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PART 0 SAR CHAR REPORT

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Date of Testing:
05/08/22 - 07/11/22
Test Site/Location:
Element, Columbia, MD, USA
Document Serial No.:
1M2204110052-30.A3L (Rev1)

FCC ID:	**A3LSMF936B**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD**

Report Type:	Part 0 SAR Characterization
DUT Type:	Portable Handset
Model(s):	SM-F936B/DS
Additional Model:	SM-F936B

Note: This revised Test Report (S/N: 1M2204110052-30.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.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.01

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1 DEVICE UNDER TEST

1.1 Device Overview

This device uses the Qualcomm® Gen2 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/MST technologies, but the output power of these modems is not controlled by the Smart Transmit algorithm.

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 12	Voice/Data	699.7 - 715.3 MHz
LTE Band 17	Voice/Data	706.5 - 713.5 MHz
LTE Band 13	Voice/Data	779.5 - 784.5 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 - 1909.3 MHz
LTE Band 41	Voice/Data	2498.5 - 2687.5 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 n41	Voice/Data	2506.02 - 2679.99 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 - 2472 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
U-NII-5	Voice/Data	5935 - 6415 MHz
U-NII-6	Voice/Data	6435 - 6525 MHz
U-NII-7	Voice/Data	6535 - 6875 MHz
U-NII-8	Voice/Data	6895 - 7115 MHz
Bluetooth	Data	2402 - 2480 MHz
NFC	Data	13.56 MHz
UWB	Data	6489.6 - 7987.2 MHz

1.2 Time-Averaging for SAR and Power Density

This device is enabled with Qualcomm® Gen2 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 *Plimit* for all technologies and bands

1.4 Bibliography

Report Type	Report Serial Number
FCC SAR Evaluation Report (Part 1)	1M2204110052-18.A3L
RF Exposure Part 2 Test Report	1M2204110052-29.A3L
RF Exposure Compliance Summary	1M2204110052-31.A3L

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:

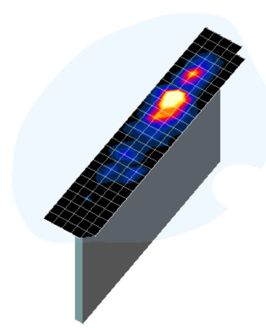

Figure 2-1
Sample SAR Area Scan

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

*Also compliant to IEEE 1528-2013 Table 6

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 – Folder Open (DSI = 4)	▪ Device positioned next to head ▪ Receiver Active ▪ Folder Open	*Head SAR per KDB Publication 648474 D04*
Head – Folder Closed (DSI = 5)	▪ Device positioned next to head ▪ Receiver Active ▪ Folder Closed	*Head SAR per KDB Publication 648474 D04*
Hotspot mode – Folder Open (DSI = 2/6)	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Folder Open	*UMPC Mini-Tablet SAR per KDB 941225 D07v01r02*
Hotspot mode – Folder Closed (DSI = 7)	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Folder Closed	*Hotspot SAR per KDB Publication 941225 D06*
Extremity Grip – Folder Open (DSI=2 or 8)	▪ Device is held with hand and grip sensor is triggered ▪ Grip sensor triggered or earjack is active ▪ Folder Open	*Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
Phablet Grip – Folder Closed (DSI=3 or 9)	▪ Device is held with hand and grip sensor is triggered ▪ Grip sensor triggered or earjack is active ▪ Folder Closed	*Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
Extremity – Folder Open (DSI = 0)	▪ Device is held with hand and grip sensor is not triggered ▪ Distance grip sensor not triggered ▪ Folder Open	*UMPC Mini-Tablet SAR per KDB 941225 D07v01r02*
Phablet – Folder Closed (DSI = 1)	▪ Device is held with hand and grip sensor is not triggered ▪ Distance grip sensor not triggered ▪ Folder Closed	*Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
Body-worn – Folder Open (DSI = 0)	▪ Device being used with a body-worn accessory ▪ Folder Open	*UMPC Mini-Tablet SAR per KDB 941225 D07v01r02*
Body-worn – Folder Closed (DSI = 1)	▪ Device being used with a body-worn accessory ▪ Folder Closed	*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**

SAR_design_target			
$SAR\_design\_target < SAR\_regulatory\_limit \times 10^{\frac{-Total\ Uncertainty}{10}}$			
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

3.3 SAR Char

SAR test results corresponding to *Pmax* for each antenna/technology/band/DSI can be found in Appendix A.

