21 April MeterEMI final workshop

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

A Testbed for Static Electricity Meter Testing

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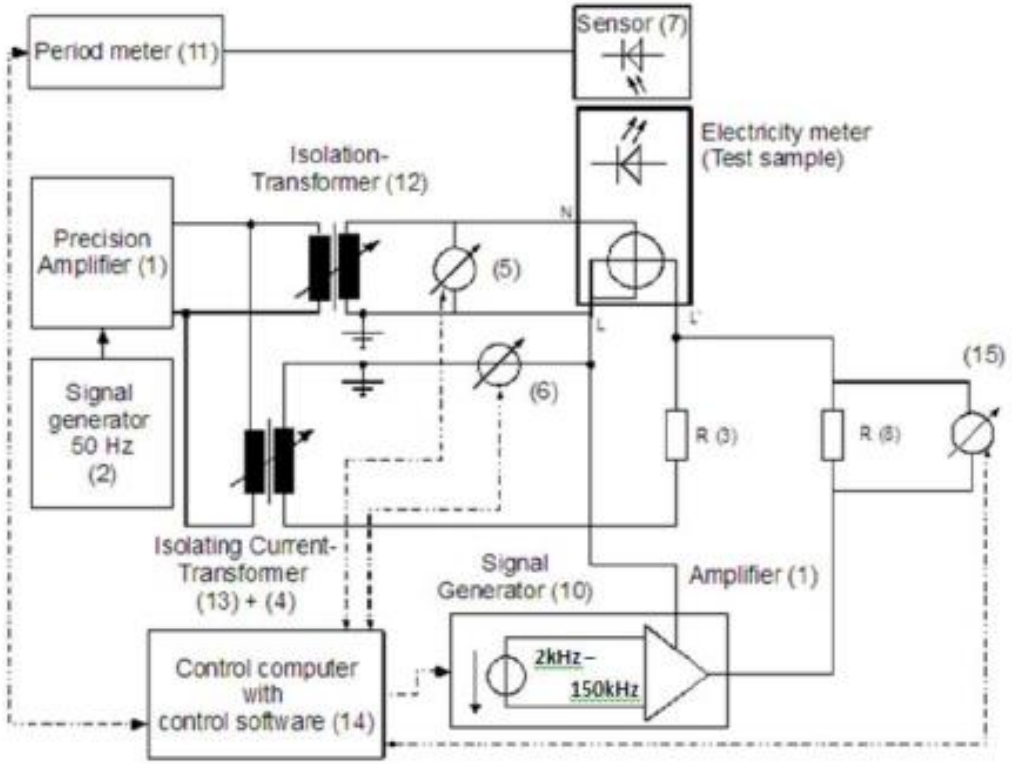
VSL – Dutch Metrology Institute

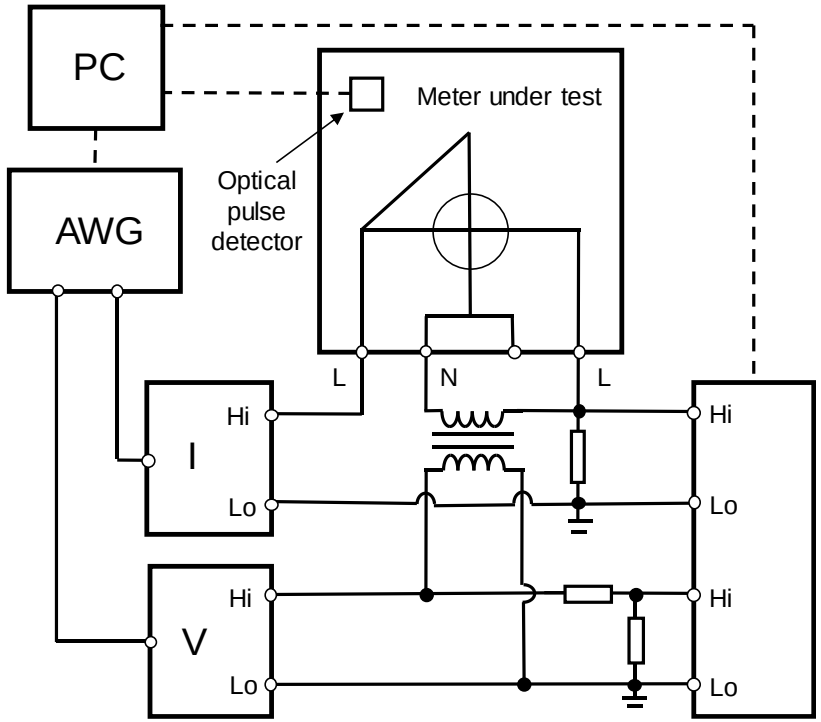
Dutch Metrology Institute

Possible Future Test Beds for Meter Approval



IEC 61000-4-19 mixed signal approach, distortion added separately (METAS and CMI)

New phantom power rig: direct generation of arbitrary current waveforms (VSL and NPL)



