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RF Exposure Part 0 Test Report

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Date of Testing:
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Test Site/Location:
Element, Columbia, MD, USA
Element, Suwon, Korea
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FCC ID:	**A3LSMF776U**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD**

Report Type:	Part 0 SAR Characterization
DUT Type:	Portable Handset
Model(s):	SM-F776U
Additional Model:	SM-F776U1

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
VP – Connected Technologies

ACCREDITED
CERT #2041.01

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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	Voice/Data	814.7 - 848.3 MHz
LTE Band 5	Voice/Data	824.7 - 848.3 MHz
LTE Band 66	Voice/Data	1710.7 - 1779.3 MHz
LTE Band 4	Voice/Data	1710.7 - 1754.3 MHz
LTE Band 25	Voice/Data	1850.7 - 1914.3 MHz
LTE Band 2	Voice/Data	1850.7 - 1909.3 MHz
LTE Band 30	Voice/Data	2307.5 - 2312.5 MHz
LTE Band 7	Voice/Data	2502.5 - 2567.5 MHz
LTE Band 41	Voice/Data	2498.5 - 2687.5 MHz
LTE Band 38	Voice/Data	2572.5 - 2617.5 MHz
LTE Band 48	Voice/Data	3552.5 - 3697.5 MHz
NR Band n71	Voice/Data	665.5 - 695.5 MHz
NR Band n12	Voice/Data	701.5 - 713.5 MHz
NR Band n14	Voice/Data	790.5 - 795.5 MHz
NR Band n26	Voice/Data	816.5 - 846.5 MHz
NR Band n5	Voice/Data	826.5 - 846.5 MHz
NR Band n70	Voice/Data	1697.5 - 1707.5 MHz
NR Band n66	Voice/Data	1712.5 - 1777.5 MHz
NR Band n25	Voice/Data	1852.5 - 1912.5 MHz
NR Band n2	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	2501.01 - 2685 MHz
NR Band n38	Voice/Data	2575 - 2615 MHz
NR Band n48	Voice/Data	3555 - 3694.98 MHz
NR Band n78	Voice/Data	3455.01 - 3544.98 MHz; 3705 - 3975 MHz
NR Band n77	Voice/Data	3455.01 - 3544.98 MHz; 3705 - 3975 MHz
NTN Band n255	Data	1629 - 1658 MHz
2.4 GHz WIFI	Voice/Data	2412 - 2462 MHz
5 GHz WIFI	Voice/Data	U-NII-1: 5180 - 5240 MHz U-NII-2A: 5260 - 5320 MHz U-NII-2C: 5500 - 5720 MHz U-NII-3: 5745 - 5825 MHz U-NII-4: 5845 - 5885 MHz
6 GHz WIFI	Voice/Data	U-NII-5: 5935 - 6415 MHz U-NII-6: 6435 - 6515 MHz U-NII-7: 6535 - 6875 MHz U-NII-8: 6895 - 7115 MHz
2.4 GHz Bluetooth	Data	2402 - 2480 MHz
NFC	Data	13.56 MHz
WPT	N/A	110 kHz - 145 kHz

This device uses the Qualcomm® Smart Transmit Plus, EFS v24 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 and WLAN/BT/NTN operations. Additionally, this device supports NFC/WPT 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 has an open and closed configuration. For the open configuration, the device is enabled with the Qualcomm® Smart Transmit Plus, EFS v24 feature and in the closed configuration, the device is enabled with the Qualcomm® Smart Transmit Gen1 feature. These features 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 and WLAN/BT/NTN is in compliance with FCC requirements.

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/WLAN/BT/NTN 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/WLAN/BT/NTN	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 1 test Report	1M2602190015-34.A3L
RF Exposure Part 2 Test Report	1M2602190015-36.A3L
RF Exposure Compliance Summary	1M2602190015-37.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:

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.

