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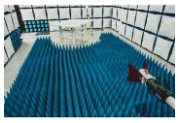

MEASUREMENT REPORT
FCC PART 15.247 / ISED RSS-247 Bluetooth (Low Energy)

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

Date of Testing:
2/10/2023 - 5/4/2023
Test Report Issue Date:
11/29/2023
Test Site/Location:
Element Materials Technology Morgan Hill, CA, USA
Test Report Serial No.:
1C2302130007-02.BCG

FCC ID:	**BCGA2117**
IC:	**579C-A2117**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2117
EUT Type:	Head Mounted Device
Max. RF Output Power:	10.641 mW (10.27 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 3
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

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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 Materials Technology Morgan Hill Test Location

These measurement tests were conducted at the Element Materials Technology Morgan Hill 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 Material Technology located in Morgan Hill, CA 95037, U.S.A.

- Element Materials Technology Morgan Hill 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 Materials Technology Morgan Hill facility is a registered (22831) test laboratory with the site description on file with ISED.

- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Head Mounted Device FCC ID: BCGA2117 and IC: 579C-A2117**. 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.: GPG3017001F20N78X, PYVWK6LLC6, WFGF7D9H60, MHP0XYH0XK, HP14K0WJ0Q

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8, HDRp4, HDRp8), NB UNII (1x, LE1M, LE2M, HDR4, HDR8, HDRp4, HDRp8)

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 [%]**			
		Ant1	**Ant2**	**NB UNII_L**	**TxBF (Ant1 + Ant2)**
1M	ePA	100.0	100.0	-	100.0
	iPA	100.0	100.0	100.0	100.0
2M	ePA	100.0	100.0	-	100.0
	iPA	100.0	100.0	100.0	100.0

Table 2-2. Measured Duty Cycles

This device supports simultaneous transmission operations. The table below shows all configurations possible.

Simultaneous Tx Config	Ant1			Ant2			NB UNII_L		NB UNII_R
	WLAN 2.4G 802.11 b/g/n/ax	BT 2.4G BDR, EDR, HDR4/8, LE1M/2M, HDRp4/p8	WIFI 5G 802.11 a/n/ac/ax	WLAN 2.4G 802.11 b/g/n/ax	BT 2.4G BDR, EDR, HDR4/8, LE1M/2M, HDRp4/p8	WIFI 5G 802.11 a/n/ac/ax	BT 2.4G BDR, EDR, HDR4/8, LE1M/2M, HDRp4/p8	NB_UNII 5G BDR, HDR4/8, LE1M/2M, HDRp4/p8	NB_UNII 5G BDR, HDR4/8, LE1M/2M, HDRp4/p8
Config 1	✓	×	✓	×	×	×	×	✓	✓
Config 2	×	×	×	✓	×	✓	×	✓	✓
Config 3	×	✓	✓	×	×	×	×	✓	✓
Config 4	×	✓	×	×	×	✓	×	✓	✓
Config 5	×	✓	✓	×	✓	×	×	×	×
Config 6	×	✓	×	×	✓	✓	×	×	×
Config 7	✓	×	✓	×	×	×	✓	✓	✓
Config 8	✓	×	×	×	×	✓	✓	✓	✓
Config 9	✓	×	✓	×	✓	×	×	×	×
Config 10	✓	×	×	×	✓	✓	×	×	×
Config 11	✓	×	✓	✓	×	✓	×	×	×
Config 12	×	✓	✓	×	×	✓	×	×	×
Config 13	✓	×	✓	×	×	✓	✓	×	×

Table 2-3. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

2.3 Antenna Description

Following antennas gains provided by manufacturer were used for testing.

Frequency [GHz]	Antenna Gain (dBi)		
	Ant1	Ant2	NB UNII_L
2.4	1.6	-1.0	-3.7

Table 2-4. Highest Antenna Gain

2.4 Test Support Equipment

1	Apple Macbook Pro	Model:	A2289	S/N:	C02DV7VGMD6T
	w/ AD/DC Adapter	Model:	A2164	S/N:	N/A
2	Apple USB-C Cable	Model:	Spartan	S/N:	000MKTR02U
3	Right Temple	Model:	N/A	S/N:	HTFGR70005J000020R
	Left Temple	Model:	N/A	S/N:	HTFGR40004A00002GY
	Headband	Model:	N/A	S/N:	GKNGNC0001H0000215
4	Light Seal	Model:	N/A	S/N:	GKNGQF000RX00003KB
	Light Seal Padding	Model:	N/A	S/N:	GKNGQ8001RD00002XA
5	EUT Power Pack	Model:	N/A	S/N:	HTFGQW0009800001MV

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.

There are two vendors of the WiFi/Bluetooth radio modules, variant 1 and variant 2. Both radio modules have the same mechanical outline, same on-board antenna matching circuit, identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances. The worst case configuration was found between the two variants. The EUT was also investigated with and without charger.

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 to USB-C Power Pack to Magnetic Charging Cable
- EUT powered by host PC via USB-C Power Pack to Magnetic Charging Cable

All possible sumultaneous transmission configurations have ben investigated and the worst case config has been reported.

Description	BT 2.4G	NB UNII 5G	WLAN 2.4G	WiFi 5G
Antenna	NB UNII_L	NB UNII_L + NB_UNII_R	Ant1 + Ant2	Ant1 + Ant2
Channel	39	1	12	36
Operating Frequency (MHz)	2480	5157	2467	5180
Mode/Modulation	BLE1M	BLE1M	WLAN 11ax (SU)	UNII 11ax (SU)

Table 2-6. Worst Case Simultaneous Transmission Configuration

2.6 Software and Firmware

The test was conducted with firmware version 20.1.467.5718 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 7.10. 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 #
Agilent	N9020A	MXA Signal Analyzer	4/26/2022	Annual	4/26/2023	MY56470202
Anritsu	MA2411B	Pulse Power Sensor	5/19/2022	Annual	5/19/2023	1911106
Anritsu	ML2496A	Power Meter	10/17/2022	Annual	10/17/2023	2002005
ETS-Lindgren	3117	Double Ridged Guide Horn Antenna (1-18 GHz)	5/24/2022	Annual	5/24/2023	240049
Keysight Technologies	N9030A	PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
Rohde & Schwarz	180-442A-KF	Horn (Small)	3/6/2023	Annual	3/6/2024	T058701-2
Rohde & Schwarz	ENV216	Two-Line V-Network	3/30/2023	Annual	3/30/2024	101364
Rohde & Schwarz	FSVA3044	Signal Analyzer 44GHz	5/12/2022	Annual	5/12/2023	101098
Rohde & Schwarz	FSW43	Signal and Spectrum Analyzer 2Hz to 43GHz	5/19/2022	Annual	5/19/2023	104093
Rohde & Schwarz	FSW67	Signal and Spectrum Analyzer (2Hz-67GHz)	4/21/2022	Annual	4/21/2023	101366
Rohde & Schwarz	HFH-2Z2	9kHz - 30MHz Loop Antenna	4/13/2022	Annual	4/13/2023	100546
Rohde & Schwarz	TS-PR1	Preamplifier - Antenna System; 30MHz - 1GHz	4/18/2022	Annual	4/18/2023	102081
Rohde & Schwarz	TS-PR18	Pre Amplifier 1-18GHz	3/3/2023	Annual	3/3/2024	102130
Rohde & Schwarz	TS-PR1840	Pre Amplifier 18-40GHz	4/18/2022	Annual	4/18/2023	100050
Schwarzbeck	VULB9162	Biconilog Antenna - (30MHz-6GHz)	7/27/2022	Annual	7/27/2023	121034

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: BCGA2117

IC: 579C-A2117

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©	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 2.0.

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

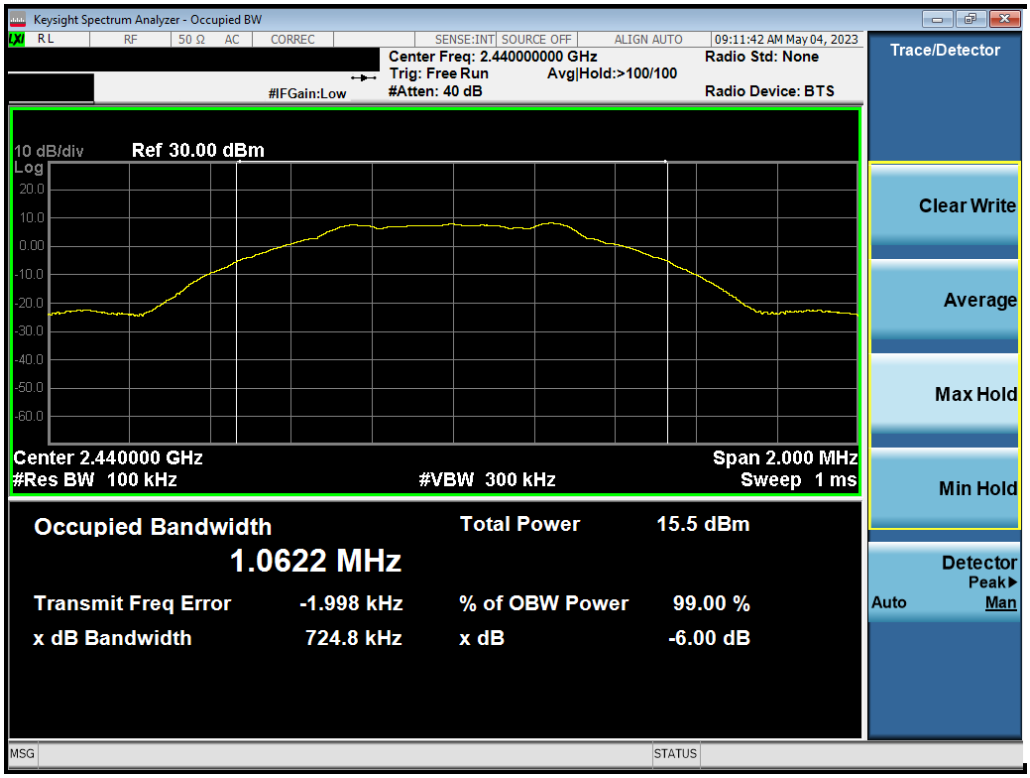
All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.

