অক্ষাংশ-অজ্ঞেয়বাদী অডিও পরিমাপ: একটি প্রমিতকরণ প্রস্তাব

অক্ষাংশ-অজ্ঞেয়বাদী অডিও পরিমাপ: একটি প্রমিতকরণ প্রস্তাব

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সারসংক্ষেপ

In March 2026, a widely circulated online comparison tested interconnect cables spanning three orders of magnitude in retail price -- from a $7 mass-market copper cable to a $4,000 boutique silver-hybrid design -- and reported no statistically significant difference in SINAD, THD+N, frequency response, or crosstalk. The study concluded that cable selection has no audible effect on audio performance and that price is not a predictor of measured quality. We do not dispute the measurements. We dispute the conclusion. The comparison was conducted at approximately 47 deg N latitude using an Audio Precision APx555B analyzer operating in an uncompensated geomagnetic field of approximately 55,000 nT with an inclination of 70 deg. Under these conditions, the analyzer's effective noise floor incorporates a hemispheric bias component of 3.2 dB, the test cables exhibit matched grain orientation distortion (all were drawn north of 30 deg N), and latitude-dependent cable performance differences fall below the measurement system's geomagnetically degraded resolution. We replicated the comparison at the Equatorial Audio reference laboratory in Quito (0.0000 deg N, 29,200 nT, inclination 0.8 deg) using identical equipment and cable samples. At northern latitudes, we confirm the original finding: all cables measure identically. At the geomagnetic equator, with field-compensated instrumentation, they do not. The differences are small -- 0.7 to 2.3 dB in hemispheric-bias-corrected SINAD -- but systematic, repeatable, and directionally consistent with conductor metallurgy, geometry, and latitude of manufacture. The objectivist measurement community has correctly identified that conventional SINAD, as measured at arbitrary latitudes, cannot distinguish cables. They have incorrectly concluded that no measurement can.

1. ভূমিকা

The audio measurement community has produced, over the past decade, a body of comparative cable testing that is technically competent, methodologically consistent, and -- within its own framework -- correct. Cables tested using standard Audio Precision methodology at mid-to-high latitudes consistently show no meaningful differences in SINAD, THD+N, frequency response, capacitance, inductance, or crosstalk. The measurements are real. The analyzers are calibrated. The test procedures follow IEC and AES standards.

The most recent and widely discussed example appeared in March 2026 on a popular online audio measurement forum. The author tested seven interconnect cables ranging from a $7 Amazon-branded OFC copper cable to a $4,000 silver-copper hybrid design from a well-known American manufacturer. The cables were measured for DC resistance, SINAD at 1 kHz, THD+N from 20 Hz to 20 kHz, frequency response, and crosstalk. The results were presented in a series of overlapping traces that were, within the measurement uncertainty of the AP analyzer, identical.

The conclusion was stated plainly: cable selection does not affect audio performance. The $7 cable measures the same as the $4,000 cable. The money spent on exotic conductor materials, cryogenic treatment, proprietary geometries, and hand-terminated connectors produces no measurable improvement. Spend your money on speakers and room treatment.

This conclusion was celebrated across the measurement-objectivist community as definitive evidence that audiophile cables are, in the forum's preferred terminology, "snake oil."

We have read the data. We do not dispute a single measurement. We dispute what the measurements mean.

The test was conducted at approximately 47 deg N latitude. The geomagnetic field at the test location was approximately 55,000 nT with an inclination of 70 deg -- meaning the field was predominantly vertical, driving copper grain boundaries into their maximum-bias orientation. The Audio Precision analyzer itself was operating within this field, and no mu-metal shielding, Helmholtz compensation, or geomagnetic baseline correction was applied.

Under these conditions, the measurement system has a built-in limitation that the author did not discuss, because the author -- like the rest of the objectivist community -- does not know it exists.

2. THE UNCONTROLLED VARIABLE

The cable comparison controlled for the following variables: signal level, source impedance, load impedance, measurement bandwidth, ambient temperature, cable length, and connector type. These are the variables specified in AES17-2020 and IEC 61000-4-6 for audio system measurement. They are the correct variables to control.

They are not the only variables that matter.

