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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						NMI Service Identifier	Comments
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
DC voltage sources: single value	Electronic voltage standard	Direct comparison with standard	1	10	V	Fixed voltage	1 V, 1.018 V, 10 V	0.1 to 1.5	µV	2	95 %	No	Mx1.1.1	1	Approved on 10 November 2014
						Ambient temperature	20 °C to 25 °C								
DC voltage sources: low values	DC voltage sources, multifunction calibrator: voltage *V*	Comparison with reference standard	0	12	V	Ambient temperature	15 °C to 30 °C	(0.05 + 0.15*V*), *V* in V, values range from 0.05 µV to 1.85 µV	µV	2	95 %	No		5	Approved on 22 November 2006
DC voltage sources:intermediate values	DC voltage sources, multifunction calibrator	Comparison with reference standard	12	1100	V	Ambient temperature	15 °C to 30 °C	0.5	µV/V	2	95 %	Yes		3	Approved on 22 November 2006
DC voltage meters: very low values	Nanovoltmeter, microvoltmeter	Comparison with reference standard	0	0.001	V	Ambient temperature	15 °C to 30 °C	0.05	µV	2	95 %	No		6	Approved on 22 November 2006
DC voltage meters: intermediate values	DC voltmeter, multimeter, multifunction transfer standard	Comparison with reference standard	12	1100	V	Ambient temperature	15 °C to 30 °C	0.5	µV/V	2	95 %	Yes		4	Approved on 22 November 2006
DC voltage meters: intermediate values	DC voltmeter, multimeter, multifunction transfer standard: voltage *V*	Comparison with reference standard	0.001	12	V	Ambient temperature	15 °C to 30 °C	(0.05 + 0.15*V*), *V* in V, values range from 0.05 µV to 1.85 µV	µV	2	95 %	No		7	Approved on 22 November 2006
DC voltage ratios: up to 1100 V	Resistive dividers, ratio meter	Reference step voltage buildup method	1	1000		Laboratory temperature	20 °C	0.0000004		2	95 %	Yes		8	Approved on 22 November 2006
						Output voltage	>= 1 V								
DC resistance standards and sources: low values	Fixed resistors, resistance box	Voltage comparator	10	1000	mΩ	Current	<= 1 A	25	µΩ/Ω	2	95 %	Yes		16	Approved on 22 November 2006
						Voltage	>= 10 mV								

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DC resistance standards and sources: low values	Fixed resistor, resistance box	Current comparator bridges	0.1	1	Ω	Temperature	15 °C to 35 °C	0.2	μΩ/Ω	2	95 %	Yes		12a	Approved on 22 November 2006
						Current	<= 100 mA								
DC resistance standards and sources: intermediate values	Fixed resistor, resistance box	Current comparator bridges	1	10000	Ω	Temperature	15 °C to 25 °C	0.12	μΩ/Ω	2	95 %	Yes		12	Approved on 22 November 2006
						Power dissipation	< 10 mW								
DC resistance standards and sources: intermediate values	Fixed resistor, resistance box	Dual voltage source	0.01	1	MΩ	Applied voltages	5 V to 100 V	0.7	μΩ/Ω	2	95 %	Yes		13	Approved on 31 October 2016
						Temperature	15 °C to 25 °C								
DC resistance standards and sources: high values	Fixed resistor, three terminal resistor, resistance box: resistance *R*	Dual voltage source	0.001	1	GΩ	Applied voltages	5 V to 100 V	$(0.7 + 27R - 20R^3)$, R in GΩ, values range from 0.7 μΩ/Ω to 7.7 μΩ/Ω	μΩ/Ω	2	95 %	Yes		14	Approved on 31 October 2016
						Temperature	15 °C to 25 °C								
DC resistance standards and sources: high values	Fixed resistor, three terminal resistor, resistance box: resistance *R*	Voltage ratio	1	5000000	MΩ	Applied voltages	100 V to 1000 V	$(35 + 6.9E\text{-}11R^2 + 9.4E\text{-}04R)$, R in MΩ, values range from 35 μΩ/Ω to 6460 μΩ/Ω	μΩ/Ω	2	95 %	Yes		15	Approved on 22 November 2006
DC resistance standards and sources: standard for high current	Fixed resistors: resistance *R*	Current comparator	0.1	1000	mΩ	Current	1 A to 875 A	$63R^{-0.35}$, R in mΩ, values range from 141 μΩ/Ω to 6 μΩ/Ω	μΩ/Ω	2	95 %	Yes		17	Approved on 22 November 2006
						Voltage	10 mV to 1 V								

