Engineered to order. Built to last.

Metrological Characterization of Low Power Instrument Transformer Integrated in MV Recloser

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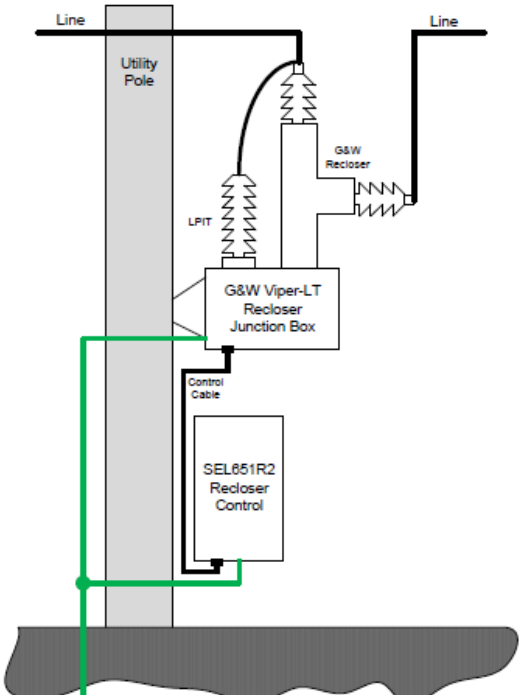
Key Topics

- Project motivation
- Equipment test
- Metrological characterization setup
- Test setup & results
- Conclusions

Project Motivation

- In depth testing under different operating conditions of Low Power Instrument Transformers (LPIT) integrated into MV reclosers
- Consideration of cabling capacitance and recloser controller affection on accuracy
- In accordance with JCGM 100/101 - GUM

LPIT System Tested

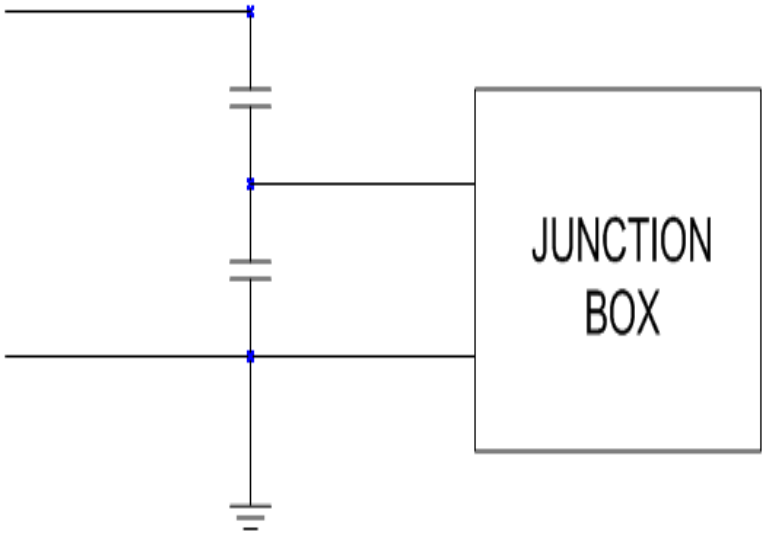


Example of LPIT and Recloser Installation

Photograph of MV recloser and recloser control

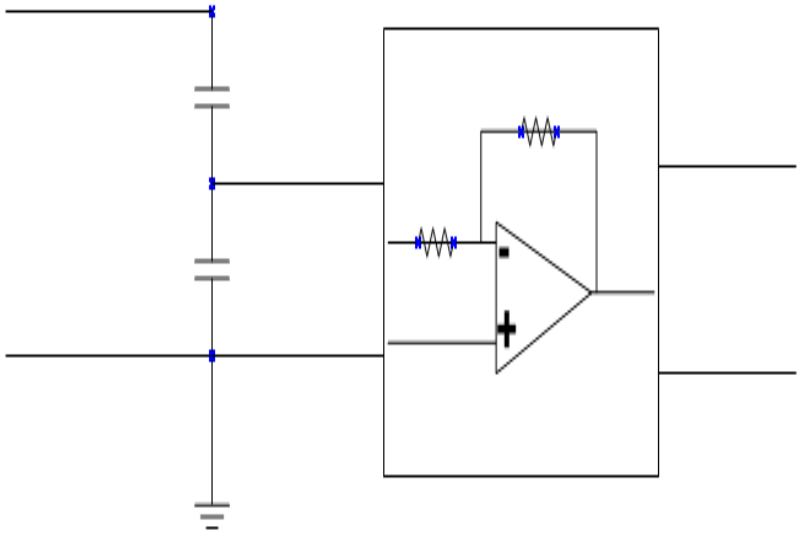
LPIT System Tested

Passive Sensors



- Simple with few components
- No power required
- Less accurate
- Requires correction factors
- Impacted by cable length, temperature, etc.

