Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

0286

Accredited to ISO/IEC 17025:2017

Optical Test & Calibration Limited

Issue No: 050 **Issue date:** 01 April 2021

19-23 Campus Road
Listerhills Science Park
Bradford
BD7 1HR

Contact: Mr K G Dove
Tel: +44 (0)1274 393857
Fax: +44 (0)1274 393336
E-Mail: sales@otc.co.uk
Website: www.otc.co.uk

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
FIBRE OPTIC CALIBRATION			
OPTICAL POWER METERS			Calibration by comparison to reference
Absolute responsivity of fibre optic power meters with FC/PC connectors	Wavelength and Power levels:		Wavelengths quoted are ± 1 nm
	850 nm - 10 dBm, - 20 dBm and - 23 dBm	0.080 dB (1.7 %)	850 nm, multimode fibre
	1310 nm - 10 dBm, - 20 dBm and - 23 dBm	0.080 dB (1.7 %)	1310 nm, 1550 nm single mode fibre
	1550 nm - 10 dBm, - 20 dBm and - 23 dBm	0.080 dB (1.7 %)	
Linearity of response of fibre optic power meters with FC/PC connectors	*850 nm* - 5 dBm to - 65 dBm - 65 dBm to - 70 dBm	0.070 dB (1.5 %) 0.120 dB (2.6 %)	850 nm, multimode fibre
	1310 nm + 5 dBm to 0 dBm 0 dBm to - 70 dBm	0.080 dB (1.7 %) 0.060 dB (1.3 %)	1310 nm 1550 nm single mode fibre
	1550 nm + 10 dBm to + 5 dBm + 5 dBm to - 70 dBm	0.080 dB (1.7 %) 0.070 dB (1.4 %)	
OPTICAL ATTENUATORS			
Insertion loss	*850 nm* *1310 nm* *1550 nm*	0.050 dB (1.1 %) 0.050 dB (1.1 %) 0.050 dB (1.1 %)	Fitted with FC/PC connectors
Attenuation setting	*850 nm:* 0 dB to 65 dB	0.060 dB (1.2 %)	Excluding insertion loss
	1310 nm: 0 dB to 65 dB	0.060 dB (1.2 %)	
	1550 nm: 0 dB to 70 dB	0.060 dB (1.2 %)	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
FIBRE OPTIC CALIBRATION (cont'd)			
OPTICAL ATTENUATORS (cont'd)			
Repeatability of attenuation setting	*850 nm* 0 dB to 65 dB	0.030 dB (0.60 %)	
	1310 nm and 1550 nm 0 dB to 65 dB	0.040 dB (0.90 %)	
OPTICAL TIME DOMAIN REFLECTOMETERS (OTDRs) (Single mode fibre)			Calibration by comparison to reference
Loss scale deviation	*1310 nm (nominal)* *1550 nm (nominal)* *1625 nm (nominal)*	0.025 dB/dB 0.050 dB/dB 0.050 dB/dB	Results reported with standard adjacent to and remote from the UUT (typically at 7 km and 20 km respectively)
Length scale:			Measured by comparison to single mode fibre physical standards. Wavelengths: 1310 nm, 1550 nm and 1625 nm.
Zero location offset		0.30 m	
Distance scale factor	6.5 km	0.80 m	
Distance scale deviation	6.5 km	0.12 m/km	
Locational readout error		0.12 m	Pulse duration 3 ns to 20 μs Maximum nominal power 25 mW, minimum nominal power 1 mW
Centre wavelength	1200 nm to 1700 nm	1.0 nm	Pulsed source with RMS spectral width of less than 25 nm
Spectral width	< 0.1 nm 0.1 nm to 9.9 nm 10 nm to 50 nm	0.20 nm 0.50 nm 0.90 nm	
CW FIBRE OPTIC LIGHT SOURCES			Calibration using optical power meter
Output power	*600 nm to 1700 nm:* - 5 dBm to - 55 dBm except where the following wavelength conditions are met: *850 nm ± 1 nm:* - 5 dBm to - 55 dBm *1310 nm ± 1 nm* + 5 dBm to - 55 dBm *1550 nm ± 1 nm* + 10 dBm to - 55 dBm	0.30dB(7.0 %) 0.070 dB(1.5 %) 0.070 dB(1.5 %) 0.070 dB(1.5 %)	CW source with RMS spectral width of less than 25 nm

