Chapter 6. Meeting 6, Controlling Gain and Processing Signals

6.1. Announcements

- Mix Graph 3 due Wednesday
- Audio materials for first Processing Report (due 7 March) will be released on Wednesday

6.2. Review Quiz 1

- ?

6.3. Amplitudes in Nature

- Each overtone has a different dynamic contour in time
- Transients: non-harmonic (non-periodic) attack portion of a sound
- ADSR dynamic contour (envelope)

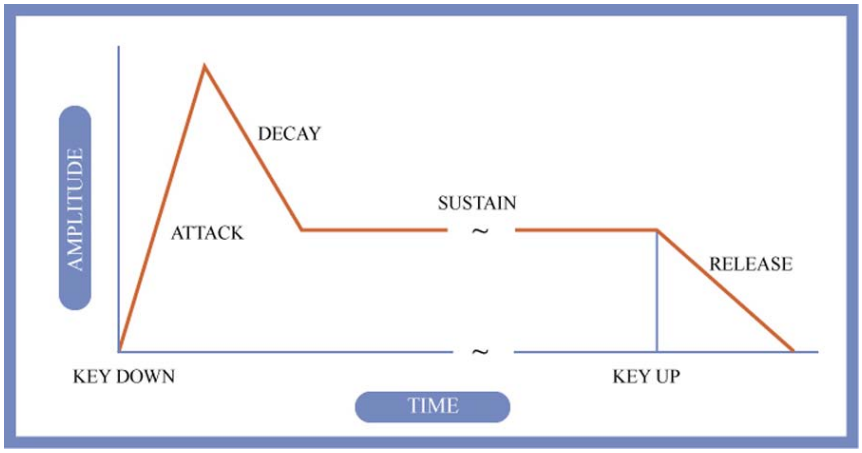


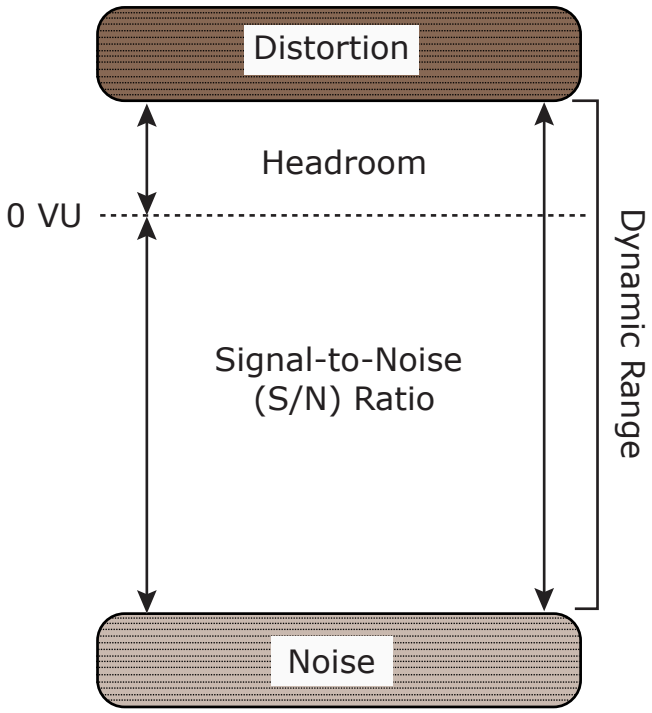
Image by MIT OpenCourseWare.

6.4. Dynamic Range

- Dynamic range: range of available amplitudes
- Standard operating level (SOL): optimum average level on a signal
  - Pro-audio: +4 dBu (-20 dBFS)

- Commercial audio: -10 dBV (-7.8 dBu)

- The maximum: peaking, clipping, saturation, overload, distortion, maximum output level (MOL)
  - As a sine wave is clipped, it becomes a square wave
  - Clipping adds harmonics
  - Example: processorsDistortion.pd
- The minimum: noise floor



Operating levels of an electronic sound system or device. We want to work above the noise floor and below the point of distortion.

Image by MIT OpenCourseWare.

- Signal to noise ratio
- Peak to average ratio

Graph removed due to copyright restrictions.
Illustration of peak level vs. average level in a sound wave.
See Fig. 11.4 in Thompson, D. M. *Understanding Audio*.
Hal Leonard Corp., 2005.

- Headroom: space between SOL and clipping (20 dB is standard)

6.5. Amplitude Meters

- A simple measure of signals power
- Potentially misleading
- Many varieties
- Considerations when evaluating amplitude meters
  - Peak or average?
  - Units in dB or something else?
  - Negative and/or positive values?
  - Where is 0 dB and what does it mean?
  - What is negative infinity?

