TEST REPORT

Applicant Name :	Advanced Card Systems Limited
Address :	Units 4108 - 4110, 41st Floor, Manhattan Place, 23 Wang Tai Road, Kowloon Bay, Hong Kong
Report Number :	SZNS220809-36126E-RF-00B
FCC ID:	V5MACR350

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	Bus Validator
Model No.:	ACR350
Multiple Model(s) No.:	N/A
Trade Mark:	acs
Date Received:	2022/08/09
Report Date:	2022/10/13

Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Roger Ling
EMC Engineer

Approved By:

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	BLE: 2402-2480MHz Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	BLE 1M: -9.31dBm Wi-Fi: 10.89dBm(802.11b), 10.03dBm(802.11g) 10.05dBm(802.11n20), 8.80dBm(802.11n40)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	BLE: 1.6dBi, Wi-Fi: 2.2dBi (provided by the applicant)
Voltage Range	DC 9V-36V
Sample serial number	SZNS220809-36126E-RF-S1 for Radiated Emissions Test SZNS220809-36126E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition
Tested Voltage	Normal Voltage: $24V_{DC}$

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Line Conducted emission		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz- 18GHz	4.98dB
	18GHz- 26.5GHz	5.06dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 2.4GHz Wi-Fi mode, total 11 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

802.11b, 802.11g and 802.11n-HT20 mode was tested with Channel 1, 6and 11.
802.11n-HT40 mode was tested with Channel 3, 6 and 9.

For BLE mode, 40 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

"HCI_TESTER" exercise software was used.

The device was tested with the worst case was performed as below:

Mode	Data rate	Power Level*		
		Low Channel	Middle Channel	High Channel
802.11b	1Mbps	15	15	15
802.11g	6Mbps	15	15	15
802.11n-HT20	MCS0	15	15	15
802.11n-HT40	MCS0	15	15	15
BLE	1Mbps	Default	Default	Default

Note: the software and power level was provided by applicant.

Duty cycle

Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

Support Equipment List and Details

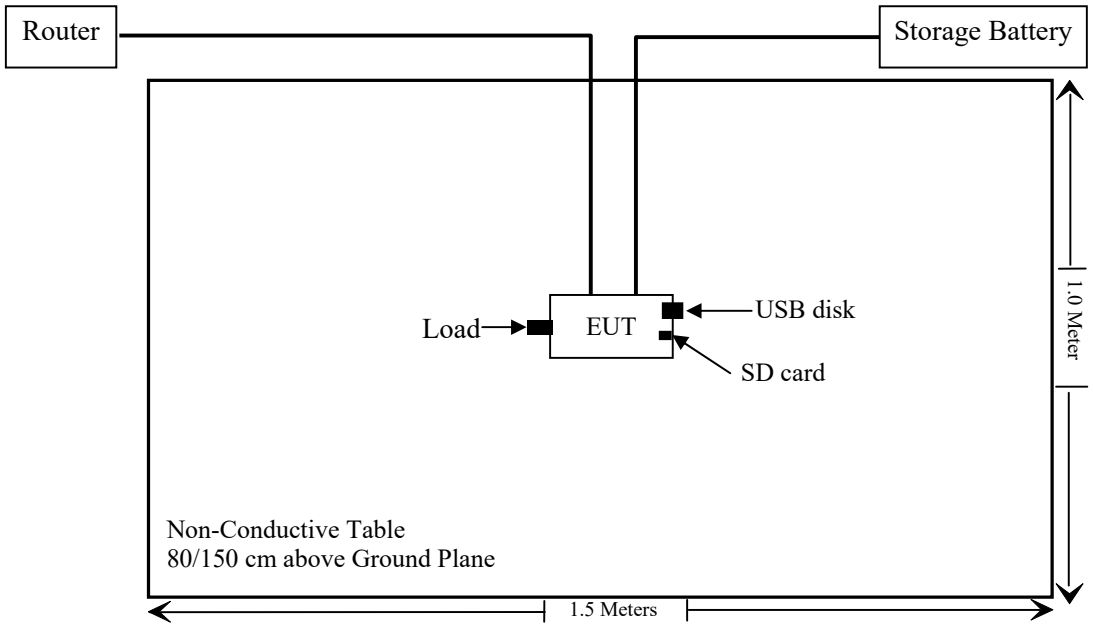
Manufacturer	Description	Model	Serial Number
Unknown	Storage Battery	Unknown	Unknown
HIKVISION	Router	DS-3WR03-E	10021642429
SanDisk	USB disk	SDCZ73-016G-Z35	2145493
SanDisk	SD card	SDSQUNC-016G-ZN6MA	0421XX7747P4
Unknown	Load	50ohm	Unknown

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable DC Cable	1.0	EUT	Storage Battery
Un-shielding Detachable RJ45 Cable	5.0	EUT	Router

Block Diagram of Test Setup

For Radiated Emissions:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i) & §2.1091	MAXIMUM PERMISSIBLE EXPOSURE (MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Not Applicable
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth & Occupied Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

Not Applicable: EUT is power by battery and used on vehicle.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated emission test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2021/12/14	2022/12/13
RF conducted test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/01/19	2023/01/18
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/10/26	2022/10/25
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.31	RF-01	Each time	

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (Minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \le 1$$

Result

For worst case:

Mode	Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BT	2402-2480	1.6	1.45	-8.0	0.16	20	0.00005	1
BLE	2402-2480	1.6	1.45	-9.0	0.13	20	0.00004	1
Wi-Fi	2412-2462	2.2	1.66	11.0	12.59	20	0.004	1
GSM850*	824-849	0.5	1.12	25.0	316.23	20	0.071	0.549
PCS1900*	1850-1910	3.0	2.00	24.0	251.19	20	0.100	1
WCDMA Band 2	1850-1910	3.0	2.00	24.5	281.84	20	0.112	1
WCDMA Band 4	1710-1755	3.0	2.00	23.5	223.87	20	0.089	1
WCDMA Band 5	824-849	0.5	1.12	23.5	223.87	20	0.050	0.549
LTE Band 2	1850-1910	3.0	2.00	21.0	125.89	20	0.050	1
LTE Band 4	1710-1755	3.0	2.00	22.0	158.49	20	0.063	1
LTE Band 5	824-849	0.5	1.12	23.0	199.53	20	0.045	0.549
LTE Band 12	699-716	0.5	1.12	23.5	223.87	20	0.050	0.466
LTE Band 38	2570-2620	3.0	2.00	20.0	100.00	20	0.040	1
LTE Band 41	2496-2690	3.0	2.00	19.0	79.43	20	0.032	1

Note : The tune-up power and antenna gain was declared by the applicant.

Note*: It was the time average power according to the below duty cycle.

For SAR, the time based average power is relevant, the difference in between depends on the duty cycle of the TDMA signal.

Number of Time slot	1	2	3	4
Duty Cycle	1:8	1:4	1:2.66	1:2
Time based Ave. power compared to slotted Ave. power	-9 dB	-6 dB	-4.25 dB	-3 dB
Crest Factor	8	4	2.66	2

Simultaneous transmitting consideration (worst case):

The ratio=$MPE_{BT}/limit_{BT} + MPE_{Wi\text{-}Fi}/limit_{Wi\text{-}Fi} + MPE_{GSM850}/limit_{GSM850}$
= 0.00005/1+0.004/1+0.071/0.549=0.133＜1.0

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has one internal antenna for BLE and one internal antenna for Wi-Fi, which were permanently attached, and the maximum antenna gain is BLE: 1.6dBi and Wi-Fi: 2.2dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

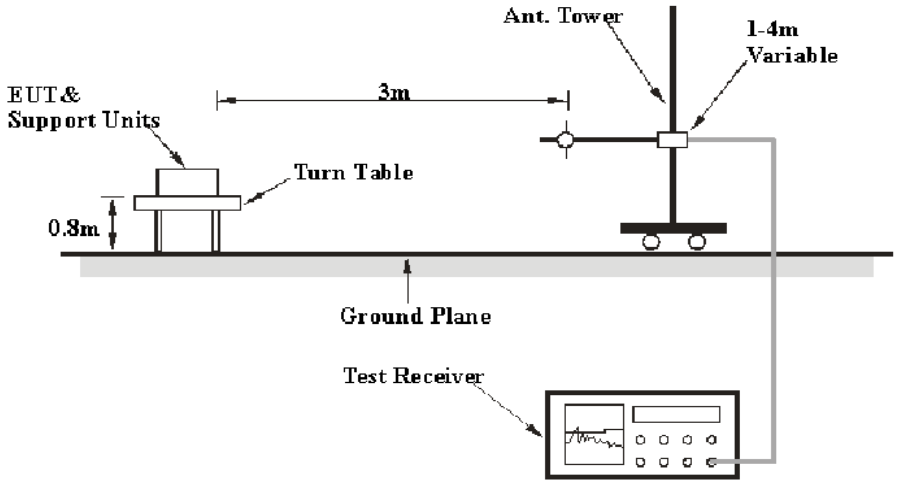
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

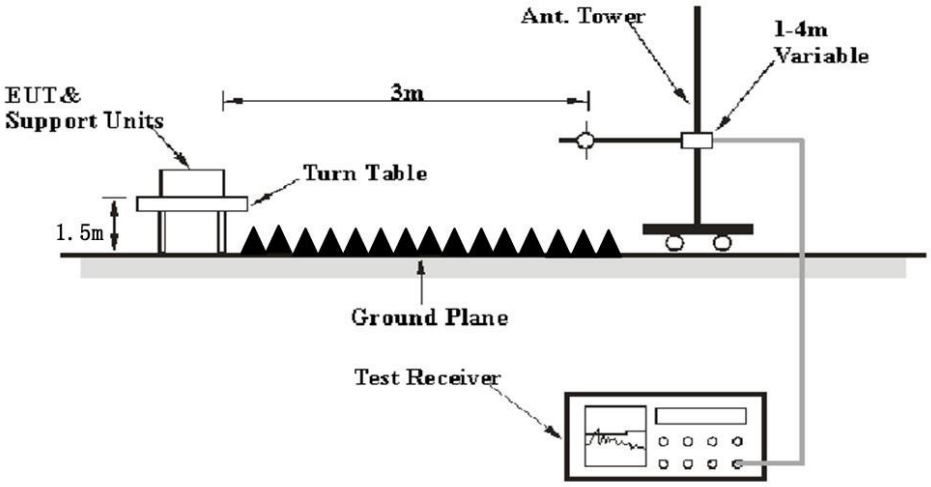
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz Note 1	/	Average
	1MHz	＞1/T Note 2	/	Average

Note 1: when duty cycle is no less than 98%
Note 2: when duty cycle is less than 98%

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Factor & Margin Calculation

The Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain. The basic equation is as follows:

Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "**Over Limit/Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit/margin of -7dB means the emission is 7dB below the limit. The equation for calculation is as follows:

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Data

Environmental Conditions

Temperature:	25~25.7 ℃
Relative Humidity:	56~60 %
ATM Pressure:	101.0 kPa

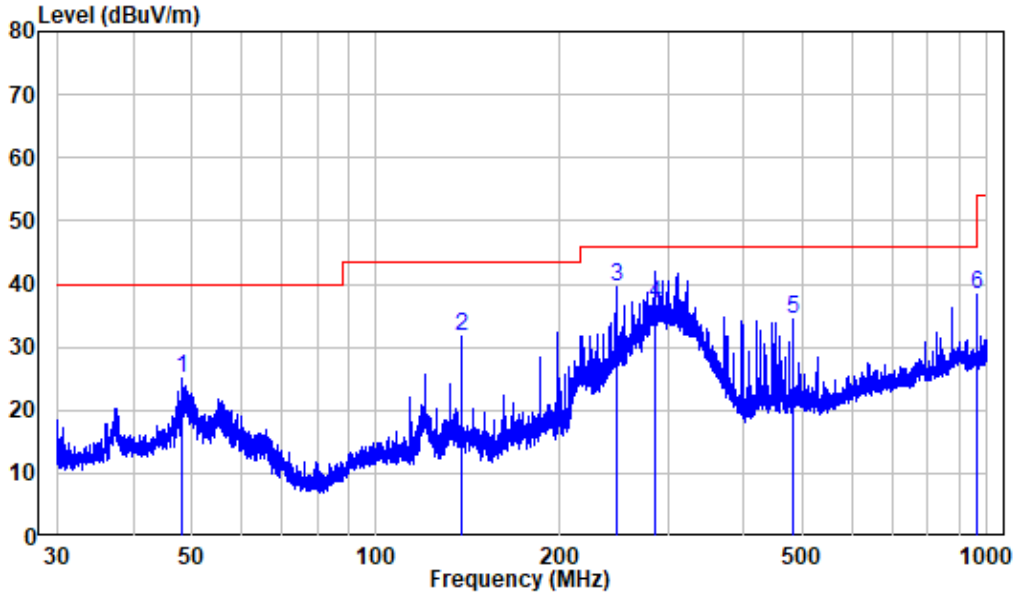
The testing was performed by Level Li on 2022-09-26 for below 1GHz and Zeki Ma on 2022-08-27 for above 1GHz.

EUT operation mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axes of orientation was recorded)

30MHz-1GHz: *(Worst case is 802.11b, low channel)*

Note: When the test result of peak was less than the limit of QP more than 6dB, just peak value were recorded.

