A Trio of 4-Transistor Line Level Buffers

XEN Audio
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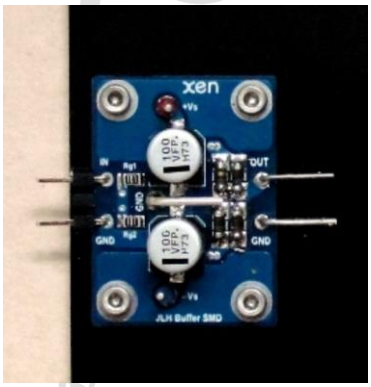
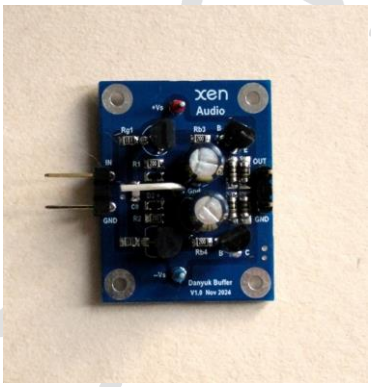
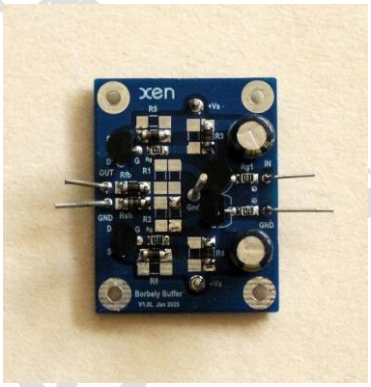






Earlier in the Le Monstre Preamp thread, we posted schematics and spice files for 3 different line level buffers, which all have JFET inputs and use 4 complementary transistors in total. For our curiosity, we have now built and measured them all, as shown above.

If we look at the circuit closely, the JLH Buffer is essentially a complementary follower with 2 Sziklai pairs, each of which has a FET input and a BJT output. The Danyuk, on the other hand, is also a complementary follower with “traditional” FET/BJT Darlington’s. The Borbely can be considered as an all-JFET F5 Preamp, i.e. with gain, although it is said to be unity gain stable. In our example, it was configured for a closed-loop gain of 5.

We built a new version of the JLH Buffer using all SMD devices, which makes it much more compact. The transistors are SMD versions of the through-hole devices, i.e. MMBF5457/5460 and 2SC3649/2SA1419. They are all mounted on the bottom side of the PCB and are thermally coupled to a heat spreader plate via flexible thermal pads.

For the Danyuk, we chose to use through-hole Toshiba devices, namely 2SK246BL/2SJ103BL and 2SC3328/2SA1315. These, although obsolete, can still be obtained relatively easily in Japan, and most probably elsewhere. For the Borbely, we used 2SK170BL/2SJ74BL throughout, with 6mA Idss for the input stage, and 10mA Idss for the output stage.

Measurements

All three modules have been measured with different amplitudes, loads and frequencies. The results can be summarised as below :

JLH SMD Version

1kHz						10kHz			
600R load	282mVrms	1Vrms	2Vrms			600R load	282mVrms	1Vrms	2Vrms
H2 (%)	0.002	0.0069	0.015			H2 (%)	0.002	0.0068	0.015
H3 (%)	0.00011	0.00075	0.0034			H3 (%)	0.00013	0.00081	0.0036
2K load	282mVrms	1Vrms	2Vrms			2K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.00063	0.0018	0.0035			H2 (%)	0.00058	0.0016	0.0032
H3 (%)	0.00013	0.00013	0.0004			H3 (%)	0.00013	0.00018	0.00047
10K load	282mVrms	1Vrms	2Vrms			10K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.00043	0.0011	0.0021			H2 (%)	0.00045	0.0009	0.0018
H3 (%)	0.000089	0.00005	0.00025			H3 (%)	0.000098	0.00012	0.00033