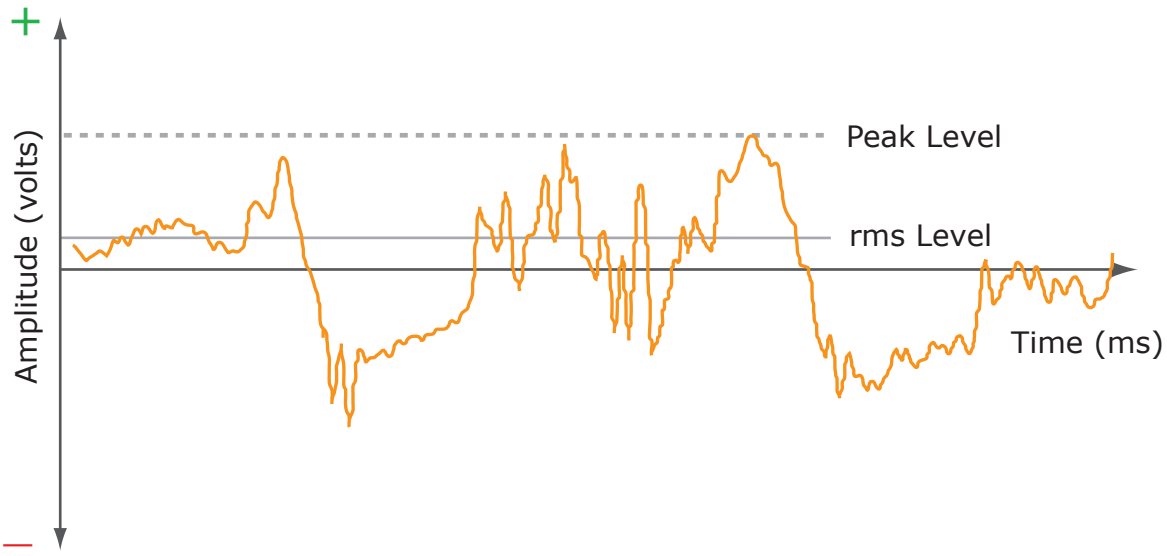
6.6. dB Meters

- dBu Meters: negative infinity to +24 dBu (sometimes 20 dBu)
- dBFS Meters: negative infinity to 0 dBFS

- dB SPL Meters: 0 to 120 dB SPL
- Comparisons
  - +4 dBu = -20 dBFS (sometimes -16 to -18 dBFS)
  - -10dBV is equivalent to -7.8 dBu

6.7. VU and RMS Meters

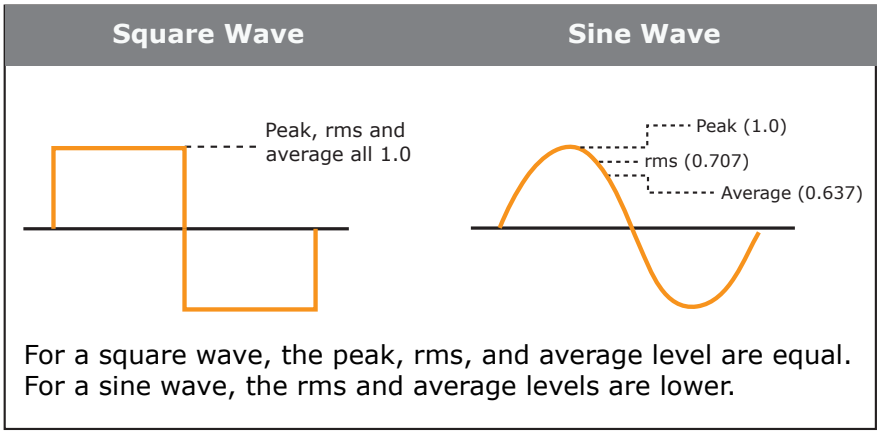
- Root Mean Square (RMS): an average
  - Mathematical average



The relationship between peak and rms levels, for a typically complex sound signal.

Image by MIT OpenCourseWare.

  - Average the square of a number (or a window) of samples, then take the square root
  - RMS of a square wave is greater than that of a sine wave



