TEST REPORT

KCTL Inc. 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea TEL: 82 70 5008 1021 FAX: 82 505 299 8311	Report No.: KCTL16-SFA0005 Page(1) / (56) Pages	KCTL http://www.kctl.co.kr

1. Applicant

Name:	E-TECH Co., Ltd.
Address:	655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

2. Manufacturer

Name:	E-TECH Co., Ltd.
Address:	655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

3. Sample Description:

Type of equipment:	FM Handheld Transceiver(VHF)
Model:	NEP100
4. Date of Receipt:	April 22, 2015
5. Date of Test:	April 22 ~ April 23, 2015
6. FCC ID:	R72NEP100
7. FCC Rule Part:	CFR §2.1093
8. Test method used:	IEEE 1528-2003, ANSI/IEEE C95.1, KDB Publication
9. Testing Environment:	Temperature:(22 ± 2) ℃

10. Test Results

Result:	Complied (Refer to page 20 ~ page 21)
Measurement Uncertainty:	Refer to test result

This result shown in this report refer only to the sample(s) tested unless otherwise stated.

Affirmation	Tested by Name: KIM DONG KYU	Technical Manager Name: CHOI, CHEON SIG

2016. 04. 26

KCTL Inc. Testing Laboratory

Contents

1. Applicant information

Applicant:	E-TECH Co., Ltd.
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Contact name:	Kim Jae-Hyeon

Manufacturer:	E-TECH Co., Ltd.
Address:	655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

2. Laboratory information

Address

KCTL Inc.

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea

TEL: 82 70 5008 1021 FAX: 82 505 299 8311

Certificate

KOLAS No.: KT231

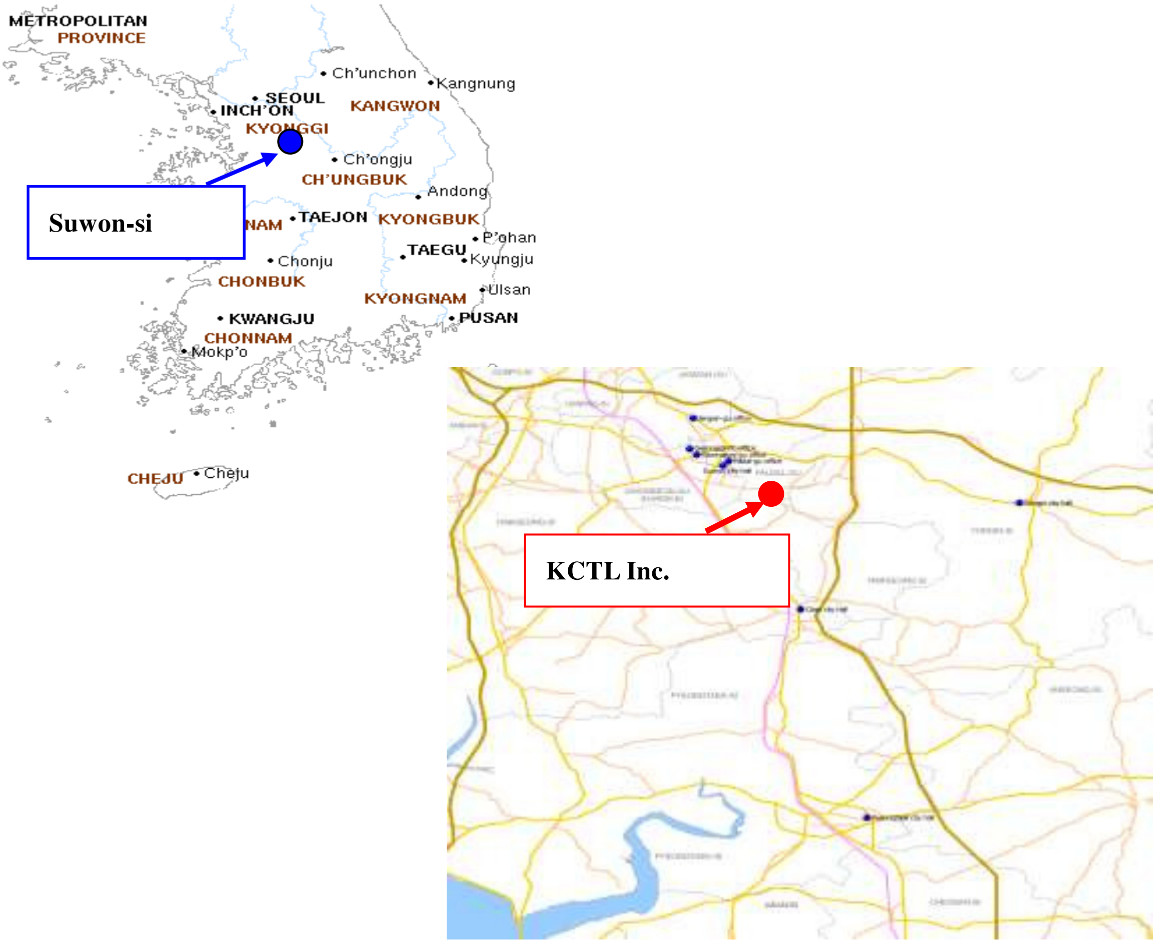
FCC Site Designation No.: KR0040

FCC Site Registration No.: 687132

VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849

IC Site Registration No.: 8035A-2

SITE MAP



3. Identification of Sample

EUT Type	FM Handheld Transceiver (VHF)
Brand Name	E-TECH Co., Ltd.
Mode of Operation	FM
Model Number	NEP100
Serial Number	N/A
Max. Power	37.99 dBm
Tx Freq.Range	136.025 ~ 173.975 MHz
Rx Freq.Range	136.025 ~ 173.975 MHz
Antenna Type	Whip Type
Normal Voltage	DC 7.4 V
H/W Version	V1.0
S/W Version	V1.0

4.Test Result Summary

4.1 FM Head SAR

Frequency		Average Power (dBm)	Max. tune up power (dBm)	Scaling Factor	EUT Position	Distance (mm)	Measured 1 g SAR (W/kg) Duty 100 %	Measured 1 g SAR (W/kg) Duty 50 %	Scaled 1 g SAR (W/kg)
MHz	Channel								
155.025	2	37.12	37.99	1.023	Front	25	1.11	0.555	0.568

* Contain the results of the worst test SAR including battery.

4.2 FM Body SAR

Frequency		Average Power (dBm)	Max. tune up power (dBm)	Scaling Factor	EUT Position	Distance (mm)	Measured 1 g SAR (W/kg) Duty 100 %	Measured 1 g SAR (W/kg) Duty 50 %	Scaled 1 g SAR (W/kg)
MHz	Channel								
155.025	2	37.12	37.99	1.023	Back	0	2.13	1.07	1.095

* Contain the results of the worst test SAR including battery.

5. Report Overview

This report details the results of testing carried out on the samples listed in section 3, 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.

This report may only be reproduced and distributed in full. If the product in this test report is used in any configuration other than that detailed in the test report, the manufacturer must ensure the new configuration complies with all relevant standards and certification requirements. Any mention of KCTL Inc. Wireless lab or testing done by KCTL Inc.Wireless lab made in connection with the distribution or use of the tested product must be approved in writing by KCTL Inc. Wireless lab.

6. Test Lab Declaration or Comments

None

7. Applicant Declaration or Comments

None

8. Measurement Uncertainty

All measurements and results are recorded and maintained at the laboratory performing the tests and measurement uncertainties are taken into account when comparing measurements to pass/ fail criteria.

