SAR EVALUATION REPORT

Test Report No.	**OT-182-RWD-027**
AGR.No.	**A17DA-067**
Applicant	**Technology Solutions (UK) Ltd** **Suite A, Loughborough Technology Centre Epinal Way,** **Leicestershire, Loughborough LE11 3GE United Kingdom**
Model Name	**2128-AS0**
DUT Type	**2128 Bluetooth Handheld RFID Reader**
Application Type	**Certification**
FCC ID	**S6J2128**
Date of Report	**Feb 19, 2018**
Date of Test	**Dec 28, 2017 ~ Jan 19, 2018**
Test Laboratory	**ONETECH** **43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea**
Procedures	**KDB 447498, KDB 865664** **IEEE 1528-2013** **ANSI/IEEE C95.1, C95.3** **FCC CFR §2.1093** **RSS-102 Issue 5**
Max SAR(10g)	**0.956 W/kg**
Test Opinion	**Satisfied to FCC requirements**

Report Author	**Jungwook Kim**	____________	**Feb 19, 2018**
Test Engineer	**Youngyong Kim**	____________	**Feb 19, 2018**

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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TABLE OF CONTENTS

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
OT-182-RWD-027	Feb 19, 2018	Initial Issue	All

DOCUMENT HISTORY

Revision No.	Issued Date	Revisions	Effect Section
Original	Feb 19, 2018	Initial Issue	-
Revision 01	Feb 19, 2018	1. Bluetooth Limb SAR 2. RFID + Bluetooth Summery limb SAR	10. SAR TEST RESULTS

1. DUT INFORMATION

DUT Description	2128 Bluetooth Handheld RFID Reader
Model Name	2128-AS0
Multiple Model Name	1190-A-EPL-CASE, IH21-EPL-D75E, 2128-CRD-01-KIT, IH21-CB-1, 1192-A-EPL-CASE, IH21-EPL-CT50
Serial Number	N/A
Mode of Operation	RFID, Bluetooth
TX Frequency Range	RFID : 902.75 MHz ~ 927.25 MHz Bluetooth : 2 402 MHz ~ 2 480 MHz
Maximum Average Conducted Power	RFID : 25.32 dBm (Max. Allowed target power : 26 ± 2 dBm) Bluetooth : 5.70 dBm (Max. Allowed target power : 5 ± 1 dBm)
Summary of peak SAR	RFID : 902.75 MHz : 0.956 W/kg Bluetooth : 2 402 MHz : 0.001 W/kg
Body Worn Accessory	N/A
Antenna Type & Gain	RFID Antenna Type : Right-Hand Circular Polarization Antenna 920 MHz : 3.0 dBic Bluetooth Antenna Type : Chip Antenna : 1 dBi
Antenna Operation	One Antenna Transmit Only for each band
Battery	DC 3.7 V, 2 400 mAh

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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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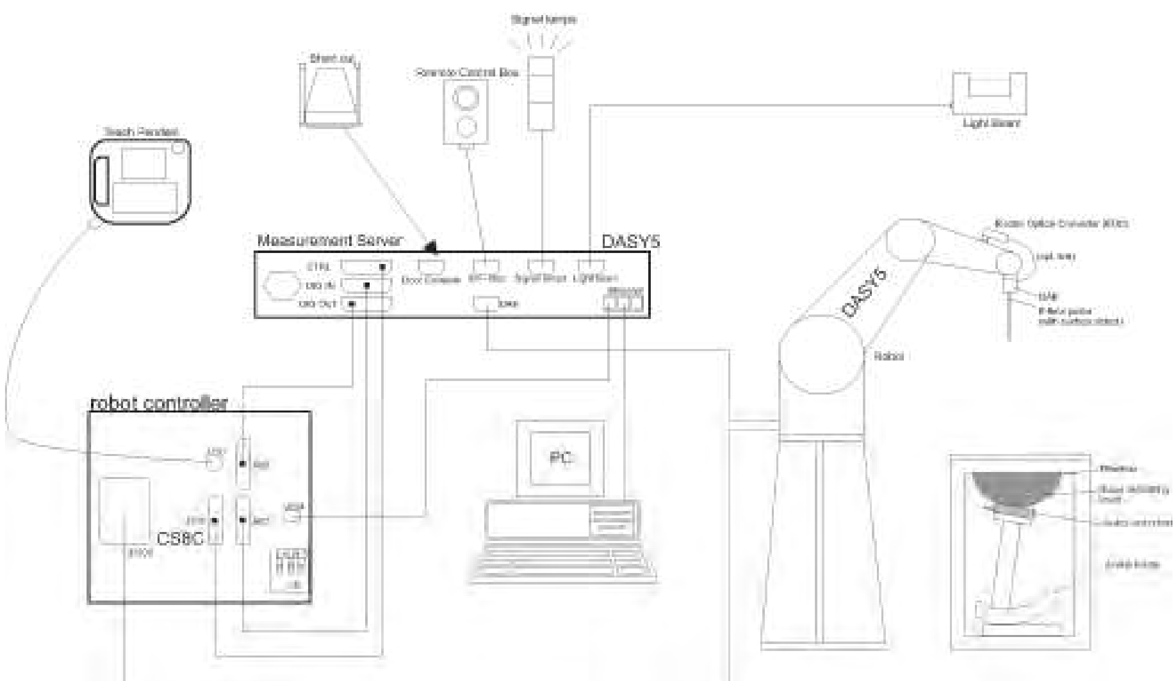
3. SAR MEASUREMENT SETUP

- 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.



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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)

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 E-Field Probe(ES3DV3)

ES3DV3
Isotropic E-Field Probe for Dosimetric Measurements

	Symmetrical design with triangular core Interleaved sensors 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 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.2 dB in TSL (rotation around probe axis) ± 0.3 dB in TSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

3.4 ELI Phantom

ELI Phantom

 	The ELI phantom is used 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 and higher has the same shell geometry and is manufactured from the same material as ELI V4.0, but has reinforced top structure. ELI V6.0, released in August 2014, has the same shell geometry as ELI V4.0 but offers increased longterm stability.
Material	Vinyl ester, fiberglass reinforced (VE-GF)
Liquid Compatibility	The phantom shell is compatible with SPEAG tissue simulating liquids (sugar and oil based). Use of other liquids may render the phantom warranty void (see note or consult SPEAG support).
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Support	DASY6: standard-size platform slot DASY52 stand-alone: SPEAG standard phantom table
Accessories	Mounting Device and Adaptors

3.5 Mounting Device

Mounting Device for Hand-Held Transmitters

MD4HHTV5 - Mounting Device for Hand-Held Transmitters

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

Material: Polyoxymethylene (POM)

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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	[illegible]	Probe Calibration	6.30	6.30	N	1.00	1.00	1.00	6.30	6.30	∞
2	[illegible]	Isotropy	1.87	1.87	R	$\sqrt{3}$	1.00	1.00	1.08	1.08	∞
3	[illegible]	Linearity	0.60	0.60	R	$\sqrt{3}$	1.00	1.00	0.35	0.35	∞
4	[illegible]	Probe modulation response	2.40	2.40	R	$\sqrt{3}$	1.00	1.00	1.39	1.39	∞
6	[illegible]	Detection Limits	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
5	[illegible]	Boundary effect	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
7	[illegible]	Readout Electronics	0.30	0.30	N	1.00	1.00	1.00	0.30	0.30	∞
8	[illegible]	Response Time	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
9	[illegible]	Integration Time	2.60	2.60	R	$\sqrt{3}$	1.00	1.00	1.50	1.50	∞
10	[illegible]	RF ambient conditions–noise	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
11	[illegible]	RF ambient conditions–reflections	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
12	[illegible]	Probe positioner mech. Restrictions	0.40	0.40	R	$\sqrt{3}$	1.00	1.00	0.23	0.23	∞
13	[illegible]	Probe positioning with respect to phantom shell	2.90	2.90	R	$\sqrt{3}$	1.00	1.00	1.67	1.67	∞
14	[illegible]	Post-processing(for max. SAR evaluation)	2.00	2.00	R	$\sqrt{3}$	1.00	1.00	1.15	1.15	∞
15	[illegible]	Device Holder Uncertainty	3.60	3.60	N	1.00	1.00	1.00	3.60	3.60	5.00
16	[illegible]	Test sample positioning	0.92	0.94	N	1.00	1.00	1.00	0.92	0.94	9.00
17	[illegible]	Power scaling	0.00	0.00	R	$\sqrt{3}$	1.00	1.00	0.00	0.00	∞
18	[illegible]	Drift of output power(measured SAR drift)	5.00	5.00	R	$\sqrt{3}$	1.00	1.00	2.89	2.89	∞
19	[illegible]	Phantom Uncertainty	6.10	6.10	R	$\sqrt{3}$	1.00	1.00	3.52	3.52	∞
20	[illegible]	Algorithm for correcting SAR for deviations in permittivity and conductivity	1.90	1.90	N	1.00	1.00	0.84	1.90	1.58	∞
21	[illegible]	Liquid Conductivity (meas.)	1.39	1.26	N	1.00	0.78	0.71	1.08	0.89	5.00
22	[illegible]	Liquid Permittivity (meas.)	0.34	0.38	N	1.00	0.23	0.26	0.08	0.10	5.00
23	[illegible]	Liquid conductivity(temperature uncertainty)	1.87	1.71	R	$\sqrt{3}$	0.78	0.71	0.84	0.70	∞
24	[illegible]	Liquid permittivity(temperature uncertainty)	0.11	0.13	R	$\sqrt{3}$	0.23	0.26	0.01	0.02	∞
		Uc(sar) Combined standard uncertainty (%)							9.82	9.73	275
		Extended uncertainty *U*(%)							19.63	19.47	

