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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix	Comments	NMI	NMI Service Identifier
DC voltage sources: single values	Standard cell, solid state voltage standard	Direct comparison with JAVS	1	10	V	Voltage	1 V, 1.018 V, 10 V	50	nV/V	2	95%	Yes		Approved on 06 August 2013	CEM	1
DC voltage sources: single values	Standard cell, solid state voltage standard	Direct comparison with calibrated standards	1	10	V	Voltage	1 V, 1.018 V, 10 V	300	nV/V	2	95%	Yes		Approved on 06 August 2013	CEM	114
DC voltage sources: low values	DC voltage source	Comparison to a characterised voltmeter	0.1	10	V			20 to 1000	nV/V	2	95%	Yes		Approved on 06 August 2013	CEM	115
DC voltage sources: low values	DC voltage source	Comparison to a voltage standard and a resistive divider	0.1	1000	mV			20 to 1000	nV	2	95%	No		Approved on 06 August 2013	CEM	4
DC voltage sources: intermediate values	DC voltage source	Comparison to a voltage standard and a resistive divider	10	1000	V			1	µV/V	2	95%	Yes		Approved on 06 August 2013	CEM	3
DC voltage meters: very low values	Nanovoltmeter, microvoltmeter	Comparison to a voltage standard and a resistive divider	0.1	1	mV			20	nV	2	95%	No		Approved on 06 August 2013	CEM	6a
DC voltage meters: intermediate values	Voltmeter, multimeter	Direct comparison with Josephson standard	0.1	10	V			20 to 500	nV	2	95%	No		Linearity, voltmeters from 7 1/2 digits Approved on 06 August 2013	CEM	116
DC voltage meters: intermediate values	Nanovoltmeter, microvoltmeter, voltmeter, multimeter	Comparison to a voltage standard and a resistive divider	0.001	1000	V			Q(0.02, 1E-06*V*), *V* in V	µV	2	95%	No		Approved on 06 August 2013	CEM	7
DC voltage ratios up to 1100 V	Resistive divider	Comparison to a reference divider	0.01	0.1		Maximum input voltage	1100 V	0.85E-06		2	95%	Yes		Approved on 06 August 2013	CEM	8
DC resistance standards and sources: low values	Fixed resistor	DCC bridge	0.001	1	Ω	Temperature	20 ºC to 25 ºC	0.1 to 2	µΩ/Ω	2	95%	Yes	Tab2.1.1	Oil and air baths Approved on 06 August 2013	CEM	9

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
DC resistance standards and sources: intermediate values	Fixed resistor	DCC bridge by substitution and/or Hamon transfer/Josephson potentiometer/High resistance bridge	1	1.00E+06	Ω	Temperature	20 ºC to 25 ºC	0.04 to 2	μΩ/Ω	2	95%	Yes	Tab2.1.23	Oil and air baths Approved on 06 August 2013	CEM	10
DC resistance standards and sources: high values	Fixed resistor	High resistance bridge by substitution and Hamon transfer	1	100	MΩ	Temperature	20 ºC to 25 ºC	3 to 4	μΩ/Ω	2	95%	Yes	Tab2.1.23	Oil and air baths Approved on 06 August 2013	CEM	11
DC resistance standards and sources: high values	Fixed resistor	High resistance bridge	0.1	1	GΩ	Voltage	10 V to 100 V	8	μΩ/Ω	2	95%	Yes		Oil and air baths Approved on 06 August 2013	CEM	96
Capacitance: low loss capacitors	Standard capacitors (fused silica)	Transformer bridge by substitution	1	100	pF	Frequency	1 kHz	3	µF/F	2	95%	Yes		Approved on 06 August 2013	CEM	19
Capacitance: low loss capacitors	Standard capacitors (dry nitrogen)	Transformer bridge by substitution	10	1000	pF	Frequency	1 kHz	6 to 15	µF/F	2	95%	Yes	Unc-tab4.2.1	Approved on 06 August 2013	CEM	20
Capacitance: dielectric capacitors	Standard capacitors (mica)	Direct comparison	1	1000	nF	Frequency	1 kHz	100	µF/F	2	95%	Yes		Approved on 06 August 2013	CEM	21
AC voltage: AC-DC transfer difference at low voltages	AC-DC transfer standard, thermal converter	Comparison	0.002	0.5	V	Frequency	10 Hz to 1 MHz	15 to 400	µV/V	2	95%	Yes	Unc-tab1	Approved on 06 August 2013	CEM	22
AC voltage: AC-DC transfer difference at medium voltages	AC-DC transfer standard, thermal converter	Comparison	0.5	6	V	Frequency	10 Hz to 1 MHz	4 to 25	µV/V	2	95%	Yes	Unc-tab1	Approved on 06 January 2015	CEM	23
AC voltage: AC-DC transfer difference at higher voltages	AC-DC transfer standard, thermal converter	Comparison	6	1000	V	Frequency	10 Hz to 1 MHz	6 to 60	µV/V	2	95%	Yes	Unc-tab1	Approved on 06 January 2015	CEM	24
AC voltage up to 1000 V: sources	Multifunction calibrator	AC-DC transfer plus DC-value	0.002	1000	V	Frequency	10 Hz to 1 MHz	25 to 900	µV/V	2	95%	Yes	Unc-tab2	Approved on 06 January 2015	CEM	35

