

**STANDARDS**  
MALAYSIA

# Certificate of Accreditation

No: SAMM 256

Accredited since: 15 October 2003

This is to certify that

METCAL TECHNOLOGIES (M) SDN. BHD.  
BAYAN LEPAS, PULAU PINANG  
MALAYSIA



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for the current scope of accreditation

has been granted accreditation in respect of the scope of accreditation described in the schedule, subject to the terms and conditions governing the *Skim Akreditasi Makmal Malaysia* (SAMM), the Laboratory Accreditation Scheme of Malaysia.

Laboratories accredited under SAMM meet the requirements of MS ISO/IEC 17025. This Malaysian Standard is identical with ISO/IEC 17025 published by the International Organization for Standardization (ISO).



(DATUK FADILAH BAHARIN)  
Director General  
Department of Standards Malaysia

Date of issue: 28 September 2017

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**LABORATORY LOCATION:**  
(PERMANENT LABORATORY)
**METCAL TECHNOLOGIES (M) SDN. BHD. (PENANG)**  
**NO. 36, CANGKAT BUKIT BELAH**  
**11920 BAYAN LEPAS**  
**PULAU PINANG**  
**MALAYSIA**
**FIELDS OF CALIBRATION:**
**DIMENSIONAL, MASS, FORCE, TORQUE,**  
**TEMPERATURE, PRESSURE, VOLUME,**  
**ELECTRICAL, TIME AND FREQUENCY**

This laboratory has demonstrated its technical competence to operate in accordance with MS ISO/IEC 17025:2017 (ISO/IEC 17025:2017).

This laboratory's fulfillment of the requirements of ISO/IEC 17025 means the laboratory meets both the technical competence requirements and management system requirements that are necessary for it to consistently deliver technically valid test results and calibrations. The management system requirements in ISO/IEC 17025 are written in language relevant to laboratory operations and operate generally in accordance with the principles of ISO 9001 (see Joint ISO-ILAC-IAF Communiqué dated April 2017).

\* The uncertainty covered by the CMC is expressed as the expanded uncertainty corresponding to a coverage probability of approximately 95 % and have a coverage factor of  $k=2$  unless stated otherwise.

**SCOPE OF CALIBRATION: DIMENSIONAL****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter             | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|--|---|---|
| Coordinate Measuring Machine                              | X-axis : 0 to 1500 mm<br>Y-axis : 0 to 1500 mm<br>Z-axis : 0 to 1500 mm<br><br>Diagonal : 0 to 1500 mm | (0.2 + 13L) $\mu$ m<br><br><i>'L' in meter</i>                                | Long Gauge Block, Ball Bar based on ISO 10360-2:2009 and 10360-5:2020 |
| Profile Projector (Measuring Accuracy of Individual Axis) | X, Y-axis : 0 to 300 mm  | 1.9 $\mu$ m   | Comparison with Standard Scale based on JIS B 7184:1999               |
| Measuring Scope (Measuring Accuracy of Individual Axis)   | X, Y-axis : 0 to 300 mm  | 1.9 $\mu$ m   | Comparison with Standard Scale based on JIS B 7153:1995               |
| Surface Plate   | 600 x 600 mm<br>1200 x 1200 mm<br>1800 x 1800 mm   | 1.4 $\mu$ m<br>1.5 $\mu$ m<br>1.6 $\mu$ m                                     | Planekator, Micro-indicator based on JIS B 7513:1992                  |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: DIMENSIONAL****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter        | Range          | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|--|----------------|---|---|
| Vernier, Dial & Digital Height Gauge / Linear Height | 0 mm to 600 mm | (0.4 + 5L) $\mu$ m<br><br><i>'L' in meter</i>                                 | Comparison with Gauge Block, Length Comparator, Height Master, Riser Block based on JIS B 7517:2018 |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: DIMENSIONAL**

| Instrument Calibrated / Measurement Parameter | Range                                | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*   | Remarks  |
|---|--------------------------------------|---|--|
| Gauge Block                                   | 0.5 mm to 100 mm<br>100 mm to 600 mm | $(0.11 + 2.3L) \mu\text{m}$<br>$(0.05 + 3L) \mu\text{m}$<br><i>'L' in meter</i> | ULM / Reference Gauge Block based on ISO 3650:1998                     |
| High Accuracy Micrometer (0.0001 mm res.)     | 0 mm to 25 mm                        | 0.3 $\mu\text{m}$   | Comparison with Gauge Block based on JIS B 7502:2016                   |
| External Micrometer                           | 0 mm to 500 mm                       | $(0.5 + 3.2L) \mu\text{m}$<br><i>'L' in meter</i>                               |  |
| Vernier, Dial & Digital Caliper               | 0 mm to 600 mm                       | $(2.6 + 7L) \mu\text{m}$<br><i>'L' in meter</i>                                 | Comparison with Caliper Checker / Gauge Block based on JIS B 7507:2016 |
| Dial Gauge / Digital Indicator                | 0 mm to 50 mm                        | 1.5 $\mu\text{m}$   | Comparison with Gauge Tester based on JIS B 7503:2017                  |
| Dial Test Indicator                           | 0 mm to 1.6 mm                       | 1.6 $\mu\text{m}$   | Comparison with Gauge Tester based on JIS B 7533:2015                  |
| Vernier, Dial & Digital Height Gauge          | 0 mm to 600 mm                       | $(0.5 + 3L) \mu\text{m}$<br><i>'L' in meter</i>                                 | Comparison with Caliper Checker / Gauge Block based on JIS B 7517:2018 |
| Depth Micrometer                              | 0 mm to 300 mm                       | $(1.2 + 3.1L) \mu\text{m}$<br><i>'L' in meter</i>                               | Comparison with Gauge Block based on JIS B 7544:1994                   |
| Depth Gauge                                   | 0 mm to 300 mm                       | $(5.8 + 3L) \mu\text{m}$<br><i>'L' in meter</i>                                 | Comparison with Gauge Block based on JIS B 7518:1993                   |
| Dial & Digital Thickness Gauge                | 0 to 20 mm                           | $(0.59 + 3L) \mu\text{m}$<br><i>'L' in meter</i>                                | Comparison with Gauge Block based on JIS B 7503:2017                   |
| Ultrasonic Thickness Gauge                    | Up to 25 mm<br>25 to 300 mm          | 3.2 $\mu\text{m}$<br>$(2.2 + 0.04L) \mu\text{m}$<br><i>'L' in mm</i>            | Gauge Block / Step Wedge based on ASTM E797/E797M-15                   |



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of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: DIMENSIONAL**

| Instrument Calibrated / Measurement Parameter                           | Range                             | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|-----------------------------------|---|--|
| Three Point Micrometer / Holtest / Borematic (Accuracy & Repeatability) | 2.0 mm to 150 mm                  | $(0.9 + 18L) \mu\text{m}$<br><i>'L' in meter</i>                              | Master Ring Gauge based on DIN 863-4:1999 (R2017)                                      |
| Feeler Gauge  | 0.01 mm to 3 mm                   | $0.61 \mu\text{m}$  | Direct Measurement with Micrometer based on JIS B 7524:2008                            |
| Plain Pin / Plug Gauge (Diameter only)                                  | 0.10 mm to 25 mm                  | $(0.5 + 1.1L) \mu\text{m}$  | ULM / Micrometer based on JIS B 7420:1997  |
|   | 0.10 mm to 100 mm                 | $(0.5 + 6L) \mu\text{m}$<br><i>'L' in meter</i>                               |  |
| Plain Ring Gauge  | 2 mm to 15 mm                     | $(0.6 + 10L) \mu\text{m}$<br><i>'L' in meter</i>                              | ULM, Master Ring, Length Comparator, Height Master based on JIS B 7420:1997            |
|   | 15 mm to 150 mm                   |   |  |
|   | 150 mm to 300 mm                  |   |  |
| Parallel Thread Plug Gauge  | Major Diameter<br>1 mm to 25 mm   | $0.6 \mu\text{m}$   | Three Wire Method based on JIS B 0261:2004   |
|   | Pitch Diameter<br>0.25 mm to 6 mm | $1.7 \mu\text{m}$   |  |
|   | Pitch<br>0.25 mm to 3 mm          | $2.4 \mu\text{m}$   |  |
| Glass Scale   | 0 mm to 200 mm                    | $(2 + 3.3L) \mu\text{m}$<br><i>'L' in meter</i>                               | Measuring System and Reference Scale based on JIS B 7541:2001                          |
| Ruler   | 0 to 300 mm                       | $0.023 \text{ mm}$  | Measuring Projector / Reference Scale / Line Scale Calibrator based on JIS B 7516:2005 |
|   | 0 to 1 m                          | $0.08 \text{ mm}$   |  |
|   | 0 to 2 m                          | $0.12 \text{ mm}$   |  |
| Measuring Tape (pi Tape, Textile Tape)                                  | 0 ~ 1 m                           | $0.062 \text{ mm}$<br>$(0.025 + 0.037L) \text{ mm}$<br><i>'L' in meter</i>    | Reference Scale with Line Scale Calibrator based on JIS B 7512:2018                    |
|   | 1 ~ 100 m                         |   |  |
| Test Sieve  | 0.020 mm to 1.12 mm               | $(3.4 + 3.4L) \mu\text{m}$<br>$(7 + 0.4L) \mu\text{m}$<br><i>'L' in mm</i>    | Non-Contact Measuring System / Measuring Projector based on BS 410-1:2000              |
|   | 1.12 mm to 125 mm                 |   |  |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: DIMENSIONAL**

| Instrument Calibrated / Measurement Parameter   | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*                         | Remarks   |
|---|---|---|---|
| Coating Thickness Foil  | Up to 1 mm<br>1 mm to 7.6 mm<br>7.6 mm to 12.7 mm | $(0.3 + 1.0L) \mu\text{m}$<br>$(1.0 + 0.3L) \mu\text{m}$<br>$3.0 \mu\text{m}$<br><br><i>'L' in mm</i> | Mu-Checker / Digital Indicator based on BS EN ISO 2178:2016                               |
| Coating Thickness Gauge   | Up to 7.6 mm                                      | $(0.5 + 1.7L) \mu\text{m}$<br><br><i>'L' in mm</i>  | Coating Thickness Foils based on AS 3894.3:2002   |
| Level<br>(Precision Level, Spirit Level, Square Level, Round Level, Bubble Level Gauge) | 0.02 mm/m<br>0.05 mm/m<br>0.1 mm/m and below      | 0.010 mm/m<br>0.014 mm/m<br>0.025 mm/m  | Bubble Calibrator and Sine Bar based on JIS B 7510:1993 (R2012)                           |
| Angle Protractor<br>(Angle Level Meter / Inclinometer / Clinometer)                     | Up to $\pm 180$ deg.                              | 0.023 deg.  | Comparator, Sine Bar, Gauge Blocks, Precision L-Square based on VDI/VDE/DGQ 2618/Part 7.2 |
| Bevel Protractors<br>(Digital / Analog)   | Up to $\pm 180$ deg.                              | 0.025 deg.  | Angle Blocks based on VDI/VDE/DGQ 2618/Part 7.2   |
| Angle Blocks  | Up to $\pm 90$ deg.                               | 0.011 deg.  | Reference Angle Block Set with Non-Contact Measuring System                               |
| Planekator / Straight Edge  | Up to 400 mm                                      | $2.4 \mu\text{m}$   | Reference Straight Edge with Digital Indicator based on JIS B 7514:1977                   |
| Height Master<br>(Riser Block, Check Master, Caliper Checker)                           | Up to 300 mm<br>300 mm to 600 mm                  | $1.4 \mu\text{m}$<br><br>$3.7 \mu\text{m}$  | Gauge Blocks / Long Gauge Block, Length Comparator based on AS 3779: 1990                 |
| Electrical Comparator<br>(M $\mu$ -checker)   | $\pm 5 \mu\text{m}$ to $\pm 1500 \mu\text{m}$     | $0.11 \mu\text{m}$  | Comparison with Gauge Block based on JIS B 7536:1982                                      |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: DIMENSIONAL**

| Instrument calibrated/<br>Measurement parameter                          | Range   | Calibration and Measurement Capability expressed as an uncertainty ( $\pm$ )*        | Remarks **   |
|--|---|--|--|
| Squares  | Up to 75 mm   | 2.5 $\mu$ m  | Comparison with Master Square Block, Precision L-Square, Length Comparator and Mu-Checker based on JIS B 7526:1995 |
|  | 75 mm to 300 mm                                       | 4.2 $\mu$ m  |  |
| (Straightness / Parallelism)   | Up to 300 mm  | 3.4 $\mu$ m  |  |
| <b>Geometric Measurement</b><br>(Fixture, Jig, Machined Part, Workpiece) |   |  |  |
| Length<br>(Contact Method)   | 0 mm to 100mm<br>100 mm to 500 mm<br>500 mm to 600 mm | (0.2 + 3L) $\mu$ m<br>(0.7 + 6L) $\mu$ m<br>(1.2 + 9L) $\mu$ m<br><i>L' in meter</i> | Mu-Checker, Gauge Block, Long Gauge Block, Linear Height, Height Master, Caliper, Ruler                            |
| Length<br>(Non-Contact Method)   | 0 mm to 300 mm  | (3.6 + 18 L) $\mu$ m<br><i>L' in meter</i>   | Non-Contact Measuring System   |
| Diameter<br>(Contact Method)   | 0 mm to 25 mm<br>25 mm to 100 mm<br>100 mm to 300 mm  | 0.49 $\mu$ m<br>2.4 $\mu$ m<br>3.2 $\mu$ m   | High Accuracy Micrometer, Micrometer, Caliper, Linear Height   |
| Diameter, Radius<br>(Non-Contact Method)                                 | 0 mm to 300 mm  | (1.4 + 24 L) $\mu$ m<br><i>L' in meter</i>   | Ring Gauge, Non-Contact Measuring System   |
| Angle<br>(Contact Method)  | 0 to $\pm$ 180 deg.                                   | 0.1 deg.   | Digital Protractor   |
| Angle<br>(Non-Contact Method)  | 0 to $\pm$ 180 deg.                                   | 0.011 deg.   | Angle Blocks, Non-Contact Measuring System   |
| Straightness   | 0 mm to 400 mm  | 2.3 $\mu$ m  | Straight Edge, Indicator   |
| Parallelism  | 0 mm to 600 mm  | 2.3 $\mu$ m  | Linear Height, Indicator   |
| Flatness   | 0 mm to 600 mm  | 2.3 $\mu$ m  | Linear Height, Indicator   |
| Squareness   | 0 mm to 300mm   | 4.9 $\mu$ m  | Precision L-Square, Indicator  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: MASS****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter  | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*  | Remarks  |
|--|---|--|--|
| Weighing Balance<br>(Analytical Balance,<br>Scale, Electronic Type,<br>Platform or Pallet) | Up to 2 g<br>Up to 20 g<br>Up to 120 g<br>Up to 250 g<br>Up to 500 g<br>Up to 1 kg<br>Up to 3 kg<br>Up to 6 kg<br>Up to 10 kg<br>Up to 30 kg<br>Up to 60 kg<br>Up to 100 kg<br>Up to 150 kg<br>Up to 300 kg<br>Up to 500 kg<br>Up to 1000 kg<br>Up to 3000 kg | 0.01 mg<br>0.02 mg<br>0.10 mg<br>0.16 mg<br>0.35 mg<br>0.6 mg<br>2 mg<br>4 mg<br>13 mg<br>27 mg<br>0.16 g<br>0.6 g<br>6 g<br>6 g<br>0.12 kg<br>0.58 kg<br>1.6 kg | Standard Weight<br><br>Weighing balances and scales with ranges intermediate from the values tabulated can be calibrated with uncertainty interpolated from the next higher and lower range values |
| Standard Weight  | 1 kg<br>2 kg<br>5 kg<br>10 kg<br>20 kg  | 9 mg<br>9 mg<br>14 mg<br>29 mg<br>50 mg  | Comparison using the ABBA or AB1.... BnA weighing sequence.<br><br>"Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated."   |