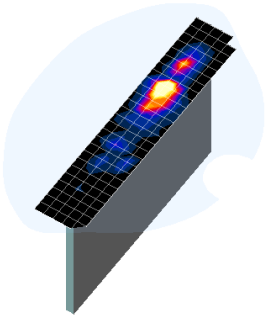

Figure 2-1
Sample SAR Area Scan

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 (DSI = 1)	▪ Device positioned next to head ▪ Receiver Active	*Head SAR per KDB Publication 648474 D04*
Free – Folder Open (DSI = 0)	▪ Device being used with a body-worn accessory ▪ Folder Open ▪ Device is held in hand	*Body-worn SAR per KDB Publication 648474 D04* *Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04*
Hotspot – Folder Open (DSI = 2)	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Folder Open	*Hotspot SAR per KDB Publication 941225 D06*
Free – Folder Closed (DSI = 3)	▪ Device being used with a body-worn accessory ▪ Folder Closed	*Body-worn SAR per KDB Publication 648474 D04*
Hotspot– Folder Closed (DSI = 4)	▪ Device transmits in hotspot mode near body ▪ Hotspot Mode Active ▪ Folder Closed	*Hotspot SAR per KDB Publication 941225 D06*

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

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	The worst-case SAR exposure is determined as maximum SAR normalized to the limit (i.e. lowest P_{limit}) among: 1. Open Body Worn SAR 2. Open Body SAR at 5 mm
1	P_{limit} is calculated based on 1g Head SAR
2	P_{limit} is calculated based on 1g Open Body SAR at 5 mm
3	The worst-case SAR exposure is determined as maximum SAR normalized to the limit (i.e. lowest P_{limit}) among: 1. Closed Body Worn SAR 2. Closed Body SAR at 5 mm
4	P_{limit} is calculated based on 1g Closed Body SAR at 5 mm

