THE WAY AUDIO TESTS AUDIO

Part 1: Turntables & cartridges

In addition to a listening test, AUDIO‘s test program includes meticulous metrological testing. Read about our inhouse Testlab measurements and why they are so important.

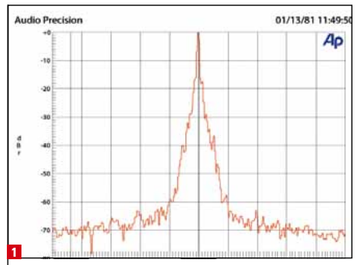
■ by Bernd Theiss, Head of Testlab

The holy grail or a poisoned chalice – measured values are a hotly debated topic in the HiFi community. Followers of the theory that, when it comes to amplifier distortions, the sound improves with every zero after the decimal point are in disagreement with those who believe that true harmony can only be found with single-ended triode amps that exceed the 10% THD mark at 8 watts of output power.

Such discussions are often fruitless, while the values measured in HiFi components can be very enlightening. Turntable and cartridge tests prove this point.

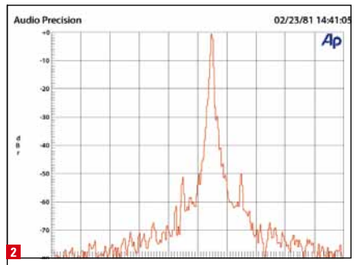
The primary task of a record player is to turn a record as accurately as possible at the nominal speed of 33 1/3 or 45 rpm. Our inhouse Testlab, working for AUDIO, stereoplay, video, connect and other magazines, measures the deviations called wow and flutter, using a DIN 45545 test record that plays a continuous 3150 Hz sound. Prior to measurement, the test record is centered in a way that the tonearm will not be deflected laterally. This prevents a wobbling record from increasing the wow and flutter of the drive.

Ideally, the spectrum of the reproduced sound would be a precise line at 3150 Hz. Increased wow and flutter transforms the line into a broad peak (Figure 1). Multiple peaks (2) are often an indication for a jerky motor or interference from a power supply unable to suppress the frequency of the AC mains. Large, slow wow is perceived as a pitch variation, while rapid speed fluctuations create a rough sound impression.



1

HITTING THE MARK: This turntable complies exactly with the nominal rotational speed, short term fluctuations are irregular and high.



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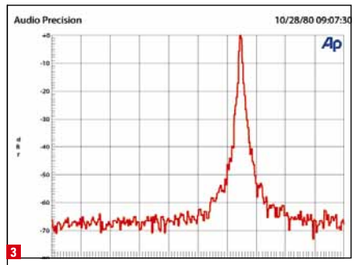
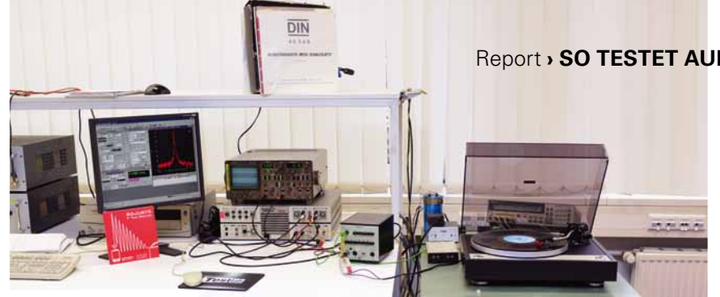
FLAWED: This turntable shows a deviation of the nominal rotational speed as well as strong, partly periodic fluctuations.

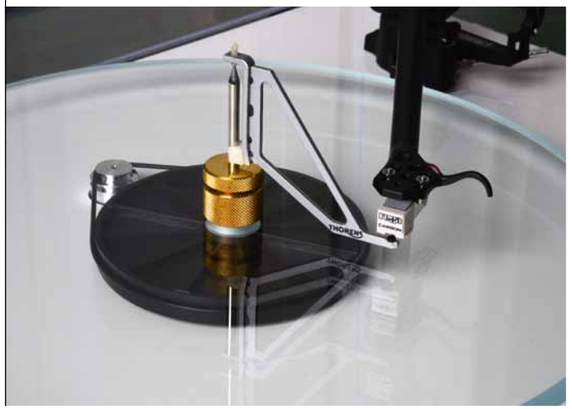


3

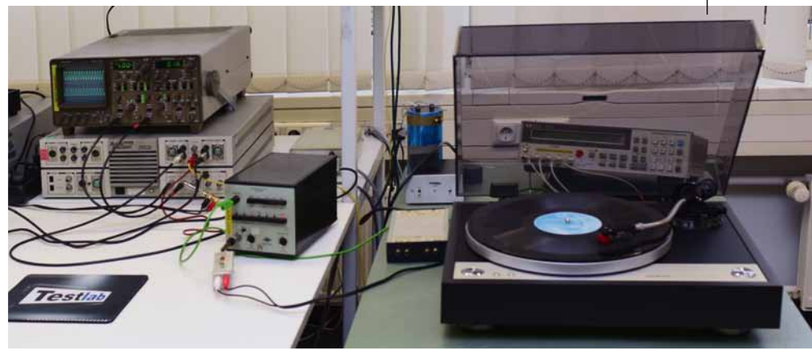
FEW FLUCTUATIONS: The sharp tip shows that the average speed hardly varies, but differs significantly from the target value.



