New High-Resolution ADC Development for HL-LHC

“HPM-7177”

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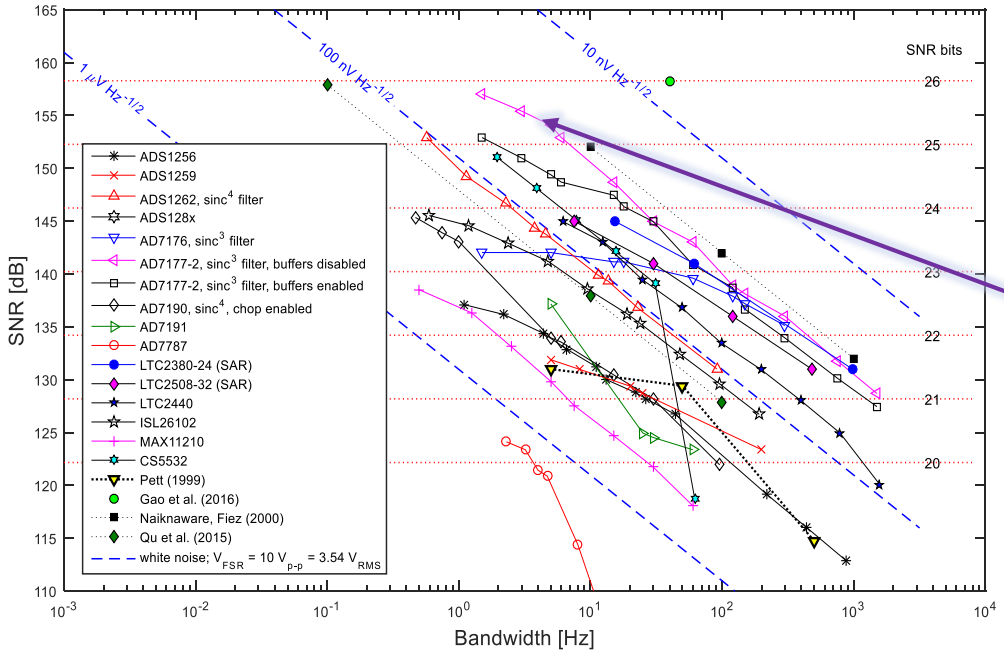
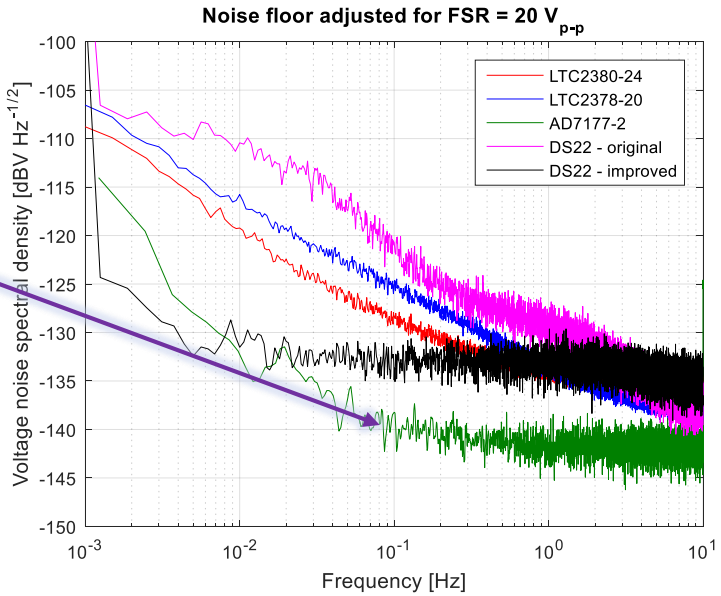
26.04.2017

ADC Selection

- Preliminary study: tens of commercial ADCs considered (≥24 bits)
- ➢ EDMS 1845562 v.1 - extended report
- ➢ conference paper to be presented on 14.05.2018 at I2MTC (Houston, TX)
- short list – SAR ADCs by Linear (LTC23xx), AD7177-2
- Ongoing tests in a dedicated high-resolution ADC tester



