SADCMET Supplementary comparison

Comparison onHand Instruments

(0-25mm and 50-75mmExternal Micrometers)

Technical Protocol

Pilot Laboratory:

Scientific and Industrial Research and Development Centre

National Metrology Institute (SIRDC-NMI)

1574 Alpes Road

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Zimbabwe

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Contents

1. Introduction

Following the decision of a SADCMET meeting held in South Africa in 2018 as per SADCMET strategic plan, Zimbabwe's Scientific and Industrial Research Centre National Metrology Institute (SIRDC-NMI) hosted a Dimensional Interlaboratory Comparison training workshop from the 11th to the 13th of February 2019. The workshop was sponsored by PTB Germany. It is during this period that the SADCMET Technical Committee for Length agreed to start comparisons in different parameters and artifacts.

The parameters chosen included Hand instruments (External Micrometers). Two micrometers were chosen in order to cover the accreditation range of most of the participating National Metrology Institutes (NMIs). It was further agreed that the intercomparison be upgraded to AFRIMETS level in order for one of the objectives, registration of Calibration and Measurement Capabilities (CMCs) in the International Bureau of Weights and Measures Key Comparison Data Base (BIPM KCDB) to be fulfilled.

This technical protocol has been drawn in consultation with the participants following the guidelines established by the BIPM[1]. The comparison project is funded by PTB.

2. Objectives

The objectives of this comparison are to:

- Assess the equivalence of the hand instruments (External Micrometers) calibration among the participants and to underpin the relevant claim of the Calibration and Measurement Capability in the International Bureau of Weights and Measures Key Comparison Data Base (BIPM KCDB).
- Enable the participating NMIs to meet the requirements of ISO17025:2017 international accreditation
- Save as a tool for procedure and method validation and to
- Ensure harmonization of standards and demonstrate measurement uniformity of SADC NMIs.

3. Organisation

3.1 Participants

3.1.1. Zimbabwe's Scientific and Industrial Research and Development Centre National Metrology Institute (SIRDC-NMI) is acting as a pilot laboratory among the participants in the comparison.

3.1.2. The participating institutes are Zimbabwe (SIRDC NMI), National Metrology Institute of South Africa (NMISA), Zambia Metrology Agency (ZMA), Malawi Bureau of Standards (MBS), Namibia Standards Institute (NSI), Mauritius Standards Bureau, Botswana Bureau of Standards (BOBS), Tanzania Bureau of Standards (TBS), Mozambique () and Democratic Republic of Congo (Office CongolaisControle). Details are in table 1.

Table 1 Participants

	Participant	Correspondence	E-mail Address Phone number	Address
1	Zimbabwe (Pilot)	Burnhard P. Gandah	Email: bgandah@sirdc.ac.zw Tel: +263242860346	SIRDC National Metrology Institute, 1574 Alpes Road, Hatcliffe, Harare
2	South Africa	Oelof Kruger (AFRIMETS TCL Chair) Zanele Nzimande	Email: okruger@nmisa.org Email: znzimande@nmisa.org Tel: 012 841 3057	NMISA, Bldg 5, CSIR, MeiringNaude Road - South Africa
3	Malawi	TruweMunkhondya	Email:truwemunkhondya@mbsmw.org	
4	Mauritius	VaneedaRamasawmy		
5	Mozambique	Emidio Mulchande	Email: emulcha@gmail.com	
6	Namibia	George Mabakeng	Email: mabakengg@nsi.com.na	
7	Tanzania	Angela K Charles	Email: angela.charles@tbs.go.tz Tel: +255714215038	Tanzania burau of standards, Ubungo, Sam Nujoma – Morogoro road junction, dares salaam
8	Zambia	Natasha Chichone	Email: sichonenatasha@gmail.com Tel: +260968862190	
9	Botswana	Ntima	Email: ntima@bobstandards.bw	BOBS, Botswana Bureau of Standards, Private Bag BO48, Main Airport Road, Plot No. 55745, Gaborone - Botswana

3.1.3. All the participants must be able to demonstrate traceability to an independent realization of the SI unit of length, the meter or make clear the route of traceability to SI unit, the meter via another named laboratory.

