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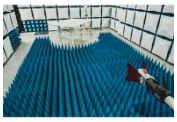


MEASUREMENT REPORT
FCC PART 15.247 / ISED RSS-247 Bluetooth (Low Energy)

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
5/30/2022 - 9/30/2022
Test Site/Location:
Element Washington DC LLC, Morgan Hill, CA, USA
Test Report Serial No.:
1C2205090028-14.BCG

FCC ID:	**BCGA2764**
IC:	**579C-A2764**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2764
EUT Type:	Tablet Device
Max. RF Output Power:	48.929 mW (16.9 dBm) Peak Conducted
Frequency Range:	2402 – 2480MHz
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15 Subpart C (15.247)
ISED Specification:	RSS-247 Issue 2
Test Procedure(s):	ANSI C63.10-2013, KDB 558074 D01 v05r02

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 558074 D01 v05r02. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 Element Washington DC LLC Test Location

These measurement tests were conducted at the Element Washington DC LLC facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Washington DC LLC located in Morgan Hill, CA 95037, U.S.A.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Washington DC LLC facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2764 and IC: 579C-A2764**. The data found in this test report was taken with the EUT operating in Bluetooth low energy mode. While in low energy mode, the Bluetooth transmitter hops pseudo-randomly between 40 channels, three of which are "advertising channels". When the transmitter is hopping only between the three advertising channels, the EUT does not fall under the category of a "hopper" as defined in 15.247(a)(iii) which states that a "frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels." As operation on only the advertising channels does not qualify the EUT as a hopper, the EUT is certified as a DTS device in this mode. The data found in this report is representative of the device when it transmits on its advertising channels. Typical Bluetooth operation is covered under the DSS report found with this application.

Test Device Serial No.: Q26GK4Q9C7, M34YQC3PX6, LJFR9N4G07, DLX2237005M22Y21Z

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1, FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), NB UNII (1x, HDR4, HDR8), WPT

This device supports BT Beamforming

BLE-1M		BLE-2M	
Ch.	**Frequency (MHz)**	**Ch.**	**Frequency (MHz)**
00	2402	01	2404
:	:	:	:
19	2440	19	2440
:	:	:	:
39	2480	38	2478

Table 2-1. Bluetooth LE Frequency / Channel Operations

Note: This device is capable of operating in hopping and non-hopping mode. The EUT can hop between 40 different channels in the 2400 – 2483.5MHz band.

Measured Duty Cycles				
BLE Mode		**Duty Cycle [%]**		
		Antenna 4a	**Antenna 2a**	**TxBF**
1M	ePA	100.0	100.0	100.0
	iPA	100.0	100.0	100.0
2M	ePA	100.0	100.0	100.0
	iPA	100.0	100.0	100.0

Table 2-2. Measured Duty Cycles

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Antenna	Simultaneous Tx Config	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	×	×	×	×	✓
2a	Config 2	×	✓	×	×	×	✓
4a	Config 3	✓	×	✓	×	×	×
4a	Config 4	×	✓	×	✓	×	×

Table 2-3. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

Note:

All above simultaneous transmission configurations have been tested and the worst case configuration was found to be configuration 2 (BT and LTE) and reported in RF Bluetooth and RF Part 96 test reports.

Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. Specific 2.4 GHz Wi-Fi antenna that can only transmit simultaneously with 2.4 GHz Bluetooth antenna is listed in the SAR test report. For BT (2.4 GHz) in connected mode and Wi-Fi (2.4 GHz) – Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4 GHz) in disconnected mode and Wi-Fi (2.4 GHz) – BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power.

2.3 Antenna Description

Following antennas gains provided by manufacturer were used for testing.

Frequency [GHz]	Antenna Gain (dBi)	
	Antenna 4a	Antenna 2a
2.4	1.8	2.4

Table 2-4. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple MacBook Pro	Model:	A2141	S/N:	C02DV7VKMD6T
	w/AC/DC Adapter	Model:	A2166	S/N:	N/A
2	Apple USB-C Cable	Model:	Spartan	S/N:	000MKTR02U
3	USB-C Cable	Model:	A246	S/N:	N/A
	w/ AC Adapter	Model:	A2305	S/N:	N/A
4	Apple Pencil	Model:	N/A	S/N:	GQXGSXBJKM9
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-5. Test Support Equipment List

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 558074 D01 v05r02. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 for antenna port conducted emissions test setups.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz and above 18GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

For AC line conducted and radiated test below 1GHz, following configuration were investigated and the worst case was reported.

- EUT powered by AC/DC adaptor via USB-C cable with wire charger
- EUT powered by host PC via USB-C cable with wire charger

2.6 Software and Firmware

The test was conducted with firmware version 20A8359 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v05r02 were used in the measurement of the EUT**.**

Deviation from measurement procedure…….....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50µH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is EPCOS 2X60A Power Line Filter (100dB Attenuation, 14kHz-18GHz) and the two EPCOs 2X48A filters (100dB Minimum Insertion Loss, 14kHz - 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that the cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.9. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.50.40.

3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

Per KDB 414788 D01 v01r01, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was rotated about its vertical axis while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15ºC to 35ºC. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antenna(s) of the EUT are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.77
Line Conducted Disturbance	2.70
Radiated Disturbance (<30MHz)	4.38
Radiated Disturbance (30MHz - 1GHz)	4.75
Radiated Disturbance (1 - 18GHz)	5.20
Radiated Disturbance (>18GHz)	4.72

6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
Anritsu	ML2496A	Power Meter	11/29/2021	Annual	11/29/2022	1840005
Anritsu	MA2411B	Pulse Power Sensor	11/30/2021	Annual	11/30/2022	1726261
Anritsu	MA2411B	Pulse Power Sensor	11/30/2021	Annual	11/30/2022	1726262
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	1/19/2022	Annual	1/19/2023	T058701-02
Com-Power Corporation	LIN-120A	Line Impedance Stabilization Network (LISN)	3/7/2022	Annual	3/7/2023	241296
ETS-Lindgren	3142E	Biconilog Antenna (26-6000MHz)	10/21/2021	Annual	10/21/2022	208204
ETS-Lindgren	3117	Double Ridged Guide Horn Antenna (1-18GHz)	10/25/2021	Annual	10/25/2022	227597
Keysight Technology	N9040B	UXA Signal Analyzer	2/8/2022	Annual	2/8/2023	MY57212015
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz-6GHz)	1/6/2022	Annual	1/6/2023	102328
Rohde & Schwarz	ESW26	EMI Test Receiver	5/19/2022	Annual	5/19/2023	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	12/2/2021	Annual	12/2/2022	101570
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/4/2022	Annual	3/4/2023	101619
Rohde & Schwarz	FSVA3044	Signal Analyzer (up to 44 GHz)	5/12/2022	Annual	5/12/2023	101098
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/3/2022	Annual	4/3/2023	100546
Rohde & Schwarz	TC-TA18	Cross-Polarized Antenna 400MHz-18GHz	1/25/2022	Annual	1/25/2023	101063
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz-18GHz)	1/6/2022	Annual	1/6/2023	101639
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz-40GHz)	4/18/2022	Annual	4/18/2023	100050

Table 6-1. Test Equipment List

Note:

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

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCGA2764

IC: 579C-A2764

FCC Classification: Digital Transmission System (DTS)

Number of Channels: 40

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	RSS-247 [5.2]	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 7.2
2.1049	RSS-Gen [6.7]	Occupied Bandwidth	N/A		N/A	Section 7.2
15.247(b)(3)	RSS-247 [5.4(d)]	Transmitter Output Power	< 1 Watt		PASS	Sections 7.3
15.247(e)	RSS-247 [5.2]	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 7.4
15.247(d)	RSS-247 [5.5]	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 7.5, 7.6
15.205 15.209	RSS-Gen [8.9]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9])	RADIATED	PASS	Sections 7.7, 7.7.1, 7.8
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits (RSS-Gen[8.8])	LINE CONDUCTED	PASS	Section 7.9

Table 7-1. Summary of Test Results

Notes:

1. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is Element "Bluetooth LE Automation," Version 4.0.
5. For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is Element "Chamber Automation," Version 1.3.2.

7.2 Bandwidth Measurement – Bluetooth (LE)

§2.1049; §15.247(a.2); RSS-247 [5.2]; RSS-Gen [6.7]

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible 6dB bandwidth is 500 kHz.

Test Procedure Used

ANSI C63.10-2013 – Subclause 11.8.2 Option 2
KDB 558074 D01 v05r02 – Section 8.2
RSS-Gen [6.7]

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 99% occupied bandwidth and the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-1. Test Instrument & Measurement Setup

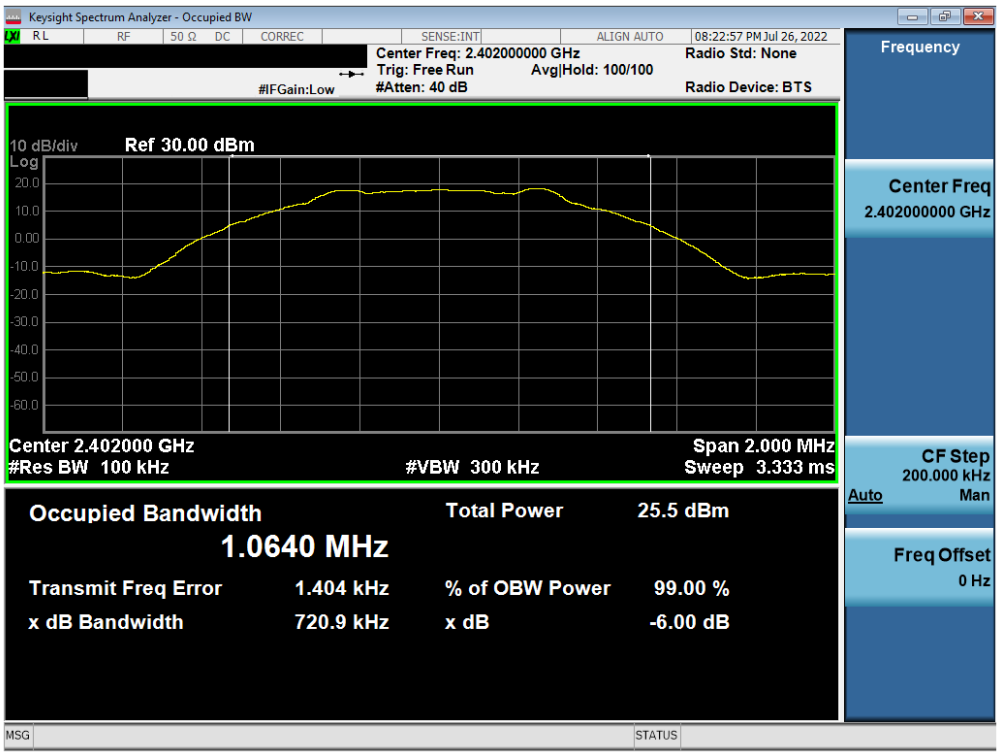
Test Notes

All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.

Antenna 4a

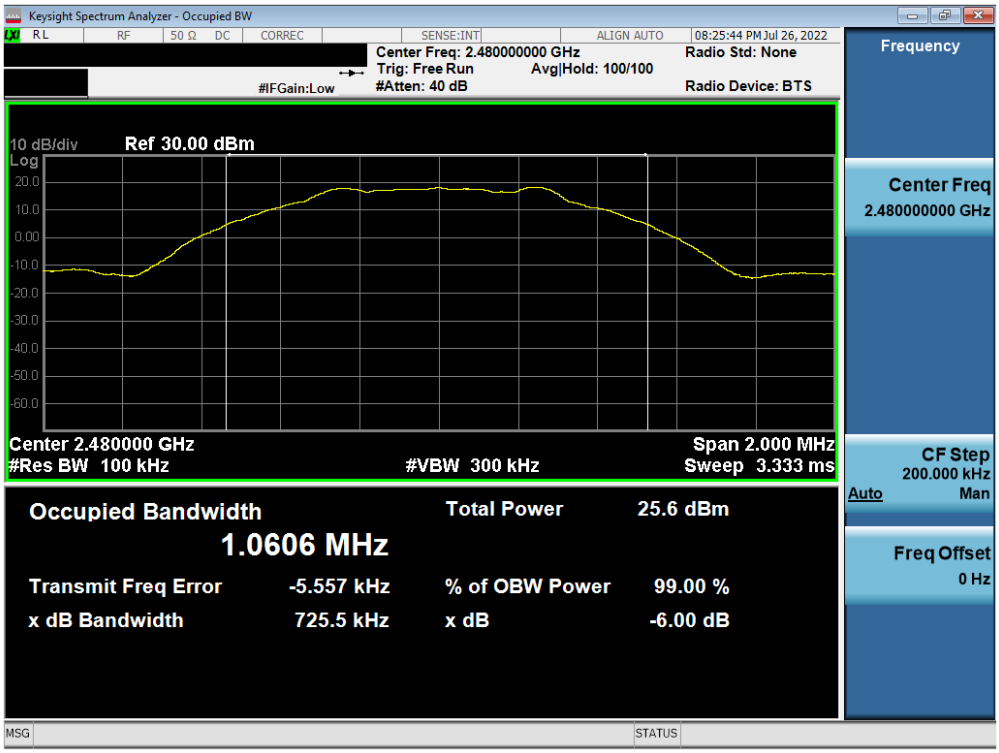
Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured 99% Occupied Bandwidth [kHz]	Measured 6dB Bandwidth [kHz]	Minimum 6dB Bandwidth [kHz]	Pass / Fail
2402	1.0	ePA	0	1064.0	720.9	500	Pass
2440	1.0	ePA	19	1060.5	722.2	500	Pass
2480	1.0	ePA	39	1060.6	725.5	500	Pass
2404	2.0	ePA	1	2074.6	1323.0	500	Pass
2440	2.0	ePA	19	2071.5	1326.0	500	Pass
2478	2.0	ePA	38	2068.6	1323.0	500	Pass

Table 7-2. 6dB BW & 99% OBW Measurements Antenna 4a

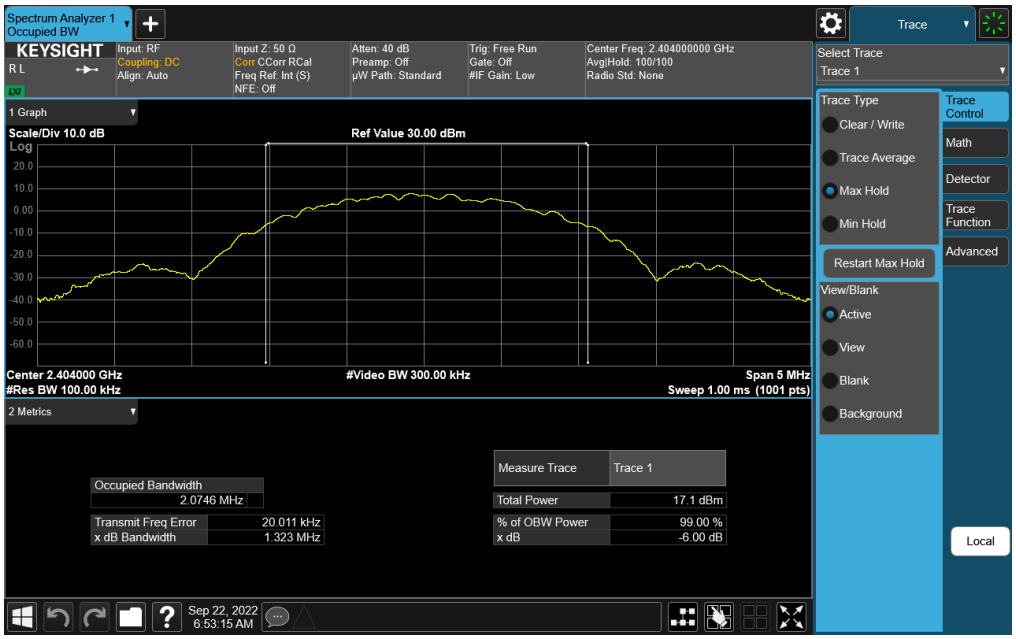


Plot 7-1. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)

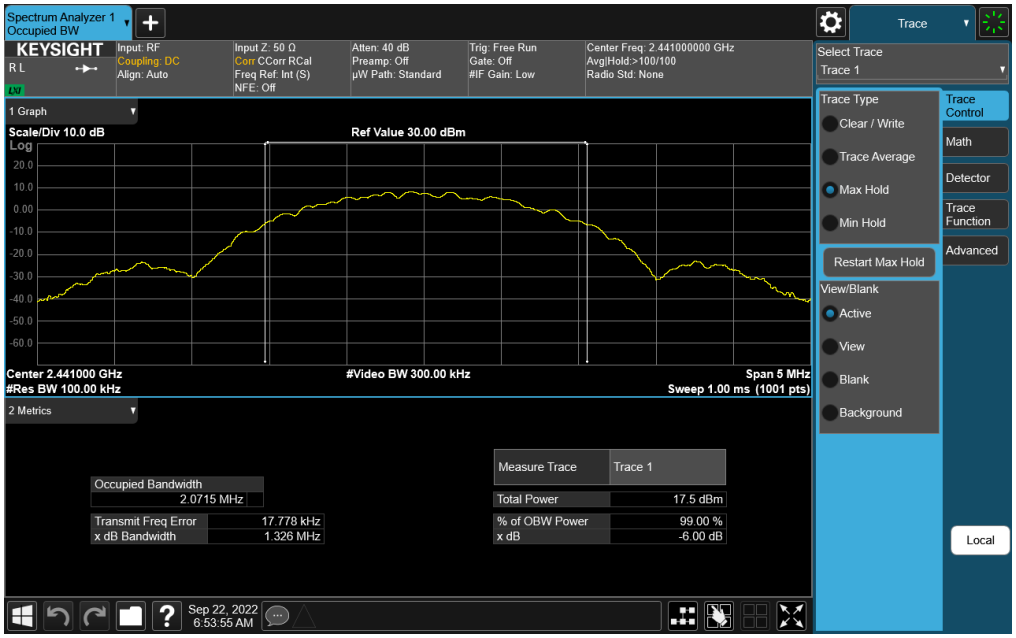
Plot 7-2. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



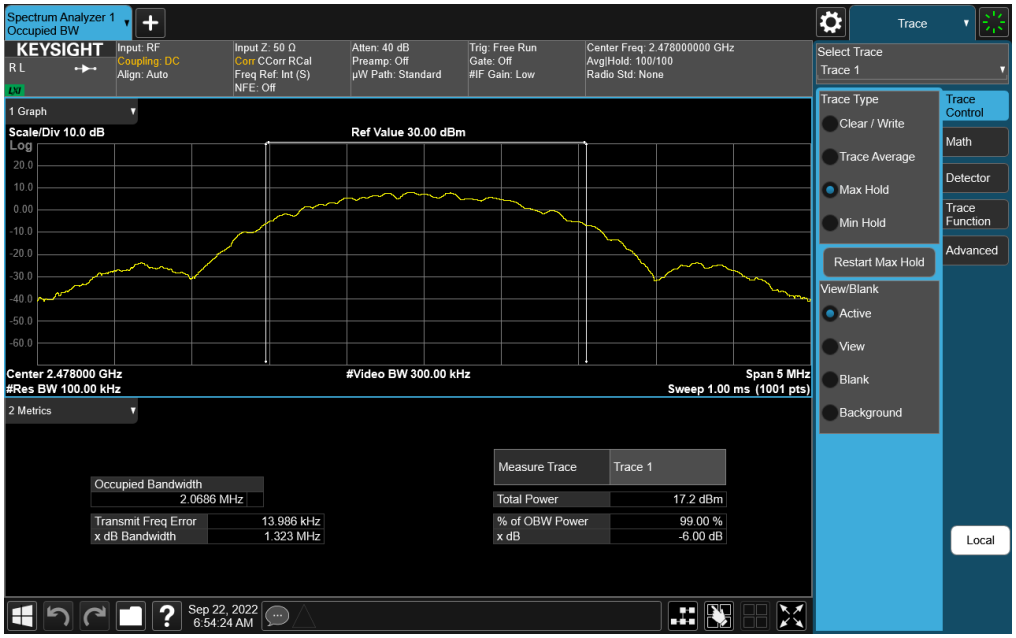
Plot 7-3. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



Plot 7-4. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-5. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



Plot 7-6. 6dB BW & 99% OBW Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

Antenna 2a

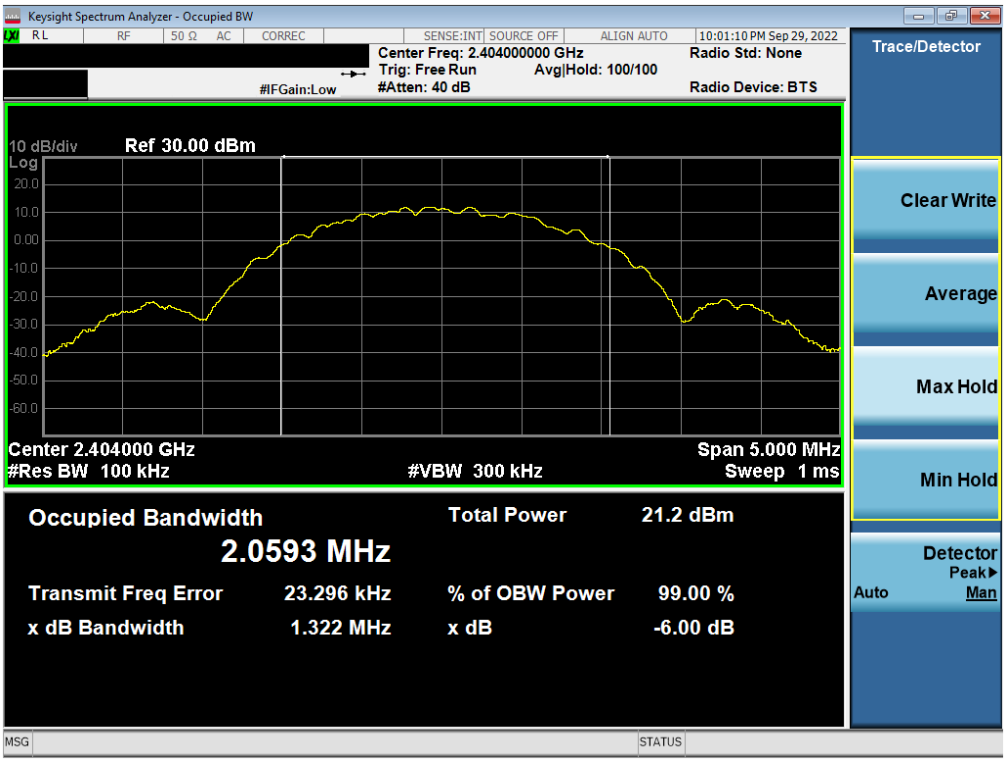
Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured 99% Occupied Bandwidth [kHz]	Measured 6dB Bandwidth [kHz]	Minimum 6dB Bandwidth [kHz]	Pass / Fail
2402	1.0	ePA	0	1066.3	724.6	500	Pass
2440	1.0	ePA	19	1062.4	723.4	500	Pass
2480	1.0	ePA	39	1063.3	724.1	500	Pass
2404	2.0	ePA	1	2059.3	1322.0	500	Pass
2440	2.0	ePA	19	2077.8	1327.0	500	Pass
2478	2.0	ePA	38	2059.1	1324.0	500	Pass

Table 7-3. 6dB BW & 99% OBW Measurements Antenna 2a

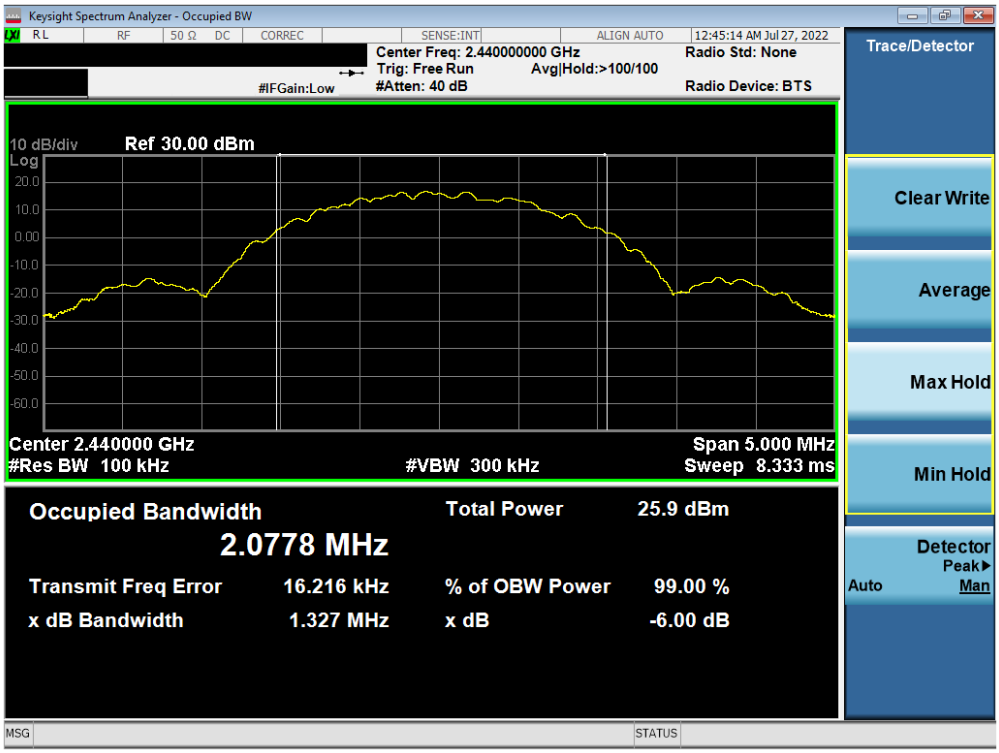
Plot 7-7. 6dB BW & 99% OBW Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)

Plot 7-8. 6dB BW & 99% OBW Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)

Plot 7-9. 6dB BW & 99% OBW Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



Plot 7-10. 6dB BW & 99% OBW Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-11. 6dB BW & 99% OBW Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)

Plot 7-12. 6dB BW & 99% OBW Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

7.3 Output Power Measurement – Bluetooth (LE)

§15.247(b.3); RSS-247 [5.4(d)]

Test Overview and Limits

The transmitter antenna terminal of the EUT is connected to the input of a spectrum analyzer. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

The conducted output power limit on paragraph above is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For DTSs employing digital modulation techniques operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W.

