

# Schedule of Accreditation

issued by

## United Kingdom Accreditation Service

21 - 47 High Street, Feltham, Middlesex, TW13 4UN, UK



0050

Accredited to  
ISO/IEC 17025:2005

### Trescal Limited

Issue No: 045 Issue date: 08 December 2011

The Service Centre  
Watchmoor Point  
Camberley  
Surrey  
GU15 3AD

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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
<p><b>Address</b> The Service Centre Watchmoor Point Camberley Surrey GU15 3AD</p> <p><b>Local contact</b> Steve Bowler</p>	Electrical DC&LF and RF	Permanent

##### 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> Steve Bowler</p>	Electrical RF	Site



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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&LF DC RESISTANCE				Permanent
Specific values	0.1 $\Omega$ 1 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$	0.70 ppm 0.50 ppm 0.50 ppm 0.50 ppm 0.50 ppm 0.50 ppm 1.0 ppm 1.4 ppm 2.6 ppm	Specific values are those which fall within $\pm 0.1\%$ of the stated values  Resistors of modest dimensions suitable for oil immersion can be measured at other temperatures in the range 15 $^{\circ}\text{C}$ to 25 $^{\circ}\text{C}$	
Other values	100 m $\Omega$ to 1 $\Omega$ 1 $\Omega$ 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 $\Omega$  0 $\Omega$ to 10 m $\Omega$ 10 m $\Omega$ to 100 m $\Omega$  10 M $\Omega$ 100 M $\Omega$ 1 G $\Omega$ 10 G $\Omega$ 100 G $\Omega$ 1 T $\Omega$	0.25 ppm + 1.8 $\mu\Omega$ 0.25 ppm + 18 $\mu\Omega$ 0.25 ppm + 180 $\mu\Omega$ 0.25 ppm + 1.8 m $\Omega$ 0.25 ppm + 18 m $\Omega$ 0.25 ppm + 180 m $\Omega$ 1.0 ppm + 2.0 $\Omega$ 1.0 ppm + 20 $\Omega$  0.86 $\mu\Omega$ 86 ppm to 17 ppm  47 ppm 40 ppm 94 ppm 140 ppm 540 ppm 0.26 %	For current carrying resistors based on voltage and current measurements  The uncertainty values quoted are for resistors capable of operating at 1000 V DC. Measurements can be made at lower voltage but the uncertainty will be increased. Other values within the range can also be measured with increased uncertainty.	
DC VOLTAGE				Permanent
Standard cell value	1.018 V 1 V 10 V	0.40 $\mu\text{V}$ 0.80 $\mu\text{V}$ 2.7 $\mu\text{V}$	The CMC can be realised with electrochemical cells only if they have their own temperature-controlled enclosure of appropriate thermal stability. Oil-immersed cells can be measured at temperatures in the range 18 $^{\circ}\text{C}$ to 24 $^{\circ}\text{C}$ , but with increased uncertainties.	



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DC VOLTAGE (continued)				Permanent
Measurement				
Other values	0 mV to 10 mV 10 mV to 100 mV 100 mV to 190 mV 190 mV to 1.9 V 1.9 V to 19 V 19 V to 190 V 190 V to 1000 V 1.1 kV to 10 kV 10 kV to 60 kV	0.080 $\mu$ V 11 ppm + 0.10 $\mu$ V 2.0 ppm + 1.0 $\mu$ V 5.0 ppm + 1.0 $\mu$ V 5.0 ppm + 10 $\mu$ V 5.0 ppm + 100 $\mu$ V 5.0 ppm + 1.0 mV 250 ppm 0.36 %		
DC VOLTAGE RATIO				Permanent
0 to unity		$2.5 \times 10^{-7}$ of input	For near-integral ratios and input voltage up to 20 V	
DC CURRENT				Permanent
Specific values	1 nA 10 nA 100 nA 1 $\mu$ A 10 $\mu$ A 100 $\mu$ A 1 mA 10 mA 100 mA 1 A 10 A 20 A 30 A 40 A 50 A 60 A 70 A 80 A 90 A 100 A	0.20 pA 0.60 pA 5.0 pA 15 ppm 15 ppm 15 ppm 15 ppm 15 ppm 15 ppm 15 ppm 15 ppm 35 ppm 160 ppm 150 ppm 160 ppm 190 ppm 240 ppm 310 ppm 400 ppm 500 ppm 600 ppm		
Other values	1 nA to 10 nA 10 nA to 100 nA 100 nA 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	0.050 ppm + 350 nA 0.25 ppm + 1.0 pA 2.0 ppm + 10 pA 15 ppm + 30 pA 15 ppm + 300 pA 15 ppm + 3.0 nA 15 ppm + 30 nA 15 ppm + 3.0 $\mu$ A 15 ppm + 3.0 $\mu$ A 40 ppm + 10 $\mu$ A		



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AC VOLTAGE	1 mV 20 Hz, 30 Hz, 40 Hz, 50 Hz, 55 Hz, 60 Hz, 300 Hz, 400 Hz, 1 kHz, 10 kHz and 20 kHz 30 kHz 50 kHz 100 kHz  10 mV 20 Hz, 30 Hz, 40 Hz, 50 Hz, 55 Hz and 60 Hz 300 Hz, 400 Hz and 1 kHz 10 kHz 20 kHz 30 kHz 50 kHz 100 kHz  100 mV 20 Hz, 30 Hz, 40 Hz, 50 Hz, 55 Hz and 60 Hz 300 Hz and 400 Hz 1 kHz 10 kHz 20 kHz 30 kHz 50 kHz 100 kHz  1 V 10 Hz, 20 Hz and 30 Hz 40 Hz, 50 Hz, 55 Hz, 60 Hz, 300 Hz and 400 Hz 1 kHz, 10 kHz, 20 kHz, 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	0.25 % 0.26 % 0.27 % 0.36 %  330 ppm 320 ppm 320 ppm 330 ppm 340 ppm 380 ppm 540 ppm  140 ppm 110 ppm 110 ppm 120 ppm 140 ppm 200 ppm 240 ppm 390 ppm  38 ppm  27 ppm 35 ppm 35 ppm 70 ppm 120 ppm 370 ppm 0.10 %	Laboratory-generated supplies are limited to 500 V below 40 Hz.  Non decade voltages can also be measured but the uncertainties will be increased. The method used to calculate the uncertainties is described in the laboratory procedure.	Permanent



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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)	10 V 10 Hz, 20 Hz and 30 Hz 40 Hz, 50 Hz, 55 Hz, 60 Hz, 300 Hz and 400 Hz 1 kHz, 10 kHz and 20 kHz 30 kHz 50 kHz and 100 kHz 300 kHz 500 kHz 1 MHz  19 V 1 kHz  100 V 10 Hz, 20 Hz and 30 Hz 40 Hz, 50 Hz, 55 Hz and 60 Hz 300 Hz, 400 Hz, 1 kHz, 10 kHz and 20 kHz 30 kHz 50 kHz 100 kHz  700 V 50 kHz 100 kHz  1000 V 40 Hz, 50 Hz, 55 Hz, 60 Hz, 300 Hz, 400 Hz and 1 kHz 10 kHz and 20 kHz 30 kHz  1 kV to 7 kV 40 Hz to 1 kHz  7 kV to 40 kV 50 Hz	40 ppm  30 ppm 31 ppm 31 ppm 33 ppm 110 ppm 240 ppm 0.10 %  30 ppm  50 ppm 45 ppm  40 ppm 40 ppm 45 ppm 70 ppm  130 ppm 370 ppm  70 ppm 75 ppm 95 ppm  0.22 % to 0.13 %  0.40 %	Laboratory generated supplies are limited to 25 kV rms	Permanent



