

«Limiter №6»

Modules and parameters description

Developed by:

Vladislav Goncharov

vladgsound.wordpress.com

With collaboration of:

Dax Liniere

www.puzzlefactory.com.au

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1 Introduction

1.1 Purpose, structure and basic features

«Limiter №6» is *modular effect designed to limit dynamic range and to suppress peaks* in stereo and mono audio signals.

«Limiter №6» contains the following *modules*, connected in series:

- 1) slow RMS dynamic range compressor («**RMS compressor**»);
- 2) fast audio peaks limiter («**peak limiter**»);
- 3) high frequency audio content limiter («**HF limiter**»);
- 4) the **clipper**;
- 5) true¹ audio peak limiter («**ISP limiter**²»).

«Limiter №6» basic *features*:

- 1) *high quality signal processing* allowing the use of this plugin for *mastering* purposes;
- 2) *flexible tuning*;
- 3) cumulative usage of serial connected modules *allows the use of small limiting amounts in each module*, in order to make the application of *high amounts of limiting possible*, while maintaining a *low subjective distortion level*;
- 4) support of M/S and *multiband* modes (for peak limiter and the clipper);
- 5) optional high quality 4-times *oversampling* (for peak limiter, HF limiter and the clipper);
- 6) ability to *limit true signal level*;
- 7) *analog-type gain reduction indication* for each of modules³;
- 8) "*fixed*" *latency* mode, allowing to avoid artifacts caused by changing processing latency "on the fly";
- 9) absence of automatic operational modes and "magic" modules;
- 10) two types of GUI: photorealistic⁴ (№1) and simplified (№2).

1.2 Software compatibility

«Limiter №6» plugin is available in the following versions:

¹ Signal peaks that can occur after digital to analog conversion.

² ISP (inter-sample peaks) – interpolated audio signal peaks between digital audio samples.

³ In simple GUI there're only 3 indicators showing at the same time.

⁴ With different localizations: Russian, English, Japanese.

- 1) VST, Windows, 32-bit version (CPU with SSE2 support required);
- 2) VST, Windows, 64-bit version;
- 3) VST, Mac OS X, 32-bit version (Intel).

In some host applications, there can be problems with using *the mouse wheel to change parameters* in «Limiter №6». In the Windows version, in order to use the mouse wheel, the plugin window must be active (to activate the window, you should click on the window header or at any point in the plugin's window background).

2 Installation

2.1 Installation for Microsoft Windows operating system

To install the «Limiter №6» effect, simply copy the "Limiter6.dll" file for the 32-bit version, or the "Limiter6-64.dll" file for the 64-bit version, from the zip-format setup archive to your VstPlugins directory (usually c:\VstPlugins, c:\Program Files\Steinberg\VstPlugins; or to another folder of your choice⁵).

2.2 Installation for Mac OS X operating system

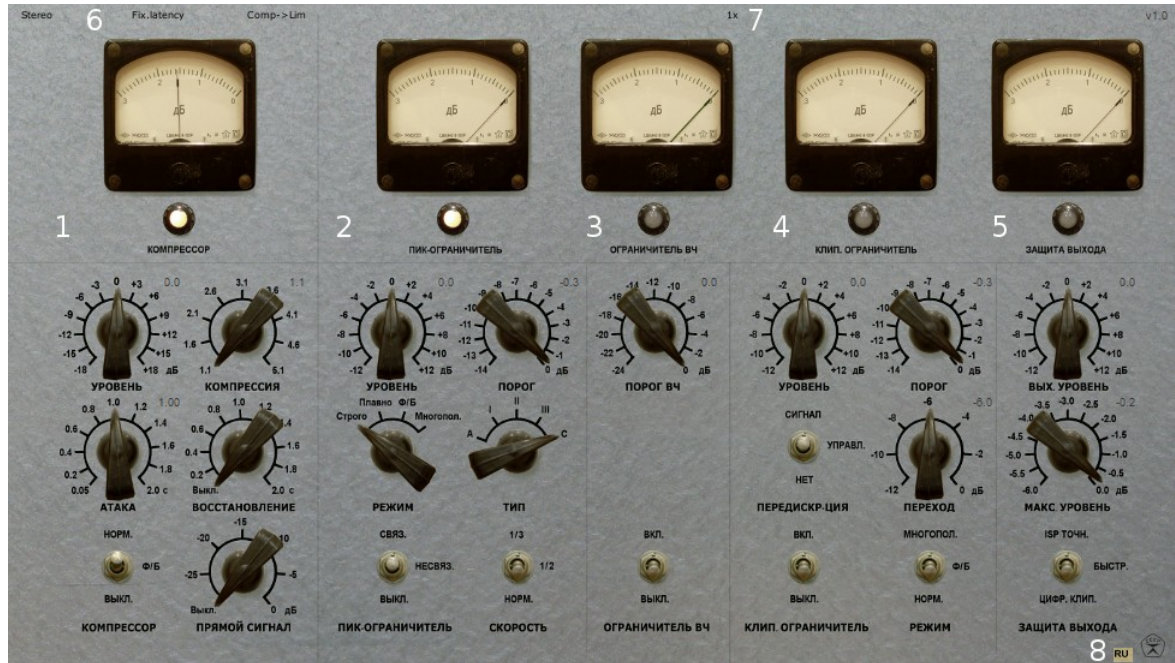
To install the «Limiter №6» plugin, simply copy the "Limiter6.vst" directory from the dmg-format setup archive to the /Library/Audio/Plug-Ins/VST directory on your system drive.

