Tonochi's Audio Room – Supplemental Information

DETAILED EXPLANATION OF GAUDI II SYSTEM SPECIFICATIONS

2021/02/18

Detailed Explanation of Gaudi II System Specifications

Main Input Source

The main input source of Gaudi II is the analog disc (vinyl, phonograph, gramophone, …).

Until little while ago, I wanted the digital source to be Gaudi II's main source. Now that a single hard disc drive (HDD) can contain my whole music collection and all the music files can be played directly from the HDD. The digital source is more convenient than the analog source by far. I planned on digitally recording my analog collection and saved the files on the HDD just like the digital collection.

However, I can't help loving vinyl discs. As I wrote in the old version of Tonochi's Audio Room, the better my Gaudi system was improved, the higher the sound quality of the vinyl became, I felt. User-friendliness is one of major priorities of Gaudi II, though, sound quality is always the top priority. So I chose the analog disc as the main source. It's another reason that most of my beloved discs are analog discs.

"Why the analog disc sounds better than the CD?" … This is very interesting theme to discuss. I discussed it before and wrote down my opinion in the old version of my homepage.

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

Lately, I've reached a conclusive hypothesis after a lot of considerations based on my experience. I wrote it down in PDF:

"Secret of Analog Sound" (https://nobody-audio.com/English/img/AnalogSound_en.pdf)

Input/Output Specifications

The table below shows the inputs and outputs of the preamplifier:
[2021/02/18] {PHONES OUT has been removed. All the inputs/outputs are unbalanced}

In/out	Name	Connected from/to	Balance	Connector	Note
In	PHONO	Record player (Tonearm)	Unbalanced	RCA jack	For MC cartridge only
In	DAP	Digital audio player	Unbalanced	RCA jack	= LINE IN
In	AUX	STB or likes	Unbalanced	RCA jack	= LINE IN
Out	EQ OUT	Digital audio recorder	Unbalanced	RCA jack	Output of phono equalizer
Out	PRE OUT	Crossover network	Unbalanced	RCA jack	Out of preamplifier

The phono input (PHONO) receives the signal from the tonearm directly (no step-up transformer will be used). The cartridge must be the MC type. MM cartridges are not supposed to be used.

I won't stick to the MC type. I happen to be fond of Audio Technica AT33PTG/II, which is the MC type and being used in Gaudi II (as of October 2018). In addition, a cartridge for SP records is also available in the AT33 series. I'd like to continue to use AT33.

I don't have an idea about which is better, MM or MC. There are good or no good in both types. The design and manufacturing quality are more important than the type, I think. My best cartridge is Grace F-14 + US-14MR (micro-ridge stylus), and it is the MM type.

One thing I can say is that there are many excellent MC cartridges in market, so you have many choices in the MC type.

The preamplifier will have two pairs of line inputs: DAP (digital audio player) and AUX (auxiliary).

The line inputs are unbalanced type and their connectors are RCA jacks.
A trouble might occur due to difference of the ground potentials between the players and the preamp. Methods to solve the problem should be considered in designing of the preamp.

The output of preamplifier is ~~the balanced type and the connector is XLR plug~~ the unbalanced type and the connector is RCA jack. This spec enables use of professional crossover network, because the standard interface of professional audio devices is the balanced type. [2021/02/18 revised] {It won't cause a problem if the unbalanced output is connected to the balanced input}

For the same reason, the inputs of the power amplifiers are the balanced type and the connectors are XLR jacks.

The preamplifier will have phono equalizer output (EQ OUT) for digitization of analog discs. This output is connected to the digital audio recorder. The interface is ~~the balanced type and the connector is XLR plug~~ the unbalanced type and the connector is RCA jack. [2021/02/18 revised]

Frequency Response

The required frequency range is 25Hz – 40kHz (+/-6dB).

