TSL SERIES · TIME

LAP TSL-A91

TAPE ECHO · V1.0.9 · USER MANUAL

What it is. TSL-A91 is a tape echo with four playback heads. A tape loop runs past one record head and four playback heads at fixed spacing, so the echoes come at about **78, 159, 247 and 336 ms** - the time is chosen by picking heads, not by turning a delay knob. **ECHO 1–4** mix each head into the output. **HALL 1–4** record each head back onto the tape: one head gives repeats at its own time, several heads at once build a dense reverb, and near the top of the travel the loop starts to oscillate, exactly as on the hardware. RECORD sets how hard the tape is driven (soft tape saturation), ORIGINAL adds the direct signal through the unit's tone stage, BASS and TREBLE shape both. Wow and flutter, tape hiss and the high-frequency losses of real tape are part of the sound. The electronics are a real-time component-level circuit model.

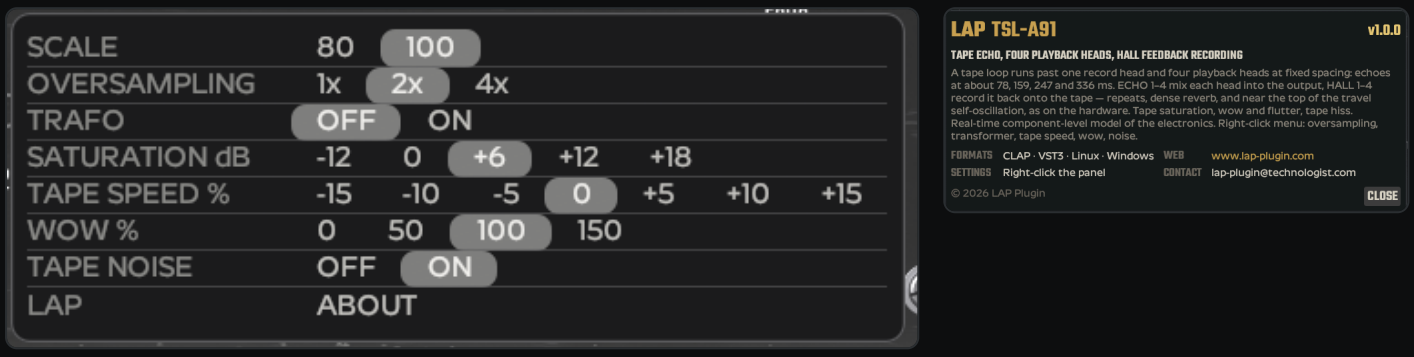
A mastering plugin. TSL-A91 - like every plugin of the TSL series - solves the electronics as a circuit in real time, and one stereo instance takes a sizeable part of a CPU core (about 20 % of real time at 48 kHz with the default 2× oversampling on the development machine, about 10 % at 1×). It is made for the master bus, for stems, for an echo send and for a few key tracks, not as an insert on every track of a session. Use it where it counts.



1 Working the panel

Action	Result
drag a knob	vertical drag changes the value; hold `Shift` for fine control; the mouse wheel works too
hover a knob	the exact value is printed below the knob: scale position and attenuation in dB, BASS / TREBLE in dB at 40 Hz / 16 kHz, MIX in %
double-click a knob	resets to default (`Ctrl` -click does the same)
click ECHO	the unit's output switch (green LED lit = on); off mutes the whole output of the unit, ORIGINAL included

slider POWER	the unit on / off; off = dry signal, delay-matched
click the LAP logo	opens the About window with the version, formats and links
right-click the panel	the settings menu, see below
preset bar	above the panel, see Presets



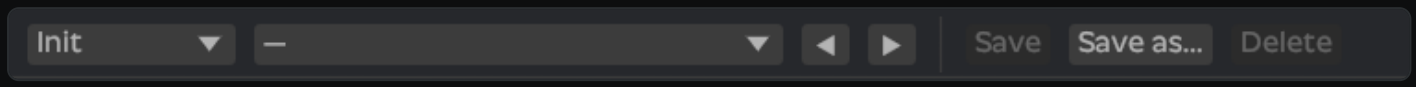
Left: the settings menu (right-click the panel). Right: the About window (click the LAP logo).