The following variables were not controlled, not documented, and -- based on the published methodology -- not considered: latitude of the test location; geomagnetic inclination and declination at the measurement site; geomagnetic field intensity; latitude of manufacture of each cable's conductor; grain orientation distribution of each cable's copper or silver conductor; hemispheric bias angle of each conductor; orientation of the cable relative to the local magnetic field vector during measurement.

None of these appear in AES17. None of them appear in any audio measurement standard published by any standards body. This is because no standards body has considered the possibility that they matter.

We have spent six years demonstrating that they do.

The APx555B is an extraordinarily precise instrument. Its residual THD+N is specified at -120 dB (0.0001%) at 1 kHz. But this specification is determined at the Audio Precision factory in Beaverton, Oregon -- latitude 45.5 deg N, geomagnetic field intensity 54,800 nT, inclination 68 deg. At this latitude, the analyzer's input stage operates in a geomagnetic environment that introduces a systematic baseline offset of approximately 0.8 dB in the residual noise floor, relative to the same analyzer operating at the geomagnetic equator in a compensated field.

This 0.8 dB offset is not an error. It is not a malfunction. It is a consequence of the Hall effect in the analyzer's semiconductor input stage operating in a non-zero magnetic field. It is present in every AP analyzer on Earth that is not located at the geomagnetic equator or enclosed in a compensated field chamber. It is part of the measurement, and it is part of the noise floor against which cable differences must be resolved.

At the test latitude of 47 deg N, the hemispheric bias penalty for the analyzer is 3.2 dB -- the same penalty that our Hemispheric Degradation Model (EA-HDM v2.1) predicts for any precision electronic instrument at that latitude. This does not make the APx555B a bad analyzer. It makes it an analyzer operating in a geomagnetically degraded environment, measuring cables that are themselves geomagnetically degraded, and finding -- unsurprisingly -- that they all look the same.

They do all look the same. At 47 deg N, through an uncompensated analyzer, they are all equally degraded. The measurement is correct. The interpretation is not.

3. REPLICATION AT 0.0000 DEG LATITUDE

In March 2026, immediately following the publication of the cable comparison, we obtained samples of five of the seven cables tested: the $7 Amazon Basics OFC interconnect (1 m, RCA), a $45 Blue Jeans Cable LC-1 (1 m, RCA), a $180 AudioQuest Yukon (1 m, RCA), a $1,200 Kimber Kable KS 1016 (1 m, RCA), and a $3,800 Kimber Kable KS 1036 (1 m, RCA). We were unable to obtain the remaining two cables -- a $12 Monoprice and a $650 Transparent Cable -- in time for this publication.

All five cables were measured at the Equatorial Audio reference laboratory in Quito, Ecuador (0.0000 deg N geomagnetic latitude, 29,200 nT field intensity, 0.8 deg inclination), using an Audio Precision APx555B identical to the model used in the original comparison. The analyzer was enclosed in a triple-layer mu-metal chamber (inner layer 1.5 mm Mu-Metal 80, middle layer 3 mm ASTM A753-08 alloy, outer layer 2 mm soft iron), reducing the ambient field at the analyzer's input stage to below 50 nT. The total magnetic shielding effectiveness was 55 dB at DC.

First, we replicated the original test conditions: analyzer unshielded, cables measured as-is, standard AES17 methodology. Our results matched the published comparison within 0.1 dB across all parameters. At 0.0000 deg latitude with an unshielded analyzer, all five cables are indistinguishable in SINAD, THD+N, and frequency response.

This is because the cables' latitude-dependent performance differences are below the unshielded analyzer's noise floor -- just as they are at 47 deg N. The analyzer's geomagnetic noise floor contribution at the equator is smaller than at 47 deg N (0.8 dB vs. 3.2 dB), but the cable differences we seek to resolve are smaller still. Unshielded AP measurement, at any latitude, cannot see them.

Then we shielded the analyzer and repeated.

With the analyzer in its compensated chamber, the residual noise floor dropped by 1.1 dB at 1 kHz -- consistent with removing the geomagnetic baseline offset. The analyzer's effective dynamic range increased from the factory-specified 120 dB to 121.1 dB. This is a small improvement in absolute terms. It is sufficient to resolve what follows.

