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NEAR-FIELD POWER DENSITY EVALUATION REPORT

Applicant Name
 Sony Mobile Communications., Inc.
 4-12-3 Higashi-Shinagawa
 Shinagawa-ku
 Tokyo, 140-0002, Japan

Date of Testing
 08/05/2020 - 08/15/2020
Test Site/Location
 PCTEST, Columbia, MD, USA
Document Serial No:
 1M2007070106-01-R1.PY7


FCC ID:	PY7-57441Y
APPLICANT:	SONY MOBILE COMMUNICATIONS., INC.

DUT Type: Portable Handset
Application Type: Certification
FCC Rule Part(s): CFR §2.1093

Band & Mode	Tx Frequency	Measured psPD	Reported psPD
	MHz	mW/cm ²	mW/cm ²
5G NR - n261	27500 - 28350	0.468	0.750
5G NR - n260	37000 - 40000	0.476	0.750
Total Exposure Ratio		0.999	
Verdict		PASS	

Note: This revised Test Report (S/N: 1M2007070106-01-R1.PY7) 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: PY7-57441Y	 NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 1 of 25

TABLE OF CONTENTS

1	DEVICE UNDER TEST	3
1.1	Device Overview	3
1.2	Time-Averaging Algorithm for RF Exposure Compliance	3
1.3	Input Power Specifications	4
1.4	DUT Antenna Locations	12
1.5	Simultaneous Transmission Capabilities	13
1.6	Guidance Applied	13
1.7	Bibliography	13
2	MEASUREMENT SYSTEM	14
2.1	Measurement Setup	14
2.2	SPEAG EUmmWV3 Probe / E-Field 5G Probe	14
2.3	Peak Spatially Averaged Power Density Assessment Based on E-field Measurements	15
2.4	Reconstruction Algorithm	15
3	RF EXPOSURE LIMITS FOR POWER DENSITY	16
3.1	Uncontrolled Environment	16
3.2	Controlled Environment	16
3.3	RF Exposure Limits for Frequencies Above 6 GHz	16
4	SYSTEM VERIFICATION	17
4.1	Test System Verification	17
5	POWER DENSITY DATA @ INPUT.POWER.LIMIT	19
5.1	Power Density Results	19
5.2	Power Density Test Notes	21
6	EQUIPMENT LIST	22
7	MEASUREMENT UNCERTAINTIES	23
8	CONCLUSION	24
8.1	Measurement Conclusion	24
9	REFERENCES	25



APPENDIX A: POWER DENSITY TEST PLOTS

APPENDIX B: SYSTEM VERIFICATION PLOTS

APPENDIX C: TOTAL EXPOSURE RATIO

APPENDIX D: DUT ANTENNA DIAGRAM AND TEST SETUP PHOTOGRAPHS

APPENDIX E: PROBE AND VERIFICATION SOURCE CALIBRATION CERTIFICATES

FCC ID: PY7-57441Y	 <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 2 of 25	

1 DEVICE UNDER TEST

1.1 Device Overview

NR FR2 Operations Information						
Form Factor	Portable Handset					
Channel Bandwidths per NR Band	NR Band n261: 50MHz, 100MHz					
Channel Bandwidths per NR Band	NR Band n260: 50MHz, 100MHz					
Channel Numbers and Frequencies	Low		Mid		High	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
NR Band n261: 50MHz BW	2071249	27525.00	2077915	27924.96	2084581	28324.92
NR Band n261: 100MHz BW	2071665	27549.96	2077915	27924.96	2084165	28299.96
NR Band n260: 50MHz BW	2229599	37026.00	2254165	38499.96	2278749	39975.00
NR Band n260: 100MHz BW	2229999	37050.00	2254165	38499.96	2278315	39949.00
Subcarrier Spacing (kHz)	120					
Total Number of Supported Uplink CCs (SISO)	2					
Total Number of Supported Uplink CCs (MIMO)	2 (CP-OFDM Only)					
Total Number of Supported DL CCs	8					
CP-OFDM Modulations Supported in UL	QPSK, 16QAM, 64QAM					
DFT-s-OFDM Modulations Supported in UL	PI/2 BPSK, QPSK, 16QAM, 64QAM					
LTE Anchor Bands (n261)	2, 4, 5, 13, 48, 66					
LTE Anchor Bands (n260)	2, 4, 5, 13, 48, 66					
Duplex Type (mmWave)	TDD					




1.2 Time-Averaging Algorithm for RF Exposure Compliance

The equipment under test (EUT) contains Qualcomm® SDX55M modem supporting 2G/3G/4G/5G NR WWAN 5G technologies and is enabled with Qualcomm® Smart Transmit feature. This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure is in compliance with FCC requirements all the time. Refer to Compliance Summary document for detailed description of Qualcomm® Smart Transmit. Note that WLAN operations are not enabled with Smart Transmit.

The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of *SAR_design_target* or *PD_design_target*, below the predefined time-averaged power limit (i.e., P_{limit} for sub-6 radio, and *input.power.limit* for 5G mmW NR), for each characterized technology and band (see RF Exposure Part 0 Test Report).

Smart Transmit allows the device to transmit at higher power instantaneously when needed, but manages power limiting to maintain time-averaged transmit power to *input.power.limit*.