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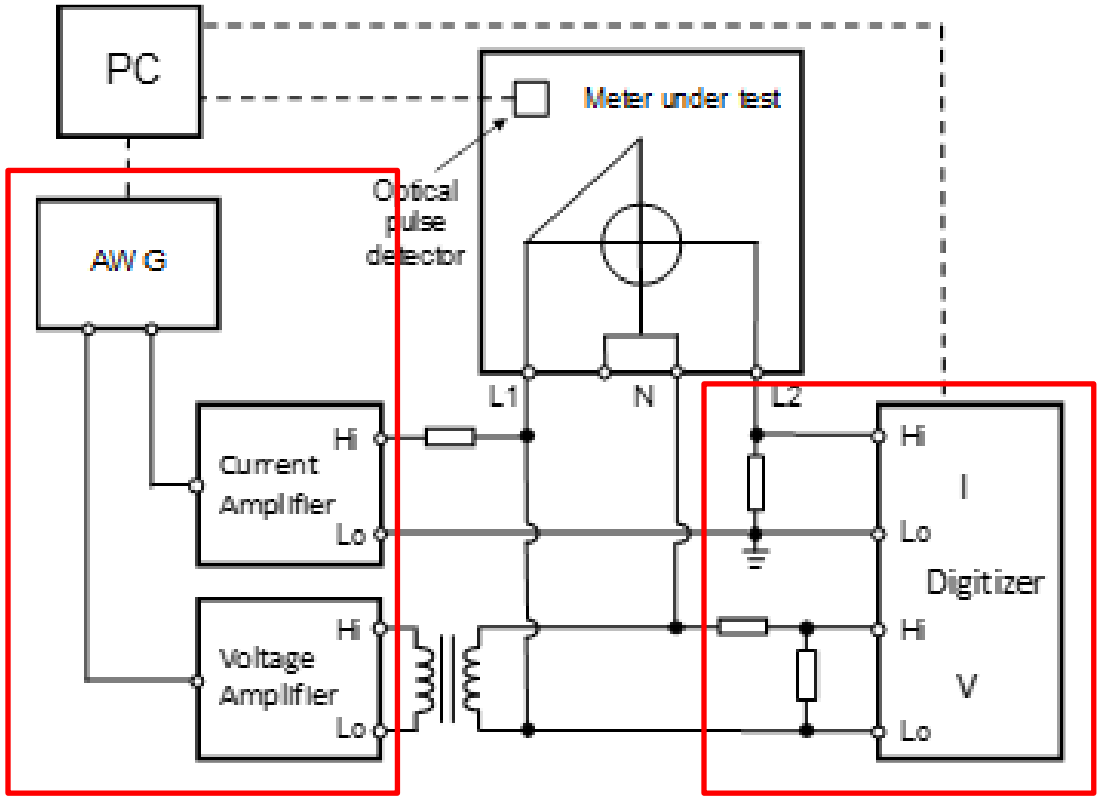
Specifications Arbitrary Waveform Testbed

- Designed for accurate and reproducible testing of meters
- Testing without using actual loads
- The testbed was designed with the following requirements in mind:
  - Single phase application
  - Energy Accuracy better than 0.1 %
  - Generation of test signals up to 50 A in peak amplitude and with frequency components up to 150 kHz.
  - Generation of test signals up to 250 V and frequency components up to 150 kHz.

Schematic overview of VSL testbed

- VSL meter testbed
  - 2-channel AWG provides signal to amplifiers
  - Voltage amplifier isolated from DUT
  - Transconductance amplifier with Lo to ground
  - Calibrated 0.05 Ω high-precision broadband shunt
  - Calibrated 150:1 voltage divider
  - Calibrated isolated 16-bit, 1 MSa/s digitizers
  - Optical sensor E_p read out by PC



H.E. van den Brom, Z. Marais, D. Hoogenboom, R. van Leeuwen, and G. Rietveld, "A Testbed for Static Electricity Meter Testing with Conducted EMI", *EMC Europe*, Barcelona, Spain, 2019

- Energy *E(T)* and reading error ε:

$$E(T) = \int_0^T V(t) \cdot I(t)\, dt \quad \Rightarrow \quad \epsilon = \frac{E(T) - E_p}{E(T)}$$

- Total uncertainty (k=2) of 0.02 % for sinewaves, 0.5 % for all signals

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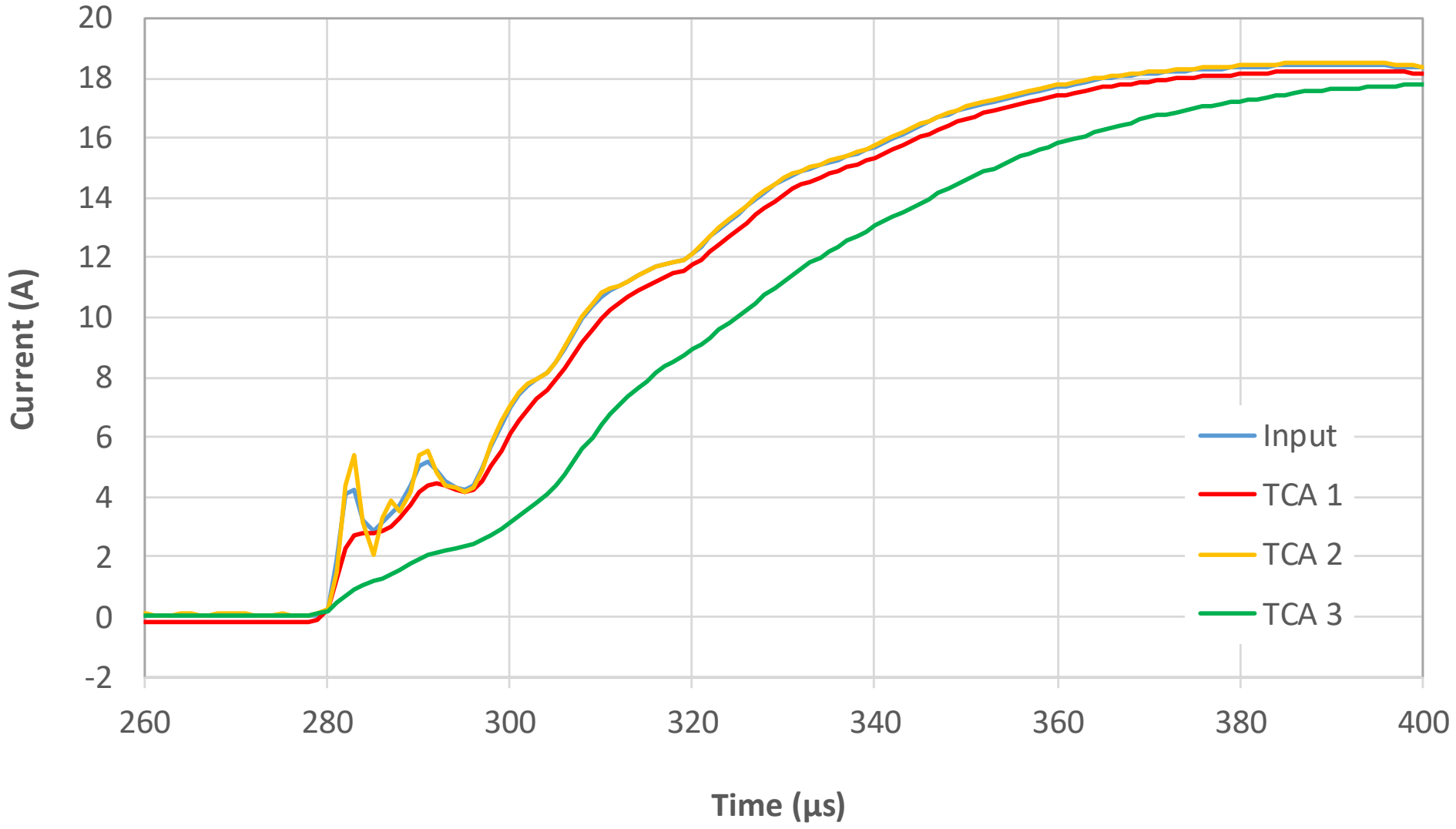
Current waveforms with TCA