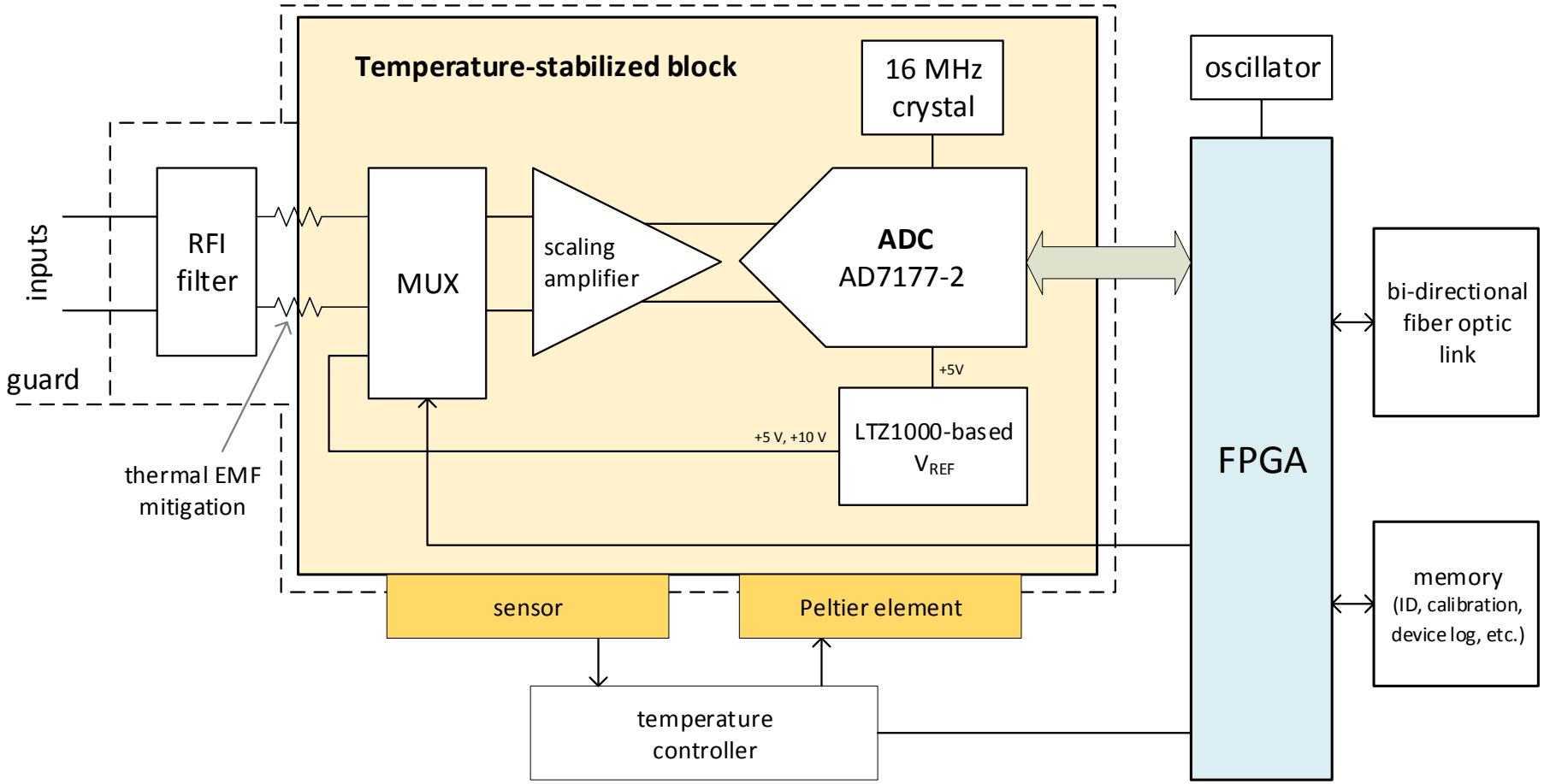


Very good agreement so far

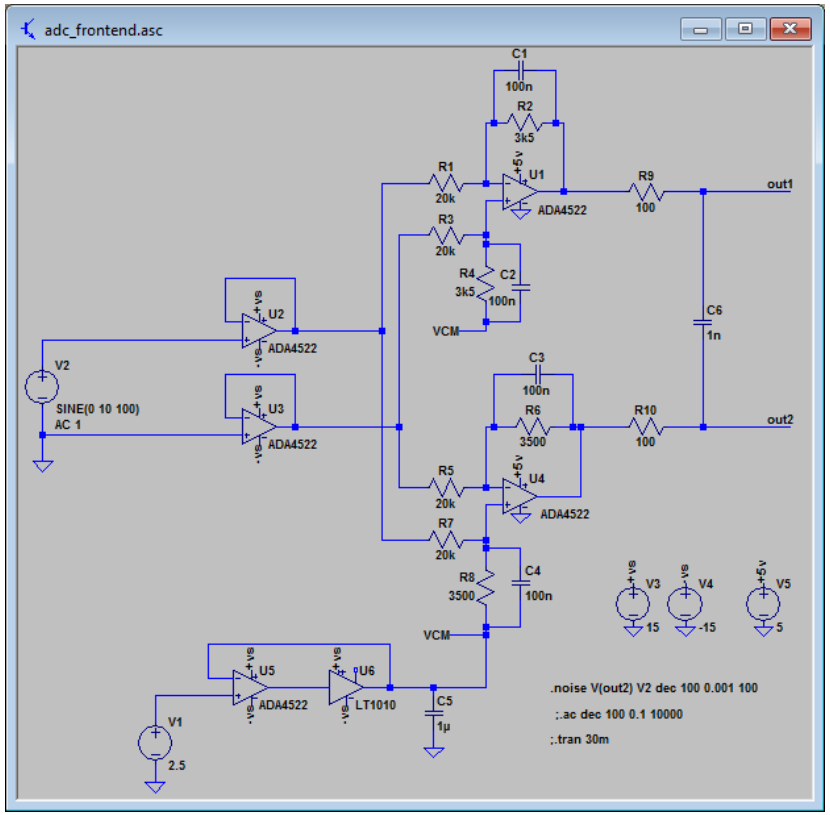
Concept

- Compact ADC mezzanine module
- Commercial ADC – AD7177-2
- Precision scaling amplifier built of ADA4522 and Vishay hermetic R array
- Balanced differential inputs for high CMRR
- LTZ1000 voltage reference with improved conditioning circuit (Vishay R array)
- Excellent thermal management – temperature stabilization at the mK level. Drift <<0.1 ppm/ºC
- Local FPGA, bi-directional optical link to FGC
- ID, Self-check, diagnostics and self-calibration

