



PART 0 SAR CHAR REPORT

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APPLICANT:

SAMSUNG ELECTRONICS CO., LTD

Report Type:

Part 0 SAR Characterization

DUT Type:

Portable Handset

Model(s):

SM-G766U

Additional Model:

SM-G766U1

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



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1 DEVICE UNDER TEST

1.1 Device Overview

This device uses the Qualcomm® Smart Transmit feature to control and manage transmitting power for 2G/3G/4G/5G WWAN operations and Qualcomm® FastConnect TAS for WLAN technologies in real time and to ensure the time-averaged RF exposure is in compliance with the FCC requirement at all times. Additionally, this device supports BT and 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 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 n14	Voice/Data	790.5 - 795.5 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 n41	Voice/Data	2501.01 - 2685 MHz
NR Band n48	Voice/Data	3555 - 3694.98 MHz
NR Band n78	Voice/Data	3455.01 - 3544.98 MHz; 3705 - 3795 MHz
NR Band n77	Voice/Data	3455.01 - 3544.98 MHz; 3705 - 3975 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: 5945 - 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

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1.2 Time-Averaging for SAR

This device is enabled with Qualcomm® Smart Transmit algorithm and Qualcomm® FastConnect TAS feature 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 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 (<i>SAR_design_target</i>) after accounting for all device design related uncertainties
	P_{max}	Maximum tune up output power
	<i>SAR_design_target</i>	Target SAR level < FCC SAR limit after accounting for all device design related uncertainties
	<i>SAR Char</i>	Table containing P_{limit} for all technologies and bands

1.4 Bibliography

Report Type	Report Serial Number
FCC SAR Evaluation Report (Part 1)	1M2501020001-01.A3L
RF Exposure Part 2 Test Report	1M2501020001-03.A3L
RF Exposure Compliance Summary	1M2501020001-04.A3L

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2 SAR 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 size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 2-1) and IEEE 1528-2013. On the

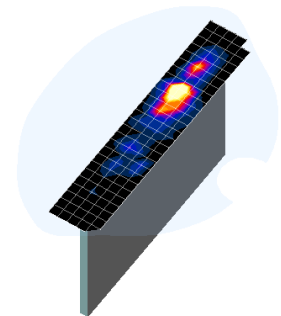


Figure 2-1
Sample SAR Area Scan

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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 and Table 3-2 represent different exposure scenarios.

Table 3-1
DSI and Corresponding Exposure Scenarios for Qualcomm® Smart Transmit algorithm

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 (DSI = 0)	Device is held with hand	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

Table 3-2
DSI and Corresponding Exposure Scenarios for Qualcomm® FastConnect TAS feature

Scenario	Description	SAR Test Cases
Head (DSI = 1)	- Device positioned next to head - Receiver Active	Head SAR per KDB Publication 648474 D04
Phablet (DSI = 0)	Device is held with hand	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
Hotspot mode (DSI = 0)	- Device transmits in hotspot mode near body - Hotspot Mode Active	Hotspot SAR per KDB Publication 941225 D06

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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 3-3 and Table 3-4).

Table 3-3
Qualcomm® Smart Transmit *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)	
<i>Total Uncertainty</i>	1.0 dB	<i>Total Uncertainty</i>	1.0 dB
<i>SAR_regulatory_limit</i>	1.6 W/kg	<i>SAR_regulatory_limit</i>	4.0 W/kg
<i>SAR_design_target</i>	0.8 W/kg	<i>SAR_design_target</i>	2.0 W/kg

Table 3-4
Qualcomm® FastConnect *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)	
<i>Total Uncertainty</i>	1.0 dB	<i>Total Uncertainty</i>	1.0 dB
<i>SAR_regulatory_limit</i>	1.6 W/kg	<i>SAR_regulatory_limit</i>	4.0 W/kg
<i>SAR_design_target</i>	0.6 W/kg	<i>SAR_design_target</i>	1.5 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 and SAR Part 1 Report.

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 3-5 and Table 3-6.