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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	<i>40 Hz to 10 kHz:</i> 0 mA to 100 mA 100 mA to 10 A  <i>50 Hz to 400 Hz:</i> 10 A to 25 A  <i>50 Hz:</i> 1 A to 70 A 70 A to 120 A	0.070 % + 5.0 $\mu$ A 0.090 %  0.080 %  0.045 % (0.027 + 0.0009 x ( $I - 50$ )) %, where $I$ is the current in amperes		Permanent
AC POWER At unity power factor	12.5 W to 12.5 kW <i>50 Hz to 400 Hz</i>	0.40 %	For voltage ranges 50 V, 100 V, 250 V and 500 V, and current ranges 0.5A, 1.0 A, 2.5 A, 5 A, 10 A and 25 A. Upper limit of input voltage is (0.25 $f_{Hz}$ ) V or 250 V, whichever is the smaller. Measurements are made at 23 °C.	Permanent
AC POWER FACTOR	<i>1 kHz:</i> 0 to 0.6 0.6 to 0.9 0.9 to 1.0	0.0090 0.0050 0.000050	Measurements can be made down to 40 Hz but the uncertainty will be increased	Permanent
PHASE ANGLE Generation (sine or square waveform)	0° to 360° <i>40 Hz to 10 kHz</i>	0.080°	The CMC relates to the calibration of a phase meter of suitable resolution and with equal input levels up to 3.5V rms. Increased uncertainties will apply for voltage ratios other than 1:1, and input levels between 3.5V rms and 180V rms.	Permanent



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PHASE ANGLE (continued) Measurement (sine or square waveform)	0° to 360° 40 Hz to 10 kHz	0.10°	Uncertainties relate to the calibration of a variable phase generator having equal amplitudes between 100 mV rms and 7V rms. Increased uncertainties will apply for voltage ratios other than 1:1 and input levels between 7V rms and 250V rms.	Permanent
INDUCTANCE Specific values	400 Hz to 2 kHz: 1 μH 3 μH 10 μH 100 μH 1 mH 10 mH 100 mH 1 H	5.0 nH 5.0 nH 5.0 nH 20 nH 0.016 % 0.016 % 0.016 % 0.016 %	Inductance measurements can also be made from near 50 Hz to 400 Hz but with increased uncertainties.	Permanent
Other values	400 Hz to 1 kHz: 10 H  400 Hz to 2 kHz: 0 μH to 10 μH 10 μH to 100 μH 100 μH to 1 H	0.016 %  10 nH 10 nH to 20 nH 0.040 % to 0.016 %	Inductance measurements can also be made from near 50 Hz to 400 Hz but with increased uncertainties.	
AC RESISTANCE	400 Hz to 1 kHz: 1 H to 10 H  1 mΩ to 100 mΩ 40 Hz to 1 kHz 1 kHz to 5 kHz  100mΩ to 1 Ω 40 Hz to 10 kHz  1 Ω to 10 Ω 40 Hz to 10 kHz  10 Ω to 100 Ω 40 Hz to 10 kHz  1 kΩ to 10 Ω 40 Hz to 10 kHz	0.016 %  0.13 % 0.25 %  70 ppm  20 ppm  20 ppm  25 ppm	For calibration of 4 terminal resistors. 2 terminal resistors can be calibrated with increased uncertainties.	Permanent



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CAPACITANCE LOSS Dissipation Factor ( $\tan \delta$ )	0.0001 to 0.01 <i>For capacitance values up to 1 <math>\mu F</math> at 1 kHz</i>	0.000030	Measurements can be made from 50 Hz to 2 kHz but the uncertainty will be increased.	Permanent
	0.01 to 0.1 <i>For capacitance values up to 0.1 <math>\mu F</math> at 1 kHz</i>	0.080 %		
	<i>For capacitance values between 0.1 <math>\mu F</math> and 1 <math>\mu F</math> at 1 kHz</i>	0.090 %		
	0.1 to 1 <i>For capacitance values up to 0.1 <math>\mu F</math> at 1 kHz</i>	0.070 %		
	<i>For capacitance values between 0.1 <math>\mu F</math> and 1 <math>\mu F</math> at 1 kHz</i>	0.070 %		
CAPACITANCE Three-terminal	<i>1 kHz:</i> 0 pF to 1 pF 1 pF to 10 pF 10 pF to 100 pF 100 pF to 1 nF 1 nF to 100 nF 100 nF to 1 $\mu F$	0.0002 pF 20 ppm 10 ppm 10 ppm 59 ppm 59 ppm	Capacitors up to 1 $\mu F$ can also be measured over the frequency range 45 Hz to 2 kHz with increased uncertainties which vary in a complex manner with capacitance and frequency.	Permanent
	<i>800 Hz to 2 kHz:</i> 0 pF to 100 pF 100 pF to 1 nF 1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 $\mu F$	0.020 pF 25 ppm 59 ppm 59 ppm 59 ppm		



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CAPACITANCE (continued) Two-terminal	1 kHz: 1 $\mu$ F to 10 $\mu$ F 10 $\mu$ F to 111 $\mu$ F	0.010 % 0.030 %	Capacitors from 1 $\mu$ F to 111 $\mu$ F can also be measured over the frequency range 45 Hz to 2 kHz with increased uncertainties which vary in a complex manner with capacitance and frequency.	Permanent
<b>DC/LF AUTOMATED CALIBRATION SYSTEM</b>				
DC VOLTAGE Measurement	100 mV 1 V 10 V 19 V 100 V 1000 V	5.2 ppm 4.1 ppm 3.7 ppm 3.9 ppm 4.3 ppm 4.6 ppm		Permanent
Generation	100 mV 1 V 10 V 19 V 100 V 1000 V	6.1 ppm 4.7 ppm 4.3 ppm 4.4 ppm 4.8 ppm 5.2 ppm		
DC VOLTAGE LINEARITY Generation	0 V to 190 mV 190 mV to 1.9 V 1.9 V to 19 V 19 V to 190 V 190 V to 1000 V	7.0 ppm + 0.50 $\mu$ V 5.0 ppm + 0.50 $\mu$ V 5.0 ppm + 1.0 $\mu$ V 6.0 ppm + 15 $\mu$ V 7.0 ppm + 150 $\mu$ V		Permanent
DC CURRENT Measurement	100 $\mu$ A 1 mA 10 mA 100 mA 1 A 10 A	31 ppm 26 ppm 26 ppm 28 ppm 34 ppm 60 ppm		Permanent



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DC CURRENT (continued)				Permanent
Generation	100 $\mu$ A 1 mA 10 mA 100 mA 1 A 10 A	56 ppm 33 ppm 33 ppm 35 ppm 58 ppm 90 ppm		
DC RESISTANCE				Permanent
Measurement	10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$ 100 M $\Omega$	8.7 ppm 6.8 ppm 4.9 ppm 4.8 ppm 6.7 ppm 12 ppm 22 ppm 97 ppm		
Generation	10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$	9.6 ppm 7.1 ppm 5.4 ppm 5.3 ppm 7.1 ppm 13 ppm 24 ppm		
AC VOLTAGE				Permanent
Measurement	1 mV 20 Hz, 30Hz, 40 Hz, 55 Hz, 300 Hz, 1 kHz, 10 kHz and 20 kHz 30 kHz 50 kHz 100 kHz	0.25 % 0.26 % 0.27 % 0.36 %		
	10 mV 20 Hz, 30 Hz, 40 Hz and 55 Hz 300 Hz and 1 kHz 10 kHz 20 kHz 30 kHz and 50 kHz 100 kHz	330 ppm 320 ppm 330 ppm 340 ppm 380 ppm 540 ppm		