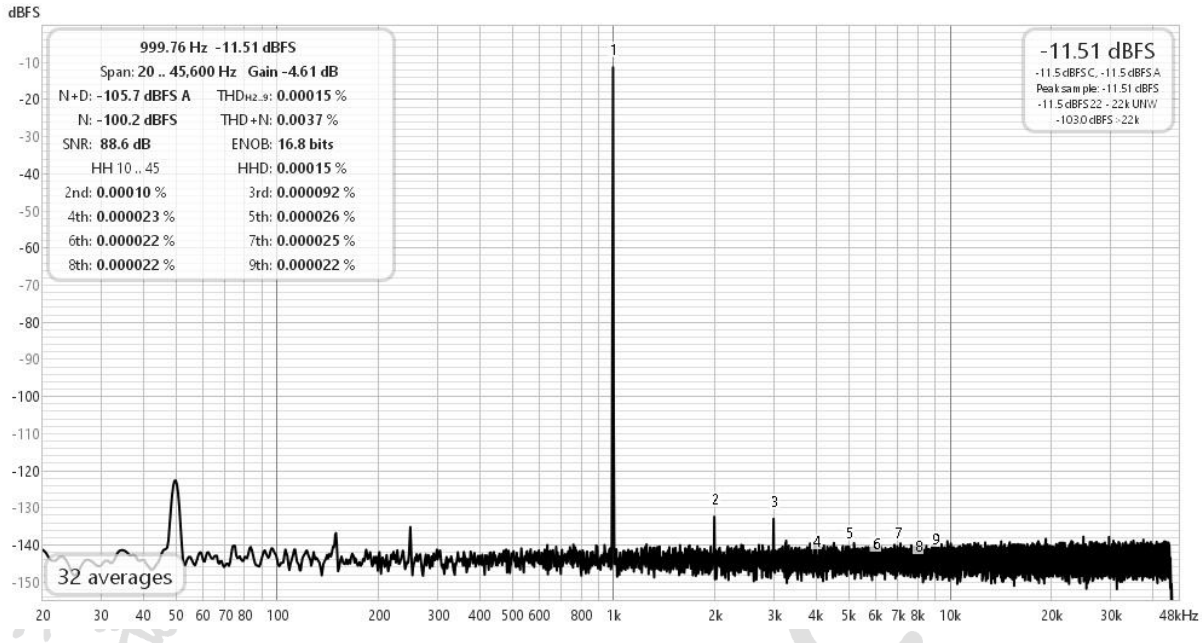
Danyuk buffer

1kHz						10kHz			
600R load	282mVrms	1Vrms	2Vrms			600R load	282mVrms	1Vrms	2Vrms
H2 (%)	0.0003	0.00032	0.00046			H2 (%)	0.00021	0.00027	0.00052
H3 (%)	-	0.000083	0.00049			H3 (%)	-	0.00017	0.00056
2K load	282mVrms	1Vrms	2Vrms			2K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.00011	0.00013	0.00014			H2 (%)	0.00014	0.00013	0.00031
H3 (%)	0.00012	0.00009	0.00031			H3 (%)	0.00018	0.00016	0.0004
10K load	282mVrms	1Vrms	2Vrms			10K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.00013	0.0001	0.000038			H2 (%)	0.00011	0.00012	0.00037
H3 (%)	0.00015	0.000092	0.00032			H3 (%)	0.00012	0.00015	0.00041

Borbely buffer

1kHz						10kHz			
600R load	282mVrms	1Vrms	2Vrms			600R load	282mVrms	1Vrms	2Vrms
H2 (%)	0.0013	0.0042	0.0086			H2 (%)	0.0012	0.0041	0.0085
H3 (%)	0.00027	0.0027	0.011			H3 (%)	0.00037	0.0029	0.012
2K load	282mVrms	1Vrms	2Vrms			2K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.0013	0.0031	0.0061			H2 (%)	0.0016	0.0047	0.0094
H3 (%)	0.0002	0.00046	0.0017			H3 (%)	0.00017	0.00066	0.0025
10K load	282mVrms	1Vrms	2Vrms			10K load	282mVrms	1Vrms	2Vrms
H2 (%)	0.0024	0.0037	0.0067			H2 (%)	0.0029	0.0074	0.014
H3 (%)	0.00036	0.00026	0.00088			H3 (%)	0.00036	0.00059	0.0019

It is worth noting that some of the distortions are so low that they are buried in the background noise. Below is the FFT of the Danyuk with 1kHz 1Vrms into 10k load.



The 50Hz comes from the lab supply used in the measurements.

It is not surprising that the Borbely has higher distortion in comparison, though still very low by any standard. They are likely to improve by some 10dB if wired as unity gain. But to be able to drive 600R load, the output stage needs beefing up, by e.g. paralleling multiple devices.

Somewhat surprising is the Danyuk buffer compared to the JLH. Normally, Sziklai pairs are known to have higher gm and lower Zout than conventional Darlington's. A possible explanation is the higher bias in the Danyuk, especially in the input stage. In both cases, the distortion at line level voltages and normal load that there is unlikely to be any audible differences. We do intend to build the JLH again with the same Toshiba devices as the Danyuk, just to be comparing purely on topology.

References

1. https://www.diyaudio.com/community/threads/preamp-for-hiraga-le-monstr-2024.421562/