Tonochi's Audio Room – Supplemental Info

Review of Behringer CX3400

2022/03/06

Review of Analog Crossover Network Behringer CX3400

I've decided to substitute Behringer CX3400 for NOBODY CD-211B, which has low stability. I bought CX3400 for as cheap as 12,774 yen in Feb. 2019. I'd like to check if this budget crossover network has such high performance and sound quality suitable for Gaudi II. I carried out a review in Tonochi Methods.

Contents

Outline of CX3400

CX3400 is a cheap crossover network whose price is less than 15,000 yen, though, it is a real crossover network that supports stereo 3-way system or mono 4-way system. In addition to basic functions such as adjustable crossover frequencies and gains of each band, it has low delay feature that enables time alignment adjustment.
CX3400 is designed for professional use. The enclosure fits in with EIA 19" rack. The height is 1U. It weighs as light as 2.5kg. It is good for home use too, because both the inputs and outputs support unbalanced cable.

Initial Settings of CX3400

I set CX3400 as shown below:

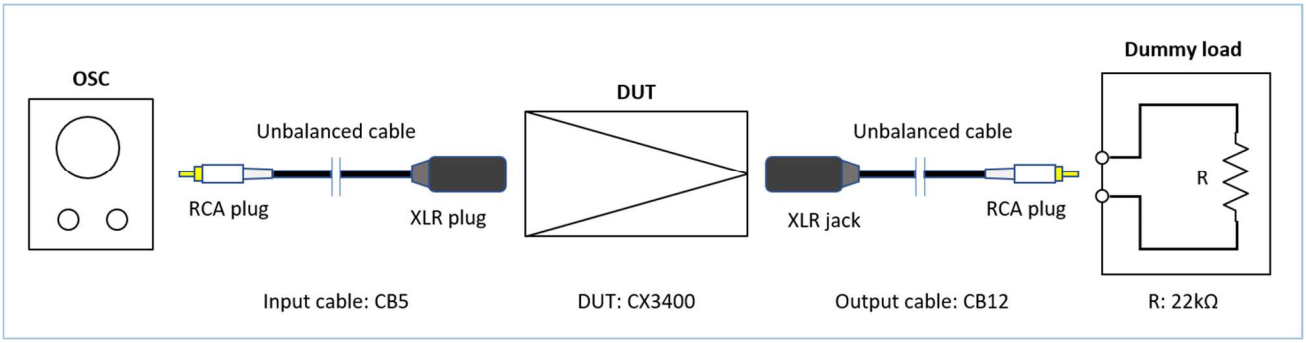
- Configuration: stereo 3-way
- Crossover frequencies: f_{c1}=1.8kHz, f_{c2}=6kHz
- Gains: 0dB
- Limiters: off
- Phase: noninverted
- Mute: off
- Low delay: 0msec

These settings would be adjusted according to measurements and audition.

In the 3-way system, the signal is divided into three bands: low, mid and high. In this document, they are denoted by LOW, MID and HIGH. And, suffixes -L and -R denote the left and right channels, respectively. For example, LOW-L indicates the low band output of the left channel.

Measurements

The signal source (an oscillator) and the dummy load are both connected to CX3400 with unbalanced cables. The cable on the source side (the input of CX3400) is CB5, and the load side (the output of CX3400) is CB12 as shown in the figure below. Both the oscillator and the dummy load don't have RCA jacks, so adaptor cables are used.
For the details of the cables, see the following document:
https://nobody-audio.com/img/LineCable_Design.pdf



Frequency Response

Frequency response is the first measurement since it is the most important for the network.

Initial Settings

The figure below shows the frequency response of CX3400 in the initial settings.
The curves look weird.