Validation of testbed using faulty meter

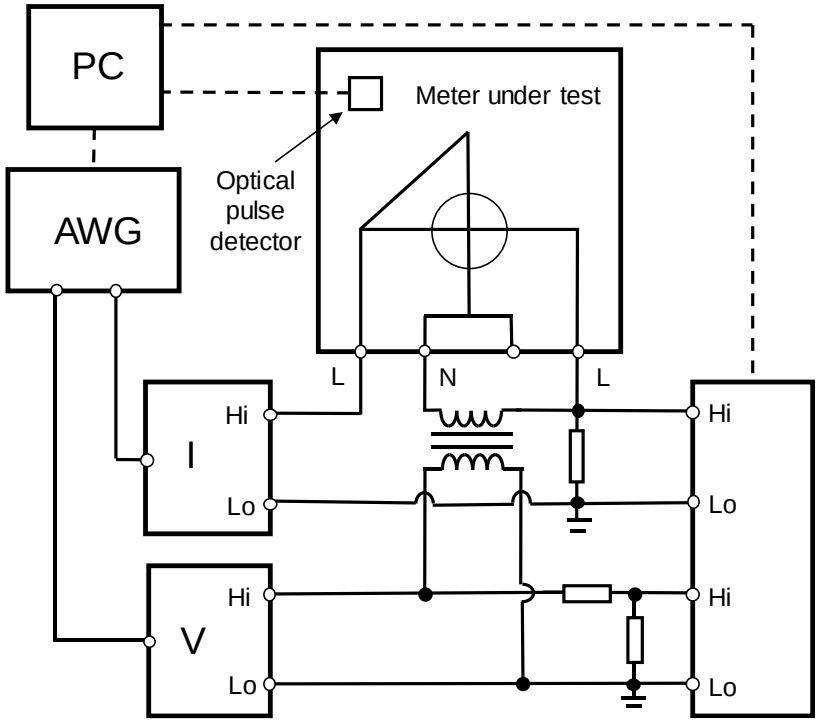
- Selected TCA2 for further testing
- Validation by comparing meter errors from testbed to original setup results
  - Sinusoidal voltage signal
  - R0 signal used as reference signal with negligible error
  - R75, CL75 and several water pump test signals used as reference with significant error

Applied waveform	Power (W)	Actual load error (%)	Testbed error (%)
R0	798	0.4	0.4
R75	148	51	46
CL75	297	136	142
WP4	34	1257	1261
WP4-M	35	1947	2038
WP9	67	145	143

Conclusions and outlook

- Developed new broadband phantom power testbed
  - Selected suitable high-power broadband TCA
  - Calibrated all components, overall uncertainty < 0.05 %
  - Validated using known faulty meter

- On-going and future work:
  - Testing of meters with real-world waveforms
  - Full uncertainty analysis on waveforms and energy content
  - Compare testbed to testbeds developed by other NMIs



