GULFMET.EM.K2

Comparison of Resistance Standards at 10 MΩ and 1 GΩ

Technical Protocol

Version 5
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CONTENTS

1. INTRODUCTION

The technical basis of the Mutual Recognition Arrangement (MRA) is a set of results obtained in a course of time through key comparisons carried out by the Consultative Committees (CCs) of the CIPM, the BIPM and the Regional Metrology Organizations (RMOs). As part of this process, the CIPM Consultative Committee for Electricity and Magnetism (CCEM) carried out the key comparison CCEM-K2.2012 of resistance standards at 10 MΩ and 1 GΩ. This comparison was piloted by the National Research Council of Canada and was approved by the CCEM for equivalence and published in March 2020. [1]

In order to link the National Metrology Institutes (NMI) organized in GULFMET to the key comparison CCEM-K2.2012, the GULFMET Technical Committee for Electricity and Magnetism decided at its June 2020 meeting to carry out the corresponding RMO key comparison GULFMET.EM-K2. The Emirates Metrology Institute (EMI) agreed to act as pilot laboratory with support from TÜBİTAK Ulusal Metroloji Enstitüsü (UME).

The scope of the comparison is calibration of resistance standards at 10 MΩ and 1 GΩ. The protocol was prepared following the CCEM guidelines for planning, organizing, conducting and reporting key and supplementary comparisons [2], and in essence is the same as that used for the CCEM-K2.2012 comparison[3].

The comparison will be carried out according to the requirement of “Measurement comparisons in the CIPM MRA, Guidelines for organizing, participating and reporting CIPM MRA-G-11” [1] and “Gulf Association for Metrology (GULFMET) Guidelines on Conducting Comparisons GULFMET 02” [3].

2. TRAVELLING STANDARDS

2.1. Description of the standards

Figure 1. The travelling standards

The standards are manufactured by Measurements International (CA), Model 9331G. The model 9331G is based on a NIST design which includes a split guard design and internal temperature sensor. The split guard circuit design allows for applying independent guard voltages at each side of the resistor. Connections are type N. The Model 9331G is hermetically sealed in a shielded enclosure and isolated from the case.

Four standards, two of each value, will be circulated to each laboratory. The comparison will be arranged in two loops, with UME measuring before, between and after the loops.

Table 1. The general specifications of the travelling standards

Model	Nominal Value	Tolerance ± ppm	Stability 1 Year	Temperature Coefficient 23 °C ± 5 °C	Voltage Coefficient	Maximum Voltage
9331G/10 M	10 MΩ	5	10 ppm	± 5 ppm/°C	0.2 ppm/V	1 kV
9331G/1 G	1 GΩ	30	25 ppm	± 5 ppm/°C	0.5 ppm/V	1 kV

2.2. Quantities to be measured

Table 2. Quantities to be measured

Resistance of the 10 MΩ standards at the following conditions:	
test voltage:	$V_{test} \leq 100$ V; preferably 10 V
ambient temperature:	(23 ± 0.2) °C
relative humidity:	(50 ± 10) %
Ambient pressure	As recorded
Resistance of the 1 GΩ standards at the following conditions:	
test voltage:	$V_{test} \leq 100$ V; preferably 100 V
ambient temperature:	(23 ± 0.2) °C
relative humidity:	(50 ± 10) %
Ambient pressure	As recorded

In the case that the measurements have to be performed at a different ambient temperature, the results will be corrected by the pilot laboratory to those expected for 23 °C using the temperature coefficients determined by UME. In the case that the measurements have to be performed at a different ambient pressure, the results will be corrected to the average pressure of the UME measurements using the pressure coefficients determined by EMI. The uncertainty of this correction will then be added to the measurement uncertainty supplied by the participant laboratory.

2.3. Calculation of the Comparison Reference Value (CRV)

The comparison reference value (CRV) will be evaluated following the principles laid down in [5]. A generalized version of the procedure described in [6] will be applied to account for the drift of the travelling standards. The proposed principles of the analysis are:

- The results obtained by UME will be used to determine the drift behaviour of the travelling standards and to link the two loops of the comparison.
- The results provided by the participants will be corrected where necessary to the nominal pressure, temperature (23 °C) and nominal test voltages (10 V for 10 MΩ standards and 100 V for 1 GΩ) using the pressure, voltage and temperature coefficients already determined by UME and EMI;
- For the calculation of the CRV, the weighted mean over the laboratories will be used. If for a result, the uncertainty contribution due to the traceability to another NMI participating in the comparison amounts to a substantial part of the overall uncertainty value, the result will not be taken into account in the calculation of the CRV.

