DASY5 Validation Report for Body TSL

Date: 17.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1012

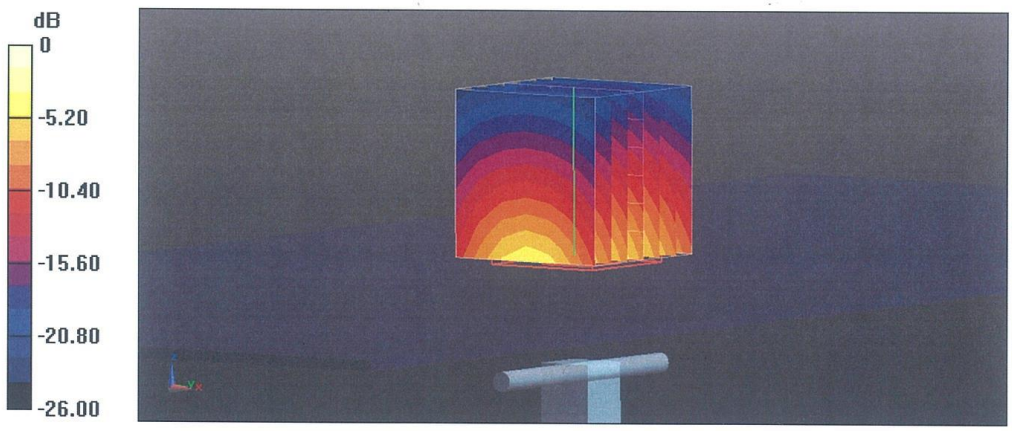
Communication System: UID 0 - CW; Frequency: 2600 MHz
Medium parameters used: f = 2600 MHz; σ = 2.2 S/m; ε_r = 50.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.8, 7.8, 7.8) @ 2600 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

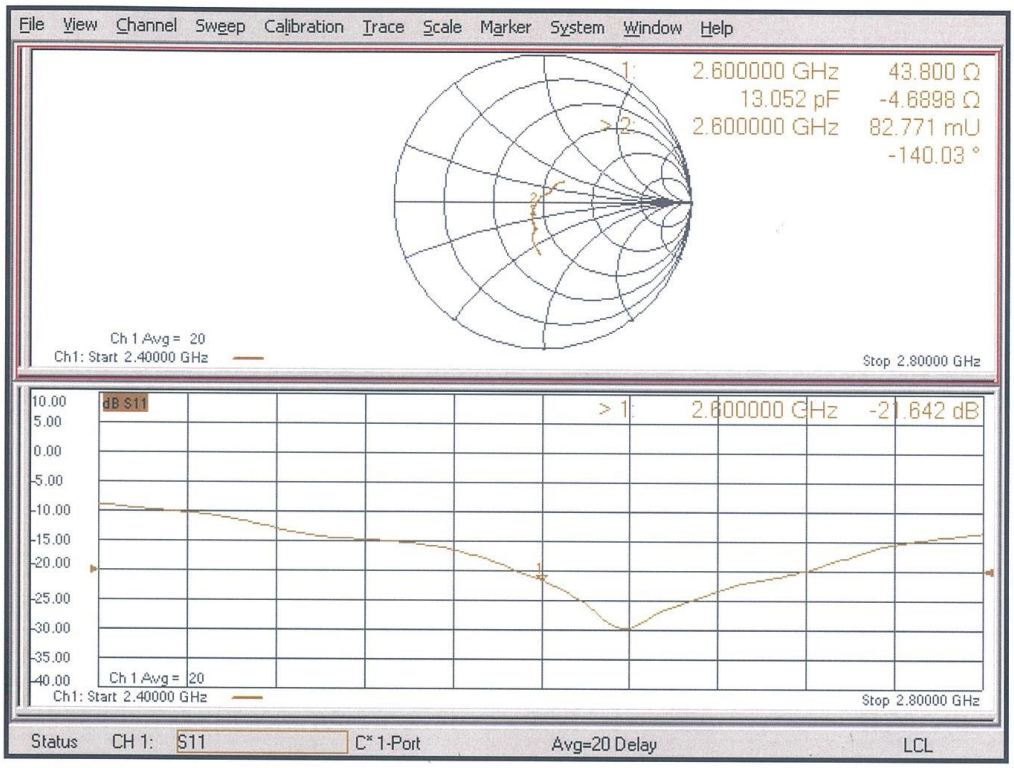
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 110.1 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 28.3 W/kg
SAR(1 g) = 14 W/kg; SAR(10 g) = 6.26 W/kg
Maximum value of SAR (measured) = 23.3 W/kg



0 dB = 23.3 W/kg = 13.67 dBW/kg

Impedance Measurement Plot for Body TSL



ANNEX I SAR Test Result

I.1 Tissue and Verification

Table I.1-1: Dielectric Performance of Tissue Simulating Liquid

Measurement Date yyyy/mm/dd	Frequency	Type	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2021/2/3	1750 MHz	Head	39.44	-1.60	1.374	0.29

Table I.1-2: System Validation of Head

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2021/2/3	1750MHz	19.1	36.5	19.04	36	-0.31%	-1.37%

I.2 LTE Measurement result

Table I.2-1: Maximum Power Reduction (MPR) for LTE

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]						MPR (dB)
	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	2

