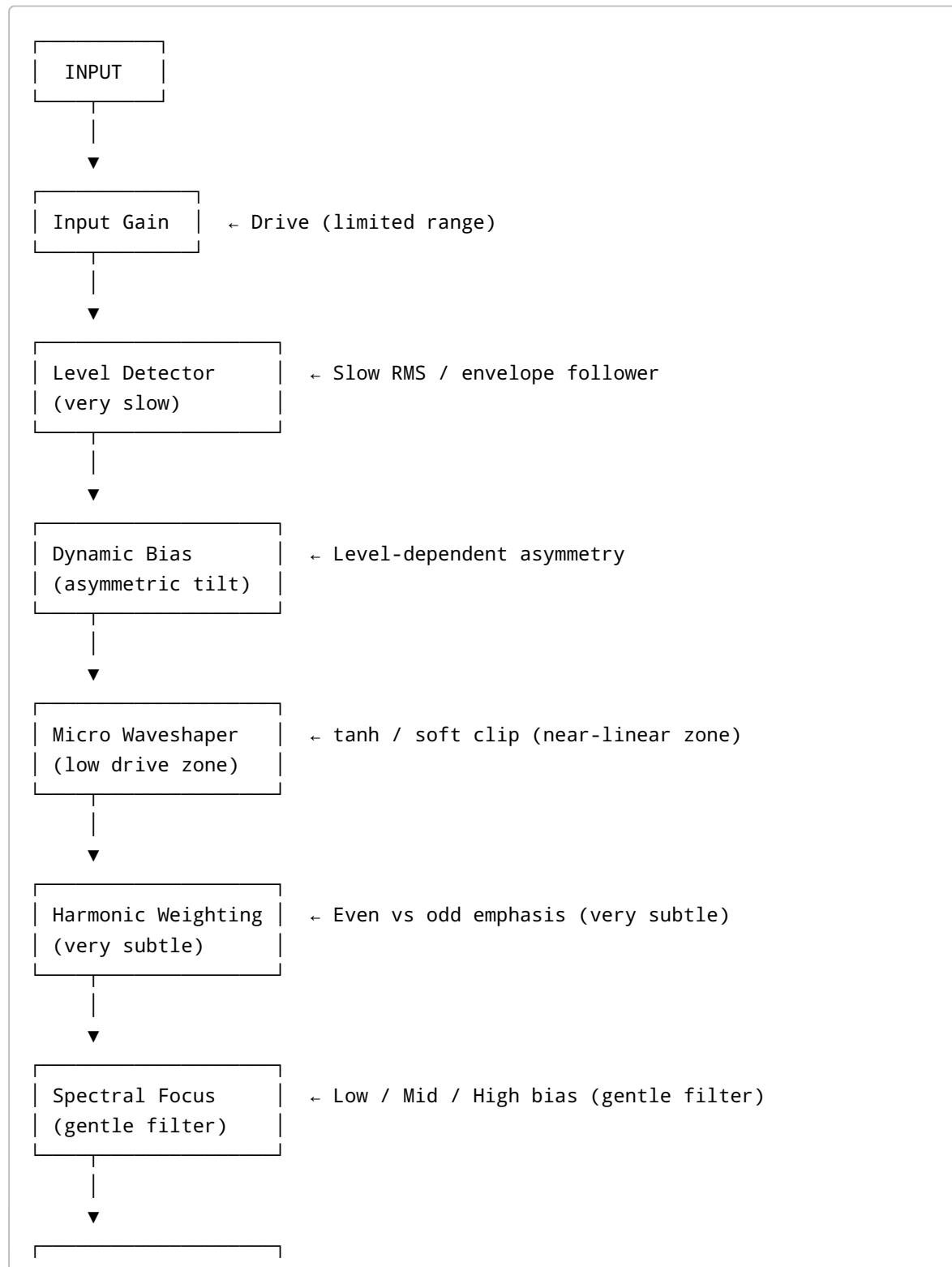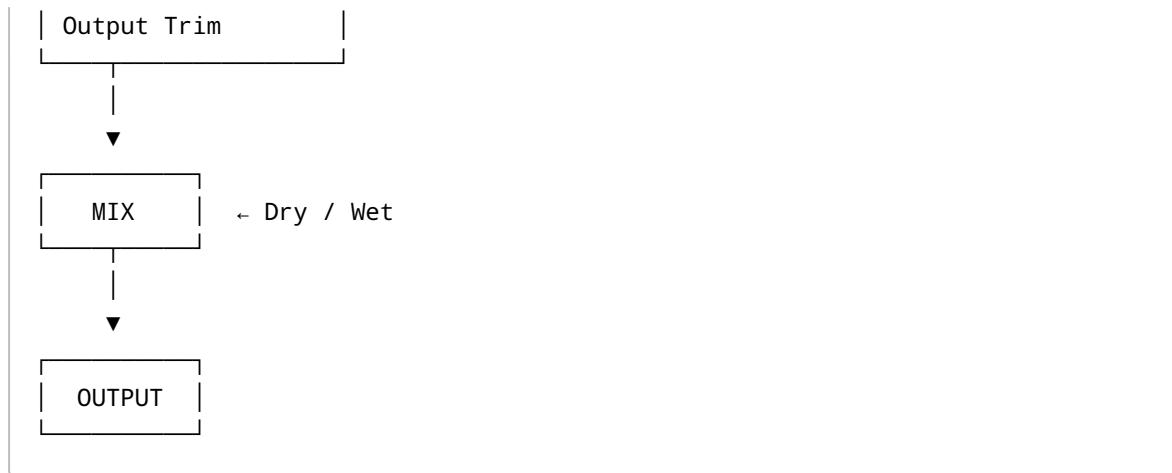# GRAIN — DSP Pipeline

