SINGAPORE LABORATORY ACCREDITATION SCHEME

Accredited Laboratory SAC-SINGLAS

# Schedule

Element Testing Services (S) Pte Ltd
Block 4010 Techplace 1
Ang Mo Kio Ave 10 #03-08 to 12
Singapore 569626

Certificate No. : LA-1987-0012-C

Issue No. : 34

Date : 03 February 2025

Expiry of Certificate : 31 March 2029



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FIELD OF TESTING : Calibration and Measurement

| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|
| **A. MECHANICAL** | | |
| **A.I. Pressure** (Lab / On-site) | | |
| Pressure (Differential mode) | a. 0 in$H_2O$ to 1.0 in$H_2O$ | 0.0044 in.$H_2O$ |
| | b. >1 in$H_2O$ to 20 in$H_2O$ | 0.011 in.$H_2O$ |
| EL-A-OP-CAL-SIN-MD102 Issue 1 | c. >20 in$H_2O$ to 64 in$H_2O$ | 0.055 in.$H_2O$ |
| | d. -30 Pa to 30 Pa | 0.42 Pa |
| | e. - 2500 Pa to 2500 Pa | 1.6 Pa |
| Pressure (Gauge mode) | | |
| Negative Pressure (Vacuum) | a. -30 inHg to 0 inHg | 0.013 in.Hg |
| Positive Pressure | b. 15 mbar to 1000 mbar | 0.20 mbar |
| | c. 1 psi to 100 psi | 0.061 psi |
| EL-A-OP-CAL-SIN-MD101 Issue 1 | d. 0 to 500 psi | 0.077 psi |
| | e. >500 psi to 2000 psi | 0.37 psi |
| | f. >2000 psi to 10000 psi | 1.3 psi |
| | g. >10000 psi to 16000 psi | 8.8 psi |
| Pressure (Absolute mode) | | |
| EL-A-OP-CAL-SIN-MD119 Issue 1 | h. 11 psi abs to 17 psi abs | 0.0025 psi abs |
| EL-A-OP-CAL-SIN-MD101 Issue 1 | i. 1.5 psi abs to 50 psi abs | 0.016 psi abs |
| | j. 0.5 psi abs to 500 psi abs | 0.091 psi abs |
| | k. 0.5 psi abs to 2000 psi abs | 0.36 psi abs |

*EL-A-OP-CAL-SIN-MDnnn are In-house procedures

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|---|---|---|
| **A.II FORCE MEASUREMENT** | | |
| 1. Force Measurement Device (Lab / On-site) (Tension/Compression) EL-A-OP-CAL-SIN-MD104 Issue 1 | a. Up to 5 kgf (Tension)<br>Up to 5 kgf (Compression) | 0.00084 kgf<br>0.00084 kgf |
| | b. Up to 20 kgf (Tension)<br>Up to 20 kgf (Compression) | 0.0070 kgf<br>0.0070 kgf |
| | c. Up to 50 kgf (Tension)<br>Up to 50 kgf (compression) | 0.014 kgf<br>0.014 kgf |
| | d. Up to 1000N (Tension)<br>Up to 1000N (Compression) | 0.32 N<br>0.16 N |
| | e. Up to 10 kN (Tension)<br>Up to 10 kN (Compression) | 0.011 kN<br>0.011 kN |
| | f. Up to 10 000 kgf (Tension)<br>Up to 10 000 kgf Compression) | 1.2 kgf<br>2.4 kgf |
| | g. Up to 30 000 kgf (Tension)<br>Up to 30 000 kgf(Compression) | 1.6 kN<br>1.6 kN |
| | h. Up to 1000 kN (Compression) | 1.4 kN |
| 2. Platform Balance Calibration (On-site) EL-A-OP-CAL-SIN-MD113 Issue 1 | Up to 4000 kg | 0.9 kg |
| 3. Balances and weighing scales (Lab / On-site) EL-A-OP-CAL-SIN-MD105 Issue 1 | a. 0.5 g to 5 g<br>b. >5 g to 50 g<br>c. >50 g to 200 g<br>d. >200 g to 600 g<br>e. >600 g to 2000 g<br>f. >2 kg to 6 kg<br>g. >6 kg to 10 kg<br>h. >10 kg to 30 kg<br>i. >30 kg to 60 kg<br>j. >60 kg to 100 kg<br>k. >100 kg to 150 kg<br>l. >150 kg to 500 kg | 0.13 mg<br>0.25 mg<br>0.77 mg<br>0.0027 g<br>0.0076 g<br>0.023 g<br>0.035 g<br>0.14 g<br>0.0013 kg<br>0.013 kg<br>0.046 kg<br>0.093 kg |

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| **A.II FORCE MEASUREMENT** | | |
| 4. Torque | | |
| a. Torque Measuring Devices (Lab / On-site) | | |
| BS 7882: 2017 | 0 - 1.5 ozf·in | 0.0059 ozf·in |
| EL-A-OP-CAL-SIN-MD107 | 0 - 10 ozf·in | 0.041 ozf·in |
| Issue 1 | 0 - 18 ozf·in | 0.076 ozf·in |
| | 0 - 60 cN·m | 0.12 cN·m |
| | 0 - 15 kgf·cm | 0.043 kgf·cm |
| | 0 - 5 N·m | 0.0017 N·m |
| | 0 - 90 lbf·in | 0.12 lbf·in |
| | 0 - 442.6 lbf·in | 0.32 lbf·in |
| | 0 - 250 lbf·ft | 0.14 lbf·ft |
| b. Torque Wrench & Driver (Lab) | | |
| BS EN ISO 6789-2:2017 | 0.0200 N·m to 1.0000 N·m | 0.53 % F.S. |
| EL-A-OP-CAL-SIN-MD115 | 1.250 N·m to 62.500 N·m | 0.43 % F.S. |
| Issue 1 | 7.50 N·m to 150.00 N·m | 0.35 % F.S. |
| | 35.00 N·m to 700.00 N·m | 0.42 % F.S. |
| | 75.0 N·m to 1500.00 N·m | 0.26 % F.S. |
| c. Torque Wrench & Driver (Lab) | | |
| BS EN 6789: 2003 | 0.0200 N·m to 1.0000 N·m | 0.72 % F.S. |
| (superseded by 2017 ver) | 0.1250 N·m to 6.2500 N·m | 0.66 % F.S. |
| EL-A-OP-CAL-SIN-MD106 | 0.250 N·m to 12.500 N·m | 0.67 % F.S. |
| Issue 1 | 1.750 N·m to 35.000 N·m | 0.61 % F.S. |
| | 3.500 N·m to 70.000 N·m | 0.69 % F.S. |
| | 7.50 N·m to 150.00 N·m | 0.66 % F.S. |
| | 17.50 N·m to 350.00 N·m | 0.59 % F.S. |
| | 35.00 N·m to 700.00 N·m | 0.61 % F.S. |
| | 30.0 N·m to 1500.0 N·m | 0.59 % F.S. |
| | 339.0 N·m to 2500 N·m | 0.60 % F.S. |

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| **A.II FORCE MEASUREMENT** | | |
| 5. Extensometer<br>(Lab / On-site)<br>EL-A-OP-CAL-SIN-MD442 Issue 2 | Gauge Length up to 50 mm<br><br>Classification Limit up to ASTM E83-23 Class B1 for Gauge Length<br>25 mm and<br><br>50 mm | 4.2 μm<br><br>Calibrator accuracy (12.5 mm) = 0.6 μm<br><br>Calibrator accuracy (25 mm) = 0.6 μm |
| ASTM E83-23 | Strain Displacement Measurement up to 25 mm | 0.000023 mm/mm |
| 6. Standard Weights (Lab)<br>OIML R111-1:2004<br>EL-A-OP-CAL-SIN-MD108 Issue 1 | a. 1 mg<br>b. 2 mg<br>c. 5 mg<br>d. 10 mg<br>e. 20 mg<br>f. 50 mg<br>g. 100 mg<br>h. 200 mg<br>i. 500 mg<br>j. 1 g<br>k. 2 g<br>l. 5 g<br>m. 10 g<br>n. 20 g<br>o. 50 g<br>p. 100 g<br>q. 200 g<br>r. 500 g<br>s. 1 kg<br>t. 2 kg<br>u. 5 kg<br>v. 10 kg<br>w. 20 kg<br>x. 30 kg | 0.02 mg<br>0.05 mg<br>0.02 mg<br>0.02 mg<br>0.02 mg<br>0.03 mg<br>0.03 mg<br>0.04 mg<br>0.05 mg<br>0.07 mg<br>0.08 mg<br>0.11 mg<br>0.13 mg<br>0.17 mg<br>0.20 mg<br>0.34 mg<br>0.80 mg<br>0.024 g<br>0.025 g<br>0.029 g<br>0.24 g<br>0.25 g<br>0.26 g<br>0.32 g |