$$E(T) = \int_0^T V(t) \cdot I(t)\, dt \ .$$

NPL Arbitrary Waveform Testbed

21/04/2021

Peter Davis

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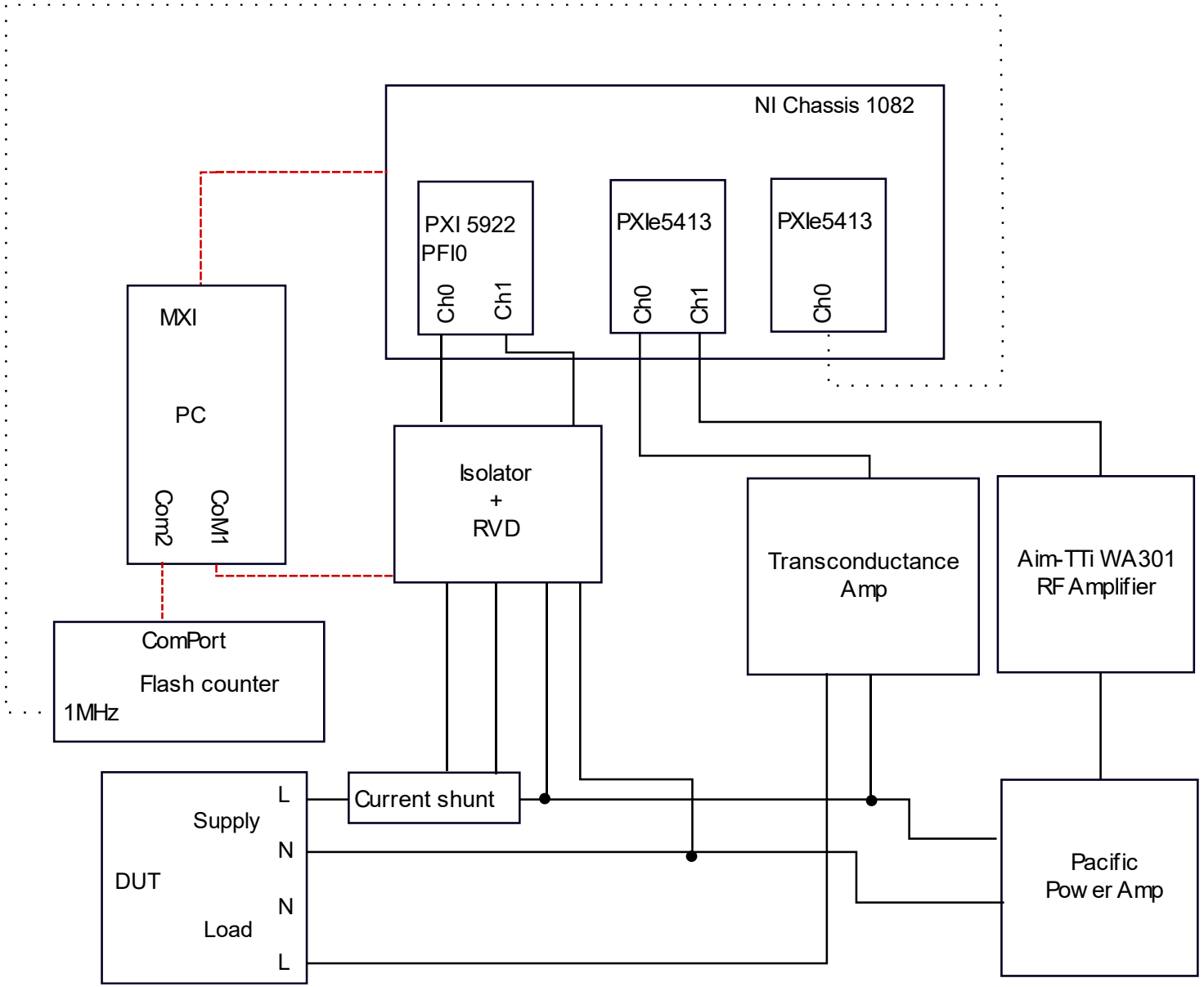
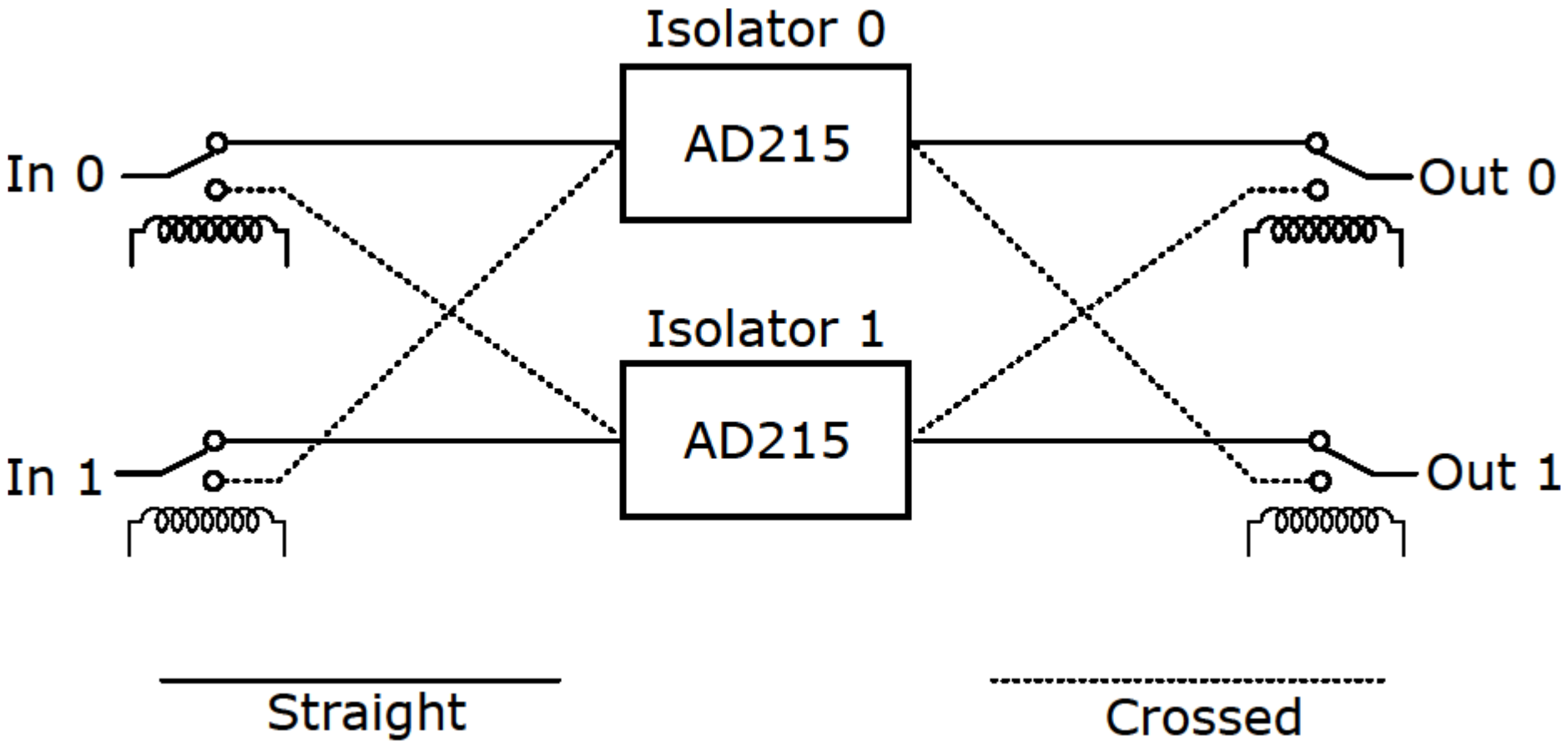
Introduction

