

## 4 TB EBU Loudness v3

Loudness and true-peak meter compliant with EBU R128, ATSC A/85, and ITU-R BS.1770.

### 4.1 Introduction

The EBU published its Loudness Recommendation EBU R128. It tells how broadcasters can measure and normalize audio using loudness meters. TB EBU Loudness and TB EBUCompact calculate k-weighted momentary loudness (LM), short-term loudness (LS), integrated loudness (LI) and loudness range (LRA) compliant with the EBU, ATSC and ITU specifications. Furthermore, true-peak levels (dBTP) are monitored as well.

Besides compliance to loudness requirements, the TB EBU Loudness plugin is also very useful tool to align the perceived loudness of different audio tracks (for example on an album). Differences in loudness (expressed as loudness units, or LU) can be directly translated into attenuation or gain expressed in dB to align the loudness of two or more tracks. Furthermore, the loudness range indicator can provide valuable information to verify the dynamic range of a track, and the potential need for dynamic range compression or expansion.

### 4.2 Features

- Loudness monitoring/metering compliant with ITU-R BS.1770, ATSC A/85, EBU R128, and EBU Tech report 3341.
- Loudness range (LRA) support according EBU Tech report 3342.
- EBU mode LUFS, EBU+9, EBU+18 and EBU+27 loudness scales and ITU-R BS.1770 LKFS loudness scale.
- Inter-sample (ISP) / ITU-R BS.1770 compliant 'true peak' detection
- Support of all sampling rates from 22 kHz upwards
- Stereo and 5.1 surround modes
- Includes a separate 'compact' plugin for stereo content only (several features are excluded)
- Virtually unlimited integration time
- Loudness history (up to a maximum of 2 hours) with hover and zoom functionality
- Ability to sync with play/pause of the DAW host (if supported by host)
- Based on the VST 2.4 specification to allow compatibility with virtually all host programs.

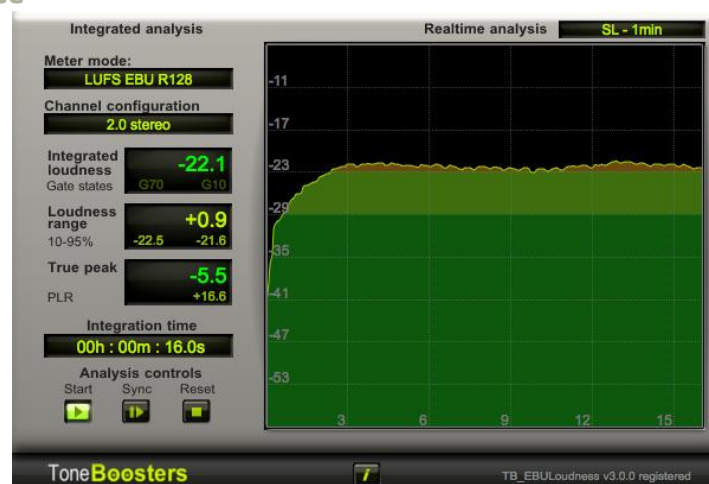
### 4.3 TB EBU Loudness and TB EBUCompact

This plugin comes as a set of two plugins:



- **TB EBU Loudness** is a 5.1-channel plugin assuming channel order Lf, Rf, C, LFE, Ls, Rs. It can process stereo and 5.1 content, provided that the host program is capable of running 6-channel plugins.
- **TB EBUCompact** is a stereo plugin and cannot process multi-channel content.