The purpose of this report (Part 1 test) is to demonstrate that the EUT meets FCC PD limits when transmitting in static transmission scenario at maximum allowable time-averaged power level given by *input.power.limit*.

FCC ID: PY7-57441Y	 PCTEST Proud to be part of 	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 3 of 25	

1.3 Input Power Specifications

All power density measurements for this device were performed at the *input.power.limit* given in below tables. Input power is per antenna element and polarization for each antenna module. When input.power.limit is calculated to be above the maximum input power, the device is limited to the maximum input power.

**Table 1-1
5G mmWave NR n261 ANT#0 patch**

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	1	-	9.8
n261	7	-	7.1
n261	8	-	7.0
n261	9	-	7.2
n261	18	-	7.1
n261	19	-	6.8
n261	29	-	4.3
n261	30	-	4.1
n261	31	-	3.8
n261	32	-	4.9
n261	33	-	5.7
n261	48	-	4.2
n261	49	-	4.0
n261	50	-	4.1
n261	51	-	5.4
n261	-	129	10.0
n261	-	135	6.2
n261	-	136	6.6
n261	-	137	7.2
n261	-	146	6.6
n261	-	147	7.0
n261	-	157	3.9
n261	-	158	4.0
n261	-	159	4.0
n261	-	160	5.0
n261	-	161	4.0
n261	-	176	4.2
n261	-	177	4.0
n261	-	178	4.1
n261	-	179	4.4
n261	1	129	4.8
n261	7	135	3.2
n261	8	136	2.1
n261	9	137	2.2
n261	18	146	1.8
n261	19	147	2.2
n261	29	157	-0.8
n261	30	158	-1.2
n261	31	159	-0.8
n261	32	160	0.4
n261	33	161	-0.2
n261	48	176	-0.7
n261	49	177	-0.9
n261	50	178	0.2
n261	51	179	-0.1



FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 4 of 25	


Table 1-2
5G mmWave NR n261 ANT#1 patch

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	0	-	9.8
n261	4	-	7.4
n261	5	-	7.1
n261	6	-	6.9
n261	16	-	7.1
n261	17	-	6.7
n261	24	-	5.1
n261	25	-	4.1
n261	26	-	3.9
n261	27	-	4.4
n261	28	-	5.6
n261	44	-	4.3
n261	45	-	4.1
n261	46	-	3.7
n261	47	-	4.8
n261	-	128	9.9
n261	-	132	7.2
n261	-	133	7.0
n261	-	134	7.1
n261	-	144	7.4
n261	-	145	6.9
n261	-	155	4.2
n261	-	154	3.9
n261	-	153	4.4
n261	-	156	4.0
n261	-	152	4.2
n261	-	174	4.1
n261	-	173	4.0
n261	-	175	4.1
n261	-	172	4.8
n261	0	128	4.8
n261	4	134	4.6
n261	5	133	4.7
n261	6	132	5.0
n261	16	144	4.5
n261	17	145	3.9
n261	24	155	-0.5
n261	25	154	-1.2
n261	26	153	-0.4
n261	27	156	-0.4
n261	28	152	0.0
n261	44	174	-0.8
n261	45	173	-0.5
n261	46	175	-0.6
n261	47	172	0.1

FCC ID: PY7-57441Y	 PCTEST <small>Provided to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 5 of 25	

**Table 1-3
5G mmWave NR n261 ANT#2 patch**

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	3	-	8.5
n261	13	-	6.7
n261	14	-	5.1
n261	15	-	6.8
n261	22	-	6.7
n261	23	-	6.8
n261	39	-	4.4
n261	40	-	3.7
n261	41	-	3.6
n261	42	-	4.4
n261	43	-	4.7
n261	56	-	3.8
n261	57	-	3.7
n261	58	-	3.8
n261	59	-	4.8
n261	-	131	9.3
n261	-	141	7.0
n261	-	142	6.0
n261	-	143	6.6
n261	-	150	6.5
n261	-	151	5.9
n261	-	168	3.5
n261	-	169	3.3
n261	-	167	3.7
n261	-	170	3.5
n261	-	171	3.7
n261	-	185	4.0
n261	-	186	3.6
n261	-	184	3.5
n261	-	187	3.7
n261	3	131	5.1
n261	13	141	4.7
n261	14	142	3.5
n261	15	143	4.8
n261	22	150	4.9
n261	23	151	2.9
n261	39	168	-1.6
n261	40	169	-1.1
n261	41	167	-0.9
n261	42	170	-1.4
n261	43	171	-0.9
n261	56	185	-1.3
n261	57	186	-1.8
n261	58	184	-1.6
n261	59	187	-0.9

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 6 of 25	

**Table 1-4
5G mmWave NR n261 ANT#3 patch**

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	2	-	10.4
n261	10	-	7.1
n261	11	-	8.8
n261	12	-	8.9
n261	20	-	9.4
n261	21	-	8.8
n261	34	-	6.4
n261	35	-	5.6
n261	36	-	5.9
n261	37	-	7.2
n261	38	-	6.5
n261	52	-	5.8
n261	53	-	5.8
n261	54	-	6.1
n261	55	-	7.0
n261	-	130	9.5
n261	-	138	7.9
n261	-	139	8.1
n261	-	140	8.5
n261	-	148	8.0
n261	-	149	8.5
n261	-	162	5.3
n261	-	163	4.9
n261	-	164	5.0
n261	-	165	5.7
n261	-	166	5.5
n261	-	180	5.2
n261	-	181	5.1
n261	-	182	6.8
n261	-	183	5.4
n261	2	130	5.4
n261	10	138	2.4
n261	11	139	2.9
n261	12	140	3.5
n261	20	148	3.2
n261	21	149	3.0
n261	34	162	0.5
n261	35	163	-0.6
n261	36	164	1.1
n261	37	165	0.8
n261	38	166	0.2
n261	52	180	0.0
n261	53	181	-0.1
n261	54	182	1.4
n261	55	183	0.5


FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 7 of 25	

Table 1-5
5G mmWave NR n260 ANT#0 patch

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	1	-	8.2
n260	7	-	6.0
n260	8	-	6.6
n260	9	-	6.5
n260	18	-	6.4
n260	19	-	6.2
n260	29	-	3.8
n260	30	-	3.5
n260	31	-	3.0
n260	32	-	3.6
n260	33	-	3.4
n260	48	-	3.5
n260	49	-	3.4
n260	50	-	3.2
n260	51	-	3.8
n260	-	129	9.0
n260	-	135	6.1
n260	-	136	5.6
n260	-	137	6.3
n260	-	146	6.2
n260	-	147	5.8
n260	-	160	3.5
n260	-	159	3.2
n260	-	158	3.0
n260	-	157	3.3
n260	-	161	3.4
n260	-	178	3.7
n260	-	177	3.3
n260	-	176	3.1
n260	-	179	3.5
n260	1	129	3.6
n260	7	137	0.8
n260	8	136	0.7
n260	9	135	0.8
n260	18	147	0.6
n260	19	146	1.0
n260	29	160	-1.6
n260	30	159	-1.8
n260	31	158	-2.3
n260	32	157	-2.2
n260	33	161	-2.2
n260	48	178	-2.0
n260	49	177	-2.0
n260	50	176	-2.4
n260	51	179	-2.2


FCC ID: PY7-57441Y	 PCTEST <small>Provided to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 8 of 25

Table 1-6
5G mmWave NR n260 ANT#1 patch

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	0	-	9.4
n260	4	-	6.0
n260	5	-	6.4
n260	6	-	6.5
n260	16	-	7.0
n260	17	-	6.9
n260	24	-	4.0
n260	25	-	3.9
n260	26	-	3.4
n260	27	-	3.5
n260	28	-	3.7
n260	44	-	4.2
n260	45	-	3.7
n260	46	-	3.4
n260	47	-	3.6
n260	-	128	9.3
n260	-	132	6.1
n260	-	133	6.0
n260	-	134	5.9
n260	-	144	5.9
n260	-	145	6.5
n260	-	152	3.8
n260	-	153	3.9
n260	-	154	3.6
n260	-	155	3.3
n260	-	156	3.7
n260	-	172	3.7
n260	-	173	4.1
n260	-	174	3.4
n260	-	175	3.4
n260	0	128	3.9
n260	4	132	0.9
n260	5	133	0.9
n260	6	134	1.2
n260	16	145	1.1
n260	17	144	1.0
n260	24	152	-1.7
n260	25	153	-2.0
n260	26	154	-2.0
n260	27	155	-1.9
n260	28	156	-1.8
n260	44	172	-1.7
n260	45	173	-1.5
n260	46	174	-2.1
n260	47	175	-2.1


FCC ID: PY7-57441Y	 PCTEST <small>Provided to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 9 of 25	

Table 1-7
5G mmWave NR n260 ANT#2 patch

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	3	-	8.2
n260	13	-	6.3
n260	14	-	6.0
n260	15	-	6.0
n260	22	-	6.3
n260	23	-	6.8
n260	39	-	3.7
n260	40	-	3.4
n260	41	-	3.6
n260	42	-	3.0
n260	43	-	3.8
n260	56	-	3.5
n260	57	-	3.3
n260	58	-	3.3
n260	59	-	4.2
n260	-	131	8.2
n260	-	141	6.1
n260	-	142	6.1
n260	-	143	5.5
n260	-	150	5.8
n260	-	151	5.6
n260	-	170	4.0
n260	-	169	4.1
n260	-	168	3.4
n260	-	167	4.1
n260	-	171	4.0
n260	-	186	4.0
n260	-	185	3.8
n260	-	184	3.5
n260	-	187	4.0
n260	3	131	3.7
n260	13	142	1.0
n260	14	143	0.9
n260	15	141	1.1
n260	22	150	1.2
n260	23	151	0.7
n260	39	170	-1.9
n260	40	169	-1.9
n260	41	168	-1.7
n260	42	167	-2.3
n260	43	171	-1.8
n260	56	186	-1.4
n260	57	185	-2.1
n260	58	184	-1.9
n260	59	187	-2.0



FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 10 of 25

Table 1-8
5G mmWave NR n260 ANT#3 patch

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	2	-	9.7
n260	10	-	7.9
n260	11	-	6.7
n260	12	-	7.0
n260	20	-	6.9
n260	21	-	6.8
n260	34	-	4.0
n260	35	-	3.7
n260	36	-	5.3
n260	37	-	3.9
n260	38	-	4.3
n260	52	-	3.8
n260	53	-	4.6
n260	54	-	4.9
n260	55	-	4.1
n260	-	130	10.0
n260	-	138	7.5
n260	-	139	7.0
n260	-	140	7.7
n260	-	148	7.7
n260	-	149	7.9
n260	-	162	4.7
n260	-	163	4.0
n260	-	164	4.9
n260	-	165	4.8
n260	-	166	4.5
n260	-	180	4.3
n260	-	181	4.7
n260	-	183	4.9
n260	-	182	4.5
n260	2	130	4.6
n260	10	138	1.8
n260	11	139	1.6
n260	12	140	3.3
n260	20	148	1.7
n260	21	149	2.4
n260	34	162	-1.4
n260	35	163	-1.2
n260	36	164	-0.5
n260	37	165	-0.6
n260	38	166	-0.9
n260	52	180	-1.3
n260	53	181	-0.7
n260	54	183	0.3
n260	55	182	-0.6


FCC ID: PY7-57441Y	 PCTEST <small>Provided to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 11 of 25

1.4 DUT Antenna Locations

The table below indicates the surfaces evaluated for near field power density (part 1) evaluation. Refer to RF Exposure Part 0 Test Report for justification of these worst-surfaces.

**Table 1-9
Device Surfaces**

Band	Antenna	Antenna Type	Back	Front	Top	Bottom	Right	Left
n261	ANT#0	patch	Yes	Yes	No	No	No	Yes
n261	ANT#1	patch	Yes	Yes	No	No	Yes	No
n261	ANT#2	patch	Yes	Yes	Yes	No	Yes	No
n261	ANT#3	patch	Yes	Yes	No	Yes	Yes	No
n260	ANT#0	patch	Yes	Yes	No	No	No	Yes
n260	ANT#1	patch	Yes	Yes	No	No	Yes	No
n260	ANT#2	patch	Yes	Yes	Yes	No	Yes	No
n260	ANT#3	patch	Yes	Yes	No	Yes	Yes	No

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 12 of 25	

1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v06, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v06 4.3.2 procedures.

**Table 1-10
Simultaneous Tx**

Capable Transmit Configuration	Head	Body-worn	Wireless Router	Phablet	Notes
LTE + 5G NR	Yes	Yes	N/A	Yes	
LTE + 5 GHz WI-FI + 5G NR	Yes	Yes	N/A	Yes	
LTE + 2.4 GHz WI-FI + 5G NR	Yes	Yes	Yes	Yes	
LTE + 2.4 GHz WI-FI MIMO + 5G NR	Yes	Yes	Yes	Yes	
LTE + 5 GHz WI-FI MIMO + 5G NR	Yes	Yes	N/A	Yes	
LTE + 2.4 GHz WI-FI MIMO+ 5 GHz WI-FI MIMO+ 5G NR	Yes	Yes	N/A	Yes	
LTE + 2.4 GHz Bluetooth + 5G NR	Yes^	Yes	Yes^	Yes	^Bluetooth Tethering is considered
LTE + 2.4 GHz Bluetooth + 5 GHz WI-FI + 5G NR	Yes^	Yes	N/A	Yes	^Bluetooth Tethering is considered
LTE + 2.4 GHz Bluetooth + 5 GHz WI-FI MIMO + 5G NR	Yes^	Yes	N/A	Yes	^Bluetooth Tethering is considered

NOTE:

- 5G NR Operations are limited to Non-Standalone (EN-DC) operations only.
- NR antenna arrays cannot transmit simultaneously.
- LTE + 5G NR FR2 Scenarios are limited to EN-DC combinations with anchor bands as shown in the NR FR2 checklist.
- 2.4 GHz WLAN, and 2.4 GHz Bluetooth share the same antenna path and cannot transmit simultaneously.
- All non-5G NR licensed modes share the same antenna path and cannot transmit simultaneously.
- 5G NR bands cannot transmit simultaneously.
- This device supports time averaging smart transmit algorithm in WWAN. Smart transmit adds directly the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G mmW NR to ensure that the normalized RF exposure from both 4G and 5G mmW NR does not exceed FCC limit.


1.6 Guidance Applied

- November 2017, October 2018, April 2019, November 2019 TCBC Workshop Notes
- SPEAG DASY6 System Handbook (September 2019)
- IEC TR 63170:2018
- FCC KDB 865664 D02 v01r04
- FCC KDB 447498 D01 v02r01

1.7 Bibliography

**Table 1-11
Bibliography**

Report Type	Report Serial Number
FCC SAR Evaluation Report (Part 1)	1M2007070106-04-R1.PY7
Power Density Part 0 Test Report	Revision B
RF Exposure Part 2 Test Report	1M2007070106-02.PY7
RF Exposure Compliance Summary Report	1M2007070106-03.PY7
Power Density Simulation Report	Revision B

FCC ID: PY7-57441Y	 PCTEST <small>Provided to be part of a document</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 13 of 25

2

MEASUREMENT SYSTEM

2.1 Measurement Setup

Peak spatially averaged power density (psPD) measurements for mmWave frequencies were performed using the DASY6 with cDASY6 5G module. The DASY6 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the 5G phantom. The robot is a six-axis industrial robot, performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF).

2.2 SPEAG EUmWV3 Probe / E-Field 5G Probe

The EUmWV3 probe consists of two dipoles optimally arranged to obtain pseudo-vector information.