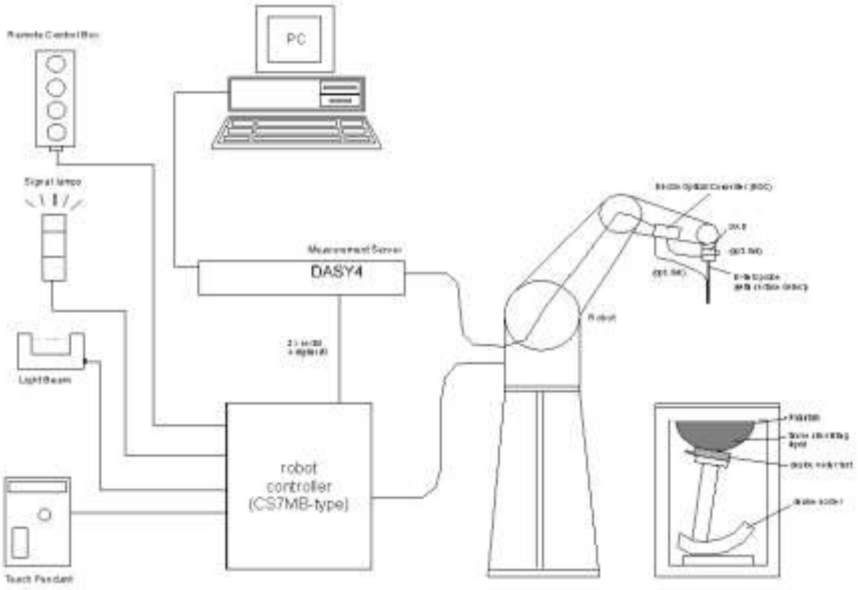
Uncertainty of SAR equipments for measurement Head

A	b	c	D	e = f(d,k)	g	i = c x g / e	k
Source of Uncertainty	**Description** IEEE P1528 (0.3 ~ 3 GHz)	**Tolerance/ Uncertainty value** ± %	**Probability Distribution**	**Div.**	**Ci** (1 g)	**Standard uncertainty** ± %, (1 g)	**Vi or Veff**
Measurement System							
Probe calibration(k=1)	E.2.1	6.30	N	1	1	6.30	∞
Axial isotropy	E.2.2	0.50	R	1.73	0.71	0.20	∞
Hemispherical isotropy	E.2.2	2.60	R	1.73	0.71	1.06	∞
Linearity	E.2.4	0.60	R	1.73	1	0.35	∞
Boundary effect	E.2.3	1.00	R	1.73	1	0.58	∞
System detection limits	E.2.5	1.00	R	1.73	1	0.58	∞
Readout electronics	E.2.6	0.30	N	1	1	0.30	∞
Response time	E.2.7	0.80	R	1.73	1	0.46	∞
Integration time	E.2.8	2.60	R	1.73	1	1.50	∞
RF ambient conditions–noise	E.6.1	3.00	R	1.73	1	1.73	∞
RF ambient conditions–reflections	E.6.1	3.00	R	1.73	1	1.73	∞
Probe positioner mechanical tolerance	E.6.2	0.40	R	1.73	1	0.23	∞
Probe positioning with respect to phantom shell	E.6.3	2.90	R	1.73	1	1.67	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	E.5	2.00	R	1.73	1	1.15	∞
Test Sample Related							
Test sample positioning	E.4.2	4.71	N	1	1	4.71	9
Device holder uncertainty	E.4.1	3.60	N	1	1	3.60	5
Output power variation—SAR drift measurement	6.6.2	5.00	R	1.73	1	2.89	∞
Phantom and Tissue Parameters							
Phantom uncertainty (shape and thickness tolerances)	E.3.1	6.10	R	1.73	1	3.52	∞
Liquid conductivity-measurement uncertainty	E.3.3	1.53	N	1	0.64	0.98	5
Liquid permittivity-measurement uncertainty	E.3.3	3.07	N	1	0.6	1.84	5
Liquid conductivity-deviation from target values	E.3.2	5.00	R	1.73	0.64	1.85	∞
Liquid permittivity-deviation from target values	E.3.2	5.00	R	1.73	0.6	1.73	∞
Combined standard uncertainty				RSS		11.00	165
Expanded uncertainty (95% CONFIDENCE INTERVAL)				K=2		22.00	

Uncertainty of SAR equipments for measurement Body

A	b	c	D	e = f(d,k)	g	i = c x g / e	k
Source of Uncertainty	Description IEEE P1528	Tolerance/ Uncertainty value	Probability Distribution	Div.	Ci	Standard uncertainty	Vi or Veff
	(0.3 ~ 3 GHz)	± %			(1 g)	± %, (1 g)	
Measurement System							
Probe calibration(k=1)	E.2.1	6.30	N	1	1	6.30	∞
Axial isotropy	E.2.2	0.50	R	1.73	0.71	0.20	∞
Hemispherical isotropy	E.2.2	2.60	R	1.73	0.71	1.06	∞
Linearity	E.2.4	0.60	R	1.73	1	0.35	∞
Boundary effect	E.2.3	1.00	R	1.73	1	0.58	∞
System detection limits	E.2.5	1.00	R	1.73	1	0.58	∞
Readout electronics	E.2.6	0.30	N	1	1	0.30	∞
Response time	E.2.7	0.80	R	1.73	1	0.46	∞
Integration time	E.2.8	2.60	R	1.73	1	1.50	∞
RF ambient conditions–noise	E.6.1	3.00	R	1.73	1	1.73	∞
RF ambient conditions–reflections	E.6.1	3.00	R	1.73	1	1.73	∞
Probe positioner mechanical tolerance	E.6.2	0.40	R	1.73	1	0.23	∞
Probe positioning with respect to phantom shell	E.6.3	2.90	R	1.73	1	1.67	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	E.5	2.00	R	1.73	1	1.15	∞
Test Sample Related							
Test sample positioning	E.4.2	4.71	N	1	1	4.71	9
Device holder uncertainty	E.4.1	3.60	N	1	1	3.60	5
Output power variation—SAR drift measurement	6.6.2	5.00	R	1.73	1	2.89	∞
Phantom and Tissue Parameters							
Phantom uncertainty (shape and thickness tolerances)	E.3.1	7.50	R	1.73	1	4.33	∞
Liquid conductivity-measurement uncertainty	E.3.3	1.53	N	1	0.64	0.98	5
Liquid permittivity-measurement uncertainty	E.3.3	3.07	N	1	0.6	1.84	5
Liquid conductivity-deviation from target values	E.3.2	5.00	R	1.73	0.64	1.85	∞
Liquid permittivity-deviation from target values	E.3.2	5.00	R	1.73	0.6	1.73	∞
Combined standard uncertainty				RSS		11.29	183
Expanded uncertainty (95% CONFIDENCE INTERVAL)				K=2		22.57	

9. The SAR Measurement System



<SAR System Configuration>

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

9.1 Isotropic E-field Probe

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

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%.
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

9.2 Phantom

Twin SAM	
	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.
Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions (incl. Wooden Support)	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters
Wooden Support	SPEAG standard phantom table
Accessories	Mounting Device and Adaptors

ELI	
	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure. ELI V6.0, released in August 2014, has the same shell geometry as ELI4 but offers increased longterm stability.
Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Wooden Support	SPEAG standard phantom table
Accessories	Mounting Device and Adaptors

9.3 Device Holder for Transmitters

Mounting Devices and Adaptors

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)

Mounting Device for Laptops

MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters

In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device (Body-Worn) enables testing of ransmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at flat phantom section.

