

Schedule of Accreditation

issued by

United Kingdom Accreditation Service

2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

| | | |
|--|---|------------------------------------|
|  <p>UKAS CALIBRATION</p> <p>0785</p> <p>Accredited to ISO/IEC 17025:2017</p> | Trescal Limited (Trescal EMS) | |
| | Issue No: 031 | Issue date: 11 January 2021 |
| Leigh Commerce Park Greenfold Way Leigh Greater Manchester WN7 3XJ | Contact: Mr Matt Gypps Tel: + 44 (0)1438 212500 E-Mail: matt.gypps@trescal.com Website: www.trescal.com | |
| Calibration performed by the Organisations at the locations specified below | | |

Locations covered by the organisation and their relevant activities

Laboratory locations:

| Location details | Activity | Location code | |
|--|---|--|------------------|
| Address Collins Aerospace Stafford Road Fordhouses Wolverhampton West Midlands WV10 7EH | Local contact Paul Bradley or Dave Moore Tel +44 (0) 1902 624 644 Fax +44 (0) 1902 624 463 Email: paul.bradley@trescal.com | Capabilities: Electrical DC and LF Dimensional | Wolverhampton |
| Address BAE Systems Warton Aerodrome Lytham Road Preston Lancashire PR4 1AX | Local contact Dave Gresty Tel +44 (0) 161 406 7878 Email: david.gresty@trescal.com | Capabilities: Dimensional | Warton |
| Address Airbus Broughton Building 10 Chester Road Broughton CH4 0DR | Local contact Paul Cashin Tel +44 (0) 1244 523920 Fax +44 (0) 1244 524189 Email: Paul.cashin@trescal.com | Capabilities: Dimensional | Airbus Broughton |



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DETAIL OF ACCREDITATION

| Measured Quantity Instrument or Gauge | Range | Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$) | Remarks | Location Code |
|--|--|--|--|---------------|
| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| ELECTRICAL MEASUREMENTS | | | Electrical Calibrations are performed as a comparison against a reference standard | |
| DC RESISTANCE Measurement | 0 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 k Ω 2 k Ω to 20 k Ω 20 k Ω to 200 k Ω 200 k Ω to 2 M Ω 2 M Ω to 20 M Ω 20 M Ω to 200 M Ω 200 M Ω to 1 G Ω | 28 ppm + 25 $\mu\Omega$ 16 ppm + 100 $\mu\Omega$ 13 ppm + 1.0 m Ω 13 ppm + 10 m Ω 16 ppm + 100 m Ω 27 ppm + 2.0 Ω 75 ppm + 100 Ω 500 ppm + 12 k Ω 1.0 % + 1.1 M Ω | | Wolverhampton |
| DC VOLTAGE Measurement | 0 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1 kV | 11 ppm + 1.2 μ V 8.5 ppm + 0.9 μ V 8.5 ppm + 4.0 μ V 13 ppm + 60 μ V 13 ppm + 600 μ V | | |
| DC CURRENT Measurement | 0 μ A to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 10 A 10 A to 100 A | 140 ppm + 0.60 nA 130 ppm + 6.0 nA 130 ppm + 60 nA 130 ppm + 1.3 μ A 240 ppm + 25 μ A 0.060 % 0.14 % | | |
| AC VOLTAGE Measurement | 10 mV to 200 mV 40 Hz to 10 kHz 200 mV to 2 V 40 Hz to 10 kHz 2 V to 20 V 40 Hz to 10 kHz 20 V to 200 V 40 Hz to 10 kHz | 320 ppm + 5.0 μ V 210 ppm + 25 μ V 210 ppm + 250 μ V 210 ppm + 2.5 mV | | |