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| **A.II FORCE MEASUREMENT** | | |
| 7. Hardness Testing Machine (On-site) | | |
| a. Force Verification of Brinell Testing Machine<br>EL-A-OP-CAL-SIN-MD109 Issue 1 | Range 0 – 500 kgf<br>Range 0 – 3000 kgf | 0.55 kgf<br>3.3 kgf |
| b. Force Verification of Vickers Testing Machine<br>EL-A-OP-CAL-SIN-MD110 Issue 1 | Range 0 – 100 kgf | 2.5 N |
| c. Force Verification of Rockwell Testing Machine<br>EL-A-OP-CAL-SIN-MD111 Issue 1 | Rockwell Superficial Hardness<br>Preliminary Test Force 3 kgf<br>Test Force 15 kgf<br>Test Force 30 kgf<br>Test Force 45 kgf<br><br>Rockwell Hardness<br>Preliminary Test Force 10 kgf<br>Test Force 60 kgf<br>Test Force 100 kgf<br>Test Force 150 kgf | <br>0.04 kgf<br>0.04 kgf<br>0.04 kgf<br>0.04 kgf<br><br>0.04 kgf<br>0.04 kgf<br>0.04 kgf<br>0.07 kgf |
| 8. Tension/Compression Testing Machine (On-site)<br>EL-A-OP-CAL-SIN-MD112 Issue 1 | a. 0 to 100 N (compression)<br><br>b. >100 N to 2000 N (Tension)<br>>100 N to 2000 N (Compression)<br><br>c. >2 kN to 10 kN (Tension)<br>>2 kN to 10 kN (Compression)<br><br>d. >10 kN to 100 kN (Tension)<br>>10 kN to 100 kN (Compression)<br><br>e. >100 kN to 1000 kN (Tension)<br>>100 kN to 1000 kN (Compression) | 0.11 N<br><br>2.3 N<br>2.2 N<br><br>0.011 kN<br>0.011 kN<br><br>0.12 kN<br>0.12 kN<br><br>1.1 kN<br>1.1 kN |

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| **A.II FORCE MEASUREMENT** | | |
| 9. Calibration of Cable Tensiometer (Lab)<br>EL-A-OP-CAL-SIN-MD114 Issue 1 | Up to 300 lbf | 1.6 lbf |
| 10. Calibration of Durometer (Lab) (Verification of the test force)<br>EL-A-OP-CAL-SIN-MD116 Issue 1 | a. ASTM D 2240:2015 Type A<br>b. ASTM D 2240:2015 Type D<br>c. BS EN ISO 868:2003 Type A<br>d. BS EN ISO 868:2003 Type D<br>e. JIS K 6301:1995 Type A<br>f. JIS K 6301:1995 Type C<br>g. JIS K 6301:1995 Type C2<br>h. JIS K 7215:1986 Type A | 0.0083 N<br>0.026 N<br>8.7 mN<br>51.4 mN<br>0.46 gf<br>5.1 gf<br>0.23 gf<br>0.88 gf |
| 11. Calibration of Metallic / Non-Metallic Objects (Lab)<br>EL-A-OP-CAL-SIN-MD117 Issue 1 | a. 0 – 210 g<br>b. >200 g – 3 kg<br>c. >3 kg – 30 kg | 0.01 g<br>0.02 g<br>0.5 g |

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| **A.III Flow Measurement** | | |
| 1. Calibration of Fluid (Gas) Flow Measurement Instrument (Lab) | | |
| EL-A-OP-CAL-SIN-MD120 Issue 1 | a. 0 to 300 cc/min<br>b. 0 to 6000 cc/min<br>c. 3000 cc/min to 30000 cc/min | 4.5 cc/min<br>142 cc/min<br>400 cc/min |
| **A.IV Rotational Speed Measurement** | | |
| 1 Calibration of Rotational Speed of Rotating Equipment (Lab / On-site) | | |
| EL-A-OP-CAL-SIN-MD208 Issue 1 | (6 to 15000) rpm | 3.0% |
| 2 Non-Contact Tachometer and RPM / Speed indicator (Lab / On-site) | 6 rpm to 30 rpm<br>31 rpm to 99.9 rpm<br>100 rpm to 999 rpm<br>1000 rpm to 99999 rpm | 0.12 %<br>0.097 %<br>0.067 %<br>0.058 % |
| Contact Tachometer and RPM / Speed indicator (Lab / On-site) EL-A-OP-CAL-SIN-MD209 Issue 2 | 6 rpm to 2000 rpm | 3.1% |
| **A.V Vibration & Acoustic** | | |
| 1. Accelerometers / Vibration (Lab) | (0.1 to 1000) mV/g or<br>(0.1 to 1000) pC/g | |
| EL-A-OP-CAL-SIN-MD210 Issue 2 | 10 Hz to 99 Hz<br>100 Hz to 2500 Hz<br>2501 Hz to 5000 Hz | 4.5 %<br>4.3 %<br>6.8 % |
| 2. Sound Level Meter (Lab) EL-A-OP-CAL-SIN-MD212 Issue 2 | 94 dB at 1 kHz<br>114 dB at 1 kHz | 0.39 dB<br>0.39 dB |

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|---|---|---|
| **B. DIMENSIONAL METROLOGY** | | |
| **B.I Limit Gauges** (Lab) | | |
| 1. Plain Plug Gauges<br>ASME B89.1.5-1998<br>EL-A-OP-CAL-SIN-MD401 Issue 1 | a. Up to 10 mm<br>b. Over 10 mm to 50 mm<br>c. Over 50 mm to 150 mm<br>d. Over 150 mm to 300 mm | 0.2 μm<br>0.4 μm<br>0.7 μm<br>1.1 μm |
| 2. Plain Ring Gauges (Lab)<br>BS 4064:1966, BS 4065:1966 and ASME B89.1.6-2002<br>EL-A-OP-CAL-SIN-MD402 Issue 1 | a. 1.5 mm to 51 mm<br>b. Over 51 mm to 150 mm<br>c. Over 150 mm to 300 mm | 0.4 μm<br>0.7 μm<br>1.1 μm |
| 3. Calibration and inspection of Jig, Fixture, Gauges, Tools and Parts etc for Size, Height, Length, Depth, Position, Angle and Geometric Dimensioning and Tolerancing (GD&T). (Lab / On-site)<br>EL-A-OP-CAL-SIN-MD405 Issue 2 | Up to 1800 mm | (0.8 + 0.0035 L) μm |
| 4. Radius Gauge (Lab)<br>EL-A-OP-CAL-SIN-MD406 Issue 2 | Up to 101.6 mm<br>Arc angle 90 º and above<br>Arc angle 30 º to below 90 º | <br>4.0 μm<br>11 μm |

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| **B.II Measuring Instruments and Tools** | | |
| 1. Surface Plates (Lab / On-site)<br>BS 817:2008<br>EL-A-OP-CAL-SIN-MD407 Issue2 | <br>Size up to 2 x 2 ft<br>Size up to 3 x 3 ft<br>Size up to 4 x 4 ft<br>Size up to 6.5 x 5 ft | <br>1.6 µm<br>2.1 µm<br>2.1 µm<br>4.4 µm |
| 2. Bevel Protractors (Lab)<br>BS 1685:2008<br>EL-A-OP-CAL-SIN-MD408 Issue 2 | | <br>3 minutes |
| 3. External Micrometer (Lab)<br>BS EN ISO 3611:2010<br>EL-A-OP-CAL-SIN-MD409 Issue 1 | <br>0.0001 mm Resolution<br>0.001 mm Resolution | <br>0.22 µm<br>1 µm |
| 4. Internal Micrometer (Lab)<br>BS 959:2008<br>EL-A-OP-CAL-SIN-MD410 Issue 1 | | <br>1.9 µm |
| 5. Depth Micrometers (Lab)<br>BS 6468:2008<br>EL-A-OP-CAL-SIN-MD411 Issue 2 | <br>Up to 300 mm | <br>1 µm |
| 6. Calibration of Displacement Sensor, Dial, Electrical Gauge and Indicator and Thickness Gauge (Lab / On-site)<br>BS EN ISO 463:2006<br>ASME B 89.1.10M-2001<br>EL-A-OP-CAL-SIN-MD412 Issue 1 | <br>Up to 30 mm<br>Up to 100 mm<br>Up to 600 mm | <br>0.5 µm<br>1.0 µm<br>2.5 µm |
| 7. Dial Test Indicators (Lab)<br>BS EN ISO 9493:2010<br>ASME ANSI B89.1.10M-2001<br>EL-A-OP-CAL-SIN-MD413 Issue 1 | <br>Up to 30 mm | <br>0.5 µm |