⁵ See also HKEY_LOCAL_MACHINE\SOFTWARE\VST in registry editor.

3 Modules and parameters description

3.1 Controls and indication

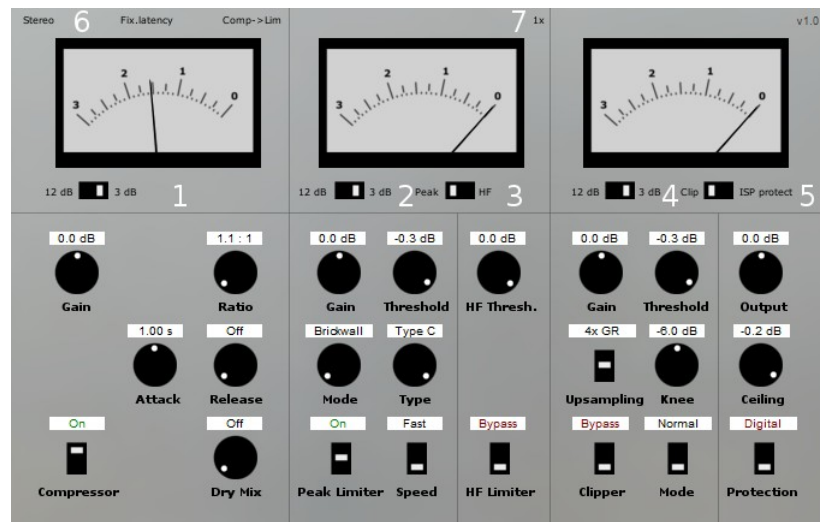
For «Limiter №6» appearance see pic 1, 2 and 3.



Pic 1. GUI №1



Pic 2. GUI №1 with English localization



Pic 3. GUI №2 (with saved proportions)

The numbered elements on pic 1, 2, 3 are:

- 1) RMS compressor area;
- 2) peak limiter area;
- 3) HF limiter area;
- 4) the clipper area;
- 5) ISP limiter area;
- 6) global settings area;
- 7) common peak and HF limiter settings area;
- 8) localization switch (GUI №1 only).

3.2 Signal processing chain

RMS compressor → peak limiter⁶ → HF limiter → clipper → ISP limiter

Purposes:

1. **RMS compressor:** reducing the difference between loud and quiet parts of the incoming audio signal and crest-factor stabilization.
2. **Peak limiter:** softened signal peaks suppression.
3. **HF limiter:** reducing the excessive brightness of the sound, which can be caused by overcompression or clipper usage. Also used to concentrate listener attention to mid-frequency content.
4. **Clipper:** rude suppression of signal peaks, that can either “dirty up” the sound, or make it “bite”.
5. **ISP limiter:** used mainly to suppress 0 dBFS true signal level trespass, but it can also be used as regular brickwall limiter. If the ISP limiter module is off, the output signal

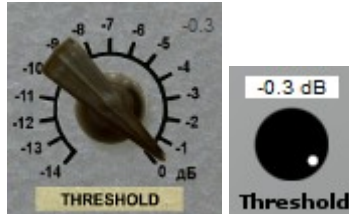
⁶ See also «RMS compressor and peak limiter plugging order parameter»

is limited by hard digital clipping.

3.3 GUI elements

3.3.1 Control knob

Control knobs allow changing either continuous parameters or operational modes (if number of these modes is greater than three).



