TEST REPORT

Applicant Name :	Seeed Technology Co., Ltd
Address :	9F, G3 Building, TCL International E City, Zhongshanyuan Road, Nanshan District, Shenzhen, China
Report Number :	SZNS1220114-02177E-00A
FCC ID:	Z4T-XIAONRF52840

Test Standard (s)

FCC PART 15.247

Sample Description

Product:	XIAO nRF52840 Sense
Trademark:	Seeed Studio
Tested Model:	XIAO-nRF52840 Sense
Multiple Product:	XIAO nRF52840
Multiple Model:	XIAO-nRF52840
Date Received:	2022-01-14
Date of Test:	2022-01-25 to 2022-04-12
Report Date:	2022-04-13

Test Result:	Pass*

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

Prepared and Checked By:

Ting Lü
EMC Engineer

Approved By:

Candy Li
EMC Engineer

ACCURATE TECHNOLOGY CO. LTD ATC APPROVED

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	XIAO nRF52840 Sense
Tested Model	XIAO-nRF52840 Sense
Multiple Product	XIAO nRF52840
Multiple Model	XIAO-nRF52840
Model difference	Please refer to the DoS letter
Frequency Range	BLE: 2402-2480MHz
Maximum Conducted Peak Output Power	BLE: 5.04dBm
Modulation Technique	BLE: GFSK
Antenna Specification*	Chip Antenna: 2dBi (provided by the applicant)
Voltage Range	DC 5V From USB Port
Sample serial number	SZNS1220114-02177E-RF-S1 (XIAO-nRF52840 Sense) SZNS1220114-02177E-RF-S2 (XIAO-nRF52840)
Sample/EUT Status	Good condition

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, 15.207, 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 Frequency		$0.082*10^{-7}$
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
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

The system was configured for testing in an engineering mode.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“PUTY”* exercise software was used for testing and the power level was default*. The software and power level was provided by the applicant.

Duty cycle

Test Result: Compliant. Please refer to the Appendix BLE.

Support Equipment List and Details

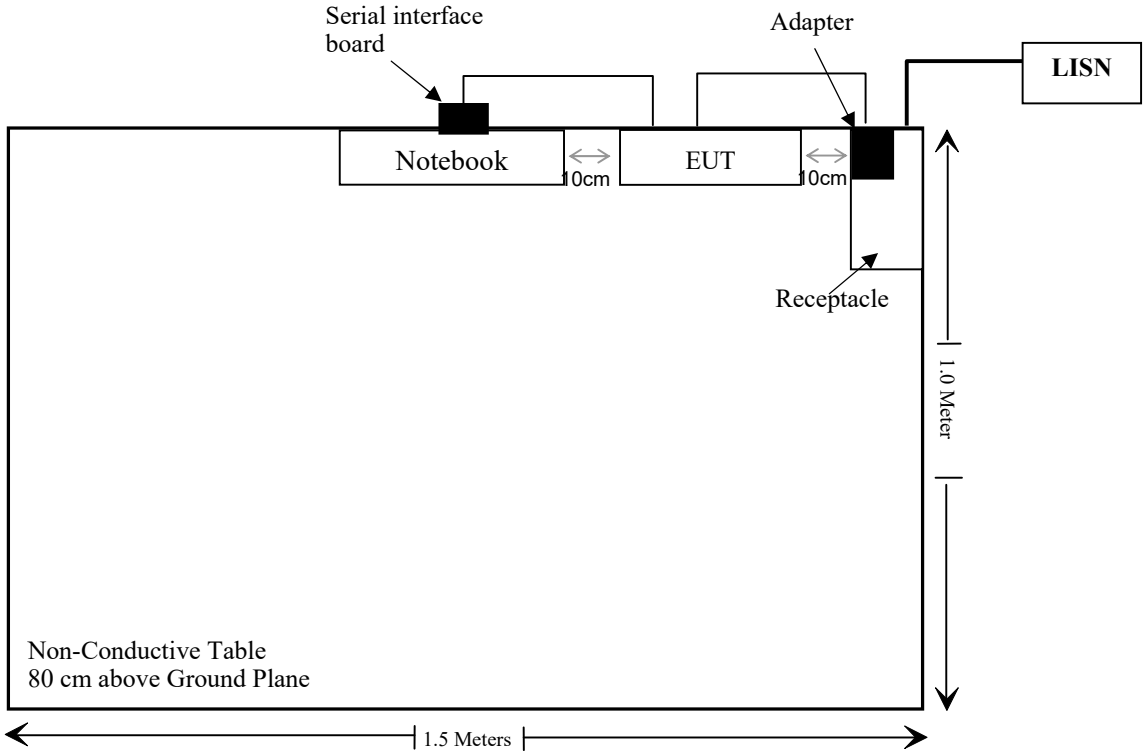
Manufacturer	Description	Model	Serial Number
Apple	Adapter	A1357	Unknown
Lenovo	Notebook	T430	Unknown
Unknown	Serial interface board	Unknown	Unknown

External I/O Cable

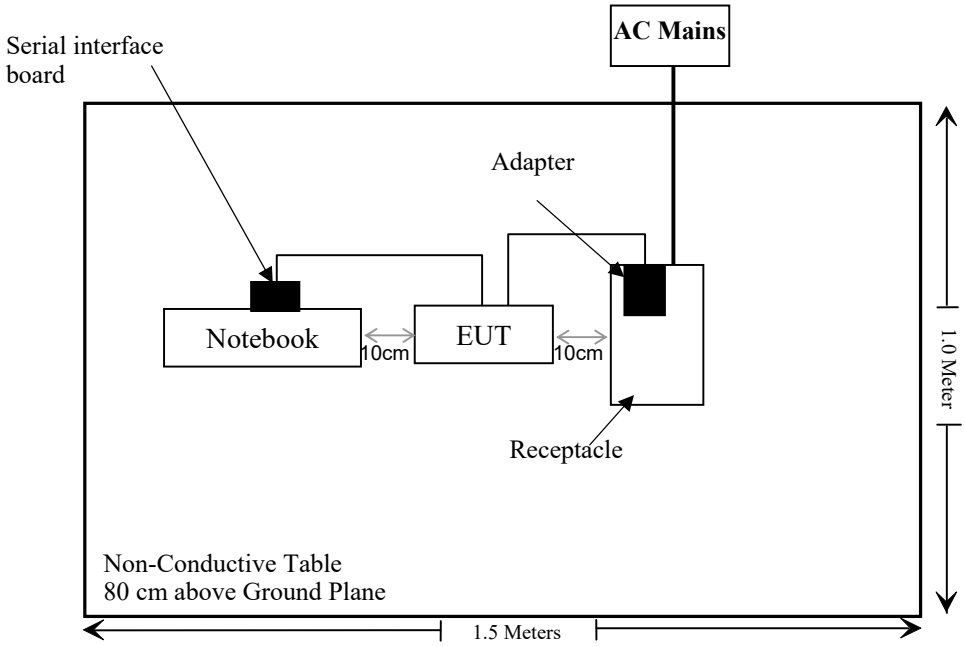
Cable Description	Length (m)	From Port	To
Unshielded Detachable USB Cable	0.75	EUT	Adapter
Unshielded Detachable Data Cable	0.2	EUT	Serial interface board

Block Diagram of Test Setup

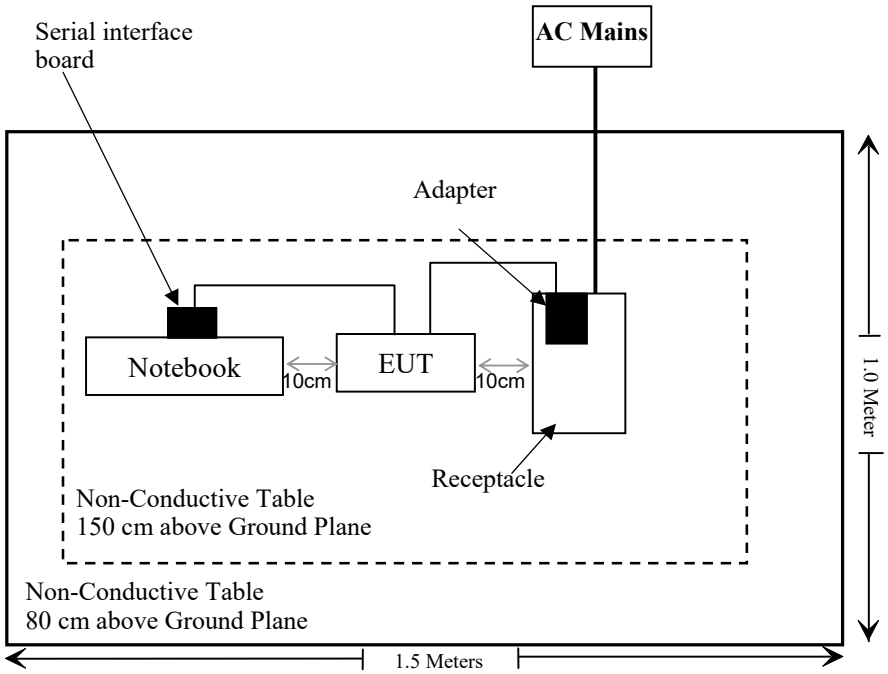
For conducted emission:



For radiated emission below 1GHz:



For radiated emission above 1GHz:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (I), §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§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

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions 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-184055 36-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
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13
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
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.32	RF-02	Each time	
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 §1.1310 & §2.1091 –MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart §2.1091 and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) 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;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:
Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = 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);

Calculated Data:

For worst case:

Mode	**Frequency Range (MHz)**	**Antenna Gain**		**Tune-up Output Power**		**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**
		(dBi)	**(numeric)**	**(dBm)**	**(mW)**			
BLE	2402-2480	2	1.58	6	3.98	20	0.0013	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 Chip antenna arrangement which was permanently attached and the antenna gain is 2dBi, fulfill the requirement of this section. Please refer to the product photos.

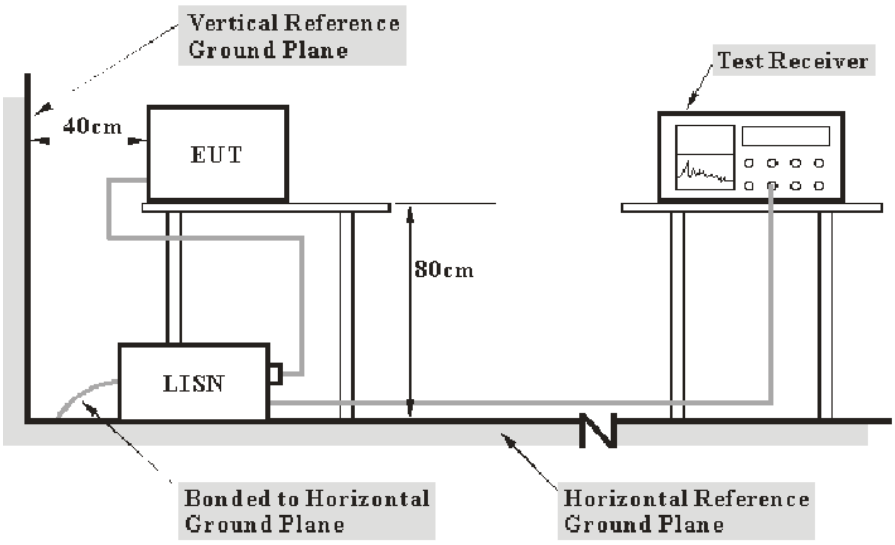
Result: Compliant.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the device was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Factor & Margin Calculation

The factor is calculated by adding LISN VDF (Voltage Division Factor) and Cable Loss. The basic equation is as follows:

Factor = LISN VDF + Cable Loss

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

Over Limit = Level – Limit
Level = Read Level + Factor

Test Data

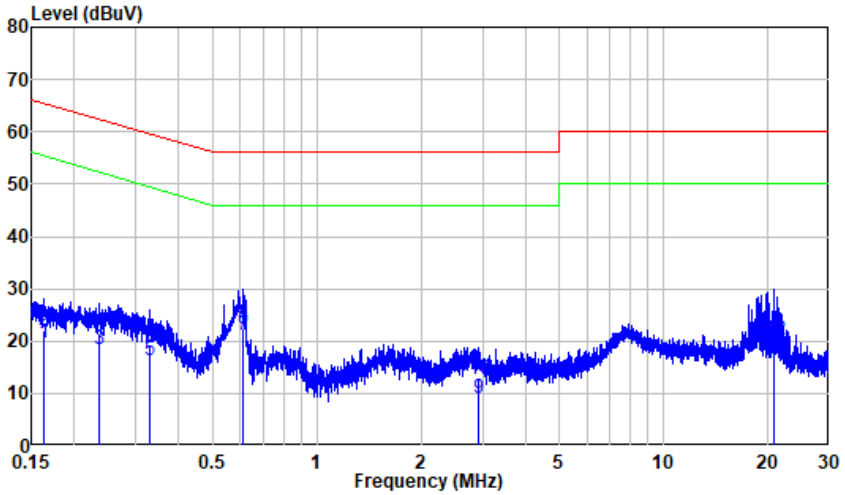
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	64 %
ATM Pressure:	101.0 kPa

The testing was performed by Bin Duan on 2022-01-25.

EUT operation mode: Transmitting (worst case is BLE 2M, low channel for the model of XIAO-nRF52840 Sense)

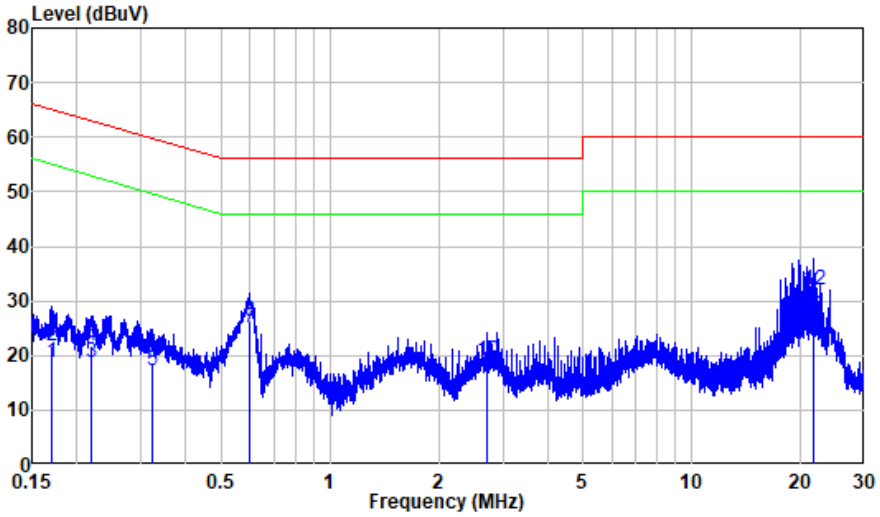
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Model : XIAO-nRF52840 Sense
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.163	9.87	9.72	19.59	55.30	-35.71	Average
2	0.163	9.87	12.14	22.01	65.30	-43.29	QP
3	0.236	9.80	8.70	18.50	52.23	-33.73	Average
4	0.236	9.80	11.54	21.34	62.23	-40.89	QP
5	0.329	9.80	6.49	16.29	49.47	-33.18	Average
6	0.329	9.80	9.13	18.93	59.47	-40.54	QP
7	0.610	9.81	11.45	21.26	46.00	-24.74	Average
8	0.610	9.81	12.58	22.39	56.00	-33.61	QP
9	2.911	9.93	-0.93	9.00	46.00	-37.00	Average
10	2.911	9.93	2.74	12.67	56.00	-43.33	QP
11	20.800	10.23	5.47	15.70	50.00	-34.30	Average
12	20.800	10.23	10.06	20.29	60.00	-39.71	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Model : XIAO-nRF52840 Sense
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.169	9.80	8.98	18.78	54.99	-36.21	Average
2	0.169	9.80	12.03	21.83	64.99	-43.16	QP
3	0.219	9.80	9.05	18.85	52.86	-34.01	Average
4	0.219	9.80	11.81	21.61	62.86	-41.25	QP
5	0.324	9.80	7.40	17.20	49.61	-32.41	Average
6	0.324	9.80	8.98	18.78	59.61	-40.83	QP
7	0.597	9.81	15.14	24.95	46.00	-21.05	Average
8	0.597	9.81	16.46	26.27	56.00	-29.73	QP
9	2.723	9.83	6.16	15.99	46.00	-30.01	Average
10	2.723	9.83	9.14	18.97	56.00	-37.03	QP
11	21.629	10.12	17.48	27.60	50.00	-22.40	Average
12	21.629	10.12	21.81	31.93	60.00	-28.07	QP

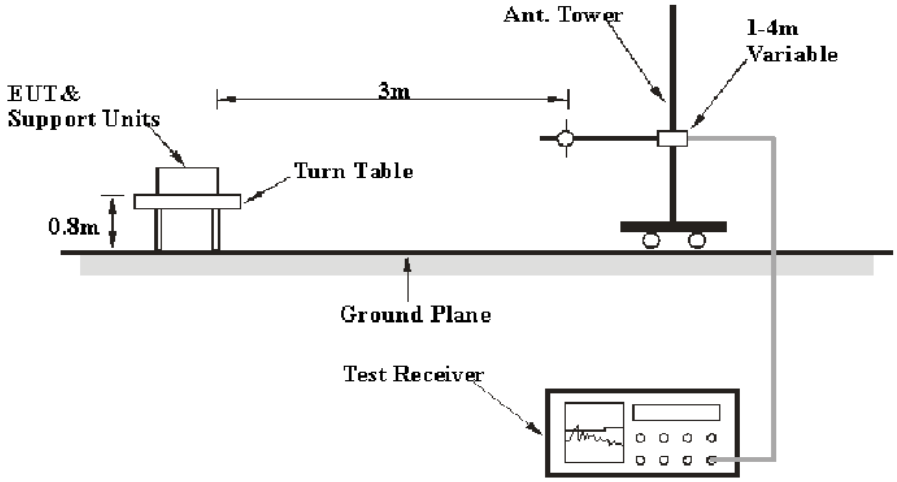
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

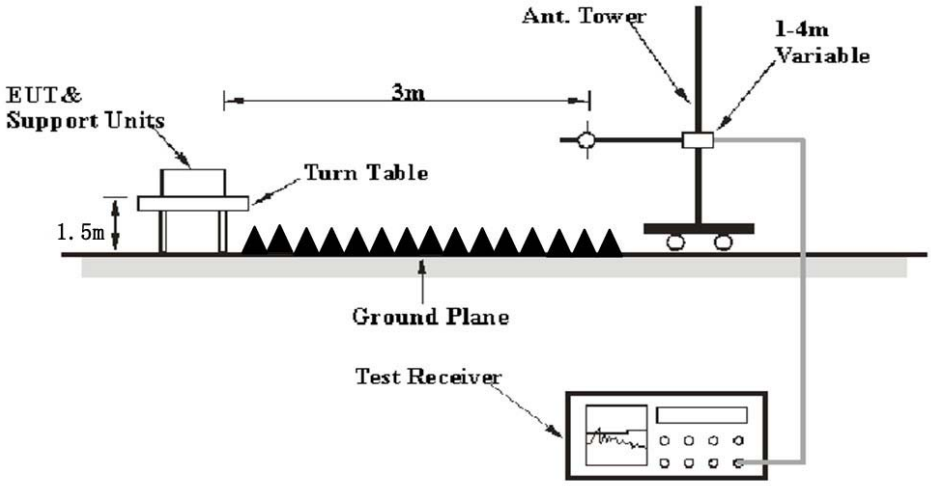
FCC §15.247 (d); §15.209; §15.205;

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:	23 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

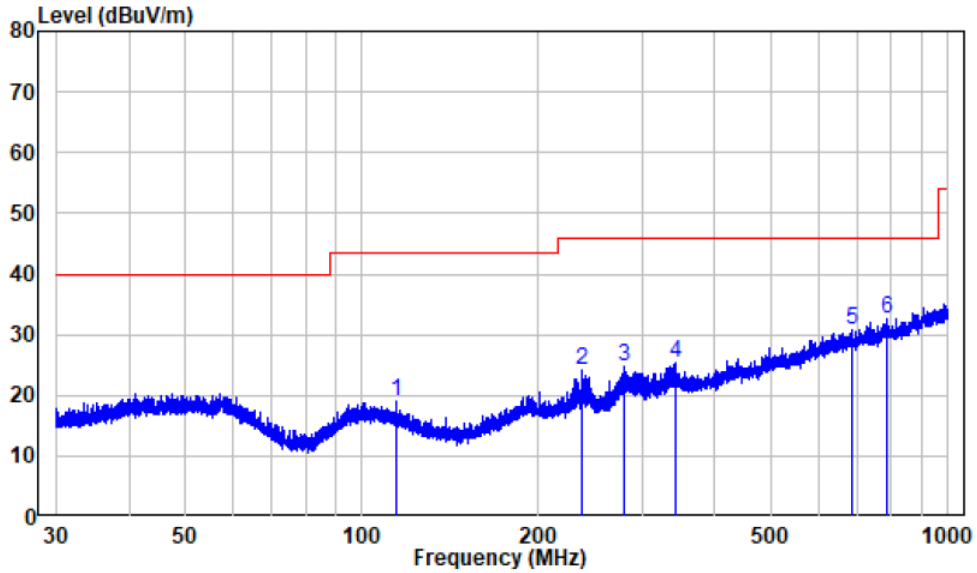
The testing was performed by Ting Lü on 2022-1-26 for below 1GHz and 2022-4-12 for above 1GHz.

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

Worst case is BLE 2M, low channel for the model of XIAO-nRF52840 Sense:

30 MHz~1 GHz:

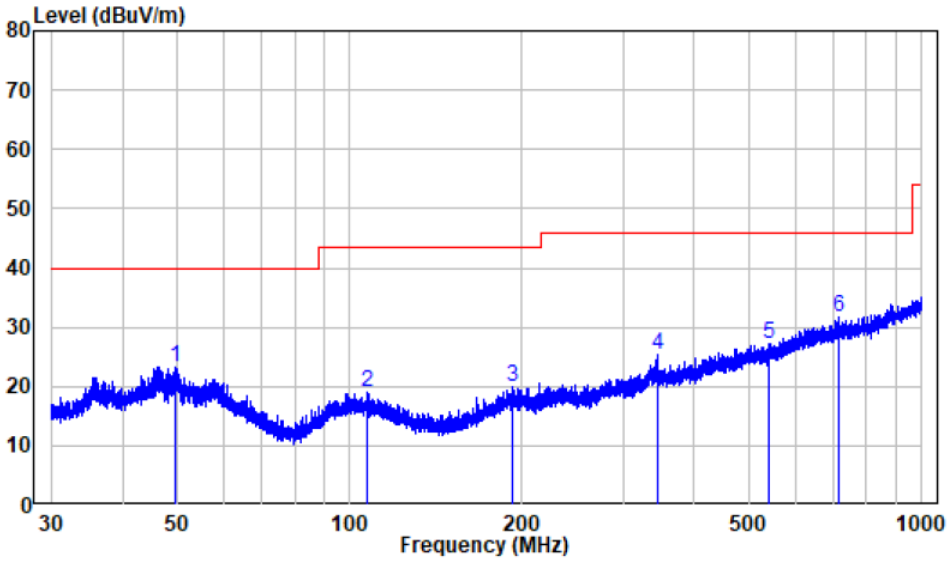
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS1220114-02177E-RF
Test Mode: Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	114.515	-12.65	31.78	19.13	43.50	-24.37	Peak
2	237.164	-10.94	35.23	24.29	46.00	-21.71	Peak
3	279.656	-9.60	34.25	24.65	46.00	-21.35	Peak
4	343.632	-7.27	32.54	25.27	46.00	-20.73	Peak
5	683.546	-1.50	32.43	30.93	46.00	-15.07	Peak
6	786.127	-0.05	32.75	32.70	46.00	-13.30	Peak

Vertical



Site : chamber
Condition: 3m Vertical
Job No. : SZNS1220114-02177E-RF
Test Mode: Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	49.468	-9.94	33.18	23.24	40.00	-16.76	Peak
2	107.228	-11.97	31.04	19.07	43.50	-24.43	Peak
3	191.829	-11.28	31.34	20.06	43.50	-23.44	Peak
4	345.747	-7.23	32.46	25.23	46.00	-20.77	Peak
5	538.533	-4.06	31.28	27.22	46.00	-18.78	Peak
6	718.255	-1.34	33.02	31.68	46.00	-14.32	Peak

Note: The results which over 6dB below to the limit were not recorded Quasi-peak.