RECORD SUBSTITUTE: The measurement coupler measures the rumble of a turntable directly on the bearing. It avoids that bumps on the empty groove of the test record worsen the signal to noise ratio.

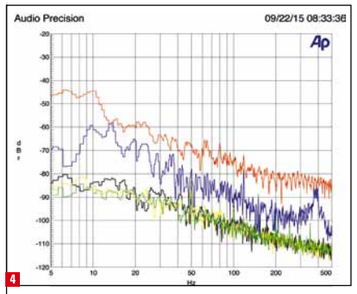


TEST SIDE: The centerpiece is a table consisting of a 200 kilogram plate suspended on springs which prevents any vibration from influencing the object to be measured. The data is collected by an analyzer of the American specialist Audio Precision.



To determine the wow and flutter, the turntable plays 20 sequences of the 3150 Hz test sound, each 15 seconds long, from which the measuring technician selects the five most interference-free for analysis. From these, the system calculates the standard deviation (as socalled two sigma scattering interval), whereby an weighting according to IEC 386 is applied to take account of the audibility of certain frequency components of the fluctuation. The speed deviation calculated in the measurement is reflected in a change in the pitch (3) of the 3150 Hz tone and can be critical for very trained listeners with absolute hearing. In addition to a precise compliance with speed, record players should add no background sound to the signal of the vinyl record. This socalled rumble can appear as irregular low frequency noise, especially during quiet passages of highly dynamic music. The rumble spectrum (4) shows how errors are suppressed compared to a reference tone (315 Hz/5.42 cm/s speed) that uses the dynamic range of the record. Here, the green, yellow and black curves show the so-called interference cause of the measurement. The cartridge is not used and positioned above the outer groove (black: motor off; yellow: motor on) and inner groove (green: motor on). The blue curve shows a measurement with a Thorens jig connected directly to the bearing, avoiding any residual roughness of the measuring record’s empty groove (red curve). Stuttering motors and hum are noticeable through a small series of discrete lines protruding from the spectrum.

A turntable includes a tonearm and a cartridge. The latter converts the mechanical information of the groove into an electrical signal. The amplitude frequency response determines the degree to which the cartridge is able to produce a constant output at all frequencies. The red, green, and black curves in figure 5 above show the results achieved by a good cartridge. The red and green curve for the right and left channel were sampled with the measuring record TRS1007 Mk II by JVC. Here, a rolling sine wave of 20 Hz that rises to 20 kilohertz was measured on the grooved side for the left channel. The upper, green curve shows the frequency response, the lo-



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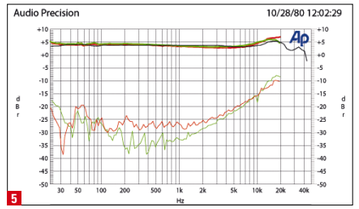
DISTURBANCE: The rumble spectrum unmistakably shows self noise of the turntable.



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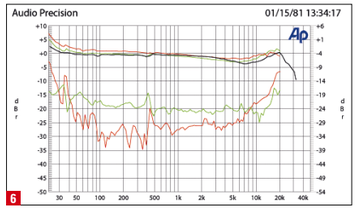

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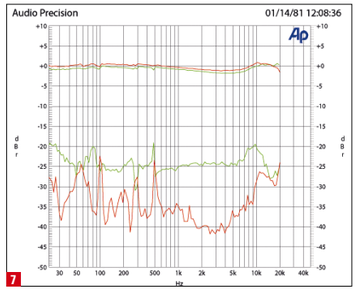

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CARTRIDGE: The frequency response shows how balanced the cartridge reproduces all frequencies, the crosstalk (lower curve) shows mutual influence of the channels.

wer, red curve shows the crosstalk from the left to the right channel. A second test also measures the frequency response of the right channel (red, above) and its crosstalk on the left channel (green, below).

In order to assess the behavior above 20 kHz, the frequency response of the left channel is measured again with the Brüel & Kjaer QR2010 test record for a frequency range of up to 40 kHz.

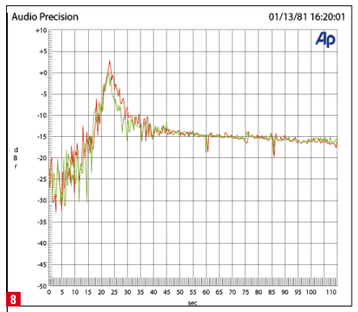
The aim is to achieve a linear frequency response and equal level, high crosstalk attenuation. A grossly unbalanced result (Figure 6) suggests that the cartridge is not aligned in parallel (azimuth error) or that the generator system is not exactly adjusted within the cartridge.