Frequency Range	750 MHz – 110 GHz
Dynamic Range	< 20 V/m – 10,000 V/m with PRE-10 (min < 50 V/m – 3,000 V/m)
Position Precision	< 0.2 mm (cDASY6)
Dimensions	Probe Overall Length: 320 mm Probe Body Diameter: 8 mm Probe Tip Length: 23 mm Probe Tip Diameter: Encapsulation 8 mm Distance from Probe Tip to Sensor X Calibration Point: 1.5 mm Distance from Probe Tip to Sensor Y Calibration Point: 1.5 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10 GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction
Compatibility	cDASY6 + 5G-Module SW 2.0.2.34

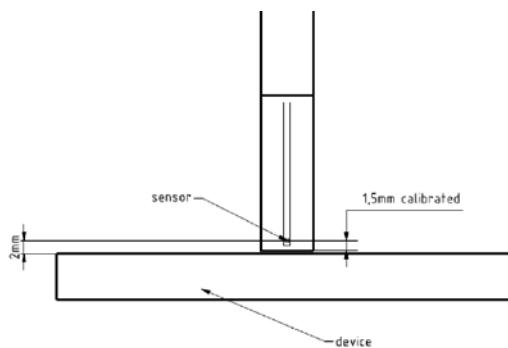





Figure 2-1
EUmWV3 Probe

FCC ID: PY7-57441Y	 PCTEST Proud to be part of 	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 14 of 25

2.3 Peak Spatially Averaged Power Density Assessment Based on E-field Measurements

Within a short distance from the transmitting source, power density was determined based on both electric and magnetic fields. Generally, the magnitude and phase of two components of either the E-field or H-field were needed on a sufficiently large surface to fully characterize the total E-field and H-field distributions. Nevertheless, solutions based on direct measurement of E-field and H-field can be used to compute power density. The general measurement approach used for this device was:


- a) The local E field on the measurement surface was measured at a reference location where the field is well above the noise level. This reference level was used at the end of this procedure to assess output power drift of the DUT during the measurement.
- b) The electric field on the measurement surface was scanned. Measurements are conducted according to the instructions provided by the measurement system manufacturer. Measurement spatial resolution can depend on the measured field characteristic and measurement methodology used by the system. The planar scan step size was configured at $\lambda/4$.
- c) For cDASY6, H-field was calculated from the measured E-field using a reconstruction algorithm. As the power density calculation requires knowledge of both amplitude and phase, reconstruction algorithms can also be used to obtain field information from the measured E-field data (e.g. the phase from the amplitude if only the amplitude is measured). H-field and phase data was reconstructed from repeated measurements (three per measurement point) on two measurement planes separated by $\lambda/4$.
- d) The total Peak spatially averaged power density (psPD) distribution on the evaluation surface is determined per the below equation. The spatial averaging area, A , is specified by the applicable exposure limits or regulatory requirements. A circular shape was used.

$$psPD = \frac{1}{2A_{av}} \iint_{A_{av}} || Re\{E \times H^*\} || dA$$

- e) The maximum spatial-average on the evaluation surface is the final quantity to determine compliance against applicable limits.
- f) The local E field reference value, at the same location as step 2, was re-measured after the scan was complete to calculate the power drift. If the drift deviated by more than 5%, the power density test and drift measurements were repeated.

2.4 Reconstruction Algorithm

Computation of the power density in general requires measurement information from the both E-field and H-field amplitudes and phases in the plane of incidence. Reconstruction of these quantities from pseudo-vector E-field measurements is feasible according to the manufacturer, as they are determined via Maxwell's equations. As such, the SPEAG reconstruction approach was based on the Gerchberg-Saxton algorithm, which benefits from the availability of the E-field polarization ellipse information obtained with the EUmmWV3 probe.

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 15 of 25

3.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

3.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

3.3 RF Exposure Limits for Frequencies Above 6 GHz




Per §1.1310 (d)(3), the MPE limits are applied for frequencies above 6 GHz. Power Density is expressed in units of W/m^2 or mW/cm^2 .

Peak Spatially Averaged Power Density was evaluated over a circular area of 4 cm^2 per interim FCC Guidance for near-field power density evaluations per October 2018 TCB Workshop notes.

**Table 3-1
Human Exposure Limits Specified in FCC 47 CFR §1.1310**

Human Exposure to Radiofrequency (RF) Radiation Limits		
Frequency Range [MHz]	Power Density [mW/cm ²]	Average Time [Minutes]
(A) Limits For Occupational / Controlled Environments		
1,500 – 100,000	5.0	6
(B) Limits For General Population / Uncontrolled Environments		
1,500 – 100,000	1.0	30

Note: 1.0 mW/cm^2 is 10 W/m^2

FCC ID: PY7-57441Y	 PCTEST Proud to be part of 	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 16 of 25	

4

SYSTEM VERIFICATION

4.1 Test System Verification

The system was verified to be within ± 0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.

