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 $\mu$W/VA and 400 $\mu$W/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 M$\Omega$ 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.

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 M$\Omega$ // 55 pF, with the resistance being frequency dependent above 10 kHz.
- Temperature coefficient is significant: -35 $\mu$V/V/°C and -45 $\mu$V/V/°C respectively for the two channels in the 2 V_{pp} range
- Self-calibration routine: < 30 $\mu$V/V and < 0.5 m° variation at 1 MHz

Uncertainty budget 1 MHz power, phase 90°

<table>
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<th>Channel</th>
<th>Calibration</th>
<th>Stability</th>
<th>Flatness</th>
<th>Linearity</th>
<th>Self-calibration</th>
<th>Temperature</th>
<th>Phase</th>
<th>Error correction</th>
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355 Combined Uncertainty:

At 10 kHz, typical total uncertainty is 67 $\mu$W/VA (best < 20 $\mu$W/VA)

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