

# Energize II 1.40 – Manual

## Introduction

Energize II is a 5-band audio processor suitable for Internet and low-power/budget FM broadcasting. The processor works only on stereo input with sampling frequency 44100 Hz. The processor is not optimized, which is why it consumes a lot of CPU power.

## Installation

Energize II can be used either in Winamp as a DSP-effect or in any software supporting the VST standard. If you are using Winamp, place the file `dsp_EnergizeII.dll` in your Plugins-directory in the Winamp directory. Now you will be able to choose EnergizeII as DSP/Effect in Winamp. If you are using VST compatible software, place the file `EnergizeII.dll` in your directory for VST plug-ins. Place the file `EnergizeII.in` directly under `c:\`.

## Processing overview

First in the signal chain, the audio is amplified or attenuated to the right level by what I call the AGC. After that, if chosen in `EnergizeII.in`, the audio is fed through a steep 15 kHz low pass filter. Then the audio is split up into five frequency bands and the stereo image is widened in each band if chosen in `EnergizeII.in`. A 5-band compressor then does dynamic compression on all bands and after that the audio in all bands is limited by different kinds of limiters suitable for each frequency range. Now each band is fed into a mixer to form two channel stereo again. This audio is then pre-emphasized if chosen in `EnergizeII.in`. Before the audio leaves Energize II, it is fed through a wide band look-ahead limiter.

## The AGC

This is a simple feed-back compressor with infinite compression ratio. At the output of the compressor each channel is squared and fed through two 1<sup>st</sup> order averagers, one for each channel. (What I call a 1<sup>st</sup> order averager can be described as  $y[n] = x[n] + k(y[n-1] - x[n])$ , where  $k$  is a time constant. Higher order averagers are cascades of the 1<sup>st</sup> order averager.) The time constant of the averagers is set by `AGC_detect_time`. The output of the averagers are summed and the result is raised to the power of  $\frac{1}{2}$ . If this result is below `AGC_threshold_gate`, the compressor freezes. If not, the result is compared to `AGC_threshold` and if the result is above this threshold the amplification is reduced by `AGC_attack` dB per second. Otherwise the amplification is increased by `AGC_release` dB per second. The amplification of the compressor is limited to `AGC_maxamp` dB.

## The 15 kHz low pass filter

This filter is a steep elliptic low pass filter with a 15 kHz cutoff frequency. It is switched on by setting `StFilter` to 1 and switched off by setting `StFilter` to 0.

## The crossover

The audio is split into five frequency bands using 2<sup>nd</sup> order Butterworth filters. The crossover frequencies are 70 Hz, 200 Hz, 1 kHz and 5 kHz. Every other band is inverted to get an approximately flat frequency response when the bands are summed to form two channel stereo in the end of the processing chain.

## The stereo widener

A simple stereo widener can be used before the compressor. The stereo widener first convert the outputs from the crossover from left and right signals to mid and side signals. (Mid is the sum of left and right divided by two and side is the difference between left and right divided by two.) The side signal is multiplied by the number `stereo_b2` for band 2, `stereo_b3` for band 3, `stereo_b4` for band 4 and `stereo_b5` for band 5. The number 1.00 means no amplification of the stereo image. After this the mid and side signals are converted back to left and right signals.

## The 5 band compressor

The compression ratio in this compressor is also infinite.

First in the compressor, the input is amplified by *in\_drive* dB. This is meant to represent the typical gain reduction in the compressor. In this compressor the 'makeup gain' is applied before the compression stage instead of after, which might be common on one-band compressor/limiters.

After that, band 1 (the lowest band) is made mono, since our ears have difficulties hearing stereo information at those frequencies. If desired, some of the other bands can also be made mono by setting their corresponding stereo widener settings to zero.