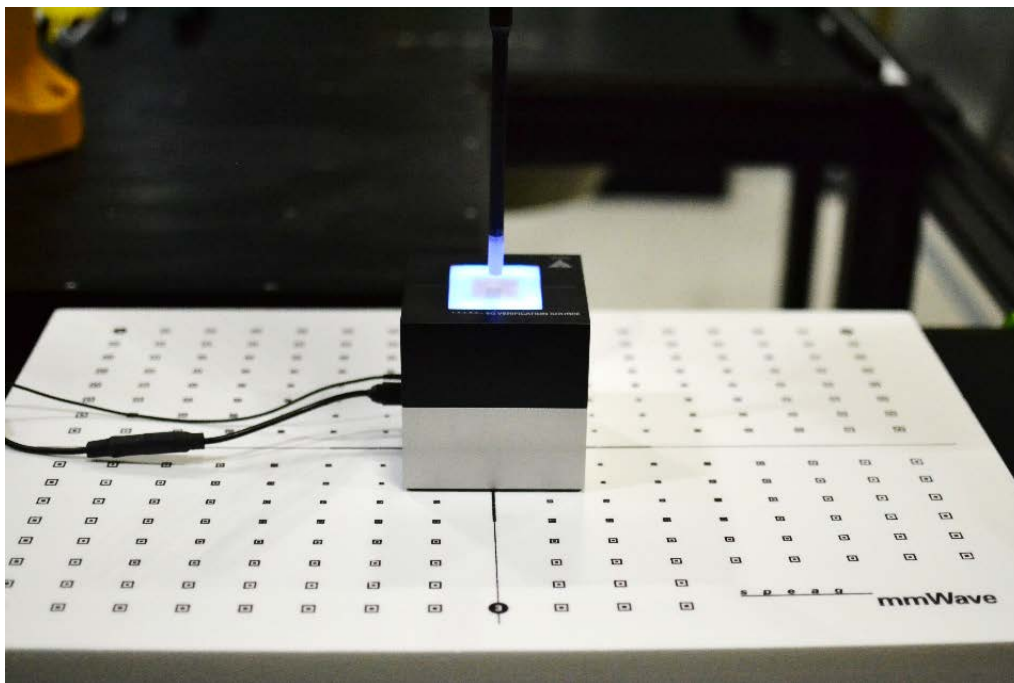





Figure 4-1
System Verification Setup Photo

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	 SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 17 of 25	

**Table 4-1
30 GHz Verifications**

System	Frequency	Date	Source S/N	Probe S/N	Normal psPD (W/m ² over 4 cm ²)		Deviation (dB)	Total psPD (W/m ² over 4 cm ²)		Deviation (dB)
					Measured	Target		Measured	Target	
Q	30	08/05/20	1035	9415	27.80	32.10	-0.62	28.30	32.50	-0.61
Q	30	08/06/20	1035	9415	28.20	32.10	-0.47	28.70	32.50	-0.56
Q	30	08/07/20	1035	9415	27.80	32.10	-0.62	28.20	32.50	-0.62
Q	30	08/10/20	1035	9415	27.90	32.10	-0.55	28.30	32.50	-0.61
Q	30	08/11/20	1035	9415	27.70	32.10	-0.56	28.00	32.50	-0.64
Q	30	08/12/20	1035	9415	27.80	32.10	-0.61	28.20	32.50	-0.62
Q	30	08/13/20	1035	9415	28.10	32.10	-0.58	28.50	32.50	-0.58
Q	30	08/15/20	1035	9415	28.10	32.10	-0.56	28.60	32.50	-0.58

Note: A **10 mm distance spacing** was used from the reference horn antenna aperture to the probe element. This includes 4.45 mm from the reference antenna horn aperture to the surface of the verification source plus 5.55 mm from the surface to the probe. The SPEAG software requires a setting of "5.55 mm" for the correct set up.

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 18 of 25	

5



POWER DENSITY DATA @ INPUT.POWER.LIMIT

5.1 Power Density Results

Power density measurements were performed with DUT transmitting at *input.power.limit* for one single beam for each polarization (H & V) and one beam-pair, for each antenna on each worst-surface.


Table 5-1
5G mmWave NR Band n261

MEASUREMENT RESULTS															
Band	Module	Antenna Type	Frequency	Channel	Beam ID 1	Beam ID 2	input.power.limit	Signal Type	DUT S/N	Power Drift	Distance	DUT Surface	Normal psPD	Total psPD	Plot #
			MHz		V	H	dBm			dB			mm	mW/cm ²	
n261	ANT#0	patch	27549.96	Low	31	-	3.8	CW	QV7100BX49	-0.04	2	Left	0.397	0.463	A1
n261	ANT#0	patch	27549.96	Low	-	157	3.9	CW	QV7100BX49	0.04	2	Left	0.254	0.344	
n261	ANT#0	patch	27549.96	Low	30	158	-1.2	CW	QV7100BX49	-0.04	2	Left	0.146	0.175	
n261	ANT#1	patch	27549.96	Low	46	-	3.7	CW	QV7100BX49	-0.20	2	Right	0.366	0.430	A2
n261	ANT#1	patch	27549.96	Low	-	154	3.9	CW	QV7100BX49	0.00	2	Right	0.359	0.426	
n261	ANT#1	patch	27549.96	Low	25	154	-1.2	CW	QV7100BX49	-0.06	2	Right	0.118	0.133	
n261	ANT#2	patch	27549.96	Low	41	-	3.6	CW	QV7100BX49	-0.14	2	Top	0.377	0.452	A3
n261	ANT#2	patch	27549.96	Low	-	169	3.3	CW	QV7100BX49	0.05	2	Top	0.321	0.387	
n261	ANT#2	patch	27549.96	Low	57	186	-1.8	CW	QV7100BX49	-0.03	2	Top	0.167	0.182	
n261	ANT#3	patch	27549.96	Low	35	-	5.6	CW	QV7100BX49	-0.03	2	Bottom	0.376	0.468	A4
n261	ANT#3	patch	27549.96	Low	-	163	4.9	CW	QV7100BX49	0.19	2	Bottom	0.369	0.445	
n261	ANT#3	patch	27924.96	Mid	35	163	-0.6	CW	QV7100BX49	-0.04	2	Bottom	0.180	0.203	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population									Power Density 1 mW/cm ² averaged over 4 cm ²						