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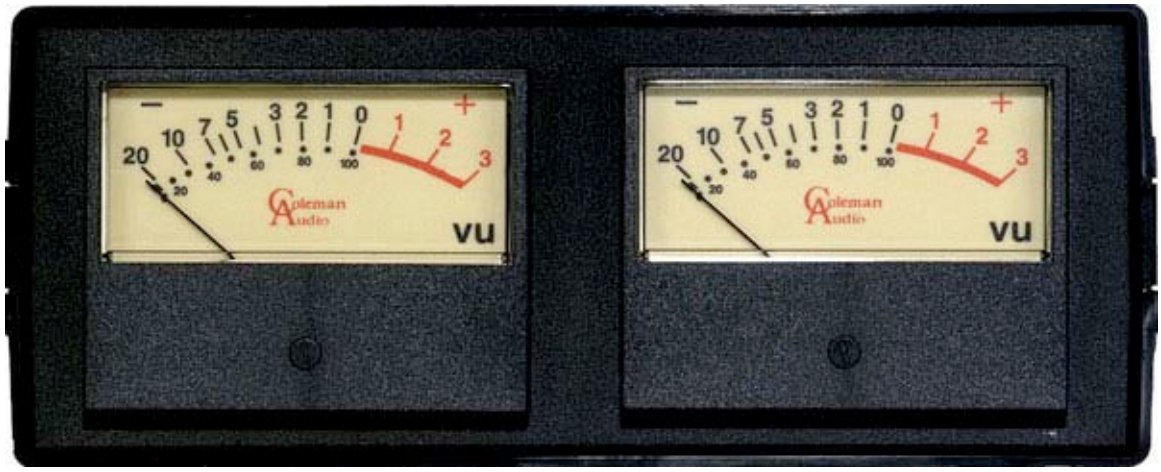
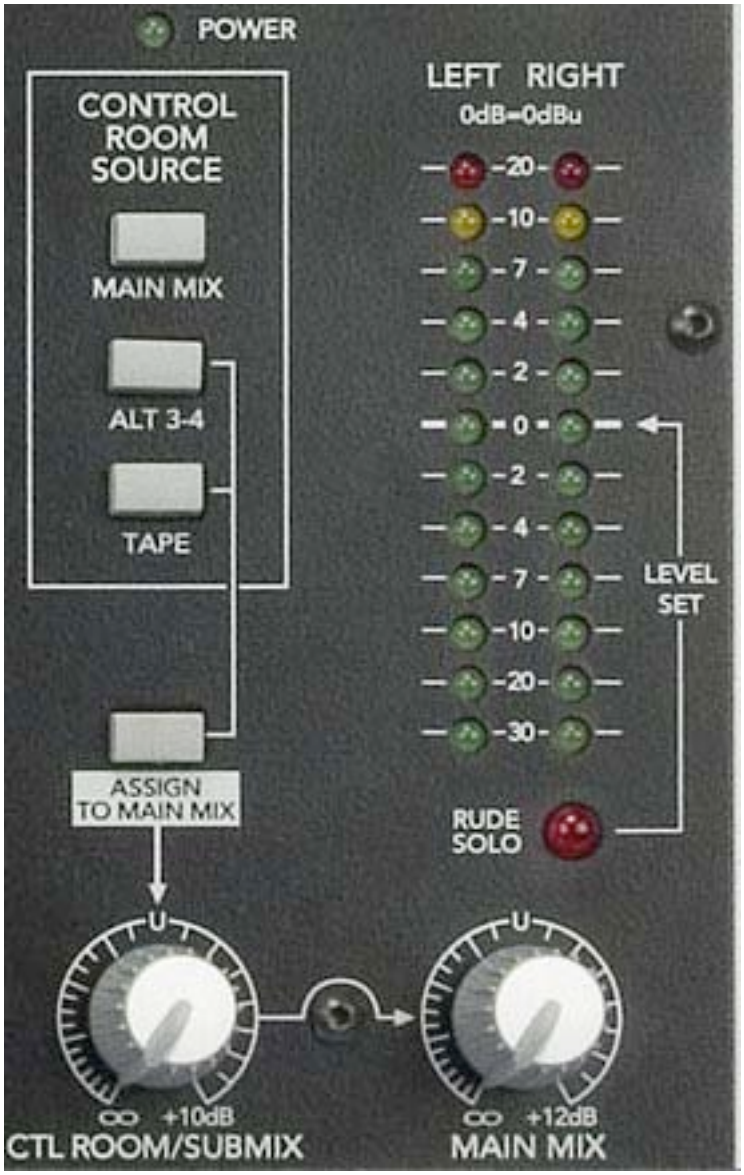
- Volume Units (VU): an average