To build a linkage between key comparison CCEM-K2.2012 and this comparison, the normal linking procedure that determine a correction value from the NMIs which participated in both of CCEM-K2.2012 [1] and this comparison will be used. Degrees of equivalence between any two labs, each of which participated in either or both comparisons, and the corresponding uncertainties will be calculated according to the CCEM Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons. [7]

3. ORGANIZATION

3.1. Coordinator and members of the support group

The Emirates Metrology Institute (EMI) will coordinate the comparison and report the measurement results.

Pilot Institute:	**Emirates Metrology Institute (EMI)**
Coordinator:	Shamsa Al Kayyoomi Tel: -971 02 403 6732 E-mail: shamsa.alkayyoomi@qcc.gov.ae

Support group:

TÜBİTAK Ulusal Metroloji Enstitüsü (UME) will characterise the voltage and temperature coefficients of the standards, monitor the stability of the standards and assist the pilot laboratory with analysis of the results.

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

The following laboratories are providing links to CCEM-K2.2012

Institute:	National Metrology Institute of South Africa (NMISA)
Coordinator :	Mr. Marcus Hlakola mhlakola@nmisa.org
Institute:	National Physical Laboratory (NPL)
Coordinator :	Colin Porter colin.porter@npl.co.uk Tel: +44 (0)20 8943 6195
Institute:	Physikalisch-Technische Bundesanstalt (PTB)
Coordinator :	Bernd Schumacher bernd.schumacher@ptb.de Tel: +49 531 592 2110

3.2. Participants

A list of participating institutes with contacts of responsible person and shipping address is listed in Appendix A.

3.3. Time schedule

The circulation of the standards will start in May 2024 and is planned to end in August 2025. The detailed comparison time schedule is given in Appendix B.

The period between measurements by each participant is **seven weeks** including the time necessary for transportation to the next laboratory. This should allow each participant to keep the standards in their laboratory for three weeks with four weeks allowed for shipping the standards to the next participant.

In agreeing with the proposed circulation time schedule, each participating laboratory confirms that it is capable to perform the measurements in the limited time period allocated in the time schedule. **If unforeseen circumstances prevent a laboratory from carrying out the measurements within the allocated time, the original schedule should be followed, and the standards must be sent to the next participant without any delay.** The laboratory may be allowed to carry out additional measurements after the completion of the original schedule and before the end of this comparison.

If delay occurs, the pilot laboratory shall inform the participants and revise - if necessary - the time schedule or skip one country and put it at the end of the circulation.

4. TRANSPORTATION

4.1. Transportation

Each participant is responsible for arranging transport and insurance from their institute to the next laboratory Transportation is at each laboratory's own responsibility and cost. Due to the time constraints, a recognised courier service guaranteeing an adequate delivery time, inclusive of the time for customs procedure, should be used. Where appropriate, customs procedures have to be examined in advance of the transport. *The courier service has to be informed that the transport case should not be exposed to extreme temperatures or mechanical shocks.*

Depending on the availability of ATA carnet in the participating country/economy, the transportation of standards may be split into two groups, namely: ATA carnet and non-ATA carnet.

For laboratories using the ATA carnet route upon each movement of the package, the person organising the transit must ensure that the carnet is presented to customs on leaving the country, and upon its arrival in the country of destination. When the package is sent unaccompanied, the carnet must be included with the other forwarding documents so that the handling agent can obtain customs clearance. In no case should the carnet be packed inside the case. In some cases, it is possible to attach the carnet to the case. The carnet must be stored in the laboratory very carefully because a loss of the carnet will cause a serious delay in the comparison schedule.

For laboratories using the non-ATA carnet route, arrangements and documentation with their local custom and the next participant's custom must be prepared in advanced.

Arrival and departure of the standards must be communicated with the pilot laboratory and the next laboratory using forms available in Appendix D of this protocol by E-mail.

- When the package arrives at your laboratory, fill in the "Receiving form" in Appendix D and send the form to the pilot laboratory by E-mail.
- When preparing the package for shipment, fill in the "Shipping checklist" in Appendix D and send the checklist to the pilot laboratory by E-mail.
- When the package is shipped, fill in the "Dispatch form" in Appendix D and send the checklist to the pilot laboratory and the next participant by E-mail.