Table I.2-2: The tune up for LTE

Band	Tune up
LTE Band 66	22

Table I.2-3: The conducted Power for LTE band66

Band 66				
Bandwidth (MHz)	RB allocation RB offset (Start RB)	Frequency (MHz)	QPSK Actual output power (dBm)	16QAM Actual output power (dBm)
1.4 MHz	1RB High (5)	1779.3	20.53	19.82
		1745	20.54	20.09
		1710.7	20.72	19.80
	1RB Middle (3)	1779.3	20.60	19.82
		1745	20.68	20.21
		1710.7	20.84	19.80
	1RB Low (0)	1779.3	20.57	19.76
		1745	20.67	20.18
		1710.7	20.61	19.60
	3RB High (3)	1779.3	20.58	19.90
		1745	20.59	19.79
		1710.7	20.85	19.53
	3RB Middle (1)	1779.3	20.59	19.85
		1745	20.77	20.04
		1710.7	20.85	19.66
	3RB Low (0)	1779.3	20.54	19.97
		1745	20.65	20.00
		1710.7	20.79	19.72
	6RB (0)	1779.3	19.51	18.81
		1745	19.62	18.88
		1710.7	19.77	18.55
3 MHz	1RB High (14)	1778.5	21.03	19.83
		1745	21.02	19.81
		1711.5	20.82	19.81
	1RB Middle (7)	1778.5	21.09	20.07
		1745	21.04	19.84
		1711.5	20.89	19.80
	1RB Low (0)	1778.5	20.78	19.93
		1745	20.94	19.80
		1711.5	20.80	19.68
	8RB High (7)	1778.5	19.57	18.74
		1745	19.70	18.75
		1711.5	19.91	18.74
	8RB Middle (4)	1778.5	19.53	18.71
		1745	19.63	18.76
		1711.5	19.78	18.75
	8RB Low (0)	1778.5	19.52	18.68
		1745	19.63	18.68
		1711.5	19.82	18.74
	15RB	1778.5	19.52	18.53

	(0)	1745	19.59	18.57
		1711.5	19.72	18.84
5 MHz	1RB High (24)	1777.5	20.56	19.75
		1745	20.71	19.62
		1712.5	20.55	19.57
	1RB Middle (12)	1777.5	20.58	19.76
		1745	20.65	19.52
		1712.5	20.54	19.58
	1RB Low (0)	1777.5	20.55	19.65
		1745	20.74	19.59
		1712.5	20.60	19.53
	12RB High (13)	1777.5	19.58	18.59
		1745	19.66	18.53
		1712.5	19.60	18.52
	12RB Middle (6)	1777.5	19.66	18.71
		1745	19.56	18.52
		1712.5	19.71	18.82
	12RB Low (0)	1777.5	19.66	18.66
		1745	19.57	18.50
		1712.5	19.67	18.65
	25RB (0)	1777.5	19.61	18.54
		1745	19.53	18.61
		1712.5	19.75	18.88
10 MHz	1RB High (49)	1775	21.09	19.74
		1745	21.08	19.72
		1715	20.58	19.55
	1RB Middle (24)	1775	21.21	19.89
		1745	20.99	20.41
		1715	20.73	19.72
	1RB Low (0)	1775	21.16	19.83
		1745	21.17	19.64
		1715	20.75	19.58
	25RB High (25)	1775	19.80	18.95
		1745	19.81	18.75
		1715	19.76	18.86
	25RB Middle (12)	1775	19.74	18.79
		1745	19.65	18.85
		1715	19.79	18.89
	25RB Low (0)	1775	19.62	18.67
		1745	19.66	18.62
		1715	19.78	18.79
	50RB (0)	1775	19.66	18.76
		1745	19.69	18.76
		1715	19.78	18.73
15 MHz	1RB High (74)	1772.5	20.52	19.80
		1745	20.71	19.88
		1717.5	21.01	19.59
	1RB	1772.5	20.66	19.74

	Middle (37)	1745	20.60	20.26
		1717.5	20.91	20.25
	1RB Low (0)	1772.5	20.57	19.56
		1745	20.67	19.83
		1717.5	21.09	19.73
	36RB High (38)	1772.5	19.75	18.89
		1745	19.79	18.89
		1717.5	19.83	18.69
	36RB Middle (19)	1772.5	19.68	18.84
		1745	19.71	18.74
		1717.5	19.78	18.90
	36RB Low (0)	1772.5	19.67	18.66
		1745	19.64	18.57
		1717.5	19.61	18.77
	75RB (0)	1772.5	19.71	18.79
		1745	19.63	18.70
		1717.5	19.66	18.74
20 MHz	1RB High (99)	1770	20.66	20.37
		1745	20.75	19.53
		1720	20.52	19.51
	1RB Middle (50)	1770	21.18	19.53
		1745	20.78	19.54
		1720	20.82	20.13
	1RB Low (0)	1770	20.71	19.53
		1745	20.53	19.55
		1720	20.51	19.52
	50RB High (50)	1770	19.71	18.68
		1745	19.85	18.76
		1720	19.68	18.71
	50RB Middle (25)	1770	19.81	18.68
		1745	19.84	18.74
		1720	19.81	18.98
	50RB Low (0)	1770	19.66	18.62
		1745	19.74	18.68
		1720	19.61	18.76
	100RB (0)	1770	19.65	18.74
		1745	19.78	18.68
		1720	19.72	18.79

I.3 SAR test result

Table I.3-1: SAR Values (LTE band66 - Body)