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Resistance meters and resistance standards	0	10	Ω	Temperature	15 °C to 25 °C	40	μΩ	2	95 %	No		18	Approved on 22 November 2006
DC resistance standards and sources: multiple ranges	Multifunction calibrator	Resistance meters and resistance standards	0.01	1000	kΩ	Temperature	15 °C to 25 °C	3	μΩ/Ω	2	95 %	Yes		18a	Approved on 22 November 2006
DC resistance standards and sources: multiple ranges	Multifunction calibrator: resistance *R*	Resistance meters and resistance standards	1	100	MΩ	Temperature	15 °C to 25 °C	$(2 + R^{0.8})$, *R* in MΩ, values range from 3 μΩ/Ω to 42 μΩ/Ω	μΩ/Ω	2	95 %	Yes		18b	Approved on 22 November 2006
DC resistance meters: low values	Microohmmeter, multimeter, multifunction transfer standard, resistance bridge: resistance *R*	Resistance meters and resistance standards	0.1	1000	mΩ	Source currents	100 mA to 875 A	$63R^{-0.35}$, *R* in mΩ, values range from 141 μΩ/Ω to 6 μΩ/Ω	μΩ/Ω	2	95 %	Yes		21a	Approved on 22 November 2006
DC resistance meters: low values	Ohmmeter, multimeter, multifunction transfer standard, resistance bridge	Resistance meters and resistance standards	0.1	1	Ω			0.2	μΩ/Ω	2	95 %	Yes		19a	Approved on 22 November 2006
DC resistance meters: intermediate values	Ohmmeter, multimeter, multifunction transfer standard, resistance bridge	Resistance meters and resistance standards	1	10000	Ω	Temperature	15 °C to 25 °C	0.12	μΩ/Ω	2	95 %	Yes		19	Approved on 22 November 2006
DC resistance meters: intermediate values	Ohmmeter, multimeter, multifunction transfer standard, resistance bridge: resistance *R*	Resistance meters and resistance standards	0.00001	1	GΩ	Source voltages	1 V to 100 V	$(1 + 27R - 20R^3)$, *R* in GΩ, values range from 1 μΩ/Ω to 8 μΩ/Ω	μΩ/Ω	2	95 %	Yes		21	Approved on 22 November 2006
DC resistance meters: high values	Multimeter, multifunction transfer standard, teraohmmeter, resistance bridge: resistance *R*	Resistance standards	1	100	GΩ	Source voltages	10 V to 1000 V	$(-0.07R^2 + 22R - 15)$, *R* in GΩ, values range from 6.9 μΩ/Ω to 1485 μΩ/Ω	μΩ/Ω	2	95 %	Yes		22	Approved on 22 November 2006

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
DC resistance meters: high values	Multimeter, multifunction transfer standard, teraohmmeter, resistance bridge: resistance *R*	Resistance standards	100	1200	GΩ	Source voltages	10 V to 1000 V	(1300 + 2.2*R*), *R* in GΩ, values range from 1520 μΩ/Ω to 3940 μΩ/Ω	μΩ/Ω	2	95 %	Yes		23	Approved on 22 November 2006
						Source currents	> 100 pA								
DC resistance: ratios	Temperature bridge, resistance ratio bridge: nominal full-scale ratio ρ	Resistance Bridge Calibrator (RBC)	0	13	Ω/Ω	Temperature	15 °C to 25 °C	2E-08 ρ		2	95 %	No		49b	Approved on 31 October 2016
DC current sources: low values	Current generator, multifunction calibrator	Voltage across resistor	1.00E-11	1.00E-04	A			560 to 5	μA/A	2	95 %	Yes	Mx3	24	Approved on 22 November 2006
DC current sources: intermediate values	Current generator, multifunction calibrator	Voltage across resistor	1.00E-04	20.0	A			5 to 18	μA/A	2	95 %	Yes	Mx3	27	Approved on 22 November 2006
DC current sources: high values	Current generator	Voltage across resistor	20	100	A			18 to 36	μA/A	2	95 %	Yes	Mx3	31	Approved on 22 November 2006
DC current meters: low values	Picoammeter, nanoammeter, multimeter, multifunction transfer standard	Voltage across resistor	1.00E-11	1.00E-04	A			560 to 5	μA/A	2	95 %	Yes	Mx3	25	Approved on 22 November 2006
DC current meters: intermediate values	Current comparator, multimeter	Voltage across resistor	1.00E-04	20.0	A			5 to 18	μA/A	2	95 %	Yes	Mx3	29	Approved on 22 November 2006
DC current meters: high values	Current transducer, dedicated equipment for heavy current	Voltage across resistor	20	100	A			18 to 36	μA/A	2	95 %	Yes	Mx3	33	Approved on 22 November 2006
AC resistance, real component and imaginary component	Fixed resistor: resistance *R*	Universal impedance bridge	0	1	MΩ	Frequency *f*	40 Hz to 2 kHz	(2000/*f* + 19*R*), *f* in Hz, *R* in Ω, values range from 1 μΩ to 19 Ω	μΩ	2	95 %	No		46	Approved on 22 November 2006

