TEST REPORT

Dt&C

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1. Report No : DRRFCC2305-0040
2. Customer
   - Name : LG Electronics USA
   - Address : 111 Sylvan Avenue North Building Englewood Cliffs New Jersey United States 07632
3. Use of Report : FCC Class II permissive change
4. Product Name / Model Name : RF Module / LGSBWAC95

   FCC ID : BEJLGSBWAC95
5. FCC Regulation(s) : CFR 47 Part 2 subpart 2.1093

   Test Method Used : IEEE 1528-2013, IEC/IEEE 62209-1528

   FCC SAR KDB Publications (Details in test report)
6. Date of Test : 2023.03.27 ~ 2023.04.13
7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing
8. Testing Environment : Refer to attached test report
9. Test Result : Refer to attached test report.

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

Affirmation	Tested by Name : YeJin Seo (Signature)	Technical Manager Name : HakMin Kim (Signature)

2023 . 05 . 04 .

Dt&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description	Tested by	Reviewed by
DRRFCC2305-0040	May. 04, 2023	Initial issue	YeJin Seo	HakMin Kim

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1. DESCRIPTION OF DEVICE

1.1 General Information

EUT type	Display			
FCC ID	BEJLGSBWAC95			
Model Name	LGSBWAC95			
Product Marketing Name	LGSBWAC95			
Hardware Version Identification Number	ETWCFMBC01			
Firmware Version Identification Number	MT7668_V1.0			
Host Marketing Name	27LX5QKNA			
Equipment serial no.	Identical prototype			
FCC & ISED MRA Designation No.	KR0034			
ISED#	5740A			
Mode(s) of Operation	2.4 GHz W-LAN (802.11b/g/n HT20/n HT40), 5 GHz W-LAN (802.11a/n HT20/n HT40/ac VHT20/ ac VHT40/ ac VHT80)			
TX Frequency Range	**Band**	**Mode**	**Bandwidth**	**Frequency**
	2.4 GHz W-LAN	802.11b/g/n	HT20	2 412 MHz ~ 2 472 MHz
		802.11n	HT40	2 422 MHz ~ 2 452 MHz
	5.2 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 180 MHz ~ 5 240 MHz
		802.11n/ac	HT40/VHT40	5 190 MHz ~ 5 230 MHz
		802.11ac	VHT80	5 210 MHz
	5.3 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 260 MHz ~ 5 320 MHz
		802.11n/ac	HT40/VHT40	5 270 MHz ~ 5 310 MHz
		802.11ac	VHT80	5 290 MHz
	5.6 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 500 MHz ~ 5 720 MHz
		802.11n/ac	HT40/VHT40	5 510 MHz ~ 5 710 MHz
		802.11ac	VHT80	5 530 MHz, 5 690 MHz
	5.8 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 745 MHz ~ 5 825 MHz
		802.11n/ac	HT40/VHT40	5 755 MHz ~ 5 795 MHz
		802.11ac	VHT80	5 775 MHz
	Bluetooth	-	-	2 402 MHz ~ 2 480 MHz
RX Frequency Range	2.4 GHz W-LAN	802.11b/g/n	HT20	2 412 MHz ~ 2 472 MHz
		802.11n	HT40	2 422 MHz ~ 2 452 MHz
	5.2 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 180 MHz ~ 5 240 MHz
		802.11n/ac	HT40/VHT40	5 190 MHz ~ 5 230 MHz
		802.11ac	VHT80	5 210 MHz
	5.3 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 260 MHz ~ 5 320 MHz
		802.11n/ac	HT40/VHT40	5 270 MHz ~ 5 310 MHz
		802.11ac	VHT80	5 290 MHz
	5.6 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 500 MHz ~ 5 720 MHz
		802.11n/ac	HT40/VHT40	5 510 MHz ~ 5 710 MHz
		802.11ac	VHT80	5 530 MHz, 5 690 MHz
	5.8 GHz W-LAN	802.11a/n/ac	HT20/VHT20	5 745 MHz ~ 5 825 MHz
		802.11n/ac	HT40/VHT40	5 755 MHz ~ 5795 MHz
		802.11ac	VHT80	5 775 MHz
	Bluetooth	-	-	2 402 MHz ~ 2 480 MHz

Equipment Class	Band	Reported SAR	
		1 g SAR (W/kg)	
		SISO (Body)	MIMO (Body)
DTS	2.4 GHz W-LAN	0.22	0.23
U-NII-1	5.2 GHz W-LAN	0.73	0.97
U-NII-2A	5.3 GHz W-LAN	0.70	0.77
U-NII-2C	5.6 GHz W-LAN	0.47	0.99
U-NII-3	5.8 GHz W-LAN	1.25	**1.51**
DSS	Bluetooth	0.02	-
Simultaneous SAR per KDB 690783 D01v01r03		**1.53**	

FCC Equipment Class	Digital Transmission System (DTS) Unlicensed National Information Infrastructure (UNII)
Date(s) of Tests	2023.03.27 ~ 2023.04.13
Antenna Type	Internal Type Antenna
Note	● Bluetooth exempted, but SAR measured for simultaneous transmission.

1.2 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

1.3 Nominal and Maximum Output Power Specifications

The Nominal and Maximum Output Power Specifications are in section 7 of this test report.

1.4 Guidance Applied

- IEEE 1528-2013
- IEC/IEEE 62209-1528
- FCC KDB Publication 248227 D01v02r02 (802.11 Wi-Fi SAR)
- FCC KDB Publication 447498 D01v06 (General RF Exposure Guidance)
- FCC KDB Publication 648474 D04v01r03 (Handset SAR)
- FCC KDB Publication 690783 D01v01r03 (SAR Listings on Grants)
- FCC KDB Publication 865664 D01v01r04 (SAR Measurement 100 MHz to 6 GHz)
- FCC KDB Publication 865664 D02v01r02 (RF Exposure Reporting)
- October 2016 TCB Workshop Notes (Bluetooth Duty Factor)

1.5 Device Serial Numbers

The serial numbers used for each test are indicated alongside the results in Section 9.

1.6 FCC & ISED MRA test lab designation no. : KR0034

1.7 SAR Test Configurations and Exclusions

(A) WIFI & BT for body SAR configuration

Per FCC KDB 447498 D01v06, **the 1 g SAR exclusion threshold for distances < 50 mm** is defined by the following equation:

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

Table 1.1 SAR exclusion threshold for distances < 50 mm

Mode	Equation	Result	SAR exclusion threshold	Required SAR
Bluetooth	[(7.67/5)* √2.480]	2.4	3.0	X 1)
Bluetooth LE	[(6.67/5)* √2.480]	2.1	3.0	X

Note 1: Bluetooth exempted, but SAR measured for simultaneous transmission.

Per KDB Publication 447498 D01v06, the maximum power of the channel was rounded to the nearest mW before calculation.

(B) Tested sides for body SAR configuration

1) Per FCC KDB 447498 D01v06, **the 1 g SAR exclusion threshold for distances < 50 mm** is defined by the following equation:

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

Table 1.2 SAR Test Exclusion for Edges (Antennas < 50 mm)

Antenna	Band	Mode/ Band	Service	Tune up Max Power [mW]	Separation Distance [mm]				Calculated Threshold Power [mW]			
					Top	Bottom	Right	Left	Top	Bottom	Right	Left
Ant.1	DTS	802.11g	OFDM	39.81	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	5.2 (O)
	U-NII-1	802.11ac	OFDM	50.12	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	9.6 (O)
	U-NII-2A	802.11ac	OFDM	46.77	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	8.9 (O)
	U-NII-2C	802.11ac	OFDM	41.69	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	8.3 (O)
	U-NII-3	802.11ac	OFDM	74.13	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	14.8 (O)
Ant.2	DTS	802.11g	OFDM	39.81	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	5.2 (O)
	U-NII-1	802.11ac	OFDM	37.15	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	7.1 (O)
	U-NII-2A	802.11ac	OFDM	39.81	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	7.6 (O)
	U-NII-2C	802.11ac	OFDM	44.67	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	8.9 (O)
	U-NII-3	802.11ac	OFDM	70.79	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	14.2 (O)
MIMO	DTS	802.11ac	OFDM	79.43	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	15.1 (O)
	U-NII-1	802.11ac	OFDM	100.00	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	19.1 (O)
	U-NII-2A	802.11ac	OFDM	100.00	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	19.9 (O)
	U-NII-2C	802.11ac	OFDM	100.00	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	20.0 (O)
	U-NII-3	802.11ac	OFDM	158.49	121.0	230.0	629.4	12.0	> 50 mm 1)	> 50 mm 1)	> 50 mm 1)	31.7 (O)

Note 1: See Table 1.3

2) Per FCC KDB 447498 D01v06, the SAR exclusion threshold for distances > 50 mm is defined by the following equation: (the SAR test exclusion threshold is determined according to the following, and as illustrated in KDB 447498 Appendix B.)

2) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance – 50 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz

Table 1.3 SAR Test Exclusion for Edges (Antennas > 50 mm)

Antenna	Band	Mode/ Band	Service	Tune up Max Power [mW]	Separation Distance [mm]				Calculated Threshold Power [mW]			
					Top	Bottom	Right	Left	Top	Bottom	Right	Left
Ant.1	DTS	802.11g	OFDM	39.81	121.0	230.0	629.4	12.0	775.9 (X)	1865.9 (X)	5859.9 (X)	< 50 mm 1)
	U-NII-1	802.11ac	OFDM	50.12	121.0	230.0	629.4	12.0	775.7 (X)	1865.7 (X)	5859.7 (X)	< 50 mm 1)
	U-NII-2A	802.11n	OFDM	46.77	121.0	230.0	629.4	12.0	770.7 (X)	1860.7 (X)	5854.7 (X)	< 50 mm 1)
	U-NII-2C	802.11ac	OFDM	41.69	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)
	U-NII-3	802.11ac	OFDM	74.13	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)
Ant.2	DTS	802.11g	OFDM	39.81	121.0	230.0	629.4	12.0	775.9 (X)	1865.9 (X)	5859.9 (X)	< 50 mm 1)
	U-NII-1	802.11ac	OFDM	37.15	121.0	230.0	629.4	12.0	775.7 (X)	1865.7 (X)	5859.7 (X)	< 50 mm 1)
	U-NII-2A	802.11n	OFDM	39.81	121.0	230.0	629.4	12.0	770.7 (X)	1860.7 (X)	5854.7 (X)	< 50 mm 1)
	U-NII-2C	802.11ac	OFDM	44.67	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)
	U-NII-3	802.11ac	OFDM	70.79	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)
MIMO	DTS	802.11g	OFDM	79.43	121.0	230.0	629.4	12.0	775.9 (X)	1865.9 (X)	5859.9 (X)	< 50 mm 1)
	U-NII-1	802.11ac	OFDM	100.00	121.0	230.0	629.4	12.0	775.7 (X)	1865.7 (X)	5859.7 (X)	< 50 mm 1)
	U-NII-2A	802.11n	OFDM	100.00	121.0	230.0	629.4	12.0	770.7 (X)	1860.7 (X)	5854.7 (X)	< 50 mm 1)
	U-NII-2C	802.11ac	OFDM	100.00	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)
	U-NII-3	802.11ac	OFDM	158.49	121.0	230.0	629.4	12.0	769.4 (X)	1859.4 (X)	5853.4 (X)	< 50 mm 1)

Note 1: See Table 1.2

Antenna	Mode	EUT Sides for SAR Testing					
		Top	Bottom	Front	Rear	Right	Left
Ant.1	2.4 GHz W-LAN (802.11b/g/n HT20/n HT40)	X	X	O	O	X	O
	5 GHz W-LAN (802.11a/n HT20/n HT40/ac VHT20/ac VHT40/ac VHT80)	X	X	O	O	X	O
Ant.2	2.4 GHz W-LAN (802.11b/g/n HT20/n HT40)	X	X	O	O	X	O
	5 GHz W-LAN (802.11a/n HT20/n HT40/ac VHT20/ac VHT40/ac VHT80)	X	X	O	O	X	O
MIMO	2.4 GHz W-LAN (802.11b/g/n HT20/n HT40)	X	X	O	O	X	O
	5 GHz W-LAN (802.11a/n HT20/n HT40/ac VHT20/ac VHT40/ac VHT80)	X	X	O	O	X	O
Bluetooth	Bluetooth	X	X	O	O	X	O

Table 1.4 Determined EUT sides for SAR Testing

Note: Particular DUT edges were not required to be evaluated for SAR based on the SAR exclusion threshold in KDB 447498 D01v06.

2. INTROCUCTION

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

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 C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. The measurement procedure described in IEEE/ANSI C95.3-2002 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 (rate) of the incremental energy (dU) 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 (see Fig. 3.1)

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

Fig. 2.1 SAR Mathematical Equation

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

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

where:

σ = conductivity of the tissue-simulating material (S/m)

ρ = mass density of the tissue-simulating material (kg/m^3)

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.

3. DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to
FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 3.1) and IEEE1528-2013.

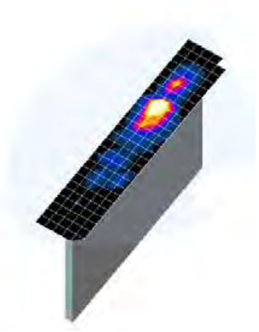

Figure 3.1
Sample SAR Area Scan

2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1 g/10 g cube evaluation. SAR at this fixed point was measured and used as a reference value.

3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 3.1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 3.1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1 g or 10 g) using a 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 then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

   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 was complete to calculate the SAR drift. If the drift deviated by more than 5 %, the SAR test and drift measurements were repeated.