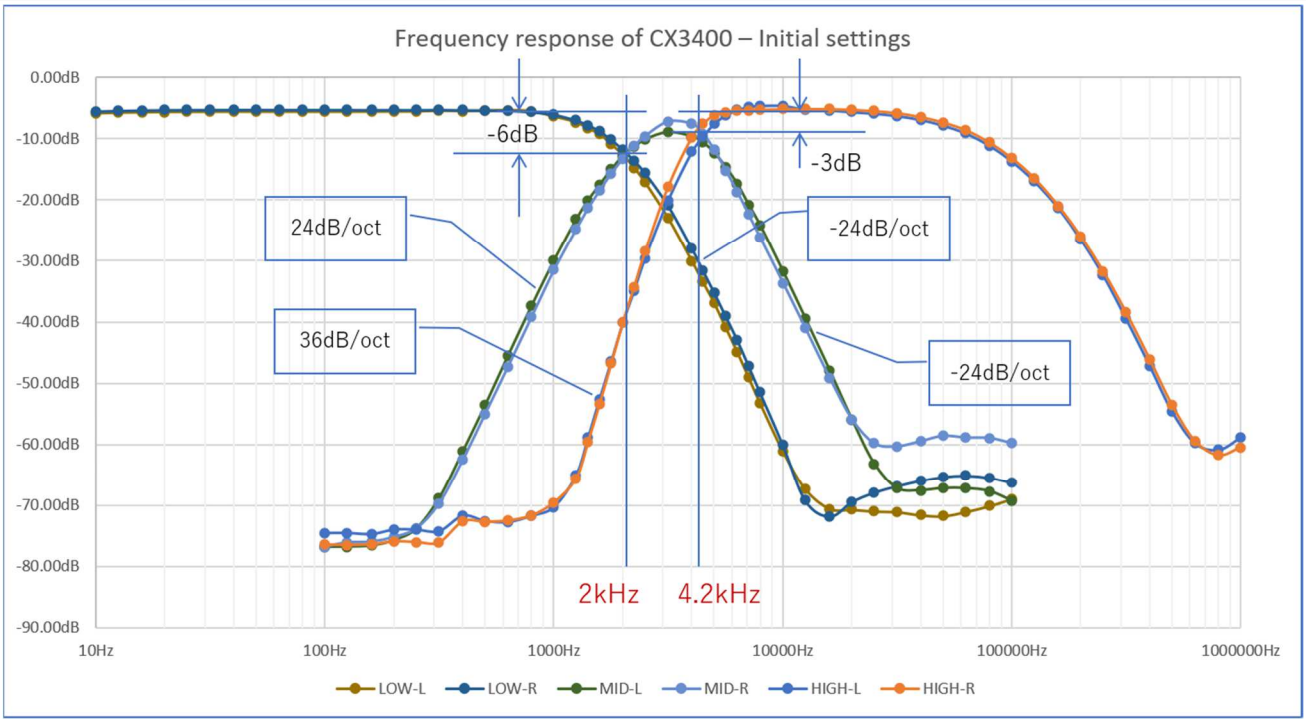
The curves of HIGH are distorted. Surprisingly, the lower cutoff slope is 36dB/oct!

I intended f_{c2}=6kHz, but it is as low as 4.2kHz actually. It might be a burden for the tweeter. But probably it's not due to the steep slope of 36dB/oct.

The attenuation at f_{c1} is -6dB, while -3dB at f_{c2}.

The difference in channels is small. Both the channels act in the same way.

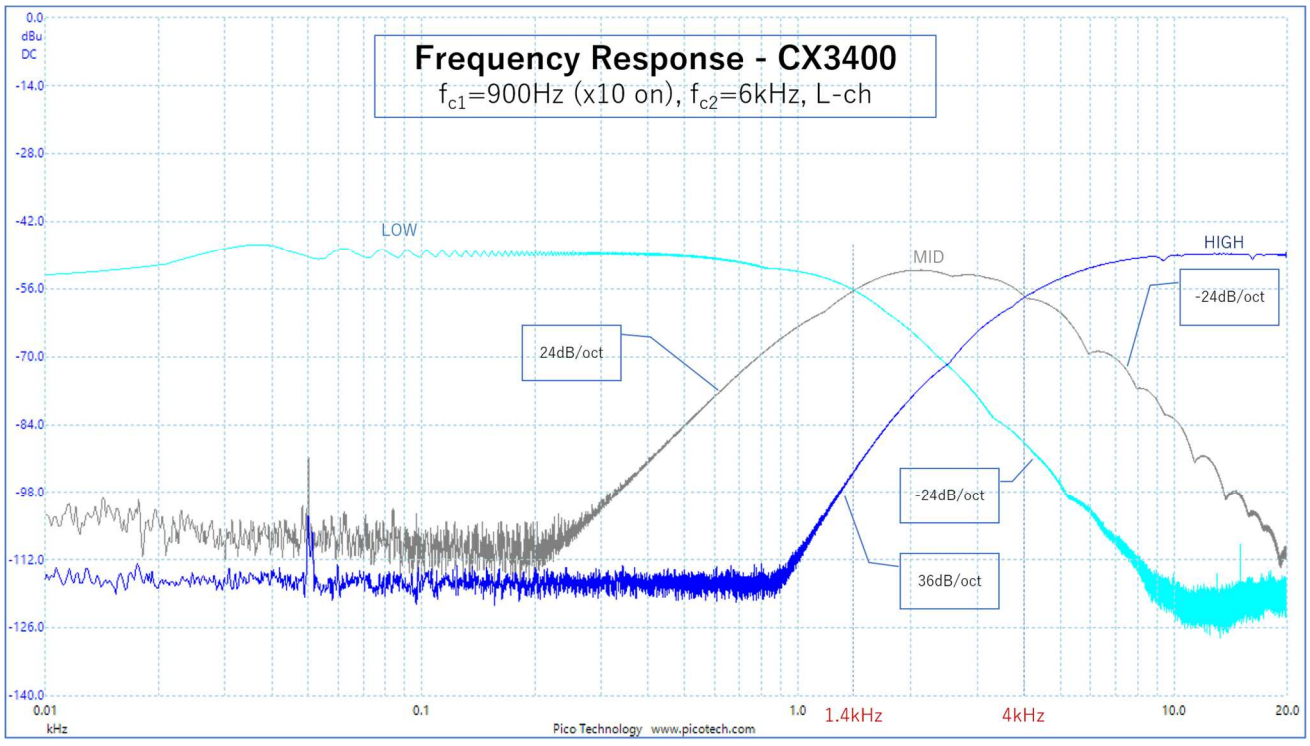
I am not able to understand this measurement at all.



