



FCC RF Test Report

APPLICANT : Motorola Mobility LLC
EQUIPMENT : Mobile Cellular Phone
BRAND NAME : Motorola
MODEL NAME : XT2451-1, XT2451-2
FCC ID : IHDT56AP9
STANDARD : FCC Part 15 Subpart C §15.247
CLASSIFICATION : (DTS) Digital Transmission System
TEST DATE(S) : Feb. 19, 2024 ~ Apr. 10, 2024

We, Sporton International Inc. (Shenzhen), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Shenzhen), the test report shall not be reproduced except in full.

Jason Jia



Approved by: Jason Jia

Sporton International Inc. (ShenZhen)

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People's Republic of China



TABLE OF CONTENTS

REVISION HISTORY..... 3

SUMMARY OF TEST RESULT 4

1 GENERAL DESCRIPTION..... 5

 1.1 Applicant 5

 1.2 Manufacturer 5

 1.3 Product Feature of Equipment Under Test..... 5

 1.4 Product Specification of Equipment Under Test..... 6

 1.5 Modification of EUT 6

 1.6 Testing Location 7

 1.7 Test Software 7

 1.8 Applicable Standards..... 8

 1.9 Specification of Accessory..... 8

2 TEST CONFIGURATION OF EQUIPMENT UNDER TEST..... 9

 2.1 Carrier Frequency Channel 9

 2.2 Test Mode..... 10

 2.3 Connection Diagram of Test System..... 11

 2.4 Support Unit used in test configuration and system 12

 2.5 EUT Operation Test Setup 12

 2.6 Measurement Results Explanation Example..... 12

3 TEST RESULT 13

 3.1 6dB and 99% Bandwidth Measurement 13

 3.2 Output Power Measurement..... 14

 3.3 Power Spectral Density Measurement 19

 3.4 Conducted Band Edges and Spurious Emission Measurement 20

 3.5 Radiated Band Edges and Spurious Emission Measurement 21

 3.6 AC Conducted Emission Measurement..... 25

 3.7 Antenna Requirements 27

4 LIST OF MEASURING EQUIPMENT..... 28

5 MEASUREMENT UNCERTAINTY 29

APPENDIX A. CONDUCTED TEST RESULTS

APPENDIX B. AC CONDUCTED EMISSION TEST RESULT

APPENDIX C. RADIATED SPURIOUS EMISSION

APPENDIX D. DUTY CYCLE PLOTS

APPENDIX E. SETUP PHOTOGRAPHS



REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR420703B	Rev. 01	Initial issue of report	Apr. 12, 2024



SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Report only	-
3.2	15.247(b)(3)	Peak Output Power	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.82 dB at 2483.52 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 14.94 dB at 0.20 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Conformity Assessment Condition:

- The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
- The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty"

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.



1 General Description

1.1 Applicant

Motorola Mobility LLC
222 W,Merchandise Mart Plaza, Chicago IL 60654 USA

1.2 Manufacturer

Motorola Mobility LLC
222 W,Merchandise Mart Plaza, Chicago IL 60654 USA

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Mobile Cellular Phone
Brand Name	Motorola
Model Name	XT2451-1, XT2451-2
FCC ID	IHDT56AP9
IMEI Code	Conducted: 350431590014232/350431590014240 Conduction: 350431590015254/350431590015262 Radiation: 350431590015650/350431590015668
HW Version	DVT2
SW Version	U3UX34.16
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. The two model names are only for market segment, no other difference.



1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	40
Carrier Frequency of Each Channel	40 Channel(37 hopping + 3 advertising channel)
Maximum Output Power to Antenna	<p><SISO Ant 5> BLE 1Mbps: 17.63 dBm (0.0579 W) BLE 2Mbps: 12.61 dBm (0.0182 W)</p> <p><SISO Ant 7> BLE 1Mbps: 17.34 dBm (0.0542 W) BLE 2Mbps: 13.24 dBm (0.0211 W)</p> <p><MIMO Ant 5 + 7> BLE 1Mbps: 15.98 dBm (0.0396 W) BLE 2Mbps: 11.79 dBm (0.0151 W)</p>
99% Occupied Bandwidth	<p><SISO Ant 5> BLE 1Mbps:1.027MHz BLE 2Mbps:2.042MHz</p> <p><SISO Ant 7> BLE 1Mbps:1.027MHz BLE 2Mbps:2.042MHz</p> <p><MIMO Ant 5 + 7> BLE 1Mbps:1.063MHz BLE 2Mbps:2.050MHz</p>
Antenna Type / Gain	Ant 5 : Loop Antenna type with gain -3.85 dBi Ant 7 : IFA Antenna type with gain -2.24 dBi
Type of Modulation	Bluetooth LE : GFSK

Note: The device supports CDD MIMO mode.

1.5 Modification of EUT

No modifications are made to the EUT during all test items.



1.6 Testing Location

Sporton International Inc. (ShenZhen) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.01.

Test Firm	Sporton International Inc. (ShenZhen)		
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen, 518055 People's Republic of China TEL: +86-755-86379589 FAX: +86-755-86379595		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	CO01-SZ TH01-SZ	CN1256	421272

Test Firm	Sporton International Inc. (ShenZhen)		
Test Site Location	101, 1st Floor, Block B, Building 1, No. 2, Tengfeng 4th Road, Fenghuang Community, Fuyong Street, Baoan District, Shenzhen City, Guangdong Province 518103 People's Republic of China TEL: +86-755-86066985		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	03CH04-SZ	CN1256	421272

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH04-SZ	AUDIX	E3	6.2009-8-24
2.	CO01-SZ	AUDIX	E3	6.120613b



1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ 47 CFR Part 15 Subpart C §15.247
- ♦ FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

1.9 Specification of Accessory

Specification of Accessory				
Battery 1	Brand Name	Motorola(ATL)	Model Name	QR10
Battery 2	Brand Name	Motorola(ATL)	Model Name	QR30
USB Cable 1	Brand Name	Motorola(SAIBAO)	Model Name	SC18D86731
USB Cable 2	Brand Name	Motorola(Luxshare)	Model Name	SC18E08103



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	21	2444
	1	2404	22	2446
	2	2406	23	2448
	3	2408	24	2450
	4	2410	25	2452
	5	2412	26	2454
	6	2414	27	2456
	7	2416	28	2458
	8	2418	29	2460
	9	2420	30	2462
	10	2422	31	2464
	11	2424	32	2466
	12	2426	33	2468
	13	2428	34	2470
	14	2430	35	2472
	15	2432	36	2474
	16	2434	37	2476
	17	2436	38	2478
	18	2438	39	2480
	19	2440	-	-
20	2442	-	-	



2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Y plane) were recorded in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

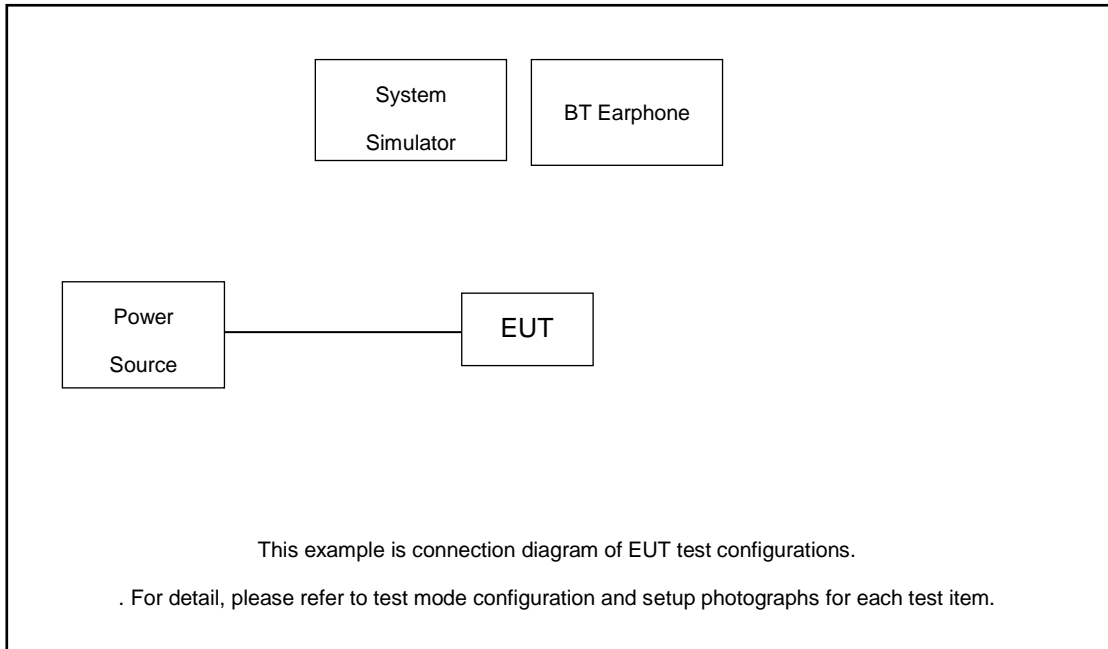
The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	Data Rate / Modulation
	Bluetooth – LE / GFSK
Conducted TCS	Mode 1: Bluetooth Tx CH00_2402 MHz_BLE 1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_BLE 1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_BLE 1Mbps Mode 4: Bluetooth Tx CH00_2402 MHz_BLE 2Mbps Mode 5: Bluetooth Tx CH19_2440 MHz_BLE 2Mbps Mode 6: Bluetooth Tx CH39_2480 MHz_BLE 2Mbps
Radiated TCS	Mode 1: Bluetooth Tx CH00_2402 MHz_BLE 1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_BLE 1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_BLE 1Mbps Mode 4: Bluetooth Tx CH00_2402 MHz_BLE 2Mbps Mode 5: Bluetooth Tx CH19_2440 MHz_BLE 2Mbps Mode 6: Bluetooth Tx CH39_2480 MHz_BLE 2Mbps
AC Conducted Emission	Mode 1: GSM 850 Idle + Bluetooth Link + Adapter + USB Cable 1+ Battery
Remark:	
1. For Radiated Test Cases, the tests were performance with Adapter and USB Cable 1.	
2. Fold Up mode is verified worse case of Open modes for RSE testing.	

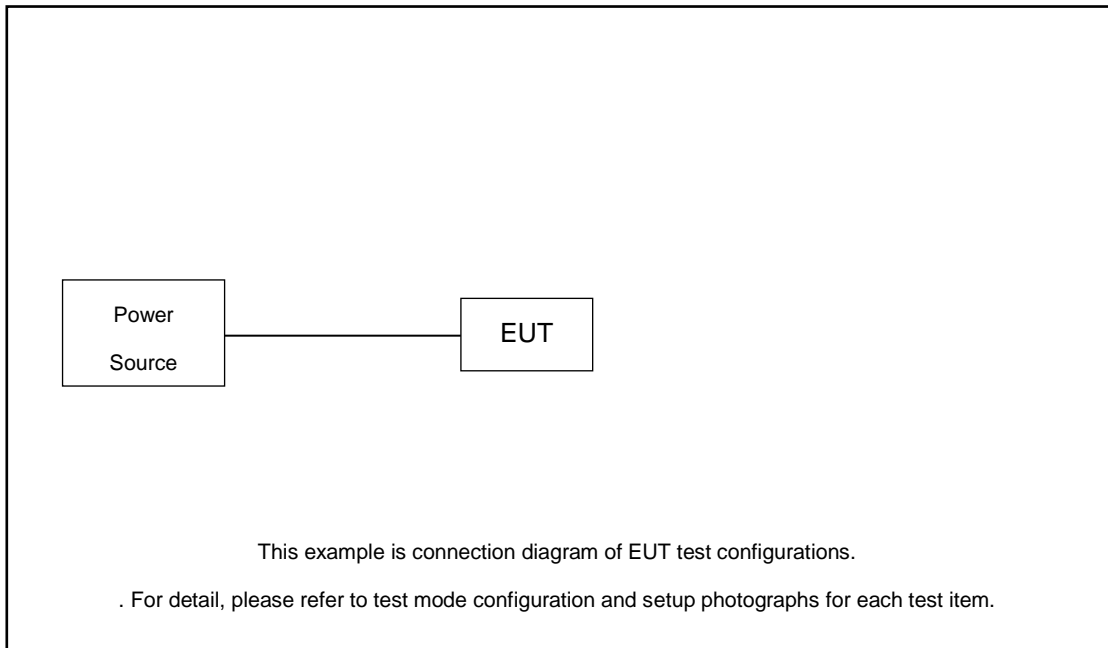
RSE Co-location
Bluetooth LE(2 Mbps) CH39_TX(Ant 5+ 7) + LTE Band 48 link(Ant 2)
Bluetooth LE(2 Mbps) CH39_TX (Ant 5) + LTE Band 48 link(Ant 2)

2.3 Connection Diagram of Test System

AC Conducted Emission:



Radiated Emission:





2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Earphone	Samsung	EO-MG900	N/A	N/A	N/A
2.	AC Adapter	Moto	N/A	N/A	N/A	N/A
3.	Base Station	Anritsu	MT8821C	N/A	N/A	Unshielded,1.8m

2.5 EUT Operation Test Setup

For BLE function, the engineering test program was provided and enabled to make EUT continuous transmit.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 2.20 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 2.20 + 10 = 12.20 \text{ (dB)} \end{aligned}$$

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

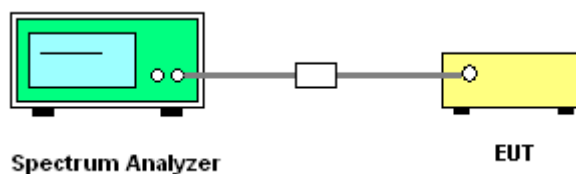
3.1.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1% to 5% of the 99% OBW and the VBW is set to 3 times of the RBW.
6. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

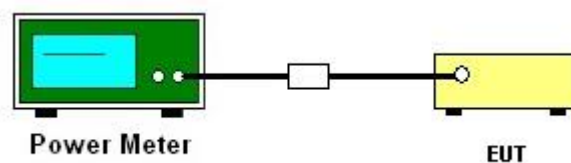
3.2.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.3 PKPM1 Peak power meter or ANSI C63.10-2013 clause 11.9.2.3.1 Method AVGPM method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup





3.2.5 Test Result of Peak Output Power

<Ant 5>

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	5	0	2402	17.07	30.00	-3.85	13.22	36.00	Pass
BLE	1Mbps	5	19	2440	17.63	30.00	-3.85	13.78	36.00	Pass
BLE	1Mbps	5	39	2480	16.95	30.00	-3.85	13.10	36.00	Pass

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	5	0	2402	12.24	30.00	-3.85	8.39	36.00	Pass
BLE	2Mbps	5	19	2440	12.61	30.00	-3.85	8.76	36.00	Pass
BLE	2Mbps	5	39	2480	11.93	30.00	-3.85	8.08	36.00	Pass

<Ant 7>

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	7	0	2402	16.60	30.00	-2.24	14.36	36.00	Pass
BLE	1Mbps	7	19	2440	17.34	30.00	-2.24	15.10	36.00	Pass
BLE	1Mbps	7	39	2480	15.78	30.00	-2.24	13.54	36.00	Pass

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	7	0	2402	12.61	30.00	-2.24	10.37	36.00	Pass
BLE	2Mbps	7	19	2440	13.24	30.00	-2.24	11.00	36.00	Pass
BLE	2Mbps	7	39	2480	11.97	30.00	-2.24	9.73	36.00	Pass



<Ant 5+7>

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	2	0	2402	15.77	30.00	-2.24	13.53	36.00	Pass
BLE	1Mbps	2	19	2440	15.98	30.00	-2.24	13.74	36.00	Pass
BLE	1Mbps	2	39	2480	15.13	30.00	-2.24	12.89	36.00	Pass

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	2	0	2402	11.39	30.00	-2.24	9.15	36.00	Pass
BLE	2Mbps	2	19	2440	11.79	30.00	-2.24	9.55	36.00	Pass
BLE	2Mbps	2	39	2480	10.90	30.00	-2.24	8.66	36.00	Pass



3.2.6 Test Result of Average Output Power (Reporting Only)

<Ant 5>

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	5	0	2402	2.01	16.60	30.00	-3.85	12.75	36.00	Pass
BLE	1Mbps	5	19	2440	2.01	17.00	30.00	-3.85	13.15	36.00	Pass
BLE	1Mbps	5	39	2480	2.01	16.30	30.00	-3.85	12.45	36.00	Pass

Power Setting: default

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	5	0	2402	4.77	12.10	30.00	-3.85	8.25	36.00	Pass
BLE	2Mbps	5	19	2440	4.77	12.40	30.00	-3.85	8.55	36.00	Pass
BLE	2Mbps	5	39	2480	4.77	11.60	30.00	-3.85	7.75	36.00	Pass

Power Setting: default

<Ant 7>

Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	7	0	2402	2.01	16.30	30.00	-2.24	14.06	36.00	Pass
BLE	1Mbps	7	19	2440	2.01	16.90	30.00	-2.24	14.66	36.00	Pass
BLE	1Mbps	7	39	2480	2.01	15.20	30.00	-2.24	12.96	36.00	Pass

Power Setting: default



Mod.	Data Rate	ANT	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	7	0	2402	4.77	12.50	30.00	-2.24	10.26	36.00	Pass
BLE	2Mbps	7	19	2440	4.77	13.00	30.00	-2.24	10.76	36.00	Pass
BLE	2Mbps	7	39	2480	4.77	11.60	30.00	-2.24	9.36	36.00	Pass

Power Setting: default

<Ant 5+7>

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Power Setting	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	2	0	2402	2.01	15.34	default	30.00	-2.24	13.10	36.00	Pass
BLE	1Mbps	2	19	2440	2.01	15.54	default	30.00	-2.24	13.30	36.00	Pass
BLE	1Mbps	2	39	2480	2.01	14.56	default	30.00	-2.24	12.32	36.00	Pass

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Power Setting	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	2Mbps	2	0	2402	4.77	11.02	default	30.00	-2.24	8.78	36.00	Pass
BLE	2Mbps	2	19	2440	4.77	11.21	default	30.00	-2.24	8.97	36.00	Pass
BLE	2Mbps	2	39	2480	4.77	10.39	default	30.00	-2.24	8.15	36.00	Pass

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

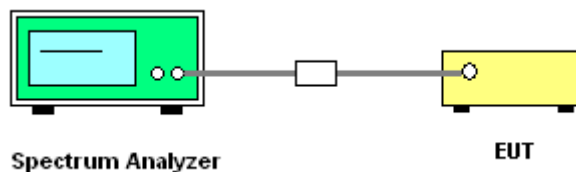
3.3.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 11.10.2 Method PKPSD.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

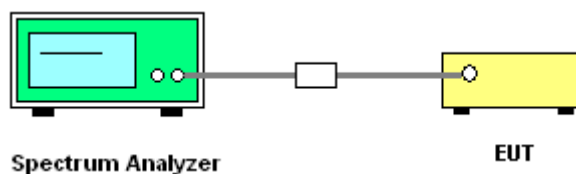
3.4.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.4.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 11.13
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges Plots

Please refer to Appendix A.

3.4.6 Test Result of Conducted Spurious Emission Plots

Please refer to Appendix A.



3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.5.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

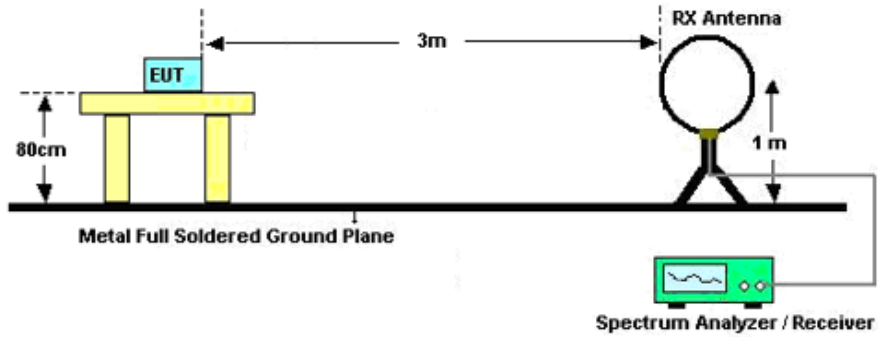


3.5.3 Test Procedures

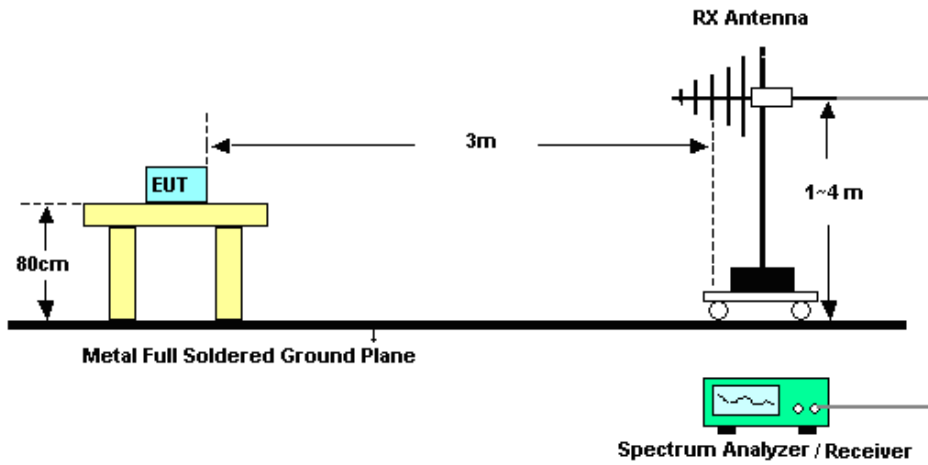
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz; $VBW \geq RBW$; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
For average measurement:
 - $VBW = 10$ Hz, when duty cycle is no less than 98 percent.
 - $VBW \geq 1/T$, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

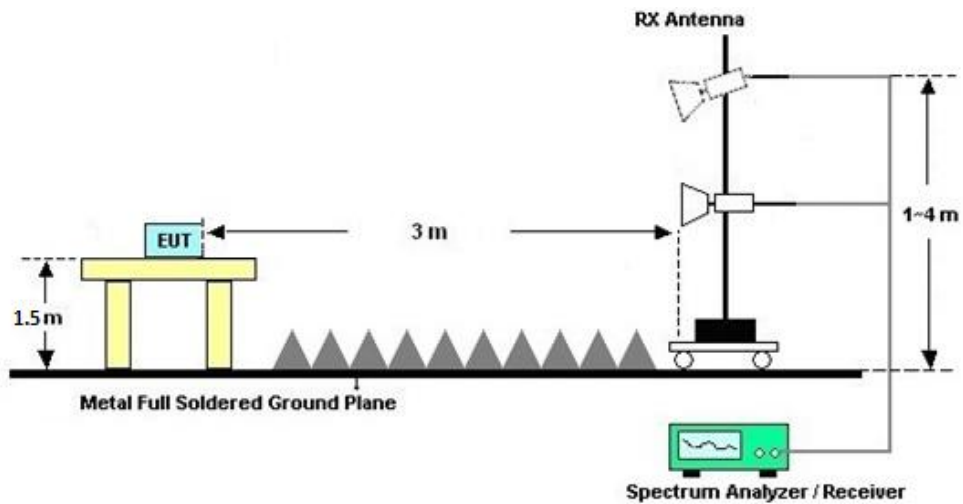
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz





3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.5.7 Duty Cycle

Please refer to Appendix D.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.



3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

3.6.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.



3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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 rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = $10 \log(N_{ANT}/N_{SS}=1)$ dB.

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$.

Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain G_{ANT} is set equal to the antenna having the highest gain, i.e., F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain "DG" is calculated as following table.

<CDD Modes>						
			DG	DG	Power	PSD
			for	for	Limit	Limit
	Ant. 7	Ant. 5	Power	PSD	Reduction	Reduction
	(dBi)	(dBi)	(dBi)	(dBi)	(dB)	(dB)
2.4 GHz	-2.24	-3.85	-2.24	0.00	0.00	0.00



4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
EMI Test Receiver	R&S	ESR7	101404	9kHz~7GHz	Oct. 18, 2023	Mar. 05, 2024~ Apr. 10, 2024	Oct. 17, 2024	Radiation (03CH04-SZ)
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY55150213	10Hz~44GHz	Jul. 07, 2023	Mar. 05, 2024~ Apr. 10, 2024	Jul. 06, 2024	Radiation (03CH04-SZ)
Loop Antenna	R&S	HFH2-Z2	100354	9kHz~30MHz	Jun. 28, 2022	Mar. 05, 2024~ Apr. 10, 2024	Jun. 27, 2024	Radiation (03CH04-SZ)
Bilog Antenna	TeseQ	CBL6111D	41909	30MHz~1GHz	May 14, 2023	Mar. 05, 2024~ Apr. 10, 2024	May 13, 2024	Radiation (03CH04-SZ)
Double Ridge Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-1474	1GHz~18GHz	Jul. 07, 2023	Mar. 05, 2024~ Apr. 10, 2024	Jul. 06, 2024	Radiation (03CH04-SZ)
Horn Antenna	SCHWARZBECK	BBHA9170	9170#679	15GHz~40GHz	Jul. 08, 2023	Mar. 05, 2024~ Apr. 10, 2024	Jul. 07, 2024	Radiation (03CH04-SZ)
Amplifier	Burgeon	BPA-530	102211	0.01Hz ~3000MHz	Oct. 18, 2023	Mar. 05, 2024~ Apr. 10, 2024	Oct. 17, 2024	Radiation (03CH04-SZ)
HF Amplifier	MITEQ	AMF-7D-0010 1800-30-10P-R	1943528	1GHz~18GHz	Oct. 18, 2023	Mar. 05, 2024~ Apr. 10, 2024	Oct. 17, 2024	Radiation (03CH04-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Jul. 07, 2023	Mar. 05, 2024~ Apr. 10, 2024	Jul. 06, 2024	Radiation (03CH04-SZ)
Amplifier	Agilent Technologies	83017A	MY57280136	500MHz~26.5GHz	Aug. 21, 2023	Mar. 05, 2024~ Apr. 10, 2024	Aug. 20, 2024	Radiation (03CH04-SZ)
AC Power Source	APC	AFV-S-600B	F119050019	N/A	Oct. 18, 2023	Mar. 05, 2024~ Apr. 10, 2024	Oct. 17, 2024	Radiation (03CH04-SZ)
Turn Table	EM	EM1000	N/A	0~360 degree	NCR	Mar. 05, 2024~ Apr. 10, 2024	NCR	Radiation (03CH04-SZ)
Antenna Mast	EM	EM1000	N/A	1 m~4 m	NCR	Mar. 05, 2024~ Apr. 10, 2024	NCR	Radiation (03CH04-SZ)
EMI Receiver	R&S	ESR7	101630	9kHz~7GHz;	Jul. 06, 2023	Feb. 19, 2024	Jul. 05, 2024	Conduction (CO01-SZ)
AC LISN	R&S	ENV216	100063	9kHz~30MHz	Aug. 21, 2023	Feb. 19, 2024	Aug. 20, 2024	Conduction (CO01-SZ)
AC LISN (for auxiliary equipment)	EMCO	3816/2SH	00103892	9kHz~30MHz	Oct. 16, 2023	Feb. 19, 2024	Oct. 15, 2024	Conduction (CO01-SZ)
AC Power Source	Chroma	61602	616020000891	100Vac~250Vac	Jul. 07, 2023	Feb. 19, 2024	Jul. 06, 2024	Conduction (CO01-SZ)
Spectrum Analyzer	R&S	FSV40	101078	10Hz~40GHz	Apr. 06, 2023	Mar. 05, 2024~ Mar. 16, 2024	Apr. 05, 2024	Conducted (TH01-SZ)
Pulse Power Sensor	Anritsu	MA2411B	1339473	30MHz~40GHz	Dec. 29, 2023	Mar. 05, 2024~ Mar. 16, 2024	Dec. 28, 2024	Conducted (TH01-SZ)
Power Meter	Anritsu	ML2495A	1218010	50MHz Bandwidth	Aug. 21, 2023	Mar. 05, 2024~ Mar. 16, 2024	Aug. 20, 2024	Conducted (TH01-SZ)
Thermo meter	Anymetre	JR593	#7	- 10°C ~ 50°C 10%RH~99%RH	Apr. 08, 2023	Mar. 05, 2024~ Mar. 16, 2024	Apr. 07, 2024	Conducted (TH01-SZ)

NCR: No Calibration Required



5 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Measurement

Test Item	Uncertainty
Conducted Spurious Emission & Bandedge	±1.34 dB
Occupied Channel Bandwidth	±0.012 MHz
Conducted Power	±1.34 dB
Conducted Power Spectral Density	±1.32 dB
Frequency	±1.3 Hz

Uncertainty of AC Conducted Emission Measurement (0.15 MHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.5 dB
---	--------

Uncertainty of Radiated Emission Measurement (9 KHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.8 dB
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.1 dB
---	--------

Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.8 dB
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Uncertainty of Radiated Emission Measurement (18 GHz ~ 40 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.1 dB
---	--------

----- THE END -----



Appendix A. Conducted Test Results



Ambient Condition: <u>24~26 °C, 45~55 %RH</u>	
According Standard: <u>■Part15C</u>	
Test Date: <u>2024/03/05~2024/03/16</u>	Test Engineer: <u>Zhang Xue Yi</u>