Ambient Temperature: 22.9 ℃ Liquid Temperature: 22.5℃											
Frequency		Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
Ch.	MHz										
132572	1770	1RB_Mid	Front	Fig.1	21.18	22	0.434	**0.52**	0.654	**0.79**	0.02
132572	1770	1RB_Mid	Rear	/	21.18	22	0.386	**0.47**	0.549	**0.66**	-0.18
132572	1770	1RB_Mid	Left	/	21.18	22	0.254	**0.31**	0.418	**0.50**	-0.14
132572	1770	1RB_Mid	Right	/	21.18	22	0.291	**0.35**	0.493	**0.60**	-0.11
132572	1770	1RB_Mid	Bottom	/	21.18	22	0.097	**0.12**	0.141	**0.17**	-0.09
132572	1770	1RB_Mid	Top	/	21.18	22	0.284	**0.34**	0.417	**0.50**	0.14
132322	1745	50RB_High	Front	/	19.85	21	0.264	**0.34**	0.561	**0.73**	0.07
132322	1745	50RB_High	Rear	/	19.85	21	0.306	**0.40**	0.428	**0.56**	0.14
132322	1745	50RB_High	Left	/	19.85	21	0.094	**0.12**	0.153	**0.20**	0.07
132322	1745	50RB_High	Right	/	19.85	21	0.216	**0.28**	0.348	**0.45**	0.08
132322	1745	50RB_High	Bottom	/	19.85	21	0.066	**0.09**	0.096	**0.13**	0.10
132322	1745	50RB_High	Top	/	19.85	21	0.202	**0.26**	0.298	**0.39**	0.10

Note1: The distance between the EUT and the phantom bottom is 10mm

Note2: The LTE mode is QPSK_20MHz.

I.4 MAIN TEST INSTRUMENTS

Table I.4-1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 14, 2021	One year
02	Power meter	NRP2	101919	May 12, 2020	One year
03	Power sensor	NRP-Z91	101547		
04	Signal Generator	E4438C	MY49071430	February 25, 2020	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	BTS	CMW500	129942	February 10, 2020	One year
07	E-field Probe	SPEAG EX3DV4	7307	May 29, 2020	One year
08	DAE	SPEAG DAE4	536	November 6, 2020	One year
09	Dipole Validation Kit	SPEAG D1750V2	1003	July 24, 2020	One year

END OF REPORT BODY

I.5 GRAPH RESULTS

LTE1700-FDD66_CH132572 Front
Date: 2/3/2021
Electronics: DAE4 Sn536
Medium: Head 1750 MHz
Medium parameters used: f = 1770; σ = 1.393 mho/m; εr = 39.38; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC, Liquid Temperature: 22.3ºC
Communication System: LTE1700-FDD66 Duty Cycle: 1：1
Probe: EX3DV4 – SN7307 ConvF(8.64,8.64,8.64)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.932 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.78 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 1.11 W/kg
SAR(1 g) = 0.654 W/kg; SAR(10 g) = 0.434 W/kg
Maximum value of SAR (measured) = 0.941 W/kg

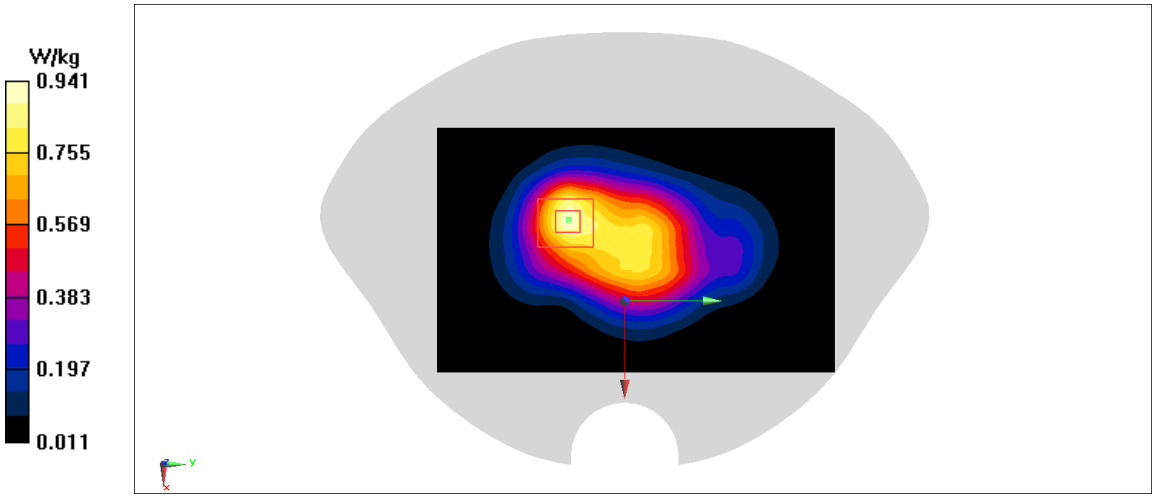


Fig A.1

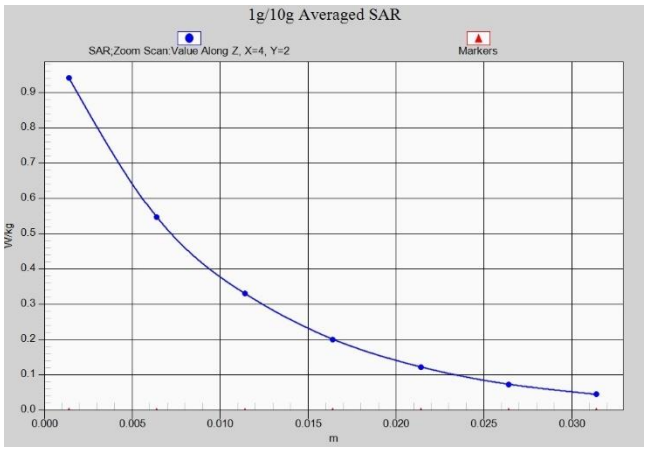


Fig. 1 Z-Scan at power reference point (LTE Band66)