Above 1 GHz:

For model of XIAO-nRF52840 Sense:

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
BLE 1M, Low Channel									
2310	52.54	PK	129	1.5	H	-7.23	45.31	74	-28.69
2310	48.96	PK	321	1.8	V	-7.23	41.73	74	-32.27
2390	51.52	PK	153	1.4	H	-7.21	44.31	74	-29.69
2390	50.32	PK	224	2.0	V	-7.21	43.11	74	-30.89
4804	56.88	PK	137	1.7	H	-3.52	53.36	74	-20.64
4804	52.91	PK	242	1.6	V	-3.52	49.39	74	-24.61
BLE 1M, Middle Channel									
4880	56.48	PK	285	2.0	H	-3.37	53.11	74	-20.89
4880	52.56	PK	75	1.9	V	-3.37	49.19	74	-24.81
BLE 1M, High Channel									
2483.5	52.48	PK	135	1.0	H	-7.2	45.28	74	-28.72
2483.5	52.35	PK	342	1.6	V	-7.2	45.15	74	-28.85
2500	51.25	PK	51	1.4	H	-7.18	44.07	74	-29.93
2500	51.66	PK	48	1.3	V	-7.18	44.48	74	-29.52
4960	54.56	PK	199	1.8	H	-3.01	51.55	74	-22.45
4960	51.94	PK	283	1.1	V	-3.01	48.93	74	-25.07
BLE 2M, Low Channel									
2310	50.69	PK	20	1.1	H	-7.23	43.46	74	-30.54
2310	51.19	PK	215	2.1	V	-7.23	43.96	74	-30.04
2390	52.22	PK	32	1.0	H	-7.21	45.01	74	-28.99
2390	52.21	PK	115	1.0	V	-7.21	45	74	-29
4804	54.75	PK	157	1.7	H	-3.52	51.23	74	-22.77
4804	54.97	PK	345	1.6	V	-3.52	51.45	74	-22.55
BLE 2M, Middle Channel									
4880	53.7	PK	358	1.9	H	-3.37	50.33	74	-23.67
4880	54.35	PK	41	2.0	V	-3.37	50.98	74	-23.02
BLE 2M, High Channel									
2483.5	50.42	PK	47	1.4	H	-7.2	43.22	74	-30.78
2483.5	51.51	PK	100	1.8	V	-7.2	44.31	74	-29.69
2500	49.92	PK	237	1.5	H	-7.18	42.74	74	-31.26
2500	50.3	PK	180	1.8	V	-7.18	43.12	74	-30.88
4960	53.22	PK	125	1.2	H	-3.01	50.21	74	-23.79
4960	52.45	PK	125	1.4	V	-3.01	49.44	74	-24.56

For model of XIAO-nRF52840:

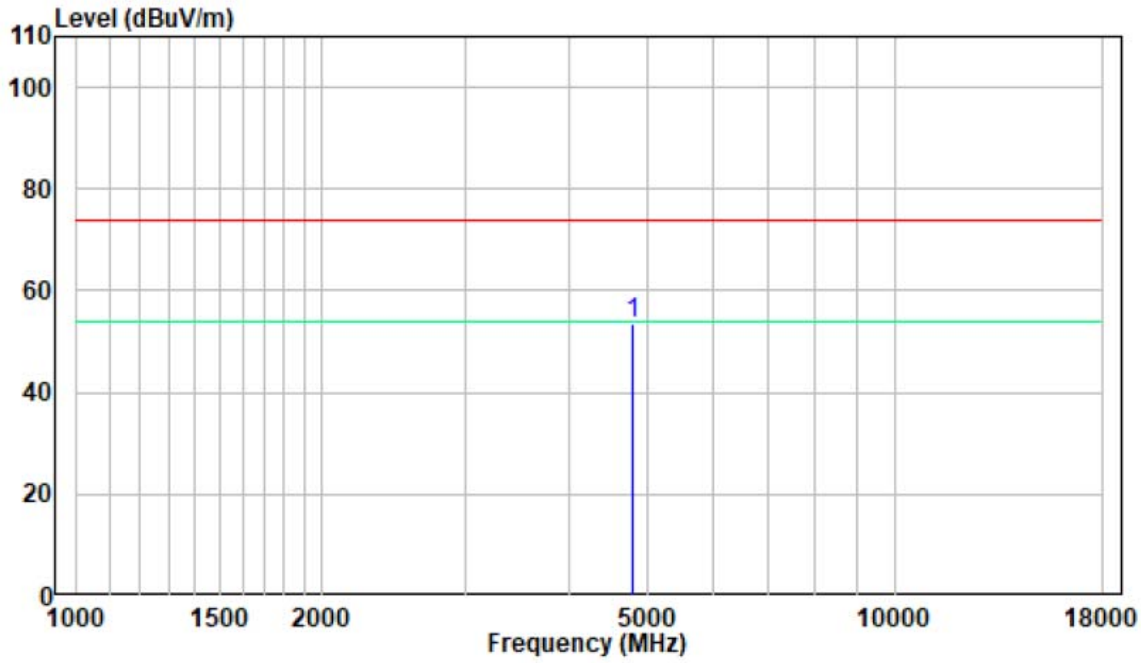
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
BLE 1M, Low Channel									
2310	49.55	PK	164	2.1	H	-7.23	42.32	74	-31.68
2310	48.27	PK	84	1.4	V	-7.23	41.04	74	-32.96
2390	50.53	PK	302	2.1	H	-7.21	43.32	74	-30.68
2390	48.91	PK	113	1.7	V	-7.21	41.7	74	-32.3
4804	52.93	PK	148	1.0	H	-3.52	49.41	74	-24.59
4804	52.79	PK	235	1.5	V	-3.52	49.27	74	-24.73
BLE 1M, Middle Channel									
4880	51.33	PK	337	1.5	H	-3.37	47.96	74	-26.04
4880	50.49	PK	256	1.7	V	-3.37	47.12	74	-26.88
BLE 1M, High Channel									
2483.5	48.49	PK	198	1.5	H	-7.2	41.29	74	-32.71
2483.5	52.28	PK	72	1.8	V	-7.2	45.08	74	-28.92
2500	46.68	PK	0	1.7	H	-7.18	39.5	74	-34.5
2500	47.19	PK	242	1.1	V	-7.18	40.01	74	-33.99
4960	49.76	PK	216	1.7	H	-3.01	46.75	74	-27.25
4960	49.12	PK	313	1.3	V	-3.01	46.11	74	-27.89
BLE 2M, Low Channel									
2310	44.35	PK	178	1.9	H	-7.23	37.12	74	-36.88
2310	45.07	PK	227	1.6	V	-7.23	37.84	74	-36.16
2390	47.71	PK	138	1.5	H	-7.21	40.5	74	-33.5
2390	48.17	PK	138	1.4	V	-7.21	40.96	74	-33.04
4804	52.72	PK	266	1.6	H	-3.52	49.2	74	-24.8
4804	56.35	PK	37	1.6	V	-3.52	52.83	74	-21.17
BLE 2M, Middle Channel									
4880	51.86	PK	133	1.2	H	-3.37	48.49	74	-25.51
4880	52.5	PK	1	1.1	V	-3.37	49.13	74	-24.87
BLE 2M, High Channel									
2483.5	53.32	PK	88	1.6	H	-7.2	46.12	74	-27.88
2483.5	58.01	PK	169	1.3	V	-7.2	50.81	74	-23.19
2500	45.06	PK	132	1.5	H	-7.18	37.88	74	-36.12
2500	46.36	PK	283	2.1	V	-7.18	39.18	74	-34.82
4960	48.45	PK	358	2.1	H	-3.01	45.44	74	-28.56
4960	49.76	PK	132	1.4	V	-3.01	46.75	74	-27.25

Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level (Corrected Amplitude) – Limit
The other spurious emission which is in the noise floor level was not recorded.
For above 1GHz, the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, so just peak value was recorded.

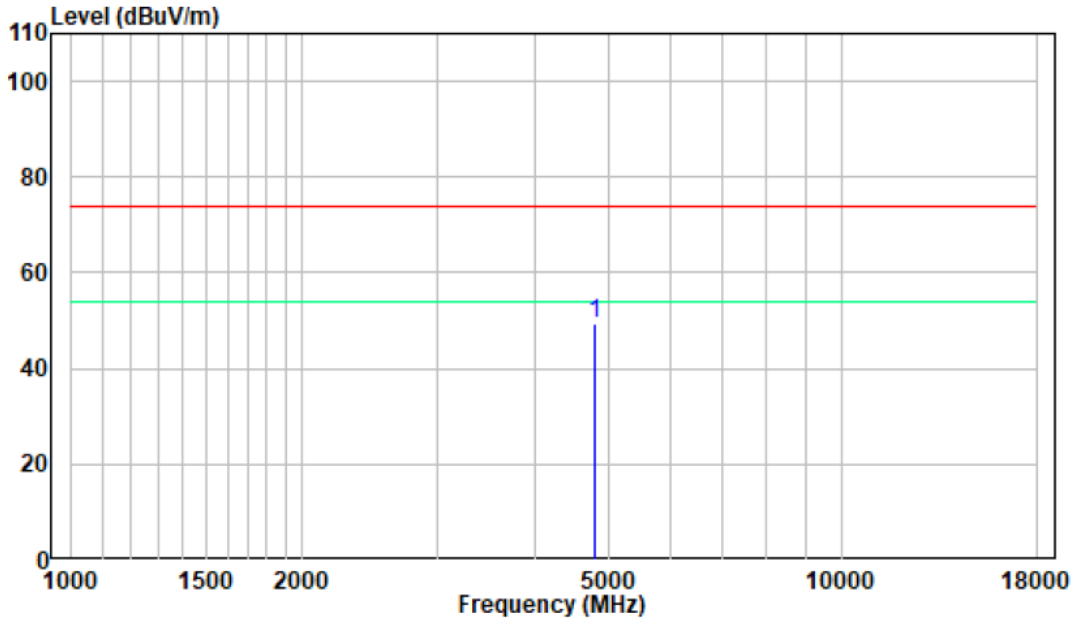
For model of XIAO-nRF52840 Sense:

1-18 GHz:
Pre-scan plots:

BLE 1M Low Channel
Horizontal

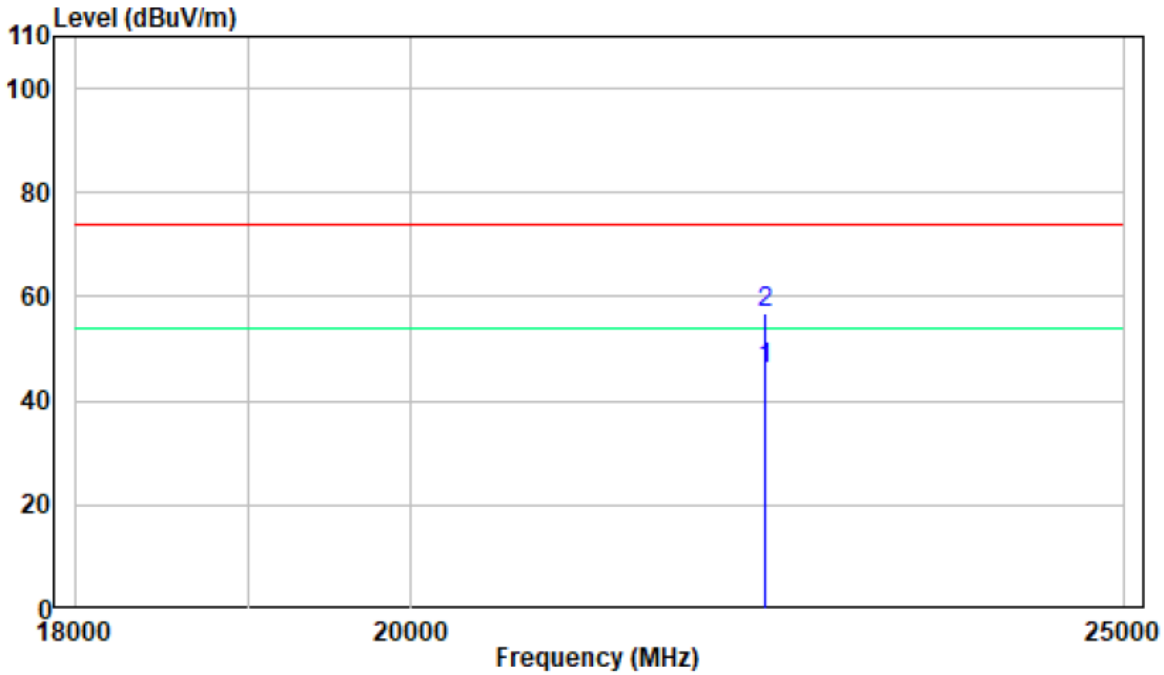


Vertical

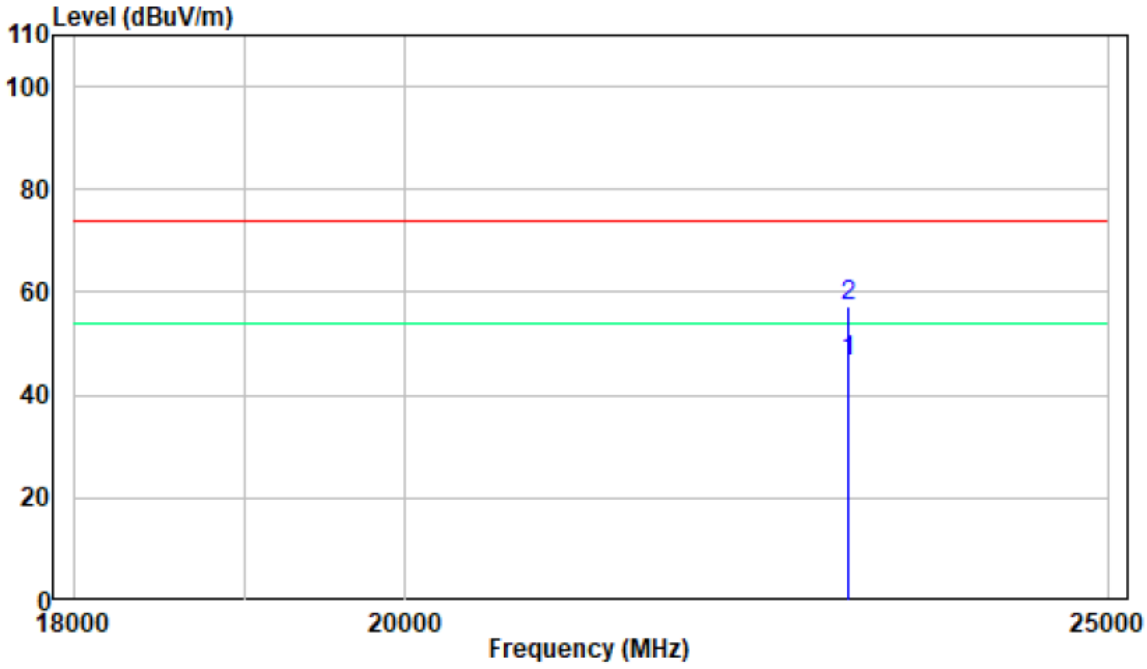


18 -25GHz:
Pre-scan plots:

BLE 1M Low Channel
Horizontal

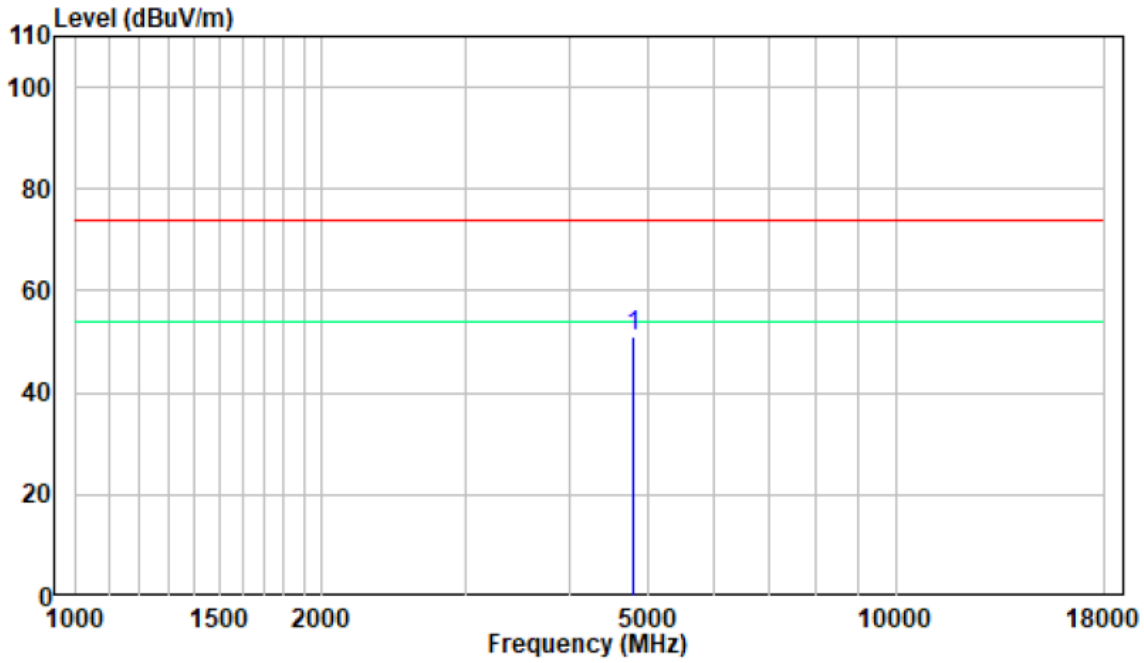


Vertical

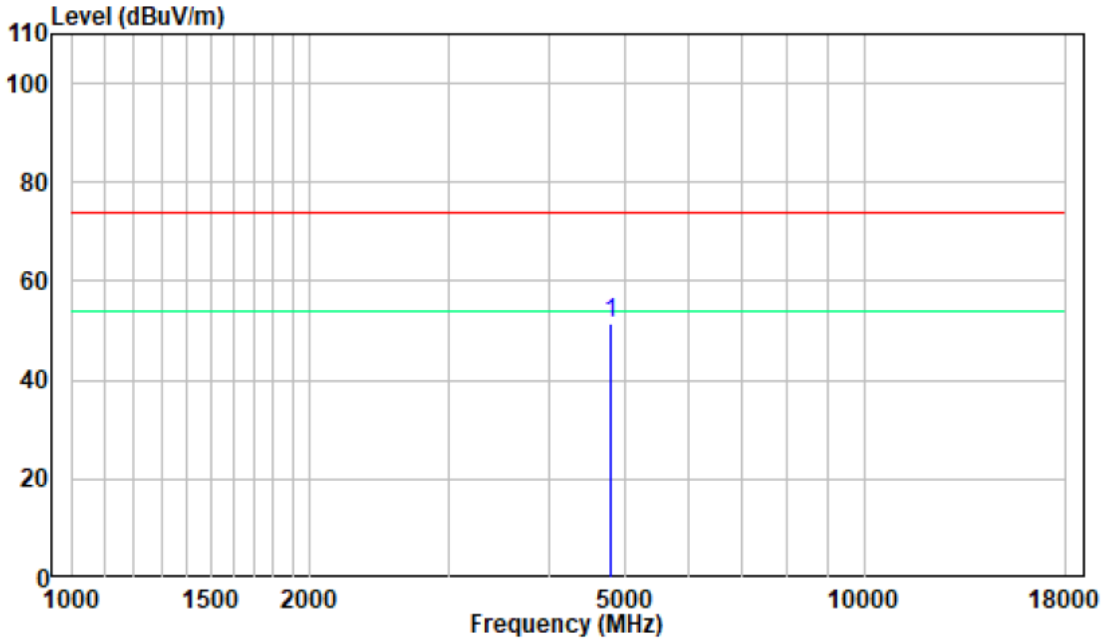


1-18 GHz:
Pre-scan plots:

BLE 2M Low Channel
Horizontal

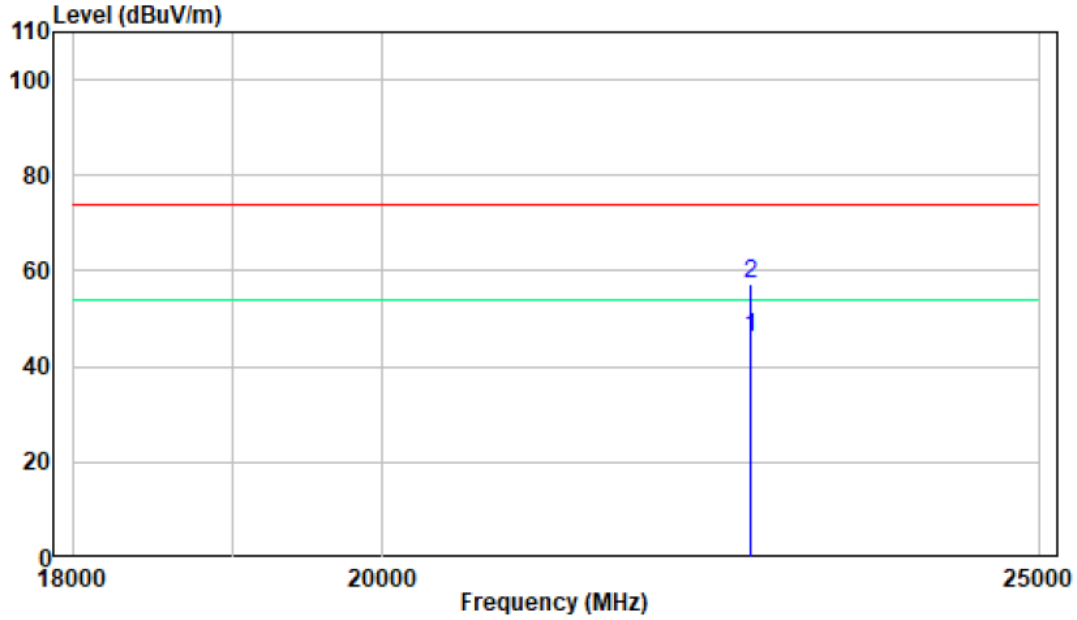


Vertical

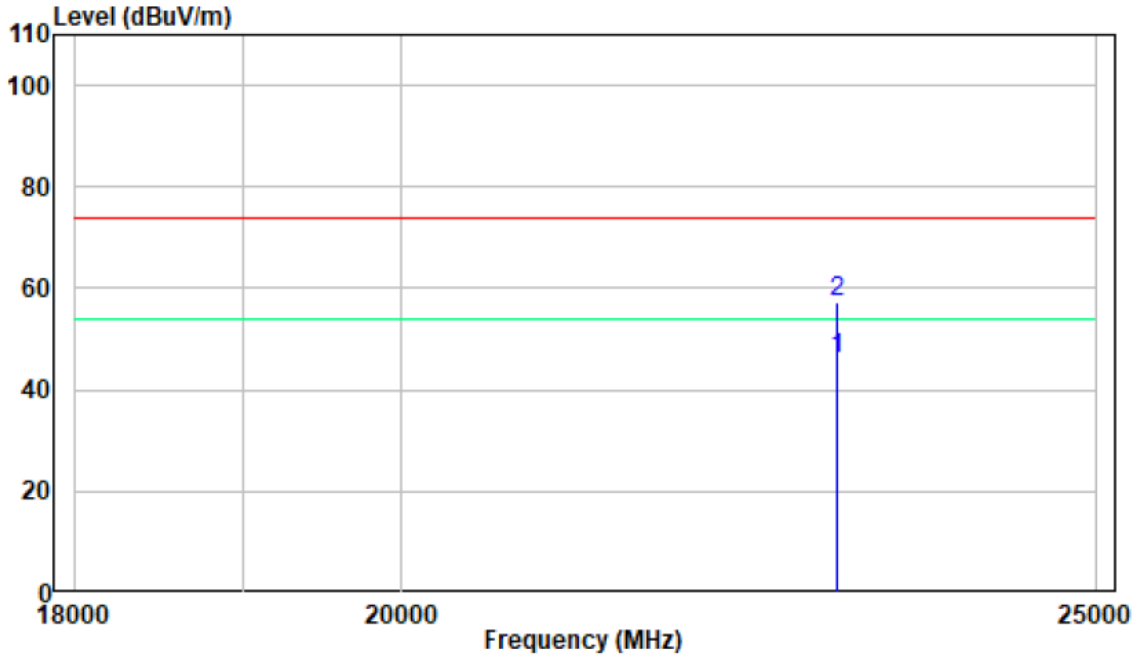


18 -25GHz:
Pre-scan plots:

BLE 2M Low Channel
Horizontal



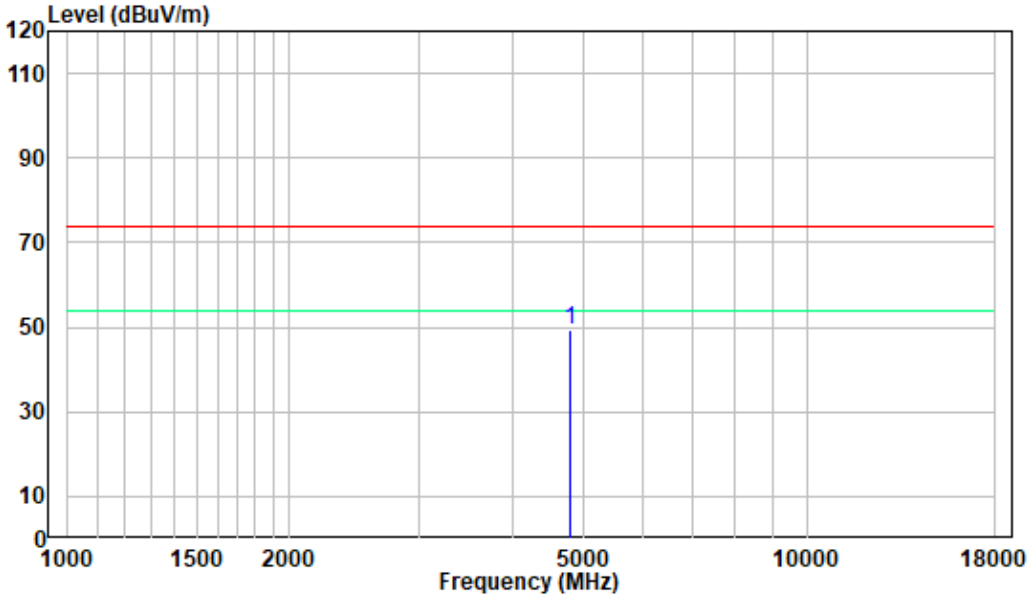
Vertical



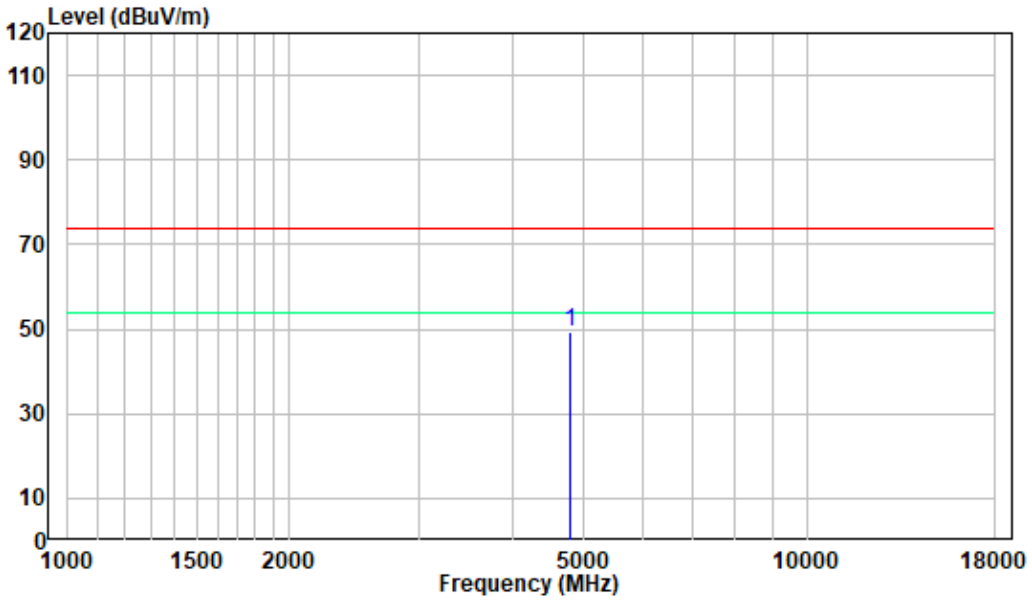
For model of XIAO-nRF52840:

1-18 GHz:
Pre-scan plots:

BLE 1M Low Channel
Horizontal

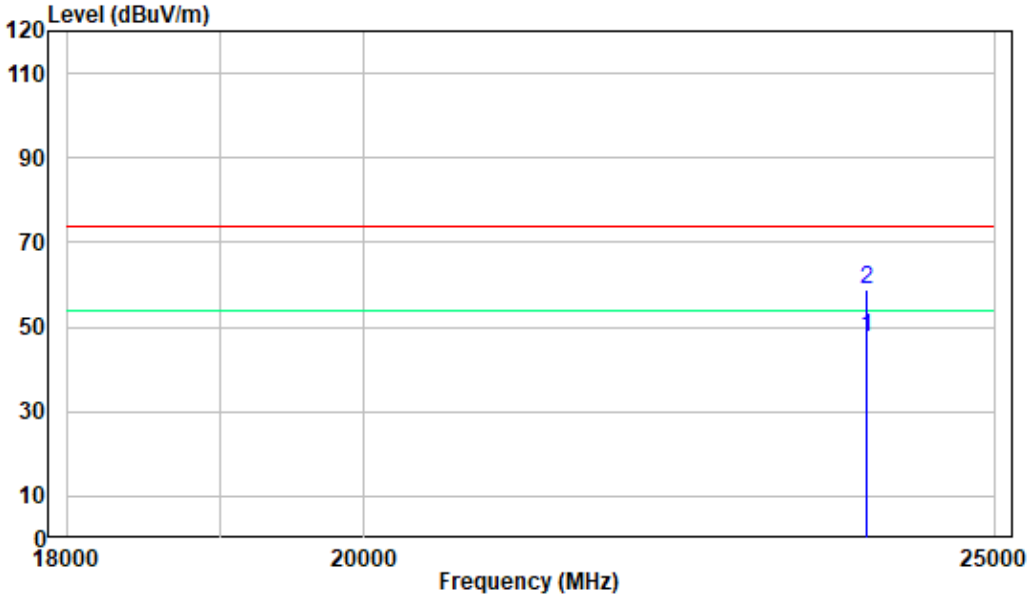


Vertical

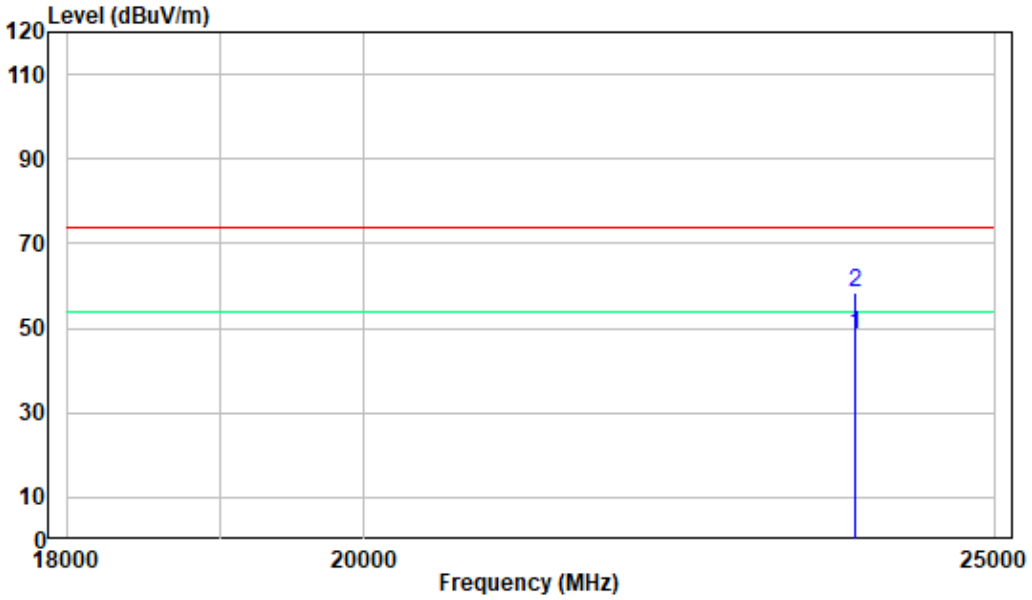


18 -25GHz:
Pre-scan plots:

BLE 1M Low Channel
Horizontal

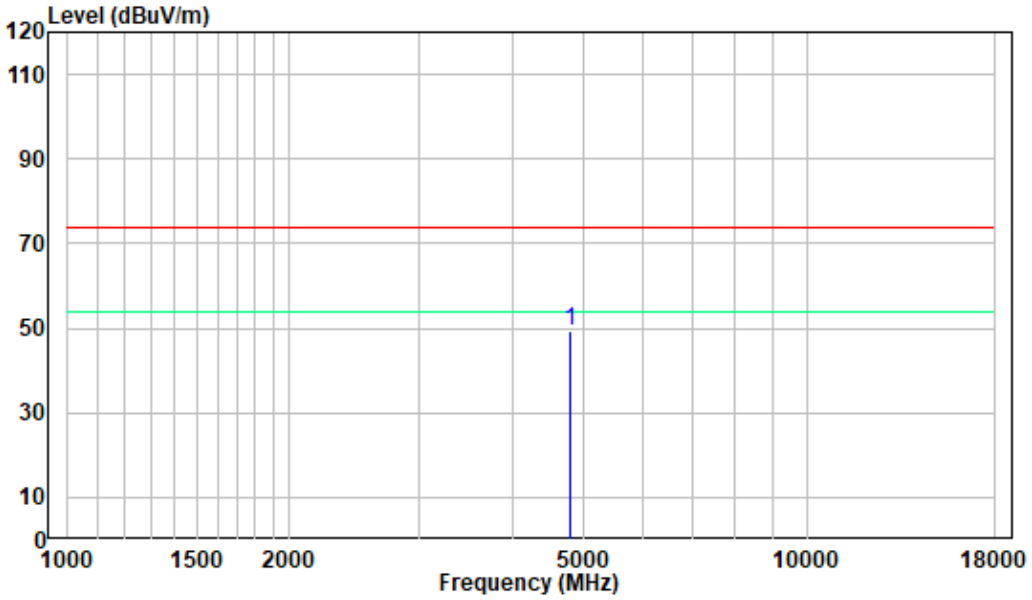


Vertical

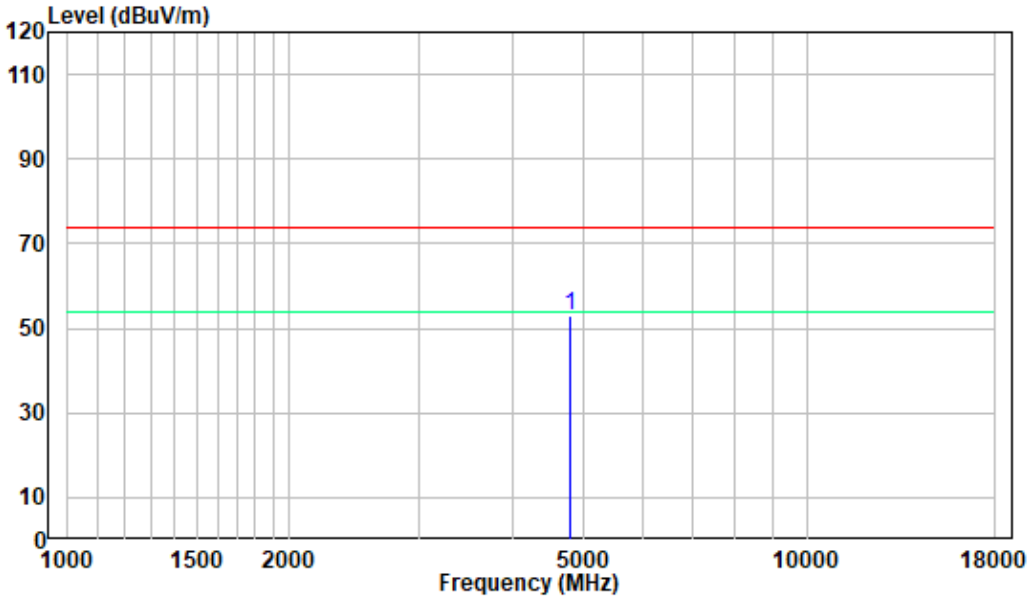


1-18 GHz:
Pre-scan plots:

BLE 2M Low Channel
Horizontal

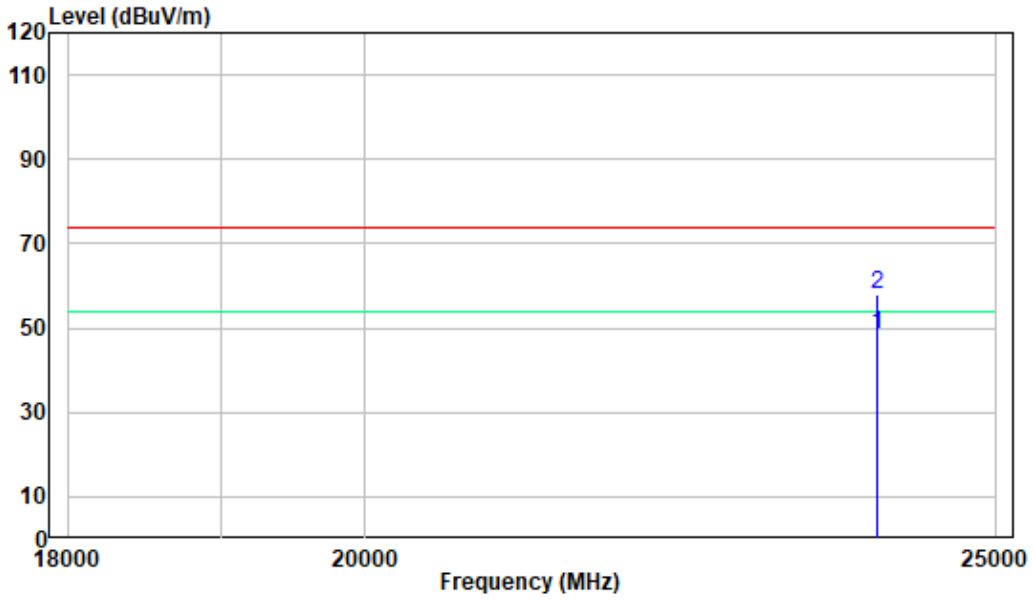


Vertical

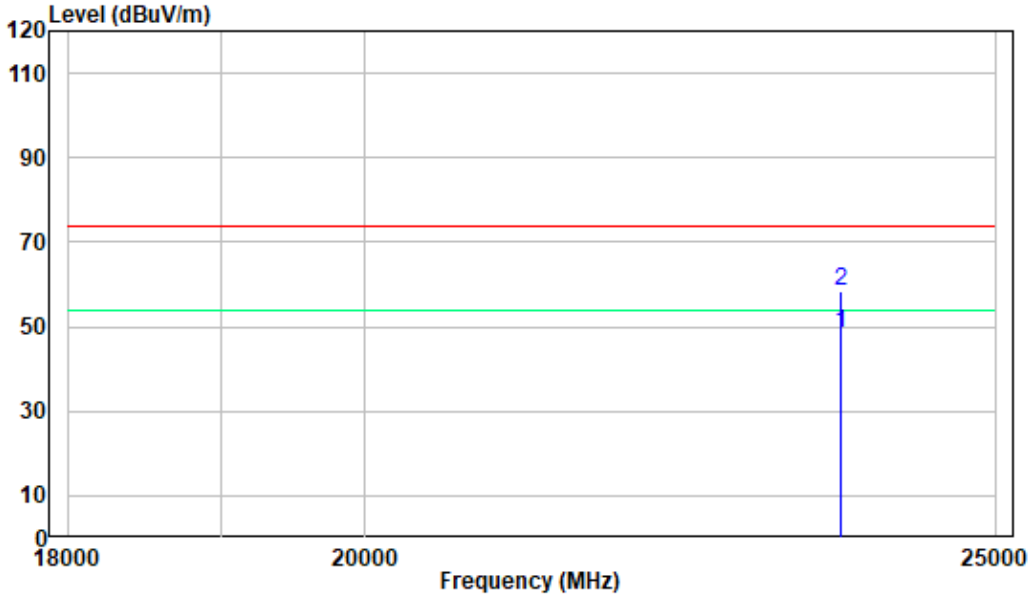


18 -25GHz:
Pre-scan plots:

BLE 2M Low Channel
Horizontal



Vertical



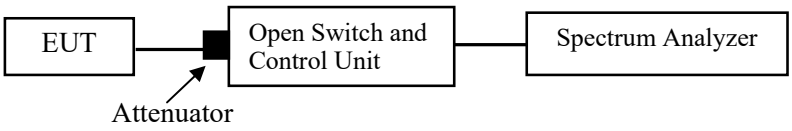
FCC §15.247(A) (2) – 6 DB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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:	25.9 ℃
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2022-01-26 to 2022-04-12.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix BLE.

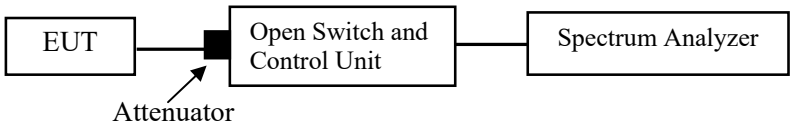
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

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.



Test Data

Environmental Conditions

Temperature:	25.9 ℃
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2022-01-26 to 2022-04-12.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix BLE.

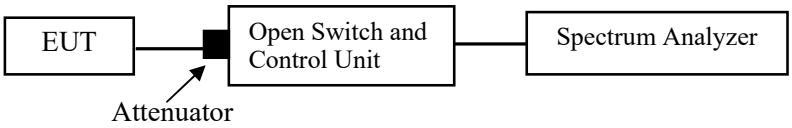
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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:	25.9 ℃
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2022-01-26 to 2022-04-12.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

Please refer to the Appendix BLE.

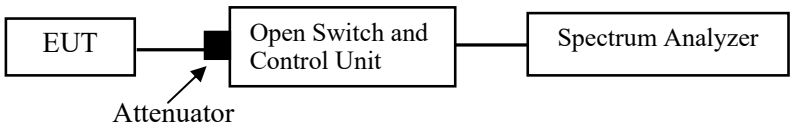
FCC §15.247(e) - POWER SPECTRAL DENSITY

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:	25.9 ℃
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2022-01-26 to 2022-04-12.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix BLE.

APPENDIX BLE

Appendix A: 6dB Emission Bandwidth

Test Result

For model of XIAO-nRF52840 Sense

TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.736	2401.676	2402.412	0.5	PASS
		2440	0.740	2439.676	2440.416	0.5	PASS
		2480	0.728	2479.676	2480.404	0.5	PASS
BLE_2M	Ant1	2402	1.344	2401.340	2402.684	0.5	PASS
		2440	1.260	2439.436	2440.696	0.5	PASS
		2480	1.224	2479.468	2480.692	0.5	PASS

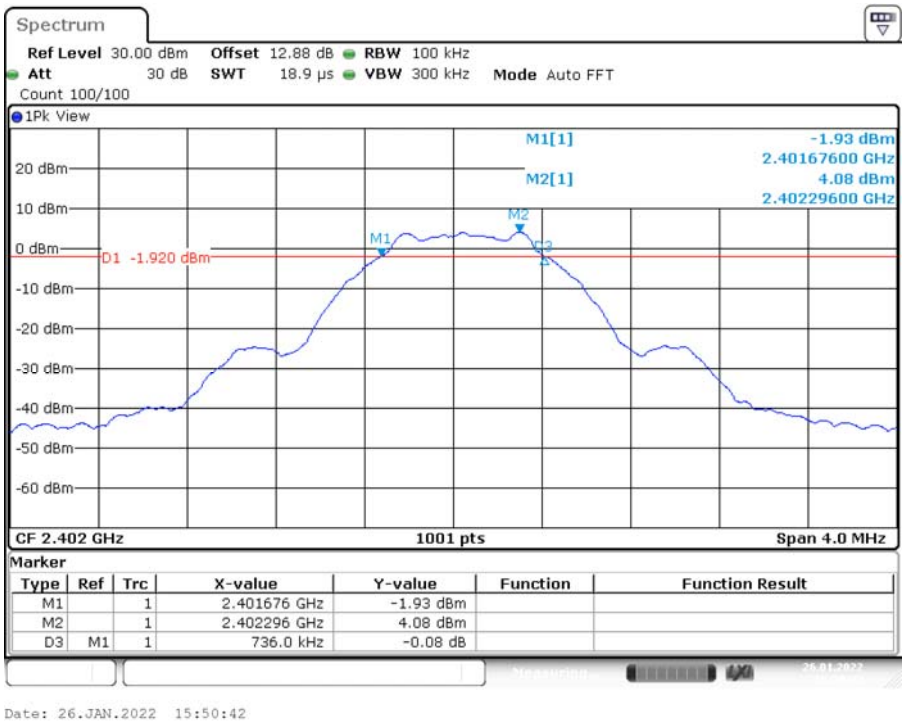
For model of XIAO-nRF52840

TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.736	2401.668	2402.404	0.5	PASS
		2440	0.740	2439.672	2440.412	0.5	PASS
		2480	0.712	2479.692	2480.404	0.5	PASS
BLE_2M	Ant1	2402	1.308	2401.404	2402.712	0.5	PASS
		2440	1.284	2439.420	2440.704	0.5	PASS
		2480	1.188	2479.428	2480.616	0.5	PASS