Changed Crossover Frequency

After the measurements and audition, I concluded f_{c1}=1.8kHz is too high. The sound was distorted. The new f_{c1} is 900Hz.

By the way, I took another method to measure frequency response because it is time-consuming. The new method utilizes repeating sine wave sweeps and FFT. Frequency response is measured automatically in this method.
The figure below shows the result of the left channel only, since both the channels exhibit similar results.



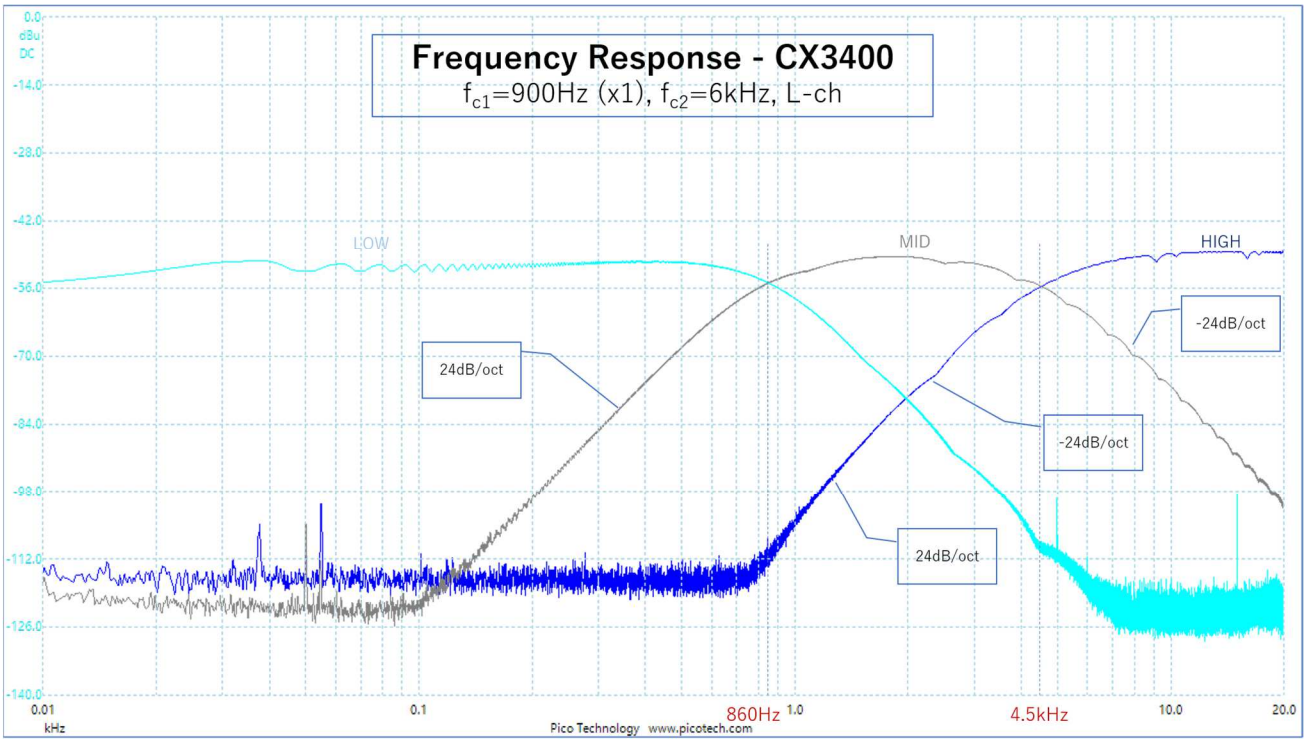
The f_{c1} is 1.4kHz, and it's far from the value I intended.