Active Sensors



- More complex, but more accurate
- Requires DC power supply
- No correction factors
- Less impacted by cable length, temperature, etc.

Metrological Characterization Hardware Setup

High Voltage

MV Recloser
&
LPIT

0.1 Class
Reference
Transformer

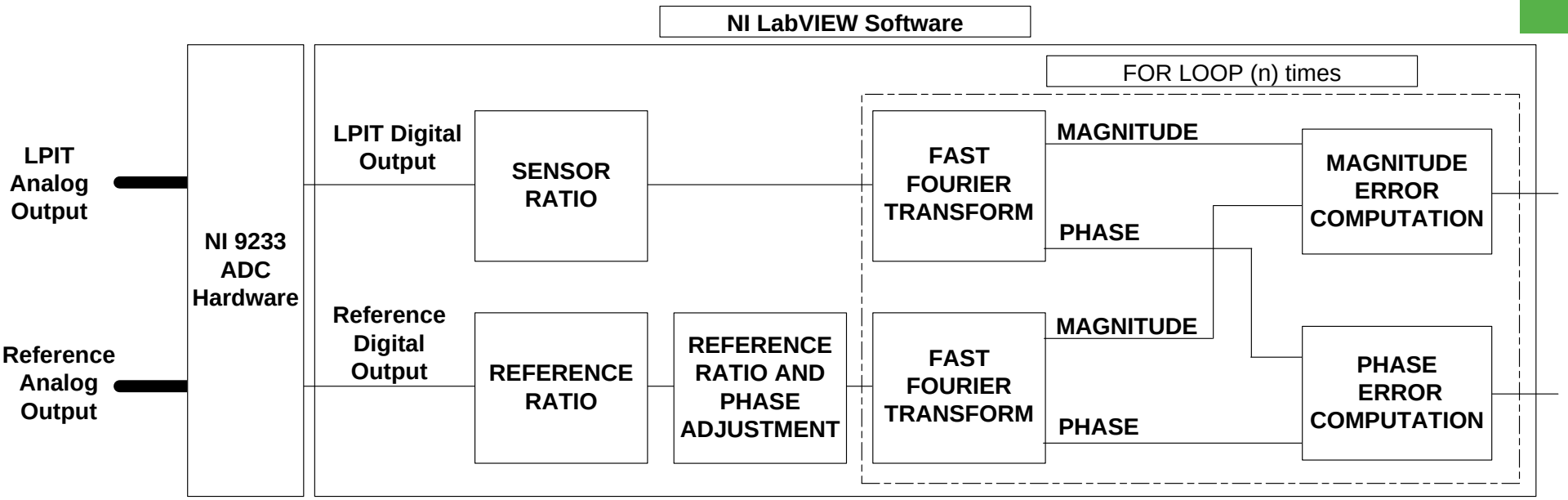
Step Up
Transformer

NI
DAQ

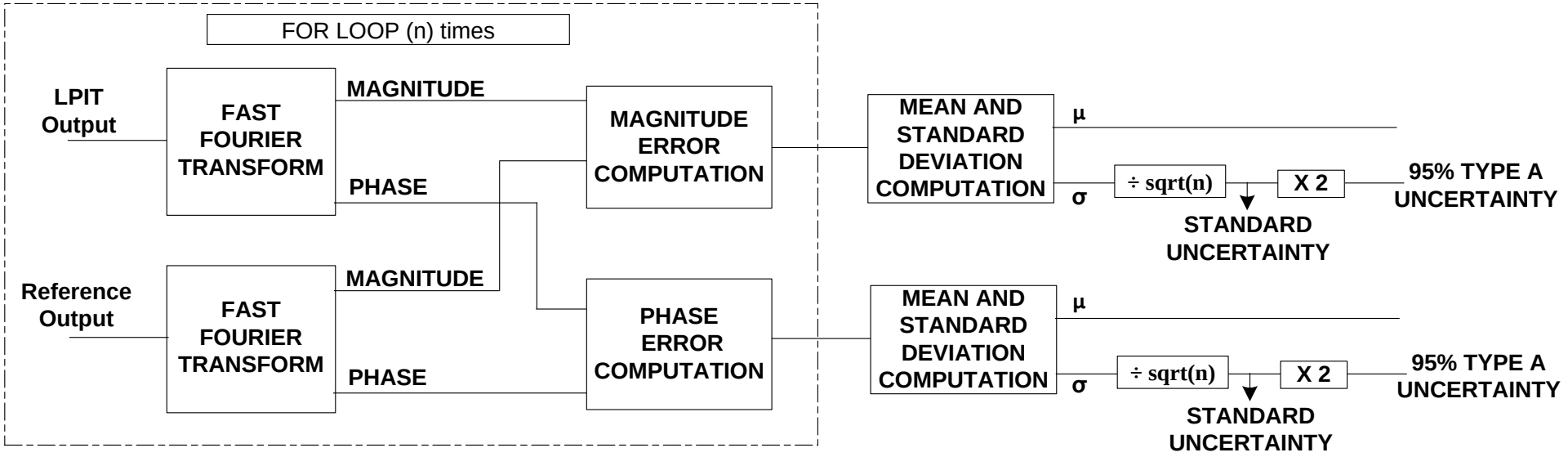
USB Interface

Variable AC