Test Procedure Used

ANSI C63.10-2013 – Subclause 11.9.1.3
ANSI C63.10-2013 – Subclause 11.9.2.3.2
KDB 558074 D01 v05r02 – Section 8.3.1.3, 8.3.2.3
ANSI C63.10-2013 – Subclause 14.2 Measure-and-Sum Technique
KDB 662911 D01 v02r01 – Section E)1) Measure-and-Sum Technique

Test Settings

Method PKPM1 (Peak Power Measurement)

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Method AVGPM-G (Average Power Measurement)

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-2. Test Instrument & Measurement Setup for Peak and Average Power Measurement

Test Notes

None

7.3.1 Peak Output Power Measurement – Bluetooth (LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Peak Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				[dBm]	[mW]						
2402	1.0	ePA	0	14.33	27.102	30.00	-15.67	1.80	16.13	36.02	-19.89
2440	1.0	ePA	19	14.36	27.290	30.00	-15.64	1.80	16.16	36.02	-19.86
2480	1.0	ePA	39	14.60	28.840	30.00	-15.40	1.80	16.40	36.02	-19.62
2402	1.0	iPA	0	10.32	10.765	30.00	-19.68	1.80	12.12	36.02	-23.90
2440	1.0	iPA	19	10.53	11.298	30.00	-19.47	1.80	12.33	36.02	-23.69
2480	1.0	iPA	39	10.29	10.691	30.00	-19.71	1.80	12.09	36.02	-23.93
2404	2.0	ePA	1	14.36	27.290	30.00	-15.64	1.80	16.16	36.02	-19.86
2440	2.0	ePA	19	14.40	27.542	30.00	-15.60	1.80	16.20	36.02	-19.82
2478	2.0	ePA	38	14.52	28.314	30.00	-15.48	1.80	16.32	36.02	-19.70
2404	2.0	iPA	1	11.10	12.882	30.00	-18.90	1.80	12.90	36.02	-23.12
2440	2.0	iPA	19	11.24	13.305	30.00	-18.76	1.80	13.04	36.02	-22.98
2478	2.0	iPA	38	11.21	13.213	30.00	-18.79	1.80	13.01	36.02	-23.01

Table 7-4. Peak Conducted Output Power Measurements Antenna 4a (Bluetooth LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Peak Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				[dBm]	[mW]						
2402	1.0	ePA	0	13.98	25.003	30.00	-16.02	2.40	16.38	36.02	-19.64
2440	1.0	ePA	19	14.04	25.351	30.00	-15.96	2.40	16.44	36.02	-19.58
2480	1.0	ePA	39	14.21	26.363	30.00	-15.79	2.40	16.61	36.02	-19.41
2402	1.0	iPA	0	10.14	10.328	30.00	-19.86	2.40	12.54	36.02	-23.48
2440	1.0	iPA	19	9.75	9.441	30.00	-20.25	2.40	12.15	36.02	-23.87
2480	1.0	iPA	39	9.95	9.886	30.00	-20.05	2.40	12.35	36.02	-23.67
2404	2.0	ePA	1	14.01	25.177	30.00	-15.99	2.40	16.41	36.02	-19.61
2440	2.0	ePA	19	14.03	25.293	30.00	-15.97	2.40	16.43	36.02	-19.59
2478	2.0	ePA	38	14.15	26.002	30.00	-15.85	2.40	16.55	36.02	-19.47
2404	2.0	iPA	1	10.12	10.280	30.00	-19.88	2.40	12.52	36.02	-23.50
2440	2.0	iPA	19	10.21	10.495	30.00	-19.79	2.40	12.61	36.02	-23.41
2478	2.0	iPA	38	10.29	10.691	30.00	-19.71	2.40	12.69	36.02	-23.33

Table 7-5. Peak Conducted Output Power Measurements Antenna 2a (Bluetooth LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Peak Conducted Power						Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Directional Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				Antenna 4a		Antenna 2a		Summed							
				[dBm]	[mW]	[dBm]	[mW]	[dBm]	[mW]						
2402	1.0	ePA	0	11.14	13.002	10.51	11.246	13.85	24.248	30.00	-16.15	5.12	18.96	36.02	-17.06
2440	1.0	ePA	19	10.78	11.967	10.62	11.535	13.71	23.502	30.00	-16.29	5.12	18.83	36.02	-17.19
2480	1.0	ePA	39	10.95	12.445	10.58	11.429	13.78	23.874	30.00	-16.22	5.12	18.89	36.02	-17.13
2402	1.0	iPA	0	10.41	10.990	10.03	10.069	13.23	21.059	30.00	-16.77	5.12	18.35	36.02	-17.67
2440	1.0	iPA	19	10.48	11.169	10.11	10.257	13.31	21.425	30.00	-16.69	5.12	18.42	36.02	-17.60
2480	1.0	iPA	39	10.53	11.298	9.85	9.661	13.21	20.958	30.00	-16.79	5.12	18.33	36.02	-17.69
2404	2.0	ePA	1	13.74	23.659	13.27	21.232	16.52	44.892	30.00	-13.48	5.12	21.64	36.02	-14.38
2440	2.0	ePA	19	13.94	24.774	13.83	24.155	16.90	48.929	30.00	-13.10	5.12	22.01	36.02	-14.01
2478	2.0	ePA	38	13.82	24.099	13.92	24.660	16.88	48.759	30.00	-13.12	5.12	22.00	36.02	-14.02
2404	2.0	iPA	1	10.53	11.298	9.87	9.705	13.22	21.003	30.00	-16.78	5.12	18.34	36.02	-17.68
2440	2.0	iPA	19	10.75	11.885	9.96	9.908	13.38	21.793	30.00	-16.62	5.12	18.50	36.02	-17.52
2478	2.0	iPA	38	10.64	11.588	9.79	9.528	13.25	21.116	30.00	-16.75	5.12	18.36	36.02	-17.66

Table 7-6. Peak Conducted Output Power Measurements TxBF (Bluetooth LE)

7.3.2 Average Output Power Measurement – Bluetooth (LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Average Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				[dBm]	[mW]						
2402	1.0	ePA	0	14.13	25.882	30.00	-15.87	1.80	15.93	36.02	-20.09
2440	1.0	ePA	19	14.15	26.002	30.00	-15.85	1.80	15.95	36.02	-20.07
2480	1.0	ePA	39	14.40	27.542	30.00	-15.60	1.80	16.20	36.02	-19.82
2402	1.0	iPA	0	10.25	10.593	30.00	-19.75	1.80	12.05	36.02	-23.97
2440	1.0	iPA	19	10.33	10.789	30.00	-19.67	1.80	12.13	36.02	-23.89
2480	1.0	iPA	39	10.10	10.233	30.00	-19.90	1.80	11.90	36.02	-24.12
2404	2.0	ePA	1	14.23	26.485	30.00	-15.77	1.80	16.03	36.02	-19.99
2440	2.0	ePA	19	14.29	26.853	30.00	-15.71	1.80	16.09	36.02	-19.93
2478	2.0	ePA	38	14.35	27.227	30.00	-15.65	1.80	16.15	36.02	-19.87
2404	2.0	iPA	1	10.33	10.789	30.00	-19.67	1.80	12.13	36.02	-23.89
2440	2.0	iPA	19	10.22	10.520	30.00	-19.78	1.80	12.02	36.02	-24.00
2478	2.0	iPA	38	10.44	11.066	30.00	-19.56	1.80	12.24	36.02	-23.78

Table 7-7. Average Conducted Output Power Measurements Antenna 4a (Bluetooth LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Average Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				[dBm]	[mW]						
2402	1.0	ePA	0	13.64	23.121	30.00	-16.36	2.40	16.04	36.02	-19.98
2440	1.0	ePA	19	13.85	24.266	30.00	-16.15	2.40	16.25	36.02	-19.77
2480	1.0	ePA	39	14.00	25.119	30.00	-16.00	2.40	16.40	36.02	-19.62
2402	1.0	iPA	0	9.98	9.954	30.00	-20.02	2.40	12.38	36.02	-23.64
2440	1.0	iPA	19	9.56	9.036	30.00	-20.44	2.40	11.96	36.02	-24.06
2480	1.0	iPA	39	9.76	9.462	30.00	-20.24	2.40	12.16	36.02	-23.86
2404	2.0	ePA	1	13.68	23.335	30.00	-16.32	2.40	16.08	36.02	-19.94
2440	2.0	ePA	19	13.74	23.659	30.00	-16.26	2.40	16.14	36.02	-19.88
2478	2.0	ePA	38	13.85	24.266	30.00	-16.15	2.40	16.25	36.02	-19.77
2404	2.0	iPA	1	9.72	9.376	30.00	-20.28	2.40	12.12	36.02	-23.90
2440	2.0	iPA	19	9.82	9.594	30.00	-20.18	2.40	12.22	36.02	-23.80
2478	2.0	iPA	38	9.86	9.683	30.00	-20.14	2.40	12.26	36.02	-23.76

Table 7-8. Average Conducted Output Power Measurements Antenna 2a (Bluetooth LE)

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Average Conducted Power						Conducted Power Limit [dBm]	Conducted Power Margin [dB]	Directional Ant. Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]
				Antenna 4a		Antenna 2a		Summed							
				[dBm]	[mW]	[dBm]	[mW]	[dBm]	[mW]						
2402	1.0	ePA	0	10.92	12.359	10.35	10.839	13.65	23.199	30.00	-16.35	5.12	18.77	36.02	-17.25
2440	1.0	ePA	19	10.59	11.455	10.45	11.092	13.53	22.547	30.00	-16.47	5.12	18.65	36.02	-17.37
2480	1.0	ePA	39	10.65	11.614	10.43	11.041	13.55	22.655	30.00	-16.45	5.12	18.67	36.02	-17.35
2402	1.0	iPA	0	10.21	10.495	9.87	9.705	13.05	20.201	30.00	-16.95	5.12	18.17	36.02	-17.85
2440	1.0	iPA	19	10.30	10.715	9.92	9.817	13.12	20.533	30.00	-16.88	5.12	18.24	36.02	-17.78
2480	1.0	iPA	39	10.36	10.864	9.67	9.268	13.04	20.133	30.00	-16.96	5.12	18.15	36.02	-17.87
2404	2.0	ePA	1	10.50	11.220	10.33	10.789	13.43	22.010	30.00	-16.57	5.12	18.54	36.02	-17.48
2440	2.0	ePA	19	10.70	11.749	10.50	11.220	13.61	22.969	30.00	-16.39	5.12	18.73	36.02	-17.29
2478	2.0	ePA	38	10.54	11.324	10.49	11.194	13.53	22.518	30.00	-16.47	5.12	18.64	36.02	-17.38
2404	2.0	iPA	1	10.25	10.593	9.62	9.162	12.96	19.755	30.00	-17.04	5.12	18.07	36.02	-17.95
2440	2.0	iPA	19	10.12	10.280	9.73	9.397	12.94	19.677	30.00	-17.06	5.12	18.06	36.02	-17.97
2478	2.0	iPA	38	10.35	10.839	9.58	9.078	12.99	19.917	30.00	-17.01	5.12	18.11	36.02	-17.91

Table 7-9. Average Conducted Output Power Measurements TxBF (Bluetooth LE)

Note:

Per ANSI C63.10-2013 and KDB 662911 D01 v02r01 Section E)1), the conducted powers at Antenna 4a and Antenna 2a were first measured separately during TxBF transmission as shown in the section above. The measured values were then summed in linear power units then converted back to dBm.

Per ANSI C63.10-2013 Section 14.4.3, the directional gain is calculated using the following formula, where G_N is the gain of the nth antenna and N_{ANT}, the total number of antennas used.

$$\text{Directional gain} = 10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}] \text{ dBi}$$

Sample TxBF Calculation:

At 2402MHz the average conducted output power was measured to be 10.92 dBm for Antenna 4a and 10.35 dBm for Antenna 2a.

Antenna 4a + Antenna 2a = TxBF

(10.92 dBm + 10.35 dBm) = (12.359 mW + 10.839 mW) = 23.199 mW = 13.65 dBm

Sample e.i.r.p. Calculation:

At 2402MHz, the average conducted output power was calculated to be 13.65 dBm with directional gain of 5.12 dBi.

e.i.r.p. (dBm) = Conducted Power (dBm) + Ant gain (dBi)

13.65 dBm + 5.12 dBi = 18.77 dBm

7.4 Power Spectral Density – Bluetooth (LE)

§15.247(e); RSS-247 [5.2]

Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible power spectral density is 8 dBm in any 3 kHz band.

Test Procedure Used

ANSI C63.10-2013 – Subclause 11.10.2 Method PKPSD
KDB 558074 D01 v05r02 – Section 8.4 DTS Maximum Power Spectral Density level in the fundamental emission
ANSI C63.10-2013 – Subclause 14.3.2.2 Measure-and-Sum Technique
KDB 662911 D01 v02r01 – Section E)2) Measure-and-Sum Technique

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-3. Test Instrument & Measurement Setup

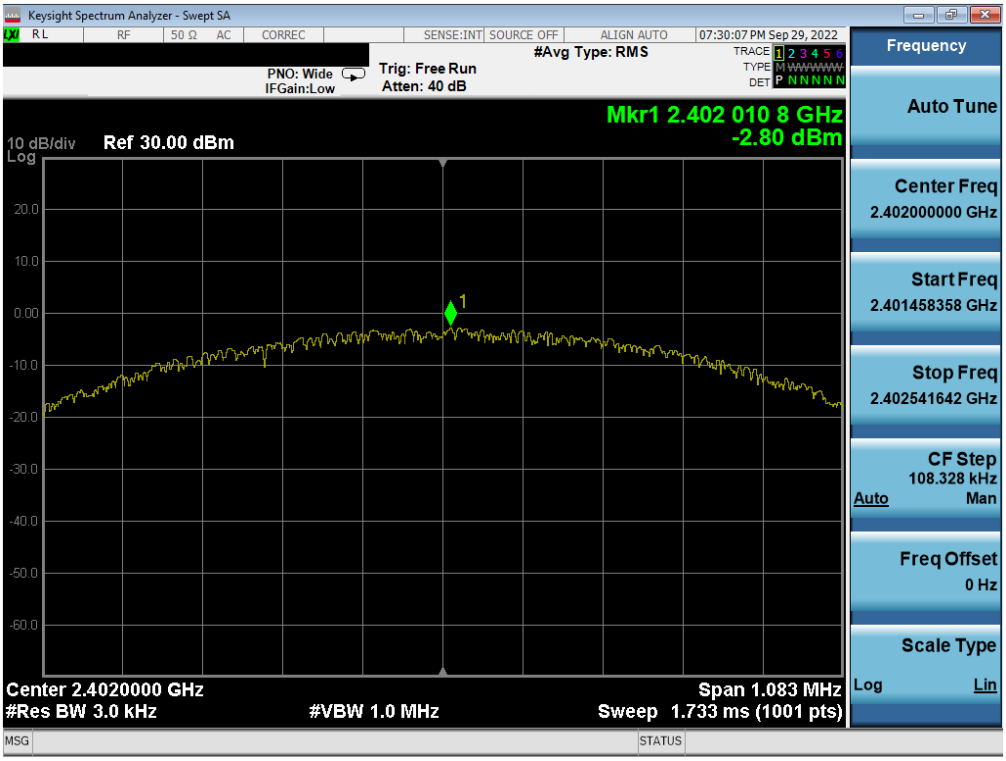
Test Notes

None

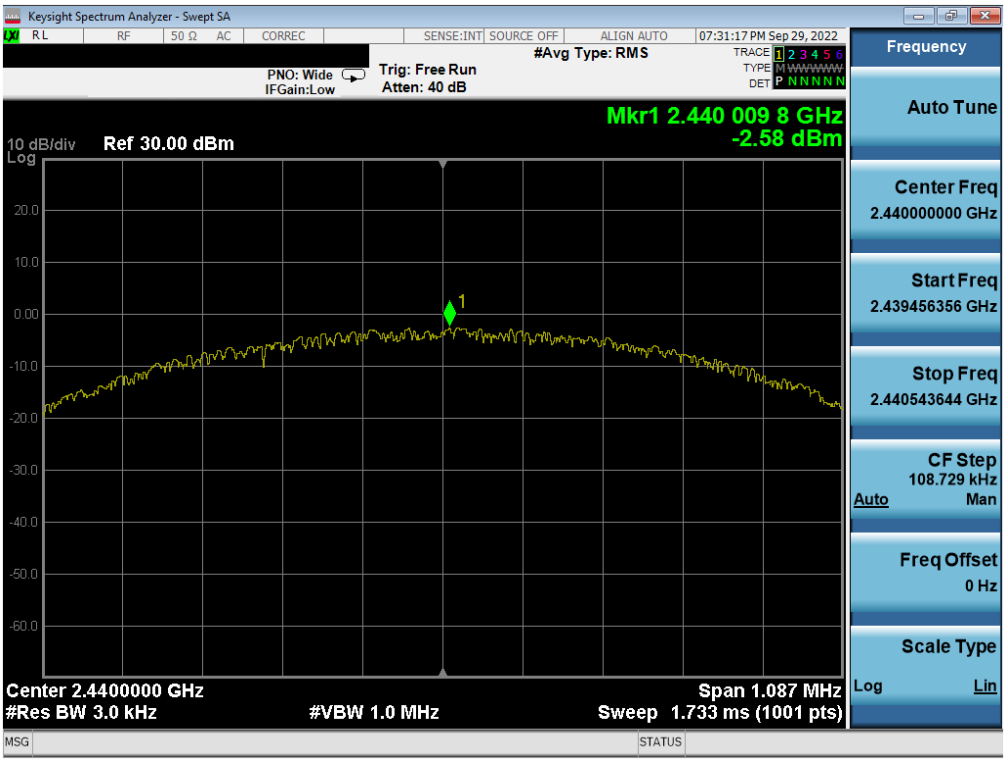
Antenna 4a

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured Power Spectral Density [dBm / 3kHz]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2402	1.0	ePA	0	-2.80	8.0	-10.80
2440	1.0	ePA	19	-2.58	8.0	-10.58
2480	1.0	ePA	39	-2.35	8.0	-10.35
2402	1.0	iPA	0	-6.74	8.0	-14.74
2440	1.0	iPA	19	-6.12	8.0	-14.12
2480	1.0	iPA	39	-6.34	8.0	-14.34
2404	2.0	ePA	1	-8.24	8.0	-16.24
2440	2.0	ePA	19	-8.11	8.0	-16.11
2478	2.0	ePA	38	-7.59	8.0	-15.59
2404	2.0	iPA	1	-12.21	8.0	-20.21
2440	2.0	iPA	19	-11.67	8.0	-19.67
2478	2.0	iPA	38	-11.49	8.0	-19.49

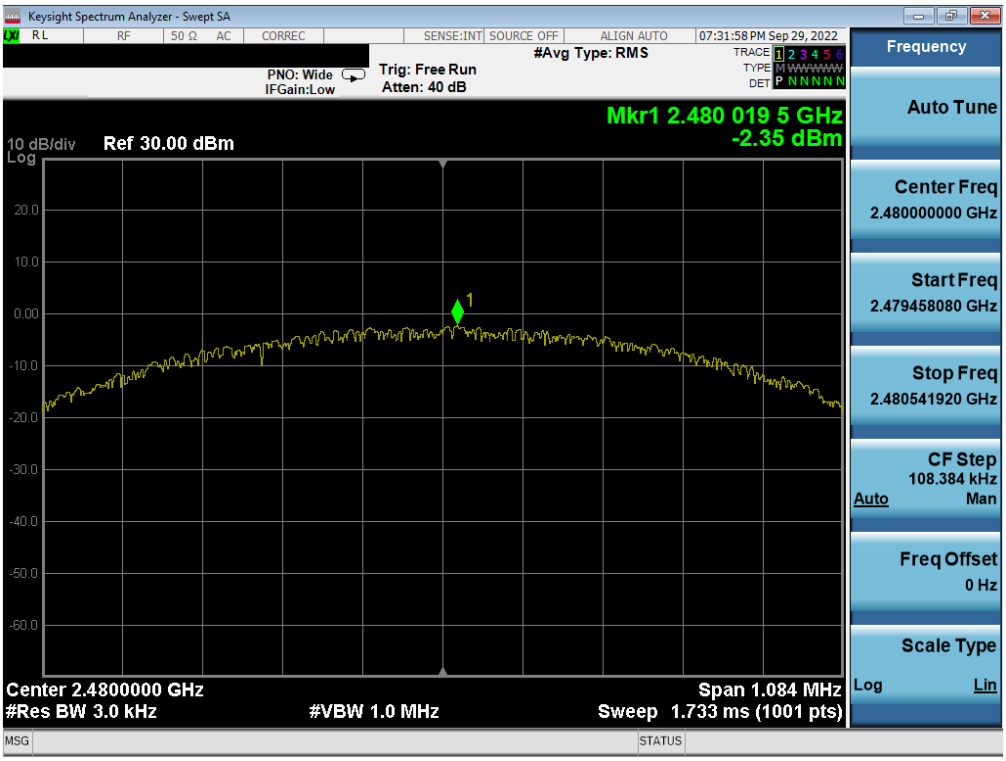
Table 7-10. Conducted Power Density Measurements Antenna 4a



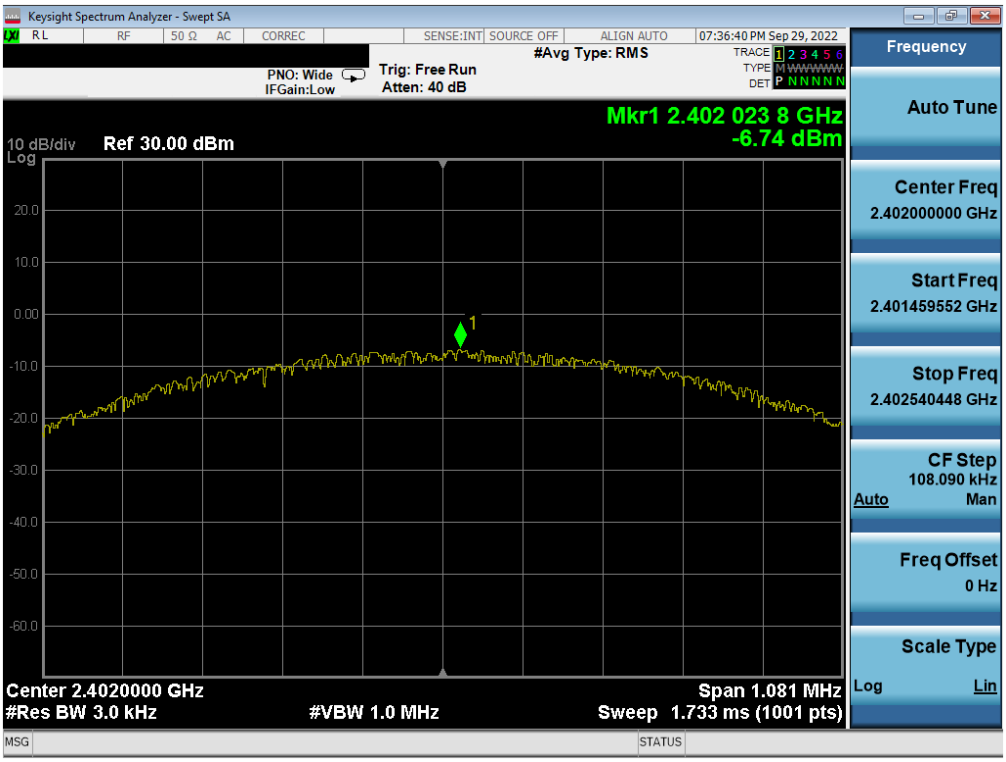
Plot 7-13. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