Table 3-4
SAR Characterizations

Exposure Scenario			Maximum Tune-Up Output Power*	Open / Freespace / Hotspot	RCV on	Closed / Freespace / Hotspot
Averaging Volume				1g, 10g	1g	1g
Spacing				10mm, 5mm, 0mm	0mm	5mm
DSI				0 / 2	1	3 / 4
Technology/Band	Antenna	Antenna Group for Open Configurations	P_{max}	P_{limit}	P_{limit}	P_{limit}
GSM 850	A	AG0	25.3	20.8	26.0	21.8
GSM 850	E	AG1	22.3	26.4	22.0	26.1
GSM 1900	B	AG0	19.8	18.3	26.0	18.3
UMTS 850	A	AG0	24.0	22.0	22.0	22.5
UMTS 850	E	AG1	24.5	23.0	22.0	23.5
UMTS 1750	B	AG0	23.5	19.0	22.4	19.0
UMTS 1900	B	AG0	23.5	17.5	22.4	18.5
LTE Band 71	A	AG0	24.0	24.1	25.0	24.9
LTE Band 71	E	AG1	24.0	22.0	21.5	22.0
LTE Band 12	A	AG0	24.0	22.5	26.0	23.5
LTE Band 12	E	AG1	24.0	22.0	21.0	22.5
LTE Band 13	A	AG0	24.0	22.5	26.0	23.5
LTE Band 13	E	AG1	24.0	21.0	20.0	21.0
LTE Band 14	A	AG0	24.0	22.5	26.0	23.5
LTE Band 14	E	AG1	24.5	21.5	20.5	21.5
LTE Band 26/5	A	AG0	23.5	21.0	26.0	22.0
LTE Band 26/5	E	AG1	24.5	22.5	21.5	23.0
LTE Band 66/4	B	AG0	24.0	18.5	26.0	19.0
LTE Band 66/4	H	AG1	24.5	21.0	19.0	21.5
LTE Band 25/2	B	AG0	24.0	17.5	26.0	19.0
LTE Band 25/2	H	AG1	24.5	20.5	18.5	20.5
LTE Band 30	B	AG0	23.5	18.0	28.0	19.5
LTE Band 30	H	AG1	24.0	18.0	17.0	19.0
LTE Band 7	B	AG0	24.5	18.0	28.0	20.0
LTE Band 7	H	AG1	24.5	18.5	16.5	19.5
LTE Band 41/38	B	AG0	22.5	19.5	28.0	20.5
LTE Band 41/38	H	AG1	23.0	19.0	16.5	19.0
LTE Band 48	F	AG1	18.5	16.0	13.0	16.0
NR Band n71	A	AG0	23.5	23.7	25.0	24.5
NR Band n71	E	AG1	24.0	22.0	21.5	22.0
NR Band n12	A	AG0	24.0	22.5	26.0	23.5
NR Band n12	E	AG1	24.0	22.0	21.0	22.5
NR Band n14	A	AG0	24.0	22.5	26.0	23.5
NR Band n14	E	AG1	24.5	21.5	20.5	21.5
NR Band n26/n5	A	AG0	23.5	21.0	26.0	22.0
NR Band n26/n5	E	AG1	24.5	22.5	21.5	23.0
NR Band n70	B	AG0	24.0	18.5	26.0	20.0
NR Band n70	H	AG1	24.5	20.5	18.5	20.5
NR Band n66	B	AG0	24.0	18.5	26.0	19.0
NR Band n66	H	AG1	24.5	21.0	19.0	21.5
NR Band n25/n2	B	AG0	24.0	17.5	26.0	19.0
NR Band n25/n2	H	AG1	24.5	20.5	18.5	20.5
NR Band n30	B	AG0	23.5	18.0	26.0	19.5
NR Band n30	H	AG1	24.0	18.0	17.0	19.0
NR Band n7	B	AG0	24.5	18.0	26.0	20.0
NR Band n7	H	AG1	24.5	18.5	16.5	19.5
NR Band n41 PC2 (Path1)	B	AG0	26.5	19.5	30.0	20.5
NR Band n41 PC2 (Path1)	H	AG1	23.5	19.0	16.5	19.0
NR Band n41 PC2 (Path1)	C	AG0	23.5	18.0	22.0	18.0
NR Band n41 PC2 (Path1)	G	AG1	19.0	17.5	17.5	17.5
NR Band n41 PC2 (Path2)	H	AG1	27.0	19.0	N/A	19.0
NR Band n41 PC2 (Path2)	B	AG0	22.5	18.0	N/A	18.0
NR Band n41 PC2 (Path2)	G	AG1	22.5	20.0	N/A	20.0
NR Band n41 PC2 (Path2)	C	AG0	18.5	15.0	N/A	15.0
NR Band n38	B	AG0	25.0	19.5	30.0	20.5
NR Band n38	H	AG1	25.0	19.0	16.5	19.0
NR Band n48	F	AG1	22.0	16.0	13.0	16.0
NR Band n48	H	AG1	21.0	17.0	14.0	17.0
NR Band n48	K	AG1	21.0	17.5	14.5	17.5
NR Band n48	C	AG0	21.0	16.5	13.0	16.5
NR Band n78 PC2	F	AG1	26.5	17.0	14.0	17.0
NR Band n78 PC2	H	AG1	25.0	17.0	14.5	17.0
NR Band n78 PC2	K	AG1	25.0	18.0	15.0	18.0
NR Band n78 PC2	C	AG0	24.0	16.5	13.5	16.5
NR Band n77 PC2	F	AG1	26.5	17.0	14.0	17.0
NR Band n77 PC2	H	AG1	25.0	17.0	14.5	17.0
NR Band n77 PC2	K	AG1	25.0	18.0	15.0	18.0
NR Band n77 PC2	C	AG0	24.0	16.5	13.5	16.5
2.4 GHz WIFI	G	AG1	19.0	21.4	17.5	17.0
2.4 GHz WIFI	C	AG0	19.0	19.7	17.5	17.0
2.4 GHz WIFI MIMO	G	AG1	19.0	19.7	17.5	17.0
2.4 GHz WIFI MIMO	C	AG0	19.0	19.7	17.5	17.0
5 GHz WIFI	F	AG1	17.0	17.7	15.0	17.8
5 GHz WIFI	I	AG1	17.0	18.6	15.0	17.3
5 GHz WIFI	MIMO	AG1	17.0	17.1	15.0	17.1
6 GHz WIFI	F	AG1	16.0	11.0	15.0	18.5
6 GHz WIFI	I	AG1	16.0	11.0	15.0	20.3
6 GHz WIFI	MIMO	AG1	16.0	11.0	15.0	17.4
2.4 GHz Bluetooth	G	AG1	18.4	20.3	15.0	22.4
2.4 GHz Bluetooth	C	AG0	17.4	18.0	15.0	19.0
2.4 GHz Bluetooth MIMO	G	AG1	13.4	18.0	12.0	14.8
2.4 GHz Bluetooth MIMO	C	AG0	10.9	18.0	9.5	14.8
NTN Band 255	M	N/A	23.0	20.5	N/A	N/A