The knob for f_{c1} adjust has two scales. When the XOVER FREQ switch on the rear panel is pushed, the scale of x10 is selected, and when the switch is off, the scale is x1 (see the figure below). I pushed the switch because the x10 scale is necessary to set the f_{c1} to 1.8kHz, and left the switch in that state.

For f_{c1}=900Hz, x1 is also selectable. I tried x1.

Rear panel

Front panel

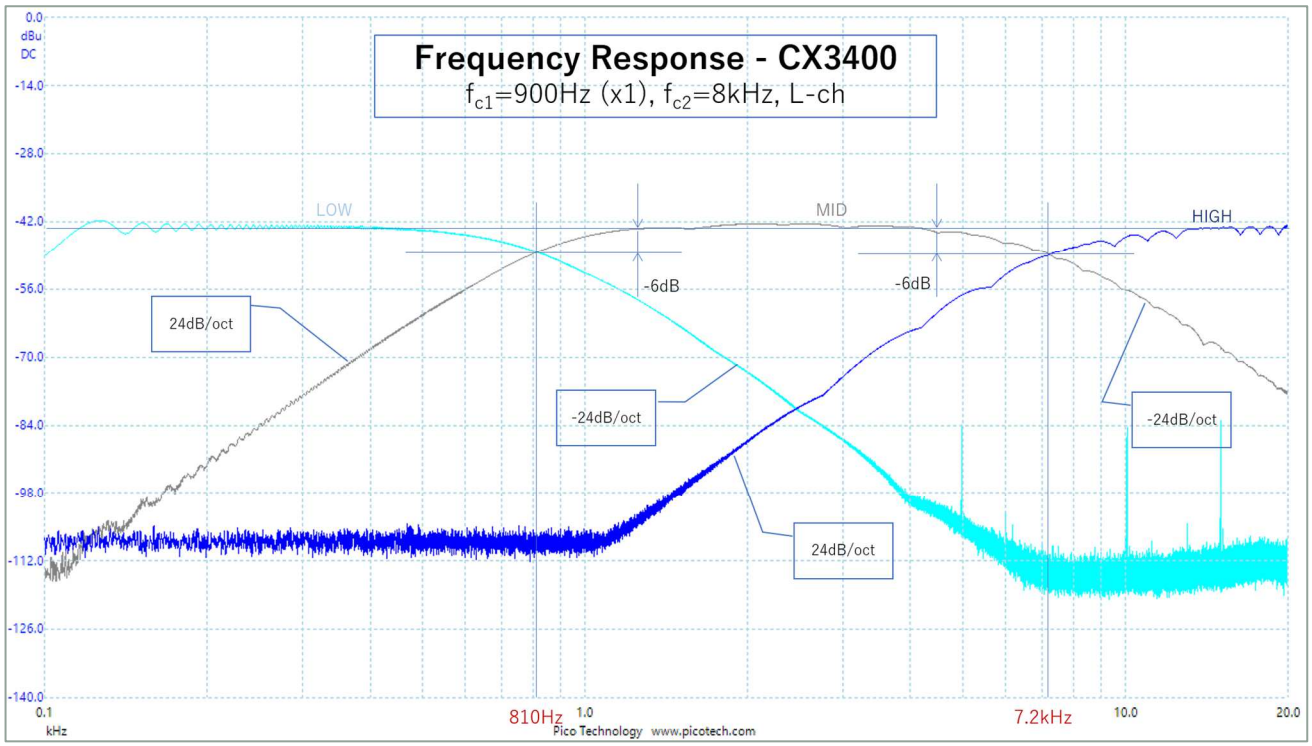


I got the curves just like I had expected.
The f_{c1} is now 860Hz. And, the slope of the HIGH filter became 24dB/oct. It is plausible.
The f_{c2} is still 4.5kHz. It's too low.

Customization of Cable

The user's manual of CX3400 says that when the unbalance connection is used, COLD and GND pins of the output should be bridged. I didn't do this because I was reluctant to ground the output.
I customized the cable CB12 to bridge COLD and GND.

I increased f_{c2} to reduce the burden of the tweeter. Now it is 8kHz.



