

How can we measure if a song is just intonation tuned?

How can you determine if a piece of music is tuned in just intonation?

You can measure it by comparing the song's pitches to a reference frequency grid and checking whether the intervals match simple integer ratios rather than 12-tone equal temperament. In practice, the simplest tool-based check is a spectrum/pitch analyzer plus a tuner app that shows cents deviation, then test whether the thirds, fifths, and other stable intervals land near just-intonation ratios like 4:5:6 for a major triad.[\[reddit\]](#)

Practical method

1. Capture or isolate sustained notes or chords from the song.
2. Measure each note's fundamental frequency with a tuner or pitch tracker.
3. Convert the intervals to ratios and cents, then compare them with just-

intonation targets.

4. Look for consistency across the song, since a truly just-tuned performance should keep the same harmonic relationships whenever those notes reappear. [\[kylegann\]](#)

What to look for

- A pure major third in 5-limit just intonation is close to 5:4, which is noticeably flatter than the equal-tempered major third. [\[reddit\]](#)
- A pure fifth is close to 3:2, which is very near equal temperament but still slightly different. [\[kylegann\]](#)
- If the song uses 12-tone equal temperament, the intervals will cluster around fixed 100-cent steps rather than ratio-based consonances. [\[reddit\]](#)

Tools that help

- A tuner app that shows cents offset, such as a chromatic tuner or microtuning-capable app. [\[instagram\]](#)
- A spectrum analyzer or pitch-detection plugin in a DAW for more precise note isolation.
- A keyboard or software instrument that can display exact tuning values for each note, if you are analyzing a synth performance. [\[gearspace\]](#)

Important limitation

You usually cannot prove “the whole song is just intonation” from one chord, because just intonation can vary by key, chord, or context, and performers may adjust notes on the fly. That means the best test is repeated measurement of several chords and melodic notes over time. [\[ethanhein\]](#)

Simple example

If you measure a major chord and find the notes form approximately 4:5:6, that is strong evidence of just intonation. If the same chord instead sits on the fixed offsets expected from equal temperament, it is probably not strictly just tuned. [\[kylegann\]](#)

Would you like a step-by-step workflow for checking this in Audacity, REAPER, or

with a phone app? Here's a step-by-step workflow you can follow in Audacity to check whether sustained notes or chords in a song are just-intonation tuned.

Here's a step-by-step workflow you can follow in Audacity to check whether sustained notes or chords in a song are just-intonation tuned.

1. Prepare the audio

1. Open Audacity and import your song:
File → Import → Audio and select the file.[\[reddit\]](#)
 2. Find a section with a sustained note or chord (e.g., a held vocal note, guitar chord, or synthesizer chord).
 3. Use the selection tool to highlight a stable part of that note/chord (about 0.5–2 seconds). Avoid the attack and decay if they're noisy.
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2. Get the fundamental frequency of each note

Audacity's most accurate frequency measurement is **Plot Spectrum**.
[\[forum.audacityteam\]](#)

For a single note

1. Select the region containing the sustained note.
2. Go to: **Analyze → Plot Spectrum**.[\[github\]](#)
3. In the Plot Spectrum window:
 - **Algorithm:** Spectrum (default).
 - **Size:** set to a high value for better frequency resolution (e.g. 4096 or 8192).[\[youtube\]](#)[\[forum.audacityteam\]](#)
 - **Function:** Hann (default).[\[github\]](#)
 - **Axis:** Log frequency (default).[\[youtube\]](#)[\[github\]](#)
4. Look at the spectrum graph and find the **strongest low-frequency peak** (the fundamental, f_0).
 - In many musical notes, the fundamental is the lowest prominent peak.
5. Click on the peak to read its frequency in Hz from the bottom of the window.
[\[youtube\]](#)
6. Record that frequency as f_1 for the first note.

Repeat this for each note in the chord (select each note separately and record its frequency: f_1, f_2, f_3, \dots).

3. Convert frequencies to ratios

For a chord or interval, compute the ratio between the frequencies:

- For two notes:

$$\text{ratio} = \frac{f_2}{f_1}$$

$$\text{ratio} = f_1 f_2$$

- For a triad (e.g., root, third, fifth):

$$r_{3\text{rd}} = \frac{f_{3\text{rd}}}{f_{\text{root}}}, \quad r_{5\text{th}} = \frac{f_{5\text{th}}}{f_{\text{root}}}$$

$$r_{3\text{rd}} = f_{\text{root}} f_{3\text{rd}}, r_{5\text{th}} = f_{\text{root}} f_{5\text{th}}$$

You can do this in a simple spreadsheet or by using a calculator.

