Schedule of Accreditation
issued by
United Kingdom Accreditation Service
2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

UKAS CALIBRATION **0117** **Accredited to ISO/IEC 17025:2017**	**Jaguar Land Rover Limited** **Issue No:** 035 **Issue date:** 23 September 2021	
	JLR Calibration Centre **Building 2 (W/2/012)** **Abbey Road** **Whitley** **Coventry** **CV3 4LF**	**Contact: Mr S Jennings** **Tel: +44 (0) 2476-565-097** **Website: www.jaguarlandrover.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 JLR Calibration Centre Building 2 (W/2/012) Abbey Road Whitley Coventry CV3 4LF	**Local contact** Mr S Jennings	Accelerometry Dimensional Electrical Force	A

Site activities performed away from the locations listed above:

Location details		Activity	Location code
Address A customers premises The location must be suitable for the nature of the particular calibrations undertaken and will be the subject of contract review arrangements between the laboratory and the customer	**Local contact** Mr S Jennings	Dimensional	B

CALIBRATION AND MEASUREMENT CAPABILITY (CMC)

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED				
LENGTH			NOTES	
Gauge Blocks Millimetre (Steel)	0.25 to 10 10 to 25 Sizes 30, 40, 50 60, 70, 75 80, 90, 100 Variation in length of the above gauge blocks	Class C (See Notes) 0.080 0.10 0.12 0.15 0.18 0.080	By comparison to K grade gauge blocks using a length measuring instrument. **Class C** uncertainties apply to the measurement of length of steel gauges by comparison with grade K standards of length of a similar material. Class C uncertainties apply to grade 0, 1 and 2 gauges to BS EN ISO 3650:1999	A
Plain plug gauges (parallel) and rollers	1 to 50 50 to 100	0.80 1.0	By comparison to a length measuring instrument.	A
Plain ring gauges (parallel) and setting standards	10 to 25 25 to 50 50 to 100	1.0 1.5 2.0	By comparison to setting ring gauges using a length measuring instrument.	A
Length gauges, flat and spherical ended	0 to 600	1.0 + (8.0 x length in m)	By comparison to a length measuring instrument and end standards.	A
Parallels	5 to 50 x 100 x 400	1.5 to 5.0	BS 906:Part 1:1972 By comparison to reference squares and datum surfaces	A
Balls - Precision	0 to 25 diameter	0.50	By comparison to a length measuring instrument.	A
Vee blocks	up to 150 vee capacity	Dependant on size and grade 2.5 up to 5.0	BS 3731:1987 By comparison to reference squares and datum surfaces	A

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED				
ANGLE			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.	
Squares, Blade type	50 to 300 300 to 600	5.0 on squareness 7.0 on squareness See Note 1	BS 939:2007 By comparison to reference squares and datum surfaces	A
Right angle and box angle plates	50 to 600	Squareness 3.0 + (1.0 per 100 mm) Parallelism 1.0 + (1.0 per 100 mm) See Note 1	BS 5535:1978 By comparison to reference squares and datum surfaces	A
FORM			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.	
Surface plates Granite and Cast iron	160 x 100 to 1600 x 1000	1.5 + (0.80 x diagonal in m) See Note 1	BS 817:2008 Using an electronic level	A, B

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED				
MEASURING INSTRUMENTS AND MACHINES				
Micrometers			By comparison to end standards and datum surfaces	A
External	0 to 300	Heads: 2.0 Setting and extension rods: 1.0 + (8.0 x length in m)	BS 870:2008	
Internal	0 to 310		BS 959:2008	
Depth	0 to 300		BS 6468:2008	
Vernier dial and digital type gauges			By comparison to end standards and datum surfaces	A
Caliper	0 to 1000	Overall performance: 10 + (30 x length in m)	BS 887:2008	
Height	0 to 1000	Overall performance: 10 + (30 x length in m)	BS 1643:2008	
Height (simple type)	0 to 1000	Overall performance: 10 + (30 x length in m)	BS EN ISO 13225:2012	
Depth	0 to 600	Overall performance: 10 + (30 x length in m)	BS 6365: 2008	
Dial gauges and dial test indicators	0 to 50	1.0	BS 907:2008 and BS 2795:1981 By comparison to a length measuring instrument.	A

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
ELECTRICAL : Electrical values and uncertainties listed below are applicable for the calibration of both measuring instruments and for instruments with an output. The method used is by direct comparison against laboratory standards unless otherwise stated in the remarks column.				
DC RESISTANCE				
Sourcing	0 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 19 MΩ 100 MΩ	40 µΩ 96 µΩ 24 ppm 11 ppm 7.9 ppm 7.2 ppm 9.7 ppm 14 ppm 41 ppm 64 ppm 130 ppm	Sourcing values for the calibration of measuring instruments.	A
Measurement	0 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ	7.6 ppm + 1.5 µΩ 7.4 ppm + 17 µΩ 7.4 ppm + 120 µΩ 7.4 ppm + 1.2 mΩ 7.6 ppm + 17 mΩ 9.2 ppm + 520 mΩ 17 ppm + 1.7 Ω 77 ppm + 59 Ω	These values can be directly measured.	A
DC VOLTAGE				
Generation	0 mV to 220 mV 220 mV to 2.2 V 2.2 V to 11 V 11 V to 22 V 22 V to 220 V 220 V to 1100 V	16 ppm + 5.8 µV 5.2 ppm + 5.9 µV 1.5 ppm + 6.1 µV 3.6 ppm + 7.2 µV 5.1 ppm + 43 µV 6.7 ppm + 420 µV	Sourcing values for the calibration of measuring instruments.	A
Measurement	0 mV to 220 mV 200 mV to 2.2 V 2.2 V to 22 V 22 V to 220 220 V to 1100 V	7.5 ppm + 1.2 µV 5.0 ppm + 1.7 µV 3.5 ppm + 2.0 µV 5.0 ppm + 12 µV 6.5 ppm + 120 µV	These values can be directly measured.	

