

# Schedule of Accreditation

issued by

## United Kingdom Accreditation Service

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

 <p><b>UKAS</b> CALIBRATION</p> <p>4688</p> <p>Accredited to ISO/IEC 17025:2005</p>	<b>Instrument Repairs and Calibration</b> <b>A trading company of IRC Limited</b>	
	<b>Issue No: 011    Issue date: 04 October 2017</b>	
<b>Unit 7</b> <b>Howard Court Industrial Estate</b> <b>East Kilbride</b> <b>Glasgow</b> <b>G74 4QZ</b>	<b>Contact: Mr Craig Moore</b> <b>Tel: +44 (0)1355 264120</b> <b>Fax: +44 (0)1355 264150</b> <b>E-Mail: service@instrument-repairs.com</b> <b>Website: www.instrument-repairs.com</b>	
<b>Calibration performed by the Organisation at the locations specified</b>		

### Locations covered by the organisation and their relevant activities

#### Laboratory locations:

Location details	Activity	Location code
<p><b>Address</b></p> <p>Unit 7 Howard Court Industrial Estate East Kilbride Glasgow G74 4QZ</p> <p><b>Local contact</b></p> <p>Contact: Mr Craig Moore Tel: +44 (0)1355 264120 E-Mail: service@instrument-repairs.com Website: www.instrument-repairs.com</p>	<p>Head Office Permanent Laboratory Electrical Dimensional</p>	<p>East Kilbride</p>
<p><b>Address</b></p> <p>Unit 40 Mallusk Enterprise Park 2 Mallusk Drive Newtownabbey BT36 4GN United Kingdom</p> <p><b>Local contact</b></p> <p>Contact: Mr Frank Silo Tel: +44 (0)2890 837300 E-Mail: Belfast@instrument-repairs.com Website: www.instrument-repairs.com</p>	<p>Permanent Laboratory Electrical</p>	<p>Belfast and site calibration</p>

#### Site activities performed away from the locations listed above:

Location details	Activity	Location code
<p>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.</p> <p><b>Local contact</b></p> <p>Contact: Mr Craig Moore Tel: +44 (0)1355 264120</p> <p>Contact: Mr Frank Silo Tel: +44 (0)2890 837300</p>	<p>Site Dimensional Site Electrical</p>	<p>East Kilbride and site calibration</p> <p>Belfast and site calibration</p>



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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 CALIBRATION				
DC Voltage Measurement	0 V to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1000 V	12 ppm + 0.50 $\mu$ V 10 ppm + 1.1 $\mu$ V 11 ppm + 10 $\mu$ V 12 ppm + 110 $\mu$ V 12 ppm + 1.1 mV		East Kilbride
Generation	1 kV to 40 kV 40 kV to 60 kV	0.24 % 0.66 kV		
DC Current Measurement	0 mV to 30 mV 30 to 300 mV 300 mV to 3 V 3 V to 30 V 30 V to 300 V 300 V to 1000 V	70 ppm + 3.6 $\mu$ V 70 ppm + 4.6 $\mu$ V 58 ppm + 16 $\mu$ V 58 ppm + 190 $\mu$ V 64 ppm + 2.5 mV 64 ppm + 8.3 V		
Generation	1 kV to 40 kV 40 kV to 60 kV	0.24 % 0.66 kV		
DC Current Measurement	0 $\mu$ A to 1 $\mu$ A 1 $\mu$ A to 10 $\mu$ A 10 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A 1 A to 10 A 10 A to 60 A 60 A to 300A	63 ppm + 54 pA 25 ppm + 71 pA 25 ppm + 0.42 nA 25 ppm + 7.0 nA 25 ppm + 70 nA 42 ppm + 0.70 $\mu$ A 130 ppm + 19 $\mu$ A 0.10 % 0.20 % 0.61%		
Generation	0 $\mu$ A to 3 mA 3 mA to 30 mA 30 mA to 300 mA 300 mA to 2 A 2 A to 10 A 10 A to 60 A	150 ppm + 95 nA 120 ppm + 0.82 $\mu$ A 120 ppm + 8.5 $\mu$ A 350 ppm + 110 $\mu$ A 700 ppm + 0.90 mA 0.20 %		
	60 A to 550 A 550 A to 1025 A	0.50 % 1.0 %	Appropriate for the calibration of clamp-on ammeters	



