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PART 0 SAR CHAR REPORT

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Date of Testing:
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APPLICANT: SAMSUNG ELECTRONICS CO., LTD

Report Type: Part 0 SAR Characterization
DUT Type: Portable Handset
Model(s): SM-S711B, SM-S711DS

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 time-averaged SAR (TAS) feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement for WLAN operations via Qualcomm FastConnect TAS and for WWAN operations via S.LSI TAS. Additionally, this device supports BT/NFC technologies, but the output power of these modems is not controlled by the TAS 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 2 (PCS)	Voice/Data	1850.7 - 1909.3 MHz
LTE Band 41	Voice/Data	2498.5 - 2687.5 MHz
NR Band n5	Voice/Data	826.5 - 846.5 MHz
NR Band n66	Voice/Data	1712.5 - 1777.5 MHz
NR Band n41	Voice/Data	2501.01 - 2685 MHz
NR Band n77	Voice/Data	3455.01 - 3544.98 MHz 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 - 6515 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

1.2 Time-Averaging for SAR

This device is enabled with Qualcomm FastConnect TAS and S.LSI TAS algorithm to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from WWAN and WLAN is in compliance with FCC requirements. This Part 0 report shows SAR characterization of WWAN and WLAN radios. Characterization is achieved by determining P_{Limit} for WWAN and WLAN that corresponds to the exposure design targets after accounting for all device design related uncertainties, i.e., SAR_design_target (< FCC SAR limit) for WWAN and WLAN radios. 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 and WLAN 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
WWAN, WLAN	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
RF Exposure Part 2 Test Report	1M2304260063-23.A3L
RF Exposure Compliance Summary Report	1M2304260063-22.A3L
RF Exposure Part 1 Test Report	1M2304260063-01.A3L
WIFI 6-8GHz RF exposure	1M2304260063-03.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:

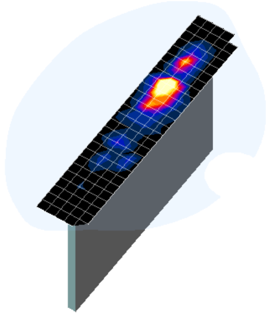

Figure 2-1
Sample SAR Area Scan

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

For WWAN operations this device uses different Radio State Index (RSI) via S.LSI TAS 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 RSI. Detailed descriptions of the detection mechanisms are included in the operational description.

For WLAN operations this device uses different Device State Index (DSI) via Qualcomm FastConnect TAS 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 (RSI) conditions used in Table 3-1 represent different exposure scenarios.

Table 3-1
Exposure Scenarios for S.LSI TAS

Scenario	Description	SAR Test Cases
Head	▪ RSI = RCV ▪ Device positioned next to head ▪ Receiver Active	*Head SAR per KDB Publication 648474 D04*
Hotspot mode	▪ RSI = Hotspot ▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active	*Hotspot SAR per KDB Publication 941225 D06*
Phablet	▪ RSI = Free ▪ Device is held with hand	*Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
Body-worn	▪ RSI = Free ▪ Device being used with a body-worn accessory	*Body-worn SAR per KDB Publication 648474 D04*

The device state index (DSI) conditions used in Table 3-2 represent different exposure scenarios.

Table 3-2
Exposure Scenarios for Qualcomm FastConnect TAS

Scenario	Description	SAR Test Cases
RCV (Head)	▪ Device positioned next to head ▪ Receiver (RCV) Active ▪ DSI = 1	*Head SAR per KDB Publication 648474 D04*
Free	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Device being used with a body-worn accessory ▪ Device is held with hand ▪ DSI = 0	*Hotspot SAR per KDB Publication 941225, D06* *Body-worn SAR per KDB Publication 648474 D04,* *Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
NR Active	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Device being used with a body-worn accessory ▪ Device is held with hand ▪ DSI = 8	*Hotspot SAR per KDB Publication 941225, D06* *Body-worn SAR per KDB Publication 648474 D04,* *Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
RCV + NR Active	▪ Device positioned next to head ▪ Receiver (RCV) active ▪ DSI = 9	*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 3-3
***SAR_design_target* Calculations for WWAN Operations**

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	0.8 W/kg	*SAR_design_target*	2.0 W/kg