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 mm ± 1 mm</td><td>½·δ·ln(2) mm ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">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 ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 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.</td></tr>
</table>

Table 3.1 Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

4. TEST CONFIGURATION POSITIONS FOR HANDSETS

4.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

4.2 Body-Worn Accessory Configurations

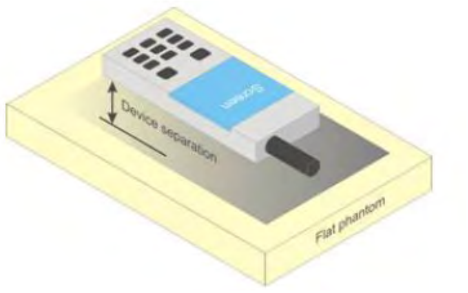

Figure 6.4 Sample Body-Worn Diagram

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6.4). Per FCC KDB Publication 648474 D04v01r03, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v06 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

5. RF EXPOSURE LIMITS

Uncontrolled Environment:

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 Environment:

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 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.

Table 5.1.SAR Human Exposure Specified in ANSI/IEEE C95.1-1992

	HUMAN EXPOSURE LIMITS	
	General Public Exposure (W/kg) or (mW/g)	Occupational Exposure (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	20.0

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams 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.

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).

6. FCC MEASUREMENT PROCEDURES

6.1 SAR Testing with 802.11 Transmitters

The normal network operating configurations are not suitable for measuring the SAR of 802.11 b/g/n transmitters. 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 248227D01v02r02 for more details.

6.1.1 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. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the 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.

6.1.2 U-NII and U-NII-2A

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following, with respect to the highest reported SAR and maximum output power specified for production units. The procedures are applied independently to each exposure configuration; for example, head, body, hotspot mode etc.

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.
2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, each band is tested independently for SAR.

6.1.3 U-NII-2C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380 MHz (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 Rader (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. When band gap channels are disabled, each band is tested independently according to the normally required OFDM SAR measurements and probe calibration frequency points requirements.

6.1.4 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 position 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, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8 W/kg or all test position are measured.

6.1.5 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a 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 in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration 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.

6.1.6 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. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a and 802.11n 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 80211n or 802.11g then 802.11n is used for SAR measurement. When the maximum output power ware 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.

6.1.7 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 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. 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.

6.1.8 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 procedure, when applicable. When the highest reported SAR for the initial test configuration, adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power is ≤ 1.2 W/kg, no additional SAR testing for the subsequent test configurations is required.

6.1.9 MIMO SAR considerations

Per KDB Publication 248227 D01v02r02, the simultaneous SAR provision in KDB Publication 447498 D01v06 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1 g 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.

7. RF CONDUCTED POWERS

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

7.1 WLAN Nominal and Maximum Output Power Spec and Conducted Powers

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
2.4	802.11b	1-11	14.00	13.00	14.00	13.00	17.00	16.00
	802.11g (6 Mbps)	1-11	16.00	15.00	16.00	15.00	19.00	17.00
	802.11n (HT20, MCS0)	1-11	15.00	14.00	15.00	14.00	18.00	17.00
	802.11n (HT40, MCS0)	3-9	14.00	13.00	14.00	13.00	17.00	16.00

Table 7.1.1 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11 (2.4 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11b	2 412	1	13.83	13.80	16.83
	2 437	6	13.04	13.87	16.49
	2 462	11	13.25	13.91	16.60
802.11g (6 Mbps)	2 412	1	15.91	15.98	18.96
	2 437	6	15.67	15.97	18.83
	2 462	11	15.48	15.81	18.66
802.11n (HT-20) (MCS0)	2 412	1	14.95	14.90	17.94
	2 437	6	14.80	14.95	17.89
	2 462	11	14.90	14.96	17.94
802.11n (HT-40) (MCS0)	2 422	3	13.84	13.77	16.82
	2 437	6	13.85	13.82	16.85
	2 452	9	13.97	13.94	16.97

Table 7.1.2 IEEE 802.11 Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11a (6 Mbps)	36-48	14.00	13.00	13.20	12.20	18.00	17.00
5 (U-NII-2A)	802.11a (6 Mbps)	52	14.70	13.70	13.20	12.20	17.00	16.00
		56-60	15.50	14.50	15.00	14.00	19.00	18.00
		64	16.50	15.50	15.00	14.00	19.00	18.00
5 (U-NII-2C)	802.11a (6 Mbps)	100-144	15.20	14.20	15.00	14.00	19.00	18.00
5 (U-NII-3)	802.11a (6 Mbps)	149-165	17.00	16.00	16.70	15.70	20.00	19.00

Table 7.1.3 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11a (5 GHz) Conducted Power[dBm]		
			Ant.1(Aux)	Ant.2 (Main)	MIMO
802.11a (6 Mbps)	5 180	36	13.31	12.85	16.10
	5 200	40	13.32	12.93	16.14
	5 220	44	13.49	13.05	16.29
	5 240	48	13.56	13.19	16.39
	5 260	52	14.60	13.05	16.90
	5 280	56	15.41	14.98	18.21
	5 300	60	15.18	14.70	17.96
	5 320	64	15.03	14.65	17.85
	5 500	100	14.99	14.61	17.81
	5 580	116	15.18	14.69	17.95
	5 660	132	14.58	14.27	17.44
	5 720	144	15.02	14.54	17.80
	5 745	149	16.47	15.99	19.25
	5 785	157	16.49	16.09	19.30
	5 825	165	16.49	16.09	19.30

Table 7.1.4 IEEE 802.11a Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11n (20 MHz) (MCS0)	36-48	14.00	13.00	13.00	12.00	18.00	17.00
5 (U-NII-2A)	802.11n (20 MHz) (MCS0)	52	14.20	13.20	13.50	12.50	18.00	17.00
		56-60	15.50	14.50	14.00	13.00	18.00	17.00
		64	16.70	15.70	16.00	15.00	20.00	19.00
5 (U-NII-2C)	802.11n (20 MHz) (MCS0)	100-144	16.00	15.00	15.50	14.50	20.00	19.00
5 (U-NII-3)	802.11n (20 MHz) (MCS0)	149-157	16.50	15.50	16.00	15.00	20.00	19.00
		165	16.70	15.70	16.20	15.20	20.00	19.00

Table 7.1.5 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11n HT20 (5 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11n (HT-20) (MCS0)	5 180	36	13.48	12.71	16.12
	5 200	40	13.79	12.95	16.40
	5 220	44	13.46	12.57	16.05
	5 240	48	13.75	12.99	16.40
	5 260	52	13.82	13.40	16.63
	5 280	56	13.93	13.59	16.77
	5 300	60	14.18	13.79	17.00
	5 320	64	15.81	15.38	18.61
	5 500	100	15.50	15.07	18.30
	5 580	116	15.45	15.05	18.26
	5 660	132	15.65	15.34	18.51
	5 720	144	15.62	15.31	18.48
	5 745	149	16.23	15.81	19.04
	5 785	157	16.42	15.98	19.22
	5 825	165	15.42	14.98	18.22

Table 7.1.6 IEEE 802.11n HT20 Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11ac (20 MHz) (MCS0)	52-60	14.00	13.00	12.50	11.50	18.00	17.00
5 (U-NII-2A)	802.11ac (20 MHz) (MCS0)	52-60	15.00	14.00	14.20	13.20	18.00	17.00
		64	16.00	15.00	15.00	14.00	19.40	18.40
5 (U-NII-2C)	802.11ac (20 MHz) (MCS0)	100-144	15.70	14.70	15.50	14.50	19.40	18.40
5 (U-NII-3)	802.11ac (20 MHz) (MCS0)	149-165	16.50	15.50	16.20	15.20	19.40	18.40

Table 7.1.7 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11ac VHT20 (5 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11ac (VHT-20) (MCS0)	5 180	36	13.66	12.31	16.05
	5 200	40	13.60	12.35	16.03
	5 220	44	13.60	12.36	16.03
	5 240	48	13.66	12.39	16.08
	5 260	52	14.46	14.06	17.27
	5 280	56	14.50	14.14	17.33
	5 300	60	14.52	14.19	17.37
	5 320	64	15.06	14.60	17.85
	5 500	100	15.58	15.11	18.36
	5 580	116	15.55	15.13	18.36
	5 660	132	15.63	15.33	18.49
	5 720	144	15.28	14.89	18.10
	5 745	149	16.32	15.88	19.12
	5 785	157	16.24	15.81	19.04
	5 825	165	16.49	16.12	19.32

Table 7.1.8 IEEE 802.11ac VHT20 Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11n (40 MHz) (MCS0)	38	16.20	15.20	14.50	13.50	19.00	18.00
		46	15.50	14.50	14.50	13.50	19.00	18.00
5 (U-NII-2A)	802.11n (40 MHz) (MCS0)	54	16.20	15.20	14.50	13.50	19.00	18.00
		62	12.50	11.50	11.00	10.00	16.00	15.00
5 (U-NII-2C)	802.11n (40 MHz) (MCS0)	102	13.00	12.00	11.50	10.50	16.00	15.00
		110	15.50	14.50	14.70	13.70	19.50	18.50
		134-142	16.00	15.00	15.50	14.50	19.50	18.50
5 (U-NII-3)	802.11n (40 MHz) (MCS0)	151	16.50	15.50	16.40	15.40	19.50	18.50
		159	18.50	17.50	18.50	17.50	22.00	21.00

Table 7.1.9 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11n HT40 (5 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11n (HT-40) (MCS0)	5 190	38	14.58	13.48	17.08
	5 230	46	14.83	14.40	17.63
	5 270	54	14.68	14.31	17.51
	5 310	62	12.19	10.89	14.60
	5 510	102	12.30	11.21	14.80
	5 590	118	15.09	14.64	17.88
	5 670	134	15.22	14.84	18.04
	5 710	142	15.26	14.84	18.07
	5 755	151	16.16	15.78	18.98
	5 795	159	18.18	17.90	21.05

Table 7.1.10 IEEE 802.11n HT40 Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11ac (40 MHz) (MCS0)	38-46	17.00	16.00	15.70	14.70	20.00	19.00
5 (U-NII-2A)	802.11ac (40 MHz) (MCS0)	54	16.70	15.70	16.00	15.00	20.00	19.00
		62	12.50	11.50	11.50	10.50	15.00	14.00
5 (U-NII-2C)	802.11ac (40 MHz) (MCS0)	102	11.50	10.50	10.50	9.50	15.00	14.00
		110	15.00	14.00	15.20	14.20	19.40	18.40
		134-142	15.50	14.50	15.20	14.20	19.40	18.40
5 (U-NII-3)	802.11ac (40 MHz) (MCS0)	151	16.50	15.50	16.20	15.20	19.40	18.40
		159	18.50	17.50	18.50	17.50	21.10	20.10

Table 7.1.11 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11ac VHT40 (5 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11ac (VHT-40) (MCS0)	5 190	38	16.75	15.67	19.25
	5 230	46	16.73	15.61	19.22
	5 270	54	16.45	15.58	19.05
	5 310	62	12.31	11.35	14.87
	5 510	102	11.25	10.25	13.79
	5 590	118	14.99	14.68	17.85
	5 670	134	15.34	14.86	18.12
	5 710	142	15.28	14.87	18.09
	5 755	151	16.19	15.70	18.96
	5 795	159	18.27	17.91	21.10

Table 7.1.12 IEEE 802.11ac VHT40 Average RF Power

Band (GHz)	Mode	Ch	Modulated Average[dBm]					
			Ant.1 (Aux)		Ant.2 (Main)		MIMO	
			Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5 (U-NII-1)	802.11ac (80 MHz) (MCS0)	42	11.70	10.70	10.20	9.20	15.00	14.00
5 (U-NII-2A)	802.11ac (80 MHz) (MCS0)	58	9.70	8.70	9.00	8.00	13.50	12.50
5 (U-NII-2C)	**802.11ac (80 MHz) (MCS0)**	106	10.50	9.50	10.00	9.00	**13.50**	**12.50**
		138	**16.20**	**15.20**	**16.50**	**15.50**	**20.00**	**19.00**
5 (U-NII-3)	**802.11ac (80 MHz) (MCS0)**	**155**	**18.70**	**17.70**	**18.50**	**17.50**	**22.00**	**21.00**

Table 7.1.13 Nominal and Maximum Output Power Spec

Mode	Freq. (MHz)	Channel	IEEE 802.11ac VHT80 (5 GHz) Conducted Power[dBm]		
			Ant.1 (Aux)	Ant.2 (Main)	MIMO
802.11ac (VHT-80) (MCS0)	5 210	42	10.38	10.06	13.23
	5 290	58	9.30	8.96	12.14
	5 530	**106**	10.25	9.83	**13.06**
	5 690	**138**	**16.01**	**15.69**	**18.86**
	5 775	**155**	**18.63**	**18.20**	**21.43**

Table 7.7.14 IEEE 802.11ac VHT80 Average RF Power

Justification for reduced test configurations for WIFI channels 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 modes 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, duo to an even number of channels, both channels were measured.
- The underlined data rate and channel above were tested for SAR.

The average output powers of this device were tested by below configuration.