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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
DC Resistance Measurement	0 $\Omega$ to 10 $\Omega$ 10 $\Omega$ to 100 $\Omega$ 100 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 10 k $\Omega$ 10 k $\Omega$ to 100 k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ 1 M $\Omega$ to 10 M $\Omega$ 10 M $\Omega$ to 100 M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$	19 ppm + 58 $\mu\Omega$ 15 ppm + 0.60 m $\Omega$ 13 ppm + 0.60 m $\Omega$ 16 ppm + 6.0 m $\Omega$ 13 ppm + 58 m $\Omega$ 20 ppm + 3.0 $\Omega$ 61 ppm + 120 $\Omega$ 700 ppm + 1.2 k $\Omega$ 0.65 % + 12 k $\Omega$		East Kilbride
Generation Specific Values	100 $\mu\Omega$ 1 m $\Omega$ 10 m $\Omega$ 100 m $\Omega$ 0.25 $\Omega$ 0.3 $\Omega$ 0.4 $\Omega$ 0.5 $\Omega$ 0.6 $\Omega$ 0.7 $\Omega$ 0.8 $\Omega$ 0.9 $\Omega$ 1 $\Omega$ 2 $\Omega$ 4 $\Omega$ 6 $\Omega$ 8 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$ 100 M $\Omega$ 1 G $\Omega$ 10 G $\Omega$ 100 G $\Omega$ 1 T $\Omega$	170 n $\Omega$ 0.21 $\mu\Omega$ 4.0 $\mu\Omega$ 92 $\mu\Omega$ 7.3 m $\Omega$ 12 m $\Omega$ 26 m $\Omega$ 5.0 m $\Omega$ 15 m $\Omega$ 9.0 m $\Omega$ 8.0 m $\Omega$ 16 m $\Omega$ 72 $\mu\Omega$ 3.0 m $\Omega$ 3.0 m $\Omega$ 3.0 m $\Omega$ 3.0 m $\Omega$ 660 $\mu\Omega$ 7.0 m $\Omega$ 120 m $\Omega$ 1.2 $\Omega$ 12 $\Omega$ 1.0 k $\Omega$ 690 ppm 0.11 % 0.12 % 0.37 % 2.6 % 1.4 %		



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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
DC Resistance (continued) Generation (continued) Other values	0 $\Omega$ to 10 $\Omega$ 10 $\Omega$ to 30 $\Omega$ 30 $\Omega$ to 100 $\Omega$ 100 $\Omega$ to 300 $\Omega$ 300 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 3 k $\Omega$ 3 k $\Omega$ to 10 k $\Omega$ 10 k $\Omega$ to 30 k $\Omega$ 30 k $\Omega$ to 100 k $\Omega$  100 k $\Omega$ to 300 k $\Omega$ 300 k $\Omega$ to 1 M $\Omega$ 1 M $\Omega$ to 3 M $\Omega$ 3 M $\Omega$ to 10 M $\Omega$ 10 M $\Omega$ to 30 M $\Omega$ 30 M $\Omega$ to 100 M $\Omega$ 100 M $\Omega$ to 300 M $\Omega$	140 ppm + 9.5 m $\Omega$ 140 ppm + 18 m $\Omega$ 100 ppm + 18 m $\Omega$ 100 ppm + 18 m $\Omega$ 100 ppm + 71 m $\Omega$ 100 ppm + 75 m $\Omega$ 100 ppm + 0.70 $\Omega$ 100 ppm + 0.75 $\Omega$ 130 ppm + 7.0 $\Omega$  140 ppm + 8.5 $\Omega$ 170 ppm + 67 $\Omega$ 170 ppm + 99 $\Omega$ 690 ppm + 700 $\Omega$ 0.12 % + 1.7 k $\Omega$ 0.58 % + 16 k $\Omega$ 0.58 % + 120 k $\Omega$	The CMCs shown are for 4-terminal measurements. The quoted uncertainty may be increased for 2- terminal measurements       2-terminal measurements	East Kilbride
AC Voltage Measurement	40 Hz to 1 kHz 1 mV to 10 mV 10 mV to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 700 V 700 V to 1000 V  1 kHz to 100 kHz 100 mV to 1 V 1 V to 10 V 10 V to 100 V  1 kHz to 20 kHz 100 V to 700 V  50 Hz 1 kV to 28 kV 28 kV to 50 kV	240 ppm + 1.5 $\mu$ V 82 ppm + 5.2 $\mu$ V 80 ppm + 46 $\mu$ V 81 ppm + 2.4 mV 230 ppm + 5.3 mV 500 ppm + 30 mV 0.13 % + 120 mV  930 ppm + 43 $\mu$ V 930 ppm + 0.40 mV 0.14 % + 5.0 mV  700 ppm + 30 mV  0.50 % 0.69 kV		



