Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

0254

Accredited to ISO/IEC 17025:2017

Devonport Royal Dockyard Limited trading as Devonport Electrical and Nucleonic Calibration Facility

Issue No: 038 **Issue date:** 29 June 2020

Babcock International Group
PC1409, Devonport Royal Dockyard
Plymouth
Devon
PL1 4SG

Contact: Mr C Burrow
Tel: +44 (0)1752 324739
Fax: +44 (0)1752 324737
E-Mail: Chris.Burrow@babcockinternational.com

Calibration performed at the above address only

DETAIL OF ACCREDITATION

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
ELECTRICAL CALIBRATION			Electrical calibrations are as a comparison against a reference standard
DC Resistance			
Generation			
Specific Values	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	61 ppm 58 ppm 32 ppm 22 ppm 21 ppm 22 ppm 24 ppm 29 ppm 110 ppm	
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 200 MΩ to 2 GΩ 2 GΩ to 100 GΩ	20 ppm + 0.20 mΩ 20 ppm + 0.60 mΩ 20 ppm + 0.60 mΩ 15 ppm + 7.0 mΩ 15 ppm + 65 mΩ 25 ppm + 1.5 Ω 150 ppm + 80 Ω 200 ppm + 9.0 kΩ 500 ppm + 1.0 MΩ 2.0 %	
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	13 ppm + 2.0 μV 5.0 ppm + 2.0 μV 6.0 ppm + 4.0 μV 6.0 ppm + 8.0 μV 6.0 ppm + 0.10 mV 6.0 ppm + 0.60 mV	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
DC Voltage (continued)			
Measurement	0 mV to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	10 ppm + 2.0 μV 10 ppm + 2.0 μV 10 ppm + 3.0 μV 10 ppm + 40 μV 10 ppm + 100 μV	
DC Current			
Generation	0 μA 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 11 A	52 ppm + 10 nA 15 ppm + 10 nA 30 ppm + 100 nA 37 ppm + 1.0 μA 100 ppm + 30 μA 190 ppm + 480 μA	
Measurement	0 μA to 200 μA 200 μA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 1 A 1 A to 10 A	50 ppm + 1.0 nA 30 ppm + 5.0 nA 40 ppm + 40 nA 40 ppm + 1.0 μA 52 ppm + 10 μA 50 ppm	
AC Voltage			
Generation	*40 Hz to 20 kHz* 10 mV to 220 mV 220 mV to 2.2 V 2.2 V to 22 V 22 V to 220 V 220 V to 750 V 750 V to 1100 V	 56 ppm + 10 μV 24 ppm + 20 μV 22 ppm + 70 μV 63 ppm + 2.0 mV 110 ppm + 6.0 mV 270 ppm + 11 mV	
	20 kHz to 50 kHz 10 mV to 220 mV 220 mV to 2.2 V 2.2 V to 22 V 22 V to 220 V 220 V to 750 V	 82 ppm + 10 μV 27 ppm + 80 μV 22 ppm + 200 μV 91 ppm + 4.0 mV 270 ppm + 11 mV	
	50 kHz to 100 kHz 10 mV to 220 mV 220 mV to 2.2 V 2.2 V to 22 V 22 V to 220 V	 160 ppm + 30 μV 56 ppm + 80 μV 52 ppm + 400 μV 200 ppm + 10 mV	
	100 kHz to 1 MHz 220 mV to 2.2 V 2.2 V to 22 V	 0.17 % + 1.0 mV 0.37 % + 9.0 mV	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC Voltage (continued)			
Measurement	*20 Hz to 10 kHz*		
	20 mV to 200 mV	270 ppm + 4.0 μV	
	200 mV to 2 V	680 ppm + 20 μV	
	2 V to 20 V	260 ppm + 200 μV	
	20 V to 200 V	230 ppm + 2.0 mV	
	10 kHz to 100 kHz		
	20 mV to 200 mV	690 ppm + 20 μV	
	200 mV to 2 V	600 ppm + 200 μV	
	2 V to 20 V	550 ppm + 2.0 mV	
	20 V to 200 V	700 ppm + 20 mV	
	55 Hz to 3 kHz		
	200 V to 1000 V	580 ppm + 10 mV	
	3 kHz to 30 kHz		
	200 V to 1000 V	940 ppm + 20 mV	
AC Current			
Generation	*50 Hz to 400 Hz*		