Pic 4. Typical control knobs

Typical GUI element «control knob» contains the next components:

- 1) the name of the parameter;
- 2) the knob;
- 3) the parameter units;
- 4) numeric value of the parameter.

Basic control knob hooks:

- 1) hold the left mouse button over the knob and move the mouse up and down to change the parameter value;
- 2) move the mouse wheel over the knob to change the parameter value⁷;
- 3) move the mouse wheel over the knob while pressing the Shift key, to change the parameter value more precisely;
- 4) Ctrl + mouse click onto knob to reset the knob to its center value⁸.

3.3.2 Control switches

Control switches used to turn modules on and off and also to change their operational modes. Switches can be two or three positional.

⁷ In Windows it is necessary for «Limiter №6» window to be active. In some DAWs the parameters change using mouse wheel doesn't work.

⁸ Use Cmd key on Mac OS X

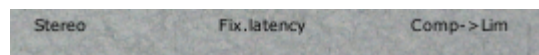


Pic 5. Three positional switch in the middle position

Basic control switch hooks:

- 1) left mouse click to shift the switch up by one step (if the switch is already up it's reset to down);
- 2) right mouse click to shift the switch down by one step (if the switch is already down it's reset to up);
- 3) turn mouse wheel up by one step to shift the switch up by one step;
- 4) turn mouse wheel down by one step to shift the switch down by one step.

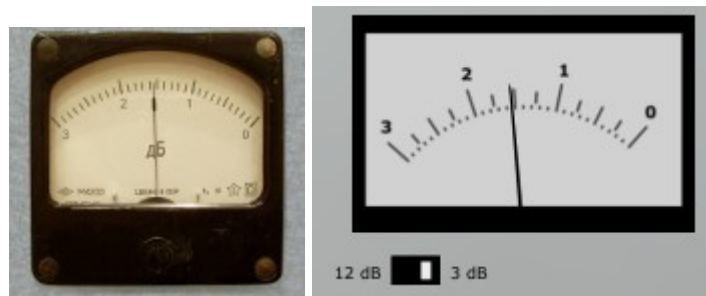
Besides that, additional settings, which look like text, are also switches and the same hooks can be applied to them.



Pic 6. Textual switches

3.3.3 Analog-style indicators

Analog-style indicators are used to show the level of signal limiting in corresponding module. Indicator scales are in dB format. Rightmost position means 0 dB of signal limiting.



Pic 7. Analog-style indicators

Indicators support **scale switching** to 3 or to 12 dB.

In GUI №1, to switch the scale, use *left mouse click on the scale*.

In GUI №2 the 12/3 dB switch is used to do that.



Pic 8. Indicator scale switched to 12 dB

If the corresponding module works in **M/S mode**, there're 2 needles on the indicator: red for *M* channel and green for *S* channel⁹.



Pic 9. Indicator scale if module works in M/S mode

If the corresponding module works in **multiband** mode, there're 3 needles on the indicator: red for low frequencies, green for mid frequencies and blue for high frequencies (you can easily remember it by RGB mnemonic)¹⁰.

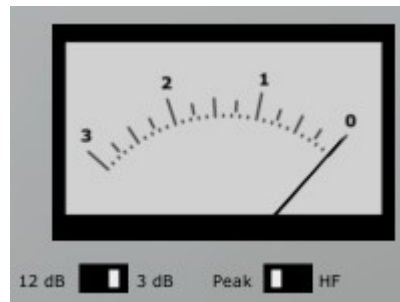


Pic 10. Indicator scale for module operating in multiband mode.

In GUI №1 there are 5 indicators that correspond to the 5 modules. In GUI №1 there are 3 indicators: two of them can be switched to the corresponding module by using the switch located at the right bottom relative to the indicator.

⁹ It applies to both GUI versions. The only GUI №1 picture showed to save the place.

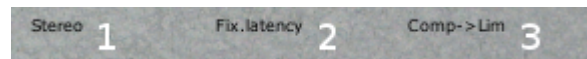
¹⁰ It applies to both GUI versions. The only GUI №1 picture showed to save the place.



Pic 11. Module switch is located at the right bottom relative to the indicator.

3.4 Global operation mode parameters

Global operation mode parameters are located at the left top corner of the «Limiter №6» window.



Pic 12. Global operation mode parameters

The numbered elements on the image are:

- 1) *stereo mode* parameter;
- 2) *latency mode* parameter;
- 3) *RMS compressor and peak limiter plugging order* parameter.