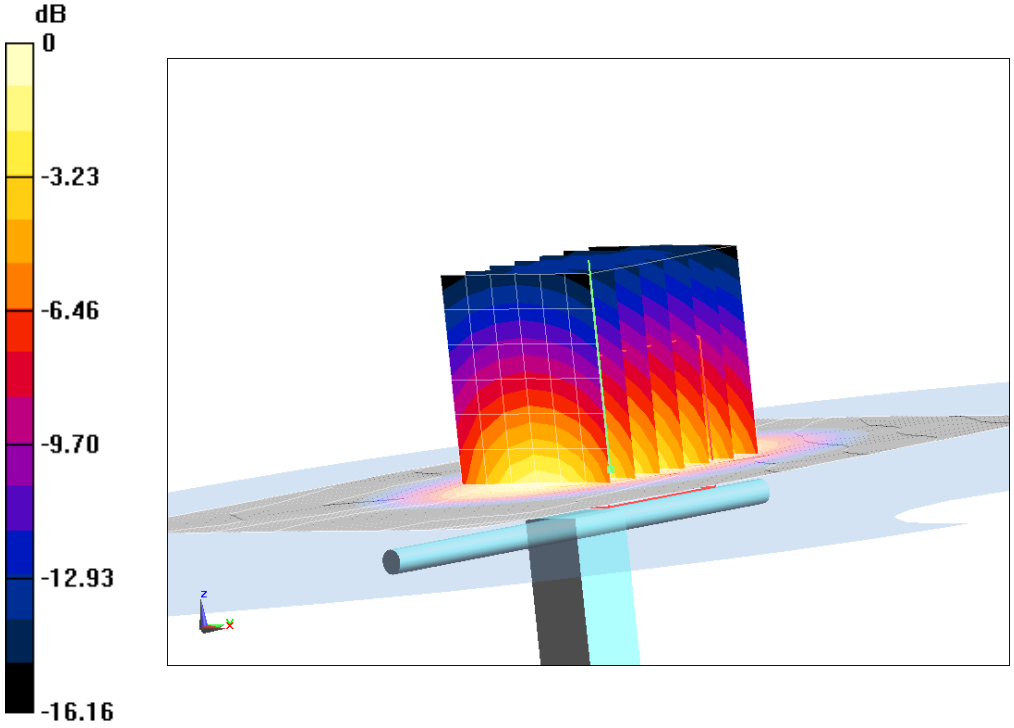
I.6 System Verification Results

1750 MHz

Date: 2/3/2021
Electronics: DAE4 Sn536
Medium: Head 1750 MHz
Medium parameters used: f = 1750 MHz; σ =1.374 mho/m; ε_r = 39.44; ρ = 1000 kg/m^3
Ambient Temperature: 22.5ºC Liquid Temperature: 22.3ºC
Communication System: CW Frequency: 1750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7307 ConvF(8.64,8.64,8.64)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 105.19 V/m; Power Drift = -0.04
Fast SAR: SAR(1 g) = 9.3 W/kg; SAR(10 g) = 4.73 W/kg
Maximum value of SAR (interpolated) = 14.12 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =105.19 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 16.67 W/kg
SAR(1 g) = 9 W/kg; SAR(10 g) = 4.76 W/kg
Maximum value of SAR (measured) = 14.22 W/kg



0 dB = 14.22 W/kg = 11.53 dB W/kg

Fig.B.1 validation 1750 MHz 250mW

I.7 Probe Calibration Certificate

Probe 7307 Calibration Certificate

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client CTTL (Auden) **Certificate No: EX3-7307_May20**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7307

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: May 29, 2020

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
DAE4	SN: 660	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-20
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 2, 2020

