the level of the digital audio so that distortion is not introduced in the converter. And as noted in the *Approach to Limiting* section above, the envelope detector can itself be oversampled to automatically protect against inter-sample peaks.

Requantizing

The limiter is usually the last stage of a mastering processing chain. If no processing will be done after this stage one might need to requantize the resulting audio to the bit-depth required by the storage media being used—for example, if the audio is to be rendered to CD, you may need to requantize the audio to 16-bit. PSP Xenon includes a built-in requantizer designed for excellent perceived dynamic range, extending the nominal dynamic range of the media while keeping the noise at very low perceived level thanks to its psychoacoustically-optimized noise shaping.

PSP Xenon's requantizer uses triangular PDF (Probability Density Function) noise generation with the amplitude allowing for full dithering. Triangular PDF has been chosen so as to entirely eliminate noise amplitude modulation, which is audible when noise with rectangular or gaussian PDF is applied.

To make the noise much less audible, its spectrum can be shaped by the process known as noise-shaping. This process exploits the fact that human hearing is not equally sensitive within the entire audible frequency range and shifts the noise containing quantization errors into frequency regions of reduced sensitivity.
PSP Xenon has six different noise spectrum curves to choose from. First three curves (A, B, C) are known from previous versions of Xenon. Because all three were izophonically optimized, however, they tend to psychoacoustically enhance certain frequency ranges.
The next three curves (D, E, F) are taken from PSP X-Dither and are technologically more advanced. Curves D, E, F provide excellent sonic quality thanks to custom perceptual optimizations. The goal behind the creation of those new filters was to obtain an equal error spread in the way that the psychoacoustic enhancement doesn't prefer any frequency range.
Psychoacoustically optimal noise-shaping coefficients for all above filters have been calculated for each sample rate (44.1, 48, 88.2, 96, 176.4, 192). The choice of the noise-shaping curve should depend on the frequency content and general character of the processed audio.
The new version of PSP Xenon contains additional 12 and 20 bit quantization settings. Both here created especially for monitoring and comparison duties. For instance in some cases it might be convenient to test a set of noise shaping settings with around 24dB higher level of dither/noise shaping (word length shortened by 4 bits roughly equals 24dB of a noise gain).

Protection system

Limitations of the demo version

The demo will operate without any limitations for 14 days from its initial installation. During the demo period you will just need to click on the GUI to engage processing once the plug- in is inserted. After the end of evaluation time you would not be able use the plug-in without authorization.

Authorization

Each PSP plug-in has to be authorized using an automatic authorization application or a batch authorizer downloaded from the user's account page on our site.

The About Screen

Each PSP plug-in offers an About window. This screen contains your authorization details, as well as the version number of the plug-in. To access each plug-in's about box, click on the name of the plug-in. To return to the controls view, click the name of the plug-in again (or anywhere in the about screen).

System Requirements

Before installing the PSP Xenon on your Windows or Macintosh computer, please make sure your system meets these minimum requirements:

PC
VST
- Windows x32 or x64 (XP Service Pack 2, Vista or 7)
- VST 2.4 compatible application

RTAS
- Windows x32 or x64 (XP Service Pack 2, Vista or 7)
- ProTools LE 8.0.0 or ProTools TDM 8.0.0 (or later)

AAX
- Windows x32 or x64 (XP Service Pack 2, Vista or 7)
- Pro Tools 11 or Pro Tools HD 11

MAC
AudioUnit
- Mac OSX 10.5 or later
- 32 or 64-bit host application capable of running AudioUnit plug-ins with Cocoa view

VST
- Mac OSX 10.5 or later
- 32 or 64-bit VST 2.4 compatible host application

RTAS
- Mac OSX 10.5 or later
- ProTools LE 8.0.0 or ProTools TDM 8.0.0 (or later)

AAX
- Mac OSX 10.8 or later
- Pro Tools 11 or Pro Tools HD 11

Please keep in mind that these CPU and RAM specifications are *minimum* requirements. For the best performance, you will want a faster CPU and as much RAM as possible!

