Electricity and Magnetism, Thailand, NIMT (National Institute of Metrology (Thailand))

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
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?**	**Uncertainty Table**	**NMI Service Identifier**	**Comments**
DC voltage sources: single values	Solid state voltage standard, standard cell	Compare against reference standard	1	10	V	Temperature	23 °C	0.03 to 0.9	µV/V	2	95%	Yes	Mx1.1.1	1.1.1	Approved on 31 October 2016
DC voltage sources: low values	DC voltage source, multifunction calibrator	Compare against DC standard	0	10	V			0.5 to 7	µV	2	95%	No	Mx1.1.2	1.1.2	Approved on 31 October 2016
DC voltage sources: intermediate values	DC voltage source, multifunction calibrator	Compare against DC standard	> 10	1000	V			20 to 1000	µV	2	95%	No	Mx1.1.3	1.1.3	Approved on 31 October 2016
DC resistance sources: low values	Fixed resistor	DCC bridge and range extender	0.001	1	Ω	Test current	0.1 A to 100 A	1.5 to 2.8	µΩ/Ω	2	95%	Yes	Mx2.1	2.1.1	Approved on 31 October 2016
						Oil bath temperature	23 °C								
DC resistance sources: intermediate values	Fixed resistor	DCC bridge, Wheastone bridge	1E-05	1	MΩ	Voltage	1 V	1.6 to 18	µΩ/Ω	2	95%	Yes	Mx2.1	2.1.2	Approved on 31 October 2016
DC resistance sources: high values	Fixed resistor	Wheastone bridge	1E-05	1	TΩ	Test voltage	1 V to 100 V	0.032 to 4.2	mΩ/Ω	2	95%	Yes	Mx2.1	2.1.3	Approved on 31 October 2016

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
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?	Uncertainty Table	NMI Service Identifier	Comments
DC current sources: low values	Current generator, multifunction calibrator	V/A method	10	100	µA			7.5 to 8.5	µA/A	2	95%	Yes	Mx3.1.1	3.1.1	Approved on 31 October 2016
DC current sources: intermediate values	Current generator, multifunction calibrator	V/A method	0.001	10	A			7 to 9	µA/A	2	95%	Yes	Mx3.1.2	3.1.2	Approved on 31 October 2016
DC current sources: high values	Current generator	V/A method	100	100	A			9.5	µA/A	2	95%	Yes		3.1.3	Approved on 31 October 2016
Capacitance and dissipation factor: low loss capacitor	Standard capacitor (air, fused silica) 3 terminal	Compare against reference standard	10	1000	pF	Frequency	1 kHz	24 to 36	µF/F	2	95%	Yes	Mx4.2.1	4.2.1	Approved on 31 October 2016
Capacitance and dissipation factor: dielectric capacitor	Fixed capacitor, capacitance box (2 and 3 terminal)	Compare against reference standard	1E-06	1	µF	Frequency	100 Hz, 120 Hz, 200 Hz, 400 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz	0.12 to 2.3	mF/F	2	95%	Yes	Mx4.2.2	4.2.2	Approved on 31 October 2016

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
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?	Uncertainty Table	NMI Service Identifier	Comments
Inductance: self inductance and equivalent series resistance, low values (< 1 mH)	Fixed inductor	Compare against reference standard	100	100	µH	Frequency	1 kHz	0.35	mH/H	2	95%	Yes		4.3.1	Approved on 31 October 2016
Inductance: self inductance and equivalent series resistance, intermediate values	Fixed inductor	Compare against reference standard	0.01	1	H	Frequency	1 kHz	0.23	mH/H	2	95%	Yes	Mx4.3	4.3.2	Approved on 31 October 2016
Inductance: self inductance and equivalent series resistance, high values (> 1 H)	Fixed inductor	Compare against reference standard	10	10	H	Frequency	1 kHz	0.23	mH/H	2	95%	Yes		4.3.3	Approved on 31 October 2016
AC-DC voltage transfer: AC-DC transfer difference at low voltages	Thermal converters, AC-DC transfer standard	AC-DC comparison	0.01	0.5	V	Frequency	10 Hz to 1 MHz	13 to 250	µV/V	2	95%	Yes	Mx5.1.1	5.1.1	Approved on 31 October 2016
AC-DC voltage transfer: AC-DC transfer difference at medium voltages	Thermal converters, AC-DC transfer standard	AC-DC comparison	0.6	5	V	Frequency	10 Hz to 1 MHz	13 to 32	µV/V	2	95%	Yes	Mx5.1.2	5.1.2	Approved on 31 October 2016