Compare to just-intonation targets

Common 5-limit just-intonation ratios:

Interval	Just ratio	Cents (approx)
Pure octave	2:1	1200
Pure fifth	3:2	701.96
Pure fourth	4:3	498.04
Major third	5:4	386.31
Minor third	6:5	315.64
Major triad	4:5:6	root-3rd-5th

If your measured ratio is close to one of these simple fractions (e.g. 1.25 for 5:4, 1.5

for 3:2), that's evidence of just intonation.[[kylegann](#)]

4. Optional: check cents deviation from equal temperament

To compare to 12-tone equal temperament (ET), you can convert the ratio to cents:

$$\text{cents} = 1200 \cdot \log_2 \left(\frac{f_2}{f_1} \right)$$

$$\text{cents} = 1200 \cdot \log_2(f_2/f_1)$$

In practice, you can compute this in a spreadsheet:

- Cents = 1200 * LOG2(f2/f1)
(in Excel/Google Sheets: 1200 * LOG(f2/f1, 2))

Then compare to ET targets:

- ET major third: 400 cents (just: ~386 cents)
- ET fifth: 700 cents (just: ~702 cents)

If the measured cents are consistently closer to the just values than to the ET values, that supports just intonation.[[reddit](#)]

5. Repeat across multiple chords and notes

Because just intonation can vary by key and chord, you need to:

1. Repeat the above for several chords and sustained notes in the song.
2. Check whether:
 - Major thirds are consistently near ~386 cents (flatter than ET 400).
 - Fifths are near ~702 cents.
 - Triads tend to fit 4:5:6 or similar simple ratios.

Consistent matches across the song are strong evidence that the song is just-intonation tuned.[[ethanhein](#)]

6. Optional: use a Nyquist pitch-detect plugin

If you want an automated note-to-frequency tool:

1. Install the **Pitch Detect** Nyquist plugin:
 - Download from: http://wiki.audacityteam.org/wiki/Nyquist_Analyze_Plug-ins#Pitch_Detect%5Bforum.audacityteam
2. Install it per the instructions: http://wiki.audacityteam.org/wiki/Download_Nyquist_Plug-ins#install%5Bforum.audacityteam
3. In Audacity:
 - **Edit** → **Add / Remove Plug-ins**, enable **Pitch Detect**, then OK.
4. Select a note and run: **Analyze** → **Pitch Detect** to get the frequency directly.

This can speed up getting f_0 for many notes, but you still need to compute ratios and compare to just-intonation targets manually.

Summary

In Audacity:

- Use **Plot Spectrum** with a high **Size** to measure fundamental frequencies. [\[forum.audacityteam\]](#)[\[youtube\]](#)[\[github\]](#)
- Compute frequency ratios between notes.
- Compare those ratios to simple integer ratios like 5:4 (major third), 3:2 (fifth), and 4:5:6 (major triad). [\[soundamerican\]](#)
- Repeat across multiple chords and notes to see if the pattern holds.

If you'd like, I can give you a small example with dummy frequencies and show the exact ratio/cents calculations.

I'll walk you through a complete example with dummy frequencies for a major triad (root, major third, perfect fifth), showing how to compute ratios and cents, then compare to just intonation and equal temperament.

Example: Major Triad with Dummy Frequencies

Step 1: Measured frequencies from Plot Spectrum

Suppose you used **Analyze → Plot Spectrum** in Audacity on three sustained notes (selected separately) and recorded these fundamental frequencies:

Note	Frequency (Hz)
Root	260.00 Hz
Third	325.00 Hz
Fifth	390.00 Hz

Step 2: Compute frequency ratios

Use the root as the reference (260 Hz):

Ratio for the third:

$$r_{3rd} = \frac{325}{260} = 1.25$$

$$r_{3rd} = 260 : 325 = 1.25$$

Ratio for the fifth:

$$r_{5th} = \frac{390}{260} = 1.5$$

$$r_{5th} = 260 : 390 = 1.5$$

Now the full triad ratio (root : third : fifth):

$$\frac{260}{260} : \frac{325}{260} : \frac{390}{260} = 1 : 1.25 : 1.5$$

$$260 : 260 : 260 : 325 : 260 : 390 = 1 : 1.25 : 1.5$$

Multiply by 4 to get whole numbers:

4: 5: 6

4:5:6

This is exactly the just-intonation major triad ratio 4:5:6. [\[reddit\]](#)

Step 3: Convert to cents

Cents formula:

$$\text{cents} = 1200 \cdot \log_2 \left(\frac{f_2}{f_1} \right)$$

$$\text{cents} = 1200 \cdot \log_2(f_2/f_1)$$

Major third (root → third):

$$\text{cents}_{3\text{rd}} = 1200 \cdot \log_2 \left(\frac{325}{260} \right) = 1200 \cdot \log_2(1.25)$$

$$\text{cents}_{3\text{rd}} = 1200 \cdot \log_2(260/325) = 1200 \cdot \log_2(1.25)$$