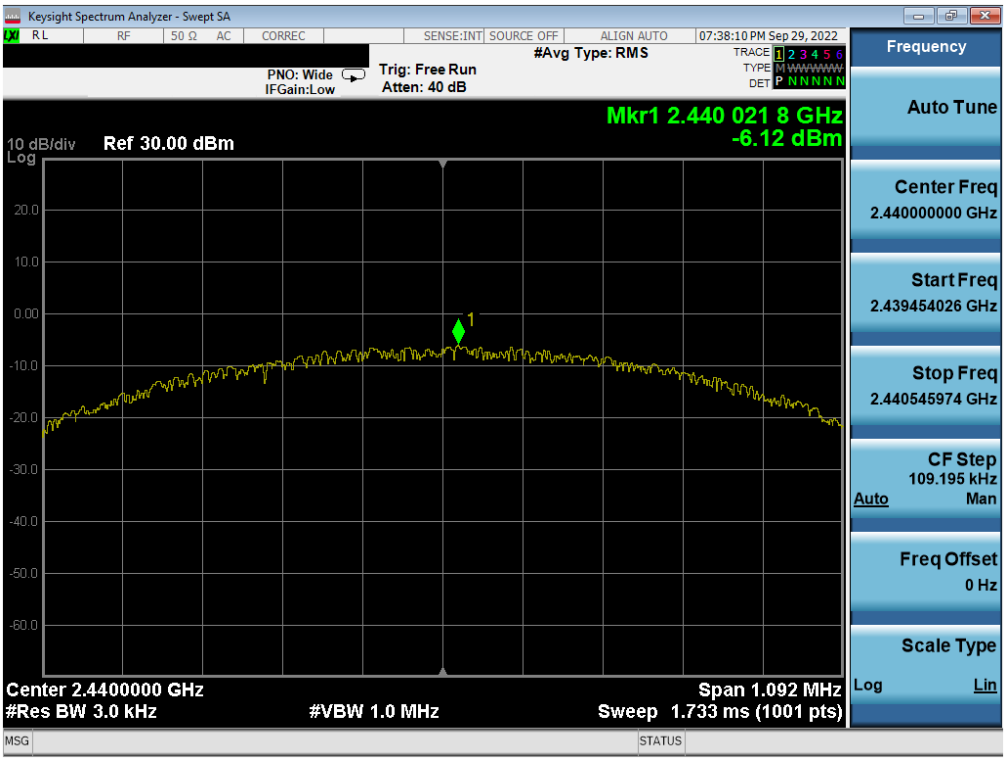
Plot 7-14. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



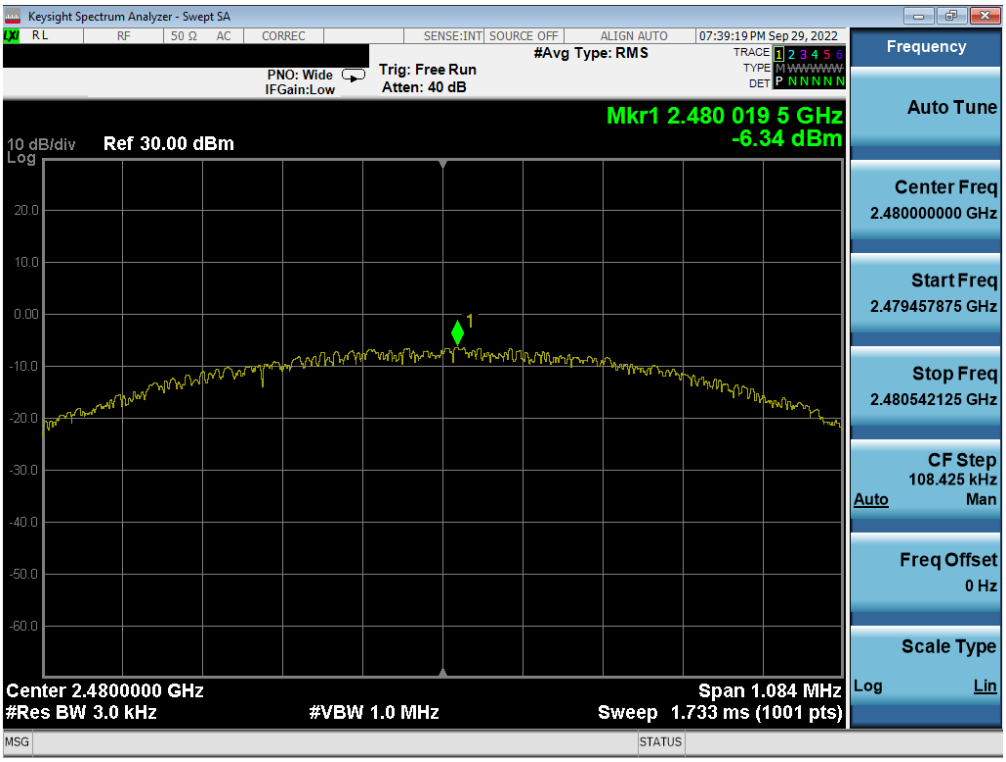
Plot 7-15. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



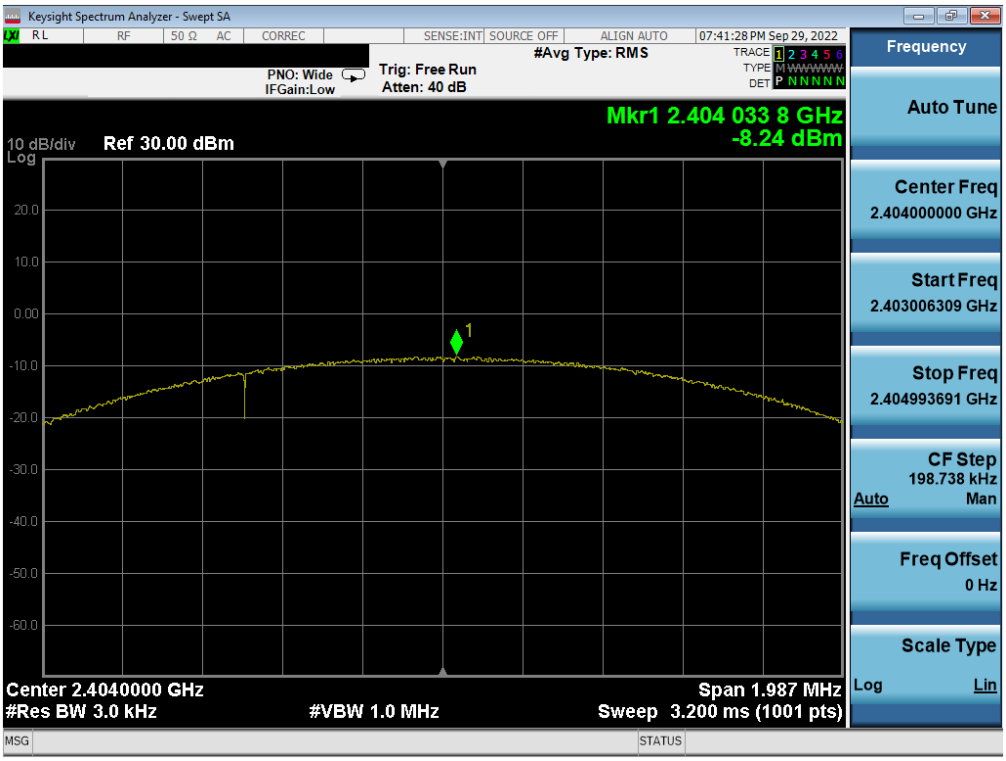
Plot 7-16. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



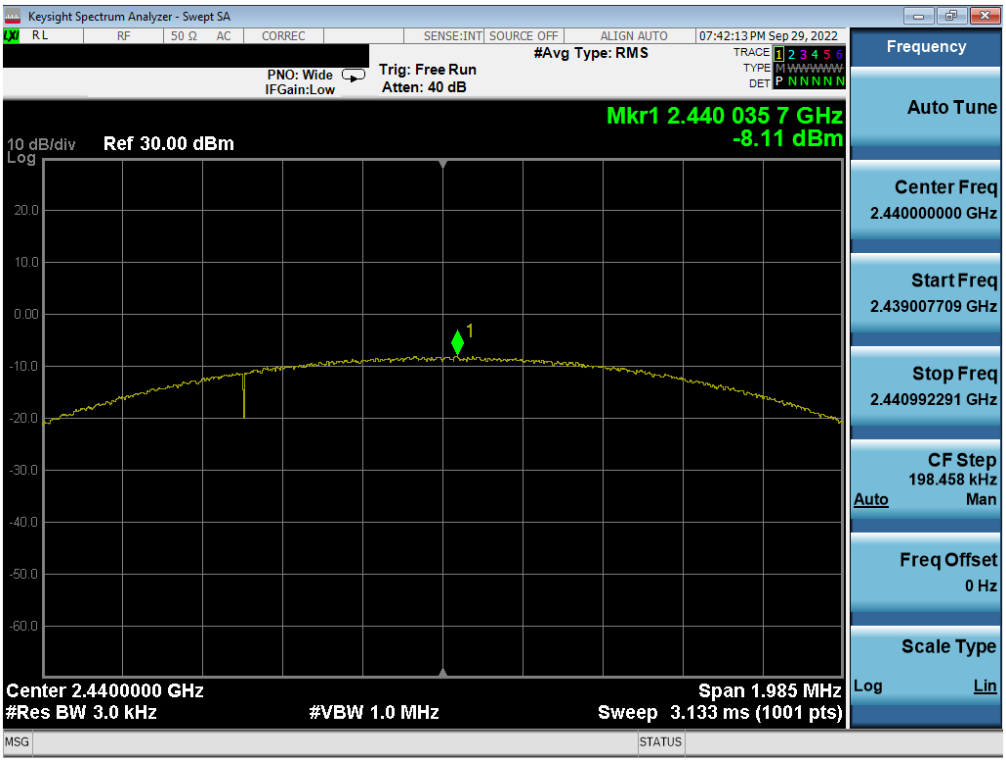
Plot 7-17. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



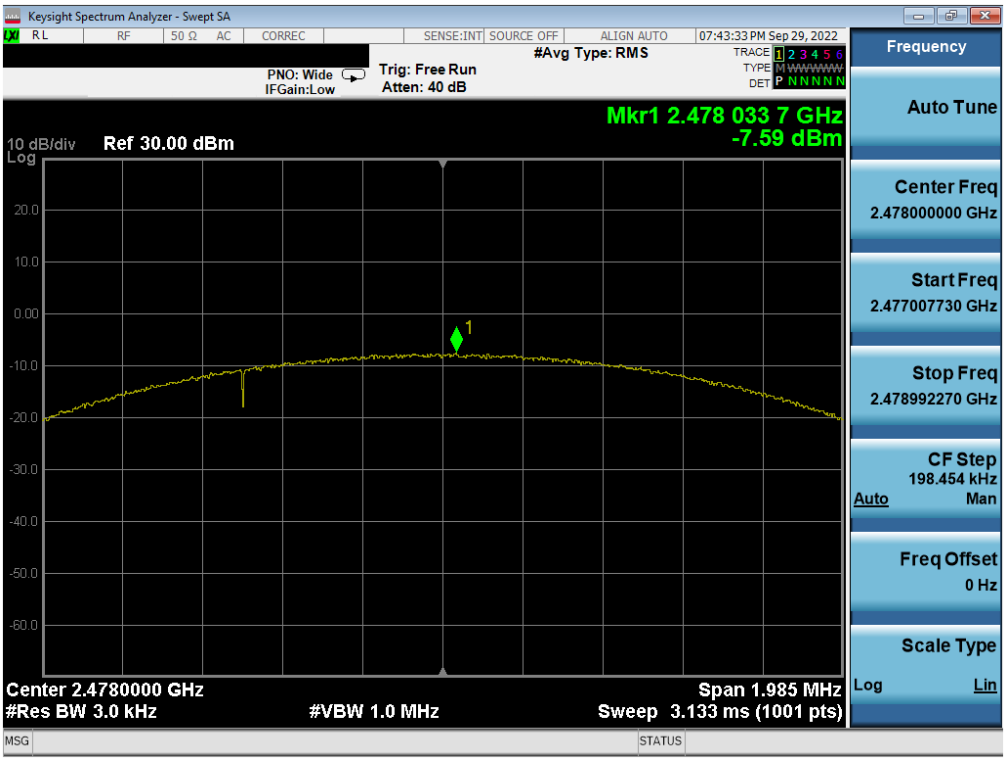
Plot 7-18. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



Plot 7-19. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)

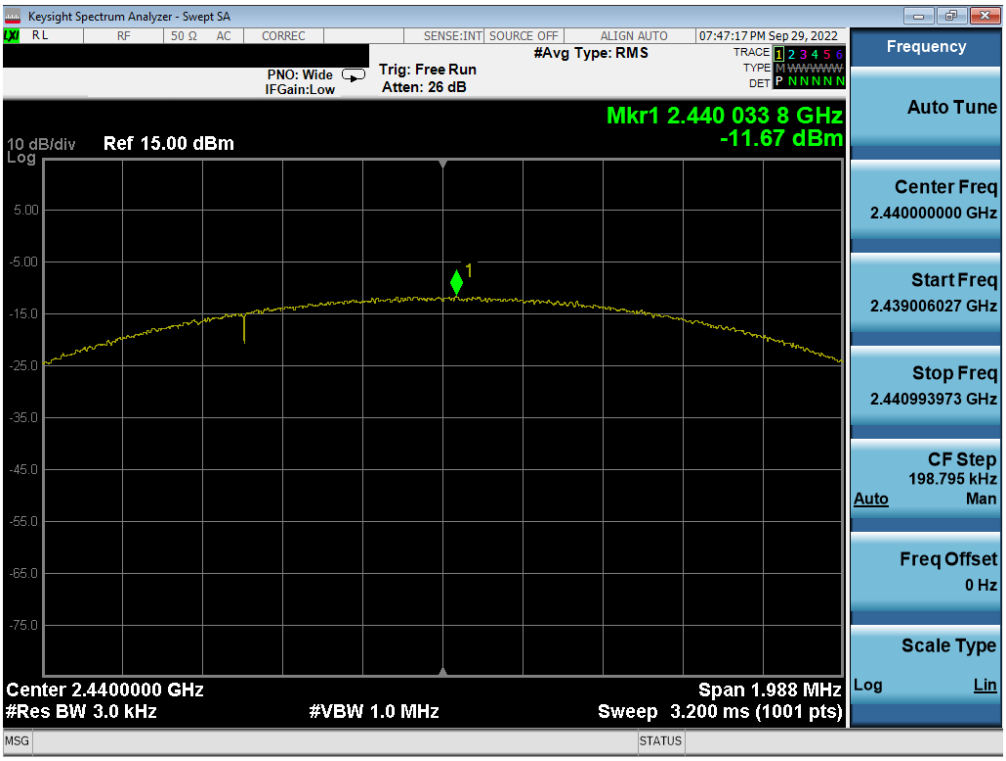


Plot 7-20. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



Plot 7-21. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

Plot 7-22. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 1)



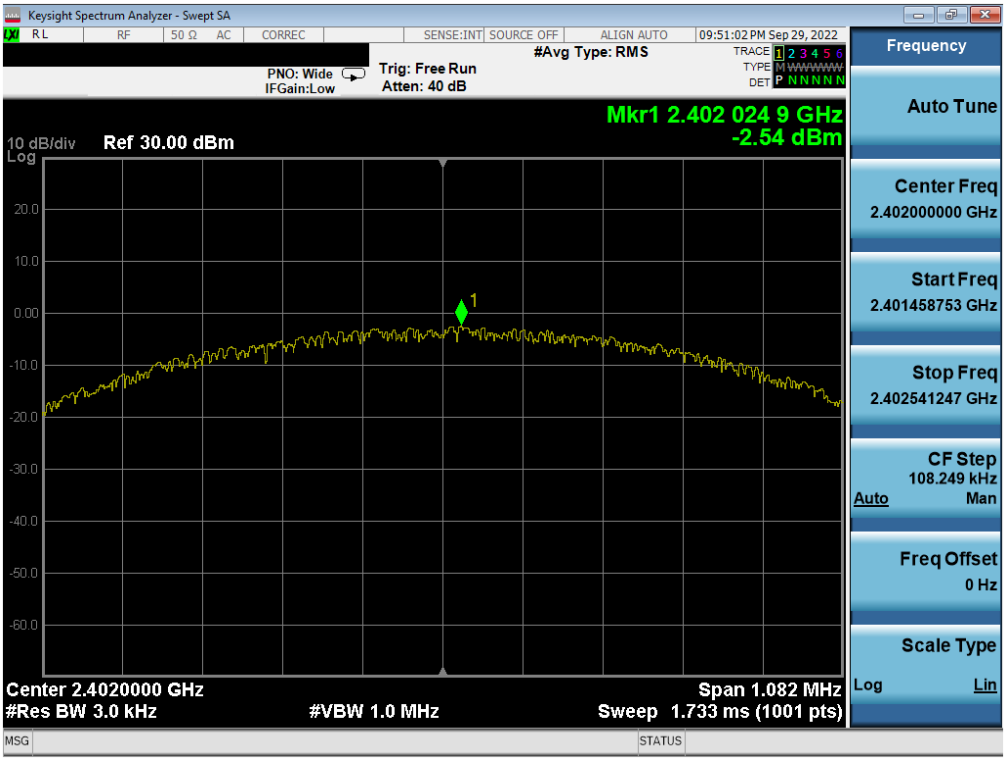
Plot 7-23. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-24. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

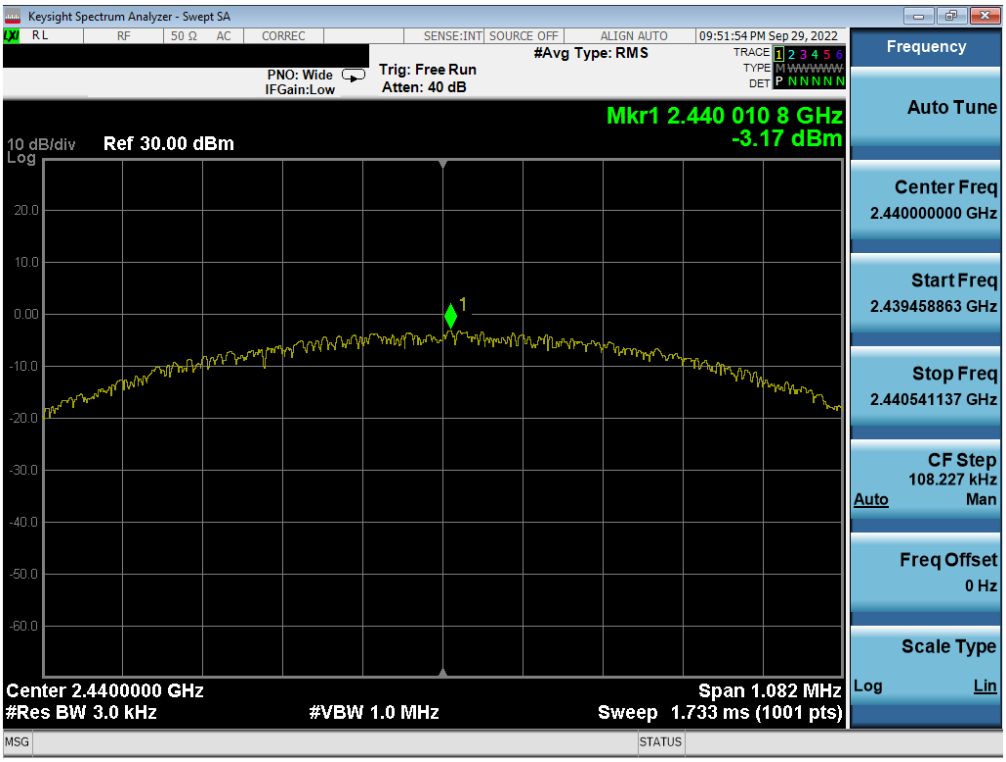
Antenna 2a

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured Power Spectral Density [dBm / 3kHz]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2402	1.0	ePA	0	-2.54	8.0	-10.54
2440	1.0	ePA	19	-3.17	8.0	-11.17
2480	1.0	ePA	39	-3.06	8.0	-11.06
2402	1.0	iPA	0	-6.44	8.0	-14.44
2440	1.0	iPA	19	-6.60	8.0	-14.60
2480	1.0	iPA	39	-6.83	8.0	-14.83
2404	2.0	ePA	1	-8.43	8.0	-16.43
2440	2.0	ePA	19	-8.30	8.0	-16.30
2478	2.0	ePA	38	-8.41	8.0	-16.41
2404	2.0	iPA	1	-12.19	8.0	-20.19
2440	2.0	iPA	19	-12.22	8.0	-20.22
2478	2.0	iPA	38	-12.24	8.0	-20.24

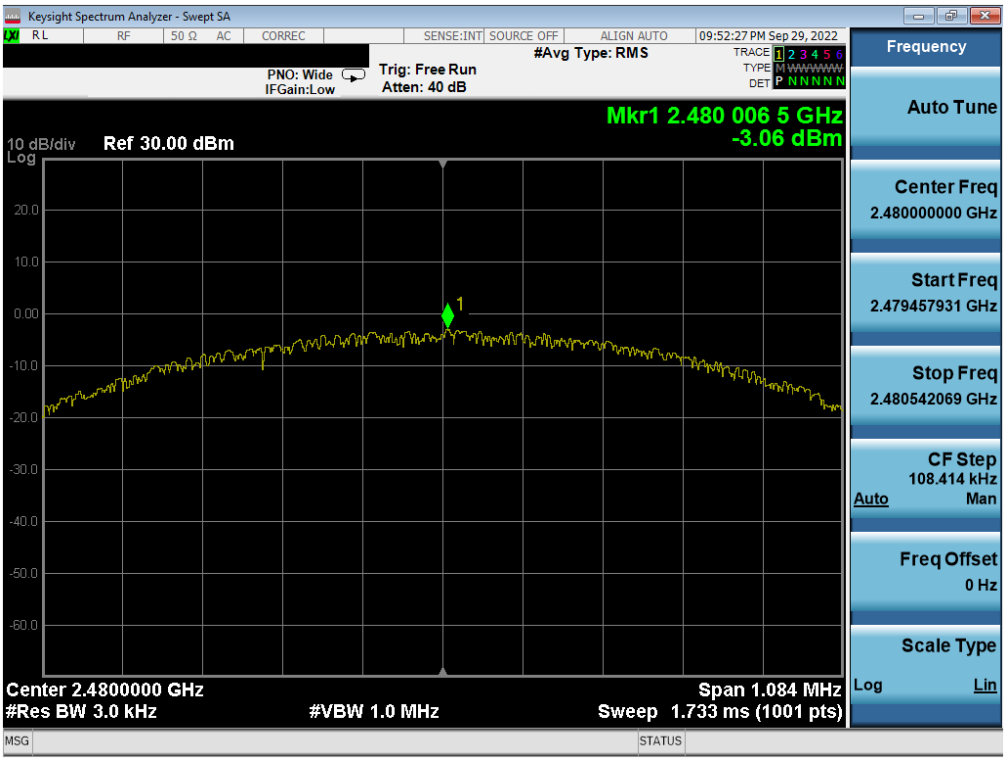
Table 7-11. Conducted Power Density Measurements Antenna 2a