**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: MASS**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|---------|---|---|
| Standard Weight                               | 1 mg    | 0.002 mg  | Comparison using the ABBA or AB1 ...BnA weighing sequence.  |
|   | 2 mg    | 0.002 mg  |   |
|   | 5 mg    | 0.002 mg  |   |
|   | 10 mg   | 0.002 mg  |   |
|   | 20 mg   | 0.002 mg  |   |
|   | 50 mg   | 0.002 mg  |   |
|   | 100 mg  | 0.003 mg  |   |
|   | 200 mg  | 0.003 mg  |   |
|   | 500 mg  | 0.005 mg  |   |
|   | 1 g     | 0.005 mg  |   |
|   | 2 g     | 0.006 mg  | "Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated." |
|   | 5 g     | 0.008 mg  |   |
|   | 10 g    | 0.014 mg  |   |
|   | 20 g    | 0.015 mg  |   |
|   | 50 g    | 0.018 mg  |   |
|   | 100 g   | 0.09 mg   |   |
|   | 200 g   | 0.12 mg   |   |
|   | 500 g   | 0.87 mg   |   |
|   | 1 kg    | 0.87 mg   |   |
|   | 2 kg    | 1.8 mg  |   |
| 5 kg  | 3.6 mg  |   |   |
| 10 kg   | 0.012 g |   |   |
| 20 kg   | 0.019 g |   |   |
| 50 kg   | 8.1 g   |   |   |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: FORCE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|--|---|---|
| Hardness Testing Machine (HRC)                | 30 to 60 HRC   | 0.25 HRC  | Standard Hardness Block   |
| Force Indicating Device (Tension)             | 0 N to 10 N<br>10 N to 50 N<br>50 N to 100 N                   | 0.0013 N<br>0.013 N<br>0.13 N   | Dead Weight Method based on ISO 7500-1:2018<br><br>Calibrations may be made in terms of Newton (N), Pounds force (lbf) or kilogram force (kgf). |
| Force Indicating Device (Compression)         | 0 N to 10 N<br>10 N to 50 N<br>50 N to 100 N<br>100 N to 500 N | 0.0013 N<br>0.013 N<br>0.13 N<br>1.3 N  |   |

**SCOPE OF CALIBRATION: FORCE**

| Instrument Calibrated / Measurement Parameter   | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|--|---|---|
| Durometer Hardness                              | Spring force for Type A, B, E & O<br><br>Spring force for Type C, D & DO | 0.49 durometer point<br><br>0.40 durometer point                              | Durometer Calibrator based on ASTM D 2240:2015  |
| Force Indicating Device (Tension & Compression) | 0 N to 10 N<br>10 N to 50 N<br>50 N to 500 N<br>500 N to 1000 N          | $\pm 0.0011$ N<br>$\pm 0.011$ N<br>$\pm 0.080$ N<br>$\pm 0.80$ N              | Dead Weight Method based on ISO 7500-1:2018<br><br>Calibrations may be made in terms of Newton (N), Pounds force (lbf) or kilogram force (kgf). |



**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: PRESSURE**

**SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter                                     | Range            | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|------------------|---|---|
| Pressure Indicating Devices (Pressure Gauge, Vacuum Gauge, Manometer, Magnehelic) |                  |   |   |
| Manometer   | -5.8 to 5.8 psi  | 0.00078 psi   | Comparison with Reference Pressure Calibrator.<br><br>"Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated." |
| Vacuum  | -12 to 0 psi     | 0.022 psi   |   |
| Pneumatic/Hydraulic   | 0 to 300 psi     | 0.049 psi   |   |
| Hydraulic   | 300 to 10000 psi | 4.8 psi   |   |

**SCOPE OF CALIBRATION: PRESSURE**

| Instrument Calibrated / Measurement Parameter                                     | Range            | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|------------------|---|---|
| Pressure Indicating Devices (Pressure Gauge, Vacuum Gauge, Manometer, Magnehelic) |                  |   |   |
| Manometer   | -5.8 to 5.8 psi  | 0.00078 psi   | Comparison with Reference Pressure Calibrator.<br><br>"Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated." |
| Vacuum  | -12 to 0 psi     | 0.022 psi   |   |
| Pneumatic/Hydraulic   | 0 to 300 psi     | 0.049 psi   |   |
| Hydraulic   | 300 to 10000 psi | 4.8 psi   |   |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: TORQUE**

**SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter                   | Range                                  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|--|---|--|
| Torque Tools (Torque Wrench, Torque Driver Fixed or Adjustable) | 0 N.m to 1 N.m<br>Above 1 N.m to 5 N.m | 0.0055 N.m<br>0.048 N.m   | Based on ISO6789-1:2017<br><br>"Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated." |

**SCOPE OF CALIBRATION: TORQUE**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|---|---|--|
| Torque Measuring Device                       | 0 N.m to 1 N.m<br>Above 1 N.m to 10 N.m<br>Above 10 N.m to 40 N.m<br>Above 40 N.m to 300 N.m<br>Above 300 N.m to 1000 N.m<br>Above 1000 N.m to 1500 N.m | 0.0012 N.m<br>0.020 N.m<br>0.042 N.m<br>0.34 N.m<br>1.1 N.m<br>2.4 N.m        | Calibration using dead weights and known radius of Torque Wheel / Double-ended Calibration Beam<br><br>"Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated." |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TORQUE**

| Instrument Calibrated / Measurement Parameter                             | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*                 | Remarks   |
|---|--|---|---|
| Torque Tools<br>(Torque Wrench,<br>Torque Driver,<br>Fixed or Adjustable) | Up to 1 N.m<br>Above 1 N.m to 5 N.m<br>Above 5 N.m to 10 N.m<br>Above 10 N.m to 40 N.m<br>Above 40 N.m to 150 N.m<br>Above 150 N.m to 600 N.m<br>Above 600 N.m to 1000 N.m<br>Above 1000 N.m to 1500 N.m | 0.0055 N.m<br>0.048 N.m<br>0.054 N.m<br>0.18 N.m<br>0.48 N.m<br>1.4 N.m<br>1.8 N.m<br>2.7 N.m | Based on<br>ISO6789-1:2017<br><br>"Intermediate values<br>can be calibrated with<br>uncertainty<br>interpolated from the<br>next higher and lower<br>nominal value<br>tabulated." |

**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|--|---|---|
| Temperature Controlled Enclosure              |  |   |   |
| Temperature Chamber                           | -95 °C to -40 °C<br>Above -40 °C to 200 °C<br>Above 200 °C to 500 °C | 0.9 °C<br>0.3 °C<br>0.6 °C  | Using Temperature Sensor / Logger with reference to IEC 60068-3-5: 2018                     |
| Furnace                                       | Above 500 °C to 900 °C<br>Above 900 °C to 1200 °C                    | 3.5 °C<br>4.7 °C  | Using Temperature Sensor with reference to DKD-R 5-7  |
| Humidity Enclosure                            | 10 %rh to 98 %rh<br><br>10°C to 95 °C                                | 1.2 %rh<br><br>0.2 °C   | Using Dry Bulb & Wet Bulb Sensor / Logger with reference to IEC 60068-3-6:2018<br>DKD-R 5-7 |