Table 3-5
 P_{Limit} Determination for Qualcomm® Smart Transmit algorithm

Device State Index (DSI)	P_{Limit} 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 for back, front, top, bottom, right and left.
2	P_{limit} is calculated based on 1g Head SAR
3	P_{limit} is calculated based on 1g Hotspot SAR at 10 mm for top, bottom, right, and left positions and at 5mm for back and front positions

Table 3-6
 P_{Limit} Determination for Qualcomm® FastConnect algorithm

Device State Index (DSI)	P_{Limit} 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 for back, front, top, and left.
1	P_{limit} is calculated based on 1g Head SAR

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Table 3-7
SAR Characterizations for Qualcomm® Smart Transmit algorithm

Exposure Scenario Averaging Volume Spacing DSI			Maximum Tune-Up Output Power*	Body-Worn or Phablet 1g/10g 5mm, 0mm	Head 1g 0mm	Hotspot 1g 10mm, 5mm
			P _{max}	P _{limit}	P _{limit}	P _{limit}
Technology/Band	Antenna	Antenna Group	P _{max}	P _{limit}	P _{limit}	P _{limit}
GSM 850	1	AG0	24.3	22.5	24.4	22.5
GSM 1900	2	AG0	21.3	19.5	18.5	19.5
UMTS 850	1	AG0	24.0	23.0	24.9	23.0
UMTS 1750	2	AG0	23.5	19.5	23.5	19.5
UMTS 1900	2	AG0	23.5	19.0	23.5	19.0
LTE Band 71	1	AG0	24.0	25.5	24.4	25.5
LTE Band 12	1	AG0	24.0	24.6	24.5	24.6
LTE Band 13	1	AG0	24.0	23.0	26.0	23.0
LTE Band 14	1	AG0	24.0	23.0	26.2	23.0
LTE Band 26	1	AG0	24.0	23.0	25.4	23.0
LTE Band 5	1	AG0	24.0	23.0	26.0	23.0
LTE Band 66/4	2	AG0	23.5	19.0	23.5	19.0
LTE Band 66/4	4	AG1	23.5	21.0	20.5	21.0
LTE Band 25/2	2	AG0	23.5	19.0	23.5	19.0
LTE Band 25/2	4	AG1	23.0	20.0	18.0	20.0
LTE Band 30	2	AG0	23.0	20.5	24.7	20.5
LTE Band 30	4	AG1	23.0	19.0	14.5	19.0
LTE Band 7	2	AG0	23.5	20.5	24.4	20.5
LTE Band 7	4	AG1	23.0	19.5	17.0	19.5
LTE Band 41/38	2	AG0	21.0	17.0	17.0	17.0
LTE Band 41/38	4	AG1	21.0	17.0	15.0	17.0
LTE Band 48	6	AG1	19.0	11.0	14.0	11.0
NR Band n71	1	AG0	24.0	24.9	24.4	24.9
NR Band n14	1	AG0	23.0	22.0	23.7	22.0
NR Band n5	1	AG0	24.0	21.5	24.9	21.5
NR Band n70	2	AG0	23.5	20.5	24.7	20.5
NR Band n70	4	AG1	23.0	20.0	19.0	20.0
NR Band n66	2	AG0	23.5	19.5	23.5	19.5
NR Band n66	4	AG1	23.0	20.5	19.5	20.5
NR Band n25/n2	2	AG0	23.5	20.0	23.6	20.0
NR Band n25/n2	4	AG1	23.5	21.0	17.0	21.0
NR Band n30	2	AG0	23.0	20.5	23.9	20.5
NR Band n30	4	AG1	23.0	19.0	14.5	19.0
NR Band n41 PC3	2	AG0	23.5	17.0	17.0	17.0
NR Band n41 PC2	2	AG0	26.0	17.0	17.0	17.0
NR Band n48	6	AG1	21.0	12.5	14.0	12.5
NR Band n48	8	AG1	16.0	14.0	15.0	14.0
NR Band n48	2	AG0	20.0	15.0	15.0	15.0
NR Band n48	4	AG1	16.0	15.0	15.0	15.0
NR Band n78 PC3	6	AG1	23.0	14.0	15.0	14.0
NR Band n78 PC3	8	AG1	18.0	17.0	17.0	17.0
NR Band n78 PC3	2	AG0	17.0	17.0	17.0	17.0
NR Band n78 PC3	4	AG1	16.0	15.0	15.0	15.0
NR Band n78 PC2	6	AG1	27.0	14.0	15.0	14.0
NR Band n78 PC2	8	AG1	23.0	17.0	17.0	17.0
NR Band n78 PC2	2	AG0	26.0	17.0	17.0	17.0
NR Band n78 PC2	4	AG1	22.0	15.0	15.0	15.0
NR Band n77 PC3	6	AG1	24.0	14.0	15.0	14.0
NR Band n77 PC3	8	AG1	18.0	17.0	17.0	17.0
NR Band n77 PC3	2	AG0	17.0	17.0	17.0	17.0
NR Band n77 PC3	4	AG1	16.0	15.0	15.0	15.0
NR Band n77 PC2	6	AG1	27.0	14.0	15.0	14.0
NR Band n77 PC2	8	AG1	23.0	17.0	17.0	17.0
NR Band n77 PC2	2	AG0	26.0	17.0	17.0	17.0
NR Band n77 PC2	4	AG1	22.0	15.0	15.0	15.0