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AC VOLTAGE (continued) Measurement	100 mV 20 Hz, 30 Hz, 40 Hz, and 55 Hz 300 Hz and 1kHz 10 kHz 20 kHz 30 kHz 50 kHz 100 kHz  1V 10 Hz, 20 Hz, and 30 Hz 40 Hz, 55 Hz, 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz 300 kHz 500kHz 1 MHz  10 V 10 Hz, 20 Hz, and 30 Hz 40 Hz, 55 Hz, 300 Hz, 1 kHz 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz  19 V 1 kHz  100 V 10 Hz, 20 Hz and 30 Hz 40 Hz and 55 Hz 300 Hz, 1 kHz, 10 kHz and 20 kHz 30 kHz 50 kHz 100 kHz  700 V 50 kHz 100 kHz	140 ppm 110 ppm 120 ppm 140 ppm 200 ppm 240 ppm 390 ppm  38 ppm  27 ppm 35 ppm 70 ppm 120 ppm 370 ppm 0.10 %  40 ppm 30 ppm 31 ppm 33 ppm 33 ppm 110 ppm 240 ppm 0.10 %  30 ppm  50 ppm 45 ppm 40 ppm 40 ppm 45 ppm 70 ppm  130 ppm 370 ppm		Permanent



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AC VOLTAGE (continued) Measurement	1000 V 40 Hz, 55 Hz, 300 Hz, 1 kHz 10 kHz 20 kHz 30 kHz	70 ppm 75 ppm 75 ppm 95 ppm		Permanent
	1 mV 20 Hz, 30 Hz 40 Hz, 55 Hz, 300 Hz, 1 kHz and 10 kHz 20 kHz, 30 kHz 50 kHz 100 kHz	0.28 % 0.27 % 0.28 % 0.29 % 0.37 %		
AC VOLTAGE Generation	10 mV 20 Hz and 30 Hz 40 Hz, 55 Hz and 10kHz 300 Hz and 1 kHz 20 kHz 30 kHz and 50 kHz 100 kHz	360 ppm 350 ppm 340 ppm 360 ppm 400 ppm 550 ppm		Permanent
	100 mV 20 Hz, 30 Hz, 40 Hz and 55 Hz 300 Hz and 1 kHz 10 kHz 20 kHz 30 kHz 50 kHz 100 kHz	140 ppm 110 ppm 130 ppm 140 ppm 210 ppm 240 ppm 390 ppm		
	1 V 10 Hz, 20 Hz and 30 Hz 40 Hz and 55 Hz 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz	45 ppm 28 ppm 27 ppm 37 ppm 71 ppm 130 ppm 460 ppm 0.11 %		



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AC VOLTAGE (continued)	10 V 10 Hz, 20 Hz, 30 Hz 40 Hz, 55 Hz, 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz  19 V 1 kHz  100 V 10 Hz, 20 Hz and 30 Hz 40 Hz and 55 Hz 300 Hz, 1 kHz, 10 kHz, 20 kHz and 30 kHz 50 kHz 100 kHz  700 V 50 kHz 100 kHz  1000 V 40 Hz, 55 Hz and 300 Hz 1 kHz 10 kHz, 20 kHz 30 kHz	47 ppm 31 ppm 34 ppm 35 ppm 52 ppm 280 ppm 350 ppm 0.10 %  31 ppm  55 ppm 45 ppm 40 ppm 50 ppm 110 ppm  140 ppm 370 ppm  80 ppm 75 ppm 85 ppm 110 ppm		Permanent
AC VOLTAGE LINEARITY Generation	0 mV to 190 mV 190 mV to 1.9 V 1.9 V to 19 V 19 V to 190 V 190 V to 1000 V	115 ppm + 5.0 μV 30 ppm + 5.0 μV 35 ppm + 50 μV 45 ppm + 300 μV 80 ppm + 3.0 mV		Permanent



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AC CURRENT Measurement	100 $\mu$ A 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	150 ppm 140 ppm 120 ppm 190 ppm		Permanent
	1 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	140 ppm 130 ppm 110 ppm 150 ppm		
	10 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	140 ppm 130 ppm 110 ppm 140 ppm		
	100 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	130 ppm 110 ppm 90 ppm 130 ppm		
	1 A 10 Hz, 20 Hz and 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	210 ppm 170 ppm 520 ppm		
	10 A 10 Hz, 20 Hz and 30 Hz 40 Hz 55 Hz, 300 Hz and 1 kHz 5 kHz 10 kHz	310 ppm 290 ppm 280 ppm 370 ppm 700 ppm		
Generation	100 $\mu$ A 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz 1 kHz 5 kHz	150 ppm 140 ppm 130 ppm 140 ppm 200 ppm		



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AC CURRENT (continued)				Permanent
Generation	1 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz and 300 Hz 1 kHz 5 kHz	140 ppm 130 ppm 110 ppm 120 ppm 150 ppm		
	10 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz and 300 Hz 1 kHz 5 kHz	140 ppm 130 ppm 110 ppm 120 ppm 150 ppm		
	100 mA 10 Hz and 20 Hz 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	130 ppm 110 ppm 95 ppm 130 ppm		
	1 A 10 Hz, 20 Hz and 30 Hz 40 Hz, 55 Hz, 300 Hz and 1 kHz 5 kHz	210 ppm 170 ppm 520 ppm		
	10 A 10 Hz, 20 Hz and 30 Hz 40 Hz 55 Hz, 300 Hz 1 kHz 5 kHz 10 kHz	320 ppm 300 ppm 290 ppm 300 ppm 520 ppm 790 ppm		
FREQUENCY				Permanent and site
Measurement	300 Hz 1 MHz	10 ppm 15 ppm	Suitable for measurement of calibrator outputs using a multifunction transfer standard.	
Generation	300 Hz 1 MHz	7.0 ppm 7.0 ppm		
Specific values	100 kHz, 1 MHz, 5 MHz and 10 MHz	6 in $10^{12}$	The uncertainty may be increased where there is a significant offset in frequency from the stated values.	



