


Schedule of Accreditation

issued by

United Kingdom Accreditation Service

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

 <p>UKAS CALIBRATION 0509</p> <p>Accredited to ISO/IEC 17025:2005</p>	Ministry of Defence Issue No: 039 Issue date: 24 July 2018	
	Calibration Centre Bolkiah Garrison BB3510 Negara Brunei Darussalam	Contact: Mr Yussof Taha Tel: +673-2-386475 Fax: +673-2-380643 E-Mail: cal_lab@mindef.gov.bn
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 Centre Bolkiah Garrison BB3510 Negara Brunei Darussalam	Local contact Mr Lim Tiong Thai +673-2-386475	Laboratory
Electrical, DC and LF Electrical, RF and microwave Mass Torque Temperature Pressure Humidity Dimensional Force Volume		

Site activities performed away from the locations listed above:

Location details	Activity	Location code
The customers' site or premises 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 Lim Tiong Thai +673-2-386475	Customers' Sites
Mass Temperature		



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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
ELECTRICAL				
DC VOLTAGE	10 V Reference	0.60 ppm	This uncertainty can be realised with voltage standards within 20 ppm of the nominal voltage and only if they have their own temperature controlled enclosure of appropriate thermal stability	Laboratory
Decade Values	10 μ V, 100 μ V and 1 mV 10 mV 100 mV 1 V 10 V 100 V 1 kV	0.50 μ V 70 ppm 10 ppm 2.5 ppm 1.5 ppm 3.0 ppm 2.5 ppm	The stated CMCs are for values that lie within 0.5 % of those listed.	
Other values	0 mV to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1 kV	1.0 μ V 8.0 ppm 7.0 ppm 11 ppm 18 ppm		
DC RESISTANCE				
Specific values				
Generation	0.1 Ω 1 Ω 1.9 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 19 k Ω 100 k Ω 1 M Ω 10 M Ω 19 M Ω 100 M Ω	4.0 ppm 4.0 ppm 20 ppm 4.0 ppm 4.0 ppm 4.0 ppm 4.0 ppm 10 ppm 3.5 ppm 4.0 ppm 3.5 ppm 28 ppm 9.0 ppm		



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DC RESISTANCE (continued) Specific Values (continued) Measurement	0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω 1.9 Ω 19 k Ω 19 M Ω	7.0 ppm 5.5 ppm 5.5 ppm 5.0 ppm 5.0 ppm 5.0 ppm 5.0 ppm 6.0 ppm 12 ppm 20 ppm 12 ppm 8.0 ppm 30 ppm	The stated CMCs are for values that lie within 10 % of those listed.	Laboratory
Other values Current carrying resistors	0 m Ω to 1 m Ω 1 m Ω to 10 m Ω 10 m Ω to 100 m Ω	0.050 % + 0.70 $\mu\Omega$ 0.090 % + 3.0 $\mu\Omega$ 240 ppm + 30 $\mu\Omega$	At 5 A DC At 5 A DC At 1 A DC	
	0 Ω to 0.1 Ω 0.1 Ω to 1 Ω 1 Ω to 5 Ω 5 Ω to 12 Ω 12 Ω to 50 Ω 50 Ω to 120 Ω 120 Ω to 120 k Ω 120 k Ω to 500 k Ω 500 k Ω to 1.2 M Ω 1.2 M Ω to 5 M Ω 5 M Ω to 12 M Ω 12 M Ω to 120 M Ω 120 M Ω to 1 G Ω	60 $\mu\Omega$ 610 ppm 66 ppm 29 ppm 54 ppm 24 ppm 18 ppm 33 ppm 26 ppm 130 ppm 86 ppm 830 ppm 0.90 %		
DC CURRENT	0 μ A to 1 μ A 1 μ A to 100 mA 100 mA to 10 A 10 A to 20 A	75 pA 65 ppm 60 ppm 110 ppm		



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Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty (k = 2)	Remarks	Location Code
AC VOLTAGE Specific values Specific frequencies	40 Hz, 1 kHz, 10 kHz, 20 kHz and 50 kHz 10 mV 20 mV 100 mV 200 mV 600 mV 1 V 2 V 6 V 10 V 20 V 60 V 100 V 200 V 1 kV 10 mV 100 Hz and 400 Hz 20 mV 500 Hz 100 mV 100 Hz and 400 Hz 200 mV and 600 mV 500 Hz 1 V 100 Hz and 400 Hz 2 V and 6 V 500 Hz 10 V 100 Hz and 400 Hz 20 V and 60 V 500 Hz 100 V 100 Hz and 400 Hz 200 V 500 Hz 1000 V 400 Hz and 500 Hz	210 ppm 170 ppm 90 ppm 90 ppm 90 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 65 ppm 75 ppm 210 ppm 170 ppm 90 ppm 90 ppm 65 ppm 65 ppm 65 ppm 65 ppm 75 ppm		Laboratory