Material: Polyoxymethylene (POM), PET-G, Foam

10. System Verification

10.1 Tissue Verification

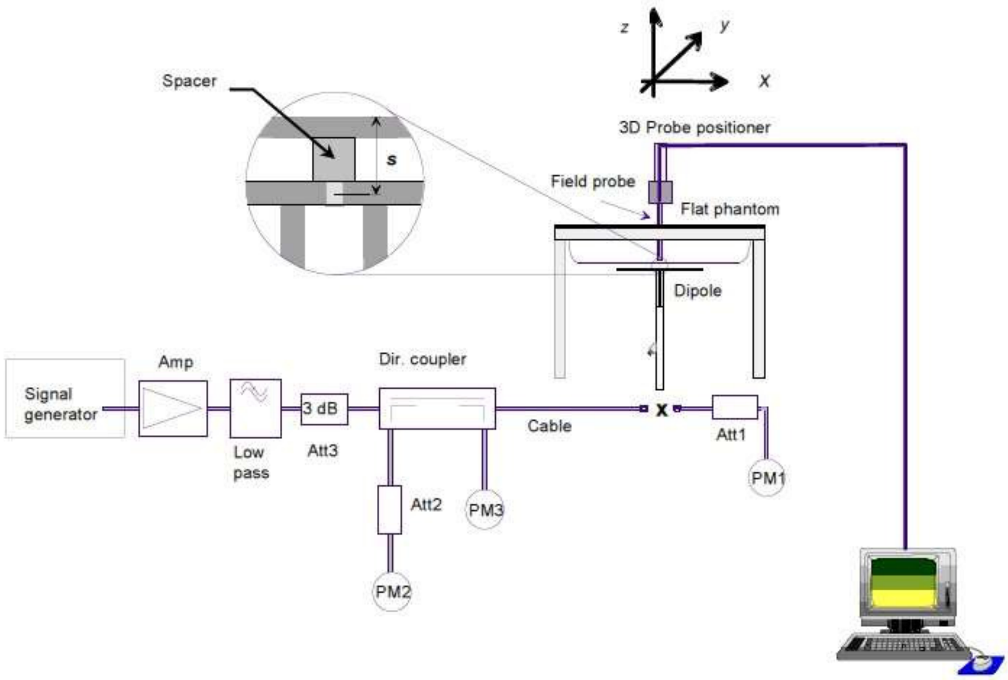
The dielectric properties for this Tissue Simulant Liquids were measured by using the SPEAG Model DAK3.5 Dielectric Probe in conjunction with Agilent E5071B Network Analyzer (300 kHz – 8 500 MHz). The Conductivity (σ) and Permittivity (ρ) are listed in Table 1.For the SAR measurement given in this report. The temperature variation of the Tissue Simulant Liquids was (22 ± 2) °C.

Freq. (MHz)	Tissue Type	Limit/Measured	Permittivity (ρ)	Conductivity (σ)	Temp (℃)
136.025	HSL	Recommended Limit	52.95± 5 % (50.30~55.60)	0.75± 5 % (0.71~0.79)	22 ± 2
		Measured, 2015-04-22	51.30	0.78	22.21
150	HSL	Recommended Limit	52.30± 5 % (48.75~53.87)	0.76± 5 % (0.72~0.80)	22 ± 2
		Measured, 2015-04-22	50.49	0.78	22.21
155.025	HSL	Recommended Limit	52.07± 5 % (49.47~54.67)	0.76± 5 % (0.72~0.80)	22 ± 2
		Measured, 2015-04-22	50.44	0.77	22.21
173.975	HSL	Recommended Limit	51.23± 5 % (48.67~53.79)	0.78± 5 % (0.74~0.82)	22 ± 2
		Measured, 2015-04-22	50.70	0.76	22.21
136.025	MSL	Recommended Limit	62.25± 5 % (59.14~65.36)	0.79± 5 % (0.75~0.83)	22 ± 2
		Measured, 2015-04-23	65.24	0.82	22.08
150	MSL	Recommended Limit	61.90± 5 % (58.81~65.00)	0.80± 5 % (0.76~0.84)	22 ± 2
		Measured, 2015-04-23	64.17	0.83	22.08
155.025	MSL	Recommended Limit	61.78± 5 % (58.69~64.87)	0.80± 5 % (0.76~0.84)	22 ± 2
		Measured, 2015-04-23	63.91	0.82	22.08
173.975	MSL	Recommended Limit	61.38± 5 % (58.31~64.45)	0.82± 5 % (0.78~0.86)	22 ± 2
		Measured, 2015-04-23	63.07	0.80	22.08

<Table 1.Measurement result of Tissue electric parameters>

10.2 Test System Verification

The microwave circuit arrangement for system verification is sketched below picture. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SARmeasurement was performed to see if the measured SAR was within ± 10% from the target SAR values. These tests were done at 150 MHz. The tests were conducted on the samedays as the measurement of the EUT. The obtained results from the system accuracy verification are displayed in the table Table 2 (A power level of 250㎽ was input to the dipole antenna). During the tests, the ambient temperature of the laboratory was in the range (22 ± 2) ℃,the relative humidity was in the range (50 ± 20)% and the liquid depth above the ear/grid reference points was above 15 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



Validation Kit	Dipole Ant. S/N	Frequency (MHz)	Tissue Type	Limit/Measurement (Normalized to 1 W)		
					1 g	10 g
CLA150	4014	150	HSL	Recommended Limit (Normalized)	3.72 ± 10 % (3.35~4.09)	2.48 ± 10 % (2.23~2.73)
				Measured, 2015-04-22	3.72	2.31
CLA150	4014	150	MSL	Recommended Limit (Normalized)	3.81 ± 10 % (3.43~4.19)	2.56 ± 10 % (2.30~2.82)
				Measured, 2015-04-23	3.99	2.65

<Table 2.Test System Verification Result>

11. Operation Configurations

Measurements were performed at the lowest, middle and highest channels of the operating band. The EUT was set to maximum power level during all tests and at the beginning of each test the battery was fully charged.

12. SAR Measurement Procedures

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift ofthe device under test in the batch process. The Minimum distance of probe sensors to surfacedetermines the closest measurement point to phantom surface. The minimum distance of probe sensorsto surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points toprobe tip as defined in the probe properties.

Step 2: Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doinga fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASYsoftware can find the maximum locations even in relatively coarse grids. When an Area Scan hasmeasured all reachable points, it computes the field maximal found in the scanned area, within a rangeof the global maximum. The range (in dB) is specified in the standards for compliance testing. Forexample, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is arequirement when compliance is assessed in accordance with the ARIB standard (Japan). If only oneZoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. Forcases where multiple maximums are detected, the number of Zoom Scans has to be increasedaccordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measument 100 MHz to 6 GHz v01r04.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan
Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing1 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 scanjob within the same procedure. When the measurement is done, the Zoom Scan evaluates theaveraged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measument 100 MHz to 6 GHz v01r04

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 mm ± 1 mm</td><td>$\frac{1}{2}\cdot\delta\cdot\ln(2)$ mm 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: ΔxArea, ΔyArea</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 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 ≤ 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: ΔxZoom, ΔyZoom</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: ΔzZoom(n)</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>ΔzZoom(1): between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>ΔzZoom(n>1): between subsequent points</td><td colspan="2">≤ 1.5·ΔzZoom(n-1) mm</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 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 IEEE Std 1528-2013 for details.
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

Step 4: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent powerreference measurement within the same procedure, and with the same settings. The Power DriftMeasurement gives the field difference in dB from the reading conducted within the last PowerReference Measurement. This allows a user to monitor the power drift of the device under test within abatch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan
The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a onedimensionalgrid. In order to get a reasonable extrapolation, the extrapolated distance should not belarger than the step size in Z-direction.