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty							
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?	Uncertainty Table	NMI Service Identifier	Comments
AC-DC voltage transfer: AC-DC transfer difference at higher voltages voltages	Thermal converters, AC-DC transfer standard	AC-DC comparison	7	1000	V	Frequency	10 Hz to 1 MHz	13 to 81	µV/V	2	95%	Yes	Mx5.1.3	5.1.3	Approved on 31 October 2016
AC voltage up to 1000 V: sources	Multifunction calibrator	AC-DC transfer standard	0.01	1000	V	Frequency	10 Hz to 1 MHz	20 to 580	µV/V	2	95%	Yes	Mx5.2.1	5.2.1	Approved on 31 October 2016
AC voltage up to 1000 V: meters	AC voltmeter, multifunction transfer standard, AC measurement standard	AC-DC transfer standard	0.01	1000	V	Frequency	10 Hz to 1 MHz	16 to 580	µV/V	2	95%	Yes	Mx5.2.2	5.2.2	Approved on 31 October 2016
AC current up to 100 A: sources	Multifunction calibrator	AC-DC current transfer	0.0025	20	A	Frequency	10 Hz to 100 kHz	0.069 to 0.20	mA/A	2	95%	Yes	Mx6.2.1	6.2.1	Approved on 31 October 2016
RF attenuation in coaxial line	Fixed and variable attenuator 50 ohm, N	IF substitution method	10	60	dB	Frequency	10 MHz to 18 GHz	0.012 to 0.14	dB	2	95%	No	Mx11.2.3	11.2.3	Approved on 31 October 2016

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Matrix Mx1.1.1

	Relative expanded uncertainty / (μV/V)	Method
1 V	0.09	Comparison against Josephson junction voltage standard
1.018 V	0.09	Comparison against Josephson junction voltage standard
10 V	0.03	Comparison against Josephson junction voltage standard
1.018 V	0.9	Comparison against Zener voltage standard
10 V	0.4	Comparison against Zener voltage standard

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Matrix Mx1.1.2

	Expanded uncertainty / (μV)
100 mV	0.5
1 V	0.6
0 V to 10 V	(0.5v + 2), v in V

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Matrix Mx1.1.3

	Expanded uncertainty / (μV)
100 V	50
1000 V	700
> 10 V to 100 V	(0.5v + 15), v in V
> 100 V to 1000 V	(0.8v + 200), v in V

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Matrix Mx2.1

	Test current/voltage	Method	Relative expanded uncertainty / (μΩ/Ω)
1 mΩ	10 A to 100 A	DCC with range extender	2.8
10 mΩ	1 A to 10 A	DCC with range extender	2.3
100 mΩ	0.1 A to 1 A	DCC with range extender	2.3
1 Ω	100 mA	DCC	1.5
10 Ω	30 mA	DCC	1.6
100 Ω	10 mA	DCC	2.2
1 kΩ	3 mA	DCC	2.5
10 kΩ	1 mA	DCC	2.4
100 kΩ	0.1 mA	DCC	2.5
1 MΩ	1 V	Wheatstone bridge	18
10 MΩ	1 V	Wheatstone bridge	32
100 MΩ	5 V	Wheatstone bridge	120
1 GΩ	20 V	Wheatstone bridge	690
10 GΩ	50 V	Wheatstone bridge	880
100 GΩ	100 V	Wheatstone bridge	4200
1 TΩ	100 V	Wheatstone bridge	4200

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Matrix Mx3.1.1

	Relative expanded uncertainty / (μA/A)
10 μA	8.5
100 μA	7.5

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Matrix Mx3.1.2

	Relative expanded uncertainty / (μA/A)
1 mA	7
10 mA	8.5
100 mA	8.5
1 A	8.5
10 A	9

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Matrix Mx4.2.1

		Relative expanded uncertainty / (μF/F)
	Capacitance	1 kHz
3 terminal Low loss capacitors	10 pF	36
3 terminal Low loss capacitors	100 pF	24
3 terminal Low loss capacitors	1000 pF	24

