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ERMSDCV2.3
Typical performances chart.

Contents

1) Overview

The typical performance chart concern the following functions of the ERMSDCV2 design :

- The DC to 1MHz RMS to DC converter.
- The Logarithmic AC voltmeter.
- The 80dB 10Hz..100kHz low noise amplifier (LNA).

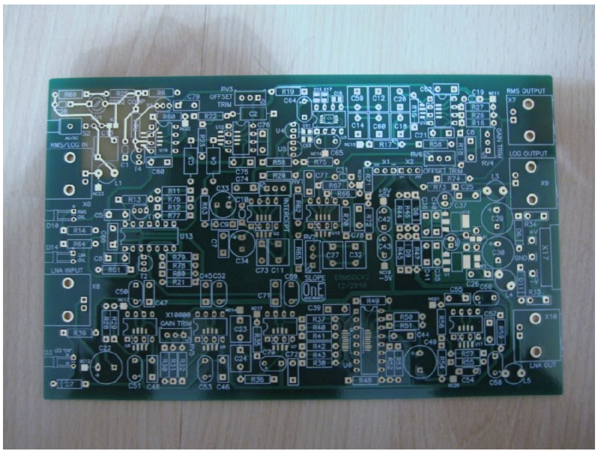
This document summarize the measurements results that I have obtain. As you will see, results are very good. The instrument could be really useful for audio & electronics investigations for a very reasonable price.

Otherwise specified, all tests are made using 1x probe (a coaxial cable) with the jumper W3 closed, and front panel switch in DC position (down). The device is powered by a standard +/-9VDC linear PSU.

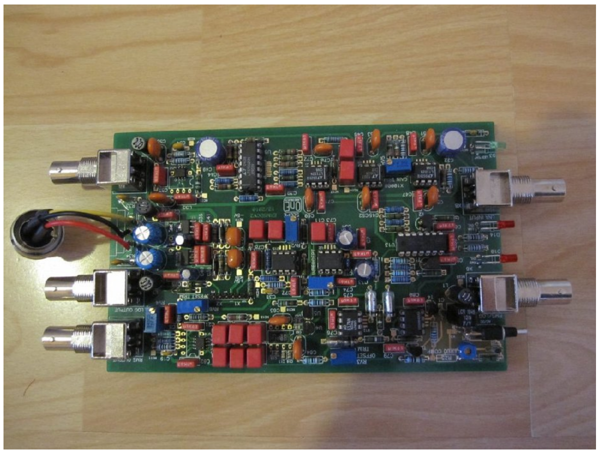
List of measurement equipments used :

- Tektronix TDS3014B DSO
- Fluke 87 III multimeter
- Solartron SI1260 Gain/Phase analyzer
- Philips PM2535 precision voltmeter
- HP3455A precision voltmeter
- Hameg HM8131-2 signal generator

Pictures of the ERMSDCV2 design:



Pict I Bare PCB



Pict II: Populated PCB

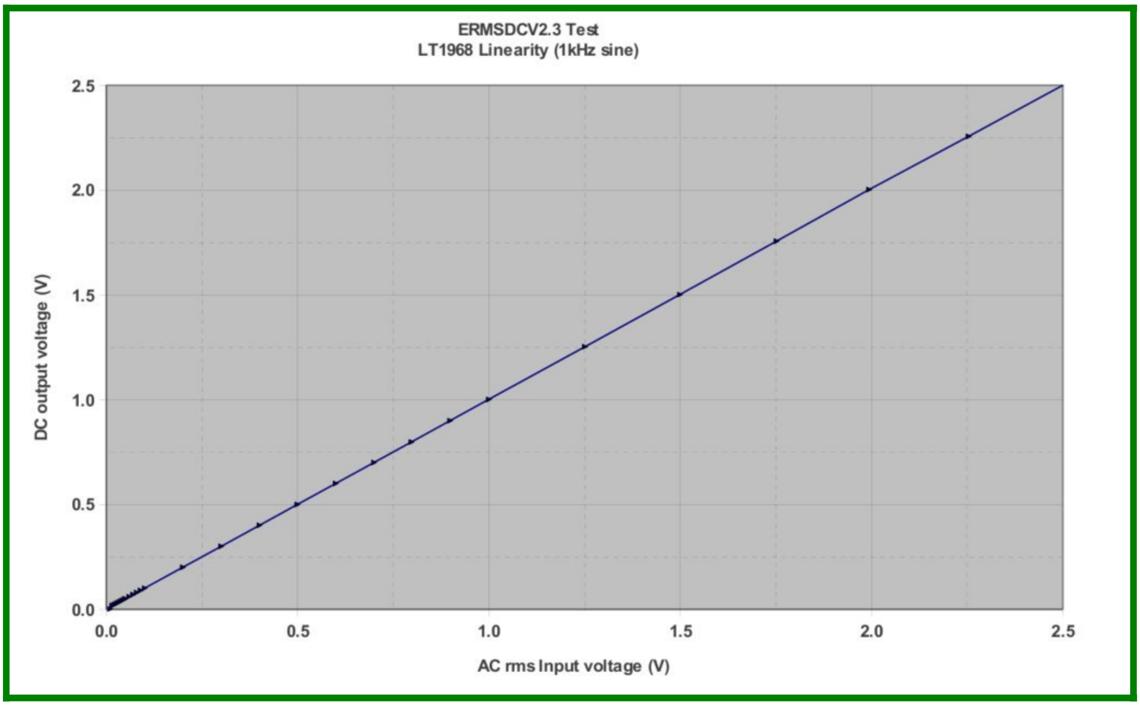
Pict III: Front panel view

Pict IV: Rear panel view

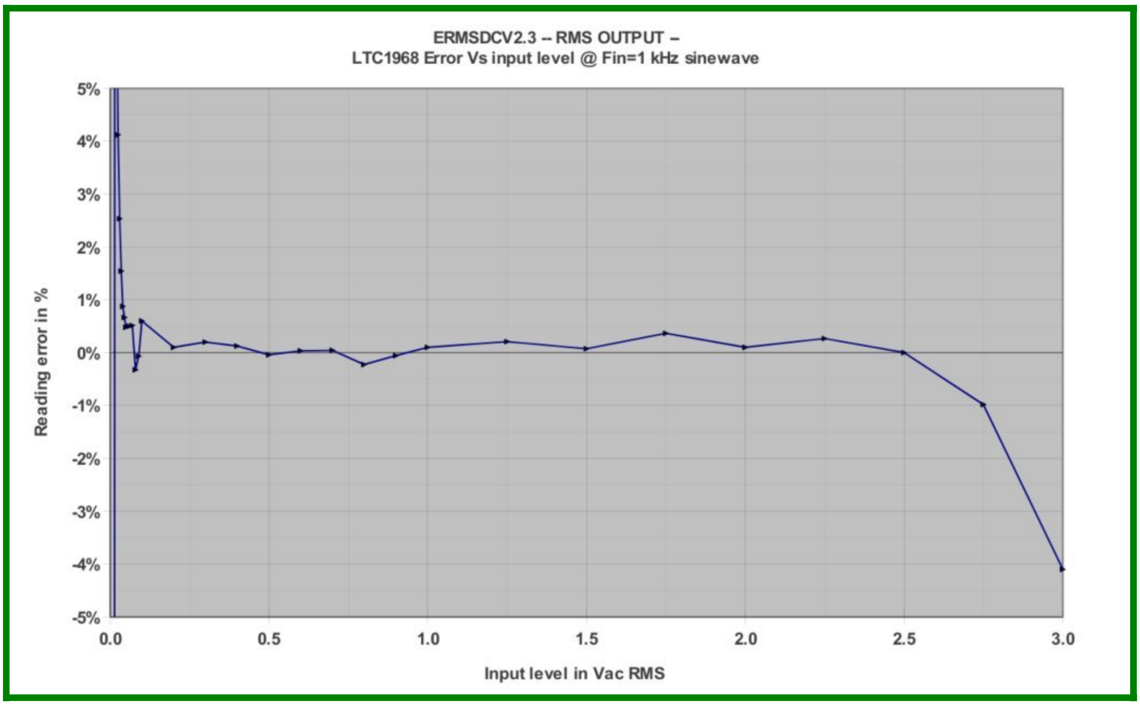
2) RMS to DC converter

2.1) Linearity test .

As you see, the RMS converter work very good from about tenth mV to more than 2.5V. The usable lower limit is about 20mV (<10% error).

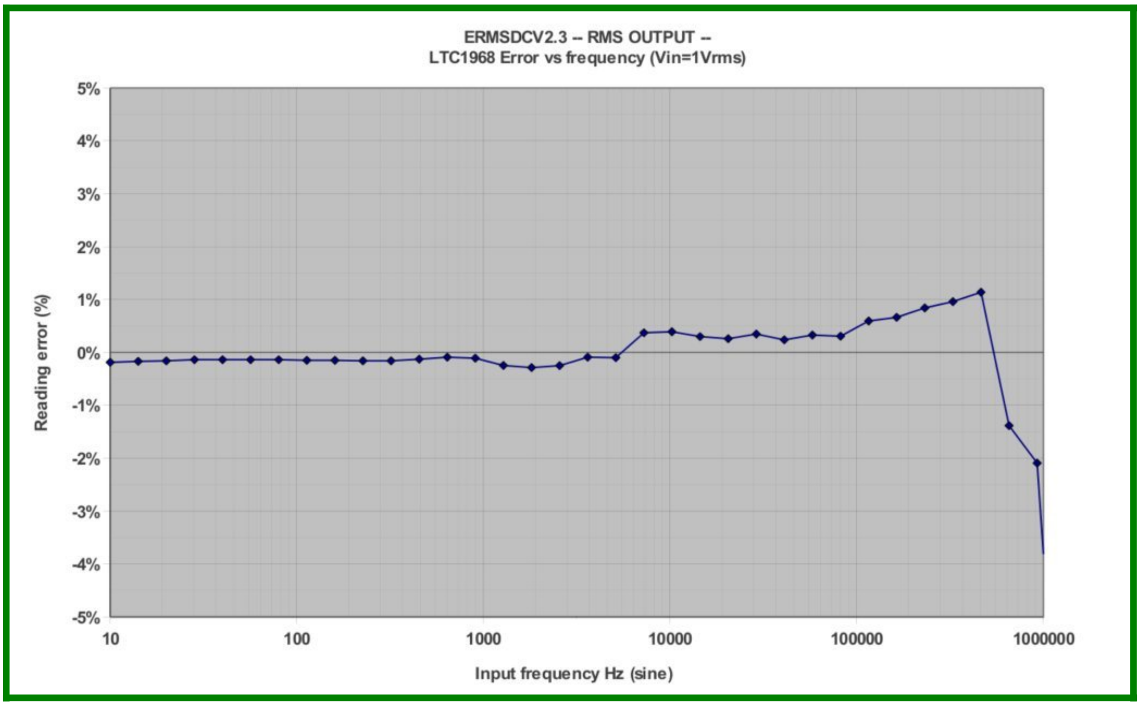


2.2) Measurement error test.



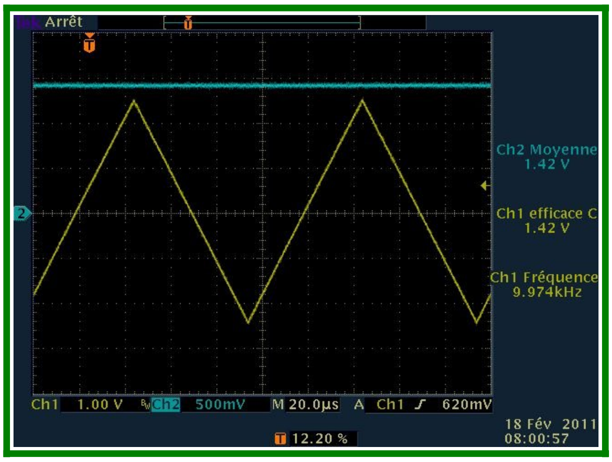
2.3) Frequency response measurement test.

The error versus frequency show very good linearity up to 400kHz and fall at about 600kHz. The frequency flatness depend largely on the AD817 low-pass filter Butterworth conformance (set to 1.8MHz cutoff).



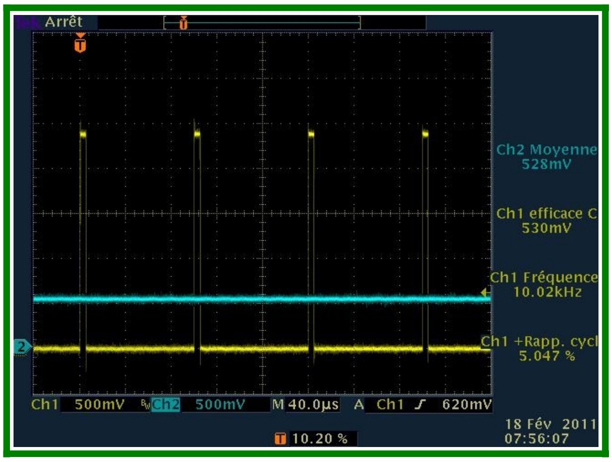
2.4) 5Vpk-pk 10kHz Triangular wave RMS measurement test.