Please resend any forms that are not acknowledged. If any delay due to transportation is expected, the sender and/or the receiver should promptly contact the pilot laboratory.

4.2. Shipping Package

The travelling standard is packed in a transport case of size (53.8 x 40.6 x 26.9) cm and a total weight of 10.6 kg. The transport case can easily be opened for customs inspection.

The traveling standards should be handled with extreme care. Extreme temperature, humidity or pressure changes as well as violent mechanical shocks must be avoided. A temperature and humidity

data logger is included in the shipping package to log the ambient condition of the transit case during transportation.

On receipt of the case, unpack the standards carefully and check for any damage and the completeness according to the packing list. The data from the ambient condition recorder should be downloaded following the instruction in APPENDIX F: Datalogger Instructions. If possible, the transport case should be stored in the laboratory. Any damage to the standards or missing items shall be reported to the pilot laboratory. Upon receiving the travelling standards, laboratory must inform the coordinator using the form provided in APPENDIX D: Forms for Transportation together with the exported MS excel data from ambient condition recorder.

After completing the measurement, the travelling standards shall be sent to the next laboratory without delay.

Before sending the case out, check the packing list and ensure everything is enclosed. Start the ambient condition recorder following the instruction in APPENDIX F: Datalogger Instructions. The standards should be packed in the original transport case as illustrated in the instruction manual. If relevant ensure that the ATA carnet is packed outside the case for easy access by customs.

The content of the transport case is given below:

Item	Qty
Resistor 9331G/10M Serial No 1104684	1
Resistor 9331G/10M Serial No 1104685	1
Resistor 9331G/1G Serial No 1102889	1
Resistor 9331G/1G Serial No 1104686	1
N-Type to Banana adaptors	4
Extech RHT35: USB Humidity/Temperature/Pressure Datalogger	1
Cable for measurement of internal thermistor resistance	1
Transit case	1

Please refer to Appendix E for illustration of the shipping package.

4.3. Failure of Travelling Standard

In case of any damage or malfunction of the standards, the participating laboratory must report to the pilot laboratory immediately

4.4. Financial aspects

Each participant institute is responsible for its own costs for the measurements, transportation to the pilot laboratory and insurance of the shipment to the pilot laboratory. Each participant institute is responsible for paying any customs charges, duties, deposits or surcharges within its country.

In case the prepared ATA carnet is not accepted by the participant’s country/economy, the customs duty (if applicable) shall be paid by the laboratory of the country/economy.

Each participant institute is responsible for any damage that may occur within its country.

The overall costs for the organisation of the comparison are covered by the pilot institute. The pilot institute has no insurance for any loss or damage of the travelling standard.

5. MEASUREMENT INSTRUCTIONS

5.1. Test before measurements.

No initial tests are required. However, depending on the measurement set-up it may be necessary to measure the isolation resistance between the resistive elements and the case of the standards.

Resistors should be stored in the intended measurement temperature at least 48 hours before measurement.

5.2. Measurement performance

Measurand: DC resistance value of the travelling standards

Test voltage: 10 MΩ: $V_{test} \leq 100$ V; preferably 10 V
1 GΩ: $V_{test} \leq 100$ V; preferably 100 V

Temperature: (23 ± 0.2) °C; or other stable temperature such as (20 ± 0.2) °C. The temperature fluctuation should not exceed the given limits.

Humidity: (50 ± 10) %.

Pressure: Ambient pressure as recorded.

Measurements: The measurements should be repeated as dictated by the procedures of the measuring laboratory

5.3. Method of measurement

It is assumed that every participant uses its normal measurement method. The method and the traceability scheme have to be described in the measurement report (see below).

The choice of the ground/guard configuration is left to the participants. Section 2.1 describes the internal configuration of the ground/guard terminals in the resistance standards.

The measurement result shall be reported as the relative error of each travelling standard and calculated by:

$$Relative\ Error = \frac{Indicated\ Value - Nominal\ Value}{Nominal\ Value}$$

6. MEASUREMENT UNCERTAINTY

A detailed uncertainty budget in accordance with the Guide to the Expression of Uncertainty in Measurement [8] shall be reported for one resistor of each nominal value.