<SISO Ant 5/7>

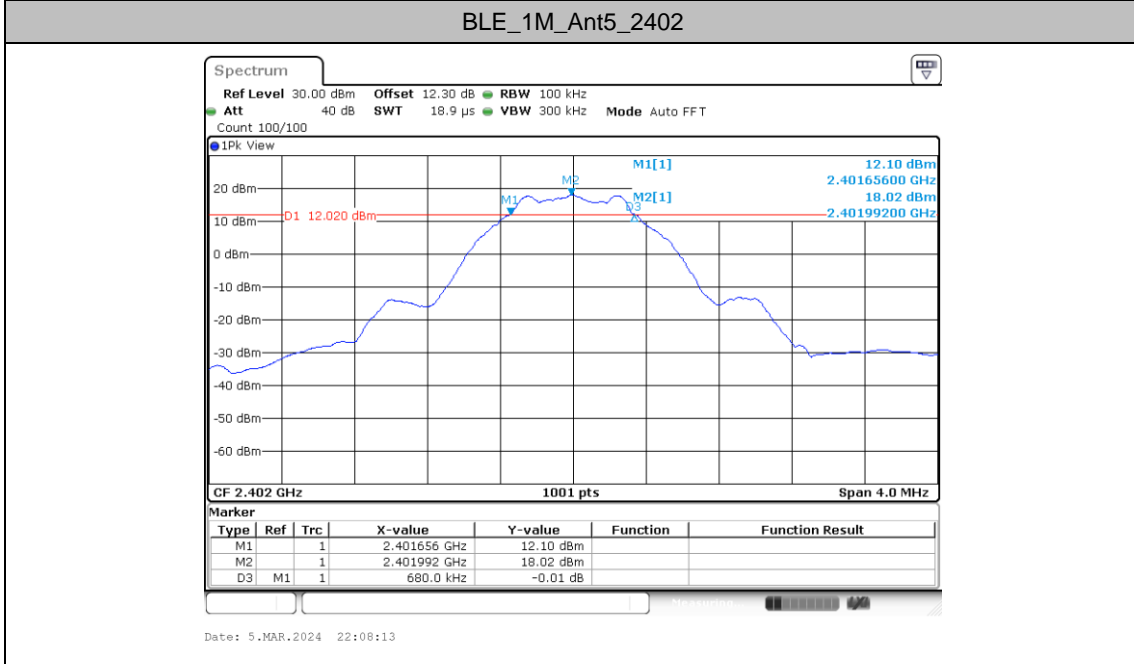
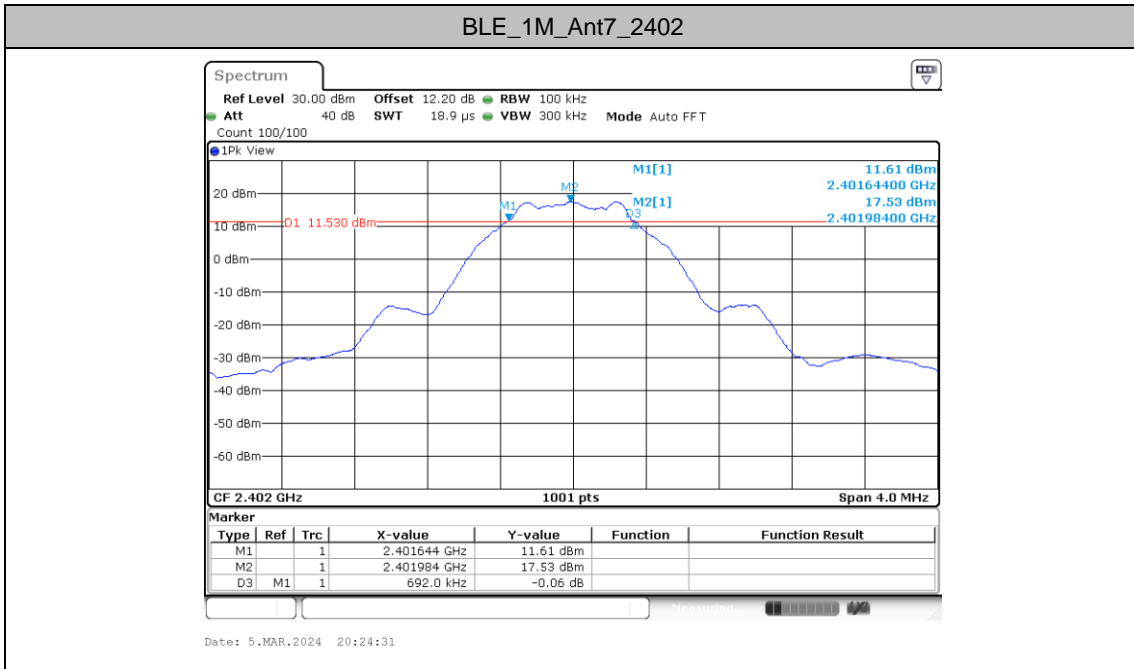
DTS Bandwidth

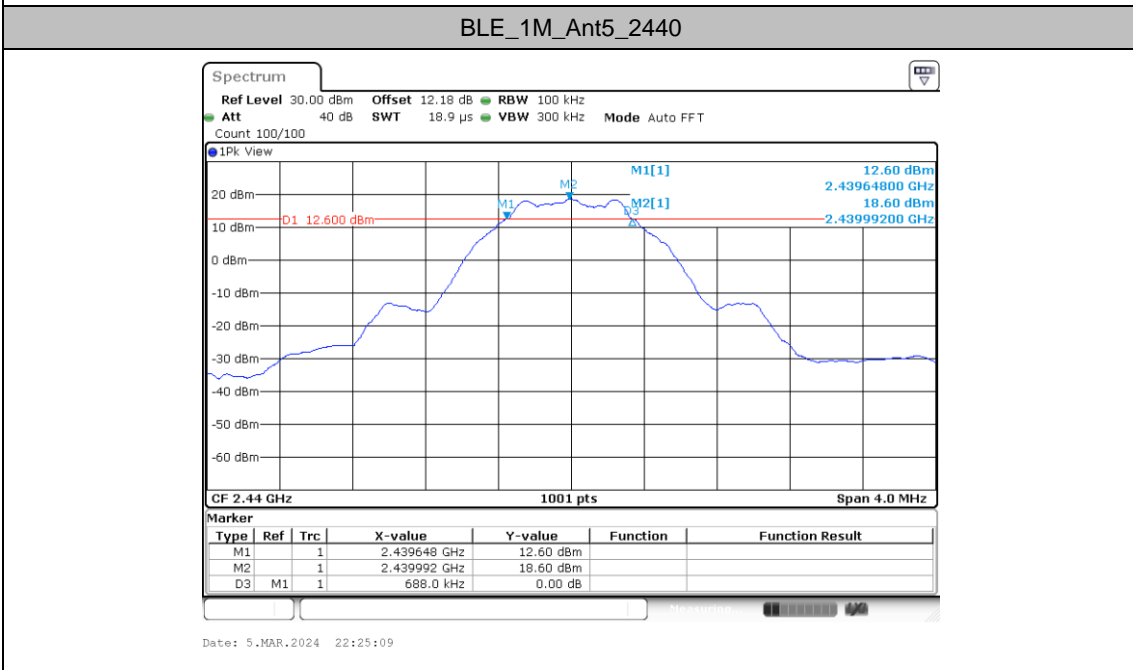
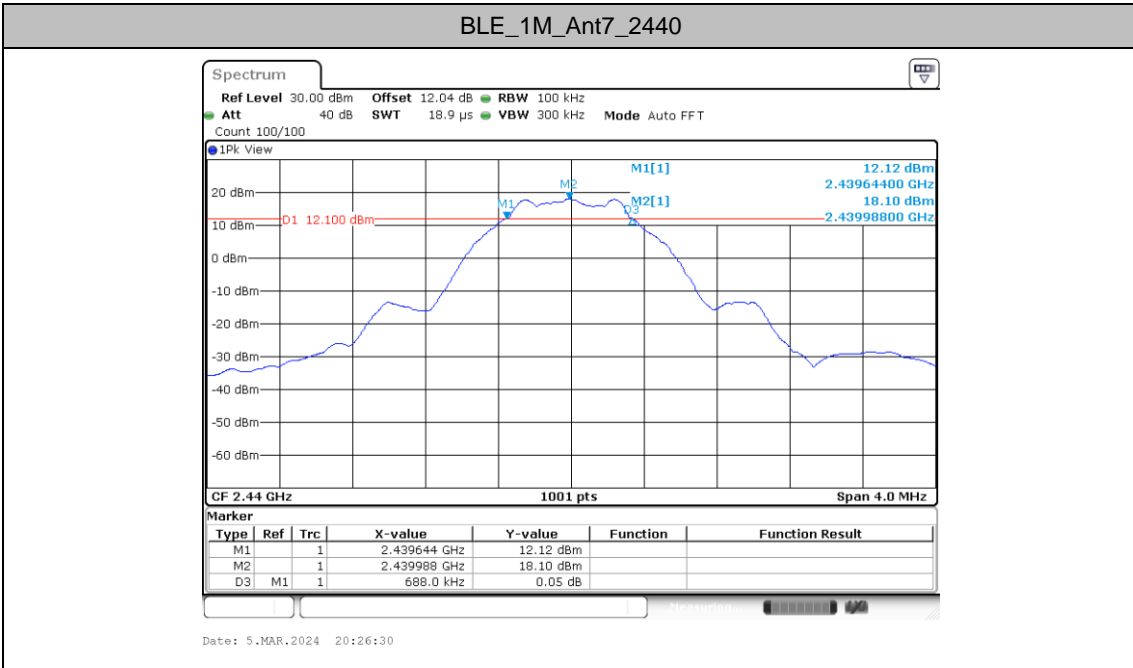
Test Result

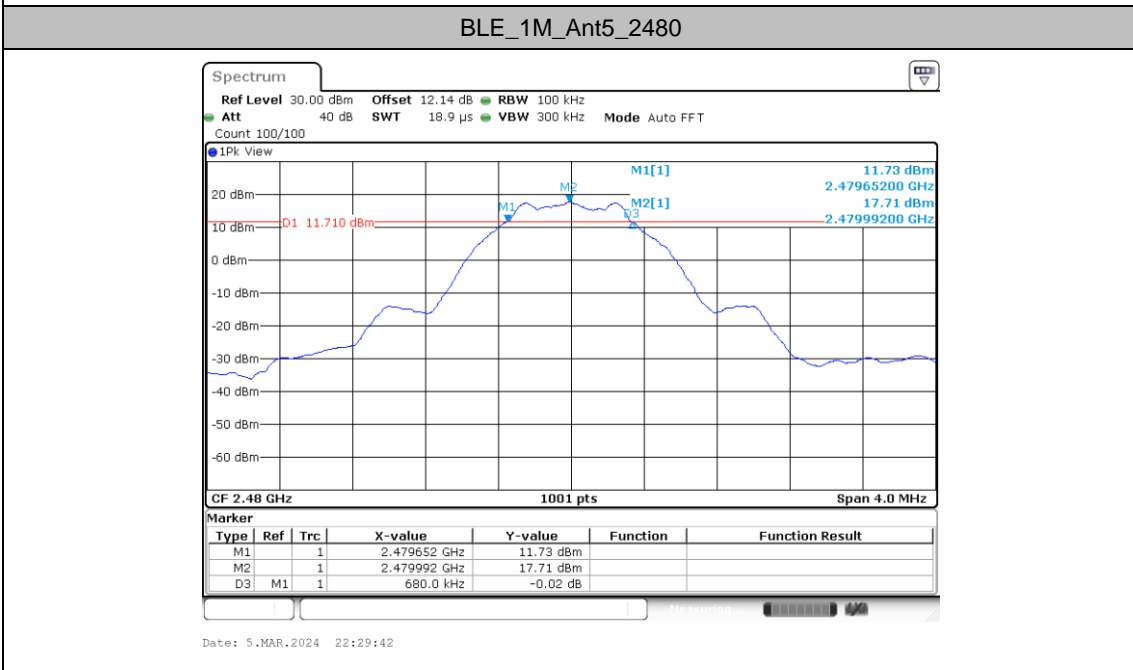
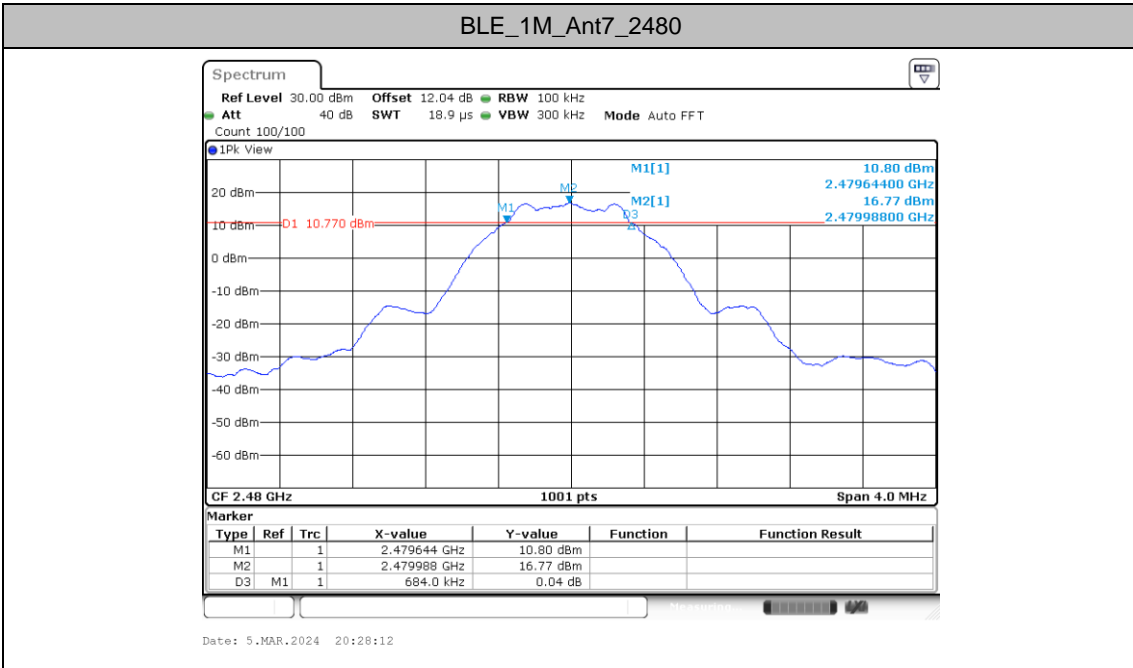
TestMode	Antenna	Freq(MHz)	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant7	2402	0.69	2401.64	2402.34	0.5	PASS
	Ant5	2402	0.68	2401.66	2402.34	0.5	PASS
	Ant7	2440	0.69	2439.64	2440.33	0.5	PASS
	Ant5	2440	0.69	2439.65	2440.34	0.5	PASS
	Ant7	2480	0.68	2479.64	2480.33	0.5	PASS
	Ant5	2480	0.68	2479.65	2480.33	0.5	PASS
BLE_2M	Ant7	2402	1.14	2401.42	2402.57	0.5	PASS
	Ant5	2402	1.14	2401.43	2402.57	0.5	PASS
	Ant7	2440	1.14	2439.42	2440.57	0.5	PASS
	Ant5	2440	1.14	2439.43	2440.57	0.5	PASS
	Ant7	2480	1.14	2479.42	2480.57	0.5	PASS
	Ant5	2480	1.13	2479.43	2480.56	0.5	PASS



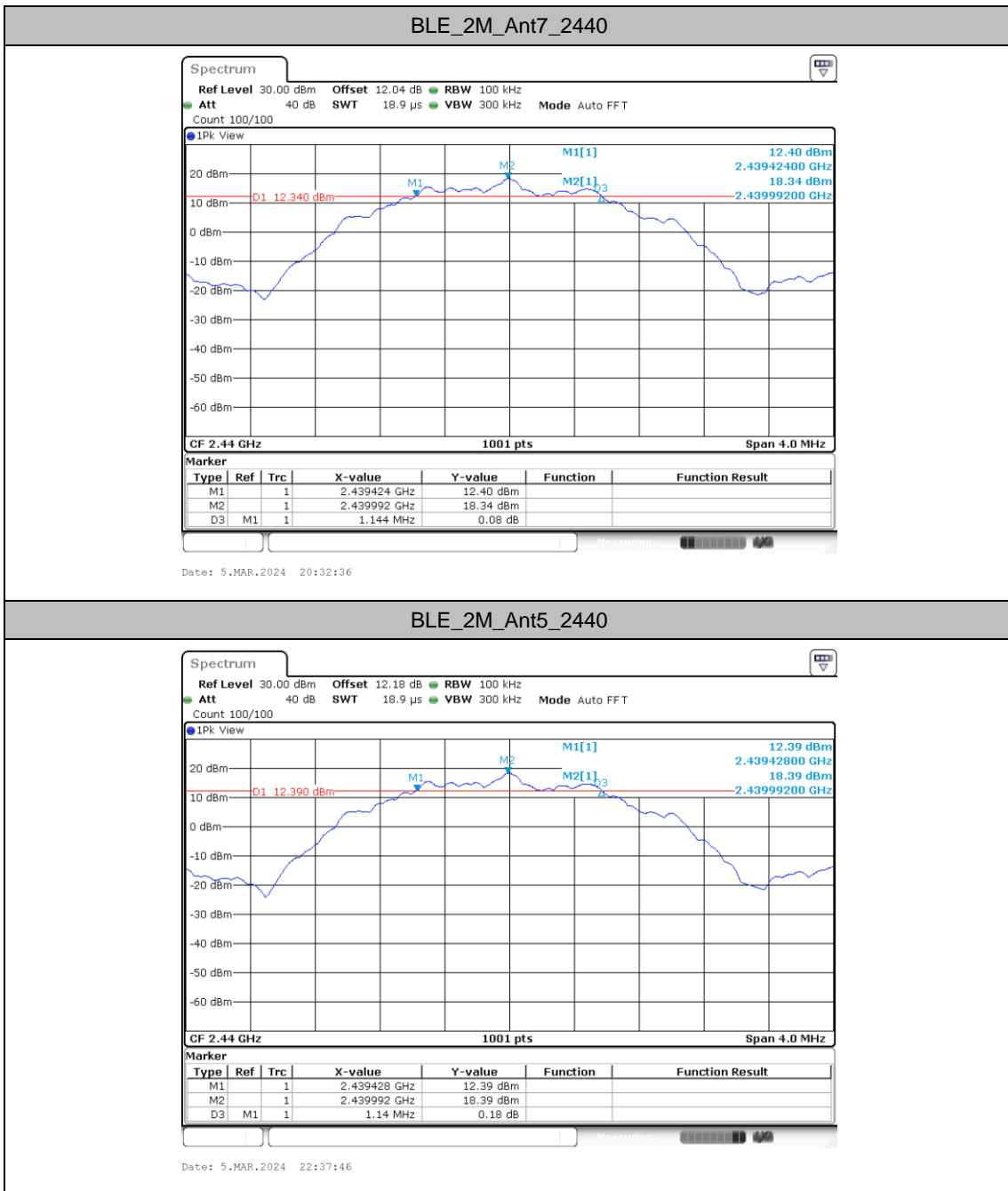
Test Graphs

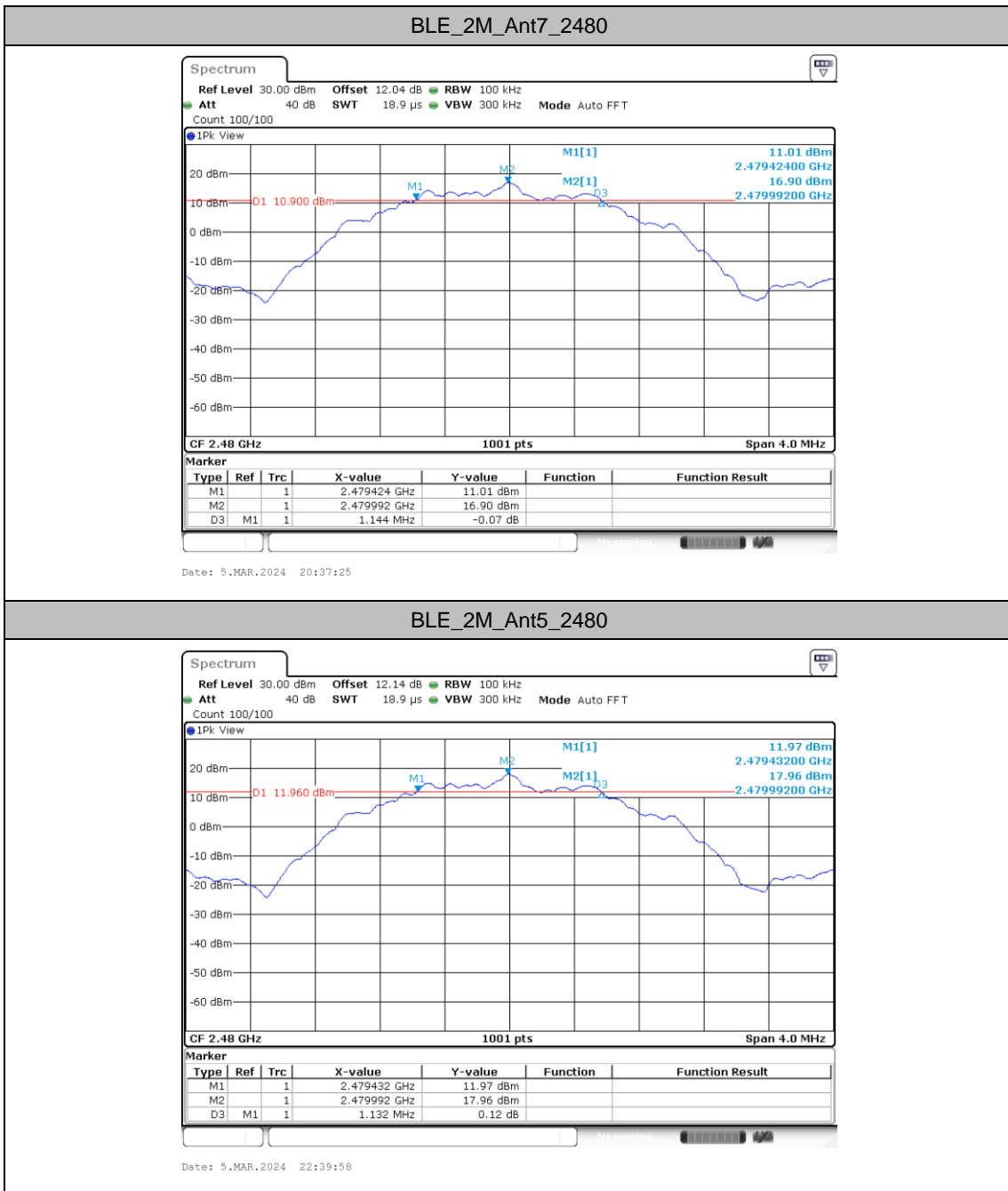














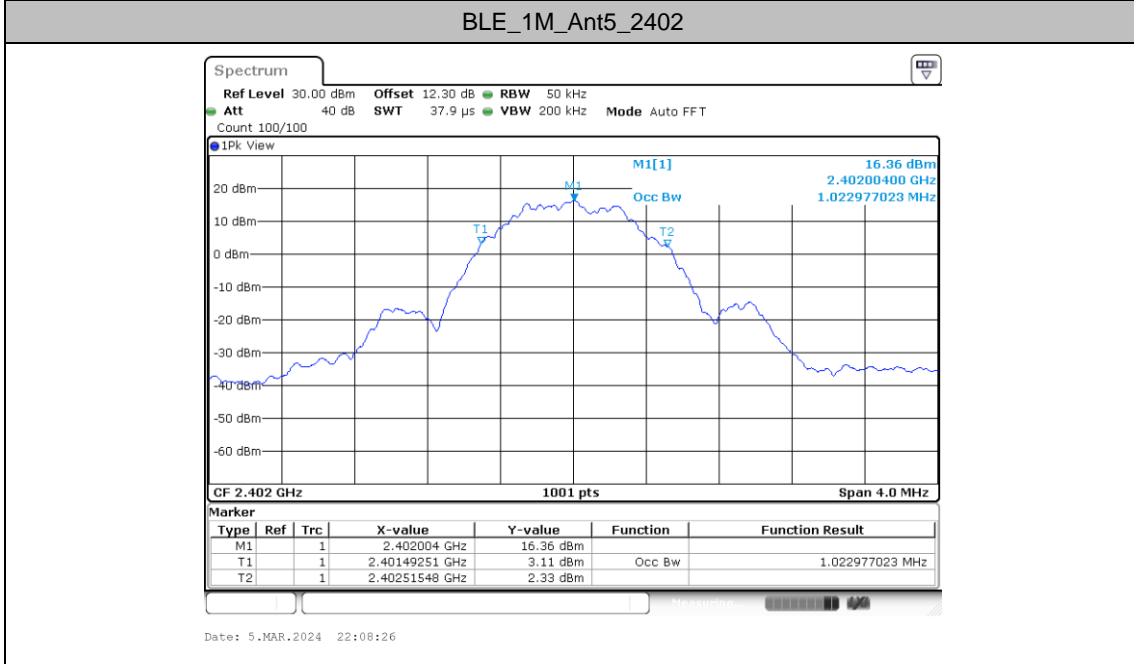
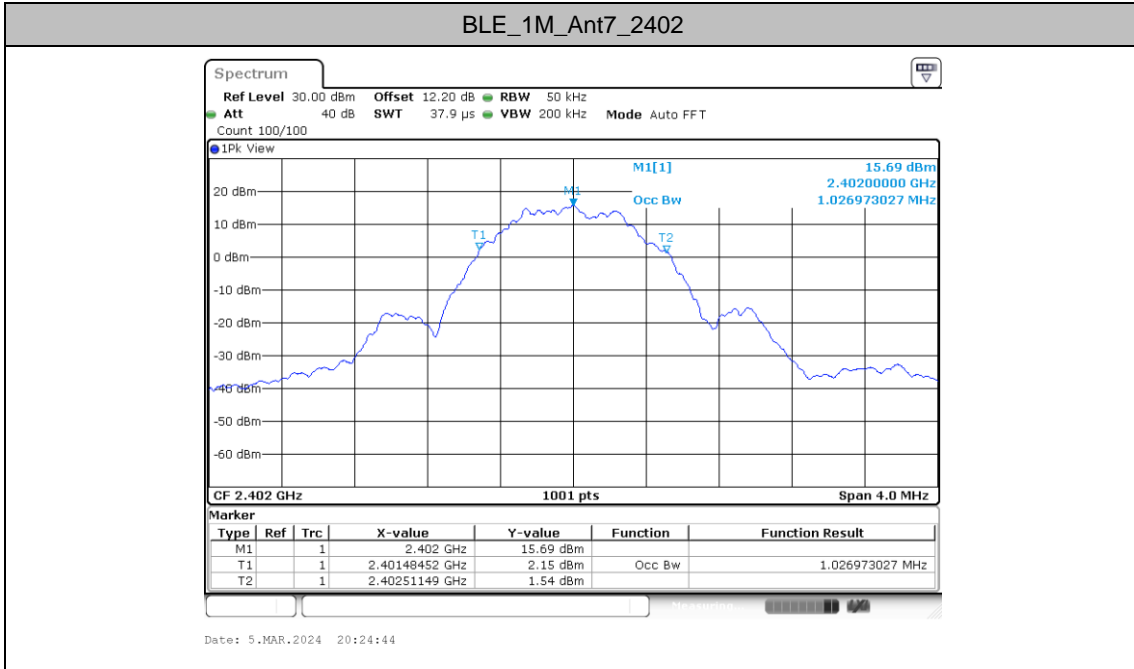
Occupied Channel Bandwidth