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
AC voltage up to 1000 V: meters	AC voltmeter, multimeter	AC-DC transfer plus DC-value	0.002	1000	V	Frequency	10 Hz to 1 MHz	25 to 900	µV/V	2	95%	Yes	Unc-tab2	Voltmeters and multimeters from 6 1/2 digits Approved on 06 January 2015	CEM	41
AC current: AC-DC transfer difference	Thermal current converter	Comparison	0.005	100	A	Frequency	10 Hz to 100 kHz	4 to 220	µA/A	2	95%	Yes	Unc-tab3	Approved on 06 August 2013	CEM	47
AC current up to 100 A: sources	Multifunction calibrator, transconductance amplifier	AC-DC transfer plus DC values	0.005	100	A	Frequency	10 Hz to 100 kHz	60 to 500	µA/A	2	95%	Yes	Unc-tab 6.2.1	Approved on 06 January 2015	CEM	
AC current up to 100 A: meters	AC ammeters, multimeters, multifuction transfer standards	AC-DC transfer plus DC values	0.005	20	A	Frequency	10 Hz to 100 kHz	100 to 400	µA/A	2	95%	Yes	Unc-tab 6.2.2	Approved on 06 January 2015	CEM	
AC power and energy: single phase (*f* <= 400 Hz), active power	Power converter, power meter	Comparison	0	48000	W	Voltage	0.5 V to 480 V	40 to 140	µW/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	52
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: single phase (*f* <= 400 Hz), active energy	Energy meter	Comparison	0	1333.33	Wh	Voltage	0.5 V to 480 V	40 to 140	µWh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	53
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
						Measuring time	100 s									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
AC power and energy: single phase (*f* <= 400 Hz), reactive power	Power meter	Comparison	0	48000	var	Voltage	0.5 V to 480 V	40 to 140	µvar/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	56
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: single phase (*f* <= 400 Hz), reactive energy	Energy meter	Comparison	0	1333.33	varh	Voltage	0.5 V to 480 V	40 to 140	µvarh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	57
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
						Measuring time	100 s									
AC power and energy: single phase (*f* <= 400 Hz), apparent power	Power meter	Comparison	0	48000	VA	Voltage	0.5 V to 480 V	40 to 140	µVA/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	119
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: single phase (*f* <= 400 Hz), apparent energy	Energy meter	Comparison	0	1333.33	VAh	Voltage	0.5 V to 480 V	40 to 140	µVAh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	120
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix	Comments	NMI	NMI Service Identifier
						Measuring time	100 s									
AC power and energy: three phase, active power	Power converter, power meter	Comparison	0	144	kW	Voltage	0.5 V to 480 V	40 to 140	µW/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: three phase, active energy	Energy meter	Comparison	0	4	kWh	Voltage	0.5 V to 480 V	40 to 140	µWh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
						Measuring time	100 s									
AC power and energy: three phase, reactive power	Power meter	Comparison	0	144	kvar	Voltage	0.5 V to 480 V	40 to 140	µvar/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: three phase, reactive energy	Energy meter	Comparison	0	4	kvarh	Voltage	0.5 V to 480 V	40 to 140	µvarh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
						Measuring time	100 s									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
AC power and energy: three phase, apparent power	Power meter	Comparison	0	144	kVA	Voltage	0.5 V to 480 V	40 to 140	µVA/VA	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
AC power and energy: three phase, apparent energy	Energy meter	Comparison	0	4	kVAh	Voltage	0.5 V to 480 V	40 to 140	µVAh/VAh	2	95%	Yes	Unc-tab7.1	Approved on 06 January 2015	CEM	
						Current	0.005 A to 100 A									
						Frequency	45 Hz to 65 Hz									
						Power factor	1 to 0, inductive or capacitive									
						Measuring time	100 s									
High DC voltage: high voltage sources	High DC voltage sources	Comparison with reference system	1	200	kV			100 (50 for 1 kV level)	mV/kV	2	95%	Yes		Approved on 06 August 2013	LCOE	59
High DC voltage: high voltage meters	Measuring system for high DC voltage	Comparison with reference system	1	200	kV			100 (50 for 1 kV level)	mV/kV	2	95%	Yes		Approved on 06 August 2013	LCOE	60
High DC voltage: ratios	DC high voltage dividers, DC high voltage probes	Comparison with reference divider	1E-06	1		Voltage	1 kV to 200 kV	100 (50 for 1 kV level)	1E-06	2	95%	Yes		Approved on 06 August 2013	LCOE	61
AC high voltage: sources	High voltage AC source	Comparison with reference system	1	200	kV	Frequency	50 Hz, 60 Hz	500	mV/kV	2	95%	Yes		Approved on 06 August 2013	LCOE	62
AC high voltage: meters, rms values	AC high voltage measuring system	Comparison with reference system	1	200	kV	Frequency	50 Hz, 60 Hz	500	mV/kV	2	95%	Yes		Approved on 06 August 2013	LCOE	63
AC high voltage: peak values	AC measuring system	Comparison with reference system	1	200	kV	Frequency	50 Hz, 60 Hz	500	mV/kV	2	95%	Yes		Approved on 06 August 2013	LCOE	64
AC high voltage: ratio error	High voltage transformer, high voltage divider	Bridge	0	2E-02		Primary voltage	1 kV to 200 kV	50E-06 to 200E-06		2	95%	No	LCOE_Unc-tab8.3.4.a	Approved on 06 August 2013	LCOE	65

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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?	Uncertainty matrix	Comments	NMI	NMI Service Identifier
						Secondary voltage	100 V to 110 V									
						Frequency	50 Hz, 60 Hz									
AC high voltage: ratio: phase displacement	High voltage transformer, high voltage divider: phase displacement	Bridge	1E-06	2	crad	Primary voltage	1 kV to 200 kV	0.003 to 0.02	crad	2	95%	No	LCOE_Unc-tab8.3.4.b	Approved on 06 August 2013	LCOE	66
						Secondary voltage	100 V to 110 V									
						Frequency	50 Hz, 60 Hz									
Pulsed high voltage and current: lightning impulse voltage parameters	High voltage divider, high voltage measuring system, EMC surge generator: peak values	Comparison with high voltage reference measuring system	1	600	kV	Impulse shape	according to IEC 60060-1	5	mV/V	2	95%	Yes		According to IEC 60060-2 Approved on 06 August 2013	LCOE	67
Pulsed high voltage and current: lightning impulse time parameters	High voltage divider, high voltage measuring system, EMC surge generator: front time	Comparison with high voltage reference measuring system	0.84	1.56	µs	Impulse shape	according to IEC 60060-1; 1 kV to 600 kV	20	1E-03	2	95%	Yes		According to IEC 60060-2 Approved on 06 August 2013	LCOE	68
Pulsed high voltage and current: lightning impulse time parameters	High voltage divider, high voltage measuring system, EMC surge generator: time to half value	Comparison with high voltage reference measuring system	40	60	µs	Impulse shape	according to IEC 60060-1; 1 kV to 600 kV	10	1E-03	2	95%	Yes		According to IEC 60060-2 Approved on 06 August 2013	LCOE	69
Pulsed high voltage and current: switching impulse voltage parameters	High voltage divider, high voltage measuring system, EMC surge generator: peak value	Comparison with high voltage reference measuring system	1	1000	kV	Impulse shape	according to IEC 60060-1; 1kV to 600 kV	1	mV/V	2	95%	Yes		According to IEC 60060-2 Approved on 06 August 2013	LCOE	70
RF voltage: RF-DC transfer difference	Thermal voltage converter	Comparison	0.5	4	V	Frequency	1 MHz to 50 MHz	30 to 1500	µV/V	2	95%	Yes	Unc-tab4	Approved on 06 August 2013	CEM	58

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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?**	**Uncertainty matrix**	**Comments**	**NMI**	**NMI Service Identifier**
DC resistance standards and sources: high values	Fixed resistor	Modified Wheatstone bridge	1	10000	GΩ	Voltage	10 V to 1000 V	7 to 850	μΩ/Ω	2	95%	Yes	CEM_Unc-tab6	Oil and air baths Approved on 06 August 2013	CEM	97
DC current sources: low values	Current generator	Voltage across standard resistor	1.00E-04	1.00E+05	nA	Temperature	(20, 23) °C	10 to 480	μA/A	2	95%	Yes	Tab3.1.1	Approved on 06 January 2015	CEM	98
DC current sources: intermediate values	Current generator	Voltage across standard resistor / current comparator	0.0001	10	A	Temperature	(20, 23) °C	2 to 10	μA/A	2	95%	Yes	Tab3.1.2	Approved on 06 January 2015	CEM	101
DC current sources: high values	Current generator	Current comparator	10	100	A	Temperature	(20, 23) °C	12	μA/A	2	95%	Yes		Approved on 06 January 2015	CEM	105
DC current meters: low values	Nanoammeter, DVM	Source characterised using voltage and standard resistor	1.00E-04	1.00E+05	nA	Temperature	(20, 23) °C	10 to 480	μA/A	2	95%	Yes	Tab3.2.1	Approved on 06 January 2015	CEM	106
DC current meters: intermediate values	Ammeter	Source characterised using voltage and standard resistor / current comparator	0.0001	10	A	Temperature	(20, 23) °C	2 to 10	μA/A	2	95%	Yes	Tab3.2.2	Approved on 06 August 2013	CEM	109
DC current meters: high values	Ammeter	Current comparator	10	100	A	Temperature	(20, 23) °C	12	μA/A	2	95%	Yes		Approved on 06 August 2013	CEM	113

