TÜVRheinland®
Precisely Right.

Produkte
Products

Prüfbericht - Nr.: *Test Report No.:*	**19660234/235 001**		**Seite 1 von 27** *Page 1 of 27*
Auftraggeber: *Client:*	**GE Healthcare** **Phase V Plot No #122,** **Phase II EPIP** **Whitefield Road,** **Bangalore 560066, India**		
Gegenstand der Prüfung: *Test item:*	**Ultrasound Scanner**		
Bezeichnung: *Identification:*	**Vscan Extend**	**Serien-Nr.:** *Serial No.*	**VH150103AI**
Wareneingangs-Nr.: *Receipt No.:*	**1803150937**	**Eingangsdatum:** *Date of receipt:*	**29.06.2016**
Prüfort: *Testing location:*	**Refer Page 4 of 27 for test facilities**		
Prüfgrundlage: *Test specification:*	**IEC 62209-2 :2010** **IEEE Std 1528-2013** **RSS 102, Issue 5**		
Prüfergebnis: *Test Result:*	**Siehe Testergebnis Zusammenfassung** *See test result summary*		
Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland (India) Pvt. Ltd.** TUV Rheinland India Pvt Ltd. 82/A, West Wing, 3rd Main Road Electronic Cit Phase 1, Bangalore – 560100		

geprüft / *tested by:*

22.08.2016	Vinay N Sr.Engineer	Vinay.N
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

kontrolliert / *reviewed by:*

24.08.2016	Raghavendra Kulkarni Sr. Mangager	Kulkarni
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges / *Other Aspects:*	**FCC ID: YOMVSCANEXTEND** **IC ID: 9136A-VSCANEXTEND**

Abkürzungen:				***Abbreviations:***			
P(ass)	=	***entspricht Prüfgrundlage***		***P(ass)***	=	***passed***	
F(ail)	=	***entspricht nicht Prüfgrundlage***		***F(ail)***	=	***failed***	
N/A	=	***nicht anwendbar***		***N/A***	=	***not applicable***	
N/T	=	***nicht getestet***		***N/T***	=	***not tested***	

Test Result Summary:

Protocol	SAR type	SAR (W/kg)	Result
802.11b	Body	0.282	Pass
802.11g	Body	0.332	Pass
802.11n	Body	0.263	Pass

Content

List of Test and Measurement Instruments

Equipment	Model	Serial Number	Periodicity	Cal due date
E-Filed Probe EX3DV4	SP-EX3 004 CC	3886	Yearly	17.03.2017
DAE 3	SD 000 D03 AE	322	Yearly	15.03.2017
RF and microwave Signal Generator	SMB100A	108788	Yearly	05.12.2016
Power Sensor	E4412A	MY50360055	Yearly	13.04.2017
Power Meter	N1913A	MY50000459	Yearly	17.04.2017
Dipole D2450V2	SA AAD 245 BB	902	Yearly	09.03.2017
Dielectric Probe	DAKS-3.5	1062	Yearly	Aug,15

Testing Facilities:

1) TUV Rheinland (India) Private Limited
No. 108, West Wing
Electronic city Phase I
Bangalore – 560100

General Product Information

Product Function and Intended Use

Vscan Extend is a general purpose handheld diagnostic ultrasound imaging system for use by qualified and trained health care professionals enabling visualization and measurement of anatomical structures and fluid.

Ratings and System Details

Frequency Range	2400MHz – 2480MHz	
No. of channel	Refer page 5 of 27	
Channel Spacing	5MHz	
Transmitted Power	802.11b	14.67 dBm
	802.11g	12.11 dBm
	802.11nHT20	11.79 dBm
	802.11nHT40	10.68 dBm
Data Rate	802.11b: 1,2, 5.5,11 Mbps 802.11g: 6, 9, 12, 18, 24, 36,48, 54 Mbps 802.11nHT20: 6.5, 13, 19.5, 26, 39, 52, 58.5,65Mbps 802.11nHT40: 13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps	
Modulation	802.11b: DSSS with CCK 802.11g: OFDM with BPSK, QPSK, 16-QAM, 64-QAM 802.11n: OFDM with BPSK, QPSK, 16-QAM, 64-QAM	
Number of antenna	One	
Antenna Gain	0dBi	
Supply Voltage	7.4 VDC Battery	
Dimensions	168 x 76 x 22 mm	
Environmental Condition	Operating temperature is 0°C to 40°C	

Test Set-up and Operation Mode

Principle of Configuration Selection

Transmission was enabled with continuous transmission on low, mid and high channel.

Test Operation and Test Software

Test software was used to enable the continuous transmission, changing channels (low/mid/high) and data rates on the EUT for the tests in this report.

Special Accessories and Auxiliary Equipment

- None

Test Results

1. SAR Limits

The below standards are applied for SAR testing of this product under FCC regulations.

IEEE Std C95.1-2005: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, Inst. of Electrical and Electronics Engineers, Inc.

IEEE Std 1528-2013: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques, Inst. of Electrical and Electronics Engineers, Inc.

KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04.
RSS 102, Issue 5

Limits:

Body Region	Devices Used by the General Public SAR Limit (W/kg)
Localized Head and Trunk	1.6

2. Tissue simulating liquid dielectric parameters

For the purpose of the tests as described in this report the following tissue dielectric parameters have been determined by use of a Vector Network Analyzer (VNA). The tables indicate the dielectric parameters of the liquids used during the tests. The indicated required values are derived from IEEE Std 1528-2013 & FCC KDB “865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04”

Dielectric parameters for 2450MHz Tissue

2450MHz muscle simulant liquid was used for the tests for 2.4GHz – 2.4835GHz band frequencies. The following liquid validation results were obtained, where the maximum deviation should not be more than ±10% of the Relative values (standard).

Results for 2.45GHz MHz Band

Frequency (MHz)	Measured Liquid Temperature (°C)	Measured relative Permittivity	Measured Conductivity (S/m)	Relative Permittivity Standard	Conductivity Standard (S/m)	Relative Permittivity Deviation (%)	Conductivity Deviation (%)
2450	23.5	53.23	1.95	52.70	1.95	1	0

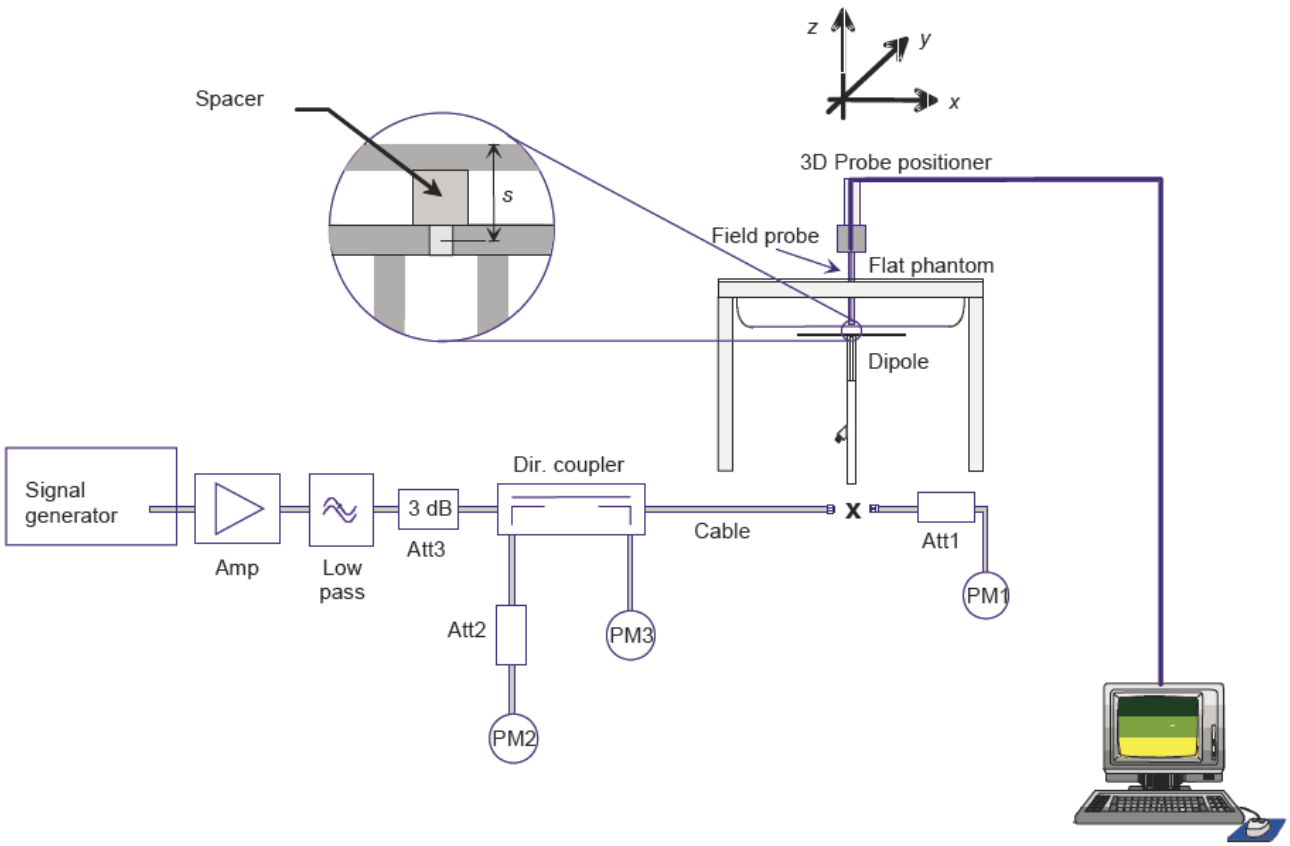
3. System Validation

The purpose of the system performance check (system check) is to verify that the system operates within its specifications at the device test frequency. The system check is to make sure that the system works correctly at the time of the compliance test. The system check has been performed using the specified tissue-equivalent liquid and at a chosen fixed frequency that is within ± 10% of the compliance test mid-band frequency. The system check is performed prior to compliance tests and the result must always be within ±10% of the target value corresponding to the test frequency, liquid and the source used. The system check detects possible short-term drift and uncertainties in the system, such as:

a) Changes in the liquid parameters (e.g., due to water evaporation or temperature change),
b) Test system component failures,
c) Test system component drift,
d) Operator errors in the set-up or software parameters,
e) Other possible adverse conditions in the system configuration, e.g., RF interference.