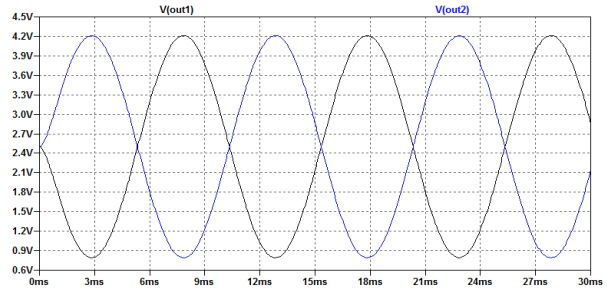
Block diagram



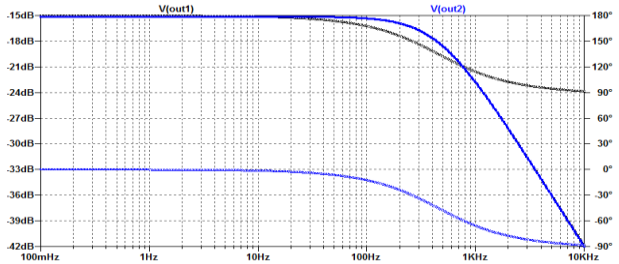
Simulations – Scaling amplifier



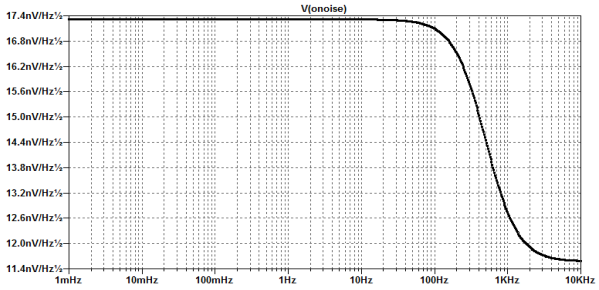
The most symmetric circuit possible – FDA built of separate amplifiers



Differential input range
±13.4 V



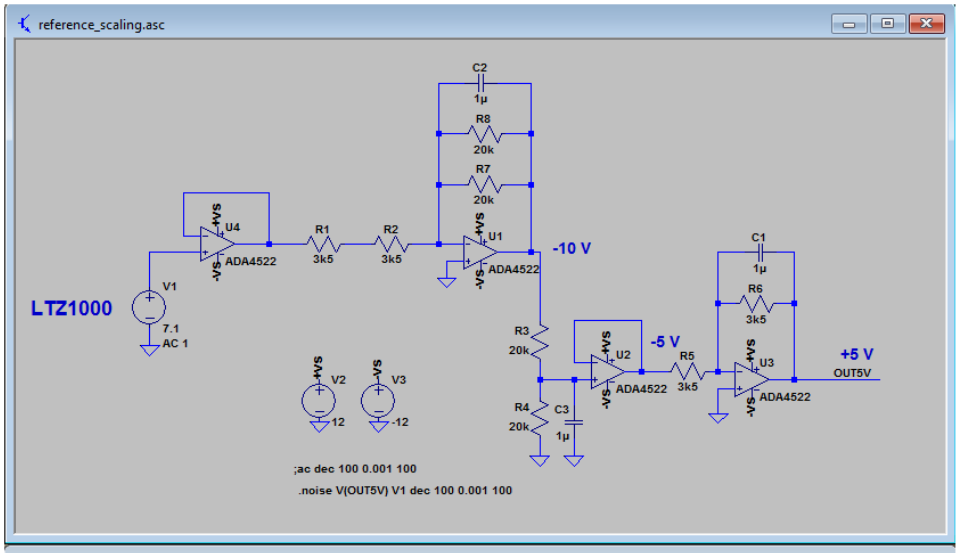
-3 dB BW
500 Hz

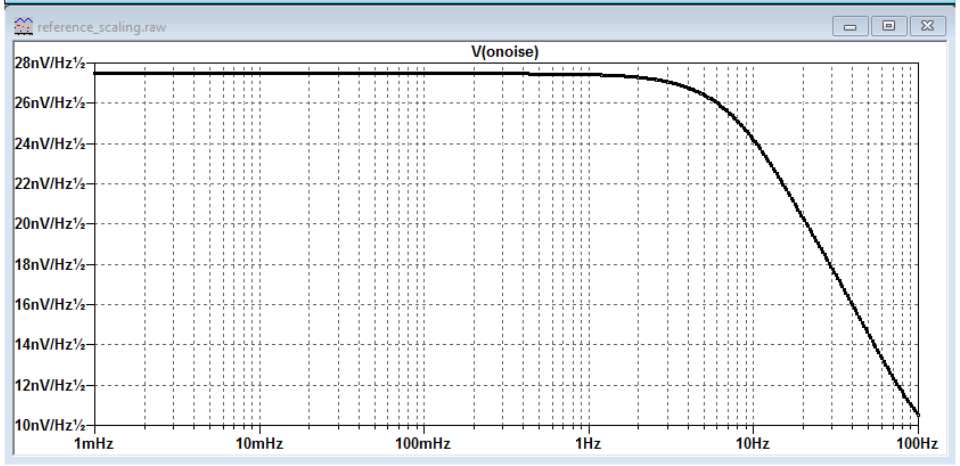


White noise
≈25 nV $Hz^{-1/2}$
(at differential ADC input)
≈70 nV $Hz^{-1/2}$ RTI (diff.)

