TEST REPORT

of

FCC Part 15 Subpart F §15.503, §15.519 and §15.521
IC RSS-220 Issue 1 and RSS-Gen Issue 5

FCC ID: A3LEIT5600
IC Certification: 649E-EIT5600

Equipment Under Test	:	Galaxy Smart Tag2
Model Name	:	EI-T5600
Variant Model Name(s)	:	-
FCC Applicant	:	Samsung Electronics Co Ltd
IC Applicant	:	SAMSUNG ELECTRONICS CO. LTD.
Manufacturer	:	Samsung Electronics Co., Ltd.
Date of Receipt	:	2023.06.01
Date of Test(s)	:	2023.06.12 ~ 2023.07.10
Date of Issue	:	2023.07.10

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

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2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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4) The data marked ※ in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(※) provided by the customer

Tested by: **Murphy Kim**

Technical Manager: **Jinhyoung Cho**

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil. Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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1.2. Details of Applicant

FCC Applicant : Samsung Electronics Co Ltd
FCC Address : 19 Chapin Rd., Building D, Pine Brook, New Jersey, United States, 07058
IC Applicant : SAMSUNG ELECTRONICS CO. LTD.
IC Address : 129 Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677, Korea (Republic Of)
Contact Person : Chun, Jenni
Phone No. : +1 973 808 6361

1.3. Details of Manufacturer

Company : Samsung Electronics Co., Ltd.
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea

1.4. Description of EUT

Kind of Product	Galaxy Smart Tag2
Model Name	EI-T5600
Serial Number	EI-T5600_003
Power Supply	DC 3.0 V
Frequency Range	Tx: 7 987.2 ㎒, Rx: 7 987.2 ㎒
Modulation Type	BPM-BPSK
Number of Channel	1
Antenna Type	FPCB antenna
Antenna Gain※	0.12 ㏈i
H/W Version	1.00
S/W Version	1.00
FVIN	N/A

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMA100B	106887	Oct. 13, 2022	Annual	Oct. 13, 2023
Spectrum Analyzer	Agilent	N9030A	US51350132	Nov. 11, 2022	Annual	Nov. 11, 2023
Spectrum Analyzer	Agilent	N9020A	MY53421758	Aug. 26, 2022	Annual	Aug. 26, 2023
DC Power Supply	R&S	HMP2020	019922876	Apr. 27, 2023	Annual	Apr. 27, 2024
Spectrum Analyzer	R&S	FSW67	103242	Aug. 26, 2022	Annual	Aug. 26, 2023
Attenuator	AEROFLEX	40AH2W-10	40G-1	Jun. 14, 2023	Annual	Jun. 14, 2024
Preamplifier	H.P.	8447F	2944A03909	Aug. 04, 2022	Annual	Aug. 04, 2023
Signal Conditioning Unit	R&S	SCU-18	10117	Jun. 15, 2023	Annual	Jun. 15, 2024
Pre Amplifier	TESTEK	TK-PA1840H	130016	Jan. 11, 2023	Annual	Jan. 11, 2024
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2021	Biennial	Aug. 23, 2023
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	01126	Feb. 09, 2023	Annual	Feb. 09, 2024
Horn Antenna	R&S	HF906	100326	Feb. 28, 2023	Annual	Feb. 28, 2024
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	9170-540	Nov. 30, 2022	Annual	Nov. 30, 2023
Test Receiver	R&S	ESU26	100109	Jan. 18, 2023	Annual	Jan. 18, 2024
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/38330516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/38330516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Apr. 04, 2023	Semi-Annual	Oct. 04, 2023
Coaxial Cable	Qualwave Inc.	QA500-18-NN-10 (10 m)	22200114	Apr. 04, 2023	Semi-Annual	Oct. 04, 2023
Coaxial Cable	RFONE	PL360P-292M292M-1.5M-A	20200324002	Apr. 14, 2023	Semi-Annual	Oct. 14, 2023

Note;

- For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 subpart F, IC RSS-220 Issue 1 and RSS-Gen Issue 5			
Section in FCC	**Section in IC**	**Test Item(s)**	**Result**
15.519(c) 15.519(e) 15.521(g)	RSS-220 Issue 1 5.3.1(d)(g)	Maximum Peak Power and Average Emissions	Complied
15.209(a) 15.505(b) 15.519(c) 15.519(d) 15.521(a) 15.521(c) 15.521(h)	RSS-220 Issue 1 3.4 5.3.1(d)(e)(f)	Radiated emissions	Complied
15.503(a) 15.519(b) 15.521(e)	RSS-220 Issue 1 2	10 ㏈ Bandwidth	Complied
-	RSS-Gen Issue 5 6.7	99 % Bandwidth	Complied
15.519(a)(1)	RSS-220 Issue 1 5.3.1(b)	Cease Transmission Time	Complied
15.207	RSS-Gen Issue 5 8.8	AC Conducted Emissions	N/A[1)]

Note;
1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

1.7. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
99 % Bandwidth	1.15 ㎒	
10 ㏈ Bandwidth	0.98 ㎒	
Cease Transmission Time	1.65 ㎳	
Radiated Emission, 9 ㎑ to 30 ㎒	H	3.40 ㏈
	V	3.40 ㏈
Radiated Emission, below 1 ㎓	H	4.50 ㏈
	V	5.10 ㏈
Radiated Emission, above 1 ㎓	H	3.70 ㏈
	V	3.90 ㏈

All measurement uncertainty values are shown with a coverage factor of *k*=2 to indicate a 95 % level of confidence.

1.8. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL004240	2023.07.10	Initial

1.9. Information of software for test

- Using the software of SerComK tool(V2.02) to testing of EUT.

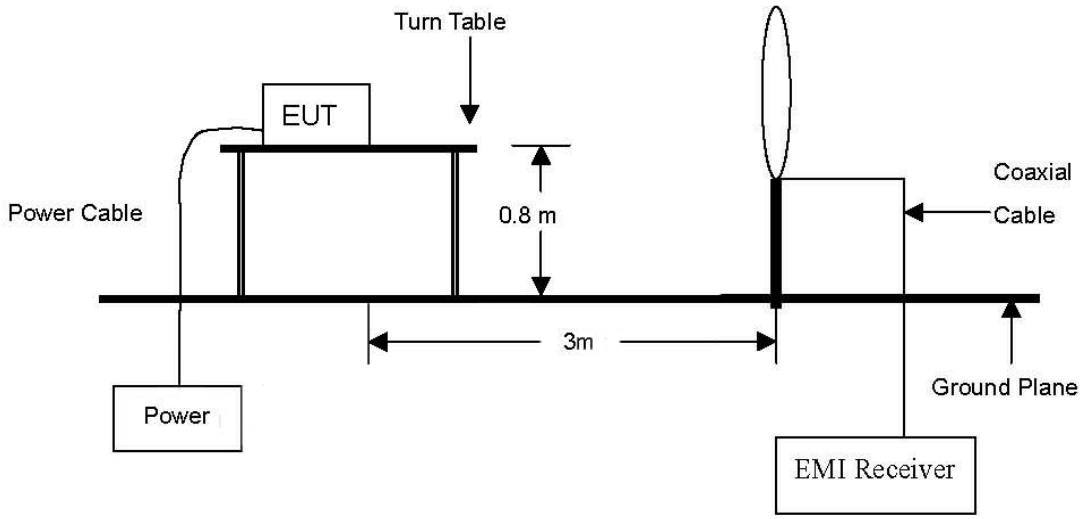
1.10. EUT description

Channel	Configuration	Packet length	Preamble
9	SP0	BPRF 4	9
			10
			11
			12
		BPRF 20	9
			10
			11
			12
	SP3	-	9
			10
			11
			12

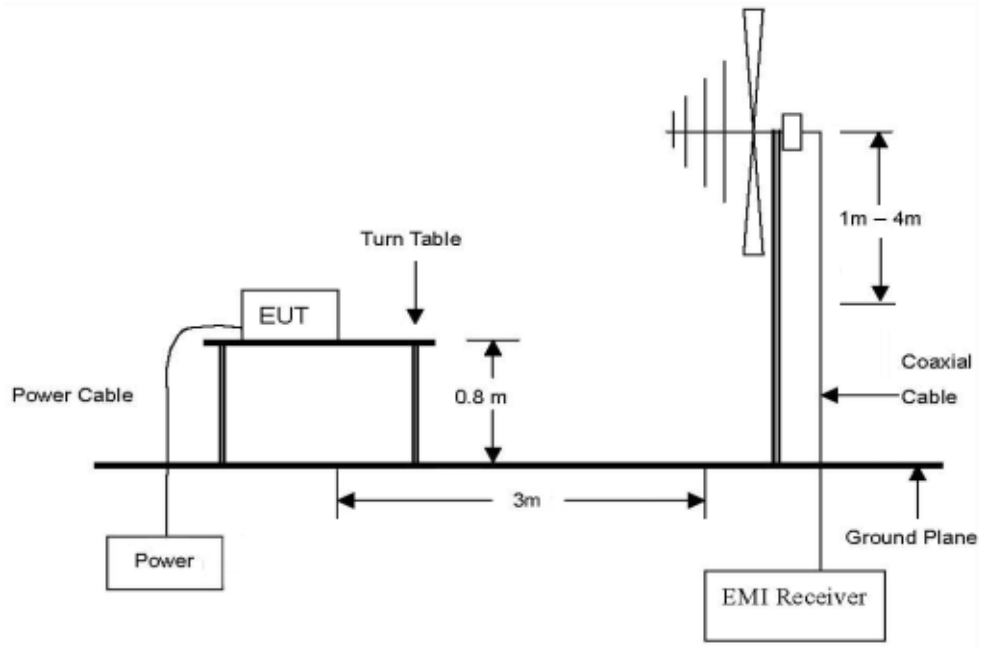
2. Maximum Peak Power and Radiated Emissions

2.1. Test Setup

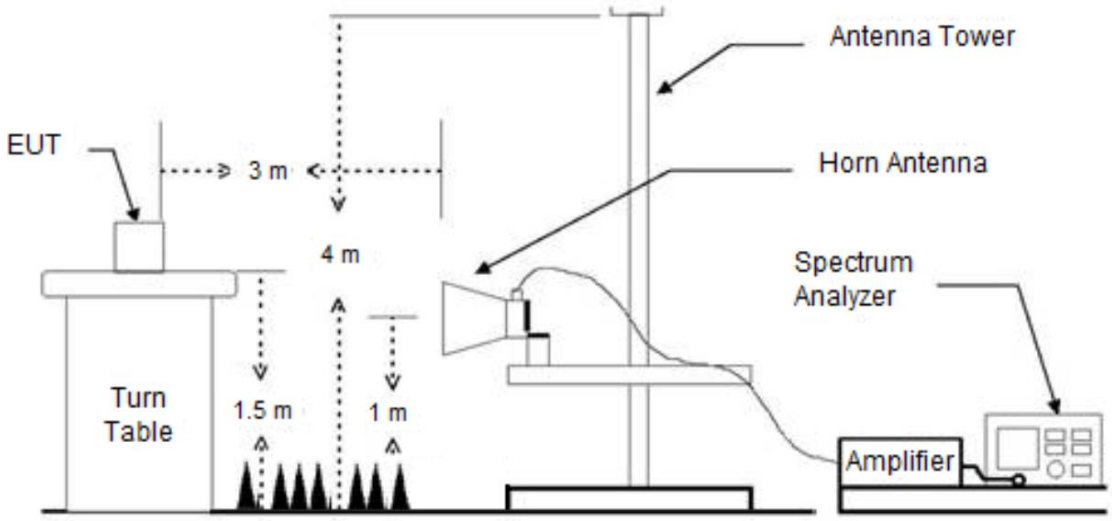
The diagram below shows the test setup that is utilized to make the measurements for emission below 30 ㎒.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.2. Limit

2.2.1. FCC

2.2.1.1. Maximum Peak Power

According to §15.519(e), there is a limit on the peak level of the emissions contained within a 50 ㎒ bandwidth centered on the frequency at which the highest radiated emission occurs, f_M. That limit is 0 ㏈m EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521(g).

2.2.1.2. Radiated Emissions at or below 960 ㎒

According to §15.519(c), the radiated emissions at or below 960 ㎒ from a device operating under the provisions of this section shall not exceed the emission levels in §15.209(a).

According to §15.521(c), Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in § 15.209(a), rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in § 15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.

According to §15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 ㎒, 76-88 ㎒, 174-216 ㎒ or 470-806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

2.2.1.3. Radiated Emissions above 960 ㎒

According to §15.519(c), the radiated emissions above 960 ㎒ from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 ㎒:

Frequency in ㎒	EIRP in ㏈m
960-1 610	-75.3
1 610-1 990	-63.3
1 990-3 100	-61.3
3 100-10 600	-41.3
Above 10 600	-61.3

According to §15.519(d), in addition to the radiated emission limits specified in the table in paragraph I of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 ㎑:

Frequency in ㎒	EIRP in ㏈m
1 164-1 240	-85.3
1 559-1 610	-85.3

According to §15.521(h), The highest frequency employed in § 15.33 to determine the frequency range over which radiated measurements are made shall be based on the center frequency, f_C, unless a higher frequency is generated within the UWB device. For measuring emission levels, the spectrum shall be investigated from the lowest frequency generated in the UWB transmitter, without going below 9 ㎑, up to the frequency range shown in § 15.33(a) or up to f_C + 3/(pulse width in seconds), whichever is higher. There is no requirement to measure emissions beyond 40 ㎓ provided f_C is less than 10 ㎓; beyond 100 ㎓ if f_C is at or above 10 ㎓ and below 30 ㎓; or beyond 200 ㎓ if f_C is at or above 30 ㎓.

2.2.2. IC

2.2.2.1. Maximum Peak Power

According to RSS-220 Issue 1 5.3.1(g), the peak level of the transmissions shall not exceed the peak equivalent of the average limit contained within any 50 ㎒ bandwidth, as defined in section 4 of the Annex.

According to RSS-220 Issue 1 section 4 of the Annex, peak measurements shall be made in addition to average measurements. Transmissions shall not exceed 0 ㏈m e.i.r.p. in any 50 ㎒ bandwidth when the average limit is -41.3 ㏈ m/㎒. This is the equivalent peak limit as calculated by combining the 6 ㏈ peak-to-average conversion with a resolution bandwidth (RBW) scaling factor of 20 log (1 ㎒/50 ㎒). Only the 50 ㎒ bandwidth, centred on the frequency f_M where the highest power occurs, needs to be measured to satisfy the peak requirements for all frequencies. A different resolution bandwidth and a correspondingly different peak limit may also be used, in which case the RBW may be set anywhere between 1 ㎒ and 50 ㎒. The peak e.i.r.p. limit is then calculated as 20 log(RBW/50) ㏈m where the RBW is in ㎒. This may be converted to a peak field strength level at 3 metres using E(㏈㎶/m) = P(e.i.r.p.(㏈m)) + 95.2. If the RBW is greater than 3 ㎒, the application for certification shall contain a detailed description of the test procedure, the calibration of the test set-up and the instrumentation used in the testing.

2.2.2.2. Radiated Emissions at or Below 960 ㎒

According to RSS-220 Issue 1 3.4, radiated emissions at or below 960 ㎒ for all subclasses of UWB device shall not exceed the following limits. Measurements of radiated emissions at and below 960 ㎒ are to be made using a CISPR quasi-peak detector. CISPR measurement bandwidth specifications are to be used.

Frequency (㎒)	Field Strength (Microvolts/m)	Measurement Distance (Metres)	E.i.r.p. (㏈㎽)
0.009-0.490	2 400/F (F in ㎑)	300	10 log (17.28 / F^2) (F in ㎑)
0.490-1.705	24 000/F (F in ㎑)	30	10 log (17.28 / F^2) (F in ㎑)
1.705-30.0	30	30	-45.7
30-88	100	3	-55.2
88-216	150	3	-51.7
216-960	200	3	-49.2

Note 1: The emission limits for the ranges 9-90 ㎑ and 110-490 ㎑ are based on measurements employing a linear average detector.

2.2.2.3. Radiated Emissions Above 960 ㎒

According to RSS-220 Issue 1 5.3.1(d), radiated emissions above 960 ㎒ from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 ㎒.