I got the result that is exactly what I'd expected. Both f_{c1} (=810Hz) and f_{c2} (=7.2kHz) are bit lower than I intended. But we must accept them because fine adjustment is difficult with the small knobs and rough scales in the first place.

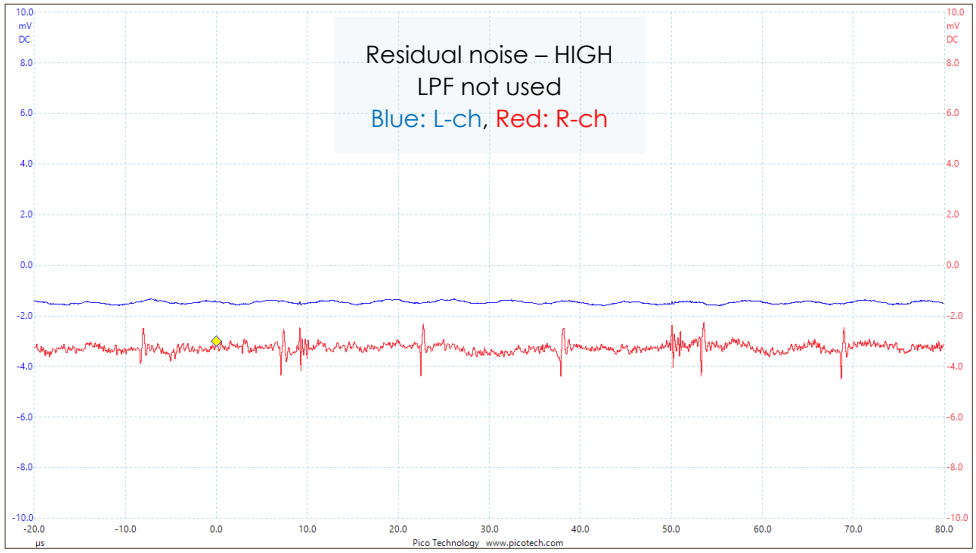
Anyway, I am so surprised that the filter characteristics are affected so much by the connection of the load.

Residual Noise

The right channel emits small RF noise, but the level is low enough.

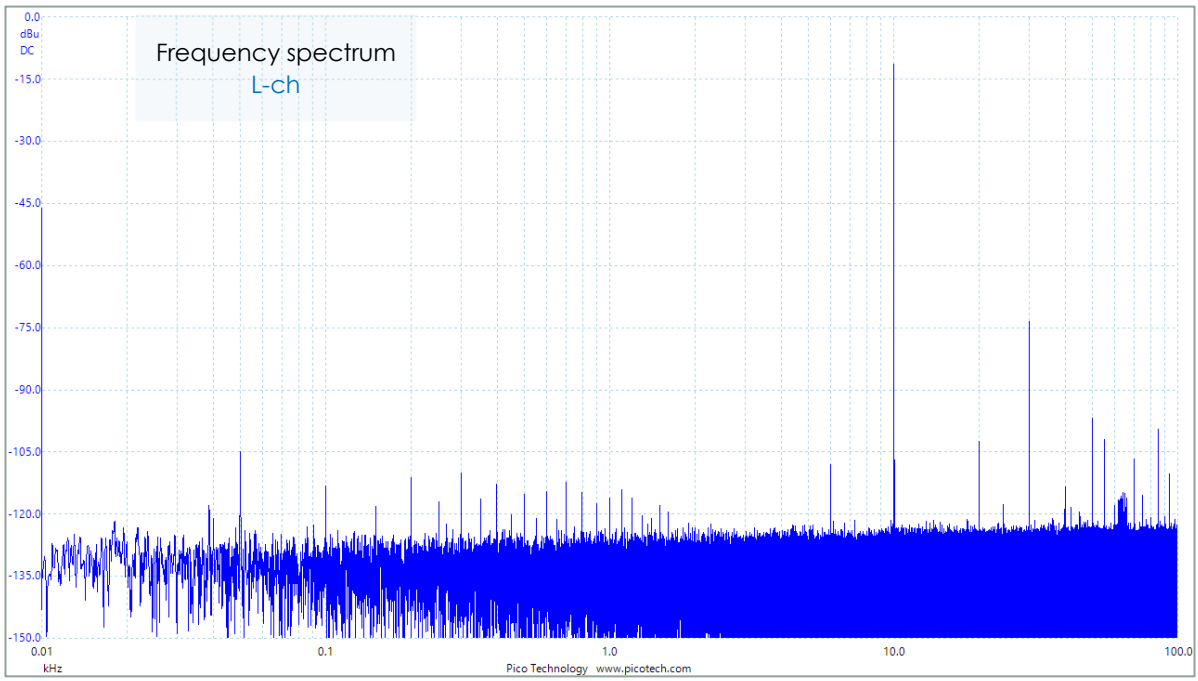
The DC offset is relatively large. It is probably because the load is connected with the unbalanced cable.

