

04_WLAN5GHz_802.11ac_VHT80 MCS0_Bottom Face _0mm_Ch58

Communication System: UID 0, 802.11ac (0); Frequency: 5290 MHz; Duty Cycle: 1:1.116

Medium: HSL_5000 Medium parameters used: $f = 5290$ MHz; $\sigma = 4.642$ S/m; $\epsilon_r = 36.47$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(5.04, 5.04, 5.04); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 2.02 W/kg

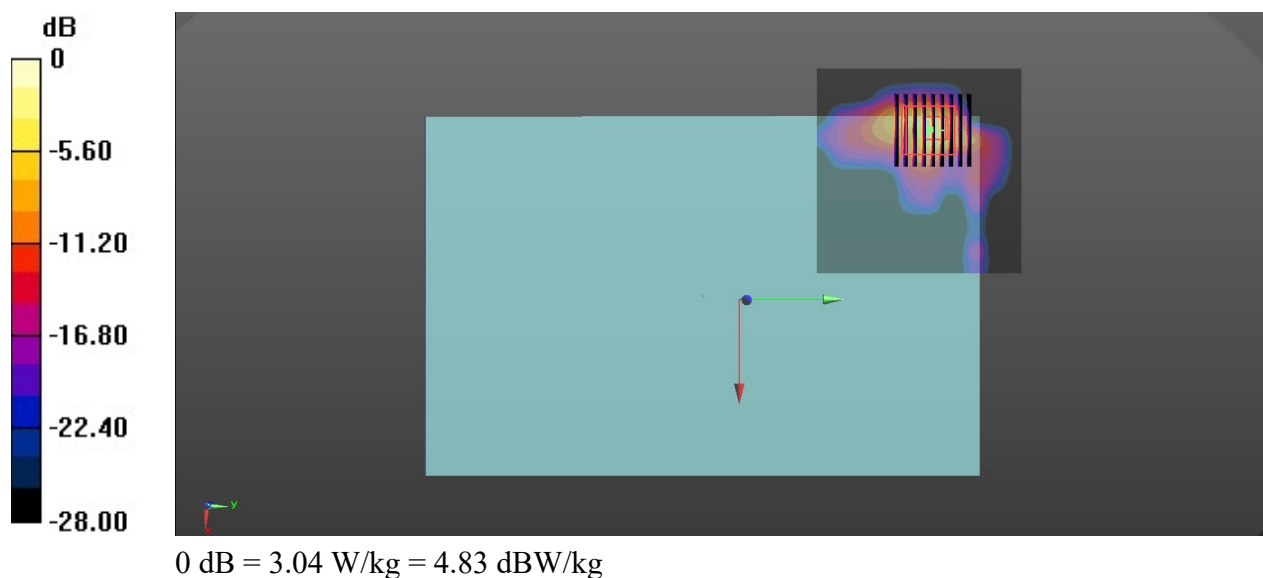
Zoom Scan (9x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0.8870 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 6.09 W/kg

SAR(1 g) = 0.946 W/kg; SAR(10 g) = 0.233 W/kg

Maximum value of SAR (measured) = 3.04 W/kg



05_WLAN5GHz_802.11ac_VHT80 MCS0_Bottom Face _0mm_Ch106

Communication System: UID 0, 802.11ac (0); Frequency: 5530 MHz; Duty Cycle: 1:1.116

Medium: HSL_5000 Medium parameters used: $f = 5530$ MHz; $\sigma = 4.915$ S/m; $\epsilon_r = 35.884$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.7 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.67, 4.67, 4.67); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.99 W/kg

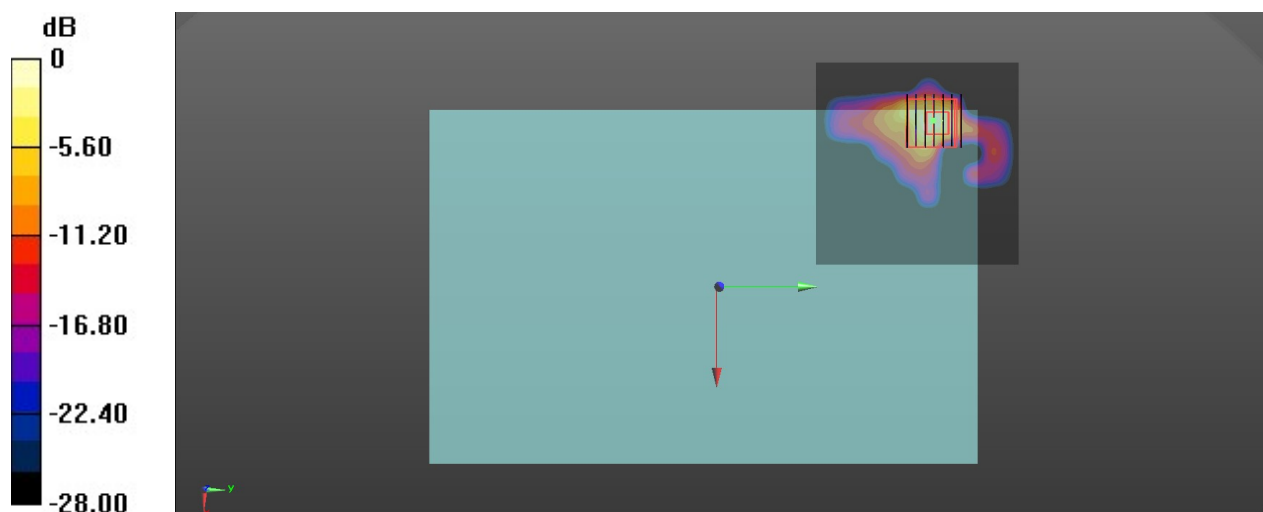
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 1.104 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 4.77 W/kg

SAR(1 g) = 0.750 W/kg; SAR(10 g) = 0.183 W/kg

Maximum value of SAR (measured) = 2.21 W/kg



0 dB = 2.21 W/kg = 3.44 dBW/kg

06_WLAN5GHz_802.11ac_VHT80 MCS0_Bottom Face _0mm_Ch155

Communication System: UID 0, 802.11n (0); Frequency: 5755 MHz; Duty Cycle: 1:1.116
Medium: HSL_5000 Medium parameters used: $f = 5755$ MHz; $\sigma = 5.235$ S/m; $\epsilon_r = 35.589$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.9 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3857; ConvF(4.93, 4.93, 4.93); Calibrated: 2020.9.25
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1358; Calibrated: 2020.4.28
- Phantom: ELI 4; Type: QDOVA002AA; Serial: TP:1201
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 2.87 W/kg

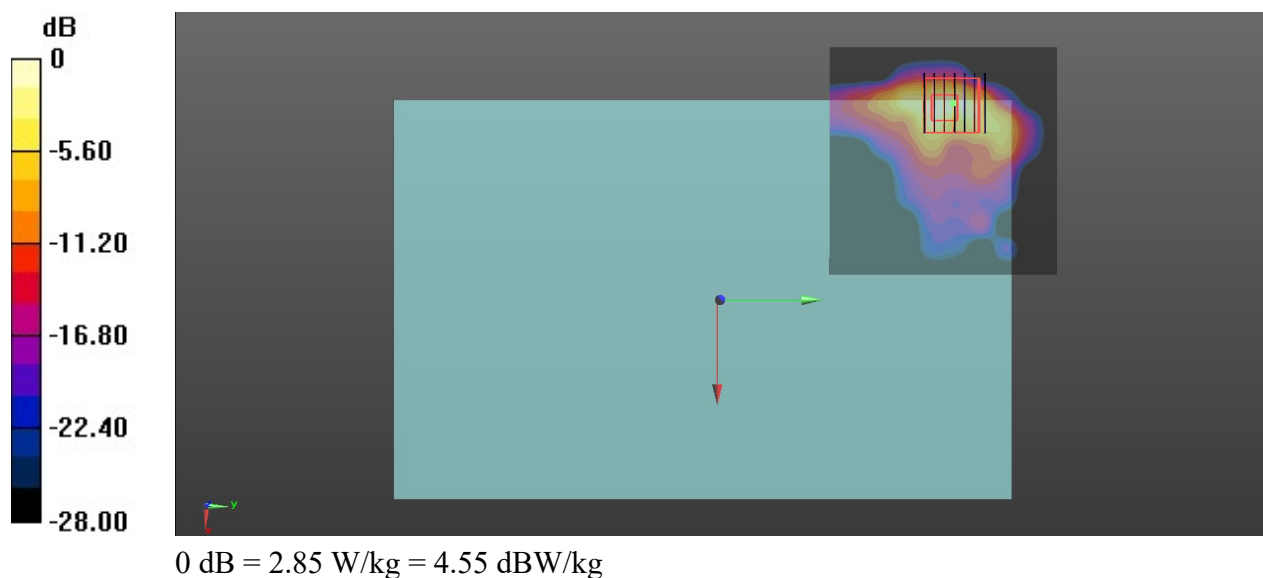
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 6.93 W/kg

SAR(1 g) = 1.03 W/kg; SAR(10 g) = 0.267 W/kg

Maximum value of SAR (measured) = 2.85 W/kg





Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.



In Collaboration with
s p e a g
CALIBRATION LABORATORY



中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

Client

Sporton

Certificate No: **Z19-60087**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 908**

Calibration Procedure(s) **FF-Z11-003-01**
Calibration Procedures for dipole validation kits

Calibration date: **March 25, 2019**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22\pm3)^{\circ}\text{C}$ and humidity $<70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
Power sensor NRP8S	104291	20-Aug-18 (CTTL, No.J18X06862)	Aug-19
Reference Probe EX3DV4	SN 3617	31-Jan-19(SPEAG,No.EX3-3617_Jan19)	Jan-20
DAE4	SN 1331	06-Feb-19(SPEAG,No.DAE4-1331_Feb19)	Feb-20
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-19 (CTTL, No.J19X00336)	Jan-20
NetworkAnalyzer E5071C	MY46110673	24-Jan-19 (CTTL, No.J19X00547)	Jan-20

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 28, 2019

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



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2079

Fax: +86-10-62304633-2504

E-mail: cttl@chinattl.com

http://www.chinattl.cn

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, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, 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	DASY52	52.10.2.1495
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
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	39.6 $\pm$ 6 %	1.84 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.8 W/kg $\pm$ 18.6 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 W/kg $\pm$ 18.7 % (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	53.8 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.8 W/kg $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.91 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.6 W/kg $\pm$ 18.7 % (k=2)



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2079

Fax: +86-10-62304633-2504

E-mail: cttl@chinattl.com

http://www.chinattl.cn

Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$57.3\Omega + 5.18j\Omega$
Return Loss	- 21.6dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$52.6\Omega + 5.81j\Omega$
Return Loss	- 24.1dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.020 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
-----------------	-------



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

DASY5 Validation Report for Head TSL

Date: 03.25.2019

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 908

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.841$ S/m; $\epsilon_r = 39.63$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.62, 7.62, 7.62) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

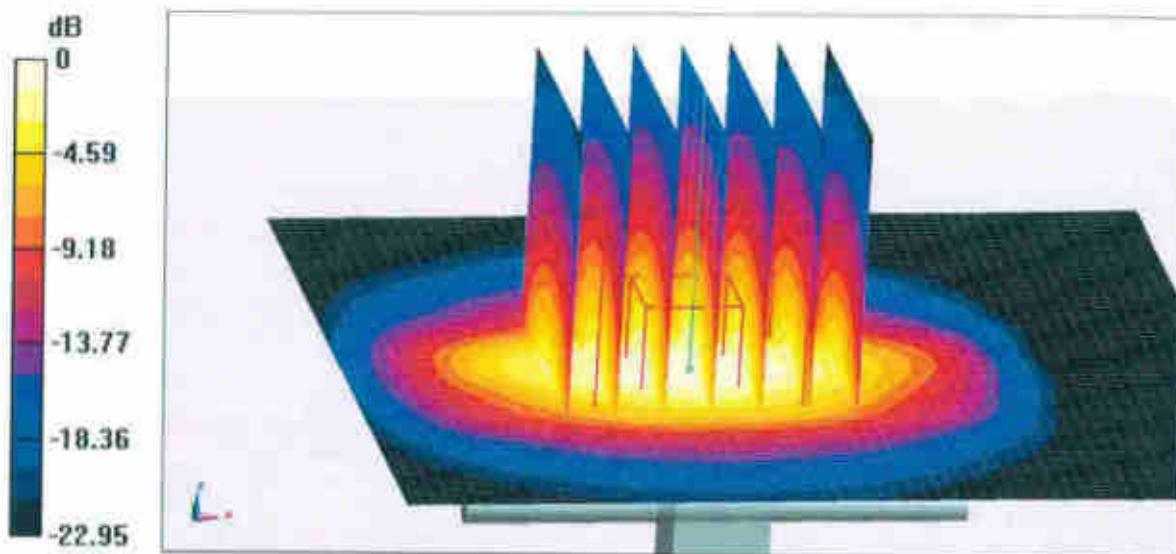
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.04 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.07 W/kg

