



PART 0 SAR CHAR REPORT

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro, Maetan dong,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

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APPLICANT: SAMSUNG ELECTRONICS CO., LTD

Report Type: Part 0 SAR Characterization
DUT Type: Portable Handset
Model(s): SM-S901U, SM-S901U1

Note: This revised Test Report (S/N: 1M2109080099-21.A3L(Rev1)) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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

Test results reported herein relate only to the item(s) tested.


Randy Ortanez
President



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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
GSM/GPRS/EDGE 850	Voice/Data	824.20 - 848.80 MHz
GSM/GPRS/EDGE 1900	Voice/Data	1850.20 - 1909.80 MHz
UMTS 850	Voice/Data	826.40 - 846.60 MHz
UMTS 1750	Voice/Data	1712.4 - 1752.6 MHz
UMTS 1900	Voice/Data	1852.4 - 1907.6 MHz
LTE Band 71	Voice/Data	665.5 - 695.5 MHz
LTE Band 12	Voice/Data	699.7 - 715.3 MHz
LTE Band 13	Voice/Data	779.5 - 784.5 MHz
LTE Band 14	Voice/Data	790.5 - 795.5 MHz
LTE Band 26 (Cell)	Voice/Data	814.7 - 848.3 MHz
LTE Band 5 (Cell)	Voice/Data	824.7 - 848.3 MHz
LTE Band 66 (AWS)	Voice/Data	1710.7 - 1779.3 MHz
LTE Band 4 (AWS)	Voice/Data	1710.7 - 1754.3 MHz
LTE Band 25 (PCS)	Voice/Data	1850.7 - 1914.3 MHz
LTE Band 2 (PCS)	Voice/Data	1850.7 - 1914.3 MHz
LTE Band 30	Voice/Data	2307.5 - 2312.3 MHz
LTE Band 7	Voice/Data	2502.5 - 2567.5 MHz
LTE Band 48	Voice/Data	3552.5 - 3649.2 MHz
LTE Band 41	Voice/Data	2498.5 - 2687.5 MHz
LTE Band 38	Voice/Data	2572.5 - 2617.5 MHz
NR Band n71	Voice/Data	665.5 - 695.5 MHz
NR Band n12	Voice/Data	701.5 - 713.5 MHz
NR Band n5 (Cell)	Voice/Data	826.5 - 846.5 MHz
NR Band n66 (AWS)	Voice/Data	1712.5 - 1777.5 MHz
NR Band n25 (PCS)	Voice/Data	1852.5 - 1912.5 MHz
NR Band n2 (PCS)	Voice/Data	1852.5 - 1907.5 MHz
NR Band n30	Voice/Data	2307.5 - 2312.5 MHz
NR Band n7	Voice/Data	2502.5 - 2567.5 MHz
NR Band n41	Voice/Data	2506.02 - 2679.99 MHz
NR Band n38	Voice/Data	2575 - 2615 MHz
NR Band n77 DoD	Voice/Data	3455.01 - 3544.98 MHz
NR Band n77	Voice/Data	3705 - 3975 MHz
2.4 GHz WLAN	Voice/Data	2412 - 2462 MHz
U-NII-1	Voice/Data	5180 - 5240 MHz
U-NII-2A	Voice/Data	5260 - 5320 MHz
U-NII-2C	Voice/Data	5500 - 5720 MHz
U-NII-3	Voice/Data	5745 - 5825 MHz
U-NII-4	Voice/Data	5845 - 5885 MHz
Bluetooth	Data	2402 - 2480 MHz
NFC Data	Data	13.56 MHz
NR Band n258	Data	24250 - 24450 MHz; 24750 - 25250 MHz
NR Band n260	Data	37000 - 40000 MHz
NR Band n261	Data	27500 - 28350 MHz

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This device uses the Qualcomm® Smart Transmit feature to control and manage transmitting power in real time and to ensure the time-averaged RF exposure is in compliance with the FCC requirement at all times for 2G/3G/4G/5G WWAN operations. Additionally, this device supports WLAN/BT/NFC technologies, but the output power of these modems is not controlled by the Smart Transmit algorithm.

