High performance digitizer and DC metrology meeting

Monday, 19 February 2024 - Monday, 19 February 2024

FEI STU, Bratislava

Book of Abstracts

Contents

1

Metrology and digitization for the highest accuracy class power converters in High Luminosity LHC at CERN

Author: Nikolai Beev[1]

[1] *CERN*

Corresponding Author: nikolai.beev@cern.ch

PART 1
I. Introduction
- What we do at CERN (in general, Electrical Power Converter group, High Precision Measurements section)
- The need for high precision + high dynamic range + stability
- Unique challenges - environment, reliability, maintainability, etc. Differences between a metrology lab and accelererator tunnel. Measurements for closed-loop control and real-time applications
- "The best digitizer"vs "the best trade-off": What is really needed in our case?
- The complete high precision measurement chain: from high current through low voltage to digital code
- Supporting the measurement chain: test and calibration infrastructure

II. Development of high-performance digitizers at CERN

- Development, deployment and use of DS22
- Other digitizers - FGC internal ADCs, PAM, PAMB, etc.
- From LHC to HL-LHC. New requirements and needs
- From DS22 to DS24. Upgrade of dipole circuits
- Evaluation of commercial ADC integrated circuits, comparison of relevant parameters

PART 2
III. HL-LHC Class 0. HPM7177

- The AD7177-2 ADC
- Building a digitizer around an ADC. A system-level view
- The input signal path. Fully differential circuits
- Supporting circuits and sub-systems. Module-level temperature stabilization
- Component level: precision resistors and resistor networks; stable capacitors; voltage references
- Interaction with other systems –connections, communication, EMC
- Sources of measurement error and uncertainty

IV. Proving digitizer performance

- The limits of classical metrology equipment. Performance limitations of buried Zeners
- Voltage calibration infrastructure at CERN
- Going beyond the specs –examples from CDC testing, cross-PSD estimation
- Going straight to the top –PJVS tests at PTB

2

Multi slope A/D converters. Why the 50 years old technology is still (the only one?) relevant for the highest performance applications? (FEI STU)

Author: Jaromir Sukuba[1]

[1] *FEI STU*

Corresponding Author: jaromir@jaromir.sk

- The talk will explain historic developments of integrating ADCs, from single-slope, through multi-slope to charge balance multi-slope types.
- Performance limitations of these ADCs will be explained, especially those relevant for metrological quality devices.
- Some arrangements of multi-slope integrating ADCs do have an overlap with sigma-delta ADCs.
- An outlook on ADC concepts other than integrating ones will close the talk.

3

Towards a true 8-digit digitiser –EU Project overview and progress

Author: Rado Lapuh[1]

[1] *Left Right s.p.*

Corresponding Author: rado.lapuh@leftright.eu

The True8DIGIT project addresses the development of a digitiser based on state-of-the-art analogue-to-digital converters (ADCs), operating from direct current (DC) to 100 kHz, meeting the demands for linearity, noise, and overall accuracy of high-level measurement applications that cannot be met using currently available digitisers.
True8DIGIT project is framed as precursor to a more extensive project. The present project will provide the foundation for such a follow-on project by performing proof-of-concept investigations and by developing the required metrological tools.
The three-year capacity building project started in June 2023 and has already achieved first results.

4

Welcome address

Author: Daniel Valuch[1]

[1] *CERN*

Corresponding Author: daniel.valuch@cern.ch

5

Voltage references, voltage standards and Josephson voltage standards (PTB)

Author: Luis Palafox[1]

[1] *PTB (Physikalisch-Technische Bundesanstalt)*

Corresponding Author: luis.palafox@ptb.de

When a digitizer or an Analogue to Digital converter (ADC) is used to measure voltage, a fundamental contribution to the quality and stability of the measurement is the voltage reference used for that measurement.
Semiconductor manufacturers specify ADCs as a “stand alone”component, but a high-resolution digitizer combines, or is limited by, the performance of the ADC and the voltage reference employed.
After an introduction to the Allan deviation concept and its use in electrical metrology, typical voltage references will be reviewed.
Performance of semiconductor based voltage standards will be covered, leading to voltage standards based on the Josephson effect providing the realization of the SI unit Volt.
An overview of DC voltage metrology will finish the talk.

6

Discussion

7

Discussion

8

Discussion and closing