* Z Scan Report on Liquid Measure the height Annex A.4 Liquid Depth photo to replace

13. Test Equipment Information

Test Platform	SPEAG DASY4 System			
Description	SAR Test System			
Software Reference	DASY4: V4.7,Build80 SEMCAD: V1.8,Build 186			
Hardware Reference				
Equipment	Model	Serial Number	Date of Calibration	Due date of next Calibration
Shield Room	Shield Room	None	N/A	N/A
DASY4 Robot	RX90BL Speag	F05/51E0A1/A01	N/A	N/A
DASY4 Controller	RX90BL Speag	F05/51E0A1/C/01	N/A	N/A
Phantom	2mm Oval Phantom ELI5	1220	N/A	N/A
Mounting Device	Mounting Device	None	N/A	N/A
DAE	DAE4	911	2015-02-20	2016-02-20
Probe	ES3DV3	3302	2014-05-20	2015-05-20
System Validation Sources	CLA150	4014	2014-09-04	2015-09-04
Network Analyzer	E5071B	MY42403524	2014-07-15	2015-07-15
Dual Directional Coupler	778D	16059	2014-08-29	2015-08-29
Signal Generator	E4438C	MY42080486	2015-01-19	2016-01-19
Power Amplifier	GRF5039	1062	2014-07-17	2015-07-17
LP Filter	LA-15N	36543	2014-08-28	2015-08-28
Dual Power Meter	E4419B	GB43312301	2014-07-17	2015-07-17
Power Sensor	8481H	3318A19377	2014-08-30	2015-08-30
Dielectric Assessment Kit	DAK-3.5	1078	2014-08-19	2015-08-19
Humidity/Baro/Temp. Data Recorder	MHB-382SD	14036	2014-08-26	2015-08-26

14. RF Average Conducted Output Power

14.1 Average Conducted Output Power

Band	Power	Conducted Power (dBm)		
		136.025 MHz	155.025 MHz	173.975 MHz
FM	1 W - Low	30.68	30.05	30.08
	5 W - High	37.14	37.12	37.13

14.2 Max. tune up power

Band	Power	Target Power (dBm)	Tolerance (dBm)	Max. Allowed Power (dBm)
FM	1 W - Low	30.00	± 1.50	31.50
	5 W - High	36.99	± 1.00	37.99

15. SAR Test Results

15.1 Head SAR Test Results

Frequency		Average Power (dBm)	Max. tune up power (dBm)	Scaling Factor	EUT Position	Distance (mm)	Measured 1 g SAR (W/kg) Duty 100 %	Measured 1 g SAR (W/kg) Duty 50 %	Scaled 1 g SAR (W/kg)
MHz	Channel								
155.025	2	37.12	37.99	1.023	Front	25	1.11	0.555	**0.568**

<Note>

1.FCC KDB Publication 643646D01v01r03.

I) When the head SAR of an antenna test

a) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna

b) > 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately adjacent channel(s) is not necessary;3 testing of the other required channels may still be required

c) > 4.0 W/kg and ≤ 6.0 W/kg, head SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration

d) > 6.0 W/kg, test all required channels for that antenna

e) for the remaining channels that cannot be excluded in b) and c), which still require consideration, the 3.5 W/kg exclusion in a) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR for the remaining channels that cannot be excluded

i) if an immediately adjacent channel measured in c) or a remaining channel

2. FCC KDB Publication 447498D01v06

I) The operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions. A duty factor of 50% should be applied to determine compliance for radios with maximum operating duty factors ≤ 50%.

15.2 Body SAR Test Results

Frequency		Average Power (dBm)	Max. tune up power (dBm)	Scaling Factor	EUT Position	Distance (mm)	Measured 1 g SAR (W/kg) Duty 100 %	Measured 1 g SAR (W/kg) Duty 50 %	Scaled 1 g SAR (W/kg)
MHz	Channel								
155.025	2	37.12	37.99	1.023	Back	0	2.13	1.07	**1.095**

<Note>

1.FCC KDB Publication 643646D01v01r03.

I) When the body SAR of an antenna test

a) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna

b) > 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately adjacent channel(s) is not necessary; testing of the other required channels may still be required

c) > 4.0 W/kg and ≤ 6.0 W/kg, body SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration

d) > 6.0 W/kg, test all required channels for that antenna

e) for the remaining channels that cannot been excluded in b) and c), which still require consideration, the 3.5 W/kg exclusion in a) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR of the remaining channels that cannot be excluded

i) if an immediately adjacent channel measured in c) or a remaining channel measured in e) is > 6.0 W/kg, test all required channels for that antenna

2. FCC KDB Publication 447498D01v06

I) The operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions. A duty factor of 50% should be applied to determine compliance for radios with maximum operating duty factors ≤ 50%.

16. Test System Verification Results

System check for 150 MHz-Body(2015-04-22)

Procedure Name: d=0 mm, Pin=250 mW, f=150

Frequency: 150 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): f = 150 MHz; σ = 0.777 mho/m; ε_r = 50.5; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.77, 6.77, 6.77); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=0 mm, Pin=250 mW, f=150/Area Scan (201x201x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 1.12 mW/g

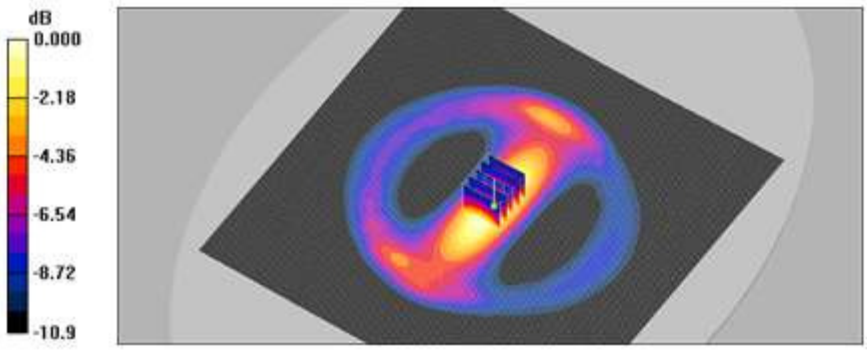
d=0 mm, Pin=250 mW, f=150/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 38.7 V/m; Power Drift = -0.085 dB

Peak SAR (extrapolated) = 1.67 W/kg

SAR(1 g) = 0.930 mW/g; SAR(10 g) = 0.578 mW/g

Maximum value of SAR (measured) = 1.11 mW/g



System check for 150 MHz-Body(2015-04-23)

Procedure Name: d=0 mm, Pin=250 mW, f=150

Frequency: 150 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): f = 150 MHz; σ = 0.826 mho/m; ε_r = 64.2; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.45, 6.45, 6.45); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=0 mm, Pin=250 mW, f=150/Area Scan (201x201x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 1.24 mW/g

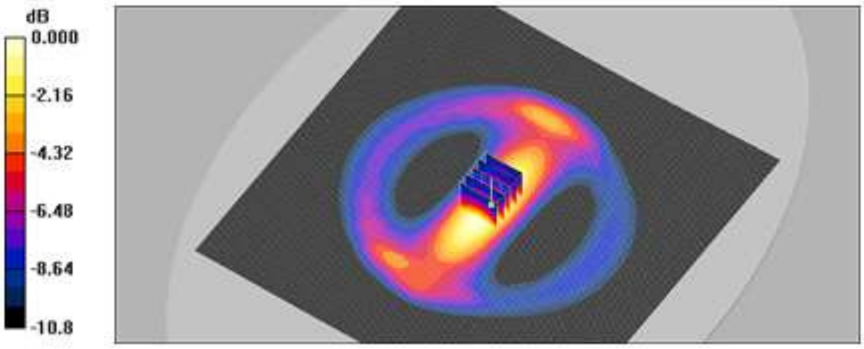
d=0 mm, Pin=250 mW, f=150/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 38.8 V/m; Power Drift = 0.018 dB