This spec is almost same as Gaudi's, but defined on different grounds.
On the days of building Gaudi, I believed ultra-sonic region (more than 20kHz) affected sound quality and should be reproduced. However, only few musical instruments produce ultra-sonic sound, and most microphones can't pick up frequencies higher than 20kHz. Some microphones for vocal have even narrower frequency range. Therefore, it can be said that musical recordings contain up to 20kHz with few exceptions.

I used to listen to a radio program of NHK (Nippon Hoso Kyokai or Japan Broadcasting Corporation) where live performances of NHK Symphony Orchestra were aired. I felt 'live performance' and was touched each time I listened to it. The frequency band of the FM is only 15kHz, but it is enough to convey live sounds.
Now I believe the bandwidth of 15kHz with very low distortion is enough. Considering the fact that most microphones can transduce up to 20kHz, I set the goal that frequencies up to 20kHz will be reproduced with very low distortion.

I specified that the high end of Gaudi II is 40kHz, because I believe the tweeter must cover up to 40kHz in order to achieve the 20kHz band with very low distortion. The same idea goes for the cartridge. The power amplifier for the tweeters is required to have flat frequency response up to 100kHz and very low output impedance.

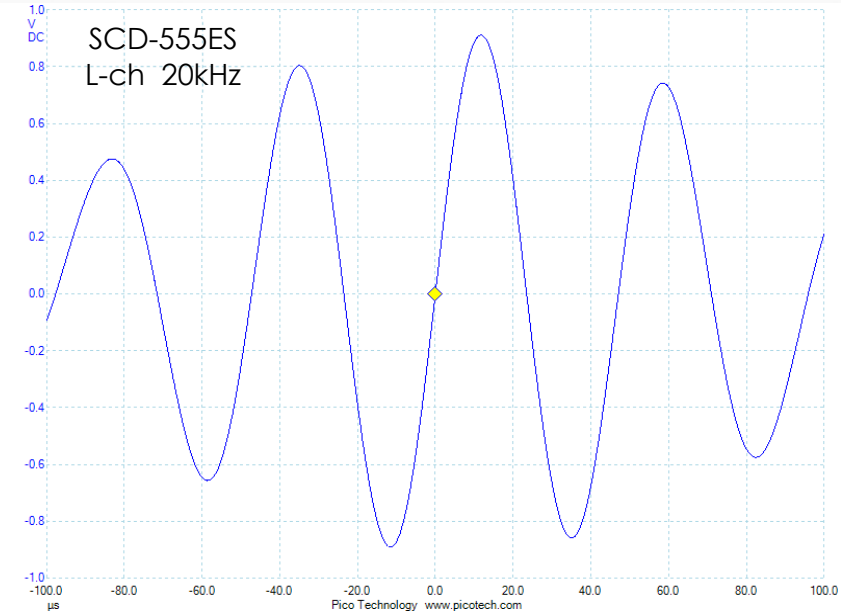
I set the low end of the frequency range to 25Hz. This covers almost all sounds from musical instruments. Some instruments like the organ and the synthesizer can produce frequencies lower than 25Hz, but I think the super lows are negligible.

Distortion Ratio

Usually, the distortion ratio is represented by total harmonic distortion (THD). But there exist amplifiers with THD of 0.001% that have their unique tone. On the other hand, there exist hi-fi amplifiers with THD of 1%. I don't think THD is reliable.
The target THD+N of Gaudi II is 0.01% or less. I believe this level of distortion won't impair sound quality. ~~As for the loudspeaker, I haven't set the goal since I don't have measurement skill for the loudspeaker.~~ [2021/02/07 revised] {Target THD is 0.01% for the amplifiers, and 1% for the system as a whole}