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
Absolute power on coaxials	Power meter, power source	Thermistor mount with bridge	0.1	25	mW	Frequency	0.1 MHz to 18 GHz	0.49 to 2.8	%	2	95.45%	Yes	INTA_Unc-tab7	The uncertainties apply to sources fitted with Type N connector and a source Voltage Reflection Coefficient not exceeding 0.02 (1 mW, 50 MHz), and for others Type N and PC-7 connectors and a source Voltage Reflection Coefficient not exceeding 0.05. Approved on 06 August 2013	INTA	72
Calibration factor on coaxials	Temperature-stabilized feedthrough mount	DC substitution method *P* = 0.5 mW to 10 mW	0.80	1.05		Frequency	0.1 MHz to 18 GHz	0.50 to 1.7	%	2	95.45%	Yes	INTA_Unc-tab8	The uncertainties apply to 50 W temperature-stabilised thermistor mounts with Type N male connector and Voltage Reflection Coefficient not exceeding 0.16 Approved on 06 August 2013	INTA	76
Calibration factor on coaxials	Bolometers, power sensor and diodes	DC substitution method *P* = 1mW and *P* = 1 µW	0.75	1.05		Frequency	0.1 MHz to 40 GHz	0.49 to 4	%	2	95.45%	Yes	INTA_Unc-tab9	The uncertainties apply to 50 W coaxial sensors with Voltage Reflection Coefficient not exceeding 0.10 Approved on 06 August 2013	INTA	77

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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?**	**Uncertainty matrix**	**Comments**	**NMI**	**NMI Service Identifier**
Reflection coefficient (S_{ii}) on coaxials (values in linear terms: magnitude)	Passive devices	Vector network analyser	0.001	1		Frequency	0.1 MHz to 26.5 GHz	0.005 to 0.060		2	95.45%	No	INTA_Unc-tab10	The uncertainties apply to coaxial 1-Port and 2-Port devices with the connectors specified in the associated table Approved on 06 August 2013	INTA	82
Reflection coefficient (S_{ii}) on coaxials (phase)	Passive devices	Vector network analyser	-180	180	°	Frequency	0.1 MHz to 26.5 GHz	0.8 to 180	°	2	95.45%	No	INTA_Unc-tab10	The uncertainties apply to coaxial 1-Port and 2-Port devices with the connectors specified in the associated table Approved on 06 August 2013	INTA	82
Transmission coefficient (S_{ij}) on coaxials (values in dB: magnitude)	Passive devices	Vector network analyser	0	60	dB	Frequency	0.1 MHz to 18 GHz	0.01 to 0.52	dB	2	95.45%	No	INTA_Unc-tab11p	The uncertainties apply to coaxial 2-Port devices with Type N (male or female) connectors, and with input and output Voltage Reflection Coefficient not exceeding 0.04 Approved on 22 February 2008	INTA	85

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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?**	**Uncertainty matrix**	**Comments**	**NMI**	**NMI Service Identifier**
Transmission coefficient (S_{ij}) on coaxials (values in linear terms: phase)	Passive devices	Vector network analyser	-180	180	°	Frequency	0.1 MHz to 18 GHz	0.1 to 3.6	°	2	95.45%	No		The uncertainties apply to coaxial 2-Port devices with Type N (male or female) connectors, and are derived from computed linear uncertainty in magnitude Approved on 22 February 2008	INTA	85a
Transmission coefficient (S_{ij}) on coaxials (values in dB: magnitude)	Passive devices	Vector network analyser	0	60	dB	Frequency	45 MHz to 18 GHz	0.024 to 0.78	dB	2	95.45%	No	INTA_Unc-tab11p	The uncertainties apply to coaxial 2-Port devices with PC-7 connectors, and with input and output Voltage Reflection Coefficient not exceeding 0.04 Approved on 22 February 2008	INTA	86
Transmission coefficient (S_{ij}) on coaxials (values in linear terms: phase)	Passive devices	Vector network analyser	-180	180	°	Frequency	45 MHz to 18 GHz	0.2 to 5.4	°	2	95.45%	No		The uncertainties apply to coaxial 2-Port devices with PC-7 connectors, and are derived from computed linear uncertainty in magnitude Approved on 22 February 2008	INTA	86a

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
Transmission coefficient (S_{ij}) on coaxials (values in dB: magnitude)	Passive devices	Vector network analyser	0	60	dB	Frequency	45 MHz to 26.5 GHz	0.019 to 0.63	dB	2	95.45%	No	INTA_Unc-tab11p	The uncertainties apply to coaxial 2-Port devices with 3.5 mm (male or female) connectors, and with input and output Voltage Reflection Coefficient not exceeding 0.04 Approved on 22 February 2008	INTA	87
Transmission coefficient (S_{ij}) on coaxials (values in linear terms: phase)	Passive devices	Vector network analyser	-180	180	°	Frequency	45 MHz to 26.5 GHz	0.1 to 4.3	°	2	95.45%	No		The uncertainties apply to coaxial 2-Port devices with 3.5 mm (male or female) connectors, and are derived from computed linear uncertainty in magnitude Approved on 22 February 2008	INTA	87a
Effective source match	Splitters	Direct calibration method	0.001	0.15		Frequency	0.1 MHz to 26.5 GHz	0.01 to 0.04		2	95.45%	No	INTA_Unc-tab11.3.5	The uncertainties apply to coaxial 3-port and 4-port splitters with the connectors specified in the associated table Approved on 06 August 2013	INTA	88

Electricity and Magnetism, Spain, CEM (Centro Español de Metrologia)

LCOE (Laboratorio Central Oficial de Electrotecnica), INTA (Instituto Nacional de Técnica Aeroespacial)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix**	**Comments**	**NMI**	**NMI Service Identifier**
Excess noise ratio in coaxials	Noise source	Direct comparison	4	16	dB	Frequency	10 MHz to 26.5 GHz	0.10 to 0.29	dB	2	95.45%	No	INTA_Unc-tab11.4.1	The uncertainties apply to the calibration of noise sources fitted with the connectors specified in the associated table, and with input Voltage Reflection Coefficient not exceeding 0.06 Approved on 06 August 2013	INTA	90
Amplitude noise parameters (noise figure)	2-port amplifier	Direct measurement with VNA	0.1	15	dB	Frequency	50 MHz to 26.5 GHz	0.27 to 0.67	dB	2	95.45%	No	INTA_Unc-tab11.4.3	The uncertainties apply to the calibration of solid-state amplifiers (without Automatic Gain Control, AGC), fitted with the connectors specified in the associated table Approved on 06 August 2013	INTA	92

Electricity and Magnetism, Spain, CEM (Centro Español de Metrologia)