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Matrix Mx4.2.2

		Relative expanded uncertainty / (mF/F)								
	Capacitance	100 Hz	120 Hz	200 Hz	400 Hz	500 Hz	1 kHz	2 kHz	5 kHz	10 kHz
2 terminal capacitor	1000 pF	-	-	-	-	-	0.12	0.12	0.12	0.12
2 terminal capacitor	10 nF	-	-	-	-	-	0.12	0.12	0.12	0.12
2 terminal capacitor	100 nF	-	-	-	-	-	0.12	0.12	0.12	0.26
2 terminal capacitor	1 µF	-	-	-	-	-	0.12	0.12	0.6	2.3
3 terminal capacitor	1 pF	-	-	-	-	-	0.15	0.15	0.15	0.15
3 terminal capacitor	10 pF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
3 terminal capacitor	100 pF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
3 terminal capacitor	1000 pF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
3 terminal capacitor	10 nF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
3 terminal capacitor	100 nF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.26
3 terminal capacitor	1 µF	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.6	2.3

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Matrix Mx4.3

		Relative expanded uncertainty / (mH/H)
	Self inductance	1 kHz
2 terminal inductor	100 µH	0.35
2 terminal inductor	10 mH	0.23
2 terminal inductor	100 mH	0.23
2 terminal inductor	1 H	0.23
2 terminal inductor	10 H	0.23

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Matrix Mx5.1.1

	Relative expanded uncertainty / (μV/V)											
	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
10 mV	106	106	85	81	81	81	81	100	150	150	250	250
20 mV	76	76	61	61	61	61	61	71	140	140	200	200
60 mV	66	66	47	47	47	47	47	52	100	100	150	150
100 mV/200 mV	37	37	24	24	24	24	24	32	76	76	120	120
300 mV/500 mV	16	16	16	13	13	13	13	14	21	21	32	32

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Matrix Mx5.1.2

	Relative expanded uncertainty / (μV/V)											
	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
600 mV/700 mV	16	16	16	13	13	13	13	14	21	21	32	32
1 V/2 V	16	16	16	13	13	13	13	14	21	21	32	32
3 V/4 V	16	16	16	13	13	13	13	14	21	21	32	32
5 V	16	16	16	13	13	13	13	14	21	21	32	32

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Matrix Mx5.1.3

	Relative expanded uncertainty / (μV/V)											
	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
7 V	16	16	16	13	13	13	13	14	21	21	32	32
10 V	16	16	16	13	13	13	13	14	21	21	32	32
20 V	24	24	23	16	16	19	19	19	30	30	42	42
30 V	24	24	23	16	16	19	19	19	30	30	42	42
40 V/50 V	32	32	24	16	16	24	24	28	-	-	-	-
60 V/70 V	32	32	24	16	16	24	24	28	-	-	-	-
100 V	32	32	24	16	16	24	24	28	-	-	-	-
200 V/300 V	32	32	24	16	16	24	24	28	-	-	-	-
500 V	42	42	32	24	24	32	32	42	-	-	-	-
1000 V	52	52	45	28	28	61	61	81	-	-	-	-

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Matrix Mx5.2.1

	Relative expanded uncertainty / (μV/V)											
	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
10 mV	110	110	93	93	93	93	93	110	280	280	340	340
20 mV	82	82	69	69	69	69	69	80	270	270	310	310
60 mV	71	71	53	53	53	53	53	61	250	250	280	280
100 mV/200 mV	45	45	34	34	34	34	34	47	240	240	260	260
300 mV/500 mV	23	23	23	21	21	21	21	31	230	230	230	230
600 mV/700 mV	23	23	23	21	21	21	21	31	230	230	230	230
1 V/2 V	20	20	20	20	20	20	20	29	180	180	350	350
3 V/4 V	20	20	20	20	20	20	20	29	180	180	350	350
5 V/6 V	20	20	20	20	20	20	20	29	180	180	350	350
7 V	20	20	20	20	20	20	20	29	180	180	350	350
10 V	29	29	29	23	23	24	24	24	230	230	580	580
20 V	29	29	29	23	23	24	24	24	230	230	580	580
30 V	29	29	29	23	23	24	24	24	230	230	580	580
40 V/50 V	35	35	27	21	21	26	26	31	-	-	-	-
60 V/70 V	35	35	27	21	21	26	26	31	-	-	-	-
100 V	35	35	27	21	21	26	26	31	-	-	-	-
200 V/300 V	35	35	27	21	21	26	26	31	-	-	-	-
500 V	44	44	35	27	27	35	35	44	-	-	-	-
1000 V	54	54	47	31	31	63	63	82	-	-	-	-