Plimit is calculated by linearly scaling with the measured SAR at the Ppart0 to correspond to the *SAR_design_target*. When *Plimit* < *Pmax*, *Ppart0* was used as Plimit in the Smart Transmit EFS. When *Plimit* > *Pmax* and *Ppart0*=Pmax, calculated *Plimit* was used in the Smart Transmit EFS. All reported SAR obtained from the Ppart0 SAR tests was less than *SAR_Design_target*+ 1 dB Uncertainty. The final *Plimit* determination for each exposure scenario corresponding to *SAR_design_target* are shown in Table 3-3.

Table 3-3
***PLimit* Determination**

Device State Index (DSI)	*PLimit* Determination Scenarios
0 or 1	The worst-case SAR exposure is determined as maximum SAR normalized to the limit (i.e. lowest plimit) among: 1. UMPC 1g SAR folder open a. For AG0: Measured SAR at 14, 12 and 18 mm for back, front, and bottom surfaces respectively and measured SAR at 10 mm for right surface. b. For AG1: Measured SAR at 10 mm for back, front, top, and right surfaces. 2. Body Worn SAR folder closed. 3. UMPC 10g SAR folder open. a. For AG0: Measured SAR at 14, 12 and 18 mm for back, front, and bottom surfaces respectively and measured SAR at 0 mm for right surface. b. For AG1: Measured SAR at 0 mm for back, front, top, and right surfaces. 4. Extremity SAR folder closed. a. For AG0: Measured SAR at 12 and 14 mm spacing for back and bottom respectively, and measured SAR at 0mm for front, left, and right surfaces For AG1: Measured SAR at 0 mm for back, front, top, left and right surfaces
2 or 8	P_{limit} is calculated based on: 1. For AG0: 1g Body SAR at 10 mm for back, front, bottom, and right surfaces and 10g Extremity SAR at 0 mm for back, front, bottom, and right surfaces with folder open For AG1: 1g Body SAR at 10 mm for back, front, top, and right surfaces and 10g Extremity SAR at 0 mm for back, front, top, and right surfaces with folder open
3 or 9	P_{limit} is calculated based on: 1. For AG0: 10g Extremity SAR at 0 mm for back, front, bottom, left, and right surfaces with folder closed For AG1: 10g Extremity SAR at 0 mm for back, front, top, left, and right surfaces with folder closed
4 or 5	P_{limit} is calculated based on 1g Head SAR
6 or 7	P_{limit} is calculated based on 1g Hotspot SAR at 10 mm