3.1.4. By their declared intention to participate in this comparison, the laboratories accept the general instructions and the technical protocols written down in this document and commit themselves to follow the procedures strictly.

3.1.5. Once the protocol has been agreed, no change to the protocol may be made without prior agreement of all the participants.

3.2. Form of comparison

3.2.1. The comparison will primarily be carried out through calibration of the artifacts which are 2 external micrometers (range: 0-25 mm and 50-75).

3.2.2. The sequence of measurements will be as in table 2.

3.2.3. The comparison will consist of one round. Every Laboratory will have a period of one month in which to i) receive the artifact ii) perform measurements and iii) send the artifacts to the next participant. The participant should immediately report to the pilot lab when a problem that delays the predetermined schedule occurs.

3.3. Time Schedule

3.3.1. The commencement date of the intercomparison is July 2019.

3.3.2. Each participant NMI will have one month (two weeks to take the measurements and a further two weeks to pass the artefacts on to the next Laboratory

3.3.3. Each Laboratory should submit measurements results (report) to the pilot within one month after completion of its measurements.

3.3.4. When all measurements are completed, the participants will be given a deadline date for submitting the results, and if they do not meet the deadline, they might be disqualified. Table 2 summarises the schedule.

Table 1 : Schedule of the comparison

Laboratory	**Starting date of measurement**
South Africa	08/07/2019
Mauritius	08/08/2019
Tanzania	08/09/2019
Malawi	08/10/2019
DRC	08/11/2019
Zambia	08/12/2020
Mozambique	08/01/2020
Zimbabwe (Pilot)	08/02/2020
Botswana	08/03/2020
Namibia	08/04/2020
Zimbabwe (Pilot)	08/05/2020

3.4. Handling of Artefacts

3.4.1. Upon receipt of the artifacts a return form (appendix A9) must be filled in and returned to the pilot lab. The External micrometers and the 50mm micrometer setting piece should be examined immediately upon receipt. The condition of the artifacts and the associated package should be noted and communicated to the pilot lab if there is anything abnormal found.

3.4.2. If there is any damage or problem found that may potentially affect the comparison measurements, the participant should immediately report it to the pilot lab by e-mail. If the pilot lab finally decides the artifact be repaired after sufficient communication, the participant should deliver the artifact to South Africa for repair.

3.4.3. When the comparison measurements are completed, the artifacts should be repackaged in their original container. Please ensure that the content of the package is complete by checking the packing list that was delivered together with the artifacts. The original packaging container should be used unless if it is significantly damaged. If the participant decides to make a new container the coordinator should first be informed.

3.4.4. The participant should inform the contact person of the next participant and the coordinator of the pilot lab of the delivery schedule when the artifact package is ready to be sent.

3.4.5. For the 0-25mm external micrometer, the participant should zero the micrometer before starting the measurements. For other external micrometer the origin must be set using the laboratories standards (eg a 50-75mm external micrometer origin can be set using a 50mm gauge block)

3.5. Transportation of Artifacts

3.5.1. It is important that the 2 micrometers and micrometer setting piece should be transported in a manner such that they will not be lost, damaged or handled by un-authorized persons. The artifacts should be packaged in a container that is suitably robust to protect them from being deformed or damaged during transportation.

3.5.2. Transportation the responsibility of each participating institute. Each participating institute should cover the cost for its own measurements, one-way transportation including insurance, customs clearance, and any expense to be incurred in its own country.

3.5.3. After completion of measurements the institute should hand deliver the artifacts to the next participant. For easy customs clearance participants are expected to use the SADC movement of intercomparison samples for test and calibration forms and letters for transporting artifacts. A letter from the Participating institute such as in appendix B should also accompany the artifacts.

3.5.4. The comparison will be terminated in the event of total loss of artifacts and a report will be prepared based of the collected results.

4. Description of Artifacts

4.1. The package contains 2 external micrometers as shown in figure 1.1 and figure 1.2 Figure 1.3 shows a micrometer setting piece.

Figure 1.1: photograph of the 0-25mm micrometer.

Figure 1.2: photograph of the 50-75 mm micrometer.

Figure 1.3: photograph of the micrometer setting piece.