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Table 3-8
SAR Characterizations for Qualcomm® FastConnect algorithm

Exposure Scenario			Maximum Tune-Up Output Power*	Body-Worn, Hotspot, or Phablet	Head
				1g/10g	1g
				5mm, 0mm	0mm
				0	1
Technology/Band	Antenna	Antenna Group	P _{max}	P _{limit}	P _{limit}
2.4 GHz WIFI	5	AGa	17.0	13.0	13.0
2.4 GHz WIFI	MIMO	AGa	17.0	13.0	13.0
5 GHz WIFI	MIMO	AGa	16.0	10.5	10.5
6 GHz WIFI	MIMO	AGa	16.0	10.5	10.5

Notes:

1. For all modes/bands, when Hotspot Mode (DSI=3) and Extremity sensor (DSI=0) 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=0.
2. When $P_{max} < P_{limit}$, the DUT will operate at a power level up to P_{max} .
3. To differentiate between Antenna Groups (AGs) controlled by Smart Transmit and those controlled by FastConnect, AGs managed by Smart Transmit will be labeled with numbers, while those managed by FastConnect will be labeled with letters. Modes outside of TAS are identified by their respective antennas.
4. All MIMO P_{max} and P_{limit} are defined per antenna chain.

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4 EQUIPMENT LIST

For SAR measurements

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E4408B	Spectrum Analyzer	N/A	N/A	N/A	MY0511242
Agilent	E4438C	ESG Vector Signal Generator	3/25/2024	Annual	3/25/2025	MY47270002
Agilent	E4449B	ESG Vector Signal Generator	11/24/2024	Annual	11/24/2025	MY49490026
Agilent	N5182A	MWG Vector Signal Generator	3/15/2024	Annual	3/15/2025	MY42500561
Agilent	N5182A	MWG Vector Signal Generator	3/7/2024	Annual	3/7/2025	MY41420605
Agilent	N5202A	MWG Vector Signal Generator	3/8/2024	Annual	3/8/2025	MY48020233
Agilent	N9232C	5-Port Power Meter Network Analyzer	9/25/2024	Annual	9/25/2025	MY40020443
Agilent	P9385	5-Port Power Meter Network Analyzer	9/25/2024	Annual	9/25/2025	US50170118
Agilent	E5151C	Wireless Communications Test Set	CBT	N/A	CBT	GB46110798
Agilent	E5151C	Wireless Communications Test Set	CBT	N/A	CBT	GB46114026
Agilent	N8200A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170844
Amplifier Research	15150G	Amplifier	CBT	N/A	CBT	438973
Amplifier Research	15150G	Amplifier	CBT	N/A	CBT	438974
Amplifier Research	15150G	Amplifier	CBT	N/A	CBT	438975
Amplifier Research	15150G	Amplifier	CBT	N/A	CBT	438976
Amplifier Research	15150G	Amplifier	7/10/2024	Annual	7/10/2025	190882
Anritsu	MA2406A	Power Meter	6/24/2024	Annual	6/24/2025	184005
Anritsu	MA2406A	Power Meter	7/8/2024	Annual	7/8/2025	180028
Anritsu	MA2411B	Pulse Power Sensor	7/10/2024	Annual	7/10/2025	112606
Anritsu	MA2411B	Pulse Power Sensor	10/21/2024	Annual	10/21/2025	102753
Anritsu	MA2408A	MicroWave Peak Power Sensor	4/9/2024	Annual	4/9/2025	1107
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	4/26/2024	Annual	4/26/2025	626180754
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	5/15/2024	Annual	5/15/2025	626210047
Anritsu	MT8821C	Radio Communication Analyzer MT8821C	5/29/2024	Annual	5/29/2025	626204475
Anritsu	MT8800A	Radio Communication Test Station	3/14/2024	N/A	3/14/2025	412133143
Anritsu	MT8800A	Radio Communication Test Station	4/10/2024	Annual	4/10/2025	626180758
Anritsu	MT8800A	Radio Communication Test Station	3/22/2024	Annual	3/22/2025	627332136
Anritsu	MA2410A	USB Power Sensor	4/7/2024	Annual	4/7/2025	184758
Anritsu	MA2410A	USB Power Sensor	4/15/2024	Annual	4/15/2025	187759
