

The Kaneda No. 168 – Preamp for GoFiSS

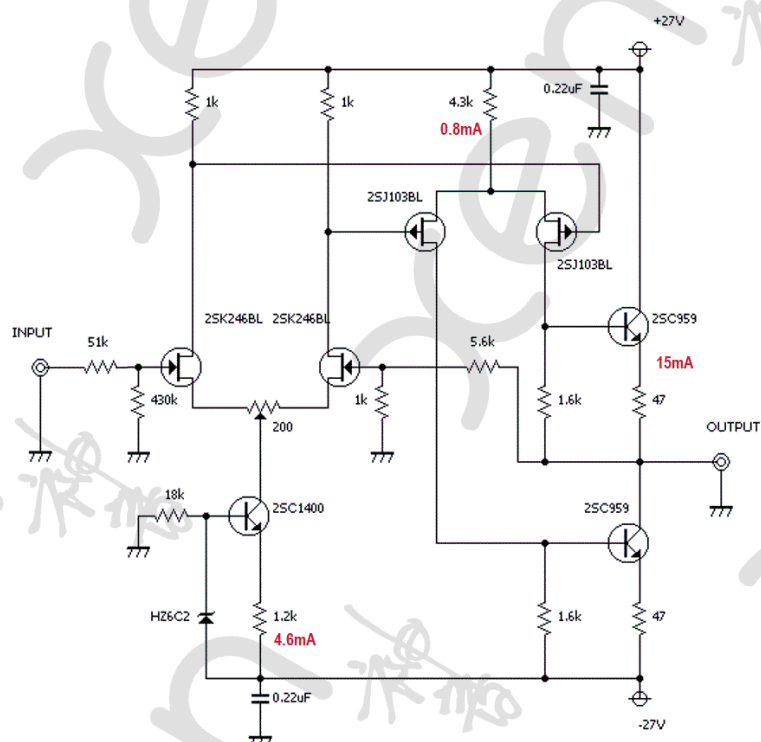
XEN Audio

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Introduction

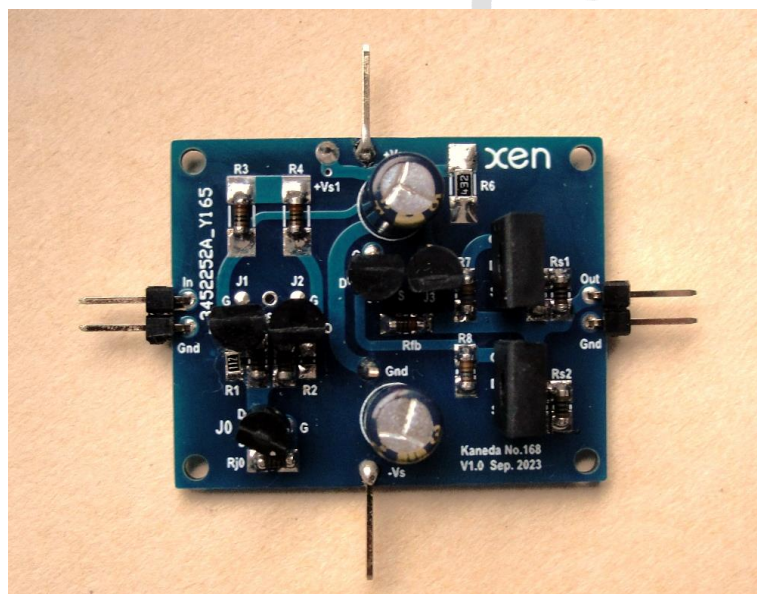
While I was looking for the schematics for the Kaneda No. 279, and others using SiC output devices^[1,2,3], I came across some Japanese DIY sites for the No.168 Lineamp, which looked interesting^[4]. Then I discovered that I actually have the full publication in Kaneda's book of 2008 (ISBN978-4-416-10807-9), it being used there as an IV converter. The basic circuit is like a JFET-input opamp, which can then be configured for different applications.