FCC ID: PY7-57441Y	 PCTEST Proud to be part of Element	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 19 of 25	

**Table 5-2
5G mmWave NR Band n260**



MEASUREMENT RESULTS																
Band	Module	Antenna Type	Frequency	Channel	Beam ID	Beam ID	input.power.limit	Signal Type	DUT S/N	Power Drift	Distance	DUT Surface	Normal psPD	Total psPD	Plot #	
					1	2							mW/cm ²	mW/cm ²		
			MHz	V		H	dBm		dB	mm			mW/cm ²	mW/cm ²		
n260	ANT#0	patch	38499.96	Mid	31	-	3.0	CW	QV7100BX49	-0.20	2	Left	0.368	0.455		
n260	ANT#0	patch	38499.96	Mid	-	158	3.0	CW	QV7100BX49	-0.05	2	Left	0.370	0.462	A5	
n260	ANT#0	patch	38499.96	Mid	50	176	-2.4	CW	QV7100BX49	-0.20	2	Left	0.082	0.113		
n260	ANT#1	patch	38499.96	Mid	26	-	3.4	CW	QV7100BX49	0.01	2	Right	0.360	0.441	A6	
n260	ANT#1	patch	38499.96	Mid	-	155	3.3	CW	QV7100BX49	0.10	2	Right	0.341	0.430		
n260	ANT#1	patch	38499.96	Mid	46	174	-2.1	CW	QV7100BX49	-0.05	2	Right	0.125	0.156		
n260	ANT#2	patch	39949.00	High	42	-	3.0	CW	QV7100BX49	-0.08	2	Top	0.316	0.410		
n260	ANT#2	patch	39949.00	High	-	168	3.4	CW	QV7100BX49	-0.16	2	Top	0.399	0.476	A7	
n260	ANT#2	patch	39949.00	High	42	167	-2.3	CW	QV7100BX49	-0.05	2	Top	0.104	0.135		
n260	ANT#3	patch	38499.96	Mid	34	-	4.0	CW	QV7100BX49	0.03	2	Back	0.317	0.369		
n260	ANT#3	patch	37050.00	Low	35	-	3.7	CW	QV7100BX49	0.00	2	Bottom	0.314	0.377	A8	
n260	ANT#3	patch	39949.00	High	-	164	4.9	CW	QV7100BX49	0.00	2	Back	0.248	0.296		
n260	ANT#3	patch	37050.00	Low	-	163	4.0	CW	QV7100BX49	-0.02	2	Bottom	0.247	0.309		
n260	ANT#3	patch	38499.96	Mid	38	166	-0.9	CW	QV7100BX49	0.08	2	Back	0.095	0.105		
n260	ANT#3	patch	37050.00	Low	34	162	-1.4	CW	QV7100BX49	0.01	2	Bottom	0.123	0.141		
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population									Power Density 1 mW/cm ² averaged over 4 cm ²							

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 20 of 25	

5.2 Power Density Test Notes

General Notes:

1. The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
2. Batteries are fully charged at the beginning of the measurements. The DUT was connected to a wall charger for some measurements due to the test duration. It was confirmed that the charger plugged into this DUT did not impact the near-field PD test results.
3. Power density was calculated by repeated E-field measurements on two measurement planes separated by $\lambda/4$.
4. DUT was configured to transmit with a manufacturer provided test software to control specific antenna(s), Beam ID(s), and signal type to ensure the test configurations constant for the entire evaluation.
5. This device utilizes power reduction for some WLAN wireless modes and technologies for simultaneous transmission compliance. These mechanisms are assessed in the SAR Test Report.
6. *PD_design_target* of 0.6166 mW/cm² was used with mmW device design related uncertainty of 2.1 dB.
7. *Input.power.limit* parameter for 5G mmW NR radio was calculated in RF Exposure Part 0 test report.
8. This device is enabled with Qualcomm® Smart Transmit feature to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from WWAN is in compliance with FCC requirements. Per FCC guidance for devices enabled with Qualcomm® Smart Transmit feature, 4G LTE and 5G mmW NR simultaneous transmission scenario does not need to be evaluated under Total Exposure Ratio (TER). The validation of the time-averaging algorithm and compliance under the Tx varying transmission scenario for WWAN technologies are reported in Part 2 report.
9. Per FCC guidance for devices enabled with Qualcomm® Smart Transmit feature, simultaneous transmission analysis is evaluated by combining the exposure from each WWAN and WLAN antenna. 5G mmW NR and WLAN simultaneous transmission scenario is evaluated under the Total Exposure Ratio (TER) in Appendix C.
10. The Beam IDs with one of the highest initial simulated power density for that surface and distance was selected for Part 1 Power Density measurements.
11. The device was configured to transmit CW wave signal for testing. Per FCC guidance for devices enabled with Qualcomm® Smart Transmit feature, additional testing was not required for different modulations (CP-OFDM: QPSK, 16QAM, 64QAM, DFT-s-OFDM: PI/2 BPSK, QPSK, 16QAM, 64QAM), RB configurations, component carriers, channel configurations (low channel, mid channel, high channel) since the smart transmit algorithm monitors powers on a per symbol basis, which is independent of these signal characteristics.
12. The device was configured to MIMO configuration with H and V polarization beams transmitting together.


