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NEAR-FIELD POWER DENSITY EVALUATION REPORT

Applicant Name
Samsung Electronics Co., Ltd.
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Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

Date of Testing
07/10/2024 – 08/01/2024
Test Site/Location
Element, Columbia, MD, USA
Document Serial No:
1M2405140039-23.A3L

FCC ID: **A3LSMX828U**

APPLICANT: **SAMSUNG ELECTRONICS CO., LTD.**

DUT Type: Portable Computing Device
Application Type: Certification
FCC Rule Part(s): CFR §2.1093
Model: SM-X828U

Band & Mode	Tx Frequency	Measured psPD	Reported psPD
	MHz	mW/cm²	mW/cm²
n258	24250 - 24450; 24750 - 25250	0.612	0.741
n261	27500 - 28350	0.543	0.741
n260	37000 - 40000	0.396	0.741
Verdict		**PASS**	

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

ilac-MRA
ACCREDITED
CERTIFICATE # 2041.01

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1 DEVICE UNDER TEST

1.1 NR FR2 Checklist

NR FR2 Operations Information	
Form Factor	Portable Computing Device
Subcarrier Spacing (kHz)	120
Total Number of Supported Uplink CCs (SISO)	4
Total Number of Supported Uplink CCs (MIMO)	4
Total Number of Supported DL CCs	4
CP-OFDM Modulations Supported in UL	PI/2 BPSK, QPSK, 16QAM, 64QAM
DFT-s-OFDM Modulations Supported in UL	PI/2 BPSK, QPSK, 16QAM, 64QAM
LTE Anchor Bands	n258:2/5/12/66/71, n261: 2/5/12/13/48/66, n260: 2/5/12/13/14/30/48/66
NR FR1 Anchor Bands	n258: 2/12/25/41/66/77, n261: 2/5/25/40/48/66/77, n260: 2/5/25/30/41/48/66/77
Duplex Type (mmWave)	TDD

NR FR2 Channels & Frequencies							
NR Band	Bandwidth (MHz)	Low		Mid		High	
		Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
n258	100	2018333	24350.04	2025833	24800.04	2032499	25200.00
n261	100	2071667	27550.08	2077915	27924.96	2084165	28299.96
n260	100	2229999	37050.00	2254165	38499.96	2278331	39949.92

1.2 Time-Averaging Algorithm for RF Exposure Compliance

The device is enabled with MediaTek TAS 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 MediaTek TAS feature (report SN could be found in Section 1.8 Bibliography). Note that WLAN, BT and NFC operations are not enabled with the TAS feature.

The MediaTek TAS (TA-SAR/TA-PD) algorithm maintains the time-average 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 mmWave NR), for each characterized technology and band (see RF Exposure Part 0 Test Report).

The MediaTek TAS algorithm 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*.

1.3 Power Density Design Target and Uncertainty

Power Density Design Specification	
***PD_design_target* (mW/cm²)**	**0.741**
Design Related Total Uncertainty (dB)	**1.3**

1.4 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 n258 Antenna L *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n258	0		2.6	n258		68	4.9
n258	1		2.2	n258		69	4.7
n258	2		2.8	n258		70	4.7
n258	3		2.8	n258		71	4.6
n258	4		2.4	n258		72	4.6
n258	5		2.7	n258		73	4.6
n258	6		2.6	n258		74	4.8
n258	7		3.3	n258		75	4.6
n258	8		2.0	n258		76	4.7
n258	9		1.6	n258		77	4.6
n258	10		2.6	n258		78	4.9
n258	11		1.7	n258		79	4.7
n258	12		2.5	n258		80	4.7
n258	13		3.1	n258		81	4.9
n258	14		2.0	n258		82	4.9
n258	15		2.1	n258		83	4.6
n258	48		4.8	n258		104	7.4
n258	49		4.7	n258		105	7.8
n258	50		4.8	n258	32	32	-0.5
n258	51		4.7	n258	33	33	-1.0
n258	52		4.7	n258	34	34	-0.4
n258	53		4.8	n258	35	35	-0.5
n258	54		4.8	n258	36	36	-0.7
n258	55		4.8	n258	37	37	-0.8
n258	56		4.8	n258	38	38	-1.0
n258	57		4.7	n258	39	39	-0.2
n258	58		4.8	n258	40	40	-1.3
n258	59		4.7	n258	41	41	-1.6
n258	60		4.8	n258	42	42	-1.0
n258	61		4.8	n258	43	43	-1.8
n258	62		4.8	n258	44	44	-0.7
n258	63		4.8	n258	45	45	-0.5
n258	64		4.8	n258	46	46	-1.4
n258	65		4.8	n258	47	47	-1.1
n258	102		7.5	n258	84	84	1.6
n258	103		7.8	n258	85	85	1.4
n258		16	2.8	n258	86	86	1.7
n258		17	2.3	n258	87	87	1.4
n258		18	2.7	n258	88	88	1.4
n258		19	2.7	n258	89	89	1.4
n258		20	2.5	n258	90	90	1.4
n258		21	3.0	n258	91	91	1.4
n258		22	2.6	n258	92	92	1.6
n258		23	3.0	n258	93	93	1.3
n258		24	1.9	n258	94	94	1.5
n258		25	1.8	n258	95	95	1.3
n258		26	2.7	n258	96	96	1.7
n258		27	1.6	n258	97	97	1.5
n258		28	2.4	n258	98	98	1.5
n258		29	3.3	n258	99	99	1.7
n258		30	2.1	n258	100	100	1.7
n258		31	2.1	n258	101	101	1.6
n258		66	4.7	n258	106	106	4.2
n258		67	4.7	n258	107	107	4.6