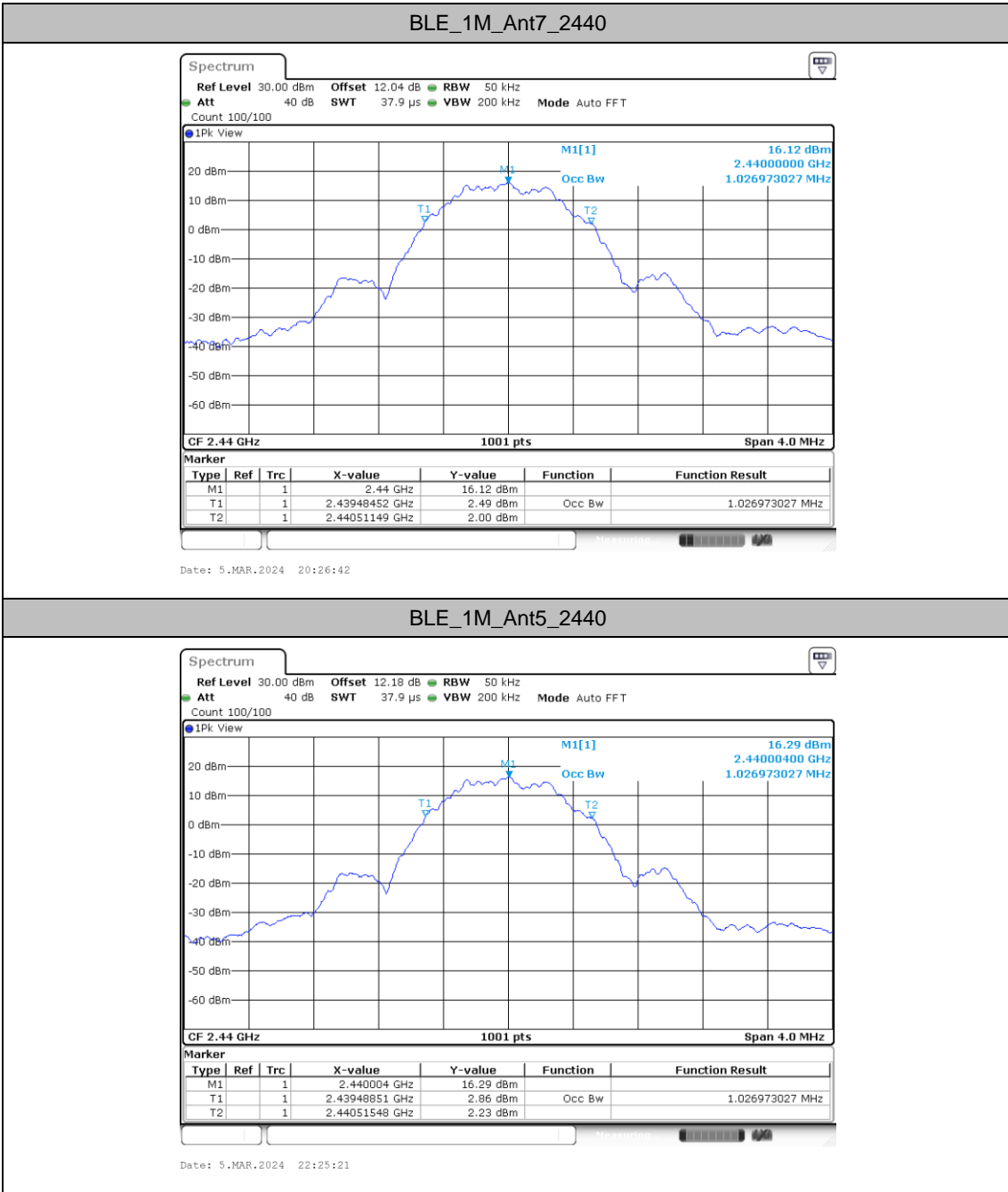
Test Result

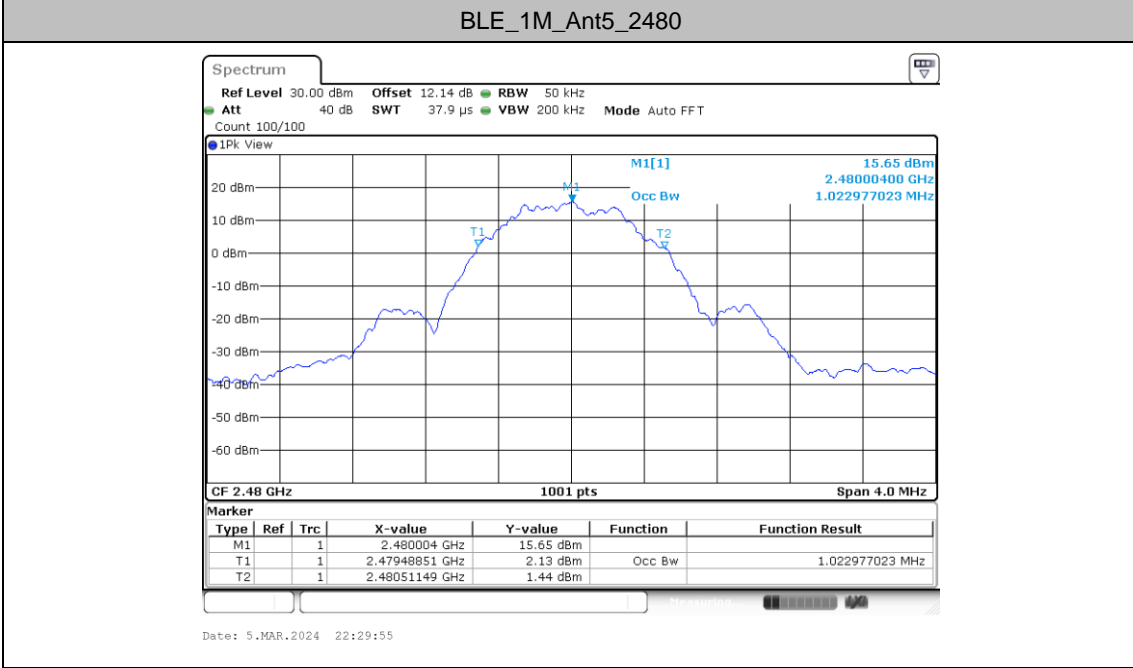
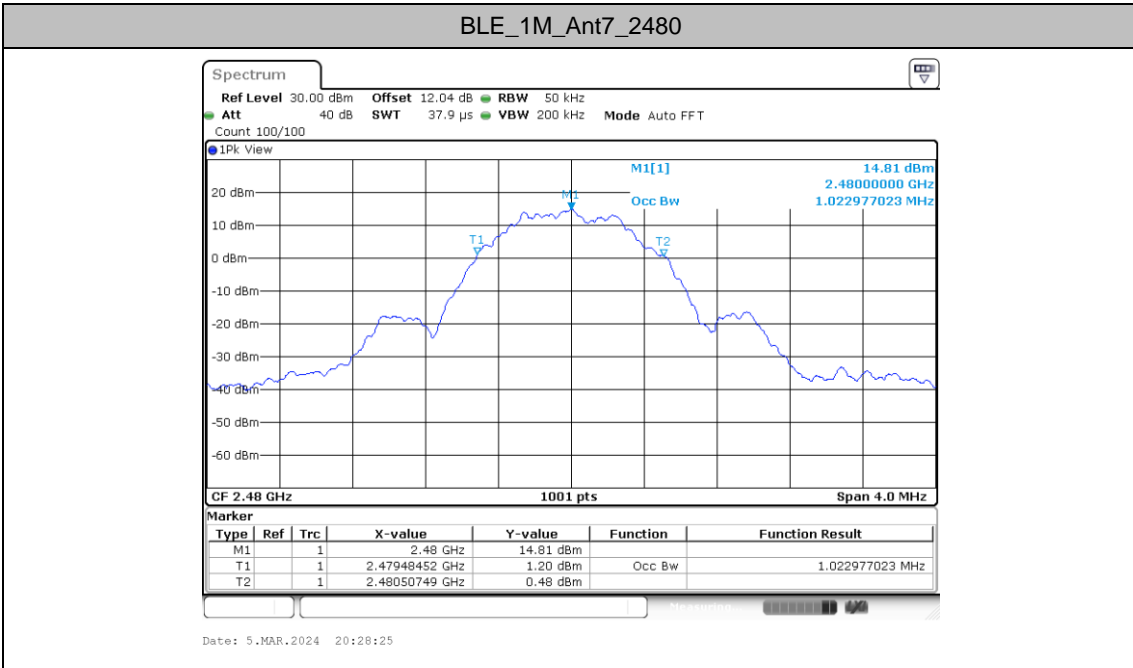
TestMode	Antenna	Freq(MHz)	OCB [MHz]	FL[MHz]	FH[MHz]
BLE_1M	Ant7	2402	1.027	2401.4845	2402.5115
	Ant5	2402	1.023	2401.4925	2402.5155
	Ant7	2440	1.027	2439.4845	2440.5115
	Ant5	2440	1.027	2439.4885	2440.5155
	Ant7	2480	1.023	2479.4845	2480.5075
	Ant5	2480	1.023	2479.4885	2480.5115
BLE_2M	Ant7	2402	2.038	2400.9890	2403.0270
	Ant5	2402	2.038	2400.9970	2403.0350
	Ant7	2440	2.042	2438.9890	2441.0310
	Ant5	2440	2.042	2438.9930	2441.0350
	Ant7	2480	2.034	2478.9890	2481.0230
	Ant5	2480	2.034	2478.9930	2481.0270

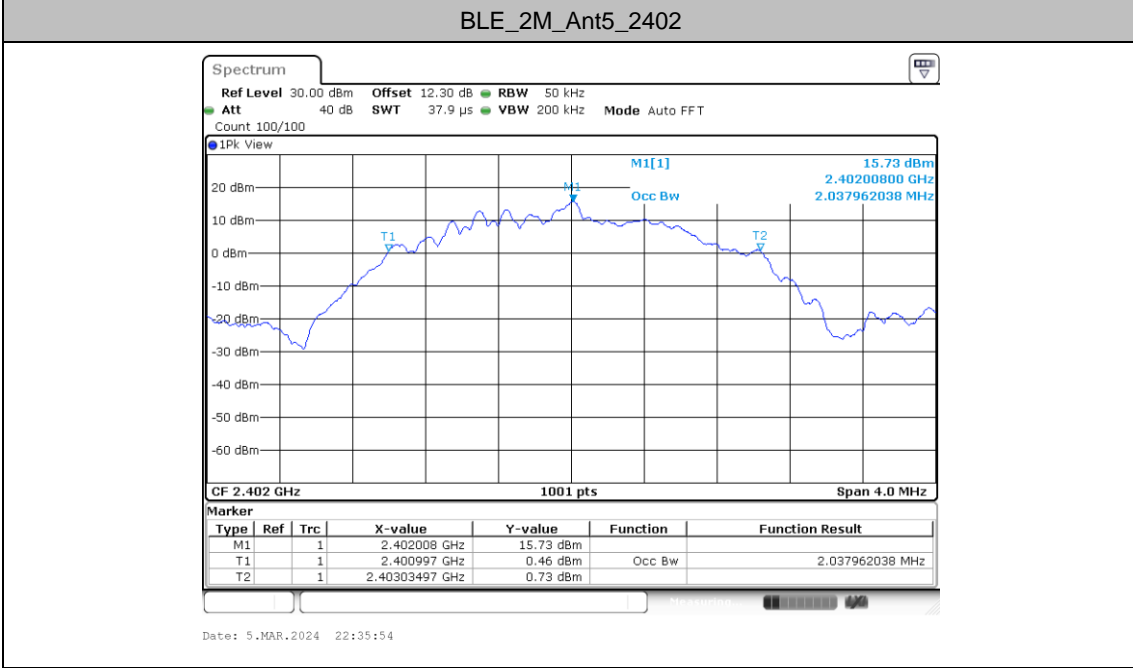
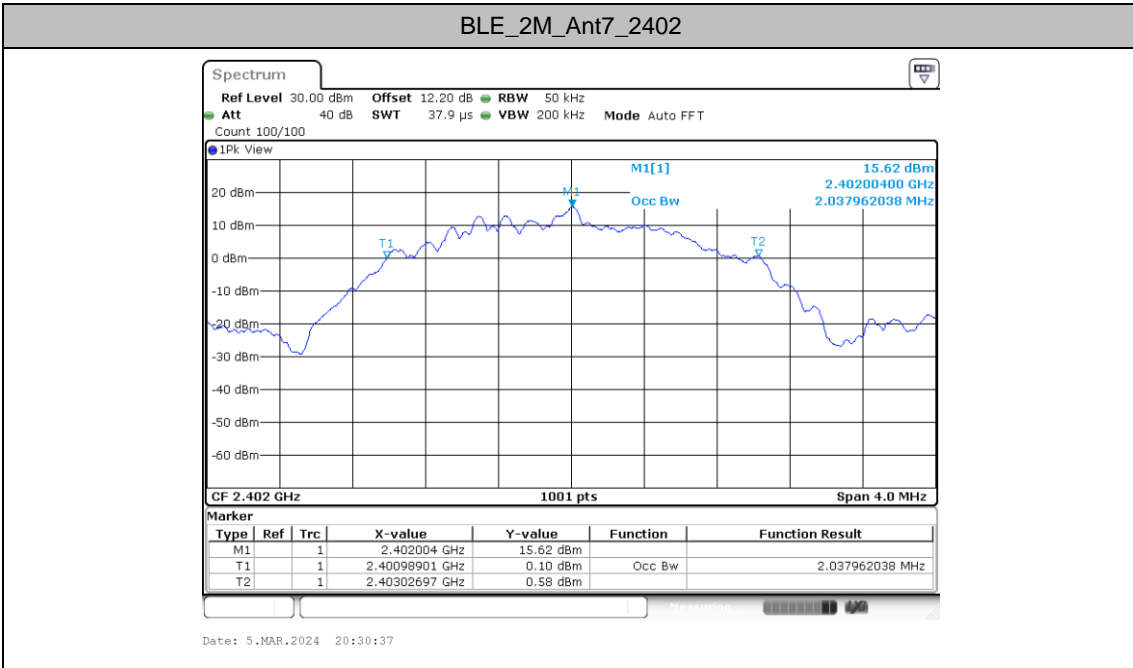


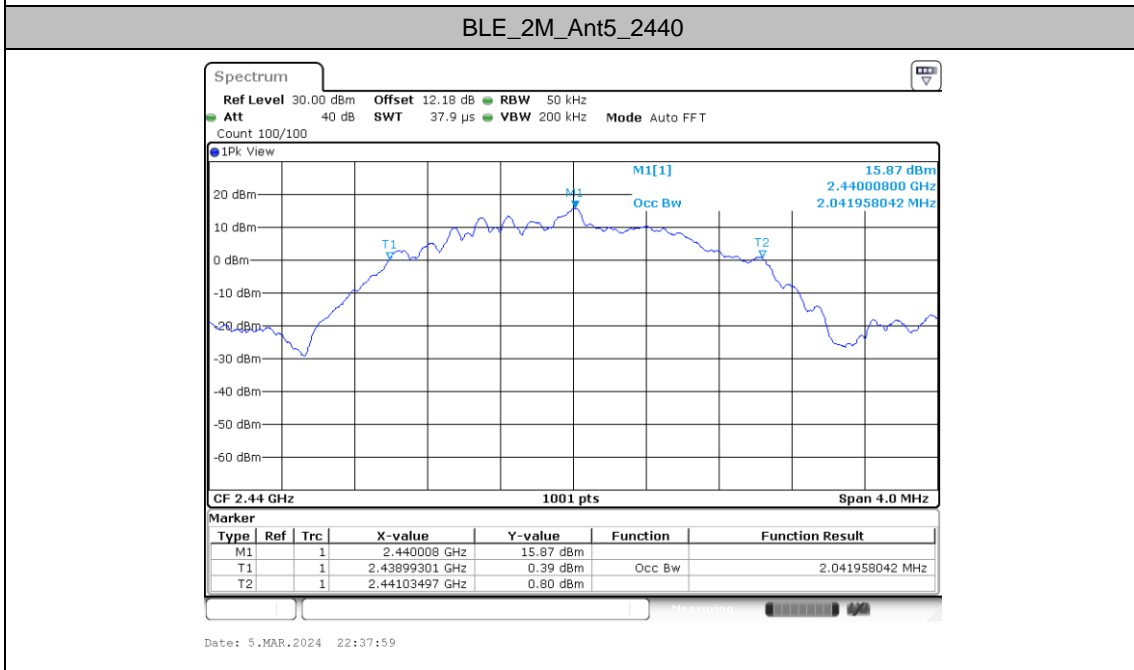
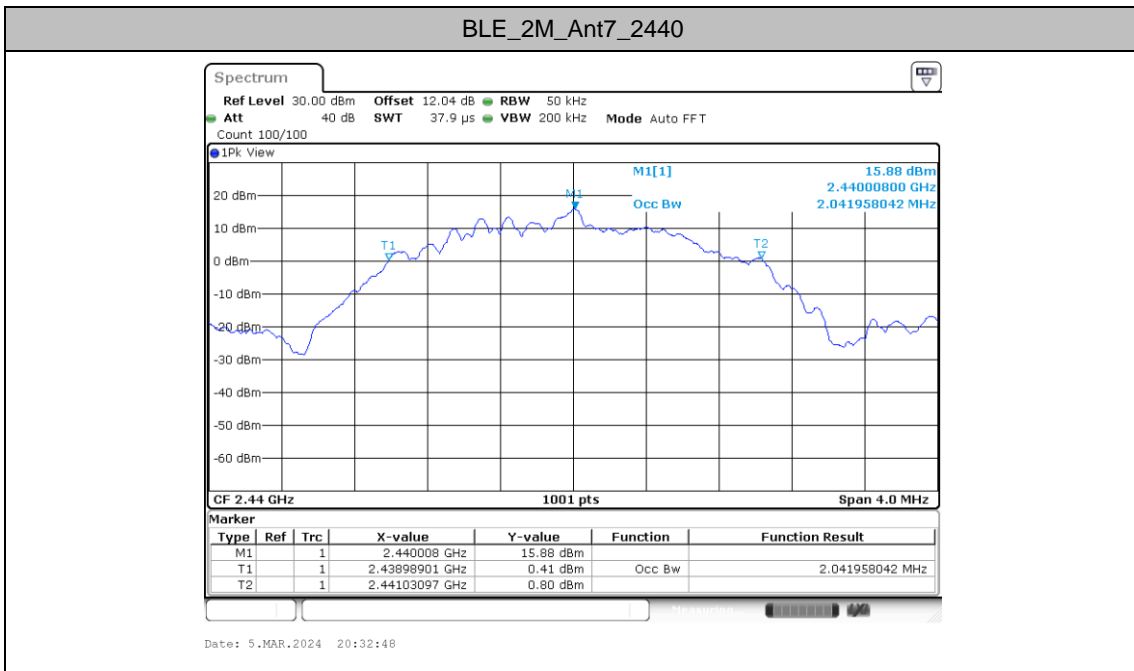
Test Graphs

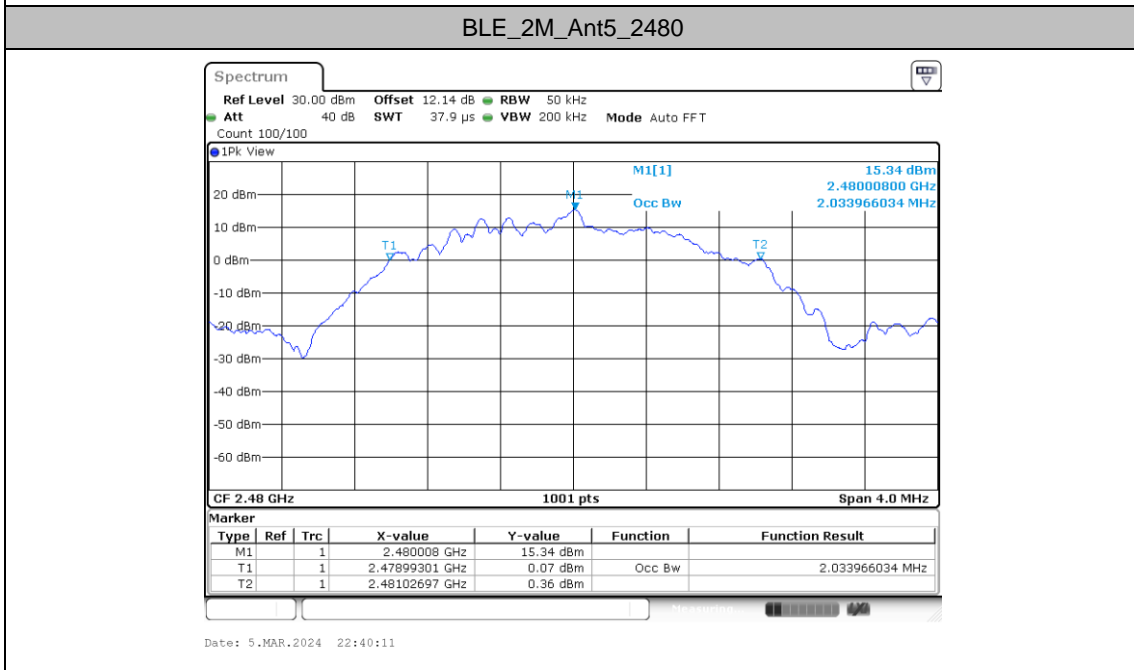
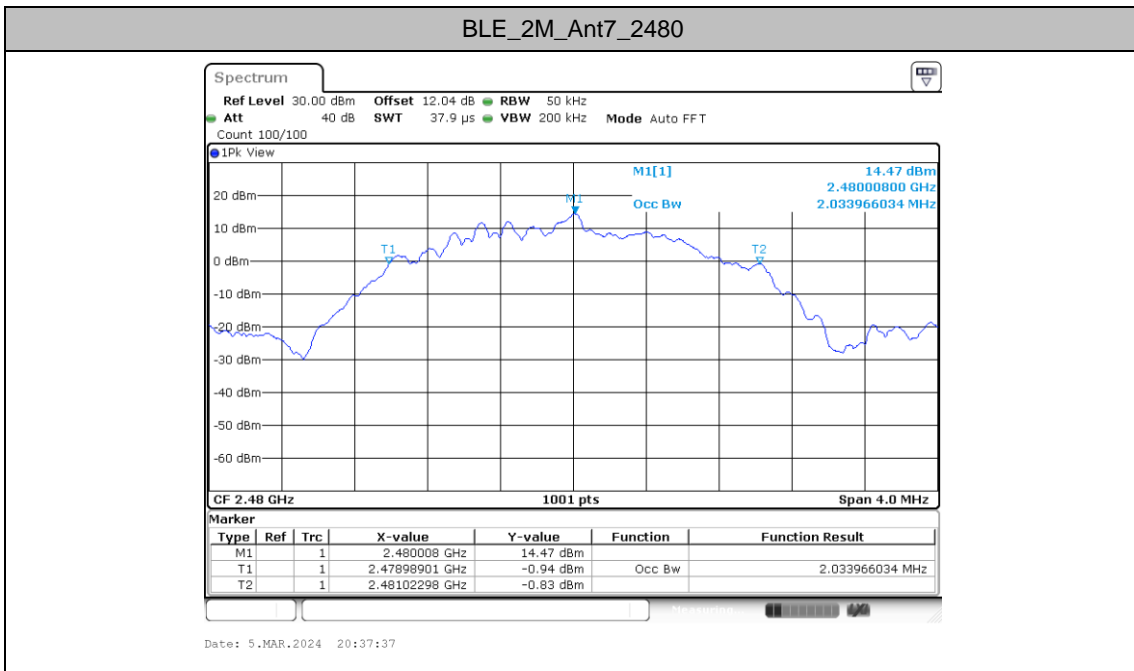














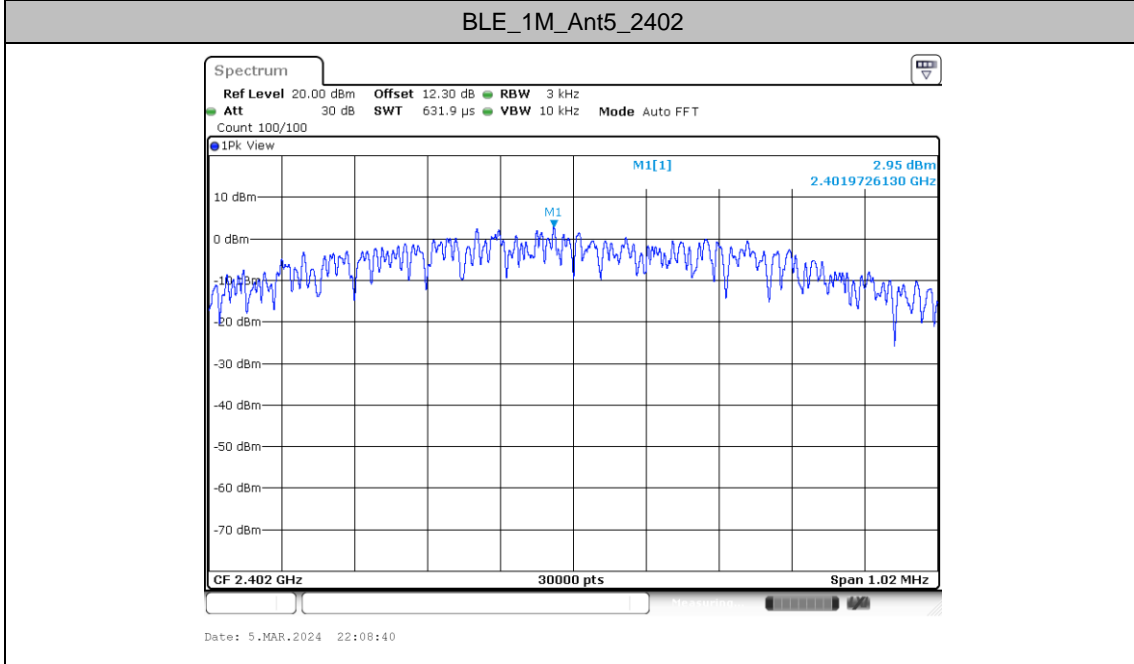
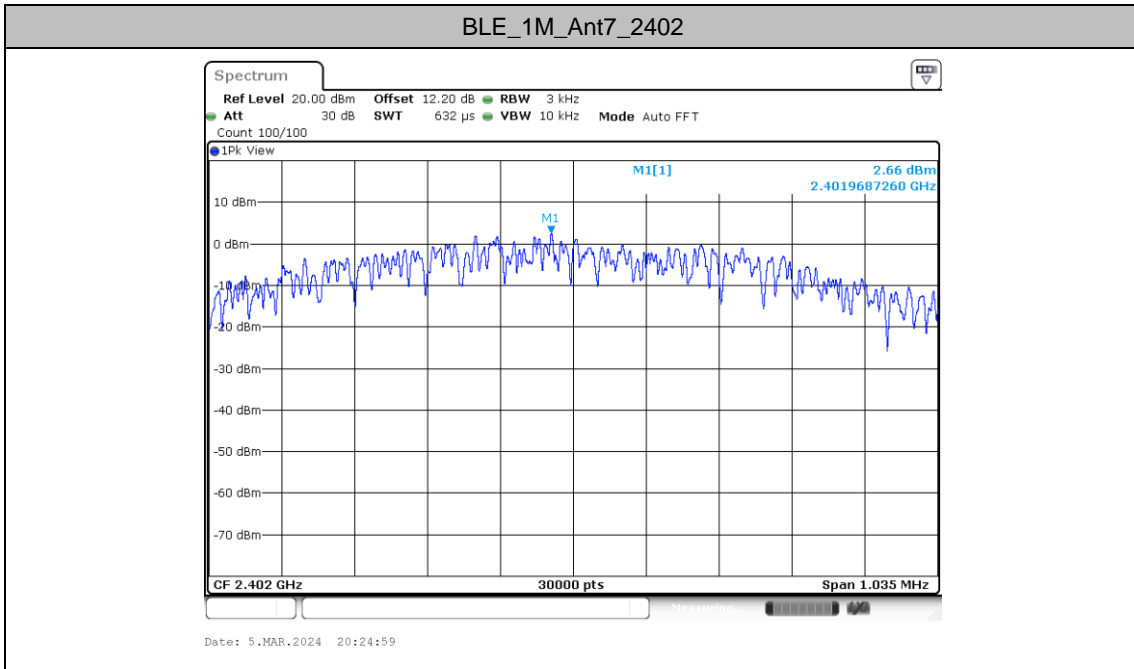
Maximum power spectral density

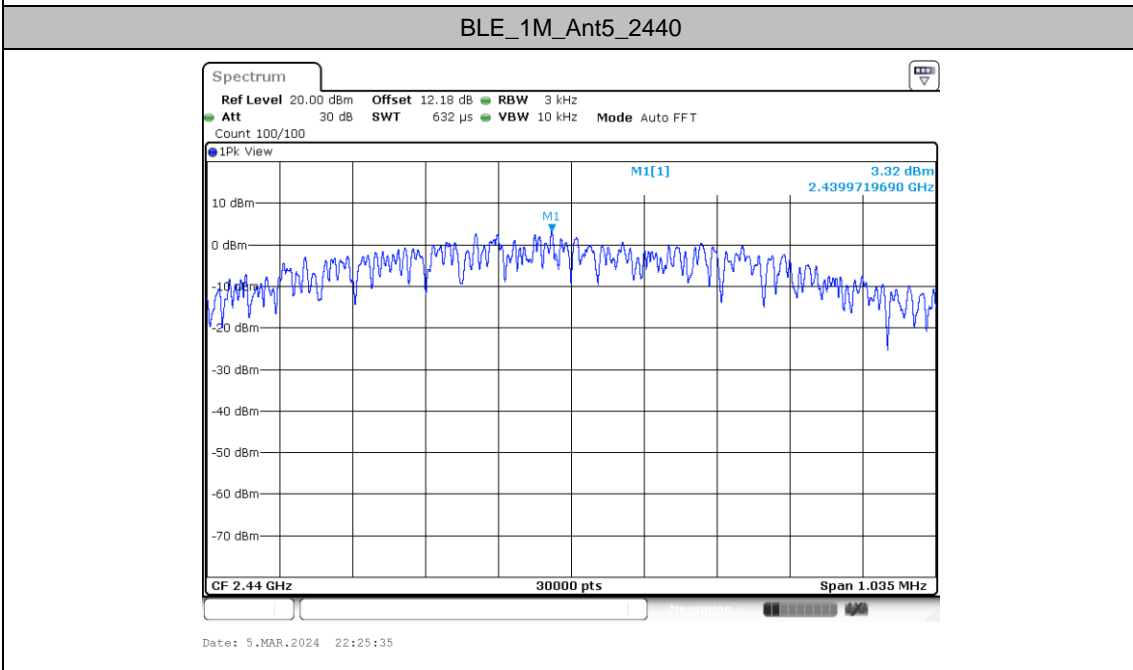
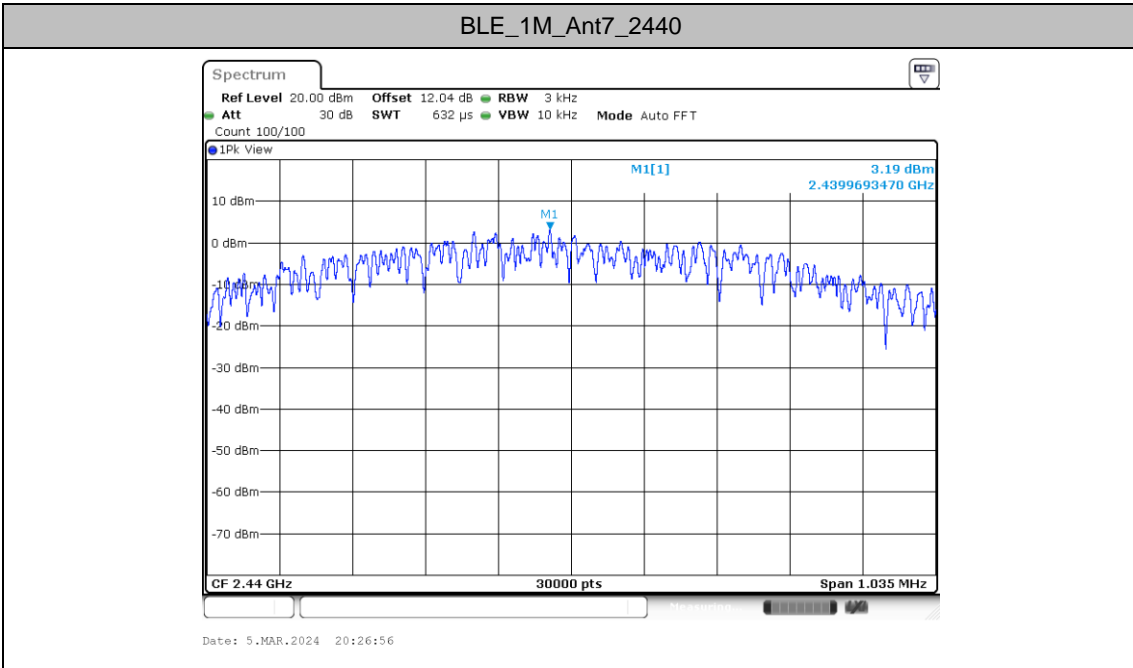
Test Result