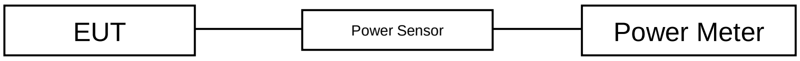

Figure 7.1.1 Power Measurement Setup

7.2 Bluetooth Conducted Powers

Burst Modulated Average[dBm]				
	Freq. (MHz)	Channel	Maximum	Nominal
0Bluetooth 1 Mbps	2 402	0	10.00	9.00
	2 441	39	10.00	9.00
	2 480	78	10.00	9.00
Bluetooth 2 Mbps	2 402	0	10.00	9.00
	2 441	39	10.00	9.00
	2 480	78	10.00	9.00
Bluetooth 3 Mbps	2 402	0	10.00	9.00
	2 441	39	10.00	9.00
	2 480	78	10.00	9.00
Bluetooth (LE / 1 Mbps)	2 402	0	9.00	8.00
	2 441	39	9.00	8.00
	2 480	78	9.00	8.00
Bluetooth (LE / 2 Mbps)	2 402	0	9.00	8.00
	2 441	39	9.00	8.00
	2 480	78	9.00	8.00

Table 7.2.1 Nominal and Maximum Output Power Spec (Burst)

Frame Modulated Average[dBm]				
	Freq. (MHz)	Channel	Maximum	Nominal
Bluetooth 1 Mbps	2 402	0	8.85	7.85
	2 441	39	8.85	7.85
	2 480	78	8.85	7.85
Bluetooth 2 Mbps	2 402	0	8.85	7.85
	2 441	39	8.85	7.85
	2 480	78	8.85	7.85
Bluetooth 3 Mbps	2 402	0	8.85	7.85
	2 441	39	8.85	7.85
	2 480	78	8.85	7.85
Bluetooth (LE / 1 Mbps)	2 402	0	8.24	7.24
	2 441	39	8.24	7.24
	2 480	78	8.24	7.24
Bluetooth (LE / 2 Mbps)	2 402	0	6.49	5.49
	2 441	39	6.49	5.49
	2 480	78	6.49	5.49

Table 7.2.2 Nominal and Maximum Output Power Spec (Frame)

Channel	Frequency	Burst AVG Output Power (1 Mbps)	Frame AVG Output Power (1 Mbps)	Burst AVG Output Power (2 Mbps)	Frame AVG Output Power (2 Mbps)	Burst AVG Output Power (3 Mbps)	Frame AVG Output Power (3 Mbps)
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2 402	8.14	7.02	9.16	8.01	9.19	8.01
Mid	2 441	9.18	8.15	9.20	8.05	9.46	8.31
High	2 480	9.02	7.89	9.50	8.35	9.52	8.37

Table 7.2.3 Bluetooth Burst and Frame Average RF Power

Channel	Frequency	Burst AVG Output Power (LE / 1 Mbps)	Frame AVG Output Power (LE / 1 Mbps)	Burst AVG Output Power (LE / 2 Mbps)	Frame AVG Output Power (LE / 2 Mbps)
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2 402	8.60	7.84	7.61	5.10
Mid	2 440	8.65	7.89	8.30	5.79
High	2 480	8.63	7.84	8.08	5.57

Table 7.2.4 Bluetooth LE Burst and Frame Average RF Power

- **Bluetooth Conducted Powers procedures**

1. Bluetooth (BDR, EDR)
   1) Enter DUT mode in EUT and operate it.
      When it operating, The EUT is transmitting at maximum power level and duty cycle fixed.
   2) Instruments and EUT were connected like Figure 7.2.1(A).
   3) The maximum output powers of BDR(1 Mbps), EDR(2, 3 Mbps) and each frequency were set by a Bluetooth Tester.
   4) Power levels were measured by a Power Meter.

2. Bluetooth (LE)
   1) Enter LE mode in EUT and operate it.
      When it operating, The EUT is transmitting at maximum power level and duty cycle fixed.
   2) Instruments and EUT were connected like Figure 7.2.1(B).
   3) The average conducted output powers of LE and each frequency can measurement according to setting program in EUT.
   4) Power levels were measured by a Power Meter.

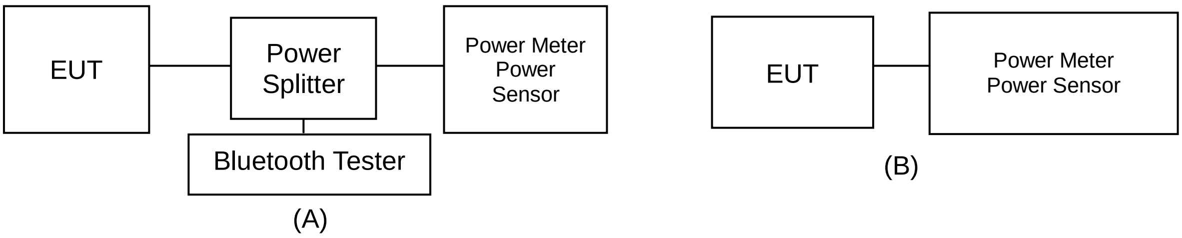

Figure 7.2.1 Average Power Measurement Setup

The average conducted output powers of Bluetooth were measured using above test setup and a wideband gated RF power meter when the EUT is transmitting at its maximum power level.

- **Bluetooth Transmission Plot**

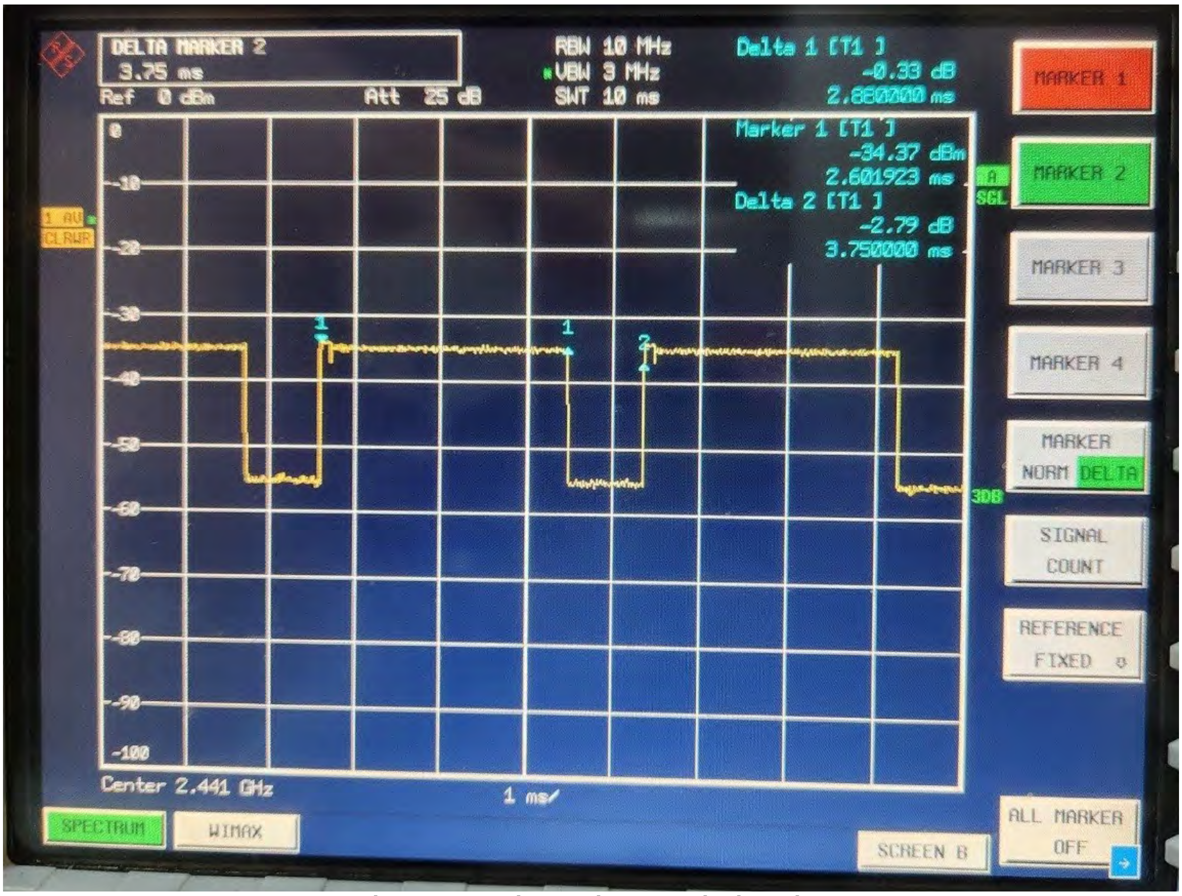

Figure 7.2.2 Bluetooth Transmission Plot

- **Bluetooth Duty Cycle Calculation**

Duty Cycle = Pulse/Period * 100 % = (2.880/3.750) * 100 = 76.8 %

8. SYSTEM VERIFICATION

8.1 Tissue Verification

MEASURED TISSUE PARAMETERS										
Date(s)	Tissue Type	Ambient Temp.[°C]	Liquid Temp.[°C]	Measured Frequency [MHz]	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	Er Deviation [%]	σ Deviation [%]
Mar. 27. 2023	2 450 Head	21.2	21.0	2 412.0	39.265	1.766	38.228	1.754	-2.64	-0.70
				2 437.0	39.222	1.788	38.138	1.784	-2.76	-0.25
				2 450.0	39.200	1.800	38.113	1.799	-2.77	-0.06
				2 462.0	39.184	1.813	38.084	1.810	-2.81	-0.15
Apr. 13. 2023	2 450 Head	21.4	21.1	2 402.0	39.282	1.757	39.763	1.711	1.22	-2.65
				2 441.0	39.215	1.792	39.640	1.753	1.08	-2.18
				2 450.0	39.200	1.800	39.620	1.763	1.07	-2.06
				2 480.0	39.160	1.832	39.562	1.795	1.03	-2.02
Apr. 12. 2023	5 200 Head	21.3	21.4	5 190.0	36.010	4.650	35.666	4.645	-0.96	-0.10
				5 200.0	36.000	4.660	35.648	4.656	-0.98	-0.09
				5 230.0	35.970	4.690	35.606	4.689	-1.01	-0.02
Apr. 12. 2023	5 300 Head	21.3	21.4	5 270.0	35.930	4.730	35.549	4.734	-1.06	0.08
				5 300.0	35.900	4.760	35.504	4.766	-1.10	0.13
				5 310.0	35.890	4.770	35.487	4.777	-1.12	0.15
Apr. 11. 2023	5 600 Head	20.7	20.5	5 500.0	35.650	4.965	35.816	5.015	0.47	1.01
				5 530.0	35.605	4.997	35.746	5.043	0.40	0.93
				5 600.0	35.500	5.070	35.595	5.144	0.27	1.46
				5 690.0	35.410	5.160	35.386	5.254	-0.07	1.82
Apr. 11. 2023	5 800 Head	20.7	20.5	5 775.0	35.325	5.245	35.217	5.348	-0.31	1.96
				5 800.0	35.300	5.270	35.154	5.396	-0.41	2.39

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB 865664 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

Measurement Procedure for Tissue verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
3) The complex admittance with respect to the probe aperture was measured
4) The complex relative permittivity , for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r'\varepsilon_0)^{1/2}\right]}{r}d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$

8.2 Test System Verification

Prior to assessment, the system is verified to the ±10 % of the specifications at using the SAR Dipole kit(s). (Graphic Plots Attached)

Table 9.2.1 System Verification Results (1 g)

SYSTEM DIPOLE VERIFICATION TARGET & MEASURED												
SAR System #	Freq. [MHz]	SAR Dipole kits	Date(s)	Tissue Type	Ambient Temp. [°C]	Liquid Temp. [°C]	Probe S/N	Input Power (mW)	1 W Target SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	1 W Normalized SAR_{1g} (W/kg)	Deviation [%]
E	2 450	D2450V2, SN: 920	Mar. 27. 2023	Head	21.2	21.0	3327	100	52.90	5.52	55.20	4.35
E	2 450	D2450V2, SN: 920	Apr. 13. 2023	Head	21.4	21.1	3916	100	52.90	5.55	55.50	4.91
E	5 200	D5GHzV2, SN:1103	Apr. 12. 2023	Head	21.3	21.4	3916	100	80.60	7.95	79.50	-1.36
E	5 300	D5GHzV2, SN:1103	Apr. 12. 2023	Head	21.3	21.4	3916	100	83.80	7.91	79.10	-5.61
E	5 500	D5GHzV2, SN:1103	Apr. 11. 2023	Head	20.7	20.5	3916	100	86.80	8.70	87.00	0.23
E	5 600	D5GHzV2, SN:1103	Apr. 11. 2023	Head	20.7	20.5	3916	100	84.80	8.59	85.90	1.30
E	5 800	D5GHzV2, SN:1103	Apr. 11. 2023	Head	20.7	20.5	3916	100	81.60	7.93	79.30	-2.82

Note(s)
1. System Verification was measured with input 100 mW and normalized to 1 W.
2. Full system validation status and results can be found in Appendix D.

