TECHNICAL PROTOCOL

Comparison of Resistance Standards at 100 Ω

GULFMET.EM.S1

TÜBİTAK UME

(Rev. 0)
November 15, 2016

Contents

1. Introduction

There is a need for the metrology institutes in GULFMET region to demonstrate technical competence in the field of resistance calibrations. Therefore, this GULFMET.EM.S1, 100 Ω resistance comparison, was planned for this purpose.

The participants are TÜBİTAK UME (Turkey-EURAMET), SCL (Hong Kong-APMP), SASO NMCC (Kingdom of Saudi Arabia-GULFMET) and EMI (United Arab Emirates (Abu Dhabi)-GULFMET).

TÜBİTAK UME is acting as the pilot laboratory. The travelling standard will be provided by TÜBİTAK UME. TÜBİTAK UME will be responsible to monitoring standard performance during the circulation and the evaluation and reporting of the comparison results.

The comparison will be carried out in accordance with the CCEM Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons [1].

2. Travelling Standard

There are 2 (two) standard resistors as travelling standards (Figure 1). Their identifications are as follows:

100 Ω Travelling Standard		100 Ω Travelling Standard	
Manufacturer	: TEGAM	Manufacturer	: TEGAM
Model	: SR102	Model	: SR102
Serial Number	: A2010101SR102D	Serial Number	: A2010700SR102D

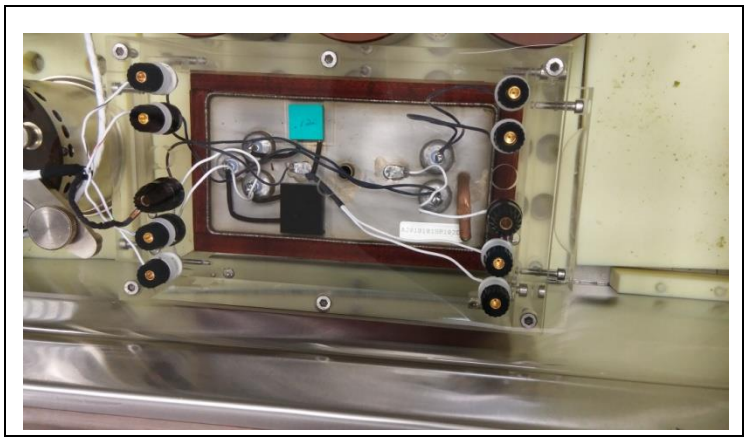

Figure 1. Representative photo of the travelling standard

Two pieces of 100 Ω Standard Resistor will be measured at 5 mA DC current in the scope of the comparison.

The travelling standard will be supplied by TÜBİTAK UME. These standards were chosen for its high accuracy and stability in time.

Table 1. Details of the travelling standards

Device	Nominal Value	Brand	Type	Serial Number
Standard Resistor	100 Ω	Tegam	SR102	A2010101SR102D
Standard Resistor	100 Ω	Tegam	SR102	A2010700SR102D

3. Participant Laboratories

The pilot institute for this comparison is TÜBİTAK UME (Turkey). The contact details of the coordinator are given below:

Pilot Institute	:	TÜBİTAK Ulusal Metroloji Enstitüsü (UME)
Coordinator	:	Enis TURHAN Tel: +90 262 679 50 00 Fax: +90 262 679 50 01 E-mail: enis.turhan@tubitak.gov.tr

The participating institutes and contact persons with their addresses are given in Table 2.