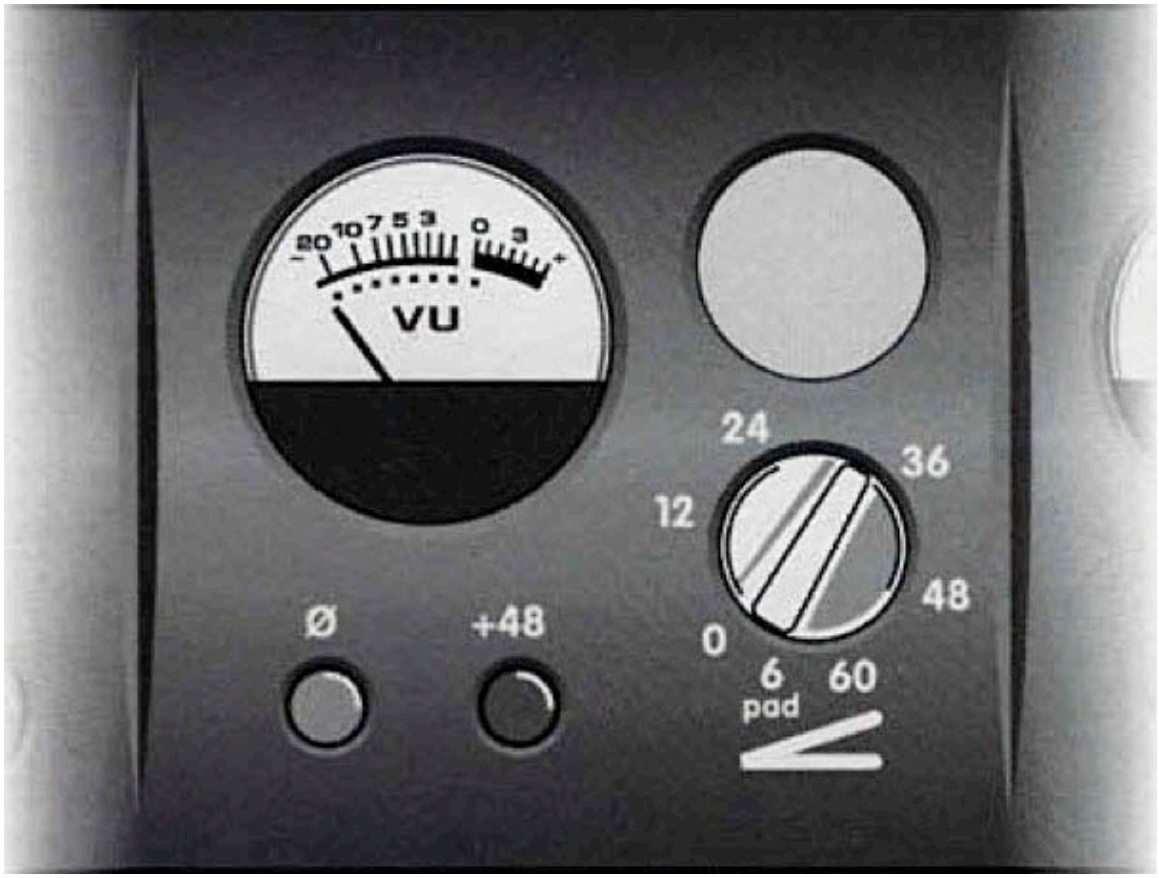


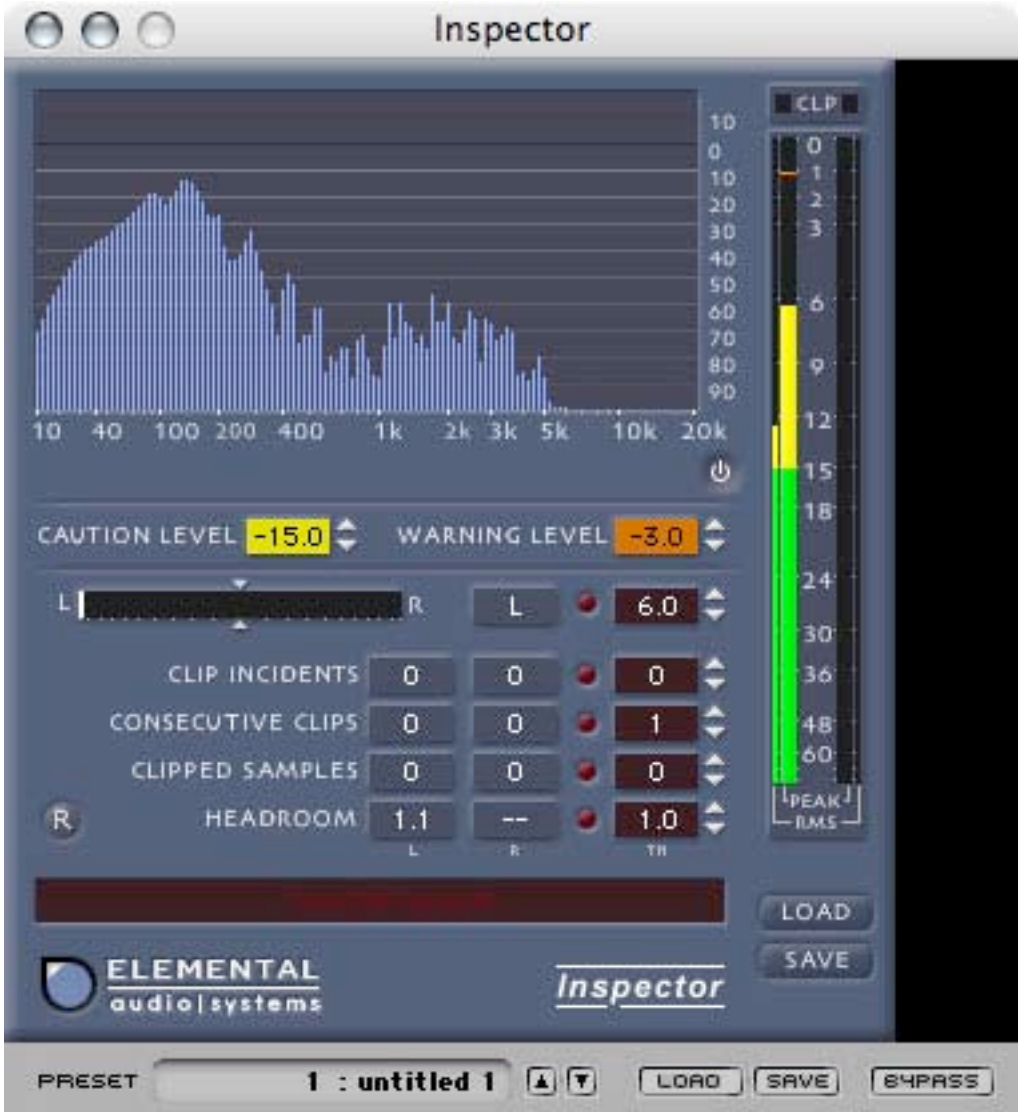
  - 0 VU is equal to +4 dBu or 1.228 V RMS for a sine wave
  - 0 VU is equal to -20 dBFS (sometimes -18 to -16 dBFS)
  - Change in 1 VU may be 1 dB change
  - Integrates 300 msec of change
  - Peak may be as much as 15 dB (8 to 20 dB) higher than VU reading
- Peak Program Meter (PPM)