Maximum value of SAR (measured) = 22.4 W/kg

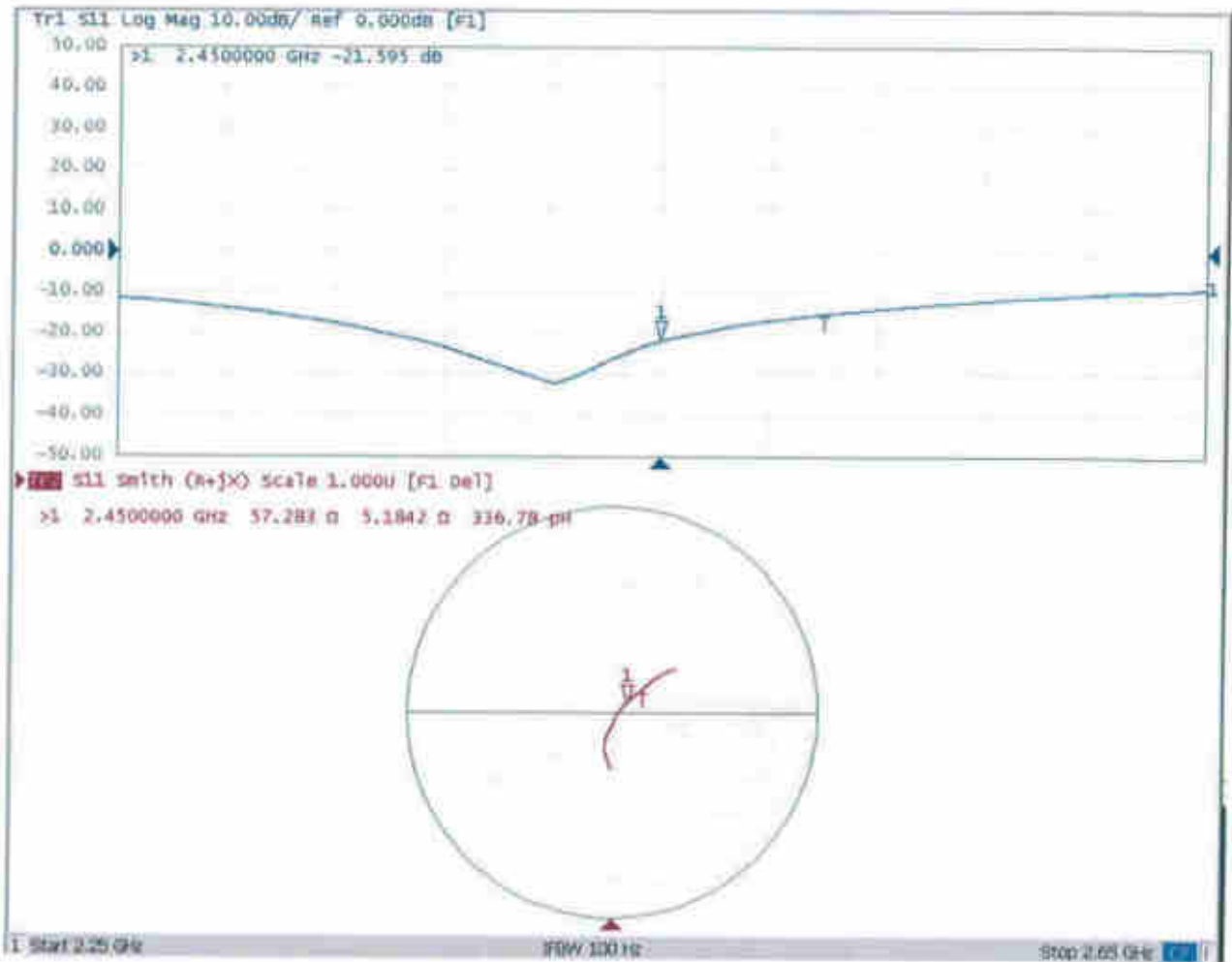




In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

Impedance Measurement Plot for Head TSL





In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

DASY5 Validation Report for Body TSL

Date: 03.25.2019

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 908

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.003$ S/m; $\epsilon_r = 53.78$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.79, 7.79, 7.79) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

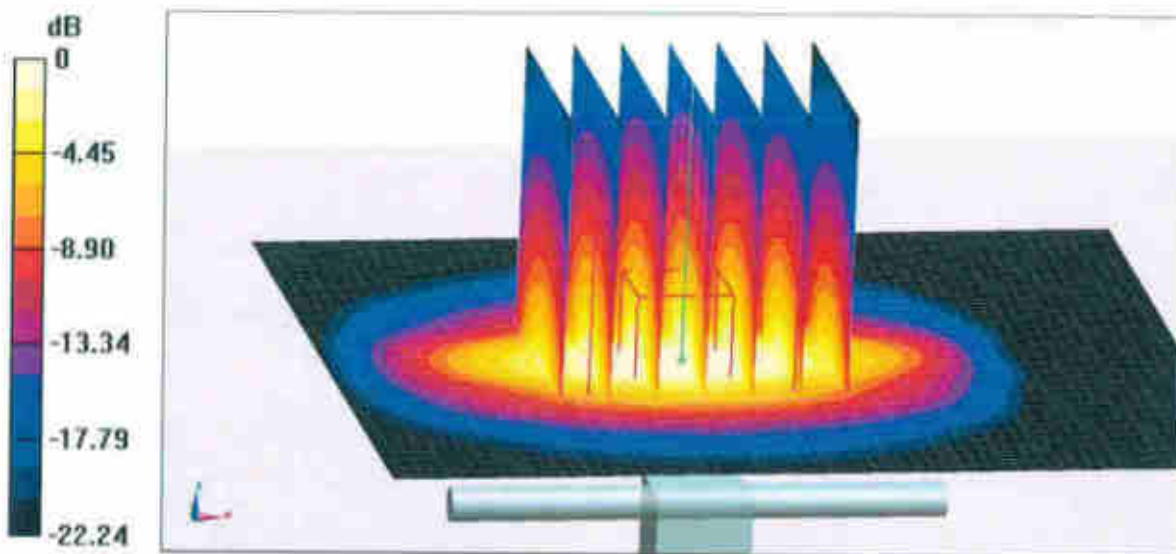
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0; Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.51 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 27.1 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.91 W/kg

Maximum value of SAR (measured) = 21.4 W/kg



0 dB = 21.4 W/kg = 13.30 dBW/kg



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China

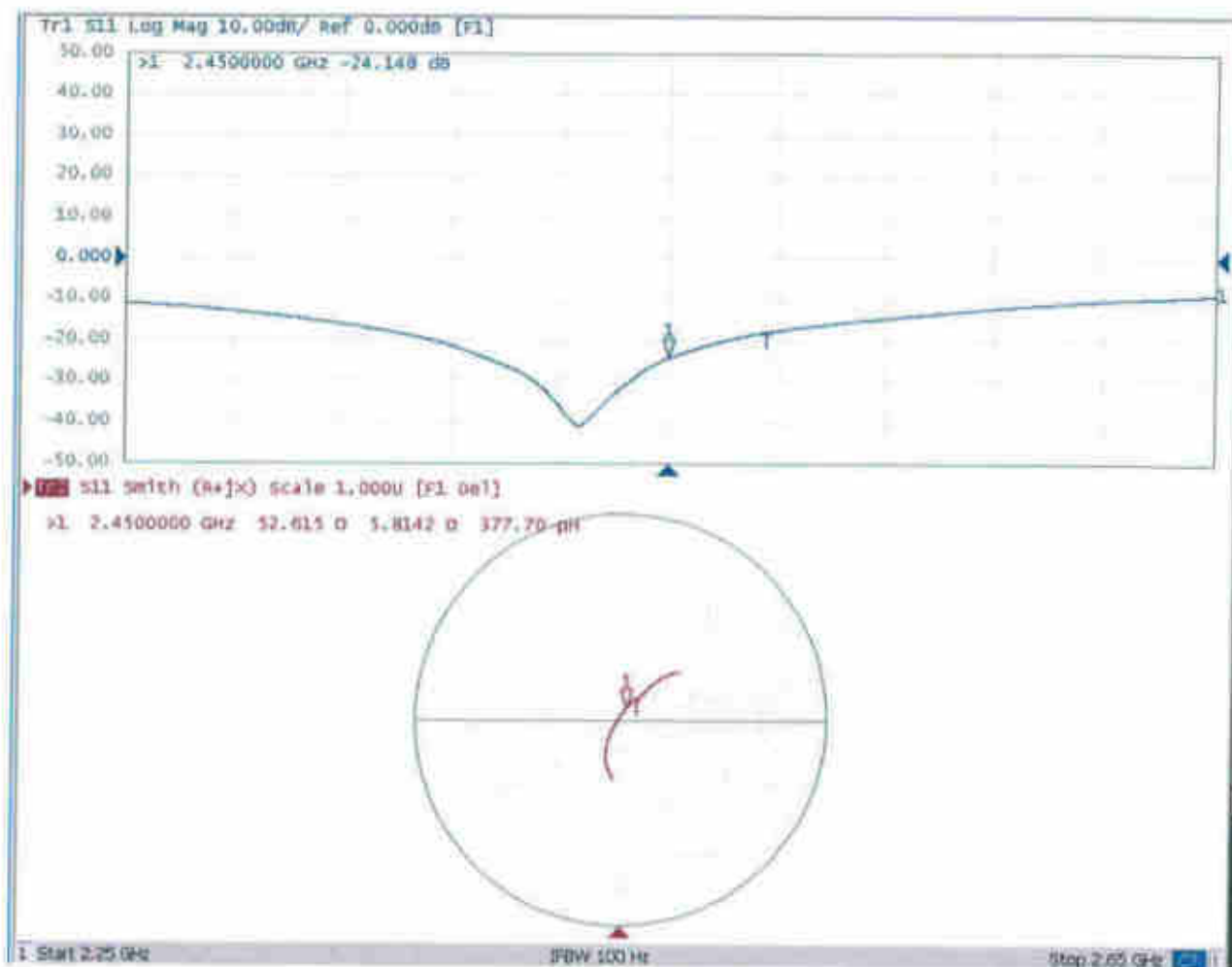
Tel: +86-10-62304633-2079

Fax: +86-10-62304633-2504

E-mail: cttl@chinattl.com

http://www.chinattl.cn

Impedance Measurement Plot for Body TSL



D2450V2, Serial No. 908 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, if dipoles are verified in return loss ($< -20\text{dB}$, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

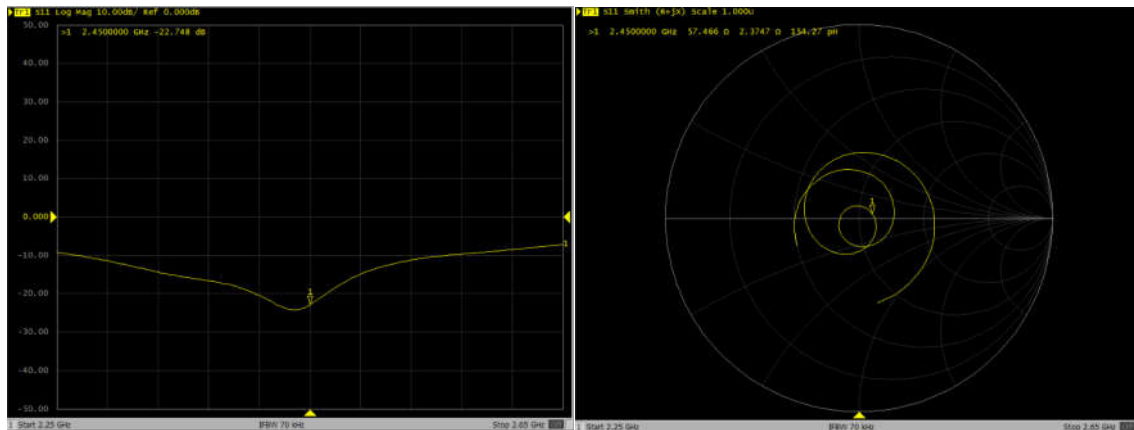
D2450V2 – serial no. 908						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.3.25	-21.60		57.28		5.18	
2020.3.24	-22.7	-0.05	57.5	-0.18	2.4	2.81
2021.3.24	-21.30	0.01	55.80	1.49	5.67	-0.49