Table 3-4
SAR Characterizations

Exposure Senario			Folder Open - Body	Folder Open - Extremity	Folder Closed - Body-Worn	Folder Closed - Phablet Max	Folder Open - Grip Sensor Active	Folder Open - Grip Sensor Active	Folder Closed - Grip Sensor Active	Folder Open - Head	Folder Closed - Head	Folder Open - Hotspot	Folder Closed - Hotspot	Folder Open - Earjack	Folder Closed - Earjack	Maximum Tune-Up Output Power*
Averaging Volume			1g	10g	1g	10g	1g	10g	10g	1g	1g	1g	1g	10g	10g	
Spacing			10, 14, 12, 18 mm	0, 14, 12, 18 mm	15 mm	12, 14, 0 mm	10 mm	0 mm	0 mm	0 mm	0 mm	10 mm	10 mm	0 mm	0 mm	
Configuration			Folder Open	Folder Open	Folder Closed	Folder Closed	Folder Open	Folder Open	Folder Closed	Folder Open	Folder Closed	Folder Open	Folder Closed	Folder Open	Folder Closed	
DSI			0	0	1	1	2	2	3	4	5	6	7	8	9	
Technology/Band	Antenna	Antenna Group														Pmax
GSM 850	A, A+B	AG0	24.5		30.0		28.7		30.0	34.8	34.8	29.0	31.8	28.7	30.0	25.3
GSM 1900	B	AG0	24.8		27.1		16.8		16.8	34.4	34.4	16.8	16.8	16.8	16.8	22.1
UMTS 850	A, A+B	AG0	28.7		28.4		28.3		28.4	33.9	33.9	28.5	30.2	28.3	28.4	24.5
UMTS 1750	B	AG0	27.1		25.3		18.0		18.0	34.5	34.5	18.0	18.0	18.0	18.0	24.0
UMTS 1900	B	AG0	26.2		28.4		18.0		18.0	35.0	35.0	18.0	18.0	18.0	18.0	24.0
LTE Band 12/17	A, A+B	AG0	27.8		28.4		27.8		28.4	32.5	32.5	29.3	29.5	27.8	28.4	24.5
LTE Band 13	A, A+B	AG0	26.5		26.4		29.1		26.6	31.4	31.4	29.1	29.6	29.1	26.6	23.0
LTE Band 26/5 (Cell)	A, A+B	AG0	28.1		27.7		27.0		27.7	33.5	33.5	27.0	30.3	27.0	27.7	24.5
LTE Band 66/4 (AWS)	B	AG0	27.0		26.9		18.0		18.0	34.3	34.3	18.0	18.0	18.0	18.0	24.0
LTE Band 66 (AWS)	F	AG1	N/A		18.0		N/A		18.0	N/A	22.2	N/A	18.0	N/A	18.0	24.0
LTE Band 4 (AWS)	F	AG1	18.0		18.0		18.0		18.0	22.2	22.2	18.0	18.0	18.0	18.0	24.0
LTE Band 25/2 (PCS)	B	AG0	27.4		28.1		18.0		18.0	35.1	35.1	18.0	18.0	18.0	18.0	24.0
LTE Band 41 (PC3)	B	AG0	20.0		20.0		15.5		15.5	20.0	20.0	15.5	15.5	15.5	15.5	22.0
LTE Band 41 (PC2)	B	AG0	20.0		20.0		15.5		15.5	20.0	20.0	15.5	15.5	15.5	15.5	21.9
NR Band n12	A, A+B	AG0	26.7		27.3		28.2		27.3	32.6	32.6	28.6	29.6	28.2	27.3	24.0
NR Band n5 (Cell)	A, A+B	AG0	27.9		27.2		27.7		27.2	34.1	34.1	28.0	30.7	27.7	27.2	24.0
NR Band n66 (AWS)	B	AG0	27.4		26.8		18.0		18.0	34.7	34.7	18.0	18.0	18.0	18.0	23.5
NR Band n66 (AWS)	F	AG1	19.0		19.0		19.0		19.0	22.0	22.0	19.0	19.0	19.0	19.0	23.5
NR Band n25/n2 (PCS)	B	AG0	27.2		28.6		18.0		18.0	34.4	34.4	18.0	18.0	18.0	18.0	23.5
NR Band n41	F	AG1	18.0		18.0		18.0		18.0	18.0	18.0	18.0	18.0	18.0	18.0	24.0
NR Band n41	B	AG0	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	16.0
NR Band n41	E	AG1	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	19.0
NR Band n41	C	AG0	11.0		11.0		11.0		11.0	11.0	11.0	11.0	11.0	11.0	11.0	14.0
NR Band n77 DoD	F	AG1	17.5		17.5		17.5		17.5	17.5	17.5	17.5	17.5	17.5	17.5	24.0
NR Band n77 DoD	E	AG1	17.0		17.0		17.0		17.0	17.0	17.0	17.0	17.0	17.0	17.0	23.0
NR Band n77 DoD	G	AG1	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	20.0
NR Band n77 DoD	D	AG0	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	17.5
NR Band n77	F	AG1	17.5		17.5		17.5		17.5	17.5	17.5	17.5	17.5	17.5	17.5	24.0
NR Band n77	E	AG1	17.0		17.0		17.0		17.0	17.0	17.0	17.0	17.0	17.0	17.0	23.0
NR Band n77	G	AG1	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	20.0
NR Band n77	D	AG0	15.0		15.0		15.0		15.0	15.0	15.0	15.0	15.0	15.0	15.0	17.5

Notes:

1. For all modes/bands, when Hotspot Mode (DSI=6/7) and Extremity sensor (DSI=2/3) are triggered at the same time, DSI=2/3 takes priority, thus the P_{limit} for DSI=2/3 is set to be less or equal to P_{limit} for DSI=6/7.
2. When $P_{max} < P_{limit}$, the DUT will operate at a power level up to P_{max}.
3. P_{limit} for DSI=2/8 and DSI =3/9 are the same.
4. For all bands when RCV is active, DSI=4/5 takes priority over all levels.