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.43	0.56	0.62	± 10.1 %
DCP (mV)[B]	100.0	98.2	100.3	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Max Unc[E] (k=2)
0	CW	X	0.00	0.00	1.00	0.00	153.0	± 3.0 %	± 4.7 %
		Y	0.00	0.00	1.00		151.6		
		Z	0.00	0.00	1.00		158.4		
10352-AAA	Pulse Waveform (200Hz, 10%)	X	1.84	62.62	7.81	10.00	60.0	± 4.6 %	± 9.6 %
		Y	6.38	76.27	14.75		60.0		
		Z	1.45	61.01	7.00		60.0		
10353-AAA	Pulse Waveform (200Hz, 20%)	X	0.81	60.00	5.70	6.99	80.0	± 3.2 %	± 9.6 %
		Y	20.00	88.66	17.39		80.0		
		Z	0.86	60.00	5.68		80.0		
10354-AAA	Pulse Waveform (200Hz, 40%)	X	0.45	60.00	4.93	3.98	95.0	± 1.7 %	± 9.6 %
		Y	20.00	91.41	17.41		95.0		
		Z	0.51	60.00	5.04		95.0		
10355-AAA	Pulse Waveform (200Hz, 60%)	X	0.29	60.62	5.22	2.22	120.0	± 1.2 %	± 9.6 %
		Y	20.00	96.26	18.63		120.0		
		Z	38.00	82.00	11.00		120.0		
10387-AAA	QPSK Waveform, 1 MHz	X	1.69	67.29	15.38	1.00	150.0	± 1.8 %	± 9.6 %
		Y	1.57	65.07	14.15		150.0		
		Z	1.73	66.94	15.28		150.0		
10388-AAA	QPSK Waveform, 10 MHz	X	2.20	68.11	15.92	0.00	150.0	± 1.1 %	± 9.6 %
		Y	2.08	66.56	14.89		150.0		
		Z	2.29	68.47	15.98		150.0		
10396-AAA	64-QAM Waveform, 100 kHz	X	2.35	68.48	18.03	3.01	150.0	± 0.8 %	± 9.6 %
		Y	2.51	68.48	17.79		150.0		
		Z	2.53	69.19	18.31		150.0		
10399-AAA	64-QAM Waveform, 40 MHz	X	3.38	66.64	15.59	0.00	150.0	± 0.9 %	± 9.6 %
		Y	3.47	66.68	15.44		150.0		
		Z	3.45	66.86	15.65		150.0		
10414-AAA	WLAN CCDF, 64-QAM, 40MHz	X	4.67	65.35	15.39	0.00	150.0	± 1.9 %	± 9.6 %
		Y	4.64	64.85	15.04		150.0		
		Z	4.77	65.48	15.43		150.0		

Note: For details on UID parameters see Appendix

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	35.6	260.75	34.45	5.76	0.00	4.90	1.28	0.00	1.00
Y	41.0	304.44	35.07	7.30	0.00	5.01	1.33	0.09	1.01
Z	40.7	299.93	34.68	9.21	0.00	4.91	0.98	0.11	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	23.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
64	54.2	0.75	14.38	14.38	14.38	0.00	1.00	± 13.3 %
150	52.3	0.76	13.49	13.49	13.49	0.00	1.00	± 13.3 %
300	45.3	0.87	11.83	11.83	11.83	0.10	1.20	± 13.3 %
450	43.5	0.87	11.16	11.16	11.16	0.12	1.30	± 13.3 %
750	41.9	0.89	10.41	10.41	10.41	0.55	0.80	± 12.0 %
835	41.5	0.90	10.20	10.20	10.20	0.47	0.80	± 12.0 %
900	41.5	0.97	9.95	9.95	9.95	0.44	0.87	± 12.0 %
1450	40.5	1.20	8.85	8.85	8.85	0.40	0.80	± 12.0 %
1640	40.2	1.31	8.74	8.74	8.74	0.39	0.86	± 12.0 %
1750	40.1	1.37	8.64	8.64	8.64	0.39	0.86	± 12.0 %
1810	40.0	1.40	8.39	8.39	8.39	0.38	0.86	± 12.0 %
1900	40.0	1.40	8.33	8.33	8.33	0.35	0.86	± 12.0 %
2000	40.0	1.40	8.31	8.31	8.31	0.35	0.88	± 12.0 %
2100	39.8	1.49	8.29	8.29	8.29	0.30	0.88	± 12.0 %
2300	39.5	1.67	8.15	8.15	8.15	0.33	0.90	± 12.0 %
2450	39.2	1.80	7.77	7.77	7.77	0.34	0.90	± 12.0 %
2600	39.0	1.96	7.61	7.61	7.61	0.35	0.90	± 12.0 %
3300	38.2	2.71	7.09	7.09	7.09	0.35	1.30	± 13.1 %
3500	37.9	2.91	6.72	6.72	6.72	0.35	1.30	± 13.1 %
3700	37.7	3.12	6.50	6.50	6.50	0.35	1.30	± 13.1 %
3900	37.5	3.32	6.60	6.60	6.60	0.40	1.60	± 13.1 %
4100	37.2	3.53	6.50	6.50	6.50	0.40	1.60	± 13.1 %
4200	37.1	3.63	6.40	6.40	6.40	0.40	1.70	± 13.1 %
4400	36.9	3.84	6.30	6.30	6.30	0.40	1.70	± 13.1 %
4600	36.7	4.04	6.22	6.22	6.22	0.40	1.70	± 13.1 %
4800	36.4	4.25	6.18	6.18	6.18	0.40	1.80	± 13.1 %
4950	36.3	4.40	5.90	5.90	5.90	0.40	1.80	± 13.1 %
5200	36.0	4.66	5.72	5.72	5.72	0.40	1.80	± 13.1 %
5250	35.9	4.71	5.61	5.61	5.61	0.40	1.80	± 13.1 %
5300	35.9	4.76	5.51	5.51	5.51	0.40	1.80	± 13.1 %
5500	35.6	4.96	5.20	5.20	5.20	0.40	1.80	± 13.1 %
5600	35.5	5.07	5.10	5.10	5.10	0.40	1.80	± 13.1 %
5750	35.4	5.22	5.05	5.05	5.05	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.95	4.95	4.95	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7307