PSP Xenon Quick Start

If you are so excited to start playing with PSP Xenon you can't read through the manual first, here are some quick steps to get you going:

1. Instantiate the PSP Xenon into an insert slot in your host DAW.
2. Verify the Power button of the PSP Xenon editor is illuminated (ON).
3. Start playback on your host DAW.
4. Adjust the *in* knob, driving the limiter, until you get a solid signal coming into PSP Xenon.
5. Adjust the *transient* knob to set the attack time and the amount of transients passed to the second processing stage.
6. Choose to the desired transients processing mode (*react* or any of the two *predict* modes)
7. Adjust the *release* knob to set the perceived loudness and find the balance between loudness and distortion.
8. Set the *leveler* knob to reduce pumping artifacts, if there are present.
9. Set the *out* knob to the desired output (ceiling) level.

As you can see, getting up and running with PSP Xenon is quite intuitive. But these steps, while enough to get you started, don't reveal the true power and creative potential of this plug-in. For that, keep reading the rest of this manual.

Remember: the manual is your friend! Please use this as a reference whenever you need more detail. Also, look out for these shaded boxes for important notes, tips, and cautions.

Layout of PSP Xenon Interface

PSP Xenon's graphical user interface is very intuitively designed to reflect the signal flow of your audio material from left to right

- At the far left of PSP Xenon's interface are the buttons and knobs relating to input and initial processing stages.
- The large, accurate meters reside in the middle of PSP Xenon's interface.
- Finally, the right side of the interface offers buttons and knobs relating to the final processing and output stages.

Furthermore, underneath each dial and meter we have included precise numeric readouts. This makes it very quick and easy to get a quick overview of how PSP Xenon is processing your program material, and to make any desired adjustments.

Each of PSP Xenon's controls is explained below, along with some usage suggestions.

PSP Xenon Processing

Below are descriptions of each GUI control that affects the sound processing of the plug-in:

detector buttons

These two buttons control the envelope detector block settings.

order - When this button is clicked on, the envelope detector uses second-order filters. This results in a slightly different release shape for the envelope detector. Also, this might result in less aliasing (however, PSP Xenon's envelope detector yields extremely little aliasing anyway, so any difference in aliasing would be hardly perceptible...)

ovrsmpl - This button controls the option to oversample the envelope detector. Engage this option to automatically compensate for true-peaks. Low sample rates loses true-peaks information, so they require a need to detect inter-sample peaks. Oversampling-algorithm development was suggested by ITU-T standards.

transient buttons

These buttons offer three predefined settings to control the way transients are processed by the second limiting stage.

react - this setting hard clips the transients. It results in the most obvious transient distortion, but for some program material, that may be just what you are looking for!

predict - both of these settings use FIR-based envelope detectors with lookahead to smoothly catch transients and limit their level.

transient knob

This knob adjusts the attack time of the first stage of limiting, effectively controlling how much of the transient will be passed to the second limiting stage. Low values reduce distortion but may significantly soften the transient. High values typically increase the distortion of the transients, but the clarity of the transients may also be much greater.

release knob

The release knob determines the release time for the first stage of limiting. Lower values result in a higher perceived loudness level at the cost of distorting the audio signal. Higher values reduce the perceived loudness level but maintain the clarity of the audio material.

in knob

This knob adjusts the input level of the audio signal, which effectively determines the amount of limiting applied. Higher settings of this knob will preamplify the input signal before it is sent to the limiter, while lower settings will attenuate the signal. As mentioned in the Integrated Leveler section, there is a threshold above which the perceived loudness no longer increases, and instead increasing the input level only adds pumping artifacts.

TIP: Another reason to avoid over-limiting, especially when limiting a full mix, is that too extreme limiting can make the material sound flat and uninteresting as all the dynamics will be lost. So remember that "less is more" when it comes to adjusting the in knob.

power button

The power button, located below the metering section, activates or deactivates the plug-in. When the power button is off, the internal engine and buffers stop running, but calibration mode and dithering noise can still be in use.
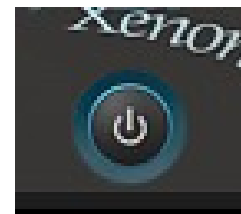
wordlength section

These buttons configure the wordlength reduction feature of PSP Xenon. Whenever truncation would occur, PSP Xenon applies its high quality dithering algorithm to keep the perceived dynamic range as close to the original as possible. Please see the *Requantize* section above for more information on wordlength and dithering.

quantize – activates wordlength reduction

bitdepth – sets the bit depth of the requantizer output. Choose the proper value depending on the desired final output media type.