To have a comparable uncertainty evaluation, a list of typical principal uncertainty contributions is given. Depending on the measuring methods, this list may vary:

- Step-up procedure
- Reference standard (drift, temperature and voltage dependence)
- Measuring set-up (stability, gain and offset-effects, configuration)
- Leakage effects
- Temperature
- Reproducibility

6.1. Scheme to report the uncertainty budget

A proposed scheme for the uncertainty budget is given in Appendix C.

7. MEASUREMENT REPORT

7.1. File Format

The participant's report must be submitted electronically to the pilot laboratory within **one month** from the completion of the measurements, using the following file format:

-Word 2003 or later version for the report including the participant's results
-Excel 2003 or later version for the raw data and detailed uncertainty budget

7.2. Contents of report

The report should contain at least the following:

- **Details of participating institute**
- **The date of the measurements**
- **Description of the measuring set-up including the ground/guard configuration**
- **Brief description of the measurement procedure**
- **The measurement standards used in the measurements,**
- **A statement of traceability for the measurements**
- **The measurement results:**
  - Mean resistance value, with uncertainty, for each standard and the corresponding mean date of measurement.
  - Individual results in the form described in Appendix C;
- **The test voltages used for the measurements**
- **The ambient conditions of the measurement**
  - the pressure, temperature and humidity with limits of variation
- **A complete uncertainty budget**
  - in accordance with the principles of the Guide to the Expression of Uncertainty in Measurement [8], including degrees of freedom for every component and calculation of the coverage factor. Such an analysis is a prerequisite to be considered in the calculation of the comparison reference value. It is also an essential part of the final report which will appear in the BIPM Key Comparison Database.

The pilot laboratory will inform a participating laboratory if there is a large deviation between the results of the laboratory and the preliminary reference values, so that it can verify the communicated results. No other information will be communicated before the completion of the circulation.

8. FINAL REPORT OF THE COMPARISON

At the conclusion of circulation of the standards, the pilot laboratory will prepare the draft A report within 4 months. This report will be prepared with the aid of the support group as necessary and will be sent to all participants for comments. The draft A report is confidential to the participants.

The participants will have two months for comments on the draft A report. In the case of results that are discrepant with the reference value or are not consistent with their published CMCs, the rules given in [1] will be followed.

On the basis of the comments received, the pilot laboratory will prepare the second draft (draft B). The draft B report will be submitted to the GULFMET TC-EMTF for approval. At this stage each participating laboratory will submit a signed statement regarding the extent to which the results of this comparison support or do not support their Calibration and Measurement Capabilities as listed in the BIPM MRA Appendix C.

Once approved by the GULFMET TC-EMTF the report will be sent to the CCEM WGLF for approval. On the basis of the comments received the pilot laboratory will prepare the Final Report. The Final Report will form the basis for the publication of results.

9. REFERENCES

[1] Final report of the CCEM-K2.2012 key comparison of resistance standards at 10 MΩ and 1 GΩ. Carlos Sanchez1 and Kai Wendler, Metrologia, Volume 57, Number 1A
https://iopscience.iop.org/article/10.1088/0026-1394/57/1A/01006

[2] Measurement comparisons in the CIPM MRA. Guidelines for organizing, participating and reporting. CIPM MRA-G-11.
https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-11.pdf/9fe6fb9a-500c-9995-2911-342f8126226c

[3] CIPM Key Comparison CCEM-K2 Comparison of Resistance Standards at 10 MΩ and 1 GΩ. TECHNICAL PROTOCOL Dave Inglis

[4] Gulf Association for Metrology (GULFMET) Guidelines on Conducting Comparisons. GULFMET 02, Issue 1, 20/ 02 /2012
https://www.gulfmet.org/document-and-guidelines

[5] M. G. Cox, The evaluation of key comparison data, Metrologia 39, pp. 589-95, 2002.

[6] N. F. Zhang, H.-K. Liu, N. Sedransk and W. E. Straderman, Statistical analysis of key comparisons with linear trends, Metrologia, 41, pp. 231-7, 2004.