The results show that this system check is within ±10% of the expected values.

System check Setup



Results

At 2450 MHz a system check was executed according KDB 865664 D01. The following system performance check results were obtained (referenced to 1W):

Frequency (MHz)	Target Value (W/kg)	Measured Value (W/kg)	Deviation from Target value (%)	Permissible deviation from target value (%)
2450	51.2	49.7	-3	±10

System Validation: 2450 MHz

Temperature of Liquid	: 23.5 ºC
Test Frequency	: 2450MHz
Measured Conductivity	: 1.95 S/m
Measured Permittivity	: 53.23

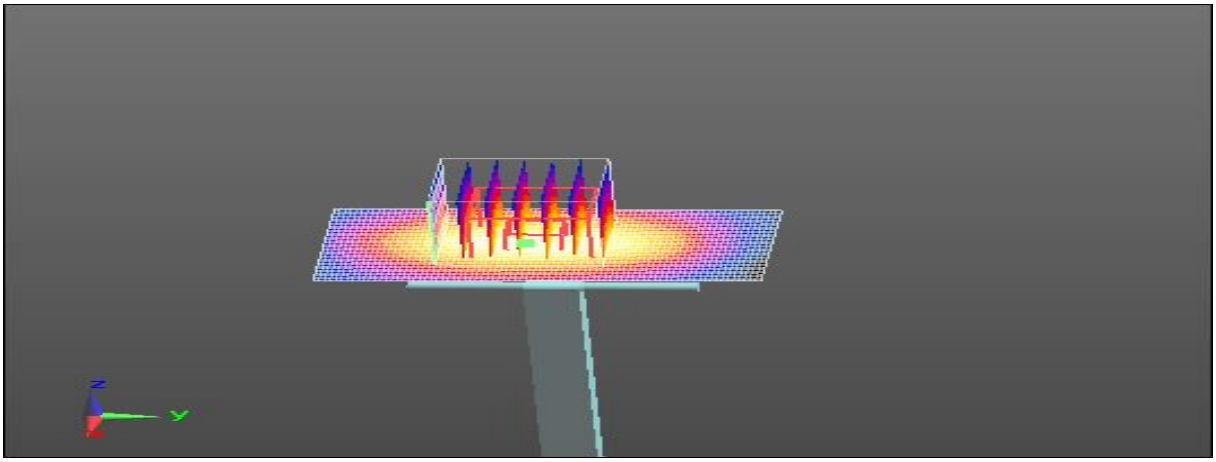
Area Scan

Power input to Dipole	: 100mW
Grid Dimension	: 51mmX81mmx1mm
SAR Normalized to 1W power	: 49.9 W/Kg

Zoom Scan

Grid Dimension	: 7mmX7mmX7mm
Power Reference	: 62.47 V/m
Measured SAR	: 4.97 W/kg
Normalized to 1W power	: 49.7 W/Kg
Power Drift	: -0.11 dB

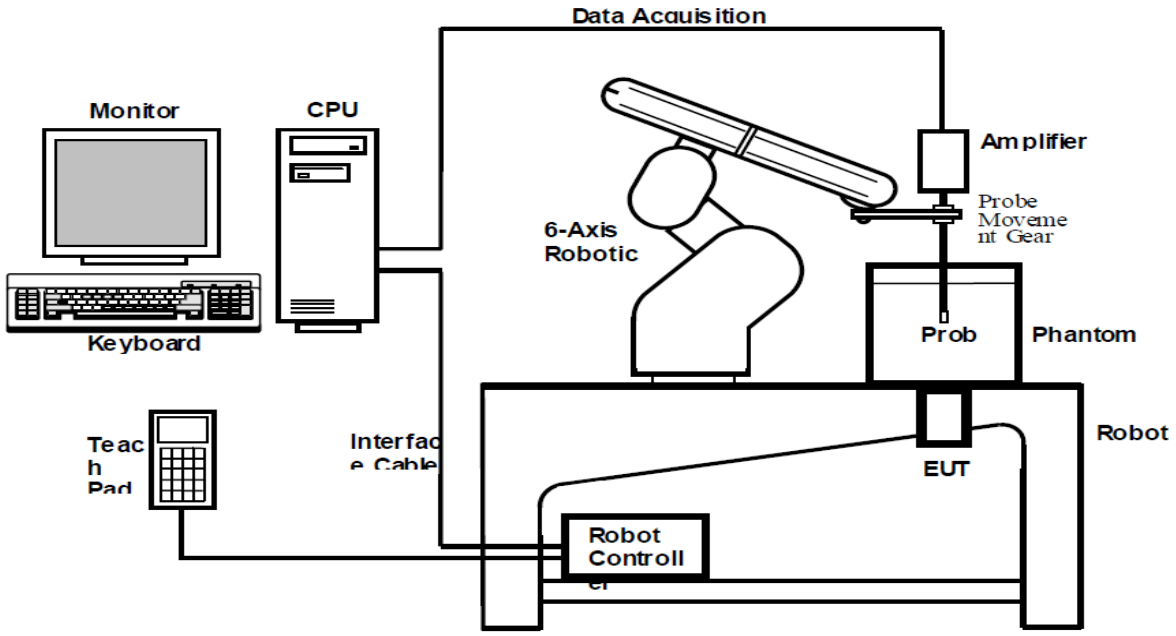
Measurement Plot



4. Specific Absorption rate of EUT

System Description

The SAR measurement system used by TUV India is the SPEAG DASY4, which consists of a Staubli robot-arm and controller, SPEAG probe and amplifier and an appropriate phantom as required and considered appropriate for the applied test. The robot is used to move and manipulate the probe to programmed positions inside the phantom to obtain the SAR readings from the EUT.



The system is remote controlled by a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans by calculating the measured values into corresponding SAR values based on the currently acceptable calculation methods.

The position and digitized shape of the phantom are made available to the software for accurate positioning of the probe and reduction of set-up time.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centered at that point to determine volume averaged SAR level.

Measurement Procedure

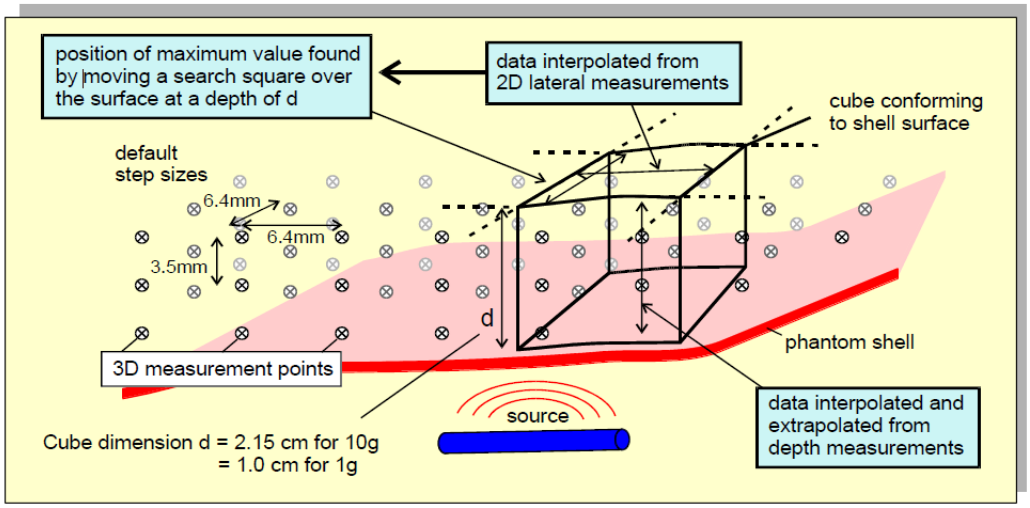
During the SAR measurement, the positioning of the probe is performed with sufficient accuracy to obtain repeatable measurements in the presence of rapid spatial attenuation phenomena. The accurate positioning of the E-field probe is accomplished by using the high precision robot. The robot can be taught to position the probe sensor following a specific pattern of points.

