



Sonic Shakedown

Protecting CD players from external vibrations using aftermarket supports, spikes, and stands can certainly pay dividends in terms of improved sound.

By Keith Howard

When the era of domestic digital audio began in 1982/3 with the launch of Compact Disc, another era was supposed to end. I don't mean by this the demise of LP as such

but audio's salvation from the effect of external vibration, which had dogged analog disc replay throughout its history. In its crudest form this sensitivity manifested itself as the groove skipping that would result from an inadvertent nudge of the turntable or passing footfalls on a suspended floor, but this wasn't something to which CD was entirely immune.

Give any optical disc player a firm enough whack and it too will skip, albeit without the risk of damage to the disc. The real benefit of digital audio in this respect, or so we supposed, was that it would banish the lower-level, more subtle effects of acoustic feedback from the speakers and thereby spare us the hand-wringing over support tables, which were just becoming a major theme of audiophile life.

It turned out to be wishful thinking. Far from being immune to external vibration, CD players proved to be equally sensitive to it in their own way. Hence the plethora of support tables and other isolation devices—some of which physically cannot provide much isolation at all—that still adorn the hi-fi accessories market.

Such products can elicit remarkable improvements in CD sound, as I was forcibly reminded at *HFN's* Hi-Fi & Home Entertainment Show last September. Playing straight man to Roy Gregory in the Hi-Fi+/Hi-Fi News closed-door demonstrations on Saturday afternoon, I marvelled with the rest of the audience at a staggering improvement in the clarity and organization of

the sound elicited by placing a Stillpoints Component Stand under the system's CD player. Many members of the six audiences I stood behind vocalized their surprise when they learned what had elicited the transformation, and I don't blame them. It was not a change that could possibly be called subtle. More than 20 years after CD's introduction, its susceptibility to external vibration still has the capacity to astonish.

READING ERRORS

The favored explanation for this occurrence has always focused (bad pun) on the transport mechanism. In the very worst case, vibration might cause reading errors that result in the player error concealing (interpolating) missing data. But this is a gross effect, not something that should afflict any stationary optical disc player in normal use.

At lower levels of vibration the data recovered from the disc should mostly be perfect once error correction has been applied, so changes in sound quality are

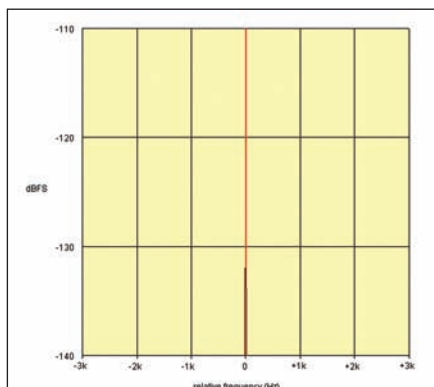


FIGURE 1: Spectrum of the 11.025kHz, -3dBFS test tone on the same horizontal and vertical scales as the graphs that follow. Because the tone is undithered, the noise floor is off the bottom of the scale.

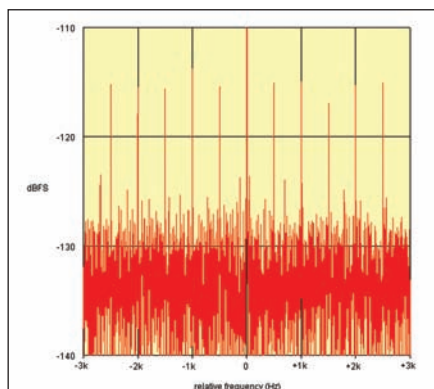


FIGURE 2: Spectrum of the test signal of Fig. 1 after computer processing to simulate jitter of 50 picoseconds RMS at frequencies of 500Hz, 1kHz, 1.5kHz, 2kHz, and 2.5kHz.

