FCC SAR TEST REPORT

KOSTEC Co., Ltd. 28(175-20, Annyeong-dong) 406-gil sejaro, Hwaseong-si, Gyeonggi-do, Korea Tel:031-222-4251, Fax:031-222-4252	Report No: KST-FCS-190001	KOSTEC Co., Ltd. http://www.kostec.org

1. Applicant

- Name : Midland Radio Corporation
- Address : 5900 Parretta Drive Kansas City,MO 64120-2134

2. Test Item

- Product Name: FRS
- Model Name : T250
- Brand Name: X-TALKER

3. Manufacturer

- Name : R12 EMS Philadelphia, Inc.
- Address : New Blk 1 Lot 4&5, Calamba Premier International Park, Barangay Batino, Calamba City, Laguna, Philippines

4. Date of Test : 2019. 03. 15. ~ 2019. 03. 15.

5. Test Method Used : FCC 47 CFR Parts 1 & 2
KDB 447498 D01 v06
KDB 865664 D01 v01r04
KDB 643646 D01 v01r03

6. Test Result : Compliance

7. Note: -

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : Lee, Mi-Young (Signature)	Technical Manager Name : Park, Gyeong-Hyeon (Signature)

2019. 03. 25.

KOSTEC Co., Ltd.

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1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for DUT are as follows.

Body Worn Configuration

Mode	Freq.	Position	Measured 1 g SAR (W/Kg)	50 % Duty cycle (W/Kg)	Scaled 1 g SAR (W/Kg)	Note
FRS	462.712 5	Body-worn	1.370	0.685	0.767	

Head Configuration

Mode	Freq.	Position	Measured 1 g SAR (W/Kg)	50 % Duty cycle (W/Kg)	Scaled 1 g SAR (W/Kg)	Note
FRS	467.587 5	Face-up	0.411	0.206	0.245	

This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General population/Uncontrolled exposure limits specified in ANSI/IEEE Standards and has been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and RF exposure KDB procedures.

1.1 Test Method List

447498 D01 General RF Exposure Guidance v06

865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04

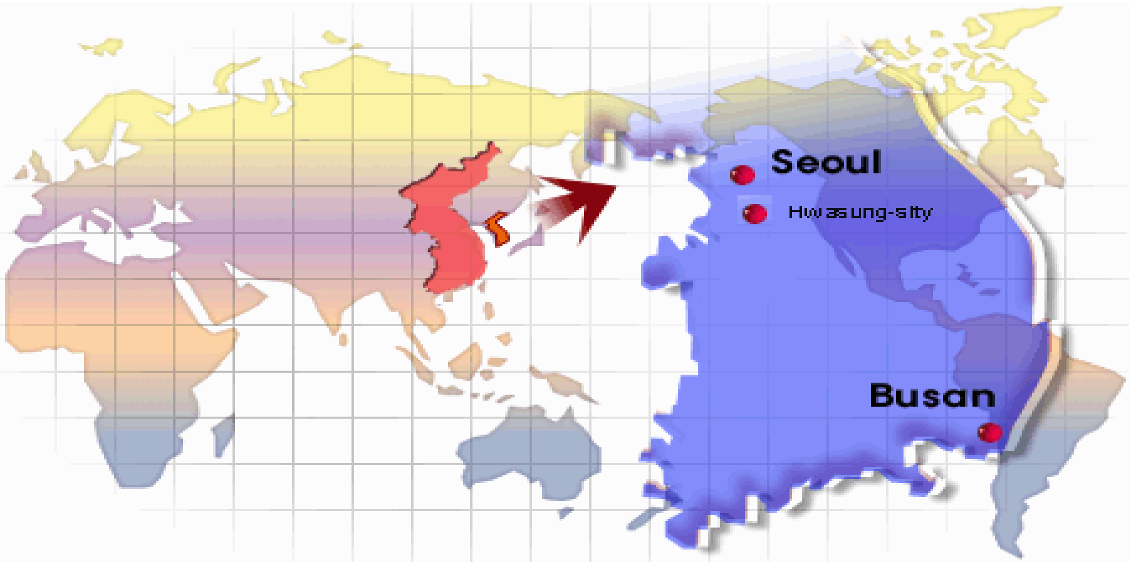
643646 D01 SAR Test for PTT Radios v01r03

2. Administration Data

2.1 Test Laboratory

KOSTEC Co., Ltd.
28(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea

2.2 Location



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2.5 Application Details

Date of Receipt of application : 2019. 03. 11.
Date of test : 2019. 03. 15. ~ 2019. 03. 15.

Revision History of test report

Rev.	Revisions	Effect page	Reviewed	Date
-	Initial issue	All	Park, Gyeong Hyeon	2019. 03. 25.

3. GENERAL INFORMATION

3.1 Description of DUT

DUT Type	Portable devices
Device Category	General population/Uncontrolled exposure
Brand Name	X-TALKER
Model Name	T250
Modulation Type	FM
Operating Frequency Range	462.562 5 MHz - 462.712 5 MHz, 467.562 5 MHz - 467.712 5 MHz, 462.550 0 MHz - 462.725 0 MHz
Operating mode	Face Up and Body-worn
Body-Worn accessories	Belt Clip
Audio accessories	Ear-mic set
Antenna Specification	Helical antenna, 0.50 dBi
Power Source	Ni-MH battery pack / 3.6 VDC nominal / 700 mAh
Max. Output power	0.355 W
Max.SAR(1 g)	0.767 W/kg
Remark	The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.
FCC ID	MMAT250

3.1.1 The DUT conducted power measurements

Channel No	Frequency [MHz]	Conducted output Power [dBm]	Conducted output Power [W]	Target power [dBm]	Max. tune-up tolerance limit [dBm]	Scaling Factor
1	462.5625	25.39	0.346	25.00	26.00	1.15
2	462.5875	25.12	0.325	25.00	26.00	1.22
3	462.6125	25.27	0.337	25.00	26.00	1.18
4	462.6375	25.34	0.342	25.00	26.00	1.16
5	462.6625	25.36	0.343	25.00	26.00	1.16
6	462.6875	25.12	0.325	25.00	26.00	1.22
7	**462.7125**	**25.50**	**0.355**	**25.00**	**26.00**	**1.12**
8	467.5625	25.24	0.334	25.00	26.00	1.19
9	**467.5875**	**25.24**	**0.334**	**25.00**	**26.00**	**1.19**
10	467.6125	25.20	0.331	25.00	26.00	1.20
11	467.6375	24.86	0.306	25.00	26.00	1.30
12	467.6625	24.91	0.310	25.00	26.00	1.29
13	467.6875	24.91	0.310	25.00	26.00	1.29
14	467.7125	24.99	0.315	25.00	26.00	1.26
15	462.5500	24.94	0.312	25.00	26.00	1.28
16	462.5750	24.86	0.306	25.00	26.00	1.30
17	462.6000	24.81	0.303	25.00	26.00	1.31
18	462.6250	24.73	0.297	25.00	26.00	1.34
19	462.6500	24.88	0.307	25.00	26.00	1.29
20	462.6750	25.15	0.328	25.00	26.00	1.22
21	462.7000	25.15	0.328	25.00	26.00	1.22
22	462.7250	24.72	0.296	25.00	26.00	1.34

Note:

1) Conducted output power;
   The maximum powers are marks in bold.
2) Scaling Factor = tune-up limit power (㎽) / EUT RF power (㎽)
3) Tune-up tolerance is ± 1 dB.

3.2 Photographs of EUT

Front

Rear

Top

Bottom

Left

Right

3.3 Accessories

BLANK

3.4 Test Condition

3.4.1 Ambient Condition

• Ambient temperature : (20 - 21) ℃ • Relative Humidity : (53 ~ 57) % R.H.

3.4.2 Test Configuration

The EUT was tested in the face position with the front of the device 25 mm away from the flat phantom and the body position with the belt clip in contact with the flat phantom. The audio accessory was used for all body measurements.

For each of the tests conducted, the device was set to continuously transmit at a maximum output power on the channel specified in the test data. The SAR for analog mode was scaled to 50% duty cycle (as this is the maximum duty cycle of the device) per KDB 643646 D01 v01r03. All test reductions were reduced based on the reductions in KDB 643646 D01 v01r03.