Peak SAR (extrapolated) = 1.78 W/kg

SAR(1 g) = 0.997 mW/g; SAR(10 g) = 0.622 mW/g

Maximum value of SAR (measured) = 1.19 mW/g



17. Test Results

#1 FM Head SAR

Procedure Name: FM_Ch.1_f.155.025_Head Front_Gap 25 mm

Frequency: 155.025 MHz; Duty Cycle: 1:1

Medium parameters used: f = 155.025 MHz; σ = 0.775 mho/m; ε_r = 50.4; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.77, 6.77, 6.77); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

FM_Ch.1_f.155.025_Head Front_Gap 25 mm/Area Scan (71x191x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 1.32 mW/g

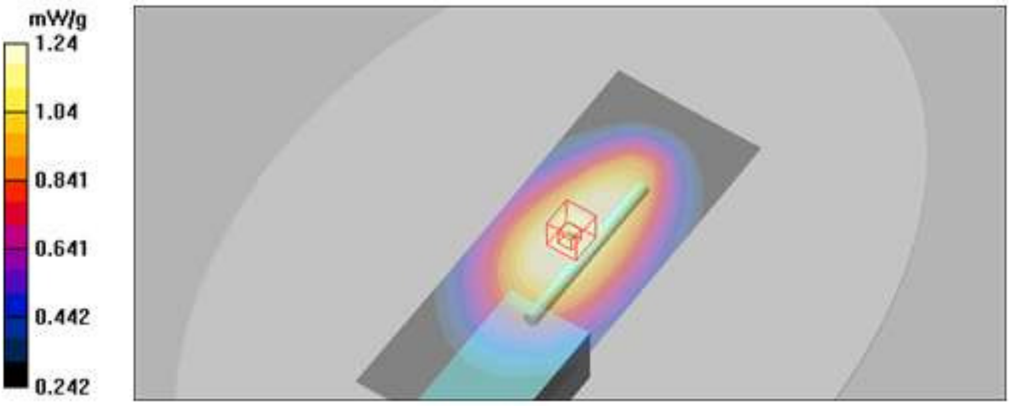
FM_Ch.1_f.155.025_Head Front_Gap 25 mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 40.5 V/m; Power Drift = -0.001 dB

Peak SAR (extrapolated) = 1.61 W/kg

SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.835 mW/g

Maximum value of SAR (measured) = 1.24 mW/g



#2 FM Body SAR

Procedure Name: FM_Ch.2_f.155.025_Body Back_Gap 0 mm

Frequency: 155.025 MHz;   Duty Cycle: 1:1

Medium parameters used: f = 155.025 MHz; σ = 0.822 mho/m; ε_r = 63.9; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.45, 6.45, 6.45); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

FM_Ch.2_f.155.025_Body Back_Gap 0 mm/Area Scan (81x191x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 2.44 mW/g

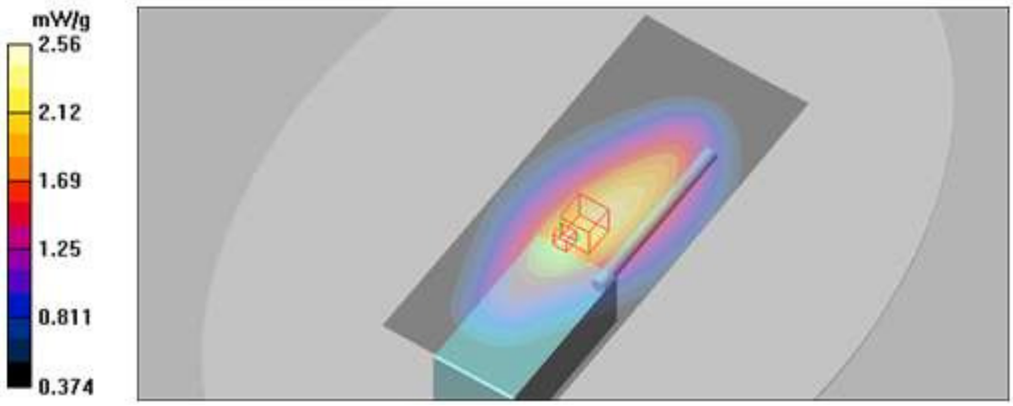
FM_Ch.2_f.155.025_Body Back_Gap 0 mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 55.6 V/m; Power Drift = -0.038 dB

