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PART 0 SAR CHAR REPORT

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Date of Testing:
 11/18/19 – 01/23/20
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 PCTEST Lab, Columbia, MD, USA
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FCC ID:	A3LSMG988U
IC:	649E-SMG988U
APPLICANT:	SAMSUNG ELECTRONICS CO., LTD

Report Type:	Part 0 SAR Characterization
DUT Type/Apparatus/Device:	Portable Handset
Application Type:	Certification
IC Specification(s):	RSS-102 Issue 5 (March 2015), Health Canada Safety Code 6
Additional Standard(s):	IEC 62209-1, IEC 62209-2
Radio Equipment Type:	Cellular Communications Apparatus
Model	SM-G988U
HVIN:	SM-G988W
Additional Model(s):	SM-G988U1, SM-G988W

Note: This revised Test Report (S/N: 1M191140187-28-R1.A3L) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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

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


 Randy Ortanez
 President



FCC ID: A3LSMG988U IC: 649E-SMG988U	 PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M191140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 1 of 10

TABLE OF CONTENTS

1	DEVICE UNDER TEST	3
1.1	Device Overview	3
1.2	Time-Averaging for SAR and Power Density	3
1.3	Nomenclature for Part 0 Report	3
1.4	Bibliography	3
2	SAR AND POWER DENSITY MEASUREMENTS	4
2.1	SAR Definition	4
2.2	SAR Measurement Procedure	4
3	SAR CHARACTERIZATION	6
3.1	DSI and SAR Determination	6
3.2	SAR Design Target	6
3.3	SAR Char	7
4	EQUIPMENT LIST	9
5	MEASUREMENT UNCERTAINTIES	10
APPENDIX A: SAR TEST RESULTS FOR <i>PLimit</i> CALCULATIONS		

FCC ID: A3L.SMG988U IC: 649E-SMG988U	PCTEST PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 2 of 10

1 DEVICE UNDER TEST

1.1 Device Overview

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

1.2 Time-Averaging for SAR and Power Density

This device is enabled with Qualcomm® Smart Transmit algorithm to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from 2G/3G/4G/5G NR WWAN is in compliance with FCC requirements. This Part 0 report shows SAR and Power Density characterization of WWAN radios for 2G/3G/4G/5G Sub-6 NR and 5G mmW NR respectively. Characterization is achieved by determining P_{Limit} for 2G/3G/4G/5G Sub-6 NR and $input.power.limit$ for 5G mmW NR that correspond to the exposure design targets after accounting for all device design related uncertainties, i.e., SAR_design_target (< SAR limit) for sub-6 radio and PD_design_target (< FCC PD limit) for mmW radio. The SAR characterization and PD characterization are denoted as SAR Char and PD 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 < SAR limit after accounting for all device design related uncertainties
	$SAR\ Char$	Table containing P_{limit} for all technologies and bands

1.4 Bibliography

Report Type	Report Serial Number
FCC Part 0 PD Characterization Report	Revision A
FCC SAR Evaluation Report (Part 1)	1M1911140187-01-R2.A3L
ISED SAR Evaluation Report (Part 1)	1M1911140187-22.A3L
FCC PD Evaluation Report (Part 1)	1M1911140187-29-R1.A3L
RF Exposure Part 2 Test Report	80-W5681-6 Rev. A
RF Exposure Compliance Summary	1M1911140187-30.A3L
Power Density Simulation Report	Revision A

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 3 of 10

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. Table 2-1) and IEEE 1528-2013.
3. 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.

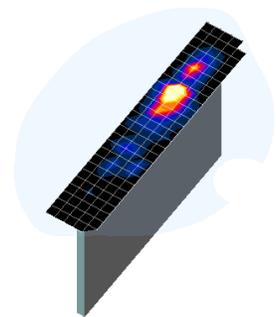


Figure 2-1
Sample SAR Area Scan

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PCTEST PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 4 of 10

4. 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
5. 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
 - b. 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).
 - c. 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.
 - d. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
6. 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) ($\Delta x_{area}, \Delta y_{area}$)	Maximum Zoom Scan Resolution (mm) ($\Delta x_{zoom}, \Delta y_{zoom}$)	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

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PCTEST	PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 5 of 10	