1.2 Time-Averaging for SAR and Power Density

This device is enabled with Qualcomm® Smart Transmit algorithm to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from 2G/3G/4G/5G Sub-6 NR WWAN is in compliance with FCC requirements. This Part 0 report shows SAR characterization of WWAN radios for 2G/3G/4G/5G Sub-6 NR. Characterization is achieved by determining P_{Limit} for 2G/3G/4G/5G Sub-6 NR that corresponds to the exposure design targets after accounting for all device design related uncertainties, i.e., SAR_design_target (< FCC SAR limit) for sub-6 radio. The SAR characterization is denoted as SAR Char in this report. Section 1.3 includes a nomenclature of the specific terms used in this report.

The compliance test under the static transmission scenario and simultaneous transmission analysis are reported in Part 1 report. The validation of the time-averaging algorithm and compliance under the dynamic (time-varying) transmission scenario for WWAN technologies are reported in Part 2 report (report SN could be found in Section 1.4 – Bibliography).

1.3 Nomenclature for Part 0 Report

Technology	Term	Description
2G/3G/4G/5G Sub-6 NR	P_{limit}	Power level that corresponds to the exposure design target (SAR_design_target) after accounting for all device design related uncertainties
	P_{max}	Maximum tune up output power
	SAR_design_target	Target SAR level < FCC SAR limit after accounting for all device design related uncertainties
	SAR Char	Table containing P_{limit} for all technologies and bands

1.4 Bibliography

Report Type	Report Serial Number
Near Field PD Report (Part 1)	1M2109080099-22.A3L
Near Field PD Part 0 Report	
RF Exposure Part 2 Test Report	1M2109080099-23.A3L
RF Exposure Compliance Summary Report	1M2109080099-24.A3L
RF Exposure Part 1 Test Report	1M2109080099-01.A3L

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2 SAR AND POWER DENSITY MEASUREMENTS

2.1 SAR Definition

Specific Absorption Rate 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 Equation 2-1).

Equation 2-1
SAR Mathematical Equation

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

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 relation 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.[6]

2.2 SAR 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 2-1) and IEEE 1528-2013.
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 1g/10g 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

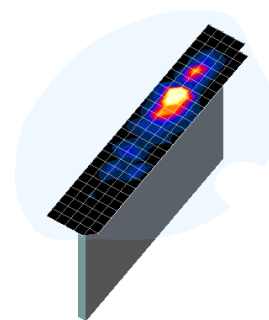


Figure 2-1
Sample SAR Area Scan

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size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 2-1) 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 2-1. 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 (1g or 10g) 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 2-1
Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

Frequency	Maximum Area Scan Resolution (mm) ($\Delta x_{\text{area}}, \Delta y_{\text{area}}$)	Maximum Zoom Scan Resolution (mm) ($\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}}$)	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
				$\Delta z_{\text{zoom}}(n)$	$\Delta z_{\text{zoom}}(1)^*$	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 22

*Also compliant to IEEE 1528-2013 Table 6

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3 SAR CHARACTERIZATION

3.1 DSI and SAR Determination

This device uses different Device State Index (DSI) to configure different time averaged power levels based on certain exposure scenarios. Depending on the detection scheme implemented in the smartphone, the worst-case SAR was determined by measurements for the relevant exposure conditions for that DSI. Detailed descriptions of the detection mechanisms are included in the operational description.

When 1g SAR and 10g SAR exposure comparison is needed, the worst-case was determined from SAR normalized to 1g or 10g SAR limit.

The device state index (DSI) conditions used in Table 3-1 represent different exposure scenarios.

Table 3-1
DSI and Corresponding Exposure Scenarios

Scenario	Description	SAR Test Cases
Head (DSI = 2)	- Device positioned next to head - Receiver Active	Head SAR per KDB Publication 648474 D04
Hotspot mode (DSI = 3)	- Device transmits in hotspot mode near body - Hotspot Mode Active	Hotspot SAR per KDB Publication 941225 D06
Phablet Grip (DSI=1 or 4)	- Device is held with hand and grip sensor is triggered - Grip sensor triggered or earjack is active	Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04
Phablet (DSI = 0)	- Device is held with hand and grip sensor is not triggered - Distance grip sensor not triggered	Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04
Body-worn (DSI = 0)	Device being used with a body-worn accessory	Body-worn SAR per KDB Publication 648474 D04

3.2 SAR Design Target

SAR_design_target is determined by ensuring that it is less than FCC SAR limit after accounting for total device designed related uncertainties specified by the manufacturer (see Table 3-2).