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AC Voltage (continued) Generation	<i>10 Hz to 45 Hz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>45 Hz to 1 kHz</i> 300 V to 1000 V  <i>1 kHz to 5 kHz</i> 300 V to 1000 V  <i>5 kHz to 10 kHz</i> 300 V to 1000 V  <i>45 Hz to 10 kHz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V 30 V to 300 V  <i>10 kHz to 20 kHz</i> 30 V to 300 V  <i>10 kHz to 100 kHz</i> 1 mV to 30 mV  <i>10 kHz to 50 kHz</i> 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>50 kHz to 100 kHz</i> 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>100 kHz to 500 kHz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V  <i>50 Hz</i> 1 kV to 28 kV 28 kV to 50 kV	0.40 % + 23 $\mu$ V 0.29 % + 59 $\mu$ V 0.17 % + 420 $\mu$ V 0.18 % + 3.2 mV  0.060 % + 98 mV  0.23 % + 32 mV  0.23 % + 32 mV  0.18 % + 23 $\mu$ V 0.060 % + 25 $\mu$ V 0.040 % + 110 $\mu$ V 0.050 % + 1.1 mV 0.10 % + 3.2 mV  0.10 % + 3.2 mV  0.40 % + 39 $\mu$ V  0.19 % + 47 $\mu$ V 0.16 % + 360 $\mu$ V 0.22 % + 5.9 mV  0.28 % + 200 $\mu$ V 0.28 % + 2.0 mV 0.28 % + 20 mV  1.2 % + 70 $\mu$ V 0.81 % + 380 $\mu$ V 0.63 % + 3.9 mV  0.50 % 0.69 kV		East Kilbride



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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 Current Measurement	<i>45 Hz to 1 kHz</i> 5 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A  <i>1 kHz to 5 kHz</i> 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A  <i>50 Hz</i> 1 A to 10 A 10 A to 100 A	700 ppm + 48 nA 700 ppm + 400 nA 700 ppm + 2.6 $\mu$ A 400 ppm + 26 $\mu$ A 0.12 % + 280 $\mu$ A  700 ppm + 2.6 $\mu$ A 400 ppm + 26 $\mu$ A 0.12 % + 24 mA  0.13 % 1.1 %		East Kilbride
Generation	<i>10 Hz to 5 kHz</i> 29 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA  <i>5 kHz to 10 kHz</i> 29 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10mA to 100 mA  <i>10 Hz to 1 kHz</i> 100 mA to 1 A  <i>1 k Hz to 5 kHz</i> 100 mA to 1 A  <i>45 Hz to 1 kHz</i> 1 A to 11 A  <i>50 Hz</i> 10 A to 100 A  <i>45 Hz to 1 kHz</i> 11 A to 16.5 A 16.5 A to 550 A 550 A to 1025 A	0.47 % + 200 nA 0.23 % + 380 nA 0.23 % + 3.8 $\mu$ A 0.24 % + 38 $\mu$ A  1.5 % + 210 nA 0.70 % + 450 nA 0.70 % + 5.8 $\mu$ A 0.70 % + 58 $\mu$ A  0.12 % + 390 $\mu$ A  0.87 % + 420 $\mu$ A  0.39 % + 4.7 mA  1.1 %  1.5 % 0.50 % 1.1 %	For the calibration of clamp-on ammeters	



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AC Power	45 Hz to 400 Hz 1 W to 11 kW	0.45 %	At unity power factor only	East Kilbride
AC phase angle	50 Hz 0° to 360°	0.28°	Voltage : Current Phase	
Tachometer calibration	600 rpm to 50000 rpm	0.60 rpm		
Inductance				
Generation	At 1 kHz: 100 μH 1 mH 10 mH 100 mH 1 H 10 H	2.6 μH 26 μH 380 μH 2.2 mH 22 mH 98 mH		
Capacitance				
Generation	At 5 kHz: 400 pF	13 pF		
	At 1 kHz: 1 nF 2 nF 3 nF 10 nF 20 nF 30 nF 100 nF 200 nF 300 nF 1 μF	17 pF 23 pF 29 pF 70 pF 180 pF 210 pF 420 pF 960 pF 1.3 nF 4.2 nF		
	At 100 Hz: 2 μF 3 μF 10 μF 20 μF 30 μF	11 nF 15 nF 53 nF 130 nF 180 nF		
	At 50 Hz: 100 μF 200 μF 300 μF	0.72 μF 2.0 μF 3.8 μF		



