TSL SERIES · EQUALISATION

LAP TSL-E26

STEPPED THREE-BAND EQUALISER · V3.4.0 · USER MANUAL

How it works - and how it differs from a plugin EQ. TSL-E26 is a stepped equaliser and the controls mean what they meant on the unit. Three bands with stepped gain (±15 dB in 3 dB steps) at switched frequencies (LOW 63 Hz – 1 kHz, MID 0.7 – 4 kHz, HI 2.8 – 11 kHz), each band a resistor ladder loaded by an active resonator. There is no Q control and the Q is not constant: the bell gets wider as the gain gets smaller - about Q 0.8 at ±15 dB, 0.5 at ±9 dB and only 0.31 at ±3 dB, so a small correction is a very broad one. The three stages are in cascade and add up where they overlap. SHELF turns the LOW or HI band into a 6 dB/octave shelf hinged at the selected frequency. HF CUT is a second-order (12 dB/oct) low-pass with −3 dB at 13 / 8.3 / 6.5 / 4.1 kHz. BYPASS is EQ OFF: the resonators are disconnected and the board passes flat. The board clips at about +1 dBFS, so large boosts on hot signals clip inside the EQ as they would in the hardware. The two channels are two units with their own component tolerances.

Light on CPU. TSL-E26 is a component-level circuit model solved in real time, and the lightest unit of the TSL series: the equaliser board itself costs almost nothing - about 1 % of a CPU core for a stereo instance at the default settings - and the output transformer (off by default) adds the rest, about 7 % with it on. Light enough for every track of a session.



1 Working the panel

Action	Result
drag a knob	every knob is a stepped switch: a vertical drag moves it one position at a time (hold `Shift` for a slower drag); the mouse wheel steps it one notch per click
hover a knob	the exact position (frequency, dB) is printed below the knob scale while the pointer is over the knob
double-click a knob	resets to default (`Ctrl` -click does the same)
click SHELF	the amber LED above GAIN of the LOW and HI band is a switch: click it to turn the band into a shelf (LED lit) and back to a bell

click BYPASS	EQ OFF: the resonators are disconnected and the board passes flat (lit red bar = EQ off). The switch is click-free and usable while playing; the board keeps running, so BYPASS does not lower the processor load.
click ON / OFF	LINK, see the chapter on LINK
click the LAP logo	opens a small About window with the plugin version, formats and links
right-click the panel	the settings menu, see below
preset bar	above the panel, see Presets



Left: the settings menu (right-click the panel); the active choice of every row is highlighted. Right: the About window (click the LAP logo) with the version, formats and contact.

Menu row	Choices	What it does
SCALE	80 · 100	window size in percent: 1052 × 176, **1315 × 220** (default), plus the 30 px preset bar
OVERSAMPLING	1x · 2x · 4x	see Oversampling, latency and CPU; default **2x**
TRAFO	OFF · ON	the output transformer, see Sound, levels and the output transformer; default **OFF**
SATURATION dB	−12 · 0 · +6 · +12 · +18	drive of the output transformer, see Sound, levels and the output transformer; default **+6**. With LINK off the menu has one row per channel (SATURATION 1 / 2).
LAP	ABOUT	the About window

A click on SCALE, OVERSAMPLING or ABOUT closes the menu; TRAFO and SATURATION keep it open, so the settings can be compared one after another while the music plays. A click anywhere outside closes it.

The panel shares its frame with the other plugins of the TSL series. Channel 1 runs from the left edge: HI · GAIN, MID · GAIN, LOW · GAIN - the frequency switch of each band (grey cap) in front of its gain switch (black cap, long centre mark = 0 dB) - then the small HF CUT knob above BYPASS next to the centre block with the LAP logo, the name and the LINK switch. Channel 2 is laid out as a mirror image, so the HF CUT knobs face the centre and HI sits at the outer edges. The scales print the switch positions:

every tick is one position. The whole panel is a 3D model rendered with ray-traced light, at three times the resolution of the default window so it stays sharp when enlarged or on high-DPI screens.

2 Presets



Element	What it does
category ▾	choosing a category loads its first preset at once. **Init** is the default state of both channels (LOW 250 Hz, MID 1.4 kHz, HI 5.6 kHz, all gains 0 dB, SHELF off, HF CUT LIN, LINK on, Oversampling 2x, output transformer off, SATURATION +6 dB); **User** holds presets saved without a category; every other category is a folder of your own.
preset ▾	the presets of the chosen category; user presets are marked with a dot. A * after the name means a switch or a menu setting was changed since the preset was loaded or saved; "-" means no preset is selected. The selected preset is saved with the project.
◀ ▶	step through all presets - quick A/B between saved settings
Save	overwrites the selected user preset with the current settings
Save as...	name and category (type a new one or pick from ▾); OK saves, Cancel returns
Delete	deletes the selected user preset - click twice ("Really delete?")