Ant1

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	1060.6	723.2	500	Pass
2440	1.0	ePA	19	1062.2	724.8	500	Pass
2480	1.0	ePA	39	1060.9	722.9	500	Pass
2404	2.0	ePA	1	2097.8	1334.0	500	Pass
2440	2.0	ePA	19	2107.6	1336.0	500	Pass
2478	2.0	ePA	38	2104.1	1333.4	500	Pass

Table 7-2. 6dB BW & 99% OBW Measurements Ant1

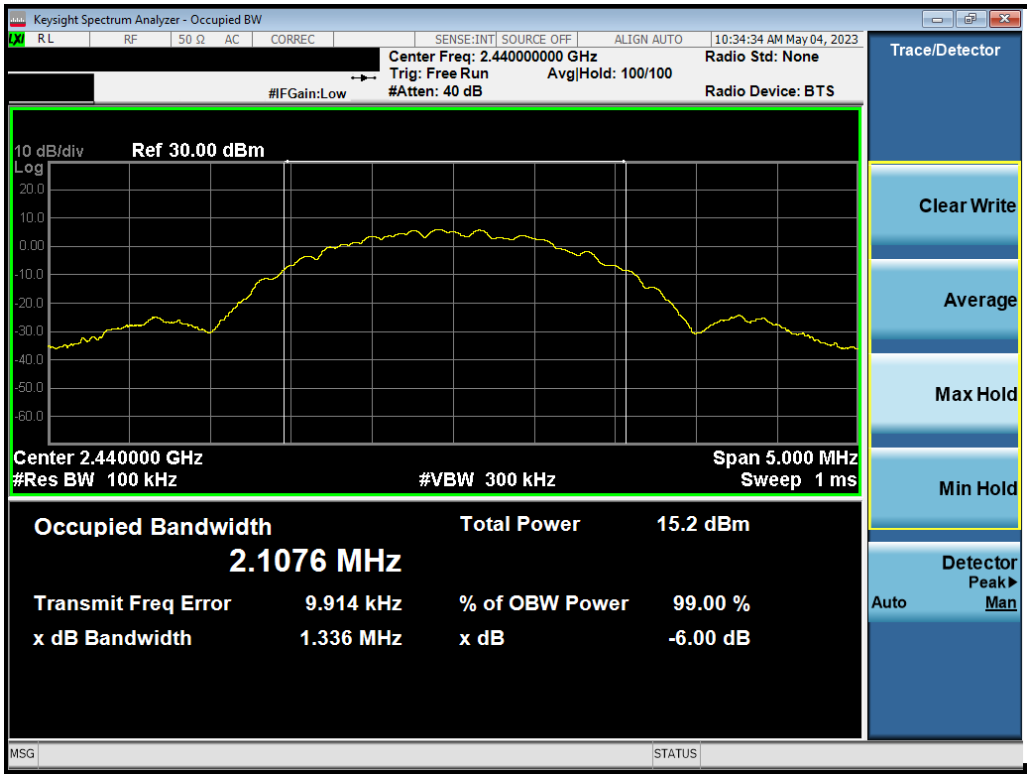
Plot 7-1. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



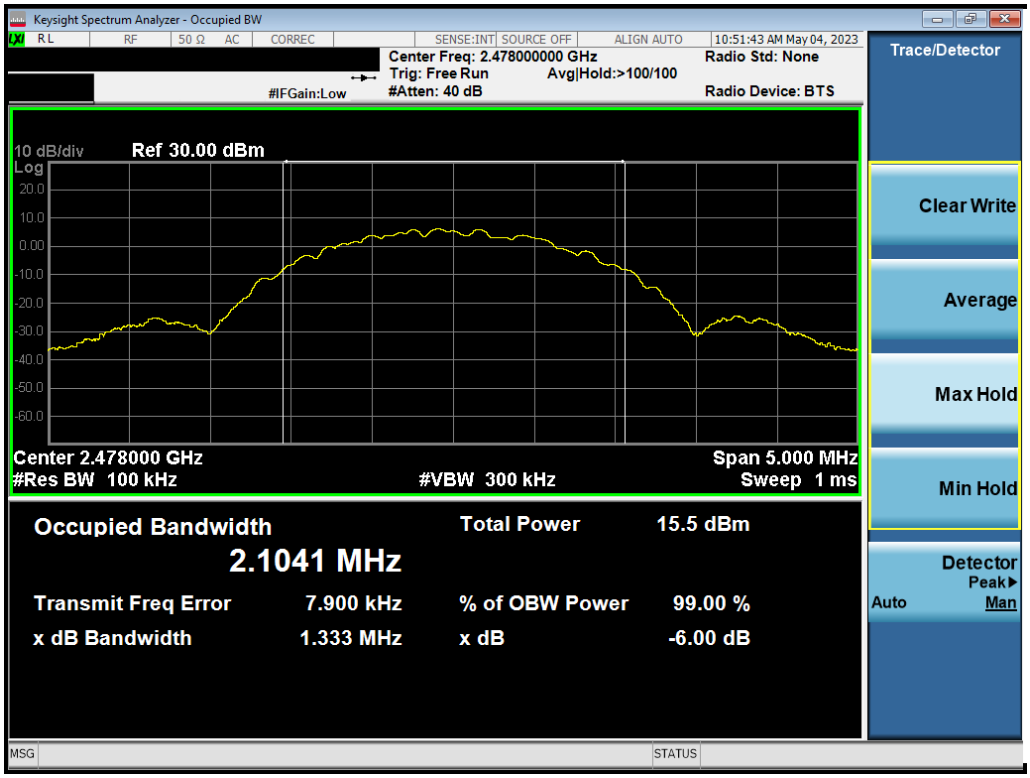
Plot 7-2. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)

Plot 7-3. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)

Plot 7-4. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-5. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



Plot 7-6. 6dB BW & 99% OBW Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

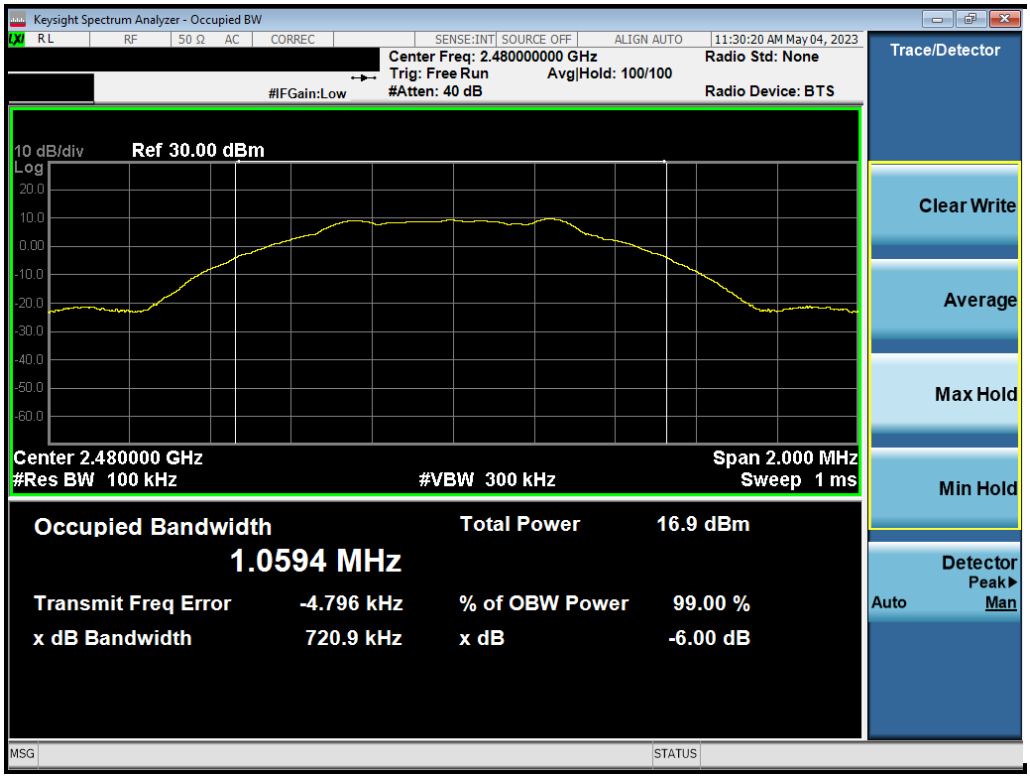
Ant2

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	1061.0	720.9	500	Pass
2440	1.0	ePA	19	1060.3	724.7	500	Pass
2480	1.0	ePA	39	1059.4	720.9	500	Pass
2404	2.0	ePA	1	2097.1	1334.0	500	Pass
2440	2.0	ePA	19	2092.2	1334.0	500	Pass
2478	2.0	ePA	38	2099.3	1335.0	500	Pass

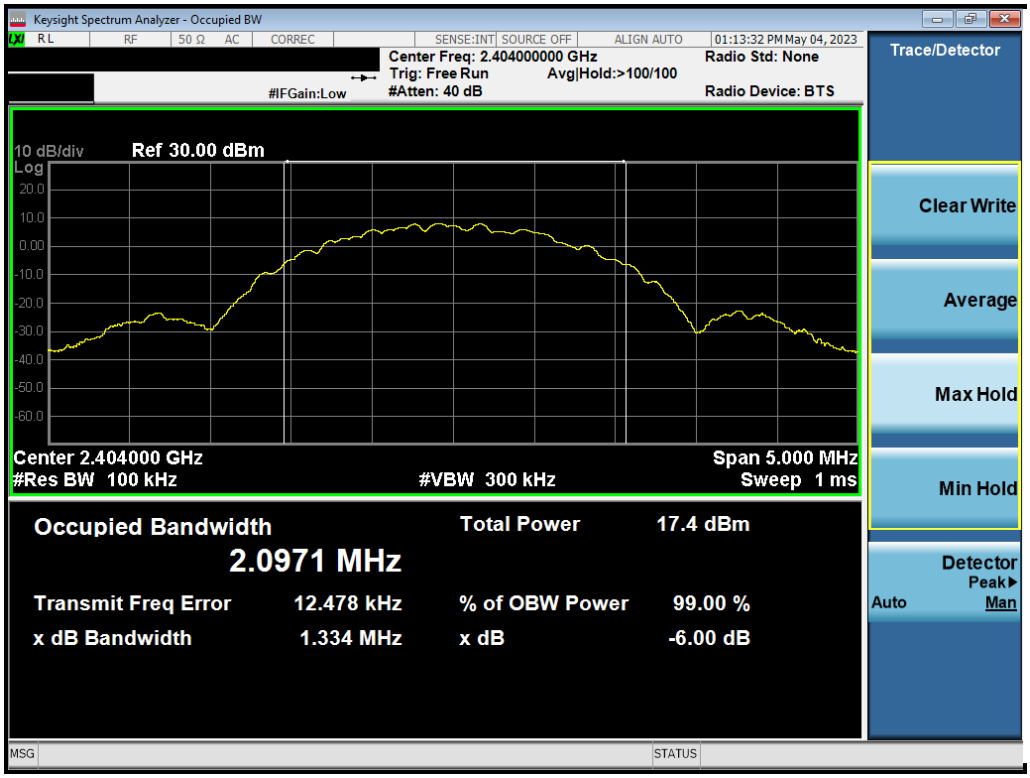
Table 7-3. 6dB BW & 99% OBW Measurements Ant2