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
FIBRE OPTIC CALIBRATION (cont'd)			Calibration by comparison to reference standards
CW FIBRE OPTIC LIGHT SOURCES (cont'd)			
Output power stability of fibre optic light sources	- 5 dBm to – 55 dBm	0.0040 dB (0.10 %)	Wavelength range 600 nm to 1700 nm
Centre & Peak Wavelength	600 nm to 1700 nm	0.50 nm	CW source with RMS spectral width of less than 25 nm
Spectral width	< 0.1 nm	0.20 nm	Minimum optical output power level – 30 dBm
	0.1 nm to 5.9 nm 6 nm to 24.9 nm	0.60 nm 1.00 nm	
PULSED FIBRE OPTIC LIGHT SOURCES			Pulse duration 3 ns to 20 μs Maximum nominal power 25 mW, minimum nominal power 1 mW
Centre wavelength	1200 nm to 1700 nm	1.0 nm	Pulsed source with RMS spectral width of less than 25 nm
Spectral width	< 0.1 nm 0.1 nm to 9.9 nm 10 nm to 50 nm	0.20 nm 0.50 nm 0.90 nm	
OPTICAL FIBRES			
Length (single mode fibre)	0.25 m to 1 m	0.0020 m	Intercomparison with physical standard
	1 m to 16 km	(0.07 + (3*10^-5*L)) m Where L is the length of the Fibre Under Test in metres.	Time of flight technique Wavelengths: 1310 nm, 1550 nm and 1625 nm
ILLUMINANCE			Calibration by comparison to reference standards
for a source colour temperature of 2856 K	1 lux to 10 lux 10 lux to 20 lux 20 lux to 200 lux 200 lux to 1000 lux 1000 lux to 2000 lux 2000 lux to 10 000 lux 10 000 lux to 20 000 lux	3.1 % 2.8 % 2.2 % 1.7 % 2.2 % 2.3 % 2.7 %	
Colour temperature	2856 K	0.80 %	
LUMINANCE (luminance meters)			
for a source colour temperature of 2856 K	1 cdm^{-2} to 20 cdm^{-2} 20 cdm^{-2} to 20000 cdm^{-2}	5.4 % 5.1 %	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
ELECTRICAL CALIBRATION			Calibrations are performed as a comparison against a reference standard
DC VOLTAGE			
Generation	0 V 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	17 ppm + 1.8 μV 13 ppm + 3.0 μV 11 ppm + 26 μV 11 ppm + 210 μV 13 ppm + 2.1 mV	These values can be generated for the calibration of measuring instruments
Measurement	0 V to 120 mV 120 mV to 1.2 V 1.2 V to 12 V 12 V to 120 V 120 V to 1 kV	8.0 ppm + 1.3 μV 6.0 ppm + 1.3 μV 4.0 ppm + 2.0 μV 4.4 ppm + 40 μV 6.0 ppm + 120 μV	Outputs of instruments within these values can be measured to the listed uncertainties
DC CURRENT			
Generation	0 μA to 330 μA 0.33 mA to 3.3 mA 3.3 mA to 33 mA 33 mA to 330 mA 330 mA to 3 A 3 A to 11 A 11 A to 20 A	100 ppm + 25 nA 41 ppm + 70 nA 49 ppm + 0.40 μA 56 ppm + 4.0 μA 170 ppm + 70 μA 290 ppm + 0.80 mA 710 ppm + 3.0 mA	These values can be generated for the calibration of measuring instruments
Measurement	0 μA to 120 μA 120 μA to 1.2 mA 1.2 mA to 12 mA 12 mA to 120 mA 120 mA to 1 A	13 ppm + 1.7 nA 11 ppm + 7.0 nA 15 ppm + 70 nA 47 ppm + 800 nA 57 ppm + 14 μA	Outputs of instruments within these values can be measured to the listed uncertainties
DC RESISTANCE			
Generation			These values can be generated for the calibration of measuring instruments
Specific Values	1 mΩ 10 mΩ 100 mΩ 1 Ω	55 ppm 63 ppm 85 ppm 25 ppm	
Other values	0 Ω to 11 Ω 11 Ω to 110 Ω 110 Ω to 1.1 kΩ 1.1 kΩ to 11 kΩ 11 kΩ to 110 kΩ 110 kΩ to 1.1 MΩ 1.1 MΩ to 11 MΩ 11 MΩ to 100 MΩ	72 ppm + 1.2 mΩ 173 ppm + 1.8 mΩ 22 ppm + 2.4 mΩ 20 ppm + 24 mΩ 17 ppm + 240 mΩ 59 ppm + 3.0 Ω 120 ppm + 59 Ω 950 ppm + 3.6 kΩ	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
ELECTRICAL CALIBRATION (cont'd)			
DC RESISTANCE (cont'd)			
Measurement	0 mΩ to 1 mΩ 1 mΩ to 10 mΩ 10 mΩ to 100 mΩ 100 mΩ to 1 Ω 1 Ω to 12 Ω 12 Ω to 120 Ω 120 Ω to 1.2 kΩ 1.2 kΩ to 12 kΩ 12 kΩ to 120 kΩ 120 kΩ to 1.2 MΩ 1.2 MΩ to 12 MΩ 12 MΩ to 120 MΩ 120 MΩ to 1 GΩ	210 ppm + 1.6 μΩ 210 ppm + 1.8 μΩ 230 ppm + 10 μΩ 70 ppm + 50 μΩ 9.0 ppm + 70 μΩ 5.0 ppm + 700 μΩ 8.0 ppm + 1.2 mΩ 3.0 ppm + 13 mΩ 5.0 ppm + 120 mΩ 11 ppm + 3.3 Ω 31 ppm + 130 Ω 120 ppm + 1.3 kΩ 600 ppm + 13 kΩ	Outputs of instruments within these values can be measured to the listed uncertainties
AC VOLTAGE			
Generation	*45 Hz to 20 kHz* 33 mV to 330 mV 330 mV to 3.3 V 3.3 V to 33 V 33 V to 330 V *20 kHz to 100 kHz* 33 mV to 330 mV 330 mV to 3.3 V 3.3 V to 33 V *45 Hz to 10 kHz* 330 V to 1000 V *500 kHz* 300 mV 3 V	 0.0090 % + 10 μV 0.0060 % + 71 μV 0.012 % + 0.72 mV 0.025 % + 7.2 mV 0.030 % + 40 μV 0.041 % + 160 μV 0.043 % + 2.0 mV 0.015 % + 12 mV 0.093 % + 14 mV 0.14 %	These values can be generated for the calibration of measuring instruments
Measurement	*45 Hz to 20 kHz* 12 mV to 120 mV *20 Hz to 20 kHz* 120 mV to 1.2 V *20 kHz to 100 kHz* 12 mV to 120 mV 120 mV to 1.2 V *20 Hz to 100 kHz* *1.2 V to 12 V* *12 V to 120 V* *50 Hz to 20 kHz* 120 V to 750 V	 0.011 % + 3.0 μV 0.011 % + 50 μV 0.011 % + 3.0 μV 0.011 % + 40 μV 0.044 % + 500 μV 0.044 % + 5.0 mV 0.045 % + 24 mV	Outputs of instruments within these values can be measured to the listed uncertainties

