

GEARLIBRARY · INTRODUCTORY GUIDE

Instrumental vs empirical turntable set-up

How to set up a turntable by ear and with measurements: where to start, what each test-record track measures, how to read the results of the Turntable bench.

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medialibrary.dev

In this guide

How to set up a turntable by ear and with measurements: where to start, what each test-record track measures, how to read the results of the Turntable bench.

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The full guide, with interactive charts, is on the website. https://medialibrary.dev/en/calibration/

1. Where do I start

The order of adjustments, before any measurement.

If you have just fitted a cartridge, or you do not know how your turntable is set up, start with the mechanical adjustments. They need only a few tools and already give a good result. Measurements come afterwards, to check and refine.

1. Clean the stylus and check that the platter is level.
2. Balance the arm and set the tracking force to the middle of the range given by the cartridge maker. A stylus scale is better than the counterweight dial.
3. Align the cartridge with a protractor (overhang and offset angle).
4. Set the arm height (VTA): to begin with, arm parallel to the record with the stylus lowered.
5. Check azimuth by eye: seen from the front, the cartridge must not lean to one side.
6. Set anti-skating to the value suggested in the arm’s manual.
7. Set the phono input load as the cartridge maker recommends (resistance and capacitance).
8. Listen to a record you know well. Then measure with the test record and refine one parameter at a time.

> **Take care** Do not exceed the maximum tracking force given by the maker and do not lower the stylus with the arm unbalanced: the cantilever bends easily and cannot be straightened.

For overhang and offset angle the website has a dedicated page, with the calculation for your arm and a printable protractor: see “Alignment geometry”. https://medialibrary.dev/en/alignment/

2. Empirical and instrumental set-up

What the ear does well, what measurements do well.

Empirical set-up uses mechanical tools (stylus scale, protractor, small mirror) and listening. It is cheap, needs nothing beyond the turntable and already gets you to a good result.

Instrumental set-up uses a test record and a measurement chain: the stylus reads tracks cut with known signals, and the app compares what comes out with what should come out. You get numbers you can repeat and compare before and after a change.

What each does well

- The ear judges the end result: whether you enjoy the music, whether the soundstage is believable.
- The ear gets used to things within minutes and cannot tell causes apart: harsh treble may come from the load, the azimuth or the tracking force.
- Measurements separate the causes: each test-record track looks at one parameter.
- Measurements find problems you only hear in difficult passages, such as one channel losing the groove at the loudest levels.
- Measurements do not tell you which sound you prefer. They put the turntable in a correct state; from there you can fine-tune by ear.

The most effective way is to use them together: adjust with the tools, check with measurements, confirm by listening.

IF YOU WANT TO KNOW MORE

Why listening alone can mislead

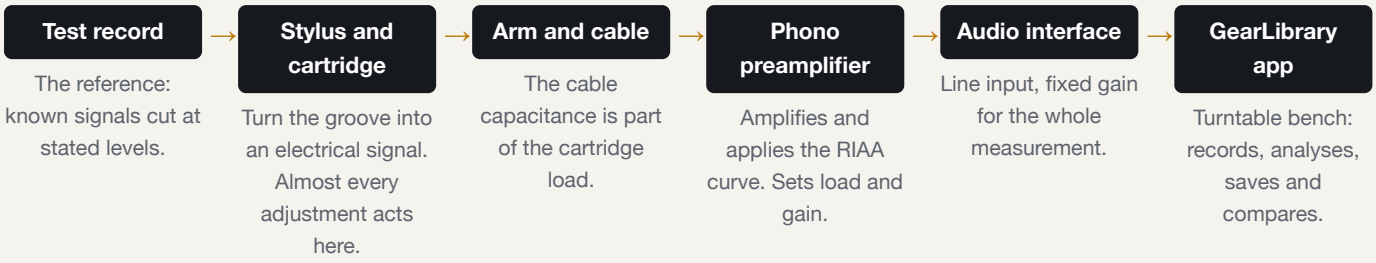
Between two listening sessions, the slightly louder one almost always seems better, even with half a decibel of difference. Many adjustments change the level (load, azimuth), so comparing by ear is not a level playing field.

Then there is memory: comparing a sound now with one from ten minutes ago, after removing the cartridge, is hard for anyone. Measurements are saved and can be compared months later.

3. The measurement chain

From record to computer: what goes into the measurement.

What you measure is the result of the whole chain, not of the cartridge alone. It pays to know what lies in between.



- Connect the phono preamplifier output to the interface's line input, not to the microphone input.
- Set the gain once, on the loudest track you will use, so the level never reaches full scale. Then leave it alone until the end.
- If you hear hum, connect the turntable ground to the preamplifier before measuring.

Reversible Connections and gains can be changed without risk. If a result looks odd, check the chain first and the cartridge second.

IF YOU WANT TO KNOW MORE

Which audio interface: the most popular ones, with pros and cons

For the bench a USB interface with two line inputs is enough. Four things matter: how much level the line input takes before clipping, whether the gain of the two channels can be set repeatably, how low the response goes in the bass (resonance needs 5–40 Hz) and, with iPhone or iPad, whether the device's power is enough.

Windows, Mac and iPhone: which interfaces work

Almost all recent USB interfaces are "class compliant" (USB Audio Class 2.0): the system recognises them by itself, with nothing to install. It is the simplest case and works on all three systems.