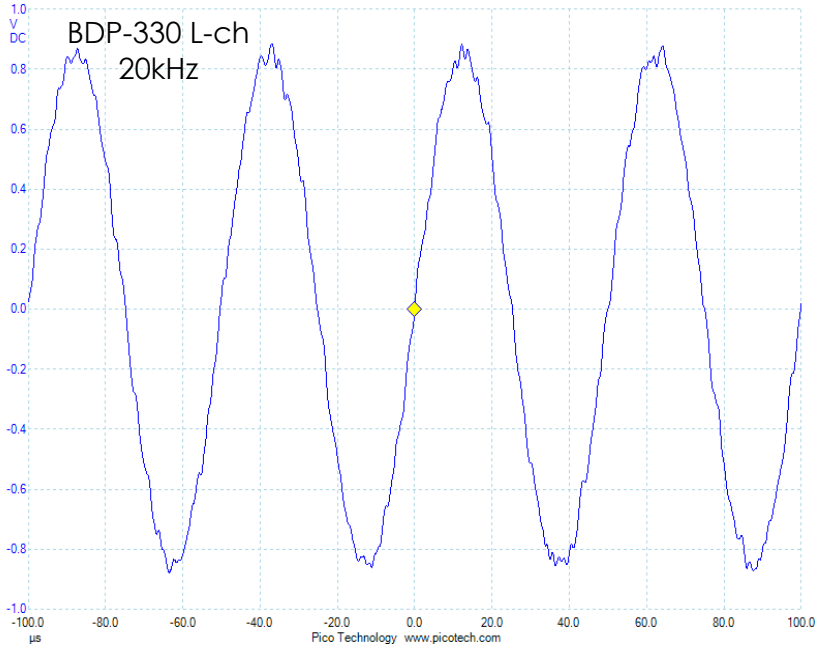
The THD indicates performance of audio equipment in frequency domain. For Gaudi II, I would like to focus on performance in time domain too. I'd rather see waveforms than numerical values. I am going to check waveforms of impulse and/or sine wave burst response measured with the oscilloscope and judge the device to be up to my criteria if any distortion is observed.

There are some commercial audio devices that show distorted waveforms in spite of their very low THD. I'll show some examples.



This figure shows the waveform of Sony SCD-555ES, SACD player. It's the waveform at the output when sine wave of 20kHz, -10dB is replayed by using a CD-R. The magnitude fluctuates.

The sound quality of the CD was apparently worse than the SACD when SCD-555ES was used in Gaudi system. Probably, this distortion at high frequencies was a cause.



This figure shows the waveform of Pioneer BDP-330 under the same conditions as SCD-555ES.

Though the waveform isn't distorted basically, it contains noise of several hundred kHz. I suppose it came from the clock oscillator of the DAC or the switching regulator.

I like BD-330's sound with no undue character.

Probably, the noise is not a big problem, because it can be eliminated by the input filter (low pass filter) of the amplifier.

Other than those two examples, I have experienced some more cases like this; I observed a distorted waveform in high frequency region (10kHz or higher), when I felt some unusual nuance. So, I think observing waveforms is the best way to evaluate sound quality other than listening.

Maximum SPL

Specifying the maximum SPL (sound pressure level) is the most crucial in system design. That's because it is the basis for calculation of the maximum output power and the gain of each amplifier.

The max SPL of Gaudi II is specified **110dB** (both channels active, at the listening position). This value is decided based on the measurement of Gaudi.

I prefer high volume when I listen to music. The measured max SPL was approximately 100dB at the listening position. When an analog disc is played, the peak level sometimes jumps up very high instantaneously. So, I set the 10dB margin.

Power dissipation

I didn't set any target about power dissipation for Gaudi. But I set the target for Gaudi II, because global warming is getting more and more serious today. The target is the system's total dissipation of **100W** when an analog disc is being played.

User-friendliness

Like power dissipation, I didn't consider user-friendliness when I designed Gaudi. Needless to say, sound quality is the top priority for Gaudi II, but I also regard user-friendliness as an important factor.

A remote control is going to be introduced. It controls the volume, the selector and the power-on/off of each amplifier. The remote may be infra-red type or an APP of smartphone. In the case of using the smartphone, the APP communicates with the preamplifier via Wi-Fi.
The preamp executes power-on sequence where the preamp is turned on first, then the network, and power amps last. The power-off is executed in reverse.
By the way, I am considering getting rid of the selector. It may not be necessary. [2021/02/18 revised] {I concluded that the selector is necessary}

The volume control itself is equipped in each power amp, while the MCU (micro controller unit), the display and the knob are equipped in the preamp. The volume control was controlled by the MCU. The user turns up/down volume by either rotating the knob or using the remote.