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	[illegible]	Probe Calibration	6.30	6.30	N	1.00	1.00	1.00	6.30	6.30	∞
2	[illegible]	Isotropy	1.87	1.87	R	$\sqrt{3}$	1.00	1.00	1.08	1.08	∞
3	[illegible]	Linearity	0.60	0.60	R	$\sqrt{3}$	1.00	1.00	0.35	0.35	∞
4	[illegible]	Probe modulation response	2.40	2.40	R	$\sqrt{3}$	1.00	1.00	1.39	1.39	∞
6	[illegible]	Detection Limits	1.00	1.00	R	$\sqrt{3}$	1.00	1.00	0.58	0.58	∞
5	[illegible]	Boundary effect	2.00	2.00	R	$\sqrt{3}$	1.00	1.00	1.15	1.15	∞
7	[illegible]	Readout Electronics	0.30	0.30	N	1.00	1.00	1.00	0.30	0.30	∞
8	[illegible]	Response Time	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
9	[illegible]	Integration Time	2.60	2.60	R	$\sqrt{3}$	1.00	1.00	1.50	1.50	∞
10	[illegible]	RF ambient conditions–noise	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
11	[illegible]	RF ambient conditions–reflections	3.00	3.00	R	$\sqrt{3}$	1.00	1.00	1.73	1.73	∞
12	[illegible]	Probe positioner mech. Restrictions	0.80	0.80	R	$\sqrt{3}$	1.00	1.00	0.46	0.46	∞
13	[illegible]	Probe positioning with respect to phantom shell	6.70	6.70	R	$\sqrt{3}$	1.00	1.00	3.87	3.87	∞
14	[illegible]	Post-processing(for max. SAR evaluation)	4.00	4.00	R	$\sqrt{3}$	1.00	1.00	2.31	2.31	∞
15	[illegible]	Device Holder Uncertainty	3.60	3.60	N	1.00	1.00	1.00	3.60	3.60	5.00
16	[illegible]	Test sample positioning	1.81	1.42	N	1.00	1.00	1.00	1.81	1.42	9.00
17	[illegible]	Power scaling	0.00	0.00	R	$\sqrt{3}$	1.00	1.00	0.00	0.00	∞
18	[illegible]	Drift of output power(measured SAR drift)	5.00	5.00	R	$\sqrt{3}$	1.00	1.00	2.89	2.89	∞
19	[illegible]	Phantom Uncertainty	6.60	6.60	R	$\sqrt{3}$	1.00	1.00	3.81	3.81	∞
20	[illegible]	Algorithm for correcting SAR for deviations in permittivity and conductivity	1.90	1.90	N	1.00	1.00	0.84	1.90	1.60	∞
21	[illegible]	Liquid Conductivity (meas.)	1.29	1.18	N	1.00	0.78	0.71	1.01	0.84	5.00
22	[illegible]	Liquid Permittivity (meas.)	0.59	0.67	N	1.00	0.23	0.26	0.14	0.17	5.00
23	[illegible]	Liquid conductivity(temperature uncertainty)	0.95	0.87	R	$\sqrt{3}$	0.78	0.71	0.43	0.36	∞
24	[illegible]	Liquid permittivity(temperature uncertainty)	0.05	0.06	R	$\sqrt{3}$	0.23	0.26	0.01	0.01	∞
/		*Uc(sar)* **Combined standard uncertainty (%)**							**10.84**	10.72	**396**
/		**Extended uncertainty** ***U*** **(%)**							**21.68**	21.44	

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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.

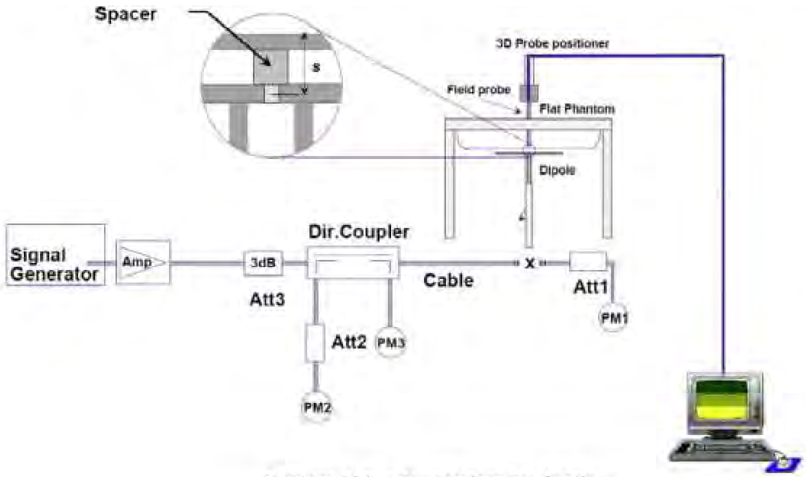
Human Exposure Limits

	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.

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 phan tom. 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.

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	306	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
835	Body	21.5	Permitivity	55.2	54.0	-2.17%	± 5	2017. 12. 28
			Conductivity	0.97	0.95	-2.06%	± 5	
2 450	Body	21.4	Permitivity	52.7	51.2	-2.87%	± 5	2018. 01. 19
			Conductivity	1.95	1.94	-0.71%	± 5	

6.4.2 Test Channel

Frequency (MHz)	Tissue Type	Liquid Temp.(℃)	Parameter	Target Value	Measured Value	Deviation	Limit (%)	Date
902.75	Body	21.5	Permitivity	55.0	53.3	-3.09%	± 5	2017. 12. 28
			Conductivity	1.05	1.02	-2.86%	± 5	
915.25	Body	21.5	Permitivity	55.0	53.2	-3.27%	± 5	2017. 12. 28
			Conductivity	1.06	1.03	-2.83%	± 5	
927.25	Body	21.5	Permitivity	55.0	53.0	-3.64%	± 5	2017. 12. 28
			Conductivity	1.07	1.04	-2.80%	± 5	
2 402	Body	21.4	Permitivity	52.8	51.3	-2.71%	± 5	2018. 01. 19
			Conductivity	1.89	1.87	-0.59%	± 5	
2 440	Body	21.4	Permitivity	52.7	51.2	-2.85%	± 5	2018. 01. 19
			Conductivity	1.94	1.92	-0.76%	± 5	
2 480	Body	21.4	Permitivity	52.7	51.1	-2.95%	± 5	2018. 01. 19
			Conductivity	1.99	1.97	-1.05%	± 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 10g	1W Normalized SAR 10g	1W Target SAR 10g	Deviation	Date
835	Body	21.6	21.5	250	4d172	3091	1.62	6.48	6.32	2.53%	2017. 12. 28
2 450	Body	21.6	21.4	250	3666	923	5.98	23.9	24	-0.33%	2018. 01. 19

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 prob e 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

<table>
<tr><th colspan="3"></th><th>$\leq$ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>$\leq$ 2 GHz: $\leq$ 15 mm
2 – 3 GHz: $\leq$ 12 mm</td><td>3 – 4 GHz: $\leq$ 12 mm
4 – 6 GHz: $\leq$ 10 mm</td></tr>
<tr><td colspan="2">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 $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>$\leq$ 2 GHz: $\leq$ 8 mm
2 – 3 GHz: $\leq$ 5 mm*</td><td>3 – 4 GHz: $\leq$ 5 mm*
4 – 6 GHz: $\leq$ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>$\leq$ 5 mm</td><td>3 – 4 GHz: $\leq$ 4 mm
4 – 5 GHz: $\leq$ 3 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>$\leq$ 4 mm</td><td>3 – 4 GHz: $\leq$ 3 mm
4 – 5 GHz: $\leq$ 2.5 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>$\geq$ 30 mm</td><td>3 – 4 GHz: $\geq$ 28 mm
4 – 5 GHz: $\geq$ 25 mm
5 – 6 GHz: $\geq$ 22 mm</td></tr>
<tr><td colspan="5">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 <u>*reported*</u> SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 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.</td></tr>
</table>