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		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 matrix	Comments	NMI	NMI Service Identifier
Amplitude noise parameters (gain)	2-port amplifier	Direct measurement with VNA	0.1	50	dB	Frequency	50 MHz to 26.5 GHz	0.25 to 0.62	dB	2	95.45%	No	INTA_Unc-tab11.4.3	The uncertainties apply to the calibration of solid-state amplifiers (without Automatic Gain Control, AGC), fitted with the connectors specified in the associated table Approved on 06 August 2013	INTA	92
Inductance: self inductance	Toroidal fixed inductor thermostated	Maxwell-Wien bridge	10	10	mH	Frequency	1000 Hz	30	µH/H	2	95%	Yes		Approved on 06 August 2013	CEM	121
DC Resistance meters: low values	Resistance meter	Direct reading of a standard calibrated with a DCC bridge and a Range Extender	0.001	1	Ω	Temperature	22 ºC to 24 ºC	0.21 to 12	µΩ/Ω	2	95.45%	Yes	Tab 2.1.3	Approved on 07 April 2016	CEM	122
DC Resistance meters: intermediate values	Resistance meter	Direct reading of a standard calibrated with a DCC bridge or a Binary Voltage Divider	1	1.00E+09	Ω	Temperature	22 ºC to 24 ºC	0.07 to 17	µΩ/Ω	2	95.45%	Yes	Tab 2.1.4	Approved on 07 April 2016	CEM	123
DC Resistance meters: very high values	Resistance meter	Direct reading of a standard calibrated with a Modified Wheatstone Bridge	10	1000	GΩ	Temperature	22 ºC to 24 ºC	14 to 150	µΩ/Ω	2	95.45%	Yes	Tab 2.1.5	Only discrete values (10 GΩ, 100 GΩ and 1000 GΩ). Approved on 07 April 2016	CEM	124

Electricity and Magnetism, Spain

Matrix: Tab2.1.1

	Instrument type or method	Expanded uncertainty / (μΩ/Ω)
0.001 Ω to 1 Ω	DCC bridge and range extender	2
1 Ω	DCC bridge by substitution and Hamon transfer	0.1
1 Ω	DCC bridge by substitution	0.2

Electricity and Magnetism, Spain

Matrix: Tab2.1.23

	Method	Expanded uncertainty / (μΩ/Ω)
10 kΩ	Josephson potentiometer	0.04
10 kΩ	DCC bridge	0.06
100 Ω	DCC bridge by substitution and Hamon transfer	0.08
1 Ω to 10 kΩ	DCC bridge by substitution	0.2
10 Ω to 100 kΩ	High resistance bridge by substitution	1
0.1 MΩ to 1 MΩ	High resistance bridge by substitution	2
1 MΩ to 10 MΩ	High resistance bridge by substitution	3
10 MΩ to 100 MΩ	High resistance bridge by substitution	4

Electricity and Magnetism, Spain

Matrix: CEM_Unc-tab6

	10 V	100 V	1000 V
1 GΩ	11	9	7
10 GΩ	57	50	11
100 GΩ	100	90	70
1 TΩ	150	120	100
10 TΩ	850	760	140

The expanded uncertainties given in this table are expressed in µΩ/Ω

Electricity and Magnetism, Spain

Matrix: Tab3.1.1

	Expanded uncertainty / (µA/A)
100 fA to 1 pA	480
1 pA to 100 pA	180
0.1 nA to 100 nA	50
100 nA to 1000 nA	17
1 µA to 100 µA	10

Electricity and Magnetism, Spain

Matrix: Tab3.1.2

	Instrument type or method	Expanded uncertainty / (μA/A)
0.1 mA to 10 mA	Voltage across standard resistor	2
10 mA to 100 mA	Voltage across standard resistor	5
0.1 A to 1 A	Current comparator	8
1 A to 10 A	Current comparator	10

Electricity and Magnetism, Spain

Matrix: Tab3.2.1

	Expanded uncertainty / (µA/A)
100 fA to 1 pA	480
1 pA to 100 pA	180
0.1 nA to 100 nA	50
100 nA to 1000 nA	17
1 µA to 100 µA	10

Electricity and Magnetism, Spain

Matrix: Tab3.2.2

	Instrument type or method	Expanded uncertainty / (µA/A)
0.1 mA to 10 mA	Voltage across standard resistor	2
10 mA to 100 mA	Voltage across standard resistor	5
0.1 A to 1 A	Current comparator	8
1 A to 10 A	Current comparator	10

Electricity and Magnetism, Spain

Matrix: Unc-tab4.2.1

	Relative expanded uncertainty / (µF/F)
10 pF to 100 pF	6
> 100 pF to 1000 pF	15

Electricity and Magnetism, Spain

Matrix: Unc-tab1

	0.01 kHz	0.02 kHz	0.03 kHz	0.04 kHz	0.055 kHz	0.06 kHz	0.12 kHz	0.3 kHz	0.4 kHz	0.5 kHz	1 kHz	10 kHz
2 mV to 10 mV	200	200	200	200	200	200	200	200	200	200	200	200
10 mV to 100 mV	60	40	40	40	40	40	40	40	40	40	40	40
100 mV to 300 mV	15	15	15	15	15	15	15	15	15	15	15	15
300 mV to 500 mV	15	15	15	15	15	15	15	15	15	15	15	15
500 mV to 1 V	6	5	5	4	4	4	4	4	4	4	4	4
1 V to 3 V	10	5	5	5	5	5	5	5	6	6	6	6
3 V to 6 V	10	6	6	6	6	6	6	6	7	7	7	7
6 V to 10 V	15	7	7	7	7	7	7	7	8	8	8	8
10 V to 20 V	15	10	10	10	10	10	10	10	10	10	10	10
20 V to 40 V	20	12	12	12	12	12	12	12	12	12	12	12
40 V to 80 V	20	15	15	15	15	15	15	15	15	15	15	15
80 V to 120 V	25	20	20	18	18	18	18	18	18	18	18	18
120 V to 200 V	30	25	25	20	20	20	20	20	20	21	21	21
200 V to 300 V	40	30	30	30	30	30	30	30	30	30	30	30
300 V to 400 V	50	40	35	35	35	35	35	35	35	35	35	35
400 V to 600 V	55	50	40	40	40	40	40	40	40	40	40	40
600 V to 1000 V	60	50	40	40	40	40	40	40	40	40	40	40

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

Continued on next page

Electricity and Magnetism, Spain

Matrix: Unc-tab1 (Continued)