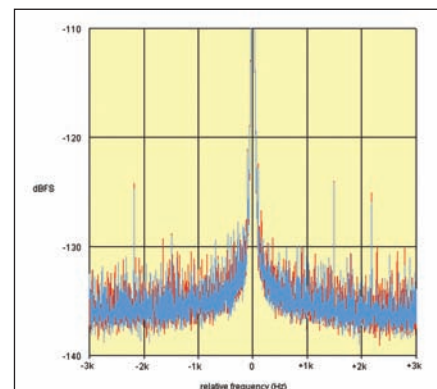


FIGURE 3: Results obtained from the Meridian 508.24 CD player. Foreground light blue trace shows the jitter spectrum measured in a quiet room. Background red trace shows the jitter spectrum when the player was exposed to a 30-second 750-850Hz sine sweep at high SPL.

presumed to occur because the player's tracking and focusing servos must work harder than they would in perfectly quiescent operating conditions. Their increased current draw modulates the power supply voltage, which can elicit audible consequences elsewhere in the circuitry of the CD player.

When I spoke to Ed Meitner of EMM Labs in 2001 (*HFN* July '01) about his pioneering use of deep cryogenic treatment, he told me of his experiments into CD vibration effects. "If you put a CD player into an anechoic chamber, in front of a loudspeaker and sweep frequency, you will find a really vicious peak in the focus servo current around 800Hz, very high Q. The disc resonates and the focus wants to follow it. This current demand modulates the power supply and generates jitter, which is influenced by the acoustic energy going to the CD player from the speakers. Since it's around 800Hz, we have this problem with female voices. If you know someone who can sing in that frequency range, very loud, they can shut CD players down (because once focus is lost, the player can't recover)."

But this isn't the only way in which vibration can affect optical disc players, as Ed explained when I spoke to him a second time recently, while preparing the review of his CDS/DAC6e two-box CD/SACD player (*HFN* Dec '05).

"Another thing that is influenced by mechanical vibration is the crystal oscillator. In the old days we got crystals in a metal can and that itself was very resonant. So we had the resonance of the chassis, the resonance of the board, and the resonance of the can. It's very dif-

ficult to sort all that out.

"I once made a recording from our jitter analyzer on a cassette while playing music in the room (where the CD player was operating). There were some situations where you could hear the words of the song within the jitter. Luckily, today we can get crystal oscillators that are embedded in a tiny ceramic chip. You can hit them with a sledgehammer and it doesn't cause jitter.

"Even printed circuit boards are affected by vibration because you have piezoelectric events through bending. That's why in our two-channel converter any long analog connections are not via a PCB trace but a wire."

REPEAT

Ever since jitter (see sidebar) became a headline issue in digital audio around 15 years ago, it has been widely credited with being the root cause of why many CD players and other digital sources sound different. Yet there has been little attempt to quantify how much of it is generated when playing music in circumstances representative of normal use, rather than with synthetic signals on the test bench. Ed Meitner's findings suggest that perhaps we've been measuring jitter incorrectly all this time, even with test signals, because equipment's susceptibility to external vibration has not been stirred into the test procedure.

To try to establish whether this is indeed the case, I decided to reproduce Ed's results, albeit in my listening room rather than in an anechoic chamber. The test setup was simple. First I generated

a test signal comprising an 11.025kHz sine wave at an amplitude of -3dBFS, and burnt it to CD-R for replay.

High amplitude, high frequency tones are the most sensitive test of jitter because the sidebands which appear on either side of the test tone are of higher amplitude than they would be with a lower frequency or amplitude, making them easier to detect. A spectral analysis of the test tone is shown in **Fig. 1**, using the same vertical and horizontal scales as for the figures that follow. Zero

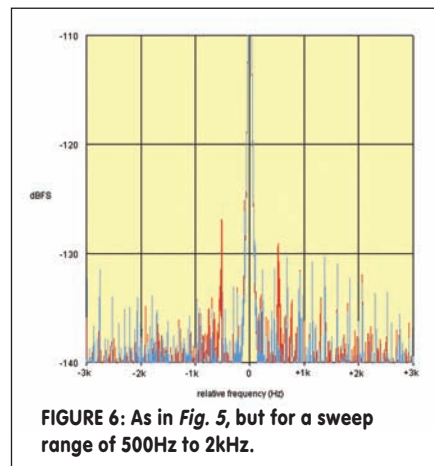


FIGURE 6: As in Fig. 5, but for a sweep range of 500Hz to 2kHz.