Plot 7-7. 6dB BW & 99% OBW Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)

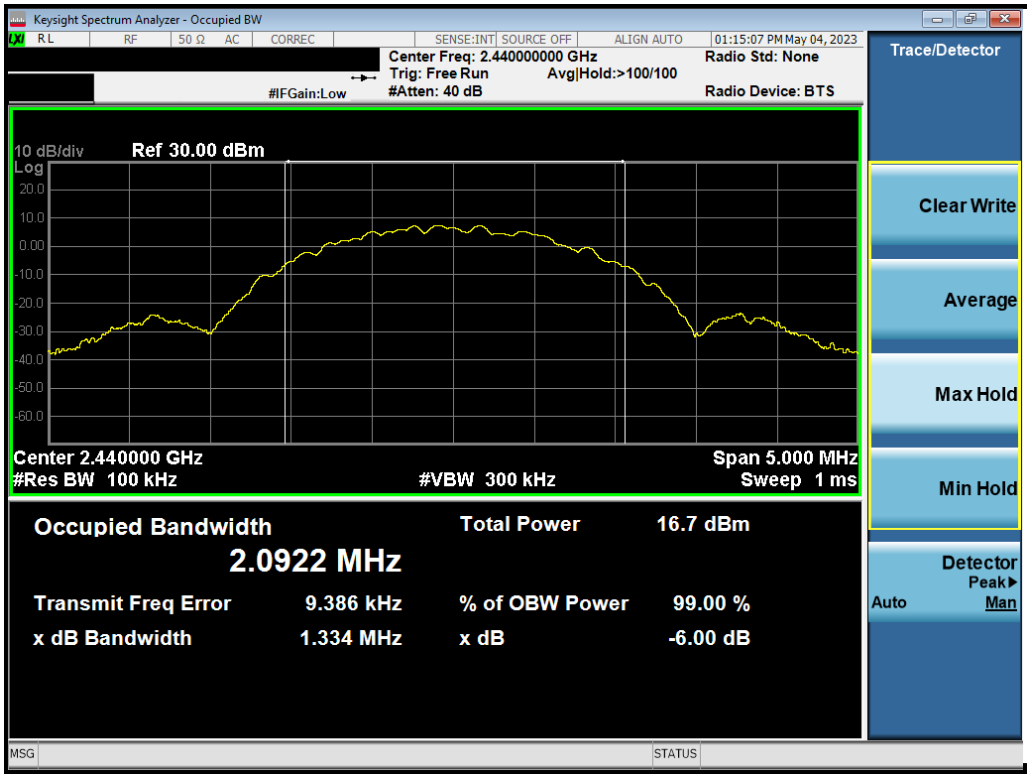
Plot 7-8. 6dB BW & 99% OBW Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



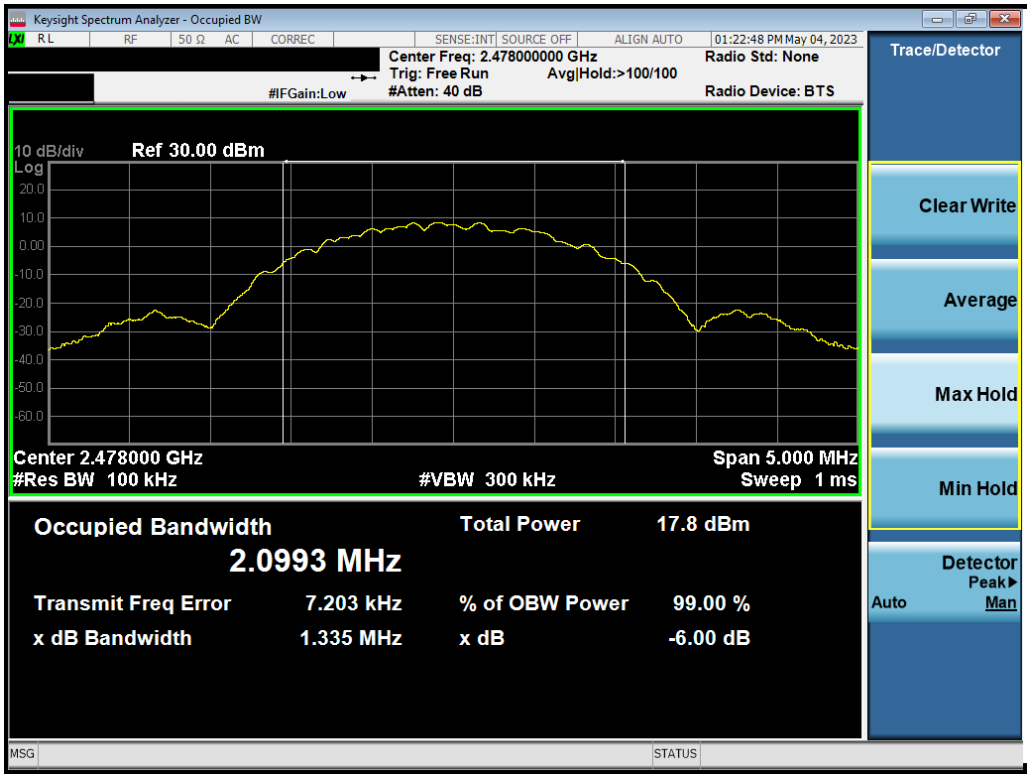
Plot 7-9. 6dB BW & 99% OBW Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



Plot 7-10. 6dB BW & 99% OBW Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-11. 6dB BW & 99% OBW Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)

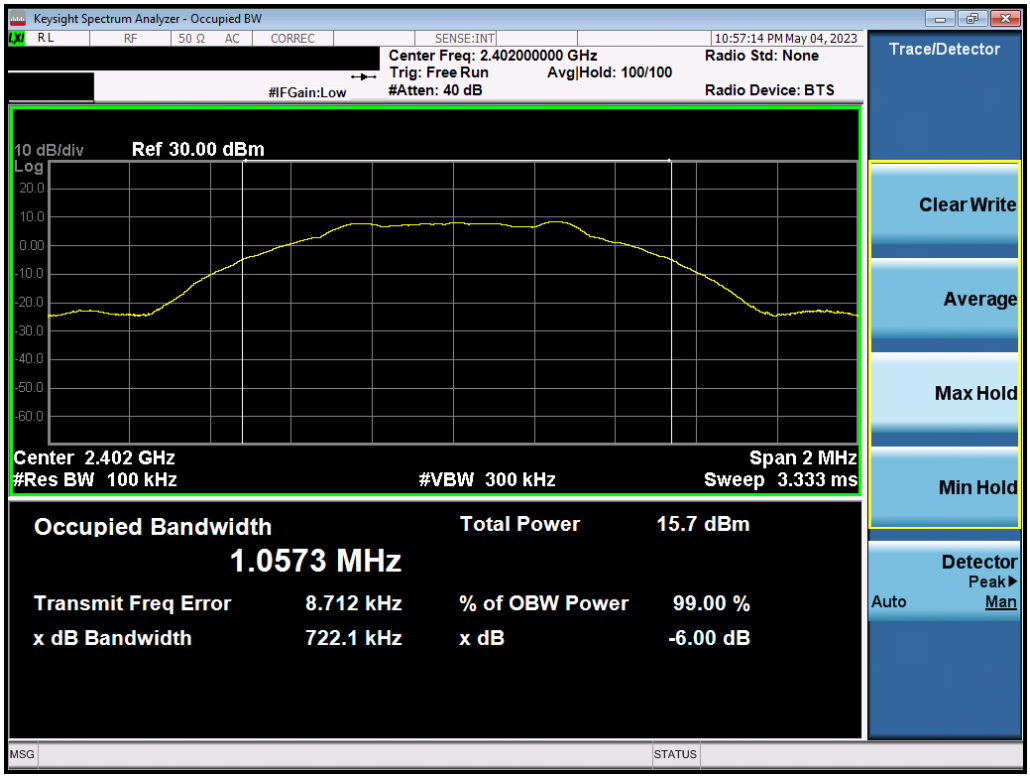


Plot 7-12. 6dB BW & 99% OBW Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

NB UNII_L

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	iPA	0	1057.3	722.1	500	Pass
2440	1.0	iPA	19	1057.9	723.9	500	Pass
2480	1.0	iPA	39	1057.9	722.3	500	Pass
2404	2.0	iPA	1	2088.8	1333.0	500	Pass
2440	2.0	iPA	19	2087.1	1333.0	500	Pass
2478	2.0	iPA	38	2088.0	1334.0	500	Pass