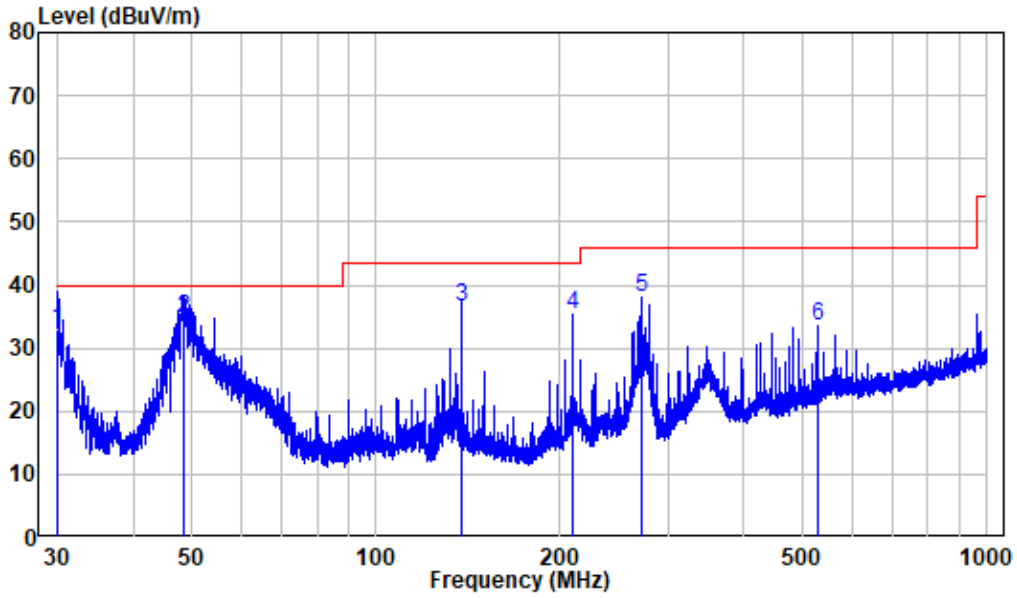
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220809-36126E-RF
Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	47.994	-10.00	35.18	25.18	40.00	-14.82	Peak
2	137.963	-15.35	46.96	31.61	43.50	-11.89	Peak
3	247.465	-10.66	50.26	39.60	46.00	-6.40	Peak
4	286.982	-9.39	46.20	36.81	46.00	-9.19	QP
5	480.107	-5.00	39.45	34.45	46.00	-11.55	Peak
6	960.056	2.36	36.01	38.37	54.00	-15.63	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220809-36126E-RF
Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	30.145	-12.39	45.31	32.92	40.00	-7.08	QP
2	48.268	-9.99	44.60	34.61	40.00	-5.39	QP
3	137.963	-15.35	52.00	36.65	43.50	-6.85	QP
4	209.956	-11.86	47.07	35.21	43.50	-8.29	Peak
5	271.563	-10.13	48.30	38.17	46.00	-7.83	Peak
6	528.014	-4.48	37.89	33.41	46.00	-12.59	Peak

1-25 GHz:

BLE:

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel(2402MHz)									
2310	67.79	PK	256	1.6	H	-7.24	60.55	74	-13.45
2310	54.26	AV	256	1.6	H	-7.24	47.02	54	-6.98
2310	68.16	PK	116	1.5	V	-7.24	60.92	74	-13.08
2310	54.31	AV	116	1.5	V	-7.24	47.07	54	-6.93
2390	69.58	PK	67	1.5	H	-7.22	62.36	74	-11.64
2390	55.08	AV	67	1.5	H	-7.22	47.86	54	-6.14
2390	54.90	PK	168	1.7	V	-7.22	47.68	74	-26.32
2390	55.03	AV	168	1.7	V	-7.22	47.81	54	-6.19
4804	54.96	PK	175	2.3	H	-3.51	51.45	74	-22.55
4804	54.67	PK	223	2.3	V	-3.51	51.16	74	-22.84
Middle Channel(2440MHz)									
4880	55.61	PK	272	1.3	H	-3.38	52.23	74	-21.77
4880	54.76	PK	289	1.3	V	-3.38	51.38	74	-22.62
High Channel(2480 MHz)									
2483.5	69.58	PK	182	2	H	-7.20	62.38	74	-11.62
2483.5	55.83	AV	182	2	H	-7.20	48.63	54	-5.37
2483.5	70.14	PK	171	2.4	V	-7.20	62.94	74	-11.06
2483.5	55.95	AV	171	2.4	V	-7.20	48.75	54	-5.25
2500	69.08	PK	115	1.9	H	-7.18	61.9	74	-12.10
2500	55.93	AV	115	1.9	H	-7.18	48.75	54	-5.25
2500	68.80	PK	21	1.9	V	-7.18	61.62	74	-12.38
2500	55.86	AV	21	1.9	V	-7.18	48.68	54	-5.32
4960	54.85	PK	166	1.5	H	-3.01	51.84	74	-22.16
4960	54.79	PK	252	1.5	V	-3.01	51.78	74	-22.22

Wi-Fi:

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11b									
Low Channel(2412MHz)									
2310	67.96	PK	38	2.3	H	-7.24	60.72	74	-13.28
2310	53.31	AV	38	2.3	H	-7.24	46.07	54	-7.93
2310	68.37	PK	60	2.2	V	-7.24	61.13	74	-12.87
2310	53.20	AV	60	2.2	V	-7.24	45.96	54	-8.04
2390	69.45	PK	47	1.1	H	-7.22	62.23	74	-11.77
2390	53.96	AV	47	1.1	H	-7.22	46.74	54	-7.26
2390	69.93	PK	351	2	V	-7.22	62.71	74	-11.29
2390	53.88	AV	351	2	V	-7.22	46.66	54	-7.34
4824	58.72	PK	301	1.6	H	-3.52	55.20	74	-18.80
4824	53.54	AV	301	1.6	H	-3.52	50.02	54	-3.98
4824	58.06	PK	145	1.9	V	-3.52	54.54	74	-19.46
4824	52.93	AV	145	1.9	V	-3.52	49.41	54	-4.59
Middle Channel(2437MHz)									
4874	58.85	PK	71	2	H	-3.42	55.43	74	-18.57
4874	54.38	AV	71	2	H	-3.42	50.96	54	-3.04
4874	58.84	PK	140	1	V	-3.42	55.42	74	-18.58
4874	54.39	AV	140	1	V	-3.42	50.97	54	-3.03
High Channel(2462MHz)									
2483.5	69.43	PK	146	1.5	H	-7.20	62.23	74	-11.77
2483.5	54.99	AV	146	1.5	H	-7.20	47.79	54	-6.21
2483.5	69.34	PK	205	2	V	-7.20	62.14	74	-11.86
2483.5	55.07	AV	205	2	V	-7.20	47.87	54	-6.13
2500	68.42	PK	65	1.3	H	-7.18	61.24	74	-12.76
2500	54.96	AV	65	1.3	H	-7.18	47.78	54	-6.22
2500	68.46	PK	241	2.4	V	-7.18	61.28	74	-12.72
2500	55.00	AV	241	2.4	V	-7.18	47.82	54	-6.18
4924	59.01	PK	108	2	H	-3.16	55.85	74	-18.15
4924	54.70	AV	108	2	H	-3.16	51.54	54	-2.46
4924	59.26	PK	138	2.2	V	-3.16	56.10	74	-17.90
4924	54.71	AV	138	2.2	V	-3.16	51.55	54	-2.45

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11g									
Low Channel(2412MHz)									
2310	68.20	PK	169	1.9	H	-7.24	60.96	74	-13.04
2310	53.60	AV	169	1.9	H	-7.24	46.36	54	-7.64
2310	68.25	PK	27	2.2	V	-7.24	61.01	74	-12.99
2310	53.79	AV	27	2.2	V	-7.24	46.55	54	-7.45
2390	69.12	PK	173	1.1	H	-7.22	61.90	74	-12.10
2390	54.46	AV	173	1.1	H	-7.22	47.24	54	-6.76
2390	69.52	PK	49	2.4	V	-7.22	62.30	74	-11.70
2390	54.61	AV	49	2.4	V	-7.22	47.39	54	-6.61
4824	53.97	PK	9	2.4	H	-3.52	50.45	74	-23.55
4824	53.87	PK	52	2.4	V	-3.52	50.35	74	-23.65
Middle Channel(2437MHz)									
4874	54.52	PK	293	2.2	H	-3.42	51.10	74	-22.90
4874	54.39	PK	110	2.2	V	-3.42	50.97	74	-23.03
High Channel(2462MHz)									
2483.5	70.14	PK	59	2.4	H	-7.20	62.94	74	-11.06
2483.5	56.06	AV	59	2.4	H	-7.20	48.86	54	-5.14
2483.5	69.90	PK	309	1.5	V	-7.20	62.7	74	-11.30
2483.5	56.06	AV	309	1.5	V	-7.20	48.86	54	-5.14
2500	68.53	PK	186	1.1	H	-7.18	61.35	74	-12.65
2500	55.57	AV	186	1.1	H	-7.18	48.39	54	-5.61
2500	68.52	PK	186	1.6	V	-7.18	61.34	74	-12.66
2500	55.48	AV	186	1.6	V	-7.18	48.3	54	-5.70
4924	54.23	PK	254	1.4	H	-3.16	51.07	74	-22.93
4924	54.16	PK	338	1.4	V	-3.16	51.00	74	-23.00

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11n20									
Low Channel(2412MHz)									
2310	68.56	PK	126	1.7	H	-7.24	61.32	74	-12.68
2310	53.62	AV	126	1.7	H	-7.24	46.38	54	-7.62
2310	68.55	PK	124	1.3	V	-7.24	61.31	74	-12.69
2310	53.61	AV	124	1.3	V	-7.24	46.37	54	-7.63
2390	69.35	PK	210	1.8	H	-7.22	62.13	74	-11.87
2390	54.44	AV	210	1.8	H	-7.22	47.22	54	-6.78
2390	69.77	PK	130	2	V	-7.22	62.55	74	-11.45
2390	54.62	AV	130	2	V	-7.22	47.40	54	-6.60
4824	53.95	PK	326	2	H	-3.52	50.43	74	-23.57
4824	53.92	PK	78	2	V	-3.52	50.40	74	-23.60
Middle Channel(2437MHz)									
4874	54.64	PK	125	1.4	H	-3.42	51.22	74	-22.78
4874	54.68	PK	46	1.4	V	-3.42	51.26	74	-22.74
High Channel(2462 MHz)									
2483.5	69.79	PK	194	2.1	H	-7.20	62.59	74	-11.41
2483.5	55.94	AV	194	2.1	H	-7.20	48.74	54	-5.26
2483.5	70.08	PK	30	2.2	V	-7.20	62.88	74	-11.12
2483.5	55.87	AV	30	2.2	V	-7.20	48.67	54	-5.33
2500	68.78	PK	94	1.5	H	-7.18	61.6	74	-12.40
2500	55.52	AV	94	1.5	H	-7.18	48.34	54	-5.66
2500	68.91	PK	211	1.5	V	-7.18	61.73	74	-12.27
2500	55.45	AV	211	1.5	V	-7.18	48.27	54	-5.73
4924	54.01	PK	186	1.6	H	-3.16	50.85	74	-23.15
4924	53.93	PK	72	1.6	V	-3.16	50.77	74	-23.23

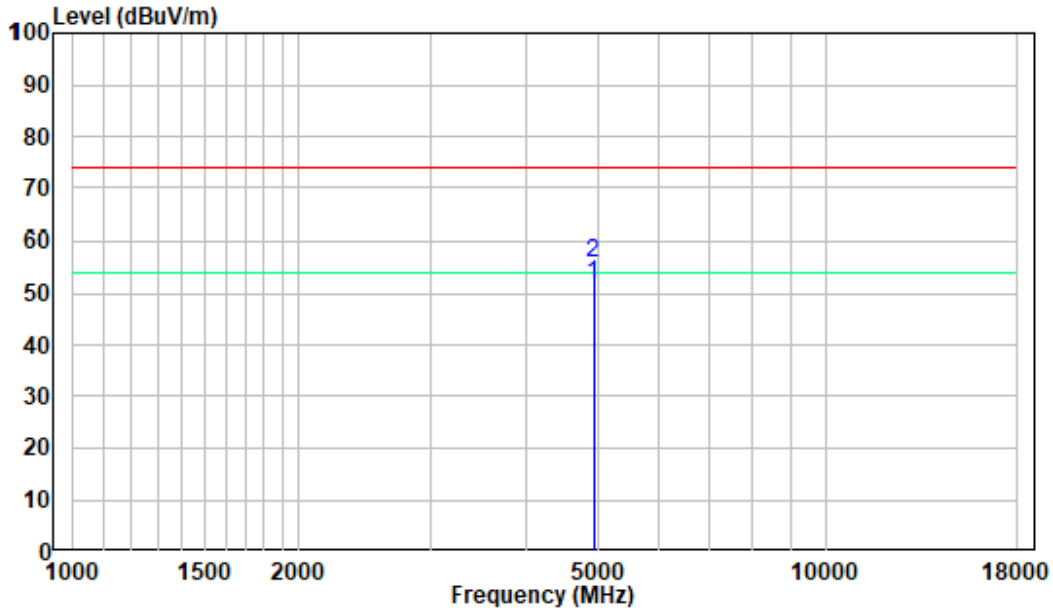
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11n40									
Low Channel(2422MHz)									
2310	67.86	PK	321	2.1	H	-7.24	60.62	74	-13.38
2310	53.87	AV	321	2.1	H	-7.24	46.63	54	-7.37
2310	68.31	PK	78	2.2	V	-7.24	61.07	74	-12.93
2310	53.71	AV	78	2.2	V	-7.24	46.47	54	-7.53
2390	69.92	PK	115	1.6	H	-7.22	62.70	74	-11.30
2390	54.51	AV	115	1.6	H	-7.22	47.29	54	-6.71
2390	69.69	PK	198	1.3	V	-7.22	62.47	74	-11.53
2390	54.48	AV	198	1.3	V	-7.22	47.26	54	-6.74
4844	54.26	PK	345	1.7	H	-3.54	50.72	74	-23.28
4844	54.07	PK	52	1.7	V	-3.54	50.53	74	-23.47
Middle Channel(2437MHz)									
4874	54.53	PK	255	2.3	H	-3.42	51.11	74	-22.89
4874	54.19	PK	174	2.3	V	-3.42	50.77	74	-23.23
High Channel(2452MHz)									
2483.5	70.28	PK	131	1.8	H	-7.20	63.08	74	-10.92
2483.5	55.94	AV	131	1.8	H	-7.20	48.74	54	-5.26
2483.5	69.80	PK	252	1.7	V	-7.20	62.6	74	-11.40
2483.5	55.95	AV	252	1.7	V	-7.20	48.75	54	-5.25
2500	68.56	PK	152	2.2	H	-7.18	61.38	74	-12.62
2500	55.33	AV	152	2.2	H	-7.18	48.15	54	-5.85
2500	68.37	PK	211	1.5	V	-7.18	61.19	74	-12.81
2500	55.51	AV	211	1.5	V	-7.18	48.33	54	-5.67
4904	54.03	PK	201	1.5	H	-3.26	50.77	74	-23.23
4904	54.48	PK	292	1.5	V	-3.26	51.22	74	-22.78

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is in the noise floor level was not recorded.
The test result of peak was less than the limit of average, so just peak values were recorded.