**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter   | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*         | Remarks   |
|---|---|---|---|
| Temperature Sensor  | -95 °C to -90 °C<br>-90 °C to -80 °C<br>Above -80 °C to -40 °C<br>Above -40 °C to 100 °C<br>Above 100 °C to 300 °C<br>Above 300 °C to 600 °C<br>Above 600 °C to 800 °C<br>Above 800 °C to 1200 °C | 0.037 °C<br>0.09 °C<br>0.072 °C<br>0.043 °C<br>0.12 °C<br>0.44 °C<br>3.9 °C<br>4.2 °C | Comparison with PT 100 / Type R in Metrology Well / Liquid Bath/ Temperature Block Calibrator |
| Temperature Block Calibrator  | -95 °C to -45 °C<br>Above -45 °C to 0 °C<br>Above 0 °C to 200 °C<br>Above 200 °C to 600 °C<br>Above 600 °C to 900 °C<br>Above 900 °C to 1200 °C   | 0.1 °C<br>0.07 °C<br>0.2 °C<br>0.7 °C<br>3.5 °C<br>4.2 °C                             | Comparison with PT100 with reference to EURAMET cg-13 Version 4.0, 09/2017                    |
| Liquid Bath Calibrator  | -80 °C to 100 °C<br>Above 100 °C to 300 °C  | 0.11 °C<br>0.52 °C  |   |
| Wood Moisture Meter (Resistive Pin Type)  | 5 %MC to 50 %MC   | 0.4 %MC   | Resistance Simulation by using High Resistance Decade Substituter / Decade Resistance Box     |
| <u>Liquid – In - Glass</u><br><br>Total Immersion thermometer & Partial Immersion thermometer | -35 °C to 150 °C  | 0.3 °C  | Comparison with PT100 in Stirred Liquid Bath  |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|---|---|--|
| Temperature Simulator                         |   |   | Measurement using Multifunction Temperature Calibrator |
| K   | -100 °C to 1300 °C                            | 0.11 °C   |  |
| J   | -100 °C to 1200 °C                            | 0.1 °C  |  |
| T   | -100 °C to 400 °C                             | 0.11 °C   |  |
| E   | -100 °C to 950 °C                             | 0.1 °C  |  |
| N   | -200 °C to 1300 °C                            | 0.2 °C  |  |
| B   | 600 to 1800 °C                                | 0.52 °C   |  |
| R   | 0 to 1700 °C                                  | 0.4 °C  |  |
| S   | 0 to 1700 °C                                  | 0.4 °C  |  |
| C   | 0 °C to 400 °C<br>Above 400 to 2315 °C        | 0.6 °C<br>1.2 °C  |  |
| D   | 0 °C to 400 °C<br>Above 400 to 2315 °C        | 0.6 °C<br>1.1 °C  |  |
| G   | 0 °C to 100 °C<br>Above 100 to 2315 °C        | 2.9 °C<br>1.5 °C  |  |
| L   | -200 °C to 900 °C                             | 0.3 °C  |  |
| U   | -200 °C to -100 °C<br>Above -100 °C to 600 °C | 0.5 °C<br>0.3 °C  |  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range             | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|-------------------|---|--|
| Temperature Simulator                         |                   |   |  |
| PT10 (385)                                    | -200 °C to 850 °C | 0.3 °C  | Measurement using Multifunction Temperature Calibrator |
| PT100 (385)                                   | -200 °C to 850 °C | 0.12 °C   |  |
| PT100 (3916)                                  | -200 °C to 630 °C | 0.2 °C  |  |
| PT100 (3926)                                  | -200 °C to 850 °C | 0.2 °C  |  |
| PT200 (385)                                   | -200 °C to 850 °C | 0.2 °C  |  |
| PT500 (385)                                   | -200 °C to 850 °C | 0.2 °C  |  |
| PT1000 (385)                                  | -200 °C to 850 °C | 0.2 °C  |  |
| Cu10 (427)                                    | -200 °C to 260 °C | 0.3 °C  |  |
| Cu50 (428)                                    | -50 °C to 150 °C  | 0.2 °C  |  |
| Cu100 (428)                                   | -50 °C to 150 °C  | 0.2 °C  |  |
| Ni100 (618)                                   | -60 °C to 180 °C  | 0.2 °C  |  |
| Ni120 (672)                                   | -80 °C to 260 °C  | 0.2 °C  |  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range                         | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|-------------------------------|---|--|
| Temperature Indicator                         |                               |   | Electrical Simulation using Multifunction Temperature Calibrator with reference to EURAMET/cg-11/ Version 2.0, 03/2011 |
| K   | -100 °C to 1300 °C            | 0.08 °C   |  |
| J   | -100 °C to 1200 °C            | 0.06 °C   |  |
| T   | -100 °C to 400 °C             | 0.08 °C   |  |
| E   | -100 °C to 950 °C             | 0.05 °C   |  |
| N   | -200 °C to 1300 °C            | 0.22 °C   |  |
| B   | 600 °C to 1800 °C             | 0.4 °C  |  |
| R   | 0 °C to 1700 °C               | 0.4 °C  |  |
| S   | 0 °C to 1700 °C               | 0.4 °C  |  |
| C   | 0 °C to 2315 °C               | 0.5 °C  |  |
| D   | 0 °C to 2315 °C               | 0.7 °C  |  |
| G   | 0 °C<br>Above 0 °C to 2315 °C | 2.5 °C<br>0.6 °C  |  |
| L   | -200 °C to 900 °C             | 0.2 °C  |  |
| U   | -200 °C to 600 °C             | 0.3 °C  |  |
| PL II   | 0 °C to 1200 °C               | 0.9 °C  |  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range                             | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|-----------------------------------|---|--|
| Temperature Indicator                         |                                   |   |  |
| PT10 (385)                                    | -200 °C to 0 °C<br>0 °C to 850 °C | 2.0 °C<br>2.7 °C  | Electrical Simulation using Temperature Calibrator with reference to EURAMET cg-11/Version 2.0 |
| PT100 (385)                                   | -200 °C to 850 °C                 | 0.3 °C  |  |
| PT100 (3916)                                  | - 200 °C to 630 °C                | 0.3 °C  |  |
| PT100 (3926)                                  | -200 °C to 850 °C                 | 0.3 °C  |  |
| PT200 (385)                                   | -200 °C to 850 °C                 | 0.2 °C  |  |
| PT500 (385)                                   | -200 °C to 850 °C                 | 0.1 °C  |  |
| PT1000 (385)                                  | -200 °C to 850 °C                 | 0.1 °C  |  |
| Cu10 (427)                                    | -200 °C to 260 °C                 | 2 °C  |  |
| Cu50 (428)                                    | -50 °C to 150 °C                  | 0.4 °C  |  |
| Cu100 (428)                                   | -180 °C to 200 °C                 | 0.2 °C  |  |
| Ni100 (618)                                   | -100 °C to 260 °C                 | 0.2 °C  |  |
| Ni120 (672)                                   | -100 °C to 260 °C                 | 0.2 °C  |  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|--|---|--|
| Temperature Sensor                            | -95 °C to below -80 °C<br>-80°C to below -60°C<br>-60 °C to 200 °C<br>Above 200 °C to 300°C<br>Above 300°C to 600°C<br>Above 600°C to 800°C<br>Above 800°C to 1200°C     | 0.025 °C<br>0.01 °C<br>0.009 °C<br>0.011 °C<br>0.44 °C<br>3.5 °C<br>4.1 °C    | Comparison with PT100 / Type R Sensor in Metrology Well / Liquid Bath / Temperature Block Calibrator |
| Surface Sensor                                | 0 °C to 50 °C<br>50 °C to 200 °C<br>200 °C to 300 °C   | 0.5 °C<br>0.55 °C<br>0.71 °C  | Comparison with Reference Surface Sensor on Electronic Hotplate / Equalizing Block of Dry Bath       |
| Temperature Block Calibrator                  | -95 °C to -20 °C<br>Above -20 °C to 300 °C<br>Above 300 °C to 600 °C<br>Above 600 °C to 700 °C<br>Above 700 °C to 900 °C<br>Above 900 °C to 1200 °C                      | 0.07 °C<br>0.061 °C<br>0.12 °C<br>1.0 °C<br>3.5 °C<br>4.2 °C                  | Comparison with PT 100 / Thermocouple Type R / EURAMET cg-13 Version 4.0, 0.9/2017                   |
| Liquid Bath Calibrator                        | -80 °C to 300 °C   | 0.011 °C  |  |
| Radiation / Infrared Thermometer              | -30 °C to 0 °C<br>Above 0 °C to 100 °C<br>Above 100 °C to 200 °C<br>Above 200 °C to 300 °C<br>Above 300 °C to 400 °C<br>Above 400 °C to 500 °C<br>Above 500 °C to 650 °C | 0.72 °C<br>0.44 °C<br>0.78 °C<br>1.2 °C<br>1.7 °C<br>2.1 °C<br>2.7 °C         | Comparison with PT100 and Type K in Blackbody Source with reference to ASTM E 2847:2021              |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range                  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|------------------------|---|--|
| <u>Thermohygro Devices</u>                    |                        |   |  |
| Relative Humidity (@ 25°C)                    | 20 %rh to 70 %rh       | 1.1 %rh   | Comparison with Humidity Transmitter/ Thermohygro Device In Humidity Chamber                   |
|   | Above 70 %rh to 97 %rh | 1.7 %rh   |  |
|   | Above 97 %rh to 98 %rh | 1.1 %rh   | Comparison with Wet & Dry Bulb in Humidity Chamber   |
| Air Temperature                               | -86 °C to below -45 °C | 0.06 °C   | Comparison with PT100 / Type-K in Temperature or Humidity Chamber                              |
|   | -45 °C to 30 °C        | 0.05 °C   |  |
|   | Above 30 °C to 60 °C   | 0.08 °C   |  |
|   | Above 60 °C to 90 °C   | 0.1 °C  |  |
|   | Above 90 °C to 150 °C  | 0.6 °C  |  |
|   | Above 150 °C to 250 °C | 0.9 °C  |  |
|   | Above 250 °C to 300 °C | 1 °C  |  |
| Relative Humidity (Fixed Point) at 25 °C      | 11 %rh                 | 0.8 %rh   | Measurement of Relative Humidity by Means of Aqueous Solution with reference to ASTM E104:2020 |
|   | 33 %rh                 | 0.9 %rh   |  |
|   | 75 %rh                 | 1.0 %rh   |  |
|   | 85 %rh                 | 1.3 %rh   |  |
|   | 97 %rh                 | 1.3%rh  |  |
| <u>Liquid – In – Glass</u>                    |                        |   |  |
| Total Immersion Thermometer                   | -80 °C to 300 °C       | 0.3 °C  | Comparison with PT100 in a Stirred Liquid Bath   |
| Partial Immersion Thermometer                 | -80 °C to 300 °C       | 0.4 °C  |  |
| Wood Moisture Meter (Resistive Pin Type)      | 5 %MC to 50 %MC        | 0.4 %MC   | Resistance Simulation by using High Resistance Decade Substituter/ Decade Resistance Box       |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range                                       | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|---|---|---|
| Temperature Indicator                         |   |   |   |
| K   | -200 °C to 0 °C<br>Above 0 °C to 1370 °C    | 0.07 °C<br>0.04 °C  | Electrical Simulation using Multi-product Calibrator and reference table ITS-90 |
| J   | -210 °C to 0 °C<br>Above 0 °C to 1200 °C    | 0.04 °C<br>0.03 °C  |   |
| T   | -200 °C to 0 °C<br>Above 0 °C to 400 °C     | 0.05 °C<br>0.02 °C  |   |
| E   | -200 °C to 0 °C<br>Above 0 °C to 1300 °C    | 0.04 °C<br>0.02 °C  |   |
| N   | -200 °C to 0 °C<br>Above 0 °C to 1300 °C    | 0.08 °C<br>0.03 °C  |   |
| B   | 250 °C to 600 °C<br>Above 600 °C to 1820 °C | 0.53 °C<br>0.13 °C  |   |
| R   | -50 °C to 0 °C<br>Above 0 °C to 1760 °C     | 0.19 °C<br>0.07 °C  |   |
| S   | -50 °C to 0 °C<br>Above 0 °C to 1760 °C     | 0.17 °C<br>0.08 °C  |   |
| C   | 0 °C to 2315 °C                             | 0.2 °C  |   |
| D   | 0 °C to 2315 °C                             | 0.2 °C  |   |
| G   | 0 °C to 100 °C<br>Above 100 °C to 2315 °C   | 0.7 °C<br>0.2 °C  |   |
| L   | -200 °C to 900 °C                           | 0.2 °C  |   |
| U   | -200 °C to 100 °C<br>Above 100 °C to 600 °C | 0.4 °C<br>0.2 °C  |   |
| PLII  | 0 °C to 1200°C                              | 0.9 °C  |   |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range             | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|-------------------|---|---|
| Temperature Indicator                         |                   |   |   |
| PT10 (385)                                    | -200 °C to 850 °C | 0.07 °C   | Electrical Simulation using Multi-product Calibrator and reference table ITS-90 |
| PT100 (385)                                   | -200 °C to 850 °C | 0.03 °C   |   |
| PT100 (3916)                                  | -200 °C to 630 °C | 0.07 °C   |   |
| PT100 (3926)                                  | -200 °C to 850 °C | 0.03 °C   |   |
| PT200 (385)                                   | -200 °C to 850 °C | 0.04 °C   |   |
| PT500 (385)                                   | -200 °C to 850 °C | 0.04 °C   |   |
| PT1000 (385)                                  | -200 °C to 850 °C | 0.03 °C   |   |
| Cu10 (427)                                    | -200 °C to 260 °C | 0.05 °C   |   |
| Cu50 (428)                                    | -50 °C to 150 °C  | 0.02 °C   |   |
| Cu100 (428)                                   | -50 °C to 150 °C  | 0.02 °C   |   |
| Ni100 (618)                                   | -60 °C to 180 °C  | 0.01 °C   |   |
| Ni120 (672)                                   | -80 °C to 260 °C  | 0.01 °C   |   |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range                                     | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|---|---|---|
| Temperature Simulator                         |   |   |   |
| K   | -200 °C to 0 °C<br>Above 0 °C to 1370 °C  | 0.16 °C<br>0.1 °C   | Measurement using Multimeter and reference table ITS-90 |
| J   | -210 °C to 0 °C<br>Above 0 °C to 1200 °C  | 0.14 °C<br>0.09 °C  |   |
| T   | -200 °C to 0 °C<br>Above 0 °C to 400 °C   | 0.15 °C<br>0.09 °C  |   |
| E   | -200 °C to 0 °C<br>Above 0 °C to 1000 °C  | 0.12 °C<br>0.09 °C  |   |
| N   | -200 °C to 0 °C<br>Above 0 °C to 1300 °C  | 0.22 °C<br>0.1 °C   |   |
| B   | 250 °C to 600 °C<br>Above 600 to 1820 °C  | 0.78 °C<br>0.19 °C  |   |
| R   | -50 °C to 0 °C<br>Above 0 °C to 1760 °C   | 0.54 °C<br>0.18 °C  |   |
| S   | -50 °C to 0 °C<br>Above 0 °C to 1760 °C   | 0.51 °C<br>0.21 °C  |   |
| C   | 0 °C to 2315 °C                           | 0.3 °C  |   |
| G   | 0 °C to 100 °C<br>Above 100 °C to 2315 °C | 1.6 °C<br>1.3 °C  |   |
| D   | 0 °C to 2315 °C                           | 0.5 °C  |   |
| L   | -200 °C to 900 °C                         | 0.2 °C  |   |
| U   | -200 °C to 600 °C                         | 0.2 °C  |   |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TEMPERATURE**

| Instrument Calibrated / Measurement Parameter | Range             | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|-------------------|---|---|
| Temperature Simulator                         |                   |   |   |
| PT10 (385)                                    | -200 °C to 850 °C | 0.2 °C  | Measurement using Multimeter and reference table ITS-90 |
| PT100 (385)                                   | -200 °C to 850 °C | 0.06 °C   |   |
| PT100 (3916)                                  | -200 °C to 630 °C | 0.06 °C   |   |
| PT100 (3926)                                  | -200 °C to 850 °C | 0.06 °C   |   |
| PT200 (385)                                   | -200 °C to 850 °C | 0.07 °C   |   |
| PT500 (385)                                   | -200 °C to 850 °C | 0.07 °C   |   |
| PT1000 (385)                                  | -200 °C to 850 °C | 0.06 °C   |   |
| Cu10 (427)                                    | -200 °C to 260 °C | 0.2 °C  |   |
| Cu50 (428)                                    | -50 °C to 150 °C  | 0.07 °C   |   |
| Cu100 (428)                                   | -50 °C to 150 °C  | 0.06 °C   |   |
| Ni100 (618)                                   | -60 °C to 180 °C  | 0.06 °C   |   |
| Ni120 (672)                                   | -80 °C to 260 °C  | 0.06 °C   |   |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE PF CALIBRATION: VOLUME****SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*             | Remarks   |
|---|--|---|---|
| pH Meter                                      | 4.00 pH<br>7.00 pH<br>10.00 pH   | 0.034 pH<br>0.032 pH<br>0.038 pH  | Standard Buffer Solution  |
| pH Meter (pH Simulation)                      | -2.00 pH to 16.00 pH   | 0.023 pH  | Electrical Simulation   |
| Conductivity Meter                            | 0 $\mu$ S/cm<br>15 $\mu$ S/cm<br>84 $\mu$ S/cm<br>1413 $\mu$ S/cm<br>12.880 mS/cm<br>111.3 mS/cm | 0.7 $\mu$ S/cm<br>0.4 $\mu$ S/cm<br>2 $\mu$ S/cm<br>10 $\mu$ S/cm<br>0.3 mS/cm<br>2 mS/cm | Calibrated NIST Traceable Standard Solution based on ASTM D 1125-14 |
| Dynamic Viscosity (Rotational Viscometer)     | 2 mPa.s to 50 mPa.s<br>50 mPa.s to 100,000 mPa.s   | 1.9 % of reading<br>1.5 % of reading  | Comparison with Certified Viscosity Reference Standard              |