After an area scan has been done a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power (SAR) drift during measurement to be assessed.

www.tuv.com

Step size and scan information

For the EUT"s 2.4 GHz band a 30 x 30 mm area is scanned centered around the hotspot using 6 steps in the x-y plane and 10 steps of 3.0 mm in the z plane. The first area scan is performed with the probe tip 5 mm above the phantom bottom shell. For the EUT"s 5 GHz band a 24 x 24 mm area is scanned centered around the hotspot using 6 steps in the x-y plane and 6 steps of 3 mm in the z plane. The first area scan is performed with the probe tip 2 mm above the phantom bottom shell.



SARA2 Interpolation and Extrapolation schemes

SARA2 software contains support for both 2D cubic B-spline interpolation as well as 3D cubic B-spline interpolation. In addition, for extrapolation purposes, a general n_{th} order polynomial fitting routine is implemented following a singular value decomposition algorithm. A 4_{th} order polynomial fit is used by default for data extrapolation.

Interpolations of 2D area scan

The 2D cubic B-spline interpolation is used after the initial area scan at fixed distance from the phantom shell wall. The initial scan data are collected with approximately 10 mm spatial resolution and spline interpolation is used to find the location of the local maximum to within a 1mm resolution for positioning the subsequent 3D scanning.

Extrapolation of 3D scan

For the 3D scan, data are collected on a spatially regular 3D grid having (by default) 6.4 mm steps in the lateral dimensions and 3.5 mm steps in the depth direction (away from the source). DASY4 enables full control over the selection of alternative step sizes in all directions. The digitized shape of the Flat Phantom is available to the DASY4 software, which decides which points in the 3D array are sufficiently well within the shell wall to be visited by the SAR probe. After the data collection, the data are extrapolated in the depth direction to assign values to points in the 3D array closer to the shell wall. A notional extrapolation value is also assigned to the first point outside the shell wall so that subsequent interpolation schemes will be applicable right up to the shell wall boundary.

Interpolation of 3D scan and volume averaging

The procedure used for defining the shape of the volumes used for SAR averaging in the SARA2 software follow the method of adapting the surface of the „cube" to conform with the surface of the phantom. This is called, here, the conformal scheme.

For each row of data in the depth direction, the data are extrapolated and interpolated to les s than 1 mm spacing and average values are calculated from the phantom surface for the row of data over distances corresponding to the requisite depth for 10g and 1g cubes. These results in two 2D arrays of data, which are then cubic B-spline interpolated to sub mm lateral resolution. A search routine then moves an averaging square around through the 2D array and records the maximum value of the corresponding 1g and 10g volume averages. For measurements in rectangular, box phantoms, the distance between the phantom wall and the closest set of gridded data points is entered into the software.

The default step size (dstep) used is 3.5 mm, but this is under user-control. The compromise is with time of scan, so it is not practical to make it much smaller or scan times become long and power -drop influences become larger. The robot positioning system specification for the repeatability of the positioning (dss) is 0.04 mm.

The flat phantom is made from Polymethylmethacrylate (PMMA), a low-loss dielectric material with dielectric constant and loss tangent less than 5.0 and 0.05 respectively. The shell thickness for all regions coupled to the test device and its antenna are within 2.0 ± 0.2 mm.

For the upright phantom, the alignment is based upon registration of the rotation axis of the phantom on its 253 mm-diameter base plate bearing and the position of the probe axis when commanded to go to the axial position. A laser alignment tool is provided. This enables the registration of the phantom tip (dmis) to be assured to within approx. 0.2 mm. This alignment is done with reference to the actual probe tip after installation and probe alignment.

Summary of Results

The tests were done with all 6 EUT Positions and the worst case emissions are found when EUT front face was touching the Phantom. The same results are reported in the below table.

Band/Protocol	Channel Frequency (MHz)	Measured Power (mW)	Tune-up Limit (mW)	Tune-Up Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)	Limit (W/kg)	Result	Worst Case EUT Position
802.11b_2.4GHz_20MHz	2412	11.66	12.04	1.033	0.273	0.282	1.6	Pass	Front Face
	2442	11.65	12.04	1.033	0.262	0.271	1.6	Pass	Front Face
	2472	13.12	12.04	0.918	0.251	0.230	1.6	Pass	Front Face
802.11g_2.4GHz_20MHz	2412	10.83	11.13	1.028	0.239	0.246	1.6	Pass	Front Face
	2442	10.67	11.13	1.043	0.318	0.332	1.6	Pass	Front Face
	2472	10.09	11.13	1.103	0.203	0.224	1.6	Pass	Front Face
802.11n_2.4GHz_20MHz	2412	10.63	10.79	1.015	0.241	0.245	1.6	Pass	Front Face
	2442	10.71	10.79	1.007	0.236	0.238	1.6	Pass	Front Face
	2472	9.85	10.79	1.095	0.21	0.230	1.6	Pass	Front Face
802.11n_2.4GHz_40MHz	2422	10.28	10.79	1.050	0.247	0.259	1.6	Pass	Front Face
	2442	9.95	10.79	1.084	0.212	0.230	1.6	Pass	Front Face
	2457	9.76	10.79	1.106	0.238	0.263	1.6	Pass	Front Face

Protocol	Data rate	Channel Frequency (MHz)
802.11b	11Mbps	2412

Temperature of Liquid : 23.4 ºC
Measured Conductivity : 1.899 S/m
Measured Permittivity : 53.231

Area Scan

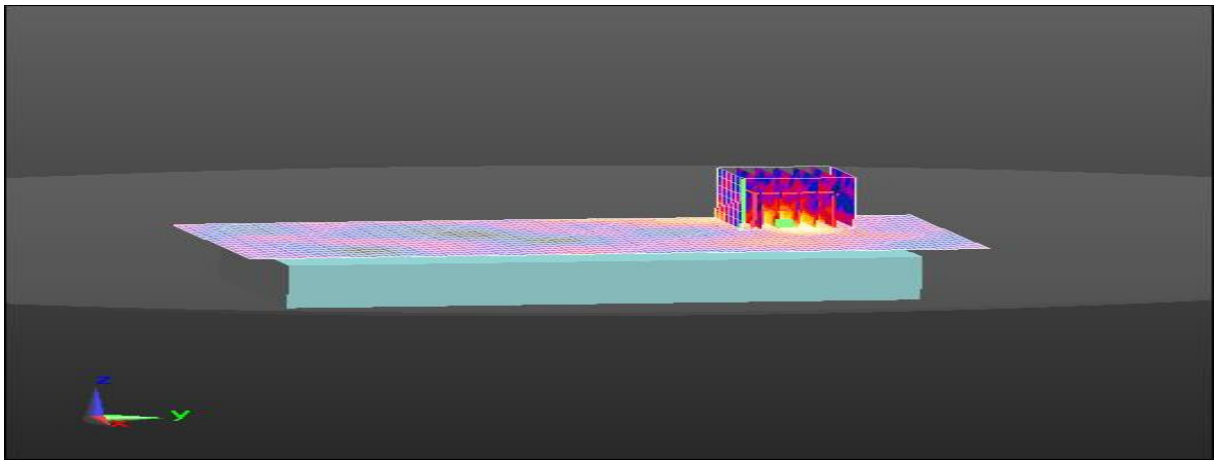
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.407 W/Kg

Zoom Scan

Grid Dimension : 7mmX7mmX7mm
Power Reference : 6.507 V/m
Measured SAR : 0.273 W/Kg
Power Drift : 0.06 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11b	11Mbps	2442

Temperature of Liquid : 23.4 ºC
Measured Conductivity : 1.947 S/m
Measured Permittivity : 53.309

Area Scan

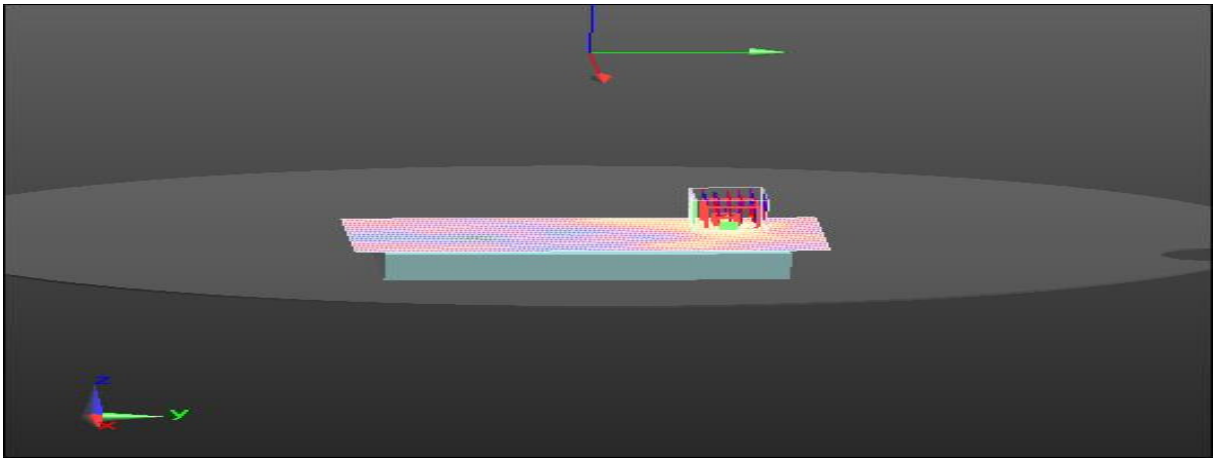
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.365 W/Kg