Peak SAR (extrapolated) = 3.69 W/kg

SAR(1 g) = 2.13 mW/g; SAR(10 g) = 1.5 mW/g

Maximum value of SAR (measured) = 2.56 mW/g



Annex A. Photographs

Annex A.1 EUT

Front View

Back View

Right side View

Left side View

Top side View

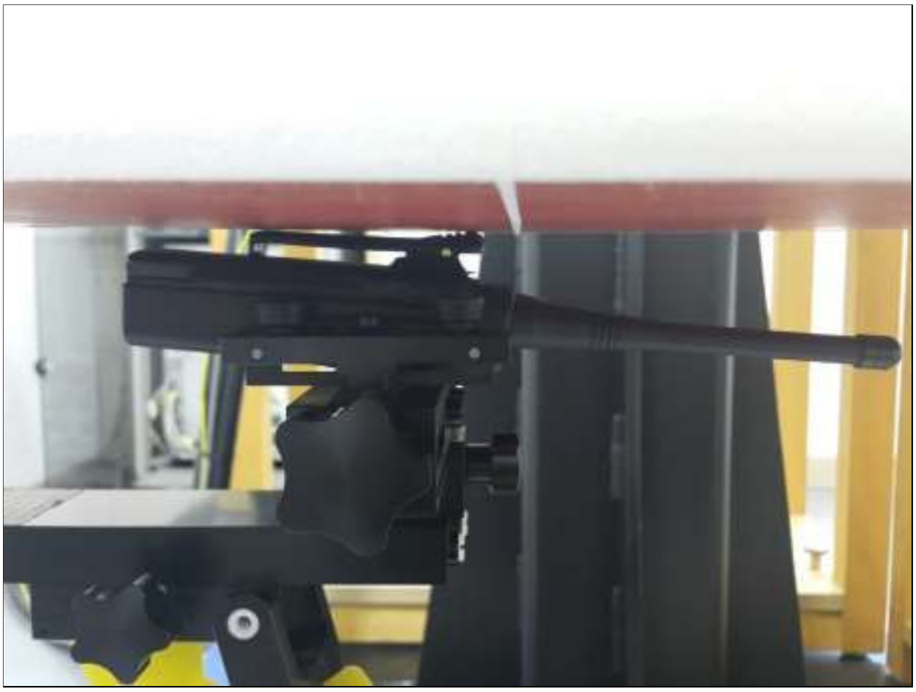
Bottom side View

Annex A.2 Photographs of Test Setup

Photograph of the SAR measurement System

Annex A.3 Test Position

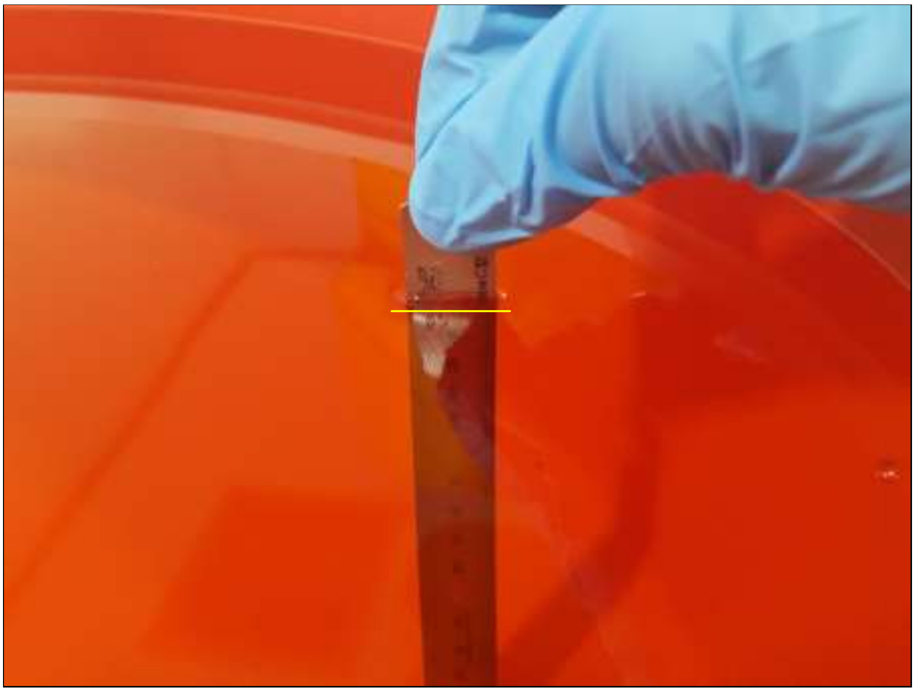
(a) Head_Front



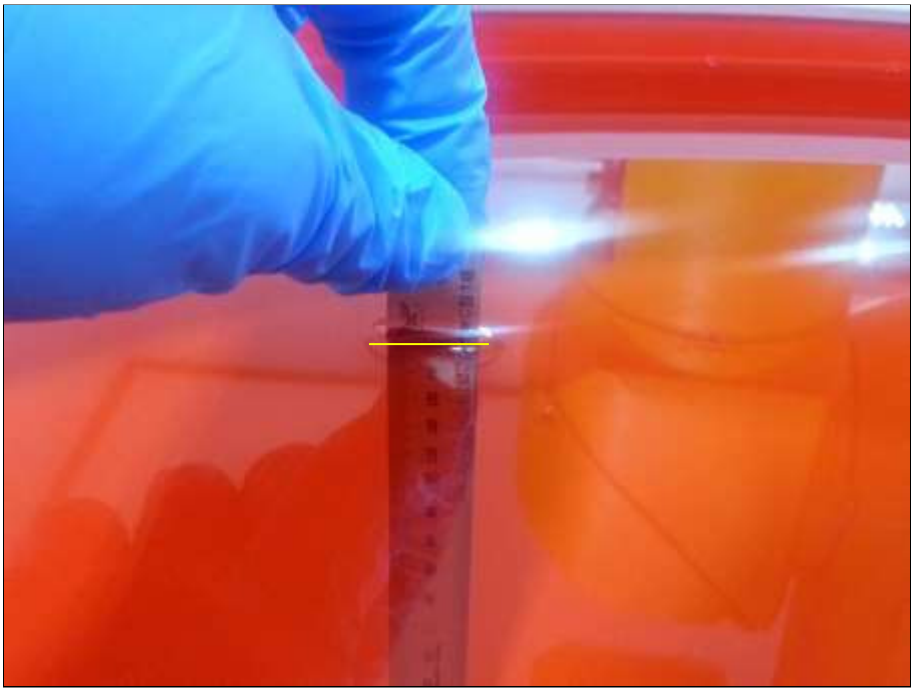
(b) Body_Back

(c) System Check 150 MHz

Annex A.4 Liquid Depth



HSL150



MSL150

Annex B. Calibration certificate

Annex B.1 Probe Calibration certificate

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

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

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

Accreditation No.: **SCS 108**

Client **EMC Compliance (Dymstec)**

Certificate No: **ES3-3302_May14**

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3302

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: May 20, 2014

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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: May 22, 2014

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

결재	작 성	검 토	승 인

Certificate No: ES3-3302_May14 Page 1 of 11

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

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

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

Accreditation No.: SCS 108

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3302

Manufactured: August 27, 2010
Calibrated: May 20, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.18	1.38	1.32	± 10.1 %
DCP (mV)[B]	103.0	102.0	101.0	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	247.9	±4.1 %
		Y	0.0	0.0	1.0		231.8	
		Z	0.0	0.0	1.0		227.1	

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.

http://www.kctl.co.kr

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
150	52.3	0.76	6.77	6.77	6.77	0.05	1.10	± 13.3 %
300	45.3	0.87	6.63	6.63	6.63	0.15	1.20	± 13.3 %
450	43.5	0.87	6.46	6.46	6.46	0.20	2.25	± 13.3 %
850	41.5	0.92	5.94	5.94	5.94	0.60	1.35	± 12.0 %
900	41.5	0.97	5.88	5.88	5.88	0.46	1.47	± 12.0 %
1750	40.1	1.37	5.06	5.06	5.06	0.77	1.24	± 12.0 %
1900	40.0	1.40	4.91	4.91	4.91	0.80	1.19	± 12.0 %
2450	39.2	1.80	4.34	4.34	4.34	0.73	1.26	± 12.0 %
2600	39.0	1.96	4.16	4.16	4.16	0.80	1.30	± 12.0 %

[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. Above 5 GHz frequency validity can be extended to ± 110 MHz. 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.
[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.

http://www.kctl.co.kr

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

Calibration Parameter Determined in Body Tissue Simulating Media

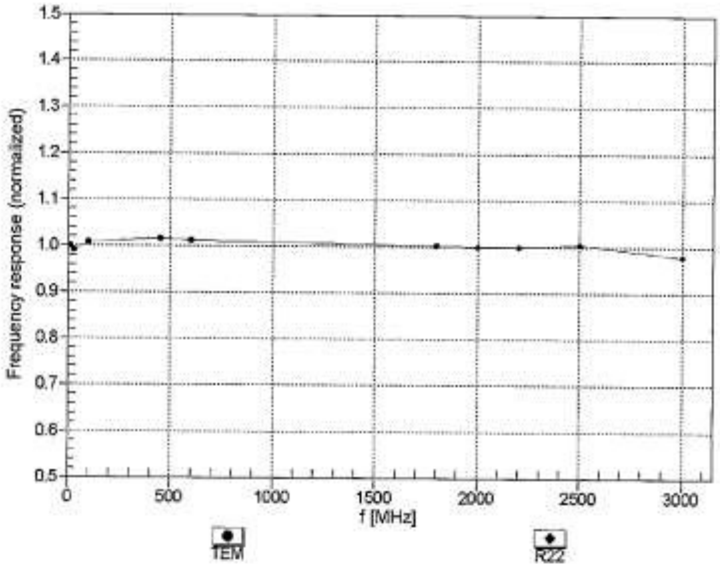
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
150	61.9	0.80	6.45	6.45	6.45	0.08	1.10	± 13.3 %
300	58.2	0.92	6.39	6.39	6.39	0.16	1.50	± 13.3 %

[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. Above 5 GHz frequency validity can be extended to ± 110 MHz. 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.
[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.