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FREQUENCY (continued)  Other values	1 Hz to 10 Hz 10 Hz to 100 Hz 100 Hz to 1 MHz 1 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 20 GHz 20 GHz to 40 GHz	3.5 in $10^5$ 3.5 in $10^6$ 3.5 in $10^7$ 3.5 in $10^8$ 3.5 in $10^9$ 2.4 in $10^9$ 8.1 in $10^{11}$	Frequencies below 1 Hz may also be reported in terms of the equivalent average periodic time.	Permanent And site
TIME INTERVAL	1 $\mu$ s to 1 s 1 s to $10^5$ s	3.0 ns 1.2 in $10^8$	For time intervals other than those described in NPL test leaflets TH42B to TH42F.	
Time of day watches	24 h	0.10 s	In accordance with NPL test leaflet TH42B.	
Mechanical stop-watches and non- time-of-day chronograph watches	1 min to 60 min	0.010 s	In accordance with NPL test leaflets TH42C, TH42E (stop-watches used under the Electricity Supply (Meters) Act, 1936).	
Quartz crystal controlled digital timers	1 min to 360 min	0.020 s	In accordance with NPL test leaflet TH42F (includes stop-watches used under the Electricity Supply (Meters) Act 1936). The uncertainty may be increased for longer time intervals.	
Marine and surveying chronometers (2-day and 8-day)	24 h	0.10 s	In accordance with NPL test leaflet TH42D	
RISETIME	50 ps to 2 ns nom 200 mV peak 2 ns to 10 ms	16 ps 5.0 %		Permanent And site
Bandwidth	100 kHz to 5 GHz 5 GHz to 18 GHz	1.4 % 2.1 %	The uncertainty quoted on a Calibration certificate will be in terms of frequency and will be Based on the relationship Between level and frequency At the -3 dB point for the System under 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					
ELECTRICAL: RF VSWR	1.0 to 1.2 <i>0.30 GHz to 3.0 GHz</i>  1.0 to 1.2 <i>3.0 GHz to 8.25 GHz</i>  1.2 to 4.0 <i>0.30 GHz to 8.25 GHz</i>	0.01 to 0.03  0.01 to 0.07  0.02 to 0.40	The uncertainties are for the measurement of VSWR in 50 Ω, 14 mm coaxial lines fitted with GR 900 precision connectors; if other types of connectors or adaptors are used, the uncertainty will be increased.	Permanent					
VOLTAGE REFLECTION COEFFICIENT	The uncertainties for Voltage Reflection Coefficient measurements from 100 kHz to 18 GHz are applicable to BNC (up to 100 MHz), 7 mm, 3.5 mm and 2.92 mm (up to 1 GHz) 50Ω coaxial line systems. The uncertainty will be increased for other connector types. The measured result may also be reported in terms of VSWR or return loss with the uncertainties being reported in the corresponding units.			Permanent					
Frequency GHz	Calibration and Measurement Capability for the Measured Voltage Reflection Coefficient given below								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0001	0.010	0.012	0.015	0.019	0.023	0.028	0.033	0.039	0.045
0.001	0.008	0.011	0.014	0.018	0.023	0.027	0.033	0.038	0.044
0.005	0.009	0.011	0.014	0.018	0.023	0.028	0.033	0.038	0.045
0.01	0.008	0.008	0.010	0.014	0.021	0.029	0.038	0.049	0.062
0.05	0.008	0.008	0.009	0.012	0.016	0.022	0.029	0.038	0.048
0.1	0.007	0.008	0.009	0.010	0.014	0.018	0.024	0.030	0.038
0.2	0.007	0.008	0.008	0.010	0.012	0.016	0.021	0.027	0.033
0.4	0.007	0.007	0.008	0.010	0.012	0.016	0.021	0.026	0.033
0.6	0.007	0.007	0.008	0.009	0.011	0.014	0.018	0.023	0.029
0.8	0.007	0.007	0.008	0.008	0.010	0.012	0.014	0.018	0.022
1	0.008	0.008	0.008	0.009	0.011	0.014	0.018	0.023	0.029
2	0.009	0.011	0.014	0.020	0.028	0.039	0.051	0.065	0.082
3	0.011	0.016	0.020	0.028	0.040	0.055	0.074	0.095	0.119
4	0.009	0.012	0.019	0.032	0.049	0.069	0.094	0.122	0.155
5	0.013	0.014	0.017	0.024	0.033	0.046	0.062	0.080	0.101
6	0.010	0.010	0.012	0.015	0.020	0.027	0.035	0.045	0.057
7	0.013	0.013	0.013	0.014	0.016	0.020	0.024	0.029	0.036
8	0.017	0.017	0.018	0.019	0.021	0.025	0.030	0.036	0.044
9	0.013	0.013	0.015	0.018	0.024	0.032	0.042	0.053	0.067
10	0.015	0.015	0.017	0.020	0.026	0.034	0.044	0.056	0.070
11	0.022	0.022	0.024	0.027	0.032	0.041	0.051	0.065	0.080
12	0.021	0.021	0.022	0.023	0.027	0.031	0.038	0.047	0.057
13	0.023	0.023	0.023	0.025	0.028	0.033	0.040	0.049	0.059
14	0.025	0.025	0.026	0.027	0.029	0.033	0.038	0.046	0.054
15	0.016	0.016	0.016	0.018	0.020	0.024	0.030	0.036	0.045
16	0.020	0.020	0.021	0.024	0.028	0.035	0.044	0.055	0.068
17	0.027	0.027	0.028	0.030	0.035	0.041	0.051	0.062	0.076
18	0.022	0.022	0.025	0.030	0.039	0.052	0.068	0.087	0.109



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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
VOLTAGE REFLECTION COEFFICIENT (continued)	0.0 to 0.3 <i>1 GHz to 22 GHz</i> <i>22 GHz to 35 GHz</i> <i>35 GHz to 40 GHz</i>  0.3 to 0.6 <i>1 GHz to 22 GHz</i> <i>22 GHz to 35 GHz</i> <i>35 GHz to 40 GHz</i>  0.6 to 0.9 <i>1 GHz to 22 GHz</i> <i>22 GHz to 35 GHz</i> <i>35 GHz to 40 GHz</i>  <i>2.6 GHz to 3.95 GHz:</i> 0 to 0.2 0.2 to 0.6  <i>8.2 GHz to 12.4 GHz:</i> 0 to 0.2 0.2 to 0.6  <i>12.4 GHz to 18 GHz:</i> 0 to 0.2 0.2 to 0.6  <i>18 GHz to 40 GHz:</i> 0 to 0.15 0.15 to 0.4 0.4 to 0.6	0.02 to 0.03 0.020 to 0.060 0.060 to 0.070  0.040 to 0.050 0.050 to 0.070 0.070 to 0.080  0.080 to 0.11 0.10 to 0.12 0.12  0.010 0.010 to 0.030  0.010 0.010 to 0.030  0.010 0.010 to 0.030  0.013 0.013 to 0.018 0.018 to 0.025	The uncertainties are applicable to devices fitted with female 2.92 mm connectors. The uncertainty will be higher in some cases for male connectors.  The measured result may also be reported in terms of VSWR or return loss with the uncertainties being reported in the relevant units.  Waveguide No 10 (WR 284, RG 48/U)  Waveguide No 16 (WR 90, RG 52/U)  Waveguide No 18 (WR 62, RG 91/U)  Waveguide Nos 20 & 22 (UBR 220, UG-599/U)	Permanent



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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
RF POWER Measurement	<p>10 MHz to 18 GHz: - 90 dBm to - 100 dBm - 90 dBm to + 13 dBm</p> <p>0.1 mW to 10 mW 10 MHz 50 MHz 100 MHz, 200 MHz, 400 MHz, 600 MHz and 800 MHz 1 GHz 2 GHz 3 GHz, 4 GHz and 5 GHz 6 GHz and 7 GHz 8 GHz 9 GHz, 10 GHz, 11 GHz and 12 GHz 13 GHz 14 GHz 15 GHz and 16 GHz 17 GHz and 18 GHz</p> <p>10 mW to 10 W 1 GHz to 5 GHz 5 GHz to 14 GHz 14 GHz to 18 GHz</p> <p>10 mW to 100 W 1 kHz to 1 GHz</p>	<p>0.35 dB 0.08 dB to 0.18 dB</p> <p>1.5 % 0.35 %</p> <p>0.50 % 0.50 % 0.60 % 0.90 % 1.1 % 1.2 %</p> <p>1.1 % 1.3 % 1.2 % 1.3 % 1.4 %</p> <p>1.0 % to 1.5 % 1.5 % to 2.0 % 2.0 % to 2.5 %</p> <p>1.70 %</p>	<p>The uncertainties are for the measurement of output power from generators having a source VRC of less than 0.03. The uncertainty will be increased for generators where the VRC exceeds this value.</p>	Permanent