Table 3-2
***SAR_design_target* Calculations**

<i>SAR_design_target</i>			
$SAR_design_target < SAR_regulatory_limit \times 10^{\frac{-Total\ Uncertainty}{10}}$			
1g SAR (W/kg)		10g SAR (W/kg)	
Total Uncertainty	1.0 dB	Total Uncertainty	1.0 dB
SAR_regulatory_limit	1.6 W/kg	SAR_regulatory_limit	4.0 W/kg
SAR_design_target	1.0 W/kg	SAR_design_target	2.5 W/kg

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3.3 SAR Char

SAR test results corresponding to P_{max} for each antenna/technology/band/DSI can be found in Appendix A.

P_{limit} is calculated by linearly scaling with the measured SAR at the P_{part0} to correspond to the SAR_{design_target} . When $P_{limit} < P_{max}$, P_{part0} was used as P_{limit} in the Smart Transmit EFS. When $P_{limit} > P_{max}$ and $P_{part0}=P_{max}$, calculated P_{limit} was used in the Smart Transmit EFS. All reported SAR obtained from the P_{part0} SAR tests was less than $SAR_{Design_target}+ 1$ dB Uncertainty. The final P_{limit} determination for each exposure scenario corresponding to SAR_{design_target} are shown in Table 3-3.

Table 3-3
 P_{Limit} Determination

Device State Index (DSI)	P_{Limit} Determination Scenarios
0	The worst-case SAR exposure is determined as maximum SAR normalized to the limit among: 1. Body Worn SAR 2. Extremity SAR measured at 8, 6 and 11 mm spacing for back, front, bottom respectively 3. Extremity SAR measured at 0 mm for top, left, and right surfaces
1 or 4	P_{limit} is calculated based on 10g Extremity SAR at 0 mm for back, front, and bottom surfaces
2	P_{limit} is calculated based on 1g Head SAR
3	P_{limit} is calculated based on 1g Hotspot SAR at 10 mm

Note:

For DSI = 0, P_{limit} is calculated by:

$$P_{limit} = \min\{ P_{limit} \text{ corresponding to 1g Body Worn SAR evaluation at 15 mm spacing, } \\ P_{limit} \text{ corresponding to 10g Extremity SAR evaluation at 6~11 mm spacing, } \\ P_{limit} \text{ corresponding to 10g Extremity SAR evaluation at 0 mm for top, left, \& \text{ right surfaces} \}$$

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Table 3-4
SAR Characterizations