ES3DV3– SN:3302 May 20, 2014

Frequency Response of E-Field

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



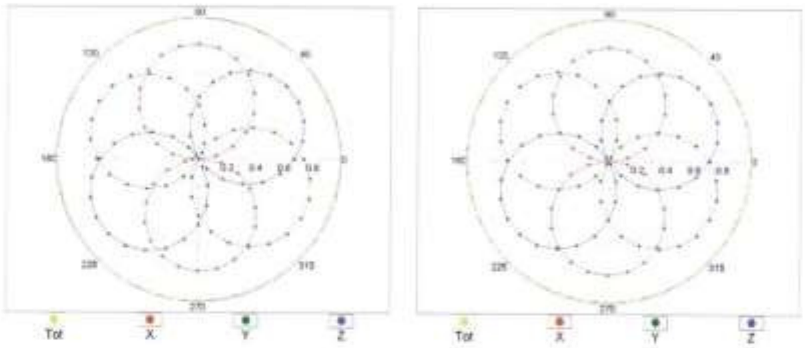
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

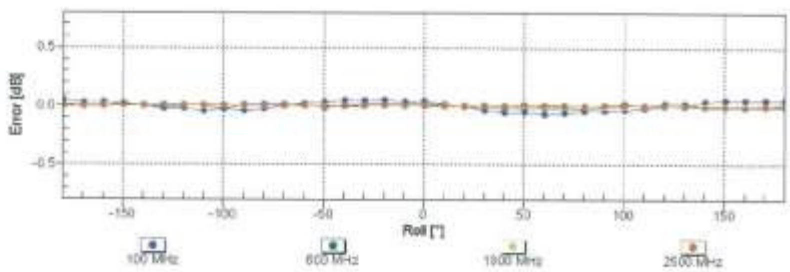
Certificate No: ES3-3302_May14 Page 7 of 11

Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM

f=1800 MHz,R22

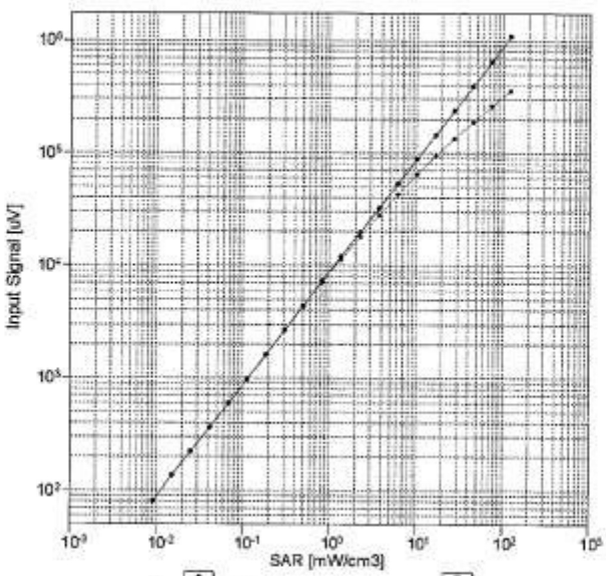


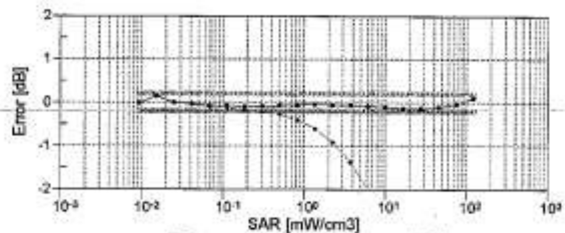


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

ES3DV3– SN:3302 May 20, 2014

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



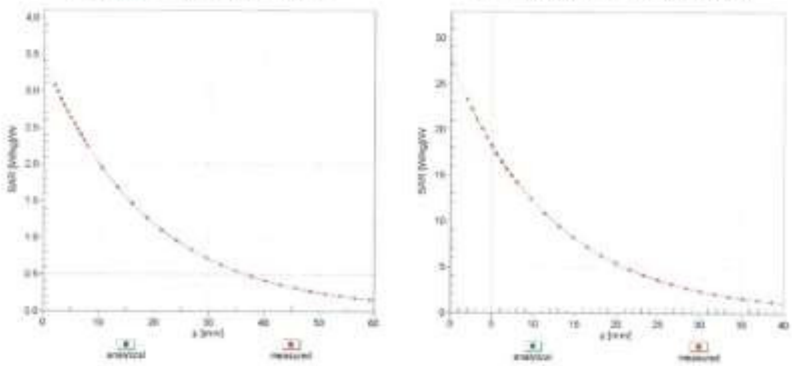


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Certificate No: ES3-3302_May14 Page 9 of 11

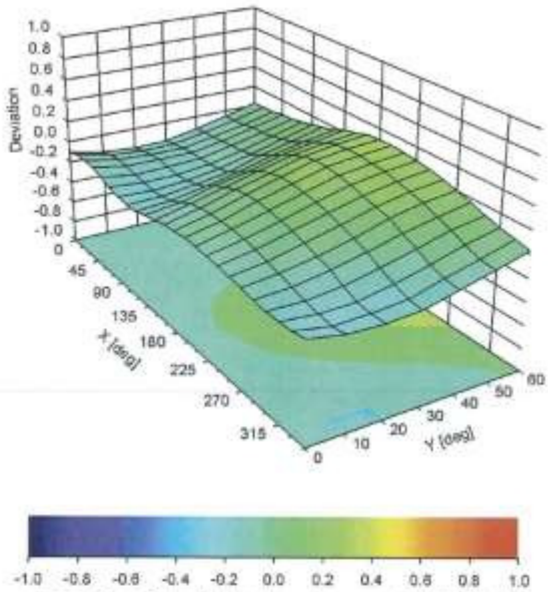
ES3DV3– SN:3302 May 20, 2014

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: ES3-3302_May14 Page 10 of 11

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-129.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Annex B.2 DAE Calibration certification

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client: Dymstec
Certificate No: DAE4-911_Feb15

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BK - SN: 911

Calibration procedure(s): QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: February 20, 2015

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
Keithley Multimeter Type 2001	SN: 0810278	03-Oct-14 (No:15573)	Oct-15
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	06-Jan-15 (in house check)	In house check: Jan-16
Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-15 (in house check)	In house check: Jan-16

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	[signature]
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V. [signature]

Issued: February 20, 2015

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Certificate No: DAE4-911_Feb15 Page 1 of 5

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Accreditation No.: **SCS 0108**

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	405.170 ± 0.02% (k=2)	404.879 ± 0.02% (k=2)	404.758 ± 0.02% (k=2)
Low Range	4.00112 ± 1.50% (k=2)	3.96552 ± 1.50% (k=2)	3.96381 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	230.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS108)

1. **DC Voltage Linearity**

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200037.32	1.46	0.00
Channel X	+ Input	20004.28	0.78	0.00
Channel X	- Input	-20004.64	1.68	-0.01
Channel Y	+ Input	200033.09	-1.68	-0.00
Channel Y	+ Input	20002.35	-1.20	-0.01
Channel Y	- Input	-20008.45	-1.96	0.01
Channel Z	+ Input	200034.70	0.03	0.00
Channel Z	+ Input	20002.39	-1.05	-0.01
Channel Z	- Input	-20004.67	1.87	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	1999.99	-0.06	-0.00
Channel X	+ Input	200.20	0.16	0.08
Channel X	- Input	-199.85	0.08	-0.04
Channel Y	+ Input	1999.61	-0.30	-0.02
Channel Y	+ Input	198.82	-1.01	-0.50
Channel Y	- Input	-200.06	0.06	-0.03
Channel Z	+ Input	1998.51	-1.46	-0.07
Channel Z	+ Input	198.92	-0.93	-0.46
Channel Z	- Input	-201.66	-1.46	0.73