3.4.1 Stereo mode parameter

Stereo mode parameter can have the next values:

- 1) “**Stereo**” – works in stereo mode (main operational mode);
- 2) “**Mono(L)**” – the left channel of the stereo input signal is processed in mono mode, then duplicated on both channels of the stereo output;
- 3) “**Mono**” – the average of both the left and right input channels is processed as “Mono(L)”.

The purpose: if the plugin is used on mono tracks, “Mono(L)” mode should be used to save CPU cycles.

3.4.2 Latency mode parameter

Latency mode parameter can be set to one of the following values:

- 1) “**Fix.latency**” – the *maximum* possible latency is always used;
- 2) “**Min.latency**” – the *minimum* possible latency for current settings is used.

The purpose: the change of processing latency «on the fly», which can be caused by turning modules on and off and also by changing their operational modes (see also Appendix 2), can lead to unpleasant audio clicks. That's *why it's recommended to use "Fix.latency" when adjusting the plugin parameters. After the plugin parameters are completely tuned, it is possible to activate "Min.latency" mode, in order to minimize the processing latency.*

Note: if presets are changing «on the fly» during the time of playback and these presets have different latency, the host application is not notified about it. To restore correct latency compensation it is necessary to stop the playback and then start it again. It is related with changing presets only and not related with changing single parameters.

3.4.3 RMS compressor and peak limiter plugging order parameter

RMS compressor and peak limiter plugging order parameter can have the next values:

- 1) **"Comp->Lim"** – regular signal processing chain: RMS compressor → peak limiter → HF limiter → ...
- 2) **"Lim->Comp"** – alternate signal processing chain: peak limiter → RMS compressor → HF limiter → ...

The alternate signal processing chain recommended uses:

- A. Vocal processing.
- B. Limiting signal peaks first can help avoiding deep compressor gain reduction «dive», which can achieve it invisible working in more extreme settings.

3.5 RMS compressor

This module is a RMS compressor with very *slow attack and release times*.

The purpose:

1. To *use* it as *second compressor* after another compressor with fast settings inserted before «Limiter №6».
2. To *lower signal level* if it is raised to the value when peak limiters start to distort sound.

Features:

1. RMS *window size in fact is equal to attack time* parameter value.
2. The *ability to turn release time off* (release time becomes equal to attack time).

Release times smaller than attack time are not supported (in this case release time becomes equal to attack time).

3. *Zero processing latency.*
4. *The ability to operate in M/S mode.*



Pic 13. RMS compressor module

The numbered elements on the image are:

1. Signal gain reduction indicator.
2. RMS compressor on indicator (GUI №1 only).
3. Input gain control knob.
4. Compression ratio control knob.
5. Attack time control knob.
6. Release time control knob.
7. Control switch to turn on RMS compressor and to choose operational mode (normal or M/S¹¹ one). In M/S mode reaching the threshold level processed for M and S components independently. Also the threshold for S component is 3 dB less than specified. In normal operational mode the gain reduction for left and right channels is 100% linked.
8. Dry mix control knob.

¹¹ In mono operational mode there's no differences between these two modes.

3.6 Peak limiter

This module is an *aggressive brickwall limiter with very fast attack time* (about 0.13 ms) and *very small lookahead* (6 samples in 44.1 kHz). This limiter is intended to *use on signal peaks only*.

Features:

1. Subjectively *preserves instruments attacks* due to chosen compromise between added distortions and attack suppressing.
2. *Soft limiting mode*, which can pass through small part of signal attack to be suppressed by the clipper.
3. *M/S and multiband modes*.
4. *Aggressive mode* («A») having release time equal to attack time.
5. Several modes with *different limiting knee value* («I-III»).
6. *Release lookahead mode* («C»), which allows the reduction of added distortions.
7. Very small processing latency (6 samples in 44.1 kHz).
8. Optional 4x *oversampling* support.



Pic 14. Peak limiter module

The numbered elements on the image are:

1. Signal gain reduction indicator.
2. Peak limiter on indicator (GUI №1 only). If the limiting occurs longer than 20 ms the

indicator light becomes brighter. In GUI №2 in the same situation the amber border appears around “Threshold” control knob.