Here, i test the RMS conversion of 10kHz triangular wave (crest factor of 1.7). (Yellow=signal input , Blue trace= DC output).



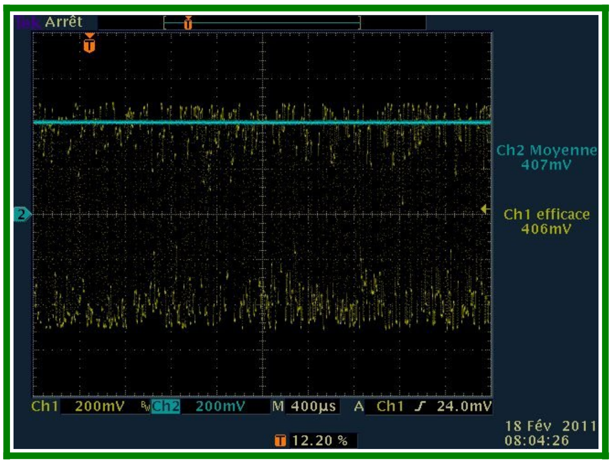
2.5) 2.5Vpk-pk 5% duty-cycle rectangular wave RMS measurement test.

Test with high crest factor signal (here 4.5), the RMS conversion stay very good despite this.
(Yellow=signal input , Blue trace= DC output).



2.6) Digital pink noise RMS measurement test.

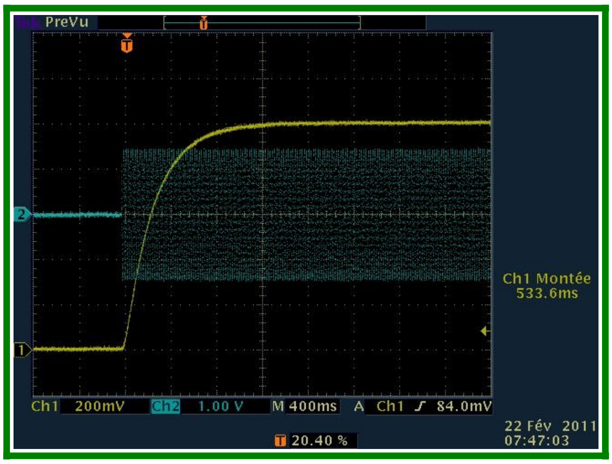
Test with random digital pink noise, again very good RMS conversion.
(Yellow=signal input , Blue trace= DC output).



I have also try measurements with x10 and x100 scope probe (W3 jumper open), allowing the extend of measurement range, and it work fine.
You just need to trim your probe compensation for frequency flatness and then you can measure up to 300Vrms ! (with a 100x probe).

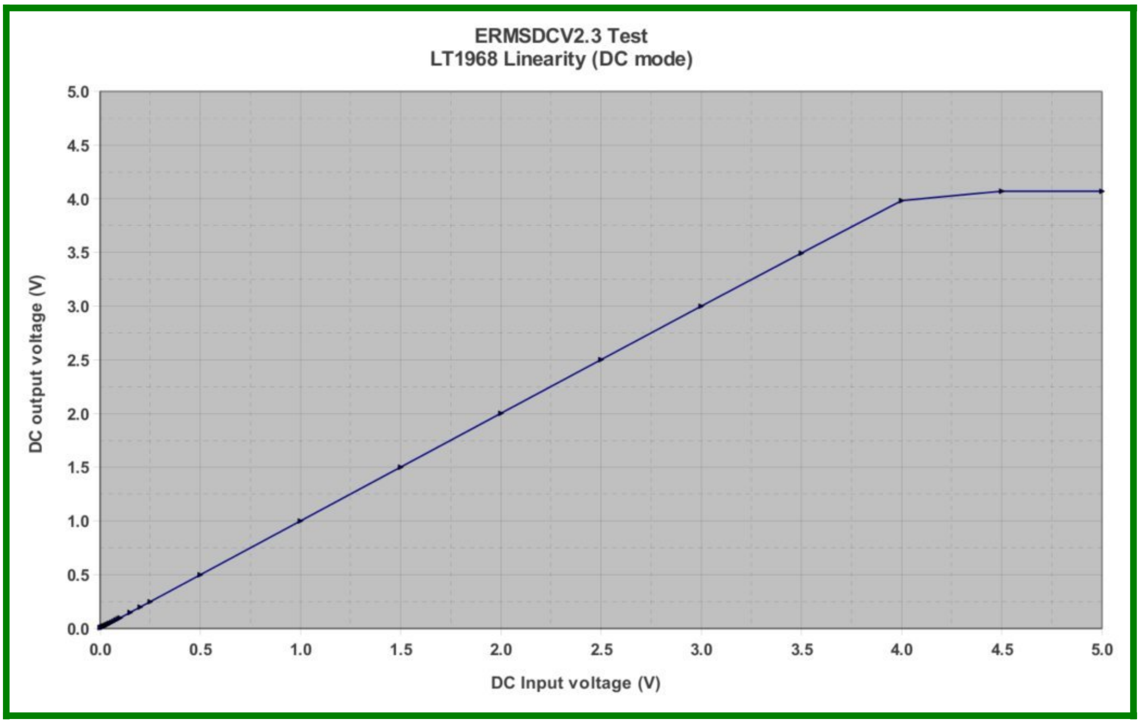
2.7) RMS converter settling time.

The input signal is a 1Vrms 100Hz sine-wave (blue), the output in yellow show the DC output response time. As you could see on the picture, the output settle in about 500ms (front panel switch in DC mode of course).