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Matrix Mx5.2.2

	Relative expanded uncertainty / (μV/V)											
	10 Hz	20 Hz	30 Hz to 300 Hz	400 Hz to 10 kHz	20 kHz to 30 kHz	50 kHz	70 kHz	100 kHz	200 kHz to 300 kHz	500 kHz	700 kHz to 800 kHz	1 MHz
10 mV	110	110	93	90	90	90	90	110	280	280	340	340
20 mV	79	79	65	65	65	65	65	74	270	270	310	310
60 mV	67	67	48	48	48	48	48	57	250	250	280	280
100 mV/200 mV	38	38	25	25	25	25	25	41	240	240	260	260
300 mV/500 mV	20	20	20	18	18	18	18	29	230	230	230	230
600 mV/700 mV	20	20	20	18	18	18	18	29	230	230	230	230
1 V/2 V	16	16	16	16	16	16	16	27	180	180	350	350
3 V/4 V	16	16	16	16	16	16	16	27	180	180	350	350
5 V/6 V	16	16	16	16	16	16	16	27	180	180	350	350
7 V	16	16	16	16	16	16	16	27	180	180	350	350
10 V	29	29	29	23	23	24	24	24	230	230	580	580
20 V	29	29	29	23	23	24	24	24	230	230	580	580
30 V	29	29	29	23	23	24	24	24	230	230	580	580
40 V/50 V	33	33	25	18	18	25	25	29	-	-	-	-
60 V/70 V	33	33	25	18	18	25	25	29	-	-	-	-
100 V	33	33	25	18	18	25	25	29	-	-	-	-
200 V/300 V	33	33	25	18	18	25	25	29	-	-	-	-
500 V	43	43	33	25	25	33	33	43	-	-	-	-
1000 V	52	52	43	29	29	63	63	81	-	-	-	-

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Matrix Mx11.2.3

	10 MHz to 100 MHz	100 MHz to 6 GHz	6 GHz to 18 GHz	Instrument
10 dB	0.076 dB	0.12 dB	0.14 dB	Fixed attenuator
20 dB	0.076 dB	0.12 dB	0.14 dB	Fixed attenuator
30 dB	0.078 dB	0.12 dB	0.14 dB	Fixed attenuator
40 dB	0.078 dB	0.12 dB	0.14 dB	Fixed attenuator
50 dB	0.082 dB	0.12 dB	0.14 dB	Fixed attenuator
60 dB	0.082 dB	0.12 dB	0.14 dB	Fixed attenuator
10 dB	0.012 dB	0.028 dB	0.062 dB	Variable attenuator
20 dB	0.012 dB	0.028 dB	0.062 dB	Variable attenuator
30 dB	0.014 dB	0.030 dB	0.065 dB	Variable attenuator
40 dB	0.014 dB	0.030 dB	0.065 dB	Variable attenuator
50 dB	0.027 dB	0.038 dB	0.070 dB	Variable attenuator
60 dB	0.027 dB	0.038 dB	0.070 dB	Variable attenuator

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Matrix Mx6.2.1

	Relative expanded uncertainty / (μA/A)											
	10 Hz	20 Hz	30 Hz	40 Hz	500 Hz	1 kHz	5 kHz	10 kHz	20 kHz	50 kHz	70 kHz	100 kHz
2.5 mA	69	69	69	69	69	69	69	69	69	71	73	75
5 mA/10 mA	69	69	69	69	69	69	69	69	69	71	73	75
20 mA	69	69	69	69	69	69	69	69	69	71	73	75
30 mA/50 mA	70	70	70	70	70	70	70	70	70	73	75	77
100 mA	70	70	70	70	70	70	70	70	71	75	77	79
200 mA	71	71	71	71	71	71	71	71	73	77	79	82
300 mA	71	71	71	71	71	71	71	71	75	79	82	85
500 mA	71	71	71	71	71	71	71	71	77	82	85	88
1 A	73	73	73	73	73	73	73	73	79	91	98	113
2 A	73	73	73	73	73	73	73	73	83	98	105	121
3 A	75	75	75	75	75	75	75	75	94	121	142	165
5 A	79	79	79	79	79	79	79	79	98	130	156	202
10 A	85	85	85	85	85	85	85	85	98	100	110	110
20 A	70	70	70	70	70	70	70	70	110	110	110	120