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| **B.II Measuring Instruments and Tools** | | |
| 8. Electronic and Mechanical Height Gauges (Lab)<br>ISO13225:2012<br>EL-A-OP-CAL-SIN-MD414 Issue 1 | Up to 300 mm<br>Up to 600 mm<br>Up to 1000 mm | 0.9 µm<br>1.6 µm<br>2.6 µm |
| 9. Feeler Gauges (Lab)<br>BS 957 : 2008<br>EL-A-OP-CAL-SIN-MD415 Issue 2 | | 0.3 µm |
| 10. Vee Blocks (Lab)<br>BS 3731 : 1987<br>EL-A-OP-CAL-SIN-MD416 Issue 1 | | 1.9 µm |
| 11. Engineer's Parallel (Lab)<br>BS 906 : 1972<br>EL-A-OP-CAL-SIN-MD417 Issue 1 | | 4.1 µm |
| 12. Engineer's Square (Lab)<br>BS 939 : 2007<br>EL-A-OP-CAL-SIN-MD418 Issue 1 | | 2.2 µm |
| 13. Right Angle and Box Angle Plates (Lab)<br>BS 5535 : 1978<br>EL-A-OP-CAL-SIN-MD419 Issue 1 | | 2.2 µm |
| 14. Straight Edge (Lab)<br>BS 5204 Part 1 : 1975 and<br>BS 5204 Part 2 : 1977<br>EL-A-OP-CAL-SIN-MD420 Issue 2 | | 4.1 µm |
| 15. Height Setting Micrometer (Lab)<br>ISO 7863 : 1984<br>EL-A-OP-CAL-SIN-MD421 Issue 1 | Up to 300 mm<br>Up to 600 mm | 1.3 µm<br>2.4 µm |

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| **B.II Measuring Instruments and Tools** | | |
| 16. Steel Rule (Lab)<br>JIS B 7516 : 2005<br>EL-A-OP-CAL-SIN-MD422 Issue 2 | <br>Up to 300 mm<br>Up to 1000 mm<br>Up to 2000 mm | <br>1.4 μm<br>6 μm<br>13 μm |
| 17. Glass Scale (Lab)<br>EL-A-OP-CAL-SIN-MD423 Issue 2 | <br>Up to 50mm<br>Up to 300mm | <br>1.1 μm<br>1.4 μm |
| 18. Measuring Tape (Lab)<br>JIS B 7512 : 2018<br>EL-A-OP-CAL-SIN-MD424 Issue 2 | <br>Up to 1.5 m<br>Up to 2.5 m<br>Up to 5 m<br>Up to 10 m<br>Up to 20 m<br>Up to 30 m | <br>10 μm<br>25 μm<br>40 μm<br>55 μm<br>75 μm<br>90 μm |
| 19. Inside micro-Checker (Lab)<br>EL-A-OP-CAL-SIN-MD425 Issue 1 | <br>Up to 300 mm<br>Up to 600 mm | <br>1.5 μm<br>2.2 μm |
| 20. Calliper Checker (Lab)<br>EL-A-OP-CAL-SIN-MD426 Issue 1 | <br>Up to 300 mm<br>Up to 600 mm | <br>1.3 μm<br>1.8 μm |
| 21. Depth Micro-Checker (Lab)<br>EL-A-OP-CAL-SIN-MD427 Issue 1 | <br>Up to 300 mm | <br>1.3 μm |
| 22. Toolmaker's Straight Edge (Lab)<br>BS 852 : 1939<br>EL-A-OP-CAL-SIN-MD428 Issue 2 | | <br>2.0 μm |

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| **B.II Measuring Instruments and Tools** | | |
| 23. Bore Gauge (Lab)<br>(Three-leg Micrometer)<br>EL-A-OP-CAL-SIN-MD429 Issue 1 | | 1 μm |
| 24 Electronic and Mechanical<br>Callipers (Lab)<br>ISO 13385-1:2019 and<br>JIS B 7507 : 2016<br>EL-A-OP-CAL-SIN-MD430 Issue 1 | Up to 150 mm<br>Up to 300 mm<br>Up to 600 mm<br>Up to 1000 mm<br>Up to 2000 mm | 2 μm<br>10 μm<br>10 μm<br>10 μm<br>20 μm |
| 25. Electronic/Mechanical Depth<br>Gauge (Lab)<br>ISO 13385-2-2020<br>EL-A-OP-CAL-SIN-MD431 Issue 1 | Up to 300 mm<br>Up to 600 mm<br>Up to 1000 mm | 10 μm<br>10 μm<br>10 μm |
| 26. Optical Projector (Lab / On-site)<br>JIS B 7184 : 2021<br>EL-A-OP-CAL-SIN-MD432 Issue 1 | | 2.1 μm |
| 27. Toolmaker Microscope (Lab / On-site)<br>JIS B 7153: 1995<br>EL-A-OP-CAL-SIN-MD433 Issue 1 | | 2.2 μm |
| 28. Universal Measuring Machine<br>(Lab / On-site)<br>EL-A-OP-CAL-SIN-MD440 Issue 1 | Up to 10 mm<br>Up to 20 mm<br>Up to 50 mm<br>Up to 70 mm<br>Up to 100 mm | 0.09 μm<br>0.11 μm<br>0.14 μm<br>0.18 μm<br>0.30 μm |
| 29. Dial Gauge Calibrator (Lab)<br>EL-A-OP-CAL-SIN-MD439 Issue 1 | 0 to 100 mm | 0.3 μm |

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| **B.II Measuring Instruments and Tools** | | |
| 30. Clinometer / Digital Protractor (Lab)<br>EL-A-OP-CAL-SIN-MD444 Issue 2 | | 0.02 degree |
| 31. Spirit Level (Lab)<br>BS 958 : 1968<br>EL-A-OP-CAL-SIN-MD445 Issue 1 | | 0.50 arc second |
| 32. Electronic Comparator (Mu-Checker) (Lab)<br>EL-A-OP-CAL-SIN-MD437 Issue 1 | | 0.2 µm |
| 33. Cylinder Gauges (Lab)<br>JIS B 7515 : 1982<br>EL-A-OP-CAL-SIN-MD446 Issue 1 | | 0.6 µm |
| 34. Square Master (Lab)<br>Up to 600 mm<br>EL-A-OP-CAL-SIN-MD447 Issue 1 | | 3.9 µm |
| 35. Test Sieve (Lab)<br>ASTM E11-22 and ISO 3310-1:2016<br>EL-A-OP-CAL-SIN-MD448 Issue 2 | 0.02 mm to 20 mm | 2.3 µm |
| 36. Calibration of Film Thickness And Thickness Gauge (Lab)<br>EL-A-OP-CAL-SIN-MD453 Issue 1 | Film Thickness<br>Up to 25mm<br><br>Thickness Gauge<br>Up to 0.05 mm<br>Over 0.05 to 1.50 mm<br>Over 1.50 to 25mm<br>Over 25 to 150mm | 0.4 µm<br><br>0.5 µm<br>1 µm<br>3 µm<br>15 µm |

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| **B.II Measuring Instruments and Tools** | | |
| 37 Co-ordinate Measuring Machine (Contact) (Lab / On-site)<br>Measuring Linear Dimension<br>ISO10360-2 : 2009<br>ISO10360-5 : 2020<br>EL-A-OP-CAL-SIN-MD435 Issue 1 | Up to 500 mm<br>Over 500 to 900 mm<br>Over 900 to 1200 mm<br>Over 1200 to 1800 mm<br>Single and Multiple stylus contacting probing and scanning systems | 1.0 μm<br>1.7 μm<br>2.2 μm<br>2.6 μm |
| 38 Calibration of Crimping Tools and Die (Lab)<br>EL-A-OP-CAL-SIN-MD452 Issue 2 | | 10 μm |