3 SAR CHARACTERIZATION

3.1 DSI and SAR Determination

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

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

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

**Table 3-1
DSI and Corresponding Exposure Scenarios**

Scenario	Description	SAR Test Cases
Head (DSI = 2)	<ul style="list-style-type: none"> Device positioned next to head Receiver Active 	Head SAR per KDB Publication 648474 D04
Hotspot mode (DSI = 3)	<ul style="list-style-type: none"> Device transmits in hotspot mode near body Hotspot Mode Active 	Hotspot SAR per KDB Publication 941225 D06
Phablet Grip (DSI=1 or 4)	<ul style="list-style-type: none"> Device is held with hand and grip sensor is triggered Grip sensor triggered or earjack is active 	Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04
Phablet (DSI = 0)	<ul style="list-style-type: none"> Device is held with hand and grip sensor is not triggered Distance grip sensor not triggered 	Phablet SAR per KDB Publication 648474 D04 & KDB Publication 616217 D04
Body-worn (DSI = 0)	<ul style="list-style-type: none"> Device being used with a body-worn accessory 	Body-worn SAR per KDB Publication 648474 D04

3.2 SAR Design Target

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

**Table 3-2
SAR_design_target Calculations**

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

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 6 of 10

3.3 SAR Char

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

P_{limit} is calculated by linearly scaling with the measured SAR at the P_{max} to correspond to the SAR_{design_target} . P_{limit} determination for each exposure scenario corresponding to SAR_{design_target} are shown in Table 3-3.

Table 3-3
 P_{Limit} Determination

Device State Index (DSI)	P_{Limit} Determination Scenarios
0	The worst-case SAR exposure is determined as maximum SAR normalized to the limit among: 1. Body Worn SAR 2. Extremity SAR measured at 8, 7 and 12 mm spacing for back, front, bottom respectively 3. Extremity SAR measured at 0 mm for left and right surfaces
1 or 4	P_{limit} is calculated based on 10g Extremity SAR at 0 mm for back, front, and bottom surfaces
2	P_{limit} is calculated based on 1g Head SAR
3	P_{limit} is calculated based on 1g Hotspot SAR at 10 mm

Note:

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

$$P_{limit} = \min\{ P_{limit} \text{ corresponding to 1g Body Worn SAR evaluation at 15 mm spacing, } \\ P_{limit} \text{ corresponding to 10g Extremity SAR evaluation at 7~12 mm spacing, } \\ P_{limit} \text{ corresponding to 10g Extremity SAR evaluation at 0 mm for left and right surfaces} \}$$

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PCTEST PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 7 of 10

**Table 3-4
SAR Characterizations**

Device State Index (DSI)	0			1	2	3	4
Exposure Scenario	Body-Worn 1g SAR at 15 mm	Phablet 10g SAR at Max Power	Body-Worn 1g SAR at 15 mm Phablet 10g SAR at Max Power	Phablet 10g SAR at Red Power	Head 1g SAR	Hotspot 1g SAR	Phablet 10g SAR at Red Power
Mode/Band	(dBm)	(dBm)	PLimit (dBm)	PLimit (dBm)	PLimit (dBm)	PLimit (dBm)	PLimit (dBm)
GSM/GPRS/EDGE 850 MHz	30.7	30.7	30.7	27.6	31.5	27.5	27.6
GSM/GPRS/EDGE 1900 MHz	25.9	25.9	25.9	18.9	32.3	18.9	18.9
UMTS B5	30.9	30.9	30.9	26.2	31.6	27.4	26.2
UMTS B4	24.7	24.7	24.7	20.2	34.1	18.2	20.2
UMTS B2	25.1	25.1	25.1	19.9	32.4	17.0	19.9
CDMA/EVDO BC10	29.8	29.8	29.8	26.9	32.6	27.2	26.9
CDMA/EVDO BC0	29.8	29.8	29.8	26.4	31.9	27.0	26.4
CDMA/EVDO BC1	25.7	25.7	25.7	19.0	31.6	17.0	19.0
LTE FDD B71	32.2	32.2	32.2	27.1	33.9	30.9	27.1
LTE FDD B12	31.3	31.3	31.3	26.1	33.3	29.8	26.1
LTE FDD B13	31.4	31.4	31.4	27.2	32.9	28.9	27.2
LTE FDD B14	31.2	31.2	31.2	26.2	32.2	28.6	26.2
LTE FDD B26	30.9	30.9	30.9	26.8	33.4	27.7	26.8
LTE FDD B5	30.7	30.7	30.7	26.8	33.2	27.3	26.8
LTE FDD B66/4	25.1	25.1	25.1	20.2	34.4	18.5	20.2
LTE FDD B25	25.2	25.2	25.2	19.8	33.3	17.3	19.8
LTE FDD B2	25.0	25.0	25.0	19.8	33.3	17.3	19.8
LTE FDD B30	26.2	26.2	26.2	21.0	36.5	19.3	21.0
LTE FDD B7	28.4	28.4	28.4	20.9	34.0	20.2	20.9
LTE TDD B48	22.1	22.1	22.1	22.1	16.0	23.0	22.1
LTE TDD B38	27.3	27.3	27.3	19.8	34.5	19.8	19.8
LTE TDD B41 (PC3 & PC2)	27.3	27.3	27.3	19.8	34.5	19.8	19.8
NR FDD n71	32.0	32.0	32.0	27.5	33.9	30.4	27.5
NR FDD n5	30.4	30.4	30.4	26.7	33.4	27.0	26.7
NR FDD n66	23.6	23.6	23.6	19.0	33.0	18.0	19.0
NR FDD n2	24.6	24.6	24.6	19.4	32.2	17.4	19.4
NR TDD n41	22.5	22.5	22.5	22.5	20.1	26.9	22.5