Hand-held (Outdoor) Communication, Measurement, Location Sensing, and Tracking Devices	
Frequency	**EIRP in a Resolution Bandwidth of 1 ㎒**
960-1 610 ㎒	-75.3 ㏈m
1.61-4.75 ㎓	-70.0 ㏈m
4.75-10.6 ㎓	-41.3 ㏈m
Above 10.6 ㎓	-61.3 ㏈m

According to RSS-220 Issue 1 5.3.1(e), in addition to the limits specified in paragraph (d) of this section, radiated emissions shall not exceed the following average limits when measured using a resolution bandwidth greater than or equal to 1 ㎑. The measurements shall demonstrate compliance with the stated limits at whatever resolution bandwidth is used.

Frequency	**EIRP in a Resolution Bandwidth of 1 ㎑**
1 164-1 240 ㎒	-85.3 ㏈m
1 559-1 610 ㎒	-85.3 ㏈m

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

2.3.1. Test Procedures for emission below 30 ㎒

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
b. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
c. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

2.3.2. Test Procedures for emission from 30 ㎒ to 1 000 ㎒

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
b. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.

2.3.3. Test Procedures for emission above 1 ㎓

a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 0.5 and 1 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The antenna is a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.

1. Peak power Measurement
- The Peak power measurement refer to section 10.3.5 and 10.3.6
The RBW = less than 50 ㎒ (but no less than 1 ㎒), VBW is set to at least 1 ㎒ (3 ㎒ is recommended), When this approach is employed, the peak emissions EIRP limit (0 dBm / 50 ㎒) is converted to a limit commensurate with the RBW by employing a [20 log (RBW / 50 ㎒)] relationship.
When a resolution bandwidth of less than 50 ㎒ is used, this measurement shall be performed over a 50 ㎒ span centered on the frequency associated with the highest detected average emission level.

2. Average Measurement
- The Average Measurement refer to section 10.3.7
Set the RBW to 1 ㎒ (1 ㎑ for emission in the GPS bands), VBW to be at least 1 ㎒ (3 ㎑ for emission in the GPS bands), Detector = RMS, Sweep time = no more than a 1 ㎳ integration period over each measurement bin.

2.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

2.4.1. Maximum peak power and Average emission

All emissions tested both horizontal and vertical. The following table shows the highest levels of radiated emissions on the worst polarization.

Frequency (㎒)	Reading (dB㎶)	Ant. Pol.	Detect Mode	AF (dB/m)	AMP+CL (dB)	E (dB㎶/m)	CF (dB)	E.I.R.P. (dB m)	Limit (dB m)	Margin (dB)
SP0_BPRF 4_Preamble 9										
7 902.46	100.93	H	Peak	36.20	-34.03	103.10	-104.80	-1.70	0	1.70
7 911.30	59.68	H	Average	36.18	-33.89	61.97	-104.80	-42.83	-41.3	1.53
SP0_BPRF 4_Preamble 10										
7 862.67	100.92	H	Peak	36.13	-33.13	103.92	-104.80	-0.88	0	0.88
7 879.30	59.51	H	Average	36.16	-33.69	61.98	-104.80	-42.82	-41.3	1.52
SP0_BPRF 4_Preamble 11										
7 885.52	100.62	H	Peak	36.17	-33.79	103.00	-104.80	-1.80	0	1.80
7 902.30	59.60	H	Average	36.20	-34.03	61.77	-104.80	-43.03	-41.3	1.73
SP0_BPRF 4_Preamble 12										
7 893.41	100.71	H	Peak	36.19	-33.95	102.95	-104.80	-1.85	0	1.85
7 904.30	59.45	H	Average	36.19	-34.00	61.64	-104.80	-43.16	-41.3	1.86
SP0_BPRF 20_Preamble 9										
7 903.00	100.84	H	Peak	36.19	-34.02	103.01	-104.80	-1.79	0	1.79
7 901.30	60.17	H	Average	36.20	-34.04	62.33	-104.80	-42.47	-41.3	1.17
SP0_BPRF 20_Preamble 10										
7 862.12	100.91	H	Peak	36.12	-33.11	103.92	-104.80	**-0.88**	0	0.88
7 879.30	59.96	H	Average	36.16	-33.69	62.43	-104.80	-42.37	-41.3	1.07
SP0_BPRF 20_Preamble 11										
7 885.87	100.16	H	Peak	36.17	-33.80	102.53	-104.80	-2.27	0	2.27
7 901.30	59.86	H	Average	36.20	-34.04	62.02	-104.80	-42.78	-41.3	1.48
SP0_BPRF 20_Preamble 12										
7 892.54	100.13	H	Peak	36.19	-33.93	102.39	-104.80	-2.41	0	2.41
7 885.30	59.41	H	Average	36.17	-33.79	61.79	-104.80	-43.01	-41.3	1.71

Frequency (㎒)	Reading (dB㎶)	Ant. Pol.	Detect Mode	AF (dB/m)	AMP+CL (dB)	E (dB㎶/m)	CF (dB)	E.I.R.P. (dB m)	Limit (dB m)	Margin (dB)
SP3_ Preamble 9										
7 925.29	92.15	H	Peak	36.15	-33.66	94.64	-104.80	-10.16	0	10.16
7 915.30	60.08	H	Average	36.17	-33.82	62.43	-104.80	-42.37	-41.3	1.07
SP3_ Preamble 10										
7 886.94	90.62	H	Peak	36.17	-33.82	92.97	-104.80	-11.83	0	11.83
7 872.30	59.66	H	Average	36.14	-33.50	62.30	-104.80	-42.50	-41.3	1.20
SP3_Preamble 11										
7 920.80	91.92	H	Peak	36.16	-33.74	94.34	-104.80	-10.46	0	10.46
7 915.30	60.14	H	Average	36.17	-33.82	62.49	-104.80	-42.31	-41.3	1.01
SP3_Preamble 12										
7 924.64	92.44	H	Peak	36.15	-33.68	94.91	-104.80	-9.89	0	9.89
7 915.30	60.18	H	Average	36.17	-33.82	62.53	-104.80	**-42.27**	-41.3	0.97

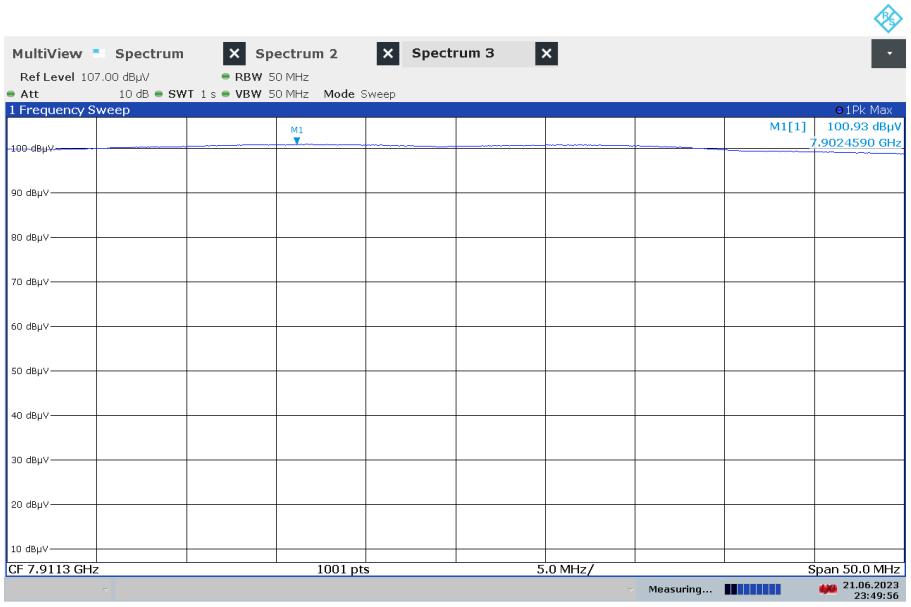
Remark;

1. E (dB㎶/m) = Reading (dB㎶) + Antenna Factor (dB/m) + Amp (dB) + Cable Loss (dB).
2. E.I.R.P. (dB m) = E (dB㎶/m) + 20 log D – 104.8; where D is the measurement distance in meters.
3. CF (dB) (E.I.R.P.) = 20 log D – 104.8;
4. All the emissions were measured at a 1 meter test distance.
5. AF = Antenna Factor, AMP = Amplifier, CL = Cable Loss.

- Test plots

- SP0_BPRF 4_Preamble 9

Maximum Peak power



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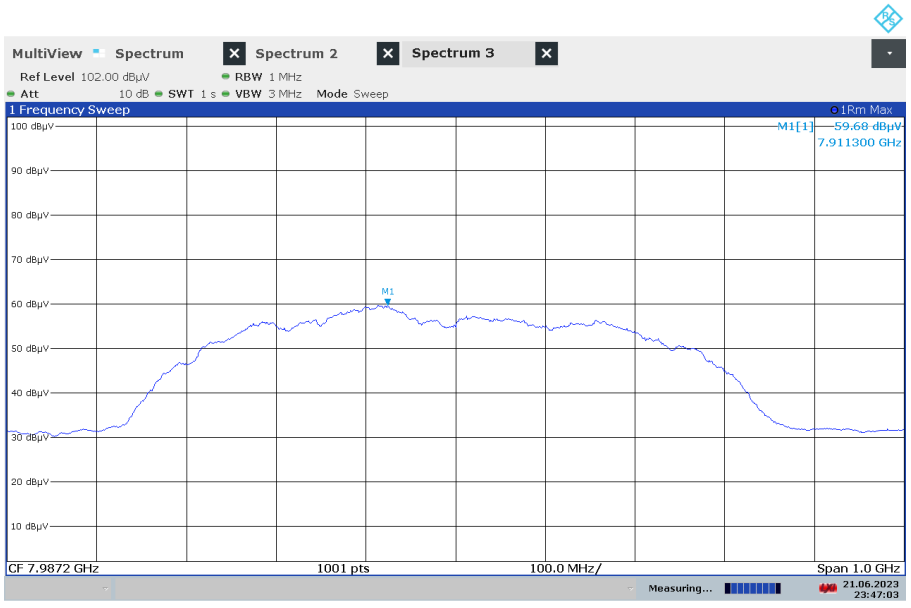
Average emission



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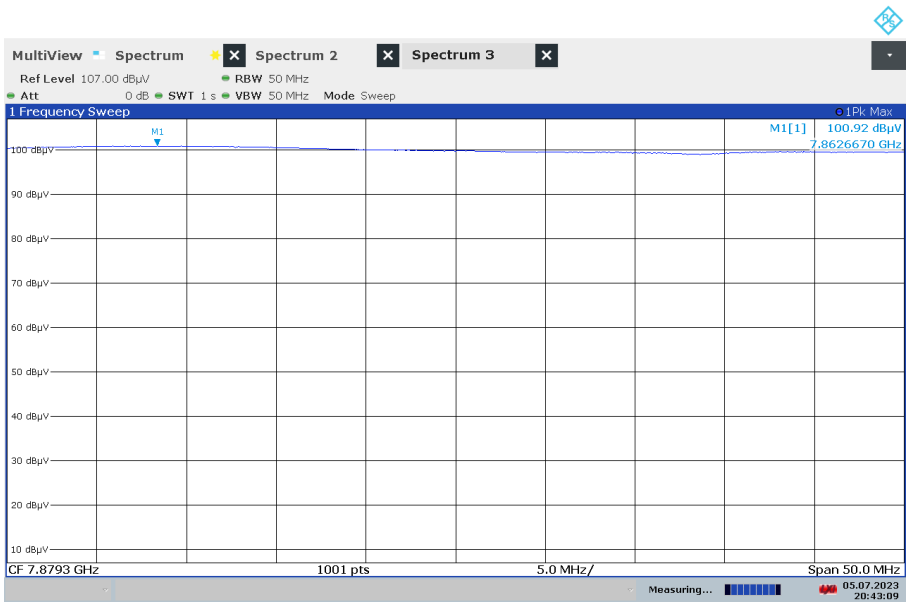
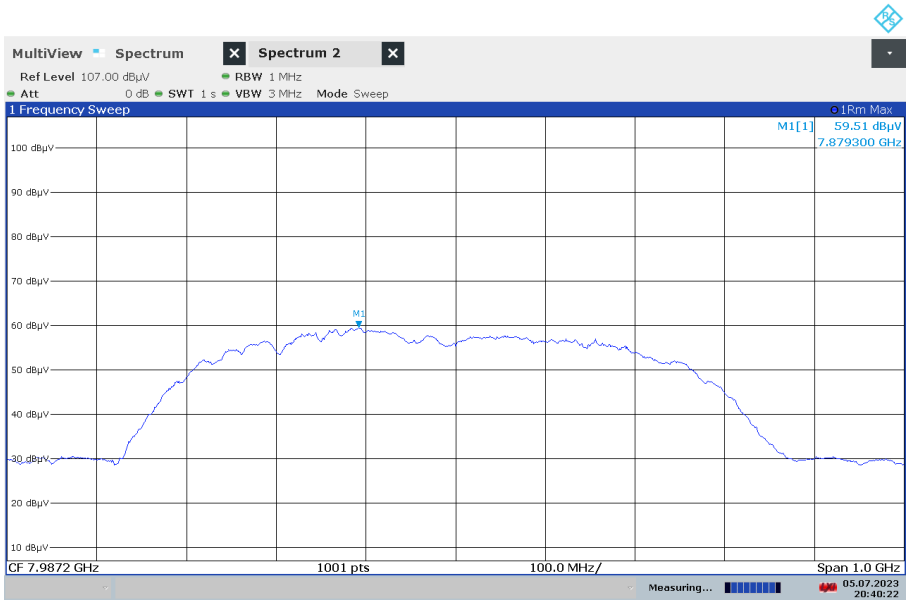
- SP0_BPRF 4_Preamble 10