Zoom Scan

Grid Dimension : 8mmX7mmX7mm
Power Reference : 6.787 V/m
Measured SAR : 0.262 W/Kg
Power Drift : -0.19 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11b	11Mbps	2472

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.995 S/m
Measured Permittivity : 53.22

Area Scan

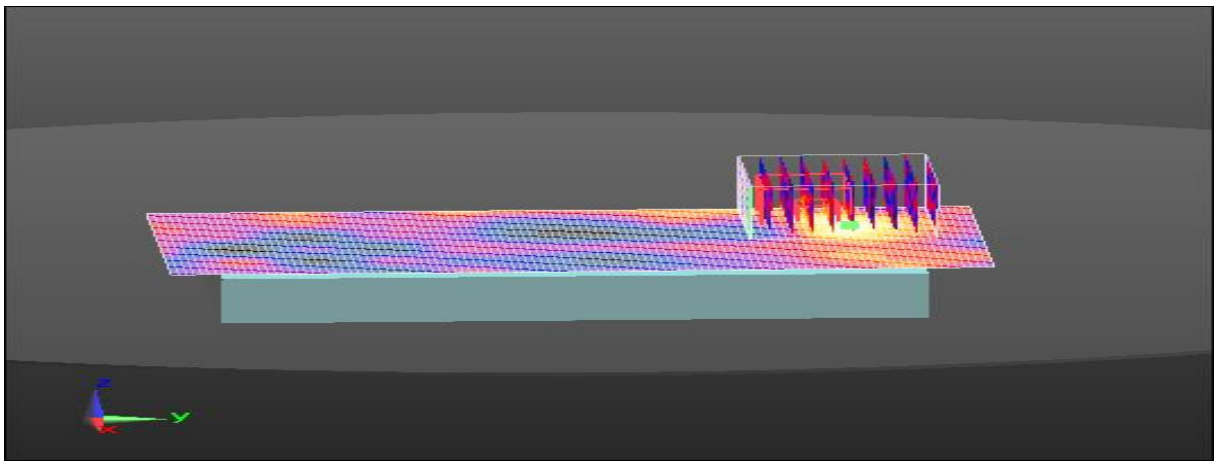
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.331 W/Kg

Zoom Scan

Grid Dimension : 10mmX10mmX7mm
Power Reference : 6.640 V/m
Measured SAR : 0.251 W/Kg
Power Drift : 0.34 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11g	6Mbps	2412

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.897 S/m
Measured Permittivity : 53.207

Area Scan

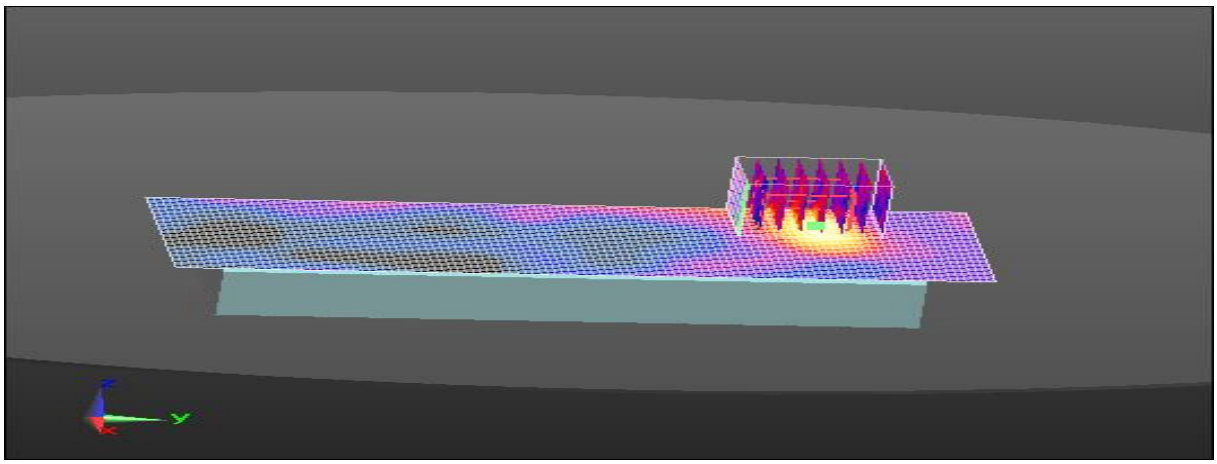
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.293 W/Kg

Zoom Scan

Grid Dimension : 8mmX8mmX7mm
Power Reference : 9.389 V/m
Measured SAR : 0.239 W/Kg
Power Drift : -0.26 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11g	6Mbps	2442

Temperature of Liquid : 23.4 ºC
Measured Conductivity : 1.9.39 S/m
Measured Permittivity : 53.225

Area Scan

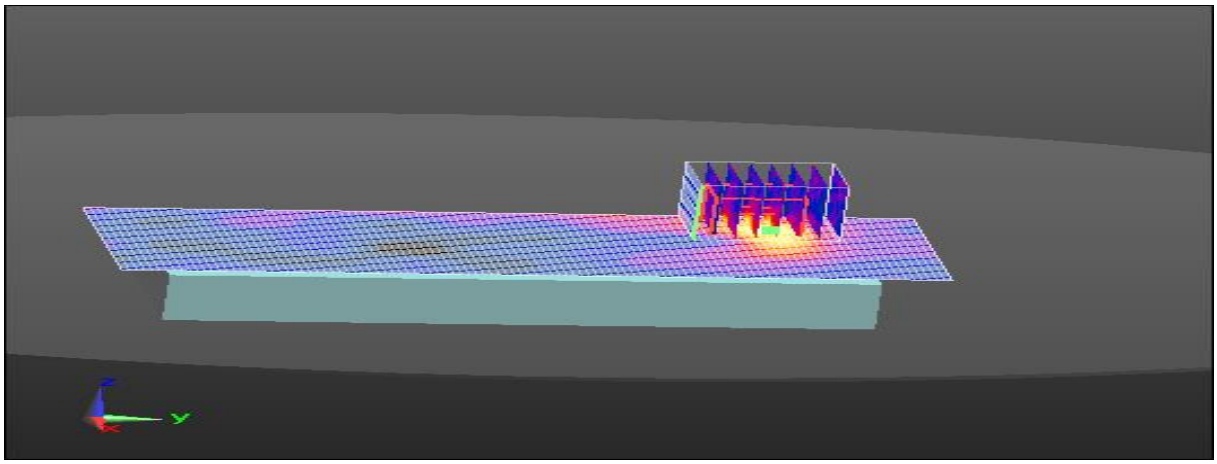
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.394 W/Kg

Zoom Scan

Grid Dimension : 8mmX8mmX7mm
Power Reference : 9.721 V/m
Measured SAR : 0.318 W/Kg
Power Drift : -0.47 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11g	6Mbps	2472

Temperature of Liquid : 23.4 ºC
Measured Conductivity : 1.995 S/m
Measured Permittivity : 53.22

Area Scan

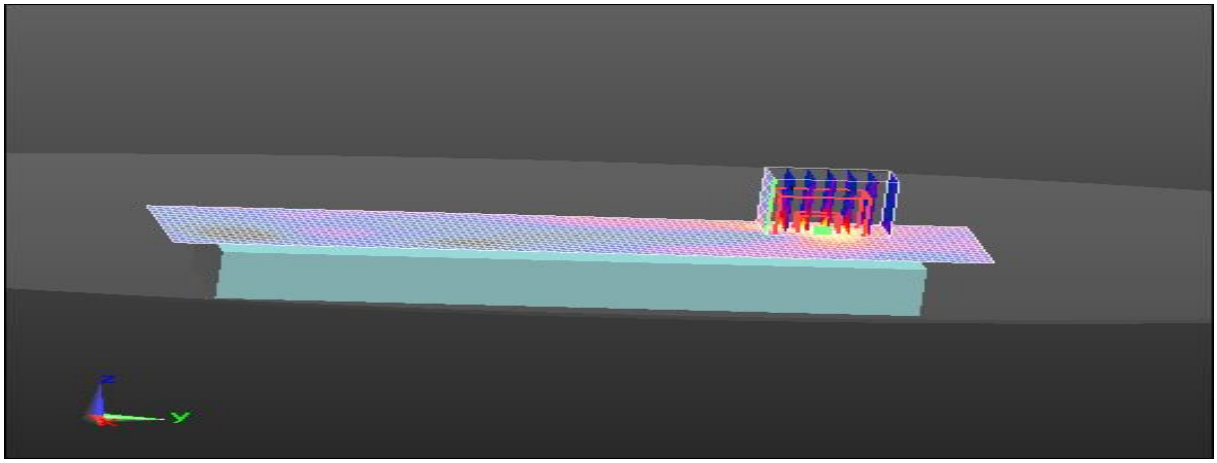
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.295 W/Kg

Zoom Scan

Grid Dimension : 7mmX7mmX7mm
Power Reference : 6.758 V/m
Measured SAR : 0.203 W/Kg
Power Drift : -0.26 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_20MHz	MCS7	2412