	10 μA to 200 μA	190 ppm + 20 nA	
	0.2 mA to 2.2 mA	150 ppm + 40 nA	
	2.2 mA to 22 mA	58 ppm + 0.40 μA	
	22 mA to 220 mA	48 ppm + 4.0 μA	
	220 mA to 2.2 A	110 ppm + 40 μA	
	2.2 A to 11 A	190 ppm + 170 μA	
	400 Hz to 1 kHz		
	10 μA to 200 μA	190 ppm + 50 nA	
	0.2 mA to 2.2 mA	150 ppm + 0.50 μA	
	2.2 mA to 22 mA	58 ppm + 5.0 μA	
	22 mA to 220 mA	54 ppm + 50 μA	
	220 mA to 2.2 A	110 ppm + 100 μA	
	2.2 A to 11 A	250 ppm + 380 μA	
	1 kHz to 5 kHz		
	10 μA to 200 μA	700 ppm + 0.10 μA	
	0.2 mA to 2.2 mA	350 ppm + 1.0 μA	
	2.2 mA to 22 mA	530 ppm + 10 μA	
	22 mA to 220 mA	640 ppm + 100 μA	
	220 mA to 2.2 A	410 ppm + 200 μA	
	2.2 A to 11 A	390 ppm + 750 μA	
	5 kHz to 10 kHz		
	10 μA to 200 μA	0.18 % + 0.10 μA	
	0.2 mA to 2.2 mA	0.12 % + 1.0 μA	
	2.2 mA to 22 mA	0.18 % + 10 μA	
	22 mA to 220 mA	0.22 % + 100 μA	
	220 mA to 2.2 A	0.090 % + 200 μA	
	2.2 A to 11 A	0.060 % + 750 μA	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
AC Current (continued)			
Measurement	*55 Hz to 1 kHz*		
	20 μA to 200 μA	850 ppm + 20 nA	
	200 μA to 2 mA	850 ppm + 200 nA	
	2 mA to 20 mA	850 ppm + 2.0 μA	
	20 mA to 200 mA	800 ppm + 20 μA	
	200 mA to 1 A	800 ppm + 200 μA	
	1 kHz to 5 kHz		
	20 μA to 200 μA	0.11 % + 20 nA	
	200 μA to 2 mA	0.11 % + 200 nA	
	2 mA to 20 mA	0.11 % + 2.0 μA	
	20 mA to 200 mA	0.10 % + 20 μA	
	200 mA to 1 A	0.18 % + 400 μA	
Capacitance	*1 kHz*		
	100 pF to 1 μF	0.070 %	2 terminal measurements
Frequency			Averaged over 100 s
Generation			
Specific Values	100 kHz, 1 MHz, 5 MHz & 10 MHz	4.0 in 10^{12}	
	1 PPS	4.0 in 10^{11}	
Range values	1 Hz to 20 GHz	1.0 in 10^{11}	
Measurement	1 Hz to 20 GHz	1.0 in 10^{11} + 10 mHz	
Voltage Reflection Coefficient	*10 MHz to 18 GHz*		
	0 to 0.33	0.040	The CMC applies to 7 mm 50 Ω coaxial line fitted with Type N connectors; for other connector types the quoted uncertainties may be increased. Results may also be quoted in terms of VSWR or Return Loss with the uncertainty being converted to the corresponding units.
RF Attenuation	*10 MHz to 1 GHz*		
	0 dB to 10dB	0.080 dB	The CMCs apply to devices with input and output VSWR not exceeding 1.1: 1. For devices that exhibit higher values of VSWR the quoted uncertainties may be increased.
	10 dB to 20 dB	0.10 dB	
	20 dB to 30 dB	0.15 dB	
	30 dB to 40 dB	0.18 dB	
	40 dB to 50 dB	0.22 dB	
	50 dB to 60 dB	0.25 dB	
	60 dB to 70 dB	0.30 dB	
	70 dB to 80 dB	0.35 dB	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
RF Power			
Specific value	*50 MHz* 1 mW	0.70 %	The CMC for measurement of 50MHz 1mW 50 Ω Reference sources with an output VSWR not exceeding 1.1 : 1, For devices that exhibit higher values of VSWR the quoted uncertainties may be increased.
Other values	-20 dBm to +20 dBm		
	10 MHz 30 MHz 50 MHz 100 MHz 200 MHz	2.5% 2.5% 2.3% 2.2% 2.2%	
	300 MHz 400 MHz 800 MHz 1 GHz 2 GHz	2.2% 2.2% 2.2% 2.2% 2.2%	
	4 GHz 5 GHz 6 GHz 7 GHz 8 GHz	2.2% 2.2% 2.2% 2.2% 2.5%	The CMCs for RF Power (Diode Sensors) apply to the measurement of the output power of a 50 Ω source with an output VSWR not exceeding 1.5:1. For devices that exhibit higher values of VSWR the quoted uncertainties may be increased.