The Prototype

All the devices in the original schematics I happen to have in my drawer, except for the 2SC959. A substitute is supposed to be 2N3440, which can still be found as NOS. But there are also modern devices which are just as good, for example the Toshiba TC004B, which I took as substitute for the output devices. The original circuit uses a BJT as frontend current source, which I also can replace with a J113 JFET and a source resistor to give the required 4.5mA LTP bias current, simplifying the circuit in the process.

So nothing stands in the way for a quick prototype test. In the prototype, 2 sets of 2k/10k resistors at both inputs set the closed loop gain to 5x. Because of the low bias currents, the dissipation of resistors are in the mW region. SMD & MELF resistors are therefore used all over, to enable short signal paths and compact PCBs.



Performance

After quick adjustments for DC offset, the prototype was taken through the usual measurement routines. The -3dB bandwidth at 2Vrms output was measured at 500kHz. A compensation cap is actually added to the positive-phase PJFET of the 2nd LTP to limit the bandwidth a bit, to prevent RF pickup. This was followed by distortion measurements at 1kHz with +/-24V rails, the output loaded with a 10k resistor. The results are beyond expectations :

Output Level	H2	H3	H4
1Vrms	0.00076%	0.00020%	0.00023%
2Vrms	0.00074%	0.00040%	0.00012%
5Vrms	0.0015%	0.0021%	0.000049%
7Vrms	0.0021%	0.0043%	0.00017%

Essentially, at line level output, the higher harmonics were buried in background noise. A low-noise, well-regulated power supply is certainly beneficial. And especially at line level output, the distortion is surprisingly low over all frequencies.

Output Frequency (1Vrms output)	H2	H3	H4
1kHz	0.00076%	0.00020%	0.00021%
2kHz	0.00097%	0.00022%	0.00020%