Table 3-4
***SAR_design_target* Calculations for WLAN Operations**

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	0.4 W/kg	*SAR_design_target*	1.0 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 3-5
***PLimit* Determination for S.LSI TAS**

Radio State Index (RSI)	***PLimit* Determination Scenarios**
Free	The worst-case SAR exposure is determined as maximum SAR normalized to the limit (i.e. lowest P_{limit}) among: 1. Body Worn SAR 2. Extremity SAR measured at 0 mm spacing
RCV	P_{limit} is calculated based on 1g Head SAR
Hotspot	P_{limit} is calculated based on 1g Hotspot SAR at 10 mm

Table 3-6
***PLimit* Determination for Qualcomm FastConnect TAS**

Device State Index (DSI)	***PLimit* Determination Scenarios**
0	The worst-case SAR exposure is determined as maximum SAR normalized to the limit (i.e. lowest P_{limit}) among: 1. Body Worn SAR 2. Extremity SAR measured at 0 mm spacing 3. P_{limit} is calculated based on 1g Hotspot SAR at 10 mm
1	P_{limit} is calculated based on 1g Head SAR
8	Scenarios are the same as DSI 0
9	Scenarios are the same as DSI 1

Table 3-7
SAR Characterizations for S.LSI TAS

Exposure Scenario		Maximum Tune-Up Output Power*	Body-Worn	Phablet	Head	Hotspot	Earjack
Averaging Volume			1g	10g	1g	1g	1g/10g
Spacing			10 mm	0 mm	0 mm	10 mm	10 mm, 0 mm
RSI			Free	Free	RCV	Hotspot	Earjack
Technology/Band	Antenna	Pmax					
GSM 850	A	24.3	27.3		30.3	27.3	27.3
GSM 1900	A	21.3	17.8		17.8	17.8	17.8
UMTS 850	A	24.5	25.1		30.6	25.1	25.1
UMTS 1750	A	23.0	17.5		17.5	17.5	17.5
UMTS 1900	A	23.5	18.0		18.0	18.0	18.0
LTE Band 12	A	24.0	27.8		31.5	27.8	27.8
LTE Band 17	A	23.5	27.8		31.5	27.8	27.8
LTE Band 13	A	24.0	25.0		29.2	25.0	25.0
LTE Band 26 (Cell)	A	24.0	25.2		29.9	25.2	25.2
LTE Band 5 (Cell)	A	24.5	25.8		30.4	25.8	25.8
LTE Band 66/4 (AWS)	A	23.5	19.0		31.7	19.0	19.0
LTE Band 66/4 (AWS)	F	23.0	16.0		16.0	16.0	16.0
LTE Band 2 (PCS)	A	23.5	19.0		30.7	19.0	19.0
LTE Band 2 (PCS)	F	23.0	17.5		17.5	17.5	17.5
LTE Band 41 (PC3)	B	22.0	20.0		32.3	20.0	20.0
LTE Band 41 (PC2)	B	21.4	20.0		32.3	20.0	20.0
NR Band n5	A	24.0	26.3		31.1	26.3	26.3
NR Band n66	A	23.5	18.5		30.9	18.5	18.5
NR Band n66	F	23.0	16.0		16.0	16.0	16.0
NR Band n41	B	24.0	17.0		17.0	17.0	17.0
NR Band n41	F	23.5	16.5		16.5	16.5	16.5
NR Band n41	E	24.0	17.0		17.0	17.0	17.0
NR Band n41	D	22.0	16.0		16.0	16.0	16.0
NR Band n77	F	24.5	14.0		14.0	14.0	14.0
NR Band n77	C	24.5	12.0		12.0	12.0	12.0
NR Band n77	I	24.5	12.0		12.0	12.0	12.0
NR Band n77	D	23.0	9.5		9.5	9.5	9.5

Table 3-8
SAR Characterizations for Qualcomm FastConnect TAS

Exposure Scenario		Maximum Tune-Up Output Power*	Free	RCV	NR Active	RCV + NR Active
Averaging Volume			1g/10g	1g	1g/10g	1g
Spacing			10 mm, 0 mm	0 mm	10, 0 mm	0 mm
DSI			0	1	8	9
Technology/Band	Antenna	Pmax				
2.4 GHz WLAN	2	17.0	15.5	13.0	13.0	13.0
2.4 GHz WLAN	MIMO	17.0	15.5	13.0	13.0	13.0
5 GHz WLAN	MIMO	15.0	12.0	12.0	12.0	12.0
6 GHz WLAN	MIMO	9.0	18.8	14.9	14.9	14.9