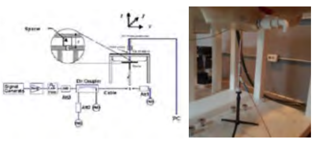

Figure 8.1 Dipole Verification Test Setup Diagram & Photo

9. SAR TEST RESULTS

9.1 Standalone Body SAR Results

Table 9.1.1 DTS Body SAR

MEASUREMENT RESULTS

FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Peak SAR of Area Scan	Data Rate [Mbps]	Duty Cycle (%)	1 g SAR (W/kg)	Scaling Factor	Scaling Factor (Duty Cycle)	SAR (W/kg)	Plots #
MHz	Ch														
2 412.0	1	802.11g Ant.1	16.00	15.91	0.020	0 mm [Front]	FCC #1	0.033	6	96.7	0.032	1.021	1.034	0.034	
2 412.0	1	802.11g Ant.1	16.00	15.91	0.110	0 mm [Rear]	FCC #1	0.014	6	96.7	0.008	1.021	1.034	0.008	
2 412.0	1	802.11g Ant.1	16.00	15.91	0.090	0 mm [Left]	FCC #1	0.184	6	96.7	0.209	1.021	1.034	**0.221**	A1
2 412.0	1	802.11g Ant.2	16.00	15.98	-0.040	0 mm [Front]	FCC #1	0.030	6	96.7	0.024	1.005	1.034	0.025	
2 412.0	1	802.11g Ant.2	16.00	15.98	-0.050	0 mm [Rear]	FCC #1	0.002	6	96.7	0.001	1.005	1.034	0.001	
2 412.0	1	802.11g Ant.2	16.00	15.98	0.100	0 mm [Left]	FCC #1	0.091	6	96.7	0.061	1.005	1.034	**0.063**	A2
2 412.0	1	802.11g MIMO	19.00	18.96	0.010	0 mm [Front]	FCC #1	0.073	6	97.2	0.071	1.009	1.028	0.074	
2 412.0	1	802.11g MIMO	19.00	18.96	0.180	0 mm [Rear]	FCC #1	0.004	6	97.2	0.009	1.009	1.028	0.009	
2 412.0	1	802.11g MIMO	19.00	18.96	0.050	0 mm [Left]	FCC #1	0.218	6	97.2	0.225	1.009	1.028	**0.233**	A3
ANSI / IEEE C95.1-1992– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure								Body 1.6 W/kg (mW/g) averaged over 1 gram							

Adjusted SAR results for OFDM SAR

FREQUENCY		Mode/ Antenna	Service	Maximum Allowed Power [dBm]	1 g Scaled SAR (W/kg)	FREQUENCY [MHz]	Mode	Service	Maximum Allowed Power [dBm]	Ratio	1 g Adjusted SAR (W/kg)	Determine SAR
MHz	Ch											
2 412.0	1	802.11g Ant.1	OFDM	15.91	0.221	2 462.0	802.11b	DSSS	14.00	0.644	**0.142**	X
2 412.0	1	802.11g Ant.1	OFDM	15.91	0.221	2 462.0	802.11n (HT20)	OFDM	15.00	0.811	**0.179**	X
2 412.0	1	802.11g Ant.1	OFDM	15.91	0.221	2 462.0	802.11n (HT40)	OFDM	14.00	0.644	**0.142**	X
2 412.0	1	802.11g Ant.2	OFDM	15.98	0.063	2 462.0	802.11b	DSSS	14.00	0.634	**0.040**	X
2 412.0	1	802.11g Ant.2	OFDM	15.98	0.063	2 462.0	802.11n (HT20)	OFDM	15.00	0.798	**0.050**	X
2 412.0	1	802.11g Ant.2	OFDM	15.98	0.063	2 462.0	802.11n (HT40)	OFDM	14.00	0.634	**0.040**	X
2 412.0	1	802.11g MIMO	OFDM	18.96	0.233	2 462.0	802.11b	DSSS	17.00	0.637	**0.148**	X
2 412.0	1	802.11g MIMO	OFDM	18.96	0.233	2 462.0	802.11n (HT20)	OFDM	18.00	0.802	**0.187**	X
2 412.0	1	802.11g MIMO	OFDM	18.96	0.233	2 462.0	802.11n (HT40)	OFDM	17.00	0.637	**0.148**	X
ANSI / IEEE C95.1-1992– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure						Body 1.6 W/kg (mW/g) averaged over 1 gram						

Table 9.1.2 UNII Body SAR

MEASUREMENT RESULTS

FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Peak SAR of Area Scan	Data Rate [Mbps]	Duty Cycle (%)	1 g SAR (W/kg)	Scaling Factor	Scaling Factor (Duty Cycle)	1 g Scaled SAR (W/kg)	Plots #
MHz	Ch														
5 190.0	38	802.11ac (VHT40) Ant.1	17.00	16.75	0.160	0 mm [Front]	FCC #1	0.041	MCS0	94.3	0.038	1.059	1.060	0.043	
5 190.0	38	802.11ac (VHT40) Ant.1	17.00	16.75	-0.100	0 mm [Rear]	FCC #1	0.064	MCS0	94.3	0.060	1.059	1.060	0.067	
5 190.0	38	802.11ac (VHT40) Ant.1	17.00	16.75	0.070	0 mm [Left]	FCC #1	0.502	MCS0	94.3	0.653	1.059	1.060	**0.733**	A4
5 190.0	38	802.11ac (VHT40) Ant.2	15.70	15.67	0.180	0 mm [Front]	FCC #1	0.033	MCS0	94.3	0.024	1.007	1.060	0.026	
5 190.0	38	802.11ac (VHT40) Ant.2	15.70	15.67	-0.140	0 mm [Rear]	FCC #1	0.054	MCS0	94.3	0.044	1.007	1.060	0.047	
5 190.0	38	802.11ac (VHT40) Ant.2	15.70	15.67	-0.010	0 mm [Left]	FCC #1	0.277	MCS0	94.3	0.217	1.007	1.060	**0.232**	A5
5 190.0	38	802.11ac (VHT40) MIMO	20.00	19.25	-0.090	0 mm [Front]	FCC #1	0.062	MCS0	94.4	0.047	1.189	1.059	0.059	
5 190.0	38	802.11ac (VHT40) MIMO	20.00	19.25	-0.090	0 mm [Rear]	FCC #1	0.085	MCS0	94.4	0.082	1.189	1.059	0.103	
5 190.0	38	802.11ac (VHT40) MIMO	20.00	19.25	0.010	0 mm [Left]	FCC #1	0.620	MCS0	94.4	0.773	1.189	1.059	**0.973**	A6
5 230.0	46	802.11ac (VHT40) MIMO	20.00	19.22	0.100	0 mm [Left]	FCC #1	0.649	MCS0	94.4	0.700	1.197	1.059	0.887	
5 270.0	54	802.11ac (VHT40) Ant.1	16.70	16.45	-0.010	0 mm [Front]	FCC #1	0.037	MCS0	94.3	0.018	1.059	1.060	0.020	
5 270.0	54	802.11ac (VHT40) Ant.1	16.70	16.45	0.020	0 mm [Rear]	FCC #1	0.050	MCS0	94.3	0.044	1.059	1.060	0.049	
5 270.0	54	802.11ac (VHT40) Ant.1	16.70	16.45	-0.110	0 mm [Left]	FCC #1	0.431	MCS0	94.3	0.620	1.059	1.060	**0.696**	A7
5 270.0	54	802.11ac (VHT40) Ant.2	16.00	15.58	-0.150	0 mm [Front]	FCC #1	0.027	MCS0	94.3	0.016	1.102	1.060	0.019	
5 270.0	54	802.11ac (VHT40) Ant.2	16.00	15.58	-0.060	0 mm [Rear]	FCC #1	0.056	MCS0	94.3	0.052	1.102	1.060	0.061	
5 270.0	54	802.11ac (VHT40) Ant.2	16.00	15.58	-0.130	0 mm [Left]	FCC #1	0.209	MCS0	94.3	0.203	1.102	1.060	**0.237**	A8
5 270.0	54	802.11ac (VHT40) MIMO	20.00	19.05	0.040	0 mm [Front]	FCC #1	0.059	MCS0	94.4	0.059	1.245	1.059	0.078	
5 270.0	54	802.11ac (VHT40) MIMO	20.00	19.05	0.120	0 mm [Rear]	FCC #1	0.098	MCS0	94.4	0.092	1.245	1.059	0.121	
5 270.0	54	802.11ac (VHT40) MIMO	20.00	19.05	-0.030	0 mm [Left]	FCC #1	0.529	MCS0	94.4	0.582	1.245	1.059	**0.767**	A9
								Body 1.6 W/kg (mW/g) averaged over 1 gram							

Table 9.1.3 UNII Body SAR

MEASUREMENT RESULTS

FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Peak SAR of Area Scan	Data Rate [Mbps]	Duty Cycle (%)	1 g SAR (W/kg)	Scaling Factor	Scaling Factor (Duty Cycle)	1 g Scaled SAR (W/kg)	Plots #
MHz	Ch														
5 690.0	138	802.11ac (VHT80) Ant.1	16.20	16.01	0.050	0 mm [Front]	FCC #1	0.040	MCS0	90.0	0.031	1.045	1.111	0.036	
5 690.0	138	802.11ac (VHT80) Ant.1	16.20	16.01	-0.050	0 mm [Rear]	FCC #1	0.034	MCS0	90.0	0.031	1.045	1.111	0.036	
5 690.0	138	802.11ac (VHT80) Ant.1	16.20	16.01	0.060	0 mm [Left]	FCC #1	0.376	MCS0	90.0	0.402	1.045	1.111	**0.467**	A10
5 690.0	138	802.11ac (VHT80) Ant.2	16.50	15.69	-0.050	0 mm [Front]	FCC #1	0.040	MCS0	90.0	0.019	1.205	1.111	0.025	
5 690.0	138	802.11ac (VHT80) Ant.2	16.50	15.69	0.110	0 mm [Rear]	FCC #1	0.039	MCS0	90.0	0.034	1.205	1.111	0.046	
5 690.0	138	802.11ac (VHT80) Ant.2	16.50	15.69	0.070	0 mm [Left]	FCC #1	0.341	MCS0	90.0	0.255	1.205	1.111	**0.341**	A11
5 690.0	138	802.11ac (VHT80) MIMO	20.00	18.86	0.030	0 mm [Front]	FCC #1	0.067	MCS0	89.3	0.062	1.300	1.120	0.090	
5 690.0	138	802.11ac (VHT80) MIMO	20.00	18.86	0.020	0 mm [Rear]	FCC #1	0.044	MCS0	89.3	0.028	1.300	1.120	0.041	
5 530.0	106	802.11ac (VHT80) MIMO	13.50	13.06	-0.040	0 mm [Left]	FCC #1	0.146	MCS0	89.3	0.136	1.107	1.120	0.169	
5 690.0	138	802.11ac (VHT80) MIMO	20.00	18.86	0.050	0 mm [Left]	FCC #1	0.637	MCS0	89.3	0.678	1.300	1.120	**0.987**	A12
5 775.0	155	802.11ac (VHT80) Ant.1	18.70	18.63	-0.010	0 mm [Front]	FCC #1	0.108	MCS0	90.0	0.112	1.016	1.111	0.126	
5 775.0	155	802.11ac (VHT80) Ant.1	18.70	18.63	-0.180	0 mm [Rear]	FCC #1	0.084	MCS0	90.0	0.086	1.016	1.111	0.097	
5 775.0	155	802.11ac (VHT80) Ant.1	18.70	18.63	0.030	0 mm [Left]	FCC #1	1.070	MCS0	90.0	1.110	1.016	1.111	**1.253**	A13
5 775.0	155	802.11ac (VHT80) Ant.1	18.70	18.63	-0.040	0 mm [Left]	FCC #1	1.050	MCS0	90.0	1.090	1.016	1.111	1.230	
5 775.0	155	802.11ac (VHT80) Ant.2	18.50	18.20	-0.030	0 mm [Front]	FCC #1	0.100	MCS0	90.0	0.102	1.072	1.111	0.121	
5 775.0	155	802.11ac (VHT80) Ant.2	18.50	18.20	-0.110	0 mm [Rear]	FCC #1	0.051	MCS0	90.0	0.045	1.072	1.111	0.054	
5 775.0	155	802.11ac (VHT80) Ant.2	18.50	18.20	0.080	0 mm [Left]	FCC #1	0.520	MCS0	90.0	0.579	1.072	1.111	**0.690**	A14
5 775.0	155	802.11ac (VHT80) MIMO	22.00	21.43	0.160	0 mm [Front]	FCC #1	0.178	MCS0	89.3	0.180	1.140	1.120	0.230	
5 775.0	155	802.11ac (VHT80) MIMO	22.00	21.43	0.120	0 mm [Rear]	FCC #1	0.116	MCS0	89.3	0.115	1.140	1.120	0.147	
5 775.0	155	802.11ac (VHT80) MIMO	22.00	21.43	0.070	0 mm [Left]	FCC #1	1.090	MCS0	89.3	1.180	1.140	1.120	**1.507**	A15
5 775.0	155	802.11ac (VHT80) MIMO	22.00	21.43	-0.040	0 mm [Left]	FCC #1	1.070	MCS0	89.3	1.150	1.140	1.120	1.468	
ANSI / IEEE C95.1-2005– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure								Body 1.6 W/kg (mW/g) averaged over 1 gram							

Note(s):
1. Yellow entries represent variability measurements.

Table 9.1.4 Bluetooth Body SAR

MEASUREMENT RESULTS														
FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Drift Power [dB]	Phantom Position	Device Serial Number	Rate [Mbps]	Duty Cycle (%)	1 g SAR (W/kg)	Scaling Factor	Scaling Factor (Duty Cycle)	1 g Scaled SAR (W/kg)	Plots #
MHz	Ch													
2 441	39	Bluetooth	8.85	8.31	0.000	0 mm [Front]	FCC #1	3	76.8	0.001	1.132	1.302	0.001	
2 441	39	Bluetooth	8.85	8.31	0.000	0 mm [Rear]	FCC #1	3	76.8	0.00097	1.132	1.302	0.001	
2 441	39	Bluetooth	8.85	8.31	0.150	0 mm [Left]	FCC #1	3	76.8	0.015	1.132	1.302	**0.022**	A16
ANSI / IEEE C95.1-1992– SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure/General Population Exposure**								**Body** **1.6 W/kg (mW/g)** averaged over 1 gram						

9.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013 and FCC 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 Publication 447498 D01v06.