- Mac: a class-compliant interface works as soon as it is plugged in. The maker's software is only needed for its internal settings (mixer, levels, filters).
- Windows 10 and 11: they include a USB Audio 2.0 driver, but it is worth installing the maker's driver, which often adds the control panel and higher sample rates. Older interfaces (USB Audio 1.0 or with a proprietary driver) only work with the driver.
- iPhone and iPad: only class-compliant interfaces work, because drivers cannot be installed on iOS. With iPhone 15 and later and with USB-C iPads a USB-C cable is enough; with Lightning models you need Apple's "Lightning to USB 3 Camera Adapter", which also has a power socket.
- Power with iPhone and iPad: the phone supplies little current. Many bus-powered interfaces switch off or do not start: in that case use the interface's power supply, a powered USB hub or the Apple adapter connected to the charger.

How to set it up for measuring

1. On the interface: input in line mode, not mic or instrument (switch off "INST" or "Hi-Z"), 48 V phantom power off, effects such as "Air", compressors and equalisers off, inputs as a stereo pair rather than mono.
2. Sample rate: 48 or 96 kHz, the same in the interface's software and in the system. Mac: Audio MIDI Setup → the interface → Format. Windows: Settings → System → Sound → the interface → Format.

3. System input level at maximum (0 dB), so the system does not attenuate the signal: the level is set only with the interface gain. On Mac in Audio MIDI Setup, on Windows in the input properties.
4. Windows: switch off the input's "audio enhancements", which can filter or compress the signal.
5. Set the interface as the system's default input and allow GearLibrary to use the microphone: Mac in System Settings → Privacy & Security → Microphone; Windows in Settings → Privacy & security → Microphone; iPhone and iPad at the first measurement, or in Settings → GearLibrary.
6. Before measuring, run a test on the loudest track: the level must never reach full scale, neither on the interface nor in the app.

Focusrite **Scarlett 2i2 (4ª generazione)**

Line input	2 balanced or unbalanced jacks (in the combos), up to +22 dBu, 60 kΩ.
Gain	One knob per channel; "Preamp Link" ties them to a single control.
iPhone and iPad	The product page lists only Windows and macOS; a support article lists it as iPad-compatible. Bus-powered (900 mA), with an extra USB-C socket for power if the device is not enough.

Pros

- Line input that takes high levels (+22 dBu).
- Stated response 20 Hz–20 kHz ±0.05 dB, THD+N –100 dB.
- Separate gain per channel, or linked.

Cons

- In "Easy Start" mode it runs at 48 kHz at most until you set it up with Focusrite Control 2 on a computer.
- The "Air" feature colours the sound: keep it off for measuring.
- iPhone and iPad compatibility not stated on the product page.

Maker's data: https://focusrite.com/products/scarlett-2i2

Behringer **U-Phoria UMC202HD**

Line input	2 XLR/jack combos with a line/instrument switch, up to +20 dBu; line impedance not stated.
Gain	How gain is adjusted is not stated on the page.
iPhone and iPad	Not stated (the page lists Mac and Windows). Bus-powered, 2.5 W maximum.

Pros

- Line input up to +20 dBu.
- 24 bit up to 192 kHz; input response 10 Hz–50 kHz (0/–3 dB).

Cons

- Dynamic range, noise and distortion of the line input not stated.
- iPhone and iPad compatibility not stated.
- USB-B socket: recent computers and phones need a USB-B to USB-C cable.

Maker's data: https://www.behringer.com/en/products/0805-AAR

MOTU **M2**

Line input	2 XLR/TRS combos; through the jack up to +16 dBu, 1 MΩ unbalanced or 2 MΩ balanced.
Gain	One analogue knob per channel, no single control.
iPhone and iPad	Stated (iOS 9 or later). With a USB-C iPad the cable is enough; with Lightning you need Apple's camera adapter and a powered USB hub.

Pros

- Dynamic range 114 dB(A), THD+N −100 dB through the jack.
- iPhone and iPad compatibility stated by the maker.

Cons

- Through the jack the stated response is 70 Hz–20 kHz: for resonance (5–40 Hz) and the bass of the sweep it is not guaranteed.
- Lower maximum level through the jack than the others (+16 dBu).
- Analogue knobs: hard to set the same gain again between sessions.

Maker's data: https://motu.com/en-us/products/m-series/m2/specs/

Steinberg **UR22C**

Line input	2 combos; balanced line up to +22 dBu, 18.5 kΩ.
Gain	Two separate knobs, one per channel.
iPhone and iPad	Stated for iPhone and iPad, but with iOS devices it always needs power from the 5 V socket (USB adapter or power bank, not included).

Pros

- Balanced line input up to +22 dBu.
- 32 bit up to 192 kHz.

Cons

- With iPhone and iPad it needs external power.
- Dynamic range and distortion stated only for the microphone input, not for the line.
- The Hi-Z switch on input 2 must be left off.

Maker's data: https://download.steinberg.net/downloads_hardware/UR-C/Manuals/UR22C_Operation_Manual_English.pdf

Universal Audio **Volt 2 (Gen 2)**

To be verified Data read from excerpts of the maker's pages, not yet double-checked.

Line input	2 XLR/TRS combos; line up to +22 dBu, 10 kΩ.
Gain	Digital encoder with a button to choose the channel; on line inputs gain may be fixed.
iPhone and iPad	Stated (iOS and iPadOS 16 or later); USB 5 V socket for power if the device is not enough.

