SAR EVALUATION REPORT

Test Report No.	**E147R-066**
Applicant	**Samsung Electronics Co., Ltd.**
	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 443-742, Korea
Model Name	**S3025-W (Alternative Model Name : FDX2530RPW, FDX2530VPW)**
DUT Type	**Wireless X-ray Detector**
Application Type	**Certification**
FCC ID	**A3LWIDT30Q**
IC ID	**649E-WIDT30Q**
Date of Report	**July 23, 2014**
Date of Test	**July 07, 2014 ~ July 21, 2014**
Test Laboratory	**ONETECH**
	301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862, Korea
Procedures	**KDB 865664**
	IEEE 1528-2003
	ANSI/IEEE C95.1, C95.3
	FCC CFR §2.1093
	RSS-102 Issue 4
Max SAR(1g)	**0.456 W/kg**
Test Opinion	**Satisfied to FCC requirements**

Report Author	**Jungwook Kim**	____________	**July 23, 2014**
Test Engineer	**Youngyong Kim**	____________	**July 23, 2014**

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1. DUT INFORMATION

DUT Description	Wireless X-ray Detector
Model Name	S3025-W (Alternative Model Name : FDX2530RPW, FDX2530VPW)
Serial Number	Identical Prototype
Mode of Operation	WLAN
TX Frequency Range	2412 MHz ~ 2462 MHz (802.11 b/g/n_HT20) 5180 MHz ~ 5240 MHz (802.11 a/n_HT20) 5190 MHz ~ 5230 MHz (802.11 n_HT40) 5260 MHz ~ 5320 MHz (802.11 a/n_HT20) 5270 MHz ~ 5310 MHz (802.11 n_HT40) 5500 MHz ~ 5700 MHz (802.11 a/n_HT20) 5510 MHz ~ 5670 MHz (802.11 n_HT40) 5745 MHz ~ 5825 MHz (802.11 a/n_HT20) 5755 MHz ~ 5795 MHz (802.11 n_HT40)
Maximum Average Conducted Power	18.04 dBm (802.11n_HT20 ch6 MCS0)
Body Worn Accessory	N/A
Antenna Type & Gain	Patch Antenna Ant 0 2450 MHz : -6.96 dBi / 5200 MHz : -11.64 dBi 5300 MHz : -8.39 dBi / 5500 MHz : -10.53 dBi 5600 MHz : -16.44 dBi / 5700 MHz : -19.78 dBi 5800 MHz : -20.56 dBi Ant 1 2450 MHz : -11.10 dBi / 5200 MHz : -14.04 dBi 5300 MHz : -12.92 dBi / 5500 MHz : -14.69 dBi 5600 MHz : -22.43 dBi / 5700 MHz : -22.74 dBi 5800 MHz : -21.26 dBi
Antenna Operation	2 Antenna transmit together
Battery	11.4 VDC / 3.4Ah

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2. INTRODUCTION

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.
The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz and Health Canada RF Exposure Guidelines Safety Code 6. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and
Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ).

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

SAR is expressed in units of watts per kilogram (W/kg). SAR can be related to the electric field at a point by

$$SAR = \frac{\sigma \mid E \mid^2}{\rho}$$

where:

σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m^3)
E = rms electric field strength (V/m)

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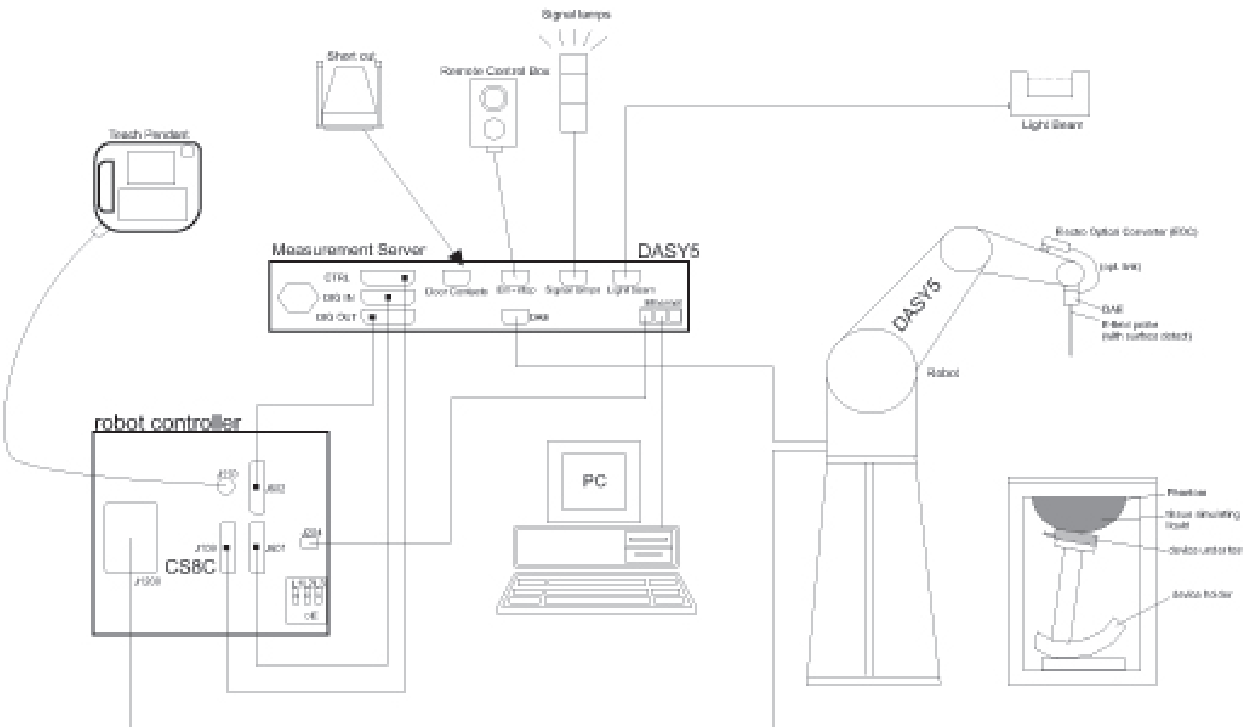
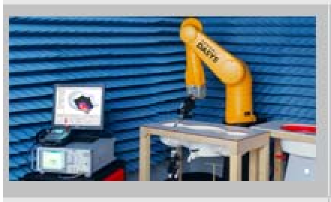
3. SAR MEASUREMENT SETUP

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- Data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing,
- AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.



3.1 Dasy 5 system

DASY52 SAR	
	DASY52 SAR is a cost-effective package for demonstration of compliance of mobile phones with specific absorption rate (SAR) limits. The fastest and most accurate scanner on the market, it is fully compatible with all worldwide standards for transmitters operating at the ear or near the body (<200 mm from the skin).
Components (typical configuration)	1 **TX90XL** Stäubli Robot and Controller CS8c incl. Cabinet 1 **EOCx** Electro Optical Converter (mounted on robot arm) 1 Robot Stand for TX90XL 1 Robot Arm Extension and Adaptors 1 Robot Remote Control 1 **LB5** Light Beam Switch for Probe Tooling (incl. LB Adaptor) 1 Light Beam Mounting Plate 1 DASY5 Measurement Server 1 PC Intel Core 2 Dual / 3.16 GHz (or higher) incl. Color-Monitor 23" - 4 GB RAM, 220 GB HD (or larger) / Win7 1 **SAM Twin** Phantom V5.0 incl. Support DASY5 1 **MD4HHTV5** Mounting Device for Hand-Held Transmitters 1 **DAEx** Data Acquisition Electronics 1 **ES3DVx** SAR Probe (incl. ConvF for HSL at 900 and 1750 MHz)

3.2 E-Field Probe

EX3DV4 Smallest Isotropic E-Field Probe for Dosimetric Measurements (Preliminary Specifications)	
	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in TSL (rotation around probe axis) ± 0.5 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

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3.3 ELI Phantom

ELI	
	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure.
Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Wooden Support	SPEAG standard phantom table

3.4 Mounting Device

 Mounting Device for Laptops	**MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters** In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device (Body-Worn) enables testing of ransmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at flat phantom section. **Material:** Polyoxymethylene (POM), PET-G, Foam

4. MEASUREMENT UNCERTAINTY

Uncertainty of SAR equipment for measurement Body 0.3 GHz to 3 GHz

No.		Error Description	Uncertainty Value (1 g) (%)	Uncertainty Value (10 g) (%)	Probe Dist.	Div.	C_i (1 g)	C_i (10 g)	$U_i(y)$ (1 g)	$U_i(y)$ (10 g)	V_i or V_{eff}
1	$U(PR_C)$	Probe Calibration	6.30	6.30	N	1.00	1.00	1.00	6.30	6.30	∞
2	$U(PR_I)$	Isotropy	1.87	1.87	R	$\sqrt{3}$	1.00	1.00	1.08	1.08	∞
3	$U(L)$	Linearity	0.60	0.60	R	$\sqrt{3}$	1.00	1.00	0.35	0.35	∞
4	$U(PR_{MR})$	Probe modulation response	2.40	2.40	R	$\sqrt{3}$	1.00	1.00	1.39	1.39	∞
6	$U(DL)$	Detection Limits	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
5	$U(BE)$	Boundary effect	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
7	$U(RE)$	Readout Electronics	0.30	0.30	N	1.00	1.00	1.00	0.30	0.30	∞
8	$U(T_{RT})$	Response Time	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
9	$U(T_{IT})$	Integration Time	2.60	2.60	R	$\sqrt{3}$	1.00	1.00	1.50	1.50	∞
10	$U(A_{NO})$	RF ambient conditions–noise	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
11	$U(A_{RF})$	RF ambient conditions–reflections	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
12	$U(PR_{PT})$	Probe positioner mech. Restrictions	0.40	0.40	R	$\sqrt{3}$	1.00	1.00	0.23	0.23	∞
13	$U(PR_{PP})$	Probe positioning with respect to phanton	2.90	2.90	R	$\sqrt{3}$	1.00	1.00	1.67	1.67	∞
14	$U(PP_{MSE})$	Post-processing(for max. SAR evaluation)	2.00	2.00	R	$\sqrt{3}$	1.00	1.00	1.15	1.15	∞
15	$U(DU)$	Device Holder Uncertainty	3.60	3.60	N	1.00	1.00	1.00	3.60	3.60	5.00
16	$U(PO_{SUT})$	Test sample positioning	8.32	6.37	N	1.00	1.00	1.00	8.32	6.37	9.00
17	$U(PS)$	Power scaling	0.00	0.00	R	$\sqrt{3}$	1.00	1.00	0.00	0.00	∞
18	$U(PD)$	Drift of output power(measured SAR drift)	5.00	5.00	R	$\sqrt{3}$	1.00	1.00	2.89	2.89	∞
19	$U(PL)$	Phantom Uncertainty	6.10	6.10	R	$\sqrt{3}$	1.00	1.00	3.52	3.52	∞
20	$U(CS_{DEC})$	Algorithm for correcting SAR for deviations in permittivity and	1.90	1.90	N	1.00	1.00	0.84	1.90	1.60	∞
21	$U(LC_M)$	Liquid Conductivity (meas.)	1.53	1.53	N	1.00	0.78	0.71	1.19	1.09	5.00
22	$U(LP_M)$	Liquid Permittivity (meas.)	3.07	3.07	N	1.00	0.23	0.26	0.71	0.80	5.00
23	$U(LC_{TU})$	Liquid conductivity(temperature uncertain	4.16	4.16	R	$\sqrt{3}$	0.78	0.71	1.87	1.71	∞
24	$U(LP_{TU})$	Liquid permittivity(temperature uncertaint	0.84	0.84	R	$\sqrt{3}$	0.23	0.26	0.11	0.13	∞
		Uc(sar) **Combined standard uncertainty (%)**							**12.97**	11.74	**50**
		Extended uncertainty ***U*(%)**							**25.94**	23.48	

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Uncertainty of SAR equipment for measurement Body 3 GHz to 6 GHz

No.		Error Description	Uncertainty Value (1 g) (%)	Uncertainty Value (10 g) (%)	Probe Dist.	Div.	C_i (1 g)	C_i (10 g)	$U_i(y)$ (1 g)	$U_i(y)$ (10 g)	V_i or V_{eff}
1	$U(PR_{c})$	Probe Calibration	6.30	6.30	N	1.00	1.00	1.00	6.30	6.30	∞
2	$U(PR_{i})$	Isotropy	1.87	1.87	R	$\sqrt{3}$	1.00	1.00	1.08	1.08	∞
3	$U(L)$	Linearity	0.60	0.60	R	$\sqrt{3}$	1.00	1.00	0.35	0.35	∞
4	$U(PR_{MR})$	Probe modulation response	2.40	2.40	R	$\sqrt{3}$	1.00	1.00	1.39	1.39	∞
6	$U(DL)$	Detection Limits	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
5	$U(BE)$	Boundary effect	2.00	2.00	R	$\sqrt{3}$	1.00	1.00	1.15	1.15	∞
7	$U(RE)$	Readout Electronics	0.30	0.30	N	1.00	1.00	1.00	0.30	0.30	∞
8	$U(T_{RT})$	Response Time	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
9	$U(T_{IT})$	Integration Time	2.60	2.60	R	$\sqrt{3}$	1.00	1.00	1.50	1.50	∞
10	$U(A_{NO})$	RF ambient conditions–noise	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
11	$U(A_{RF})$	RF ambient conditions–reflections	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
12	$U(PR_{PT})$	Probe positioner mech. Restrictions	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
13	$U(PR_{PP})$	Probe positioning with respect to phantom	6.70	6.70	R	$\sqrt{3}$	1.00	1.00	3.87	3.87	∞
14	$U(PP_{MAX})$	Post-processing(for max. SAR evaluation)	4.00	4.00	R	$\sqrt{3}$	1.00	1.00	2.31	2.31	∞
15	$U(DU)$	Device Holder Uncertainty	3.60	3.60	N	1.00	1.00	1.00	3.60	3.60	5.00
16	$U(PO_{EUT})$	Test sample positioning	7.76	6.03	N	1.00	1.00	1.00	7.76	6.03	9.00
17	$U(PS)$	Power scaling	0.00	0.00	R	$\sqrt{3}$	1.00	1.00	0.00	0.00	∞
18	$U(PD)$	Drift of output power(measured SAR drift)	5.00	5.00	R	$\sqrt{3}$	1.00	1.00	2.89	2.89	∞
19	$U(PU)$	Phantom Uncertainty	6.60	6.60	R	$\sqrt{3}$	1.00	1.00	3.81	3.81	∞
20	$U(CS_{ERR})$	Algorithm for correcting SAR for deviations in permittivity and	1.90	1.90	N	1.00	1.00	0.84	1.90	1.60	∞
21	$U(LC_{M})$	Liquid Conductivity (meas.)	1.50	1.50	N	1.00	0.78	0.71	1.17	1.07	5.00
22	$U(LP_{M})$	Liquid Permittivity (meas.)	2.23	2.23	N	1.00	0.23	0.26	0.51	0.58	5.00
23	$U(LC_{TU})$	Liquid conductivity(temperature uncertain	2.12	2.12	R	$\sqrt{3}$	0.78	0.71	0.95	0.87	∞
24	$U(LP_{TU})$	Liquid permittivity(temperature uncertaint	0.40	0.40	R	$\sqrt{3}$	0.23	0.26	0.05	0.06	∞
		Uc(sar) **Combined standard uncertainty (%)**							**13.26**	**12.27**	**71**
		Extended uncertainty *U*(%)							**26.52**	**24.54**	

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5. ANSI/IEEE C95.1-2005 RF EXPOSURE LIMIT

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements are included in the user's manual.

5.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

5.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Human Exposure Limits

	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIROMENT Professional Population (W/kg) or (mW/g)
SPATIAL PEAK SAR[1] Brain	1.60	8.00
SPATIAL AVERAGE SAR[2] Whole Body	0.08	0.40
SPATIAL PEAK SAR[3] Hands, Feet, Ankles, Wrists	4.00	20.00

[1] The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
[2] The Spatial Average value of the SAR averaged over the whole body.
[3] The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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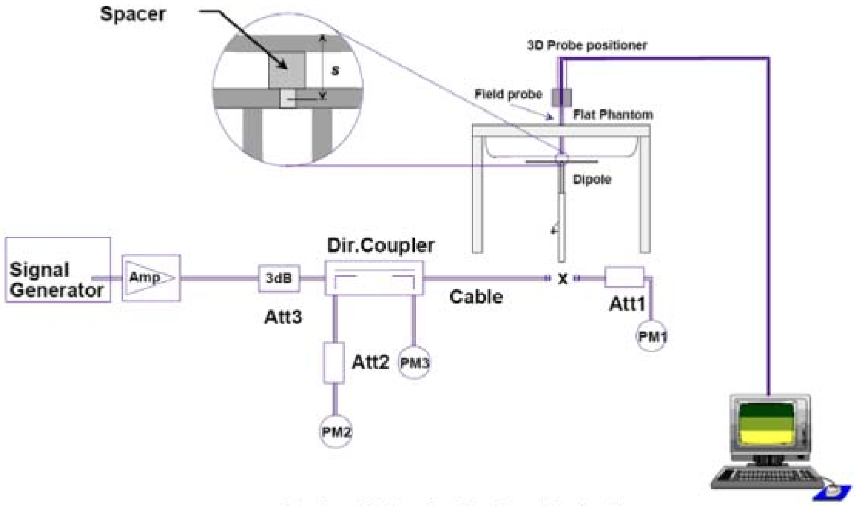
6. SYSTEM AND LIQUID VERIFICATION

6.1 System Verification setup



System Setup for System Evaluation

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole

The output power on dipole port must be calibrated to 30 dBm (1000 mW) before dipole is connected.

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Numerical reference SAR values (W/kg) for reference dipole and flat phantom

1	2	3	4	5	6
Frequency MHz	Phantom shell thickness mm	1 g SAR W/kg	10 g SAR W/kg	Local SAR at surface (above feedpoint) W/kg	Local SAR at surface (y = 2 cm offset from feedpoint) W/kg
300	6,3	3,02	2,04	4,40	2,10
300	2,0	2,85	1,94	4,14	2,00
450	6,3	4,92	3,28	7,20	3,20
450	2,0	4,58	3,06	6,75	2,98
750	2,0	8,49	5,55	12,6	4,59
835	2,0	9,56	6,22	14,1	4,90
900	2,0	10,9	6,99	16,4	5,40
1 450	2,0	29,0	16,0	50,2	6,50
1 800	2,0	38,4	20,1	69,5	6,80
1 900	2,0	39,7	20,5	72,1	6,60
1 950	2,0	40,5	20,9	72,7	6,60
2 000	2,0	41,1	21,1	74,6	6,50
2 450	2,0	52,4	24,0	104	7,70
2 585	2,0	55,9	24,4	119	7,90
2 600	2,0	55,3	24,6	113	8,29
3 000	2,0	63,8	25,7	140	9,50
3 500	2,0	67,1	25,0	169	12,1
3 700	2,0	67,4	24,2	178	12,7
5 000	2,0	77,9	22,1	305	15,1
5 200	2,0	76,5	21,6	310	15,9
5 500	2,0	83,3	23,4	349	18,1
5 800	2,0	78,0	21,9	341	20,3

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6.2 Liquid Validation

The dielectric parameters were checked prior to assessment using the DAK dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

6.3 Recommended Tissue Dielectric Parameters

The head and body tissue dielectric parameters recommended by KDB865664 have been incorporated in the following table.

Target Frequency	Head		Body	
(MHz)	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

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6.4 Liquid Confirmation Results

6.4.1 System Verification

Frequency (MHz)	Tissue Type	Liquid Temp.(℃)	Parameter	Target Value	Measured Value	Deviation	Limit (%)	Date
2450	Head	20.62	Permitivity	39.20	38.27	-2.37%	± 5	07/09/2014
			Conductivity	1.80	1.86	3.33%	± 5	
2450	Body	20.89	Permitivity	52.70	54.30	3.04%	± 5	07/10/2014
			Conductivity	1.95	2.02	3.59%	± 5	
5200	Head	21.48	Permitivity	36.00	36.18	0.50%	± 5	07/14/2014
			Conductivity	4.66	4.49	-3.65%	± 5	
5200	Body	20.51	Permitivity	49.03	48.64	-0.80%	± 5	07/16/2014
			Conductivity	5.35	5.30	-0.93%	± 5	
5300	Head	21.48	Permitivity	35.90	36.07	0.47%	± 5	07/14/2014
			Conductivity	4.76	4.60	-3.36%	± 5	
5300	Body	20.51	Permitivity	48.90	48.40	-1.02%	± 5	07/16/2014
			Conductivity	5.46	5.45	-0.18%	± 5	
5600	Head	20.84	Permitivity	35.50	35.70	0.56%	± 5	07/15/2014
			Conductivity	5.07	4.99	-1.58%	± 5	
5600	Body	20.64	Permitivity	48.48	46.89	-3.28%	± 5	07/17/2014
			Conductivity	5.79	5.96	2.94%	± 5	
5800	Head	21.03	Permitivity	35.30	34.41	-2.52%	± 5	07/11/2014
			Conductivity	5.27	5.15	-2.28%	± 5	
5800	Head	21.48	Permitivity	35.30	35.40	0.28%	± 5	07/14/2014
			Conductivity	5.27	5.11	-3.04%	± 5	
5800	Body	21.17	Permitivity	48.20	47.40	-1.66%	± 5	07/18/2014
			Conductivity	6.00	6.21	3.50%	± 5	

6.5 System Verification Results

Freq. (MHz)	Tissue Type	Amb. Temp (℃)	Liquid Temp (℃)	Input Power (mW)	Dipole S/N	Probe S/N	Measured SAR 1g	1W Normalized SAR 1g	1W Target SAR 1g	Deviation	Date
2450	Head	21.0	20.7	250	923	3666	13.4	53.6	52.4	2.29%	07/09/2014
2450	Body	20.9	20.9	250	923	3666	13.3	53.2	52.1	2.11%	07/10/2014
5200	Head	21.1	21.4	250	1094	3666	19.2	76.8	76.3	0.66%	07/14/2014
5200	Body	21.1	20.5	250	1094	3666	18.8	75.2	74.6	0.80%	07/16/2014
5300	Head	21.1	21.4	250	1094	3666	19.7	78.8	79.8	-1.25%	07/14/2014
5300	Body	21.1	20.5	250	1094	3666	19.4	77.6	76.3	1.70%	07/16/2014
5600	Head	20.9	20.9	250	1094	3666	20.4	81.6	80.2	1.75%	07/15/2014
5600	Body	21.0	20.6	250	1094	3666	19.8	79.2	80.8	-1.98%	07/17/2014
5800	Head	21.3	21.1	250	1094	3666	19.8	79.2	77.9	1.67%	07/11/2014
5800	Head	21.1	21.5	250	1094	3666	19.9	79.6	77.9	2.18%	07/14/2014
5800	Body	20.9	21.2	250	1094	3666	19.2	76.8	75.2	2.13%	07/18/2014

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7. SAR MEASUREMENT PROCEDURES

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing.

For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 5x5x7 points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job’s label.