Table 1-2
5G mmWave NR n258 Antenna K *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n258	0		2.9	n258		68	5.7
n258	1		2.8	n258		69	5.7
n258	2		3.2	n258		70	5.6
n258	3		3.1	n258		71	5.6
n258	4		3.3	n258		72	5.7
n258	5		3.9	n258		73	5.6
n258	6		2.7	n258		74	5.4
n258	7		2.6	n258		75	5.7
n258	8		3.3	n258		76	5.6
n258	9		3.1	n258		77	5.7
n258	10		4.0	n258		78	5.4
n258	11		2.8	n258		79	5.7
n258	12		3.0	n258		80	5.7
n258	13		3.3	n258		81	5.7
n258	14		3.8	n258		82	5.7
n258	15		4.0	n258		83	5.7
n258	48		5.5	n258		104	8.5
n258	49		5.7	n258		105	8.2
n258	50		5.4	n258	32	32	-0.5
n258	51		5.7	n258	33	33	-0.9
n258	52		5.4	n258	34	34	-0.4
n258	53		5.9	n258	35	35	-1.4
n258	54		5.4	n258	36	36	-1.0
n258	55		5.4	n258	37	37	-1.4
n258	56		6.0	n258	38	38	-0.9
n258	57		5.7	n258	39	39	-1.9
n258	58		5.9	n258	40	40	-1.2
n258	59		5.4	n258	41	41	-1.3
n258	60		6.0	n258	42	42	-0.6
n258	61		5.7	n258	43	43	-1.1
n258	62		5.7	n258	44	44	-1.0
n258	63		5.7	n258	45	45	-1.2
n258	64		5.5	n258	46	46	-1.1
n258	65		5.7	n258	47	47	-1.3
n258	102		8.2	n258	84	84	1.7
n258	103		8.3	n258	85	85	1.8
n258		16	3.0	n258	86	86	1.5
n258		17	3.0	n258	87	87	1.4
n258		18	3.3	n258	88	88	1.2
n258		19	3.8	n258	89	89	1.6
n258		20	3.4	n258	90	90	1.5
n258		21	2.6	n258	91	91	1.2
n258		22	2.9	n258	92	92	1.7
n258		23	3.5	n258	93	93	1.4
n258		24	2.7	n258	94	94	1.6
n258		25	4.3	n258	95	95	1.5
n258		26	3.5	n258	96	96	1.7
n258		27	3.0	n258	97	97	1.4
n258		28	2.8	n258	98	98	1.4
n258		29	3.9	n258	99	99	1.4
n258		30	3.0	n258	100	100	2.5
n258		31	2.7	n258	101	101	1.4
n258		66	5.7	n258	106	106	4.3
n258		67	5.5	n258	107	107	4.3