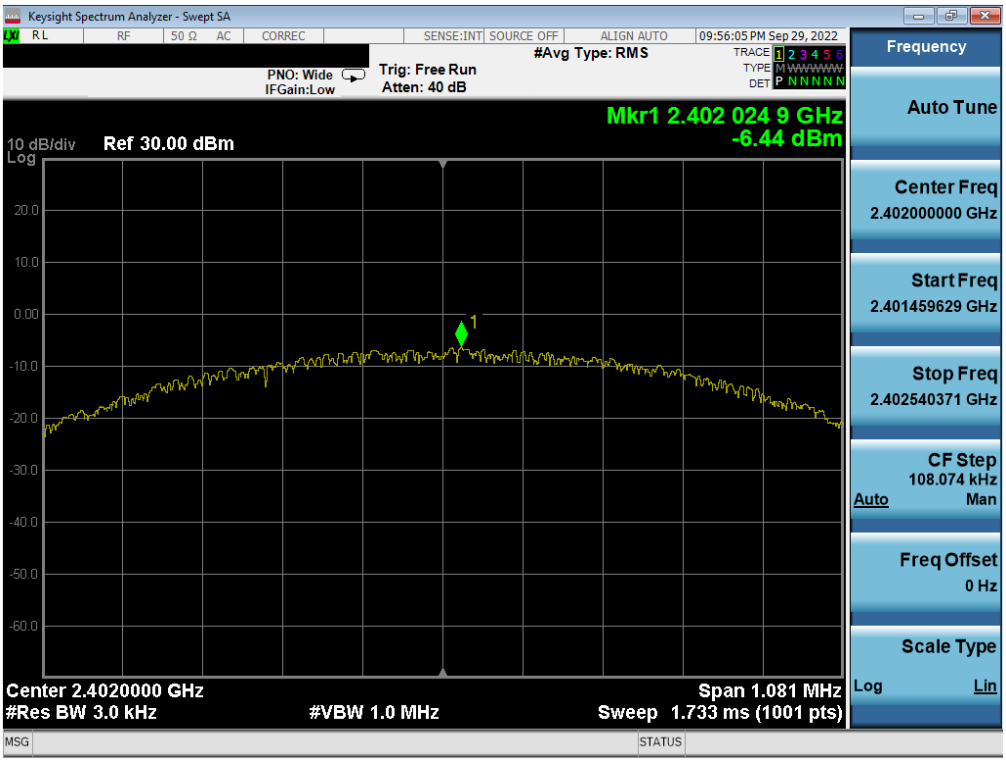
Plot 7-25. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



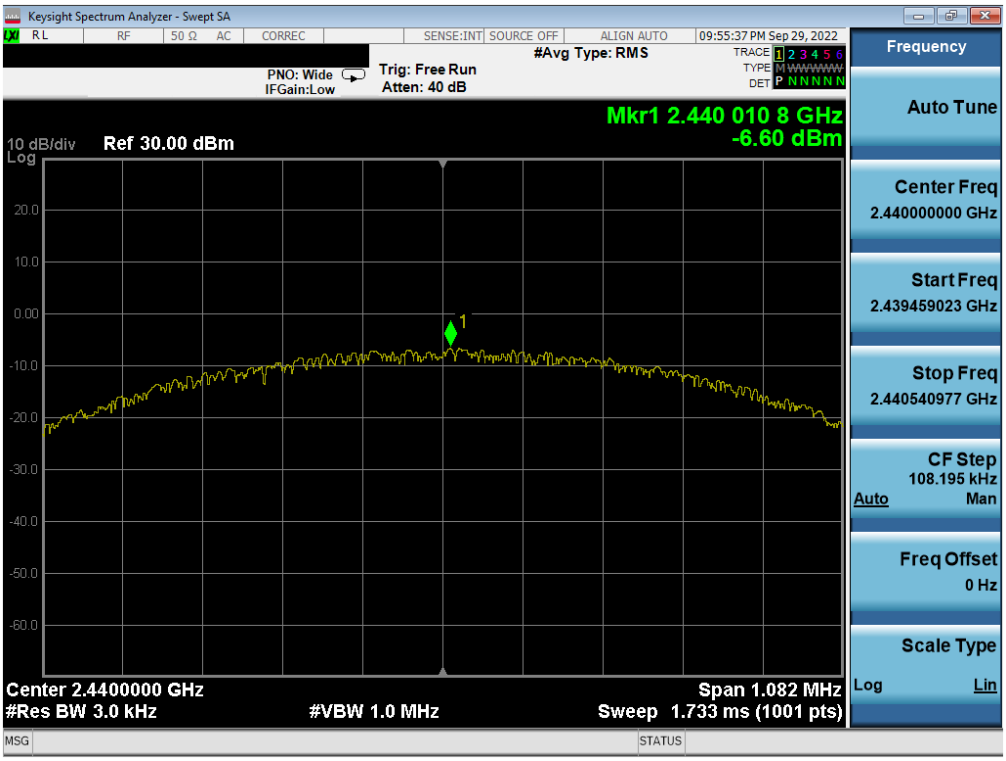
Plot 7-26. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



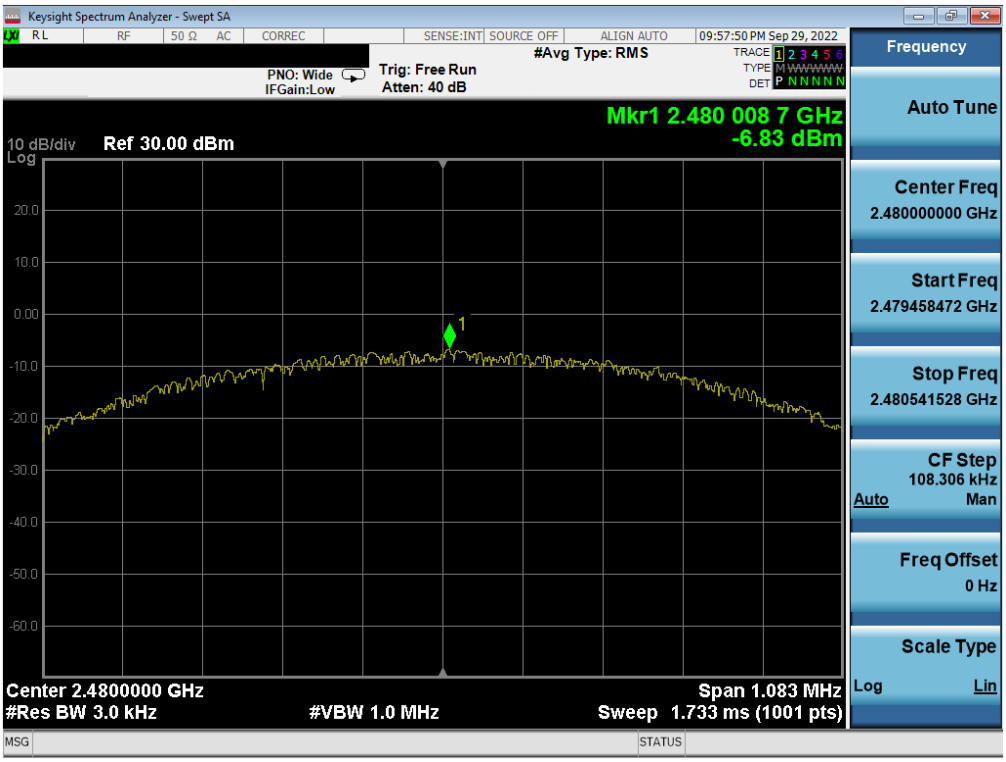
Plot 7-27. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



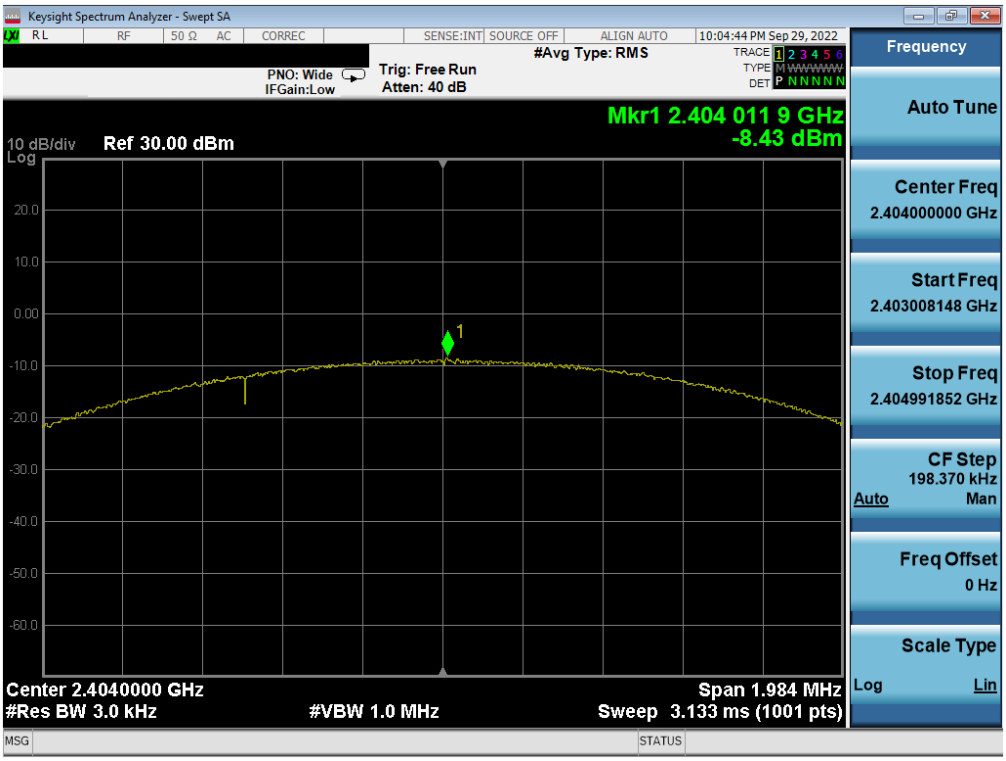
Plot 7-28. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



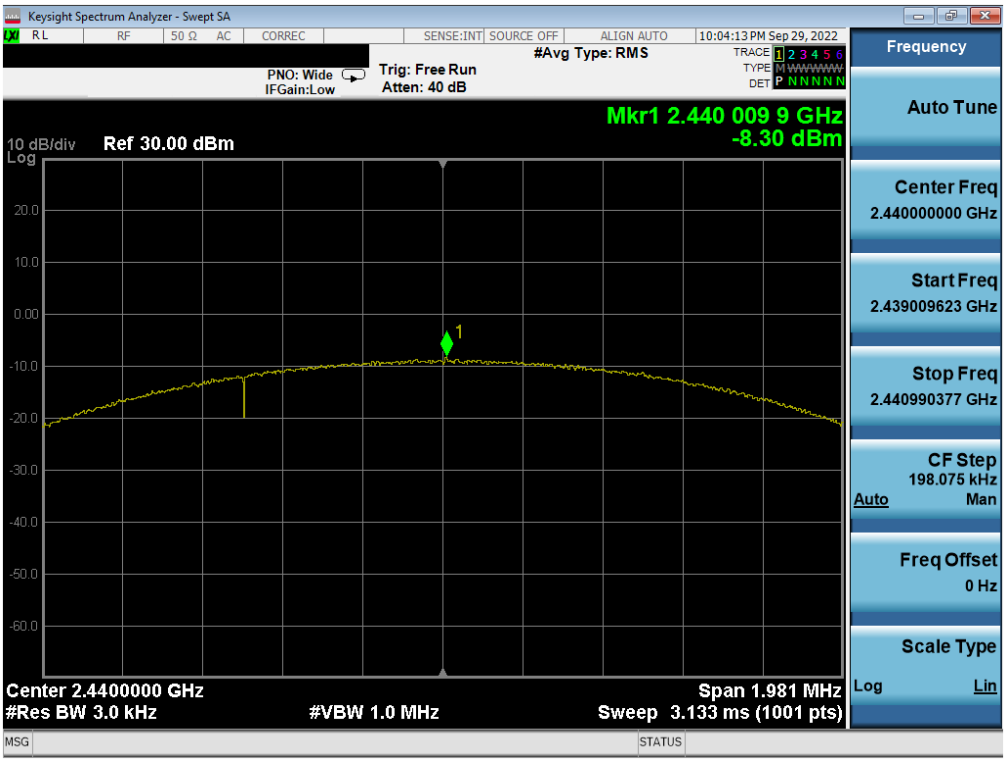
Plot 7-29. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



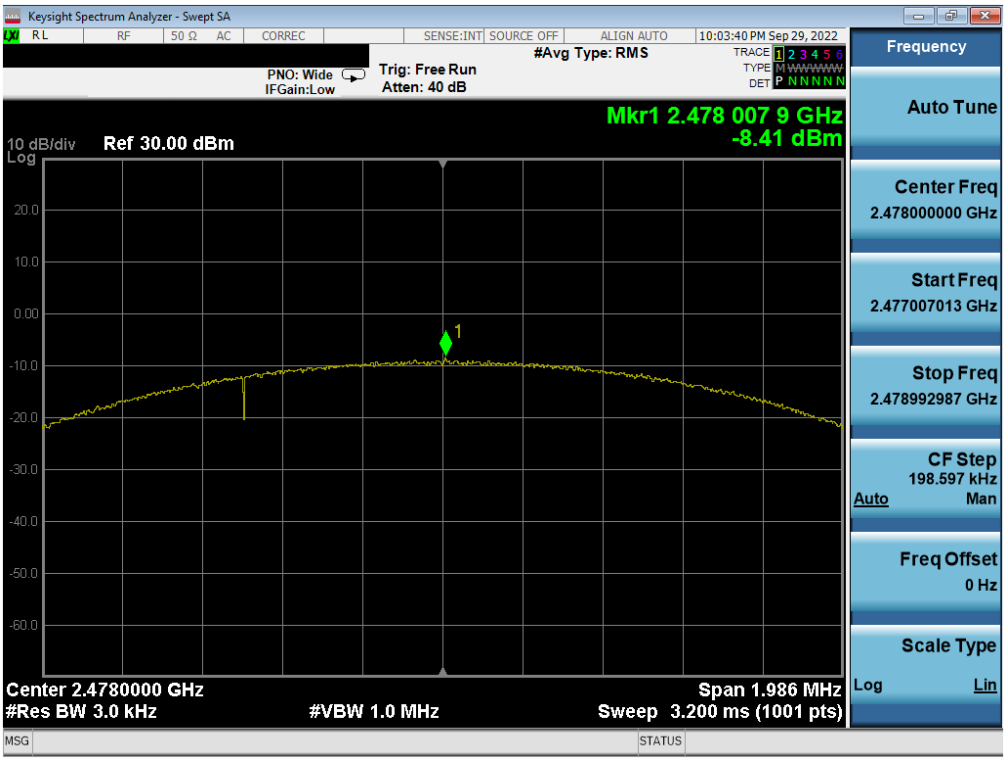
Plot 7-30. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



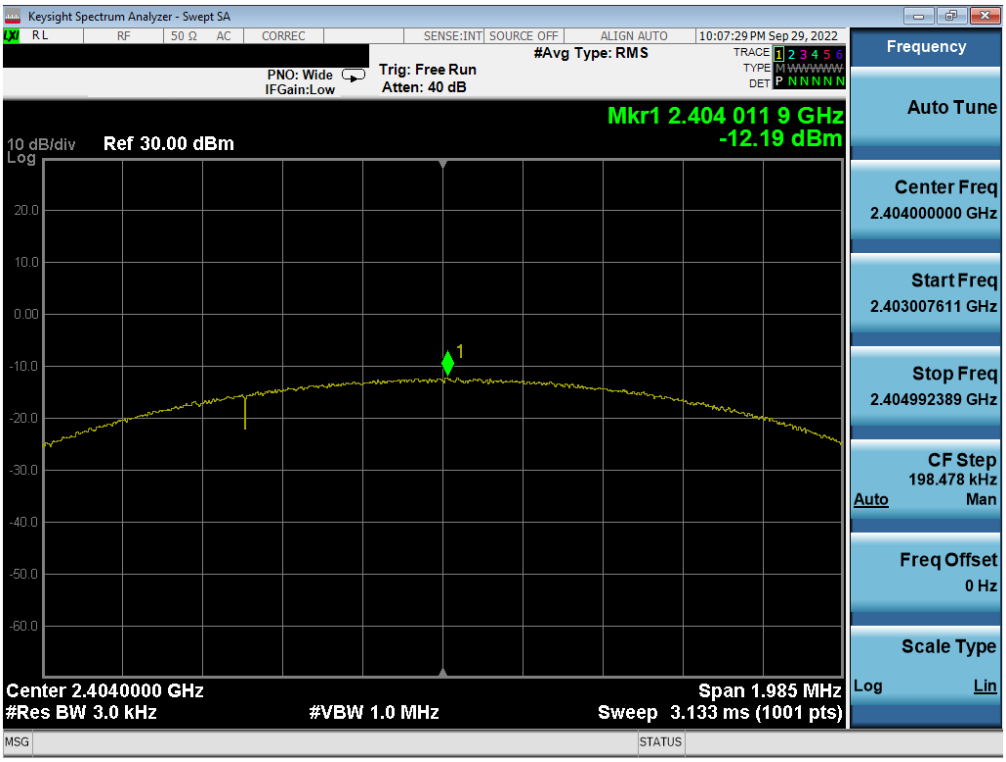
Plot 7-31. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



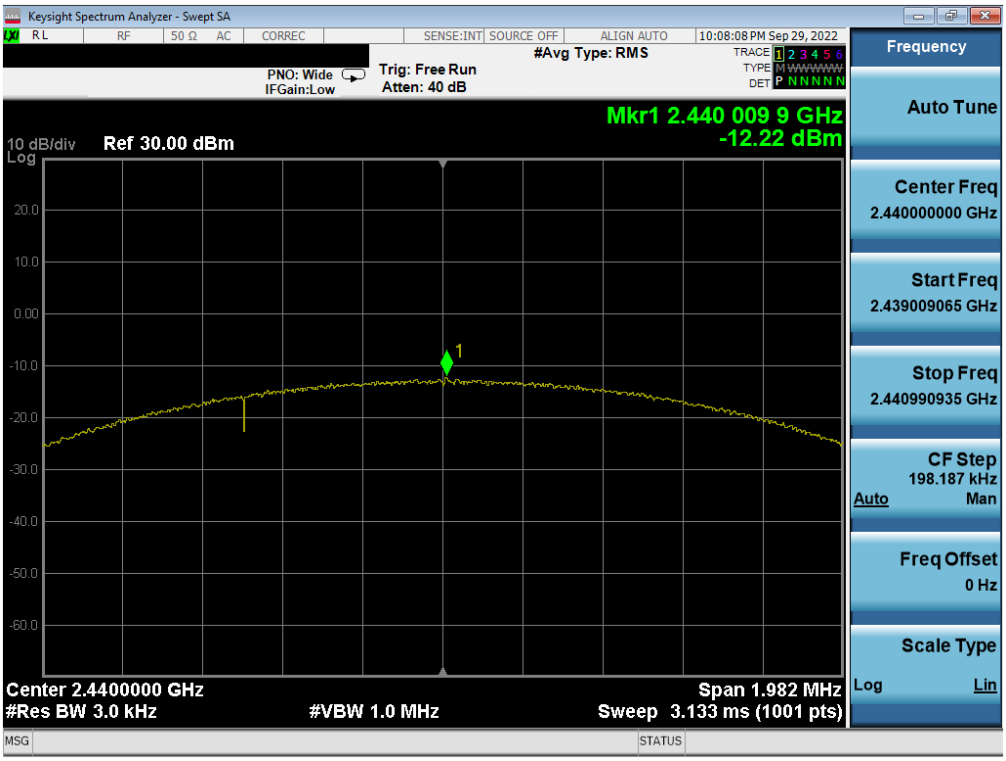
Plot 7-32. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



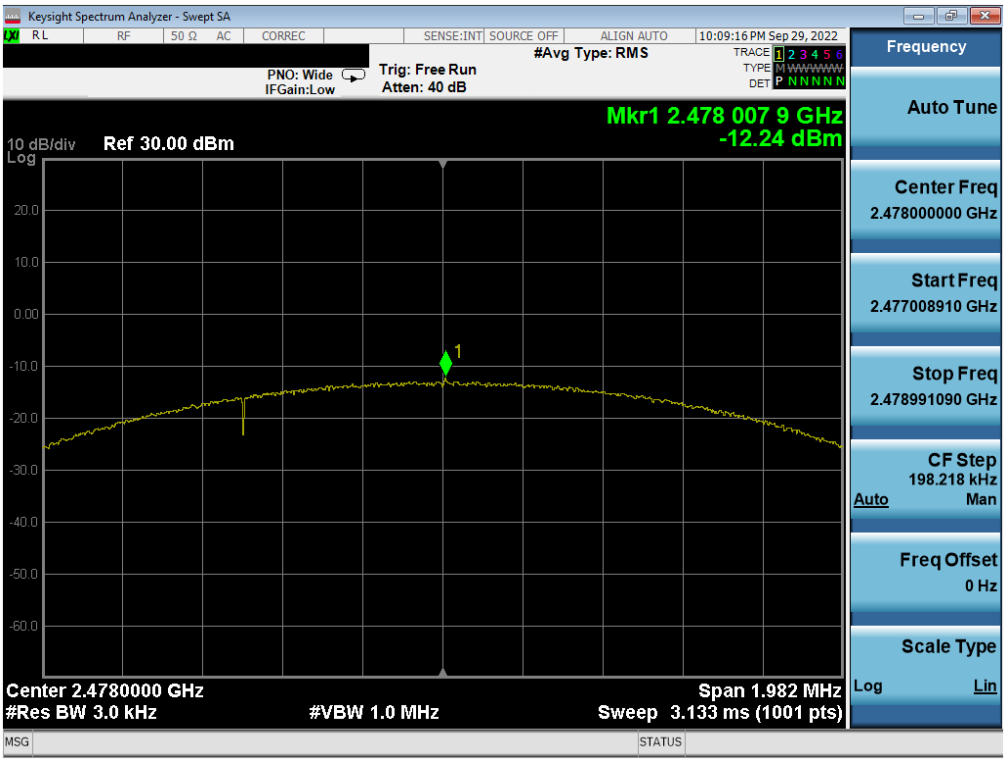
Plot 7-33. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)



Plot 7-34. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 1)