W-LAN Notes:

1. The initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 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 802.11g/n) was not required duo to the maximum allowed powers and the highest reported DSSS SAR when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output and the adjust SAR is ≤ 1.2 W/kg.
3. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 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 modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg.
4. When the maximum reported 1 g averaged SAR ≤ 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 rate, channel bandwidth and signal modulation, using the highest transmission duty factor to determine compliance.
6. Per KDB Publication 248227 D01v02r02, SAR for MIMO was evaluated by following the simultaneous SAR provisions from KDB Publication 447498 D01v06 by making a SAR measurement with both antennas transmitting simultaneously.

10. FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

10.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to handsets with built-in unlicensed transmitters such as 802.11b/g/n and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

10.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2,simultaneous transmission SAR test exclusion may be applied when the sum of the sum 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6 W/kg. The different test positon in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1-g or 10-g SAR.

10.3 Simultaneous Transmission Capabilities

According to FCC KDB Publication 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.

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

Table 10.3.1 Simultaneous SAR Cases

No.	Capable Transmit Configuration	Body
1	W-LAN 2.4 GHz + BT 2.4 GHz	Yes
2	W-LAN 5 GHz + BT 2.4 GHz	Yes
3	W-LAN 2.4 GHz Ant.1 + W-LAN 5 GHz Ant.2 + BT	Yes

10.4 Body SAR Simultaneous Transmission Analysis

Table 10.4.1 Simultaneous Transmission Scenario : W-LAN 2.4 GHz + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	2.4 GHz W-LAN Ant.1 SAR (W/kg)	2.4 GHz W-LAN Ant.2 SAR (W/kg)	2.4 GHz W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)		
		1	2	3	4	1+2	1+3	1+4
Body SAR	Top	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Front	0.001	0.034	0.026	0.075	0.035	0.027	0.076
	Rear	0.001	0.008	0.001	0.010	0.009	0.002	0.011
	Right	-	-	-	-	-	-	-
	Left	0.022	0.221	0.063	0.233	0.243	0.085	0.255

Table 10.4.2 Simultaneous Transmission Scenario : W-LAN 5.2 GHz + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	5.2 GHz W-LAN Ant.1 SAR (W/kg)	5.2 GHz W-LAN Ant.2 SAR (W/kg)	5.2 GHz W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)		
		1	2	3	4	1+2	1+3	1+4
Body SAR	Top	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Front	0.001	0.043	0.026	0.059	0.044	0.027	0.060
	Rear	0.001	0.067	0.047	0.103	0.068	0.048	0.104
	Right	-	-	-	-	-	-	-
	Left	0.022	0.733	0.232	0.973	0.755	0.254	0.995

Table 10.4.3 Simultaneous Transmission Scenario : W-LAN 5.3 GHz + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	5.3 GHz W-LAN Ant.1 SAR (W/kg)	5.3 GHz W-LAN Ant.2 SAR (W/kg)	5.3 GHz W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)		
		1	2	3	4	1+2	1+3	1+4
Body SAR	Top	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Front	0.001	0.020	0.019	0.078	0.021	0.020	0.079
	Rear	0.001	0.049	0.061	0.121	0.050	0.062	0.122
	Right	-	-	-	-	-	-	-
	Left	0.022	0.696	0.237	0.767	0.718	0.259	0.789

Table 10.4.4 Simultaneous Transmission Scenario : W-LAN 5.6 GHz + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	5.6 GHz W-LAN Ant.1 SAR (W/kg)	5.6 GHz W-LAN Ant.2 SAR (W/kg)	5.6 GHz W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)		
		1	2	3	4	1+2	1+3	1+4
Body SAR	Top	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Front	0.001	0.036	0.025	0.090	0.037	0.026	0.091
	Rear	0.001	0.036	0.046	0.041	0.037	0.047	0.042
	Right	-	-	-	-	-	-	-
	Left	0.022	0.467	0.341	0.987	0.489	0.363	1.009

Table 10.4.5 Simultaneous Transmission Scenario : W-LAN 5.8 GHz + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	5.8 GHz W-LAN Ant.1 SAR (W/kg)	5.8 GHz W-LAN Ant.2 SAR (W/kg)	5.8 GHz W-LAN MIMO SAR (W/kg)	ΣSAR (W/kg)		
		1	2	3	4	1+2	1+3	1+4
Body SAR	Top	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-
	Front	0.001	0.126	0.121	0.230	0.127	0.122	0.231
	Rear	0.001	0.097	0.054	0.147	0.098	0.055	0.148
	Right	-	-	-	-	-	-	-
	Left	0.022	1.253	0.690	1.507	1.275	0.712	**1.529**

Table 10.4.6 Simultaneous Transmission Scenario : W-LAN 2.4 GHz Ant.1 + W-LAN 5 GHz Ant.2 + Bluetooth 2.4 GHz

Exposure Condition	Configuration	Bluetooth 2.4 GHz (W/kg)	2.4 GHz W-LAN Ant.1 SAR (W/kg)	5.2 GHz W-LAN Ant.2 SAR (W/kg)	5.3 GHz W-LAN Ant.2 SAR (W/kg)	5.6 GHz W-LAN Ant.2 SAR (W/kg)	5.8 GHz W-LAN Ant.2 SAR (W/kg)	ΣSAR (W/kg)			
		1	2	3	4	5	6	1+2+3	1+2+4	1+2+5	1+2+6
Body SAR	Top	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Front	0.001	0.034	0.026	0.019	0.025	0.121	0.061	0.054	0.060	0.156
	Rear	0.001	0.008	0.047	0.061	0.046	0.054	0.056	0.070	0.055	0.063
	Right	-	-	-	-	-	-	-	-	-	-
	Left	0.022	0.221	0.232	0.237	0.341	0.690	0.475	0.480	0.584	0.933

11. SAR MEASUREMENT VARIABILITY

11.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was 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. When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2. A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10 % from the 1-g SAR limit).
3. A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4. Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg
5. The same procedures should be adapted for measurements according to extremity exposure limits by applying a factor of 2.5 for extremity exposure to the corresponding SAR thresholds.

Table 11.1 Body SAR Measurement Variability Results

Frequency		Mode	Service	# of Time Slots	Spacing [Side]	Measured SAR (1 g)	1st Repeated SAR (1 g)	Ratio	2nd Repeated SAR(1g)	Ratio	3rd Repeated SAR(1g)	Ratio
MHz	Ch.					(W/kg)	(W/kg)		(W/kg)		(W/kg)	
5 775.0	155	802.11ac VHT80 (Ant.1)	OFDM	-	0 mm [Left]	1.110	1.090	1.018	-	-	-	-
5 775.0	155	802.11ac VHT80 (MIMO)	OFDM	-	0 mm [Left]	1.180	1.150	1.026	-	-	-	-
ANSI / IEEE C95.1-1992– SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population Exposure							Body 1.6 W/kg (mW/g) averaged over 1 gram					

11.2 Measurement Uncertainty

The measured SAR was < 1.5 W/kg for 1 g and < 3.75 W/kg for 10 g for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

12. EQUIPMENT LIST

Table 12.1.1 Test Equipment Calibration

	Type	Manufacturer	Model	Cal.Date	Next.Cal.Date	S/N
☒	SEMITEC Engineering	SEMITEC	N/A	N/A	N/A	Shield Room
☒	Robot	SPEAG	TX60L	N/A	N/A	F15/50NHA1/A/01
☒	Robot Controller	SPEAG	CS8C	N/A	N/A	F15/50NHA1/C/01
☒	Joystick	SPEAG	N/A	N/A	N/A	D21142605A
☒	Intel Core i7-8 700K 3.70 GHz Window 10 Pro	N/A	N/A	N/A	N/A	N/A
☒	Probe Alignment Unit LB	N/A	N/A	N/A	N/A	SE UKS 030 AA
☒	Device Holder	SPEAG	SD000H01KA	N/A	N/A	N/A
☒	Laptop Holder	SPEAG	SMLH1001CD	N/A	N/A	N/A
☒	2 mm Oval Phantom ELI6	SPEAG	QDOVA003AA	N/A	N/A	2039
☒	Data Acquisition Electronics	SPEAG	DAE4V1	2022-09-21	2023-09-21	1453
☒	Dosimetric E-Field Probe	SPEAG	ES3DV3	2023-01-22	2024-01-22	3327
☒	Dosimetric E-Field Probe	SPEAG	EX3DV4	2023-03-22	2024-03-22	3916
☒	2 450 MHz SAR Dipole	SPEAG	D2450V2	2022-08-18	2024-08-18	920
☒	5 GHz SAR Dipole	SPEAG	D5GHzV2	2023-01-25	2025-01-25	1103
☒	Network Analyzer	Agilent	E5071C	2022-06-24	2023-06-24	MY46106970
☒	Signal Generator	Agilent	E4438C	2022-06-24	2023-06-24	US41461520
☒	High Power RF Amplifier	EMPOWER	BBS3Q8CCJ	2022-06-24	2023-06-24	1005
☒	Power Meter	HP	EPM-442A	2022-12-16	2023-12-16	GB37170267
☒	Power Meter	Anritsu	ML2488B	2022-12-16	2023-12-16	0846003
☒	Power Sensor	Anritsu	MA2472D	2022-12-16	2023-12-16	0845419
☒	Power Sensor	HP	8481A	2022-12-16	2023-12-16	2702A65976
☒	Power Sensor	HP	8481A	2022-12-16	2023-12-16	2702A61707
☒	Dual Directional Coupler	HP	772D	2022-06-24	2023-06-24	2889A01064
☒	Low Pass Filter 3.0 GHz	Micro LAB	LA-30N	2022-06-24	2023-06-24	N/A
☒	Low Pass Filter 6.0 GHz	Micro LAB	LA-60N	2022-12-16	2023-12-16	03942
☒	Attenuators(10 dB)	WEINSCHEL	23-10-34	2022-12-16	2023-12-16	BP4387
☒	Attenuator	Saluki	3.5TS2-3dB-26.5G	2022-06-24	2023-06-24	21090703
☒	Dielectric Assessment kit	SPEAG	DAKS-3.5	2022-07-25	2023-07-25	1046
			R140	2022-07-26	2023-07-26	0101213

1. The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Verification measurement is performed by Dt&C before each test. The brain and muscle simulating material are calibrated by Dt&C using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain and muscle-equivalent material. Each equipment item was used solely within its respective calibration period.
2. CBT(Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

13. MEASUREMENT UNCERTAINTIES

2 450 MHz Head (SN: 3327)

Error Description	Uncertainty value (%)	Probability Distribution	Divisor	(Ci) 1 g	(Ci) 10 g	Standard 1 g (%)	Standard 10 g (%)	Ci x U_i 1 g	Ci x U_i 10 g	vi 2 or Veff
Measurement System										
Probe calibration	6.0	Normal	1	1	1	6.0	6.0	6.0	6.0	∞
Axial isotropy	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Hemispherical isotropy	9.6	Rectangular	√3	1	1	5.5	5.5	5.5	5.5	∞
Boundary Effects	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Probe Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Probe modulation response	2.4	Rectangular	√3	1	1	1.4	1.4	1.4	1.4	∞
Detection limits	0.25	Rectangular	√3	1	1	0.14	0.14	0.14	0.14	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	1.0	1.0	∞
Response time	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Integration time	2.6	Rectangular	√3	1	1	1.5	1.5	1.5	1.5	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.8	1.8	1.8	1.8	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.8	1.8	1.8	1.8	∞
Probe Positioner	0.4	Rectangular	√3	1	1	0.23	0.23	0.23	0.23	∞
Probe Positioning	2.9	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
Spatial x-y-Resolution	3.0	Rectangular	√3	1	1	5.8	5.8	5.8	5.8	∞
Fast SAR z-Approximation	3.0	Rectangular	√3	1	1	4.0	4.0	4.0	4.0	∞
Test Sample Related										
Device Positioning	2.9	Normal	1	1	1	2.9	2.9	2.9	2.9	145
Device Holder	3.6	Normal	1	1	1	3.6	3.6	3.6	3.6	5
Power Drift	5.0	Rectangular	√3	1	1	2.9	2.9	2.9	2.9	∞
SAR Scaling	2.0	Rectangular	√3	1	1	1.2	1.2	1.2	1.2	∞
Physical Parameters										
Phantom Shell	7.6	Rectangular	√3	1	1	4.4	4.4	4.4	4.4	∞
Liquid conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	1.8	1.2	1.2	0.5	∞
Liquid conductivity (Meas.)	3.8	Normal	1	0.78	0.71	3.0	2.7	2.3	1.9	10
Liquid permittivity (Target)	5.0	Rectangular	√3	0.60	0.49	1.7	1.4	1.0	0.7	∞
Liquid permittivity (Meas.)	3.7	Normal	1	0.23	0.26	0.85	1.0	0.20	0.25	10
Temp. unc. - Conductivity	1.8	Rectangular	√3	0.78	0.71	0.81	0.74	0.63	0.52	∞
Temp. unc. - Permittivity	1.9	Rectangular	√3	0.23	0.26	0.25	0.29	0.06	0.07	∞
Combined Standard Uncertainty		RSS				**13**	**13**			330
Expanded Uncertainty (k=2)						**26**	**26**			

U(1 g) = $k \times u_c$
= 2 x 13 %
= 26 % (The confidence level is about 95 % k = 2)
U(10 g) = $k \times u_c$
= 2 x 13 %
= 26 % (The confidence level is about 95 % k = 2)

Note. Refer to “DTNC-UP-TS06-2023”

2 450 MHz Head (SN: 3916)

