SAR Compliance Test Report

Date of Report	18/05/2021	**Client's Contact person:**	Viktor Linde
Number of pages:	56	**Responsible Test engineer:**	Kirsi Kyllönen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Mobilaris AB** Kyrkogatan 2 972 32 Lulea Sweden
Tested device	Mobilaris Multitag		
Related reports:	-		
Testing has been carried out in accordance with:	**47CFR §2.1093** Radiofrequency Radiation Exposure Evaluation: Portable Devices **FCC published RF exposure KDB procedures** **IEEE 1528 - 2013** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Technique		
Documentation:	The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory		
Test Results:	**The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document		

Date and signatures:

18.05.2021

For the contents:

Miia Nurkkala

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Päiväys: 2021.05.18 13:03:48 +03'00'

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Mobilaris Multitag
Manufacturer:	Mobilaris AB
Model:	Multitag 1.0
IMEI Number:	352656109474893, 352656109475221, 352656109477508
FCC ID Number:	2AL7AMULTITAG1
DUT Number:	22000, 22001, 22002
Battery Type used in testing:	Integrated
State of the Sample	Production sample

Testing information:

Testing Performed:	23.4.2021 – 3.5.2021, 5.5.2021
Notes:	-
Document ID:	FCC SAR report Mobilaris ID4594b 18052021
Document history:	Initial version
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Jesper Varis, Kirsi Kyllönen
FCC Test Firm Designation Number	FI00005

1.2 Maximum Results

The maximum reported* SAR value for Body-worn configuration with 5mm separation distance for transmitting systems are shown in a table below. The device conforms to the requirements of the standards when the maximum reported SAR value is less than or equal to the limit. The SAR limit specified in FCC 47 CFR part 2 (2.1093) for Body is SAR_{1g} 1.6 W/kg.

System	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation	Result
LTE-M1, Band 12	**0.27**	**PASS**
LTE-M1, Band 13	**0.44**	**PASS**
LTE-M1, Band 26	**0.46**	**PASS**
LTE-M1, Band 66	**0.59**	**PASS**
NB-IoT, Band 12	**0.27**	**PASS**
NB-IoT, Band 13	**0.46**	**PASS**
NB-IoT, Band 17	**0.23**	**PASS**
NB-IoT, Band 26	**0.48**	**PASS**
NB-IoT, Band 66	**0.63**	**PASS**

* Reported SAR Values are scaled to maximum theoretical output power.

1.2.1 Power Density

The device conforms the radio frequency radiation exposure limits when the calculated power density values is less than equal to the limit.

Modes of Operation	Power Density, S [mW/cm^2]	Power Density Limit [mW/cm^2]	Result
UWB Positioning at 6739.6 MHz	**0.0057**	**1.0**	**PASS**

1.2.2 Simultaneous Transmission

UWB < 6GHz

Highest Simultaneous Transmission SAR	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation distance	Result
UWB positioning SAR at 4742.8MHz + Bluetooth SAR + NB-IoT SAR	**0.64**	**PASS**

UWB > 6GHz

Simultaneous Transmission Evaluation, UWB positioning at 6739.6 MHz	Highest SUM	Limit	Result
(NB-IoT SAR / SAR requirement) + (Bluetooth SAR / SAR requirement) + (UWB positioning at 6739.6 MHz Power Density / Power Density requirement)	**0.4**	**1.0**	**PASS**

1.2.3 Maximum Drift

Maximum Drift During Measurements	-0.23 dB*

*Drifts >5% have been considered in the scaling factor

1.2.4 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±23.4%

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The device is intended to be used as a tracker with capability to report GPS and other sensor data over a wireless interface to a back-end server. Sensor data to be reported are temperature, humidity, accelerometer data, gyro data, air pressure and gas data.

The device supports BLE, UWB, LTE-M1 and NB-IoT technologies. According to manufacturer LTE-M1 and NB-IoT the maximum transmission time is 0.285 seconds over every 5th second thus transmission duty cycle is 0.285/5 = 6%. For BLE the maximum duty cycle is 1.5% and for the UWB 10%.

For LTE-M1 and NB-IoT, SAR testing was conducted using a duty cycle of 33% thus the measured SAR values are conservative for the DUT.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

	Modes of Operation	**Transmitter Frequency Range (MHz)**
TX Frequency bands	Bluetooth Low Energy	2402-2480
	LTE-M1, Band 4	1710-1755
	LTE-M1, Band 5	824-849
	LTE-M1, Band 12	698-716
	LTE-M1, Band 13	777-787
	LTE-M1, Band 26	814-849
	LTE-M1, Band 66	1710-1780
	NB-IoT, Band 4	1710-1755
	NB-IoT, Band 5	824-849
	NB-IoT, Band 12	698-716
	NB-IoT, Band 13	777-787
	NB-IoT, Band 17	704-716
	NB-IoT, Band 26	814-849
	NB-IoT, Band 66	1710-1780
	UWB	3244.4-6739.6

2.2 SAR Test Exclusions

2.2.1 Bluetooth SAR Test Exclusion

According to Appendix A of 447498D01, the SAR test exclusion power threshold for 2450MHz is 10mW at <5mm separation distance. The maximum averaged power of the Bluetooth transmitter is 0.0945mW thus it is below the test exclusion threshold.

Transmission mode	Antenna to user separation [mm]	Output power [dBm]	Output power [mW]	Power Gain of Antenna, G [dBi]	Time averaged output power [mW]
Bluetooth Low Energy	5	8	6.3	2	0.0945

2.2.2 UWB Below 6GHz SAR Test Exclusion

Highest channel for the UWB below 6GHz is channel 3 which is operating at 4742.8MHz. According to Appendix A of 447498D01, the SAR test exclusion power threshold for 5200MHz is 7mW at <5mm separation distance. The maximum averaged power of the UWB transmitter is 0.1mW thus it is below the test exclusion threshold.

Transmission mode	Antenna to user separation [mm]	Output power [dBm]	Output power [mW]	Power Gain of Antenna, G [dBi]	Time averaged output power [mW]
UWB	5	0	1	2.5	0.1

Above 6 GHz, power density is the appropriate metric to assess RF exposure compliance.

2.2.3 Excluded Bands from Testing

According to April 2015 TCB workshop, SAR test exclusion can be applied for testing overlapping LTE bands when the specified maximum output power, including tune-up tolerance, is less or same for the smaller band as for the larger band.
The channel bandwidth and other operating parameters for the smaller band must be fully supported by the larger band.

For this product LTE-M1 4 band, 1710-1755 MHz, is excluded from the testing as it is fully covered by LTE-M1 66 band, 1710-1780 MHz. LTE-M1 5 band, 824-849 MHz is excluded as it is fully covered by LTE-M1 26 band, 814-849 MHz.

2.3 Simultaneous Transmission

Bluetooth, UWB, LTE-M1 or NB-IoT can be operated simultaneously.

Possible simultaneous transmissions are:

Bluetooth + LTE-M1
Bluetooth + NB-IoT
Bluetooth + UWB
UWB + LTE-M1
UWB + NB-IoT
Bluetooth + UWB + LTE-M1
Bluetooth + UWB + NB-IoT

3. OUTPUT POWER

3.1 Maximum Output Power

From a Customer, maximum defined output power, including tune-up tolerance;

LTE-M1/NB-IoT	Max Output Power [dBm]
LTE-M1, Band 12	23.5
LTE-M1, Band 13	23.5
LTE-M1, Band 26	23.5
LTE-M1, Band 66	23.5
NB-IoT, Band 12	23.5
NB-IoT, Band 13	23.5
NB-IoT, Band 17	23.5
NB-IoT, Band 26	23.5
NB-IoT, Band 66	23.5

Bluetooth	Max Output Power [dBm]
Bluetooth Low Energy	8

UWB	Max Output Power [dBm]
UWB	0

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector [dBm].

3.2.1 LTE-M1

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 23017 699.7 MHz	CH 23095 707.5 MHz	CH 23173 715.3 MHz	3GPP MPR [dB]	CH 23017 699.7 MHz	CH 23095 707.5 MHz	CH 23173 715.3 MHz	3GPP MPR [dB]
12 / 1.4M	1	0	23.19	23.03	23.06	0	22.22	22.05	21.98	1
	1	2	23.27	23.2	23.17	0	22.28	22.29	22.16	1
	1	5	23.13	23.04	22.93	0	22.25	22.15	21.88	1
	3	0	22.24	22.16	22.07	1	21.21	21.28	21.09	2
	3	1	22.26	22.21	22.17	1	21.26	21.3	21.19	2
	3	3	22.27	22.18	22.06	1	21.2	21.33	21.13	2
	6	0	21.3	21.23	21.13	2	23.19	23.23	23.13	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 23025 700.5 MHz	CH 23095 707.5 MHz	CH 23165 714.5 MHz	3GPP MPR [dB]	CH 23025 700.5 MHz	CH 23095 707.5 MHz	CH 23165 714.5 MHz	3GPP MPR [dB]
12 / 3M	1	0	23.13	23.1	22.99	0	22.14	22.07	22.13	1
	1	2	23.29	23.17	23.18	0	22.33	22.25	22.24	1
	1	5	23.12	23.03	23.01	0	22.17	22.08	22.14	1
	3	0	22.29	22.29	22.1	1	21.2	21.27	21.16	2
	3	1	22.34	22.26	22.22	1	21.29	21.38	21.3	2
	3	3	22.2	22.16	22.11	1	21.27	21.28	21.22	2
	6	0	21.22	21.2	21.19	2	23.17	23.18	23.19	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 23035 701.5 MHz	CH 23095 707.5 MHz	CH 23155 713.5 MHz	3GPP MPR [dB]	CH 23035 701.5 MHz	CH 23095 707.5 MHz	CH 23155 713.5 MHz	3GPP MPR [dB]
12 / 5M	1	0	23.18	23.11	23.12	0	22.99	23.02	22.97	0
	1	2	23.28	23.23	23.2	0	23.15	23.21	23.08	0
	1	5	23.18	23.01	23.05	0	22.94	22.95	22.98	0
	3	0	22.28	22.23	22.22	1	22.3	22.29	22.3	1
	3	1	22.35	22.22	22.24	1	22.41	22.37	22.27	1
	3	3	22.29	22.17	22.17	1	22.33	22.31	22.31	1
	6	0	22.28	22.24	22.11	1	22.93	22.98	23.0	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 23060 704.0 MHz	CH 23095 707.5 MHz	CH 23130 711.0 MHz	3GPP MPR [dB]	CH 23060 704.0 MHz	CH 23095 707.5 MHz	CH 23130 711.0 MHz	3GPP MPR [dB]
12 / 10M	1	0	23.13	23.14	23.13	0	23.09	22.95	22.94	0
	1	2	23.27	23.24	23.2	0	23.07	23.19	23.2	0
	1	5	23.16	23.06	23.03	0	22.93	22.99	22.95	0
	3	0	23.29	23.18	23.24	0	22.99	22.97	23.07	0
	3	1	23.28	23.28	23.23	0	22.99	23.06	23.05	0
	3	3	23.2	23.2	23.14	0	22.97	22.99	22.97	0
	6	0	22.28	22.18	22.11	1	22.92	22.84	22.87	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 23205 779.5 MHz	CH 23230 782.0 MHz	CH 23255 784.5 MHz	3GPP MPR [dB]	CH 23205 779.5 MHz	CH 23230 782.0 MHz	CH 23255 784.5 MHz	3GPP MPR [dB]
13 / 5M	1	0	23.12	23.02	22.99	0	23.1	22.96	22.97	0
	1	2	23.19	23.18	23.19	0	23.14	23.09	23.18	0
	1	5	23.02	23.01	23.0	0	23.09	22.97	22.95	0
	3	0	22.31	22.11	22.21	1	22.35	22.24	22.29	1
	3	1	22.27	22.19	22.22	1	22.3	22.29	22.3	1
	3	3	22.19	22.11	22.2	1	22.32	22.23	22.29	1
	6	0	22.2	22.12	22.21	1	22.86	22.89	22.83	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			NA	CH 23230 782.0 MHz	NA	3GPP MPR [dB]	NA	CH 23230 782.0 MHz	NA	3GPP MPR [dB]
13 / 10M	1	0	23.07	23.07	23.07	0	22.94	22.94	22.94	0
	1	2	23.24	23.24	23.24	0	23.04	23.04	23.04	0
	1	5	23.04	23.04	23.04	0	22.94	22.94	22.94	0
	3	0	23.19	23.19	23.19	0	22.92	22.92	22.92	0
	3	1	23.17	23.17	23.17	0	23.02	23.02	23.02	0
	3	3	23.09	23.09	23.09	0	22.88	22.88	22.88	0
	6	0	22.17	22.17	22.17	1	22.79	22.79	22.79	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 26697 814.7 MHz	CH 26865 831.5 MHz	CH 27033 848.3 MHz	3GPP MPR [dB]	CH 26697 814.7 MHz	CH 26865 831.5 MHz	CH 27033 848.3 MHz	3GPP MPR [dB]
26 / 1.4M	1	0	23.0	23.03	22.9	0	22.03	22.09	22.0	1
	1	2	23.11	23.14	23.03	0	22.11	22.22	22.21	1
	1	5	22.94	23.0	22.88	0	21.96	22.1	21.95	1
	3	0	22.04	22.21	22.05	1	21.06	21.21	21.04	2
	3	1	22.13	22.23	22.13	1	21.07	21.27	21.16	2
	3	3	22.06	22.12	21.96	1	21.12	21.18	21.06	2
	6	0	21.13	21.22	21.03	2	22.99	23.06	22.94	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 26705 815.5 MHz	CH 26865 831.5 MHz	CH 27025 847.5 MHz	3GPP MPR [dB]	CH 26705 815.5 MHz	CH 26865 831.5 MHz	CH 27025 847.5 MHz	3GPP MPR [dB]
26 / 3M	1	0	23.04	23.07	22.98	0	22.05	22.11	21.94	1
	1	2	23.12	23.19	23.05	0	22.2	22.26	22.08	1
	1	5	22.91	22.99	22.9	0	22.03	22.04	21.97	1
	3	0	22.14	22.16	22.03	1	21.0	21.13	21.07	2
	3	1	22.05	22.21	22.07	1	21.17	21.27	21.26	2
	3	3	22.06	22.17	21.97	1	21.12	21.13	21.11	2
	6	0	21.13	21.13	21.03	2	23.0	23.1	23.0	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 26715 816.5 MHz	CH 26865 831.5 MHz	CH 27015 846.5 MHz	3GPP MPR [dB]	CH 26715 816.5 MHz	CH 26865 831.5 MHz	CH 27015 846.5 MHz	3GPP MPR [dB]
26 / 5M	1	0	23.06	23.08	23.03	0	22.97	22.93	22.85	0
	1	2	23.24	23.21	23.1	0	23.1	23.07	23.01	0
	1	5	23.08	23.01	22.83	0	22.98	22.9	22.87	0
	3	0	22.03	22.14	22.07	1	22.14	22.29	22.19	1
	3	1	22.1	22.16	22.05	1	22.16	22.34	22.23	1
	3	3	22.04	22.17	22.07	1	22.13	22.15	22.19	1
	6	0	22.03	22.15	21.96	1	22.7	22.74	22.79	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 26740 819 MHz	CH 26865 831.5 MHz	CH 26990 844 MHz	3GPP MPR [dB]	CH 26740 819 MHz	CH 26865 831.5 MHz	CH 26990 844 MHz	3GPP MPR [dB]
26 / 10M	1	0	23.06	23.08	22.95	0	22.88	22.94	23.02	0
	1	2	23.17	23.14	23.08	0	23.02	23.08	23.11	0
	1	5	22.96	22.95	22.87	0	22.85	23.0	22.85	0
	3	0	23.06	23.13	23.08	0	22.82	22.98	22.89	0
	3	1	23.15	23.23	23.11	0	22.92	23.03	22.98	0
	3	3	23.11	23.14	23.0	0	22.85	22.99	22.9	0
	6	0	22.03	22.18	22.02	1	22.73	22.77	22.69	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 26765 821.5 MHz	CH 26865 831.5 MHz	CH 26965 841.5 MHz	3GPP MPR [dB]	CH 26765 821.5 MHz	CH 26865 831.5 MHz	CH 26965 841.5 MHz	3GPP MPR [dB]
26 / 15M	1	0	21.8	23.06	23.04	0	22.78	22.84	22.78	0
	1	2	23.16	23.21	23.14	0	23.05	22.98	23.17	0
	1	5	23.01	23.0	22.93	0	22.84	23.03	22.8	0
	3	0	23.24	23.21	23.01	0	22.87	22.94	22.85	0
	3	1	23.21	23.23	23.03	0	22.86	22.99	22.93	0
	3	3	23.12	23.21	23.01	0	22.89	22.93	22.81	0
	6	0	23.11	23.22	23.01	0	22.65	22.76	22.69	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 131979 1710.7 MHz	CH 132322 1745.0 MHz	CH 132665 1779.3 MHz	3GPP MPR [dB]	CH 131979 1710.7 MHz	CH 132322 1745.0 MHz	CH 132665 1779.3 MHz	3GPP MPR [dB]
66 / 1.4M	1	0	23.34	23.19	23.22	0	22.25	22.25	22.28	1
	1	2	23.43	23.31	23.35	0	22.48	22.3	22.35	1
	1	5	23.26	23.11	23.17	0	22.21	22.28	22.09	1
	3	0	22.42	22.35	22.21	1	21.4	21.4	21.26	2
	3	1	22.57	22.39	22.34	1	21.51	21.43	21.32	2
	3	3	22.49	22.32	22.23	1	21.45	21.42	21.25	2
	6	0	21.4	21.27	21.34	2	23.33	23.31	23.26	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 131987 1711.5 MHz	CH 132322 1745.0 MHz	CH 132657 1778.5 MHz	3GPP MPR [dB]	CH 131987 1711.5 MHz	CH 132322 1745.0 MHz	CH 132657 1778.5 MHz	3GPP MPR [dB]
66 / 3M	1	0	23.35	23.12	23.16	0	22.35	22.29	22.23	1
	1	2	23.47	23.29	23.29	0	22.48	22.41	22.3	1
	1	5	23.31	23.09	23.1	0	22.28	22.21	22.14	1
	3	0	22.44	22.3	22.26	1	21.43	21.38	21.36	2
	3	1	22.52	22.39	22.38	1	21.48	21.43	21.44	2
	3	3	22.46	22.29	22.24	1	21.45	21.33	21.33	2
	6	0	21.43	21.31	21.32	2	23.37	23.24	23.24	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 131997 1712.5 MHz	CH 132322 1745.0 MHz	CH 132647 1777.5 MHz	3GPP MPR [dB]	CH 131997 1712.5 MHz	CH 132322 1745.0 MHz	CH 132647 1777.5 MHz	3GPP MPR [dB]
66 / 5M	1	0	23.33	23.29	23.29	0	22.65	22.47	22.47	0
	1	2	23.43	23.4	23.4	0	22.73	22.58	22.54	0
	1	5	23.31	23.25	23.2	0	22.62	22.45	22.49	0
	3	0	22.45	22.39	22.23	1	22.48	22.45	22.35	1
	3	1	22.54	22.37	22.34	1	22.58	22.47	22.45	1
	3	3	22.51	22.28	22.27	1	22.48	22.42	22.4	1
	6	0	22.46	22.38	22.24	1	23.09	22.98	22.95	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 132022 1715.0 MHz	CH 132322 1745.0 MHz	CH 132622 1775.0 MHz	3GPP MPR [dB]	CH 132022 1715.0 MHz	CH 132322 1745.0 MHz	CH 132622 1775.0 MHz	3GPP MPR [dB]
66 / 10M	1	0	23.33	23.21	23.3	0	22.55	22.53	22.41	0
	1	2	23.5	23.35	23.41	0	22.71	22.57	22.55	0
	1	5	23.26	23.15	23.31	0	22.59	22.42	22.49	0
	3	0	23.42	23.31	23.32	0	22.58	22.45	22.37	0
	3	1	23.51	23.45	23.38	0	22.55	22.43	22.51	0
	3	3	23.44	23.27	23.32	0	22.46	22.38	22.36	0
	6	0	22.49	22.26	22.27	1	23.08	22.96	22.95	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 132047 1717.5 MHz	CH 132322 1745.0 MHz	CH 132597 1772.5 MHz	3GPP MPR [dB]	CH 132047 1717.5 MHz	CH 132322 1745.0 MHz	CH 132597 1772.5 MHz	3GPP MPR [dB]
66 / 15M	1	0	23.32	23.22	23.19	0	22.55	22.43	22.41	0
	1	2	23.38	23.37	23.26	0	22.66	22.52	22.5	0
	1	5	23.32	23.13	23.12	0	22.48	22.57	22.39	0
	3	0	23.38	23.33	23.38	0	22.36	22.47	22.4	0
	3	1	23.48	23.34	23.36	0	22.47	22.43	22.41	0
	3	3	23.4	23.27	23.28	0	22.4	22.52	22.34	0
	6	0	23.4	23.26	23.27	0	23.03	23.02	22.93	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 132072 1720.0 MHz	CH 132322 1745.0 MHz	CH 132572 1770.0 MHz	3GPP MPR [dB]	CH 132072 1720.0 MHz	CH 132322 1745.0 MHz	CH 132572 1770.0 MHz	3GPP MPR [dB]
66 / 20M	1	0	23.25	23.3	23.23	0	22.68	22.57	22.3	0
	1	2	23.39	23.38	23.36	0	22.44	22.69	22.54	0
	1	5	23.23	23.19	23.23	0	22.49	22.47	22.4	0
	3	0	23.38	23.37	23.28	0	22.43	22.39	22.32	0
	3	1	23.44	23.44	23.34	0	22.54	22.37	22.38	0
	3	3	23.29	23.38	23.26	0	22.42	22.41	22.3	0
	6	0	23.28	23.38	23.25	0	23.03	23.01	22.82	0

3.2.2 NB-IoT

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 23011 699.1 MHz	CH 23095 707.5 MHz	CH 23179 715.9 MHz	3GPP MPR [dB]	CH 23011 699.1 MHz	CH 23095 707.5 MHz	CH 23179 715.9 MHz	3GPP MPR [dB]
12	3.75	1	0	23.08	23.13	23.02	N/A	23.1	23.14	23.03	N/A
		1	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	47	23.02	23.06	22.95	N/A	23.04	23.09	22.97	N/A
	15	1	0	23.24	23.15	23.04	N/A	23.08	23.03	23.15	N/A
		1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	11	23.14	23.07	23.2	N/A	23.09	23.05	23.15	N/A
		3	0	N/A	N/A	N/A	N/A	22.9	22.97	22.85	N/A
		3	3	N/A	N/A	N/A	N/A	22.88	22.91	22.9	N/A
		3	6	N/A	N/A	N/A	N/A	23.0	22.96	22.79	N/A
		3	9	N/A	N/A	N/A	N/A	22.92	22.88	22.74	N/A
		6	0	N/A	N/A	N/A	N/A	22.18	21.89	21.86	N/A
		6	6	N/A	N/A	N/A	N/A	22.14	22.07	21.85	N/A
		12	0	N/A	N/A	N/A	N/A	20.94	20.99	21.01	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 23181 777.1 MHz	CH 23230 782 MHz	CH 23279 786.9 MHz	3GPP MPR [dB]	CH 23181 777.1 MHz	CH 23230 782 MHz	CH 23279 786.9 MHz	3GPP MPR [dB]
13	3.75	1	0	23.09	22.98	23.08	N/A	23.1	22.99	23.1	N/A
		1	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	47	23.01	22.91	23.01	N/A	23.04	22.93	23.03	N/A
	15	1	0	23.11	23.01	23.04	N/A	23.12	23.12	23.14	N/A
		1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	11	23.08	23.1	23.12	N/A	23.12	23.11	23.12	N/A
		3	0	N/A	N/A	N/A	N/A	22.97	22.88	22.87	N/A
		3	3	N/A	N/A	N/A	N/A	22.91	22.79	22.89	N/A
		3	6	N/A	N/A	N/A	N/A	22.91	22.79	22.89	N/A
		3	9	N/A	N/A	N/A	N/A	22.95	22.75	22.85	N/A
		6	0	N/A	N/A	N/A	N/A	22.23	22.05	21.96	N/A
		6	6	N/A	N/A	N/A	N/A	22.23	22.05	22.13	N/A
		12	0	N/A	N/A	N/A	N/A	21.31	20.92	21.21	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 23731 704.1 MHz	CH 23790 710 MHz	CH 23849 715.9 MHz	3GPP MPR [dB]	CH 23731 704.1 MHz	CH 23790 710 MHz	CH 23849 715.9 MHz	3GPP MPR [dB]
17	3.75	1	0	23.02	22.95	22.91	N/A	23.05	22.96	22.92	N/A
		1	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	47	22.97	22.88	22.83	N/A	22.99	22.9	22.86	N/A
	15	1	0	23.1	23.03	23.08	N/A	23.12	23.08	23.05	N/A
		1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	11	23.18	23.12	23.07	N/A	23.16	23.08	23.04	N/A
		3	0	N/A	N/A	N/A	N/A	22.93	22.87	22.78	N/A
		3	3	N/A	N/A	N/A	N/A	22.92	22.86	22.8	N/A
		3	6	N/A	N/A	N/A	N/A	23.02	22.93	22.89	N/A
		3	9	N/A	N/A	N/A	N/A	22.89	22.81	22.76	N/A
		6	0	N/A	N/A	N/A	N/A	22.06	22.07	22.02	N/A
		6	6	N/A	N/A	N/A	N/A	22.1	21.95	21.93	N/A
		12	0	N/A	N/A	N/A	N/A	21.17	21.13	21.09	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 26691 814.1 MHz	CH 26865 831.5 MHz	CH 27039 848.9 MHz	3GPP MPR [dB]	CH 26691 814.1 MHz	CH 26865 831.5 MHz	CH 27039 848.9 MHz	3GPP MPR [dB]
26	3.75	1	0	22.97	22.98	22.97	N/A	22.98	22.99	22.95	N/A
		1	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	47	22.92	22.94	22.91	N/A	22.92	22.94	22.9	N/A
	15	1	0	22.97	23.11	23.0	N/A	23.06	23.12	23.09	N/A
		1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	11	23.07	23.1	23.07	N/A	23.04	23.09	22.99	N/A
		3	0	N/A	N/A	N/A	N/A	22.95	22.98	22.86	N/A
		3	3	N/A	N/A	N/A	N/A	22.88	23.02	22.9	N/A
		3	6	N/A	N/A	N/A	N/A	22.95	22.94	22.91	N/A
		3	9	N/A	N/A	N/A	N/A	22.88	22.9	22.77	N/A
		6	0	N/A	N/A	N/A	N/A	22.11	21.94	22.01	N/A
		6	6	N/A	N/A	N/A	N/A	22.1	21.94	22.01	N/A
		12	0	N/A	N/A	N/A	N/A	20.91	21.02	20.86	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 131973 1710.1 MHz	CH 132322 1745 MHz	CH 132671 1779.9 MHz	3GPP MPR [dB]	CH 131973 1710.1 MHz	CH 132322 1745 MHz	CH 132671 1779.9 MHz	3GPP MPR [dB]
66	3.75	1	0	23.23	23.34	23.27	N/A	23.34	23.31	23.29	N/A
		1	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	47	23.31	23.28	23.21	N/A	23.29	23.26	23.22	N/A
	15	1	0	23.4	23.35	23.25	N/A	23.42	23.39	23.26	N/A
		1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1	11	23.41	23.34	23.24	N/A	23.42	23.39	23.25	N/A
		3	0	N/A	N/A	N/A	N/A	23.29	23.16	23.12	N/A
		3	3	N/A	N/A	N/A	N/A	23.24	23.21	23.16	N/A
		3	6	N/A	N/A	N/A	N/A	23.24	23.12	23.17	N/A
		3	9	N/A	N/A	N/A	N/A	23.3	23.09	23.14	N/A
		6	0	N/A	N/A	N/A	N/A	22.34	22.33	22.17	N/A
		6	6	N/A	N/A	N/A	N/A	22.34	22.33	22.26	N/A
		12	0	N/A	N/A	N/A	N/A	21.48	21.31	21.4	N/A

4. TEST EQUIPMENT

Dasy52 near field scanning systems, manufactured by SPEAG were used for SAR testing. The test system consists of high precision robotics system (Staubli), robot controller, computer, near-field probe, probe alignment sensor, and a phantom containing the tissue equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location of maximum electromagnetic field.

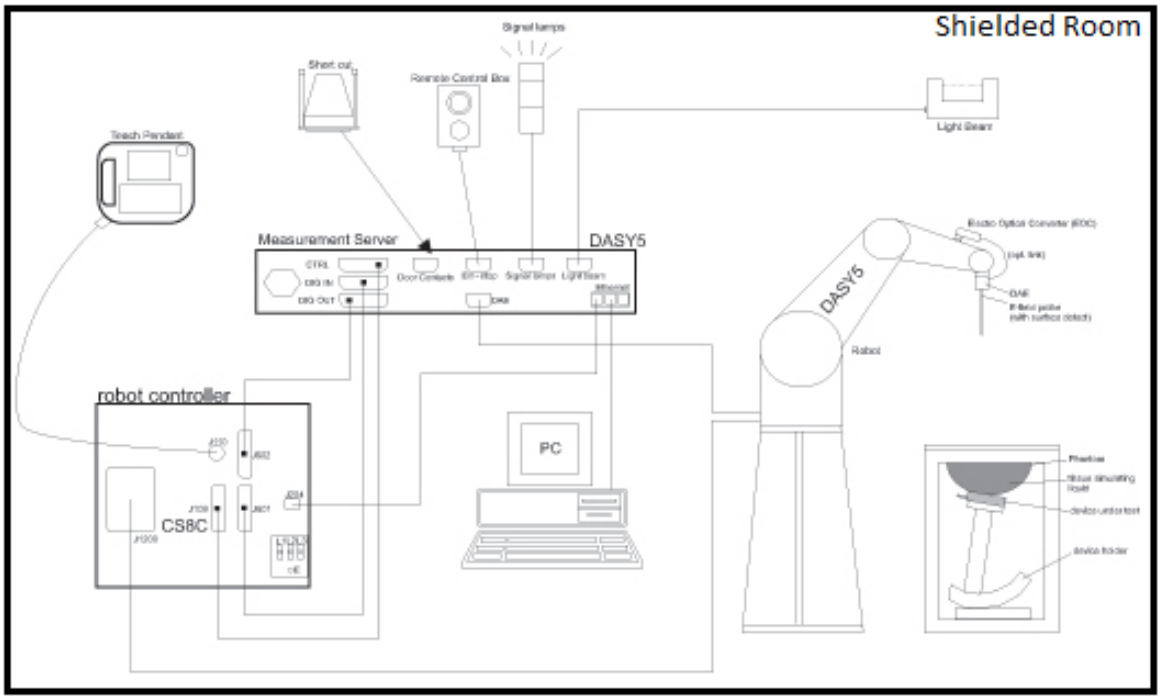


Figure 1 Schematic Laboratory Picture

4.1 Test Equipment List

Main used test system components are listed below. For full equipment list and calibration intervals, please contact the testing laboratory.

Test Equipment	Model	Serial Number	Calibration Date
DAE	DAE4	710	03.2021
Probe	EX3DV4	7447	03.2021
Dipole	D750V3	42/17 DIP 0G750-454	12.2018
Dipole	D1800V2	2d075	12.2020
DASY5 Software	52.8.8.1258	-	NA
Signal generator	R&S SMIQ 06B	1125.5555.06	NA
Amplifier	AR	10S1G4A	NA
Power Reflection Meter	NRT	835065/049	02.2021
Directional Power Sensor	NRT-Z44	835374/021	02.2021
Radio Communication Tester	R&S CMW500	1201.002K50-159661-pb	03.2021

Dipole calibration period supporting data:

		Measured on 09/2020			Calibrated		
Dipole and serial number	**Frequency (MHz)**	**Return loss (dB)**	**Impedance (Ω)**		**Return loss (dB)**	**Impedance (Ω)**	
42/17 DIP 0G750-454	750	-22.8	52.9	-6.9	-27.76	52.5	-3.3

4.1.1 Isotropic E-field Probe Type EX3DV4

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	Calibration certificate in Appendix D
Frequency	10 MHz to >6 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g, Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 10 mm Body diameter: 12 mm Tip diameter: 2.5 mm Distance from probe tip to dipole centers: 1.0 mm
Application	General dosimetry up to 6 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The Triple Modular Phantom consists of three identical modules that can be installed and removed separately without emptying the liquid. It is used for compliance testing of small wireless devices in body-worn configurations. The phantom conforms to the requirements of IEEE 1528 and FCC published RF Exposure KDB Procedures. The shell thickness of the bottom plate is 2±0.2mm. The dimensions are 308x192x182mm and filling volume is 9.2 liters giving a filling height of 155mm.

4.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEEE 1528 and FCC published RF Exposure KDB Procedures. The dielectric parameters of the used tissue simulants were within ±10% of the recommended values in all frequencies used. A liquid compensation algorithm was used in DASY5 with which measured peak average SAR values were corrected for the deviation of used liquid. Depth of the tissue simulant was at least 15.0 cm from the inner surface of the flat phantom.

Head 600-6000 MHz tissue simulant liquid Ingredients
Deionized Water, oil, salt, emulsifiers

4.4 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Dielectric Constant [ε] Head tissue simulant	Conductivity σ [S/m] Head tissue simulant	Validation Done
							Head tissue simulant
750	D750V3 - SN: 454	EX3DV4 - SN: 7447	CW	DAE 4 / 710	42.55	0.92	04/2021
1800	D1800V2-SN:2D075	EX3DV4 - SN: 7447	CW	DAE 4 / 710	37.87	1.32	04/2021

4.5 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power [mW]	Measured SAR_{1g} [W/kg]	1 W Target SAR_{1g} [W/kg]	1 W Normalized SAR_{1g} [W/kg]	Deviation [%]	Plot #
23.4.2021	WB HEAD	22±2	750	250	1.97	8.52	7.88	-7.51 %	1
26.4.2021	WB HEAD	22±2	750	250	1.95	8.52	7.8	-8.45 %	2
26.4.2021	WB HEAD	22±2	1800	250	9.42	39.44	37.68	-4.46 %	3
29.4.2021	WB HEAD	22±2	750	250	2.01	8.52	8.04	-5.63 %	4
3.5.2021	WB HEAD	22±2	750	250	1.94	8.52	7.76	-8.92 %	5
3.5.2021	WB HEAD	22±2	1800	250	9.82	39.44	39.28	-0.41 %	6

4.5.1 Tissue Simulant Verification

				Target		Measured		Deviation	
Date	Tissue Type	Tissue Temp [°C]	Frequency [MHz]	Dielectric Constant [ε]	Conductivity. σ [S/m]	Dielectric Constant [ε]	Conductivity σ [S/m]	ε (%)	σ (%)
23.04.2021	WB Head	22	704	42.18	0.89	40.09	0.9	-4.9	0.8
23.04.2021	WB Head	22	750	41.94	0.89	39.96	0.91	-4.7	2.2
23.04.2021	WB Head	22	782	41.78	0.9	39.86	0.92	-4.6	3.1
23.04.2021	WB Head	22	821.5	41.6	0.91	39.74	0.94	-4.5	3.6
23.04.2021	WB Head	22	831.5	41.57	0.91	39.73	0.94	-4.4	3.6
26.04.2021	WB Head	22	704	42.18	0.89	39.83	0.89	-5.6	-0.3
26.04.2021	WB Head	22	707.5	42.16	0.89	39.82	0.89	-5.6	-0.2
26.04.2021	WB Head	22	711	42.14	0.89	39.81	0.89	-5.5	-0.1
26.04.2021	WB Head	22	750	41.94	0.89	39.68	0.9	-5.4	1.2
26.04.2021	WB Head	22	779.5	41.79	0.9	39.6	0.91	-5.2	2.0
26.04.2021	WB Head	22	782	41.78	0.9	39.59	0.91	-5.2	2.1
26.04.2021	WB Head	22	784.5	41.76	0.9	39.58	0.92	-5.2	2.1
26.04.2021	WB Head	22	821.5	41.6	0.91	39.47	0.93	-5.1	2.6
26.04.2021	WB Head	22	831.5	41.57	0.91	39.44	0.93	-5.1	2.6
26.04.2021	WB Head	22	841.5	41.53	0.91	39.41	0.94	-5.1	2.6
26.04.2021	WB Head	22	1720	40.13	1.35	37.61	1.35	-6.3	-0.5
26.04.2021	WB Head	22	1745	40.09	1.37	37.56	1.36	-6.3	-0.5
26.04.2021	WB Head	22	1770	40.05	1.38	37.52	1.38	-6.3	-0.5
26.04.2021	WB Head	22	1800	40	1.4	37.47	1.39	-6.3	-0.5
29.04.2021	WB Head	22	699.1	42.21	0.89	39.55	0.89	-6.3	0.4
29.04.2021	WB Head	22	707.5	42.16	0.89	39.52	0.9	-6.3	0.6
29.04.2021	WB Head	22	715.9	42.12	0.89	39.49	0.9	-6.2	0.9
29.04.2021	WB Head	22	750	41.94	0.89	39.38	0.91	-6.1	2.0
03.05.2021	WB Head	22	750	41.94	0.89	40.06	0.88	-4.5	-1.2
03.05.2021	WB Head	22	777.1	41.8	0.9	39.99	0.89	-4.3	-0.2
03.05.2021	WB Head	22	782	41.78	0.9	39.97	0.9	-4.3	-0.1
03.05.2021	WB Head	22	786.9	41.75	0.9	39.95	0.9	-4.3	0.1
03.05.2021	WB Head	22	814.1	41.63	0.9	39.86	0.91	-4.2	0.5
03.05.2021	WB Head	22	831.5	41.57	0.91	39.81	0.91	-4.2	0.6
03.05.2021	WB Head	22	848.9	41.5	0.92	39.77	0.92	-4.2	0.6
03.05.2021	WB Head	22	1710.1	40.14	1.35	37.84	1.35	-5.7	0.0
03.05.2021	WB Head	22	1745	40.09	1.37	37.78	1.37	-5.7	-0.0
03.05.2021	WB Head	22	1779.9	40.03	1.39	37.72	1.39	-5.8	-0.0
03.05.2021	WB Head	22	1800	40	1.4	37.69	1.4	-5.8	0.0
03.05.2021	WB Head	22	704.1	42.18	0.89	40.21	0.87	-4.7	-2.7
03.05.2021	WB Head	22	710	42.15	0.89	40.19	0.87	-4.7	-2.5
03.05.2021	WB Head	22	715.9	42.12	0.89	40.17	0.87	-4.6	-2.3

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D01. KDB 941225 D05 was used to select LTE-M1 and NB-IoT test modes for testing.

The DUT was set to transmit with full power by using communication tester for cellular technologies.

For LTE-M1 and NB-IoT, SAR testing was conducted with 33% duty cycle which is an overestimation of the DUT duty cycle.

5.1 Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the Dasy system.

Device holder supplied by SPEAG

5.2 Test Positions

5.2.1 Body-worn Configuration, 5mm separation distance

The device was placed on the SPEAG holder and lifted towards the phantom until the distance between the phantom and the device was 5mm. All six sides of the device were tested.

Photos of the test positions are presented in appendix A.

5.3 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan with was performed around the highest E-field value to determine the averaged SAR value. Power drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.4 SAR Averaging Methods

The maximum SAR value was averaged over a cube of tissue using interpolation and extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy52 are all based on the modified Quadratic Shepard's method (Robert J. Renka," Multivariate Interpolation of Large Sets of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).
The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighboring points by a least-square method. For the zoom scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the zoom scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

Uncertainty Budget
IEEE 1528-2013

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0 %	N	1	1	1	±6.0 %	±6.0 %	∞
Axial Isotropy	±4.7 %	R		0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	1.73	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	1.73	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	1.73	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	1.73	1	1	±0.6 %	±0.6 %	∞
Modulation Response^m	±2.4 %	R	1.73	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	1.73	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	1.73	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	1.73	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	1.73	1	1	±1.2 %	±1.2 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	1.73	1	1	±2.9 %	±2.9 %	∞
Power Scaling	±6 %	R	1.73	1	1	±3.5 %	± 3.5%	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	1.73	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	1.73	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.)	±2.5 %	R	1.73	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.)	±2.5 %	R	1.73	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity	±3.4 %	R	1.73	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity	±0.4 %	R	1.73	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±11.7 %	±11.6 %	361
Expanded STD Uncertainty						**±23.4 %**	**±23.3 %**	

7. TEST RESULTS

7.1 SAR Results for Body-Worn Condition with 5 mm separation distance:

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
LTE-M1 12	23060	QPSK/10	1	2	Front	23.5	23.27	0.239	-0.23*	1.11	1:3.3	0.27	7
LTE-M1 12	23060	QPSK/10	3	0	Front	23.5	23.29	0.241	0.06	1.05	1:3.3	0.25	
LTE-M1 12	23060	QPSK/10	1	2	Back	23.5	23.27	0.194	0.03	1.05	1:3.3	0.20	
LTE-M1 12	23060	QPSK/10	3	0	Back	23.5	23.29	0.194	0.04	1.05	1:3.3	0.20	
LTE-M1 12	23060	QPSK/10	1	2	Left	23.5	23.27	0.0962	0.06	1.05	1:3.3	0.10	
LTE-M1 12	23060	QPSK/10	3	0	Left	23.5	23.29	0.097	0.04	1.05	1:3.3	0.10	
LTE-M1 12	23060	QPSK/10	1	2	Right	23.5	23.27	0.092	-0.09	1.05	1:3.3	0.10	
LTE-M1 12	23060	QPSK/10	3	0	Right	23.5	23.29	0.0898	0.05	1.05	1:3.3	0.09	
LTE-M1 12	23060	QPSK/10	1	2	Top	23.5	23.27	0.0459	-0.03	1.05	1:3.3	0.05	
LTE-M1 12	23060	QPSK/10	3	0	Top	23.5	23.29	0.0456	0.06	1.05	1:3.3	0.05	
LTE-M1 12	23060	QPSK/10	1	2	Bottom	23.5	23.27	0.012	0.03	1.05	1:3.3	0.01	
LTE-M1 12	23060	QPSK/10	3	0	Bottom	23.5	23.29	0.012	0.05	1.05	1:3.3	0.01	
LTE-M1 12	23095	QPSK/10	1	2	Front	23.5	23.24	0.232	0.05	1.06	1:3.3	0.25	
LTE-M1 12	23130	QPSK/10	1	2	Front	23.5	23.2	0.192	0.02	1.07	1:3.3	0.21	

*Larger than 5% drifts included to scaling factor

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
LTE-M1 13	23230	QPSK/10	1	2	Front	23.5	23.24	0.304	0.03	1.06	1:3.3	0.32	
LTE-M1 13	23230	QPSK/10	3	0	Front	23.5	23.19	0.299	0.03	1.07	1:3.3	0.32	
LTE-M1 13	23230	QPSK/10	1	2	Back	23.5	23.24	0.244	0.02	1.06	1:3.3	0.26	
LTE-M1 13	23230	QPSK/10	3	0	Back	23.5	23.19	0.244	0.01	1.07	1:3.3	0.26	
LTE-M1 13	23230	QPSK/10	1	2	Left	23.5	23.24	0.134	-0.05	1.06	1:3.3	0.14	
LTE-M1 13	23230	QPSK/10	3	0	Left	23.5	23.19	0.133	0	1.07	1:3.3	0.14	
LTE-M1 13	23230	QPSK/10	1	2	Right	23.5	23.24	0.175	0.03	1.06	1:3.3	0.19	
LTE-M1 13	23230	QPSK/10	3	0	Right	23.5	23.19	0.175	0.04	1.07	1:3.3	0.19	
LTE-M1 13	23230	QPSK/10	1	2	Top	23.5	23.24	0.0544	0.01	1.06	1:3.3	0.06	
LTE-M1 13	23230	QPSK/10	3	0	Top	23.5	23.19	0.0538	0.05	1.07	1:3.3	0.06	
LTE-M1 13	23230	QPSK/10	1	2	Bottom	23.5	23.24	0.015	0.03	1.06	1:3.3	0.02	
LTE-M1 13	23230	QPSK/10	3	0	Bottom	23.5	23.19	0.015	0.21	1.07	1:3.3	0.02	
LTE-M1 13	23205	QPSK/5	1	2	Front	23.5	23.19	0.317	0.03	1.07	1:3.3	0.34	
LTE-M1 13	23255	QPSK/5	1	2	Front	23.5	23.19	0.407	0.03	1.07	1:3.3	0.44	8

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
LTE-M1 26	26865	QPSK/15	1	2	Front	23.5	23.21	0.414	0.05	1.07	1:3.3	0.44	
LTE-M1 26	26765	QPSK/15	3	0	Front	23.5	23.24	0.425	0.02	1.06	1:3.3	0.45	
LTE-M1 26	26865	QPSK/15	1	2	Back	23.5	23.21	0.324	0.08	1.07	1:3.3	0.35	
LTE-M1 26	26765	QPSK/15	3	0	Back	23.5	23.24	0.322	0.02	1.06	1:3.3	0.34	
LTE-M1 26	26865	QPSK/15	1	2	Left	23.5	23.21	0.218	0.01	1.07	1:3.3	0.23	
LTE-M1 26	26765	QPSK/15	3	0	Left	23.5	23.24	0.203	0	1.06	1:3.3	0.22	
LTE-M1 26	26865	QPSK/15	1	2	Right	23.5	23.21	0.241	0.07	1.07	1:3.3	0.26	
LTE-M1 26	26765	QPSK/15	3	0	Right	23.5	23.24	0.233	0.02	1.06	1:3.3	0.25	
LTE-M1 26	26865	QPSK/15	1	2	Top	23.5	23.21	0.0423	0.08	1.07	1:3.3	0.05	
LTE-M1 26	26765	QPSK/15	3	0	Top	23.5	23.24	0.0426	0.06	1.06	1:3.3	0.05	
LTE-M1 26	26865	QPSK/15	1	2	Bottom	23.5	23.21	0.013	-0.06	1.07	1:3.3	0.01	
LTE-M1 26	26765	QPSK/15	3	0	Bottom	23.5	23.24	0.015	-0.09	1.06	1:3.3	0.02	
LTE-M1 26	26765	QPSK/15	1	2	Front	23.5	23.16	0.428	0	1.08	1:3.3	0.46	9
LTE-M1 26	26965	QPSK/15	1	2	Front	23.5	23.14	0.379	0.05	1.09	1:3.3	0.41	

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
LTE-M1 66	132072	QPSK/20	1	2	Front	23.5	23.39	0.579	-0.1	1.03	1:3.3	0.59	10
LTE-M1 66	132072	QPSK/20	3	1	Front	23.5	23.44	0.577	-0.07	1.01	1:3.3	0.59	
LTE-M1 66	132072	QPSK/20	1	2	Back	23.5	23.39	0.474	-0.22	1.08	1:3.3	0.51	
LTE-M1 66	132072	QPSK/20	3	1	Back	23.5	23.44	0.467	-0.06	1.01	1:3.3	0.47	
LTE-M1 66	132072	QPSK/20	1	2	Left	23.5	23.39	0.18	-0.12	1.03	1:3.3	0.18	
LTE-M1 66	132072	QPSK/20	3	1	Left	23.5	23.44	0.178	-0.14	1.01	1:3.3	0.18	
LTE-M1 66	132072	QPSK/20	1	2	Right	23.5	23.39	0.227	0.08	1.03	1:3.3	0.23	
LTE-M1 66	132072	QPSK/20	3	1	Right	23.5	23.44	0.229	0.11	1.01	1:3.3	0.23	
LTE-M1 66	132072	QPSK/20	1	2	Top	23.5	23.39	0.0882	0.03	1.03	1:3.3	0.09	
LTE-M1 66	132072	QPSK/20	3	1	Top	23.5	23.44	0.0909	-0.02	1.01	1:3.3	0.09	
LTE-M1 66	132072	QPSK/20	1	2	Bottom	23.5	23.39	0.0792	-0.06	1.03	1:3.3	0.08	
LTE-M1 66	132072	QPSK/20	3	1	Bottom	23.5	23.44	0.0818	0.09	1.01	1:3.3	0.08	
LTE-M1 66	132322	QPSK/20	1	2	Front	23.5	23.38	0.565	-0.07	1.03	1:3.3	0.58	
LTE-M1 66	132572	QPSK/20	1	2	Front	23.5	23.36	0.534	-0.05	1.03	1:3.3	0.55	

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
NB-IOT 12	23179	QPSK/15	1	0	Front	23.5	23.15	0.187	0.18	1.08	1:3.3	0.20	
NB-IOT 12	23179	QPSK/15	1	0	Back	23.5	23.15	0.146	0.07	1.08	1:3.3	0.16	
NB-IOT 12	23179	QPSK/15	1	0	Left	23.5	23.15	0.0811	0.03	1.08	1:3.3	0.09	
NB-IOT 12	23179	QPSK/15	1	0	Right	23.5	23.15	0.118	0.14	1.08	1:3.3	0.13	
NB-IOT 12	23179	QPSK/15	1	0	Top	23.5	23.15	0.0624	0.07	1.08	1:3.3	0.07	
NB-IOT 12	23179	QPSK/15	1	0	Bottom	23.5	23.15	0.0126	-0.12	1.08	1:3.3	0.01	
NB-IOT 12	23011	QPSK/15	1	11	Front	23.5	23.09	0.248	-0.19	1.10	1:3.3	0.27	11
NB-IOT 12	23095	QPSK/15	1	11	Front	23.5	23.05	0.207	-0.04	1.11	1:3.3	0.23	

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
NB-IOT 13	23279	QPSK/15	1	0	Front	23.5	23.14	0.425	0.01	1.09	1:3.3	0.46	12
NB-IOT 13	23279	QPSK/15	1	0	Back	23.5	23.14	0.301	0.02	1.09	1:3.3	0.33	
NB-IOT 13	23279	QPSK/15	1	0	Left	23.5	23.14	0.19	0.02	1.09	1:3.3	0.21	
NB-IOT 13	23279	QPSK/15	1	0	Right	23.5	23.14	0.21	-0.04	1.09	1:3.3	0.23	
NB-IOT 13	23279	QPSK/15	1	0	Top	23.5	23.14	0.0365	0.01	1.09	1:3.3	0.04	
NB-IOT 13	23279	QPSK/15	1	0	Bottom	23.5	23.14	0.0159	0.16	1.09	1:3.3	0.02	
NB-IOT 13	23181	QPSK/15	1	0	Front	23.5	23.12	0.3	-0.02	1.09	1:3.3	0.33	
NB-IOT 13	23230	QPSK/15	1	0	Front	23.5	23.12	0.422	0.06	1.09	1:3.3	0.46	

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
NB-IoT 17	23731	QPSK/15	1	11	Front	23.5	23.16	0.214	-0.15	1.08	1:3.3	0.23	13
NB-IoT 17	23731	QPSK/15	1	11	Back	23.5	23.16	0.183	0.02	1.08	1:3.3	0.20	
NB-IoT 17	23731	QPSK/15	1	11	Left	23.5	23.16	0.0913	-0.02	1.08	1:3.3	0.10	
NB-IoT 17	23731	QPSK/15	1	11	Right	23.5	23.16	0.0854	0.03	1.08	1:3.3	0.09	
NB-IoT 17	23731	QPSK/15	1	11	Top	23.5	23.16	0.045	-0.02	1.08	1:3.3	0.05	
NB-IoT 17	23731	QPSK/15	1	11	Bottom	23.5	23.16	0.0129	0.04	1.08	1:3.3	0.01	
NB-IoT 17	23790	QPSK/15	1	0	Front	23.5	23.08	0.19	0.07	1.10	1:3.3	0.21	
NB-IoT 17	23849	QPSK/15	1	0	Front	23.5	23.08	0.175	0.01	1.10	1:3.3	0.19	

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
NB-IoT 26	26865	QPSK/15	1	0	Front	23.5	23.12	0.43	0.02	1.09	1:3.3	0.47	
NB-IoT 26	26865	QPSK/15	1	0	Back	23.5	23.12	0.346	0.08	1.09	1:3.3	0.38	
NB-IoT 26	26865	QPSK/15	1	0	Left	23.5	23.12	0.213	-0.1	1.09	1:3.3	0.23	
NB-IoT 26	26865	QPSK/15	1	0	Right	23.5	23.12	0.253	0.11	1.09	1:3.3	0.28	
NB-IoT 26	26865	QPSK/15	1	0	Top	23.5	23.12	0.0429	0.09	1.09	1:3.3	0.05	
NB-IoT 26	26865	QPSK/15	1	0	Bottom	23.5	23.12	0.0159	-0.13	1.09	1:3.3	0.02	
NB-IoT 26	26691	QPSK/15	1	0	Front	23.5	23.06	0.438	-0.18	1.11	1:3.3	0.48	14
NB-IoT 26	27039	QPSK/15	1	0	Front	23.5	23.09	0.401	0.01	1.10	1:3.3	0.44	

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Test Position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR 1g [mW/g]	Plot #
NB-IoT 66	131973	QPSK/15	1	0	Front	23.5	23.42	0.617	-0.09	1.02	1:3.3	0.63	15
NB-IoT 66	131973	QPSK/15	1	0	Back	23.5	23.42	0.522	-0.08	1.02	1:3.3	0.53	
NB-IoT 66	131973	QPSK/15	1	0	Left	23.5	23.42	0.176	-0.05	1.02	1:3.3	0.18	
NB-IoT 66	131973	QPSK/15	1	0	Right	23.5	23.42	0.205	-0.02	1.02	1:3.3	0.21	
NB-IoT 66	131973	QPSK/15	1	0	Top	23.5	23.42	0.0553	-0.01	1.02	1:3.3	0.06	
NB-IoT 66	131973	QPSK/15	1	0	Bottom	23.5	23.42	0.078	0.16	1.02	1:3.3	0.08	
NB-IoT 66	132322	QPSK/15	1	0	Front	23.5	23.39	0.599	-0.03	1.03	1:3.3	0.61	
NB-IoT 66	132671	QPSK/15	1	0	Front	23.5	23.26	0.57	-0.05	1.06	1:3.3	0.60	

7.2 Calculated SAR Results for Bluetooth and UWB < 6GHz

For simultaneous transmission evaluation the Bluetooth and UWB standalone SAR value is estimated according to the following equation:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, where x = 7.5 for 1-g SAR.

The minimum separation distance between the user and the device is ≤5mm.

Bluetooth SAR_{1g} = (0.0945mW/5mm) * $(2.48GHz)^{1/2}$/7.5 = 0.004 W/kg
UWB SAR_{1g} = (0.1mW/5mm) * $(4.8428GHz)^{1/2}$/7.5 = 0.006 W/kg

7.3 Calculated Power Density for UWB > 6GHz

According to 47CFR §2.1093 Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

Power Density is calculated with equation:

$$S = \frac{P \cdot G}{4 \cdot \pi \cdot R^2}$$

Where
S = Power Density
P = Power Input to Antenna
G = Gain of Antenna
R = Distance from transmitting Antenna

Modes of Operation	Frequency [MHz]	Distance, R [cm]	Maximum Power Input to Antenna, P [dBm]	Power Input to Antenna, P [mW]	Power Gain of Antenna, G [dBi]	Power Density, S [mW/cm^2]
UWB	6739.6	5	0	1	2.5	0.0057

7.4 Simultaneous Transmission Analysis

Simultaneous transmission analysis for maximum cellular SAR, maximum Bluetooth SAR and maximum UWB SAR is in a table below. Direct summation of SAR results is performed.

	Exposure Condition	Body SAR_{1g} [W/kg]
Cellular	LTE-M1, Band 12	0.27
	LTE-M1, Band 13	0.44
	LTE-M1, Band 26	0.46
	LTE-M1, Band 66	0.59
	NB-IoT, Band 12	0.27
	NB-IoT, Band 13	0.46
	NB-IoT, Band 17	0.23
	NB-IoT, Band 26	0.48
	NB-IoT, Band 66	0.63
Maximum Cellular SAR:		**0.63**
Bluetooth:		**0.004**
UWB Positioning at 4742.8MHz:		**0.006**
SAR Summation:		**0.64**

Simultaneous transmission analysis for maximum cellular SAR, maximum Bluetooth SAR and UWB power density, for a situation where UWB operates > 6 GHz.

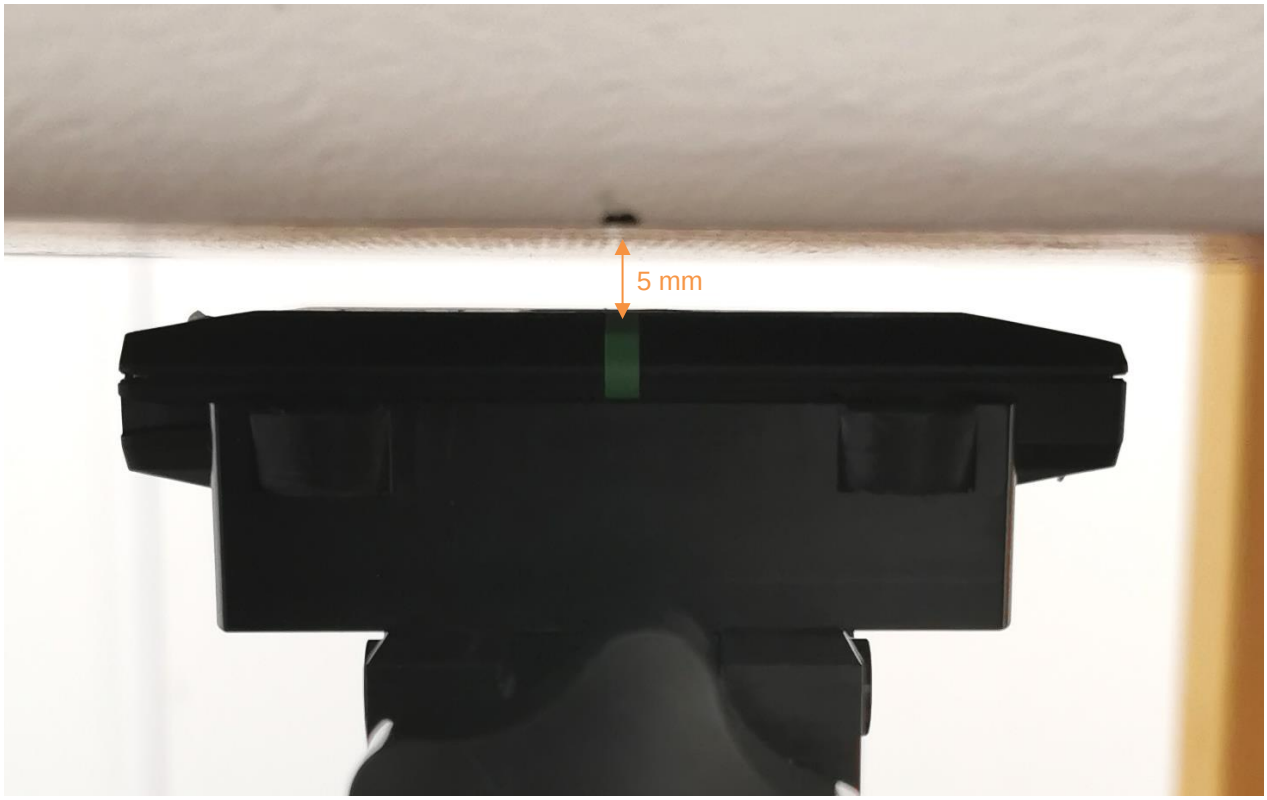
	Exposure Condition	Body SAR_{1g} [W/kg] or Power Density [mW/cm^2] / Requirement
Cellular	LTE-M1, Band 12	0.17
	LTE-M1, Band 13	0.28
	LTE-M1, Band 26	0.29
	LTE-M1, Band 66	0.37
	NB-IoT, Band 12	0.17
	NB-IoT, Band 13	0.29
	NB-IoT, Band 17	0.14
	NB-IoT, Band 26	0.30
	NB-IoT, Band 66	0.39
Maximum Cellular SAR:		**0.39**
Bluetooth:		**0.0025**
UWB Positioning at 6548.9MHz:		**0.0057**
SAR Summation:		**0.4**
Simultaneous Exposure Evaluation		**SUM <1**

APPENDIX A: PHOTOS OF THE DUT

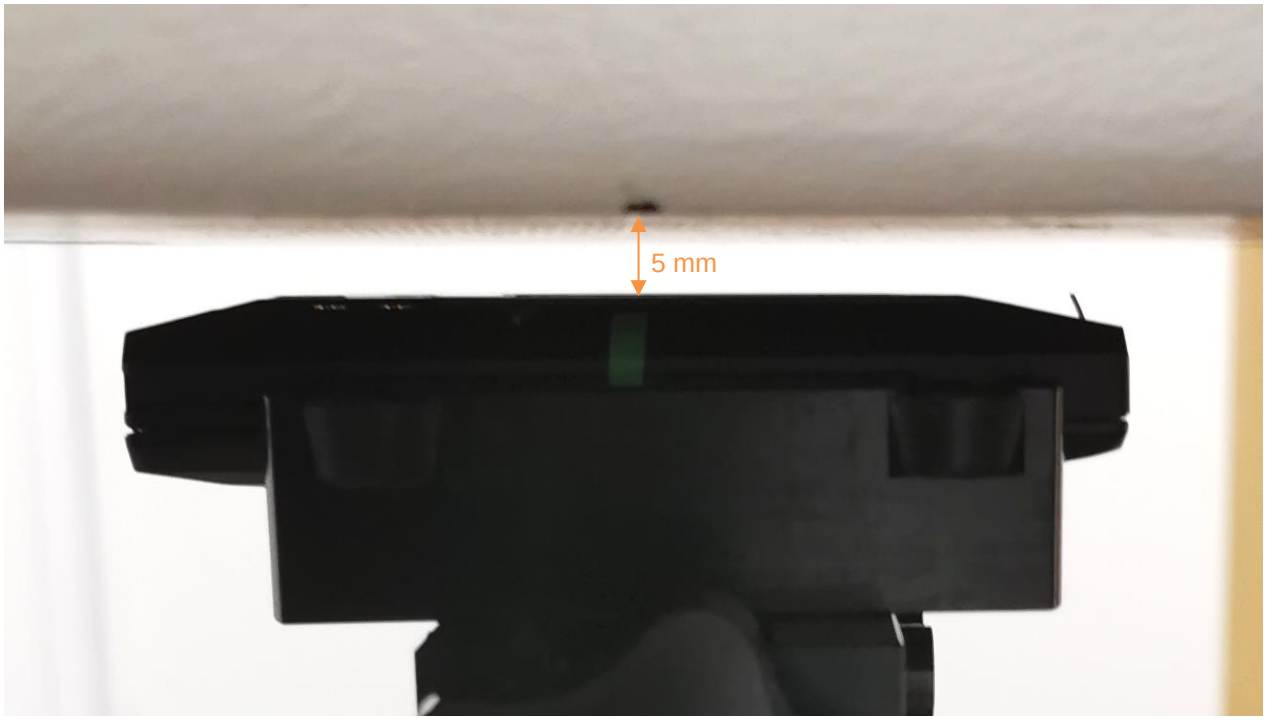
Size of the device is: 90 mm x 60 mm x 15 mm.

Front side of the device

Back side of the device

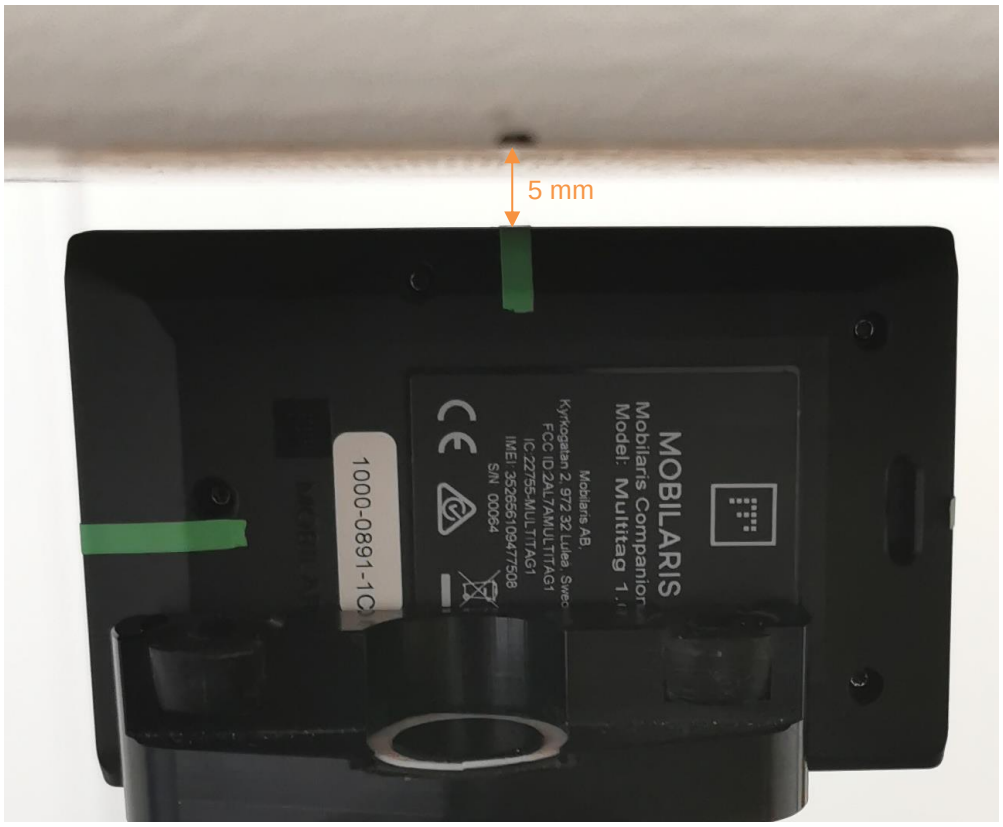


Front side of the device against the phantom, 5mm separation distance



Back side of the device against the phantom, 5mm separation distance

Left side of the device against the phantom, 5mm separation distance



Right side of the device against the phantom, 5mm separation distance

Top of the device against the phantom, 5mm separation distance

Bottom of the device against the phantom, 5mm separation distance

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 23/04/2021 9.24.48

Test Laboratory: Verkotan Oy

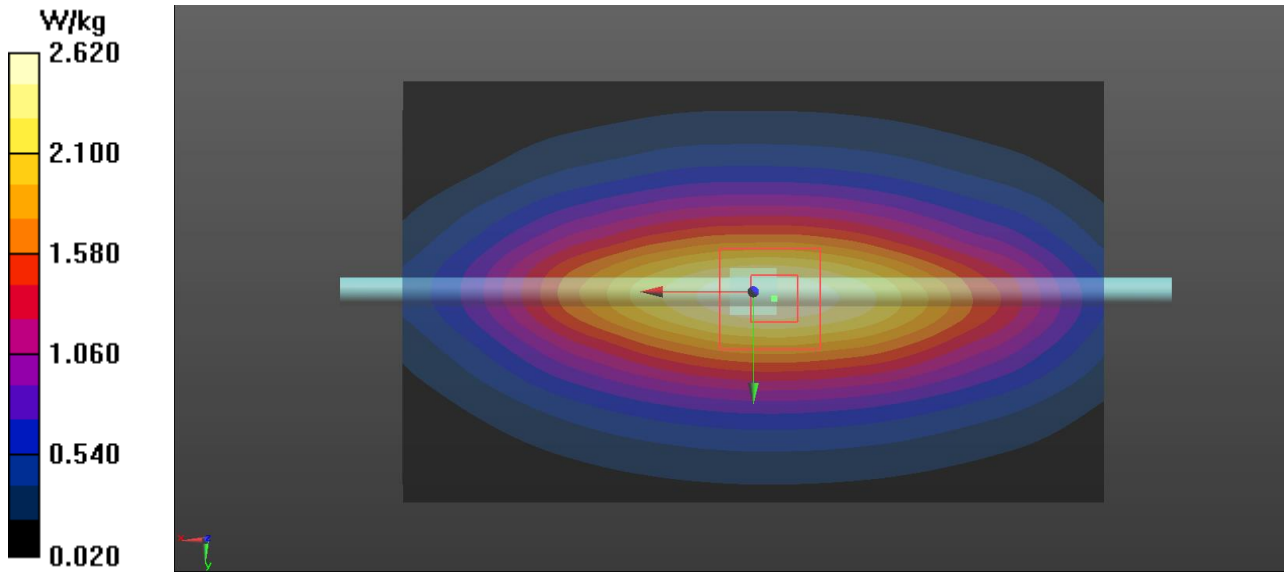
DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:454

Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.913 S/m; ε_r = 39.965; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 750 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 49.39 V/m; Power Drift = -0.23 dB
Peak SAR (extrapolated) = 2.96 W/kg
SAR(1 g) = 1.97 W/kg; SAR(10 g) = 1.29 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 66%
Maximum value of SAR (measured) = 2.64 W/kg
Configuration/system check/Area Scan (101x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.62 W/kg



Plot 2

Date/Time: 26/04/2021 8.07.11

Test Laboratory: Verkotan Oy

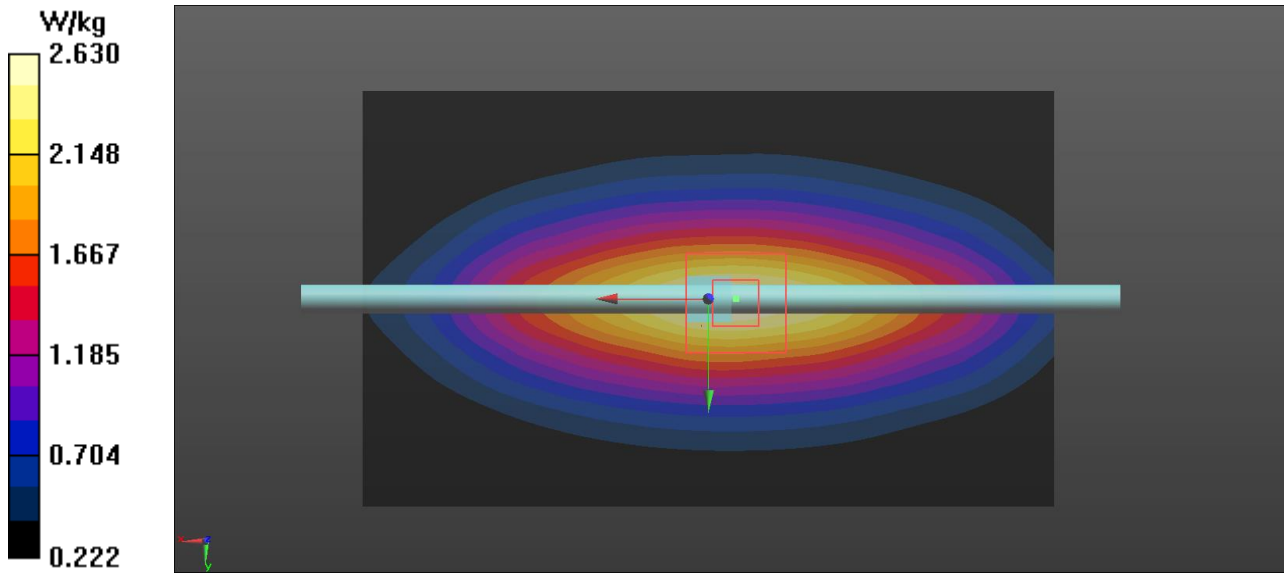
DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:454

Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.904 S/m; ε_r = 39.684; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 750 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 2/Area Scan (101x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.59 W/kg
Configuration/system check 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 47.97 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 2.97 W/kg
SAR(1 g) = 1.95 W/kg; SAR(10 g) = 1.26 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 19.5 mm
Ratio of SAR at M2 to SAR at M1 = 65.2%
Maximum value of SAR (measured) = 2.63 W/kg



Plot 3

Date/Time: 26/04/2021 8.55.13

Test Laboratory: Verkotan Oy

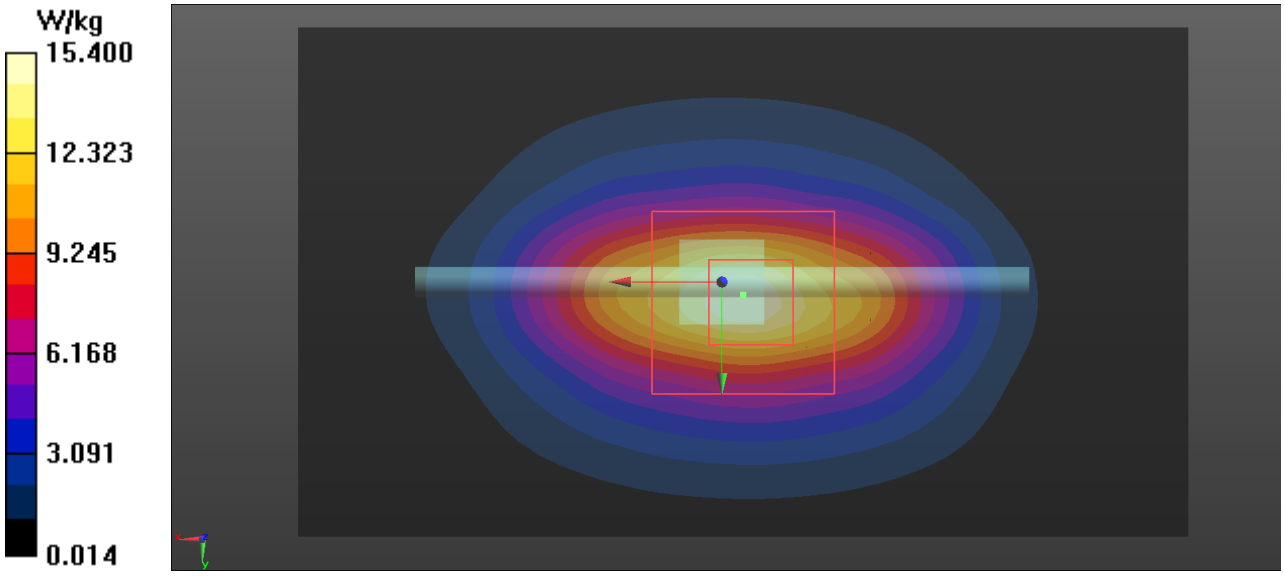
DUT: Dipole 1800 MHz D1800V2; Type: D1800V2; Serial: D1800V2 - SN:2d075

Communication System: UID 0, CW (0); Communication System Band: D1800 (1800.0 MHz); Frequency: 1800 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1800 MHz; σ = 1.393 S/m; ε_r = 37.47; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.52, 8.52, 8.52) @ 1800 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 86.30 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 17.1 W/kg
SAR(1 g) = 9.42 W/kg; SAR(10 g) = 4.93 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 10.1 mm
Ratio of SAR at M2 to SAR at M1 = 54.5%
Maximum value of SAR (measured) = 14.6 W/kg
Configuration/system check/Area Scan (71x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 15.4 W/kg



Plot 4

Date/Time: 29/04/2021 7.36.35

Test Laboratory: Verkotan Oy

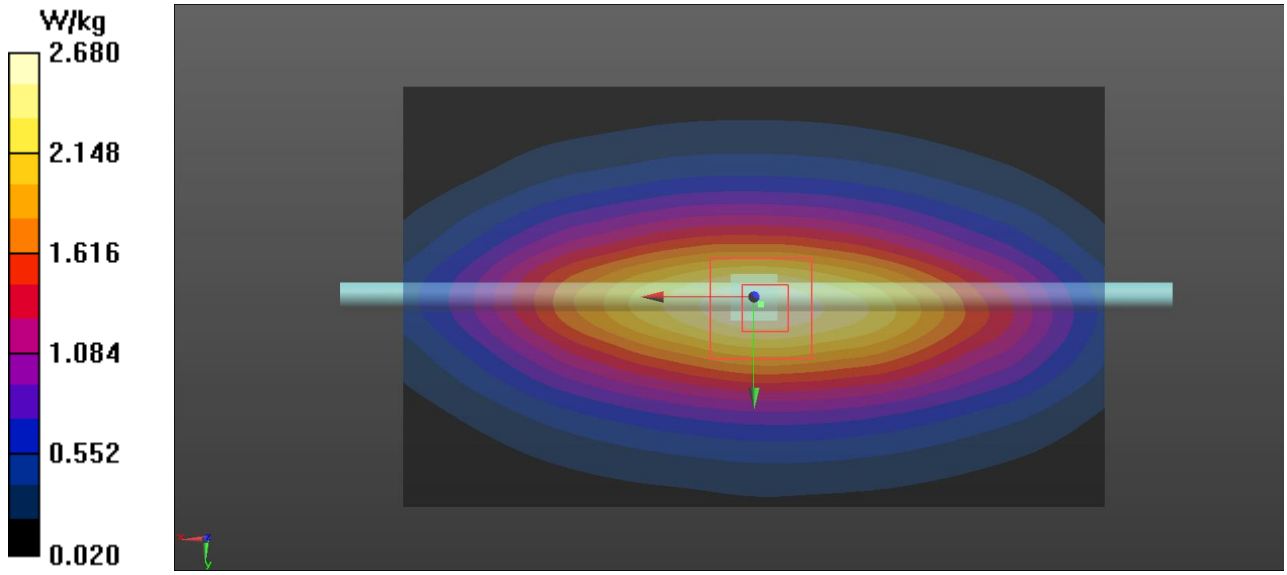
DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:454

Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.911 S/m; ε_r = 39.375; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 750 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 49.01 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 3.04 W/kg
SAR(1 g) = 2.01 W/kg; SAR(10 g) = 1.3 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 18.1 mm
Ratio of SAR at M2 to SAR at M1 = 65.4%
Maximum value of SAR (measured) = 2.70 W/kg
Configuration/system check/Area Scan (101x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.68 W/kg



Plot 5

Date/Time: 03/05/2021 7.49.43

Test Laboratory: Verkotan Oy

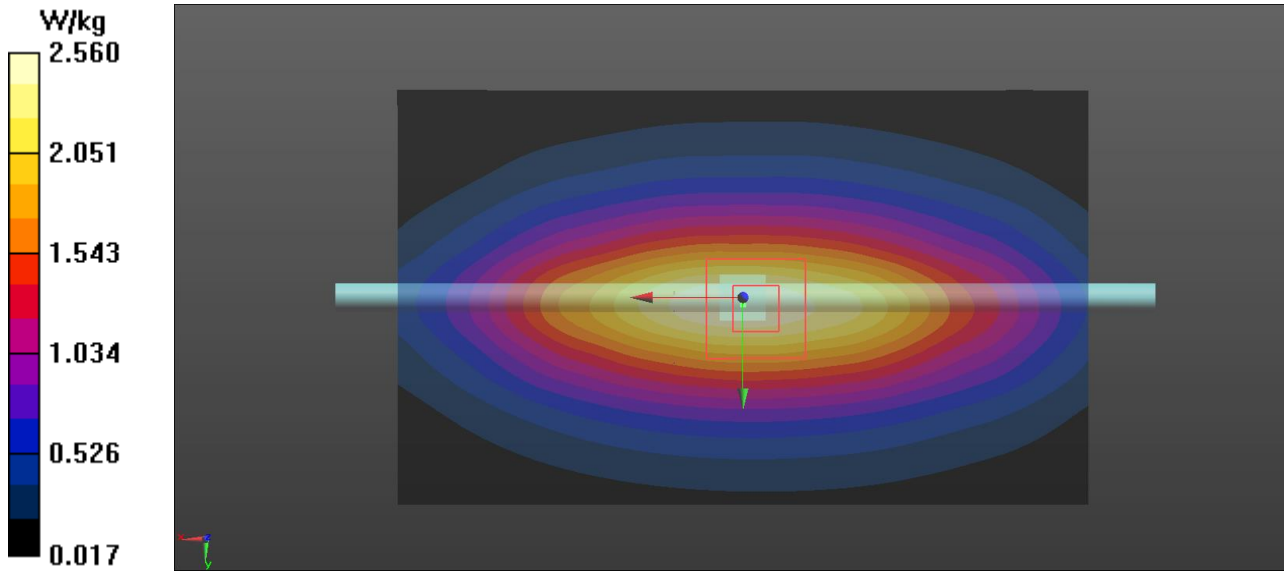
DUT: Dipole 750 MHz D750V3; Type: D750V3; Serial: D750V3 - SN:454

Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.883 S/m; ε_r = 40.063; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 750 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 49.30 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 2.93 W/kg
SAR(1 g) = 1.94 W/kg; SAR(10 g) = 1.27 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 19.2 mm
Ratio of SAR at M2 to SAR at M1 = 66%
Maximum value of SAR (measured) = 2.61 W/kg
Configuration/system check/Area Scan (101x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.56 W/kg



Plot 6

Date/Time: 03/05/2021 8.08.01

Test Laboratory: Verkotan Oy

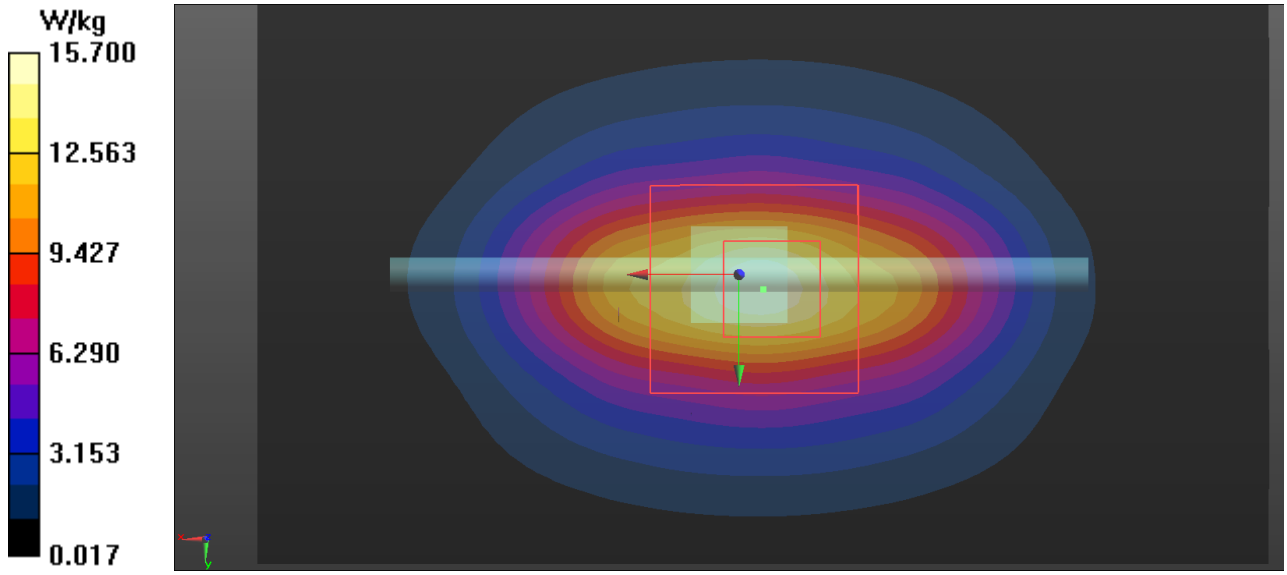
DUT: Dipole 1800 MHz D1800V2; Type: D1800V2; Serial: D1800V2 - SN:2d075

Communication System: UID 0, CW (0); Communication System Band: D1800 (1800.0 MHz); Frequency: 1800 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1800 MHz; σ = 1.4 S/m; ε_r = 37.687; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.52, 8.52, 8.52) @ 1800 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 88.08 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 18.0 W/kg
SAR(1 g) = 9.82 W/kg; SAR(10 g) = 5.12 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 10.5 mm
Ratio of SAR at M2 to SAR at M1 = 54.2%
Maximum value of SAR (measured) = 15.3 W/kg
Configuration/system check/Area Scan (71x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 15.7 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 7

Date/Time: 23/04/2021 10.28.45

Test Laboratory: Verkotan Oy

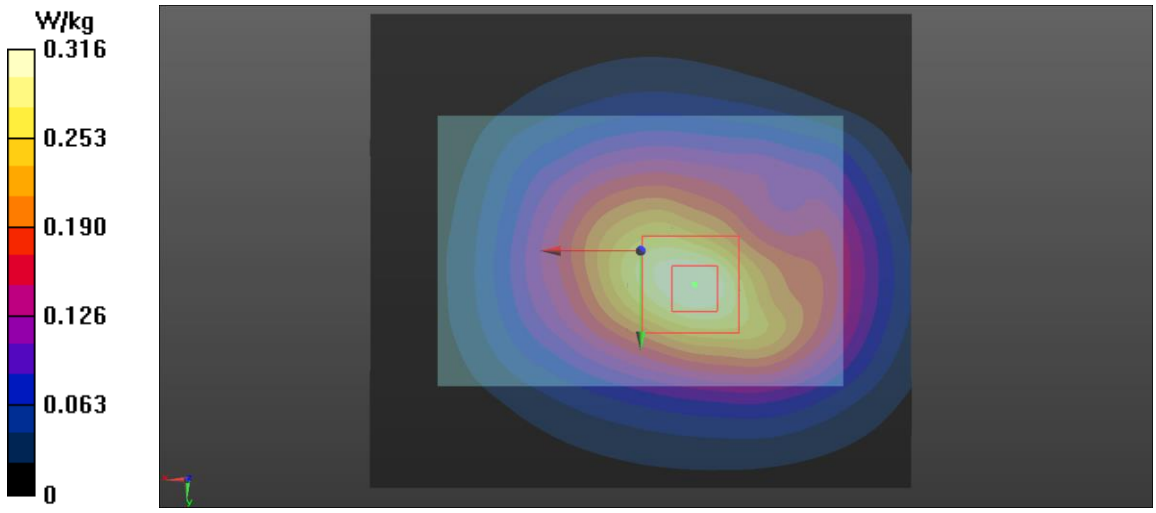
DUT: Mobilaris MultiTag;

Communication System: UID 0, LTE-M1 (0); Communication System Band: Band 12; Frequency: 704 MHz;Communication System PAR: 5.22 dB;
Medium parameters used: f = 704 MHz; σ = 0.897 S/m; ε_r = 40.093; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 704 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Front_Back/DUT 22001 LTE-M1 12, Front 5mm LOW, BW10 RB 1 Offset 2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 16.27 V/m; Power Drift = -0.23 dB
Peak SAR (extrapolated) = 0.359 W/kg
SAR(1 g) = 0.239 W/kg; SAR(10 g) = 0.157 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 18.9 mm
Ratio of SAR at M2 to SAR at M1 = 67.7%
Maximum value of SAR (measured) = 0.316 W/kg
Front_Back/DUT 22001 LTE-M1 12, Front 5mm LOW, BW10 RB 1 Offset 2/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.316 W/kg



Plot 8

Date/Time: 27/04/2021 9.22.56

Test Laboratory: Verkotan Oy

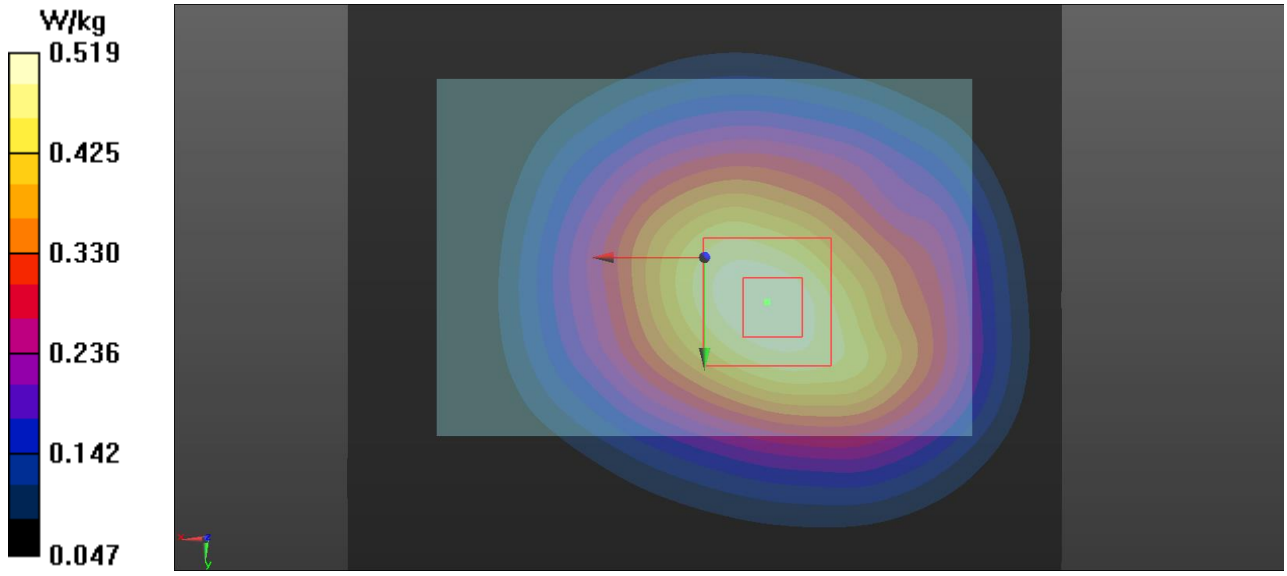
DUT: Mobilaris_Tag;

Communication System: UID 0, LTE-M1 (0); Communication System Band: Band 13; Frequency: 784.5 MHz;Communication System PAR: 5.22 dB;
Medium parameters used (interpolated): f = 784.5 MHz; σ = 0.915 S/m; ε_r = 39.578; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 784.5 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22001 LTE-M1 13, Front 5mm HIGH, BW5 RB 1 Offset 2 2/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.517 W/kg
Configuration/DUT 22001 LTE-M1 13, Front 5mm HIGH, BW5 RB 1 Offset 2 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 20.46 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.571 W/kg
SAR(1 g) = 0.407 W/kg; SAR(10 g) = 0.279 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 71.4%
Maximum value of SAR (measured) = 0.519 W/kg



Plot 9

Date/Time: 27/04/2021 8.50.58

Test Laboratory: Verkotan Oy

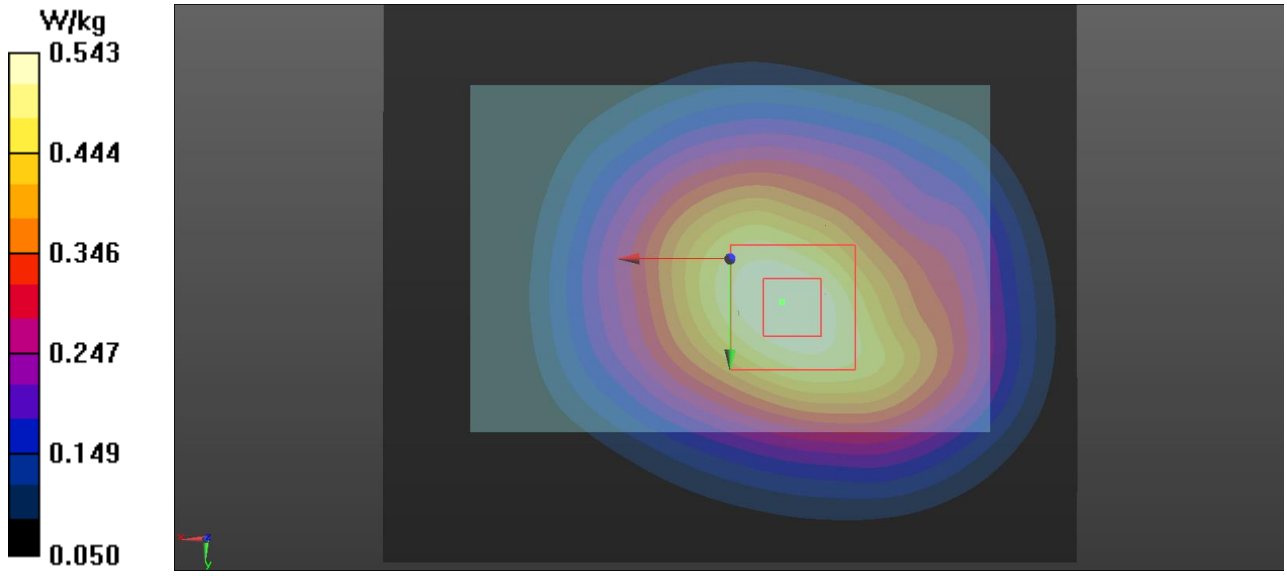
DUT: Mobilaris Multitag;

Communication System: UID 0, LTE-M1 (0); Communication System Band: Band 26; Frequency: 821.5 MHz;Communication System PAR: 5.22 dB;
Medium parameters used (interpolated): f = 821.5 MHz; σ = 0.929 S/m; ε_r = 39.474; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(9.98, 9.98, 9.98) @ 821.5 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22001 LTE-M1 26, Front 5mm LOW, BW15 RB 1 Offset 2/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.546 W/kg
Configuration/DUT 22001 LTE-M1 26, Front 5mm LOW, BW15 RB 1 Offset 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 20.91 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 0.598 W/kg
SAR(1 g) = 0.428 W/kg; SAR(10 g) = 0.292 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 71.3%
Maximum value of SAR (measured) = 0.543 W/kg



Plot 10

Date/Time: 27/04/2021 8.10.58

Test Laboratory: Verkotan Oy

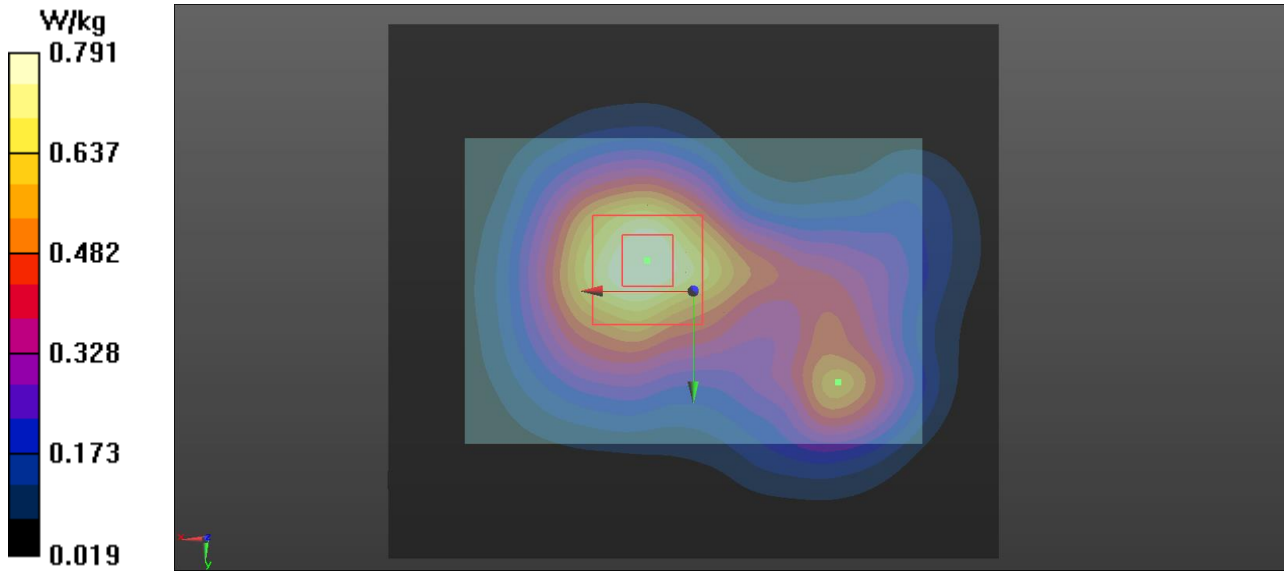
DUT: Mobilaris Multitag;

Communication System: UID 0, LTE-M1 (0); Communication System Band: Band 66; Frequency: 1720 MHz;Communication System PAR: 5.22 dB;
Medium parameters used: f = 1720 MHz; σ = 1.347 S/m; ε_r = 37.609; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.52, 8.52, 8.52) @ 1720 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22001 LTE-M1 66, Front 5mm LOW, BW20 RB 1 Offset 2/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.822 W/kg
Configuration/DUT 22001 LTE-M1 66, Front 5mm LOW, BW20 RB 1 Offset 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 19.50 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 0.893 W/kg
SAR(1 g) = 0.579 W/kg; SAR(10 g) = 0.351 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 16.2 mm
Ratio of SAR at M2 to SAR at M1 = 65.5%
Maximum value of SAR (measured) = 0.791 W/kg



Plot 11

Date/Time: 30/04/2021 10.51.33

Test Laboratory: Verkotan Oy

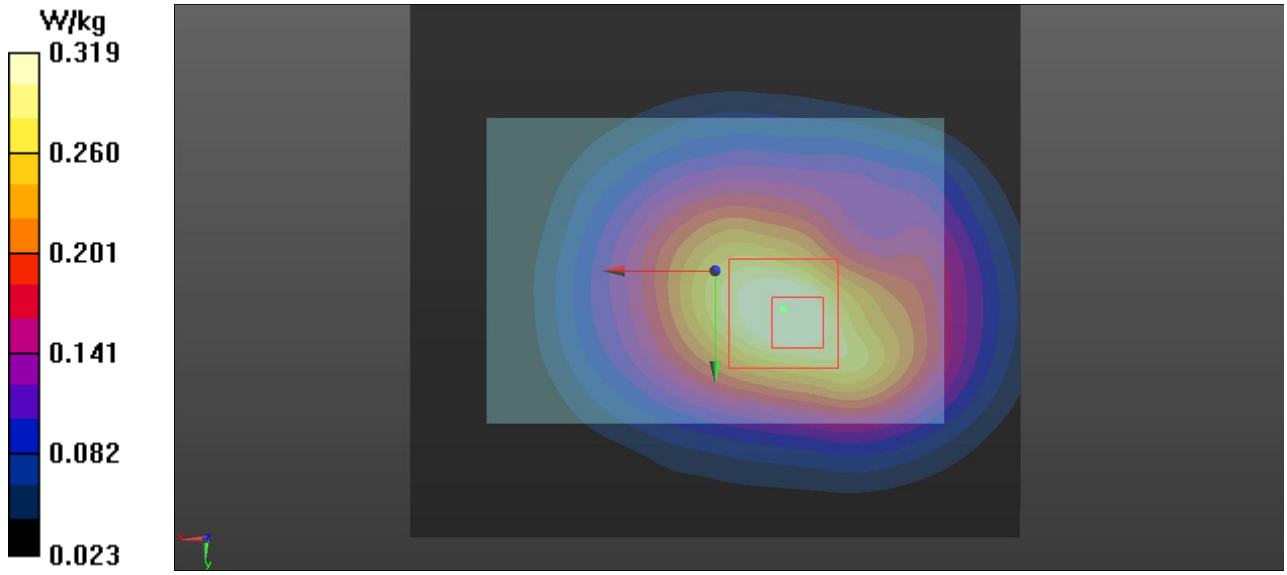
DUT: Mobilaris Multitag;

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 12; Frequency: 699.1 MHz;Communication System PAR: 5.19 dB
Medium parameters used (interpolated): f = 699.1 MHz; σ = 0.893 S/m; ε_r = 39.55; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 699.1 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration 2/DUT 22002 NB-IoT 12, Front 5mm LOW, SC15 subcarriers 1 Start 11/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.335 W/kg
Configuration 2/DUT 22002 NB-IoT 12, Front 5mm LOW, SC15 subcarriers 1 Start 11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 16.29 V/m; Power Drift = -0.19 dB
Peak SAR (extrapolated) = 0.371 W/kg
SAR(1 g) = 0.248 W/kg; SAR(10 g) = 0.164 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 20.1 mm
Ratio of SAR at M2 to SAR at M1 = 66.8%
Maximum value of SAR (measured) = 0.319 W/kg



Plot 12

Date/Time: 03/05/2021 10.17.37

Test Laboratory: Verkotan Oy

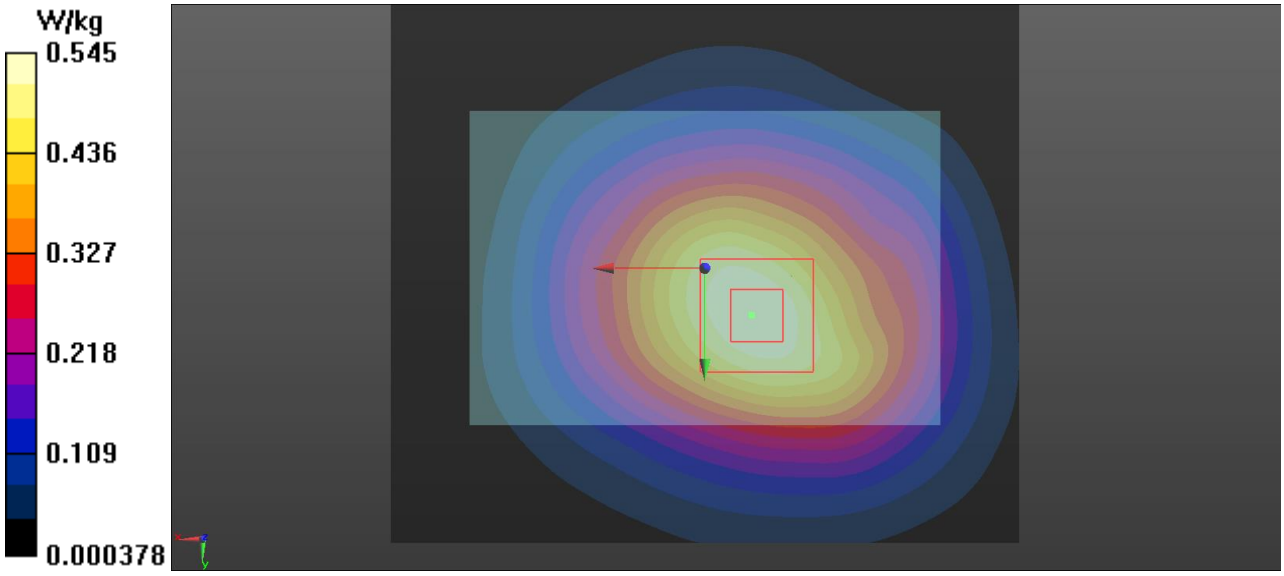
DUT: Mobilaris Multitag;

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 13; Frequency: 786.9 MHz;Communication System PAR: 5.19 dB;
Medium parameters used: f = 787 MHz; σ = 0.897 S/m; ε_r = 39.953; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 786.9 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22002 NB-IoT 13, Front 5mm HIGH, SC15 subcarriers 1 Start 0/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 21.01 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.597 W/kg
SAR(1 g) = 0.425 W/kg; SAR(10 g) = 0.293 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 70.9%
Maximum value of SAR (measured) = 0.541 W/kg
Configuration/DUT 22002 NB-IoT 13, Front 5mm HIGH, SC15 subcarriers 1 Start 0/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.545 W/kg



Plot 13

Date/Time: 05/05/2021 9.58.30

Test Laboratory: Verkotan Oy

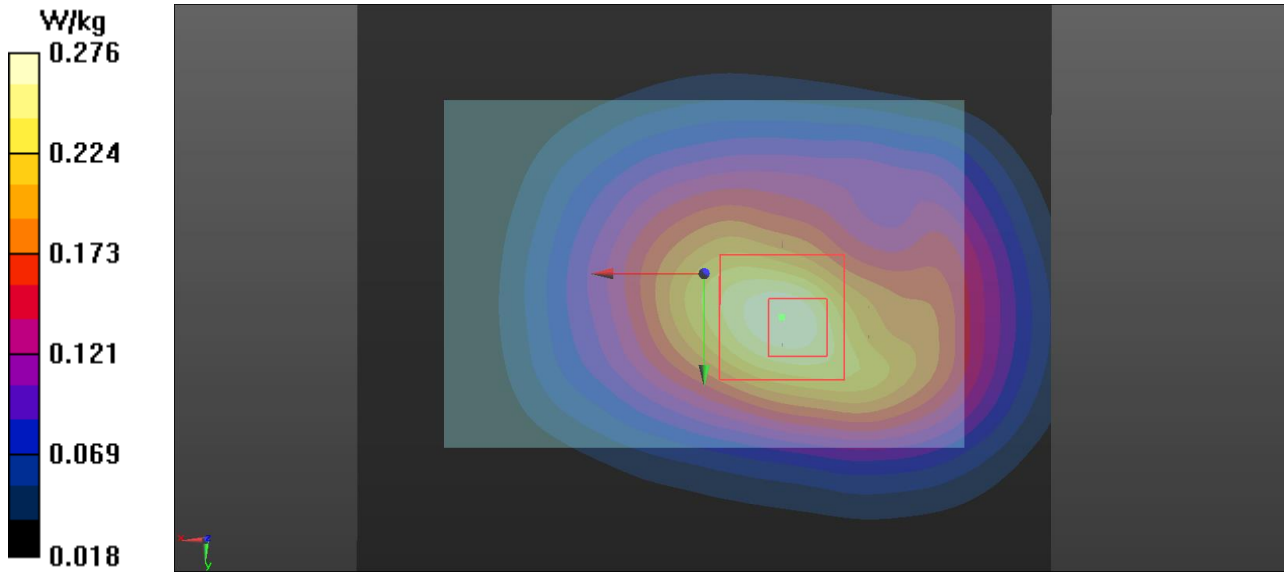
DUT: Mobilaris Multitag

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 17; Frequency: 704.1 MHz;Communication System PAR: 5.19 dB;
Medium parameters used (interpolated): f = 704.1 MHz; σ = 0.866 S/m; ε_r = 40.212; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.51, 10.51, 10.51) @ 704.1 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration 2/DUT 22002 NB-IoT 17, Front 5mm LOW, SC15 subcarriers 1 Start 11/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.274 W/kg
Configuration 2/DUT 22002 NB-IoT 17, Front 5mm LOW, SC15 subcarriers 1 Start 11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 14.65 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 0.325 W/kg
SAR(1 g) = 0.214 W/kg; SAR(10 g) = 0.138 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 18.1 mm
Ratio of SAR at M2 to SAR at M1 = 68.2%
Maximum value of SAR (measured) = 0.276 W/kg



Date/Time: 03/05/2021 12.53.18

Test Laboratory: Verkotan Oy

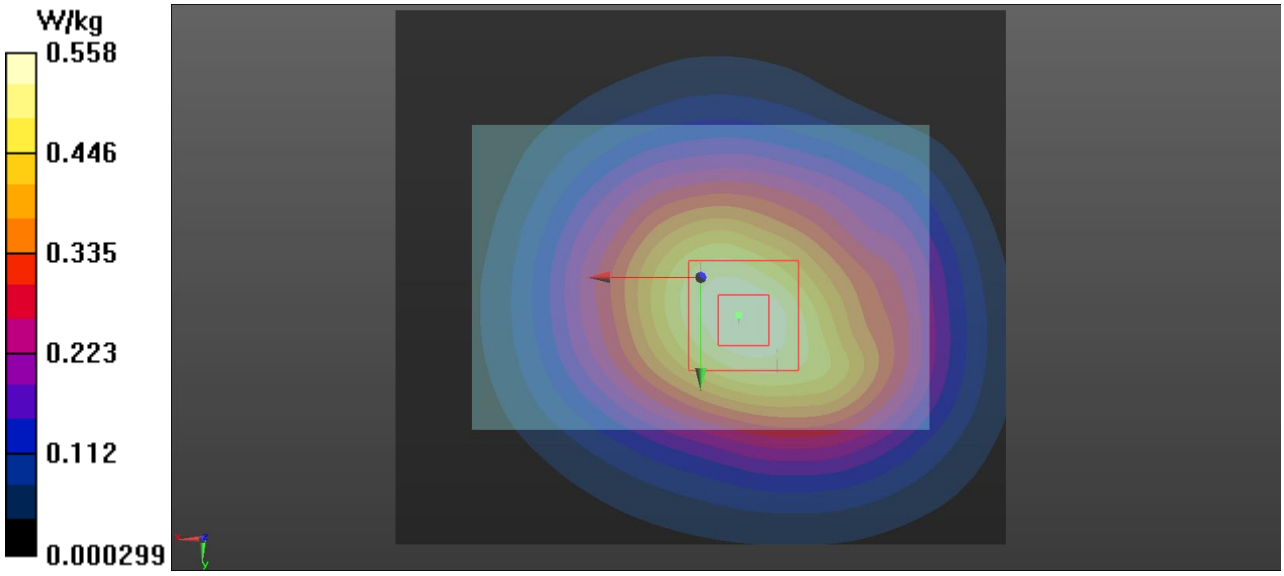
DUT: Mobilaris Multitag;

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 26; Frequency: 814.1 MHz;Communication System PAR: 5.19 dB;
Medium parameters used (interpolated): f = 814.1 MHz; σ = 0.907 S/m; ε_r = 39.863; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(9.98, 9.98, 9.98) @ 814.1 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22002 NB-IoT 26, Front 5mm, LOW, SC15 subcarriers 1 Start 0/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 21.93 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 0.628 W/kg
SAR(1 g) = 0.438 W/kg; SAR(10 g) = 0.300 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 69.3%
Maximum value of SAR (measured) = 0.568 W/kg
Configuration/DUT 22002 NB-IoT 26, Front 5mm, LOW, SC15 subcarriers 1 Start 0/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.558 W/kg



Plot 15

Date/Time: 03/05/2021 13.16.09

Test Laboratory: Verkotan Oy

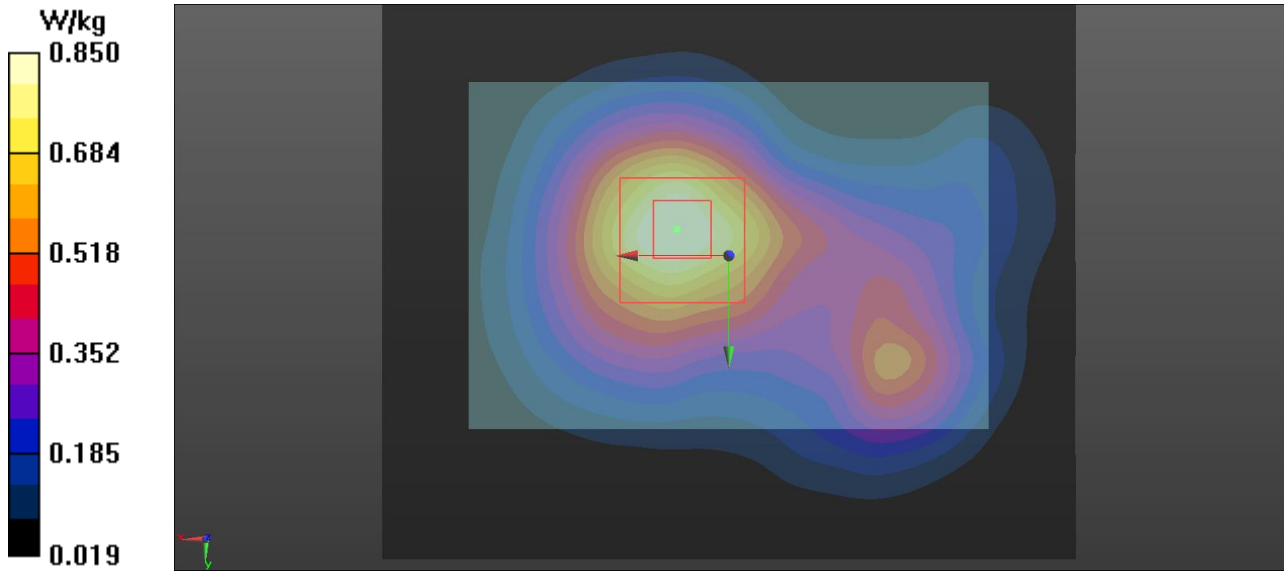
DUT: Mobilaris Multitag;

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 66; Frequency: 1710.1 MHz;Communication System PAR: 5.19 dB;
Medium parameters used (interpolated): f = 1710.1 MHz; σ = 1.348 S/m; ε_r = 37.837; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.52, 8.52, 8.52) @ 1710.1 MHz; Calibrated: 22/03/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn710; Calibrated: 12/03/2021
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/DUT 22002 NB-IoT 66, Front 5mm,LOW, SC15 subcarriers 1 Start 0/Area Scan (81x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.882 W/kg
Configuration/DUT 22002 NB-IoT 66, Front 5mm,LOW, SC15 subcarriers 1 Start 0/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 20.50 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.961 W/kg
SAR(1 g) = 0.617 W/kg; SAR(10 g) = 0.372 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 16.8 mm
Ratio of SAR at M2 to SAR at M1 = 65.7%
Maximum value of SAR (measured) = 0.850 W/kg



APPENDIX D: RELEVANT PAGES FROM 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 Verkotan **Certificate No: EX3-7447_Mar21**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7447
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	March 22, 2021

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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
DAE4	SN: 660	23-Dec-20 (No. DAE4-660_Dec20)	Dec-21
Reference Probe ES3DV2	SN: 3013	30-Dec-20 (No. ES3-3013_Dec20)	Dec-21
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 23, 2021

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7447

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.41	0.42	0.42	± 10.1 %
DCP (mV)[B]	94.4	91.5	100.1	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	140.4	± 3.3 %	± 4.7 %
		Y	0.0	0.0	1.0		148.8		
		Z	0.0	0.0	1.0		145.0		

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7447

Calibration Parameter Determined in Head Tissue Simulating Media

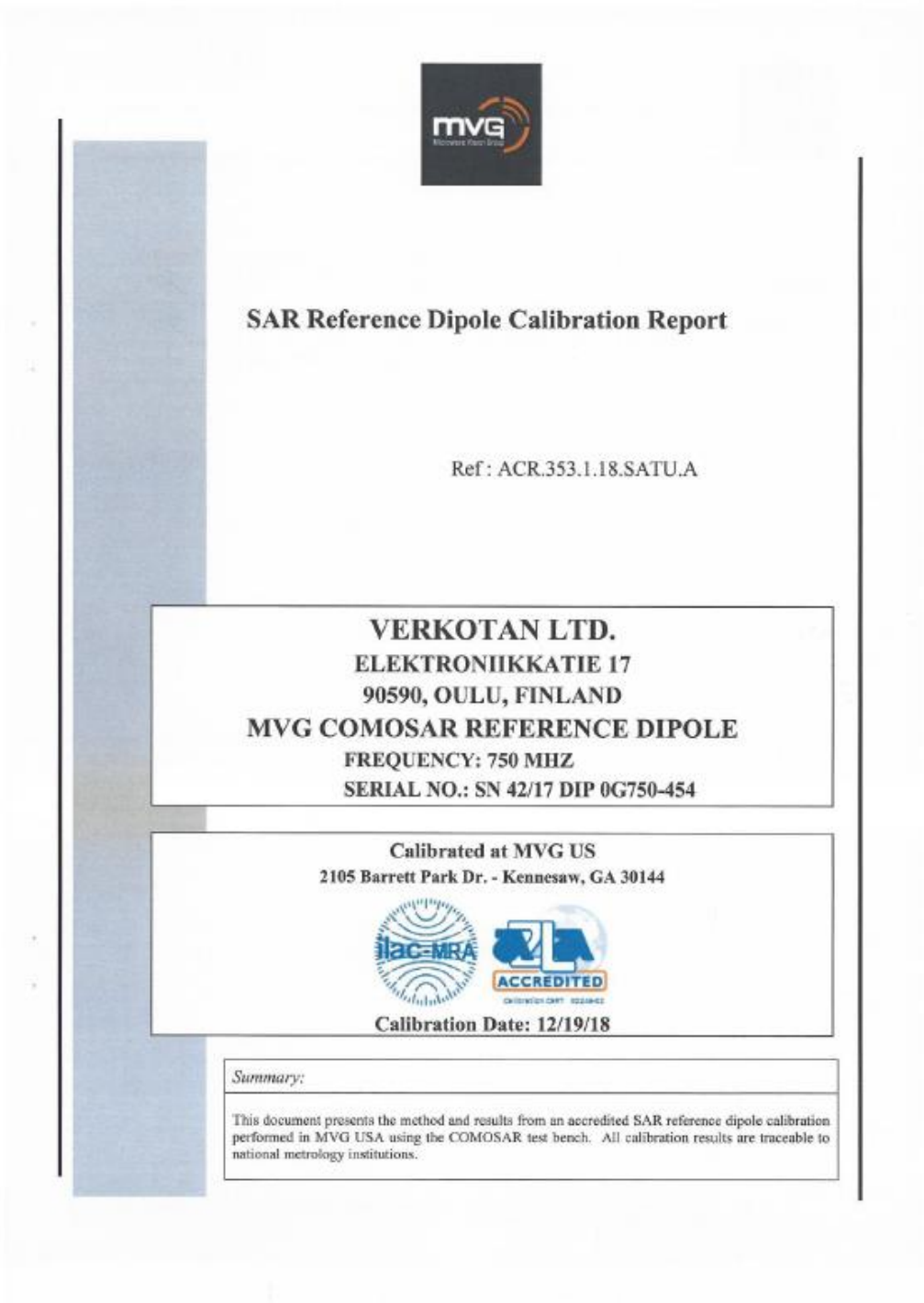
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
13	55.0	0.75	14.92	14.92	14.92	0.00	1.00	± 13.3 %
750	41.9	0.89	10.51	10.51	10.51	0.48	0.80	± 12.0 %
900	41.5	0.97	9.98	9.98	9.98	0.37	0.98	± 12.0 %
1750	40.1	1.37	8.52	8.52	8.52	0.36	0.86	± 12.0 %
1950	40.0	1.40	8.33	8.33	8.33	0.30	0.86	± 12.0 %
2150	39.7	1.53	8.22	8.22	8.22	0.31	0.86	± 12.0 %
2300	39.5	1.67	8.10	8.10	8.10	0.34	0.90	± 12.0 %
2450	39.2	1.80	7.85	7.85	7.85	0.31	0.90	± 12.0 %
2600	39.0	1.96	7.69	7.69	7.69	0.27	0.90	± 12.0 %
3300	38.2	2.71	7.00	7.00	7.00	0.30	1.30	± 13.1 %
5250	35.9	4.71	5.25	5.25	5.25	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.53	4.53	4.53	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.63	4.63	4.63	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. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. 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.

APPENDIX E: RELEVANT PAGES FROM DIPOLE CALIBRATION REPORTS



SAR Reference Dipole Calibration Report

Ref : ACR.353.1.18.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 42/17 DIP 0G750-454

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED

Calibration Date: 12/19/18

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 40.0 sigma : 0.93
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.52 (0.85)	5.55	5.62 (0.56)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

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SAR Reference Dipole Calibration Report

Ref : ACR.352.4.20.MVGB.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 1800 MHZ
SERIAL NO.: SN 2D075

Calibrated at MVG MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 12/17/20

ilac-MRA cofrac ETALONNAGE

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %		0.87 ±10 %	
750	41.9 ±10 %		0.89 ±10 %	
835	41.5 ±10 %		0.90 ±10 %	
900	41.5 ±10 %		0.97 ±10 %	
1450	40.5 ±10 %		1.20 ±10 %	
1500	40.4 ±10 %		1.23 ±10 %	
1640	40.2 ±10 %		1.31 ±10 %	
1750	40.1 ±10 %		1.37 ±10 %	
1800	40.0 ±10 %	43.7	1.40 ±10 %	1.34
1900	40.0 ±10 %		1.40 ±10 %	
1950	40.0 ±10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	
2100	39.8 ±10 %		1.49 ±10 %	
2300	39.5 ±10 %		1.67 ±10 %	
2450	39.2 ±10 %		1.80 ±10 %	
2600	39.0 ±10 %		1.96 ±10 %	
3000	38.5 ±10 %		2.40 ±10 %	
3300	38.2 ±10 %		2.71 ±10 %	
3500	37.9 ±10 %		2.91 ±10 %	
3700	37.7 ±10 %		3.12 ±10 %	
3900	37.5 ±10 %		3.32 ±10 %	
4200	37.1 ±10 %		3.63 ±10 %	
4600	36.7 ±10 %		4.04 ±10 %	
4900	36.3 ±10 %		4.35 ±10 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

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Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: eps' : 43.7 sigma : 1.34
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4	39.44 (3.94)	20.1	20.87 (2.09)
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3300	-		-	
3500	67.1		25	
3700	67.4		24.2	
3900	-		-	
4200	-		-	
4600	-		-	
4900	-		-	

Template_ACR.DDD.N.YY.MVGB.ISSUE_SAR Reference Dipole vG
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