Notes:

- For all modes/bands, when Hotspot Mode (DSI=3) and Extremity sensor (DSI=1) are triggered at the same time, DSI=3 takes priority, thus the P_{limit} for DSI=1 is set to be less or equal to P_{limit} for DSI=3.
- For LTE Band 48, when RCV is active, DSI=2 takes priority over all levels.
- When $P_{max} < P_{limit}$, the DUT will operate at a power level up to P_{max} .
- P_{limit} for DSI=1 and DSI =4 are the same.
- CDMA BC10/CDMA BC1/LTE Band 14/LTE Band 26/LTE Band 48/LTE Band 41 PC2/ NR Band n5/NR Band n2 are not supported in Canada

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 8 of 10

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753E S	Network Analyzer	3/19/2019	Annual	3/19/2020	MY40001472
Agilent	8753E S	S Parameter Network Analyzer	8/26/2019	Annual	8/26/2020	MY40000670
Agilent	8753E S	S Parameter Vector Network Analyzer	9/19/2019	Annual	9/19/2020	MY40003841
Agilent	E4432B	ESG D Series Signal Generator	7/14/2019	Annual	7/14/2020	US40053896
Agilent	E4438C	ESG Vector Signal Generator	5/22/2019	Annual	5/22/2020	MY45091346
Agilent	E5515C	Wireless Communications Test Set	2/28/2018	Biennial	2/28/2020	GB41450275
Agilent	N4010.A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Agilent	N5182.A	MVG Vector Signal Generator	6/27/2019	Annual	6/27/2020	US46240505
Agilent	N9020.A	MXA Signal Analyzer	4/20/2019	Annual	4/20/2020	US46470561
Agilent	N9030.A	PXA Signal Analyzer (44GHz)	6/12/2019	Annual	6/12/2020	MY52350166
Amplifier Research	1551G6	Amplifier	CBT	N/A	CBT	343972
Amplifier Research	1551G6	Amplifier	N/A	N/A	CBT	343971
Anritsu	MA24106A	USB Power Sensor	8/5/2019	Annual	8/5/2020	1827527
Anritsu	MA24106A	USB Power Sensor	1/31/2019	Annual	1/31/2020	1244524
Anritsu	MA2411B	Pulse Power Sensor	3/6/2019	Annual	3/6/2020	1339018
Anritsu	MA2411B	Pulse Power Sensor	6/11/2019	Annual	6/11/2020	1207864
Anritsu	MT8820C	Radio Communication Analyzer	3/29/2019	Annual	3/29/2020	6201300731
Anritsu	MT8821C	Radio Communication Analyzer	1/25/2019	Annual	1/25/2020	6261895213
Anritsu	MT8821C	Radio Communication Analyzer	3/6/2019	Annual	3/6/2020	6201381794
Anritsu	MT8821C	Radio Communication Analyzer	5/13/2019	Annual	5/13/2020	6201524637
Anritsu	MT8821C	Radio Communication Analyzer	8/16/2019	Annual	8/16/2020	6201144418
Anritsu	MT8821C	Radio Communication Analyzer	10/2/2019	Annual	10/2/2020	6201664756
Anritsu	MT8862A	Wireless Connectivity Test Set	8/8/2019	Annual	8/8/2020	6261782395
Control Company	4040	Therm / Clock / Humidity Monitor	10/9/2018	Biennial	10/9/2020	181647811
Control Company	4040	Therm / Clock / Humidity Monitor	10/9/2018	Biennial	10/9/2020	181647802
Control Company	4040	Therm / Clock / Humidity Monitor	10/9/2018	Biennial	10/9/2020	181647812
Control Company	4352	Ultra Long Stem Thermometer	2/28/2018	Biennial	2/28/2020	170330360
Control Company	4352	Ultra Long Stem Thermometer	2/28/2018	Biennial	2/28/2020	170330358
Keysight	772D	Dual Directional Coupler	CBT	N/A	CBT	MY52180215
Keysight Technologies	8503BE	Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm)	7/2/2019	Annual	7/2/2020	MY53401181
Keysight Technologies	AT/N6705B	DC Power Supply	CBT	N/A	CBT	MY53001315
MCL	BW-N6W+	6dB Attenuator	CBT	N/A	CBT	1139
MiniCircuits	SLP-2400+	Low Pass Filter	CBT	N/A	CBT	8897950090.3
MiniCircuits	VLF-6000+	Low Pass Filter	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
Mitutoyo	CD-10CS3	Digital Caliper	4/18/2018	Biennial	4/18/2020	13264165
Narda	4014C-6	4 - 8 GHz SMA & B Bidirectional Coupler	CBT	N/A	CBT	N/A
Narda	4172-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Patersonck	NC 100	Torque Wrench	5/23/2018	Biennial	5/23/2020	N/A