Maximum Peak power

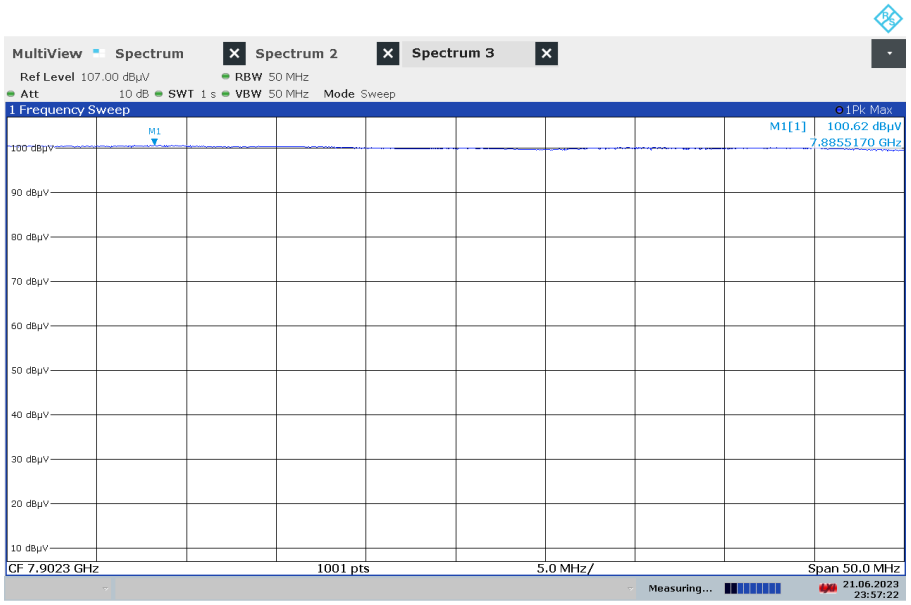


Average emission



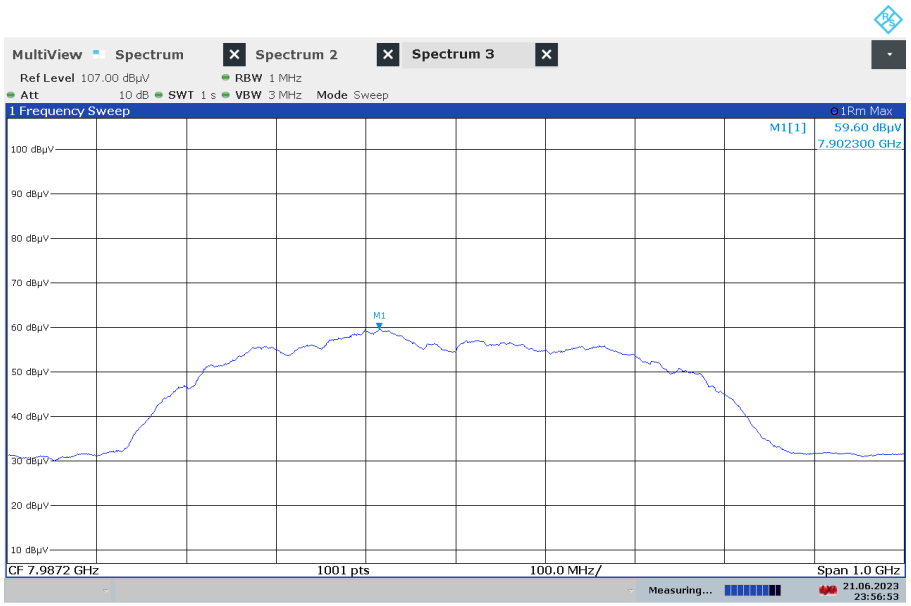
- SP0_BPRF 4_Preamble 11

Maximum Peak power



23:57:22 21.06.2023

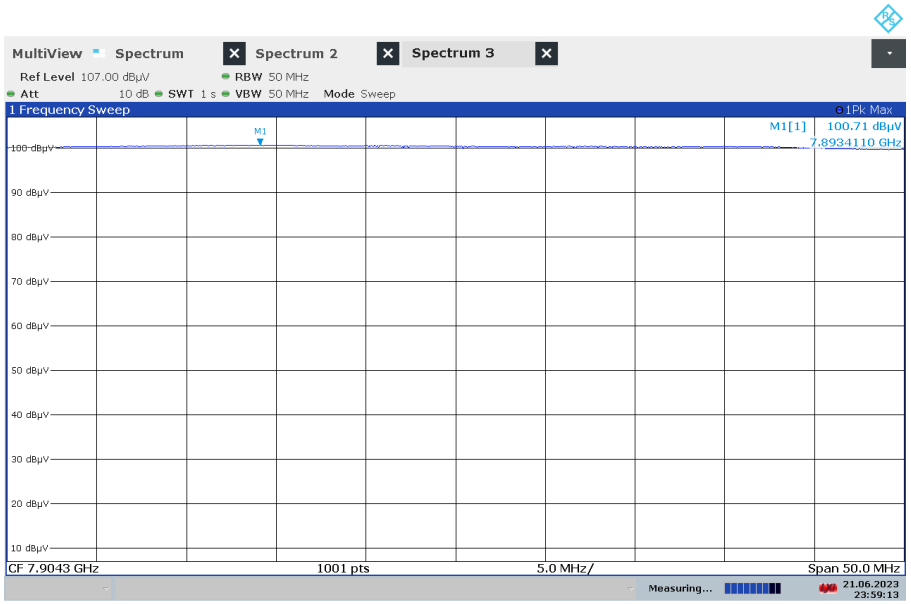
Average emission



23:56:54 21.06.2023

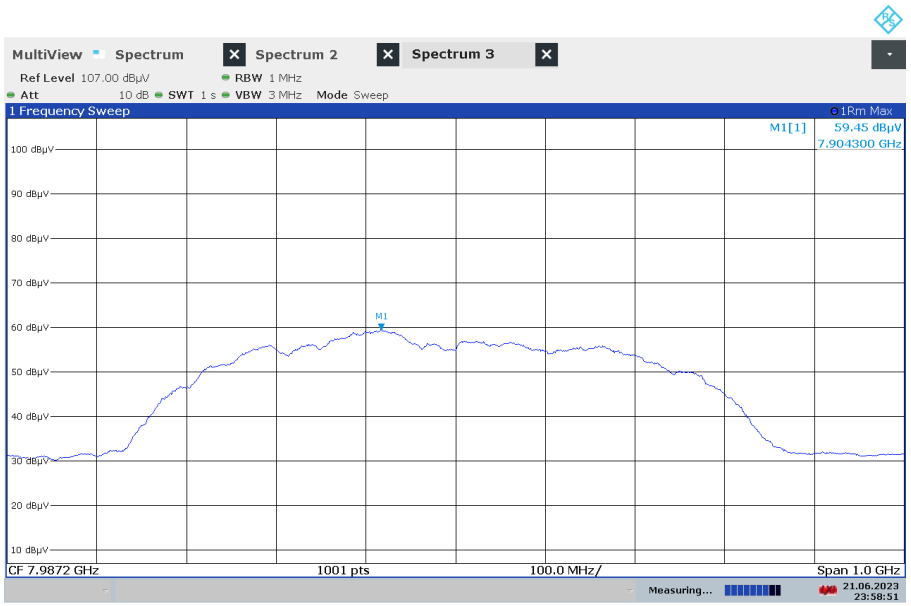
- SP0_BPRF 4_Preamble 12

Maximum Peak power



23:59:14 21.06.2023

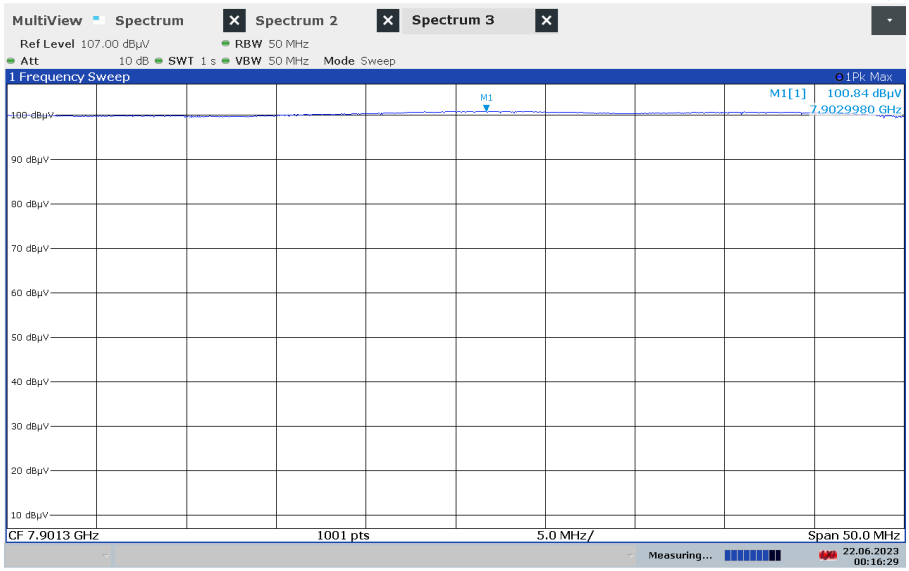
Average emission



23:58:51 21.06.2023

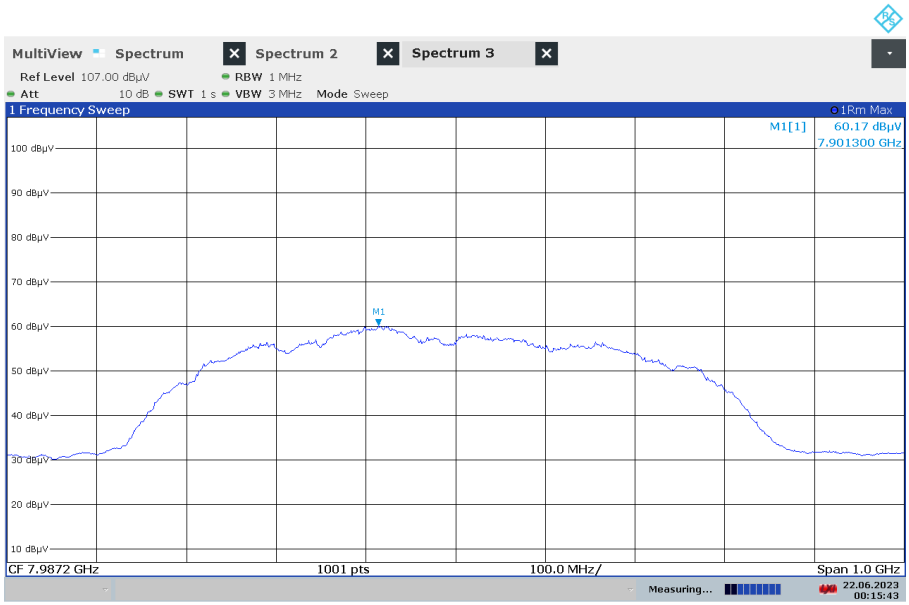
- SP0_BPRF 20_Preamble 9

Maximum Peak power



00:16:30 22.06.2023

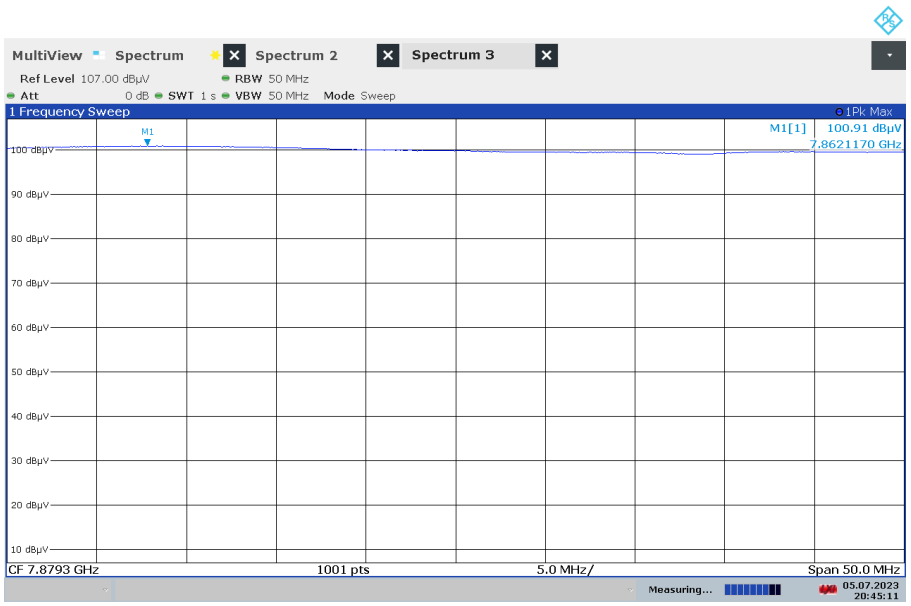
Average emission



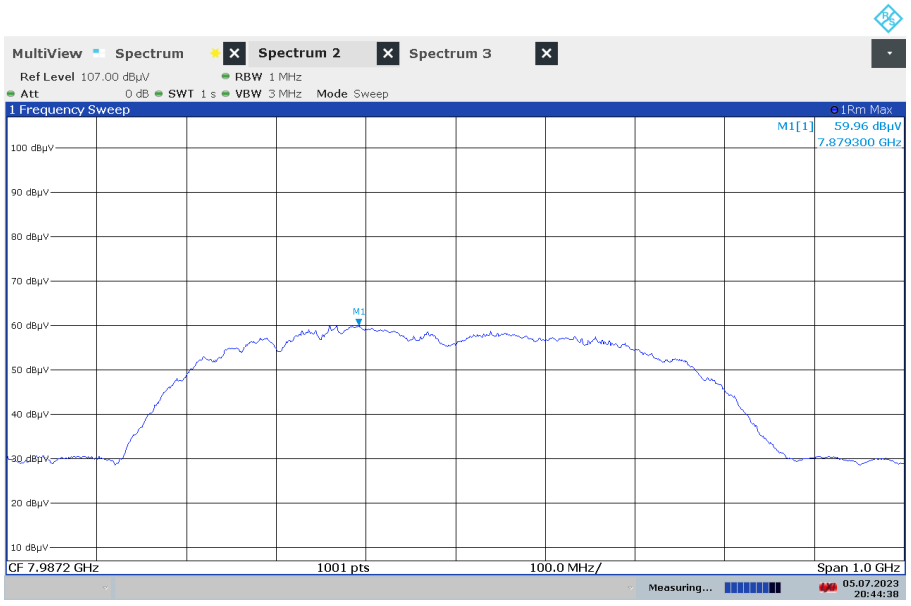
00:15:43 22.06.2023

- SP0_BPRF 20_Preamble 10

Maximum Peak power

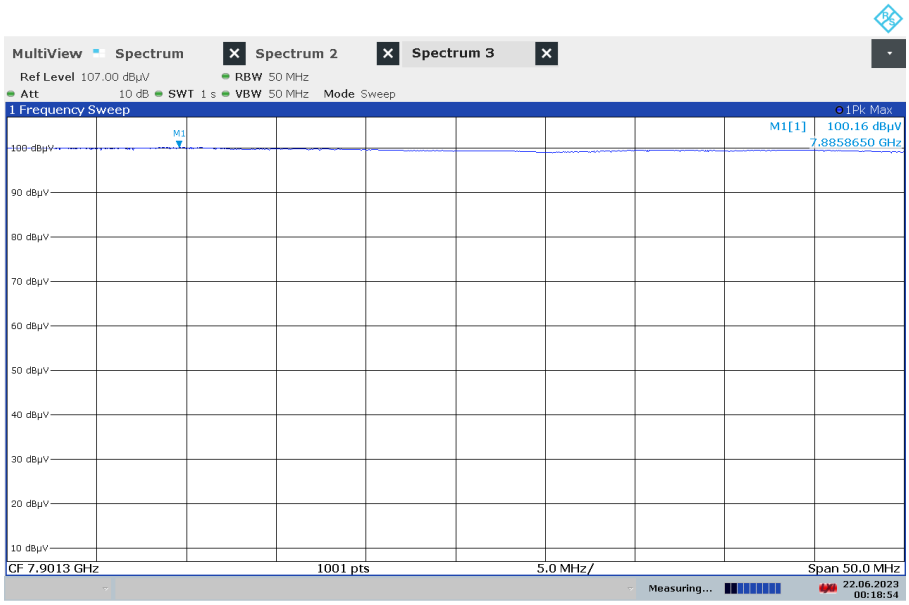


Average emission



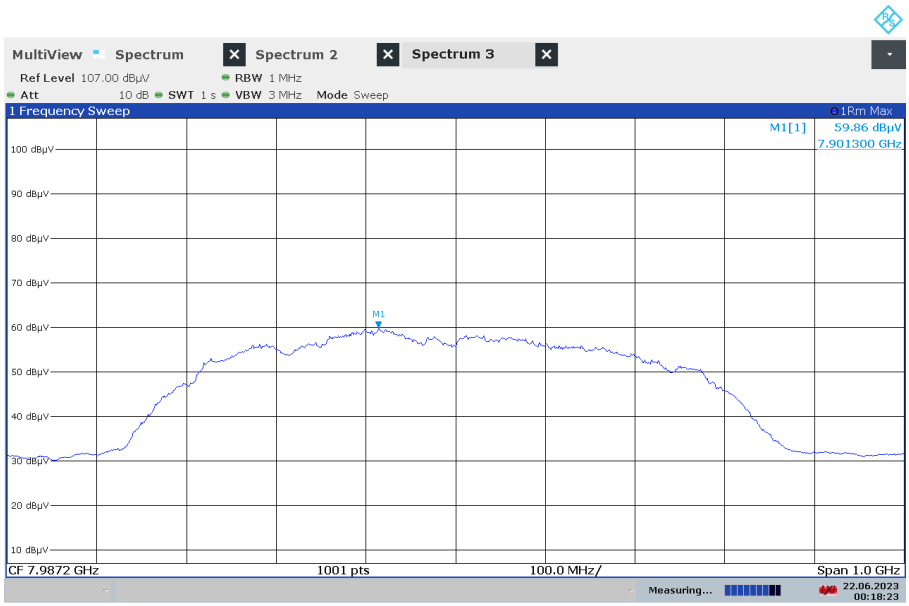
- SP0_BPRF 20_Preamble 11

Maximum Peak power



00:18:55 22.06.2023

Average emission



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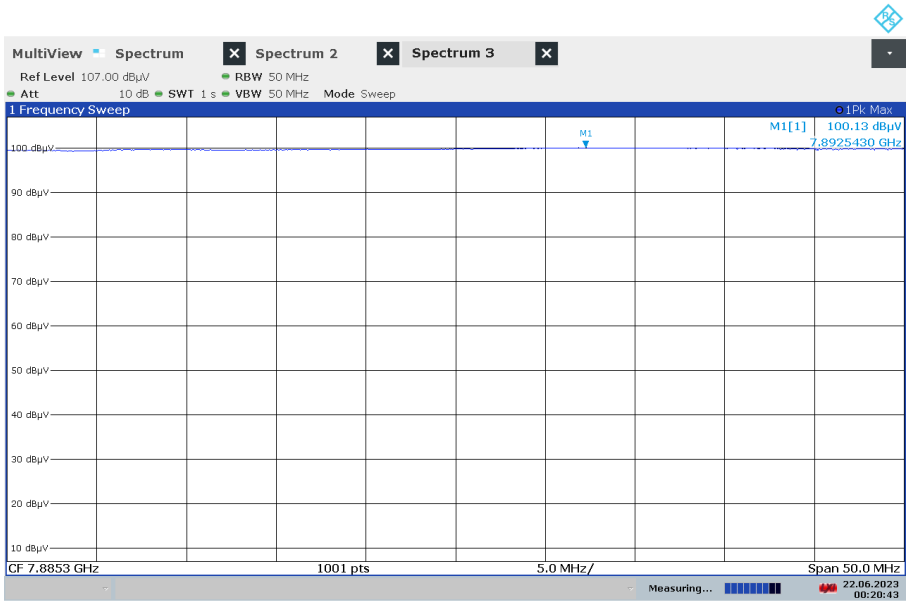
- SP0_BPRF 20_Preamble 12