Exposure Scenario			Body-Worn	Phablet Max	Phablet Reduced	Head	Hotspot	Earjack	Maximum Tune-Up Output Power*
Averaging Volume			1g	10g	10g	1g	1g	10g	
Spacing			15 mm	11, 8, 6, 0 mm	0 mm	0 mm	10 mm	0 mm	
DSI			0	0	1	2	3	4	
Technology/Band	Antenna	Antenna Group							Pmax
GSM 850	A	AG0	29.6		28.1	32.3	28.1	28.1	25.3
GSM 1900	A	AG0	26.2		18.3	29.9	18.3	18.3	22.1
UMTS 850	A	AG0	29.9		26.5	30.2	26.5	26.5	24.5
UMTS 1750	A	AG0	23.6		20.0	30.4	18.5	20.0	23.0
UMTS 1900	A	AG0	24.6		19.0	30.6	18.5	19.0	23.7
LTE Band 71	A	AG0	30.8		28.9	33.4	28.9	28.9	24.5
LTE Band 12	A	AG0	29.7		28.7	31.7	28.1	28.7	24.5
LTE Band 13	A	AG0	29.7		27.2	31.3	27.2	27.2	24.5
LTE Band 14	A	AG0	29.9		27.5	31.2	27.5	27.5	24.5
LTE Band 26 (Cell)	A	AG0	30.5		27.8	31.4	27.8	27.8	24.5
LTE Band 5 (Cell)	A	AG0	29.3		26.4	30.0	26.4	26.4	24.5
LTE Band 66/4 (AWS)	A	AG0	23.9		19.0	29.5	19.0	19.0	23.5
LTE Band 25/2 (PCS)	A	AG0	24.7		19.5	29.6	19.0	19.5	23.7
LTE Band 30	A	AG0	25.6		20.0	33.4	19.0	20.0	22.5
LTE Band 30	B	AG0	25.9		20.0	36.4	19.0	20.0	22.5
LTE Band 7	B	AG0	24.7		19.5	35.4	19.5	19.5	23.0
LTE Band 41/38 (PC3)	B	AG0	25.2		19.0	32.6	19.0	19.0	22.0
LTE Band 41 (PC2)	B	AG0	25.2		19.0	32.6	19.0	19.0	22.0
LTE Band 48	G	AG1	17.5		17.5	14.5	17.5	17.5	21.0
NR Band n71	A	AG0	27.4		27.6	32.1	27.6	27.6	24.5
NR Band n12	A	AG0	28.6		27.4	30.9	27.3	27.4	24.5
NR Band n5 (Cell)	A	AG0	29.0		28.7	30.2	26.9	28.7	24.5
NR Band n66 (AWS)	A	AG0	22.3		19.5	22.3	18.0	19.5	23.8
NR Band n66 (AWS)	F	AG1	20.0		20.0	17.5	20.0	20.0	23.5
NR Band n25/2 (PCS)	A	AG0	25.9		19.0	29.9	17.5	19.0	23.7
NR Band n25/2 (PCS)	F	AG1	21.0		21.0	19.5	21.0	21.0	24.0
NR Band n30	A	AG0	23.5		18.5	31.0	18.5	18.5	22.5
NR Band n30	B	AG0	26.6		18.5	34.8	18.5	18.5	22.5
NR Band n30	F	AG1	21.5		21.5	18.0	21.0	21.5	22.0
NR Band n7	B	AG0	21.5		19.5	21.5	18.5	19.5	23.0
NR Band n41 SRS 1 (PC3)	F	AG1	20.0		20.0	18.0	20.0	20.0	24.5
NR Band n41 SRS 1 (PC2)	F	AG1	20.0		20.0	18.0	20.0	20.0	26.5
NR Band n41 SRS 2 (PC3)	B	AG0	16.5		16.5	16.5	16.5	16.5	21.5
NR Band n41 SRS 2 (PC2)	B	AG0	16.5		16.5	16.5	16.5	16.5	23.0
NR Band n41 SRS 3 (PC3)	E	AG1	15.5		15.5	15.5	15.5	15.5	20.5
NR Band n41 SRS 3 (PC2)	E	AG1	15.5		15.5	15.5	15.5	15.5	22.0
NR Band n41 SRS 4 (PC3)	D	AG0	14.5		14.5	14.5	14.5	14.5	19.0
NR Band n41 SRS 4 (PC2)	D	AG0	14.5		14.5	14.5	14.5	14.5	20.5
NR Band n38	F	AG1	20.0		20.0	18.0	20.0	20.0	24.0
NR Band n77 DoD SRS 1 (PC3)	G	AG1	17.0		17.0	14.0	17.0	17.0	24.0
NR Band n77 DoD SRS 1 (PC2)	G	AG1	17.0		17.0	14.0	17.0	17.0	26.0
NR Band n77 DoD SRS 2 (PC3)	C	AG0	11.5		11.5	11.5	11.5	11.5	20.0
NR Band n77 DoD SRS 2 (PC2)	C	AG0	11.5		11.5	11.5	11.5	11.5	22.0
NR Band n77 DoD SRS 3 (PC3)	H	AG1	17.0		17.0	14.0	17.0	17.0	23.0
NR Band n77 DoD SRS 3 (PC2)	H	AG1	17.0		17.0	14.0	17.0	17.0	25.0
NR Band n77 DoD SRS 4 (PC3)	D	AG0	11.5		11.5	11.5	11.5	11.5	18.0
NR Band n77 DoD SRS 4 (PC2)	D	AG0	11.5		11.5	11.5	11.5	11.5	20.0
NR Band n77 SRS 1 (PC3)	G	AG1	17.0		17.0	14.0	17.0	17.0	24.0
NR Band n77 SRS 1 (PC2)	G	AG1	17.0		17.0	14.0	17.0	17.0	26.0
NR Band n77 SRS 2 (PC3)	C	AG0	11.5		11.5	11.5	11.5	11.5	20.0
NR Band n77 SRS 2 (PC2)	C	AG0	11.5		11.5	11.5	11.5	11.5	22.0
NR Band n77 SRS 3 (PC3)	H	AG1	17.0		17.0	14.0	17.0	17.0	23.0
NR Band n77 SRS 3 (PC2)	H	AG1	17.0		17.0	14.0	17.0	17.0	25.0
NR Band n77 SRS 4 (PC3)	D	AG0	11.5		11.5	11.5	11.5	11.5	18.0
NR Band n77 SRS 4 (PC2)	D	AG0	11.5		11.5	11.5	11.5	11.5	20.0