- Description of NPL arbitrary waveform testbed
- Overview of isolator
- Uncertainty
- An ongoing comparisons results in progress

NPL system


NI Chassis 1082
PXI 5922
PFI0
Ch0
Ch1
PXIe5413
Ch0
Ch1
PXIe5413
Ch0
MXI
PC
Com2
CoM1
Isolator
+
RVD
Transconductance
Amp
Aim-TTi WA301
RF Amplifier
ComPort
Flash counter
1MHz
Current shunt
DUT
Supply
L
N
N
Load
L
Pacific
Pow er Amp

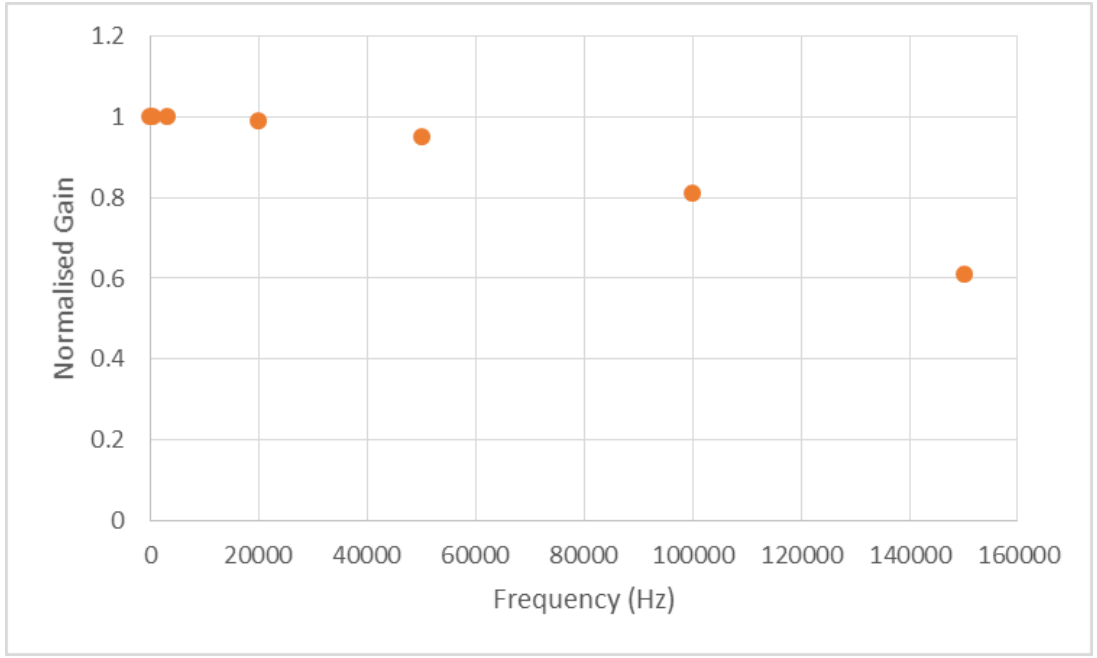
Switched Isolator

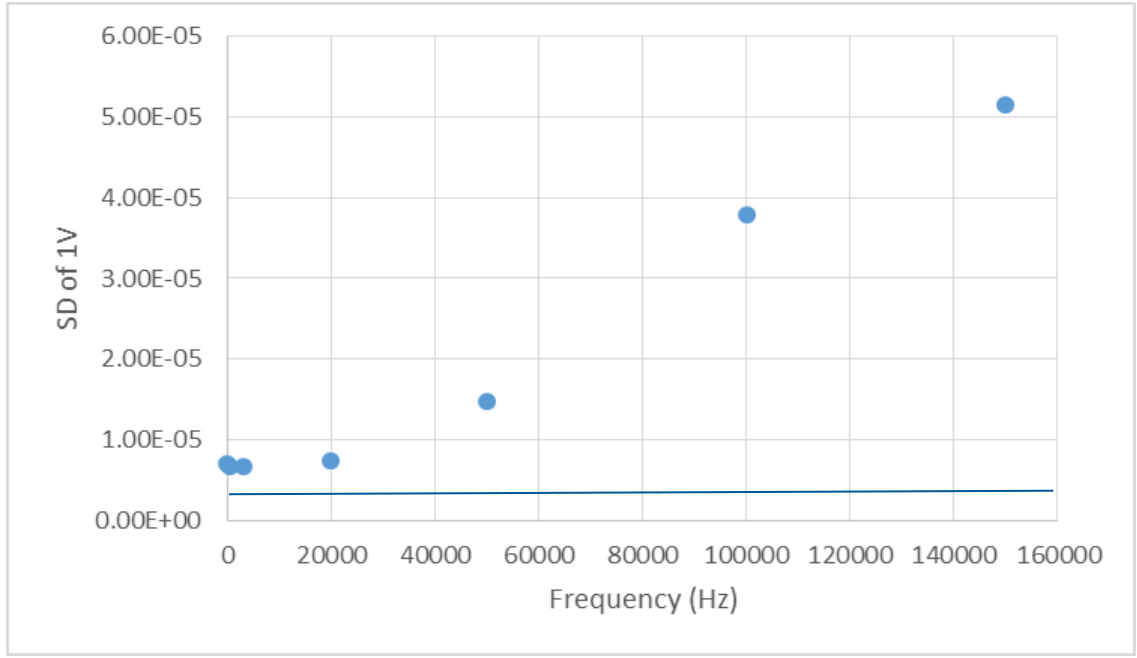


Further problems

- Frequency Response
- Temperature