Table 2. Participants

Country	Institute	Acronym	Shipping Address	Contact Person
Turkey	TÜBİTAK Ulusal Metroloji Enstitüsü	TÜBİTAK UME	TÜBİTAK Ulusal Metroloji Enstitüsü (UME) TÜBİTAK Gebze Yerleşkesi Barış Mah. Dr. Zeki Acar Cad. No:1 41470 Gebze-Kocaeli, TURKEY	Enis TURHAN enis.turhan@tubitak.gov.tr Tel: +90 262 679 50 00
Saudi Arabia	SASO The National Measurement and Calibration Center	SASO NMCC	Saudi Standards, Metrology and Quality Organization Of the Kingdom of Saudi Arabia (SASO) Riyadh - Al Muhammadiyah - in front of King Saud University, Al Imam Saud Ibn Abdul Alziz Rd Riyadh, 11471 P.O. Box 3437 , KINGDOM of SAUDI ARABIA	Abdullah Al Roubaish a.robaish@saso.gov.sa Tel: +966 11 252 9730
Hong Kong	ITC The HKSARG Standards and Calibration Laboratory	SCL	36/F., Immigration Tower, 7 Gloucester Road, Wanchai, Hong Kong	Steven Yang steven.yang@itc.gov.hk Tel: +852 2829 4855
United Arab Emirates	Emirates Metrology Institute	EMI	EMIRATES METROLOGY INSTITUTE (EMI) Centre of Excellence for Applied Research and Training (CERT) 881 Sultan Bin Zayed The First Street, PO Box 853, Abu Dhabi United Arab Emirates	Jon Bartholomew Jon.Bartholomew@qcc.abudhabi.ae Tel: +971 50 386 2676

4. Time Schedule

The time schedule for the comparison is given in the Table 3. The circulation of travelling standard will be organized so that to monitor the performance of the travelling standard. Each laboratory will have 3 weeks to carry out the measurements and 2 weeks for transportation. Any deviation in the agreed plan should be approved by the pilot institute. The pilot laboratory will measure the travelling standards at the beginning, in the middle and at the end of comparison to allow close monitoring of the behaviour of the standard.

Table 3. Circulation Time Schedule

Acronym of Institute	Country	Starting Date	Time for measurement and transportation
TÜBİTAK UME	Turkey	12.12.2016	6 weeks
EMI	Abu Dhabi	23.01.2017	5 weeks
SCL	Hong Kong	27.02.2017	5 weeks
TÜBİTAK UME	Turkey	03.04.2017	5 weeks
SASO NMCC	Saudi Arabia	08.05.2017	5 weeks
TÜBİTAK UME	Turkey	12.06.2017	5 weeks

5. Transport Case

The travelling standard is packed in a transport case of size (55 x 67 x 29) cm and a total weight of 20 kg. The transport case can easily be opened for customs inspection.

The content of the transport case is given at Table 1.

6. Transportation of Travelling Standard

Each participant laboratory is responsible for the transportation of the travelling standard to the next participant laboratory. The transportation can be carried our by hand-carrying or by cargo. Unless the transport cases are damaged, it will be requested to use the same cases for transport of the standards to the next participant.

The pilot institute must be informed of receipt and dispatch of the standard using the receipt form (Annex 1) and dispatch form (Annex 2) by e-mail.

6.1. Failure of Travelling Standard

In case of any damage or malfunction of the travelling standard, the comparison will be carried out after the travelling standard is repaired.

6.2. Financial aspects

Each participant laboratory is responsible for its own costs for the measurements as well as any damage that may occur within its country.

Each participant laboratory is responsible for the transportation of the travelling standard to the next participant laboratory. The pilot laboratory has no insurance for any loss or damage of the travelling standard.

7. Measurement Quantities and Points

The quantities to be measured and the measurement frequency are given in Table 4.

Table 4. Measurement quantity & points

Quantity	Nominal Value	Measurement Current
DC Resistance	100 Ω	5 mA

The main parameter is resistance. In addition, the quantities given below must be measured;

- Temperature of oil bath
- Ambient temperature

The measurements should be performed at (23 ± 0.01) °C temperature in oil bath. The temperature coefficients of the standards have been determined to allow for corrections. They are intentionally not provided with this protocol.

8. Calculation of the Comparison Reference Value

The Comparison Reference Value (CRV) will be calculated using the results of TUBİTAK UME and SCL laboratories.