Table 1-3
5G mmWave NR n261 Antenna L *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n261	0		0.0	n261		68	2.3
n261	1		0.4	n261		69	2.3
n261	2		0.1	n261		70	2.3
n261	3		0.5	n261		71	2.4
n261	4		0.1	n261		72	2.4
n261	5		0.0	n261		73	2.5
n261	6		0.5	n261		74	2.4
n261	7		0.1	n261		75	2.4
n261	8		0.3	n261		76	2.3
n261	9		0.9	n261		77	2.5
n261	10		0.6	n261		78	2.4
n261	11		-0.1	n261		79	2.5
n261	12		0.8	n261		80	2.3
n261	13		0.1	n261		81	2.4
n261	14		0.4	n261		82	2.4
n261	15		0.4	n261		83	2.4
n261	48		2.4	n261		104	5.1
n261	49		2.3	n261		105	5.3
n261	50		2.4	n261	32	32	-3.4
n261	51		2.3	n261	33	33	-3.5
n261	52		2.4	n261	34	34	-3.5
n261	53		2.4	n261	35	35	-3.9
n261	54		2.2	n261	36	36	-3.3
n261	55		2.2	n261	37	37	-3.4
n261	56		2.2	n261	38	38	-3.7
n261	57		2.2	n261	39	39	-3.4
n261	58		2.3	n261	40	40	-3.6
n261	59		2.2	n261	41	41	-2.9
n261	60		2.2	n261	42	42	-4.2
n261	61		2.2	n261	43	43	-3.5
n261	62		2.3	n261	44	44	-3.4
n261	63		2.2	n261	45	45	-3.5
n261	64		2.4	n261	46	46	-4.4
n261	65		2.2	n261	47	47	-3.2
n261	102		5.0	n261	84	84	-1.0
n261	103		5.2	n261	85	85	-1.8
n261		16	-0.2	n261	86	86	-1.3
n261		17	0.3	n261	87	87	-1.8
n261		18	0.0	n261	88	88	-1.3
n261		19	0.3	n261	89	89	-1.0
n261		20	0.0	n261	90	90	-2.0
n261		21	-0.1	n261	91	91	-1.5
n261		22	0.9	n261	92	92	-1.8
n261		23	0.4	n261	93	93	-1.8
n261		24	0.9	n261	94	94	-1.8
n261		25	1.0	n261	95	95	-1.3
n261		26	0.3	n261	96	96	-1.8
n261		27	0.0	n261	97	97	-1.5
n261		28	0.9	n261	98	98	-1.8
n261		29	0.5	n261	99	99	-2.0
n261		30	0.2	n261	100	100	-1.2
n261		31	0.5	n261	101	101	-1.8
n261		66	2.4	n261	106	106	1.2
n261		67	2.3	n261	107	107	1.4

Table 1-4
5G mmWave NR n261 Antenna K *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n261	0		4.4	n261		68	6.7
n261	1		4.2	n261		69	6.3
n261	2		4.6	n261		70	6.3
n261	3		4.0	n261		71	6.6
n261	4		4.2	n261		72	6.0
n261	5		3.6	n261		73	6.7
n261	6		4.0	n261		74	6.3
n261	7		4.1	n261		75	6.3
n261	8		4.3	n261		76	6.7
n261	9		3.7	n261		77	6.0
n261	10		4.2	n261		78	6.0
n261	11		3.5	n261		79	6.8
n261	12		4.3	n261		80	6.6
n261	13		3.8	n261		81	6.7
n261	14		3.8	n261		82	6.8
n261	15		4.2	n261		83	6.3
n261	48		6.7	n261		104	9.2
n261	49		6.9	n261		105	9.4
n261	50		6.5	n261	32	32	0.8
n261	51		6.1	n261	33	33	0.9
n261	52		6.1	n261	34	34	1.0
n261	53		6.3	n261	35	35	-0.5
n261	54		6.3	n261	36	36	0.5
n261	55		6.5	n261	37	37	-0.6
n261	56		6.1	n261	38	38	0.1
n261	57		6.1	n261	39	39	0.5
n261	58		6.5	n261	40	40	-0.2
n261	59		6.0	n261	41	41	-0.8
n261	60		6.3	n261	42	42	0.7
n261	61		6.8	n261	43	43	-0.8
n261	62		6.3	n261	44	44	0.6
n261	63		6.5	n261	45	45	0.0
n261	64		6.9	n261	46	46	-0.6
n261	65		6.1	n261	47	47	0.8
n261	102		9.0	n261	84	84	2.9
n261	103		9.3	n261	85	85	3.3
n261		16	4.2	n261	86	86	3.0
n261		17	4.3	n261	87	87	2.3
n261		18	4.8	n261	88	88	2.3
n261		19	3.8	n261	89	89	2.6
n261		20	4.3	n261	90	90	2.4
n261		21	3.5	n261	91	91	3.0
n261		22	3.7	n261	92	92	2.3
n261		23	4.2	n261	93	93	2.3
n261		24	4.1	n261	94	94	3.0
n261		25	3.4	n261	95	95	2.2
n261		26	4.4	n261	96	96	2.4
n261		27	3.2	n261	97	97	3.3
n261		28	4.1	n261	98	98	2.6
n261		29	3.8	n261	99	99	3.0
n261		30	3.6	n261	100	100	3.3
n261		31	4.4	n261	101	101	2.8
n261		66	6.4	n261	106	106	5.5
n261		67	6.8	n261	107	107	5.6