	20 kHz	30 kHz	50 kHz	70 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	800 kHz	1000 kHz
2 mV to 10 mV	200	200	200	200	200	200	250	300	300	400	400
10 mV to 100 mV	40	50	50	50	60	80	100	130	140	160	170
100 mV to 300 mV	15	20	20	20	30	30	40	50	50	60	80
300 mV to 500 mV	15	15	15	15	15	25	25	40	40	40	50
500 mV to 1 V	4	4	4	4	5	10	10	12	15	20	20
1 V to 3 V	6	6	6	6	6	10	15	15	20	20	25
3 V to 6 V	7	7	7	7	7	10	15	20	25	25	25
6 V to 10 V	8	8	8	8	8	15	20	20	30	30	30
10 V to 20 V	10	10	10	10	14	15	25	25	30	35	35
20 V to 40 V	12	12	12	12	12	20	20	30	-	-	-
40 V to 80 V	15	15	15	15	15	20	-	-	-	-	-
80 V to 120 V	18	18	18	18	20	-	-	-	-	-	-
120 V to 200 V	21	21	23	25	30	-	-	-	-	-	-
200 V to 300 V	30	30	30	30	30	-	-	-	-	-	-
300 V to 400 V	35	35	35	35	40	-	-	-	-	-	-
400 V to 600 V	40	40	40	45	50	-	-	-	-	-	-
600 V to 1000 V	40	40	45	45	60	-	-	-	-	-	-

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

Electricity and Magnetism, Spain

Matrix: Unc-tab2

	0.01 kHz	0.02 kHz	0.03 kHz	0.04 kHz	0.055 kHz	0.06 kHz	0.12 kHz	0.3 kHz	0.4 kHz	0.5 kHz	1 kHz	10 kHz	20 kHz
2 mV to 10 mV	520	520	520	520	520	520	520	520	520	520	520	520	520
> 10 mV to 100 mV	180	180	180	180	180	180	180	180	180	180	180	180	180
> 100 mV to 300 mV	75	70	70	70	70	70	70	70	70	70	70	70	70
> 300 mV to 500 mV	50	50	50	50	40	40	40	40	40	40	40	40	40
> 500 mV to 1 V	25	25	25	25	25	25	25	25	25	25	25	25	25
> 1 V to 3 V	30	30	30	30	30	30	30	30	30	30	30	30	30
> 3 V to 6 V	30	30	30	30	30	30	30	30	30	30	30	30	30
> 6 V to 10 V	30	30	30	30	30	30	30	30	30	30	30	30	30
> 10 V to 20 V	35	30	30	30	30	30	30	30	30	30	30	30	30
> 20 V to 40 V	35	30	30	30	30	30	30	30	30	30	30	30	30
> 40 V to 80 V	35	30	30	30	30	30	30	30	30	30	30	30	30
> 80 V to 120 V	40	35	35	35	35	35	35	35	35	35	35	35	35
> 120 V to 200 V	45	40	40	40	40	40	40	40	40	40	40	40	40
> 200 V to 300 V	50	40	45	45	45	45	45	45	45	45	45	45	45
> 300 V to 400 V	60	50	50	50	50	50	50	50	50	50	50	50	50
> 400 V to 600 V	70	60	50	50	50	50	50	50	50	50	50	50	50
> 600 V to 1000 V	80	60	55	55	55	55	55	55	55	55	55	55	55

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

Continued on next page

Electricity and Magnetism, Spain

Matrix: Unc-tab2 (Continued)

	30 kHz	50 kHz	70 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	800 kHz	1000 kHz
2 mV to 10 mV	520	520	520	520	580	600	630	800	850	900
> 10 mV to 100 mV	180	180	180	200	300	350	450	600	650	800
> 100 mV to 300 mV	80	80	80	100	160	300	300	400	600	700
> 300 mV to 500 mV	40	40	40	64	85	120	130	220	300	400
> 500 mV to 1 V	25	25	25	60	72	75	92	190	190	210
> 1 V to 3 V	30	30	30	60	72	76	93	190	190	210
> 3 V to 6 V	30	30	30	60	72	76	94	190	190	210
> 6 V to 10 V	30	30	40	60	73	77	94	190	190	210
> 10 V to 20 V	30	30	40	61	73	79	95	190	200	220
> 20 V to 40 V	30	30	30	61	74	77	97	-	-	-
> 40 V to 80 V	30	30	30	62	74	-	-	-	-	-
> 80 V to 120 V	35	35	35	63	-	-	-	-	-	-
> 120 V to 200 V	40	40	45	68	-	-	-	-	-	-
> 200 V to 300 V	45	45	45	68	-	-	-	-	-	-
> 300 V to 400 V	50	50	50	74	-	-	-	-	-	-
> 400 V to 600 V	50	50	60	80	-	-	-	-	-	-
> 600 V to 1000 V	55	60	60	87	-	-	-	-	-	-

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

Electricity and Magnetism, Spain

Matrix: Unc-tab3

	10 Hz	20 Hz	30 Hz	40 Hz	55 Hz	60 Hz	120 Hz	300 Hz	400 Hz	500 Hz
> 0.005 A to 0.01 A	8	5	4	4	4	4	4	4	4	4
> 0.01 A to 0.02 A	11	6	5	5	5	5	5	5	5	5
> 0.02 A to 0.05 A	13	8	6	6	6	6	6	6	6	6
> 0.05 A to 0.1 A	15	9	7	7	7	7	7	7	7	7
> 0.1 A to 0.2 A	17	10	7	7	7	7	7	7	7	7
> 0.2 A to 0.5 A	19	11	8	8	8	8	8	8	8	8
> 0.5 A to 1 A	21	12	9	9	9	9	9	9	9	9
> 1 A to 2 A	25	15	11	11	11	11	11	11	11	11
> 2 A to 5 A	30	20	15	15	15	15	15	15	15	15
> 5 A to 10 A	35	30	25	25	25	25	25	25	25	25
> 10 A to 20 A	45	35	35	35	35	35	35	35	35	35
> 20 A to 50 A	55	50	45	45	45	45	45	45	45	45
> 50 A to 100 A	70	60	60	60	60	60	60	60	60	60

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

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Electricity and Magnetism, Spain

Matrix: Unc-tab3 (Continued)

	1 kHz	2 kHz	5 kHz	10 kHz	20 kHz	30 kHz	50 kHz	70 kHz	100 kHz
> 0.005 A to 0.01 A	4	4	4	4	4	5	7	8	13
> 0.01 A to 0.02 A	5	5	5	5	5	7	9	11	16
> 0.02 A to 0.05 A	6	6	6	6	6	8	11	14	19
> 0.05 A to 0.1 A	7	7	7	7	7	9	13	16	22
> 0.1 A to 0.2 A	7	7	7	7	8	11	15	18	25
> 0.2 A to 0.5 A	8	8	8	8	9	13	17	25	30
> 0.5 A to 1 A	9	9	9	9	11	15	20	25	40
> 1 A to 2 A	11	11	11	11	15	20	25	35	45
> 2 A to 5 A	15	15	15	16	20	25	35	45	60
> 5 A to 10 A	25	25	25	25	35	40	50	70	90
> 10 A to 20 A	35	35	35	35	45	50	70	90	130
> 20 A to 50 A	45	45	45	50	65	80	100	130	170
> 50 A to 100 A	60	60	60	70	90	110	130	170	220