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AC VOLTAGE Specific values (continued) Specific frequencies	2 mV to 10 mV 5 mV to 12 mV 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 12 mV to 50 mV 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.35 % 0.16 % 0.14 % 0.14 % 0.18 % 0.60 % 670 ppm 550 ppm 570 ppm 670 ppm 0.11 %		Laboratory



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AC VOLTAGE (continued) Other values (continued)	50 mV to 120 mV 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 120 mV to 500 mV 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 500 mV to 1.2 V 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 1.2 V to 5 V 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 5.0 V to 12 V 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 12 V to 50 V 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 50 V to 120 V 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	300 ppm 170 ppm 220 ppm 440 ppm 970 ppm 130 ppm 230 ppm 270 ppm 410 ppm 950 ppm 150 ppm 130 ppm 190 ppm 360 ppm 950 ppm 410 ppm 230 ppm 270 ppm 410 ppm 950 ppm 160 ppm 130 ppm 190 ppm 360 ppm 930 ppm 460 ppm 320 ppm 320 ppm 460 ppm 0.15 % 270 ppm 250 ppm 250 ppm 420 ppm 0.14 %		Laboratory



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Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$)	Remarks	Location Code
AC VOLTAGE (continued) Other values (continued)	120 V to 500 V 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz	620 ppm 810 ppm 0.15 %		Laboratory
	500 V to 1 kV 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz	590 ppm 790 ppm 0.15 %		
AC CURRENT	10 mA to 12 mA 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.25 % 0.11 % 0.060 %		
	12 mA to 50 mA 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.32 % 0.22 % 0.21 %		
	50 mA to 120 mA 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.26 % 0.11 % 0.070 %		
	120 mA to 500 mA 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.33 % 0.24 % 0.26 %		
	500 mA to 1 A 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.27 % 0.14 % 0.18 %		
	1 A to 10 A 40 Hz to 1 kHz	0.070 %		
	10 A to 20 A 40 Hz to 400 Hz	0.10 %		



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Measured Quantity Instrument or Gauge	Range	Calibration and Measurement Capability (CMC) Expressed as an Expanded Uncertainty ($k = 2$)	Remarks	Location Code
DISTORTION				Laboratory
Distortion Factor	0.1 % to 0.25 % 0.2 V to 0.5 V 0.5 V to 2 V 2 V to 300 V	0.083 % distortion factor 0.043 % distortion factor 0.023 % distortion factor	The capabilities for distortion factor relate to fundamental components in the frequency range 20 Hz to 100 kHz.	
	0.25 % to 0.4 % 0.2 V to 0.5 V 0.5 V to 2 V 2 V to 300 V	0.068 % distortion factor 0.068 % distortion factor 0.032 % distortion factor		
	0.4 % to 1.0 % 0.2 V to 0.5 V 0.5 V to 2 V 2 V to 300 V	0.17 % distortion factor 0.090 % distortion factor 0.080 % distortion factor		
	1.0 % to 100 % 0.2 V to 0.5 V 0.5 V to 2 V 2 V to 300 V	0.90 % distortion factor 0.80 % distortion factor 0.80 % distortion factor		
FREQUENCY				
Specific values	100 kHz 1 MHz 5 MHz 10 MHz	2.7 parts in 10^{11} 2.7 parts in 10^{11} 5.4 parts in 10^{12} 3.5 parts in 10^{12}		
Other Values	dc to 10 kHz 10 kHz to 1 MHz 1 MHz to 10 MHz 10 MHz to 100 MHz 100 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 15 GHz	26 μ Hz 160 μ Hz 1.6 mHz 16 mHz 160 mHz 1.6 Hz 3 in 10^{12}	Can be reported as elapsed time for repetitive events. 1/f	
RPM	10 RPM to 10 000 RPM 10 000 RPM to 100 000 RPM	0.10 RPM 0.60 RPM	Optical Tachometers and Mechanical Tachometer Calibrators.	
TIME INTERVAL				
Stopwatch calibration	10 s to 24 Hrs	40 ms	Manually Triggered	
RF POWER				
Signal sources	300 kHz to 4.2 GHz + 20 dBm to - 20 dBm	0.27 dB	The stated CMCs relate to the calibration of stable 50 Ω coaxial sources having an output VSWR of 1.01 or less and fitted with Type N connectors.	
	3 MHz to 1.3 GHz - 20 dBm to - 40 dBm	0.31 dB		
	- 40 dBm to - 80 dBm - 80 dBm to - 100 dBm	0.36 dB 0.38 dB		