Notes:

- For all modes/bands, when Hotspot Mode (DSI=3) and Extremity sensor (DSI=1) are triggered at the same time, DSI=3 takes priority, thus the P_{limit} for DSI=3 is set to be less or equal to P_{limit} for DSI=1.
- When $P_{max} < P_{limit}$, the DUT will operate at a power level up to P_{max} .
- P_{limit} for DSI=1 and DSI =4 are the same.
- For all bands on AG1, when RCV is active, DSI=2 takes priority over all levels.

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4 EQUIPMENT LIST

For SAR measurements

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	80018	3 mm Standard Calibration Kit	7/7/2021	Annual	7/7/2022	MV3400352
Agilent	8904A	(8650-2.924) Spectrum Analyzer	CBT	N/A	CBT	3051400187
Agilent	87599	5 Parameter Vector Network Analyzer	12/15/2020	Annual	12/15/2021	M14003891
Agilent	8735S	5 Parameter Vector Network Analyzer	2/2/2021	Annual	2/2/2022	U639170112
Agilent	E4432B	ESG-D Series Signal Generator	2/24/2021	Annual	2/24/2022	U540053896
Agilent	E4438C	ESG Vector Signal Generator	5/6/2021	Annual	5/6/2022	M14282628
Agilent	E5353C	Wireless Communications Test Set	2/4/2021	Annual	2/4/2022	0843159503
Agilent	E5353C	Wireless Communications Test Set	2/4/2021	Annual	2/4/2022	0843159578
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	0846170464
Agilent	N5182A	MMV Vector Signal Generator	6/15/2021	Annual	6/15/2022	M147432600
Agilent	N5182A	MMV Vector Signal Generator	6/21/2021	Annual	6/21/2022	M147432600
Amplifier Research	150166	Amplifier	CBT	N/A	CBT	353117
Amplifier Research	150166	Amplifier	CBT	N/A	CBT	353168
Anritsu	ML2486A	Power Meter	3/19/2021	Annual	3/19/2022	1118001
Anritsu	ML2486A	Power Meter	6/21/2021	Annual	6/21/2022	1151001
Anritsu	MA2418A	USB Power Sensor	1/19/2021	Annual	1/19/2022	1145001
Anritsu	MA2418A	USB Power Sensor	1/19/2021	Annual	1/19/2022	1146001
Anritsu	MA2418B	Pulse Power Sensor	12/18/2020	Annual	12/18/2021	1126006
Anritsu	MA2418B	Pulse Power Sensor	3/9/2021	Annual	3/9/2022	1126740
Anritsu	MB1812B	VCO Adaptor	CBT	N/A	CBT	026117061
Anritsu	MT8813C	Radio Communication Analyzer	2/1/2021	Annual	2/1/2022	020164796
Anritsu	MT8813C	Radio Communication Analyzer	3/2/2021	Annual	3/2/2022	026204715
Anritsu	MT8813C	Radio Communication Analyzer	4/18/2021	Annual	4/18/2022	020114449
Anritsu	MT8813C	Radio Communication Analyzer	6/14/2021	Annual	6/14/2022	026185313
Anritsu	MT8813C	Radio Communication Analyzer	4/16/2021	Annual	4/16/2022	020090180
Anritsu	MT8813C	Radio Communication Analyzer	1/18/2021	Annual	1/18/2022	026210047
Anritsu	MT8800A	Radio Communication Test Station	7/28/2021	Annual	7/28/2022	027131419
CDMTech	AWB729-S	Signal State Amplifier	CBT	N/A	CBT	M135400-009
CDMTech	AWB729-S17598	Signal State Amplifier	CBT	N/A	CBT	M135400-009
Control Company	4006	Therm / Clock / Humidity Monitor	2/17/2020	Biannual	2/17/2022	200112061
Control Company	4006	Therm / Clock / Humidity Monitor	6/17/2020	Biannual	6/17/2022	200112724
