VANGUARDFX

DSP Engine — User Guide

Audio analysis & spectrum visualizer • v1.0.3

The **VanguardFX DSP Engine** is the audio analysis brain of the VanguardFX ecosystem. Load any audio file, analyze it across 31–512 frequency bands, visualize in real-time, and export to CSV for use in the LSP plugin (or any third-party tool that reads tabular spectrum data).

What DSP does

- **Real-time spectrum analysis** — see audio energy across the frequency range
- **FFT-based** — Fast Fourier Transform with configurable window size
- **3–512 frequency bands** — from broad (3-band bass/mid/treble) to ultra-fine
- **SmartEQ** — perceptual frequency weighting for natural-sounding analysis
- **Pattern masks** — apply pre-built shapes to the spectrum (gates, ramps, curves)
- **Multi-format export** — CSV with frame index, time, bass/mid/treble averages, RMS, peak
- **Visual gradients** — 12+ color palettes for the spectrum display
- **EQ widget** — boost/cut bass, mid, treble before analysis
- **Waveform display** — view the source audio alongside the spectrum
- **Batch processing** — analyze multiple files at once
- **Sync bus integration** — feeds LSP and MSP plugins in real-time
- **Sidecar metadata** — JSON file with FPS, sample rate, duration, settings

System requirements

Operating system	Windows 10/11, macOS 11+, Linux (Ubuntu 20+)
Python	Python 3.9+ (standalone, not bundled with Max)
Required packages	PyQt6, pyqtgraph, numpy, pandas, sounddevice, soundfile
Audio formats	WAV, MP3, FLAC, OGG, M4A, AIFF (anything libsndfile supports)
RAM	4 GB minimum
Display	1280×720 minimum (1920×1080 recommended)

Installation

From the VanguardFX archive:

1. Extract the DSP folder from your downloaded archive
2. Open a command prompt / terminal in that folder
3. Install dependencies:
   ```
   pip install PyQt6 pyqtgraph numpy pandas sounddevice soundfile
   ```
4. Run the DSP:
   ```
   python DSP.py
   ```

The DSP window opens with tabs for Analyzer, CSV, Batch, and Help.

The four tabs

1. Analyzer

The main workspace. Load an audio file, see the live spectrum, adjust settings, and export. Includes the waveform timeline, spectrum canvas (bars or curve), EQ widget, and playback transport controls (Play, Pause, Stop, Seek).

2. CSV

Inspect an exported CSV before sending to LSP. View the columns, validate frame count vs. duration, spot outliers, and re-export with different settings if needed.

3. Batch

Drop in multiple audio files. DSP analyzes and exports CSV for each automatically, using the current Analyzer settings. Useful for music albums, podcast series, or long event recordings split into chapters.

4. Help

Built-in documentation, shortcuts, FAQ, and links to support resources.

Key settings explained

Bands (31–512)

Number of frequency bins. **31 bands** is standard (matches consumer audio equipment, easy to work with). **64–128** for medium detail. **256–512** for scientific or art projects where fine frequency detail matters. More bands = larger CSV file and slower processing.

Frame / Hop size

FFT window (frame) determines frequency resolution. Hop determines time resolution. **Frame = 4096, Hop = 512** is the default — good balance of detail and speed. Smaller hop = smoother but more frames in output CSV.

FPS (frames per second of output)

Derived automatically from sample rate ÷ hop size. **For 3ds Max scenes, use 30 or 60 FPS** — and set your scene timeline to match. Mismatched FPS causes drift between audio and lights.

SmartEQ

Perceptual weighting that compresses extreme highs and lows so the spectrum looks natural to human ears. **Turn ON** for music visualization. **Turn OFF** for scientific analysis where you need raw amplitude.

Pattern masks

Apply mathematical patterns to the spectrum before export — e.g., emphasize bass only, create gated frequency windows, or generate spectrum-based animations. Useful for designing specific LSP behaviors at

the source instead of in 3ds Max.

Color gradient

12+ palettes for the live spectrum display: ■ Orange, ■ Ocean, ■ Rainbow, ■ Diamond, ■ Aurora, ■ Magic, and more. The gradient is just visual — it does not affect the exported CSV. (Color comes from LSP/MSP downstream.)

Exported CSV format

The exported CSV is a tabular file with one row per frame. The exact columns depend on your export settings, but typically:

Frame	Integer frame index, starting at 0
Time_ms	Time in milliseconds from start of audio
bass_avg	Average energy in the bass range (20-250 Hz)
mid_avg	Average energy in the mid range (250-4000 Hz)
high_avg	Average energy in the high range (4000-20000 Hz)
Band_001…Band_N	Energy per individual band (0.0 to ~1.5)
RMS_Total	(optional) Total root-mean-square energy
Peak_Band	(optional) Index of the loudest band
Peak_Val	(optional) Value of the loudest band

A sidecar JSON file (.dsp.json) is saved alongside the CSV containing metadata: sample rate, FPS, band count, duration, settings used, export timestamp. LSP reads this automatically to configure itself.

Tips & best practices

Match FPS to your scene. If exporting for 3ds Max at 30 FPS, ensure DSP is set to 30 FPS export. The frame count will then equal duration × 30. Mismatched FPS = visual drift over time.

Use loudness-normalized audio. If your audio is very quiet, the spectrum bars will be tiny. Normalize the file in Audacity or your DAW before analysis (target -3 dBFS peak). This gives more dynamic range in the exported CSV.

For music videos, use 30 FPS / 31 bands / SmartEQ ON. This is the sweet spot — modest file size, natural spectrum, syncs perfectly with standard timelines.

For scientific or art installations, use 60 FPS / 128 bands / SmartEQ OFF. Maximum detail. Files are 4× larger but lossless.

Troubleshooting

"No module named PyQt6" error on launch

Install dependencies: pip install PyQt6 pyqtgraph numpy pandas sounddevice soundfile. If you have multiple Python versions, ensure you're using the right pip (e.g., python3.11 -m pip install ...).

Audio plays but spectrum is flat / not moving

Check that the audio file is not silent. Try a different file. Increase the gain with the EQ widget. Confirm sample rate is supported (44.1k or 48k is safest).

Export takes a very long time

Reduce the band count (try 31 instead of 256). Reduce FPS to 30 or 24. For files longer than 30 minutes, consider splitting in your DAW first.

CSV won't load in LSP

Open the CSV in a text editor — first line should be a header comment with "VanguardFX DSP". If missing, the file may be corrupted or from an unsupported tool. Re-export from DSP. Also check the .dsp.json sidecar is in the same folder.

Spectrum looks "blocky" / not smooth

Increase band count for higher resolution. Reduce hop size for smoother time transitions. Switch the display to "Curve" instead of "Bars" in Analyzer settings.

Support

- **Telegram:** @VanguardFX_Support
- **Website:** vanguardfx.pro
- **Documentation:** vanguardfx.pro/docs
- **Email:** support@vanguardfx.pro