9. Measurement Instructions

9.1. Precautions

- Visual check of the device must be performed before putting resistors into oil bath. If any damage detected the responsible person must contact with Enis TURHAN immediately.

9.2. Before the Measurements

- The travelling standard should be allowed to stabilize in temperature controlled oil bath for at least 1 day before commencing measurements.

9.3. Environmental Conditions

- The ambient temperature and oil bath temperature must be measured and recorded.
- Preferably, the measurements should be carried out at the ambient conditions given below;

Oil Bath Temperature : (23 ± 0.01) °C
Ambient Temperature : (23 ± 1) °C
Relative humidity : (45 ± 20) %rh

9.4. Method of measurement

- Each participant laboratory may use its own measurement method.

9.5. Connections

- There are two sides of connectors at the travelling standards. One side is for temperature measurement the other side is for resistance measurement. Only resistance connections will be used in the measurements. The resistance connection terminals are under the name plate on the resistors. The connection scheme is shown in the figure below.

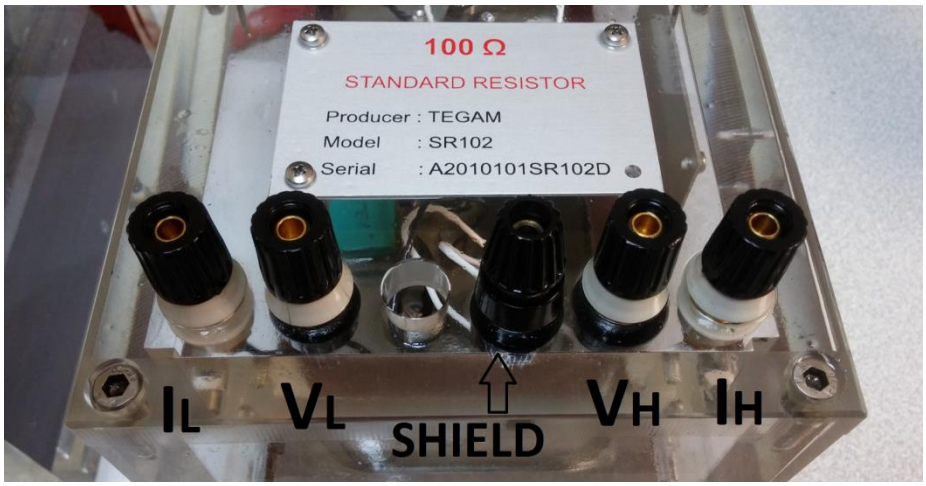

Figure 2. Connections of the travelling resistors

10. Measurement Uncertainty

The uncertainty of measurement must be calculated according to the JCGM 100 “Guide to the Expression of Uncertainty in Measurement” [2] for the coverage probability of approximately 95%.

All contributions to the measurement uncertainty should be listed in the report submitted by each participant.

Each laboratory should be declare measurement uncertainty budget where they take into account their measurement system uncertainty contributions, according to the format given Annex A

11. Reporting of Results

The results should be prepared and send to the pilot institute within 30 days after completing the measurements.

Results shall be reported to the pilot laboratory. The report must contain at least:

- Details of participating laboratory,
- The date of the measurements,
- A detailed description of the measurement method and system used,
- The measurement standards used in the comparison measurements,
- The environmental conditions during the measurements,
    - ambient temperature
    - Oil bath temperature
    - Maximum temperature change during every set of measurements
    - Ambient relative humidity
- Results of measurement; the measurement results shall be provided according to the Annex 3 format.
- A statement of traceability,
- Model function of measurement with explanations of the symbols,
- Expanded measurement uncertainty, estimated for the coverage probability of approximately 95%.

12. Final Report of the Comparison

The pilot laboratory is responsible for the preparation of a comparison report.

The draft version of the comparison report will be issued within two months after receiving the participant report by the pilot laboratory. Draft report will be sent to participant laboratories for discussion and approval. This draft will be confidential between the participants.