Table 1-5
5G mmWave NR n260 Antenna L *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n260	0		1.9	n260		68	3.8
n260	1		1.8	n260		69	2.8
n260	2		1.9	n260		70	2.8
n260	3		0.8	n260		71	3.3
n260	4		1.1	n260		72	2.8
n260	5		1.0	n260		73	3.2
n260	6		1.4	n260		74	3.3
n260	7		1.2	n260		75	2.8
n260	8		1.1	n260		76	2.8
n260	9		1.3	n260		77	3.2
n260	10		1.1	n260		78	3.6
n260	11		1.4	n260		79	2.8
n260	12		1.0	n260		80	2.9
n260	13		1.0	n260		81	2.9
n260	14		1.3	n260		82	2.8
n260	15		1.2	n260		83	3.8
n260	48		3.9	n260		104	5.5
n260	49		3.6	n260		105	6.7
n260	50		3.9	n260	32	32	-1.8
n260	51		2.8	n260	33	33	-2.0
n260	52		2.9	n260	34	34	-1.8
n260	53		3.2	n260	35	35	-2.9
n260	54		2.8	n260	36	36	-2.6
n260	55		3.3	n260	37	37	-2.6
n260	56		3.2	n260	38	38	-2.5
n260	57		2.9	n260	39	39	-2.5
n260	58		2.8	n260	40	40	-2.3
n260	59		3.3	n260	41	41	-2.5
n260	60		3.7	n260	42	42	-3.2
n260	61		2.9	n260	43	43	-2.1
n260	62		2.9	n260	44	44	-2.1
n260	63		2.9	n260	45	45	-3.1
n260	64		3.9	n260	46	46	-2.5
n260	65		2.8	n260	47	47	-2.6
n260	102		5.9	n260	84	84	0.2
n260	103		6.4	n260	85	85	0.2
n260		16	2.1	n260	86	86	0.2
n260		17	1.7	n260	87	87	-0.7
n260		18	2.1	n260	88	88	-0.6
n260		19	0.7	n260	89	89	0.1
n260		20	1.0	n260	90	90	-0.7
n260		21	0.9	n260	91	91	-0.1
n260		22	0.9	n260	92	92	0.1
n260		23	1.1	n260	93	93	-0.6
n260		24	1.3	n260	94	94	-0.7
n260		25	1.1	n260	95	95	-0.1
n260		26	0.6	n260	96	96	0.4
n260		27	1.3	n260	97	97	-0.6
n260		28	1.3	n260	98	98	-0.5
n260		29	0.7	n260	99	99	-0.5
n260		30	1.1	n260	100	100	-0.6
n260		31	0.9	n260	101	101	0.1
n260		66	3.8	n260	106	106	2.4
n260		67	3.6	n260	107	107	3.2

Table 1-6
5G mmWave NR n260 Antenna K *input.power.limit*

Band	Beam ID 1	Beam ID 2	input.power.limit	Band	Beam ID 1	Beam ID 2	input.power.limit
n260	0		3.5	n260		68	6.0
n260	1		3.4	n260		69	6.0
n260	2		3.3	n260		70	5.2
n260	3		3.5	n260		71	5.3
n260	4		3.5	n260		72	5.2
n260	5		3.3	n260		73	5.2
n260	6		3.1	n260		74	5.5
n260	7		3.5	n260		75	5.3
n260	8		3.2	n260		76	5.2
n260	9		3.1	n260		77	5.9
n260	10		3.3	n260		78	5.8
n260	11		3.4	n260		79	5.2
n260	12		3.4	n260		80	5.5
n260	13		3.2	n260		81	5.5
n260	14		3.3	n260		82	5.2
n260	15		3.1	n260		83	6.0
n260	48		5.9	n260		104	8.0
n260	49		5.9	n260		105	8.7
n260	50		5.7	n260	32	32	0.3
n260	51		5.7	n260	33	33	0.1
n260	52		5.1	n260	34	34	0.1
n260	53		5.0	n260	35	35	0.3
n260	54		5.1	n260	36	36	0.3
n260	55		5.4	n260	37	37	-0.1
n260	56		5.2	n260	38	38	-0.1
n260	57		5.0	n260	39	39	0.2
n260	58		5.4	n260	40	40	0.0
n260	59		5.5	n260	41	41	-0.4
n260	60		5.9	n260	42	42	0.3
n260	61		5.1	n260	43	43	0.1
n260	62		5.2	n260	44	44	0.1
n260	63		5.2	n260	45	45	0.1
n260	64		5.9	n260	46	46	0.1
n260	65		5.0	n260	47	47	-0.2
n260	102		8.1	n260	84	84	2.6
n260	103		8.3	n260	85	85	2.6
n260		16	3.5	n260	86	86	2.6
n260		17	3.6	n260	87	87	2.6
n260		18	3.5	n260	88	88	1.8
n260		19	3.6	n260	89	89	1.7
n260		20	3.8	n260	90	90	1.8
n260		21	3.2	n260	91	91	2.0
n260		22	3.3	n260	92	92	2.0
n260		23	3.7	n260	93	93	1.7
n260		24	3.2	n260	94	94	2.0
n260		25	3.1	n260	95	95	2.4
n260		26	3.8	n260	96	96	2.6
n260		27	3.5	n260	97	97	1.8
n260		28	3.6	n260	98	98	2.0
n260		29	3.6	n260	99	99	2.0
n260		30	3.4	n260	100	100	1.8
n260		31	3.1	n260	101	101	2.4
n260		66	5.9	n260	106	106	4.9
n260		67	5.8	n260	107	107	5.2