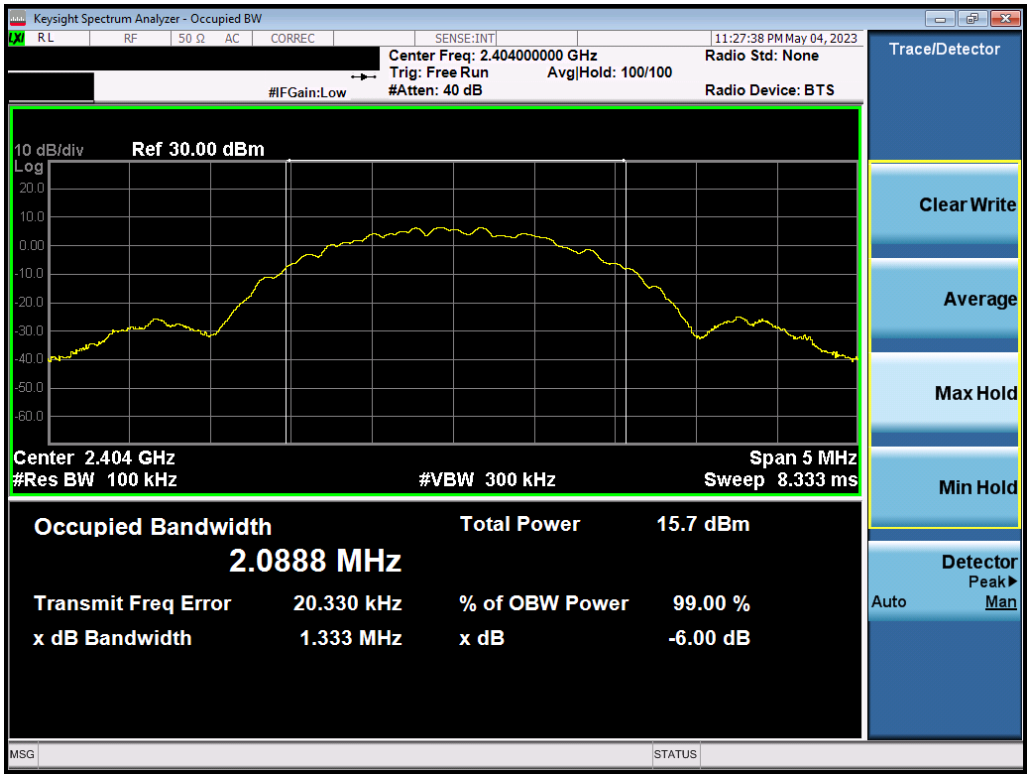
Table 7-4. 6dB BW & 99% OBW Measurements NB UNII_L



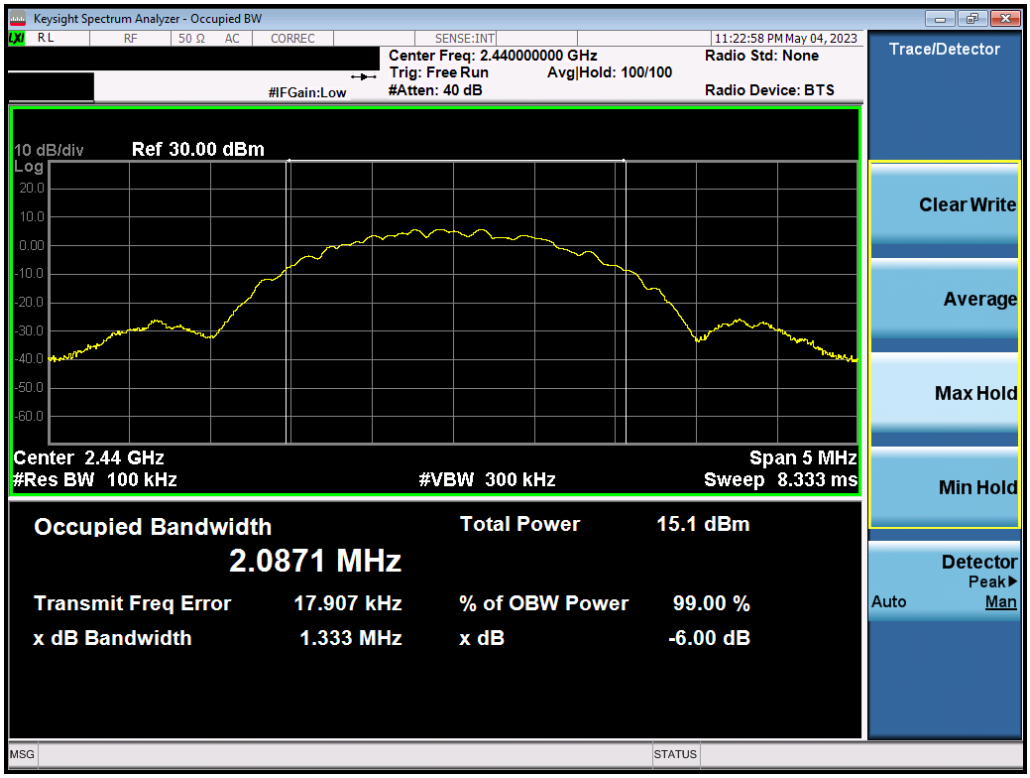
Plot 7-13. 6dB BW & 99% OBW Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 0)

Plot 7-14. 6dB BW & 99% OBW Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 19)

Plot 7-15. 6dB BW & 99% OBW Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



Plot 7-16. 6dB BW & 99% OBW Plot NB UNII_L (Bluetooth (LE), 2Mbps, iPA – Ch. 1)



Plot 7-17. 6dB BW & 99% OBW Plot NB UNII_L (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-18. 6dB BW & 99% OBW NB UNII_L (Bluetooth (LE), 2Mbps, iPA – 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 maximum peak conducted output power of digital modulation systems operating in the 2400-2483.5 MHz band is 1 Watt.

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	7.12	5.152	30.00	-22.88	1.60	8.72	36.02	-27.30
2440	1.0	ePA	19	6.84	4.831	30.00	-23.16	1.60	8.44	36.02	-27.58
2480	1.0	ePA	39	6.86	4.853	30.00	-23.14	1.60	8.46	36.02	-27.56
2402	1.0	iPA	0	7.26	5.321	30.00	-22.74	1.60	8.86	36.02	-27.16
2440	1.0	iPA	19	7.28	5.346	30.00	-22.72	1.60	8.88	36.02	-27.14
2480	1.0	iPA	39	6.85	4.842	30.00	-23.15	1.60	8.45	36.02	-27.57
2404	2.0	ePA	1	7.26	5.321	30.00	-22.74	1.60	8.86	36.02	-27.16
2440	2.0	ePA	19	6.98	4.989	30.00	-23.02	1.60	8.58	36.02	-27.44
2478	2.0	ePA	38	6.99	5.000	30.00	-23.01	1.60	8.59	36.02	-27.43
2404	2.0	iPA	1	7.25	5.309	30.00	-22.75	1.60	8.85	36.02	-27.17
2440	2.0	iPA	19	6.99	5.000	30.00	-23.01	1.60	8.59	36.02	-27.43
2478	2.0	iPA	38	6.96	4.966	30.00	-23.04	1.60	8.56	36.02	-27.46

Table 7-5. Peak Conducted Output Power Measurements Ant1 (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	9.07	8.072	30.00	-20.93	-1.00	8.07	36.02	-27.95
2440	1.0	ePA	19	8.88	7.727	30.00	-21.12	-1.00	7.88	36.02	-28.14
2480	1.0	ePA	39	9.05	8.035	30.00	-20.95	-1.00	8.05	36.02	-27.97
2402	1.0	iPA	0	9.05	8.035	30.00	-20.95	-1.00	8.05	36.02	-27.97
2440	1.0	iPA	19	8.92	7.798	30.00	-21.08	-1.00	7.92	36.02	-28.10
2480	1.0	iPA	39	9.07	8.072	30.00	-20.93	-1.00	8.07	36.02	-27.95
2404	2.0	ePA	1	9.11	8.147	30.00	-20.89	-1.00	8.11	36.02	-27.91
2440	2.0	ePA	19	9.10	8.128	30.00	-20.90	-1.00	8.10	36.02	-27.92
2478	2.0	ePA	38	9.33	8.570	30.00	-20.67	-1.00	8.33	36.02	-27.69
2404	2.0	iPA	1	9.26	8.433	30.00	-20.74	-1.00	8.26	36.02	-27.76
2440	2.0	iPA	19	9.05	8.035	30.00	-20.95	-1.00	8.05	36.02	-27.97
2478	2.0	iPA	38	9.32	8.551	30.00	-20.68	-1.00	8.32	36.02	-27.70

Table 7-6. Peak Conducted Output Power Measurements Ant2 (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	iPA	0	9.09	8.110	30.00	-20.91	-3.70	5.39	36.02	-30.63
2440	1.0	iPA	19	8.77	7.534	30.00	-21.23	-3.70	5.07	36.02	-30.95
2480	1.0	iPA	39	8.98	7.907	30.00	-21.02	-3.70	5.28	36.02	-30.74
2402	2.0	iPA	1	9.24	8.395	30.00	-20.76	-3.70	5.54	36.02	-30.48
2440	2.0	iPA	19	8.94	7.834	30.00	-21.06	-3.70	5.24	36.02	-30.78
2480	2.0	iPA	38	9.12	8.166	30.00	-20.88	-3.70	5.42	36.02	-30.60

Table 7-7. Peak Conducted Output Power Measurements NB UNII_L (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]
				Ant1		Ant2		Summed							
				[dBm]	[mW]	[dBm]	[mW]	[dBm]	[mW]						
2402	1.0	ePA	0	7.19	5.236	7.05	5.070	10.13	10.304	30.00	-19.87	3.41	13.54	36.02	-22.48
2440	1.0	ePA	19	7.23	5.284	7.29	5.358	10.27	10.641	30.00	-19.73	3.41	13.68	36.02	-22.34
2480	1.0	ePA	39	7.17	5.212	7.31	5.383	10.25	10.593	30.00	-19.75	3.41	13.66	36.02	-22.36
2402	1.0	iPA	0	7.21	5.260	7.08	5.105	10.16	10.375	30.00	-19.84	3.41	13.57	36.02	-22.45
2440	1.0	iPA	19	7.25	5.309	7.14	5.176	10.21	10.495	30.00	-19.79	3.41	13.62	36.02	-22.40
2480	1.0	iPA	39	7.19	5.236	7.33	5.408	10.27	10.641	30.00	-19.73	3.41	13.68	36.02	-22.34
2404	2.0	ePA	1	7.35	5.433	7.03	5.047	10.20	10.471	30.00	-19.80	3.41	13.61	36.02	-22.41
2440	2.0	ePA	19	6.92	4.920	6.90	4.898	9.92	9.817	30.00	-20.08	3.41	13.33	36.02	-22.69
2478	2.0	ePA	38	6.91	4.909	7.12	5.152	10.03	10.069	30.00	-19.97	3.41	13.44	36.02	-22.58
2404	2.0	iPA	1	7.37	5.458	7.05	5.070	10.22	10.520	30.00	-19.78	3.41	13.63	36.02	-22.39
2440	2.0	iPA	19	6.95	4.955	6.91	4.909	9.94	9.863	30.00	-20.06	3.41	13.35	36.02	-22.67
2478	2.0	iPA	38	6.90	4.898	7.11	5.140	10.02	10.046	30.00	-19.98	3.41	13.43	36.02	-22.59