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						NMI Service Identifier	Comments
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
AC resistance, real component	Fixed resistor: resistance *R*	Resistance ratio bridge	0	400	Ω	Frequency	0.01 Hz to 100 Hz	(6 + 0.3*R*), *R* in Ω, values range from 6 μΩ to 126 μΩ	μΩ	2	95 %	No		46a	Approved on 22 November 2006
AC resistance: AC-DC difference	Fixed resistor: resistance *R*	Universal impedance bridge	0	1	MΩ	Frequency *f*	40 Hz to 2 kHz	(2000/*f* + 19*R*), *f* in Hz, *R* in Ω, values range from 1 μΩ to 19 Ω	μΩ	2	95 %	No		47	Approved on 22 November 2006
AC resistance: resistors for high current	AC current shunt: resistance *R*	Universal impedance bridge	0	100	Ω	Frequency *f*	40 Hz to 2 kHz	(2000/*f* + 19*R*), *f* in Hz, *R* in Ω, values range from 1 μΩ to 1900 μΩ	μΩ	2	95 %	No		48	Approved on 22 November 2006
AC resistance: meters	LCR meter, temperature bridge, resistance ratio bridge: nominal full-scale ratio ρ	Resistance Bridge Calibrator (RBC)	0	13	Ω/Ω	Frequency	0 Hz to 100 Hz	2E-08 ρ		2	95 %	No		49a	Approved on 22 November 2006
Capacitance: capacitance for dielectric capacitors	Fixed capacitor, switched capacitor, capacitance box: capacitance *C*	Universal impedance bridge	0	100	μF	Frequency *f*	40 Hz to 2 kHz	(0.2/*f* + 22*C*), f in Hz, *C* in μF, values range from 0.0001 pF to 2200 pF	pF	2	95 %	No		39	Approved on 22 November 2006
Capacitance: dissipation factor for dielectric capacitors	Fixed capacitor, switched capacitor, capacitance box	Universal impedance bridge	0	0.2		Frequency	40 Hz to 2 kHz	(0.000027 + 0.00027/*C*), *C* in pF, values range from 0.000567 to 0.000027		2	95 %	No		39a	Approved on 22 November 2006
						Capacitance *C*	0.5 pF to 100 μF								
Capacitance: meters	Capacitance bridge, LCR Meter: capacitance *C*	Comparison	0	100	μF	Frequency *f*	40 Hz to 2 kHz	(0.2/*f* + 22*C*), *f* in Hz, *C* in μF, values range from 0.0001 pF to 2200 pF	pF	2	95 %	No		40	Approved on 22 November 2006

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
Inductance: self inductance, low values	Fixed inductor, variable inductor, inductance box: inductance	Universal impedance bridge	0	1	mH	Frequency	40 Hz to 2 kHz	0.0001 to 5288	µH	2	95 %	No	Inductance	41	Approved on 22 November 2006
						Series resistance	0 Ω to 1 MΩ								
Inductance: equivalent series resistance, low values	Fixed inductor, variable inductor, inductance box	Universal impedance bridge	0	1	MΩ	Frequency	40 Hz to 2 kHz	0.000001 to 53	Ω	2	95 %	No	Series Resistance of Inductor	41a	Approved on 22 November 2006
						Series inductance	0 mH to 1 mH								
Inductance: self inductance, intermediate values	Fixed inductor, variable inductor, inductance box: inductance	Universal impedance bridge	0.001	1	H	Frequency	40 Hz to 2 kHz	0.001 to 5288	µH	2	95 %	No	Inductance	42	Approved on 22 November 2006
						Series resistance	0 Ω to 1 MΩ								
Inductance: equivalent series resistance, intermediate values	Fixed inductor, variable inductor, inductance box	Universal impedance bridge	0	1	MΩ	Frequency	40 Hz to 2 kHz	0.00001 to 53	Ω	2	95 %	No	Series Resistance of Inductor	42a	Approved on 22 November 2006
						Series inductance	0.001 H to 1 H								
Inductance: self inductance, high values	Fixed inductor, variable inductor, inductance box: inductance	Universal impedance bridge	1	100	H	Frequency	40 Hz to 2 kHz	1 to 5288	µH	2	95 %	No	Inductance	43	Approved on 22 November 2006
						Series resistance	0 Ω to 1 MΩ								
Inductance: equivalent series resistance, high values	Fixed inductor, variable inductor, inductance box	Universal impedance bridge	0	1	MΩ	Frequency	40 Hz to 2 kHz	0.01 to 53	Ω	2	95 %	No	Series Resistance of Inductor	43a	Approved on 22 November 2006
						Series inductance	1 H to 100 H								