	9 GHz 10 GHz 11 GHz 12 GHz 13 GHz	2.7% 2.5% 2.5% 2.5% 2.7%	
	14 GHz 15 GHz 16 GHz 17 GHz 18 GHz	3.0% 2.7% 2.7% 3.5% 4.5%	
	50 dBm to -20 dBm *10 MHz to 30 MHz* *30 MHz to 8 GHz* *8 GHz to 18 GHz*	 8.0 % 3.5% 4.5 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
RF Calibration Factor			
Nominal 1 mW	*10 MHz and 30 MHz*	1.6 %	The stated CMCs are for the measurement of RF Calibration Factor of power sensors in a 50 Ω coaxial system at a nominal level of 1 mW, with respect to a reference frequency of 50 MHz.
	100 MHz, 200 MHz, 300 MHz, 400 MHz, 800 MHz and 1000 MHz	1.4 %	
	2 GHz, 3 GHz and 4 GHz	1.7 %	
	5 GHz, 6 GHz, 7 GHz and 8 GHz	3.8 %	
	9 GHz, 10 GHz and 11 GHz	6.0 %	
	12 GHz, 13 GHz and 14 GHz	5.5 %	
	15 GHz, 16 GHz, 17 GHz and 18 GHz	5.3 %	
Nominal 1 μW	*10 MHz*	1.7 %	The stated CMCs are for the measurement of RF Calibration Factor of power sensors in a 50 Ω coaxial system at a nominal level of 1 μW, with respect to a reference frequency of 50 MHz.
	30 MHz, 100 MHz, 200 MHz, 300 MHz, 400 MHz, 800 MHz, 1 GHz, 2 GHz, 3 GHz and 4 GHz	1.5 %	
	5 GHz	1.6 %	
	6 GHz, 7 GHz and 8 GHz	3.0 %	
	9 GHz to 18 GHz	3.4 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
RADIOLOGICAL CALIBRATION			
Air Kerma Rate	^{137}Cs: 2.0 μGyh^{-1} to 1.4 Gyh^{-1}	3.5 %	Calibration of air kerma/air kerma rate monitors using air kerma rates traceable to national standards through a secondary standard dosemeter
	^{60}Co: 270.4 μGyh^{-1} to 15.0 mGyh^{-1}	3.0 %	
	^{241}Am: 4.2 μGyh^{-1} to 4.6 mGyh^{-1}	5.0 %	
Ambient Dose Equivalent Rate	^{137}Cs: 2 μSvh^{-1} to 1.713 Svh^{-1}	3.5 %	Calibration of ambient dose equivalent/dose rate monitors using air kerma rates traceable to national standards through a secondary standard dosemeter and using appropriate coefficients given in ISO Standards for H*(10).
	^{60}Co: 311 μSvh^{-1} to 18.0mSvh^{-1}	3.0 %	
	^{241}Am: 7.2 μSvh^{-1} to 8 mSvh^{-1}	5.0 %	
Personal Dose Equivalent Rate	^{137}Cs: 2 μSvh^{-1} to 1.713 Svh^{-1}	3.5 %	Calibration of electronic personal dosemeters using air kerma rates traceable to national standards through a secondary standard dosemeter, and using appropriate coefficients given in ISO Standards for Hp(10)
	^{60}Co: 292 μSvh^{-1} to 18.0 mSvh^{-1}	3.0 %	
	^{241}Am: 7.8 μSvh^{-1} to 8.7 mSvh^{-1}	5.0 %	
Surface Contamination			
Monitor Response:			
Statutory tests, including: Test before first use; Periodic tests			
Alpha (α) Contamination	Alpha-emitting nuclides: ^{241}Am, 238Pu, ^{238}U	5.0 % to 20 % depending upon monitor type	Calibration against large area radioactive sources In with GPG 14
Beta (β) Contamination	Beta-emitting nuclides: ^{90}Sr/^{90}Y, ^{147}Pm, ^{36}Cl, ^{14}C, ^{60}Co, ^{137}Cs	5.0 % to 20 % depending upon monitor type	Calibration against large area radioactive sources In with GPG 14

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.