4.2. Table 3 shows the range, resolution as well as the thermal expansion coefficient of the artifacts.

Table 3: Artifacts Description

Artefact	**Make**	**Serial Number**	**Range (mm)**	**Resolution (mm)**	**Expansion Coefficient (10^{-6}K)**
Micrometer	-	0207124456	50-75mm	0.001	11.5
Micrometer	-	161202229	0-25mm	0.01	11.5
Micrometer setting piece	-	-	50mm	-	11.5

5. Measurement Instructions

5.1 Traceability

5.1.1. Temperature measurement should be made using the International Temperature Scale of 1990(ITS-90).

5.1.2. Length measurement should be traceable to the latest realization of the SI unit the meter.

5.2. Measurand

5.2.1. The Calibration is performed on the length scale of the external micrometer (Consultative Committee for length (CCL) category 6.1.1) so that the error of indicated size is measured.

5.2.2. The calibration process should be performed in a laboratory capable of maintaining environmental conditions of temperature at $20^{o}\pm1^{0}$C. It is highly recommended that the micrometers, and standards used are brought into the laboratory at least 12 hours before any measurement is performed.

5.2.3. The exact temperature of the laboratory during the comparison measurements should be reported.

5.2.4. Correction of temperature mismatch should be made, and the corresponding uncertainty should be included in the uncertainty budget in case of need.

5.3. Calibration Instruction

5.3.1. **0-25mm Micrometer:**

(a) Screw thread Error of indicated size at the prescribed positions is determined by measuring 10 Gauge blocks which have the lengths in mm of (2.5, 5.1, 7.7, 10.3, 12.9, 15, 17.6, 20.2, 22.8 and 25 mm). Micrometer must be zeroed. Zero reading must be recorded after zeroing. Repeatability must be measured at 15mm.

(b)Flatness of both anvils (optional measurements which will not appear in the final report) may be measured using an optical flat. The flat must be placed on each anvil and maneuvered to have the least number of fringes and the amount of fringes counted or the percentage of curvature measured. The amount of fringe or percentage must be multiplied with the wavelength of the light source used, divided by 2.

(c)Parallelism between the anvils (an optional measurement which will not appear in the final report) may be measured by using optical parallels, or by measuring a steel (any hard material) ball. For the use of an optical parallel, place it between the anvils and close the anvils using the ratchet. Lightly move the parallel until the least number of fringes are observed at the one anvil. Count the number of fringes on both anvils and add them together. Multiply with the wavelength/2.

5.3.2. **50-75mm Micrometer:**

(a) Screw thread Error of indicated at the prescribed positions is determined by measuring4 Gauge blocks which have the lengths in mm of (50, 60, 70 and 75

mm). Origin must be set to 50 mm. Origin must be recorded after being set. Repeatability must be measured at 60mm.

(b) Centre length of the micrometer setting piece can be measured in a horizontal or vertical orientation.

5.3.3. Any other set of gauge blocks that covers the micrometer range may be used. If two or more gauge blocks are wrung to generate measuring positions, this should be included as one of the contributing factors in the uncertainty budget.

5.3.4. The participant shall determine the value of error of micrometer at each of the mentioned positions. This should be done according to the laboratory's internal procedures. Appendices A1 to A7 should be completed.

6. Reporting of Results and Measurement Uncertainties

6.1. Uncertainties

6.1.1 The report should contain a comprehensive uncertainty budget, comprising all the contributions to the total uncertainty. The uncertainty of measurements shall be estimated according to the ISO Guide to the Expression of Uncertainty in Measurements. A result will not be considered complete without an associated uncertainty and will not be included in the draft report unless it is accompanied by an uncertainty supported by a complete uncertainty budget.

6.1.2 In the uncertainty budget, the following uncertainty contributions should be included (but is not limited to):

1) Uncertainty contributor due to the repeatability and reproducibility during measurements.
2) Uncertainty contributor due to the resolution of instrument.
3) contributor due to the reference standards used in measurements.
4) Uncertainty contributor due to the temperature effect.

6.1.3 Each uncertainty component should come with a probability distribution function and a degree of freedom. Finally, the combined standard uncertainty, the resultant probability distribution function, and the effective degree of freedom should be reported (Level of Confidence 95% approximated by using coverage factor k equal to 2).