Output	Left channel		Right channel	
	AC (rms)	DC	AC (rms)	DC
LOW	76.1[uV]	-1061[uV]	199[uV]	-1830[uV]
MID	53.7[uV]	-3865[uV]	190[uV]	-3823[uV]
HIGH	56.1[uV]	-1451[uV]	186[uV]	-3255[uV]



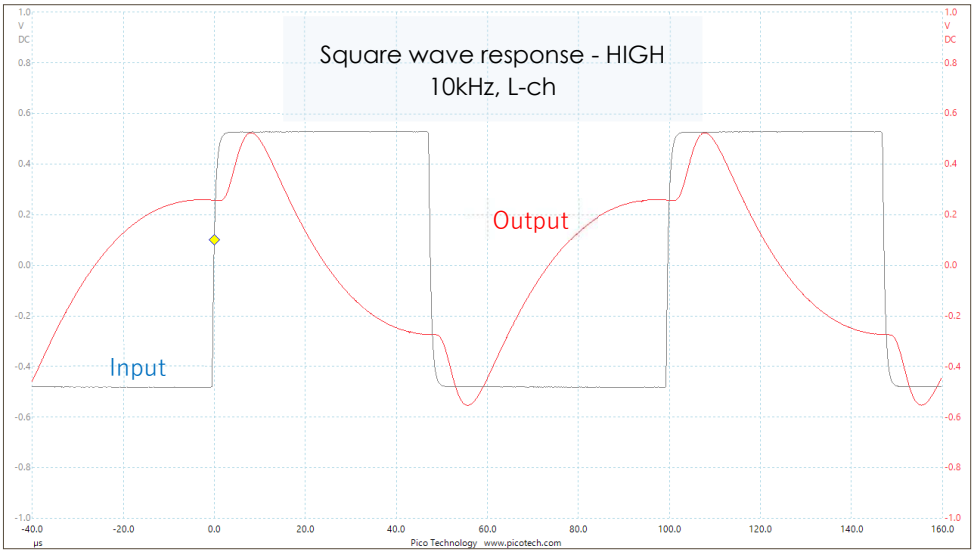
FFT Analysis

FFT analysis is not applicable to the crossover network since each output has a narrow frequency band.
I observed the frequency spectrum of HIGH output. The input signal is sine wave of 10kHz. I ignored the numeric values such as THD.



Square Wave Response

I observed the waveform of HIGH output when the input was square wave of 10kHz. The figure below is the result of the left channel. The right channel exhibits exactly the same waveform.



The waveform of the output is totally different from that of the input. I can't understand it.
The waveform is the same whether COLD pin is grounded or not.

No doubt that this distortion has an adverse effect on sound quality.