~~The preamp has a headphone amplifier in it. This feature was not in Gaudi system.~~ [2021/02/18 revised] {The headphone amp has been omitted}

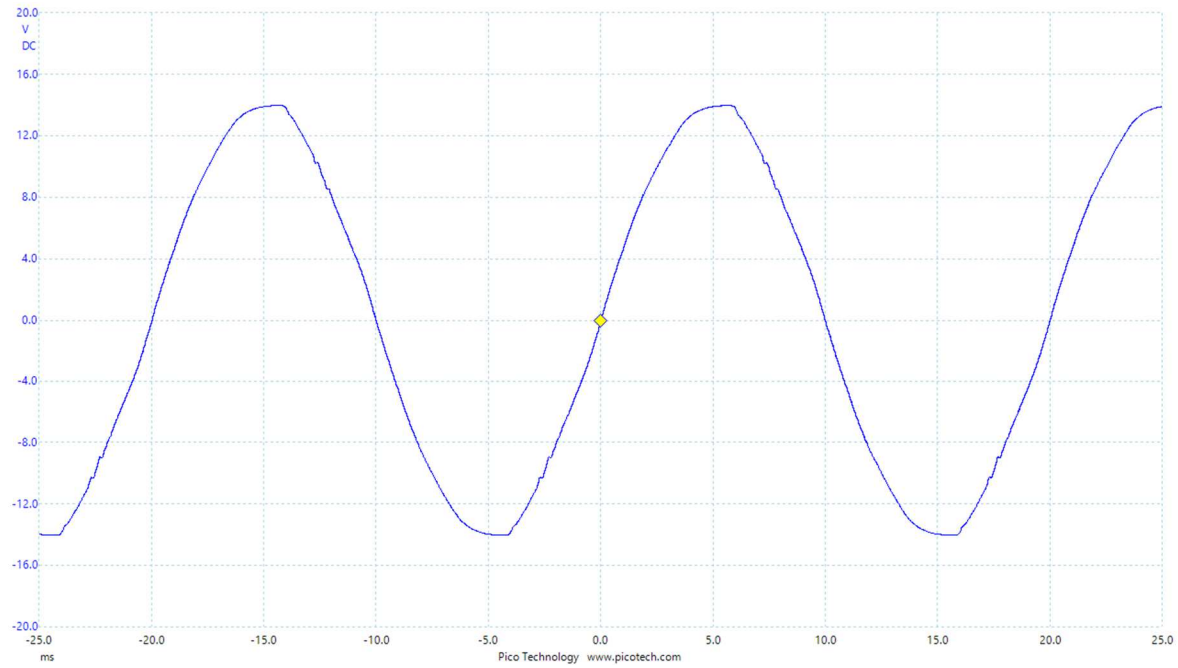
Other Specifications

Gaudi's ground potential was the center between the hot and cold of the AC line. I experienced that sound quality declined when a commercial audio device was connected to Gaudi, because its ground potential was the earth.

The ground potential of Gaudi II is the earth like commercial audio equipment in order to avoid this problem.

In addition, I am planning another method to avoid worsening sound quality even when the ground potential doesn't match among audio devices, such as using an input transformer or balanced line input/output, where the signals are separate from the ground.

An effective method is also needed for fluctuation and noises of the AC line.
The figure below shows the waveform of the AC line measured at my house at noon of February 11 (mid winter).
The vertical scale is 1/10. "20.0V" means 200V.
Some noise is observed, and, more badly, the wave form is distorted. It doesn't look like sine wave. The future NOBODY devices must be designed so that they are not affected by a low-quality AC line.



The wave form of AC line in my house began distorting a few years ago. I don't know the cause. I am afraid this phenomenon will continue. For your information, the home appliances except the refrigerator weren't working when the above waveform was measured.

[END OF DOCUMENT]

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