Notes:

1. For all modes/bands, when Hotspot Mode and Free are triggered at the same time, Hotspot Mode takes priority, thus the P_{limit} for Hotspot Mode is set to be less or equal to P_{limit} for Free.
2. When $P_{max} < P_{limit}$, the DUT will operate at a power level up to P_{max}.
3. For all WLAN operations, RCV+NR takes highest priority, then comes NR Active, and RCV active.

4 EQUIPMENT LIST

For SAR measurements

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.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E4404B	Spectrum Analyzer	N/A	N/A	N/A	MY45113242
Agilent	E4438C	ESG Vector Signal Generator	1/18/2023	Annual	1/18/2024	MY47270002
Agilent	E4438C	ESG Vector Signal Generator	4/25/2023	Annual	4/25/2024	US41460739
Agilent	N5182A	MXG Vector Signal Generator	11/30/2022	Annual	11/30/2023	MY47420603
Agilent	N5182A	MXG Vector Signal Generator	4/1/2023	Annual	4/1/2024	MY47420837
Agilent	N5182A	MXG Vector Signal Generator	7/4/2022	Annual	7/4/2023	MY48180366
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/2/2023	Annual	6/2/2024	MY40003841
Agilent	8753ES	S-Parameter Vector Network Analyzer	1/12/2023	Annual	1/12/2024	MY40001472
Agilent	E5515C	Wireless Communications Test Set	1/12/2023	Annual	1/12/2024	MY50262130
Agilent	E5515C	Wireless Communications Test Set	CBT	N/A	CBT	GB46310798
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433972
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433971
Amplifier Research	150A100C	Amplifier	CBT	N/A	CBT	350132
Anritsu	ML2496A	Power Meter	8/16/2022	Annual	8/16/2023	1351001
Anritsu	ML2496A	Power Meter	6/15/2023	Annual	6/15/2024	1138001
Anritsu	MA2411B	Pulse Power Sensor	1/10/2023	Annual	1/10/2024	1315051
Anritsu	MA2411B	Pulse Power Sensor	6/15/2023	Annual	6/15/2024	1126066
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	1/10/2023	Annual	1/10/2024	6201524637
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	3/31/2023	Annual	3/31/2024	6201381794
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	11/28/2022	Annual	11/28/2023	6262150047
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	6/27/2022	Annual	6/27/2023	6261895213
Anritsu	MT8000A	Radio Communication Test Station	6/23/2023	Annual	6/23/2024	6261914237
Anritsu	MT8000A	Radio Communication Test Station	3/1/2023	Annual	3/1/2024	6272337419
Anritsu	MT8000A	Radio Communication Test Station	2/9/2023	Annual	2/9/2024	6272337408
Anritsu	MA24106A	USB Power Sensor	2/9/2023	Annual	2/9/2024	1520505
Anritsu	MA24106A	USB Power Sensor	6/15/2023	Annual	6/15/2024	1827530
Anritsu	MA24106A	USB Power Sensor	1/13/2023	Annual	1/13/2024	1344557
Mini-Circuits	PWR-4GHS	USB Power Sensor	11/11/2022	Annual	11/11/2023	11710030062
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774678
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774685
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774675
Control Company	4040	Therm./ Clock/ Humidity Monitor	1/17/2023	Annual	1/17/2024	160574418
Mitutoyo	500-196-30	CD-6"ASX 6Inch Digital Caliper	2/16/2022	Triennial	2/16/2025	A20238413
Keysight Technologies	N6705B	DC Power Analyzer	5/5/2021	Triennial	5/5/2024	MY53004059
Keysight Technologies	N9020A	MXA Signal Analyzer	3/15/2023	Annual	3/15/2024	US46470561
Keysight Technologies	N9020A	MXA Signal Analyzer	4/6/2023	Annual	4/6/2024	MY48010233
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	31634
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
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	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	CBT	N/A	CBT	2050
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	CBT	N/A	CBT	2111