**SCOPE OF CALIBRATION: VOLUME**

| Instrument Calibrated / Measurement Parameter            | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*             | Remarks   |
|--|---|---|---|
| pH Meter   | 4.00 pH<br>7.00 pH<br>10.00 pH  | 0.032 pH<br>0.030 pH<br>0.032 pH  | Standard Buffer Solution  |
| pH Meter (pH Simulation)                                 | -2.00 pH to 16.00 pH  | 0.011 pH  | Electrical Simulation   |
| Conductivity Meter                                       | 0 $\mu$ S/cm<br>15 $\mu$ S/cm<br>84 $\mu$ S/cm<br>1413 $\mu$ S/cm<br>12.880 mS/cm<br>111.3 mS/cm  | 0.7 $\mu$ S/cm<br>0.4 $\mu$ S/cm<br>2 $\mu$ S/cm<br>10 $\mu$ S/cm<br>0.2 mS/cm<br>2 mS/cm | Calibrated NIST Traceable Standard Solution based on ASTM D 1125-14 |
| Refractometer / Sucrose Mass Fraction / Refractive Index | 0 % to 10 % Brix (1.333 nD ~ 1.3478 nD)<br><br>10 % to 30 % Brix (1.3478 nD ~ 1.3812 nD)<br><br>30 % to 50 % Brix (1.3812 nD ~ 1.4201 nD) | 0.10 % Brix<br><br>0.13 % Brix<br><br>0.16 % Brix   | Sucrose Powder with Analytical Balance                              |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: VOLUME**

| Instrument Calibrated / Measurement Parameter   | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|---|---|--|
| Dynamic Viscosity<br>(Rotational Viscometer)  | 2 mPa.s to 50 mPa.s   | 1.3 % of reading  | Comparison with Certified Viscosity Reference Standard |
|   | 50 mPa.s to 100,000 mPa.s   | 1.0 % of reading  |  |
| Kinematic Viscosity<br><br>(Zahn Cup, DIN Cup, Flow Cup, ASTM / Ford Cup, ISO Cup, Frikmar Cup, Alfnor Cup and Dip Cup)             | 30 mm <sup>2</sup> /s to 120 mm <sup>2</sup> /s                             | 1.7% of readings  | Comparison with Certified Viscosity Reference Standard |
|   | 120 mm <sup>2</sup> /s to 400 mm <sup>2</sup> /s                            | 1.9% of readings  |  |
| Volumetric Apparatus<br>(To Deliver)<br><br>Piston-Operated Pipette<br><br>Burette<br>(Accuracy, delivery time)                     | 0.1 $\mu$ l to 20 $\mu$ l   | 0.020 $\mu$ l   | Gravimetric Method based on ISO 8655-6:2022            |
|   | Above 20 $\mu$ l to 100 $\mu$ l   | 0.026 $\mu$ l   |  |
|   | Above 100 $\mu$ l to 200 $\mu$ l  | 0.031 $\mu$ l   |  |
|   | Above 200 $\mu$ l to 1000 $\mu$ l   | 0.16 $\mu$ l  |  |
|   | Above 1000 $\mu$ l to 5000 $\mu$ l  | 0.76 $\mu$ l  |  |
|   | Above 5000 $\mu$ l to 10000 $\mu$ l<br>Above 10000 $\mu$ l to 20000 $\mu$ l | 1.6 $\mu$ l<br>3.1 $\mu$ l  |  |
| One-Mark Pipette  | 1 ml to 10 ml   | 0.0012 ml   | Gravimetric Method based on ASTM E 542-2022            |
|   | Above 10 ml to 100 ml   | 0.0025 ml   |  |
|   | Above 100 ml to 200 ml  | 0.0045 ml   |  |
|   | Above 200 ml to 500 ml  | 0.022 ml  |  |
|   | Above 500 ml to 1000 ml   | 0.029 ml  |  |
| Volumetric Apparatus<br>(To Contain)<br><br>(Measuring Cylinder, Flask, Beaker, BEVS Density Cup, Specific Gravity Cup, Pyknometer) | 1 ml to 10 ml   | 0.041 ml  | Gravimetric Method based on ASTM E 542-2022            |
|   | Above 10 ml to 100 ml   | 0.24 ml   |  |
|   | Above 100 ml to 200 ml  | 0.35 ml   |  |
|   | Above 200 ml to 500 ml  | 0.58 ml   |  |
|   | Above 500 ml to 1000 ml   | 1.6 ml  |  |
| Density Hydrometer<br>(S.G, API, Baume, g/cm <sup>3</sup> , Sikes, %Brix, Plato)  | 0.500 g/ml to 0.800 g/ml  | 0.00050 g/ml  | Cuckow's Method by Hydrostatic Weighing                |
|   | 0.800 g/ml to 2.000 g/ml  | 0.00056 g/ml  |  |
|   | 2.000 g/ml to 4.000 g/ml  | 0.00087 g/ml  |  |

**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*  | Remarks   |   |
|---|---|--|---|---|
| <b><u>OSCILLOSCOPE</u></b>                    |   |  |   |   |
| <b>Vertical Deflection (DC Signal)</b>        | <b>(50 <math>\Omega</math> Impedance Load)</b><br>0 mV to $\pm$ 110 mV<br>110 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6.6 V                      | 2.9 mV/V + 0.096 mV<br>2.9 mV/V + 0.14 mV<br>2.9 mV/V + 1.1 mV   | Generation using Fluke 5820A / Fluke 5520A (SC 600) |   |
|   | <b>(1 M<math>\Omega</math> Impedance Load)</b><br>0 mV to $\pm$ 110 mV<br>110 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 11 V<br>11 V to $\pm$ 130V | 0.29 mV/V + 0.084 mV<br>0.29 mV/V + 0.12 mV<br>0.29 mV/V + 1.3 mV<br>0.30 mV/V + 11 mV   |   |   |
|   | <b>Vertical Deflection (Square Wave Signal)</b>   | <b>(50 <math>\Omega</math> Impedance Load)</b><br>1 mV to $\pm$ 25 mV<br>25 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6.6 V                     |   | 3.0 mV/V + 0.096 mV<br>3.0 mV/V + 0.13 mV<br>2.9 mV/V + 0.99 mV                           |
|   |   | <b>(1 M<math>\Omega</math> Impedance Load)</b><br>1 mV to $\pm$ 25 mV<br>25 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6 V<br>6 V to $\pm$ 130 V |   | 0.61 mV/V + 0.014 mV<br>0.58 mV/V + 0.090 mV<br>0.59 mV/V + 0.82 mV<br>0.59 mV/V + 8.2 mV |
| <b>Time Base / TimeMarker</b>                 | 2 ns to 10 ns   | 0.42 $\mu$ s/s + 0.0086 ns   |   |   |
|   | 10 ns to 100 ns   | 0.42 $\mu$ s/s + 0.085 ns  |   |   |
|   | 100 ns to 10 $\mu$ s  | 0.42 $\mu$ s/s + 0.0085 $\mu$ s  |   |   |
|   | 10 $\mu$ s to 50 ms   | 0.42 $\mu$ s/s + 8.5 $\mu$ s   |   |   |
|   | 50 ms to 5 s  | 33 $\mu$ s/s + 1.7 ms  |   |   |
| <b>Rise Time</b>                              | 0.5 ns to 5 ns  | 4.6 ps/ns + 40 ps  |   |   |
|   | 5 ns to 50 ns   | 0.055 ns   |   |   |
|   | 50 ns to 500 ns   | 0.083 ns   |   |   |
| <b>Bandwidth</b>                              | 50 kHz to 100 MHz   | 0.39 Hz/MHz + 5.0 MHz  |   |   |
|   | 100 MHz to 300 MHz  | 0.39 Hz/MHz + 12 MHz   |   |   |
|   | 300 MHz to 500 MHz  | 0.39 Hz/MHz + 20 MHz   |   |   |
|   | 500 MHz to 600 MHz  | 0.39 Hz/MHz + 30 MHz   |   |   |
|   | 600 MHz to 2.1 GHz  | 0.39 Hz/MHz + 0.11 GHz   |   |   |
| <b>Flatness</b>                               | <b><u>Sine Wave relative to 50 kHz</u></b><br>50 kHz to 100 MHz   | 0.20 dB  |   |   |
|   | 100 MHz to 600 MHz  | 0.43 dB  |   |   |
|   | <b><u>Sine Wave relative to 10 MHz</u></b><br>600 MHz to 2.1 GHz  | 0.62 dB  |   |   |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL****SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter    | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*   | Remarks   |
|--|---|---|---|
| <b>Measuring Instruments</b>                     |   |   |   |
| Inductance<br>(Inductance Meter,<br>LCR Meter)   | <p><b>100 Hz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> <p><b>120 Hz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> <p><b>1 kHz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> | <p>58 <math>\mu</math>H/mH + 2.5 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 12 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 0.12 mH<br/>12 <math>\mu</math>H/mH + 1.2 mH<br/>12 <math>\mu</math>H/mH + 2.9 mH</p> <p>58 <math>\mu</math>H/mH + 2.1 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 13 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 0.12 mH<br/>12 <math>\mu</math>H/mH + 1.2 mH<br/>12 <math>\mu</math>H/mH + 2.9 mH</p> <p>58 <math>\mu</math>H/mH + 1.2 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 12 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 0.12 mH<br/>12 <math>\mu</math>H/mH + 1.2 mH<br/>12 <math>\mu</math>H/mH + 2.8 mH</p> | Generation using<br>Decade<br>Inductance Boxes<br>Lionmount LD8                           |
| <b>Measuring Instruments</b>                     |   |   |   |
| Capacitance<br>(Capacitance Meter,<br>LCR Meter) | <p><b>100 Hz</b></p> <p>50 pF to 10.50 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p> <p><b>120 Hz</b></p> <p>50 pF to 10.50 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p> <p><b>1 kHz</b></p> <p>50 pF to 10.50 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p>  | <p>5.9 pF/nF + 6.1 pF<br/>5.9 nF/<math>\mu</math>F + 0.019 nF<br/>5.9 nF/<math>\mu</math>F + 0.065 nF</p> <p>5.9 pF/nF + 6.0 pF<br/>5.9 nF/<math>\mu</math>F + 0.010 nF<br/>5.9 nF/<math>\mu</math>F + 0.059 nF</p> <p>6.0 pF/nF + 5.9 pF<br/>5.9 nF/<math>\mu</math>F + 0.010 nF<br/>5.9 nF/<math>\mu</math>F + 0.067 nF</p>   | Generation using<br>General Radio<br>1412-BC /<br>Decade<br>Capacitance ED<br>Lab CU-410A |



**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

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| Instrument Calibrated / Measurement Parameter                            | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |   |
|--|--|---|--|---|
| <b>Measuring Instruments</b>   |  |   |  |   |
| Resistance   | 0 $\Omega$                                   | 0.13 m $\Omega$   | Short connection   |   |
| (Resistance Meter, LCR Meter, Earth Continuity Tester, Insulation Meter) | 0.01 $\Omega$ to 0.1 $\Omega$                | 1.2 m $\Omega$ / $\Omega$ + 4.4 m $\Omega$                                    | Generation using Decade Resistance Box TIME 1051/ Yokogawa 2793-01 |   |
|  | 0.1 $\Omega$ to 1.1 $\Omega$                 | 0.12 m $\Omega$ / $\Omega$ + 5.1 m $\Omega$                                   |  |   |
|  | 1.1 $\Omega$ to 10.1 $\Omega$                | 0.12 m $\Omega$ / $\Omega$ + 6.2 m $\Omega$                                   |  |   |
|  | 10.1 $\Omega$ to 100.1 $\Omega$              | 0.13 m $\Omega$ / $\Omega$ + 2.4 m $\Omega$                                   |  |   |
|  | 100.1 $\Omega$ to 1000.1 $\Omega$            | 0.12 m $\Omega$ / $\Omega$ + 2.5 m $\Omega$                                   |  |   |
|  | 1 k $\Omega$ to 10 k $\Omega$                | 0.59 $\Omega$ /k $\Omega$ + 0.059 $\Omega$                                    |  | Generation using Yokogawa 2793-03 / IET HRRS -F-6-1M-10 kV-WT |
|  | 10 k $\Omega$ to 100 k $\Omega$              | 0.61 $\Omega$ /k $\Omega$ + 0.23 $\Omega$                                     |  |   |
|  | 100 k $\Omega$ to 1000 k $\Omega$            | 0.61 $\Omega$ /k $\Omega$ + 4.1 $\Omega$                                      |  |   |
|  | 1 M $\Omega$ to 10 M $\Omega$                | 0.61 k $\Omega$ /M $\Omega$ + 0.57 k $\Omega$                                 |  |   |
|  | 10 M $\Omega$ to 100 M $\Omega$              | 0.71 k $\Omega$ /M $\Omega$ + 20 k $\Omega$                                   |  |   |
| 0.1 G $\Omega$ to 1 G $\Omega$   | 12 M $\Omega$ /G $\Omega$ + 0.57 M $\Omega$  |   |  |   |
| 1 G $\Omega$ to 10 G $\Omega$  | 12 M $\Omega$ /G $\Omega$ + 5.7 M $\Omega$   |   |  |   |
| 10 G $\Omega$ to 100 G $\Omega$  | 13 M $\Omega$ /G $\Omega$ + 0.078 G $\Omega$ |   |  |   |
| 100 G $\Omega$ to 1000 G $\Omega$  | 13 M $\Omega$ /G $\Omega$ + 1.5 G $\Omega$   |   |  |   |
| 1000 G $\Omega$ to 1111 G $\Omega$                                       | 22 M $\Omega$ /G $\Omega$ + 16 G $\Omega$    |   |  |   |
| Dissipation Factor (LCR Meter)   | 0.000 to 2.000 $\Omega$ / $\Omega$ @ 100 Hz  | 0.59 % + 0.056 $\Omega$ / $\Omega$  | Generation using Yokogawa Decade Box & General Radio 1412-BC       |   |
|  | 0.000 to 2.000 $\Omega$ / $\Omega$ @ 1 kHz   | 0.59 % + 0.056 $\Omega$ / $\Omega$  |  |   |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL****SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter                          | Range           | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|--|-----------------|---|--|
| <b>Measuring Instruments</b>   |                 |   |  |
| DC Voltage Meter<br>(High Voltage Meter,<br>Electrostatic Field Meter) | 0.5 kV to 10 kV | 12 V/kV + 7.6 V   | Kikusui<br>TOS 5101<br>Comparison<br>with Kikusui<br>149-10A |
| AC Voltage Meter<br>(High Voltage Meter)<br>@ 50Hz                     | 0.5 kV to 10 kV | 24 V/kV + 19 V  |  |

| Instrument Calibrated / Measurement Parameter     | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|--|---|---|
| <b>Generating Instruments</b>                     |  |   |   |
| DC High Voltage<br>(Hipot, Insulation<br>Voltage) | 0.5 kV to 10 kV<br>10 kV + 40 kV                         | 12 V/kV + 9.5 V<br>0.58 kV  | HV Digital Meter<br>Kikusui 149-10A /<br>HV Probe with<br>DMM |
| AC High Voltage<br>(Hipot, Insulation<br>Voltage) | <b>50 Hz / 60 Hz</b><br>0.5 kV to 10 kV<br>10 kV + 28 kV | 24 V/kV + 20 V<br>0.58 kV   |   |
| DC Leakage Current<br>(DC Withstand<br>Current)   | 0.5 to 50 mA<br>50 mA to 100 mA                          | 1.2 $\mu$ A/mA + 13 $\mu$ A<br>1.2 $\mu$ A/mA + 60 $\mu$ A                    | Kikusui TOS 1200 /<br>Keysight U1282A                         |
| AC Leakage Current<br>(AC Withstand<br>Current)   | <b>50 Hz / 60 Hz</b><br>0.5 to 50 mA<br>50 mA to 100 mA  | 14 $\mu$ A/mA + 60 $\mu$ A<br>14 $\mu$ A/mA + 0.30 mA                         |   |