### 4.4 The user interface



GUI section	Control	Purpose
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<b>Integrated analysis</b>	Integrated loudness	K-weighted LI integrated loudness across the full integration time expressed in LU, LUFS or LKFS.  The G10 and G70 indicators will illuminate when the relative and absolute gates are active, respectively (not for ITU-R 1770-0).
	Loudness range	K-weighted LRA loudness range across the full integration time, expressed in LU, LUFS or LKFS.  The numbers below of the loudness range indicate the 10% and 95% percentiles of the short-term loudness distribution*.
	True peak	Maximum true peak (dBTP) observed since the last meter reset. The number below the true peak value will indicate the PLR (peak-to-loudness ratio)*.
	Meter mode	Sets the display and metering modes to one of: <ul style="list-style-type: none"> <li>• LU EBU R128 (2014)</li> <li>• LU EBU +9</li> <li>• LU EBU +18</li> <li>• LU EBU +27</li> <li>• LKFS ATSC A/85 (2013)</li> <li>• LUFS EBU R128 TB-3</li> <li>• LKFS ITU-R BS.1770-0</li> <li>• LKFS ITU-R BS.1770-3</li> <li>• LU K20 v2 (-20 LUFS)</li> <li>• LU K16 v2 (-16 LUFS)</li> <li>• LU K14 v2 (-14 LUFS)</li> <li>• LU K12 v2 (-12 LUFS)</li> <li>• LU K16 v2 d (-16 LUFS)</li> </ul>
	Channel configuration*	Select 2.0 stereo or 5.1 surround metering configuration. For 5.1 surround, the channel order must be front left, front right, center, LFE, left surround, right surround.
<b>Realtime analysis</b>	Mode*	Selects the real-time analysis mode: <ul style="list-style-type: none"> <li>• VU meters: shows momentary and short-term loudness VU meters, as well as true-peak meters for each audio channel.</li> <li>• LS (time): Shows the history of observed short-term loudness values. Time indicates the range from most recent value backward. In this mode, the following interactions are enabled: <ul style="list-style-type: none"> <li>○ Hover: if one moves the mouse pointer over the plot, the loudness value corresponding to the x-coordinate of the mouse pointer is given.</li> <li>○ Select: by left-mouse-click and dragging, a selection of the curve can be made for a zoom / detailed view of the data.</li> <li>○ Left-mouse-click (without drag) to zoom out completely.</li> </ul> </li> </ul>
<b>Analysis controls</b>	Start	Start / continue the integrated loudness and loudness range measurement.
	Sync	Enable or disable the pausing of the integrated loudness and loudness range meters if the host DAW stops playback (only for hosts that support this function).
	Reset	Reset all meters.
<b>Integration time</b>	-	Amount of time used for integrated loudness and loudness range measurement.

\* Not available in the EBUCompact meter

## 4.5 Loudness standards and target loudness

Both EBU R128 (for Europe) and ATSC A/85 (for USA) are both based on loudness metering defined in ITU-R BS.1770. The target loudness, gating mechanism, the loudness units and maximum allowed true peak levels are

nevertheless different, as indicated in the table below. If true peaks or the integrated loudness value are outside the valid range, the plugin will display the values in red instead of green.

Please note that the values below are taken from the 2011/2012 versions of the standards; please consult the respective documents to verify that these values are still correct.

Mode	Loudness unit	Gating	Target loudness	Maximum true peak
<b>LUFS EBU R-128 (2014)</b>	LUFS	Yes	-23 +/- 1 LUFS	-1 dB FS
<b>LU EBU +9</b>	LU	Yes	0 +/- 1 LU	-1 dB FS
<b>LU EBU +18</b>	LU	Yes	0 +/- 1 LU	-1 dB FS
<b>LU EBU +27</b>	LU	Yes	0 +/- 1 LU	-1 dB FS
<b>LKFS ATSC A/85 (2013)</b>	LKFS	Yes	-24 +/- 2 LKFS	-2 dB FS
<b>LKFS ITU-R BS.1770-0</b>	LKFS	No	-23 +/- 1 LKFS	-1 dB FS
<b>LKFS ITU-R BS.1770-3</b>	LKFS	Yes	-23 +/- 1 LKFS	-1 dB FS
<b>LUFS EBU R128 TB-3</b>	LUFS	Yes	-23 +/- 1 LUFS	-3 dB FS
<b>LU K-20 v2</b>	LU	Yes	-20 +/- 1 LU	-1 dB FS
<b>LU K-16 v2(d)</b>	LU	Yes	-16 +/- 1 LU	-1 dB FS
<b>LU K-14 v2</b>	LU	Yes	-14 +/- 1 LU	-1 dB FS
<b>LU K-12 v2</b>	LU	Yes	-12 +/- 1 LU	-1 dB FS

## 4.6 Setting up and measuring loudness

- Include the plugin in the last stage of the master bus as 'insert' plugin. Make sure that no other audio processing is performed subsequent to the loudness measurement. The loudness measurement plugin does not modify the audio signal, it only performs real-time metering.
- Specify the desired loudness measurement method. Use the 'mode' drop-down menu to select one of the supported loudness measurement methods / standards.
- Reset the meters by clicking on the 'reset' button.
- Determine whether you want to stop and start measurement of integrated loudness via the host (sync enabled) or via the plugin (sync disabled).
- Play the audio with the meters activated. Stop the host and/or plugin when the measurement period is finished.
- Read out the loudness and peak values of interest.