Error Description	Uncertainty value (%)	Probability Distribution	Divisor	(Ci) 1 g	(Ci) 10 g	Standard 1 g (%)	Standard 10 g (%)	Ci x U_i 1 g	Ci x U_i 10 g	vi 2 or Veff
Measurement System										
Probe calibration	6.0	Normal	1	1	1	6.0	6.0	6.0	6.0	∞
Axial isotropy	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Hemispherical isotropy	9.6	Rectangular	√3	1	1	5.5	5.5	5.5	5.5	∞
Boundary Effects	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Probe Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Probe modulation response	2.4	Rectangular	√3	1	1	1.4	1.4	1.4	1.4	∞
Detection limits	0.3	Rectangular	√3	1	1	0.14	0.14	0.14	0.14	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	1.0	1.0	∞
Response time	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Integration time	2.6	Rectangular	√3	1	1	1.5	1.5	1.5	1.5	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
Probe Positioner	0.4	Rectangular	√3	1	1	0.23	0.23	0.23	0.23	∞
Probe Positioning	2.9	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
Spatial x-y-Resolution	10.0	Rectangular	√3	1	1	5.8	5.8	5.8	5.8	∞
Fast SAR z-Approximation	7.0	Rectangular	√3	1	1	4.0	4.0	4.0	4.0	∞
Test Sample Related										
Device Positioning	2.9	Normal	1	1	1	2.9	2.9	2.9	2.9	145
Device Holder	3.6	Normal	1	1	1	3.6	3.6	3.6	3.6	5
Power Drift	5.0	Rectangular	√3	1	1	2.9	2.9	2.9	2.9	∞
SAR Scaling	2.0	Rectangular	√3	1	1	1.2	1.2	1.2	1.2	∞
Physical Parameters										
Phantom Shell	7.6	Rectangular	√3	1	1	4.4	4.4	4.4	4.4	∞
Liquid conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	1.8	1.2	1.2	0.5	∞
Liquid conductivity (Meas.)	3.5	Normal	1	0.78	0.71	2.7	2.5	2.1	1.8	10
Liquid permittivity (Target)	5.0	Rectangular	√3	0.60	0.49	1.7	1.4	1.0	0.7	∞
Liquid permittivity (Meas.)	3.8	Normal	1	0.23	0.26	0.87	1.0	0.20	0.26	10
Temp. unc. - Conductivity	1.9	Rectangular	√3	0.78	0.71	0.86	0.78	0.67	0.55	∞
Temp. unc. - Permittivity	2.0	Rectangular	√3	0.23	0.26	0.27	0.30	0.06	0.08	∞
Combined Standard Uncertainty						**13**	**13**			330
Expanded Uncertainty (k=2)						**26**	**26**			

$U(1\ g) = k \times u_c$
= 2 x 13 %
= 26 % (The confidence level is about 95 % k = 2)
$U(10\ g) = k \times u_c$
= 2 x 13 %
= 26 % (The confidence level is about 95 % k = 2)

Note. Refer to “DTNC-UP-TS02-2023”

5 200 MHz ~ 5 800 MHz Head (SN: 3916)

Error Description	Uncertainty value (%)	Probability Distribution	Divisor	(Ci) 1 g	(Ci) 10 g	Standard 1 g (%)	Standard 10 g (%)	Ci x U_i 1 g	Ci x U_i 10 g	vi 2 or Veff
Measurement System										
Probe calibration	6.6	Normal	1	1	1	6.6	6.6	6.6	6.6	∞
Axial isotropy	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Hemispherical isotropy	9.6	Rectangular	√3	1	1	5.5	5.5	5.5	5.5	∞
Boundary Effects	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Probe Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	2.7	2.7	∞
Probe modulation response	2.4	Rectangular	√3	1	1	1.4	1.4	1.4	1.4	∞
Detection limits	0.3	Rectangular	√3	1	1	0.14	0.14	0.14	0.14	∞
Readout Electronics	1.0	Normal	1	1	1	1.0	1.0	1.0	1.0	∞
Response time	0.8	Rectangular	√3	1	1	0.46	0.46	0.46	0.46	∞
Integration time	2.6	Rectangular	√3	1	1	1.5	1.5	1.5	1.5	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
Probe Positioner	0.4	Rectangular	√3	1	1	0.23	0.23	0.23	0.23	∞
Probe Positioning	2.9	Rectangular	√3	1	1	1.7	1.7	1.7	1.7	∞
Spatial x-y-Resolution	10.0	Rectangular	√3	1	1	5.8	5.8	5.8	5.8	∞
Fast SAR z-Approximation	7.0	Rectangular	√3	1	1	4.0	4.0	4.0	4.0	∞
Test Sample Related										
Device Positioning	2.9	Normal	1	1	1	2.9	2.9	2.9	2.9	145
Device Holder	3.6	Normal	1	1	1	3.6	3.6	3.6	3.6	5
Power Drift	5.0	Rectangular	√3	1	1	2.9	2.9	2.9	2.9	∞
SAR Scaling	2.0	Rectangular	√3	1	1	1.2	1.2	1.2	1.2	∞
Physical Parameters										
Phantom Shell	7.6	Rectangular	√3	1	1	4.4	4.4	4.4	4.4	∞
Liquid conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	1.8	1.2	1.2	0.5	∞
Liquid conductivity (Meas.)	3.9	Normal	1	0.78	0.71	3.0	2.7	2.3	1.9	10
Liquid permittivity (Target)	5.0	Rectangular	√3	0.60	0.49	1.7	1.4	1.0	0.7	∞
Liquid permittivity (Meas.)	4.0	Normal	1	0.23	0.26	0.87	1.0	0.20	0.26	10
Temp. unc. - Conductivity	2.0	Rectangular	√3	0.78	0.71	0.81	0.74	0.63	0.52	∞
Temp. unc. - Permittivity	1.8	Rectangular	√3	0.23	0.26	0.24	0.27	0.05	0.07	∞
Combined Standard Uncertainty						**14**	**13**			330
Expanded Uncertainty (k=2)						**28**	**26**			

U(1 g) = $k \times u_c$
= 2 x 14 %
= 28 % (The confidence level is about 95 % k = 2)
U(10 g) = $k \times u_c$
= 2 x 13 %
= 26 % (The confidence level is about 95 % k = 2)

Note. Refer to "DTNC-UP-TS02-2023"

14. CONCLUSION

Measurement Conclusion

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

Please note that the absorption and distribution of electromagnetic energy in the body are every complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role impossible biological effect are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease).

Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

15. REFERENCES

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, Aug. 1996.

[2] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radiofrequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[3] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radiofrequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

[4] ANSI/IEEE C95.3-2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, December 2002.

[5] IEEE Standards Coordinating Committee 39 –Standards Coordinating Committee 34 – IEEE Std. 1528-2003, Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices.

[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. -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 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 300MHz, 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, Bio electromagnetics, 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 Recipes 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: 10kHz-300GHz, Jan. 1995.

[19] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, 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 300MHz to 3 GHz), Feb. 2005.

[21] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radio communication Apparatus (All Frequency Bands) Issue 5, March 2015.

[22] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2009

[23] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225,D01-D07

[24] SAR Measurement procedures for IEEE 802.11a/b/g KDB Publication 248227 D01v02

[25] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474D02-D04

[26] FCC SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers, FCC KDB Publication 616217 D04

[27] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[28] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[29] 615223 D01 802 16e WI-Max SAR Guidance v01, Nov. 13, 2009

[30] Anexo à Resolução No. 533, de 10 de September de 2009.

[31] 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.

APPENDIX A. – Probe Calibration Data

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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Accreditation No.: **SCS 0108**

Client **DT&C (Dymstec)** Certificate No **ES-3327_Jan23**

CALIBRATION CERTIFICATE

Object	ES3DV3 - SN:3327
Calibration procedure(s)	QA CAL-01.v10, QA CAL-12.v10, QA CAL-23.v6, QA CAL-25.v8 Calibration procedure for dosimetric E-field probes
Calibration date	January 22, 2023

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-22 (OCP-DAK3.5-1249_Oct22)	Oct-23
OCP DAK-12	SN: 1016	20-Oct-22 (OCP-DAK12-1016_Oct22)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	10-Oct-22 (No. DAE4-660_Oct22)	Oct-23
Reference Probe ES3DV2	SN: 3013	06-Jan-23 (No. ES3-3013_Jan23)	Jan-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: January 23, 2023

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

Calibration Laboratory of
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Accreditation No.: SCS 0108

Glossary

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ 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:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

Parameters of Probe: ES3DV3 - SN:3327

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm (μV/(V/m)^2) A	1.05	1.13	1.03	±10.1%
DCP (mV) B	105.0	102.0	104.0	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc^E $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	183.1	±2.5%	±4.7%
		Y	0.00	0.00	1.00		196.0		
		Z	0.00	0.00	1.00		182.9		

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

A The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Page 5).
B Linearization parameter uncertainty for maximum specified field strength.
E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Parameters of Probe: ES3DV3 - SN:3327

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-35.8°
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	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Parameters of Probe: ES3DV3 - SN:3327

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
750	41.9	0.89	6.90	6.36	6.41	0.40	1.27	±12.0%
835	41.5	0.90	6.90	6.20	6.26	0.40	1.27	±12.0%
900	41.5	0.97	6.73	6.29	6.19	0.40	1.27	±12.0%
1750	40.1	1.37	6.17	5.66	5.64	0.40	1.27	±12.0%
1900	40.0	1.40	5.91	5.42	5.43	0.40	1.27	±12.0%
2450	39.2	1.80	5.43	4.96	5.03	0.40	1.27	±12.0%
2600	39.0	1.96	5.10	4.67	4.73	0.40	1.27	±12.0%

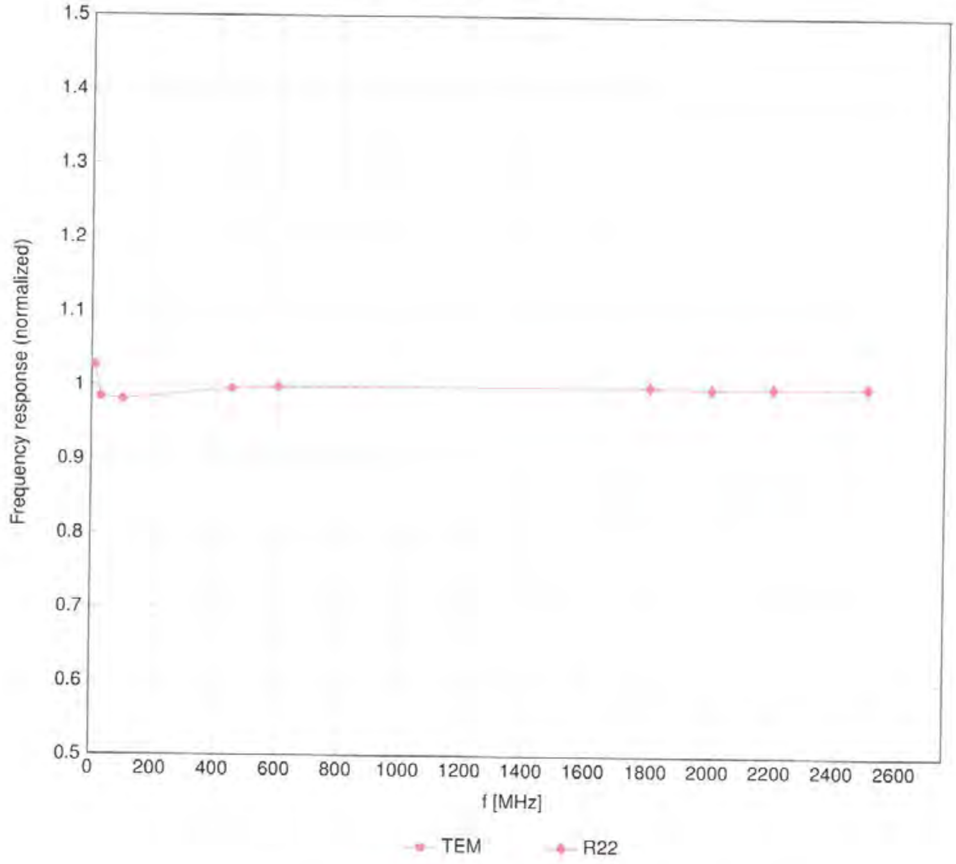
[C] Frequency validity above 300 MHz of ±100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ±50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is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

[F] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10%. If TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

[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)

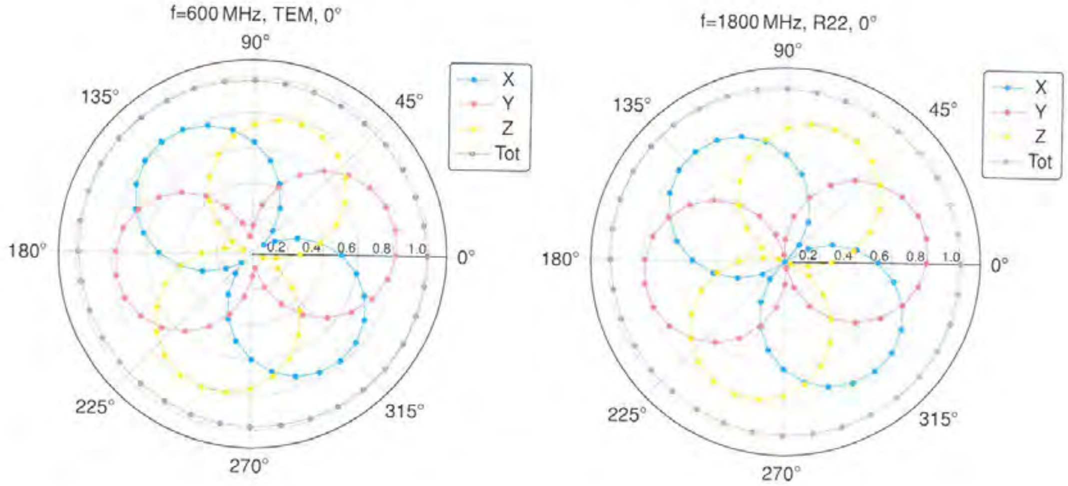


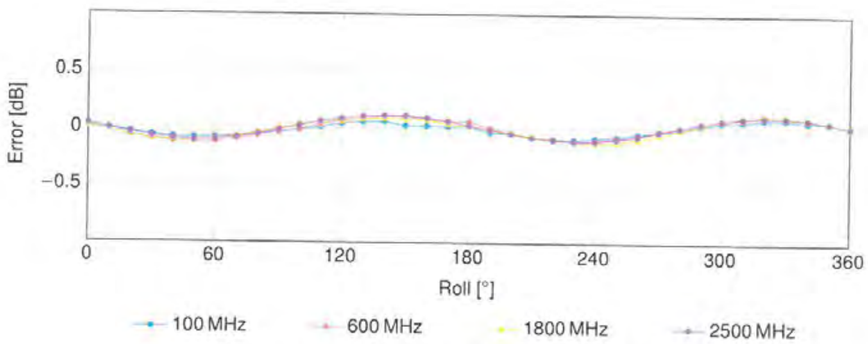
Uncertainty of Frequency Response of E-field: ±6.3% (k=2)

