

# Power and Power Quality measurements at SIQ

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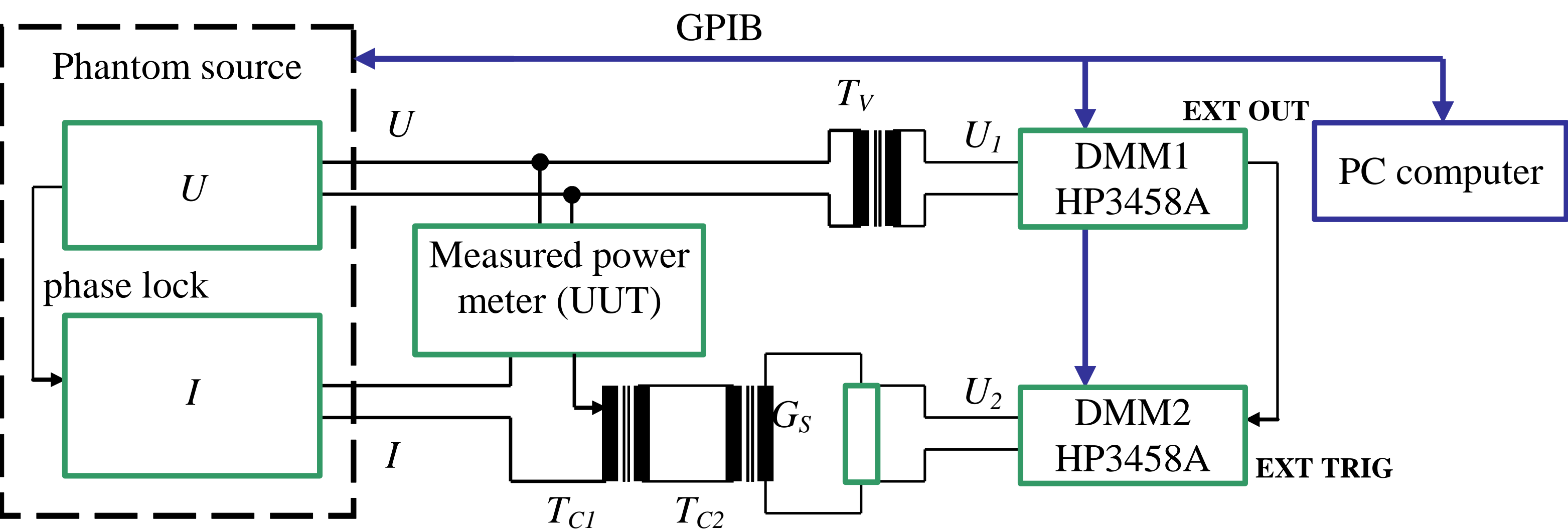
## Introduction

This poster shows accredited calibration procedures used at SIQ for the following:

- LF sinusoidal power (apparent, active and reactive),
- phase,
- current and voltage PQ parameters.

## Power measurements

- LF power:
  - $V = 100 \text{ mV to } 700 \text{ V}$
  - $I = 1 \text{ mA to } 50 \text{ A}$
  - $f = 45 \text{ Hz to } 65 \text{ Hz}$
  - $\varphi = 0^\circ - 360^\circ$
  - CMC:  $25 \mu\text{VA/VA}$
- DMMs are in DC sampling mode
- $A$ ,  $f$  and  $\varphi$  are retrieved with PSFE (or 3PSF) algorithm