1.5 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 1-7
Device Surfaces

Band	Antenna	Back	Front	Top	Bottom	Right	Left
n258	L	Yes	No	No	No	No	No
n261	L	Yes	No	No	No	No	No
n260	L	Yes	No	No	No	No	No
n258	K	No	Yes	No	No	Yes	No
n261	K	No	Yes	No	No	Yes	No
n260	K	No	Yes	No	No	Yes	No

1.6 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. Please refer to Part 1 SAR Multi-Tx and Antenna SAR Considerations Appendix for simultaneous transmission analysis.

1.7 Guidance Applied

- November 2017, October 2018, April 2019, November 2019 TCBC Workshop Notes
- SPEAG DASY6 System Handbook
- FCC KDB 865664 D02 v01r04
- FCC KDB 447498 D04 v01
- IEC/IEEE 63195-1:2022

1.8 Bibliography

Table 1-8
Bibliography

Report Type	Report Serial Number
FCC SAR Evaluation Report (Part 1)	1M2405140039-20.A3L
Power Density Part 0 Test Report	
FCC TAS Validation Report (Part 2)	TESA2406000425ES
RF Exposure Compliance Summary Report	1M2405140039-21.A3L
Power Density Simulation Report	

2 MEASUREMENT SYSTEM

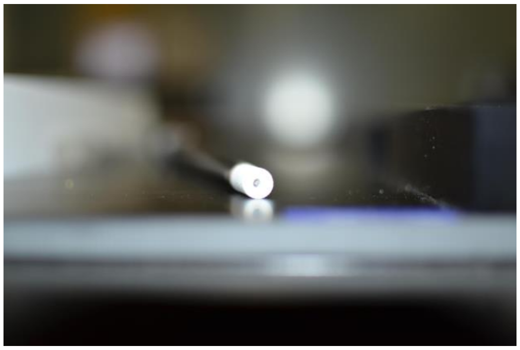
2.1 Measurement Setup

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 EUmmWVx Probe / E-Field 5G Probe

The EUmmWVx 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



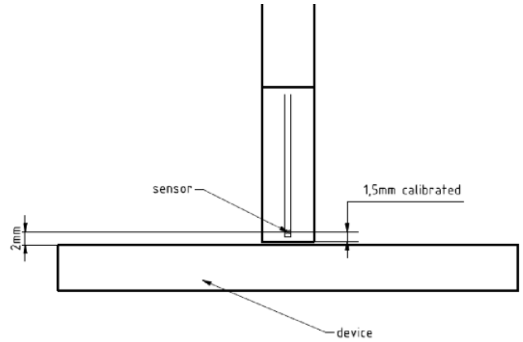


Figure 2-1
EUmmWVx Probe

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 λ/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 λ/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 EUmmWVx probe.

3 RF EXPOSURE LIMITS FOR POWER DENSITY

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

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.