Goal: Micro-harmonic saturation (texture), not obvious distortion.

High-level signal flow

```
┌─────────────┐
│   INPUT     │
└─────────────┘
       │
       ▼
┌─────────────┐
│ Input Gain  │   ← Drive (limited range)
└─────────────┘
       │
       ▼
┌─────────────┐
│ Level Detector │   ← Slow RMS / envelope follower
│ (very slow)    │
└─────────────┘
       │
       ▼
┌─────────────┐
│ Dynamic Bias   │   ← Level-dependent asymmetry
│ (asymmetric tilt) │
└─────────────┘
       │
       ▼
┌─────────────┐
│ Micro Waveshaper │   ← tanh / soft clip (near-linear zone)
│ (low drive zone) │
└─────────────┘
       │
       ▼
┌─────────────┐
│ Harmonic Weighting │   ← Even vs odd emphasis (very subtle)
│ (very subtle)      │
└─────────────┘
       │
       ▼
┌─────────────┐
│ Spectral Focus │   ← Low / Mid / High bias (gentle filter)
│ (gentle filter) │
└─────────────┘
       │
       ▼
┌─────────────┐
```

```
│ Output Trim        │
└───────┬────────────┘
        │
        ▼
┌───────────────┐
│    MIX        │   ← Dry / Wet
└───────┬───────┘
        │
        ▼
┌───────────────┐
│   OUTPUT      │
└───────────────┘
```

Notes (design intent)

- **Level Detector (slow RMS):** intentionally *does not* chase transients; it drives overall texture behavior.
- **Dynamic Bias:** introduces **asymmetry** to promote **even harmonics** in a controlled, musical way.
- **Micro Waveshaper:** operates close to linear range to avoid obvious distortion.
- **Harmonic Weighting:** small control to steer harmonic "flavor" (warmth).
- **Spectral Focus:** gentle filtering to bias where harmonics are generated (low/mid/high).
- **Mix:** crucial for subtle use (often 5–20% wet).

Suggested parameters (minimal UI)

- **Grain** (amount)
- **Warmth** (even/odd tilt)
- **Focus** (Low / Mid / High)
- **Mix** (Dry/Wet)
- **Output** (trim)