Table 7-8. 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	6.83	4.819	30.00	-23.17	1.60	8.43	36.02	-27.59
2440	1.0	ePA	19	6.54	4.508	30.00	-23.46	1.60	8.14	36.02	-27.88
2480	1.0	ePA	39	6.56	4.529	30.00	-23.44	1.60	8.16	36.02	-27.86
2402	1.0	iPA	0	6.96	4.966	30.00	-23.04	1.60	8.56	36.02	-27.46
2440	1.0	iPA	19	7.00	5.012	30.00	-23.00	1.60	8.60	36.02	-27.42
2480	1.0	iPA	39	6.55	4.519	30.00	-23.45	1.60	8.15	36.02	-27.87
2404	2.0	ePA	1	6.91	4.909	30.00	-23.09	1.60	8.51	36.02	-27.51
2440	2.0	ePA	19	6.63	4.603	30.00	-23.37	1.60	8.23	36.02	-27.79
2478	2.0	ePA	38	6.64	4.613	30.00	-23.36	1.60	8.24	36.02	-27.78
2404	2.0	iPA	1	6.89	4.887	30.00	-23.11	1.60	8.49	36.02	-27.53
2440	2.0	iPA	19	6.64	4.613	30.00	-23.36	1.60	8.24	36.02	-27.78
2478	2.0	iPA	38	6.61	4.581	30.00	-23.39	1.60	8.21	36.02	-27.81

Table 7-9. Average Conducted Output Power Measurements Ant1 (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	8.79	7.568	30.00	-21.21	-1.00	7.79	36.02	-28.23
2440	1.0	ePA	19	8.60	7.244	30.00	-21.40	-1.00	7.60	36.02	-28.42
2480	1.0	ePA	39	8.75	7.499	30.00	-21.25	-1.00	7.75	36.02	-28.27
2402	1.0	iPA	0	8.76	7.516	30.00	-21.24	-1.00	7.76	36.02	-28.26
2440	1.0	iPA	19	8.62	7.278	30.00	-21.38	-1.00	7.62	36.02	-28.40
2480	1.0	iPA	39	8.78	7.551	30.00	-21.22	-1.00	7.78	36.02	-28.24
2404	2.0	ePA	1	8.77	7.534	30.00	-21.23	-1.00	7.77	36.02	-28.25
2440	2.0	ePA	19	8.75	7.499	30.00	-21.25	-1.00	7.75	36.02	-28.27
2478	2.0	ePA	38	8.98	7.907	30.00	-21.02	-1.00	7.98	36.02	-28.04
2404	2.0	iPA	1	8.91	7.780	30.00	-21.09	-1.00	7.91	36.02	-28.11
2440	2.0	iPA	19	8.70	7.413	30.00	-21.30	-1.00	7.70	36.02	-28.32
2478	2.0	iPA	38	8.97	7.889	30.00	-21.03	-1.00	7.97	36.02	-28.05

Table 7-10. Average Conducted Output Power Measurements Ant2 (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	iPA	0	8.81	7.603	30.00	-21.19	-3.70	5.11	36.02	-30.91
2440	1.0	iPA	19	8.50	7.079	30.00	-21.50	-3.70	4.80	36.02	-31.22
2480	1.0	iPA	39	8.70	7.413	30.00	-21.30	-3.70	5.00	36.02	-31.02
2404	2.0	iPA	1	8.91	7.780	30.00	-21.09	-3.70	5.21	36.02	-30.81
2440	2.0	iPA	19	8.60	7.244	30.00	-21.40	-3.70	4.90	36.02	-31.12
2478	2.0	iPA	38	8.80	7.586	30.00	-21.20	-3.70	5.10	36.02	-30.92

Table 7-11. Average Conducted Output Power Measurements NB UNII_L (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]
				Ant1		Ant2		Summed							
				[dBm]	[mW]	[dBm]	[mW]	[dBm]	[mW]						
2402	1.0	ePA	0	6.90	4.898	6.72	4.699	9.82	9.594	30.00	-20.18	3.41	13.23	36.02	-22.79
2440	1.0	ePA	19	6.93	4.932	6.96	4.966	9.96	9.908	30.00	-20.04	3.41	13.37	36.02	-22.65
2480	1.0	ePA	39	6.88	4.875	6.97	4.977	9.94	9.863	30.00	-20.06	3.41	13.35	36.02	-22.67
2402	1.0	iPA	0	6.91	4.909	6.75	4.732	9.84	9.638	30.00	-20.16	3.41	13.25	36.02	-22.77
2440	1.0	iPA	19	6.95	4.955	6.82	4.808	9.90	9.772	30.00	-20.10	3.41	13.31	36.02	-22.71
2480	1.0	iPA	39	6.89	4.887	7.00	5.012	9.96	9.908	30.00	-20.04	3.41	13.37	36.02	-22.65
2404	2.0	ePA	1	6.99	5.000	6.65	4.624	9.83	9.616	30.00	-20.17	3.41	13.24	36.02	-22.78
2440	2.0	ePA	19	6.55	4.519	6.52	4.487	9.55	9.016	30.00	-20.45	3.41	12.96	36.02	-23.06
2478	2.0	ePA	38	6.54	4.508	6.74	4.721	9.65	9.226	30.00	-20.35	3.41	13.06	36.02	-22.96
2404	2.0	iPA	1	7.00	5.012	6.67	4.645	9.85	9.661	30.00	-20.15	3.41	13.26	36.02	-22.76
2440	2.0	iPA	19	6.58	4.550	6.53	4.498	9.57	9.057	30.00	-20.43	3.41	12.98	36.02	-23.04
2478	2.0	iPA	38	6.54	4.508	6.74	4.721	9.65	9.226	30.00	-20.35	3.41	13.06	36.02	-22.96

Table 7-12. 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 Ant1 and Ant2 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 6.90 dBm for Ant1 and 6.72 dBm for Ant2.

Ant1 + Ant2 = TxBF

(6.90 dBm + 6.72 dBm) = (4.90 mW + 4.70 mW) = 9.60 mW = 9.82 dBm

Sample e.i.r.p. Calculation:

At 2402MHz, the average conducted output power was calculated to be 9.82 dBm with directional gain of 3.41 dBi.