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
Inductance: mutual inductance	Fixed mutual inductor: inductance *H*	Universal impedance bridge	0	100	H	Frequency *f*	40 Hz to 2 kHz	(0.2/*f* + 14*H*), *f* in Hz, *H* in H, values range from 0.0001 µH to 1400 µH	µH	2	95 %	No		44	Approved on 22 November 2006
AC-DC voltage transfer: AC-DC transfer difference at low voltages	Thermal converter with amplifier, micropotentiometer, AC-DC transfer standard	Comparison with calibrated source or meter	0.002	0.6	V	Frequency	10 Hz to 1 MHz	11 to 321	µV/V	2	95 %	Yes	AC-DC Voltage	50	Approved on 25 August 2008
AC-DC voltage transfer: AC-DC transfer difference at medium voltages	Thermal converter (directly connected), AC-DC transfer standard	Comparison with calibrated source or meter	0.6	6	V	Frequency	10 Hz to 1 MHz	6 to 77	µV/V	2	95 %	Yes	AC-DC Voltage	51	Approved on 25 August 2008
AC-DC voltage transfer: AC-DC transfer difference at higher voltages voltages	Thermal converter with range extender, AC-DC transfer standard	Comparison with calibrated source or meter	6	1000	V	Frequency	10 Hz to 1 MHz	9 to 77	µV/V	2	95 %	Yes	AC-DC Voltage	52	Approved on 25 August 2008
AC voltage up to 1000 V: sources	Multifunction calibrator	Comparison with calibrated source or meter	0.002	1000	V	Frequency	10 Hz to 1 MHz	6 to 649	µV/V	2	95 %	Yes	ACV Sources	53	Approved on 22 November 2006
AC voltage up to 1000 V: meters	AC voltmeter, multimeter, multifunction transfer standard	Comparison with calibrated source or meter	0.002	1000	V	Frequency	10 Hz to 1 MHz	9 to 862	µV/V	2	95 %	Yes	ACV Meters	54	Approved on 25 August 2008
AC-DC current transfer: AC-DC transfer difference	Thermal converter plus shunt, AC-DC transfer standard plus shunt	Calibrated shunts, thermal converters and sources	0.0001	20	A	Frequency	40 Hz to 100 kHz	15 to 71	µA/A	2	95 %	Yes	AC-DC Current	57	Approved on 22 November 2006
AC current up to 100 A: sources	Multifunction calibrator, transconductance amplifier	Calibrated shunts, thermal converters and sources	0.0001	2	A	Frequency	40 Hz to 2 kHz	35 to 170	µA/A	2	95 %	Yes		58	Approved on 22 November 2006. For defined burden

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AC current up to 100 A: sources	Multifunction calibrator, transconductance amplifier	Calibrated shunts, current transformers, and ac voltmeters	0.01	100	A	Frequency	47 Hz to 75 Hz	25	µA/A	2	95 %	Yes		58a	Approved on 22 November 2006
AC current up to 100 A: meters	AC ammeter, multimeter, multifunction transfer standard	Calibrated shunts, thermal converters and sources	0.0001	2	A	Frequency	40 Hz to 2 kHz	60 to 140	µA/A	2	95 %	Yes		59	Approved on 22 November 2006
AC current up to 100 A: meters	AC ammeter, multimeter, multifunction transfer standard	Calibrated shunts, current transformers, and ac voltmeters	0.2	100	A	Frequency	47 Hz to 75 Hz	25	µA/A	2	95 %	Yes		59a	Approved on 22 November 2006
AC power and energy: single phase (frequencies below or equal to 400 Hz), active power	Power meter, energy meter, power converter, wattmeter, single phase source	Power bridge	0	24000	W	Power factor, *PF*	1 to 0, inductive or capacitive	(40 + 6(1 - *PF*)), values range from 40 µW/VA to 46 µW/VA	µW/VA	2	95 %	Yes		60	Approved on 10 November 2014
						Voltage	60 V to 240 V								
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								
AC power and energy: single phase (frequencies below or equal to 400 Hz), reactive power	Power meter, energy meter, power converter, wattmeter, VAR meters, single phase source	Power bridge	0	24000	var	Reactive power factor, *QF*	1 to 0, inductive or capacitive	(40 + 90*QF*), values range from 40 µvar/VA to 130 µvar/VA	µvar/VA	2	95 %	Yes		60b	Approved on 10 November 2014
						Voltage	60 V to 240 V								
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								