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| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | | |
| AC VOLTAGE Measurement continued | 200 V to 1 kV 55 Hz to 1 kHz 1 kHz to 10 kHz | 360 ppm + 50 mV 450 ppm + 50 mV | | Wolverhampton | |
| AC CURRENT Measurement | 10 μ A to 200 μ A 55 Hz to 1 kHz | 600 ppm + 25 nA | | | |
| | 200 μ A to 2 mA 55 Hz to 1 kHz | 400 ppm + 250 nA | | | |
| | 2 mA to 20 mA 55 Hz to 1 kHz | 400 ppm + 2.5 μ A | | | |
| | 20 mA to 200 mA 55 Hz to 1 kHz | 400 ppm + 25 μ A | | | |
| | 200 mA to 2 A 55 Hz to 1 kHz | 900 ppm + 500 μ A | | | |
| DC RESISTANCE Generation | 0 Ω to 11 Ω 11 Ω to 33 Ω 33 Ω to 110 Ω 110 Ω to 330 Ω 330 Ω to 1.1 k Ω 1.1 k Ω to 3.3 k Ω 3.3 k Ω to 11 k Ω 11 k Ω to 33 k Ω 33 k Ω to 110 k Ω 110 k Ω to 330 k Ω 330 k Ω to 1.1 M Ω 1.1 M Ω to 3.3 M Ω 3.3 M Ω to 11 M Ω 11 M Ω to 33 M Ω 33 M Ω to 110 M Ω 110 M Ω to 330 M Ω | 180 ppm + 11 m Ω 150 ppm + 19 m Ω 110 ppm + 19 m Ω 110 ppm + 19 m Ω 110 ppm + 90 m Ω 110 ppm + 90 m Ω 110 ppm + 900 m Ω 110 ppm + 900 m Ω 140 ppm + 9.0 Ω 150 ppm + 9.0 Ω 180 ppm + 80 Ω 200 ppm + 80 Ω 710 ppm + 800 Ω 0.14 % + 800 Ω 0.60 % + 8.0 k Ω 0.60 % + 21 k Ω | | | Wolverhampton |
| DC VOLTAGE Generation | 0 mV to 330 mV 330 mV to 3.3 V 3.3 V to 33 V 33 V to 330 V 330 V to 1 kV | 75 ppm + 6.0 μ V 60 ppm + 13 μ V 60 ppm + 130 μ V 70 ppm + 1.3 mV 70 ppm + 11 mV | | | |



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| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| DC CURRENT Generation | 0 mA to 3.3 mA 3.3 mA to 33 mA 33 mA to 330 mA 330 mA to 2.2 A 2.2 A to 10 A 10 A to 100 A | 160 ppm + 130 nA 130 ppm + 1.1 µA 130 ppm + 12 µA 370 ppm + 120 µA 0.060 % 0.14 % | | Wolverhampton |
| AC VOLTAGE Generation | 1 mV to 33 mV 45 Hz to 10 kHz | 1650 ppm + 27 µV | | Wolverhampton |
| | 33 mV to 330 mV 45 Hz to 10 kHz | 600 ppm + 29 µV | | |
| | 330 mV to 3.3 V 45 Hz to 10 kHz | 360 ppm + 130 µV | | |
| | 3.3 V to 33 V 45 Hz to 10 kHz | 470 ppm + 1.3 mV | | |
| | 33 V to 330 V 45 Hz to 1 kHz 1 kHz to 10 kHz | 600 ppm + 14 mV 900 ppm + 22 mV | | |
| | 330 V to 1 kV 45 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz | 600 ppm + 150 mV 2100 ppm + 170 mV 2100 ppm + 600 mV | | |
| AC CURRENT Generation | 29 µA to 0.33 mA 45 Hz to 1 kHz | 0.18 % + 320 nA | | |
| | 0.33 mA to 3.3 mA 45 Hz to 1 kHz | 0.12 % + 380 nA | | |
| | 3.3 mA to 33 mA 45 Hz to 1 kHz | 0.11 % + 3.8 µA | | |
| | 33 mA to 330 mA 45 Hz to 1 kHz | 0.11 % + 38 µA | | |
| | 330 mA to 2.2 A 45 Hz to 1 kHz | 0.12 % + 380 µA | | |