Anritsu	MA2410A	USB Power Sensor	7/9/2024	Annual	7/9/2025	124512
Mini-Circuits	PWR-40H5	Long Stem Thermometer	6/12/2024	Annual	6/12/2025	1300507013
Control Company	4052	Long Stem Thermometer	2/27/2024	Biennial	2/27/2026	240114146
Control Company	4052	Long Stem Thermometer	2/27/2024	Biennial	2/27/2026	240171096
Control Company	4053	Ultra Long Stem Thermometer	10/20/2024	Annual	10/20/2025	20046516
Control Company	4040	Therm / Clock Humidity Monitor	4/15/2024	Biennial	4/15/2026	240310280
Control Company	4040	Therm / Clock Humidity Monitor	4/15/2024	Biennial	4/15/2026	240310282
Control Company	56279	Therm / Clock Humidity Monitor	2/16/2024	Biennial	2/16/2026	240240551
Testo	608-H1	ALARM-HYGROMETER	4/11/2024	Annual	4/11/2025	83316971
Testo	608-H1	ALARM-HYGROMETER	4/11/2024	Annual	4/11/2025	83316952
Testo	608-H1	ALARM-HYGROMETER	4/11/2024	Annual	4/11/2025	83316953
Mitsutoyo	500 196 30	CP-608 608 Digital Caliper	2/16/2024	Technical	2/16/2025	412133143
Keysight Technologies	N9200A	MRA Signal Analyzer	4/11/2024	Annual	4/11/2025	MY54000644
Agilent	N9200A	MRA Signal Analyzer	6/14/2024	Annual	6/14/2025	MY56470302
Keysight Technologies	N9200A	MRA Signal Analyzer	7/9/2024	Annual	7/9/2025	MY48020233
MCL	BW-N20W+	Attenuator	7/9/2024	Annual	7/9/2025	1107
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	VLF-4000+	Low Pass Filter DC to 4000 Mhz	CBT	N/A	CBT	N/A
Mini-Circuits	VLF-4000+	Low Pass Filter DC to 4000 Mhz	7/10/2024	Annual	7/10/2025	151634
Mini-Circuits	BW-N20W+	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-1200+	Low Pass Filter DC to 1200 Mhz	7/10/2024	Annual	7/10/2025	1043130328
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2900 Mhz	7/10/2024	Annual	7/10/2025	1043020207
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2900 Mhz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	ZUK-20-85-S+	Directional Coupler	CBT	N/A	CBT	2050
Mini-Circuits	ZUK-20-85-S+	Directional Coupler	7/9/2024	Annual	7/9/2025	2111
Narda	4772.3	Attenuator (3dB)	CBT	N/A	CBT	9456
Narda	BW-430A2	Attenuator (3dB)	CBT	N/A	CBT	129
MCL	BW-N6W5+	Attenuator	7/9/2024	Annual	7/9/2025	1008
Seekonk	NC-100	Torque Wrench	CBT	N/A	CBT	22217
Seekonk	NC-100	Torque Wrench	4/2/2024	Biennial	4/2/2026	1262
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	7/9/2024	Annual	7/9/2025	168818
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	6/11/2024	Annual	6/11/2025	168869
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	4/29/2024	Annual	4/29/2025	140147
SPAG	DAK-3.5	Portable Dielectric Assessment Kit	5/14/2024	Annual	5/14/2025	1070
SPAG	DAK-3.5	Portable Dielectric Assessment Kit	8/7/2024	Annual	8/7/2025	1041
SPAG	DAK-3.5	Portable Dielectric Assessment Kit	7/9/2024	Annual	7/9/2025	1039
SPAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1427
SPAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1331
SPAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1390
SPAG	DA-12	Dielectric Assessment Kit (4MHz - 3GHz)	3/11/2024	Annual	3/11/2025	1102
SPAG	CLA-13	Confined Loop Antenna	9/4/2024	Annual	9/4/2025	1002
SPAG	D750V3	750 Mhz SAR Dipole	3/7/2024	Annual	3/7/2025	1046
SPAG	D750V3	750 Mhz SAR Dipole	5/10/2024	Annual	5/10/2025	1003
SPAG	D810V2	810 Mhz SAR Dipole	4/8/2024	Annual	4/8/2025	1413
SPAG	D1750V2	1750 Mhz SAR Dipole	11/7/2024	Annual	11/7/2025	1150
SPAG	D1750V2	1750 Mhz SAR Dipole	4/15/2024	Annual	4/15/2025	1051