Now the RMS is calculated at the input of each band of the compressor. This is done for band 1 by squaring the input (which now is only one channel), feeding it through a 1<sup>st</sup> order averager with time constant *b1\_detect\_time* seconds and raising this to the power of  $\frac{1}{2}$ . For the other bands, the RMS is calculated by squaring the left and right signal, feeding these two results through averagers with the same time constant *bx\_detect\_time* (x denotes the band number), summing the output of the averager from the left channel with the output of the averager from the right channel and raising this to the power of  $\frac{1}{2}$ . For band x the input to the RMS calculator is delayed by minus *detectorlookaheadx* samples to compensate for the delay in the averagers. The largest possible value for these parameters is 2200. Let us call the calculated RMS RMS1 for band 1, RMS2 for band 2 etc.

Now RMS1, RMS2, RMS3 etc are combined, which I call coupling. Let us call the coupled values RMS1coupled, RMS2coupled etc for each band. These values are calculated like this.

$$\begin{aligned} \text{RMS1coupled} &= \text{Max}(\text{RMS1}, \text{RMS2} * \text{Coupling21}, \text{RMS3} * \text{Coupling31}, \text{RMS4} * \text{Coupling41}) \\ \text{RMS2coupled} &= \text{Max}(\text{RMS2}, \text{RMS3} * \text{Coupling32}, \text{RMS4} * \text{Coupling42}) \\ \text{RMS3coupled} &= \text{Max}(\text{RMS3}, \text{RMS2} * \text{Coupling23}, \text{RMS4} * \text{Coupling43}) \\ \text{RMS4coupled} &= \text{Max}(\text{RMS4}, \text{RMS2} * \text{Coupling24}, \text{RMS3} * \text{Coupling34}) \\ \text{RMS5coupled} &= \text{Max}(\text{RMS5}, \text{RMS2} * \text{Coupling25}, \text{RMS3} * \text{Coupling35}, \text{RMS4} * \text{Coupling45}) \end{aligned}$$

Max is a function returning the most positive of the arguments. CouplingXY is the connection from band X to band Y. Note that there are no couplings from bands 1 and 5.

The audio in all bands is delayed by 50 ms. This way the compressor can start increasing the gain reduction before the actual peak. This is done for band 1 and 2. For band 3, 4 and 5, the compressor does not do this kind of 'look-ahead' compression. When the compressor does not increase the gain reduction for a particular band (called attack), it enters release mode for that particular band. When the compressor is in release mode, the compressor waits for *CompressorxHold* samples before the gain reduction is reduced. The speed with which the gain reduction is reduced is set by *bx\_release* which is in seconds. The threshold for each band is set by *bx\_threshold*. (x denotes the band number.)

At the output of Energize II there is an RMS detector. The detection time for the averager in this RMS detector is set by *GateLevelDetector\_detecttime*. If this detector detects values below *bx\_threshold\_gate* dB, the compressor can only reduce its gain reduction with a time constant *bx\_release\_gate* seconds.

The release times for band 3, 4 and 5 are adaptive. The gain reduction of these bands are averaged by 1<sup>st</sup> order averagers with time constants *b3\_gain\_average\_t*, *b4\_gain\_average\_t* and *b5\_gain\_average\_t*. If the current gain reduction for one of these bands is larger than the current average value and the band is in release mode, the gain reduction is reduced with a very small time constant (also the compressor does not wait before the the gain reduction is reduced).

## The 5 band limiter

At the output of the compressor, each band is limited by dual mono limiters. The thresholds of the limiters can be set by *bx\_limiter\_threshold* in dB. (x denotes the band number.)

The limiter for band 1 is a soft clipper which starts deforming the signal at the limiter threshold and becomes a hard clipper about 3 dB above the limiter threshold.

Band 2, 3 and 4 are limited by look-ahead limiters with a 2 ms look-ahead time, hold time and release time. Band 5 is limited by a look-ahead limiter with a 0.5 ms look-ahead time, hold time and release time.

## The mixer

After the multiband limiter, each band is amplified by *bx\_output\_mix* dB. All the bands for which *OutSwitchBx* is 1 are summed and the result is fed to the next stage in Energize II. (x denotes the band number.)