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<b>EQUIPMENT FOR IEE 17<sup>TH</sup> EDITION WIRING TESTING</b>					
<u>RCD Testers</u>					
Trip Time	20 ms to 390 ms 390 ms to 900 ms	0.90 ms 8.2 ms	Other, similar, equipment that includes the same quantities and ranges can also be calibrated.	East Kilbride	
Trip Current	<i>At 50 Hz:</i> 10 mA 30 mA 100 mA 300 mA 1 A 2 A	34 $\mu$ A 0.26 mA 0.17 mA 2.0 mA 3.3 mA 10 mA			For trip times < 200 ms
	<i>At 50 Hz:</i> 10 mA 30 mA 100 mA 300 mA 1 A 2 A	34 $\mu$ A 0.28 mA 0.17 mA 2.0 mA 3.3 mA 10 mA	For trip times > 200 ms		
<u>Loop Testers</u>					
AC Resistance	<i>At 50 Hz:</i> 0.05 $\Omega$ 0.1 $\Omega$ 0.22 $\Omega$ 0.33 $\Omega$ 0.5 $\Omega$ 1 $\Omega$ 5 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$	2.9 m $\Omega$ 1.5 m $\Omega$ 1.3 m $\Omega$ 3.5 m $\Omega$ 3.1 m $\Omega$ 4.0 m $\Omega$ 9.2 m $\Omega$ 25 m $\Omega$ 100 m $\Omega$ 140 m $\Omega$			
<u>Continuity Testers</u>					
DC Resistance	See <i>Specific Values</i> on Page 3.				
DC Continuity Current	10 mA to 100 mA 100 mA to 200 mA 200 mA to 300 mA	0.98 mA 0.65 mA 1.5 mA			





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<u>Insulation Testers</u>					
DC Resistance	See <i>Specific Values</i> on Page 4.				
DC Voltage	50 V 100 V 250 V 500 V 1000 V 1000 V to 10 kV	1.0 V 1.0 V 1.0 V 1.4 V 1.6 V See <i>DC Voltage</i> measurement capability on Page 2.			
<u>Portable Appliance Testers</u>					
Earth bond resistance	<i>At 50 Hz:</i> 40 mΩ 100 mΩ 200 mΩ 500 mΩ 1 Ω 5 Ω 10 Ω	2.6 mΩ 1.3 mΩ 2.0 mΩ 2.2 mΩ 1.8 mΩ 7.5 mΩ 35 mΩ		East Kilbride	
Earth bond current	<i>At 50 Hz:</i> 0 mA to 100 mA 100 mA to 300 mA 1 A to 30 A	4.7 mA 9.0 mA 420 mA			
Leakage current	<i>At 50 Hz:</i> 2 mA 4.7 mA 7.7 mA	15 μA 25 μA 59 μA			
Flash test	<i>At 50 Hz:</i> 1 kV to 7 kV	See <i>AC Voltage</i> measurement capability on Page 4.			
Load test	<i>At 50 Hz:</i> 3 kVA	2.0 %			
<b>OSCILLOSCOPE CALIBRATION</b>					
Vertical coefficients	5 mV to 50 V p-p	0.47 %			
Horizontal coefficients	2 ns to 1 μs 1 μs to 5 s	29 ppm 32 ppm			



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ELECTRICAL SIMULATION OF TEMPERATURE				
<u>Calibration of thermocouple indicators</u>				
Thermocouple type			Including cold junction compensation	East Kilbride
Type B	600 °C to 800 °C 800 °C to 1820 °C	1.1 °C 1.1 °C		
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 1000 °C to 1800 °C 1800 °C to 2316 °C	0.55 °C 0.58 °C 0.67 °C 0.76 °C 1.2 °C		
Type E	-250 °C to -100 °C -100 °C to +650 °C 650 °C to 1000 °C	0.59 °C 0.24 °C 0.29 °C		
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to +150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.36 °C 0.24 °C 0.22 °C 0.25 °C 0.32 °C		
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to +120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.41 °C 0.26 °C 0.24 °C 0.34 °C 0.49 °C		
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to +410 °C 410 °C to 1300 °C	0.53 °C 0.35 °C 0.32 °C 0.39 °C		
Type R	0 °C to 250 °C 250 °C to 1767 °C	1.2 °C 1.1 °C		
Type S	0 °C to 250 °C 250 °C to 1767 °C	1.2 °C 1.1 °C		
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.73 °C 0.31 °C 0.24 °C 0.22 °C		



