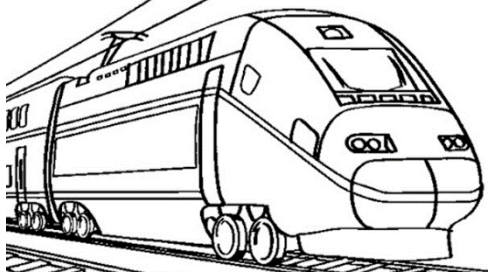


Laboratory calibration of EMF under AC distorted signals

Context – setup – algorithm

Daniela Istrate (LNE)
daniela.istrate@lne.fr



Context



Directive n° 2008/57/EC on the interoperability of the rail system within the European Community published in June 2008.

To establish a single European railway area, energy billings shall be computed on the actual consumed energy.

All trains shall be equipped with an energy measurement function (EMF).
It's accuracy shall be assessed and periodically re-verified (EN 50463-2).

LNE developed a reference setup for the calibration of EMF working under AC distorted waveforms.

LNE Setup presentation

Watch the video included :

Laboratory calibration of EMF under AC distorted signals



Context

Directive n° 2008/57/EC on the interoperability of the rail system within the Community published in June 2008.

To establish a single European railway area, energy billings shall be computed on the actual consumed energy.

All trains shall be equipped with an energy measurement function (EMF).
It's accuracy shall be assessed and periodically re-verified (EN 50463-2).

LNE developed a reference setup for the calibration of EMF working under AC distorted waveforms.

LNE Software

The sampling frequency is calculated according to:

- the fundamental frequency of the signal to be measured, F ,
- the number of points, N ,
- the periods to be recorded, M

$$F_s = \frac{N}{M} \cdot F$$

1024 samples

5 cycles

The LNE software :

- drives the multimeters,
- pilots the data acquisition,
- treats data,
- performs the mathematical analysis and computations.

The screenshot displays the LNE software interface with the following components:

- Hardware and Calibration:**

DMM 3458A	ADD GPIB	Calibre (V)
U	22	1
I	23	1
- Measurement Parameters:**

Paramètres	Value
Fs (Hz)	50
Fo (Hz)	10240,000000
Te (µs)	98
N échantillons	1024
M périodes	5
Ta (µs)	50
tm = Te-Ta > 50 µs	48
- Measurement Results (Fundamental):**

N° LECTURE	56
FONDAMENTAL	
U (V)	24647,193659
I (A)	192,71203
PHI (°)	-34,841935
P (W)	3898318,273108
- Summary Table (Récapitulatif Etalon):**

U (V)	MOYENNE	24646,858552
	ECART-TYPE	1487752
I (A)	MOYENNE	192,688375
	ECART-TYPE	0,034542
PHI (°)	MOYENNE	-34,841822
	ECART-TYPE	0,003300
PHI (rad)	MOYENNE	-0,278505
	ECART-TYPE <th>1,427565</th>	1,427565
P (W)	MOYENNE	3897681,323977
	ECART-TYPE <th>815,440018</th>	815,440018
- Graphical Data:** A graph titled "P (W)" showing power fluctuations over time. The y-axis ranges from 3845000 to 3900000. The x-axis is labeled "Méthode M2BIS" and ranges from 0 to 60.
- Log Table:** A table on the right side of the interface listing "N° LECTURE" and "TimeDate" for 56 consecutive measurements.

LNE Software

The outputs of the LNE reference system are:

- the RMS values of voltage, respectively current and their standard deviations,
- the phase displacement between their fundamental components,
- the active power and the associated standard deviation,

