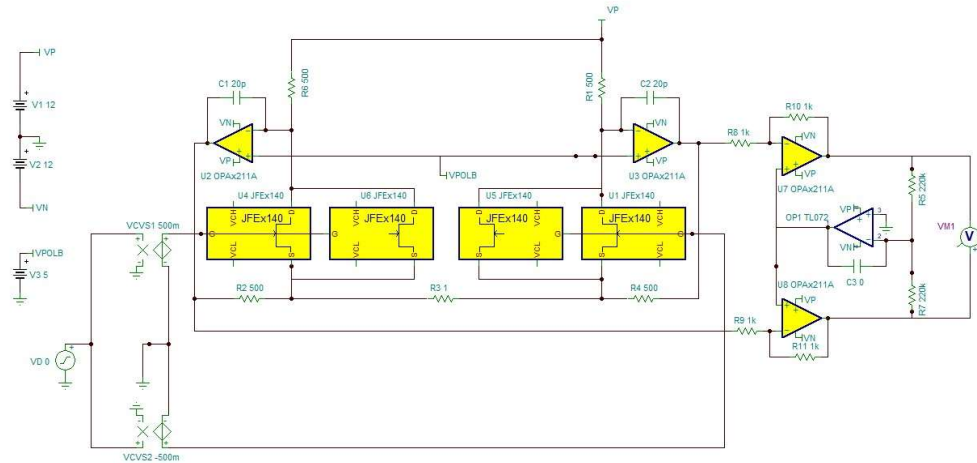


Supplementary material of “An ultra-low noise fully-differential amplifier”

Several files are included as “Supplementary material” for the interested reader to reproduce the figures and to simulate the circuit behavior with components’ values different to that used in the article.

