Characterisation of a wideband digitiser for power measurements up to 1 MHz

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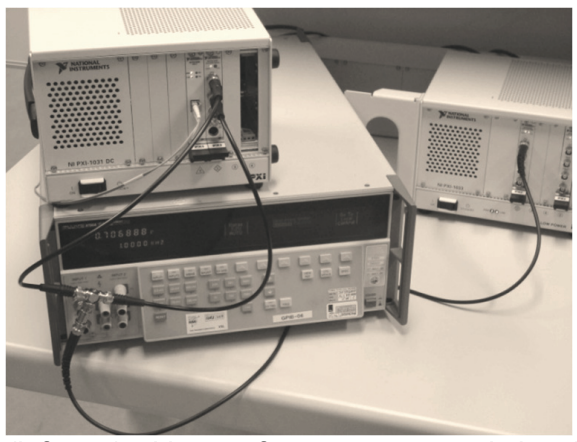
Abstract **A two-channel high-speed digitizer is extensively characterized in the frequency range of 50 Hz to 1 MHz. The measurements involve ac flatness, phase, linearity, input impedance and the effects of dc offsets, temperature, and internal self-calibration routine.**
The overall uncertainty contribution of the digitiser in wideband power measurements under practical circumstances is not more than 70 μW/VA and 400 μW/VA (*k* = 1) at 10 kHz and 1 MHz respectively.

Digitiser

NI PXI-5922 two-channel digitizer

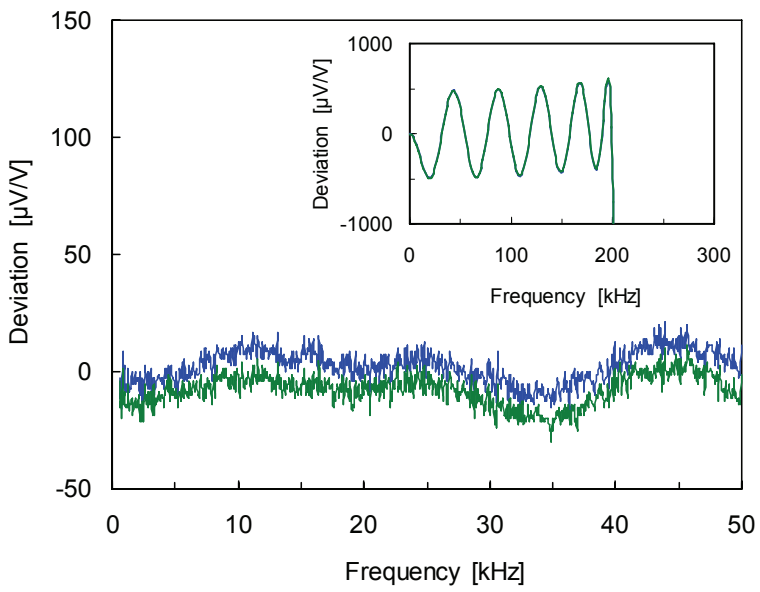
- 2 V_{pp} and 10 V_{pp} ranges, with 1 MΩ input impedance.
- 100 kSa/s – 10 kHz, 1 MSa/s – 100 kHz, 10 MSa/s – 1 MHz
- 24 bit (100 kSa/s) – 18 bit (10 Msa/s).

Characterisation set-up



Digitiser (left, top) with ac reference meter and signal source.

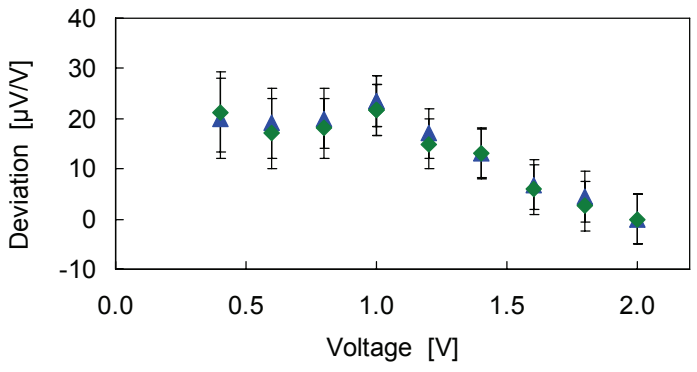
Frequency response



Flat frequency response for 0.7 V_{rms} signal in 2 V_{pp} range, via inverse compensation filter: 51 tap FIR filter for f_{sa} < 1 MSa/s.