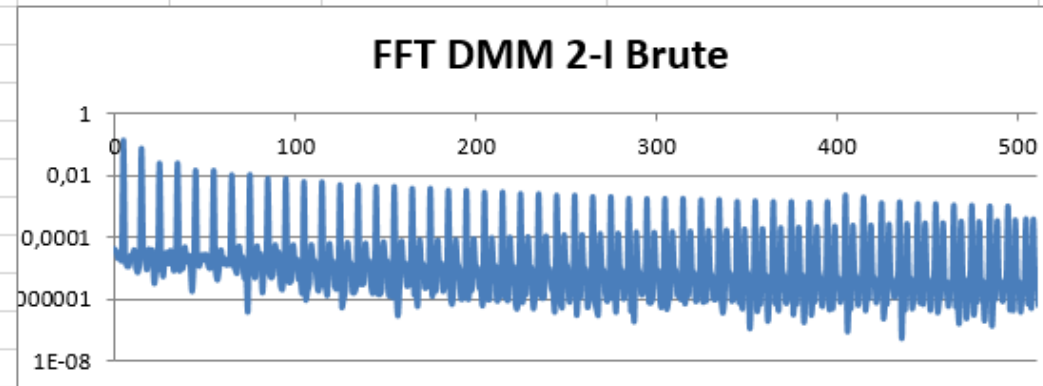
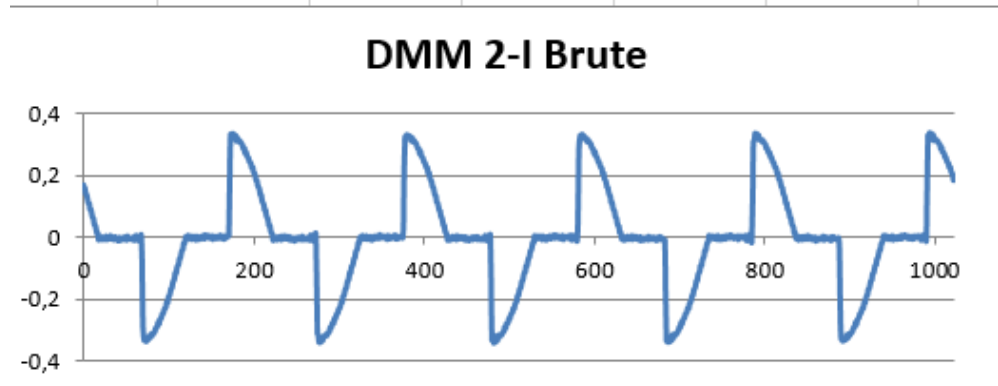
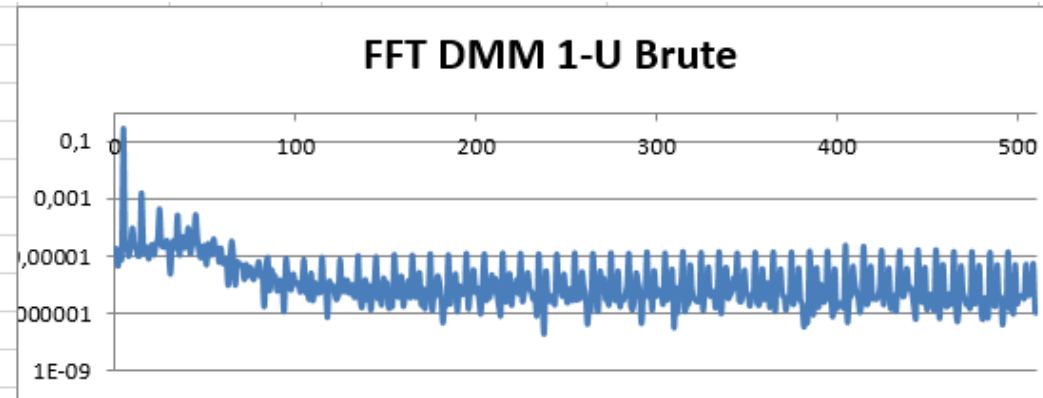
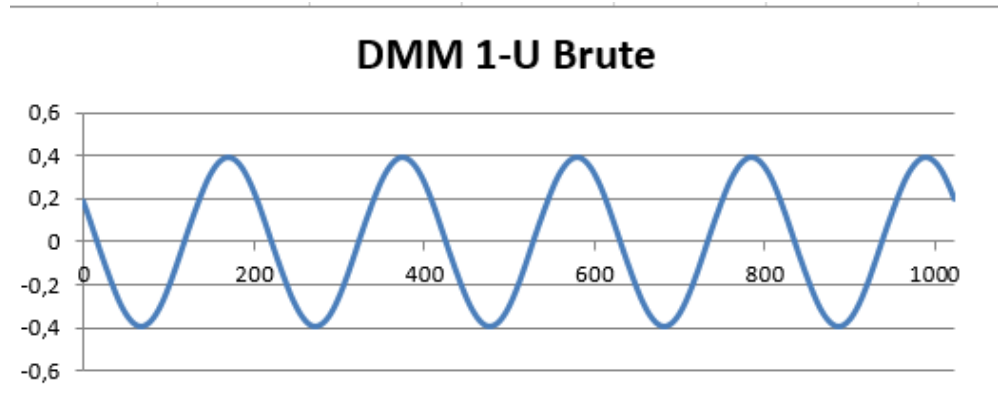
FONDAMENTAL	
U (V)	24647,193659
I (A)	192,71203
PHI (°)	-34,841935
P (W)	3898318,273108
START LECTURE	STOP LECTURE

