Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

0026

Accredited to ISO/IEC 17025:2017

Taylor Hobson Ltd

Issue No: 035 **Issue date:** 24 May 2019

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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 Calibration Laboratory 2 New Star Road Leicester LE4 9JD **Local contact** Jon Leeman	Dimensional	A

Site activities performed away from the locations listed above:

Location Details	Activity	Location code
Address At customer's premises **Local contact** Jon Leeman	Dimensional	B

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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				
LENGTH				
Balls (Steel Ceramic and Tungsten carbide)	1 to 50 diameter	0.50 on diameter (0.40 on derived radius) 0.025 on form	NOTES:	A
Plain plug gauges (parallel)	1 to 50 diameter 50 to 100 diameter 100 to 200 diameter 200 to 400 diameter 400 to 600 diameter	0.50 0.60 1.0 2.5 3.0 on diameter	1. The uncertainty quoted is for the distance separating the two parallel plane lines which just enclose the profile under consideration.	A
Plain ring gauges (parallel)	10 to 50 diameter 50 to 100 diameter 100 to 150 diameter 150 to 200 diameter 200 to 300 diameter	0.60 0.70 1.0 1.0 1.4 on diameter	2. All linear calibrations may be given in inch units. 3. Machine tools calibrated to the manufacturers specification.	A
ANGLE				
Angle gauges	0° to 360°	1.0 seconds of arc. 0.050 flatness of faces (see note 1)	4. Measurement ranges as specified below for surface texture measurement standards.	A
Polygons	4 to 36 sides	1.0 seconds of arc. 0.050 flatness of faces (see note 1)		
Constant deviation prisms Optical squares (specific value)	90°	0.70 seconds of arc	5. The uncertainty quoted applies to high accuracy Auto collimators manufacturered by Taylor Hobson.	A
Rotary tables and Angular Encoders	0° to 360° Capacity 0 to 1000	1.5 second of arc	6. Type C1 –C2 Spacing standards includes square waveform standards not listed within ISO 5436:2001.	A, B
Indexing tables	0° to 360°	0.30 seconds of arc		A
FORM			7. Type E1-E2 Profile coordinate measurement standards includes the category Balls (Steel, Ceramic and Tungsten carbide) listed separately on the schedule.	
Roundness reference standards	12 to 50 diameter	0.0050 radial		A
Cylindrical roundness magnification standards	Radial displacement 1 μm to 500 μm	0.10		A
Surface texture measurement standards	As BS EN ISO 5436-1:2001			
	Depth measurement standards (Type A) 0.025 μm	0.0040		

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				
Surface texture measurement standards (cont'd)	As BS EN ISO 5436-1:2001			A
	Depth measurement standards (Type A1) 0.025 μm to 2.5 μm	0.015		
	Depth measurement standards (Type A1) 2.5 μm to 50μm	0.060		
	Spacing measurement standards (Type C1-C2)(see note 6) Ra 0.010μm to 6.4μm Rsm 25μm to 250μm	 2% + 4.0nm 0.60 μm		A
	Roughness measurement standards (Type D1) 0.3 μm to 1.5 μm Ra	(3.0 % + 4.0 nm) Ra of the stated value over the calibration area Rt (see CMC for Type A depth measurement standard)		A
	Profile coordinate measurement standard (Type E1-E2) (see note 7) Radius/form type: 49, 80 & 110 Prism type: 0° to 30°	 2.0 radius 0.11 form 1.0 second of arc		A
Harmonic Standards Nominal diameter 44 mm (1500 to 15) upr (undulations per revolution)	 Rq 0.037 μm (Rsm 0.092 mm) Rq 0.095 μm (Rsm 0.276 mm) Rq 0.38 μm (Rsm 0.92 mm) Rq 0.38 μm (Rsm 2.76 mm)	 0.063 0.066 0.122 0.121	 Harmonic amplitude can be derived from Rq x √2	A
Optical flats	10 to 100 diameter	0.050		A
Optical straightedges	1 to 500	0.10		A
Cylindrical straightedges	1 to 1000	0.10		A
Surface Plates and Tables Granite Cast Iron	As BS 817: 2008 160 x 100 to 2500 x 1600	1.5 + (0.80 x diagonal in m) See Note 1		A, B

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				
MEASURING INSTRUMENTS				
Small step height (recording type)	0.0005 μm to 10 μm	see CMC for Type A depth measurement standard)		A
Optical alignment telescopes also targets and collimators	1.2 displacement	Alignment at ∞ 2.0 seconds of arc Targets 4.0 Line of site 10.0		A
Auotcollimators				A
Optical	60 minutes of arc	0.5 seconds of arc		
Photo-electric	10 minutes of arc	0.5 seconds of arc		
Digital	15 minutes of arc	0.5 seconds of arc		
Digital (High Accuracy)	14.5 minutes of arc	0.20 seconds of arc (See Note 5)		
Spirit levels	BS 3509:1962 and BS 958:1968 5 seconds of arc to 60 minutes of arc nominal sensitivity	Mean sensitivity: 10% of nominal Minimum 0.50 seconds or arc		A
Electronic indicating levels	0 minutes of arc to 60 minutes of arc	1.0 second of arc		A
Clinometers	0° to 360°	Mechanical instruments: 10 seconds of arc Optical instruments: 1.0 second of arc		A
Roundness measuring machines	Internal 1 to 350 diameter	0.050		B
	External 0.05 to 350 diameter	0.050		
	Straightness 0 to 1000	0.10		
Surface texture measuring machines	As BS EN ISO 12179:2001 See Note 4	0.020		B
Talyrond precision cylinder	Parallelism 0 to 100	0.3	In-house procedure 1302	A
END				

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 µV

Over the range 100 mV to 1 V, the CMC is 0.0025 %·V + 5.0 µV, 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 $0.0036\ \%\cdot p + (0.12\cdot 10^{-6}\cdot p\cdot 10^{-6}) + 4.0$ 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 $1.5 \cdot 0.01 \cdot i$, where i is the instrument indication.