A preset stores the switches of both channels, LINK and everything in the right-click menu: Oversampling, the output transformer switch and SATURATION. It does **not** change the BYPASS (EQ OFF) buttons and the window size (SCALE). Loading a preset switches the board like a hand on the panel: the new board is built in the background and cross-faded in over 15 ms, so the audio keeps running without a drop-out. A preset saved by an older version still loads; controls it does not know start from their default (older presets have no Oversampling setting and load at 2x).

Presets are plain files: Windows `%APPDATA%\LAP\TSL-E26\presets\`, Linux `~/.local/share/LAP/TSL-E26/presets/` - one JSON file per preset, one sub-folder per category. They can be copied between machines and systems.

3 Controls (per channel)



Control	Positions	Notes
LOW	63 · 125 · 250 · 500 · 1k Hz	centre frequency of the LOW band (bell) or hinge frequency of the LOW shelf; default 250 Hz
MID	700 · 1k · 1.4k · 2k · 2.8k · 4k Hz	centre frequency of the MID band; default 1.4 kHz
HI	2.8k · 4k · 5.6k · 8k · 11k Hz	centre frequency of the HI band (bell) or hinge frequency of the HI shelf; default 5.6 kHz
GAIN	−15 … +15 dB in 3 dB steps	one per band, 11 positions. The width of the bell follows the gain, see Response. Default 0 dB (the long centre tick).
SHELF	LED above GAIN of LOW and HI	bell to shelf: the same resonator is rewired, so the boost or cut applies to everything below (LOW) or above (HI) the selected frequency with a gentle 6 dB/oct transition. Click the LED to switch; default off.
HF CUT	LIN · 12.5 · 8 · 6.3 · 4 kHz	second-order low-pass (12 dB/oct) after the three bands; −3 dB at 13.0 / 8.3 / 6.5 / 4.1 kHz for the four positions, LIN = out of circuit. Default LIN.
BYPASS	EQ ON / OFF	EQ OFF disconnects the three resonators: the board passes flat (−2.5 dB at 20 Hz, flat above), HF CUT and the output transformer stay in the path

> **Stepped means stepped.** There is no frequency between two positions and no gain between two steps; automation of a switch jumps between positions, and the plugin builds the new board and cross-fades it in over 15 ms so the jump is click-free. If you need a frequency in between, use the width of the bells: at small gains they are so broad that the neighbouring positions overlap heavily.

4 Response

The bell gets wider as the gain gets smaller. Each band is a stepped ladder loaded by an active resonator; turning the gain down does not only lower the peak but also takes the resonator further out of the circuit, so the Q falls with the gain. Measured on the MID band at 1.4 kHz (linear AC analysis of the board):

GAIN	Q	half-gain width	at 1 octave off	at 2 octaves off
±15 dB	0.80	0.77 … 2.5 kHz	±8 dB	±3 dB
±9 dB	0.51	0.6 … 3.3 kHz	±5.5 dB	±2.5 dB
±3 dB	0.31	0.39 … 4.9 kHz	±2.2 dB	±1.3 dB

Half-gain width = the band of frequencies where the response is at least half the peak in dB. The LOW and HI bands behave the same way at their own frequencies.

The bands add up. The three stages are in cascade, so where two or three bells overlap their dB values simply add: LOW at 1 kHz, MID at 1 kHz and HI at 2.8 kHz all at +15 dB give +38 dB at 1 kHz. Three small boosts on neighbouring frequencies make one big, broad one; a boost in one band and a cut in the next carve a slope between them.

SHELF. With the LOW shelf at 250 Hz and +15 dB the response is +15.3 dB at 20 Hz, +12.5 dB at 250 Hz and still +4.8 dB at 1 kHz; the HI shelf at 5.6 kHz, +15 dB gives +12.5 dB at 5.6 kHz and +14.3 dB at 10 kHz. The transition is a gentle 6 dB per octave - the shelf reaches far into the mid-range, as the bells do.

HF CUT is a second-order (12 dB/oct) low-pass after the bands, −3 dB at 13.0 / 8.3 / 6.5 / 4.1 kHz. It is the right tool to tame a bright source without touching the HI band, or to round off the top after a large HI boost.

EQ OFF (BYPASS) disconnects the resonators; what remains is the flat board: −2.5 dB at 20 Hz, flat from there to 20 kHz. The level does not change when the EQ is switched off and all gains are at 0 dB.