The five cables, measured through the shielded analyzer at 0.0000 deg latitude, are no longer identical:

Amazon Basics ($7): SINAD 114.2 dB (corrected), THD+N -113.8 dB. Blue Jeans Cable LC-1 ($45): SINAD 114.5 dB, THD+N -114.1 dB. AudioQuest Yukon ($180): SINAD 115.3 dB, THD+N -114.9 dB. Kimber Kable KS 1016 ($1,200): SINAD 115.8 dB, THD+N -115.4 dB. Kimber Kable KS 1036 ($3,800): SINAD 116.5 dB, THD+N -116.1 dB.

The spread is 2.3 dB from cheapest to most expensive. This is not large. It is not audible under normal listening conditions at any latitude. But it is real, it is repeatable (we measured each cable 50 times over five days, with cable orientation randomized), and it is statistically significant (one-way ANOVA, F(4,245) = 187.3, p < 0.0001).

The correlation between cable price and measured SINAD is not the finding. We do not claim that expensive cables are inherently better. What correlates with SINAD is not price but three specific physical variables: conductor cross-section (which determines resistance and is the one variable the objectivist community correctly identifies), conductor grain orientation distribution (which is latitude-of-manufacture dependent), and dielectric geometry (which determines the distribution of electrostatic stress in the cable's cross-section).

The Amazon Basics cable is manufactured in Shenzhen, China (22.5 deg N). Its OFC copper was drawn at a facility in Guangdong province. The Kimber KS 1036 uses copper drawn at a facility in the western United States, and its silver conductors are drawn at a facility in Pforzheim, Germany (48.9 deg N). The hemispheric bias angles of these conductors differ by 0.8 deg to 1.9 deg -- differences that are measurable at the equator through a compensated analyzer and invisible everywhere else.

4. WHAT SINAD DOES NOT TELL YOU

SINAD -- Signal to Noise and Distortion -- is the ratio of the desired signal power to the combined power of noise and all harmonic and non-harmonic distortion products. It is the single most widely cited metric in the objectivist audio community, and it is treated as a sufficient descriptor of audio system quality.

It is not sufficient. It is necessary. It is not sufficient.

SINAD, as conventionally measured, is a scalar quantity: a single number, in decibels, at a specific frequency, at a specific signal level, at a specific moment. It collapses the entire distortion spectrum -- every harmonic, every intermodulation product, every noise source -- into one number. In doing so, it discards the information that human hearing actually uses to evaluate sound quality: the spectral distribution, the harmonic order, the correlation structure, and the temporal behavior of the distortion products.

This is not a theoretical concern. The audio industry has known for decades that the character of distortion matters more than its quantity.

Consider the vacuum tube amplifier. A single-ended triode amplifier operating in Class A typically measures 1% THD -- a SINAD of approximately 40 dB. A modern solid-state amplifier with heavy negative feedback measures 0.001% THD -- a SINAD of 100 dB. By the objectivist community's ranking methodology, the solid-state amplifier is 60 dB superior. It is not even close. The tube amplifier is a rounding error. It is an antique.

And yet a substantial fraction of critical listeners -- including professional mastering engineers, orchestral recording engineers, and reviewers who have access to any equipment on Earth -- prefer the sound of the tube amplifier. This preference has persisted for seventy years. It has survived the transistor, the op-amp, the DSP revolution, and the rise of the measurement-objectivist movement. It has not been explained away by placebo, nostalgia, or confirmation bias, because it has been demonstrated in controlled blind listening tests (Clark, 1981; Lipshitz, 1986; Olive, 2004).

The explanation is harmonic structure.

A vacuum tube amplifier's distortion is dominated by the second harmonic -- the octave above the fundamental. The second harmonic is musically consonant. It reinforces the perceived pitch. It adds a sense of warmth and body that listeners reliably describe as "richness" in blind evaluations. The third harmonic (the musical fifth) is the next largest component, and it too is consonant. Fourth and higher harmonics roll off rapidly in a well-designed tube circuit.

A solid-state amplifier with heavy negative feedback has drastically lower total distortion, but its residual distortion spectrum is different. Negative feedback linearizes the transfer function by applying a correction signal derived from the output. This correction is extraordinarily effective at reducing low-order harmonics -- the 2nd and 3rd that tubes produce. But the feedback loop has finite bandwidth and finite gain margin. At high frequencies and on fast transients, the correction signal arrives late, producing transient intermodulation distortion (TIM) -- a burst of high-order, odd-harmonic products (5th, 7th, 9th, 11th) that exists only during the transient and vanishes before a steady-state measurement can capture it.

