SIM.EM-S8

COMPARISON PROTOCOL

Instrument Current Transformers

April – 2013

DRAFT

1 Introduction

In order to strengthen the Inter-American Metrology System (SIM), interaction among its National Metrology Institutes (NMI´s) must be promoted. At the same time, in accordance with the CIPM Mutual Recognition Agreement (MRA) objectives, NMI´s must establish the degree of equivalence between their national measurement standards by performing regional comparisons, among other activities.

The objective of this comparison is to compare the measurement capabilities of NMI´s in SIM in the field of instrument current transformers and link this round with the European round of EUROMET. This action is aimed to determine the degree of equivalence of measuring capabilities in current ratio errors and phase displacement at the selected ratios. The proposed test points were selected to evaluate the measuring capabilities of the participants, both their measurement standards and their measurement procedures.

2 Traveling Standard

2.1 General requirements

Pilot Laboratory, UTE, uses a current comparator LABUTE serial N° 201105 with a standard transformer Conimed type TN 1205, N° 97026 as reference standard.

Participation criterion: For participation in the SIM.EM-S8, participants should have current transformers measurement capability (including reference) with a combined relative standard uncertainty equal or lower than 500×10^{-6} in ratio errors, and 500 μrad in phase displacements (50 Hz or 60 Hz).

2.2 Description of the transfer standard

Current transformer trademark CONIMED, type TI 1205, N° 11023. All technical characteristics of the standard transformer are detailed in Annex 1.

2.3 Quantities to be measured

Participants should measure the ratio errors and phase displacements at different ratios and currents according to this document.

The definition of the error in the comparison is:

$$\varepsilon = \frac{10^6 \times (K_n I_S - I_P)}{I_P} \qquad (1)$$

K_n Rated transformation ratio

I_P Primary current (fundamental component)

I_S Secondary current (fundamental component)

2.4 Method of computation of the Comparison Reference Values

All independent participant ratio errors and phase displacements measurements will be used to determine the Comparison Reference Values (CRV).

The CRV will be determined according to the sum of weighted means according to

$$CRV = \sum_{i=1}^{n} w_i \varepsilon_i \tag{2}$$

where ε_i is the reported ratio error or phase displacement value for lab ***i*** in parts in 10^6, *n* is the number of laboratories with independently-derived measurement results, and the weight w_i is determined according to

$$w_i = \frac{\frac{1}{u_i^2}}{\sum_{i=1}^{n} \frac{1}{u_i^2}} \tag{3}$$

where u_i is the combined standard uncertainty for measurement ε_i, in parts in 10^6.

3 Organization

UTE Laboratory will be the pilot laboratory. The transfer standard will begin at UTE and will travel regionally between the participating laboratories. The transfer standard will return to the pilot laboratory at the end of the intercomparison. The intercomparison will conclude with measurements at the pilot laboratory.

3.1 Coordinator and members of the review committee

Alejandro Santos, UTE.
Daniel Slomovitz, UTE.
Jose Luis Casais, INTI.

3.2 Participants

Argentina
Brazil
Colombia
Panama
Mexico
Uruguay (pilot)
Germany

3.3 Time Schedule

The standard will stay in each country for a maximum of 6 weeks.
Once the measurements and dispatch of the Transfer Standard were concluded, the laboratory will have a maximum of three weeks to report the results.

3.4 Transportation

It is proposed to use courier services. Laboratories must use a recognized shipment service for transportation.

The pilot laboratory should provide a letter for customs with characteristics and costs of the standard. This letter should accompany the standard to all participating countries. Transportation can be done by courier services. Shipment should be arranged in the shortest possible time. The sending laboratory should inform the coordinator via e-mail (with copy to the SIM EM chairman) when the standard is ready for transportation. Please use the form in Annex 7, as an attachment in pdf format. The shipment of the standard to the next laboratory must be coordinated well in advance, to allow the receiving laboratory to advance customs requirements according to the particular regulations of each country.