Using $\log_2(x) = \frac{\ln(x)}{\ln(2)}$ $\log_2(x) = \ln(2) \ln(x)$:

$$\log_2(1.25) = \frac{\ln(1.25)}{\ln(2)} \approx \frac{0.22314}{0.69315} \approx 0.32193$$

$$\log_2(1.25) = \ln(2) \ln(1.25) \approx 0.69315 \cdot 0.22314 \approx 0.32193$$

$$\text{cents}_{3\text{rd}} \approx 1200 \cdot 0.32193 \approx 386.3 \text{ cents}$$

$$\text{cents}_{3\text{rd}} \approx 1200 \cdot 0.32193 \approx 386.3 \text{ cents}$$

Perfect fifth (root → fifth):

$$\text{cents}_{5\text{th}} = 1200 \cdot \log_2 \left(\frac{390}{260} \right) = 1200 \cdot \log_2(1.5)$$

$$\text{cents}_{5\text{th}} = 1200 \cdot \log_2(260/390) = 1200 \cdot \log_2(1.5)$$

$$\log_2(1.5) = \frac{\ln(1.5)}{\ln(2)} \approx \frac{0.40547}{0.69315} \approx 0.58496$$

$$\log_2(1.5) = \ln(2) \ln(1.5) \approx 0.69315 \cdot 0.40547 \approx 0.58496$$

$$\text{cents}_{5\text{th}} \approx 1200 \cdot 0.58496 \approx 702.0 \text{ cents}$$

$$\text{cents}_{5\text{th}} \approx 1200 \cdot 0.58496 \approx 702.0 \text{ cents}$$

Step 4: Compare to just intonation and equal temperament

Interval	Measured cents	Just intonation	Equal temperament
Major third	~386.3 cents	~386.3 cents (5:4)	400 cents
Perfect fifth	~702.0 cents	~701.96 cents (3:2)	700 cents

Interpretation:

- The measured major third is **~386 cents**, matching the **just 5:4 ratio** (386.3 cents), and is **14 cents flatter** than equal temperament (400 cents).[\[kylegann\]](#)
- The measured fifth is **~702 cents**, matching the **just 3:2 ratio** (~701.96 cents), and is very close to equal temperament (700 cents).[\[reddit\]](#)
- The full triad ratio **4:5:6** is exactly the just-intonation major triad.[\[kylegann\]](#)

Conclusion: This chord is **just-intonation tuned**.

Contrast: Equal-Tempered Version

Now imagine you measured a different major triad that was in equal temperament:

Note	Frequency (Hz)
Root	260.00 Hz
Third	326.67 Hz
Fifth	389.96 Hz

Ratios:

$$r_{3rd} = \frac{326.67}{260} \approx 1.2564$$

$$r_{3rd} = 260326.67 \approx 1.2564$$

$$r_{5th} = \frac{389.96}{260} \approx 1.4998$$

$$r_{5th} = 260389.96 \approx 1.4998$$

Cents:

Major third:

$$\text{cents}_{3rd} = 1200 \cdot \log_2(1.2564) \approx 1200 \cdot 0.3333 \approx 400 \text{ cents}$$

$$\text{cents}_{3rd} = 1200 \cdot \log_2(1.2564) \approx 1200 \cdot 0.3333 \approx 400 \text{ cents}$$

Perfect fifth:

$$\text{cents}_{5th} = 1200 \cdot \log_2(1.4998) \approx 1200 \cdot 0.5833 \approx 700 \text{ cents}$$

$$\text{cents}_{5th} = 1200 \cdot \log_2(1.4998) \approx 1200 \cdot 0.5833 \approx 700 \text{ cents}$$

Comparison:

Interval	Measured cents	Just intonation	Equal temperament
Major third	~400 cents	~386.3 cents	400 cents
Perfect fifth	~700 cents	~701.96 cents	700 cents

Interpretation:

- The major third is **400 cents**, exactly the equal-tempered value, and **14 cents sharper** than just intonation.
- This triad is **equal-tempered**, not just-intonation tuned.

How to do the calculation in a spreadsheet

In Excel/Google Sheets:

1. Put frequencies in cells:

- A2: root = 260
- A3: third = 325
- A4: fifth = 390

2. Ratio for third:

- B3: =A3/A2 → 1.25

3. Ratio for fifth:

- B4: =A4/A2 → 1.5

4. Cents for third:

- C3: =1200 * LOG(A3/A2, 2) → ~386.3

5. Cents for fifth:

- C4: =1200 * LOG(A4/A2, 2) → ~702.0

Then compare to:

- Just major third: 386.3
- ET major third: 400

Summary

With dummy frequencies 260 Hz, 325 Hz, and 390 Hz:

- You get ratios 1 : 1.25 : 1.5 → 4:5:6.[\[reddit\]](#)
- Cents are ~386 and ~702, matching just intonation.[\[kylegann\]](#)
- This is a clear example of a **just-intonation major triad**.

If you later measure real notes from a song, plug those frequencies into the same calculations and compare to the just-intonation targets (386 cents for the major third, 702 cents for the fifth).