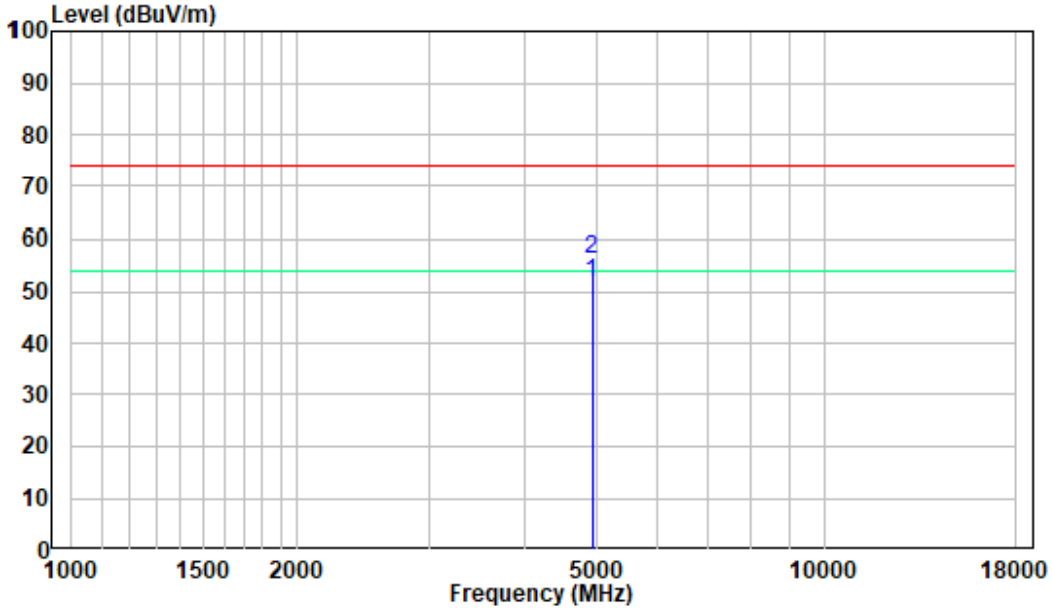
1-18 GHz:

Pre-scan for 802.11b, High Channel

Horizontal



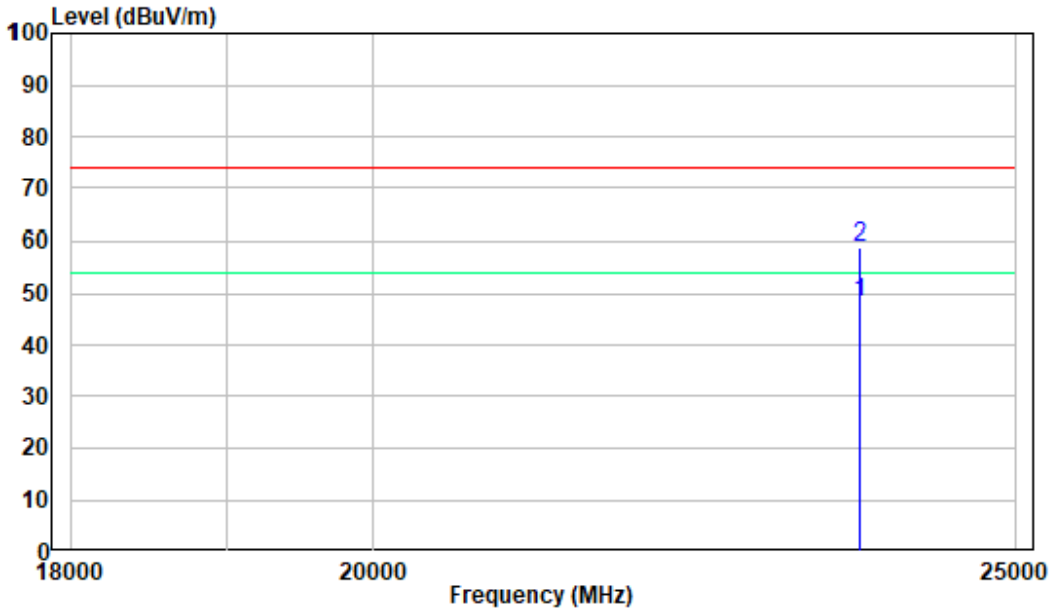
Vertical



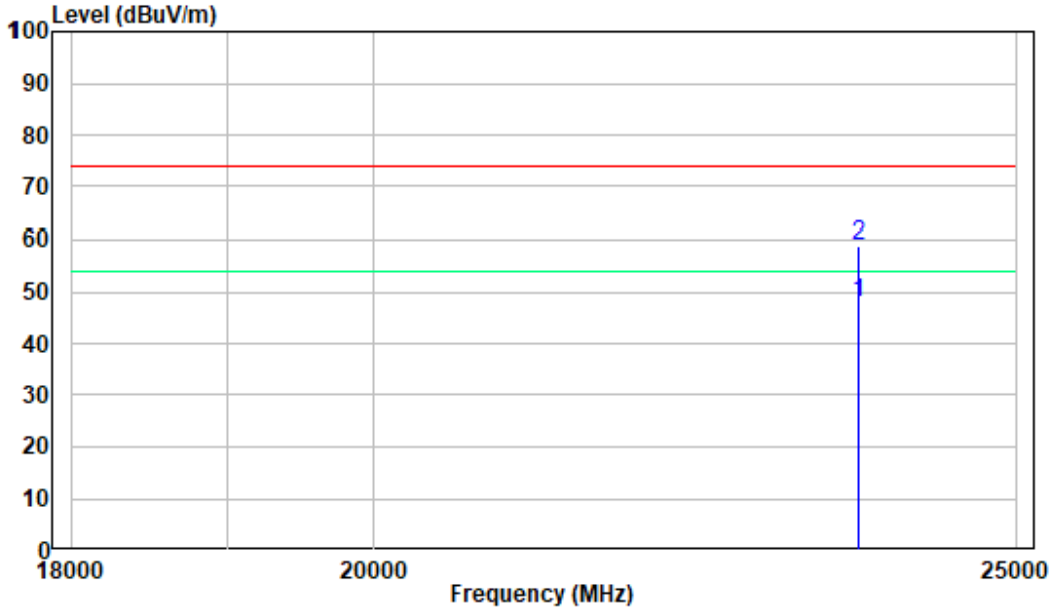
18 -25GHz:

P Pre-scan for 802.11b, High Channel

Horizontal



Vertical



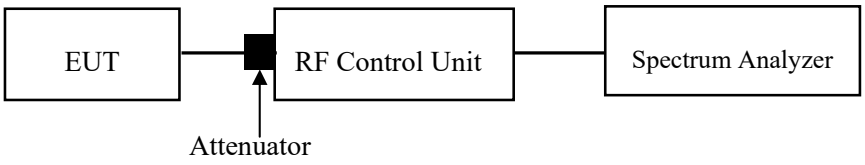
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



Test Data

Environmental Conditions

Temperature:	25.2 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-10-09.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

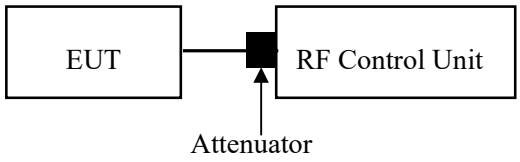
Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

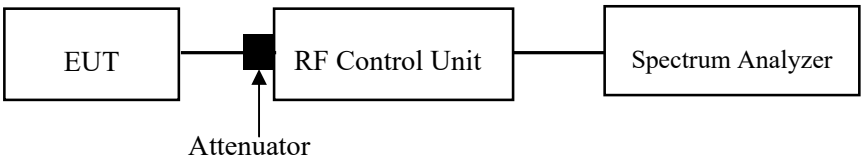
1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

For wifi mode:



Note: the RF control unit has a built-in power sensor.

For BLE mode:



Test Data

Environmental Conditions

Temperature:	25.2 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-10-09.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

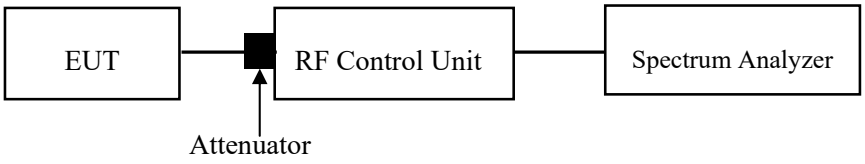
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	25.2 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-10-09.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

Please refer to the Appendix Wi-Fi and Appendix BLE.

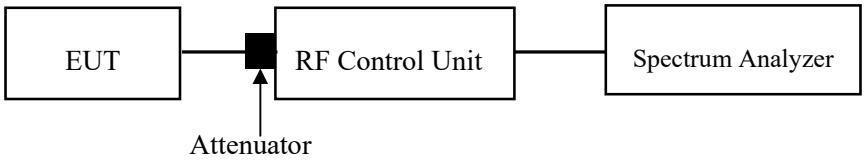
FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: 3kHz≤ RBW≤100 kHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	25.2 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-10-09.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

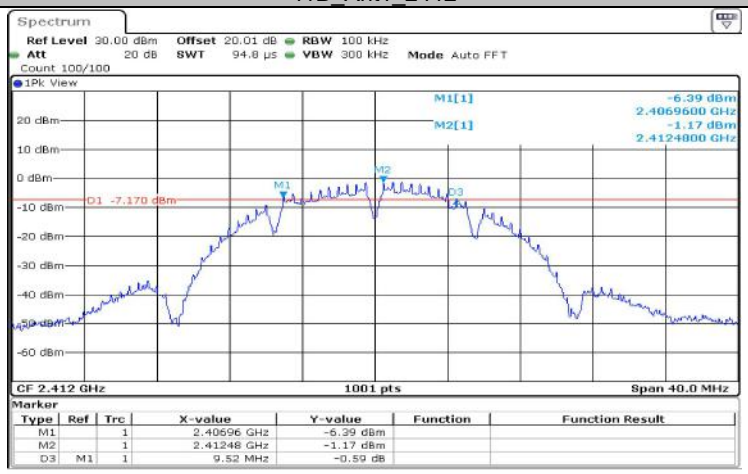
APPENDIX Wi-Fi

Appendix A: DTS Bandwidth
Test Result

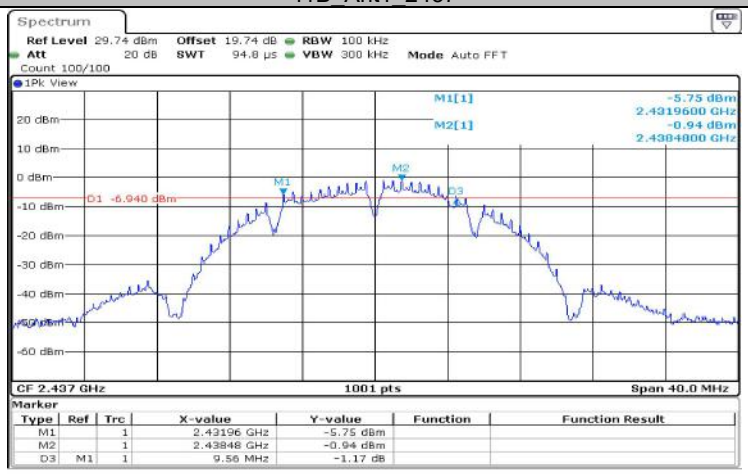
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	9.52	0.5	PASS
		2437	9.56	0.5	PASS
		2462	10.04	0.5	PASS
11G	Ant1	2412	16.32	0.5	PASS
		2437	16.28	0.5	PASS
		2462	16.36	0.5	PASS
11N20SISO	Ant1	2412	17.56	0.5	PASS
		2437	17.28	0.5	PASS
		2462	17.56	0.5	PASS
11N40SISO	Ant1	2422	35.68	0.5	PASS
		2437	35.20	0.5	PASS
		2452	35.68	0.5	PASS