ES3DV3 - SN:3327

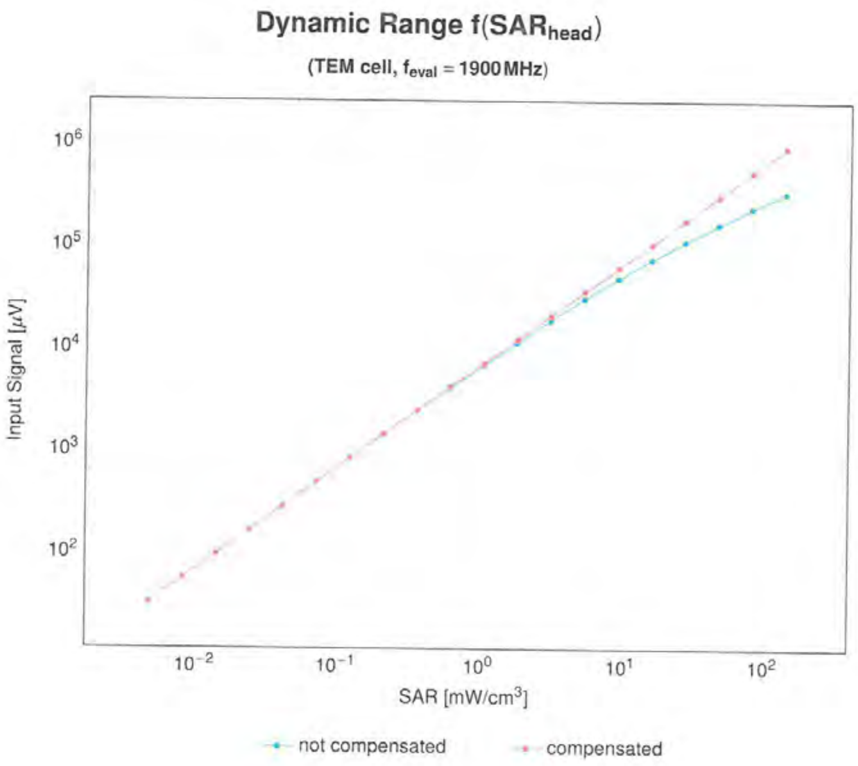
January 22, 2023

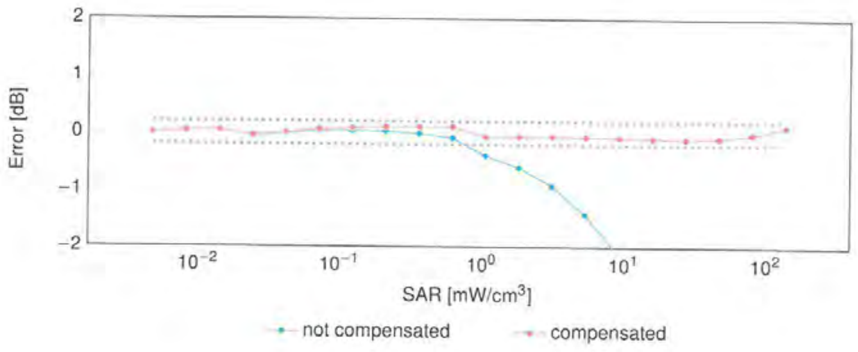
Receiving Pattern (ϕ), $\vartheta = 0°$





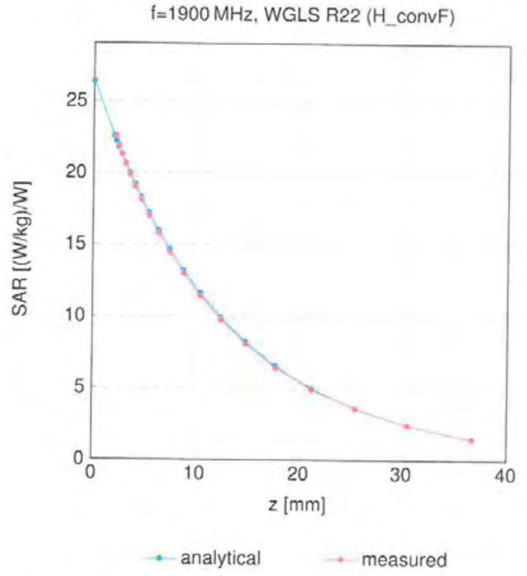
Uncertainty of Axial Isotropy Assessment: ±0.5% (k=2)





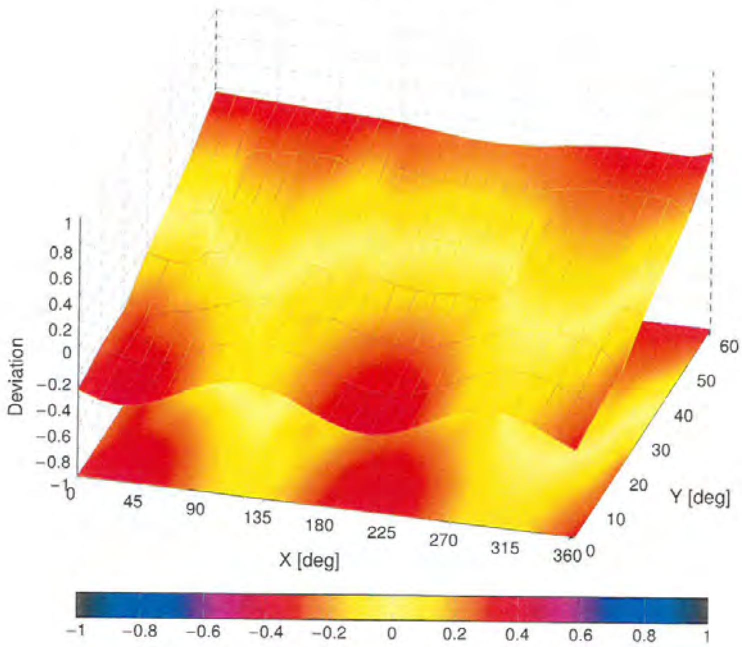
Uncertainty of Linearity Assessment: ±0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (φ, θ), f = 900 MHz



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

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Accreditation No.: SCS 0108

Client **Dt&C**
Gyeonggi-do, Republic of Korea

Certificate No. **EX-3916_Mar23**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3916
Calibration procedure(s)	QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6, QA CAL-25.v8 Calibration procedure for dosimetric E-field probes
Calibration date	March 22, 2023

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-22 (OCP-DAK3.5-1249_Oct22)	Oct-23
OCP DAK-12	SN: 1016	20-Oct-22 (OCP-DAK12-1016_Oct22)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe ES3DV2	SN: 3013	06-Jan-23 (No. ES3-3013_Jan23)	Jan-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	[signature]
Approved by	Sven Kühn	Technical Manager	[signature]

Issued: April 05, 2023

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

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Accreditation No.: SCS 0108

Glossary

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ 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:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

Parameters of Probe: EX3DV4 - SN:3916

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm (μV/(V/m)^2) [A]	0.56	0.48	0.52	±10.1%
DCP (mV) [B]	100.6	100.3	101.0	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	146.2	±2.7%	±4.7%
		Y	0.00	0.00	1.00		159.4		
		Z	0.00	0.00	1.00		163.7		
10352	Pulse Waveform (200Hz, 10%)	X	20.00	92.96	22.67	10.00	60.0	±2.9%	±9.6%
		Y	20.00	90.54	20.65		60.0		
		Z	20.00	93.39	22.61		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	20.00	92.81	21.42	6.99	80.0	±1.5%	±9.6%
		Y	20.00	91.61	20.29		80.0		
		Z	20.00	94.29	21.88		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	20.00	94.15	20.58	3.98	95.0	±1.1%	±9.6%
		Y	20.00	94.83	20.65		95.0		
		Z	20.00	96.69	21.53		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	20.00	95.91	19.98	2.22	120.0	±1.0%	±9.6%
		Y	20.00	98.58	21.16		120.0		
		Z	20.00	98.87	21.09		120.0		
10387	QPSK Waveform, 1 MHz	X	1.65	65.42	14.67	1.00	150.0	±2.5%	±9.6%
		Y	1.52	65.06	14.13		150.0		
		Z	1.51	64.57	13.91		150.0		
10388	QPSK Waveform, 10 MHz	X	2.21	67.73	15.41	0.00	150.0	±1.0%	±9.6%
		Y	2.01	66.55	14.87		150.0		
		Z	2.00	66.36	14.66		150.0		
10396	64-QAM Waveform, 100 kHz	X	3.22	70.99	18.88	3.01	150.0	±0.8%	±9.6%
		Y	2.85	70.42	18.71		150.0		
		Z	3.07	71.09	18.96		150.0		
10399	64-QAM Waveform, 40 MHz	X	3.49	67.01	15.63	0.00	150.0	±2.0%	±9.6%
		Y	3.36	66.45	15.32		150.0		
		Z	3.34	66.33	15.20		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	4.91	65.59	15.46	0.00	150.0	±3.8%	±9.6%
		Y	4.71	65.27	15.24		150.0		
		Z	4.74	65.22	15.18		150.0		

Note: For details on UID parameters see Appendix

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

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 to 7).
[B] Linearization parameter uncertainty for maximum specified field strength.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Parameters of Probe: EX3DV4 - SN:3916

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms V^{-2}$	T2 $ms V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
x	53.2	397.64	35.54	21.90	0.73	5.10	0.67	0.48	1.01
y	41.6	307.28	34.75	22.39	0.03	5.10	1.59	0.15	1.01
z	46.2	341.11	34.80	17.57	0.55	5.10	1.36	0.27	1.01

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-88.5°
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.

Parameters of Probe: EX3DV4 - SN:3916

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
13	55.0	0.75	17.86	17.86	17.86	0.00	1.00	±13.3%
750	41.9	0.89	10.13	10.13	10.13	0.46	0.89	±12.0%
835	41.5	0.90	9.62	9.62	9.62	0.37	0.90	±12.0%
900	41.5	0.97	9.42	9.42	9.42	0.30	1.04	±12.0%
1750	40.1	1.37	8.42	8.42	8.42	0.45	0.86	±12.0%
1900	40.0	1.40	8.31	8.31	8.31	0.32	0.86	±12.0%
2450	39.2	1.80	7.44	7.44	7.44	0.43	0.90	±12.0%
2600	39.0	1.96	7.19	7.19	7.19	0.46	0.90	±12.0%
3300	38.2	2.71	7.10	7.10	7.10	0.30	1.35	±14.0%
3500	37.9	2.91	7.03	7.03	7.03	0.30	1.35	±14.0%
3700	37.7	3.12	6.78	6.78	6.78	0.30	1.35	±14.0%
3900	37.5	3.32	6.64	6.64	6.64	0.40	1.60	±14.0%
4100	37.2	3.53	6.58	6.58	6.58	0.40	1.60	±14.0%
4200	37.1	3.63	6.49	6.49	6.49	0.40	1.70	±14.0%
4400	36.9	3.84	6.42	6.42	6.42	0.40	1.70	±14.0%
4600	36.7	4.04	6.36	6.36	6.36	0.40	1.70	±14.0%
4800	36.4	4.25	6.35	6.35	6.35	0.40	1.80	±14.0%
4950	36.3	4.40	6.09	6.09	6.09	0.40	1.80	±14.0%
5200	36.0	4.66	5.06	5.06	5.06	0.40	1.80	±14.0%
5300	35.9	4.76	4.95	4.95	4.95	0.40	1.80	±14.0%
5500	35.6	4.96	4.77	4.77	4.77	0.40	1.80	±14.0%
5600	35.5	5.07	4.63	4.63	4.63	0.40	1.80	±14.0%
5750	35.4	5.22	4.72	4.72	4.72	0.40	1.80	±14.0%
5800	35.3	5.27	4.67	4.67	4.67	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] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10%. If TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

[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.