Upon arrival of the transfer standard at the destination laboratory, the receiving NMI should send notification to the coordinator via e-mail (with copy to the SIM EM chairman) using the form in Annex 6, as an attachment in pdf format. The NMI, or a formally designated laboratory, is responsible for this notification.

Each sending laboratory covers the costs of courier service, including insurance.

Each participating laboratory should also cover customs costs within its respective country.

3.5 Shipping and Handling

The transfer standard will be shipped in a properly padded container. See Annex 11. Please note how the container arrives at your laboratory and be sure to repack and ship it the same way. Transportation will be the responsibility of the sending laboratory. Each laboratory must pack and ship the traveling standard to the next laboratory.

Each laboratory must inform all participants that the transfer standard was received with all equipment, upon receipt.

Parts List

The transport container will contain:

One Standard Transformer:
Manufacturer CONIMED
Model: TI 1205

Serial Number: 11023
Two electronics devices: LABUTE 201108-01, serial Number: 130201 and 130202.
One 12 V, 7 Ah battery to supply the electronic device.
One battery charger.
Two copper bars for parallel or series connection.
One copper cylinder.
Five screws and nuts.

Photos of the standard and the electronic devices are included in Annex 8. Please review the photographs to verify that all parts are present when shipment is received and when shipment is sent to the next laboratory.

3.6 Failure of the transfer standard

Please at the arrival of the transfer standard to your laboratory, test it to verify if there is any damage caused during transportation, especially if you notice damage to the shipping container. In case of damage or evident malfunctioning of the transfer standard, the pilot laboratory should be informed immediately.

3.7 Financial issues, insurance

Each participating laboratory covers the costs of the measurement, shipment, transportation, transportation insurance and customs clearance.

4 Measurement instructions

4.1 Tests before measurements

Inspect the outside of the transport case for any signs of physical damage. Open the transport case and check that the standard transformer is in good condition.
The standard transformer should be removed from the transport case and put into the laboratory.

4.2 Measurements

Laboratories shall perform traceable ratio errors measurements by any appropriate method. Primary terminal P_i must be close to ground potential, but not grounded. The input current of this terminal must be the same than the output current of the NMI laboratory standard (one terminal of the laboratory standard must be connected to terminal P_i). A Wagner guard is recommended.
Secondary terminal *s* must be grounded.

Measurement ratios will be: 5 A, 10 A, 25 A, 50 A, 100 A, 250 A, 500 A, 1000 A to 5 A.
The currents for each ratio will be: 5%, 20%, 100% and 120% of In.
The frequency used for calibration will be 50 Hz or 60 Hz or both.
The burden used for calibration will be 6 VA with cos phi=1.

The actual calibration burden must be recorded.
The temperature should be in the range 20 +/- 5 °C.
Ambient temperature should be measured and recorded during measurements.

Annex 5 shows the table to fill all data.

4.3 The transfer transformer has an auxiliary electronic device. Its connections are shown in Annex 9. Unless it is requested, only the #130201 device must be used.

4.4 For 500 A and 1000 A ranges, copper bars are installed in the transfer transformer. They can be connected in series or parallel using auxiliary bars. Annex 10 has a connection diagram.

4.5 The transfer transformer has an electrostatic shield between primary and secondary windings (green binding post). It must be connected to ground.

5 Measurement results and uncertainty

Individual measurement results must be provided with date and ambient temperature. Please take at least five independent measurements in different days for each measuring point. Combined standard uncertainties, with a cover factor k=2, must also be provided to the pilot laboratory with the results. Refer to the *ISO Guide to the Expression of Uncertainty in Measurement.* Annex 2 shows a sample of the uncertainty budget. If results are submitted, they will be published with the intercomparison results. Please do not submit results that you do not wish to be published. See the attached Measurement Results form for submission of results (annex 5). Please submit results to the pilot laboratory. Be sure to include the source of traceability for current transformer measurement.

6 Measurement report

The results should be sent to the pilot laboratory within two weeks after the standards are sent to the next laboratory including:

- Description of method of measurement (indicating if this is the same as declared in CMC's).
- Description of measurement system (preferably including schematics).
- Description of source of traceability to the SI, specifying where independently, including reference standards.
- Result of the measurement including combined standard uncertainty (Annex 5).
- Uncertainty budget (Annex 2).
- Uncertainty of burden.
- Uncertainty of frequency.