Maximum Peak power



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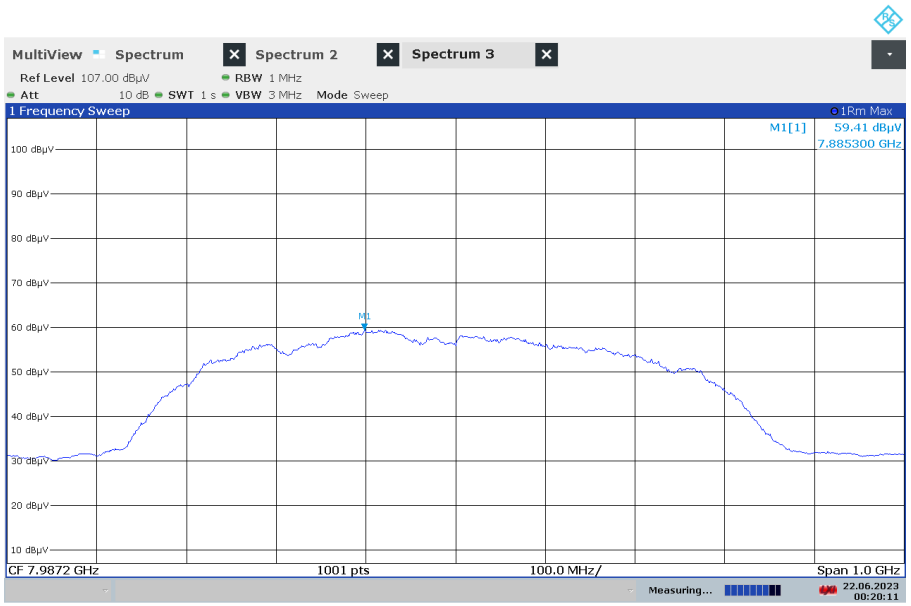
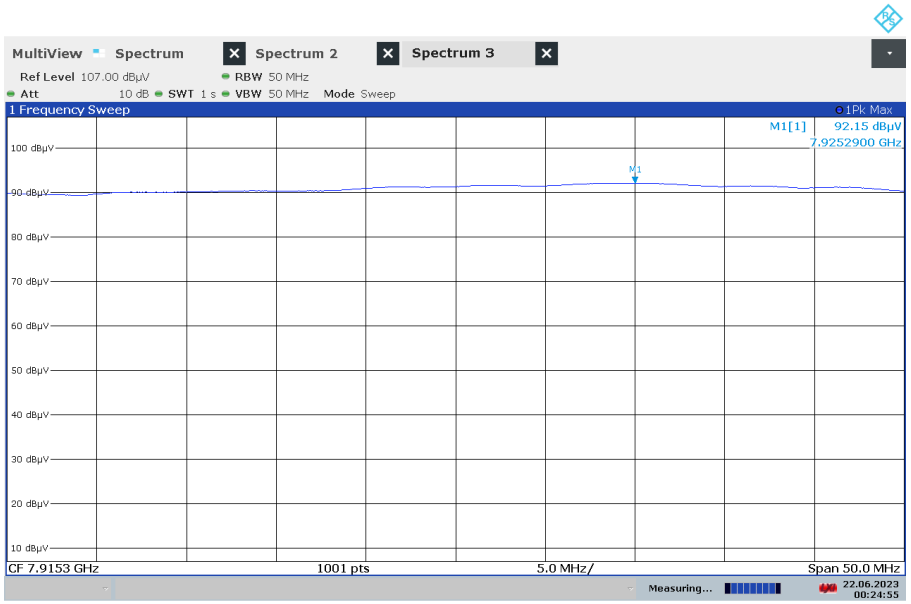
Average emission



00:20:11 22.06.2023

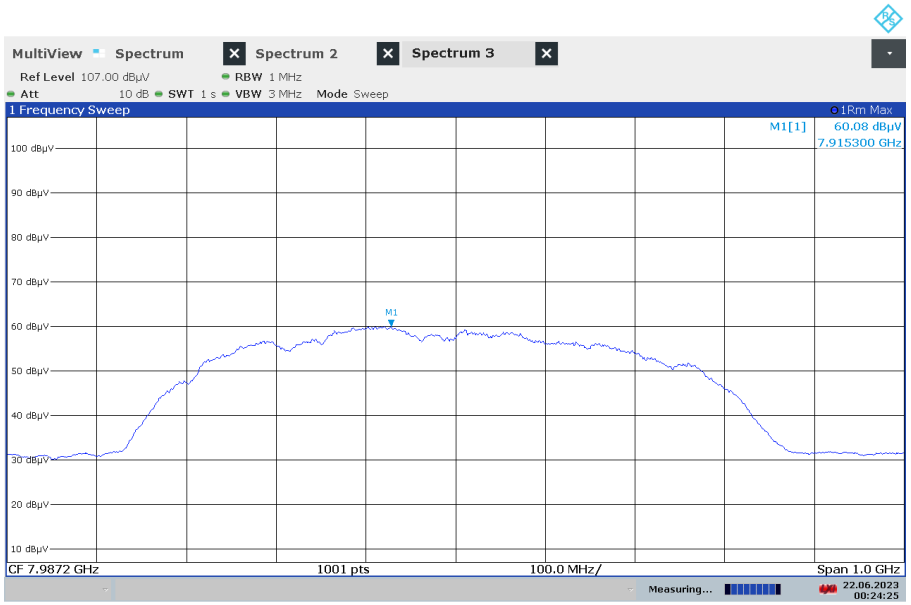
- SP3_Preamble 9

Maximum Peak power



00:24:56 22.06.2023

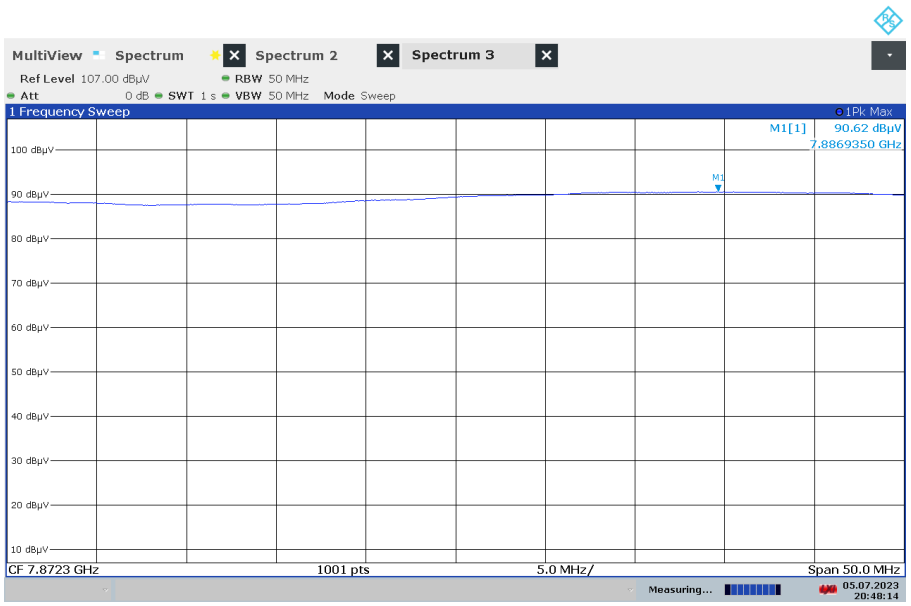
Average emission



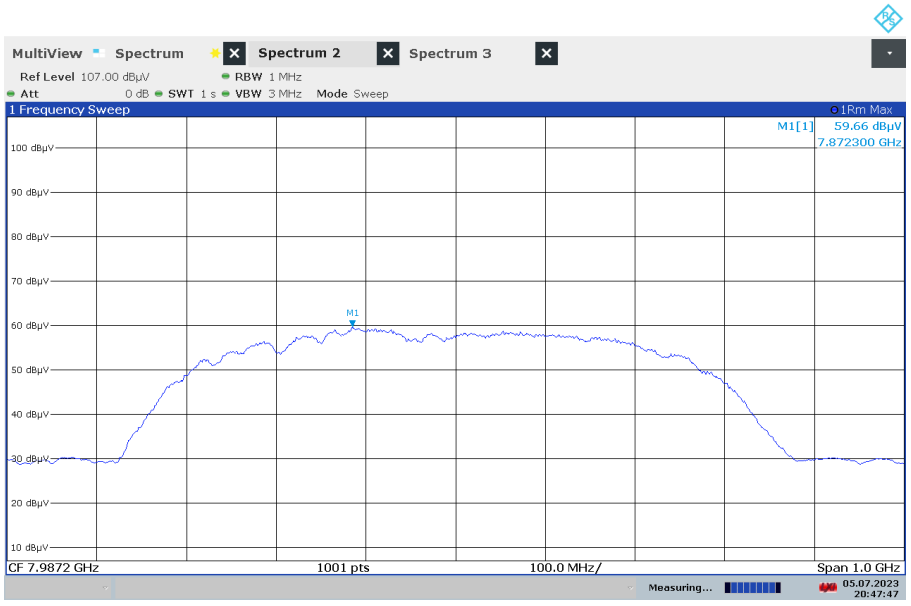
00:24:26 22.06.2023

- SP3_Preamble 10

Maximum Peak power

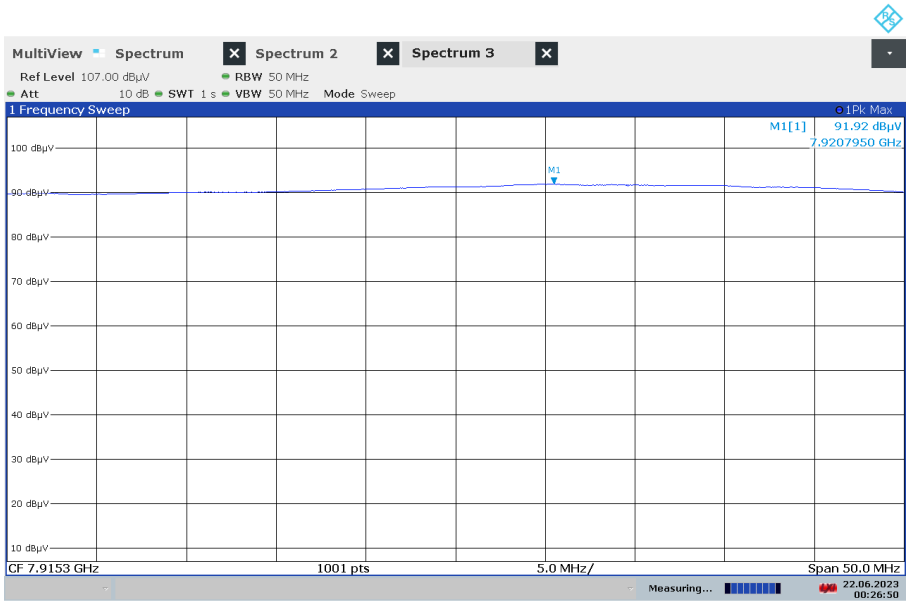


Average emission



- SP3_Preamble 11

Maximum Peak power



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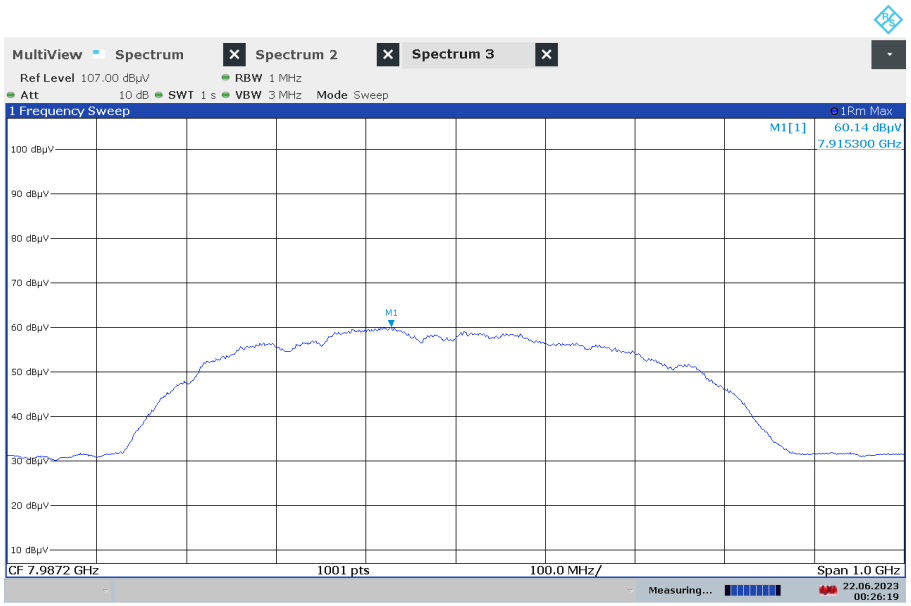
Average emission



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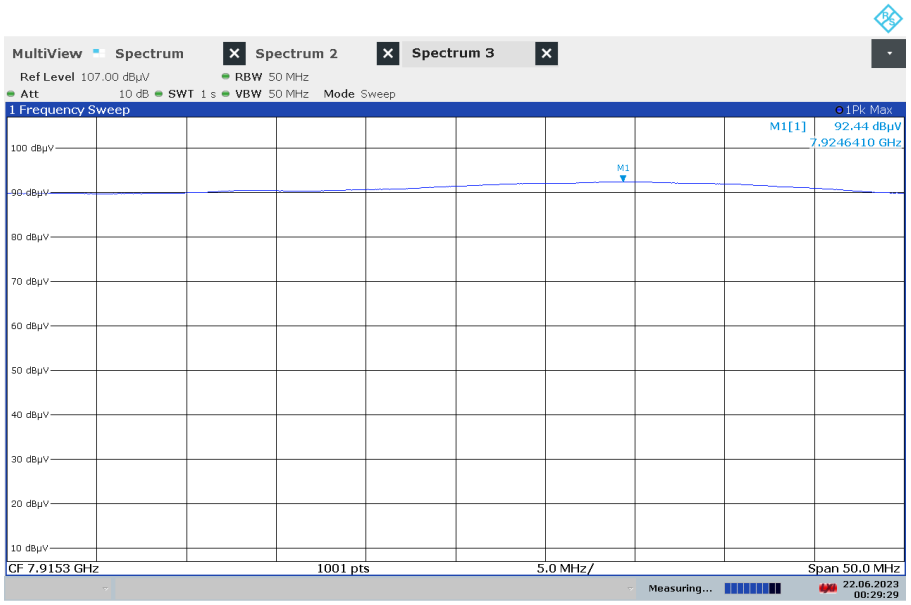
- SP3_Preamble 12