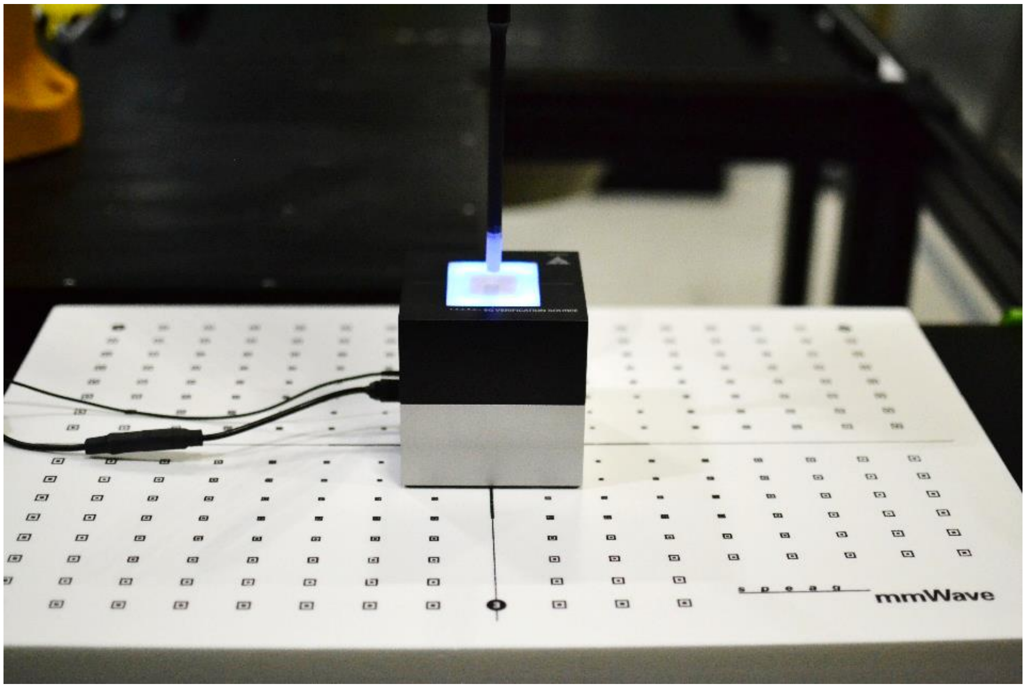


Figure 4-1
System Verification Setup Photo

Table 4-1
30 GHz Verifications

System Verification											
System	Frequency (GHz)	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)	Plot #
					Measured	Target		Measured	Target		
R	30	07/08/2024	1043	9421	29.10	27.10	0.31	29.50	27.10	0.37	B1
N	30	07/09/2024	1043	9389	27.10	27.10	0.00	27.50	27.10	0.06	B2
R	30	07/11/2024	1043	9421	29.00	27.10	0.29	29.40	27.10	0.35	B3
N	30	07/11/2024	1043	9389	26.60	27.10	-0.08	26.90	27.10	-0.03	B4
N	30	07/16/2024	1043	9389	26.70	27.10	-0.06	27.00	27.10	-0.02	B5
N	30	07/18/2024	1043	9389	26.60	27.10	-0.08	26.90	27.10	-0.03	B6
N	30	07/29/2024	1044	9389	33.60	34.00	-0.05	34.20	34.00	0.03	B7
N	30	08/01/2024	1044	9389	32.00	34.00	-0.26	32.30	34.00	-0.22	B8

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.

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 n258

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	Keyboard Type	Add'l info	Normal psPD	Total psPD	Plot #
			MHz		V	H	dBm			dB	mm			mW/cm²	mW/cm²	
n258	L	Patch	24350.04	Low	9		1.64	CW	XFE0511M	-0.04	2	Back	N/A	0.262	0.340	A1
n258	L	Patch	24350.04	Low	9		1.64	CW	XFE0511M	-0.19	2	Back	Variant 1	0.023	0.026	
n258	L	Patch	24350.04	Low	9		1.64	CW	XFE0511M	0.13	2	Back	Variant 2	0.067	0.076	
n258	L	Patch	24800.04	Mid		27	1.61	CW	XFE0511M	-0.13	2	Back	N/A	0.171	0.257	
n258	L	Patch	24350.04	Low	43	43	-1.82	CW	XFE0511M	0.00	2	Back	N/A	0.201	0.285	
n258	K	Patch	24800.04	Mid	1		2.83	CW	XFE0508M	0.02	2	Right	N/A	0.252	0.327	
n258	K	Patch	24800.04	Mid		22	2.91	CW	XFE0508M	0.00	2	Right	N/A	0.253	0.360	
n258	K	Patch	24800.04	Mid	38	38	-0.92	CW	XFE0508M	0.01	2	Right	N/A	0.092	0.136	
n258	K	Patch	24350.04	Low	7		2.55	CW	XFE0508M	0.02	2	Front	N/A	0.230	0.383	
n258	K	Patch	25200.00	High		21	2.61	CW	XFE0508M	0.04	2	Front	N/A	0.326	0.479	
n258	K	Patch	25200.00	High		21	2.61	CW	XFE0508M	-0.16	2	Front	Variant 1	0.450	0.612	A2
n258	K	Patch	25200.00	High		21	2.61	CW	XFE0508M	0.15	2	Front	Variant 2	0.460	0.558	
n258	K	Patch	25200.00	High	39	39	-1.90	CW	XFE0508M	0.19	2	Front	N/A	0.103	0.207	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population									Power Density 1 mW/cm² averaged over 4 cm²							