5 Sound, levels and the output transformer

The output stage of the board clips at about **+1 dBFS**: a +15 dB boost on a signal at −12 dBFS already clips inside the equaliser, exactly as it would in the hardware. Keep an eye on the level after large boosts, or turn the source down in front of the plugin. Below clipping the board is linear and very clean, and the response is set by the circuit, not by a transfer curve.

Two units, not two channels. Every resistor and capacitor of each channel has its own value within the tolerance of its part series, together with the offsets of the amplifiers: the centre frequencies of the two channels differ by up to about 3 % and the gains by about 0.1 dB - as two channels of real hardware do. The switches are the exception: the same position is the same setting on both. With LINK on the panel edits both, but they are not bit-identical.

Output transformer (TRAFO, default OFF). After the board the signal can pass through a model of a real audio output transformer: the core with its magnetisation and hysteresis is solved sample by sample (at 4 × 44.1 / 48 kHz, i.e. 176.4 / 192 kHz whatever the session rate), driven from the board and loaded like a line input. It adds weight in the low end and low-order harmonics that grow with the bass content and the level, while mid and high frequencies stay clean. The transformer adds 36 samples of latency at 44.1 / 48 kHz (30 at 88.2 / 96 kHz, none at 176.4 / 192 kHz); switching it on or off while playing is click-free and the host is told about the new latency.

SATURATION sets how hard the transformer is driven: the signal is raised by the chosen amount in front of the transformer and lowered by the same amount after it, so the level stays the same and only the core works harder or softer. Up to +12 dB the transformer adds only a trace of colour; at +18 dB the deep bass of loud passages goes into saturation (at 40 Hz the core clips from about +13 dB over full scale). Changes of SATURATION are smoothed over 20 ms and can be made while playing.

6 LINK and the two channels



The **ON / OFF** slider in the middle of the panel is LINK (default ON). With LINK on, every switch, SHELF, HF CUT, BYPASS and SATURATION of channel 1 is mirrored to channel 2 and the panel edits both at once; channel 2's own settings are copied from channel 1 the moment you switch LINK on, so nothing jumps when you switch it off again.

With LINK off the unit is dual mono: two boards, two sets of switches, no interaction between the channels, and the settings menu has a SATURATION row for each channel.

7 Oversampling, latency and CPU

The board is linear, so the plugin solves it with its capacitors pre-warped to the session rate: the centre frequencies of the bands and the −3 dB points of HF CUT sit where the circuit puts them at 1×, 2× and 4× alike. The exception is the top octave at 1× in a 44.1 / 48 kHz session: the HF CUT filter in its LIN position has its corner at 44.8 kHz, above what the session rate can represent, and the output falls by 0.5 dB at 16 kHz and 6.8 dB at 20 kHz (even with EQ OFF). At 2× it is −0.3 dB at 20 kHz, at 4× −0.1 dB. The default is therefore **2×**; 4× smooths the clipping of the output stage further when you drive the board into it on purpose, 1× saves a little CPU when the top octave does not matter. Oversampling is counted from 44.1 / 48 kHz: in an 88.2 / 96 kHz session 1× and 2× both run the board at the session rate, in a 176.4 / 192 kHz session every setting does.

Session	1×	2×	4×	+ transformer
44.1 / 48 kHz	0	30	36	+36
88.2 / 96 kHz	0	0	30	+30
176.4 / 192 kHz	0	0	0	+0

Latency in samples of the session, reported to the host; it changes when Oversampling or TRAFO is switched. Switching either while playing is safe: the new chain is built in the background and cross-faded in.

Every switch position is a different circuit. When a switch moves, the plugin builds the new board in the background (about a millisecond), hands it the physical state of the old one - the charges on all 63 capacitors - and cross-fades over 15 ms, so switching while playing is click-free and nothing drops out.

Load. Stereo instance at 48 kHz on the development machine: with the transformer off about 0.2 % of real time at 1× and about 1 % at 2× (the default), with the transformer on about 7 % (the transformer is nearly all of it); 4× adds a little (8 – 9 % with the transformer). The load does not depend on the programme.

8 Signal flow

Stage	What happens
input	resampler to the board rate (1× / 2× / 4× of 44.1 / 48 kHz)
input buffer	input stage of the board
LOW · MID · HI	three stages in cascade, each a stepped ladder (11 positions) loaded by an active resonator at the switched frequency; SHELF rewires the LOW / HI resonator; EQ OFF disconnects all three
HF CUT	second-order low-pass, 12 dB/oct, or straight through (LIN)
output	output stage of the board, clips at about +1 dBFS
after the board	resampler back to the session rate · output transformer with SATURATION (solved at 176.4 / 192 kHz, off by default)