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8. TEST EQUIPMENT LIST

Manufacturer	Model	Serial No.	CaL.Due	Used
STAUBLI	TX90XL	F17/59RBA1/A/01	N/A	V
STAUBLI	CS8C Speag TX90	F17/59RBA1/C/01	N/A	V
SPEAG	SE UMS 028 BB	1544	N/A	V
STAUBLI	SP1	D 221 426 06B	N/A	V
SPEAG	SE UKS 030 AA	1040	N/A	V
SPEAG	Twin Phantom	TP-1381	N/A	
SPEAG	ELI4 Phantom V8.0	TP-2056	N/A	V
SPEAG	Mounting Device	N/A	N/A	V
SPEAG	Mounting Device	SM LH1 001 AC	N/A	
Agilent	85033E	N/A	N/A	V
SPEAG	SD 000 D04 BJ	444	2018-11-22	
SPEAG	SD 000 D03 AA	383	2018-03-15	
SPEAG	SD 000 D04 BM	663	2018-06-13	V
SPEAG	EX3DV4	3666	2018-05-29	
SPEAG	EX3DV4	3716	2018-11-27	V
SPEAG	ES3DV3	3091	2018-01-30	V
SPEAG	D835V2	4d172	2018-07-19	V
SPEAG	D1750V2	1122	2018-07-20	
SPEAG	D1950V2	1156	2018-07-27	
SPEAG	D2450V2	923	2019-11-21	V
SPEAG	D5GHzV2	1094	2019-11-22	
Speag	DAK-3.5 Short	1140	2018-11-21	V
HP	8665B	3744A01349	2018-09-11	V
EMPOWER	BBS3Q7ECK-2001	1045D/C0536	2018-09-11	V
SUNGSAN	M1001	1	2018-09-11	
SUNGSAN	SMA104	1	2018-09-11	
HP	778D	16500	2018-09-12	V
HP	11692D	1212A05057	2018-09-12	
Agilent	E4419B	MY45100284	2018-09-12	V
Agilent	E4419B	MY45100286	2018-09-12	V
HP	8481H	3318A17600	2018-09-14	V
HP	8481A	US37290447	2018-09-14	V
HP	8481A	3318A89373	2018-09-14	V
WAINWRIGHT	WLJS1500-6EF	1	2018-09-12	
WAINWRIGHT	WLJS3000-6EF	1	2018-09-12	
Agilent	E8357A	US41070399	2018-09-11	V
HP	8564E	3650A00756	2018-09-12	V
LKM Electronic GmbH	DTM3000-Spezial	3247	2018-09-14	V
CAS	TE-201	14011777-1	2018-09-14	V
Bird	50-6A-MFN-30	N/A	2018-09-12	V
ROHDE&SCHWARZ	E5515C	MY48367171	2018-06-08	
ROHDE&SCHWARZ	CMU200	106222	2018-09-12	
ROHDE&SCHWARZ	CMW500	102332	2018-06-20	
DIGITAL	DRP-305DN	4030195	2018-09-01	

9. RF CONDUCTED POWER

9.1 RFID 900

Mode	Freq. (MHz)	CH	Conducted Power (dBm)	Tolerance (dBm)
RFID 900	902.75	1	25.32	26 ± 2.0
	915.25	2	25.25	
	927.25	3	24.30	

9.2 Bluetooth

BDR

Mode	Freq. (MHz)	CH	DH1	DH3	DH5	Tolerance (dBm)
BDR (1M)	2 402	0	4.59	4.60	4.58	5 ± 1.0
	2 441	39	4.89	4.88	4.89	
	2 480	78	4.40	4.42	4.40	

EDR

Mode	Freq. (MHz)	CH	DH1	DH3	DH5	Tolerance (dBm)
EDR (2M)	2 402	0	5.42	5.45	5.40	5 ± 1.0
	2 441	39	5.69	5.70	5.64	
	2 480	78	5.01	5.07	5.05	
EDR (3M)	2 402	0	5.01	5.08	5.08	
	2 441	39	5.45	5.37	5.50	
	2 480	78	5.00	4.88	4.94	

LE

Mode	Freq. (MHz)	CH		Tolerance (dBm)
LE	2 402	0	1.94	3 ± 1.0
	2 440	19	2.97	
	2 480	39	3.65	

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10.SAR TEST RESULTS

< RFID 900 limb SAR >

Mode	Position	Freq. (MHz)	CH	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
RFID 900	Bottom	902.75	1	25.32	28.00	1.85	0.516	**0.956**
		915.25	2	25.25	28.00	1.88	0.435	0.819
		927.25	3	24.30	28.00	2.34	0.364	0.853
	Top	915.25	2	25.25	28.00	1.88	0.036	0.068
	Front	915.25	2	25.25	28.00	1.88	0.404	0.761
	Left	915.25	2	25.25	28.00	1.88	0.303	0.571
	Right	915.25	2	25.25	28.00	1.88	0.347	0.654

< Bluetooth limb SAR >

Mode	Position	Freq. (MHz)	CH	Conducted Power (dBm)	Max Allowed Power (dBm)	Scaling Factor	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
EDR 2 M	Back	2 402	0	5.45	6.00	1.14	0.001	**0.001**
		2 441	39	5.70	6.00	1.07	0.000	0.000
		2 480	78	5.07	6.00	1.24	0.000	0.000
	Top	2 441	39	5.70	6.00	1.07	0.000	0.000
	Bottom	2 441	39	5.70	6.00	1.07	0.000	0.000
	Left	2 441	39	5.70	6.00	1.07	0.000	0.000
	Right	2 441	39	5.70	6.00	1.07	0.000	0.000

< RFID + Bluetooth Summery limb SAR >

Position	RFID	Bluetooth	RFID+Bluetooth Summery
Front	0.761	-	0.000
Back	-	0.001	0.001
Top	0.068	0.000	0.068
Bottom	0.956	0.000	**0.956**
Left	0.571	0.000	0.571
Right	0.654	0.000	0.654

Note:

- Apply limb standard because this product only use hand hold.

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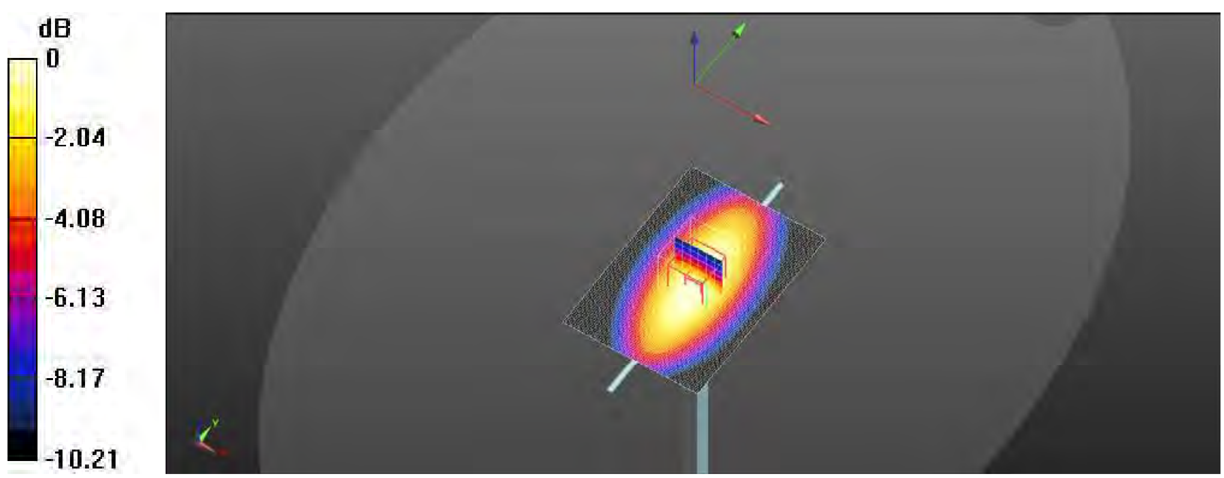
ANNEX A. SYSTEM VERIFICATION PLOTS

< 835 MHz Head / Date : Dec 28, 2017 >

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:4d172
Communication System: UID 0, CW (0); Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 835 MHz; σ = 0.95 S/m; εr = 53.996; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/835 MHz SPC/Area Scan (71x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 2.84 W/kg

Configuration/835 MHz SPC/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.14 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 3.62 W/kg
SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.62 W/kg
Maximum value of SAR (measured) = 2.86 W/kg



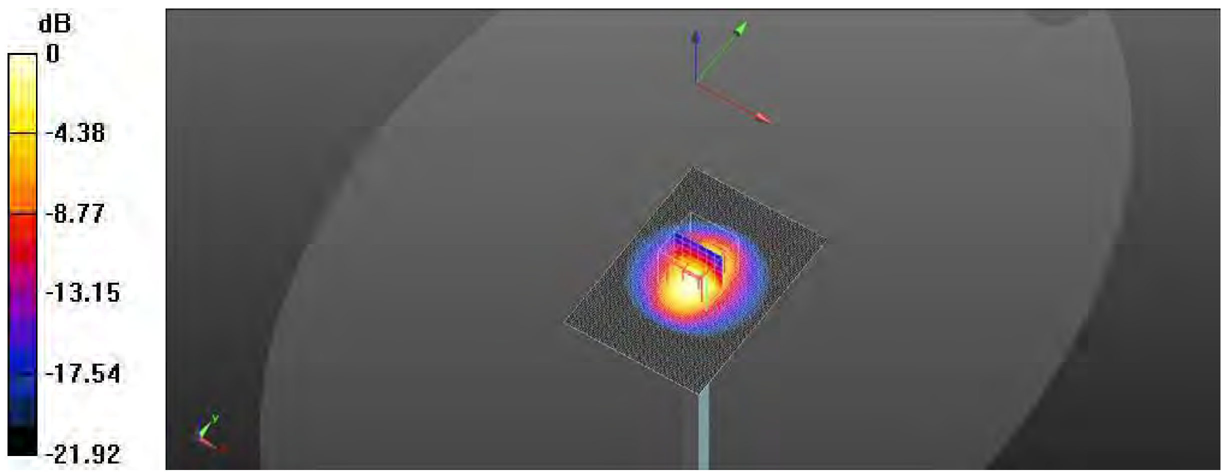
0 dB = 2.86 W/kg = 4.56 dBW/kg

< 2 450 MHz Head / Date : Jan 19, 2018 >

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:923
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz);
Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.936 S/m; εr = 51.187; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:
Probe: EX3DV4 - SN3716; ConvF(7.27, 7.27, 7.27); Calibrated: 11/27/2017;
Modulation Compensation:
Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 1.0, 31.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/2 450 MHz SPC/Area Scan (71x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 20.9 W/kg