Table 5-2
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	Keyboard Type | Add'l info	Normal psPD	Total psPD	Plot #
			MHz		V	H	dBm			dB	mm			mW/cm²	mW/cm²	
n261	L	Patch	27550.08	Low	11		-0.08	CW	XFE0511M	-0.13	2	Back	N/A	0.223	0.263	
n261	L	Patch	27550.08	Low		16	-0.22	CW	XFE0511M	-0.17	2	Back	N/A	0.237	0.262	
n261	L	Patch	27550.08	Low	46	46	-4.37	CW	XFE0508M	-0.17	2	Back	N/A	0.361	0.477	A3
n261	L	Patch	27550.08	Low	46	46	-4.37	CW	XFE0508M	-0.12	2	Back	Variant 1	0.028	0.038	
n261	L	Patch	27550.08	Low	46	46	-4.37	CW	XFE0508M	-0.16	2	Back	Variant 2	0.034	0.041	
n261	K	Patch	27924.96	Mid	11		3.46	CW	XFE0508M	-0.03	2	Right	N/A	0.337	0.379	
n261	K	Patch	27924.96	Mid		21	3.52	CW	XFE0508M	-0.11	2	Right	N/A	0.292	0.343	
n261	K	Patch	27924.96	Mid	43	43	-0.83	CW	XFE0508M	-0.07	2	Right	N/A	0.207	0.217	
n261	K	Patch	27924.96	Mid	11		3.46	CW	XFE0511M	0.08	2	Front	N/A	0.238	0.356	
n261	K	Patch	27924.96	Mid		27	3.22	CW	XFE0508M	0.06	2	Front	N/A	0.326	0.457	
n261	K	Patch	27924.96	Mid	43	43	-0.83	CW	XFE0508M	-0.04	2	Front	N/A	0.382	0.525	
n261	K	Patch	27924.96	Mid	43	43	-0.83	CW	XFE0508M	-0.14	2	Front	Variant 1	0.416	0.543	A4
n261	K	Patch	27924.96	Mid	43	43	-0.83	CW	XFE0508M	0.13	2	Front	Variant 2	0.369	0.504	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population									Power Density 1 mW/cm² averaged over 4 cm²							

Table 5-3
5G mmWave NR Band n260

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	Keyboard Type | Add'l info	Normal psPD	Total psPD	Plot #
			MHz		V	H	dBm			dB	mm			mW/cm²	mW/cm²	
n260	L	Patch	38499.96	Mid	3		0.75	CW	XFE0511M	0.19	2	Back	N/A	0.238	0.287	
n260	L	Patch	38499.96	Mid		26	0.60	CW	XFE0511M	0.03	2	Back	N/A	0.233	0.320	
n260	L	Patch	37050.00	Low	42	42	-3.15	CW	XFE0511M	0.07	2	Back	N/A	0.279	0.381	A5
n260	L	Patch	37050.00	Low	42	42	-3.15	CW	XFE0511M	-0.11	2	Back	Variant 1	0.018	0.020	
n260	L	Patch	37050.00	Low	42	42	-3.15	CW	XFE0511M	-0.11	2	Back	Variant 2	0.019	0.022	
n260	K	Patch	38499.96	Mid	7		3.51	CW	XFE0511M	-0.01	2	Right	N/A	0.288	0.333	
n260	K	Patch	38499.96	Mid		27	3.45	CW	XFE0511M	-0.01	2	Right	N/A	0.285	0.328	
n260	K	Patch	38499.96	Mid	43	43	0.12	CW	XFE0511M	-0.06	2	Right	N/A	0.167	0.231	
n260	K	Patch	39949.92	High	6		3.11	CW	XFE0511M	0.10	2	Front	N/A	0.055	0.067	
n260	K	Patch	38499.96	Mid		25	3.09	CW	XFE0511M	0.01	2	Front	N/A	0.297	0.367	
n260	K	Patch	38499.96	Mid		25	3.09	CW	XFE0511M	-0.12	2	Front	Variant 1	0.316	0.393	
n260	K	Patch	38499.96	Mid		25	3.09	CW	XFE0511M	-0.01	2	Front	Variant 2	0.318	0.396	A6
n260	K	Patch	38499.96	Mid	41	41	-0.38	CW	XFE0511M	0.10	2	Front	N/A	0.234	0.284	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population									Power Density 1 mW/cm² averaged over 4 cm²							

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 λ/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/BT wireless modes and technologies for simultaneous transmission compliance. These mechanisms are assessed in the SAR Test Report.
6. *PD_design_target* of 0.741 mW/cm^2 was used with mmW device design related uncertainty of 1.3 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 MediaTek TAS (TA-SAR/TA-PD) 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 MediaTek TAS feature, 4G LTE/5G NR FR1 and 5G mmW NR FR2 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 MediaTek TAS 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 the FCC SAR Evaluation Report (Part 1) Appendix E Mulit - TX and Antenna SAR Considerations.
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 MediaTek TAS 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.
13. When additional sides are tested at a distance further than 2mm, the beam ID with the highest ratio of simulated power density of the tested distance to worst case 2mm was selected for power density measurements for that specific side and distance.