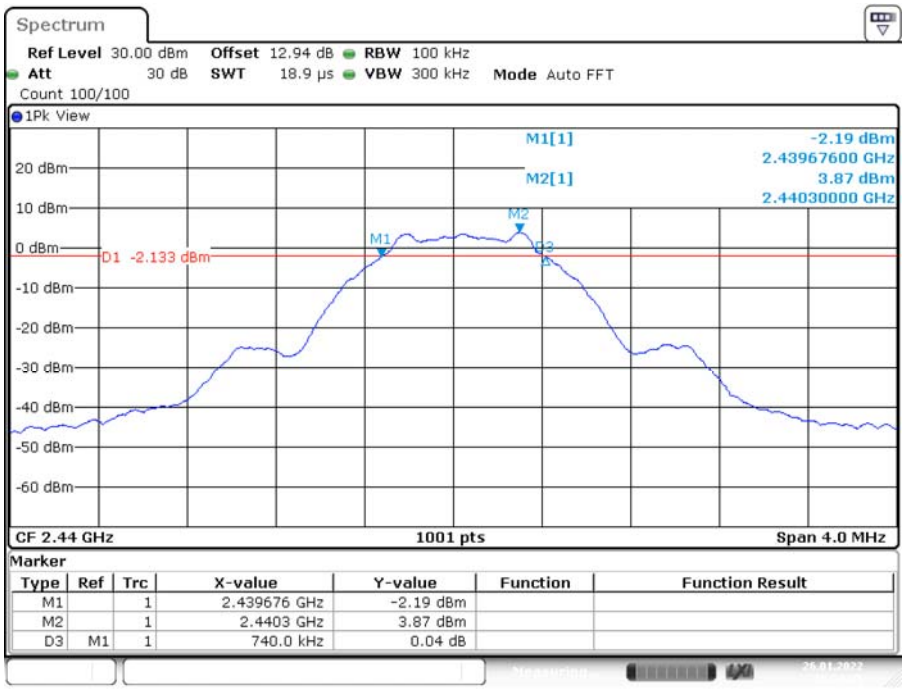
Test Graphs

For model of XIAO-nRF52840 Sense

6dB Bandwidth, BLE 1M Low Channel

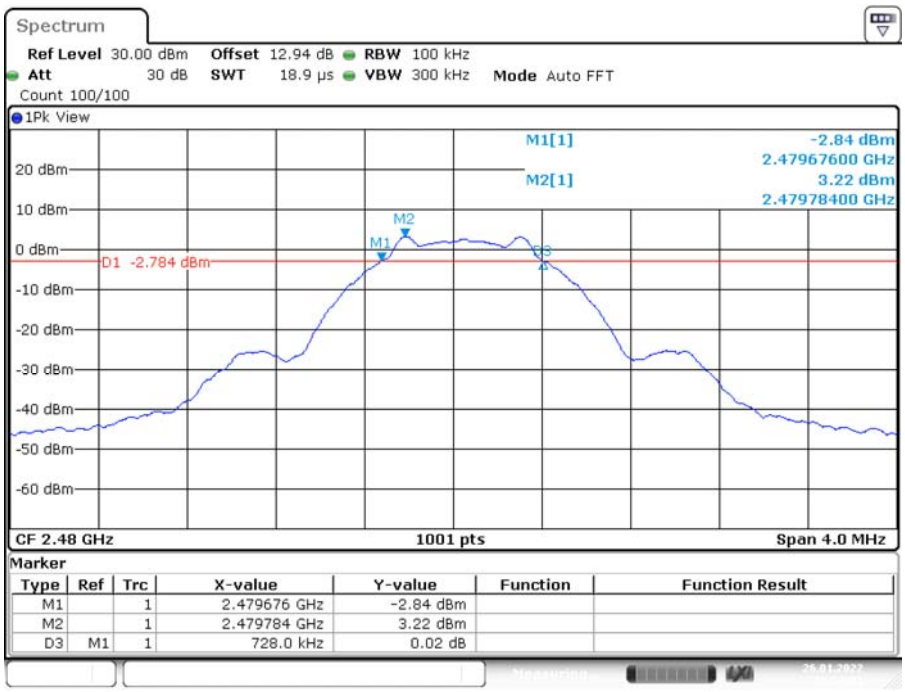


6dB Bandwidth, BLE 1M Middle Channel



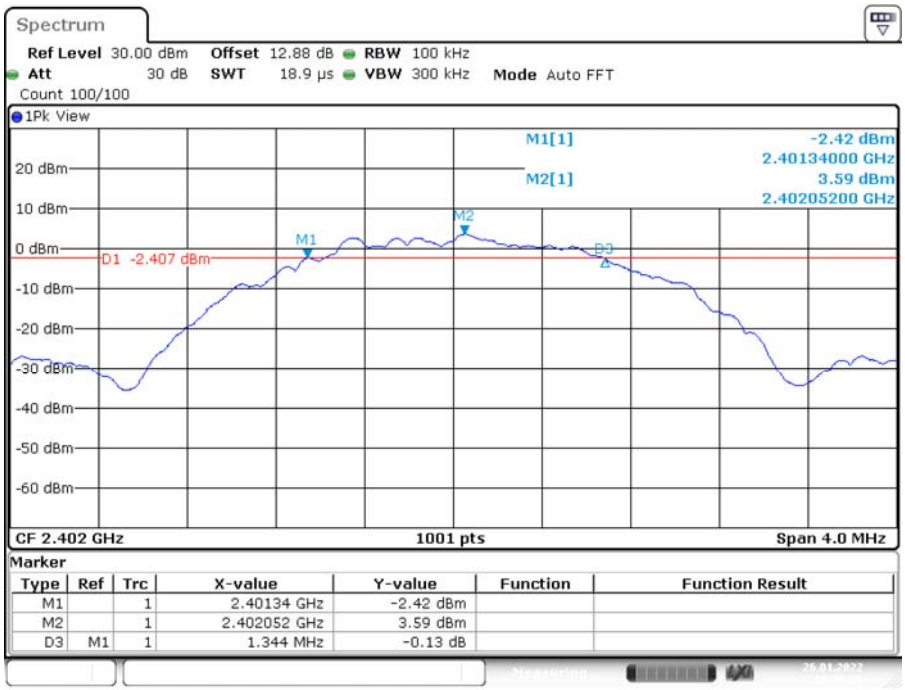
Date: 26.JAN.2022 15:54:25

6dB Bandwidth, BLE 1M High Channel



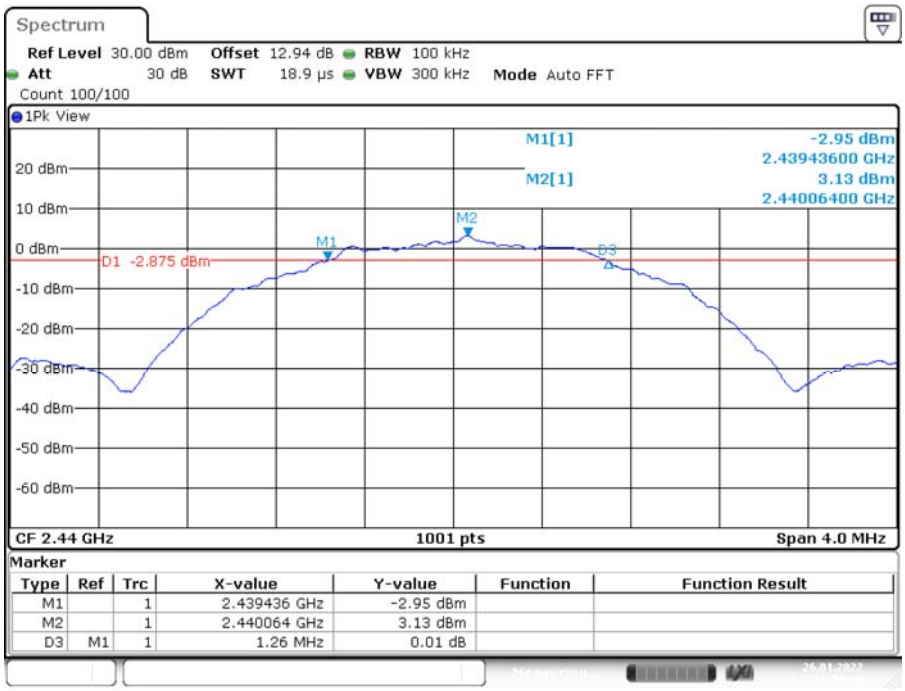
Date: 26.JAN.2022 15:57:01

6dB Bandwidth, BLE 2M Low Channel



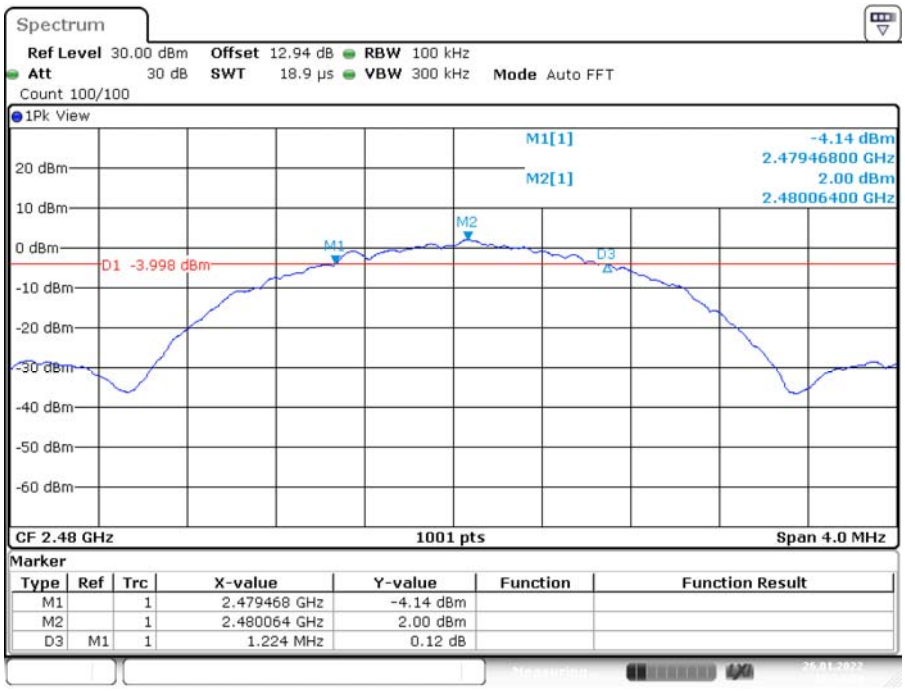
Date: 26.JAN.2022 16:06:36

6dB Bandwidth, BLE 2M Middle Channel



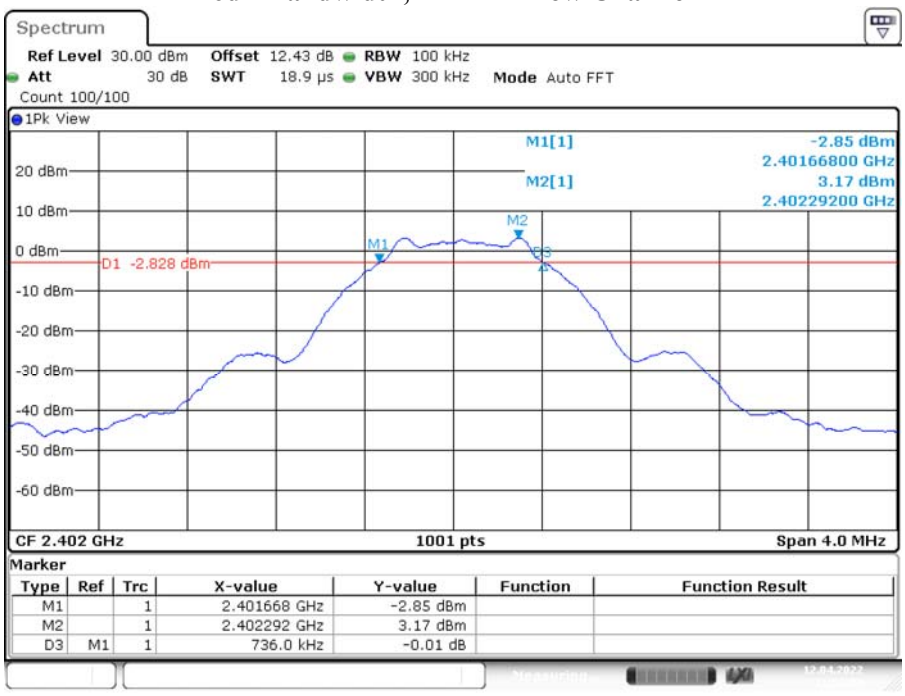
Date: 26.JAN.2022 16:10:30

6dB Bandwidth, BLE 2M High Channel

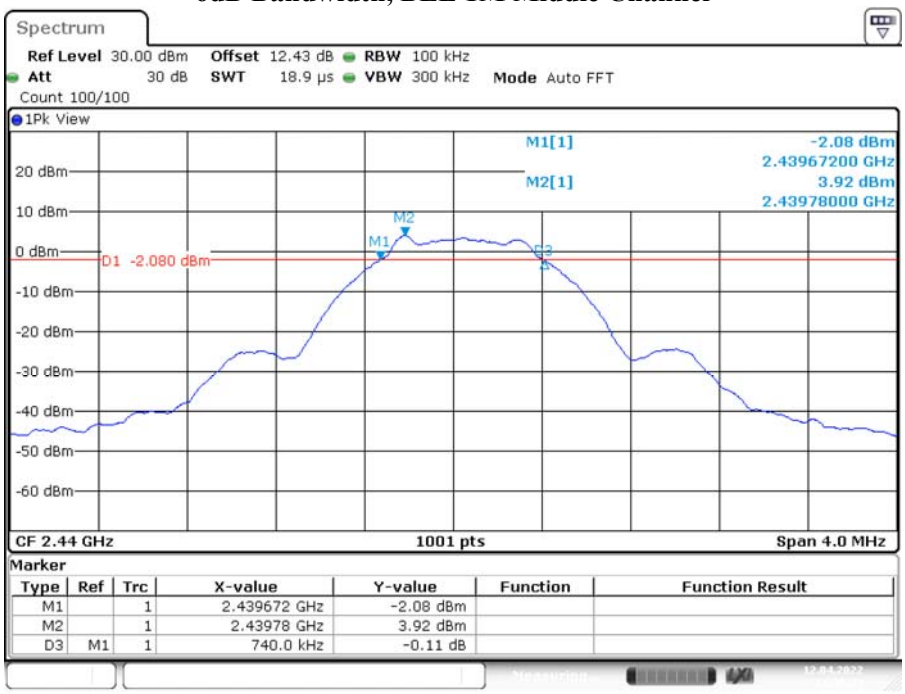


For model of XIAO-nRF52840

6dB Bandwidth, BLE 1M Low Channel

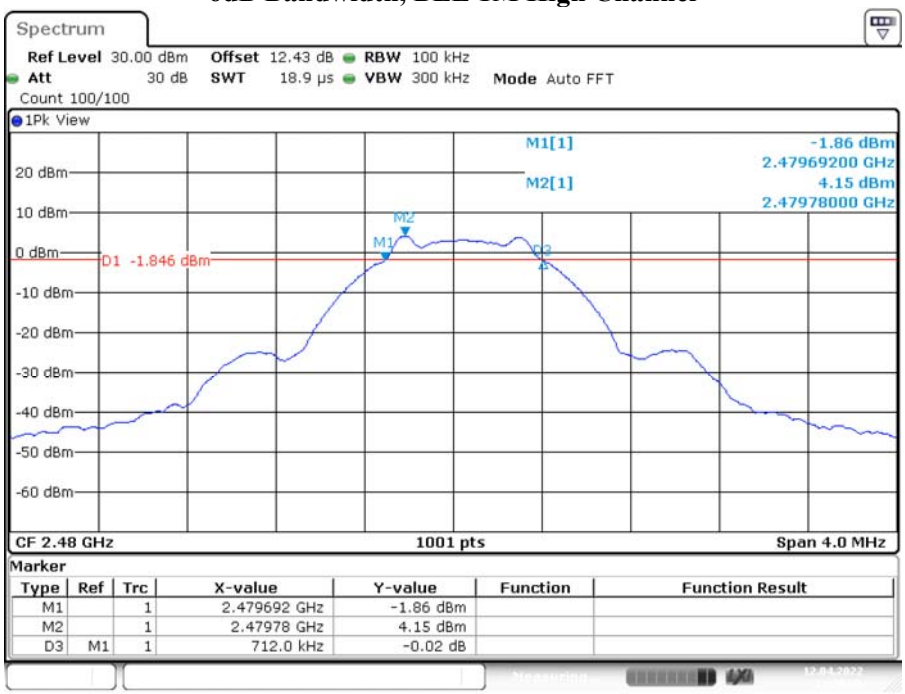


6dB Bandwidth, BLE 1M Middle Channel



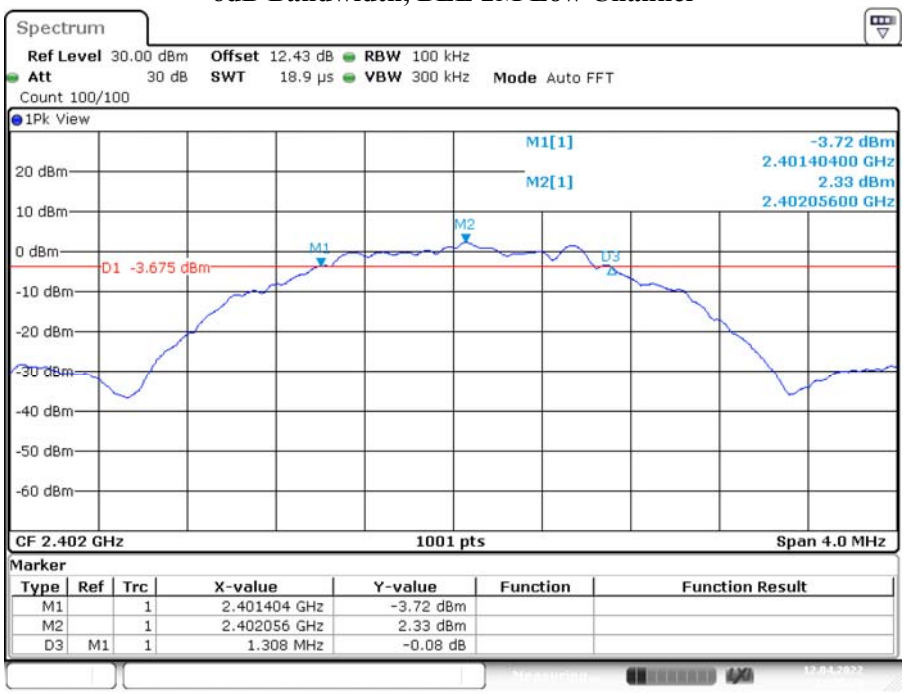
Date: 12.APR.2022 11:29:24

6dB Bandwidth, BLE 1M High Channel



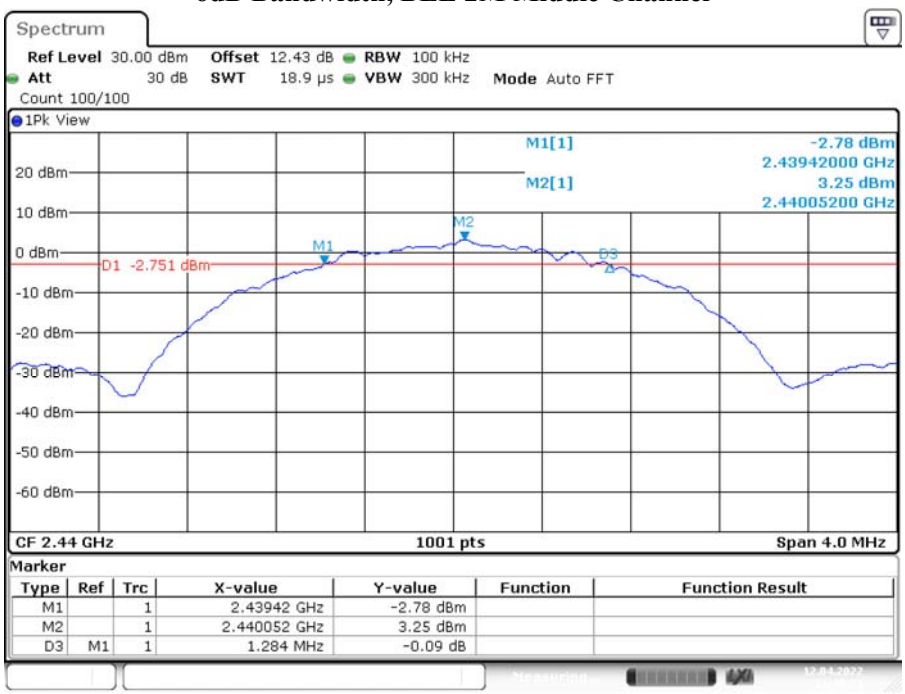
Date: 12.APR.2022 11:30:47

6dB Bandwidth, BLE 2M Low Channel



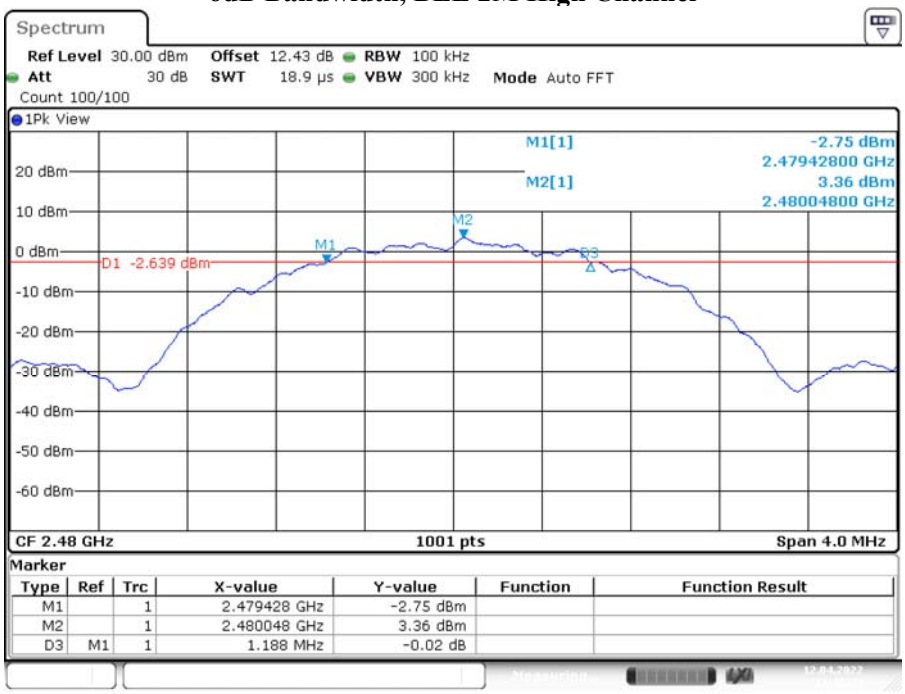
Date: 12.APR.2022 11:35:20

6dB Bandwidth, BLE 2M Middle Channel



Date: 12.APR.2022 11:40:12

6dB Bandwidth, BLE 2M High Channel



Date: 12.APR.2022 11:41:34

Appendix B: Occupied Channel Bandwidth

Test Result

For model of XIAO-nRF52840 Sense

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.071	2401.500	2402.571	---	PASS
		2440	1.075	2439.497	2440.571	---	PASS
		2480	1.071	2479.500	2480.571	---	PASS
BLE_2M	Ant1	2402	2.062	2401.001	2403.063	---	PASS
		2440	2.086	2438.985	2441.071	---	PASS
		2480	2.102	2478.977	2481.079	---	PASS

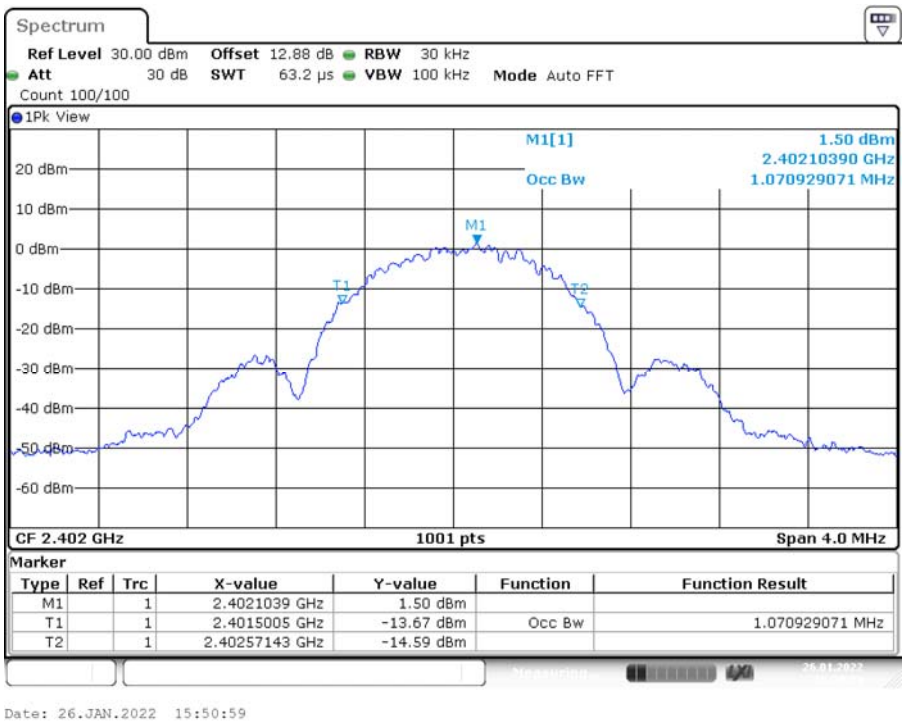
For model of XIAO-nRF52840

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.071	2401.497	2402.567	---	PASS
		2440	1.079	2439.493	2440.571	---	PASS
		2480	1.079	2479.493	2480.571	---	PASS
BLE_2M	Ant1	2402	2.086	2400.989	2403.075	---	PASS
		2440	2.086	2438.985	2441.071	---	PASS
		2480	2.082	2478.985	2481.067	---	PASS