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

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Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

* Z Scan Report on Liquid Measure the height ANNEX C. Liquid Depth photo to replace

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	$\frac{1}{2}\cdot\delta\cdot\ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5\cdot\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

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8. TEST EQUIPMENT LIST

Manufacturer	Model	Serial No.	Description	Cal. Date	Cal. Interval	Cal. Due	Used
STAUBLI	RX90XL	F07/56X0A1/A/01	DASY5 Robot	N/A	N/A	N/A	V
STAUBLI	CS8C Speag TX90XL	F07/56X0A1/C/01	DASY5 Controller	N/A	N/A	N/A	V
SPEAG	SE UMS 011 AA	1019	DASY5 Measurement Server	N/A	N/A	N/A	V
STAUBLI	RX90BL	F01/5J92A1/A/01	DASY4 Robot	N/A	N/A	N/A	
STAUBLI	CS7MBsp RX90BL	F01/5J92A1/C/01	DASY4 Controller	N/A	N/A	N/A	
SPEAG	SE UMS 001 BC	1164	DASY4 Measurement Server	N/A	N/A	N/A	
STAUBLI	SP1	D 211 421 02	Robot Remote Control	N/A	N/A	N/A	V
STAUBLI	Manual Control III Operator	D 221 340 01	Robot Remote Control	N/A	N/A	N/A	V
Di-Soric	LB5	80	Light Beam	N/A	N/A	N/A	
Di-Soric	LB2	270	Light Beam	N/A	N/A	N/A	
SPEAG	Twin Phantom	TP-1069	Head Phantom	N/A	N/A	N/A	
SPEAG	Twin Phantom	TP-1086	Head Phantom	N/A	N/A	N/A	
SPEAG	Twin Phantom	TP-1112	Head Phantom	N/A	N/A	N/A	
SPEAG	Twin Phantom	TP-1155	Head Phantom	N/A	N/A	N/A	
SPEAG	ELI4 Phantom	SM 000 T01 DA	Body Phantom	N/A	N/A	N/A	V
SPEAG	Triple Phantom	QD 000 P51 CA	Body Phantom	N/A	N/A	N/A	
SPEAG	Mounting Device	N/A	Head Positioner	N/A	N/A	N/A	
SPEAG	Mounting Device	SM LH1 001 AC	Laptop Holder	N/A	N/A	N/A	V
Agilent	85033E	N/A	Calibration Kit	N/A	N/A	N/A	V
SPEAG	DAE4	444	DAE	12/02/2013	1 Year	12/01/2014	V
SPEAG	DAE3	383	DAE	12/02/2013	1 Year	12/01/2014	
SPEAG	EX3DV4	3666	SAR Probe	11/27/2013	1 Year	11/26/2014	V
SPEAG	ES3DV3	3171	SAR Probe	11/22/2013	1 Year	11/21/2014	
SPEAG	D2450V2	923	Dipole Antenna	11/13/2013	1 Year	11/12/2014	V
SPEAG	D5GHzV2	1094	Dipole Antenna	12/16/2013	1 Year	12/15/2014	V
SPEAG	DAK-3.5	1140	Dielectric Assessment Kit	11/26/2013	1 Year	11/25/2014	V
HP	8665B	3744A01333	Signal Generator	11/11/2013	1 Year	11/10/2014	V
EMPOWER	BBS3Q7ELU-2001	1009D/C0105	High Power RF Amplifier	12/27/2013	1 Year	12/26/2014	V
VARIAN	VZC6961K11212	6673	RF Amplifier	12/09/2013	1 Year	12/08/2014	V
HP	778D	12679	Dual Directional Coupler	11/04/2013	1 Year	11/03/2014	
Agilent	772D	2839A01119	Dual Directional Coupler	11/04/2013	1 Year	11/03/2014	V
Agilent	E4419B	MY41291366	Dual Power Meter	11/26/2013	1 Year	11/25/2014	V
HP	437B	3125U25121	Power Meter	04/30/2014	1 Year	04/29/2015	V
HP	8481H	3318A18722	Power Meter Sensor	11/08/2013	1 Year	11/07/2014	V
HP	8481H	3318A17600	Power Meter Sensor	11/08/2013	1 Year	11/07/2014	V
HP	8481A	155A14928	Power Meter Sensor	11/05/2013	1 Year	11/04/2014	V
HP	8491A	50864	Coaxial Fixed Attenuator	10/30/2013	1 Year	10/29/2014	V
HP	8491A	18610	Coaxial Fixed Attenuator	10/30/2013	1 Year	10/29/2014	
WAAINWRIGHT	WLJS1500-6EF	1	Low Pass Filter	12/07/2013	1 Year	12/06/2014	
WAAINWRIGHT	WLJS3000-6EF	1	Low Pass Filter	12/07/2013	1 Year	12/06/2014	
WAAINWRIGHT	WLJS6000-7EF	1	Low Pass Filter	12/07/2013	1 Year	12/06/2014	V
Agilent	E8357A	US41070399	Pna Series Network Analyzer	11/05/2013	1 Year	11/04/2014	V
Rohde-Schwarz	FSP	100017	Spectrum Analyzer	11/05/2013	1 Year	11/04/2014	V
LKM electronic GmbH	DTM3000-spezial	3247	Digital Hand-held Thermometers	01/20/2014	1 Year	01/19/2015	V
CAS	TE-201	N/A	Hygro-Thermometer	01/20/2014	1 Year	01/19/2015	V
CAS	TE-201	N/A	Hygro-Thermometer	01/20/2014	1 Year	01/19/2015	

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9. RF CONDUCTED POWER

9.1 Antenna 0

< 802.11b >

Mode	Freq. (MHz)	CH	802.11b Conducted Power (dBm)				Tolerance (dBm)
			Data Rate (Mbps)				
			1	2	5.5	11	
802.11b	2412	1	17.96	17.91	17.87	17.79	18.0 ± 1.5
	2437	6	**18.04**	18.01	17.98	17.85	
	2462	11	17.55	17.49	17.44	17.35	

< 802.11g >

Mode	Freq. (MHz)	CH	802.11g Conducted Power (dBm)								Tolerance (dBm)
			Data Rate (Mbps)								
			6	9	12	18	24	36	48	54	
802.11g	2412	1	15.81	15.71	15.68	15.62	15.54	15.34	15.10	15.02	15.0 ± 1.5
	2437	6	17.17	17.13	17.10	16.99	16.89	16.77	16.61	16.48	18.0 ± 1.5
	2462	11	15.49	15.41	15.36	15.28	15.20	15.13	14.97	14.90	15.0 ± 1.5

< 802.11n HT20 >

Mode	Freq. (MHz)	CH	802.11n HT20 Conducted Power (dBm)								Tolerance (dBm)
			Data Rate (Mbps)								
			6.5	13	20	26	39	52	58	65	
802.11n HT20	2412	1	16.22	16.10	15.97	15.87	15.71	15.60	15.48	15.40	16.0 ± 1.5
	2437	6	**18.04**	17.90	17.78	17.70	17.53	17.42	17.31	17.19	18.0 ± 1.5
	2462	11	15.95	15.78	15.69	15.60	15.49	15.42	15.31	15.24	16.0 ± 1.5

< 802.11a >

Mode	Freq. (MHz)	CH	802.11a Conducted Power (dBm) Data Rate (Mbps)								Tolerance (dBm)
			6	9	12	18	24	36	48	54	
802.11a	5180	36	**11.42**	11.37	11.34	11.28	11.22	11.11	11.01	10.97	12.0 ± 1.5
	5200	40	12.54	12.47	12.43	12.39	12.33	12.24	12.15	12.10	
	5220	44	12.51	12.45	12.42	12.39	12.34	12.24	12.13	12.09	
	5240	48	**12.47**	12.37	12.34	12.28	12.24	12.15	12.04	11.95	
	5260	52	**15.15**	15.11	15.09	15.03	14.97	14.94	14.84	14.75	15.0 ± 1.5
	5280	56	14.52	14.46	14.42	14.38	14.35	14.29	14.26	14.21	14.0 ± 1.5
	5300	60	14.14	14.11	14.09	14.05	13.99	13.97	13.85	13.72	
	5320	64	**14.12**	14.03	14.00	13.95	13.88	13.82	13.77	13.72	
	5500	100	14.21	14.18	14.14	14.10	14.06	14.01	13.94	13.88	
	5520	104	**13.83**	13.81	13.78	13.74	13.68	13.65	13.59	13.55	
	5540	108	14.09	14.07	14.04	13.98	13.92	13.88	13.84	13.75	
	5560	112	**14.88**	14.85	14.81	14.77	14.70	14.66	14.64	14.61	15.0 ± 1.5
	5580	116	14.81	14.77	14.74	14.70	14.67	14.62	14.59	14.55	
	5600	120	15.33	15.30	15.27	15.22	15.18	15.12	15.08	15.04	
	5620	124	**15.23**	15.16	15.14	15.09	15.04	15.01	14.98	14.95	
	5640	128	15.58	15.54	15.49	15.44	15.39	15.35	15.29	15.27	
	5660	132	15.25	15.21	15.19	15.12	15.07	15.01	14.94	14.85	
	5680	136	**15.14**	15.11	15.08	15.03	14.96	14.90	14.81	14.74	
	5700	140	15.49	15.45	15.42	15.37	15.31	15.26	15.21	15.19	
	5745	149	**14.54**	14.51	14.48	14.42	14.36	14.32	14.26	14.16	14.0 ± 1.5
	5765	153	14.47	14.42	14.40	14.35	14.29	14.22	14.17	14.13	
	5785	157	**14.14**	14.11	14.07	14.02	13.95	13.86	13.73	13.67	
	5805	161	14.04	14.00	13.97	13.91	13.84	13.81	13.68	13.60	
	5825	165	**14.41**	14.33	14.30	14.27	14.24	14.18	14.10	14.07	

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< 802.11n HT20 (5GHz) >

Mode	Freq. (MHz)	CH	802.11n HT20 (5GHz) Conducted Power (dBm)								Tolerance (dBm)
			Data Rate (Mbps)								
			6.5	13	20	26	39	52	58	65	
802.11n HT20	5180	36	9.82	9.75	9.69	9.65	9.53	9.45	9.37	9.30	10.0 ± 1.5
	5200	40	10.43	10.36	10.30	10.25	10.15	10.12	10.10	10.05	10.5 ± 1.5
	5220	44	10.48	10.41	10.34	10.32	10.20	10.11	10.07	10.02	
	5240	48	9.88	9.79	9.73	9.68	9.64	9.57	9.54	9.49	
	5260	52	12.09	12.03	11.99	11.95	11.86	11.81	11.74	11.69	12.0 ± 1.5
	5280	56	11.29	11.21	11.16	11.13	11.05	11.01	10.98	10.94	
	5300	60	11.09	11.03	10.97	10.91	10.82	10.80	10.76	10.72	11.5 ± 1.5
	5320	64	10.97	10.89	10.84	10.80	10.70	10.61	10.59	10.54	
	5500	100	12.19	12.15	12.10	12.07	11.96	11.92	11.80	11.76	12.5 ± 1.5
	5520	104	12.35	12.29	12.25	12.21	12.12	12.06	12.01	11.98	
	5540	108	12.58	12.51	12.45	12.42	12.39	12.37	12.33	12.29	13.0 ± 1.5
	5560	112	12.95	12.88	12.85	12.82	12.75	12.69	12.66	12.61	
	5580	116	13.27	13.21	13.14	13.10	13.06	13.03	12.98	12.94	13.5 ± 1.5
	5600	120	13.41	13.35	13.29	13.24	13.20	13.17	13.13	13.07	
	5620	124	13.29	13.21	13.16	13.12	13.08	13.05	13.00	12.95	
	5640	128	13.74	13.67	13.61	13.57	13.51	13.46	13.39	13.32	
	5660	132	12.06	11.99	11.92	11.86	11.81	11.76	11.72	11.68	14.0 ± 1.5
	5680	136	12.32	12.26	12.21	12.16	12.11	12.06	12.01	11.94	
	5700	140	12.82	12.77	12.70	12.66	12.59	12.51	12.46	12.42	
	5745	149	11.76	11.70	11.63	11.58	11.48	11.44	11.38	11.33	12.5 ± 1.5
	5765	153	11.74	11.68	11.62	11.57	11.46	11.36	11.32	11.29	
	5785	157	12.24	12.17	12.11	12.06	11.96	11.94	11.89	11.84	
	5805	161	12.14	12.07	12.01	11.95	11.88	11.83	11.76	11.73	
	5825	165	12.15	12.07	12.02	11.97	11.86	11.79	11.74	11.69	

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< 802.11n HT40 (5GHz) >

Mode	Freq. (MHz)	CH	802.11n HT40 (5GHz) Conducted Power (dBm) Data Rate (Mbps)								Tolerance (dBm)
			13.5	27	40.5	54	81	108	121.5	135	
802.11n HT40	5190	38	9.76	9.66	9.59	9.50	9.44	9.31	9.24	9.13	10.0 ± 1.5
	5230	46	9.71	9.58	9.47	9.37	9.26	9.17	9.11	9.02	
	5270	54	11.58	11.46	11.35	11.24	11.16	11.10	11.01	10.89	11.5 ± 1.5
	5310	62	10.74	10.62	10.52	10.43	10.31	10.20	10.13	10.02	10.5 ± 1.5
	5510	102	8.55	8.42	8.32	8.23	8.12	8.04	7.92	7.84	9.0 ± 1.5
	5550	110	8.81	8.70	8.61	8.49	8.33	8.22	8.13	8.08	9.5 ± 1.5
	5590	118	8.54	8.43	8.32	8.22	8.10	7.98	7.89	7.80	10.0 ± 1.5
	5630	126	8.68	8.56	8.45	8.35	8.22	8.15	8.03	7.96	
	5670	134	9.58	9.44	9.33	9.26	9.10	9.02	8.94	8.85	
	5755	151	8.78	8.66	8.56	8.48	8.32	8.17	8.10	8.05	9.0 ± 1.5
	5795	159	8.76	8.64	8.53	8.43	8.30	8.18	8.06	7.98	

9.2 Antenna 1

< 802.11b >

Mode	Freq. (MHz)	CH	802.11b Conducted Power (dBm) Data Rate (Mbps)				Tolerance (dBm)
			1	2	5.5	11	
802.11b	2412	1	17.38	17.33	17.30	17.13	18.0 ± 1.5
	2437	6	**17.91**	17.85	17.78	17.71	
	2462	11	17.51	17.46	17.41	17.35	

< 802.11g >

Mode	Freq. (MHz)	CH	802.11g Conducted Power (dBm) Data Rate (Mbps)								Tolerance (dBm)
			6	9	12	18	24	36	48	54	
802.11g	2412	1	15.81	15.72	15.69	15.58	15.48	15.35	15.14	15.05	15.0 ± 1.5
	2437	6	17.59	17.51	17.45	17.36	17.26	17.22	17.02	16.96	18.0 ± 1.5
	2462	11	15.85	15.76	15.73	15.63	15.53	15.36	15.23	15.10	15.0 ± 1.5

< 802.11n HT20 >

Mode	Freq. (MHz)	CH	802.11n HT20 Conducted Power (dBm) Data Rate (Mbps)								Tolerance (dBm)
			6.5	13	20	26	39	52	58	65	
802.11n HT20	2412	1	17.00	16.94	16.81	16.75	16.72	16.66	16.60	16.52	16.0 ± 1.5
	2437	6	**18.02**	17.91	17.78	17.69	17.56	17.45	17.39	17.30	18.0 ± 1.5
	2462	11	16.63	16.55	16.44	16.36	16.19	16.12	16.02	15.94	16.0 ± 1.5

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< 802.11a >

Mode	Freq. (MHz)	CH	802.11a Conducted Power (dBm) Data Rate (Mbps) 6	9	12	18	24	36	48	54	Tolerance (dBm)
802.11a	5180	36	**11.63**	11.56	11.49	11.43	11.37	11.32	11.29	11.22	12.0 ± 1.5
	5200	40	11.77	11.72	11.69	11.64	11.58	11.54	11.46	11.38	
	5220	44	11.83	11.80	11.76	11.71	11.66	11.61	11.59	11.52	
	5240	48	**11.95**	11.89	11.85	11.80	11.73	11.68	11.60	11.51	
	5260	52	**15.31**	15.25	15.16	15.11	15.07	15.03	14.94	14.85	15.0 ± 1.5
	5280	56	14.25	14.22	14.19	14.13	14.09	14.05	14.03	13.99	14.0 ± 1.5
	5300	60	14.64	14.60	14.58	14.52	14.46	14.40	14.33	14.29	
	5320	64	**13.88**	13.83	13.80	13.75	13.69	13.62	13.58	13.51	
	5500	100	14.43	14.40	14.38	14.32	14.27	14.22	14.17	14.12	
	5520	104	**13.97**	13.93	13.90	13.85	13.80	13.76	13.71	13.66	
	5540	108	14.47	14.44	14.40	14.35	14.29	14.25	14.19	14.15	
	5560	112	14.62	14.59	14.56	14.50	14.44	14.39	14.33	14.27	15.0 ± 1.5
	5580	116	**15.15**	15.12	15.10	15.04	14.99	14.93	14.85	14.81	
	5600	120	15.04	15.00	14.97	14.92	14.85	14.80	14.72	14.64	
	5620	124	**14.95**	14.88	14.84	14.79	14.73	14.69	14.57	14.52	
	5640	128	14.84	14.81	14.78	14.72	14.66	14.60	14.52	14.43	
	5660	132	15.14	15.10	15.08	15.03	14.97	14.88	14.86	14.80	
	5680	136	**15.07**	15.02	14.99	14.94	14.86	14.83	14.76	14.70	
	5700	140	15.03	14.99	14.93	14.87	14.81	14.77	14.72	14.65	
	5745	149	**14.23**	14.19	14.15	14.10	14.05	13.98	13.92	13.85	14.0 ± 1.5
	5765	153	14.19	14.15	14.13	14.06	14.01	13.91	13.86	13.80	
	5785	157	**14.09**	14.06	14.03	13.97	13.91	13.83	13.76	13.72	
	5805	161	13.93	13.89	13.84	13.77	13.75	13.70	13.65	13.61	
	5825	165	**13.80**	13.75	13.72	13.68	13.62	13.55	13.49	13.44	

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< 802.11n HT20 (5GHz) >

Mode	Freq. (MHz)	CH	802.11n HT20 (5GHz) Conducted Power (dBm)								Tolerance (dBm)
			Data Rate (Mbps)								
			6.5	13	20	26	39	52	58	65	
802.11n HT20	5180	36	9.98	9.90	9.84	9.80	9.73	9.66	9.59	9.51	10.0 ± 1.5
	5200	40	10.15	10.08	10.01	9.97	9.90	9.86	9.81	9.74	10.5 ± 1.5
	5220	44	10.14	10.08	10.02	9.99	9.93	9.90	9.82	9.76	
	5240	48	9.81	9.76	9.72	9.66	9.61	9.57	9.51	9.45	
	5260	52	11.00	10.94	10.88	10.83	10.80	10.77	10.72	10.67	12.0 ± 1.5
	5280	56	10.67	10.62	10.56	10.53	10.44	10.41	10.38	10.34	
	5300	60	10.60	10.53	10.47	10.43	10.38	10.34	10.29	10.23	11.5 ± 1.5
	5320	64	10.52	10.48	10.45	10.43	10.39	10.34	10.31	10.28	
	5500	100	11.01	10.95	10.89	10.86	10.77	10.68	10.62	10.55	12.5 ± 1.5
	5520	104	10.55	10.49	10.43	10.39	10.34	10.29	10.25	10.20	
	5540	108	10.84	10.78	10.74	10.71	10.63	10.56	10.49	10.42	13.0 ± 1.5
	5560	112	11.67	11.62	11.56	11.49	11.42	11.35	11.28	11.24	
	5580	116	12.76	12.70	12.65	12.62	12.59	12.51	12.47	12.43	13.5 ± 1.5
	5600	120	13.35	13.25	13.21	13.18	13.08	12.99	12.95	12.90	
	5620	124	13.13	13.05	12.98	12.94	12.85	12.77	12.72	12.69	
	5640	128	13.07	13.00	12.94	12.90	12.80	12.71	12.66	12.62	
	5660	132	12.06	12.01	11.96	11.91	11.83	11.74	11.70	11.66	14.0 ± 1.5
	5680	136	11.90	11.84	11.75	11.71	11.61	11.53	11.50	11.47	
	5700	140	12.34	12.27	12.19	12.13	12.05	11.96	11.91	11.88	
	5745	149	11.64	11.58	11.53	11.49	11.40	11.32	11.25	11.20	12.5 ± 1.5
	5765	153	11.61	11.54	11.48	11.42	11.30	11.21	11.18	11.14	
	5785	157	11.62	11.53	11.49	11.45	11.35	11.27	11.21	11.19	
	5805	161	11.52	11.45	11.38	11.32	11.24	11.19	11.13	11.08	
	5825	165	11.38	11.29	11.24	11.19	11.12	11.03	10.95	10.92	

< 802.11n HT40 (5GHz) >

Mode	Freq. (MHz)	CH	802.11n HT40 (5GHz) Conducted Power (dBm)								Tolerance (dBm)
			Data Rate (Mbps)								
			13.5	27	40.5	54	81	108	121.5	135	
802.11n HT40	5190	38	10.53	10.47	10.36	10.30	10.25	10.19	10.12	10.08	10.0 ± 1.5
	5230	46	10.66	10.62	10.54	10.47	10.35	10.21	10.11	10.02	
	5270	54	11.15	11.04	10.93	10.84	10.70	10.56	10.42	10.39	11.5 ± 1.5
	5310	62	10.74	10.63	10.52	10.43	10.29	10.20	10.11	10.06	10.5 ± 1.5
	5510	102	7.27	7.24	7.16	7.09	6.93	6.81	6.75	6.68	9.0 ± 1.5
	5550	110	7.75	7.62	7.50	7.43	7.31	7.22	7.11	7.03	9.5 ± 1.5
	5590	118	7.90	7.78	7.67	7.59	7.43	7.30	7.18	7.08	10.0 ± 1.5
	5630	126	8.34	8.23	8.15	8.03	7.89	7.78	7.66	7.58	
	5670	134	8.62	8.49	8.41	8.33	8.18	8.02	7.95	7.91	
	5755	151	8.48	8.37	8.26	8.20	8.09	7.95	7.89	7.85	9.0 ± 1.5
	5795	159	8.44	8.33	8.22	8.14	8.00	7.85	7.72	7.67	

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012/April 2013 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The bolded data rate and channel above were tested for SAR.

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10.SAR TEST RESULTS

< 802.11b/n_HT20 Head SAR >

Mode	Freq. (MHz)	CH	Antenna	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 1g SAR (W/kg)	Reported SAR (W/Kg)	Sum
11b	2437	6	0	18.04	19.5	1.40	0.099	0.138	0.340
			1	17.91	19.5	1.44	**0.140**	**0.202**	
11n HT20	2437	6	0	18.04	19.5	1.40	0.112	0.157	0.413
			1	18.02	19.5	1.41	**0.182**	**0.256**	

< 802.11b/n_HT20 Body SAR >

Mode	Freq. (MHz)	CH	Antenna	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 1g SAR (W/kg)	Reported SAR (W/Kg)	Sum
11b	2437	6	0	18.04	19.5	1.40	0.084	0.118	0.388
			1	17.91	19.5	1.44	**0.187**	**0.270**	
11n HT20	2437	6	0	18.04	19.5	1.34	0.108	0.151	**0.456**
			1	18.02	19.5	1.12	**0.217**	**0.305**	

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< 802.11a Head SAR >

Mode	Freq. (MHz)	CH	Antenna	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 1g SAR (W/kg)	Reported SAR (W/Kg)	Sum
11a	5180	36	0	11.42	13.5	1.61	0.005	0.008	0.031
			1	11.63	13.5	1.54	0.015	0.023	
11a	5240	48	0	12.47	13.5	1.27	0.018	0.023	0.127
			1	11.95	13.5	1.43	**0.073**	**0.104**	
11a	5260	52	0	15.15	16.5	1.36	0.071	0.096	0.290
			1	15.31	15.5	1.04	**0.185**	**0.193**	
11a	5320	64	0	14.12	16.5	1.73	0.045	0.077	0.209
			1	13.88	15.5	1.45	0.091	0.132	
11a	5520	104	0	13.83	15.5	1.47	0.061	0.089	0.129
			1	13.97	15.5	1.42	0.029	0.041	
11a	5580	116	0	14.81	16.5	1.48	0.005	0.008	0.192
			1	15.15	16.5	1.36	**0.135**	**0.184**	
11a	5620	124	0	15.23	16.5	1.34	0.003	0.005	0.103
			1	14.95	16.5	1.43	0.069	0.099	
11a	5680	136	0	15.14	16.5	1.37	0.003	0.005	0.025
			1	15.07	16.5	1.39	0.015	0.021	
11a	5745	149	0	14.54	15.5	1.25	0.003	0.004	0.020
			1	14.23	15.5	1.34	0.012	0.016	
11a	5785	157	0	14.14	15.5	1.37	0.000	0.000	0.016
			1	14.09	15.5	1.38	0.012	0.016	
11a	5825	165	0	14.41	15.5	1.29	0.002	0.003	0.020
			1	13.8	15.5	1.48	**0.012**	**0.017**	

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< 802.11a Body SAR >

Mode	Freq. (MHz)	CH	Antenna	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 1g SAR (W/kg)	Reported SAR (W/Kg)	Sum
11a	5180	36	0	11.42	13.5	1.61	0.008	0.013	0.038
			1	11.63	13.5	1.54	0.016	0.025	
11a	5240	48	0	12.47	13.5	1.27	0.018	0.023	0.117
			1	11.95	13.5	1.43	**0.066**	**0.094**	
11a	5260	52	0	15.15	16.5	1.36	0.073	0.100	0.288
			1	15.31	15.5	1.04	**0.180**	**0.188**	
11a	5320	64	0	14.12	16.5	1.73	0.079	0.136	0.259
			1	13.88	15.5	1.45	0.085	0.123	
11a	5520	104	0	13.83	15.5	1.47	0.054	0.080	0.114
			1	13.97	15.5	1.42	0.024	0.034	
11a	5580	116	0	14.81	16.5	1.48	0.008	0.012	0.179
			1	15.15	16.5	1.36	**0.122**	**0.166**	
11a	5620	124	0	15.23	16.5	1.34	0.004	0.005	0.089
			1	14.95	16.5	1.43	0.059	0.084	
11a	5680	136	0	15.14	16.5	1.37	0.037	0.051	0.074
			1	15.07	16.5	1.39	0.016	0.023	
11a	5745	149	0	14.54	15.5	1.25	0.003	0.004	0.006
			1	14.23	15.5	1.34	0.002	0.002	
11a	5785	157	0	14.14	15.5	1.37	0.003	0.004	0.019
			1	14.09	15.5	1.38	0.011	0.015	
11a	5825	165	0	14.41	15.5	1.29	0.003	0.003	0.022
			1	13.8	15.5	1.48	**0.013**	**0.019**	

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ANNEX A. SYSTEM VERIFICATION PLOTS

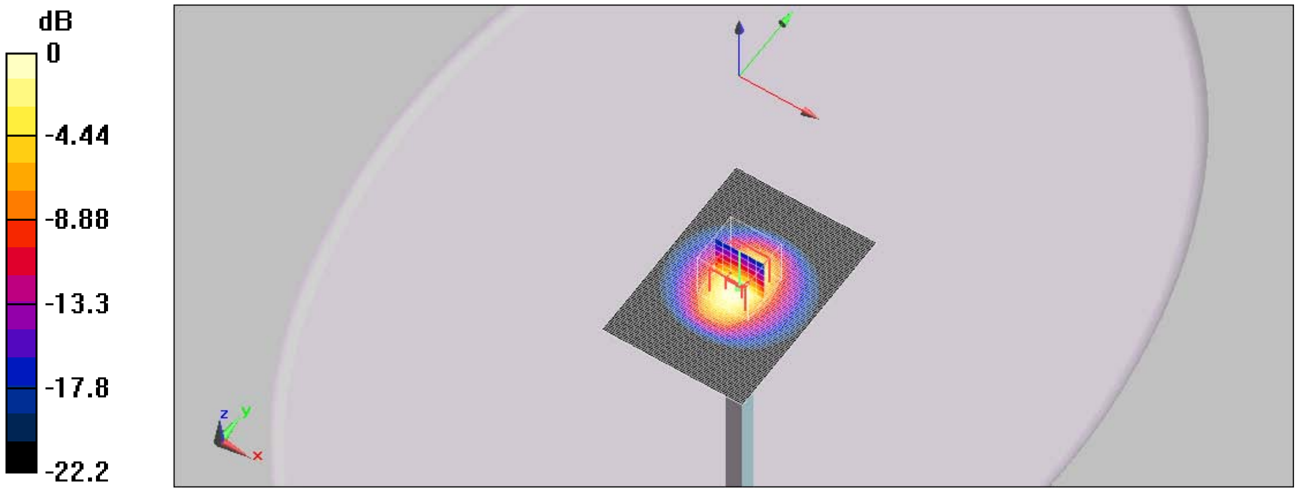
< 2450 MHz Head / Date : July 09, 2014 >

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:923
Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.86 mho/m; εr = 38.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.78, 7.78, 7.78); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