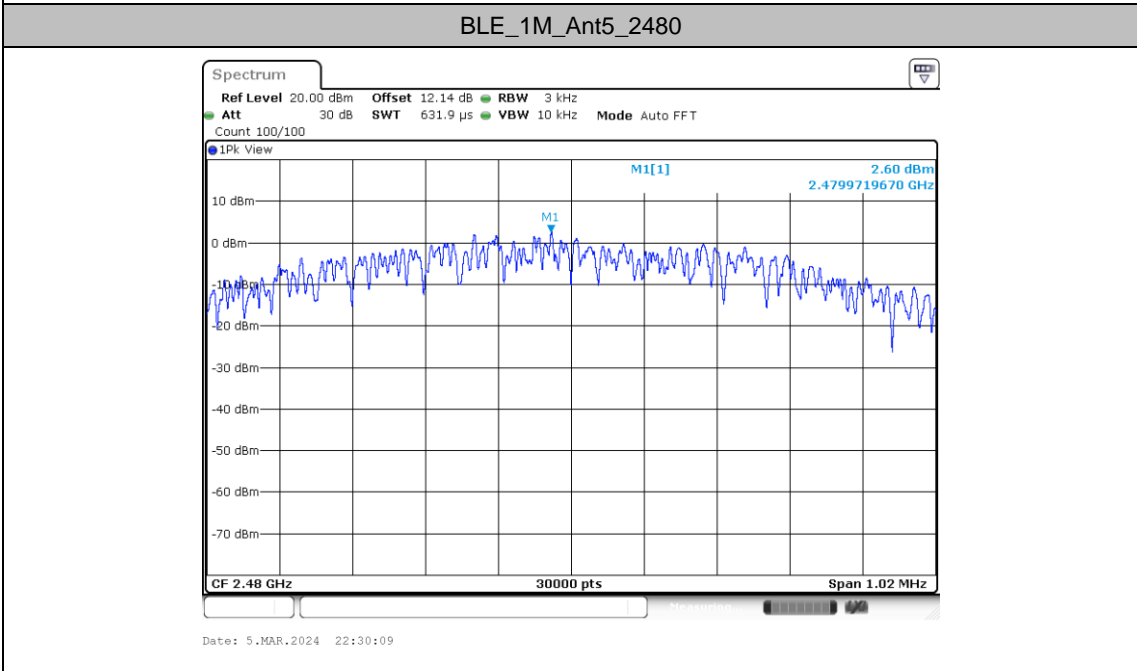
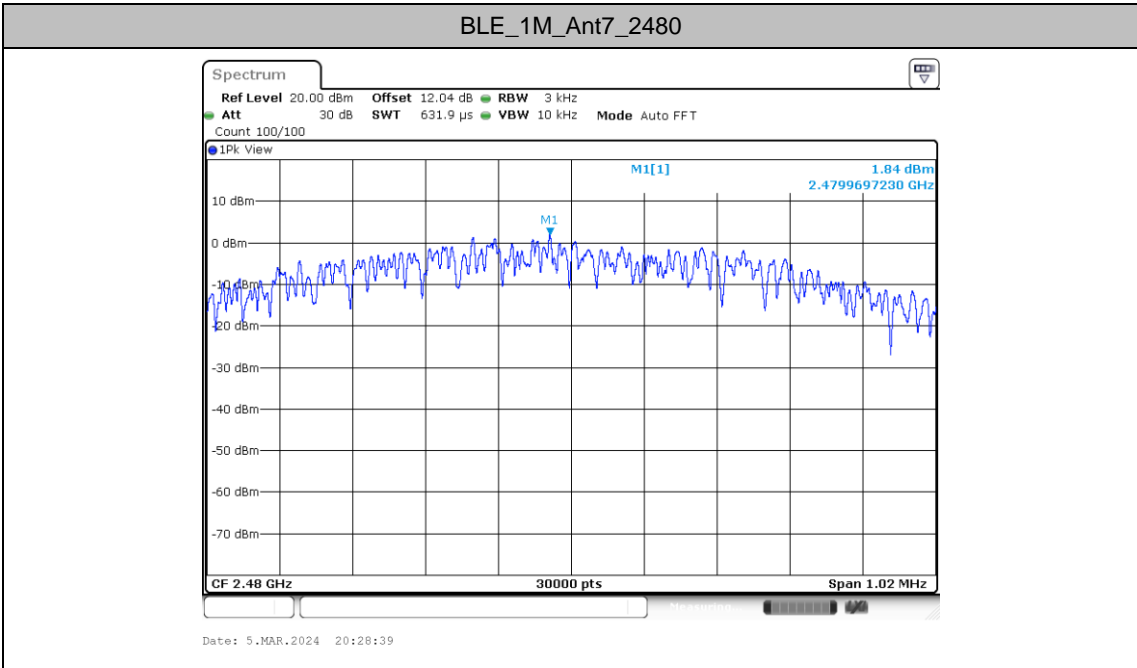
TestMode	Antenna	Freq(MHz)	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant7	2402	2.66	≤8.00	PASS
	Ant5	2402	2.95	≤8.00	PASS
	Ant7	2440	3.19	≤8.00	PASS
	Ant5	2440	3.32	≤8.00	PASS
	Ant7	2480	1.84	≤8.00	PASS
	Ant5	2480	2.60	≤8.00	PASS
BLE_2M	Ant7	2402	0.64	≤8.00	PASS
	Ant5	2402	1.12	≤8.00	PASS
	Ant7	2440	1.37	≤8.00	PASS
	Ant5	2440	1.33	≤8.00	PASS
	Ant7	2480	-0.08	≤8.00	PASS
	Ant5	2480	0.89	≤8.00	PASS

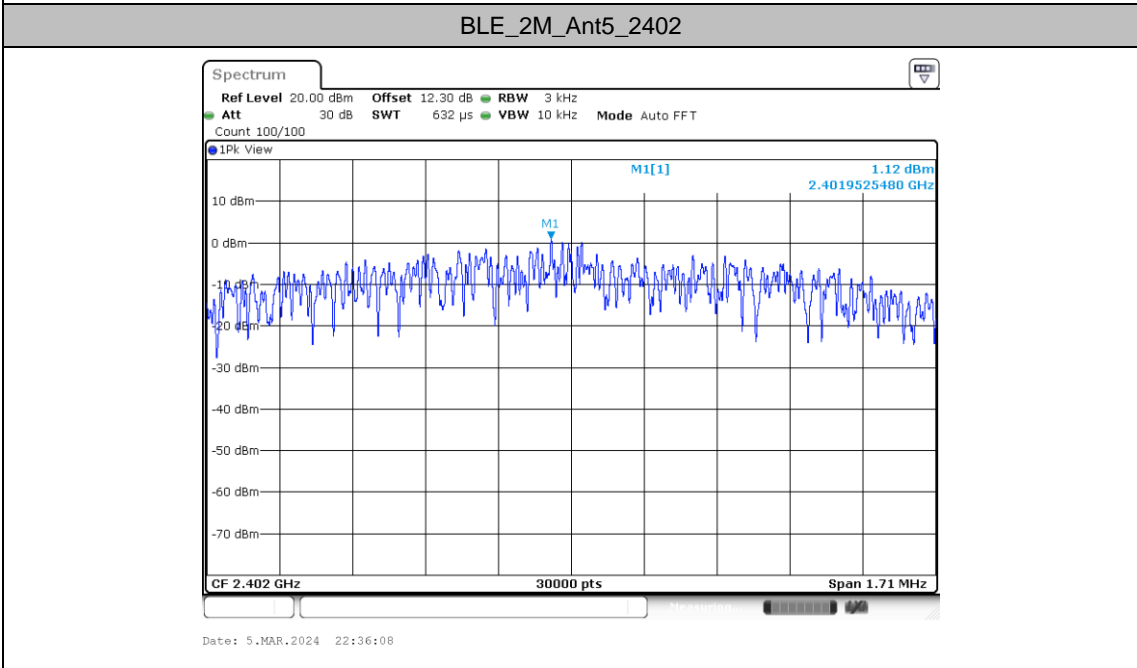
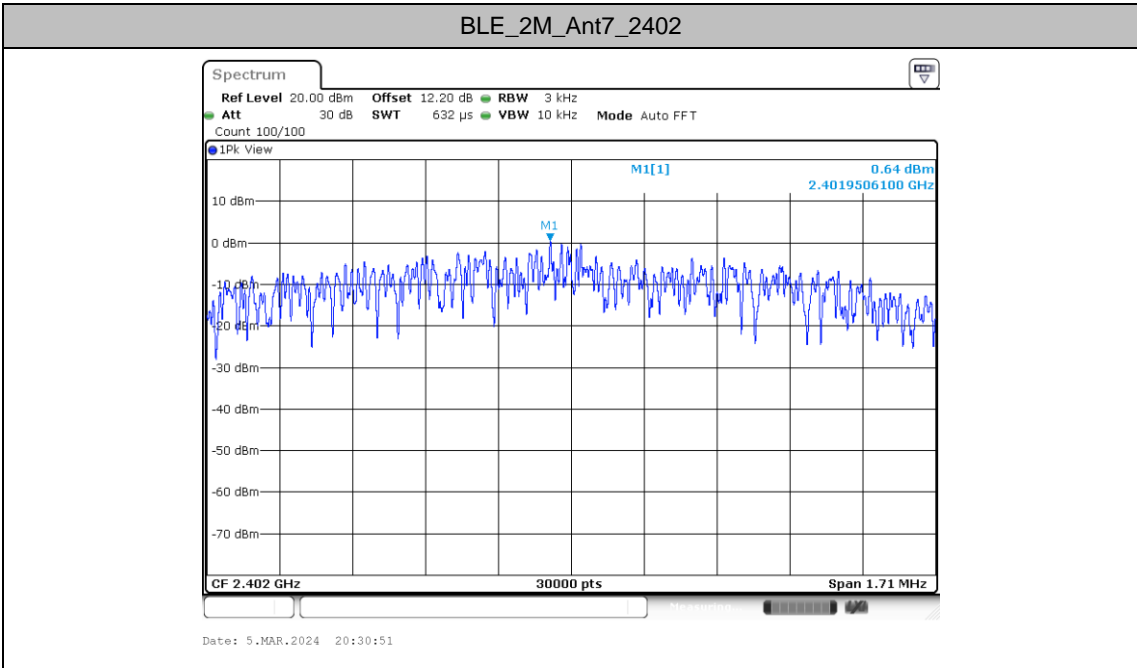


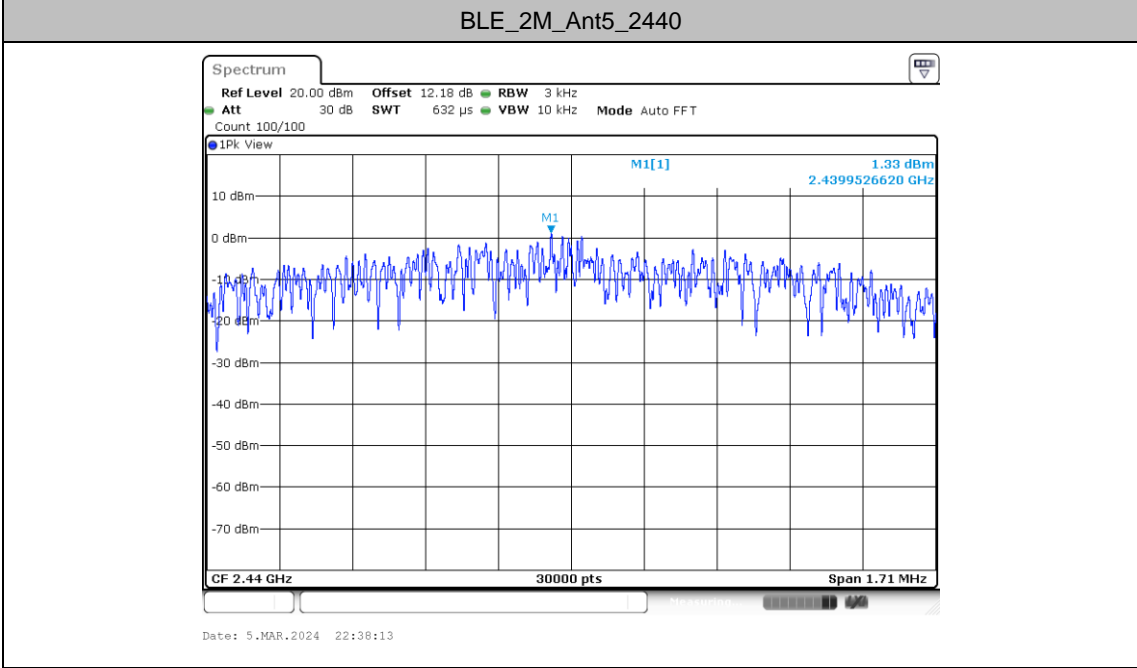
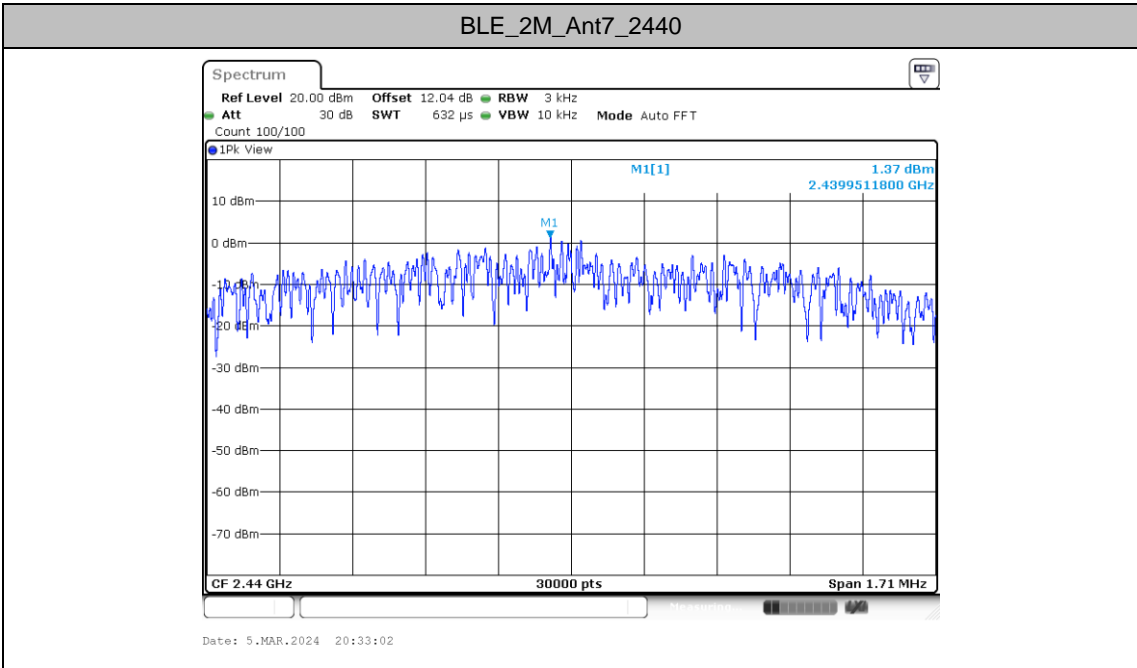
Test Graphs

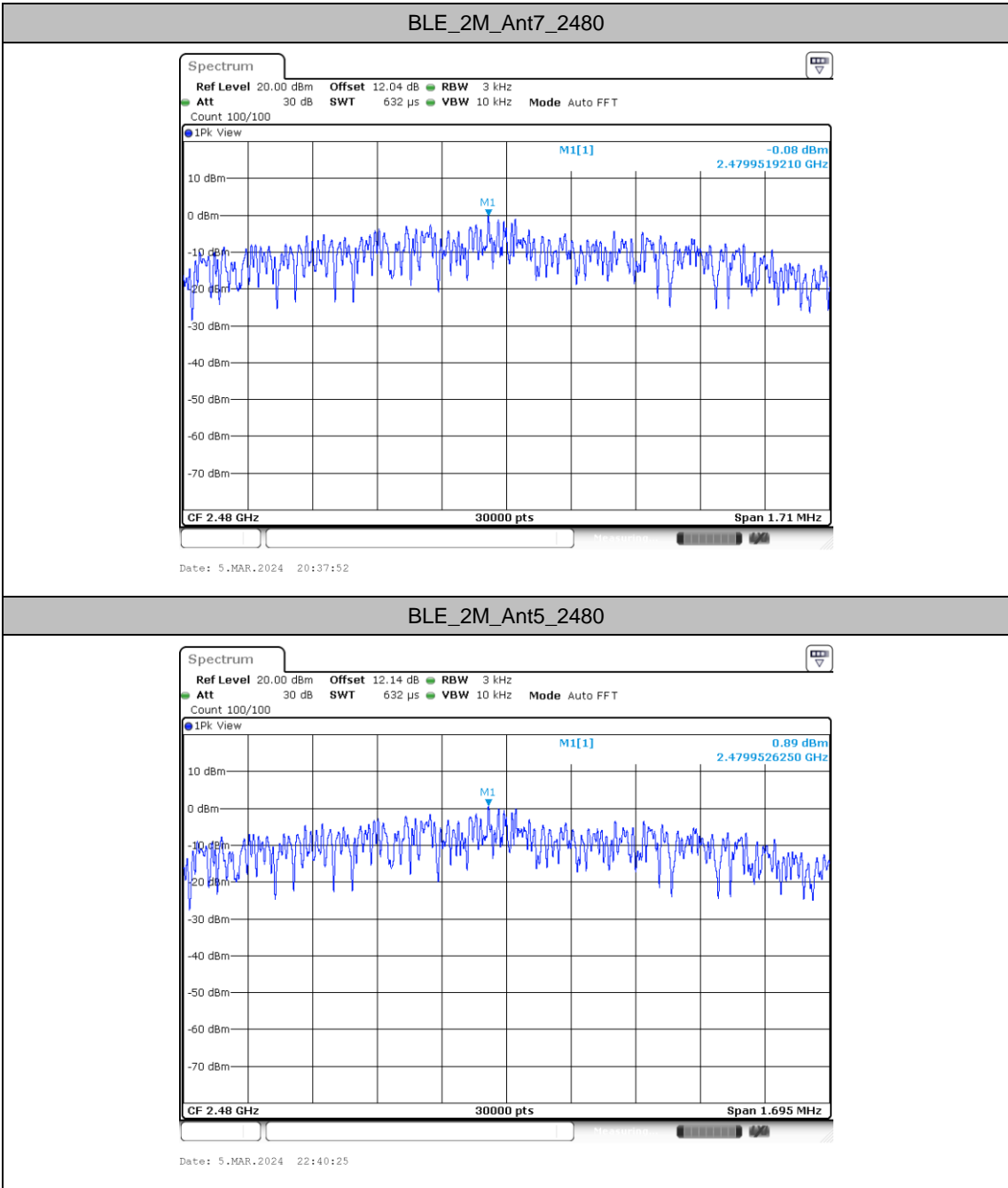














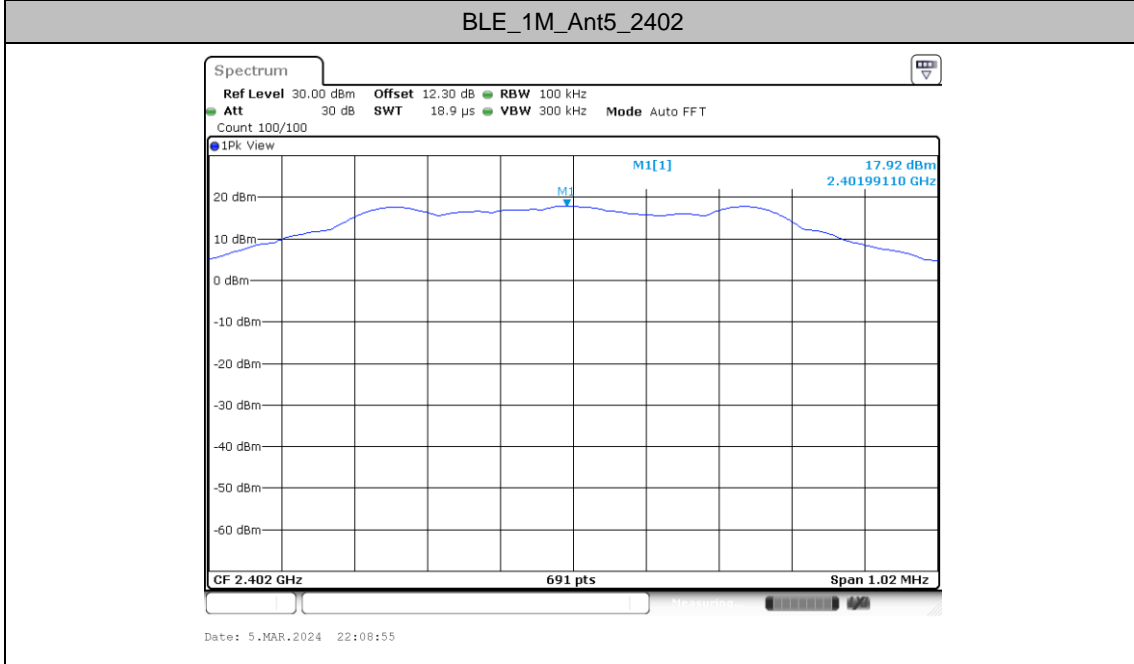
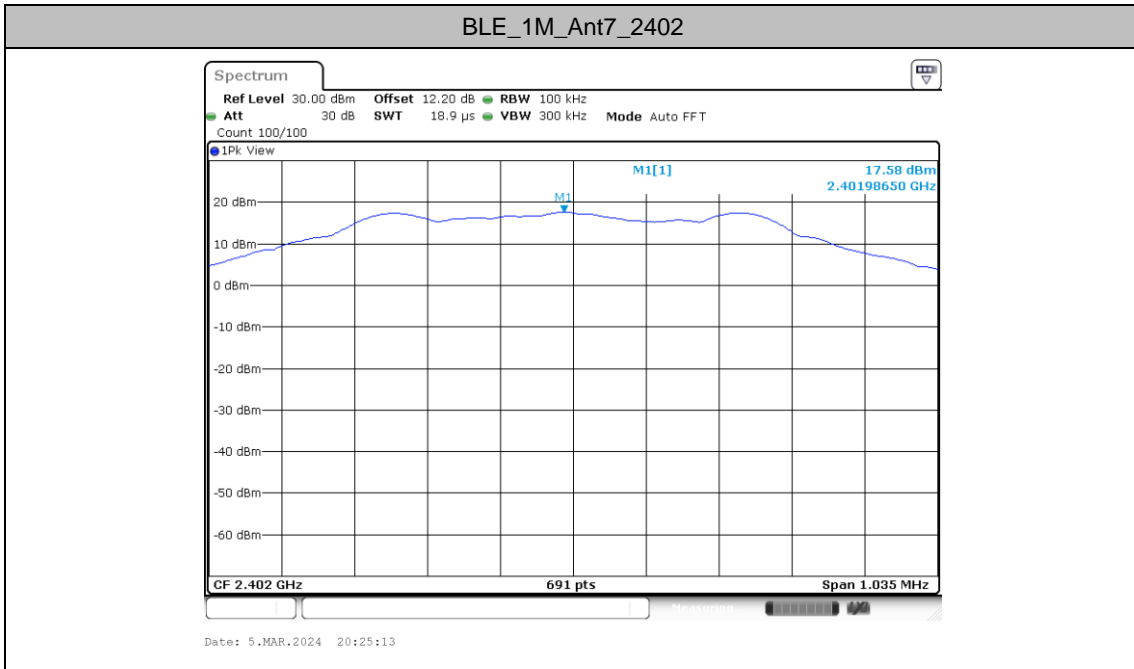
Reference level measurement

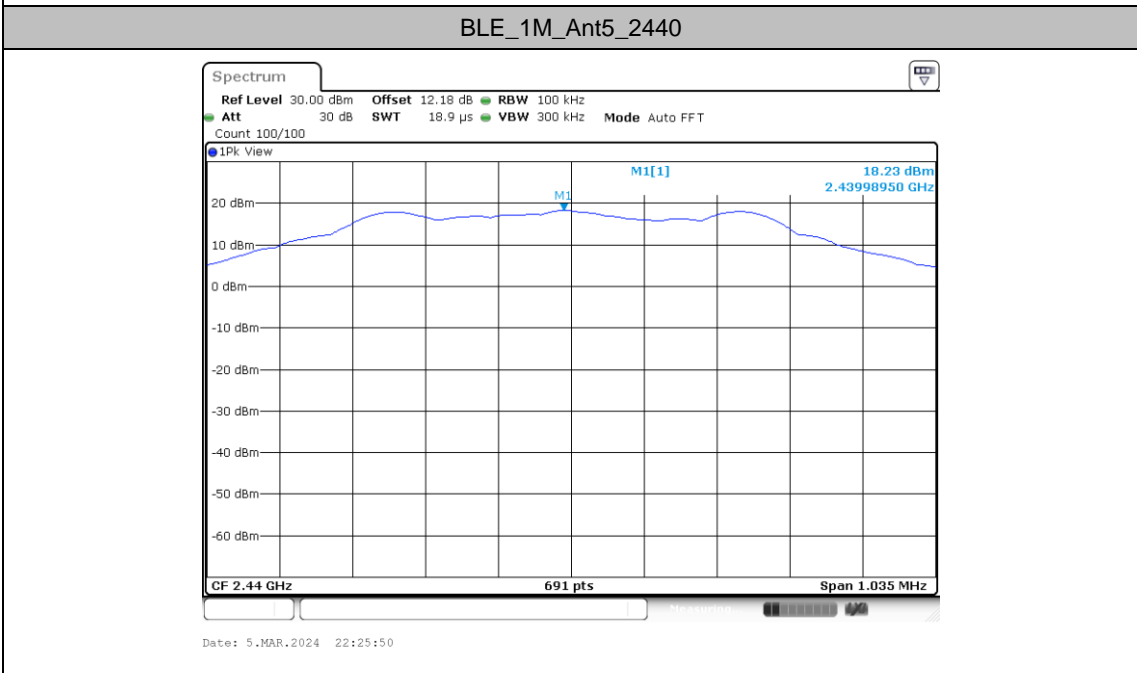
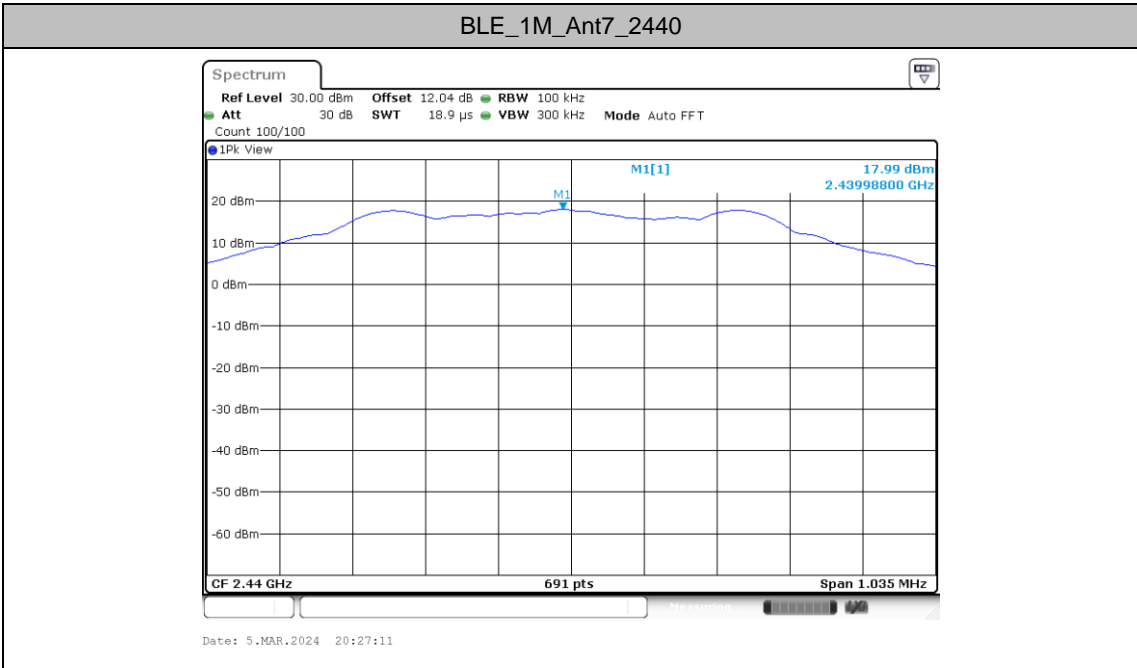
Test Result

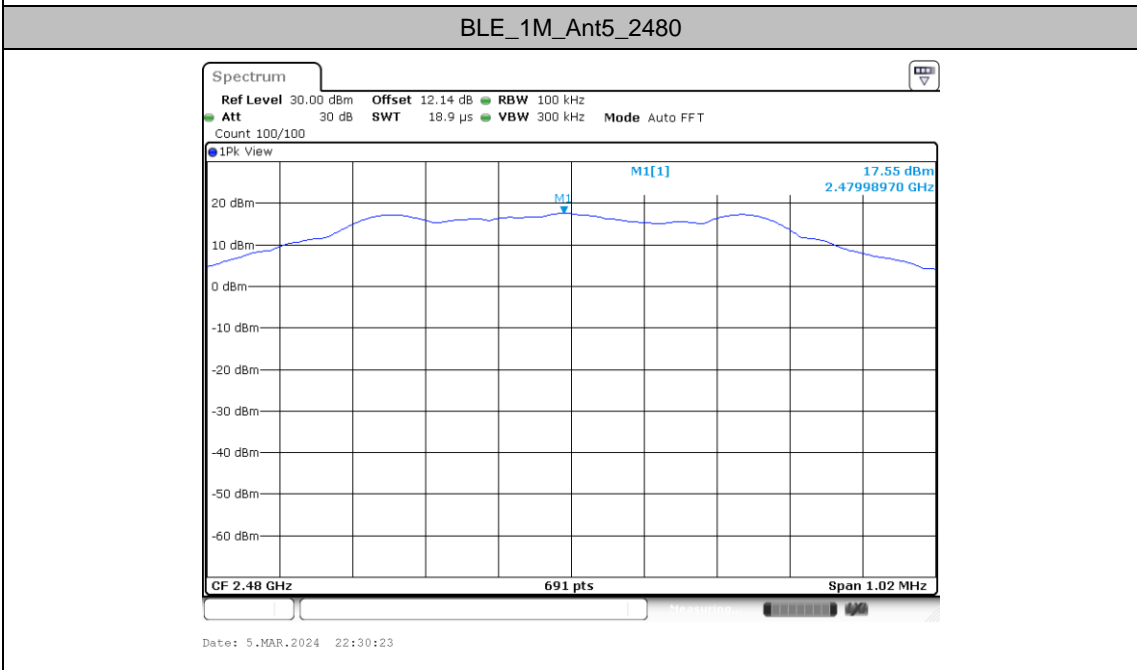
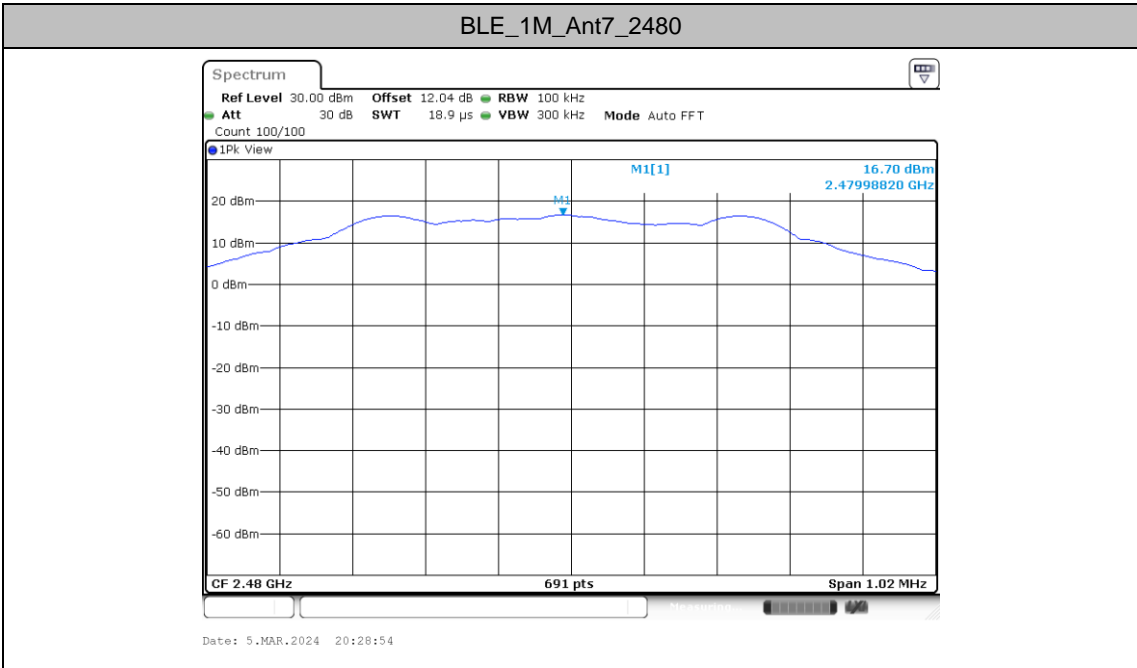
TestMode	Antenna	Freq(MHz)	Max.Point[MHz]	Result[dBm/100KHz]
BLE_1M	Ant7	2402	2401.99	17.58
	Ant5	2402	2401.99	17.92
	Ant7	2440	2439.99	17.99
	Ant5	2440	2439.99	18.23
	Ant7	2480	2479.99	16.70
	Ant5	2480	2479.99	17.55
BLE_2M	Ant7	2402	2401.99	17.71
	Ant5	2402	2401.99	18.20
	Ant7	2440	2439.99	18.31
	Ant5	2440	2439.99	18.36
	Ant7	2480	2479.99	16.91
	Ant5	2480	2479.99	17.96