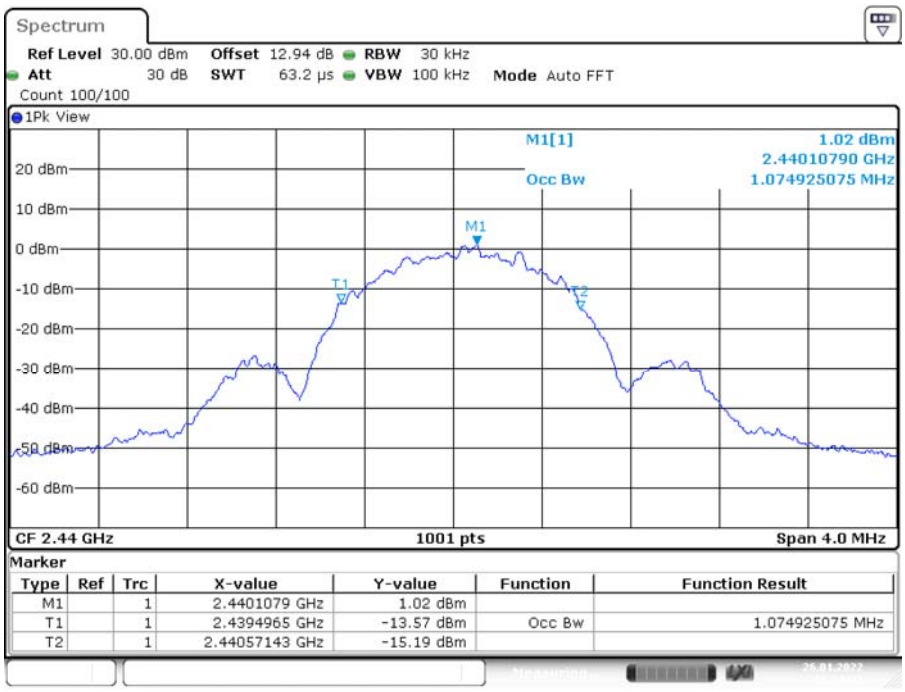
Test Graphs

For model of XIAO-nRF52840 Sense

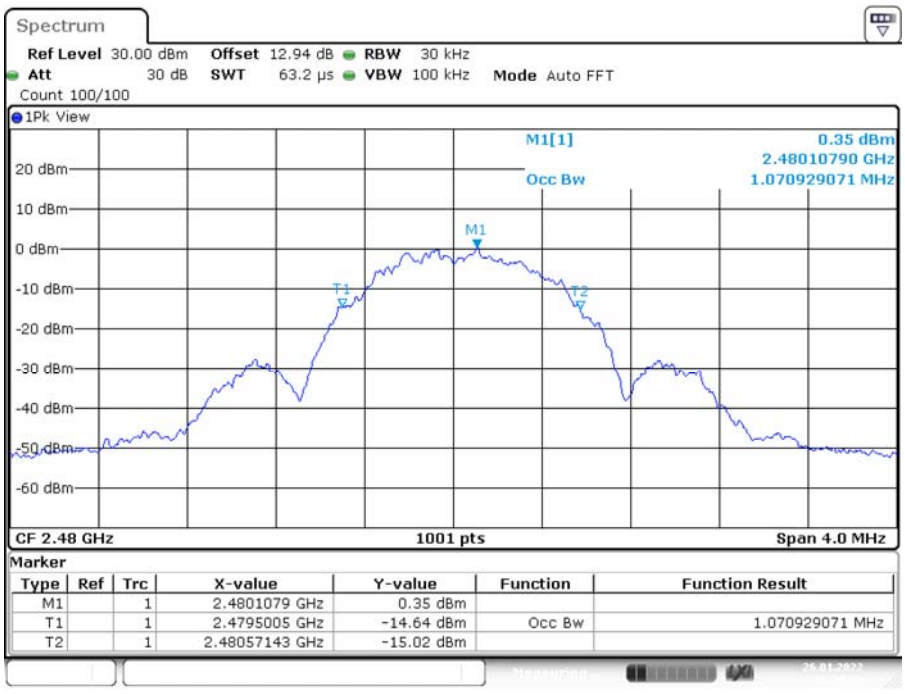
99% Bandwidth, BLE 1M Low Channel



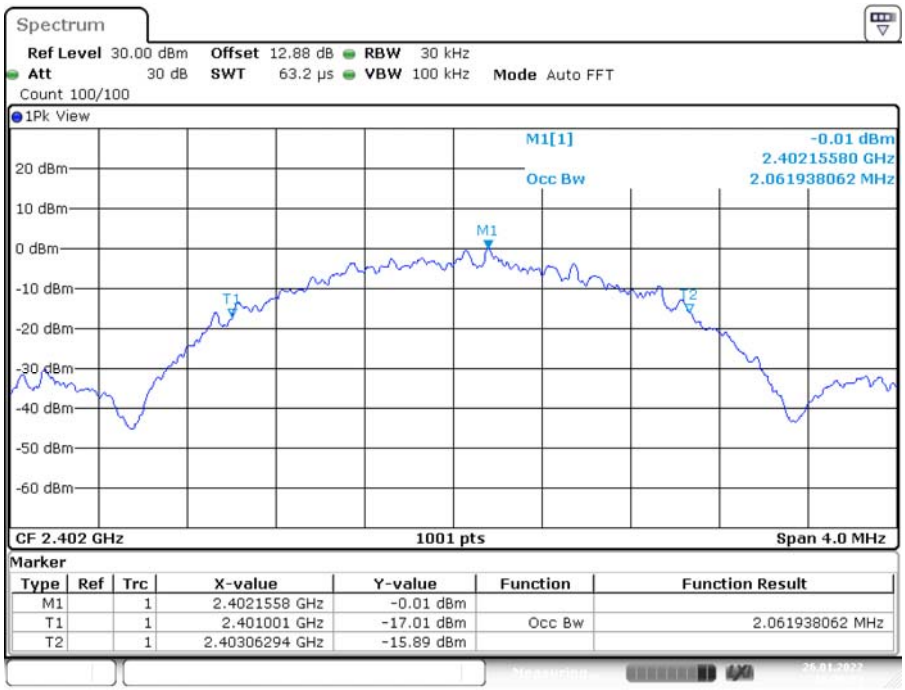
99% Bandwidth, BLE 1M Middle Channel



99% Bandwidth, BLE 1M High Channel

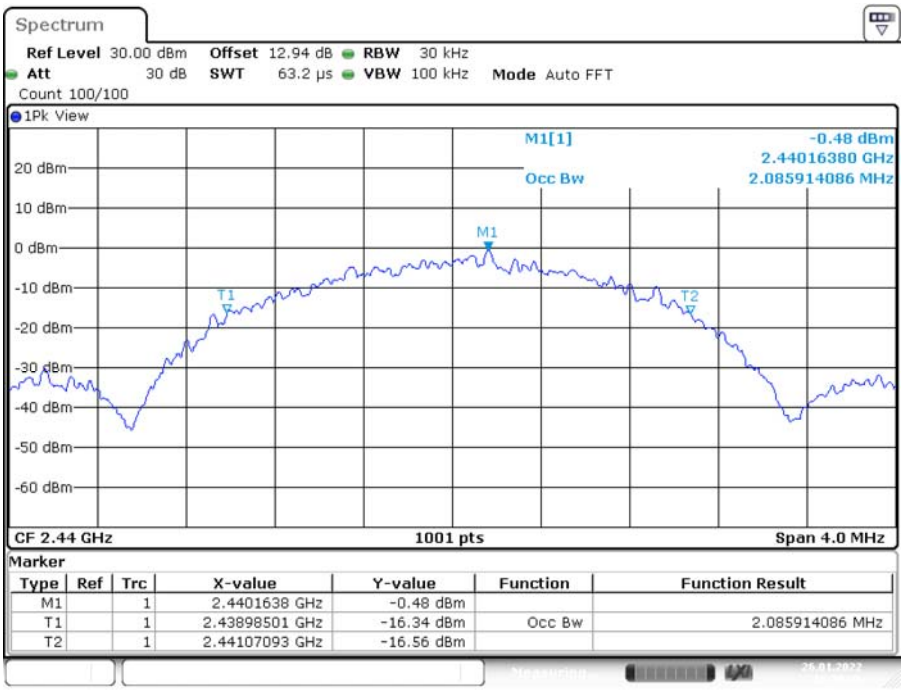


99% Bandwidth, BLE 2M Low Channel



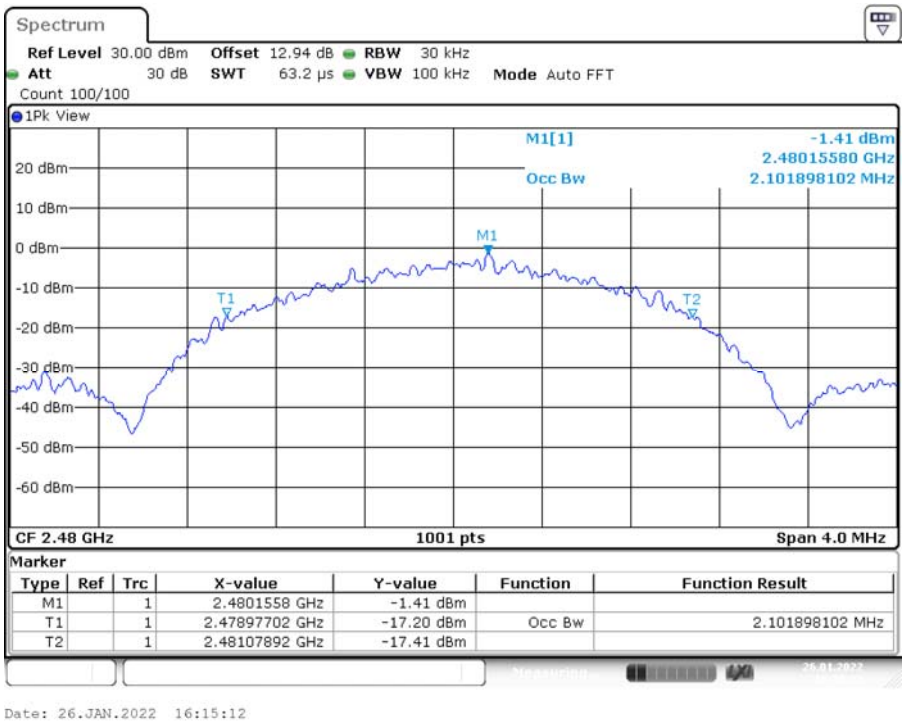
Date: 26.JAN.2022 16:06:53

99% Bandwidth, BLE 2M Middle Channel



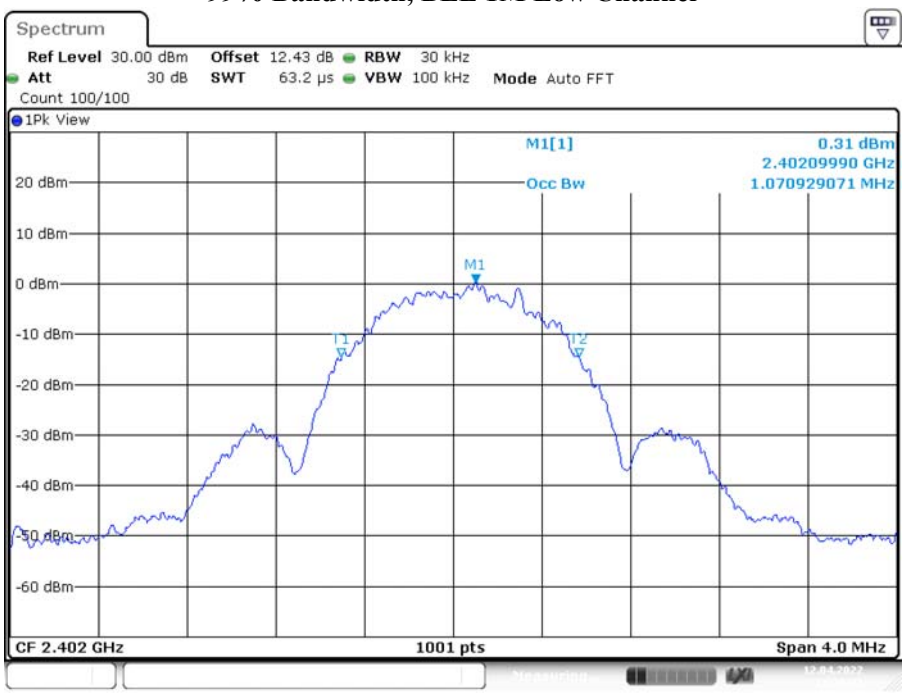
Date: 26.JAN.2022 16:10:46

99% Bandwidth, BLE 2M High Channel



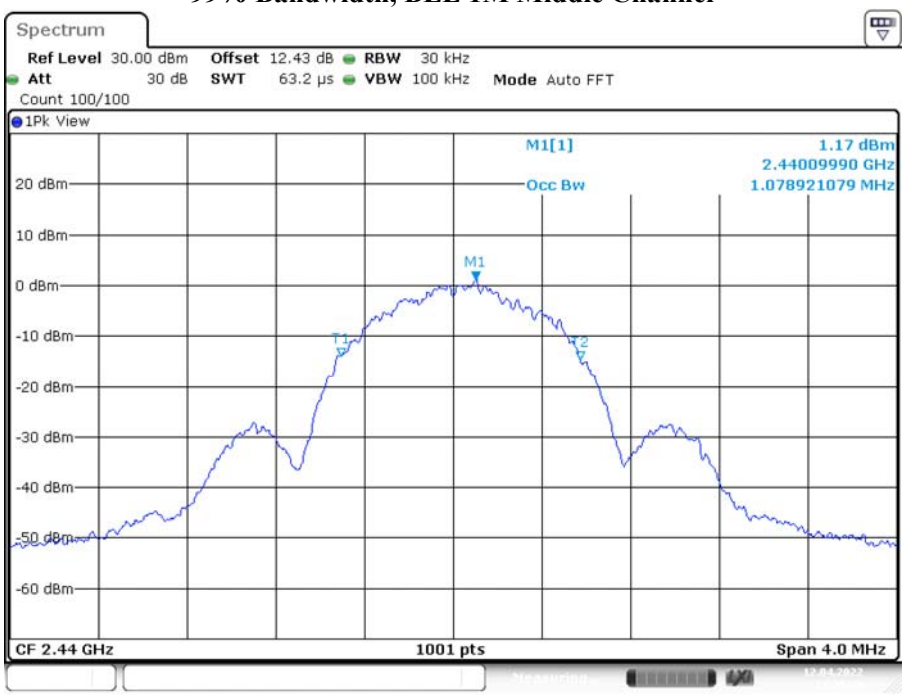
For model of XIAO-nRF52840

99% Bandwidth, BLE 1M Low Channel



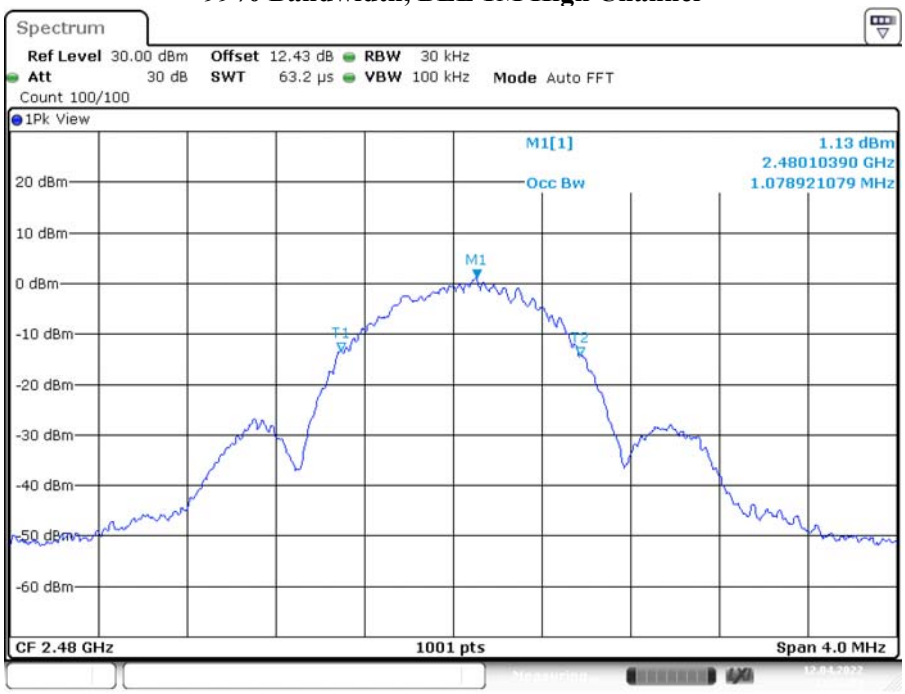
Date: 12.APR.2022 11:24:42

99% Bandwidth, BLE 1M Middle Channel



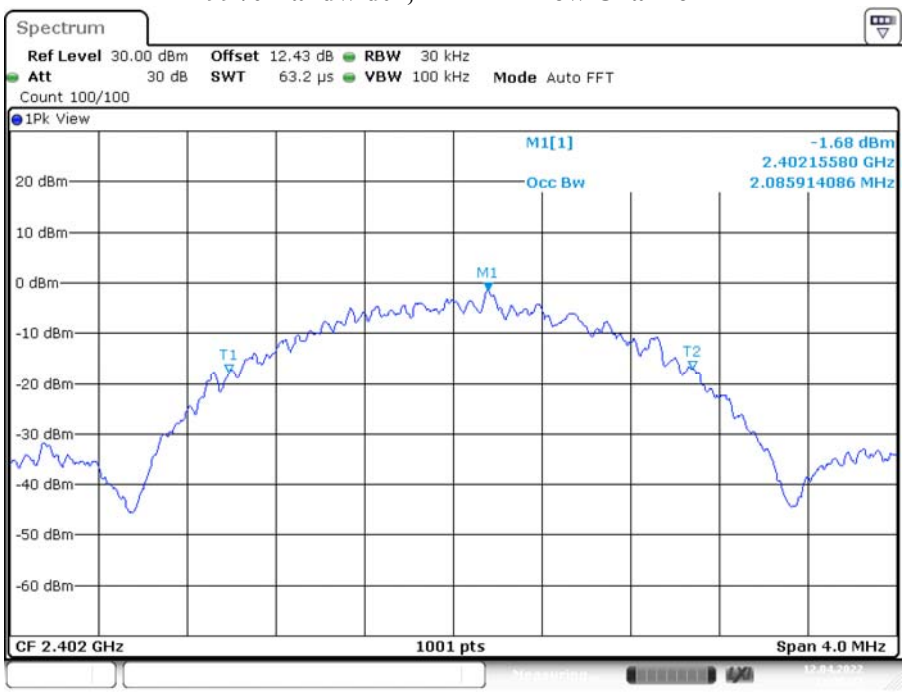
Date: 12.APR.2022 11:29:41

99% Bandwidth, BLE 1M High Channel



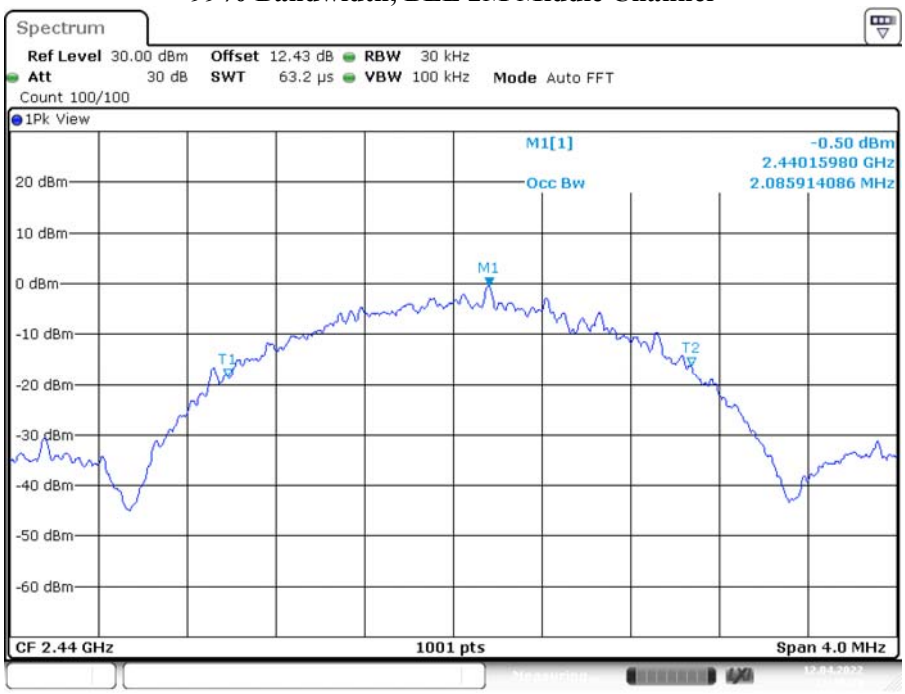
Date: 12.APR.2022 11:31:04

99% Bandwidth, BLE 2M Low Channel



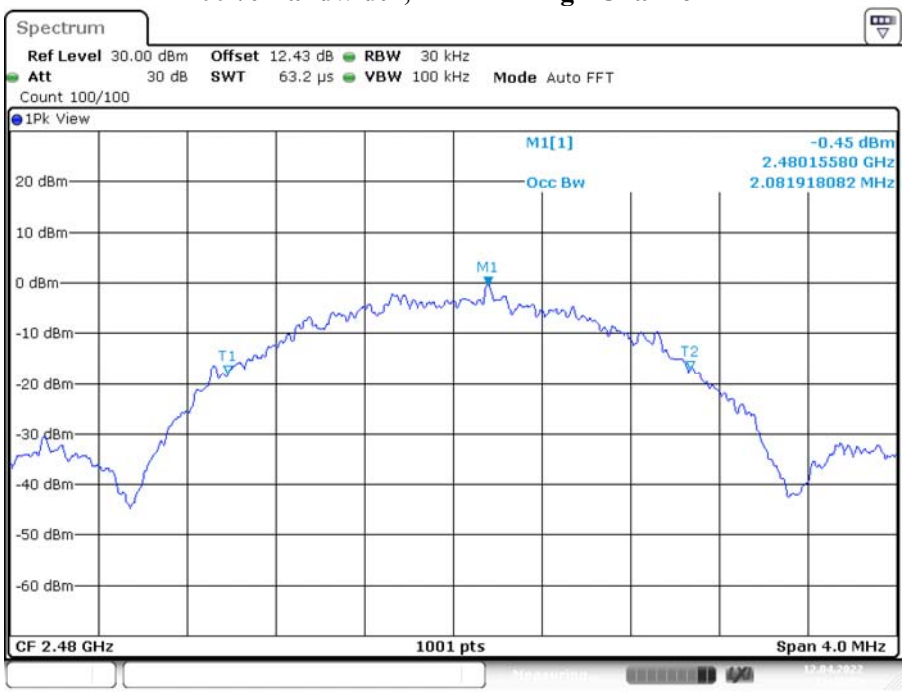
Date: 12.APR.2022 11:35:37

99% Bandwidth, BLE 2M Middle Channel



Date: 12.APR.2022 11:40:29

99% Bandwidth, BLE 2M High Channel



Date: 12.APR.2022 11:41:51

Appendix C: Maximum conducted Peak output power

Test Result

For model of XIAO- nRF52840 Sense

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	4.68	<=30	PASS
		2440	4.24	<=30	PASS
		2480	3.5	<=30	PASS
BLE_2M	Ant1	2402	4.74	<=30	PASS
		2440	4.26	<=30	PASS
		2480	3.47	<=30	PASS

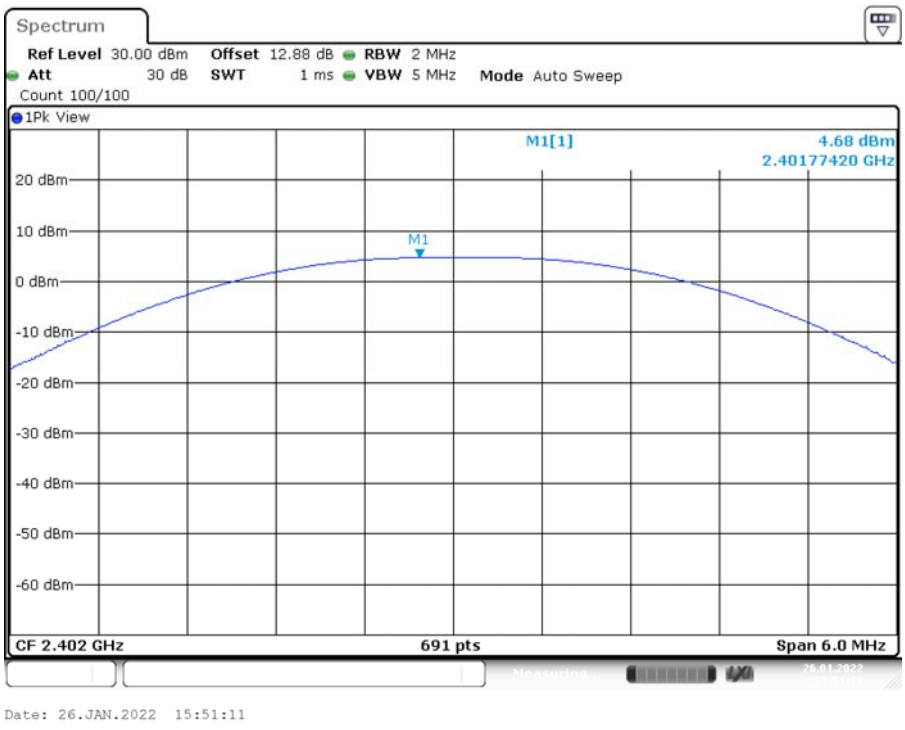
For model of XIAO-nRF52840

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	5.04	<=30	PASS
		2440	4.35	<=30	PASS
		2480	4.3	<=30	PASS
BLE_2M	Ant1	2402	3.54	<=30	PASS
		2440	3.74	<=30	PASS
		2480	3.01	<=30	PASS