**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter        | Range  | Calibration and Measurement Capability Expressed as an Uncertainty(±)*   | Remarks  |
|--|--|--|--|
| <p><b>Generating Instruments</b><br/>Capacitance</p> | <p><b>100 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 µF to 2 µF<br/>2 µF to 20 µF<br/>20 µF to 200 µF<br/>200 µF to 1000 µF</p> <p><b>120 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 µF to 2 µF<br/>2 µF to 20 µF<br/>20 µF to 200 µF<br/>200 µF to 1000 µF</p> <p><b>1000 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 µF to 2 µF<br/>2 µF to 20 µF</p> | <p>5.9 pF/nF + 1.2 pF<br/>2.6 pF/nF + 2.4 pF<br/>2.6 nF/µF + 0.024 nF<br/>2.6 nF/µF + 0.24 nF<br/>2.6 nF/µF + 2.4 nF<br/>5.9 µF/mF + 0.024 µF<br/>12 µF/mF + 0.25 µF</p> <p>5.9 pF/nF + 0.90 pF<br/>2.6 pF/nF + 2.4 pF<br/>2.6 nF/µF + 0.024 nF<br/>2.6 nF/µF + 0.24 nF<br/>2.6 nF/µF + 2.4 nF<br/>5.9 µF/mF + 0.024 µF<br/>12 µF/mF + 0.25 µF</p> <p>5.9 pF/nF + 0.59 pF<br/>2.6 pF/nF + 2.4 pF<br/>2.6 nF/µF + 0.024 nF<br/>2.6 nF/µF + 0.24 nF<br/>2.6 nF/µF + 2.4 nF</p> | <p>Measurement using<br/>GWInstek LCR<br/>Meter / Keysight<br/>E4980AL (032)<br/>Precision LCR<br/>Meter</p> |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty(±)*   | Remarks   |
|---|--|--|---|
| <b>Generating Instruments</b><br>Inductance   | <p><b><u>100 Hz</u></b><br/>0 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1000 mH<br/>1 H to 10 H</p> <p><b><u>120 Hz</u></b><br/>0 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1000 mH<br/>1 H to 10 H</p> <p><b><u>1000 Hz</u></b><br/>0 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1000 mH<br/>1 H to 10 H</p> | <p>6.1 µH/mH + 5.9 µH<br/>2.7 mH/H + 0.025 mH<br/>2.4 mH/H + 0.26 mH<br/>2.8 mH/H + 2.6 mH</p> <p>6.1 µH/mH + 5.9 µH<br/>2.7 mH/H + 0.025 mH<br/>2.4 mH/H + 0.26 mH<br/>2.8 mH/H + 2.6 mH</p> <p>5.9 µH/mH + 5.9 µH<br/>2.4 mH/H + 0.025 mH<br/>2.4 mH/H + 0.25 mH<br/>2.5 mH/H + 2.6 mH</p> | Measurement using<br>GW Instek LCR<br>Meter / Keysight<br>E4980AL (032)<br>Precision LCR<br>Meter |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL****SITE: CATEGORY 1**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*  | Remarks  |
|---|--|--|--|
| Measuring Instruments                         |  |  | Generation using<br>Fluke 5520A,<br>Keysight 3458A |
| DC Voltage                                    | 0 mV to 320 mV<br>0.32 V to 3.2 V<br>3.2 V to 32 V<br>32 V to 320 V<br>320 V to 1000 V   | 0.0096 mV/V + 0.0069 mV<br>0.0097 mV/V + 0.13 mV<br>0.012 mV/V + 0.43 mV<br>0.012 mV/V + 5.9 mV<br>12 $\mu$ V/V + 6.1 mV   |  |
| AC Voltage                                    | 0 V to 1020 V  | 12 $\mu$ V/V + 6.1 mV  |  |
| DC Current                                    | 0 $\mu$ A to 320 $\mu$ A<br>0.32 mA to 3.2 mA<br>3.2 mA to 32 mA<br>32 mA to 330 mA<br>0.33 A to 3 A<br>3 A to 20 A  | 0.025 mA/A + 0.000021 mA<br>0.026 mA/A + 0.00060 mA<br>0.043 mA/A + 0.0026 mA<br>0.14 mA/A + 0.14 mA<br>0.14 mA/A + 0.14 mA<br>0.80 mA/A + 18 mA   |  |
| AC Current                                    | 0 A to 20 A  | See Matrix B   |  |
| Resistance                                    | 0 $\Omega$ to 40 $\Omega$<br>40 $\Omega$ to 400 $\Omega$<br>400 $\Omega$ to 4 k $\Omega$<br>4 k $\Omega$ to 40 k $\Omega$<br>40 k $\Omega$ to 400 k $\Omega$<br>400 k $\Omega$ to 4 M $\Omega$<br>4 M $\Omega$ to 40 M $\Omega$<br>40 M $\Omega$ to 400 M $\Omega$ | 0.015 m $\Omega$ / $\Omega$ + 2.9 m $\Omega$<br>0.012 m $\Omega$ / $\Omega$ + 6.8 m $\Omega$<br>0.013 m $\Omega$ / $\Omega$ + 0.22 $\Omega$<br>0.014 m $\Omega$ / $\Omega$ + 24 $\Omega$<br>0.022 k $\Omega$ /M $\Omega$ + 500 $\Omega$<br>0.063 k $\Omega$ /M $\Omega$ + 13 k $\Omega$<br>0.61 k $\Omega$ /M $\Omega$ + 1100 k $\Omega$<br>5.9 k $\Omega$ /M $\Omega$ + 1500 k $\Omega$ |  |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

**Matrix A**

**AC Voltage Measurement**

| Range           | Frequency     |               |              |              |             |
|-----------------|---------------|---------------|--------------|--------------|-------------|
|                 | Hz            | kHz           |              |              |             |
|                 | 10 to 50      | 0.05 to 1     | 1 to 20      | 20 to 50     | 50 to 100   |
| 0 mV to 320 mV  | 0.094 + 0.025 | 0.091 + 0.024 | 0.36 + 0.026 | 0.36 + 0.025 | 0.97 + 0.89 |
| 320 mV to 3.2 V | 0.085 + 0.26  | 0.085 + 0.33  | 0.35 + 0.73  | 0.36 + 2.8   | 0.97 + 11   |
| 3.2 V to 32 V   | 0.24 + 2.4    | 0.24 + 2.7    | 0.42 + 25    | 0.42 + 41    | 1.4 + 4.2   |
| 32 V to 320 V   | 0.48 + 25     | 0.47 + 29     | 1.4 + 29     |              |             |
| 320 V to 1020 V | 0.43 + 18     | 0.43 + 17     |              |              |             |

The expanded uncertainties given in above table are expressed in mV/V + mV

**Matrix B**

**AC Current Measurement**

| Range             | Frequency (Hz)       | Frequency (kHz)       |                      |                     |                    |
|-------------------|----------------------|-----------------------|----------------------|---------------------|--------------------|
|                   | 10 to 45             | 0.045 to 1            | 1 to 5               | 5 to 10             | 10 to 30           |
| 29 µA to 330 µA   | 1.2 µA/mA + 0.086 µA | 0.97 µA/mA + 0.078 µA | 2.3 µA/mA + 0.12 µA  | 6.3 µA/mA + 0.16 µA | 13 µA/mA + 0.32 µA |
| 0.33 mA to 3.3 mA | 0.98 µA/mA + 1.2 µA  | 0.79 µA/mA + 1.0 µA   | 1.6 µA/mA + 1.0 µA   | 3.9 µA/mA + 1.8 µA  | 7.8 µA/mA + 1.9 µA |
| 3.3 mA to 33 mA   | 0.75 µA/mA + 3.5 µA  | 0.36 µA/mA + 3.5 µA   | 0.67 µA/mA + 3.5 µA  | 1.6 µA/mA + 3.9 µA  | 3.2 µA/mA + 4.4 µA |
| 33 mA to 330 mA   | 0.72 mA/A + 0.091 mA | 0.36 mA/A + 0.092 mA  | 0.80 mA/A + 0.098 mA | 1.6 mA/A + 0.12 mA  | 3.1 mA/A + 0.18 mA |
| 0.33 A to 1.1 A   | 1.4 mA/A + 0.12 mA   | 0.41 mA/A + 0.12 mA   | 4.6 mA/A + 0.77 mA   | 20 mA/A + 0.39 mA   |                    |
| 1.1 A to 3 A      | 1.6 mA/A + 0.55 mA   | 0.80 mA/A + 0.55 mA   | 4.8 mA/A + 0.91 mA   | 20 mA/A + 4.0 mA    |                    |
| 3 A to 11 A       |                      | 0.78 mA/A + 2.1 mA    | 24 mA/A + 2.0 mA     |                     |                    |
| 11 A to 20 A      |                      | 1.2 mA/A + 4.0 mA     | 24 mA/A + 4.0 mA     |                     |                    |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

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| Instrument Calibrated / Measurement Parameter   | Range   | Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*   | Remarks  |
|---|---|--|--|
| Measuring Instruments<br><br>Frequency  | 0.5 Hz to 120 Hz<br>120 Hz to 1.2 kHz<br>1.2 kHz to 12 kHz<br>12 kHz to 120 kHz<br>120 kHz to 1.2 MHz<br>1.2 MHz to 2 MHz<br>2 MHz to 10 MHz  | 2.0 ppm + 0.0082 Hz<br>2.0 ppm + 0.082 Hz<br>2.0 ppm + 0.82 Hz<br>2.0 ppm + 8.2 Hz<br>2.0 ppm + 82 Hz<br>2.0 ppm + 0.82 kHz<br>24 ppm + 0.32 kHz   | Generation using<br>Fluke 5520A<br>/ HP 33120A       |
| Capacitance   | 0.5 nF to 1.1 nF<br>1.1 nF to 3.3 nF<br>3.3 nF to 11 nF<br>11 nF to 33 nF<br>33 nF to 110 nF<br>0.11 $\mu$ F to 0.33 $\mu$ F<br>0.33 $\mu$ F to 1.1 $\mu$ F<br>1.1 $\mu$ F to 3.3 $\mu$ F<br>3.3 $\mu$ F to 11 $\mu$ F<br>11 $\mu$ F to 33 $\mu$ F<br>33 $\mu$ F to 110 $\mu$ F<br>0.11 mF to 0.33 mF<br>0.33 mF to 1.1 mF<br>1.1 mF to 3.3 mF<br>3.3 mF to 11 mF<br>11 mF to 33 mF<br>33 mF to 40 mF | 1.3 pF/nF + 7.9 pF<br>1.3pF/nF + 7.9 pF<br>0.45 pF/nF + 8.0 pF<br>0.62 pF/nF + 78 pF<br>0.59 pF/nF + 0.078 nF<br>0.61 nF/ $\mu$ F + 0.24 nF<br>0.59 nF/ $\mu$ F + 0.78 nF<br>0.61 nF/ $\mu$ F + 2.4 nF<br>0.59 nF/ $\mu$ F + 7.8 nF<br>0.61 nF/ $\mu$ F + 24 nF<br>0.21 nF/ $\mu$ F + 79 nF<br>0.36 $\mu$ F/mF + 0.29 $\mu$ F<br>0.13 $\mu$ F/mF + 0.78 $\mu$ F<br>0.13 $\mu$ F/mF + 2.4 $\mu$ F<br>0.16 $\mu$ F/mF + 8.7 $\mu$ F<br>0.13 $\mu$ F/mF + 24 $\mu$ F<br>0.17 $\mu$ F/mF + 0.13 mF | Generation using<br>Fluke 5520A                      |
| Current Measuring Device (Clamp Meter, Current Probe, Current Sensor)<br><br>DC Current<br>- 50 Turn Coil | (+/- polarities)<br>1.6 to 16 A<br><br>16 to 160 A<br><br>160 to 525 A<br><br>525 to 1000 A   | 0.12 A + 3.3 mA/A<br><br>0.21 A + 4.7 mA/A<br><br>0.36 A + 8.3 mA/A<br><br>0.31 A + 3.0 mA/A   | Generation using<br>Fluke 5520A<br>with Current Coil |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL****SITE: CATEGORY 1**

| Instrument Calibrated/<br>Measurement<br>Parameter   | Range  | Calibration and<br>Measurement Capability<br>Expressed as an<br>Uncertainty( $\pm$ )*   | Remarks  |
|--|--|---|--|
| Current<br>Measuring<br>Device<br>(Clamp Meter,<br>Current Probe,<br>Current Sensor)<br><br>AC Current<br>- 50 Turn Coil | <u>1.6 to 16 A</u><br>10 to 440 Hz   | 0.27 A + 35 mA/A  | Generation using<br>Fluke 5520A with<br>Current Coil   |
|  | <u>16 to 160 A</u><br>10 to 100 Hz<br>100 to 440 Hz  | 0.26 A + 23 mA/A<br>0.23 A + 23 mA/A  |  |
|  | <u>160 to 1000 A</u><br>10 to 440 Hz   | 0.80 A + 13 mA/A  |  |
| Generating<br>Instruments<br><br>DC Voltage  | 0 to 100 mV<br>100 mV to 1 V<br>1 V to 10 V<br>10 V to 100 V<br>100 V to 1000 V              | 6.2 $\mu$ V + 11 $\mu$ V/V<br>9.1 $\mu$ V + 9.4 $\mu$ V/V<br>0.14 mV + 9.4 $\mu$ V/V<br>0.76 mV + 12 $\mu$ V/V<br>8.4 mV + 12 $\mu$ V/V | Measurement<br>Keysight 3458A<br>Digital Multimeter  |
| AC Voltage   | 0 to 1000 V  | See Matrix C  |  |
| DC Current<br>(Rectifier, Power<br>Supply Unit,<br>Welding Machine)  | 0 to 100 $\mu$ A<br>100 $\mu$ A to 1 mA<br>1 mA to 10 mA<br>10 mA to 100 mA<br>100 mA to 1 A | 0.0000047 mA + 0.023 mA/A<br>0.000036 mA + 0.025 mA/A<br>0.00065 mA + 0.026 mA/A<br>0.0040 mA + 0.043 mA/A<br>0.14 mA + 0.14 mA/A       | Measurement Agilent<br>34401A Multimeter<br><br>Keysight 34330A<br>Current Shunt with<br>Keysight 3458A<br>Multimeter / Fluke 376<br>Clamp Meter |
|  | 1 A to 3 A   | 2.6 mA + 1.4 mA/A   |  |
|  | 3 A to 30 A  | 0.011 mA/A + 8.8 mA   |  |
| AC Current<br>(Rectifier, Power<br>Supply Unit)  | 0 to 30 A  | See Matrix D  | Measurement using<br>Keysight 3458A<br>Multimeter  |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL****SITE: CATEGORY 1**

| Instrument Calibrated/<br>Measurement<br>Parameter | Range   | Calibration and<br>Measurement Capability<br>Expressed as an<br>Uncertainty( $\pm$ )*  | Remarks   |
|--|---|--|---|
| Resistance   | 0 to 10 $\Omega$<br>10 $\Omega$ to 100 $\Omega$<br>100 $\Omega$ to 1 k $\Omega$<br>1 k $\Omega$ to 10 k $\Omega$<br>10 k $\Omega$ to 100 k $\Omega$<br>100 k $\Omega$ to 1 M $\Omega$<br>1 M $\Omega$ to 10 M $\Omega$<br>10 M $\Omega$ to 100 M $\Omega$<br>100 M $\Omega$ to 1 G $\Omega$ | 3.4 m $\Omega$ + 0.020 m $\Omega$ / $\Omega$<br>3.3 m $\Omega$ + 0.015 m $\Omega$ / $\Omega$<br>15 m $\Omega$ + 0.012 m $\Omega$ / $\Omega$<br>0.25 $\Omega$ + 0.012 m $\Omega$ / $\Omega$<br>24 $\Omega$ + 0.14 m $\Omega$ / $\Omega$<br>500 $\Omega$ + 0.022 m $\Omega$ / $\Omega$<br>13 k $\Omega$ + 0.064 m $\Omega$ / $\Omega$<br>0.61 m $\Omega$ / $\Omega$ + 0.83 M $\Omega$<br>9.7 M $\Omega$ /G $\Omega$ + 1.1 M $\Omega$ | Measurement<br>Keysight 3458A<br>Digital Multimeter |
| Frequency  | 1 Hz to 40 Hz<br>40 Hz to 100 Hz<br>100 Hz to 100 kHz<br>100 kHz to 10 MHz  | 0.024 Hz<br>0.012 Hz<br>12 Hz<br>1.2 kHz   |   |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE: CATEGORY 1**