2450MHz SPC/Area Scan (71x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 20.8 mW/g

2450MHz SPC/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 106.6 V/m; Power Drift = 0.030 dB
Peak SAR (extrapolated) = 27.7 W/kg
SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.22 mW/g
Maximum value of SAR (measured) = 20.6 mW/g



0 dB = 20.6mW/g

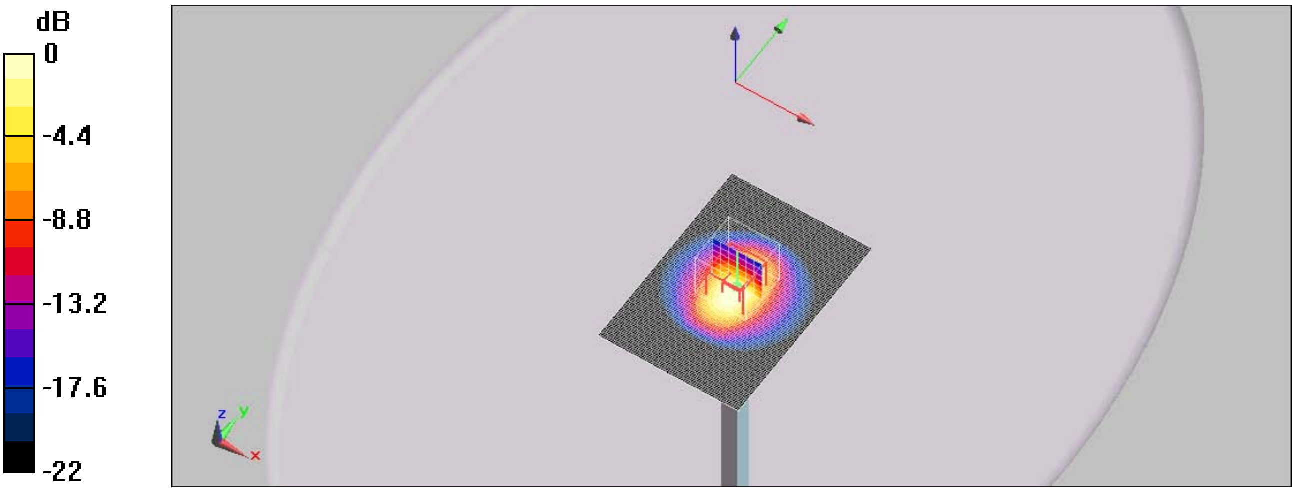
< 2450 MHz Body / Date : July 10, 2014 >

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:923
Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 2.02 mho/m; εr = 54.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.45, 7.45, 7.45); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

2450MHz SPC/Area Scan (71x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 20.3 mW/g

2450MHz SPC/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.3 V/m; Power Drift = 0.021 dB
Peak SAR (extrapolated) = 26.4 W/kg
SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.23 mW/g
Maximum value of SAR (measured) = 19.8 mW/g



0 dB = 19.8mW/g

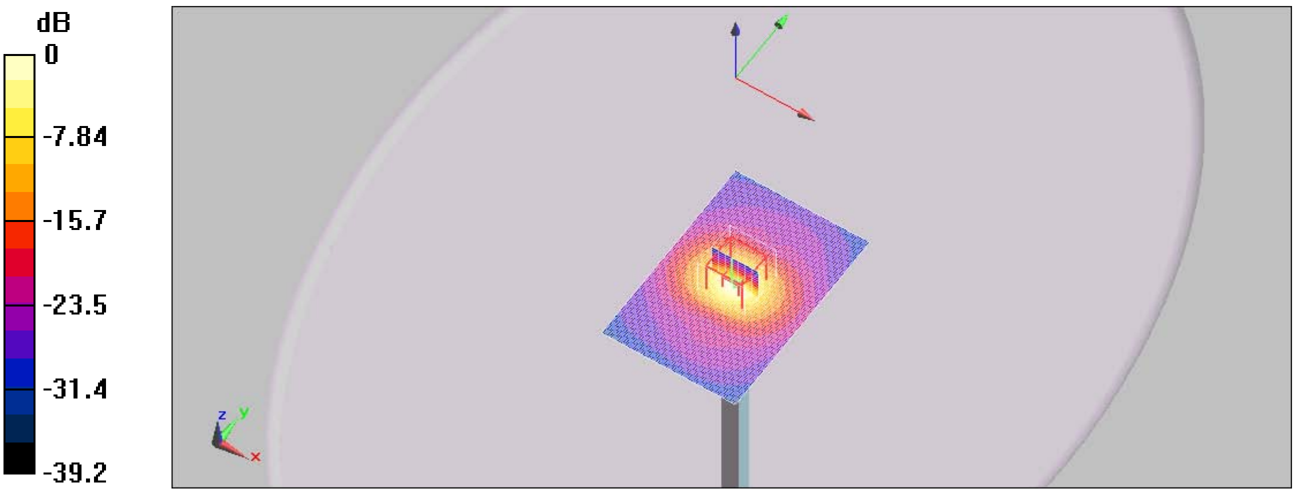
< 5200 MHz Head / Date : July 14, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 4.49 mho/m; εr = 36.2; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(5.57, 5.57, 5.57); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5200MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 40.5 mW/g

5200MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 95.2 V/m; Power Drift = 0.025 dB
Peak SAR (extrapolated) = 80.5 W/kg
SAR(1 g) = 19.2 mW/g; SAR(10 g) = 5.48 mW/g
Maximum value of SAR (measured) = 37.3 mW/g



0 dB = 37.3mW/g

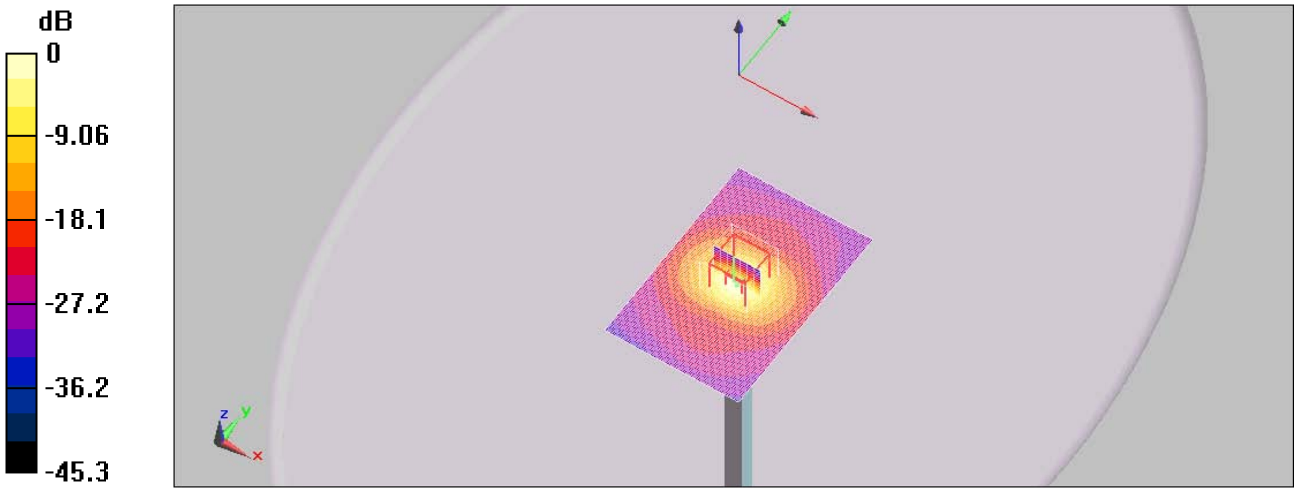
< 5200 MHz Body / Date : July 16, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.29 mho/m; εr = 48.6; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.99, 4.99, 4.99); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5200MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 39.6 mW/g

5200MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 90 V/m; Power Drift = -0.055 dB
Peak SAR (extrapolated) = 83 W/kg
SAR(1 g) = 18.8 mW/g; SAR(10 g) = 5.28 mW/g
Maximum value of SAR (measured) = 35.7 mW/g



0 dB = 35.7mW/g

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

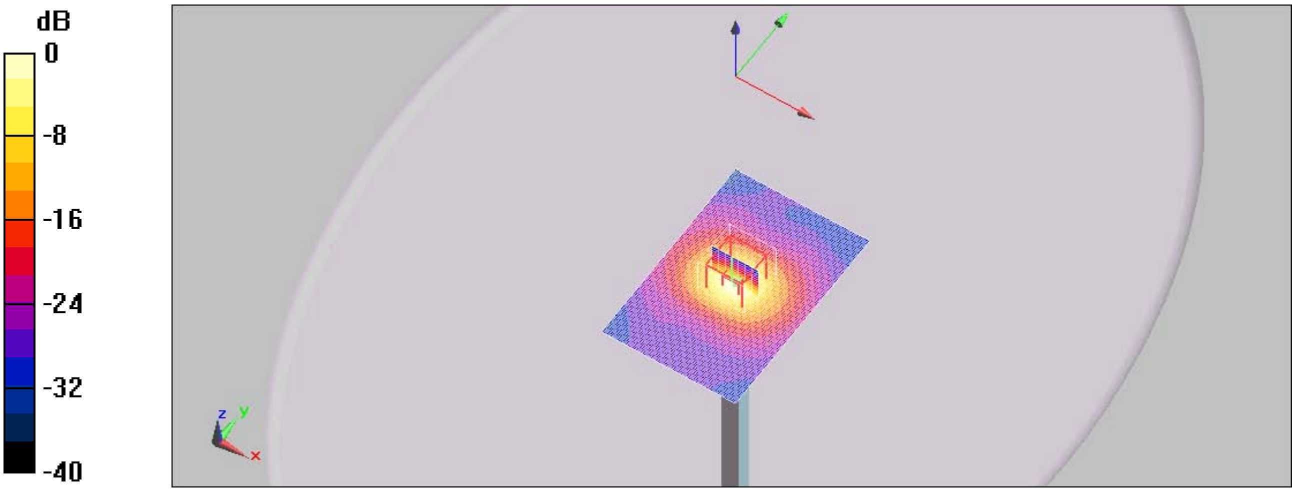
< 5300 MHz Head / Date : July 14, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5300 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5300 MHz; σ = 4.59 mho/m; εr = 36.1; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(5.41, 5.41, 5.41); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5300MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 40.9 mW/g

5300MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 95.1 V/m; Power Drift = -0.00611 dB
Peak SAR (extrapolated) = 84.7 W/kg
SAR(1 g) = 19.7 mW/g; SAR(10 g) = 5.66 mW/g
Maximum value of SAR (measured) = 38.7 mW/g



0 dB = 38.7mW/g

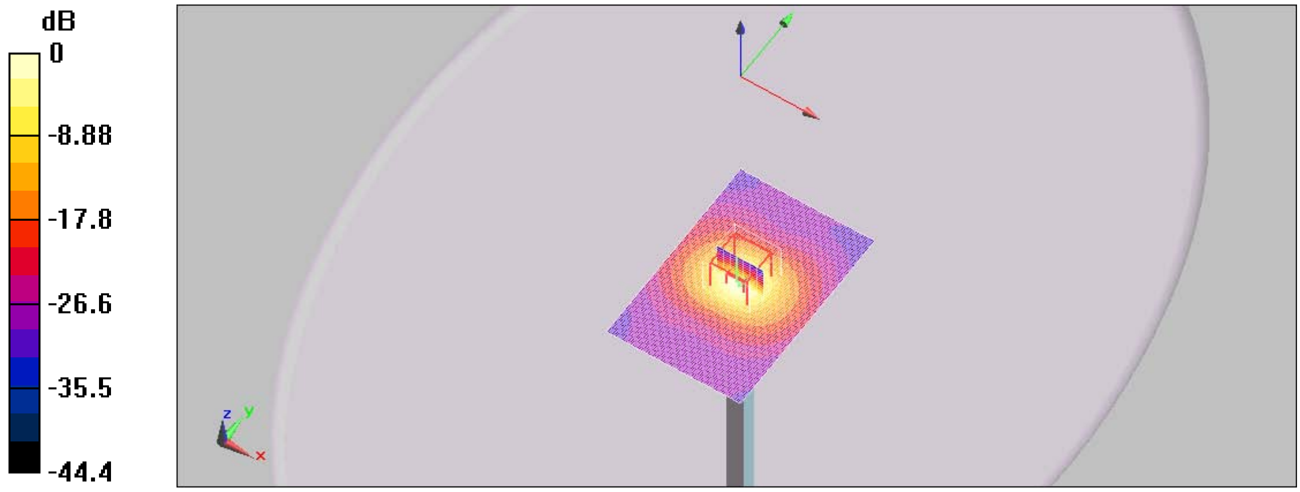
< 5300 MHz Body Date : July 16, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5300 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5300 MHz; σ = 5.45 mho/m; εr = 48.4; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.68, 4.68, 4.68); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5300MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 40.9 mW/g

5300MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 88.7 V/m; Power Drift = -0.053 dB
Peak SAR (extrapolated) = 84.5 W/kg
SAR(1 g) = 19.4 mW/g; SAR(10 g) = 5.5 mW/g
Maximum value of SAR (measured) = 38.4 mW/g



0 dB = 38.4mW/g

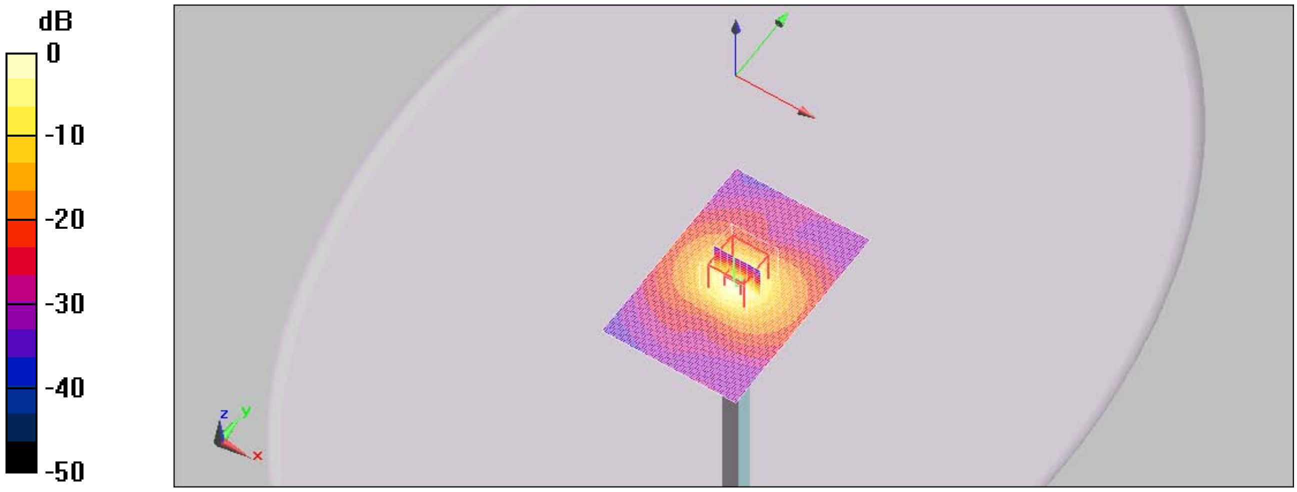
< 5600 MHz Head / Date : July 15, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5600 MHz; σ = 5 mho/m; εr = 35.7; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- **Probe: EX3DV4 - SN3666; ConvF(4.91, 4.91, 4.91); Calibrated: 2013-11-27**
- **Sensor-Surface: 2mm (Mechanical Surface Detection)**
- **Electronics: DAE4 Sn444; Calibrated: 2013-11-22**
- **Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030**
- **Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125**

5600MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 44 mW/g

5600MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 96.1 V/m; Power Drift = -0.153 dB
Peak SAR (extrapolated) = 91.5 W/kg
SAR(1 g) = 20.4 mW/g; SAR(10 g) = 5.78 mW/g
Maximum value of SAR (measured) = 41.6 mW/g



0 dB = 41.6mW/g

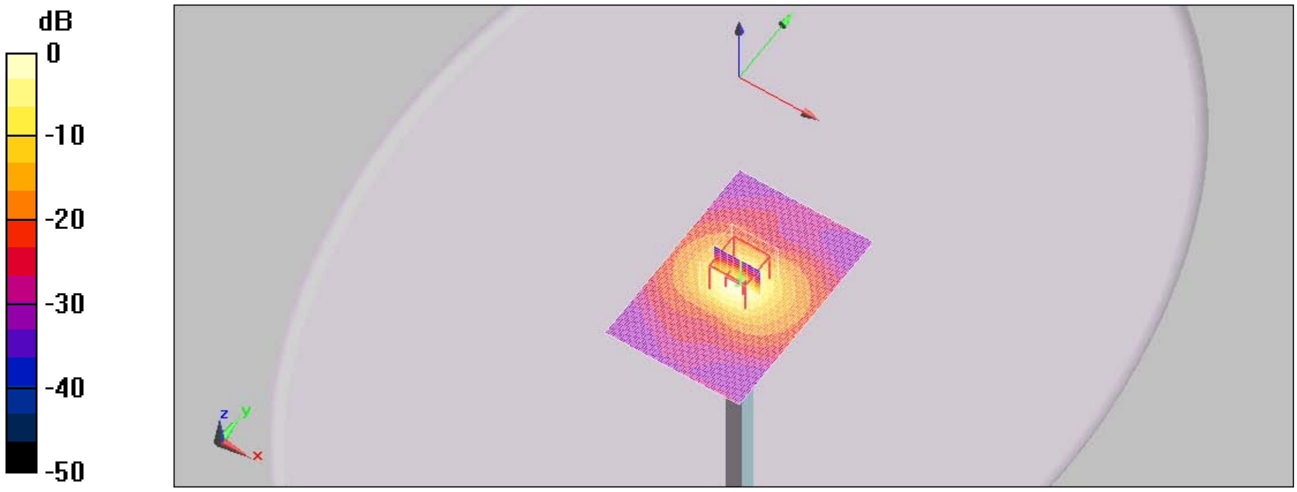
< 5600 MHz Body / Date : July 17, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5600 MHz; σ = 5.96 mho/m; εr = 46.9; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.2, 4.2, 4.2); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5600MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 41 mW/g

5600MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 87.7 V/m; Power Drift = 0.00371 dB
Peak SAR (extrapolated) = 91.2 W/kg
SAR(1 g) = 19.8 mW/g; SAR(10 g) = 5.53 mW/g
Maximum value of SAR (measured) = 38.8 mW/g



0 dB = 38.8mW/g

< 5800 MHz Head / Date : July 11, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5800 MHz; σ = 5.15 mho/m; εr = 34.4; ρ = 1000 kg/m3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3666; ConvF(4.97, 4.97, 4.97); Calibrated: 2013-11-27

- Sensor-Surface: 2mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn444; Calibrated: 2013-11-22

- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030

- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5800MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 42.7 mW/g

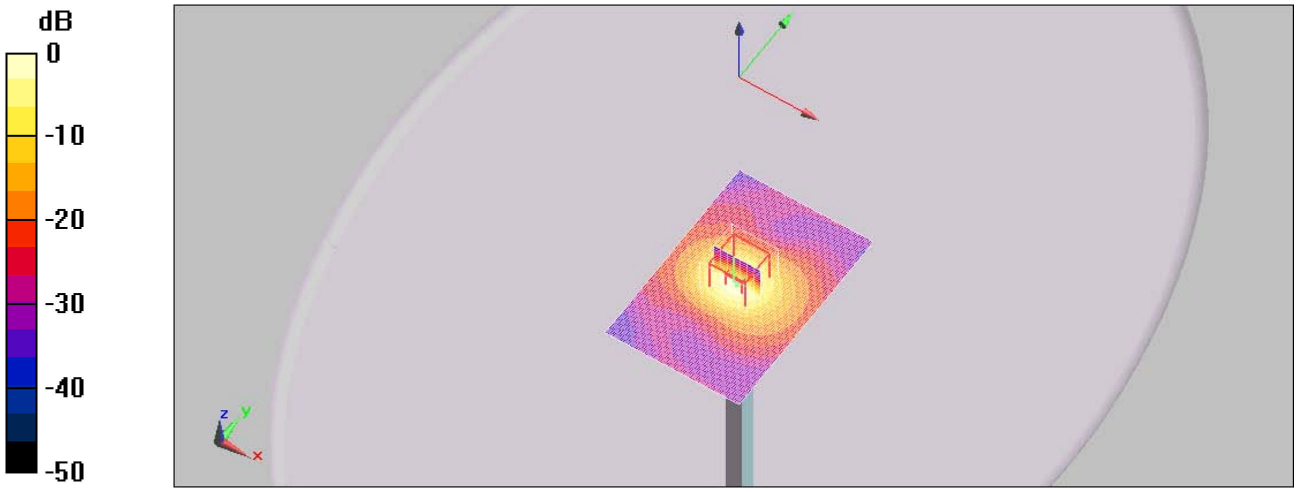
5800MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 93 V/m; Power Drift = -0.248 dB

Peak SAR (extrapolated) = 86.9 W/kg

SAR(1 g) = 19.8 mW/g; SAR(10 g) = 5.66 mW/g

Maximum value of SAR (measured) = 39.1 mW/g



0 dB = 39.1mW/g

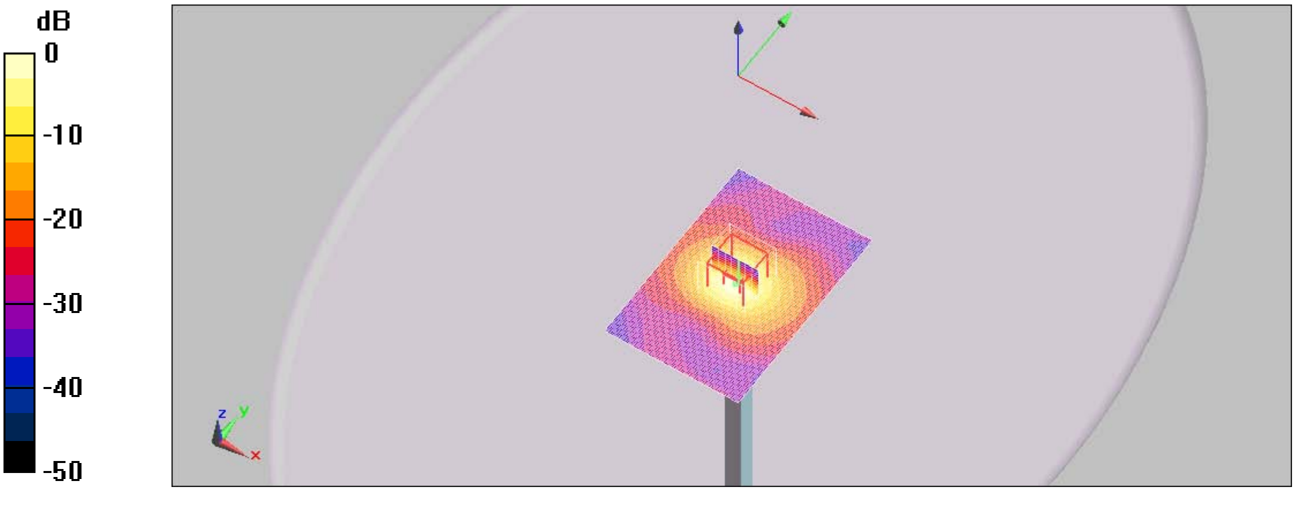
< 5800 MHz Head / Date : July 14, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094
Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 5.11 mho/m; εr = 35.4; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.97, 4.97, 4.97); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

5800MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 42.2 mW/g

5800MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 96 V/m; Power Drift = 0.107 dB
Peak SAR (extrapolated) = 91.9 W/kg
SAR(1 g) = 19.9 mW/g; SAR(10 g) = 5.66 mW/g
Maximum value of SAR (measured) = 40.8 mW/g



0 dB = 40.8mW/g

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< 5800 MHz Body / July 18, 2014 >

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1094

Communication System: CW; Frequency: 5800 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5800 MHz; σ = 6.21 mho/m; εr = 47.4; ρ = 1000 kg/m3

Phantom section: Flat Section

DASY5 Configuration:

- **Probe: EX3DV4 - SN3666; ConvF(4.68, 4.68, 4.68); Calibrated: 2013-11-27**
- **Sensor-Surface: 2mm (Mechanical Surface Detection)**
- **Electronics: DAE4 Sn444; Calibrated: 2013-11-22**
- **Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030**
- **Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125**

5800MHz SPC/Area Scan (81x121x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 40.6 mW/g

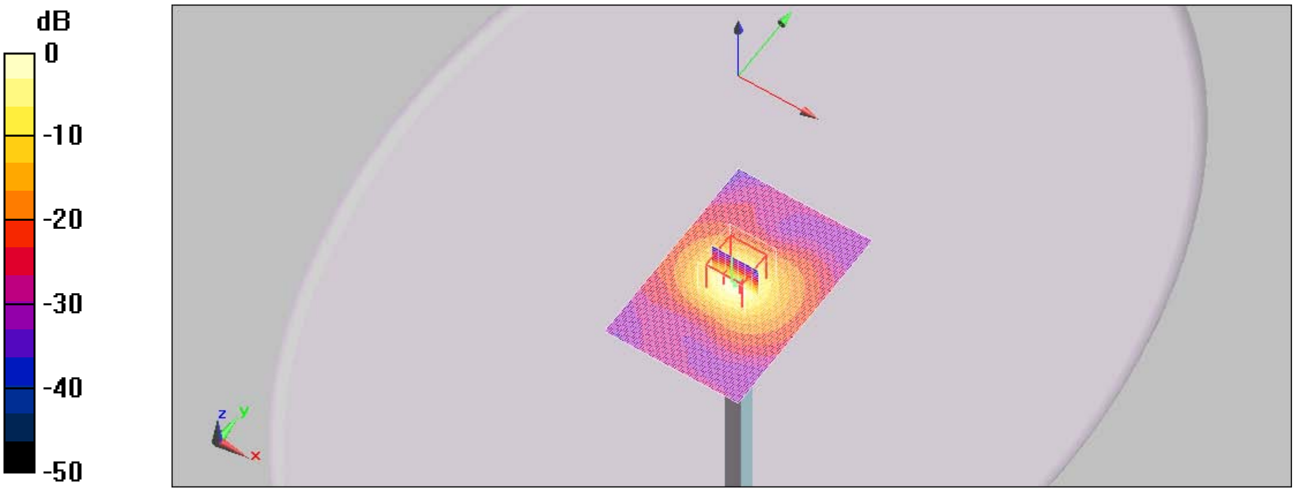
5800MHz SPC/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 85.4 V/m; Power Drift = 0.106 dB

