Tonochi's Audio Room – Supplemental Information

SECRET OF ANALOG SOUND

2018/10/25

Why does the vinyl disc sound better than the CD?

"Why do some vinyl discs seem to have better sound quality than CDs?" … This is an interesting question. I already discussed this matter in my old website:

https://nobody-audio.com/ver1/English/Gaudi/Lessons_en.html#VinylRecord

Since then, I have been considering this question further, and I've reached a conclusion. To make a long story short, high quality in super treble region and exact reproduction of waveforms are the strong points of the vinyl disc. In other words, the vinyl has better performance in time domain than the CD.

Importance of quality in super high frequencies

If you use a multi-amplifier system, you can understand at once that the quality in super HF has a great influence on the sound quality of the whole system.

The tweeter of Gaudi/Gaudi II reproduces frequency of 7kHz or higher. This band includes little fundamental tones of musical instruments but harmonic tones. If you turn off the squawker and woofer (it's easy with a multi-amplifier system), you should hear small sizzling or tweeting sounds only. You may wonder whether these small sounds are really important.

However, it is really a fact that super HF (7kHz or higher in this context) gives a great influence on sound quality. Try to play music with the tweeter off, then you can realize the tone is unnatural. Not only tone but volume is influenced.

Relation between SPL in super HF and volume

When the SPL (sound pressure level) of the left tweeter is higher than the right, sounds of almost all the musical instruments shift to left. Even bass sounds produced by the contrabass is affected. It can be said from my experience that the tweeter's level can compensate unbalance of the woofers. For example, when the right woofer's level is too high, you can balance by turning up the left tweeter. The tweeter influences the volume actually, although the woofer's volume seems to be overwhelmingly louder than the tweeter.

The table below shows an example; it indicates the system total gain (the voltage gain between the line input of the preamplifier and the output of the power amplifier) measured with Gaudi system. I used Gaudi in this setting for several months, and I felt channel balance was well adjusted.

f-range	L-ch gain [dB]	R-ch gain [dB]	R - L [dB]
High	-5.4	2.0	7.4
Mid	-5.7	-2.7	3.0
Low	7.7	9.6	1.9

The room where Gaudi was installed was not symmetrically shaped, and bass was boosted in the left channel. To obtain good channel balance, the level of the right woofer should be increased a little. However, in the table above, the level of the right woofer was not high enough. I made up the imbalance by making the level of the right tweeter higher.

I adjusted the system once more afterwards; I increased the level difference between the woofers (1.9dB → 6.5dB), and decreased the level difference between the tweeters (7.4dB → 1dB). This resulted in the better channel balance. I'm convinced it is the right way, because the woofer band is affected by the room acoustics more than the tweeter.

Formerly, I highly evaluated an audio device that didn't sound so loud even when the SPL was high, because I believed such a device had low distortion ratio. These days, however, I don't think the idea is right. Because, attenuation in the super HF region makes the sound less loud. This attenuation is a kind of distortion, so it can't be said the device is of low distortion. The attenuation in the super HF makes the sound mild. On the other hand, hard-hitting sound can hardly be reproduced. Especially, it spoils swingy/groovy touches of jazz.

Relation between super HF and sound image

What forms the sound image is harmonic tone (higher harmonics). Simple fundamental tone (fundamental wave), which is a sine wave, doesn't form sound image, and can't be localized. This thing can apply to other animals. Animals that form groups notify their fellows of danger by uttering high pitch voice that is nearly sine wave. By doing that, the individual who utters the alarm can avoid being found by the predator.

For sharp sound image and stable localization in stereo imaging, harmonic tone must be reproduced without distortion. In this respect, analog media have an advantage, because super HF and even ultra-sonic tone can be recorded/reproduced precisely to/from the analog media. I believe this is the reason why LP is better at stereo imaging than CD in spite of the low channel separation (up to 30dB) of LP. LP offers wider sound stage in both width and depth, and exact sound localization (to my ears).