Configuration/2 450 MHz SPC/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.3 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 25.9 W/kg
SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.76 W/kg
Maximum value of SAR (measured) = 20.6 W/kg



0 dB = 20.6 W/kg = 13.14 dBW/kg

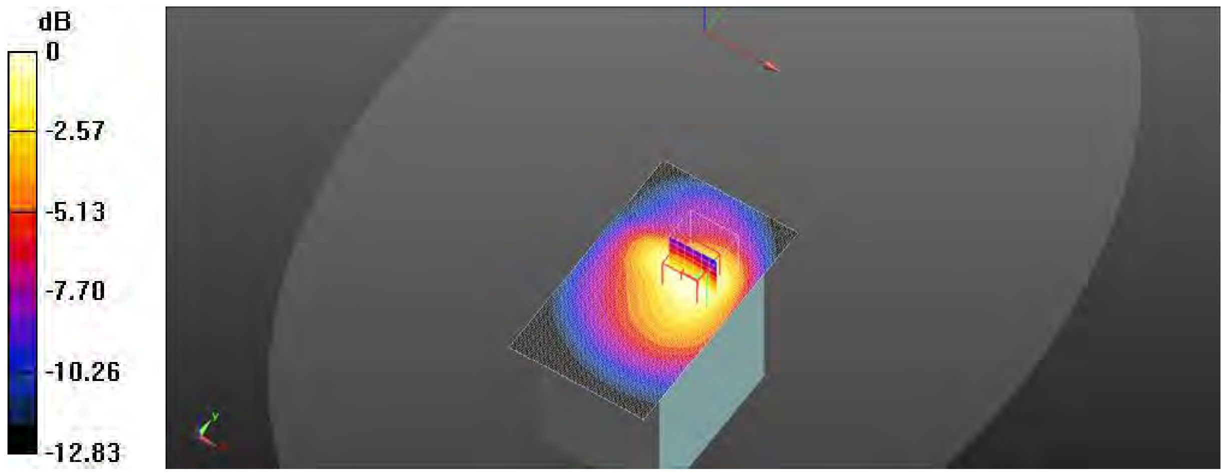
ANNEX B. SAR TEST PLOTS

< RFID_CH1_902.75 MHz Bottom / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 902.75 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 902.75 MHz; σ = 1.019 S/m; εr = 53.295; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 1_902.75 MHz_Bottom/Area Scan (71x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 1.02 W/kg

Configuration/RFID_ch 1_902.75 MHz_Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 30.07 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 1.10 W/kg
SAR(1 g) = 0.779 W/kg; SAR(10 g) = 0.516 W/kg
Maximum value of SAR (measured) = 0.901 W/kg



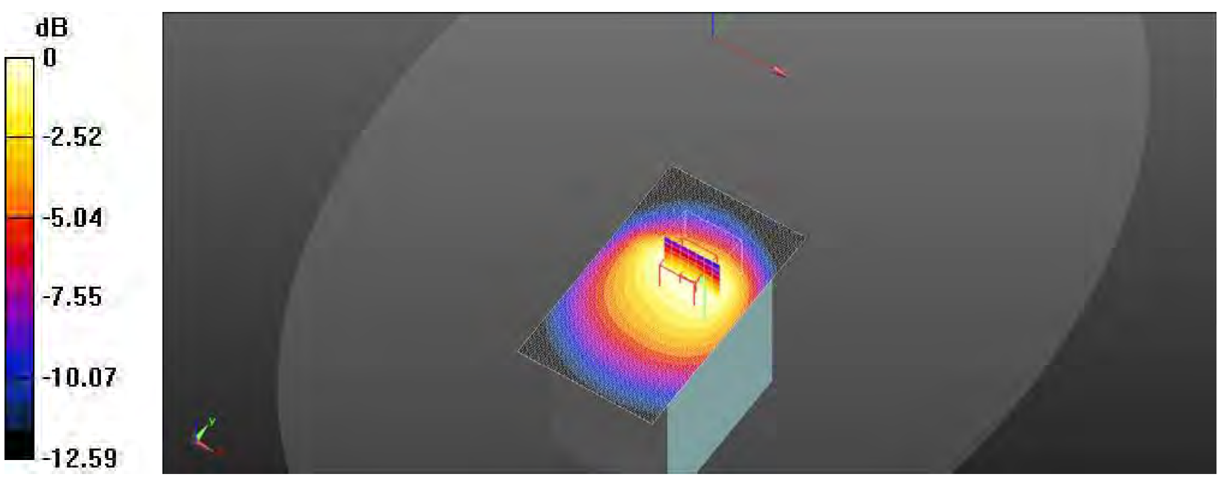
0 dB = 0.901 W/kg = -0.45 dBW/kg

< RFID_CH2_915.25 MHz Bottom / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 915.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 915.25 MHz; σ = 1.032 S/m; εr = 53.177; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 2_915.25 MHz_Bottom/Area Scan (71x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.753 W/kg

Configuration/RFID_ch 2_915.25 MHz_Bottom/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 26.52 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.862 W/kg
SAR(1 g) = 0.627 W/kg; SAR(10 g) = 0.435 W/kg
Maximum value of SAR (measured) = 0.710 W/kg



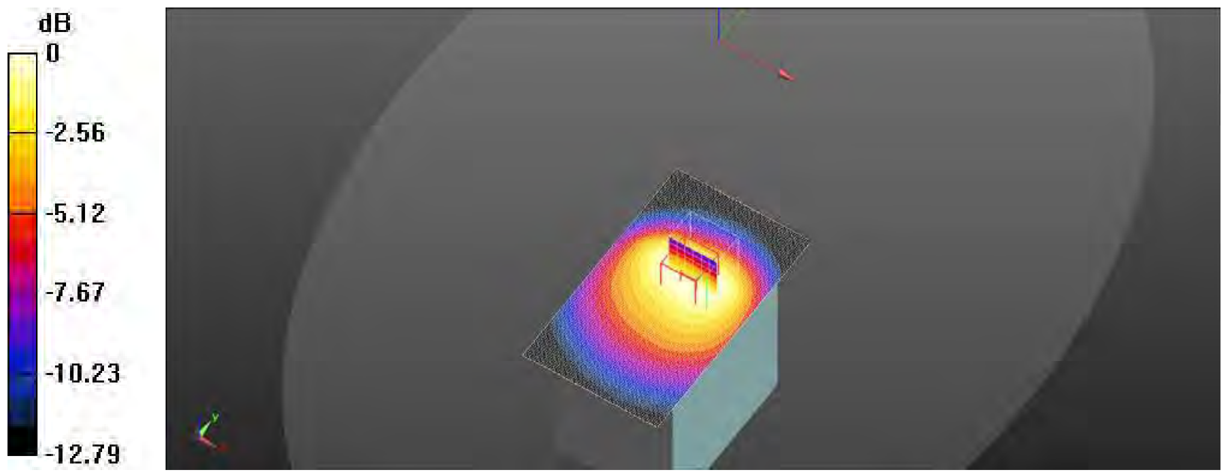
0 dB = 0.710 W/kg = -1.49 dBW/kg

< RFID_CH3_927.25 MHz Bottom / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 927.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 927.25 MHz; σ = 1.043 S/m; εr = 53.036; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 3_927.25 MHz_Bottom/Area Scan (71x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.667 W/kg

Configuration/RFID_ch 3_927.25 MHz_Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 23.29 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 0.751 W/kg
SAR(1 g) = 0.536 W/kg; SAR(10 g) = 0.364 W/kg
Maximum value of SAR (measured) = 0.614 W/kg



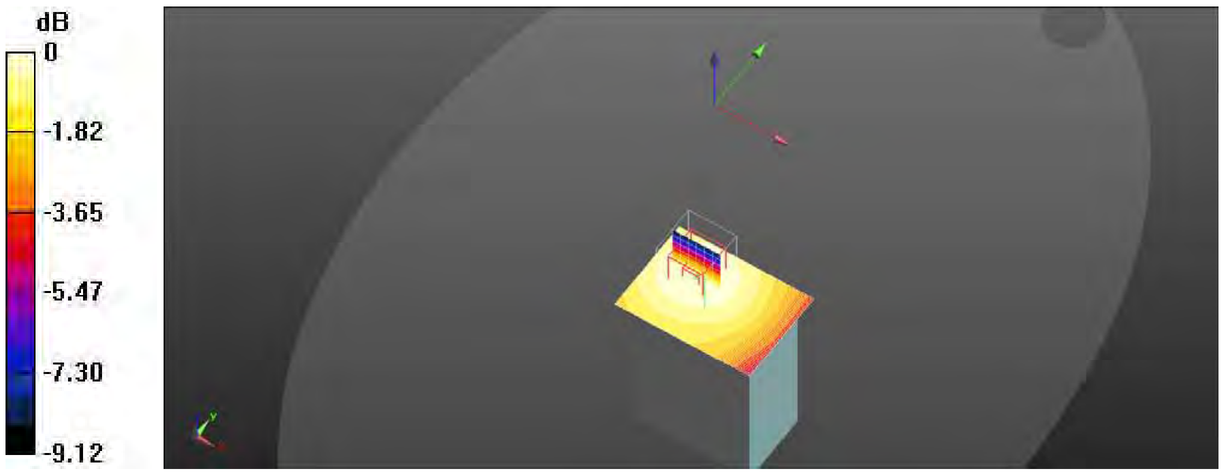
0 dB = 0.614 W/kg = -2.12 dBW/kg

< RFID_CH2_915.25 MHz Top / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 915.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 915.25 MHz; σ = 1.032 S/m; εr = 53.177; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 2_915.25 MHz_Top/Area Scan (71x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0556 W/kg