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AC power and energy: three phase, active power	Power meter, energy meter, power converter, wattmeter, three phase source	Power bridge	0	72000	W	Power factor, *PF*	1 to 0, inductive or capacitive	(40 + 6(1 - *PF*)), values range from 40 µW/VA to 46 µW/VA	µW/VA	2	95 %	Yes		61	Approved on 10 November 2014. Voltage and current ranges are per phase
						Voltage	60 V to 240 V								
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								
AC power and energy: three phase, reactive power	Power meter, energy meter, power converter, wattmeter, VAR meters, three phase source	Power bridge	0	72000	var	Reactive power factor, *QF*	1 to 0, inductive or capacitive	(40 + 90*QF*), values range from 40 µvar/VA to 130 µvar/VA	µvar/VA	2	95 %	Yes		61b	Approved on 10 November 2014. Voltage and current ranges are per phase
						Voltage	60 V to 240 V								
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								
Phase angle: sources	Phase source	Power bridge	-3.14	3.14	rad	Voltage	0.7 V to 7 V, 42 V to 240 V	40	µrad	2	95 %	No		87	Approved on 19 March 2012
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								
Phase angle: meters	Phase meter	Power bridge	-3.14	3.14	rad	Voltage	0.7 V to 7 V, 42 V to 240 V	40	µrad	2	95 %	No		88	Approved on 19 March 2012
						Current	0.01 A to 100 A								
						Frequency	45 Hz to 75 Hz								
High DC voltage: high voltage sources	DC kilovolt source	Reference divider	1100	50000	V	Laboratory temperature	20 °C	0.5 to 3	mV/V	2	95 %	Yes	Mx8.1.1	9	Approved on 10 November 2014
High DC voltage: high voltage meters	DC kilovoltmeter, dedicated set-up for high voltage	Reference divider	1100	50000	V	Laboratory temperature	20 °C	3	mV/V	2	95 %	Yes		10	Approved on 10 November 2014

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High DC voltage: ratios	High voltage resistive divider, DC high voltage probe	Reference divider	2.0E-05	1		Input voltage	1 kV to 50 kV	3	mV/V	2	95 %	Yes		11	Approved on 10 November 2014
AC high voltage: sources	High voltage AC source	Capacitive divider and source	1	35	kV rms	Frequency	50 Hz to 3 kHz	1	mV/V	2	95 %	Yes		55	Approved on 22 November 2006
AC high voltage: meters	AC high voltage meter, dedicated set-up for high voltage measurements (resistive and capacitive dividers)	Capacitive divider and source	1	35	kV rms	Frequency	50 Hz to 3 kHz	1	mV/V	2	95 %	Yes		56	Approved on 22 November 2006
AC high voltage and voltage transformers: voltage transformers: ratio error	Voltage transformer bridge	Inject known error voltage	-0.2	0.2		Frequency	45 Hz to 65 Hz	5E-07 to 8E-05		2	95 %	No	Mx8.3.4	75	Approved on 31 October 2016
						Voltage	5 V to 300 V								
AC high voltage and voltage transformers: voltage transformers: phase displacement	Voltage transformer bridge	Inject known error voltage	-0.2	0.2	rad	Frequency	45 Hz to 65 Hz	5E-07 to 9E-05	rad	2	95 %	No	Mx8.3.4	78	Approved on 31 October 2016
						Voltage	5 V to 300 V								

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
High AC current: ratio error	Current transformer	Arnold test set and calibrated current transformers	-25	25	%	Ratio	0.2 A/A to 4000 A/A	0.0010 to 0.13	%	2	95 %	No	Mx8.6.3	73	Approved on 22 November 2006. Uncertainty dependent on the standard transformer and the range of the test set
						Primary current	1 A to 4000 A								
						Secondary current	1 A, 5 A								
						Frequency	50 Hz								
High AC current: Phase error	Current transformer	Arnold test set and calibrated current transformers	-36	36	crad	Ratio	0.2 A/A to 4000 A/A	0.0010 to 0.18	crad	2	95 %	No	Mx8.6.3	74	Approved on 22 November 2006. Uncertainty dependent on the standard transformer and the range of the test set
						Primary current	1 A to 4000 A								
						Secondary current	1 A, 5 A								
						Frequency	50 Hz								
High AC current and current tranformers: current tranformers: ratio error	Current transformer bridge	Inject known error current	-0.2	0.2		Frequency	45 Hz to 65 Hz	5E-07 to 8E-05		2	95 %	No	Mx8.6.3a	81	Approved on 31 October 2016
						Current	0.01 A to 10 A								