Test Graphs

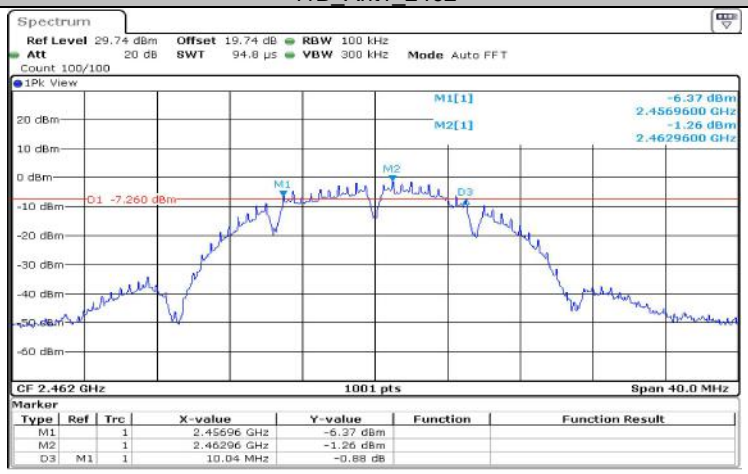
11B_Ant1_2412



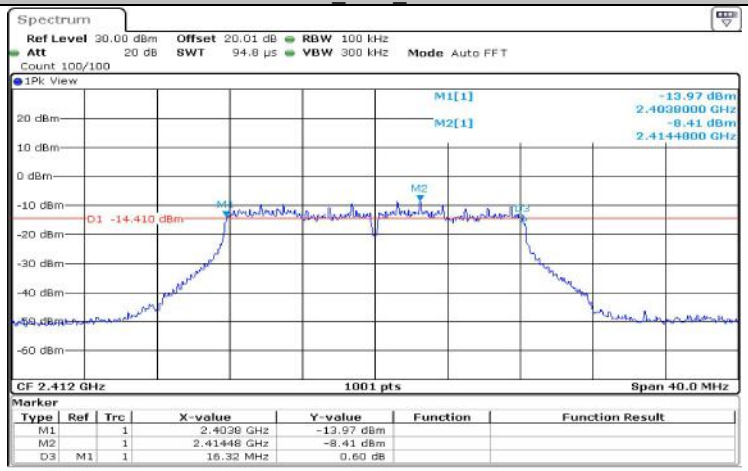
11B_Ant1_2437



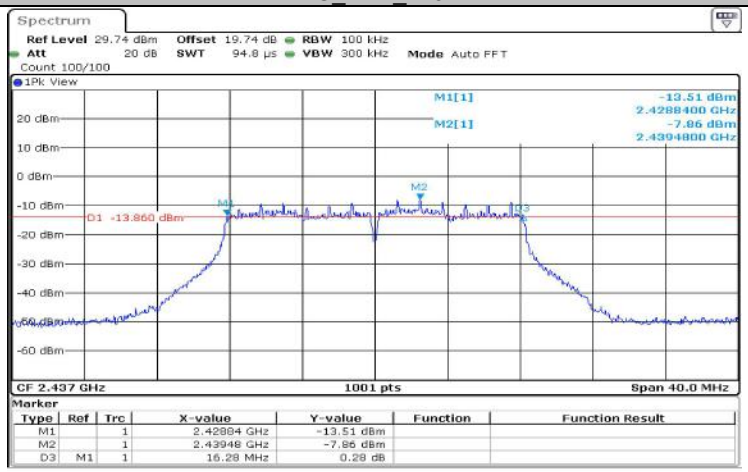
11B_Ant1_2462



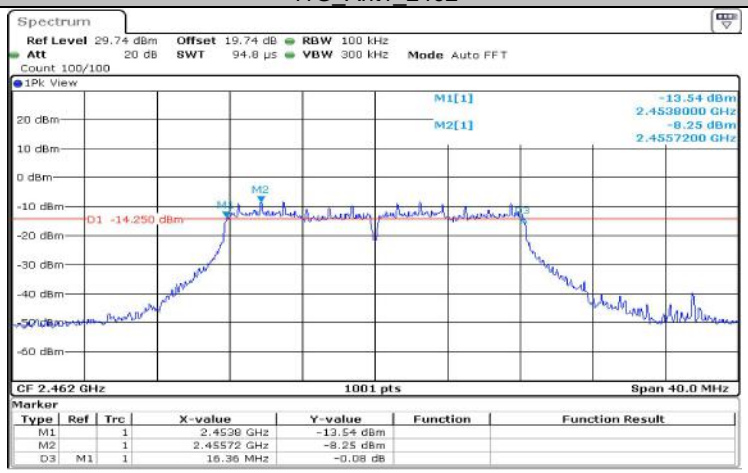
11G_Ant1_2412



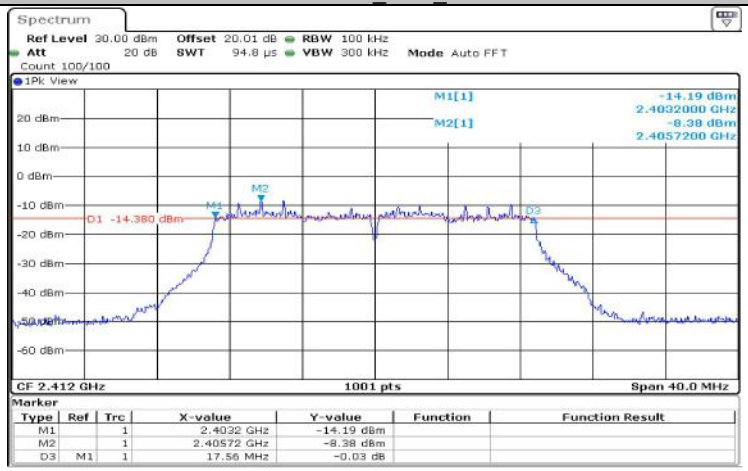
11G_Ant1_2437



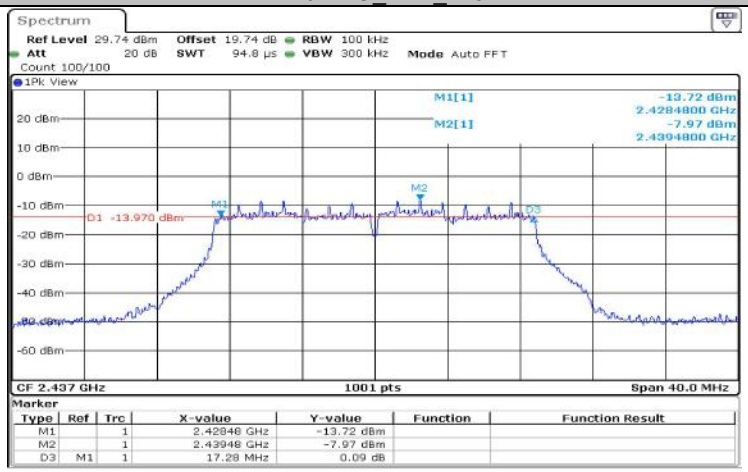
11G_Ant1_2462



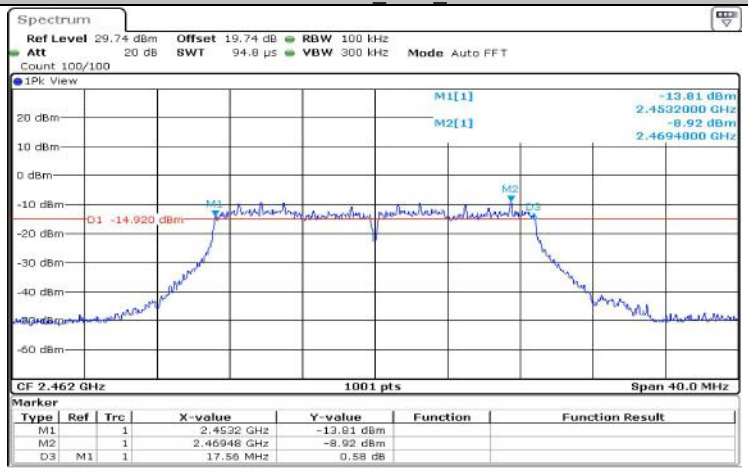
11N20SISO_Ant1_2412



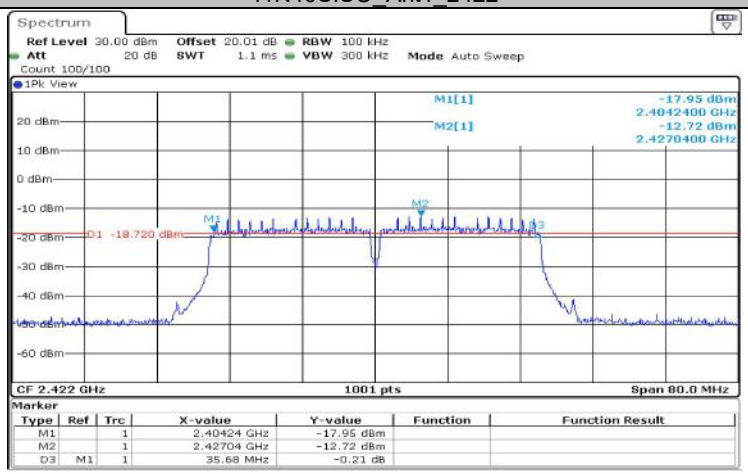
11N20SISO_Ant1_2437



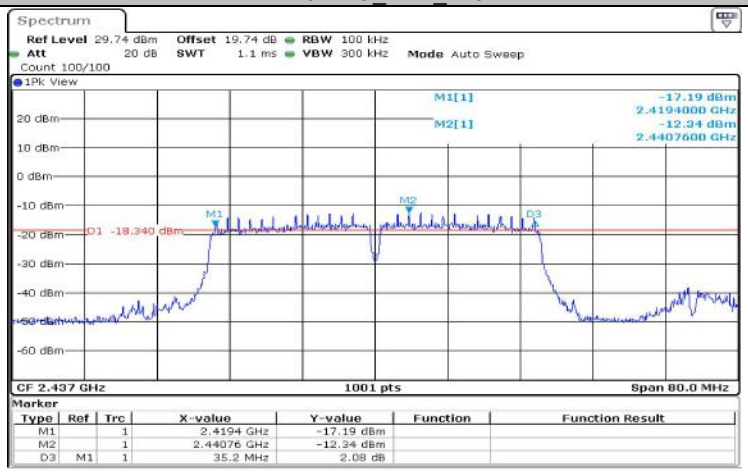
11N20SISO_Ant1_2462



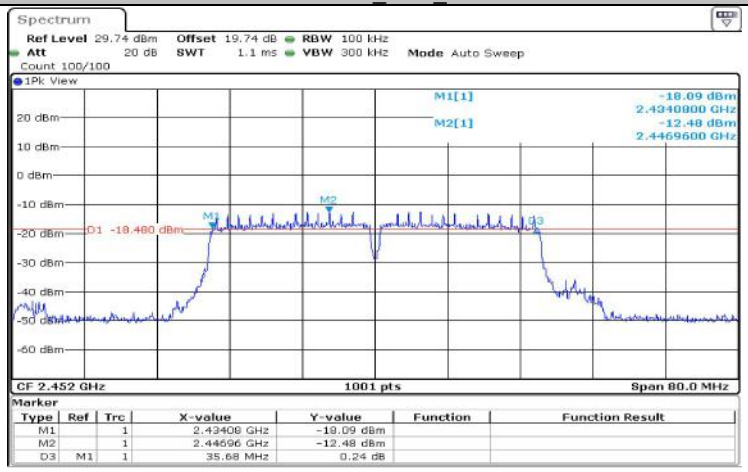
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



11N40SISO_Ant1_2452

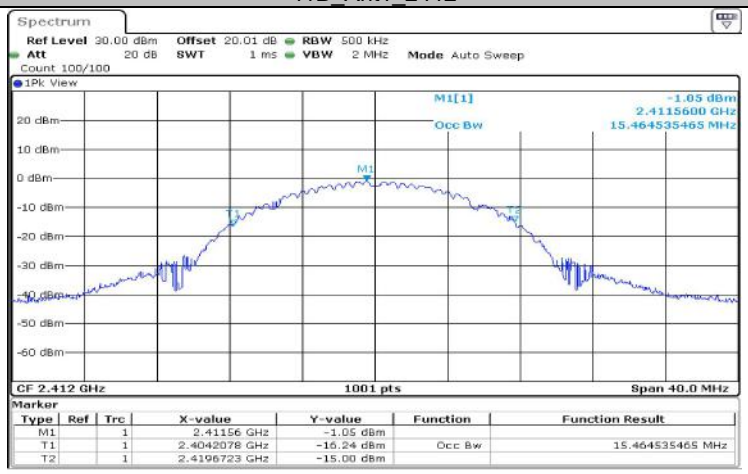


Appendix B: Occupied Channel Bandwidth
Test Result

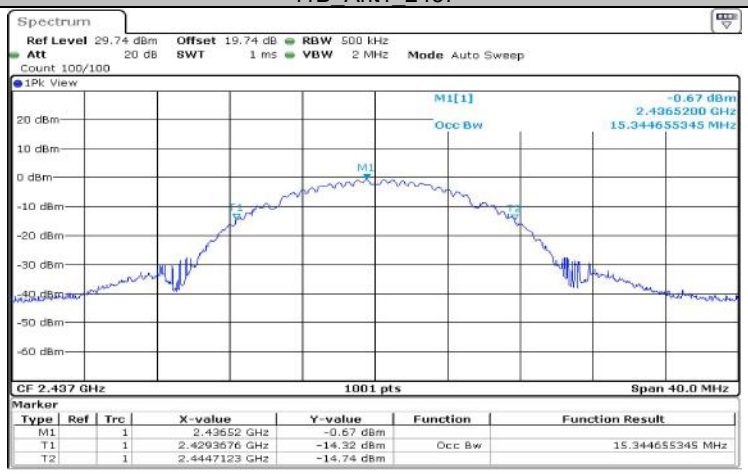
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	15.465	---	---
		2437	15.345	---	---
		2462	15.425	---	---
11G	Ant1	2412	17.982	---	---
		2437	17.622	---	---
		2462	18.382	---	---
11N20SISO	Ant1	2412	18.861	---	---
		2437	18.661	---	---
		2462	19.061	---	---
11N40SISO	Ant1	2422	36.763	---	---
		2437	36.683	---	---
		2452	36.843	---	---