Notes:

1. When $P_{max} < P_{limit}$ EFS, the DUT will operate at a power level up to P_{max}
2. All P_{limit} EFS and maximum tune-up output power P_{max} levels entered in above Table correspond to average power levels after accounting for duty cycle in the case of GMSK, TDD, or OFDM modulation schemes (e.g. GSM, LTE TDD, WLAN, BT, NTN).
3. Maximum tune-up output power P_{max} is used to configure EUT during RF tune up procedure. The maximum allowed output power is equal to maximum tune-up output power + 1dB device design uncertainty.
4. WLAN MIMO P_{max} and P_{limit} are defined per antenna chain.
5. Based on Qualcomm guidance, for multi_tx_factor > 1.0, the reported SAR for each tech/band/ant/DSI is scaled using min{Plimit *multi_tx_factor*10^(sub6 device uncertainty/10), Pmax} in simultaneous transmission evaluations. For this device, the manufacturer declared a multi_tx_factor of 1.27.
6. For Closed configuration, there are no separate antenna groups

4 EQUIPMENT LIST

For SAR measurements

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	2025-11-02	Annual	2026-11-02	MY45093852
Agilent	N5182A	MXG Vector Signal Generator	2025-05-30	Annual	2026-05-30	MY48180366
Agilent	8753ES	S-Parameter Vector Network Analyzer	2025-10-28	Annual	2026-10-28	MY40003841
Agilent	8753ES	S-Parameter Vector Network Analyzer	2025-10-27	Annual	2026-10-27	US39170118
Agilent	E5515C	Wireless Communications Test Set	2025-07-03	Annual	2026-07-03	MY50262130
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433973
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433974
Amplifier Research	150A100C	Amplifier	CBT	N/A	CBT	350132
Anritsu	MN8110B	I/O Adaptor	CBT	N/A	CBT	6261747881
Anritsu	ML2496A	Power Meter	2025-08-21	Annual	2026-08-21	1138001
Anritsu	ML2496A	Power Meter	2025-06-27	Annual	2026-06-27	1840005
Anritsu	MA2411B	Pulse Power Sensor	2025-10-14	Annual	2026-10-14	1726262
Anritsu	MA2411B	Pulse Power Sensor	2025-10-14	Annual	2026-10-14	1027293
Insize	1108-150	Insize - Digital Caliper	2026-01-07	Annual	2027-01-07	1410255640
Anritsu	MA24106A	USB Power Sensor	2025-08-04	Annual	2026-08-04	1827530
Anritsu	MA24106A	USB Power Sensor	2026-02-20	Annual	2027-02-20	1520501
Mini-Circuits	PWR-4GHS	9-KHz-4000MHz USB Power Sensor	2025-06-20	Annual	2026-06-20	12503270057
Control Company	4352	Long Stem Thermometer	2025-12-22	Biennial	2027-12-22	250770121
Control Company	4352	Long Stem Thermometer	2025-12-22	Biennial	2027-12-22	250770096
Control Company	4040	Therm./ Clock/ Humidity Monitor	2025-12-29	Biennial	2027-12-29	250778120
Control Company	4040	Therm./ Clock/ Humidity Monitor	2025-10-24	Biennial	2027-10-24	250652331
Control Company	4040	Therm./ Clock/ Humidity Monitor	2024-10-15	Biennial	2026-10-15	240763503
Keysight Technologies	N9020A	MXA Signal Analyzer	2025-07-07	Annual	2026-07-07	MY48010233
Agilent	N9020A	MXA Signal Analyzer	2025-07-07	Biennial	2027-07-07	MY56470202
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	N/A
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	2025-07-03	Annual	2026-07-03	31634
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
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	NC-100	Torque Wrench	2025-05-29	Biennial	2027-05-29	N/A
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2025-07-09	Annual	2026-07-09	166462
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2024-08-27	Biennial	2026-08-27	167085
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2025-10-24	Annual	2026-10-24	131453
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2025-10-24	Annual	2026-10-24	131454
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2025-10-23	Annual	2026-10-23	150117
Anritsu	MT8000A	Radio Communication Test Station	2025-10-17	Annual	2026-10-17	6272337405
Anritsu	MT8000A	Radio Communication Test Station	2025-06-05	Annual	2026-06-05	6261987986
Anritsu	MT8821C	Radio Communication Analyzer	2025-09-15	Annual	2026-09-15	6201144419
Anritsu	MT8821C	Radio Communication Analyzer	2025-09-15	Annual	2026-09-15	6201381786
Anritsu	MT8821C	Radio Communication Analyzer	2025-09-15	Annual	2026-09-15	6201381794