Configuration/RFID_ch 2_915.25 MHz_Top/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.822 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 0.0690 W/kg
SAR(1 g) = 0.050 W/kg; SAR(10 g) = 0.036 W/kg
Maximum value of SAR (measured) = 0.0559 W/kg



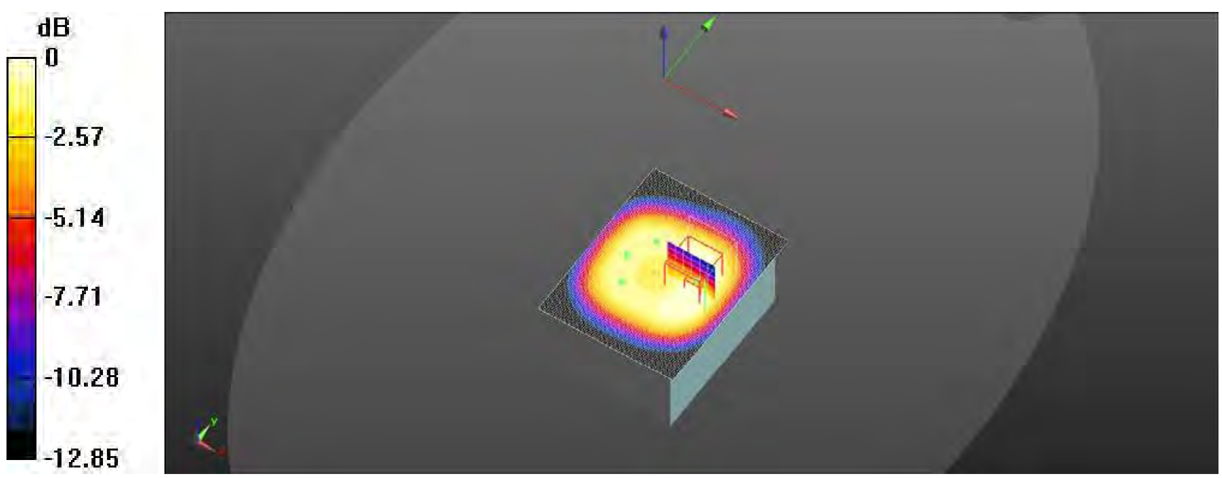
0 dB = 0.0559 W/kg = -12.53 dBW/kg

< RFID_CH2_915.25 MHz Front / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 915.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 915.25 MHz; σ = 1.032 S/m; εr = 53.177; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 2_915.25 MHz_Front/Area Scan (71x91x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.872 W/kg

Configuration/RFID_ch 2_915.25 MHz_Front/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 30.86 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 1.05 W/kg
SAR(1 g) = 0.639 W/kg; SAR(10 g) = 0.404 W/kg
Maximum value of SAR (measured) = 0.761 W/kg



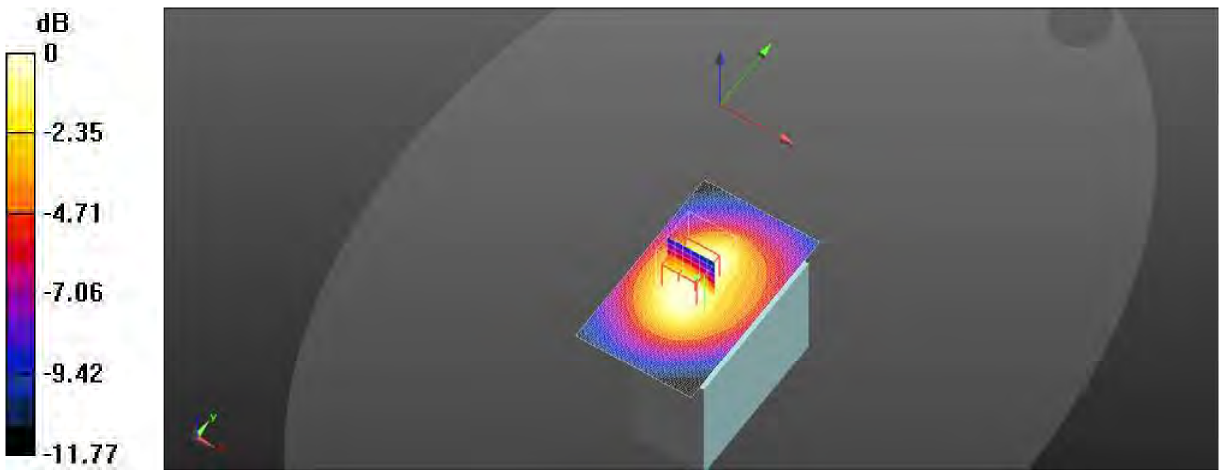
0 dB = 0.761 W/kg = -1.19 dBW/kg

< RFID_CH2_915.25 MHz Left / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 915.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 915.25 MHz; σ = 1.032 S/m; εr = 53.177; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 2_915.25 MHz_Left/Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.566 W/kg

Configuration/RFID_ch 2_915.25 MHz_Left/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 26.59 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 0.667 W/kg
SAR(1 g) = 0.456 W/kg; SAR(10 g) = 0.303 W/kg
Maximum value of SAR (measured) = 0.535 W/kg



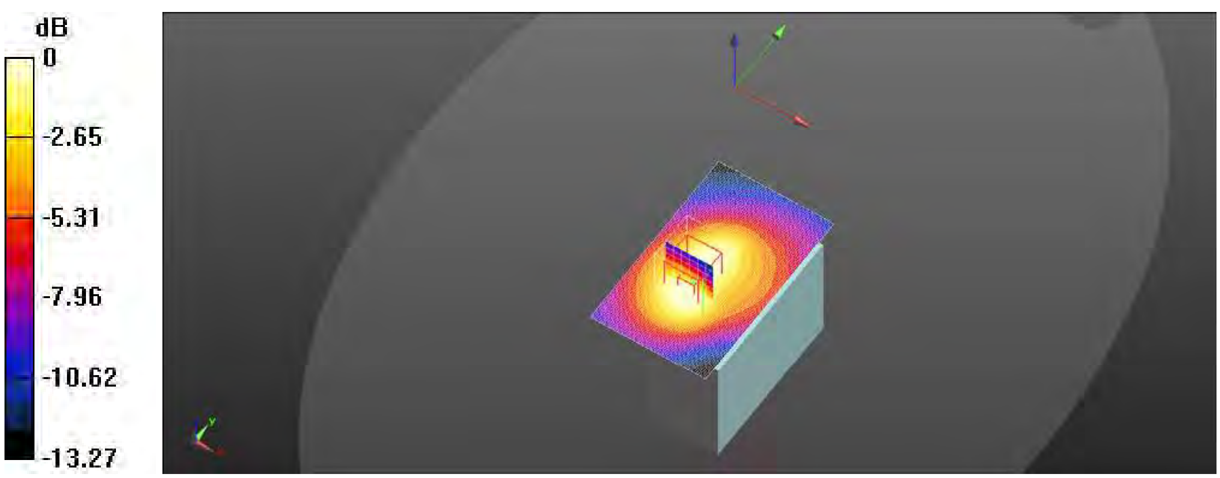
0 dB = 0.535 W/kg = -2.72 dBW/kg

< RFID_CH2_915.25 MHz Right / Date : Dec 28, 2017 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, RFID FCC (0); Communication System Band: RFID FCC; Frequency: 915.25 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 915.25 MHz; σ = 1.032 S/m; εr = 53.177; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: ES3DV3 - SN3091; ConvF(6.24, 6.24, 6.24); Calibrated: 1/30/2017; Modulation Compensation: Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/RFID_ch 2_915.25 MHz_Right/Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.676 W/kg

Configuration/RFID_ch 2_915.25 MHz_Right/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 29.62 V/m; Power Drift = 0.19 dB
Peak SAR (extrapolated) = 0.813 W/kg
SAR(1 g) = 0.538 W/kg; SAR(10 g) = 0.347 W/kg
Maximum value of SAR (measured) = 0.636 W/kg