Menu row	Choices	What it does
SCALE	80 · **100**	window size: 1052 × 176 or **1315 × 220**, plus the 30 px preset bar
OVERSAMPLING	1x · **2x** · 4x	how fast electronics and tape are solved, counted from 44.1 / 48 kHz
TRAFO	**OFF** · ON	a model of a real audio output transformer after the unit
SATURATION dB	−12 · 0 · **+6** · +12 · +18	how hard the transformer is driven, at the same level
TAPE SPEED %	−15 … **0** … +15	tape speed within the tolerance of the hardware: all four echo times move together (+15 %: 68 … 292 ms, −15 %: 92 … 395 ms); the motor takes about 0.3 s to settle, with the pitch bend of a real machine
WOW %	0 · 50 · **100** · 150	depth of wow and flutter; 100 % = the hardware (1.5 % speed variation)
TAPE NOISE	OFF · **ON**	tape hiss, −42 dB per head relative to full tape level
LAP	ABOUT	the About window

The panel shares its frame and styling with the other plugins of the TSL series. On the left the **input**: RECORD (black cap) with the TAPE LED above it, and ORIGINAL. Then the **tape heads**: HALL 1–4 on the top row, ECHO 1–4 below with the nominal echo time printed under each, one column per head, head 1 nearest to the record head. In the centre the LAP logo, the name and the POWER slider. On the right the **tone** stage (BASS, TREBLE) and the **output**: VOLUME (red cap), MIX (blue cap) and the ECHO switch with its LED. The hardware uses sliders with a 0–6 scale for RECORD, ORIGINAL and VOLUME; here they are knobs marked MIN … MAX, and the hover value shows the 0–6 scale position and the

attenuation in dB. The whole panel is a 3D model rendered at three times the resolution of the default window.

2 Presets



Element	What it does
category ▾	choosing a category loads its first preset. Init is the default state (see Controls); User holds presets saved without a category; every other category is a folder of your own.
preset ▾	the presets of the chosen category; "-" means the current settings do not come from a preset
◀ ▶	step through all presets
Save / Save as... / Delete	overwrite the selected user preset, save under a new name and category, delete (click twice)

A preset stores all knobs and the right-click menu settings (oversampling, transformer, saturation, tape speed, wow, tape noise); the selected preset is saved with the project. It does **not** change the ECHO switch and POWER - those belong to the session. Loading a preset moves the controls like a hand on the knobs: the audio keeps running.

Presets are plain files: Windows `%APPDATA%\LAP\TSL-A91\presets\`, Linux `~/.local/share/LAP/TSL-A91/presets/` - one JSON file per preset, one sub-folder per category.

3 Controls

Control	Range	Notes
RECORD	MIN … MAX (0 … 6)	record level onto the tape (logarithmic). At 6 a −18 dBFS signal drives the tape to full level. Default 5.4 (−5 dB): programme around −18 dBFS RMS saturates the tape gently.
ORIGINAL	MIN … MAX (0 … 6)	the direct signal into the output mixer, through the tone stage and the output filter. At 6 the gain is unity. Default 6.
ECHO 1–4	0 … 10	how much of each playback head goes to the output (logarithmic). Default: head 2 at 9, head 4 at 8.
HALL 1–4	0 … 10	how much of each playback head is recorded back onto the tape. Default: head 4 at 7.5 (repeats every 336 ms, about 2.5 s to fade). See HALL.

BASS	−18 … +18 dB	at 40 Hz, centre = flat; acts on echo and ORIGINAL
TREBLE	−21 … +21 dB	at 16 kHz, centre = flat
VOLUME	MIN … MAX (0 … 6)	output level of the unit (logarithmic). Default 6.
MIX	DRY … WET	an addition for use as an insert: the dry input (delay-matched) against the output of the unit. **100 % = the unit exactly as it is** (default). The unit itself mixes only through ORIGINAL.
ECHO	button + LED	output switch of the unit (default on)
POWER	ON / OFF	off = dry signal, delay-matched; the model keeps running
TAPE LED	-	lights when the record current reaches full tape level (the start of the red field of the hardware's level meter)

4 How the echo works

The input amplifier feeds two faders. **RECORD** goes to the record amplifier, which also receives the HALL return, and through a treble pre-emphasis to the record head. **ORIGINAL** goes straight to the output mixer. On the tape the signal passes the four playback heads in turn; each has its own playback amplifier with the usual tape equalisation. From each head one knob (**ECHO**) feeds the output mixer and another (**HALL**) feeds the record amplifier. The output mixer adds the echoes and ORIGINAL, then come the tone stage, a filter that keeps the bias frequency out of the output (steep above 15 kHz), VOLUME and the ECHO switch. After the last head the tape is erased, so nothing returns from an earlier pass of the loop.