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

9.82 dBm + 3.41 dBi = 13.23 dBm

7.4 Power Spectral Density – Bluetooth (LE)

§15.247©; 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

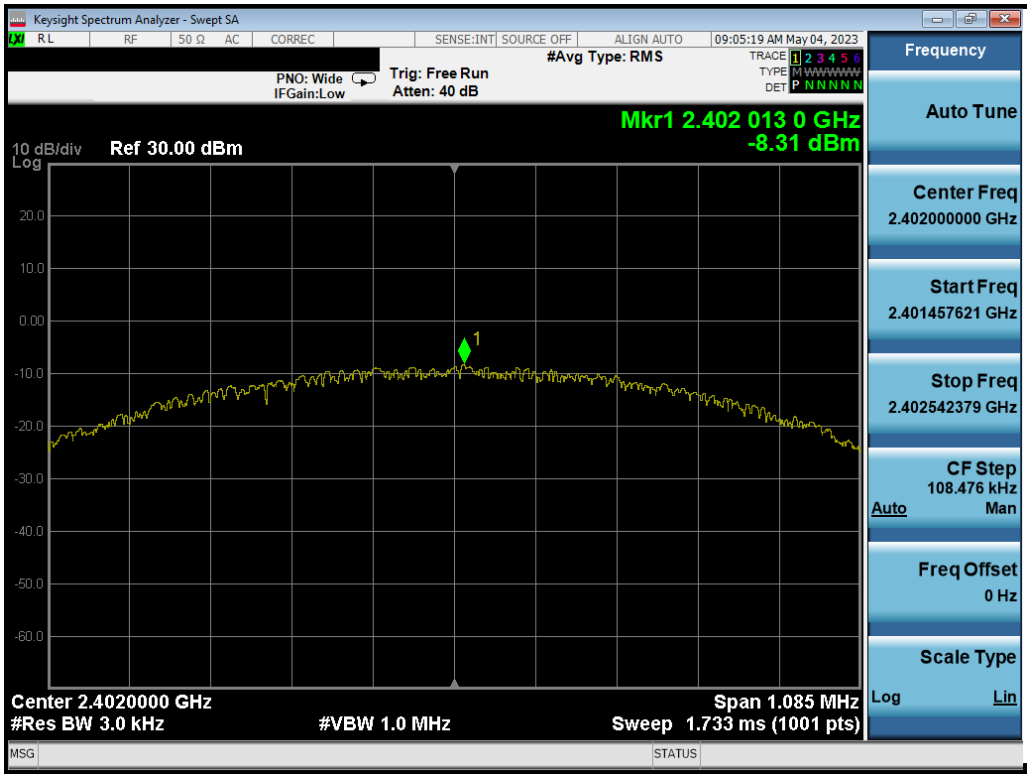
Test Notes

None

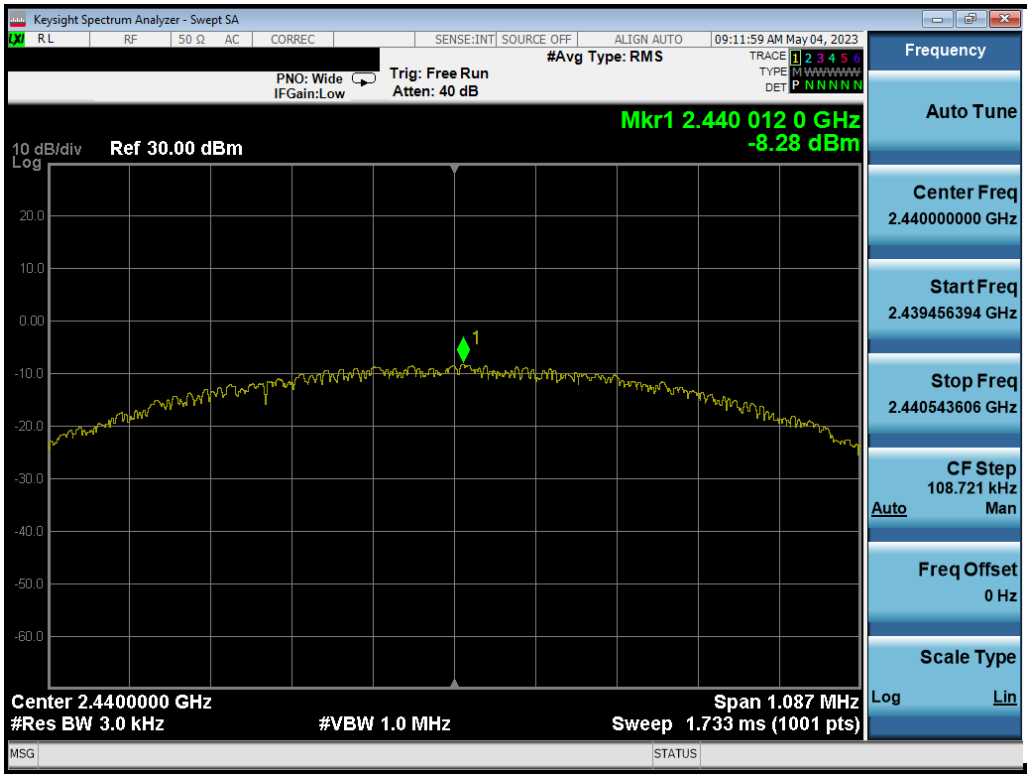
Ant1

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	-8.31	8.0	-16.31
2440	1.0	ePA	19	-8.28	8.0	-16.28
2480	1.0	ePA	39	-8.26	8.0	-16.26
2402	1.0	iPA	0	-8.41	8.0	-16.41
2440	1.0	iPA	19	-8.31	8.0	-16.31
2480	1.0	iPA	39	-8.33	8.0	-16.33
2404	2.0	ePA	1	-13.89	8.0	-21.89
2440	2.0	ePA	19	-14.22	8.0	-22.22
2478	2.0	ePA	38	-14.10	8.0	-22.10
2404	2.0	iPA	1	-13.80	8.0	-21.80
2440	2.0	iPA	19	-14.18	8.0	-22.18
2478	2.0	iPA	38	-13.92	8.0	-21.92

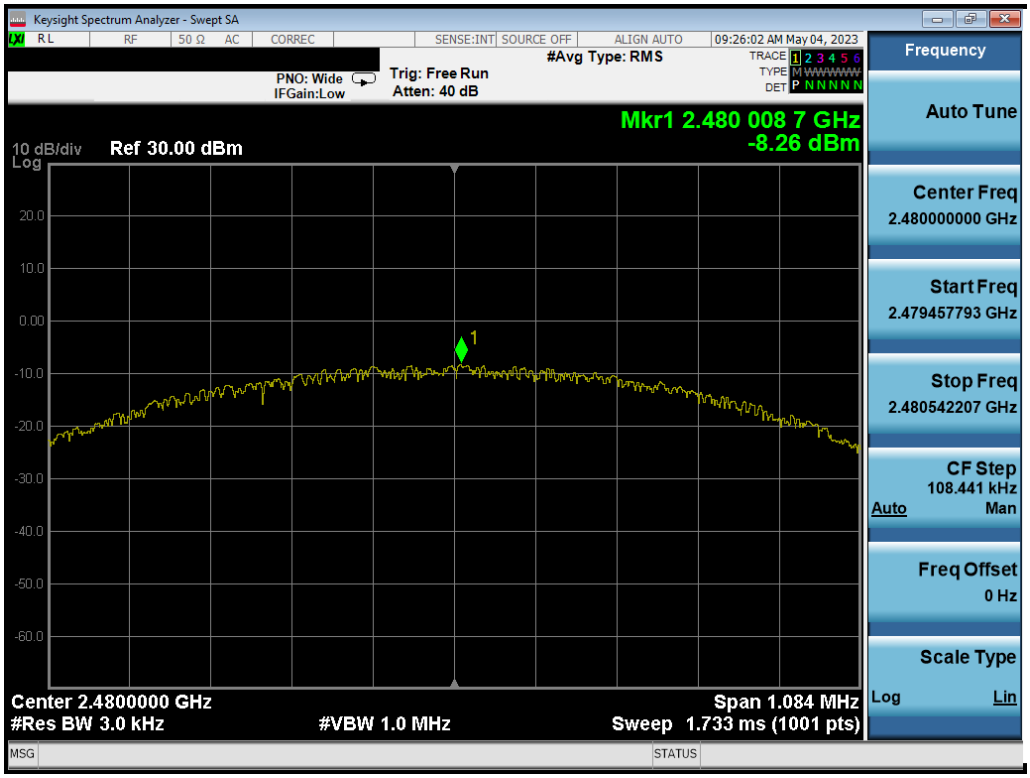
Table 7-13. Conducted Power Density Measurements Ant1



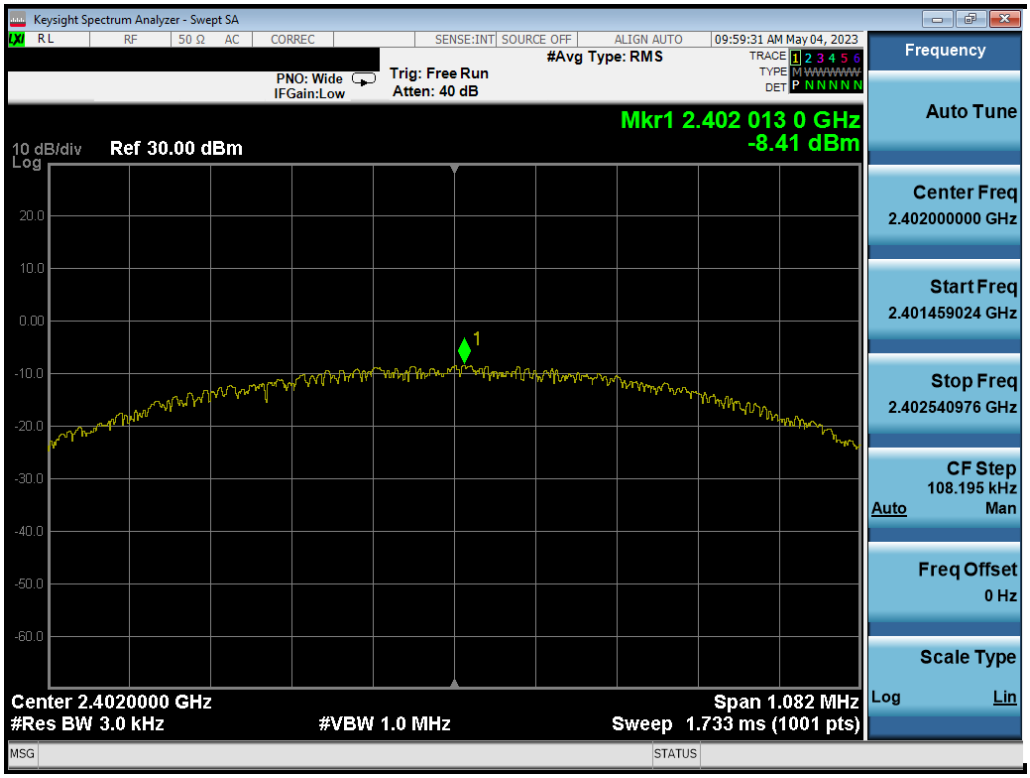
Plot 7-19. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



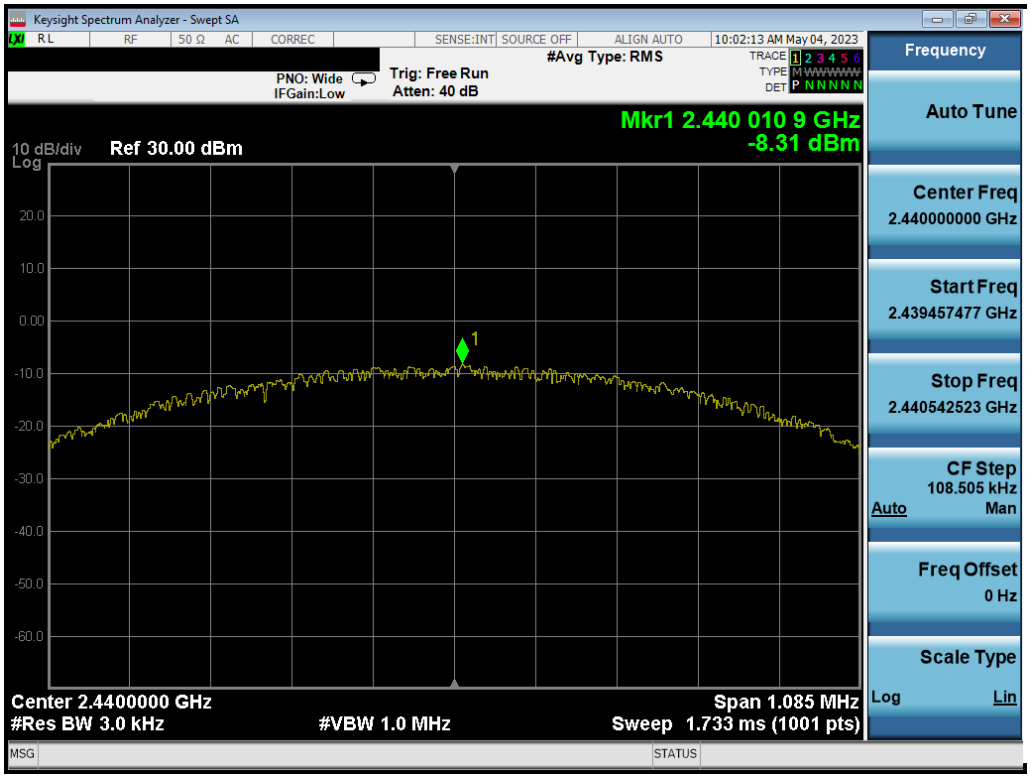
Plot 7-20. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