**Generating Instruments**

**AC Voltage:**

**Matrix C**

| Frequency<br>Voltage | Hz                      | kHz                     |                         |                        |                        |
|----------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|
|                      | 0 to 40                 | 0.04 to 1               | 1 to 20                 | 20 to 50               | 50 to 100              |
| 0 to 10 mV           | 0.50 mV +<br>0.40 mV/V  | 0.40 mV +<br>0.28 mV/V  | 0.67 mV +<br>0.40 mV/V  | 0.38 mV +<br>1.3 mV/V  | 0.37 mV +<br>6.1 mV/V  |
| 10 mV to 100 mV      | 0.11 mV +<br>0.15 mV/V  | 0.092 mV +<br>0.13 mV/V | 0.092 mV +<br>0.21 mV/V | 0.19 mV +<br>0.41 mV/V | 0.18 mV +<br>1.1 mV/V  |
| 100 mV to 1 V        | 0.15 mV +<br>0.082 mV/V | 0.14 mV +<br>0.082 mV/V | 0.14 mV +<br>0.17 mV/V  | 0.14 mV +<br>0.35 mV/V | 0.91 mV +<br>0.93 mV/V |
| 1 V to 10 V          | 1.4 mV +<br>0.084 mV/V  | 1.5 mV +<br>0.084 mV/V  | 1.5 mV +<br>0.17 mV/V   | 2.7 mV +<br>0.35 mV/V  | 12 mV +<br>0.93 mV/V   |
| 10 V to 100 V        | 14 mV +<br>0.24 mV/V    | 13 mV +<br>0.24 mV/V    | 28 mV +<br>0.24 mV/V    | 42 mV +<br>0.41 mV/V   | 19 mV +<br>0.11 mV/V   |
| 100 V to 1000 V      | 50 mV +<br>0.48 mV/V    | 31 mV +<br>0.48 mV/V    |                         |                        |                        |

**AC Current:**

**Matrix D**

| Frequency<br>Current | Hz                     | kHz                    |                        |                       | Measuring Instrument                              |
|----------------------|------------------------|------------------------|------------------------|-----------------------|---|
|                      | 0 to 50                | 0.05 to 1              | 1 to 5                 | 5 to 30               |   |
| 0 A to 1 mA          | 0.37 µA +<br>0.70 mA/A | 0.33 µA +<br>0.36 mA/A | 0.34 µA +<br>0.37 mA/A | 0.52 µA +<br>4.7 mA/A | Keysight 3458A                                    |
| 1 mA to 10 mA        | 4.2 µA +<br>0.70 mA/A  | 4.1 µA +<br>0.36 mA/A  | 3.9 µA +<br>0.37 mA/A  | 5.8 µA +<br>4.7 mA/A  |   |
| 10 mA to 100 mA      | 33 µA +<br>0.70 mA/A   | 35 µA +<br>0.36 mA/A   | 35 µA +<br>0.37 mA/A   | 55 µA +<br>4.7 mA/A   |   |
| 100 mA to 1 A        | 0.40 mA +<br>0.94 mA/A | 0.40 mA +<br>1.2 mA/A  | 0.34 mA +<br>1.2 mA/A  | -                     |   |
| 1 A to 3 A           | 7.7 mA +<br>1.8 mA/A   | 7.9 mA +<br>1.8 mA/A   | 7.8 mA +<br>1.8 mA/A   | -                     | Agilent 34401A                                    |
| 3 A to 20 A          | 0.16 mA/A +<br>11 mA   | 0.13 mA/A +<br>18 mA   | 0.15 mA/A +<br>25 mA   | -                     | Keysight 34330A Current Shunt with Keysight 3458A |
| 20 to 30 A           | 0.16 mA/A +<br>16 mA   |                        |                        | -                     |   |

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## NO: SAMM 256

(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)

## SCOPE OF CALIBRATION: ELECTRICAL

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*  | Remarks   |  |
|---|---|--|---|--|
| <b><u>OSCILLOSCOPE</u></b>                    |   |  |   |  |
| <b>Vertical Deflection (DC Signal)</b>        | <b>(50 <math>\Omega</math> Impedance Load)</b><br>0 mV to $\pm$ 110 mV<br>110 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6.6 V                | 2.9 mV/V + 0.048 mV<br>2.9 mV/V + 0.10 mV<br>2.9 mV/V + 0.83 mV  | Generation using Fluke 5820A / Fluke 5520A (SC 600) |  |
|   | <b>(1 M<math>\Omega</math> Impedance Load)</b><br>0 mV to $\pm$ 110 mV<br>110 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 11 V<br>11 V to 130V | 0.29 mV/V + 0.031 mV<br>0.29 mV/V + 0.087 mV<br>0.29 mV/V + 0.82 mV<br>0.30 mV/V + 8.2 mV  |   |  |
|   | <b>Vertical Deflection (Square Wave Signal)</b>   | <b>(50 <math>\Omega</math> Impedance Load)</b><br>1 mV to $\pm$ 25 mV<br>25 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6.6 V                     |   | 3.0 mV/V + 0.049 mV<br>3.0 mV/V + 0.095 mV<br>2.9 mV/V + 0.83 mV                           |
|   |   | <b>(1 M<math>\Omega</math> Impedance Load)</b><br>1 mV to $\pm$ 25 mV<br>25 mV to $\pm$ 500 mV<br>0.5 V to $\pm$ 6 V<br>6 V to $\pm$ 130 V |   | 0.61 mV/V + 0.0061 mV<br>0.58 mV/V + 0.083 mV<br>0.59 mV/V + 0.82 mV<br>0.59 mV/V + 8.2 mV |
|   | <b>Time Base / Time Marker</b>  | 2 ns to 10 ns  |   | 0.42 $\mu$ s/s + 0.0083 ns   |
|   |   | 10 ns to 100 ns  |   | 0.42 $\mu$ s/s + 0.083 ns  |
| 100 ns to 10 $\mu$ s                          |   | 0.42 $\mu$ s/s + 0.0083 $\mu$ s  |   |  |
| 10 $\mu$ s to 50 ms                           |   | 0.42 $\mu$ s/s + 8.3 $\mu$ s   |   |  |
| 50 ms to 5 s                                  |   | 33 $\mu$ s/s + 1.7 ms  |   |  |
| <b>Rise Time</b>                              | 0.5 ns to 5ns   | 4.6 ps/ns + 38 ps  |   |  |
|   | 5 ns to 50 ns   | 0.053 ns   |   |  |
|   | 50 ns to 500 ns   | 0.082 ns   |   |  |
| <b>Bandwidth</b>                              | 50 kHz to 100 MHz   | 0.39 Hz/MHz + 4.9 MHz  |   |  |
|   | 100 MHz to 300 MHz  | 0.39 Hz/MHz + 12 MHz   |   |  |
|   | 300 MHz to 500 MHz  | 0.39 Hz/MHz + 20 MHz   |   |  |
|   | 500 MHz to 600 MHz  | 0.39 Hz/MHz + 30 MHz   |   |  |
|   | 600 MHz to 2.1 GHz  | 0.40 Hz/MHz + 0.11 GHz   |   |  |
| <b>Flatness</b>                               | <b><u>Sine Wave relative to 50 kHz</u></b><br>50 kHz to 100 MHz   | 0.20 dB  |   |  |
|   | 100 MHz to 600 MHz  | 0.43 dB  |   |  |
|   | <b><u>Sine Wave relative to 10 MHz</u></b><br>600 MHz to 2.1 GHz  | 0.62 dB  |   |  |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter  | Range                        | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|--|------------------------------|---|--|
| <b>Measuring Instruments</b><br><br>Inductance<br>(Fixed Points)<br><br>(Inductance Meter,<br>LCR Meter) | <b>100 <math>\mu</math>H</b> |   |  |
|  | 100 Hz                       | 5.0 $\mu$ H   | Generation using<br>Standard Inductor<br>General Radio<br>1482-B<br>1482-C<br>1482-E<br>1482-H<br>1482-L<br>1482-P |
|  | 120 Hz                       | 3.7 $\mu$ H   |  |
|  | 1 kHz                        | 0.30 $\mu$ H  |  |
|  | <b>200 <math>\mu</math>H</b> |   |  |
|  | 100 Hz                       | 9.8 $\mu$ H   |  |
|  | 120 Hz                       | 7.4 $\mu$ H   |  |
|  | 1 kHz                        | 0.59 $\mu$ H  |  |
|  | 10 kHz                       | 0.24 $\mu$ H  |  |
|  | <b>300 <math>\mu</math>H</b> |   |  |
|  | 100 Hz                       | 11 $\mu$ H  |  |
|  | 120 Hz                       | 8.2 $\mu$ H   |  |
|  | 1 kHz                        | 0.65 $\mu$ H  |  |
|  | <b>1 mH</b>                  |   |  |
|  | 100 Hz                       | 5.9 $\mu$ H   |  |
|  | 120 Hz                       | 4.6 $\mu$ H   |  |
|  | 1 kHz                        | 1.3 $\mu$ H   |  |
|  | 10 kHz                       | 1.1 $\mu$ H   |  |
|  | <b>10 mH</b>                 |   |  |
|  | 100 Hz                       | 10 $\mu$ H  |  |
|  | 120 Hz                       | 8.7 $\mu$ H   |  |
|  | 1 kHz                        | 5.5 $\mu$ H   |  |
|  | 10 kHz                       | 5.3 $\mu$ H   |  |
|  | <b>100 mH</b>                |   |  |
|  | 100 Hz                       | 0.058 mH  |  |
|  | 120 Hz                       | 0.057 mH  |  |
|  | 1 kHz                        | 0.053 mH  |  |
|  | <b>1 H</b>                   |   |  |
| 100 Hz   | 0.54 mH                      |   |  |
| 120 Hz   | 0.53 mH                      |   |  |
| 1 kHz  | 0.54 mH                      |   |  |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter   | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*   | Remarks  |
|---|---|---|--|
| <p><b>Measuring Instruments</b></p> <p>Inductance<br/>(Inductance Meter, LCR Meter)</p>   | <p><b>100 Hz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> <p><b>120 Hz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> <p><b>1 kHz</b></p> <p>100 <math>\mu</math>H to 1000 <math>\mu</math>H<br/>1 mH to 10 mH<br/>10 mH to 100 mH<br/>100 mH to 1 H<br/>1 H to 2.222 H</p> | <p>58 <math>\mu</math>H/mH + 2.4 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 7.3 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 71 mH<br/>12 <math>\mu</math>H/mH + 0.71 mH<br/>12 <math>\mu</math>H/mH + 2.0 mH</p> <p>58 <math>\mu</math>H/mH + 2.0 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 7.6 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 71 mH<br/>12 <math>\mu</math>H/mH + 0.72 mH<br/>12 <math>\mu</math>H/mH + 2.0 mH</p> <p>58 <math>\mu</math>H/mH + 0.73 <math>\mu</math>H<br/>35 <math>\mu</math>H/mH + 7.2 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 71 <math>\mu</math>H<br/>12 <math>\mu</math>H/mH + 0.70 mH<br/>12 <math>\mu</math>H/mH + 2.0 mH</p> | <p>Generation using Decade Inductance Boxes Lionmount LD8</p>                    |
| <p><b>Measuring Instruments</b></p> <p>Capacitance<br/>(Capacitance Meter, LCR Meter)</p> | <p><b>100 Hz</b></p> <p>50 pF to 10.05 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p> <p><b>120 Hz</b></p> <p>50 pF to 10.50 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p> <p><b>1 kHz</b></p> <p>50 pF to 10.50 nF<br/>10.05 nF to 100.05 nF<br/>100.05 nF to 1000.05 nF</p>  | <p>5.9 pF/nF + 6.1 pF<br/>5.9 nF/<math>\mu</math>F + 0.019 nF<br/>5.9 nF/<math>\mu</math>F + 0.065 nF</p> <p>5.9 pF/nF + 6.0 pF<br/>5.9 nF/<math>\mu</math>F + 0.012 nF<br/>5.9 nF/<math>\mu</math>F + 0.059 nF</p> <p>6.0 pF/nF + 5.9 pF<br/>5.9 nF/<math>\mu</math>F + 0.011 nF<br/>5.9 nF/<math>\mu</math>F + 0.059 nF</p>   | <p>Generation using General Radio 1412-BC /Decade Capacitance ED Lab CU-410A</p> |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument calibrated / Measurement parameter                            | Range                                       | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|--|---|---|--|
| <b>Measuring Instruments</b>   |   |   |  |
| Resistance   | 0 $\Omega$                                  | 0.051 m $\Omega$  | Short Connection   |
| (Resistance Meter, LCR Meter, Earth Continuity Tester, Insulation Meter) | 0.01 $\Omega$ to 0.1 $\Omega$               | 0.12 m $\Omega$ / $\Omega$ + 4.0 m $\Omega$                                   | Generation using Decade Resistance Box TIME 1051/ Yokogawa 2793-01         |
|  | 0.1 $\Omega$ to 1.1 $\Omega$                | 0.12 m $\Omega$ / $\Omega$ + 4.9 m $\Omega$                                   |  |
|  | 1.1 $\Omega$ to 10.1 $\Omega$               | 0.12 m $\Omega$ / $\Omega$ + 4.8 m $\Omega$                                   |  |
|  | 10.1 $\Omega$ to 100.1 $\Omega$             | 0.13 m $\Omega$ / $\Omega$ + 2.4 m $\Omega$                                   |  |
|  | 100.1 $\Omega$ to 1000.1 $\Omega$           | 0.12 m $\Omega$ / $\Omega$ + 2.4 m $\Omega$                                   |  |
|  | 1 k $\Omega$ to 10 k $\Omega$               | 0.59 $\Omega$ /k $\Omega$ + 0.082 $\Omega$                                    | Generation using Yokogawa 2793-03 / IET HRRS -F-6-1M-10 kV-WT/ Fluke 5320A |
|  | 10 k $\Omega$ to 100 k $\Omega$             | 0.59 $\Omega$ /k $\Omega$ + 0.59 $\Omega$                                     |  |
|  | 100 k $\Omega$ to 1000 k $\Omega$           | 0.59 $\Omega$ /k $\Omega$ + 5.9 $\Omega$                                      |  |
|  | 1 M $\Omega$ to 10 M $\Omega$               | 0.59 k $\Omega$ /M $\Omega$ + 0.16 k $\Omega$                                 |  |
|  | 10 M $\Omega$ to 100 M $\Omega$             | 0.70 k $\Omega$ /M $\Omega$ + 15 k $\Omega$                                   |  |
|  | 0.1 G $\Omega$ to 1 G $\Omega$              | 12 M $\Omega$ /G $\Omega$ + 0.57 M $\Omega$                                   |  |
|  | 1 G $\Omega$ to 10 G $\Omega$               | 12 M $\Omega$ /G $\Omega$ + 5.7 M $\Omega$                                    |  |
|  | 10 G $\Omega$ to 100 G $\Omega$             | 13M $\Omega$ /G $\Omega$ + 0.078 G $\Omega$                                   |  |
|  | 100 G $\Omega$ to 1000 G $\Omega$           | 13 M $\Omega$ /G $\Omega$ + 1.5 G $\Omega$                                    |  |
| 1000 G $\Omega$ to 1111 G $\Omega$                                       | 22 M $\Omega$ /G $\Omega$ + 16 G $\Omega$   |   |  |
| Dissipation Factor (LCR Meter)   | 0.000 to 2.000 $\Omega$ / $\Omega$ @ 100 Hz | 0.034 $\Omega$ / $\Omega$ + 0.59 %  | Generation using Yokogawa Decade Box & General Radio 1412-BC               |
|  | 0.000 to 2.000 $\Omega$ / $\Omega$ @ 1 kHz  | 0.034 $\Omega$ / $\Omega$ + 0.59 %  |  |