- Linearity

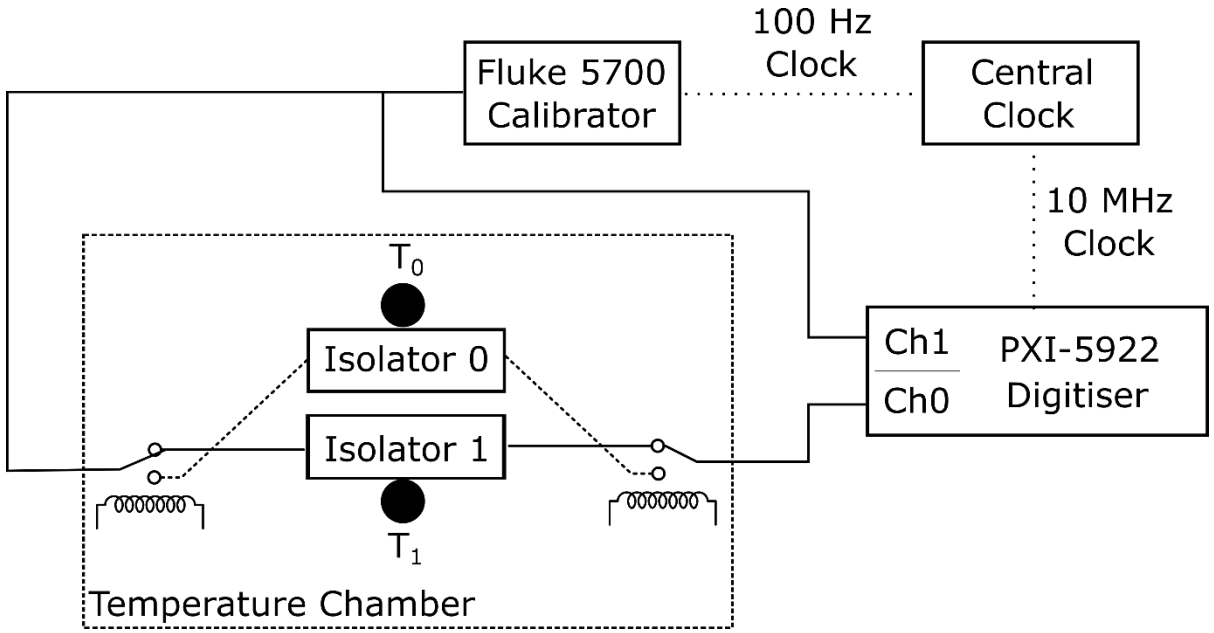
Frequency Response



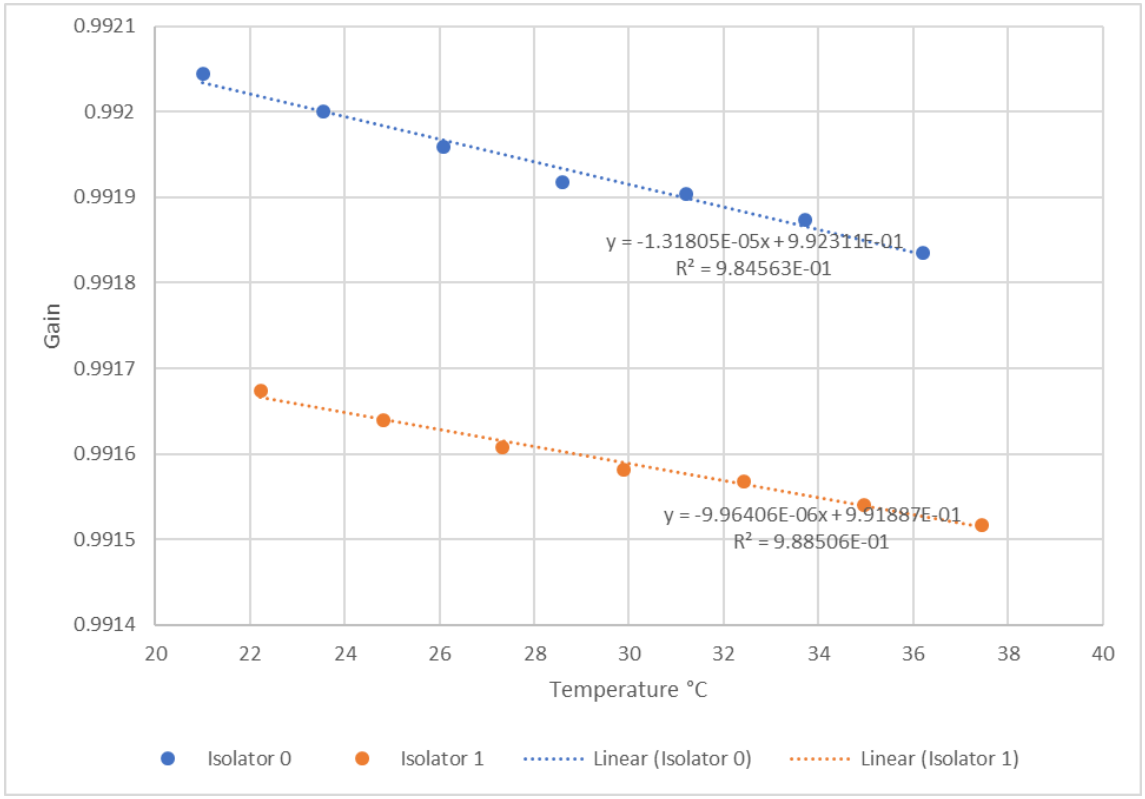


Low pass filter implemented, but stable

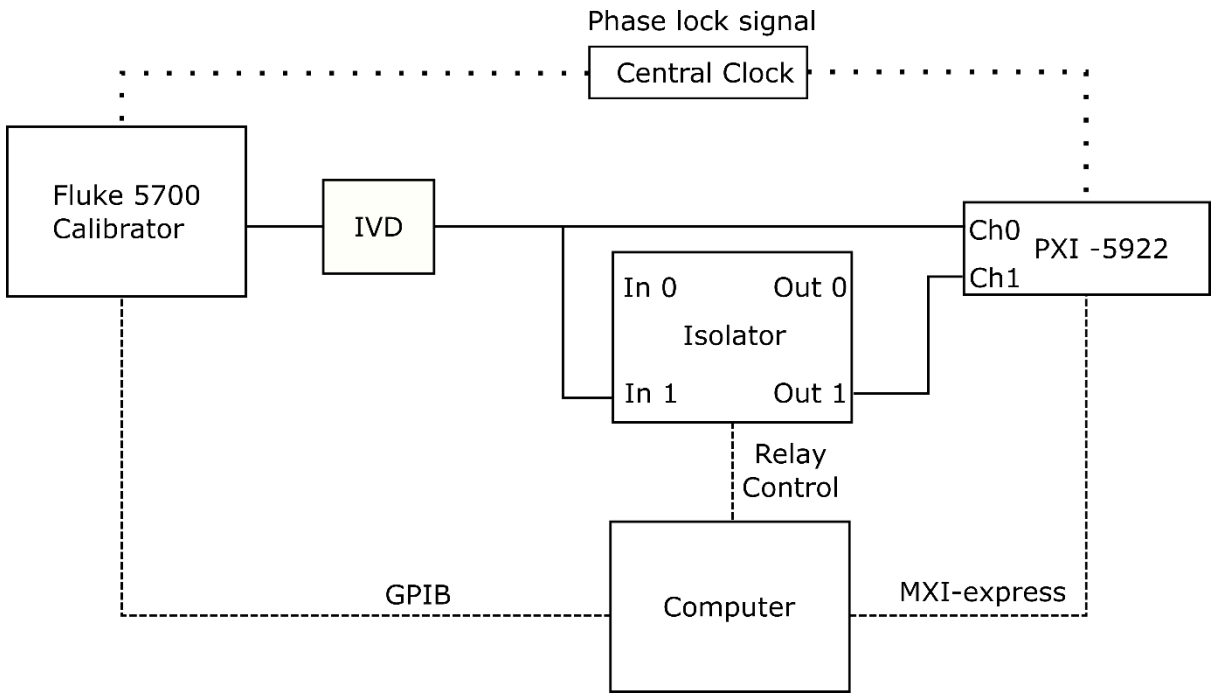
Temperature



Equipment Setup

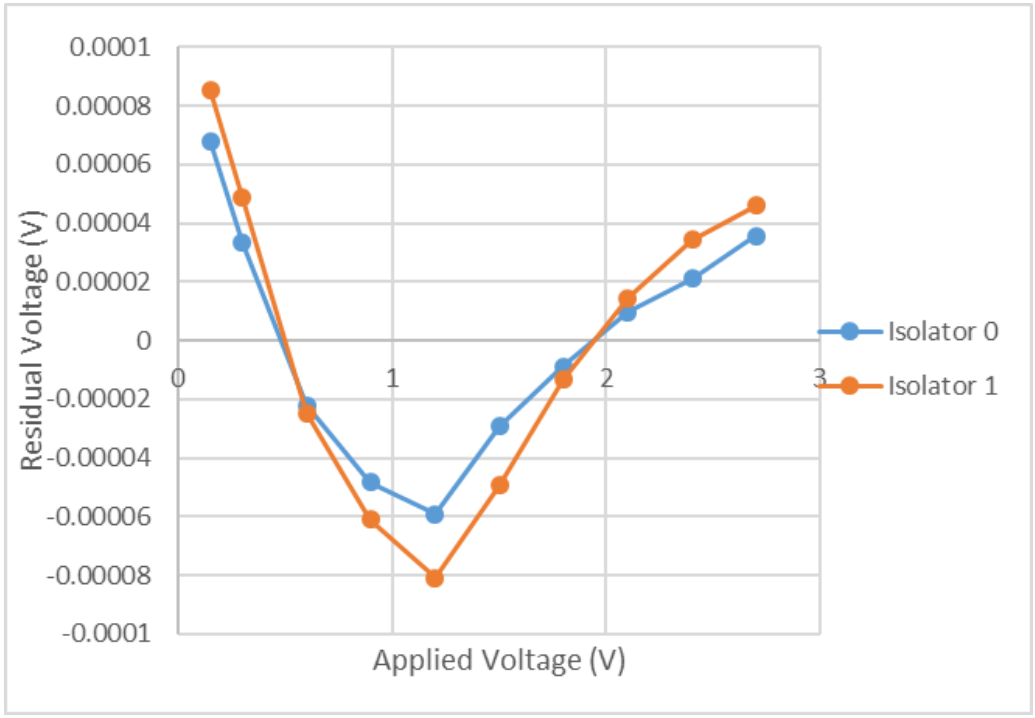