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Calibration of RTD indicators	-200 °C to +800 °C	0.0031 °C		East Kilbride	
Temperature of reference junction / Cold junction compensation	At ambient temperature of 20 °C ± 3 °C, or nominal 0°C	0.030 °C			
DIMENSIONAL CALIBRATION					
RANGE IN MILLIMETRES AND UNCERTAINTY IN MICROMETRES UNLESS OTHERWISE STATED					
LENGTH				East Kilbride	
Plain plug gauges (parallel)	1 to 50 diameter 50 to 100 diameter 100 to 200 diameter 200 to 300 diameter	1.0 1.1 on diameter 1.6 1.8			
Length gauges, flat and spherical ended	25 to 1000	1 + (7.0 x length in m)			
Feeler gauges	BS 957:2008 0.025 to 1	1.0			
MEASURING INSTRUMENTS AND MACHINES					
Micrometers					
External	BS 870:2008 (and above) 0 to 1000	Heads:2.0 between any two points			
Internal	BS 959:2008 0 to 900	Setting and extension rods			
Depth	BS 6468:2008 0 to 300	1.0 + (7.0 x length in m)			
Vernier caliper, height and depth gauges	BS 887:2008 0 to 1000 BS 1643:2008 0 to 1000 BS 6365:2008 0 to 600	Overall performance 10 + (30 x length in m)			
Dial gauges and dial test indicators	BS 907:2008 and BS 2795:1981 0 to 50	1.0			



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FORM  Surface plates & tables Granite and Cast iron	BS 817:2008 (and above) 160 x 100 to 4000 x 4000	1.5 + (0.80 x diagonal in m)	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.	East Kilbride and site calibration
ELECTRICAL CALIBRATION  DC Voltage  Measurement	0 V to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1000 V 1 kV to 40 kV 40 kV to 60 kV	12 ppm + 0.50 $\mu$ V 10 ppm + 1.1 $\mu$ V 11 ppm + 10 $\mu$ V 12 ppm + 110 $\mu$ V 12 ppm + 1.1 mV 0.24 % 0.66 kV		Belfast and site calibration
Generation	0 mV to 30 mV 30 to 300 mV 300 mV to 3 V 3 V to 30 V 30 V to 300 V 300 V to 1000 V	70 ppm + 3.6 $\mu$ V 70 ppm + 4.6 $\mu$ V 58 ppm + 16 $\mu$ V 58 ppm + 190 $\mu$ V 64 ppm + 2.5 mV 64 ppm + 8.3 V		
DC Current  Measurement	1 kV to 40 kV 40 kV to 60 kV	0.24 % 0.66 kV		
Generation	0 $\mu$ A to 1 $\mu$ A 1 $\mu$ A to 10 $\mu$ A 10 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A 1 A to 60 A 60 A to 300A	63 ppm + 54 pA 25 ppm + 71 pA 25 ppm + 0.42 nA 25 ppm + 7.0 nA 25 ppm + 70 nA 42 ppm + 0.70 $\mu$ A 130 ppm + 19 $\mu$ A 0.20 % 0.61%		
	60 A to 550 A 550 A to 1025 A	0.50 % 1.0 %	Appropriate for the calibration of clamp-on ammeters	



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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
DC Resistance Measurement	0 $\Omega$ to 10 $\Omega$ 10 $\Omega$ to 100 $\Omega$ 100 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 10 k $\Omega$ 10 k $\Omega$ to 100 k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ 1 M $\Omega$ to 10 M $\Omega$ 10 M $\Omega$ to 100 M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$	19 ppm + 58 $\mu\Omega$ 15 ppm + 0.60 m $\Omega$ 13 ppm + 0.60 m $\Omega$ 16 ppm + 6.0 m $\Omega$ 13 ppm + 58 m $\Omega$ 20 ppm + 3.0 $\Omega$ 61 ppm + 120 $\Omega$ 700 ppm + 1.2 k $\Omega$ 0.65 % + 12 k $\Omega$		Belfast and site calibration
Generation Specific Values	100 $\mu\Omega$ 1 m $\Omega$ 10 m $\Omega$ 100 m $\Omega$ 0.25 $\Omega$ 0.3 $\Omega$ 0.4 $\Omega$ 0.5 $\Omega$ 0.6 $\Omega$ 0.7 $\Omega$ 0.8 $\Omega$ 0.9 $\Omega$ 1 $\Omega$ 2 $\Omega$ 4 $\Omega$ 6 $\Omega$ 8 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$ 100 M $\Omega$ 1 G $\Omega$ 10 G $\Omega$ 100 G $\Omega$ 1 T $\Omega$	170 n $\Omega$ 0.21 $\mu\Omega$ 4.0 $\mu\Omega$ 92 $\mu\Omega$ 64 m $\Omega$ 33 m $\Omega$ 34 m $\Omega$ 35 m $\Omega$ 36 m $\Omega$ 37 m $\Omega$ 39 m $\Omega$ 40 m $\Omega$ 75 $\mu\Omega$ 52 m $\Omega$ 75 m $\Omega$ 99 m $\Omega$ 120 m $\Omega$ 670 $\mu\Omega$ 7.0 m $\Omega$ 120 m $\Omega$ 1.2 $\Omega$ 12 $\Omega$ 1.6 % 0.060 % 0.15 % 0.13 % 0.40 % 2.7 % 1.7 %		