10kHz

0.00085%

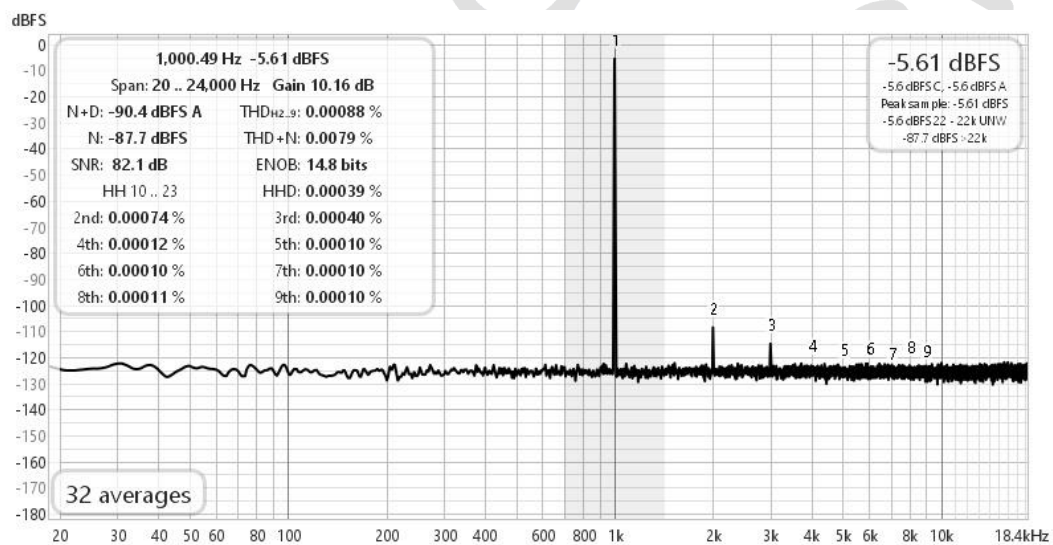
0.00020%

0.00021%

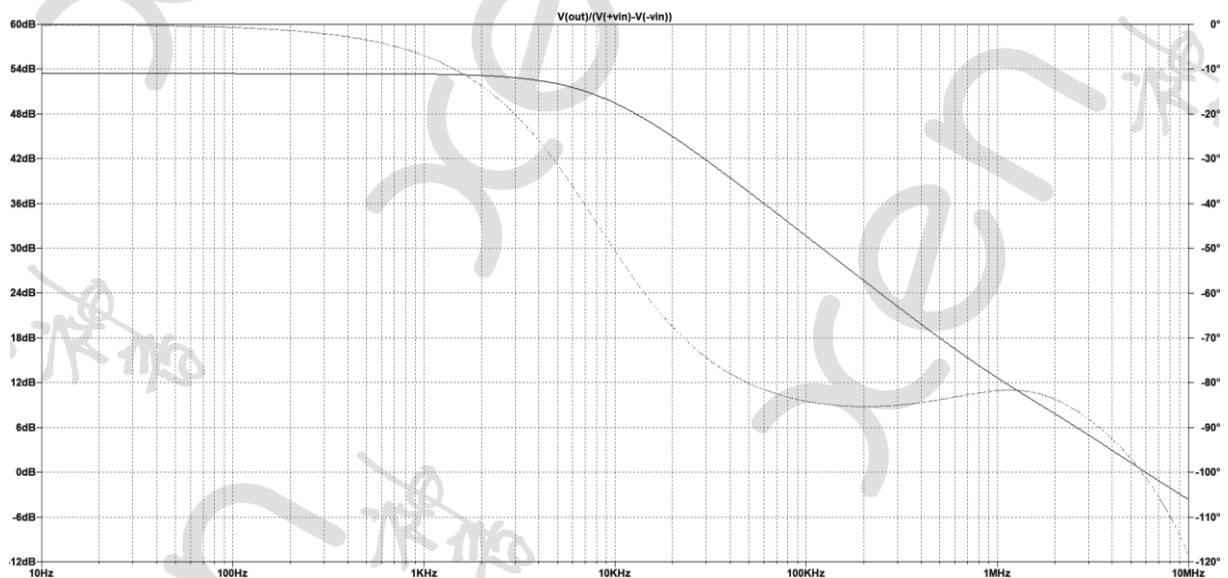
Rail voltages do have an impact on the distortion levels :

Supply Rail Voltages (1Vrms output)	H2	H3	H4
+/-24V	0.00076%	0.00020%	0.00021%
+/-18V	0.00086%	0.00021%	0.00023%
+/-15V	0.0031%	0.00028%	0.00026%
+/-12V	0.0081%	0.00093%	0.00035%

This indicates that 18V rails would be the lowest one should go for.



Below is a plot of simulated open loop gain and phase as per LT Spice :



As one can see, OLG is flat at 54dB up to 8kHz -3dB, and still has 80° phase margin at 0dB. With a gain of 5, NFB is about 40dB.

Unity Gain ?

When used in combination with the GoFiSS power amplifier which has a gain of 25x, the combination has a total gain of 125. Some might find this too high, although in real life usage, the W-ONE is set to Step 45 out of 128 (-0.5dB per step).

The standard version was then further tested for an overall gain of 1. This has an input resistor network of 5k/5k, and a feedback network of 2k/2k. The 10kHz square wave is near perfect, and distortion of 1Vrms 1kHz into 10k is :

	H2	H3	H4
1Vrms	0.00055%	0.00011%	0.00002%

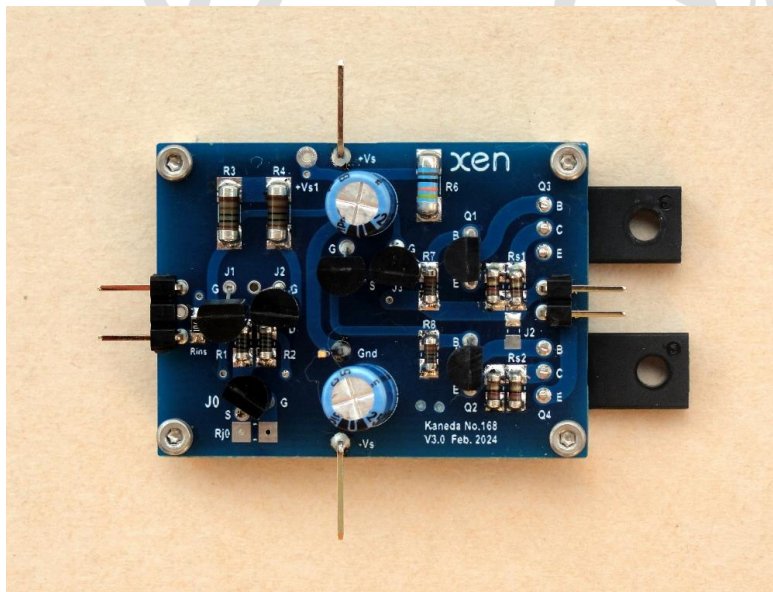
which is even lower than that for 5x, as expected.