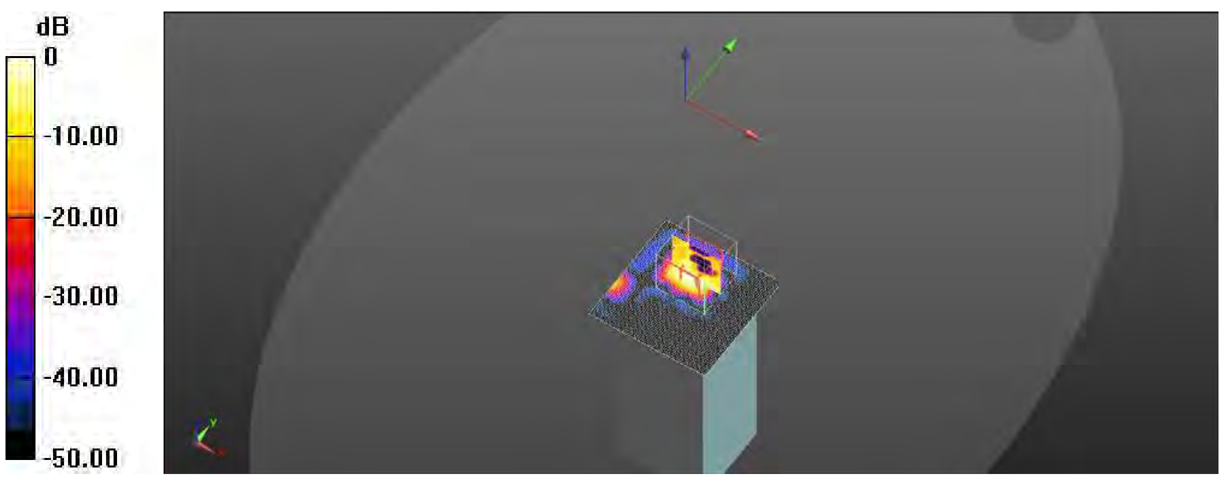
0 dB = 0.636 W/kg = -1.97 dBW/kg

< Bluetooth EDR 2 M_CH 0_DH 3_2 402 MHz Back / Date : Jan 19, 2018 >

DUT: 2128-AS0; Type: Sample; Serial: Not Specified
Communication System: UID 0, Bluetooth (0); Communication System Band: Bluetooth; Frequency: 2402 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 2402 MHz; σ = 1.877 S/m; εr = 51.329; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:Probe: EX3DV4 - SN3716; ConvF(7.27, 7.27, 7.27); Calibrated: 11/27/2017;
Modulation Compensation: Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 1.0, 31.0
Electronics: DAE4 Sn663; Calibrated: 7/19/2017
Phantom: ELI V8.0_20170913; Type: QD OVA 004 AA; Serial: 2056
DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Configuration/Bluetooth_EDR 2 M_ch 0_DH3_Back/Area Scan (61x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.00565 W/kg

Configuration/Bluetooth_EDR 2 M_ch 0_DH3_Back/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.513 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.00961 W/kg
SAR(1 g) = 0.00252 W/kg; SAR(10 g) = 0.000695 W/kg
Maximum value of SAR (measured) = 0.00587 W/kg



0 dB = 0.00587 W/kg = -22.31 dBW/kg

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

ANNEX C. PHOTOGRAPHS

< System Verification >

< 835 MHz >

< 2 450 MHz >

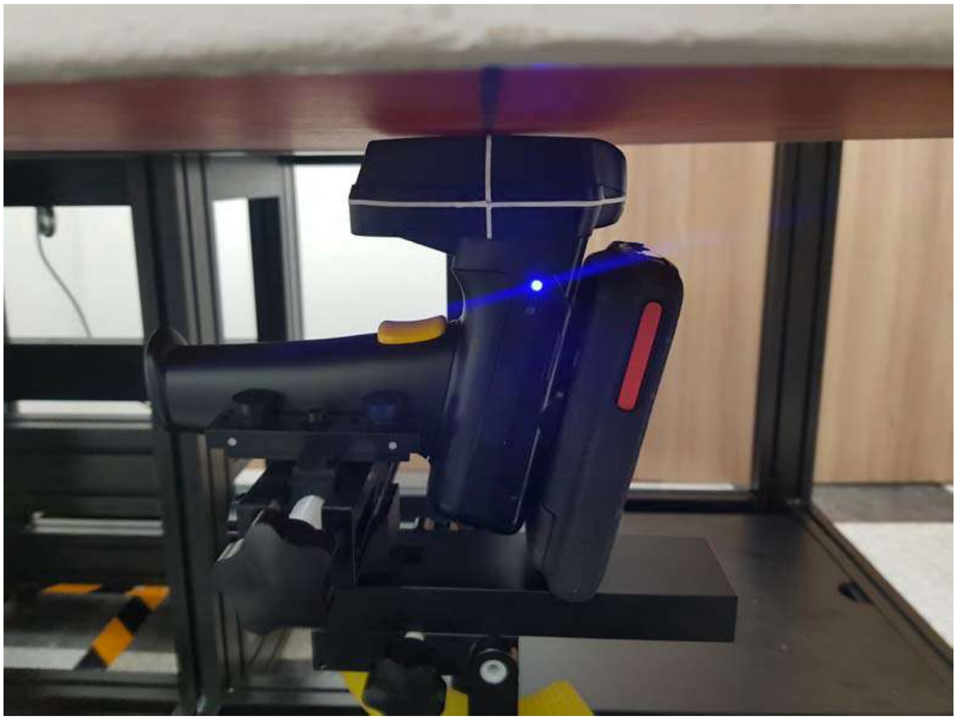
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

< Liquid Depth >

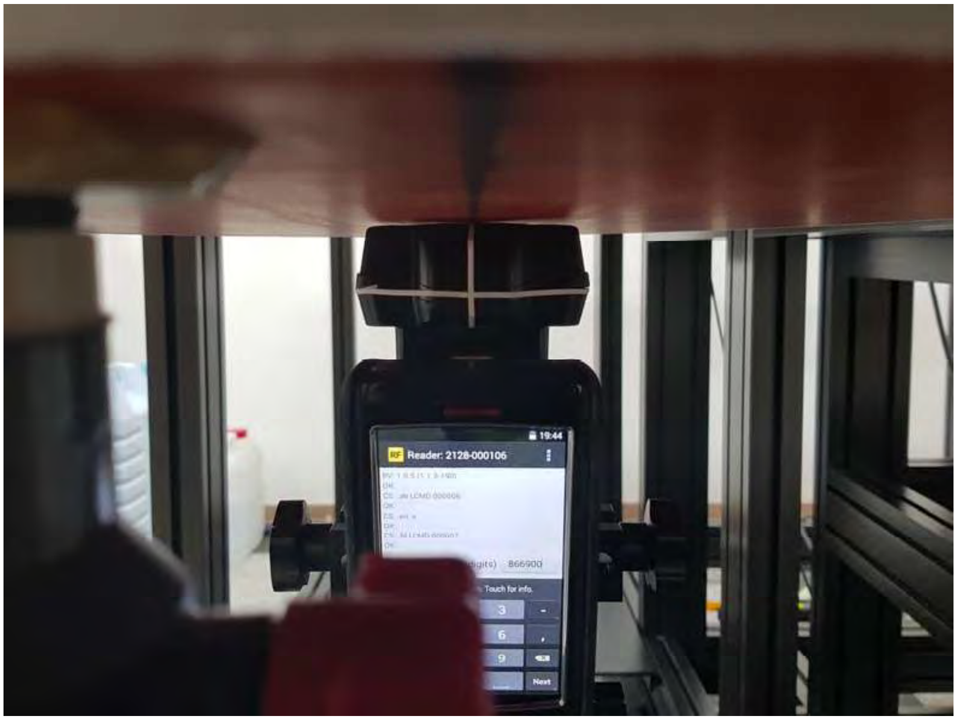
< 835 MHz >

< 2 450 MHz >

< Test position >

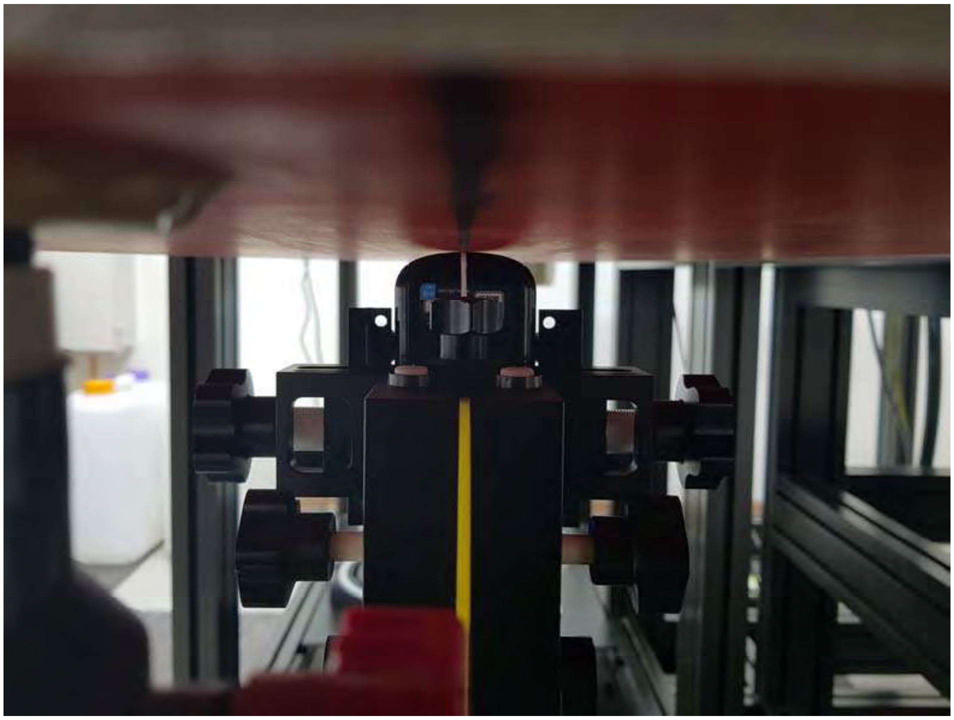


Front view (Front of DUT)