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Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
High AC current and current tranformers: current tranformers: phase displacement	Current transformer bridge	Inject known error current	-0.2	0.2	rad	Frequency	45 Hz to 65 Hz	5E-07 to 9E-05	rad	2	95 %	No	Mx8.6.3a	84	Approved on 31 October 2016
						Current	0.01 A to 10 A								
High DC current: sources	Current generator	Voltage across resistor	100	1000	A			36 to 100	µA/A	2	95 %	Yes	Mx8.7	31a	Approved on 31 October 2016
High DC current: meters	Current transducer, dedicated equipment for heavy current	Voltage across resistor	100	875	A			36 to 90	µA/A	2	95 %	Yes	Mx8.7	33a	Approved on 31 October 2016
Signal and pulse characteristics: pulse amplitude	Pulse generator	Sampling voltmeter	0	10	V	Voltmeter range, *Vr*	10 mV, 100 mV, 1 V, 10 V	(30 + 100*Va* + 420*Vr)* , applied voltage *Va* in V, values range from 34.2 µV to 5230 µV	µV	2	95 %	No		89	Approved on 25 August 2008
						Pulse length	greater than 200 µs								
Signal and pulse characteristics: pulse time parameters, pulse risetime	Pulse generator: risetime *T*	Calibrated oscilloscope	0.005	1.00E+06	µs	Pulse amplitude	10 mV to 10 V	Q[2 ns, 0.05*T*], *T* in s	s	2	95 %	No		90	Approved on 19 March 2012
						Risetime, *T*	Greater than 5 ns								
RF voltage and current: RF-DC difference	Thermal voltage converter	Comparison with calibrated thermal voltage converter	1	3	V	Frequency	1 MHz to 100 MHz	0.16 to 2.6	mV/V	2	95 %	Yes	RF-DC Voltage	64	Approved on 10 November 2014
RF voltage and current: RF voltage sources	RF generator	Comparison with calibrated source or meter	1	3	V	Frequency	1 MHz to 100 MHz	0.3 to 8	mV/V	2	95 %	Yes		65	Approved on 10 November 2014

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						NMI Service Identifier	Comments
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Matrix uncertainty		
RF voltage and current: RF voltage meters	RF voltmeter	Comparison with calibrated source or meter	1	3	V	Frequency	1 MHz to 100 MHz	0.3 to 8	mV/V	2	95 %	Yes		66	Approved on 10 November 2014

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Uncertainty matrix: Mx1.1.1

	Expanded uncertainty / μV
1 V	0.1
1.018 V	0.1
10 V	1.5

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Uncertainty matrix: Mx3

	Expanded uncertainty / (μA/A)
10 pA	560
100 pA	540
1 nA	150
10 nA	20
100 nA	10
1 μA	10
10 μA	5
100 μA	5
1 mA	5
10 mA	5
100 mA	5
1 A	5
10 A	13
20 A	18
100 A	36

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Uncertainty matrix: Inductance

	100 µH	1 mH	10 mH	100 mH	1 H	10 H	100 H
1 Ω	Q[0.000014*L* , 0.001*R* , 0.2/*f*]. Values range from 0.0001 µH to 0.0053 µH						
10 Ω		Q[0.000014*L* , 0.001*R* , 2/*f*]. Values range from 0.001 µH to 0.053 µH					
100 Ω			Q[0.000014*L* , 0.001*R* , 20/*f*]. Values range from 0.01 µH to 0.53 µH				
1 kΩ				Q[0.000014*L* , 0.001*R* , 200/*f*]. Values range from 0.1 µH to 5.3 µH			
10 kΩ					Q[0.000014*L* , 0.001*R* , 2000/*f*]. Values range from 1 µH to 53 µH		
100 kΩ						Q[0.000014*L* , 0.001*R* , 20000/*f*]. Values range from 10 µH to 529 µH	
1 MΩ							Q[0.000014*L* , 0.001*R* , 200000/*f*]. Values range from 100 µH to 5288 µH

Inductance expanded uncertainty expressed in µH as a function of range of the Universal Impedance Bridge

L and *R* are the measured values. *L* is expressed in µH, *R* in Ω and *f* in Hz

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Uncertainty matrix: Series Resistance of Inductor

	100 µH	1 mH	10 mH	100 mH	1 H	10 H	100 H
1 Ω	Q[0.000014R , 0.0000001L , 0.002/f]. Values range from 0.000001 Ω to 0.000053 Ω						
10 Ω		Q[0.000014R , 0.0000001L , 0.02/f]. Values range from 0.00001 Ω to 0.00053 Ω					
100 Ω			Q[0.000014R , 0.0000001L , 0.2/f]. Values range from 0.0001 Ω to 0.0053 Ω				
1 kΩ				Q[0.000014R , 0.0000001L , 2/f]. Values range from 0.001 Ω to 0.053 Ω			
10 kΩ					Q[0.000014R , 0.0000001L , 20/f]. Values range from 0.01 Ω to 0.53 Ω		
100 kΩ						Q[0.000014R , 0.0000001L , 200/f]. Values range from 0.1 Ω to 5.3 Ω	
1 MΩ							Q[0.000014R , 0.0000001L , 2000/f]. Values range from 1 Ω to 53 Ω

Resistance expanded uncertainty expressed in Ω as a function of range of the Universal Impedance Bridge