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
SPEAG	DAK-3.5	Dielectric Assessment Kit	2025-11-10	Annual	2026-11-10	1277
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	2025-08-05	Annual	2026-08-05	1041
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	2025-07-14	Annual	2026-07-14	1039
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1237
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1331
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1390
SPEAG	DAK-12	Dielectric Assessment Kit (4MHz - 3GHz)	2025-11-16	Annual	2026-11-16	1220
GW Instek	GPS-3030DD	DC Power Supply	N/A	N/A	N/A	EI883874
SPEAG	CLA-13	Confined Loop Antenna	2025-09-04	Annual	2026-09-04	1002
SPEAG	D1640V2	1640 MHz SAR Dipole	2025-11-03	Annual	2026-11-03	321
SPEAG	D1750V2	1750 MHz SAR Dipole	2025-06-04	Annual	2026-06-04	1092
SPEAG	D1750V2	1750 MHz SAR Dipole	2025-06-04	Annual	2026-06-04	1051
SPEAG	D1750V2	1750 MHz SAR Dipole	2024-11-07	Biennial	2026-11-07	1150
SPEAG	D1750V2	1750 MHz SAR Dipole	2025-01-13	Biennial	2027-01-13	1148
SPEAG	D1900V2	1900 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	5d026
SPEAG	D1900V2	1900 MHz SAR Dipole	2025-02-07	Biennial	2027-02-07	5d148
SPEAG	D1900V2	1900 MHz SAR Dipole	2025-08-07	Annual	2026-08-07	5d080
SPEAG	D1900V2	1900 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	5d141
SPEAG	D2300V2	2300 MHz SAR Dipole	2026-02-12	Annual	2027-02-12	1008
SPEAG	D2300V2	2300 MHz SAR Dipole	2024-06-14	Biennial	2026-06-14	1116
SPEAG	D2450V2	2450 MHz SAR Dipole	2025-10-07	Annual	2026-10-07	797
SPEAG	D2450V2	2450 MHz SAR Dipole	2024-08-07	Biennial	2026-08-07	719
SPEAG	D2450V2	2450 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	945
SPEAG	D2600V2	2600 MHz SAR Dipole	2025-08-11	Annual	2026-08-11	1126
SPEAG	D2600V2	2600 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	1009
SPEAG	D2600V2	2600 MHz SAR Dipole	2025-11-10	Annual	2026-11-10	1071
SPEAG	D2600V2	2600 MHz SAR Dipole	2025-06-06	Annual	2026-06-06	1064
SPEAG	D3500V2	3500 MHz SAR Dipole	2025-12-08	Annual	2026-12-08	1068
SPEAG	D3500V2	3500 MHz SAR Dipole	2025-06-02	Annual	2026-06-02	1127
SPEAG	D3700V2	3700 MHz SAR Dipole	2025-12-08	Annual	2026-12-08	1029
SPEAG	D3700V2	3700 MHz SAR Dipole	2025-06-02	Annual	2026-06-02	1096
SPEAG	D3900V2	3900 MHz SAR Dipole	2025-11-03	Annual	2026-11-03	1113
SPEAG	D3900V2	3900 MHz SAR Dipole	2025-06-02	Annual	2026-06-02	1074
SPEAG	D5GHzV2	5 GHz SAR Dipole	2024-02-21	Triennial	2027-02-21	1057
SPEAG	D5GHzV2	5 GHz SAR Dipole	2026-01-16	Annual	2027-01-16	1191
SPEAG	D6.5GHzV2	6.5 GHz SAR Dipole	2025-12-05	Annual	2026-12-05	1018
SPEAG	D6.5GHzV2	6.5 GHz SAR Dipole	2026-02-10	Annual	2027-02-10	1111
SPEAG	D750V3	750 MHz SAR Dipole	2026-02-03	Annual	2027-02-03	1046
SPEAG	D750V3	750 MHz SAR Dipole	2024-10-07	Biennial	2026-10-07	1161