Pros

- Dynamic range 119 dB(A), THD+N −108 dB stated for the line input.
- Response 20 Hz–20 kHz ±0.05 dB.

Cons

- If the line gain is fixed, level can only be set at the phono preamplifier.

Maker's data: https://www.uaudio.com/products/volt-2-gen-2

Audient **EVO 4**

Line input	2 combos; balanced line through the jack, over 10 kΩ, with a –10 dB pad; maximum line level not stated.
Gain	Digital, with a single knob: you choose the channel with a button; “Stereo Link” ties them.
iPhone and iPad	Stated: with a USB-C iPad the cable is enough, bus-powered; with Lightning you need Apple’s adapter and a powered hub.

Pros

- Works with a USB-C iPad without a power supply.
- ADC with 113 dB(A) dynamic range and THD+N below 0.001%.

Cons

- 96 kHz maximum.
- Maximum line input level not stated.

Maker’s data: https://audient.com/products/audio-interfaces/evo-4/tech-specs/

RME **Babyface Pro FS**

Line input	Inputs 3-4: unbalanced line jacks, up to +13 dBu, 1 MΩ. Inputs 1-2: XLR, up to +19 dBu only with the PAD.
Gain	Digital and separate per channel, in 1 dB steps on inputs 1-2: the same value can always be set again.
iPhone and iPad	Stated in Class Compliant mode; with iPhone and iPad it needs an external power supply, except with a USB-C iPad Pro.

Pros

- Inputs 3-4 with a stated response from 5 Hz to 20.8 kHz (–0.1 dB): suitable for resonance too.
- Repeatable stepped gain; very low noise (116 dB unweighted on inputs 3-4).

Cons

- Line inputs 3-4 are unbalanced and take up to +13 dBu.
- With iOS it must be put in Class Compliant mode and nearly always powered separately.
- USB-B socket (a USB-C to USB-B cable is included).

Maker’s data: https://www.rme-audio.de/babyface-pro-fs.html

Topping Professional **E2x2 OTG**

To be verified Data from a retailer: the maker's page could not be reached.

Line input	2 XLR/jack combos; line level on the TRS jack, up to +23.9 dBu, 9 kΩ.
Gain	One knob per channel, up to 58 dB analogue plus 20 dB digital.
iPhone and iPad	Stated for iOS and Android via an OTG cable, but with a phone it runs at 48 kHz at most. With a smartphone the maker recommends an external power supply (dedicated USB-C socket).

Pros

- Line input that takes high levels (+23.9 dBu); response 20 Hz–40 kHz ±0.1 dB.
- Very high performance for the price: THD+N −107 dB and 115 dB dynamic range on the line input.
- Can be connected to a computer and a phone at the same time.

Cons

- Continuous gain knob: to repeat a measurement you must mark its position.
- With a phone 48 kHz at most and an external power supply recommended.

Maker's data: https://www.audiophonics.fr/en/home-studio/topping-professional-e2x2-otg-black-p-19297.html

RME **ADI-2 Pro FS R Black Edition**

Line input	2 servo-balanced XLR/TRS combos (unbalanced and RCA with an adapter too), up to +24 dBu, 18 kΩ balanced.
Gain	Four stepped reference levels (+24, +19, +13, +4 dBu) plus a 0–6 dB digital trim, per channel; automatic setting too.
iPhone and iPad	USB Class Compliant stated for iPhone and iPad. It runs on the included power supply or a battery, not from the phone.

Pros

- Reference converter: THD −116 dB at −1 dBFS, 120 dB unweighted noise, separation over 110 dB.
- Response from 5 Hz (−0.1 dB at 44.1 kHz): suitable for resonance and rumble too.
- Stepped levels: the same measurement always repeats identically.

Cons

- High-end price.
- Always needs its power supply (or a battery), even with a computer.

Maker's data: https://rme-audio.de/adi-2-pro-fs-be.html

Lynx Studio **Hilo 2**

Line input	2 balanced female XLRs, full scale up to +24 dBu, 200 kΩ balanced (100 kΩ unbalanced).
Gain	Stepped full-scale levels (from +0 dBV to +24 dBu), set separately per input.
iPhone and iPad	The maker does not state iPhone or iPad use; it runs on mains or a 9–18 V battery.

Pros

- Among the converters most used as a measurement reference: THD+N −117 dB, 122 dB A-weighted dynamic range.
- Response 20 Hz–20 kHz ±0.04 dB and very high input impedance, which does not load the phono preamp.

Cons

- List price in the order of 4,000 dollars.
- XLR inputs only: from an RCA phono preamp you need an adapter cable.
- iPhone and iPad use not stated.

Maker's data: https://www.lynxstudio.com/products/hilo2/

The data come from the makers' pages and manuals; where a figure is not stated we say so. We do not give prices or say where to buy. Whatever interface you use, the app normalises the two channels on the reference track: a small gain difference between channels does not skew the measurements.

IF YOU WANT TO KNOW MORE

The preamplifier is part of the measurement

The measured frequency response also includes the accuracy of your preamplifier's RIAA curve. A deviation of a few tenths of a decibel in the bass or treble may come from there rather than from the cartridge.

Likewise, channel balance includes the gain differences of the preamplifier and the interface. To find out whether an imbalance belongs to the cartridge, swap the left and right cables after the cartridge and measure again: if the imbalance changes side, it is downstream.