Patersonck	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Patersonck	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	CMW500	Radio Communication Tester	4/15/2019	Annual	4/15/2020	167283
Rohde & Schwarz	CMW500	Radio Communication Tester	4/15/2019	Annual	4/15/2020	167284
Rohde & Schwarz	CMW500	Radio Communication Tester	4/16/2019	Annual	4/16/2020	167286
Rohde & Schwarz	CMW500	Radio Communication Tester	4/17/2019	Annual	4/17/2020	167285
Seekonk	NC 100	Torque Wrench	4/18/2018	Biennial	4/18/2020	N/A
Seekonk	NC 100	Torque Wrench (8" lb)	5/10/2018	Biennial	5/10/2020	21053
SPEAG	D1750V2	1750 MHz SAR Dipole	3/15/2019	Annual	3/15/2020	1148
SPEAG	D1750V2	1750 MHz SAR Dipole	10/22/2018	Biennial	10/22/2020	1150
SPEAG	D1760V2	1763 MHz SAR Dipole	5/23/2018	Biennial	5/23/2020	1008
SPEAG	D1900V2	1900 MHz SAR Dipole	10/23/2018	Biennial	10/23/2020	5d149
SPEAG	D1900V2	1900 MHz SAR Dipole	2/21/2019	Annual	2/21/2020	5d148
SPEAG	D1900V2	1900 MHz SAR Dipole	10/23/2018	Biennial	10/23/2020	5d380
SPEAG	D2300V2	2300 MHz SAR Dipole	8/13/2018	Biennial	8/13/2020	1073
SPEAG	D2450V2	2450 MHz SAR Dipole	9/11/2017	Triennial	9/11/2020	797
SPEAG	D2450V2	2450 MHz SAR Dipole	8/14/2019	Annual	8/14/2020	719
SPEAG	D2450V2	2450 MHz SAR Dipole	8/16/2018	Biennial	8/16/2020	981
SPEAG	D2600V2	2600 MHz SAR Dipole	4/11/2018	Biennial	4/11/2020	1004
SPEAG	D2600V2	2600 MHz SAR Dipole	6/14/2019	Annual	6/14/2020	1064
SPEAG	D3500V2	3500 MHz SAR Dipole	1/11/2018	Biennial	1/11/2020	1059
SPEAG	D3700V2	3700 MHz SAR Dipole	1/11/2018	Biennial	1/11/2020	1018
SPEAG	D500HV2	5 GHz SAR Dipole	9/17/2019	Annual	9/17/2020	1191
SPEAG	D750V3	750 MHz Dipole	3/18/2019	Annual	3/18/2020	1054
SPEAG	D750V3	750 MHz SAR Dipole	10/19/2018	Biennial	10/19/2020	1161
SPEAG	D835V2	835 MHz SAR Dipole	10/19/2018	Biennial	10/19/2020	4d133
SPEAG	D835V2	835 MHz SAR Dipole	3/13/2019	Annual	3/13/2020	4d047
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/17/2019	Annual	9/17/2020	1333
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/11/2019	Annual	7/11/2020	1322
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/14/2019	Annual	2/14/2020	1272
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/14/2019	Annual	8/14/2020	1450
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/8/2019	Annual	5/8/2020	728
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/13/2019	Annual	2/13/2020	665
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/18/2019	Annual	4/18/2020	1407
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/15/2019	Annual	1/15/2020	1530
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/11/2019	Annual	7/11/2020	1323
SPEAG	DAE4	Dasy Data Acquisition Electronics	6/20/2019	Annual	6/20/2020	1334
SPEAG	DAE4	Data Acquisition Electronics	12/5/2019	Annual	12/5/2020	1533
SPEAG	DAK 3.5	Dielectric Assembly Kit	10/22/2019	Annual	10/22/2020	1091
SPEAG	EX30V4	SAR Probe	9/19/2019	Annual	9/19/2020	7351
SPEAG	EX30V4	SAR Probe	7/16/2019	Annual	7/16/2020	7410
SPEAG	EX30V4	SAR Probe	2/19/2019	Annual	2/19/2020	3914
SPEAG	EX30V4	SAR Probe	8/16/2019	Annual	8/16/2020	7308
SPEAG	EX30V4	SAR Probe	8/16/2019	Annual	8/16/2020	7308
SPEAG	EX30V4	SAR Probe	5/16/2019	Annual	5/16/2020	7406
SPEAG	EX30V4	SAR Probe	2/19/2019	Annual	2/19/2020	7417
SPEAG	EX30V4	SAR Probe	4/24/2019	Annual	4/24/2020	7357
SPEAG	EX30V4	SAR Probe	1/24/2019	Annual	1/24/2020	7488
SPEAG	EX30V4	SAR Probe	12/11/2019	Annual	12/11/2020	7571
SPEAG	EX30V4	SAR Probe	7/15/2019	Annual	7/15/2020	7547
SPEAG	EX30V4	SAR Probe	6/19/2019	Annual	6/19/2020	7409