Control Company	4312	Logic State Thermometer	1/24/2020	Biannual	1/24/2022	200045081
Control Company	4312	Logic State Thermometer	1/24/2020	Biannual	1/24/2022	200045081
Fluke	1108-150	Digital Caliper	1/17/2020	Biannual	1/17/2022	609193536
Keysight	7720	Dual Directional Coupler	CBT	N/A	CBT	M152180215
Keysight Technologies	N4250A	Network Analyzer	1/5/2021	Annual	1/5/2022	M152180215
Keysight Technologies	N9900A	MSA Signal Analyzer	2/24/2021	Annual	2/24/2022	M140002513
MLI	BW-N50V+	SdB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	SV-2400	Low Pass Filter	CBT	N/A	CBT	080703040
Mini-Circuits	VLP-6000	Low Pass Filter	CBT	N/A	CBT	1236
Mini-Circuits	BW-N20V+	Power Attenuator	CBT	N/A	CBT	1236
Mini-Circuits	BW-N20V+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1200 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2900+	Low Pass Filter DC to 2900 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	TVA-1L-422	RF Power Amp	CBT	N/A	CBT	0A1303002
Narda	2046-4	4 - 8 GHz SMA 1.6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	2777-1	Attenuator (1 dB)	CBT	N/A	CBT	9606
Narda	BW-S392	Attenuator (3dB)	CBT	N/A	CBT	120
Patterson	HC-100	Torque Wrench	8/4/2020	Biannual	8/4/2022	N/A
Patterson	HC-100	Torque Wrench	8/4/2020	Biannual	8/4/2022	N/A
Patterson	PE220B-6	Bi-directional Coupler	CBT	N/A	CBT	N/A
Patterson	PE220B-6	Bi-directional Coupler	CBT	N/A	CBT	N/A
Robo & Schwarz	CMW500	Radio Communication Tester	1/18/2021	Annual	1/18/2022	111427
Robo & Schwarz	CMW500	Radio Communication Tester	2/18/2021	Annual	2/18/2022	100767
Robo & Schwarz	CMW500	Radio Communication Tester	2/23/2021	Annual	2/23/2022	156488
Robo & Schwarz	CMW500	Radio Communication Tester	1/18/2021	Annual	1/18/2022	126683
SPEAG	D1750V2	1750 MHz SAR Dipole	10/21/2018	Triannual	10/21/2021	1150
SPEAG	D1750V2	1750 MHz SAR Dipole	5/12/2020	Biannual	5/12/2022	1148
SPEAG	D1900V2	1900 MHz SAR Dipole	10/21/2018	Triannual	10/21/2021	1150
SPEAG	D1900V2	1900 MHz SAR Dipole	10/21/2018	Triannual	10/21/2021	1150
SPEAG	D1900V2	1900 MHz SAR Dipole	2/21/2020	Triannual	2/21/2022	16148
SPEAG	D2300V2	2300 MHz SAR Dipole	6/18/2021	Annual	6/18/2022	1116
SPEAG	D2300V2	2300 MHz SAR Dipole	6/18/2021	Annual	6/18/2022	1117
SPEAG	D2450V2	2450 MHz SAR Dipole	1/18/2021	Annual	1/18/2022	981
SPEAG	D2450V2	2450 MHz SAR Dipole	5/9/2021	Annual	5/9/2022	797
SPEAG	D2450V2	2450 MHz SAR Dipole	1/18/2021	Annual	6/18/2022	1119
SPEAG	D2600V2	2600 MHz SAR Dipole	11/11/2018	Triannual	11/11/2021	1071
SPEAG	D2600V2	2600 MHz SAR Dipole	4/14/2021	Annual	4/14/2022	1034
SPEAG	D2600V2	2600 MHz SAR Dipole	4/14/2021	Annual	4/14/2022	1034
SPEAG	D3000V2	3000 MHz SAR Dipole	1/18/2021	Annual	1/18/2022	1059
SPEAG	D3000V2	3000 MHz SAR Dipole	1/21/2020	Biannual	1/21/2022	1097
SPEAG	D3700V2	3700 MHz SAR Dipole	1/18/2021	Annual	1/18/2022	1059
SPEAG	D3700V2	3700 MHz SAR Dipole	1/21/2020	Biannual	1/21/2022	1067
