

## Acoustic and psychoacoustic stimuli

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This collection provides a set of commonly used synthetic audio signals for acoustic measurements and psychoacoustic research.

### General Definitions for all Stimuli

- Sampling rate: 44,100 Hz
- Duration: 5.0 sec (at 67.5% point of the envelope), except calibration stimuli (30 sec) and noise bursts (burst duration)
- Gaussian onset- and offset slopes (50 ms between 10% and 90% points of the envelope, applied to -60 dB; except temporally varying stimuli)
- Pedestal level: -20 dB FS rms-level (before applying envelope slopes)
- All stimuli were synthetically generated in Matlab (double-float processing, >100 dB numerical dynamic range)
- All stimuli are stored in Matlab structures in one Matlab-file and in 196 24-bit wav-files. Files/Stimuli are named by the stimulus category, name and parameter as given below. Data in Matlab structure and wav-files are sample-identical (same noises).
- Note that there are no zeros added at the beginning and the end of the stimuli, which could cause samples being omitted when playing them with some audioplayers and soundcards.

### Calibration Stimuli

Duration: 30 sec

- **Calibration tone:** Frequency: 1 kHz, level: -20 dB FS (rms)
- **Calibration noise:** Narrow-band noise at 1 kHz, 3<sup>rd</sup>-octave bandwidth, level: -20 dB FS (rms).

### Tones

- **Sine tones** with frequencies of: 20, 31.5, 50, 63, 80, 100, 125, 160, 200, 250, 300, 315, 400, 500, 630, 750, 800, 1000, 1250, 1500, 1600, 2000, 2500, 3000, 3150, 4000, 5000, 6000, 6300, 8000, 10000, 12500, 15000, 16000, 18000, 20000 Hz (selected ISO 266 frequencies and audiometric frequencies)
- **Harmonic complex tones:** (up to) 50 harmonics with -3dB/oct damping in zero (sine) starting phase, harmonics limited to 20 kHz, Fundamental frequencies of: 20, 31.5, 50, 63, 80, 100, 125, 160, 200, 250, 300, 315, 400, 500, 630, 750, 800, 1000, 1250, 1500, 1600, 2000, 2500, 3000, 3150, 4000, 5000, 6000, 6300, 8000, 10000, 12500, 15000, 16000, 18000, 20000 Hz (from 10 kHz as sine tones).

### Noises

- **White noise:** 20 Hz – 20 kHz, @-20 dB FS (rms)
- **Pink noise:** 20 Hz – 20 kHz, @-20 dB FS (rms)
- **Uniform-exciting noise (UEN):** noise with equal energy per BARK frequency band in 20 Hz – 20 kHz (pg. 170, fig. 6.16 in [1])

- **Equally-exciting noise (EEN):** noise with equal energy per ERB frequency band, 20 Hz – 20 kHz (as UEN, but for ERB frequency definition, see pg. 74 in [2])
- **Uniform-masking noise (UMN):** noise which produces frequency-independent masking on tones, 20 Hz – 20 kHz (pg. 63, fig. 4.2 in [1])
- **CCITT noise:** made from White Noise, 20 Hz – 20 kHz using CCITT filter (unmodulated speech simulating noise)
- **3<sup>rd</sup>-octave-band noise:** center frequencies at 20, 31.5, 50, 63, 80, 100, 125, 160, 200, 250, 300, 315, 400, 500, 630, 750, 800, 1000, 1250, 1500, 1600, 2000, 2500, 3000, 3150, 4000, 5000, 6000, 6300, 8000, 10000, 12500, 15000, 16000, 18000, 20000 Hz
- **Octave-band noise:** center frequencies according to ISO 266 (31.5 Hz basis) and to octaves of 100 Hz: 31.5, 63, 100, 125, 200, 250, 400, 500, 800, 1000, 1600, 2000, 3200, 4000, 6400, 8000, 12800, 16000 Hz
- **Critical-band-wide noise** (i.e. 1-BARK wide noise): for critical bands 1-24 BARK according to tabled definition by Zwicker (Table 6.1 in [1]). The noise slopes follow the excitation patterns.

### Stimuli with particular temporal properties

- **Pulse train:** one pulse every 100 ms, 30 ms on-duration (at 67.5% point, 5 ms Gaussian slopes 10-90% of the envelope amplitude);  
Note: -20 dB FS (rms) pedestal level before envelope modulation applied.
- **White Noise Bursts** (20 Hz – 20 kHz White Noise) with durations of 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500 ms each with Gaussian slopes of 0.5 ms (10-90%);  
Note: -20 dB FS (rms) pedestal level before envelope modulation applied.  
**Pink Noise Bursts** (50 Hz – 20 kHz) with durations of 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500 ms each with Gaussian slopes of 0.5 ms (10-90%);  
Note: -20 dB FS (rms) pedestal level before envelope modulation applied.
- **AM noise:** White Noise (20 Hz – 20 kHz), amplitude modulation with 100% depth applied, AM starting in zero sinusoidal phase;  
AM rates: 1, 2, 3, 5, 7, 10, 20, 30, 50, 70, 100, 150, 200 Hz.

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### References

- [1] Fastl and Zwicker: *Psychoacoustics*, 3<sup>rd</sup> ed., Springer, 2007.
- [2] Moore: *An Introduction to the Psychology of Hearing*, 5<sup>th</sup> ed., Academic Press, 2003.