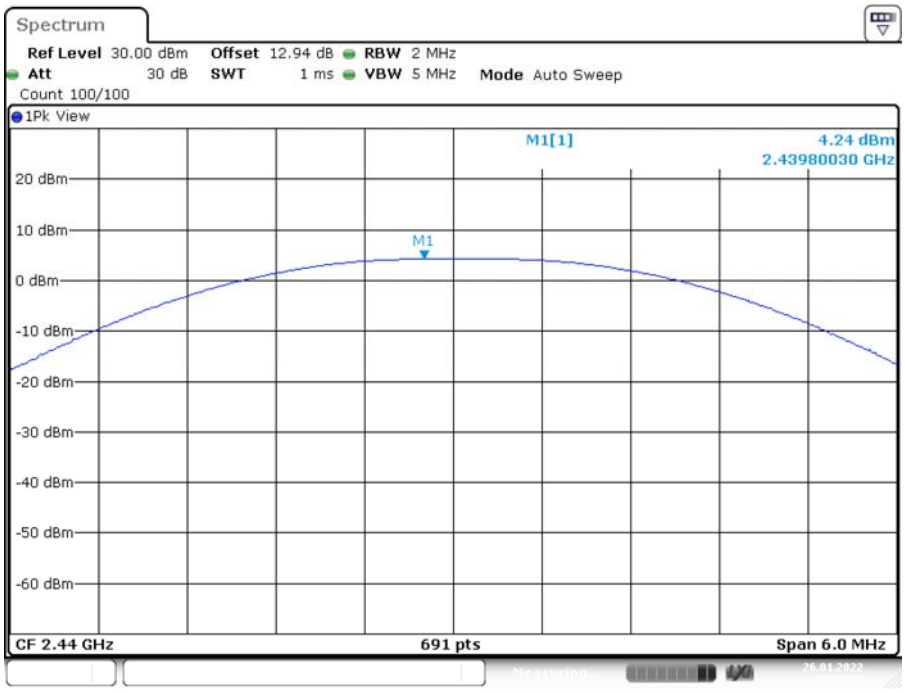
Test Graphs

For model of XIAO- nRF52840 Sense

BLE 1M Low Channel

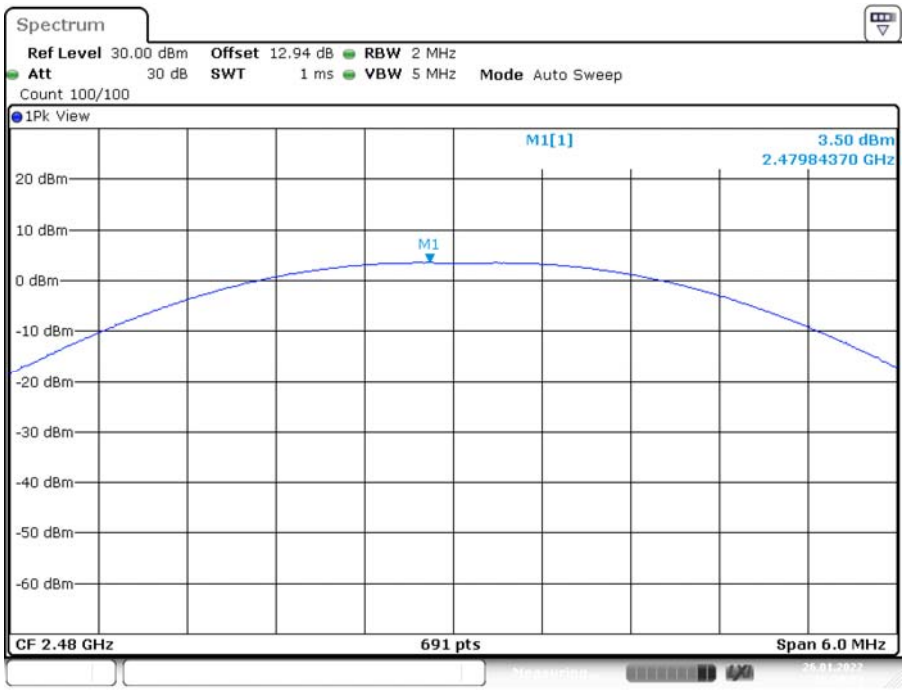


BLE 1M Middle Channel



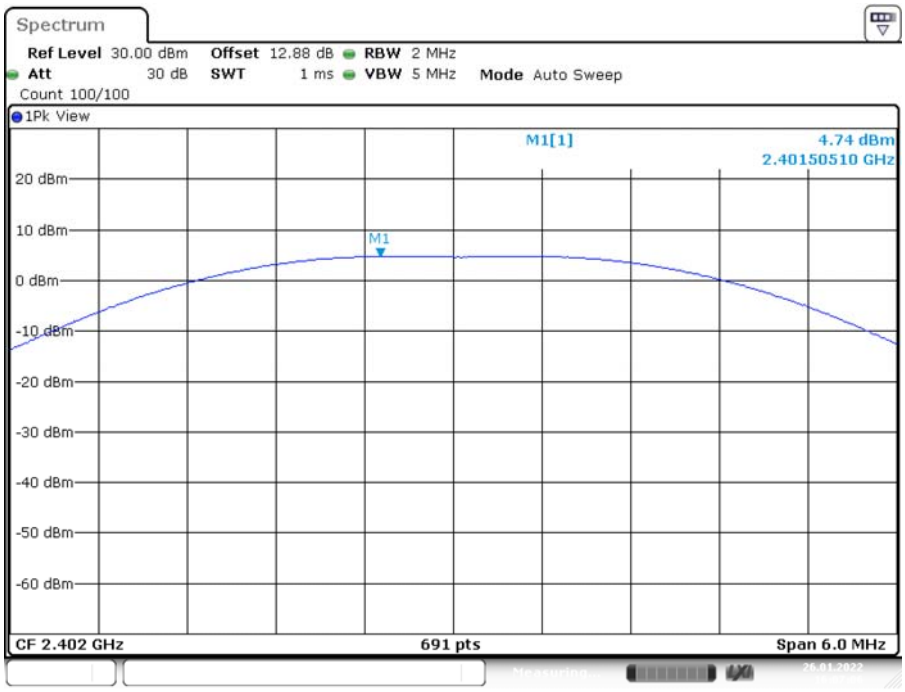
Date: 26.JAN.2022 15:54:54

BLE 1M High Channel

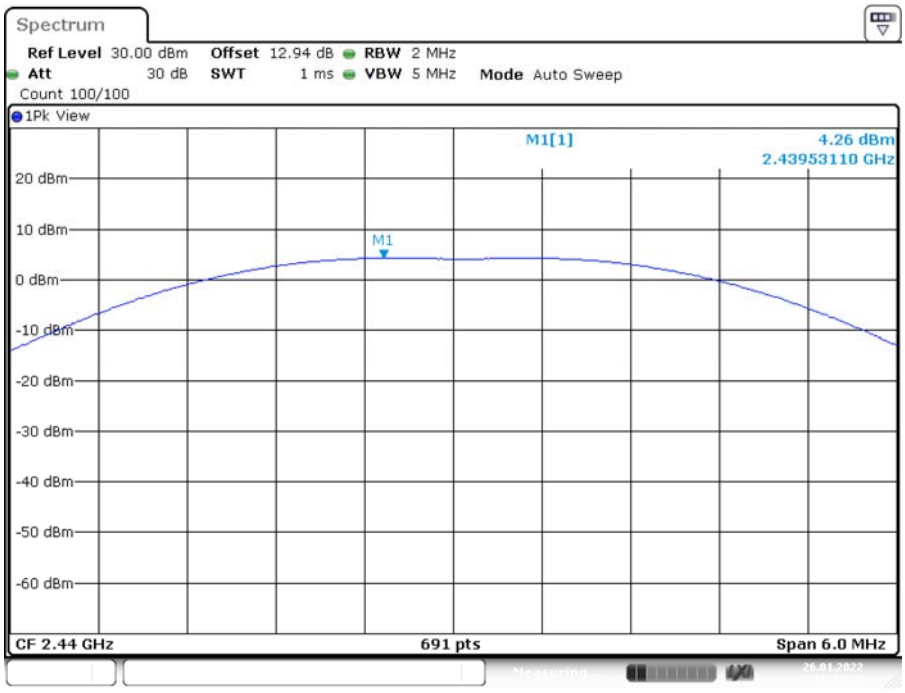


Date: 26.JAN.2022 15:58:53

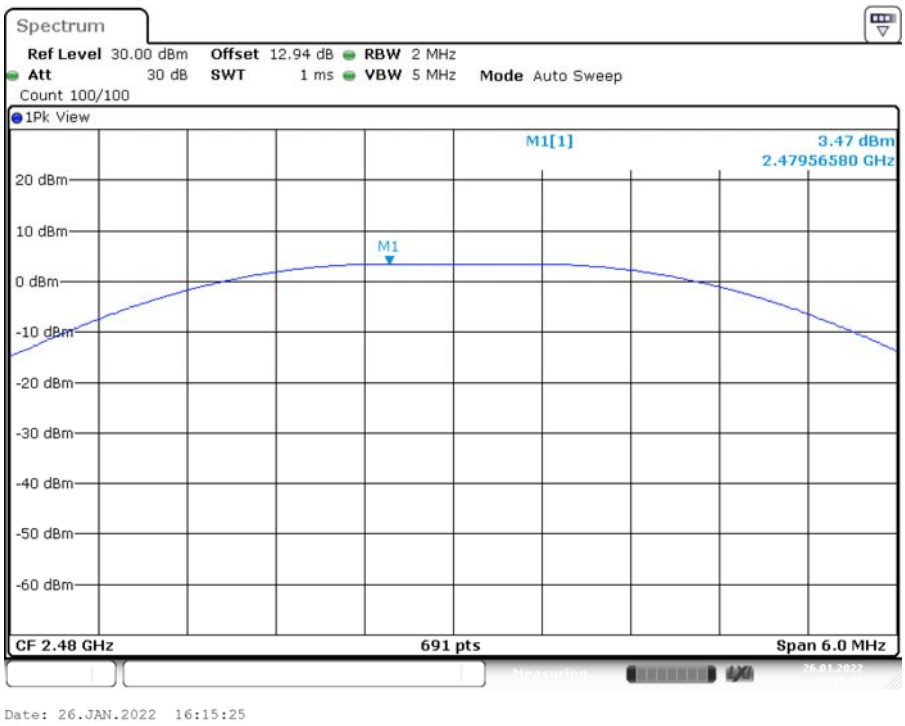
BLE 2M Low Channel



BLE 2M Middle Channel

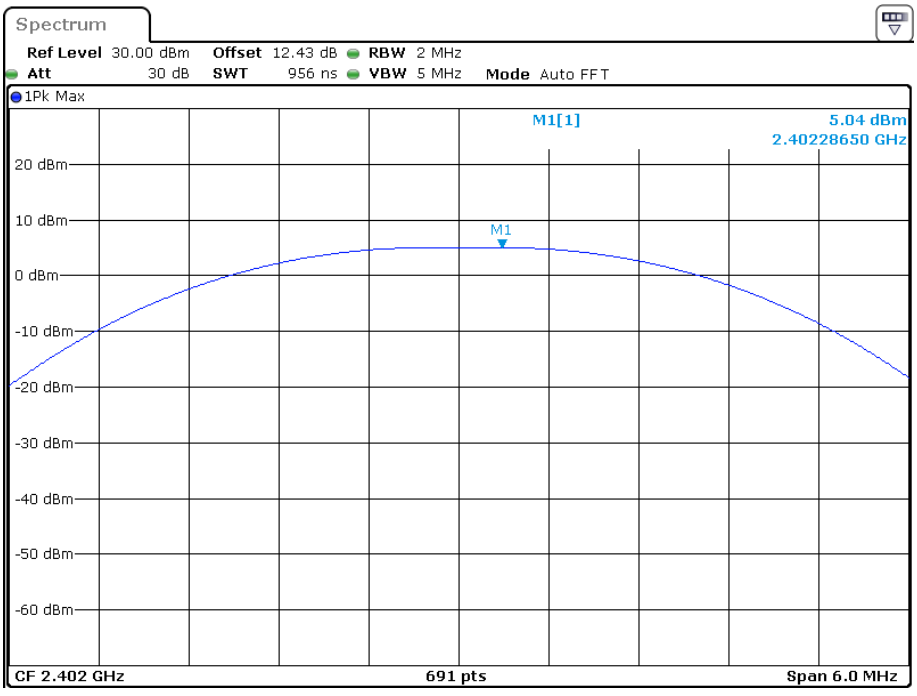


BLE 2M High Channel

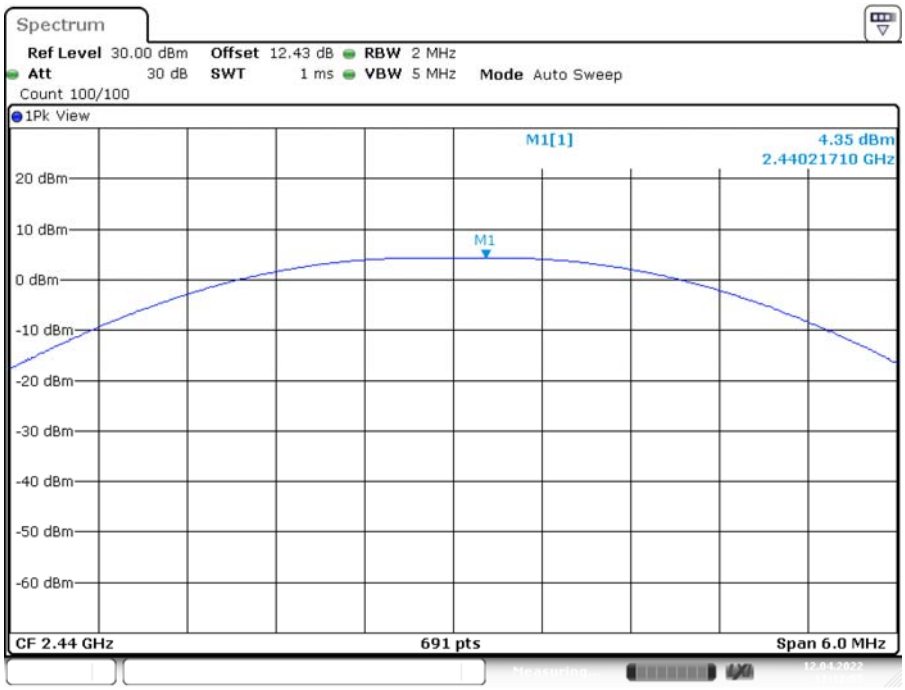


For model of XIAO-nRF52840

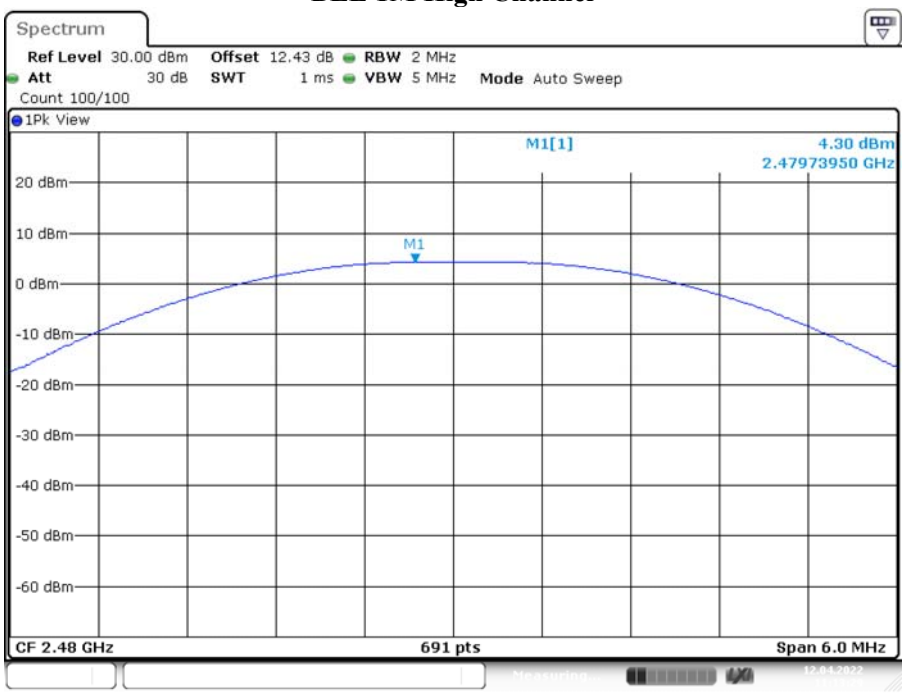
BLE 1M Low Channel



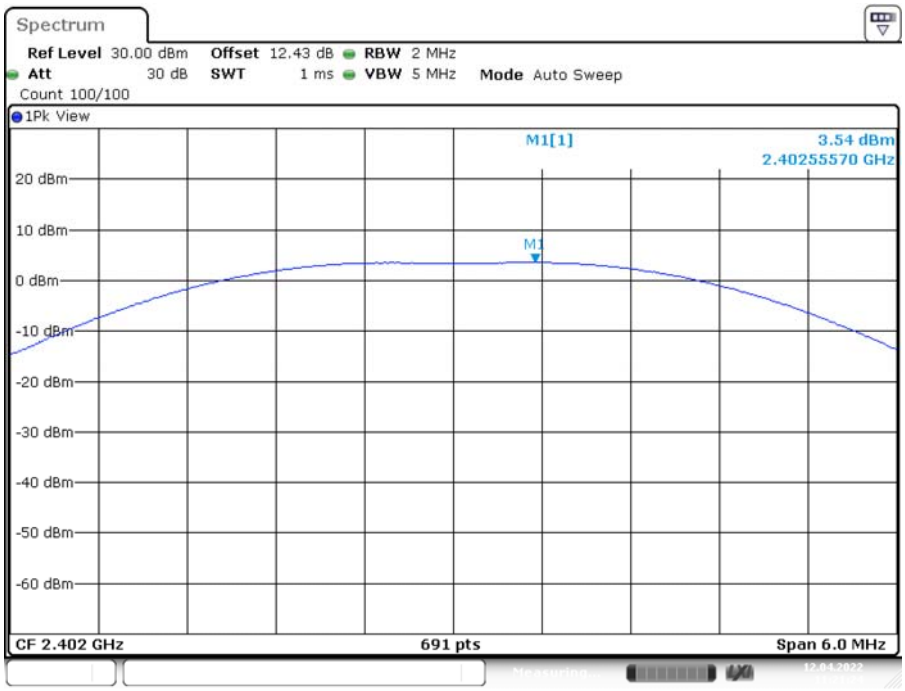
BLE 1M Middle Channel



BLE 1M High Channel

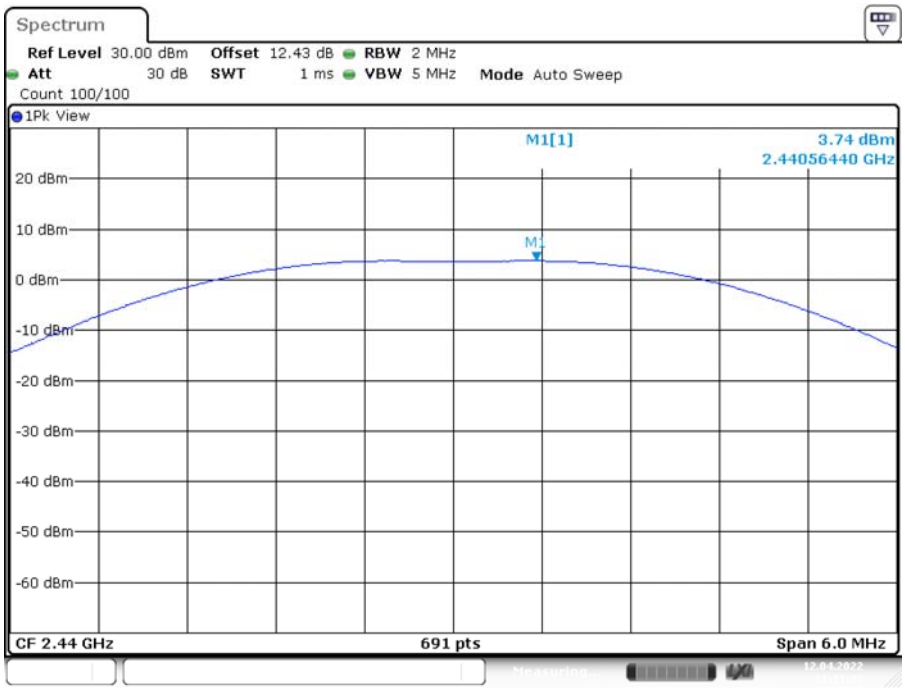


BLE 2M Low Channel



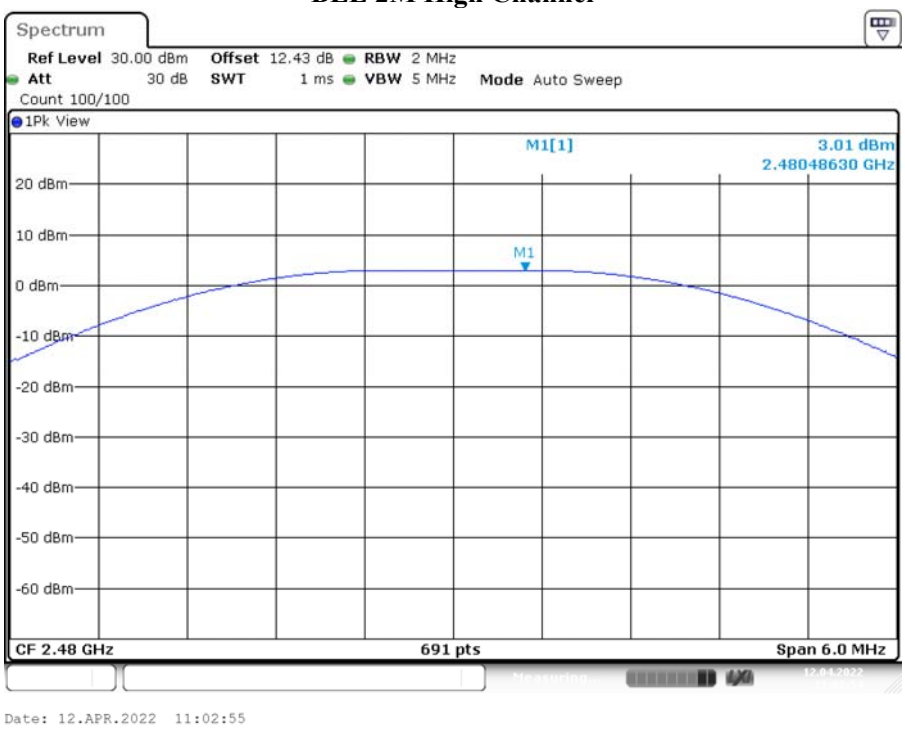
Date: 12.APR.2022 11:21:24

BLE 2M Middle Channel



Date: 12.APR.2022 11:11:34

BLE 2M High Channel



Appendix D: Power spectral density

Test Result

For model of XIAO-nRF52840 Sense

TestMode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-9.16	<=8	PASS
		2440	-9.42	<=8	PASS
		2480	-10.22	<=8	PASS
BLE_2M	Ant1	2402	-11.04	<=8	PASS
		2440	-10.41	<=8	PASS
		2480	-11.71	<=8	PASS

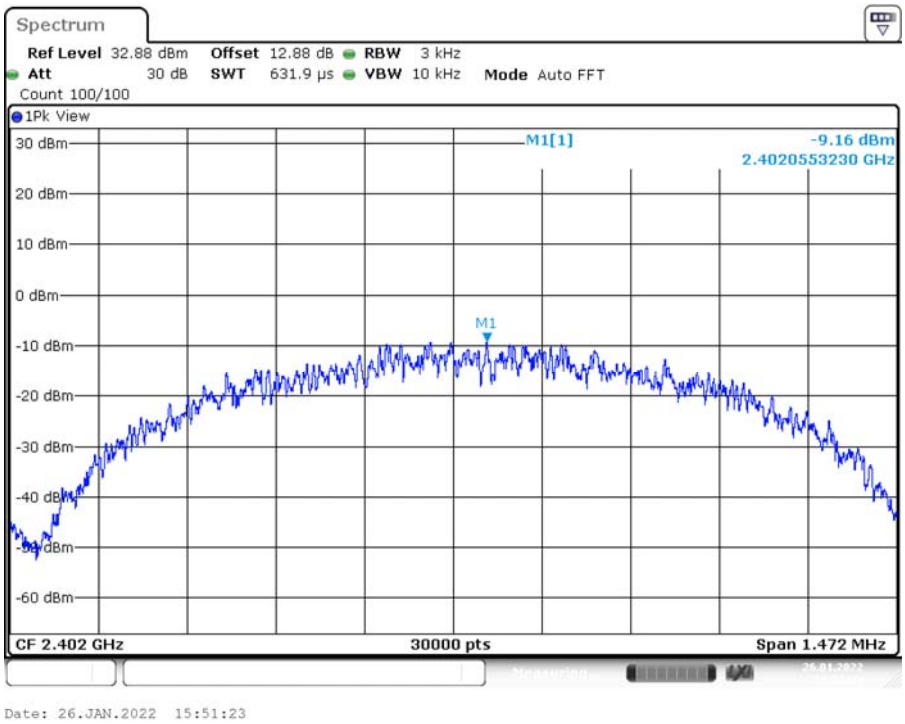
For model of XIAO-nRF52840

TestMode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-9.88	<=8	PASS
		2440	-9.26	<=8	PASS
		2480	-7.14	<=8	PASS
BLE_2M	Ant1	2402	-11.78	<=8	PASS
		2440	-11.35	<=8	PASS
		2480	-12.13	<=8	PASS

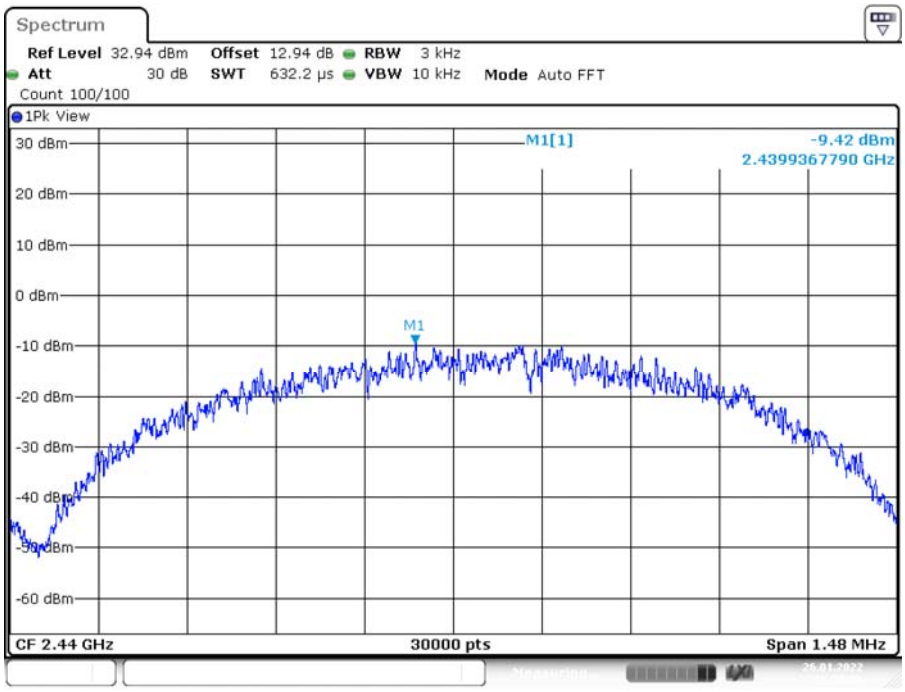
Test Graphs

For model of XIAO-nRF52840 Sense

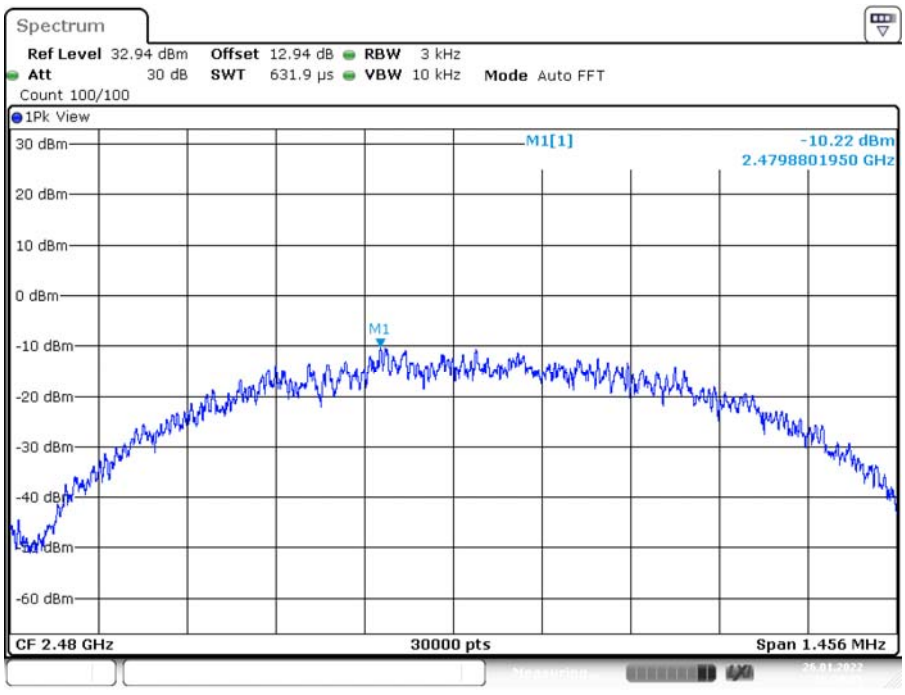
Power Spectral Density, BLE 1M Low Channel



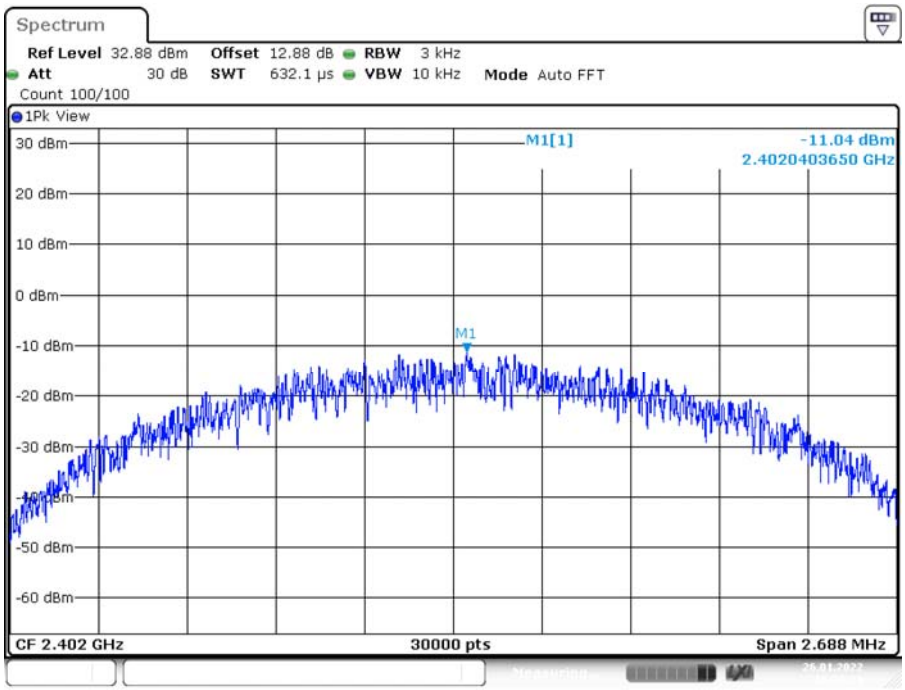
Power Spectral Density, BLE 1M Middle Channel



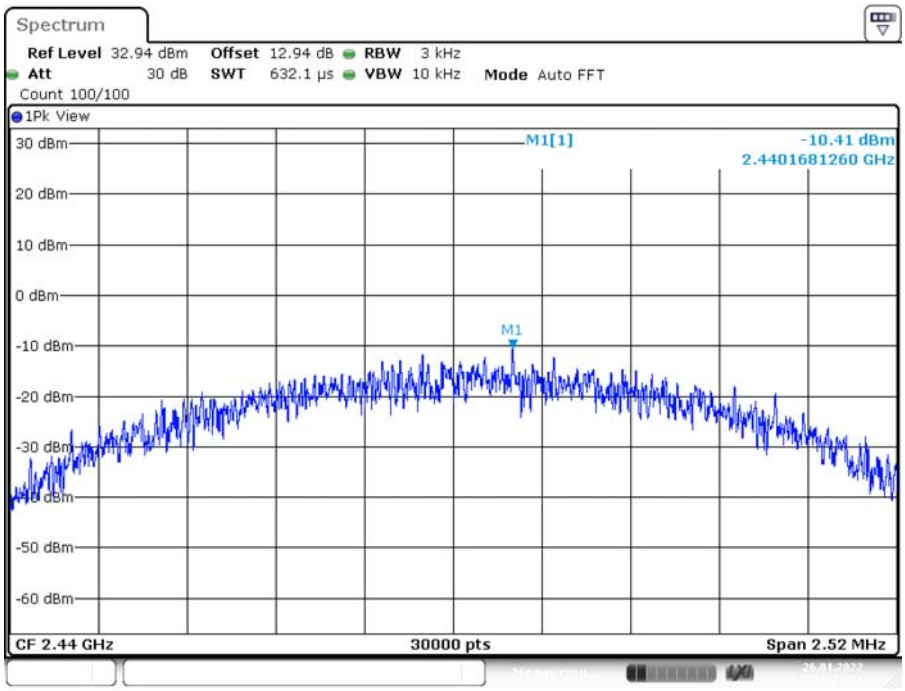
Power Spectral Density, BLE 1M High Channel