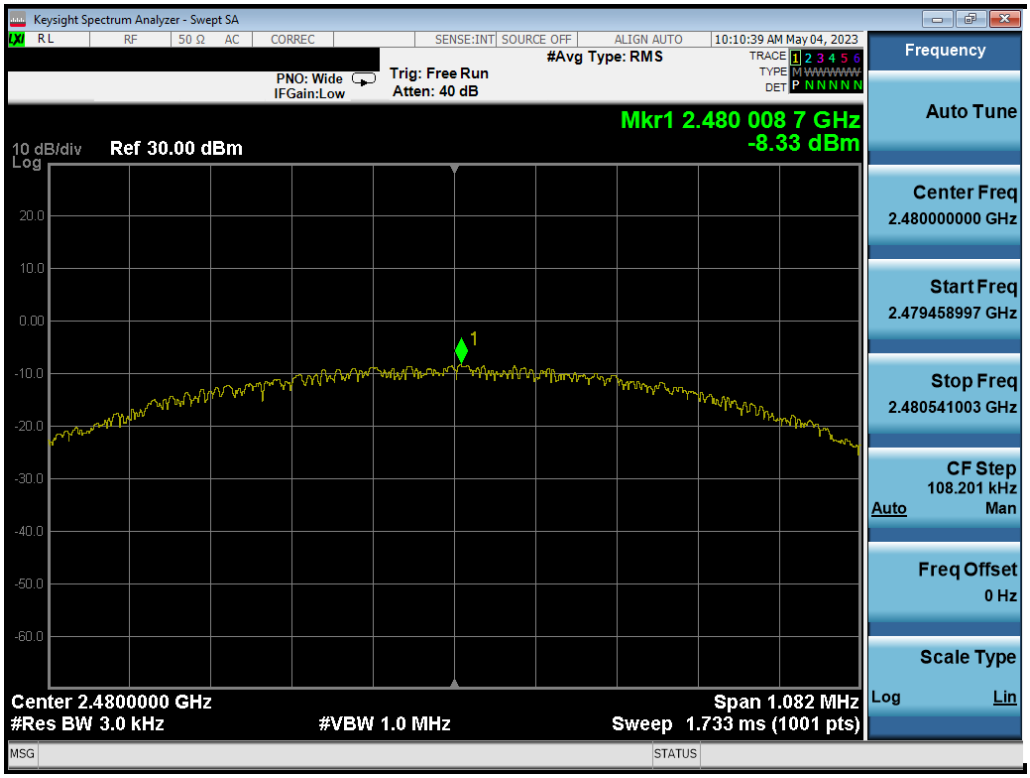
Plot 7-21. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



Plot 7-22. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 0)

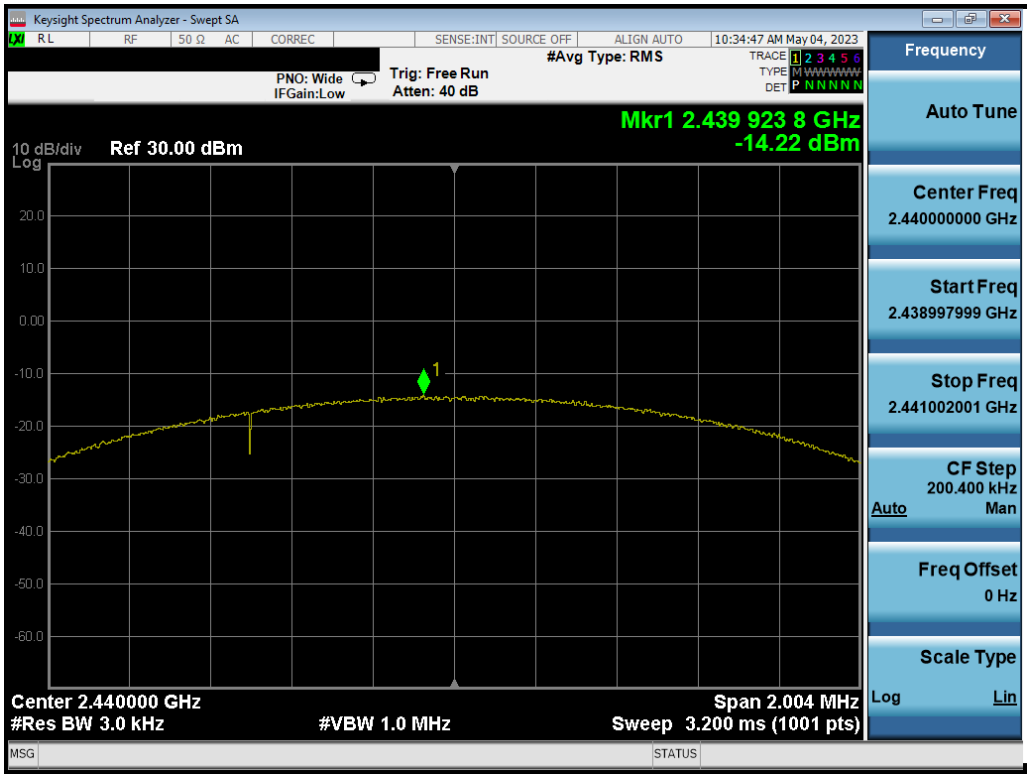


Plot 7-23. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 19)

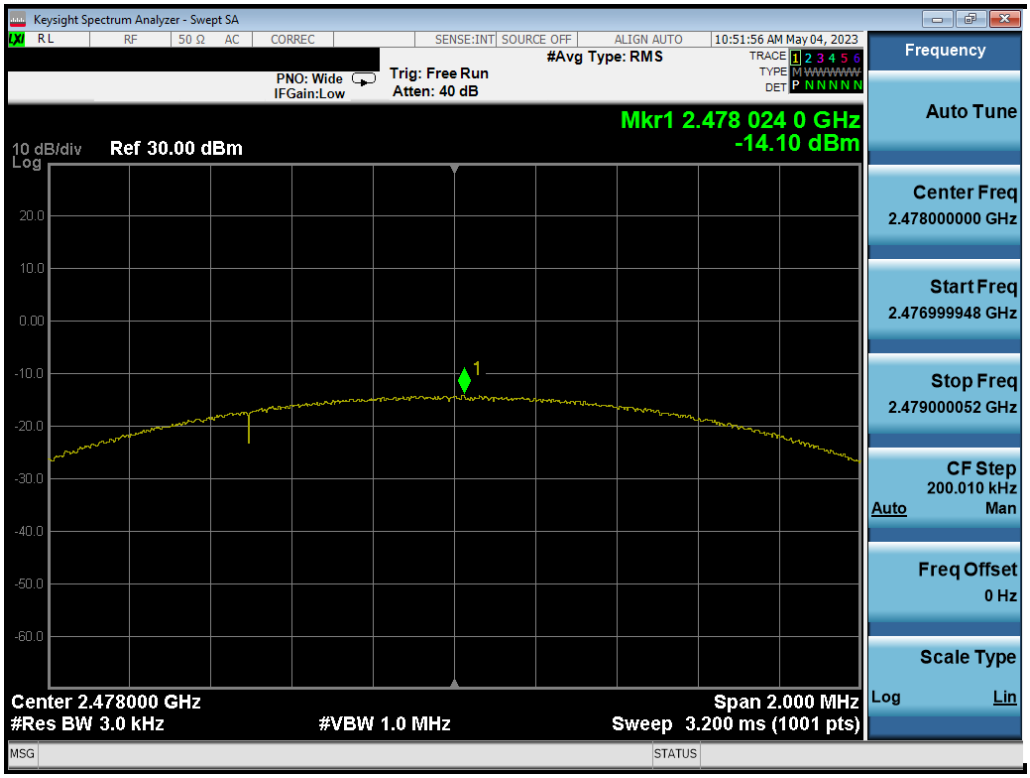


Plot 7-24. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 39)

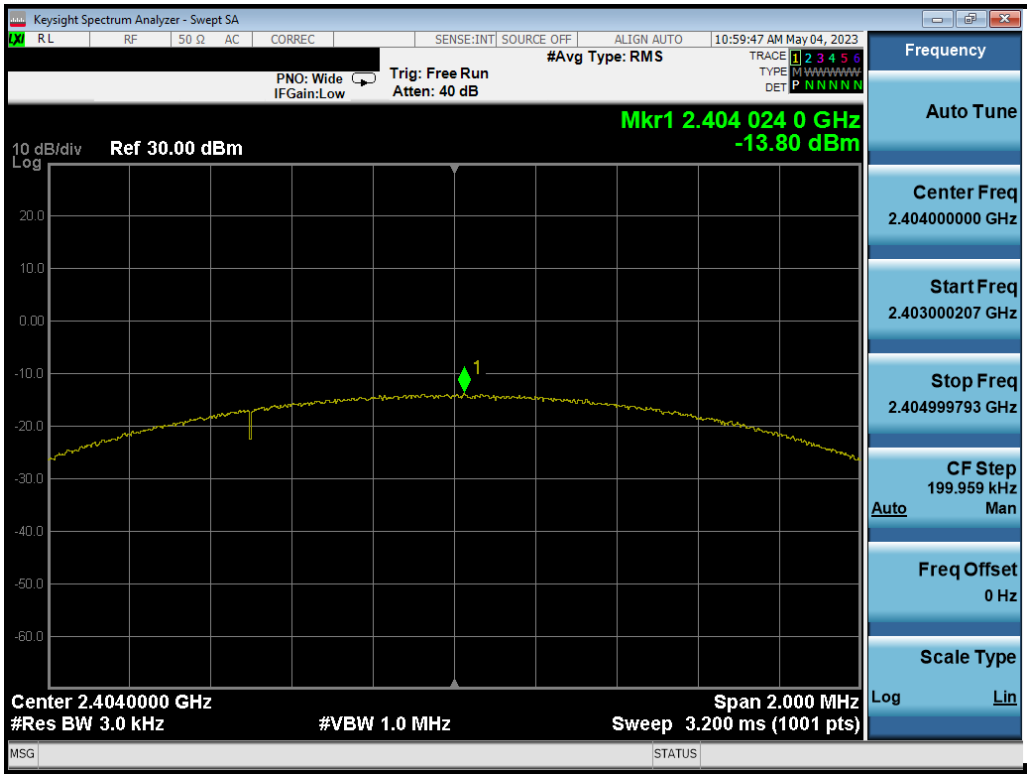
Plot 7-25. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



Plot 7-26. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)