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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
RF POWER (continued) Generation	0.1 mW to 10 mW 10 MHz to 50 MHz 50 MHz 50 MHz to 2 GHz 2 GHz to 5 GHz 5 GHz to 16 GHz 16 GHz to 18 GHz  10 mW to 10 W 1 GHz to 5 GHz 5 GHz to 14 GHz 14 GHz to 18 GHz  10 mW to 100 W 1 kHz to 1 GHz  At 100 kHz, 1 MHz, 10 MHz, 30 MHz, 1 GHz, 3 GHz, 5 GHz, 7 GHz, 9 GHz, 10 GHz, 12 GHz, 14 GHz, 15 GHz, 16 GHz, 17 GHz and 18 GHz: - 10 dBm to - 110 dBm  - 10 dBm to 0 dBm 100 kHz to 14 GHz 14 GHz to 26 GHz 26 GHz to 29 GHz 29 GHz to 38 GHz 38 GHz to 40 GHz	1.0 % 0.70 % 1.1 % 1.2 % 1.6 % 1.8 %  1.2 % to 1.6 % 1.6 % to 2.0 % 2.0 % to 3.0 %  1.2 % to 1.6 %  0.20 dB (4.7 %)  0.10 dB 0.15 dB 0.20 dB 0.25 dB 0.30 dB	The uncertainties are for the calibration of coaxial power measuring instruments having a VRC of less than 0.02. The uncertainties will be increased for devices where the VRC exceeds this value.  For the generation of RF signals applicable to EMC receivers etc. The uncertainty may be increased at other frequencies in the frequency range or if the input VRC exceeds 0.02.  For the generation of RF signals applicable to analysers and other power indicating instruments fitted with 2.92 mm connectors. The uncertainties apply to devices with input VRC exceeding 0.02, the uncertainty may be increased for higher VRC.	Permanent
CALIBRATION FACTOR	1 µW to 1 mW  100 kHz 300 kHz to 2 GHz 2 GHz to 5 GHz 5 GHz to 12 GHz 12 GHz to 18 GHz	1.2 % 0.80 % 1.0 % 1.5 % 1.6 %		Permanent



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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 FACTOR (continued)				Permanent
	1 mW 100 kHz 300 kHz to 2 GHz 2 GHz to 5 GHz 5 GHz to 12 GHz 12 GHz to 18 GHz	1.1 % 0.60 % 0.90 % 1.3 % 1.5 %	Uncertainties are dependent on power sensor type and are for specific frequencies within the stated ranges. Uncertainties may be increased at other frequencies or if the input VRC exceeds 0.02.	
	1 mW to 10 mW 100 kHz 300 kHz to 2 GHz 2 GHz to 5 GHz 5 GHz to 12 GHz 12 GHz to 18 GHz	1.3 % 1.0 % 1.1 % 1.5 % 1.6 %		
	-10 dBm to + 5 dBm 100 kHz 500 kHz 1 MHz 5 MHz 10 MHz 50 MHz 100 MHz 500 MHz 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz 13 GHz 14 GHz 15 GHz 16 GHz 17 GHz 18 GHz 19 GHz 20 GHz 21 GHz 22 GHz 23 GHz 24 GHz 25 GHz 26 GHz 27 GHz 28 GHz	1.1 % 1.1 % 1.1 % 1.1 % 1.1 % 0.80 % 0.80 % 0.90 % 0.90 % 0.90 % 1.0 % 1.0 % 1.0 % 1.0 % 1.1 % 1.2 % 1.2 % 1.3 % 1.3 % 1.3 % 1.4 % 1.5 % 1.7 % 1.9 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.0 % 2.1 % 2.7 % 2.9 %	Uncertainties are for power sensor fitted with 2.92 mm connectors (jacks) with VRC not exceeding 0.02, the uncertainty may be increased for higher VRC.	



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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 FACTOR (continued)	29 GHz 30 GHz 31 GHz 32 GHz 33 GHz 34 GHz 35 GHz 36 GHz 37 GHz 38 GHz 39 GHz 40 GHz	3.1 % 3.2 % 3.2 % 3.2 % 3.4 % 3.4 % 3.2 % 3.1 % 3.7 % 4.4 % 4.9 % 4.4 %		Permanent
RF ATTENUATION	10 MHz to 18 GHz: 0 dB to 40 dB 40 dB to 50 dB 50 dB to 80 dB 80 dB to 90 dB 90 dB to 100 dB 100 dB to 110 dB  2.6 GHz to 18 GHz: 0 dB to 40 dB 40 dB to 50 dB 50 dB to 80 dB 80 dB to 90 dB 90 dB to 100 dB 100 dB to 110 dB  18 GHz to 40 GHz: 0 dB to 40 dB 40 dB to 60 dB 60 dB to 80 dB	0.017 dB 0.017 dB to 0.020 dB 0.020 dB to 0.035 dB 0.035 dB to 0.10 dB 0.10 dB to 0.27 dB 0.40 dB  0.017 dB 0.017 dB to 0.020 dB 0.020 dB to 0.035 dB 0.035 to 0.10 dB 0.10 dB to 0.27 dB 0.40 dB  0.020 dB 0.020 dB to 0.080 dB 0.080 dB to 0.20 dB	14 mm, 7 mm and 3.5 mm 50 Ω coaxial line. The uncertainties apply to the measurement of increments of attenuation of a variable attenuator with input and output VRC of less than 0.02. The uncertainty will be increased for insertable devices or for higher values of VRC.  Waveguide Nos. 10, 11A, 12, 14, 15, 16, 17, 18, 20 and 22. The uncertainties apply to the measurement of increments of attenuation of a variable attenuator with input and output VRC of less than 0.02. The uncertainty will be increased for insertable devices or for those with a higher VRC.	Permanent