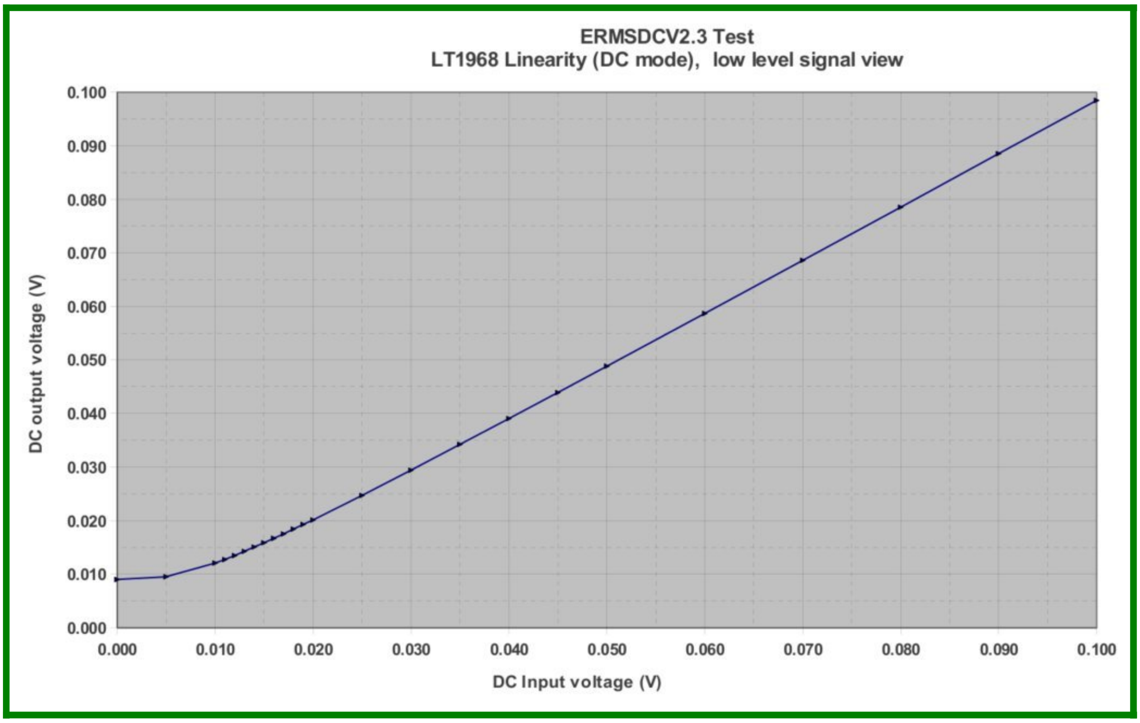


2.8) Linearity vs DC input level 0 to 5VDC .

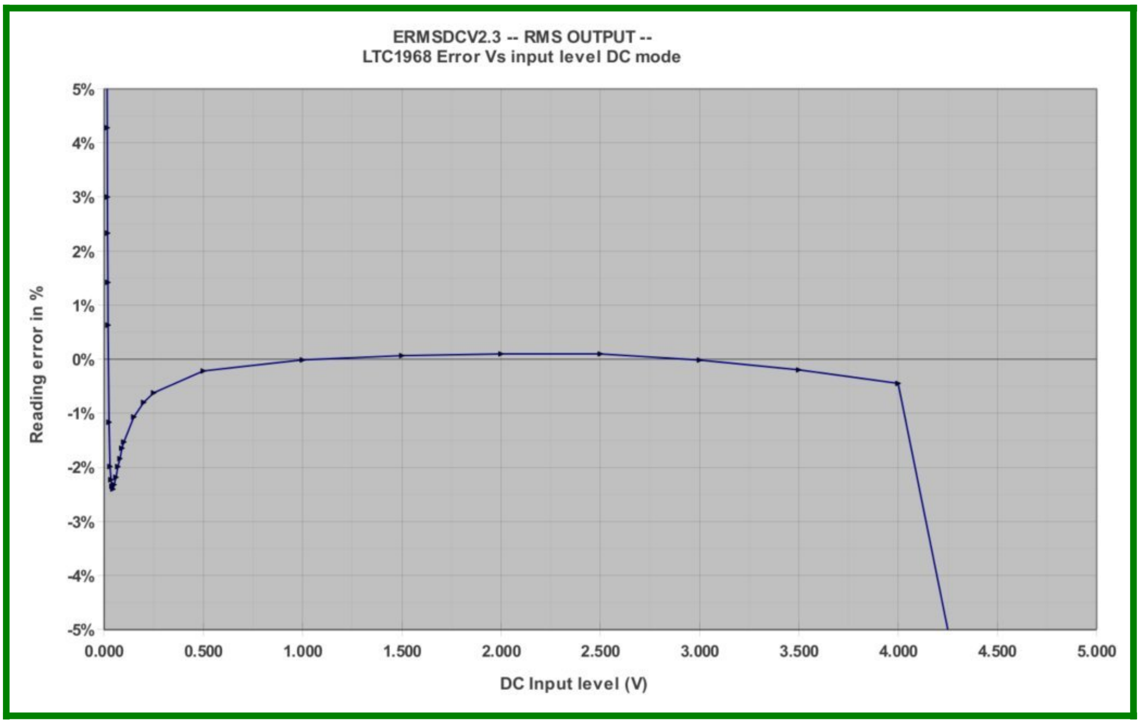
In these tests i use a DC signal to be measured by the ERMDCV2 (switch in DC mode).



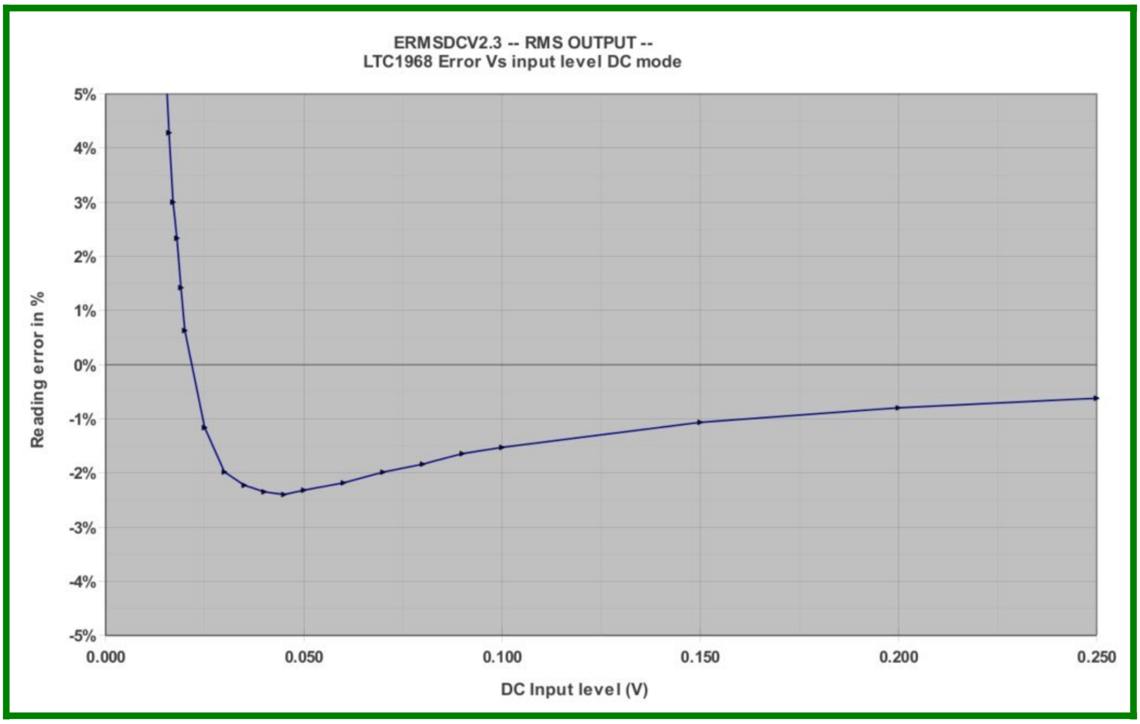
2.9) Linearity vs DC input level zoomed view, 0 to 250mVDC.