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
ELECTRICAL CALIBRATION (cont'd)			
AC CURRENT			
Generation	*33 µA to 330 µA*		These values can be generated for the calibration of measuring instruments
	20 Hz to 45 Hz	0.14 % + 0.12 µA	
	45 Hz to 1 kHz	0.080 % + 0.12 µA	
	1 kHz to 5 kHz	0.15 % + 0.18 µA	
	330 µA to 3.3 mA		
	20 Hz to 45 Hz	0.040 % + 0.18 µA	
	45 Hz to 1 kHz	0.031 % + 0.18 µA	
	1 kHz to 5 kHz	0.052 % + 0.24 µA	
	3.3 mA to 33 mA		
	20 Hz to 45 Hz	0.030 % + 2.4 µA	
	45 Hz to 1 kHz	0.022 % + 2.4 µA	
	1 kHz to 5 kHz	0.030 % + 2.4 µA	
	33 mA to 330 mA		
	20 Hz to 45 Hz	0.040 % + 24 µA	
	45 Hz to 1 kHz	0.030 % + 24 µA	
	1 kHz to 5 kHz	0.040 % + 60 µA	
	330 mA to 3 A		
	20 Hz to 45 Hz	0.050 % + 0.20 mA	
	45 Hz to 1 kHz	0.036 % + 0.12 mA	
	1 kHz to 5 kHz	0.16 % + 1.2 mA	
	3 A to 11 A		
	45 Hz	0.063 % + 2.4 mA	
	45 Hz to 1 kHz	0.090 % + 2.4 mA	
	1 kHz to 5 kHz	1.16 % + 2.4 mA	
	11 A to 20 A		
	45 Hz	0.070 % + 6.0 mA	
	45 Hz to 1 kHz	0.10 % + 6.0 mA	
	1 kHz to 5 kHz	1.06 % + 6.0 mA	
Measurement	*20Hz to 1 kHz*		Outputs of instruments within these values can be measured to the listed uncertainties
	10 µA to 120 µA	0.022 % + 35 nA	
	20 Hz to 5 kHz		
	120 µA to 1.2 mA	0.035 % + 0.24 µA	
	1.2 mA to 12 mA	0.041 % + 2.3 µA	
	12 mA to 120 mA	0.045 % + 23 µA	
	120 mA to 1 A	0.17 % + 240 µA	

Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks
ELECTRICAL CALIBRATION (cont'd)			
CAPACITANCE			
Generation	0.2 nF to 0.4 nF 0.4 nF to 1.1 nF 1.1 nF to 11 nF 11 nF to 110 nF 110 nF to 1.1 µF 1.1 µF to 11 µF 11 µF to 110 µF 110 µF to 1.1 mF	1.93 % + 12 pF 0.60 % + 12 pF 0.20 % + 12 pF 0.11 % + 120 pF 0.13 % + 1.2 nF 0.14 % + 12 nF 0.28 % + 120 nF 0.16 % + 1.2 µF	These values can be generated for the calibration of measuring instruments
FREQUENCY			
Generation	0.5 Hz to 10 Hz 10 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 100 kHz 100 kHz to 2 MHz	18 ppm + 6 µHz 2.6 ppm + 6 µHz 1.6 ppm + 6 µHz 1.0 ppm + 6 µHz 1.0 ppm + 6 µHz	May also be expressed as 1/ f for periodic time of repetitive events
Measurement	1 Hz to 40 Hz 40 Hz to 10 MHz	37 ppm 34 ppm	
RADIOMETRY			Calibration by comparison to reference standards
Responsivity of UV detectors at power levels 0.3 to 5 $mWcm^{-2}$	365 nm		
Detectors up to 25 mm		10 %	
Responsivity of uv detectors at power levels 0.3 to 2 $mWcm^{-2}$			
Detectors 25 mm to 40 mm		10 %	

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 %·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.