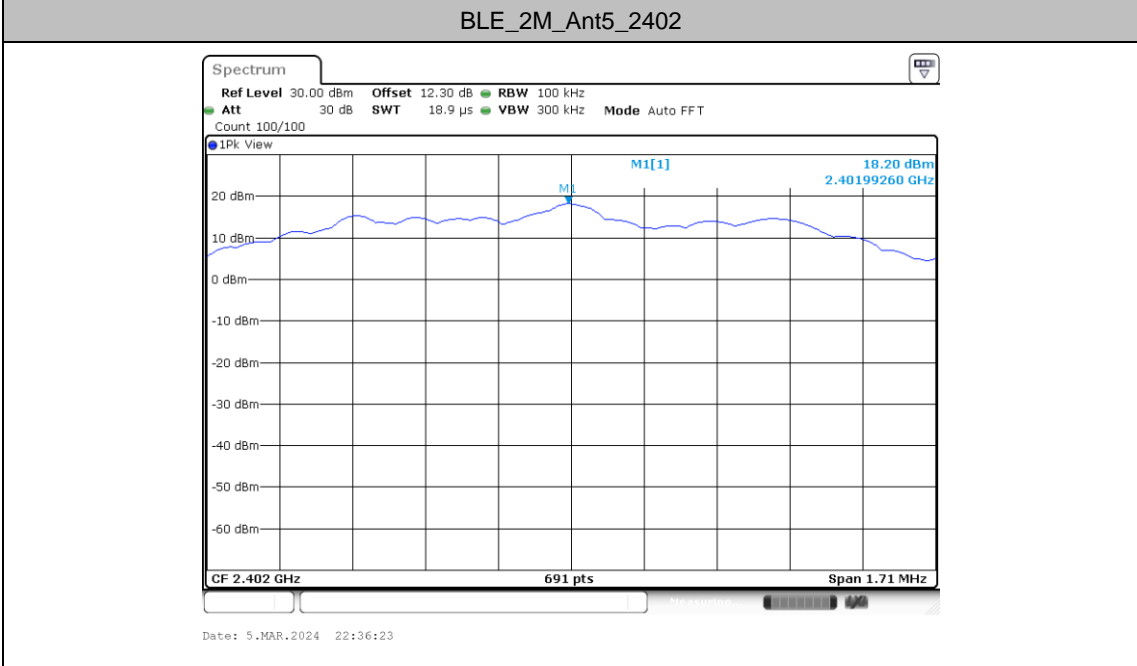
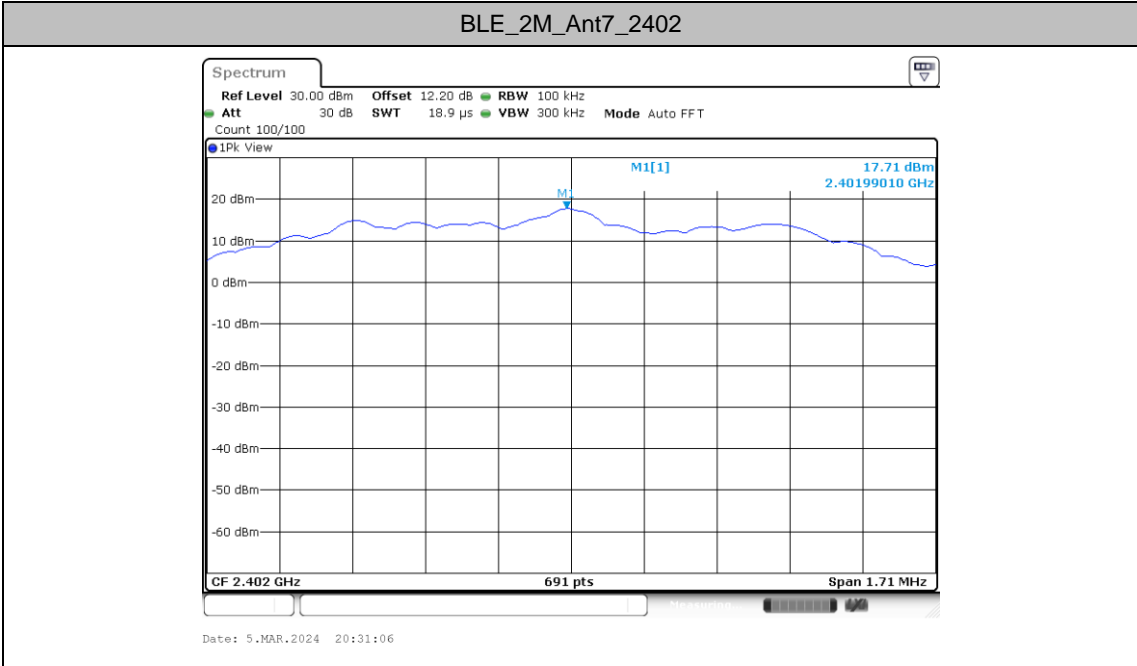


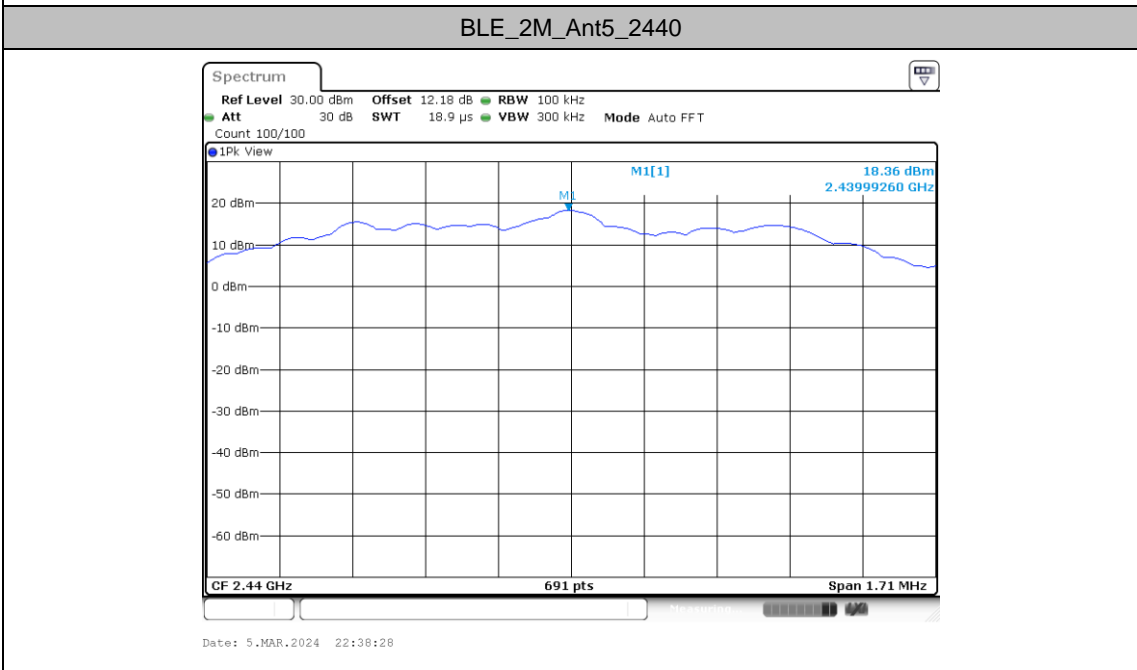
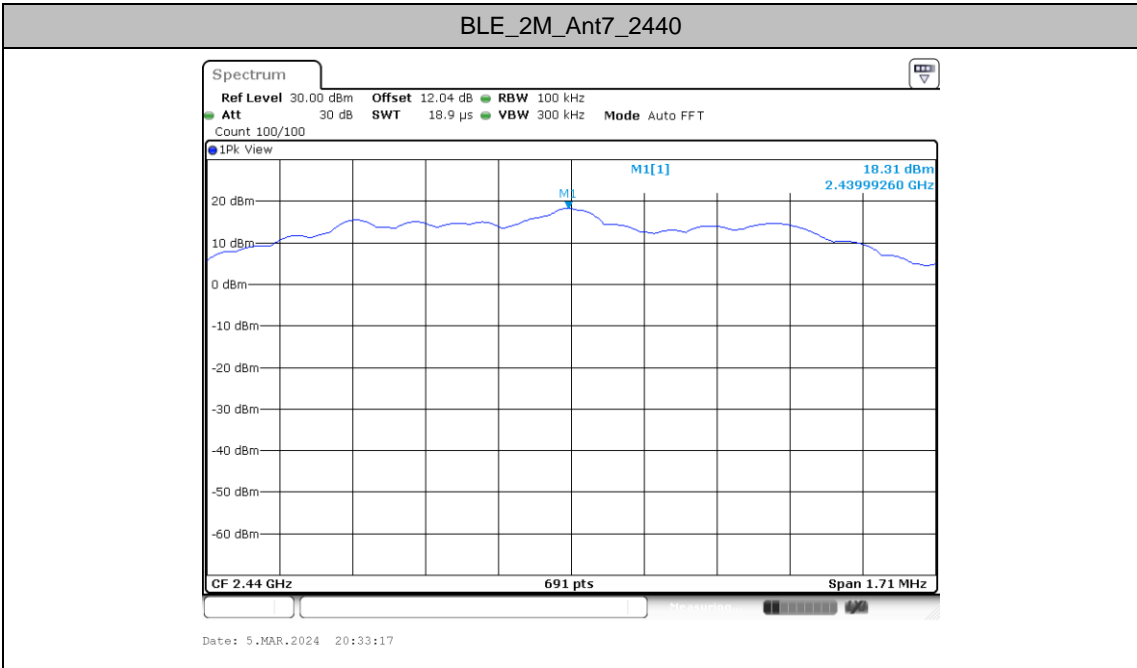
Test Graphs

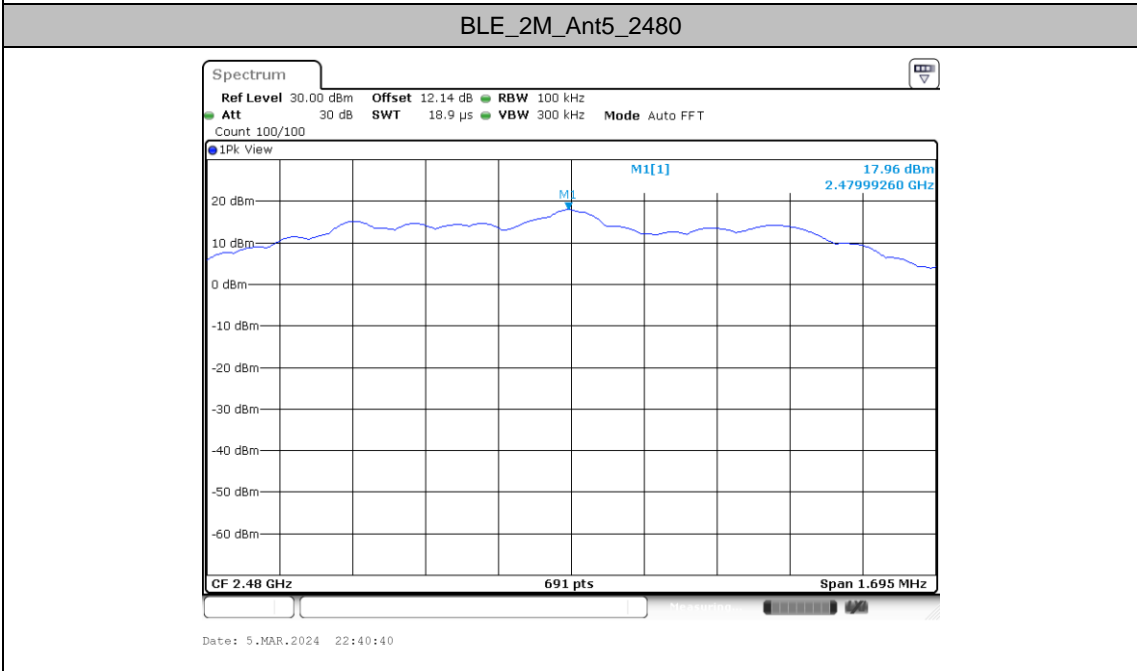
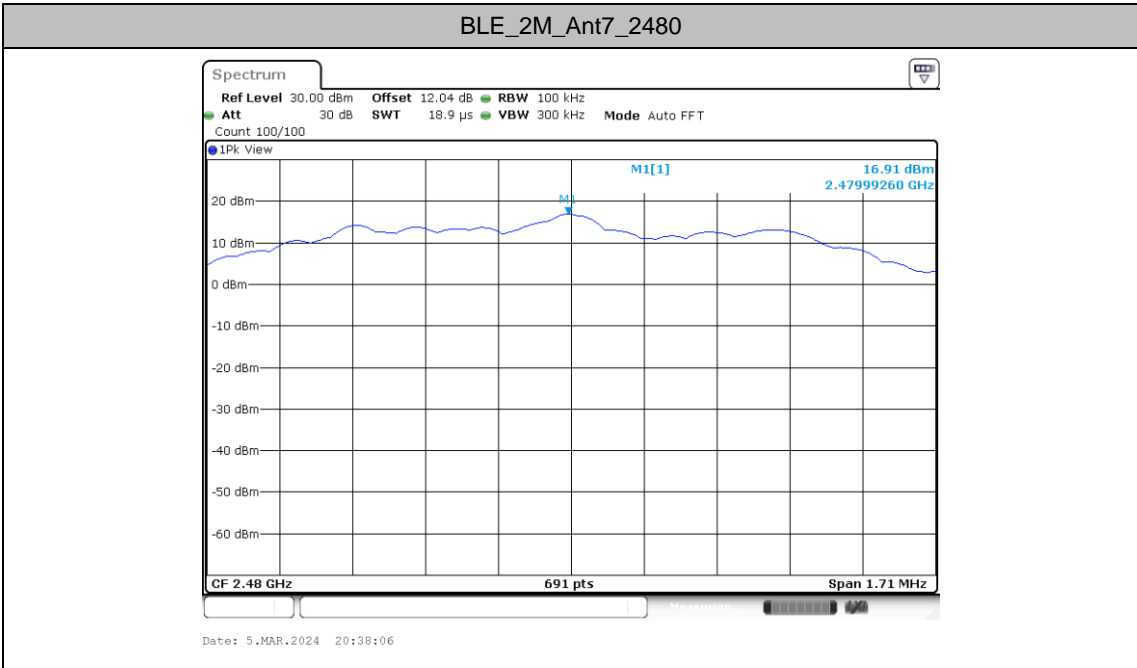














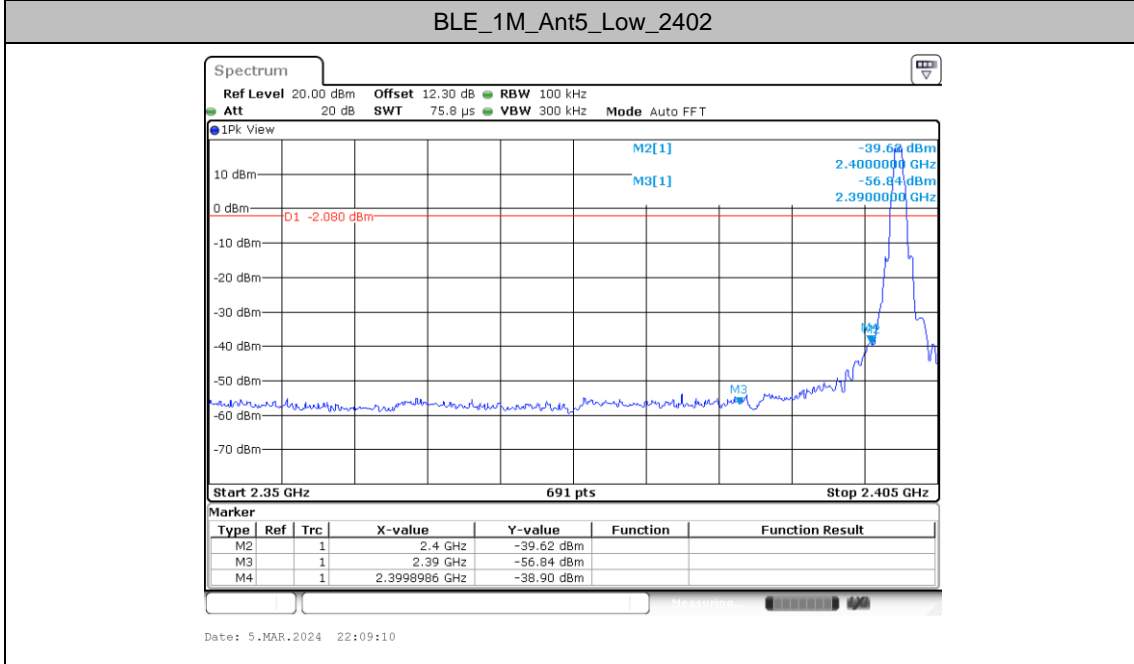
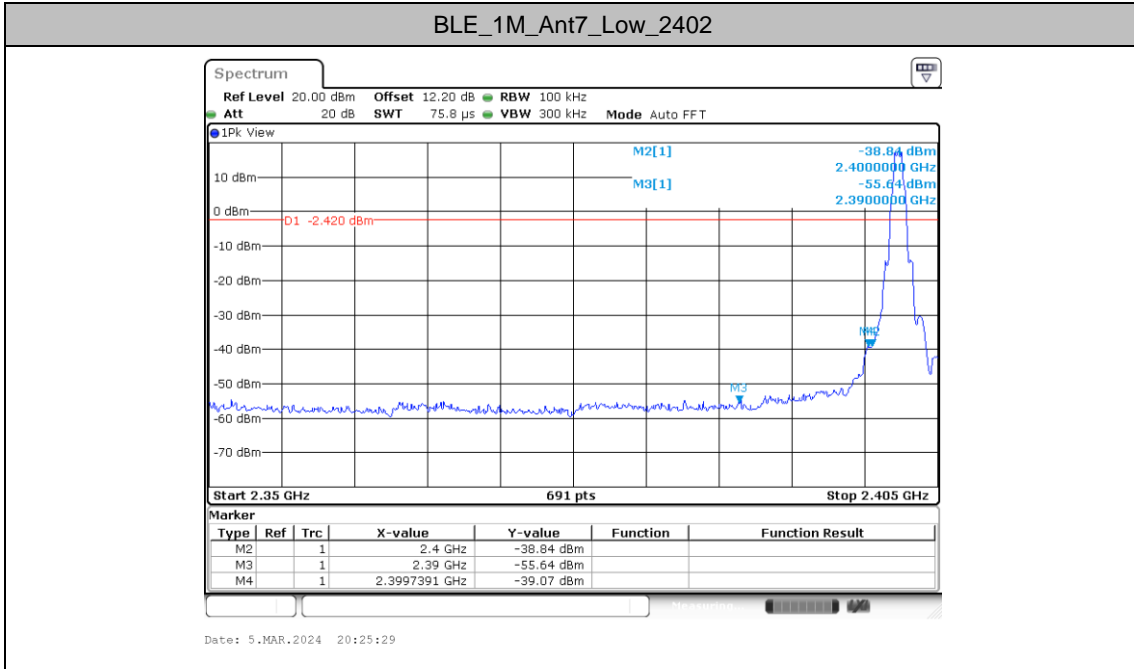
Band edge measurements

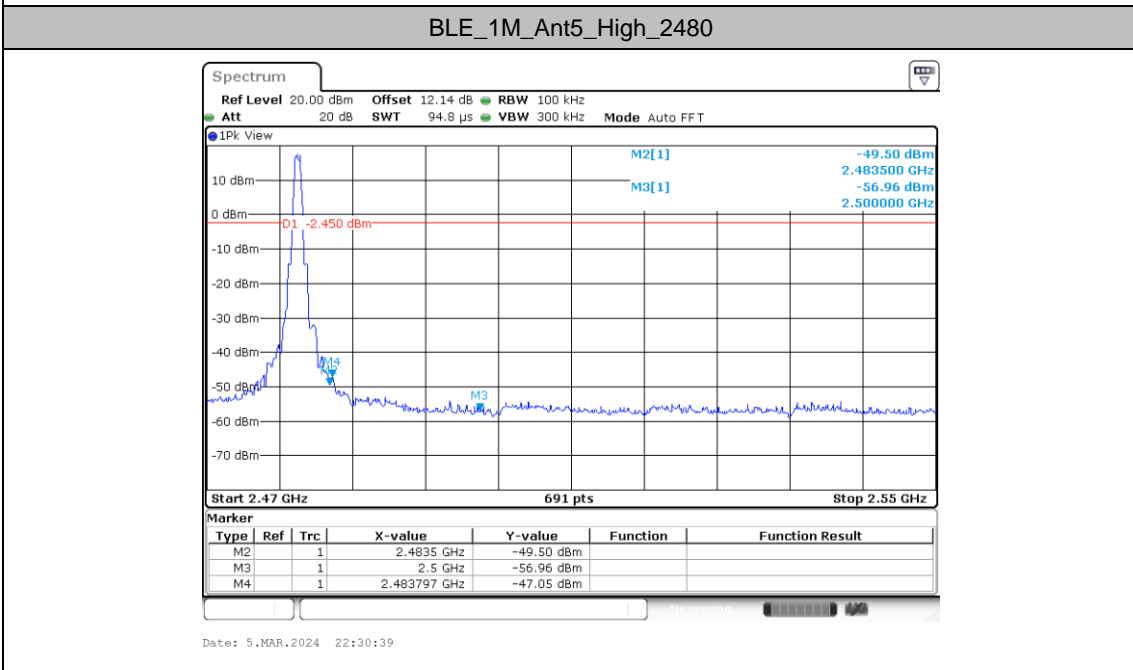
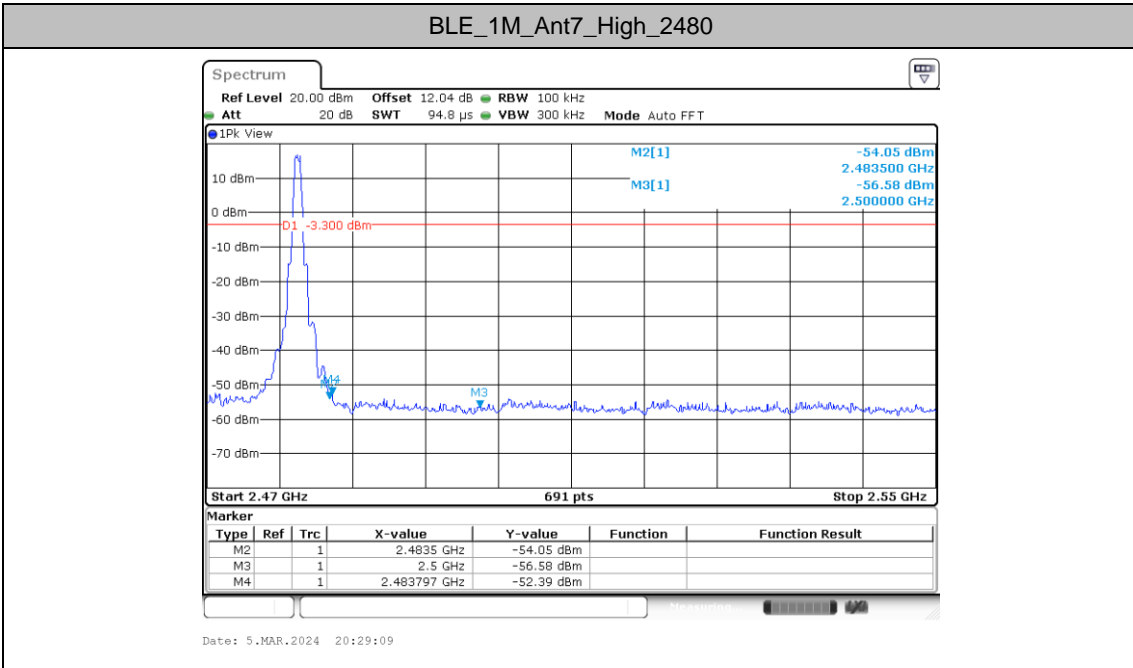
Test Result

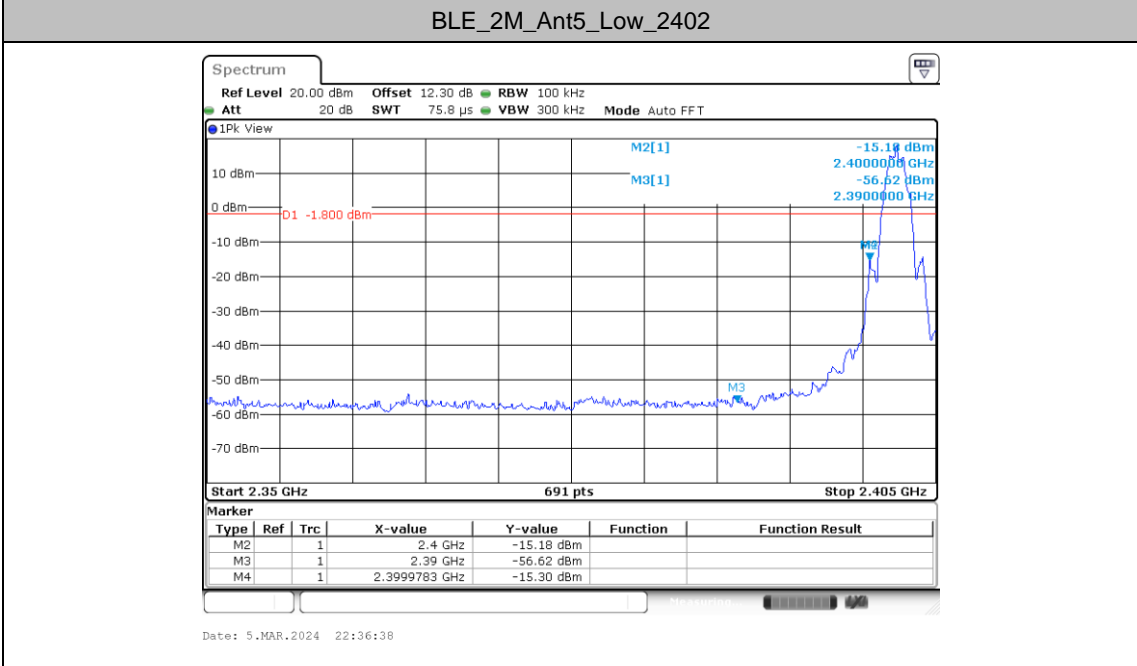
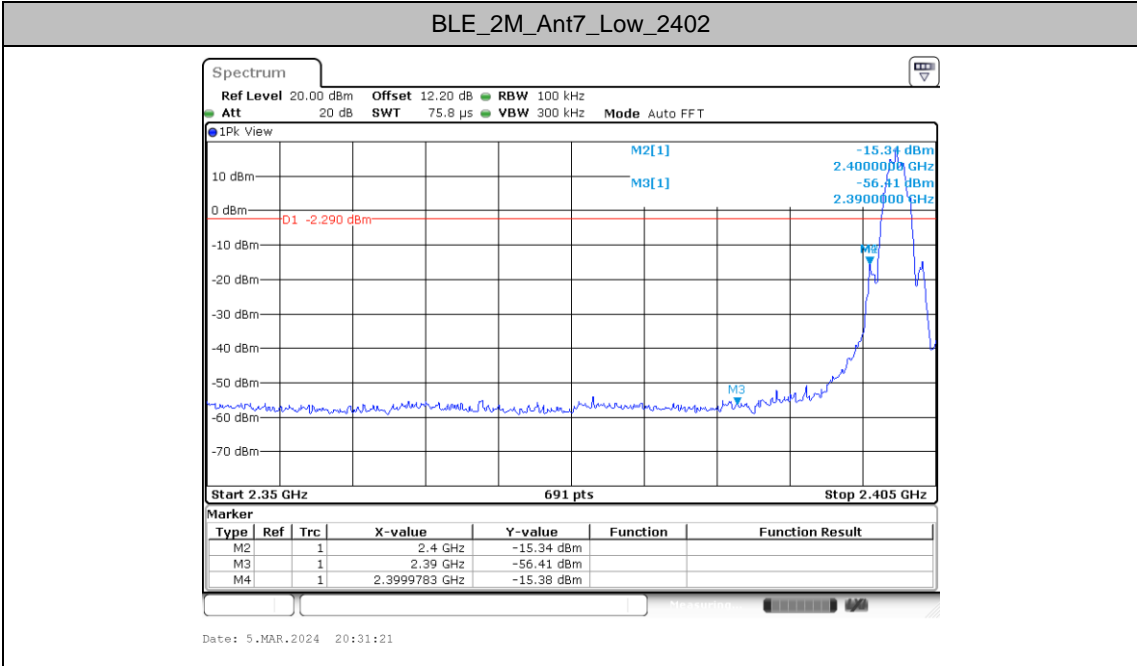
TestModel	Antenna	Channel Name	Freq(MHz)	RefLevel[dBm/100KHz]	Result[dBm/100KHz]	Limit[dBm/100KHz]	Verdict
BLE_1M	Ant7	Low	2402	17.58	-39.07	≤-2.42	PASS
	Ant5	Low	2402	17.92	-38.9	≤-2.08	PASS
	Ant7	High	2480	16.70	-52.39	≤-3.3	PASS
	Ant5	High	2480	17.55	-47.05	≤-2.45	PASS
BLE_2M	Ant7	Low	2402	17.71	-15.38	≤-2.29	PASS
	Ant5	Low	2402	18.20	-15.3	≤-1.8	PASS
	Ant7	High	2480	16.91	-43.12	≤-3.09	PASS
	Ant5	High	2480	17.96	-39.52	≤-2.04	PASS