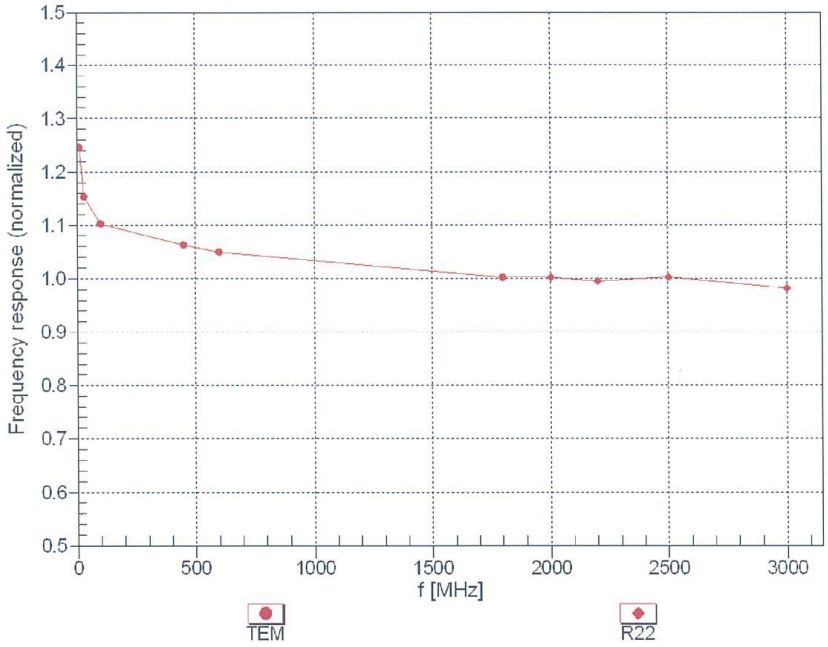
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
150	61.9	0.80	13.01	13.01	13.01	0.00	1.00	± 13.3 %
300	58.2	0.92	11.81	11.81	11.81	0.06	1.20	± 13.3 %
450	56.7	0.94	11.33	11.33	11.33	0.07	1.30	± 13.3 %
750	55.5	0.96	10.47	10.47	10.47	0.34	0.95	± 12.0 %
835	55.2	0.97	10.12	10.12	10.12	0.51	0.80	± 12.0 %
900	55.0	1.05	9.88	9.88	9.88	0.43	0.88	± 12.0 %
1450	54.0	1.30	8.90	8.90	8.90	0.34	0.80	± 12.0 %
1640	53.7	1.42	8.70	8.70	8.70	0.39	0.86	± 12.0 %
1750	53.4	1.49	8.41	8.41	8.41	0.45	0.86	± 12.0 %
1810	53.3	1.52	8.34	8.34	8.34	0.45	0.86	± 12.0 %
1900	53.3	1.52	8.30	8.30	8.30	0.32	0.88	± 12.0 %
2000	53.3	1.52	8.27	8.27	8.27	0.32	0.88	± 12.0 %
2100	53.2	1.62	8.24	8.24	8.24	0.42	0.88	± 12.0 %
2300	52.9	1.81	7.91	7.91	7.91	0.40	0.90	± 12.0 %
2450	52.7	1.95	7.79	7.79	7.79	0.34	0.90	± 12.0 %
2600	52.5	2.16	7.63	7.63	7.63	0.27	0.90	± 12.0 %
3300	51.6	3.08	6.66	6.66	6.66	0.40	1.30	± 13.1 %
3500	51.3	3.31	6.36	6.36	6.36	0.40	1.40	± 13.1 %
3700	51.0	3.55	6.27	6.27	6.27	0.40	1.40	± 13.1 %
3900	51.2	3.78	6.24	6.24	6.24	0.40	1.60	± 13.1 %
4100	50.5	4.01	6.20	6.20	6.20	0.40	1.60	± 13.1 %
4200	50.4	4.13	6.10	6.10	6.10	0.40	1.60	± 13.1 %
4400	50.1	4.37	6.02	6.02	6.02	0.40	1.70	± 13.1 %
4600	49.8	4.60	5.81	5.81	5.81	0.40	1.70	± 13.1 %
4800	49.6	4.83	5.50	5.50	5.50	0.50	1.90	± 13.1 %
4950	49.4	5.01	5.30	5.30	5.30	0.50	1.90	± 13.1 %
5200	49.0	5.30	4.85	4.85	4.85	0.50	1.90	± 13.1 %
5250	48.9	5.36	4.81	4.81	4.81	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.80	4.80	4.80	0.50	1.90	± 13.1 %
5500	48.6	5.65	4.47	4.47	4.47	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.37	4.37	4.37	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.45	4.45	4.45	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.31	4.31	4.31	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4– SN:7307 May 29, 2020

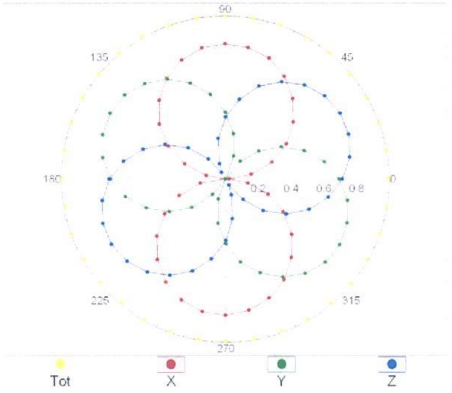
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



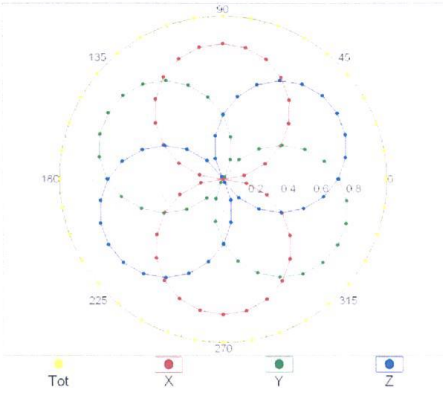
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