[7] CCEM Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons Version 2.1 (June 2017).
https://www.bipm.org/documents/20126/30125107/CCEM+Guidelines+for+Planning%2C+Organizing%2C+Conducting+and+Reporting+Key%2C+Supplementary+and+Pilot+Comparisons/8e6c27ff-db90-e4a6-f659-8e95d25b8ed4\

[8] JCGM 100:2008 – Evaluation of measurement data – Guide to the expression of uncertainty in measurement, September 2008
https://www.bipm.org/en/publications/guides

APPENDIX A: List of Participants

No	Country / Economy	Acronym of Institute	Name of Institute	Shipping Address	Contact Person	ATA Carnet
1.	United Arab Emirates	EMI	Emirates Metrology Institute	Emirates Metrology Institute Abu Dhabi Quality and Conformity Council (QCC) Kryptolabs Building, Masdar City Abu Dhabi, UAE	Shamsa Al Kayyoomi shamsa.alkayyoomi@qcc.gov.ae Tel: -971 02 403 6732	No
2.	Turkey	UME	TÜBİTAK Ulusal Metroloji Enstitüsü	TUBITAK UME Tubitak Gebze Yerleskesi Baris Mah. Dr. Zeki Acar Cad. No.1 Gebze Kocaeli, Turkey	Enis TURHAN enis.turhan@tubitak.gov.tr Tel: +90 262 679 50 00	Yes
3.	Saudi Arabia	SASO-NMCC	Saudi Standards, Metrology and Quality Organization National Measurement and Calibration Center	Saudi Standards, Metrology and Quality Organization (SASO)-National Measurements & Calibration Center PO. B 3437 Riyadh- Al Muhammadiyah – in front of King Saud University (Bldg. # 4, NMCC) 11471 Riyadh Kingdom of Saudi Arabia	Mr. Ahmed AlAyali a.ayli@saso.gov.sa	No

No	Country / Economy	Acronym of Institute	Name of Institute	Shipping Address	Contact Person	ATA Carnet
4.	Qatar	QGOSM	Qatar General Organization for Standards and Metrology	Qatar General Organization for Standards and Metrology	Nany S. Al-Kuwari nsalkwary@qs.gov.qa	No
5.	Morocco	LPEE-LNM	Laboratoire Public d'Essais et d'Études, Laboratoire National de Métrologie	Division Métrologie Physique LPEE-LNM km 7, Route d'El Jadida, Casablanca Morocco	Mr Abdellah Ziti ziti@lpee.ma Tel: +212 5 22 48 87 29 Mr Said Amzil amzil@lpee.ma Tel : +212 6 60 44 16 06	Yes
6.	South Africa	NMISA	National Metrology Institute of South Africa	National Metrology Institute of South Africa Meiring Naudé Road, Brummeria, Pretoria, South Africa	Mr. Marcus Hlakola mhlakola@nmisa.org	Yes
7.	Germany	PTB	Physikalisch-Technische Bundesanstalt	Physikalisch-Technische Bundesanstalt AG 2.11 Gleichstrommesstechnik 38116 Braunschweig Bundesallee 100	Bernd Schumacher bernd.schumacher@ptb.de Tel: +49 531 592 2110	Yes
8.	United Kingdom	NPL	National Physical Laboratory	National Physical Laboratory Hampton Road Teddington Middlesex TW11 0LW	Colin Porter colin.porter@npl.co.uk Tel: +44 (0)20 8943 6195	Yes or No

No	Country / Economy	Acronym of Institute	Name of Institute	Shipping Address	Contact Person	ATA Carnet
9.	Uzbekistan	UzNIM	Uzbek National Institute of Metrology of Uzstandard Agency	Department of Electr and magnetic measurements 1000049, Farobiy street, 333A, Tashkent city, Uzbekistan	Mr Kamoliddin Makhamatov k.makhamatov@nim.uz Tel: +99878 150 26 03 +99897 773 37 22 or Sardor Ikramov, s.ikramov@nim.uz Tel: +99878 150 26 03 +99897 704 44 21	No
10.	Bosnia and Herzegovina	IMBIH	Institute of metrology of Bosnia and Herzegovina	Laboratory for electrical quantities and time and frequency Branilaca Sarajeva 25 Sarajevo 71000, BiH	Srdjan Calija srdjan.calija@met.gov.ba Tel +387 33 568 942 Vladimir Milojevic vladimir.milojevic@met.gov.ba Tel +387 33 568 924	No

APPENDIX B: Measurement Schedule

Measurement Dates	Country / Economy	Acronym of Institute
Initial Measurements	Turkey	UME
13 May to 14 June 2024	United Arab Emirates	EMI
8 July to 2 August 2024	Saudi Arabia	SASO-NMCC
26 August to 20 September 2024	Qatar	QGOSM
14 October to 8 November 2024	Uzbekistan	UzNIM
2 December to 27 December 2024	Turkey	UME
20 January 2025 to 14 February 2025	Germany	PTB
10 March to 4 April 2025	United Kingdom	NPL
28 April to 23 May 2025	South Africa	NMISA
16 June to 11 July 2025	Morocco	LPEE-LNM
4 August to 29 August 2025	Bosnia and Herzegovina	IMBIH
Final Measurements	Turkey	UME

The period between measurements by each participant is **seven weeks** including the time necessary for transportation to the next laboratory.