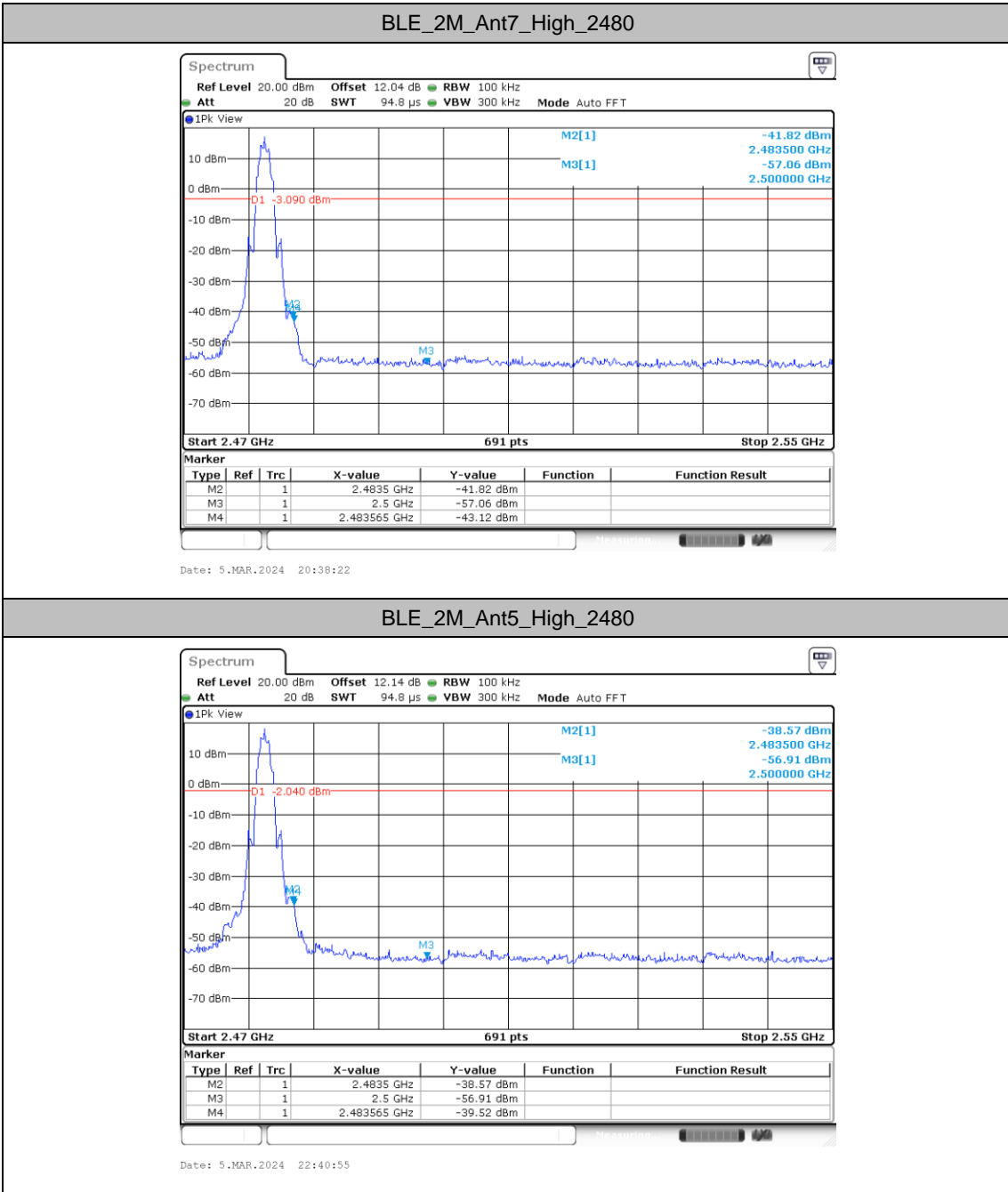


Test Graphs











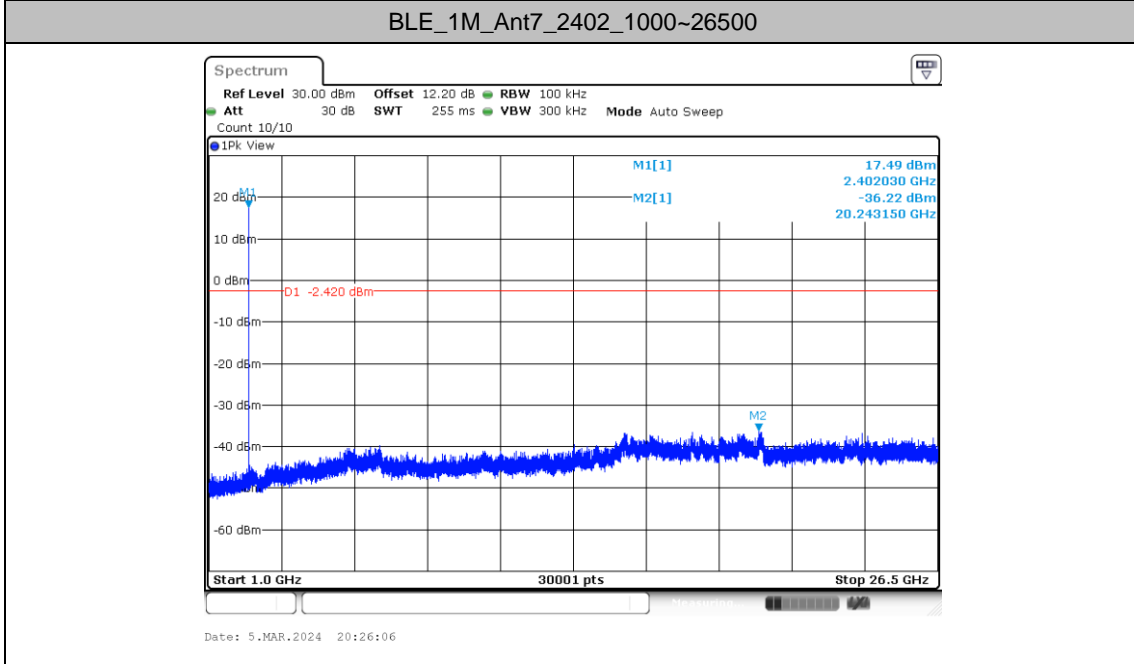
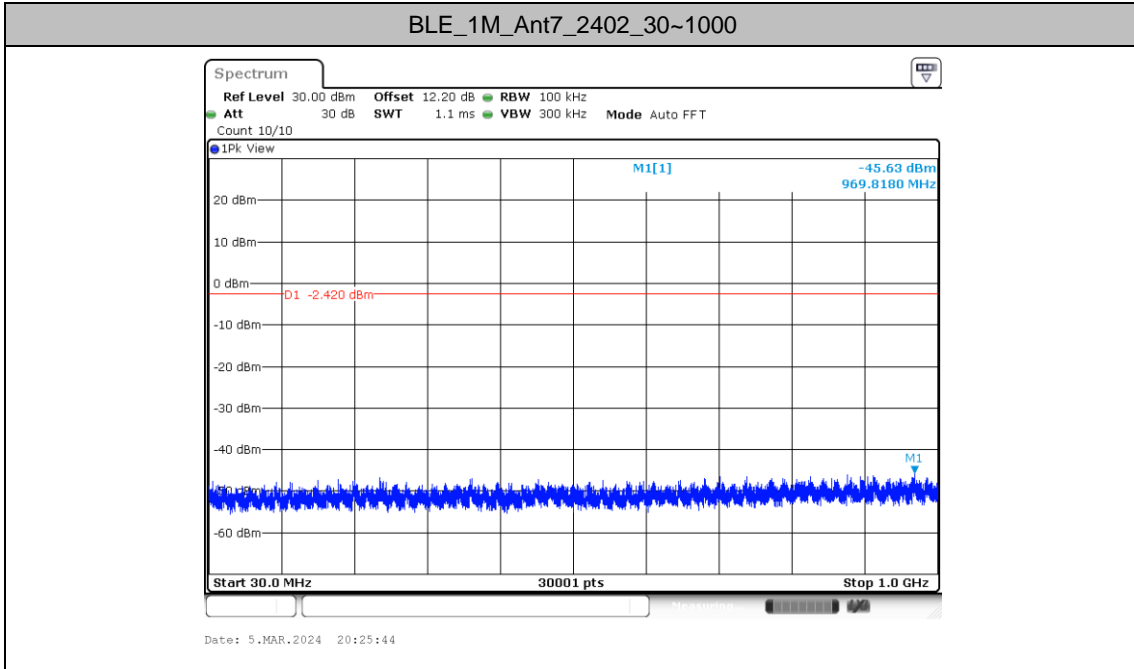
Conducted Spurious Emission

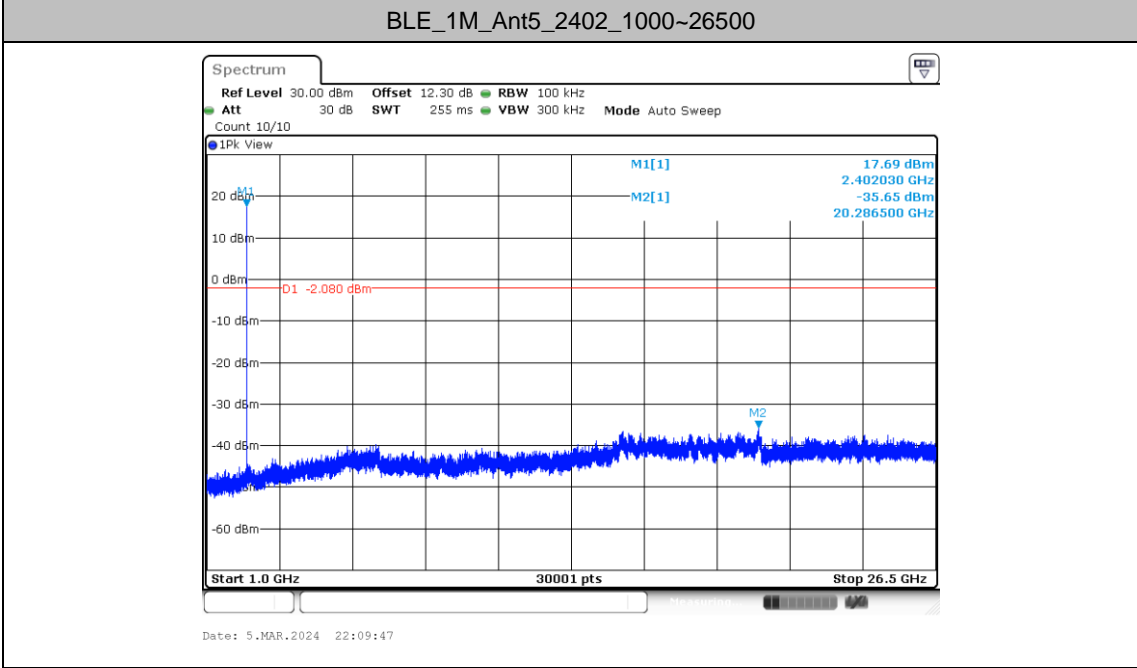
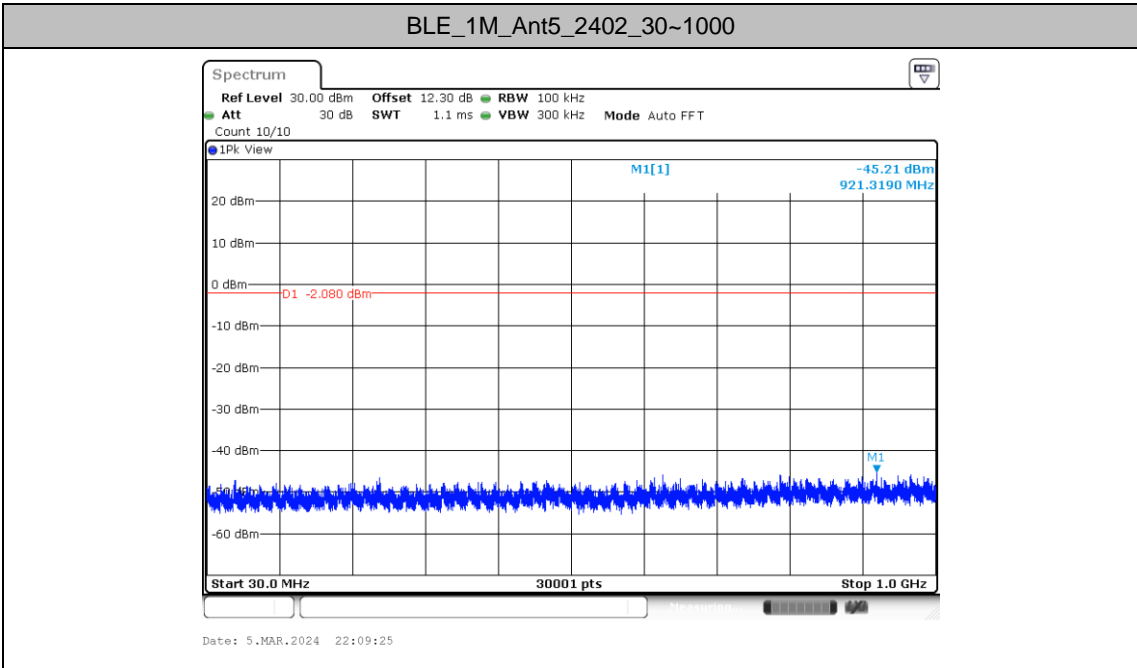
Test Result

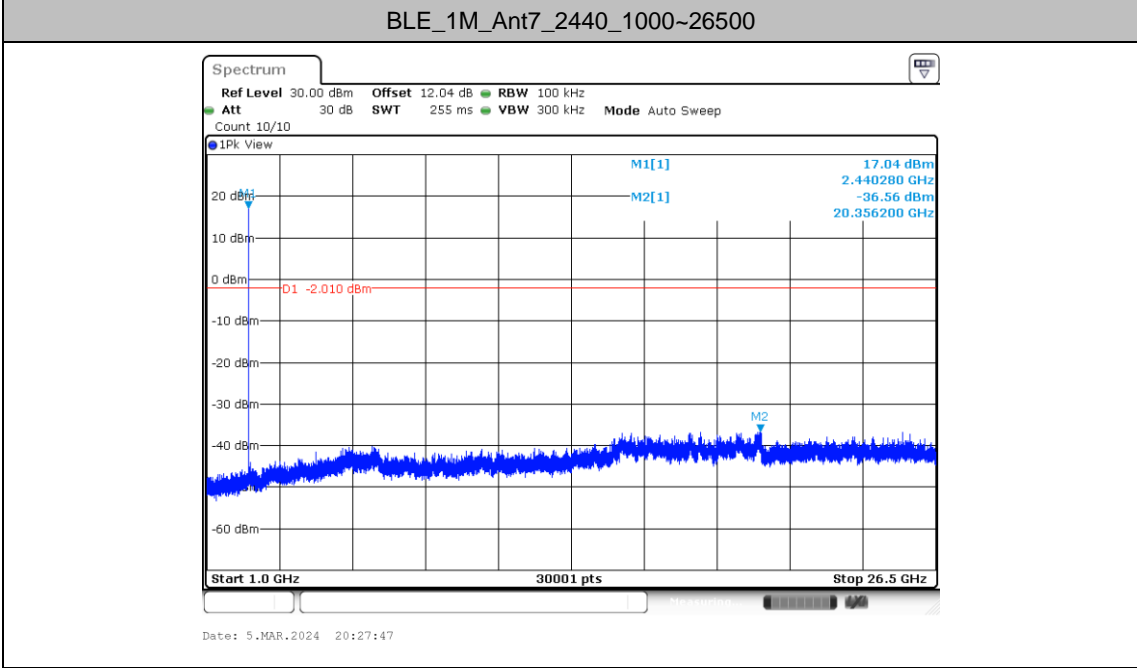
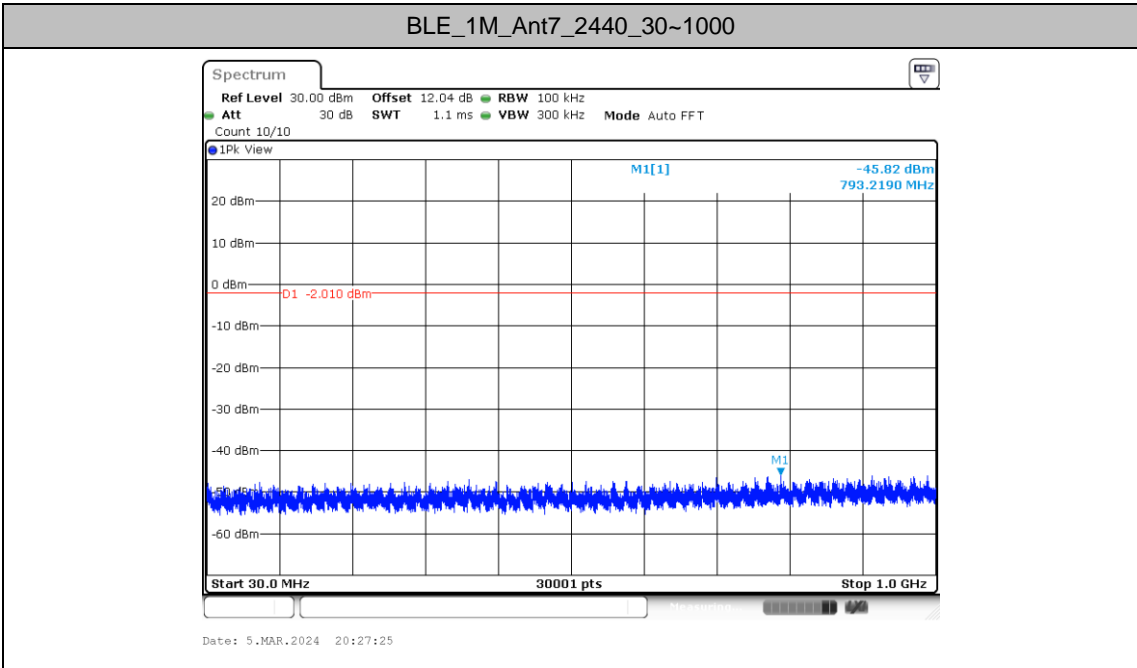
TestMode	Antenna	Freq(MHz)	FreqRange [MHz]	RefLevel [dBm/100KHz]	Result [dBm/100KHz]	Limit [dBm/100KHz]	Verdict
BLE_1M	Ant7	2402	30~1000	17.58	-45.63	≤-2.42	PASS
			1000~26500	17.58	-36.22	≤-2.42	PASS
	Ant5	2402	30~1000	17.92	-45.21	≤-2.08	PASS
			1000~26500	17.92	-35.65	≤-2.08	PASS
	Ant7	2440	30~1000	17.99	-45.82	≤-2.01	PASS
			1000~26500	17.99	-36.56	≤-2.01	PASS
	Ant5	2440	30~1000	18.23	-45.49	≤-1.77	PASS
			1000~26500	18.23	-35.41	≤-1.77	PASS
	Ant7	2480	30~1000	16.70	-45.3	≤-3.3	PASS
			1000~26500	16.70	-36.35	≤-3.3	PASS
	Ant5	2480	30~1000	17.55	-44.85	≤-2.45	PASS
			1000~26500	17.55	-36.12	≤-2.45	PASS
BLE_2M	Ant7	2402	30~1000	17.71	-46.31	≤-2.29	PASS
			1000~26500	17.71	-36.12	≤-2.29	PASS
	Ant5	2402	30~1000	18.20	-45.79	≤-1.8	PASS
			1000~26500	18.20	-35.36	≤-1.8	PASS
	Ant7	2440	30~1000	18.31	-45.1	≤-1.69	PASS
			1000~26500	18.31	-35.34	≤-1.69	PASS
	Ant5	2440	30~1000	18.36	-45.35	≤-1.64	PASS
			1000~26500	18.36	-36.7	≤-1.64	PASS
	Ant7	2480	30~1000	16.91	-45.76	≤-3.09	PASS
			1000~26500	16.91	-36.63	≤-3.09	PASS
	Ant5	2480	30~1000	17.96	-44.61	≤-2.04	PASS
			1000~26500	17.96	-35.74	≤-2.04	PASS

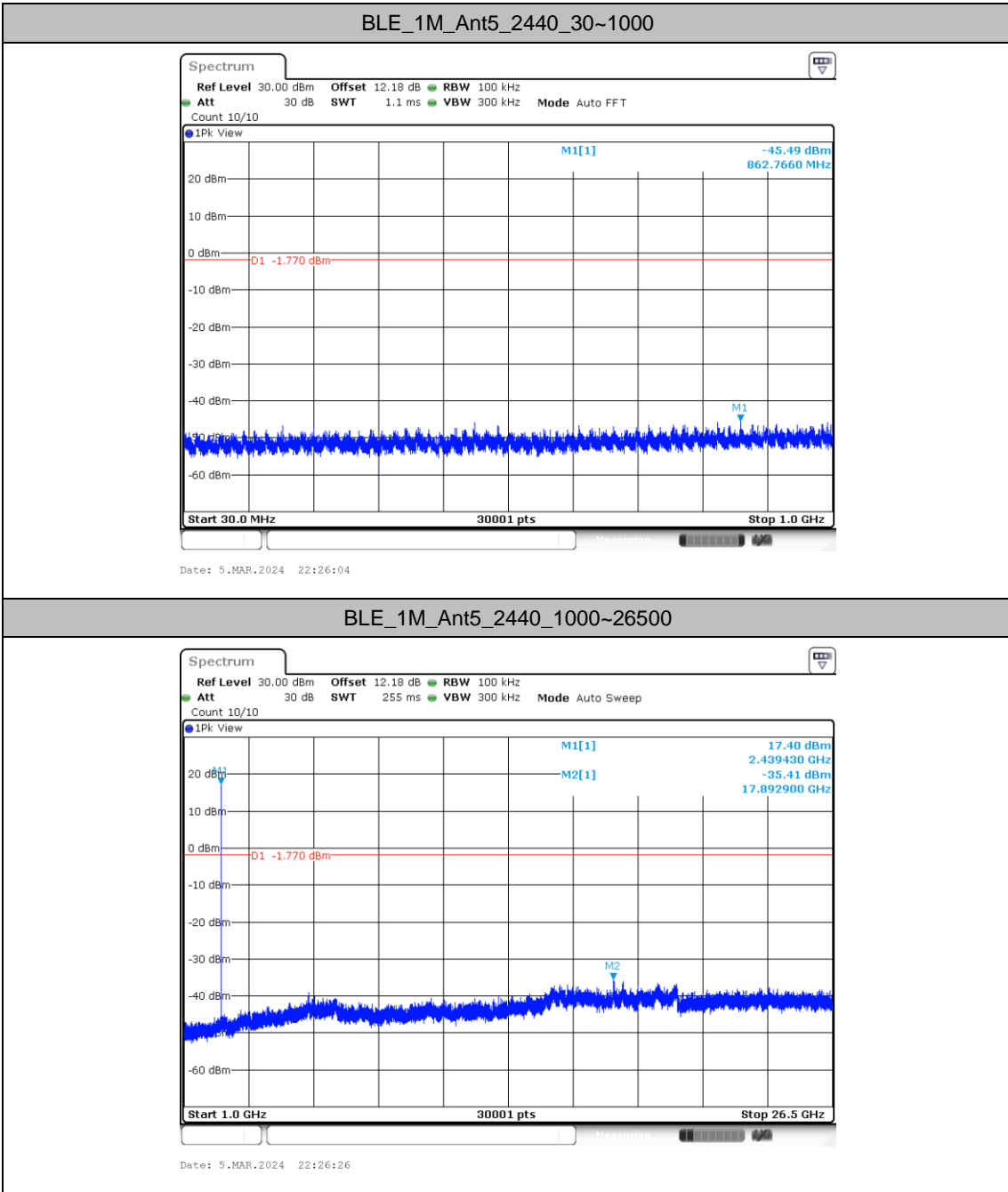


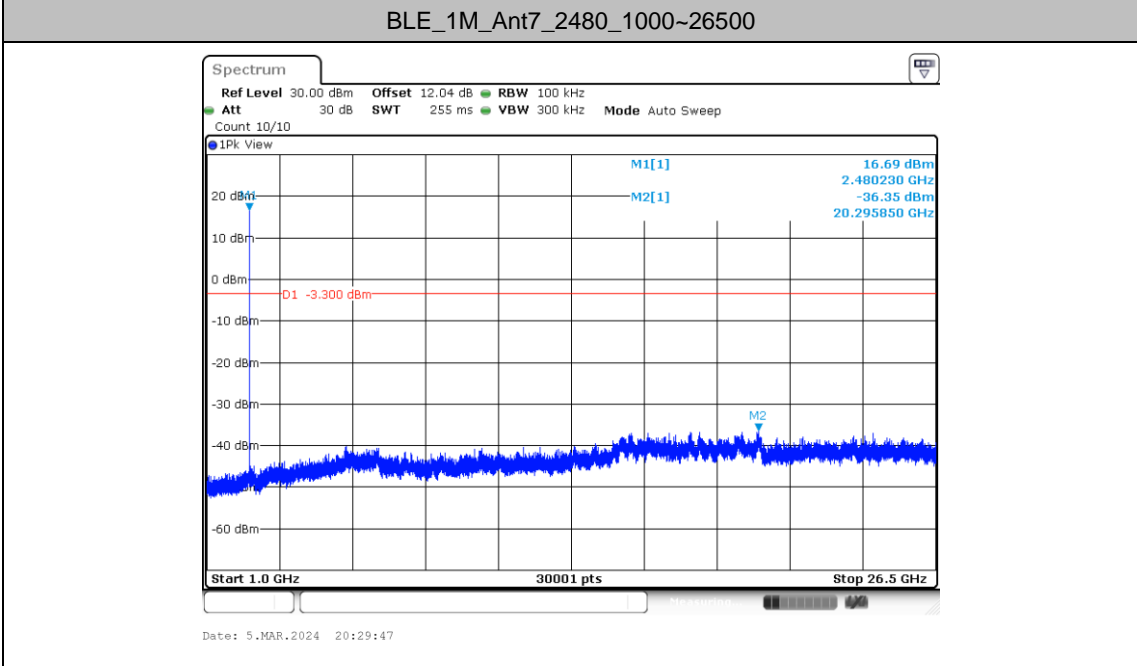
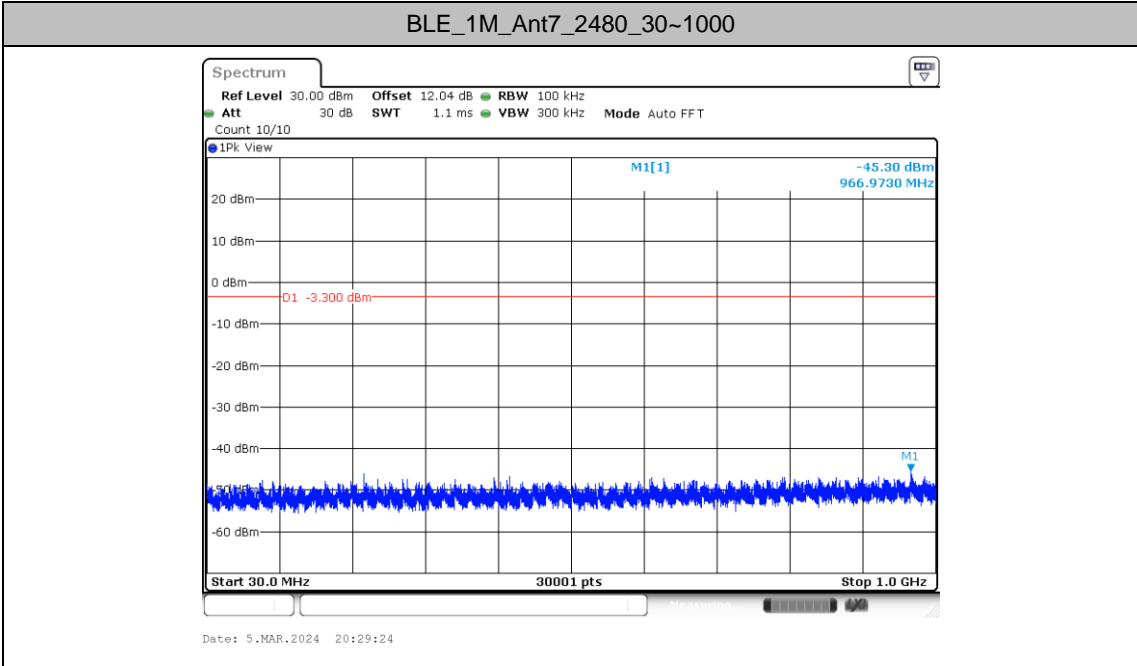
Test Graphs