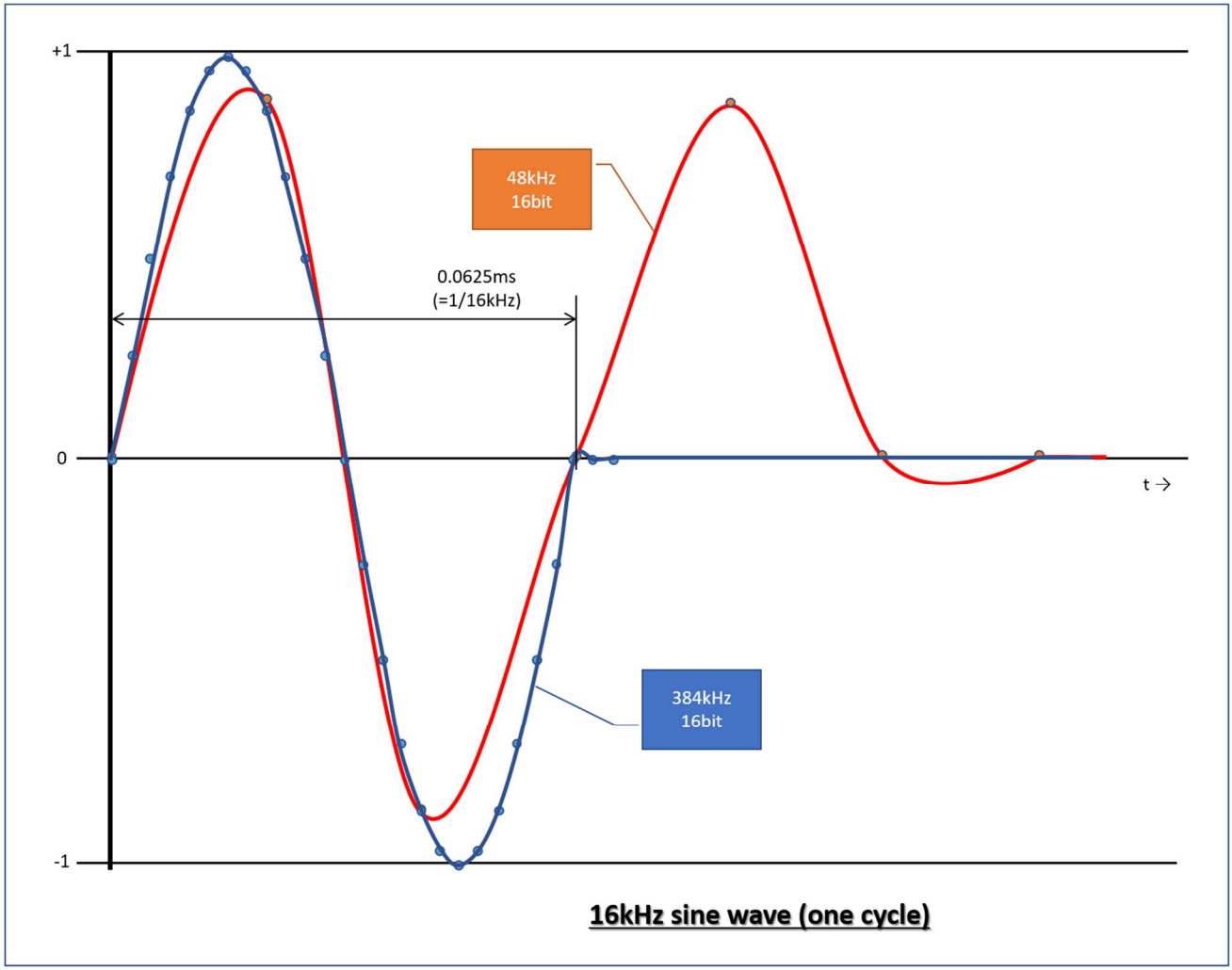
Reproduction of Waveform

CD has enough performance in frequency domain. It covers up to 20kHz, so there shouldn't be any problem. However, when it comes to reproduction of waveform in super HF, CD's quality is questionable.

According to the sampling theorem (Shannon & Someya's theorem), frequencies up to the half of the sampling frequency (f_s) can be recorded. CD's f_s is 44.1kHz. So 20kHz can be reproduced without error. But it can only be said on the assumption that the signal is continuous.

When only one cycle of sine wave of 20kHz is recorded and reproduced, large distortion is inevitable. Normally, only two samples can be obtained in the one cycle, and three samples in the best case. (at the beginning and the end of the cycle, higher harmonics are included. So higher f_s is required for reproduction in high fidelity)

As a trial, I made a simulation of sine wave of 16kHz (one cycle) at f_s =48kHz. For comparison, I overlaid a simulated waveform of the same signal at f_s =384kHz. The latter one is almost true waveform.



As I anticipated, the waveforms are different between f_s =48kHz and f_s =384kHz. As 384kHz is nearer the true waveform, it can be said that the waveform of 48kHz is distorted. Since I am not good at mathematics, I am unable

to quantify this distortion, though, it may be tens of per cent of distortion ratio. Because you can recognize it at a glance.

The figure above shows the waveform for f_s =48kHz has the additional half cycle. I don't know how it happened. This data was generated by a signal generator program WaveGene offered by Mr. efu.

In many cases, the distortion ratio is represented by THD (Total Harmonic Distortion), which is an index in frequency domain. It's easy to achieve THD of 0.01% or lower for audio equipment other than loudspeakers. But I can sense difference in sound quality between amplifiers of which THD is 0.001%. It is very questionable that THD really represents sound quality.