## The pre-emphasis filter

The setting *PreEmpUS* controls the pre-emphasis filter. The value 0 switches off the filter. If a higher value is chosen, this value will be the time constant in microseconds of the pre-emphasis filter. Typical values are 50 and 75 microseconds.

## The final wide band limiter

The final wide band limiter is a look-ahead limiter with a 1 ms look-ahead time. At the input of the limiter the audio is amplified by *FinalGain* dB. The threshold of the limiter is *final\_threshold* dB.

A 1<sup>st</sup> order averager with time constant *final\_average\_t* seconds has as input Min(Amplification for the left channel, Amplification for the right channel). If the gain reduction for a channel is larger than the output of the averager, the release time is 1 ms, but if not, the release time is *final\_slowrelease* seconds.

## The settings file EnergizeII.in

The settings in EnergizeII.in are read once every second, so if you want to change a setting while Energize II is running, just open EnergizeII.in, change the setting and save the file. The change should take effect after a second or two.

This is an example of how the settings in EnergizeII.in can be set:

```
AGC_release = 0.2
AGC_threshold = -5.0
AGC_threshold_gate = -40.0
AGC_attack = 0.5
AGC_maxamp = 20.0
AGC_detect_time = 1.000
StFilter = 0
stereo_b2 = 1.00
stereo_b3 = 1.00
stereo_b4 = 1.00
stereo_b5 = 1.00
in_drive = 8.0
b1_detect_time = 0.030
b2_detect_time = 0.030
b3_detect_time = 0.030
b4_detect_time = 0.030
b5_detect_time = 0.030
detectorlookahead3 = 700
detectorlookahead4 = 700
detectorlookahead5 = 700
Coupling21 = 0.40
Coupling23 = 0.32
Coupling24 = 0.18
Coupling25 = 0.13
Coupling31 = 0.50
Coupling32 = 0.79
```

```

Coupling34 = 0.40
Coupling35 = 0.28
Coupling41 = 0.45
Coupling42 = 0.71
Coupling43 = 0.63
Coupling45 = 0.50
b1_threshold = -14.0
b2_threshold = -13.0
b3_threshold = -17.0
b4_threshold = -19.0
b5_threshold = -19.0
bx_threshold_gate = -40.0
bx_release_gate = 30.0
GateLevelDetector_detecttime = 0.050
b1_release = 2.000
b2_release = 2.000
b3_release = 2.000
b4_release = 2.000
b5_release = 2.000
Compressor1Hold = 11025
Compressor2Hold = 11025
Compressor3Hold = 11025
Compressor4Hold = 11025
Compressor5Hold = 11025
b3_gain_average_t = 0.150
b4_gain_average_t = 0.150
b5_gain_average_t = 0.150
b1_limiter_threshold = -14.0
b2_limiter_threshold = -11.0
b3_limiter_threshold = -11.0
b4_limiter_threshold = -11.0
b5_limiter_threshold = -11.0
b1_output_mix = 0.0
b2_output_mix = 0.0
b3_output_mix = 0.0
b4_output_mix = 0.0
b5_output_mix = 0.0
OutSwitchB1 = 1
OutSwitchB2 = 1
OutSwitchB3 = 1
OutSwitchB4 = 1
OutSwitchB5 = 1
PreEmpUS = 0
FinalGain = 6.0
final_threshold = -0.2
final_average_t = 0.050
final_slowrelease = 0.3

```

These are probably not the best settings for Energize II. If you find some better sounding settings you are most welcome to email them to me, so that I can put them om [www.bustad.com](http://www.bustad.com).

## Energizell.html

Energizell.html can be found under c:\. It contains the current gain reductions for the compressors and the amplification in the AGC. It is however only updated once every second and is reloaded automatically in modern web browsers.

## License

Energize II is freeware. I, Christofer Bustad, do not take responsibility of anything that may be caused by Energize II. Use it at your own risk.

## Who made this?

This plug-in is made by Christofer Bustad from Sweden. For more information, see <http://www.bustad.com>.

## About VST...

VST Plug-In Technology by Steinberg.



See <http://www.steinberg.net> for more information.