Peak SAR (extrapolated) = 89.9 W/kg

SAR(1 g) = 19.2 mW/g; SAR(10 g) = 5.41 mW/g

Maximum value of SAR (measured) = 39.2 mW/g



0 dB = 39.2mW/g

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ANNEX B. SAR TEST PLOTS

< 802.11b CH6 1Mbps Head / Date : July 09, 2014 >

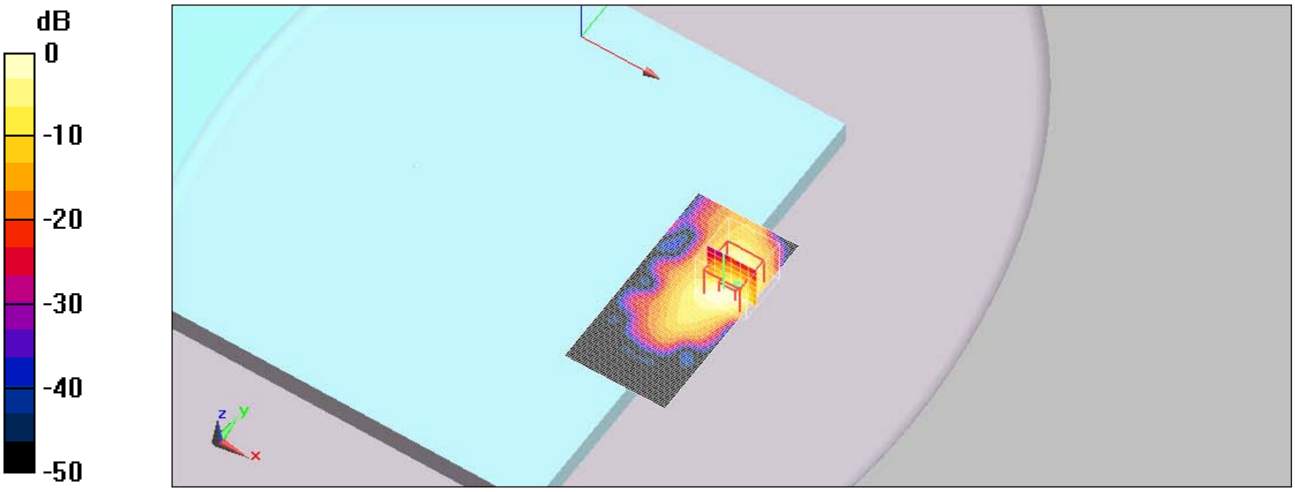
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11 b/g/n; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 1.85 mho/m; εr = 38.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.78, 7.78, 7.78); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11b_ch6_2437MHz_1Mbps_Head_Ant 1/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.221 mW/g

802.11b_ch6_2437MHz_1Mbps_Head_Ant 1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.35 V/m; Power Drift = -0.794 dB
Peak SAR (extrapolated) = 0.433 W/kg
SAR(1 g) = 0.140 mW/g; SAR(10 g) = 0.049 mW/g
Maximum value of SAR (measured) = 0.230 mW/g



0 dB = 0.230mW/g

< 802.11n_HT20 CH6 MCS0 Head / Date : July 09, 2014 >

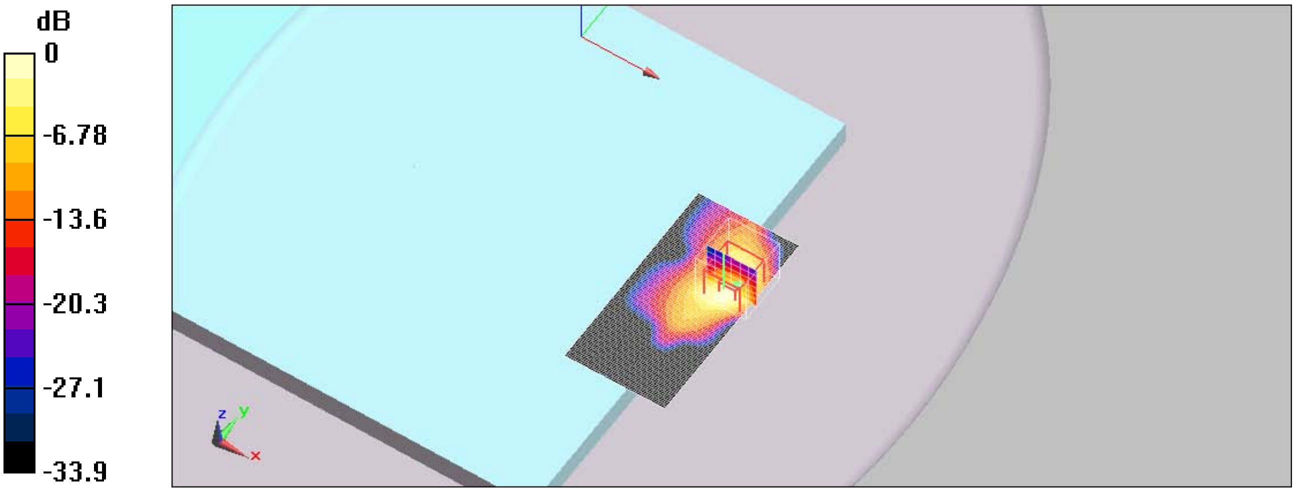
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11 b/g/n; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used : f = 2437 MHz; σ = 1.85 mho/m; εr = 38.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.78, 7.78, 7.78); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11n20_ch6_2437MHz_MCS0_Head_Ant 1/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.285 mW/g

802.11n20_ch6_2437MHz_ MCS0_Head_Ant 1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.28 V/m; Power Drift = -0.725 dB
Peak SAR (extrapolated) = 0.558 W/kg
SAR(1 g) = 0.182 mW/g; SAR(10 g) = 0.064 mW/g
Maximum value of SAR (measured) = 0.296 mW/g



0 dB = 0.296mW/g

< 802.11a CH48 6Mbps Head / Date : July 14, 2014 >

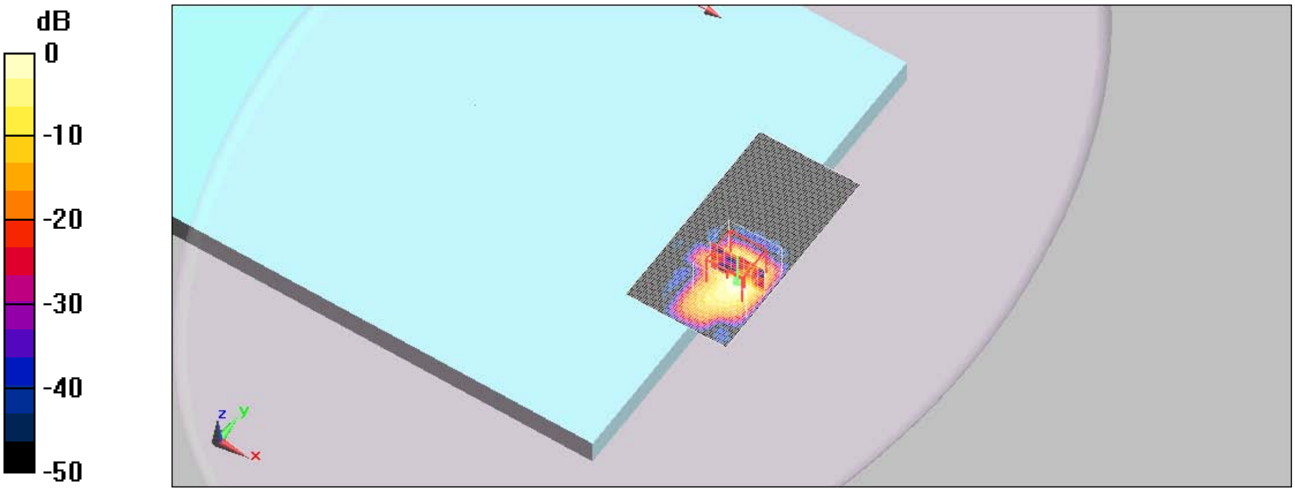
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5240 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5240 MHz; σ = 4.53 mho/m; εr = 36.1; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(5.57, 5.57, 5.57); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch48_5240MHz_6Mbps_Head_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.178 mW/g

802.11a_ch48_5240MHz_6Mbps_Head_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.29 V/m; Power Drift = -0.146 dB
Peak SAR (extrapolated) = 0.407 W/kg
SAR(1 g) = 0.073 mW/g; SAR(10 g) = 0.017 mW/g
Maximum value of SAR (measured) = 0.200 mW/g



0 dB = 0.200mW/g

< 802.11a CH52 6Mbps Head / Date : July 14, 2014 >

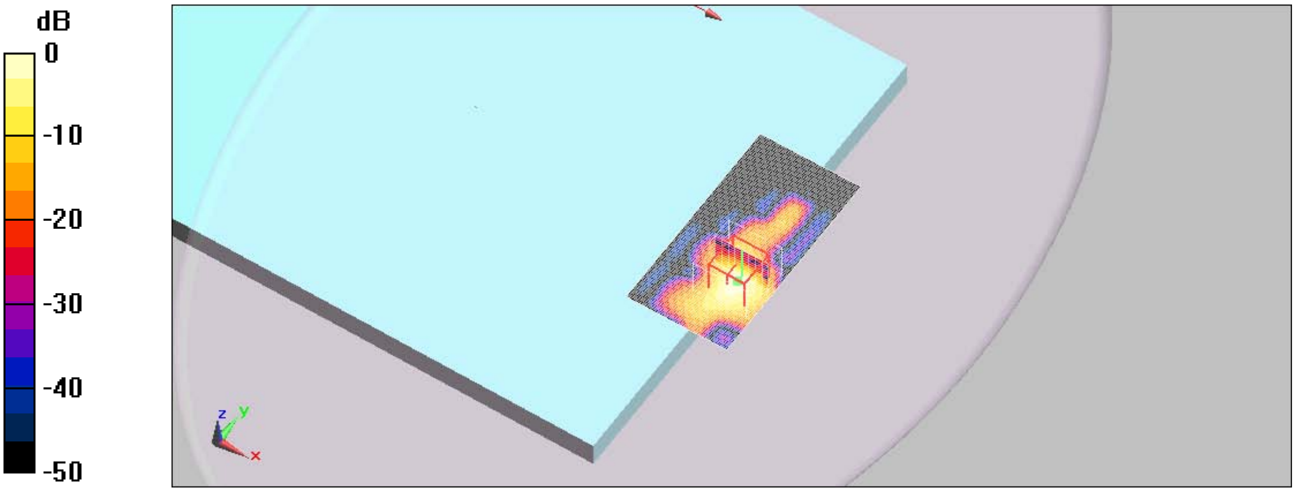
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5260 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 4.55 mho/m; εr = 36.1; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(5.41, 5.41, 5.41); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch52_5260MHz_6Mbps_Head_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.436 mW/g

802.11a_ch52_5260MHz_6Mbps_Head_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 9.92 V/m; Power Drift = -0.379 dB
Peak SAR (extrapolated) = 0.836 W/kg
SAR(1 g) = 0.185 mW/g; SAR(10 g) = 0.049 mW/g
Maximum value of SAR (measured) = 0.438 mW/g



0 dB = 0.438mW/g

< 802.11a CH116 6Mbps Head / Date : July 15, 2014 >

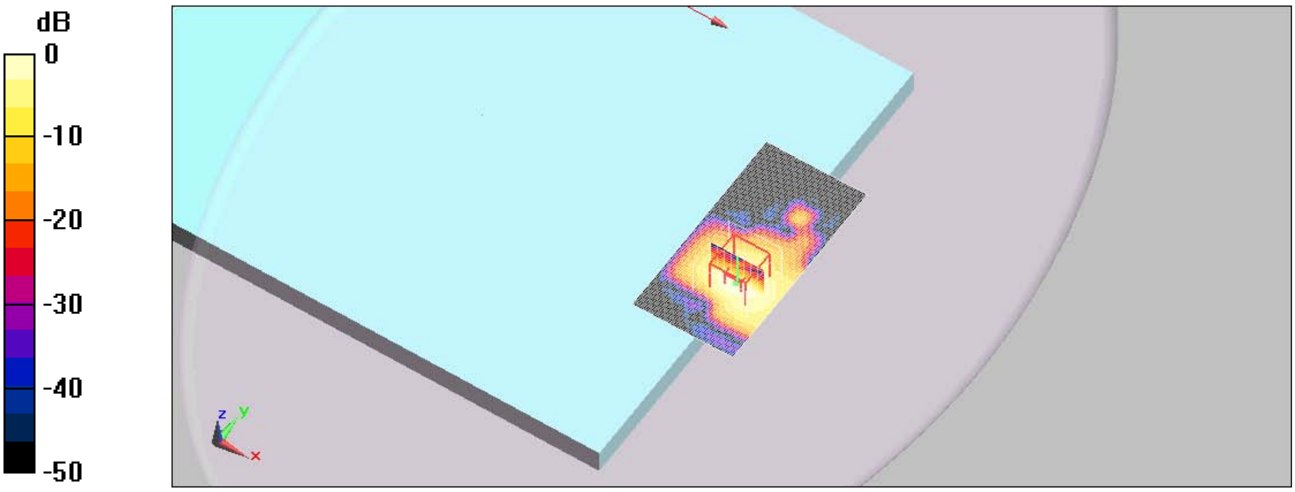
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5580 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 4.97 mho/m; εr = 35.7; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.91, 4.91, 4.91); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch116_5580MHz_6Mbps_Head_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.275 mW/g

802.11a_ch116_5580MHz_6Mbps_Head_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 7.79 V/m; Power Drift = -0.053 dB
Peak SAR (extrapolated) = 0.595 W/kg
SAR(1 g) = 0.135 mW/g; SAR(10 g) = 0.043 mW/g
Maximum value of SAR (measured) = 0.267 mW/g



0 dB = 0.267mW/g

< 802.11a CH165 6Mbps Head / Date : June 14, 2014 >

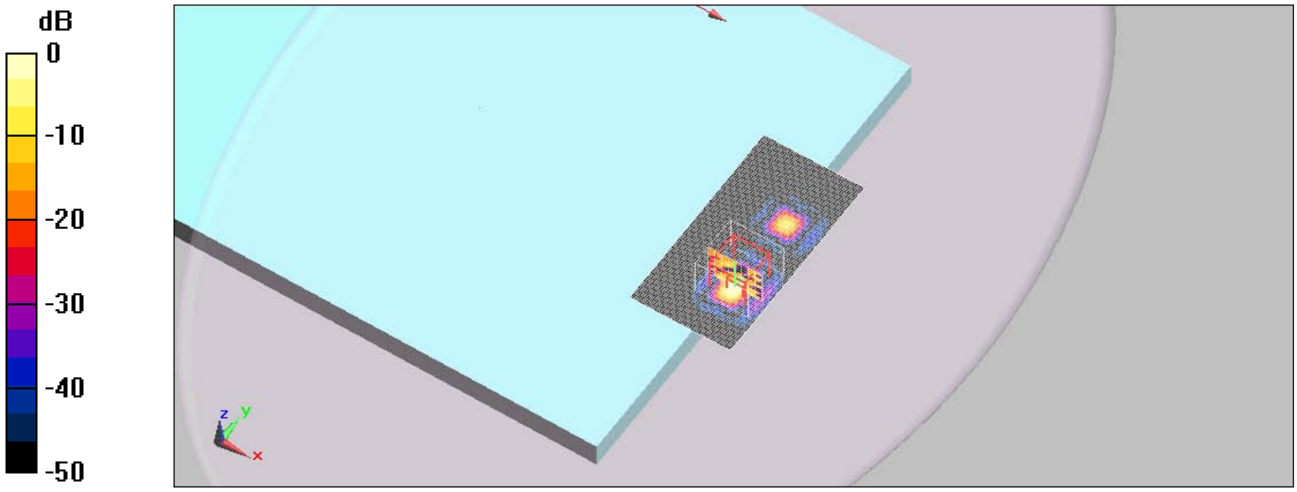
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5825 MHz;Duty Cycle: 1:1
Medium parameters used : f = 5825 MHz; σ = 5.14 mho/m; εr = 35.4; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- **Probe: EX3DV4 - SN3666; ConvF(4.97, 4.97, 4.97); Calibrated: 2013-11-27**
- **Sensor-Surface: 2mm (Mechanical Surface Detection)**
- **Electronics: DAE4 Sn444; Calibrated: 2013-11-22**
- **Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030**
- **Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125**

802.11a_ch165_5825MHz_6Mbps_Head_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.032 mW/g

802.11a_ch165_5825MHz_6Mbps_Head_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.19 V/m; Power Drift = 1.06 dB
Peak SAR (extrapolated) = 0.141 W/kg
SAR(1 g) = 0.012 mW/g; SAR(10 g) = 0.00209 mW/g
Maximum value of SAR (measured) = 0.028 mW/g



0 dB = 0.028mW/g

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< 802.11b CH6 1Mbps Body / Date : July 10, 2014 >

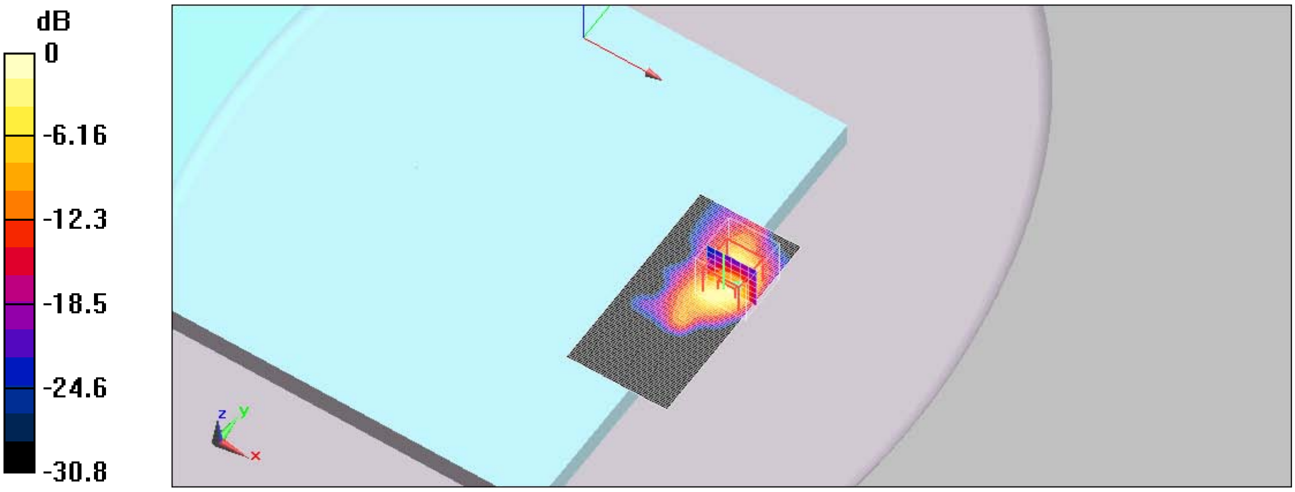
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11 b/g/n; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used : f = 2437 MHz; σ = 2 mho/m; εr = 54.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.45, 7.45, 7.45); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11b_ch6_2437MHz_1Mbps_Body_Ant 1/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.238 mW/g

802.11b_ch6_2437MHz_1Mbps_Body_Ant 1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.5 V/m; Power Drift = -0.353 dB
Peak SAR (extrapolated) = 0.573 W/kg
SAR(1 g) = 0.187 mW/g; SAR(10 g) = 0.064 mW/g
Maximum value of SAR (measured) = 0.314 mW/g



0 dB = 0.314mW/g

< 802.11n_HT20 CH6 MCS0 Body / Date : July 10, 2014 >

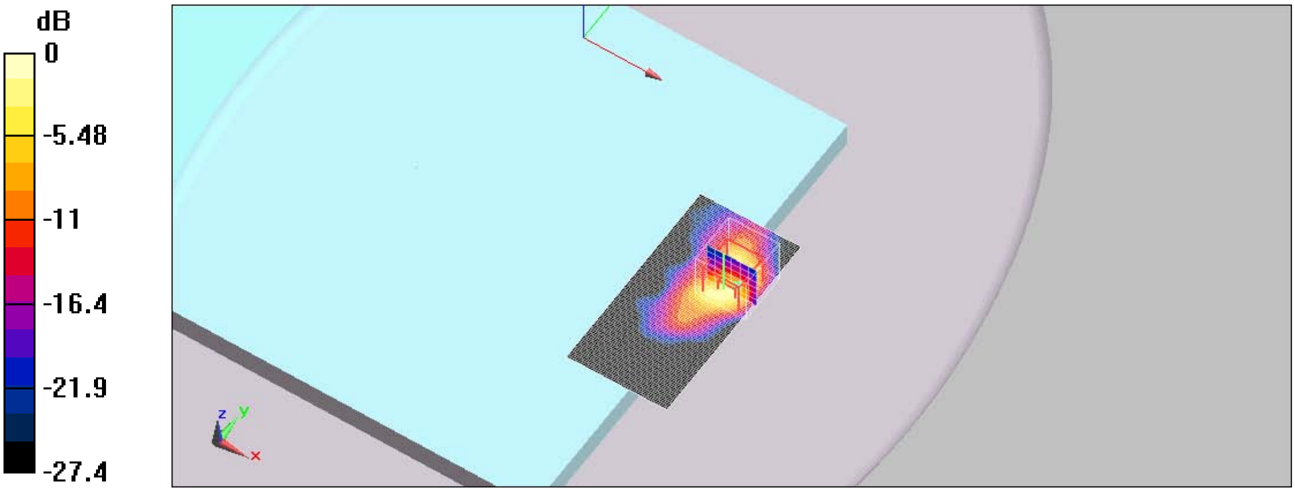
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11 b/g/n; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used : f = 2437 MHz; σ = 2 mho/m; εr = 54.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(7.45, 7.45, 7.45); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11n20_ch6_2437MHz_ MCS0_Body_Ant 1/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.283 mW/g

802.11n20_ch6_2437MHz_ MCS0_Body_Ant 1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.4 V/m; Power Drift = -0.471 dB
Peak SAR (extrapolated) = 0.666 W/kg
SAR(1 g) = 0.217 mW/g; SAR(10 g) = 0.075 mW/g
Maximum value of SAR (measured) = 0.363 mW/g



0 dB = 0.363mW/g

< 802.11a CH48 6Mbps Body / Date : July 16, 2014 >

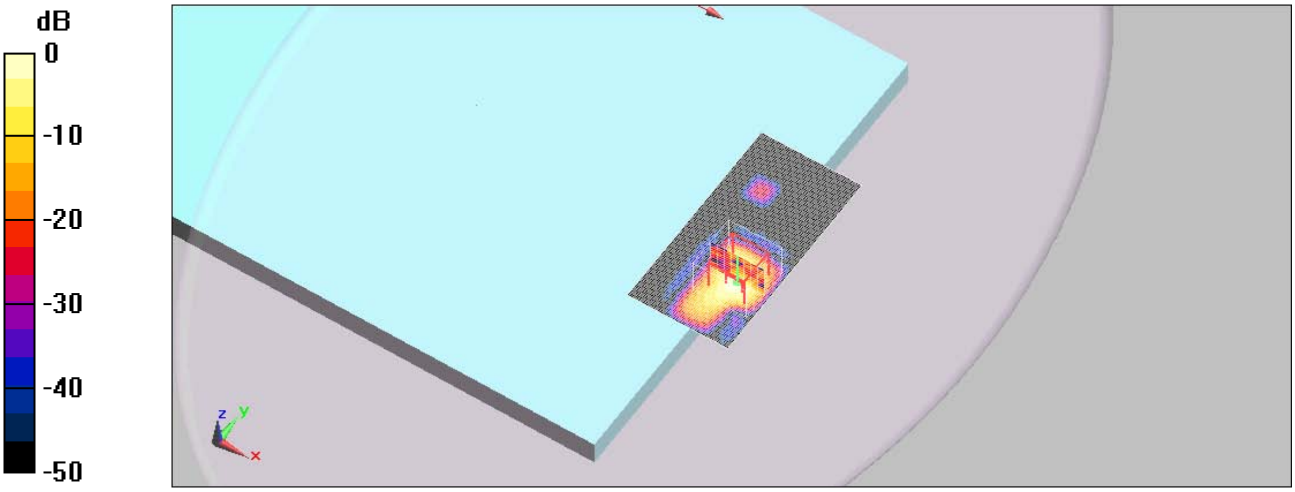
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5240 MHz;Duty Cycle: 1:1
Medium parameters used : f = 5240 MHz; σ = 5.33 mho/m; εr = 48.5; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.99, 4.99, 4.99); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch48_5240MHz_6Mbps_Body_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.184 mW/g

802.11a_ch48_5240MHz_6Mbps_Body_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.92 V/m; Power Drift = -0.237 dB
Peak SAR (extrapolated) = 0.294 W/kg
SAR(1 g) = 0.066 mW/g; SAR(10 g) = 0.017 mW/g
Maximum value of SAR (measured) = 0.177 mW/g



0 dB = 0.177mW/g

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< 802.11a CH52 6Mbps Body / Date : July 16, 2014 >