7 Report of comparison

Drafts A and B will be the responsibility of the review committee, following the BIPM guidelines.

Annex 1

Technical characteristics of standard transformer

Trademark	CONIMED
Model	TI 1205
Serial Number	11023
Frequency	50 Hz, 60 Hz
Primary current	5 A to 1200 A
Secondary current	5 A
Burden	5 VA
Accuracy	± 0.005% ±0.5 min (145 μrad)
Dimensions	0.22 X 0.44 X 0.55 m (Wide x long x height)
Weight	85 kg

Annex 2

Sample of an uncertainty budget

Source of uncertainty	Value of standard uncertainty $u(x_i)\times10^{-6}$	Type (A,B)	Prob. distribution	$c_i=df/dx_i$	$u_i=c_i.u(x_i)$ $\times10^{-6}$	Degree of freedom
Combined uncertainty						
Expanded uncertainty (k=2)						

Source of uncertainty	Value of standard uncertainty μrad	Type (A,B)	Prob. distribution	$c_i=df/dx_i$	$u_i=c_i.u(x_i)$ $\times10^{-6}$	Degree of freedom
Combined uncertainty						
Expanded uncertainty (k=2)						

Annex 3

List of participants

Organization	Country	Contact Person	E-mail	Shipping Address
INTI	Argentina	José Luis Casais	jcasais@inti.gob.ar	Av. Gral. Paz 5445 B1650WAB San Martín Buenos Aires Argentina tel. 5411 4724 6200
INMETRO	Brazil	Patrícia Cals de Oliveira Vitorio	pcoliveira@inmetro.gov.br	Instituto Nacional de Metrologia, Qualidade e Tecnologia - (Inmetro) Diretoria de Metrologia Científica - (Dimci) Divisão de Metrologia Elétrica – (Diele) Tel. (021) 2679-9095/2679-3395
INM	Colombia	Alvaro Zipaquira Triana	azipaquira@inm.gov.co	Av, Cr 50 No. 26 – 55 Int. 2 CAN Bogotá - Colombia
CENAMEP	Panamá	Julio Gonzalez	jgonzalez@cenamep.org.pa	Centro Nacional de Metrología de Panamá (CENAMEP AIP). Panamá, Ciudad de Panamá, Clayton, Ciudad del Saber, Edificio 215. Apartado 0843-01353 República de Panamá.
LAPEM	Mexico	Sergio Ochoa	sergio.ochoa@cfe.gob.mx	Laboratorio de Pruebas a Equipos y Materiales, LAPEM Edificio 5. Oficina de Metrología Av. Apaseo Ote. S/N Ciudad Industrial 36541 Irapuato, Gto. MEXICO
PTB	Germany	Enrico Mohns	Enrico.Mohns@ptb.de	Physikalisch-Technische Bundesanstalt - PTB Bundesallee 100 D-38116 Braunschweig Germany
UTE	Uruguay	Alejandro Santos	asantos@ute.com.uy	Paraguay 2385, Montevideo 11800, Uruguay, tel. 598-29242042

Annex 4
Schedule of the measurements

Country	Receipt of Traveling Standard	Departure of Traveling Standard
Uruguay		June 1st, 2013
Brazil	November 11, 2013	December 20, 2013
Colombia	January 6, 2014	14 February 2014
Panama	March 3, 2014	April 11, 2014
Mexico	April 28, 2014	June 6, 2014
Argentina	June 20, 2014	August 1, 2014
Uruguay	August 15, 2014	September 26, 2014
Germany	October 20, 2014	November 28, 2014
Uruguay	December 22, 2014	February 25, 2015

Annex 5

Measurement Results

Date _____(DY/MN/YR)

Laboratory _____ Country _____

Contact Name and Address _____

_____

_____

Method of Measurement (Include source of traceability, specify whether independently derived)