4. The procedure in the app

The Turntable bench measurements, in the order worth doing them.

In the Turntable bench choose “New measurement”, enter turntable, arm, cartridge and test record, then the procedure. For each step the app tells you which side and track to play; you record and see the result straight away.

1. “1 kHz reference (left + right)”: channel balance and crosstalk in both directions, hence azimuth. It also gives speed and wow & flutter.
2. “Trackability at 315 Hz”: tracking force and anti-skating.
3. “VTA with intermodulation (IMD)”: arm height.
4. “Frequency response (sweep)”: cartridge load.
5. “Tonearm–cartridge resonance”: match between arm mass and cartridge compliance.
6. “Speed and wow & flutter (3150 Hz)”: turntable mechanics.

> **Reversible** Change one parameter at a time and note in the measurement what you changed. With “Compare with…” you overlay two measurements and see whether the change helped.

The first procedure measures balance and crosstalk at the same time, using the two 1 kHz tracks cut on one channel only. If the record also has the in-phase track, the app can use it as a reference to normalise the two channels.

If your record is not in the catalogue, add it in “Test records” and link each track to the measurement it serves: from then on the app shows side and track for each step.

5. How to read the results, parameter by parameter

What you hear, what you look at, what you adjust.

For each parameter you will find what you hear when it is wrong, which value to look at in the app and what to adjust. The charts show a wrong and a correct case, with simulated data.

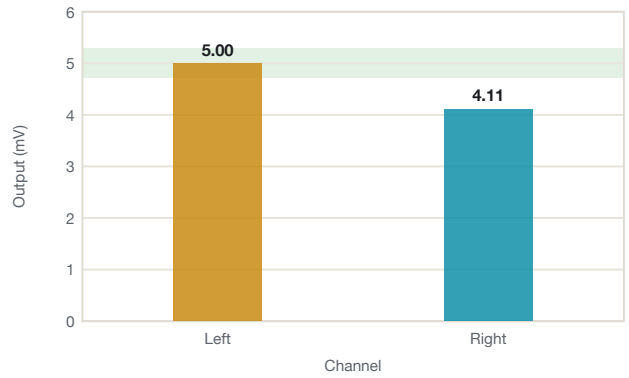
Channel balance

Where you measure it	“1 kHz reference (left + right)” → “L – R balance”
What you hear	The lead vocal is not centred; the soundstage leans to one side.
How to read the result	It is the level difference between left and right, in dB. Within ±0.5 dB is fine; beyond 1 dB you can hear it.
What to adjust	Check the cartridge clips and the plugs. Then azimuth, which also shifts balance a little. If a difference remains, it belongs to the cartridge: compensate it with the amplifier’s balance control.

Reversible Contacts and amplifier balance can be changed without risk.

Balance at 1 kHz

WRONG SETTING

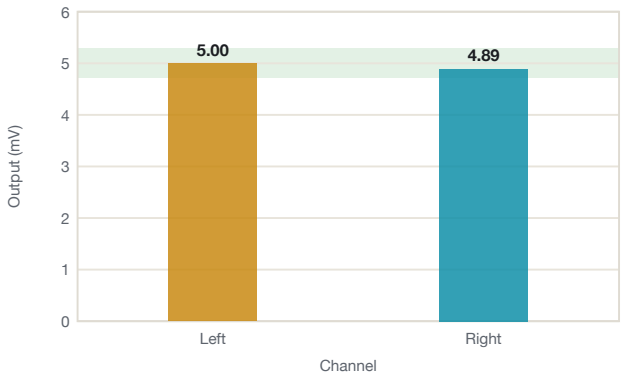


Left Right

The right channel is 1.7 dB lower: the image shifts to the left.

Left	**5.00 mV**
Right	**4.11 mV**
L – R balance	**+1.7 dB**

CORRECT SETTING



Left Right

The channels differ by 0.2 dB: a centred voice stays centred.

Left	**5.00 mV**
Right	**4.89 mV**
L – R balance	**+0.2 dB**

The two bars are the output of the two channels on the same 1 kHz track. The green band is ±0.5 dB around the left channel: if the right one falls inside it, the channels are balanced.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

Cartridges have a stated channel-balance tolerance, often between 1 and 2 dB. A difference within that range is not a fault, though it is worth compensating.

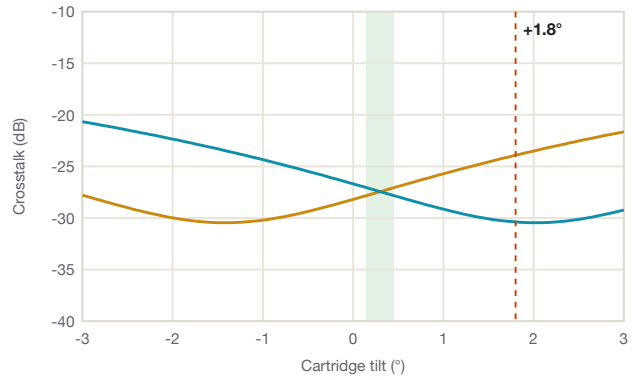
Azimuth

Where you measure it	“1 kHz reference (left + right)” → “Crosstalk L → R”, “Crosstalk R → L” and “Difference between the two directions”
What you hear	A narrower, shallower soundstage, instruments not in their place.
How to read the result	Crosstalk is how much of one channel leaks into the other: the more negative, the better. Azimuth is right when both directions are equal; a “Difference between the two directions” within 1 dB is fine.
What to adjust	Tilt the cartridge slightly towards the direction with worse crosstalk, measure again, repeat. On arms without adjustment a thin shim under one side of the cartridge is used.