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| **B.III Form** | | |
| 1. Roundness (Lab)<br>EL-A-OP-CAL-SIN-MD402 Issue 1 | Up to 300 mm diameter | 0.20 μm |
| **B.IV Screw Thread Measurement** | | |
| 1. Parallel Screw Plug Gauge (Lab)<br>For compliance with ISO 1502, Fed Std H28 and equivalent Standards<br>EL-A-OP-CAL-SIN-MD449 Issue 2 | Measurement pitch from 0.5 mm to 6 mm | |
| | Pitch diameter<br>1 mm to 50 mm<br>Over 50 mm to 150 mm | <br>2.5 μm<br>3.5 μm |
| 2. Parallel Screw Ring Gauge (Lab)<br>For compliance with ISO 1502, Fed Std H 28 and equivalent standards<br>EL-A-OP-CAL-SIN-MD450 Issue 1 | Measurement pitch from 0.5 mm to 6 mm | |
| | Pitch diameter<br>4 mm to 10 mm<br>Over 10 mm to 50 mm<br>Over 50 mm to 100mm | <br>2.0 μm<br>2.5 μm<br>3.5 μm |

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|---|---|---|
| **C. TEMPERATURE** | | |
| 1. Temperature Enclosure (Lab / On-site)<br>EL-A-OP-CAL-SIN-MD301 Issue 1 | a. -80 °C to 0 °C<br>b. >0 °C to 100 °C<br>c. >100 °C to 200 °C<br>d. >200 °C to 1000 °C<br>e. >1000 °C to 1260 °C | 1.5 °C<br>1.4 °C<br>1.6 °C<br>2.1 °C<br>3.7 °C |
| 2. Temperature Indicator c/w Sensor (Lab)<br>PT100 / Thermistor<br>EL-A-OP-CAL-SIN-MD304 Issue 2 | i. -80 °C to 0 °C<br>ii. >0 °C to 50 °C<br>iii. >50 °C to 200 °C | 0.15 °C<br>0.15 °C<br>0.15 °C |
| Base Metal: Type E, K, J, N & T<br>Noble Metal: Type B, R & S (Lab) | iv. -80 °C to 0 °C<br>v. >0 °C to 50 °C<br>vi. >50 °C to 260 °C<br>vii. >260 °C to 500 °C<br>viii. >500°C to 1000 °C | 0.20 °C<br>0.12 °C<br>0.12 °C<br>1.8 °C<br>3.4 °C |
| Temperature Indicator c/w Sensor (On-site) | ix. -40 °C to 140 °C<br>x. >140 °C to 300 °C | 0.30 °C<br>1.7 °C |
| 3. Liquid in Glass Thermometer (Lab)<br>Graduation 0.02 °C<br>EL-A-OP-CAL-SIN-MD306 Issue 2 | a. Partial Immersion<br>0 °C to 200 °C<br>Graduation: 1.0°C<br>b. Total Immersion<br>0 °C to 200 °C<br>Graduation: 0.2°C | 1.1 °C<br>0.12 °C |
| 4. Calibration Bath - Liquid Bath (Lab)<br>EL-A-OP-CAL-SIN-MD302 Issue 1 | a. -80 °C to 260 °C | 0.61 °C |
| 5. Temperature Block Calibrator (Lab)<br>EL-A-OP-CAL-SIN-MD309 Issue 1 | a. -45 °C to 140 °C<br>b. >140 °C to 650 °C<br>c. >650 °C to 1000 °C | 1.1 °C<br>3.7 °C<br>3.9 °C |

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|---|---|---|
| 6. Thermocouple Sensor (Lab)<br>Base Metal: Type E, K, J, N & T<br>Noble Metal: Type B, R & S<br>EL-A-OP-CAL-SIN-MD303 Issue 2 | a. -80 °C to 0 °C<br>b. >0 °C to 50 °C<br>c. >50 °C to 260 °C<br>d. >260 °C to 500 °C<br>e. >500 °C to 800 °C<br>f. >800 °C to 1000 °C | 0.34 °C<br>0.34 °C<br>0.37 °C<br>3.6 °C<br>3.7 °C<br>3.7 °C |
| 7a Temperature Indicator (Measure) (Lab / On-site)<br>EL-A-OP-CAL-SIN-MD305 Issue 2 | i. Type K<br>-200 °C to 1372 °C | 0.14 °C |
| | ii. Type T<br>-200 °C to 400 °C | 0.13 °C |
| | iii. Type J<br>-200 °C to 1200 °C | 0.13 °C |
| | iv. Type N<br>-200 °C to 1300 °C | 0.15 °C |
| | v. Type E<br>-200 °C to 1000 °C | 0.14 °C |
| | vi. Type R<br>0 °C to 1700 °C | 0.48 °C |
| | vii. Type S<br>0 °C to 1700 °C | 0.67 °C |
| | viii. RTD 100Ω<br>-200 °C to 800 °C | 0.12 °C |
| | ix. Current<br>4 mA to 20 mA | 0.010 °C |
| | x. Voltage<br>0 V to 24 V | 0.010 °C |

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|---|---|---|
| 7b Temperature Simulator (Source) (Lab / On-site) EL-A-OP-CAL-SIN-MD305 Issue 2 | i. Type K<br>-200 °C to 1372 °C | 0.12 °C |
| | ii. Type T<br>-200 °C to 400 °C | 0.12 °C |
| | iii. Type J<br>-200 °C to 1200 °C | 0.11 °C |
| | iv. Type N<br>-200 °C to 1300 °C | 0.12 ºC |
| | v. Type E<br>-200 °C to 1000 °C | 0.13 ºC |
| | vi. Type R<br>0 °C to 1700 °C | 0.25 ºC |
| | vii. Type S<br>0 °C to 1700 °C | 0.30 ºC |
| | viii. RTD 100Ω<br>-200 °C to 800 °C | 0.018 ºC |
| 8. Thermohygrometer/ Thermohygrograph (Lab) EL-A-OP-CAL-SIN-MD307 Issue 2<br><br>**% RH - % Relative Humidity** | a. 15 °C to 70 °C<br>b. (15 to 19) °C at (40 to 95) %RH<br>c. (20 to 39) °C at (35 to 95) %RH<br>d. (40 to 70) °C at (12 to 95) %RH | 0.35 °C<br>2.1 %RH<br>1.7 %RH<br>1.9 %RH |