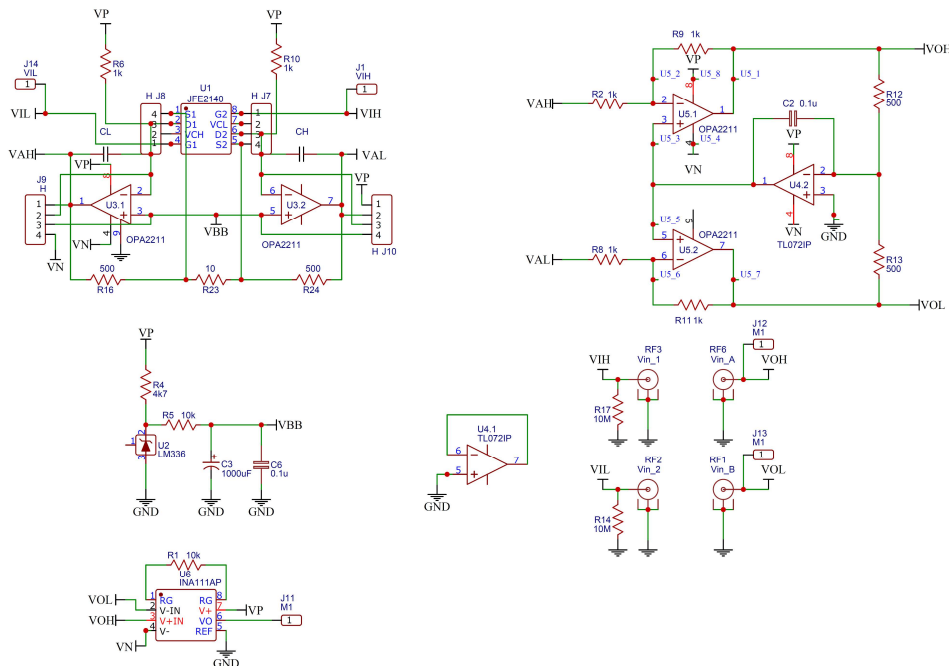
Simulation model

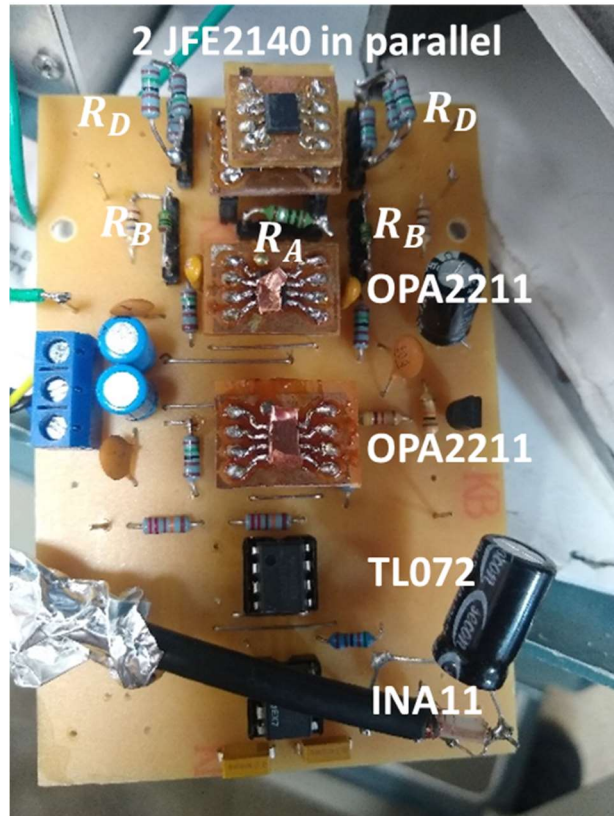
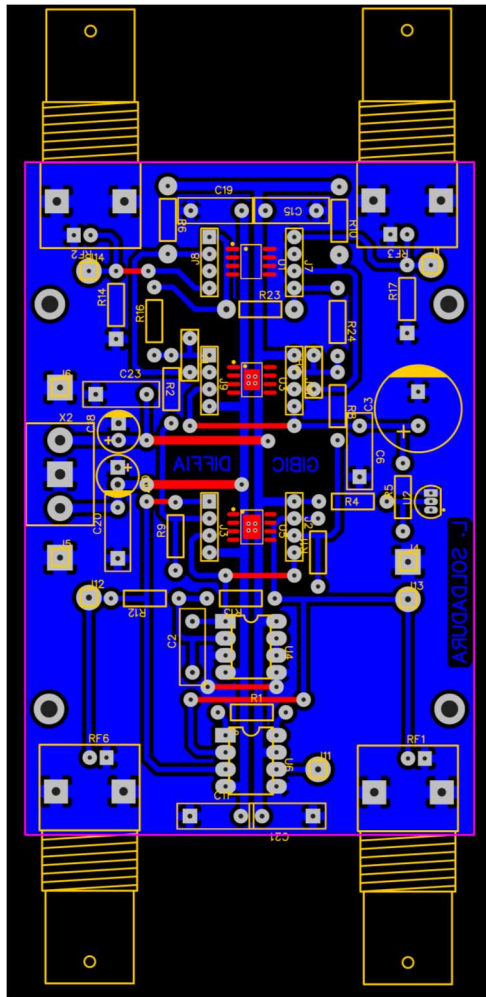
DIFF_JFET_08.TSC: TINA model to simulate the proposed amplifier. It allows observing operation bias point, frequency response and expected noise.



Circuit implementation

The schematic of the implemented circuit is shown in the figures bellow. Note that an instrumentation amplifier INA111 has been added at the differential output of the amplifier to perform the measurements by standard instruments with single-ended input.





Prototype used for the first tests

Bias drain currents up to 12 mA on each JFET were tested and cooper ribbons added over the operational amplifiers to improve their dissipation (they do not work so much but help...). The BNC connectors for input and output were not included to reduce the board size for insert it in the shield box.

Frequency response measurements

MATLAB script

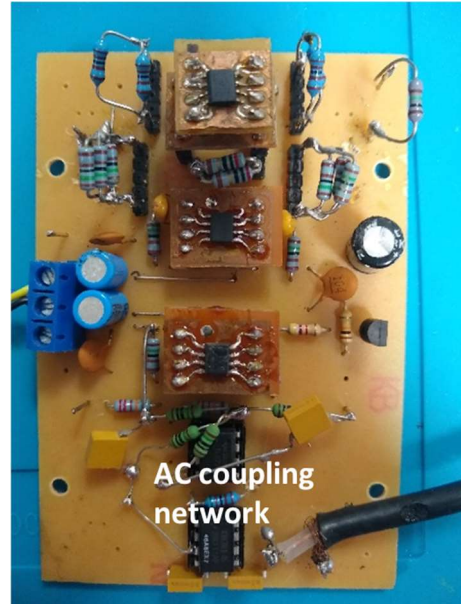
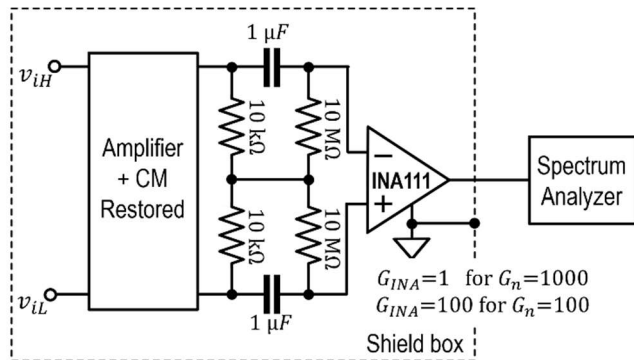
FrequencyResponse_IA01.m (experimental data embedded in the script)