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-10.84	-12.46
	- 200	15.93	14.84
Channel Y	200	20.13	19.14
	- 200	-20.31	-20.82
Channel Z	200	-20.75	-20.21
	- 200	17.28	17.42

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	0.34	-5.35
Channel Y	200	6.51	-	0.09
Channel Z	200	9.54	4.62	-

4. AD-Converter Values with inputs shorted
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15852	16154
Channel Y	15998	16109
Channel Z	16437	14961

5. Input Offset Measurement
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.94	-1.06	3.07	0.63
Channel Y	0.10	-1.29	1.79	0.60
Channel Z	-0.37	-2.17	1.01	0.56

6. Input Offset Current
Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

Annex B.3 Dipole Calibration certification

CLA150

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 108**

Client: HCT (Dymstec)

Certificate No: CLA150-4014_Sep14

CALIBRATION CERTIFICATE

Object	CLA150 - SN: 4014
Calibration procedure(s)	QA CAL-15.v8 Calibration procedure for system validation sources below 700 MHz
Calibration date:	September 04, 2014

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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe EX3DV4	SN: 3877	06-Jan-14 (No. EX3-3877_Jan14)	Jan-15
DAE4	SN: 654	30-Jun-14 (No. DAE4-654_Jun14)	Jun-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	04-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: September 11, 2014

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Certificate No: CLA150-4014_Sep14 Page 1 of 8

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "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 2013
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
EUT Positioning	Touch Position	
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	
Frequency	150 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	52.3	0.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	51.5 ± 6 %	0.78 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	1 W input power	3.77 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**3.72 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	1 W input power	2.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**2.48 W/kg ± 18.0 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	61.9	0.80 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	61.1 ± 6 %	0.81 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	1 W input power	3.86 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**3.81 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	1 W input power	2.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**2.56 W/kg ± 18.0 % (k=2)**

Certificate No: CLA150-4014_Sep14 Page 3 of 8

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	46.6 Ω - 5.9 jΩ
Return Loss	- 23.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.4 Ω + 6.7 jΩ
Return Loss	- 23.2 dB

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 30, 2014

http://www.kctl.co.kr

DASY5 Validation Report for Head TSL

Date: 05.09.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4014

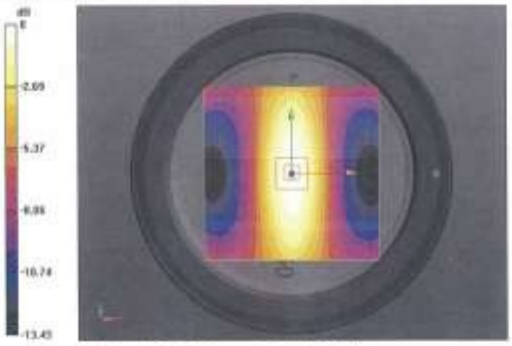
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; σ = 0.77 S/m; ε_r = 51.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.76, 11.76, 11.76); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 4.74 W/kg

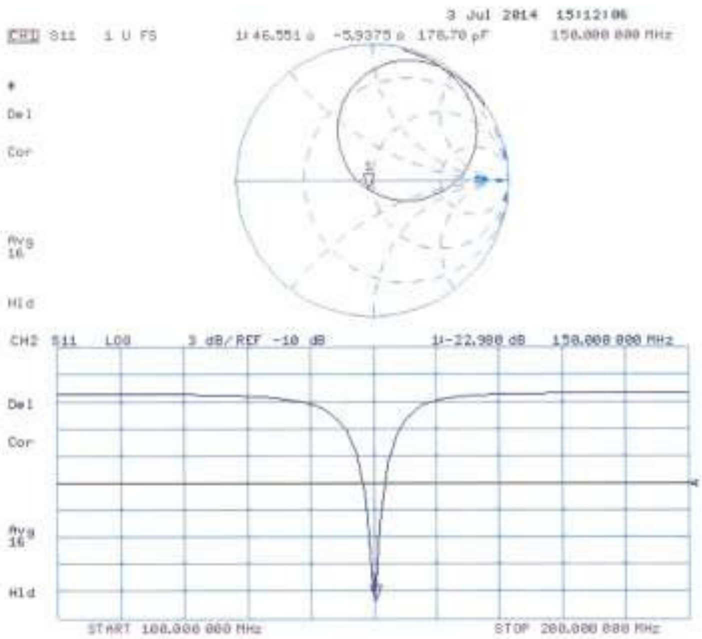
CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 78.54 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 7.09 W/kg
SAR(1 g) = 3.77 W/kg; SAR(10 g) = 2.51 W/kg
Maximum value of SAR (measured) = 5.24 W/kg



0 dB = 4.74 W/kg = 6.76 dBW/kg

Certificate No: CLA150-4014_Sep14 Page 5 of 8

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 04.09.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA-150; Type: CLA-150; Serial: 4014

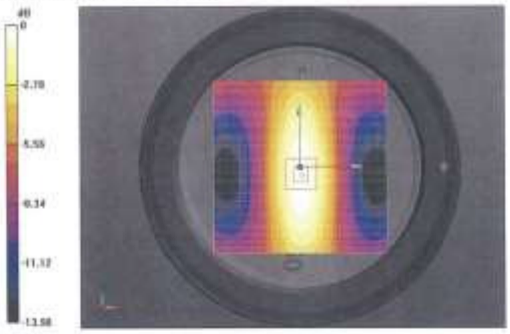
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; σ = 0.81 S/m; ε_r = 61.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.45, 11.45, 11.45); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 4.83 W/kg

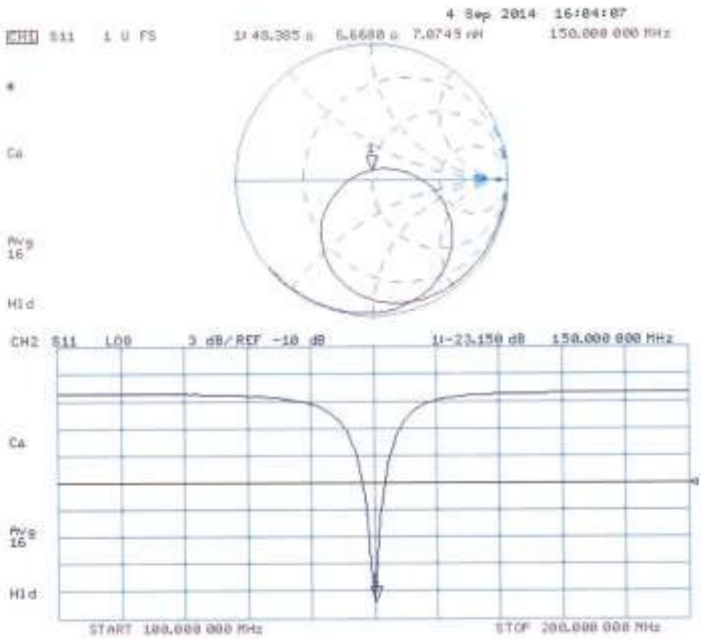
CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.28 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 7.09 W/kg
SAR(1 g) = 3.86 W/kg; SAR(10 g) = 2.59 W/kg
Maximum value of SAR (measured) = 5.36 W/kg



0 dB = 4.83 W/kg = 6.84 dBW/kg

Certificate No: CLA150-4014_Sep14 Page 7 of 8

Impedance Measurement Plot for Body TSL



-END OF REPORT -

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