4 EQUIPMENT LIST

For SAR measurements

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial #
Agilent	8753ES	S-Parameter Vector Network Analyzer	12/17/2021	Annual	12/17/2022	MY40000670
Agilent	E4438C	ESG Vector Signal Generator	1/18/2022	Annual	1/18/2023	MY42081752
Agilent	E4440A	PSA Series Spectrum Analyzer	3/22/2022	Annual	3/22/2023	MY46186272
Agilent	E5515C	Wireless Communications Test Set	5/4/2021	Biennial	5/4/2023	GB41450275
Agilent	N5182A	MXG Vector Signal Generator	6/21/2022	Annual	6/21/2023	MY47420651
Agilent	N9020A	MXA Vector Signal Analyzer	3/22/2022	Annual	3/22/2023	MY50200571
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343971
Anritsu	MA24106A	USB Power Sensor	8/10/2021	Annual	8/10/2022	1231535
Anritsu	MA24106A	USB Power Sensor	8/10/2021	Annual	8/10/2022	1231538
Anritsu	MA2411B	Pulse Power Sensor	8/10/2021	Annual	8/10/2022	1207364
Anritsu	MA2411B	Pulse Power Sensor	4/29/2022	Annual	4/29/2023	1207470
Anritsu	Microwace Peak Power Sensor	Microwace Peak Power Sensor	5/9/2022	Annual	5/9/2023	11678
Anritsu	ML2496A	Power Meter	2/11/2022	Annual	2/11/2023	1405003
Anritsu	MS2028C	Vector Network Analyzer	5/4/2022	Annual	5/4/2023	1204153
Anritsu	MT8000A	Radio Communication Test Station	3/30/2022	Annual	3/30/2023	6261914237
Anritsu	MT8820C	Radio Communication Analyzer MT8820C	10/4/2021	Annual	10/4/2022	6201240328
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	7/18/2021	Annual	7/18/2022	6201381794
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	9/26/2021	Annual	9/26/2022	6201524637
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	3/31/2022	Annual	3/31/2023	6201664756
Anritsu	MT8862A	Wireless Connectivity Test Set	10/27/2021	Annual	10/27/2022	6261782395
Control Company	4040	Therm./ Clock/ Humidity Monitor	1/21/2022	Annual	1/21/2023	160574418
Control Company	4352	Ultra Long Stem Thermometer	1/21/2022	Annual	1/21/2023	160508097
Keysight Technologies	772D	Dual Directional Coupler	CBT	N/A	CBT	MY52180215
Keysight Technologies	85033E	Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm)	9/27/2021	Annual	9/27/2022	MY53401181
Keysight Technologies	N9020A	MXA Signal Analyzer	4/14/2022	Annual	4/14/2023	MY48010233
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Rohde & Schwarz	CMU200	Base Station Simulator	N/A	N/A	N/A	836371/0079
MCL	BW-N10W5+	Attenuator	CBT	N/A	CBT	1507
MCL	BW-N3W5+	Attenuator	CBT	N/A	CBT	1608
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	BW-N10W5+	Attenuator	CBT	N/A	CBT	1350
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	PWR-4GHS	USB Power Sensor	CBT	N/A	CBT	11710030062
Mini-Circuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	R8979500903
Mini-Circuits	UNAT-3+	Attenuator	CBT	N/A	CBT	UU89101643
Mini-Circuits	VAT-10+	Attenuator	CBT	N/A	CBT	31618
Mini-Circuits	VAT-3+	Attenuator	CBT	N/A	CBT	31647
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	31634
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	CBT	N/A	CBT	2050
Mitutoyo	500-196-30	CD-6"ASX 6Inch Digital Caliper	2/16/2022	Triennial	2/16/2025	A20238413