Take care Loosen the screws only as much as needed and raise the arm before touching the cartridge: a knock with the stylus lowered can bend the cantilever.

Crosstalk and azimuth

WRONG SETTING

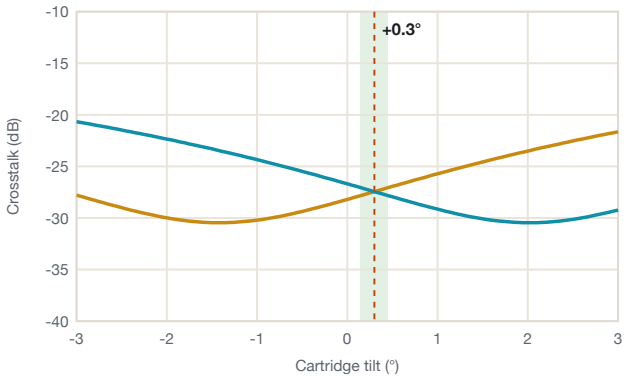


Crosstalk L → R Crosstalk R → L

Cartridge tilted by 1.8°: one direction is at –24 dB, the other at –30 dB.

Crosstalk L → R	**–23.9 dB**
Crosstalk R → L	**–30.4 dB**
Difference between the two directions	**6.5 dB**

CORRECT SETTING



Crosstalk L → R Crosstalk R → L

At the crossing both directions are equal, around –27 dB.

Crosstalk L → R	**–27.4 dB**
Crosstalk R → L	**–27.4 dB**
Difference between the two directions	**0.0 dB**

The two curves are the crosstalk in each direction (L → R and R → L) as you tilt the cartridge. The right point is where they cross: there both directions are equal. The green band is where they differ by no more than 1 dB.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

Looking at the cartridge square from the front is a good start, but the cantilever and stylus may be fitted slightly crooked inside the body. Crosstalk looks at what really counts: how the stylus reads the groove.

The point where both directions are equal is not always the one with the lowest absolute crosstalk. Equality is preferred because it keeps the soundstage symmetrical.

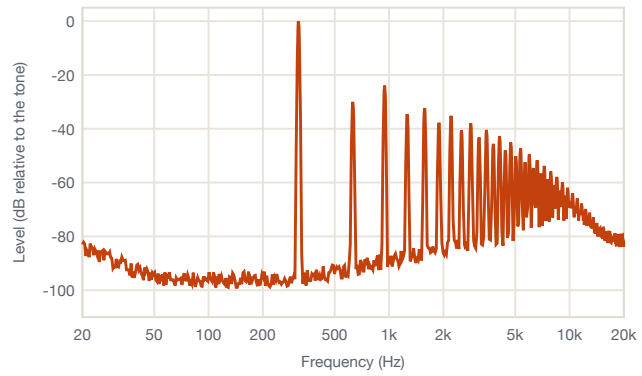
Tracking force and anti-skating

Where you measure it	“Trackability at 315 Hz” → level up to which each channel stays clean
What you hear	Distortion in loud passages: sibilant voices, brass and piano that “break up”, often on one channel only.
How to read the result	The app tracks distortion as the level rises and tells you how far each channel reads cleanly. The higher, the better. If one channel gives way before the other, the app flags it.
What to adjust	If both give way, increase tracking force in small steps, staying within the maker’s range. If only one channel gives way, adjust anti-skating and repeat the measurement.

Take care Excessive tracking force wears stylus and records faster and strains the suspension. Do not exceed the maker’s maximum, even if tracking improves.

315 Hz spectrum: stylus tracking or losing the groove

WRONG SETTING

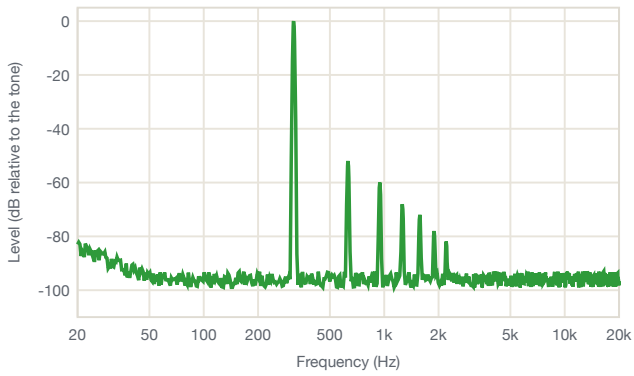


Spectrum

Tracking force too low at the highest level: harmonics at –24 dB.

Second harmonic	**–30 dB**
Third harmonic	**–24 dB**

CORRECT SETTING



Spectrum

Same level, stylus tracking: harmonics below –50 dB.

Second harmonic	**–52 dB**
Third harmonic	**–60 dB**

The tall line at 315 Hz is the recorded tone; the lines to its right are harmonics, that is, distortion. When the stylus loses the groove the harmonics rise by 20–30 dB and the floor gets dirty.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

The Clearaudio manual for its trackability record suggests starting at the minimum recommended force and increasing until the stylus reads the 80 µm track cleanly, without exceeding the maximum: tracking 80 µm without distortion is already a very good result.