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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
NOISE TEMPERATURE				Permanent
Excess noise ratio (ENR) in dB of coaxial noise tube sources and mounts over that of a source at 290 K	10 MHz 30 MHz 60 MHz 100 MHz 300 MHz 600 MHz 1.0 GHz 1.5 GHz 2.0 GHz 3.0 GHz 4.0 GHz 5.4 GHz 6.0 GHz 7.0 GHz 8.0 GHz 9.0 GHz 10.0 GHz 11.2 GHz 12.4 GHz 13.5 GHz 15.0 GHz 17.5 GHz 18.0 GHz	0.22 dB 0.22 dB 0.22 dB 0.18 dB 0.22 dB 0.22 dB 0.15 dB 0.18 dB 0.15 dB 0.12 dB 0.12 dB 0.12 dB 0.20 dB 0.13 dB 0.13 dB 0.15 dB 0.15 dB 0.12 dB 0.12 dB 0.23 dB 0.13 dB 0.13 dB	Measurements may also be made of ENR values over the range 4 dB to 35 dB.  The uncertainties relate to coaxial noise sources and mounts, fitted with APC7 precision coaxial connectors and a VSWR not greater than 1.05. The uncertainty will be increased for ENR values significantly different from 15 dB, or for other connector types or higher VSWR.	
Excess noise ratio (ENR) in dB of gas discharge tube sources and mounts over that of a source at 290 K	10 MHz to 600 MHz 600 MHz to 1.5 GHz 2.0 GHz to 5.4 GHz 5.4 GHz to 18 GHz	0.25 dB 0.25 dB to 0.22 dB 0.25 dB to 0.15 dB 0.15 dB to 0.25 dB	Measurements may also be made of ENR values in the range 4 dB to 35 dB.  The uncertainties relate to waveguide noise sources and mounts having VSWR not greater than 1.05. The uncertainty will be increased for ENR values significantly different from 15 dB or for higher values of VSWR.	
ENR values around 15 dB nominal	2.75 GHz 3.0 GHz 3.5 GHz 4.0 GHz 2.6 GHz to 4.0 GHz  9.0 GHz 10.0 GHz 11.2 GHz 8.5 GHz to 11.5 GHz	0.075 dB 0.085 dB 0.075 dB 0.080 dB 0.10 dB  0.075 dB 0.075 dB 0.075 dB 0.10 dB	Waveguide10 (WR284, R32)    Waveguide16 (WR90, R100)	



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NOISE TEMPERATURE (continued)	13.5 GHz 15.0 GHz 17.5 GHz 12.4 GHz to 18.0 GHz	0.075 dB 0.075 dB 0.080 dB 0.10 dB	Waveguide 18 (WG62, R140/U)	Permanent
AMPLITUDE MODULATION  Modulation Factor				Permanent and site
0.03 to 0.30 0.30 to 0.90	Carrier 1 MHz to 1 GHz; Modulation 1 kHz	0.006 0.012		
0.03 to 0.30 0.30 to 0.90	Carrier 1 MHz to 1 GHz; Modulation 30 Hz to 50 kHz	0.018 0.024		
FREQUENCY MODULATION				Permanent and site
Frequency Deviation	1 kHz to 2 kHz 2 kHz to 6 kHz 6 kHz to 500 kHz	0.80 % + 20 Hz 0.70 % + 20 Hz 1.0 %	Carrier 1 MHz to 1 GHz; Modulation 1 kHz.	
PHASE MODULATION				Permanent and site
Phase Deviation	1 radian to 2 radians 2 radians to 6 radians 6 radians to 500 radians	0.80 % + 0.02 radians 0.70 % + 0.02 radians 1.0 %	Carrier 1 MHz to 1 GHz; Modulation 1 kHz	
RF VOLTAGE				Permanent and site
	1 mV to 0.5 V and 1 V to 10 V 9 kHz to 10 MHz 10 MHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 1 GHz	1.5 % 1.6 % 1.8 % 3.7 %	The uncertainties given are for the calibration of voltmeters, signal generators and other instruments either at a T-junction comparator reference plane or in terms of the RF voltage developed in a perfectly matched 50 Ω coaxial line system. The uncertainties will be increased if the device being measured presents an imperfect match.	
	0.5 V to 1 V 10 kHz to 10 MHz 10 MHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 1 GHz	1.4 % 1.6 % 1.7 % 2.9 %		



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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 EMC TEST EQUIPMENT				Permanent and site
Frequency	10 Hz to 18 GHz	1 in $10^\circ$	Appropriate for the calibration of receivers and spectrum analysers	
IF Bandwidth	1.5 dB, 3 dB, 6dB, 10 dB and 20 dB points 60 dB point	0.10 dB 1.0 dB	There may be additional uncertainties due to the resolution of the receiver. The shape factor may be calculated from the results of the 6 dB and the 60 dB measurements.	
RF Power Generation	-60 dBm to +13 dBm <i>9 kHz to 2GHz</i> <i>2 GHz to 3 GHz</i> <i>3 GHz to 8 GHz</i> <i>8 GHz to 18 GHz</i>	0.10 dB 0.11 dB 0.41 dB 0.90 dB		
RF Power Measurement	- 60 dBm to + 13 dBm <i>9 kHz to 8 GHz</i> <i>8 GHz to 18 GHz</i>	0.070 dB 0.31 dB		
RF Voltage Generation	1 mV to 1 V <i>9 kHz to 500 MHz</i> <i>500 MHz to 2 GHz</i> <i>2 GHz to 2.5 GHz</i> <i>2.5 GHz to 3 GHz</i>	0.21 dB 0.25 dB 0.35 dB 0.38 dB		
RF Voltage Measurement	1 mV to 1 V <i>9 kHz to 500 MHz</i> <i>500 MHz to 2 GHz</i> <i>2 GHz to 2.5 GHz</i> <i>2.5 GHz to 3 GHz</i>	0.15 dB 0.22 dB 0.36 dB 0.40 dB		
RF Attenuation at 30 MHz	0 dB to 40 dB 40 dB to 60 dB 60 dB to 100 dB 100 dB to 110 dB	0.071 dB 0.093 dB 0.38 dB 0.59 dB	For linearity and dynamic range calibration of receivers and spectrum analysers	
Spectrum Amplitude	40 dB $\mu$ V nominal <i>9 kHz to 150 kHz</i>	1.5 %		
	40 dB $\mu$ V to 60 dB $\mu$ V <i>150 kHz to 1 GHz</i>	1.0 dB		
Voltage reflection coefficient	0 to 0.5 <i>100 kHz to 18 GHz</i>	0.050 to 0.060		
Impulse Bandwidth	200 Hz to 1 MHz	1.5 %		



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CALIBRATION OF EMC TEST EQUIPMENT (continued)				Permanent and site
LF & RF Impedance	Magnitude 1 Ω to 100 Ω 10 Hz to 1 MHz 1 MHz to 108 MHz 108 MHz to 200 MHz 200 MHz to 300 MHz 300 MHz to 500 MHz	0.20 Ω 1.0 Ω 2.0 Ω 4.0 Ω 5.0 Ω	For measurement of Line Impedance Stabilisation Networks (LISNs)	
	Phase 0 ° to 180 ° 9 kHz to 108 MHz	1.0 °		
	Magnitude 80 Ω to 250 Ω 150 kHz to 30 MHz 30 MHz to 230 MHz	1.0 % 2.0 %	For measurement of Coupling/Decoupling Networks (CDNs)	
Insertion Loss	10 dB to 25 dB 30 MHz to 1 GHz	0.60 dB	For calibration of Absorbing Clamps as described in CISPR 16	
DISCONTINUOUS INTERFERENCE ANALYSERS				
Pulse Amplitude	-2.5 dB to + 25 dB relative to a set limit in the range 45 dBμV to 52 dBμV	0.20 dB		
Pulse Duration	150 kHz to 30 MHz	10 ppm		
Pulse Separation	0.1 ms to 200 ms	0.10 % 10 ppm	Test in accordance with BS 55016-1-1:2007	
	Initial 13 s Subsequent pulses			