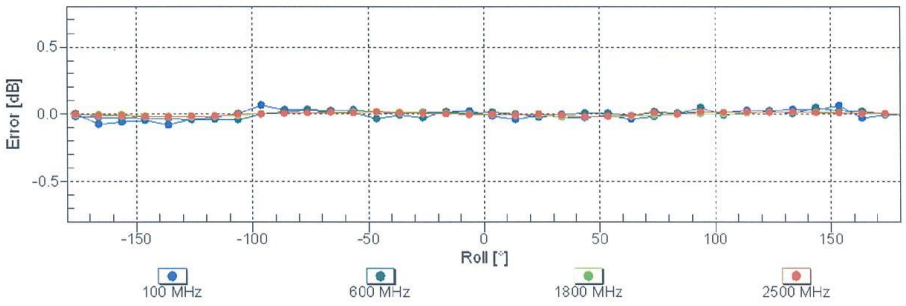
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



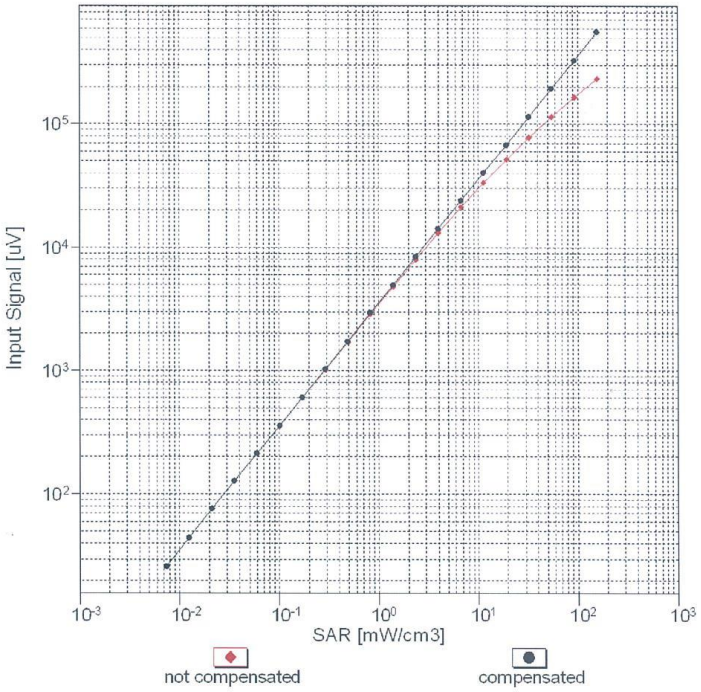
f=1800 MHz,R22

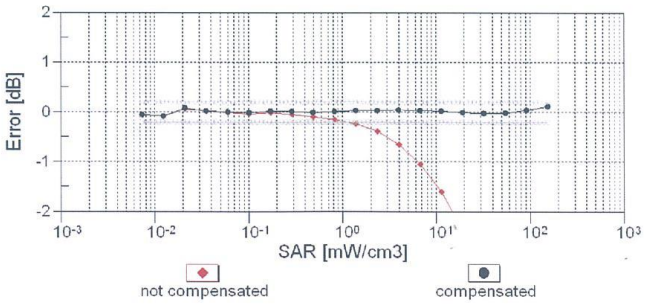




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR$_{head}$)
(TEM cell , f_{eval}= 1900 MHz)