2.10) % Error vs DC input level 0 to 5VDC



2.11) % Error vs DC input level 0 to 250mVDC .

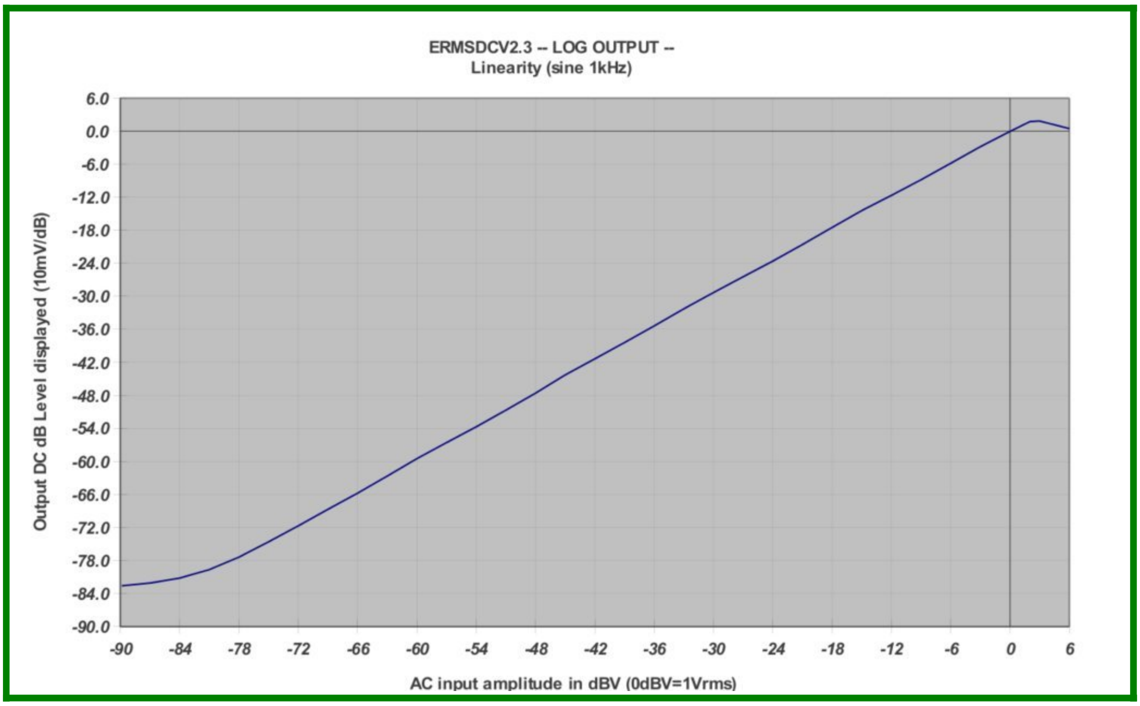


Note that all measurements i have done has been made with precision calibrated DC voltmeter and DC generator.

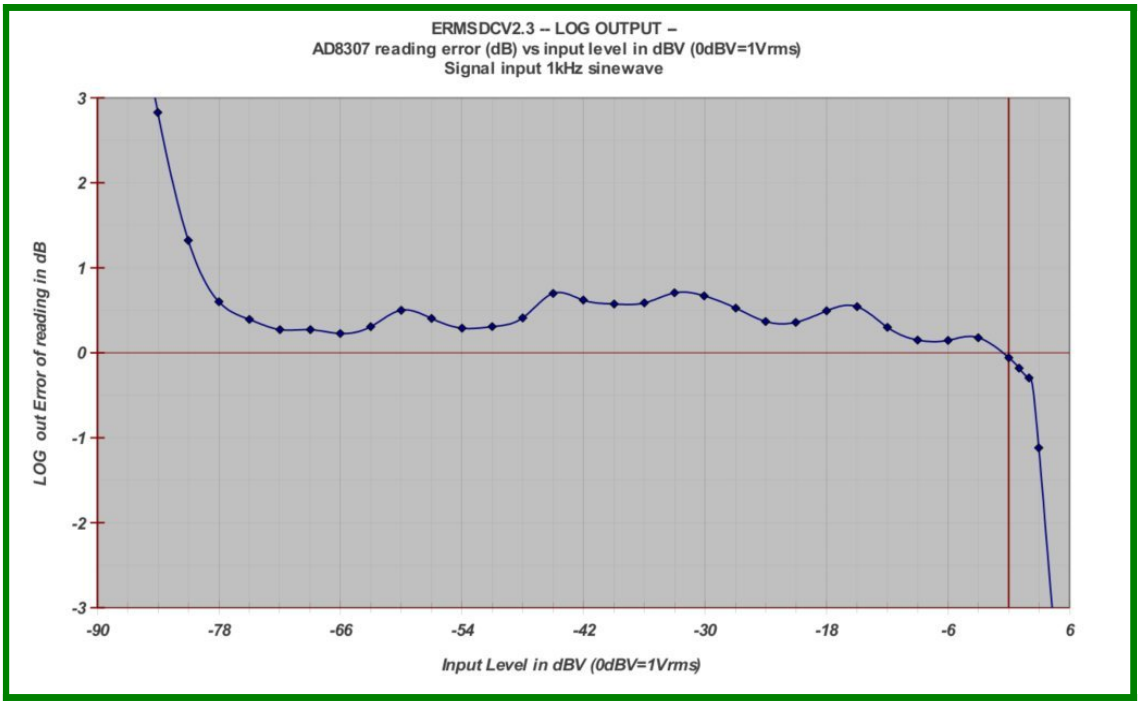
3) Logarithmic AC voltmeter output

Note: To test the log voltmeter output, the input signal must be very very low, so i use precision shielded passive voltage divider to get the right input level.