Maximum Peak power



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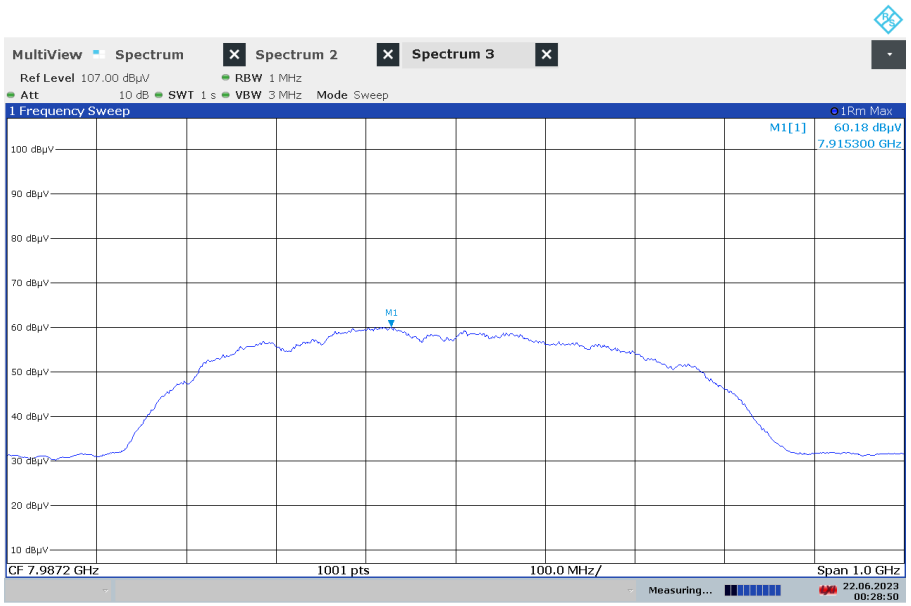
Average emission



00:28:50 22.06.2023

2.4.2. Radiated Spurious Emission below 960 ㎒

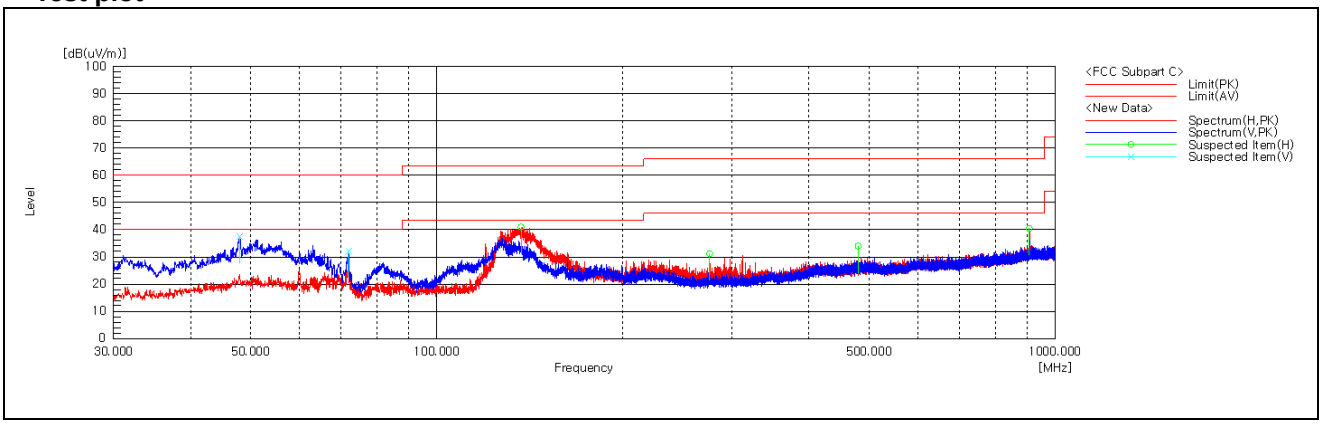
The frequency spectrum from 9 ㎑ to 960 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
47.99	45.10	Peak	V	19.70	-27.36	37.44	40.00	2.56
71.99	44.90	Peak	V	14.31	-27.05	32.16	40.00	7.84
136.86	53.50	Peak	H	13.90	-26.45	**40.95**	43.50	2.55
276.26	38.20	Peak	H	18.51	-25.56	31.15	46.00	14.85
480.00	37.10	Peak	H	22.60	-25.65	34.05	46.00	11.95
907.73	37.30	Peak	H	27.90	-24.66	40.54	46.00	5.46

Remark;

1. Test from 30 ㎒ to 960 ㎒ was performed using the software of EP5RE(V5.3.70) from TOYO.
2. Reported spurious emissions are measured in worst case among configurations.
3. Radiated spurious emission measurement as below.
   (Actual = Reading + AF + AMP + CL)
4. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.

- Test plot



2.4.3. Radiated Spurious Emission above 960 ㎒

All emissions tested both horizontal and vertical. The following table shows the highest levels of radiated emissions on the worst polarization.

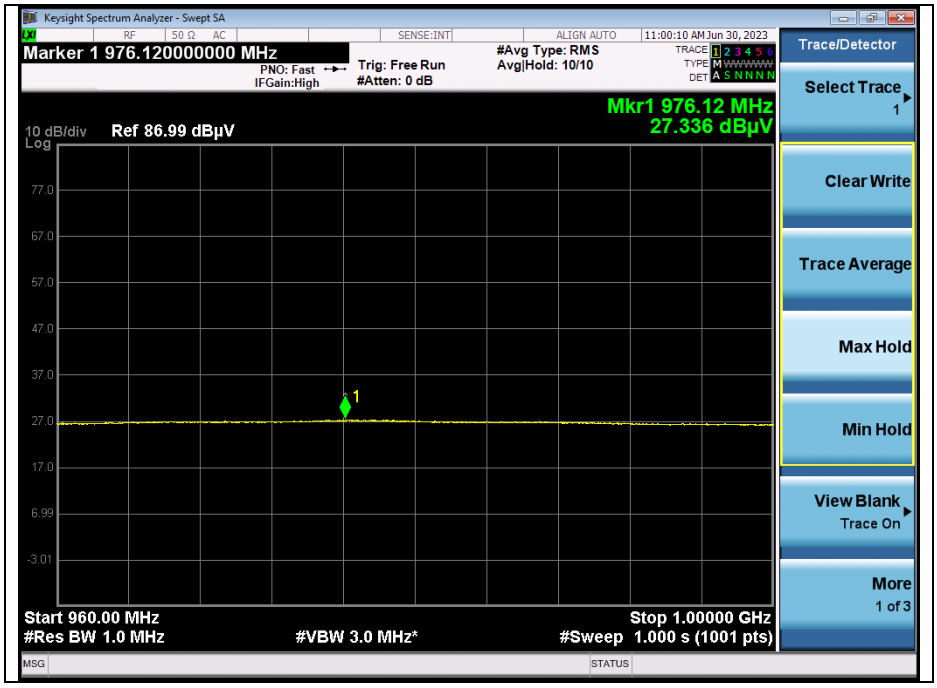
Frequency (㎒)	Reading (dB㎶)	Ant. Pol.	AF (dB/m)	AMP+CL (dB)	E (dB㎶/m)	CF (dB)	E.I.R.P. (dB m)	Limit (dB m)		Margin (dB)	
								FCC	IC	FCC	IC
976.12	27.34	H	28.00	-24.19	31.15	-110.82	-79.67	-75.30		4.37	
1 024.40	38.28	H	24.25	-41.62	20.91	-110.82	-89.91	-75.30		14.61	
*1 174.36	9.06	H	25.10	-41.04	-6.88	-110.82	-117.70	-85.30		32.40	
*1 572.52	7.96	H	25.35	-40.29	-6.98	-110.82	-117.80	-85.30		32.50	
1 745.66	36.73	H	26.87	-39.87	23.73	-110.82	-87.09	-63.30	-70.00	23.79	17.09
2 012.20	36.22	H	27.88	-39.12	24.98	-110.82	-85.84	-61.30	-70.00	24.54	15.84
3 155.55	34.57	H	30.33	-37.97	26.93	-110.82	-83.89	-41.30	-70.00	42.59	13.89
5 283.52	31.56	H	33.83	-35.26	30.13	-110.82	-80.69	-41.30		39.39	
10 647.36	27.09	H	37.89	-31.00	33.98	-110.82	-76.84	-61.30		15.54	
Above 10 700.00	Not detected	-	-	-	-	-	-	-		-	

Remark;

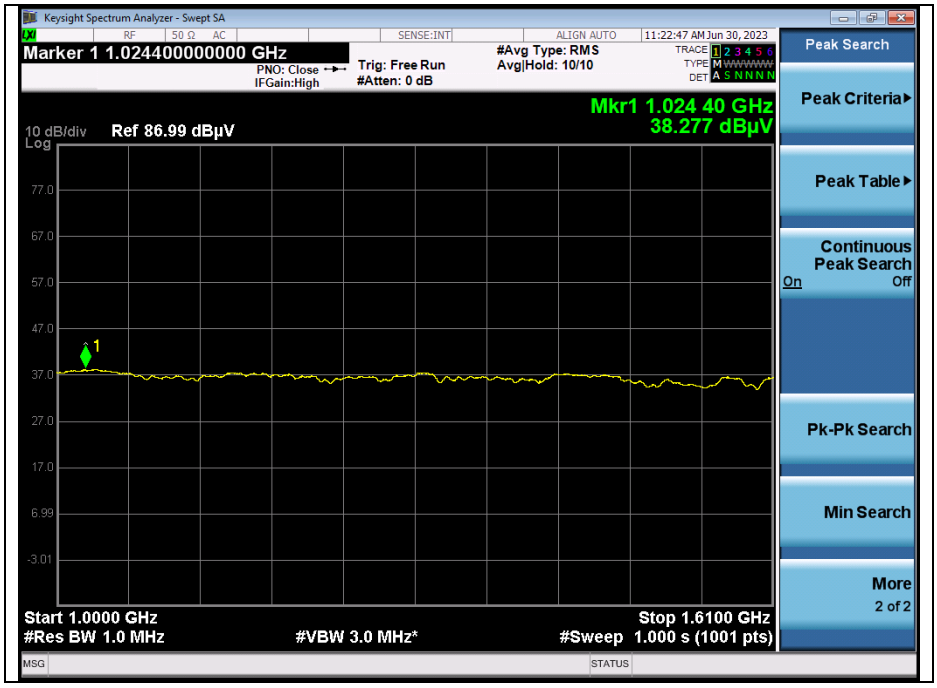
1. E (dB㎶/m) = Reading (dB㎶) + Antenna Factor (dB/m) + Amp (dB) + Cable Loss (dB).
2. E.I.R.P. (dB m) = E (dB㎶/m) + 20 log D - 104.8; where D is the measurement distance in meters.
3. CF (dB) (E.I.R.P.) = 20 log D - 104.8
4. All the emissions above 960 ㎒ were measured at a 0.5 meter test distance.
5. Reported spurious emissions are measured in worst case among configurations.
6. "*" means the GPS band.
7. Measurement In frequency 1 164-1 240 ㎒ and 1 559-1 610 ㎒, RBW is set to 1 ㎑.
8. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 dB.
9. AF = Antenna Factor, AMP = Amplifier, CL = Cable Loss.