_____

_____

_____

_____

Frequency Hz	Burden (at nominal current) VA	Ambient Temperature °C	Nominal ratio (xxx/5)	Primary current A	Ratio error $\times 10^{-6}$	Ratio error uncertainty $\times 10^{-6}$	Phase displacement µrad	Phase displacement uncertainty µrad

Annex 6

Confirmation note of receipt

SIM comparison receipt form

(Send via e-mail to the comparison coordinator, with copy to the SIM EM chair, as a pdf attachment)

To

UTE LABORATORIO

Paraguay 2385, Montevideo, 11800, Uruguay

Tel/fax: +598 2 924 2042

Attn.: Alejandro Santos

E.mail: asantos@ute.com.uy

www.ute.com.uy

From: (receiving laboratory):

Re: **SIM comparison SIM.EM-S8, - Receipt of traveling standard**

Date: ..... (dd/mm/yyyyy)

We confirm having received the traveling standard of the SIM.EM-S8 comparison on.....(dd/mm/yyyyy)

After visual inspection:

□ No damage of the suitcase and the traveling standard has been noticed

□ The following damage(s) must be reported (if possible add a photo):

.....

.....

Date: Signature:

Page___of___

Annex 7

Confirmation note of dispatch.
SIM comparison sending form.

(Send via e-mail to the comparison coordinator, with copy to the SIM EM chair, as a pdf attachment)

To:

UTE LABORATORIO

Paraguay 2385, Montevideo, 11800, Uruguay

Tel/fax: +598 2 924 2042

Attn.: Alejandro Santos

E.mail: asantos@ute.com.uy

www.ute.com.uy

From: (sending laboratory):

Re: **SIM comparison SIM.EM-S8 - Sending off of traveling standard**

Date:……..(dd/mm/yyyyy)

We have informed the next participant on.....(dd/mm/yyyyy) that we will send the traveling standard to them next time.

We confirm having sent the traveling standard of the SIM.EM-S8 comparison on.....(dd/mm/yyyyy) to the next participant.

Additional information:

.....

.....

Date:..... Signature:.....

Page___of___

Annex 8

Photographs of the Transfer Standard

Fig. 1. Front view of the transformer.

Fig. 2. Rear of the transformer.

Fig. 3. Up view of the transformer.

Fig. 4. Bars for 500 and 1000 to 5 A

Fig. 5. Electronic device

Fig. 6. Auxiliary bars for parallel conexion.

Fig. 7. Auxiliary bars for series conexion.

Annex 9

Connection of the electronic device to the transfer Standard

The Transfer Standard is a two stage transformer. For this reason it has a compensating winding (A-A_i). The secondary current to be measured is the main secondary current (S-Si) plus the current of the compensator winding. The method for adding these currents is utilizing the electronic device supplied in the package.
The connection of the electronic device to the transfer standard is shown in the next figure:

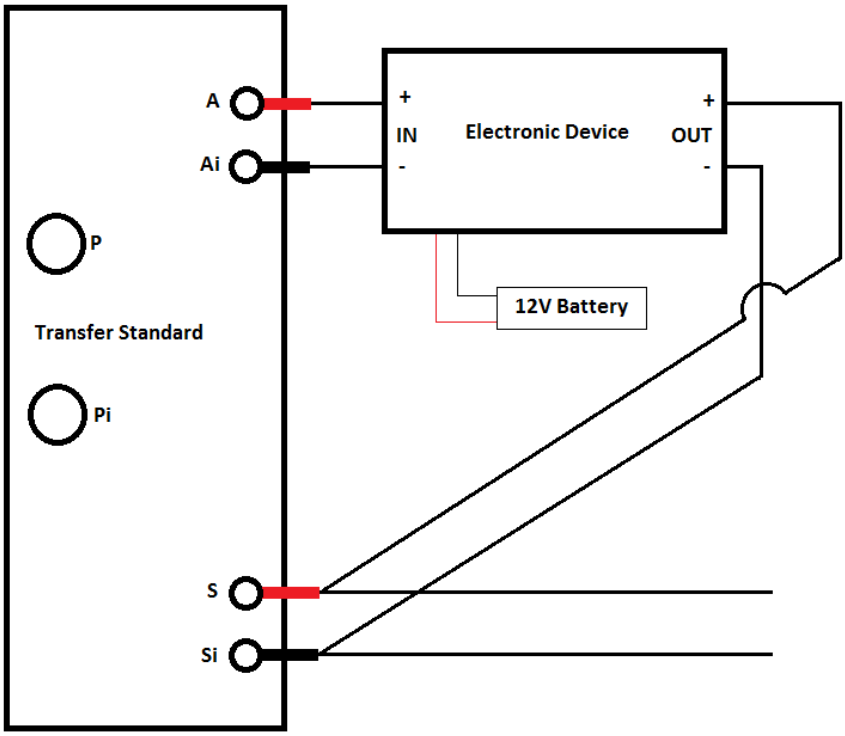

Fig. 8. Connection between the transfer transformer and the electronic device.

Annex 10

Connection of copper bars for the 500:5 and 1000:5 ratios.

The bars and copper auxiliary parts are joined by nuts and screws provided in the package.

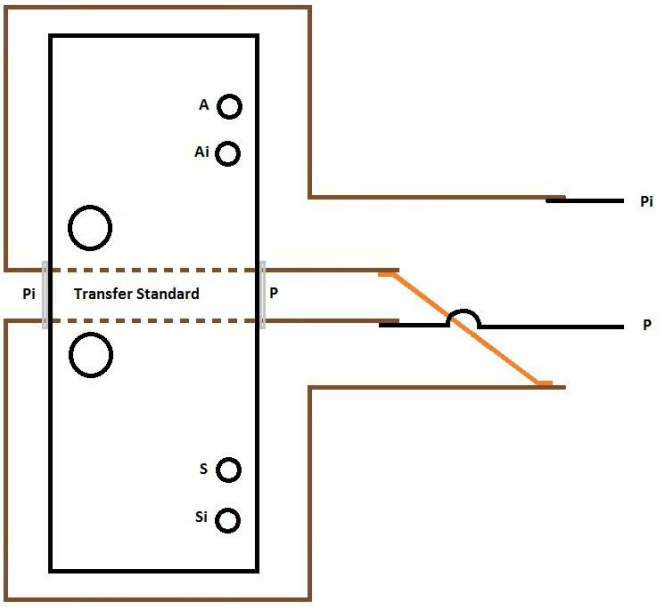

Fig. 9. Connection for 500 A to 5 A

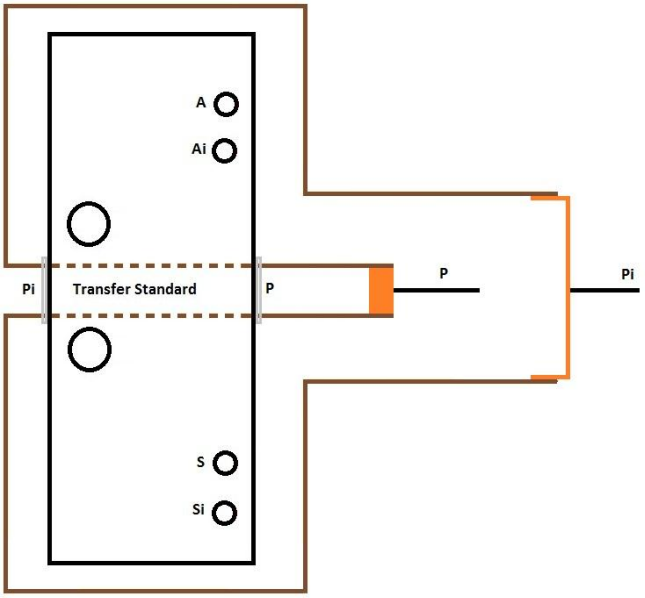

Fig. 10. Connection for 1000 A to 5 A.

Warning! When not using the 500 A and 1000 A ranges, the bars should be disconnected.

Annex 11

Transportation case

The upper part of the case is aluminum made and the base is plastic. No wood is used.

Fig. 11. Transportation case