**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter                          | Range           | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|--|-----------------|---|--|
| <b>Measuring Instruments</b>   |                 |   |  |
| DC Voltage Meter<br>(High Voltage Meter,<br>Electrostatic Field Meter) | 0.5 kV to 10 kV | 5.8 V/kV + 7.6 V  | Kikusui<br>TOS 5101<br>Comparison<br>with Kikusui<br>149-10A |
| AC Voltage Meter<br>(High Voltage Meter)<br>@ 50 Hz                    | 0.5 kV to 10 kV | 12 V/kV + 19 V  |  |

**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter  | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|--|---|---|---|
| <b>Generating Instruments</b>                  |   |   |   |
| DC High Voltage<br>(Hipot, Insulation Voltage) | 0.5 kV to 10 kV<br>10 kV to 40 kV                         | 5.8 V/kV + 9.5 V<br>0.58 kV   | HV Digital Meter<br>Kikusui 149-10A<br>/ HV Probe with<br>DMM |
| AC High Voltage<br>(Hipot, Insulation Voltage) | <b>50 Hz / 60 Hz</b><br>0.5 kV to 10 kV<br>10 kV to 28 kV | 12 V/kV + 20 V<br>0.58 kV   |   |
| DC Leakage Current<br>(DC Withstand Current)   | 0.5 to 50 mA<br>50 mA to 100 mA                           | 0.58 $\mu$ A/mA + 15 $\mu$ A<br>0.58 $\mu$ A/mA + 61 $\mu$ A                  | Kikusui TOS 1200<br>/Keysight<br>U1282A                       |
| AC Leakage Current<br>(AC Withstand Current)   | <b>50 Hz / 60 Hz</b><br>0.5 to 50 mA<br>50 mA to 100 mA   | 7.1 $\mu$ A/mA + 61 $\mu$ A<br>7.1 $\mu$ A/mA + 0.30 mA                       |   |

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**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated/<br>Measurement Parameter         | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*   | Remarks   |
|---|--|---|---|
| <p><b>Generating Instruments</b></p> <p>Capacitance</p> | <p><b>100 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 <math>\mu</math>F to 2<math>\mu</math>F<br/>2 <math>\mu</math>F to 20<math>\mu</math>F<br/>20 <math>\mu</math>F to 200 <math>\mu</math>F<br/>200 <math>\mu</math>F to 1000 <math>\mu</math>F</p> <p><b>120 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 <math>\mu</math>F to 2 <math>\mu</math>F<br/>2 <math>\mu</math>F to 20 <math>\mu</math>F<br/>20 <math>\mu</math>F to 200 <math>\mu</math>F<br/>200 <math>\mu</math>F to 1000 <math>\mu</math>F</p> <p><b>1000 Hz</b><br/>0 to 2 nF<br/>2 nF to 20 nF<br/>20 nF to 200 nF<br/>0.2 <math>\mu</math>F to 2 <math>\mu</math>F<br/>2 <math>\mu</math>F to 20 <math>\mu</math>F</p> | <p>5.9 pF/nF + 0.91 pF<br/>2.5 pF/nF + 2.5 pF<br/>2.5 nF/<math>\mu</math>F + 0.024 nF<br/>2.5 nF/<math>\mu</math>F + 0.24 nF<br/>2.5 nF/<math>\mu</math>F + 2.4 nF<br/>5.9 <math>\mu</math>F/mF + 0.025 <math>\mu</math>F<br/>12 <math>\mu</math>F/mF + 0.25 <math>\mu</math>F</p> <p>5.9 pF/nF + 0.90 pF<br/>2.5 pF/nF + 2.5 pF<br/>2.5 nF/<math>\mu</math>F + 0.025 nF<br/>2.5 nF/<math>\mu</math>F + 0.25 nF<br/>2.5 nF/<math>\mu</math>F + 2.5 nF<br/>5.9 <math>\mu</math>F/mF + 0.025 <math>\mu</math>F<br/>12 <math>\mu</math>F/mF + 0.25 <math>\mu</math>F</p> <p>0.59 pF/nF + 0.59 pF<br/>2.5 pF/nF + 2.4 pF<br/>2.5 nF/<math>\mu</math>F + 0.024 nF<br/>2.5 nF/<math>\mu</math>F + 0.24 nF<br/>2.5 nF/<math>\mu</math>F + 2.4 nF</p> | <p>Measurement using GW Instek LCR Meter / Keysight E4980AL (032) Precision LCR Meter</p> |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*                  | Remarks  |
|---|--|--|--|
| <b>Generating Instruments</b><br>Inductance   | <b>100 Hz</b><br>0 mH to 10 mH<br>10 mH to 100 mH<br>100 mH to 1000 mH<br>1 H to 10 H  | 6.1 $\mu$ H/mH + 5.9 $\mu$ H<br>2.7 mH/H + 0.025 mH<br>2.4 mH/H + 0.26 mH<br>2.8 mH/H + 2.6 mH | Measurement using GW Instek LCR Meter / Keysight E4980AL (032) Precision LCR Meter |
|   | <b>120 Hz</b><br>0 mH to 10 mH<br>10 mH to 100 mH<br>100 mH to 1000 mH<br>1 H to 10 H  | 6.1 $\mu$ H/mH + 5.9 $\mu$ H<br>2.7 mH/H + 0.025 mH<br>2.4 mH/H + 0.26 mH<br>2.8 mH/H + 2.6 mH |  |
|   | <b>1000 Hz</b><br>0 mH to 10 mH<br>10 mH to 100 mH<br>100 mH to 1000 mH<br>1 H to 10 H | 5.9 $\mu$ H/mH + 5.9 $\mu$ H<br>2.4 mH/H + 0.025 mH<br>2.4 mH/H + 0.25 mH<br>2.5 mH/H + 2.6 mH |  |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*  | Remarks                                      |
|---|--|--|--|
| Measuring Instrument<br>DC Voltage            | 0 V to 320 mV<br>0.32 V to 3.2 V<br>3.2 V to 32 V<br>32 V to 320 V<br>320 V to 1020 V  | 0.0096 mV/V + 0.0060mV<br>0.0095 mV/V + 0.042 mV<br>0.012 mV/V + 0.32 mV<br>0.012 mV/V + 2.1 mV<br>12 $\mu$ V/V + 2.1 mV   | Generating using Fluke 5520A, Keysight 3458A |
| AC Voltage                                    | 0 V to 1050 V  | See Matrix A   |  |
| DC Current                                    | 0 A to 320 $\mu$ A<br>0.32 mA to 3.2 mA<br>3.2 mA to 32 mA<br>32 mA to 320 mA<br>0.32 A to 1 A<br>1 A to 20 A  | 0.026 mA/A + 0.0000059 mA<br>0.026 mA/A + 0.00054 mA<br>0.043 mA/A + 0.00059 mA<br>0.14 mA/A + 0.018 mA<br>0.14 mA/A + 0.019 mA<br>1.3 mA/A + 81 mA  |  |
| AC Current                                    | 0 A to 20 A  | See Matrix B   |  |
| Resistance                                    | 0 $\Omega$ to 40 $\Omega$<br>40 $\Omega$ to 400 $\Omega$<br>400 $\Omega$ to 4 k $\Omega$<br>4 k $\Omega$ to 40 k $\Omega$<br>40 k $\Omega$ to 400 k $\Omega$<br>400 k $\Omega$ to 4 M $\Omega$<br>4 M $\Omega$ to 40 M $\Omega$<br>40 M $\Omega$ to 400 M $\Omega$ | 0.015 m $\Omega$ / $\Omega$ + 0.99 m $\Omega$<br>0.012 m $\Omega$ / $\Omega$ + 1.6 m $\Omega$<br>0.013 m $\Omega$ / $\Omega$ + 0.21 $\Omega$<br>0.014 m $\Omega$ / $\Omega$ + 3.7 $\Omega$<br>0.022 k $\Omega$ /M $\Omega$ + 370 $\Omega$<br>0.68 k $\Omega$ /M $\Omega$ + 1.6 k $\Omega$<br>0.62 k $\Omega$ /M $\Omega$ + 830 k $\Omega$<br>5.9 k $\Omega$ /M $\Omega$ + 790 k $\Omega$ |  |

**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**Matrix A**

**AC Voltage Measurement**

| Range           | Frequency     |               |              |              |             |
|-----------------|---------------|---------------|--------------|--------------|-------------|
|                 | Hz            | kHz           |              |              |             |
|                 | 10 to 50      | 0.05 to 1     | 1 to 20      | 20 to 50     | 50 to 100   |
| 0 mV to 320 mV  | 0.094 + 0.025 | 0.091 + 0.024 | 0.36 + 0.026 | 0.36 + 0.025 | 0.97 + 0.89 |
| 320 mV to 3.2 V | 0.085 + 0.26  | 0.085 + 0.33  | 0.35 + 0.73  | 0.36 + 2.8   | 0.97 + 11   |
| 3.2 V to 32 V   | 0.24 + 2.4    | 0.24 + 2.7    | 0.42 + 25    | 0.42 + 41    | 1.4 + 4.2   |
| 32 V to 320 V   | 0.48 + 25     | 0.47 + 29     | 1.4 + 29     |              |             |
| 320 V to 1020 V | 0.43 + 18     | 0.43 + 17     |              |              |             |