<Justification of the extended calibration>

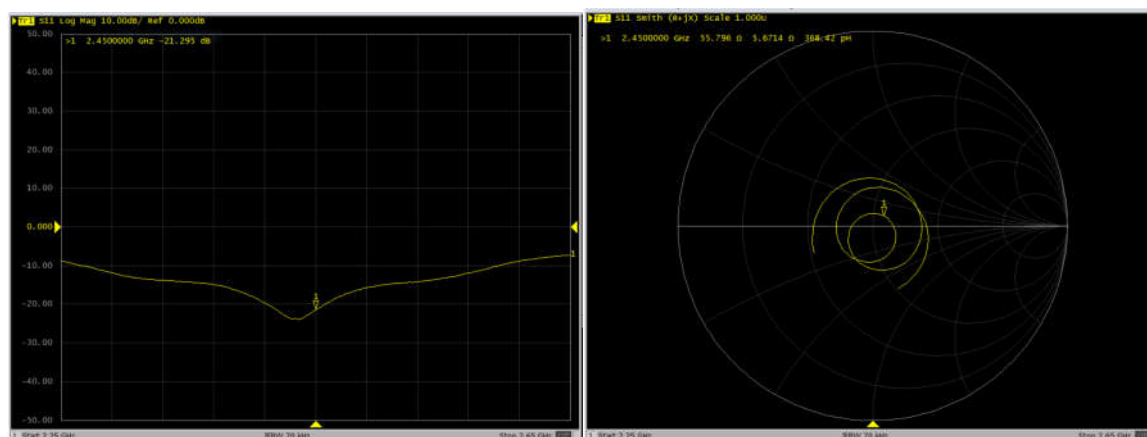
The return loss is $< -20\text{dB}$, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data> D2450V2, serial no. 908

2450MHz – Head----2020.3.24



2450MHz – Head----2021.3.24





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

Client **Sporton**

Certificate No: **D2600V2-1061_Nov20**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1061**

Calibration procedure(s) **QA CAL-05.v11
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **November 26, 2020**

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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310962 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 7405	29-Jun-20 (No. EX3-7405_Jun20)	Jun-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by: **Claudio Leubler** **Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Signature

Issued: November 26, 2020

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



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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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	V52.10.4
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	37.6 $\pm$ 6 %	2.03 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	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.6 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	6.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.1 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	55.6 Ω - 2.3 $j\Omega$
Return Loss	- 24.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 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
-----------------	-------

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1061

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

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 37.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7405; ConvF(7.54, 7.54, 7.54) @ 2600 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 119.2 V/m; Power Drift = -0.04 dB

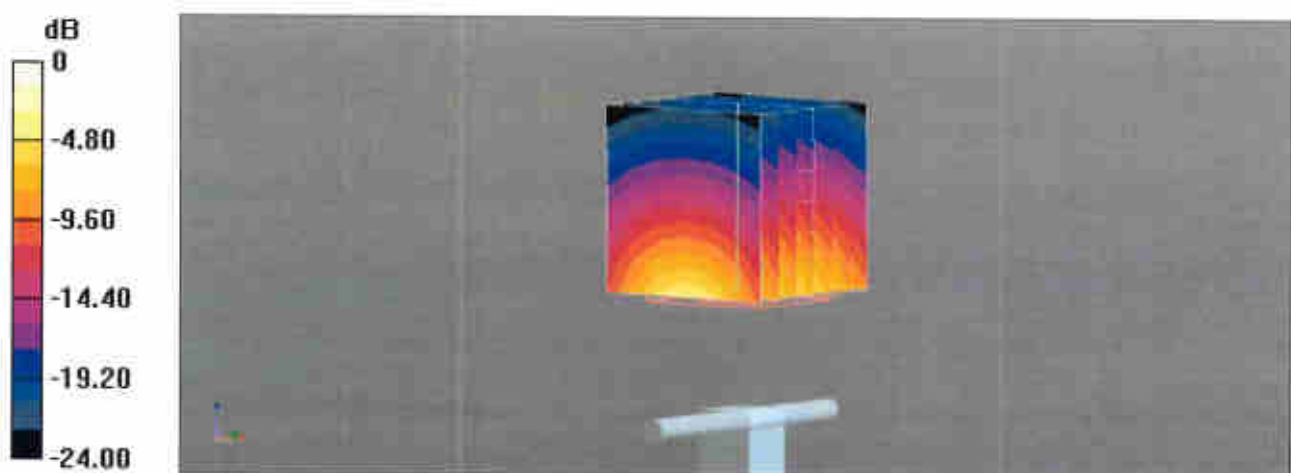
Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.37 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

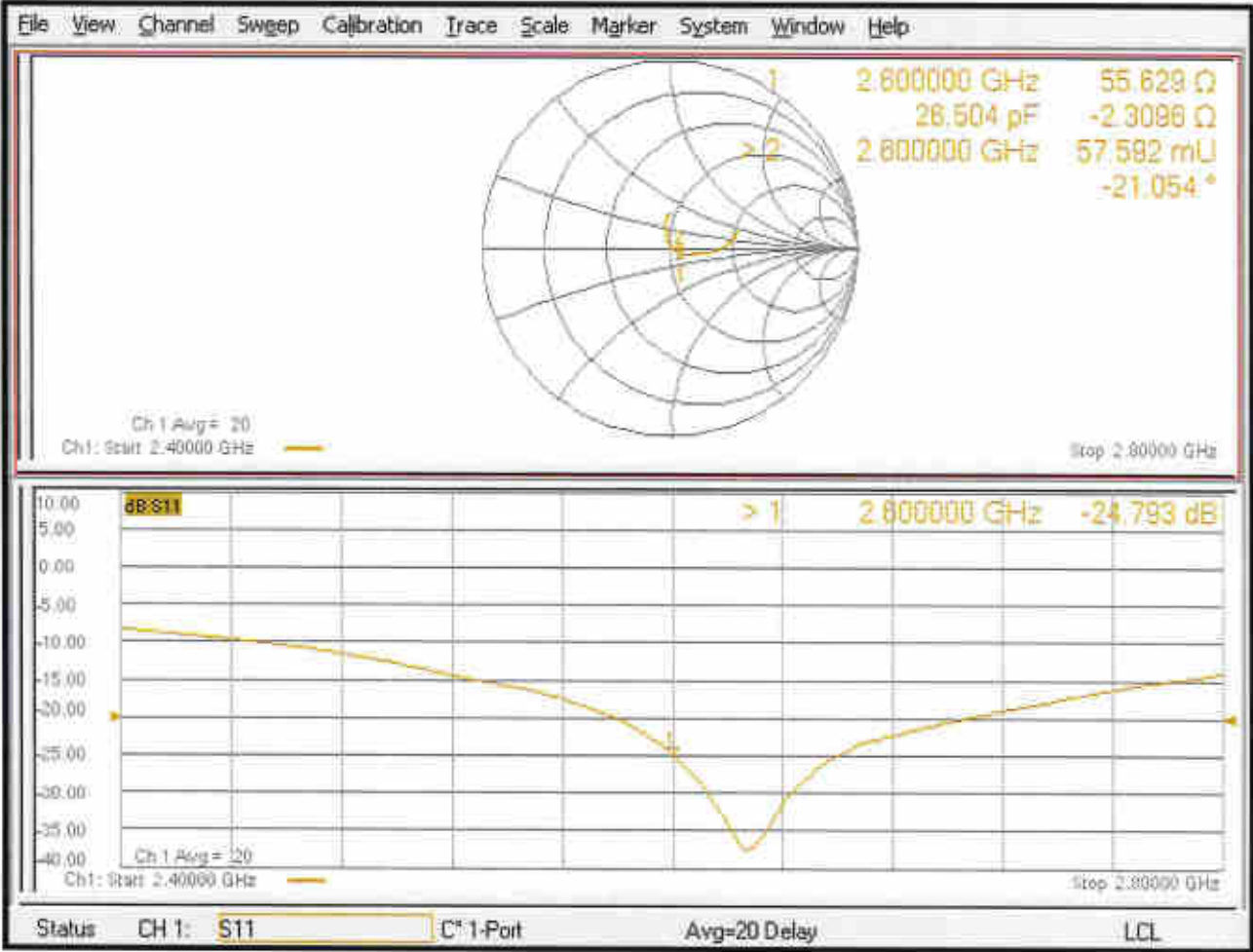
Ratio of SAR at M2 to SAR at M1 = 47%

Maximum value of SAR (measured) = 25.0 W/kg



0 dB = 25.0 W/kg = 13.98 dBW/kg

Impedance Measurement Plot for Head TSL





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 **Sporton**

Certificate No: **D5GHzV2-1113_Sep19**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1113**

Calibration procedure(s) **QA CAL-22.v4
Calibration Procedure for SAR Validation Sources between 3-6 GHz**

Calibration date: **September 24, 2019**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ 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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	Mar-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

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

Issued: September 25, 2019

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



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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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	V52.10.2
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	35.1 $\pm$ 6 %	4.53 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	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.5 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	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 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	34.6 $\pm$ 6 %	4.88 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	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.4 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	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 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	34.4 ± 6 %	5.03 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 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	51.7 Ω - 6.2 $j\Omega$
Return Loss	- 24.0 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	56.0 Ω - 2.7 $j\Omega$
Return Loss	- 24.1 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.7 Ω - 1.0 $j\Omega$
Return Loss	- 23.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.195 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
-----------------	-------

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1113Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz,
Frequency: 5750 MHzMedium parameters used: $f = 5250$ MHz; $\sigma = 4.53$ S/m; $\epsilon_r = 35.1$; $\rho = 1000$ kg/m³,Medium parameters used: $f = 5600$ MHz; $\sigma = 4.88$ S/m; $\epsilon_r = 34.6$; $\rho = 1000$ kg/m³,Medium parameters used: $f = 5750$ MHz; $\sigma = 5.03$ S/m; $\epsilon_r = 34.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.4, 5.4, 5.4) @ 5250 MHz, ConvF(4.95, 4.95, 4.95) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 78.54 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.33 W/kg

Maximum value of SAR (measured) = 18.1 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 = 78.00 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 8.40 W/kg; SAR(10 g) = 2.40 W/kg

Maximum value of SAR (measured) = 19.4 W/kg

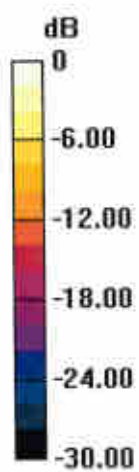
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 75.13 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 31.8 W/kg