lower than ADC noise

Simulations – Reference scaling



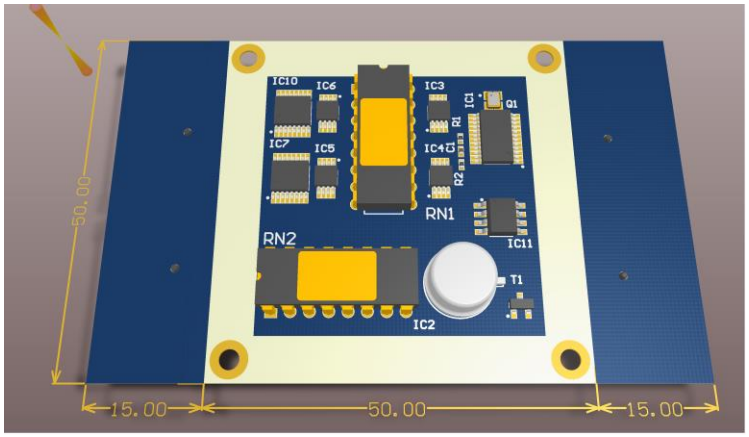


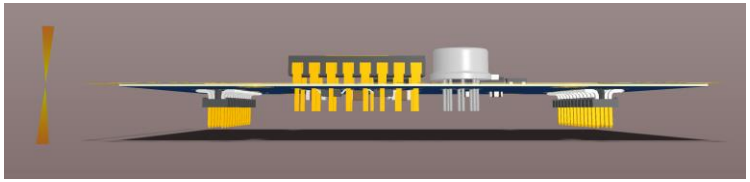
This circuit uses exactly the same resistor array (3K5-20K) for scaling the LTZ1000 Zener voltage.

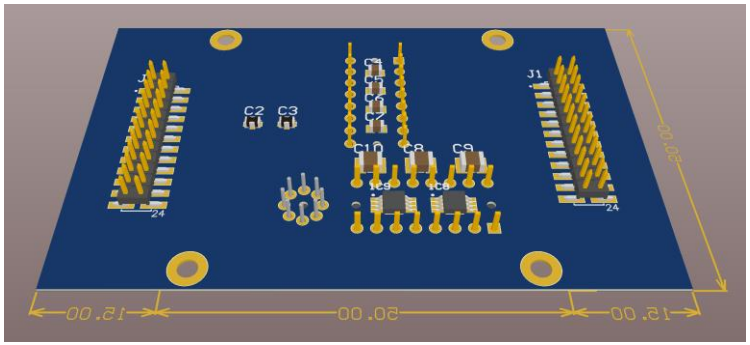
It generates +5V, -5V and -10 V that can be used for self-calibration at ±5 and ±10 V

Output noise is lower than the ADC noise; 1/f will be entirely due to the LTZ1000.

Mock-up design







Top side

- ADC, op amps
- 2x resistor arrays – Vishay 1446
- LTZ1000
- Temperature sensor (not shown)
- Lid/enclosure (not shown)

Side view

R arrays, LTZ1000 and temperature sensor - top surfaces should be flat

Bottom side

More real estate for components; maybe a low-profile shielding lid

Comparison against DS22 (*preliminary*)

	DS22 (improved)	HPM-7177
PCB size	82x145 mm	50x70 mm
Number of components	>220	<80
Idle tones	<130 dBFS around 0V	none
Inputs	Pseudo-differential, non-balanced	Fully differential, balanced
Offset/gain drift	<0.1 ppm/°C	<0.01 ppm/°C
RTI noise (>10 Hz)	200 nV $Hz^{-1/2}$	140 nV $Hz^{-1/2}$
RTI noise (<1 Hz)	300 nV $Hz^{-1/2}$	140 nV $Hz^{-1/2}$
Self-calibration, remote diagnostics, etc.	no	yes
Design documentation	CERN only	open under CERN OHL

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