Power Source

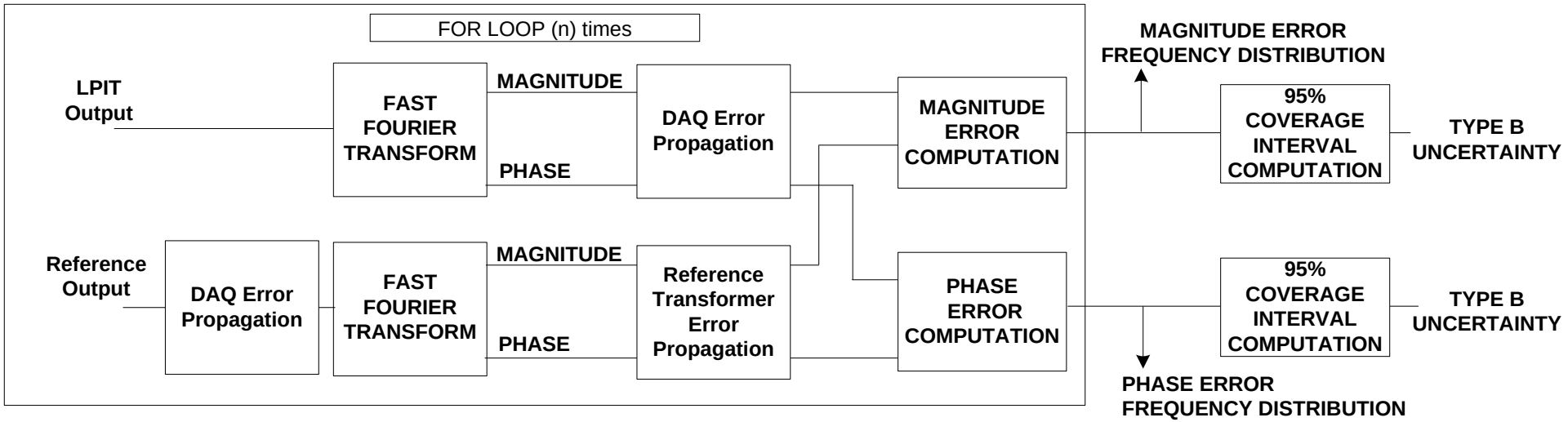
Voltage Error Percentage and Phase Error Computation



Type A Uncertainty Evaluation



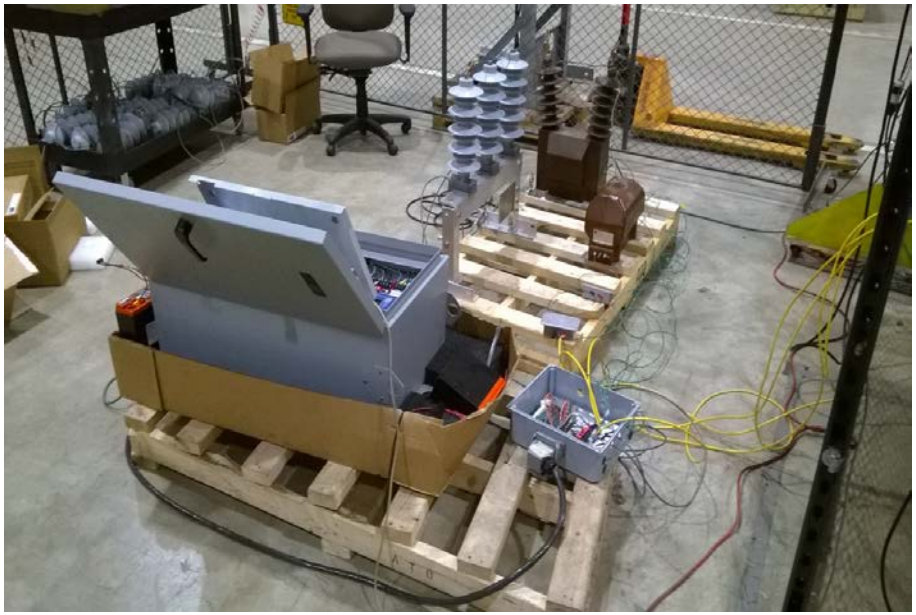
Type B Uncertainty Evaluation



Test Setup & Results

Basic Accuracy Test Results

- Room temperature
- Rated frequency (60 Hz)
- Three different cable configurations:
  - no cable
  - 10 ft cable
  - 100 ft cable