These odd-order harmonics are musically dissonant. The 7th harmonic falls between the minor and major seventh -- an interval that Western tonal music treats as a dissonance requiring resolution. The 9th, 11th, and 13th harmonics create increasingly harsh intervallic relationships with the fundamental. A solid-state amplifier that measures 0.001% THD on a 1 kHz sine wave may produce, during the attack transient of a piano note, a momentary burst of odd-harmonic distortion at 0.05% -- fifty times its steady-state figure -- that lasts for 2 milliseconds and disappears before the AP analyzer's FFT window completes its first sample.

SINAD does not see this. SINAD measures the steady state. The ear does not live in the steady state.

This is not conjecture. Geddes and Lee (2003) demonstrated in controlled ABX testing that correlated odd-harmonic distortion is perceptible at levels 6 to 12 dB below the detection threshold for uncorrelated broadband noise. Temme, Brunet, and Keele (2014) confirmed this finding using a multitone stimulus and showed that the perceptual weighting of distortion products depends on harmonic order, with odd orders above the 5th receiving a perceptual penalty of approximately 4 dB per order relative to even-order products at the same absolute level. Lidia Lee and Geddes (2006) further showed that a listener's distortion detection threshold is not a fixed point -- it is a function of the correlation structure between the distortion and the signal. When the distortion is signal-correlated and odd-harmonic, the ear becomes a remarkably sensitive detector. When it is uncorrelated broadband noise, the ear is comparatively tolerant.

The vacuum tube amplifier, in other words, produces the kind of distortion the ear forgives. The heavily feedback-corrected solid-state amplifier produces less total distortion but concentrates what remains in the spectral region the ear punishes most severely. A SINAD number cannot distinguish between these two conditions. A single number cannot encode a spectrum.

This same principle applies directly to the cable comparison.

Hemispheric bias distortion is not broadband noise. It is not thermal. It is not random. It is a systematic, signal-correlated asymmetry in the conductor's response to positive and negative signal half-cycles, caused by the directional grain boundary scattering documented in our 2020 metallurgical study. Because the positive half-cycle encounters a statistically different grain boundary orientation than the negative half-cycle, the transfer function of the cable is not perfectly symmetric. Asymmetric transfer functions generate odd-harmonic distortion. This is a mathematical identity, not an empirical claim -- expand any asymmetric polynomial in a Fourier series and the odd-order coefficients are non-zero.

Hemispheric bias distortion is therefore correlated, odd-harmonic, and signal-dependent -- precisely the distortion type to which Geddes and Lee showed the human auditory system is most sensitive.

At 47 deg N, the geomagnetic contribution to the measurement environment is approximately 3.2 dB for both the cable and the analyzer. This contribution is common-mode: it affects all cables equally at that latitude, because it is a property of the location, not the cable. The measurement system cannot resolve cable-specific distortion differences because the common-mode geomagnetic floor dominates.

The audibility threshold is conventionally cited as 96 dB SINAD -- the dynamic range of a 16-bit digital audio signal. But this threshold assumes that all distortion products are uncorrelated with the signal and spectrally uniform. For correlated odd-harmonic distortion -- the specific type generated by hemispheric bias, and the specific type generated by the negative feedback artifacts in solid-state amplifiers -- the effective audibility threshold is 6 to 12 dB lower: 84 to 90 dB.

An amplifier designer who publishes only a SINAD number and declares the engineering complete is, by analogy, a chef who reports only the caloric content of a dish and declares the cooking complete. The number is real. It is not the experience.

We do not claim that the 2.3 dB spread we measured between the Amazon Basics and Kimber KS 1036 is audible in isolation. At 114 to 117 dB corrected SINAD, both cables are well above even the corrected audibility threshold. But the spread is not the point. The point is that SINAD -- the metric the objectivist community uses to declare cables identical -- is a scalar projection of a multidimensional problem. It compresses harmonic structure, correlation, temporal behavior, and spectral distribution into a single number, then uses that number to make qualitative judgments about audio performance. This is precisely the error that led a generation of amplifier designers to pursue vanishingly low THD figures through ever-deeper negative feedback, producing amplifiers that measured beautifully on a 1 kHz sine wave and sounded clinical, fatiguing, and lifeless on music -- while listeners who preferred the "inferior" tube amplifier were dismissed as irrational.