3.5 Requirements for compliance testing defined by FCC

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones.
For consumer products, the applicable limit is 1.6 W/kg for an uncontrolled environment and 8.0 W/kg for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1.

According to the KDB publications by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

4. Specific Absorption Rate (SAR)

4.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

4.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (Dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

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

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = C\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

However, for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

4.3 SAR Measurement Procedure

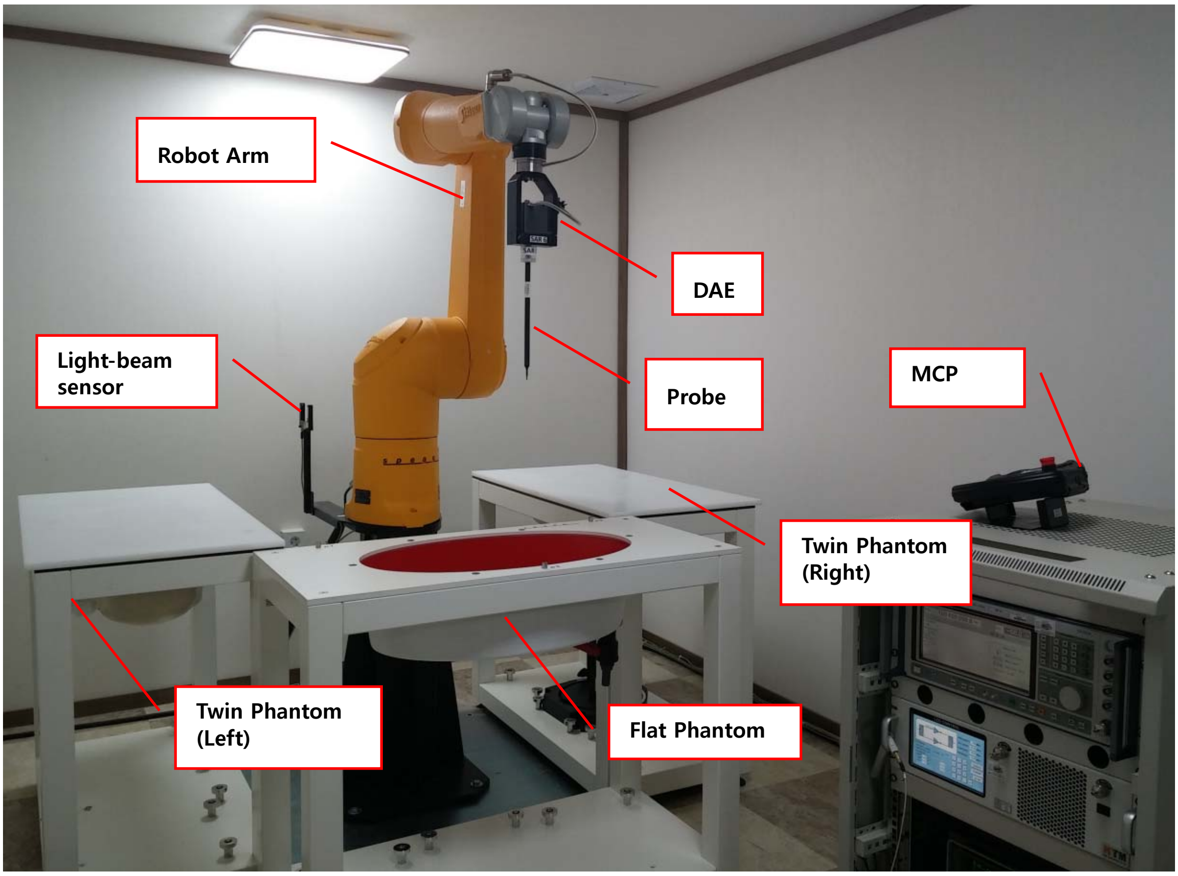
The DUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

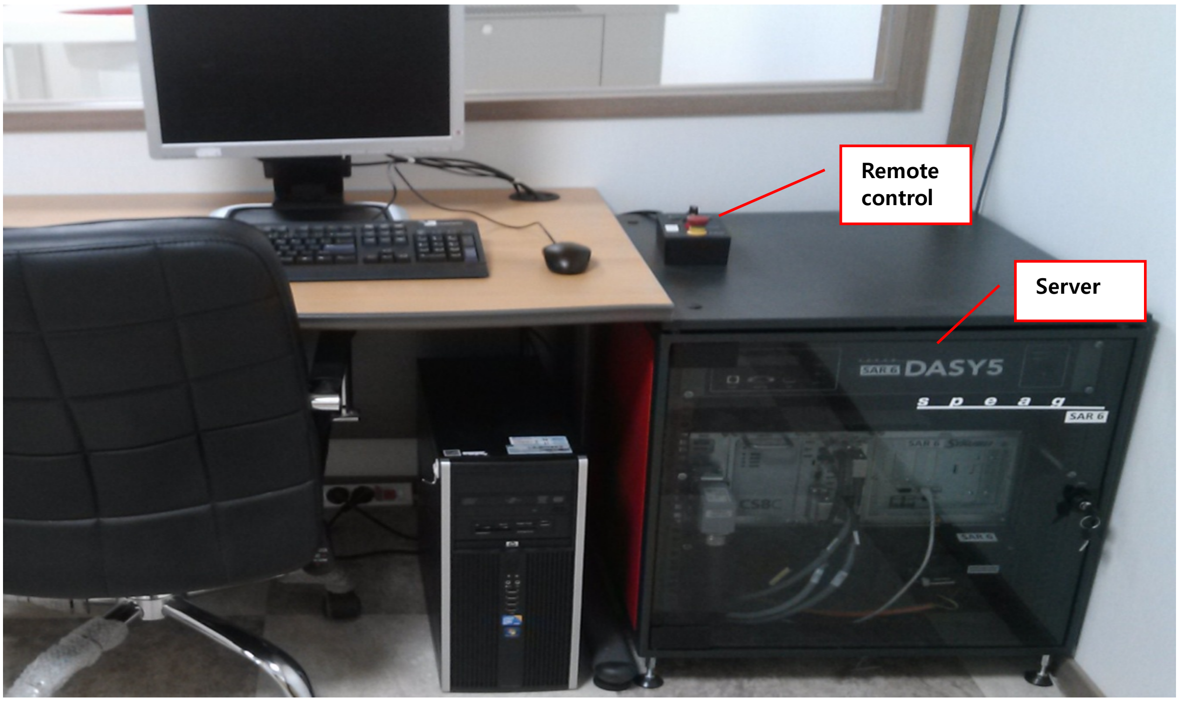
Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The DUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at 1 mm^2) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1 g and 10 g averages are derived from the zoom scan volume (interpolated resolution set at 1mm^3)

5. SAR Measurement System





[DASY52 SAR System Description]

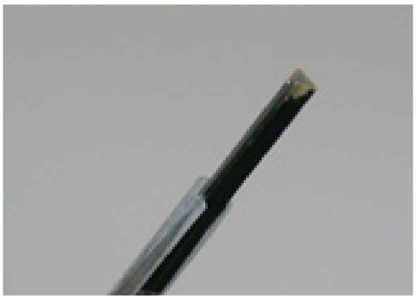
DASY52 SAR is a cost-effective package for demonstration of compliance of mobile phones with specific absorption rate (SAR) limits. The fastest and most accurate scanner on the market, it is fully compatible with all worldwide standards for transmitters operating at the ear or near the body (<200 mm from the skin).

The system consists of the following components;

1) TX90XL Stäubli Robot and Controller CS8c incl. Cabinet
2) EOCx Electro Optical Converter (mounted on robot arm)
3) Robot Stand for TX90XL
4) Robot Arm Extension and Adaptors
5) Robot Remote Control
6) LB5 Light Beam Switch for Probe Tooling (incl. LB Adaptor)
7) Light Beam Mounting Plate
8) DASY5 Measurement Server
9) Desktop PC / 3.4 GHz (or higher) incl. Color-Monitor 23"
10) SAM Twin Phantom V5.0 incl. Support DASY5
11) MD4HHTV5 Mounting Device for Hand-Held Transmitters
12) DAEx Data Acquisition Electronics
13) EX3 SAR Probe
14) DP5 Dummy Probe for Training Purposes
15) Dipoles (not in picture)

Some of the components are described in details in the following sub-sections.

5.1 E-field Probe



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

5.2 Mounting Devices

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)

5.3 DASY5 Robots

Our TX90 series of medium payload robots features an articulated arm with 6 degrees of freedom for optimum flexibility. A unique spherical work envelope allows maximum utilization of cell workspace. Additional benefits include floor, wall and ceiling mount options for easy robot integration. The robot arm's fully enclosed structure (rated IP65) makes it ideal for a wide range of applications, even in harsh environments.

Number of Axes	6
Nominal Load	5 kg
Maximum Load	12 kg
Reach	1450 mm
Repeatability	± 0.035 mm
Control Unit	CS8c
Programming Language	VAL3
Weight	116 kg

5.4 SAM Phantoms

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

5.5 ELI Phantoms

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

5.6 DAE4 - Data Acquisition Electronics

Signal amplifier, multiplexer, A/D converter, and control logic
Serial optical link for communication with DASY4/5 embedded system (fully remote controlled)
Two-step probe touch detector for mechanical surface detection and emergency robot stop

Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5 μV (with auto zero)
Input Resistance	200 MOhm
Input Bias Current	< 50 fA
Battery Power	> 10 hours of operation (with two 9.6 V NiMH accus)
Dimensions (L x W x H)	60 x 60 x 68 mm
Calibration	ISO/IEC 17025 calibration service available.

5.7 Validation Dipoles

Symmetrical dipole with l/4 balun
Enables measurement of feedpoint impedance with NWA
Matched for use near flat phantoms filled with tissue simulating solutions

Calibration	ISO/IEC 17025 calibration service available.
Return Loss	> 20 dB at specified validation position
Power Capability	> 100 W (f < 1GHz); > 40 W (f > 1GHz)

5.8 Test Equipment List

No.	Instrument	Manufacturer	Model	S/N	Due to cal date	Cal interval	used
1	Staubli robot	SPEAG	TX90XL	F10/5E6EA1/A/01 F10/5E6EA1/C/01	N/A	N/A	☒
2	DAE	SPEAG	DAE4	1240	2019.08.21	1 Year	☒
3	Twin SAM Phantom	SPEAG	QD 000 P40 CC	1600	N/A	N/A	☐
4	Twin SAM Phantom	SPEAG	QD 000 P40 CC	1601	N/A	N/A	☐
5	Flat Phantom	SPEAG	ELI V6.0	2002	N/A	N/A	☒
6	Mounting Device for Hand-Held Devices	SPEAG	MD4HHTV5	SD 000H01 MA	N/A	N/A	☒
7	SAR Probe	SPEAG	EX3 DV4	3664	2019.09.26	1 Year	☒
8	Reference Dipole	SPEAG	D450V3	1099	2019.10.25	2 Year	☒
9	Low pass filter	WAINWRIGMCS INSTRUMNENTS GMBH	WLJS1000-6EF	1	2020.01.24	1 Year	☒
10	Low pass filter	WAINWRIGMCS INSTRUMNENTS GMBH	WLJS2500-6EF	1	2020.01.24	1 Year	☐
11	High pass Filter	WAINWRIGMCS INSTRUMNENTS GMBH	WHJS3000-10EF	1	2020.01.24	1 Year	☐
12	Dual directional coupler	HEWLETT PACKARD	778D	17693	2020.01.24	1 Year	☒
13	Dual directional coupler	HEWLETT PACKARD	772D	2839A00924	2020.01.24	1 Year	☐
14	3.5 ㎜ Cal. Kit	Agilent Technologies	85033D	3423A07123	N/A	N/A	☒
15	3 ㏈ Attenuator	Weinschel Corp	23-3-34	BK2093	2019.12.19	1 Year	☒
16	Attenuator	Aeroflex / Weinschel	24-30-34	BX5630	2019.12.19	1 Year	☒
17	EPM Series Power meter	Agilent Technology	E4418B	MY41293610	2020.01.24	1 Year	☒
18	Power sensor	Agilent Technology	E9300A	MY41496666	2020.01.24	1 Year	☒
19	EPM Series Power meter	Agilent Technology	E4418B	GB39512547	2020.01.23	1 Year	☒
20	Power Sensor	Agilent Technology	E9300A	MY41496631	2020.01.23	1 Year	☒
21	RF Amplifier	Sung san Electronics Communications	SSA024	SSEC0001	2020.01.24	1 Year	☒
22	Signal Generator	Agilent Technology	E4428C	MY49070070	2020.01.25	1 Year	☒
23	Network Analyzer	Agilent	8753ES	US39170869	2019.09.03	1 Year	☒
24	85070E.Dielectric Probe kit	Agilent	85070 E	None	N/A	N/A	☒
25	Wideband Radio Communication Tester	ROHDE&SCHWARZ	CMW500	127302	2020.01.24	1 Year	☐
26	Radio Communication Analyzer	Anritsu	MT8821C	6261830568	2019.06.19	1 Year	☐

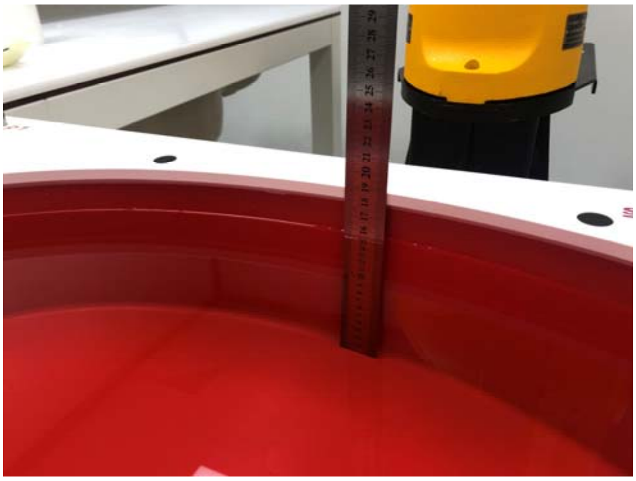
6. Measurement Results

6.1 Tissue Simulating Liquids

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. The uncertainty due to the liquid conductivity and permittivity arises from two different sources. The first source of error is the deviation of the liquid conductivity from its target value (max± 5 %)

For head SAR testing, the liquid height from the ear reference point of the phantom to the liquid top surface is larger than 15 cm. for body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm.

Head Tissue



Body Tissue

[Photo of liquid height for SAR testing]

6.1.1 Recipes for tissue simulating liquid.

Ingredients (% by weight)	Freq. (MHz)	
	450	
Tissue Type	Head	Body
Water	38.56	51.16
Salt (NaCl)	3.95	1.49
Sugar	56.32	46.78
HEC	0.98	0.52
Bactericide	0.19	0.05
Triton X-100	0.00	0.00
DGBE	0.00	0.00
Dielectric Constant	43.42	58.0
Conductivity (S/m)	0.85	0.83

6.1.2 Simulated tissue liquid parameter confirmation

The head and Body tissue dielectric parameters recommended by the KDB865664 D01 have been incorporated in the following table.

Target Frequency (MHz)	Head		Body	
	εr	σ (S/m)	εr	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
(εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3)				

6.1.3 Measuring result for simulating liquid

Liquid		Parameters	Target	Measured	Deviation (%)	Limit (%)	Date	Note
Freq. (MHz)	Temp. (°C)							
450.000 0	20	Permitivity	43.5	43.06	1.02	±5	2019.03.15.	Head tissue
		Conductivity	0.87	0.86	0.77	±5		
462.712 5	20	Permitivity	43.5	42.80	1.61	±5		
		Conductivity	0.87	0.87	0.00	±5		
467.587 5	20	Permitivity	43.5	42.70	1.84	±5		
		Conductivity	0.87	0.88	1.15	±5		
450.000 0	20	Permitivity	56.7	55.60	1.94	±5	2019.03.15.	Body tissue
		Conductivity	0.94	0.94	0.00	±5		
462.712 5	20	Permitivity	56.7	55.40	2.29	±5		
		Conductivity	0.94	0.95	1.06	±5		
467.587 5	20	Permitivity	56.7	55.32	2.43	±5		
		Conductivity	0.94	0.95	1.06	±5		

Note: Please see appendix for the plot of measured tissue.

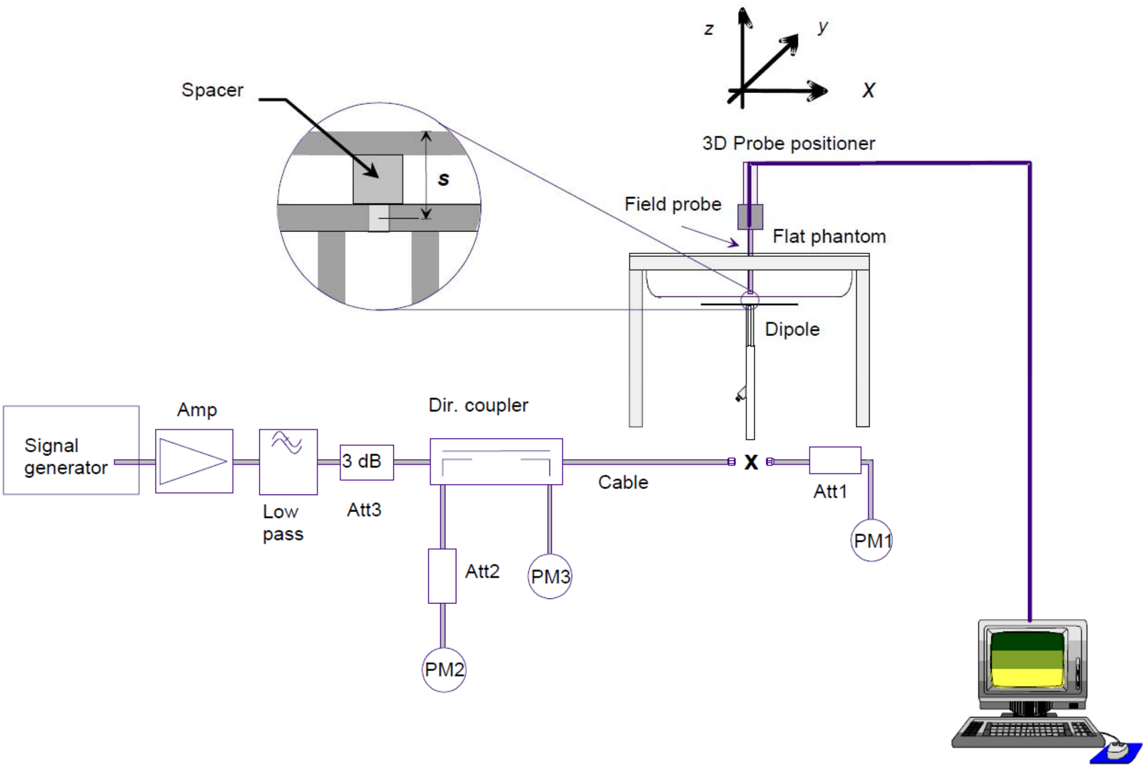
6.2 System Verification

6.2.1 Purpose of system performance check

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of ±5 %. Since the SAR value is calculated from the measured electric field, dielectric constant and conductivity of the body tissue and the SAR is proportional to the square of the electric field. So, the SAR value will be also proportional to the RF power input to the system validation dipole under the same test environment. In our system validation test, 100 mW RF dipole input power was used. The 1 g and 10 g spatial average SAR values normalized to 1 W dipole input power give reference data for comparisons and it's equal to 10 x (dipole forward power)

6.2.2 System setup

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



[System set-up for system verification]

[Photo of dipole setup]

6.2.3 Verification Results

Freq [MHz]	Test Results								Date	Tissue Type
	Measured 1 g SAR [W/kg]		Measured 10 g SAR [W/kg]		Target					
					1 g SAR	10 g SAR	1 g Dev.	10 g Dev.		
	100 mW	1 W	100 mW	1 W	[W/kg]	[W/kg]	[%]	[%]		
450	0.45	4.52	0.304	3.04	4.48	2.99	0.89	1.67	2019. 03. 15.	Head
450	0.47	4.69	0.312	3.12	4.49	3.01	4.45	3.65	2019. 03. 15.	Body

Note:

1. Comparing to the original SAR value provided by SPEAG, the validation data should be within its specification of 10 %. Above table shows the target SAR and measured SAR after normalized to 1W input power.

2. Please see appendix for the plot of system verification test.

6.3 DUT Testing Position

Please see appendix for the DUT setup photos

6.4 SAR measurement procedure

The ALSAS-10U calculates SAR using the following equation,

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

The measurement procedures are as follows:

1) For DUT, using engineering software and (or) radio communication tester to transmit RF power continuously in the middle channel.
2) Mesure output power through RF cable and power meter.
3) Place the DUT in the positions described in the appendix for the DUT setup photos.
4) set area scan, grid size and other setting on the ALSAS-10U software.
5) Taking data for the middle channel on each testing position.
6) Find out the largest SAR result on these testing positions of each band
7) measure SAR results for the lowest and highest channels in worst SAR testing position.

The area scan is then run to establish the peak SAR location (interpolated resolution set at 1 mm^2) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1 g and 10 g averages are derived from the zoom scan volume (interpolated resolution set at 1 mm^3).

6.5 SAR Exposure Limits

Type of Exposure	SAR Limit(W/kg)	
	(General Population /Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.6	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

6.6 SAR test result

HEAD Configuration

No	Mode	Freq.	CH	Test Position	Cond Pwr. (dBm)	Power Drift (dB)	Measured 1 g SAR (W/Kg)	50 % Duty cycle	Scaled 1 g SAR (W/Kg)	Scaling factor	Limit (W/Kg)	NOTE
1	FRS	462.7125	7	Face-up	25.50	-0.18	0.389	0.195	0.218	1.12	1.6	2.5 cm
2		467.5875	9	Face-up	25.24	-0.15	0.411	0.206	0.245 #1	1.19	1.6	

BODY Configuration

No	Mode	Freq.	CH	Test Position	Cond Pwr. (dBm)	Power Drift (dB)	Measured 1 g SAR (W/Kg)	50 % Duty cycle	Scaled 1 g SAR (W/Kg)	Scaling factor	Limit (W/Kg)	NOTE
1	FRS	462.7125	7	Body-worn	25.50	-0.14	1.370	0.685	0.767 #2	1.12	-0.14	0 cm
2		467.5875	9	Body-worn	25.24	-0.17	1.010	0.505	0.601	1.19	-0.17	

Note:

1. 50% duty cycle only applies to PTT devices.
2. Only one body-worn accessory(Belt-Clip) and one audio accessory are supplied with a EUT.
3. The EUT only supports Ni-MH battery pack.
4. # means the Plot's number.

Repeated SAR test Result

No	Mode	Freq.	CH	Test Position	Measured 1 g SAR (W/Kg)			Ratio	NOTE
					Original	1st Repeat	2nd Repeat		
Note: Not Applicable.									

SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).

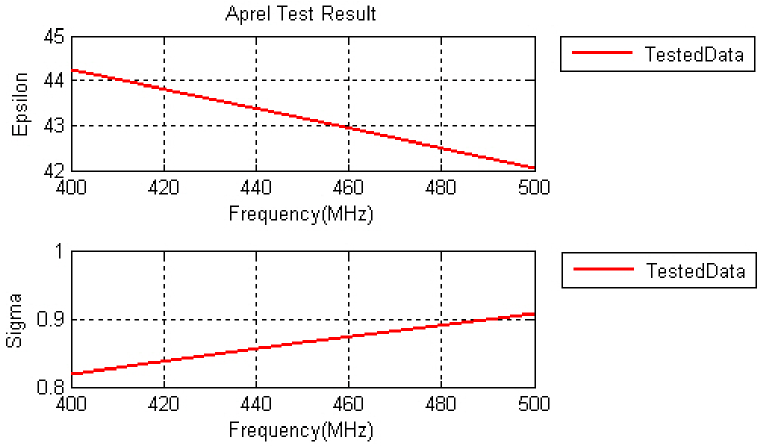
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

7. Uncertainty Assessment

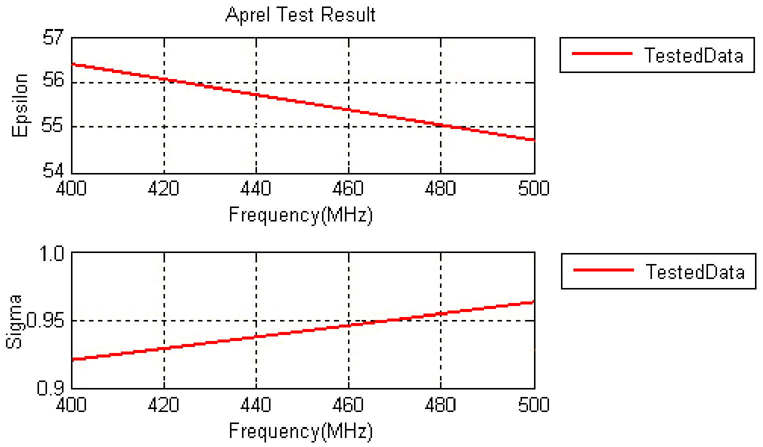
Error Description	Uncert. Value	Prob. Dist.	Div.	(ci) 1g	(ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(vi)
Measurement System								
Probe Calibration	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Linearity	4.7	R	√3	1	1	2.7	2.7	∞
Modulation Response	2.4	R	√3	1	1	1.4	1.4	∞
System Detection Limits	1.0	R	√3	1	1	0.6	0.6	∞
Boundary Effects	2.0	R	√3	1	1	1.2	1.2	∞
Readout Electronics	0.3	N	1	1	1	0.3	0.3	∞
Response Time	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	2.6	R	√3	1	1	1.5	1.5	∞
RF Amient Noise	3.0	R	√3	1	1	1.7	1.7	∞
RF Amient Reflecions	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner	0.8	R	√3	1	1	0.5	0.5	∞
Probe Positioing	6.7	R	√3	1	1	3.9	3.9	∞
Post-processing	4.0	R	√3	1	1	2.3	2.3	∞
Test Sample Related								
Device Holder	3.6	N	1	1	1	3.6	3.6	5.0
Test sample Positioning	2.9	N	1	1	1	2.9	2.9	145.0
Power Drift	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Setup								
Phantom Uncertainty	7.6	R	√3	1	1	4.4	4.4	∞
SAR correction	1.9	R	√3	1	0.84	1.1	0.9	∞
Liquid Conductivity (mea.)	5.0	R	√3	0.78	0.71	2.3	2.0	∞
Liquid Permittivity (mea.)	5.0	R	√3	0.26	0.26	0.8	0.8	∞
Temp. unc. - Conductivity	3.4	R	√3	0.78	0.71	1.5	1.4	∞
Temp. unc. - Permittivity	0.4	R	√3	0.23	0.26	0.1	0.1	∞
Combined Std. Uncertainty						12.1	12.0	
Expanded STD Uncertainty						24.3	24.1	

[Exposure Assessment Measurement Uncertainty]

Appendix A : Plot of measured tissue.



450 MHz Head



450 MHz Body

Measuring result table for simulating liquid

450 MHz Head

Freq	Test_e	Test_s
0.400000	44.27	0.83
0.450000	43.06	0.86
0.4627125	42.80	0.87*
0.4675875	42.70	0.88*
0.500000	42.05	0.91

*value interpolated

450 MHz Body

Freq	Test_e	Test_s
0.400000	56.56	0.92
0.450000	55.60	0.94
0.4627125	55.40	0.95*
0.4675875	55.32	0.95*
0.500000	54.81	0.96

*value interpolated

Appendix B : Plot of system verification test.

Date/Time: 3/15/2019 9:18:17 AM

Test Laboratory: Kostec Co., Ltd.

System Performance Check_450M Head

DUT: Dipole 450 MHz D450V2; Type: D450V2; Serial: D450V2 - SN:xxx

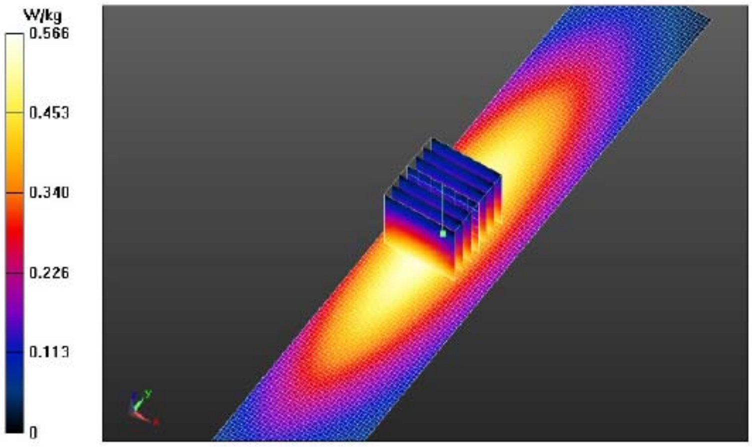
Communication System: UID 0, CW (0); Communication System Band: D450 (450.0 MHz); Frequency: 450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 450 MHz; σ = 0.86 S/m; ε_r = 43.06; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3664; ConvF(10.81, 10.81, 10.81); Calibrated: 9/26/2018;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1240; Calibrated: 8/21/2018
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration 2/System Perfomance Check_450 MHz/Area Scan (31x201x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.566 W/kg

Configuration 2/System Perfomance Check_450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 26.04 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 0.685 W/kg
SAR(1 g) = 0.452 W/kg; SAR(10 g) = 0.304 W/kg
Maximum value of SAR (measured) = 0.572 W/kg



Date/Time: 3/15/2019 12:40:25 PM

Test Laboratory: Kostec Co., Ltd.

System Performance Check_450M Body

DUT: Dipole 450 MHz D450V2; Type: D450V2; Serial: D450V2 - SN:xxx

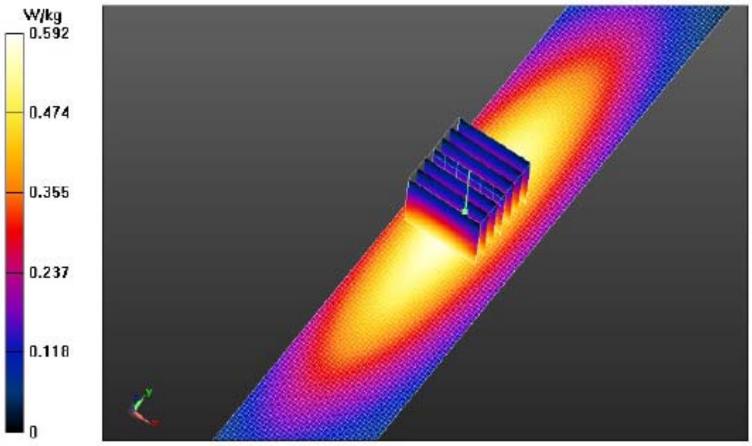
Communication System: UID 0, CW (0); Communication System Band: D450 (450.0 MHz); Frequency: 450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 450 MHz; σ = 0.94 S/m; ε_r = 55.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3664; ConvF(10.98, 10.98, 10.98); Calibrated: 9/26/2018;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1240; Calibrated: 8/21/2018
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/System Perfomance Check_450 MHz/Area Scan (31x201x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.592 W/kg

Configuration/System Perfomance Check_450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 25.35 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.731 W/kg
SAR(1 g) = 0.469 W/kg; SAR(10 g) = 0.312 W/kg
Maximum value of SAR (measured) = 0.599 W/kg



Appendix C : Plot of SAR test.

Test Plot list

No	Mode	Freq.	CH	Test Position	Measured 1 g SAR (W/Kg)	50 % Duty cycle(W/Kg)	Scaled 1 g SAR (W/Kg)	NOTE
1	FRS	467.588	9	Face-up	0.411	0.206	0.245	
2	FRS	462.713	7	Body-worn	1.370	0.685	0.767	

Date/Time: 3/15/2019 11:31:25 AM

Test Laboratory: Kostec Co., Ltd.

FRS_9CH_467.5875MHz Face-up

DUT: Midland Radio Corporation; Type: T250; Serial: Proto type

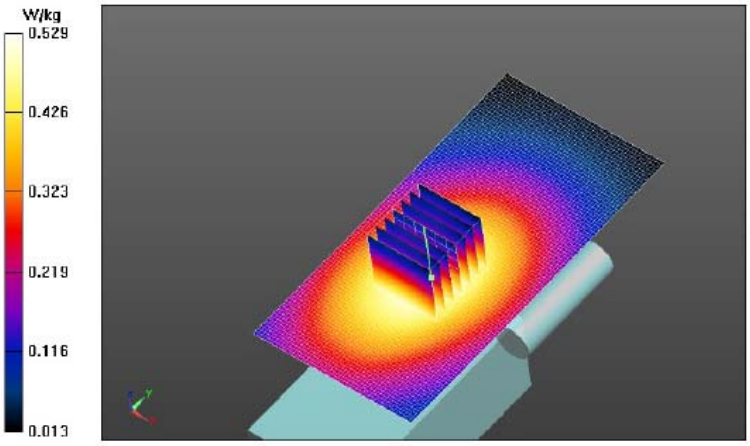
Communication System: UID 0, WALKIE TALKIE (0); Communication System Band: FRS; Frequency: 467.587 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used: f = 467.587 MHz; σ = 0.88 S/m; ε_r = 42.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3664; ConvF(10.81, 10.81, 10.81); Calibrated: 9/26/2018;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1240; Calibrated: 8/21/2018
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration 2/FRS_9ch_467.5875MHz Front/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.529 W/kg

Configuration 2/FRS_9ch_467.5875MHz Front/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 23.77 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 0.556 W/kg
SAR(1 g) = **0.411 W/kg**; SAR(10 g) = **0.302 W/kg**
Maximum value of SAR (measured) = 0.488 W/kg



Date/Time: 3/15/2019 1:15:35 PM

Test Laboratory: Kostec Co., Ltd.

FRS_CH7_462.7125 MHz Body-worn

DUT: Midland Radio Corporation; Type: T250; Serial: Proto type

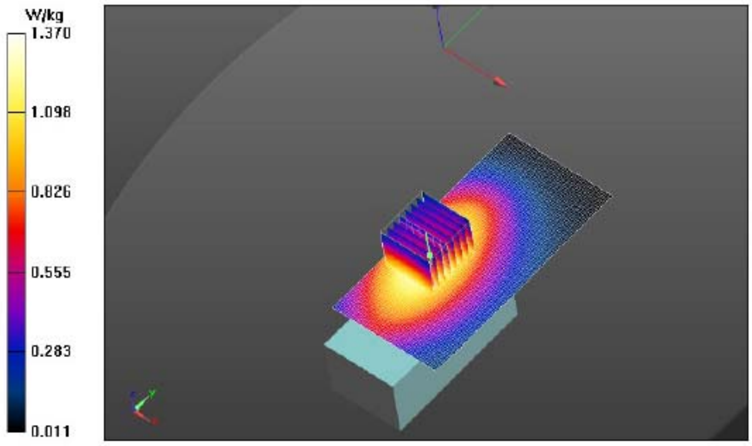
Communication System: UID 0, WALKIE TALKIE (0); Communication System Band: FRS; Frequency: 462.712 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used: f = 462.712 MHz; σ = 0.95 S/m; ε_r = 55.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3664; ConvF(10.98, 10.98, 10.98); Calibrated: 9/26/2018;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1240; Calibrated: 8/21/2018
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

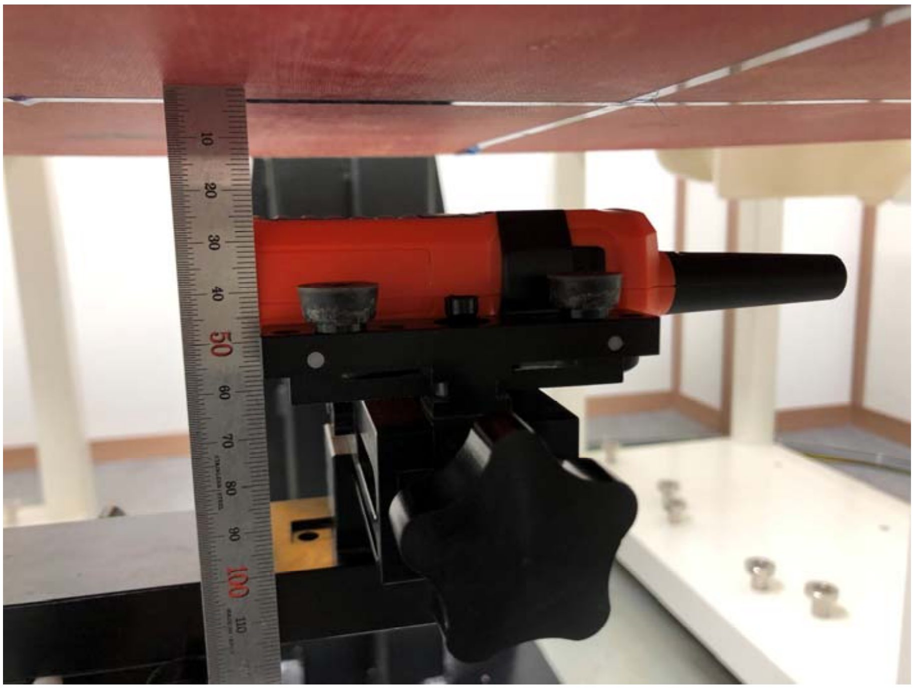
Configuration/FRS_7ch_462.7125MHz Rear/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.37 W/kg

Configuration/FRS_7ch_462.7125MHz Rear/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 34.11 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 1.91 W/kg
SAR(1 g) = 1.37 W/kg; SAR(10 g) = 0.998 W/kg
Maximum value of SAR (measured) = 1.65 W/kg



Appendix D: DUT setup photos

Face held configration



[FRONT]

Body worn configuration

[REAR]

Appendix E: System Certificate & calibration

E-1: Probe Calibration

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

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

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

Accreditation No.: **SCS 0108**

Client: **Kostec (Dymstec)**

Certificate No: **EX3-3664_Sep18**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3664

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: September 26, 2018

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	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
Reference Probe ES3DV2	SN: 3013	30-Dec-17 (No. ES3-3013_Dec17)	Dec-18
DAE4	SN: 660	21-Dec-17 (No. DAE4-660_Dec17)	Dec-18
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-17)	In house check: Oct-18

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

Issued: September 27, 2018

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

Certificate No: EX3-3664_Sep18 Page 1 of 11

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3664

Manufactured: October 20, 2008
Calibrated: September 26, 2018

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3664

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.62	0.49	0.50	± 10.1 %
DCP (mV)[B]	97.6	100.5	95.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	141.7	±3.0 %
		Y	0.0	0.0	1.0		146.8	
		Z	0.0	0.0	1.0		137.9	

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

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3664

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	43.5	0.87	10.81	10.81	10.81	0.14	1.20	± 13.3 %
600	42.7	0.88	10.60	10.60	10.60	0.10	1.20	± 13.3 %
750	41.9	0.89	10.48	10.48	10.48	0.46	0.86	± 12.0 %
835	41.5	0.90	10.21	10.21	10.21	0.45	0.80	± 12.0 %
900	41.5	0.97	10.04	10.04	10.04	0.42	0.86	± 12.0 %
1810	40.0	1.40	8.62	8.62	8.62	0.33	0.87	± 12.0 %
1900	40.0	1.40	8.56	8.56	8.56	0.28	0.87	± 12.0 %
2450	39.2	1.80	7.75	7.75	7.75	0.34	0.90	± 12.0 %
2600	39.0	1.96	7.69	7.69	7.69	0.32	0.99	± 12.0 %
5200	36.0	4.66	5.56	5.56	5.56	0.40	1.80	± 13.1 %
5300	35.9	4.76	5.36	5.36	5.36	0.40	1.80	± 13.1 %
5500	35.6	4.96	5.20	5.20	5.20	0.40	1.80	± 13.1 %
5600	35.5	5.07	5.05	5.05	5.05	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.10	5.10	5.10	0.40	1.80	± 13.1 %

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3664

Calibration Parameter Determined in Body Tissue Simulating Media

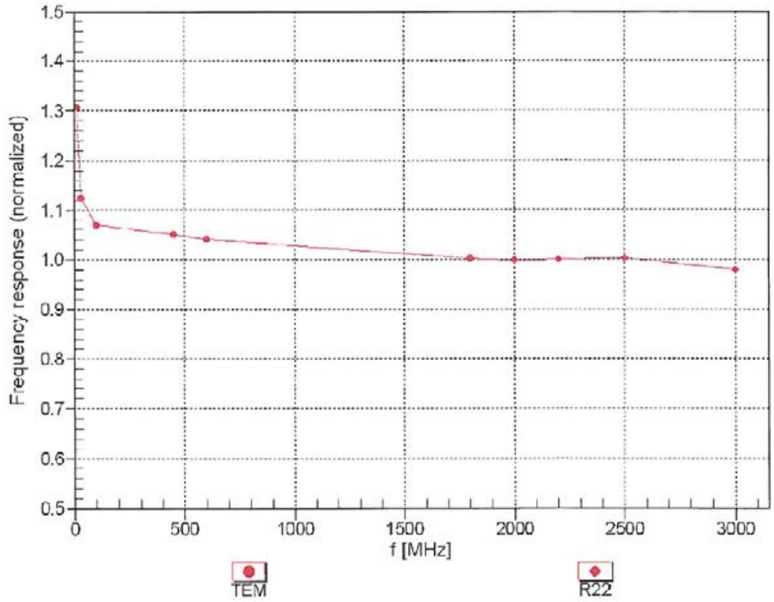
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	56.7	0.94	10.98	10.98	10.98	0.08	1.20	± 13.3 %

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

EX3DV4– SN:3664 September 26, 2018

Frequency Response of E-Field

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



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

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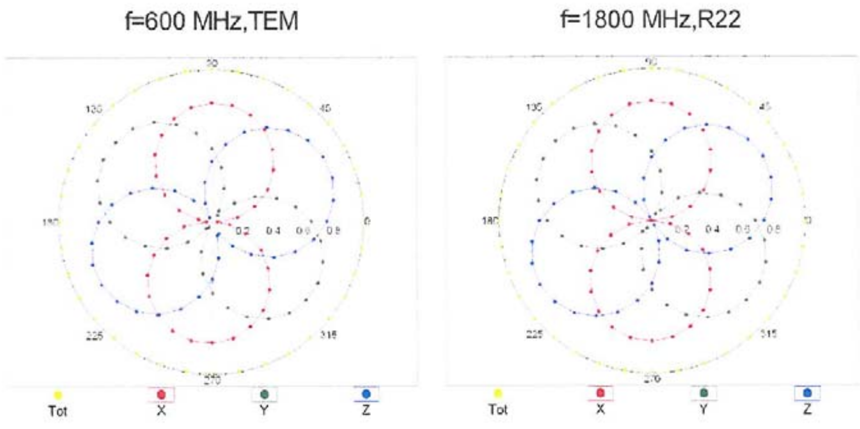
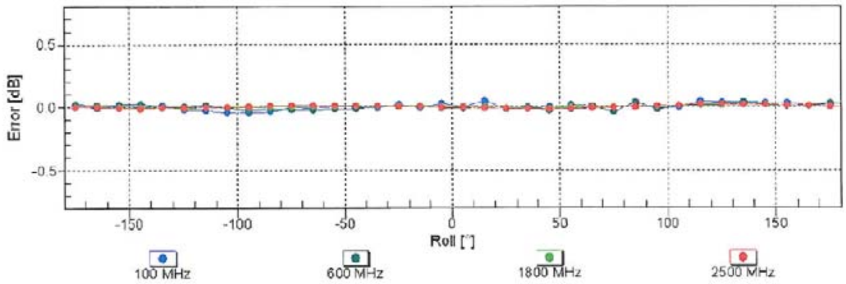
EX3DV4– SN:3664 September 26, 2018

Receiving Pattern (ϕ), ϑ = 0°





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

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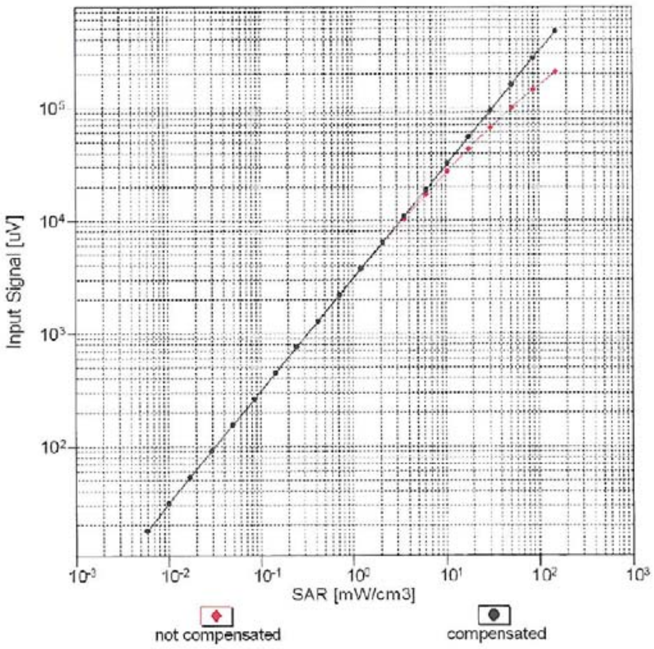
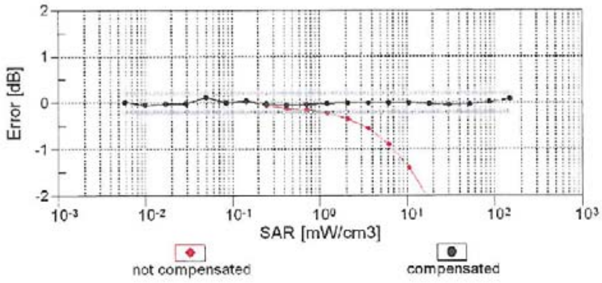
EX3DV4– SN:3664

September 26, 2018

Dynamic Range f(SAR$_{head}$)

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





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

Certificate No: EX3-3664_Sep18

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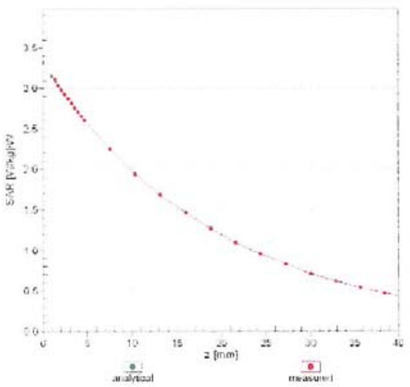
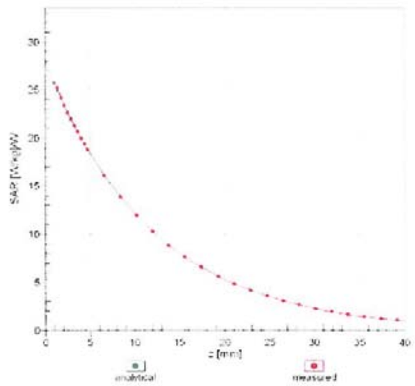
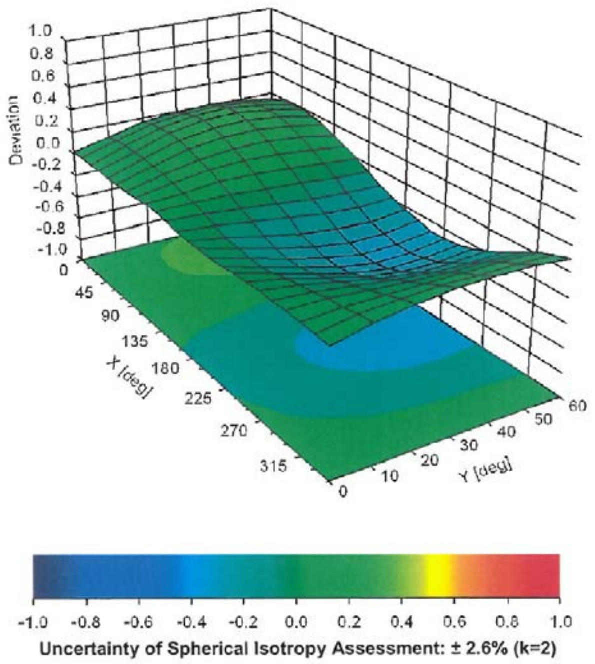
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3664

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	115.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

E-2: Dipole antenna Calibration (450 MHz)

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 **KOSTEC (Dymstec)**

Certificate No: **D450V3-1099_Oct17**

CALIBRATION CERTIFICATE

Object	D450V3 - SN:1099
Calibration procedure(s)	QA CAL-15.v8 Calibration procedure for dipole validation kits below 700 MHz
Calibration date:	October 25, 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	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 3877	31-Dec-16 (No. EX3-3877_Dec16)	Dec-17
DAE4	SN: 654	24-Jul-17 (No. DAE4-654_Jul17)	Jul-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (No. 217-02285/02284)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (No. 217-02285)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (No. 217-02284	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-17)	In house check: Oct-18

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

Issued: October 25, 2017

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	43.5 ± 6 %	0.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**4.48 W/kg ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.748 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**2.99 W/kg ± 17.6 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	56.7	0.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.2 ± 6 %	0.93 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**4.49 W/kg ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.751 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**3.01 W/kg ± 17.6 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	58.3 Ω - 2.7 jΩ
Return Loss	- 21.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	56.5 Ω - 4.7 jΩ
Return Loss	- 22.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.353 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	August 15, 2016

DASY5 Validation Report for Head TSL

Date: 25.10.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1099

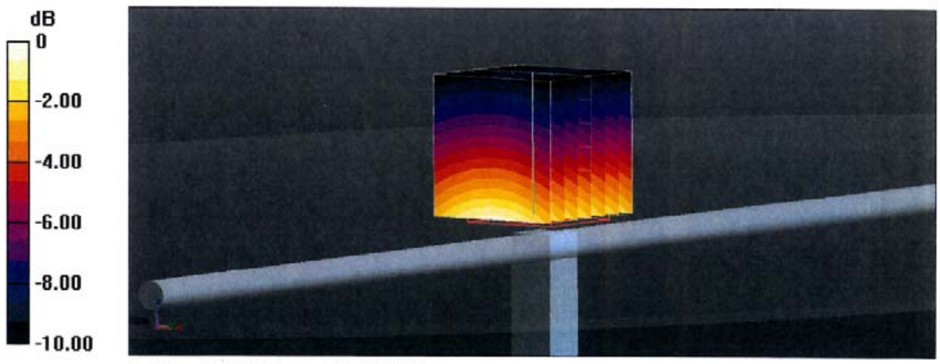
Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma = 0.87$ S/m; $\varepsilon_r = 43.5$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.5, 10.5, 10.5); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 43.26 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 1.73 W/kg
SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.748 W/kg
Maximum value of SAR (measured) = 1.51 W/kg



0 dB = 1.51 W/kg = 1.79 dBW/kg

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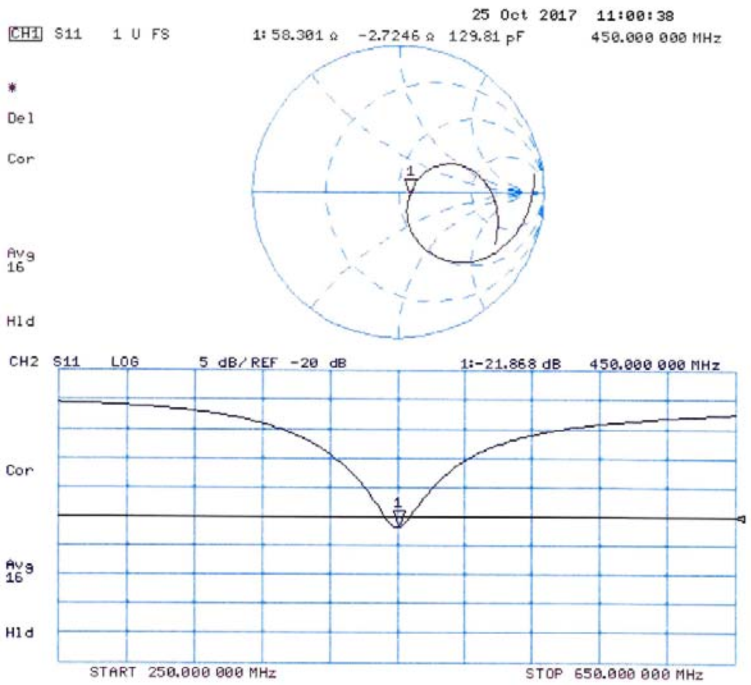
Impedance Measurement Plot for Head TSL



Certificate No: D450V3-1099_Oct17 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 25.10.2017

Test Laboratory: SPEAG, Zurich, Switzerland

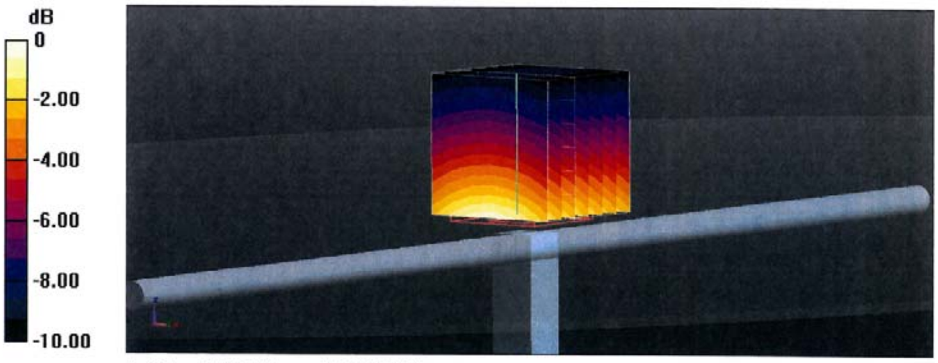
DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1099

Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; σ = 0.93 S/m; ε_r = 55.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

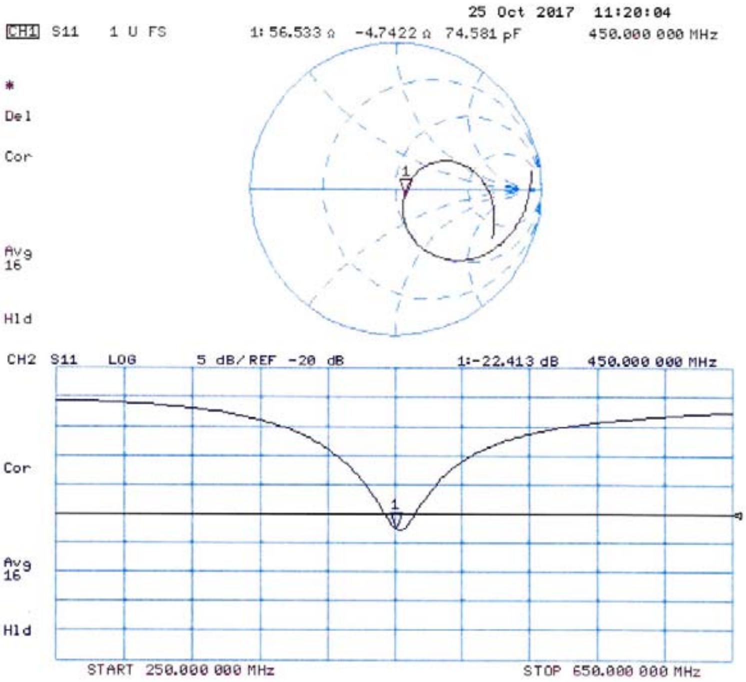
- Probe: EX3DV4 - SN3877; ConvF(10.7, 10.7, 10.7); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 41.76 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 1.74 W/kg
SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.751 W/kg
Maximum value of SAR (measured) = 1.51 W/kg



0 dB = 1.51 W/kg = 1.79 dBW/kg

Impedance Measurement Plot for Body TSL



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