- Test plots

960 ㎒ ~ 1 000 ㎒

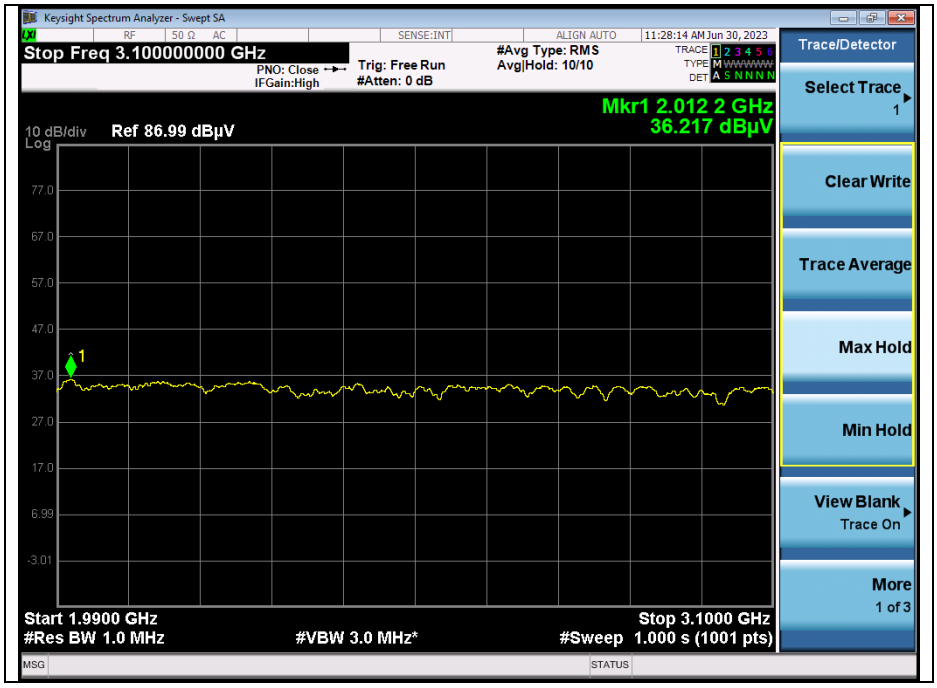


1 000 ㎒ ~ 1 610 ㎒

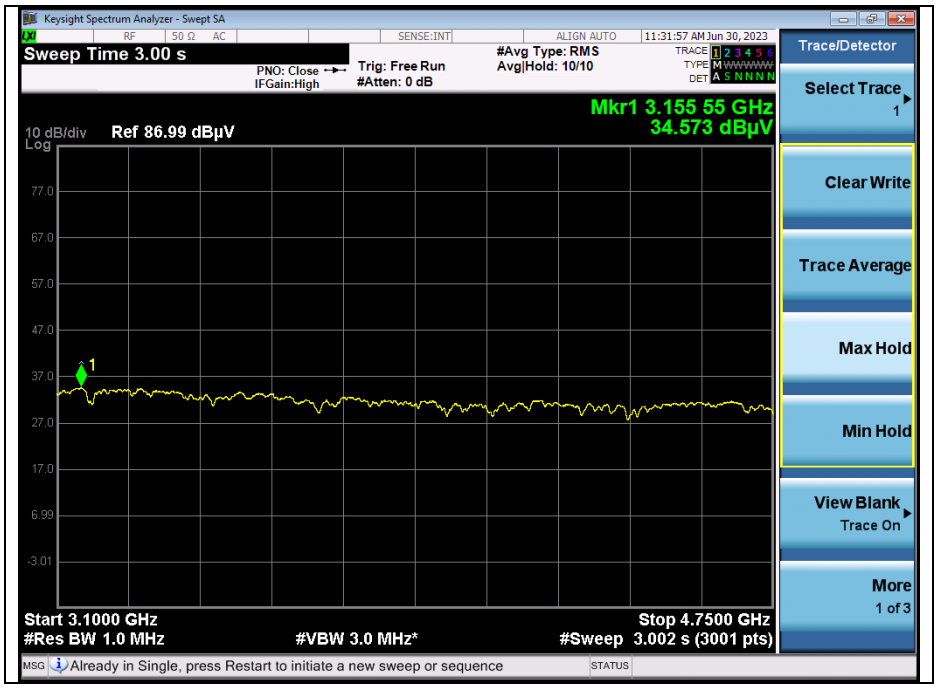


1 610 ㎒ ~ 1 990 ㎒

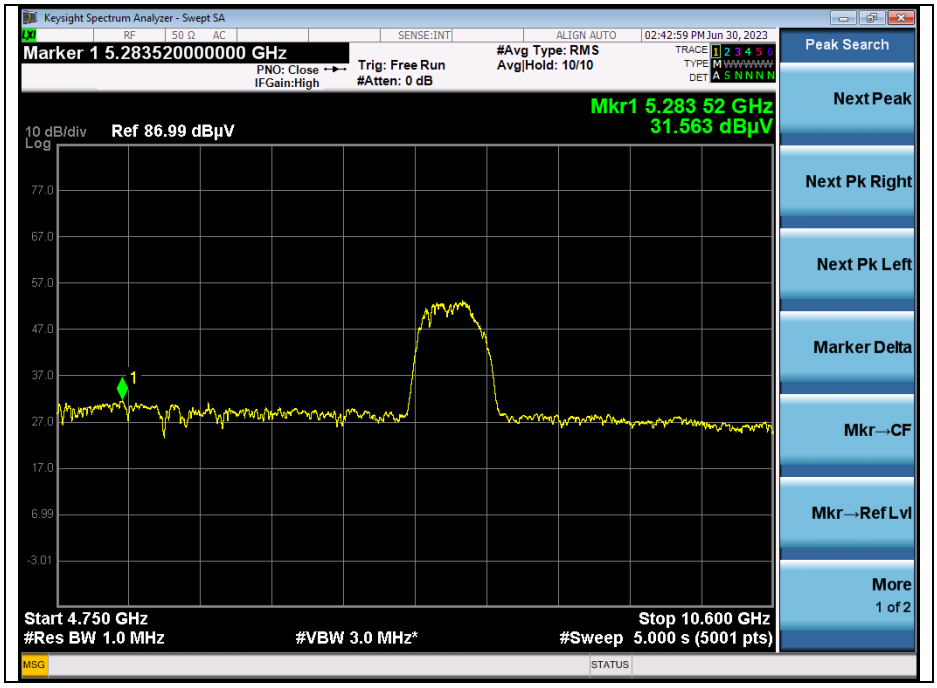
1 990 ㎒ ~ 3 100 ㎒



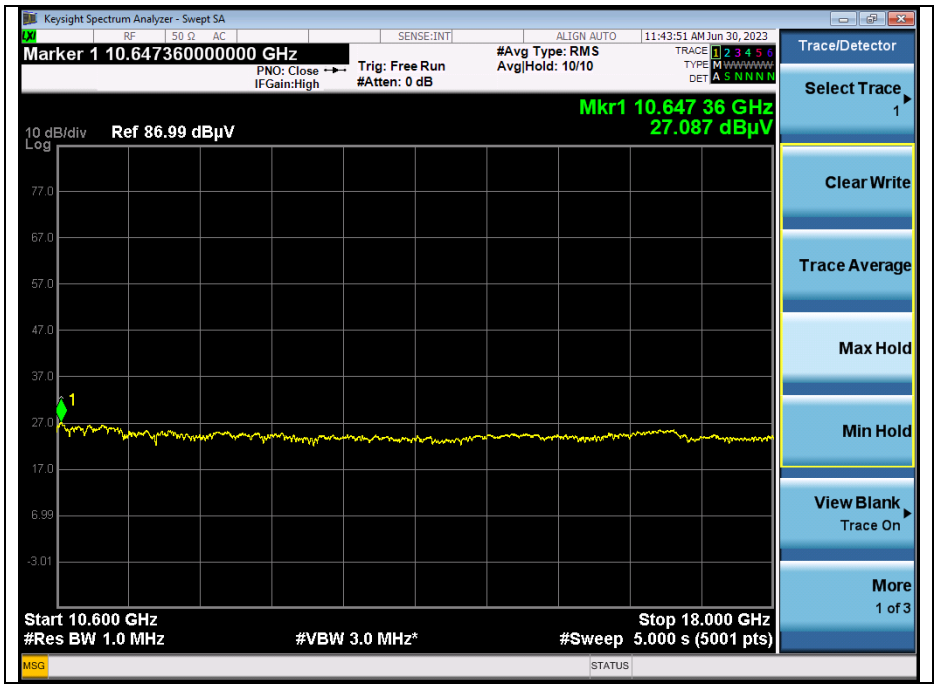
3 100 ㎒ ~ 4 750 ㎒



4 750 ㎒ ~ 10 600 ㎒

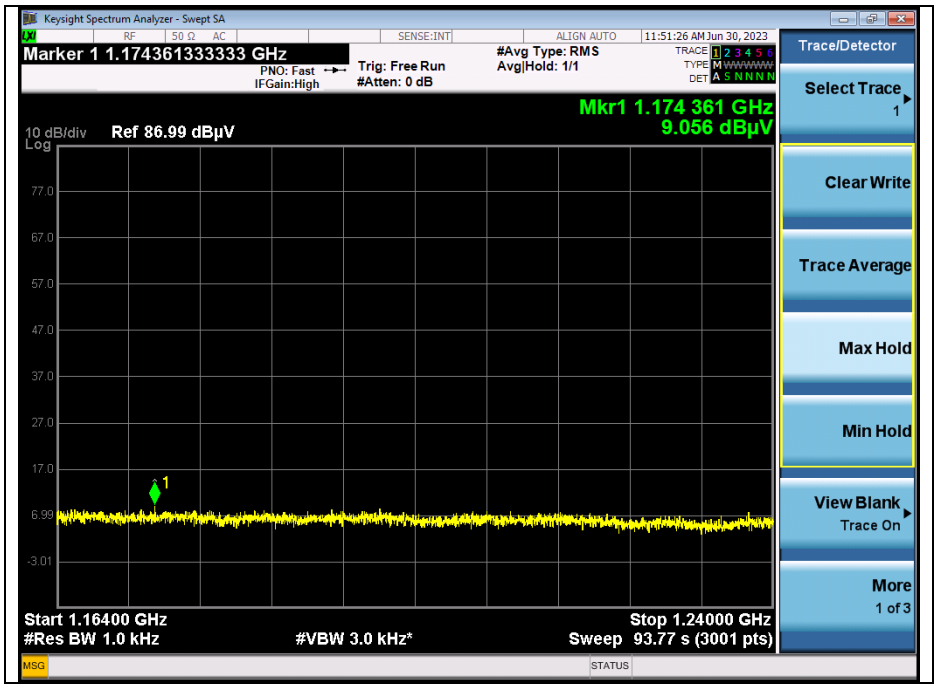


10 600 ㎒ ~ 18 000 ㎒

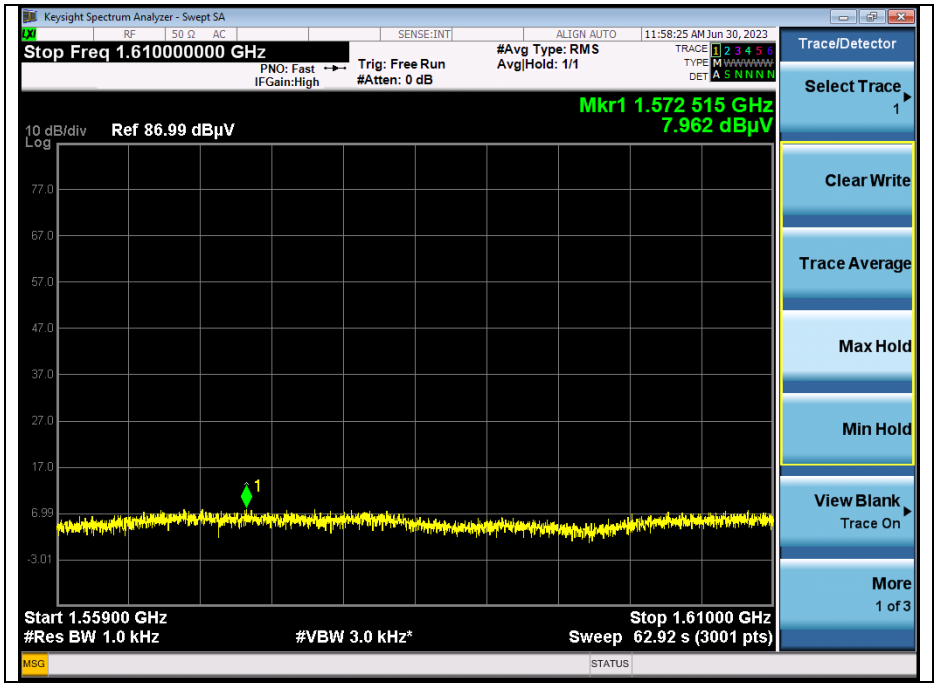

Keysight Spectrum Analyzer - Swept SA
Marker 1 10.647360000000 GHz
PNO: Close
IFGain:High
Trig: Free Run
#Atten: 0 dB
#Avg Type: RMS
Avg|Hold: 10/10
11:43:51 AM Jun 30, 2023
Mkr1 10.647 36 GHz
27.087 dBµV
10 dB/div
Log
Ref 86.99 dBµV
77.0
67.0
57.0
47.0
37.0
27.0
17.0
6.99
-3.01
Start 10.600 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz*
Stop 18.000 GHz
#Sweep 5.000 s (5001 pts)
Trace/Detector
Select Trace 1
Clear Write
Trace Average
Max Hold
Min Hold
View Blank Trace On
More 1 of 3
MSG
STATUS

- GPS Band

1 164 - 1 240 ㎒

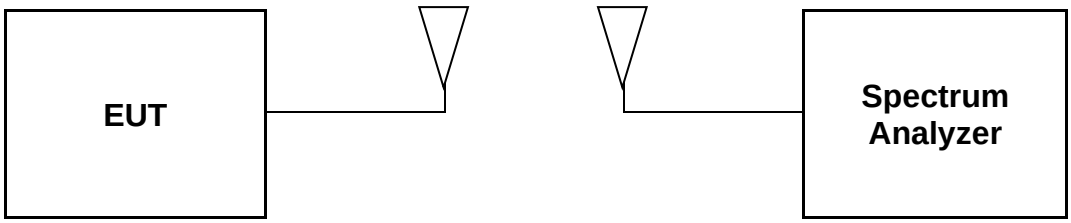


1 559 - 1 610 ㎒



3. 10 dB Bandwidth

3.1. Test Setup



3.2. Limit

3.2.1. FCC

According to §15.503(a), for the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna.

According to §15.519(b), the UWB bandwidth of a device operating under the provisions of this section must be contained between 3 100 MHz and 10,600 MHz.

According to §15.521(e), The frequency at which the highest radiated emission occurs, f_M, must be contained within the UWB bandwidth.

3.2.2. IC

According to 2 of RSS-220 Issue 1, a UWB device is an intentional radiator that has either a -10 dB bandwidth of at least 500 MHz or a -10 dB fractional bandwidth greater than 0.2. There are eight distinct subclasses of UWB device.

3.3. Test Procedure

10 dB Bandwidth

The test follows section 10.1 of ANSI C63.10-2013.

The frequency at which the maximum power level is measured with the peak detector is designated f_M. The peak power measurements shall be made using a spectrum analyzer or EMI receiver with a 1 MHz resolution bandwidth and a video bandwidth of 1 MHz or greater. The instrument shall be set to peak detection using the maximum-hold trace mode. The outermost 1 MHz segments above and below f_M, where the peak power falls by 10 dB relative to the level at f_M, are designated as f_H and f_L, respectively:

a) For the lowest frequency bound f_L, the emission is searched from a frequency lower than f_M that has, by inspection, a peak power much lower than 10 dB less than the power at f_M and increased toward f_M until the peak power indicates 10 dB less than the power at f_M. The frequency of that segment is recorded.

b) This process is repeated for the highest frequency bound f_H, beginning at a frequency higher than f_M that has, by inspection, a peak power much lower than 10 dB below the power at f_M. The frequency of that segment is recorded.

c) The two recorded frequencies represent the highest f_H and lowest f_L bounds of the UWB transmission, and the -10 dB bandwidth (B – 10) is defined as (f_H – f_L). The center frequency (f_c) is mathematically determined from (f_H – f_L) / 2.

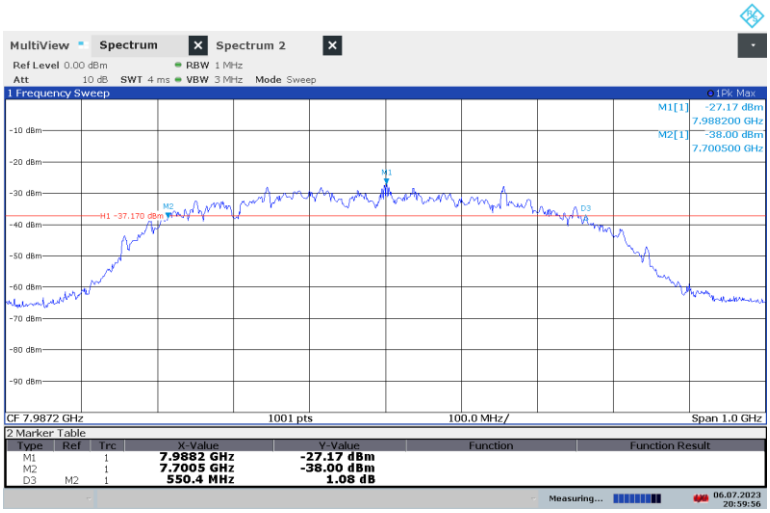
3.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

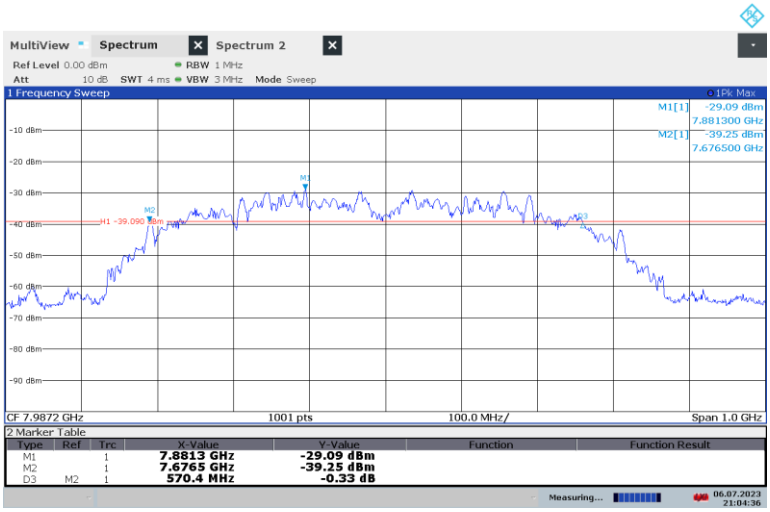
Channel	Configure	Packet length	Preamble	f_M (㎒)	f_L (㎒)	f_H (㎒)	f_C (㎒)	10 dB BW (㎒)	Minimum BW (㎒)
9	SP0	4	9	7 988.20	7 700.50	8 250.90	7 975.70	550.40	500
			10	7 881.30	7 676.50	8 246.90	7 961.70	570.40	
			11	7 887.30	7 676.50	8 259.90	7 968.20	583.40	
			12	7 891.30	7 676.50	8 253.90	7 965.20	577.40	
		20	9	7 902.30	7 676.50	8 251.90	7 964.20	575.40	
			10	7 829.40	7 676.50	8 245.90	7 961.20	569.40	
			11	7 879.30	7 685.50	8 262.90	7 974.20	577.40	
			12	7 875.30	7 678.50	8 246.90	7 962.70	568.40	
	SP3	-	9	7 893.30	7 702.50	8 243.00	7 972.75	540.50	
			10	7 893.30	7 701.50	8 244.00	7 972.75	542.50	
			11	7 893.30	7 704.50	8 243.00	7 973.75	538.50	
			12	7 893.30	7 704.50	8 243.00	7 973.75	538.50	