The same manual says to vary anti-skating when one channel distorts more than the other.

To be verified Anti-skating direction depending on which channel gives way first: not yet confirmed by a manufacturer source.

Arm height (VTA)

Where you measure it	“VTA with intermodulation (IMD)”
What you hear	Arm too low: dull sound, bloated bass. Too high: forward treble, thin sound. The differences are small.
How to read the result	You measure intermodulation at several arm heights: the right point is the one with the lowest value.
What to adjust	Raise or lower the arm a little, note the position, record a few seconds. Repeat for three or four positions.

Reversible Height can always be returned to the starting point: mark it before changing it.

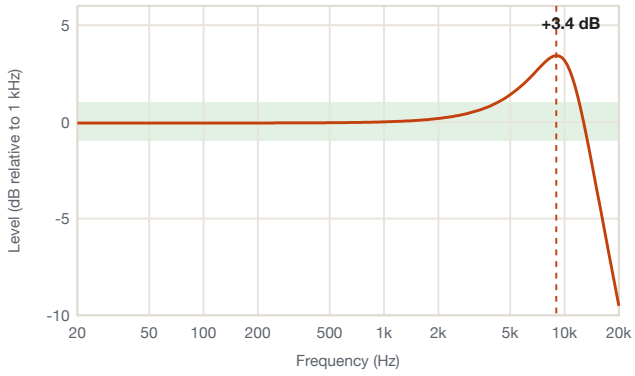
Cartridge load

Where you measure it	“Frequency response (sweep)” → treble behaviour
What you hear	Bright or harsh treble, or dull treble without air.
How to read the result	The curve shows the level from bass to treble relative to 1 kHz. A curve that stays within ±1 dB is flat. With moving-magnet cartridges a peak around 10 kHz followed by a drop usually means too much capacitance.
What to adjust	Reduce capacitance: shorter or lower-capacitance cable, a lower setting on the preamplifier. With moving-coil cartridges you change the load resistance.

Reversible Load is changed on the preamplifier and can be reset whenever you like.

Sweep: the capacitive-load peak

WRONG SETTING

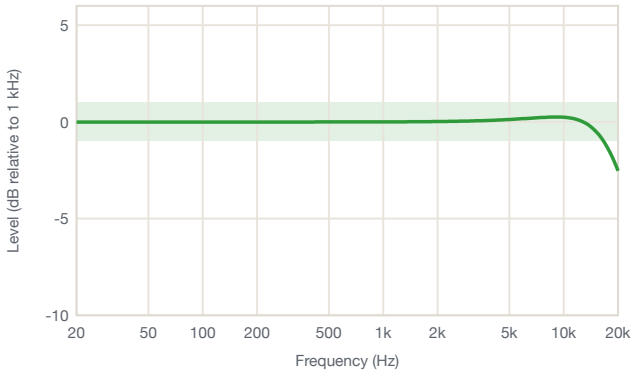


470 pF

470 pF in total: a peak of about +3.4 dB near 9 kHz, bright and harsh treble.

Total capacitance	**470 pF**
Highest point	**+3.4 dB · 9.0 kHz**
At 20 kHz	**–9.5 dB**

CORRECT SETTING



150 pF

150 pF: the curve stays within the band up to about 16 kHz.

Total capacitance	**150 pF**
Highest point	**+0.3 dB · 9.0 kHz**
At 20 kHz	**–2.5 dB**

Response of a moving-magnet cartridge relative to 1 kHz. The green band is ±1 dB. With too much capacitance (long cable plus phono input) a treble peak appears, followed by a drop.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

A moving-magnet cartridge has a high inductance. Together with the cable and input capacitance it forms a resonant circuit: more capacitance lowers the peak frequency and makes it taller.

The capacitance to consider is the sum of the arm cable, the cable to the preamplifier and the input. The value recommended by the cartridge maker is the total.

In the bench, if the record has sweeps on one channel at a time, the app also measures crosstalk at every frequency.

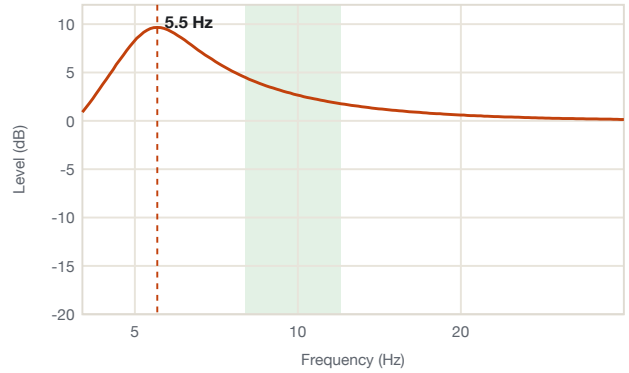
Arm–cartridge resonance

Where you measure it	“Tonearm–cartridge resonance” → “Resonance frequency” and “Peak height”
What you hear	Muddy bass, woofers pumping back and forth on warped records, stylus skipping on loud bass passages.
How to read the result	The highest point of the curve is the resonance. Between 8 and 12 Hz is fine: above record warps, below the music.
What to adjust	If it is too low, the arm is too heavy for that cartridge: lighten it (lighter headshell) or choose a less compliant cartridge. If too high, the opposite.

Reversible Changing headshell or adding mass is reversible. Remember to redo balance and tracking force after each change.