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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	
DC Resistance (continued) Generation (continued) Other values	0 $\Omega$ to 10 $\Omega$ 10 $\Omega$ to 30 $\Omega$ 30 $\Omega$ to 100 $\Omega$ 100 $\Omega$ to 300 $\Omega$ 300 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 3 k $\Omega$ 3 k $\Omega$ to 10 k $\Omega$ 10 k $\Omega$ to 30 k $\Omega$ 30 k $\Omega$ to 100 k $\Omega$	140 ppm + 9.5 m $\Omega$ 140 ppm + 18 m $\Omega$ 100 ppm + 18 m $\Omega$ 100 ppm + 18 m $\Omega$ 100 ppm + 71 m $\Omega$ 100 ppm + 75 m $\Omega$ 100 ppm + 0.70 $\Omega$ 100 ppm + 0.75 $\Omega$ 130 ppm + 7.0 $\Omega$	The CMCs shown are for 4-terminal measurements. The quoted uncertainty may be increased for 2-terminal measurements	Belfast and site calibration	
	100 k $\Omega$ to 300 k $\Omega$ 300 k $\Omega$ to 1 M $\Omega$ 1 M $\Omega$ to 3 M $\Omega$ 3 M $\Omega$ to 10 M $\Omega$ 10 M $\Omega$ to 30 M $\Omega$ 30 M $\Omega$ to 100 M $\Omega$ 100 M $\Omega$ to 300 M $\Omega$	140 ppm + 8.5 $\Omega$ 150 ppm + 67 $\Omega$ 150 ppm + 99 $\Omega$ 690 ppm + 700 $\Omega$ 0.12 % + 1.7 k $\Omega$ 0.58 % + 16 k $\Omega$ 0.58 % + 120 k $\Omega$			2-terminal measurements
AC Voltage Measurement	40 Hz to 1 kHz 1 mV to 10 mV 10 mV to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 700 V 700 V to 1000 V	240 ppm + 1.5 $\mu$ V 82 ppm + 5.2 $\mu$ V 80 ppm + 46 $\mu$ V 81 ppm + 2.4 mV 230 ppm + 5.3 mV 500 ppm + 30 mV 0.13 % + 120 mV			
	1 kHz to 100 kHz 100 mV to 1 V 1 V to 10 V 10 V to 100 V	930 ppm + 43 $\mu$ V 930 ppm + 0.40 mV 0.14 % + 5.0 mV			
	1 kHz to 20 kHz 100 V to 700 V	700 ppm + 30 mV			
	50 Hz 1 kV to 28 kV 28 kV to 50 kV	0.50 % 0.69 kV			



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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) Generation	<i>10 Hz to 45 Hz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>45 Hz to 1 kHz</i> 300 V to 1000 V  <i>1 kHz to 5 kHz</i> 300 V to 1000 V  <i>5 kHz to 10 kHz</i> 300 V to 1000 V  <i>45 Hz to 10 kHz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V 30 V to 300 V  <i>10 kHz to 20 kHz</i> 30 V to 300 V  <i>10 kHz to 100 kHz</i> 1 mV to 30 mV  <i>10 kHz to 50 kHz</i> 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>50 kHz to 100 kHz</i> 30 mV to 300 mV 300 mV to 3 V 3 V to 30 V  <i>100 kHz to 500 kHz</i> 1 mV to 30 mV 30 mV to 300 mV 300 mV to 3 V  <i>50 Hz</i> 1 kV to 28 kV 28 kV to 50 kV	0.40 % + 23 $\mu$ V 0.29 % + 59 $\mu$ V 0.17 % + 420 $\mu$ V 0.18 % + 3.2 mV  0.060 % + 98 mV  0.23 % + 32 mV  0.23 % + 32 mV  0.18 % + 23 $\mu$ V 0.060 % + 25 $\mu$ V 0.040 % + 110 $\mu$ V 0.050 % + 1.1 mV 0.10 % + 3.2 mV  0.10 % + 3.2 mV  0.40 % + 39 $\mu$ V  0.19 % + 47 $\mu$ V 0.16 % + 360 $\mu$ V 0.22 % + 5.9 mV  0.28 % + 200 $\mu$ V 0.28 % + 2.0 mV 0.28 % + 20 mV  1.2 % + 70 $\mu$ V 0.81 % + 380 $\mu$ V 0.63 % + 3.9 mV  0.50 % 0.69 kV		Belfast and site calibration