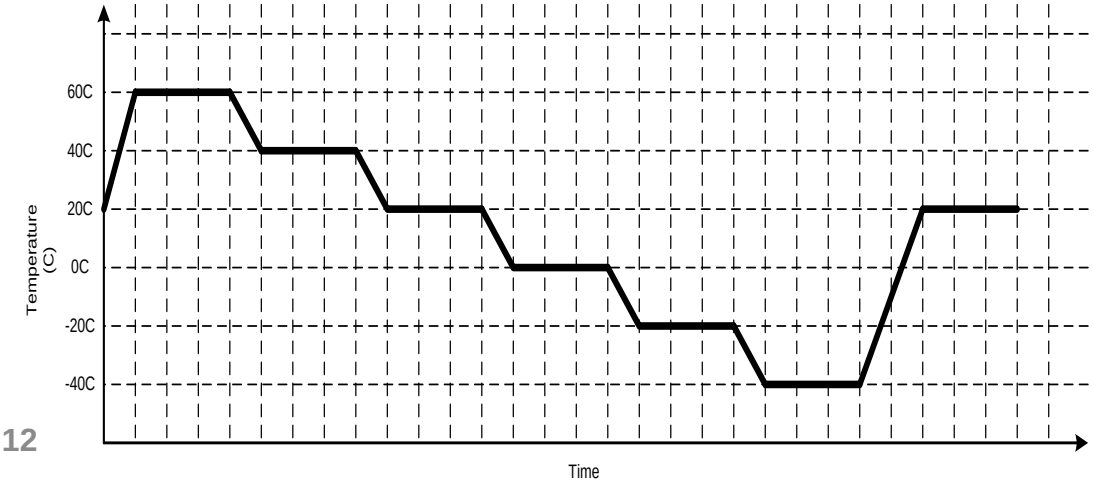
Basic Accuracy Test Results

Vapp (kV)	No Cable		10' Cable		100' Cable	
	Magnitude Error (%)	Phase Error (mrad)	Magnitude Error (%)	Phase Error (mrad)	Magnitude Error (%)	Phase Error (mrad)
12.5	0.28	1.8	0.28	1.8	0.28	1.8
15.6	0.28	1.9	0.28	1.9	0.28	1.9
18.7	0.29	1.9	0.29	1.9	0.29	2.0

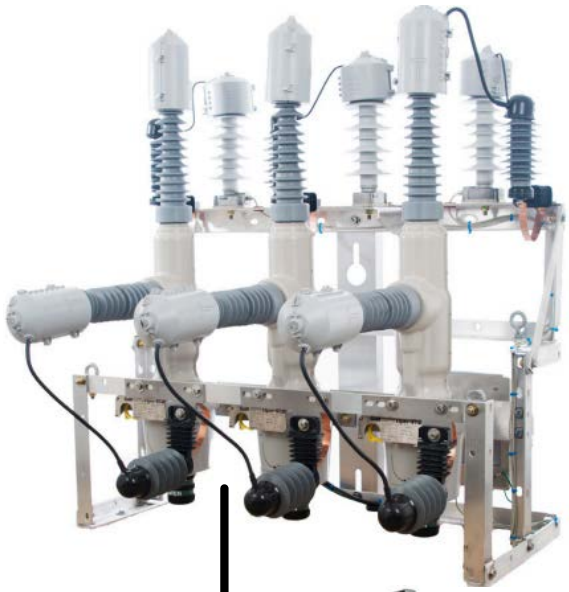
- No impact of cable on magnitude or phase measurements

Accuracy vs. Temperature Test Setup

- Temperature
  - -40°C to +65°C
  - 20°C Steps
- Rated frequency (60 Hz)
- Three different cable configurations:
  - No cable
  - 10 ft cable
  - 100 ft cable