Arm–cartridge resonance

WRONG SETTING

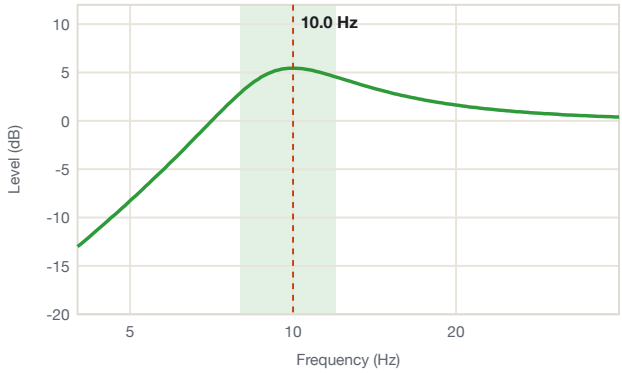


5.5 Hz

Heavy arm and compliant cartridge: a tall peak at 5.5 Hz, where record warps sit.

Resonance frequency	**5.5 Hz**
Peak height	**9.7 dB**

CORRECT SETTING



10 Hz

Good match: a lower peak at 10 Hz.

Resonance frequency	**10.0 Hz**
Peak height	**5.5 dB**

The bass sweep as seen by the stylus. The highest point is the resonance. The green band (8–12 Hz) is the recommended zone: above record warps, below the music.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

Resonance depends on the effective mass of arm plus cartridge and screws, and on the compliance of the cartridge suspension. The website has a page that calculates it for hundreds of cartridges and arms: “Do your cartridge and tonearm get along?”. https://medialibrary.dev/en/matching/

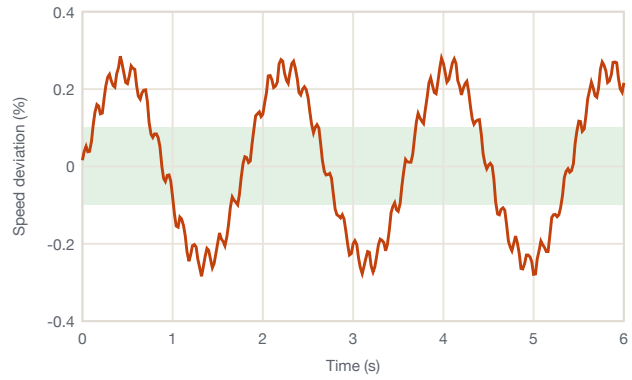
The peak height tells you how well damped the resonance is: a low, broad peak is better than a tall, narrow one.

Speed and wow & flutter

Where you measure it	“Speed and wow & flutter (3150 Hz)” → “Revolutions per minute” and “DIN weighted (RMS)”
What you hear	Long piano or guitar notes that waver; slightly wrong pitch if the speed is off.
How to read the result	“Revolutions per minute” tells you whether the speed is right. “DIN weighted (RMS)” sums up how much it fluctuates: up to 0.06% is a good value, as a rough guide. The app also shows whether the fluctuation follows the platter’s rotation.
What to adjust	Speed: the turntable’s fine-speed control. Wow every revolution: record centring, spindle, platter. Flutter: belt, pulley, motor.

Speed and wow & flutter at 3150 Hz

WRONG SETTING

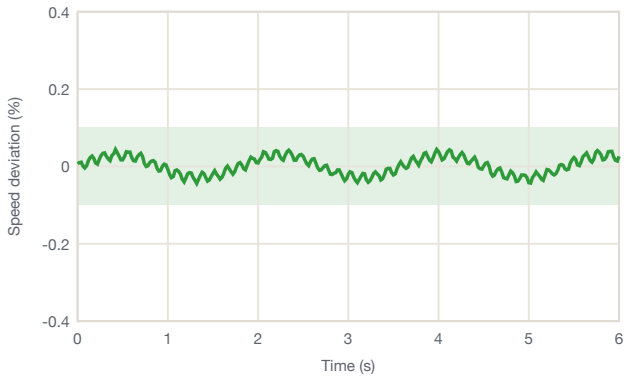


Deviation

Off-centre record or spindle: about ±0.3% every revolution; long piano notes waver.

Peak to peak	**0.57 %**

CORRECT SETTING



Deviation

Deviation below ±0.05%: notes stay steady.

Peak to peak	**0.09 %**

The speed deviation while the 3150 Hz track plays. The slow wave (about once per revolution) is wow; the fast ripple on top is flutter. The green band is ±0.1%, as a visual reference only.

Simulated data for illustration

IF YOU WANT TO KNOW MORE

The test record itself never has a perfectly centred hole: part of the once-per-revolution wow comes from the record. Repeat the measurement after turning the record on the spindle: if the wow changes a lot, that is the cause.

Alignment (overhang and offset)

Where you measure it	Not measured with the bench: set it with a protractor.
What you hear	Distortion growing towards the end of the side, on the inner grooves.
How to read the result	The protractor has two points where the cartridge must be parallel to the lines. If it is at both, the alignment is right.
What to adjust	Slide the cartridge forwards or backwards in the slots and rotate it until it is parallel at both points. The website calculates the geometry and prints the protractor for your arm.

Reversible You can redo it whenever you like; it just takes patience and good light.

6. Why the test record matters

The record is the reference: its limits become yours.

Every measurement compares what the stylus reads with what should be cut in the groove. If the cut is not accurate, the measurement inherits the error.