3. Input gain control knob.
4. Limiting threshold control knob.
5. *Operational* mode switch: “**Brickwall**” – to act as brickwall limiter, “**Soft**” – signal peaks smaller than 1 ms can be passed though, “**M/S**” – operate in M/S mode, “**Multiband**” – operate in 3 bands mode. In M/S mode the reaching of threshold processed for M and S components independently. Also in “**Linked**” mode the threshold of S component is 3 dB less than given. In 3 bands mode the 6 dB/Oct crossover with 160 Hz and 6.4 kHz bands used¹².
6. *Release and knee type* mode switch: “**A**” – release time is equal to attack time; knee is -6 dB relative to the threshold (*aggressive* mode). “**I-III**” – release time is 4.2 ms; knee is -6 dB, -3 dB, 0 dB (*normal* operational mode). “**C**” – release lookahead of 2 ms used; knee is 0 dB (*soft* operational mode).
7. Control switch to turn peak limiter on and choose its *operational* mode: “**Unlinked/On**” – left and right channels are limiting independently, “**Linked**” – left and right channel gain reduction affects each other for frequencies below 100 Hz (6 dB/Oct)¹³.
8. Peak limiter operational *speed* control switch. In «**1/2**» and «**1/3**» positions attack, release and lookahead times become accordingly 2 and 3 times greater (e.g. limiter speed becomes slower).

3.7 HF limiter

This module is the limiter for high-frequency signal component. It *can soften harsh high-frequency sounds caused by overcompression or clipping* (in some cases this module sounds like a de-esser). The module operates like the peak limiter, but only for *frequencies higher than 11 kHz* (6 dB/Oct) in M/S and “A” modes.

¹² In the next version it is planned to provide access to multiband mode parameters.

¹³ In the next version it is planned to provide access to stereo-link parameters.



Pic 15. HF limiter module

The numbered elements on the image are:

1. Signal gain reduction indicator.
2. HF limiter on indicator (GUI №1 only).
3. HF limiter threshold control knob.
4. Control switch to turn HF limiter on.

3.8 The clipper

This module is soft-clipper with 4x oversampling support.

Features:

1. *Soft knee* with fine-tuning.
2. Supports M/S and *multiband* modes.
3. *Analog-style indication for gain reduction*.
4. Gain reduction signal *oversampling* mode. In this mode the signal below clipping level (threshold minus “knee”) is passed through without any processing.
5. High quality 4x (64-bit floating point processing, passband at 0.931 of Nyquist: 20.5 kHz in 44.1, -170 dB stopband attenuation).



Pic 16. The clipper module

The numbered elements on the image are:

1. Signal gain reduction indicator.
2. HF limiter on indicator (GUI №1 only). If the input signal reaches threshold plus “knee” value (e.g. enters “horizontal” zone) *the light of indicator becomes brighter*. In GUI №2 in the same situation the orange border appears around “Threshold” control knob.
3. Input gain control knob.
4. Clipping threshold control knob.
5. Oversampling control switch: “**Off**” – oversampling is not used. Use this mode if high frequency rate is used and also to save CPU time. “**GR**” – *oversampling only of gain reduction signal* is used. Use this mode if clipping occurs only for very short periods of time (in this case most of input signal passed through unaltered) and also to save CPU time. “**Signal**” – full 4x signal oversampling is used. Due to specifics of chosen filter implementation this mode softens the sound.
6. Knee control knob. Soft clipping starts with threshold value minus knee value.
7. Control switch to turn the clipper on.
8. Operational mode control switch: “**Norm.**” – normal operational mode, “**M/S**” – M/S operational mode, “**Multiband**” – 3 bands operational mode. In 3 bands mode the 6 dB/Oct

crossover used with 160 Hz and 6.4 kHz bands¹⁴. 3 bands mode doesn't support "GR" oversampling. That's why even if "GR" mode is selected the "Signal" mode is used in this case.

Note: if oversampled mode is used, due to specifics of the implementation and Gibbs phenomena (it's about band-limited square wave) it is possible for short peaks (usually of one sample) to trespass the threshold. That's why it is necessary to use the next module to suppress such peaks.