L and R are the measured values. L is expressed in µH, R in Ω and f in Hz

New Zealand, MSL (Measurement Standards Laboratory)

Uncertainty matrix: AC-DC Voltage

	10 Hz	20 Hz	40 Hz	53 Hz	100 Hz	1 kHz	5 kHz	10 kHz	20 kHz	30 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	800 kHz	1 MHz
2 mV	-	-	-	-	193	179	-	172	172	-	187	184	-	211	237	-	321
10 mV	130	87	61	60	59	60	61	61	61	-	64	72	-	99	141	189	205
20 mV	114	66	45	45	45	46	-	48	48	-	51	64	-	94	129	-	189
100 mV	83	43	28	28	28	29	31	32	33	-	34	39	-	60	80	132	143
200 mV	76	37	25	25	24	25	-	28	30	-	31	40	-	63	85	-	167
300 mV	58	31	-	-	21	21	-	26	28	-	29	37	-	57	71	-	133
600 mV	41	25	-	-	11	11	-	11	11	-	14	18	-	33	40	-	66
1 V	29	18	7	7	7	7	-	8	9	-	14	18	-	32	41	52	58
2 V	36	18	6	7	6	6	-	6	8	-	13	16	-	27	36	-	49
3 V	29	18	-	6	6	6	-	6	8	-	13	16	-	38	48	-	54
6 V	31	18	-	9	9	9	-	9	10	-	14	18	-	38	52	-	77
10 V	32	18	9	9	9	9	-	9	10	-	13	18	-	36	46	65	76
20 V	31	19	9	10	9	9	-	10	11	-	14	19	-	39	56	-	-
30 V	31	19	-	-	13	12	-	14	13	-	17	22	36	-	-	-	-
60 V	31	19	-	-	14	13	-	14	13	-	18	24	-	-	-	-	-
100 V	33	20	13	13	13	13	-	13	13	-	18	24	-	-	-	-	-
200 V	31	20	14	14	15	14	-	15	14	-	19	26	-	-	-	-	-
300 V	-	22	-	-	-	-	-	15	-	-	-	27	-	-	-	-	-
600 V	-	-	16	16	16	16	-	18	19	21	28	39	-	-	-	-	-
1000 V	-	-	18	17	17	17	-	19	22	26	36	51	-	-	-	-	-

The expanded uncertainties given in this table are expressed in µV/V

New Zealand, MSL (Measurement Standards Laboratory)

Uncertainty matrix: ACV Sources

	10 Hz	20 Hz	40 Hz	53 Hz	100 Hz	1 kHz	10 kHz	20 kHz	30 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	1 MHz
2 mV					241	190	224	195		205	210		250	435	605
10 mV	133	88	65	65	61	61	61	62		65	96		194	244	564
20 mV	115	66	45	45	46	46	48	49		53	77		178	269	454
100 mV	86	45	29	29	28	29	33	33		36	40		67	97	195
200 mV	76	37	25	25	24	25	29	30		31	40		63	79	147
300 mV					21	21	26	28		29	37		72	138	533
600 mV	41	25			11	11	11	11		14	18		54	140	525
1 V	33	18	7	7	7	7	8	9		13	17	25	50	144	536
2 V	36	18	6	7	6	6	7	9		12	15	22	51	150	587
3 V	32	19		6	6	6	7	8		12	16	22	197	321	649
6 V	31	18		10	9	9	9	10		13	18		196	293	648
10 V	47	18	9	9	9	9	9	10		13	17		192	285	616
20 V	31	19	9	10	9	9	10	11		14	19	31	194	295	
30 V	40	32			13	13	14	13		17	22	38			
60 V	31	19			13	14	14	13		17	23				
100 V	36	20	14	13	13	14	14	13		18	24				
200 V	30	20	14	14	15	14	15	14		19	26				
300 V				16		16									
600 V				16	16	17									
1000 V				17	17	17									

The expanded uncertainties given in this table are expressed in µV/V

New Zealand, MSL (Measurement Standards Laboratory)