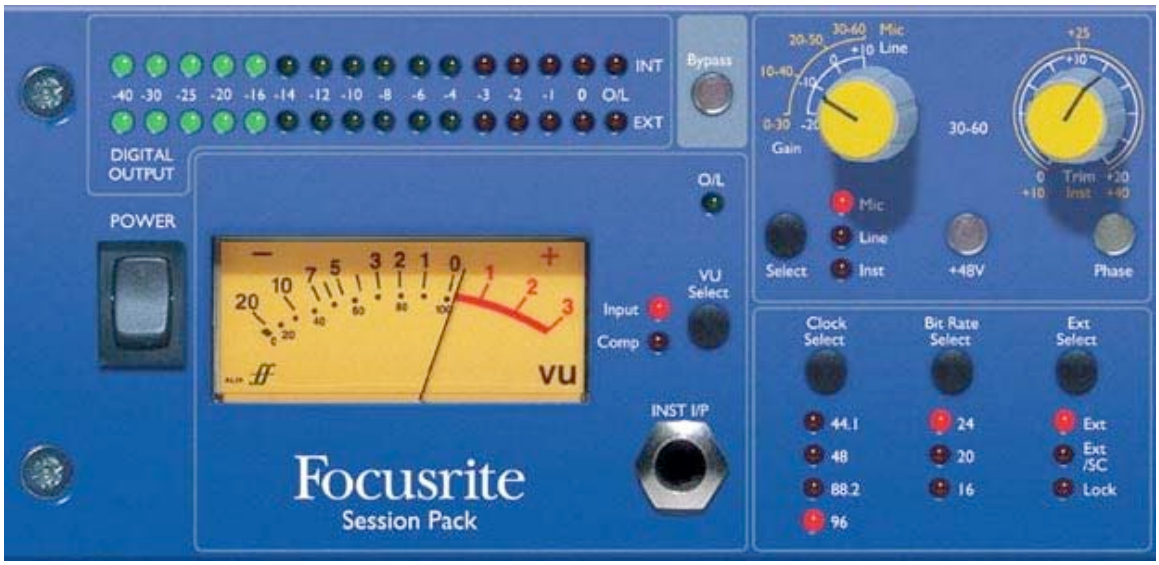
- Scale from 1 to 7; each segment is 4 dB change
- Faster attack time than VU meters (10 ms)
- PPM 6 = 100% reading, +4 dBu = 0 VU
- Adjusts after 10-12 ms

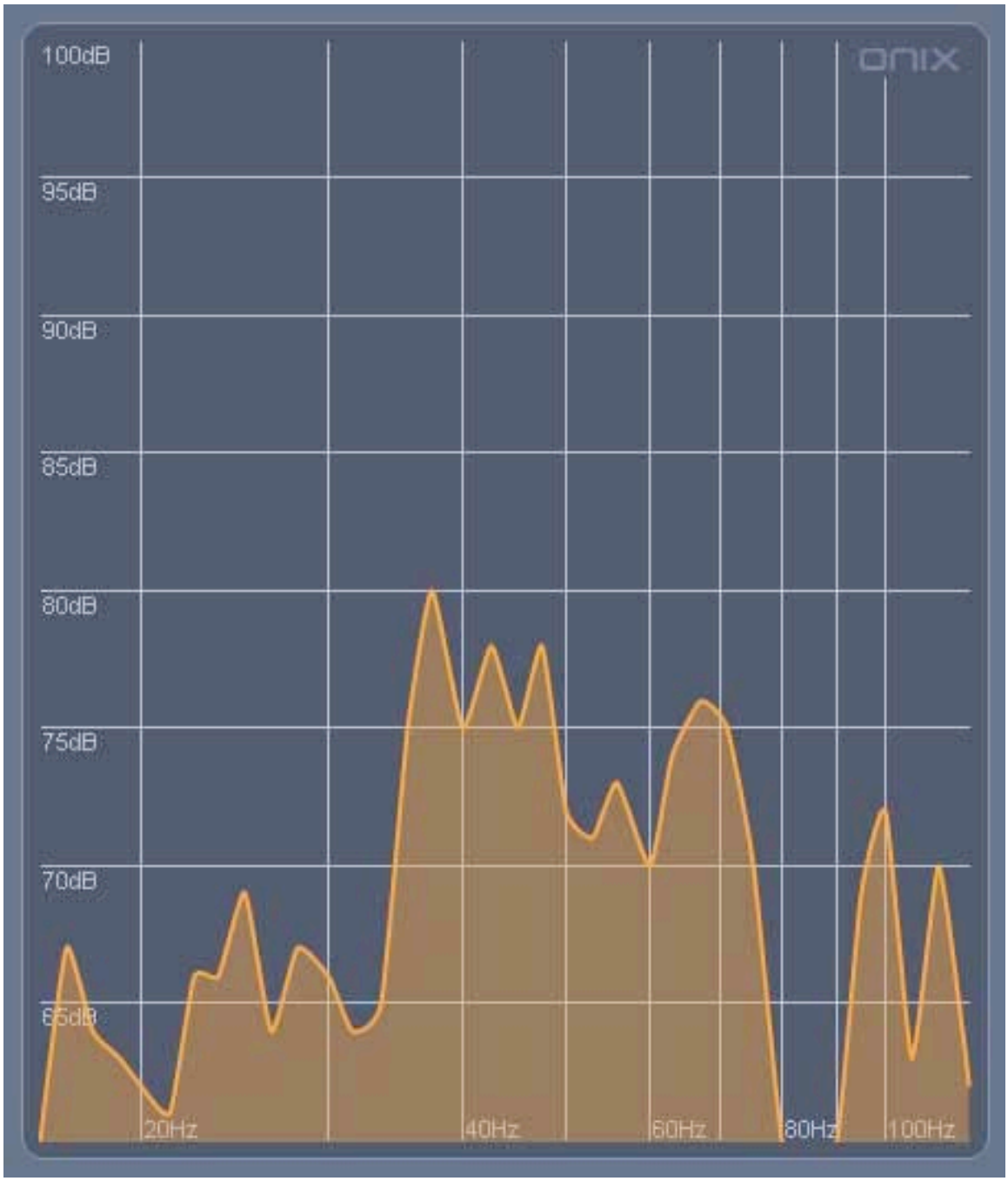
6.8. Meter Examples











6.9. Changing Amplitudes

- Pre-amp (trim): amplifier with a wide range of gain (0 to 60 dB) designed for bringing very quite signals up to SOL
- Power amp: amplifier for a taking a signal from SOL to a high-powered signal necessary to drive speakers
- Pad (attenuator): reduces gain by a fixed amount with a switch (-6 dB, -20 dB)
- Fader: scales a signal at SOL: unity (no change), boost +10 dB, attenuate to -infinity dB
- Direct Box: convert from -10 dBV to +4 dBu