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

Electricity and Magnetism, Spain

Matrix: Unc-tab 6.2.1

	10 Hz	20 Hz	30 Hz	40 Hz	55 Hz	60 Hz	120 Hz	300 Hz	400 Hz	500 Hz
0.005 A to 0.01 A	60	60	60	60	60	60	60	60	60	60
> 0.01 A to 0.02 A	60	60	60	60	60	60	60	60	60	60
> 0.02 A to 0.05 A	60	60	60	60	60	60	60	60	60	60
> 0.05 A to 0.1 A	70	60	60	60	60	60	60	60	60	60
> 0.1 A to 0.2 A	70	60	60	60	60	60	60	60	60	60
> 0.2 A to 0.5 A	70	60	60	60	60	60	60	60	60	60
> 0.5 A to 1 A	70	60	60	60	60	60	60	60	60	60
> 1 A to 2 A	80	65	60	60	60	60	60	60	60	60
> 2 A to 5 A	85	70	65	65	65	65	65	65	65	65
> 5 A to 10 A	90	90	80	80	80	80	80	80	80	80
> 10 A to 20 A	110	100	100	100	100	100	100	100	100	100
> 20 A to 50 A	140	130	120	120	120	120	120	120	120	120
> 50 A to 100 A	160	140	140	140	140	140	140	140	140	140

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

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Electricity and Magnetism, Spain

Matrix: Unc-tab 6.2.1 (Continued)

	1 kHz	2 kHz	5 kHz	10 kHz	20 kHz	30 kHz	50 kHz	70 kHz	100 kHz
0.005 A to 0.01 A	60	60	60	60	60	60	70	70	90
> 0.01 A to 0.02 A	60	60	60	60	60	60	70	70	90
> 0.02 A to 0.05 A	60	60	60	60	60	60	70	80	95
> 0.05 A to 0.1 A	60	60	60	60	60	60	75	80	95
> 0.1 A to 0.2 A	60	60	60	60	60	60	75	80	110
> 0.2 A to 0.5 A	60	60	60	60	60	65	80	85	120
> 0.5 A to 1 A	60	60	60	60	60	65	80	90	130
> 1 A to 2 A	60	60	60	60	65	70	85	100	150
> 2 A to 5 A	65	65	65	65	70	75	100	120	170
> 5 A to 10 A	80	80	80	80	100	110	140	180	220
> 10 A to 20 A	100	100	100	100	120	130	200	230	300
> 20 A to 50 A	120	120	120	130	170	200	260	310	400
> 50 A to 100 A	140	140	140	160	210	250	320	400	500

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

Electricity and Magnetism, Spain

Matrix: Unc-tab 6.2.2

	10 Hz	20 Hz	30 Hz	40 Hz	55 Hz	60 Hz	120 Hz	300 Hz	400 Hz	500 Hz
0.005 A to 0.01 A	120	100	100	100	100	100	100	100	100	100
> 0.01 A to 0.02 A	120	100	100	100	100	100	100	100	100	100
> 0.02 A to 0.05 A	120	100	100	100	100	100	100	100	100	100
> 0.05 A to 0.1 A	120	100	100	100	100	100	100	100	100	100
> 0.1 A to 0.2 A	120	100	100	100	100	100	100	100	100	100
> 0.2 A to 0.5 A	120	100	100	100	100	100	100	100	100	100
> 0.5 A to 1 A	120	100	100	100	100	100	100	100	100	100
> 1 A to 2 A	130	120	120	120	120	120	120	120	120	120
> 2 A to 5 A	130	120	120	120	120	120	120	120	120	120
> 5 A to 10 A	140	120	120	120	120	120	120	120	120	120
> 10 A to 20 A	150	130	130	130	130	130	130	130	130	130

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

Continued on next page

Electricity and Magnetism, Spain

Matrix: Unc-tab 6.2.2 (Continued)

	1 kHz	2 kHz	5 kHz	10 kHz	20 kHz	30 kHz	50 kHz	70 kHz	100 kHz
0.005 A to 0.01 A	100	100	100	100	130	130	250	250	250
> 0.01 A to 0.02 A	100	100	100	100	150	150	250	250	250
> 0.02 A to 0.05 A	100	100	100	100	150	150	250	250	250
> 0.05 A to 0.1 A	100	100	100	100	150	150	250	250	250
> 0.1 A to 0.2 A	100	100	100	100	150	150	250	250	250
> 0.2 A to 0.5 A	100	100	100	100	150	150	250	250	250
> 0.5 A to 1 A	100	100	100	100	150	150	250	250	250
> 1 A to 2 A	120	120	120	120	150	150	300	300	300
> 2 A to 5 A	120	120	120	120	150	150	300	300	300
> 5 A to 10 A	120	120	120	120	160	160	320	320	350
> 10 A to 20 A	130	130	130	130	160	170	350	350	400

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

Electricity and Magnetism, Spain

Matrix: Unc-tab4

	1 MHz	10 MHz	30 MHz	50 MHz
0.5 V / 1 V	100	200	600	1500
2 V / 3 V	30	80	270	820
4 V	40	100	300	1000

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

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab7

	0.1 mW	0.2 mW	1 mW	25 mW
50 MHz	-	-	0.55	-
0.1 MHz to 10 MHz	2.3 to 2.8	1.3 to 2.1	0.74 to 1.8	0.70 to 1.8
10 MHz to 100 MHz	2.2 to 2.3	1.2 to 1.3	0.55 to 0.74	0.49 to 0.70
50 MHz to 18 GHz	2.3 to 2.7	1.2 to 1.9	0.59 to 1.5	0.54 to 1.5

The expanded uncertainties given in this table are expressed in %

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab8

	P_{subs} = 0.5 mW	P_{subs} = 1 mW	P_{subs} = 10 mW
0.1 MHz to 10 MHz	0.84 to 1.5	0.74 to 1.5	0.70 to 1.5
10 MHz to 100 MHz	0.67 to 0.84	0.55 to 0.74	0.49 to 0.70
50 MHz to 18 GHz	0.67 to 1.7	0.55 to 1.7	0.50 to 1.7

The expanded uncertainties given in this table are expressed in %

Electricity and Magnetism, Spain

Matrix: Unc-tab7.1

	5 mA to 1 A	> 1 A to 10 A	> 10 A to 50 A	> 50 A to 100 A
0.5 V to 120 V	40	60	80	140
> 120 V to 240 V	40	60	80	140
> 240 V to 480 V	70	80	90	140

The expanded uncertainties given in this table are expressed in µW/VA, µWh/VAh, µvar/VA, µvarh/VAh, µVA/VA or µVAh/VAh

Electricity and Magnetism, Spain

Matrix: LCOE_Unc-tab8.3.4.a

	Expanded uncertainty
1 kV to 22 kV	50E-06
23 kV to 200 kV	200E-06

The expanded uncertainties given in this table are relative to the measured value and thus dimensionless