head	1	2	3	4
echo time, nominal speed	78 ms	159 ms	247 ms	336 ms
TAPE SPEED +15 %	68 ms	138 ms	215 ms	292 ms
TAPE SPEED −15 %	92 ms	187 ms	291 ms	395 ms

Tape. Recording with bias gives a soft saturation without hysteresis: relative to a quiet signal the echo is 0.6 dB lower at −6 dB, 2 dB lower with 5 % third harmonic at full tape level, 5.5 dB lower at +6 dB. The highs saturate first (pre-emphasis), there are no even harmonics. Through the tape the response is within 5 dB from 100 Hz to 6.5 kHz and within 8 dB from 50 Hz to 12.5 kHz, falling steeply above. Wow and flutter (1.5 % speed variation) is common to all heads, so the later heads waver more in pitch. Tape hiss is −42 dB per head.

5 HALL and self-oscillation

HALL records a playback head back onto the tape - the classic feedback of a tape echo. One head gives a train of repeats at its time; several heads at once give a dense, irregular reverb, because the repeats of the different heads interleave. The loop gain of a single head reaches about 1 at the top of the travel: the unit was designed to the edge. **HALL 1 alone starts to oscillate from about 9.4, HALL 4 alone from about 9.1, all four together from about 7.0.** Above that the loop builds up by itself - even from tape hiss alone - and settles where the tape saturates. This is kept as on the hardware; the output stays bounded, but it can get loud. The default (HALL 4 at 7.5) fades out.

What you see	What is happening
no TIME knob	the time is the choice of head; TAPE SPEED in the menu moves all heads by up to ±15 %
hiss in silence	tape noise, as on the hardware; TAPE NOISE OFF in the menu
HALL up, it starts to howl by itself	loop gain above 1 - turn HALL down
ECHO off and silence	ECHO is the output switch of the unit; for the dry signal use POWER or MIX
ORIGINAL darker than the input	the direct path runs through the tone stage and the output filter; a clean dry signal is MIX
echoes waver	wow and flutter; WOW 0 or 50 % in the menu
loud input, echo does not grow	tape saturation; at RECORD 6, −18 dBFS is already full tape level

6 Levels, stereo and POWER

Levels. −18 dBFS corresponds to the nominal input level of the hardware and to its nominal output at full tape level: with RECORD, one ECHO and VOLUME at maximum, a −18 dBFS signal comes back at −18 dBFS. ORIGINAL at maximum passes the input at unity gain. **Stereo.** The unit is mono; a stereo track gets two units with one set of controls, each with its own wow and tape hiss, as two machines would be - a mono source gets a slight width. **POWER** off passes the dry signal delay-matched; the model keeps running, POWER does not save CPU.

7 Oversampling, transformer and CPU

Electronics and tape run at a multiple of 44.1 / 48 kHz whatever the session rate: 1× at 44.1 / 48 kHz, **2×** (the default) at 88.2 / 96 kHz, 4× at 176.4 / 192 kHz. In 96 and 192 kHz sessions the signal is resampled down and back, so the load does not grow with the session rate. Changing OVERSAMPLING while playing builds a new pair of units in the background; the old one keeps playing for about 0.4 s until the new tape is filled, then they are cross-faded (only the HALL tail from before the switch is lost).

Output transformer (TRAFO, default OFF) - the same transformer model as in the other plugins of the TSL series, after the unit; the level drops by about 1.5 dB, SATURATION drives the core harder at the same level.

Session	1×	2×	4×	+ transformer
44.1 / 48 kHz	0	30	36	+36
88.2 / 96 kHz	61	0	30	+30
176.4 / 192 kHz	147	61	0	+0

Latency in samples of the session, reported to the host. The echo times are not latency - they are the echoes.

Load. Stereo instance at 48 kHz on the development machine (pink noise): about 10 % of real time at 1×, about 20 % at 2× (the default) and about 43 % at 4×; the transformer adds about 10 %, moving a knob adds a few percent while it moves (the circuit is re-solved for the new pot positions). Driving the unit into hard clipping - RECORD at maximum with loud programme, TREBLE or BASS at maximum, HALL fully up - costs more, because the amplifiers keep switching between their linear and clipped states: with everything at maximum on loud drums the load stays around 22 % at 2× with the worst block under real time. The same figures apply in 96 and 192 kHz sessions.