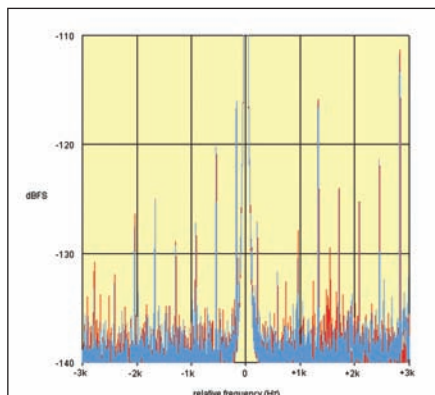


FIGURE 4: As in Fig. 3, but this time using an Arcam DV89 DVD player to replay the test disc under the same conditions.

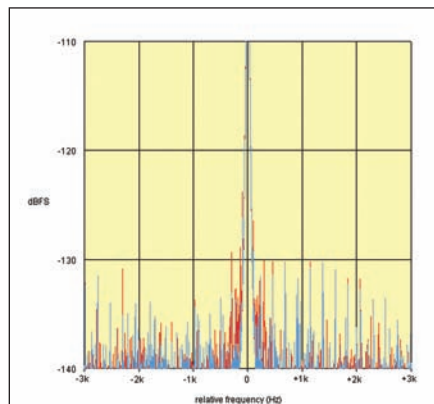


FIGURE 5: As in Fig. 3, but now for the Meridian 508.24 in combination with an Arcam Delta Black Box (top panel removed) and over a sweep range of 125 to 500Hz.

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on the frequency scale corresponds to 11.025kHz, which puts the test tone right in the middle of the spectrum. Frequencies of up to ± 3 kHz are accommodated on either side, so that the spectrum covers 8.025 to 14.025kHz overall.

Figure 2 shows what happens if we introduce some jitter to this test signal, in this case using computer simulation. Five frequencies of sinusoidal jitter (500Hz, 1kHz, 1.5kHz, 2kHz, and

2.5kHz) were applied to produce this spectrum, each at an amplitude of 50 picoseconds RMS, which is equivalent to half of one ten-thousandth of a millionth of a second. As you can see, the resulting sidebands appear at either side of the central peak, at spacings corresponding to the jitter frequencies, and with an amplitude of about -115 dBFS. This confirms the amazing sensitivity of

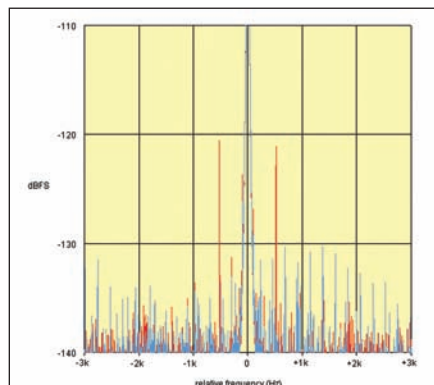


FIGURE 7: As in Fig. 5, but at a fixed frequency of 518Hz.

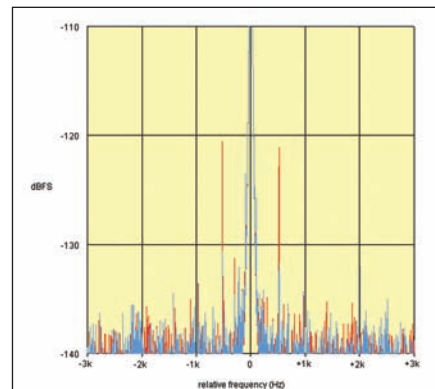


FIGURE 8: The effect of replacing the lid on the Black Box: light blue trace lid closed, red trace lid removed.

WHAT IS JITTER ?

Digital audio operates by sampling the amplitude of the original waveform at precise time intervals during recording, and reproducing the sampled amplitudes at exactly the same time intervals on reply. Only if each sample is measured and expressed at precisely the right instant will the recording and replay processes capture and reconstruct the signal accurately. Any temporal errors—termed jitter—will change the wave shape and thereby introduce distortion.