Test Graphs

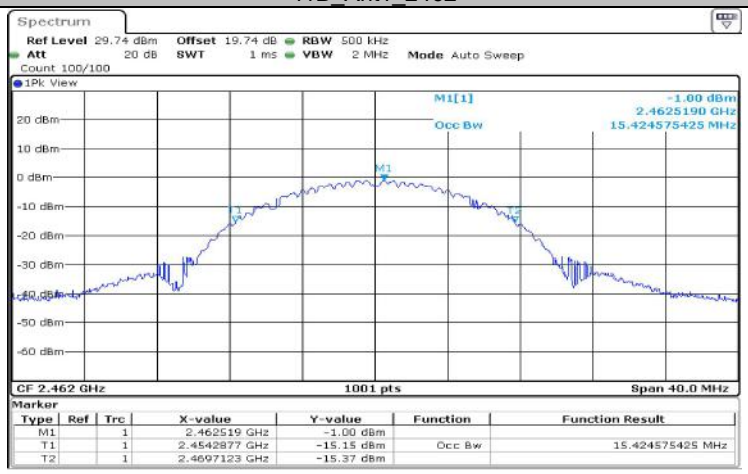
11B_Ant1_2412



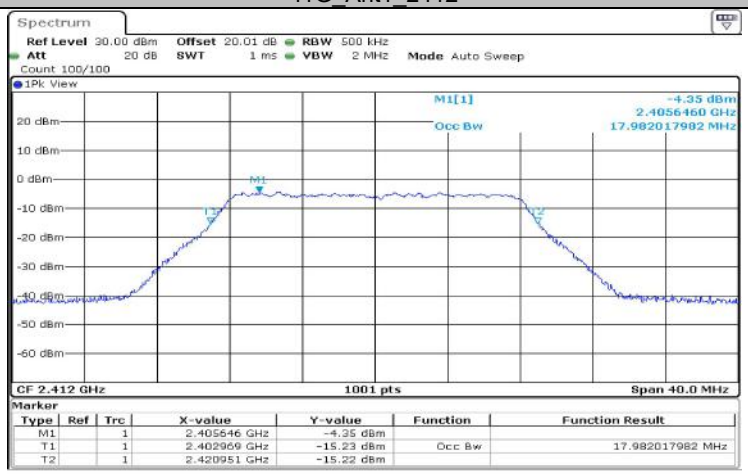
11B_Ant1_2437



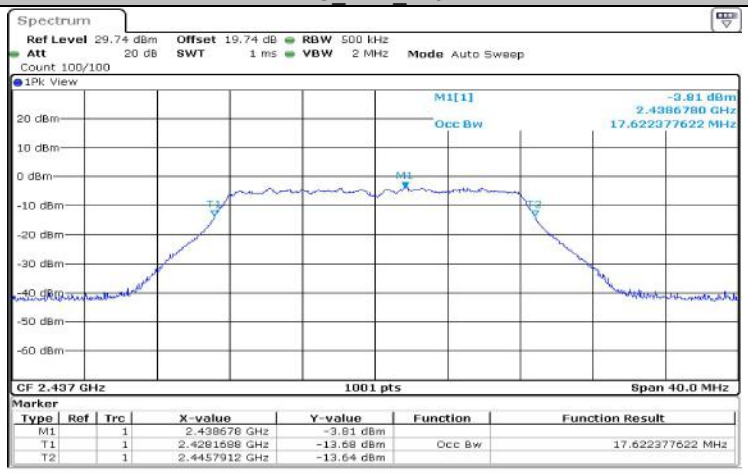
11B_Ant1_2462



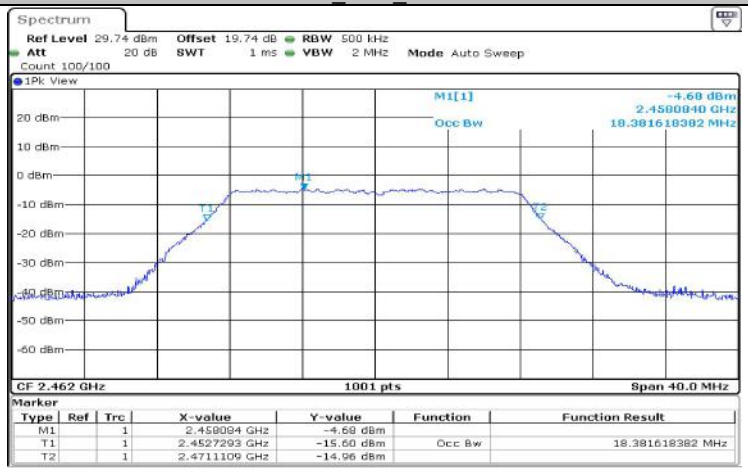
11G_Ant1_2412



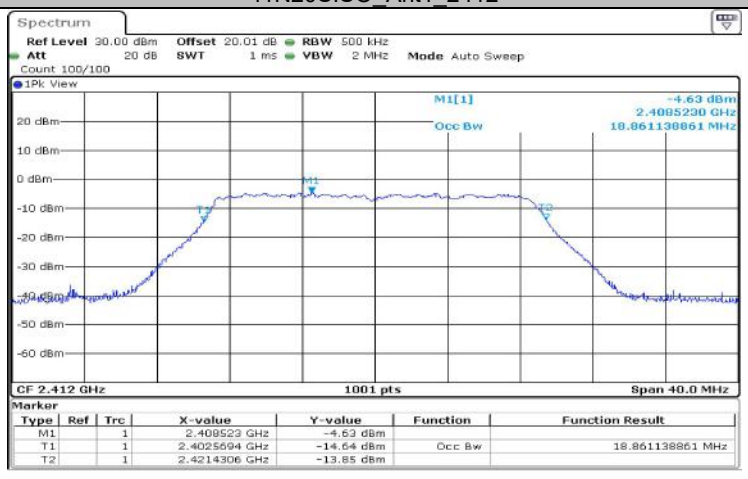
11G_Ant1_2437



11G_Ant1_2462

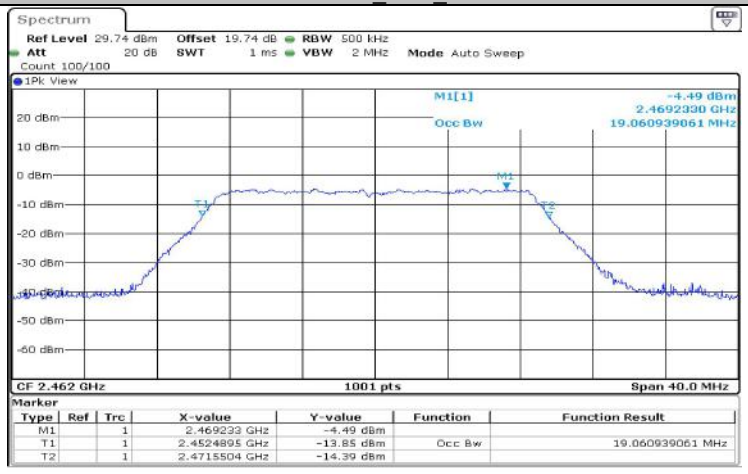


11N20SISO_Ant1_2412

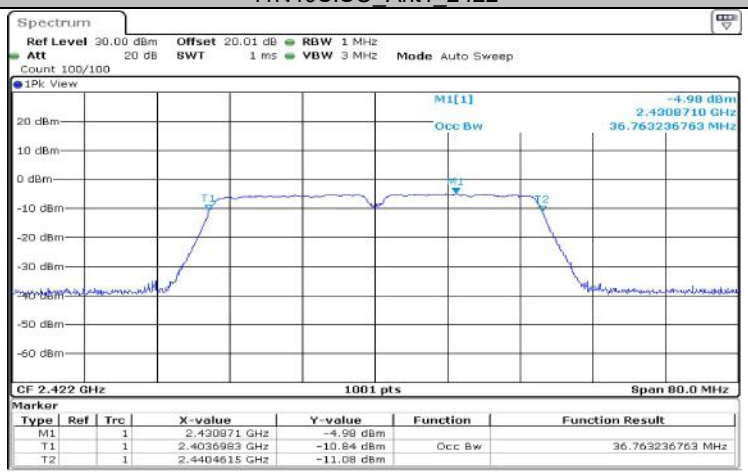


11N20SISO_Ant1_2437

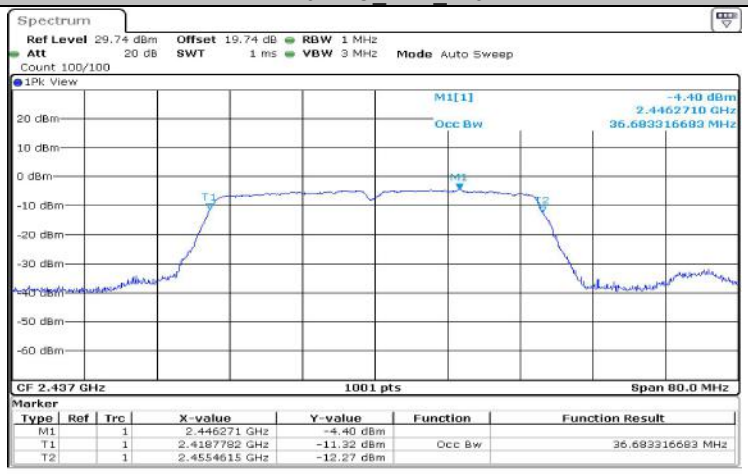
11N20SISO_Ant1_2462



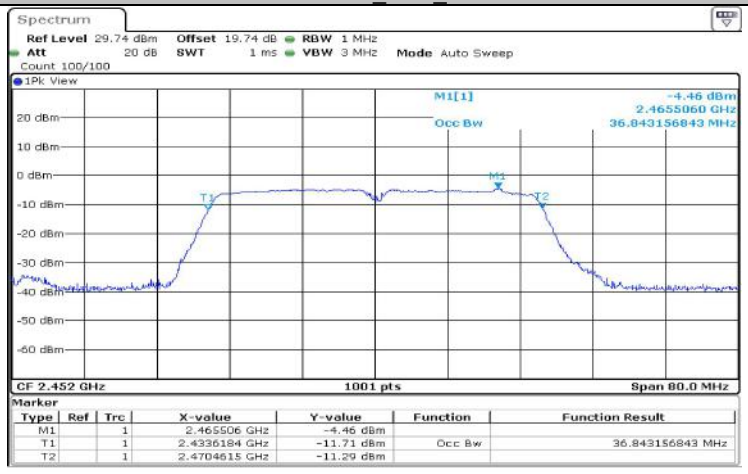
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



11N40SISO_Ant1_2452



Appendix C: Maximum conducted output power
Test Result

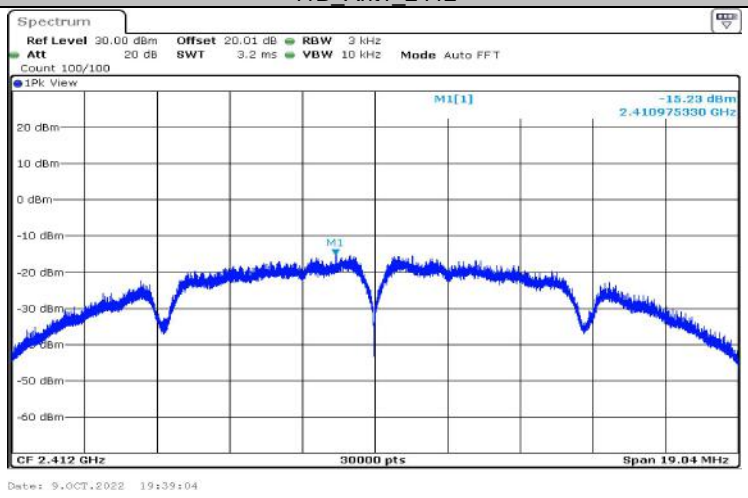
Test Mode	Antenna	Channel	Peak Power [dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	10.61	≤30.00	PASS
		2437	10.89	≤30.00	PASS
		2462	10.65	≤30.00	PASS
11G	Ant1	2412	9.66	≤30.00	PASS
		2437	10.03	≤30.00	PASS
		2462	9.98	≤30.00	PASS
11N20SISO	Ant1	2412	9.71	≤30.00	PASS
		2437	10.05	≤30.00	PASS
		2462	9.91	≤30.00	PASS
11N40SISO	Ant1	2422	8.61	≤30.00	PASS
		2437	8.74	≤30.00	PASS
		2452	8.80	≤30.00	PASS

Appendix D: Maximum power spectral density
Test Result

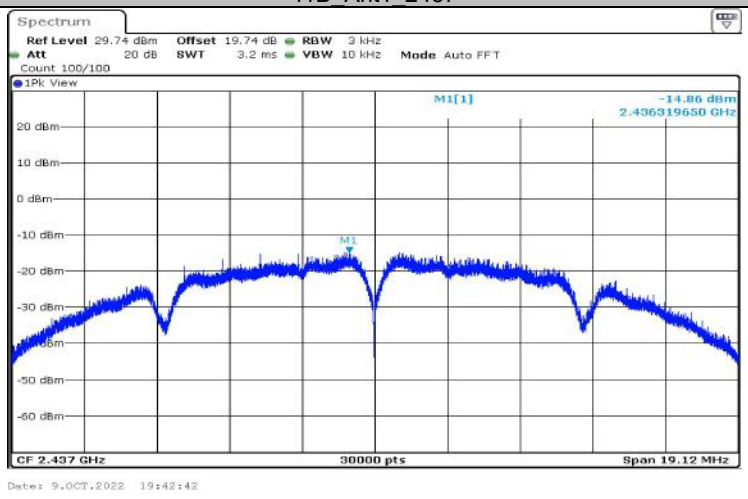
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-15.23	≤8.00	PASS
		2437	-14.86	≤8.00	PASS
		2462	-15.51	≤8.00	PASS
11G	Ant1	2412	-23.04	≤8.00	PASS
		2437	-22.70	≤8.00	PASS
		2462	-23.18	≤8.00	PASS
11N20SISO	Ant1	2412	-23.36	≤8.00	PASS
		2437	-22.69	≤8.00	PASS
		2462	-23.00	≤8.00	PASS
11N40SISO	Ant1	2422	-26.99	≤8.00	PASS
		2437	-25.08	≤8.00	PASS
		2452	-26.63	≤8.00	PASS