Side view (Front of DUT)

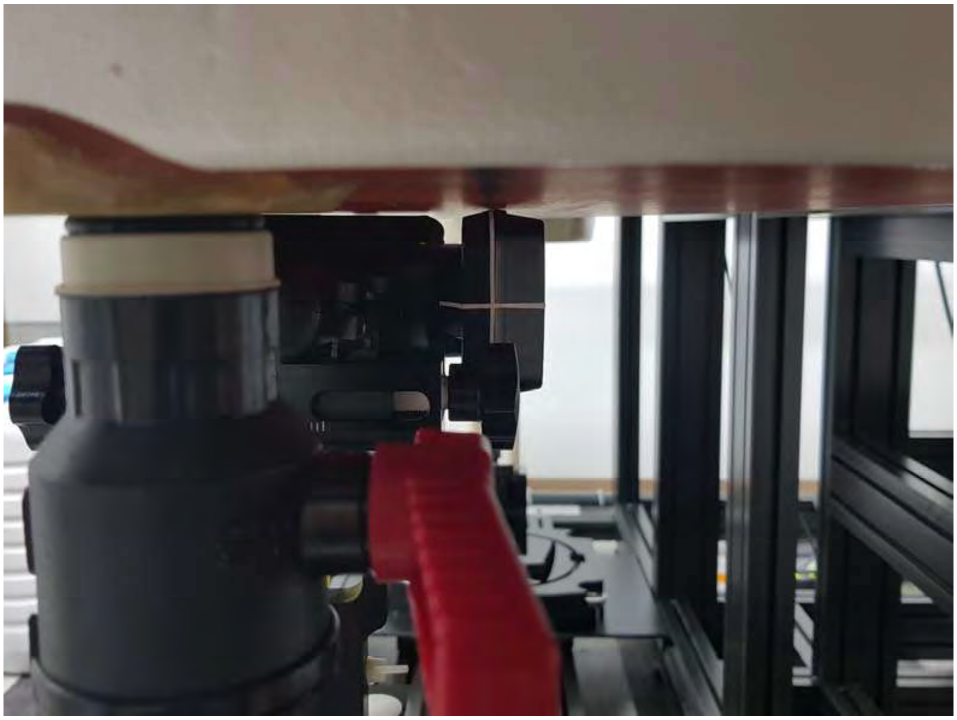
Front view (Back of DUT)



Side view (Back of DUT)

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

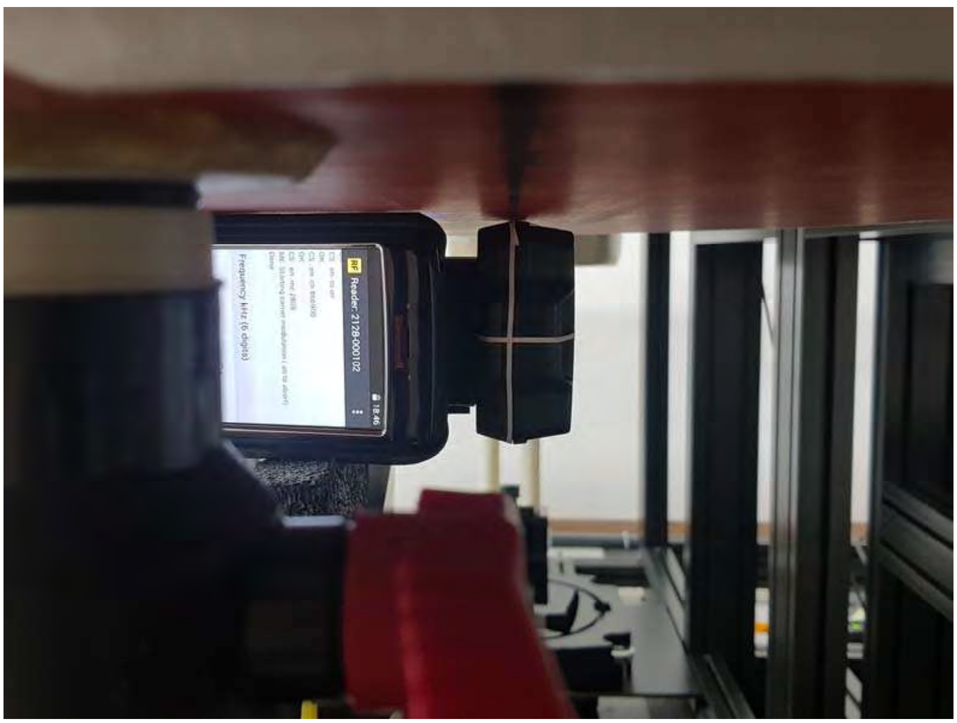
Front view (Left of DUT)



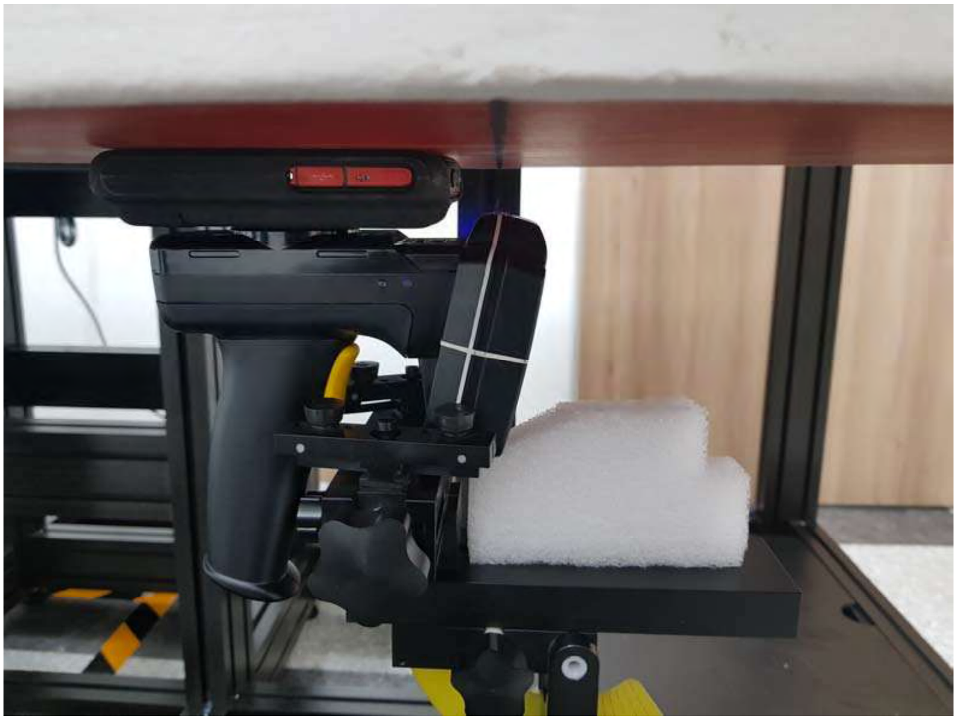
Side view (Left of DUT)

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

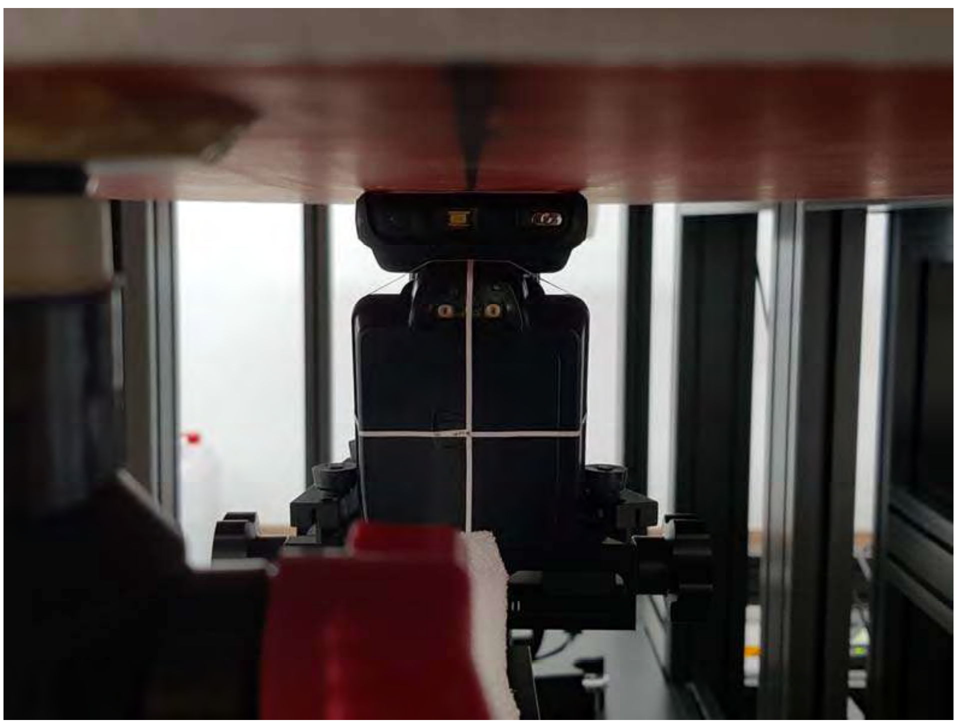
Front view (Right of DUT)