TINA simulation results

FrequencyResponseIA_20dBC20p.txt, FrequencyResponseIA_40dBC20p.txt

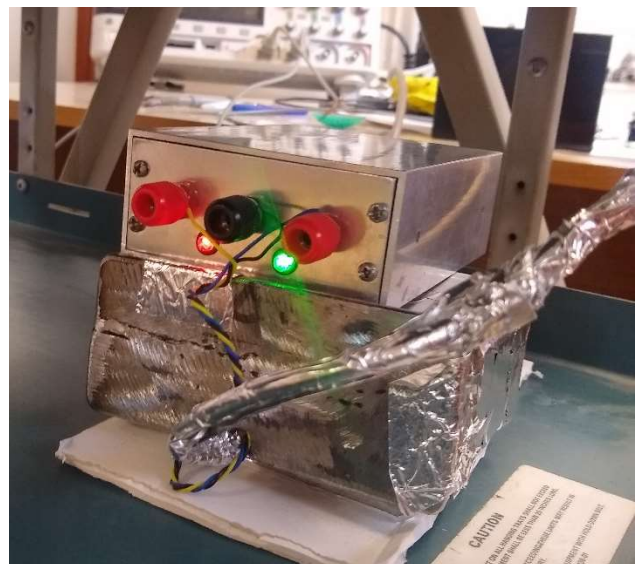
Prototype used for noise experiments

For noise tests @ $G_n=100$, an AC coupling network was added before the INA111 instrumentation amplifier to remove amplifier dc offset, thus allowing set a gain of 40 dB for the INA111 to relax the spectrum analyzer measuring conditions.



Shield box construction.

Since we do not have mu-metal available, we try with a magnetic shield implemented by a 6 mm iron box. The box and the connecting cable were covered with aluminum film to improve electric field shielding. The aluminum case with LEDs contains 6 Lipo batteries composing a $\pm 12.6\text{ V}$ power supply.



Noise measurements and scripts

Noise_FDIA_03.m: MATLAB script used for Fig.7 in the manuscript.

Experimental data

freq_L.txt: frequency axis from 0 to 200 Hz

freq_H.txt: frequency axis from 200 Hz to 10 kHz

noise_2x7mA_L.txt: two JFET in parallel per side, 7 mA each JFET, 0 to 200 Hz.

noise_2x7mA_H.txt: two JFET in parallel per side, 7 mA each JFET, 200 Hz to 10 kHz.

noise_1x7mA_L.txt: one JFET in parallel per side, 7 mA each JFET, 0 to 200 Hz.

noise_1x7mA_H.txt: one JFET in parallel per side, 7 mA each JFET, 200 Hz to 10 kHz.

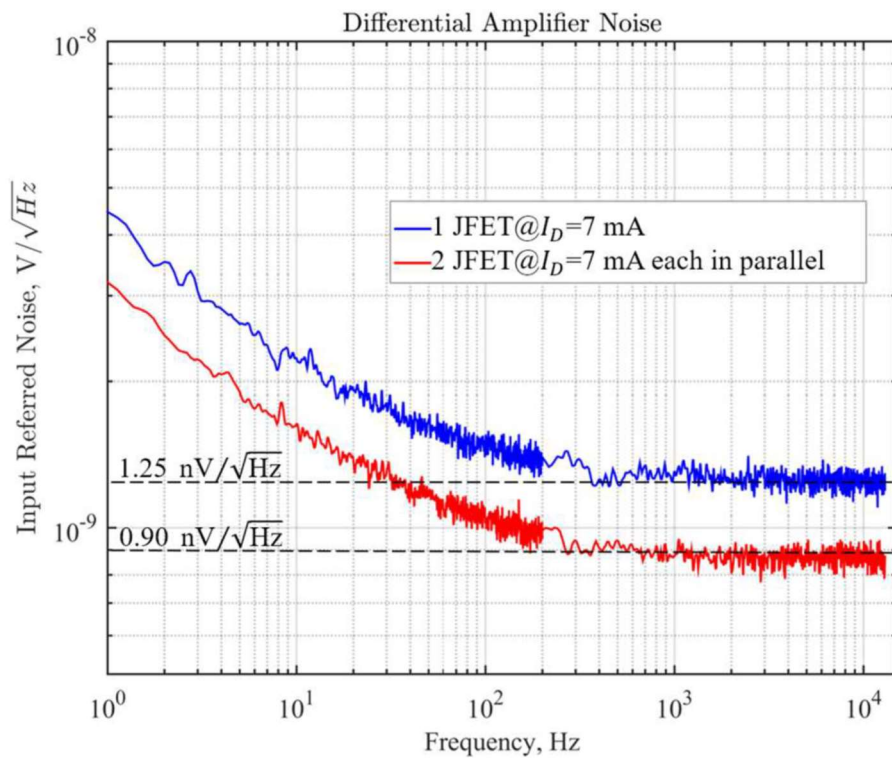


Fig. 7. Experimental voltage noise spectral density of the ultra-low noise fully-differential amplifier with one JFET per side (in blue) and with two JFETs per side in parallel (in red).