The expanded uncertainties given in above table are expressed in mV/V +mV

**Matrix B**

**AC Current Measurement**

| Range             | Frequency (Hz)       | Frequency (kHz)       |                      |                     |                    |
|-------------------|----------------------|-----------------------|----------------------|---------------------|--------------------|
|                   | 10 to 45             | 0.045 to 1            | 1 to 5               | 5 to 10             | 10 to 30           |
| 29 µA to 330 µA   | 1.2 µA/mA + 0.086 µA | 0.97 µA/mA + 0.078 µA | 2.3 µA/mA + 0.12 µA  | 6.3 µA/mA + 0.16 µA | 13 µA/mA + 0.32 µA |
| 0.33 mA to 3.3 mA | 0.98 µA/mA + 1.2 µA  | 0.79 µA/mA + 1.0 µA   | 1.6 µA/mA + 1.0 µA   | 3.9 µA/mA + 1.8 µA  | 7.8 µA/mA + 1.9 µA |
| 3.3 mA to 33 mA   | 0.75 µA/mA + 3.5 µA  | 0.36 µA/mA + 3.5 µA   | 0.67 µA/mA + 3.5 µA  | 1.6 µA/mA + 3.9 µA  | 3.2 µA/mA + 4.4 µA |
| 33 mA to 330 mA   | 0.72 mA/A + 0.091 mA | 0.36 mA/A + 0.092 mA  | 0.80 mA/A + 0.098 mA | 1.6 mA/A + 0.12 mA  | 3.1 mA/A + 0.18 mA |
| 0.33 A to 1.1 A   | 1.4 mA/A + 0.12 mA   | 0.41 mA/A + 0.12 mA   | 4.6 mA/A + 0.77 mA   | 20 mA/A + 0.39 mA   |                    |
| 1.1 A to 3 A      | 1.6 mA/A + 0.55 mA   | 0.80 mA/A + 0.55 mA   | 4.8 mA/A + 0.91 mA   | 20 mA/A + 4.0 mA    |                    |
| 3 A to 11 A       |                      | 0.78 mA/A + 2.1 mA    | 24 mA/A + 2.0 mA     |                     |                    |
| 11 A to 20 A      |                      | 1.2 mA/A + 4.0 mA     | 24 mA/A + 4.0 mA     |                     |                    |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated/<br>Measurement<br>Parameter  | Range   | Calibration and<br>Measurement Capability<br>Expressed as an<br>Uncertainty ( $\pm$ )*   | Remarks  |
|---|---|--|--|
| Measuring<br>Instruments<br><br>Frequency   | 0.5 Hz to 120 Hz<br>120 Hz to 1.2 kHz<br>1.2 kHz to 12 kHz<br>12 kHz to 120 kHz<br>120 kHz to 1.2 MHz<br>1.2 MHz to 2 MHz<br>2 MHz to 10 MHz  | 2.0 ppm + 0.0082 Hz<br>2.0 ppm + 0.082 Hz<br>2.0 ppm + 0.82 Hz<br>2.0 ppm + 8.2 Hz<br>2.0 ppm + 82 Hz<br>2.0 ppm + 0.82 kHz<br>24 ppm + 0.32 kHz   | Generating using<br>Fluke 5520A /<br>HP 33120A       |
| Capacitance   | 0.5 nF to 1.1 nF<br>1.1 nF to 3.3 nF<br>3.3 nF to 11 nF<br>11 nF to 33 nF<br>33 nF to 110 nF<br>0.11 $\mu$ F to 0.33 $\mu$ F<br>0.33 $\mu$ F to 1.1 $\mu$ F<br>1.1 $\mu$ F to 3.3 $\mu$ F<br>3.3 $\mu$ F to 11 $\mu$ F<br>11 $\mu$ F to 33 $\mu$ F<br>33 $\mu$ F to 110 $\mu$ F<br>0.11 mF to 0.33 mF<br>0.33 mF to 1.1 mF<br>1.1 mF to 3.3 mF<br>3.3 mF to 11 mF<br>11 mF to 33 mF<br>33 mF to 40 mF | 1.3 pF/nF + 7.9 pF<br>1.3pF/nF + 7.9 pF<br>0.45 pF/nF + 8.0 pF<br>0.62 pF/nF + 78 pF<br>0.59 pF/nF + 0.078 nF<br>0.61 nF/ $\mu$ F + 0.24 nF<br>0.59 nF/ $\mu$ F + 0.78 nF<br>0.61 nF/ $\mu$ F + 2.4 nF<br>0.59 nF/ $\mu$ F + 7.8 nF<br>0.61 nF/ $\mu$ F + 24 nF<br>0.21 nF/ $\mu$ F + 79 nF<br>0.36 $\mu$ F/mF + 0.29 $\mu$ F<br>0.13 $\mu$ F/mF + 0.78 $\mu$ F<br>0.13 $\mu$ F/mF + 2.4 $\mu$ F<br>0.16 $\mu$ F/mF + 8.7 $\mu$ F<br>0.13 $\mu$ F/mF + 24 $\mu$ F<br>0.17 $\mu$ F/mF + 0.13 mF | Generating using<br>Fluke 5520A                      |
| Current Measuring<br>Device<br>(Clamp Meter,<br>Current Probe,<br>Current Sensor)<br><br>DC Current<br>- 50 Turn Coil | (+/- polarities)<br>1.6 A to 16 A<br>16 A to 160 A<br>160 A to 525 A<br>525 A to 1000 A   | 3.3 mA/A + 78 mA<br>4.7 mA/A + 0.16 A<br>8.3 mA/A + 0.33 A<br>3.0 mA/A + 0.29 A  | Generating using<br>Fluke 5520A with<br>Current Coil |

## NO: SAMM 256

(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)

## SCOPE OF CALIBRATION: ELECTRICAL

| Instrument Calibrated / Measurement Parameter  | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )*   | Remarks   |
|--|--|---|---|
| Current Measuring Device<br>(Clamp Meter, Current Probe, Current Sensor)<br><br>AC Current<br>- 50 Turn Coil | <b>1.6 A to 16 A</b><br>10 Hz to 440 Hz  | 35 mA/A + 0.25 A  | Generating using Fluke 5520A with Current Coil  |
|  | <b>16 A to 160A</b><br>10 Hz to 440 Hz   | 23 mA/A + 0.2 A   |   |
|  | <b>160 A to 1000 A</b><br>10 Hz to 440 Hz  | 13 mA/A + 0.56 A  |   |
| Generating Instruments<br><br>DC Voltage ( $\pm$ )   | 0 mV to 100 mV<br>100 mV to 1 V<br>1 V to 10 V<br>10 V to 100 V<br>100 V to 1000 V   | 11 $\mu$ V/V + 6.4 $\mu$ V<br>9.4 $\mu$ V/V + 8.2 $\mu$ V<br>9.3 $\mu$ V/V + 70 $\mu$ V<br>12 $\mu$ V/V + 0.66 mV<br>12 $\mu$ V/V + 6.1 mV  | Measurement using Keysight 3458A Digital Multimeter   |
| AC Voltage   | 0 V to 1000 V  | See Matrix C  |   |
| DC Current<br>(Rectifier, Power Supply Unit, Welding Machine)  | 0 $\mu$ A to 100 $\mu$ A<br>100 $\mu$ A to 1 mA<br>1 mA to 10 mA<br>10 mA to 100 mA<br>100 mA to 1 A   | 0.023 mA/A + 0.0000024 mA<br>0.027 mA/A + 0.0000083 mA<br>0.026 mA/A + 0.00053 mA<br>0.044 mA/A + 0.00083 mA<br>0.14 mA/A + 0.019 mA  | Measurement using Agilent 34401A Multimeter<br><br>Keysight 34330A Current Shunt with Keysight 3458A Multimeter / Fluke 376 Clamp Meter |
|  | 1 A to 3 A   | 1.5 mA/A + 0.82 mA  |   |
|  | 3 A to 30 A  | 0.011 mA/A + 8.8 mA   |   |
| AC Current<br>(Rectifier, Power Supply Unit)   | 0 to 30 A  | See Matrix D  |   |
| Resistance   | 0 $\Omega$ to 10 $\Omega$<br>10 $\Omega$ to 100 $\Omega$<br>100 k $\Omega$ to 1 k $\Omega$<br>1 k $\Omega$ to 10 k $\Omega$<br>10 k $\Omega$ to 100 k $\Omega$<br>100 k $\Omega$ to 1 M $\Omega$<br>1 M $\Omega$ to 10 M $\Omega$<br>10 M $\Omega$ to 100 M $\Omega$<br>100 M $\Omega$ to 1 G $\Omega$ | 0.020 m $\Omega$ / $\Omega$ + 1.8 m $\Omega$<br>0.015 m $\Omega$ / $\Omega$ + 1.2 m $\Omega$<br>0.012 m $\Omega$ / $\Omega$ + 6.0 m $\Omega$<br>0.013 m $\Omega$ / $\Omega$ + 0.21 $\Omega$<br>0.014 m $\Omega$ / $\Omega$ + 3.6 $\Omega$<br>0.022 m $\Omega$ / $\Omega$ + 370 $\Omega$<br>0.064 m $\Omega$ / $\Omega$ + 1.7 k $\Omega$<br>0.62 m $\Omega$ / $\Omega$ + 0.83 M $\Omega$<br>6.2 M $\Omega$ /G $\Omega$ + 0.85 M $\Omega$ | Measurement using Keysight 3458A Digital Multimeter   |

**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: ELECTRICAL**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks   |
|---|---|---|---|
| Generating Instruments<br><br>Frequency       | 1 Hz to 40 Hz<br>40 Hz to 100 Hz<br>100Hz to 100 kHz<br>100 kHz to 10 MHz | 0.024 Hz<br>0.012 Hz<br>12 Hz<br>1.2 kHz                                      | Measurement using Keysight 3458A Digital Multimeter |

**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: ELECTRICAL**

**AC Voltage:**

**Matrix C**

| Frequency<br>Voltage | Hz                       | kHz                      |                          |                         |                       |
|----------------------|--------------------------|--------------------------|--------------------------|-------------------------|-----------------------|
|                      | 0 to 40                  | 0.04 to 1                | 1 to 20                  | 20 to 50                | 50 to 100             |
| 0 to 10 mV           | 0.40 mV/V<br>+ 0.35 mV   | 0.28 mV/V<br>+ 0.38 mV   | 0.40 mV/V<br>+ 38 mV     | 1.3 mV/V<br>+ 0.37 mV   | 6.1 mV/V<br>+ 0.35 mV |
| 10 mV to 100 mV      | 0.15 mV/V<br>+ 0.089 mV  | 0.12 mV/V<br>+ 0.024 mV  | 0.20 mV/V<br>+ 0.0039 mV | 0.41 mV/V<br>+ 0.13 mV  | 1.1 mV/V<br>+ 0.16 mV |
| 100 mV to 1 V        | 0.086 mV/V<br>+ 0.048 mV | 0.083 mV/V<br>+ 0.026 mV | 0.17 mV/V<br>+ 0.028 mV  | 0.35 mV/V<br>+ 0.031 mV | 0.93 mV/V<br>+ 11 mV  |
| 1 V to 10 V          | 0.085 mV/V<br>+ 0.47 mV  | 0.085 mV/V<br>+ 0.34 mV  | 0.17 mV/V<br>+ 0.73 mV   | 0.35 mV/V<br>+ 2.7 mV   | 0.94 mV/V<br>+ 11 mV  |
| 10 V to 100 V        | 0.24 mV/V<br>+ 4.7 mV    | 0.25 mV/V<br>+ 2.8 mV    | 0.24 mV/V<br>+ 24 mV     | 0.41 mV/V<br>+ 39 mV    | 0.11 mV/V<br>+ 3.6 mV |
| 100 V to 1000 V      | 0.48 mV/V<br>+ 50 mV     | 0.48 mV/V<br>+ 30 mV     | -                        | -                       | -                     |

**AC Current:**

**Matrix D**

| Frequency<br>Current | Hz                     | kHz                    |                        |                       | Measuring Instrument                                    |
|----------------------|------------------------|------------------------|------------------------|-----------------------|---|
|                      | 0 to 50                | 0.05 to 1              | 1 to 5                 | 5 to 30               |   |
| 0 A to 1 mA          | 0.71 mA/A +<br>0.24 µA | 0.36 mA/A +<br>0.24 µA | 0.38 mA/A +<br>0.24 µA | 4.7 mA/A +<br>0.47 µA | Keysight 3458A  |
| 1 mA to 10 mA        | 0.70 mA/A +<br>2.7 µA  | 0.36 mA/A +<br>2.6 µA  | 0.37 mA/A +<br>2.7 µA  | 4.7 mA/A +<br>5.0 µA  |   |
| 10 mA to 100 mA      | 0.70 mA/A +<br>24 µA   | 0.36 mA/A +<br>26 µA   | 0.37 mA/A +<br>26 µA   | 4.7 mA/A +<br>49 µA   |   |
| 100 mA to 1 A        | 0.94 mA/A +<br>0.25 mA | 1.2 mA/A +<br>0.26 mA  | 1.2 mA/A +<br>0.25 mA  | -                     |   |
| 1 A to 3 A           | 1.8 mA/A +<br>2.6 mA   | 1.8 mA/A +<br>3.0 mA   | 1.8 mA/A +<br>3.0 mA   | -                     | Agilent 34401A  |
| 3 A to 20 A          | 0.16 mA/A +<br>11 mA   | 0.13 mA/A +<br>18 mA   | 0.15 mA/A +<br>25 mA   | -                     | Keysight 34330A<br>Current Shunt<br>with Keysight 3458A |
| 20 to 30 A           | 0.16 mA/A +<br>16 mA   |                        |                        | -                     |   |

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**NO: SAMM 256**(Issue 2, 19 January 2024 replacement  
of SAMM 256 dated 26 October 2023)**SCOPE OF CALIBRATION: TIME AND FREQUENCY****SITE: CATEGORY I**

| Instrument Calibrated / Measurement Parameter | Range   | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|---|---|--|
| Stopwatch and Timer                           | 0 to 9 hours  | 0.35 sec  | Time measurement according to NIST Stopwatch and Timer Calibration |
| Tachometer (rpm measuring devices)            | (Non-contact)<br>0 to 599 rpm<br>600 to 30,000 rpm                              | 25 ppm<br>3.6 ppm + 0.013 rpm   | Frequency Generator with Agilent 34401A Multimeter                 |
|   | 0 to 500 rpm<br>500 to 1,000 rpm<br>1,000 to 10,000 rpm<br>10,000 to 30,000 rpm | 0.00063 rpm<br>0.0061 rpm<br>0.075 rpm<br>0.74 rpm                            | Frequency Generator HP33120A / Digital Tachometer                  |
|   | (Contact)<br>0 to 5,000 rpm   | 1.6 rpm   | Comparison with Reference Tachometer                               |



**NO: SAMM 256**

(Issue 2, 19 January 2024 replacement of SAMM 256 dated 26 October 2023)

**SCOPE OF CALIBRATION: TIME AND FREQUENCY**

| Instrument Calibrated / Measurement Parameter | Range  | Calibration and Measurement Capability Expressed as an Uncertainty ( $\pm$ )* | Remarks  |
|---|--|---|--|
| Stopwatch and Timer                           | 0 to 9 hours   | 0.11 sec  | Time measurement according to NIST Stopwatch and Timer calibration |
| Tachometer (rpm measuring devices)            | (Non-contact)<br>0 to 599 rpm<br>600 to 30,000 rpm                               | 25 ppm<br>3.6 ppm + 0.13 rpm  | Frequency Generator with Agilent 34401A Multimeter                 |
|   | 0 to 500 rpm<br>500 to 1,000 rpm<br>1,000 to 10,000 rpm<br>10,000 to 100,000 rpm | 0.00063 rpm<br>0.0058 rpm<br>0.063 rpm<br>0.62 rpm                            | Frequency Generator HP33120A / Digital Tachometer                  |
|   | (Contact)<br>0 to 5,000 rpm  | 1.6 rpm   | Comparison with Reference Tachometer                               |

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