- Test plot

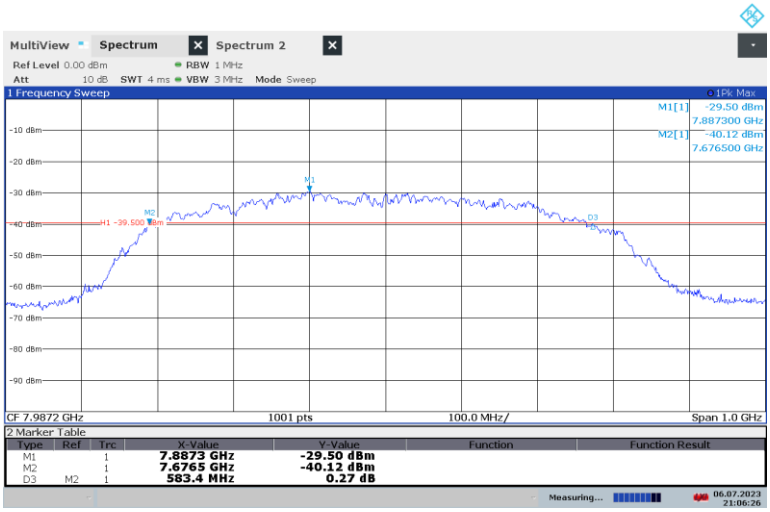
SP0_BPRF 4_Preamble 9



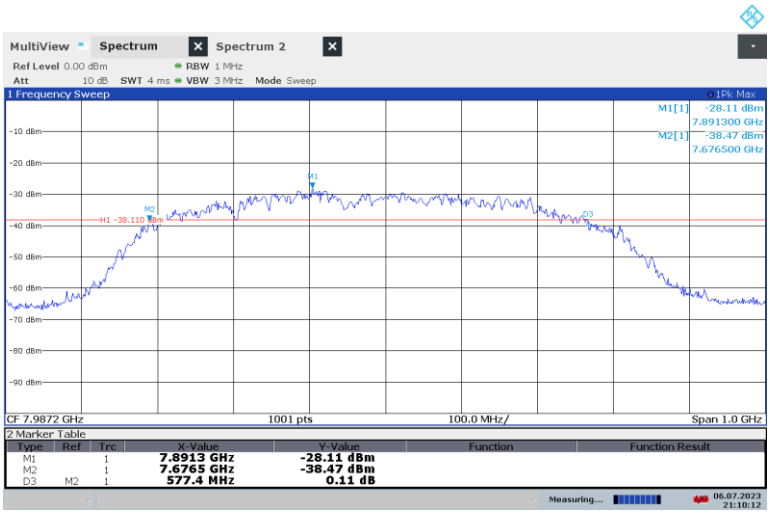
SP0_BPRF 4_Preamble 10



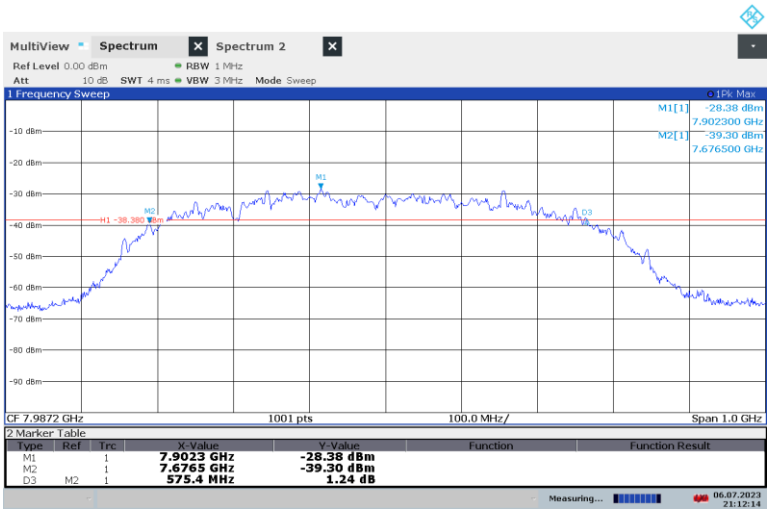
SP0_BPRF 4_Preamble 11



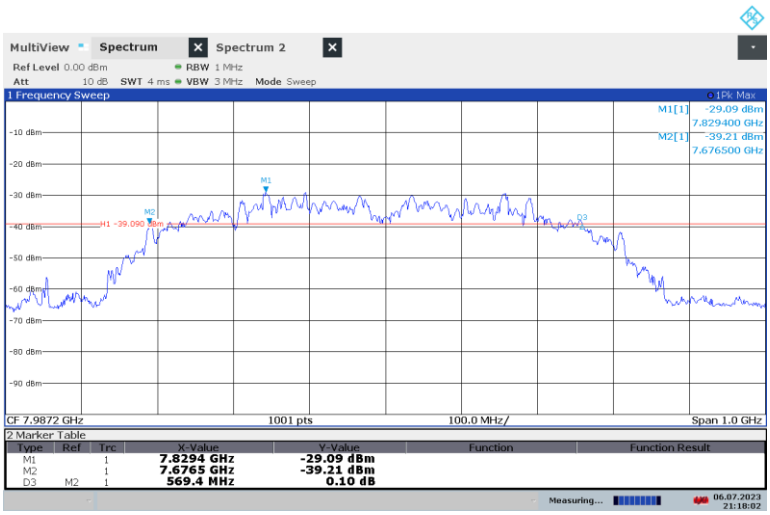
SP0_BPRF 4_Preamble 12



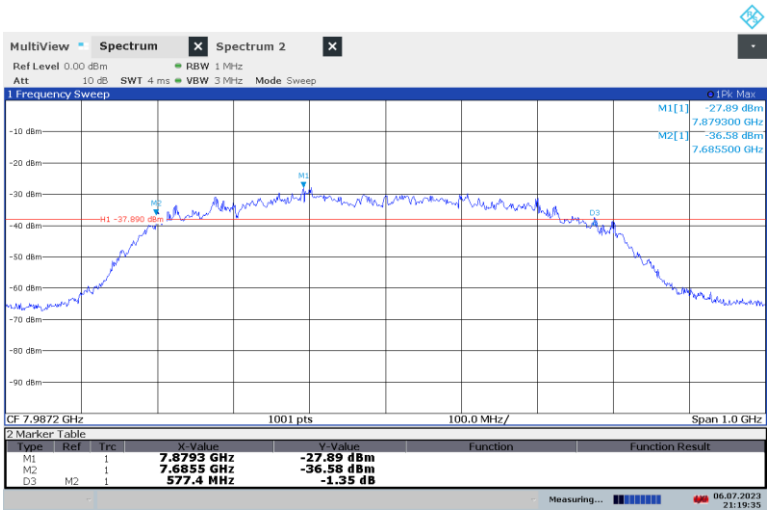
SP0_BPRF 20_Preamble 9



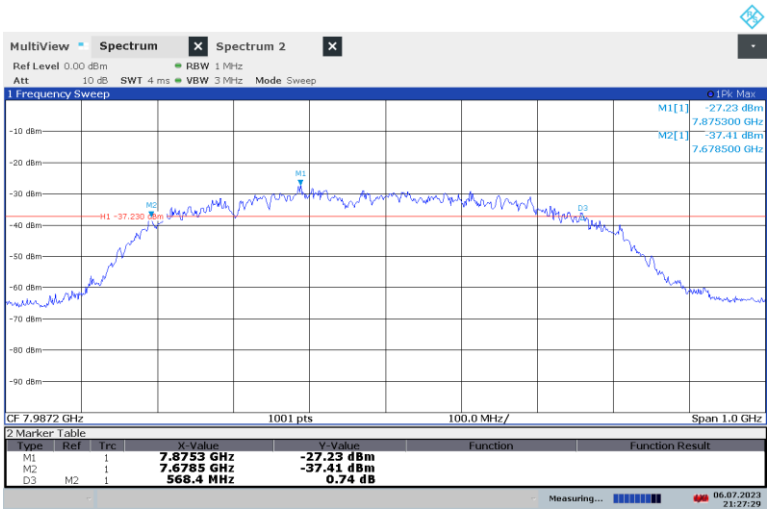
SP0_BPRF 20_Preamble 10



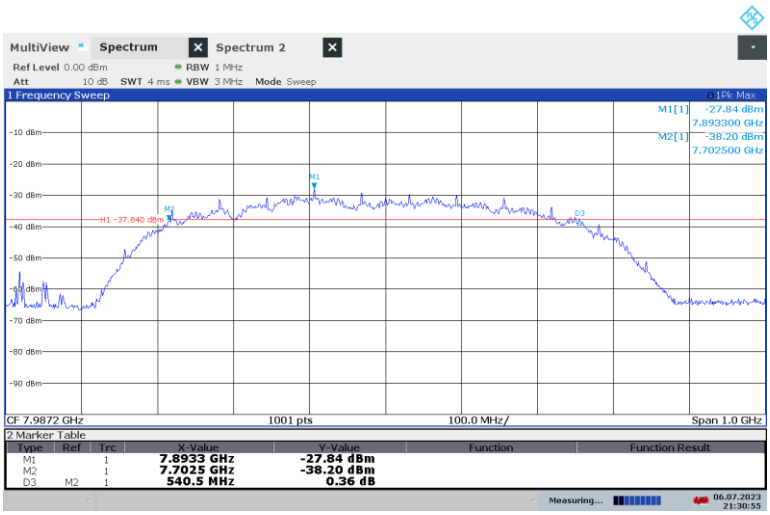
SP0_BPRF 20_Preamble 11



SP0_BPRF 20_Preamble 12



SP3_Preamble 9



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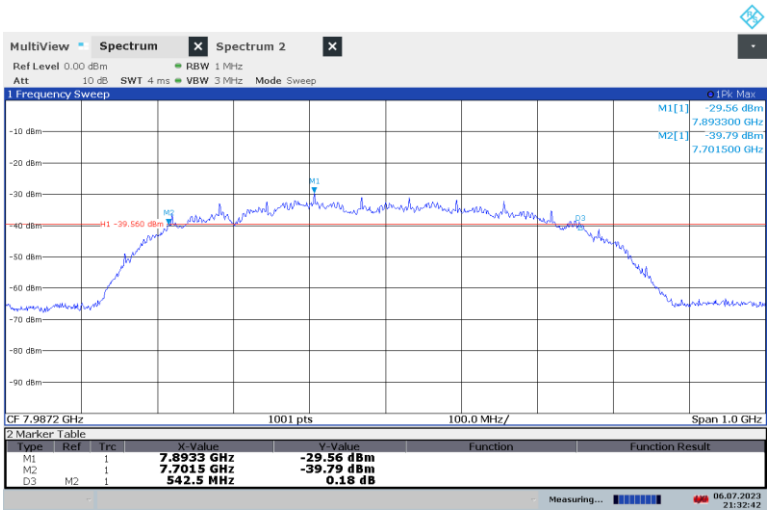

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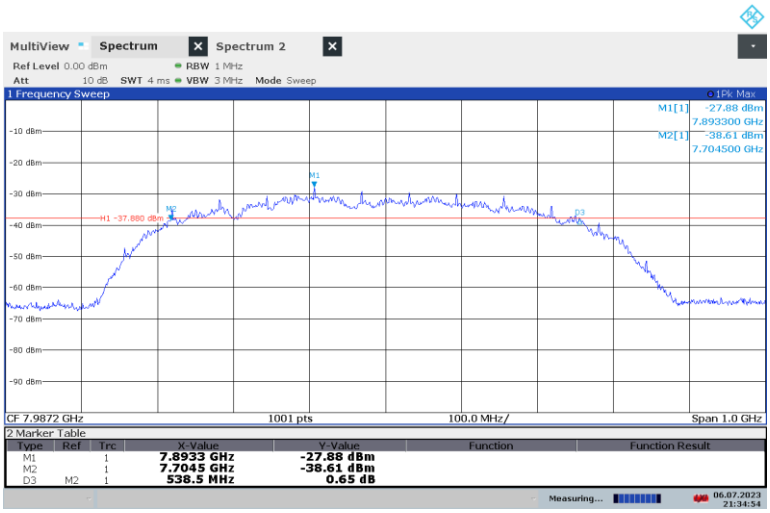

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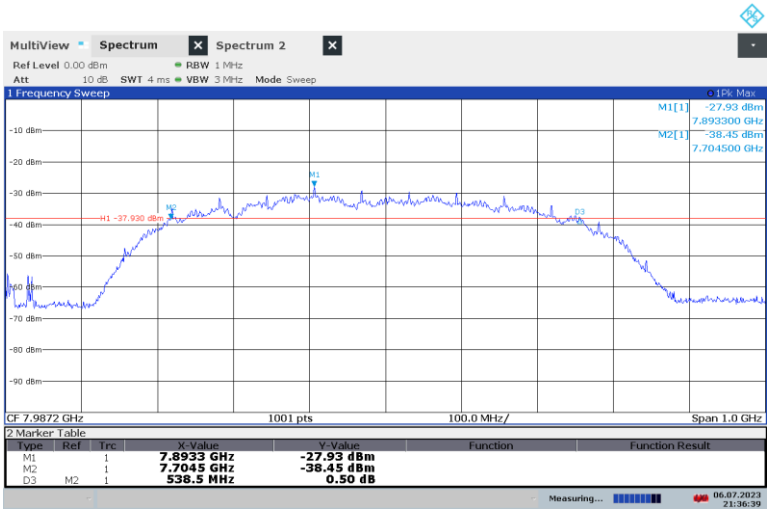
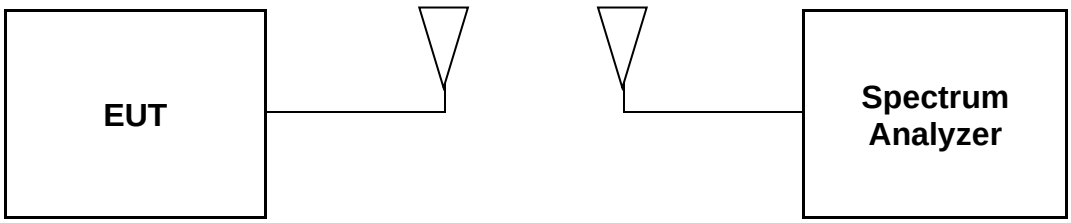


4. 99 % Bandwidth

4.1. Test Setup



4.2. Limit

Limit: Not Applicable

4.3. Test Procedure

99 % Bandwidth

● The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

● The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

● The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99 % emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99 % emission bandwidth).

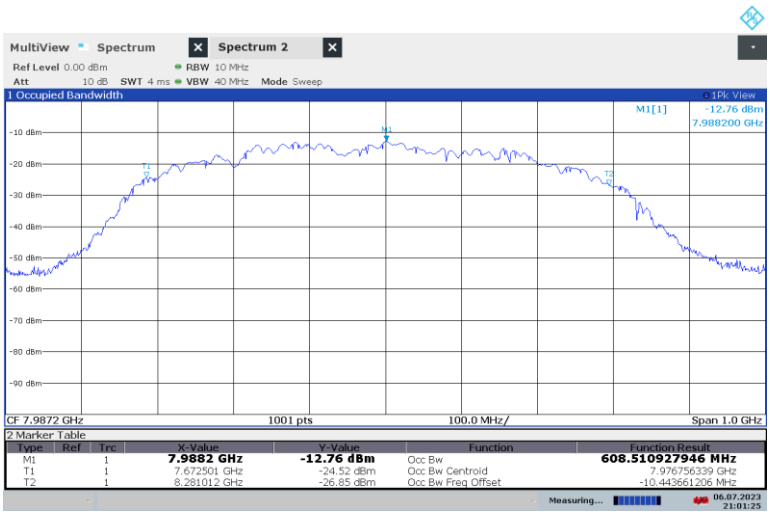
4.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

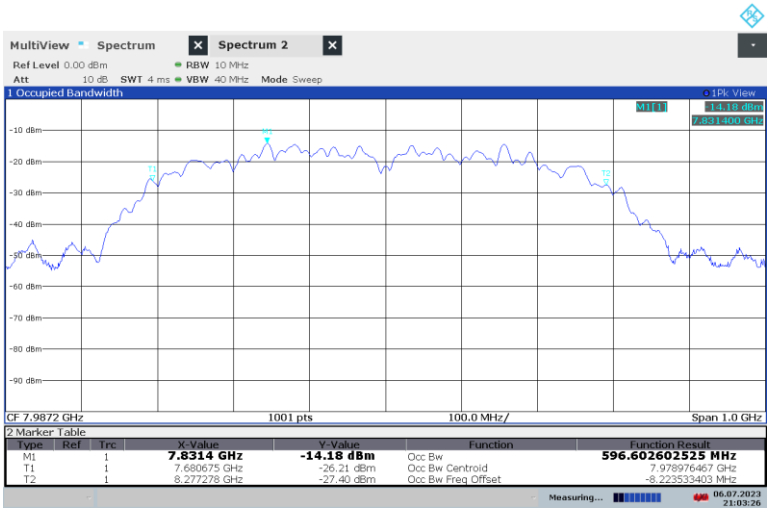
Channel	Configure	Packet length	Preamble	Frequency (㎒)	99 % Bandwidth (㎒)	Remark
9	SP0	4	9	7 987.20	608.51	99 % Occupied bandwidth
			10	7 987.20	596.60	
			11	7 987.20	603.82	
			12	7 987.20	605.98	
		20	9	7 987.20	610.23	
			10	7 987.20	597.42	
			11	7 987.20	603.78	
			12	7 987.20	606.35	
	SP3	-	9	7 987.20	603.57	
			10	7 987.20	605.16	
			11	7 987.20	603.86	
			12	7 987.20	605.90	