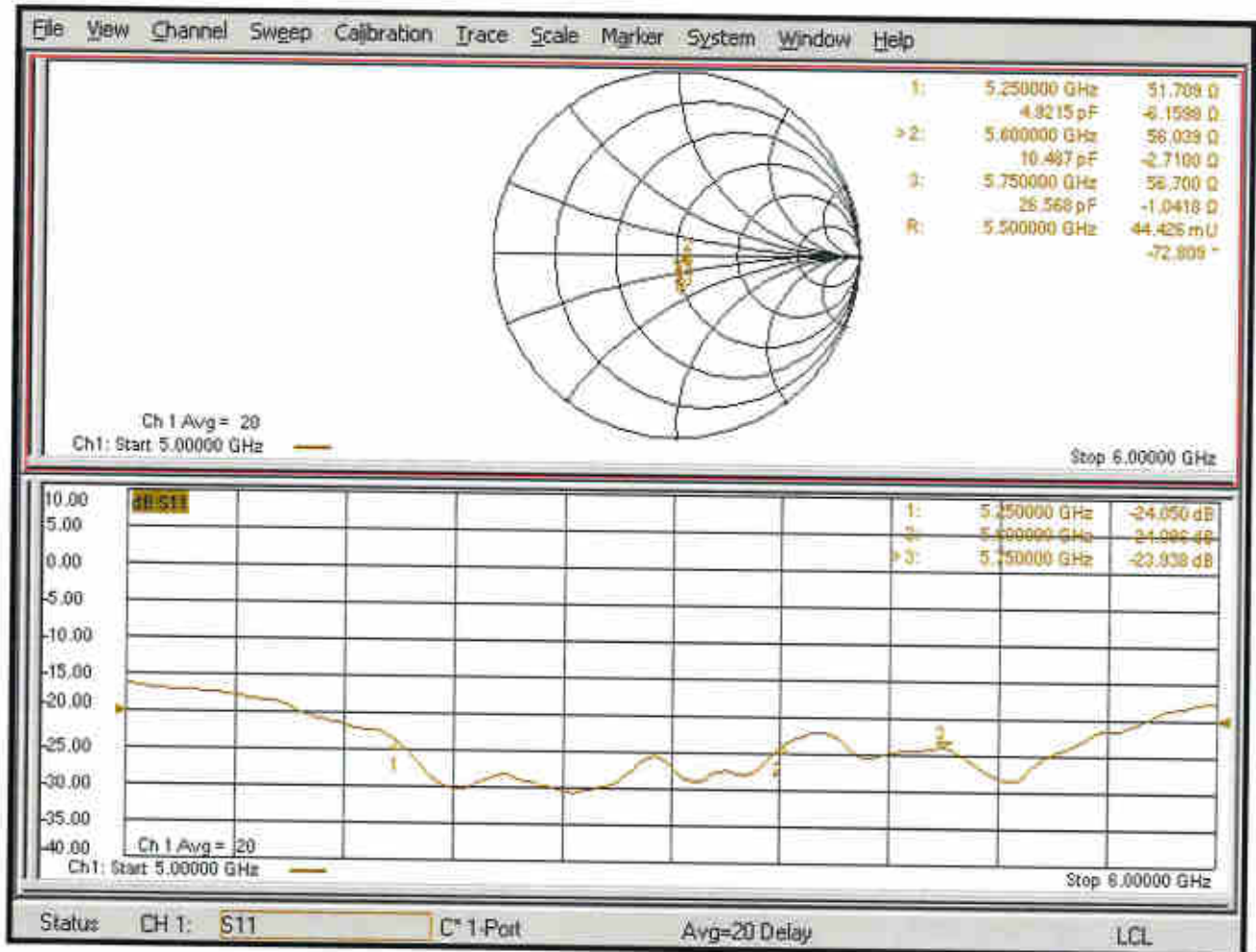
SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.30 W/kg

Maximum value of SAR (measured) = 19.0 W/kg



0 dB = 18.1 W/kg = 12.58 dBW/kg

Impedance Measurement Plot for Head TSL



D5GHzV2, Serial No. 1113 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, if dipoles are verified in return loss ($< -20\text{dB}$, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

D5GHzV2 – serial no. 1113						
5250 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.9.24	-24.05		51.71		-6.16	
2020.9.23	-24.80	-0.03	50.56	1.15	-5.94	-0.22

D5GHzV2 – serial no. 1113						
5600 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.9.24	-24.09		56.04		-2.71	
2020.9.23	-23.95	0.01	57.70	-1.66	-2.85	0.14

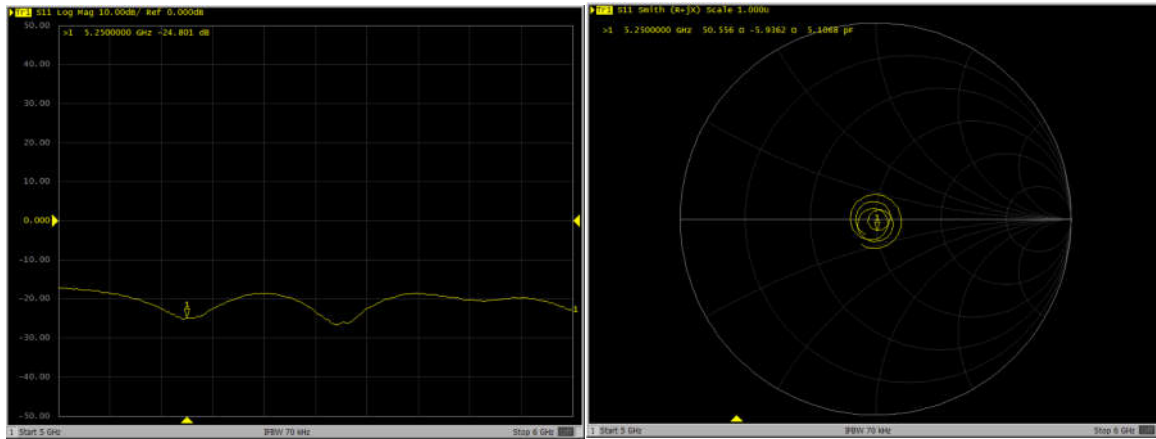
D5GHzV2 – serial no. 1113						
5750 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.9.24	-23.94		56.70		-1.04	
2020.9.23	-21.92	0.08	58.56	-1.86	-1.58	0.54

<Justification of the extended calibration>

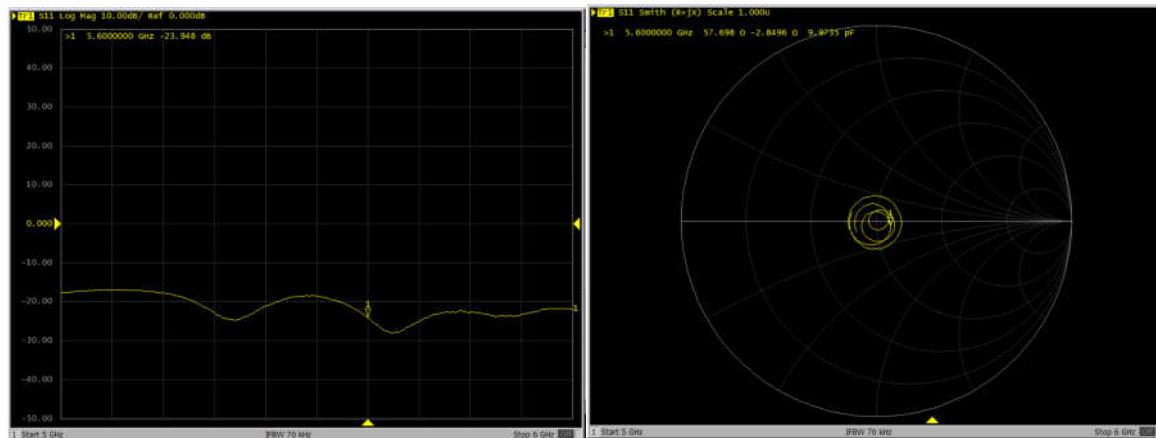
The return loss is $< -20\text{dB}$, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data> D3700V2, serial no. 1008

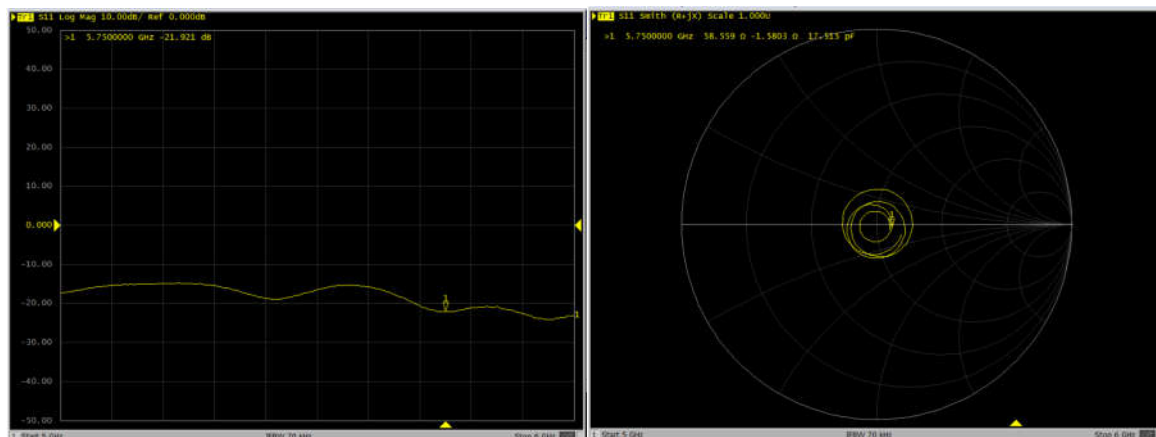
5250MHz – Head



5600MHz – Head



5750MHz – Head





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

Client **Sporton**

Certificate No: **DAE4-1358_Apr20**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BN - SN: 1358**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **April 28, 2020**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Sep-19 (No:25949)	Sep-20
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	09-Jan-20 (in house check)	In house check: Jan-21
Calibrator Box V2.1	SE UMS 006 AA 1002	09-Jan-20 (in house check)	In house check: Jan-21

Calibrated by: **Name**
Eric Hainfeld **Function**
Laboratory Technician

Signature

Approved by: **Sven Kühn** **Deputy Manager**

Issued: April 29, 2020

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



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

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	403.411 $\pm$ 0.02% (k=2)	403.452 $\pm$ 0.02% (k=2)	403.463 $\pm$ 0.02% (k=2)
Low Range	3.96158 $\pm$ 1.50% (k=2)	3.98747 $\pm$ 1.50% (k=2)	3.99174 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	113.5 ° $\pm$ 1 °
---	-------------------

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	200024.85	-8.32	-0.00
Channel X + Input	20005.36	0.39	0.00
Channel X - Input	-20003.50	2.72	-0.01
Channel Y + Input	200030.06	-2.90	-0.00
Channel Y + Input	20004.14	-0.70	-0.00
Channel Y - Input	-20008.00	-1.63	0.01
Channel Z + Input	200034.52	1.89	0.00
Channel Z + Input	20005.02	0.16	0.00
Channel Z - Input	-20007.28	-0.87	0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2000.94	0.03	0.00
Channel X + Input	200.94	0.01	0.01
Channel X - Input	-198.93	0.16	-0.08
Channel Y + Input	2000.58	-0.17	-0.01
Channel Y + Input	199.97	-0.81	-0.40
Channel Y - Input	-200.24	-0.99	0.50
Channel Z + Input	2000.83	0.21	0.01
Channel Z + Input	199.97	-0.67	-0.34
Channel Z - Input	-199.90	-0.63	0.32

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	23.26	21.16
	- 200	-21.29	-22.70
Channel Y	200	-27.83	-28.04
	- 200	26.48	26.49
Channel Z	200	-11.47	-11.06
	- 200	9.80	9.70

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	1.92	-3.40
Channel Y	200	8.27	-	3.32
Channel Z	200	9.47	5.42	-

4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15579	16774
Channel Y	16044	14871
Channel Z	16074	16518

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.87	-0.93	1.98	0.46
Channel Y	-0.62	-1.71	0.15	0.38
Channel Z	-0.46	-1.45	0.52	0.39

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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



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 **Sporton**

Certificate No: **EX3-3857_Sep20**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3857**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 25, 2020**

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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
DAE4	SN: 660	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-20
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

Calibrated by:	Name Leif Klysner	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: September 30, 2020			



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., $\vartheta = 0$ 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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 $\vartheta = 0$ ($f \leq 900$ 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).

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.18	0.43	0.46	± 10.1 %
DCP (mV) ^B	99.3	100.5	102.2	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	182.0	± 3.0 %	± 4.7 %
		Y	0.0	0.0	1.0		178.6		
		Z	0.0	0.0	1.0		188.1		

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

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Page 5).