> **TIP:** Please note that additional 12 and 20 bit word lengths can be used for monitoring of the operation of the selected dithering or noise shaping mode. In this case the 12 bit setting raises a noise floor roughly by 24dB compared to a usual 16 bit setting while the 20 bit setting raises a noise floor roughly by 24dB over the noise floor of 24 bit mode. Hence using those intermediate modes may help to select the best sounding (least destructive mode for a processed audio.

noiseshp - select which, if any, of the six types of dither noise spectral distribution is used. As noted in the Requantizing section, each noise shaping curve is based to some extent on the izophonic curve of the human auditory system, with C being the most faithful curve. If no noise shaping button is selected, plain white noise with triangular PDF is applied.

autoblck – activates dithering autoblacking, the feature which cuts off the dither noise completely when no signal (silence) is present on requantizer input. When mastering multiple songs in one pass (f.ex. an album) this feature allows to achieve absolute silence between songs when dither noise could otherwise be audible.

> **TIP:** Buttons in PSP Xenon respond to a variety of different mouse moves – just to be sure this product supports users favourite method. You can use classic value rotation mode (clicking in the middle of a button), click and drag mode, inc/dec mode (clicking on arrows) or even mouse wheel scroll.

leveler knob

This knob controls the threshold of the leveler. Lower values make its action more obvious. Keep in mind that the time constant of the leveler's envelope detector is very slow. In other words, the leveler's gain reduction will not be immediately apparent upon the signal exceeding the threshold. Rather, once the threshold is exceeded, the leveler will gradually apply gain reduction. The leveler is especially useful for loudness maximization, because it can greatly reduce pumping artifacts. When the knob is set fully clockwise, the leveler is off.

link knob

The link knob controls the extent to which the first limiting stage gain reduction of the left and right channels are tied together. When set to 100%, the gain reduction applied to both channels is identical. Setting this knob to 0% completely decouples the gain reduction coefficients, and each channel is then processed independently. When the two channels are completely decoupled, PSP Xenon operates as if it were two separate limiters working in parallel, one on each channel, although each shares the same transient, release, and level settings.

When the two channels are decoupled, this normally results in louder overall output, because each channel's level and loudness are maximized separately (and optimally for that specific channel). However, one side affect of decoupling the two channels is that the stereo image may fluctuate. Thus, with PSP Xenon you can use the link knob to dial in the optimal blend between the extra loudness gained by de-linking a stereo signal versus the stability of the stereo image gained by partial or complete linking.

The second limiting stage, which operates on transients, is always decoupled because it does not adversely affect the stereo imaging due to very short time constant (fast attack and release).

out knob

The output knob attenuates the final output signal, effectively setting the ceiling level. Usually this is left at 0dBFS in order to maintain the full dynamic range of the media. However, sometimes you may need to attenuate the output in order to prevent intersample peaks at the digital-to-analog converter.

> **TIP:** PSP Xenon offers another, even better way to automatically eliminate intersample peaks: *oversmpl* button in the envelope detector. Try activating this feature instead of reducing the output knob.

auto button

For easier identification of the limiter's action PSP Xenon is equipped with an *auto output* mode. When this mode is on, the output is automatically attenuated or amplified to compensate for the input gain, as set by the input knob. This makes it possible to compare the original and processed signals at similar loudness levels by switching the bypass button on and off. Auto output mode is useful for determining the desired amount of input gain and the trade-off between loudness and possible processing artifacts

PSP Xenon Metering

PSP Xenon offers stereo input, output and attenuation meters and various modes and calibration options to control the levels and calibrate your listening environment to comply with the K-system standards.

meter bars

PSP Xenon includes three stereo meter bars:
* *input* - shows the input signal level
* *attenuation* - shows how much gain reduction the plug-in is being applied to the signal
* *output* - shows the output signal level

Below each meter, the numeric readout tells you the precise extreme level of the corresponding signal.

show attenuation

The three switches comprising this section allow for independent metering of the gain reduction applied by each plug-in block:

lim1 – first limiter stage (main limiter),

lim2 – second limiter stage (brickwall transient processing),

level – the leveler

zoom

Selects the attenuation meter range (24dB or 12dB)

mode buttons

The mode buttons toggle between the different metering modes and scales. The various modes are:

- *peak* - this shows the sample peak value
- *K-12* - this activates K-system metering at the K-12 scale (broadcasting)
- *K-14* - this activates K-system metering at the K-14 scale (CD production)
- *K-20* - this activates K-system metering at the K-20 scale (cinema production)

recon

This oversamples the signal going to the output meters to estimate the intersample peaks. When on, the output meters will attempt to show the signal level after the DA converter and its reconstruction filter.