6.10. Gain Staging

- Every signal goes through numerous amplifiers from source to destination
- Each amplifier is a gain stage
- Each amplifier (and any process in between) adds noise (has its own noise floor)
- Each gain stage, if above unity, can amplify the last gain stage's noise floor
- Optimal gain staging: first gain stage does all amplification; all subsequent gain stages are at unity
- Optimal gain staging: as much as possible as early as possible

6.11. Gain Staging: Example

- Inserting a device with a poor signal to noise ratio can degrade the entire signal path

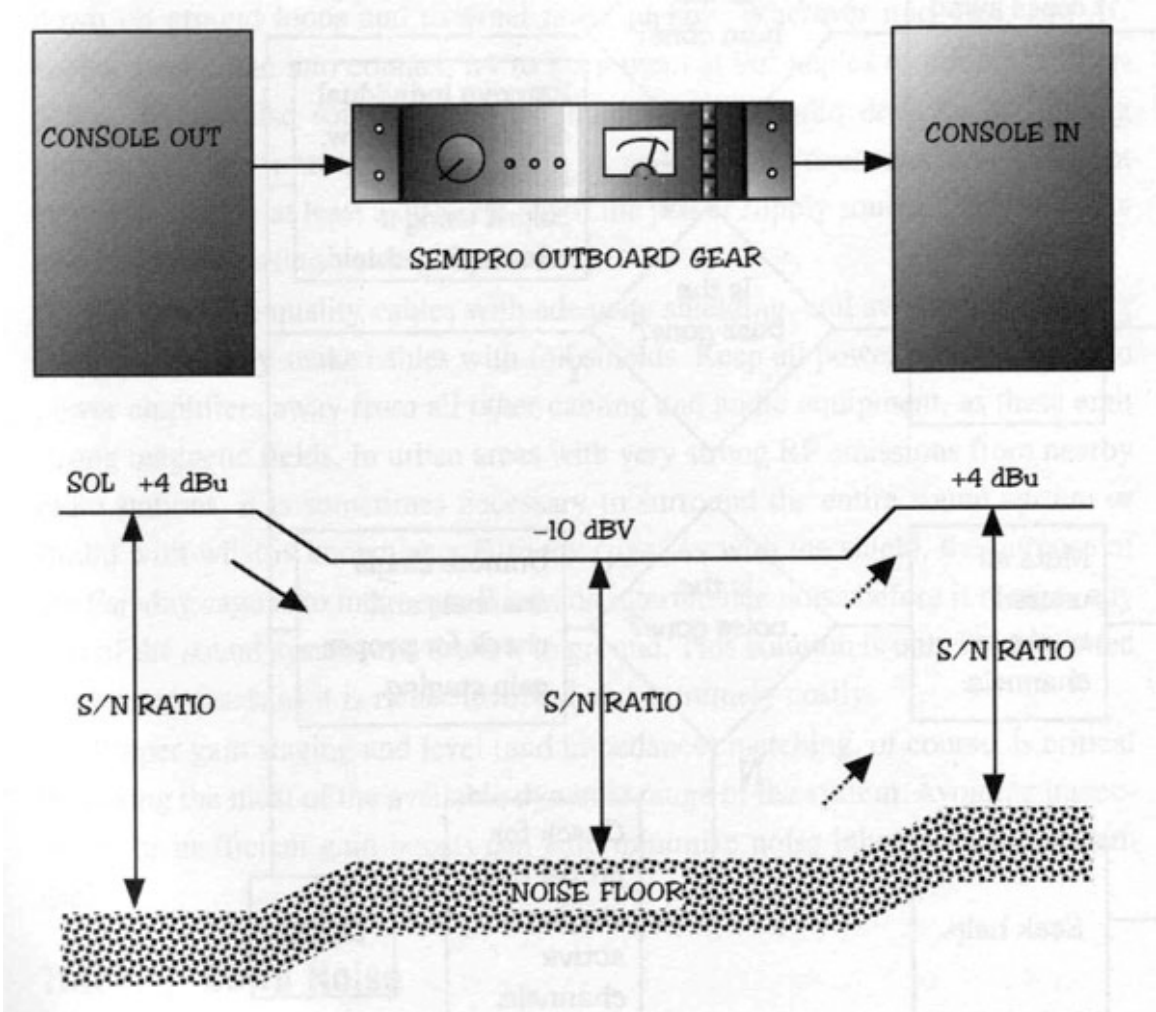


Figure 7.21. *Inserting semipro gear into the flow reduces available dynamic range by bringing the noise floor up. Semipro gear not only has a lower SOL (standard operating level) but tends to be inherently noisier as well (higher noise floor).*

6.12. Level Setting: Principles

- The essential first step when working with an input
- Mantra: as much as possible as early as possible
- Optimizes signal to noise ratio with ideal gain-staging

6.13. Level Setting: Procedure

- Reset, clear, and zero all controls (set trim at minimum)
- Connect or select input
- Set meters (if necessary) to display only the trim gain stage and skip other gain stages
  - On some mixers, this may mean engaging SOLO
  - On some mixers, this may mean engaging Pre-fader listen (PFL) SOLO
- Must get typical material from the source (musician, device, et cetera)
- Raise the trim slowly
- Find amplitude peaks and estimate average peaks with meters
- Continue to raise the trim until average peaks are at +4 dBu (-20 dBFS, 0 VU)