6 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	WL25-1	Conducted Cable Set (25GHz)	N/A	N/A	N/A	WL25-1
-	WL40-1	Conducted Cable Set (40GHz)	N/A	N/A	N/A	WL40-1
Agilent	N9038A	MXE EMI Receiver	N/A	N/A	N/A	MY51210133
EMCO	3160-09	Small Horn (18 - 26.5GHz)	N/A	N/A	N/A	00135427
Emco	3116	Horn Antenna (18 - 40GHz)	N/A	N/A	N/A	9203-2178
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	N/A	N/A	N/A	102133
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	N/A	N/A	N/A	103200
SPEAG	EUmmWV3	EUmmWV3 Probe	01/05/2024	Annual	01/05/2025	9389
SPEAG	DAE4	Dasy Data Acquisition Electronics	01/09/2024	Annual	01/09/2025	859
SPEAG	EUmmWV3	EUmmWV3 Probe	03/04/2024	Annual	03/04/2025	9421
SPEAG	DAE4	Dasy Data Acquisition Electronics	03/04/2024	Annual	03/04/2025	1638
SPEAG	5G Verification Source 30GHz	30GHz System Verification Antenna	06/10/2024	Annual	06/10/2025	1043
SPEAG	5G Verification Source 30GHz	30GHz System Verification Antenna	05/07/2024	Annual	05/07/2025	1044
Agilent	N9030A	PXA Signal Analyzer (44GHz)	N/A	N/A	N/A	MY52350166
Emco	3115	Horn Antenna (1-18GHz)	N/A	N/A	N/A	9704-5182
Keysight Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	N/A	N/A	N/A	MY49430494
Rohde & Schwarz	180-442-KF	Horn (Small)	N/A	N/A	N/A	U157403-01
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	N/A	N/A	N/A	100342
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	N/A	N/A	N/A	102134
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	N/A	N/A	N/A	A051107
Virginia Diodes Inc	SAX252	Spectrum Analyzer Extension Module	N/A	N/A	N/A	SAX252
Virginia Diodes Inc	SAX253	Spectrum Analyzer Extension Module	N/A	N/A	N/A	SAX253
Virginia Diodes Inc	SAX254	Spectrum Analyzer Extension Module	N/A	N/A	N/A	SAX254

Note:
1. Each equipment item was used solely within its respective calibration period.

7 MEASUREMENT UNCERTAINTIES

a	b	c	d	e	f = c x f/e	g
Uncertainty Component	Unc. (± dB)	Prob. Dist.	Div.	c_i	u_i (± dB)	v_i
Measurement System						
Calibration	0.49	N	1	1	0.49	∞
Probe Correction	0.00	R	1.73	1	0.00	∞
Frequency Response	0.20	R	1.73	1	0.12	∞
Sensor Cross Coupling	0.00	R	1.73	1	0.00	∞
Isotropy	0.50	R	1.73	1	0.29	∞
Linearity	0.20	R	1.73	1	0.12	∞
Probe Scattering	0.00	R	1.73	1	0.00	∞
Probe Positioning offset	0.30	R	1.73	1	0.17	∞
Probe Positioning Repeatability	0.04	R	1.73	1	0.02	∞
Sensor MechanicalOffset	0.00	R	1.73	1	0.00	∞
Probe Spatial Resolution	0.00	R	1.73	1	0.00	∞
Field Impedence Dependance	0.00	R	1.73	1	0.00	∞
Amplitude and Phase Drift	0.00	R	1.73	1	0.00	∞
Amplitude and Phase Noise	0.04	R	1.73	1	0.02	∞
Measurement Area Truncation	0.00	R	1.73	1	0.00	∞
Data Acquisition	0.03	N	1	1	0.03	∞
Sampling	0.00	R	1.73	1	0.00	∞
Field Reconstruction	0.60	R	1.73	1	0.35	∞
Forward Transformation	0.00	R	1.73	1	0.00	∞
Power Density Scaling	0.00	R	1.73	1	0.00	∞
Spatial Averaging	0.10	R	1.73	1	0.06	∞
System Detection Limit	0.04	R	1.73	1	0.02	∞
Test Sample Related						
Probe Coupling with DUT	0.00	R	1.73	1	0.00	∞
Modulation Response	0.40	R	1.73	1	0.23	∞
Integration Time	0.00	R	1.73	1	0.00	∞
Response Time	0.00	R	1.73	1	0.00	∞
Device Holder Influence	0.10	R	1.73	1	0.06	∞
DUT alignment	0.00	R	1.73	1	0.00	∞
RF Ambient Conditions	0.04	R	1.73	1	0.02	∞
Ambient Reflections	0.04	R	1.73	1	0.02	∞
Immunity/Secondary Reception	0.00	R	1.73	1	0.00	∞
Drift of DUT	0.21	R	1.73	1	0.12	∞
Combined Standard Uncertainty (k=1)		RSS			0.76	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)		k=2			1.52	

8 CONCLUSION

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.

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[12] November 2019 Telecommunications Certification Body Council (TCBC) Workshop Notes

[13] SPEAG DASY6 System Handbook (September 2019)