Plot 7-35. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

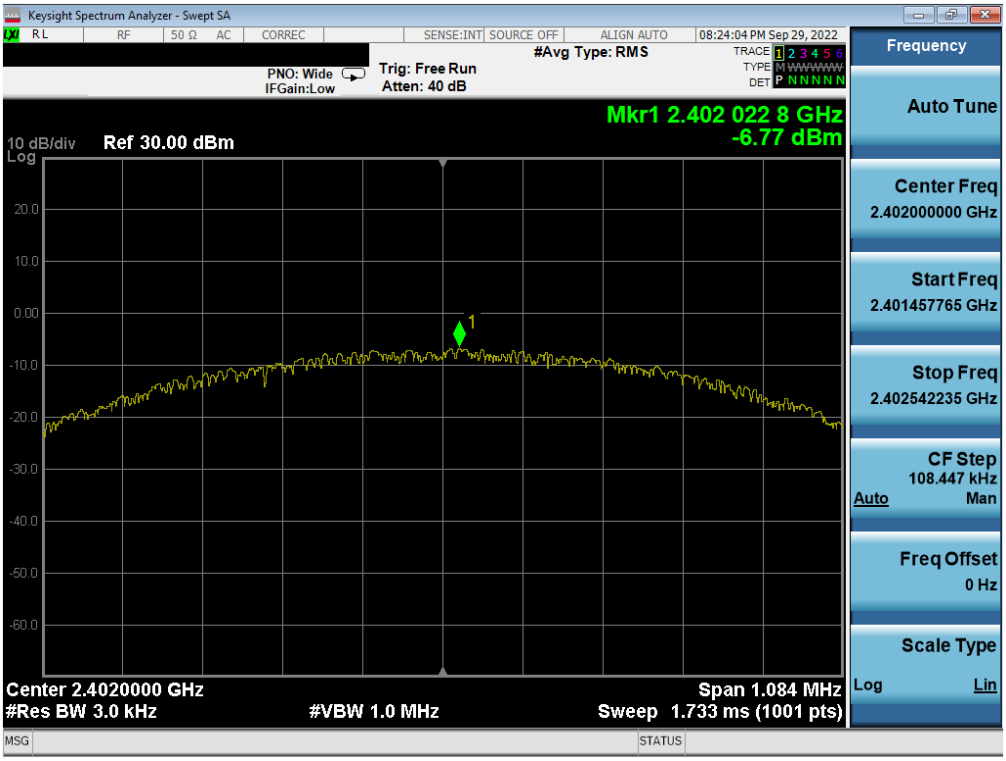


Plot 7-36. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

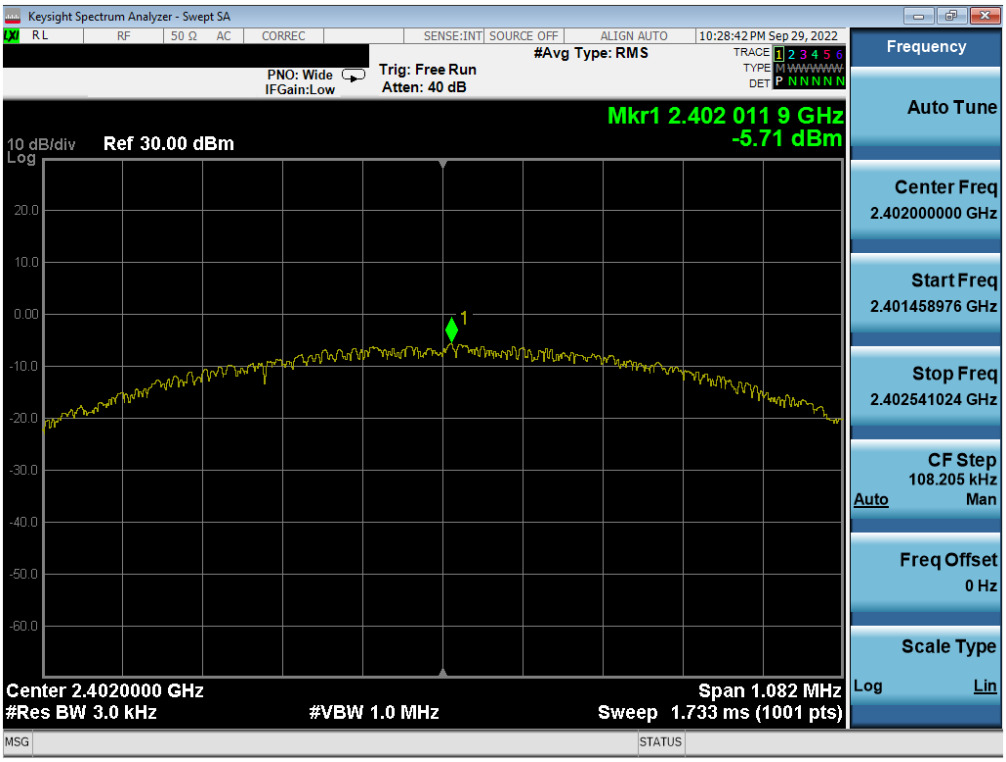
TxBF

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured Power Spectral Density [dBm / 3kHz]			Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
				Antenna 4a	Antenna 2a	Summed		
2402	1.0	ePA	0	-6.77	-5.71	-3.20	8.0	-11.20
2440	1.0	ePA	19	-6.20	-5.88	-3.03	8.0	-11.03
2480	1.0	ePA	39	-6.31	-5.68	-2.97	8.0	-10.97
2402	1.0	iPA	0	-7.27	-7.93	-4.58	8.0	-12.58
2440	1.0	iPA	19	-6.69	-7.67	-4.14	8.0	-12.14
2480	1.0	iPA	39	-6.67	-7.48	-4.05	8.0	-12.05
2404	2.0	ePA	1	-11.94	-10.61	-8.21	8.0	-16.21
2440	2.0	ePA	19	-11.28	-10.60	-7.91	8.0	-15.91
2478	2.0	ePA	38	-11.69	-10.43	-8.00	8.0	-16.00
2404	2.0	iPA	1	-12.60	-13.25	-9.90	8.0	-17.90
2440	2.0	iPA	19	-11.89	-13.05	-9.42	8.0	-17.42
2478	2.0	iPA	38	-11.86	-13.35	-9.53	8.0	-17.53

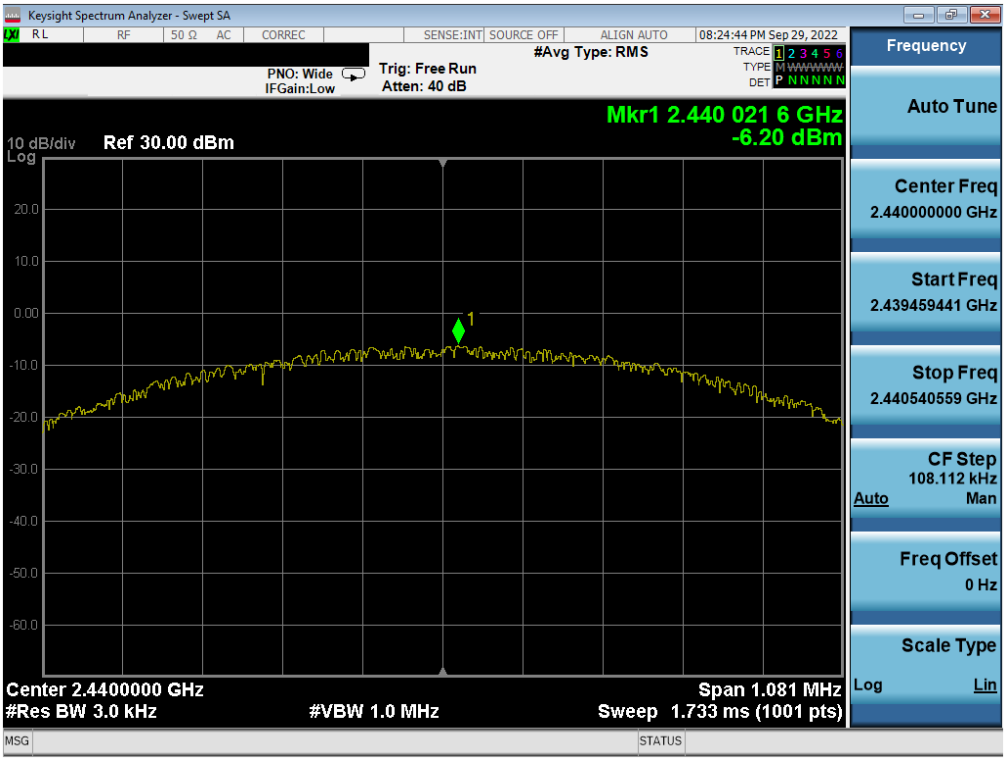
Table 7-12. Conducted Power Density Measurements TxBF



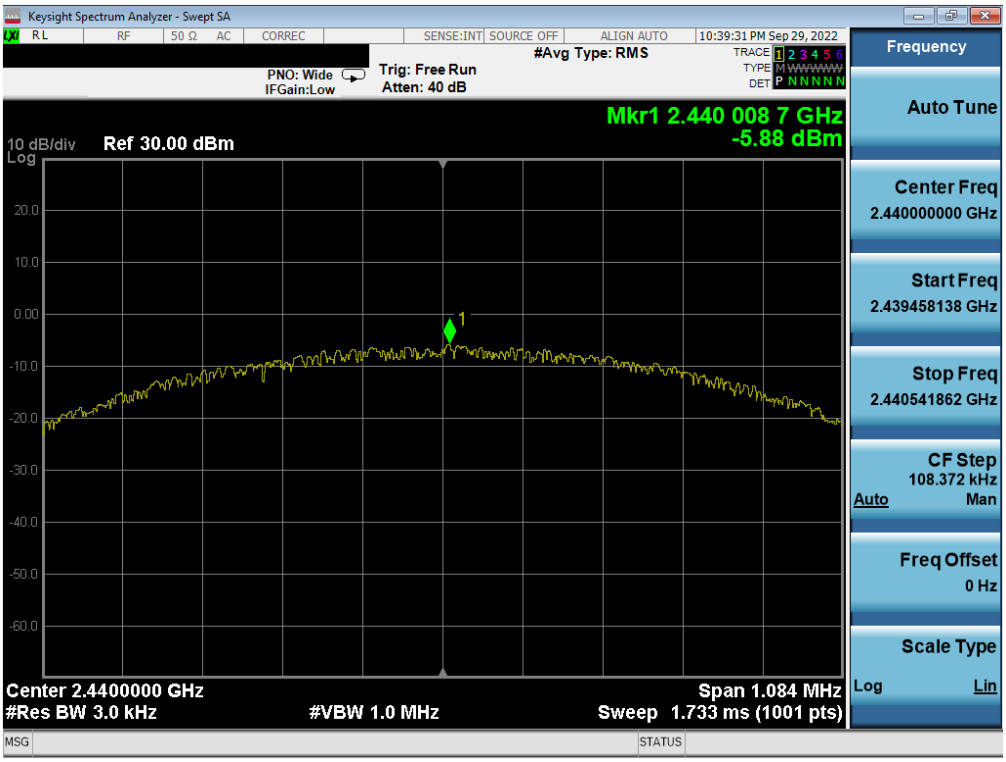
Plot 7-37. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



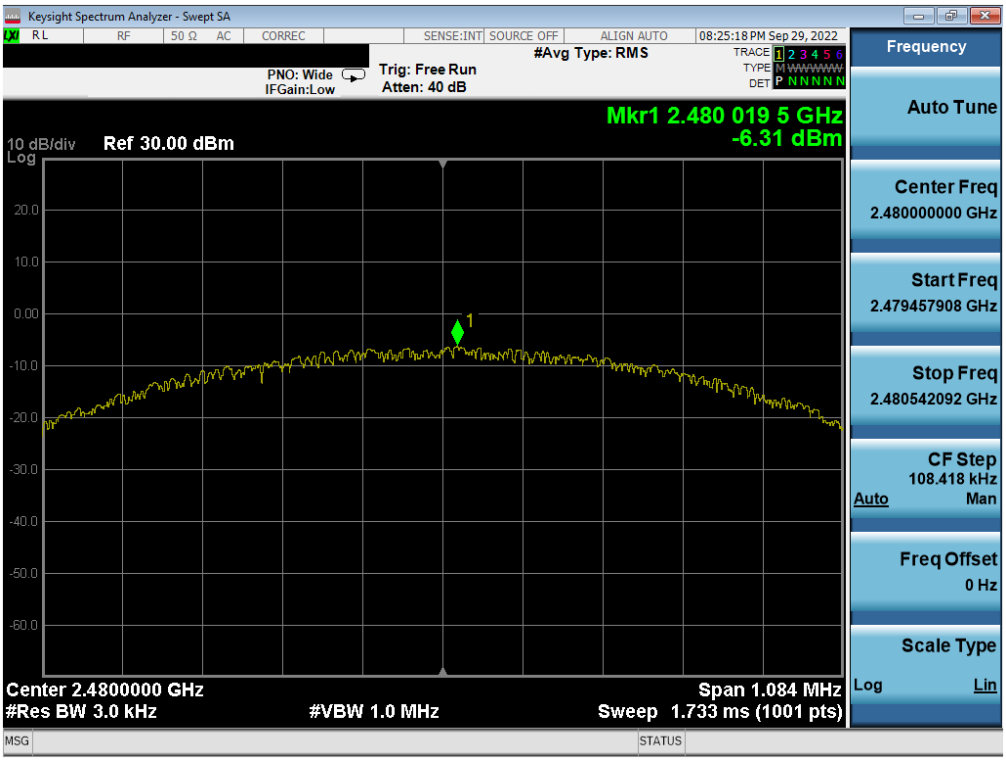
Plot 7-38. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



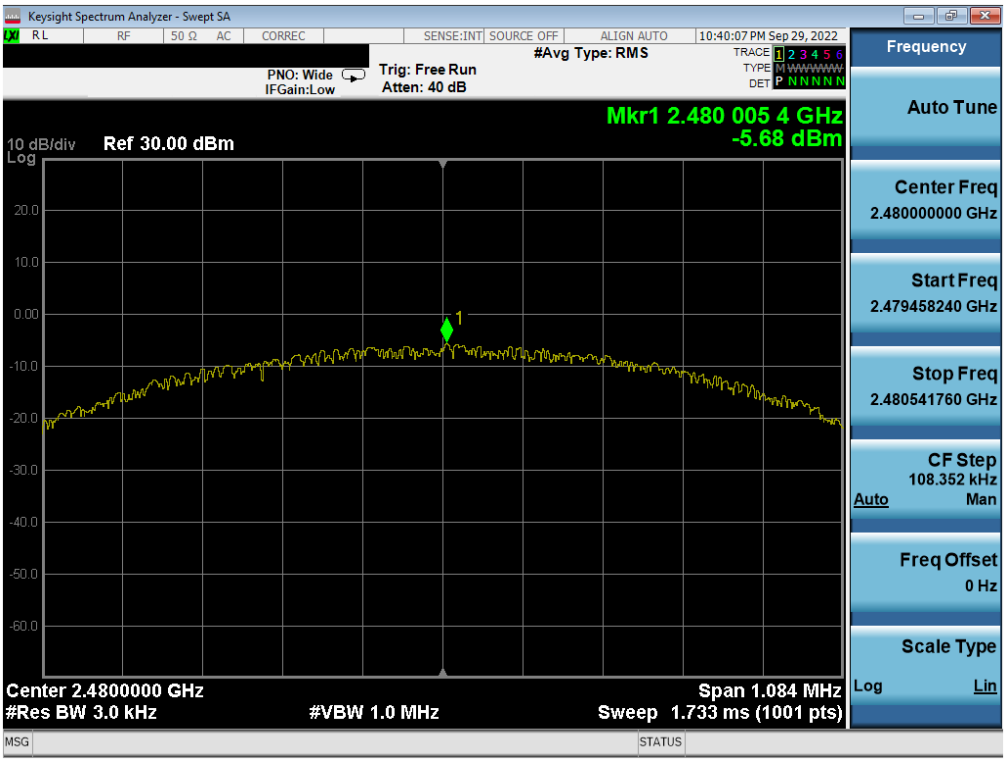
Plot 7-39. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



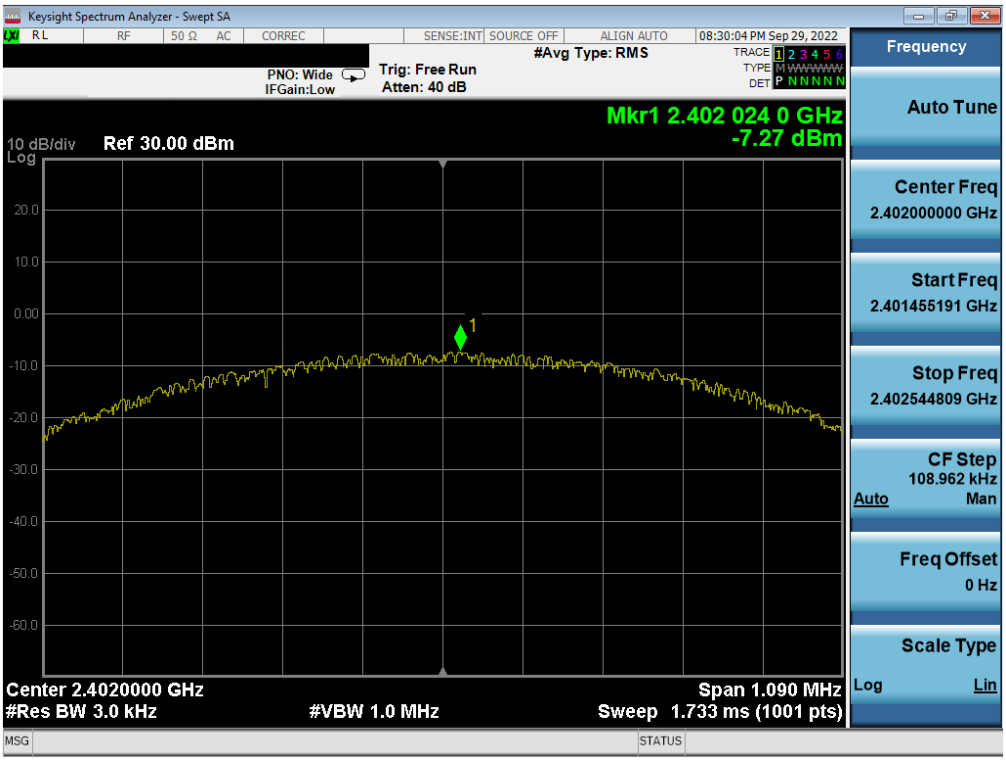
Plot 7-40. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



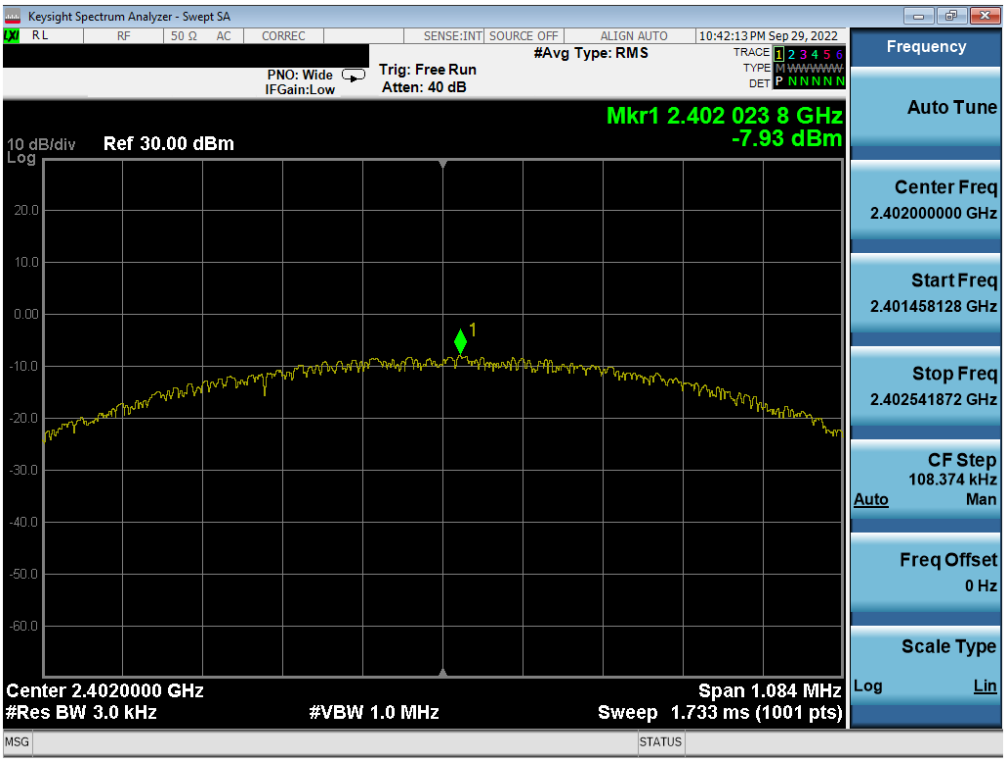
Plot 7-41. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



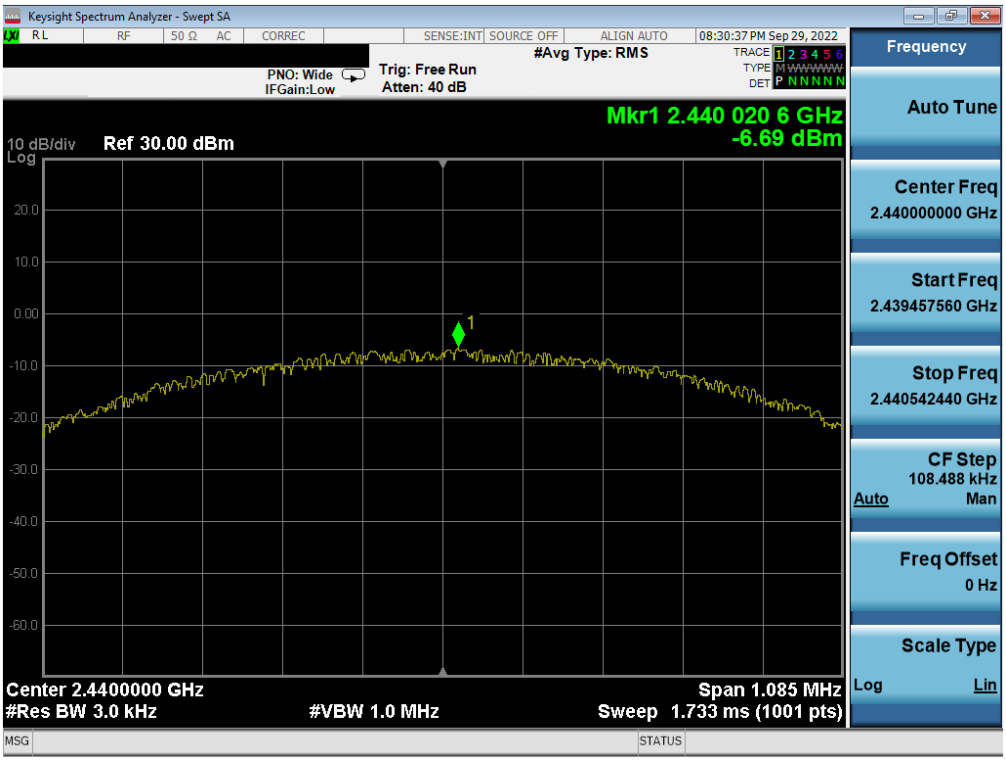
Plot 7-42. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



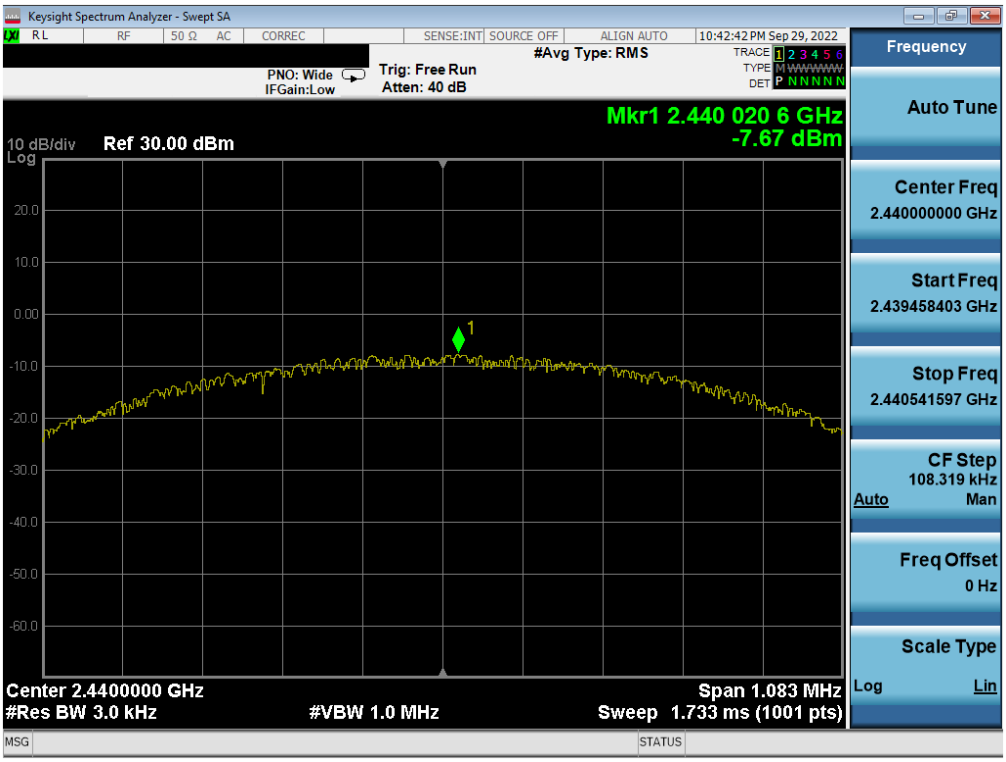
Plot 7-43. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



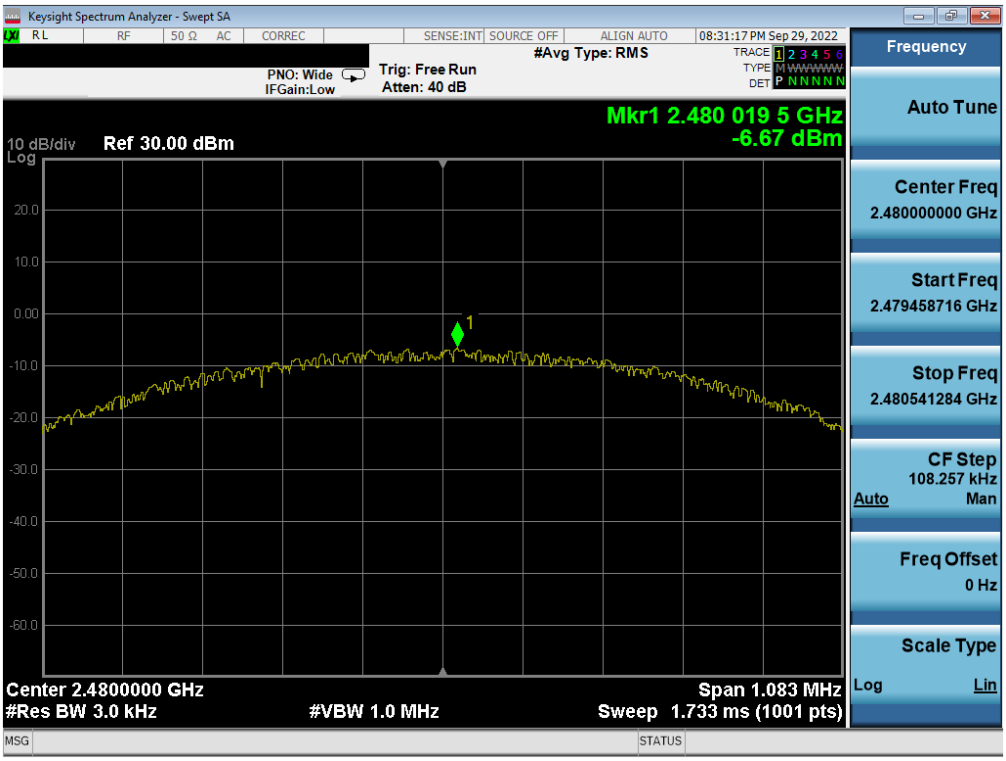
Plot 7-44. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