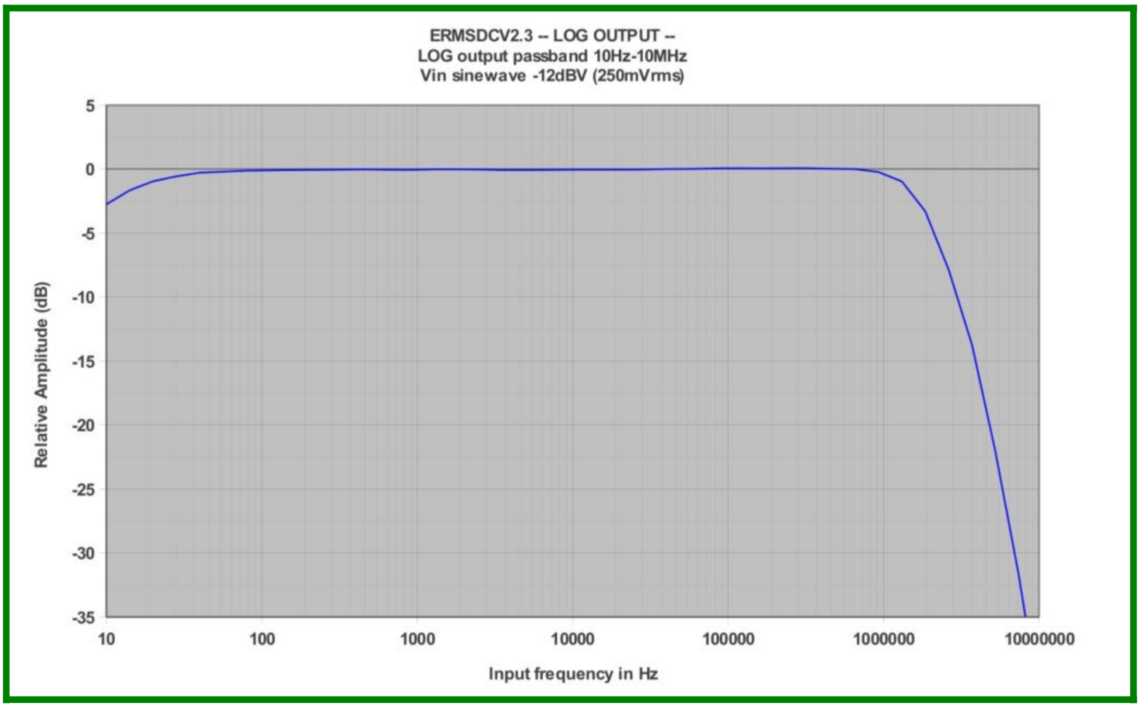
3.1) Linearity test.



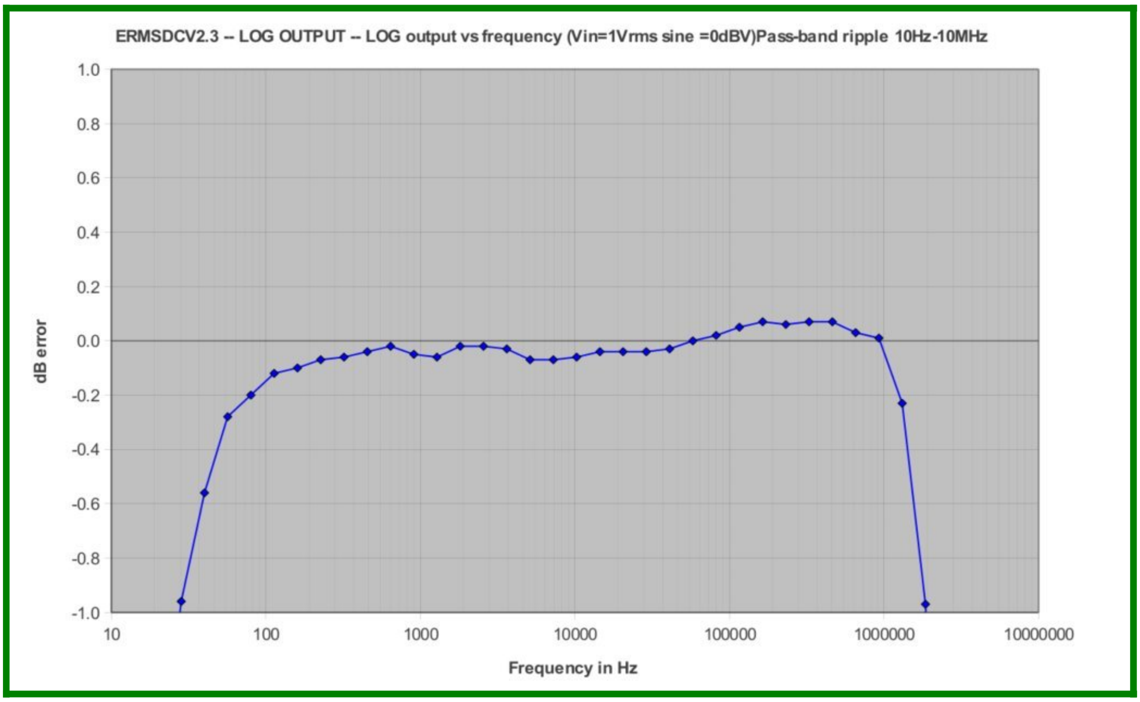
3.2) Measurement error test.



3.3) Log output frequency response test.



3.4) Log output frequency response test, zoomed view of the previous graph.

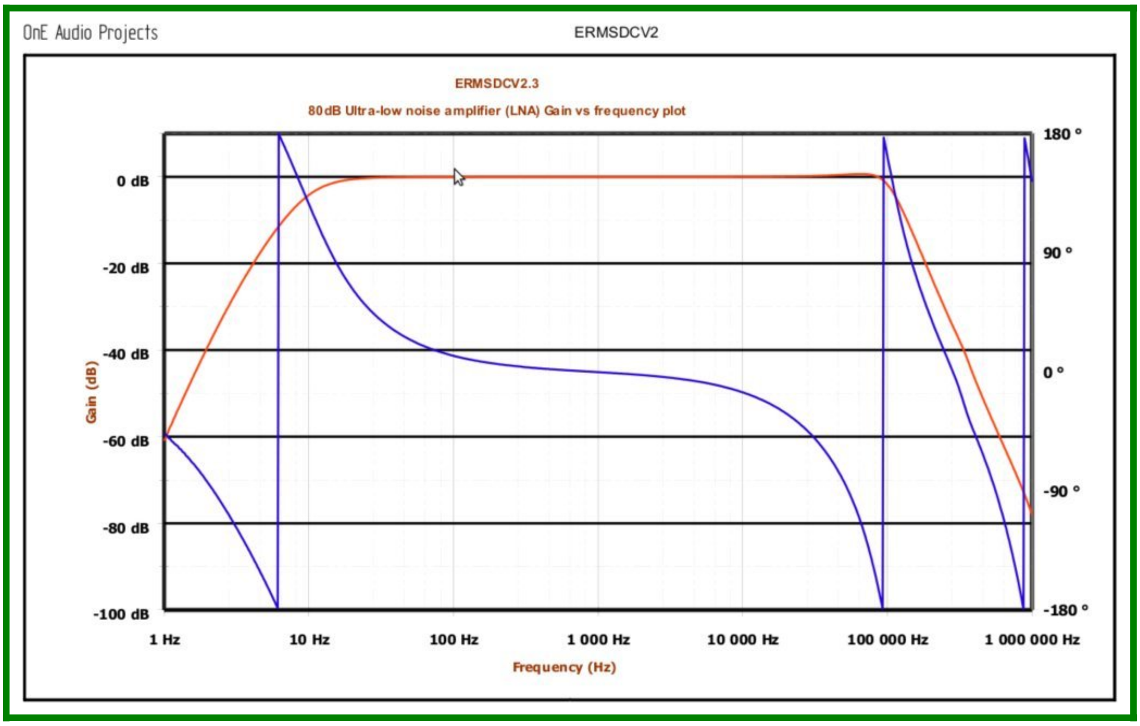


The front-end of the LOG voltmeter(U16-U12)) use an OPA627 followed by an AD817. The noise floor of the log voltmeter depend largely of the noise of these two IC.