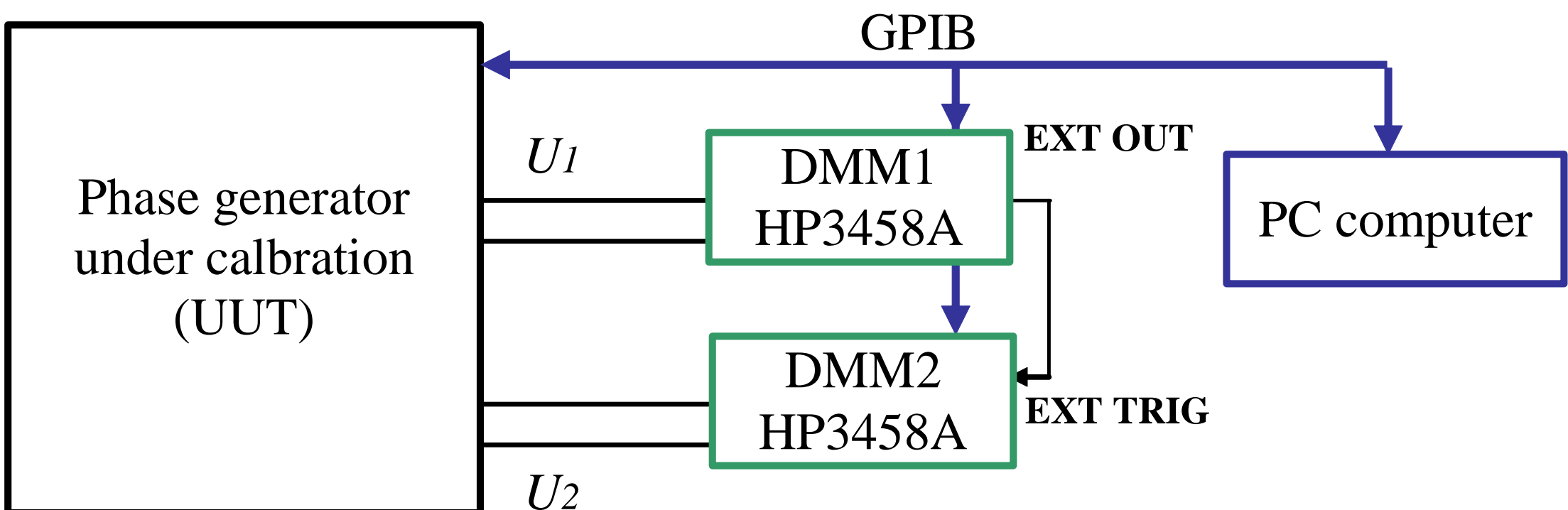


Setup for power meter and phantom source calibration ( $T_{C1}$  and/or  $T_{C2}$  at low currents or  $T_V$  at low voltages could be omitted)

- $T_{C1} / T_{C2}$  are current transformers and  $T_V$  is voltage transformer
- current shunts could be used instead of current transformers

## Phase measurements

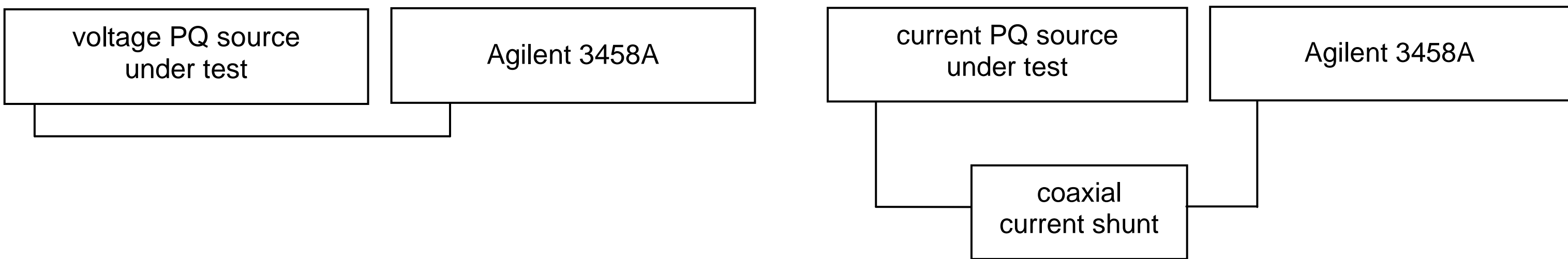
- LF power:
  - $\varphi = 0^\circ - 360^\circ$
  - $f = 10 \text{ Hz to } 1 \text{ kHz}$
  - CMC:  $0.0005^\circ$
- same setup and SW (algorithms) as for LF power is used
- CMC achieved when measured (sampled) on 1 or 10 V range



Setup for calibration of phase on generator

## PQ measurements

- PQ generators / calibrators are calibrated by sampling the signals and calculating parameters with appropriate algorithms
- PQ meters are calibrated directly with Fluke 6100A



Setup for calibration sinewave voltage (a) and current sources

### Sinewave:

- real-time reading from DMM, no internal memory needed
- currents are measured as voltage drop on coaxial current shunt
- $A$ ,  $f$  and  $\varphi$  are determined with **PSFE** algorithm
- similar procedure is used when measuring other PQ parameters