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|---|---|---|
| 9. Humidity Chamber (Lab) EL-A-OP-CAL-SIN-MD308 Issue 2 | a. (20 to 30) °C | |
| | 30 %RH to 50 %RH | 0.60 °C<br>2.4 %RH |
| | >50 %RH to 70 %RH | 3.2 %RH |
| | >70 %RH to 95 %RH | 4.2 %RH |
| | b. (30 to 50) °C | |
| | 30 %RH to 50 %RH | 0.60 °C<br>2.5 %RH |
| | >50 %RH to 70 %RH | 3.2 %RH |
| **%RH - % relative humidity** | >70 %RH to 95 %RH | 4.2 %RH |
| (On site) | c. (20 to 30) °C | |
| | 30 %RH to 50 %RH | 0.80 °C<br>2.8 %RH |
| | >50 %RH to 70 %RH | 4.6 %RH |
| | >70 %RH to 95 %RH | 5.8 %RH |
| | d. (30 to 50) °C | |
| | 30 %RH to 50 %RH | 0.80 °C<br>2.8 %RH |
| | >50 %RH to 70 %RH | 3.2 %RH |
| | >70 %RH to 95 %RH | 4.3 %RH |
| 10. Infrared Thermometer (Lab) | 8 µm to 14 µm<br>Emissivity: 0.95 | |
| EL-A-OP-CAL-SIN-MD310 Issue 1 | i. -15 °C to 0 °C | 2.0 °C |
| | ii. >0 °C to 120 °C | 2.0 °C |
| | iii. >120 °C to 200 °C | 13.0 °C |
| | iv. >200 °C to 350 °C | 14.0 °C |
| | v. >350 °C to 500 °C | 16.0 °C |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 1. DC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | a. 0.01 mV to 0.09999 mV<br>b. 0.1 mV to 0.99999 mV<br>c. 1 mV to 9.99999 mV<br>d. 10 mV to 99.99999 mV<br>e. 100 mV to 199.99999 mV<br>f. 200 mV to 219.99999 mV<br>g. 0.22 V to 2.1999999 V<br>h. 2.2 V to 10.999999 V<br>i. 11 V to 21.999999 V<br>j. 22 V to 219.99999 V<br>k. 220 V to 1000 V | 4.2 %<br>0.42 %<br>0.042 %<br>0.0050 %<br>0.0012 %<br>0.00096 %<br>0.00083 %<br>0.00047 %<br>0.00040 %<br>0.00069 %<br>0.00084 % |
| 2. AC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | a. 0.50001 mV - 1 mV<br>10 Hz to 20 Hz<br>20 Hz to 40 Hz<br>40 Hz to 20 kHz<br>20 kHz to 50 kHz<br>50 kHz to 100 kHz<br>100 kHz to 300 kHz<br>300 kHz to 500 kHz<br><br>b. 1.000001 mV - 2.19999 mV<br>10 Hz to 20 Hz<br>20 Hz to 40 Hz<br>40 Hz to 20 kHz<br>20 kHz to 50 kHz<br>50 kHz to 100 kHz<br>100 kHz to 300 kHz<br>300 kHz to 500 kHz<br>500 kHz to 1 MHz<br><br>c. 2.2 mV - 5 mV<br>10 Hz to 20 Hz<br>20 Hz to 40 Hz<br>40 Hz to 20 kHz<br>20 kHz to 50 kHz<br>50 kHz to 100 kHz<br>100 kHz to 300 kHz<br>300 kHz to 500 kHz<br>500 kHz to 1 MHz | <br>0.90 %<br>0.90 %<br>0.90 %<br>1.1 %<br>1.1 %<br>2.4 %<br>4.2 %<br><br>0.43 %<br>0.43 %<br>0.42 %<br>0.43 %<br>0.56 %<br>1.2 %<br>2.2 %<br>2.3 %<br><br>0.21 %<br>0.20 %<br>0.21 %<br>0.21 %<br>0.28 %<br>0.56 %<br>1.1 %<br>1.2 % |

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# Schedule

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| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|
| **D. ELECTRICAL** | | |
| 2 AC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | d. 5.00001 mV - 10 mV | |
| | 10 Hz to 20 Hz | 0.11 % |
| | 20 Hz to 40 Hz | 0.090 % |
| | 40 Hz to 20 kHz | 0.092 % |
| | 20 kHz to 50 kHz | 0.11 % |
| | 50 kHz to 100 kHz | 0.16 % |
| | 100 kHz to 300 kHz | 0.31 % |
| | 300 kHz to 500 kHz | 0.54 % |
| | 500 kHz to 1 MHz | 0.68 % |
| | e. 10.00001 mV - 21.99999 mV | |
| | 10 Hz to 20 Hz | 0.065 % |
| | 20 Hz to 40 Hz | 0.052 % |
| | 40 Hz to 20 kHz | 0.050 % |
| | 20 kHz to 50 kHz | 0.061 % |
| | 50 kHz to 100 kHz | 0.11 % |
| | 100 kHz to 300 kHz | 0.21 % |
| | 300 kHz to 500 kHz | 0.35 % |
| | 500 kHz to 1 MHz | 0.48 % |
| | f. 22 mV - 50 mV | |
| | 10 Hz to 20 Hz | 0.059 % |
| | 20 Hz to 40 Hz | 0.049 % |
| | 40 Hz to 20 kHz | 0.029 % |
| | 20 kHz to 50 kHz | 0.041 % |
| | 50 kHz to 100 kHz | 0.095 % |
| | 100 kHz to 300 kHz | 0.16 % |
| | 300 kHz to 500 kHz | 0.24 % |
| | 500 kHz to 1 MHz | 0.40 % |
| | g. 50.00001 mV - 100 mV | |
| | 10 Hz to 20 Hz | 0.054 % |
| | 20 Hz to 40 Hz | 0.049 % |
| | 40 Hz to 20 kHz | 0.024 % |
| | 20 kHz to 50 kHz | 0.035 % |
| | 50 kHz to 100 kHz | 0.14 % |
| | 100 kHz to 300 kHz | 0.14 % |
| | 300 kHz to 500 kHz | 0.20 % |
| | 500 kHz to 1 MHz | 0.37 % |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 2 AC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | h. 0.1 V - 0.21999999 V | |
| | 10 Hz - 20 Hz | 0.037 % |
| | 20 Hz - 40 Hz | 0.037 % |
| | 40 Hz - 20 kHz | 0.017 % |
| | 20 kHz - 50 kHz | 0.028 % |
| | 50 kHz - 100 kHz | 0.064 % |
| | 100 kHz - 300 kHz | 0.12 % |
| | 300 kHz - 500 kHz | 0.32 % |
| | 500 kHz - 1 MHz | 0.32 % |
| | i. 0.22 V - 0.5 V | |
| | 10 Hz - 20 Hz | 0.045 % |
| | 20 Hz - 40 Hz | 0.043 % |
| | 40 Hz - 20 kHz | 0.017 % |
| | 20 kHz - 50 kHz | 0.013 % |
| | 50 kHz - 100 kHz | 0.025 % |
| | 100 kHz - 300 kHz | 0.079 % |
| | 300 kHz - 500 kHz | 0.20 % |
| | 500 kHz - 1 MHz | 0.31 % |
| | j. 0.5000001 V - 1 V | |
| | 10 Hz - 20 Hz | 0.033 % |
| | 20 Hz - 40 Hz | 0.033 % |
| | 40 Hz - 20 kHz | 0.013 % |
| | 20 kHz - 50 kHz | 0.0096 % |
| | 50 kHz - 100 kHz | 0.018 % |
| | 100 kHz - 300 kHz | 0.058 % |
| | 300 kHz - 500 kHz | 0.14 % |
| | 500 kHz - 1 MHz | 0.24 % |
| | k. 1.00001 V - 2.1999999 V | |
| | 10 Hz - 20 Hz | 0.029 % |
| | 20 Hz - 40 Hz | 0.029 % |
| | 40 Hz - 20 kHz | 0.011 % |
| | 20 kHz - 50 kHz | 0.0085 % |
| | 50 kHz - 100 kHz | 0.015 % |
| | 100 kHz - 300 kHz | 0.051 % |
| | 300 kHz - 500 kHz | 0.13 % |
| | 500 kHz - 1 MHz | 0.21 % |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 2 AC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | l. 2.2 V - 5 V | |
| | 10 Hz to 20 Hz | 0.043 % |
| | 20 Hz to 40 Hz | 0.043 % |
| | 40 Hz to 20 kHz | 0.016 % |
| | 20 kHz to 50 kHz | 0.013 % |
| | 50 kHz to 100 kHz | 0.02 % |
| | 100 kHz to 300 kHz | 0.055 % |
| | 300 kHz to 500 kHz | 0.20 % |
| | 500 kHz to 1 MHz | 0.30 % |
| | m. 5.000001 V - 10 V | |
| | 10 Hz to 20 Hz | 0.033 % |
| | 20 Hz to 40 Hz | 0.033 % |
| | 40 Hz to 20 kHz | 0.013 % |
| | 20 kHz to 50 kHz | 0.0096 % |
| | 50 kHz to 100 kHz | 0.015 % |
| | 100 kHz to 300 kHz | 0.040 % |
| | 300 kHz to 500 kHz | 0.15 % |
| | 500 kHz to 1 MHz | 0.22 % |
| | n. 10.000001 V - 21.999999 V | |
| | 10 Hz to 20 Hz | 0.029 % |
| | 20 Hz to 40 Hz | 0.029 % |
| | 40 Hz to 20 kHz | 0.011 % |
| | 20 kHz to 50 kHz | 0.0086 % |
| | 50 kHz to 100 kHz | 0.013 % |
| | 100 kHz to 300 kHz | 0.034 % |
| | 300 kHz to 500 kHz | 0.13 % |
| | 500 kHz to 1 MHz | 0.19 % |
| | o. 22 V - 50 V | |
| | 10 Hz to 20 Hz | 0.043 % |
| | 20 Hz to 40 Hz | 0.043 % |
| | 40 Hz to 20 kHz | 0.016 % |
| | 20 kHz to 50 kHz | 0.013 % |
| | 50 kHz to 100 kHz | 0.027 % |
| | 100 kHz to 300 kHz | 0.17 % |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 2 AC Voltage Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | p. 50.00001 V - 100 V | |
| | 10 Hz to 20 Hz | 0.033 % |
| | 20 Hz to 40 Hz | 0.033 % |
| | 40 Hz to 20 kHz | 0.013 % |
| | 20 kHz to 50 kHz | 0.011 % |
| | 50 kHz to 100 kHz | 0.021 % |
| | q. 100.00001 V - 219.99999 V | |
| | 10 Hz to 20 Hz | 0.031 % |
| | 20 Hz to 40 Hz | 0.031 % |
| | 40 Hz to 20 kHz | 0.019 % |
| | 20 kHz to 50 kHz | 0.0091 % |
| | 50 kHz to 100 kHz | 0.018 % |
| | r. 220 V - 249.9999 V | |
| | 15 Hz to 50 Hz | 0.041 % |
| | s. 220 V - 500 V | |
| | 50 Hz to 1 kHz | 0.032 % |
| | t. 501 V - 1000 V | |
| | 50 Hz to 1 kHz | 0.0078 % |
| 3 DC Current Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | a. 0.1 uA to 0.9999 uA | 6.1 % |
| | b. 1 uA to 9.9999 uA | 0.61 % |
| | c. 10 uA to 99.9999 uA | 0.065 % |
| | d. 100 uA to 199.9999 uA | 0.011 % |
| | e. 200 uA to 219.9999 uA | 0.0071 % |
| | f. 0.22 mA to 2.19999 mA | 0.0067 % |
| | g. 2.2 mA to 21.9999 mA | 0.004 % |
| | h. 22 mA to 219.9999 mA | 0.0053 % |
| | i. 0.22 A to 2.19999 A | 0.039 % |
| | j. 2.2 A to 10 A | 0.059 % |
| | k. 10.1 A to 500 A | 0.79 % |
| | l. 501 A to 1000 A | 0.86 % |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 4 AC Current Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | a. 9 μA – 99.999 μA | |
| | 10 Hz to 20 Hz | 0.21 % |
| | 20 Hz to 40 Hz | 0.21 % |
| | 40 Hz to 1 kHz | 0.13 % |
| | 1 kHz to 5 kHz | 0.17 % |
| | 5 kHz to 10 kHz | 0.84 % |
| | b. 100 μA – 199.999 μA | |
| | 10 Hz to 20 Hz | 0.045 % |
| | 20 Hz to 40 Hz | 0.045 % |
| | 40 Hz to 1 kHz | 0.030 % |
| | 1 kHz to 5 kHz | 0.041 % |
| | 5 kHz to 10 kHz | 0.18 % |
| | c. 200 μA – 219.999 μA | |
| | 10 Hz to 20 Hz | 0.037 % |
| | 20 Hz to 40 Hz | 0.037 % |
| | 40 Hz to 1 kHz | 0.023 % |
| | 1 kHz to 5 kHz | 0.035 % |
| | 5 kHz to 10 kHz | 0.15 % |
| | d. 0.22 mA – 2.19999 mA | |
| | 10 Hz to 20 Hz | 0.036 % |
| | 20 Hz to 40 Hz | 0.036 % |
| | 40 Hz to 1 kHz | 0.028 % |
| | 1 kHz to 5 kHz | 0.034 % |
| | 5 kHz to 10 kHz | 0.18 % |
| | e. 2.2 mA – 21.9999 mA | |
| | 10 Hz to 20 Hz | 0.034 % |
| | 20 Hz to 40 Hz | 0.034 % |
| | 40 Hz to 1 kHz | 0.027 % |
| | 1 kHz to 5 kHz | 0.026 % |
| | 5 kHz to 10 kHz | 0.17 % |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 4 AC Current Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | f. 22 mA – 219.999 mA | |
| | 10 Hz to 20 Hz | 0.034 % |
| | 20 Hz to 40 Hz | 0.034 % |
| | 40 Hz to 1 kHz | 0.027 % |
| | 1 kHz to 5 kHz | 0.024 % |
| | 5 kHz to 10 kHz | 0.14 % |
| | g. 0.22 A – 2.19999 A | |
| | 20 Hz to 5 kHz | 0.69 % |
| | h. 2.2 A – 10 A | |
| | 45 Hz to 1 kHz | 0.33 % |
| | i. 10.1 A – 550 A | |
| | 45 Hz to 65 Hz | 0.78 % |
| | j. 551 A – 1000 A | |
| | 40 Hz to 60 Hz | 0.60 % |
| 5 Resistance Measuring Instrument Range Values (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | | |
| | a. 1 Ω to 10.99 Ω | 0.64 % |
| | b. 11 Ω to 32.999 Ω | 0.12 % |
| | c. 33 Ω to 109.999 Ω | 0.043 % |
| | d. 110 Ω to 329.999 Ω | 0.018 % |
| | e. 0.33 kΩ to 1.09999 kΩ | 0.021 % |
| | f. 1.1 kΩ to 3.29999 kΩ | 0.012 % |
| | g. 3.3 kΩ to 10.9999 kΩ | 0.022 % |
| | h. 11 kΩ to 32.9999 kΩ | 0.012 % |
| | i. 33 kΩ to 109.999 kΩ | 0.023 % |
| | j. 110 kΩ to 329.999 kΩ | 0.014 % |
| | k. 0.33 MΩ to 0.99999 MΩ | 0.025 % |
| | l. 1 MΩ to 10 MΩ | 0.057 % |
| | m. 10.0001 MΩ to 15.9999 MΩ | 0.081 % |
| | n. 16 MΩ to 20 MΩ | 0.081 % |
| | o. 20.0001 MΩ to 32.9999 MΩ | 0.081 % |
| | p. 33 MΩ to 1.1 GΩ | 1.3 % |
| | q. 1.2 GΩ to 111 GΩ | 2.4 % |