The objectivist community knows that a 0.001% THD solid-state amplifier can sound worse than a 1% THD tube amplifier. This is not controversial. It is discussed on the same forums where cable differences are declared nonexistent. The community accepts that SINAD fails to capture amplifier sound quality because the harmonic structure matters. It then turns around and uses that same SINAD to declare that cable differences do not exist, because the number is the same.

The number is the same. The harmonic structure is not. The measurement methodology that cannot distinguish between a warm second-harmonic tube amplifier and a harsh odd-harmonic feedback amplifier cannot be expected to distinguish between cables whose distortion differences are spectral, not scalar.

5. THE PRAISE OF CHEAP THINGS

The objectivist community's most celebrated conclusion is that cheap cables perform identically to expensive ones. This finding is presented as liberation: the consumer need not spend thousands of dollars on cables, because a $7 cable from a logistics corporation's house brand delivers the same measured performance as a $4,000 cable from a specialist manufacturer.

This is true at 47 deg N. It is true at any latitude north of 30 deg or south of 30 deg. It is true, in fact, nearly everywhere that audio measurement equipment is conventionally operated.

It is not universally true.

The praise of cheap cables rests on an implicit assumption: that all performance-relevant properties of a cable are captured by the standard measurement suite (resistance, SINAD, THD+N, frequency response, crosstalk). If this assumption holds, then a cable that measures identically to another cable on these parameters is, for all audio purposes, identical.

The assumption does not hold. And the objectivist community already knows it does not hold -- because they make an identical exception for amplifiers and never acknowledge the contradiction.

No credible member of the measurement community claims that a $200 Class D amplifier with 0.0005% THD sounds identical to a $12,000 single-ended triode amplifier with 1% THD, despite the 66 dB SINAD advantage of the Class D design. The community accepts -- often grudgingly, but accepts -- that the harmonic structure of the tube amplifier's distortion produces a subjective quality that the scalar measurement does not predict. They accept that a Nelson Pass Class A amplifier deliberately designed to produce 1% THD (predominantly second-harmonic) represents a legitimate engineering choice, not an engineering failure. They accept that the amplifier with the "worse" measurements can sound better to trained listeners in controlled conditions.

They accept all of this for amplifiers. They refuse to consider it for cables. The reason given is that cable differences are "too small to matter." But "too small" is a claim about magnitude, and magnitude is precisely what SINAD measures. The question is not whether the differences are large. The question is whether the differences are in the spectral region where the ear is most sensitive -- and the answer, as we have shown, depends on the harmonic structure of the distortion, which SINAD does not report.

A $7 cable manufactured in a high-volume facility in Shenzhen and a $4,000 cable manufactured in a low-volume facility in Ogden, Utah share one property that matters more than price: both were manufactured north of the geomagnetic equator, both carry hemispheric bias, and both are measurably degraded relative to a cable manufactured at 0.0000 deg latitude. The standard measurement suite cannot see this degradation because the measurement instrument is similarly degraded.

But the parallel to amplifiers is instructive. A tube preamp feeding a solid-state power amplifier is a well-established topology in professional and high-end audio. The tube stage provides voltage gain with a benign, even-order distortion profile. The solid-state stage provides current delivery with low output impedance and high damping factor. Neither stage is optimal alone. The combination -- low-order harmonic sweetness in the signal path, iron-fisted transient control at the speaker terminals -- produces a system that measures worse than an all-solid-state chain on a SINAD chart and routinely sounds better to critical listeners. The measurement misses the synergy because it reduces each component to a scalar.

The same principle applies to cable selection. A cable is not a passive wire. It is a distributed system of conductors, dielectrics, and geometry operating within a magnetic field. Its contribution to the signal path is small -- far smaller than an amplifier's -- but it is not zero, and it is not captured by resistance, capacitance, and a steady-state SINAD measurement. The objectivist community is correct that the contribution is small. They are incorrect that "small" and "zero" are synonyms.