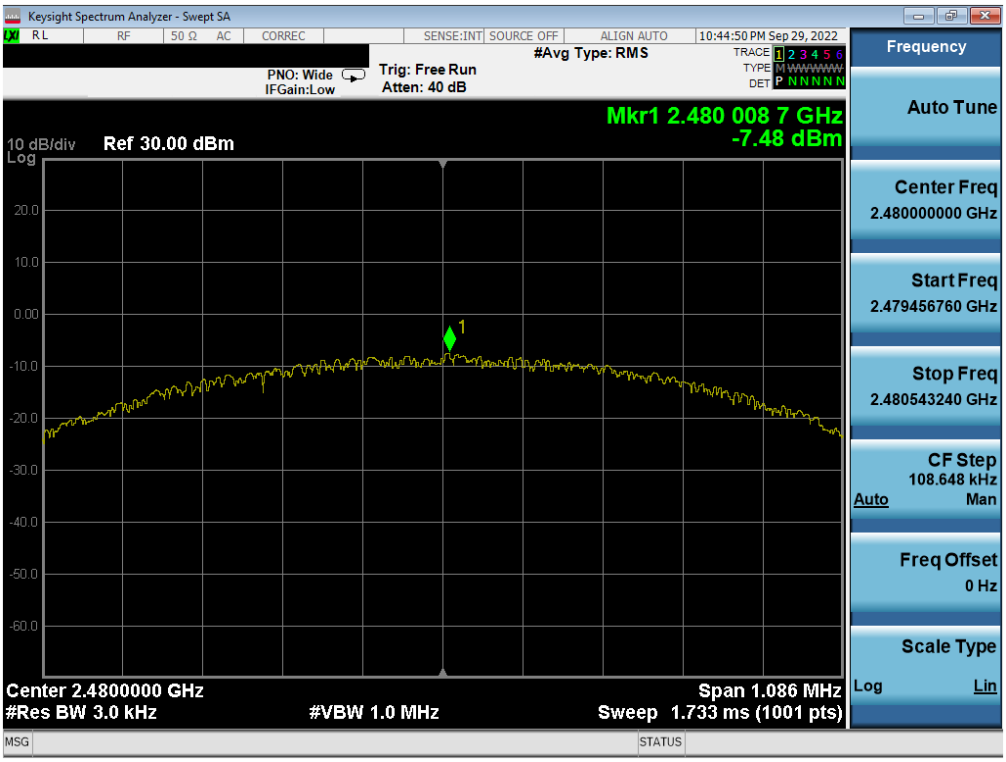
Plot 7-45. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



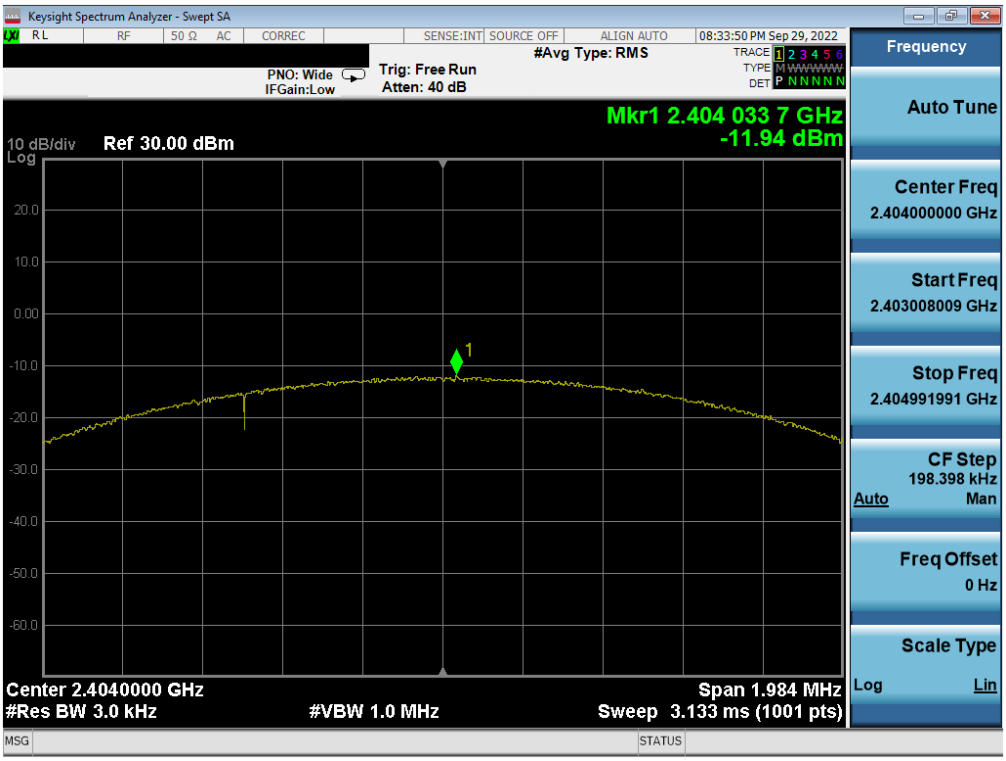
Plot 7-46. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



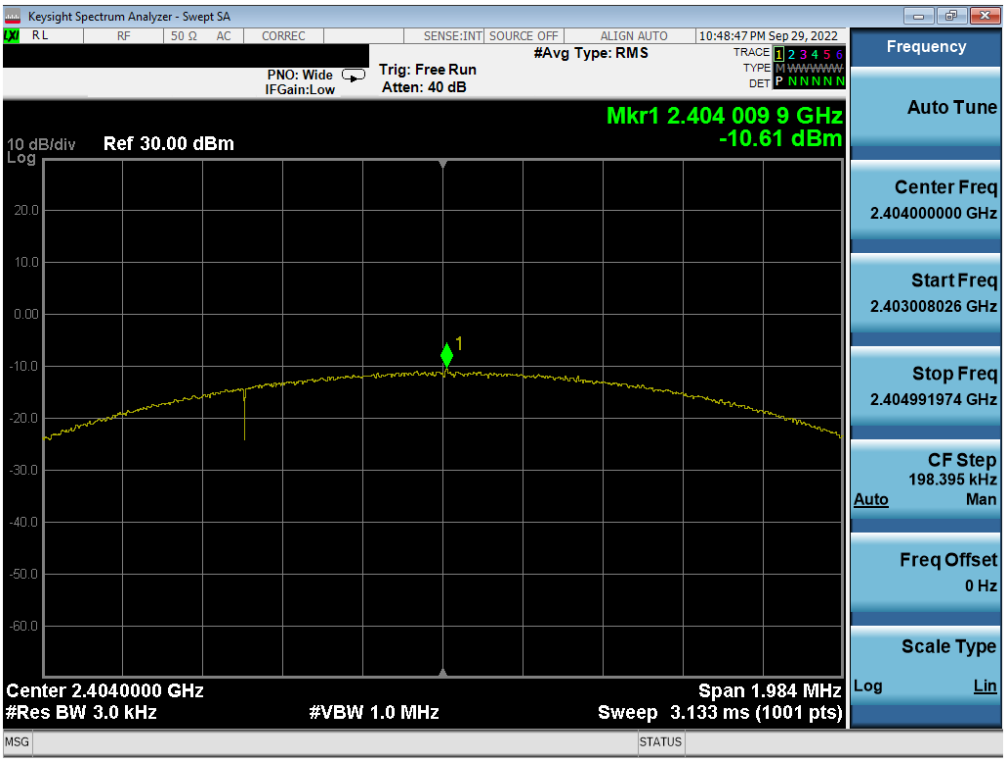
Plot 7-47. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



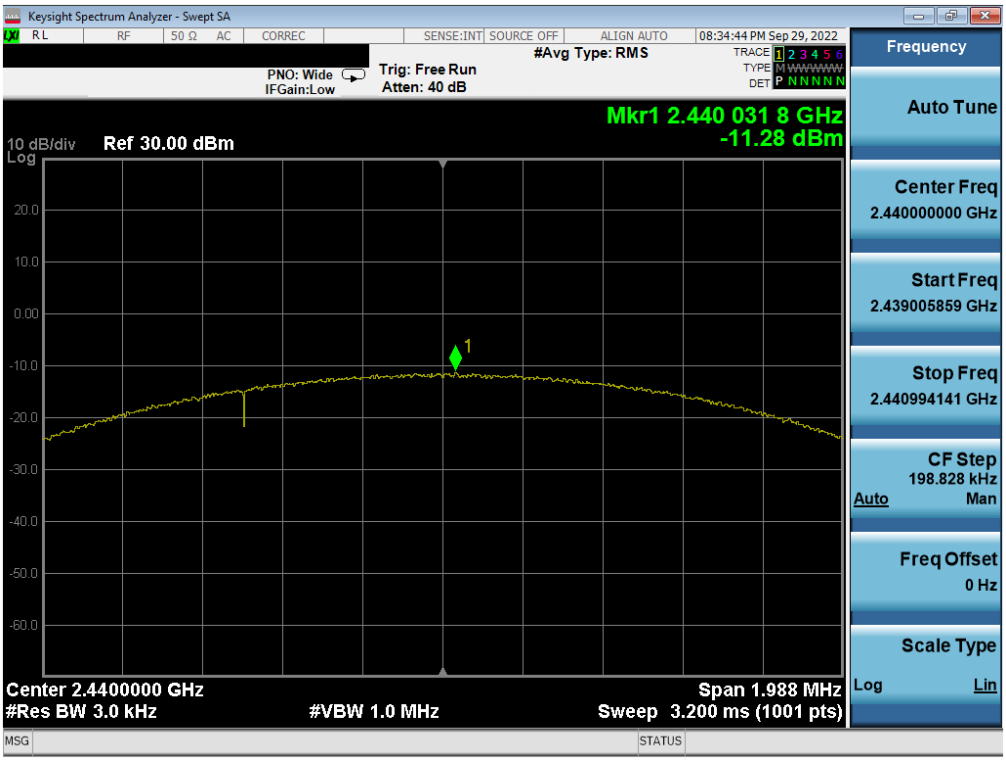
Plot 7-48. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



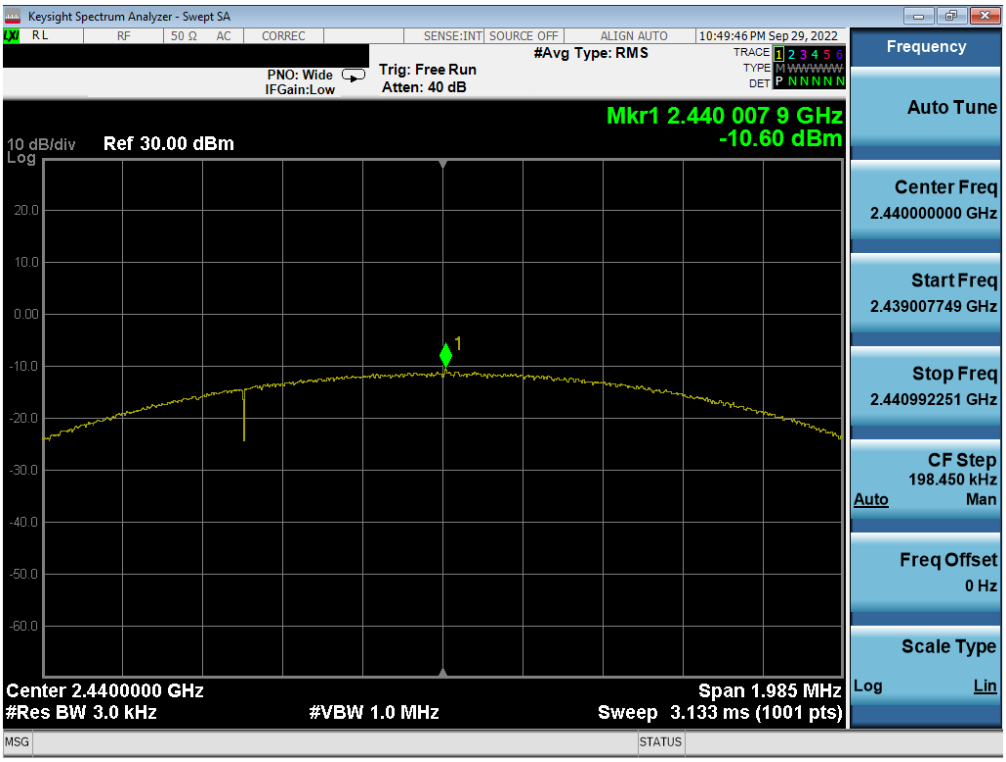
Plot 7-49. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



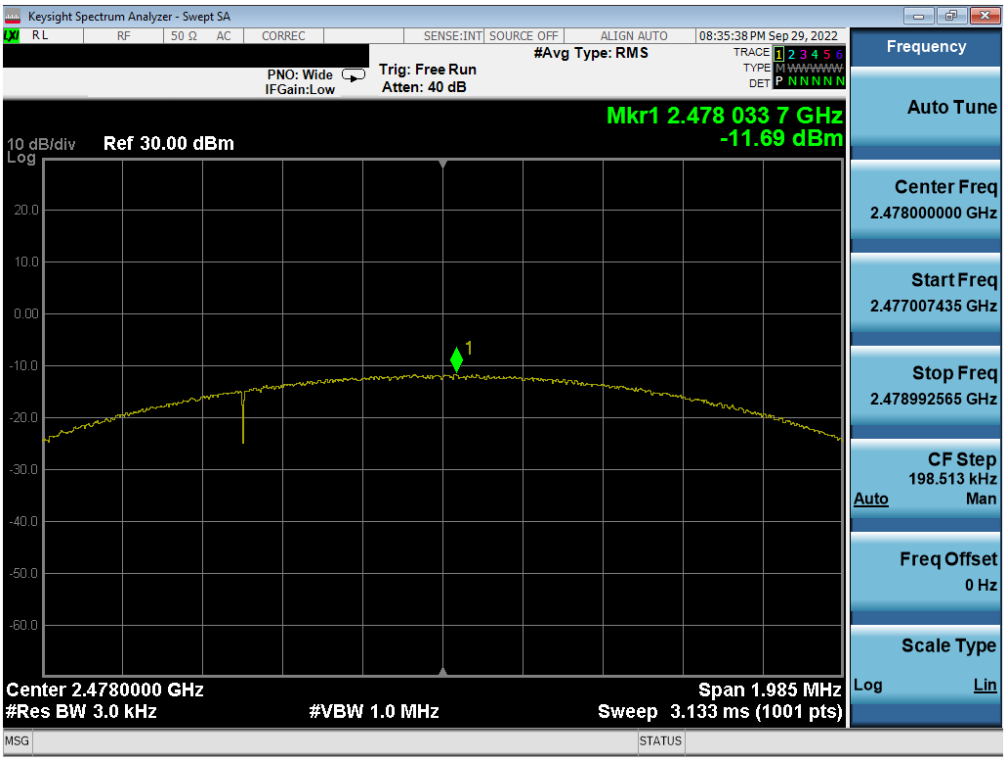
Plot 7-50. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



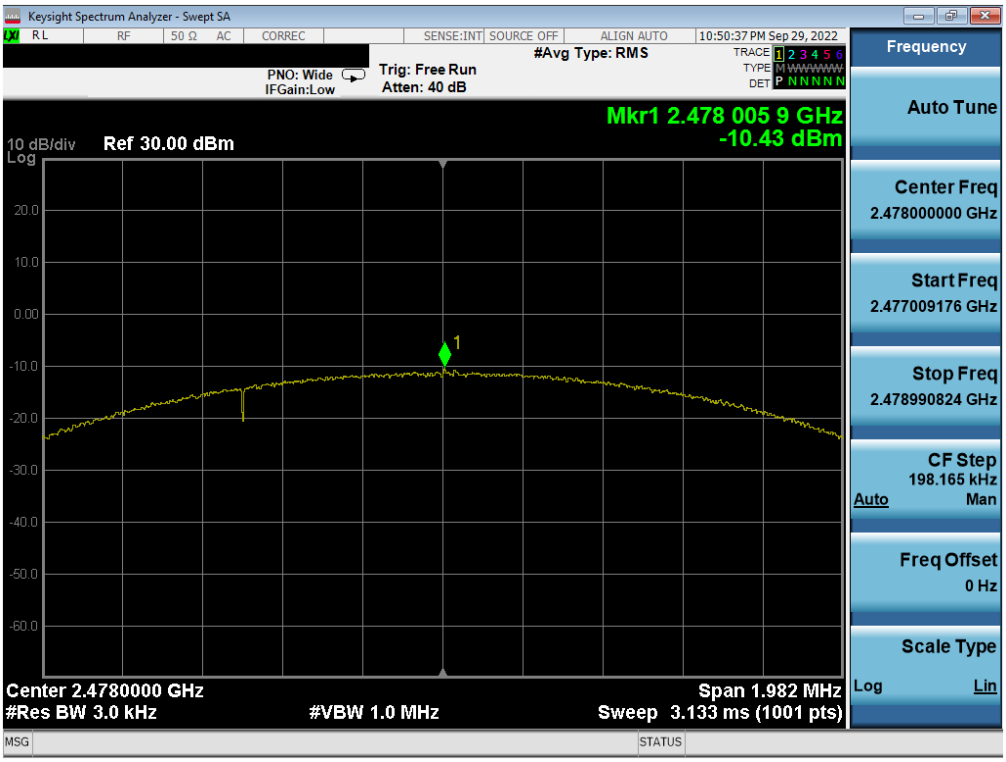
Plot 7-51. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



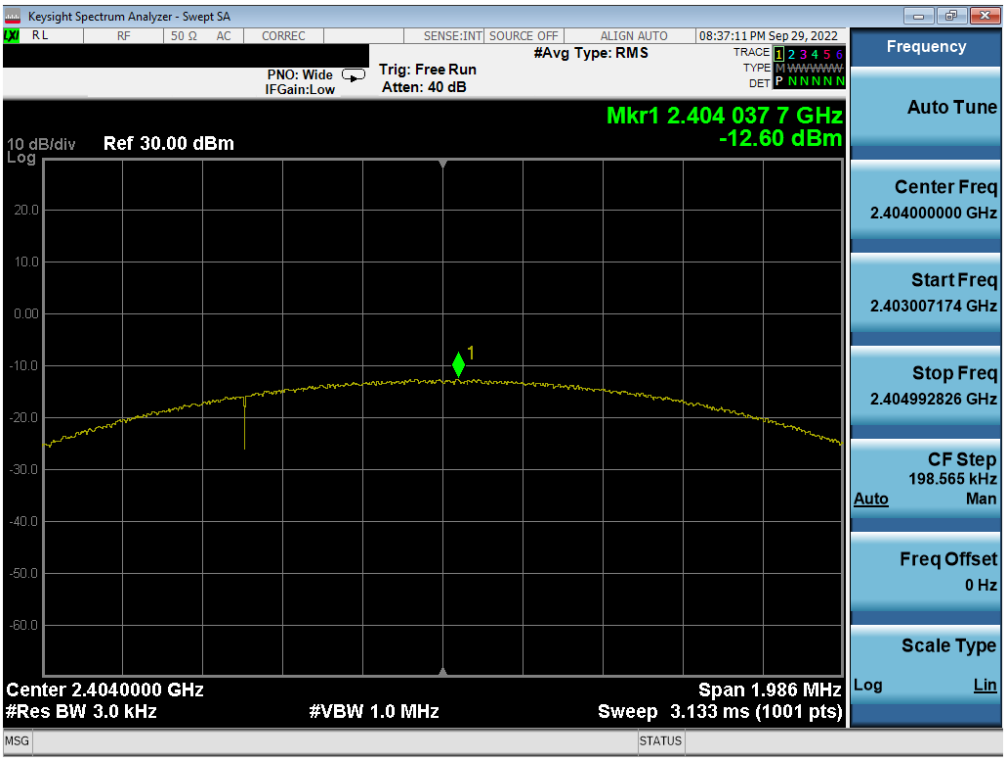
Plot 7-52. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



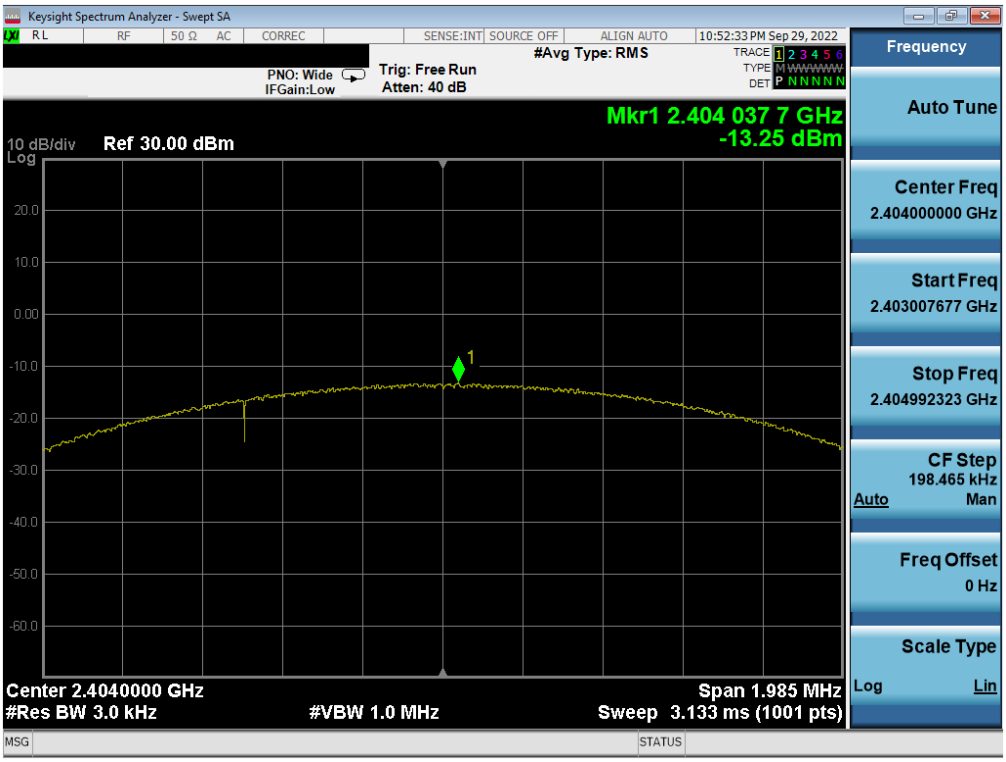
Plot 7-53. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)



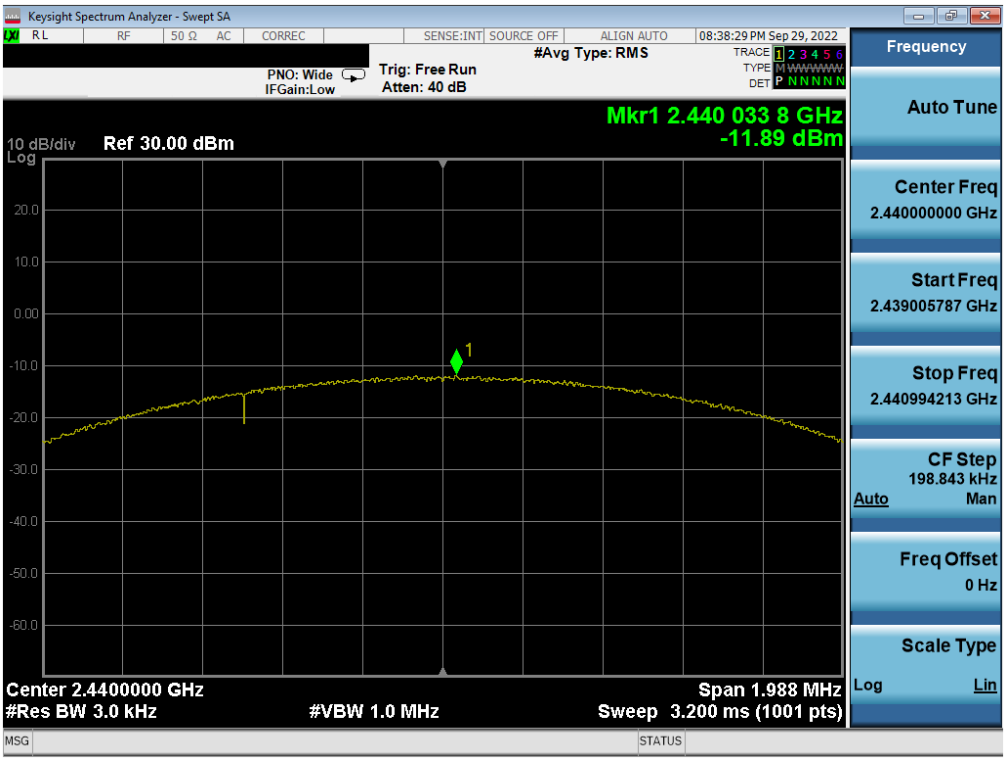
Plot 7-54. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)