^B Numerical linearization parameter; uncertainty not required.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-118.9
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

Note: Measurement distance from surface can be increased to 3-4 mm for an *Area Scan* job.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3857

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
750	41.9	0.89	9.50	9.50	9.50	0.32	0.99	± 12.0 %
835	41.5	0.90	9.18	9.18	9.18	0.45	0.80	± 12.0 %
900	41.5	0.97	9.10	9.10	9.10	0.47	0.80	± 12.0 %
1750	40.1	1.37	8.06	8.06	8.06	0.27	0.86	± 12.0 %
1900	40.0	1.40	7.81	7.81	7.81	0.37	0.86	± 12.0 %
2000	40.0	1.40	7.78	7.78	7.78	0.40	0.86	± 12.0 %
2300	39.5	1.67	7.56	7.56	7.56	0.31	0.92	± 12.0 %
2450	39.2	1.80	7.44	7.44	7.44	0.40	0.92	± 12.0 %
2600	39.0	1.96	7.19	7.19	7.19	0.37	0.92	± 12.0 %
3300	38.2	2.71	6.70	6.70	6.70	0.30	1.35	± 14.0 %
3500	37.9	2.91	6.67	6.67	6.67	0.30	1.35	± 14.0 %
3700	37.7	3.12	6.61	6.61	6.61	0.30	1.35	± 14.0 %
3900	37.5	3.32	6.58	6.58	6.58	0.40	1.50	± 14.0 %
4100	37.2	3.53	6.08	6.08	6.08	0.35	1.50	± 14.0 %
4200	37.1	3.63	5.99	5.99	5.99	0.35	1.50	± 14.0 %
4400	36.9	3.84	5.93	5.93	5.93	0.35	1.70	± 14.0 %
4600	36.7	4.04	5.91	5.91	5.91	0.40	1.70	± 14.0 %
4800	36.4	4.25	5.76	5.76	5.76	0.40	1.80	± 14.0 %
4950	36.3	4.40	5.45	5.45	5.45	0.40	1.80	± 14.0 %
5250	35.9	4.71	5.04	5.04	5.04	0.40	1.80	± 14.0 %
5600	35.5	5.07	4.67	4.67	4.67	0.40	1.80	± 14.0 %
5750	35.4	5.22	4.93	4.93	4.93	0.40	1.80	± 14.0 %

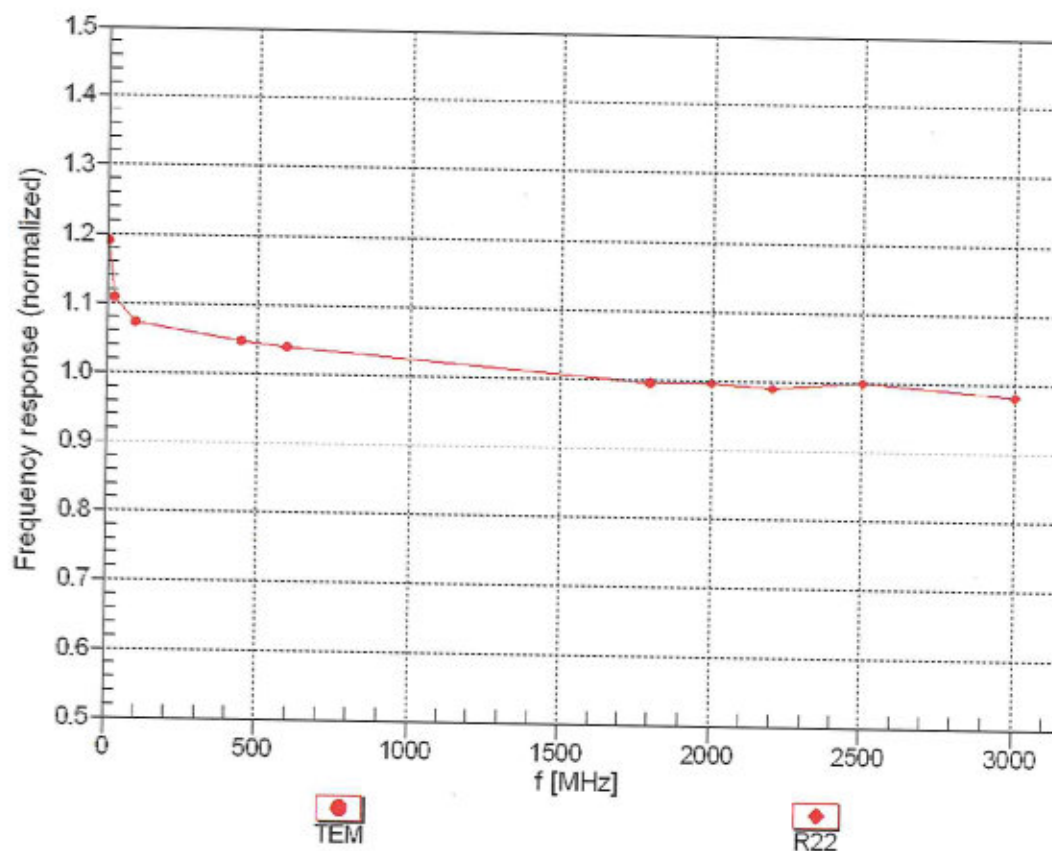
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequencies up to 6 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. 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.

Frequency Response of E-Field

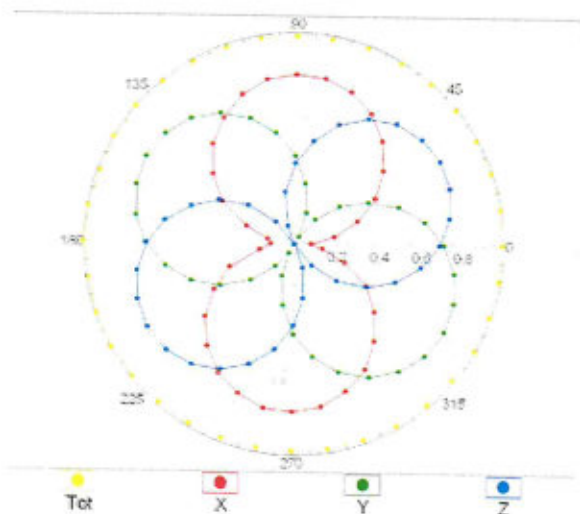
(TEM-Cell:ifi110 EXX, Waveguide: R22)



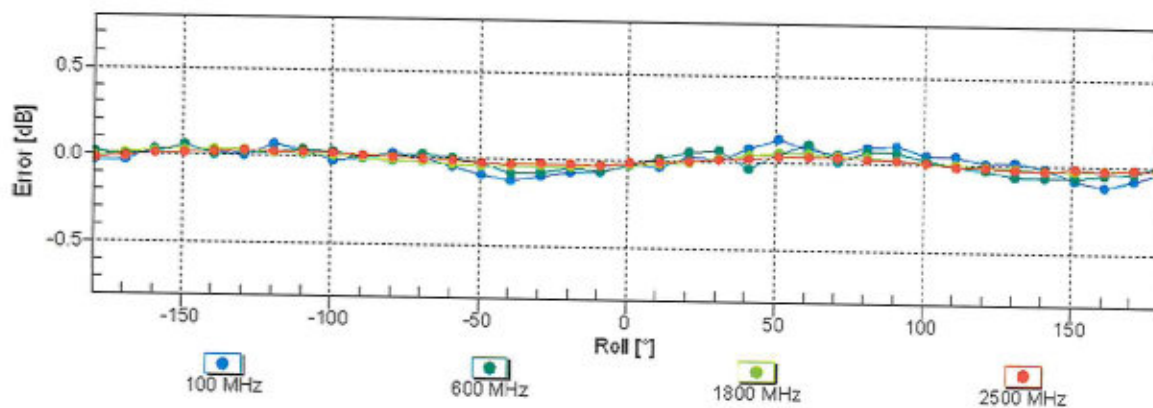
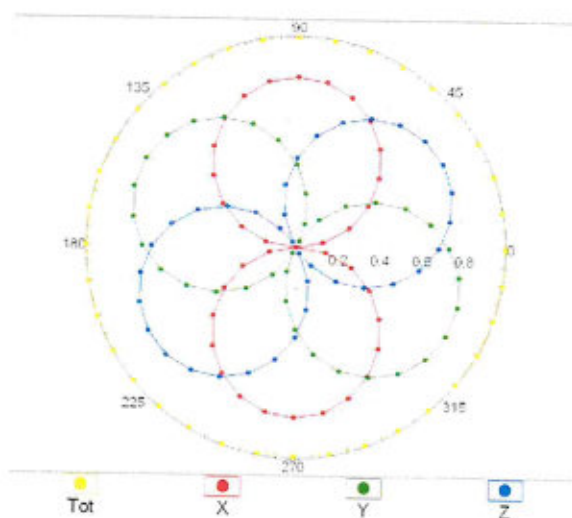
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz, TEM

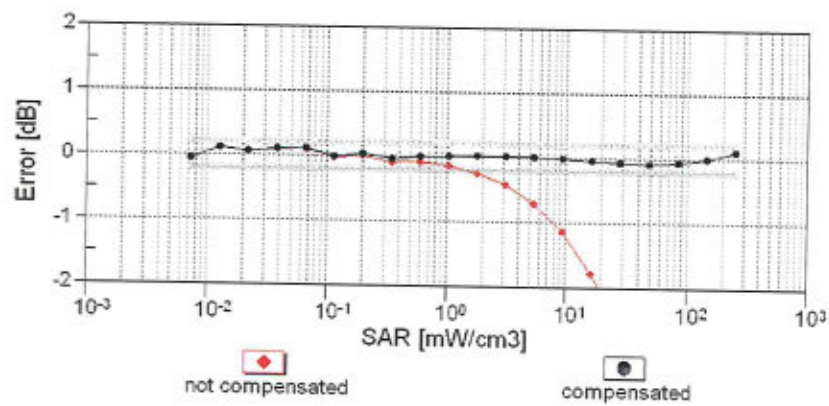
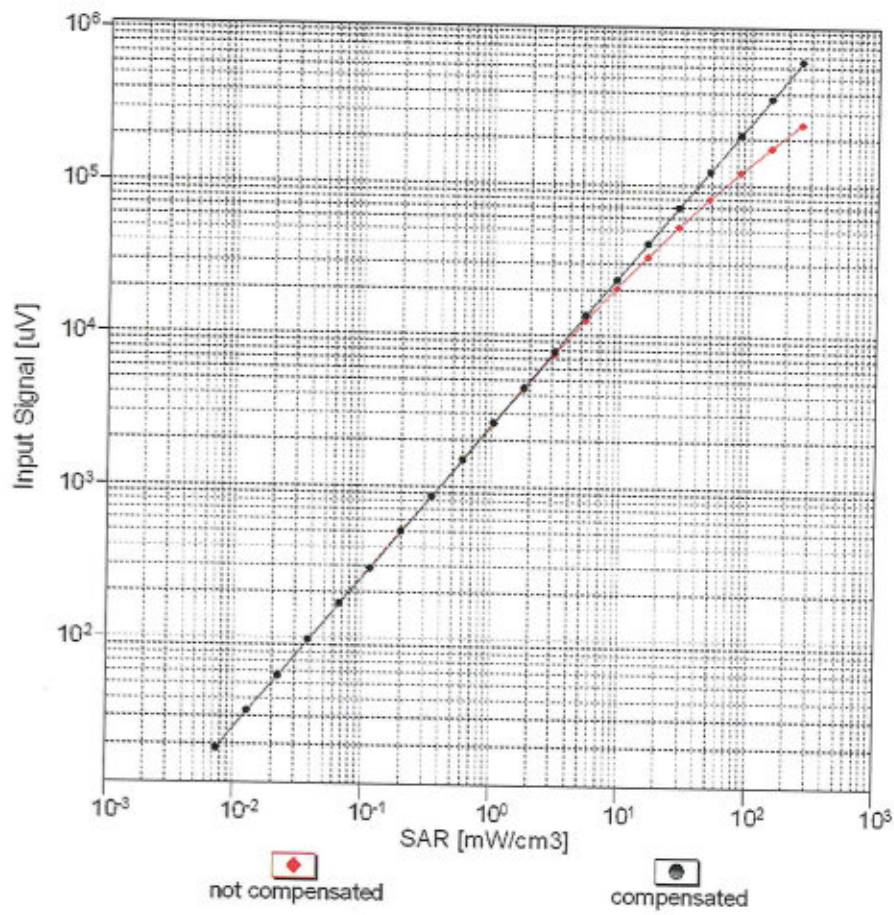


