SAR Compliance Test Report

Date of Report	14/11/2019	**Client's Contact person:**	Thomas Augustin
Number of pages:	59		
		Responsible Test engineer:	Kirsi Kyllönen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Exelonix GmbH** Washingtonstraße 16/16a D-01139 Dresden Germany
Tested device	USB Connect LPWA		
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:

14.11.2019

For the contents:

Miia Nurkkala

Digitally signed by Miia Nurkkala
Date: 2019.11.14 14:39:24 +02'00'

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	USB Connect LPWA
Manufacturer:	Exelonix GmbH
IMEI Number:	352753099063685
FCC ID Number:	2AUC4-VODEXL-01
Model:	VODEXL-01
DUT Number:	22727
Battery Type used in testing:	External power UBS source
Portable/ Mobile device	Portable
State of the Sample	Production sample

Testing information:

Testing Performed:	29.08.2019-10.09.2019
Notes:	-
Document ID:	FCC SAR report MDE Exelonix 1902 ID3730 14112019.docx
Temperature °C	22±2 / Controlled
Humidity RH%	20±20 / Controlled
Measurement performed by:	Kirsi Kyllönen, Ilari Kinnunen

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	Equipment Class	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation	Result
LTE M1, Band 2	**PCB**	0.83	**PASS**
LTE M1, Band 4	**PCB**	0.87	**PASS**
LTE M1, Band 5	**PCB**	0.53	**PASS**
LTE M1, Band 12	**PCB**	0.43	**PASS**
LTE M1, Band 13	**PCB**	0.5	**PASS**
NB-IoT, Band 2	**PCB**	0.67	**PASS**
NB-IoT, Band 4	**PCB**	0.79	**PASS**
NB-IoT, Band 5	**PCB**	0.39	**PASS**
NB-IoT, Band 12	**PCB**	0.39	**PASS**
NB-IoT, Band 13	**PCB**	0.44	**PASS**

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

1.2.1 Maximum Drift

Maximum Drift During Measurements	-0.7 dB*

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

1.2.2 Measurement Uncertainty

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

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The device is an USB-Dongle for cellular machine type communication and supports the cellular 3GPP standards NB-IoT and CAT-M1.
The device will be connected to a host device, which supplies the USB-Dongle with power and transmit and receive date via by using the VODEXL-01.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

	Modes of Operation	**Transmitter Frequency Range (MHz)**
TX Frequency bands	LTE M1, Band 2	1851-1910
	LTE M1, Band 4	1710-1755
	LTE M1, Band 5	824-849
	LTE M1, Band 12	698-716
	LTE M1, Band 13	777-787
	NB-IoT, Band 2	1851-1910
	NB-IoT, Band 4	1710-1755
	NB-IoT, Band 5	824-849
	NB-IoT, Band 12	698-716
	NB-IoT, Band 13	777-787

3. OUTPUT POWER

3.1.1 Maximum Output Power

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

LTE M1/NB-IoT	Max Output Power [dBm]
LTE M1 2	25
LTE M1 4	25
LTE M1 5	25
LTE M1 12	25
LTE M1 13	25
NB-IoT 2	25
NB-IoT 4	25
NB-IoT 5	25
NB-IoT 12	25
NB-IoT 13	25

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector.

3.2.1 LTE-M1

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18607 1850.7 MHz	CH 18900 1880.0 MHz	CH 19193 1909.3 MHz	3GPP MPR [dB]	CH 18607 1850.7 MHz	CH 18900 1880.0 MHz	CH 19193 1909.3 MHz	3GPP MPR [dB]
2 / 1.4M	1	0	22.05	21.97	22.47	0	21.65	21.57	21.07	1
	1	2	22.14	22.15	22.42	0	21.75	21.7	21.23	1
	1	5	22.08	22.09	22.68	0	21.65	21.58	21.04	1
	3	0	21.33	21.43	21.64	1	19.93	20.11	20.3	2
	3	1	21.37	21.36	21.46	1	19.98	19.94	20.47	2
	3	3	21.32	21.32	21.58	1	19.93	19.9	20.52	2
	6	0	20.41	20.39	20.56	2	20.44	20.54	20.55	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18615 1851.5 MHz	CH 18900 1880.0 MHz	CH 19185 1918.5 MHz	3GPP MPR [dB]	CH 18615 1851.5 MHz	CH 18900 1880.0 MHz	CH 19185 1918.5 MHz	3GPP MPR [dB]
2 / 3M	1	0	22.4	21.98	22.5	0	20.93	21.55	21.07	1
	1	2	22.45	22.13	22.49	0	20.98	21.94	21.17	1
	1	5	22.42	22.11	22.45	0	20.95	21.9	21.04	1
	3	0	21.39	21.43	21.53	1	20.17	20.16	20.44	2
	3	1	21.48	21.43	21.53	1	20.18	19.92	20.2	2
	3	3	21.38	21.43	21.52	1	20.27	19.93	20.21	2
	6	0	20.45	20.39	20.55	2	20.37	20.55	20.51	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18625 1852.5 MHz	CH 18900 1880.0 MHz	CH 19175 1907.5 MHz	3GPP MPR [dB]	CH 18625 1852.5 MHz	CH 18900 1880.0 MHz	CH 19175 1907.5 MHz	3GPP MPR [dB]
2 / 5M	1	0	22.2	22.15	22.69	0	22.78	22.72	22.17	0
	1	2	22.25	22.21	22.57	0	23.13	23.14	21.99	0
	1	5	22.24	22.12	22.58	0	22.83	22.78	22.12	0
	3	0	21.36	21.37	21.48	1	21.61	21.52	20.97	1
	3	1	21.44	21.49	21.47	1	21.56	21.51	21.07	1
	3	3	21.37	21.37	21.45	1	21.43	21.43	21.39	1
	6	0	21.43	21.39	21.44	1	20.38	20.48	20.5	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18650 1855 MHz	CH 18900 1880.0	CH 19150 1905 MHz	3GPP MPR [dB]	CH 18650 1855 MHz	CH 18900 1880.0 MHz	CH 19150 1905 MHz	3GPP MPR [dB]
2 / 10M	1	0	22.55	22.12	22.44	0	22.03	22.78	22.07	0
	1	2	22.47	22.28	22.68	0	22.15	22.81	22.12	0
	1	5	22.27	22.14	22.39	0	22.03	22.8	22.18	0
	3	0	22.25	22.27	22.54	0	22.13	22.53	22.04	0
	3	1	22.38	22.41	22.41	0	22.0	22.46	22.04	0
	3	3	22.28	22.32	22.36	0	21.98	22.47	22.09	0
	6	0	21.36	21.46	21.52	1	20.37	20.43	20.4	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18675 1857.5 MHz	CH 18900 1880.0	CH 19125 1902.5 MHz	3GPP MPR [dB]	CH 18675 1857.5 MHz	CH 18900 1880.0 MHz	CH 19125 1902.5 MHz	3GPP MPR [dB]
2 / 15M	1	0	22.33	22.12	22.36	0	22.02	22.68	22.18	0
	1	2	22.43	22.37	22.68	0	21.94	22.98	22.21	0
	1	5	22.27	22.18	22.42	0	22.06	22.84	22.21	0
	3	0	22.42	22.29	22.56	0	21.99	22.53	22.03	0
	3	1	22.3	22.39	22.55	0	22.23	22.53	22.36	0
	3	3	22.35	22.33	22.48	0	22.18	22.47	22.12	0
	6	0	22.37	22.38	22.45	0	22.4	22.5	22.56	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 18700 1860.0 MHz	CH 18900 1880.0 MHz	CH 19100 1900.0 MHz	3GPP MPR [dB]	CH 18700 1860.0 MHz	CH 18900 1880.0 MHz	CH 19100 1900.0 MHz	3GPP MPR [dB]
2 / 20M	1	0	22.36	22.18	22.35	0	22.0	22.7	22.94	0
	1	2	22.48	22.23	22.42	0	22.17	23.09	23.23	0
	1	5	22.31	22.14	22.39	0	22.17	22.8	22.98	0
	3	0	22.37	22.37	22.39	0	21.97	22.51	22.8	0
	3	1	22.38	22.47	22.55	0	21.98	22.52	22.71	0
	3	3	22.35	22.34	22.43	0	22.2	22.48	22.73	0
	6	0	22.35	22.36	22.51	0	22.38	22.49	22.65	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 19957 1710.7 MHz	CH 20175 1732.5 MHz	CH 20393 1754.3 MHz	3GPP MPR [dB]	CH 19957 1710.7 MHz	CH 20175 1732.5 MHz	CH 20393 1754.3 MHz	3GPP MPR [dB]
4 / 1.4M	1	0	22.41	22.0	22.06	0	20.99	21.65	21.51	1
	1	2	22.46	22.16	22.11	0	21.05	21.93	21.89	1
	1	5	22.39	22.09	22.04	0	21.08	21.82	21.76	1
	3	0	21.44	21.36	21.26	1	20.17	20.09	19.9	2
	3	1	21.47	21.27	21.28	1	20.31	20.13	19.94	2
	3	3	21.43	21.35	21.23	1	20.33	20.18	19.89	2
	6	0	20.45	20.28	20.21	2	20.46	20.55	20.36	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 19965 1711.5 MHz	CH 20175 1732.5 MHz	CH 20385 1753.5 MHz	3GPP MPR [dB]	CH 19965 1711.5 MHz	CH 20175 1732.5 MHz	CH 20385 1753.5 MHz	3GPP MPR [dB]
4 / 3M	1	0	22.54	22.04	22.29	0	21.01	21.39	20.93	1
	1	2	22.58	22.08	22.28	0	21.01	21.66	20.93	1
	1	5	22.54	22.14	22.25	0	21.0	21.81	21.04	1
	3	0	21.48	21.4	21.28	1	20.17	19.96	20.16	2
	3	1	21.47	21.4	21.28	1	20.18	19.95	20.18	2
	3	3	21.46	21.39	21.23	1	20.27	20.04	20.18	2
	6	0	20.46	20.32	20.32	2	20.46	20.61	20.18	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 19975 1711.5 MHz	CH 20175 1732.5 MHz	CH 20375 1753.5 MHz	3GPP MPR [dB]	CH 19975 1711.5 MHz	CH 20175 1732.5 MHz	CH 20375 1753.5 MHz	3GPP MPR [dB]
4 / 5M	1	0	22.44	22.21	22.24	0	22.31	22.72	21.9	0
	1	2	22.48	22.26	22.34	0	22.23	23.1	21.83	0
	1	5	22.47	22.25	22.33	0	22.25	22.76	21.97	0
	3	0	21.5	21.29	21.36	1	21.25	21.59	20.99	1
	3	1	21.39	21.38	21.15	1	21.25	21.6	21.19	1
	3	3	21.41	21.28	21.21	1	21.35	21.5	21.06	1
	6	0	21.47	21.36	21.38	1	20.57	20.35	20.31	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20000 1715.0 MHz	CH 20175 1732.5 MHz	CH 20350 1750.0 MHz	3GPP MPR [dB]	CH 20000 1715.0 MHz	CH 20175 1732.5 MHz	CH 20350 1750.0 MHz	3GPP MPR [dB]
4 / 10M	1	0	22.33	22.15	22.24	0	22.84	22.75	21.9	0
	1	2	22.43	22.36	22.36	0	22.94	22.86	21.93	0
	1	5	22.39	22.25	22.26	0	22.84	22.84	21.85	0
	3	0	22.37	22.31	22.23	0	22.57	22.6	22.09	0
	3	1	22.48	22.4	22.14	0	22.58	22.55	22.09	0
	3	3	22.4	22.34	22.08	0	22.55	22.56	22.05	0
	6	0	21.44	21.4	21.35	1	20.62	20.57	20.21	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20025 1717.0 MHz	CH 20175 1732.5 MHz	CH 20325 1747.5 MHz	3GPP MPR [dB]	CH 20025 1717.0 MHz	CH 20175 1732.5 MHz	CH 20325 1747.5 MHz	3GPP MPR [dB]
4 / 15M	1	0	22.48	22.18	22.31	0	22.07	22.87	22.07	0
	1	2	22.56	22.37	22.59	0	22.15	23.05	22.09	0
	1	5	22.41	22.25	22.39	0	22.1	22.9	22.08	0
	3	0	22.48	22.35	22.15	0	22.33	22.66	21.99	0
	3	1	22.36	22.39	22.3	0	22.2	22.56	21.99	0
	3	3	22.31	22.27	22.17	0	22.31	22.52	22.02	0
	6	0	22.42	22.31	22.24	0	22.28	22.53	22.25	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20050 1720.0 MHz	CH 20175 1732.5 MHz	CH 20300 1745.0 MHz	3GPP MPR [dB]	CH 20050 1720.0 MHz	CH 20175 1732.5 MHz	CH 20300 1745.0 MHz	3GPP MPR [dB]
4 / 20M	1	0	22.33	22.17	22.33	0	22.8	23.11	21.92	0
	1	2	22.36	22.21	22.36	0	23.18	23.51	21.97	0
	1	5	22.34	22.12	22.32	0	22.99	23.18	21.94	0
	3	0	22.37	22.38	22.14	0	22.56	22.68	22.01	0
	3	1	22.57	22.57	22.17	0	22.67	22.69	21.96	0

	3	3	22.42	22.41	22.16	0	22.53	22.65	22.04	0
	6	0	22.42	22.42	22.31	0	22.64	22.47	22.28	0

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20407 824.7 MHz	CH 20525 836.5 MHz	CH 20643 848.3 MHz	3GPP MPR [dB]	CH 20407 824.7 MHz	CH 20525 836.5 MHz	CH 20643 848.3 MHz	3GPP MPR [dB]
5 / 1.4M	1	0	22.33	22.85	22.51	0	21.81	21.43	22.0	1
	1	2	22.38	22.9	22.77	0	21.87	21.72	22.14	1
	1	5	22.3	22.78	22.61	0	21.78	21.33	22.02	1
	3	0	21.68	21.78	21.81	1	20.5	20.83	20.61	2
	3	1	21.7	21.76	21.75	1	20.53	20.7	20.57	2
	3	3	21.66	21.76	21.69	1	20.27	20.83	20.61	2
	6	0	20.65	20.81	20.87	2	20.74	20.84	21.03	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20415 825.5 MHz	CH 20525 836.5 MHz	CH 20635 847.5 MHz	3GPP MPR [dB]	CH 20415 825.5 MHz	CH 20525 836.5 MHz	CH 20635 847.5 MHz	3GPP MPR [dB]
5 / 3M	1	0	22.8	22.52	22.73	0	21.34	22.27	21.37	1
	1	2	22.84	22.56	22.81	0	21.4	22.32	21.36	1
	1	5	22.81	22.52	22.76	0	21.36	22.27	21.42	1
	3	0	21.84	21.82	21.79	1	20.62	20.41	20.61	2
	3	1	21.84	21.82	21.79	1	20.63	20.42	20.62	2
	3	3	21.83	21.81	21.67	1	20.62	20.41	20.6	2
	6	0	20.8	20.8	20.73	2	20.82	21.06	20.69	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20425 826.5 MHz	CH 20525 836.5 MHz	CH 20625 846.5 MHz	3GPP MPR [dB]	CH 20425 826.5 MHz	CH 20525 836.5 MHz	CH 20625 846.5 MHz	3GPP MPR [dB]
5 / 5M	1	0	22.77	22.71	22.77	0	22.54	23.15	22.56	0
	1	2	22.82	22.77	22.8	0	22.5	23.2	22.38	0
	1	5	22.8	22.66	22.78	0	22.57	23.18	22.4	0
	3	0	21.83	21.74	21.76	1	21.47	22.0	21.65	1
	3	1	21.83	21.92	21.75	1	21.59	21.89	21.64	1
	3	3	21.84	21.74	21.71	1	21.61	21.82	21.71	1
	6	0	21.81	21.72	21.8	1	20.89	20.81	20.81	2

LTE Band / BW	RB Size RBs	RB Offset RB Start	QPSK				16QAM			
			CH 20450 829.0 MHz	CH 20525 836.5 MHz	CH 20600 844 MHz	3GPP MPR [dB]	CH 20450 829.0 MHz	CH 20525 836.5 MHz	CH 20600 844 MHz	3GPP MPR [dB]
5 / 10M	1	0	22.72	22.61	23.07	0	22.47	23.13	22.77	0
	1	2	22.75	22.72	**23.11**	0	22.57	23.25	22.76	0
	1	5	22.72	22.7	23.11	0	22.47	23.23	22.78	0
	3	0	22.64	22.68	22.66	0	22.57	22.82	22.65	0
	3	1	22.75	22.89	**23.01**	0	22.57	22.84	22.64	0
	3	3	22.65	22.76	22.69	0	22.58	22.83	22.59	0
	6	0	21.73	21.82	21.72	1	20.84	20.81	20.84	2

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	23.24	22.92	23.32	0	21.76	22.39	21.87	1
	1	2	23.31	23.01	23.38	0	21.73	22.49	22.06	1
	1	5	23.25	22.95	23.32	0	21.88	22.4	21.88	1
	3	0	22.25	22.15	22.33	1	20.96	20.96	21.31	2
	3	1	22.29	22.19	22.36	1	21.01	20.98	21.0	2
	3	3	22.25	22.16	22.31	1	21.01	20.88	21.24	2
	6	0	21.24	21.1	21.27	2	21.31	21.3	21.12	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	23.32	22.91	23.3	0	21.73	22.19	21.8	1
	1	2	23.32	23.12	23.3	0	21.78	22.38	21.81	1
	1	5	23.34	22.93	23.33	0	21.76	22.32	21.79	1
	3	0	22.23	22.17	22.24	1	20.93	20.66	20.98	2
	3	1	22.32	22.17	22.25	1	20.97	20.58	20.99	2
	3	3	22.23	22.11	22.15	1	20.97	20.66	20.99	2
	6	0	21.22	21.09	21.17	2	21.18	21.34	21.12	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	23.37	23.1	23.24	0	22.94	23.54	23.0	0
	1	2	23.35	23.04	23.19	0	22.98	23.89	22.81	0
	1	5	23.35	23.04	23.28	0	22.99	23.52	22.9	0
	3	0	22.23	22.13	22.33	1	22.03	22.37	22.13	1
	3	1	22.23	22.26	22.27	1	22.03	22.36	21.84	1
	3	3	22.17	22.09	22.25	1	22.06	22.3	21.92	1
	6	0	22.22	22.15	22.24	1	21.2	21.08	21.21	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	23.21	22.99	23.49	0	22.88	23.58	23.2	0
	1	2	23.37	23.17	23.54	0	22.97	23.68	23.23	0
	1	5	23.25	23.07	**23.57**	0	22.93	23.58	23.17	0
	3	0	23.14	23.19	23.26	0	23.0	23.32	23.05	0
	3	1	23.23	23.22	**23.44**	0	22.81	23.34	22.95	0
	3	3	23.17	23.24	23.28	0	22.83	23.35	23.16	0
	6	0	22.25	22.24	22.27	1	21.32	21.19	21.26	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	23.24	23.13	23.13	0	22.8	23.64	22.79	0
	1	2	23.29	23.19	23.17	0	22.84	24.0	22.74	0
	1	5	23.26	23.16	23.15	0	22.92	23.67	22.89	0
	3	0	22.21	22.26	22.16	1	22.16	22.48	22.11	1
	3	1	22.2	22.39	22.15	1	22.15	22.42	22.1	1
	3	3	22.21	22.26	22.12	1	22.16	22.35	22.06	1
	6	0	22.28	22.27	22.11	1	21.27	21.27	21.12	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	NA	23.28	NA	0	NA	22.93	NA	0
	1	2	NA	23.35	NA	0	NA	22.86	NA	0
	1	5	NA	23.32	NA	0	NA	22.92	NA	0
	3	0	NA	23.15	NA	0	NA	22.98	NA	0
	3	1	NA	23.35	NA	0	NA	23.0	NA	0
	3	3	NA	23.16	NA	0	NA	23.0	NA	0
	6	0	NA	22.2	NA	1	NA	21.2	NA	2

3.2.2 NB-IoT

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 18601 1850.1 MHz	CH 18900 1880 MHz	CH 19199 1909.9 MHz	3GPP MPR [dB]	CH 18601 1850.1 MHz	CH 18900 1880 MHz	CH 19199 1909.9 MHz	3GPP MPR [dB]
2	3.75	1	0	22	22.06	22.18	N/A	22	21.98	22.17	N/A
		1	23	22.61	22.74	22.87	N/A	22.49	22.49	22.71	N/A
		1	47	21.98	22.07	22.21	N/A	21.99	22.09	22.16	N/A
	15	1	0	21.17	21.37	21.46	N/A	21.17	21.37	21.46	N/A
		1	5	21.41	21.63	21.73	N/A	21.44	21.64	21.76	N/A
		1	11	21.12	21.36	21.44	N/A	21.16	21.36	21.46	N/A
		3	0	N/A	N/A	N/A	N/A	21.9	22.32	22.32	N/A
		3	3	N/A	N/A	N/A	N/A	22.32	22.63	22.85	N/A
		3	6	N/A	N/A	N/A	N/A	22.34	22.65	22.87	N/A
		3	9	N/A	N/A	N/A	N/A	21.91	22.33	22.33	N/A
		6	0	N/A	N/A	N/A	N/A	21.51	21.8	22.01	N/A
		6	6	N/A	N/A	N/A	N/A	21.51	21.81	22.01	N/A
		12	0	N/A	N/A	N/A	N/A	20.57	20.81	20.97	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 19951 1710.1 MHz	CH 20175 1732.5 MHz	CH 20399 1754.9 MHz	3GPP MPR [dB]	CH 19951 1710.1 MHz	CH 20175 1732.5 MHz	CH 20399 1754.9 MHz	3GPP MPR [dB]
4	3.75	1	0	22.16	21.98	21.93	N/A	22.17	21.97	21.93	N/A
		1	23	22.76	22.6	22.49	N/A	22.64	22.5	22.41	N/A
		1	47	22.13	22	21.91	N/A	22.15	21.96	21.94	N/A
	15	1	0	22.45	22.18	21.97	N/A	22.44	22.19	21.97	N/A
		1	5	22.69	22.44	22.22	N/A	22.71	22.45	22.23	N/A
		1	11	22.4	22.17	21.95	N/A	22.42	22.18	21.96	N/A
		3	0	N/A	N/A	N/A	N/A	22.34	21.96	21.66	N/A
		3	3	N/A	N/A	N/A	N/A	22.59	22.33	22.11	N/A
		3	6	N/A	N/A	N/A	N/A	22.61	22.35	22.13	N/A
		3	9	N/A	N/A	N/A	N/A	22.35	21.96	21.67	N/A
		6	0	N/A	N/A	N/A	N/A	21.78	21.52	21.32	N/A
		6	6	N/A	N/A	N/A	N/A	21.78	21.52	21.33	N/A
		12	0	N/A	N/A	N/A	N/A	20.82	20.58	20.39	N/A

LTE Band	Subcarrier Spacing kHz SC Spacing	SCs SCs	Start SC Start SC	BPSK				QPSK			
				CH 20401 824.1 MHz	CH 20525 836.5 MHz	CH 20649 848.9 MHz	3GPP MPR [dB]	CH 20401 824.1 MHz	CH 20525 836.5 MHz	CH 20649 848.9 MHz	3GPP MPR [dB]
5	3.75	1	0	22.56	22.57	22.59	N/A	22.57	22.58	22.52	N/A
		1	23	23.19	23.12	23.16	N/A	23.02	23.03	22.98	N/A
		1	47	22.63	22.54	22.59	N/A	22.56	22.57	22.51	N/A
	15	1	0	21.79	21.74	21.69	N/A	21.8	21.75	21.7	N/A
		1	5	22.04	21.99	21.95	N/A	22.05	22	21.97	N/A
		1	11	21.75	21.71	21.68	N/A	21.79	21.74	21.69	N/A
		3	0	N/A	N/A	N/A	N/A	22.43	22.36	22.44	N/A
		3	3	N/A	N/A	N/A	N/A	22.88	22.82	22.83	N/A
		3	6	N/A	N/A	N/A	N/A	22.9	22.84	22.85	N/A
		3	9	N/A	N/A	N/A	N/A	22.44	22.37	22.45	N/A
		6	0	N/A	N/A	N/A	N/A	21.99	21.96	21.94	N/A
		6	6	N/A	N/A	N/A	N/A	22	21.96	21.95	N/A
		12	0	N/A	N/A	N/A	N/A	21.09	21.03	21	N/A

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	23.03	22.93	23	N/A	23.03	22.94	22.9	N/A
		1	23	23.63	23.53	23.59	N/A	23.53	23.43	23.4	N/A
		1	47	23.02	22.92	22.99	N/A	23.03	22.94	22.91	N/A
	15	1	0	22.24	22.18	22.21	N/A	22.26	22.2	22.21	N/A
		1	5	22.52	21.46	22.47	N/A	22.54	21.47	22.48	N/A
		1	11	22.23	22.18	22.17	N/A	22.25	21.19	22.21	N/A
		3	0	N/A	N/A	N/A	N/A	22.96	22.88	22.84	N/A
		3	3	N/A	N/A	N/A	N/A	23.41	23.32	23.36	N/A
		3	6	N/A	N/A	N/A	N/A	23.43	23.34	23.38	N/A
		3	9	N/A	N/A	N/A	N/A	22.98	22.89	22.85	N/A
		6	0	N/A	N/A	N/A	N/A	22.56	22.49	22.48	N/A
		6	6	N/A	N/A	N/A	N/A	22.57	22.5	22.49	N/A
		12	0	N/A	N/A	N/A	N/A	21.56	21.49	21.46	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	22.92	22.9	22.85	N/A	22.93	22.91	22.86	N/A
		1	23	23.37	23.47	23.37	N/A	23.39	23.37	23.32	N/A
		1	47	22.99	22.97	22.83	N/A	22.92	22.9	22.86	N/A
	15	1	0	22.11	22.1	20.99	N/A	22.12	22.12	22.1	N/A
		1	5	22.37	22.37	22.34	N/A	22.38	22.38	22.36	N/A
		1	11	22.09	22.09	22.07	N/A	22.11	22.11	22.09	N/A
		3	0	N/A	N/A	N/A	N/A	22.89	22.86	22.79	N/A
		3	3	N/A	N/A	N/A	N/A	23.25	23.22	23.15	N/A
		3	6	N/A	N/A	N/A	N/A	23.27	23.24	23.18	N/A
		3	9	N/A	N/A	N/A	N/A	22.9	22.86	22.8	N/A
		6	0	N/A	N/A	N/A	N/A	22.32	22.32	22.26	N/A
		6	6	N/A	N/A	N/A	N/A	22.33	22.33	22.27	N/A
		12	0	N/A	N/A	N/A	N/A	21.35	21.31	21.27	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.

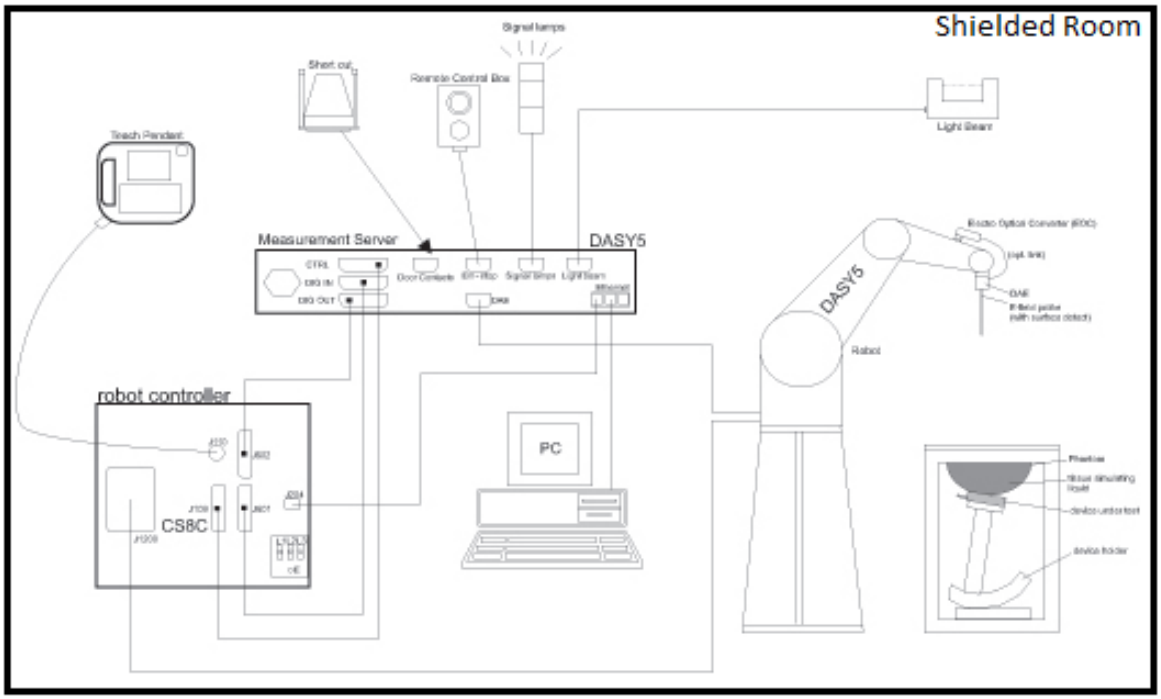


Figure 1 Schematic Laboratory Picture

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	705	04.2019
Probe	EX3DV4	3892	04.2019
Dipole	D750V3	42/17 DIP 0G750-454	12.2018
Dipole	D835V2	51/18 DIP 0G835-473	12.2018
Dipole	D1800V2	2D075	06.2017
Dipole	D1900V2	5D004	06.2017
DASY5 Software	52.8.8.1258	-	NA
Communication tester	R&S CMW500	1201.002K50-159661-pb	03.2019
Signal generator	R&S SMIQ 06B	1125.5555.06	NA
Amplifier	AR	10S1G4A	NA
Power Reflection Meter	NRT	835065/049	02.2019
Directional Power Sensor	NRT-Z44	835374/021	02.2019

Dipole calibration period supporting data:

		Measured on 08/2019			Calibrated		
Dipole and serial number	**Frequency (MHz)**	**Return loss (dB)**	**Impedance (Ω)**		**Return loss (dB)**	**Impedance (Ω)**	
DIP 0G750-454 42/17	750	-22.42	56.05	-5.29	-27.8	52.5	-3.3
DIP 0G835-473 51/18	835	-28.88	49.34	3.52	-30.0	51.7	2.6
D1800V2 2D075	1800	-29.51	46.78	-0.30	-25.4	46.0	3.3
D1900V2 5D004	1900	-26.52	45.93	1.99	-29.9	48.5	-2.7

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.

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 600-3000 MHz tissue simulant liquid Ingredients
Deionized Water, tween, salt

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: 42/17	EX3DV4 - SN: 3892	CW	DAE 4 / 705	40.84	0.93	05.2019
835	D835V2 - SN: 455	EX3DV4 - SN: 3892	CW	DAE 4 / 705	42.29	0.98	05.2019
1800	D1800V2 - SN: 2D075	EX3DV4 - SN: 3892	CW	DAE 4 / 705	40.29	1.46	05.2019
1900	D1900V2 - SN: 5D004	EX3DV4 - SN: 3892	CW	DAE 4 / 705	40.10	1.50	05.2019

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 1g [%]	Plot #
02.09.2019	WB Head	22	1800	250	9.21	38.01	36.84	-3.1	1
03.09.2019	WB Head	22	1800	250	9.22	38.01	36.88	-3.0	2
03.09.2019	WB Head	22	1900	250	9.30	39.74	37.2	-6.4	3
05.09.2019	WB Head	22	750	250	1.92	8.52	7.68	-9.9	4
09.09.2019	WB Head	22	750	250	1.92	8.52	7.68	-9.9	5
10.09.2019	WB Head	22	835	250	2.45	9.63	9.8	1.8	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 (%)
02.09.2019	**WB Head**	22	1800	40.0	1.40	37.3	1.28	-6.7	-8.8
02.09.2019	**WB Head**	22	1720	40.1	1.35	37.5	1.24	-6.6	-8.7
02.09.2019	**WB Head**	22	1732.5	40.1	1.36	37.4	1.24	-6.6	-8.8
02.09.2019	**WB Head**	22	1747.5	40.1	1.37	37.4	1.25	-6.6	-8.8
03.09.2019	**WB Head**	22	1800	40.0	1.40	38.5	1.28	-3.6	-8.6
03.09.2019	**WB Head**	22	1900	40.0	1.40	38.3	1.32	-4.2	-5.5
03.09.2019	**WB Head**	22	1710.1	40.1	1.35	38.7	1.23	-3.6	-8.5
03.09.2019	**WB Head**	22	1712.5	40.1	1.35	38.7	1.23	-3.6	-8.5
03.09.2019	**WB Head**	22	1747.5	40.1	1.37	38.6	1.25	-3.6	-8.5
03.09.2019	**WB Head**	22	1782.5	40.0	1.39	38.6	1.27	-3.6	-8.6
03.09.2019	**WB Head**	22	1784.9	40.0	1.39	38.6	1.27	-3.6	-8.6
03.09.2019	**WB Head**	22	1909.9	40.0	1.40	38.3	1.33	-4.2	-5.1
04.09.2019	**WB Head**	22	1720	40.1	1.35	38.2	1.26	-4.8	-7.1
04.09.2019	**WB Head**	22	1732.5	40.1	1.36	38.2	1.26	-4.8	-7.1
04.09.2019	**WB Head**	22	1745	40.1	1.37	38.1	1.27	-4.8	-7.0
04.09.2019	**WB Head**	22	1860	40.0	1.40	37.9	1.33	-5.3	-5.3
04.09.2019	**WB Head**	22	1880	40.0	1.40	37.9	1.33	-5.4	-4.7
04.09.2019	**WB Head**	22	1900	40.0	1.40	37.8	1.34	-5.4	-4.1
05.09.2019	**WB Head**	22	750	41.9	0.89	42.4	0.86	1.1	-3.9
05.09.2019	**WB Head**	22	711	42.1	0.89	42.6	0.84	1.1	-5.2
05.09.2019	**WB Head**	22	725.5	42.1	0.89	42.5	0.85	1.1	-4.7
05.09.2019	**WB Head**	22	782	41.8	0.90	42.2	0.87	1.1	-3.1
06.09.2019	**WB Head**	22	700	42.2	0.89	42.1	0.82	-0.3	-7.3
06.09.2019	**WB Head**	22	711	42.1	0.89	42.0	0.83	-0.3	-7.0
06.09.2019	**WB Head**	22	725.5	42.1	0.89	41.9	0.83	-0.3	-6.5
06.09.2019	**WB Head**	22	782	41.8	0.90	41.6	0.85	-0.4	-4.9
09.09.2019	**WB Head**	22	750	41.9	0.89	42.0	0.84	0.1	-6.3
09.09.2019	**WB Head**	22	699.1	42.2	0.89	42.3	0.82	0.2	-7.6
09.09.2019	**WB Head**	22	703.1	42.2	0.89	42.3	0.82	0.2	-7.5
09.09.2019	**WB Head**	22	704.5	42.2	0.89	42.3	0.82	0.2	-7.4
09.09.2019	**WB Head**	22	725.5	42.1	0.89	42.1	0.83	0.2	-7.0
09.09.2019	**WB Head**	22	746.5	42.0	0.89	42.0	0.84	0.1	-6.4
09.09.2019	**WB Head**	22	747.9	42.0	0.89	42.0	0.84	0.1	-6.4
09.09.2019	**WB Head**	22	782	41.8	0.90	41.8	0.85	0.1	-5.1
10.09.2019	**WB Head**	22	835	41.5	0.90	42.5	0.90	2.4	0.1
10.09.2019	**WB Head**	22	824.1	41.6	0.90	42.5	0.90	2.3	-0.3
10.09.2019	**WB Head**	22	832.1	41.5	0.90	42.5	0.90	2.4	0.0
10.09.2019	**WB Head**	22	842	41.5	0.91	42.5	0.90	2.3	-0.3
10.09.2019	**WB Head**	22	844	41.5	0.91	42.5	0.91	2.3	-0.5
10.09.2019	**WB Head**	22	847	41.5	0.91	42.4	0.91	2.3	-0.7

10.09.2019	**WB Head**	22	857	41.5	0.92	42.4	0.91	2.1	-1.4
10.09.2019	**WB Head**	22	861.9	41.5	0.93	42.4	0.91	2.1	-1.8

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D01 and D02. KDB 941225 D05 was used to select LTE M1 and NB-IoT test modes for testing.

5.1 Test Positions

5.1.1 Body-worn Configuration, 5mm separation distance

The device was placed below the flat modular box phantom with 5mm separation distance in five different test positions. The positions for testing the USB-dongle are according the figure 2.

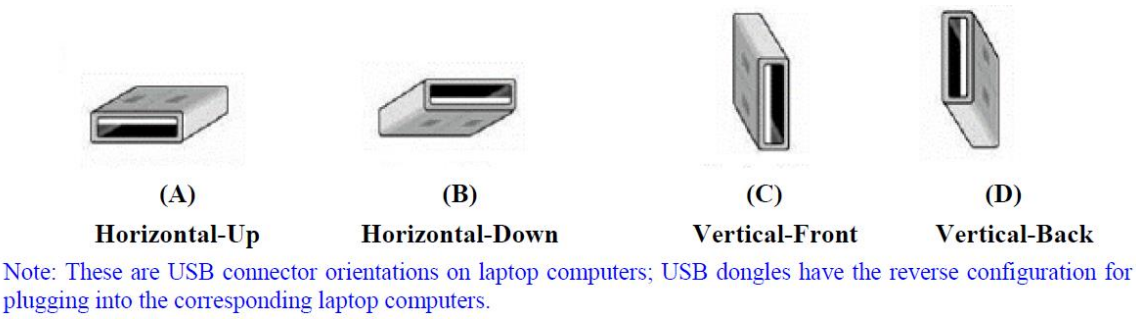


Figure 2 The test position for USB-Dongle

Photos of the test positions are presented in appendix A.

5.2 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.

5.3 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:

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
LTE M1 2	18700	QPSK/20	1	2	25	22.48	Horizontal-Up	1:3.3	0.403	-0.09	1.79	0.72	
LTE M1 2	19100	QPSK/20	3	1	25	22.55	Horizontal-Up	1:3.3	0.473	0.05	1.76	**0.83**	7
LTE-M1 2	18700	QPSK/20	3	1	25	22.38	Horizontal-Up	1:3.3	0.428	-0.13	1.83	0.78	
LTE M1 2	18900	QPSK/20	3	1	25	22.47	Horizontal-Up	1:3.3	0.422	-0.22*	1.88	0.79	
LTE-M1 2	19100	QPSK/20	6	0	25	22.51	Horizontal-Up	1:3.3	0.44	0.04	1.77	0.78	
LTE M1 2	19100	16QAM/20	1	2	25	23.23	Horizontal-Up	1:3.3	0.4	-0.12	1.50	0.60	
LTE-M1 2	19100	16QAM/20	3	0	25	22.8	Horizontal-Up	1:3.3	0.416	-0.05	1.66	0.69	
LTE M1 2	18700	QPSK/20	1	2	25	22.48	Horizontal-Down	1:3.3	0.296	0.16	1.79	0.53	
LTE-M1 2	19100	QPSK/20	3	1	25	22.55	Horizontal-Down	1:3.3	0.348	0.33*	1.90	0.66	
LTE M1 2	19100	16QAM/20	1	2	25	23.23	Horizontal-Down	1:3.3	0.316	0.16	1.50	0.47	
LTE-M1 2	19100	16QAM/20	3	0	25	22.8	Horizontal-Down	1:3.3	0.303	0.19	1.66	0.50	
LTE M1 2	18700	QPSK/20	1	2	25	22.48	Vertical-Front**	1:3.3	0.112	0.28*	1.91	0.21	
LTE-M1 2	19100	QPSK/20	3	1	25	22.55	Vertical-Front**	1:3.3	0.107	0.22*	1.85	0.20	
LTE M1 2	19100	16QAM/20	1	2	25	23.23	Vertical-Front**	1:3.3	0.0967	0.21	1.50	0.15	
LTE-M1 2	19100	16QAM/20	3	0	25	22.8	Vertical-Front**	1:3.3	0.0959	0.13	1.66	0.16	
LTE M1 2	18700	QPSK/20	1	2	25	22.48	Vertical-Back	1:3.3	0.302	-0.08	1.79	0.54	
LTE-M1 2	19100	QPSK/20	3	1	25	22.55	Vertical-Back	1:3.3	0.341	-0.03	1.76	0.60	
LTE M1 2	19100	16QAM/20	1	2	25	23.23	Vertical-Back	1:3.3	0.319	0.09	1.50	0.48	
LTE-M1 2	19100	16QAM/20	3	0	25	22.8	Vertical-Back	1:3.3	0.355	0.02	1.66	0.59	
LTE M1 2	18700	QPSK/20	1	2	25	22.48	Top	1:3.3	0.102	-0.29*	1.91	0.19	
LTE-M1 2	19100	QPSK/20	3	1	25	22.55	Top	1:3.3	0.118	-0.06	1.76	0.21	
LTE M1 2	19100	16QAM/20	1	2	25	23.23	Top	1:3.3	0.107	-0.12	1.50	0.16	
LTE-M1 2	19100	16QAM/20	3	0	25	22.8	Top	1:3.3	0.105	0.03	1.66	0.17	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
LTE M1 4	20050	QPSK/20	1	2	25	22.36	Horizontal-Up	1:3.3	0.476	-0.09	1.84	**0.87**	8
LTE M1 4	20175	QPSK/20	1	2	25	22.21	Horizontal-Up	1:3.3	0.459	-0.03	1.90	0.87	
LTE M1 4	20300	QPSK/20	1	2	25	22.36	Horizontal-Up	1:3.3	0.374	-0.01	1.84	0.69	
LTE M1 4	20050	QPSK/20	3	1	25	22.57	Horizontal-Up	1:3.3	0.478	-0.04	1.75	0.84	
LTE M1 4	20175	QPSK/20	3	1	25	22.57	Horizontal-Up	1:3.3	0.405	-0.11	1.75	0.71	
LTE M1 4	20300	QPSK/20	3	1	25	22.17	Horizontal-Up	1:3.3	0.357	-0.17	1.92	0.68	
LTE M1 4	20050	QPSK/20	6	0	25	22.42	Horizontal-Up	1:3.3	0.418	-0.15	1.81	0.76	
LTE M1 4	20175	16QAM/20	1	2	25	23.51	Horizontal-Up	1:3.3	0.517	-0.08	1.41	0.73	
LTE M1 4	20175	16QAM/20	3	1	25	22.69	Horizontal-Up	1:3.3	0.452	-0.09	1.70	0.77	
LTE M1 4	20050	QPSK/20	1	2	25	22.36	Horizontal-Down	1:3.3	0.175	-0.03	1.84	0.32	
LTE M1 4	20050	QPSK/20	3	1	25	22.57	Horizontal-Down	1:3.3	0.174	-0.05	1.75	0.30	
LTE M1 4	20175	16QAM/20	1	2	25	23.51	Horizontal-Down	1:3.3	0.387	-0.06	1.41	0.55	
LTE M1 4	20175	16QAM/20	3	1	25	22.69	Horizontal-Down	1:3.3	0.335	-0.05	1.70	0.57	
LTE M1 4	20050	QPSK/20	1	2	25	22.36	Vertical-Front	1:3.3	0.13	-0.34*	1.99	0.26	
LTE M1 4	20050	QPSK/20	3	1	25	22.57	Vertical-Front	1:3.3	0.131	-0.37*	1.91	0.25	
LTE M1 4	20175	16QAM/20	1	2	25	23.51	Vertical-Front	1:3.3	0.135	-0.24*	1.49	0.20	
LTE M1 4	20175	16QAM/20	3	1	25	22.69	Vertical-Front	1:3.3	0.119	-0.27*	1.81	0.22	
LTE M1 4	20050	QPSK/20	1	2	25	22.36	Vertical-Back	1:3.3	0.388	0.03	1.84	0.71	
LTE M1 4	20050	QPSK/20	3	1	25	22.57	Vertical-Back	1:3.3	0.39	0.04	1.75	0.68	
LTE M1 4	20175	16QAM/20	1	2	25	23.51	Vertical-Back	1:3.3	0.389	-0.20	1.41	0.55	
LTE M1 4	20175	16QAM/20	3	1	25	22.69	Vertical-Back	1:3.3	0.348	-0.14	1.70	0.59	
LTE M1 4	20050	QPSK/20	1	2	25	22.36	Top	1:3.3	0.0764	-0.39*	2.01	0.15	
LTE M1 4	20050	QPSK/20	3	1	25	22.57	Top	1:3.3	0.0765	0.24*	1.85	0.14	
LTE M1 4	20175	16QAM/20	1	2	25	23.51	Top	1:3.3	0.0829	0.13	1.41	0.12	
LTE M1 4	20175	16QAM/20	3	1	25	22.69	Top	1:3.3	0.0714	0.02	1.70	0.12	

*Larger than 5% drifts included to scaling factor

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
LTEM1 5	20600	QPSK/10	1	2	25	23.11	Horizontal-Up	1:3.3	0.33	-0.06	1.55	0.51	
LTEM1 5	20600	QPSK/10	3	1	25	23.01	Horizontal-Up	1:3.3	0.324	-0.02	1.58	0.51	
LTEM1 5	20600	QPSK/10	1	2	25	23.11	Horizontal-Down	1:3.3	0.339	-0.02	1.55	0.52	
LTEM1 5	20600	QPSK/10	3	1	25	23.01	Horizontal-Down	1:3.3	0.336	-0.01	1.58	**0.53**	9
LTEM1 5	20600	QPSK/10	1	2	25	23.11	Vertical-Front**	1:3.3	0.128	0.25*	1.64	0.21	
LTEM1 5	20600	QPSK/10	3	1	25	23.01	Vertical-Front**	1:3.3	0.123	0.33*	1.71	0.21	
LTEM1 5	20600	QPSK/10	1	2	25	23.11	Vertical-Back	1:3.3	0.242	-0.10	1.55	0.37	
LTEM1 5	20600	QPSK/10	3	1	25	23.01	Vertical-Back	1:3.3	0.227	-0.12	1.58	0.36	
LTEM1 5	20600	QPSK/10	1	2	25	23.11	Top	1:3.3	0.0235	-0.21	1.55	0.04	
LTEM1 5	20600	QPSK/10	3	1	25	23.01	Top	1:3.3	0.0221	-0.21	1.58	0.03	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
LTE M1 12	23130	QPSK/10	1	5	25	23.57	Horizontal-Up	1:3.3	0.284	-0.03	1.39	0.39	
LTE M1 12	23130	QPSK/10	3	1	25	23.44	Horizontal-Up	1:3.3	0.303	0.03	1.43	**0.43**	10
LTE M1 12	23130	QPSK/10	1	5	25	23.57	Horizontal-Down	1:3.3	0.286	0.13	1.39	0.40	
LTE M1 12	23130	QPSK/10	3	1	25	23.44	Horizontal-Down	1:3.3	0.284	-0.16	1.43	0.41	
LTE M1 12	23130	QPSK/10	1	5	25	23.57	Vertical-Front**	1:3.3	0.102	-0.35*	1.51	0.15	
LTE M1 12	23130	QPSK/10	3	1	25	23.44	Vertical-Front**	1:3.3	0.0994	-0.62*	1.65	0.16	
LTE M1 12	23130	QPSK/10	1	5	25	23.57	Vertical-Back	1:3.3	0.204	-0.41*	1.53	0.31	
LTE M1 12	23130	QPSK/10	3	1	25	23.44	Vertical-Back	1:3.3	0.2	-0.17	1.43	0.29	
LTE M1 12	23130	QPSK/10	1	5	25	23.57	Top	1:3.3	0.0149	-0.57*	1.58	0.02	
LTE M1 12	23130	QPSK/10	3	1	25	23.44	Top	1:3.3	0.0152	0.45*	1.59	0.02	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ BW [MHz]	RB Size	RB Offset	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle	Measured SAR1g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
LTE M1 13	23230	QPSK/10	1	2	25	23.35	Horizontal-Up	1:3.3	0.345	-0.01	1.46	**0.50**	11
LTE M1 13	23230	QPSK/10	3	1	25	23.35	Horizontal-Up	1:3.3	0.338	-0.07	1.46	0.49	
LTE M1 13	23230	QPSK/10	1	2	25	23.35	Horizontal-Down	1:3.3	0.298	-0.07	1.46	0.44	
LTE M1 13	23230	QPSK/10	3	1	25	23.35	Horizontal-Down	1:3.3	0.314	-0.05	1.46	0.46	
LTE M1 13	23230	QPSK/10	1	2	25	23.35	Vertical-Front**	1:3.3	0.12	-0.50*	1.64	0.20	
LTE M1 13	23230	QPSK/10	3	1	25	23.35	Vertical-Front**	1:3.3	0.103	-0.51*	1.64	0.17	
LTE M1 13	23230	QPSK/10	1	2	25	23.35	Vertical-Back	1:3.3	0.226	-0.34*	1.58	0.36	
LTE M1 13	23230	QPSK/10	3	1	25	23.35	Vertical-Back	1:3.3	0.232	-0.35*	1.58	0.37	
LTE M1 13	23230	QPSK/10	1	2	25	23.35	Top	1:3.3	0.0167	-0.70*	1.72	0.03	
LTE M1 13	23230	QPSK/10	3	1	25	23.35	Top	1:3.3	0.0165	-0.43*	1.61	0.03	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle [%]	Measured SAR10g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 10g [mW/g]	Plot #
NB-IoT 2	19199	QPSK/15	1	5	25	21.76	Horizontal-Up	1:2	0.316	0.13	2.11	**0.67**	12
NB-IoT 2	19199	QPSK/15	6	0	25	22.01	Horizontal-Up	1:2	0.145	-0.18	1.99	0.29	
NB-IoT 2	19199	QPSK/15	1	5	25	21.76	Horizontal-Down	1:2	0.281	0.14	2.11	0.59	
NB-IoT 2	19199	QPSK/15	6	0	25	22.01	Horizontal-Down	1:2	0.12	0.07	1.99	0.24	
NB-IoT 2	19199	QPSK/15	1	5	25	21.76	Vertical-Front**	1:2	0.103	-0.12	2.11	0.22	
NB-IoT 2	19199	QPSK/15	6	0	25	22.01	Vertical-Front**	1:2	0.0439	-0.35*	2.16	0.09	
NB-IoT 2	19199	QPSK/15	1	5	25	21.76	Vertical-Back	1:2	0.298	-0.09	2.11	0.63	
NB-IoT 2	19199	QPSK/15	6	0	25	22.01	Vertical-Back	1:2	0.106	-0.21	1.99	0.21	
NB-IoT 2	19199	QPSK/15	1	5	25	21.76	Top	1:2	0.0858	-0.05	2.11	0.18	
NB-IoT 2	19199	QPSK/15	6	0	25	22.01	Top	1:2	0.0412	-0.63*	2.30	0.09	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle [%]	Measured SAR10g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 10g [mW/g]	Plot #
NB-IoT 4	19951	QPSK/15	1	5	25	22.71	Horizontal-Up	1:2	0.469	-0.19	1.69	**0.79**	13
NB-IoT 4	19951	QPSK/15	6	0	25	21.78	Horizontal-Up	1:2	0.205	0.07	2.10	0.43	
NB-IoT 4	19951	QPSK/15	1	5	25	22.71	Horizontal-Down	1:2	0.239	-0.1	1.69	0.40	
NB-IoT 4	19951	QPSK/15	6	0	25	21.78	Horizontal-Down	1:2	0.104	-0.03	2.10	0.22	
NB-IoT 4	19951	QPSK/15	1	5	25	22.71	Vertical-Front**	1:2	0.06	-0.68*	1.98	0.12	
NB-IoT 4	19951	QPSK/15	6	0	25	21.78	Vertical-Front**	1:2	0.0428	-0.47*	2.34	0.10	
NB-IoT 4	19951	QPSK/15	1	5	25	22.71	Vertical-Back	1:2	0.304	-0.22*	1.78	0.54	
NB-IoT 4	19951	QPSK/15	6	0	25	21.78	Vertical-Back	1:2	0.113	-0.2	2.10	0.24	
NB-IoT 4	19951	QPSK/15	1	5	25	22.71	Top	1:2	0.0555	-0.11	1.69	0.09	
NB-IoT 4	19951	QPSK/15	6	0	25	21.78	Top	1:2	0.0237	0.51*	2.36	0.06	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle [%]	Measured SAR10g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 10g [mW/g]	Plot #
NB-IoT 5	20401	QPSK/15	1	5	25	22.05	Horizontal-Up	1:2	0.181	-0.13	1.97	0.36	
NB-IoT 5	20401	QPSK/15	6	6	25	22.00	Horizontal-Up	1:2	0.0782	-0.03	2.00	0.16	
NB-IoT 5	20401	QPSK/15	1	5	25	22.05	Horizontal-Down	1:2	0.196	-0.02	1.97	**0.39**	14
NB-IoT 5	20401	QPSK/15	6	6	25	22.00	Horizontal-Down	1:2	0.0841	-0.12	2.00	0.17	
NB-IoT 5	20401	QPSK/15	1	5	25	22.05	Vertical-Front**	1:2	0.0671	0.023	1.97	0.13	
NB-IoT 5	20401	QPSK/15	6	6	25	22.00	Vertical-Front**	1:2	0.0276	0.33*	2.15	0.06	
NB-IoT 5	20401	QPSK/15	1	5	25	22.05	Vertical-Back	1:2	0.152	-0.17	1.97	0.30	
NB-IoT 5	20401	QPSK/15	6	6	25	22.00	Vertical-Back	1:2	0.0697	-0.18	2.00	0.14	
NB-IoT 5	20401	QPSK/15	1	5	25	22.05	Top	1:2	0.0135	0.07	1.97	0.03	
NB-IoT 5	20401	QPSK/15	6	6	25	22.00	Top	1:2	0.00587	-0.15	2.00	0.01	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle [%]	Measured SAR10g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 10g [mW/g]	Plot #
NB-IoT 12	23011	QPSK/15	1	5	25	22.54	Horizontal-Up	1:2	0.188	-0.20	1.76	0.33	
NB-IoT 12	23011	QPSK/15	6	6	25	22.57	Horizontal-Up	1:2	0.083	-0.00	1.75	0.15	
NB-IoT 12	23011	QPSK/15	1	5	25	22.54	Horizontal-Down	1:2	0.202	-0.42*	1.94	**0.39**	15
NB-IoT 12	23011	QPSK/15	6	6	25	22.57	Horizontal-Down	1:2	0.0887	-0.09	1.75	0.16	
NB-IoT 12	23011	QPSK/15	1	5	25	22.54	Vertical-Front**	1:2	0.0961	-0.52*	1.99	0.19	
NB-IoT 12	23011	QPSK/15	6	6	25	22.57	Vertical-Front**	1:2	0.0411	-0.01	1.75	0.07	
NB-IoT 12	23011	QPSK/15	1	5	25	22.54	Vertical-Back	1:2	0.137	-0.39*	1.93	0.26	
NB-IoT 12	23011	QPSK/15	6	6	25	22.57	Vertical-Back	1:2	0.059	-0.53*	1.98	0.12	
NB-IoT 12	23011	QPSK/15	1	5	25	22.54	Top	1:2	0.00871	0.29*	1.76	0.02	
NB-IoT 12	23011	QPSK/15	6	6	25	22.57	Top	1:2	0.00352	0.08	1.75	0.01	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

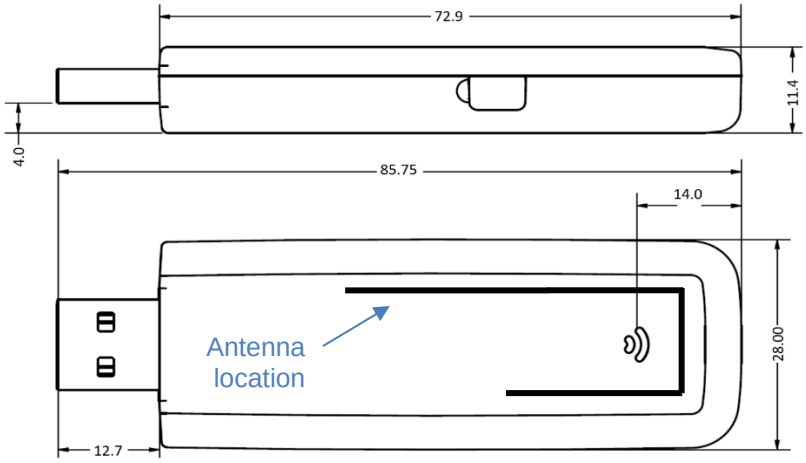
Band	Channel	Modulation/ SC Spacing [kHz]	Subcarriers	Subcarrier Start	Maximum Power [dBm]	Conducted Power [dBm]	Test Position	Duty Cycle [%]	Measured SAR10g [mW/g]	Power Drift [dB]	Scaling Factor	Reported SAR 10g [mW/g]	Plot #
NB-IoT 13	23230	QPSK/15	1	5	25	22.38	Horizontal-Up	1:2	0.216	-0.45*	2.03	**0.44**	16
NB-IoT 13	23230	QPSK/15	6	6	25	22.33	Horizontal-Up	1:2	0.0917	-0.05	1.85	0.17	
NB-IoT 13	23230	QPSK/15	1	5	25	22.38	Horizontal-Down	1:2	0.205	-0.12	1.83	0.37	
NB-IoT 13	23230	QPSK/15	6	6	25	22.33	Horizontal-Down	1:2	0.0871	-0.11	1.85	0.16	
NB-IoT 13	23230	QPSK/15	1	5	25	22.38	Vertical-Front**	1:2	0.0354	-0.44*	2.02	0.07	
NB-IoT 13	23230	QPSK/15	6	6	25	22.33	Vertical-Front**	1:2	0.0153	-0.31*	1.99	0.03	
NB-IoT 13	23230	QPSK/15	1	5	25	22.38	Vertical-Back	1:2	0.162	-0.13	1.83	0.30	
NB-IoT 13	23230	QPSK/15	6	6	25	22.33	Vertical-Back	1:2	0.0682	-0.37*	2.01	0.14	
NB-IoT 13	23230	QPSK/15	1	5	25	22.38	Top	1:2	0.00971	-0.24*	1.93	0.02	
NB-IoT 13	23230	QPSK/15	6	6	25	22.33	Top	1:2	0.00378	-0.20	1.85	0.01	

*Larger than 5% drifts included to scaling factor **20cm USB cable was used in vertical-front test position.

The pictures of the test positions are presented in appendix A.

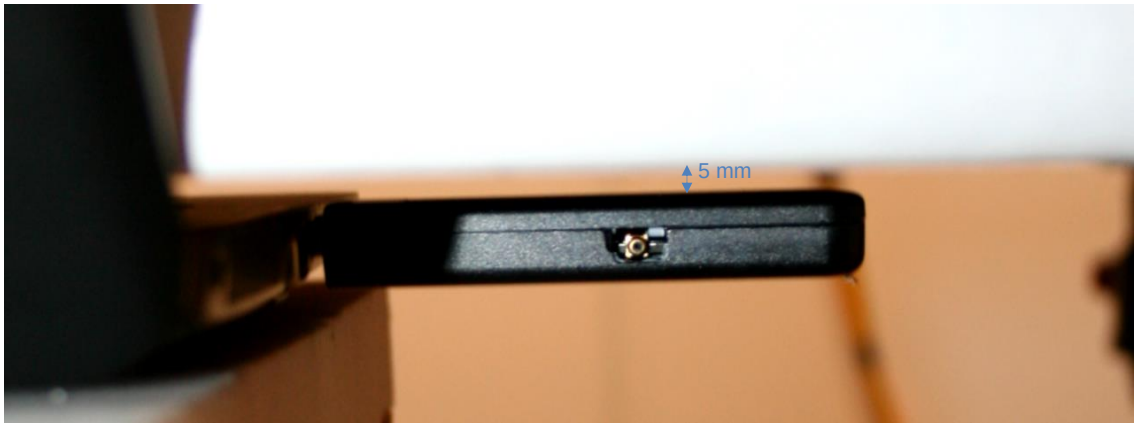
APPENDIX A: PHOTOS OF THE DUT

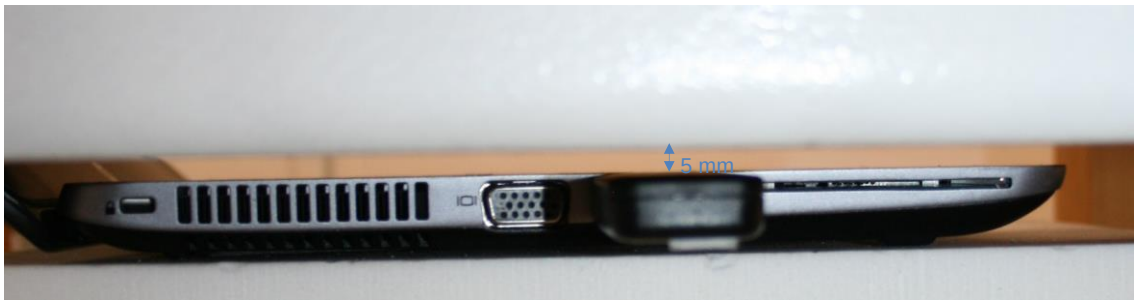
Size of the device is: 72.9x28x11.4mm



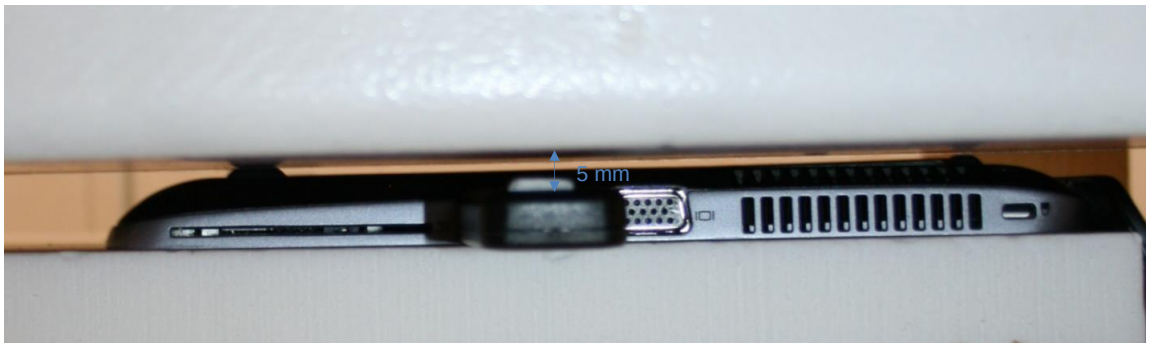
Device top view

Device bottom view





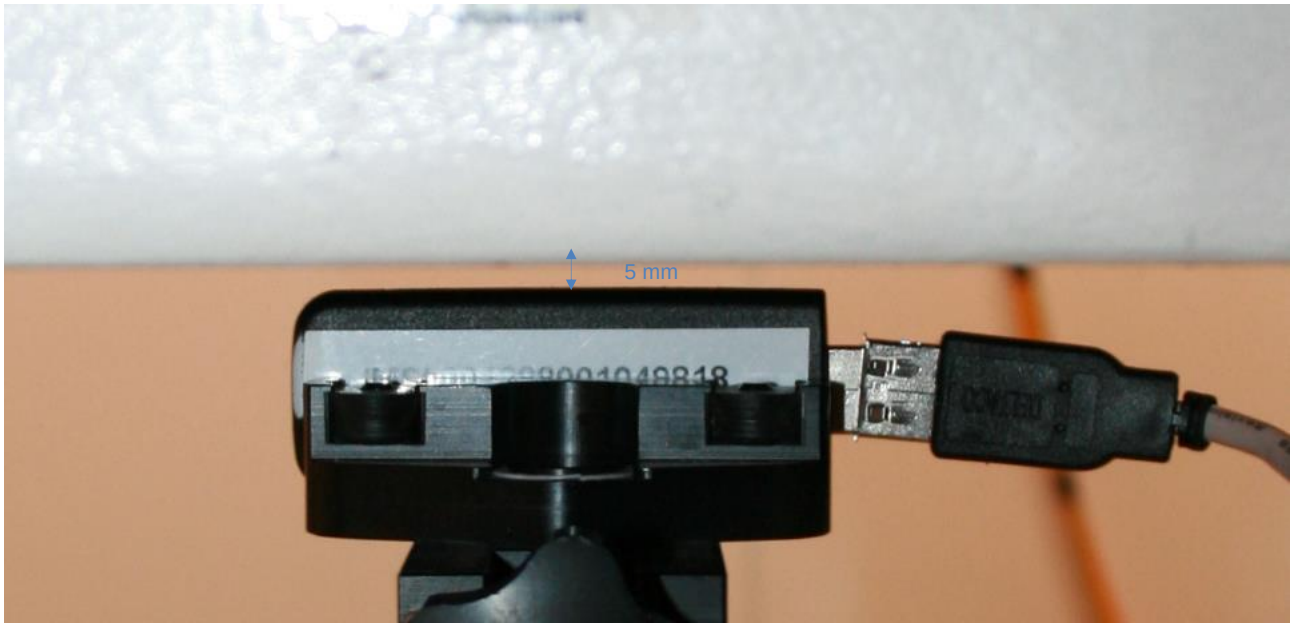
Horizontal-Up



Horizontal-Down

Vertical-Back

Vertical-Front



Vertical-Front with 20cm USB cable

Top configuration

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 2.9.2019 11:56:53

Test Laboratory: Verkotan Oy

DUT: Dipole 1800 MHz D1800V2; Type: D1800V2; Serial: D1800V2

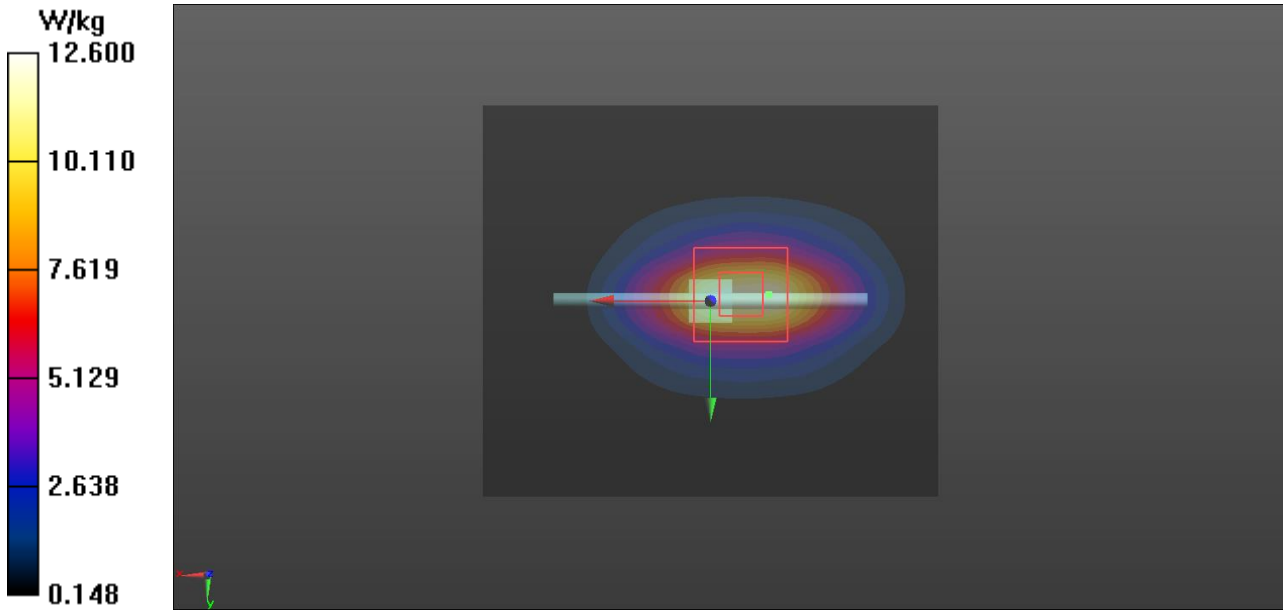
Communication System: UID 0, CW (0); Communication System Band: D1800 (1800.0 MHz); Frequency: 1800 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1800 MHz; σ = 1.277 S/m; ε_r = 37.332; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.69, 8.69, 8.69); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 85.22 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 15.6 W/kg
SAR(1 g) = 9.21 W/kg; SAR(10 g) = 4.86 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 12.6 W/kg

System check/Area Scan (71x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 12.7 W/kg



Plot 2

Date/Time: 3.9.2019 9:16:16

Test Laboratory: Verkotan Oy

DUT: Dipole 1800 MHz D1800V2; Type: D1800V2;

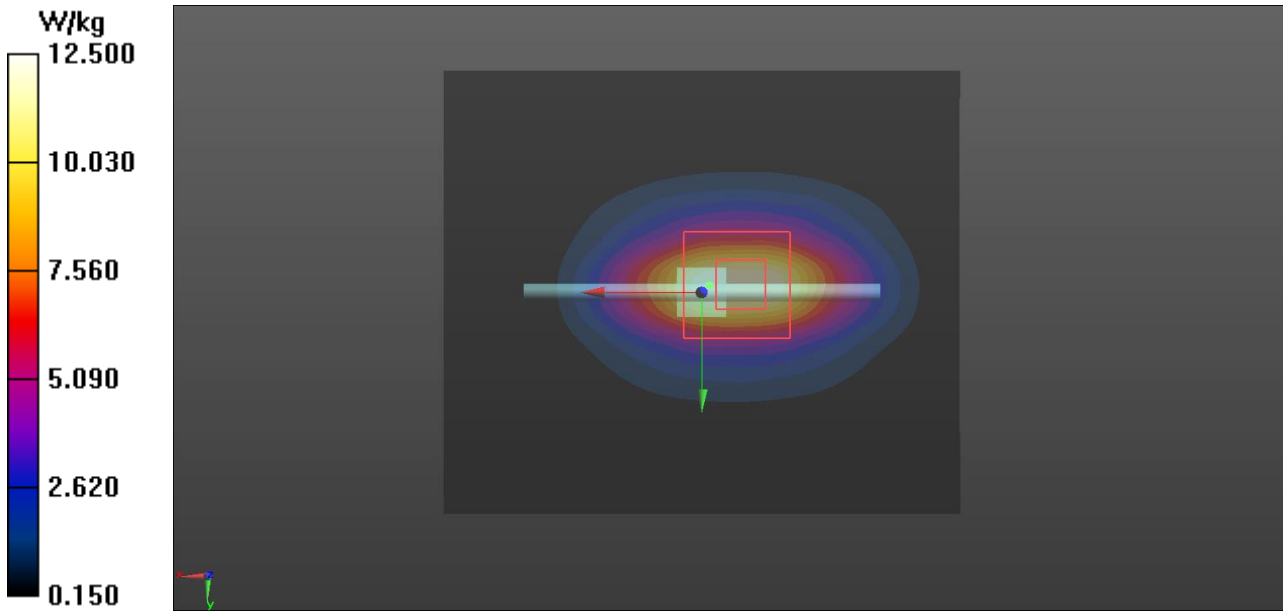
Communication System: UID 0, CW (0); Communication System Band: D1800 (1800.0 MHz); Frequency: 1800 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1800 MHz; σ = 1.28 S/m; ε_r = 38.544; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.69, 8.69, 8.69); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 85.25 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 15.7 W/kg
SAR(1 g) = 9.22 W/kg; SAR(10 g) = 4.83 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 12.5 W/kg

System check/Area Scan (71x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 12.5 W/kg



Date/Time: 3.9.2019 9:38:12

Test Laboratory: Verkotan Oy

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2;

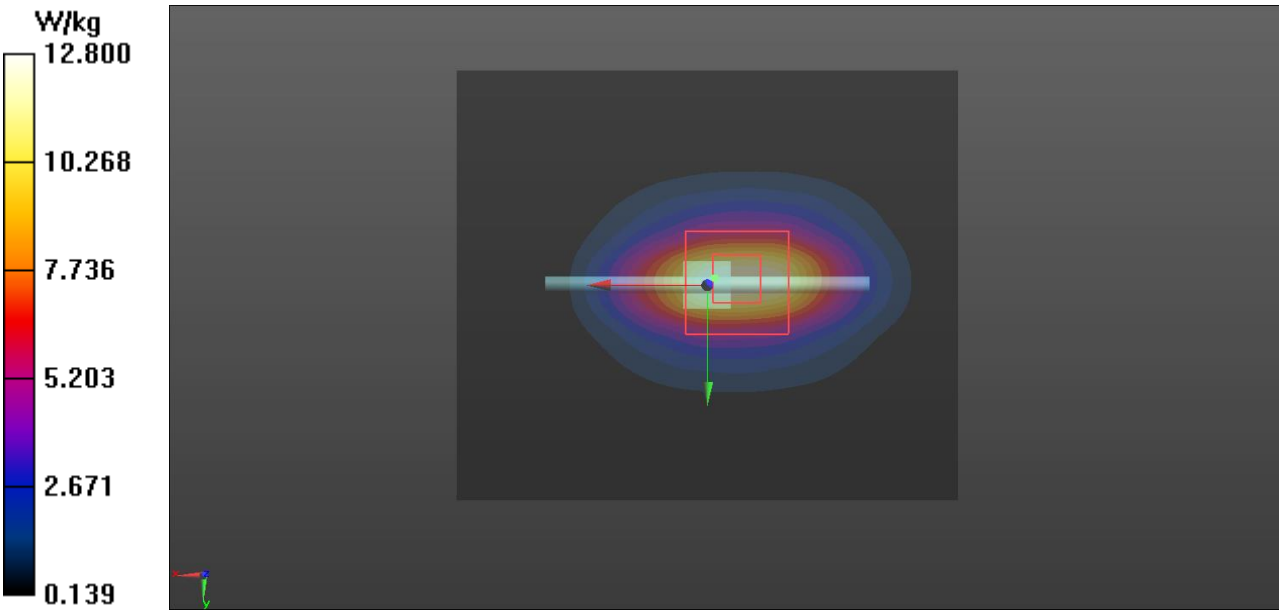
Communication System: UID 0, CW (0); Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1900 MHz; σ = 1.324 S/m; ε_r = 38.325; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.46, 8.46, 8.46); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 85.85 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 16.2 W/kg
SAR(1 g) = 9.3 W/kg; SAR(10 g) = 4.86 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 12.8 W/kg

System check/Area Scan (71x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 13.1 W/kg



Plot 4

Date/Time: 5.9.2019 10:28:29

Test Laboratory: Verkotan Oy

DUT: Dipole 750 MHz D750V3; Type: D750V3;

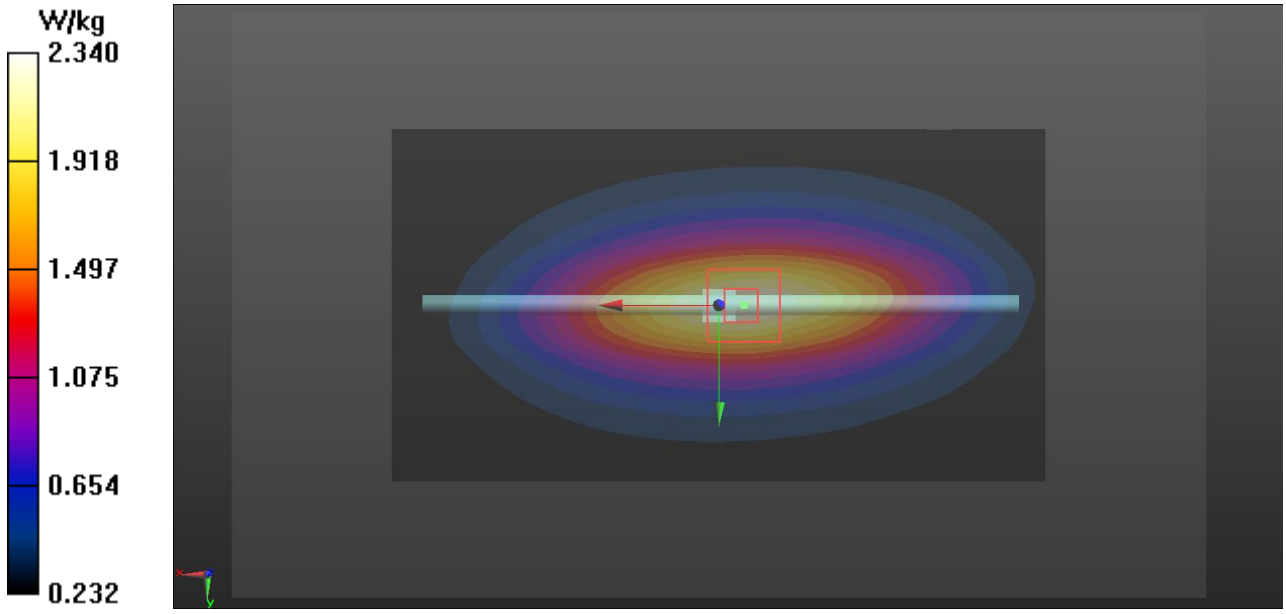
Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.858 S/m; ε_r = 42.407; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 48.13 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 2.75 W/kg
SAR(1 g) = 1.92 W/kg; SAR(10 g) = 1.26 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 2.34 W/kg

System check/Area Scan (131x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.30 W/kg



Date/Time: 9.9.2019 8:49:40

Test Laboratory: Verkotan Oy

DUT: Dipole 750 MHz D750V3; Type: D750V3;

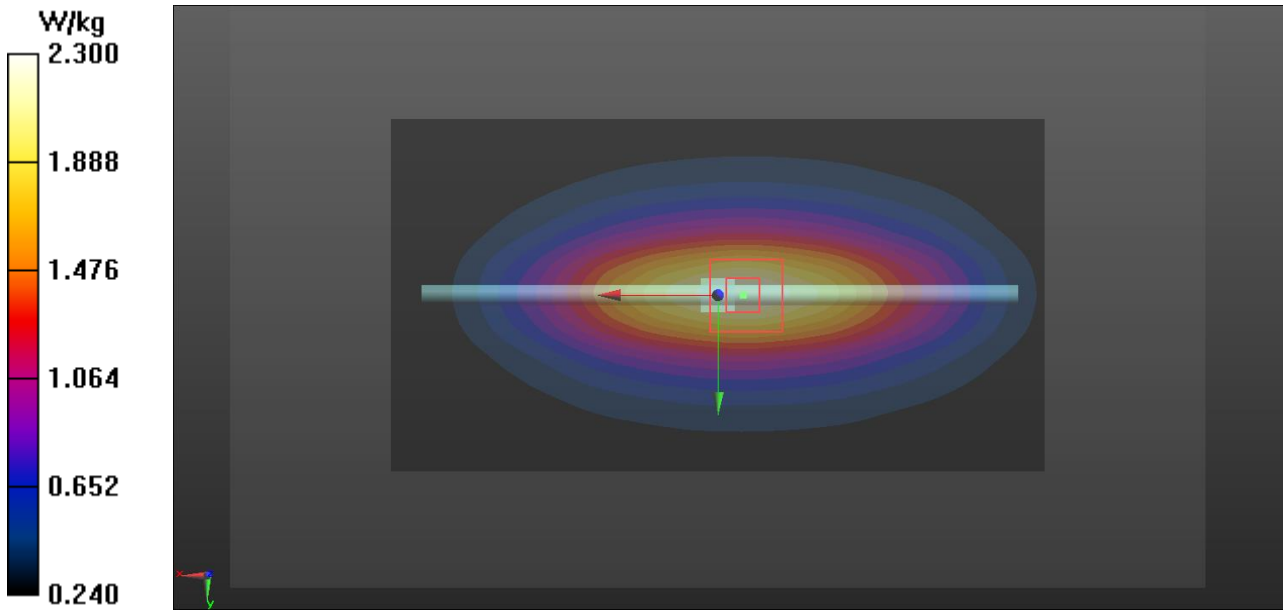
Communication System: UID 0, CW (0); Communication System Band: D750 (750.0 MHz); Frequency: 750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 750 MHz; σ = 0.837 S/m; ε_r = 41.971; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 48.39 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 2.69 W/kg
SAR(1 g) = 1.92 W/kg; SAR(10 g) = 1.26 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 2.30 W/kg

System check/Area Scan (131x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.23 W/kg



Plot 6

Date/Time: 10.9.2019 9:04:06

Test Laboratory: Verkotan Oy

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2

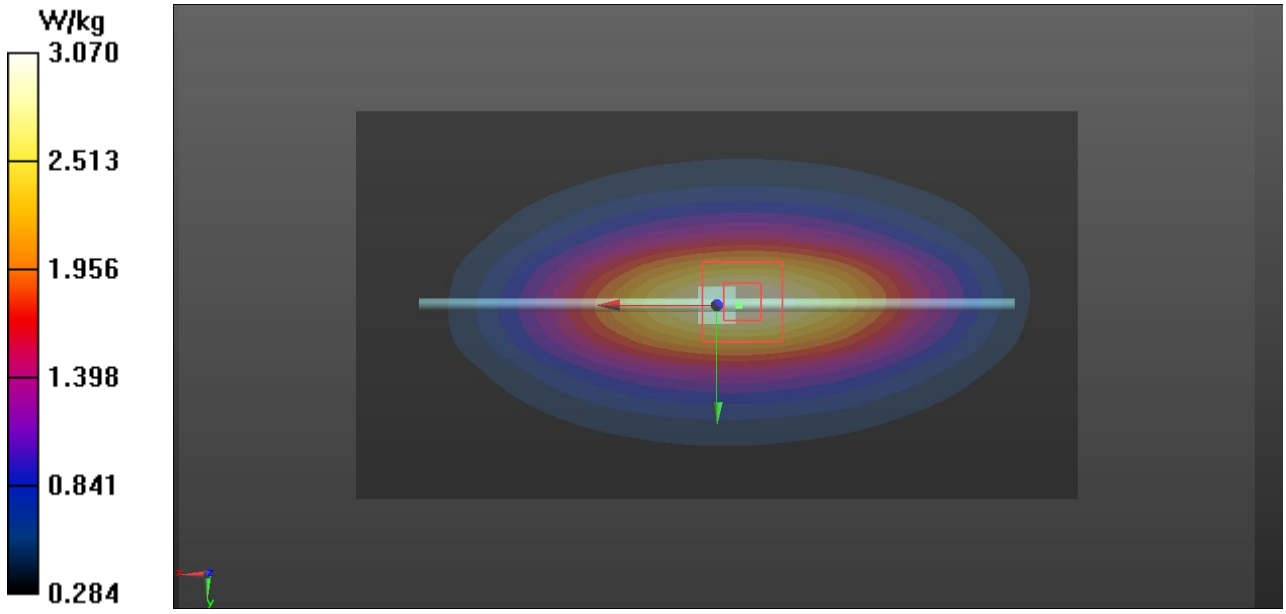
Communication System: UID 0, CW (0); Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 835 MHz; σ = 0.901 S/m; ε_r = 42.49; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(9.98, 9.98, 9.98); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 55.18 V/m; Power Drift = -0.23 dB
Peak SAR (extrapolated) = 3.56 W/kg
SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.6 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 3.07 W/kg

System check/Area Scan (131x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.03 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 7

Date/Time: 4.9.2019 9:19:13

Test Laboratory: Verkotan Oy

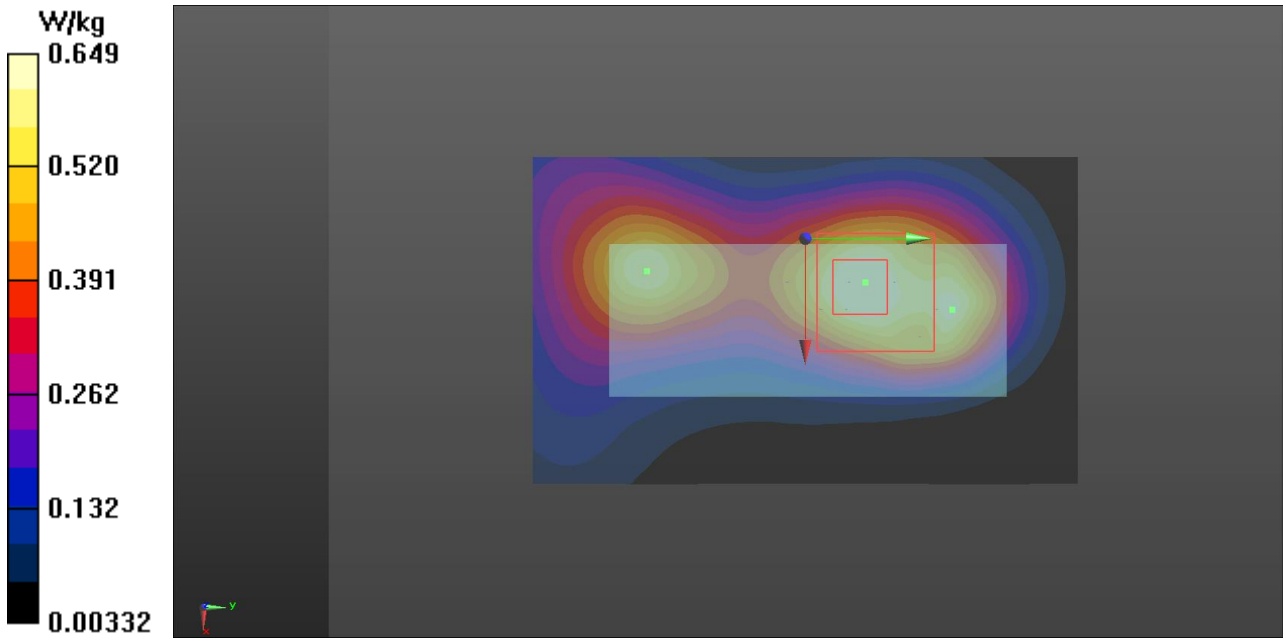
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, LTE M1 (0); Communication System Band: Band 2; Frequency: 1900 MHz;Communication System PAR: 5.22 dB;
Medium parameters used: f = 1900 MHz; σ = 1.343 S/m; ε_r = 37.836; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.46, 8.46, 8.46); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC LTE-M1 1800 Band 2 Horizontal-up RB3, Offset1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 21.03 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 0.812 W/kg
SAR(1 g) = 0.473 W/kg; SAR(10 g) = 0.266 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.642 W/kg
FCC LTE-M1 1800 Band 2 Horizontal-up RB3, Offset1/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.674 W/kg



Plot 8

Date/Time: 2.9.2019 16:04:45

Test Laboratory: Verkotan Oy

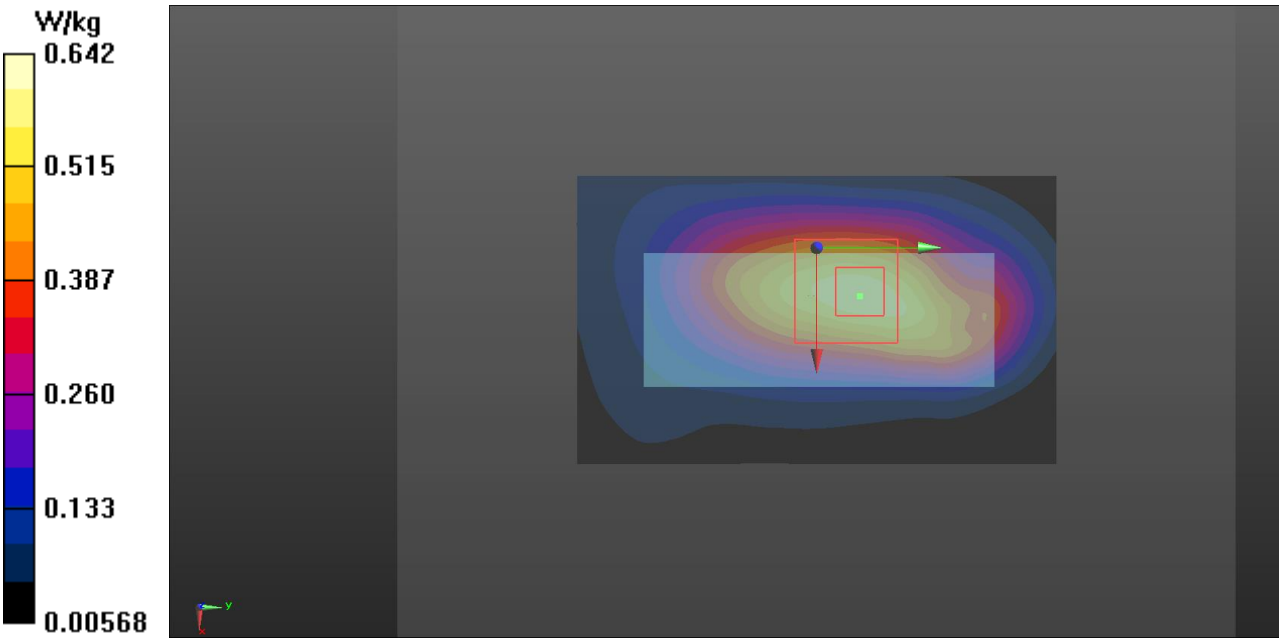
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, LTE M1 (0); Communication System Band: Band 4; Frequency: 1720 MHz;Communication System PAR: 5.22 dB;
Medium parameters used: f = 1720 MHz; σ = 1.236 S/m; ε_r = 37.471; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.69, 8.69, 8.69); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC LTEM1 1800 Band 4 Horizontal-up Bw20/Rb1/start2/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.591 W/kg
FCC LTEM1 1800 Band 4 Horizontal-up Bw20/Rb1/start2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.25 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.742 W/kg
SAR(1 g) = 0.476 W/kg; SAR(10 g) = 0.278 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.603 W/kg



Date/Time: 10.9.2019 10:44:19

Test Laboratory: Verkotan Oy

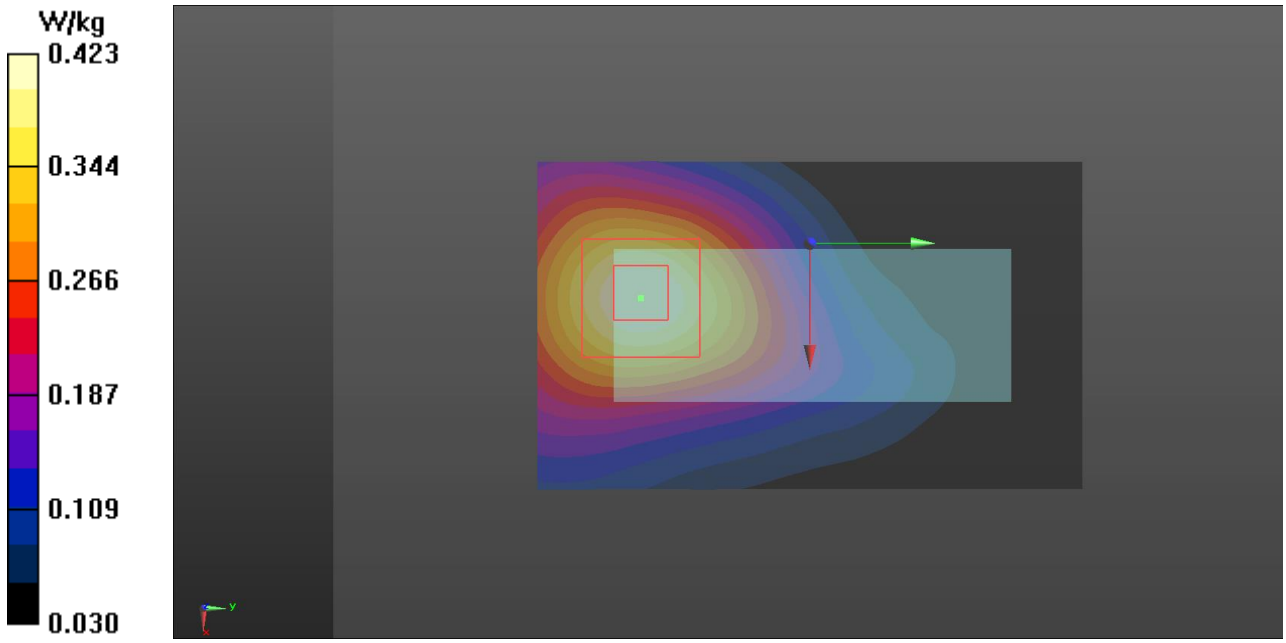
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, LTE M1 (0); Communication System Band: Band 5; Frequency: 844 MHz;Communication System PAR: 5.22 dB
Medium parameters used: f = 844 MHz; σ = 0.905 S/m; ε_r = 42.45; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(9.98, 9.98, 9.98); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC LTE-M1, Band 5, QPSK/10, RB3, Start1, Horizontal-Down/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.428 W/kg
FCC LTE-M1, Band 5, QPSK/10, RB3, Start1, Horizontal-Down/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 19.60 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.494 W/kg
SAR(1 g) = 0.336 W/kg; SAR(10 g) = 0.216 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.423 W/kg



Plot 10

Date/Time: 5.9.2019 11:20:03

Test Laboratory: Verkotan Oy

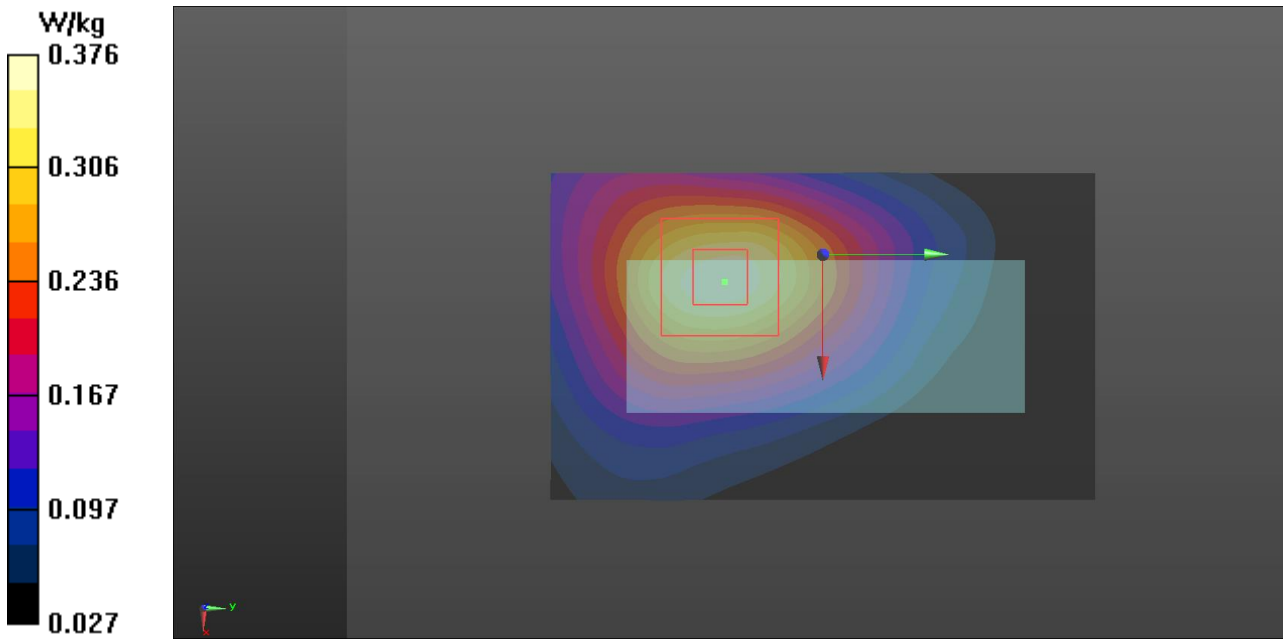
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, LTE M1 (0); Communication System Band: Band 12; Frequency: 711 MHz;Communication System PAR: 5.22 dB
Medium parameters used (interpolated): f = 711 MHz; σ = 0.843 S/m; ε_r = 42.626; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC LTE-M1, Band 12, Horizontal-up, RB3, Offset1/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.367 W/kg
FCC LTE-M1, Band 12, Horizontal-up, RB3, Offset1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 20.54 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.446 W/kg
SAR(1 g) = 0.303 W/kg; SAR(10 g) = 0.194 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.376 W/kg



Date/Time: 5.9.2019 12:02:14

Test Laboratory: Verkotan Oy

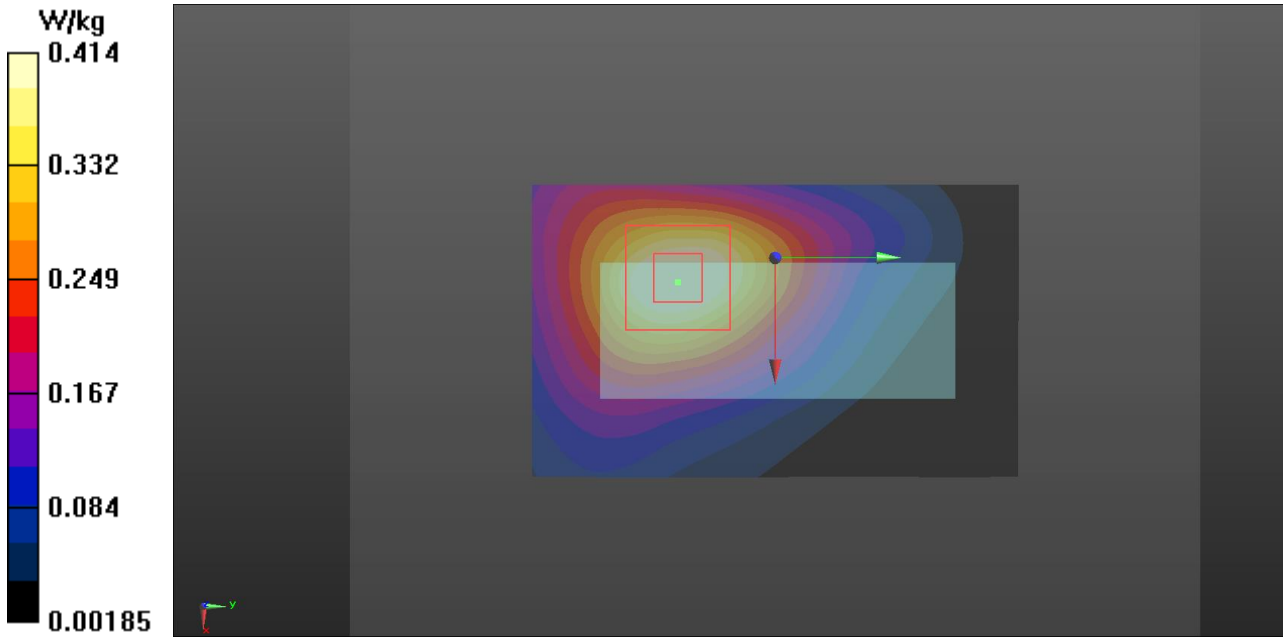
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, LTE M1 (0); Communication System Band: Band 13; Frequency: 782 MHz;Communication System PAR: 5.22 dB
Medium parameters used: f = 782 MHz; σ = 0.868 S/m; ε_r = 42.24; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC LTE-M1, Band 13, Horizontal-up, RB1, Offset2/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.427 W/kg
FCC LTE-M1, Band 13, Horizontal-up, RB1, Offset2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 21.37 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.512 W/kg
SAR(1 g) = 0.345 W/kg; SAR(10 g) = 0.218 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.428 W/kg



Date/Time: 3.9.2019 15:41:46

Test Laboratory: Verkotan Oy

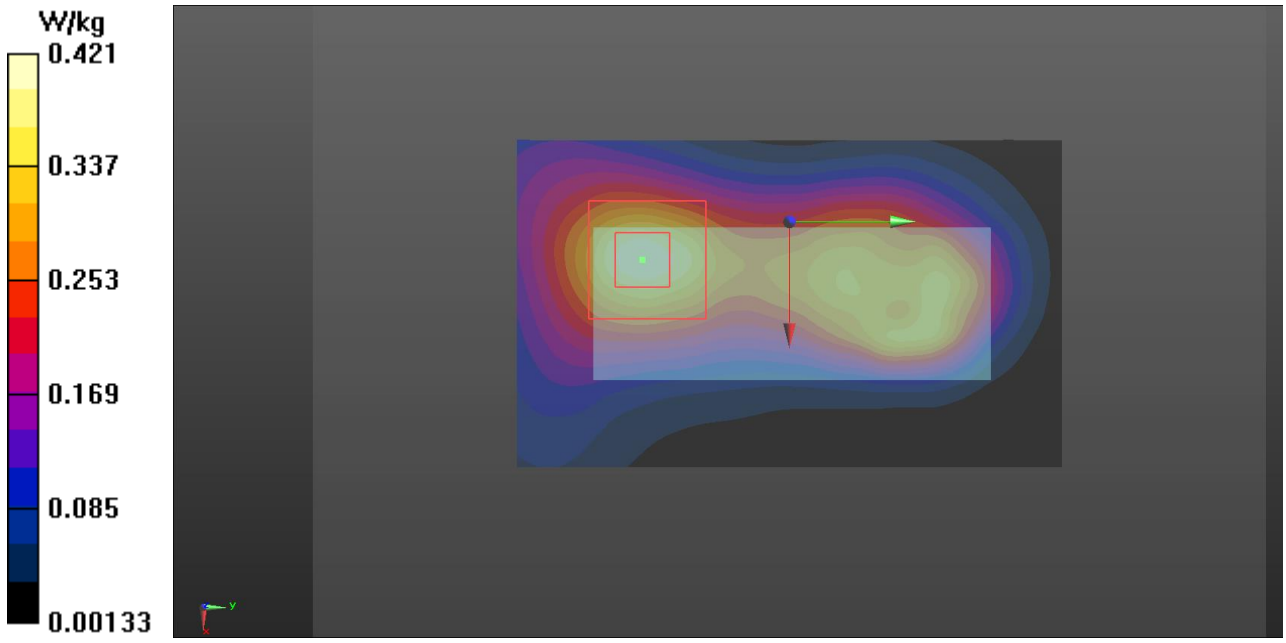
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 2; Frequency: 1909.9 MHz;Communication System PAR: 3.01 dB
Medium parameters used: f = 1910 MHz; σ = 1.328 S/m; ε_r = 38.312; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.46, 8.46, 8.46); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC NB-IoT 1800 Band 2 Horizontal-up SC1, SCstart 5/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 15.25 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 0.497 W/kg
SAR(1 g) = 0.316 W/kg; SAR(10 g) = 0.179 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.408 W/kg
FCC NB-IoT 1800 Band 2 Horizontal-up SC1, SCstart 5/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.421 W/kg



Date/Time: 3.9.2019 16:44:51

Test Laboratory: Verkotan Oy

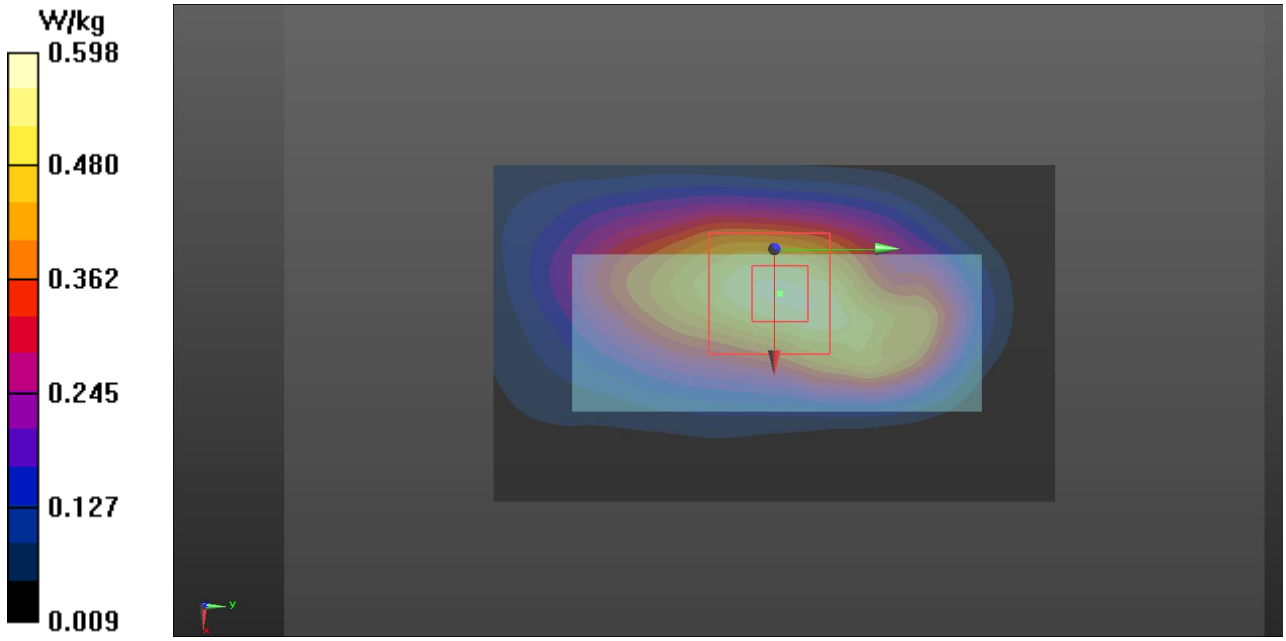
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 4; Frequency: 1710.1 MHz;Communication System PAR: 3.01 dB
Medium parameters used (interpolated): f = 1710.1 MHz; σ = 1.234 S/m; ε_r = 38.673; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(8.69, 8.69, 8.69); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC NB-IoT 1800 Band 4 Horizontal-up SC1, SCstart 5/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.572 W/kg
FCC NB-IoT 1800 Band 4 Horizontal-up SC1, SCstart 5/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 19.36 V/m; Power Drift = -0.19 dB
Peak SAR (extrapolated) = 0.721 W/kg
SAR(1 g) = 0.469 W/kg; SAR(10 g) = 0.266 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.598 W/kg



Date/Time: 10.9.2019 17:40:50

Test Laboratory: Verkotan Oy

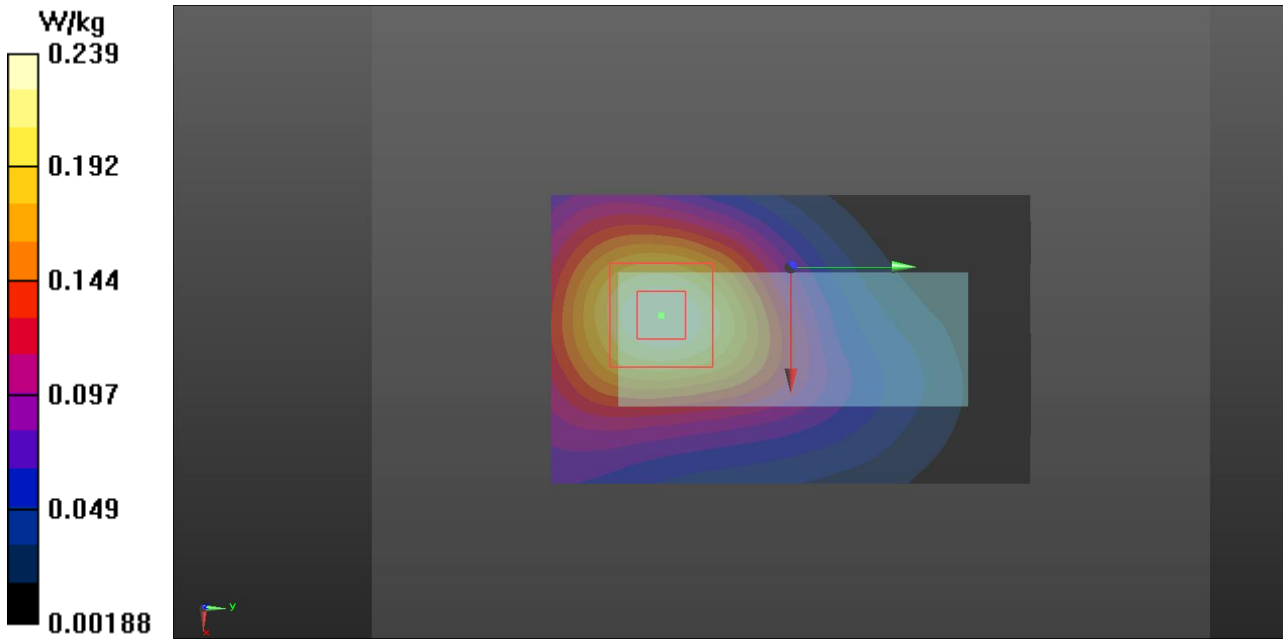
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 5; Frequency: 824.1 MHz;Communication System PAR: 3.01 dB
Medium parameters used (interpolated): f = 824.1 MHz; σ = 0.897 S/m; ε_r = 42.528; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(9.98, 9.98, 9.98); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC NBIOT, Band 5, QPSK/15, RB1 Start5, Horizontal-Down/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 15.70 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.282 W/kg
SAR(1 g) = 0.196 W/kg; SAR(10 g) = 0.127 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.244 W/kg
FCC NBIOT, Band 5, QPSK/15, RB1 Start5, Horizontal-Down/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.242 W/kg



Date/Time: 9.9.2019 9:43:58

Test Laboratory: Verkotan Oy

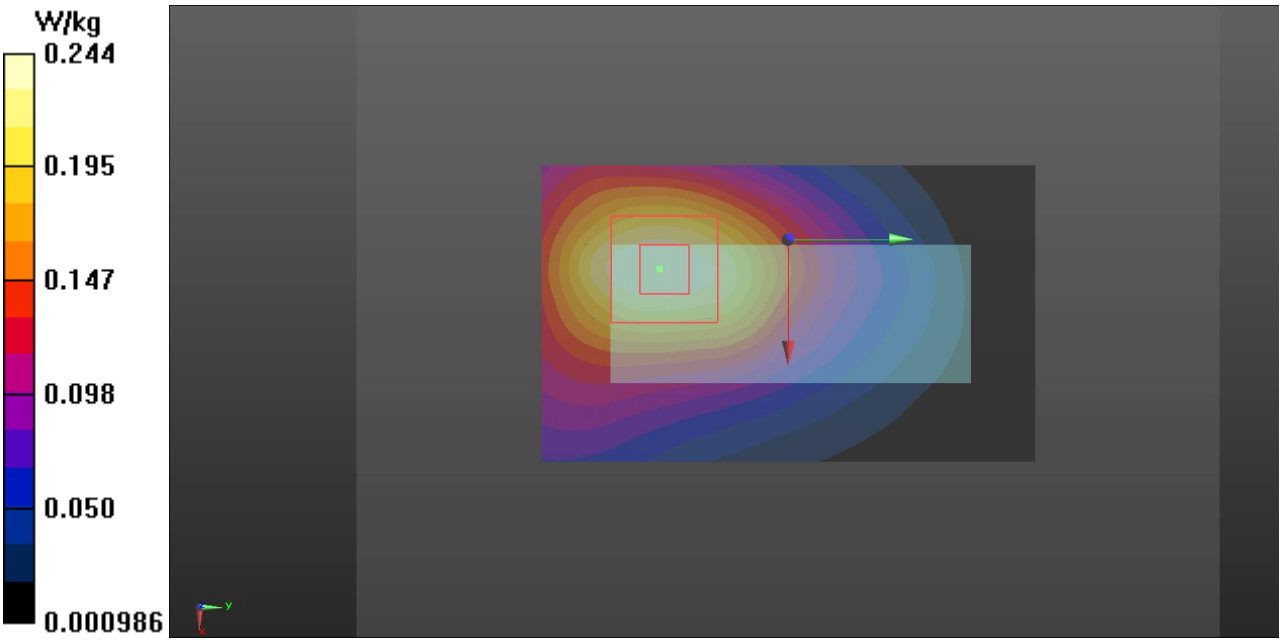
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 12; Frequency: 699.1 MHz;Communication System PAR: 3.01 dB
Medium parameters used (extrapolated): f = 699.1 MHz; σ = 0.821 S/m; ε_r = 42.303; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC NB-IoT, Band 12, QPSK/15, SC1, Start5, Horizontal-Down/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 17.12 V/m; Power Drift = -0.42 dB
Peak SAR (extrapolated) = 0.289 W/kg
SAR(1 g) = 0.202 W/kg; SAR(10 g) = 0.132 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.243 W/kg
FCC NB-IoT, Band 12, QPSK/15, SC1, Start5, Horizontal-Down/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm



Date/Time: 6.9.2019 15:02:07

Test Laboratory: Verkotan Oy

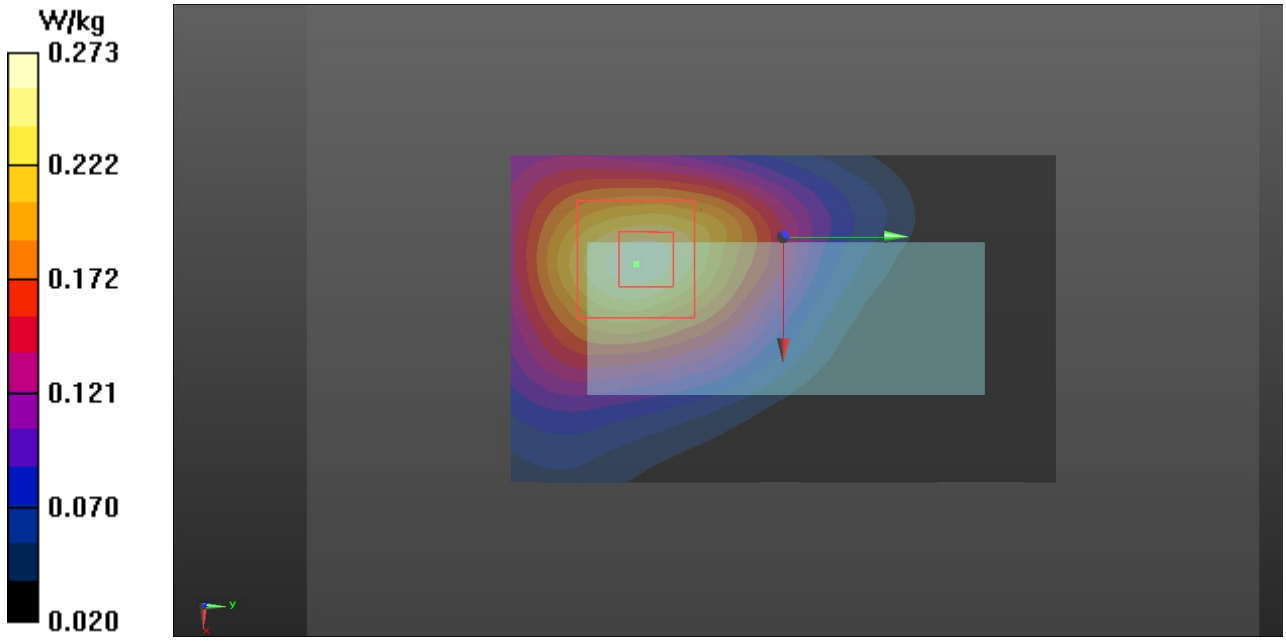
DUT: USB Connect LPWA; Type: Dongle; IMEI: 352753099063685

Communication System: UID 0, NB-IoT 15kHz (0); Communication System Band: Band 13; Frequency: 782 MHz;Communication System PAR: 3.01 dB
Medium parameters used: f = 782 MHz; σ = 0.852 S/m; ε_r = 41.619; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.63, 10.63, 10.63); Calibrated: 23.4.2019;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

FCC NB-IoT, Band 13, QPSK/15, SC1, Start5, Horizontal-Up/Area Scan (61x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.266 W/kg
FCC NB-IoT, Band 13, QPSK/15, SC1, Start5, Horizontal-Up/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 16.65 V/m; Power Drift = -0.45 dB
Peak SAR (extrapolated) = 0.328 W/kg
SAR(1 g) = 0.216 W/kg; SAR(10 g) = 0.138 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.273 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIB

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 c

Accreditation No.: SCS 0108

Client Verkotan

Certificate No: EX3-3892_Apr19

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3892
Calibration procedure(s)	QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	April 23, 2019

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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 660	19-Dec-18 (No. DAE4-660_Dec18)	Dec-19
Reference Probe ES3DV2	SN: 3013	31-Dec-18 (No. ES3-3013_Dec18)	Dec-19
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-10)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 25, 2019

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

Certificate No: EX3-3892_Apr19 Page 1 of 10

RATION

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3892

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)
750	41.9	0.89	10.63	10.63	10.63	0.49	0.80	± 12.0 %
900	41.5	0.97	9.98	9.98	9.98	0.51	0.85	± 12.0 %
1750	40.1	1.37	8.69	8.69	8.69	0.39	0.80	± 12.0 %
1900	40.0	1.40	8.46	8.46	8.46	0.41	0.84	± 12.0 %
2450	39.2	1.80	7.56	7.56	7.56	0.41	0.85	± 12.0 %
2600	39.0	1.96	7.51	7.51	7.51	0.35	0.91	± 12.0 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. 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

mvg

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

ilac-MRA 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.353.2.18.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 51/18 DIP 0G835-473

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

ilac-MRA
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 : 0.90
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	835 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		5.55	
835	9.56	9.63 (0.96)	6.22	6.19 (0.62)
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.165.30.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 1800 MHZ
SERIAL NO.: D1800V2-2D075

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

Calibration Date: 06/14/17

Summary:

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

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' : 41.7 sigma : 1.46
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	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		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	38.01 (3.80)	20.1	20.02 (2.00)
1900	39.7		20.5	
1950	40.5		20.9	

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SAR Reference Dipole Calibration Report

Ref : ACR.165.31.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 1900 MHZ
SERIAL NO.: D1900V2-5D004

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

Calibration Date: 06/14/17

Summary:

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

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' : 38.5 sigma : 1.45
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	1900 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		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		20.1	
1900	39.7	39.74 (3.97)	20.5	20.44 (2.04)
1950	40.5		20.9	

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