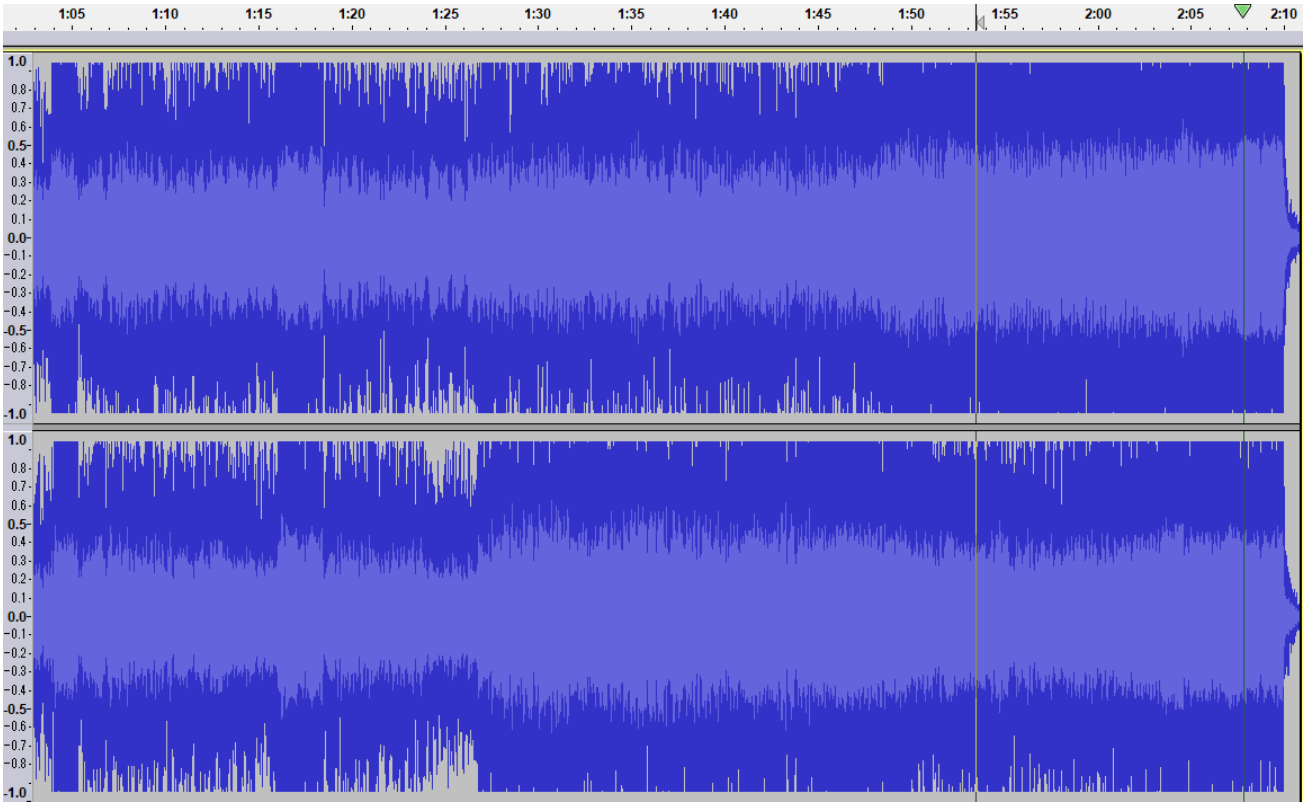
The vinyl disc, which has more distortion and noise than the CD, reproduces more realistic sounds to my ears. I think that's because the vinyl is better at reproduction of waveforms in super HF. This assumption is nearly my conclusion. I'd like to hear experts' opinions on this subject.

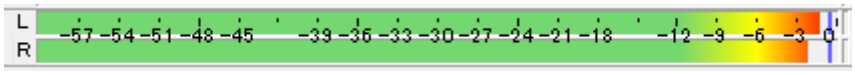
Some audio manufacturers are focusing on the performance in time domain. Fujitsu Ten's TD (time domain) speaker is a good example. I didn't like it so much when I auditioned it before. But that's probably because I used CDs for music source. I should have used vinyl or hi-res source to know the potential of the TD speaker.

Actual Dynamic Range

For some vinyl discs, the limiter is not used in the mastering or the cutting process. Vinyl discs with an indication like 'High Quality Record' and 'Super Analog Disc' are such a kind. On the other hand, I hear the limiter is used for all the CDs.

I think that very high-output CDs have been increasing in number since the late 1990s. The figure below shows an example. It indicates the output level of a certain CD (the last one minute of the second track of the album "2Cellos"). The level seldom drops below -6dB (+/-0.5 in the vertical axis corresponds to -6dB). The peak level meter with the hold time of 0.5 seconds shows the peak level moves within very narrow range between -3dB and 0dB. I would have to say the CD's actual dynamic range is very narrow.





This kind of recordings can't be called 'hi-fi', because the waveforms are obviously different from the original ones. In a way, the output of the CD player may be largely distorted however magnificent the specifications of the CD and the CD player are.

The peak level of the vinyl disc without the limiter exceeds 0dB. But extra +7~8dB causes no problem. The higher level may or may not cause distortion according to the quality of the pickup and/or the phono EQ amplifier. The peak level of up to +20dB is recorded on the vinyl with the widest dynamic range. It is up to the system designer to determine whether or not this extremely high level should be reproduced without distortion.

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