NOISE PERFORMANCE OF THE

SADC20 A/D CONVERTER

and

4.5Hz geophone with nominal sensitivity 80 V/m/s
2.0Hz geophone with nominal sensitivity with 78 V/m/s
2.0Hz geophone with nominal sensitivity 200 V/m/s

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Introduction

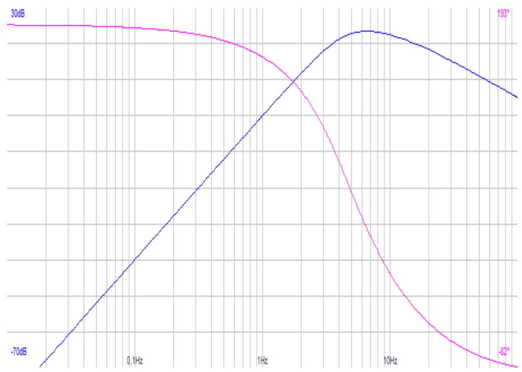
Users often asks regarding the lowest signal level that can be resolved with the SADC20 A/D converter with geophones. Since there it is not possible to describe the behaviour of a complete system with an unique number this document is prepared to explain the frequency noise response of three different systems composed by an SADC20 (SR04/SL06 digitizer recorder) and using:

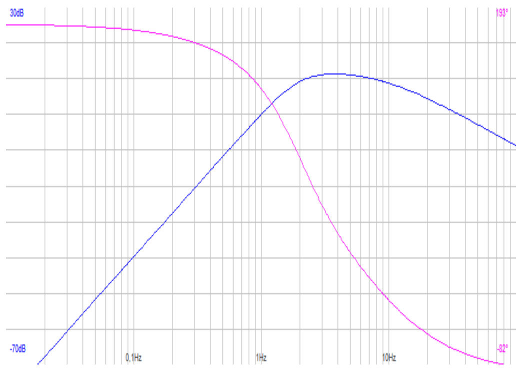
- 4.5 Hz sensor with nominal sensitivity of 80 V/m/s
- 2.0 Hz sensor with nominal sensitivity of 78 V/m/s
- 2.0 Hz sensor with nominal sensitivity of 200 V/m/s

Test procedure

A dataset of instrumental noise has been recorded with a SADC20 converter board with input shorted with a resistor of 4000 ohm; this match the output impedance of the 4.5Hz sensor of 4000 ohm, and which is very similar to the other sensor output impedance respectively of 3810 ohm and 5500 ohms.

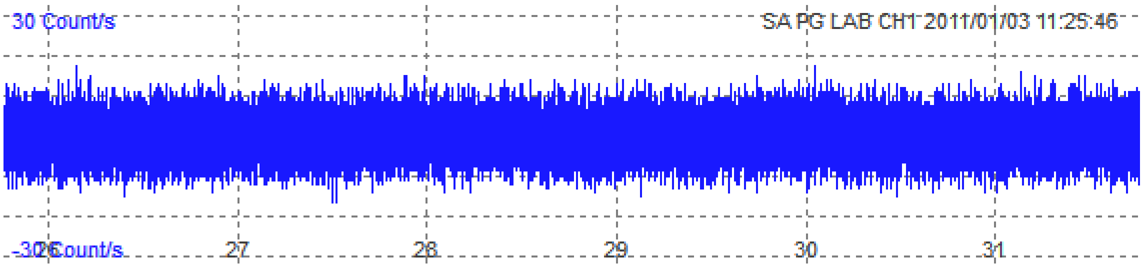
At the same time a system transfer function has been computed for both setup considering a sensitivity of 2 V full range of the a/d converter which dividing for 2^24 numbers of divisions give a bit weight of 119nV. The following pictures shows the system response for both cases. Left 4.5Hz, right 2.0Hz geophone.





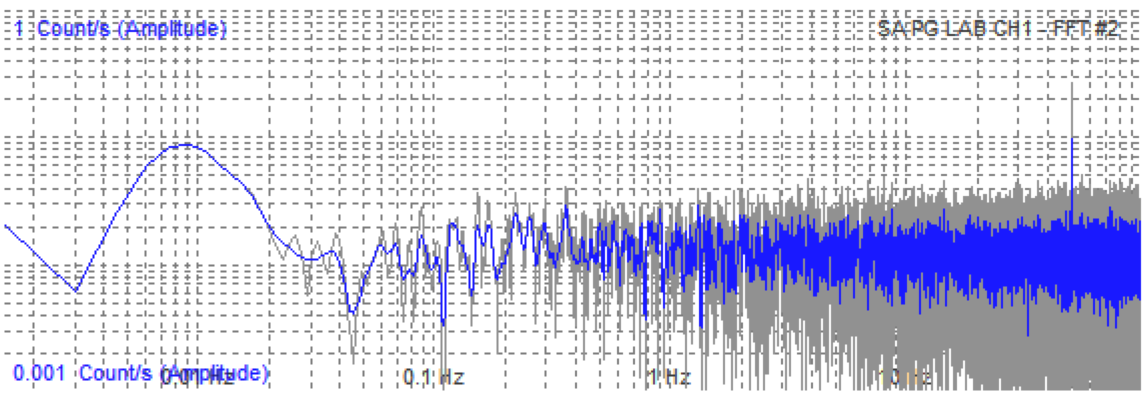
Plot is normalized a 0dB (unity gain) at 1Hz. Please notice that the right plot (referred to the 2Hz sensor) only apparently has not a lower sensitivity of 10dB because of the frequency normalization at 1Hz. Both geophones are considered to have a 0.707 critical damping.