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.897 S/m
Measured Permittivity : 53.207

Area Scan

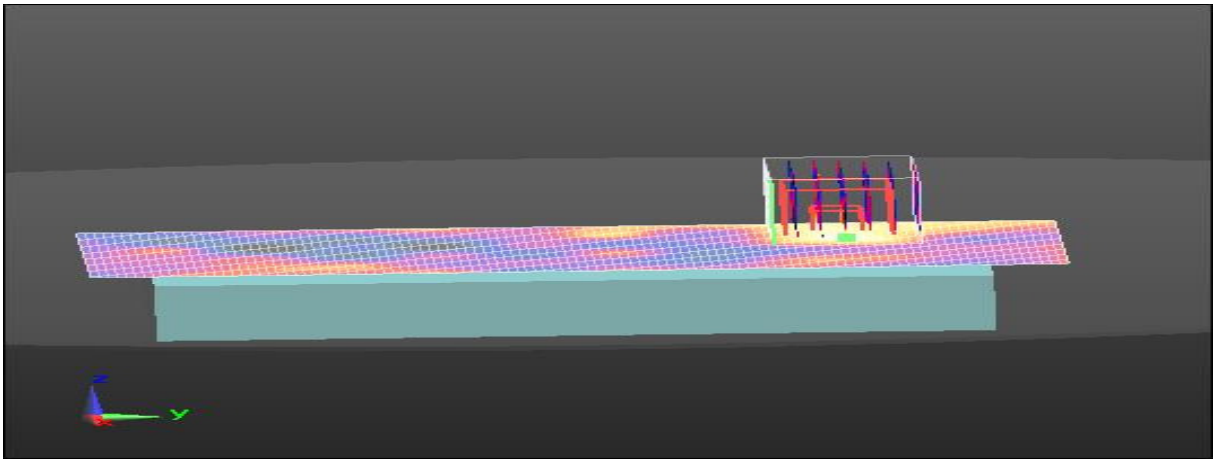
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.319 W/Kg

Zoom Scan

Grid Dimension : 10mmX7mmX7mm
Power Reference : 9.332 V/m
Measured SAR : 0.241 W/Kg
Power Drift : -0.29dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_20MHz	MCS7	2442

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.939 S/m
Measured Permittivity : 53.225

Area Scan

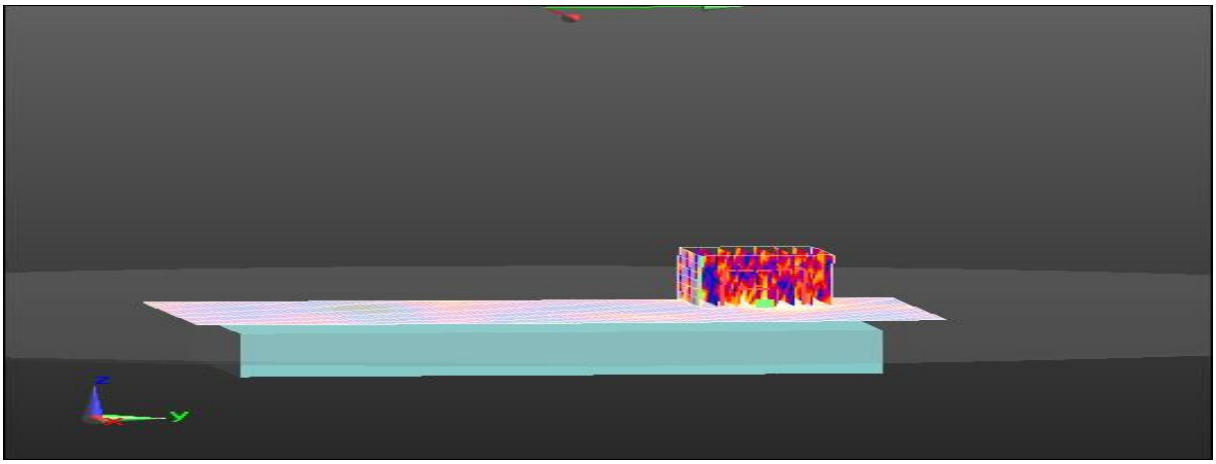
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.313 W/Kg

Zoom Scan

Grid Dimension : 8mmX8mmX7mm
Power Reference : 8.954 V/m
Measured SAR : 0.236 W/Kg
Power Drift : -0.37 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_20MHz	MCS7	2472

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.99 S/m
Measured Permittivity : 53.164

Area Scan

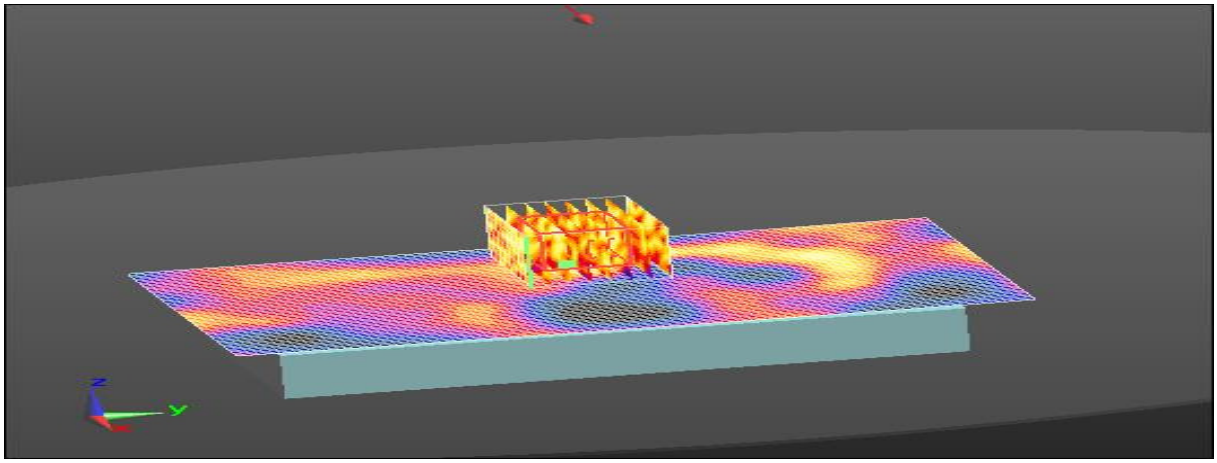
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.244 W/Kg

Zoom Scan

Grid Dimension : 9mmX8mmX7mm
Power Reference : 9.239 V/m
Measured SAR : 0.210 W/Kg
Power Drift : -0.13 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_40MHz	MCS7	2422

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.911 S/m
Measured Permittivity : 53.213

Area Scan

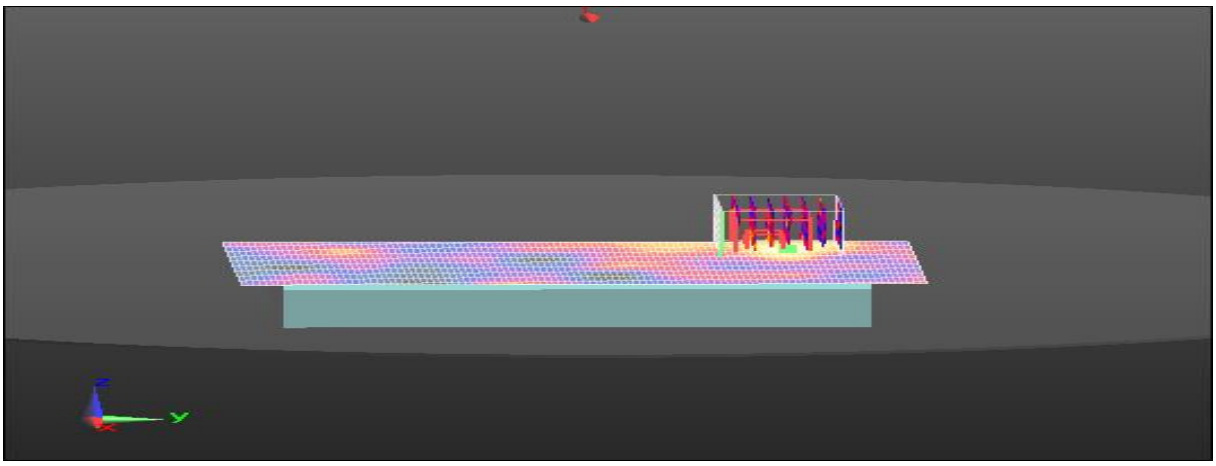
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.309 W/Kg

Zoom Scan

Grid Dimension : 8mmX8mmX7mm
Power Reference : 9.112 V/m
Measured SAR : 0.247 W/Kg
Power Drift : -0.39dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_40MHz	MCS7	2442

Temperature of Liquid : 23.4 ºC
Measured Conductivity : 1.939 S/m
Measured Permittivity : 53.225