SPEAG	D750V3	750 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	1003
SPEAG	D835V2	835 MHz SAR Dipole	2024-03-11	Triennial	2027-03-11	4d133
SPEAG	D835V2	835 MHz SAR Dipole	2025-06-03	Annual	2026-06-03	4d180
SPEAG	5G Verification Source 10 GHz	10GHz System Verification Antenna	2025-08-06	Annual	2026-08-06	1004
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-06-04	Annual	2026-06-04	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-06-05	Annual	2026-06-05	1558
SPEAG	DAE4	Dasy Data Acquisition Electronics	2026-03-10	Annual	2027-03-10	1450
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-05-09	Annual	2026-05-09	1678
SPEAG	DAE4	Dasy Data Acquisition Electronics	2026-02-09	Annual	2027-02-09	859
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-09-10	Annual	2026-09-10	1364
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-10-13	Annual	2026-10-13	1449
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-06-04	Annual	2026-06-04	1652
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-06-04	Annual	2026-06-04	1502
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-12-04	Annual	2026-12-04	1322
SPEAG	DAE4	Dasy Data Acquisition Electronics	2026-01-12	Annual	2027-01-12	1466
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-11-05	Annual	2026-11-05	1677
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-10-13	Annual	2026-10-13	1583
SPEAG	DAE4ip	Dasy Data Acquisition Electronics	2026-02-09	Annual	2027-02-09	1638
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-04-07	Annual	2026-04-07	1368
SPEAG	DAE4	Dasy Data Acquisition Electronics	2025-04-10	Annual	2026-04-10	1272
SPEAG	DAE4ip	Dasy Data Acquisition Electronics	2026-01-08	Annual	2027-01-08	1639
SPEAG	EX3DV4	SAR Probe	2025-06-12	Annual	2026-06-12	7402
SPEAG	EX3DV4	SAR Probe	2025-06-11	Annual	2026-06-11	7409
SPEAG	EX3DV4	SAR Probe	2025-10-13	Annual	2026-10-13	7670
SPEAG	EX3DV4	SAR Probe	2025-12-10	Annual	2026-12-10	7547
SPEAG	EX3DV4	SAR Probe	2025-10-13	Annual	2026-10-13	7803
SPEAG	EX3DV4	SAR Probe	2026-02-11	Annual	2027-02-11	7570
SPEAG	EX3DV4	SAR Probe	2026-01-14	Annual	2027-01-14	7565
SPEAG	EX3DV4	SAR Probe	2025-06-11	Annual	2026-06-11	7661
SPEAG	EX3DV4	SAR Probe	2025-05-09	Annual	2026-05-09	7660
SPEAG	EX3DV4	SAR Probe	2025-10-14	Annual	2026-10-14	7527
SPEAG	EX3DV4	SAR Probe	2025-11-07	Annual	2026-11-07	7406
SPEAG	EX3DV4	SAR Probe	2025-09-15	Annual	2026-09-15	7558
SPEAG	EX3DV4	SAR Probe	2026-02-11	Annual	2027-02-11	7417
SPEAG	EX3DV4	SAR Probe	2026-03-11	Annual	2027-03-11	7539
SPEAG	EX3DV4	SAR Probe	2025-06-12	Annual	2026-06-12	7637
SPEAG	EX3DV4	SAR Probe	2025-04-07	Annual	2026-04-07	7659
SPEAG	EX3DV4	SAR Probe	2025-04-11	Annual	2026-04-11	7546
SPEAG	EUmmWV3	EUmmWV3 Probe	2025-10-08	Annual	2026-10-08	9407