6.14. Level Setting: Example

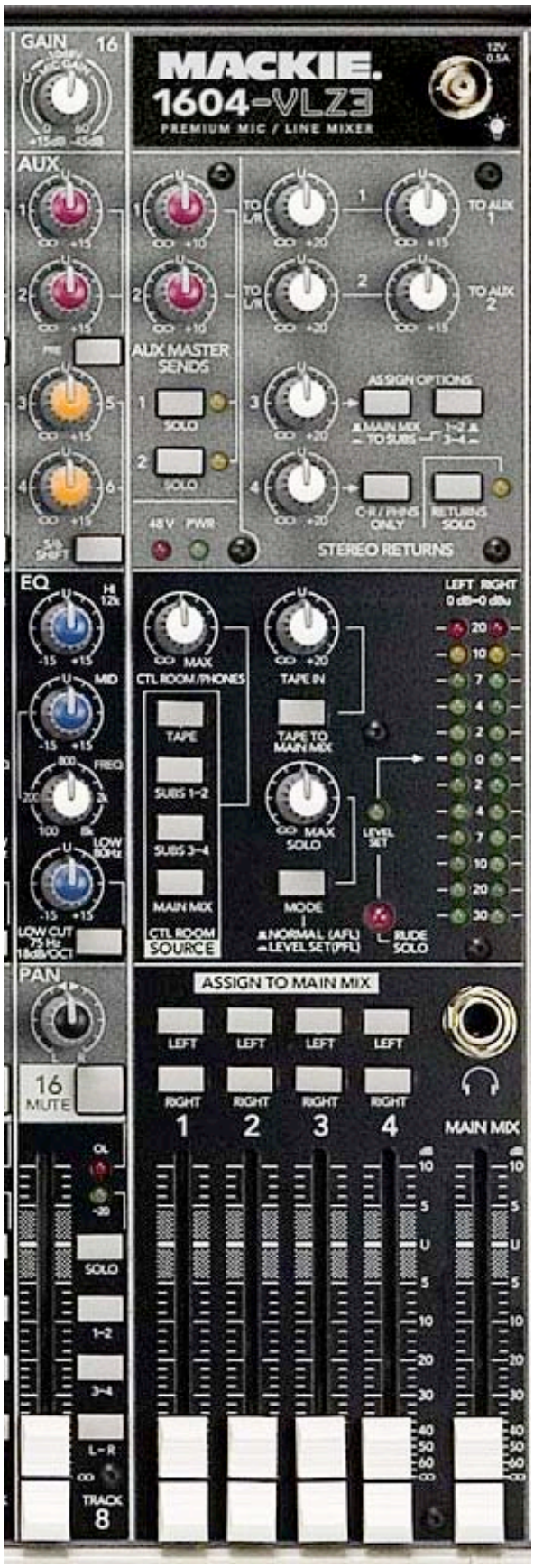
- Tascam HD-P2 portable recorder

6.15. Level Setting: Example

- Avalon AD 2022 preamp

6.16. Level Setting: Example

- Mackie 1604 VLZ3

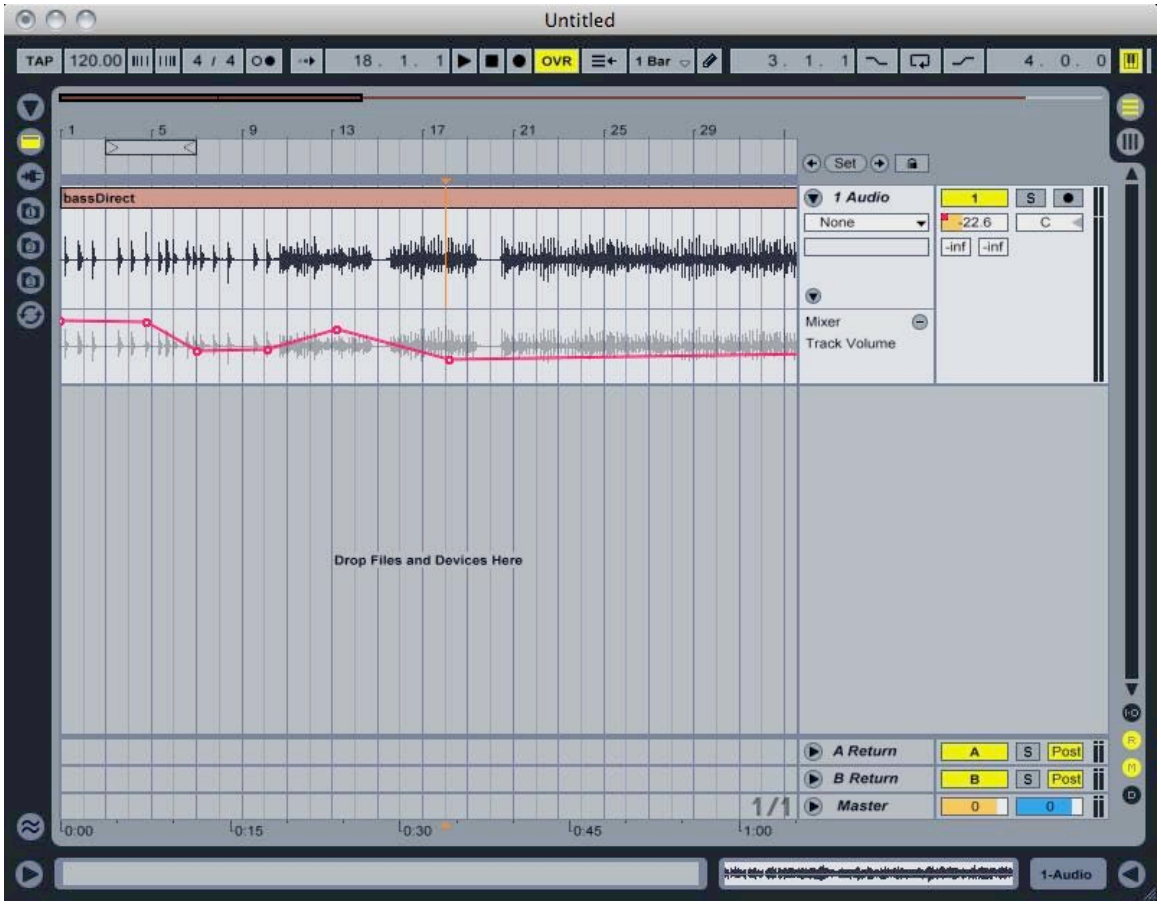


6.17. Automation: Fader Levels

- Automating fader levels in a DAW
- Live: under Mixer, select Track Volume

  Double click to add / remove points

  Can view view on waveform or in separate lane



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6.18. Panning Amplifiers: Linear

- Take a signal, split into two signals, and inversely vary amplitudes
- A fader that as one turns up, the other turns down