Some poor quality reproduction systems don't have enough headroom to handle analog signal levels exceeding the equivalent of 0dBFS without distortion. Oversampled metering can be used to predict such excessive levels. At this point, you can reduce the PSP Xenon output to avoid them.

post

Toggles between two available input knob locations within the signal chain – before or after the input meter. Allows to decide whether the input meter should reflect the input gain or not.

Note: When you engage the oversampling option for the output meters, the signal level displayed will only be an *estimate*. The *actual* level after the digital-to-audio converter (DAC) will depend on the DAC reconstruction filter design, which there is no way for PSP Xenon to determine.

TIP: If you engage the envelope detector oversampling mode, the envelope detector will calculate the intersample peaks, and automatically compensate for them by applying the requisite amount of gain reduction. This way, if you also oversample the output meters, you can verify that absolutely no intersample peaks will exceed 0dBFS.

When the reconstruction mode is engaged and the envelope detector oversampling is off you can observe overloads on Xenon's output meters which will not occur on most of ordinary (not up sampled) DAW meters. This shows the persistent level difference between analog and digital signal.

calibration buttons

The buttons under the calib label activate the pink noise generator for K-system speaker calibration. The RMS level of the noise depends on which K-System scale is chosen. You can choose to generate pink noise in the Left, Right, or Left+Right channels, depending on which button you select.

TIP: Right-clicking (or ctrl-clicking) on any of the metering-related buttons saves the current metering settings to the registry (or preferences file) as the default configuration. This configuration will be restored whenever new instance of the plug-in is launched.

Preset Handling

PSP Xenon is provided with factory sets of presets.
The main aim of the included presets is to show you the features of the plug-in and help you to learn how to use the controls. In addition, the presets can be used as a starting point for further adjustments or as quick fix presets.
The PSP Xenon presets can be accessed from the PSPaudioware standard PRESET bar at the bottom of the plug-in interface. Here you can select from among the factory presets, as well as load and save individual presets or banks of presets. There are three sections to this bar, the PRESET section, the Preset window, and the BANK section.

BANK SECTION

Click the green arrow icon to load a bank from a disk. Click the red arrow icon to save a bank. Double click the BANK label to permanently store the default preset bank. Press Command (Mac) or Control (PC) and double click to restore the factory default bank.

PRESET SECTION

Click the green arrow icon to load a preset. Click the red arrow icon to save a preset. Double click the PRESET label to permanently store the default preset. Press Command (Mac) or Control (PC) and double click to restore the factory default preset.

PRESET EDIT BOX

Click the menu button to the right of the preset edit box to see and the popup menu of all the presets in the currently loaded preset bank and to choose a preset from the list. Click the name of the preset to rename it.

PRESET SELECTION

Click on the bright left arrow to switch to a previous preset on the list. Click on the bright right arrow to switch to a next preset on the list..

MEMO A and B

Both A and B are permanently stored on your disk. This allows you to compare alternative settings or share a preset between various instances of the plug-in in the same project or even between various projects. Click the green arrow icon to load a preset from memo A or B.
Click the red arrow icon to save a preset to memo A or B.

?

Click on the question mark whenever you need to open the operation manual.

HINT

Click on the bulb to enable hints. Move mouse over desired control to display functionality reminder.

Support

If you have any questions about the principles or operation of our plug-ins, please visit our website http://www.pspaudioware.com where you can find the latest product information, free software updates and answers to the most frequently asked questions.

You can also contact us by e-mail: support@PSPaudioware.com . We will gladly answer all of your questions. As a rule we respond within 24 hours.

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User Comments

We welcome any opinions and comments related to PSP Xenon. We would also be grateful if you shared with us your experiences using PSP Xenon. For example, if you've created a useful preset then let us know.

Please, contact us at:
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