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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 Current Measurement	<i>45 Hz to 1 kHz</i> 5 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A  <i>1 kHz to 5 kHz</i> 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A  <i>50 Hz</i> 10 A to 100 A	700 ppm + 48 nA 700 ppm + 400 nA 700 ppm + 2.6 $\mu$ A 400 ppm + 26 $\mu$ A 0.12 % + 280 $\mu$ A  700 ppm + 2.6 $\mu$ A 400 ppm + 26 $\mu$ A 0.12 % + 24 mA  1.1 %		Belfast and site calibration
Generation	<i>10 Hz to 5 kHz</i> 29 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA  <i>5 kHz to 10 kHz</i> 29 $\mu$ A to 100 $\mu$ A 100 $\mu$ A to 1 mA 1 mA to 10 mA 10mA to 100 mA  <i>10 Hz to 1 kHz</i> 100 mA to 1 A  <i>1 k Hz to 5 kHz</i> 100 mA to 1 A  <i>45 Hz to 1 kHz</i> 1 A to 11 A  <i>50 Hz</i> 10 A to 100 A  <i>45 Hz to 1 kHz</i> 11 A to 16.5 A 16.5 A to 550 A 550 A to 1025 A	0.47 % + 200 nA 0.23 % + 380 nA 0.23 % + 3.8 $\mu$ A 0.24 % + 38 $\mu$ A  1.5 % + 210 nA 0.70 % + 450 nA 0.70 % + 5.8 $\mu$ A 0.70 % + 58 $\mu$ A  0.12 % + 390 $\mu$ A  0.87 % + 420 $\mu$ A  0.39 % + 4.7 mA  1.1 %  1.5 % 0.50 % 1.1 %	For the calibration of clamp-on ammeters	





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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 Power	45 Hz to 400 Hz 1 W to 11 kW	0.41 %	At unity power factor only	Belfast and site calibration
AC phase angle	50 Hz 0° to 360°	0.28°	Voltage : Current Phase	
Tachometer calibration	600 rpm to 50000 rpm	0.60 rpm		
Inductance				
Generation	At 1 kHz: 100 µH 1 mH 10 mH 100 mH 1 H 10 H	2.6 µH 26 µH 380 µH 2.2 mH 22 mH 98 mH		
Capacitance				
Generation	At 5 kHz: 400 pF	13 pF		
	At 1 kHz: 1 nF 2 nF 3 nF 10 nF 20 nF 30 nF 100 nF 200 nF 300 nF 1 µF	17 pF 23 pF 29 pF 70 pF 180 pF 210 pF 420 pF 960 pF 1.3 nF 4.2 nF		
	At 100 Hz: 2 µF 3 µF 10 µF 20 µF 30 µF	11 nF 15 nF 53 nF 130 nF 180 nF		
	At 50 Hz: 100 µF 200 µF 300 µF	0.72 µF 2.0 µF 3.8 µF		