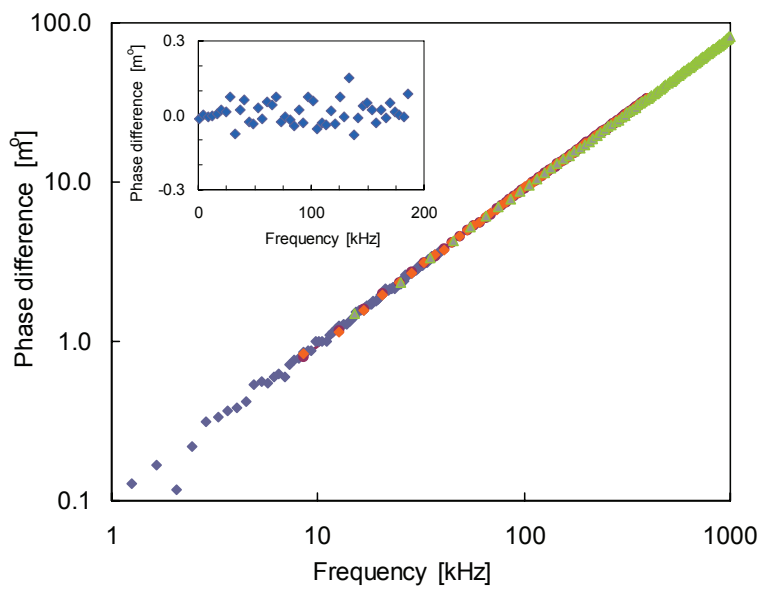
- improvement of factor 25 w.r.t. original response (< 25 μV/V)
- inverse filter independent of f_{sa} for f_{sa} < 1 MSa/s
- above 1 MSa/s separate filter; maximum deviation 100 μV/V

Linearity



Non-linearity for input signals of 50 – 100 % of full scale up to 1 MHz < (60 ± 30) μV/V for 2 V_{pp} range and < (30 ± 9) μV/V for 10 V_{pp} range.

Phase deviation



Phase deviation is linear in frequency and not affected by inverse filter (inset), f_{sa}, signal amplitude or signal phase.
Model: time delay of (250 ± 30) ps between channels for 2 V_{pp} range.

Additional effects

- *Input impedance* can be approximated by 1 MΩ // 55 pF, with the resistance being frequency dependent above 10 kHz.
- *Temperature coefficient* is significant: -35 μV/V/°C and –45 μV/V/°C respectively for the two channels in the 2 V_{pp} range
- Self-calibration routine: < 30 μV/V and < 0.5 m° variation at 1 MHz

Uncertainty budget 1 MHz power, phase 90°

		Distribution	σ [μW/VA]
Channel 0:	Calibration	Normal	150
	Stability	Uniform	35
	Flatness	Uniform	58
	Linearity	Uniform	35
	Self-calibration	Uniform	20
	Temperature	Uniform	14
Channel 1:	Calibration	Normal	150
	Stability	Uniform	35
	Flatness	Uniform	58
	Linearity	Uniform	35
	Self-calibration	Uniform	20
	Temperature	Uniform	14
Phase	Stability	Uniform	50
	Error correction	Uniform	91
	DC offset	Uniform	5
	Self-calibration	Uniform	7
	Combined Uncertainty:		355

At 10 kHz, typical total uncertainty is 67 μW/VA (best < 20 μW/VA)

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