f=1800 MHz, R22



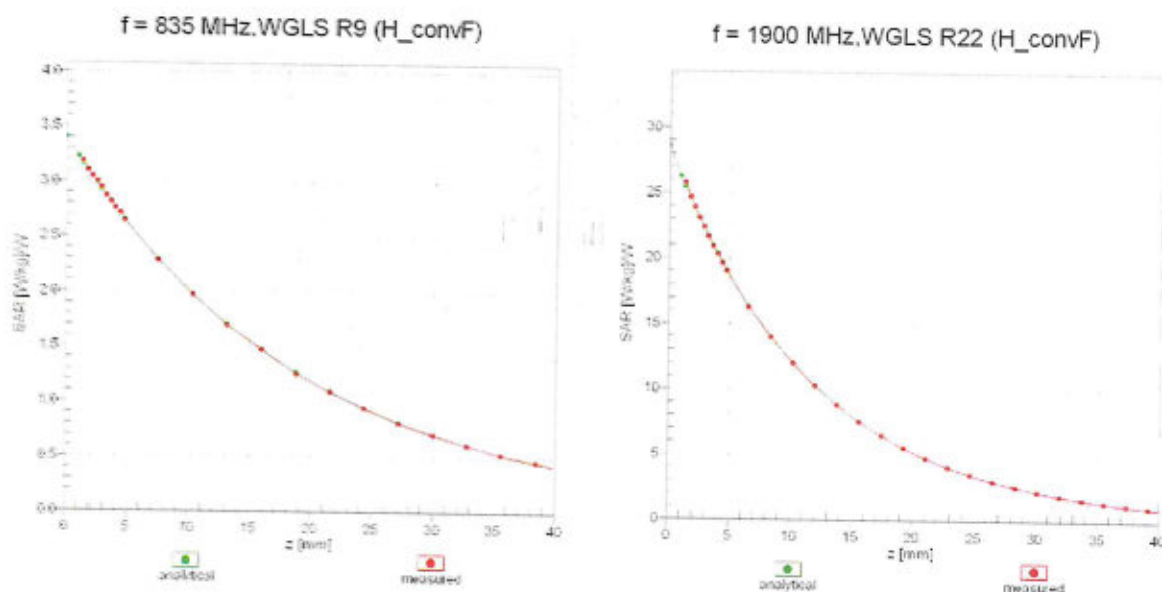
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



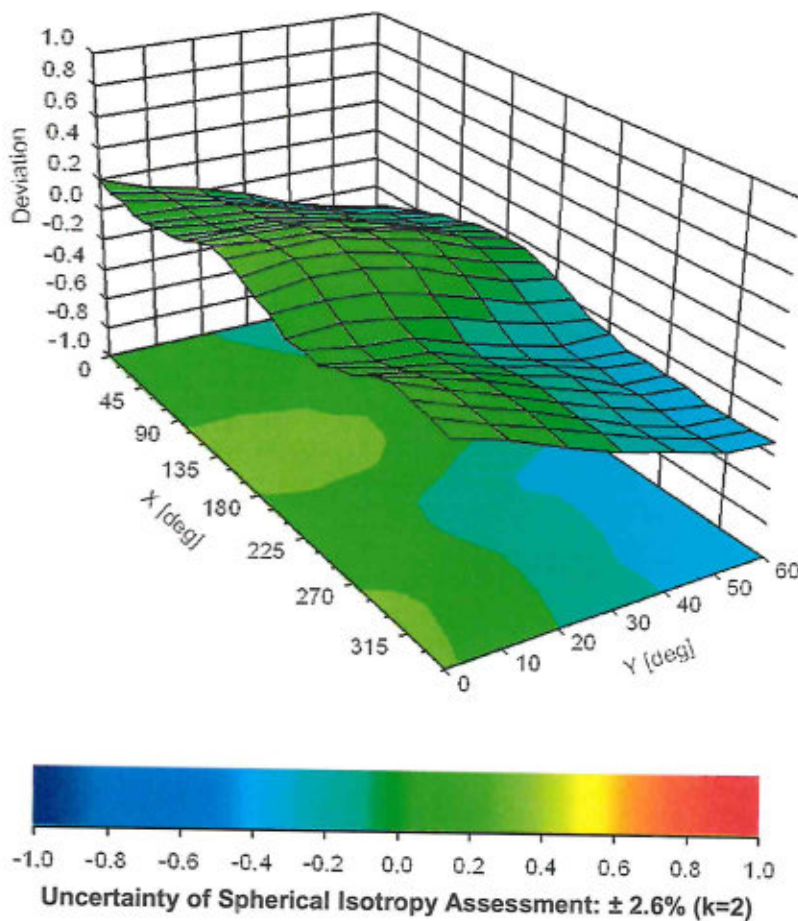
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$





Appendix E. Conducted RF Output Power Table

The detailed power tables are shown as follows.

Full Power

Band 41 (2.6G Band)										
BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low Middle Ch. / Freq.	Power Middle Ch. / Freq.	Power High Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				39750	40185	40620	41055	41490	24	0
Frequency (MHz)				2506	2549.5	2593	2636.5	2680		
20	QPSK	1	0	23.48	23.55	23.63	23.51	23.42	23	1
20	QPSK	1	49	23.60	23.54	23.28	23.18	23.28		
20	QPSK	1	99	23.58	23.61	23.28	23.40	23.42		
20	QPSK	50	0	22.49	22.55	22.56	22.49	22.38		
20	QPSK	50	24	22.55	22.49	22.44	22.33	22.38	23	1
20	QPSK	100	0	22.45	22.41	22.49	22.48	22.42		
20	16QAM	1	49	22.67	22.58	22.47	22.40	22.23		
20	16QAM	1	99	22.45	22.41	22.35	22.32	22.18		
20	16QAM	50	0	21.50	21.57	21.47	21.53	21.47	22	2
20	16QAM	50	24	21.61	21.65	21.56	21.57	21.56		
20	16QAM	50	50	21.59	21.54	21.51	21.42	21.38		
20	16QAM	100	0	21.55	21.57	21.46	21.49	21.52		
20	64QAM	1	0	21.39	21.49	21.36	21.31	21.29	22	2
20	64QAM	1	49	21.59	21.57	21.50	21.46	21.35		
20	64QAM	1	99	21.41	21.30	21.22	21.23	21.35		
20	64QAM	50	0	20.50	20.63	20.48	20.55	20.38		
20	64QAM	50	24	20.67	20.65	20.59	20.59	20.21	21	3
20	64QAM	50	50	20.58	20.57	20.53	20.45	20.28		
20	64QAM	100	0	20.56	20.55	20.44	20.51	20.45		
Channel				39725	40173	40620	41068	41515	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				2503.5	2548.3	2593	2637.8	2682.5		
15	QPSK	1	0	23.52	23.55	23.48	23.45	23.35	23	0
15	QPSK	1	37	23.58	23.53	23.51	23.55	23.50		
15	QPSK	1	74	23.55	23.50	23.42	23.40	23.34		
15	QPSK	36	0	22.49	22.59	22.43	22.50	22.40		
15	QPSK	36	20	22.56	22.57	22.49	22.52	22.49	23	1
15	QPSK	36	39	22.55	22.53	22.45	22.40	22.35		
15	QPSK	75	0	22.51	22.54	22.46	22.45	22.38		
15	16QAM	1	0	22.58	22.64	22.54	22.50	22.44		
15	16QAM	1	37	22.68	22.67	22.57	22.56	22.56	23	1
15	16QAM	1	74	22.58	22.50	22.45	22.44	22.31		
15	16QAM	36	0	21.45	21.54	21.42	21.45	21.48		
15	16QAM	36	20	21.55	21.51	21.48	21.49	21.54		
15	16QAM	36	39	21.53	21.51	21.40	21.36	21.44	22	2
15	16QAM	75	0	21.60	21.54	21.50	21.47	21.45		
15	64QAM	1	0	21.53	21.56	21.44	21.41	21.34		
15	64QAM	1	37	21.61	21.60	21.49	21.50	21.42		
15	64QAM	1	74	21.49	21.45	21.32	21.32	21.27	22	2
15	64QAM	36	0	20.50	20.58	20.45	20.46	20.48		
15	64QAM	36	20	20.59	20.58	20.45	20.47	20.58		
15	64QAM	36	39	20.56	20.50	20.45	20.38	20.44		
15	64QAM	75	0	20.60	20.57	20.56	20.50	20.44		
Channel				39700	40160	40620	41080	41540	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				2501	2547	2593	2639	2685		
10	QPSK	1	0	23.56	23.50	23.49	23.40	23.40	23	0
10	QPSK	1	25	23.52	23.58	23.50	23.48	23.50		
10	QPSK	1	49	23.59	23.51	23.46	23.44	23.37		
10	QPSK	25	0	22.51	22.55	22.45	22.46	22.44		
10	QPSK	25	12	22.56	22.55	22.48	22.47	22.46	23	1
10	QPSK	25	25	22.60	22.54	22.46	22.38	22.42		
10	QPSK	50	0	22.56	22.57	22.48	22.40	22.41		
10	16QAM	1	0	22.65	22.70	22.59	22.53	22.52		
10	16QAM	1	25	22.71	22.68	22.57	22.55	22.55	23	1
10	16QAM	1	49	22.61	22.59	22.53	22.50	22.42		
10	16QAM	25	0	21.53	21.57	21.46	21.47	21.45		
10	16QAM	25	12	21.54	21.57	21.50	21.51	21.48		
10	16QAM	25	25	21.55	21.54	21.53	21.40	21.37	22	2
10	16QAM	50	0	21.62	21.63	21.57	21.46	21.46		
10	64QAM	1	0	21.56	21.60	21.50	21.41	21.32		
10	64QAM	1	25	21.59	21.57	21.48	21.47	21.40		
10	64QAM	1	49	21.51	21.43	21.42	21.40	21.25	21	3
10	64QAM	25	0	20.58	20.64	20.51	20.48	20.43		
10	64QAM	25	12	20.62	20.67	20.56	20.56	20.49		
10	64QAM	25	25	20.67	20.59	20.59	20.48	20.39		
Channel				39675	40148	40620	41093	41565	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				2498.5	2545.8	2593	2640.20	2687.5		
5	QPSK	1	0	23.43	23.45	23.36	23.37	23.49	24	0
5	QPSK	1	12	23.51	23.57	23.43	23.46	23.53		
5	QPSK	1	24	23.44	23.41	23.32	23.29	23.45		
5	QPSK	12	0	22.53	22.57	22.44	22.47	22.47		
5	QPSK	12	7	22.56	22.60	22.50	22.50	22.48	23	1
5	QPSK	12	13	22.52	22.55	22.46	22.40	22.43		
5	QPSK	25	0	22.48	22.50	22.38	22.40	22.46		
5	16QAM	1	0	22.52	22.56	22.44	22.42	22.54		
5	16QAM	1	12	22.62	22.70	22.53	22.53	22.61	23	1
5	16QAM	1	24	22.56	22.56	22.42	22.41	22.45		
5	16QAM	12	0	21.48	21.51	21.39	21.41	21.49		
5	16QAM	12	7	21.48	21.52	21.39	21.40	21.51		
5	16QAM	12	13	21.45	21.45	21.35	21.32	21.43	22	2
5	16QAM	25	0	21.50	21.53	21.43	21.44	21.53		
5	64QAM	1	0	21.44	21.50	21.38	21.33	21.33		
5	64QAM	1	12	21.54	21.57	21.45	21.44	21.41		
5	64QAM	1	24	21.45	21.44	21.32	21.29	21.33	22	2
5	64QAM	12	0	20.52	20.59	20.45	20.50	20.54		
5	64QAM	12	7	20.56	20.63	20.43	20.49	20.58		
5	64QAM	12	13	20.54	20.58	20.43	20.41	20.47		
5	64QAM	25	0	20.55	20.61	20.48	20.46	20.53	21	3
5	64QAM	25	0	20.55	20.61	20.48	20.46	20.53		
5	64QAM	25	0	20.55	20.61	20.48	20.46	20.53		
5	64QAM	25	0	20.55	20.61	20.48	20.46	20.53		