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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
<b>ELECTRICAL CALIBRATION OF TEMPERATURE SIMULATORS</b>				
Noble metal thermocouples	- 50 °C to + 200 °C 200 °C to 1800 °C	0.30 °C to 0.14 °C 0.14 °C to 0.10 °C	Without cold junction compensation	
	- 50 °C to + 200 °C 200 °C to 1800 °C	0.84 °C to 0.37 °C 0.37 °C to 0.28 °C	With cold junction compensation	
Base metal thermocouples	- 200 °C to 0 °C 0 °C to 1380 °C	0.11 °C to 0.040 °C 0.040 °C	Without cold junction compensation	
	- 200 °C to 0 °C 0 °C to 1380 °C	0.34 °C to 0.13 °C 0.13 °C	With cold junction compensation	
Resistance sensors	- 200 °C to + 100 °C 100 °C to 800 °C	0.0030 °C to 0.008 °C 0.0080 °C to 0.030 °C		
Electrical calibration of temperature indicators, controllers and recorders for the following sensors:				
Noble metal thermocouples	- 50 °C to + 200 °C 200 °C to 1800 °C	0.30 °C to 0.14 °C 0.14 °C to 0.10 °C	Without cold junction compensation	
	- 50 °C to + 200 °C 200 °C to 1800 °C	0.84 °C to 0.37 °C 0.37 °C to 0.28 °C	With cold junction compensation	
Base metal thermocouples	- 200 °C to 0 °C 0 °C to 1380 °C	0.11 °C to 0.040 °C 0.040 °C	Without cold junction compensation	
	- 200 °C to 0 °C 0 °C to 1380 °C	0.34 °C to 0.13 °C 0.13 °C	With cold junction compensation	
Resistance sensors	- 200 °C to + 250 °C 250 °C to 800 °C	0.0030 °C to 0.0070 °C 0.0070 °C to 0.028 °C		
Thermocouple reference junctions				
Type T/K		0.11 °C		
Type N		0.12 °C		
Type R		0.22 °C		
Reporting the ambient temperature	17 °C to 23 °C	0.40 °C	In support of temperature simulation.	



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**DC/LF AUTOMATED SYSTEMS FOR GENERATION**

<b>DC RESISTANCE</b> Generation	1 $\Omega$ 1.9 $\Omega$ 10 $\Omega$	86 ppm 86 ppm 26 ppm		
	19 $\Omega$ 100 $\Omega$ 190 $\Omega$	24 ppm 16 ppm 16 ppm		
	1 k $\Omega$ 1.9 k $\Omega$ 10 k $\Omega$	12 ppm 12 ppm 11 ppm		
	19 k $\Omega$ 100 k $\Omega$ 190 k $\Omega$	11 ppm 13 ppm 13 ppm		
	1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$	18 ppm 20 ppm 37 ppm		
	19 M $\Omega$ 100 M $\Omega$	45 ppm 105 ppm		
<b>DC VOLTAGE</b> Generation	0 V to 220 mV 220 mV to 2.2 V 2.2 V to 11 V	7.5 ppm + 0.65 $\mu$ V 6.5 ppm + 1.0 $\mu$ V 6.5 ppm + 3.5 $\mu$ V		
	11 V to 22 V 22 V to 220 V 220 V to 1100 V	6.5 ppm + 6.5 $\mu$ V 7.0 ppm + 80 $\mu$ V 8.5 ppm + 470 $\mu$ V		
<b>DC CURRENT</b> Generation	0 A to 220 $\mu$ A 220 $\mu$ A 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	47 ppm + 8.0 nA 47 ppm + 8.0 nA 47 ppm + 80 nA 55 ppm + 800 nA 75 ppm + 24 $\mu$ A 280 ppm + 380 $\mu$ A		
<b>DC CURRENT</b> Simulation	11 A to 550 A	0.30 % + 600 mA	Using a 50 turn coil	
<b>AC VOLTAGE</b> Generation	0.1 mV to 2.2 mV 10 Hz to 20 Hz 20 to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	850 ppm + 4.0 $\mu$ V 750 ppm + 4.0 $\mu$ V 720 ppm + 4.0 $\mu$ V 800 ppm + 4.0 $\mu$ V 0.10 % + 6.5 $\mu$ V 0.12 % + 12 $\mu$ V 0.17 % + 25 $\mu$ V 0.33 % + 25 $\mu$ V		



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<p><b>AC VOLTAGE</b> Generation (Cont'd)</p>	<p>2.2 mV to 22 mV 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz</p> <p>22 mV to 220 mV 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz</p> <p>220 mV to 2.2 V 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz</p> <p>2.2 V to 22 V 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz</p>	<p>480 ppm + 5.0 <math>\mu</math>V 220 ppm + 5.0 <math>\mu</math>V 140 ppm + 5.0 <math>\mu</math>V 340 ppm + 5.0 <math>\mu</math>V 750 ppm + 6.5 <math>\mu</math>V 0.11 % + 12 <math>\mu</math>V 0.15 % + 25 <math>\mu</math>V 0.30 % + 25 <math>\mu</math>V</p> <p>470 ppm + 13 <math>\mu</math>V 190 ppm + 8.0 <math>\mu</math>V 105 ppm + 8.0 <math>\mu</math>V 290 ppm + 8.0 <math>\mu</math>V 700 ppm + 25 <math>\mu</math>V 860 ppm + 25 <math>\mu</math>V 0.14 % + 32 <math>\mu</math>V 0.28 % + 80 <math>\mu</math>V</p> <p>470 ppm + 80 <math>\mu</math>V 150 ppm + 25 <math>\mu</math>V 75 ppm + 6.0 <math>\mu</math>V 115 ppm + 16 <math>\mu</math>V 220 ppm + 65 <math>\mu</math>V 380 ppm + 115 <math>\mu</math>V 950 ppm + 320 <math>\mu</math>V 0.19 % + 800 <math>\mu</math>V</p> <p>470 ppm + 800 <math>\mu</math>V 150 ppm + 240 <math>\mu</math>V 75 ppm + 55 <math>\mu</math>V 120 ppm + 160 <math>\mu</math>V 220 ppm + 320 <math>\mu</math>V 470 ppm + 1.3 mV 0.11 % + 4.0 mV 0.24 % + 7.0mV</p>		
<p><b>AC VOLTAGE</b> Generation</p>	<p>22 V to 220 V 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 300 kHz to 50 kHz 50 kHz to 100 kHz</p> <p>220 V to 1100 V 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 30 kHz</p> <p>220 V to 750 V 30 kHz to 50 kHz 50 kHz to 100 kHz</p>	<p>470 ppm + 8.0 mV 150 ppm + 2.5 mV 80 ppm + 800 <math>\mu</math>V 200 ppm + 3.1 mV 470 ppm + 8.0 mV</p> <p>80 ppm + 3.1 mV 140 ppm + 5.0 mV 470 ppm + 8.5 mV</p> <p>470 ppm + 8.5 mV 0.18 % + 35 mV</p>		