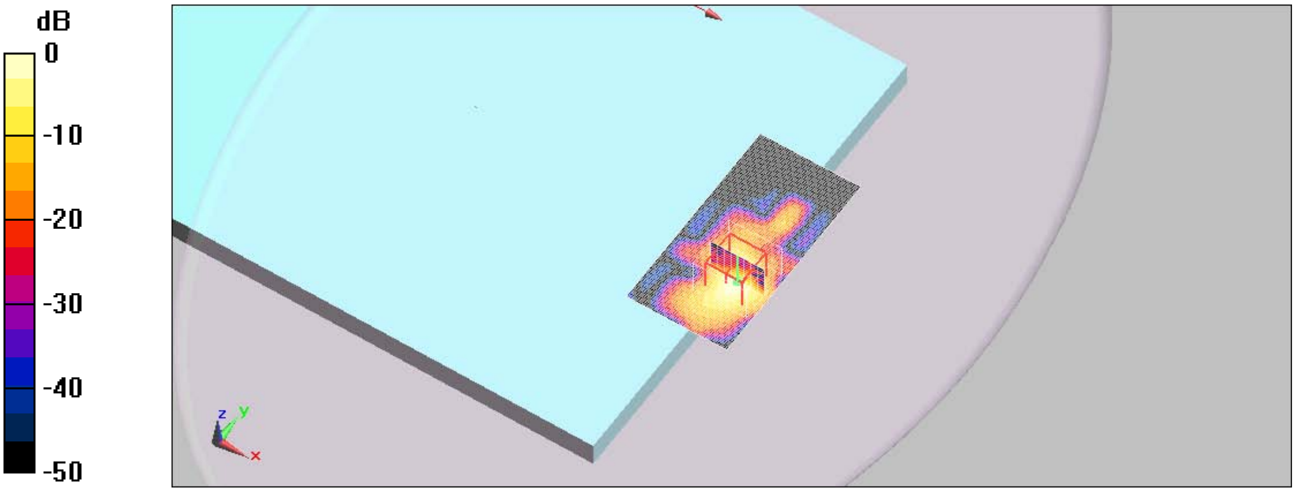
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5260 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 5.35 mho/m; εr = 48.4; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.68, 4.68, 4.68); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch52_5260MHz_6Mbps_Body_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.437 mW/g

802.11a_ch52_5260MHz_6Mbps_Body_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 9.48 V/m; Power Drift = -0.105 dB
Peak SAR (extrapolated) = 1.03 W/kg
SAR(1 g) = 0.180 mW/g; SAR(10 g) = 0.047 mW/g
Maximum value of SAR (measured) = 0.453 mW/g



0 dB = 0.453mW/g

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< 802.11a CH116 6Mbps Body / July 17, 2014 >

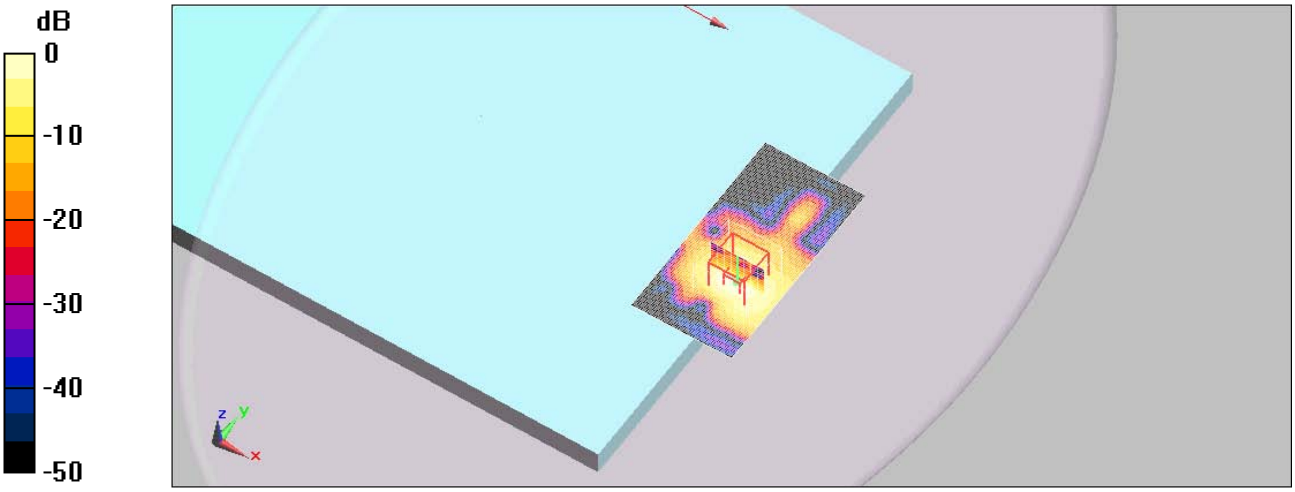
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5580 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.93 mho/m; εr = 46.9; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3666; ConvF(4.2, 4.2, 4.2); Calibrated: 2013-11-27
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn444; Calibrated: 2013-11-22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

802.11a_ch116_5580MHz_6Mbps_Body_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.248 mW/g

802.11a_ch116_5580MHz_6Mbps_Body_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.87 V/m; Power Drift = 0.113 dB
Peak SAR (extrapolated) = 0.759 W/kg
SAR(1 g) = 0.122 mW/g; SAR(10 g) = 0.039 mW/g
Maximum value of SAR (measured) = 0.241 mW/g



0 dB = 0.241mW/g

< 802.11a CH165 6Mbps Body / Date : July 18, 2014 >

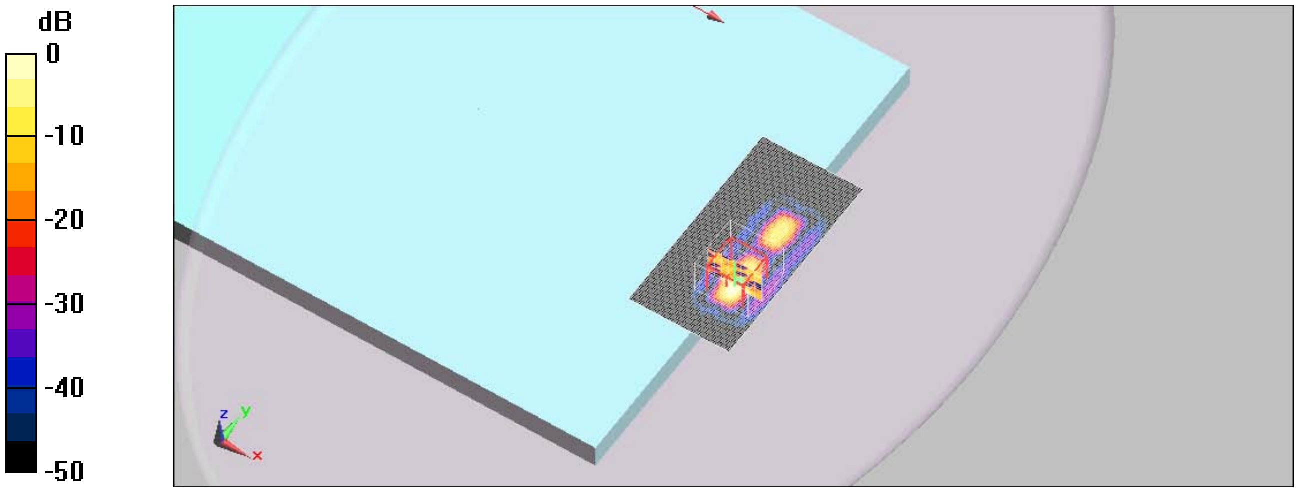
DUT: S3025-W; Type: Sample; Serial: Not Specified

Communication System: 802.11a; Frequency: 5825 MHz;Duty Cycle: 1:1
Medium parameters used : f = 5825 MHz; σ = 6.24 mho/m; εr = 47.3; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY5 Configuration:
- **Probe: EX3DV4 - SN3666; ConvF(4.68, 4.68, 4.68); Calibrated: 2013-11-27**
- **Sensor-Surface: 2mm (Mechanical Surface Detection)**
- **Electronics: DAE4 Sn444; Calibrated: 2013-11-22**
- **Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1030**
- **Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125**

802.11a_ch165_5825MHz_6Mbps_Body_Ant 1/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.030 mW/g

802.11a_ch165_5825MHz_6Mbps_Body_Ant 1/Zoom Scan (9x9x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.58 V/m; Power Drift = 0.607 dB
Peak SAR (extrapolated) = 0.162 W/kg
SAR(1 g) = 0.013 mW/g; SAR(10 g) = 0.00245 mW/g
Maximum value of SAR (measured) = 0.033 mW/g



0 dB = 0.033mW/g

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ANNEX C. PHOTOGRAPHS

< System Verification >

< Test position >

Front view of Ant 0 (front of DUT)

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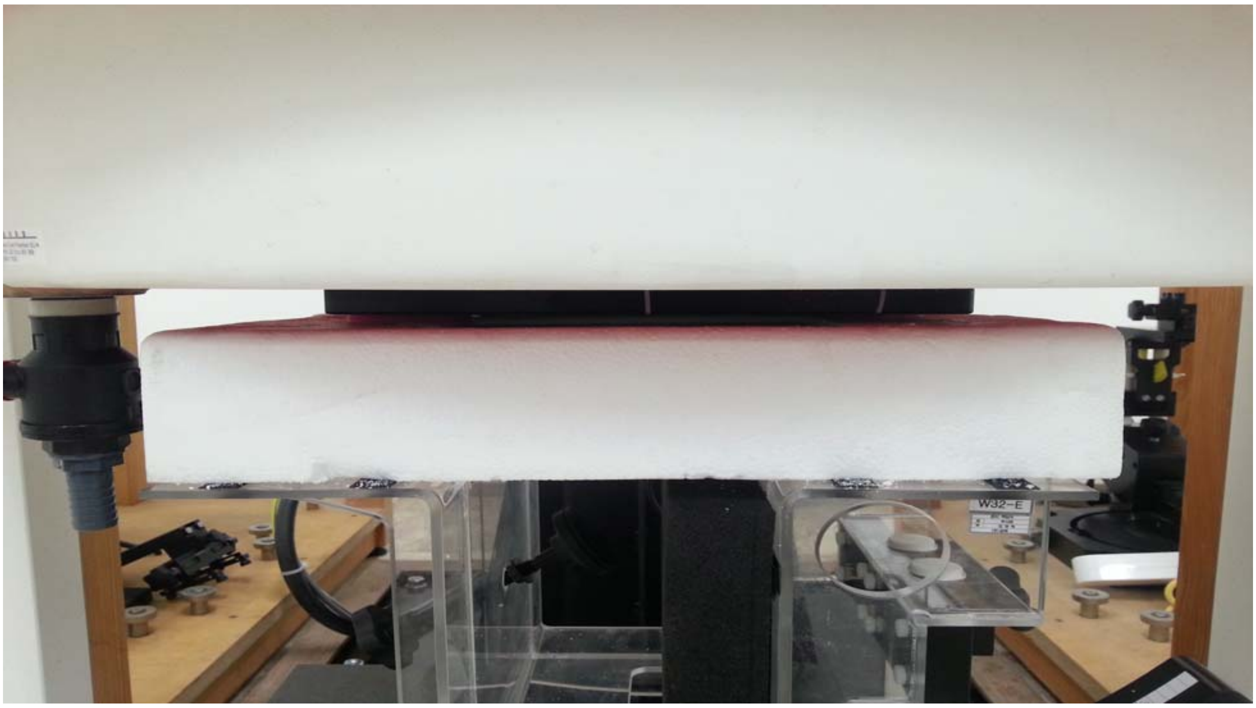
Side view of Ant 0 (front of DUT)



Front view of Ant 1 (front of DUT)

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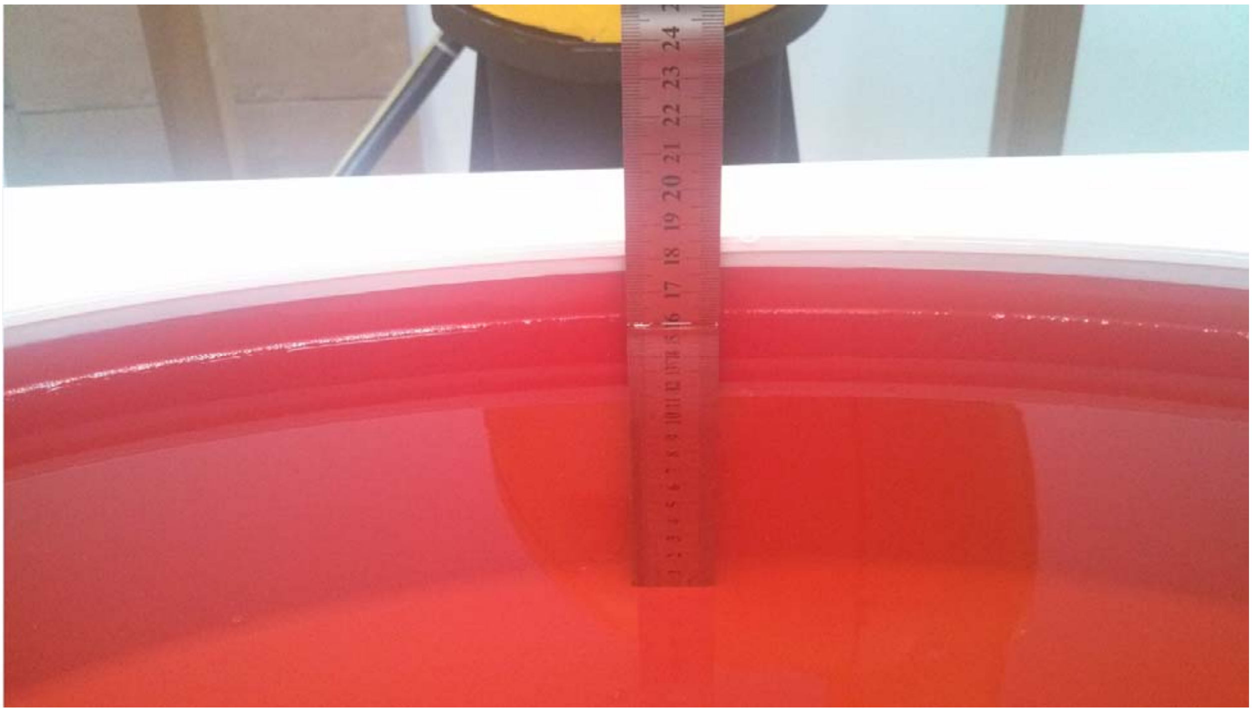
Side view of Ant 1 (front of DUT)

< Liquid Depth >



2.4GHz

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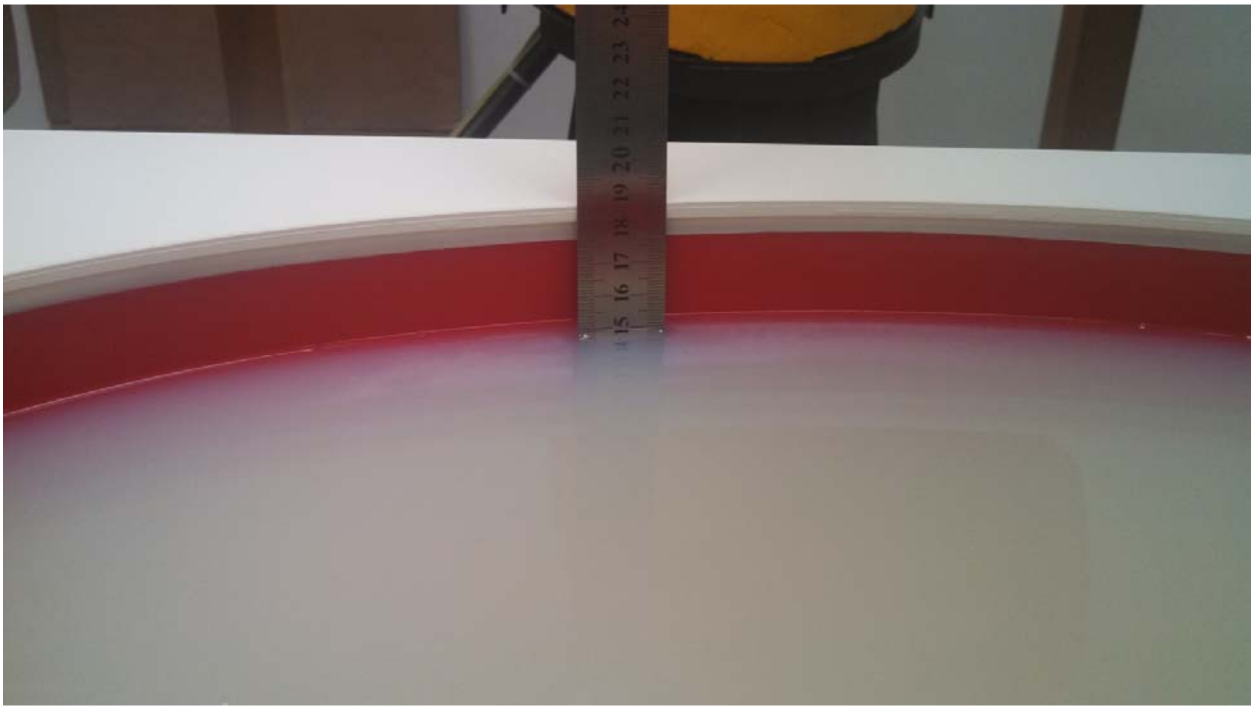

5GHz

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< DUT Photograph >

Front

Back

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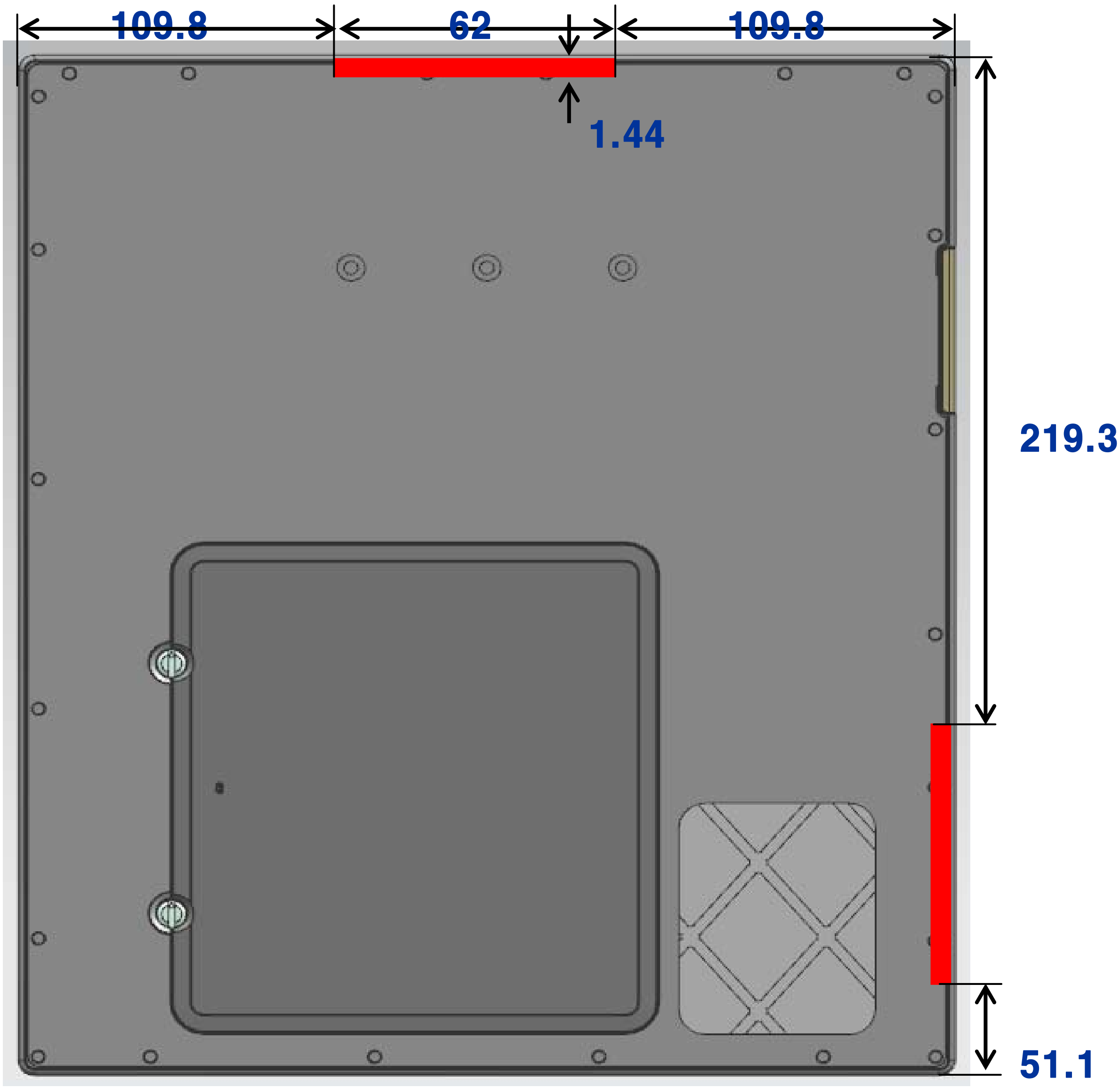
ANNEX D. ANTENNA INFORMATION

< Antenna location >



HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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< Antenna Data Sheet >

IVIEW

Attn. : SAMSUNG

SPECIFICATION

Product Name : C1 X-ray Detector Antenna

Product P/N : MI42-01001A / MI42-01002A

Approval Model : SDR-G4335W

Accepted for this product

(Approval No. :)

Approval by SAMSUNG	Division	Circuital	Mech.	Approved
	Name			
	Signature			
Approval By IVIEW	Division	Submitted	Checked	Approved
	Name			
	Signature			

IVIEW Co.,Ltd.
Address : A-#808, DaeSung D-POLIS, Knowledge Industry Center, 543-1
Gasan-dong, Geumcheon-gu, Seoul City, Korea

Tel. : +82-70-4101-1056
FAX : +82-303-3130-1056
C.P : +82-10-2629-1056
E–mail : myogeun@i-view.co.kr

i VIEW

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HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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iVIEW

1. OUTLINE

This Approval sheet is regulation for WIFI ANTENNA

2. STANDARD

Refer to the outdrawing of WIFI Antenna including material specification on page 6~7.

3. ELECTRICAL SPEC.

3.1 Frequency Range

Service / Frequency	WIFI	
	2.45GHz	5.4GHz
Frequency(MHz)	2400 ~ 2500	5200 ~ 5800

3.2 Directivity

OMNI-DIRECTIONAL

3.3 V.S.W.R.

Impedance Matching optimization is performed under the below mentioned environment.

3.3.1 Free-space Environment

Service / Mode	WIFI	
	Frequency(MHz)	
	2450	5400
V.S.W.R. (WIFI_SAMSUNG-002)	< 3.0	< 3.0
V.S.W.R. (WIFI_SAMSUNG-003)	< 3.0	< 3.0

(Free Space means the handset is held in a non-conductive device and away from any conductive objects)

3.3.2 V.S.W.R. Measurement Method

- By using Network Analyzer, Needs to calibrate with testing cable.
- Network Analyzer calibration range is from 2000[MHz] to 3000[MHz].
- Set the probe length within 500mm after positioned with target device.
- Measure the target device after put on roughly 20cm polystyrene from bottom surface.

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3.4 Gain

3.4.1 WIFI-SAMSUNG-002(MI42-01002A) Antenna

Peak & 3D Avg. Gain (Efficiency) (Unit:dBi)

Mode \ Service	WIFI	
	Frequency(MHz)	
	2400	5400
Peak Gain	-3.0	-3.0
Avg. Gain (Efficiency)	-8.0	-8.0

3.4.2 WIFI-SAMSUNG-003(MI42-01001A) Antenna

Peak & 3D Avg. Gain (Efficiency) (Unit:dBi)

Mode \ Service	WIFI	
	Frequency(MHz)	
	2400	5400
Peak Gain	-7.0	-9.0
Avg. Gain (Efficiency)	-11.0	-15.0

3.4.3 Measurement Method

Measure the radiation pattern from the different frequency (Rxmin, Rxmax) each other of two service band.
On the anechoic chamber, measure the source antenna polarization after put on the target device like as Fig 3.5.1 (a),
Fig 3.5.1(b) is measured the average value for maximum gain and average gain for average value of each different frequency after check the receiving level of target device by each rotate angle with vertical polarization & horizontal polarization.

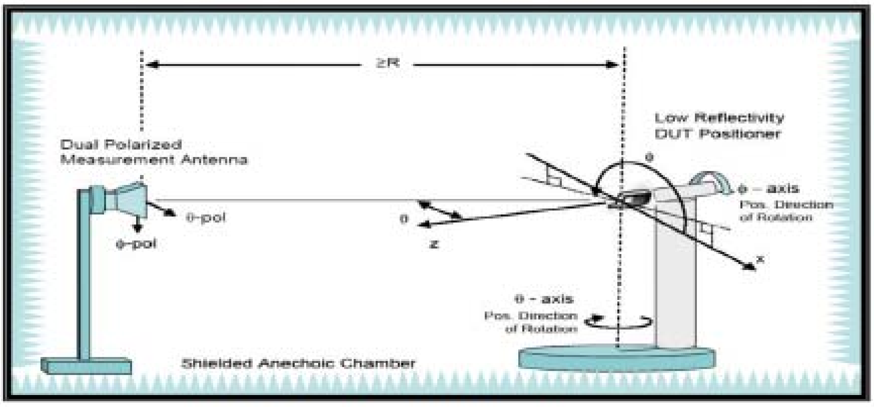

Fig.3.5.1 Gain Measurement system.

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VIEW

3.6 Handling Power

P = 2W under

Etc. Items

1) Follow by mutual consent when if add the new item besides this approval sheet.
2) Notice : This WIFI Antenna may become damage for organic solvent, acidified aqueous solution, alkali aqueous solution, so please handle it carefully
3) For TBD(To Be Determined) items, it will be fixed after decided packing specification.