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
DC CURRENT				
Generation	0 mV to 220 µA 220 µA to 2.2 mA 2.2 mA to 22 mA 22 mA to 220 mA 220 mA to 2.2 A 2.2 A to 120 A	51 ppm + 350 nA 41 ppm + 11 nA 36 ppm + 41 nA 46 ppm + 5.9 µA 81 ppm + 14 µA 80 ppm + 5.9 mA	Sourcing values for the calibration of measuring instruments.	A
Measurement	0 mA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A	9.9 ppm + 2.6 nA 9.4 ppm + 12 nA 34 ppm + 120 nA 180 ppm + 1.8 µA	These values can be directly measured.	A
AC VOLTAGE				
Generation	*20 Hz to 40 Hz* 22 mV to 220 mV 0.22 V to 2.2 V *40 Hz to 20 kHz* 22 mV to 220 mV 0.22 V to 2.2 V 2.2 V to 22 V 22 V to 220 V 220 V to 1000 V	 110 ppm + 9.1 µV 94 ppm + 16 µV 110 ppm + 9.1 µV 47 ppm + 10 µV 56 ppm + 52 µV 87 ppm + 2.8 mV 91 ppm + 4.4 mV	Sourcing values for the calibration of measuring instruments.	A
Measurement	200 mV to 2.2 V *20 Hz to 40 Hz* *40 Hz to 20 kHz* *40 Hz to 20 kHz* 20 mV to 200 mV 2 V to 20 V 20 V to 200 V 200 V to 1000 V *55 Hz* 20 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 100 V to 1000 V	 270 ppm + 35 µV 110 ppm + 10 µV 500 ppm + 17 µV300 ppm + 790 µV 310 ppm + 7.9 mV 460 ppm + 45 mV 120 ppm + 2.4 µV 83 ppm + 5.3 µV 83 ppm + 17 µV 88 ppm + 590 µV 95 ppm + 9.6 mV	These values can be directly measured.	A
AC CURRENT				
Generation	*55 Hz to 1 kHz* 2.2 µA to 220 µA 0.22 mA to 2.2 mA 2.2 mA to 22 mA 22 mA to 220 mA 0.22 A to 2.2 A *40 Hz to 400 Hz* 2.2 A to 20 A 20 A to 120 A	 190 ppm + 10 nA 160 ppm + 38 nA 110 ppm + 480 nA 110 ppm + 6.4 µA 250 ppm + 38 µA 58 ppm + 5.9 mA 120 ppm + 6.0 mA	Sourcing values for the calibration of measuring instruments.	A

Measured Quantity Instrument or Gauge	Range	Expanded Measurement Uncertainty (k = 2)	Remarks	Location Code
AC CURRENT				
Measurement	*40 Hz to 1 kHz* 20 µA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 0.2 A to 2 A	 420 ppm + 190 nA 390 ppm + 1.6 µA 390 ppm + 19 µA 780 ppm + 380 µA	These values can be directly measured.	A
	55 Hz 20 µA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A	 280 ppm + 12 nA 280 ppm + 170 nA 280 ppm + 2.8 µA 620 ppm + 26 µA		
FREQUENCY	1 Hz to 100 MHz	4.0 in 10^{12} + 100 µHz	Directly traceable to NIST	
	100 MHz to 1 GHz	4.0 in 10^{12}		A
Generate only	1 GHz to 6 GHz	4.0 in 10^{12}		
ACCELEROMETRY			Calibration method is by direct comparison against laboratory references.	
ACCELERATION TRANSDUCERS				
Accelerometer Types: Piezo electric minimum sensitivity >1 pC/m/s^2 Integral electronic minimum sensitivity >1 mV/m/s^2 Piezo resistive minimum sensitivity >1 mV/m/s^2				
All types with a nominal mass of up to 100 grams, a nominal Peak Acceleration of 14 ms^{-2} to 98 ms^{-2} and a minimum sensitivity of 5.0 mV ms^{-2}.	*10 Hz to 20 Hz* *20 Hz to 5 kHz*	3.0 % 2.5 %		A
FORCE				
FORCE MEASURING DEVICES				
Calibration of load cells (excluding proving devices) in tension and compression	2 kN to 100 kN	0.50 %	By comparison to reference proving devices	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.

<u>DC voltage, 100 mV to 1 V</u>: 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.

<u>Hydraulic pressure, 0.5 MPa to 140 MPa</u>: 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 · 0.01 · i, where i is the instrument indication.