Area Scan

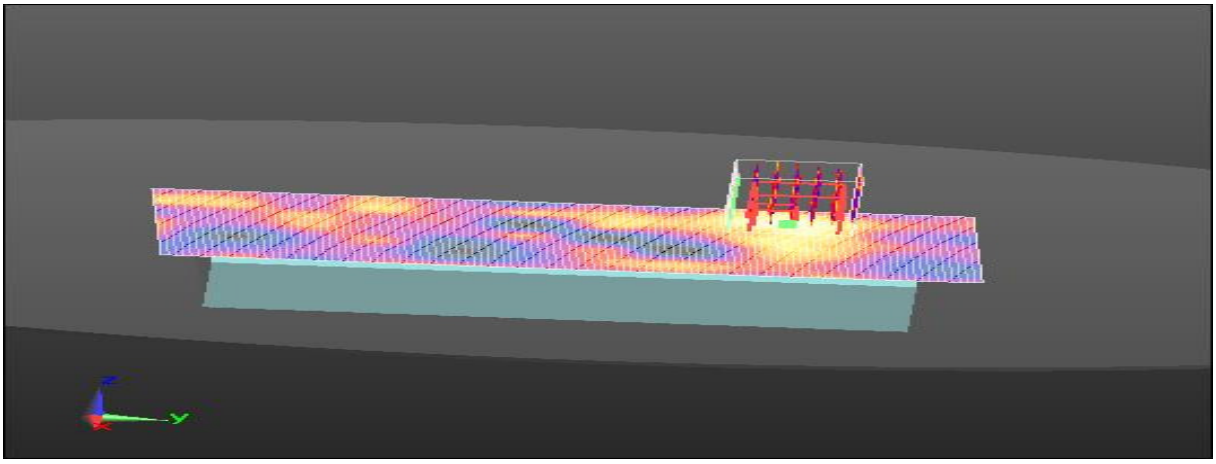
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.270 W/Kg

Zoom Scan

Grid Dimension : 7mmX7mmX7mm
Power Reference : 8.806 V/m
Measured SAR : 0.212 W/Kg
Power Drift : -0.18 dB

Measurement Plot:

EUT Position: Front Face



Protocol	Data rate	Channel Frequency (MHz)
802.11n_40MHz	MCS7	2462

Temperature of Liquid : 23.5 ºC
Measured Conductivity : 1.972 S/m
Measured Permittivity : 53.194

Area Scan

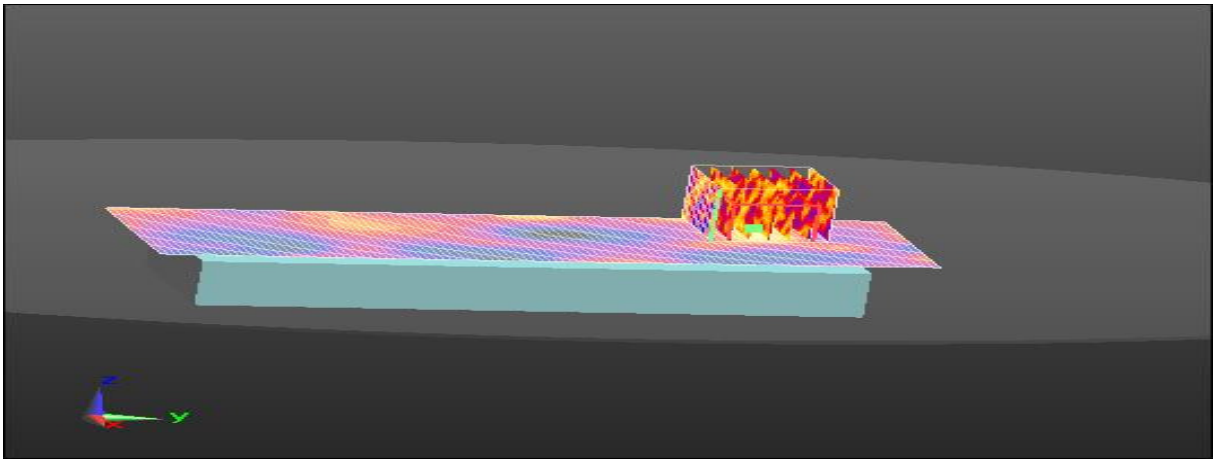
Grid Dimension : 111mmX51mmX1mm
Maximum SAR : 0.313 W/Kg

Zoom Scan

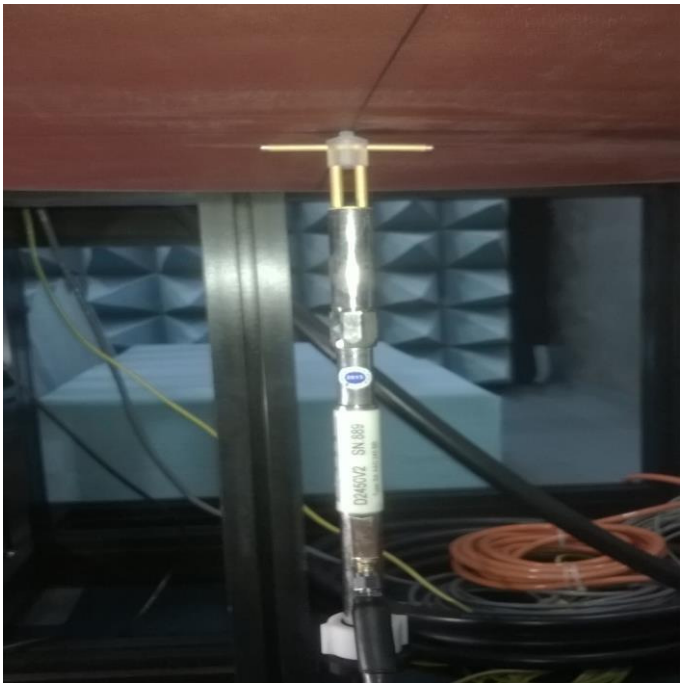
Grid Dimension : 10mmX7mmX7mm
Power Reference : 8.334 V/m
Measured SAR : 0.238 W/Kg
Power Drift : -0.25 dB

Measurement Plot:

EUT Position: Front Face



Test Setup Photos:



System Validation

SAR Test Setup

*****END OF TEST REPORT*****

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
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

Client **TÜV Rheinland (BNN)**

Certificate No: D2450V2-902_Mar16

CALIBRATION CERTIFICATE

Object D2450V2 - SN:902

Calibration procedure(s) QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: March 09, 2016

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	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec16)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

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

Issued: March 9, 2016

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
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
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) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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	V52.8.8
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	38.6 ± 6 %	1.88 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	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**53.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.7 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 2.6 jΩ
Return Loss	- 27.4 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	June 19, 2012

DASY5 Validation Report for Head TSL

Date: 09.03.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:902

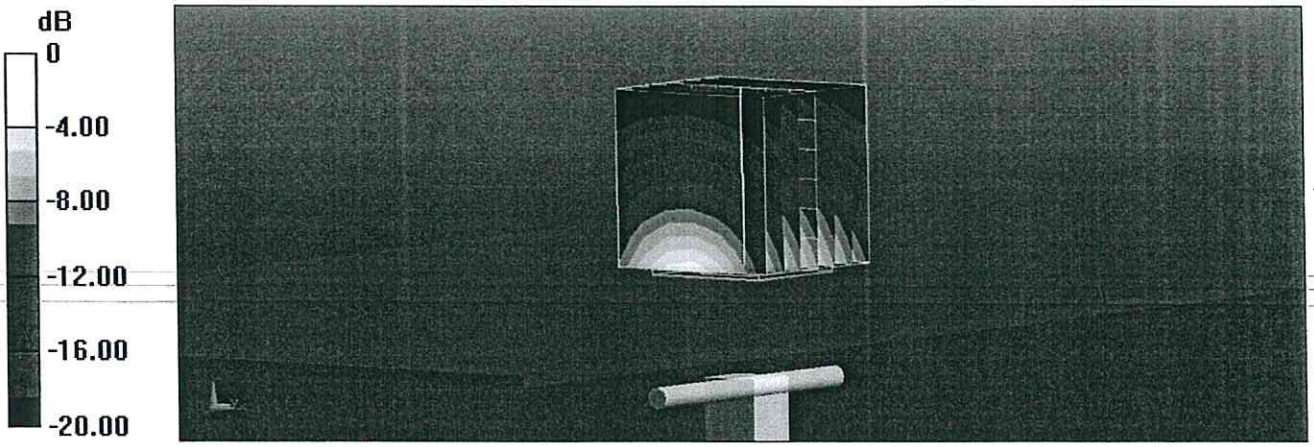
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.88 S/m; ε_r = 38.6; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom Type: QD000P50AA
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