Electricity and Magnetism, Spain

Matrix: LCOE_Unc-tab8.3.4.b

	1 kV to 22 kV	23 kV to 200 kV
1E-06 crad to 2 crad	0.003	0.02

The expanded uncertainties given in this table are expressed in crad

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab9

	Reference standard used	Connectors	Method	Frequency	*P* sust = 0.5 mW	*P* sust = 1 mW	*P* sust = 10 mW
Temperature-stabilized feedthrough mount	Temperature-stabilized Thermistor Mount	-	DC substitution method	0.1 MHz to 10 MHz	0.84E-02 to 1.5E-02	0.74E-02 to 1.5E-02	0.70E-02 to 1.5E-02
Temperature-stabilized feedthrough mount	Temperature-stabilized Thermistor Mount	-	DC substitution method	10 MHz to 100 MHz	0.67E-02 to 0.84E-02	0.55E-02 to 0.74E-02	0.49E-02 to 0.70E-02
Temperature-stabilized feedthrough mount	Temperature-stabilized Thermistor Mount	-	DC substitution method	50 MHz to 18 GHz	0.67E-02 to 1.7E-02	0.55E-02 to 1.7E-02	0.50E-02 to 1.7E-02
Power sensor	Temperature-stabilized Thermistor Mount	Test connector: type 3.5 mm	DC substitution method *P* = 1 mW	50 MHz to 26.5 GHz	-	1.5E-02 to 3E-02	-
Power sensor	Temperature-stabilized Thermistor Mount	Test connector: type 2.4 mm	DC substitution method *P* = 1 mW	50 MHz to 40 GHz	-	1.5E-02 to 4E-02	-
Bolometer (N type connector)	Temperature-stabilized Feedthrough Mount	-	DC substitution method *P* = 1 mW	10 MHz to 100 MHz	-	0.7E-02 to 1.7E-02	-
Bolometer (N type connector)	Temperature-stabilized Feedthrough Mount	-	DC substitution method *P* = 1 mW	50 MHz to 18 GHz	-	0.7E-02 to 2.3E-02	-
Power sensor	Temperature-stabilized Feedthrough Mount	Test connector: type N	DC substitution method *P* = 1 mW	0.1 MHz to 10 MHz	-	1.3E-02 to 2.0E-02	-
Power sensor	Temperature-stabilized Feedthrough Mount	Test connector: type N	DC substitution method *P* = 1 mW	10 MHz to 100 MHz	-	1.0E-02 to 1.3E-02	-
Power sensor	Temperature-stabilized Feedthrough Mount	Test connector: type N	DC substitution method *P* = 1 mW	50 MHz to 18 GHz	-	1.1E-02 to 2.2E-02	-
Diode (N type connector)	Temperature-stabilized Feedthrough Mount	-	DC substitution method *P* = 1 µW	10 MHz to 100 MHz	-	1.4E-02 to 1.6E-02	-
Diode (N type connector)	Temperature-stabilized Feedthrough Mount	-	DC substitution method P = 1 µW	50 MHz to 18 GHz	-	1.5E-02 to 2.7E-02	-

The expanded uncertainties given in this table are dimensionless

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab10

	Test connector	Frequency	Sii: 0.001 to 0.5	Sii: 0.5 to 1.0	Sii: 0.001 to 0.1	Sii: 0.1 to 0.5	Sii: 0.5 to 1.0
Magnitude	Type N	0.1 MHz to 500 MHz	0.005 to 0.009	0.007 to 0.016	-	-	-
Magnitude	Type N	45 MHz to 8 GHz	-	-	0.009 to 0.010	0.009 to 0.016	0.013 to 0.032
Magnitude	Type N	8 GHz to 12 GHz	-	-	0.009 to 0.015	0.009 to 0.020	0.013 to 0.036
Magnitude	Type N	12 GHz to 18 GHz	-	-	0.012 to 0.020	0.012 to 0.026	0.018 to 0.047
Magnitude	APC 7	45 MHz to 8 GHz	-	-	0.010 to 0.013	0.010 to 0.021	0.018 to 0.048
Magnitude	APC 7	8 GHz to 12 GHz	-	-	0.010 to 0.018	0.010 to 0.027	0.018 to 0.055
Magnitude	APC 7	12 GHz to 18 GHz	-	-	0.016 to 0.019	0.017 to 0.028	0.025 to 0.056
Magnitude	3.5 mm	45 MHz to 8 GHz	-	-	0.009 to 0.015	0.009 to 0.020	0.013 to 0.037
Magnitude	3.5 mm	8 GHz to 12 GHz	-	-	0.007 to 0.012	0.007 to 0.016	0.009 to 0.030
Magnitude	3.5 mm	12 GHz to 26.5 GHz	-	-	0.007 to 0.029	0.007 to 0.036	0.009 to 0.060
Phase (°)	Type N	0.1 MHz to 500 MHz	0.8 to 180	0.8 to 1.1	-	-	-
Phase (°)	Type N	45 MHz to 8 GHz	-	-	4.9 to 180	1.5 to 5.9	1.4 to 1.8
Phase (°)	Type N	8 GHz to 12 GHz	-	-	4.9 to 180	1.5 to 8.5	1.4 to 2.3
Phase (°)	Type N	12 GHz to 18 GHz	-	-	7.1 to 180	2.0 to 11.4	1.9 to 3.0
Phase (°)	APC 7	45 MHz to 8 GHz	-	-	5.6 to 180	2.0 to 7.2	2.0 to 2.7
Phase (°)	APC 7	8 GHz to 12 GHz	-	-	5.6 to 180	2.0 to 10.5	2.0 to 3.1
Phase (°)	APC 7	12 GHz to 18 GHz	-	-	9.6 to 180	2.8 to 10.9	2.7 to 3.2
Phase (°)	3.5 mm	45 MHz to 8 GHz	-	-	5.0 to 180	1.4 to 8.6	1.3 to 2.2
Phase (°)	3.5 mm	8 GHz to 12 GHz	-	-	3.8 to 180	1.0 to 6.6	0.9 to 1.8
Phase (°)	3.5 mm	12 GHz to 26.5 GHz	-	-	3.8 to 180	1.0 to 16.6	0.9 to 4.1

The expanded uncertainties given in this table are dimensionless (upper part of the table) or expressed in ° (lower part of the table)

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab11p

Test connector: Type N	S_{ij} = 0 dB to 40 dB	S_{ij} = 40 dB to 60 dB
0.1 MHz to 500 MHz	0.01 to 0.06	0.05 to 0.41

Test connector: Type N	S_{ij} = 0 dB to 20 dB	S_{ij} = 20 dB to 50 dB	S_{ij} = 50 dB to 60 dB
45 MHz to 8 GHz	0.020 to 0.036	0.033 to 0.15	0.084 to 0.52
8 GHz to 12 GHz	0.020 to 0.039	0.033 to 0.094	0.084 to 0.38
12 GHz to 18 GHz	0.029 to 0.043	0.039 to 0.095	0.093 to 0.38

Test connector: APC 7	S_{ij} = 0 dB to 20 dB	S_{ij} = 20 dB to 50 dB	S_{ij} = 50 dB to 60 dB
45 MHz to 8 GHz	0.024 to 0.036	0.035 to 0.24	0.086 to 0.78
8 GHz to 12 GHz	0.024 to 0.043	0.035 to 0.093	0.087 to 0.37
12 GHz to 18 GHz	0.033 to 0.044	0.041 to 0.13	0.091 to 0.46

Test connector: 3.5 mm	S_{ij} = 0 dB to 20 dB	S_{ij} = 20 dB to 50 dB	S_{ij} = 50 dB to 60 dB
45 MHz to 8 GHz	0.019 to 0.034	0.032 to 0.19	0.084 to 0.63
8 GHz to 12 GHz	0.019 to 0.038	0.032 to 0.090	0.084 to 0.37
12 GHz to 26.5 GHz	0.026 to 0.054	0.037 to 0.12	0.087 to 0.43