Band 41 (2.6G Band) HPUE (Limit 27)										
BW (MHz)	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low Middle Ch. / Freq.	Power Middle Ch. / Freq.	Power High Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dbm)	MPR (db)
Channel				39750	40185	40620	41055	41490	26	0
Frequency (MHz)				2506	2549.5	2593	2636.5	2680		
20	QPSK	1	0	25.01	25.04	25.17	24.98	25.09	26	0
20	QPSK	1	49	25.12	25.15	25.10	24.84	24.92		
20	QPSK	1	99	24.72	24.75	24.76	24.77	24.75		
20	QPSK	50	0	24.05	23.99	24.10	23.83	23.84		
20	QPSK	50	24	24.05	24.00	23.82	23.93	23.87	25	1
20	QPSK	50	50	23.98	23.83	23.74	23.88	23.81		
20	QPSK	100	0	23.96	23.91	24.00	23.88	23.85		
20	16QAM	1	0	24.19	24.06	23.91	24.09	24.00		
20	16QAM	1	49	24.35	24.26	24.05	24.12	24.06	25	1
20	16QAM	1	99	24.00	24.08	24.05	24.07	23.86		
20	16QAM	50	0	22.98	22.99	22.78	22.86	22.83		
20	16QAM	50	24	23.03	23.03	22.81	22.90	22.86		
20	16QAM	50	50	22.87	22.83	22.76	22.87	22.76	24	2
20	16QAM	100	0	22.92	22.88	22.76	22.84	22.90		
20	64QAM	1	0	23.13	22.98	22.92	22.96	22.96		
20	64QAM	1	49	23.22	23.15	22.97	23.12	23.04		
20	64QAM	1	99	22.93	23.06	22.86	22.98	22.88	23	3
20	64QAM	50	0	22.01	22.01	21.84	21.92	21.90		
20	64QAM	50	24	22.05	22.02	21.86	21.96	21.88		
20	64QAM	50	50	21.99	21.83	21.82	21.98	21.78		
20	64QAM	100	0	21.96	21.88	21.80	21.89	21.80		
Channel				39725	40173	40620	41068	41515	25	1
Frequency (MHz)				2503.5	2546.3	2593	2637.5	2682.5		
15	QPSK	1	0	24.86	24.83	24.81	24.86	24.85	26	0
15	QPSK	1	37	24.98	24.93	24.82	24.85	24.88		
15	QPSK	1	74	24.86	24.86	24.80	24.86	24.82		
15	QPSK	36	0	23.97	23.94	23.84	23.84	23.91		
15	QPSK	36	20	24.03	23.94	23.84	23.93	23.90	25	1
15	QPSK	36	39	23.96	23.91	23.78	23.90	23.81		
15	QPSK	75	0	24.00	23.95	23.84	23.92	23.88		
15	16QAM	1	0	24.23	24.08	24.01	24.08	24.11		
15	16QAM	1	37	24.26	24.13	23.99	24.16	24.09	25	1
15	16QAM	1	74	24.13	24.22	24.00	24.11	23.91		
15	16QAM	36	0	22.96	22.95	22.82	22.84	22.89		
15	16QAM	36	20	23.03	22.96	22.83	22.93	22.87		
15	16QAM	36	39	22.98	22.94	22.76	22.92	22.78	24	2
15	16QAM	75	0	23.00	22.94	22.80	22.88	22.84		
15	64QAM	1	0	23.13	23.03	22.96	23.11	22.96		
15	64QAM	1	37	23.25	23.22	22.94	23.12	22.93		
15	64QAM	1	74	23.08	23.16	22.92	23.02	22.94	24	2
15	64QAM	1	0	22.00	21.98	21.81	21.90	21.87		
15	64QAM	36	20	22.07	22.00	21.88	21.98	21.89		
15	64QAM	36	39	22.02	22.00	21.82	21.97	21.81		
15	64QAM	75	0	22.01	21.95	21.85	21.95	21.83	23	3
Channel				39700	40160	40620	41080	41540		
Frequency (MHz)				2497.5	2543.7	2593	2635.7	2681.7		
10	QPSK	1	0	24.93	24.87	24.71	24.77	24.73		
10	QPSK	1	25	24.93	24.93	24.80	24.88	24.84		
10	QPSK	1	49	24.91	24.90	24.66	24.77	24.73		
10	QPSK	25	0	23.95	24.00	23.78	23.83	23.86		
10	QPSK	25	12	23.99	23.99	23.80	23.89	23.78	25	1
10	QPSK	25	25	23.95	23.88	23.77	23.87	23.85		
10	QPSK	50	0	23.97	23.97	23.78	23.86	23.84		
10	16QAM	1	0	24.29	24.24	23.93	23.98	23.98		
10	16QAM	1	25	24.30	24.25	23.92	24.14	23.97	25	1
10	16QAM	1	49	24.15	24.26	23.92	24.01	23.88		
10	16QAM	25	0	22.99	23.03	22.75	22.80	22.84		
10	16QAM	25	12	23.03	23.04	22.76	22.89	22.84		
10	16QAM	25	25	22.98	22.93	22.73	22.83	22.73	24	2
10	16QAM	50	0	22.98	22.97	22.76	22.85	22.81		
10	64QAM	1	0	23.14	23.09	22.80	22.95	22.90		
10	64QAM	1	25	23.26	23.19	22.98	23.12	22.96		
10	64QAM	1	49	23.13	23.17	22.84	22.93	22.81	24	2
10	64QAM	25	0	22.01	22.06	21.82	21.90	21.86		
10	64QAM	25	12	22.06	22.04	21.88	21.97	21.88		
10	64QAM	25	25	22.01	21.95	21.80	21.95	21.87		
10	64QAM	50	0	21.98	21.99	21.80	21.90	21.73	23	3
Channel				39675	40143	40620	41053	41553		
Frequency (MHz)				2495.5	2545.8	2593	2640.30	2687.5		
5	QPSK	1	0	24.84	24.80	24.77	24.82	24.80		
5	QPSK	1	12	24.94	24.97	24.82	24.83	24.88		
5	QPSK	1	24	24.85	24.84	24.76	24.77	24.75		
5	QPSK	12	0	23.87	23.92	23.80	23.83	23.84		
5	QPSK	12	7	24.02	23.99	23.82	23.93	23.87	25	1
5	QPSK	12	13	23.98	23.88	23.74	23.88	23.81		
5	QPSK	25	0	23.99	23.95	23.80	23.88	23.85		
5	16QAM	1	0	24.07	24.17	23.91	24.09	24.00		
5	16QAM	12	0	24.30	24.24	24.06	24.12	24.06	25	1
5	16QAM	1	24	24.18	24.15	24.05	24.07	23.86		
5	16QAM	12	0	22.96	22.96	22.78	22.86	22.83		
5	16QAM	12	7	23.08	23.03	22.81	22.90	22.86		
5	16QAM	12	13	22.96	22.90	22.76	22.87	22.76	24	2
5	16QAM	25	0	23.02	22.90	22.78	22.84	22.80		
5	64QAM	1	0	23.10	23.04	22.92	22.96	22.92		
5	64QAM	1	12	23.20	23.20	22.97	23.12	23.04		
5	64QAM	1	24	23.04	23.08	22.86	22.98	22.88	24	2
5	64QAM	12	0	22.03	22.02	21.84	21.92	21.90		
5	64QAM	12	7	22.08	22.10	21.86	21.96	21.88		
5	64QAM	12	13	22.04	22.01	21.82	21.98	21.78		
5	64QAM	25	0	22.04	22.01	21.80	21.89	21.80	23	3

Reduced Power for Sensor On

Band 41 (2.6G Band) PC3/HPUE

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low-Middle Ch. / Freq.	Power Middle Ch. / Freq.	Power High-Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				39750	40185	40620	41055	41490	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				2506	2549.5	2593	2636.5	2680		
20	QPSK	1	0	13.56	13.70	13.76	13.27	13.41	14	0
20	QPSK	1	49	13.46	13.71	13.52	13.43	13.73		
20	QPSK	1	99	13.36	13.58	13.65	13.36	13.31		
20	QPSK	50	0	13.09	13.26	13.61	13.46	13.32		
20	QPSK	50	24	13.16	13.28	13.53	13.43	13.19	14	0
20	QPSK	50	50	13.23	13.32	13.43	13.31	13.24		
20	QPSK	100	0	13.10	13.25	13.53	13.41	13.48		
20	16QAM	1	0	13.27	13.55	13.35	13.21	13.35		
20	16QAM	1	49	13.26	13.46	13.34	13.37	13.42	14	0
20	16QAM	1	99	13.74	13.71	13.59	13.29	13.35		
20	16QAM	50	0	13.04	13.20	13.15	13.10	13.19		
20	16QAM	50	24	13.09	13.26	13.18	13.18	13.22		
20	16QAM	50	50	13.21	13.26	13.03	13.03	13.15	14	0
20	16QAM	100	0	13.12	13.26	13.16	13.10	13.21		
20	64QAM	1	0	13.16	13.37	13.24	13.11	13.25		
20	64QAM	1	49	13.20	13.32	13.24	13.26	13.38		
20	64QAM	1	99	13.62	13.65	13.48	13.18	13.24	14	0
20	64QAM	50	0	13.10	13.22	13.15	13.14	13.26		
20	64QAM	50	24	13.12	13.24	13.16	13.20	13.32		
20	64QAM	50	50	13.22	13.29	13.02	12.99	13.13		
20	64QAM	100	0	13.05	13.22	13.15	13.15	13.23	Tune-up limit (dBm)	MPR (dB)
Channel				39725	40173	40620	41068	41515		
Frequency (MHz)				2503.5	2546.3	2593	2637.8	2682.5		
15	QPSK	1	0	13.15	13.32	13.33	13.56	13.64	14	0
15	QPSK	1	37	13.42	13.68	13.48	13.30	13.44		
15	QPSK	1	74	13.27	13.42	13.20	13.36	13.43		
15	QPSK	36	0	13.11	13.23	13.07	13.38	13.53		
15	QPSK	36	20	13.08	13.20	13.06	13.35	13.50	14	0
15	QPSK	36	36	12.98	13.22	13.04	13.31	13.46		
15	QPSK	75	0	13.07	13.19	13.04	13.31	13.48		
15	16QAM	1	0	13.55	13.71	13.65	13.27	13.48		
15	16QAM	1	37	13.44	13.58	13.22	13.27	13.50	14	0
15	16QAM	1	74	13.46	13.50	13.39	13.36	13.36		
15	16QAM	36	0	13.07	13.20	13.11	13.00	13.12		
15	16QAM	36	20	13.09	13.21	13.04	13.01	13.27		
15	16QAM	36	36	13.00	13.17	13.01	12.98	13.09	14	0
15	16QAM	75	0	13.06	13.22	13.05	12.99	13.15		
15	64QAM	1	0	13.45	13.66	13.56	13.29	13.45		
15	64QAM	1	37	13.08	13.25	13.00	13.08	13.34		
15	64QAM	1	74	13.35	13.49	13.29	13.14	13.24	14	0
15	64QAM	36	0	13.06	13.28	13.14	13.07	13.23		
15	64QAM	36	20	13.14	13.28	13.04	13.05	13.28		
15	64QAM	36	36	13.05	13.20	13.02	13.03	13.19		
15	64QAM	75	0	13.09	13.26	13.07	13.07	13.22	Tune-up limit (dBm)	MPR (dB)
Channel				39700	40160	40620	41080	41540		
Frequency (MHz)				2501	2547	2593	2639	2685		
10	QPSK	1	0	13.23	13.46	13.28	13.47	13.64	14	0
10	QPSK	1	25	13.41	13.41	13.34	13.46	13.43		
10	QPSK	1	49	13.56	13.59	13.09	13.67	13.61		
10	QPSK	25	0	12.98	12.93	13.03	13.38	13.42		
10	QPSK	25	12	13.03	13.06	12.95	13.48	13.45	14	0
10	QPSK	25	25	13.05	13.09	12.99	13.51	13.57		
10	QPSK	50	0	12.99	13.08	12.99	13.42	13.49		
10	16QAM	1	0	12.96	12.95	13.49	13.49	13.66		
10	16QAM	1	25	13.34	13.41	13.19	13.33	13.42	14	0
10	16QAM	1	49	13.66	13.66	13.15	13.65	13.64		
10	16QAM	25	0	13.00	12.82	13.05	13.10	13.13		
10	16QAM	25	12	12.99	13.07	12.99	13.16	13.17		
10	16QAM	25	25	13.14	13.08	12.94	13.21	13.30	14	0
10	16QAM	50	0	13.02	13.02	12.93	13.18	13.27		
10	64QAM	1	0	12.91	12.99	13.51	13.56	13.62		
10	64QAM	1	25	13.10	13.13	12.88	13.26	13.20		
10	64QAM	1	49	13.59	13.55	13.06	13.59	13.73	14	0
10	64QAM	25	0	13.00	12.87	13.05	13.07	13.13		
10	64QAM	25	12	13.04	13.09	12.82	13.15	13.18		
10	64QAM	25	25	13.17	13.08	12.89	13.14	13.34		
10	64QAM	50	0	13.01	13.05	13.00	13.16	13.25	Tune-up limit (dBm)	MPR (dB)
Channel				39675	40148	40620	41093	41565		
Frequency (MHz)				2498.5	2545.8	2593	2640.3	2687.5		
5	QPSK	1	0	12.99	13.25	13.29	13.53	13.57	14	0
5	QPSK	1	12	13.22	13.24	12.90	13.24	13.42		
5	QPSK	1	24	13.22	13.18	12.91	13.43	13.49		
5	QPSK	12	0	13.08	13.05	12.80	13.43	13.49		
5	QPSK	12	7	13.10	12.99	12.72	13.29	13.46	14	0
5	QPSK	12	13	12.89	12.99	12.65	13.29	13.46		
5	QPSK	25	0	13.06	13.00	12.76	13.31	13.43		
5	16QAM	1	0	13.44	13.46	13.14	13.45	13.46		
5	16QAM	1	12	13.30	13.27	12.99	13.24	13.38	14	0
5	16QAM	1	24	13.29	13.28	12.97	13.35	13.46		
5	16QAM	12	0	13.11	13.12	12.79	13.20	13.23		
5	16QAM	12	7	13.08	13.03	12.75	13.04	13.16		
5	16QAM	12	13	12.98	12.99	12.74	13.06	13.17	14	0
5	16QAM	25	0	13.07	13.03	12.76	13.01	13.18		
5	64QAM	1	0	13.27	13.23	13.08	13.28	13.44		
5	64QAM	1	12	13.14	13.15	12.90	13.30	13.25		
5	64QAM	1	24	13.13	13.11	12.85	13.23	13.29	14	0
5	64QAM	12	0	13.09	13.12	12.86	13.13	13.22		
5	64QAM	12	7	13.06	13.04	12.79	13.08	13.16		
5	64QAM	12	13	12.97	12.98	12.67	13.08	13.22		
5	64QAM	25	0	13.12	13.03	12.82	13.08	13.21	Tune-up limit (dBm)	MPR (dB)
Channel				39650	40125	40620	41093	41565		
Frequency (MHz)				2496	2543	2593	2640	2687		