On my design, with 0dBV calibrated to 1Vrms, i get a noise floor of about -84.5dBV (60µV). The AD8307 noise floor is about -90dBV. As you see the frequency flatness is about +/-0.1dB in 100Hz to 1MHz range !

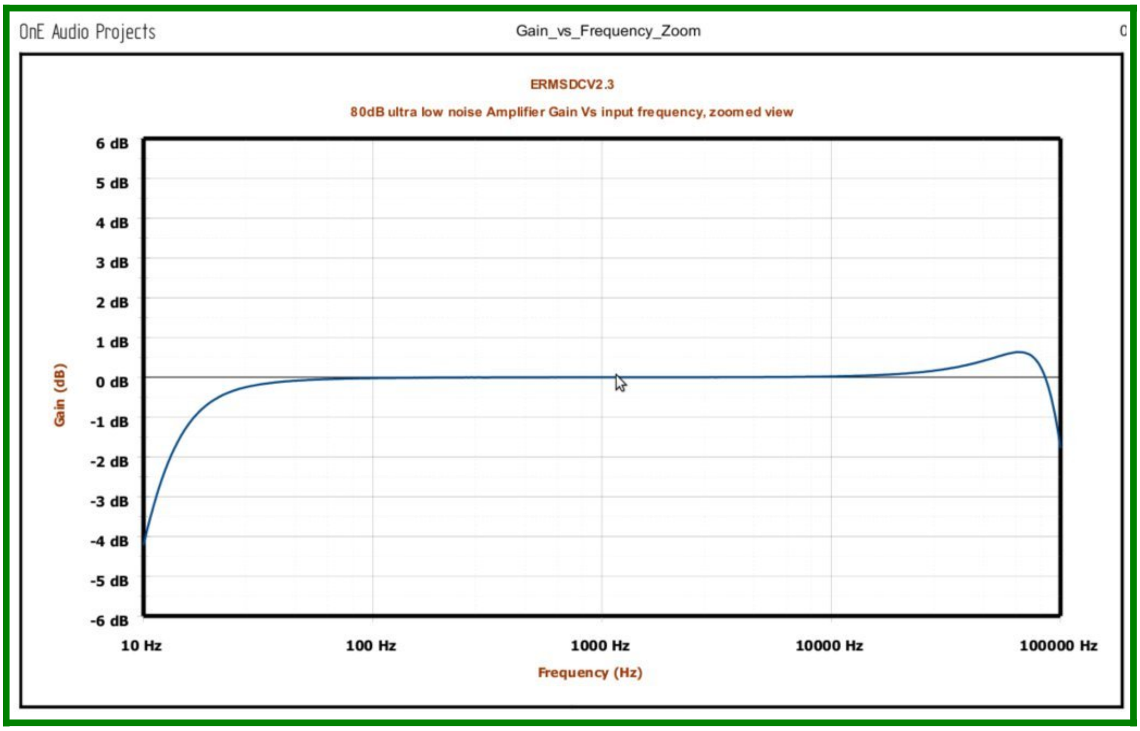
4) 10Hz..100kHz low noise amplifier.

4.1) LNA frequency response test (normalized).



Vin=100μVrms, Red= Gain ,Blue=Phase

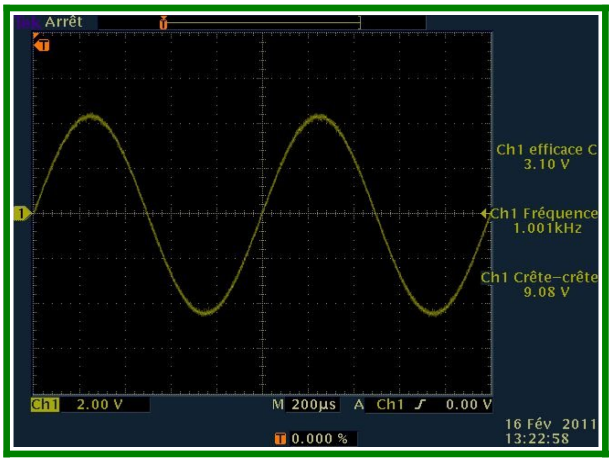
4.2) LNA frequency response test, zoomed view (normalized).



(Vin=100μVrms).

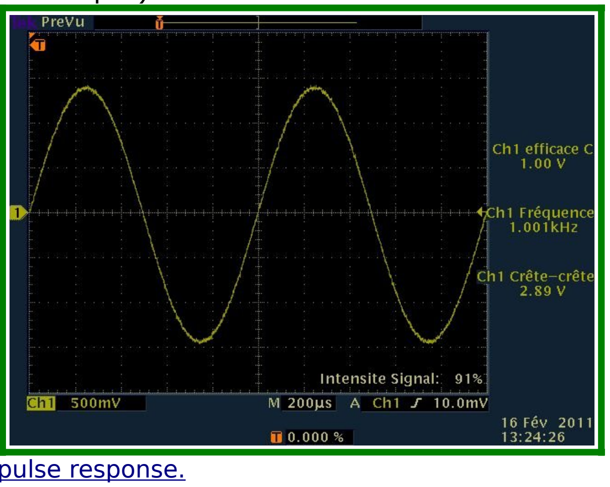
4.3) LNA maximum output voltage before saturate.

(Vin=310µVrms Yellow=LNA output).



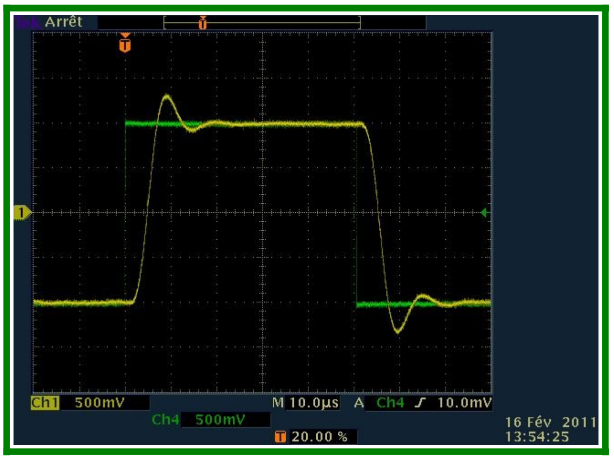
4.4) LNA output voltage for 100µV 1kHz sine wave input.