### Harmonics / Interharmonics / THD:

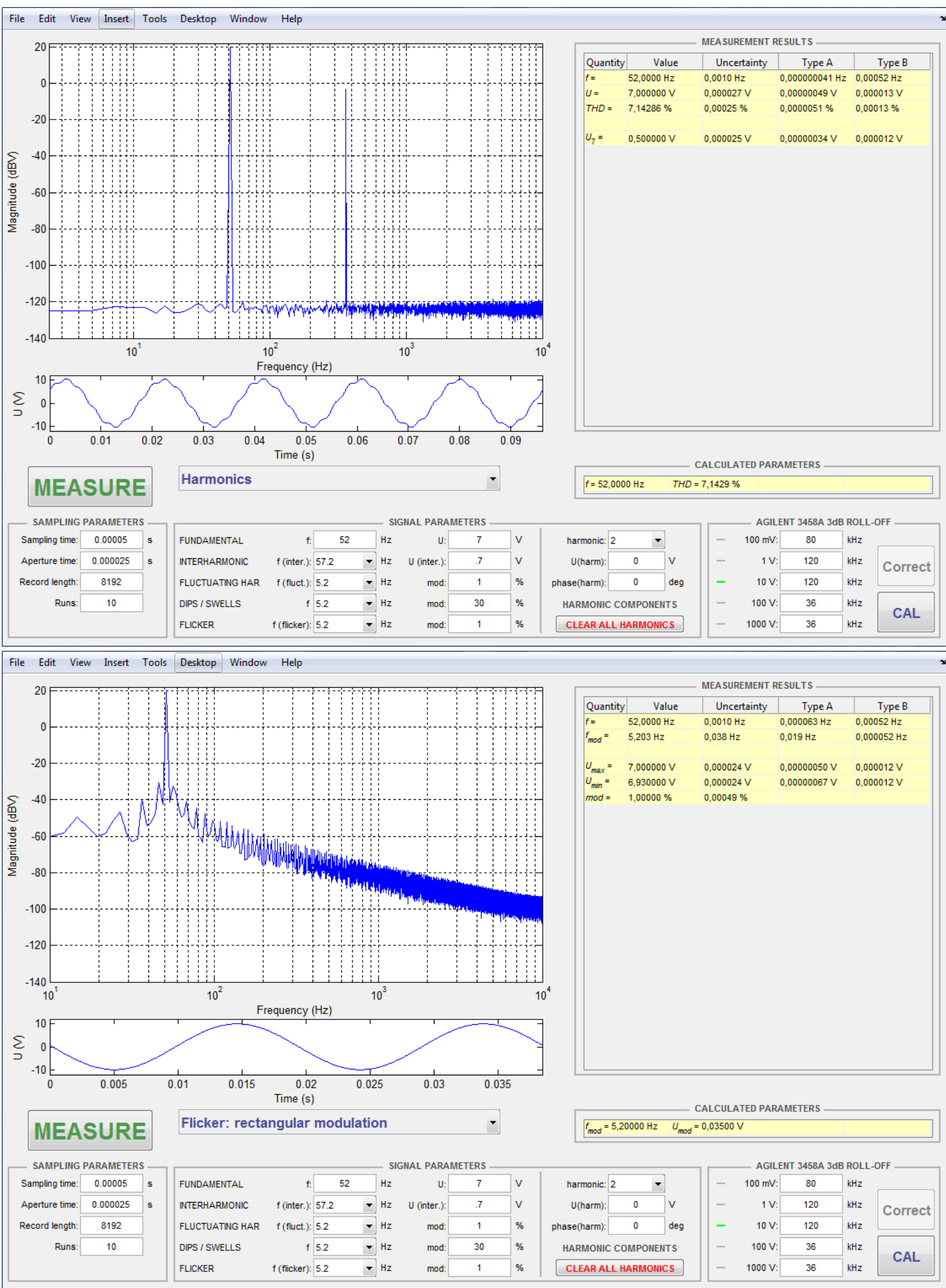
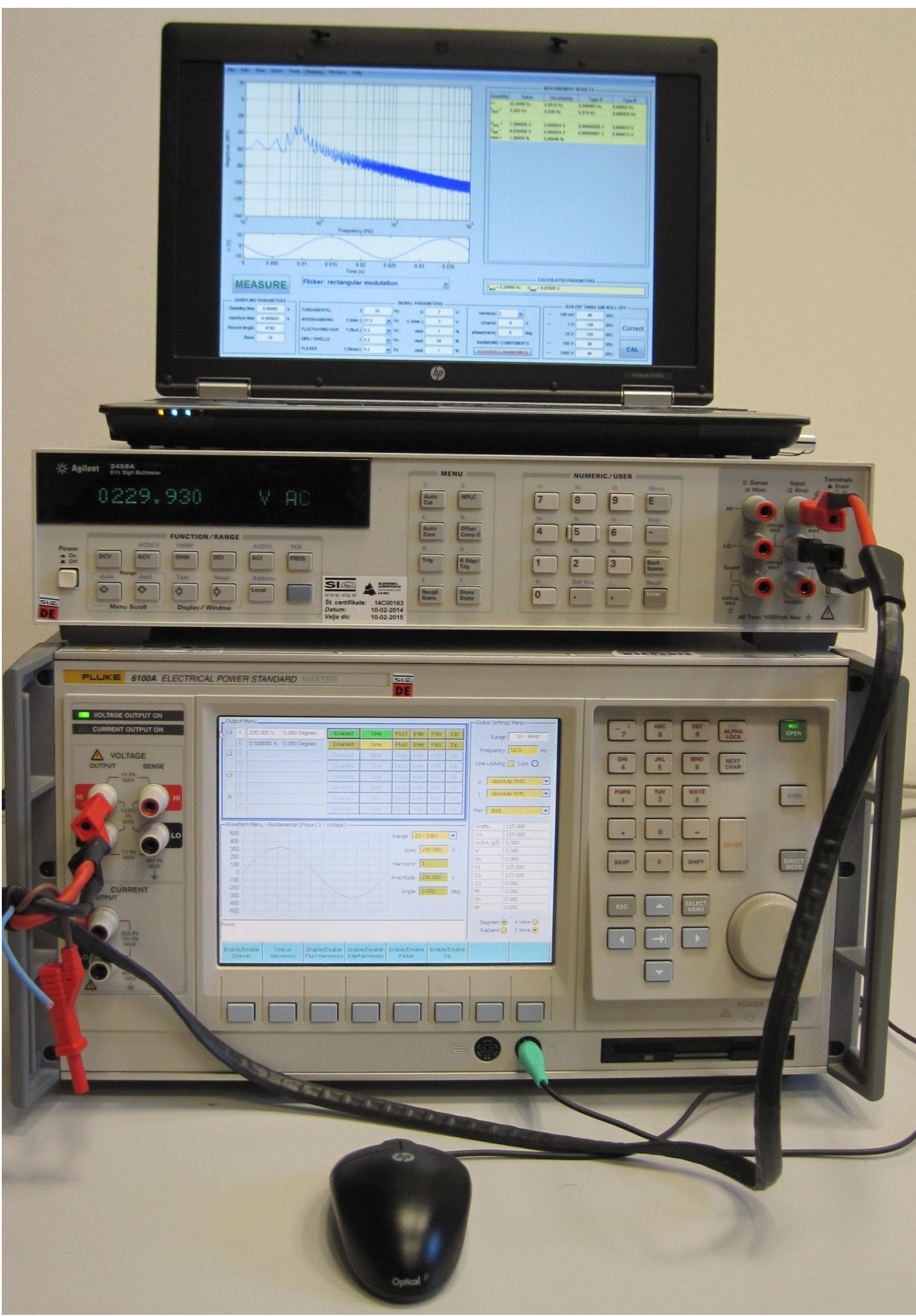
- the fundamental and harmonic components are determined with **MHFE** algorithm
- CMC:  $0.0035\%$  ( $h = 0 - 40\%$  @  $f = 10 \text{ Hz} - 500 \text{ Hz}$ )