Plot 7-55. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 1)

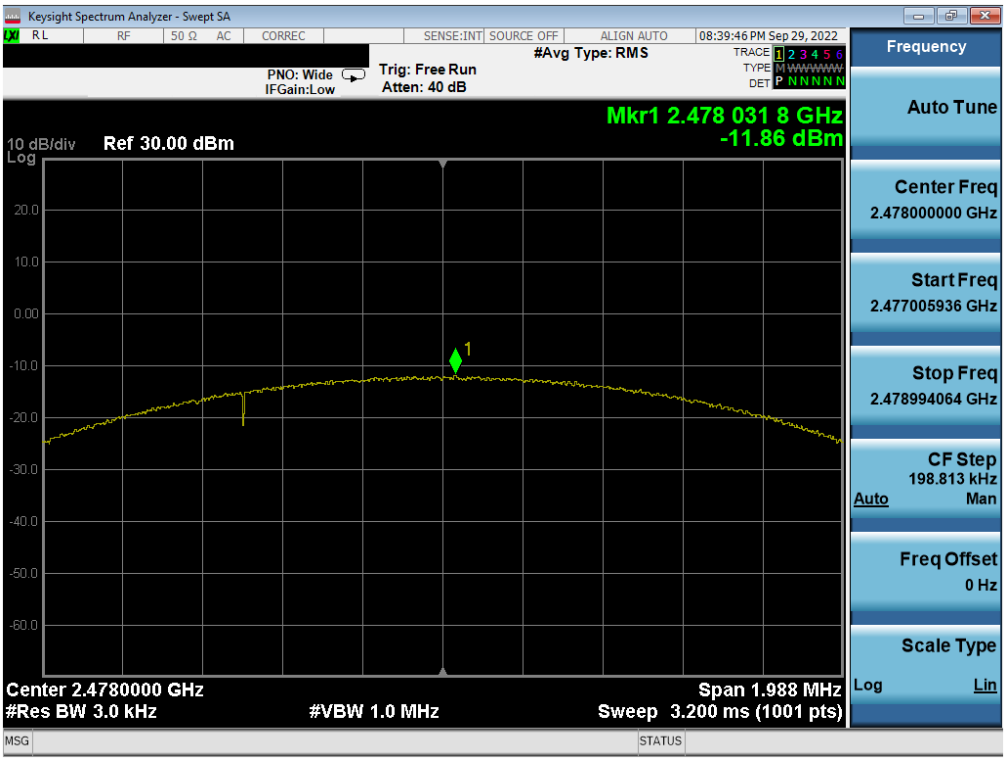


Plot 7-56. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 1)



Plot 7-57. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-58. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 19)



Plot 7-59. Power Spectral Density Plot Antenna 4a (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

Plot 7-60. Power Spectral Density Plot Antenna 2a (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

Note:

Per ANSI C63.10-2013 Subclause 14.3.2.2 and KDB 662911 D01 v02r01 Section E)2), the power spectral density at Antenna 4a and Antenna 2a were first measured separately as shown in the section above. The measured values were then summed in linear power units then converted back to dBm.

Sample TxBF Calculation:

At 2402MHz the average conducted power spectral density was measured to be 1.29 dBm for Antenna 4a and 0.65 dBm for Antenna 2a.

Antenna 4a + Antenna 2a = TxBF

(1.29 dBm + 0.65 dBm) = (1.346 mW + 1.159 mW) = 2.505mW = 3.99dBm

7.5 Conducted Authorized Band Edge

§15.247(d); RSS-247 [5.5]

Test Overview and Limit

For the following out of band conducted spurious emissions plots at the band edge, the EUT was set to transmit at maximum power with the largest packet size available. These settings produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth.

Test Procedure Used

ANSI C63.10-2013 – Subclause 11.11.3
KDB 558074 D01 v05r02 – Section 8.7.2

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

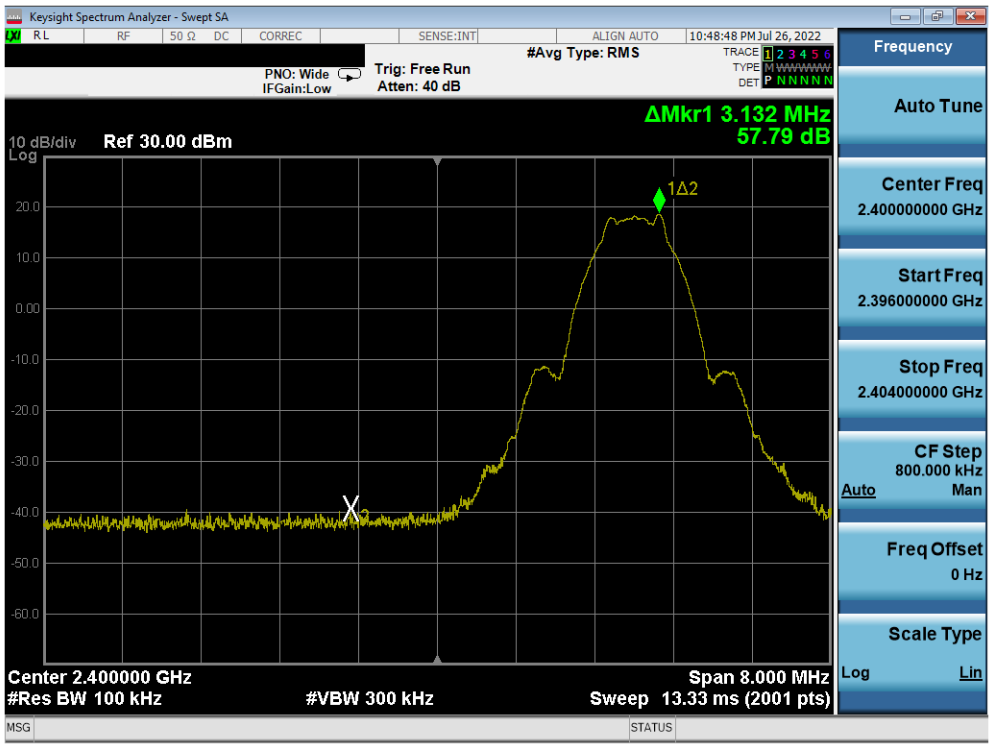
The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-4. Test Instrument & Measurement Setup

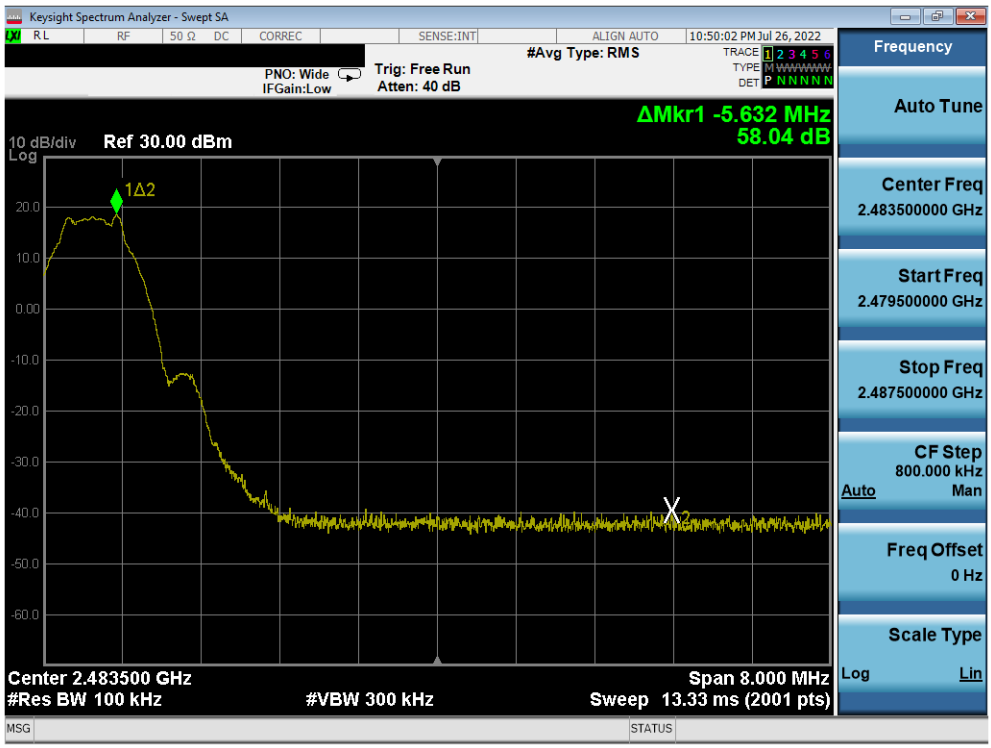
Test Notes

All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.

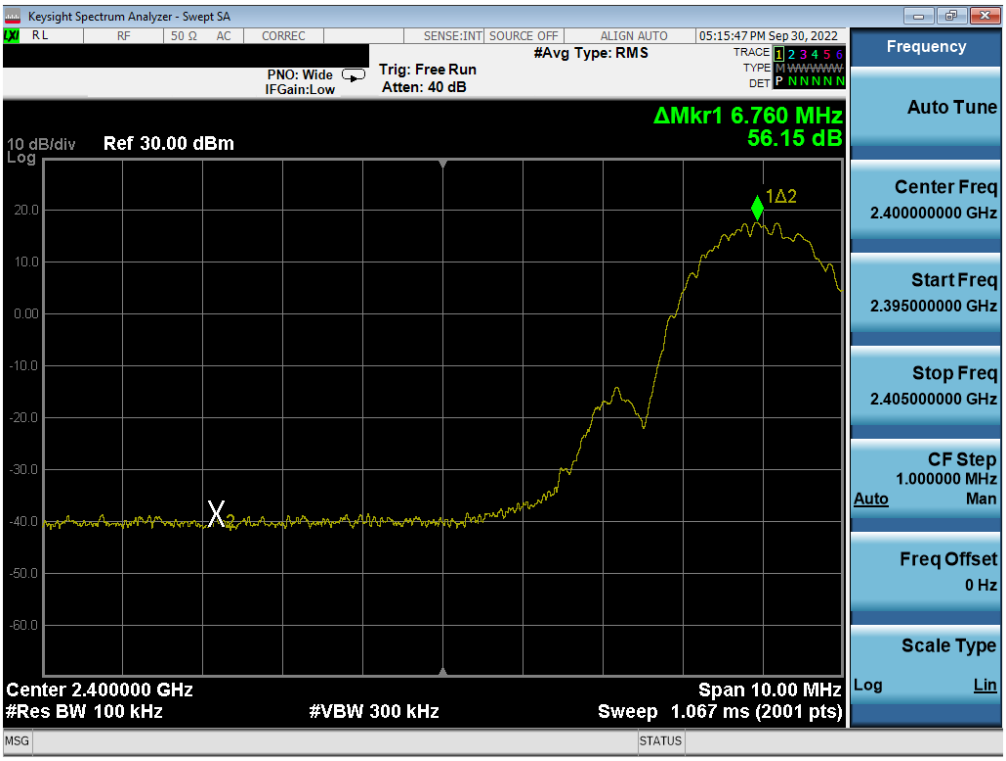
Antenna 4a



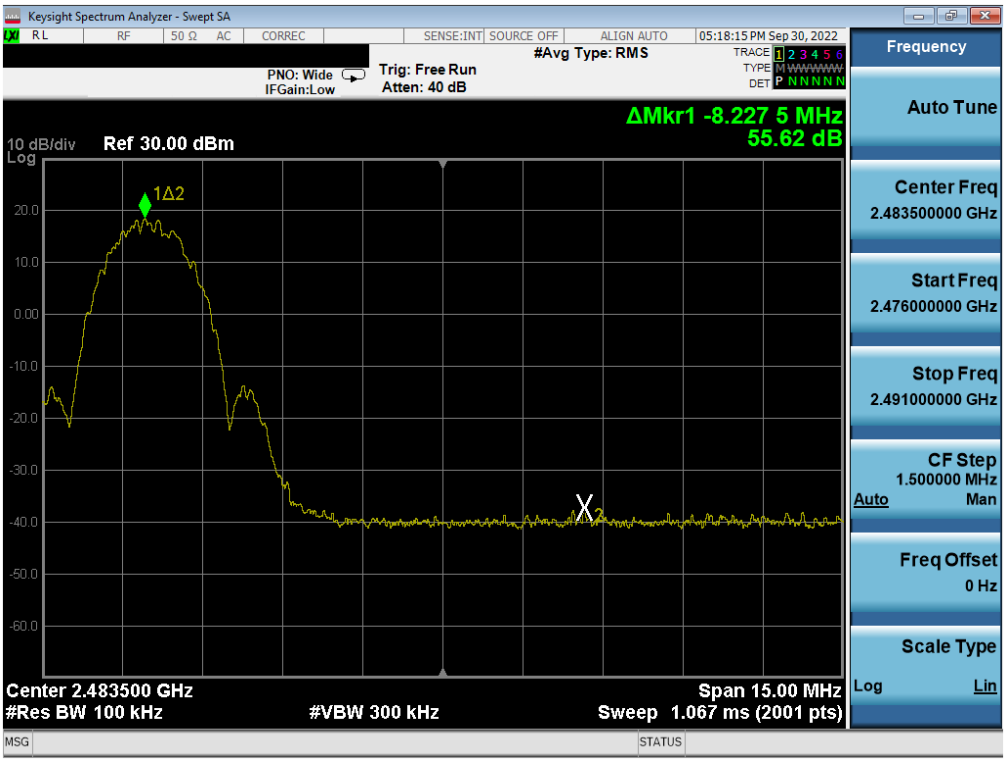
Plot 7-61. Band Edge Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



Plot 7-62. Band Edge Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)

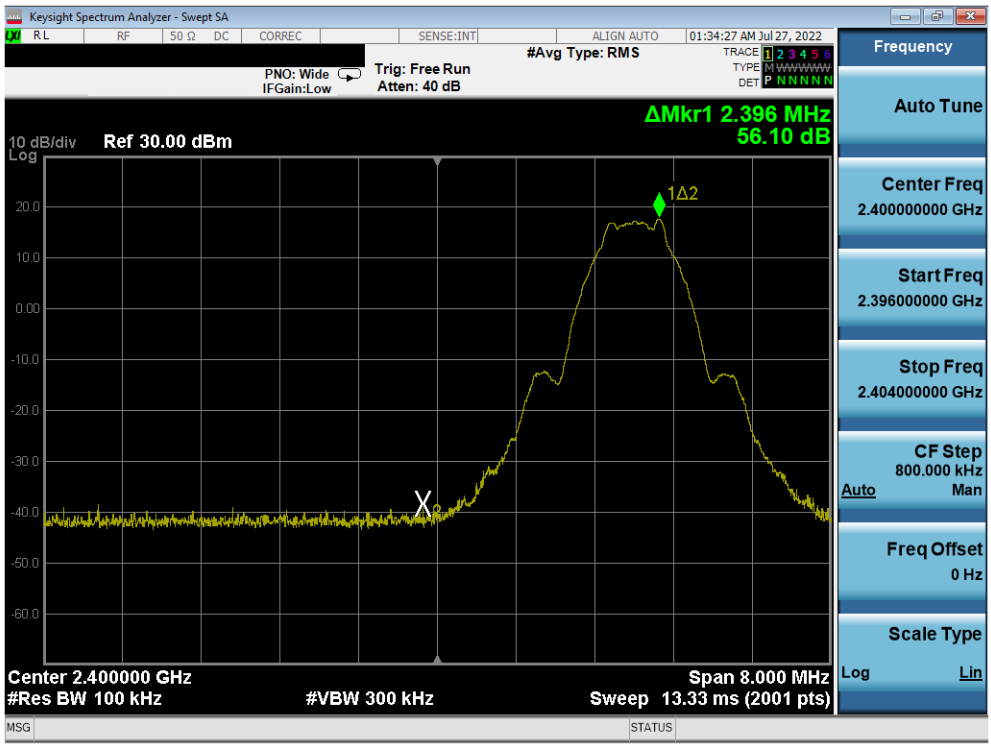


Plot 7-63. Band Edge Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)

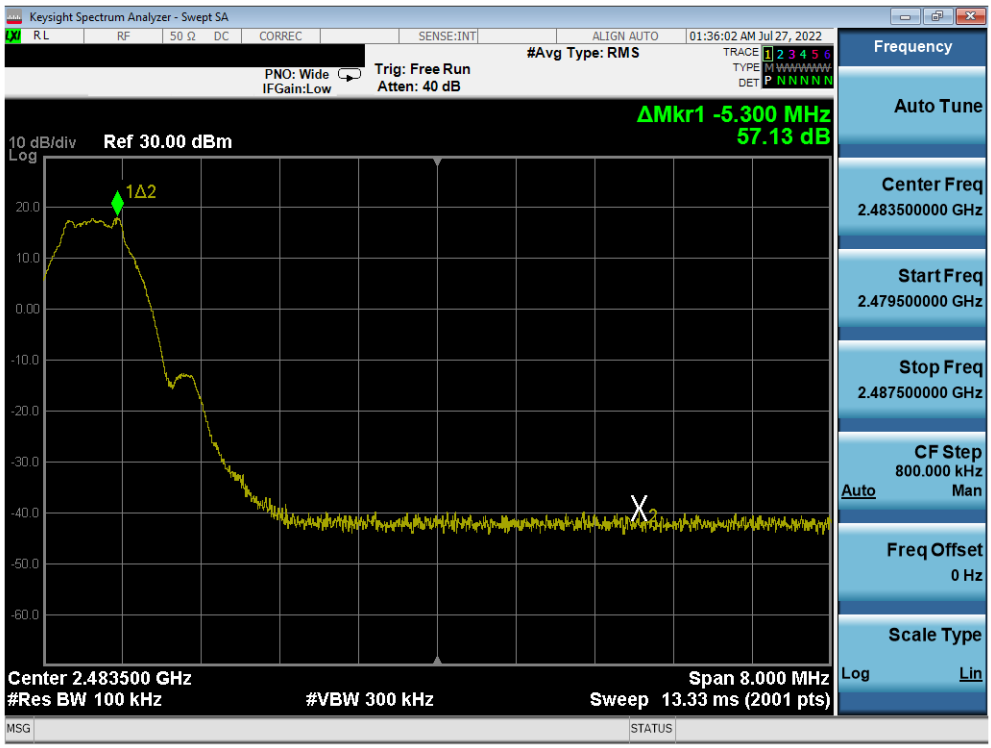


Plot 7-64. Band Edge Plot Antenna 4a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

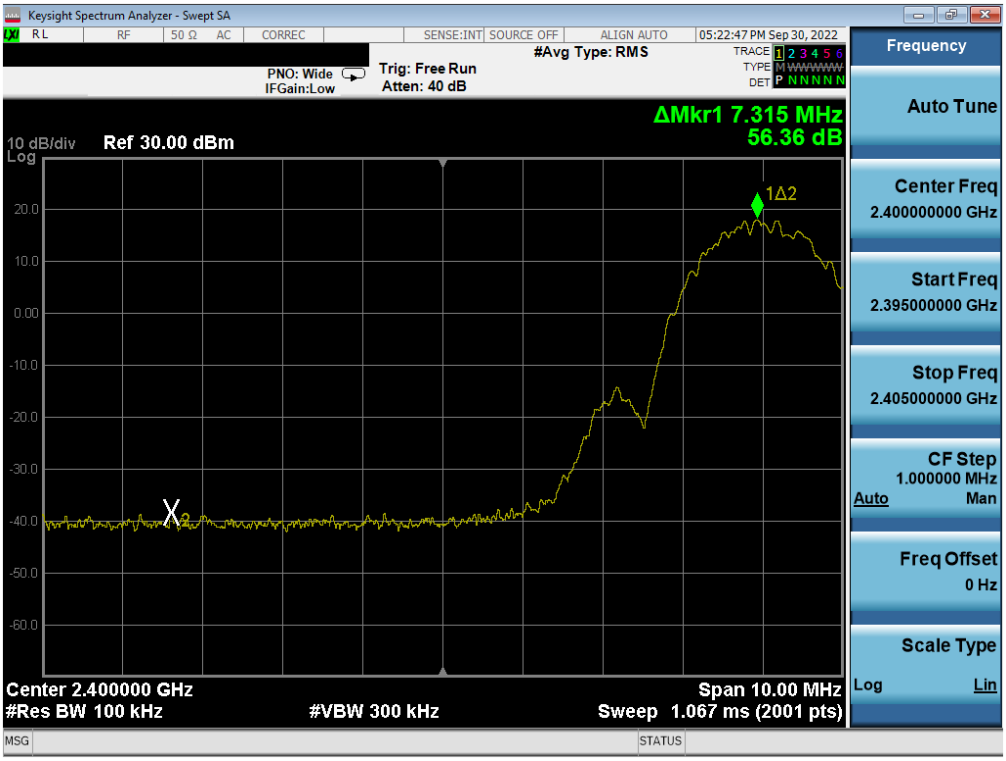
Antenna 2a



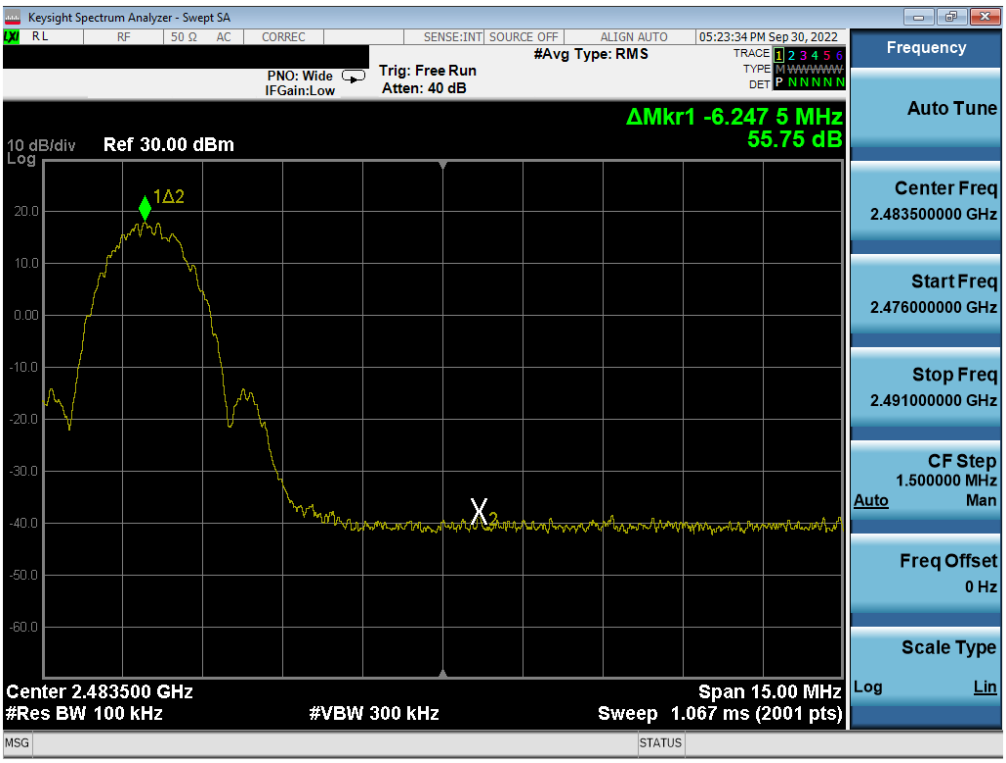
Plot 7-65. Band Edge Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



Plot 7-66. Band Edge Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



Plot 7-67. Band Edge Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-68. Band Edge Plot Antenna 2a (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

7.6 Conducted Spurious Emissions

§15.247(d); RSS-247 [5.5]

Test Overview and Limit

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 8.5 of KDB 558074 D01 v05r02 and Section 11.11 of ANSI C63.10-2013.