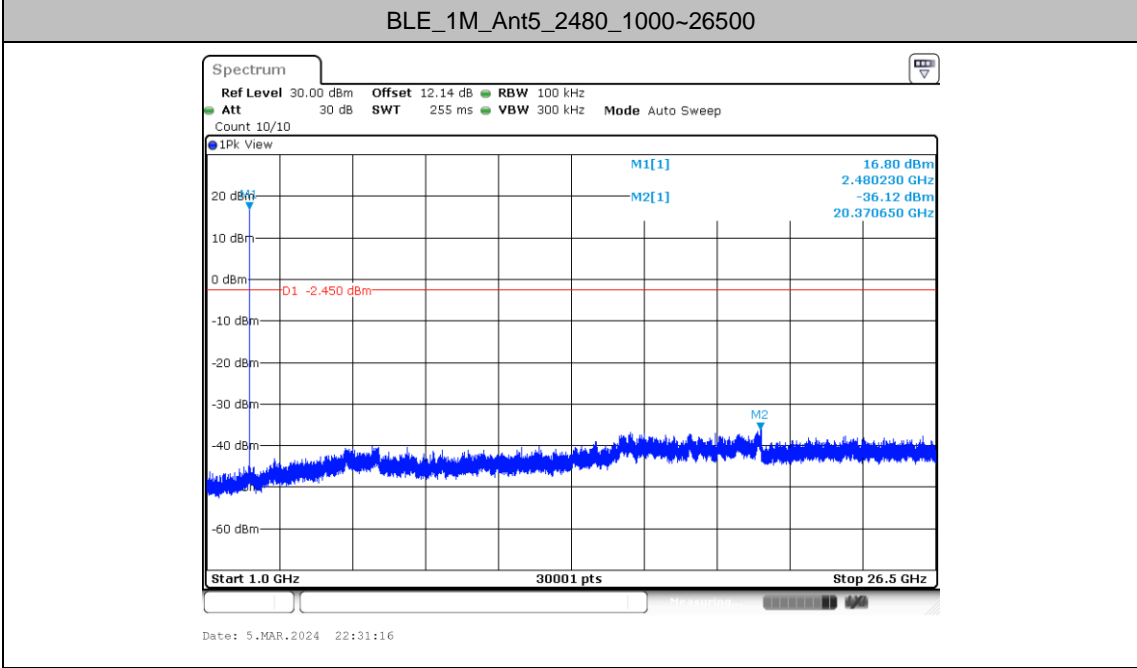
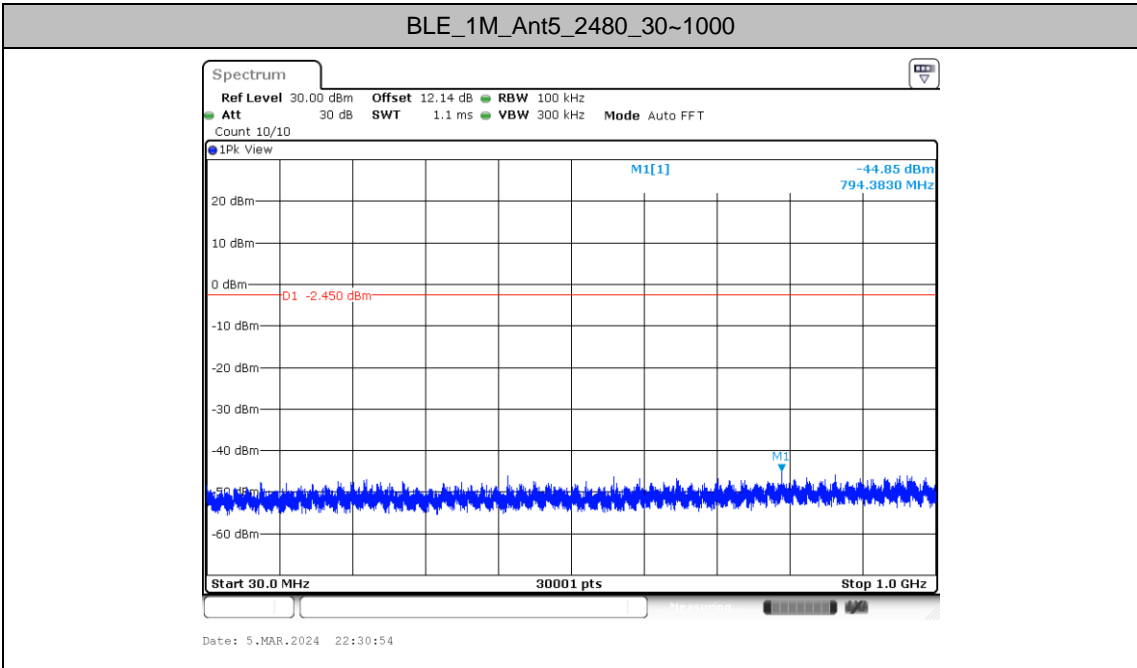


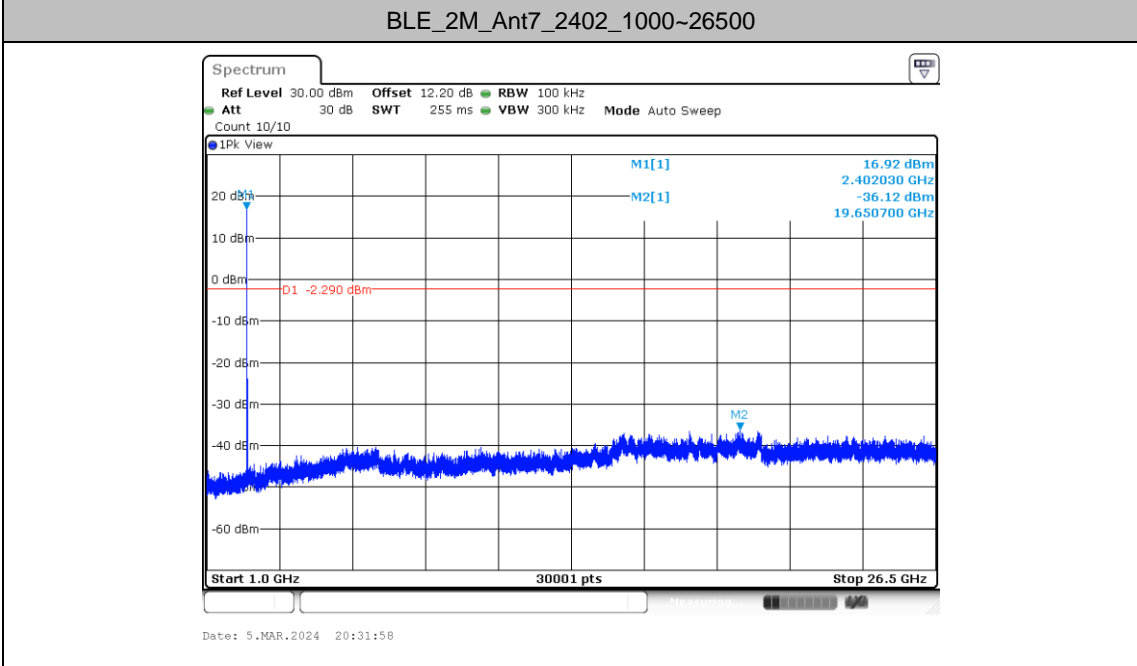
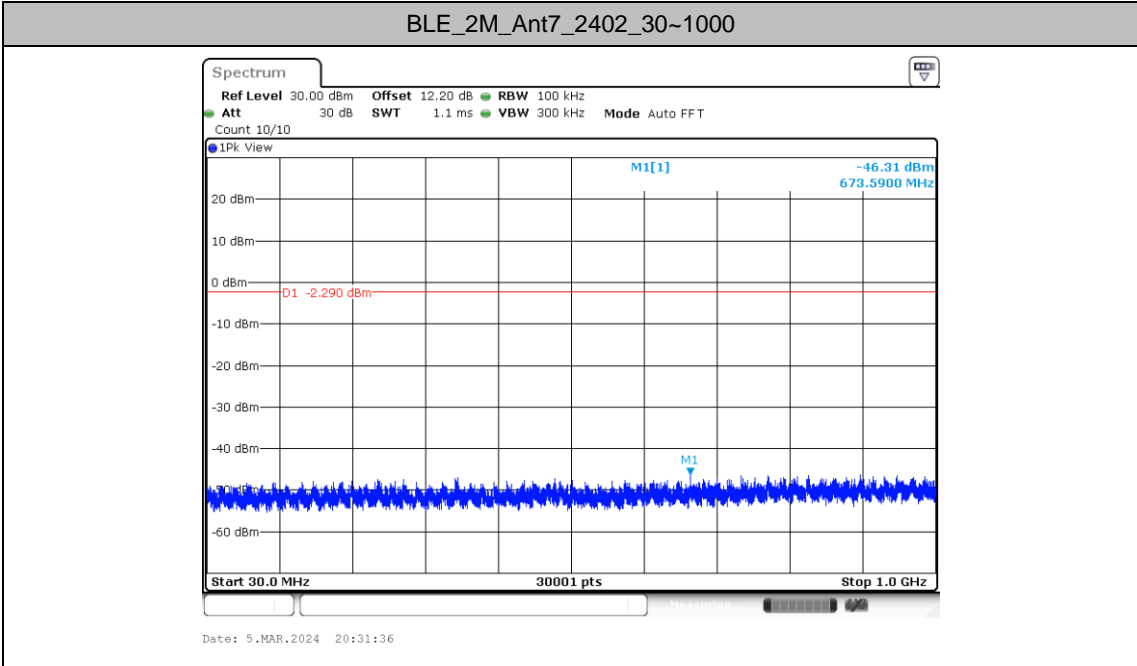


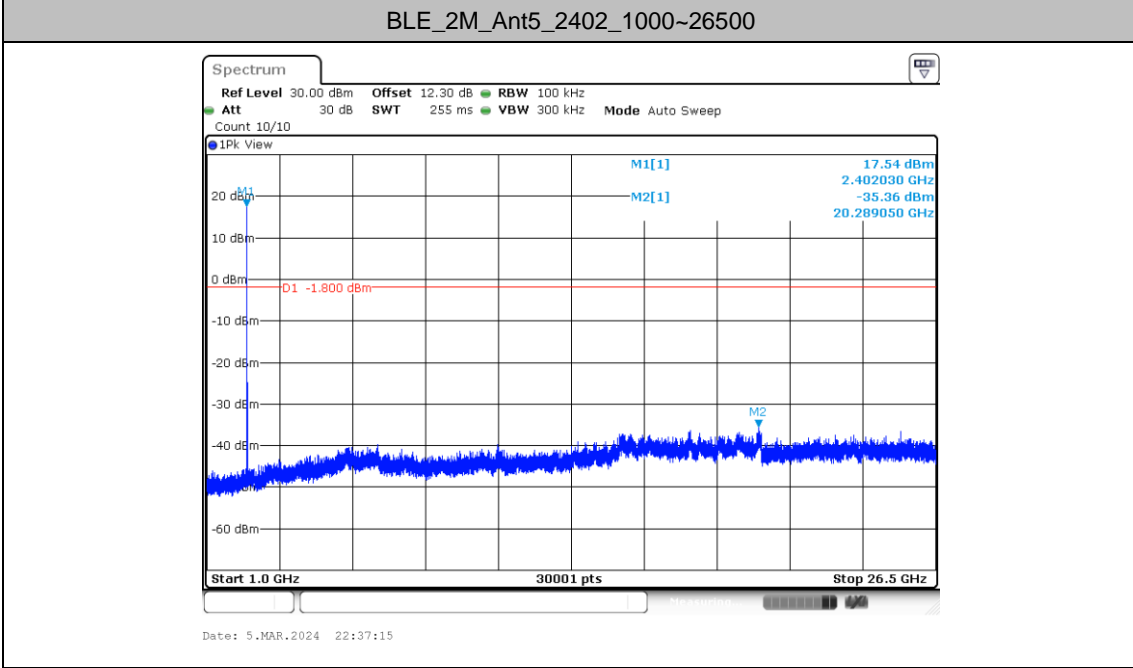
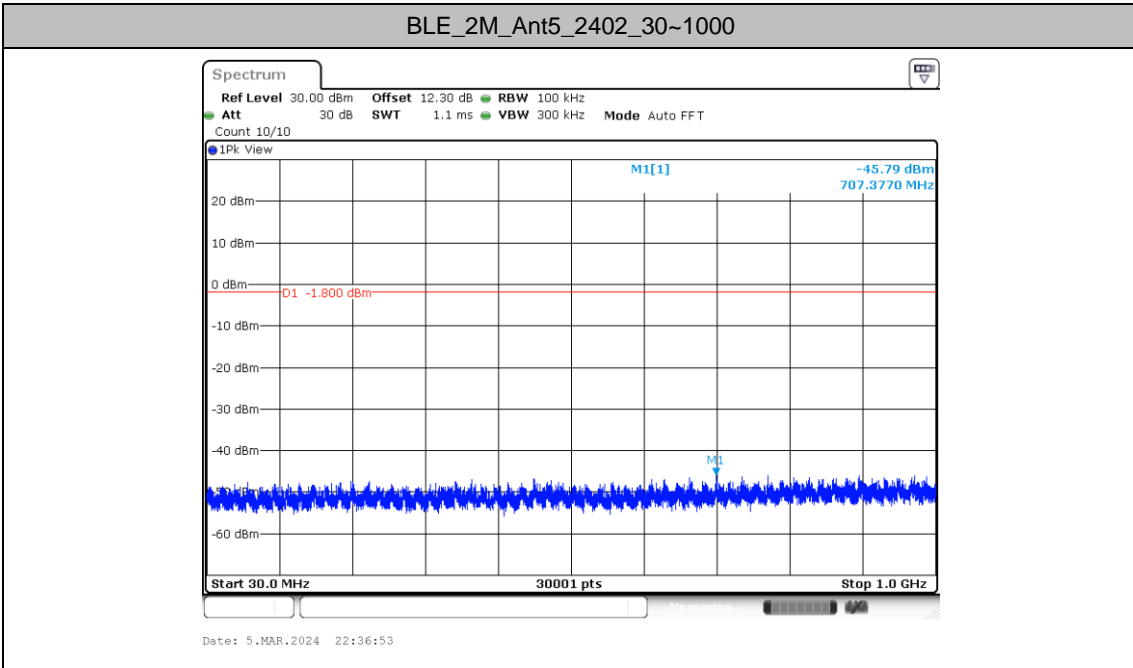


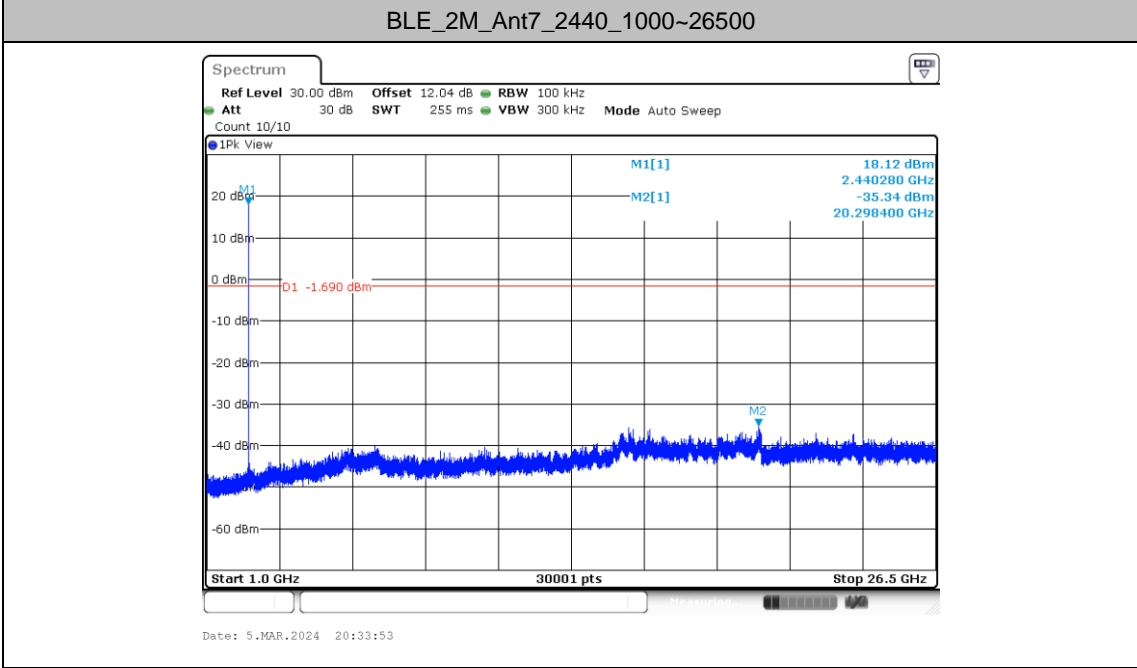
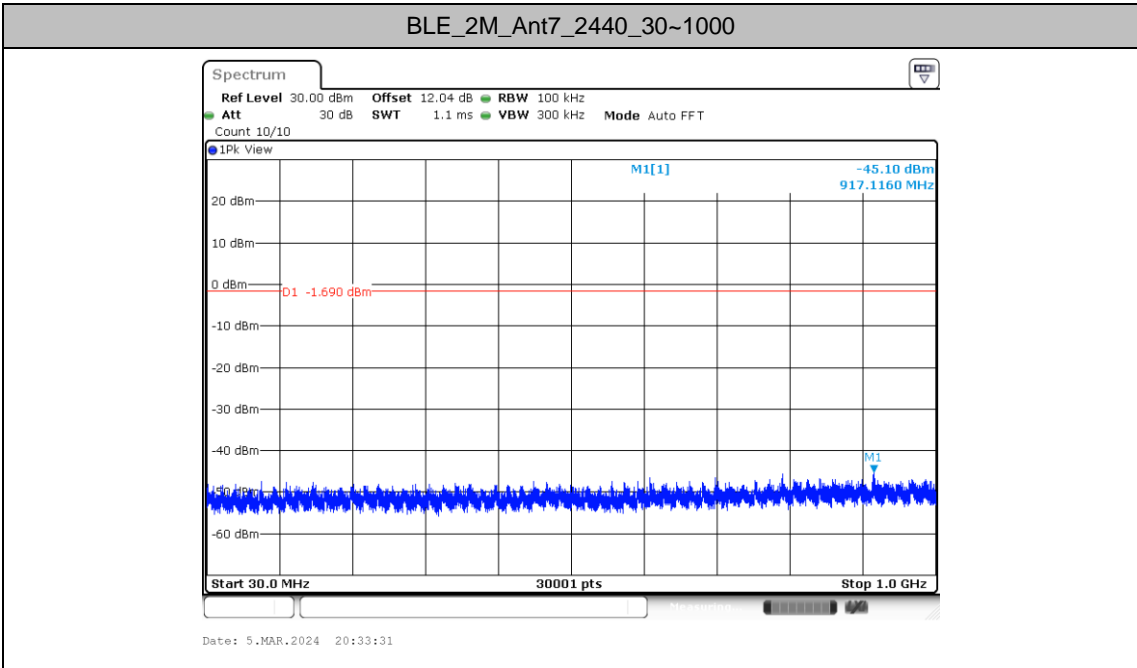


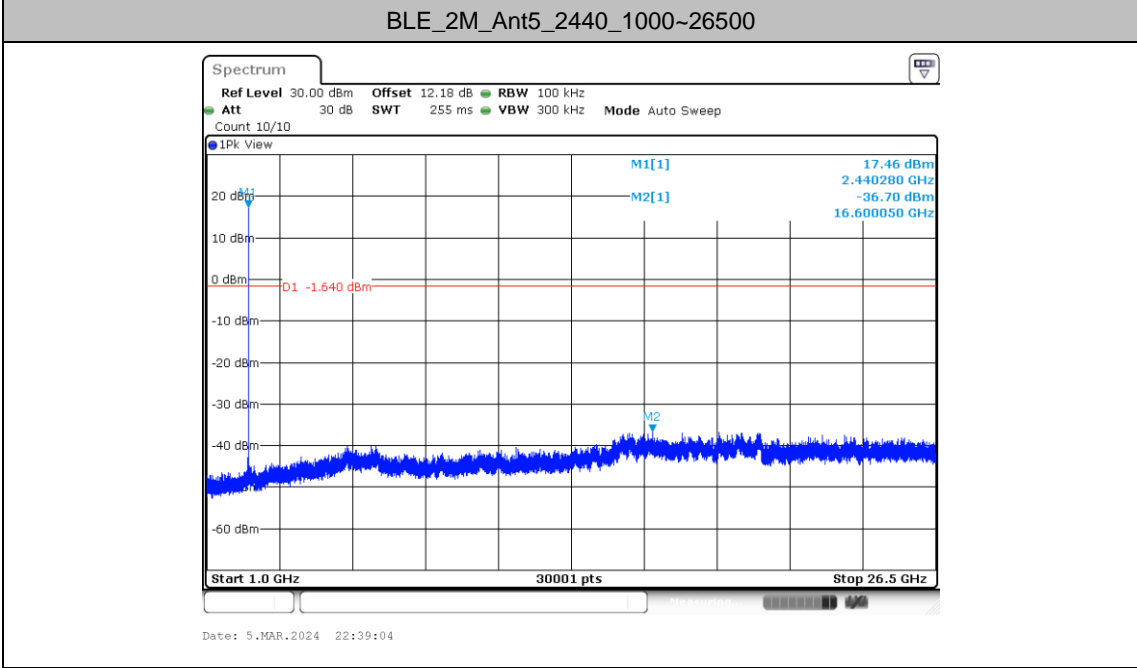
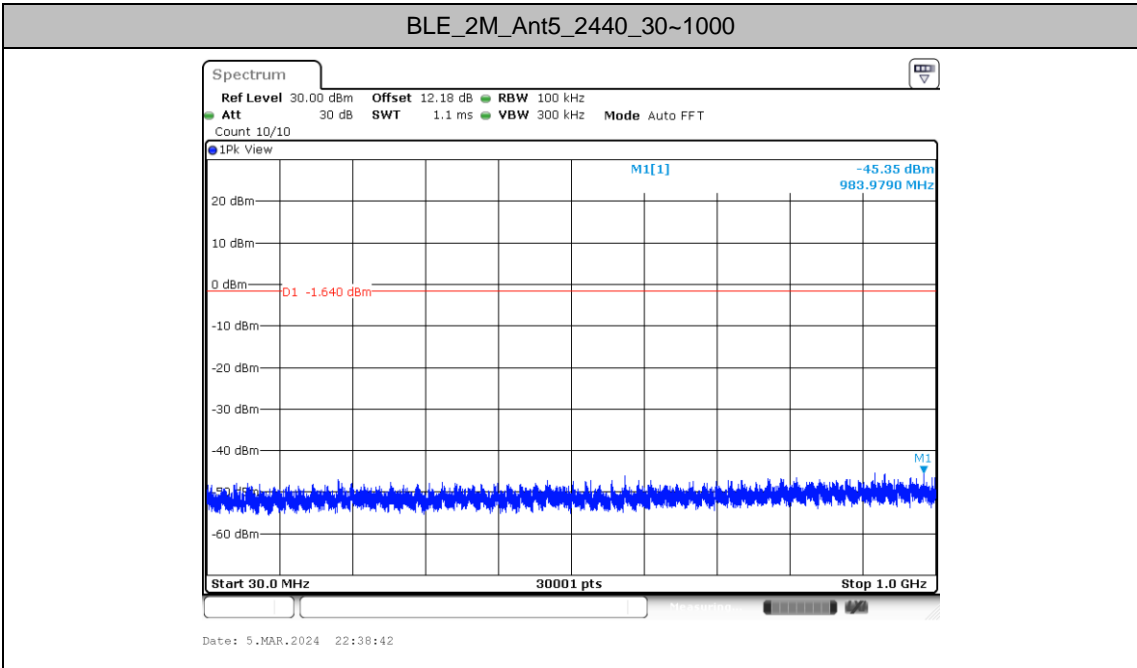


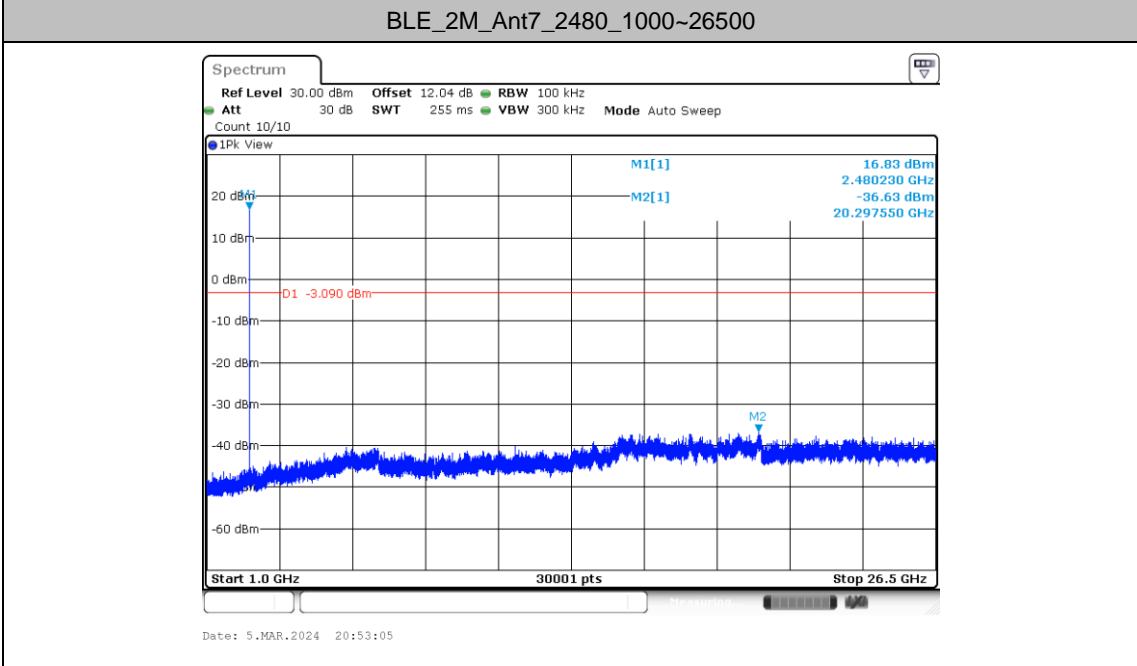
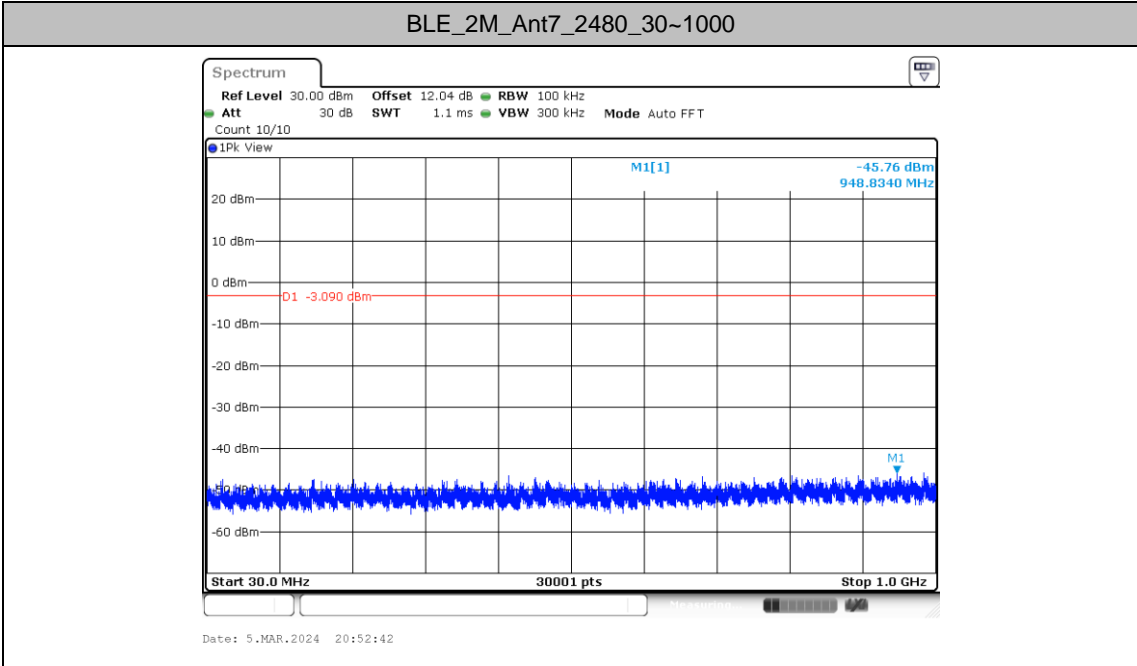