Uncertainty matrix: ACV Meters

	10 Hz	20 Hz	40 Hz	53 Hz	100 Hz	1 kHz	10 kHz	20 kHz	30 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	1 MHz
2 mV	-	-	-	-	238	227	221	221	-	233	270	-	364	593	862
6 mV	223	153	113	111	110	111	113	113	-	118	130	-	172	298	433
10 mV	135	94	70	69	68	69	70	70	-	73	80	-	104	145	208
20 mV	115	68	49	48	48	49	51	51	-	54	66	-	96	130	189
60 mV	139	73	48	48	48	49	54	56	-	58	66	-	100	134	239
100 mV	84	44	30	30	30	31	34	35	-	36	40	-	61	81	144
200 mV	76	38	26	26	25	26	29	31	-	32	41	-	64	86	168
300 mV	58	32	-	-	23	23	27	29	-	30	38	-	58	71	133
600 mV	41	26	-	-	13	12	12	12	-	15	19	-	34	41	66
1 V	31	21	13	13	13	13	13	14	-	17	21	-	34	42	59
2 V	36	19	9	9	9	9	9	10	-	14	17	-	28	36	50
3 V	30	20	-	10	10	10	10	12	-	15	18	-	39	48	54
6 V	32	20	-	12	12	12	12	13	-	16	20	-	39	52	78
10 V	33	20	12	12	12	12	12	13	-	15	19	-	37	47	77
20 V	32	21	12	13	12	12	13	14	-	16	20	-	39	57	-
30 V	32	20	-	-	15	14	16	16	-	19	23	37	-	-	-
60 V	32	21	-	-	16	15	16	15	-	19	25	-	-	-	-
100 V	34	21	16	16	15	15	16	15	-	20	25	-	-	-	-
200 V	32	22	16	16	17	16	17	16	-	20	27	-	-	-	-
300 V	-	23	-	-	-	-	17	-	-	-	28	-	-	-	-
600 V	-	-	18	18	18	18	19	20	22	29	39	-	-	-	-
1000 V	-	-	20	19	19	19	21	24	28	37	51	-	-	-	-

The expanded uncertainties given in this table are expressed in µV/V

New Zealand, MSL (Measurement Standards Laboratory)

Uncertainty matrix: AC-DC Current

	40 Hz	53 Hz	400 Hz	1 kHz	2 kHz	5 kHz	10 kHz	20 kHz	50 kHz	100 kHz
0.1 mA	26	38		26	26					
1 mA	24	24		24	24					
10 mA	15	15	15	15	15	15	15	15	32	33
20 mA	15	15	15	15	15	15	15	23	32	32
50 mA	18	18	18	18	19	18	18	22	32	51
100 mA	18	18	18	18	18	18	21	30	37	
200 mA	23	23	23	22	25	22	25	34	43	
500 mA	27	28	27	27	27	27	28	54		
1 A	27	27	27	27	27	32	43			
2 A	27	27	27	27	27	32	41			
5 A	27	27	27	27	27	51	71			
10 A	27	27	27	28	27	51	71			
20 A	27	28	27	29	27	51				

The expanded uncertainties given in this table are expressed in μA/A

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Uncertainty matrix: Mx8.1.1

	Expanded uncertainty / (mV/V)
1100 V to 1500 V	0.5
1500 V to 50 kV	3

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Uncertainty matrix: Mx8.3.4

	Expanded uncertainty	
Ratio error or (Phase error) / rad	Ratio	Phase / rad
±(0 to 0.002)	5E-07 to 1.0E-06	5E-07 to 1.0E-06
±(0.002 to 0.02)	2E-06 to 8E-06	5E-06 to 9E-06
±(0.02 to 0.2)	2E-05 to 8E-05	5E-05 to 9E-05

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Uncertainty matrix: Mx8.6.3

		Expanded Uncertainty			
		1 A to 500 A Primary		>500 A to 4000 A Primary	
Ratio Error	Phase Displacement	Ratio Error	Phase Displacement	Ratio Error	Phase Displacement
Magnitude	Magnitude				
(%)	(crad)	(%)	(crad)	(%)	(crad)
0	0	0.0010	0.0010	0.0041	0.0041
0.5	0.7	0.0027	0.0038	0.0048	0.0055
1	1	0.0051	0.0073	0.0065	0.0084
5	7	0.025	0.036	0.025	0.037
7.5	11	0.10	0.11	0.10	0.11
25	36	0.13	0.18	0.13	0.18

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Uncertainty matrix: Mx8.6.3a

	Expanded uncertainty	
Ratio error or (Phase error) / rad	Ratio	Phase / rad
±(0 to 0.002)	5E-07 to 1.0E-06	5E-07 to 1.0E-06
±(0.002 to 0.02)	2E-06 to 8E-06	5E-06 to 9E-06
±(0.02 to 0.2)	2E-05 to 8E-05	5E-05 to 9E-05

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Uncertainty matrix: Mx8.7

	Expanded uncertainty / (μA/A)
100 A	36
200 A	50
500 A	70
875 A	90
1000 A (8.7.1 only)	100

New Zealand, MSL (Measurement Standards Laboratory)

Uncertainty matrix: RF-DC_Voltage

	1 MHz	3 MHz	10 MHz	30 MHz	50 MHz	70 MHz	100 MHz
1 V	0.16	0.30	0.7	1.6	2.5	2.5	2.6
3 V	0.16	0.30	0.7	1.6	2.5	2.5	2.6

The expanded uncertainties given in this table are expressed in mV/V