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.

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M1911140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 9 of 10

5

MEASUREMENT UNCERTAINTIES

a	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	Tol. (± %)	Prob. Dist.	Div.	c _i 1gm	c _i 10 gms	1gm u _i (± %)	10gms u _i (± %)	v _i
Measurement System								
Probe Calibration	6.55	N	1	1.0	1.0	6.6	6.6	∞
Axial Isotropy	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	1.3	N	1	0.7	0.7	0.9	0.9	∞
Boundary Effect	2.0	R	1.73	1.0	1.0	1.2	1.2	∞
Linearity	0.3	N	1	1.0	1.0	0.3	0.3	∞
System Detection Limits	0.25	R	1.73	1.0	1.0	0.1	0.1	∞
Readout Electronics	0.3	N	1	1.0	1.0	0.3	0.3	∞
Response Time	0.8	R	1.73	1.0	1.0	0.5	0.5	∞
Integration Time	2.6	R	1.73	1.0	1.0	1.5	1.5	∞
RF Ambient Conditions - Noise	3.0	R	1.73	1.0	1.0	1.7	1.7	∞
RF Ambient Conditions - Reflections	3.0	R	1.73	1.0	1.0	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.4	R	1.73	1.0	1.0	0.2	0.2	∞
Probe Positioning w/ respect to Phantom	6.7	R	1.73	1.0	1.0	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	4.0	R	1.73	1.0	1.0	2.3	2.3	∞
Test Sample Related								
Test Sample Positioning	2.7	N	1	1.0	1.0	2.7	2.7	35
Device Holder Uncertainty	1.67	N	1	1.0	1.0	1.7	1.7	5
Output Power Variation - SAR drift measurement	5.0	R	1.73	1.0	1.0	2.9	2.9	∞
SAR Scaling	0.0	R	1.73	1.0	1.0	0.0	0.0	∞
Phantom & Tissue Parameters								
Phantom Uncertainty (Shape & Thickness tolerances)	7.6	R	1.73	1.0	1.0	4.4	4.4	∞
Liquid Conductivity - measurement uncertainty	4.2	N	1	0.78	0.71	3.3	3.0	10
Liquid Permittivity - measurement uncertainty	4.1	N	1	0.23	0.26	1.0	1.1	10
Liquid Conductivity - Temperature Uncertainty	3.4	R	1.73	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Uncertainty	0.6	R	1.73	0.23	0.26	0.1	0.1	∞
Liquid Conductivity - deviation from target values	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Permittivity - deviation from target values	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Combined Standard Uncertainty (k=1)	RSS					11.5	11.3	60
Expanded Uncertainty (95% CONFIDENCE LEVEL)	k=2					23.0	22.6	

FCC ID: A3L.SMG988U IC: 649E-SMG988U	 PCTEST PART 0 SAR CHARACTERIZATION REPORT		Approved by: Quality Manager
Document S/N: 1M191140187-28-R1.A3L	Test Dates: 11/18/19 – 01/23/20	DUT Type: Portable Handset	Page 10 of 10