The following picture show the used dataset.



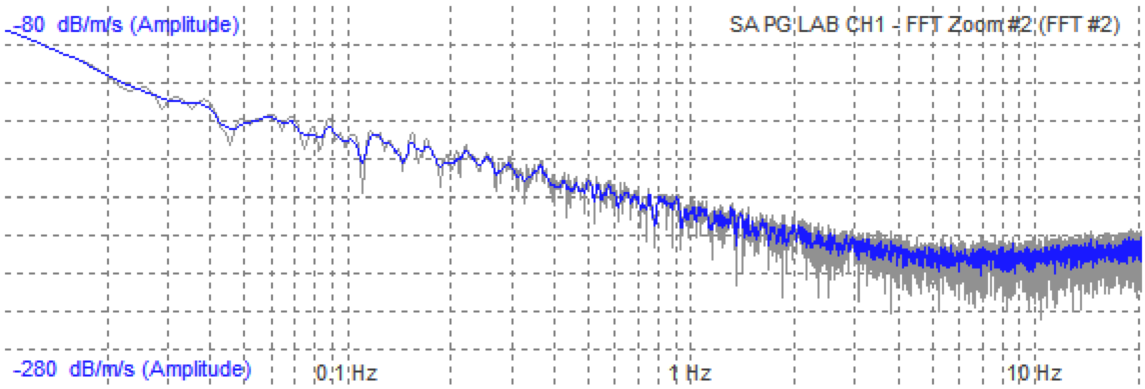
Sampling rate is 200Hz, time series noise results in 21 counts p-p RMS equivalent to a 118dB of absolute dynamic range.

Frequency domain analysis has been accomplished using a Blackmann windowing with right zero pad of the time series. The resulting FFT is showed in the following diagram. A little 50Hz noise grid contribution is visible.

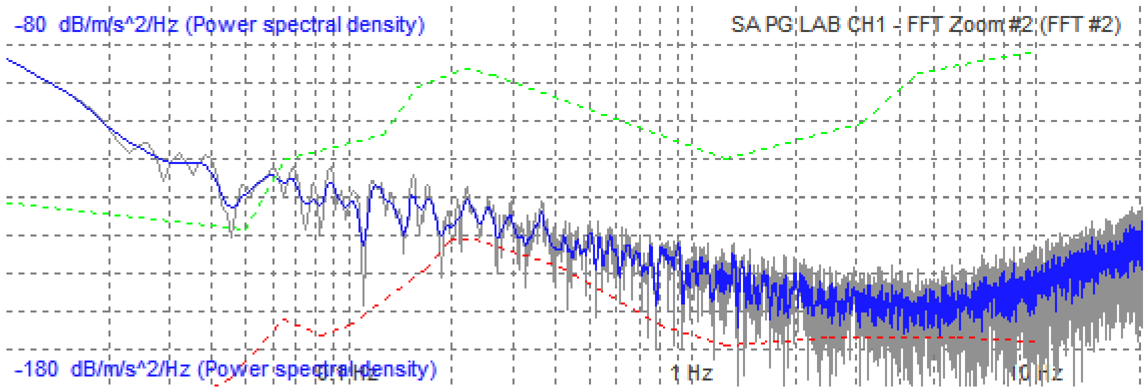


The FFT output is in counts over a log grid showing how the noise is distributed basicly equally on all frequency band for which the SADC20 is designed (0.1Hz – 30Hz).