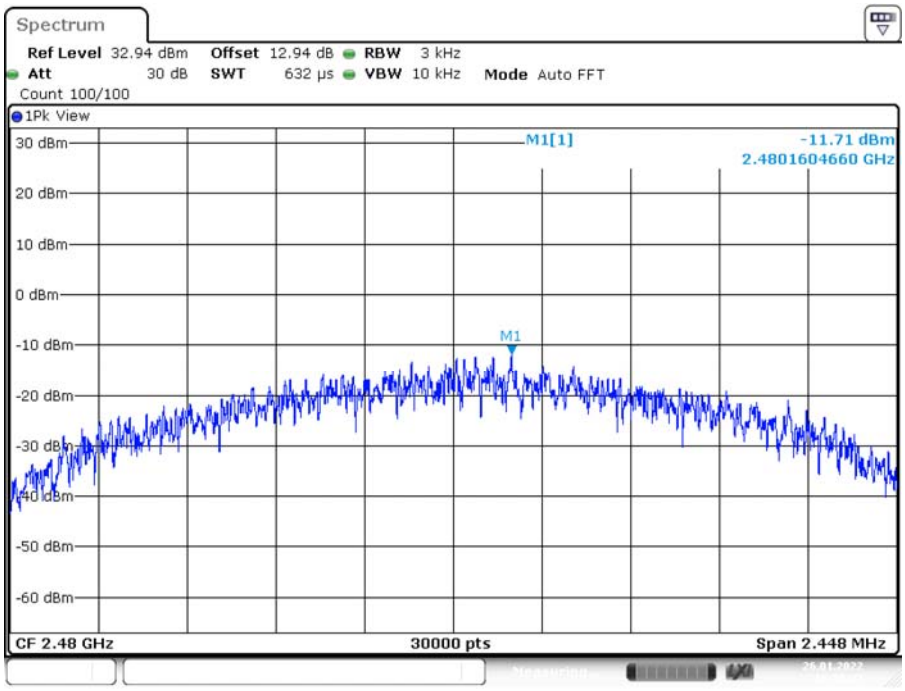
Power Spectral Density, BLE 2M Low Channel