Parameters of Probe: EX3DV4 - SN:3916

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
750	55.5	0.96	10.25	10.25	10.25	0.39	0.96	±12.0%
835	55.2	0.97	10.12	10.12	10.12	0.49	0.80	±12.0%
900	55.0	1.05	9.69	9.69	9.69	0.42	0.88	±12.0%
1750	53.4	1.49	8.32	8.32	8.32	0.42	0.86	±12.0%
1900	53.3	1.52	8.12	8.12	8.12	0.36	0.86	±12.0%
2450	52.7	1.95	7.63	7.63	7.63	0.43	0.90	±12.0%
2600	52.5	2.16	7.48	7.48	7.48	0.35	0.90	±12.0%
3300	51.6	3.08	6.64	6.64	6.64	0.40	1.35	±14.0%
3500	51.3	3.31	6.62	6.62	6.62	0.40	1.35	±14.0%
3700	51.0	3.55	6.46	6.46	6.46	0.40	1.35	±14.0%
3900	50.8	3.78	6.26	6.26	6.26	0.40	1.70	±14.0%
4100	50.5	4.01	6.08	6.08	6.08	0.40	1.70	±14.0%
4200	50.4	4.13	5.92	5.92	5.92	0.40	1.80	±14.0%
4400	50.1	4.37	5.86	5.86	5.86	0.40	1.80	±14.0%
4600	49.8	4.60	5.84	5.84	5.84	0.40	1.80	±14.0%
4800	49.6	4.83	5.82	5.82	5.82	0.40	1.80	±14.0%
4950	49.4	5.01	5.41	5.41	5.41	0.50	1.90	±14.0%
5200	49.0	5.30	4.61	4.61	4.61	0.50	1.90	±14.0%
5300	48.9	5.42	4.43	4.43	4.43	0.50	1.90	±14.0%
5500	48.6	5.65	4.19	4.19	4.19	0.50	1.90	±14.0%
5600	48.5	5.77	4.07	4.07	4.07	0.50	1.90	±14.0%
5800	48.2	6.00	4.10	4.10	4.10	0.50	1.90	±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] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10%. If TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

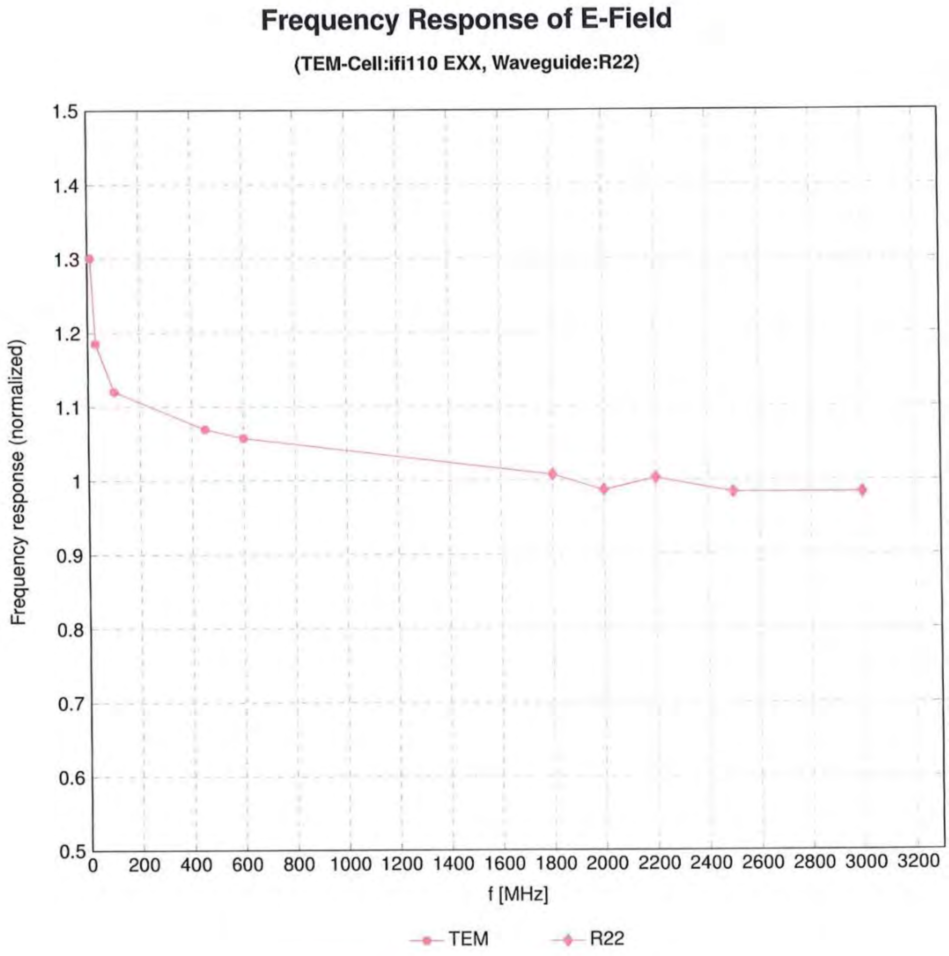
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the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

Parameters of Probe: EX3DV4 - SN:3916

Calibration Parameter Determined in Head Tissue Simulating Media

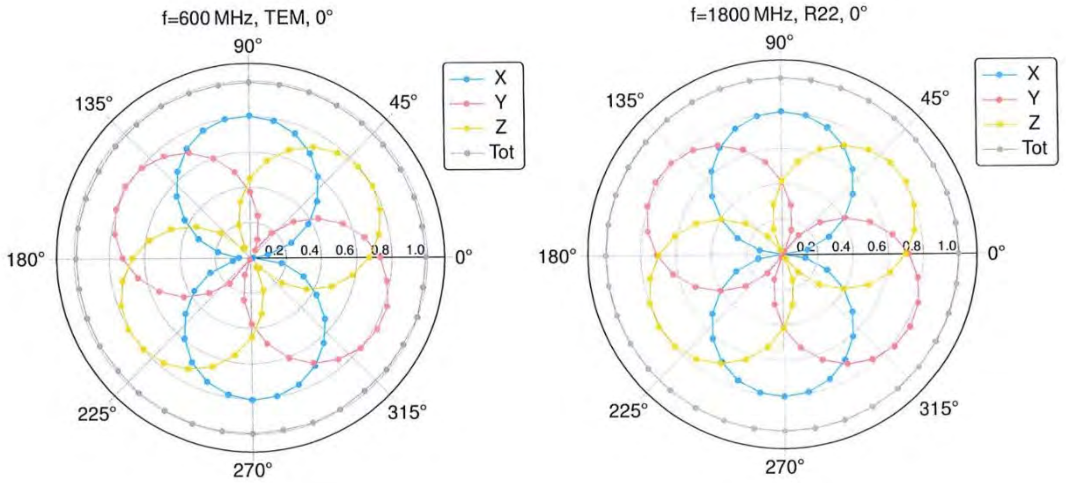
f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
6500	34.5	6.07	5.30	5.30	5.30	0.20	2.50	±18.6%
7000	33.9	6.65	5.35	5.35	5.35	0.20	2.00	±18.6%
8000	32.7	7.84	5.50	5.50	5.50	0.50	1.50	±18.6%
9000	31.6	9.08	5.55	5.55	5.55	0.50	1.50	±18.6%

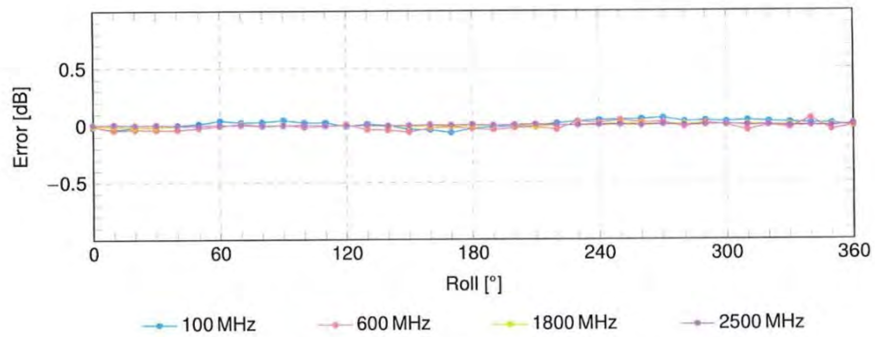
[C] Frequency validity at 6.5 GHz is −600/+700 MHz, and ±700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±10% from the target values (typically better than ±6%) and are valid for TSL with deviations of up to ±10%.
[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; below ±2% for frequencies between 3–6 GHz; and below ±4% for frequencies between 6–10 GHz at any distance larger than half the probe tip diameter from the boundary.



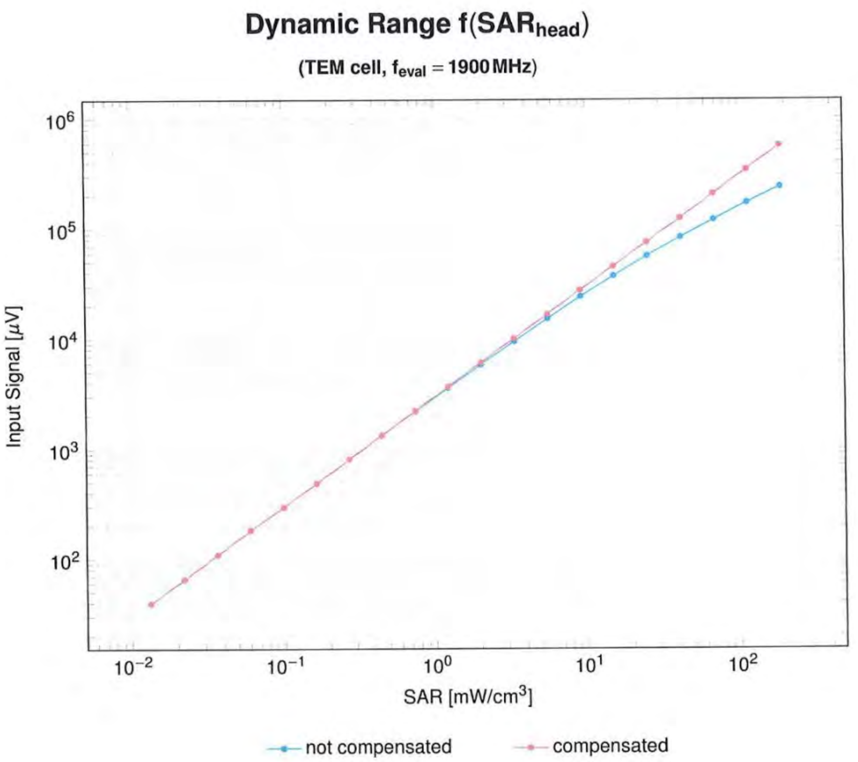
Uncertainty of Frequency Response of E-field: ±6.3% (k=2)

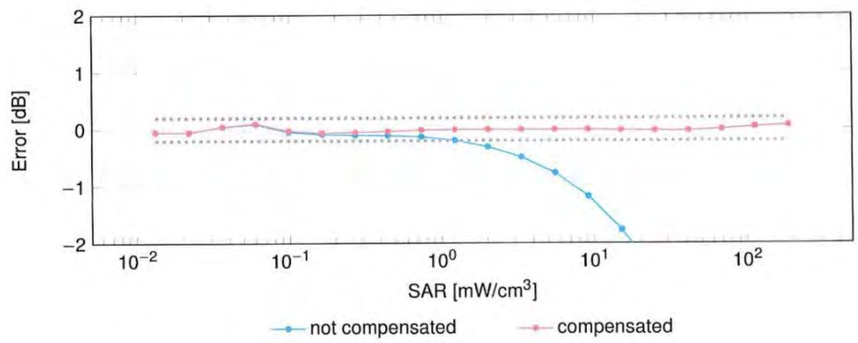
Receiving Pattern (ϕ), $\vartheta = 0°$





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





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

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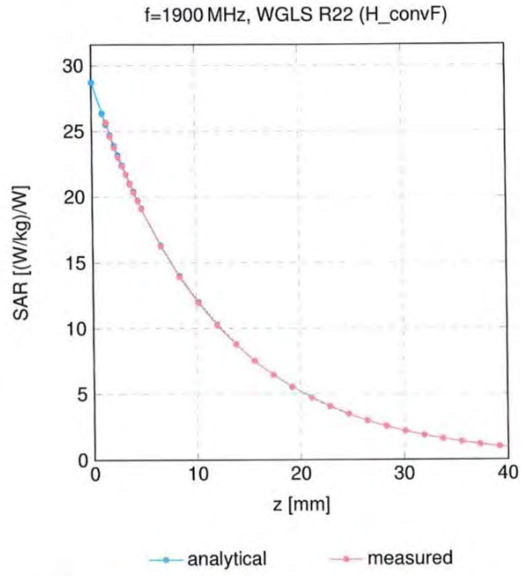
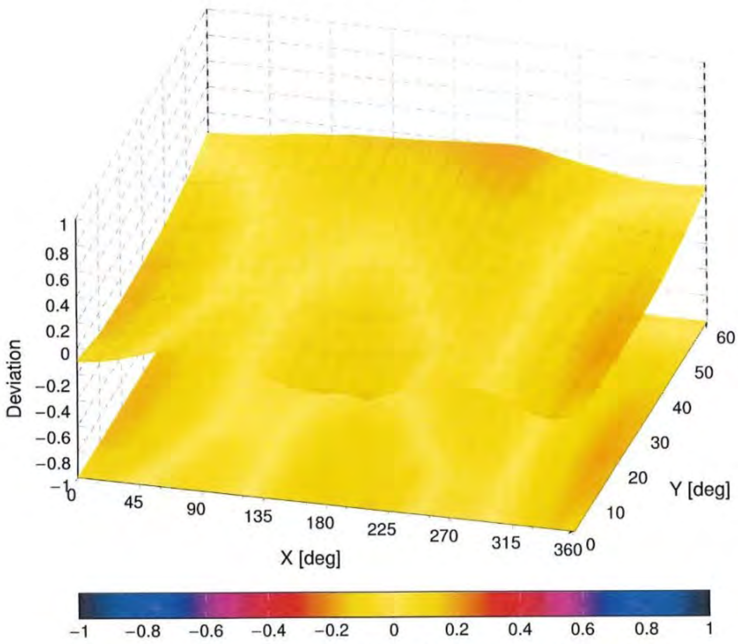
Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



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