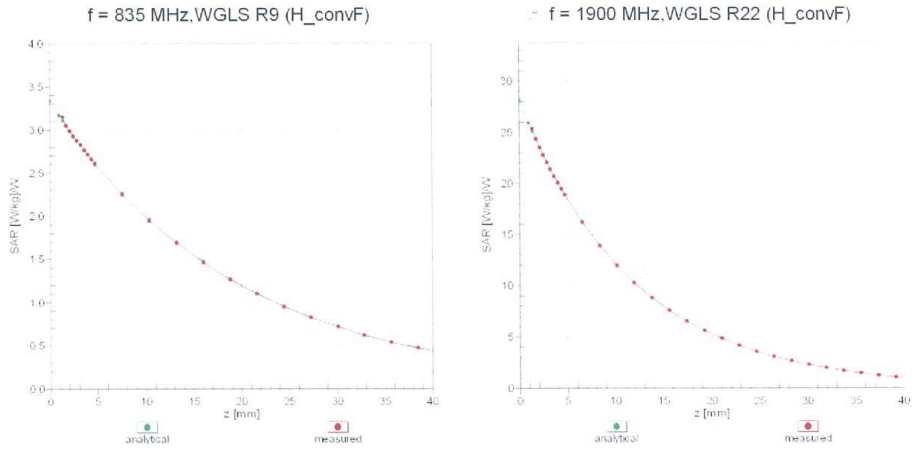




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

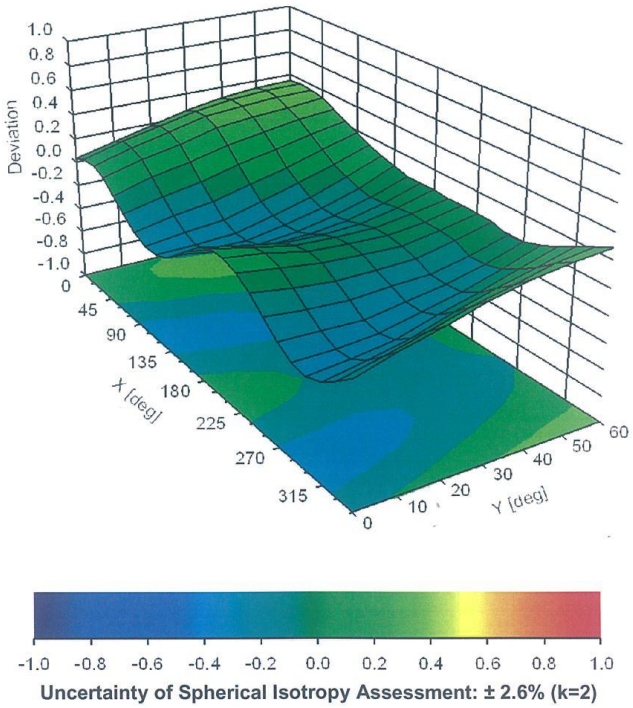
EX3DV4– SN:7307 May 29, 2020

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Appendix: Modulation Calibration Parameters

UID	Rev	Communication System Name	Group	PAR (dB)	Unc^E (k=2)
0		CW	CW	0.00	± 4.7 %
10010	CAA	SAR Validation (Square, 100ms, 10ms)	Test	10.00	± 9.6 %
10011	CAB	UMTS-FDD (WCDMA)	WCDMA	2.91	± 9.6 %
10012	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	WLAN	1.87	± 9.6 %
10013	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	WLAN	9.46	± 9.6 %
10021	DAC	GSM-FDD (TDMA, GMSK)	GSM	9.39	± 9.6 %
10023	DAC	GPRS-FDD (TDMA, GMSK, TN 0)	GSM	9.57	± 9.6 %
10024	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1)	GSM	6.56	± 9.6 %
10025	DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	GSM	12.62	± 9.6 %
10026	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1)	GSM	9.55	± 9.6 %
10027	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	GSM	4.80	± 9.6 %
10028	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	GSM	3.55	± 9.6 %
10029	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	GSM	7.78	± 9.6 %
10030	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH1)	Bluetooth	5.30	± 9.6 %
10031	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH3)	Bluetooth	1.87	± 9.6 %
10032	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	Bluetooth	1.16	± 9.6 %
10033	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1)	Bluetooth	7.74	± 9.6 %
10034	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3)	Bluetooth	4.53	± 9.6 %
10035	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5)	Bluetooth	3.83	± 9.6 %
10036	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH1)	Bluetooth	8.01	± 9.6 %
10037	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH3)	Bluetooth	4.77	± 9.6 %
10038	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH5)	Bluetooth	4.10	± 9.6 %
10039	CAB	CDMA2000 (1xRTT, RC1)	CDMA2000	4.57	± 9.6 %
10042	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate)	AMPS	7.78	± 9.6 %
10044	CAA	IS-91/EIA/TIA-553 FDD (FDMA, FM)	AMPS	0.00	± 9.6 %
10048	CAA	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	DECT	13.80	± 9.6 %
10049	CAA	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	DECT	10.79	± 9.6 %
10056	CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	TD-SCDMA	11.01	± 9.6 %
10058	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	GSM	6.52	± 9.6 %
10059	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)	WLAN	2.12	± 9.6 %
10060	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)	WLAN	2.83	± 9.6 %
10061	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	WLAN	3.60	± 9.6 %
10062	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	WLAN	8.68	± 9.6 %
10063	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)	WLAN	8.63	± 9.6 %
10064	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)	WLAN	9.09	± 9.6 %
10065	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)	WLAN	9.00	± 9.6 %
10066	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)	WLAN	9.38	± 9.6 %
10067	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)	WLAN	10.12	± 9.6 %
10068	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)	WLAN	10.24	± 9.6 %
10069	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	WLAN	10.56	± 9.6 %
10071	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)	WLAN	9.83	± 9.6 %
10072	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps)	WLAN	9.62	± 9.6 %
10073	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps)	WLAN	9.94	± 9.6 %
10074	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps)	WLAN	10.30	± 9.6 %
10075	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps)	WLAN	10.77	± 9.6 %
10076	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps)	WLAN	10.94	± 9.6 %
10077	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	WLAN	11.00	± 9.6 %
10081	CAB	CDMA2000 (1xRTT, RC3)	CDMA2000	3.97	± 9.6 %
10082	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate)	AMPS	4.77	± 9.6 %
10090	DAC	GPRS-FDD (TDMA, GMSK, TN 0-4)	GSM	6.56	± 9.6 %
10097	CAB	UMTS-FDD (HSDPA)	WCDMA	3.98	± 9.6 %
10098	CAB	UMTS-FDD (HSUPA, Subtest 2)	WCDMA	3.98	± 9.6 %
10099	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-4)	GSM	9.55	± 9.6 %
10100	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	LTE-FDD	5.67	± 9.6 %
10101	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	LTE-FDD	6.42	± 9.6 %
10102	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	LTE-FDD	6.60	± 9.6 %
10103	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	LTE-TDD	9.29	± 9.6 %
10104	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	LTE-TDD	9.97	± 9.6 %
10105	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	LTE-TDD	10.01	± 9.6 %
10108	CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	LTE-FDD	5.80	± 9.6 %