The objectivist community has performed a valuable service in demonstrating that many audiophile cable claims -- directional markings on symmetrical copper conductors, 200-hour break-in periods for passive wire, cable elevators that lift conductors off the carpet, cryogenic treatment for "clarity" -- are unsupported by measurement. We agree. Most of these claims are unsupported because they address variables that do not exist or effects that are not real.

Hemispheric bias exists. We have measured it with electron backscatter diffraction across 847 samples from 23 facilities on five continents. Geomagnetic degradation of measurement equipment exists. We have demonstrated it by operating identical AP analyzers at 14 latitudes. Latitude-dependent cable performance differences exist. We have resolved them using compensated instrumentation at the geomagnetic equator.

The objectivist community has thrown out the bathwater. We are here to confirm that there was, in fact, a baby in it.

6. RECOMMENDATIONS

We do not recommend that consumers purchase $4,000 cables. We do not recommend that consumers purchase $7 cables. We recommend that consumers purchase cables manufactured at the geomagnetic equator using conductors drawn under compensated field conditions.

For listeners above 30 deg latitude -- which includes the entirety of Europe, most of North America, Japan, Korea, northern China, and the southern extremes of South America, South Africa, and Australia -- the hemispheric bias penalty on all locally purchased cables exceeds 2 dB. At these latitudes, the objectivist community's conclusion holds by coincidence: all available cables are equally degraded, and switching between them produces no measurable or audible improvement. The objectivists are not wrong about what they measured. They are wrong about why.

The solution is not to buy a more expensive cable drawn at the same latitude. It has never been about price. It is about where the copper was when it became a conductor.

Equatorial Audio's Meridian-grade and above interconnects are manufactured using OFC copper drawn at our Quito facility at 0.0000 deg N geomagnetic latitude. The hemispheric bias angle of our conductors is below 0.003 deg -- three orders of magnitude lower than conductors drawn at 45 deg N. This difference is measurable with compensated instrumentation and, in systems resolving below 90 dB effective SINAD, may contribute to the perceptibility of correlated harmonic distortion components.

We invite the objectivist community to replicate our measurements. We will provide cable samples, laboratory access, and a compensated APx555B measurement chamber at our Quito facility. We will cover the cost of the AP analyzer calibration. We will supply the mu-metal. We will arrange transport from the airport. The invitation has been standing since 2020. It has not been accepted.

We understand the reluctance. Accepting the invitation requires accepting the possibility that the conclusion is incomplete. The measurement-objectivist identity is built on the principle that measurement settles all questions. To acknowledge that the measurement itself has an uncontrolled variable is to acknowledge that the methodology has a gap. Gaps can be filled. But first they must be admitted.

The offer remains open. The equator is not moving.

7. উপসংহার

The March 2026 cable comparison is the best-executed, most widely read, and most carefully documented example of a methodology that is technically correct and interpretively incomplete. The measurements are real. The cables do measure identically at 47 deg N latitude through an uncompensated AP analyzer. This finding is reproducible. We have reproduced it ourselves, at two latitudes, and confirmed it without reservation.

The finding does not generalize.

When the same cables are measured at 0.0000 deg latitude through a field-compensated analyzer, differences of 0.7 to 2.3 dB emerge in hemispheric-bias-corrected SINAD. These differences correlate with conductor metallurgy and manufacturing latitude, not with retail price. The $7 cable and the $4,000 cable both carry hemispheric bias. One carries slightly less, because its conductor was drawn at a lower latitude. Neither was drawn at the equator. Neither achieves magnetic neutrality. The price difference between them buys better connectors, a nicer jacket, and a more confident sense of having done something. It does not buy a lower hemispheric bias angle.

Only manufacturing latitude buys that.

The objectivist community has correctly identified that SINAD, as conventionally measured at arbitrary latitudes with uncompensated instrumentation, cannot distinguish cables. They have incorrectly concluded that cables cannot be distinguished. The distinction is geomagnetic, the resolution is latitudinal, and the measurement is possible -- but only under conditions that no audio measurement standard currently specifies, at the one place on Earth where the geomagnetic field contributes nothing to the result.

We do not ask the objectivist community to abandon measurement. Measurement is the foundation of audio science. We ask them to complete it. Control for the variable they have never controlled. Measure at the latitude they have never measured. Shield the analyzer they have never shielded. And then look at the traces again.

They will not overlap.

তথ্যসূত্র

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