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.

5 MEASUREMENT UNCERTAINTIES

Note: The tables below represent the worst-case uncertainty budget among the uncertainty budgets of all testing laboratories listed in Section 1.2

Applicable for SAR measurements < 6GHz on a flat phantom:

SAR Uncertainty Budget based on IEEE 1528-2013 and SPEAG (0.3 GHz to 6 GHz)

a	b	c	d	e *f(d,k)*	f	g	h cxf/e	i cxg/e	k
Uncertainty component	**Reference**	**Tol. (± %)**	**Prob. dist.**	**Dvi.**	**ci (1g)**	**ci (10g)**	**1g ui (± %)**	**10g ui (± %)**	**vi**
Measurement system									
Probe calibration	E.2.1	6.55	N	1	1	1	6.55	6.55	∞
Axial isotropy	E.2.2	0.25	N	1	0.707	0.707	0.18	0.18	∞
Hemispherical isotropy	E.2.2	1.30	N	1	0.707	0.707	0.92	0.92	∞
Boundary effect	E.2.3	2.00	R	1.73	1	1	1.15	1.15	∞
Linearity	E.2.4	0.30	R	1.73	1	1	0.17	0.17	∞
System detection limits	E.2.4	0.25	R	1.73	1	1	0.14	0.14	∞
Modulation response	E.2.5	4.80	R	1.73	1	1	2.77	2.77	∞
Readout electronics	E.2.6	0.30	N	1	1	1	0.30	0.30	∞
Response time	E.2.7	1.01	R	1.73	1	1	0.58	0.58	∞
Integration time	E.2.8	2.60	R	1.73	1	1	1.50	1.50	∞
RF ambient conditions - noise	E.6.1	3.00	R	1.73	1	1	1.73	1.73	∞
RF ambient conditions - reflections	E.6.1	3.00	R	1.73	1	1	1.73	1.73	∞
Probe positioner mechanical tolerance	E.6.2	0.04	R	1.73	1	1	0.02	0.02	∞
Probe positioning with respect to phantom shell	E.6.3	0.80	R	1.73	1	1	0.46	0.46	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	E.5	4.00	R	1.73	1	1	2.31	2.31	∞
Test sample related									
Test sample positioning	E.4.2	3.12	N	1	1	1	3.12	3.12	35
Device holder uncertainty	E.4.1	1.67	N	1	1	1	1.67	1.67	5
Output power variation - SAR drift	E.2.9	5.00	R	1.73	1	1	2.89	2.89	∞
SAR scaling	E.6.5	0.00	R	1.73	1	1	0.00	0.00	∞
Phantom and tissue parameters									
Phantom shell uncertainty - shape, thickness and permittivity	E.3.1	7.60	R	1.73	1	1	4.39	4.39	∞
Uncertainty in SAR correction for deviations in permittivity and conductivity	E.3.2	0.00	N	1	1	1	0.00	0.00	∞
Liquid conductivity measurement	E.3.3	2.50	N	1	0.78	0.71	1.95	1.78	∞
Liquid permittivity measurement	E.3.3	2.50	N	1	0.23	0.26	0.58	0.65	∞
Liquid conductivity - temperature uncertainty	E.3.4	3.36	R	1.73	0.78	0.71	1.51	1.38	∞
Liquid permittivity - temperature uncertainty	E.3.4	0.77	R	1.73	0.23	0.26	0.10	0.12	∞
Liquid Conductivity - deviation from target values	E.3.2	5.00	R	1.73	0.64	0.43	1.85	1.24	∞
Liquid Permittivity - deviation from target values	E.3.2	5.00	R	1.73	0.60	0.49	1.73	1.41	∞
Combined standard uncertainty							**11.0**	**10.8**	**40**
Expanded uncertainty (95% confidence interval)							**21.9**	**21.6**	