6.2. Reporting of Results

6.2.1. The participant should submit the report by e-mail in word and pdf format to the pilot within one month after completion of measurements. In case of any discrepancy found between the two reports, the pdf version will be regarded as a definitive version and used for drafting the comparison report.

6.2.2. Within four months following the receipt of all measurement reports from the participating laboratories, the pilot laboratory will analyze the results and prepare first draft reports on each comparison. These will be circulated to the participants for comments and corrections. The procedure outlined in the BIPM Guidelines will be followed.

6.2.3. The Guidelines require that after conclusion of the circulation of the artifact the pilot laboratory will prepare a draft (Draft A) of the final report within four months and will send it to the participants. Draft A will be confidential and participants will have two months to send their comments on the draft [1,5].

6.2.4. If a Laboratory's result is anomalous, it can decide at this stage to withdraw its results, or if explanation is found, can correct it.

6.2.5. The pilot laboratory will prepare a second draft B on the basis of the comments received, where the withdrawn results will not appear. Where there has been a correction the original and the corrected result with an explanation are reported.

6.2.6. After discussions have been made the report will be submitted to AFRIMETS TCL for approval and publication in the KCDB.

6.2.7. Reference value to be used in this comparison is the mean of the results of the participating Labs.

6.2.8. The measurement results from the participants together with their associated uncertainities and the reference values will be used to calculate Normalised Error (En values) as follows

$$E_n = \frac{\left| x_{ref} - x_{lab} \right|}{\sqrt{U_{ref}^2 + U_{lab}^2}}$$

7. Where

x_{ref} is the reference value

andU_{ref} is referencethe expanded uncertainty..

x_{lab} and U_{lab} are the reported value and expanded uncertainty, respectively, for a participating laboratory.

A.1 Measurement Results

Laboratory:.....

Micrometer 0-25mm : Serial Number: 161202229

Nominal value (mm)	STD: Standard Value of Gauge block used (mm)	UUT: Micrometer Reading (mm)	Error (UUT-STD) (mm)	Estimated Uncertainty
0				
2.5				
5.1				
7.7				
10.3				
12.9				
15				
17.6				
20.2				
22.8				
25				

Repeatability Measurement

Nominal	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
15mm					

Standard deviation…….

Experimental standard deviation (ESDM)……..

Date: .....

Signature: .....

A.2 Measurement Results

Laboratory:.....

Micrometer 50-75mm: Serial Number: 0207124456

Nominal value (mm)	STD: Standard Value of Gauge block used (mm)	UUT: Micrometer Reading (mm)	Error (UUT-STD) (mm)	Estimated Uncertainty
50				
60				
70				
75				

Repeatability Measurement

Nominal	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
60mm					

Standard deviation…….

Experimental standard deviation (ESDM)……..

Date: .....

Signature: .....

A.3 Measurement Results

Laboratory:.....

Flatness Measurement

Micrometer 0-25mm: Serial Number: 161202229

MeasuringFace	Number of fringes	Wavelength (µm)	Flatness (µm)
Fixed Anvil			
Moving Anvil			

Estimated Uncertainty:

Parallelism Measurement

Micrometer 0-25mm: Serial Number:161202229

	Fixed Anvil	Moving Anvil	Wavelength (µm)	Parallelism (µm)
Number of fringes				

Estimated Uncertainty:

Date: .....

Signature: .....

A.4 Measurement Results

Laboratory:.....

50mm Micrometer setting Piece: Serial Number:

Nominal value of setting Piece (mm)	**STD: Measured Value of setting piece(mm)**	**Deviation (50-STD) (mm)**
50		

Estimated Uncertainty:

Date: .....

Signature: .....