Test Graphs

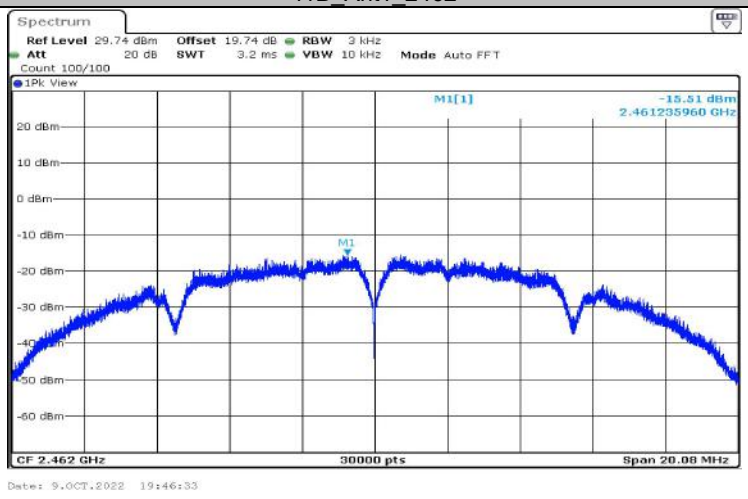
11B_Ant1_2412



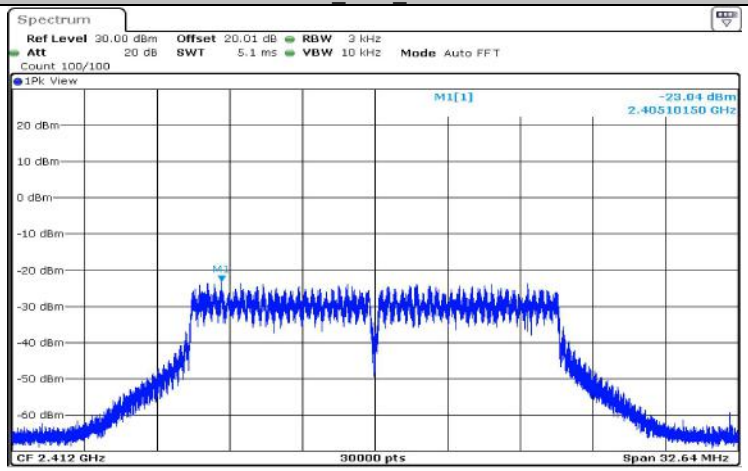
11B_Ant1_2437



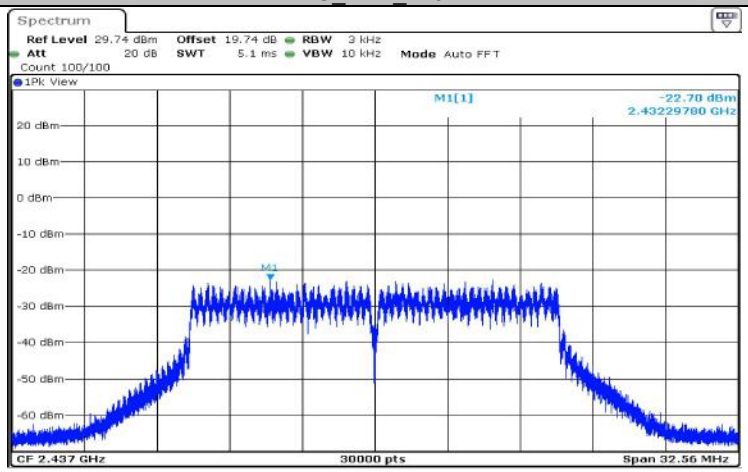
11B_Ant1_2462



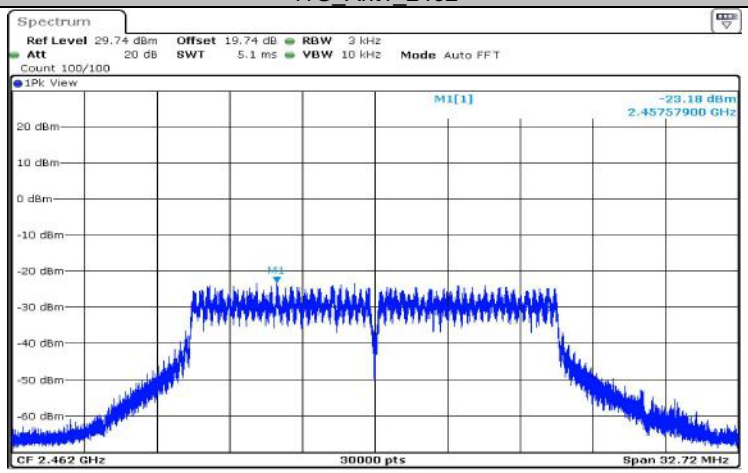
11G_Ant1_2412



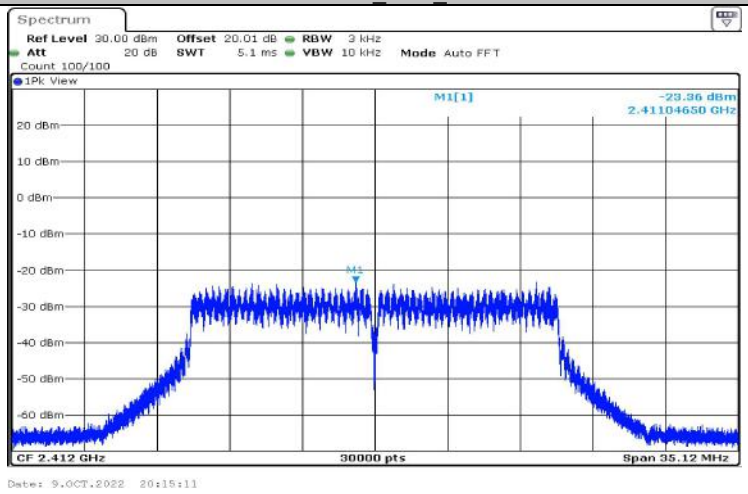
11G_Ant1_2437



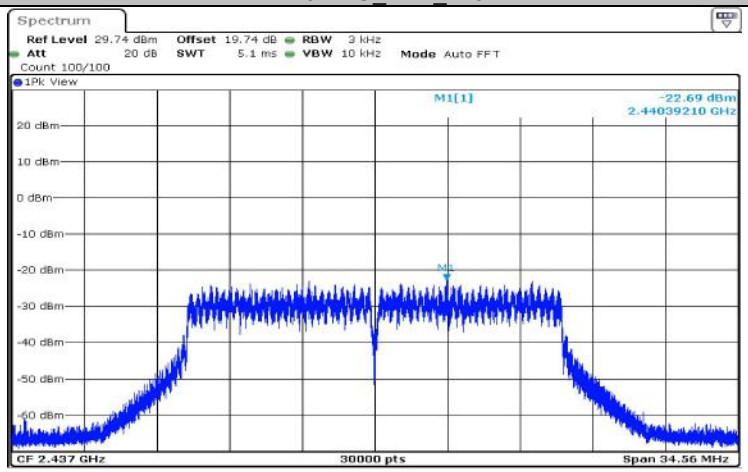
11G_Ant1_2462



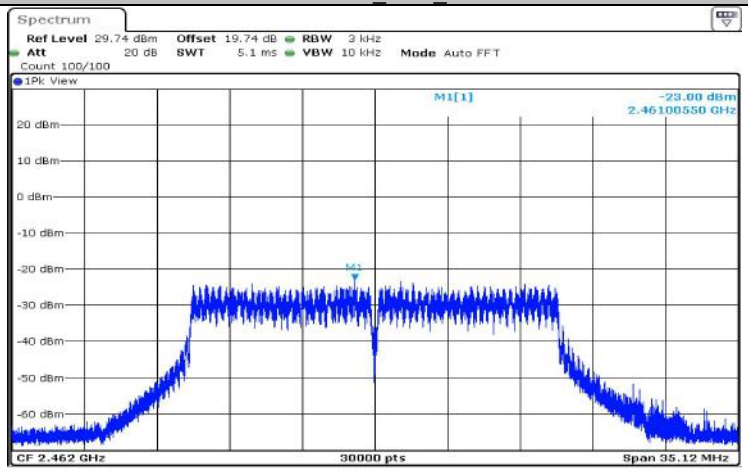
11N20SISO_Ant1_2412



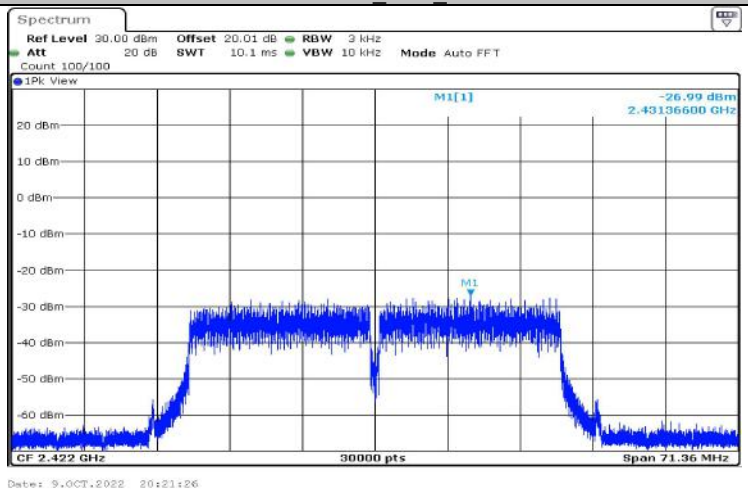
11N20SISO_Ant1_2437



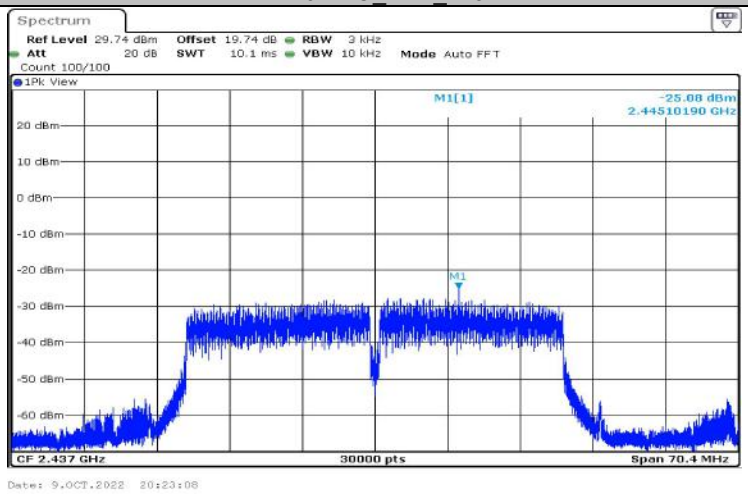
11N20SISO_Ant1_2462



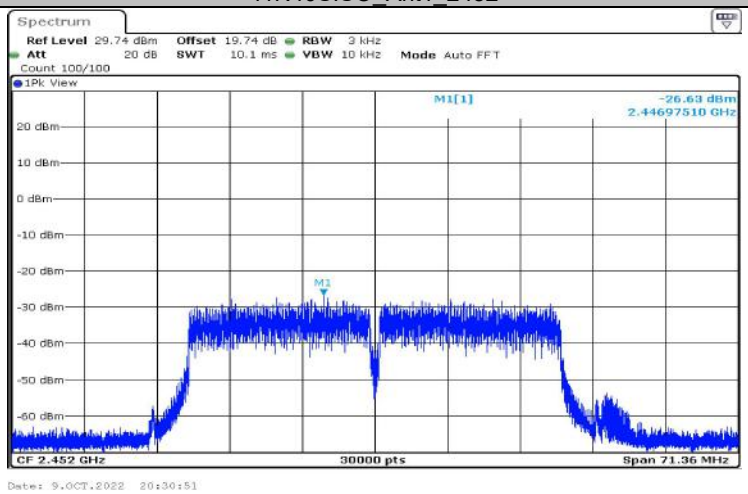
11N40SISO_Ant1_2422



11N40SISO_Ant1_2437

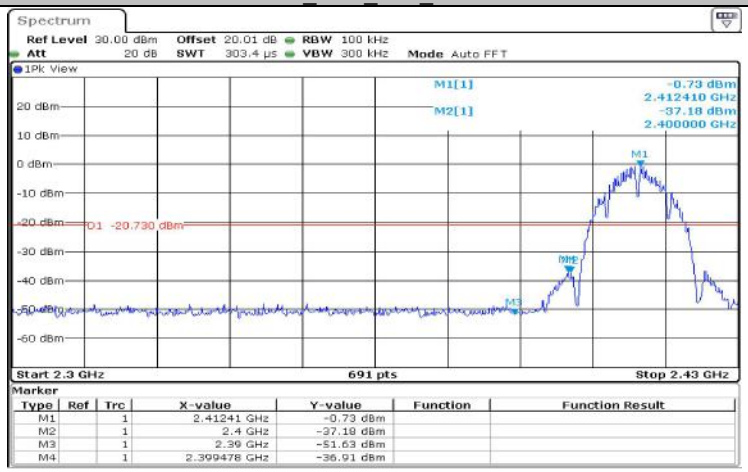


11N40SISO_Ant1_2452

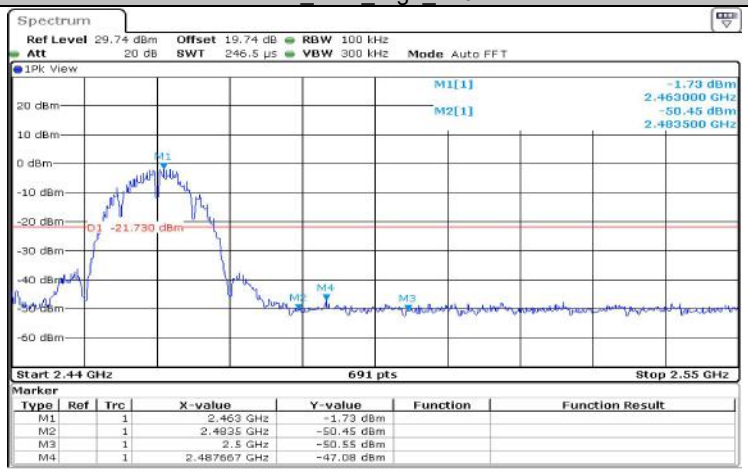


Appendix E: Band edge measurements
Test Graphs

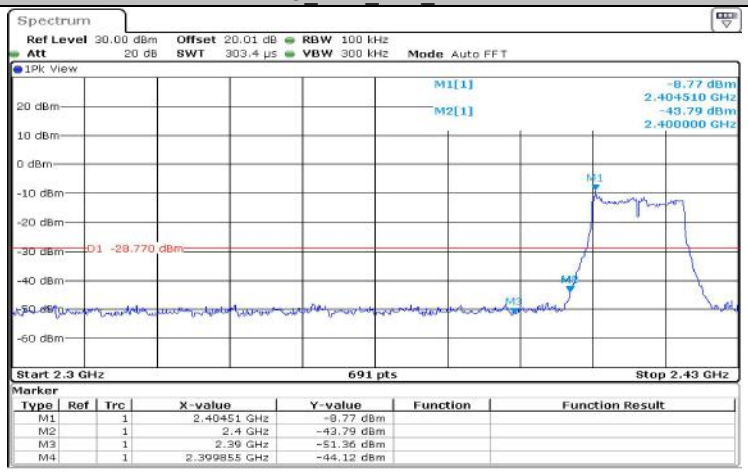
11B_Ant1_Low_2412



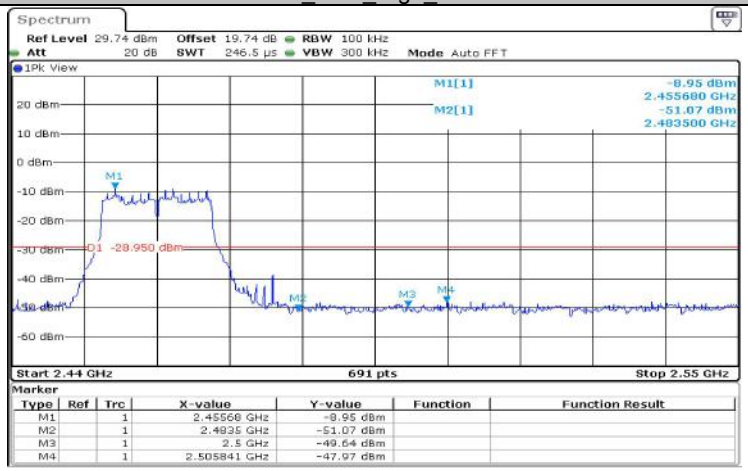
11B_Ant1_High_2462



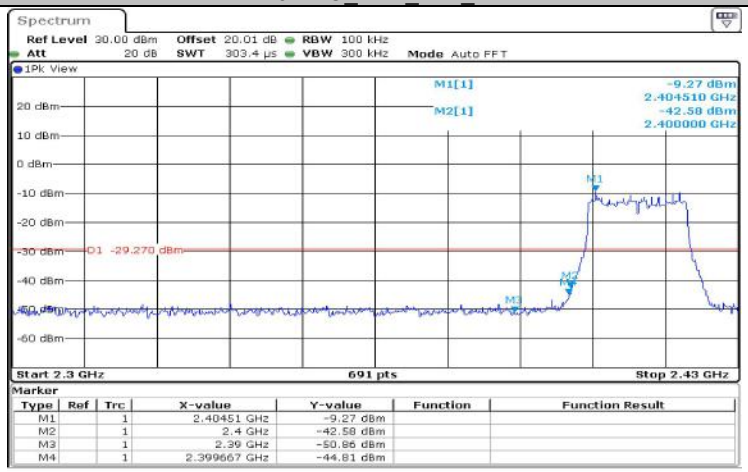
11G_Ant1_Low_2412



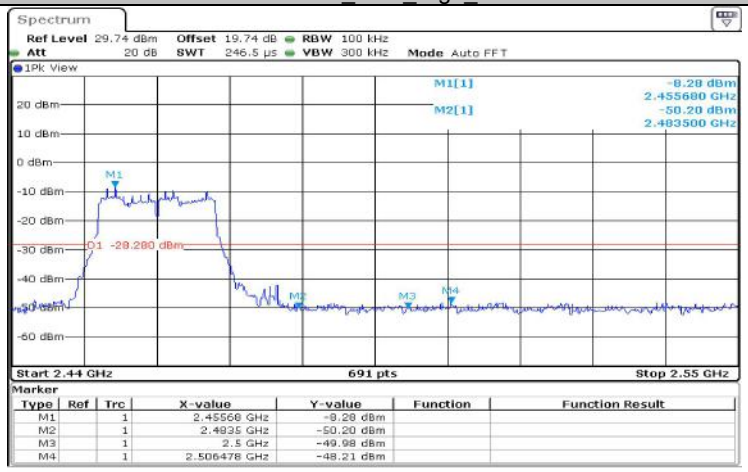