SPEAG	D3900V2	3900 MHz SAR Dipole	10/9/2020	Biannual	10/9/2022	1056
SPEAG	D3900V2	3900 MHz SAR Dipole	6/10/2021	Annual	6/10/2022	1057
SPEAG	D500V2	5 GHz SAR Dipole	1/20/2021	Annual	1/20/2022	1057
SPEAG	D500V2	5 GHz SAR Dipole	6/15/2021	Annual	6/15/2022	1181
SPEAG	D750V1	750 MHz SAR Dipole	10/19/2018	Triannual	10/19/2021	1161
SPEAG	D750V1	750 MHz SAR Dipole	1/17/2021	Annual	1/17/2022	1054
SPEAG	D750V1	750 MHz SAR Dipole	6/11/2021	Annual	6/11/2022	1034
SPEAG	D750V1	750 MHz SAR Dipole	3/16/2020	Biannual	3/16/2022	1003
SPEAG	D750V1	750 MHz SAR Dipole	1/17/2021	Annual	1/17/2022	1054
SPEAG	D830V2	835 MHz SAR Dipole	10/19/2018	Triannual	10/19/2021	1161
SPEAG	D830V2	835 MHz SAR Dipole	1/21/2021	Annual	1/21/2022	10132
SPEAG	D830V2	835 MHz SAR Dipole	3/19/2020	Biannual	3/19/2022	10047
SPEAG	D830V2	835 MHz SAR Dipole	5/11/2021	Annual	5/11/2022	10133
SPEAG	D830V2	835 MHz SAR Dipole	4/15/2021	Annual	4/15/2022	10119
SPEAG	D4E4	Deep Data Acquisition Electronics	4/9/2021	Annual	4/9/2022	1552
SPEAG	D4E4	Deep Data Acquisition Electronics	1/16/2021	Annual	1/16/2022	1496
SPEAG	D4E4	Deep Data Acquisition Electronics	8/1/2021	Annual	8/1/2022	1481
SPEAG	D4E4	Deep Data Acquisition Electronics	8/16/2021	Annual	8/16/2022	1490
SPEAG	D4E4	Deep Data Acquisition Electronics	10/16/2020	Annual	10/16/2021	1131
SPEAG	D4E4	Deep Data Acquisition Electronics	11/7/2020	Annual	11/7/2021	1133
SPEAG	D4E4	Deep Data Acquisition Electronics	1/13/2021	Annual	1/13/2022	1158
SPEAG	D4E4	Deep Data Acquisition Electronics	1/18/2021	Annual	1/18/2022	1158
SPEAG	D4E4	Deep Data Acquisition Electronics	3/18/2021	Annual	3/18/2022	1172
SPEAG	D4E4	Deep Data Acquisition Electronics	4/7/2021	Annual	4/7/2022	1407
SPEAG	D4E4	Deep Data Acquisition Electronics	6/11/2021	Annual	6/11/2022	1408
SPEAG	D4E4	Deep Data Acquisition Electronics	8/15/2021	Annual	8/15/2022	1334
SPEAG	D4E4	Deep Data Acquisition Electronics	6/21/2021	Annual	6/21/2022	1676
SPEAG	D4E4	Deep Data Acquisition Electronics	6/21/2021	Annual	6/21/2022	1678
SPEAG	D4E4	Deep Data Acquisition Electronics	6/22/2021	Annual	6/22/2022	1677
SPEAG	D4E4	Deep Data Acquisition Electronics	7/13/2021	Annual	7/13/2022	1583
SPEAG	D4E4	Deep Data Acquisition Electronics	12/9/2020	Annual	12/9/2021	1278
SPEAG	EX30V4	SAR Probe	10/20/2020	Annual	10/20/2021	7551
SPEAG	EX30V4	SAR Probe	11/23/2020	Annual	11/23/2021	7538
SPEAG	EX30V4	SAR Probe	1/28/2021	Annual	1/28/2022	7539
SPEAG	EX30V4	SAR Probe	1/16/2021	Annual	1/16/2022	7539
SPEAG	EX30V4	SAR Probe	4/18/2021	Annual	4/18/2022	7557
SPEAG	EX30V4	SAR Probe	3/18/2021	Annual	3/18/2022	7514
SPEAG	EX30V4	SAR Probe	6/21/2021	Annual	6/21/2022	7559
SPEAG	EX30V4	SAR Probe	6/28/2021	Annual	6/28/2022	7600
SPEAG	EX30V4	SAR Probe	7/20/2021	Annual	7/20/2022	7406
SPEAG	EX30V4	SAR Probe	1/20/2021	Annual	1/20/2022	7419
SPEAG	EX30V4	SAR Probe	4/16/2021	Annual	4/16/2022	7400
SPEAG	EX30V4	SAR Probe	11/13/2020	Annual	11/13/2021	7585