Narda	4014C-6	4 - 8 GHz SMA 6 dB Directional Coupler	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-6	Dual Directional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	1/11/2022	Annual	1/11/2023	101699
Seekonk	NC-100	Torque Wrench (8" lb)	8/5/2020	Biennial	8/5/2022	N/A
SPEAG	DAK-12	Dielectric Assessment Kit (10MHz - 3GHz)	3/21/2022	Annual	3/21/2023	1102
SPEAG	DAK-3.5	Dielectric Assessment Kit	10/20/2021	Annual	10/20/2022	1091
SPEAG	CLA-13	Confined Loop Antenna	9/16/2021	Annual	9/16/2022	1002
SPEAG	D1750V2	1750 MHz SAR Dipole	4/20/2022	Annual	4/20/2023	1051
SPEAG	D1750V2	1750 MHz SAR Dipole	9/9/2020	Biennial	9/9/2022	1104
SPEAG	D1765V2	1750 MHz SAR Dipole	5/14/2021	Biennial	5/14/2023	1008
SPEAG	D1750V2	1750 MHz SAR Dipole	10/22/2021	Annual	10/22/2022	1150
SPEAG	D1900V2	1900 MHz SAR Dipole	10/22/2021	Annual	10/22/2022	5d080
SPEAG	D1900V2	1900 MHz SAR Dipole	4/14/2022	Annual	4/14/2023	5d141
SPEAG	D1900V2	1900 MHz SAR Dipole	9/21/2021	Annual	9/21/2022	5d149
SPEAG	D1900V2	1900 MHz SAR Dipole	8/10/2020	Biennial	8/10/2022	5d180
SPEAG	D1900V2	1900 MHz SAR Dipole	9/10/2020	Biennial	9/10/2022	5d181
SPEAG	D2450V2	2450 MHz SAR Dipole	8/18/2021	Annual	8/18/2022	719
SPEAG	D2450V2	2450 MHz SAR Dipole	9/9/2020	Biennial	9/9/2022	797
SPEAG	D2450V2	2450 MHz SAR Dipole	2/22/2022	Annual	2/22/2023	882
SPEAG	D2450V2	2450 MHz SAR Dipole	11/9/2021	Annual	11/9/2022	921
SPEAG	D2450V2	2450 MHz SAR Dipole	11/25/2021	Annual	11/25/2022	981
SPEAG	D2600V2	2600 MHz SAR Dipole	4/14/2021	Biennial	4/14/2023	1004
SPEAG	D2600V2	2600 MHz SAR Dipole	9/9/2020	Biennial	9/9/2022	1069
SPEAG	D2600V2	2600 MHz SAR Dipole	11/12/2019	Triennial	11/12/2022	1071
SPEAG	D2600V2	2600 MHz SAR Dipole	8/18/2021	Annual	8/18/2022	1126
SPEAG	D3500V2	3500 MHz SAR Dipole	8/16/2019	Triennial	8/16/2022	1055
SPEAG	D3500V2	3500 MHz SAR Dipole	1/21/2020	Triennial	1/21/2023	1097
SPEAG	D3500V2	3500 MHz SAR Dipole	6/9/2021	Annual	6/9/2022	1126
SPEAG	D3700V2	3700 MHz SAR Dipole	10/17/2019	Triennial	10/17/2022	1002
SPEAG	D3700V2	3700 MHz SAR Dipole	1/19/2021	Biennial	1/19/2023	1018
SPEAG	D3900V2	3900 MHz SAR Dipole	11/13/2020	Biennial	11/13/2022	1062
SPEAG	D3900V2	3900 MHz SAR Dipole	6/10/2021	Biennial	6/10/2023	1073
SPEAG	D5GHzV2	5 GHz SAR Dipole	1/10/2022	Annual	1/10/2023	1057
SPEAG	D5GHzV2	5 GHz SAR Dipole	9/15/2021	Annual	9/15/2022	1191
SPEAG	D750V3	750 MHz SAR Dipole	2/14/2022	Annual	2/14/2023	1046
SPEAG	D750V3	750 MHz SAR Dipole	3/14/2022	Annual	3/14/2023	1054
SPEAG	D750V3	750 MHz SAR Dipole	10/19/2021	Annual	10/19/2022	1161
SPEAG	D835V2	835 MHz SAR Dipole	4/14/2022	Annual	4/14/2023	4d119
SPEAG	D835V2	835 MHz SAR Dipole	1/21/2021	Biennial	1/21/2023	4d132
SPEAG	D835V2	835 MHz SAR Dipole	10/19/2021	Annual	10/19/2022	4d133
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/13/2022	Annual	1/13/2023	793
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/16/2022	Annual	3/16/2023	1272
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/10/2021	Annual	11/10/2022	1323
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/13/2021	Annual	9/13/2022	1364
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/14/2022	Annual	4/14/2023	1402