The following diagram result applying the 4.5 Hz – 4000 ohm coil geophone

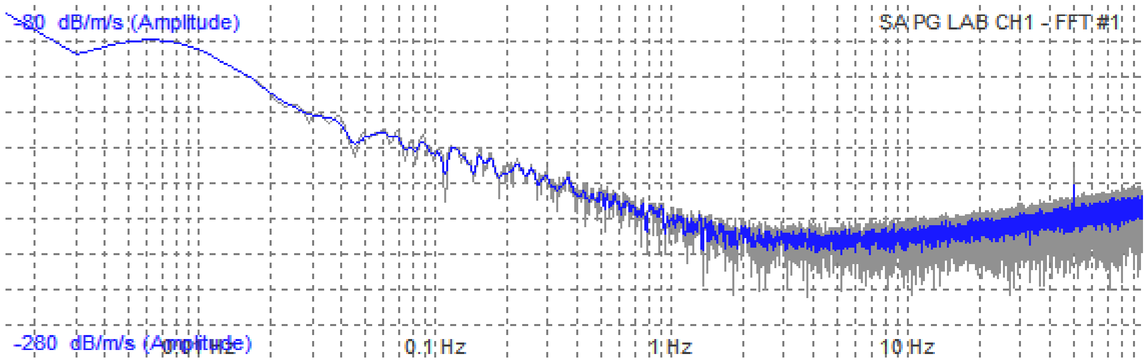


If compared to the global noise model the signal have to be corrected for acceleration and plotted in power spectral densitiy in respect of 1 m/s/s of acceleration.

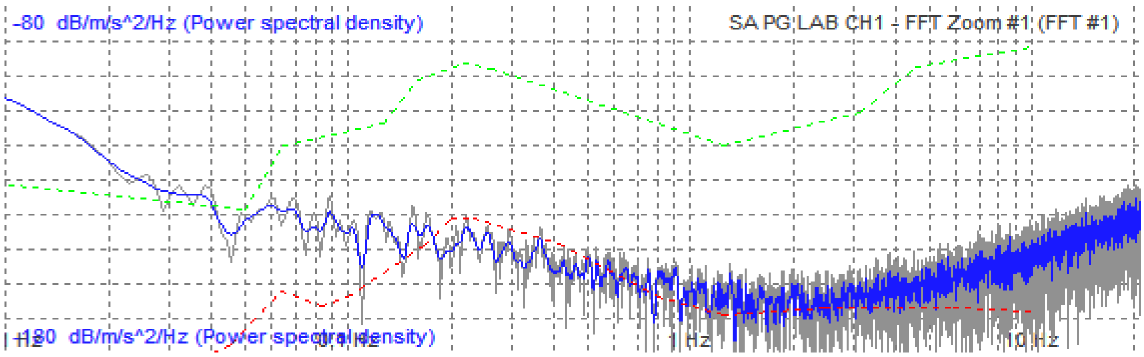


In this case the 4.5Hz geophone is near to resolve the Low Noise Model down to 0.2Hz (5 seconds).

The same dataset can be applied to a 2Hz sensor considering it transfer function. Here the plot for a 2Hz, 78 V/m/s geophone.

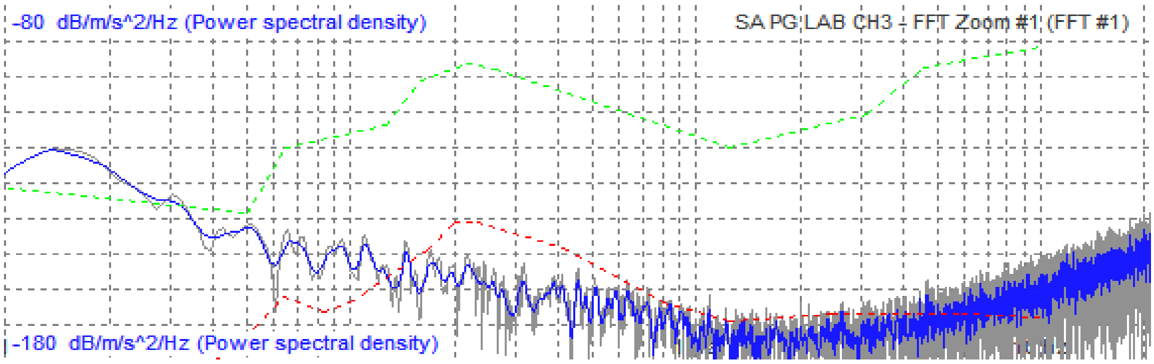


The following chart show the instrumental noise compared to the global noise model



In this case the system take benefit of the lower resonance frequency of the geophone (2Hz instead of 4.5Hz) and thus an higher sensitivity below 4.5Hz which results in a better global resolution which give a possibility to stay near to the lower global noise model down to 0.1Hz.

A third plot can be considered using an higher sensitivity geophones available now (from january 2012) at SARA which has a nominal sensitivity of 200 V/m/s.



In this case the results is in a lower noise level with higher resolution which bring the system to the range of an extended band seismometer capable to resolve near the Low Noise Model at frequencies lower than 0.1Hz.

Conclusions

SADC20 board have excellent results at low frequencies and exceptional performance used in combination with relatively high impedance geophones of about 4000 ohm. This key feature allow the use of standard, cheap and robust geophones (4.5Hz, 2.0Hz resonance frequency) with good results for both earthquake monitoring, structure vibration monitoring and site noise surveys.