Power Spectral Density, BLE 2M Middle Channel

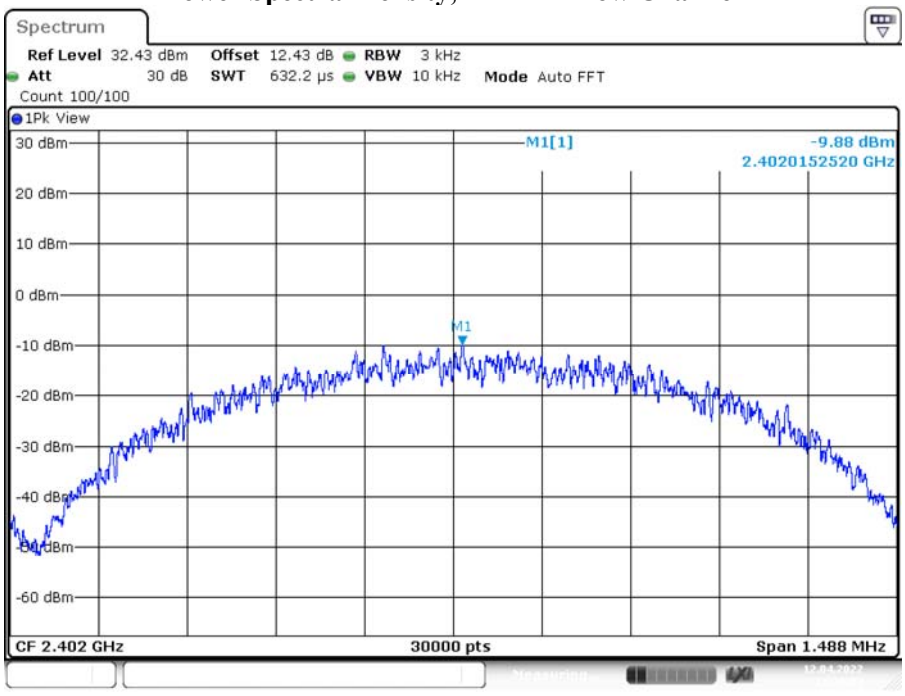


Power Spectral Density, BLE 2M High Channel

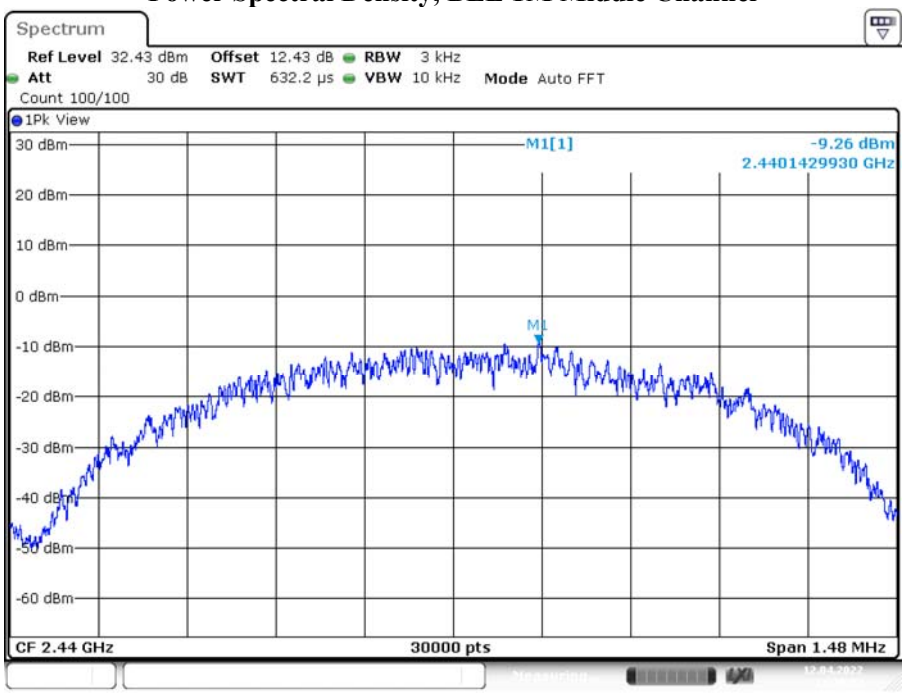


For model of XIAO-nRF52840

Power Spectral Density, BLE 1M Low Channel

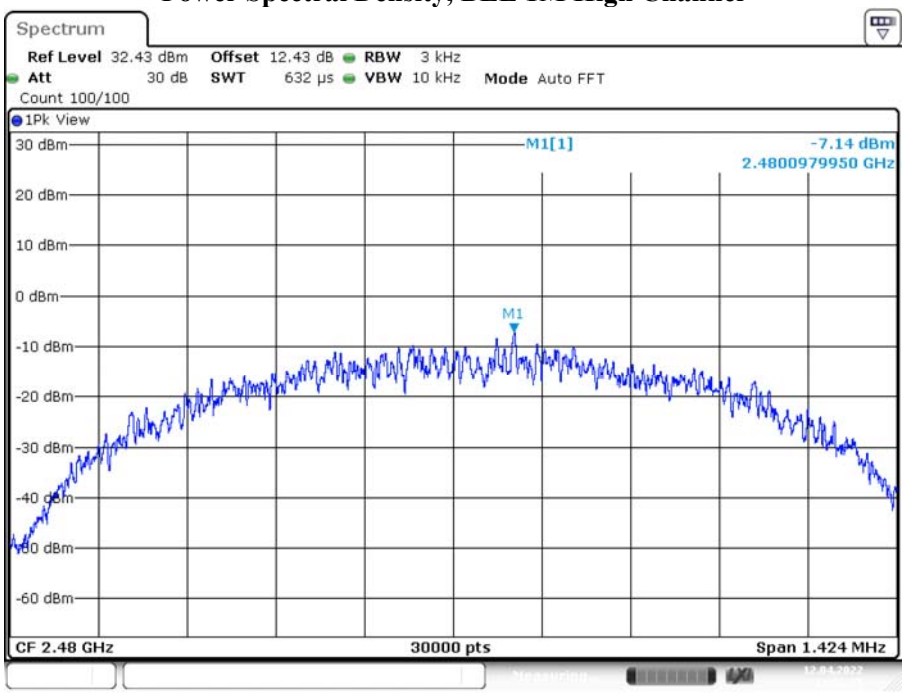


Power Spectral Density, BLE 1M Middle Channel



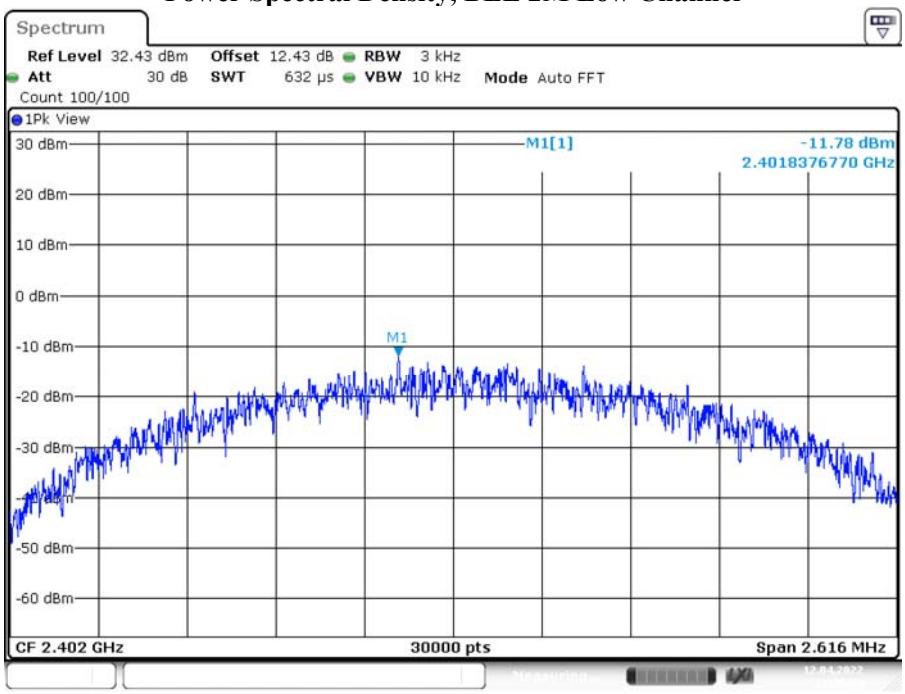
Date: 12.APR.2022 11:29:52

Power Spectral Density, BLE 1M High Channel



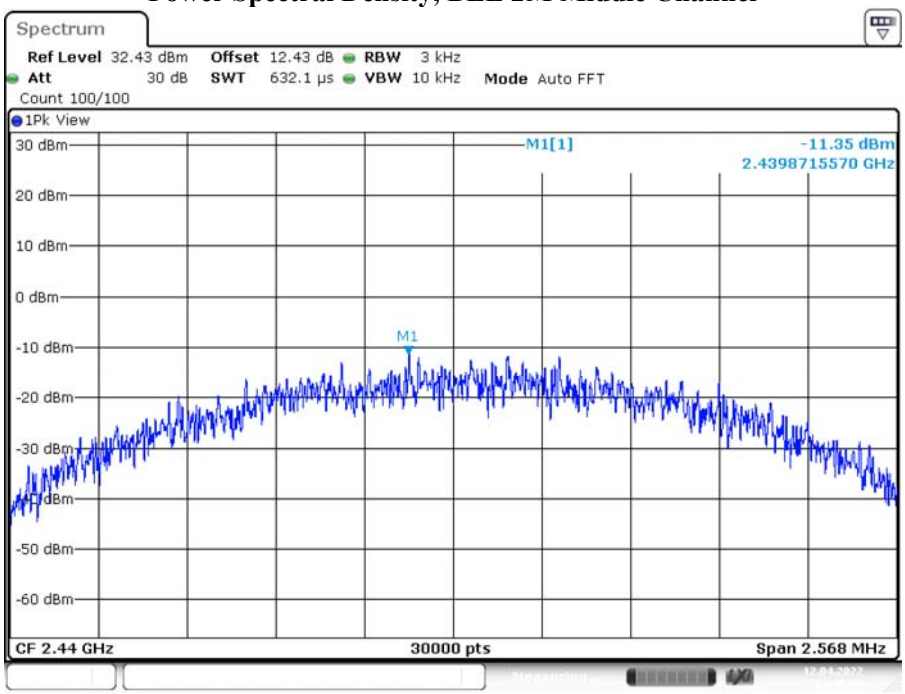
Date: 12.APR.2022 11:31:15

Power Spectral Density, BLE 2M Low Channel



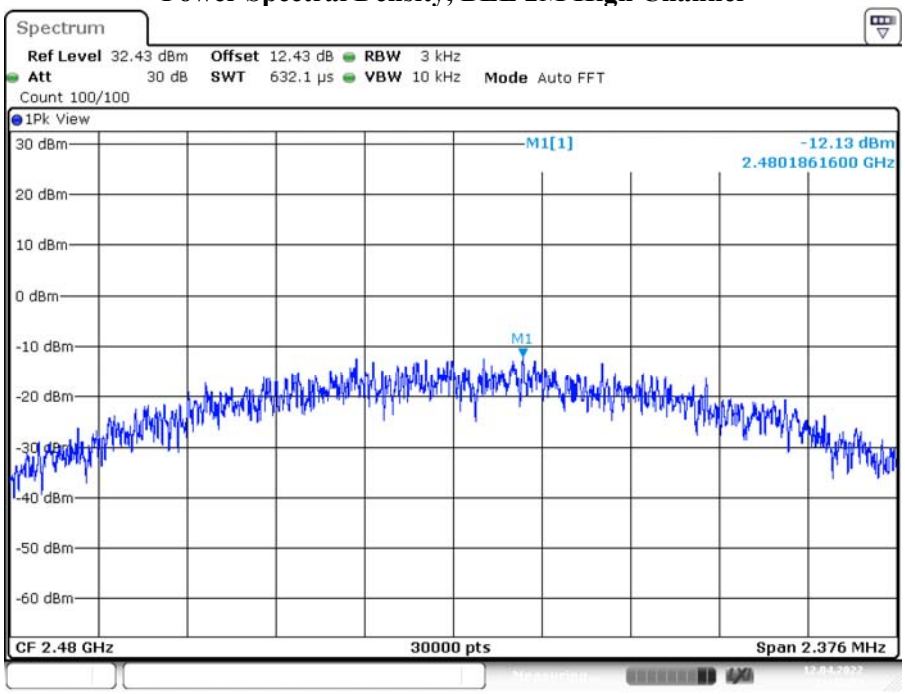
Date: 12.APR.2022 11:35:49

Power Spectral Density, BLE 2M Middle Channel



Date: 12.APR.2022 11:40:40

Power Spectral Density, BLE 2M High Channel

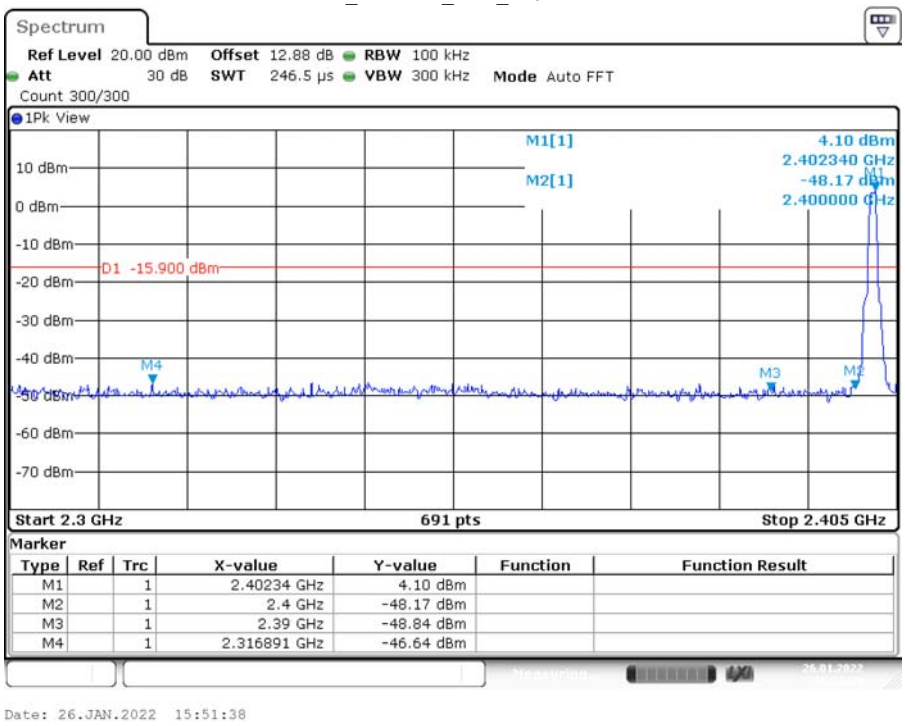


Appendix E: Band edge measurements

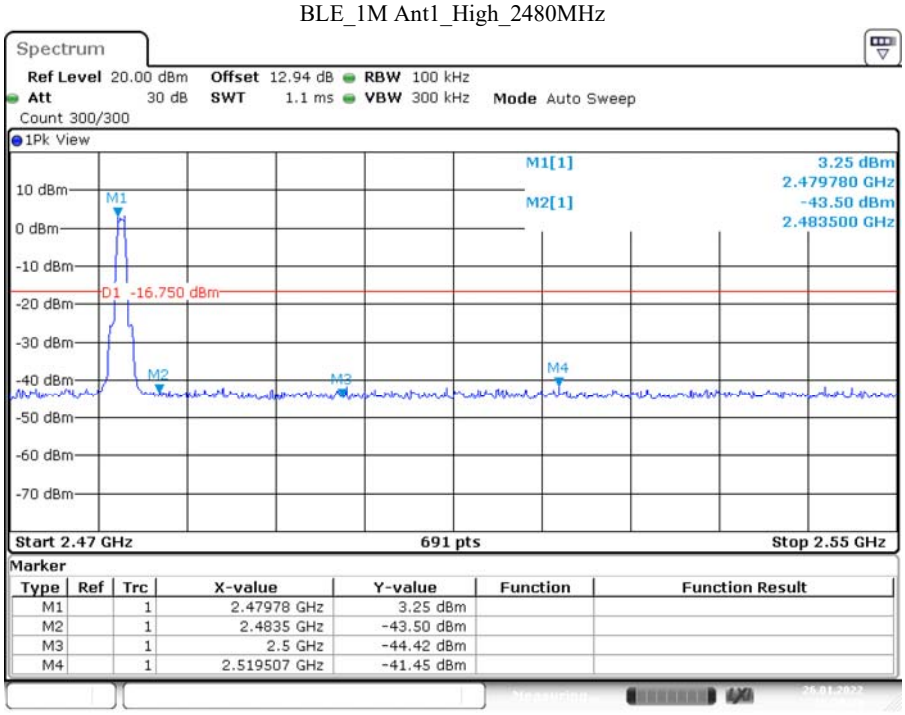
Test Graphs

For model of XIAO-nRF52840 Sense

BLE_1M Ant1_Low_2402MHz

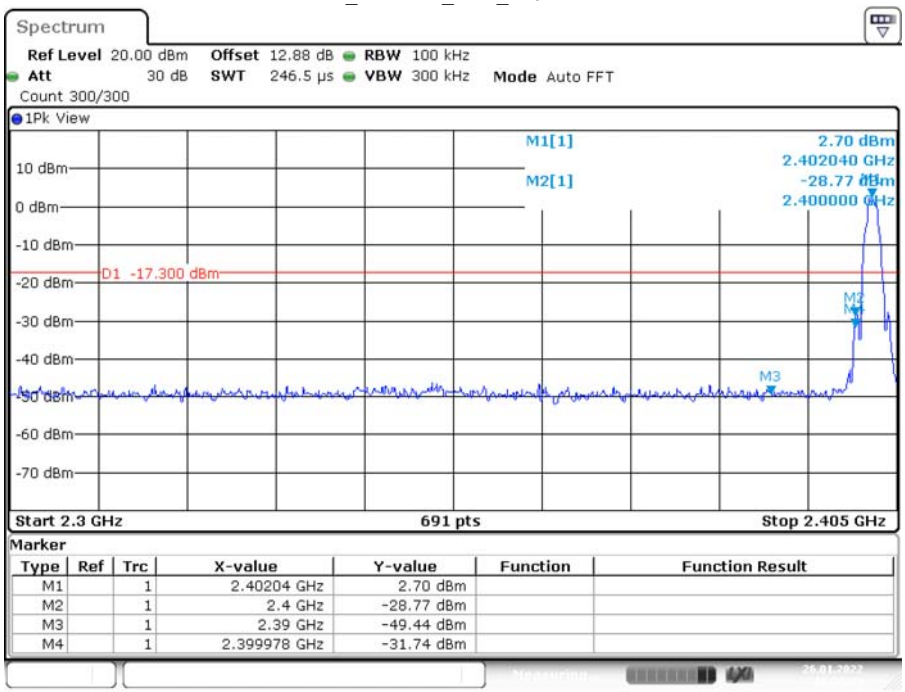


BLE_1M Ant1_High_2480MHz



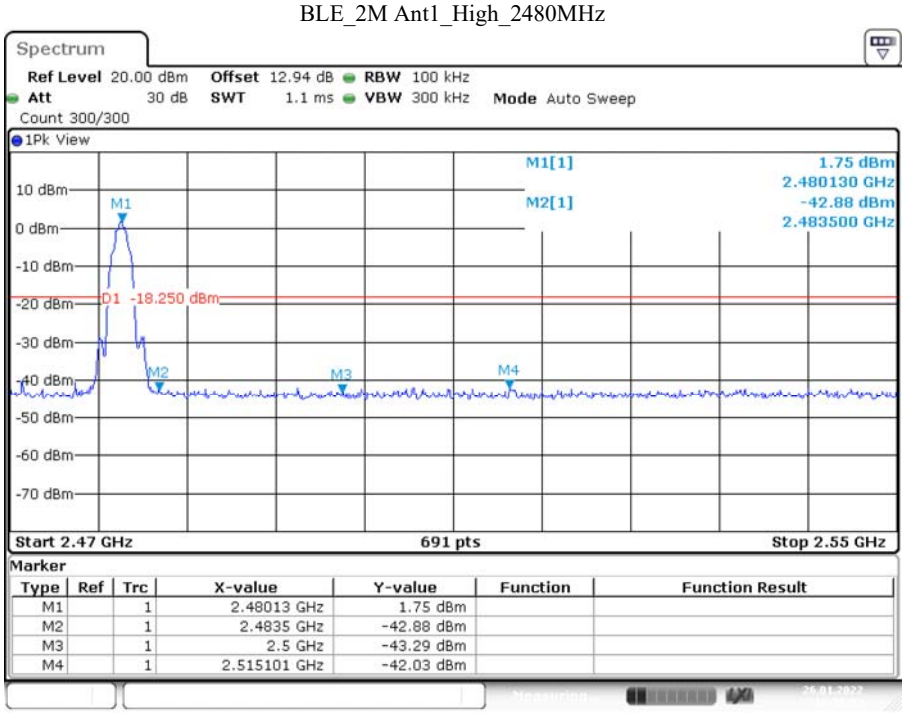
Date: 26.JAN.2022 15:59:20

BLE_2M Ant1_Low_2402MHz



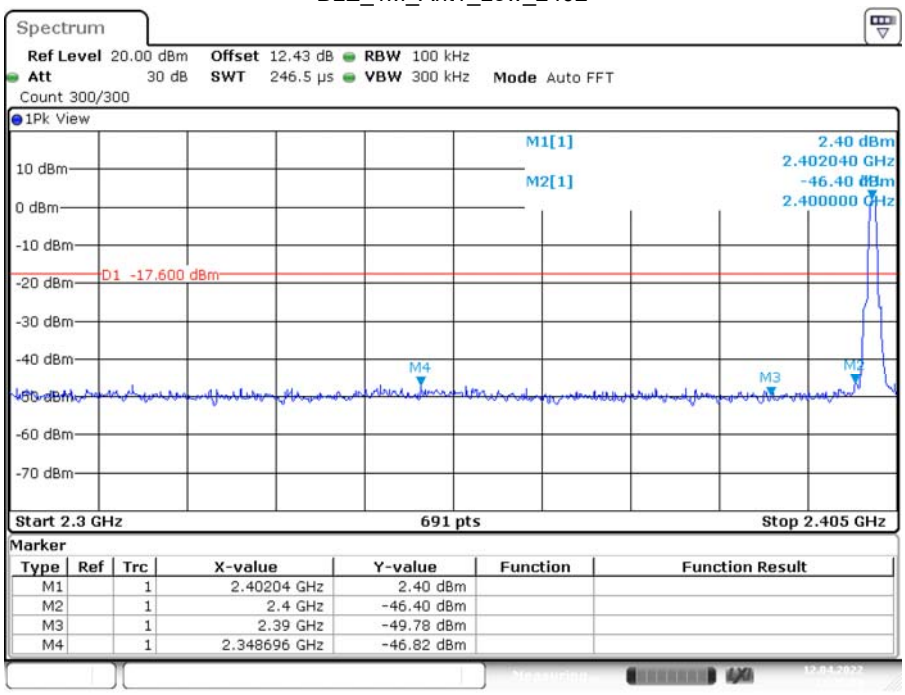
Date: 26.JAN.2022 16:07:33

BLE_2M Ant1_High_2480MHz

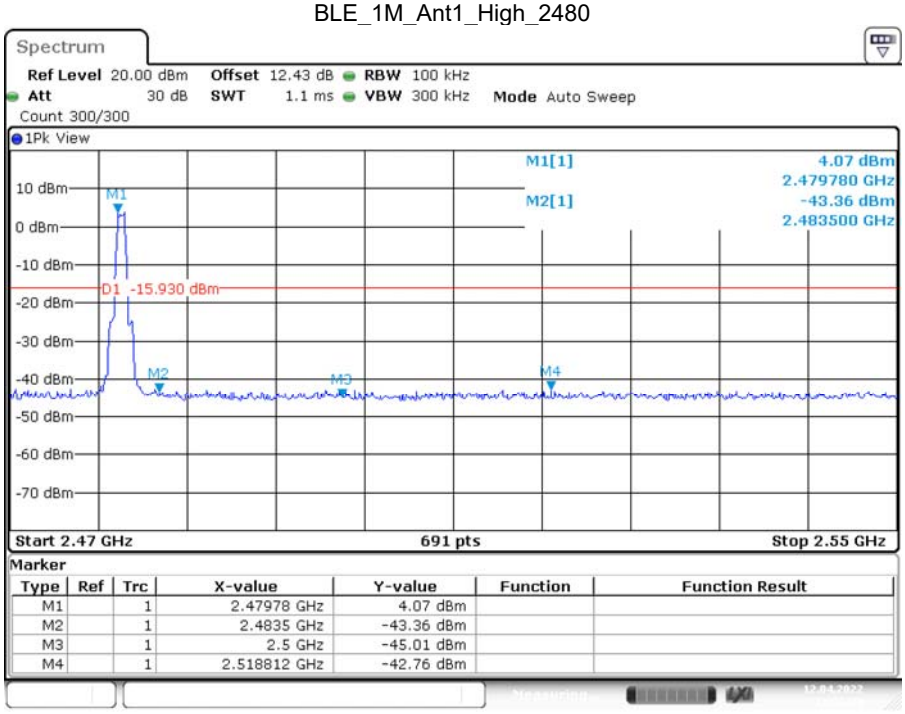


For model of XIAO-nRF52840

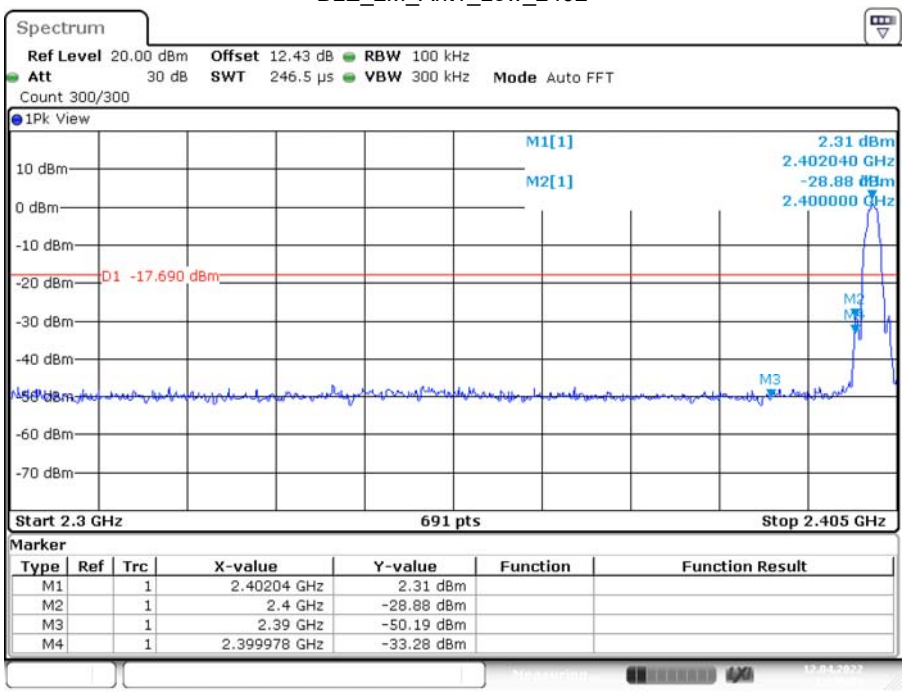
BLE_1M_Ant1_Low_2402



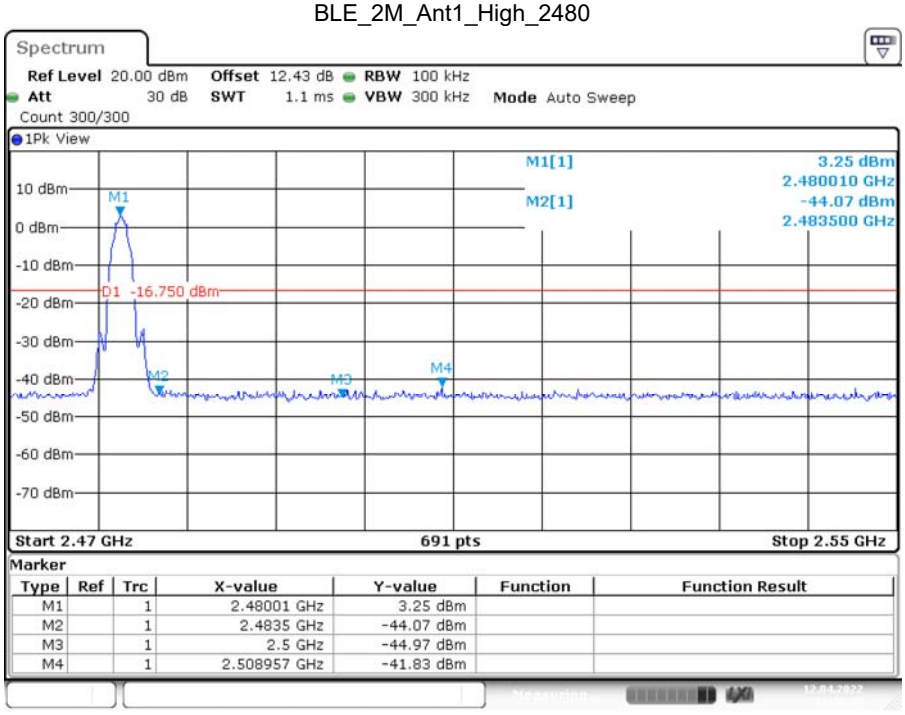
BLE_1M_Ant1_High_2480



BLE_2M_Ant1_Low_2402



BLE_2M_Ant1_High_2480



Appendix F: Duty Cycle

Test Result

For model of XIAO-nRF52840 Sense

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2402	100	100	100.00
		2440	100	100	100.00
		2480	100	100	100.00
BLE_2M	Ant1	2402	100	100	100.00
		2440	100	100	100.00
		2480	100	100	100.00

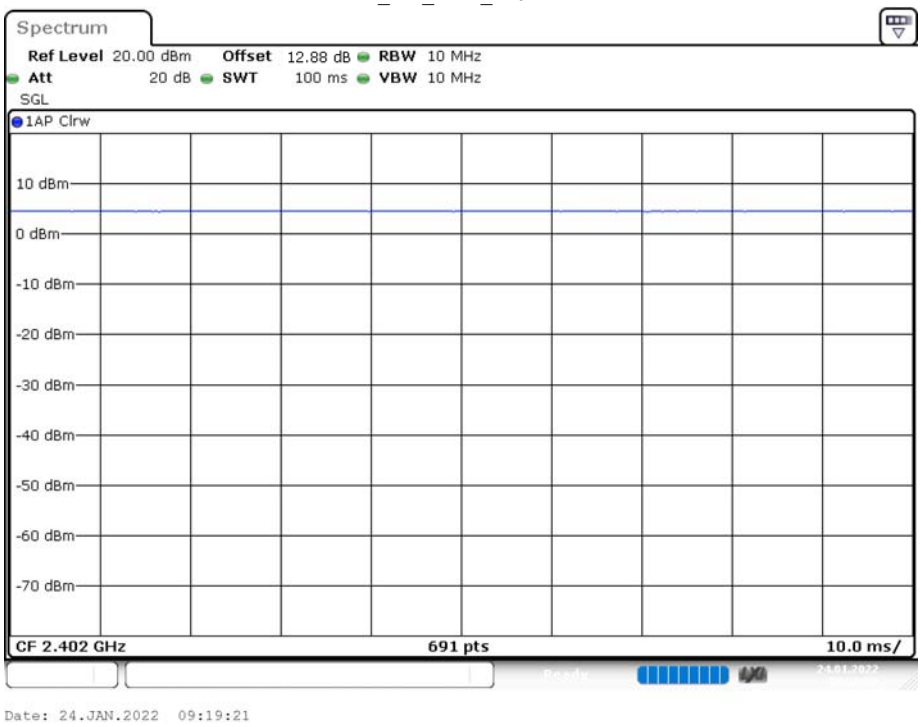
For model of XIAO-nRF52840

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2402	100	100	100.00
		2440	100	100	100.00
		2480	100	100	100.00
BLE_2M	Ant1	2402	100	100	100.00
		2440	100	100	100.00
		2480	100	100	100.00

Test Graphs

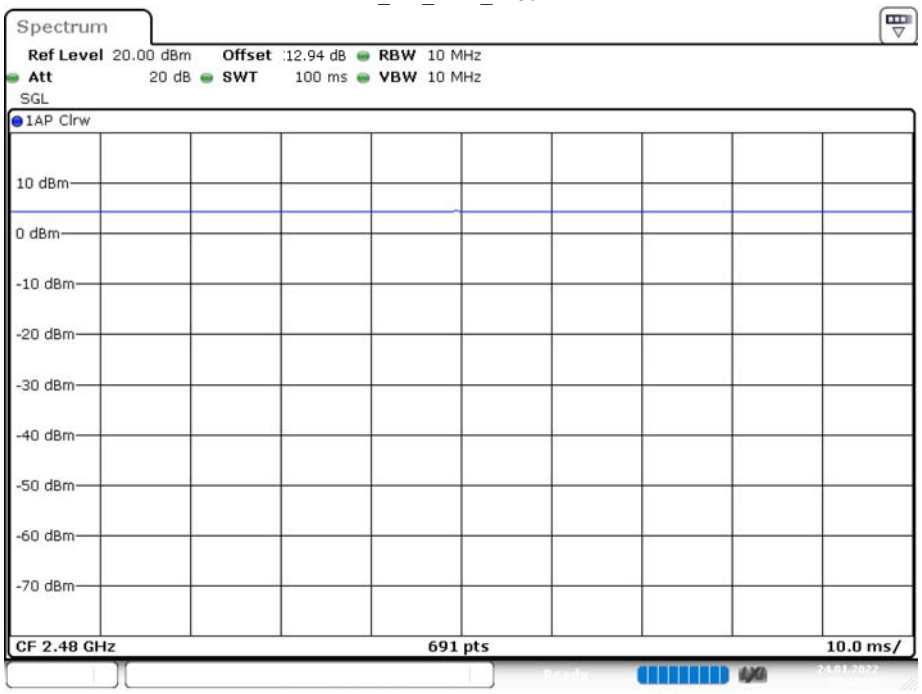
For model of XIAO-nRF52840 Sense

BLE_1M_Ant1_2402MHz

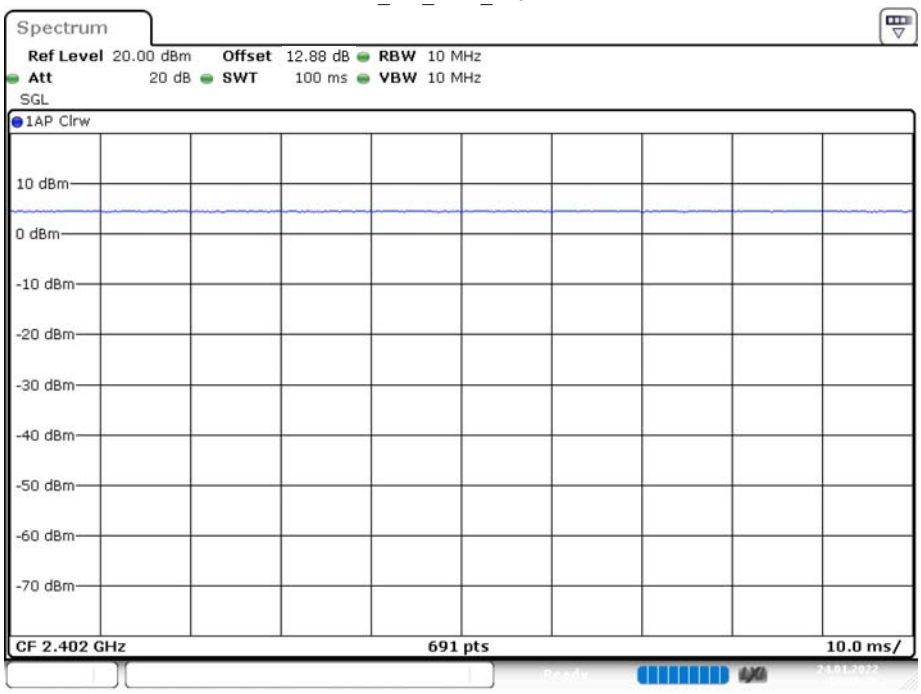


BLE_1M_Ant1_2440MHz

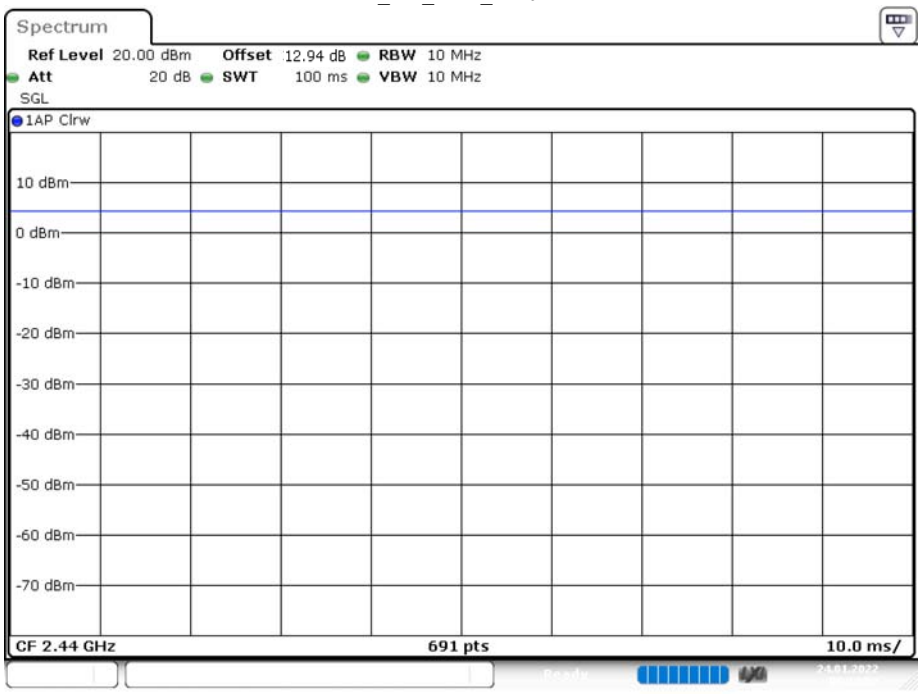
BLE_1M_Ant1_2480MHz



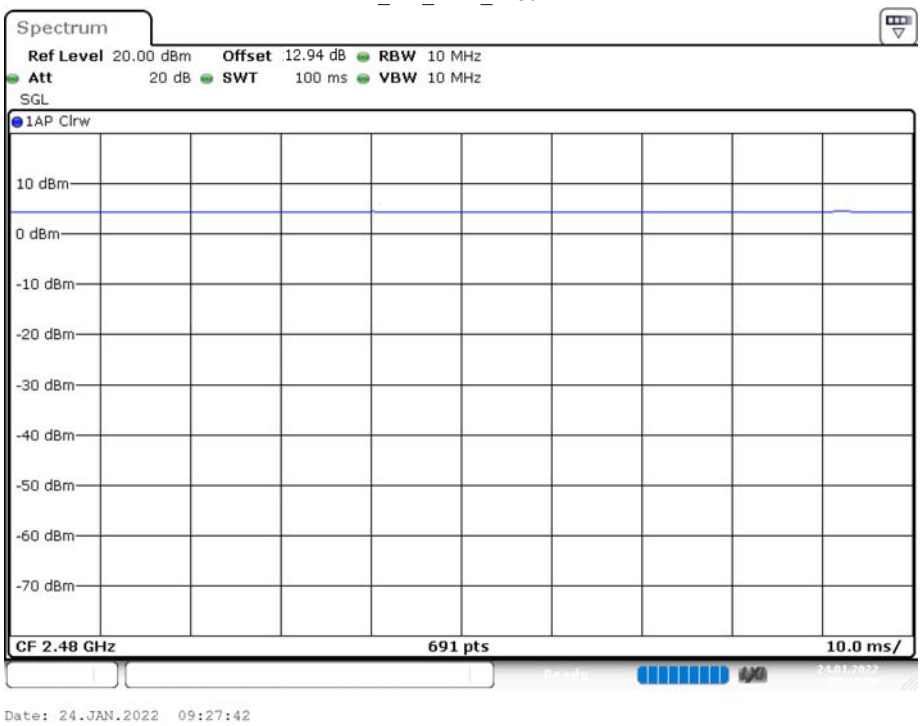
BLE_2M_Ant1_2402MHz



BLE_2M_Ant1_2440MHz

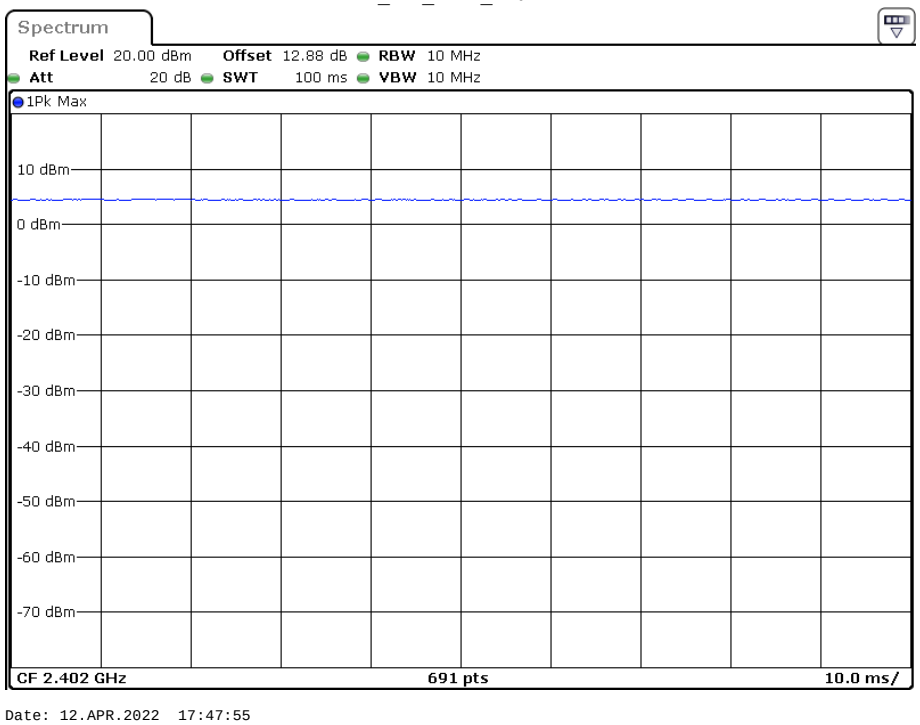


BLE_2M_Ant1_2480MHz



For model of XIAO-nRF52840

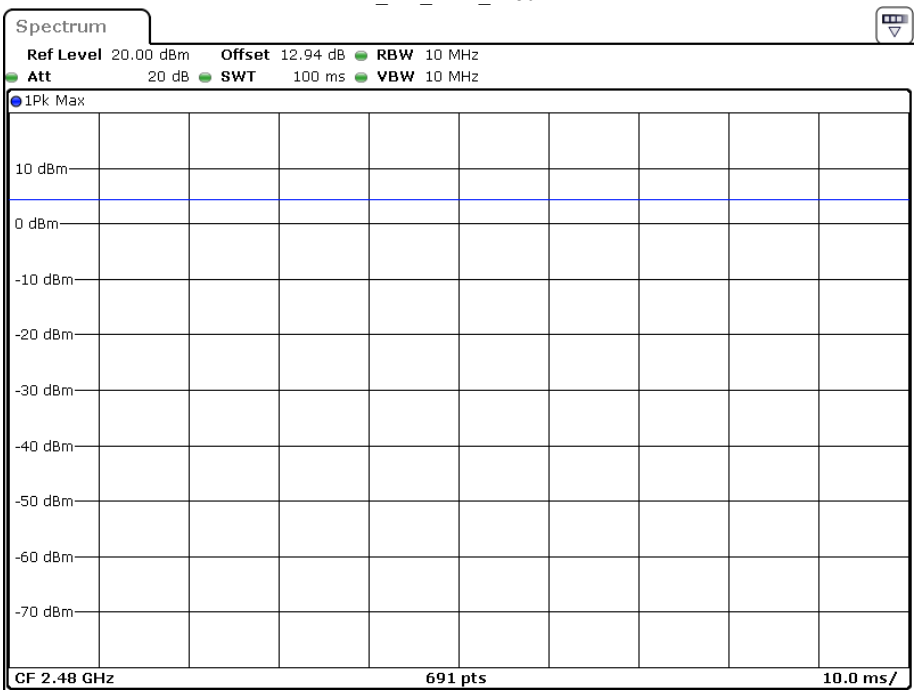
BLE_1M_Ant1_2402MHz



BLE_1M_Ant1_2440MHz

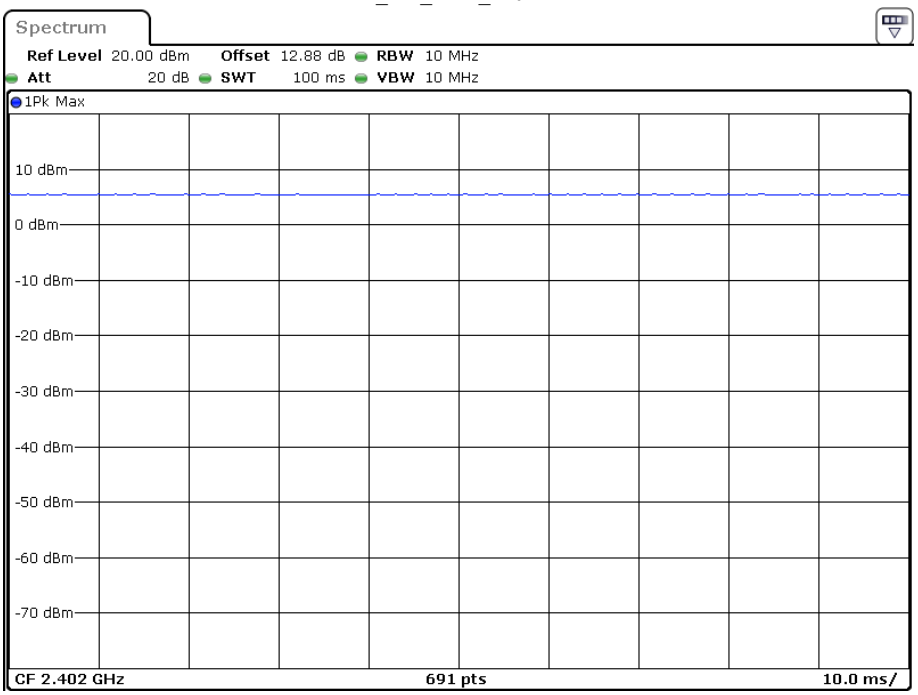
Date: 12.APR.2022 17:55:51

BLE_1M_Ant1_2480MHz



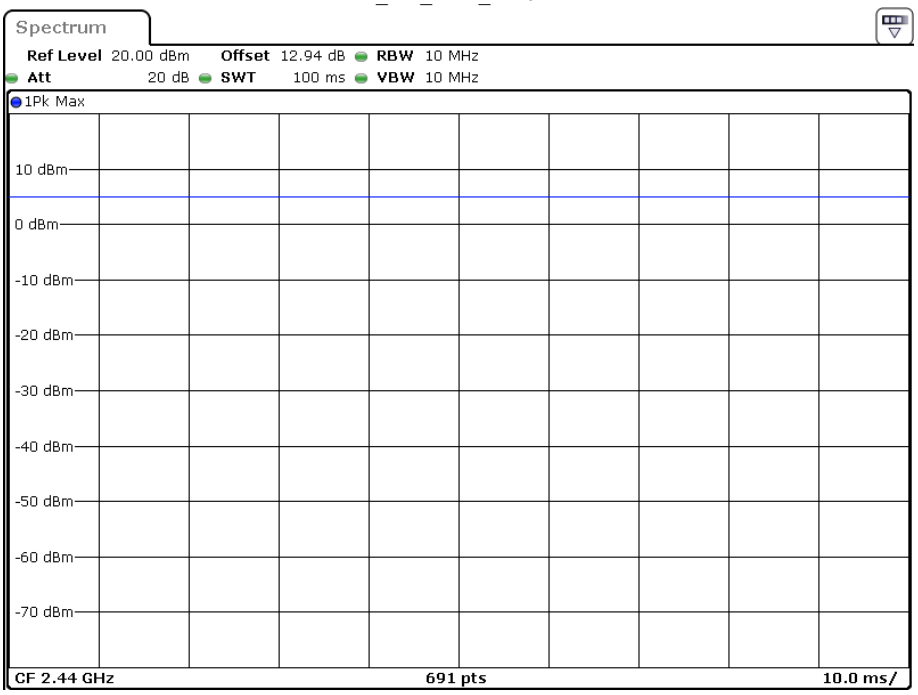
Date: 12.APR.2022 17:59:47

BLE_2M_Ant1_2402MHz



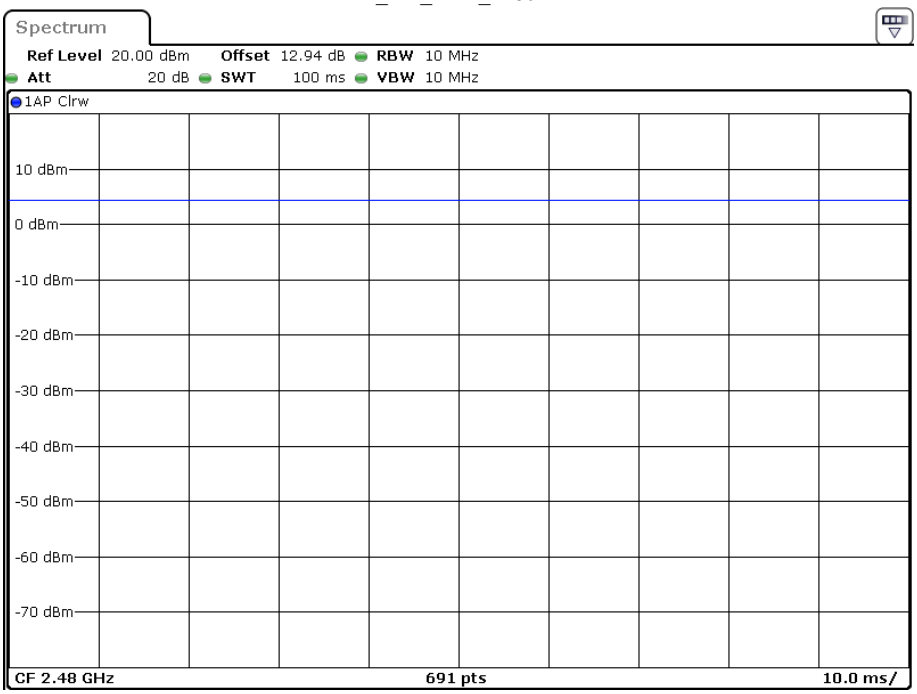
Date: 12.APR.2022 18:01:00

BLE_2M_Ant1_2440MHz



Date: 12.APR.2022 18:02:15

BLE_2M_Ant1_2480MHz



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