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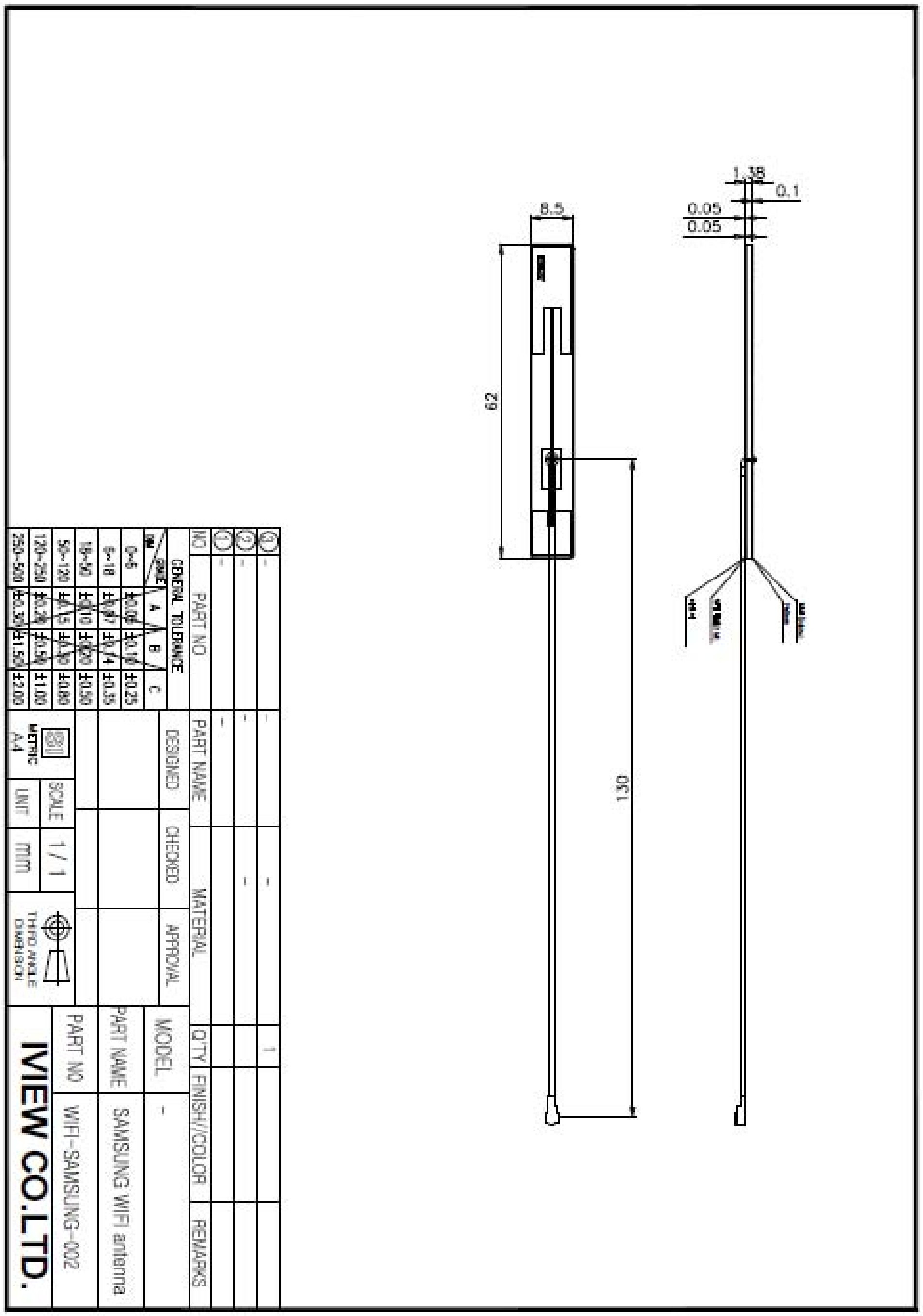
4. DRAWING

4-1. Antenna Drawing



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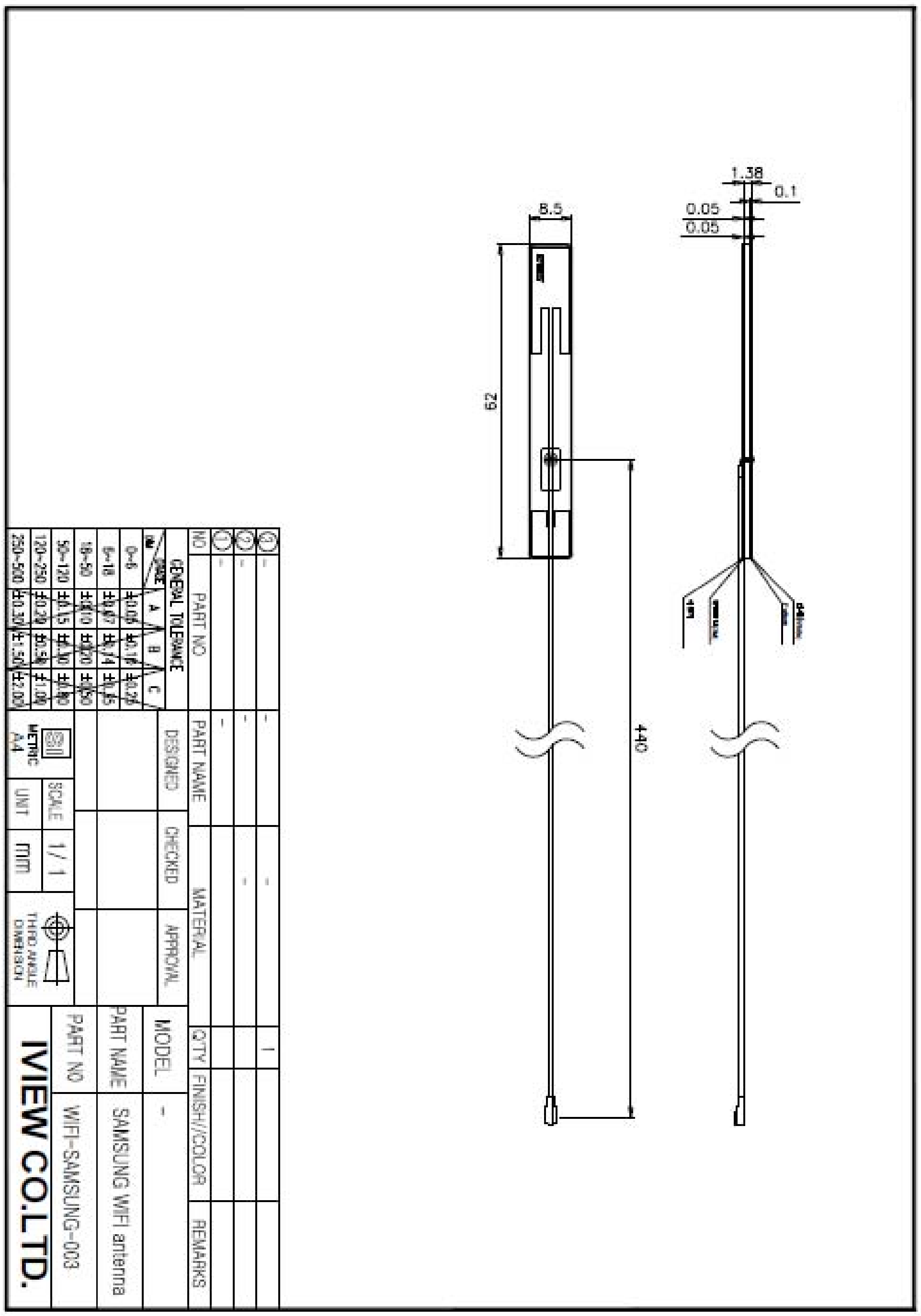
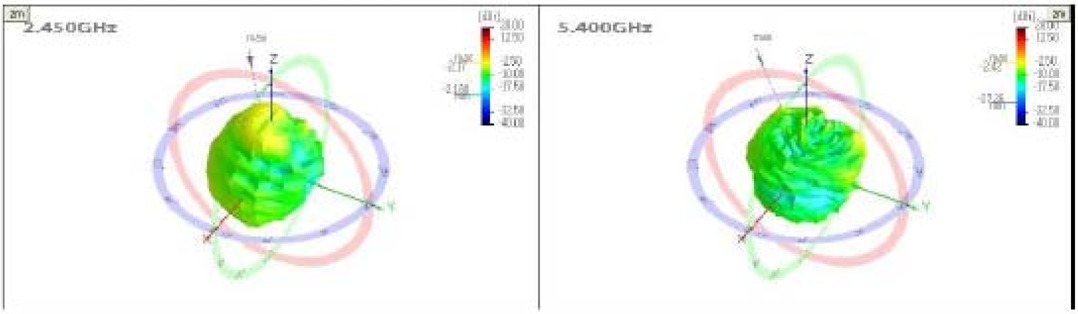

1.38
0.1
0.05
0.05
8.5
62
440
GENERAL TOLERANCE
PART NO
PART NAME
MATERIAL
QTY
FINISH//COLOR
REMARKS
DESIGNED
CHECKED
APPROVAL
SCALE
1/1
UNIT
mm
METRIC
A4
THIRD ANGLE DIMENSION
MODEL
PART NAME SAMSUNG WIFI antenna
PART NO WIFI-SAMSUNG-003
IVIEW CO.LTD.

7 / 8

5. ELECTRICAL PERFORMANCE

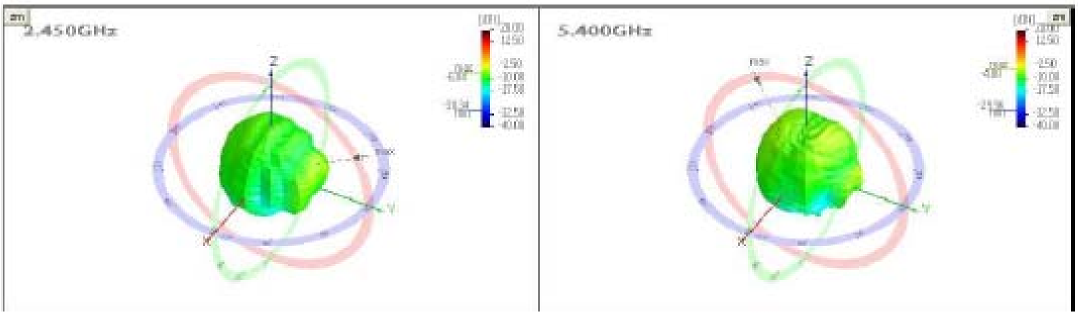
5.1 3D Gain Pattern

5.1.1 WIFI-SAMSUNG-002 Antenna



		PwrSum					H(θ=90)				E1(φ=0)				E2(φ=90)			
No.	Freq.	Eff.[%]	Avg.[dBi]	Peak[dBi]	θ[deg]	φ[deg]	Avg.[dBi]	Peak[dBi]	φ[deg]	BW[deg]	Avg.[dBi]	Peak[dBi]	θ[deg]	BW[deg]	Avg.[dBi]	Peak[dBi]	θ[deg]	BW[deg]
1	2.400	2.96	-15.29	-9.97	-110.00	90.00	-14.70	-10.92	255.00	121.27	-15.65	-12.42	25.00	999.00	-15.35	-9.97	-110.00	56.69
2	2.450	20.13	-6.96	-2.17	-20.00	60.00	-6.79	-2.84	255.00	116.05	-7.24	-3.75	25.00	999.00	-6.84	-2.27	-115.00	71.54
3	2.500	3.81	-14.20	-8.90	-26.00	60.00	-14.41	-10.36	255.00	105.01	-14.26	-10.02	20.00	999.00	-13.90	-9.15	-20.00	999.00
4	5.200	6.86	-11.64	-6.31	-145.00	45.00	-16.26	-10.27	270.00	38.17	-11.61	-6.49	-160.00	24.36	-11.17	-7.33	-55.00	999.00
5	5.300	14.49	-8.39	-2.28	-120.00	45.00	-10.67	-5.36	135.00	19.74	-8.82	-3.20	-150.00	14.40	-8.21	-4.25	-85.00	999.00
6	5.400	13.42	-8.72	-2.42	-50.00	80.00	-9.82	-5.41	255.00	28.57	-9.80	-4.29	-110.00	14.72	-9.23	-3.58	-115.00	26.63
7	5.500	8.85	-10.53	-4.04	100.00	150.00	-9.96	-6.65	135.00	49.33	-11.75	-6.61	-15.00	999.00	-10.72	-5.84	-120.00	31.77
8	5.600	2.27	-16.44	-11.04	-125.00	45.00	-15.90	-13.16	285.00	116.19	-16.76	-12.84	-15.00	999.00	-16.39	-11.22	-80.00	999.00
9	5.700	1.06	-19.78	-12.82	-75.00	45.00	-19.87	-14.62	165.00	51.77	-20.43	-14.44	-105.00	51.36	-20.69	-14.66	-120.00	15.06
10	5.800	0.86	-20.66	-12.92	100.00	165.00	-19.83	-15.14	210.00	11.54	-20.76	-14.78	-85.00	38.46	-21.07	-14.96	-15.00	999.00

5.1.2 WIFI-SAMSUNG-003 Antenna



		PwrSum					H(θ=90)				E1(φ=0)				E2(φ=90)			
No.	Freq.	Eff.[%]	Avg.[dBi]	Peak[dBi]	θ[deg]	φ[deg]	Avg.[dBi]	Peak[dBi]	φ[deg]	BW[deg]	Avg.[dBi]	Peak[dBi]	θ[deg]	BW[deg]	Avg.[dBi]	Peak[dBi]	θ[deg]	BW[deg]
1	2.400	3.34	-14.76	-10.53	-30.00	75.00	-14.96	-11.76	120.00	79.14	-14.13	-11.21	-25.00	999.00	-14.81	-10.74	-30.00	999.00
2	2.450	7.77	-11.10	-6.84	60.00	80.00	-11.05	-7.55	120.00	76.16	-10.85	-8.20	5.00	999.00	-10.90	-6.84	60.00	999.00
3	2.500	1.54	-18.11	-13.16	75.00	75.00	-17.81	-13.98	120.00	71.83	-18.36	-15.96	10.00	999.00	-17.71	-13.28	65.00	999.00
4	5.200	3.95	-14.04	-8.19	75.00	90.00	-14.30	-8.84	105.00	20.60	-14.04	-9.69	10.00	999.00	-13.14	-8.19	75.00	999.00
5	5.300	5.11	-12.92	-7.77	75.00	90.00	-13.44	-8.22	75.00	20.28	-13.22	-9.14	0.00	999.00	-12.15	-7.77	75.00	999.00
6	5.400	8.83	-10.54	-4.80	-25.00	105.00	-11.25	-6.23	105.00	19.25	-11.37	-6.77	-25.00	999.00	-10.02	-5.04	-25.00	999.00
7	5.500	3.40	-14.69	-8.43	-25.00	90.00	-16.06	-12.90	150.00	31.67	-16.46	-12.79	0.00	999.00	-14.41	-8.42	-25.00	999.00
8	5.600	0.57	-22.43	-15.04	-25.00	45.00	-24.37	-19.49	165.00	10.64	-27.01	-21.37	-140.00	5.92	-23.00	-16.54	-25.00	999.00
9	5.700	0.63	-22.74	-16.10	75.00	90.00	-23.91	-20.57	160.00	34.80	-24.48	-19.71	-25.00	999.00	-22.48	-16.10	75.00	999.00
10	5.800	0.75	-21.26	-13.16	75.00	90.00	-20.56	-14.90	75.00	41.73	-20.61	-16.66	-25.00	999.00	-19.79	-13.16	75.00	999.00

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

ANNEX E. PROBE AND DIPOLE CALIBRATION CERTIFICATES

< E-Field Probe : EX3DV4 – SN 3666 >

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 108**

Client **One-Tech (Dymstec)**

Certificate No: **EX3-3666_Nov13**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3666

Calibration procedure(s): QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: November 27, 2013

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	[signature]
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: November 30, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: EX3-3666_Nov13 Page 1 of 11

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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 108

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

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).

Probe EX3DV4

SN:3666

Manufactured: October 20, 2008
Calibrated: November 27, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3666

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.57	0.62	0.55	± 10.1 %
DCP (mV)[B]	98.5	97.8	97.3	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	164.9	±2.5 %
		Y	0.0	0.0	1.0		138.6	
		Z	0.0	0.0	1.0		161.7	

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 NormX,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.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3666

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)	Unct. (k=2)
2450	39.2	1.80	7.78	7.78	7.78	0.31	0.96	± 12.0 %
5200	36.0	4.66	5.57	5.57	5.57	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.41	5.41	5.41	0.30	1.80	± 13.1 %
5500	35.6	4.96	5.09	5.09	5.09	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.91	4.91	4.91	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.97	4.97	4.97	0.40	1.80	± 13.1 %

[C] Frequency validity 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.
[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.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3666

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)	Unct. (k=2)
2450	52.7	1.95	7.45	7.45	7.45	0.50	0.80	± 12.0 %
5200	49.0	5.30	4.99	4.99	4.99	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.68	4.68	4.68	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.46	4.46	4.46	0.40	1.90	± 13.1 %
5600	48.5	5.77	4.20	4.20	4.20	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.68	4.68	4.68	0.45	1.90	± 13.1 %

[C] Frequency validity 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.
[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.

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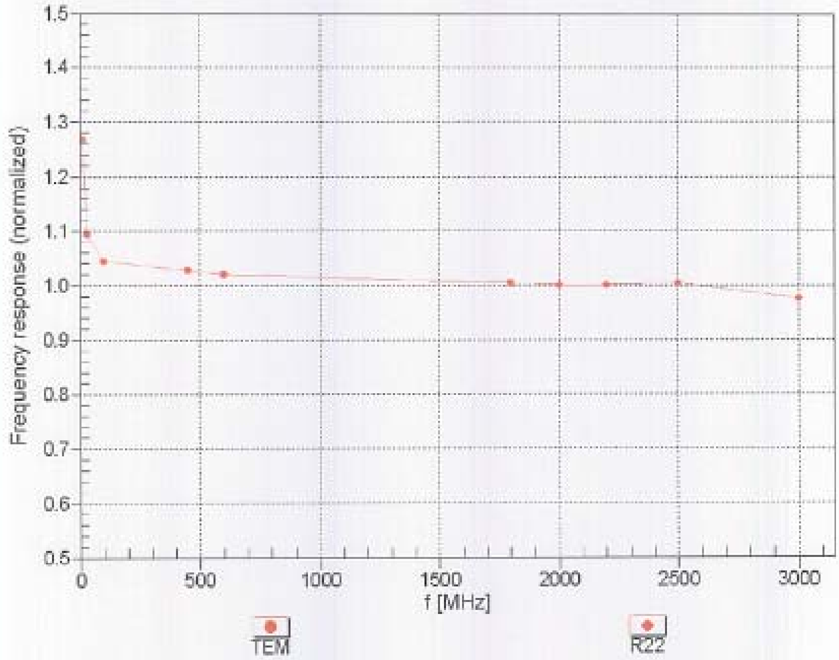
Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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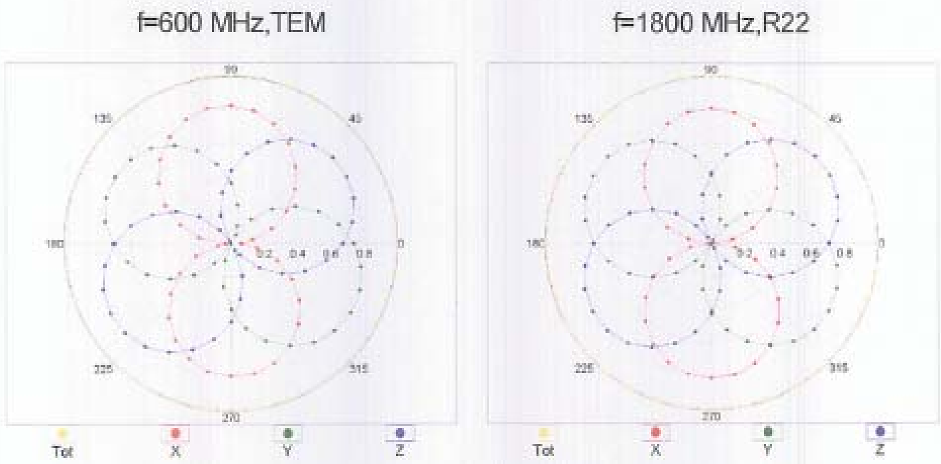
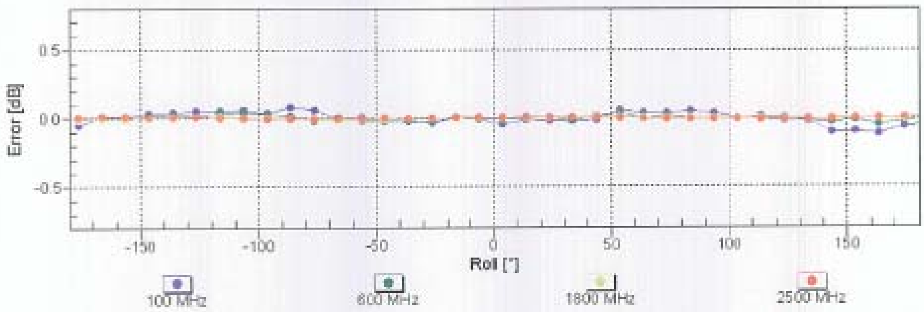
Receiving Pattern (ϕ), ϑ = 0°





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

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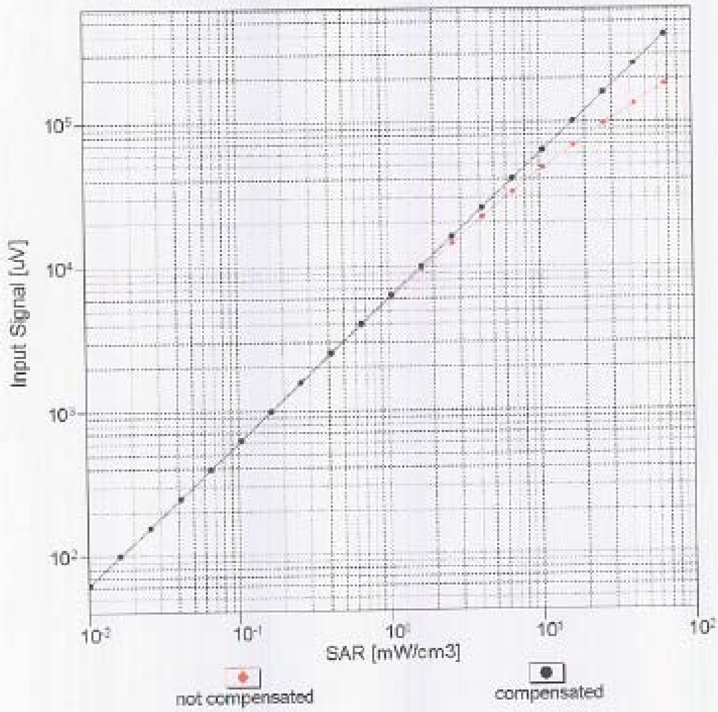
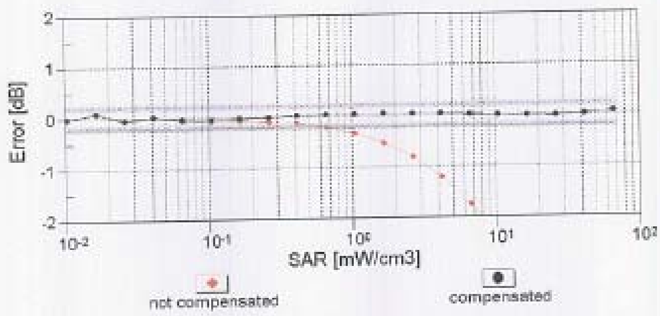
Dynamic Range f(SAR$_{head}$)
(TEM cell , f = 900 MHz)





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

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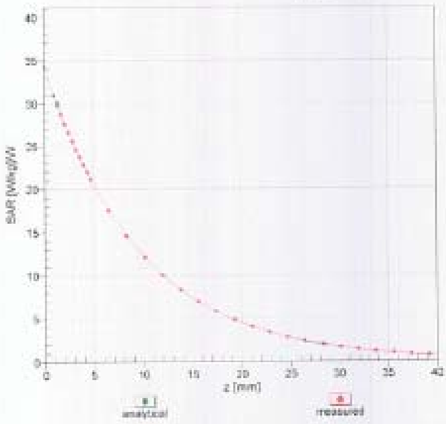
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

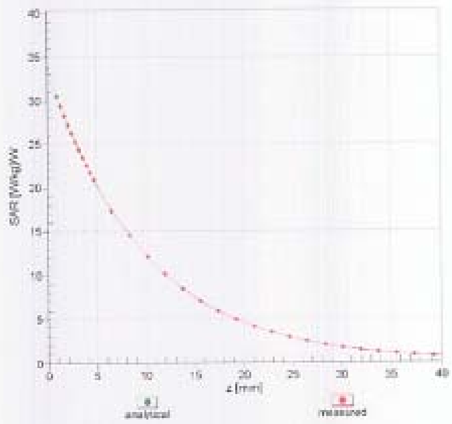
EX3DV4– SN:3666 November 27, 2013

Conversion Factor Assessment

f = 2450 MHz,WGLS R22 (H_convF)

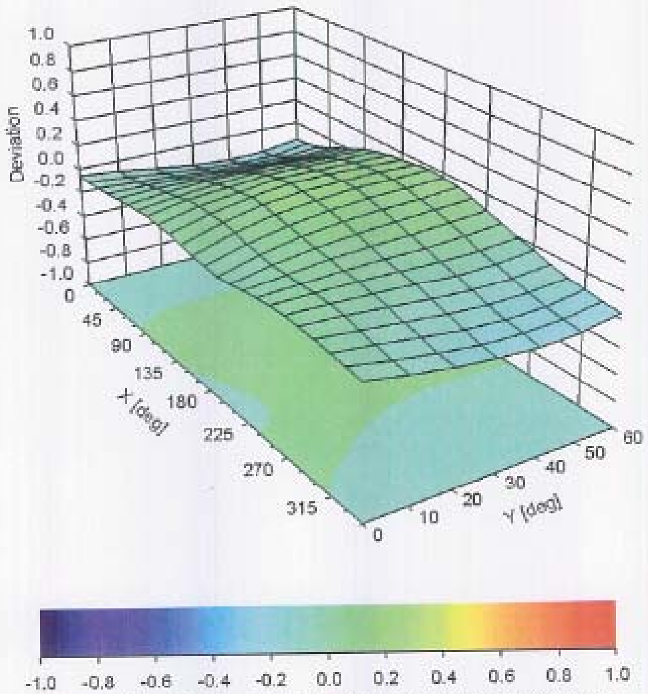


f = 2450 MHz,WGLS R22 (M_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3666