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RF POWER (continued) Specific frequencies	2 MHz, 10 MHz, 15 MHz, 25 MHz, 30 MHz, 43 MHz, 50 MHz, 60 MHz, 88 MHz, 100 MHz, 125 MHz, 180 MHz, 200 MHz, 250 MHz, 350 MHz, 400 MHz and 500 MHz 1 W to 100 W	3.0 %	The uncertainties for RF attenuation and VRC refer to a 50Ω coaxial system using type N precision connectors	Laboratory
	550 MHz 600 MHz 650 MHz, 700 MHz, 750 MHz, 800 MHz, 850 MHz, 900 MHz, 950 MHz 1 GHz 1 W to 100 W	4.0 %		
RF ATTENUATION	0 dB, to 40 dB 50 MHz to 6 GHz	0.10 dB		
VOLTAGE REFLECTION COEFFICIENTSWR	1.0 to 1.20 to 0.1 50 MHz to 61 GHz 1 GHz to 3 GHz 3 GHz to 6 GHz	0.050 0.10 0.15		



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RF CALIBRATION FACTOR				
Substitution Method	100 kHz 300 kHz 500 kHz 1 MHz 3 MHz 5 MHz 10 MHz 30 MHz 100 MHz 300 MHz 500 MHz 1 GHz 1.5 GHz 2 GHz 2.6 GHz	2.2 % 1.9 % 1.9 % 1.9 % 1.8 % 1.8 % 1.8 % 1.8 % 1.8 % 1.8 % 1.8 % 1.8 % 1.8 % 1.9 % 1.9 % 2.1 %	Referenced to 1 mW at 50 MHz	Laboratory
Splitter method	100 kHz 100 kHz to 4.2 GHz 300 kHz 500 kHz 1 MHz 3 MHz 10 MHz 50 MHz 100 MHz 300 MHz 1 GHz 2 GHz 3 GHz 4.2 GHz	2.9 % 1.7 % 1.4 % 1.3 % 1.3 % 1.2 % 1.0 % 1.1 % 1.2 % 1.3 % 1.3 % 1.5 % 2.1 %	Referenced to 1 mW at 50 MHz	



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CAPACITANCE and DISSIPATION FACTOR					
Specific frequencies		C_p (pF)	D (tan δ)		
	1 pF 1 kHz to 100 kHz 1 MHz	0.0037 0.0043	0.0027 0.0029		
	10 pF 1 kHz to 100 kHz 1 MHz	0.0032 0.0011	0.00049 0.0012	For the calibration of standard four terminal pair capacitors. The CMCs quoted for dissipation factor apply to D values between zero and 0.002	
	100 pF 1 kHz to 100 kHz 1 MHz	0.030 0.056	0.00033 0.00049		
	1000 pF 1 kHz to 100 kHz 1 MHz	0.62 0.71	0.00035 0.00035		
OSCILLOSCOPE CALIBRATION					
TIME INTERVAL (Horizontal deflection coefficients)					Laboratory
	1 μ s	2.0 %			
	5 μ s	2.0 %			
	20 μ s	2.0 %			
	500 μ s	2.0 %			
	1 ms	2.0 %			
	5 ms	2.0 %			
	10 ms	2.0 %			
	50 ms	2.0 %			
	100 ms	2.1 %			
DC AMPLITUDE (Vertical deflection coefficients)					
	10 mV	1.3 %			
	20 mV	0.80 %			
	50 mV	0.62 %			
	100 mV	0.61 %			
	200 mV	0.80 %			
	500 mV	0.54 %			
	1 V	0.62 %			
	2 V	0.80 %			
	5 V	0.73 %			
	10 V	0.62 %			
RISETIME	1 ns to 10 ns	210 ps		Nominal 25 mV	
	1 ns to 10 ns	200 ps		Nominal 250 mV	
	1 ns to 10 ns	200 ps		Nominal 1 V	
BANDWIDTH	50 kHz to 300 MHz	3.1 % 5.0 %		Digital Oscilloscopes Analogue Oscilloscopes	



