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Subject Area	Wireless Communications
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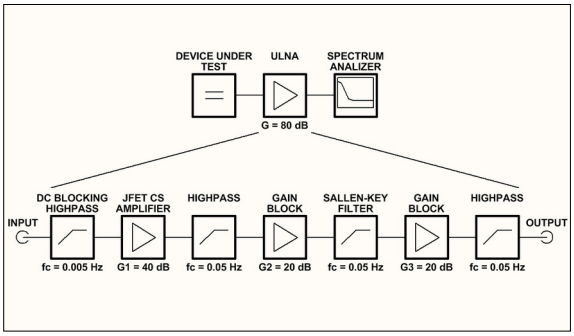
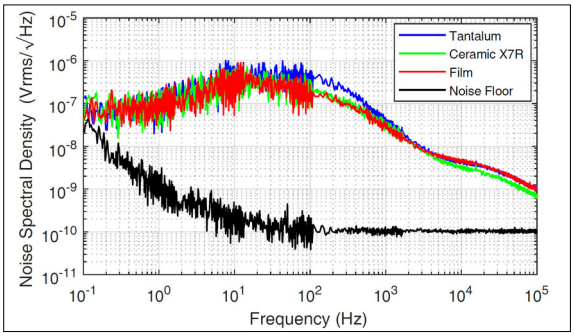
Ultra-Low-Noise Amplifier for Power Supply Noise Measurements



Block diagram of the developed multi-stage 80 dB ULNA for high-impedance power supply noise measurements

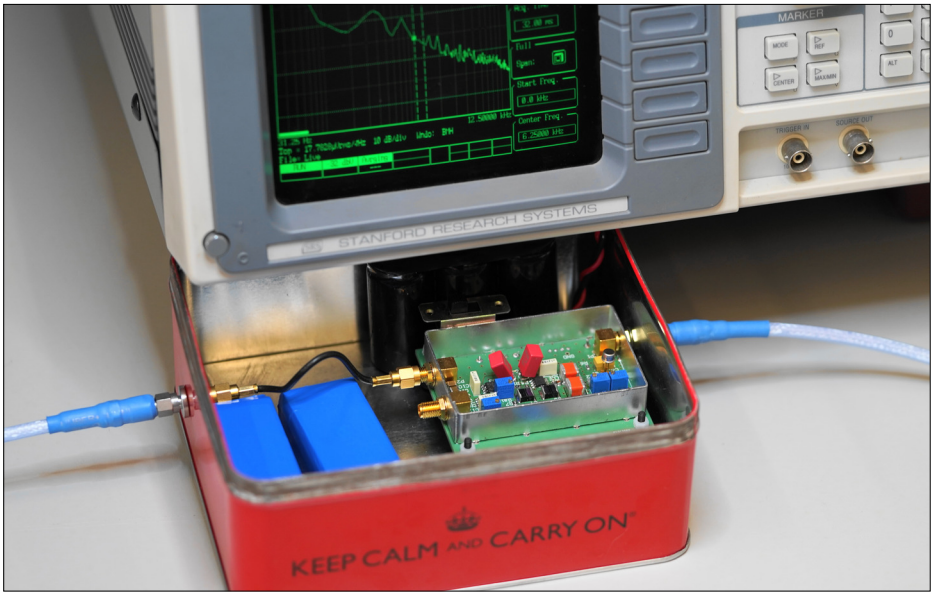


Measured output voltage noise spectral density of an LDO (TI TPS7A8101) with different noise reduction capacitor types

Introduction: Modern communication systems and related applications require precise signal sources with very low frequency deviations, known as phase-noise or jitter. Experience shows that such imperfections can stem from low-frequency noise injected into the system via the power supply such as low-dropout (LDO) voltage regulators as well as the associated filtering capacitors. The absolute level of these supply voltage fluctuations is generally very small, but can have a crucial impact on the overall performance of such systems.

Objective: Measuring and optimizing the noise performance of such power supplies requires a broadband ultra-low-noise amplifier (ULNA) with a very high amplification factor and much better noise performance than the device under test. One of the main difficulties is to maintain a low noise floor down to frequencies of 1 Hz and below, where Flicker noise (1/f noise) commonly dominates. Such highly specialized amplifiers are not available as standard components and continue to be a challenging topic in electronics research.

Result: In this project, a multi-stage ULNA for LDO noise measurement has been developed. It consists of a high-impedance JFET input stage, a Sallen-Key active filter and additional stages based on operational amplifiers. It features a gain of 80 dB over a wide bandwidth, ranging from 0.1 Hz to 1 MHz. The realized amplifier has excellent low-noise performance and a very low 1/f-corner frequency with an input-referred voltage noise density of 40 nV/sqrt(Hz) at 0.1 Hz, 2 nV/sqrt(Hz) at 1 Hz, and 0.2 nV/sqrt(Hz) at 10Hz, as well as < 0.2 nV/sqrt(Hz) at 100 Hz and above. Preliminary measurements of low-noise LDO and capacitor configurations confirm that the required performance can be achieved - and show that, indeed, the noise performance of such power supplies can depend on the choice of LDO and smoothing capacitors.



Measuring noise spectral density using the developed UNLA (with open shielding boxes, to reveal the internal buildup consisting of battery packs, capacitor bank and the ULNA)