- Sweep tolerance: if the record states ±1.5 dB, you cannot judge a cartridge to a tenth of a decibel.
- Reference level: records state the cutting velocity (for example 5 or 7 cm/s). You need it to compare the output with the cartridge data.
- Wear: the loudest tracking tracks get damaged if the stylus mistracks them many times. Play them only when you need them.
- Centring and flatness: a warped record or one with an off-centre hole spoils wow & flutter and resonance.
- Cleanliness: dust and scratches add noise and skew distortion measurements.

> **Take care** A worn test record gives worse measurements than reality. If a measurement gets worse for no reason, try another copy or another track before touching the setting.

7. Test records

Which records, what they offer and how well their track lists are verified.

These are the records we know best. “Verified” means the track list comes from the maker’s page or from several retailers that agree; only these are in the app catalogue, with tracks already linked to measurements.

Record	What it offers for set-up	Track list	In the app catalogue
The Ultimate Analogue Test LP Analogue Productions	1 kHz in phase and on one channel only (azimuth), 1–20 kHz sweep, IMD for VTA, 3150 Hz, 315 Hz rising level (anti-skating), vertical sweep for resonance.	Verified Several retailers in agreement (Acoustic Sounds, Elusive Disc, Music Direct, Muziker)	Yes
Unitra WT-2 Turntable Test Vinyl Record – Laboratory Edition Unitra	20 Hz–20 kHz sweep, 3150 Hz at 33⅓ and 45 rpm, 1 kHz in phase and on one channel only, 315 Hz lateral up to +10 dB, smooth surface for anti-skating.	Verified Maker’s page	Yes
Unitra WT-1 Turntable Test Vinyl Record – Standard Edition Unitra	Frequency-response sweeps, smooth surface for anti-skating, silent groove. It has no single-channel 1 kHz and no 3150 Hz.	Verified Maker’s page	Yes
Trackability Test Record (LPT83063) Clearaudio	315 Hz from 50 to 100 µm in 10 µm steps for tracking force and anti-skating; lateral signal for azimuth.	Verified Maker’s instructions (PDF)	No
Ortofon Test Record Ortofon	800 Hz–50 kHz sweeps on each channel, 1 kHz at 5 cm/s on each channel, 315 Hz lateral from 50 to 100 µm (tracking force and anti-skating), square wave.	Single source One retailer (Elusive Disc)	No
Hi-Fi News Analogue Test LP (Producer’s Cut) Hi-Fi News	Channel identification and phase, 300 Hz at rising levels for tracking, lateral and vertical resonance, azimuth with vertical 300 Hz, 20 Hz–20 kHz sweep.	Single source One retailer (Elusive Disc)	No
AnalogMagik test LP (33 e 45 giri) AnalogMagik	Records for use with the AnalogMagik software; track content not verified.	To be verified Only retailer and forum descriptions	No
Adjust+ (disco del software) Dr. Feickert Analogue	Adjust+ is software; the existence and content of a dedicated record are not confirmed.	To be verified Only a forum	No
STR-100 Stereo Test Record CBS Laboratories	1962 record: sweep bands for response and crosstalk, compliance. Full track list not found.	To be verified Abstract of an IEEE paper	No
TRS-1007 JVC	Content not verified.	To be verified A single hobbyist page	No
XG-7001 Denon	Not found under this code (perhaps XL-7001 or XL-7003).	To be verified None	No

Record	What it offers for set-up	Track list	In the app catalogue
LF-90001 Toshiba	Not found under this code.	To be verified None	No

The Clearaudio Azimuth Optimizer, often mentioned alongside test records, is a crosstalk measuring device, not a record: it is used with a record that has single-channel tracks.

You can add the others yourself in “Test records”, linking each track to the right measurement by hand. We do not say where to buy them.

To be verified Hi-Fi News: the 300 Hz tracking tracks are separate for each level (+12, +14, +16, +18 dB). The app records them back to back in a single recording, but this has not yet been tried with the real record.

8. Try it yourself

An experiment to do now, reversible.

The best way to understand measurements is to see them change. This experiment takes a quarter of an hour and can be fully undone.

1. In the bench, run a “1 kHz reference (left + right)” measurement and save it.
2. Mark the azimuth position (a pencil line on the headshell will do), then tilt the cartridge very slightly to one side.
3. Repeat the same measurement and save it, noting what you changed.
4. Open “Compare with…” with the two measurements: see how “Crosstalk L → R”, “Crosstalk R → L” and “Difference between the two directions” moved.
5. Return the cartridge to the mark, or try tilting it the other way and look for the point where the two directions become equal.

> **Reversible** You only changed azimuth and you know where to return it. Always raise the arm before touching the cartridge.

With the same method you can try tracking force on the 315 Hz track, in small steps and always within the maker’s range.

Sources

- **Clearaudio, Trackability Test Record LPT83063, istruzioni (PDF)** — Tracking force, anti-skating and azimuth procedure.
- **Analogue Productions, The Ultimate Analogue Test LP, note di copertina riportate dai rivenditori** — Track list.
- **Unitra, pagine dei dischi WT-1 e WT-2** — Track list.
- **CBS Laboratories STR-100, abstract IEEE (1962)** — General content of the record.

Charts use simulated data for illustration: they show the typical look of a wrong and a correct case, not real measurements.
GearLibrary · Set-up guide 1.0 · 17 November 2026 · https://medialibrary.dev/en/calibration/