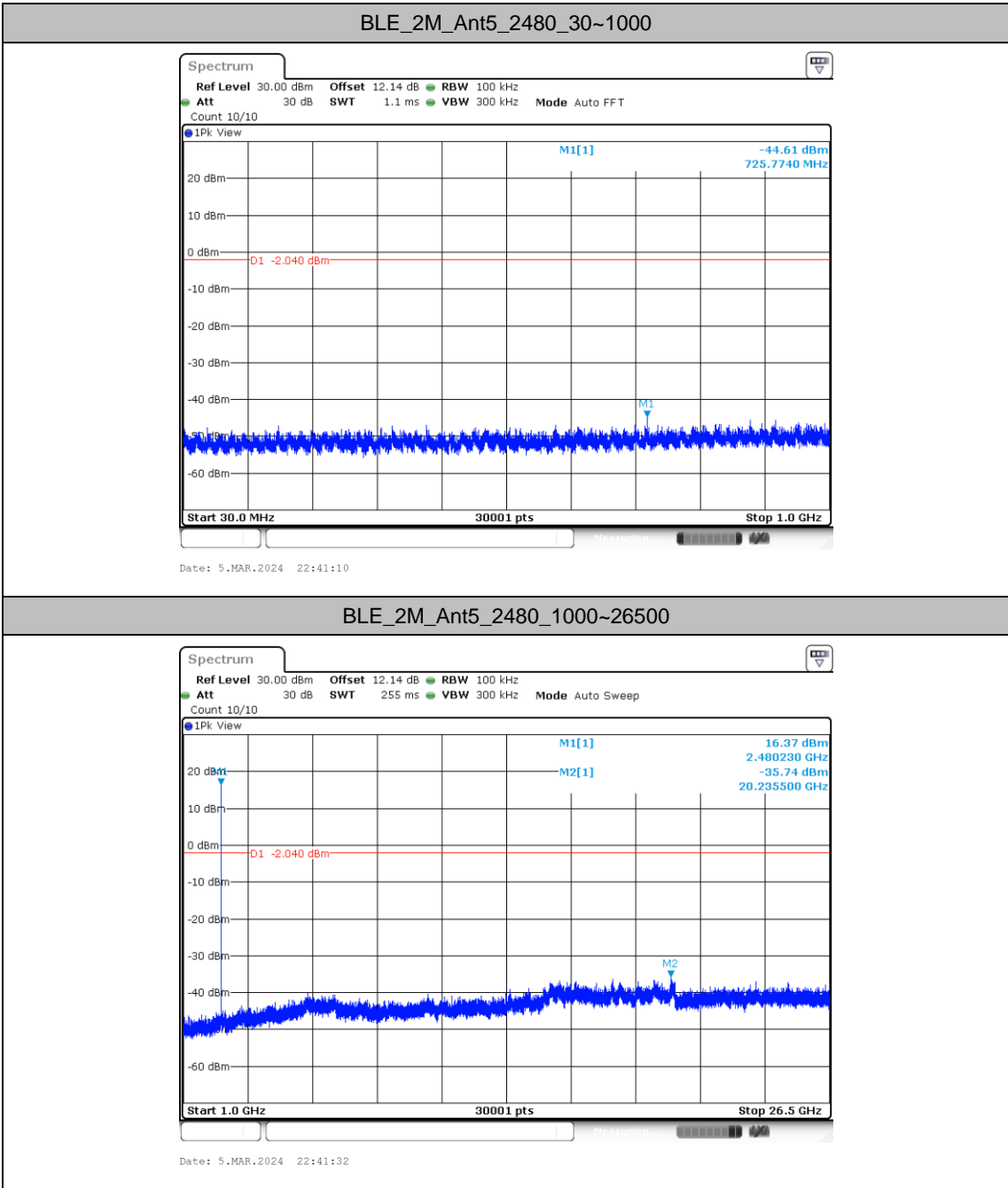














<MIMO Ant 5+7>

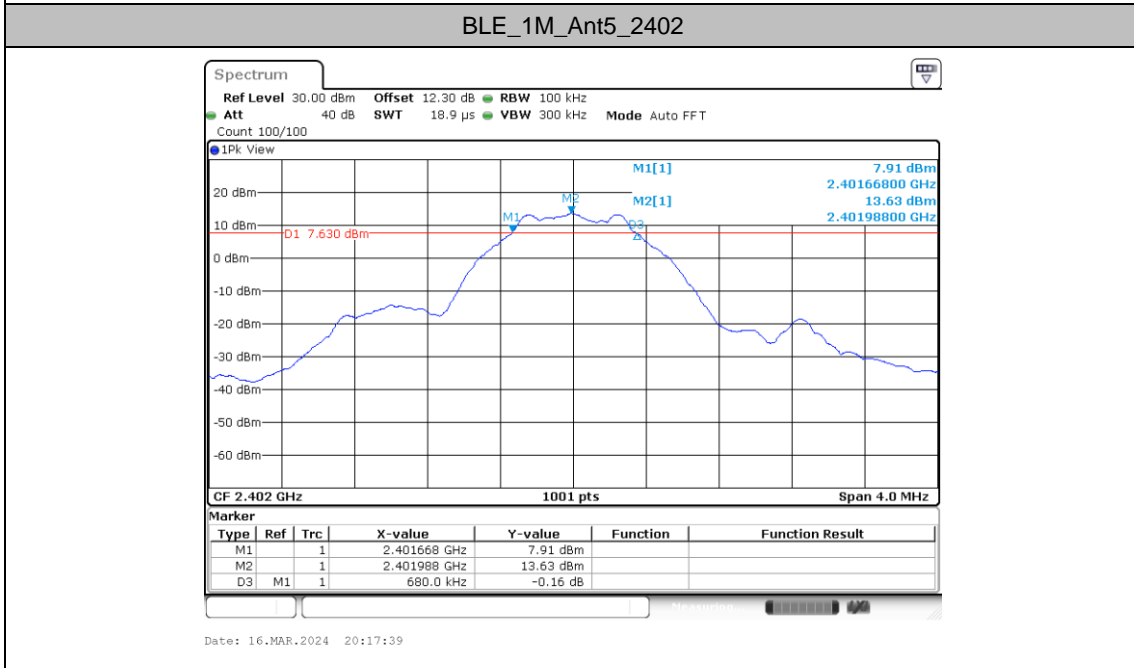
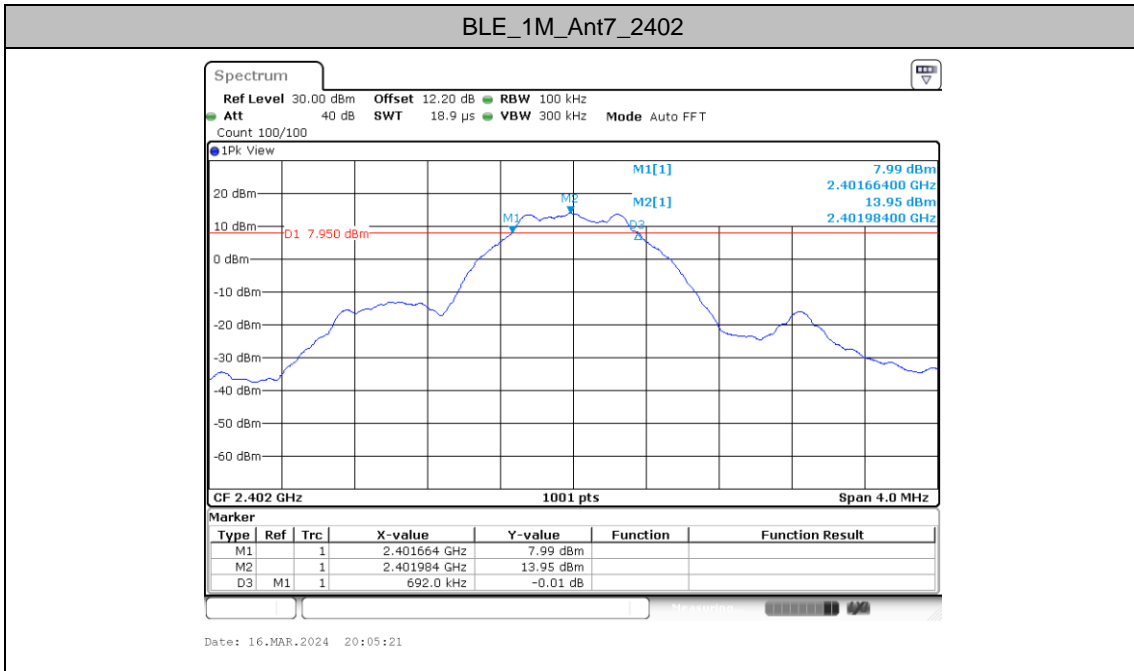
DTS Bandwidth

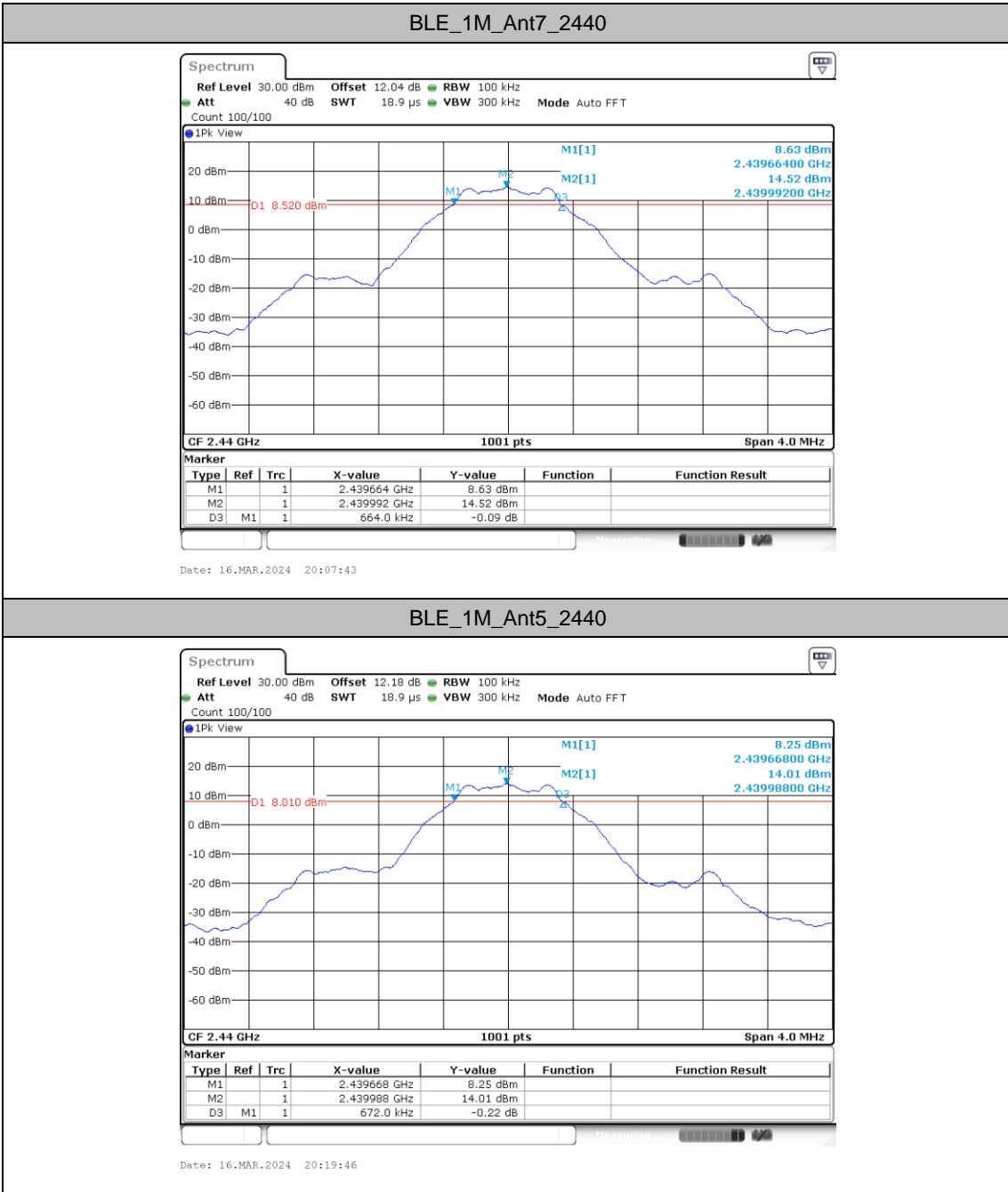
Test Result

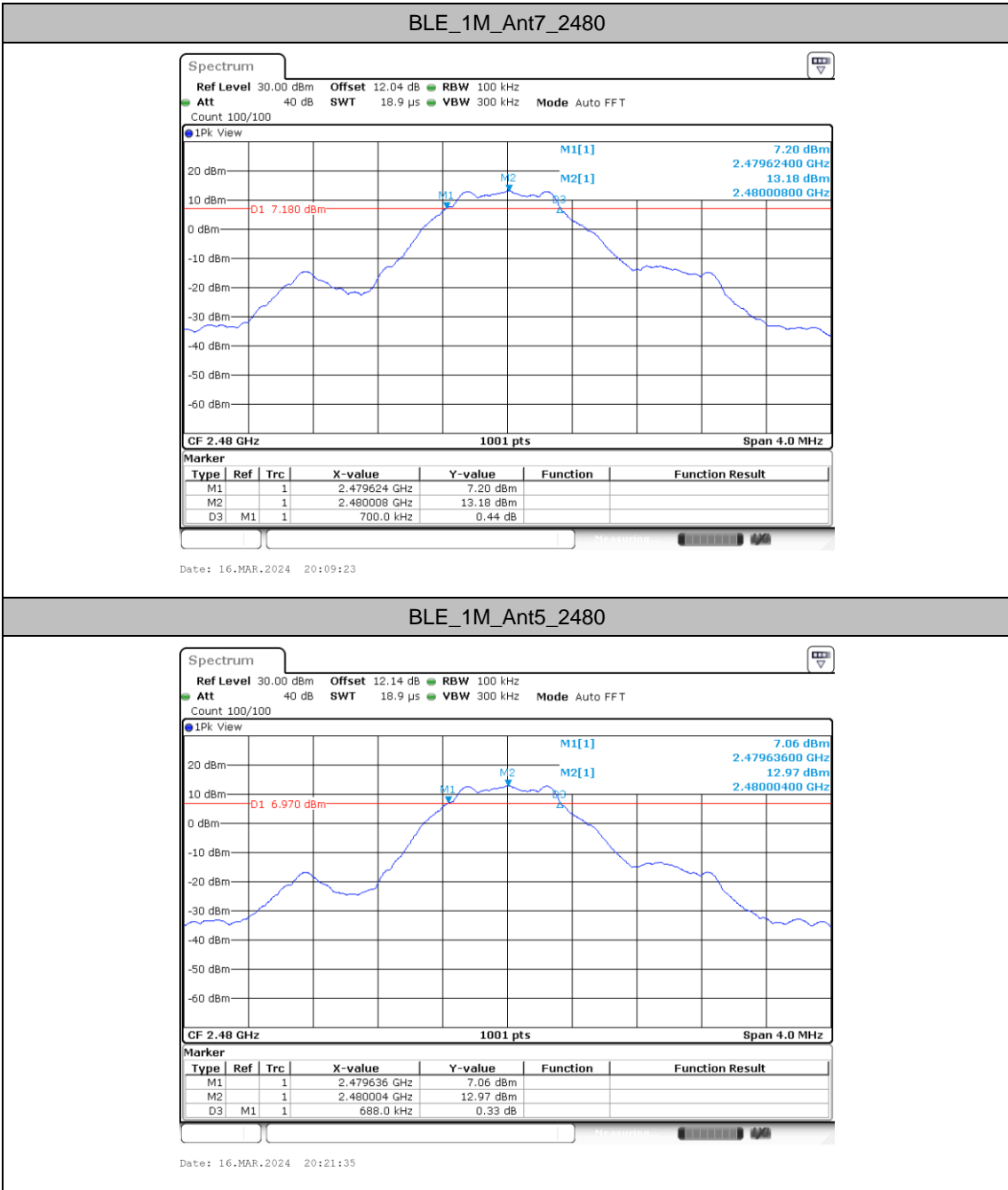
TestMode	Antenna	Freq(MHz)	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant7	2402	0.69	2401.66	2402.36	0.5	PASS
	Ant5	2402	0.68	2401.67	2402.35	0.5	PASS
	Ant7	2440	0.66	2439.66	2440.33	0.5	PASS
	Ant5	2440	0.67	2439.67	2440.34	0.5	PASS
	Ant7	2480	0.70	2479.62	2480.32	0.5	PASS
	Ant5	2480	0.69	2479.64	2480.32	0.5	PASS
BLE_2M	Ant7	2402	1.15	2401.43	2402.58	0.5	PASS
	Ant5	2402	1.15	2401.43	2402.58	0.5	PASS
	Ant7	2440	1.14	2439.44	2440.57	0.5	PASS
	Ant5	2440	1.14	2439.44	2440.58	0.5	PASS
	Ant7	2480	1.21	2479.35	2480.56	0.5	PASS
	Ant5	2480	1.13	2479.43	2480.56	0.5	PASS

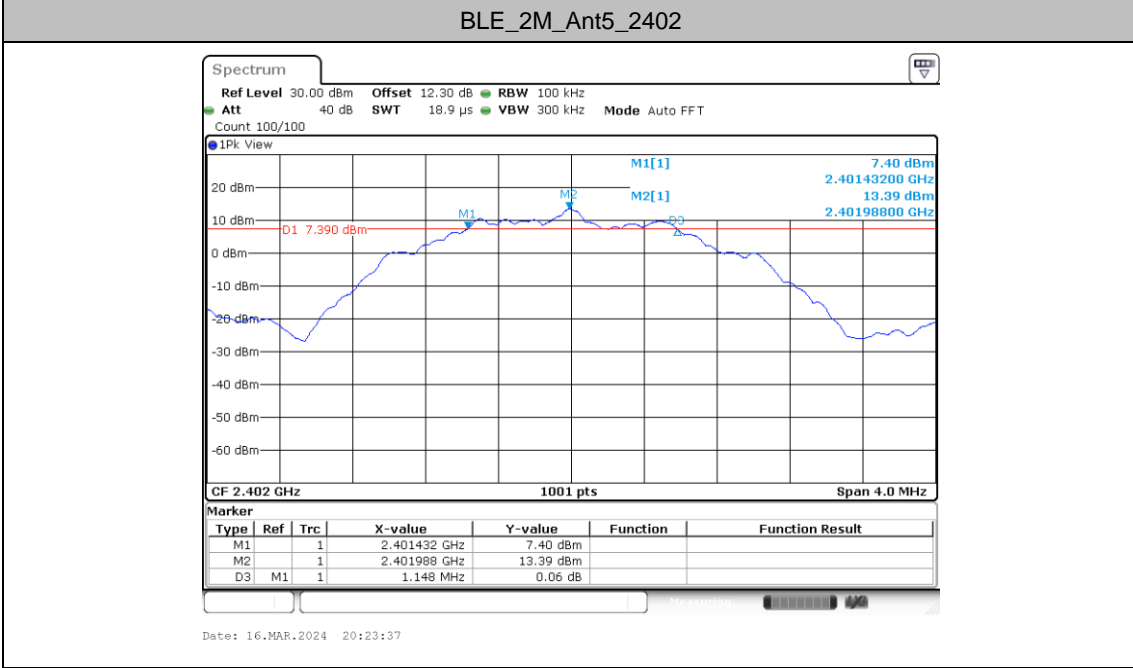
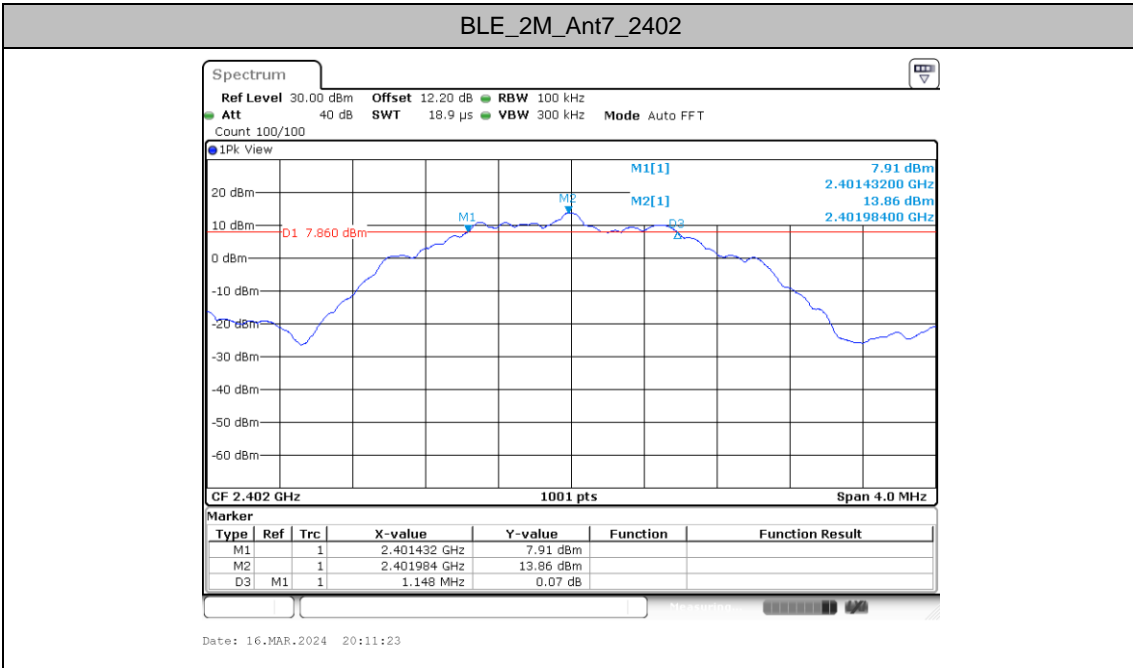


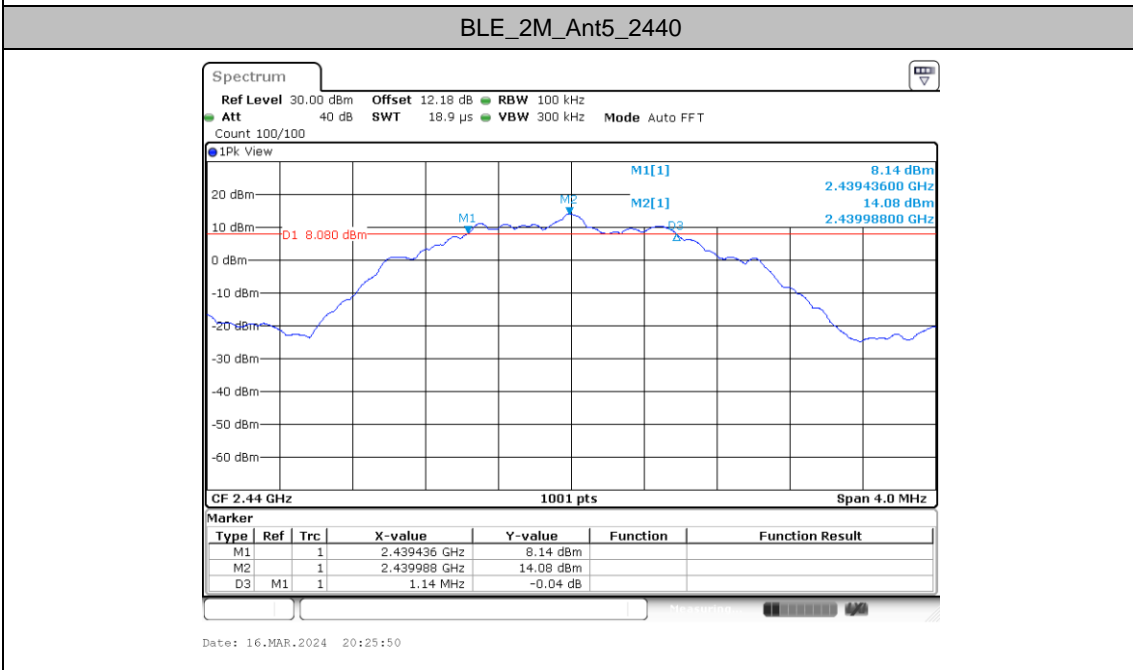
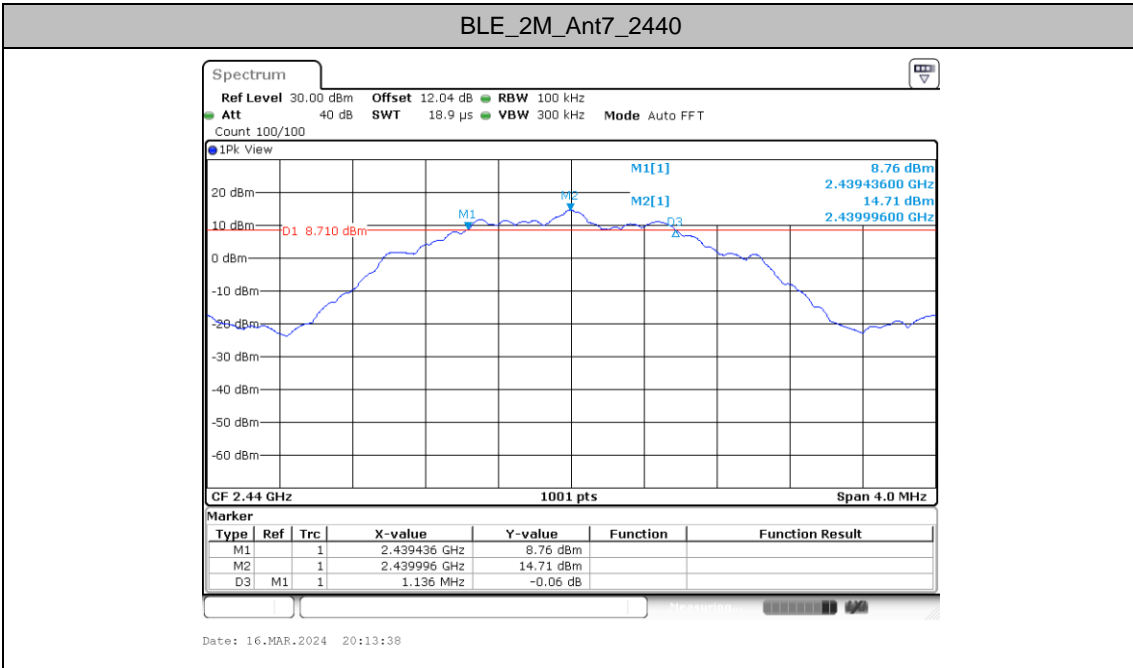
Test Graphs

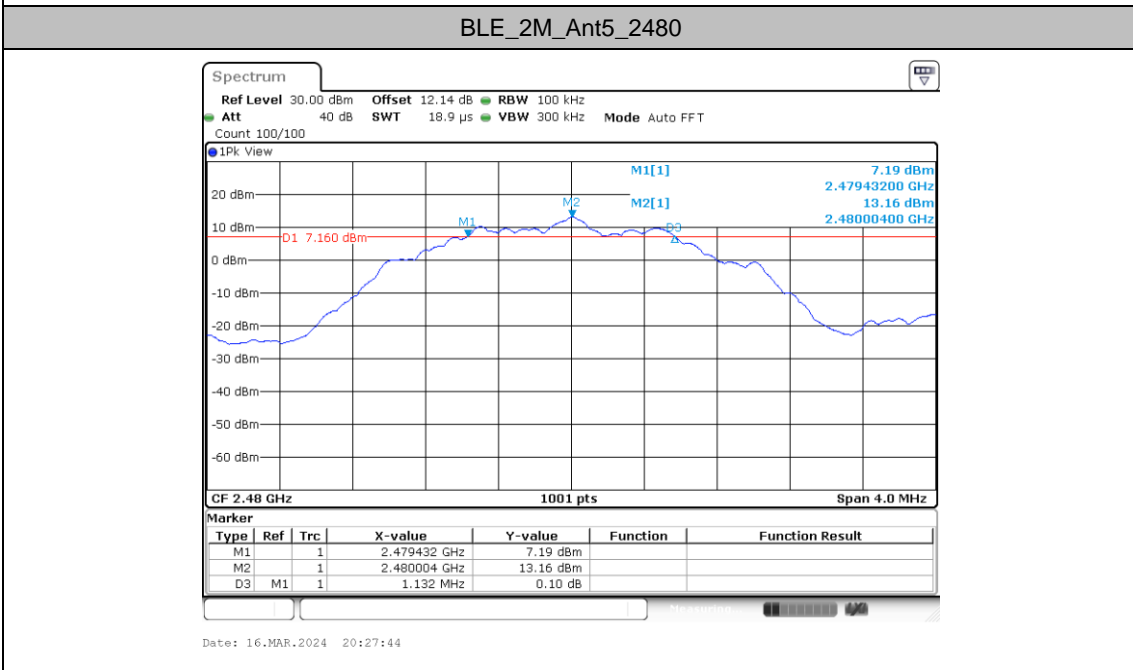
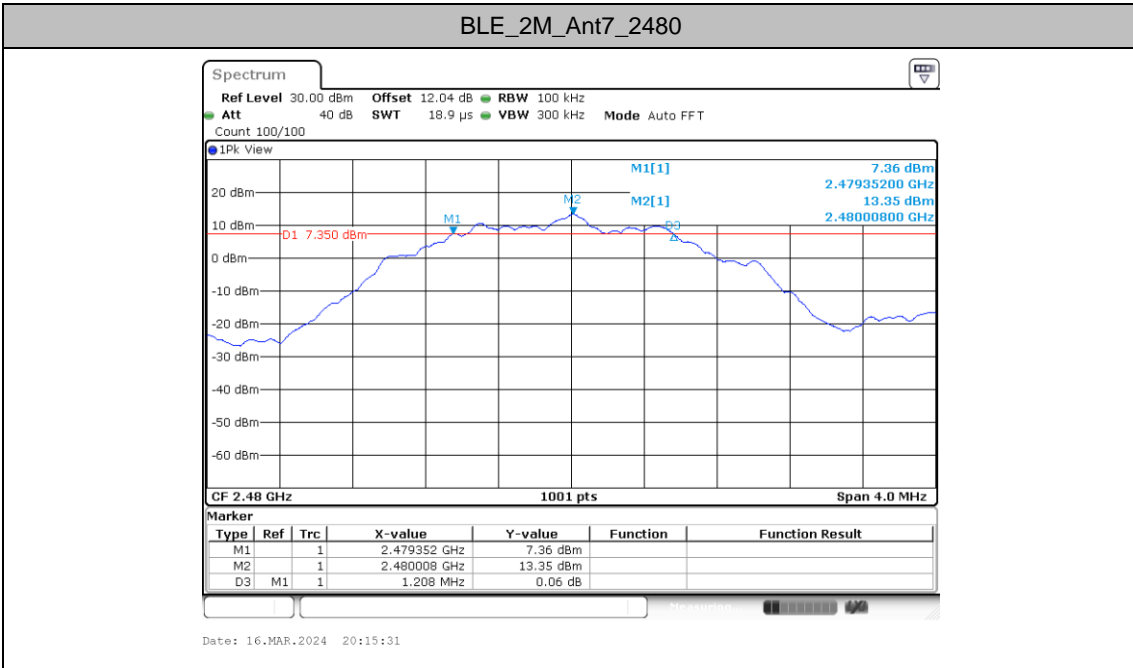














Occupied Channel Bandwidth

Test Result

TestMode	Antenna	Freq(MHz)	OCB [MHz]	FL[MHz]	FH[MHz]
BLE_1M	Ant7	2402	1.043	2401.4845	2402.5275
	Ant5	2402	1.039	2401.4885	2402.5275
	Ant7	2440	1.063	2439.4725	2440.5355
	Ant5	2440	1.051	2439.4805	2440.5315
	Ant7	2480	1.059	2479.4725	2480.5315
	Ant5	2480	1.043	2479.4845	2480.5275
BLE_2M	Ant7	2402	2.042	2400.9970	2403.0390
	Ant5	2402	2.046	2400.9970	2403.0430
	Ant7	2440	2.05	2438.9890	2441.0390
	Ant5	2440	2.046	2438.9970	2441.0430
	Ant7	2480	2.046	2478.9850	2481.0310
	Ant5	2480	2.038	2478.9970	2481.0350