(Vin=310µVrms Yellow=LNA output).



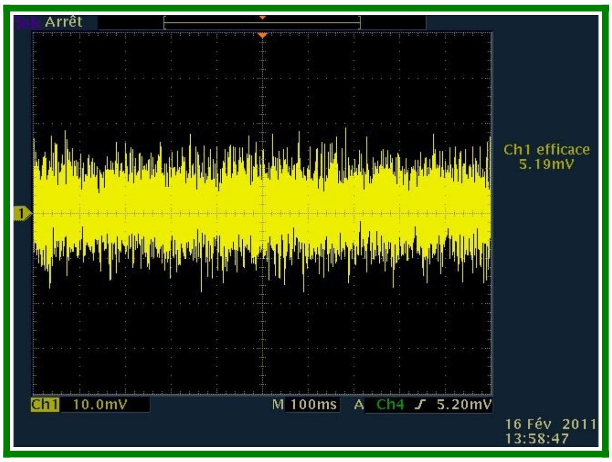
4.5) LNA pulse response.

(Vin=+/-100µV 10kHz square wave Green=signal input before attenuator Yellow=LNA output). This test show clean response of the Butterworth fifth order low pass filter.



4.6) LNA noise floor.

(No signal, 50 Ohms plug on LNA input, Yellow=LNA output).
This signal show the own output noise of the LNA This represent about 520nV RTI (Referred To Input). It's mainly the noise of input OPAMPs, this is why they must have very good noise specs.



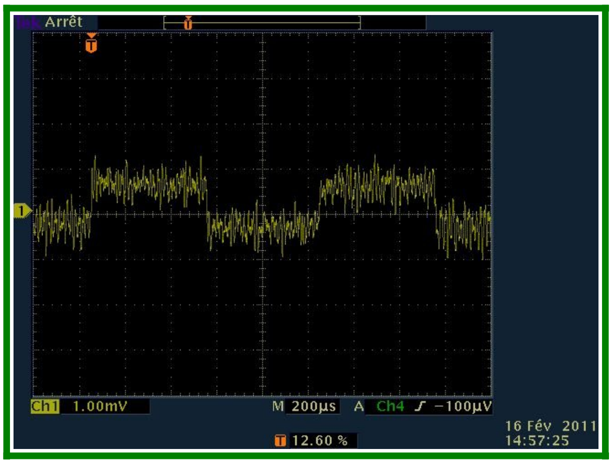
4.7) LNA low level signal reconstruction.

Vin=500nV 1kHz sine wave (Green=signal input before attenuator Yellow=LNA output).

Using the scope digital averaging to eliminate the uncorrelated noise, you can show clearly a sine wave signal as small as 500nVrms.
The 50mV (green trace) is attenuated by 100dB (1/100000) before to go at LNA input.

4.8) LNA Ultra low level signal reconstruction.

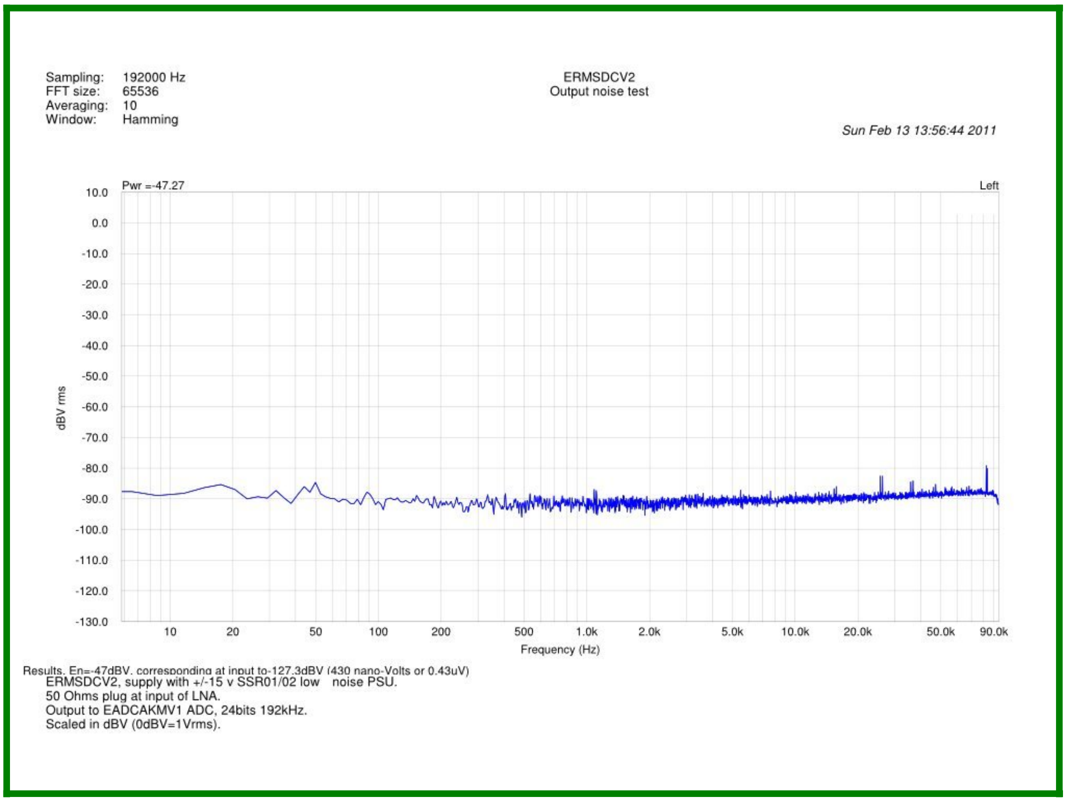
(Vin=100nV 1kHz square wave Yellow=LNA output).
Here, it's same as previous screenshot, with 100nV pk-pk square wave signal and scope digital averaging.



4.9) LNA noise floor spectral view.

No signal, 50 Ohms plug on LNA input, Blue=LNA output spectrum.
Here, the full output spectrum of the LNA output noise. The noise is very flat in all bandwidth, showing white noise type. No visible harmonics of main (50/60Hz and multiples) and no spurious.

The ADC show a RMS level of -47.27dBV that correspond to about 4.33mVrms. (433nV RTI). Roughly the same measurement value done with scope on § 4.6).



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