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| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| AC CURRENT Generation continued | 2.2 A to 11 A 45 Hz to 500 Hz 500 Hz to 1 kHz | 0.13 % + 2.7 mA 0.38 % + 2.7 mA | | Wolverhampton |
| DC CONDUCTANCE | 10 mS to 10 nS | 1.0 % | | |
| CAPACITANCE | 10 μ F to 1 mF 100 Hz | 1.5 % | | |
| | 10 pF to 1 μ F 1 kHz 100 pF to 1 μ F 10 kHz | 0.060 % 0.080 % | | |
| INDUCTANCE | 10 μ H to 100 μ H 1 kHz | 0.50 % | | |
| | 100 μ H to 10 H 1 kHz | 0.10 % | | |
| FREQUENCY | 0.1 Hz to 10 Hz | 35 ppm | | Wolverhampton |
| | 10 Hz to 100 Hz | 3.5 ppm | | |
| | 100 Hz to 1 kHz | 0.70 ppm | | |
| | 1 kHz to 10 kHz 10 kHz to 10 MHz | 8.0 parts in 10^8 2.0 parts in 10^8 | | |
| DIMENSIONAL MEASUREMENTS | | | | |
| LENGTH | | | | |
| NOTES | | | | |
| <p>1. In addition to the items listed above, other similar items, including parts of measuring instruments and machines, may be calibrated to the uncertainties stated. Where the item or part calibrated is of lower quality due to wear, errors in geometry or form, or poor surface texture, or where any other factor adversely affects the measurement capability, greater uncertainties must be quoted.</p> <p>2. The uncertainty quoted if for the departure from flatness, straightness, or squareness, i.e. the distance separating the two parallel planes, which just enclose the surface under consideration.</p> <p>3. Single start, symmetrical thread forms only.</p> | | | | |
| Plain plug gauges (parallel) cylindrical setting standards and rollers | 1 to 50 diameter 50 to 100 100 to 150 | 0.80 1.0 1.2 | By comparison with end standards using a length measuring machine | Wolverhampton and Warton |



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| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| Plain ring gauges (parallel) | 6 to 50 diameter 50 to 100 100 to 150 | 1.0 1.6 2.0 | By comparison with master rings using a length measuring machine | Wolverhampton and Warton |
| Screw plug gauges (parallel) including check and setting plugs See Note 3 | 3 to 100 diameter | 3.0 on pitch diameter | By comparison with end standards using a length measuring machine | Warton |
| Screw ring gauges (parallel) See Note 3 | 6 to 100 diameters | 5.0 on pitch diameter | By comparison with end standards using a length measuring machine. Angle using projector. | |
| Pitch: 1.5 Flank angle: 2.0 + ((800/MxP)) Minutes of arc Where M is the projector magnification and P is pitch in mm | | | | |
| Parallels | As BS 906:1972 | Dependent on size and grade 1.5 to 5.0 | | Wolverhampton |
| ANGLE | | | | |
| Squares Blade type | As BS 939:2007 up to 300 300 up to 600 | 3.0 on squareness 5.0 See note 2 | | Warton |
| Roundness | As BS 3730:1982 | | | |
| External Internal | 0 to 350 diameter 3 to 350 diameter | 0.050 on radius 0.050 on radius | | |



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| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| MEASURING INSTRUMENTS AND MACHINES | | | | |
| Micrometers | | | | |
| External Internal Depth | As BS 870:2008 and above As BS 959:2008 As BS 6468:2008 | Heads: 2.0 between any two points Setting and extension rods: $1.0 + 5.0 \times \text{length in m}$ | Note: Internal micrometers not covered at Airbus. | Wolverhampton, Airbus and Warton |
| Bore micrometers (3 point) | 0 mm to 100mm | Overall performance 5.0 | Using master rings or adjustable setting gauge. | Wolverhampton and Airbus |
| Micrometer heads | As BS 1734:1951 | 1.0 | | Warton |
| Bench micrometer | | Overall performance 2.0 | In-house method based on MOY/SCMI/22 | |
| Height setting micrometer | 0 to 300 | Heads: 1.5 between any two points stepped column 2.5 Overall performance: 3.0 | By comparison with end standards using surface table, indicator and length standards. | Wolverhampton and Warton |
| Riser blocks for above | 150 300 | 2.5 5.0 | By comparison with end standards | |
| Vernier gauges Caliper Height Depth | As BS 887:2008 As BS 1643:2008 As BS 6365:2008 | Overall performance: $10 + (30 \times \text{length in m})$ | | Wolverhampton, Airbus and Warton |
| Dial gauges and dial test indicators | As BS 907:2008 and BS 2795:1981 | 1.0 | | |
| Bevel protractors | As BS 1685:2008 | 1.0 min of arc + 1.0 vernier division | | Wolverhampton |