APPENDIX C: Measurement Results

Standard Serial No:

Date	Temperature and Standard Uncertainty T (°C)	Relative Humidity and Standard Uncertainty RH (%)	Pressure and Standard Uncertainty P (kPa)	Test voltage and Standard Uncertainty (V)	Difference from nominal value (μΩ/Ω)	Expanded Uncertainty (μΩ/Ω)

Quantity Xi	Estimate xi	Standard uncertainty u(xi)	Probability distribution /method of evaluation (A, B)	Sensitivity coefficient ci	Uncertainty contribution u(Ri)=ci· u(xi)	Degree of freedom νi
R_x						
		Combined standard uncertainty:				
		Effective degrees of freedom:				
		Expanded uncertainty (95% coverage factor):				

The detailed uncertainty shall be provided in this form for one standard of each nominal value.

APPENDIX D: Forms for Transportation

GULFMET.EM.K2 COMPARISON
Receiving Form

(Send this form to the pilot laboratory as soon as you have received the standard)

Arrival Date & Time	Date:_____ Time:_____	
Is the package damaged?	Yes ☐	No ☐
	Comments:	
Is the standard damaged?	Yes ☐	No ☐
	Comments:	
Are all materials listed in the packing list available in the package?	Yes ☐	No ☐
	Comments:	

The transport case was received by:

(Please fill in your contact information)

Institute	
Contact Person	
E-mail Address	
Telephone No	

GULFMET.EM.K2 COMPARISON
Despatch Form

(Send this form to the pilot as soon as the standard is shipped.)

The despatch date of transport case	Date:_____ Time:_____
The travelling standards are in working condition?	Yes ☐ No ☐
Comments on the behaviour of the standards:	
Method of Shipment	Courier Name: Tracking No: *Airline (if available):* *Flight No (if available):*
Informed courier about documentation requirement of ATA carnet. (if applicable)	Yes ☐ No ☐
Shipping to **(Participant Name & Address)**	

The transport case was despatched by:

(Please fill in your contact information)

Institute	
Contact Person	
E-mail Address	
Telephone No	

APPENDIX E: Shipping package

APPENDIX F: Datalogger Instructions

On Receipt

1. When you get the package and you want to stop recording, press the “START/STOP” button for about 5 sec. to stop recording. (Figure 3)
2. To export data, plug in Datalogger to USB Port of PC.
3. Run “PDF Logger Configuration Tool.exe”.
4. Go to either “Convert to PDF” or “Convert to Excel” window.
5. Save data in one of two formats

On Despatch

(Please, replace two batteries (CR2032) before you ship the package.)

1. Plug in Datalogger to USB Port of PC.
2. Run “PDF Logger Configuration Tool.exe” (Figure 2) to configure parameters (“5 min rate*” & “Metric”).
   * Do not select “30 sec.” Logger will store data for only less than a week.
3. Press “Save” button.
4. Turn on the Logger by pressing “START/STOP” button.
5. Press the “START/STOP” button for about 5 sec. to start recording temperature, humidity, and barometric pressure (Figure 3), before shipping.
   Warning: If you cannot start “REC” for recording then perform from step 1 to step 3 again.

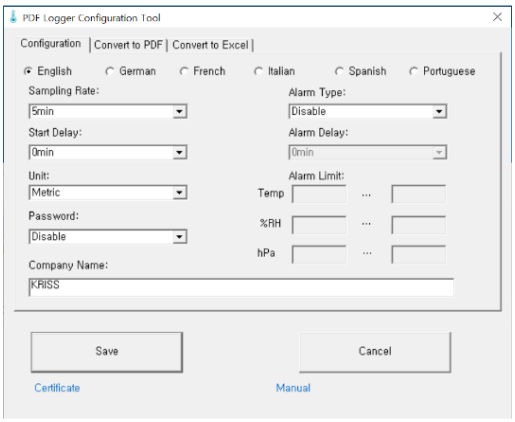

Figure 2

Figure 3

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