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| **D. ELECTRICAL** | | |
| 6 Resistance Measuring Instrument<br>Fixed values (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | a. 1 Ω, 1.9 Ω | 0.0097 % |
| | b. 10 Ω, 19 Ω | 0.0029 % |
| | c. 100 Ω, 190 Ω | 0.0018 % |
| | d. 1 kΩ, 1.9 kΩ, 10 kΩ, 19 kΩ | 0.0014 % |
| | e. 100 kΩ, 190 kΩ | 0.0015 % |
| | f. 1 MΩ | 0.0021 % |
| | g. 1.9 MΩ | 0.0025 % |
| | h. 10 MΩ | 0.0044 % |
| | i. 19 MΩ | 0.0056% |
| | j. 100 MΩ | 0.013 % |
| 7 Capacitance Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | Range Values<br><u>50 Hz to 1 kHz</u> | |
| | a. 0.33 nF to 0.4999 nF | 0.35% + 0.0079 pF |
| | b. 0.5 nF to 1.0999 nF | 0.43% + 0.0078 nF |
| | c. 1.1 nF to 3.2999 nF | 0.38% + 0.008 nF |
| | d. 3.3 nF to 10.999 nF | 0.39% + 0.008 nF |
| | e. 11 nF to 32.999 nF | 0.19% + 0.08 nF |
| | f. 33 nF to 109.99 nF | 0.19% + 0.09 nF |
| | g. 110 nF to 329.99 nF | 0.20% + 0.30 nF |
| | h. 0.33 uF to 1.0999 uF | 0.19% + 0.0009 uF |
| | i. 1.1 u to 3.2999 uF | 0.27% + 0.003 uF |
| | <u>50 Hz to 400 Hz</u> | |
| | j. 3.3 uF to 10.999 uF | 0.27% + 0.009 uF |
| | k. 11 uF to 32.999 uF | 0.31% + 0.03 uF |
| | <u>50 Hz to 200 Hz</u> | |
| | l. 33 uF to 109.99 uF | 0.39% + 0.08 uF |
| | <u>50 Hz to 100 Hz</u> | |
| | m. 110 uF to 329.99 uF | 0.54% + 0.3 uF |
| | n. 0.33 mF to 1.1 mF | 0.78% + 1.0 uF |