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/22/2022	Annual	2/22/2023	1403
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/13/2022	Annual	4/13/2023	1407
SPEAG	DAE4	Dasy Data Acquisition Electronics	6/15/2021	Annual	6/15/2022	1532
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/14/2022	Annual	1/14/2023	1558
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/13/2021	Annual	7/13/2022	1583
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/21/2022	Annual	2/21/2023	1645
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/11/2021	Annual	11/11/2022	1646
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/14/2022	Annual	3/14/2023	1652
SPEAG	DAE4	Dasy Data Acquisition Electronics	6/21/2021	Annual	6/21/2022	1676
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/10/2022	Annual	5/10/2023	1678
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/4/2021	Annual	8/4/2022	1680
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/3/2021	Annual	8/3/2022	1681
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/6/2021	Annual	8/6/2022	1683
SPEAG	EX3DV4	SAR Probe	1/19/2022	Annual	1/19/2023	3837
SPEAG	EX3DV4	SAR Probe	7/20/2021	Annual	7/20/2022	7406
SPEAG	EX3DV4	SAR Probe	7/20/2021	Annual	7/20/2022	7410
SPEAG	EX3DV4	SAR Probe	2/22/2022	Annual	2/22/2023	7427
SPEAG	EX3DV4	SAR Probe	6/21/2021	Annual	6/21/2022	7491
SPEAG	EX3DV4	SAR Probe	3/21/2022	Annual	3/21/2023	7527
SPEAG	EX3DV4	SAR Probe	11/16/2021	Annual	11/16/2022	7538
SPEAG	EX3DV4	SAR Probe	4/22/2022	Annual	4/22/2023	7546
SPEAG	EX3DV4	SAR Probe	9/20/2021	Annual	9/20/2022	7552
SPEAG	EX3DV4	SAR Probe	9/17/2021	Annual	9/17/2022	7558
SPEAG	EX3DV4	SAR Probe	1/19/2022	Annual	1/19/2023	7570
SPEAG	EX3DV4	SAR Probe	3/22/2022	Annual	3/22/2023	7637
SPEAG	EX3DV4	SAR Probe	11/21/2021	Annual	11/21/2022	7639
SPEAG	EX3DV4	SAR Probe	2/24/2022	Annual	2/24/2023	7640
SPEAG	EX3DV4	SAR Probe	4/20/2022	Annual	4/20/2023	7659
SPEAG	EX3DV4	SAR Probe	5/18/2022	Annual	5/18/2023	7660
SPEAG	EX3DV4	SAR Probe	8/5/2021	Annual	8/5/2022	7670
SPEAG	EX3DV4	SAR Probe	9/6/2021	Annual	9/6/2022	7674
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1237

Note: 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.
Note: All equipment was used solely within its respective calibration period.

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	1.732	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	1.732	1	1	0.1	0.1	∞
Modulation Response	E.2.5	4.8	R	1.732	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	1.732	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.732	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E.6.3	6.7	R	1.732	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	4	R	1.732	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	1.732	1	1	2.9	2.9	∞
SAR Scaling	E.6.5	0	R	1.732	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	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Unceritainty	E.3.4	0.6	R	1.732	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	191
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				24.4	24.0	

The above measurement uncertainties are according to IEEE Std. 1528-2013