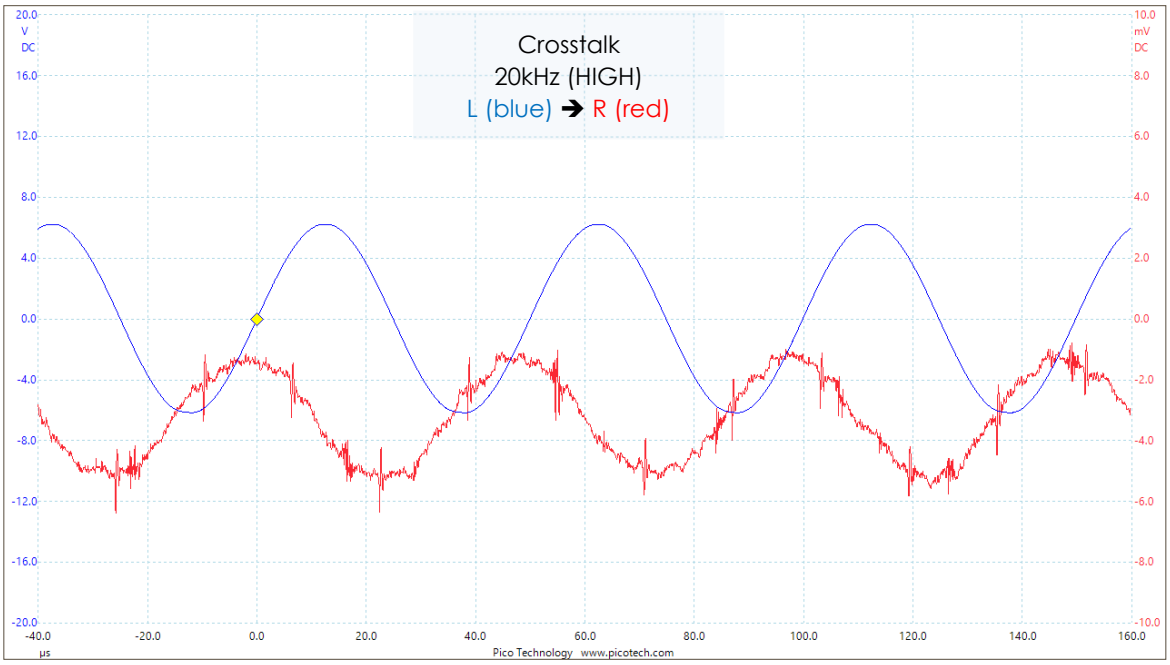
Channel Separation

The input is sine waves of maximum permissible level (4.4V).

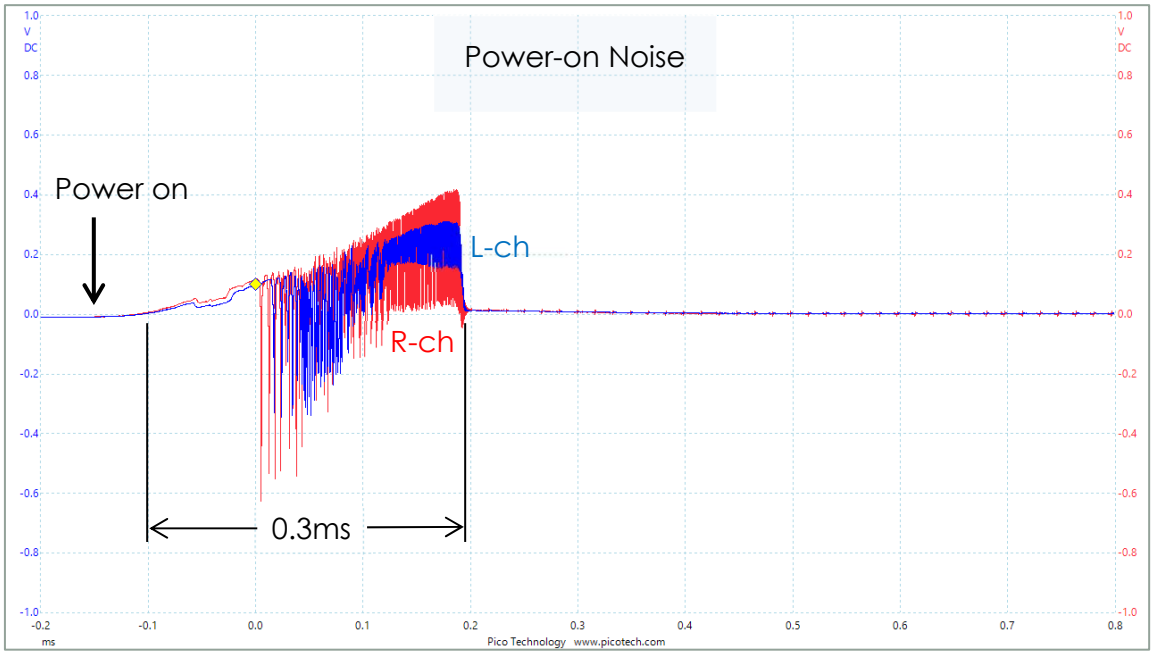
The frequencies are 20Hz, 3.15kHz and 20kHz. They are measured at the output of LOW, MID and HIGH, respectively.