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|---|---|---|
| **D. ELECTRICAL** | | |
| 8 Capacitance Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2 | Fixed Values<br>a. 1 pF, 1 kHz<br>b. 10 pF, 1 kHz<br>c. 100 pF, 1 kHz<br>d. 1000 pF, 1 kHz | <br><br>0.13 %<br>0.12 %<br>0.12 %<br>0.12 % |
| 9 Inductance Measuring Instrument (Lab)<br>EL-A-OP-CAL-SIN-MD207 Issue 1 | Ranged values<br>1 mH - 1000 mH, 1 kHz | <br>1.2 % |
| 10 DC Voltage Source (Lab)<br>EL-A-OP-CAL-SIN-MD204 Issue 1<br>EL-A-OP-CAL-SIN-MD203 Issue 1 | a. 0.01 mV to 0.1 mV<br>b. 0.10001 mV to 1 mV<br>c. 1.00001 mV to 10 mV<br>d. 10.00001 mV to 100 mV<br>e. 100.00001 mV to 120 mV<br>f. 0.12000001 V to 1.2 V<br>g. 1.2000001 V to 12 V<br>h. 12.000001 V to 120 V<br>i. 120.00001 V to 1000 V<br>j. 1000 V to 2000 V<br>k. 2000 V to 10000 V | 3.6 %<br>0.37 %<br>0.037 %<br>0.0049 %<br>0.0016 %<br>0.0015 %<br>0.0017 %<br>0.0017 %<br>0.002 %<br>0.93 %<br>0.70 % |
| 11 AC Voltage Source (Lab)<br>EL-A-OP-CAL-SIN-MD204 Issue 1<br>EL-A-OP-CAL-SIN-MD203 Issue 1 | a. 1 mV - 12 mV<br>40 Hz - 1 kHz<br>1 kHz - 20 kHz<br>20 kHz - 50 kHz<br>50 kHz – 100kHz<br>100 kHz – 300 kHz<br><br>b. 12.001 mV - 120 mV<br>40 Hz - 1 kHz<br>1 kHz - 20 kHz<br>20 kHz - 50 kHz<br>50 kHz - 100 kHz<br>100 kHz - 300 kHz | <br>0.39 %<br>0.17 %<br>0.25 %<br>0.71%<br>4.9%<br><br><br>0.047 %<br>0.036 %<br>0.055 %<br>0.12 %<br>0.45 % |

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| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|
| 11 AC Voltage Source (Lab) | c. 0.120001 V - 1.2 V | |
| | 40 Hz - 1 kHz | 0.047 % |
| | 1 kHz - 20 kHz | 0.036 % |
| | 20 kHz - 50 kHz | 0.055 % |
| | 50 kHz - 100 kHz | 0.12 % |
| | 100 kHz - 300 kHz | 0.45 % |
| | d. 1.20001 V - 12 V | |
| | 40 Hz - 1 kHz | 0.062 % |
| | 1 kHz - 20 kHz | 0.043 % |
| | 20 kHz - 50 kHz | 0.06 % |
| | 50 kHz - 100 kHz | 0.16 % |
| | e. 12.0001 V - 120 V | |
| | 40 Hz to 1 kHz | 0.063 % |
| | 1 kHz to 20 kHz | 0.043 % |
| | f. 120.001 V - 700 V | |
| | 50 Hz to 1 kHz | 0.085 % |
| | 1 kHz to 10 kHz | 0.089 % |
| | g. 700 V to 750 V | |
| | 50 Hz to 1 kHz | 0.13 % |
| | h. 750 V to 1000 V | |
| | 50 Hz to 1 kHz | 0.85 % |
| | i. 1 kV to 10 kV | |
| | 50Hz / 60 Hz | 1.8 % |

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| | SCOPE / INSTRUMENTS / LOCATION / METHOD | | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|---|---|
| 12 | DC Current Source (Lab)<br>EL-A-OP-CAL-SIN-MD204 Issue 1<br>EL-A-OP-CAL-SIN-MD203 Issue 1 | a. | 1 nA to 10 nA | 4.7 % |
| | | b. | 10.001 nA to 100 nA | 0.46 % |
| | | c. | 110 nA to 120 nA | 0.047 % |
| | | d. | 0.1201 uA to 1.2 uA | 0.043 % |
| | | e. | 1.2001 uA to 12 uA | 0.013 % |
| | | f. | 12.0001 uA to 120 uA | 0.011 % |
| | | g. | 0.1200001 mA to 1.2 mA | 0.0078 % |
| | | h. | 1.200001 mA to 12 mA | 0.0095 % |
| | | i. | 12.00001 mA to 120 mA | 0.0095 % |
| | | j. | 0.1200001 A to 1.05 A | 0.023 % |
| | | k. | 1.20001 A to 3 A | 0.29 % |
| | | l. | 3 A to 3.6 A | 0.18 % |
| | | m. | 3.60001 A to 10 A | 0.18 % |
| 13 | AC Current Source (Lab)<br>EL-A-OP-CAL-SIN-MD204 Issue 1<br>EL-A-OP-CAL-SIN-MD203 Issue 1 | a. | 10 μA - 120 μA | |
| | | | 10 Hz to 20 Hz | 0.81 % |
| | | | 20 Hz to 45 Hz | 0.81 % |
| | | | 45 Hz to 100Hz | 0.53 % |
| | | | 100 Hz to 1 kHz | 0.42 % |
| | | | 1 kHz to 5 kHz | 0.42 % |
| | | | 5 kHz to 10 kHz | 2.4 % |
| | | b. | 0.12001 mA – 1.2 mA | |
| | | | 10 Hz to 20 Hz | 0.66 % |
| | | | 20 Hz to 45 Hz | 0.66 % |
| | | | 45 Hz to 100 Hz | 0.37 % |
| | | | 100 Hz to 1 kHz | 0.27 % |
| | | | 1 kHz to 5 kHz | 0.23 % |
| | | | 5 kHz to 10 kHz | 0.27 % |
| | | c. | 1.20001 mA – 12 mA | |
| | | | 10 Hz to 20 Hz | 0.66 % |
| | | | 20 Hz to 45 Hz | 0.66 % |
| | | | 45 Hz to 100 Hz | 0.37 % |
| | | | 100 Hz to 1 kHz | 0.27 % |
| | | | 1 kHz to 5 kHz | 0.23 % |
| | | | 5 kHz to 10 kHz | 0.27 % |

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| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|
| | d. 12.0001 mA – 120 mA | |
| | 10 Hz to 20 Hz | 0.66 % |
| | 20 Hz to 45 Hz | 0.66 % |
| | 45 Hz to 100 Hz | 0.38 % |
| | 100 Hz to 1 kHz | 0.31 % |
| | 1 kHz to 5 kHz | 0.31 % |
| | 5 kHz to 10 kHz | 0.54 % |
| | e. 0.120001 A – 1.00000 A | |
| | 10 Hz to 20 Hz | 0.66 % |
| | 20 Hz to 45 Hz | 0.66 % |
| | 45 Hz to 100 Hz | 0.38 % |
| | 100 Hz to 1 kHz | 0.31 % |
| | 1 kHz to 5 kHz | 0.31 % |
| | 5 kHz to 10 kHz | 0.54 % |
| | f. 1.00001 A – 3.00000 A | |
| | 45 Hz to 1 kHz | 0.71% |
| | g. 3.00001 A – 3.60000 A | |
| | 45 Hz to 1 kHz | 0.57 % |
| | h. 3.60001 A – 10 A | |
| | 45 Hz to 1 kHz | 0.54 % |
| 14 Resistance Source (Lab) | | |
| EL-A-OP-CAL-SIN-MD204 Issue 1 | a. 0.001 Ω to 0.01 Ω | 6.4 % |
| EL-A-OP-CAL-SIN-MD203 Issue 1 | b. 0.011 Ω to 0.1 Ω | 0.62 % |
| | c. 0.11 Ω to 10 Ω | 0.068 % |
| | d. 10.001 Ω to 100 Ω | 0.0076 % |
| | e. 100.001 Ω to 1 kΩ | 0.060 % |
| | f. 1.001 kΩ to 10 kΩ | 0.0017 % |
| | g. 10.001 kΩ to 100 kΩ | 0.0021 % |
| | h. 100.001 kΩ to 1 MΩ | 0.0044 % |
| | i. 1.00001 MΩ to 12 MΩ | 0.068 % |
| | j. 12.0001 MΩ to 120 MΩ | 0.068 % |
| | k. 0.121 GΩ to 1 GΩ | 0.067 % |