Side view (Right of DUT)

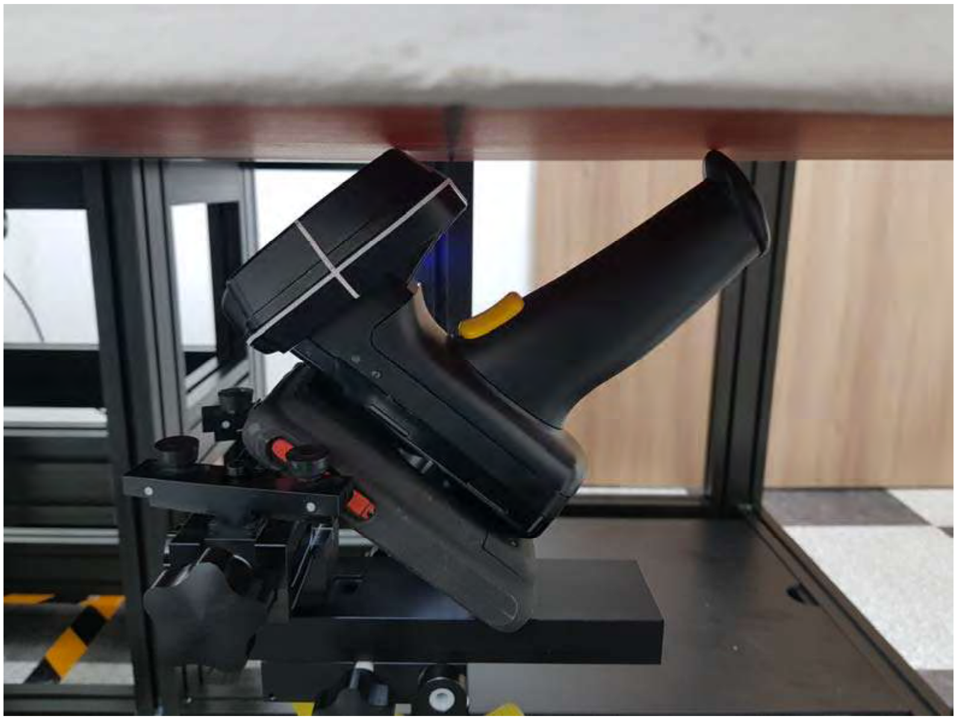


Front view (Top of DUT)

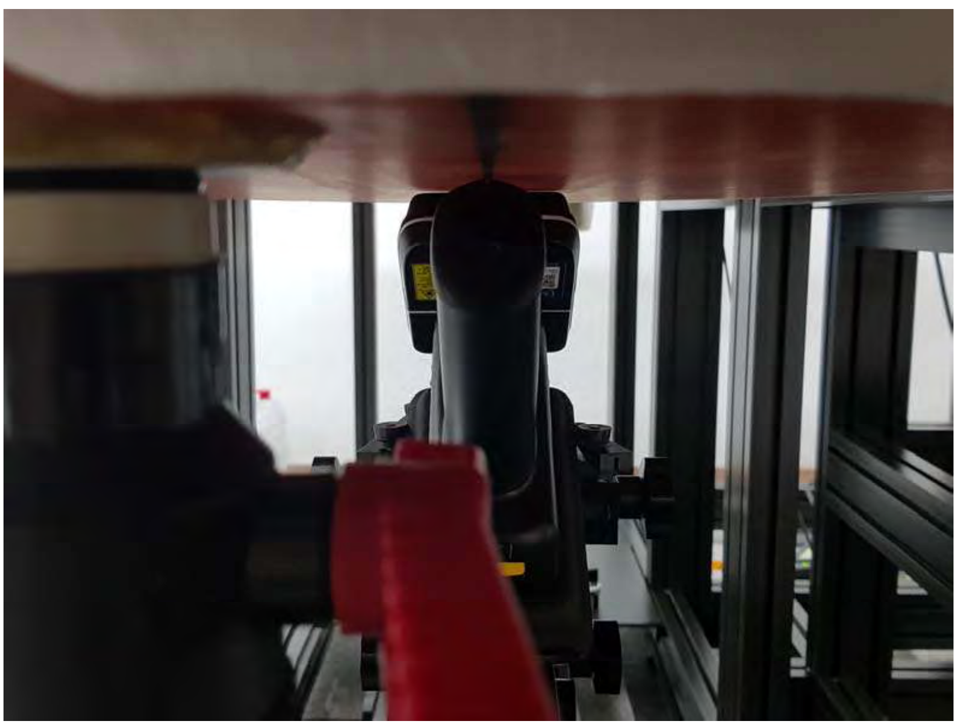


Side view (Top of DUT)

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



Front view (Bottom of DUT)



Side view (Bottom of DUT)

< DUT Photograph >

< Front >

< Back >

< Left >

< Right >

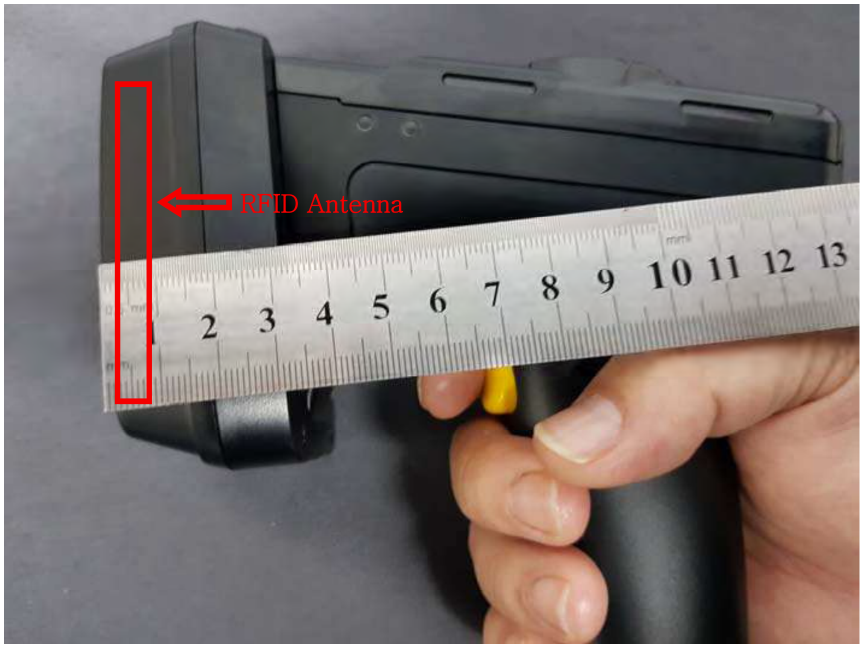
< Top >

< Bottom >

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

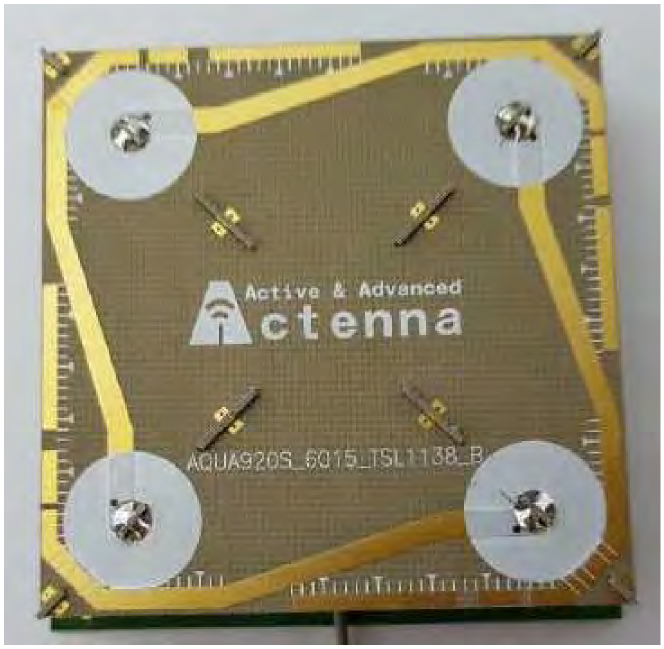
ANNEX D. ANTENNA INFORMATION

< Antenna location >



< Bluetooth Antenna >

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



< RFID Antenna >

< Bluetooth Antenna >

ANNEX E. PROBE AND DIPOLE CALIBRATION CERTIFICATES

< E-Field Probe : ES3DV3 – SN 3091 >

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

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

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

Accreditation No.: **SCS 0108**

Client **Onetech (Dymstec)** Certificate No: **ES3-3091_Jan17**

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3091

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: January 30, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: February 1, 2017

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

Certificate No: ES3-3091_Jan17 Page 1 of 11

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

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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 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).