Applicable for SAR measurements <300 MHz and > 6 GHz on a flat phantom:

SAR Uncertainty Budget based on IEC/IEEE 62209-1528:2020 (4 MHz to 10 GHz)

Symbol	Input quantity X (source of uncertainty)	Ref.	Prob. Dist. PDFi	Unc. a(xi)	Div. qi	u(xi) = a(xi)/qi	ci (1g)	ci (10g)	u(y) = cixu(xi) 1g (± %)	u(y) = cixu(xi) 10g (± %)	vi
	Measurement system errors										
CF	Probe calibration	8.4.1.1	N (k=2)	9.30	1	9.30	1	1	9.30	9.30	∞
CFdrift	Probe calibration drift	8.4.1.2	R	1.70	1.73	0.98	1	1	0.98	0.98	∞
LIN	Probe linearity and detection limit	8.4.1.3	R	4.70	1.73	2.71	1	1	2.71	2.71	∞
BBS	Broadband signal	8.4.1.4	R	2.80	1.73	1.62	1	1	1.62	1.62	∞
ISO	Probe isotropy	8.4.1.5	R	7.60	1.73	4.39	1	1	4.39	4.39	∞
DAE	Other probe and data acquisition errors	8.4.1.6	N	2.40	1	2.40	1	1	2.40	2.40	∞
AMB	RF ambient and noise	8.4.1.7	N	1.80	1	1.80	1	1	1.80	1.80	∞
Δxyz	Probe positioning errors	8.4.1.8	N	0.30	1	0.30	1	1	0.30	0.30	∞
DAT	Data processing errors	8.4.1.9	N	3.50	1.00	3.50	1	1	3.50	3.50	∞
	Phantom and device (DUT or validation antenna) errors										
LIQ(σ)	Measurement of phantom conductivity	8.4.2.1	N	2.50	1	2.50	0.78	0.71	1.95	1.78	∞
LIQ(Tc)	Temperature effects (medium)	8.4.2.2	R	5.40	1.73	3.12	0.78	0.71	2.43	2.21	∞
EPS	Shell permitivitty	8.4.2.3	R	14.00	1.73	8.08	0.5	0.5	4.04	4.04	∞
DIS	Distance between the radiating element of the DUT and the phantom medium	8.4.2.4	N	2.00	1	2.00	2	2	4.00	4.00	∞
Dxyz	Repeatability of positioning the DUT or source against the phantom	8.4.2.5	N	3.12	1	3.12	1	1	3.12	3.12	35
H	Device holder effects	8.4.2.6	N	1.67	1	1.67	1	1	1.67	1.67	5
MOD	Effect of operating mode on probe sensitivity	8.4.2.7	R	2.40	1.73	1.39	1	1	1.39	1.39	∞
TAS	Time-average SAR	8.4.2.8	R	1.73	1.73	1.00	1	1	1.00	1.00	∞
RFdrift	Variation in SAR due to drift in output power of DUT	8.4.2.9	N	2.50	1	2.50	1	1	2.50	2.50	∞
VAL	Validation antenna uncertainty (validation measurement only)	8.4.2.10	N	0.00	1	0.00	1	1	0.00	0.00	∞
Pin	Uncertainty in accepted power (validation measurement only)	8.4.2.11	N	0.00	1	0.00	1	1	0.00	0.00	∞
	Corrections to the SAR result (if applied)										
C(ε′,σ)	Phantom deviation from target	8.4.3.1	R	5.00	1.73	2.89	0.64	0.43	1.85	1.24	∞
C(R)	SAR scaling	8.4.3.2	R	0.00	1.73	0.00	1	1	0.00	0.00	∞
u(ΔSAR)	**Combined uncertainty**								**14.32**	**14.20**	**40**
U	**Expanded unsertainty and effective degrees of freedom**								**28.65**	**28.40**	