The expanded uncertainties given in this table are expressed in dB

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab11.3.5

	Frequency	Effective source match: 0.01 to 0.15
Test connector: type N	0.01 MHz to 18 GHz	0.01 to 0.04
Test connector: type 3.5 mm	45 MHz to 26.5 GHz	0.01 to 0.03

The expanded uncertainties given in this table are dimensionless

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab11.4.1

	Frequency	ENR: 4 dB to 16 dB
Test connector: type N	0.01 GHz to 18 GHz	0.12 dB to 0.18 dB
Test connector: type 3.5 mm	0.05 GHz to 26.5 GHz	0.10 dB to 0.29 dB

Electricity and Magnetism, Spain

Matrix: INTA_Unc-tab11.4.3

	Connectors	Frequency	NF : 0.1 dB to 15 dB	G: 0.1 dB to 50 dB
Noise figure	Test connector: type N	0.05 GHz to 18 GHz	0.27 dB to 0.61 dB	-
Noise figure	Test connector: type 3.5 mm	0.05 GHz to 26.5 GHz	0.27 dB to 0.67 dB	-
Gain	Test connector: type N	-	-	0.25 dB to 0.41 dB
Gain	Test connector: type 3.5 mm	-	-	0.27 dB to 0.62 dB

Electricity and Magnetism, Spain

Matrix: Tab_2.1.3

	Instrument type or method	Expanded ucertainty / (μΩ/Ω)
1 mΩ	Standard calibrated with a DCC bridge	2.0
1 mΩ to 10 mΩ	Freshly calibrated value in this specific range of decade box resistor	12
10 mΩ	Standard calibrated with a DCC bridge	2.9
10 mΩ to 100 mΩ	Freshly calibrated value in this specific range of decade box resistor	12
100 mΩ	Standard calibrated with a DCC bridge	5.9
0.1 Ω to 1 Ω	Freshly calibrated value in this specific range of decade box resistor	12
1 Ω	Standard calibrated with a DCC bridge	0.21

Electricity and Magnetism, Spain

Matrix: Tab_2.1.4

	Instrument type or method	Specifications	Expanded uncertainty / (μΩ/Ω)
1 Ω to 10 Ω	Freshly calibrated value in this specific range of decade box resistor/ DCC bridge		8.7
10 Ω	Standard calibrated with a DCC bridge		0.20
10 Ω to 100 Ω	Freshly calibrated value in this specific range of decade box resistor/DCC bridge		0.62
25 Ω	Standard calibrated with a DCC bridge		0.21
100 Ω	Standard calibrated with a DCC bridge		0.08
43.56 Ω	White type calibrator/ DCC bridge		0.22
48.41 Ω	White type calibrator/ DCC bridge		0.21
56.49 Ω	White type calibrator/ DCC bridge		0.21
56.92 Ω	White type calibrator/ DCC bridge		0.21
68.44 Ω	White type calibrator/ DCC bridge		0.21
77.19 Ω	White type calibrator/ DCC bridge		0.22
81.20 Ω	White type calibrator/ DCC bridge		0.22
100.00 Ω	White type calibrator/ DCC bridge		0.22
113.41 Ω	White type calibrator/ DCC bridge		0.23
116.84 Ω	White type calibrator/ DCC bridge		0.23
122.00 Ω	White type calibrator/ DCC bridge		0.23
124.76 Ω	White type calibrator/ DCC bridge		0.23
129.81 Ω	White type calibrator/ DCC bridge		0.23
133.68 Ω	White type calibrator/ DCC bridge		0.24
139.57 Ω	White type calibrator/ DCC bridge		0.24
145.62 Ω	White type calibrator/ DCC bridge		0.24
148.41 Ω	White type calibrator/ DCC bridge		0.25
156.93 Ω	White type calibrator/ DCC bridge		0.25
158.38 Ω	White type calibrator/ DCC bridge		0.25
166.09 Ω	White type calibrator/ DCC bridge		0.26
173.38 Ω	White type calibrator/ DCC bridge		0.26
177.19 Ω	White type calibrator/ DCC bridge		0.27
181.20 Ω	White type calibrator/ DCC bridge		0.27
186.73 Ω	White type calibrator/ DCC bridge		0.28
198.25 Ω	White type calibrator/ DCC bridge		0.28
207.00 Ω	White type calibrator/ DCC bridge		0.29
216.80 Ω	White type calibrator/ DCC bridge		0.30
229.82 Ω	White type calibrator/ DCC bridge		0.31
249.42 Ω	White type calibrator/ DCC bridge		0.33
260.37 Ω	White type calibrator/ DCC bridge		0.35
265.21 Ω	White type calibrator/ DCC bridge		0.35
273.29 Ω	White type calibrator/ DCC bridge		0.36
293.99 Ω	White type calibrator/ DCC bridge		0.38
316.81 Ω	White type calibrator/ DCC bridge		0.41
346.61 Ω	White type calibrator/ DCC bridge		0.44
100 Ω to 1000 Ω	Freshly calibrated value in this specific range of decade box resistor/ DCC bridge		1.7
1 kΩ	Standard calibrated with a DCC bridge		0.21

Electricity and Magnetism, Spain

Matrix: Tab_2.1.4

	Instrument type or method	Specifications	Expanded uncertainty / (µΩ/Ω)
1 kΩ to 10 kΩ	Freshly calibrated value in this specific range of decade box resistor/ DCC bridge		1.7
6.453 kΩ	Standard calibrated with a DCC bridge		0.21
10 kΩ	Standard calibrated with a DCC bridge		0.07
12.906 kΩ	Standard calibrated with a DCC bridge		0.23
10 kΩ to 100 kΩ	Freshly calibrated value in this specific range of decade box resistor/ Binary Voltage Divider		2.0
100 kΩ	Standard calibrated with a Binary Voltage Divider		1.0
0.1 MΩ to 1 MΩ	Freshly calibrated value in this specific range of decade box resistor / Binary Voltage Divider		2.6
1 MΩ	Standard calibrated with a Binary Voltage Divider		2.0
1 MΩ to 10 MΩ	Freshly calibrated value in this specific range of decade box resistor/ Binary Voltage Divider		3.5
10 MΩ	Standard calibrated with a Binary Voltage Divider		3.0
10 MΩ to 100 MΩ	Freshly calibrated value in this specific range of decade box resistor/ Binary Voltage Divider		5.0
100 MΩ	Standard resistor/ High Resistance bridge		17
1 GΩ	Standard calibrated with a Binary Voltage Divider	10 V	13
1 GΩ	Standard calibrated with a Binary Voltage Divider	100 V	12
1 GΩ	Standard calibrated with a Binary Voltage Divider	1000 V	10

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Matrix: Tab_2.1.5

	10 V	100 V	100 V	Instrument type or method
10 GΩ	58	51	14	Standard resistor calibrated with a Modified Wheatstone Bridge
100 GΩ	100	90	70	Standard resistor calibrated with a Modified Wheatstone Bridge
1 TΩ	150	125	110	Standard resistor calibrated with a Modified Wheatstone Bridge

The expanded uncertainties given in this table are expressed in μΩ/Ω