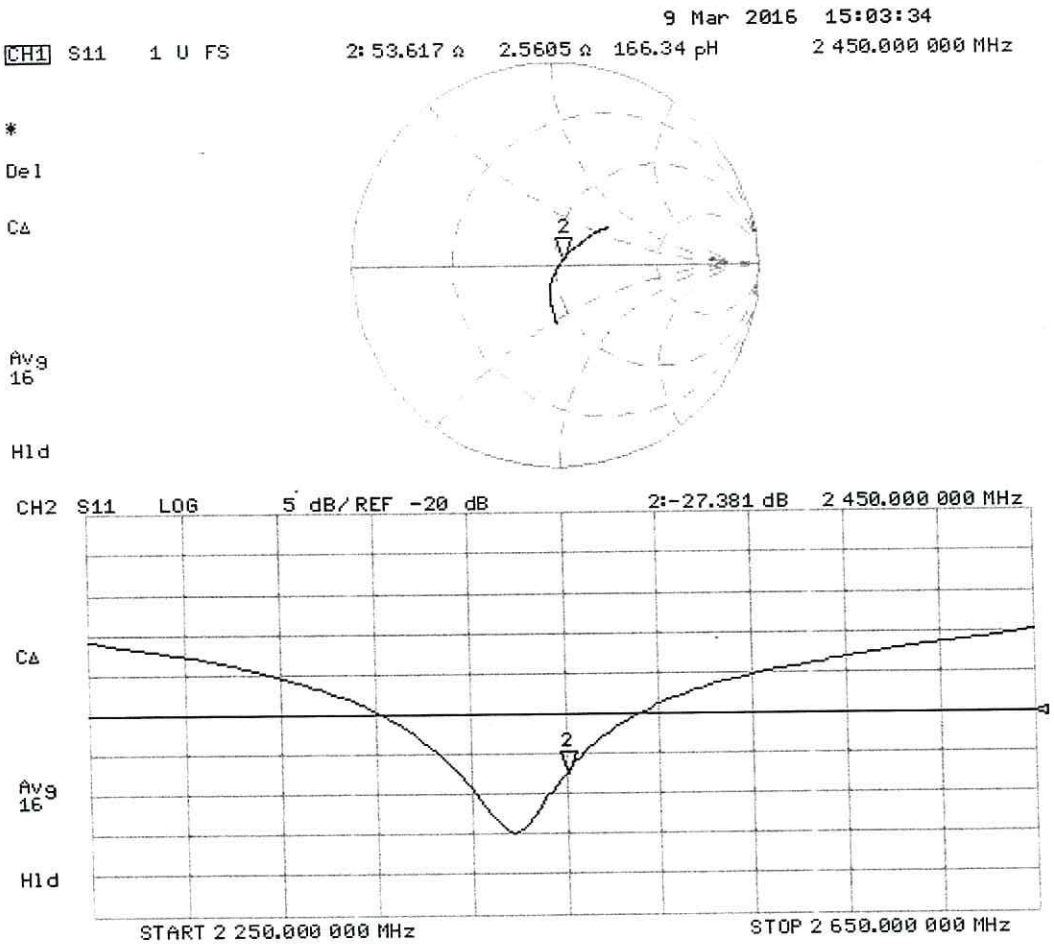
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 114.2 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 27.5 W/kg
SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.27 W/kg
Maximum value of SAR (measured) = 22.2 W/kg



0 dB = 22.2 W/kg = 13.46 dBW/kg

Impedance Measurement Plot for Head TSL



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
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

Client **TüV Rheinland (BNN)**

Certificate No: EX3-3886_Mar16

CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3886

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: March 17, 2016

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	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
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-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 17, 2016

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

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

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3886

Manufactured:	April 30, 2012
Repaired:	March 14, 2016
Calibrated:	March 17, 2016

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3886

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.17	0.40	0.39	± 10.1 %
DCP (mV)[B]	94.5	104.1	101.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	166.2	±3.0 %
		Y	0.0	0.0	1.0		161.6	
		Z	0.0	0.0	1.0		160.5	

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 Page 5).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3886

Calibration Parameter Determined in Head Tissue Simulating Media

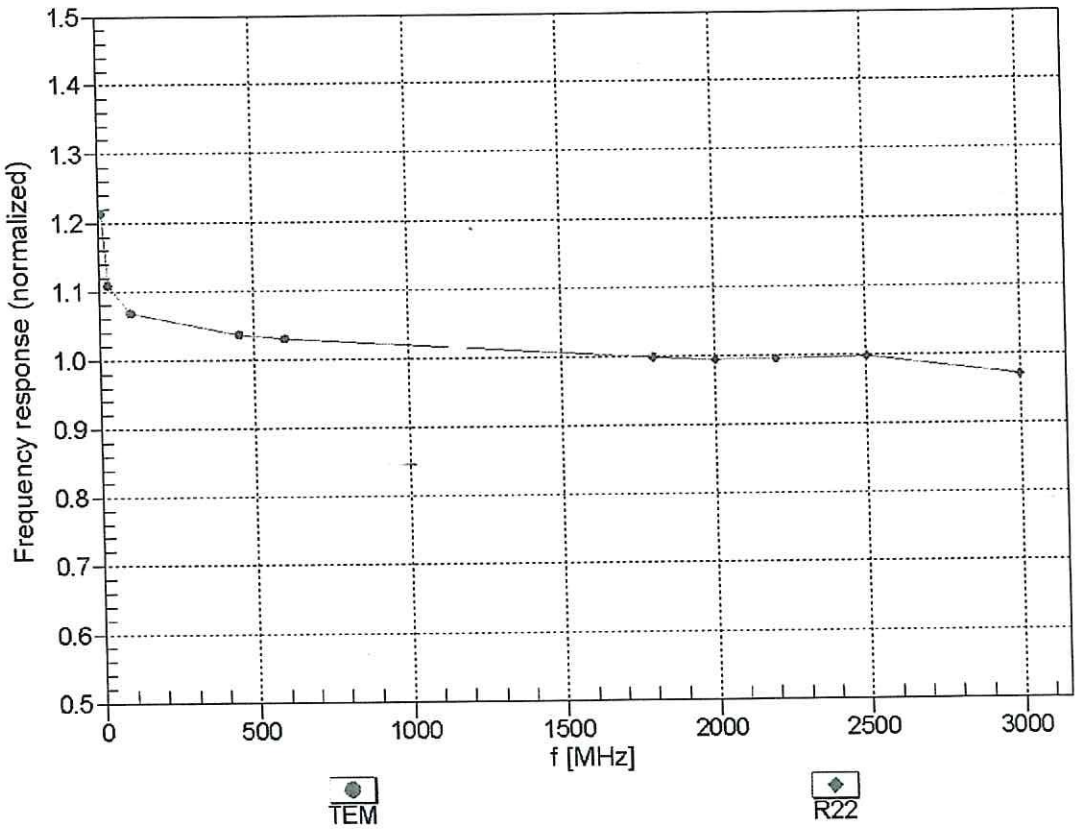
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
835	41.5	0.90	10.18	10.18	10.18	0.36	1.01	± 12.0 %
900	41.5	0.97	9.77	9.77	9.77	0.25	1.23	± 12.0 %
1750	40.1	1.37	8.33	8.33	8.33	0.27	0.80	± 12.0 %
1950	40.0	1.40	7.77	7.77	7.77	0.34	0.80	± 12.0 %
2450	39.2	1.80	7.26	7.26	7.26	0.38	0.80	± 12.0 %
5200	36.0	4.66	5.11	5.11	5.11	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.40	4.40	4.40	0.45	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

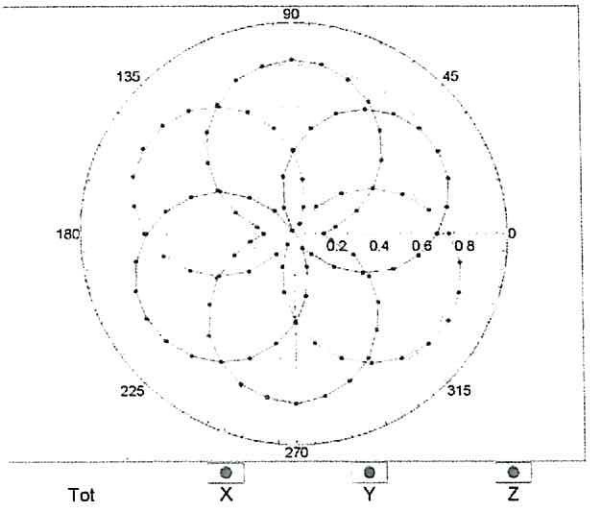
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



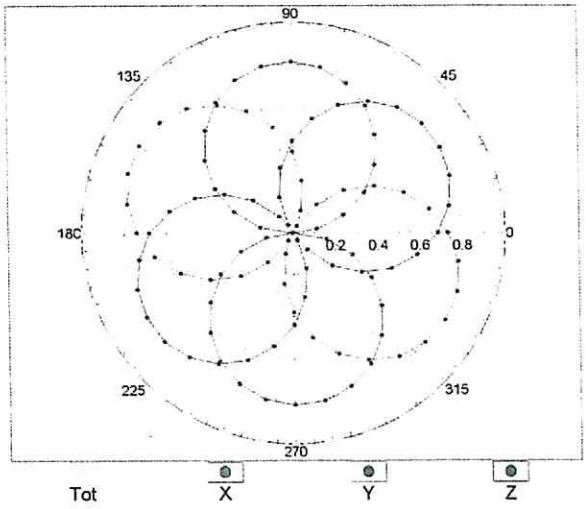
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