2CA DL

Configure		CA List	PCC						SCC				Power		
			LTE	BW	UL	UL	Mod	UL#	UL	LTE	BW	DL	DL	With CA	Without CA
			Band	(MHz)	Freq	Channel		RB	RB	Band	(MHz)	Freq	Channel	Tx Power	Tx Power
					(MHz)				Offset			(MHz)		(dBm)	(dBm)
Intra-Band	Contiguous	CA_41C(4x4 MIMO)	Band 41	20M	2593	40620	QPSK	1	0	Band 41	20M	2612.8	40618	23.43	23.63

Full Power						
2.4GHz WLAN				Ant 1		
2.4GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11b 1Mbps	1	2412	17.87	19.00	98.93
		6	2437	17.99	19.00	
		11	2462	17.83	19.00	
	802.11g 6Mbps	1	2412	16.00	17.00	97.47
		6	2437	15.83	17.00	
		11	2462	15.79	17.00	
	802.11n-HT20 MCS0	1	2412	14.99	16.00	97.30
		6	2437	14.77	16.00	
		11	2462	14.76	16.00	
	802.11n-HT40 MCS0	3	2422	14.09	15.00	92.75
		6	2437	14.06	15.00	
		9	2452	13.18	15.00	

5.2GHz WLAN					Ant 1	
5.2GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	36	5180	16.01	17.00	97.88
		40	5200	16.16	17.00	
		44	5220	16.37	17.00	
		48	5240	16.18	17.00	
	802.11n-HT20 MCS0	36	5180	15.13	16.00	97.31
		40	5200	15.13	16.00	
		44	5220	15.04	16.00	
		48	5240	15.15	16.00	
	802.11n-HT40 MCS0	38	5190	15.86	17.00	94.90
		46	5230	15.95	17.00	
	802.11ac-VHT20 MCS0	36	5180	15.06	16.00	97.44
		40	5200	14.97	16.00	
		44	5220	15.12	16.00	
	802.11ac-VHT40 MCS0	48	5240	15.13	16.00	94.98
		38	5190	15.17	16.00	
		46	5230	15.09	16.00	
	802.11ac-VHT80 MCS0	42	5210	14.62	16.00	89.60

5.3GHz WLAN					Ant 1	
5.3GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	52	5260	16.07	17.00	97.88
		56	5280	16.06	17.00	
		60	5300	16.12	17.00	
		64	5320	16.09	17.00	
	802.11n-HT20 MCS0	52	5260	15.25	16.00	97.31
		56	5280	15.15	16.00	
		60	5300	14.73	16.00	
		64	5320	14.78	16.00	
	802.11n-HT40 MCS0	54	5270	16.21	17.00	94.90
		62	5310	16.15	17.00	
	802.11ac-VHT20 MCS0	52	5260	15.18	16.00	97.44
		56	5280	15.07	16.00	
		60	5300	15.22	16.00	
	802.11ac-VHT40 MCS0	64	5320	14.87	16.00	94.98
		54	5270	15.15	16.00	
		62	5310	15.11	16.00	
	802.11ac-VHT80 MCS0	58	5290	15.25	16.00	89.60

5.5GHz WLAN					Ant 1	
5.5GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	100	5500	16.08	17.00	97.88
		116	5580	16.09	17.00	
		124	5620	16.01	17.00	
		132	5660	15.86	17.00	
		140	5700	15.75	17.00	
		144	5720	15.79	17.00	
	802.11n-HT20 MCS0	100	5500	14.94	16.00	97.31
		116	5580	14.90	16.00	
		124	5620	14.78	16.00	
		132	5660	14.74	16.00	
		140	5700	14.81	16.00	
		144	5720	14.80	16.00	
	802.11n-HT40 MCS0	102	5510	15.92	17.00	94.90
		110	5550	15.90	17.00	
		126	5630	15.81	17.00	
		134	5670	16.11	17.00	
		142	5710	16.09	17.00	
		100	5500	14.90	16.00	
	802.11ac-VHT20 MCS0	116	5580	14.89	16.00	97.44
		124	5620	14.74	16.00	
		132	5660	14.79	16.00	
		140	5700	14.74	16.00	
		144	5720	14.65	16.00	
		102	5510	14.99	16.00	
	802.11ac-VHT40 MCS0	110	5550	15.00	16.00	94.98
		126	5630	15.18	16.00	
		134	5670	14.97	16.00	
		142	5710	14.90	16.00	
	802.11ac-VHT80 MCS0	106	5530	15.19	16.00	89.60
		122	5610	15.20	16.00	
		138	5690	15.11	16.00	

5.8GHz WLAN					Ant 1	
5.8GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	149	5745	16.12	17.00	97.88
		157	5785	16.06	17.00	
		165	5825	15.90	17.00	
	802.11n-HT20 MCS0	149	5745	15.01	16.00	97.31
		157	5785	14.83	16.00	
		165	5825	14.81	16.00	
	802.11n-HT40 MCS0	151	5755	16.19	17.00	94.90
		159	5795	16.06	17.00	
		149	5745	14.90	16.00	
	802.11ac-VHT20 MCS0	157	5785	14.93	16.00	97.44
		165	5825	14.63	16.00	
		151	5755	14.99	16.00	
	802.11ac-VHT40 MCS0	159	5795	15.02	16.00	94.98
		155	5775	15.02	16.00	
	802.11ac-VHT80 MCS0	155	5775	15.02	16.00	89.60



BT BR/EDR

Mode	Channel	Frequency (MHz)	Average power (dBm)		
			1Mbps	2Mbps	3Mbps
BR / EDR	CH 00	2402	9.50	7.15	7.11
	CH 39	2441	9.32	6.87	7.05
	CH 78	2480	9.12	6.83	6.97
Tune-up Limit			10.00	8.00	8.00

BT LE

Mode	Channel	Frequency (MHz)	Average power (dBm)
			GFSK
LE	CH 00	2402	2.69
	CH 19	2440	2.52
	CH 39	2480	4.27
Tune-up Limit			4.50

BT LE 5.0

Mode	Channel	Frequency (MHz)	Average power (dBm)
			1Mbps
LE	CH 00	2402	2.62
	CH 19	2440	3.03
	CH 39	2480	3.95
Tune-up Limit			4.50

Reduced Power for Sensor On

2.4GHz WLAN				Ant 1		
	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	11.11	12.00	98.93
		6	2437	11.28	12.00	
		11	2462	10.98	12.00	
	802.11g 6Mbps	1	2412	Not Required	12.00	97.47
		6	2437		12.00	
		11	2462		12.00	
	802.11n-HT20 MCS0	1	2412		12.00	97.30
		6	2437		12.00	
		11	2462		12.00	
	802.11n-HT40 MCS0	3	2422		12.00	92.75
		6	2437		12.00	
		9	2452		12.00	

5.2GHz WLAN				Ant 1		
	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	Not Required	15.00	97.88
		40	5200		15.00	
		44	5220		15.00	
		48	5240		15.00	
	802.11n-HT20 MCS0	36	5180		15.00	97.31
		40	5200		15.00	
		44	5220		15.00	
		48	5240		15.00	
	802.11n-HT40 MCS0	38	5190		15.00	94.90
		46	5230		15.00	
	802.11ac-VHT20 MCS0	36	5180		15.00	97.44
		40	5200		15.00	
		44	5220		15.00	
		48	5240		15.00	
	802.11ac-VHT40 MCS0	38	5190		15.00	94.98
		46	5230		15.00	
	802.11ac-VHT80 MCS0	42	5210		15.00	89.60

5.3GHz WLAN				Ant 1		
	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	Not Required	15.00	97.88
		56	5280		15.00	
		60	5300		15.00	
		64	5320		15.00	
	802.11n-HT20 MCS0	52	5260		15.00	97.31
		56	5280		15.00	
		60	5300		15.00	
		64	5320		15.00	
	802.11n-HT40 MCS0	54	5270		15.00	94.90
		62	5310		15.00	
		52	5260		15.00	
		56	5280		15.00	
	802.11ac-VHT20 MCS0	52	5260		15.00	97.44
		56	5280		15.00	
		60	5300		15.00	
		64	5320		15.00	
	802.11ac-VHT40 MCS0	54	5270		15.00	94.98
		62	5310		15.00	
	802.11ac-VHT80 MCS0	58	5290	14.81	15.00	89.60

5.5GHz WLAN				Ant 1		
	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	Not Required	15.00	97.88
		116	5580		15.00	
		124	5620		15.00	
		132	5660		15.00	
		140	5700		15.00	
		144	5720		15.00	
	802.11n-HT20 MCS0	100	5500		15.00	97.31
		116	5580		15.00	
		124	5620		15.00	
		132	5660		15.00	
		140	5700		15.00	
		144	5720		15.00	
	802.11n-HT40 MCS0	102	5510		15.00	94.90
		110	5550		15.00	
		126	5630		15.00	
		134	5670		15.00	
		142	5710		15.00	
		100	5500		15.00	
	802.11ac-VHT20 MCS0	116	5580		15.00	97.44
		124	5620		15.00	
		132	5660		15.00	
		140	5700		15.00	
		144	5720		15.00	
		102	5510		15.00	
	802.11ac-VHT40 MCS0	110	5550		15.00	94.98
		126	5630		15.00	
		134	5670		15.00	
		142	5710		15.00	
		106	5530	14.15	15.00	89.60
		122	5610	14.08	15.00	
	802.11ac-VHT80 MCS0	138	5690	14.13	15.00	

5.8GHz WLAN				Ant 1		
	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a 6Mbps	149	5745	Not Required	14.00	97.88
		157	5785		14.00	
		165	5825		14.00	
	802.11n-HT20 MCS0	149	5745		14.00	97.31
		157	5785		14.00	
		165	5825		14.00	
	802.11n-HT40 MCS0	151	5755		14.00	94.90
		159	5795		14.00	
		149	5745		14.00	
	802.11ac-VHT20 MCS0	157	5785		14.00	97.44
		165	5825		14.00	
		151	5755		14.00	
	802.11ac-VHT40 MCS0	159	5795		14.00	94.98
		155	5775	13.85	14.00	
	802.11ac-VHT80 MCS0					89.60