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<p><b>AC VOLTAGE</b> (WIDEBAND to 30 MHz) Generation</p>	<p>10 µV to 1.1 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p> <p>1.1 mV to 3 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p> <p>3 mV to 11 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p>	<p>0.85 % + 1.6 µV 0.70 % + 1.6 µV 0.80 % + 4.0 µV 0.95 % + 4.0 µV 1.1 % + 4.0 µV 1.8 % + 14 µV</p> <p>0.80 % + 2.5 µV 0.65% + 2.4 µV 0.65 % + 5.2 µV 0.80 % + 5.0 µV 0.95 % + 5.0 µV 1.7 % + 5.0 µV</p> <p>0.80 % + 6.5 µV 0.65 % + 6.5 µV 0.65 % + 8.5 µV 0.80 % + 8.5 µV 0.95 % + 8.5 µV 1.7 % + 8.5 µV</p>		
<p><b>AC VOLTAGE</b> (WIDEBAND to 30 MHz) Generation</p>	<p>11 mV to 33 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p> <p>33 mV to 110 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p> <p>110 mV to 330 mV 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p> <p>330 mV to 1.1 V 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p>	<p>0.7 % + 12.5 µV 0.55 % + 12.5 µV 0.55 % + 15 µV 0.65 % + 15 µV 0.80 % + 15 µV 1.3 % + 15 µV</p> <p>0.70 % + 31 µV 0.55 % + 31 µV 0.55 % + 35 µV 0.65 % + 35 µV 0.80 % + 35 µV 1.3 % + 35 µV</p> <p>0.62 % + 80 µV 0.50 % + 80 µV 0.50 % + 80 µV 0.55 % + 80 µV 0.70 % + 80 µV 1.20 % + 80 µV</p> <p>0.65 % + 310 µV 0.50 % + 310 µV 0.50 % + 310 µV 0.55 % + 310 µV 0.70 % + 310 µV 1.20 % + 310 µV</p>		



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<p><b>AC VOLTAGE</b> (WIDEBAND to 30 MHz) Generation (Cont'd)</p>	<p>1.1 V to 3.5 V 10 Hz to 30 Hz 30 Hz to 120 Hz 120 Hz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz</p>	<p>0.55 % + 400 <math>\mu</math>V 0.40 % + 400 <math>\mu</math>V 0.40 % + 400 <math>\mu</math>V 0.50 % + 400 <math>\mu</math>V 0.65 % + 400 <math>\mu</math>V 1.1 % + 400 <math>\mu</math>V</p>		
<p><b>AC CURRENT</b> Generation</p>	<p>100 nA to 220 <math>\mu</math>A 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>130 ppm + 16 nA 550 ppm + 40 nA 0.14 % + 870 nA</p>		
	<p>220 <math>\mu</math>A to 2.2 mA 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>130 ppm + 31 nA 550 ppm + 400 nA 0.14 % + 800 nA</p>		
<p><b>AC CURRENT</b> Generation</p>	<p>2.2 mA to 22 mA 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>140 ppm + 410 nA 550 ppm + 4.0 <math>\mu</math>A 0.14 % + 8.0 <math>\mu</math>A</p>		
	<p>22 mA to 220 mA 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>150 ppm + 3.1 <math>\mu</math>A 550 ppm + 40 <math>\mu</math>A 0.14 % + 80 <math>\mu</math>A</p>		
	<p>220 mA to 2.2 A 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>590 ppm + 31 <math>\mu</math>A 670 ppm + 80 <math>\mu</math>A 0.80 % + 120 <math>\mu</math>A</p>		
	<p>2.2 A to 11 A 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz</p>	<p>370 ppm + 140 <math>\mu</math>A 750 ppm + 300 <math>\mu</math>A 0.28 % + 600 <math>\mu</math>A</p>		
<p><b>AC CURRENT</b> Simulation</p>	<p>11 A to 550 A 45 Hz to 65 Hz</p>	<p>0.30 % + 600 mA</p>	<p>Using a 50 turn coil</p>	



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**DC/LF AUTOMATED SYSTEMS FOR MEASUREMENT**

<b>DC RESISTANCE</b> Measurement	0 Ω to 12 Ω 12 Ω to 120 120 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 1.2 GΩ	45 ppm + 0.10 mΩ 30 ppm + 1.0 mΩ 22 ppm + 1.0 mΩ 21 ppm + 10 mΩ 23 ppm + 100 mΩ 35 ppm + 3.0 Ω 80 ppm + 140 Ω 600 ppm + 2.1 kΩ 0.65 % + 160 kΩ		
<b>DC VOLTAGE</b> 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 1050 V	12.5 ppm + 1.8 μV 11.5 ppm + 2 μV 11.5 ppm + 6.5 μV 13 ppm + 130 μV 19 ppm + 750 μV		
<b>DC CURRENT</b> Measurement	0 A to 1.2 μA 1.2 μA to 12 μA 12 μA to 120 μA 120 μA to 1.2 mA  1.2 mA to 12 mA 12 mA to 120 mA 120 mA to 1.05 A	210 ppm + 85 pA 110 ppm + 210 pA 75 ppm + 1.7 nA 75 ppm + 11 nA  75 ppm + 75 nA 95 ppm + 1.1 μA 170 ppm + 18 μA		
<b>AC VOLTAGE</b> Measurement	10 μV to 12 mV 10 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz  12 mV to 120 mV 10 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz  120 mV to 1.2 V 10 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz	800 ppm + 9.0 μV 300 ppm + 8.0 μV 400 ppm + 8.0 μV 0.13 % + 8.0 μV 0.60 % + 11 μV 4.7 % + 21 μV  800 ppm + 21 μV 175 ppm + 13 μV 225 ppm + 13 μV 400 ppm + 13 μV 0.15 % + 40 μV 0.40 % + 40 μV 1.3 % + 40 μV 1.8 % + 40 μV  800 ppm + 140 μV 140 ppm + 30 μV 200 ppm + 30 μV 400 ppm + 40 μV 0.10 % + 110 μV 0.36 % + 225 μV 1.2 % + 1.1 mV 1.8 % + 1.2 mV		



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<b>AC VOLTAGE</b> Measurement (Cont'd)	1.2 V to 12 V 10 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz	750 ppm + 1.3 mV 140 ppm + 300 $\mu$ V 200 ppm + 300 $\mu$ V 400 ppm + 400 $\mu$ V 0.10 % + 600 $\mu$ V 0.36 % + 25 mV 1.25 % + 12 mV 1.8 % + 12 mV		
<b>AC VOLTAGE</b> Measurement	12 V to 120 V 10 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	750 ppm + 14 mV 275 ppm + 3.5 mV 275 ppm + 3.5 mV 510 ppm + 6 mV 0.16 % + 13 mV		
	120 V to 700 V 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 30 kHz	500 ppm + 20 mV 750 ppm + 20 mV 0.16 % + 25 mV		
	At 700 V 30 kHz to 50 kHz 50 kHz to 100 kHz	0.20 % + 25 mV 0.45 % + 25 mV		
	220 V to 1.1 kV 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	210 ppm + 25 mV 760 ppm + 60 mV 0.65 % + 250 mV		
<b>AC CURRENT</b> Measurement	100 nA to 120 $\mu$ A 40 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.18 % + 40 nA 0.08 % + 40 nA 0.11 % + 70 nA		
	120 $\mu$ A to 1.2 mA 25 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 10 kHz	0.18 % + 300 nA 0.08 % + 300 nA 0.09 % + 700 nA 0.25 % + 1.25 $\mu$ A		
	1.2 mA to 12 mA 25 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 10 kHz	0.18 % + 3.0 $\mu$ A 0.08 % + 3.0 $\mu$ A 0.090 % + 37 $\mu$ A 0.25 % + 13 $\mu$ A		
	12 mA to 120 mA 25 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 10 kHz	0.18 % + 30 $\mu$ A 0.080 % + 30 $\mu$ A 0.090 % + 70 $\mu$ A 0.25 % + 130 $\mu$ A		



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<b>AC CURRENT</b> Measurement (Cont'd)	120 mA to 1.050 A 25 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 10 kHz	0.19 % + 250 $\mu$ A 0.11 % + 250 $\mu$ A 0.16 % + 550 $\mu$ A 1.3 % + 1.0 mA		
END				