Note:

1. 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. a 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.
2. Each equipment item was used solely within its respective calibration period.

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5 MEASUREMENT UNCERTAINTIES

For SAR Measurements

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c _i 1gm	c _i 10 gms	1gm u _i (± %)	10gms u _i (± %)	v _i
Measurement System									
Probe Calibration	E.2.1	7	N	1	1	1	7.0	7.0	∞
Axial Isotropy	E.2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E.2.2	1.3	N	1	0.7	0.7	0.9	0.9	∞
Boundary Effect	E.2.3	2	R	1.73	1	1	1.2	1.2	∞
Linearity	E.2.4	0.3	N	1	1	1	0.3	0.3	∞
System Detection Limits	E.2.4	0.25	R	1.73	1	1	0.1	0.1	∞
Modulation Response	E.2.5	4.8	R	1.73	1	1	2.8	2.8	∞
Readout Electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E.2.7	0.8	R	1.73	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.73	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E.6.1	3	R	1.73	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	3	R	1.73	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.73	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E.6.3	6.7	R	1.73	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	4	R	1.73	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E.4.2	3.12	N	1	1	1	3.1	3.1	35
Device Holder Uncertainty	E.4.1	1.67	N	1	1	1	1.7	1.7	5
Output Power Variation - SAR drift measurement	E.2.9	5	R	1.73	1	1	2.9	2.9	∞
SAR Scaling	E.6.5	0	R	1.73	1	1	0.0	0.0	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E.3.1	7.6	R	1.73	1.0	1.0	4.4	4.4	∞
Liquid Conductivity - measurement uncertainty	E.3.3	4.3	N	1	0.78	0.71	3.3	3.0	76
Liquid Permittivity - measurement uncertainty	E.3.3	4.2	N	1	0.23	0.26	1.0	1.1	75
Liquid Conductivity - Temperature Uncertainty	E.3.4	3.4	R	1.73	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Uncertainty	E.3.4	0.6	R	1.73	0.23	0.26	0.1	0.1	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Permittivity - deviation from target values	E.3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Combined Standard Uncertainty (k=1)							RSS	12.2	12.0
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	24.4	24.0

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