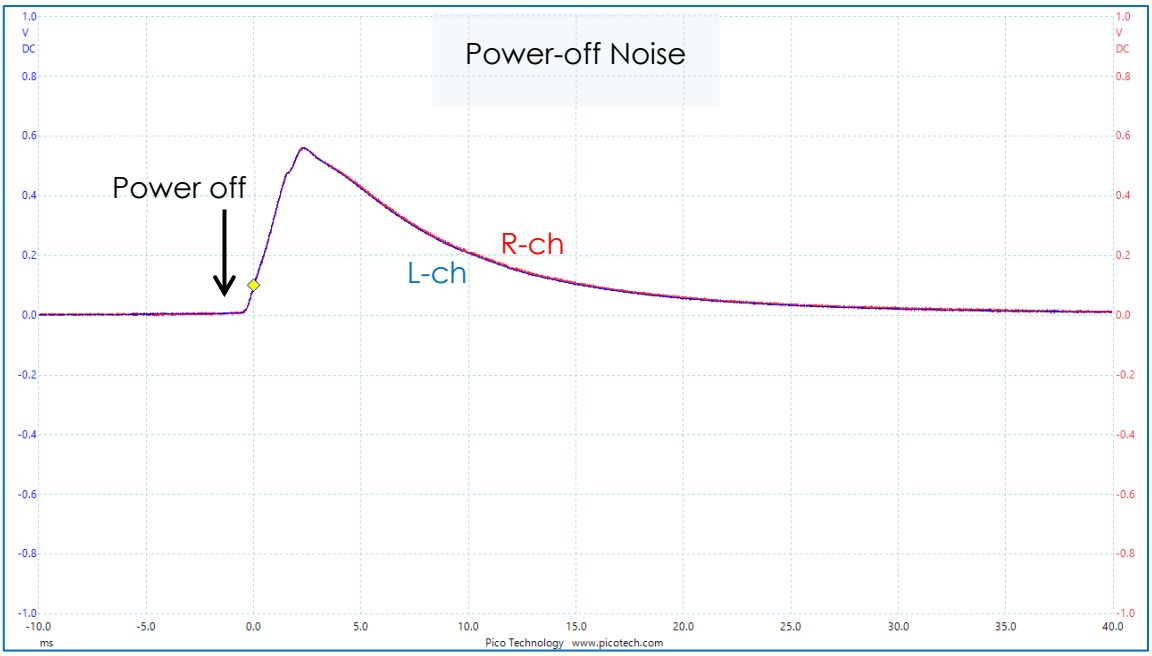
As frequency increases, separation decreases. Separation at 20kHz is too low.

周波数	方向	セパレーション
20 [Hz]	L ➔ R	91.6 [dB]
	R ➔ L	93.9 [dB]
3.15 [kHz]	L ➔ R	82.3 [dB]
	R ➔ L	86.7 [dB]
20 [kHz]	L ➔ R	70.1 [dB]
	R ➔ L	83.1 [dB]



Noise at Power-on/off





Large noise comes out at both power-on and power-off.
CX3400 must be turned on before the power amplifier is turned on, and it must be turned off after the power amp is turned off.

Sound Quality

When I installed CX3400 in Gaudi II system and played some music, terrible sound came out. I couldn't tolerate it.

Sound quality (SQ) has improved step-by-step, as frequency response has improved (see the section [Measurements] – [Frequency Response]).

1. Changed f_{c1} from 1.8kHz to 900Hz
2. Set XOVER FREQ switch to x1
3. Bridged COLD and GND pins of the cable

Gaudi II still sounds unnatural, though SQ has improved. I feel CX3400 is apparently worse than CD-211B.
I surmise it is related to the distortion in the square wave response.

CX3400 has LOW Delay feature. LOW output can be delayed up to 2msec. By using this feature, the user can adjust timing so that the sonic waves emitted from woofer and squawker reach the listening position at the same time (for the squawker and tweeter, the timing can be adjusted by sliding tweeter back and forth). This adjustment is time alignment adjustment.

I confirmed that sound image is more clearly focused and stereo imaging is more stable and accurate after time alignment adjustment.
However, the sound of Gaudi II with CX3400 is still unnatural and unrealistic. I concluded CX3400 is not good for Gaudi II.

Conclusion

I concluded SQ of CX3400 isn't good. But it is my evaluation when CX3400 is connected with unbalanced cables. The conclusion may be different when a preamp equipped with balanced output and power amps with balanced inputs are used.

I was optimistic before setting up CX3400. I thought it was easier to use a commercial network than a DIY network, because the commercial network is adjustable. But it's not so easy.

I hadn’t anticipated at all that the characteristics vary a lot by the way of connecting the load and the waveform of the input signal.

Originally, I intended to use CX3400 temporarily. I’d like to replace it with a digital crossover network as in the system design of Gaudi II at the earliest opportunity.

By the way, I could prevent the loudspeaker units from being damaged by making the measurements before installing CX3400 in Gaudi II. I believe precaution like this is necessary even when a commercial component is installed.
In addition, the measurements are so helpful to find (a) cause(s) when SQ is not satisfactory.

[END OF DOCUMENT]

NOBODY Audio
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