Linearity

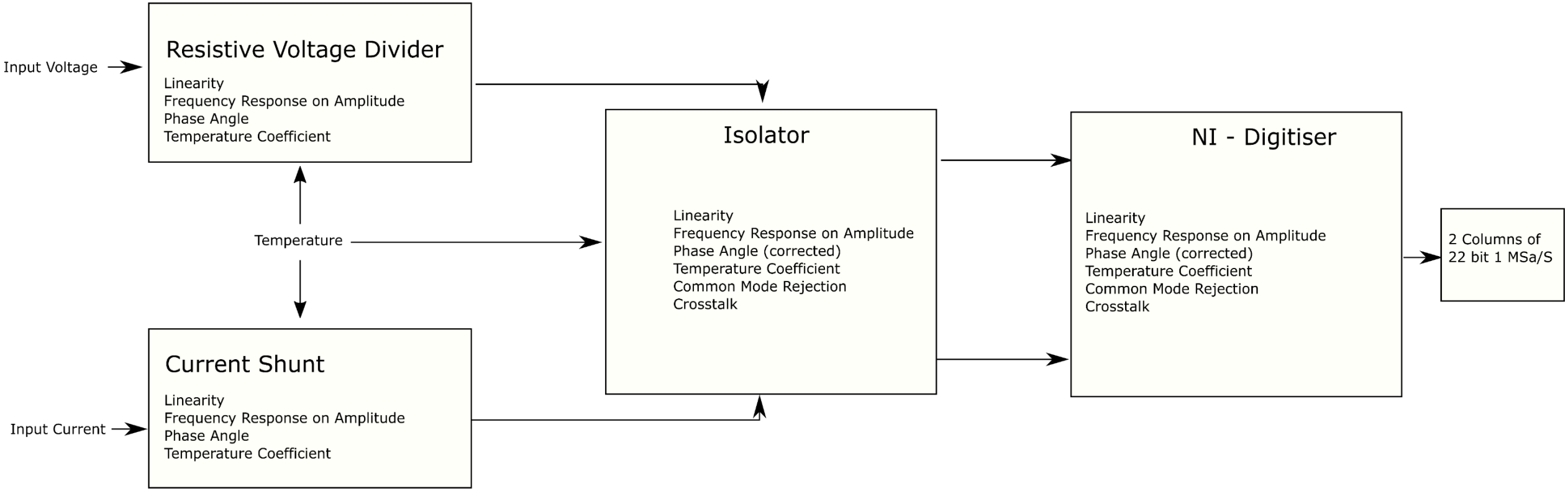


Equipment Setup

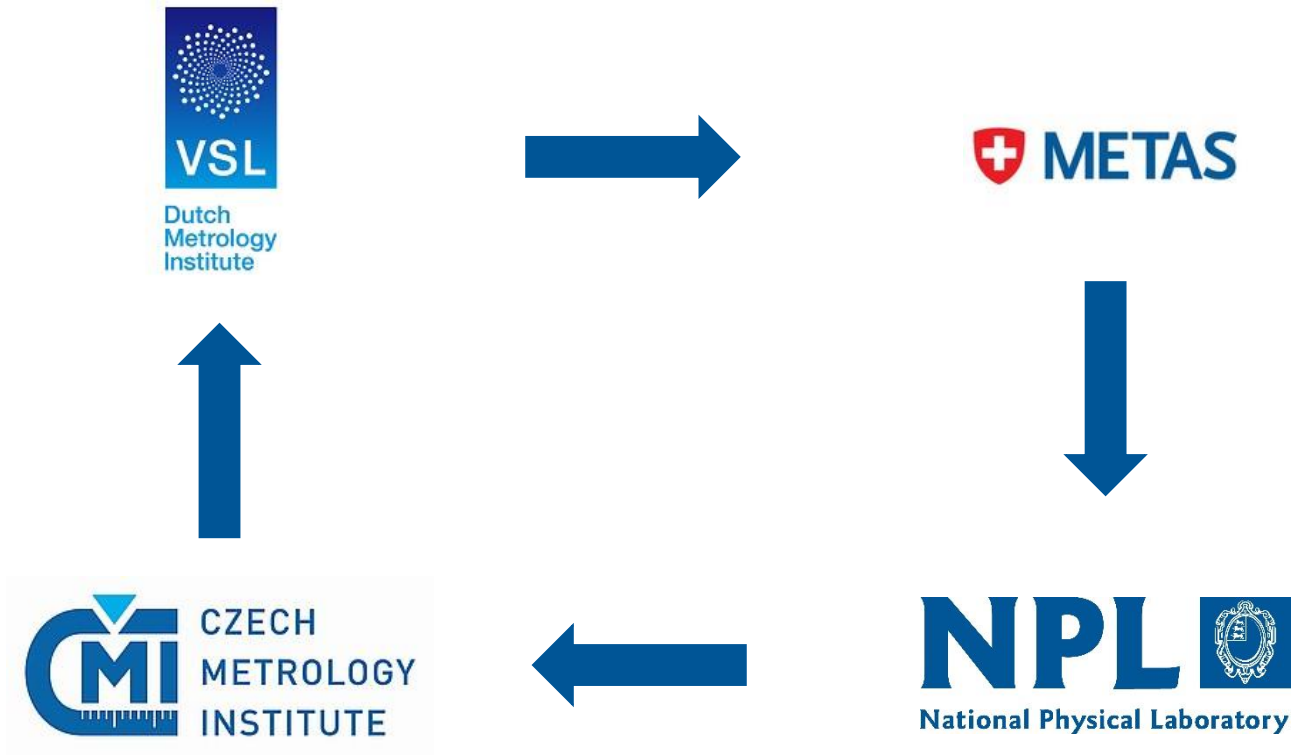
Residual Voltage



Uncertainty



Intercomparison



- Two meter selected for testing
- Passed between four NMIs
- Results to be finalised