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<b>EQUIPMENT FOR IEE 17<sup>TH</sup> EDITION WIRING TESTING</b>					
<u>RCD Testers</u>					
Trip Time	20 ms to 390 ms 390 ms to 900 ms	0.90 ms 8.2 ms	Other, similar, equipment that includes the same quantities and ranges can also be calibrated.	Belfast and site calibration	
Trip Current	<i>At 50 Hz:</i> 10 mA 30 mA 100 mA 300 mA 1 A 2 A	0.80 mA 2.0 mA 6.0 mA 20 mA 60 mA 120 mA			For trip times < 200 ms
	<i>At 50 Hz:</i> 10 mA 30 mA 100 mA 300 mA 1 A 2 A	0.80 mA 2.0 mA 6.0 mA 20 mA 60 mA 120 mA 0.80 mA	For trip times > 200 ms		
<u>Loop Testers</u>					
AC Resistance	<i>At 50 Hz:</i> 0.05 $\Omega$ 0.1 $\Omega$ 0.22 $\Omega$ 0.33 $\Omega$ 0.5 $\Omega$ 1 $\Omega$ 5 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$	5.0 m $\Omega$ 6.0 m $\Omega$ 6.0 m $\Omega$ 6.7 m $\Omega$ 7.7 m $\Omega$ 11 m $\Omega$ 34 m $\Omega$ 63 m $\Omega$ 600 m $\Omega$ 5.8 $\Omega$			
<u>Continuity Testers</u>					
DC Resistance	See <i>Specific Values</i> on Page 13.				
DC Continuity Current	10 mA to 100 mA 100 mA to 200 mA 200 mA to 300 mA	2.2 mA 4.0 mA 5.3 mA			



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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	
<u>Insulation Testers</u>					
DC Resistance	See <i>Specific Values</i> on Page 14.				
DC Voltage	50 V 100 V 250 V 500 V 1000 V 1000 V to 10 kV	1.8 V 2.3 V 3.1 V 6.8 V 13 V See <i>DC Voltage</i> measurement capability on Page 12.			
<u>Portable Appliance Testers</u>					
Earth bond resistance	<i>At 50 Hz:</i> 40 m $\Omega$ 100 m $\Omega$ 200 m $\Omega$ 500 m $\Omega$ 1 $\Omega$ 5 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$	5.0 m $\Omega$ 5.3 m $\Omega$ 6.0 m $\Omega$ 7.7 m $\Omega$ 11 m $\Omega$ 34 m $\Omega$ 63 m $\Omega$ 0.60 $\Omega$ 5.8 $\Omega$		Belfast and site calibration	
Earth bond current	<i>At 50 Hz:</i> 0 mA to 100 mA 100 mA to 300 mA 1 A to 30 A	4.7 mA 9.0 mA 420 mA			
Leakage current	<i>At 50 Hz:</i> 2 mA 4.7 mA 7.7 mA	15 $\mu$ A 25 $\mu$ A 59 $\mu$ A			
Flash test	<i>At 50 Hz:</i> 1 kV to 7 kV	See <i>AC Voltage</i> measurement capability on Page 4.			
Load test	<i>At 50 Hz:</i> 3 kVA	2.0 %			
<b>OSCILLOSCOPE CALIBRATION</b>					
Vertical coefficients	5 mV to 50 V p-p	0.47 %			
Horizontal coefficients	2 ns to 1 $\mu$ s 1 $\mu$ s to 5 s	29 ppm 32 ppm			



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ELECTRICAL SIMULATION OF TEMPERATURE				
<u>Calibration of thermocouple indicators</u>			Including cold junction compensation	
Thermocouple type				Belfast and site calibration
Type B	600 °C to 800 °C 800 °C to 1820 °C	1.1 °C 1.1 °C		
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 1000 °C to 1800 °C 1800 °C to 2316 °C	0.55 °C 0.58 °C 0.67 °C 0.76 °C 1.2 °C		
Type E	-250 °C to -100 °C -100 °C to +650 °C 650 °C to 1000 °C	0.59 °C 0.24 °C 0.29 °C		
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to +150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.36 °C 0.24 °C 0.22 °C 0.25 °C 0.32 °C		
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to +120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.41 °C 0.26 °C 0.24 °C 0.34 °C 0.49 °C		
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to +410 °C 410 °C to 1300 °C	0.53 °C 0.35 °C 0.32 °C 0.39 °C		
Type R	0 °C to 250 °C 250 °C to 1767 °C	1.2 °C 1.1 °C		
Type S	0 °C to 250 °C 250 °C to 1767 °C	1.2 °C 1.1 °C		
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.73 °C 0.31 °C 0.24 °C 0.22 °C		



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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
Calibration of RTD indicators  Temperature of reference junction / Cold junction compensation	-200 °C to +800 °C  At ambient temperature of 20 °C $\pm$ 3 °C, or nominal 0°C	0.0031 °C  0.030 °C		Belfast and site calibration
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  $\mu$ V:

Over the range 100 mV to 1 V, the CMC is 0.0025 %  $\cdot$  V + 5.0  $\mu$ 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 %  $\cdot$  p + (0.12  $\cdot$  10<sup>-6</sup>  $\cdot$  p  $\cdot$  10<sup>-6</sup>) + 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.