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| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|
| **D. ELECTRICAL** | | |
| 15 Capacitance Source (Lab)<br>EL-A-OP-CAL-SIN-MD204<br>Issue 1 | 1 Vac @ 1 kHz<br>a. 1 nF to 10 nF<br>b. 10.0001 nF to 100 nF<br>c. 100.001 nF to 1000 nF<br>d. 1.0001 uF to 10 uF | <br>0.12 %<br>0.12 %<br>0.12 %<br>0.35 % |
| 16 Frequency Measuring Instrument (Internal Time-base) (Lab)<br>EL-A-OP-CAL-SIN-MD201 Issue 2<br>EL-A-OP-CAL-SIN-MD202 Issue 1 | a. 100 mHz to 20 MHz<br>b. 21 MHz to 1.3 GHz | 0.0025 %<br>$8.8 \times 10^{-8}$ |
| 17 Stopwatch / Timer<br>(Lab)<br>EL-A-OP-CAL-SIN-MD205 Issue 1 | a. 1 s to 24 hours | 0.13 s |
| (Site)<br>EL-A-OP-CAL-SIN-MD205 Issue 1 | b. 1 s to 24 hours | 0.14 s |
| 18 RF Frequency<br>(External Timebase) (Lab)<br>EL-A-OP-CAL-SIN-MD202 Issue 1<br>EL-A-OP-CAL-SIN-MD204 Issue 1 | Source:<br>a. 1 Hz to 1 kHz<br>b. 1 kHz – 1 MHz<br>c. 1 MHz – 1 GHz<br>d. 1 GHz – 20 GHz<br><br>Measure:<br>a. 1 Hz to 1 kHz<br>b. 1 kHz to 1 MHz<br>c. 1 MHz to 1 GHz<br>d. 1 GHz to 20 GHz | <br>$5.8 \times 10^{-5}$<br>$5.8 \times 10^{-7}$<br>$1.2 \times 10^{-9}$<br>$1 \times 10^{-9}$<br><br><br>$5.8 \times 10^{-6}$<br>$5.8 \times 10^{-7}$<br>$5.8 \times 10^{-8}$<br>$1 \times 10^{-9}$ |
| 19 RF Power<br>(Lab)<br>EL-A-OP-CAL-SIN-MD202 Issue 1 | a. 20 dBm to -20 dBm at 1 GHz<br>b. 10 dBm to -20 dBm at 10 GHz<br>c. 10 dBm to -20 dBm at 18 GHz | 0.17 dB<br>0.36 dB<br>0.36 dB |
| 20 Amplitude Modulation<br>(Lab)<br>EL-A-OP-CAL-SIN-MD202 Issue 1 | % of Depth: 5 to 95<br>Carrier Frequency / Modulation Rate<br>150 kHz – 10 MHz / 50 Hz to 10 kHz<br>10 MHz – 1.3 GHz / 50 Hz to 50 kHz<br>1.3 GHz – 10 GHz / 50 Hz to 50 kHz | <br><br>2.7 %<br>2.1 %<br>2.1 % |

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# Schedule

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| SCOPE / INSTRUMENTS / LOCATION / METHOD | RANGE TO BE CALIBRATED / MEASURED QUANTITIES / FREQUENCY | | | CALIBRATION MEASUREMENT CAPABILITY (*) |
|---|---|---|---|---|
| **D. ELECTRICAL** | | | | |
| 21. Frequency Modulation (Lab)<br>EL-A-OP-CAL-SIN-MD202<br>Issue 1 | Carrier Frequency | Peak Freq Dev | Modulation Rate | |
| | 250 kHz to 10 MHz | Up to 40 kHz | 20 Hz-10 kHz | 3.0 % |
| | 10 MHz to 1.3 GHz | Up to 400 kHz | 50 Hz-100 kHz | 1.2 % |
| | 10 MHz to 1.3 GHz | Up to 400 kHz | 20 Hz-200 kHz | 5.9 % |
| | 10 MHz to 18 GHz | Up to 100 kHz | 50 Hz-100 kHz | 1.3 % |
| 22 Phase Modulation (Lab)<br>EL-A-OP-CAL-SIN-MD202<br>Issue 1 | Carrier Frequency | Peak Phase Dev | Modulation Rate | |
| | 150 kHz to 10 MHz | Up to 4 rad | 200 Hz-10 kHz | 5.0 % |
| | 10 MHz to 1.3 GHz | Up to 20 rad | 200 Hz-20 kHz | 4.1 % |
| | 1.3 GHz to 20 GHz | Up to 20 rad | 200 Hz-20 kHz | 4.1 % |
| 23 Oscilloscope (Lab)<br>EL-A-OP-CAL-SIN-MD206<br>Issue 1 | a. Vertical Deflection<br>2 mV – 30 V | | | 2 % |
| | b. Horizontal Deflection<br>2 ns – 4 s | | | 0.15 % |
| | c. Bandwidth (-3dB)<br>50 kHz – 500 MHz | | | 4.6 % |
| **E OPTICAL** | | | | |
| 1. Light Meter (Lab)<br>EL-A-OP-CAL-SIN-MD211<br>Issue 1 | a. 10 lx – 99 lx | | | 6.4 % |
| | b. 100 lx – 4000 lx | | | 6.1 % |

* CMC is expressed as an expanded uncertainty estimated at a level of confidence of approximately 95%.

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# Schedule

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Approved Signatories:

| Name | Cat. A Mechanical | Cat. B Dimensional | Cat. C Temperature | Cat. D Electrical | Cat. E Optical |
|---|---|---|---|---|---|
| Mr Mohd Haron B. Junaidi | A(I), A(II) 1 - 3 | All | - | - | - |
| Mr Law Eng Soon | A(I), A(II) 1 - 5 | All | - | - | - |
| Mr Pek Leong Beng, Joseph | A(I), A(II), A(III), A(IV) 1-2 | - | All | D17 | - |
| Mr Toh Kheng Leong | A (I),<br>A (II - excluding 5, 7, 8) | - | - | - | - |
| Mr Teo Kang Boon | A (II) 1 | - | - | - | - |
| Mr Richard Chan Yee Keong | A (I), A (II) 1 | - | - | - | - |
| Mr Yap Hwee Soon | A (I), A (II), A (III), A (IV), A (V) 1 | - | All | All (excluding D7-8, 18-22) | - |
| Mr Ang Zhong Li | A (IV) 1 & 2 | - | - | D1-7, 16-17 | - |
| Mr Yip Hang Ming, Sam | A (IV) 1 & 2,<br>A (V) | - | - | All | All |
| Ms Ong Yok Khuan | - | B (I) 1-3,<br>B (II) 3, 6-9, 11, 14, 23-25, 30,<br>B (III) 1 | - | - | - |
| Mr Teo Tong Nee, Anthony | - | B (I) 1-4,<br>B (II) 1, 3 - 9, 11, 14, 23-27, 30-31, 33, 36,<br>B (III) 1,<br>B (IV) 1, 2 | - | - | - |
| Mr Sim Chee Chong | - | B (I) 1, 2,<br>B (II) 3, 6-8, 24-25,<br>B (III) 1 | - | - | - |
| Mr Wong Wee Ang | - | - | C1 - 2,<br>C6 - 10 | D1-7 | - |
| Mr Tan Li Zhi, Dennis | - | - | C1 - 3,<br>C6 - 10 | D1-7 | - |
| Ms Tan Soon Keow Winnie | - | B(I) 1, 2,<br>B(II) 6-8, 23-25,<br>B(III) 1 | - | - | - |
| Mr Sonny Setyawidjaya | - | B(I) 3 (CMM Only) | - | - | - |
| Mr Steven Tan Kin Hwa | A (V) 1 | - | - | - | - |

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Approved Signatories: *(cont)*

| Name | Cat. A Mechanical | Cat. B Dimensional | Cat. C Temperature | Cat. D Electrical | Cat. E Optical |
|---|---|---|---|---|---|
| Jenmark Sorreda | A (IV)1 & 2 | - | C7A & B | D1-7, D10-14, D16 | - |
| Renganayaki Kannan | - | - | - | D17 | - |
| Shanmugam Sankar | - | B (I) 1-2, 4, B (II) 1, 3-4, 6-9, 11, 17, 23-25, 30-31, 33, 36, B (III) 1, B (IV) 1, 2 | - | - | - |
| Tee Kim Meng Gabriel | - | B (I) 1, 2, B (II) 3, 6-8, 24-25 B (III) 1 | - | - | - |

Note:

This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. A laboratory's fulfilment 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 calibration results. 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.

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