Récapitulatif Etalon		
U (V)	MOYENNE	24646,158592
	ECART-TYPE	1,467752
I (A)	MOYENNE	192,688375
	ECART-TYPE	0,034542
PHI (°)	MOYENNE	-34,841822
	ECART-TYPE	0,009300
PHI (rad)	MOYENNE	-0,271505
	ECART-TYPE	1,427565
P (W)	MOYENNE	3897681,323977
	ECART-TYPE	815,140018
NB LECTURES		56

LNE Software

The outputs of the LNE reference system are:

- the Fast Fourier Transform of voltage, respectively current waveforms.



Calibration results

The values determined by the reference measurement system will be compared to the values given by the Device Under Test.

90° phase-fired current waveform	Reference	DUT
U (V)	24646.16	25350
I(A)	192.69	228.16
PHI(°)	-34.84	-
P (Wh)	1082.69	1100.57
P (W)	3897681.32	3962048.4
Corrections P (%) with respect to sin	-0.20	OK

Device initially designed to work at 50 Hz !

The relative value of the expanded uncertainty (for a coverage probability of 95,45%, coverage factor = 2) of **active power measurement for LNE's reference system** is

0.1% for sinusoidal signals of high amplitudes
(25 kV, 500 A).

0.5% for phase fired waveform.

Publications



November 2020
DOI: 10.3390/s20216301



Journals Information Author Services Initiatives About

Sign In / Sign Up

Submit

Search for Articles:

Search

Advanced

Journals / Sensors / Volume 20 / Issue 21 / 10.3390/s20216301



Submit to this Journal

Review for this Journal

Edit a Special Issue

Article Menu

Article Overview

- Abstract
- Supplementary Material
- Open Access and Permissions
- Share and Cite
- Article Metrics
- Related Articles
- Open Access Results

Open Access Article

Laboratory Calibration of Energy Measurement Systems (EMS) under AC Distorted Waveforms

by Daniela Istrate¹, Abderrahim Khamlichi², Soureche Soccalingame¹, Jorge Rovira², Dominique Fortune¹, Martin Sira³, Pascual Simon² and Fernando Gamacho²

¹ Electrical Metrology Department, LNE, 78197 Trappes CEDEX, France

² FFII-LCOE, Eric Kandel Street 1, Getafe, 28906 Madrid, Spain

³ Department of Primary Metrology of Electrical Quantities, Czech Metrology Institute, Okružní 772/31, 638 00 Brno, Czech Republic

* Author to whom correspondence should be addressed.

Sensors 2020, 20(21), 6301; <https://doi.org/10.3390/s20216301>

Received: 28 September 2020 / Revised: 2 November 2020 / Accepted: 3 November 2020 / Published: 5 November 2020

(This article belongs to the Special Issue *Advanced Transducers and Systems for Voltage and Current Measurement*)

View Full-Text

Download PDF

Browse Figures

Cite This Paper

Thank you for your attention.