FCC ID: PY7-57441Y	 NEAR-FIELD POWER DENSITY EVALUATION REPORT 		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 21 of 25

**Table 6-1
5G mmWave NR Equipment List**

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	WL25-1	Conducted Cable Set (25GHz)	10/30/19	Annual	10/30/20	WL25-1
-	WL40-1	Conducted Cable Set (40GHz)	10/30/19	Annual	10/30/20	WL40-1
Emco	3116	Horn Antenna (18 - 40GHz)	06/07/18	Triennial	06/07/21	9203-2178
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	09/23/19	Annual	09/23/20	100348
SPEAG	EUmmWV3	EUmmWV3 Probe	02/14/20	Annual	02/14/21	9415
SPEAG	SM 003 100 AA	30GHz System Verification Ka- Band Source Antenna	02/12/20	Annual	02/12/21	1035
SPEAG	DAE4	Dasy Data Acquisition Electronics	03/12/20	Annual	03/12/21	1415
Rohde & Schwarz	180-442-KF	Horn (Small)	08/21/18	Biennial	08/21/20	U157403-01
Virginia Diodes Inc	SAX252	Spectrum Analyzer Extension Module	09/30/19	Annual	09/30/20	SAX252
Virginia Diodes Inc	SAX253	Spectrum Analyzer Extension Module	09/30/19	Annual	09/30/20	SAX253
Virginia Diodes Inc	SAX254	Spectrum Analyzer Extension Module	09/30/19	Annual	09/30/20	SAX254

Note:



- Each equipment item was used solely within its respective calibration period.

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 22 of 25	

7

MEASUREMENT UNCERTAINTIES



a Uncertainty Component	b	c	d	e	f = b x e/d	g
	Unc. (± dB)	Prob. Dist.	Div.	ci	ui (± dB)	vi
Calibration	0.49	N	1	1.0	0.49	∞
Probe correction	0	R	1.73	1.0	0.00	∞
Frequency Response (BW ≤ 1 GHz)	0.20	R	1.73	1.0	0.12	∞
Sensor cross coupling	0	R	1.73	1.0	0.00	∞
Isotropy	0.50	R	1.73	1.0	0.29	∞
Linearity	0.20	R	1.73	1.0	0.12	∞
Probe Scattering	0	R	1.73	1.0	0	∞
Probe Positioning Offset	0.30	R	1.73	1.0	0.17	∞
Probe Positioning Repeatability	0.04	R	1.73	1.0	0.02	∞
Sensor Mechanical Offset	0	R	1.73	1.0	0	∞
Probe Spatial Resolution	0	R	1.73	1.0	0	∞
Field Impedance Dependence	0	R	1.73	1.0	0	∞
Amplitude and phase drift	0	R	1.73	1.0	0	∞
Amplitude and phase noise	0.04	R	1.73	1.0	0.02	∞
Measurement area truncation	0	R	1.73	1.0	0	∞
Data acquisition	0.03	N	1	1.0	0.03	∞
Sampling	0	R	1.73	1.0	0	∞
Field Reconstruction	0.60	R	1.73	1.0	0.35	∞
Forward Transformation	0	R	1.73	1.0	0	∞
Power Density Scaling	-	R	1.73	1.0	-	∞
Spatial Averaging	0.10	R	1.73	1.0	0.06	∞
System Detection Limit	0.04	R	1.73	1.0	0.02	∞
Test Sample and Environmental Factors						
Probe Coupling with DUT	0	R	1.73	1.0	0	∞
Modulation Response	0.40	R	1.73	1.0	0.23	∞
Integration Time	0	R	1.73	1.0	0	∞
Response Time	0	R	1.73	1.0	0	∞
Device Holder Influence	0.10	R	1.73	1.0	0.06	∞
DUT Alignment	0	R	1.73	1.0	0	∞
RF Ambient Conditions	0.04	R	1.73	1.0	0.02	∞
Ambient Reflections	0.04	R	1.73	1.0	0.02	∞
Immunity / Secondary Reception	0	R	1.73	1.0	0	∞
Drift of the DUT	0.22	R	1.73	1.0	0.13	∞
Combined Standard Uncertainty (k=1)		RSS			0.76	∞
(95% CONFIDENCE LEVEL)	k=2				1.53	

FCC ID: PY7-57441Y	 PCTEST Proud to be part of 	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 23 of 25	

8.1 Measurement Conclusion

The power density measurements and total exposure ratio analysis indicate that the DUT complies with the RF radiation exposure limits of the FCC, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.


Please note that the RF Exposure and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT		Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset	Page 24 of 25	

9

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FCC ID: PY7-57441Y	 PCTEST <small>Proved to be part of Element</small>	NEAR-FIELD POWER DENSITY EVALUATION REPORT	SONY	Approved by: Quality Manager
Document S/N: 1M2007070106-01-R1.PY7	Test Dates: 08/05/2020 - 08/15/2020	DUT Type: Portable Handset		Page 25 of 25