A.5 Description of the measuring system and procedure

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(If possible, photos of the setup can be attached to the e-mail)

Make and type of standard

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Procedure of the measuring setup:

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A.6 Uncertainty of measurement

Uncertainty of measurementof screw error

Source of uncertainty	x_i	$u(x_i)$	v_i	$c_i=\partial\beta_i/\partial x_i$	$u_i(\beta_i)/sec$
StandardsGauge blocks					
Resolution					
Repeatability on 15 or 60 mm GB					
Temperature diff. between UUT and Std					
CTE diff.					
		veff.			
		t distribution		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i)$ = **.....**

Expanded standard uncertainty: = **.....**

Uncertainty of measurement of Flatness of fixed and moving anvils

Source of uncertainty	x_i	$u(x_i)$	v_i	$c_i=\partial\beta_i/\partial x_i$	$u_i(\beta_i)/sec$
StandardFlat, uncertainty					
StandardFlat, error					
Repeatability, 5 readings					
StandardLight source					
		veff.			
		t distribution		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i)$ = **.....**

Expanded standard uncertainty: = **.....**

Uncertainty of measurement of Parallelism of anvils

Source of uncertainty	x_i	$u(x_i)$	v_i	$c_i = \partial\beta_i / \partial x_i$	$u_i(\beta_i)$/sec
Standard Flat, uncertainty					
Standard Flat, error					
Repeatability, 5 readings					
Standard Light source					
		veff.			
		t distribution		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i)$ = **.....**

Expanded standard uncertainty: = **.....**

Uncertainty of measurement of Parallelism of anvils using ball bearings

Source of uncertainty	x_i	$u(x_i)$	v_i	$c_i = \partial\beta_i / \partial x_i$	$u_i(\beta_i)$/sec
Resolution of Micrometer					
Repeatability of micrometer					
		veff.			
		t distribution		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i)$ = **.....**

Expanded standard uncertainty: = **.....**

Uncertainty of measurement of setting pieces

Source of uncertainty	x_i	$u(x_i)$	v_i	$c_i=\partial\beta_i/\partial x_i$	$u_i(\beta_i)/sec$
StandardsGauge blocks					
Repeatability on 15 or 60 mm GB					
Temperature diff. between UUT and Std					
CTE diff.					
		veff.			
		t distribution		$u_c^2(\alpha_{il})$	

Combined standard uncertainty: $u_c(\alpha_i)$ = **.....**

Expanded standard uncertainty: = **.....**

A.7 Return Form

Attention: Burnhard Panda Gandah

National Metrology Institute
Scientific and Industrial Research and Development Centre
1574 Alpes Road/ Technology drive, Hatcliffe
P.O. Box 6640
Harare, Zimbabwe

e-mail: bgandah@sirdc.ac.zw

We confirm having received the artefacts for the SADCMET -_____, on a Hand Instruments (0-25 mm and 50-75mm Micrometers) as well as the 50mm micrometer setting piece:

(date) .....

Report of artefact condition:

(After visual inspection)

No damage has been observed

OR

Damage has been observed *(detailed comments)*:

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.....

Laboratory: .....…
Name: .....…
Signature: .....…

APPENDIX B

Example of a letter for security control

This must be modified depending on the people and NMIs involved in the transfer of the artifacts

April 2019

I the undersigned, _____, Director of SIRDC National Metrology Institute (SIRDC-NMI) certify that _____, from the Metrology Dimensional laboratory is carrying _____(list of atrefacts)from SIRDC, Zimbabwe to Zambia Metrology Agency, _____ (address of receiving Lab)

These artefacts are made of stainless steel and are of huge metrology (scientific) value. They are sent between participating National Metrology Institutes and/or Bureau of Standards for inter-laboratory comparison. The standards are very delicate and must not be manipulated by unauthorized persons. Improper handling during transportation would make them useless. They are specially packed in containers that will ensure they remain clean and protected during transportation.

It is important that they travel in the cabin as hand luggage and not in the baggage hold. They are safe and do not pose any risk to the health and safety of fellow passengers.

_____

Mathew Ranganai
Director –National metrology Institute
SIRDC-NMI, Harare, Zimbabwe
Tel: +263-242-860346
Email: mranganai@sirdc.ac.zw

REFERENCES

[1]Measurement Comparisons in the CIPM MRA (CIPM MRA-D05 Vers 1.6), https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-D-05.pdf

[2] CIPM MRA Guidelines for Authorship of Key, Supplementary and Pilot study comparison reports (CIPM MRA- G-04 vers 1, https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-G-04.pdf

[3] CCL Service Classification (DimVIM) Version 11 (2018).

[4] Protocol for SADCMET.LS11

[5]Protocol for AMP.L-S7