- A bad approach (1 is left, 0.5 is middle, 0 is right)

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L == (1 - x)
R == x
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6.19. Panning Amplifiers: Non-Linear

- Must reduce amplitude in center to reduce increase in loudness
- Reduction between 3 dB and 4.5 dB

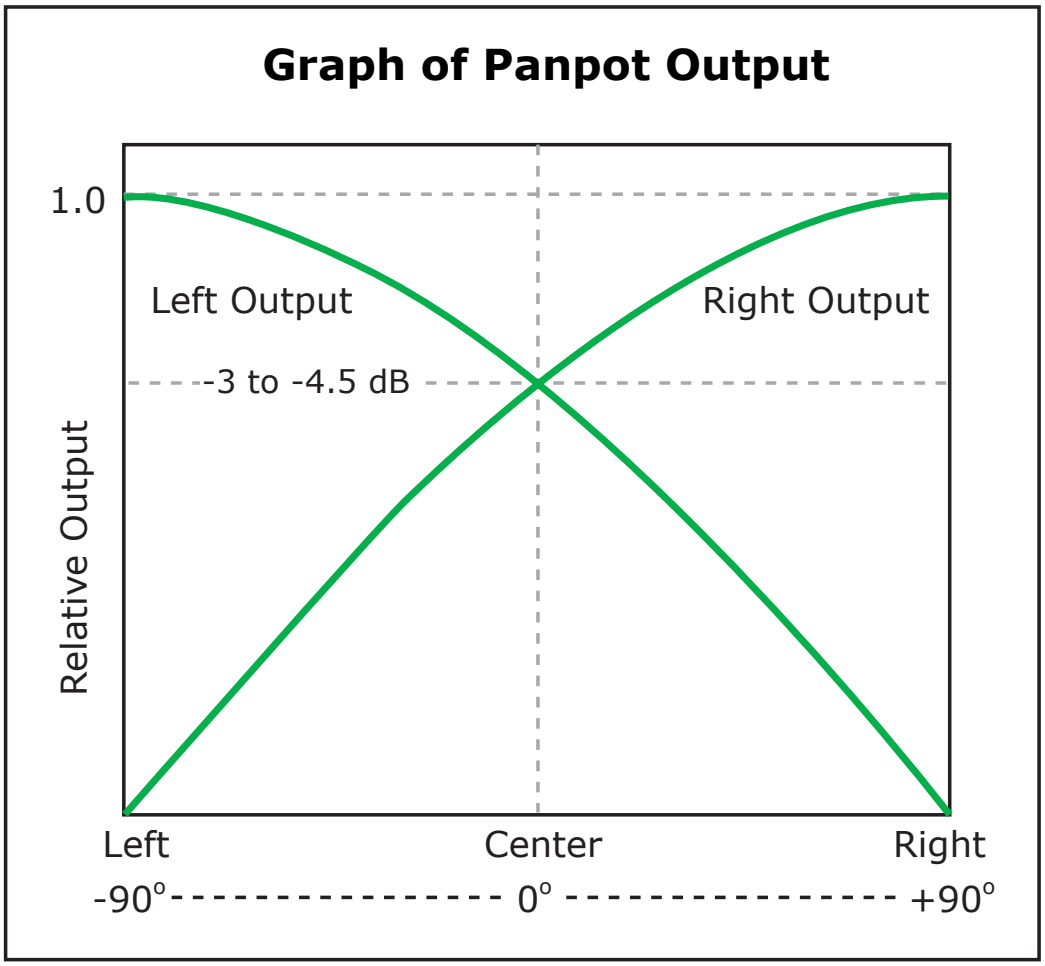

Image by MIT OpenCourseWare.

6.20. Automation: Stereo Panning

- Automating pan position in a DAW

- Live: under Mixer, select Track Panning

  Double click to add / remove points

  Can view view on waveform or in separate lane

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