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-16.3
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	2 mm

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

< Dipole Antenna : D2450V2 – SN 923 >

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Engineering AG
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Accreditation No.: SCS 108

Client **One-Tech (Dymstec)**

Certificate No: **D2450V2-923_Nov13**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 923
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	November 13, 2013

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 EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	

Issued: November 13, 2013

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Certificate No: D2450V2-923_Nov13 Page 1 of 8

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.7 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.4 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.98 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.7 W/kg ± 16.5 % (k=2)**

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.8 Ω + 0.4 jΩ
Return Loss	- 26.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.8 Ω + 1.9 jΩ
Return Loss	- 34.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 26, 2013

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DASY5 Validation Report for Head TSL

Date: 13.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

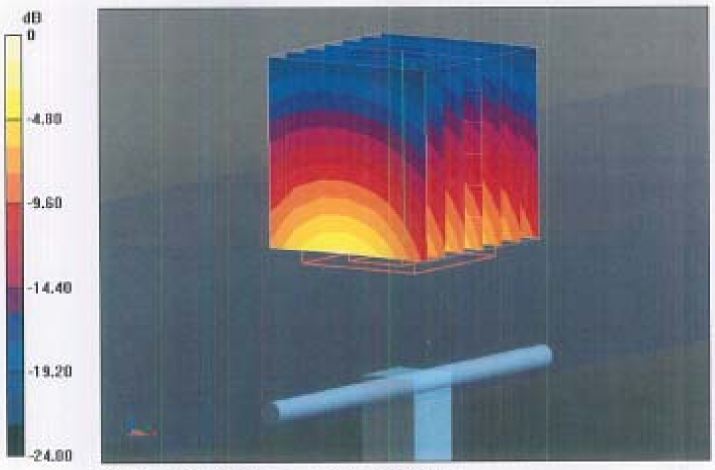
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 923

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ε_r = 39.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.97 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 27.5 W/kg
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg
Maximum value of SAR (measured) = 16.8 W/kg



0 dB = 16.8 W/kg = 12.25 dBW/kg

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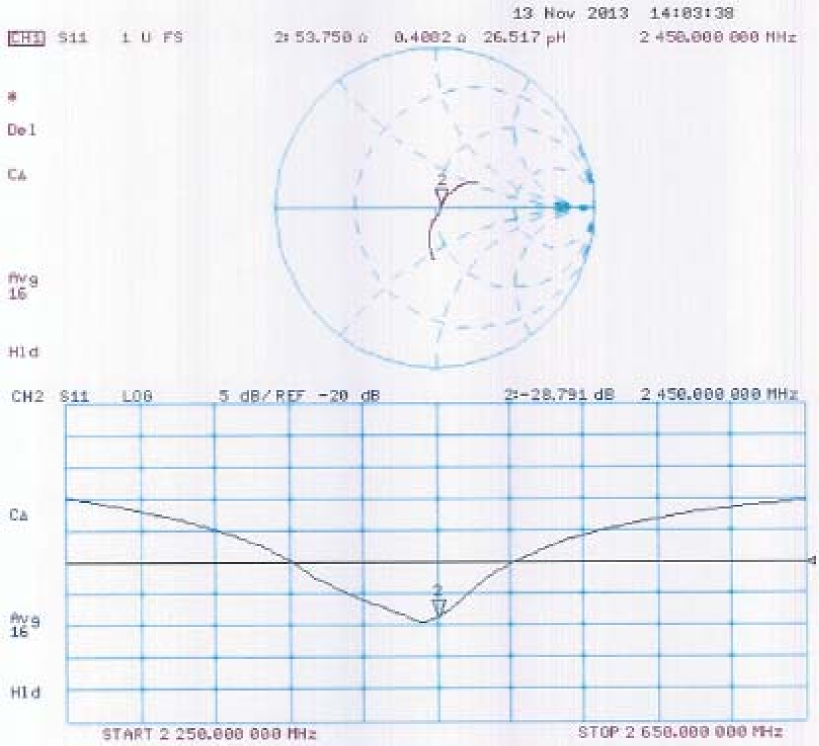
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 13.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

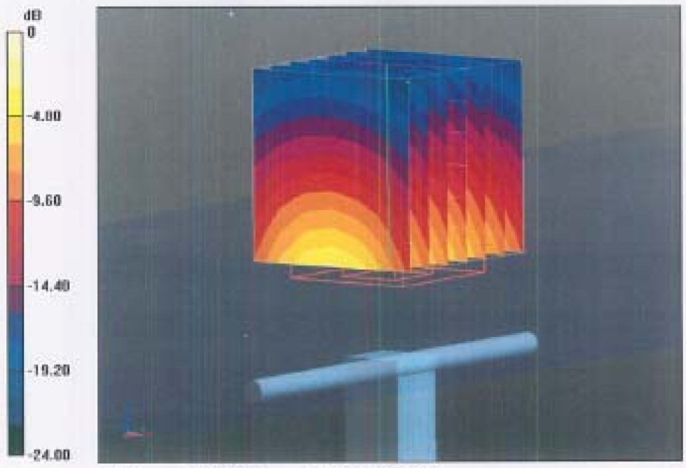
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 923

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

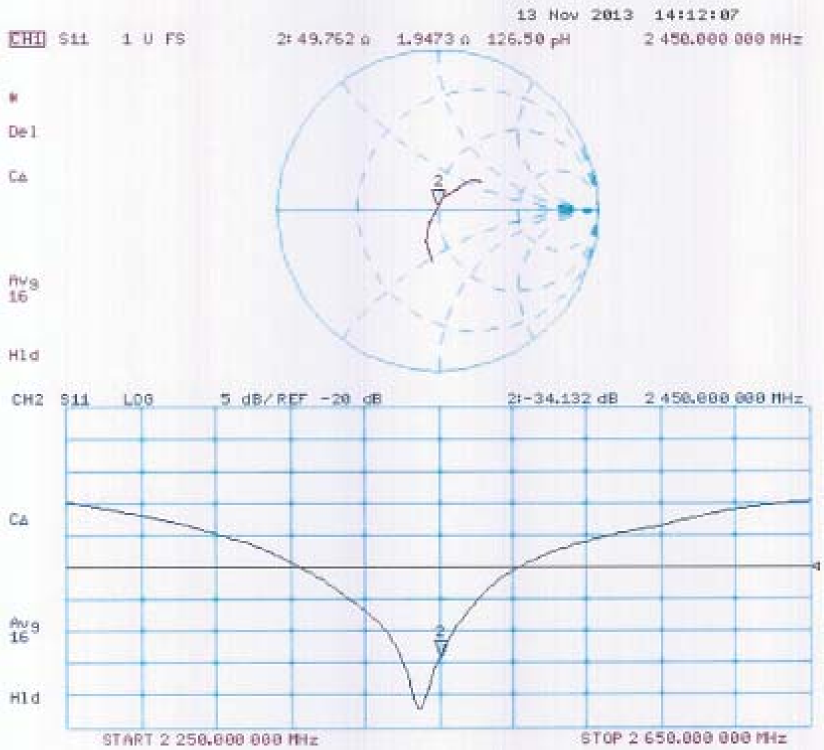
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.525 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.98 W/kg
Maximum value of SAR (measured) = 17.0 W/kg



0 dB = 17.0 W/kg = 12.30 dBW/kg

Certificate No: D2450V2-923_Nov13 Page 7 of 8

Impedance Measurement Plot for Body TSL



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< Dipole Antenna : D5GHzV2 – SN 1094 >

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Accreditation No.: **SCS 108**

Client: **One-Tech (Dymstec)**

Certificate No: **D5GHzV2-1094_Dec13/2**

CALIBRATION CERTIFICATE (Replacement of No:D5GHzV2-1094_Dec13)

Object	D5GHzV2 - SN: 1094
Calibration procedure(s)	QA CAL-22.v2 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	December 16, 2013

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 EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 21, 2014

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Certificate No: D5GHzV2-1094_Dec13/2 Page 1 of 16

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
c) 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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	4.43 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**76.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.8 W/kg ± 19.5 % (k=2)**

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Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	4.54 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.8 W / kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	4.75 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.0 W/kg ± 19.5 % (k=2)**

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**80.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.9 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.7 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.83 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**77.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.1 W/kg ± 19.5 % (k=2)**

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Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.2 ± 6 %	5.38 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.51 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**74.6 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.10 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.8 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.69 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**76.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.3 W/kg ± 19.5 % (k=2)**

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Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**79.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.2 W/kg ± 19.5 % (k=2)**

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.6 ± 6 %	5.92 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**80.8 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

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Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.2 ± 6 %	6.20 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.57 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**75.2 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.09 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.7 W/kg ± 19.5 % (k=2)**

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	47.7 Ω - 9.3 jΩ
Return Loss	- 20.2 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	46.8 Ω - 7.2 jΩ
Return Loss	- 22.6 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	52.1 Ω - 5.2 jΩ
Return Loss	- 25.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.1 Ω - 4.9 jΩ
Return Loss	- 24.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.6 Ω - 6.2 jΩ
Return Loss	- 21.5 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	47.5 Ω - 9.2 jΩ
Return Loss	- 20.3 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	49.1 Ω - 6.6 jΩ
Return Loss	- 23.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	52.3 Ω - 4.6 jΩ
Return Loss	- 26.0 dB

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Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	54.4 Ω - 4.9 jΩ
Return Loss	- 23.9 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.5 Ω - 5.4 jΩ
Return Loss	- 22.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.204 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 24, 2010

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DASY5 Validation Report for Head TSL

Date: 16.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1094

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.43 S/m; ε_r = 35.5; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 4.54 S/m; ε_r = 35.3; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.75 S/m; ε_r = 35.1; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 4.84 S/m; ε_r = 35; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.05 S/m; ε_r = 34.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.432 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 28.1 W/kg
SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.19 W/kg
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.106 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.3 W/kg
Maximum value of SAR (measured) = 18.6 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.704 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 32.7 W/kg
SAR(1 g) = 8.44 W/kg; SAR(10 g) = 2.41 W/kg
Maximum value of SAR (measured) = 19.9 W/kg

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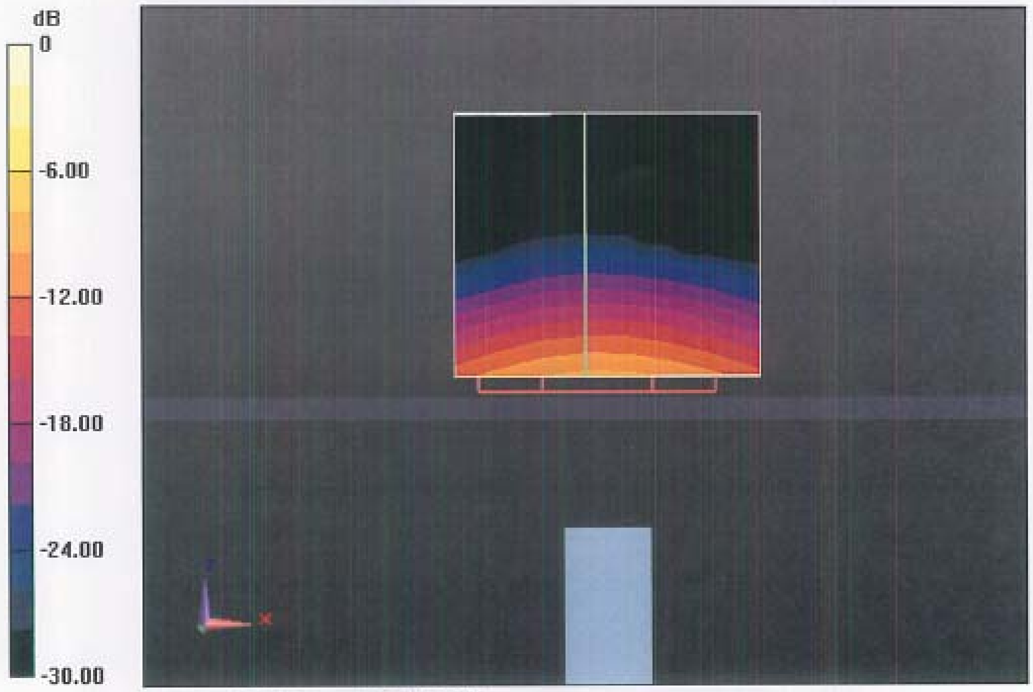
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.899 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.3 W/kg
Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 61.848 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 32.3 W/kg
SAR(1 g) = 7.83 W/kg; SAR(10 g) = 2.22 W/kg
Maximum value of SAR (measured) = 18.8 W/kg



0 dB = 18.8 W/kg = 12.74 dBW/kg

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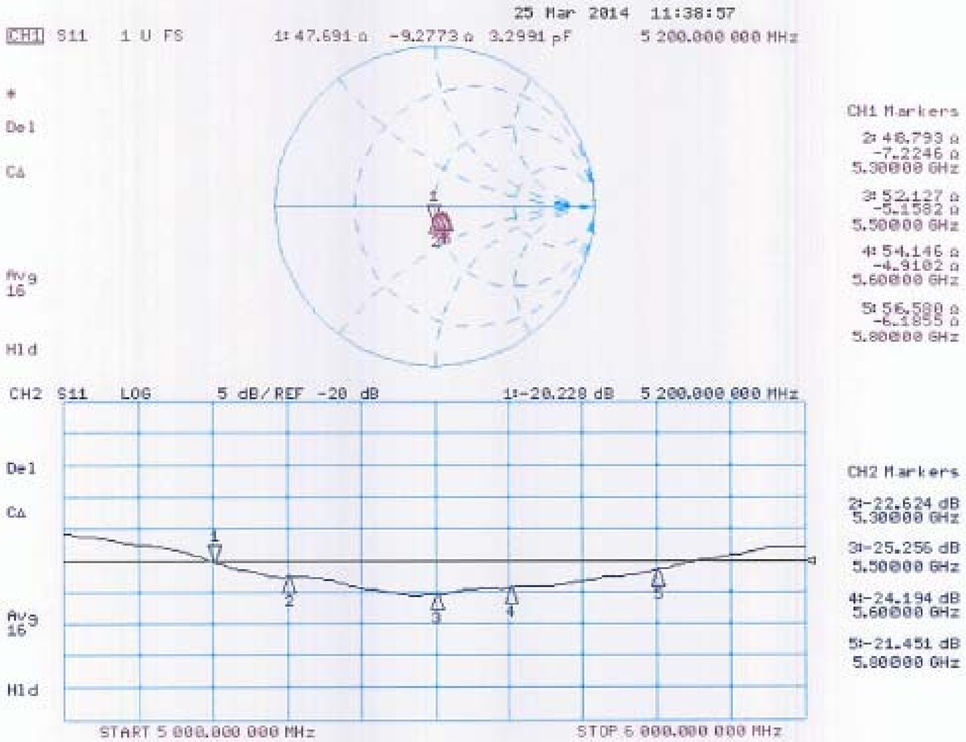
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

Impedance Measurement Plot for Head TSL



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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

DASY5 Validation Report for Body TSL

Date: 12.12.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1094

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.38 S/m; ε_r = 47.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5300 MHz; σ = 5.52 S/m; ε_r = 47; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.8 S/m; ε_r = 46.7; ρ = 1000 kg/m^3 , Medium parameters used: f = 5600 MHz; σ = 5.92 S/m; ε_r = 46.6; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.2 S/m; ε_r = 46.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.43, 4.43, 4.43); Calibrated: 28.12.2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.101 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 7.51 W/kg; SAR(10 g) = 2.1 W/kg
Maximum value of SAR (measured) = 17.6 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.212 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 31.4 W/kg
SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.071 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 34.7 W/kg
SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.24 W/kg
Maximum value of SAR (measured) = 19.4 W/kg

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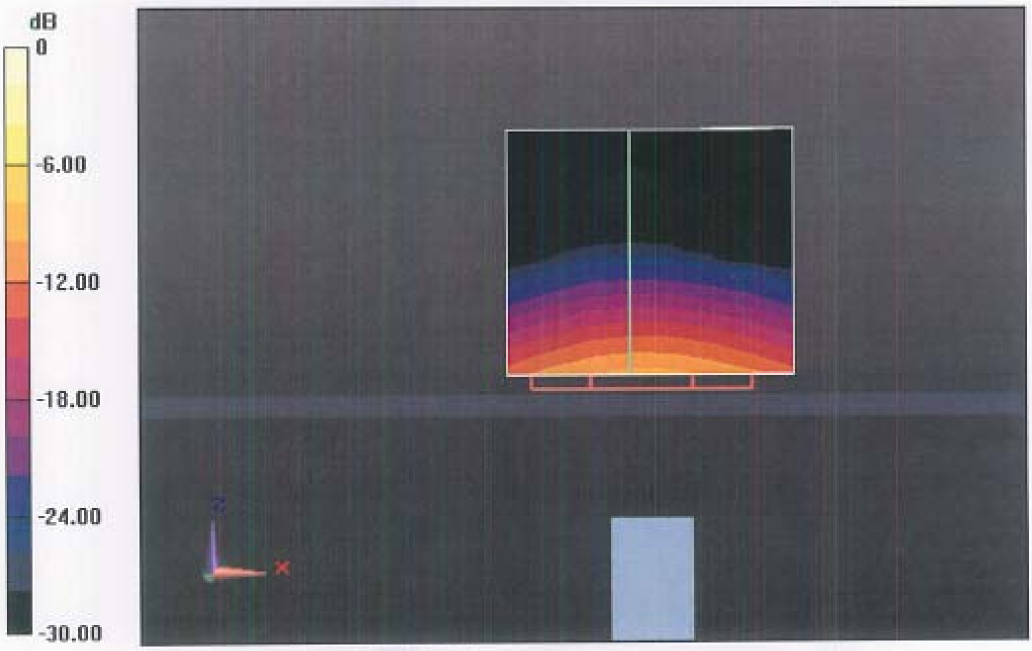
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.181 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 36.4 W/kg
SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 55.908 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 35.7 W/kg
SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.09 W/kg
Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

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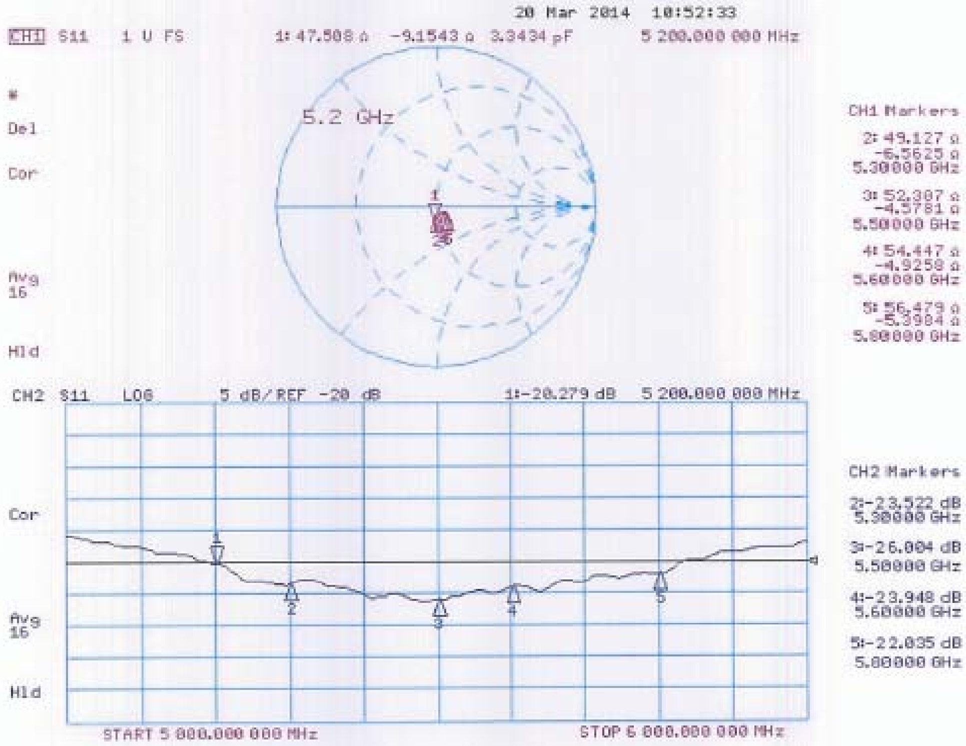
Impedance Measurement Plot for Body TSL



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< Dielectric Probe : DAK-3.5 SN 1140 >

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
C Servizio svizzero di taratura
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Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: **SCS 108**

Client **Onetech (Dymstec)**

Certificate No: **OCP-DAK3.5-1140_Nov13**

CALIBRATION CERTIFICATE

Object	DAK-3.5 - SN: 1140
Calibration procedure(s)	QA CAL-33.v2 Calibration of dielectric parameter probes
Calibration date:	November 26, 2013

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
OCP DAK-3.5 (weighted)	SN: 1084	9-Oct-13 (OCP-DAK3.5-1084_Oct13)	Oct-14
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Rohde & Schwarz ZVA50	T0170	4-Jun-12 (in house check May-13)	May-14
Digital Thermometer DTM3000	2148	28-Mar-13 (in house check Mar-13)	Mar-14
Methanol 99.9% Type 34860	SZBC143SV	4-Mar-13 (batch opened)	Apr-14
Head Liquid, HSL U12	121204-1	25-Apr-13 (in house check Apr-13)	Apr-14
0.1 mol/L NaCl solution Type 35275	SZBA2560	25-Apr-13 (in house check Apr-13)	Apr-14
0.05 mol/L NaCl solution	120427-1	25-Apr-13 (in house check Apr-13)	Apr-14
Head Gel, SL AGH U07 AA	120423	1-May-13 (sample opened)	Apr-14
Solid Substrate	AK9	1-May-13 (in house check)	Apr-14

	Name	Function	Signature
Calibrated by:	Ferenc Muranyi	External Expert	Muranyi Ferenc
Approved by:	Katja Pokovic	Technical Manager	

Issued: November 26, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: OCP-DAK3.5-1140_Nov13 Page 1 of 13

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

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Swiss Calibration Service

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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

References

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Description of the dielectric probe

Dielectric probes are used to measure the dielectric parameters of tissue simulating media in a wide frequency range. The complex permittivity $\varepsilon_r^* = (\varepsilon'/\varepsilon_0) - j(\varepsilon''/\varepsilon_0)$ is determined from the S parameters measured with a vector network analyzer (VNA) with software specific to the probe type. The parameters of interest e.g. in standards [1, 2, 3] and for other applications are presented are calculated as follows:
(Relative) permittivity ε' (real part of $\varepsilon_r^* = (\varepsilon'/\varepsilon_0) - j(\varepsilon''/\varepsilon_0)$ where $\varepsilon_0 = 8.854$ pF/m is the permittivity in free space)
Conductivity $\sigma = 2\,\pi\,f\,\varepsilon''\,\varepsilon_0$,
Loss Tangent = $(\varepsilon''/\varepsilon')$

The **OCP** (open ended coaxial) is a cut off section of 50 Ohm transmission line, similar to the system described in [1, 2, 3, 5], used for contact measurement The material is measured either by touching the probe to the surface of a solid/gelly or by immersing it into a liquid media. The electromagnetic fields at the probe end fringe into the material to be measured, and its parameters are determined from the change of the S_{11} parameters. With larger diameter of the dielectrics, the probe can be used down to lower frequencies.
The flange surrounding the active area shapes the near field similar to a semi-infinite geometry and is inserted fully into the measured lossy liquid.

The probe is connected with a phase and amplitude stable cable to a VNA which is then calibrated with Open, Short and a Liquid with well-known parameters.
All parts in the setup influencing the amplitude and phase of the signal are important and shall remain stable.

Handling of the item

Before usage, the active probe area has to be cleaned from any material residuals potentially contaminating the reference standards. The metal and dielectric surface must be protected to keep the precision of the critical mechanical dimensions. The connector and cable quality are critical; any movements between calibration and measurement shall be avoided.
The temperature must be stable and must not differ from the material temperature.

Methods Applied and Interpretation of Parameters

The calibration of the dielectric probe system is done in the steps described below for the desired frequency range and calibration package (SAR/MRI liquids, Semi-solid/solid material). Because the standard calibration in step 3 is critical for the results in steps 4 to 8, the sequence 3 to 8 is repeated 3 times. As a result, the result from these 3 sets is represented.

1. Configuration and mechanical / optical status.
2. Measurement resolution is 5 MHz from 10 to 300 MHz, 50 MHz from 300 to 6000 MHz and 250 MHz from 6 to 20 GHz.
3. Standard calibration uses Air / Short / Liquid. 1 liter liquid quantity is used to reduce the influence the reflections. The liquid type is selected depending on the lowest frequency and probe diameter:
   DAK-1.2, DAK-3.5, Agilent OCP: de-ionized water (approx. 22 °C)
   DAK-12: saline solution with static conductivity 1 S/m (approx. 22 °C)
   NPL OCP: pure ethanol (approx. 22 °C)
4. The cable used in the setup stays in a fixed position, i.e. the probe is fixed and measuring from the top in an angle of typ. 20° from the vertical axis. For DAK and Agilent probes, the refresh function (air standard) is used previous to the individual measurements in order to compensate for possible deviations from cable movements. After insertion of the probe into a liquid, the possible air bubbles are removed from the active surface.
5. Measurement of multiple shorts if not already available from the calibration in the previous step (NPL). Evaluation of the deviation from the previous calibration short with graphical representation of the complex quantities and magnitude over the frequency range. The specific probe short will be used if provided. This assessment shows ability to define a short circuit at the end of the probe for the VNA calibration in the setup which is essential at high frequencies and depends on the probe surface quality.
6. Measurement of validation liquids in a quantity of 1 liter at well defined temperature. Evaluation of the deviations from the target. The targets base on traceable data from reference sources. The deviation of the measurement is graphically presented for permittivity and conductivity (for lossy liquids) or loss tangent (for low losses at low frequencies).
7. Measurement of lossy liquids in a quantity of 1 liter at well defined temperature. Head tissue simulating liquid or saline solution with 0.5 S/m static conductivity are representative. The target data base on traceable data from reference sources or from multiple measurements with precision reference probes or different evaluations such as transmission line or slotted line methods. Evaluation of the deviation from the target and graphical representation for permittivity and conductivity over the frequency range
8. Semi-solid / solid material calibration:
   Measurements of an elastic lossy broadband semi-solid gel with parameters close to the head tissue target. Measurements of a planar very low loss solid microwave-substrate. The average of 4 measurements of the same sample at different location is shown as a single result. The deviation of the permittivity and conductivity from the reference data is evaluated.
   Measurements of a planar very low loss solid microwave-substrate. The average of 4 measurements of the same sample at different location is shown as a single result. The relative deviation of the permittivity and the absolute deviation of the loss tangent is evaluated.
   The targets base on multiple measurements (on the same material batch at identical temperature) on convex and planar surfaces with precision reference OCP.