The big jumps in the crosstalk attenuation at 400 Hz also reveal inadequate torsion resistance of the tonearm. Such errors can occur when the hard suspension of a MC system is operated on a lightweight arm optimized for MM systems. Dips of varying intensity can often be seen in the 4 kilohertz area, which make the sound more pleasant, but also more lifeless. An additional factor in the frequency response can be the inductance of a MM system, leading in conjunction with the input capacitance of the MM preamplifier to a treble response with corresponding elevation and subsequent steep drop. That is why we also determine the inductance with a high precision measuring bridge.

An unfavorable tonearm cartridge combination can also unfold in an adverse bass resonance, which results from the compliance of the cartridge (spring) and the effective mass of the tonearm. The bass resonance should ideally be 10 Hz, but any value between 8 and 12 Hz is considered acceptable. If the resonance is too deep, for example when combining a magnetic systems with soft suspension with a heavy tonearm, the cartridge will attempt to track the record warps at 1.8 to 5.4 Hz. This leads to periodic distortions, due to the large cantilever deflections when the diamond tip immerses into the cartridge body and emerges out again. In contrast, an exceedingly high resonance frequency – such as when a stiff suspension MC system operates in a light tonearm – results in a raising response towardsthe lowest frequencies. The result will be a boomy, uncontrolled bass.

The resonance frequency is determined with a DIN45543 test record, where the bass signals are carried once as lateral and once vertical information in the groove. In pivoted tonearms, the two resonance frequen-cies are usually close to each other (7). This is not so with many tangential tonearms (8), which often move a heavy slider in horizontal direction and a short, light armtube in vertical direction. Since record warps are usually in the vertical direction and the horizontal eccentricity of records is small, the higher resonance frequency is a more important factor in tangential tonearms. In cartridges, low distortions levels are significant. To examine this, we measure the tracking ability at 315 Hz in 10micron increments from 50 to 120 µm at low frequencies. With 80 µm and over, one is on the safe side for extreme recordings; some highend cartridges can manage far more. A tonearm with high bearing friction may decrease the value. At 10 kHz, we measure the highfrequency distortions.

If they are low, this contributes to an effortless sound in complex passages.



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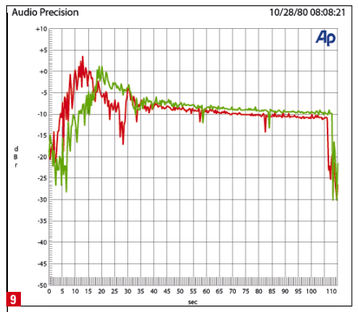
GOOD COMBINATION: In this cartridge tonearm combination, the lateral and vertical bass response resonance are nearly ideal at 9 Hz.



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TYPICAL: In tangential arms, the mass is often greater for horizontal (red) than for vertical (green) movements, leading to different resonance frequencies.

„MEASUREMENTS PROVE WHEN COMPONENTS MAKE A PERFECT MATCH“

MEASUREMENT EQUIPMENT

Prior to the measurement, the turntable is placed on a special table with a tabletop weighing more than 200 kilos, is suspended on four springs and decoupled through vibration dampers. Disturbances caused by staff entering the lab or cars driving into the underground garage can therefore not influence the highly sensitive measurements, which sometimes take several minutes.

The measurement is made using the PC steered System One from the U.S. specialists Audio Precision. The Testlab is equipped with seven high precision test records as signal suppliers, not including the backups.

The signal from the turntable is processed by a Brüel & Kjaer Response Test Unit Type 4416 that, in addition to the usual RIAA equalization, also enables targeted use of evaluation filters and shutdown of parts of the equalization curve to suppress for example the crackle of dust in specific measurements.

In moving coil systems, a special MC prepreamplifier ensures low noise. To also measure pickup cartridges independently, we use a Thorens TD 810 with TP 250 arm (similar to Rega RB 250; effective mass 12 g). Turntables can also be measured with one of three purpose built Ortofon MC Quintet Blue, These are calibrated to a pre defined dynamic compliance for the measurement of tonearm mass.

Various jigs and scales allows
us to adjust each turntable accurately before the measurement. The wiring has also been specially designed for minimum hum interference in magnetic systems. For new turntables, we also allow for longer play-in times if necessary, until the wow and flutter is

CONCLUSION

Bernd Theiss,
Head of Testlab

Measured data do not reveal everything about the sound of a HiFi component, but are a great help in detecting gross errors. In turntables, nobody wants even slight pitch instability caused by increased wow, or distortions occurring periodically with the warp of the record, due to a too low resonance frequency of the tonearm cartridge combination. Tracking distortions in the high frequency range or frequency response errors in vincinity to 4 kilohertz are easily audible. This is why they should be excluded by checking the measurements prior to a potential purchase.