For an overall gain of 2, one can use 3.3k/6.8k at the input, and 3.9k/2k for the feedback network. In any case, there is no stability issue for real-life audio signals.

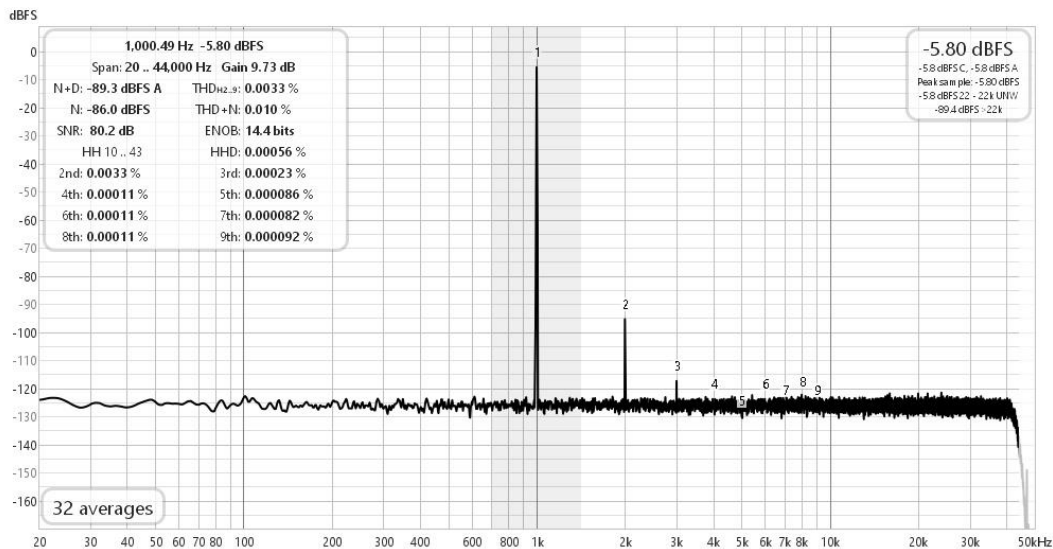
Driving Low Impedance Load

Although this configuration simulated quite well, I wanted it to see if it can be used to drive low impedance load down to 100R with low distortion and with increased bias (~60mA). Instead of using a Darlington at the output, I chose to use a Sziklai pair with 2SC224BL and TTA004B. One can also use KSC1845 which is of course easier to get.

The PCB was designed for both versions, so a pair was quickly built and measured.



Distortion Spectrum 1kHz 2Vrms into 600R load :



Distortion Measurement Summary :