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The measurement on semi-solid / solid materials is sensitive to the quality and planarity of the probe contact area, such as air gaps due to imperfect probes (resulting lower permittivity values).

9. Table for the probe uncertainty: The uncertainty of the probe depending on probe type, size, material parameter range and frequency is given in a table. It represents the best measurement capability of the specific probe but does not include the material (deviation from the target values).
10. Appendix with detailed results of all measurements with the uncertainties for the specific measurement. In addition to the probe uncertainty (see above), it includes the uncertainty of the reference material used for the measurement. A set of results from independent calibrations represents the capability of the setup and the lossy materials used, including the precision of the measured material and the influence of temperature deviations. Temperature and operator influence was minimized and gives a good indication of the achievable repeatability of a measurement.
11. Summary assessment of the measured deviations and detailed comments if not typical for the probe type.

Dielectric probe identification and configuration data

Item description

Probe type	**OCP** Open-ended coaxial probe
Probe name	SPEAG Dielectric Assessment Kit DAK-3.5
Type No	**SM DAK 040 CA**
Serial No	**1140**
Description	Open-ended coaxial probe with flange Flange diameter: 19.0 mm Dielectric diameter: 3.5 mm Material: stainless steel
Connector 1	PC 3.5 pos.
Software version	**DAK Measurement Solver 1.10.321.11** Calibration Type: Air / short / water (set to measured water temp.) Probe type: "DAK3.5" (software setting)
Further settings	VNA bandwidth setting: 50 Hz

Accessories

Cable	Huber & Suhner Sucoflex 404, SN: 1695, length 1 m, PC3.5 neg. – PC3.5 neg.
Short	DAK-3.5 shorting block, type SM DAK 200 BA Contact area covered with cleaned Cu stripe

Additional items used during measurements

Adapter 1	PC3.5 pos. – PC2.4 (VNA side)
Adapter 2	PC3.5 pos. – PC3.5 neg. (probe side)

Notes

- Before the calibration, the connectors of the probe and cable were inspected and cleaned.
- Probe visual inspection: according to requirements
- Short inspection: according to the requirements

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Probe Uncertainty

The following tables provide material and frequency specific uncertainties (k=2) for the dielectric probe. The values in the tables represent the measurement capability for the probe when measuring a material in the indicated parameter range. They include all uncertainties of

- probe system
- possible systematic errors due to the design
- calibration
- temperature differences during the calibration and measurements, as described,
- VNA noise

Apart from the material used for the calibration (de-ionized water), material uncertainties of the reference materials used during the measurement in Appendix A are not included in these tables.

DAK-3.5				
Permittivity range		Frequency range	(sigma / LT range)	Unc. (k=2)
	1 – 15	10 MHz - 20 MHz		---
		20 MHz - 200 MHz		---
		200 MHz - 3 GHz	LT < 0.1	2.4%
		3 GHz - 6 GHz	LT < 0.1	2.0%
		6 GHz - 20 GHz	LT < 0.1	2.1%
	10 – 40	10 MHz - 20 MHz		---
		20 MHz - 200 MHz		---
		200 MHz - 3 GHz	sigma : 1 – 10 S/m	1.9%
		3 GHz - 6 GHz	sigma : 1 – 10 S/m	2.3%
		6 GHz - 20 GHz	sigma > 10 S/m	3.5%
	35 – 100	10 MHz - 20 MHz		---
		20 MHz - 200 MHz		---
		200 MHz - 3 GHz	sigma : 1 – 10 S/m	1.8%
		3 GHz - 6 GHz	sigma : 1 – 10 S/m	1.9%
		6 GHz - 20 GHz	sigma > 10 S/m	2.4%
Conductivity range (S/m)		Frequency range	(epsilon / LT range)	Unc. (k=2)
	1 – 10	10 MHz - 20 MHz		---
		20 MHz - 200 MHz		---
		200 MHz - 3 GHz	eps : 35 - 100	2.7%
		3 GHz - 6 GHz	eps : 35 - 100	3.0%
		6 GHz - 20 GHz	eps : 10 - 40	3.0%
Loss tangent range		Frequency range	(epsilon / LT range)	Unc. (k=2)
	< 0.1	10 MHz - 20 MHz		---
		20 MHz - 200 MHz		---
		200 MHz - 3 GHz	eps : 1 - 15	0.03
		3 GHz - 6 GHz	eps : 1 - 15	0.03
		6 GHz - 20 GHz	eps : 1 - 15	0.03

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Calibration Results

Uncertainty limits (k=2) for the material measurements in the figures of Appendix A are represented with red dashed lines. These uncertainties contain - in addition to probe uncertainty - the uncertainty of the material target parameter determination.
The measurements show the results obtained from independent calibrations for the same material. The differences between the individual measurement curves give therefore an indication for the obtainable repeatability and shall lie within the uncertainties stated in the tables.

Materials for DAK-3.5 calibration:
Appendix A with curves for Methanol, HSL, and 0.05 mol/L NaCl solution (200 MHz - 6 GHz, optional 20 GHz), HS gel and low loss solid substrate are optional.

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Appendix A: Detailed Results

A.1 Probe appearance and calibration sequence

A.1.1 Appearance

The OCP appearance is fully according to the expectations:
- the flange surface is intact

A.1.2 Calibration sequence

The following sequence was repeated 3 times in the low frequency range from 200 – 300 MHz in 5 MHz steps and in the high frequency range from 300 to 6000 MHz in 50 MHz steps, and from 6 GHz to 20 GHz in 250 MHz steps.

- Air
- Short — 1 short, then immediate verification with a second short (with eventual repetition)
- Water — De-ionized water, temperature measured and set in the software (for DAK-12 0.1 mol/L saline solution, temperature measured and set in the software)
- Methanol — Pure methanol, temperature measured and set in the software
- Liquids — Measurement of further liquids (e.g. Head tissue simulating liquid and 0.05 mol/l saline)
- Cleaning — Probe washed with water and isopropanol at the end of the sequence.
- Shorts — 4 additional separate short measurements to determine the deviation from the original
- Refresh — Refresh with Air
- Solid — 4 separate solid low loss planar substrate measurements to determine one average (optional)
- Semisolid — 4 separate head gel measurements on fresh intact surface to determine one average (optional)
- Cleaning — Probe washed with water and isopropanol at the end of the sequence

Evaluation of the additional shorts from the calibrated (ideal) short point at the left edge of the Smith Chart, represented as magnitude over the frequency range (fig. 2.1.x) and in polar representation (fig. 2.2.x).

Evaluation of the Liquid measurements and representation of the permittivity and conductivity deviation from their reference data at the measurement temperature. The results of each of the 3 calibrations is shown in the appendix for each material (fig. 3ff) in black, red, blue. The red dashed line shows the uncertainty of the reference material parameter determination.

Evaluation of the Semisolid measurements (optional) by representing the 3 average deviations (each resulting from the 4 separate measurements per set), equivalent to the liquid measurement. Representation of the permittivity and conductivity deviation from their reference data at the nominal temperature.

Evaluation of the Solid measurements (optional) by representing the 3 average deviations (each resulting from the 4 separate measurements per set), equivalent to the liquid measurement. Representation of the permittivity deviation from their reference data and the loss tangent at the nominal temperature.

A.2 Short residual magnitudes

After each of the 3 calibrations with a single short (as per the DAK software), 4 additional separate, short measurements were performed after the liquid measurements and evaluated from the S11 data. The residuals in the graphs represent the deviation from the ideal short point on the polar representation on the VNA screen.

Fig. 2.1a Magnitude of the residual of the shorts, 200 MHz – 20 GHz, after calibration a)

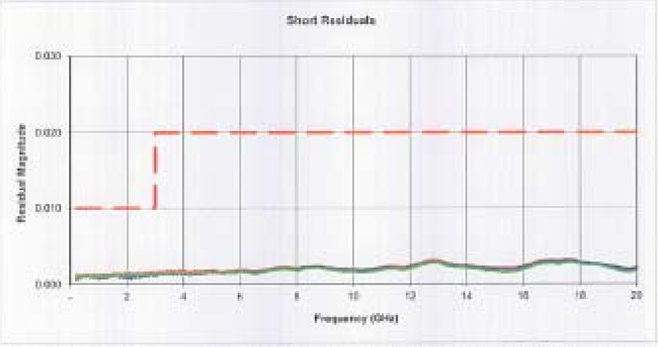

Fig. 2.1b Magnitude of the residual of the shorts, 200 MHz – 20 GHz, after calibration b)

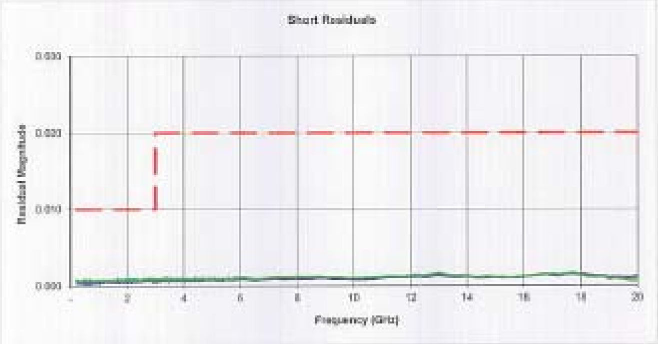

Fig. 2.1c Magnitude of the residual of the shorts, 200 MHz – 20 GHz, after calibration c)

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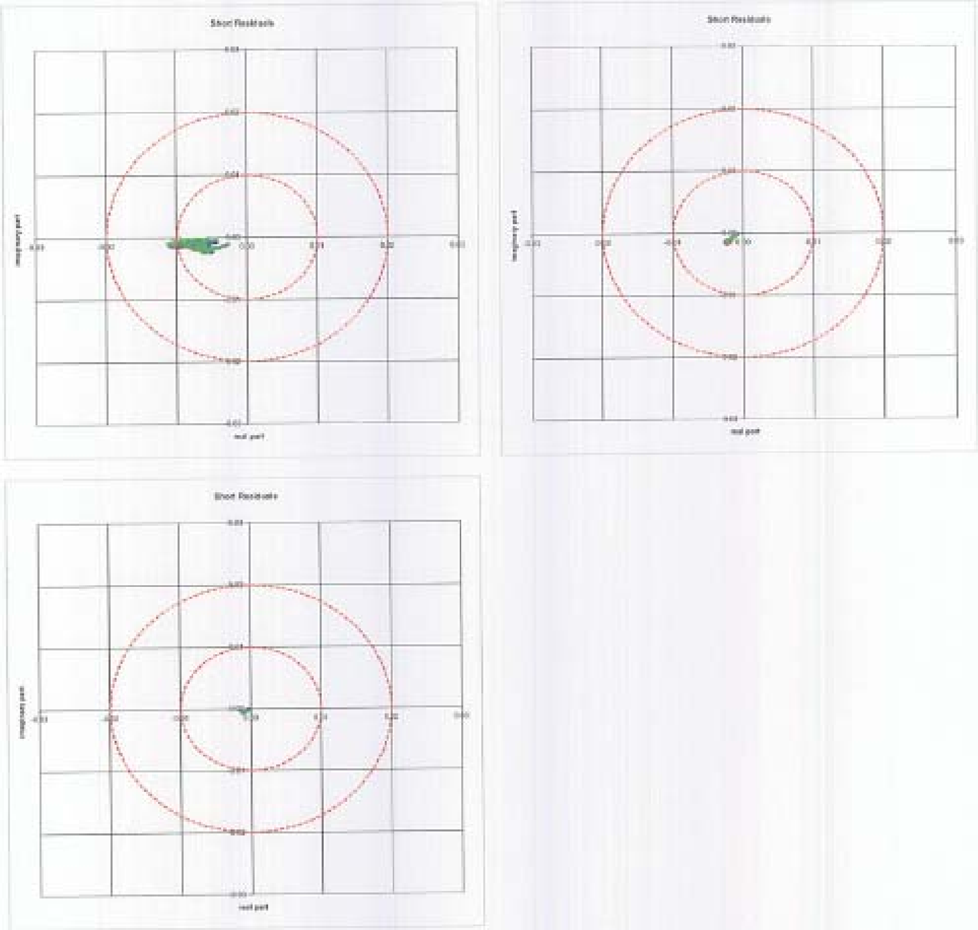

Fig. 2.2a-c Complex representation of the residuals of the shorts, 200 MHz - 20 GHz, after calibrations a)-b) in the top and c) in the bottom

All shorts have good quality. Some minor deviations might be visible from contact quality (left - right).

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A.3 Methanol

Methanol (99.9% pure) was measured at a temperature of 22 +/- 2 °C. The liquid temperature was stabilized within 0.05 °C of the desired temperature. Deviations are presented relative to the nominal material parameters at this temperature, calculated from NPL data for this temperature.

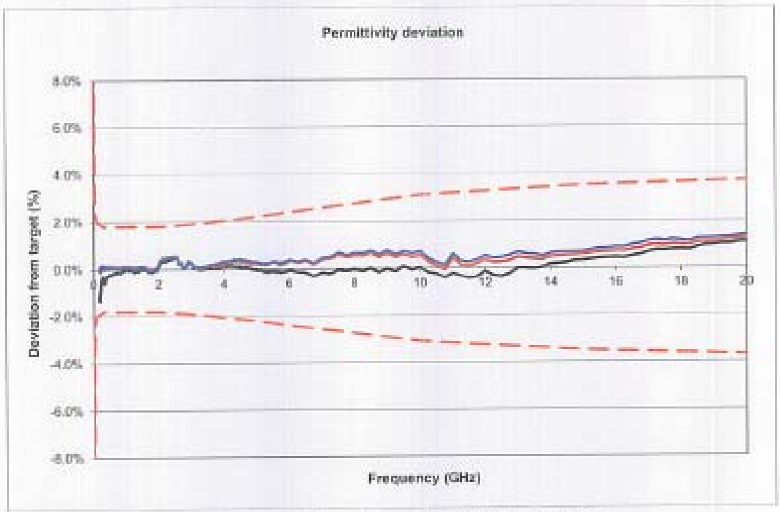

Fig. 3.1 Methanol permittivity deviation from target, 200 MHz – 20 GHz

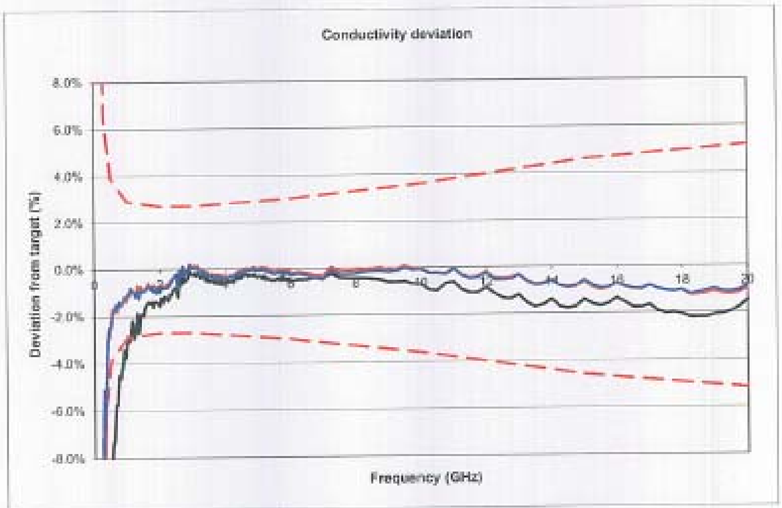

Fig. 3.2 Methanol conductivity deviation from target, 200 MHz – 20 GHz

Conductivity error can be high at low frequencies due to the low absolute conductivity values.

A.4 Head Tissue

Broadband head simulating liquid was measured at a temperature of 22 +/- 2 °C. The liquid temperature was stabilized within 0.05 °C of the desired temperature. Deviations are presented relative to the reference data for this material. Those parameters have been evaluated from multiple measurements on the used bath with precision reference OCP and further methods.

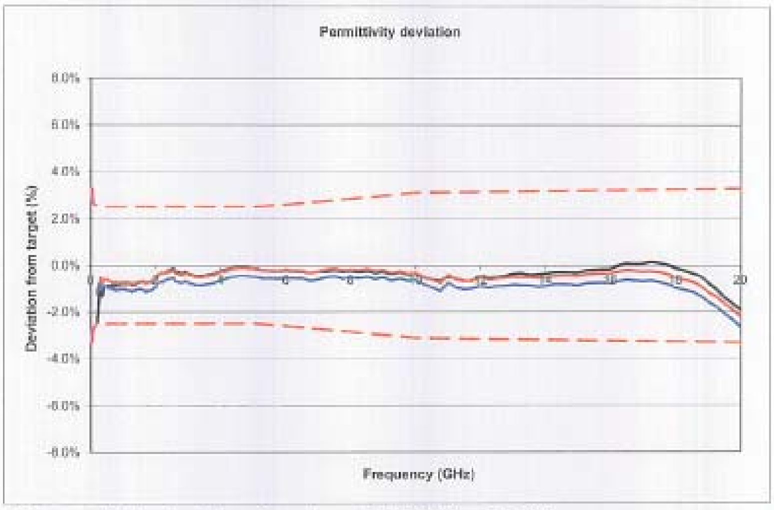

Fig. 4.1 HSL permittivity deviation from target, 200 MHz – 20 GHz

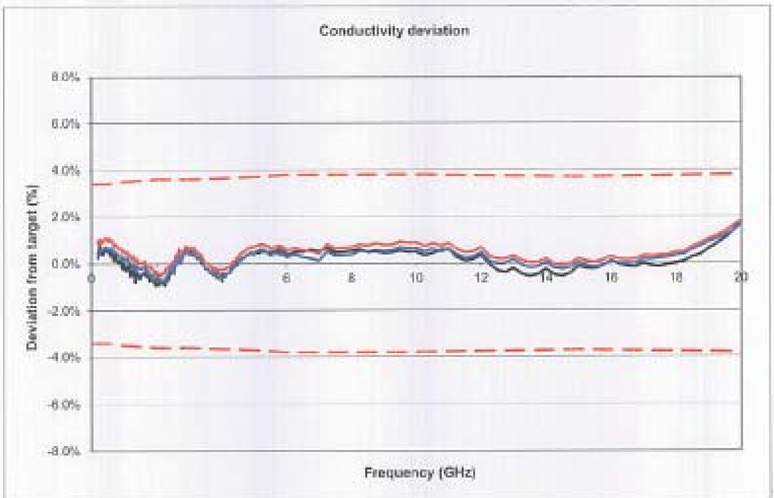

Fig. 4.2 HSL conductivity deviation from target, 200 MHz – 20 GHz

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A.5 0.05 mol/L NaCl solution

0.05 mol/L NaCl / water solution has a static conductivity of 0.5 S/m, similar to MRI HCL (High Conductivity Liquid). It was measured at a temperature of 22 +/- 2 °C. The liquid temperature was stabilized within 0.05 °C of the desired temperature. Deviations are presented relative to the reference data for this material. These parameters have been derived from the theoretical model according to [7], matched to the measurements from reference probes and other sources.
A quantity of 1 liter was used for the measurement.

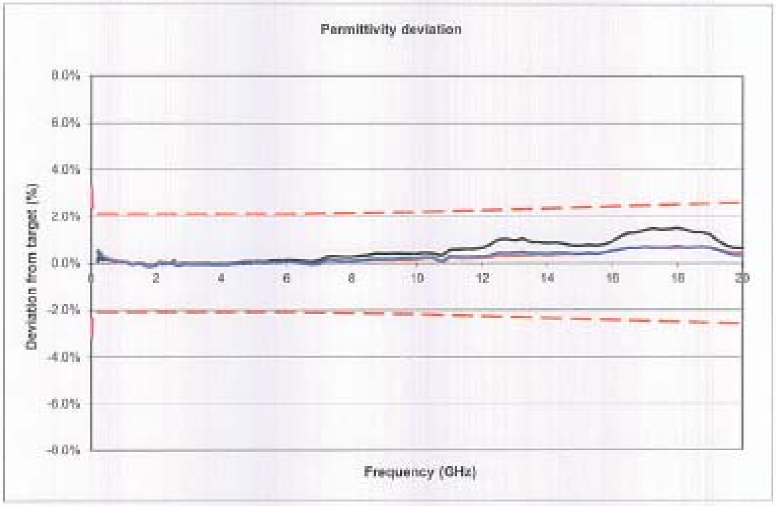

Fig. 5.1 0.05 mol/L solution permittivity deviation from target, 200 MHz – 20 GHz

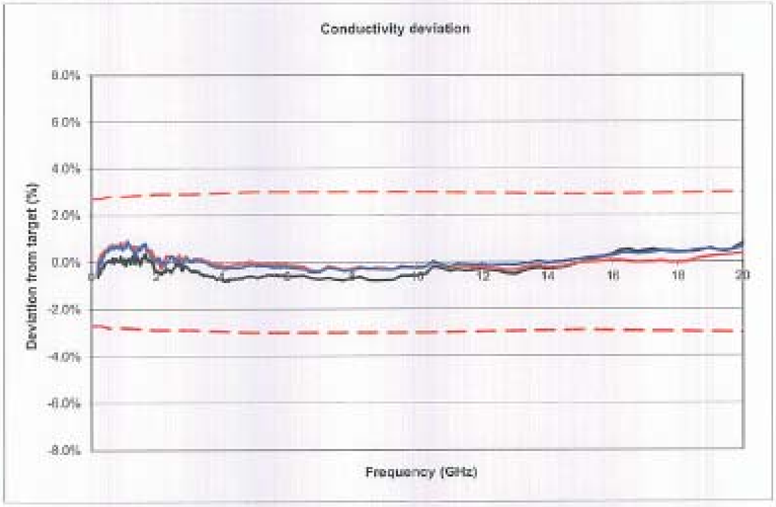

Fig. 5.2 0.05 mol/L solution conductivity deviation from target, 200 MHz – 20 GHz

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Appendix B: Nominal parameters of reference materials used for calibration

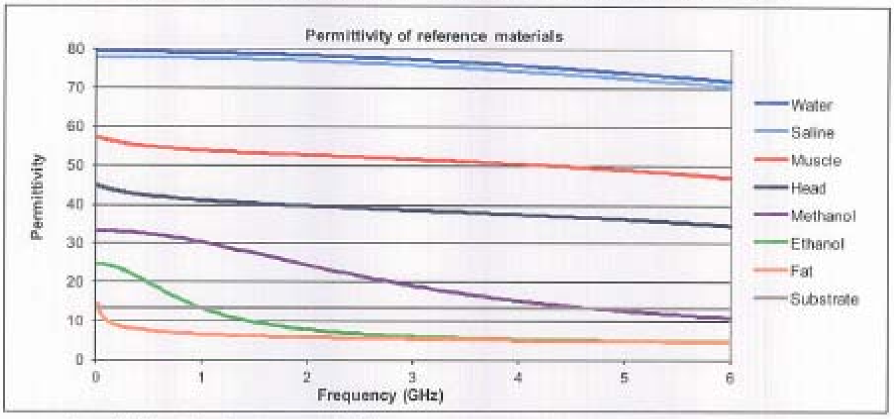

Fig. B.1 Permittivity of reference materials

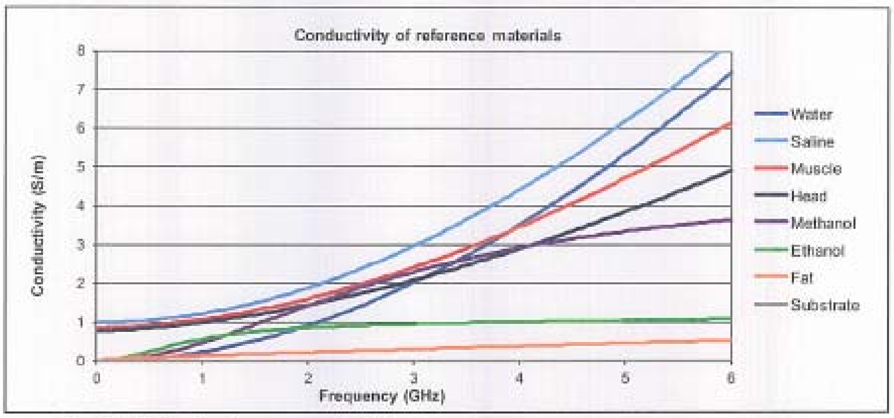

Fig. B.2 Conductivity of reference materials

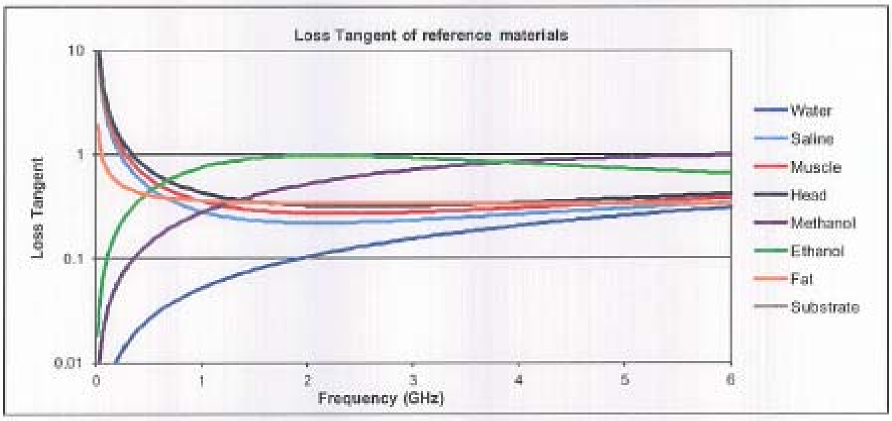

Fig. B.3 Loss tangent of reference materials

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