SPAG	D1900V2	1900 Mhz SAR Dipole	3/10/2024	Annual	3/10/2025	16149
SPAG	D1900V2	1900 Mhz SAR Dipole	2/21/2024	Triennial	2/21/2025	16148
SPAG	D1900V2	1900 Mhz SAR Dipole	4/13/2024	Annual	4/13/2025	16141
SPAG	D2300V2	2300 Mhz SAR Dipole	8/25/2022	Triennial	8/25/2025	1073
SPAG	D3500V2	3500 Mhz SAR Dipole	5/14/2024	Annual	5/14/2025	1116
SPAG	D4500V2	4500 Mhz SAR Dipole	8/7/2024	Annual	8/7/2025	739
SPAG	D2600V2	2600 Mhz SAR Dipole	11/15/2022	Biennial	11/15/2025	1071
SPAG	D2600V2	2600 Mhz SAR Dipole	12/12/2024	Annual	12/12/2025	1068
SPAG	D3500V2	3500 Mhz SAR Dipole	6/10/2024	Annual	6/10/2025	1127
SPAG	D3500V2	3500 Mhz SAR Dipole	3/12/2024	Biennial	3/12/2026	1059
SPAG	D1700V2	1700 Mhz SAR Dipole	12/11/2024	Annual	12/11/2025	1079
SPAG	D1700V2	1700 Mhz SAR Dipole	6/10/2024	Annual	6/10/2025	1066
SPAG	D1700V2	1700 Mhz SAR Dipole	1/9/2024	Biennial	1/9/2026	1018
SPAG	D1900V2	1900 Mhz SAR Dipole	6/10/2024	Annual	6/10/2025	1074
SPAG	D1900V2	1900 Mhz SAR Dipole	1/21/2024	Annual	1/21/2025	1057
SPAG	DE-5GHzV2	6.5 GHz SAR Dipole	11/6/2024	Annual	11/6/2025	1018
SPAG	DE-5GHzV2	6.5 GHz SAR Dipole	3/22/2024	Annual	3/22/2025	1111
SPAG	5G Verification Source 1350a	100W System Verification Antenna	5/24/2024	Annual	5/24/2025	1002
SPAG	DAE4	Day Data Acquisition Electronics	11/4/2024	Annual	11/4/2025	1121
SPAG	DAE4	Day Data Acquisition Electronics	11/9/2024	Annual	11/9/2025	1121
SPAG	DAE4	Day Data Acquisition Electronics	5/9/2024	Annual	5/9/2025	1102
SPAG	DAE4	Day Data Acquisition Electronics	9/10/2024	Annual	9/10/2025	1104
SPAG	DAE4	Day Data Acquisition Electronics	7/9/2024	Annual	7/9/2025	1103
SPAG	DAE4	Day Data Acquisition Electronics	5/9/2024	Annual	5/9/2025	1078
SPAG	DAE4	Day Data Acquisition Electronics	1/13/2025	Annual	1/13/2026	859
SPAG	DAE4	Day Data Acquisition Electronics	5/9/2024	Annual	5/9/2025	728
SPAG	DAE4	Day Data Acquisition Electronics	8/9/2024	Annual	8/9/2025	1132
SPAG	DAE4	Day Data Acquisition Electronics	6/11/2024	Annual	6/11/2025	1134
SPAG	DAE4	Day Data Acquisition Electronics	1/12/2024	Annual	1/12/2025	1171
SPAG	DAE4	Day Data Acquisition Electronics	9/10/2024	Annual	9/10/2025	1449
SPAG	EX-RV4	SAR Probe	10/9/2024	Annual	10/9/2025	7551
SPAG	EX-RV4	SAR Probe	12/16/2024	Annual	12/16/2025	7407
SPAG	EX-RV4	SAR Probe	5/10/2024	Annual	5/10/2025	7402
SPAG	EX-RV4	SAR Probe	9/11/2024	Annual	9/11/2025	7558
SPAG	EX-RV4	SAR Probe	6/28/2024	Annual	6/28/2025	7601
SPAG	EX-RV4	SAR Probe	5/9/2024	Annual	5/9/2025	7605
SPAG	EX-RV4	SAR Probe	1/8/2025	Annual	1/8/2026	7571
SPAG	EX-RV4	SAR Probe	5/10/2024	Annual	5/10/2025	7554
SPAG	EX-RV4	SAR Probe	11/16/2024	Annual	11/16/2025	7611
SPAG	EX-RV4	SAR Probe	6/17/2024	Annual	6/17/2025	7409
SPAG	EX-RV4	SAR Probe	3/9/2024	Annual	3/9/2025	7527
SPAG	EumWV4	EumWV4 Probe	1/9/2025	Annual	1/9/2026	9899

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

"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:

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

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

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Applicable for SAR measurements > 6GHz:

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	9.3	N	1	1	1	9.3	9.3	∞
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	13.8	13.6
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	27.6	27.1

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

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