MusicReason RESOURCE

Tuning, Cents, Temperament, and Reference Pitch

https://musicreason.com/resources/tuning-cents-temperament-and-reference-pitch/ · Last updated 2026-09-06

Calling a note "in tune" is meaningless without two prior decisions: which frequency counts as the reference pitch, and which tuning system maps every other note relative to it. Cents then express how far a measured frequency sits from that system's nearest note, as a distance, not a verdict.

A4 = 440 Hz is a convention, not a constant of nature

The relationship between any MIDI note number and a frequency is f = A4 × 2^((m−69)/12), which only produces a number once A4 is fixed. 440 Hz is the widely adopted modern reference, but historical and regional practice has used references from roughly 415 Hz (some Baroque ensembles) to 445 Hz (some contemporary orchestras). Reference Pitch and Cents lets you change A4 for exactly this reason: every conversion on this site depends on it.

Cents measure logarithmic distance, not a percentage

440 Hz to 442.55 Hz is about +10 cents, roughly a tenth of an equal-tempered semitone.
One octave is exactly 1200 cents and one equal-tempered semitone is exactly 100 cents, by definition, regardless of register. A reading of "+15 cents" means the measured frequency sits 15 hundredths of a semitone above the nearest equal-tempered pitch for the active A4; it is not 15% sharp in any linear sense, since cents scale with the logarithm of the frequency ratio.

Equal temperament trades purity for portability

A pure (just) perfect fifth has a frequency ratio of exactly 3:2. Equal temperament instead divides the octave into twelve identical steps so every key sounds equally usable, which makes its fifth about 2 cents narrower than the pure 3:2 ratio. That small, consistent compromise is what Temperament Comparator quantifies interval by interval against alternative tuning systems.

Beating is a distance effect, not a defect in either note

Two frequencies close together produce an audible pulsing at a rate equal to their absolute difference; two notes at 440 Hz and 442 Hz beat at 2 Hz, a slow pulse, not a buzz. Beat Frequency Calculator reports that rate directly. Beating does not by itself mean either note is "wrong": two equal-tempered notes a major third apart beat audibly against each other by design, because equal temperament widens that interval away from its pure, beat-free ratio.

What Microphone Tuner's cents reading does and does not claim

Microphone Tuner reports cents deviation from the nearest equal-tempered note under your chosen A4, alongside a confidence band describing how clean the incoming signal was. It is a local estimate from a captured signal, not a calibrated instrument-repair measurement, and it never claims certainty the underlying signal quality does not support.

Frequently asked questions

Why is A4 = 440 Hz, and is it the only correct reference?

440 Hz is a 20th-century standardization, not a law of physics. Orchestras and historical tunings have used references from roughly 415 Hz to 445 Hz. Reference Pitch and Cents lets you change A4 because every frequency-to-note conversion depends on which reference you picked.

What does a cents value actually measure?

Cents measure logarithmic distance between two frequencies, 1200 cents to an octave, 100 cents to an equal-tempered semitone. A note that reads "+15 cents" is not "15% too high"; it is a fixed fraction of a semitone sharp of the nearest equal-tempered pitch.

Why can two correctly-tuned notes still produce audible beating?

Beat frequency comes from the difference between two close frequencies, not from either one being "wrong." Two notes an equal-tempered major third apart beat audibly against each other because equal temperament deliberately widens or narrows most intervals away from their pure, beat-free ratio.

Where this shows up

PITCH AND TUNING
Reference Pitch and Cents

SCALES KEYS AND INTERVALS
Note to Frequency

SCALES KEYS AND INTERVALS
Frequency to Note

PITCH AND TUNING
Temperament Comparator

PITCH AND TUNING
Beat Frequency Calculator

AUDIO ANALYSIS
Microphone Tuner

PITCH AND TUNING
Intonation Drift Tracker