Accuracy vs. Temperature Test Setup



High Voltage

MV Recloser
&
LPIT

0.1 Class
Reference
Transformer

Step Up
Transformer

Recloser
Control

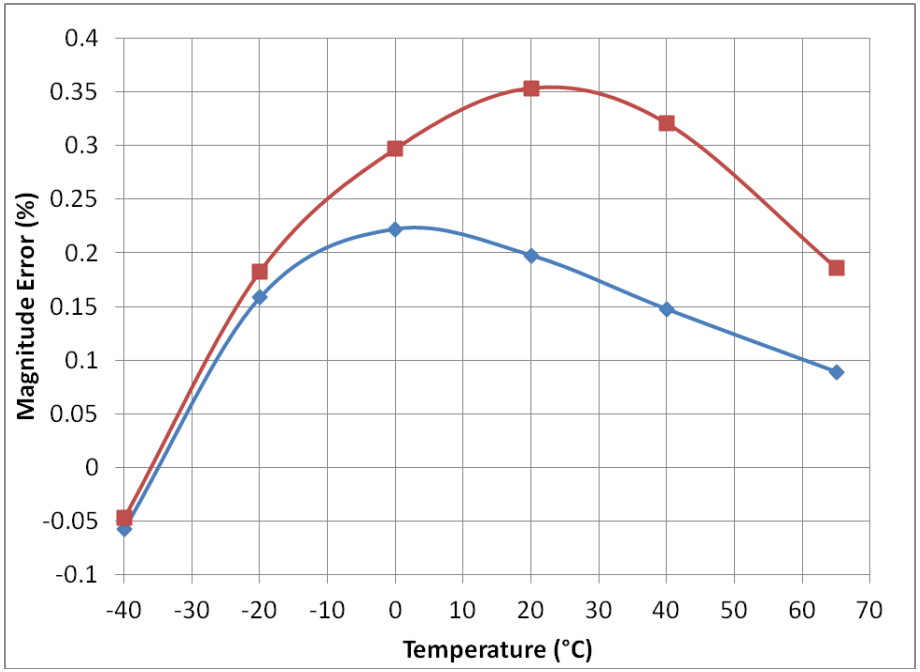
Serial
Interface

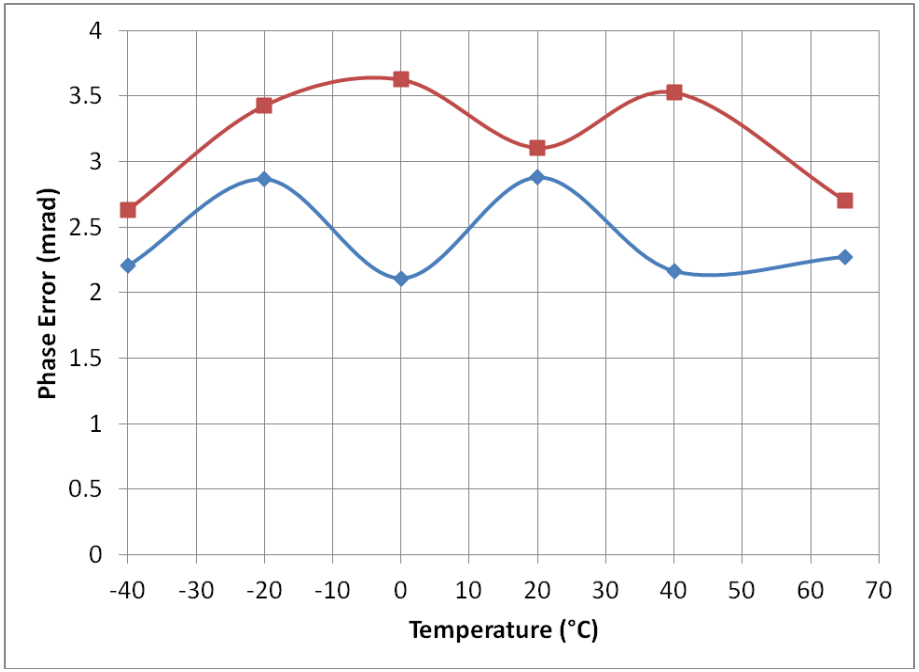
USB
Interface

Variable AC
Power Source

Accuracy vs. Temperature Test Results

- Voltage magnitude error was impacted by temperature but not cable length
- Phase error not significantly impacted by both temperature and cable length





Conclusions

- Test setup created to allow for a complete metrological characterization in accordance with the GUM
- Basic accuracy and temperature accuracy tests completed in different conditions to prove compliance with 0.5 accuracy class per IEC 60044-7
- Deep understanding of the system including the LPIT, cables, control, etc. is required to guarantee compliance with 0.5 class.
- Setups can be used for future work including more extensive testing
  - Harmonics
  - Frequency
  - Other major sources of influence on the accuracy.