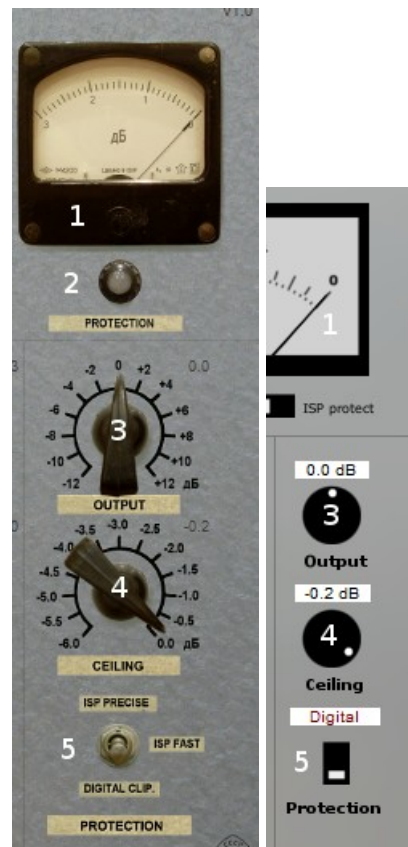
3.9 ISP limiter

This module is a **true signal value limiter**. This module gets true peak signal value by samples interpolation and then generates gain reduction curve in such a way that after limiting the new true peak signal value will be less or equal than threshold given. If ISP limiter is off this module implements hard digital clipping.

The purpose:

- 1) *to prevent distortions* after digital to analog conversion;
- 2) using this module like an interesting-sounding brickwall limiter;
- 3) using this module for *hard digital clipping* (when ISP limiter is off);
- 4) *using this module to suppress occasional peaks if oversampled clipper or limiters are used.*

¹⁴ In the next version it is planned to provide access to multiband mode parameters.



Pic 17. ISP limiter module

The numbered elements on the image are:

1. Signal gain reduction indicator (used only if ISP limiter is on).
2. ISP limiter on indicator (GUI №1 only). If ISP limiter is off, this lamp indicator shows hard digital clipping. In GUI №2 for the same purpose the red border appears around the “Protection” control knob.
3. Output signal level control knob (works independently of the ISP limiter's setting to on or off).
4. Maximum output signal value control knob (works independently of the ISP limiter's setting to on or off).
5. Control switch to turn on ISP limiter and set its operational mode: “**Digital.clip**” – ISP limiter is off and hard digital clipping is used. “**ISP Fast**” – simplified algorithm for true signal peak level is used (polynomial 4x interpolation). “**ISP Precise**” – precise algorithm for true signal peak level is used (4x sinc-function interpolation with subsequent more precise polynomial interpolation).

3.10 Peak and HF limiters oversampling

It is possible to run peak and HF limiters inside oversampling used in the clipper module. If initial signal processing chain looks like this:

RMS compressor \rightarrow peak limiter \rightarrow HF limiter $\rightarrow x*4 \rightarrow$ clipper $\rightarrow x : 4 \rightarrow \dots$,

then after activation of this mode the chain will look like this:

RMS compressor $\rightarrow x*4 \rightarrow$ peak limiter \rightarrow HF limiter \rightarrow clipper $\rightarrow x : 4 \rightarrow \dots$,

where “ $x*4$ ” – 4x upsampling, and “ $x : 4$ ” – 4x downsampling.

This mode has the next restrictions:

1. It can't be used if the clipper uses “GR” oversampling.
2. It can't be used if peak limiter is plugged before RMS compressor (“Lim- \rightarrow Comp” mode).

This mode can be activated by “1x/4x” switch. If this mode can't be activated the switch disappears.



Pic 18. “1x/4x” switch is located at the top right corner relative to HF limiter

3.11 Localization switch

GUI №1 supports localization change. At this moment the next languages are supported: Russian (RU), English (EN), Japanese (JP)¹⁵. The localization control switch is located at the right bottom corner of the window.



Pic 19. Localization control switch in GUI №1

¹⁵ Languages are chosen by the site statistics. German language is not included because Germans use English terms for audio.

Appendix 1. Thanks to

Dax Liniere <http://www.puzzlefactory.com.au/>

Vitaly Zolotarev <http://www.vitalymusic.com/>

Dean Aka Nekro,

Jay Key,

Jonas Ekström <http://www.mastertone.se/>

Paul Schwartz,

Ryoma Nishiyama.

For help with English manual:

Tavi Scurtu,

sinkmusic <http://www.sinkmusic.com/>

Appendix 2. Latency for modules and their operation modes

Module	Operating modes	Latency introduced
RMS compressor	all	none
Peak limiter	«A», «I-III»	0.13 ms
Peak limiter	«C»	2.13 ms
Peak limiter	«1/2»	double
Peak limiter	«1/3»	thrice
HF limiter	all	0.13 ms
The clipper	oversampling is off	none
The clipper	“GR” oversampling	256 samples
The clipper	“Signal” oversampling	228 samples
ISP limiter	«Fast»	2.18 ms
ISP limiter	«ISP Precise»	257 samples