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Seekonk	TSF-100	Torque Wrench	7/11/2022	Annual	7/11/2023	47639-29
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	3/8/2023	Annual	3/8/2024	128635
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	6/1/2023	Annual	6/1/2024	108843
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	1/12/2023	Annual	1/12/2024	150117
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2/17/2023	Annual	2/17/2024	164948
SPEAG	DAK-3.5	Dielectric Assessment Kit	12/15/2022	Annual	12/15/2023	1278
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/9/2023	Annual	5/9/2024	1070
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/15/2022	Annual	8/15/2023	1041
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	9/19/2022	Annual	9/19/2023	1045
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1379
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1243
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1237
SPEAG	CLA-13	Confined Loop Antenna	9/13/2022	Annual	9/13/2023	1002
SPEAG	D750V3	750 MHz SAR Dipole	5/11/2023	Annual	5/11/2024	1003
SPEAG	D750V3	750 MHz SAR Dipole	2/13/2023	Annual	2/13/2024	1046
SPEAG	D835V2	835 MHz SAR Dipole	4/13/2023	Annual	4/13/2024	4d119
SPEAG	D835V2	835 MHz SAR Dipole	5/11/2023	Annual	5/11/2024	4d180
SPEAG	D1750V2	1750 MHz SAR Dipole	1/18/2022	Biennial	1/18/2024	1148
SPEAG	D1750V2	1750 MHz SAR Dipole	10/22/2021	Biennial	10/22/2023	1150
SPEAG	D1900V2	1900 MHz SAR Dipole	9/21/2021	Biennial	9/21/2023	5d149
SPEAG	D2450V2	2450 MHz SAR Dipole	11/25/2021	Biennial	11/25/2023	981
SPEAG	D2600V2	2600 MHz SAR Dipole	11/15/2022	Annual	11/15/2023	1071
SPEAG	D2600V2	2600 MHz SAR Dipole	9/9/2020	Triennial	9/9/2023	1069
SPEAG	D3500V2	3500 MHz SAR Dipole	8/17/2022	Annual	8/17/2023	1055
SPEAG	D3700V2	3700 MHz SAR Dipole	10/21/2022	Annual	10/21/2023	1002
SPEAG	D3900V2	3900 MHz SAR Dipole	11/13/2020	Triennial	11/13/2023	1062
SPEAG	D5GHzV2	5 GHz SAR Dipole	1/18/2023	Annual	1/18/2024	1191
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/18/2022	Annual	7/18/2023	1583
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/15/2023	Annual	2/15/2024	665
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/18/2023	Annual	1/18/2024	1530
SPEAG	DAE4	Dasy Data Acquisition Electronics	6/15/2023	Annual	6/15/2024	1334
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2023	Annual	1/17/2024	1558
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/11/2023	Annual	5/11/2024	728
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2023	Annual	1/17/2024	793
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/13/2023	Annual	3/13/2024	1408
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/16/2023	Annual	2/16/2024	1645
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/16/2023	Annual	3/16/2024	1652
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/15/2023	Annual	2/15/2024	467
SPEAG	EX3DV4	SAR Probe	7/19/2022	Annual	7/19/2023	7410
SPEAG	EX3DV4	SAR Probe	2/8/2023	Annual	2/8/2024	7417
SPEAG	EX3DV4	SAR Probe	1/17/2023	Annual	1/17/2024	7713
SPEAG	EX3DV4	SAR Probe	6/15/2023	Annual	6/15/2024	7409
SPEAG	EX3DV4	SAR Probe	1/11/2023	Annual	1/11/2024	7570
SPEAG	EX3DV4	SAR Probe	6/14/2023	Annual	6/14/2024	7661
SPEAG	EX3DV4	SAR Probe	1/17/2023	Annual	1/17/2024	3837
SPEAG	EX3DV4	SAR Probe	3/16/2023	Annual	3/16/2024	7638
SPEAG	EX3DV4	SAR Probe	3/16/2023	Annual	3/16/2024	7637
SPEAG	EX3DV4	SAR Probe	5/10/2023	Annual	5/10/2024	7402
SPEAG	EX3DV4	SAR Probe	2/10/2023	Annual	2/10/2024	7640
SPEAG	EX3DV4	SAR Probe	2/13/2023	Annual	2/13/2024	7308

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