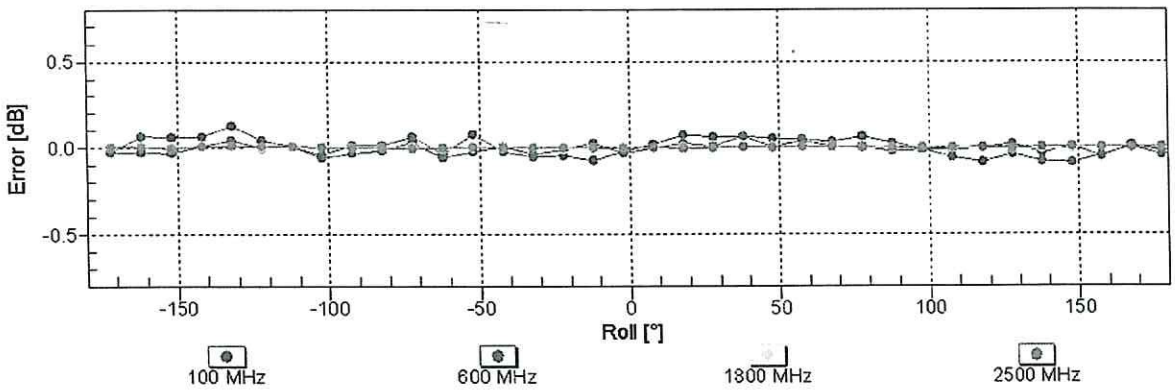
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

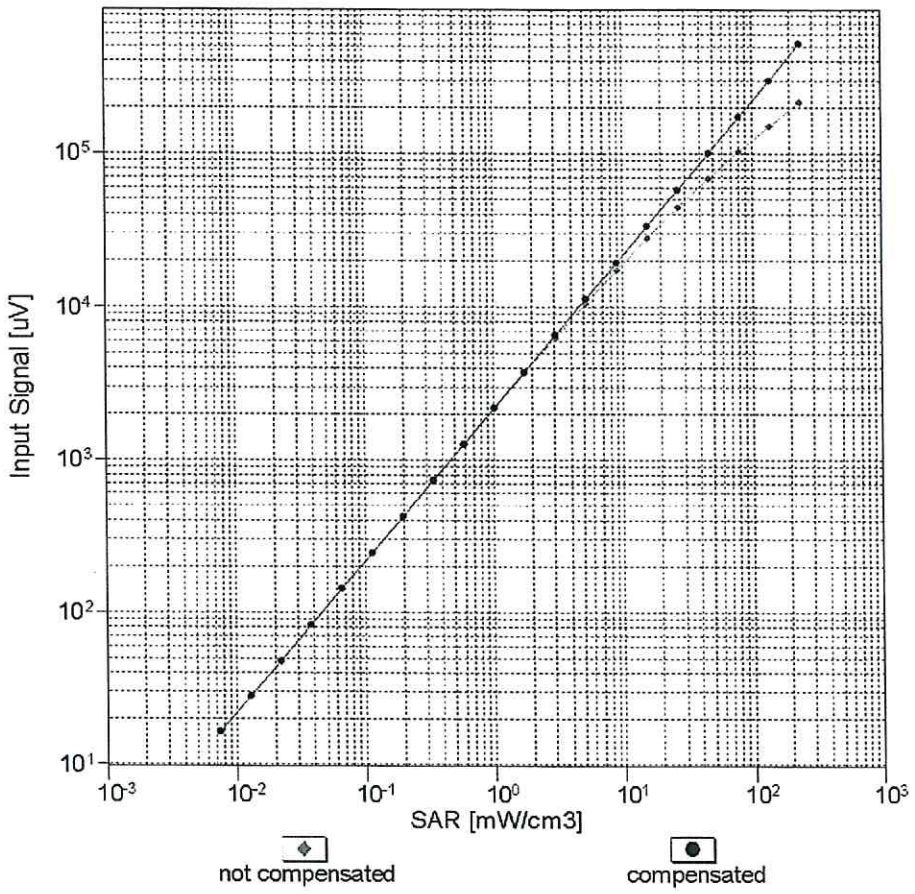


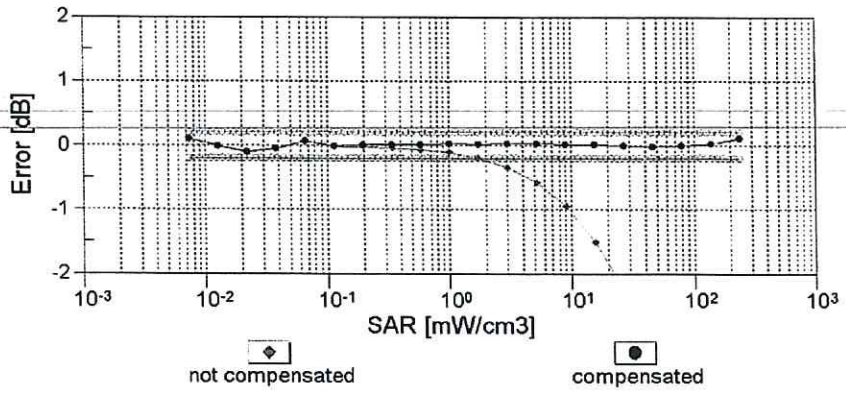


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f_{eval}= 1900 MHz)

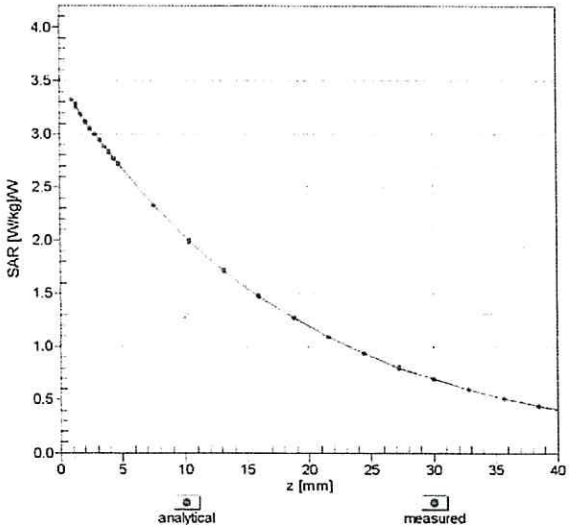




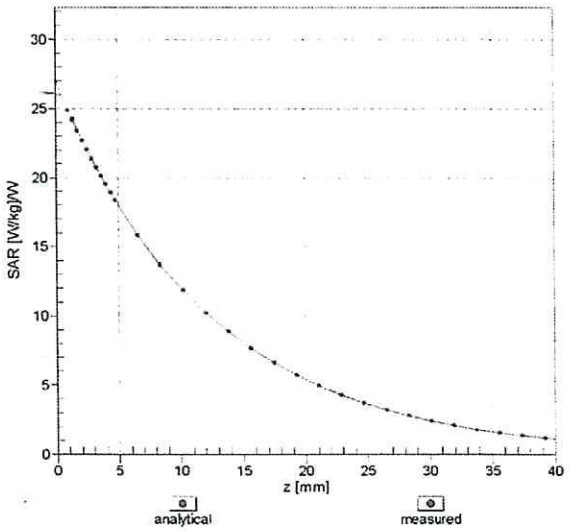
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

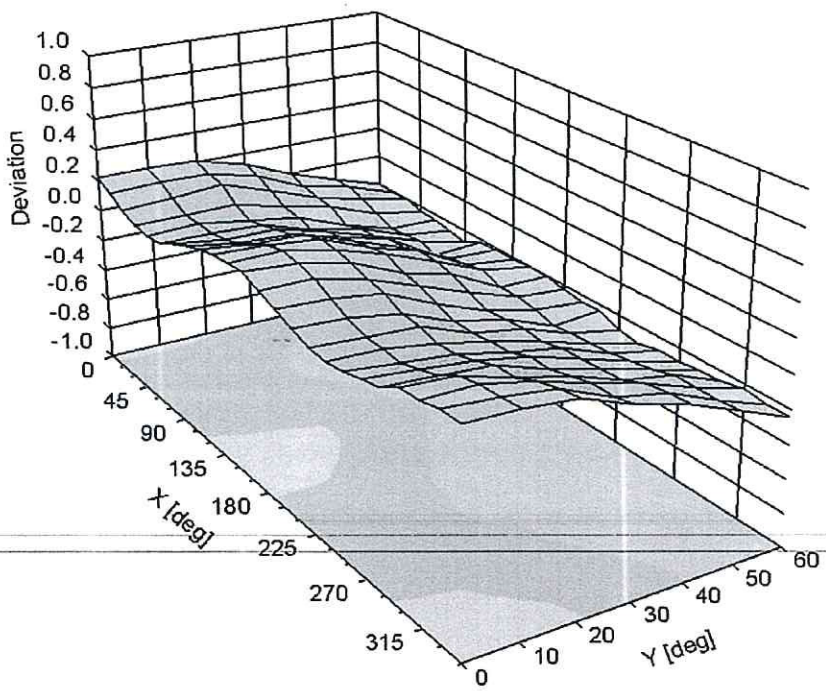


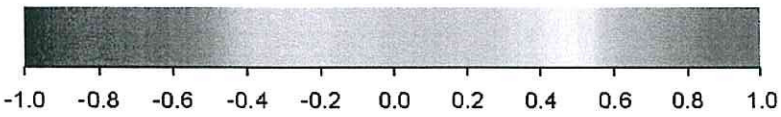
f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3886

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	37.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm