

SAR TEST REPORT

Applicant Name:

SAMSUNG Electronics Co., Ltd.
129, Samsung-ro, Yeongtong-gu, Suwon-Si,
Gyeonggi-do, 16677 Rep. of Korea

Date of Issue: 06. 20, 2017

Test Report No.: HCT-A-1706-F003-4

Test Site: HCT CO., LTD.

FCC ID:

A3LSMW728Y

Equipment Type:

Tablet

Model Name:

SM-W728Y

Testing has been carried out in accordance with:

47CFR §2.1093
ANSI/ IEEE C95.1 – 1992
IEEE 1528-2013

Date of Test:

05/22/2017 ~ 05/26/2017, 06/09/2017,
06/16/2017 ~ 06/17/2017

This device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in FCC KDB procedures and had been tested in accordance with the measurement procedures specified in FCC KDB procedures.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By



Tae-Jun Kang
Test Engineer / SAR Team
Certification Division

Reviewed By



Yun-Jeang Heo
Technical Manager / SAR Team
Certification Division

This report only responds to the tested sample and may not be reproduced, except in full, without written approval of the HCT Co., Ltd.

DOCUMENT HISTORY

Rev.	DATE	DESCRIPTION
HCT-A-1706-F003	06. 02, 2017	First Approval Report
HCT-A-1706-F003-1	06. 13, 2017	Sec.2,Sec.9.3,Sec.11,Sec 12 were revised. WLAN UNII-3 were revised.
HCT-A-1706-F003-2	06. 15, 2017	Sec 9.3,Sec.11.1,Sec.10,Sec.12, Page 4,Page 84 were revised
HCT-A-1706-F003-3	06. 16, 2017	2.4GHz Body was retested
HCT-A-1706-F003-4	06. 20, 2017	LTE Band 7 was tested

Table of Contents

1. Attestation of Test Result of Device Under Test.....	4
2. Device Under Test Description.....	5
3. INTRODUCTION	2 2
4. DESCRIPTION OF TEST EQUIPMENT	2 3
5. SAR MEASUREMENT PROCEDURE.....	2 4
6. DESCRIPTION OF TEST POSITION.....	2 6
7. ANSI/ IEEE C95.1 - 1992 RF EXPOSURE LIMITS	2 7
8. FCC SAR GENERAL MEASUREMENT PROCEDURES	2 8
9. Output Power Specifications.....	3 4
10. SYSTEM VERIFICATION.....	4 9
11. SAR TEST DATA SUMMARY	5 1
13. SAR Measurement Variability and Uncertainty	6 9
14. MEASUREMENT UNCERTAINTY	7 0
15. SAR TEST EQUIPMENT	7 1
16. CONCLUSION.....	7 2
17. REFERENCES	7 3
Attachment 1. – SAR Test Plots	7 5
Attachment 2. – Dipole Verification Plots.....	8 7
Attachment 3. – Probe Calibration Data	9 5
Attachment 4. – Dipole Calibration Data	1 1 8
Attachment 5. – SAR Tissue Characterization.....	1 6 6
Attachment 6. – SAR SYSTEM VALIDATION	1 6 7

1. Attestation of Test Result of Device Under Test

Test Laboratory	
Company Name:	HCT Co., LTD
Address	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of Korea
Telephone	+82 31 645 6300
Fax.	+82 31 645 6401

Attestation of SAR test result			
Applicant Name:	SAMSUNG Electronics Co., Ltd.		
FCC ID:	A3LSMW728Y		
Model:	SM-W728Y		
EUT Type:	Tablet		
Application Type:	Certification		
The Highest Reported SAR			
Band	Tx. Frequency	Equipment Class	Reported 1g Body SAR (W/kg)
	(MHz)		
UMTS 850	826.4 - 846.6	PCB	0.54
UMTS 1900	1 852.4 - 1 907.6	PCB	0.85
LTE 5	824.7 - 848.3	PCB	0.62
LTE 7	2 502.5 - 2 567.5	PCB	0.96
802.11b	2 412 - 2 472	DTS	0.35
U-NII-1	5 180 - 5 240	NII	0.46
U-NII-2A	5 260 - 5 320	NII	0.55
U-NII-2C	5 500 - 5 720	NII	0.60
U-NII-3	5 745 - 5 825	NII	0.39
Bluetooth	2 402 - 2 480	DSS	0.51
Simultaneous SAR per KDB 690783 D01v01r03			1.57
Date(s) of Tests:	05/22/2017 ~ 05/26/2017, 06/09/2017, 06/16/2017 ~ 06/17/2017		

2. Device Under Test Description

2.1 DUT specification

Device Wireless specification overview		
Band & Mode	Operating Mode	Tx Frequency
UMTS 850	Voice / Data	826.4 – 846.6 MHz
UMTS 1900	Voice / Data	1 852.4 – 1 907.6 MHz
LTE Band 5 (Cell)	Data	824.7 – 848.3 MHz
LTE Band 7	Data	2 502.5 – 2 567.5 MHz
2.4 GHz WLAN	Data	2 412 – 2 472 MHz
U-NII-1	Data	5 180 – 5 240 MHz
U-NII-2A	Data	5 260 – 5 320 MHz
U-NII-2C	Data	5 500 – 5 720 MHz
U-NII-3	Data	5 745 – 5 825 MHz
Bluetooth	Data	2 402 – 2 480 MHz
Device Description		
Device Dimension:	Overall (Length x Width): 287.5 mm x 196 mm Overall Diagonal: 348 mm Display Diagonal: 315 mm	
Battery Options	Standard (Li-ion Battery)	
	Type: EB-BW720ABE	
	Manufacturer: SDI	
Hardware Version:	REV1.0	
Software Version :	W728Y.001	
Device Serial Numbers	Mode	Serial Number
	UMTS 850, UMTS 1900 , LTE 5	A81DR32J40005PP A81DR32J40005NB
	LTE 7	A81DR32J40005NB A81DR32J40005PP
	WiFi 2.4GHz, 5GHz / Bluetooth	A81DR32J400052M A81DR32J400076A
	Several samples with identical hardware were used to SAR testing. The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics are within operational tolerances expected for production units.	
Cover	Keyboard cover	

2.2 DUT Wireless mode

Wireless Modulation	Band	Operating Mode		Duty Cycle
WCDMA (UMTS)	Band 5 Band 2	UMTS Rel.99 (Voice / DATA) HSDPA (Rel. 5,Cat.14) HSUPA (Rel. 6 Cat.6) DC-HSDPA (Rel.8, Cat.24) HSPA+ (Rel. 7) (Uplink QPSK Only)		100 %
LTE Band	5 (Cell) 7	Data (QPSK, 16QAM)		100 % (FDD)
2.4 GHz WLAN		Data	802.11b, 802.11g, 802.11n (HT20)	99.28 % (ANT 0) 99.20 % (ANT 1)
5 GHz WLAN		Data	802.11 a, 802.11 n (HT20/HT40) 802.11 ac (VHT20/40/80)	94.82 % (802.11a) ANT 0 94.95 % (802.11a) ANT 1 85.00 % (802.11ac 80MHz)
Bluetooth		Data		77.0 % (DH5)
Bluetooth LE 4.1		Data		N/A

2.2.1 Power Reduction for SAR

This device uses a power reduction mechanism for SAR compliance. The power reduction mechanism is activated when the device is used in close proximity to the user's body. FCC KDB Publication 616217 D04v01r02 Section 2.6 was used as a guideline for selection SAR test distances for this device. Detailed description of the power reduction mechanism are include in Proximity Sensor considerations document.

2.3 LTE information

Item.		Description		
Frequency Range	LTE Band 5 (Cell)	824.7 MHz ~ 848.3 MHz		
	LTE Band 7	2 502.5 MHz ~ 2 567.5 MHz		
Channel Bandwidths	LTE Band 5 (Cell)	1.4 MHz, 3 MHz, 5 MHz, 10 MHz		
	LTE Band 7	5 MHz, 10 MHz, 15 MHz, 20 MHz		
Channel Numbers & Freq.(MHz)		Low	Mid	High
LTE Band 5 (Cell)	1.4 MHz	824.7 (20407)	836.5 (20525)	848.3 (20643)
	3 MHz	825.5 (20415)	836.5 (20525)	847.5 (20635)
	5 MHz	826.5 (20425)	836.5 (20525)	846.5 (20625)
	10 MHz	829.0 (20450)	836.5 (20525)	844.0 (20600)
LTE Band 7	5 MHz	2 502.5 (20775)	2 535 (21100)	2 567.5 (21425)
	10 MHz	2 505.0 (20800)	2 535 (21100)	2 565.0 (21400)
	15 MHz	2 507.5 (20825)	2 535 (21100)	2 562.5 (21375)
	20 MHz	2 510.0 (20850)	2 535 (21100)	2 560.0 (21350)
UE Category		Rel.10, UE Category 6		
Modulations Supported in UL		QPSK, 16QAM		
LTE voice/data requirements		Data Only		
Hotspot with LTE+WIFI		Yes		
LTE MPR options		The EUT incorporates MPR as per 3GPP TS 36.101 sec. 6.2.3 ~ 6.2.5		
		The MPR is permanently built-in by design as a mandatory.		
		A-MPR is not implemented in the DUT.		
Description of the LTE Transmitter & antenna		2 Main TX/RX Ant and 2 Diversity RX Ant		
		See Operation Description		
LTE Carrier Aggregation		This device doesn't supports Carrier Aggregation.		
LTE Release 10 information		This device does not support full CA features on 3GPP Release 10. The following LTE Release 10 features are not supported. Uplink and Downlink Carrier aggregations, Relay, HetNet, Enhanced MIMO, eICI, WiFi offloading, MDH, eMBMA, Cross-Carrier Scheduling, Enhanced SC-FDMA.		

2.4 TEST METHODOLOGY and Procedures

The tests documented in this report were performed in accordance with IEEE Standard 1528-2013 and the following published KDB procedures.

- FCC KDB Publication 941225 D01 3G SAR Procedures v03r01
- FCC KDB Publication 941225 D05 SAR for LTE Devices v02r05
- FCC KDB Publication 941225 D05A LTE Rel.10 KDB Inquiry sheet v01r02
- FCC KDB Publication 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB Publication 447498 D01 General SAR Guidance v06
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- FCC KDB Publication 865664 D02 SAR Reporting v01r02
- FCC KDB Publication 616217 D04 SAR Tablet v01r02
- April 2015 TCB Workshop Notes (Simultaneous transmission summation clarified)

2.5 Nominal and Maximum Output Power Specifications

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB publication 447498 D01v06.

2.5.1 Maximum Main Output Power

Mode / Band			3GPP WCDMA	3GPP HSDPA	3GPP HSUPA	3GPP DC-HSDPA
			(dBm)	(dBm)	(dBm)	(dBm)
UMTS Band 5 (850 MHz)	Active	Maximum	18.0	18.0	18.0	18.0
		Nominal	17.5	17.5	17.5	17.5
	Inactive	Maximum	24.5	24.0	24.0	24.0
		Nominal	24.0	23.5	23.5	23.5
UMTS Band 2 (1900 MHz)	Active	Maximum	13.0	12.5	12.5	12.5
		Nominal	12.5	12.0	12.0	12.0
	Inactive	Maximum	23.0	22.5	22.5	22.5
		Nominal	22.5	22.0	22.0	22.0

Mode / Band			Modulated Average (dBm)
LTE Band 5 (Cell)	Active	Maximum	18.0
		Nominal	17.5
	Inactive	Maximum	24.5
		Nominal	24.0
LTE Band 7	Active	Maximum	13.0
		Nominal	12.5
	Inactive	Maximum	23.7
		Nominal	23.2

2.5.2 Maximum WLAN(Ant 0, Ant 1)/ BT Power

Mode/Band			Modulated Average (dBm)				
	Sensor State		a	b	g	n	ac
2.4 GHz WIFI (Ch.1 ~ 11)	Active	Maximum		8.5	8.5	8.5	
		Nominal		8.0	8.0	8.0	
	Inactive	Maximum		14.5	12.5	12.5	
		Nominal		14.0	12.0	12.0	
2.4 GHz WIFI (Ch.12)	Active	Maximum		8.5	8.5	8.5	
		Nominal		8.0	8.0	8.0	
	Inactive	Maximum		8.5	8.5	8.5	
		Nominal		8.0	8.0	8.0	
2.4 GHz WIFI (Ch.13)	Active	Maximum		8.5	3.5	1.5	
		Nominal		8.0	3.0	1.0	
	Inactive	Maximum		8.5	3.5	1.5	
		Nominal		8.0	3.0	1.0	

Mode/Band			Modulated Average (dBm)				
	Sensor State		a	b	g	n	ac
5 GHz WIFI (20MHz BW)							
5200 MHz	Active	Maximum	7.5			7.5	7.5
		Nominal	7.0			7.0	7.0
	Inactive	Maximum	12.5			11.5	11.5
		Nominal	12.0			11.0	11.0
5300 MHz	Active	Maximum	7.5			7.5	7.5
		Nominal	7.0			7.0	7.0
	Inactive	Maximum	12.5			11.5	11.5
		Nominal	12.0			11.0	11.0
5500 MHz	Active	Maximum	7.5			7.5	7.5
		Nominal	7.0			7.0	7.0
	Inactive	Maximum	12.5			11.5	11.5
		Nominal	12.0			11.0	11.0
5800 MHz	Active	Maximum	7.5			7.5	7.5
		Nominal	7.0			7.0	7.0
	Inactive	Maximum	12.5			11.5	11.5
		Nominal	12.0			11.0	11.0
5 GHz WIFI (40MHz BW)							
5200 MHz	Active	Maximum				7.5	7.5
		Nominal				7.0	7.0
	Inactive	Maximum				10.5	10.5
		Nominal				10.0	10.0
5300 MHz	Active	Maximum				7.5	7.5
		Nominal				7.0	7.0
	Inactive	Maximum				10.5	10.5
		Nominal				10.0	10.0
5500 MHz	Active	Maximum				7.5	7.5
		Nominal				7.0	7.0
	Inactive	Maximum				10.5	10.5
		Nominal				10.0	10.0
5800 MHz	Active	Maximum				7.5	7.5
		Nominal				7.0	7.0
	Inactive	Maximum				10.5	10.5
		Nominal				10.0	10.0

Mode/Band			Modulated Average (dBm)				
	Sensor State		a	b	g	n	ac
5 GHz WIFI (80MHz BW)							
5200 MHz	Active	Maximum					7.5
		Nominal					7.0
	Inactive	Maximum					10.5
		Nominal					10.0
5300 MHz	Active	Maximum					7.5
		Nominal					7.0
	Inactive	Maximum					10.5
		Nominal					10.0
5500 MHz	Active	Maximum					7.5
		Nominal					7.0
	Inactive	Maximum					10.5
		Nominal					10.0
5800 MHz	Active	Maximum					7.5
		Nominal					7.0
	Inactive	Maximum					10.5
		Nominal					10.0

Mode / Band		Modulated Average (dBm)
Bluetooth (DH5)	Maximum	10.0
	Nominal	9.5
Bluetooth LE	Maximum	4.5
	Nominal	4.0

2.6 Power Reduction by Proximity Sensing

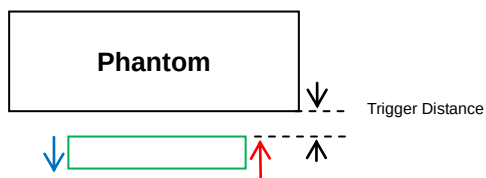
2.6.1 Proximity Sensor Triggering Distance

Rear of the DUT was placed directly below the flat phantom. The DUT was moved toward the phantom in accordance with the steps outlined in KDB 616217 §6.2 to determine the trigger distance for enabling power reduction. The DUT was moved away from the phantom to determine the trigger distance for resuming full power.

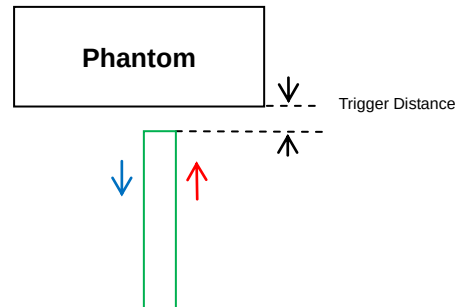
The measurement was repeated for the surface of Rear and Top side.

The DUT featured a visual indicator on its display that showed the status of the proximity sensor (Triggered or not triggered). This was used to determine the status of the sensor during the proximity sensor assessment as monitoring the output power directly was not practical without affecting the measurement.

It was confirmed separately that the output power was altered according to the proximity sensor status indication. This was achieved by observing the proximity sensor status at the same time as monitoring the conducted power. Section 9 contains both the full and reduced conducted power measurements.



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, Rear side



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, Top side

LEGEND

- Direction of DUT travel for determination of power reduction triggering point
- Direction of DUT travel for determination of full power resumption triggering point

Proximity sensor triggering distance measurement results Wi-Fi

Wi-Fi Ant 0

Rear side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	12	11	10	9	8	7	6	5	4	3	2
2.4GHz 802.11b	14.11	14.13	14.12	14.13	14.11	7.48	7.45	7.46	7.45	7.48	7.45
2.4GHz 802.11g	11.61	11.61	11.57	11.58	11.57	7.37	7.37	7.39	7.37	7.39	7.35
2.4GHz 802.11n	11.30	11.3	11.26	11.31	11.28	7.29	7.28	7.26	7.27	7.30	7.29
5 GHz 802.11a [BW 20]	11.54	11.52	11.49	11.51	11.50	7.31	7.28	7.28	7.27	7.25	7.27
5 GHz 802.11n [BW 20]	10.35	10.37	10.34	10.35	10.38	6.89	6.88	6.64	6.83	6.85	6.85
5 GHz 802.11n [BW 40]	9.38	9.30	9.31	9.31	9.32	6.78	6.80	6.77	6.80	6.87	6.77
5 GHz 802.11ac [BW 20]	10.33	10.35	10.34	10.35	10.32	6.66	6.68	6.68	6.67	6.67	6.59
5 GHz 802.11ac [BW 40]	9.20	9.22	9.21	9.21	9.22	6.59	6.60	6.58	6.48	6.50	6.48
5 GHz 802.11ac [BW 80]	9.18	9.23	9.25	9.24	9.28	6.59	6.54	6.59	6.52	6.57	6.58

Rear side – EUT Moving away (Release) from the Phantom

Distance (mm)	2	3	4	5	6	7	8	9	10	11	12
2.4GHz 802.11b	7.48	7.45	7.46	7.45	7.48	7.45	14.11	14.13	14.12	14.13	14.11
2.4GHz 802.11g	7.37	7.37	7.39	7.37	7.39	7.35	11.61	11.61	11.57	11.58	11.57
2.4GHz 802.11n	7.29	7.28	7.26	7.27	7.30	7.29	11.30	11.3	11.26	11.31	11.28
5 GHz 802.11a [BW 20]	7.31	7.28	7.28	7.27	7.25	7.27	11.54	11.52	11.49	11.51	11.50
5 GHz 802.11n [BW 20]	6.89	6.88	6.64	6.83	6.85	6.85	10.35	10.37	10.34	10.35	10.38
5 GHz 802.11n [BW 40]	6.78	6.80	6.77	6.80	6.87	6.77	9.38	9.30	9.31	9.31	9.32
5 GHz 802.11ac [BW 20]	6.66	6.68	6.68	6.67	6.67	6.59	10.33	10.35	10.34	10.35	10.32
5 GHz 802.11ac [BW 40]	6.59	6.60	6.58	6.48	6.50	6.48	9.20	9.22	9.21	9.21	9.22
5 GHz 802.11ac [BW 80]	6.59	6.54	6.59	6.52	6.57	6.58	9.18	9.23	9.25	9.24	9.28

Based on the most conservative measured triggering distance of 7mm, additional SAR measurements were required at 6mm from rear side for the above modes

Top side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	13	12	11	10	9	8	7	6	5	4	3
2.4GHz 802.11b	14.11	14.13	14.12	14.13	14.11	14.11	7.48	7.45	7.46	7.45	7.48
2.4GHz 802.11g	11.61	11.61	11.57	11.58	11.57	11.61	7.37	7.37	7.39	7.37	7.39
2.4GHz 802.11n	11.30	11.3	11.26	11.31	11.28	11.30	7.29	7.28	7.26	7.27	7.30
5 GHz 802.11a [BW 20]	11.54	11.52	11.49	11.51	11.50	11.54	7.31	7.28	7.28	7.27	7.25
5 GHz 802.11n [BW 20]	10.35	10.37	10.34	10.35	10.38	10.35	6.89	6.88	6.64	6.83	6.85
5 GHz 802.11n [BW 40]	9.38	9.30	9.31	9.31	9.32	9.38	6.78	6.80	6.77	6.80	6.87
5 GHz 802.11ac [BW 20]	10.33	10.35	10.34	10.35	10.32	10.33	6.66	6.68	6.68	6.67	6.67
5 GHz 802.11ac [BW 40]	9.20	9.22	9.21	9.21	9.22	9.20	6.59	6.60	6.58	6.48	6.50
5 GHz 802.11ac [BW 80]	9.18	9.23	9.25	9.24	9.28	9.18	6.59	6.54	6.59	6.52	6.57

Top side – EUT Moving away (Release) from the Phantom

Distance (mm)	3	4	5	6	7	8	9	10	11	12	13
2.4GHz 802.11b	7.41	7.43	7.42	7.44	7.45	14.11	14.13	14.12	14.13	14.11	14.12
2.4GHz 802.11g	7.37	7.39	7.38	7.36	7.38	11.61	11.61	11.57	11.58	11.57	11.59
2.4GHz 802.11n	7.29	7.25	7.25	7.24	7.27	11.30	11.3	11.26	11.31	11.28	11.31
5 GHz 802.11a [BW 20]	7.23	7.24	7.23	7.25	7.21	11.54	11.52	11.49	11.51	11.50	11.54
5 GHz 802.11n [BW 20]	6.72	6.71	6.70	6.71	6.71	10.35	10.38	10.34	10.35	10.38	10.35
5 GHz 802.11n [BW 40]	6.71	6.72	6.70	6.73	6.71	9.38	9.37	9.35	9.36	9.38	9.37
5 GHz 802.11ac [BW 20]	6.66	6.68	6.68	6.67	6.67	10.35	10.37	10.34	10.35	10.36	10.35
5 GHz 802.11ac [BW 40]	6.51	6.50	6.49	6.45	6.44	9.20	9.22	9.21	9.21	9.22	9.20
5 GHz 802.11ac [BW 80]	6.52	6.53	6.51	6.52	6.52	9.18	9.23	9.25	9.24	9.28	9.18

Based on the most conservative measured triggering distance of 7mm, additional SAR measurements were required at 6mm from Top side for the above modes

Wi-Fi Ant 1

Rear side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	12	11	10	9	8	7	6	5	4	3	2
2.4GHz 802.11b	13.41	13.43	13.41	13.43	13.41	7.38	7.34	7.33	7.31	7.33	7.34
2.4GHz 802.11g	11.11	11.10	11.17	11.18	11.12	7.30	7.31	7.30	7.32	7.31	7.30
2.4GHz 802.11n	11.00	11.05	11.06	11.02	11.05	7.31	7.30	7.32	7.30	7.31	7.29
5 GHz 802.11a [BW 20]	11.33	11.32	11.35	11.37	11.40	7.28	7.28	7.25	7.28	7.29	7.26
5 GHz 802.11n [BW 20]	10.20	10.17	10.21	10.23	10.20	7.19	7.12	7.14	7.13	7.15	7.14
5 GHz 802.11n [BW 40]	9.21	9.22	9.23	9.20	9.22	6.88	6.88	6.87	6.82	6.85	6.87
5 GHz 802.11ac [BW 20]	10.18	10.19	10.20	10.22	10.21	6.96	6.95	6.97	6.95	6.97	6.99
5 GHz 802.11ac [BW 40]	9.19	9.18	9.16	9.18	9.20	6.59	6.60	6.61	6.57	6.55	6.56
5 GHz 802.11ac [BW 80]	9.15	9.14	9.15	9.17	9.18	6.52	6.54	6.55	6.55	6.53	6.51

Rear side – EUT Moving away (Release) from the Phantom

Distance (mm)	2	3	4	5	6	7	8	9	10	11	12
2.4GHz 802.11b	7.38	7.34	7.33	7.31	7.33	7.34	13.41	13.43	13.41	13.43	13.41
2.4GHz 802.11g	7.30	7.28	7.30	7.32	7.29	7.30	11.10	11.13	11.12	11.14	11.11
2.4GHz 802.11n	7.31	7.30	7.32	7.30	7.31	7.29	11.00	11.05	11.06	11.02	11.05
5 GHz 802.11a [BW 20]	7.28	7.28	7.25	7.28	7.29	7.26	11.30	11.27	11.25	11.27	11.20
5 GHz 802.11n [BW 20]	7.19	7.12	7.14	7.13	7.15	7.14	10.20	10.17	10.21	10.23	10.20
5 GHz 802.11n [BW 40]	6.88	6.88	6.87	6.82	6.85	6.87	9.21	9.22	9.23	9.20	9.22
5 GHz 802.11ac [BW 20]	6.96	6.95	6.97	6.95	6.97	6.99	10.18	10.19	10.20	10.22	10.21
5 GHz 802.11ac [BW 40]	6.59	6.60	6.61	6.57	6.55	6.56	9.19	9.18	9.16	9.18	9.20
5 GHz 802.11ac [BW 80]	6.52	6.54	6.55	6.55	6.53	6.51	9.15	9.14	9.15	9.17	9.18

Based on the most conservative measured triggering distance of 7mm, additional SAR measurements were required at 6mm from rear side for the above modes

Top side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	13	12	11	10	9	8	7	6	5	4	3
2.4GHz 802.11b	13.41	13.43	13.41	13.43	13.41	13.41	7.38	7.34	7.33	7.31	7.33
2.4GHz 802.11g	11.11	11.10	11.17	11.18	11.12	11.11	7.30	7.31	7.30	7.32	7.31
2.4GHz 802.11n	11.00	11.05	11.06	11.02	11.05	11.00	7.31	7.34	7.32	7.30	7.31
5 GHz 802.11a [BW 20]	11.33	11.32	11.35	11.37	11.40	11.33	7.28	7.28	7.33	7.31	7.30
5 GHz 802.11n [BW 20]	10.20	10.17	10.21	10.23	10.20	10.20	7.19	7.20	7.21	7.20	7.19
5 GHz 802.11n [BW 40]	9.21	9.22	9.23	9.20	9.22	9.21	6.88	6.88	6.87	6.82	6.85
5 GHz 802.11ac [BW 20]	10.18	10.19	10.20	10.22	10.21	10.18	6.92	6.91	6.94	6.95	6.92
5 GHz 802.11ac [BW 40]	9.19	9.18	9.16	9.18	9.20	9.19	6.62	6.61	6.61	6.60	6.62
5 GHz 802.11ac [BW 80]	9.15	9.14	9.15	9.17	9.18	9.15	6.57	6.55	6.57	6.55	6.55

Top side – EUT Moving away (Release) from the Phantom

Distance (mm)	3	4	5	6	7	8	9	10	11	12	13
2.4GHz 802.11b	7.40	7.41	7.38	7.31	7.37	13.40	13.42	13.44	13.42	13.40	13.42
2.4GHz 802.11g	7.32	7.31	7.35	7.33	7.31	11.15	11.14	11.12	11.17	11.17	11.11
2.4GHz 802.11n	7.29	7.30	7.31	7.30	7.29	11.00	11.05	11.06	11.02	11.05	11.00
5 GHz 802.11a [BW 20]	7.26	7.24	7.25	7.26	7.27	11.30	11.29	11.30	11.37	11.38	11.33
5 GHz 802.11n [BW 20]	7.20	7.21	7.21	7.20	7.22	10.20	10.17	10.21	10.23	10.21	10.20
5 GHz 802.11n [BW 40]	6.90	6.91	6.97	6.92	6.97	9.21	9.22	9.23	9.20	9.22	9.21
5 GHz 802.11ac [BW 20]	6.95	6.96	6.97	6.96	6.97	10.18	10.19	10.20	10.22	10.21	10.18
5 GHz 802.11ac [BW 40]	6.61	6.65	6.64	6.60	6.65	9.19	9.18	9.16	9.18	9.20	9.19
5 GHz 802.11ac [BW 80]	6.52	6.53	6.51	6.52	6.52	9.15	9.14	9.15	9.17	9.18	9.15

Based on the most conservative measured triggering distance of 7mm, additional SAR measurements were required at 6mm from Top side for the above modes

Proximity sensor triggering distance measurement results Main Band

Rear side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	20	19	18	17	16	15	14	13	12	11	10
WCDMA 5	23.60	23.62	23.59	23.60	23.61	16.78	16.77	16.79	16.74	16.75	16.73
WCDMA 2	22.14	22.13	22.14	22.13	22.15	12.50	12.48	12.49	12.50	12.47	12.49
LTE 5	23.64	23.65	23.63	23.64	23.65	17.31	17.28	17.18	17.20	17.21	17.23
LTE 7	22.92	22.91	22.89	22.91	22.90	11.90	11.87	11.90	11.91	11.90	11.87

Rear side – EUT Moving away (Release) from the Phantom

Distance (mm)	10	11	12	13	14	15	16	17	18	19	19
WCDMA 5	16.69	16.70	16.71	16.69	16.70	16.70	23.61	23.59	23.58	23.59	23.60
WCDMA 2	12.43	12.46	12.44	12.42	12.44	12.43	22.18	22.47	22.16	22.15	22.19
LTE 5	17.32	17.30	17.29	17.20	17.21	17.19	23.60	23.59	23.61	23.59	23.61
LTE 7	11.90	11.91	11.93	11.91	11.90	11.91	22.94	22.93	22.93	22.94	22.93

Based on the most conservative measured triggering distance of 15mm, additional SAR measurements were required at 14mm from rear side for the above modes

Top side – EUT Moving toward (trigger) to the Phantom

Distance (mm)	26	25	24	23	22	21	20	19	18	17	16
WCDMA 5	23.64	23.62	23.65	23.63	23.62	16.69	16.69	16.70	16.68	16.71	16.68
WCDMA 2	22.21	22.18	22.20	22.15	22.15	12.19	12.25	12.34	12.28	12.22	12.24
LTE 5	23.67	23.66	23.66	23.67	23.65	17.32	17.35	17.34	17.30	17.31	17.36
LTE 7	22.89	22.91	22.91	22.89	22.90	11.88	11.87	11.89	11.90	11.90	11.87

Top side – EUT Moving away (Release) from the Phantom

Distance (mm)	16	17	18	19	20	21	22	23	24	25	26
WCDMA 5	16.72	16.70	16.69	16.71	16.72	16.70	23.66	23.67	23.64	23.65	23.64
WCDMA 2	12.20	12.18	12.17	12.2	12.20	12.21	22.19	22.17	22.16	22.20	22.18
LTE 5	17.36	17.35	17.33	17.38	17.35	17.36	23.67	23.66	23.68	23.69	23.67
LTE 7	11.90	11.90	11.89	11.88	11.91	11.92	22.91	22.92	22.91	22.93	22.92

Based on the most conservative measured triggering distance of 21mm, additional SAR measurements were required at 20mm from Top side for the above modes

Tissue simulating liquid	Trigger distance - Rear		Trigger distance - Top	
	Moving toward phantom	Moving from phantom	Moving from phantom	Moving from phantom
850 muscle	15	15	21	21
1900 muscle	15	15	21	21
2450 muscle	7	7	7	7
2600 muscle	15	15	21	21
5000 muscle	7	7	7	7

Summary of Trigger Distances

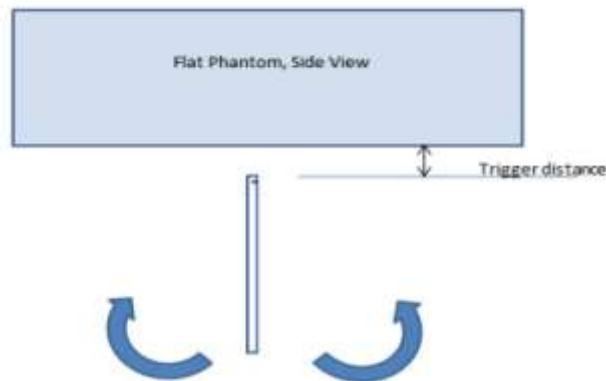
2.6.2 Proximity Sensor Coverage for SAR measurements

As there is no spatial offset between the antenna and the proximity sensor element, proximity sensor coverage did not need to be assessed.

2.6.3 Proximity Sensor Tilt Angle Assessment (KDB 616217 §6.4)

The DUT was positioned directly below the flat phantom at the minimum measured trigger distance with Top side parallel to the base of the flat phantom for each band.

The EUT was rotated about Top side for angles up to $\pm 45^\circ$. If the output power increased during the rotation the DUT was moved 1mm toward the phantom and the rotation repeated. This procedure was repeated until the power remained reduced for all angles up to $\pm 45^\circ$.



Proximity sensor tilt angle assessment (Top side) KDB 616217 §6.4

Summary of Tablet Tilt Angle influence to Proximity Sensor Triggering (Top side)

Band (MHz)	Minimum distance at which power reduction was maintained over-45°	Power reduction status										
		-45°	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	45°
850	21 mm	On	On	On	On	On	On	On	On	On	On	On
1900	21 mm	On	On	On	On	On	On	On	On	On	On	On
2450	7 mm	On	On	On	On	On	On	On	On	On	On	On
2600	21 mm	On	On	On	On	On	On	On	On	On	On	On
5000	7 mm	On	On	On	On	On	On	On	On	On	On	On

2.6.4 Resulting test positions for SAR measurements

Wireless technologies	Position	§6.2 Triggering Distance	§6.3 Coverage	§6.4 Tilt Angle	Worst case distance for SAR
WWAN	Rear	15	N/A	N/A	14
	Top	21	N/A	21	20
WLAN	Rear	7	N/A	N/A	6
	Top	7	N/A	7	6

2.6.5 SAR Test Configurations

Full Power Condition: Sensor Inactive

Antenna	Band	Freq. (MHz)	Maximum Power		Separation Distances (mm)					Device Configurations for SAR Testing				
			dBm	mW	Rear	Top	Left	Right	Bottom	Rear	Top	Left	Right	Bottom
Main	WCDMA 5	846.6	24.5	281.8	2	3.4	44	193	191	YES	YES	YES	NO	NO
Main	WCDMA 2	1 907.6	23.0	199.5	2	3.4	108	163	191	YES	YES	NO	NO	NO
Main	LTE 5	848.3	24.5	281.8	2	3.4	44	193	191	YES	YES	YES	NO	NO
Main	LTE 7	2560	23.7	234.4	2	3.4	44	193	191	YES	YES	YES	NO	NO
WLAN Ant1	2.4GHz	2 462	14.5	28.2	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant1	BT	2 480	10	10	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant1	5GHz	5 825	12.5	17.8	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant2	2.4GHz	2 462	14.5	28.2	3.1	3.4	177	95.5	188.5	YES	YES	NO	NO	NO
WLAN Ant2	5GHz	5 825	12.5	17.8	3.1	3.4	177	95.5	188.5	YES	YES	NO	NO	NO

Reduced Power Condition: Sensor Active

Antenna	Band	Freq. (MHz)	Maximum Power		Separation Distances (mm)					Device Configurations for SAR Testing				
			dBm	mW	Rear	Top	Left	Right	Bottom	Rear	Top	Left	Right	Bottom
Main	WCDMA 5	846.6	18	63.1	2	3.4	44	193	191	YES	YES	NO	NO	NO
Main	WCDMA 2	1 907.6	13	20	2	3.4	108	163	191	YES	YES	NO	NO	NO
Main	LTE 5	848.3	18	63.1	2	3.4	44	193	191	YES	YES	NO	NO	NO
Main	LTE 7	2560	13	20	2	3.4	44	193	191	YES	YES	NO	NO	NO
WLAN Ant1	2.4GHz	2 462	8.5	7.1	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant1	5GHz	5 825	8.5	7.1	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant2	2.4GHz	2 462	8.5	7.1	3.1	3.4	196.2	81	188.5	YES	YES	NO	NO	NO
WLAN Ant2	5GHz	5 825	8.5	7.1	3.1	3.4	177	95.5	188.5	YES	YES	NO	NO	NO

Antennas <50mm to adjacent edges: According to KDB 447498 D01v06, if the calculated threshold value >3 then SAR test is required.

Antennas >50mm to adjacent edges: According to KDB 447498 D01v06, if the power threshold is less than the output power, SAR is required.

Note; All test configurations are based on front view.

Per FCC KDB Publication 616217 D04v01r02, the rear surface and edges of tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR Exclusion Threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configurations. The closet distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

2.7 SAR Summation Scenario

According to FCC KDB 447498 D01v06, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the EUT are shown below paths and are mode in same rectangle to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.



Simultaneous transmission paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB 447498 D01v06.

FCC KDB 447498 D01v06 General RF Exposure Guidance introduces a new formula for calculating the SAR a Peak Location Ratio(SPLSR) between pairs of simultaneously transmitting antennas:

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / R_i$$

Where:

SAR_1 is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest measured of estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

R_i is the separation distance between the pair of simultaneous transmitting antennas, When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $\sqrt{[(X_1 - X_2)^2 + (Y_1 - Y_2)^2]}$

In order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$$

Simultaneous Transmission Scenarios	
Applicable Combination	Body
UMTS + 2.4 GHz WiFi	Yes
UMTS + 5 GHz WiFi	Yes
UMTS + 2.4GHz Bluetooth	Yes
UMTS + 2.4 GHz WiFi MIMO	Yes
UMTS + 5 GHz WiFi MIMO	Yes
LTE + 2.4 GHz WiFi	Yes
LTE + 5 GHz WiFi	Yes
LTE + 2.4GHz Bluetooth	Yes
LTE + 2.4 GHz WiFi MIMO	Yes
LTE + 5 GHz WiFi MIMO	Yes

1. All licensed modes cannot transmit simultaneously.
2. This device support 2X2 MIMO Tx for WLAN 802.11a/n/ac .each antenna can transmit independently or together when operating with MIMO.

2.8 SAR Test Exclusions Applied

(A) WiFi

Since wireless router operations are not allowed by the chipset firmware using U-NII-1, U-NII-2A & U-NII-2C WiFi, WiFi Hotspot SAR test and combinations are considered only 2.4 GHz and U-NII-3 for SAR with respected to wireless router configurations according to FCC KDB 941225 D06v02.

Since U-NII-1 and U-NII-2A bands have the same maximum output power and the highest reported SAR for U-NII-2A is less than 1.2 W/kg for 1g SAR and is less than 3.0 W/kg for 10g SAR, SAR is not required for U-NII-1 band according to FCC KDB 248227D01v02r01.

This device supports IEEE 802.11 ac with the following features:

- a) Up to 80 MHz Bandwidth only
- b) No aggregate channel configurations
- c) 1 Tx antenna output
- d) 256 QAM is supported
- e) TDWR channels are supported.
- f) Band gap channels are not supported

(B) BT LE

Per FCC KDB 447498 D01v06, The SAR exclusion threshold for distance < 50mm is defined by the following equation:

$$\frac{\text{Max Power of Channel(mW)}}{\text{Test Separation Distance (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 3.0$$

Mode	Frequency	Maximum Allowed Power	Separation Distance	≤ 3.0
	[MHz]	[mW]	[mm]	
Bluetooth LE	2 480	3.00	5	0.9

Based on the maximum conducted power of Bluetooth LE and antenna to use separation distance, Bluetooth LE SAR was not required $[(3/5)*\sqrt{2.480}] = 0.9 < 3.0$.

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 IV.C.1iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6W/kg. When standalone SAR is not required to be measured per FCC KDB 447498 D01v06 4.3.22, the following equation must be used to estimate the standalone 1-g SAR for simultaneous transmission assessment involving that transmitter.

$$\text{Estimated SAR} = \frac{\sqrt{f(\text{GHZ})}}{7.5} * \frac{(\text{Max Power of channel mW})}{\text{Min Seperation Distance}}$$

Mode	Frequency	Maximum Allowed Power	Separation Distance (Body)	Estimated SAR (Body)
	[MHz]	[mW]	[mm]	[W/kg]
Bluetooth LE	2 480	3	5	0.126

Note:.

1) The frequency of Bluetooth and Bluetooth LE using for estimated SAR was selected highest channel of Bluetooth LE for highest estimated SAR.

(C) Licensed Transmitter(s)

This device is only capable of QPSK HSUPA in the uplink. Therefore, no additional SAR tests are required beyond that described for devices with HSUPA in FCC KDB 941225 D01v03r01.

LTE SAR for the higher modulations and lower bandwidths were not tested since the maximum average output power of all required channels and configurations was not more than 0.5 dB higher than the highest bandwidth; and the reported LTE SAR for the highest bandwidth was less than 1.45 W/kg for all configurations according to FCC KDB 941225 D05v02r05.

Per FCC KDB 941225 D01v03r01, 12.2 kbps RMC is the primary mode and HSPA (HSUPA/HSDPA with RMC) is the secondary mode.

Per FCC KDB 941225 D01v03r01, The SAR test exclusion is applied to the secondary mode by the following equation.

$$\text{Adjusted SAR} = \text{Highest Reported SAR} * \frac{\text{Secondary Max tune - up (mW)}}{\text{Primary Max tune tune - up(mW)}} \leq 1.2 \text{ W/kg.}$$

Based on the highest Reported SAR, the secondary mode is not required.

And the maximum output power and tune-up tolerance in secondary mode is ≤ 0.25 dB higher than the primary mode.

3. INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-2005 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative of the incremental electromagnetic energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body.

$$SAR = \frac{d}{dt} \left(\frac{dU}{dm} \right) = \frac{d}{dt} \left(\frac{dU}{\rho dV} \right)$$

Figure 1. SAR Mathematical Equation

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

$$SAR = \sigma E^2 / \rho$$

Where:

- σ = conductivity of the tissue-simulant material (S/m)
- ρ = mass density of the tissue-simulant material (kg/m³)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

4. DESCRIPTION OF TEST EQUIPMENT

4.1 SAR MEASUREMENT SETUP

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium III computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure.2).

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC with Windows XP or Windows 7 is working with SAR Measurement system DASY4 & DASY5, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

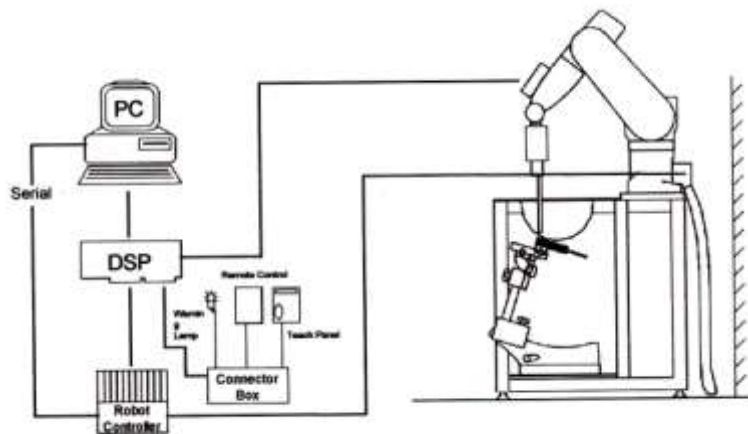


Figure 2. HCT SAR Lab. Test Measurement Set-up

The DAE consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

5. SAR MEASUREMENT PROCEDURE

The evaluation was performed with the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no more than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the DUT's head and body area and the horizontal grid resolution was depending on the FCC KDB 865664 D01v01r04 table 4-1 & IEEE 1528-2013.
2. Based on step, the area of the maximum absorption was determined by sophisticated interpolations routines implemented in DASY software. When an Area Scan has measured all reachable point. DASY system computes the field maximal found in the scanned are, within a range of the maximum. SAR at this fixed point was measured and used as a reference value.
3. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB 865664 D01v01r04 table 4-1 and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (reference from the DASY manual.)
 - a. The data at the surface were extrapolated, since the center of the dipoles is no more than 2.7 mm away from the tip of the probe (it is different from the probe type) and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
 - b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan. If the value changed by more than 5 %, the SAR evaluation and drift measurements were repeated.

Area scan and zoom scan resolution setting follow KDB 865664 D01v01r04 quoted below.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	$\frac{1}{2} \delta \ln(2)\pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			$30^{\circ}\pm 1^{\circ}$	$20^{\circ}\pm 1^{\circ}$
Maximum area scan Spatial resolution: $\Delta x_{Area}, \Delta y_{Area}$			≤ 2 GHz: ≤ 15 mm 2-3 GHz: ≤ 12 mm	3-4 GHz: ≤ 12 mm 4-6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan Spatial resolution: $\Delta x_{zoom}, \Delta y_{zoom}$			≤ 2 GHz: ≤ 8 mm 2-3 GHz: ≤ 5 mm*	3-4 GHz: ≤ 5 mm* 4-6 GHz: ≤ 4 mm*
Maximum zoom scan Spatial resolution normal to phantom surface	uniform grid: $\Delta z_{zoom}(n)$		≤ 5 mm	3-4 GHz: ≤ 4 mm 4-5 GHz: ≤ 3 mm 5-6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{zoom}(1)$: between 1 st two Points closest to phantom surface	≤ 4 mm	3-4 GHz: ≤ 3 mm 4-5 GHz: ≤ 2.5 mm 5-6 GHz: ≤ 2 mm
		$\Delta z_{zoom}(n>1)$: between subsequent Points	$\leq 1.5 \cdot \Delta z_{zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3-4 GHz: ≥ 28 mm 4-5 GHz: ≥ 25 mm 5-6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.				
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

6. DESCRIPTION OF TEST POSITION

6.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ϵ and loss tangent $\delta=0.02$

6.2 SAR Testing for Tablet Per KDB Publication 616217 D04v01r02

Per FCC KDB Publication 616217 D04v01r02, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR Exclusion Threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configuration. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

6.3 Proximity Sensor Considerations.

This device uses a sensor to reduce output powers in certain use conditions when the device is used close the user's body.

When the sensor detects a user is touching the device on or near to the antenna the device reduces the maximum allowed output power. However, the proximity sensor is not active when the device is moved beyond the sensor triggering distance and the maximum output power is no longer limited. Therefore, an additional exposure condition is needed in the vicinity of the triggering distance to ensure SAR is compliant when the device is allowed to operate at a non-reduced output power level.

FCC KDB 616217 D04 Section 8 was used as a guideline for selecting SAR test distances for this device at these additional exposure conditions. The smallest separation distance determined by the sensor triggering and sensor coverage for each applicable edge, minus 1 mm. was used as the test separation distance for SAR testing. Sensor triggering distance summary data is included in below table.

The proximity sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the proximity sensor entirely covers the antennas.

7. ANSI/ IEEE C95.1 - 1992 RF EXPOSURE LIMITS

HUMAN EXPOSURE	UNCONTROLLED ENVIRONMENT General Population	CONTROLLED ENVIRONMENT Occupational
	(W/kg) or (mW/g)	(W/kg) or (mW/g)
SPATIAL PEAK SAR * (Brain)	1.60	8.00
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.40
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.00	20.00

Table 8.1 Safety Limits for Partial Body Exposure

NOTES:

* The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole-body.

*** The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

8. FCC SAR GENERAL MEASUREMENT PROCEDURES

8.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as Reported SAR. The highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

8.2 SAR Measurement Conditions for UMTS

8.2.1 Output Power Verification

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in sec. 5.2 of 3GPP TS 34.121, using the appropriate RMC with TPC (transmit power control) set to all "1s" or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCH, DPDCHn and spreading codes, HS-DPCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

8.2.2 Body SAR measurements

SAR for body exposure configurations is measured using the 12.2kbps RMC with the TPC bits all "1s". the 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using and applicable RMC configuration with the corresponding spreading code or DPDCHn, for the highest reported SAR configuration in 12.2kbps RMC.

8.2.3 SAR Measurements with Rel. 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSDPA is measured using and FRC with H-SET 1 in Sub-test and a 12.2 kbps RMC without HSDPA. Handsets with both HSDPA and HSUPA are tested according to release 6 HSPA test procedures. 8.4.5 SAR Measurement with Rel. 6 HSUPA The 3G SAR test Reduction Procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSPA is measured with E-DCH Sub-test 5, Using H-Set 1 and QPSK for FRC and a 12.2kbps RMC configured in Test Loop Mode 1 and Power Control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing.

8.2.4 SAR Measurements with Rel. 6 HSUPA

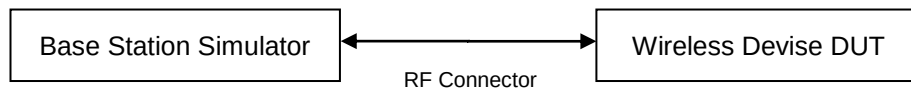
The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA.

8.2.5 DC-HSDPA

UMTS SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB publication 941225 D01v03r01. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

DC-HSDPA Considerations:

- 3GPP Specification 34.121-1 Release 8 Ver 8.10.0 was used for DC-HSDPA guidance
- H-Set 12(QPSK) was confirmed to be used during DC-HSDPA measurements
- Measured maximum output powers for DC-HSDPA were not greater than 1/4 dB higher than the WCDMA 12.2 kbps RMC maximum output and as a result, SAR is not required for DC-HSDPA
- The DUT supports UE category 24 for HSDPA.



8.3 SAR Measurement Conditions for LTE

LTE modes are tested according to FCC KDB 941225 D05v02r05 publication. Establishing connections with base station simulators ensure a consistent means for testing SAR and are recommended for evaluation SAR [4]. The R&S CMW500 or Anritsu MT8820C simulators are used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI).

8.3.1 Spectrum Plots for RB Configurations

A properly configured base station simulator was used for SAR tests and power measurements. Therefore, spectrum plots for RB configurations were not required to be included in this report.

8.3.2 MPR

MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to 3GPP TS36. 101 Section 6.2.3 – 6.2.5 under Table 6.2.3-1.

8.3.3 A-MPR

A-MPR (Additional MPR) has been disabled for all SAR tests by setting NS=01 on the base station simulator.

8.3.4 Required RB Size and RB offsets for SAR testing

According to FCC KDB 941225 D05v02r05

- a. Per sec 4.2.1, SAR is required for QPSK 1 RB Allocation for the largest bandwidth
 - i. The required channel and offset combination with the highest maximum output power is required for SAR.
 - ii. When the reported SAR is ≤ 0.8 W/Kg, testing of the remaining RB offset configurations and required test channels is not required. Otherwise, SAR is required for the remaining required test channels using the RB offset configuration with highest output power for that channel.
 - iii. When the reported SAR for a required test channel is > 1.45 W/kg, SAR is required for all RB offset configurations for that channel.
- b. Per Sec 4.2.2, SAR is required for 50% RB allocation using the largest bandwidth following the same procedures outlined in Sec 4.2.1.
- c. Per Sec. 4.2.3, QPSK SAR is not required for the 100% allocation when the highest maximum output power for the 100% allocation is less than the highest maximum output power of the 1 RB and 50% RB allocations and the reported SAR for the 1 RB and 50% RB allocations is < 0.8 W/kg.
- d. Per Sec. 4.2.4 and 4.3, SAR test for higher order modulations and lower bandwidths configurations are not required when the conducted power of the required test configurations determined by Sec. 4.2.1 through 4.2.3 is less than or equal to 1/2 dB higher than the equivalent configuration using QPSK modulation and when the QPSK SAR for those configurations is < 1.45 W/Kg.

8.3.5 Downlink Carrier Aggregation

Conducted power measurements with LTE Carrier aggregation (CA) downlink only active are made in accordance to KDB publication 941225 D05Av01r02. The RRC connection is only handled by one cell, the primary component carrier (PCC) for downlink and uplink communications. After making a data connection to the PCC, the UE device adds secondary component carrier (SCC) on the downlink only. All uplink communications and acknowledgements remain identical to specifications when downlink carrier aggregation is inactive on the PCC. For every supported combination of downlink only carrier aggregation, additional conducted output Powers are measured with downlink carrier aggregation active for the configuration with highest measured maximum conducted power with the downlink carrier aggregation inactive measured among the channel bandwidth, modulation and RB combinations in each frequency band. Per FCC KDB Publication 941225 D05Av01r02, no SAR measurements are required for carrier aggregation configurations when the average output power with downlink only carrier aggregation active is not more than 0.25dB higher than the average output power with downlink only carrier aggregation inactive.

8.4 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v02r02 for more details.

8.4.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters.

A periodic duty factor is required for current generation SAR system to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

8.4.2 U-NII-1 and U-NII-2A

For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, SAR measurement using OFDM SAR test procedures is not required for U-NII-1 unless the highest reported SAR for U-NII-2A is > 1.2 W/kg for 1g SAR or > 3.0 W/kg for 10g SAR. When different maximum output powers are specified for the bands, SAR measurement for the U-NII band with the lower maximum output power is not required unless the highest reported SAR for the U-NII band with the higher maximum output power, adjusted by the ratio of lower to higher specified maximum output power for the two bands, is > 1.2 W/kg for 1g SAR or > 3.0 W/kg for 10g SAR.

8.4.3 U-NII-C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 - 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification. Unless band gap channels are permanently disabled, SAR must be considered for these channels.

8.4.4 Initial Test Position Procedure

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg for 1g SAR and ≤ 1.0 W/kg for 10g SAR, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg for 1g SAR and ≤ 2.0 W/kg for 10g SAR or all test positions are measured.

8.4.5 2.4 GHz SAR test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

- 1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS is that exposure configuration.
- 2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed.

8.4.6 OFDM Transmission Mode and SAR Test Channel Selection

For the 2.4 GHz and 5 GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate and lowest order 802.11 a/g/n/ac mode. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a, 802.11n and 802.11 ac or 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

8.4.7 Initial Test Configuration Procedure

For OFDM, in both 2.4 GHz and 5 GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output power is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements.

8.4.8 Subsequent Test Configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position on procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is ≤ 1.2 W/kg for 1g SAR and ≤ 3.0 W/kg for 10g SAR, no additional SAR tests for the subsequent test configurations are required.

8.4.9 MIMO SAR Considerations

Per KDB Publication 248227 D01v02r02, the simultaneous SAR provisions in KDB publication 447498D01v06 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1g single transmission chain SAR measurements is <1.6 W/kg, no additional SAR Measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

9. Output Power Specifications

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB publication 447498 D01v06.

9.1 UMTS

HSPA+

This DUT is only capable of QPSK HSPA+ in uplink. Therefore, the RF conducted power is not measured according to 941225 D01 3G SAR.

9.1.1 Maximum Average Conducted output powers

3GPP Release Version	Mode	3GPP 34.121	WCDMA Band 5 [dBm]		
		Subtest	UL 4132 DL 4357	UL 4183 DL 4408	UL 4233 DL 4458
99	WCDMA	12.2 kbps RMC	23.72	23.66	23.52
5	HSDPA	Subtest 1	23.67	23.61	23.43
5		Subtest 2	23.38	23.32	23.21
5		Subtest 3	23.14	23.08	22.96
5		Subtest 4	22.88	22.83	22.67
6	HSUPA	Subtest 1	22.44	22.40	22.24
6		Subtest 2	21.58	21.53	21.39
6		Subtest 3	22.40	22.35	22.11
6		Subtest 4	21.76	21.71	21.57
6		Subtest 5	22.32	22.27	22.10
8	DC-HSDPA	Subtest 1	23.46	23.32	23.30
8		Subtest 2	23.22	23.09	23.07
8		Subtest 3	22.68	22.58	22.45
8		Subtest 4	22.68	22.58	22.47

3GPP Release Version	Mode	3GPP 34.121	WCDMA Band 2 [dBm]		
		Subtest	UL 9262 DL 9662	UL 9400 DL 9800	UL 9538 DL 9938
99	WCDMA	12.2 kbps RMC	22.31	22.14	22.17
5	HSDPA	Subtest 1	22.36	22.14	22.21
5		Subtest 2	22.16	21.82	21.94
5		Subtest 3	21.88	21.56	21.67
5		Subtest 4	21.68	21.27	21.39
6	HSUPA	Subtest 1	21.92	21.67	21.79
6		Subtest 2	20.41	20.14	20.22
6		Subtest 3	21.01	20.86	20.94
6		Subtest 4	20.39	20.14	20.20
6		Subtest 5	21.89	21.63	21.69
8	DC-HSDPA	Subtest 1	22.42	22.25	22.16
8		Subtest 2	22.43	22.24	22.18
8		Subtest 3	22.24	22.05	21.89
8		Subtest 4	22.25	22.06	21.91

9.1.2 Reduced Average Conducted output powers

3GPP Release Version	Mode	3GPP 34.121	WCDMA Band 5 [dBm]		
		Subtest	UL 4132 DL 4357	UL 4183 DL 4408	UL 4233 DL 4458
99	WCDMA	12.2 kbps RMC	16.91	16.88	16.70
5	HSDPA	Subtest 1	16.84	16.79	16.61
5		Subtest 2	16.82	16.78	16.60
5		Subtest 3	16.82	16.78	16.59
5		Subtest 4	16.83	16.78	16.59
6	HSUPA	Subtest 1	16.40	16.35	16.18
6		Subtest 2	16.35	16.31	16.32
6		Subtest 3	16.48	16.43	16.27
6		Subtest 4	16.60	16.55	16.38
6		Subtest 5	16.33	16.28	16.11
8	DC-HSDPA	Subtest 1	16.63	16.48	16.43
8		Subtest 2	16.65	16.47	16.44
8		Subtest 3	16.68	16.49	16.42
8		Subtest 4	16.68	16.48	16.42

3GPP Release Version	Mode	3GPP 34.121	WCDMA Band 2 [dBm]		
		Subtest	UL 9262 DL 9662	UL 9400 DL 9800	UL 9538 DL 9938
99	WCDMA	12.2 kbps RMC	12.37	12.53	12.23
5	HSDPA	Subtest 1	12.30	12.28	12.17
5		Subtest 2	12.28	12.02	12.15
5		Subtest 3	12.27	12.00	12.14
5		Subtest 4	12.28	11.98	12.15
6	HSUPA	Subtest 1	12.02	11.79	11.90
6		Subtest 2	11.88	11.64	11.81
6		Subtest 3	12.03	11.70	11.92
6		Subtest 4	12.03	11.74	11.90
6		Subtest 5	11.91	11.51	11.73
8	DC-HSDPA	Subtest 1	12.33	11.97	11.99
8		Subtest 2	12.36	12.01	11.92
8		Subtest 3	12.38	12.03	11.93
8		Subtest 4	12.40	12.02	11.94

Note : MPR is not applied when proximity sensor is in operation.

9.2 LTE

9.2.1 Maximum Conducted Power

- LTE Band 5

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20407	20525	20643		
				824.7 MHz	836.5 MHz	848.3 MHz		
1.4 MHz	QPSK	1	0	23.74	23.66	23.57	0	0
		1	3	23.30	23.23	23.14	0	0
		1	5	23.78	23.69	23.60	0	0
		3	0	23.76	23.57	23.54	0	0
		3	1	23.63	23.43	23.40	0	0
		3	3	23.73	23.60	23.52	0	0
		6	0	22.64	22.53	22.46	0-1	1
	16QAM	1	0	22.99	22.95	22.96	0-1	1
		1	3	22.60	22.64	22.51	0-1	1
		1	5	22.96	22.98	22.93	0-1	1
		3	0	22.82	22.61	22.42	0-1	1
		3	1	22.69	22.49	22.31	0-1	1
		3	3	22.78	22.66	22.47	0-1	1
		6	0	21.64	21.68	21.27	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20415	20525	20635		
				825.5 MHz	836.5 MHz	847.5 MHz		
3 MHz	QPSK	1	0	23.57	23.67	23.56	0	0
		1	7	23.62	23.64	23.61	0	0
		1	14	23.57	23.55	23.53	0	0
		8	0	22.67	22.66	22.54	0-1	1
		8	3	22.61	22.60	22.51	0-1	1
		8	7	22.56	22.60	22.51	0-1	1
		15	0	22.64	22.59	22.54	0-1	1
	16QAM	1	0	22.64	22.67	22.54	0-1	1
		1	7	22.68	22.61	22.48	0-1	1
		1	14	22.57	22.67	22.39	0-1	1
		8	0	21.60	21.58	21.56	0-2	2
		8	3	21.57	21.49	21.54	0-2	2
		8	7	21.55	21.50	21.51	0-2	2
		15	0	21.60	21.54	21.45	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20425	20525	20625		
				826.5 MHz	836.5 MHz	846.5 MHz	[dB]	[dB]
5 MHz	QPSK	1	0	23.44	23.49	23.21	0	0
		1	12	23.51	23.51	23.33	0	0
		1	24	22.38	23.32	23.22	0	0
		12	0	22.52	22.60	22.39	0-1	1
		12	6	22.50	22.61	22.32	0-1	1
		12	11	22.50	22.59	22.35	0-1	1
		25	0	22.56	22.63	22.42	0-1	1
	16QAM	1	0	22.67	22.63	22.54	0-1	1
		1	12	22.58	22.70	22.67	0-1	1
		1	24	22.65	22.53	22.56	0-1	1
		12	0	21.52	21.65	21.42	0-2	2
		12	6	21.53	21.62	21.39	0-2	2
		12	11	21.53	21.62	21.38	0-2	2
		25	0	21.53	21.57	21.39	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)	MPR Allowed Per 3GPP	MPR
				20525	[dB]	[dB]
				836.5 MHz		
10 MHz	QPSK	1	0	23.55	0	0
		1	24	23.58	0	0
		1	49	23.36	0	0
		25	0	22.62	0-1	1
		25	12	22.54	0-1	1
		25	24	22.48	0-1	1
		50	0	22.53	0-1	1
	16QAM	1	0	22.61	0-1	1
		1	24	22.63	0-1	1
		1	49	22.48	0-1	1
		25	0	21.51	0-2	2
		25	12	21.53	0-2	2
		25	24	21.39	0-2	2
		50	0	21.46	0-2	2

Note: LTE Band 5 at 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

- LTE Band 7

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20775	21100	21425		
				2502.5 MHz	2535 MHz	2567.5 MHz	[dB]	[dB]
5 MHz	QPSK	1	0	22.56	22.87	23.08	0	0
		1	12	22.73	23.01	23.15	0	0
		1	24	22.54	22.72	22.87	0	0
		12	0	21.88	21.8	22.15	0	0
		12	6	21.81	21.78	22.06	0	0
		12	11	21.73	21.79	22.05	0	0
		25	0	21.84	21.82	22.09	0-1	1
	16QAM	1	0	21.95	22.14	22.05	0-1	1
		1	12	22.12	22.01	22.06	0-1	1
		1	24	21.93	22.03	22.05	0-1	1
		12	0	20.68	20.87	21.26	0-1	1
		12	6	20.72	20.8	21.17	0-1	1
		12	11	20.72	20.84	21.19	0-1	1
		25	0	20.73	20.86	21.1	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20800	21100	21400		
				2505 MHz	2535 MHz	2565 MHz	[dB]	[dB]
10 MHz	QPSK	1	0	22.79	22.82	23.2	0	0
		1	24	22.83	22.77	23.16	0	0
		1	49	22.79	22.85	22.92	0	0
		25	0	21.64	21.83	22.22	0-1	1
		25	12	21.82	21.8	22.14	0-1	1
		25	24	21.77	21.76	22.07	0-1	1
		50	0	21.89	21.79	22.13	0-1	1
	16QAM	1	0	21.9	22.06	22.09	0-1	1
		1	24	21.92	22.02	22.01	0-1	1
		1	49	21.83	22.11	22.09	0-1	1
		25	0	20.87	20.99	21.25	0-2	2
		25	12	20.79	20.78	21.21	0-2	2
		25	24	20.87	20.82	21.12	0-2	2
		50	0	20.72	20.86	21.17	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20825	21100	21375		
				2507.5 MHz	2535 MHz	2562.5 MHz	[dB]	[dB]
15 MHz	QPSK	1	0	22.76	22.73	22.97	0	0
		1	36	22.87	22.86	23.05	0	0
		1	74	22.79	22.44	22.62	0	0
		36	0	21.76	21.98	22.35	0	0
		36	18	21.8	21.84	22.17	0	0
		36	39	21.84	21.82	22.14	0	0
		75	0	21.72	21.83	22.16	0-1	1
	16QAM	1	0	21.81	22.15	22.06	0-1	1
		1	36	21.81	22.17	22.01	0-1	1
		1	74	21.75	21.85	22.08	0-1	1
		36	0	20.82	20.96	21.34	0-1	1
		36	18	20.78	20.78	21.15	0-1	1
		36	39	20.76	20.81	21.2	0-1	1
		75	0	20.82	20.91	21.23	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20850	21100	21350		
				2510 MHz	2535 MHz	2560 MHz	[dB]	[dB]
20 MHz	QPSK	1	0	23.15	23.17	23.50	0	0
		1	49	22.71	22.80	23.00	0	0
		1	99	22.98	23.17	22.12	0	0
		50	0	21.91	21.97	22.24	0-1	1
		50	25	21.81	21.86	22.06	0-1	1
		50	49	21.87	21.77	21.97	0-1	1
		100	0	21.89	21.79	22.17	0-1	1
	16QAM	1	0	21.79	21.88	22.04	0-1	1
		1	49	21.96	22.08	22.01	0-1	1
		1	99	22.02	22.09	21.85	0-1	1
		50	0	20.89	21.05	21.20	0-2	2
		50	25	20.76	20.9	21.08	0-2	2
		50	49	20.76	20.76	21.01	0-2	2
		100	0	20.82	20.86	21.10	0-2	2

9.2.2 Reduced Conducted Power

- LTE Band 5

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20407	20525	20643		
				824.7 MHz	836.5 MHz	848.3 MHz	[dB]	[dB]
1.4 MHz	QPSK	1	0	17.28	17.33	17.15	0	0
		1	3	16.83	16.84	16.71	0	0
		1	5	17.30	17.30	17.19	0	0
		3	0	17.13	17.23	17.14	0	0
		3	1	16.96	17.09	17.00	0	0
		3	3	17.14	17.21	17.08	0	0
		6	0	16.22	16.21	16.06	0-1	1
	16QAM	1	0	16.45	16.48	16.38	0-1	1
		1	3	16.15	16.11	16.27	0-1	1
		1	5	16.40	16.50	16.49	0-1	1
		3	0	16.29	16.40	16.09	0-1	1
		3	1	16.16	16.20	15.98	0-1	1
		3	3	16.29	16.36	16.16	0-1	1
		6	0	15.36	15.23	14.99	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20415	20525	20635		
				825.5 MHz	836.5 MHz	847.5 MHz	[dB]	[dB]
3 MHz	QPSK	1	0	17.23	17.27	17.13	0	0
		1	7	17.22	17.36	17.22	0	0
		1	14	17.18	17.28	17.10	0	0
		8	0	16.27	16.31	16.19	0-1	1
		8	3	16.20	16.28	16.10	0-1	1
		8	7	16.19	16.33	16.06	0-1	1
		15	0	16.24	16.31	16.13	0-1	1
	16QAM	1	0	16.37	16.44	16.47	0-1	1
		1	7	16.18	16.47	16.48	0-1	1
		1	14	16.44	16.38	16.38	0-1	1
		8	0	15.29	15.34	15.17	0-2	2
		8	3	15.19	15.36	15.17	0-2	2
		8	7	15.17	15.35	15.10	0-2	2
		15	0	15.27	15.29	15.14	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20425	20525	20625		
				826.5 MHz	836.5 MHz	846.5 MHz		
5 MHz	QPSK	1	0	16.87	17.11	16.72	0	0
		1	12	16.94	17.14	16.87	0	0
		1	24	16.87	16.96	16.72	0	0
		12	0	16.11	16.14	16.02	0-1	1
		12	6	16.06	16.10	15.98	0-1	1
		12	11	16.09	16.11	15.99	0-1	1
		25	0	16.12	16.12	15.99	0-1	1
	16QAM	1	0	16.33	16.29	16.25	0-1	1
		1	12	16.40	16.41	16.35	0-1	1
		1	24	16.32	16.15	16.18	0-1	1
		12	0	15.24	15.19	15.20	0-2	2
		12	6	15.20	15.15	15.16	0-2	2
		12	11	15.22	15.17	15.13	0-2	2
		25	0	15.19	15.22	15.05	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)	MPR Allowed Per 3GPP	MPR
				20525	[dB]	[dB]
				836.5 MHz		
10 MHz	QPSK	1	0	17.17	0	0
		1	24	17.17	0	0
		1	49	16.98	0	0
		25	0	16.22	0-1	1
		25	12	16.15	0-1	1
		25	24	16.11	0-1	1
		50	0	16.19	0-1	1
	16QAM	1	0	16.43	0-1	1
		1	24	16.41	0-1	1
		1	49	16.21	0-1	1
		25	0	15.24	0-2	2
		25	12	15.20	0-2	2
		25	24	15.10	0-2	2
		50	0	15.19	0-2	2

Note: LTE Band 5 at 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

- LTE Band 7

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20775	21100	21425		
				2502.5 MHz	2535 MHz	2567.5 MHz	[dB]	[dB]
5 MHz	QPSK	1	0	12.04	12.33	12.49	0	0
		1	12	12.24	12.47	12.46	0	0
		1	24	12.03	12.23	12.34	0	0
		12	0	11.13	11.32	11.68	0	0
		12	6	11.06	11.30	11.55	0	0
		12	11	11.18	11.32	11.55	0	0
		25	0	11.09	11.31	11.61	0-1	1
	16QAM	1	0	11.33	11.47	11.56	0-1	1
		1	12	11.43	11.37	11.49	0-1	1
		1	24	11.29	11.36	11.52	0-1	1
		12	0	10.42	10.39	10.54	0-1	1
		12	6	10.33	10.35	10.57	0-1	1
		12	11	10.23	10.32	10.67	0-1	1
		25	0	10.37	10.36	10.69	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20800	21100	21400		
				2505 MHz	2535 MHz	2565 MHz	[dB]	[dB]
10 MHz	QPSK	1	0	12.31	12.37	12.73	0	0
		1	24	12.31	12.37	12.74	0	0
		1	49	12.07	12.19	12.53	0	0
		25	0	11.35	11.41	11.78	0-1	1
		25	12	11.37	11.35	11.66	0-1	1
		25	24	11.33	11.28	11.56	0-1	1
		50	0	11.38	11.34	11.55	0-1	1
	16QAM	1	0	11.41	11.31	11.36	0-1	1
		1	24	11.25	11.28	11.30	0-1	1
		1	49	11.42	11.37	11.34	0-1	1
		25	0	10.32	10.47	10.51	0-2	2
		25	12	10.46	10.48	10.55	0-2	2
		25	24	10.32	10.4	10.66	0-2	2
		50	0	10.54	10.45	10.58	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20825	21100	21375		
				2507.5 MHz	2535 MHz	2562.5 MHz	[dB]	[dB]
15 MHz	QPSK	1	0	11.99	12.15	12.44	0	0
		1	36	12.05	12.29	12.56	0	0
		1	74	11.86	11.89	12.06	0	0
		36	0	11.33	11.47	11.73	0	0
		36	18	11.16	11.36	11.58	0	0
		36	39	11.19	11.32	11.54	0	0
		75	0	11.28	11.37	11.55	0-1	1
	16QAM	1	0	11.18	11.37	11.45	0-1	1
		1	36	11.32	11.49	11.46	0-1	1
		1	74	10.93	11.15	11.34	0-1	1
		36	0	10.51	10.53	10.83	0-1	1
		36	18	10.41	10.36	10.65	0-1	1
		36	39	10.35	10.37	10.71	0-1	1
		75	0	10.41	10.44	10.74	0-2	2

Bandwidth	Modulation	RB Size	RB Offset	Max. Average Power (dBm)			MPR Allowed Per 3GPP	MPR
				20850	21100	21350		
				2510 MHz	2535 MHz	2560 MHz	[dB]	[dB]
20 MHz	QPSK	1	0	12.71	12.87	12.93	0	0
		1	49	12.38	12.39	12.53	0	0
		1	99	12.48	12.61	12.61	0	0
		50	0	11.39	11.47	11.85	0-1	1
		50	25	11.31	11.36	11.63	0-1	1
		50	49	11.37	11.24	11.54	0-1	1
		100	0	11.34	11.39	11.76	0-1	1
	16QAM	1	0	11.38	11.37	11.44	0-1	1
		1	49	11.37	11.35	11.46	0-1	1
		1	99	11.56	11.38	10.96	0-1	1
		50	0	10.53	10.57	10.76	0-2	2
		50	25	10.44	10.46	10.62	0-2	2
		50	49	10.38	10.48	10.54	0-2	2
		100	0	10.27	10.41	10.66	0-2	2

Note:

The EUT enables maximum power reduction in accordance with 3GPP 36.101. The MPR settings are configured during the manufacture process and are not configurable by the network, carrier, or end user.

9.3 WiFi

9.3.1 Maximum Power : Sensor Inactive Conditions:

IEEE 802.11 Average RF Conducted Power – Antenna 0

Mode	Freq.	Channel	IEEE 802.11 (2.4 GHz) Conducted Power
	[MHz]		[dBm]
802.11b	2412	1	14.09
	2437	6	14.05
	2462	11	14.15
	2467	12	7.16
	2472	13	6.99
802.11g	2412	1	11.67
	2437	6	11.57
	2462	11	11.80
	2467	12	6.68
	2472	13	1.64
802.11n	2412	1	11.45
	2437	6	11.28
	2462	11	11.56
	2467	12	6.5
	2472	13	0.25

IEEE 802.11a Average RF Conducted Power – 20 MHz Bandwidth – Antenna 0

Mode	Freq.	Channel	IEEE 802.11 (5 GHz) Conducted Power
	[MHz]		[dBm]
802.11a	5 180	36	11.60
	5 200	40	11.77
	5 220	44	11.64
	5 240	48	11.72
	5 260	52	11.80
	5 280	56	11.75
	5 300	60	11.57
	5 320	64	10.99
	5 500	100	11.62
	5 520	104	11.73
	5 540	108	11.13
	5 560	112	11.64
	5 580	116	12.10
	5 660	132	11.84
	5 680	136	11.81
	5 700	140	12.44
	5 745	149	11.55
	5 765	153	11.58
	5 785	157	11.63
	5 805	161	11.75
	5 825	165	11.95

IEEE 802.11 Average RF Conducted Power – Antenna 1

Mode	Freq.	Channel	IEEE 802.11 (2.4 GHz) Conducted Power
	[MHz]		[dBm]
802.11b	2412	1	13.57
	2437	6	13.81
	2462	11	13.80
	2467	12	7.12
	2472	13	6.79
802.11g	2412	1	10.96
	2437	6	11.20
	2462	11	11.27
	2467	12	6.36
	2472	13	1.48
802.11n	2412	1	10.87
	2437	6	11.18
	2462	11	11.21
	2467	12	6.41
	2472	13	0.85

IEEE 802.11a Average RF Conducted Power – 20 MHz Bandwidth – Antenna 1

Mode	Freq.	Channel	IEEE 802.11 (5 GHz) Conducted Power
	[MHz]		[dBm]
802.11a	5 180	36	11.78
	5 200	40	11.68
	5220	44	11.51
	5 240	48	11.30
	5 260	52	11.56
	5280	56	11.48
	5 300	60	11.47
	5 320	64	11.35
	5 500	100	11.13
	5520	104	11.28
	5540	108	11.50
	5560	112	11.71
	5 580	116	12.13
	5660	132	11.70
	5680	136	11.68
	5 700	140	11.97
	5 745	149	11.73
	5765	153	11.59
	5 785	157	11.78
	5805	161	11.60
	5 825	165	11.54

9.3.2 Reduced Power Condition: Sensor Active Conditions:

IEEE 802.11 Reduced Average RF Conducted Power – Antenna 0

Mode	Freq.	Channel	IEEE 802.11 (2.4 GHz) Conducted Power
	[MHz]		[dBm]
802.11b	2412	1	8.24
	2437	6	7.26
	2462	11	7.10
	2467	12	7.16
	2472	13	6.99
802.11g	2412	1	7.60
	2437	6	7.44
	2462	11	7.28
	2467	12	6.68
	2472	13	1.64
802.11n	2412	1	7.49
	2437	6	7.34
	2462	11	7.16
	2467	12	6.5
	2472	13	0.25

IEEE 802.11ac Average RF Conducted Power – 80 MHz Bandwidth – Antenna 0

Mode	Freq.	Channel	IEEE 802.11 (5 GHz) Conducted Power
	[MHz]		[dBm]
802.11ac	5 210	42	6.85
	5 290	58	7.12
	5 530	106	7.05
	5 775	155	6.65

IEEE 802.11 Reduced Average RF Conducted Power – Antenna 1

Mode	Freq.	Channel	IEEE 802.11 (2.4 GHz) Conducted Power
	[MHz]		[dBm]
802.11b	2412	1	8.20
	2437	6	7.72
	2462	11	7.25
	2467	12	7.12
	2472	13	6.79
802.11g	2412	1	7.61
	2437	6	7.35
	2462	11	7.36
	2467	12	6.36
	2472	13	1.48
802.11n	2412	1	7.29
	2437	6	7.24
	2462	11	7.38
	2467	12	6.41
	2472	13	0.85

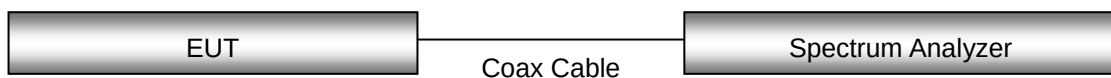
IEEE 802.11ac Average RF Conducted Power – 80 MHz Bandwidth – Antenna 1

Mode	Freq.	Channel	IEEE 802.11 (5 GHz) Conducted Power
	[MHz]		[dBm]
802.11ac	5 210	42	6.85
	5 290	58	6.88
	5 530	106	6.91
	5 775	155	6.71

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission mode with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.
- Output power and SAR measurement is not required for 802.11n channels when the specified tune-up tolerances for 802.11n are lower than 802.11a by more than 1/2dB and the measured SAR is ≤ 1.2 W/kg

Test Configuration



9.4 BT

Averaged-conducted Power

Mode	Channel	BT Power
		[dBm]
DH5	0	8.39
	39	8.84
	78	8.29
2-DH5	0	6.62
	39	7.45
	78	6.44
3-DH5	0	6.63
	39	7.46
	78	6.45

Per October 2016 TCB Workshop Notes:

When call box and Bluetooth protocol are used for BT SAR measurement, time-domain plot is required to identify duty factor for supporting the test setup and result.

Bluetooth duty cycle was measured using Bluetooth tester equipment (CBT / R&S) with Bluetooth protocol. DH5 mode is the highest duty cycle and conducted power. SAR test were performed at DH5 mode.



Duty Cycle

$$= (\text{BT-On time} / \text{BT-Full time}) = (2.886 / 3.750) = 0.77 (\text{DH5})$$

$$\text{Duty factor} = 1 / \text{Duty cycle} : 1.3$$

10. SYSTEM VERIFICATION

10.1 Tissue Verification

The Head /body simulating material is calibrated by HCT using the DAKS 3.5 to determine the conductivity and permittivity.

Table for Body Tissue Verification										
Date of Tests	Tissue Temp	Tissue Type	Freq. (MHz)	Measured Conductivity σ (S/m)	Measured Dielectric Constant, ϵ	Target Conductivity σ (S/m)	Target Dielectric Constant, ϵ	% dev σ	% dev ϵ	
05/22/2017	21.2	835B	820	0.974	57.015	0.969	55.258	0.52%	3.18%	
			835	0.986	56.900	0.970	55.200	1.65%	3.08%	
			850	0.999	56.762	0.988	55.154	1.11%	2.92%	
05/23/2017	21.2	1900B	1 850	1.509	53.264	1.520	53.300	-0.72%	-0.07%	
			1 900	1.570	53.100	1.520	53.300	3.29%	-0.38%	
			1 910	1.581	53.069	1.520	53.300	4.01%	-0.43%	
06/16/2017	21.5	2450B	2 400	1.920	53.700	1.902	52.770	0.95%	1.76%	
			2 412	1.940	53.600	1.916	52.753	1.25%	1.61%	
			2 437	1.970	53.500	1.940	52.718	1.55%	1.48%	
			2 441	1.970	53.500	1.944	52.713	1.34%	1.49%	
			2 450	1.990	53.500	1.950	52.700	2.05%	1.52%	
			2 462	2.010	53.400	1.970	52.686	2.03%	1.36%	
			2 500	2.060	53.300	2.021	52.640	1.93%	1.25%	
06/17/2017	21.3	2600B	2 500	2.059	52.577	2.024	52.640	1.73%	-0.12%	
			2 510	2.072	52.553	2.038	52.626	1.67%	-0.14%	
			2 535	2.104	52.495	2.074	52.591	1.45%	-0.18%	
			2 560	2.134	52.428	2.109	52.558	1.19%	-0.25%	
			2 600	2.188	52.310	2.166	52.510	1.02%	-0.38%	
05/26/2017	20.4	5200B-5800B	5 180	5.150	48.900	5.283	49.038	-2.52%	-0.28%	
			5 250	5.270	48.700	5.377	48.936	-1.99%	-0.48%	
			5 280	5.320	48.600	5.400	48.908	-1.48%	-0.63%	
			5 320	5.380	48.500	5.447	48.852	-1.23%	-0.72%	
			5 500	5.682	47.973	5.650	48.610	0.57%	-1.31%	
			5 600	5.840	47.700	5.766	48.470	1.28%	-1.59%	
06/09/2017	20.3		5200B-5800B	5 750	6.112	47.094	5.944	48.277	2.83%	-2.45%
				5 800	6.189	46.980	6.000	48.200	3.15%	-2.53%
				5 825	6.226	46.901	6.037	48.165	3.13%	-2.62%

10.2 System Verification

Prior to assessment, the system is verified to the $\pm 10\%$ of the specifications at 835 MHz / 1 900 MHz / 2 450 MHz / 2 600MHz/ 5 250 MHz / 5 600 MHz / 5 750 MHz by using the system Verification kit. (Graphic Plots Attached)

System Verification Results

Freq.	Date	Probe (S/N)	Dipole (S/N)	Liquid	Amb. Temp.	Liquid Temp.	1 W Target SAR _{1g} (SPEAG)	Measured SAR _{1g}	1 W Normalized SAR _{1g}	Deviation	Limit [%]
[MHz]					[°C]	[°C]	[W/kg]	[W/kg]	[W/kg]	[%]	[%]
835	05/22/2017	1605	441	Body	21.3	21.2	9.62	0.979	9.79	+ 1.77	± 10
1 900	05/23/2017	1605	5d032	Body	21.3	21.2	40.5	3.9	39.0	- 3.70	± 10
2 450	06/16/2017	7370	743	Body	21.8	21.5	50.6	5.18	51.8	+2.37	± 10
2 600	06/17/2017	7370	1015	Body	21.5	21.3	55.1	5.44	54.4	- 1.27	± 10
5 250	05/26/2017	7370	1253	Body	20.6	20.4	76.4	7.51	75.1	- 1.70	± 10
5 600	05/26/2017	7370	1253	Body	20.6	20.4	80.0	8.03	80.3	+ 0.37	± 10
5 750	06/09/2017	7370	1253	Body	20.5	20.3	77.1	7.16	71.6	- 7.13	± 10

10.3 System Verification Procedure

SAR measurement was prior to assessment, the system is verified to the $\pm 10\%$ of the specifications at each frequency band by using the system Verification kit. (Graphic Plots Attached)

- Cabling the system, using the Verification kit equipments.
- Generate about 100 mW Input Level from the Signal generator to the Dipole Antenna.
- Dipole Antenna was placed below the Flat phantom.
- The measured one-gram SAR at the surface of the phantom above the dipole feed-point should be within 10 % of the target reference value.
- The results are normalized to 1 W input power.

NOTE;

SAR Verification was performed according to the FCC KDB 865664 D01v01r04.

11. SAR TEST DATA SUMMARY

11.1 SAR Measurement Results

UMTS 850 Body SAR													
Frequency		Mode	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(dB)	(dB)	(dB)				(mm)	(W/kg)		(W/kg)	
836.6	4183	RMC	18.0	16.88	-0.11	Rear	Active	1:1	0	0.415	1.294	0.537	1
836.6	4183	RMC	24.5	23.66	-0.01	Rear	Inactive	1:1	14	0.432	1.213	0.524	2
836.6	4183	RMC	18.0	16.88	0.15	Top	Active	1:1	0	0.370	1.294	0.479	-
836.6	4183	RMC	24.5	23.66	0.10	Top	Inactive	1:1	20	0.243	1.213	0.295	-
836.6	4183	RMC	24.5	23.66	0.11	Left	Inactive	1:1	0	0.195	1.213	0.237	-
836.6	4183	RMC	24.5	23.66	0.16	Rear *1)	Inactive	1:1	14	0.297	1.213	0.360	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population									Body 1.6 W/kg Averaged over 1 gram				

* With Keyboard cover

UMTS 1900 Body SAR													
Frequency		Mode	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(dB)	(dB)	(dB)				(mm)	(W/kg)		(W/kg)	
1 852.4	9262	RMC	13.0	12.37	0.13	Rear	Active	1:1	0	0.719	1.156	0.831	-
1 880.0	9400	RMC	13.0	12.53	0.11	Rear	Active	1:1	0	0.764	1.114	0.851	3
1 907.6	9538	RMC	13.0	12.23	0.08	Rear	Active	1:1	0	0.707	1.194	0.844	-
1 880.0	9400	RMC	23.0	22.14	0.18	Rear	Inactive	1:1	14	0.599	1.219	0.730	-
1 880.0	9400	RMC	13.0	12.53	0.15	Top	Active	1:1	0	0.166	1.114	0.185	-
1 880.0	9400	RMC	23.0	22.14	0.10	Top	Inactive	1:1	20	0.269	1.219	0.328	-
1 880.0	9400	RMC	23.0	22.14	-0.09	Left	Inactive	1:1	0	0.164	1.219	0.200	-
1 880.0	9400	RMC	13.0	12.53	0.17	Rear *1)	Active	1:1	0	0.440	1.114	0.490	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population									Body 1.6 W/kg Averaged over 1 gram				

* With Keyboard cover

LTE Band 5 (Cell) Body SAR																	
Frequency		Mode	Band width	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	MPR	RB Size	RB offset	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.								(dB)								
836.5	20525	QPSK	10	18.0	17.17	-0.15	Rear	Active	0	1	0	1:1	0	0.472	1.211	0.572	-
836.5	20525	QPSK	10	17.0	16.22	0.02	Rear	Active	1	25	0	1:1	0	0.372	1.197	0.445	-
836.5	20525	QPSK	10	24.5	23.58	0.13	Rear	Inactive	0	1	24	1:1	14	0.371	1.236	0.459	-
836.5	20525	QPSK	10	23.5	22.62	0.16	Rear	Inactive	1	25	0	1:1	14	0.299	1.225	0.366	-
836.5	20525	QPSK	10	18.0	17.17	0.05	Top	Active	0	1	0	1:1	0	0.508	1.211	0.615	4
836.5	20525	QPSK	10	17.0	16.22	-0.19	Top	Active	1	25	0	1:1	0	0.410	1.197	0.491	-
836.5	20525	QPSK	10	24.5	23.58	0.14	Top	Inactive	0	1	24	1:1	20	0.307	1.236	0.379	-
836.5	20525	QPSK	10	23.5	22.62	0.14	Top	Inactive	1	25	0	1:1	20	0.254	1.225	0.311	-
836.5	20525	QPSK	10	24.5	23.58	-0.05	Left	Inactive	0	1	24	1:1	0	0.250	1.236	0.309	-
836.5	20525	QPSK	10	23.5	22.62	-0.04	Left	Inactive	1	25	0	1:1	0	0.204	1.225	0.250	-
836.5	20525	QPSK	10	18.0	17.17	0.17	Top *1)	Active	0	1	0	1:1	0	0.373	1.211	0.452	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population													Body 1.6 W/kg Averaged over 1 gram				

* With Keyboard cover

LTE Band 7 Body SAR																	
Frequency		Mode	Band width	Tune- Up Limit	Meas. Power	Power Drift	Test Position	Sensor	MPR	RB Size	RB offset	Duty Cycle	Distance	Meas. SAR	Scalin g Factor	Scaled SAR	Plot No.
MHz	Ch.								(dB)				(mm)	(W/kg)		(W/kg)	
2 560	21350	QPSK	20	13.0	12.93	0.19	Rear	Active	0	1	0	1:1	0	0.725	1.016	0.737	-
2 560	21350	QPSK	20	12.0	11.85	0.00	Rear	Active	1	50	0	1:1	0	0.671	1.035	0.694	-
2 560	21350	QPSK	20	23.7	23.50	-0.17	Rear	Inactive	0	1	0	1:1	14	0.694	1.047	0.727	-
2 560	21350	QPSK	20	22.7	22.24	0.17	Rear	Inactive	1	50	0	1:1	14	0.559	1.112	0.622	-
2 510	20850	QPSK	20	13.0	12.71	-0.13	Top	Active	0	1	0	1:1	0	0.812	1.069	0.868	-
2 535	21100	QPSK	20	13.0	12.87	0.18	Top	Active	0	1	0	1:1	0	0.791	1.030	0.815	-
2 560	21350	QPSK	20	13.0	12.93	0.18	Top	Active	0	1	0	1:1	0	0.943	1.016	0.958	5
2 560	21350	QPSK	20	12.0	11.85	-0.12	Top	Active	1	50	0	1:1	0	0.727	1.035	0.752	-
2 560	21350	QPSK	20	12.0	11.76	-0.12	Top	Active	1	100	0	1:1	0	0.714	1.057	0.755	-
2 560	21350	QPSK	20	23.7	23.50	-0.08	Top	Inactive	0	1	0	1:1	20	0.671	1.047	0.703	-
2 560	21350	QPSK	20	22.7	22.24	-0.19	Top	Inactive	1	50	0	1:1	20	0.589	1.112	0.655	-
2 560	21350	QPSK	20	23.7	23.50	0.09	Left	Inactive	0	1	0	1:1	0	0.434	1.047	0.454	-
2 560	21350	QPSK	20	22.7	22.24	0.13	Left	Inactive	1	50	0	1:1	0	0.391	1.112	0.435	-
2 560	21350	QPSK	20	13.0	12.93	0.12	Top *1)	Active	0	1	0	1:1	0	0.699	1.016	0.710	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population													Body 1.6 W/kg Averaged over 1 gram				

* With Keyboard cover

Wi-Fi (DTS) Body SAR - Antenna 0

Frequency		Mode	Band width	Data Rate	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(MHz)	(Mbps)	(dBm)	(dBm)	(dB)				(mm)	(W/kg)		(Duty)	(W/kg)	
2 412	1	802.11b	22	1	8.5	8.24	0.008	Rear	Active	99.28	0	0.326	1.062	1.007	0.349	6
2 462	11	802.11b	22	1	14.5	14.15	-0.01	Rear	Inactive	99.28	6	0.290	1.084	1.007	0.317	-
2 412	1	802.11b	22	1	8.5	8.24	-0.03	Top	Active	99.28	0	0.084	1.062	1.007	0.090	-
2 462	11	802.11b	22	1	14.5	14.15	0.026	Top	Inactive	99.28	6	0.202	1.084	1.007	0.221	-
2 412	1	802.11b	22	1	8.5	8.24	-0.01	Rear *1)	Active	99.28	0	0.228	1.062	1.007	0.244	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population											Body 1.6 W/kg Averaged over 1 gram					

* With Keyboard cover

Wi-Fi (DTS) Body SAR - Antenna 1

Frequency		Mode	Band width	Data Rate	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(MHz)	(Mbps)	(dBm)	(dBm)	(dB)				(mm)	(W/kg)		(Duty)	(W/kg)	
2 412	1	802.11b	22	1	8.5	8.20	-0.011	Rear	Active	99.20	0	0.248	1.072	1.008	0.268	7
2437	6	802.11b	22	1	14.5	13.81	0.021	Rear	Inactive	99.20	6	0.148	1.172	1.008	0.175	-
2 412	1	802.11b	22	1	8.5	8.20	0.02	Top	Active	99.20	0	0.060	1.072	1.008	0.065	-
2 437	6	802.11b	22	1	14.5	13.81	0.005	Top	Inactive	99.20	6	0.056	1.172	1.008	0.066	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population											Body 1.6 W/kg Averaged over 1 gram					

Bluetooth Body SAR

Frequency		Mode	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Distance	Meas. SAR	Scaling Factor	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(dBm)	(dBm)	(dB)		(mm)	(W/kg)		(Duty)	(W/kg)	
2 441	39	Bluetooth DH5	10.0	8.84	0.004	Rear	0	0.302	1.306	1.3	0.513	8
2 441	39	Bluetooth DH5	10.0	8.84	0.013	Top	0	0.088	1.306	1.3	0.149	-
2 441	39	Bluetooth DH5	10.0	8.84	-0.038	Rear *1)	0	0.178	1.306	1.3	0.302	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population							Body 1.6 W/kg Averaged over 1 gram					

* With Keyboard cover

Wi-Fi (NII) Body SAR - Antenna 0

Frequency		Mode	Band width	Data Rate	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(MHz)	(Mbps)	(dBm)	(dBm)	(dB)				(mm)	(W/kg)		(Duty)	(W/kg)	
5210	42	802.11ac	80	MCS0	7.5	6.85	-0.044	Rear	Active	85.00	0	0.152	1.161	1.176	0.208	-
5200	40	802.11a	20	6Mbps	12.5	11.77	0.033	Rear	Inactive	94.82	6	0.095	1.183	1.055	0.119	-
5210	42	802.11ac	80	MCS0	7.5	6.85	0.047	Top	Active	85.00	0	0.150	1.161	1.176	0.205	-
5200	40	802.11a	20	6Mbps	12.5	11.77	0.022	Top	Inactive	94.82	6	0.112	1.183	1.055	0.140	-
5290	58	802.11ac	80	MCS0	7.5	7.12	0.010	Rear	Active	85.00	0	0.184	1.091	1.176	0.236	9
5260	52	802.11a	20	6Mbps	12.5	11.80	0.020	Rear	Inactive	94.82	6	0.095	1.175	1.055	0.118	-
5290	58	802.11ac	80	MCS0	7.5	7.12	0.003	Top	Active	85.00	0	0.138	1.091	1.176	0.177	-
5260	52	802.11a	20	6Mbps	12.5	11.80	0.057	Top	Inactive	94.82	6	0.099	1.175	1.055	0.123	-
5530	106	802.11ac	80	MCS0	7.5	7.05	0.002	Rear	Active	85.00	0	0.176	1.109	1.176	0.230	-
5700	140	802.11a	20	6Mbps	12.5	12.44	0.035	Rear	Inactive	94.82	6	0.088	1.014	1.055	0.094	-
5530	106	802.11ac	80	MCS0	7.5	7.05	-0.048	Top	Active	85.00	0	0.093	1.091	1.176	0.119	-
5700	140	802.11a	20	6Mbps	12.5	12.44	0.047	Top	Inactive	94.82	6	0.122	1.014	1.055	0.131	-
5775	155	802.11ac	80	MCS0	7.5	6.65	-0.10	Rear	Active	85.00	0	0.162	1.216	1.176	0.232	-
5825	165	802.11a	20	6Mbps	12.5	11.95	0.01	Rear	Inactive	94.82	6	0.123	1.135	1.055	0.147	-
5775	155	802.11ac	80	MCS0	7.5	6.65	0.10	Top	Active	85.00	0	0.087	1.216	1.176	0.124	-
5825	165	802.11a	20	6Mbps	12.5	11.95	0.04	Top	Inactive	94.82	6	0.134	1.135	1.055	0.160	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population											Body 1.6 W/kg Averaged over 1 gram					

Wi-Fi (NII) Body SAR - Antenna 1

Frequency		Mode	Band width	Data Rate	Tune-Up Limit	Meas. Power	Power Drift	Test Position	Sensor	Duty Cycle	Distance	Meas. SAR	Scaling Factor	Scaling Factor	Scaled SAR	Plot No.
MHz	Ch.		(MHz)	(Mbps)	(dBm)	(dBm)	(dB)				(mm)	(W/kg)	(Duty)	(Duty)	(W/kg)	
5210	42	802.11ac	80	MCS0	7.5	6.85	0.011	Rear	Active	85.00	0	0.337	1.161	1.176	0.460	-
5180	36	802.11a	20	6Mbps	12.5	11.78	-0.110	Rear	Inactive	94.95	6	0.216	1.180	1.053	0.268	-
5210	42	802.11ac	80	MCS0	7.5	6.85	0.071	Top	Active	85.00	0	0.128	1.161	1.176	0.175	-
5180	36	802.11a	20	6Mbps	12.5	11.78	0.042	Top	Inactive	94.95	6	0.097	1.180	1.053	0.121	-
5290	58	802.11ac	80	MCS0	7.5	6.88	0.100	Rear	Active	85.00	0	0.403	1.153	1.176	0.546	-
5260	52	802.11a	20	6Mbps	12.5	11.56	0.011	Rear	Inactive	94.95	6	0.208	1.242	1.053	0.272	-
5290	58	802.11ac	80	MCS0	7.5	6.88	-0.078	Top	Active	85.00	0	0.123	1.153	1.176	0.167	-
5260	52	802.11a	20	6Mbps	12.5	11.56	0.005	Top	Inactive	94.95	6	0.103	1.242	1.053	0.135	-
5530	106	802.11ac	80	MCS0	7.5	6.91	-0.027	Rear	Active	85.00	0	0.443	1.146	1.176	0.597	10
5580	116	802.11a	20	6Mbps	12.5	12.13	-0.015	Rear	Inactive	94.95	6	0.181	1.089	1.053	0.208	-
5530	106	802.11ac	80	MCS0	7.5	6.91	-0.104	Top	Active	85.00	0	0.137	1.146	1.176	0.185	-
5580	116	802.11a	20	6Mbps	12.5	12.13	0.077	Top	Inactive	94.95	6	0.164	1.089	1.053	0.188	-
5530	106	802.11ac	80	MCS0	7.5	6.91	0.077	Rear*1)	Active	85.00	0	0.178	1.146	1.176	0.240	-
5775	155	802.11ac	80	MCS0	7.5	6.71	0.02	Rear	Active	85.00	0	0.276	1.199	1.176	0.389	-
5785	157	802.11a	20	6Mbps	12.5	11.78	0.13	Rear	Inactive	94.95	6	0.205	1.180	1.053	0.255	-
5775	155	802.11ac	80	MCS0	7.5	6.71	0.07	Top	Active	85.00	0	0.084	1.199	1.176	0.118	-
5785	157	802.11a	20	6Mbps	12.5	11.78	0.10	Top	Inactive	94.95	6	0.122	1.180	1.053	0.167	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population											Body 1.6 W/kg Averaged over 1 gram					

* With Keyboard cover

11.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 616217 D04v01r02 and KDB Publication 447498 D01v06
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB 447498 D01v06.
6. This device utilizes power reduction for wireless mode and technologies, as outlined in sec. 2.5 and sec.9. The maximum output power allowed for each transmitter and exposure condition was evaluated for SAR compliance based on expected use conditions and simultaneous scenarios.
7. FCC KDB Publication 616217 D04v01r02 Section 4.3, SAR tests are required for the back surface and edges of the tablet with the tablet touching the phantom. The SAR Exclusion Threshold in FCC KDB 447498 D01v06 was applied to determine SAR test exclusion for adjacent edge configurations.

UMTS Notes:

1. The 12.2 kbps RMC mode is the primary mode per KDB 941225 D01v03r01.
2. UMTS mode in Body SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB 941225 D01v03r01. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and Adjusted SAR value was less than 1.2 W/kg.
3. Per FCC KDB 447498 D01v06, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the channel highest output power channel was used.
4. UMTS SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB publication 941225 D01v03r01. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Consideration for LTE Devices in FCC KDB 941225 D05v02r05.
2. According to FCC KDB 941225 D05v02r05:
When the reported SAR is ≤ 0.8 W/kg, testing of the 100%RB allocation and required test channels is not required. Otherwise, SAR is required for the remaining required test channels using the 1RB, 50%RB and 100%RB allocation with highest output power for that channel.
Only one channel, and as reported SAR values for 1RB allocation and 50%RB allocation were less than 1.45W/Kg only the highest power RB offset for each allocation was required.
3. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to target MPR is indicated alongside the SAR results.
4. A-MPR was disabled for all SAR tests by setting NS=01 on the base station simulator.
5. SAR test reduction is applied using the following criteria:
Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB, and 50% RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is >0.8 W/kg, testing for other Channels is performed at the highest output power level for 1RB, and 50% RB configuration for that channel. Testing for 100% RB configuration is performed at the highest output power level for 100% RB configuration across the Low, Mid and High Channel when the highest reported SAR for 1 RB and 50% RB are >0.8 W/kg, Testing for the remaining required channels is not needed because the reported SAR for 100% RB Allocation <1.45 W/kg. Testing for 16-QAM modulation is not required because the reported SAR for QPSK is <1.45 W/kg and its output power is not more than 0.5 dB higher than that a QPSK. Testing for the other channel bandwidths is not required because the reported SAR for the highest channel bandwidth is <1.45 W/kg and its output power is not more than 0.5 dB higher than that of the highest channel bandwidth.

WLAN Notes:

1. Per KDB 2482227 D01v02r02 justification for test configurations of 2.4 GHz WiFi Single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11 g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR.
2. Per KDB 2482227 D01v02r02 justification for test configurations of 5 GHz WiFi Single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed powers. Other transmission mode were not investigated since the highest reported SAR for initial test configuration adjusted by the ration of maximum output powers is less than 1.2 W/kg for 1g SAR and less than 3.0 W/kg for 10 g SAR.
3. Per KDB 2482227 D01v02r02, SAR for MIMO was evaluated by following the simultaneous SAR Provisions from KDB 447498D01v06.
4. When the maximum reported 1g averaged SAR is ≤ 0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg or all test channels were measured.
5. The device was configured to transmit continuously at the required data rated, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance. Procedures used to measure the duty factor are identical to that in the associated WLAN test reports.
6. Only channels in the U-NII-2C (> 5.65 GHz WIFI) & U-NII-3 aggregate band that support wireless router were considered for hotspot SAR tests.

Bluetooth Notes:

1. Bluetooth SAR was measured with the device connected to a call box with hopping disabled with DH5 operation and Tx Tests mode type. Per October 2016 TCBC Workshop Notes, the reported SAR was scaled to 100% transmission duty factor to determine compliance. Please see sec.9.5 for the time-domain plot and calculation for duty factor of the device.

12. Simultaneous Transmission SAR Analysis

12.1 Simultaneous Transmission Summation for Body

Simultaneous Tx	Configurations	WCDMA5 (W/kg)	2.4 Ant 0 (W/kg)	2.4 GHz Ant 1 (W/kg)	$\sum$ 1-g SAR (W/kg)	SPLSR (Yes/No)
Body SAR	Rear	0.537	0.349	0.268	1.154	No
	Top	0.479	0.221	0.066	0.766	No
	Left	0.237	0.400	0.400	1.037	No
Simultaneous Tx	Configurations	WCDMA2 (W/kg)	2.4 Ant 0 (W/kg)	2.4 GHz Ant 1 (W/kg)	$\sum$ 1-g SAR (W/kg)	SPLSR (Yes/No)
Body SAR	Rear	0.851	0.349	0.268	1.468	No
	Top	0.328	0.221	0.066	0.615	No
	Left	0.200	0.400	0.400	1.000	No
Simultaneous Tx	Configurations	LTE 5 (W/kg)	2.4 Ant 0 (W/kg)	2.4 GHz Ant 1 (W/kg)	$\sum$ 1-g SAR (W/kg)	SPLSR (Yes/No)
Body SAR	Rear	0.572	0.349	0.268	1.189	No
	Top	0.615	0.221	0.066	0.902	No
	Left	0.309	0.400	0.400	1.109	No
Simultaneous Tx	Configurations	LTE 7 (W/kg)	2.4 Ant 0 (W/kg)	2.4 GHz Ant 1 (W/kg)	$\sum$ 1-g SAR (W/kg)	SPLSR (Yes/No)
Body SAR	Rear	0.737	0.349	0.268	1.354	No
	Top	0.958	0.221	0.066	1.245	No
	Left	0.454	0.400	0.400	1.254	No

Simultaneous Tx	Configurations	WCDMA5	5GHz Ant 0	5GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.236	0.597	1.370	No
	Top	0.479	0.205	0.188	0.872	No
	Left	0.237	0.400	0.400	1.037	No
Simultaneous Tx	Configurations	WCDMA2	5GHz Ant 0	5GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.236	0.597	1.684	Yes
	Top	0.328	0.205	0.188	0.721	No
	Left	0.200	0.400	0.400	1.000	No
Simultaneous Tx	Configurations	LTE 5	5GHz Ant 0	5GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.236	0.597	1.405	No
	Top	0.615	0.205	0.188	1.008	No
	Left	0.309	0.400	0.400	1.109	No
Simultaneous Tx	Configurations	LTE 7	5GHz Ant 0	5GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.236	0.597	1.570	No
	Top	0.958	0.205	0.188	1.351	No
	Left	0.454	0.400	0.400	1.254	No

Simultaneous Tx	Configurations	WCDMA5	2.4 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.349	0.886	No
	Top	0.479	0.221	0.700	No
	Left	0.237	0.400	0.637	No
Simultaneous Tx	Configurations	WCDMA2	2.4 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.349	1.200	No
	Top	0.328	0.221	0.549	No
	Left	0.200	0.400	0.600	No
Simultaneous Tx	Configurations	LTE 5	2.4 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.349	0.921	No
	Top	0.615	0.221	0.836	No
	Left	0.309	0.400	0.709	No
Simultaneous Tx	Configurations	LTE 7	2.4 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.349	1.086	No
	Top	0.958	0.221	1.179	No
	Left	0.454	0.400	0.854	No

Simultaneous Tx	Configurations	WCDMA5	2.4 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.268	0.805	No
	Top	0.479	0.066	0.545	No
	Left	0.237	0.400	0.637	No
Simultaneous Tx	Configurations	WCDMA2	2.4 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.268	1.119	No
	Top	0.328	0.066	0.394	No
	Left	0.200	0.400	0.600	No
Simultaneous Tx	Configurations	LTE 5	2.4 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.268	0.840	No
	Top	0.615	0.066	0.681	No
	Left	0.309	0.400	0.709	No
Simultaneous Tx	Configurations	LTE 7	2.4 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.268	1.005	No
	Top	0.958	0.066	1.024	No
	Left	0.454	0.400	0.854	No

Simultaneous Tx	Configurations	WCDMA5	5 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.236	0.773	No
	Top	0.479	0.205	0.684	No
	Left	0.237	0.400	0.637	No
Simultaneous Tx	Configurations	WCDMA2	5 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.236	1.087	No
	Top	0.328	0.205	0.533	No
	Left	0.200	0.400	0.600	No
Simultaneous Tx	Configurations	LTE 5	5 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.236	0.808	No
	Top	0.615	0.205	0.820	No
	Left	0.309	0.400	0.709	No
Simultaneous Tx	Configurations	LTE 7	5 GHz Ant 0	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.236	0.973	No
	Top	0.958	0.205	1.163	No
	Left	0.454	0.400	0.854	No

Simultaneous Tx	Configurations	WCDMA5	5 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.597	1.134	No
	Top	0.479	0.188	0.667	No
	Left	0.237	0.400	0.637	No
Simultaneous Tx	Configurations	WCDMA2	5 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.597	1.448	No
	Top	0.328	0.188	0.516	No
	Left	0.200	0.400	0.600	No
Simultaneous Tx	Configurations	LTE 5	5 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.597	1.169	No
	Top	0.615	0.188	0.803	No
	Left	0.309	0.400	0.709	No
Simultaneous Tx	Configurations	LTE 7	5 GHz Ant 1	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.597	1.334	No
	Top	0.958	0.188	1.146	No
	Left	0.454	0.400	0.854	No

Simultaneous Tx	Configurations	WCDMA5	BT	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.537	0.513	1.050	No
	Top	0.479	0.149	0.628	No
	Left	0.237	0.400	0.637	No
Simultaneous Tx	Configurations	WCDMA2	BT	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.851	0.513	1.364	No
	Top	0.328	0.149	0.477	No
	Left	0.200	0.400	0.600	No
Simultaneous Tx	Configurations	LTE 5	BT	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.572	0.513	1.085	No
	Top	0.615	0.149	0.764	No
	Left	0.309	0.400	0.709	No
Simultaneous Tx	Configurations	LTE 7	BT	$\sum$ 1-g SAR	SPLSR
		(W/kg)	(W/kg)	(W/kg)	(Yes/No)
Body SAR	Rear	0.737	0.513	1.250	No
	Top	0.958	0.149	1.107	No
	Left	0.454	0.400	0.854	No

Note:

1. When the antenna separation distance was >50mm, an estimated SAR of 0.4W/kg was used to determine the simultaneous transmission SAR exclusion for test positions exclude per FCC KDB Publication 447498D01v06
2. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLSR ratio between the antenna pairs was not greater than 0.04 per FCC KDB447498 D01v06
3. For SAR summation, the highest reported SAR across all test distances was used as the most conservative evaluation for simultaneous transmission analysis for each device edge

12.2 SAR to Peak Location Separation Ratio (SPLSR)

FCC KDB 447498 D01v06 General RF Exposure Guidance introduces a new formula for calculating the SAR a Peak Location Separation Ratio(SPLSR) between pairs of simultaneously transmitting antennas:

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / R_i$$

Where:

SAR_1 is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest measured of estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

R_i is the separation distance between the pair of simultaneous transmitting antennas, When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $\sqrt{[(X_1 - X_2)^2 + (Y_1 - Y_2)^2]}$

In order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$$

Per Sec. 12, below simultaneous transmission summations need to be calculated SPLSR.

12.2.1 WCDMA Band2 & 5GHz WiFi (Ant 0 + Ant 1)

Mode	SAR	X	Y
	[mW/g]	M	M
WCDMA Band2	0.851	-0.0115	-0.0225
5GHz Antenna 0	0.236	-0.00995	0.065
5GHz Antenna 1	0.597	-0.00396	0.043

SAR to Peak Location Separation Ratio (SPLSR)

Plot No	Standalone SAR Value	WCDMA 2	5GHz Ant 0	5GHz Ant 1	Sum SAR		Calculated Distance (mm)	SPLSR
		SAR (W/kg)	SAR (W/kg)	SAR (W/kg)				
		1	2	3				
#1	Configuration	0.851	0.236	0.597	1+2+3	1.684		
			0.236		1+2	1.087	87.51	0.01
				0.597	1+3	1.448	65.93	0.03
			0.236	0.597	2+3	0.833	22.8	0.03

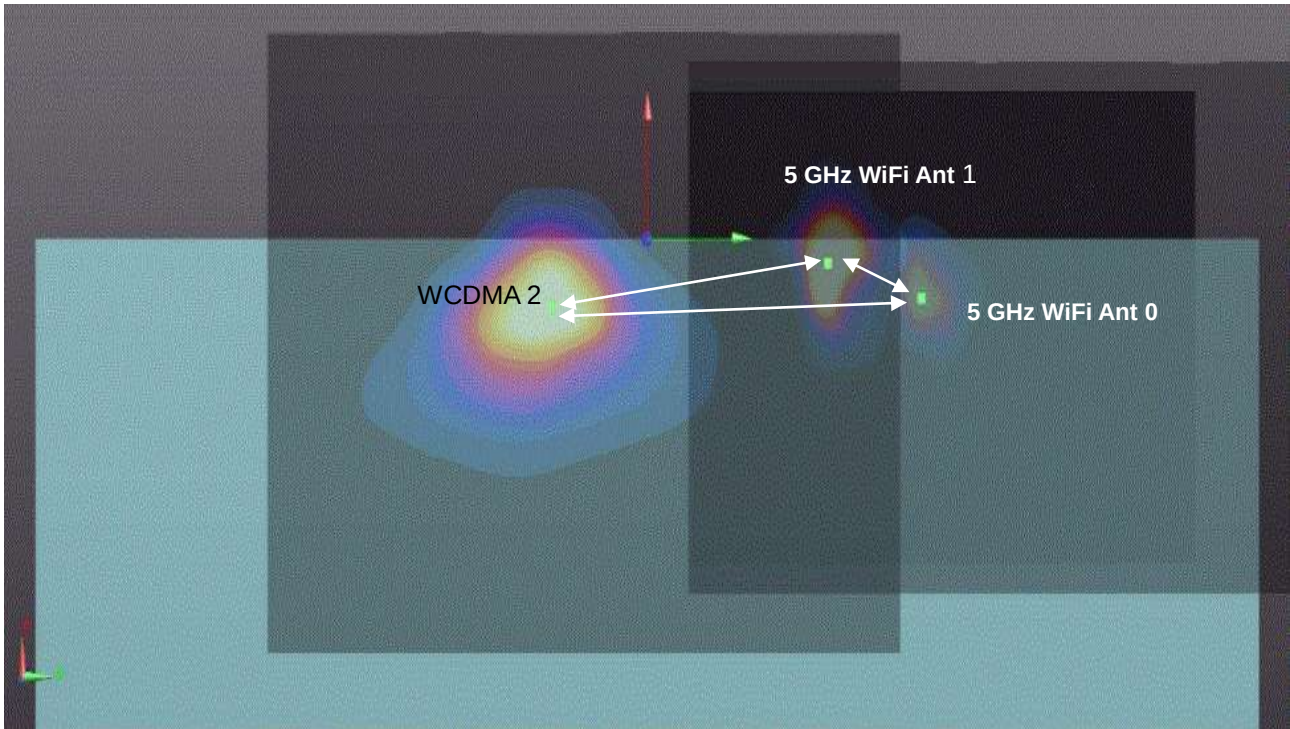
SPLSR Conclusion

Simultaneous transmission SAR measurement (Volume Scan) is not required because the either sum of the 1-g SAR is < 1.6 W/kg or the SPLSR is ≤ 0.04 for all circumstances that require SPLSR calculation.

12.2.3 SAR to Peak Location Ratio (SPLSR) Figures

Plot : #1

WCDMA Band2 & 5GHz WiFi (Ant 0 + Ant 1)



12.3 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit. And therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528-2013.

13. SAR Measurement Variability and Uncertainty

In accordance with KDB procedure 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz, SAR additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement variability was assessed using the following procedures for each frequency band:

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg for 1g SAR or < 2.0 W/kg for 10g SAR; steps 2) through 4) do not apply.
- 2) When the original highest measured 1g SAR is ≥ 0.80 W/kg or 10g SAR ≥ 2.0 W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg for 1g SAR or ≥ 3.625 W/kg for 10g SAR (~ 10% from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg for 1g SAR or ≥ 3.75 W/kg for 10g SAR and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

Frequency		Modulation	Battery	Configuration	Original SAR	Repeated SAR	Largest to Smallest SAR Ratio	Plot No.
MHz	Channel				(W/kg)	(W/kg)		
2 560	21350	LTE Band 7	Standard	Top	0.943	0.937	1.01	11

14. MEASUREMENT UNCERTAINTY

Error Description	Tol (± %)	Prob. dist.	Div.	c _i	Standard Uncertainty (± %)	V _{eff}
1. Measurement System						
Probe Calibration	6.55	N	1	1	6.55	∞
Axial Isotropy	4.70	R	1.73	0.70	1.90	∞
Hemispherical Isotropy	9.60	R	1.73	0.70	3.88	∞
Boundary Effects	2.00	R	1.73	1	1.15	∞
Linearity	4.70	R	1.73	1	2.71	∞
System Detection Limits	0.25	R	1.73	1	0.14	∞
Readout Electronics	0.30	N	1.00	1	0.30	∞
Response Time	0.80	R	1.73	1	0.46	∞
Integration Time	2.60	R	1.73	1	1.50	∞
RF Ambient Noise	3.00	R	1.73	1	1.73	∞
RF Ambient Reflections	3.00	R	1.73	1	1.73	∞
Probe Positioner	0.80	R	1.73	1	0.46	∞
Probe Positioning	6.70	R	1.73	1	3.87	∞
Max SAR Eval	4.00	R	1.73	1	2.31	∞
2. Test Sample Related						
Device Positioning	2.11	N	1.00	1	2.11	9
Device Holder	3.60	N	1.00	1	3.60	5
Power Drift	5.00	R	1.73	1	2.89	∞
Power Scaling	0.00	R	1.73	1	0.00	∞
3. Phantom and Setup						
Phantom Uncertainty	7.90	R	1.73	1	3.82	∞
Liquid Conductivity(target)	5.00	R	1.73	0.64	1.85	∞
Liquid Permittivity(target)	5.00	R	1.73	0.60	1.73	∞
Liquid Conductivity(meas.)	3.80	N	1	0.78	2.96	5
Liquid Permittivity(meas.)	2.60	N	1	0.23	0.60	5
Liquid Conductivity(temp.)	1.70	R	1.73	0.78	0.77	∞
Liquid Permittivity(temp.)	2.70	R	1.73	0.23	0.36	∞
Combine Standard Uncertainty					12.49	
Coverage Factor for 95 %					k=2	
Expanded STD Uncertainty					24.98	

15. SAR TEST EQUIPMENT

Manufacturer	Type / Model	S/N	Calib. Date	Calib.Interval	Calib.Due
SPEAG	ELI Phantom	-	N/A	N/A	N/A
HP	SAR System Control PC	-	N/A	N/A	N/A
Staubli	Robot RX90B L	F01/ 5K08A1/ A/ 01	N/A	N/A	N/A
Staubli	Robot ControllerCS7MB	F01/ 5K08A1/ C/ 01	N/A	N/A	N/A
Staubli	Teach Pendant (Joystick)	D22134001 1	N/A	N/A	N/A
SPEAG	DAE3	446	01/19/2017	Annual	01/19/2018
SPEAG	DAE4	1417	01/19/2017	Annual	01/19/2018
SPEAG	E-Field Probe EX3DV4	7370	08/30/2016	Annual	08/30/2017
SPEAG	E-Field Probe ET3DV6	1605	07/29/2016	Annual	07/29/2017
SPEAG	Dipole D835V2	441	11/16/2016	Annual	11/16/2017
SPEAG	Dipole D1900V2	5d032	03/21/2017	Annual	03/21/2018
SPEAG	Dipole D2450V2	743	03/15/2017	Annual	03/15/2018
SPEAG	Dipole D2600V2	1015	01/18/2017	Annual	01/18/2018
SPEAG	Dipole D5GHzV2	1253	01/09/2017	Annual	01/09/2018
Agilent	Power Meter N1911A	MY45101406	09/28/2016	Annual	09/28/2017
HP	Power Sensor N1921A	MY55220026	08/24/2016	Annual	08/24/2017
SPEAG	DAKS 3.5	1038	05/31/2016	Annual	05/31/2017
SPEAG	DAKS 3.5	1031	04/27/2017	Annual	04/27/2018
Agilent	Directional Bridge	86205A	10/16/2016	Annual	10/16/2017
Agilent	Base Station E5515C	GB44400269	02/02/2017	Annual	02/08/2018
HP	Signal Generator E4433B	US40052109	03/10/2017	Annual	03/10/2018
HP	11636B/Power Divider	58698	03/05/2017	Annual	03/05/2018
TESTO	175-H1/Thermometer	40332651310	02/10/2017	Annual	02/10/2018
TESTO	175-H1/Thermometer	40331939309	02/10/2017	Annual	02/10/2018
EMPOWER	RF Power amplifier	1011	10/17/2016	Annual	10/17/2017
Agilent	Attenuator(3dB)	52744	10/16/2016	Annual	10/16/2017
Agilent	Attenuator(20dB)	52664	10/16/2016	Annual	10/16/2017
HP	Dielectric Probe Kit 85070C	00721521	N/A	N/A	N/A
HP	Dual Directional Coupler	16072	10/16/2016	Annual	10/16/2017
R&S	Wideband Radio Communication Tester CMW500	101519	04/27/2017	Annual	04/27/2018
Anritsu	Radio Communication Analyzer/ MT8820C	6200628628	07/05/2016	Annual	07/05/2017
Anritsu	Radio Communication Analyzer/ MT8820C	6200576565	07/05/2016	Annual	07/05/2017
R&S	Bluetooth CBT	101519	04/27/2017	Annual	04/27/2018

NOTE:

1. The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Verification measurement is performed by HCT Lab. before each test. The brain/body simulating material is calibrated by HCT using the DAKS 3.5 to determine the conductivity and permittivity (dielectric constant) of the brain/body-equivalent material.

16. CONCLUSION

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the ANSI/IEEE C95.1- 1992

These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests.

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

17. REFERENCES

- [1] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-2013, IEEE Recommended Practice or Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices.
- [2] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio frequency Radiation, Aug. 1996.
- [3] ANSI/IEEE C95.1 - 1991, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 kHz to 100 GHz, New York: IEEE, Aug. 1992
- [4] ANSI/IEEE C 95.1 - 2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz, New York: IEEE, 2006.
- [5] ANSI/IEEE C95.3 - 1991, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, 1992.
- [6] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.
- [7] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.
- [8] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 120-124.
- [9] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.
- [10] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.
- [11] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Head Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.
- [12] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300 MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.
- [13] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectro magnetics, Canada: 1987, pp. 29-36.
- [14] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.
- [15] W. Gander, Computer mathematick, Birkhaeuser, Basel, 1992.
- [16] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.
- [17] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.
- [18] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10 kHz-300 GHz, Jan. 1995.
- [19] Prof. Dr. Niels Kuster, ETH, Eidgenøssische Technische Hoschschule Zòrich, Dosimetric Evaluation of the Cellular Phone.
- [20] IEC 62209-1, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation and procedures – Part 1:Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz), Feb. 2005.

- [21] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz) Mar. 2010.
- [22] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Band) Issue 5, March 2015.
- [23] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2009
- [24] FCC SAR Test procedures for 2G-3G Devices, Mobile Hotspot and UMPC Device KDB 941225 D01.
- [25] SAR Measurement Guidance for IEEE 802.11 transmitters, KDB 248227 D01v02r02
- [26] SAR Evaluation of Handsets with Multiple Transmitters and Antennas KDB 648474 D03, D04.
- [27] SAR Evaluation for Laptop, Notebook, Netbook and Tablet computers KDB 616217 D04.
- [28] SAR Measurement and Reporting Requirements for 100 MHz – 6 GHz, KDB 865664 D01, D02.
- [29] FCC General RF Exposure Guidance and SAR procedures for Dongles, KDB 447498 D01,D02.

Attachment 1. – SAR Test Plots

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.2 °C
Ambient Temperature: 21.3 °C
Test Date: 05/22/2017
Plot No.: 1

DUT: SM-W728Y; Type: Tablet

Communication System: UID 0, WCDMA850; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 836.6 \text{ MHz}$; $\sigma = 0.987 \text{ S/m}$; $\epsilon_r = 56.867$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY Configuration:

- Probe: ET3DV6 - SN1605; ConvF(6.42, 6.42, 6.42); Calibrated: 2016-07-29;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

WCDMA 5 Body Rear 4183ch back off 0mm/Area Scan (11x8x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
Maximum value of SAR (measured) = 0.344 W/kg

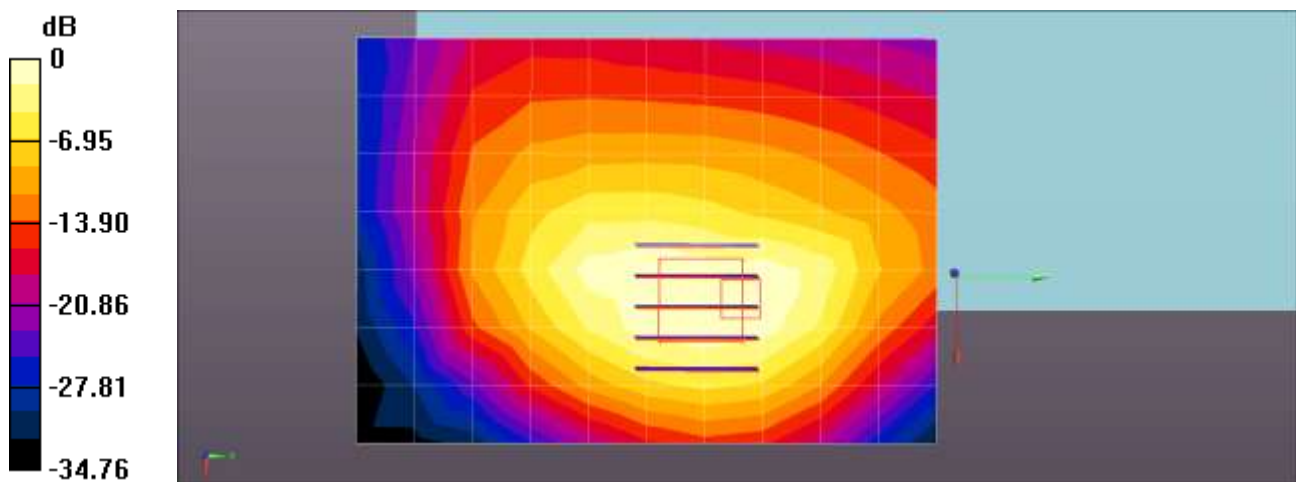
WCDMA 5 Body Rear 4183ch back off 0mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 2.635 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 1.04 W/kg

SAR(1 g) = 0.415 W/kg; SAR(10 g) = 0.220 W/kg

Maximum value of SAR (measured) = 0.434 W/kg



0 dB = 0.344 W/kg = -4.63 dBW/kg

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.2 °C
Ambient Temperature: 21.3 °C
Test Date: 05/22/2017
Plot No.: 2

DUT: SM-W728Y; Type: Tablet

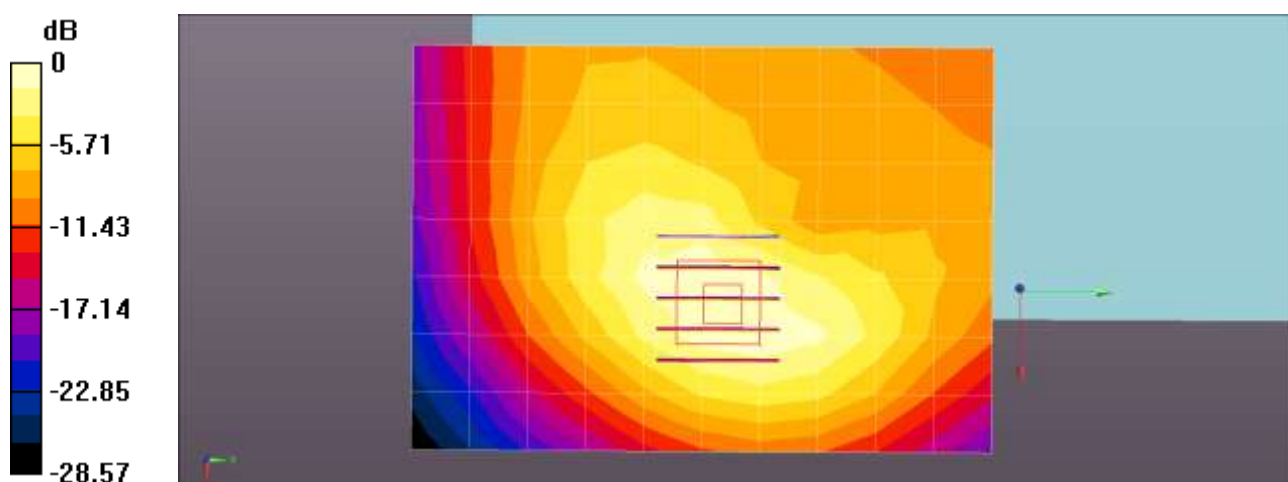
Communication System: UID 0, WCDMA850; Frequency: 836.6 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 836.6$ MHz; $\sigma = 0.987$ S/m; $\epsilon_r = 56.867$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: ET3DV6 - SN1605; ConvF(6.42, 6.42, 6.42); Calibrated: 2016-07-29;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

WCDMA 5 Body Rear 4183ch Max 14mm/Area Scan (11x8x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.439 W/kg

WCDMA 5 Body Rear 4183ch Max 14mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 5.881 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.642 W/kg
SAR(1 g) = 0.432 W/kg; SAR(10 g) = 0.277 W/kg
Maximum value of SAR (measured) = 0.469 W/kg



0 dB = 0.439 W/kg = -3.57 dBW/kg

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.2 °C
Ambient Temperature: 21.3 °C
Test Date: 05/23/2017
Plot No.: 3

DUT: SM-W728Y; Type: Tablet

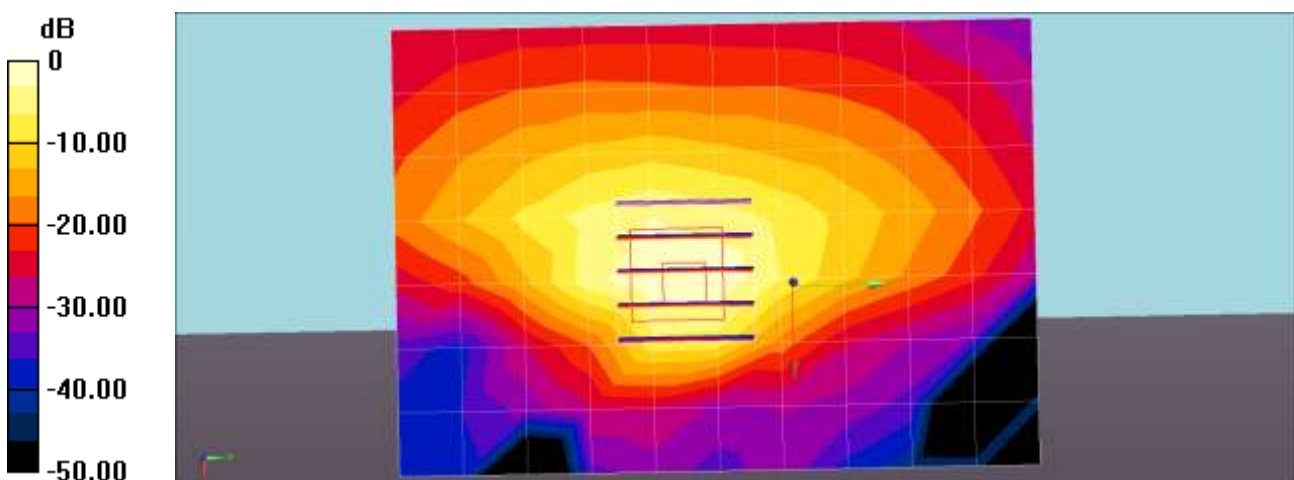
Communication System: UID 0, WCDMA1900; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1880$ MHz; $\sigma = 1.546$ S/m; $\epsilon_r = 53.139$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: ET3DV6 - SN1605; ConvF(4.55, 4.55, 4.55); Calibrated: 2016-07-29;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

WCDMA 2 Body Rear 9400ch back off 0mm/Area Scan (11x8x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.636 W/kg

WCDMA 2 Body Rear 9400ch back off 0mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.874 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 1.64 W/kg
SAR(1 g) = 0.764 W/kg; SAR(10 g) = 0.329 W/kg
Maximum value of SAR (measured) = 0.872 W/kg



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

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.2 °C
Ambient Temperature: 21.3 °C
Test Date: 05/22/2017
Plot No.: 4

DUT: SM-W728Y; Type: Tablet

Communication System: UID 0, LTE Band 5 (FCC); Frequency: 836.5 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 836.5$ MHz; $\sigma = 0.987$ S/m; $\epsilon_r = 56.867$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

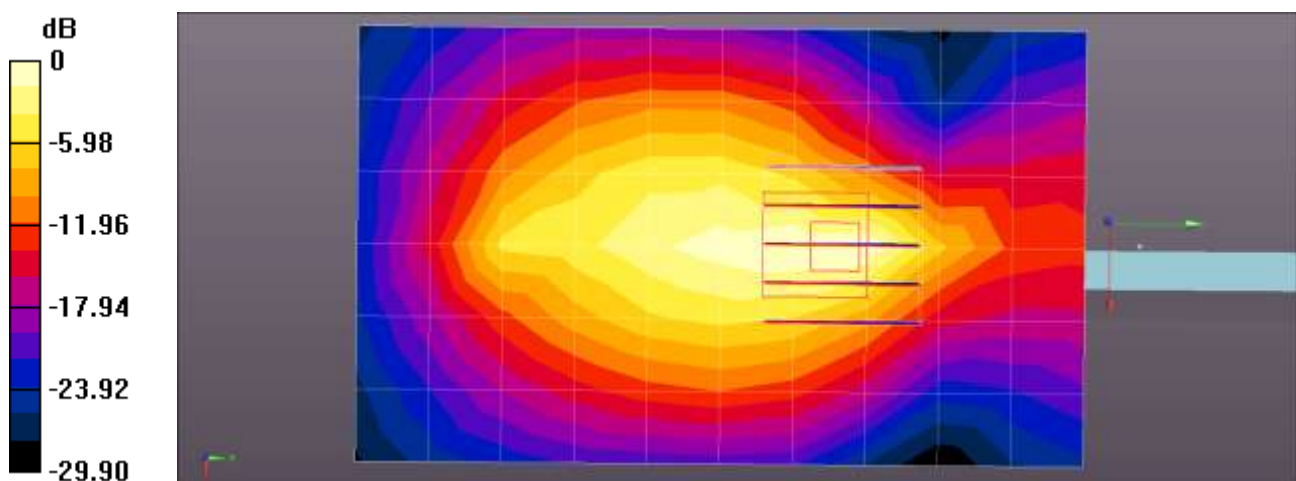
DASY Configuration:

- Probe: ET3DV6 - SN1605; ConvF(6.42, 6.42, 6.42); Calibrated: 2016-07-29;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

LTE5 Body Top QPSK 10MHz 1RB 0offset 20525ch back off touch/Area Scan (11x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.583 W/kg

LTE5 Body Top QPSK 10MHz 1RB 0offset 20525ch back off touch/Zoom Scan (5x5x7)/Cube 0:

Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.413 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 1.66 W/kg
SAR(1 g) = 0.508 W/kg; SAR(10 g) = 0.234 W/kg
Maximum value of SAR (measured) = 0.629 W/kg



0 dB = 0.583 W/kg = -2.34 dBW/kg

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.3 °C
Ambient Temperature: 21.5 °C
Test Date: 06/17/2017
Plot No.: 5

DUT: SM-W728Y; Type: Tablet

Communication System: UID 0, LTE Band 7; Frequency: 2560 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2560$ MHz; $\sigma = 2.134$ S/m; $\epsilon_r = 52.428$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.42, 7.42, 7.42); Calibrated: 2016-08-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

LTE Band 7 Body Top 20MHz 1RB 0offset 21350ch 0mm 2/Area Scan (13x7x1): Measurement grid:
dx=12mm, dy=12mm

Maximum value of SAR (measured) = 1.01 W/kg

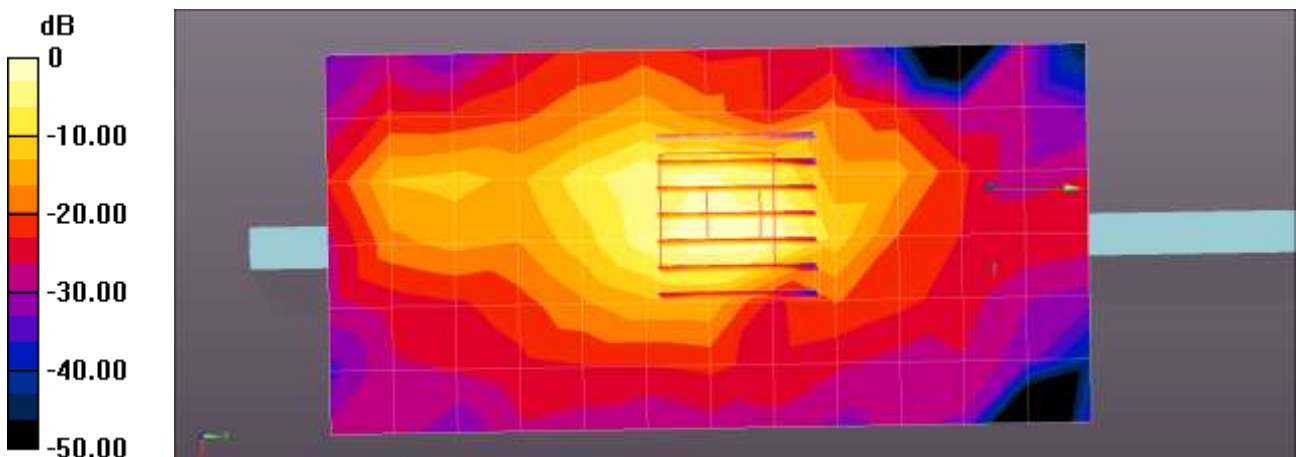
LTE Band 7 Body Top 20MHz 1RB 0offset 21350ch 0mm 2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.154 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 2.37 W/kg

SAR(1 g) = 0.943 W/kg; SAR(10 g) = 0.343 W/kg

Maximum value of SAR (measured) = 1.66 W/kg



0 dB = 1.01 W/kg = 0.04 dBW/kg

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.5 °C
Ambient Temperature: 21.8°C
Test Date: 06/16/2017
Plot No.: 6

DUT: SM-W728Y; Type: Tablet

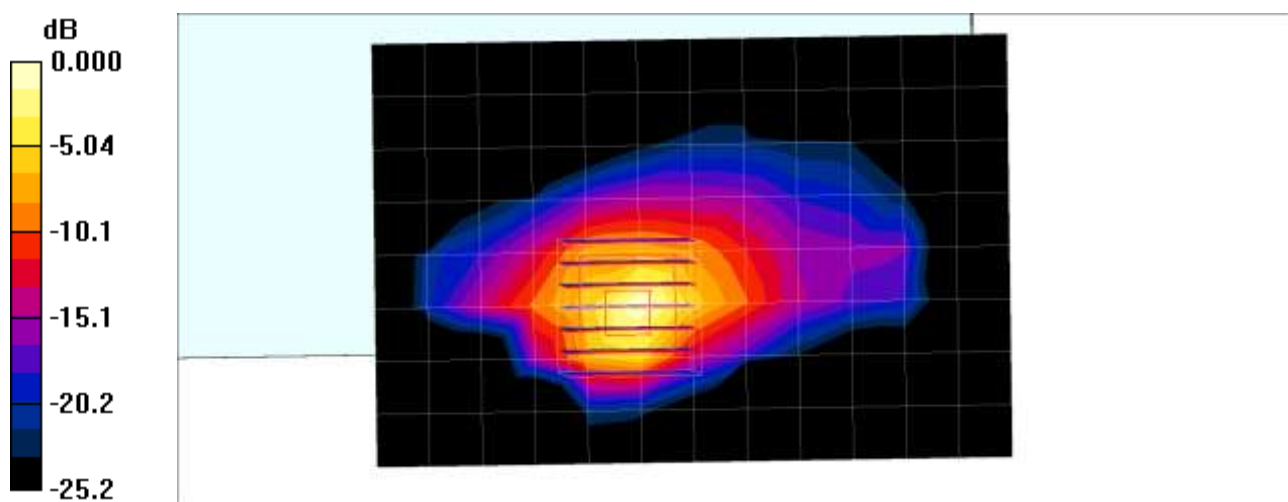
Communication System: 2450MHz FCC; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2412 \text{ MHz}$; $\sigma = 1.94 \text{ mho/m}$; $\epsilon_r = 53.6$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.62, 7.62, 7.62); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b Ant 0 Body Rear 1Mbps 1ch back off 0mm/Area Scan (13x9x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$
Maximum value of SAR (measured) = 0.545 mW/g

802.11b Ant 0 Body Rear 1Mbps 1ch back off 0mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 0.987 V/m; Power Drift = 0.008 dB
Peak SAR (extrapolated) = 0.844 W/kg
SAR(1 g) = 0.326 mW/g; SAR(10 g) = 0.123 mW/g
Maximum value of SAR (measured) = 0.563 mW/g



0 dB = 0.563mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.5 °C
Ambient Temperature: 21.8°C
Test Date: 06/16/2017
Plot No.: 7

DUT: SM-W728Y; Type: Tablet

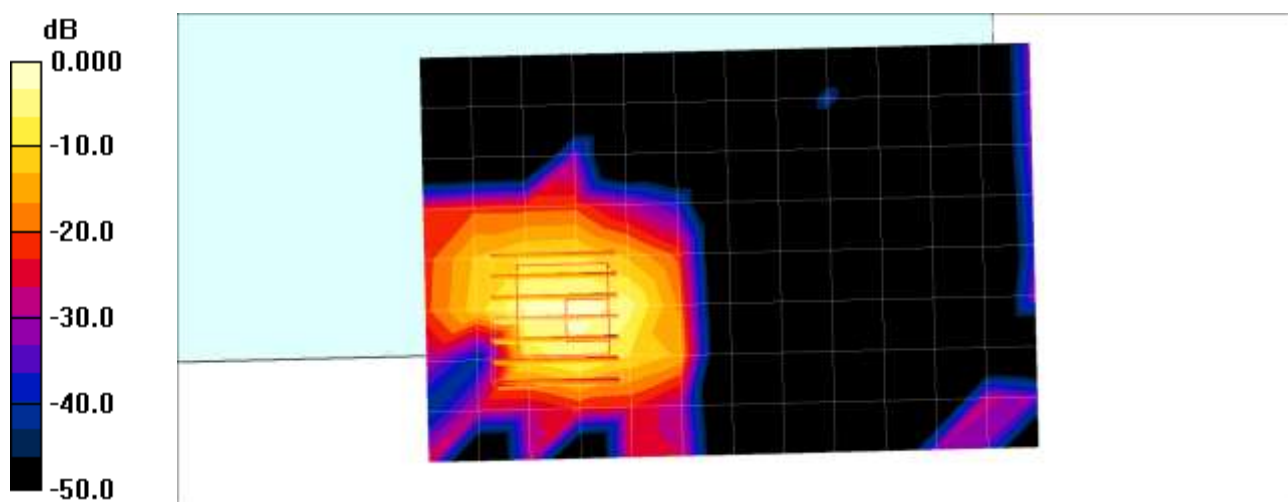
Communication System: 2450MHz FCC; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2412$ MHz; $\sigma = 1.94$ mho/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.62, 7.62, 7.62); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b Ant 1 Body Rear 1Mbps 1ch back off 0mm/Area Scan (13x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 0.351 mW/g

802.11b Ant 1 Body Rear 1Mbps 1ch back off 0mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0.980 V/m; Power Drift = -0.011 dB
Peak SAR (extrapolated) = 0.747 W/kg
SAR(1 g) = 0.248 mW/g; SAR(10 g) = 0.097 mW/g
Maximum value of SAR (measured) = 0.445 mW/g



0 dB = 0.445mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.5 °C
Ambient Temperature: 21.8°C
Test Date: 06/16/2017
Plot No.: 8

DUT: SM-W728Y; Type: Tablet

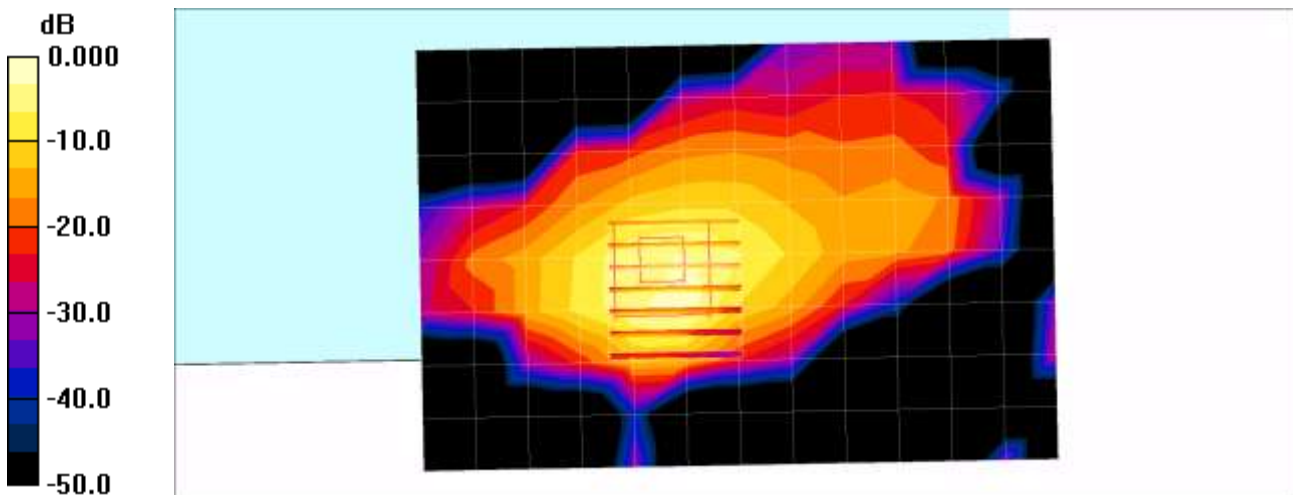
Communication System: Bluetooth; Frequency: 2441 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2441 \text{ MHz}$; $\sigma = 1.97 \text{ mho/m}$; $\epsilon_r = 53.5$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.62, 7.62, 7.62); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

BT Body Rear DH5 39ch/Area Scan (13x9x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$
Maximum value of SAR (measured) = 0.343 mW/g

BT Body Rear DH5 39ch/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 0.880 V/m; Power Drift = 0.004 dB
Peak SAR (extrapolated) = 0.789 W/kg
SAR(1 g) = 0.302 mW/g; SAR(10 g) = 0.105 mW/g
Maximum value of SAR (measured) = 0.486 mW/g



0 dB = 0.486mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 20.4 °C
Ambient Temperature: 20.6 °C
Test Date: 05/26/2017
Plot No.: 9

DUT: SM-W728Y; Type: Tablet

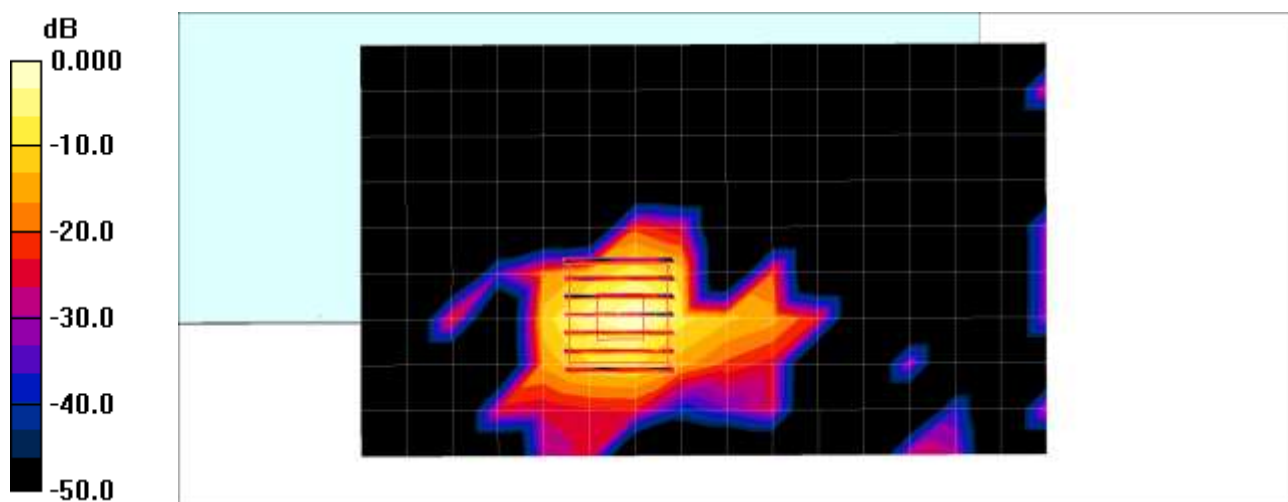
Communication System: WIFI 5GHz; Frequency: 5290 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 5290$ MHz; $\sigma = 5.33$ mho/m; $\epsilon_r = 48.6$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(4.66, 4.66, 4.66); Calibrated: 2016-08-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Ant 0 Body Rear 802.11ac 80MHz MCS0 58ch back off 0mm/Area Scan (16x10x1): Measurement grid:
dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.490 mW/g

Ant 0 Body Rear 802.11ac 80MHz MCS0 58ch back off 0mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 0.000 V/m; Power Drift = 0.010 dB
Peak SAR (extrapolated) = 1.19 W/kg
SAR(1 g) = 0.184 mW/g; SAR(10 g) = 0.042 mW/g
Maximum value of SAR (measured) = 0.581 mW/g



0 dB = 0.581mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 20.4 °C
Ambient Temperature: 20.6 °C
Test Date: 05/26/2017
Plot No.: 10

DUT: SM-W728Y; Type: Tablet

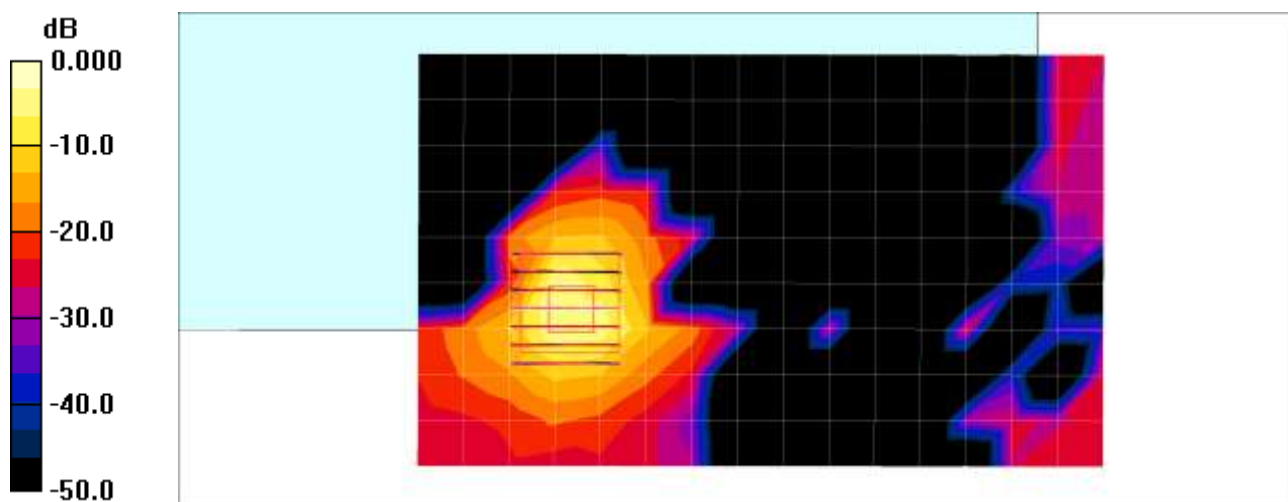
Communication System: WIFI 5GHz; Frequency: 5530 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 5530$ MHz; $\sigma = 5.74$ mho/m; $\epsilon_r = 47.9$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(3.92, 3.92, 3.92); Calibrated: 2016-08-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Ant 1 Body Rear 802.11ac 80MHz MCS0 106ch back off 0mm 2/Area Scan (16x10x1): Measurement grid:
dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.607 mW/g

Ant 1 Body Rear 802.11ac 80MHz MCS0 106ch back off 0mm 2/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio:1.4
Reference Value = 0.641 V/m; Power Drift = -0.027 dB
Peak SAR (extrapolated) = 2.22 W/kg
SAR(1 g) = 0.443 mW/g; SAR(10 g) = 0.088 mW/g
Maximum value of SAR (measured) = 1.34 mW/g



0 dB = 1.34mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Tablet
Liquid Temperature: 21.3 °C
Ambient Temperature: 21.5 °C
Test Date: 06/17/2017
Plot No.: 11

DUT: SM-W728Y; Type: Tablet

Communication System: UID 0, LTE Band 7; Frequency: 2560 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2560$ MHz; $\sigma = 2.134$ S/m; $\epsilon_r = 52.428$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.42, 7.42, 7.42); Calibrated: 2016-08-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

LTE Band 7 Body Top 20MHz 1RB 0offset 21350ch 0mm/Area Scan (13x7x1): Measurement grid:

$dx=12$ mm, $dy=12$ mm

Maximum value of SAR (measured) = 1.00 W/kg

LTE Band 7 Body Top 20MHz 1RB 0offset 21350ch 0mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

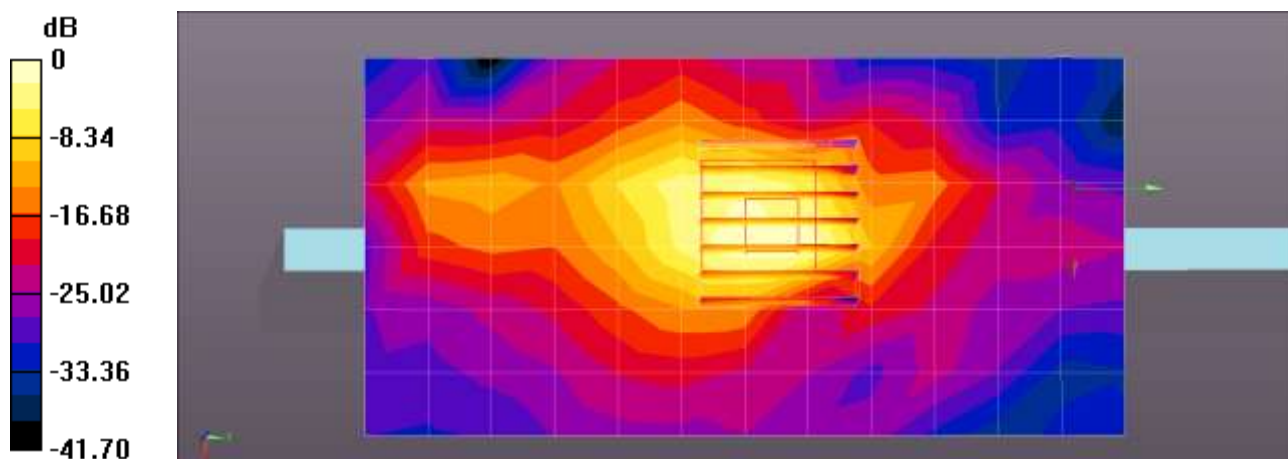
$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 1.326 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 2.36 W/kg

SAR(1 g) = 0.937 W/kg; SAR(10 g) = 0.341 W/kg

Maximum value of SAR (measured) = 1.65 W/kg



0 dB = 1.00 W/kg = 0.00 dBW/kg

Attachment 2. – Dipole Verification Plots

■ Verification Data (835 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.2 °C
Test Date: 05/22/2017

DUT: Dipole 835 MHz D835V2; Type: D835V2

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.986 \text{ S/m}$; $\epsilon_r = 56.9$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1605; ConvF(6.42, 6.42, 6.42); Calibrated: 2016-07-29
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

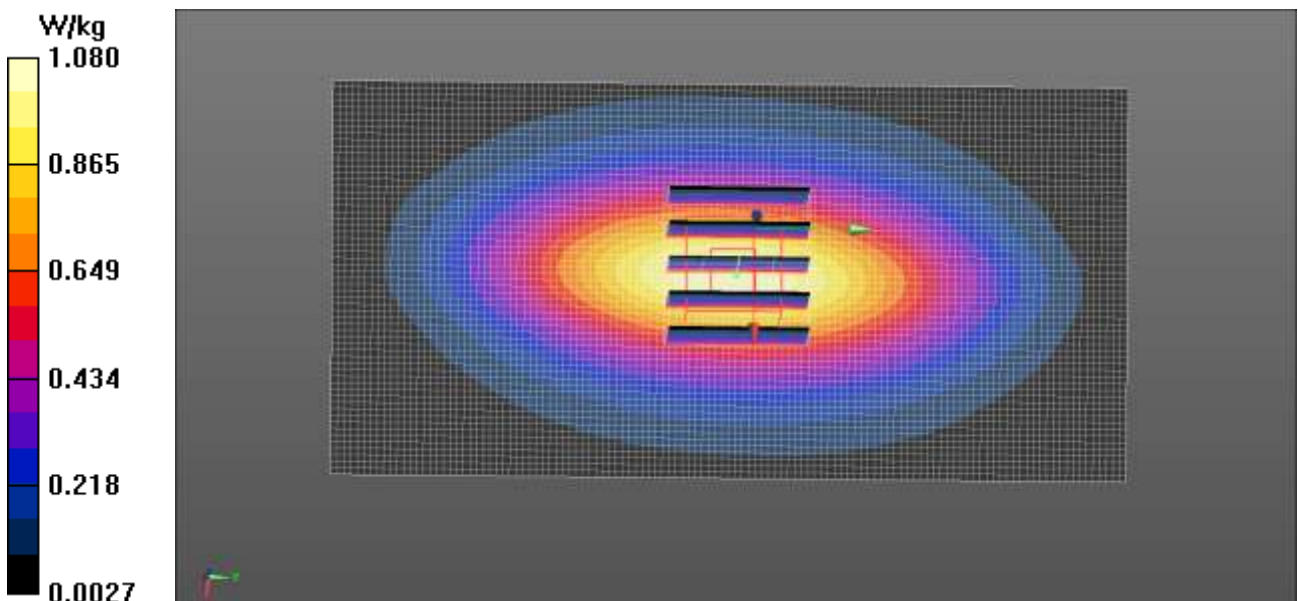
835MHz Verification/Area Scan (61x121x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
Maximum value of SAR (interpolated) = 1.08 W/kg

835MHz Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
Reference Value = 34.63 V/m; Power Drift = -0.22 dB

Peak SAR (extrapolated) = 1.44 W/kg

SAR(1 g) = 0.979 W/kg; SAR(10 g) = 0.642 W/kg

Maximum value of SAR (measured) = 1.06 W/kg



■ Verification Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 21.2 °C
Test Date: 05/23/2017

DUT: Dipole 1900 MHz; Type: D1900V2

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.57$ mho/m; $\epsilon_r = 53.1$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1605; ConvF(4.55, 4.55, 4.55); Calibrated: 2016-07-29
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Verification 1900MHz/Area Scan (7x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 4.38 mW/g

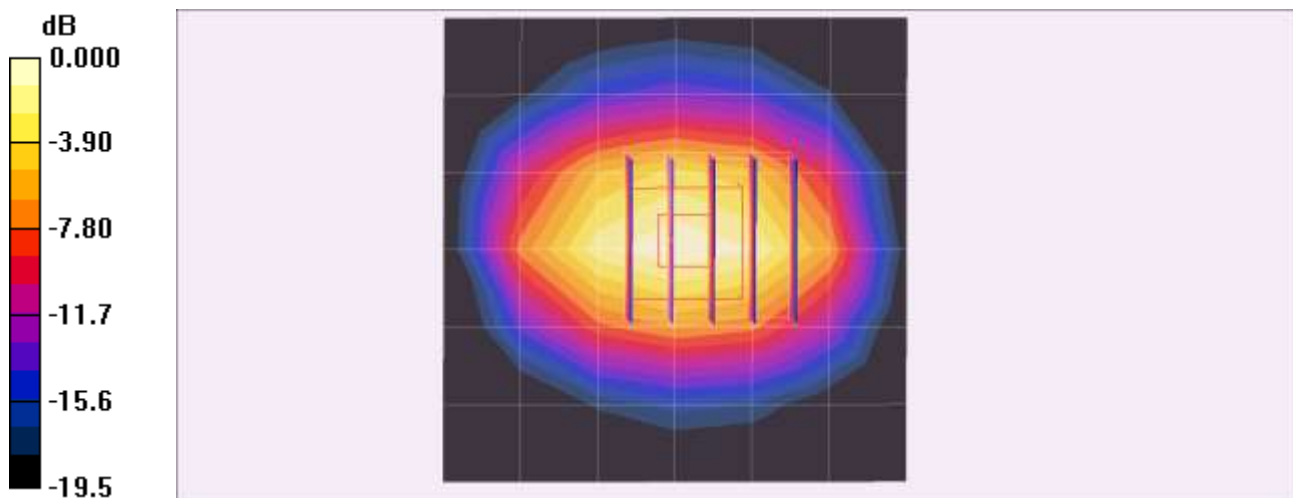
Verification 1900MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 57.9 V/m; Power Drift = -0.050 dB

Peak SAR (extrapolated) = 6.25 W/kg

SAR(1 g) = 3.9 mW/g; SAR(10 g) = 2.07 mW/g

Maximum value of SAR (measured) = 4.37 mW/g



0 dB = 4.37mW/g

Verification Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.5 °C
Test Date: 06/16/2017

DUT: Dipole 2450 MHz; Type: D2450V2

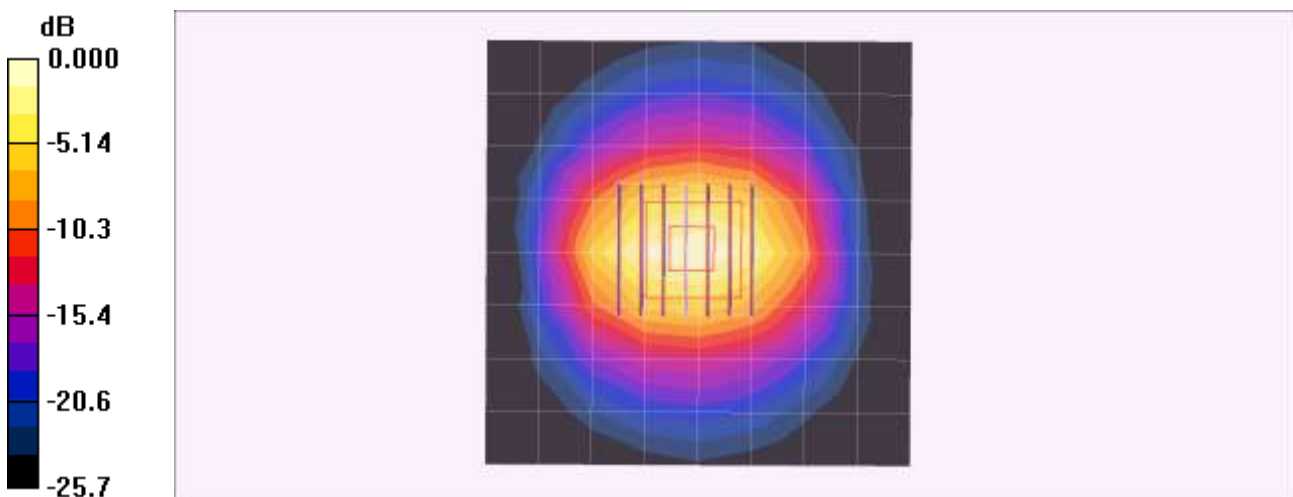
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.99$ mho/m; $\epsilon_r = 53.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.62, 7.62, 7.62); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Verification 2450MHz/Area Scan (9x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 8.15 mW/g

Verification 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.2 V/m; Power Drift = 0.008 dB
Peak SAR (extrapolated) = 11.8 W/kg
SAR(1 g) = 5.18 mW/g; SAR(10 g) = 2.28 mW/g
Maximum value of SAR (measured) = 8.20 mW/g



0 dB = 8.20mW/g

Verification Data (2 600 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.3 °C
Test Date: 06/17/2017

DUT: Dipole 2600MHz; Type: D2600V2

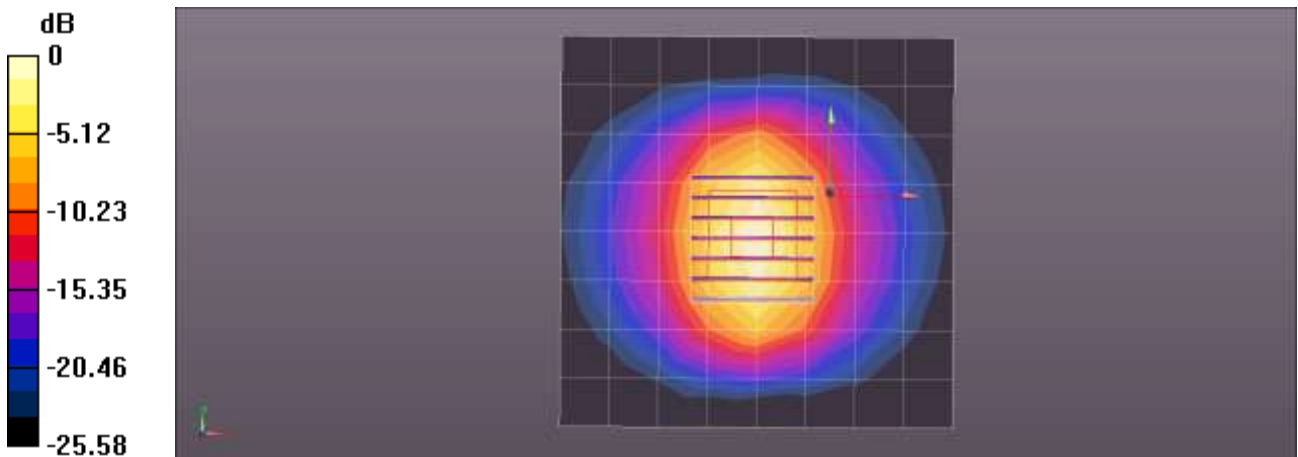
Communication System: CW; Frequency: 2600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2600$ MHz; $\sigma = 2.188$ S/m; $\epsilon_r = 52.31$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7370; ConvF(7.42, 7.42, 7.42); Calibrated: 2016-08-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, Version 4.7 (80);

Verification 2600MHz/Area Scan (9x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 8.60 W/kg

Verification 2600MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.04 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 12.4 W/kg
SAR(1 g) = 5.44 W/kg; SAR(10 g) = 2.39 W/kg
Maximum value of SAR (measured) = 8.72 W/kg



$$0 \text{ dB} = 8.72 \text{ W/kg} = 9.41 \text{ dBW/kg}$$

■ Verification Data (5.25 GHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 20.4 °C
Test Date: 05/26/2017

DUT: Dipole 5GHz; Type: D5000V2

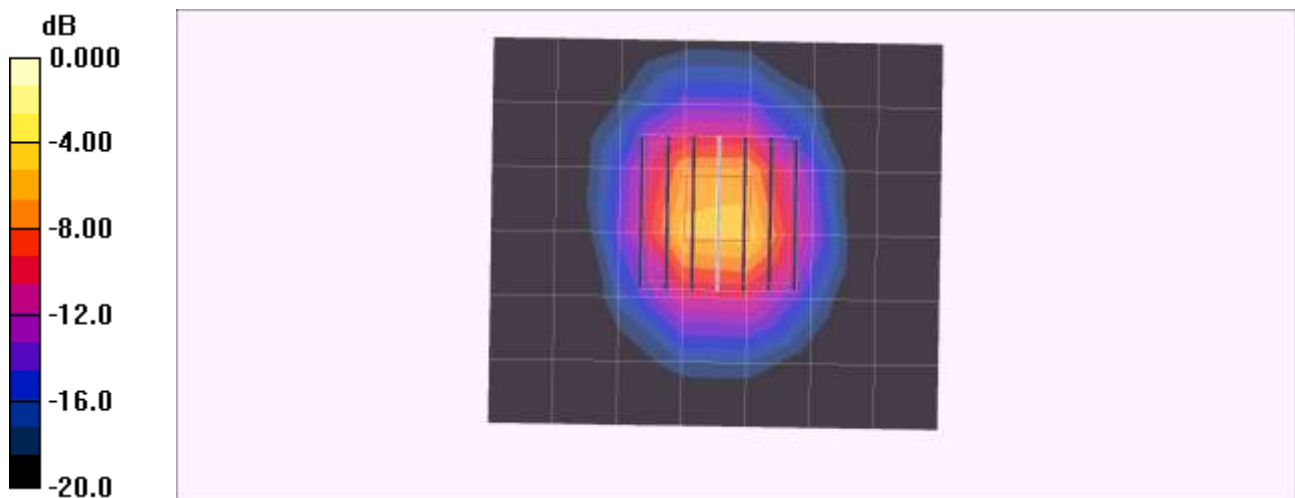
Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5250$ MHz; $\sigma = 5.27$ mho/m; $\epsilon_r = 48.7$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(4.66, 4.66, 4.66); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Verification 5250MHz/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 6.13 mW/g

Verification 5250MHz/Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 39.3 V/m; Power Drift = 0.013 dB
Peak SAR (extrapolated) = 32.5 W/kg
SAR(1 g) = 7.51 mW/g; SAR(10 g) = 2.08 mW/g
Maximum value of SAR (measured) = 16.2 mW/g



0 dB = 16.2mW/g

■ Verification Data (5.6 GHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 20.4 °C
Test Date: 05/26/2017

DUT: Dipole 5GHz; Type: D5000V2

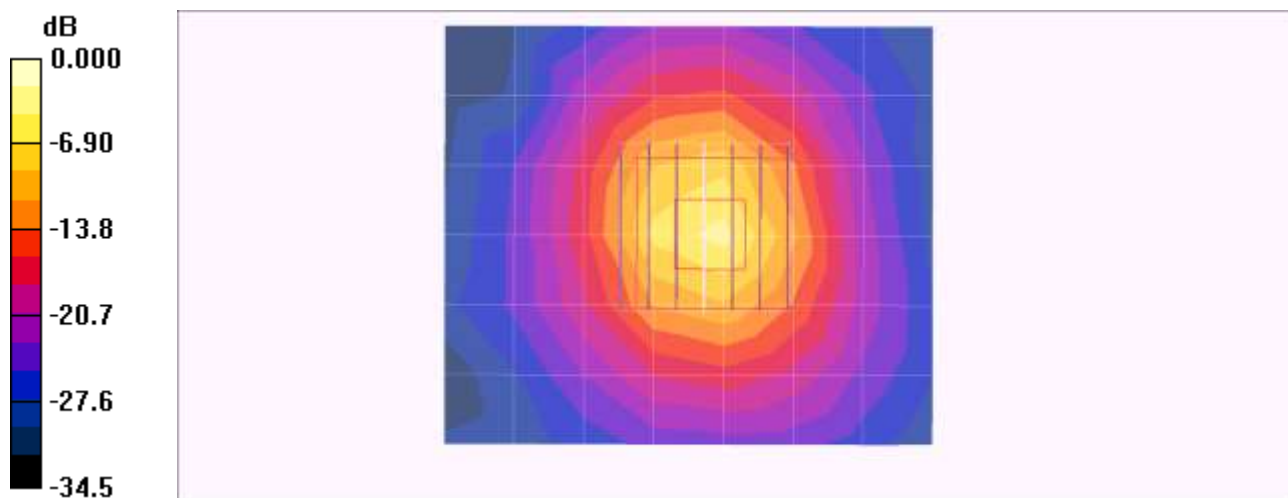
Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.84$ mho/m; $\epsilon_r = 47.7$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN7370; ConvF(3.92, 3.92, 3.92); Calibrated: 2016-08-30
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: Flat Phantom ELI4.0
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

Verification 5600MHz/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 7.56 mW/g

Verification 5600MHz/Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 37.6 V/m; Power Drift = 0.042 dB
Peak SAR (extrapolated) = 33.7 W/kg
SAR(1 g) = 8.03 mW/g; SAR(10 g) = 2.2 mW/g
Maximum value of SAR (measured) = 17.2 mW/g



■ Verification Data (5.75 GHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 20.3 °C
Test Date: 06/09/2017

DUT: Dipole D5GHzV2; Type: D5GHzV2

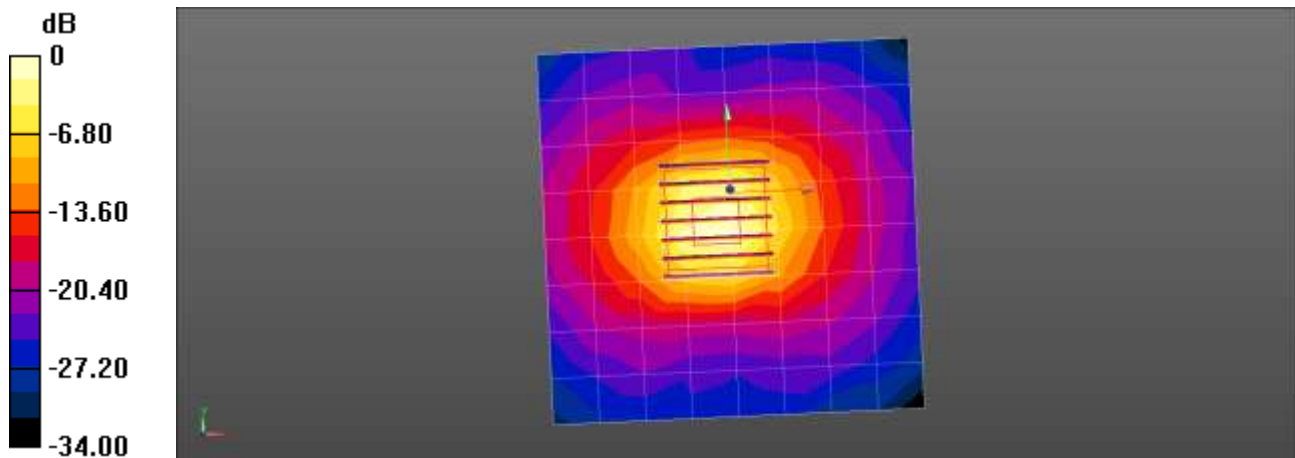
Communication System: UID 0, CW; Frequency: 5750 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 5750 \text{ MHz}$; $\sigma = 6.112 \text{ S/m}$; $\epsilon_r = 47.094$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7370; ConvF(4.25, 4.25, 4.25); Calibrated: 2016-08-30;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2017-01-19
- Phantom: ELI v5.0
- Measurement SW: DASY52, Version 52.8 (1);

5.75GHz Head Verification/Area Scan (9x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$
Maximum value of SAR (measured) = 14.6 W/kg

5.75GHz Head Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$;
Graded Ratio: 1.4
Reference Value = 56.30 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 27.6 W/kg
SAR(1 g) = 7.16 W/kg; SAR(10 g) = 2.06 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 17.4 W/kg



0 dB = 14.6 W/kg = 11.64 dBW/kg

Attachment 3. – Probe Calibration Data

**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 **HCT (Dymstec)**

Certificate No: **ET3-1605_Jul16**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1605**

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

Calibration date: **July 29, 2016**

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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 55277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013, Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660, Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: G841293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: MY41458087	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
RF generator HP 8648C	SN: US364ZU01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-16
Network Analyzer HP 8753E	SN: US37360585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: July 29, 2016			

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

Certificate No: ET3-1605_Jul16

Page 1 of 11

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



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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

ET3DV6 – SN:1605

July 29, 2016

Probe ET3DV6

SN:1605

Manufactured: July 27, 2001
Calibrated: July 29, 2016

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

ET3DV6- SN:1605

July 29, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1605

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.46	1.83	1.55	± 10.1 %
DCP (mV) ^B	100.9	99.5	99.3	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	218.2	±3.8 %
		Y	0.0	0.0	1.0		232.5	
		Z	0.0	0.0	1.0		210.7	

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ET3DV6- SN:1605

July 29, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1605

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 ^o	Depth ^g (mm)	Unc (k=2)
750	41.9	0.89	6.96	6.96	6.96	0.32	2.81	± 12.0 %
835	41.5	0.90	6.60	6.60	6.60	0.35	2.80	± 12.0 %
900	41.5	0.97	6.50	6.50	6.50	0.31	2.84	± 12.0 %
1450	40.5	1.20	5.64	5.64	5.64	0.48	2.60	± 12.0 %
1750	40.1	1.37	5.37	5.37	5.37	0.72	2.15	± 12.0 %
1900	40.0	1.40	5.18	5.18	5.18	0.80	2.08	± 12.0 %
1950	40.0	1.40	5.03	5.03	5.03	0.80	2.10	± 12.0 %
2300	39.5	1.67	4.79	4.79	4.79	0.80	2.05	± 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. 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.

ET3DV6- SN:1605

July 29, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1605

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unc (k=2)
750	55.5	0.96	6.55	6.55	6.55	0.39	2.28	± 12.0 %
835	55.2	0.97	6.42	6.42	6.42	0.42	2.23	± 12.0 %
1750	53.4	1.49	4.79	4.79	4.79	0.80	2.39	± 12.0 %
1900	53.3	1.52	4.55	4.55	4.55	0.80	2.46	± 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

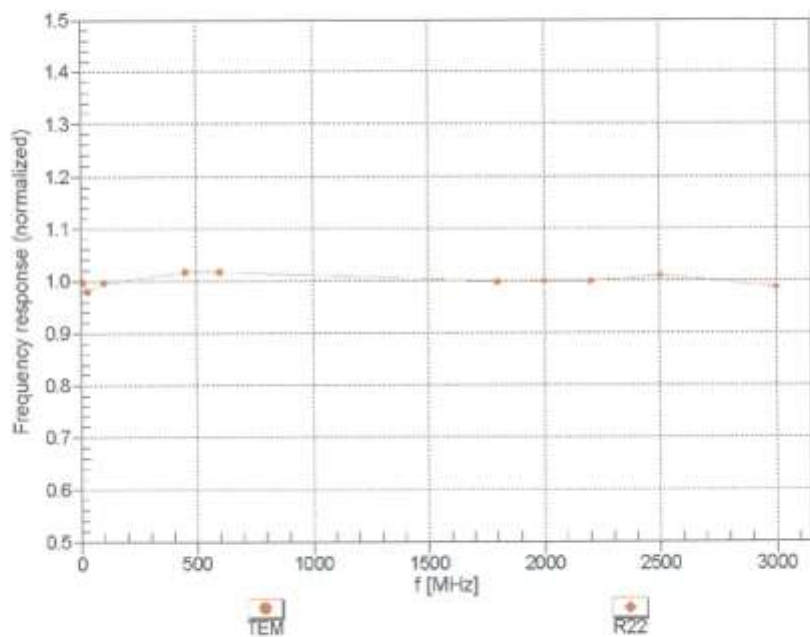
^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty 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.

ET3DV6-SN:1605

July 29, 2016

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

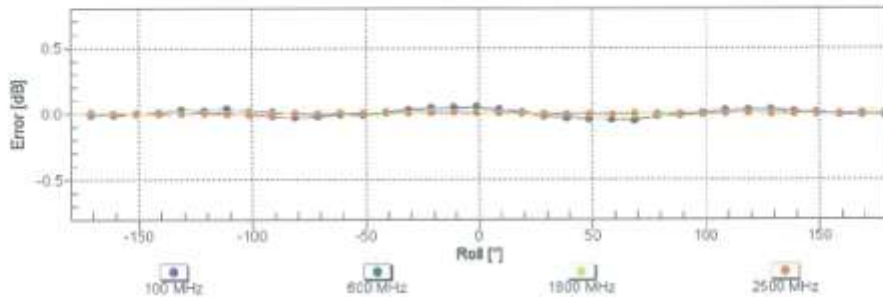
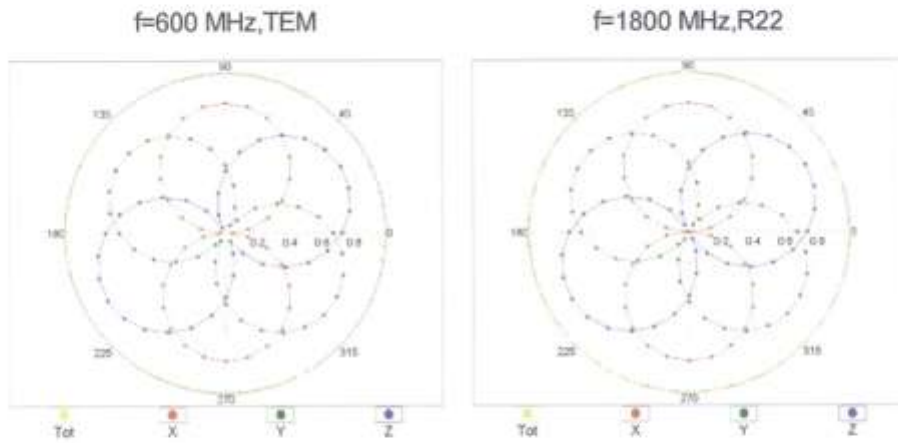


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

ET3DV6-- SN:1605

July 29, 2016

Receiving Pattern (ϕ), $\theta = 0^\circ$

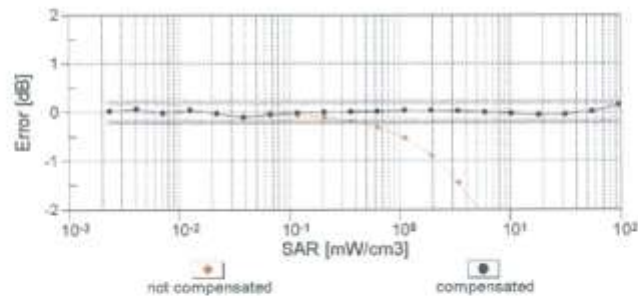
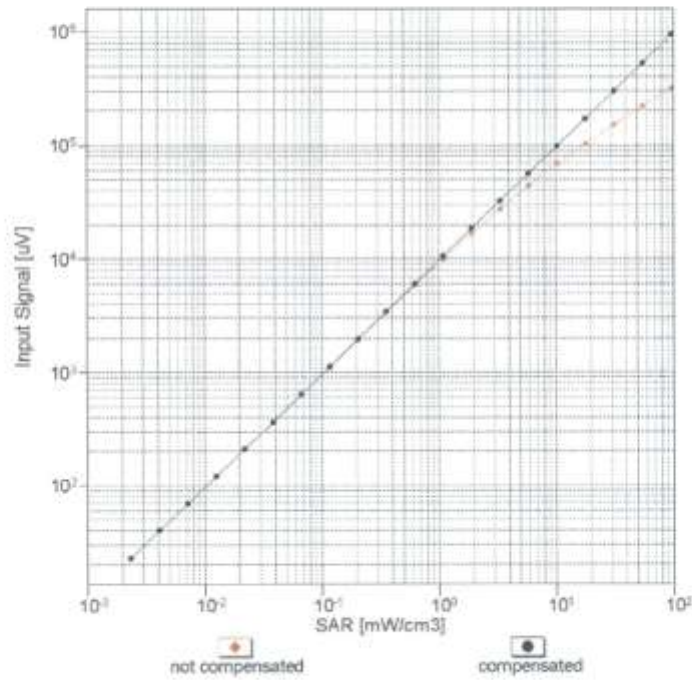


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

ET3DV6--SN:1605

July 29, 2016

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

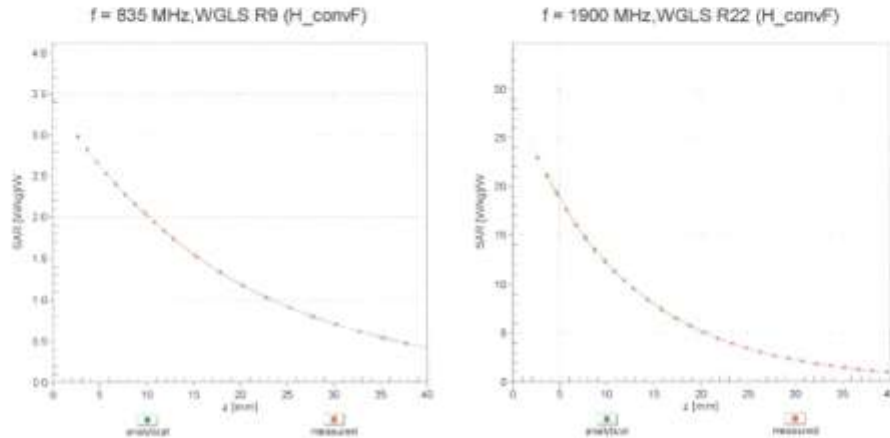


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

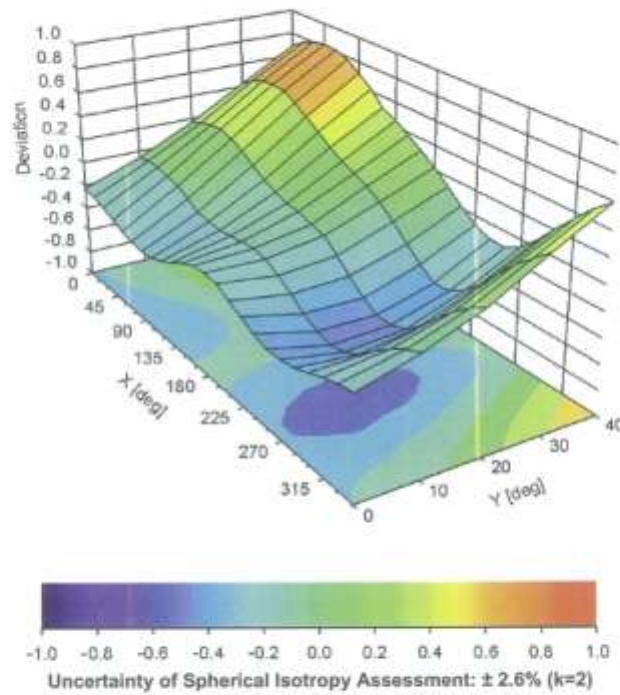
ET3DV6- SN:1605

July 29, 2016

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), f = 900 MHz



ET3DV6-- SN:1605

July 29, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1605

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	58.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

**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 **HCT (Dymstec)**

Certificate No: **EX3-7370_Aug16**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7370**

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

Calibration date: **August 30, 2016**

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 dosed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 55277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: MY41498067	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Jonas Kastrali	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: September 1, 2016			

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

Certificate No: EX3-7370_Aug16

Page 1 of 11

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



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

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:7370

August 30, 2016

Probe EX3DV4

SN:7370

Manufactured: March 17, 2015
Calibrated: August 30, 2016

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

EX3DV4- SN:7370

August 30, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7370

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$) ^A	0.46	0.49	0.42	± 10.1 %
DCP (mV) ^B	88.7	108.3	93.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	139.8	±3.3 %
		Y	0.0	0.0	1.0		136.4	
		Z	0.0	0.0	1.0		142.6	

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4-SN:7370

August 30, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7370

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 ^D (mm)	Unc (k=2)
150	52.3	0.76	13.30	13.30	13.30	0.00	1.00	± 13.3 %
300	45.3	0.87	12.29	12.29	12.29	0.10	1.30	± 13.3 %
450	43.5	0.87	11.07	11.07	11.07	0.17	1.60	± 13.3 %
750	41.9	0.89	10.41	10.41	10.41	0.42	0.91	± 12.0 %
835	41.5	0.90	10.00	10.00	10.00	0.43	0.80	± 12.0 %
900	41.5	0.97	9.75	9.75	9.75	0.39	0.93	± 12.0 %
1450	40.5	1.20	8.60	8.60	8.60	0.41	0.80	± 12.0 %
1750	40.1	1.37	8.52	8.52	8.52	0.40	0.80	± 12.0 %
1900	40.0	1.40	8.16	8.16	8.16	0.37	0.80	± 12.0 %
1950	40.0	1.40	7.94	7.94	7.94	0.39	0.80	± 12.0 %
2300	39.5	1.67	7.92	7.92	7.92	0.31	0.80	± 12.0 %
2450	39.2	1.80	7.28	7.28	7.28	0.41	0.80	± 12.0 %
2600	39.0	1.96	7.15	7.15	7.15	0.41	0.80	± 12.0 %
5250	35.9	4.71	5.26	5.26	5.26	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.60	4.60	4.60	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.85	4.85	4.85	0.45	1.80	± 13.1 %

^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^D Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4-SN:7370

August 30, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7370

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
150	61.9	0.80	12.43	12.43	12.43	0.00	1.00	± 13.3 %
300	58.2	0.92	11.62	11.62	11.62	0.08	1.20	± 13.3 %
450	56.7	0.94	11.22	11.22	11.22	0.10	1.50	± 13.3 %
750	55.5	0.96	9.96	9.96	9.96	0.49	0.86	± 12.0 %
835	55.2	0.97	9.87	9.87	9.87	0.38	0.94	± 12.0 %
1750	53.4	1.49	8.24	8.24	8.24	0.37	0.80	± 12.0 %
1900	53.3	1.52	7.92	7.92	7.92	0.42	0.80	± 12.0 %
2450	52.7	1.95	7.62	7.62	7.62	0.35	0.80	± 12.0 %
2600	52.5	2.16	7.42	7.42	7.42	0.43	0.80	± 12.0 %
5250	48.9	5.36	4.66	4.66	4.66	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.92	3.92	3.92	0.55	1.90	± 13.1 %
5750	48.3	5.94	4.25	4.25	4.25	0.55	1.90	± 13.1 %

^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

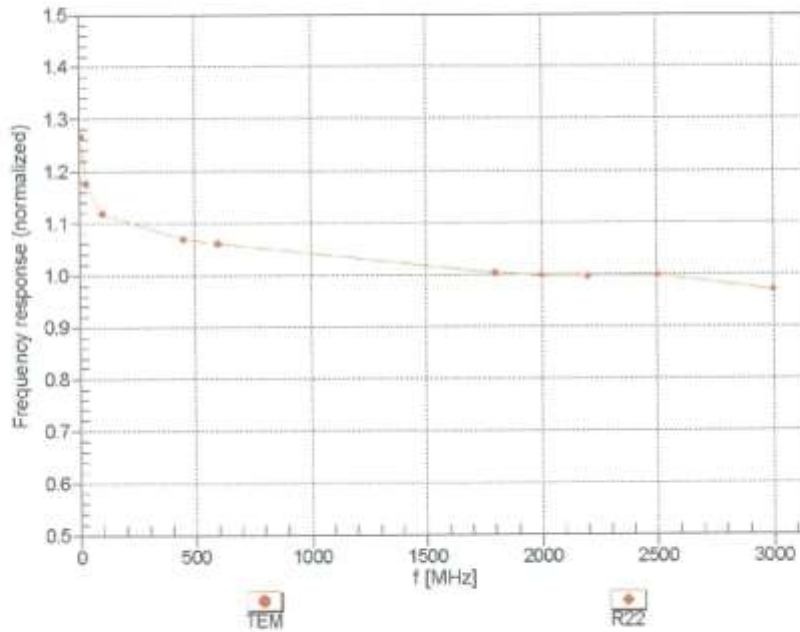
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4-SN:7370

August 30, 2016

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

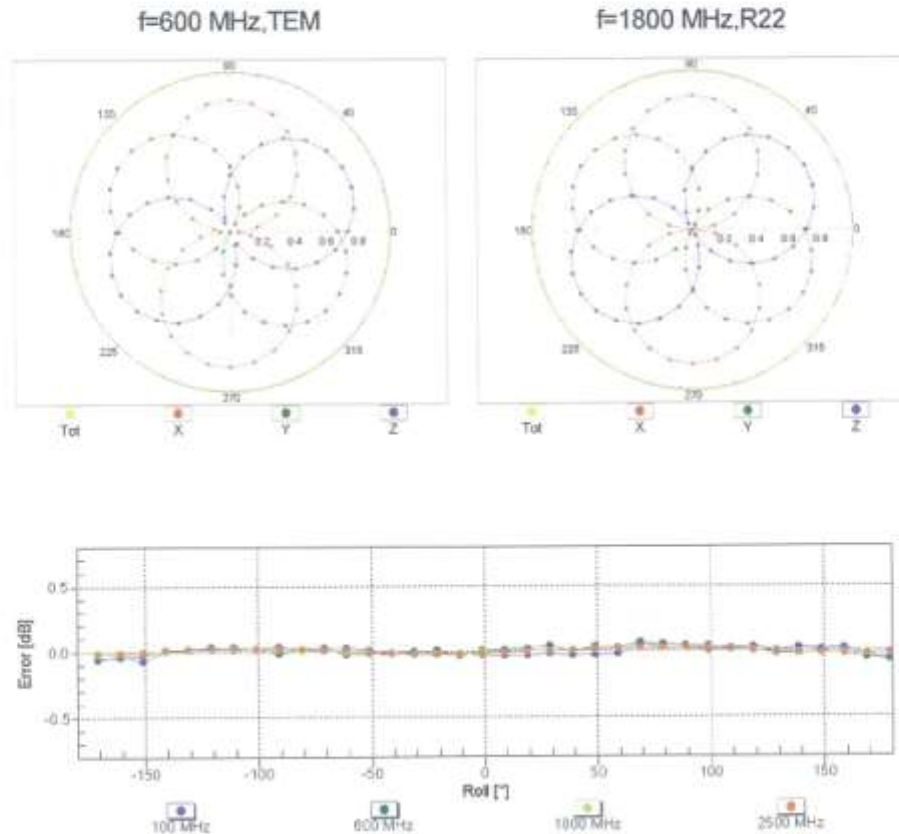


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4-SN:7370

August 30, 2016

Receiving Pattern (ϕ), $\theta = 0^\circ$

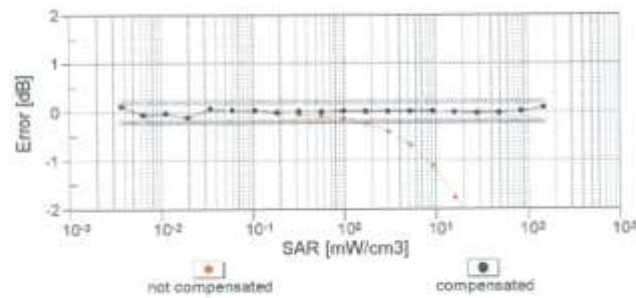
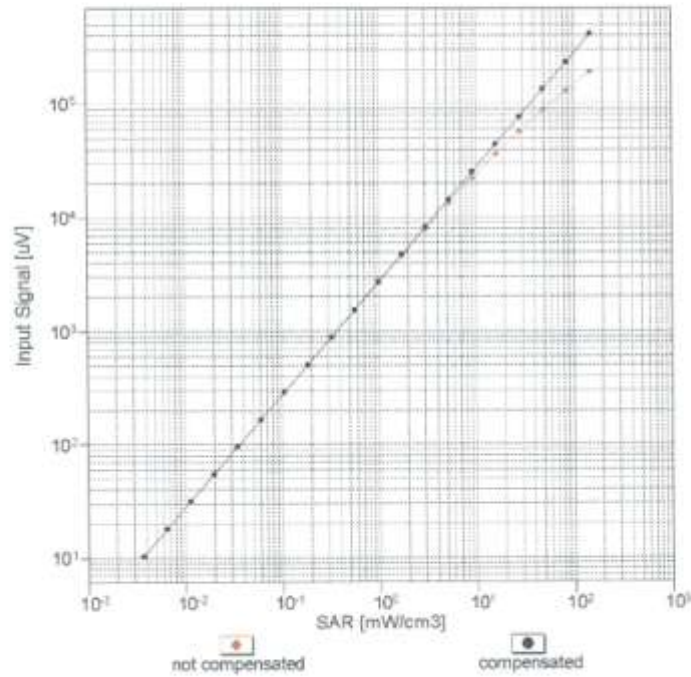


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:7370

August 30, 2016

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

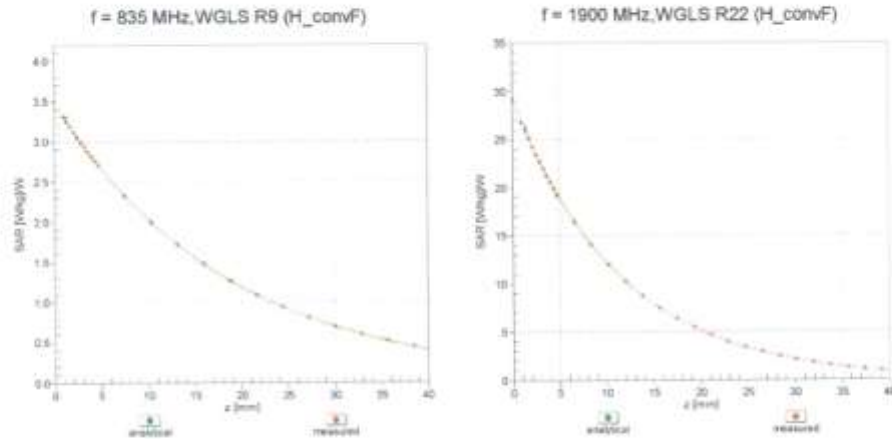


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

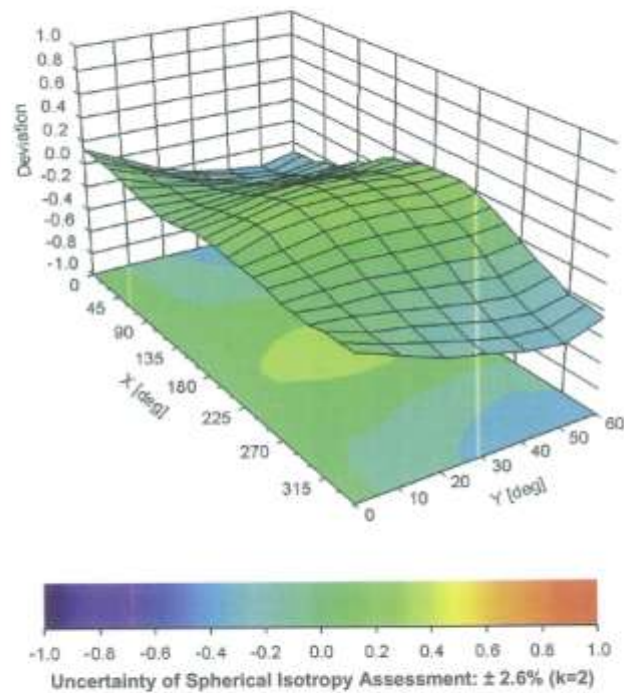
EX3DV4- SN.7370

August 30, 2016

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), $f = 900 \text{ MHz}$



EX3DV4- SN:7370

August 30, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7370**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	98.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Attachment 4. – Dipole Calibration Data

**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 **HCT (Dymstec)**

Certificate No: **D835V2-441_Nov16**

CALIBRATION CERTIFICATE

Object **D835V2 - SN:441**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **November 16, 2016**

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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&E critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292793	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: November 17, 2016

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

Certificate No: D835V2-441_Nov16

Page 1 of 8

**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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.9 $\pm$ 6 %	0.94 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.38 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.11 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	55.2 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.62 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.63 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.37 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 1.8 j Ω
Return Loss	- 34.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.0 Ω - 4.6 j Ω
Return Loss	- 24.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.369 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 09, 2001

DASY5 Validation Report for Head TSL

Date: 16.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:441

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 61.83 V/m; Power Drift = -0.02 dB

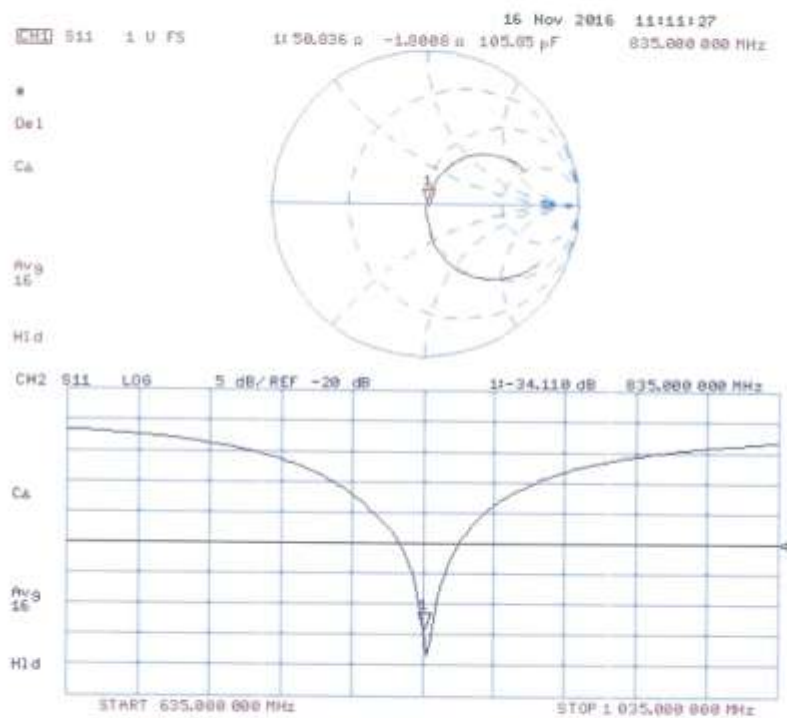
Peak SAR (extrapolated) = 3.67 W/kg

SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.57 W/kg

Maximum value of SAR (measured) = 3.27 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.11.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:441

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 1.01 \text{ S/m}$; $\epsilon_r = 55.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

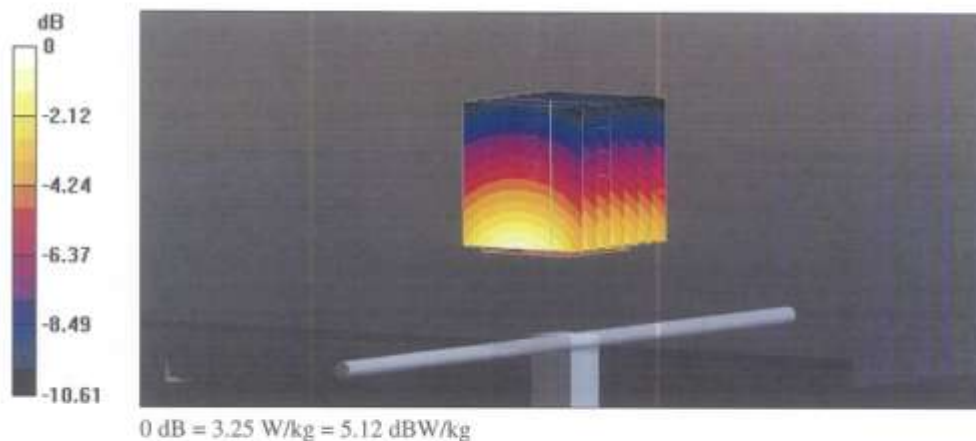
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 59.90 V/m; Power Drift = 0.01 dB

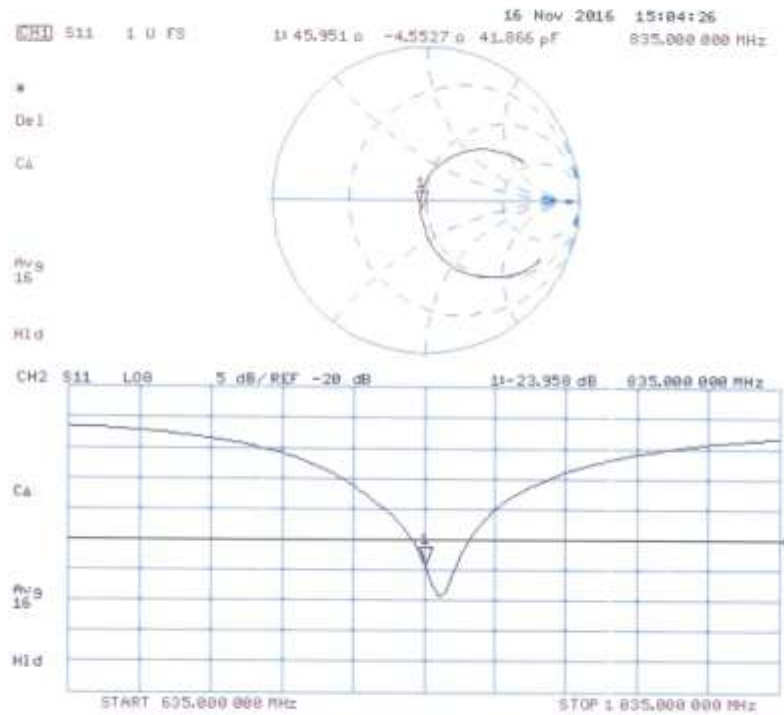
Peak SAR (extrapolated) = 3.61 W/kg

SAR(1 g) = 2.48 W/kg; SAR(10 g) = 1.63 W/kg

Maximum value of SAR (measured) = 3.25 W/kg



Impedance Measurement Plot for Body TSL



**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 **HCT (Dymstec)**

Certificate No: **D1900V2-5d032_Mar17**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN:5d032**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **March 21, 2017**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Johannes Kurikka	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 23, 2017

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

Certificate No: D1900V2-5d032_Mar17

Page 1 of 8

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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.3 $\pm$ 6 %	1.38 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.0 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.9 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.1 $\pm$ 6 %	1.50 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	-----	-----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.30 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.4 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$51.7 \Omega + 5.3 j\Omega$
Return Loss	- 25.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$47.1 \Omega + 6.2 j\Omega$
Return Loss	- 23.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.194 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 17, 2003

DASY5 Validation Report for Head TSL

Date: 21.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d032

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 40.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x8x7)/Cube 0:

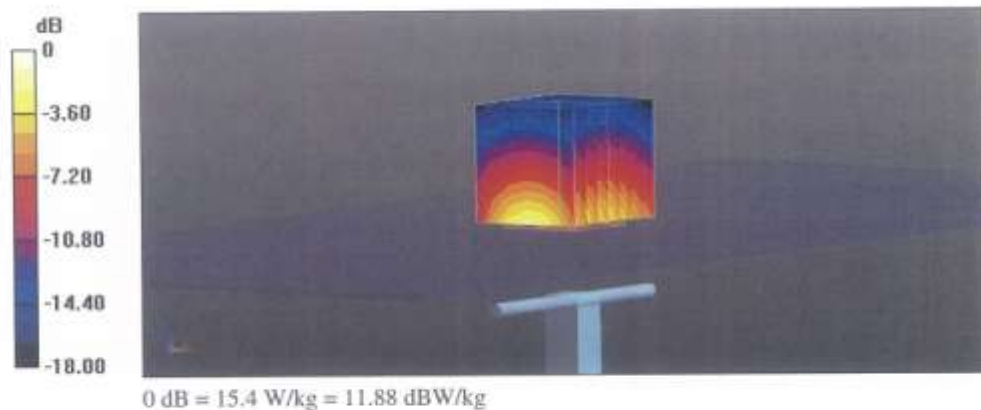
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.2 V/m; Power Drift = -0.07 dB

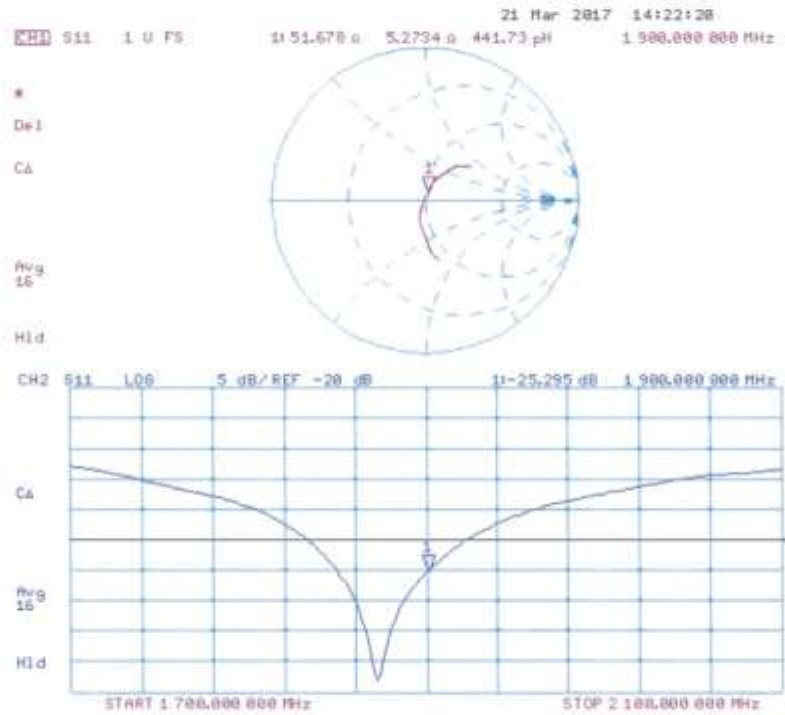
Peak SAR (extrapolated) = 18.6 W/kg

SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.18 W/kg

Maximum value of SAR (measured) = 15.4 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d032

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.5$ S/m; $\epsilon_r = 54.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

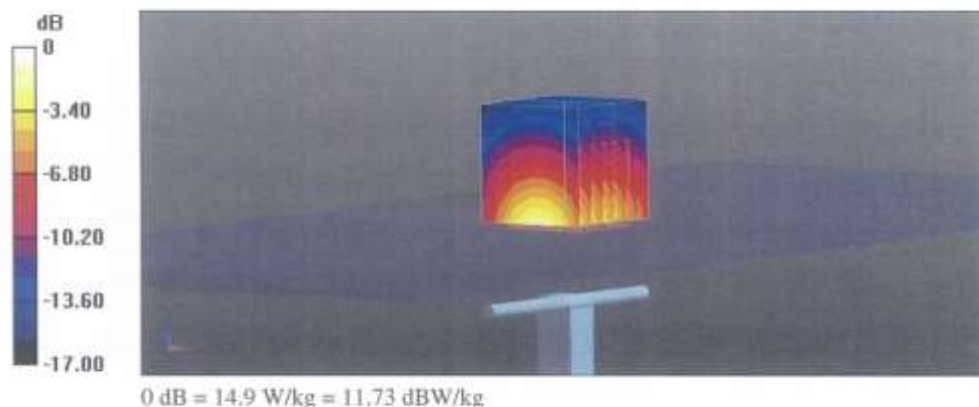
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.1 V/m; Power Drift = -0.05 dB

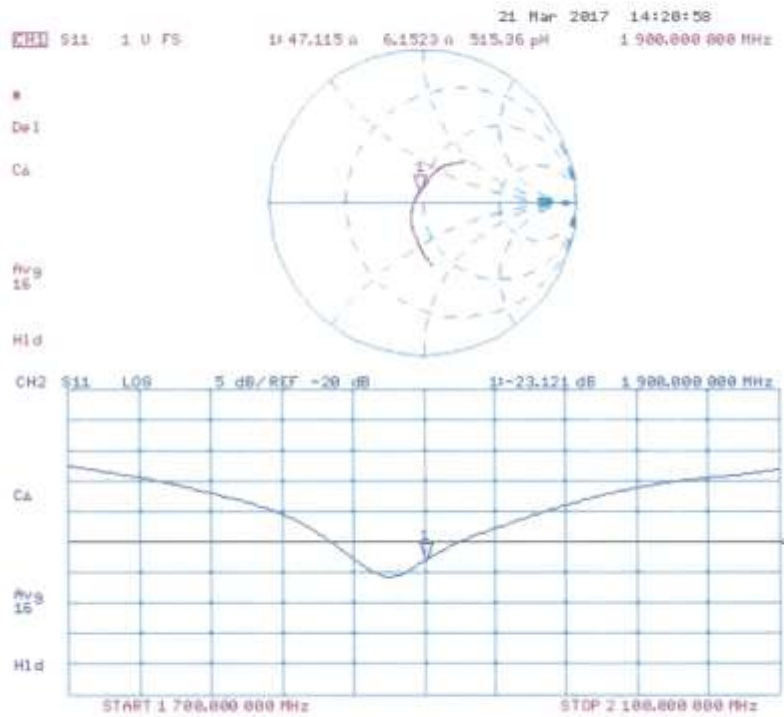
Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.3 W/kg

Maximum value of SAR (measured) = 14.9 W/kg



Impedance Measurement Plot for Body TSL



**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 **HCT (Dymstec)**

Certificate No: **D2450V2-743_Mar17**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:743**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **March 15, 2017**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02282)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP B481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP B481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Johannes Kurikka	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 16, 2017

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

Certificate No: D2450V2-743_Mar17

Page 1 of 8

**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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.8 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.0 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.8 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.8 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.9 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	54.4 Ω + 7.2 j Ω
Return Loss	- 21.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 7.8 j Ω
Return Loss	- 22.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 01, 2003

DASY5 Validation Report for Head TSL

Date: 15.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:743

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.87$ S/m; $\epsilon_r = 37.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

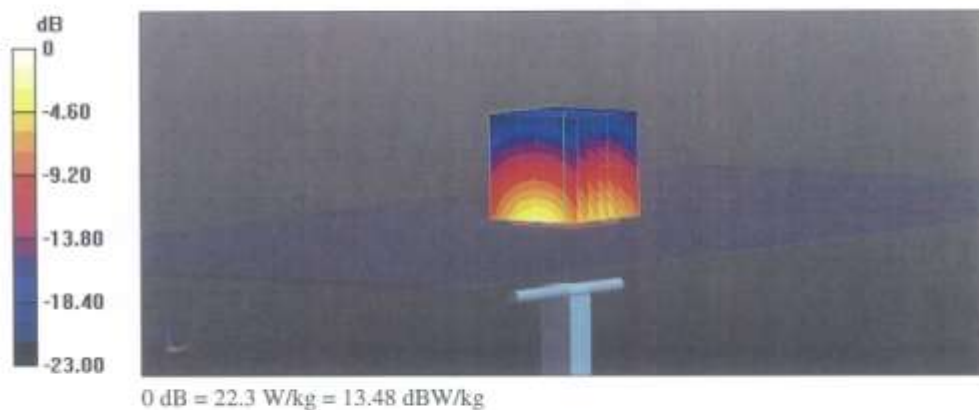
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.8 V/m; Power Drift = -0.08 dB

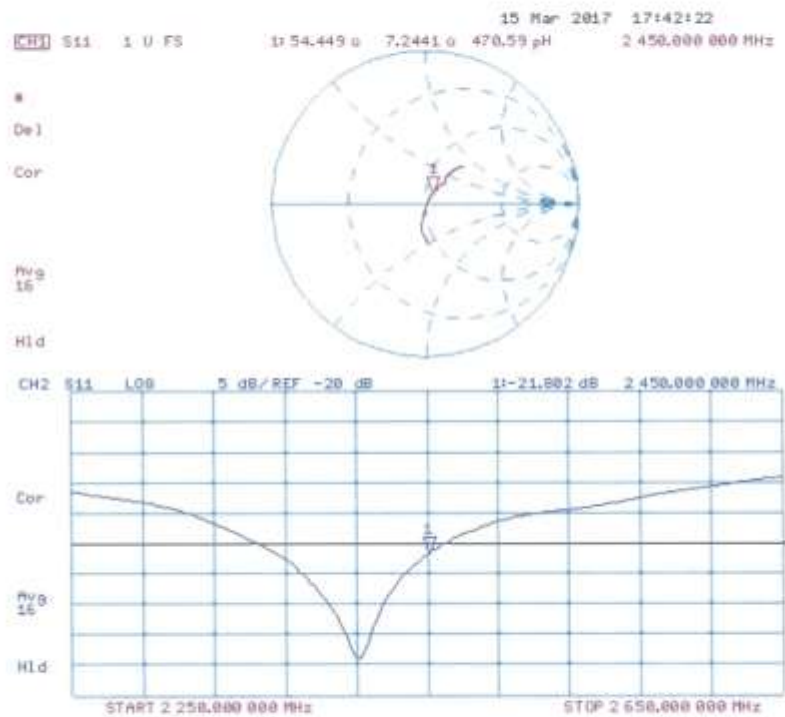
Peak SAR (extrapolated) = 27.7 W/kg

SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.3 W/kg

Maximum value of SAR (measured) = 22.3 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:743

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 52.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

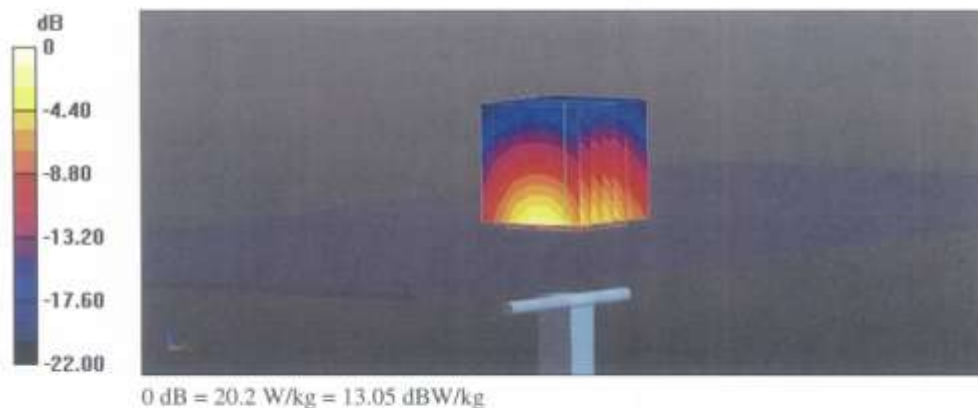
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.3 V/m; Power Drift = -0.08 dB

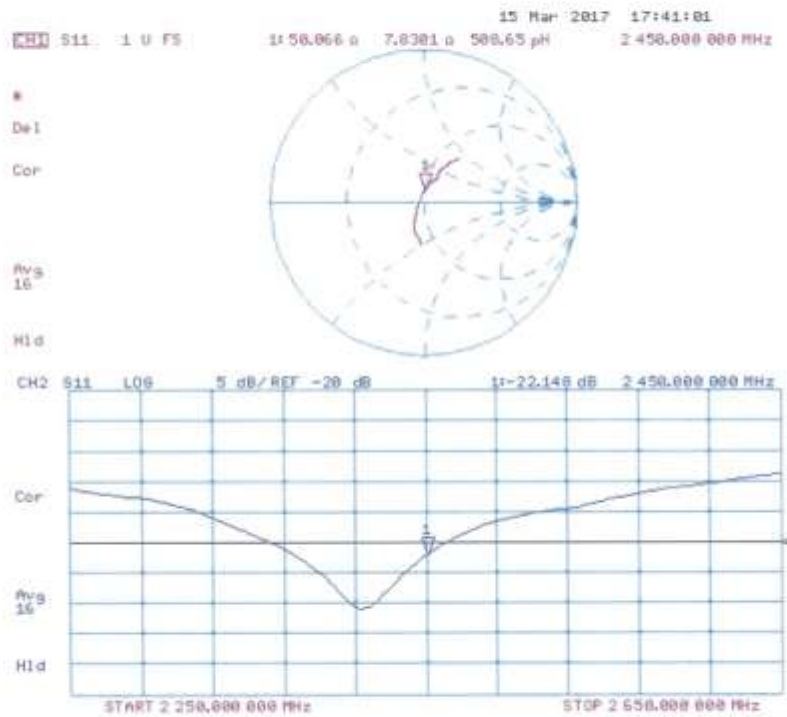
Peak SAR (extrapolated) = 25.5 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.04 W/kg

Maximum value of SAR (measured) = 20.2 W/kg



Impedance Measurement Plot for Body TSL



**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 **HCT (Dymstec)**

Certificate No: **D2600V2-1015_Jan17**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1015**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **January 18, 2017**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 6753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Leif Klynsner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 19, 2017

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

Certificate No: D2600V2-1015_Jan17

Page 1 of 8

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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.4 $\pm$ 6 %	2.05 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.49 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.5 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.3 $\pm$ 6 %	2.20 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	55.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.17 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.6 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.8 Ω - 2.8 j Ω
Return Loss:	- 30.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.1 Ω - 2.5 j Ω
Return Loss:	- 24.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.150 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole-arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 30, 2007

DASY5 Validation Report for Head TSL

Date: 17.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1015

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.05$ S/m; $\epsilon_r = 37.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.56, 7.56, 7.56); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

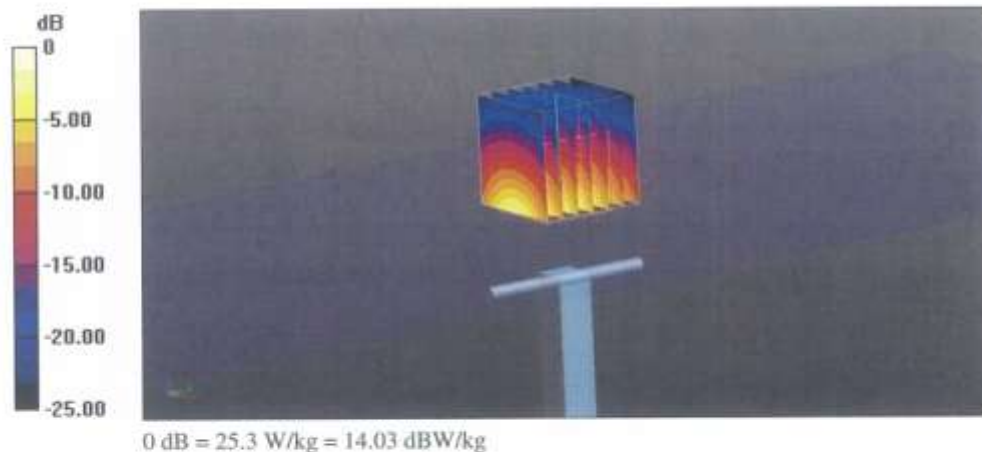
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 116.7 V/m; Power Drift = -0.04 dB

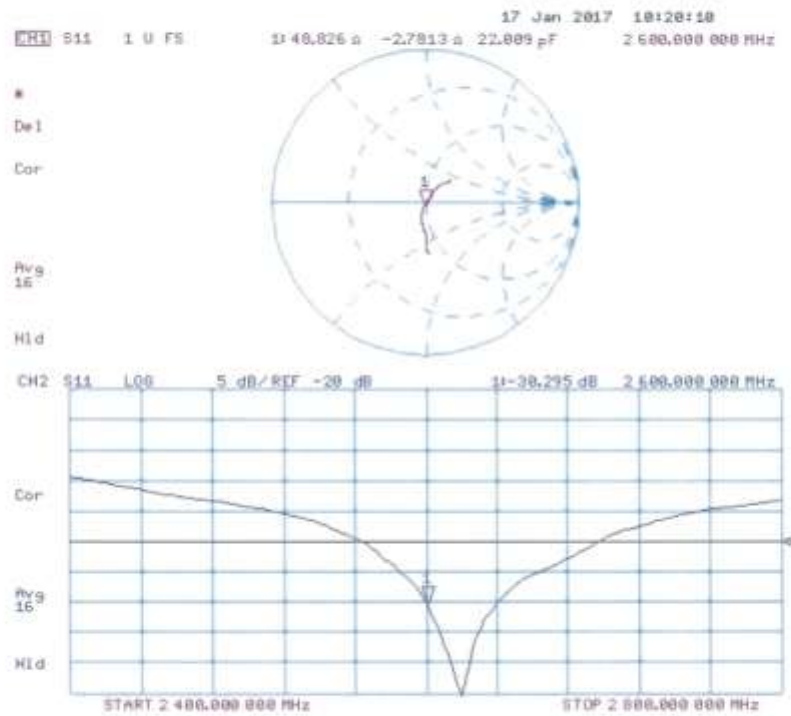
Peak SAR (extrapolated) = 32.4 W/kg

SAR(1 g) = 14.8 W/kg; SAR(10 g) = 6.49 W/kg

Maximum value of SAR (measured) = 25.3 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 18.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1015

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.2$ S/m; $\epsilon_r = 52.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.48, 7.48, 7.48); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

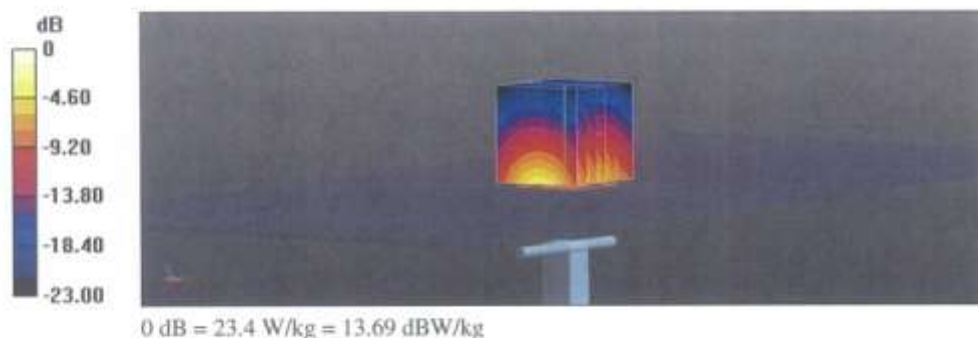
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 108.8 V/m; Power Drift = 0.06 dB

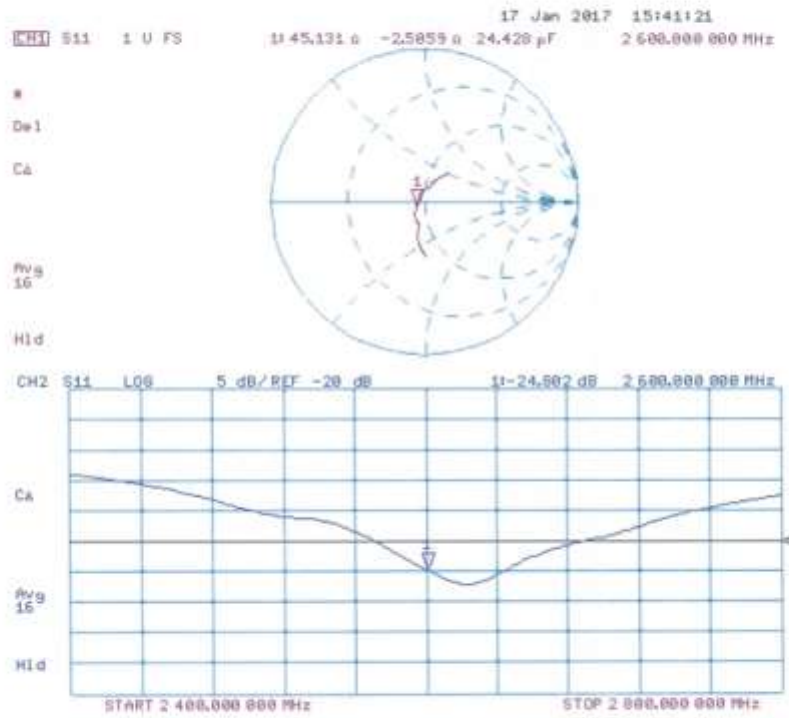
Peak SAR (extrapolated) = 28.6 W/kg

SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.17 W/kg

Maximum value of SAR (measured) = 23.4 W/kg



Impedance Measurement Plot for Body TSL



**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 **HCT (Dymstec)**

Certificate No: **D5GHzV2-1253_Jan17**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1253**

Calibration procedure(s) **QA CAL-22.v2**
Calibration procedure for dipole validation kits between 3-6 GHz

Calibration date: **January 09, 2017**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (MSTE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 3503	31-Dec-16 (No. EX3-3503_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Johannes Kurika	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 11, 2017

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

Certificate No: D5GHzV2-1253_Jan17

Page 1 of 14

**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**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.3 $\pm$ 6 %	4.50 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.90 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.6 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.7 $\pm$ 6 %	4.85 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.9 W / kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	4.99 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.01 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.0 ± 6 %	5.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.70 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.4 ± 6 %	6.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	---	----

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	80.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.1 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.77 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.4 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL at 5250 MHz**

Impedance, transformed to feed point	50.1 Ω - 4.3 j Ω
Return Loss	- 27.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	51.3 Ω + 1.3 j Ω
Return Loss	- 34.8 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	54.3 Ω + 3.4 j Ω
Return Loss	- 25.6 dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	49.3 Ω - 2.8 j Ω
Return Loss	- 30.6 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	52.8 Ω + 2.2 j Ω
Return Loss	- 29.3 dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	55.1 Ω + 3.9 j Ω
Return Loss	- 24.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 22, 2016

DASY5 Validation Report for Head TSL

Date: 09.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1253

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 4.5$ S/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³, Medium parameters used:
 $f = 5600$ MHz; $\sigma = 4.85$ S/m; $\epsilon_r = 34.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 4.99$
S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

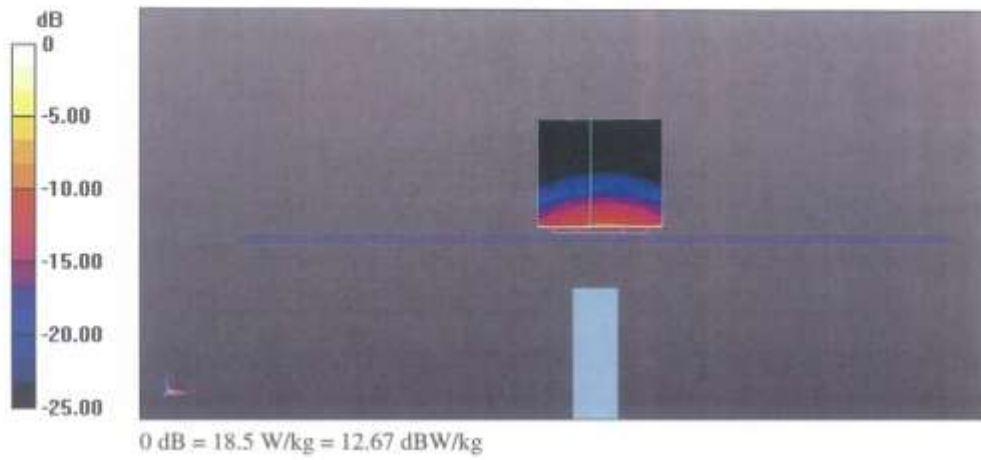
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.58, 5.58, 5.58); Calibrated: 31.12.2016, ConvF(5.09, 5.09, 5.09); Calibrated: 31.12.2016, ConvF(5.02, 5.02, 5.02); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7331)

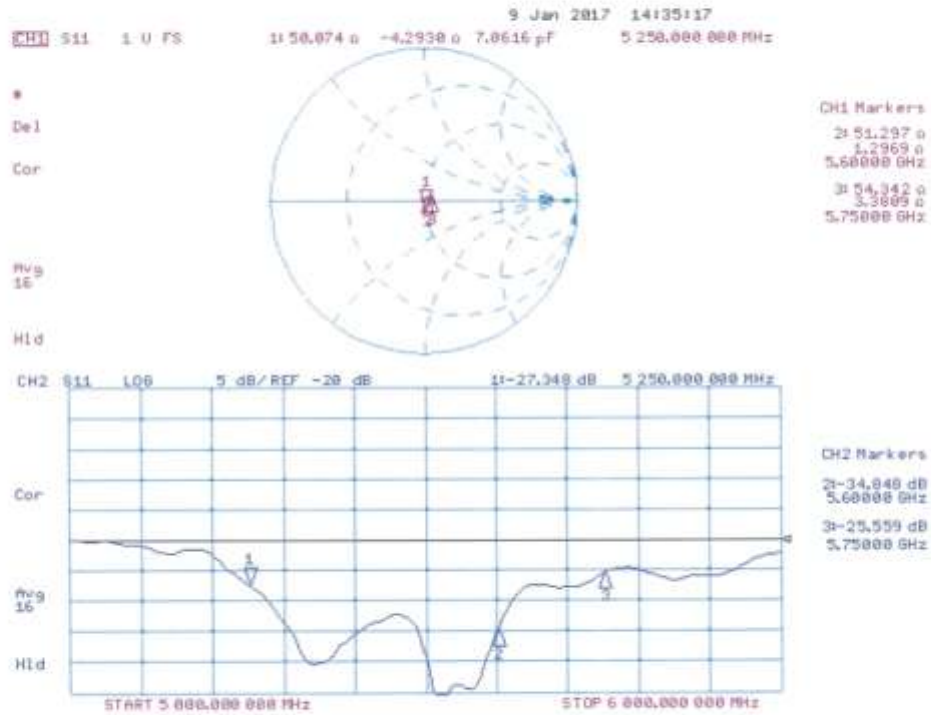
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.85 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 29.9 W/kg
SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.26 W/kg
Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.17 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 33.6 W/kg
SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.35 W/kg
Maximum value of SAR (measured) = 19.9 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 70.45 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 33.7 W/kg
SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.27 W/kg
Maximum value of SAR (measured) = 19.3 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 06.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1253

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 5.52$ S/m; $\epsilon_r = 47$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 6$ S/m; $\epsilon_r = 46.4$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 6.21$ S/m; $\epsilon_r = 46.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

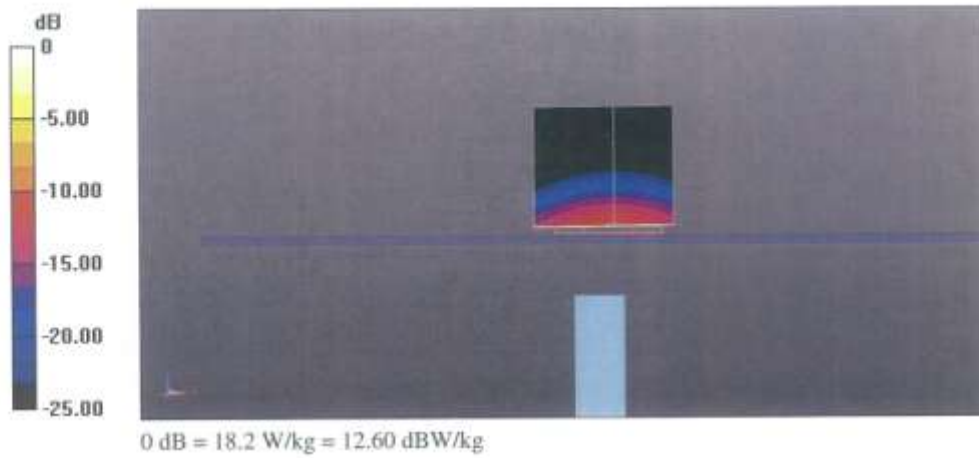
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.14, 5.14, 5.14); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 31.12.2016, ConvF(4.52, 4.52, 4.52); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7331)

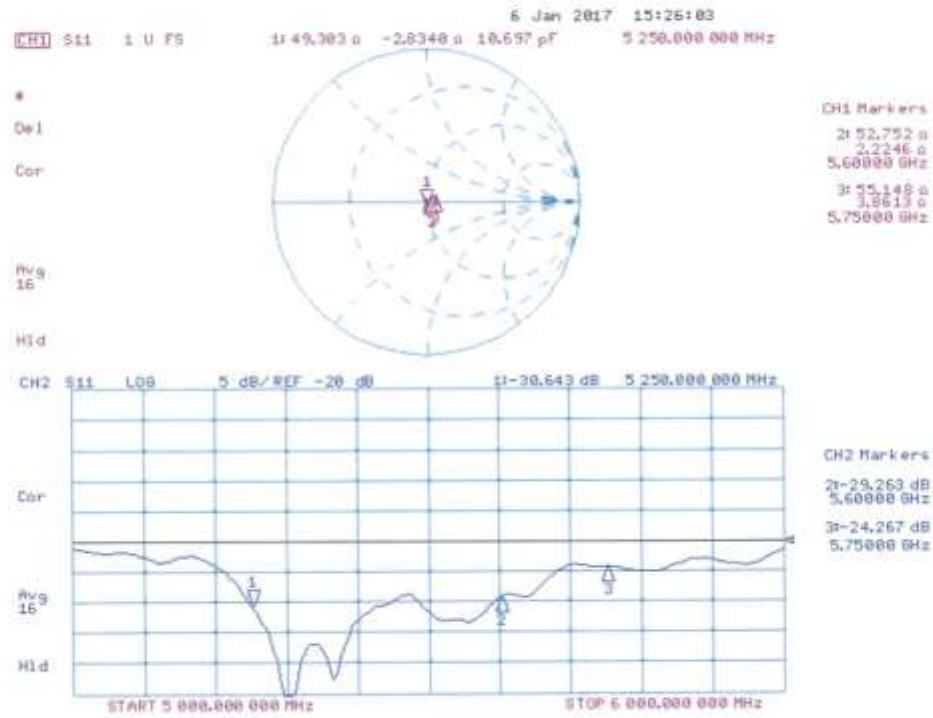
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.21 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.2 W/kg
SAR(1 g) = 7.7 W/kg; SAR(10 g) = 2.15 W/kg
Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.67 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 34.1 W/kg
SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.27 W/kg
Maximum value of SAR (measured) = 19.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.63 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 34.5 W/kg
SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.16 W/kg
Maximum value of SAR (measured) = 19.2 W/kg



Impedance Measurement Plot for Body TSL



Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Certificate of conformity / First Article Inspection

Item	Triple Modular Flat Phantom V5.1
Type No	QD 000 P51 C
Series No	1100 and higher
Manufacturer / Origin	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

The sub-units of item 1100 are identified with the designation 1100/1, 1100/2 and 1100/3. Tests were conducted on all 3 sub-units of this phantom.

Test	Requirement	Details	Units tested
Material thickness	Compliant with the standard requirements.	2 mm +/- 0.2 mm 30 points over the bottom area	all
Material parameters	Dielectric parameters for required frequencies	200 MHz – 6 GHz - Relative permittivity 3 - 5 Loss tangent < 0.05.	Material sample
Material resistivity	The material is compatible with the liquids defined in the standards if handled and cleaned according to the instructions.	DGBE based simulating liquids, Observe Technical Note for material compatibility.	Material Samples
Shape	Internal dimensions	Internal height: > 175 mm Bottom internal length: 280 mm Bottom internal width: 175 mm Nominal filling height: 155 mm Nominal volume: 9.2 l	Pre-series, design
Sagging	Depending on standard	No initial sagging (negative preshaped, change < 0.5 mm)	1100/2

Standards

- [1] 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 Techniques", June 2013
- [2] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [3] IEC 62209 – 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures, Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", March 2010
- [4] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Conformity

Based on the dimensions and sample tests above, we certify that this item is in compliance with the standards [1] to [4] for frequencies > 700 MHz, if operated according to the specific requirements.

Date

16.07.2015

Signature / Stamp

s p e a g

Schmid & Partner Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Attachment 5. – SAR Tissue Characterization

The brain and muscle mixtures consist of a viscous gel using hydrox-ethyl cellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrave.

Ingredients (% by weight)	Frequency (MHz)							
	835		1 900		2 450 – 2 700		5 200 - 5 800	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body
Water	40.45	53.06	54.9	70.17	71.88	73.2	65.52	78.66
Salt (NaCl)	1.45	0.94	0.18	0.39	0.16	0.1	0.0	0.0
Sugar	57.0	44.9	0.0	0	0.0	0.0	0.0	0.0
HEC	1.0	1.0	0.0	0	0.0	0.0	0.0	0.0
Bactericide	0.1	0.1	0.0	0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	19.97	0.0	17.24	10.67
DGBE	0.0	0.0	44.92	29.44	7.99	26.7	0.0	0.0
Diethylene glycol hexyl ether	-	-	-	-	-	-	-	-

Salt:	99 % Pure Sodium Chloride	Sugar:	98 % Pure Sucrose
Water:	De-ionized, 16M resistivity	HEC:	Hydroxyethyl Cellulose
DGBE:	99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]		
Triton X-100(ultra pure):	Polyethylene glycol mono[4-(1,1,3,3-tetramethylbutyl)phenyl] ether		

Composition of the Tissue Equivalent Matter

Attachment 6. – SAR SYSTEM VALIDATION

Per FCC KCB 865664 D02v01r02, SAR system validation status should be document to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2013 and FCC KDB 865664 D01v01r04. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

SAR System No.	Probe	Probe Type	Probe Calibration Point		Dipole	Date	Dielectric Parameters		CW Validation			Modulation Validation		
							Measured Permittivity	Measured Conductivity	Sensitivity	Probe Linearity	Probe Isotropy	MOD. Type	Duty Factor	PAR
4	1605	ET3DV6	Body	835	441	2016.11.25	55.4	0.98	PASS	PASS	PASS	N/A	N/A	N/A
4	1605	ET3DV6	Body	835	441	2016.11.25	55.4	0.98	PASS	PASS	PASS	GMSK	PASS	N/A
4	1605	ET3DV6	Body	1900	5d032	2017.03.31	53.3	1.53	PASS	PASS	PASS	GMSK	PASS	N/A
12	7370	EX3DV4	Body	2450	743	2017.03.24	52.8	1.94	PASS	PASS	PASS	OFDM	N/A	PASS
12	7370	EX3DV4	Body	2600	1015	2017.01.31	52.3	2.17	PASS	PASS	PASS	NA	N/A	NA
12	7370	EX3DV4	Body	5250	1253	2017.01.31	48.8	5.35	PASS	PASS	PASS	OFDM	N/A	PASS
12	7370	EX3DV4	Body	5600	1253	2017.01.31	48.3	5.79	PASS	PASS	PASS	OFDM	N/A	PASS
12	7370	EX3DV4	Body	5750	1253	2017.01.31	48.4	5.96	PASS	PASS	PASS	OFDM	N/A	PASS

SAR System Validation Summary 1g

Note;

All measurement were performed using probes calibrated for CW signal only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04. SAR system were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664 D01v01r04.