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MASS	Nominal value (g)	(mg)		
Artefacts	26 000	20	E2 from 200 µg to 26 kg	Laboratory
	25 000	20		
	20 000	10		
	10 000	10		
	5 000	3.0		
	2 000	2.0		
	1 000	0.50		
	500	0.25		
	200	0.10		
	100	0.050		
	50	0.033		
	20	0.025		
	10	0.020		
	5	0.017		
	2	0.012		
	1	0.010		
	Non-Automatic Weighing Machines	0.5		
0.2		0.0065		
0.1		0.0086		
0.05		0.0070		
0.02		0.0040		
0.01		0.0027		
0.005		0.0049		
0.002		0.0020		
0.001		0.0020		
Non-Automatic Weighing Machines		5g	0.023 mg	Weights are available in OIML Class
	10g	0.032 mg		
	20 g	0.044 mg		
	50 g	0.073 mg		
	100 g	0.13 mg		
	200 g	0.27 mg		
	500 g	0.69 mg		
	1 kg	1.3 mg		
	2 kg	3.8 mg		
	5 kg	9.6 mg		
	10 kg	19 mg		
	20 kg	306 mg		
	50 kg	770 mg		
Non-Automatic Weighing Machines	100 kg	1.7 g	Other loads within the overall listed range may also be used	Laboratory & Customers' Sites
	200 kg	5.2 g		
	250 kg	5.6 g		
	500 kg	8.9 g		



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TORQUE				
Hand torque tools	To BS EN ISO 6789:2003 (withdrawn) 1356 N·m to 6780 N·m 680 N·m to 1356 N·m 340 N·m to 680 N·m 135 N·m to 340 N·m 56 N·m to 135 N·m 3 N·m to 56 N·m	50 N·m 18 N·m 5.0 N·m 2.5 N·m 1.0 N·m 0.40 N·m		Laboratory
Torque measuring devices	To BS 7882:2008 400 N·m to 6780 N·m	0.085 %	In clockwise and/or anticlockwise direction in increasing torque only.	
TEMPERATURE				
Temperature indicators with sensors	-30 °C to 0 °C 0 °C 0 °C to 80 °C 80 °C to 300 °C	0.090 °C 0.065 0.080 °C 0.055 °C		Laboratory
Liquid in glass thermometers	0 °C 80 °C to 90 °C 90 °C to 250 °C	0.16 °C 0.32 °C 0.094 °C		
Calibration of temperature probes in air	0 °C to 70 °C	0.20 °C		
Temperature controlled, chambers, environmental cabinets and ovens and similar apparatus	25 °C to 50 °C 50 °C to 200 °C	1.2 °C 1.4 °C		Site
RELATIVE HUMIDITY				
Hygrometers	35 %rh 50 %rh 80 %rh	1.2 %rh 1.2 %rh 1.3 %rh	For the temperature range 15 °C to 30 °C	Laboratory



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<p>LENGTH</p> <p>Measuring Instruments and Machines</p> <p>Micrometers</p> <p>External</p>	As BS 870:2008 2 micrometres to 25 mm	2.0 micrometres between any two points		Laboratory
<p>PRESSURE</p> <p><u>Hydraulic Pressure (Gauge)</u></p> <p>"Pressure equivalent" calibration of dead weight testers.</p>	500 kPa to 140 MPa	0.0060 % + 30 Pa		
<p>Calibration of pressure indicating instruments and gauges</p> <p><u>Pneumatic Pressure (Gauge)</u></p>	500 kPa to 140 MPa	0.0060 % + 30 Pa	Calibration of pressure measuring devices with an electrical output may be undertaken.	
<p>Calibration of pressure indicating instruments and gauges</p> <p><u>Pneumatic Pressure (Absolute)</u></p>	-95 kPa to -17 kPa 16 kPa to 621 kPa 621 kPa to 6.6 MPa	0.075 % + 40 Pa 0.0075 % 0.0060 %	Pressure measurements may be expressed in other units of pressure as required.	
<p>Calibration of pressure indicating instruments and gauges</p>	16 kPa to 621 kPa 621 kPa to 6.6 MPa	0.0075 % + 1.0 Pa 0.0060 % + 1.0 Pa		
<p>FORCE</p> <p>Calibration of force measuring devices e.g. load cells and load measuring rings but excluding proving devices. Compression only.</p>	.45 kN to 44.48 kN (1 000 lbf to 10 000 lbf)	0.31 %		
<p>VOLUME</p> <p>Measuring cylinders</p>	100 ml to 2 l 2 l to 20 l	0.18 ml 6.5 ml		
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, and an indication of how they are to be interpreted, are shown 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.