11G_Ant1_High_2462



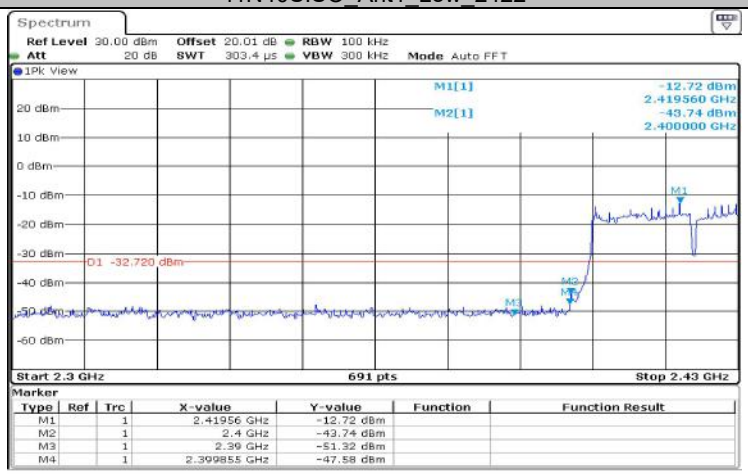
11N20SISO_Ant1_Low_2412



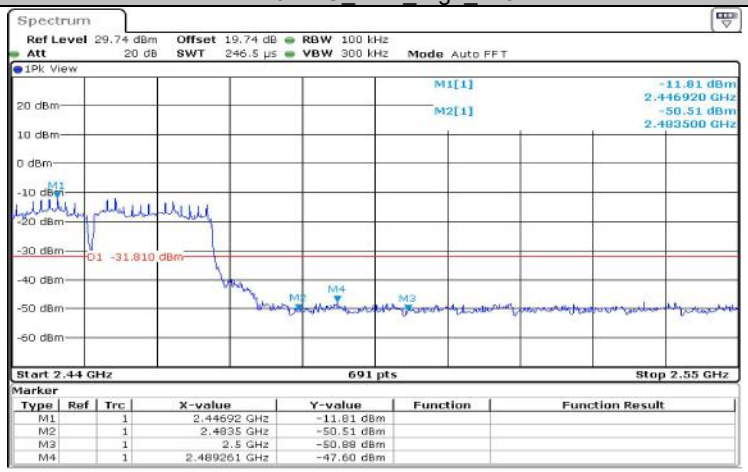
11N20SISO_Ant1_High_2462



11N40SISO_Ant1_Low_2422



11N40SISO_Ant1_High_2452



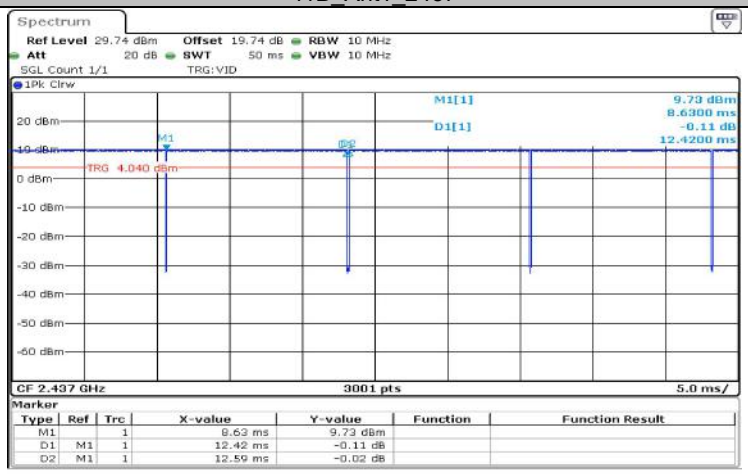
Appendix F: Duty Cycle

Test Result

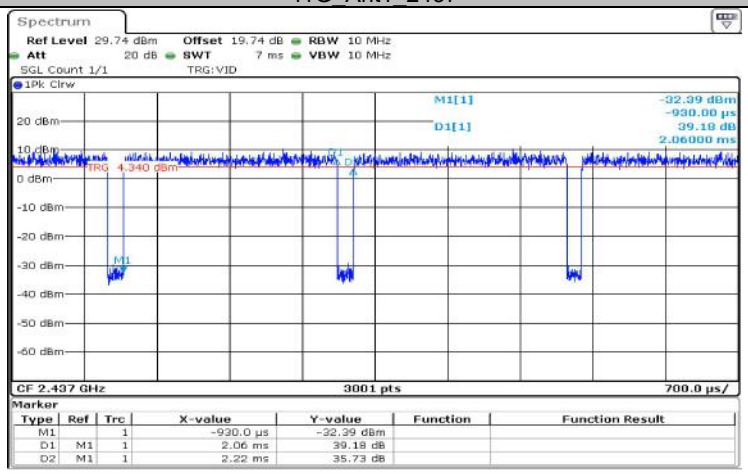
Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2437	12.42	12.59	98.65
11G	Ant1	2437	2.06	2.22	92.79
11N20SISO	Ant1	2437	1.92	2.02	95.05
11N40SISO	Ant1	2437	0.94	1.07	87.85

Test Graphs

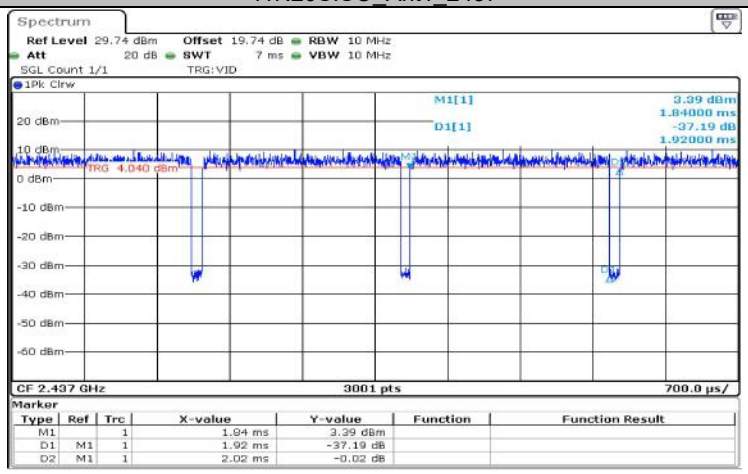
11B_Ant1_2437



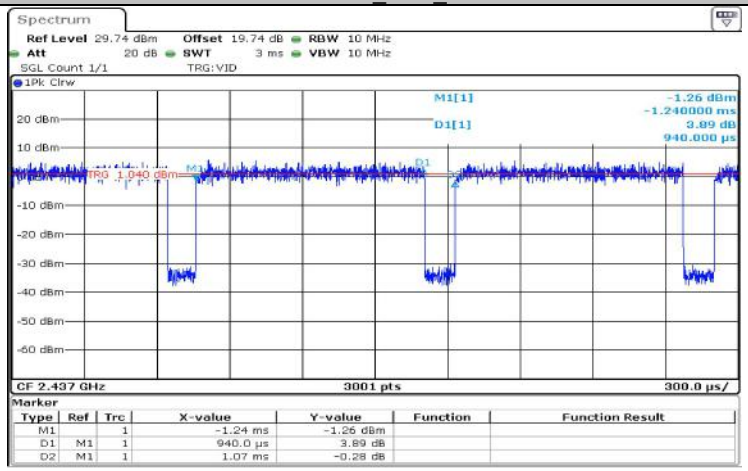
11G_Ant1_2437



11N20SISO_Ant1_2437



11N40SISO_Ant1_2437



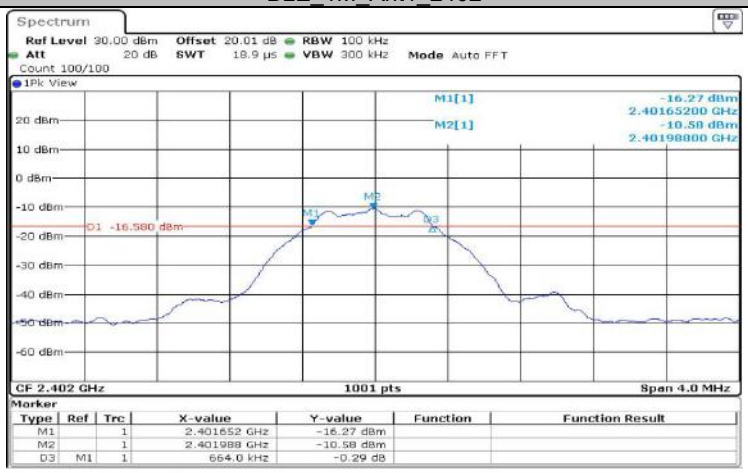
APPENDIX BLE

Appendix A: DTS Bandwidth
Test Result

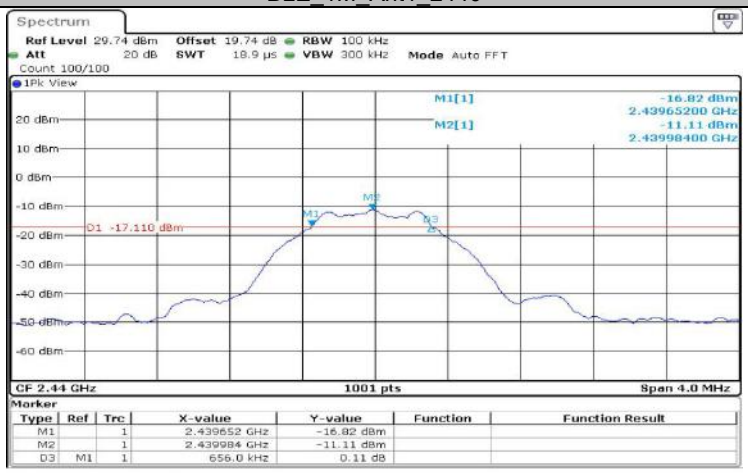
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.66	0.5	PASS
		2440	0.66	0.5	PASS
		2480	0.66	0.5	PASS

Test Graphs

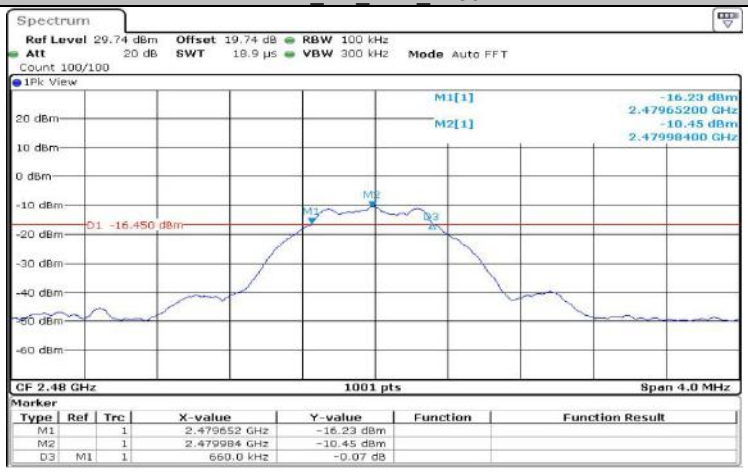
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480