### Fluctuating harmonics / Flickers:

- **MHFE** for sinusoidal modulation and **PSFE** algorithm for rectangular modulation is used
- CMC:  $0.0001$  ( $m = 0 - 1$  @  $f = 10 \text{ Hz} - 600 \text{ Hz}$ ) – fluct. harmonics
- CMC:  $0.00005$  ( $m = 0 - 1$  @  $U = 0.1 - 70 \text{ V}$ ) – flickers

### Dips / Swells:

- normal and dip/swell levels in a stable steady-state are windowed separately and estimated independently
- **PSFE** algorithm is used
- CMC:  $0.0001$  ( $m = 0 - 1$  @  $U = 0.1 - 70 \text{ V}$ ) – flickers



## Measurements standards available in the laboratory

- **DMMs:** Agilent (HP) 3458A, Fluke 8508A
- **calibrators:** Fluke 5500A, 5520A, 5700A, 5720A, 5730A
- **electrical power standard:** Fluke 6100A
- **amplifiers:** Fluke 5205A, Fluke 5220A, Fluke 5725A
- **transconductance amplifier:** Clarke-Hess Model 8100

- **voltage transformer:**  $120 \text{ V}/0.8 \text{ V}$  ( $T_V$ )
- **current transformer:** H&B Ti53 ( $T_{C1}$ )
- **electronically compensated current transformer** ( $T_{C2}$ )
- **coaxial current shunts:**  $1 \text{ mA} - 100 \text{ A}$
- **power converter:** HEG C1-1