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|---|----------------|---|---------|---------------|
| RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED | | | | |
| FORM Surface Plates | | | | Warton |
| NOTES | | | | |
| 1. The uncertainty quoted is for the departure from flatness, straightness or squareness; i.e. the distance separating the two parallel planes, which just enclose the surface under consideration. | | | | |
| Granite Cast iron | As BS 817:2008 | 1.5 + (0.8 x diagonal in m) See Note 1 | | Warton |
| END | | | | |



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Appendix - Calibration and Measurement Capabilities

Introduction

The definitive statement of the accreditation status of a calibration laboratory is the Accreditation Certificate and the associated Schedule of Accreditation. This Schedule of Accreditation is a critical document, as it defines the measurement capabilities, ranges and boundaries of the calibration activities for which the organisation holds accreditation.

Calibration and Measurement Capabilities (CMCs)

The capabilities provided by accredited calibration laboratories are described by the Calibration and Measurement Capability (CMC), which expresses the lowest uncertainty of measurement that can be achieved during a calibration. If a particular device under calibration itself contributes significantly to the uncertainty (for example, if it has limited resolution or exhibits significant non-repeatability) then the uncertainty quoted on a calibration certificate will be increased to account for such factors. The CIPM-ILAC definition of the CMC is as follows:

A CMC is a calibration and measurement capability available to customers under normal conditions:

- (a) as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or
- (b) as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement.

The CMC is normally used to describe the uncertainty that appears in an accredited calibration laboratory's schedule of accreditation and is the uncertainty for which the laboratory has been accredited using the procedure that was the subject of assessment. The CMC is calculated according to the procedures given in M3003 and is normally stated as an expanded uncertainty at a coverage probability of 95 %, which usually requires the use of a coverage factor of $k = 2$. An accredited laboratory is not permitted to quote an uncertainty that is smaller than the published CMC in certificates issued under its accreditation.

The CMC may be described using various methods in the Schedule of Accreditation:

As a single value that is valid throughout the range.

As an explicit function of the measurand or of a parameter (see below).

As a range of values. The range is stated such that the customer can make a reasonable estimate of the likely uncertainty at any point within the range.

As a matrix or table where the CMCs depend on the values of the measurand and a further quantity.

In graphical form, providing there is sufficient resolution on each axis to obtain at least two significant figures for the CMC.

Expression of CMCs - symbols and units

In general, only units of the SI and those units recognised for use with the SI are used to express the values of quantities and of the associated CMCs. Nevertheless, other commonly used units may be used where considered appropriate for the intended audience. For example, the term "ppm" (part per million) is frequently used by manufacturers of test and measurement equipment to specify the performance of their products. Terms like this may be used in Schedules of Accreditation where they are in common use and understood by the users of such equipment, providing their use does not introduce any ambiguity in the capability that is being described.

When the CMC is expressed as an explicit function of the measurand or of a parameter, this often comprises a relative term (e.g., percentage) and an absolute term, i.e. one expressed in the same units as those of the measurand. This form of expression is used to describe the capability that can be achieved over a range of values. Some examples are shown below. It should be noted that these expressions are *not* mathematical formulae but are instead written in a commonly used shorthand for expressing uncertainties - therefore, for purposes of clarity, an indication of how they are to be interpreted is also provided below.

DC voltage, 100 mV to 1 V: 0.0025 % + 5.0 μ V

Over the range 100 mV to 1 V, the CMC is 0.0025 %-V + 5.0 μ V, where V is the measured voltage.

Hydraulic pressure, 0.5 MPa to 140 MPa: 0.0036 % + 0.12 ppm/MPa + 4.0 Pa

Over the range 0.5 MPa to 140 MPa, the CMC is 0.0036 %·p + (0.12·10⁻⁶·p·10⁻⁶) + 4.0 Pa, where p is the measured pressure in Pa.

It should be noted that the percentage symbol (%) simply represents the number 0.01. In cases where the CMC is stated only as a percentage, this is to be interpreted as meaning percentage of the measured value or indication.

Thus, for example, a CMC of 1.5 % means 1.5 · 0.01 · i, where i is the instrument indication.