- Test plot

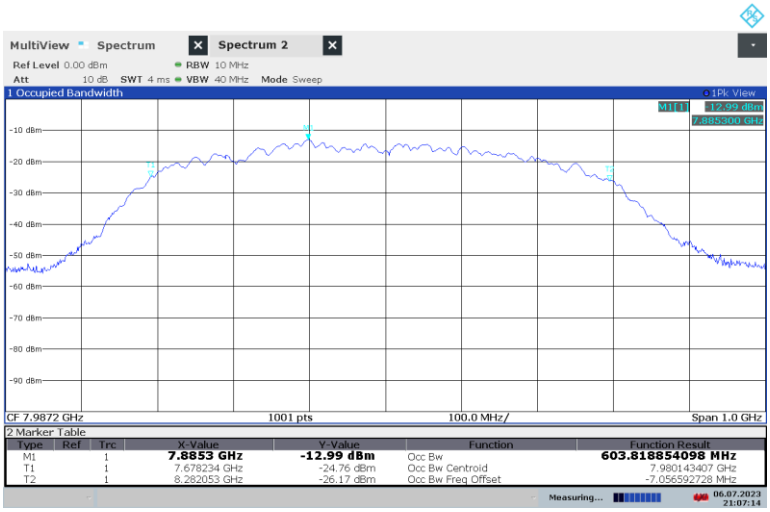
SP0_BPRF 4_Preamble 9



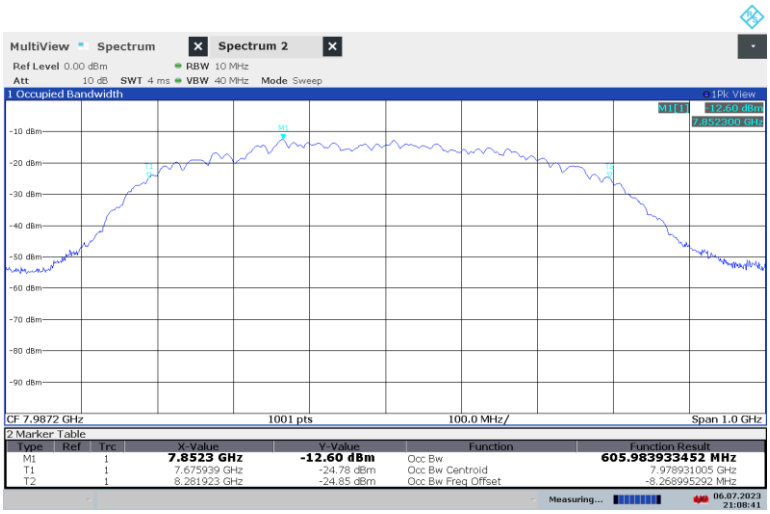
SP0_BPRF 4_Preamble 10



SP0_BPRF 4_Preamble 11

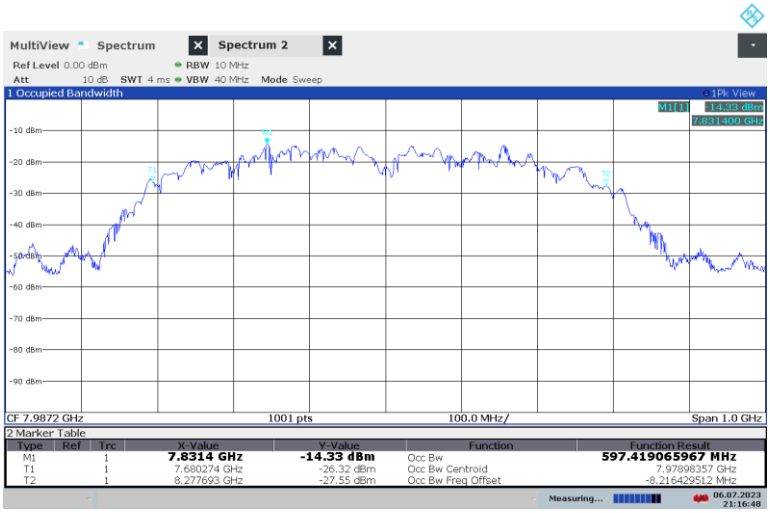


SP0_BPRF 4_Preamble 12

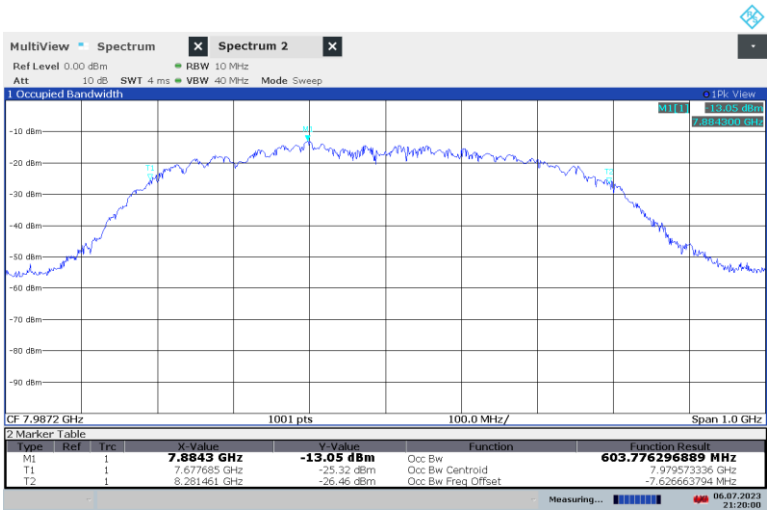


SP0_BPRF 20_Preamble 9

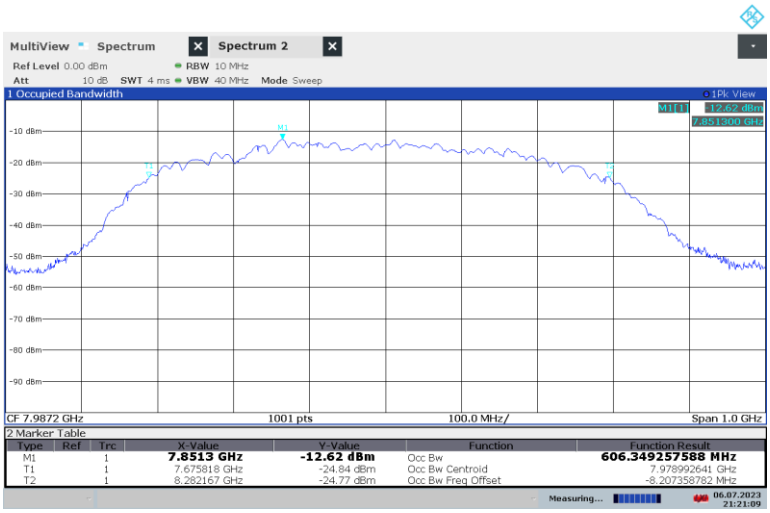
SP0_BPRF 20_Preamble 10



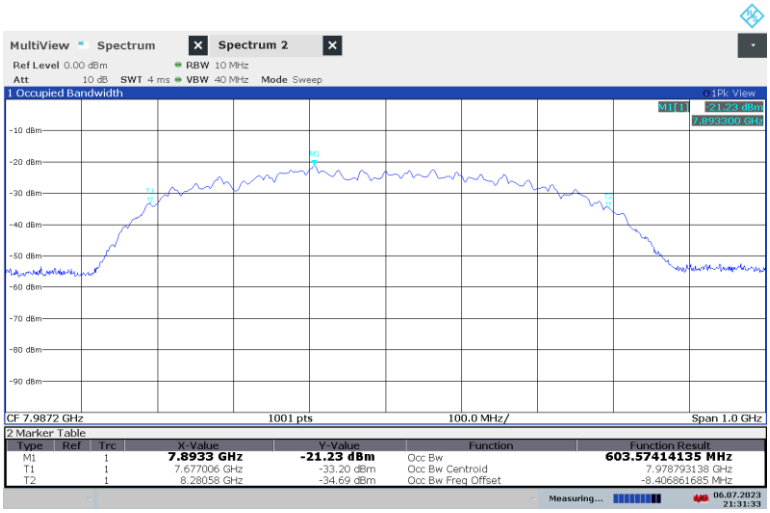
SP0_BPRF 20_Preamble 11



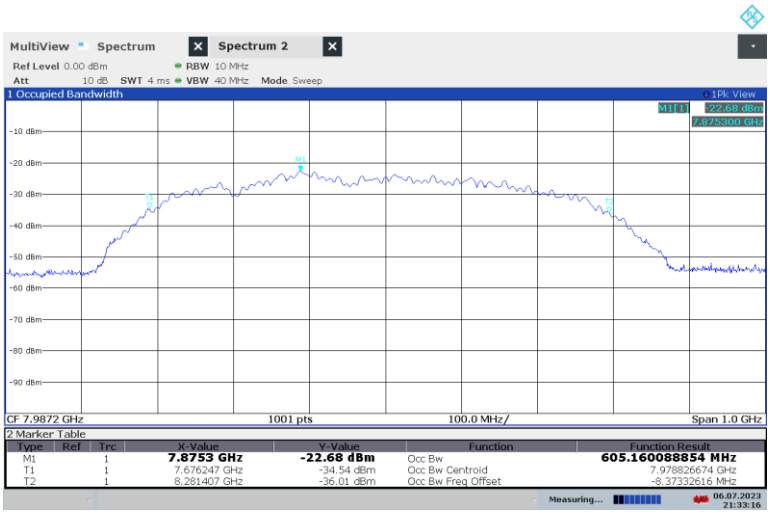
SP0_BPRF 20_Preamble 12



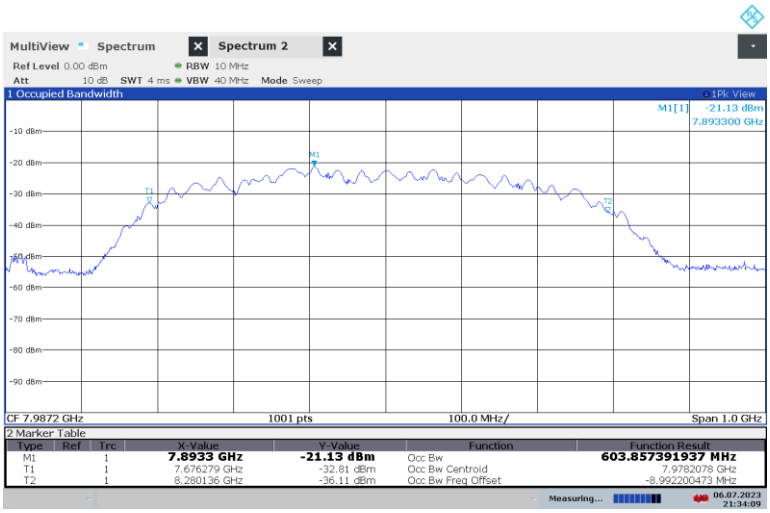
SP3_Preamble 9



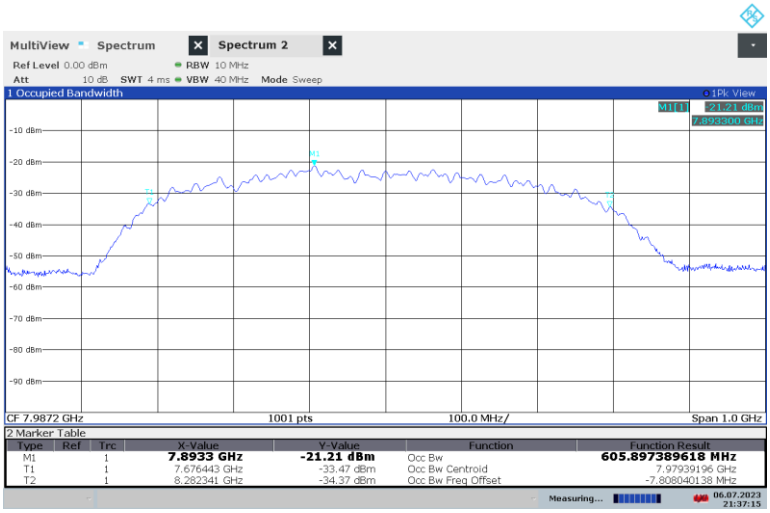
SP3_Preamble 10



SP3_Preamble 11

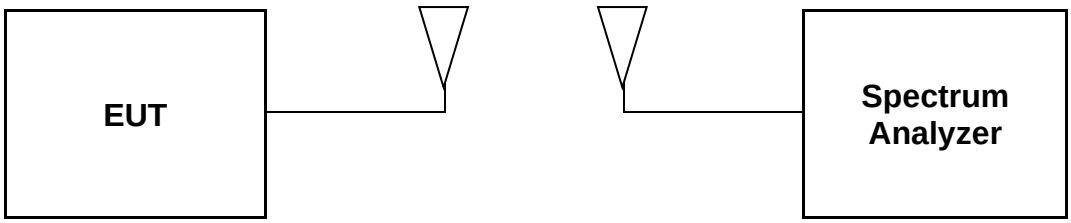


SP3_Preamble 12



5. Cease Transmission Time

5.1. Test Setup



5.2. Limit

5.2.1. FCC

According to §15.519(a)(1), a UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

5.2.2. IC

According to 5.3.1(b) of RSS-220 Issue 1, the device is to transmit only when it is sending information to an associated receiver. The device shall cease transmission of information within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received.
An acknowledgment of reception must continue to be received by the UWB device at least every 10 seconds or the UWB device shall cease transmitting any information other than periodic signals used for the establishment or re-establishment of a communication link with an associated receiver.

5.3. Test Procedure

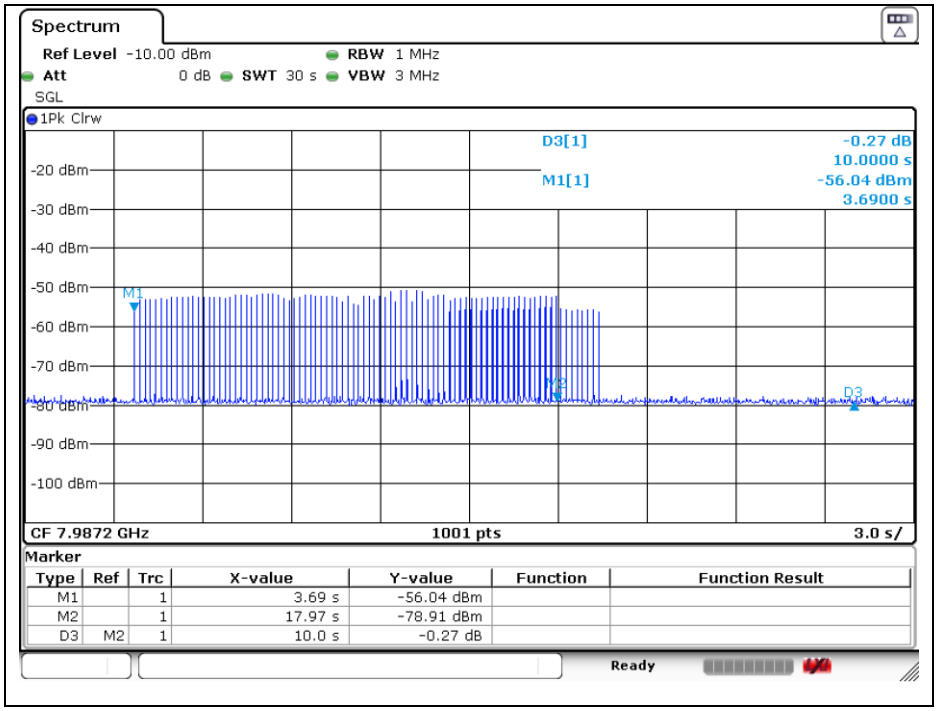
1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 ㎒, VBW = 3 ㎒, Span = 0 ㎐.

5.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Frequency (㎒)	Limit (sec)	Remark
7 987.20	10	Pass

- Test plot



Remark;

Marker 1 : EUT and smart phone are linked.
Marker 2 : EUT ends UWB link.
Marker 2△ 3 : 10s after EUT ends UWB link.

6. Antenna Requirement

6.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.519 (a)(2), the use of antennas mounted on outdoor structures, e.g., antenna mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.

6.2. Antenna Connected Construction

Antenna used in this product is FPCB antenna with gain of 0.12 dBi.

- End of the Test Report -