The nature of this distortion—just as with analog timing errors in the form of wow and flutter—is generally frequency modulation, although there is a second manifestation of jitter that occurs with some digital converters which results in amplitude modulation. So unlike quantization error, which has no analog equivalent, jitter is something broadly familiar from the pre-digital era. Wow and flutter in analog tape recorders, the same in cutting lathes and turntables, and Doppler distortion in loudspeakers all have a broadly similar effect and are

present at a level which is generally very much higher than the jitter in high quality digital audio equipment.

This suggests that the jitter in such equipment should be inaudible, and the few attempts to ascertain the subjective significance of jitter scientifically have reached that same conclusion. But anecdotal evidence indicates otherwise. Many audiophiles have experienced the changes in sound quality that result from fitting improved, lower-jitter master clocks to CD players, or have had the opportunity to experiment with different clocking provisions within the same equipment, as was the case when I reviewed the EMM Labs CDS/DAC6e. Typically the improvements heard in these instances are obvious.

So what makes jitter audible at much lower levels than predicted? One of the key issues is likely to be signal-dependence, where the pattern of jitter varies in accordance with the signal. This can potentially occur through a variety of mechanisms, outlined in the text, including equipment susceptibility to the effects of external vibration from loudspeakers. ■

this type of jitter measurement which, using 24-bit recording and a high degree of FFT averaging to suppress the noise floor, can identify jitter components down to less than 10 picoseconds.

Measurements were taken from three players—a Meridian 508.24 CD player, Arcam DV89 DVD player, and the Meridian combined with an old Arcam Delta Black Box outboard DAC—using a Lynx L22 sound card both to record the player's right channel analog output playing the test disc and to generate a test signal that was replayed through a loudspeaker placed close to the player. Sound pressure level at the player was around 105dB (varying somewhat with frequency due to standing wave effects in the room), which is substantially higher than would usually be experienced in normal listening. Each player's output was recorded with and without the loudspeaker operating, to see whether the vibrations from it had any effect on the measured jitter performance. Various signals were used to bombard the players, as I will describe.

I began by measuring the Meridian and Arcam players, using a linear swept sine wave of 30 seconds duration running from 750 to 850Hz, to see whether this would provoke the c800Hz disc resonance found by Ed Meitner. The results are shown in **Figs. 3 and 4**, respectively, the light blue spectrum in the foreground representing the result when the loudspeaker was not operating, and the red spectrum in the background showing the result when the speaker was active. In both cases the differences between the two spectra are minimal, suggesting little if any effect from the loudspeaker. Sweeps from 125-500Hz and from 500Hz to 2kHz were also applied to the Meridian and Arcam players, again with little visible effect.

Digging out an old Black Box outboard DAC to use with the Meridian was prompted by recollections that its Philips TDA1541 D-to-A converter chip was notoriously sensitive to vibration. Indeed, Arcam went to the trouble of isolating it in the Black Box by placing it on an "island" within the main circuit board that is detached around most of its perimeter, like a moated castle.

Removing the Black Box's top plate and standing it on end atop the Merid-

ian to expose it more fully to the loudspeaker gave the results shown in **Figs. 5 and 6**, for sweeps of 125-500Hz and 500Hz-1.5kHz, respectively. This time there are clear effects on the jitter spectrum, with peaks at ± 518 Hz. Exposing the Black Box to a steady tone at this frequency gave the spectrum of **Fig. 7**, where the vibration-induced jitter sidebands are now of even higher amplitude because they are no longer being diluted across a swept frequency range.

Here is hard evidence that CD players can indeed be affected by vibration. But let's put this in context. The effect was substantially reduced when the Black Box's top panel was replaced (**Fig. 8**); the sound pressure level to which it was being exposed was much higher than would usually be the case in normal use; these jitter levels are way below experimentally determined audible thresholds; and the Black Box is an old, outmoded design whose point of vibration weakness is almost certainly the defunct TDA1541.

It is comforting news, of course, that modern digital disc players appear to have suppressed vibration-induced jitter effects to insignificant levels. But this makes it even more difficult to explain why support tables such as the Stillpoints can have such a remarkable effect on sound quality. It remains, regrettably, one of audio's many unresolved mysteries. *aX*

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