After the loudness of a program is measured, the required corrective gain (in dB) for loudness compliance can be simply obtained by taking the target integrated loudness and subtracting the measured integrated loudness:

$$G(\text{dB}) = L_{\text{target}} - L_{\text{measured}}$$

For true-peak compliance, it is advised to use an ITU-R BS.1770 compatible peak limiter with true-peak detection functionality, such as TB Barricade.

## 5 TB Barricade v3

Mastering-grade, transparent, highly customizable peak limiter with integrated dithering and perceptual noise shaping.

### 5.1 Introduction

TB Barricade is a stereo, mastering-grade peak limiter which supports control over the attack and release times, look-ahead time, and includes a quantization, dithering and perceptual noise shaping module to deliver high-quality delivery signals with limited bit depths. It is especially suitable to generate pristine final delivery signals for CD, DVD, online delivery, broadcast or podcast applications.

### 5.2 Features

- Fixed delay (1023 samples)
- Adjustable input and output gains
- Adjustable look ahead, attack and release times
- Inter-sample (ISP) / ITU-R BS.1770 / EBU R128 compliant ‘true peak’ detection and limiting
- Supports both waveform and envelope limiting
- Highly transparent limiting even with very high input levels
- Peak-hold VU meters with adjustable scales (K12, K14 or K20, or digital peak)
- Peak-hold RMS meters
- Quantization, dithering and perceptual noise shaping module
- Support of all sampling rates from 22 to 192 kHz
- Based on the VST 2.4 specification to allow compatibility with virtually all host programs.

### 5.3 The user interface



GUI section	Control	Purpose
Limiter gain	Env	Displays the limiter envelope reduction in dB including peak hold. Click on the scale to reset the peak hold function.
	Multiband	Displays the signal amplitude reduction resulting from multi-band limiting. Click on the scale to reset the peak hold function.
Signal levels	Input gain	Gain applied to the input signal before limiting (in dB).
	Out ceiling	Maximum output level of the limiter (in dB).

<b>Limiter dynamics</b>	Attack	Response time constant to loudness increases (in seconds).
	Release	Response time constant to loudness decreases (in seconds).
	Lookahead	Lookahead time of the limiter to respond to overs (in seconds).
	Stereo link	Amount of linkage between the limiter operating on the left and right audio channels. Higher stereo link levels will improve the stereo image at the (potential) expense of lower overall loudness. Stereo link does not influence the waveform auto saturation operation.
	Multiband	Amount of multiband limiting. Set to 0 to exclude multiband limiting.
<b>Output resolution</b>	Dithering	Bit depth for final delivery output signals. Set to 'off' to exclude quantization and dithering.
	Noise shaping	Amount of perceptual noise shaping applied to the quantization errors and dithering signals. Higher values will result in lower quantization noise audibility.
<b>Output level</b>	VU meters	Peak (with peak hold) and RMS (with peak hold) display. Click to reset peak-hold values.
	Meter type	Select the meter scale (peak, K12, K14 or K20).
<b>Switches</b>	ISP	Enable true-peak / ISP limiting (for final delivery signals).
	Monitor	When enabled, the limiter operation is applied to the input signal without incorporation of the input and output gains. This allows to listen to the limiter operation without impacting loudness.
	AES17 +3dB	When enabled, the RMS readout is increased by 3.01 dB to align peak and RMS levels of sinusoidal signals.
	Meter reset	Reset all peak-hold values of the GUI VU meters.

## 5.4 Setting up and using TB Barricade

### 5.4.1 Input gain and output limit

TB Barricade limits the maximum amplitude of its input signals. The amount of limiting is determined by

- the input signal level;
- the input gain control, and
- the output ceiling control.

Input signals are first attenuated or amplified by an amount determined by the input gain control. Subsequently, the maximum amplitude is limited to the value of the out ceiling control. Values above the value of the output limit control are referred to as 'overs'.

The amount of gain (or attenuation) applied by the limiter is indicated by the limiter gain meters for the left and right channels individually.

The effect of the limiter (gain) can be evaluated without actual incorporation of the input gain by activating the 'mon' (monitor) switch.

### 5.4.2 Lookahead, attack and release times

Limiters need a certain amount of lookahead to allow for a smooth gain curve. If an over is detected, the limiter will already gently start attenuating the signal a few milliseconds in advance of the over. This lookahead prevents distortion and intermodulation artefacts. Depending on the audio content, values between 1 and 3 milliseconds will generally suffice.

Part of the character and transparency of TB Barricade results from its intelligent algorithm that discriminates between instantaneous (short) peaks, or overs, and long-term loudness increases that result in many consecutive overs.