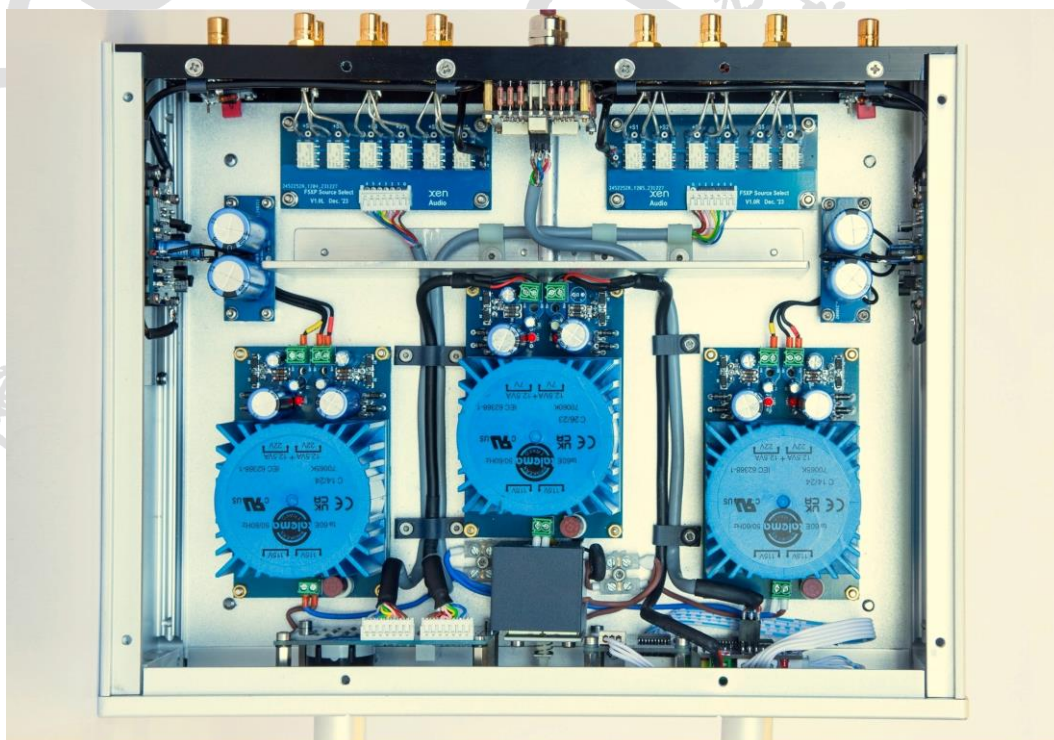
K168SZ						
for 10kHz only H1-4 is measured						
10k load						
Output level (Vrms)	%THD 1kHz	H2	H3	%THD10kHz	H2	H3
1	0.0013	0.0011	0.00021	0.0014	0.0014	0.00018
2	0.0033	0.0033	0.0002	0.0036	0.0036	0.00036
7	0.016	0.015	0.0039	0.017	0.016	0.0043
2k load						
Output level (Vrms)	%THD 1kHz	H2	H3	%THD10kHz	H2	H3
1	0.0013	0.0012	0.00019	0.0016	0.0015	0.00024
2	0.0033	0.0033	0.00022	0.0037	0.0037	0.00041
7	0.015	0.015	0.0038	0.017	0.016	0.0043
600r load						
Output level (Vrms)	%THD 1kHz	H2	H3	%THD10kHz	H2	H3
1	0.0014	0.0013	0.00022	0.0017	0.0017	0.00021
2	0.0033	0.0033	0.00023	0.0041	0.0041	0.0004
7	0.016	0.016	0.0043	0.018	0.018	0.0047

If you look at the individual harmonics, they are more or less the same, whether 1kHz or 10kHz, and whether 10k or 600R load. Distortion only increases with amplitude, as one would expect. H2 is ~3dB higher than the non-SZ version with 10k load, and H3 is easily 5~10x lower. SZ is thus a good choice, when its load driving capabilities is desired.

Preamp Case, Source Select and Volume Control

A well proven layout for preamp has been used previously for the F5 Preamp and the Preamp for Le Monstre^[5,6]. There is a variant of the BZ3207 case available with pre-machined front panel and knobs, as well as a central acrylic window for channel and volume level displays. This ideally allows the use of the same W-ONE relay-switched-resistor-ladder attenuator as in the F5 Preamp, as well as

the same source select relay boards. The exception this time is the 7-Segment display for the source select, which is connected directly to the rotary switch outputs via a SMD diode matrix.



This makes a perfect match to the GoFiSS power amplifier, which is also based on the same Kaneda-Double-Differential topology.



References :

1. <https://www.diyaudio.com/community/threads/semisouth-goes-dodo-what-now.222098/post-7452361>
2. <https://www.diyaudio.com/community/threads/semisouth-goes-dodo-what-now.222098/post-7233757>
3. <https://www.diyaudio.com/community/threads/semisouth-goes-dodo-what-now.222098/post-7281961>
4. <https://www7b.biglobe.ne.jp/~konton/No-168%20seisaku-4.htm>
5. <https://www.diyaudio.com/community/threads/the-f5-preamp-2024.419289/>
6. <https://www.diyaudio.com/community/threads/preamp-for-hiraga-le-monstr-2024.421562/>