The participant will have one week to send their comments on Draft Report. After approval, Draft Report will become the Final Report.

Comparison results will be evaluated according to the En value which is calculated Equation 1 stated at ISO / IEC 17043 “Conformity assessment — General requirements for proficiency testing” [3] Standard.

$$E_n = \frac{x_{lab} - x_{ref}}{\sqrt{U_{lab}{}^2 + U_{ref}{}^2}} \quad (1)$$

x_{lab}: Participant laboratory measurement result

x_{ref}: Pilot laboratory measurement result

U_{lab}: Participant laboratory measurement uncertainty

U_{ref}: Pilot laboratory measurement uncertainty

The laboratory measurement results will be utilized according to the criteria of E_n value which is given below.

If $|E_n| \leq 1$ then it is successful

If $|E_n| > 1$ then it is unsuccessful

13. References

[1] CCEM Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons, 2007 (available on the BIPM website: http://www.bipm.org/utils/common/pdf/CC/CCEM/ccem_guidelines.pdf)

[2] Evaluation of measurement data - Guide to the Expression of Uncertainty in Measurement (GUM), JCGM 100, First edition, September 2008 (available on the BIPM website: http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf)

[3] ISO / IEC 17043 “Conformity assessment — General requirements for proficiency testing”, International Standardization Organization”, 2010

Annex 1: The Receipt Form

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The received date of transport case		
Was there any serious damage on the transport case?	Yes ☐	No ☐
Was the contents of the transport case (two pieces of standard resistors) completed?	Yes ☐ If No, please list missing items:	No ☐
After inspection, the travelling standard is in working condition?	Yes ☐	No ☐
Is there an unexpected deviation from the nominal value of the travelling standards?	Yes ☐	No ☐
Remarks		

The transport case was received by:

Institute	
Contact Person	
E-mail Address	
Telephone No	

Please send the form to the coordinator of the comparison!

enis.turhan@tubitak.gov.tr

Annex 2: The Dispatch Form

Comparison of Resistance Standards at 100 Ω

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The dispatch date of transport case		
After inspection, the travelling standard is in working condition?	Yes ☐	No ☐
Is there an unexpected deviation from the nominal value of the travelling standards?	Yes ☐	No ☐
Is the contents of the transport case (two pieces of standard resistors) completed?	Yes ☐	No ☐
Shipping way (Courier, in hand etc.)		
	Courier Name: Tracking No: Airline: Flight No: Date:	
Shipping to (Participant Name & Address)		
Remarks		

The transport case was dispatch by:

Institute	
Contact Person	
E-mail Address	
Telephone No	

Please send the form to the next participant and the coordinator of the comparison!

enis.turhan@tubitak.gov.tr

Annex 3. Participant Report

PARTICIPANT REPORT

1. PARTICIPANT INFORMATION

Laboratory Name	
Related Person Name	
Telephone No	
Fax No	
E-mail	
Adress	

2. MEASUREMENT DATE

3. ENVIRONMENTAL CONDITION

Temperature : (±) °C

Relative Humidity : (±) rh%

4. REFERENCES USED IN MEASUREMENT

Instrument Name	Manufacturer	Type / Model	Serial No	Traceability

5. MEASUREMENT METHOD

6. MEASUREMENT RESULTS

Table 1. 100 Ω Measurements at 5 mA

Date	Resistance Value (Ω)	Oil Bath Temp. (°C)	Max. Oil Bath Temp. Change (°C)	Lab. Temp. (°C)	Lab. Humidity (%rh)

7. UNCERTAINTY BUDGET

7.1. Uncertainty Budget for 100 Ω Resistance Measurements

Model function :

Definition	Expected Value x_i	Standard Uncertainty $u(x_i)$	Distribution Function	Sensitivity Coefficient c_i	Uncertainty contribution $u(y_i)$
Measured Value		**Combined Uncertainty**			
		Expanded Uncertainty (k=2)			