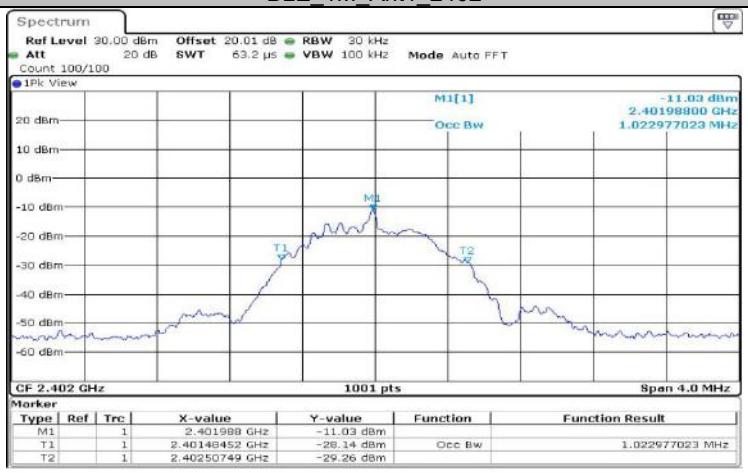


Appendix B: Occupied Channel Bandwidth
Test Result

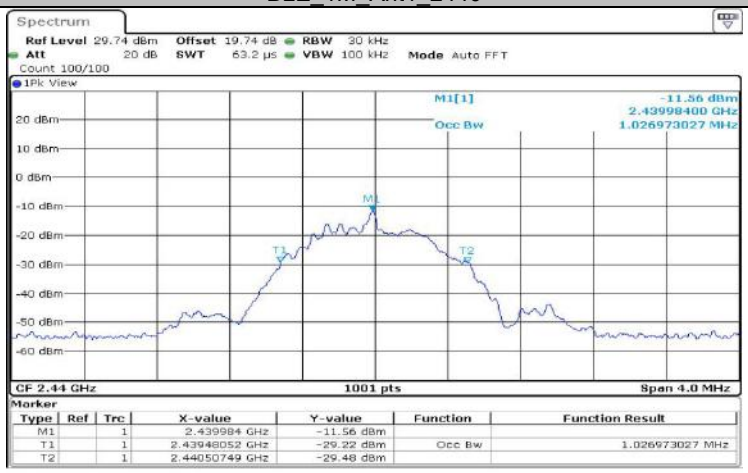
Test Mode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.023	2401.485	2402.507	---	---
		2440	1.027	2439.481	2440.507	---	---
		2480	1.031	2479.481	2480.511	---	---

Test Graphs

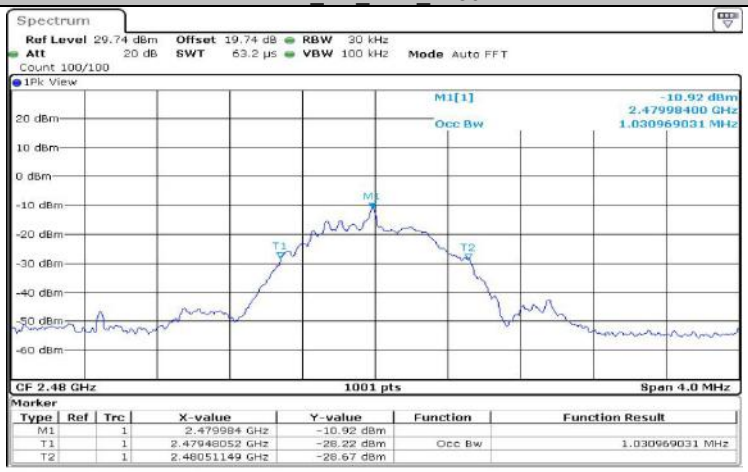
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



Appendix C: Maximum output power

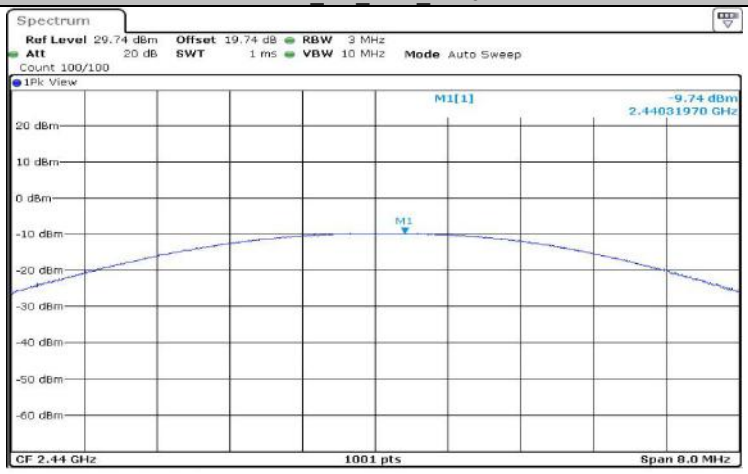
Test Result

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	-9.78	≤30	PASS
		2440	-9.74	≤30	PASS
		2480	-9.31	≤30	PASS

Test Graphs

BLE_1M_Ant1_2402

BLE_1M_Ant1_2440



BLE_1M_Ant1_2480

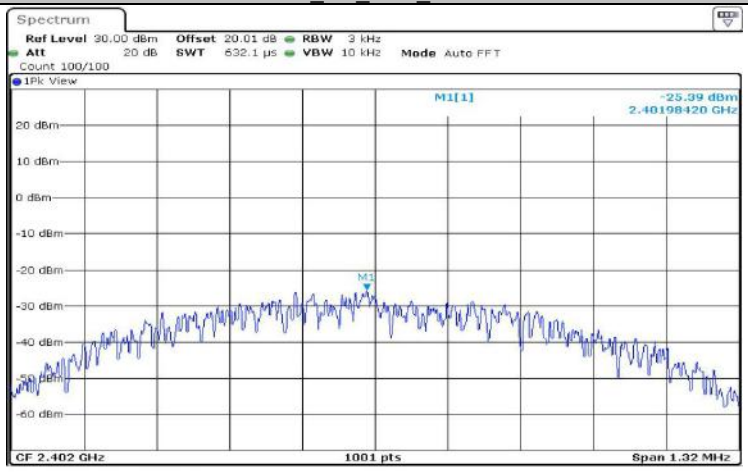
Appendix D: Maximum power spectral density

Test Result

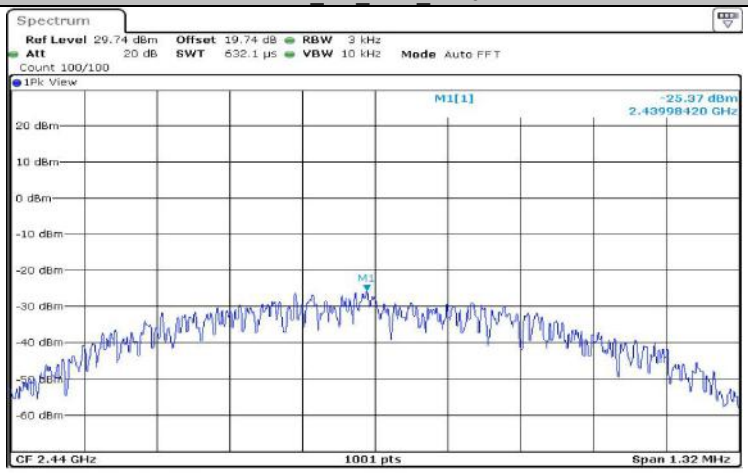
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-25.39	≤8.00	PASS
		2440	-25.37	≤8.00	PASS
		2480	-24.87	≤8.00	PASS

Test Graphs

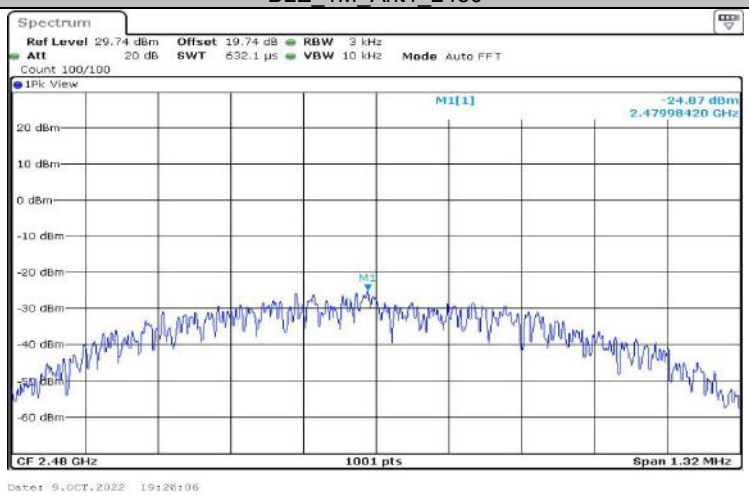
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440

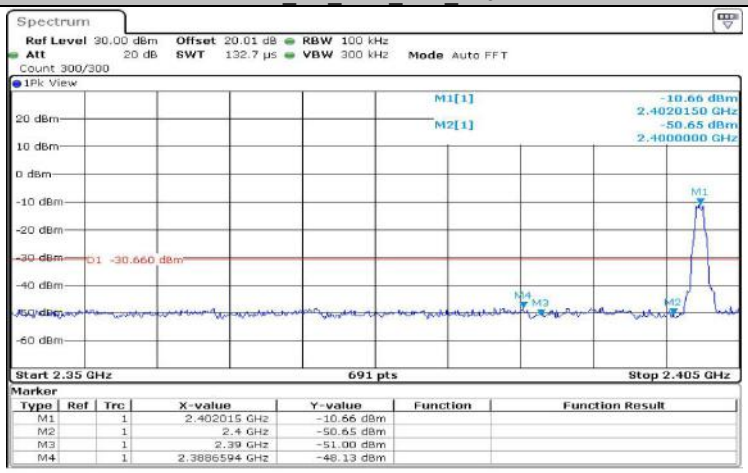


BLE_1M_Ant1_2480

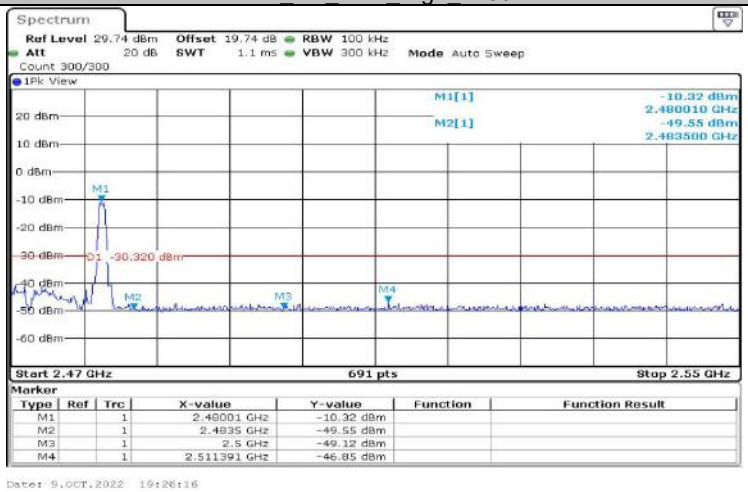


Appendix E: Band edge measurements
Test Graphs

BLE_1M_Ant1_Low_2402



BLE_1M_Ant1_High_2480

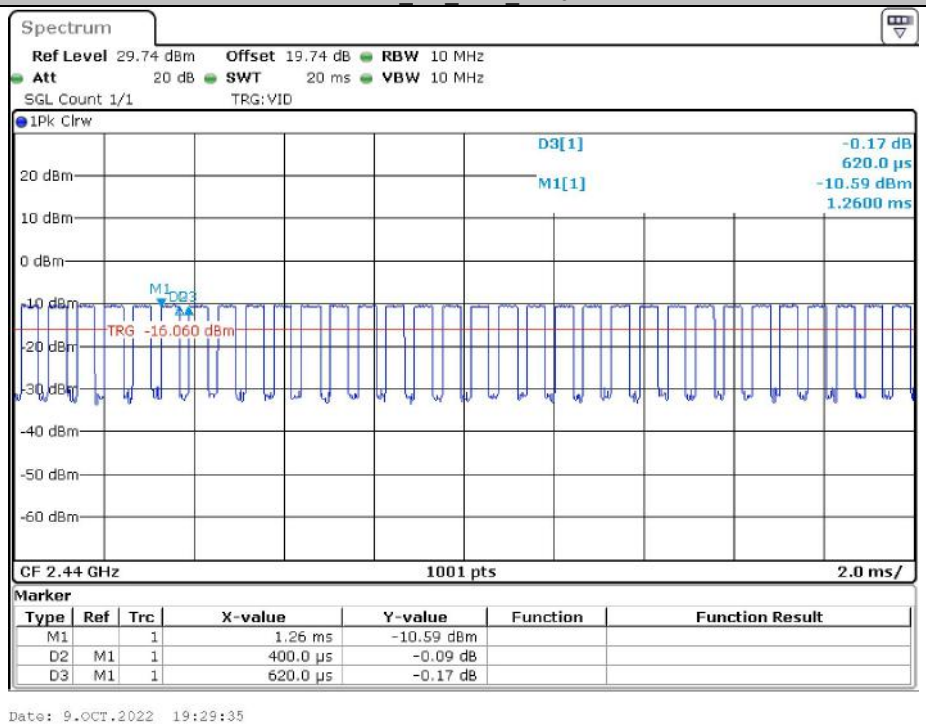


Appendix F: Duty Cycle
Test Result

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	0.40	0.62	64.52

Test Graphs

BLE_1M_Ant1_2440



******* END OF REPORT *******