- Instantaneous, sporadic overs are limited by fast reacting limiting action which is determined by the lookahead time.
- Long-term loudness increases resulting in many or consecutive overs are limited by longer-term loudness estimation. The attack and release times of this loudness analysis are set by the attack and release controls:
- A long attack time will result in a slow reaction to loudness increases, and will typically result in more loudness at the output of the limiter.
- A short release time will quickly recover the limiter from loud passages, resulting in more loudness at the expense of a (risk of) breathing/pumping artefacts.

#### 5.4.3 Stereo link

If the limiting gain is different for both audio channels, the spatial image of the audio content may shift towards the center position. To prevent distortion of the spatial image, TB Barricade allows to link the limiter action between the channels.

- Stereo link values between 0 and 50% will gradually link loudness estimates between the channels, but allow the limiter to still process instantaneous peaks in channels individually.
- Values above 50% will gradually link instantaneous peaks across channels as well.

#### 5.4.4 Multiband

Barricade features a fully automatic multiband limiting algorithm. Opposed to wide-band envelope limiting, this stage processes individual frequency components. For many types of content, a certain amount of multiband limiting will result in more transparent limiter behavior in situations of very high signal levels, or extreme limiting. Setting the control to 0 will switch off the multiband limiter. The amount of multiband limiting is visualized in the limiter gain VU meters. In most cases, the signal attenuation as a result of multiband limiting will not exceed 6-8 dB to ensure that the timbre of the audio content is not changed significantly.

#### 5.4.5 VU meters and scales

TB Barricade features RMS and peak output meters. Peak meters indicate instantaneous digital peak (maximum amplitude); RMS meters indicate the average signal power with an exponentially-decaying time constant of 300 ms.

Four different output scales can be used:

- 'Digital peak': A full-scale digital signal corresponds to 0 dB on the meters.
- 'K12': A full-scale digital signal corresponds to 12 dB on the meters. This scale is typically used for broadcast applications.
- 'K14': A full-scale digital signal corresponds to 14 dB on the meters. This scale is also typically used for CD mastering.
- 'K20': A full-scale digital signal corresponds to 20 dB on the meters. This scale is typical for DVD authoring, and classical music.

The aim of these various scales is to control the amount of headroom for peaks in the audio content with respect to the RMS (or loudness) level. The proper use of these metering systems is beyond the scope of this manual. The reader is referred to other resources. The peak hold values indicated by the meters can be reset by clicking on the respective indicator.

#### 5.4.6 AES17 RMS+3

Mathematically, a sinusoidal signal has a peak value that is 3.01 dB higher than its power (RMS). For output metering, on the other hand, it can be convenient to align peak and RMS values for sinusoidal signals. If this behaviour is intended, the RMS+3 control should be activated. This setting will increase the RMS readout by 3.01 dB and is recommended when interpreting RMS values of the various K scales.

#### 5.4.7 ISP

The 'True peak / ISP' switch determines whether Inter-Sample Peaks (ISP) will be taken into account in the limiter (if set to 'on'). Digital-to-Analog (D/A) converters often employ up-sampling and interpolation of audio signals. During this process, new audio samples are inserted in-between current audio samples. These samples may extend the full digital scale, even if the original samples are all within the full digital scale.

When the True peak/ISP switch is on, the limiter will protect against such potential clipping problems. The use of True peak/ISP is only necessary if used as limiter operating on the master bus for generation of final output delivery signals.

The True peak/ISP implementation of TB Barricade is compliant with ITU-R BS.1770.

#### 5.4.8 DC reject filter

To ensure a DC-free output signals, TB Barricade has a build-in DC rejection filter with a fixed -3 dB cut-off frequency of 1 Hz.

#### 5.4.9 Output resolution

If TB Barricade is used to deliver final delivery signals (e.g. on a master bus) with a limited bit depth (for example 16 or 24 bits), dithering and perceptual noise shaping module should be enabled. Set the dithering resolution to the number of bits of the final output format (16 or 24 bits).

Quantization and dithering always results in the generation of quantization errors, or quantization noise. The audibility of this noise can be greatly reduced by the processes of perceptual noise shaping. Noise shaping changes the spectrum of the quantization noise such that it becomes less audible. The amount of perceptual noise shaping can be controlled with the noise shaping control. A value of 0 indicates no noise shaping; 100% indicates maximum noise shaping.



Dithering and noise shaping should only be enabled if TB Barricade is the **last processing plugin** to render a final output signal.