Test Procedure Used

ANSI C63.10-2013 – Subclause 11.11.3
ANSI C63.10-2013 – Section 14.3.2.3
KDB 558074 D01 v05r02 – Section 8.5

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-5. Test Instrument & Measurement Setup

Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.

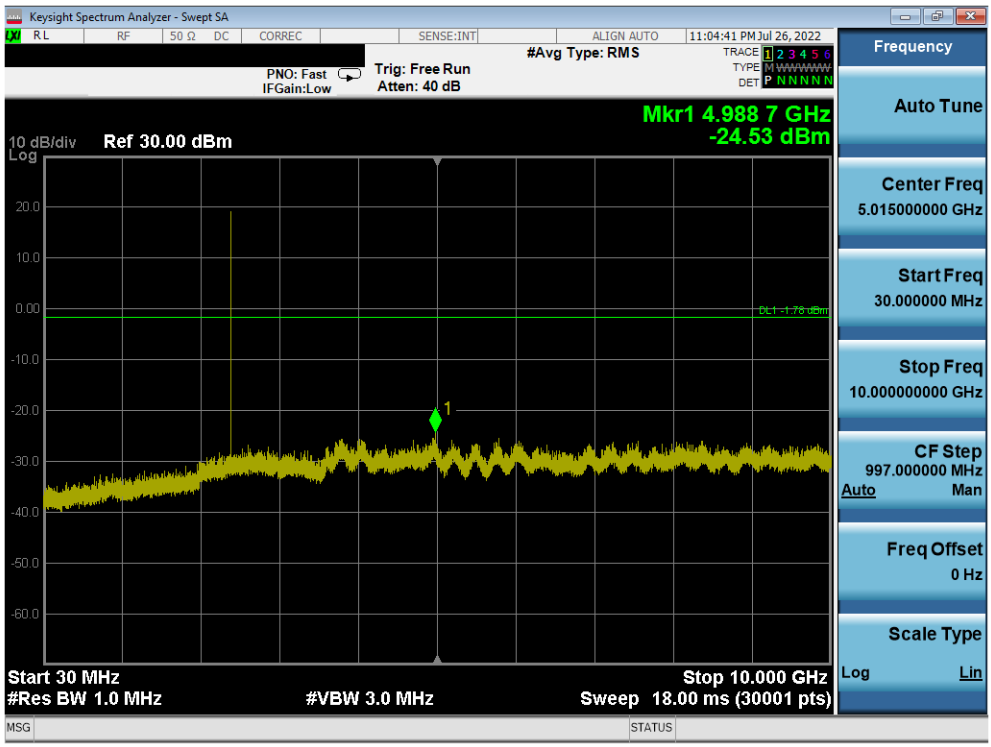
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

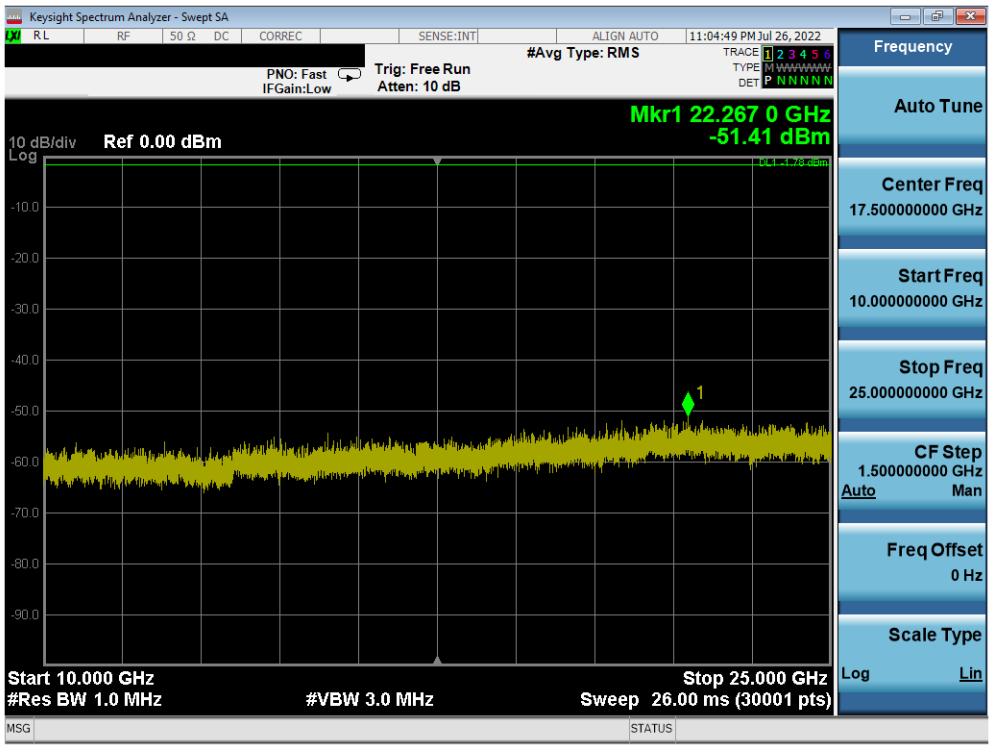
4. All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.

5. The conducted spurious emission measurements in this section for each antenna are still found to be compliant when adding 3dB to each plot per the guidance of ANSI C63.10-2013 Section 14.3.2.3 for two antennas.

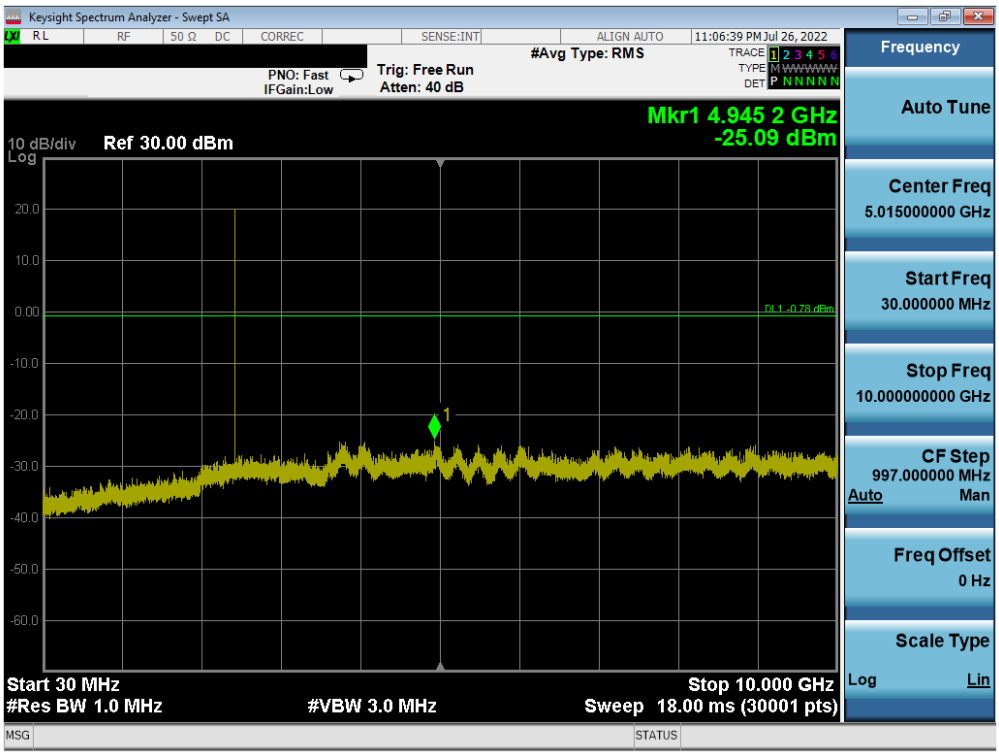
Antenna 4a



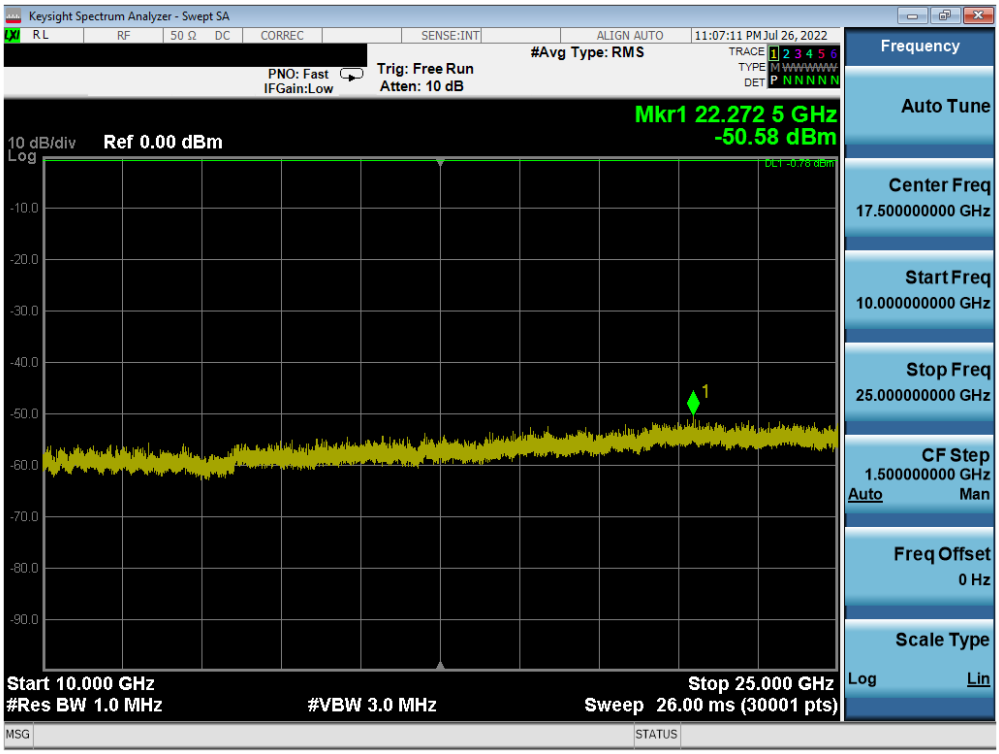
Plot 7-69. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



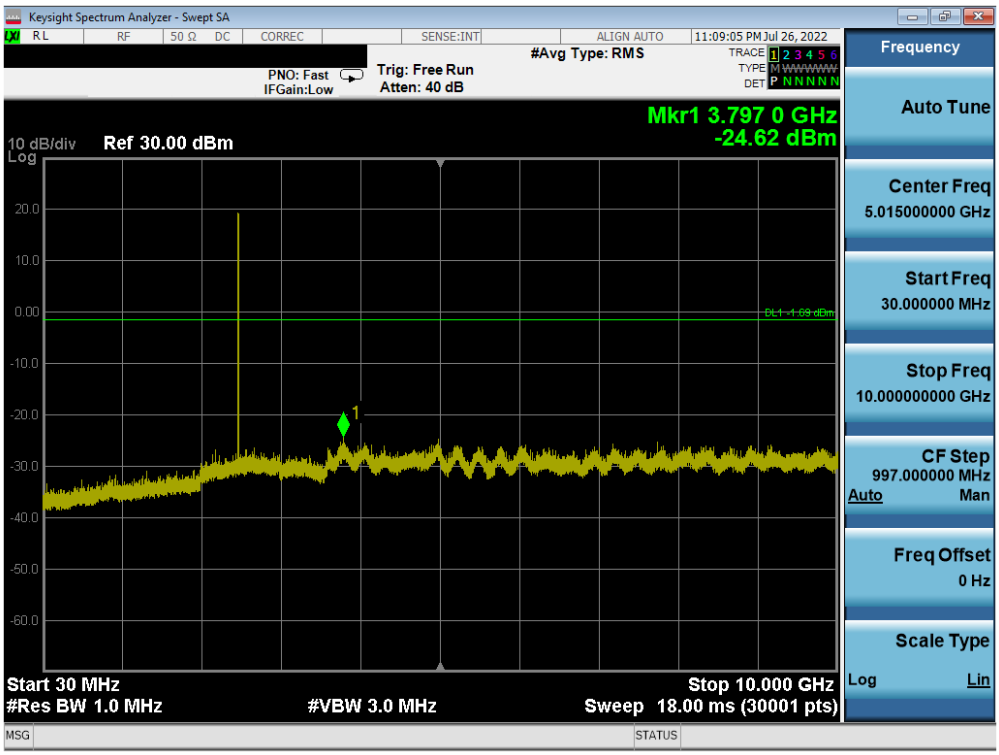
Plot 7-70. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



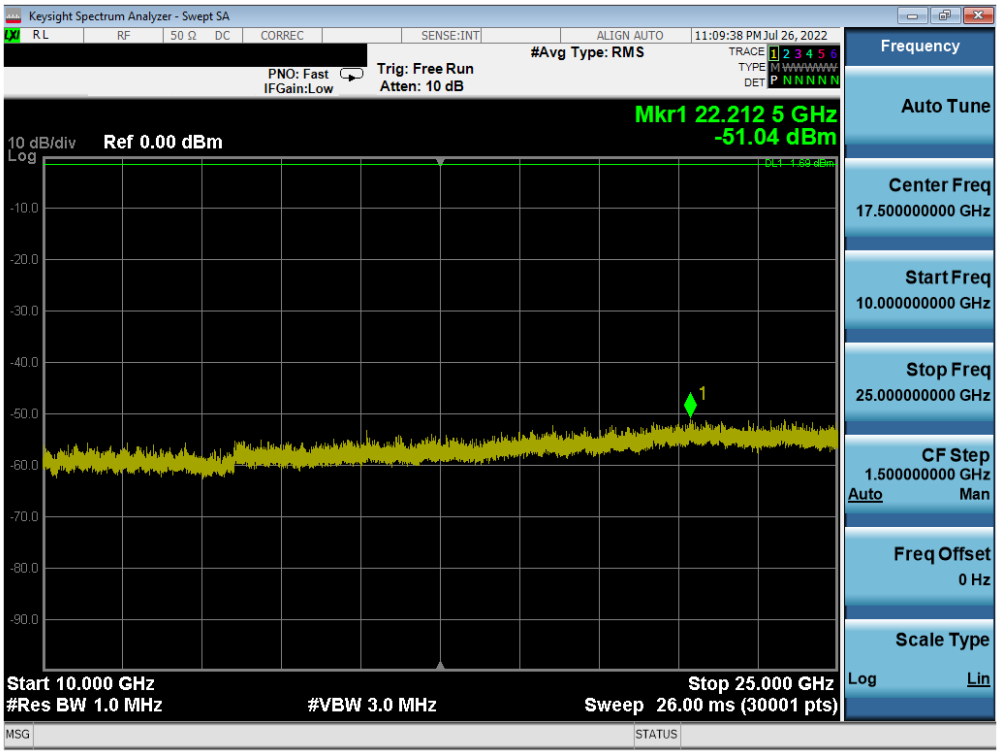
Plot 7-71. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



Plot 7-72. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)

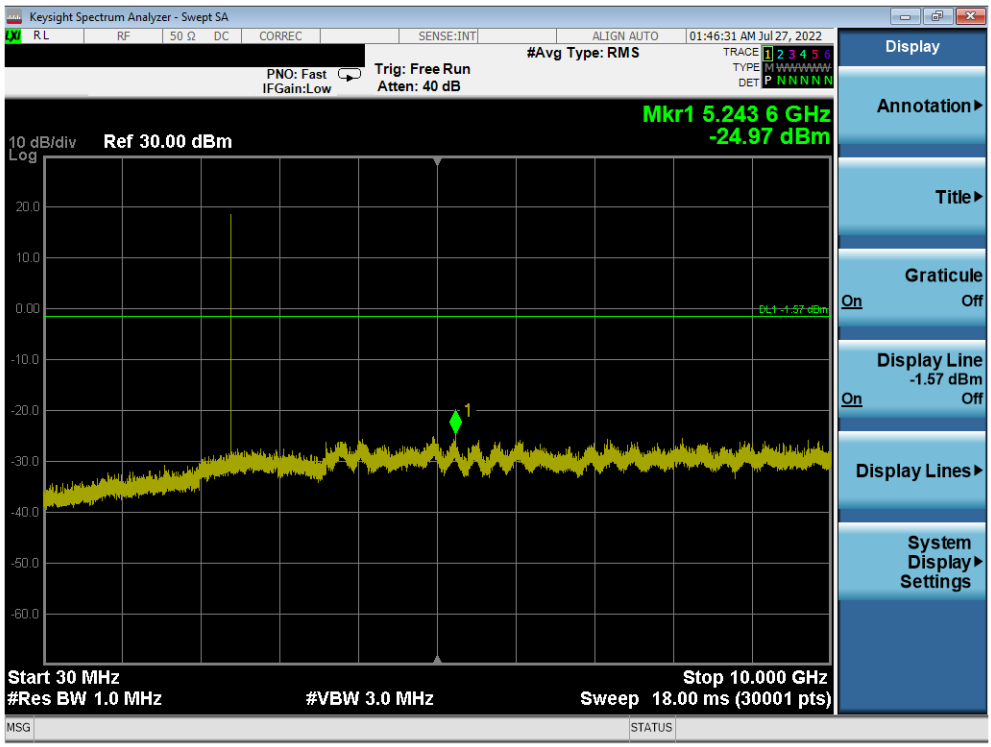


Plot 7-73. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)

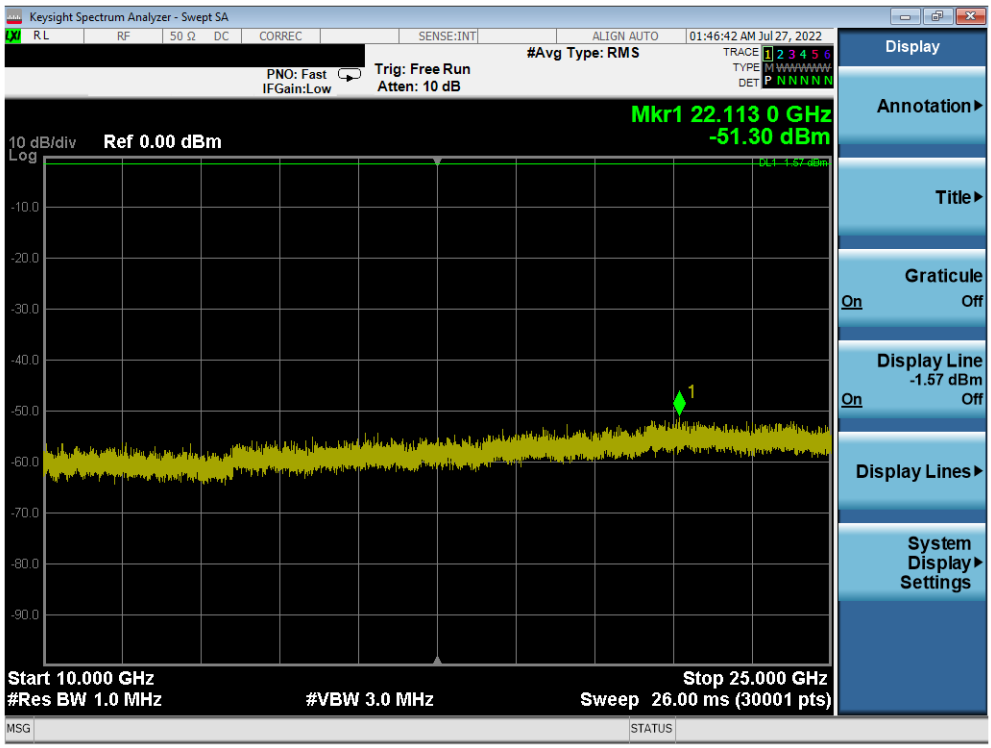


Plot 7-74. Conducted Spurious Plot Antenna 4a (Bluetooth (LE), 1Mbps, ePA – Ch. 39)

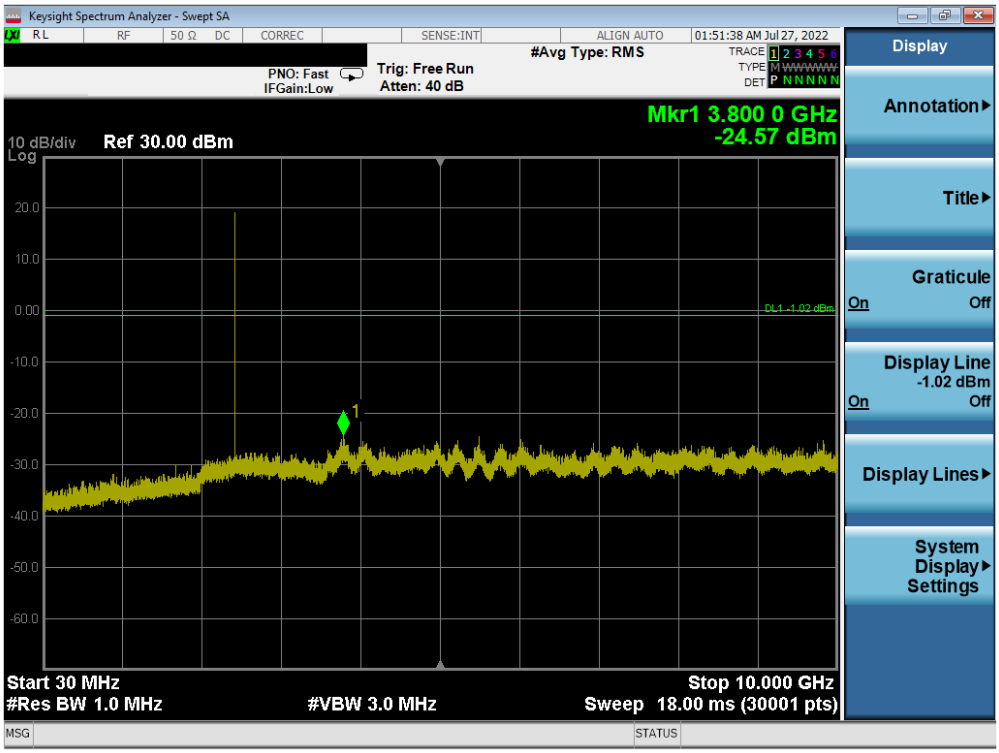
Antenna 2a



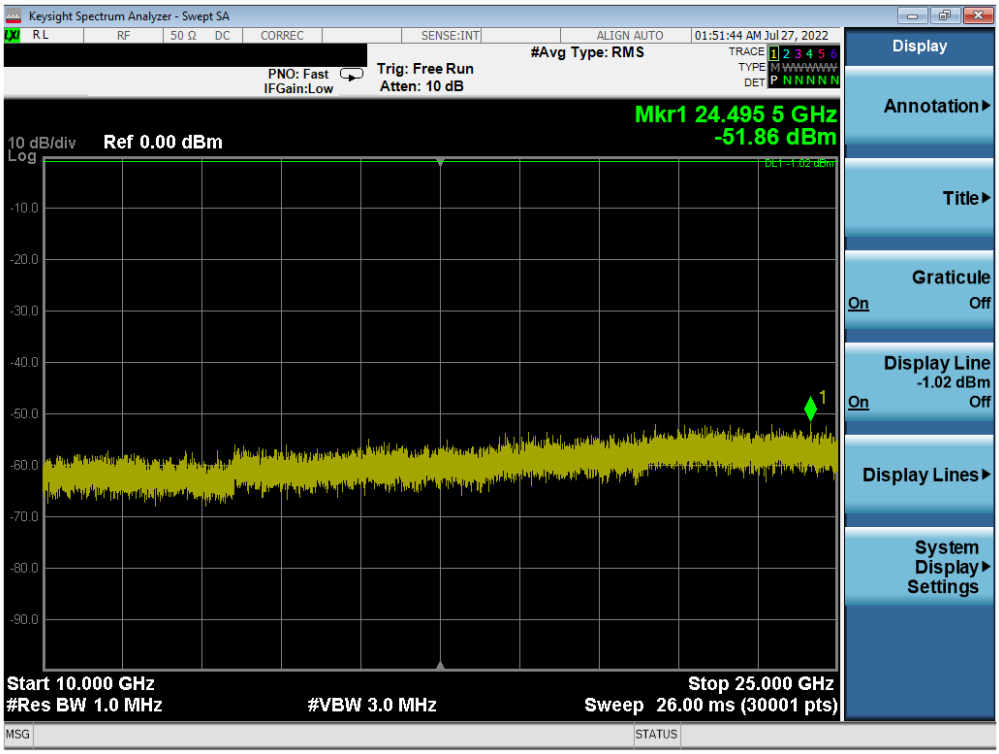
Plot 7-75. Conducted Spurious Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



Plot 7-76. Conducted Spurious Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



Plot 7-77. Conducted Spurious Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



Plot 7-78. Conducted Spurious Plot Antenna 2a (Bluetooth (LE), 1Mbps, ePA – Ch. 19)