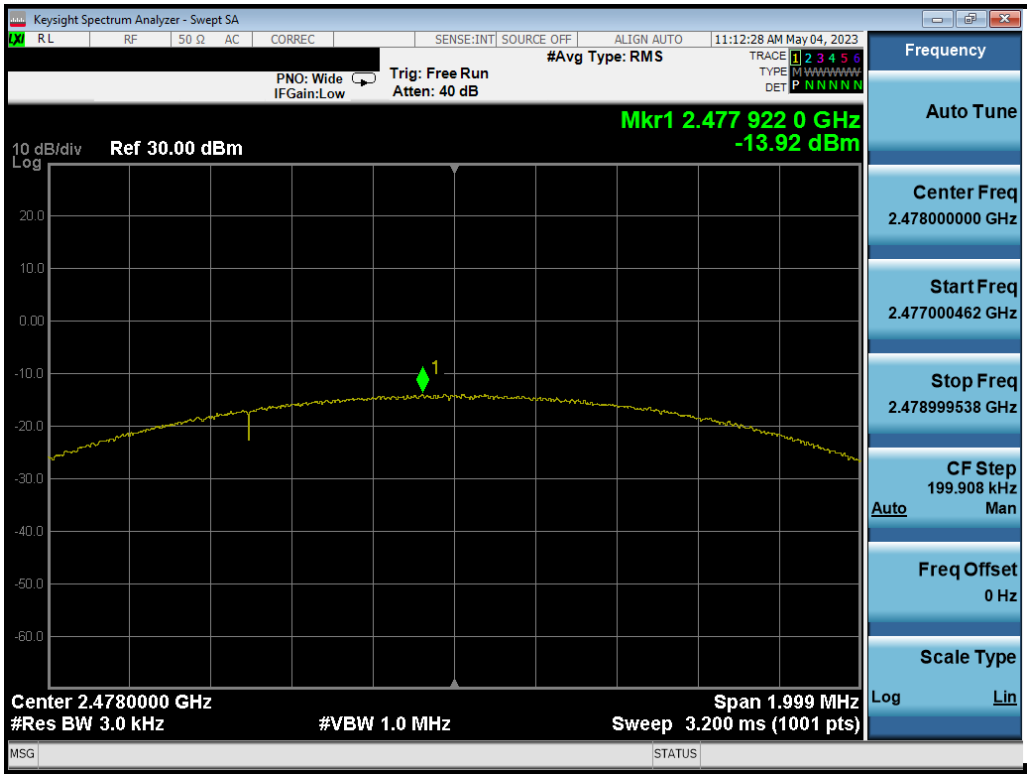


Plot 7-27. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)



Plot 7-28. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 1)

Plot 7-29. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

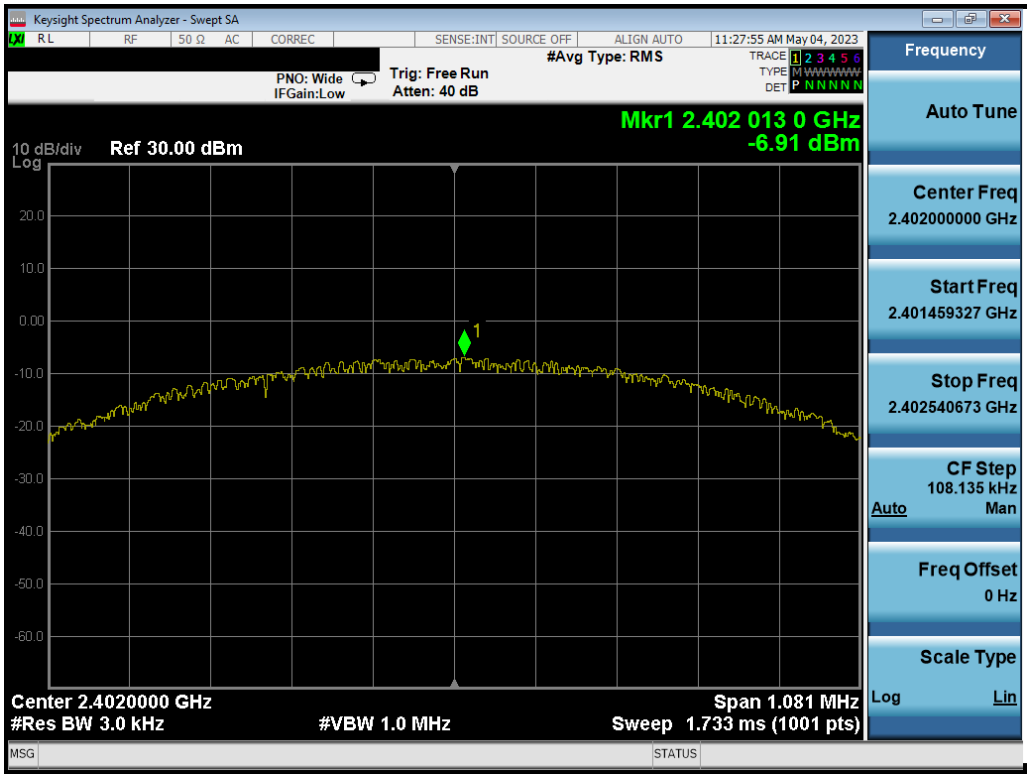


Plot 7-30. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

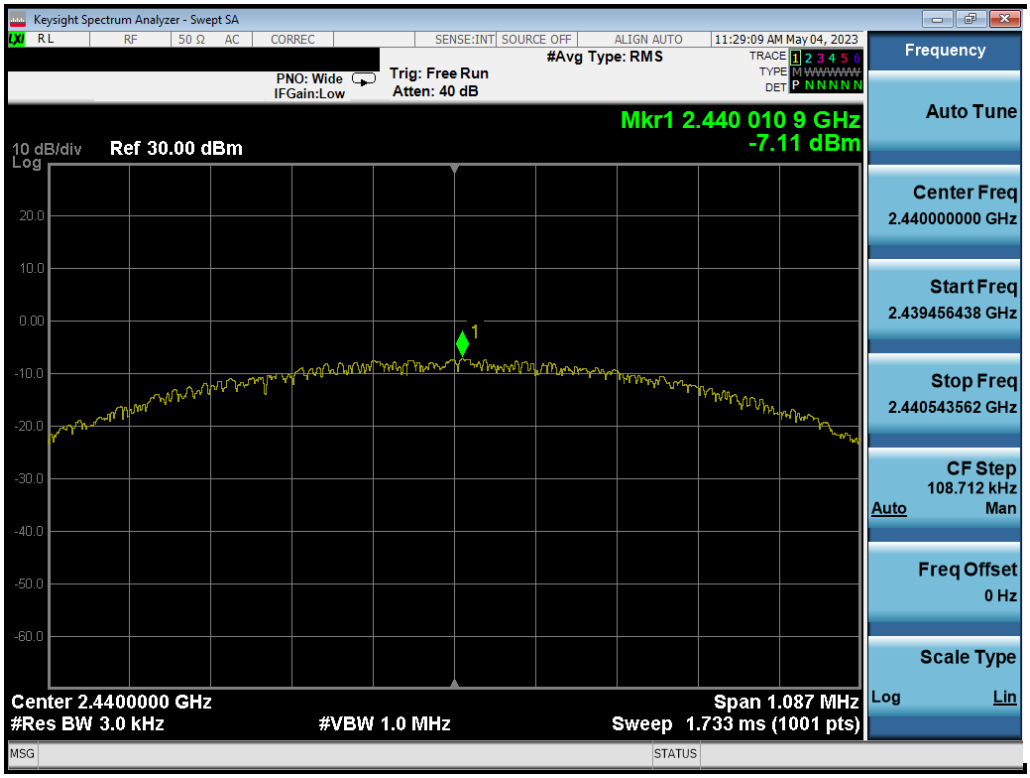
Ant2

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	-6.91	8.0	-14.91
2440	1.0	ePA	19	-7.11	8.0	-15.11
2480	1.0	ePA	39	-6.82	8.0	-14.82
2402	1.0	iPA	0	-6.80	8.0	-14.80
2440	1.0	iPA	19	-7.16	8.0	-15.16
2480	1.0	iPA	39	-7.04	8.0	-15.04
2404	2.0	ePA	1	-12.13	8.0	-20.13
2440	2.0	ePA	19	-12.56	8.0	-20.56
2478	2.0	ePA	38	-11.49	8.0	-19.49
2404	2.0	iPA	1	-12.39	8.0	-20.39
2440	2.0	iPA	19	-12.76	8.0	-20.76
2478	2.0	iPA	38	-11.57	8.0	-19.57

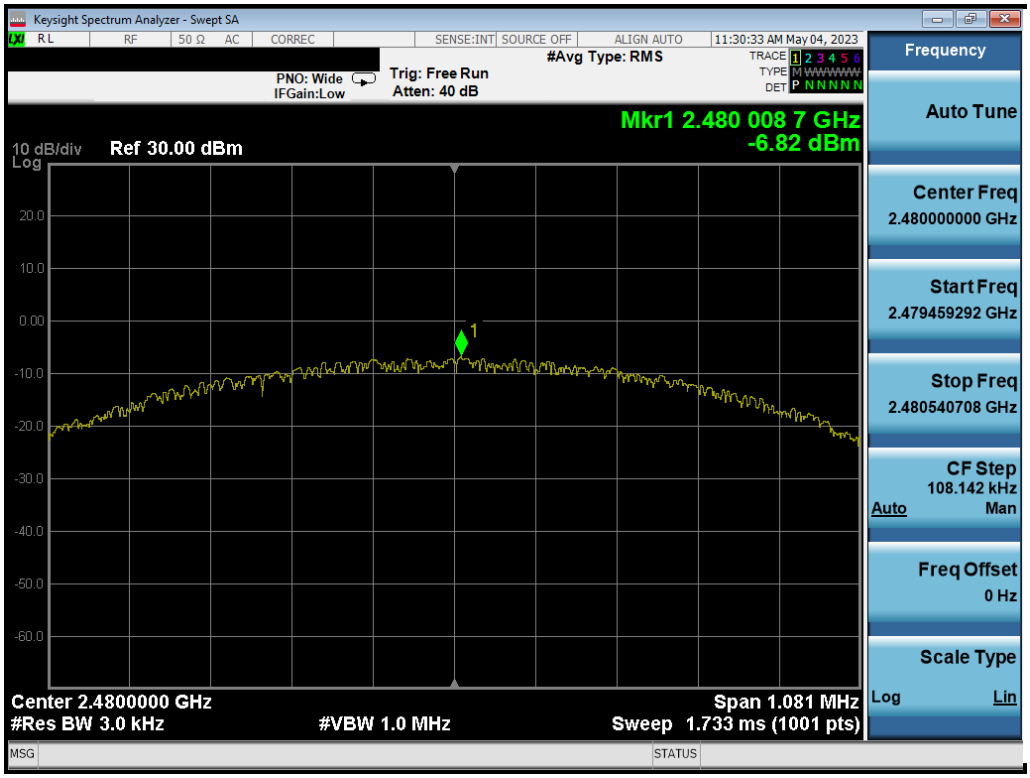
Table 7-14. Conducted Power Density Measurements Ant2



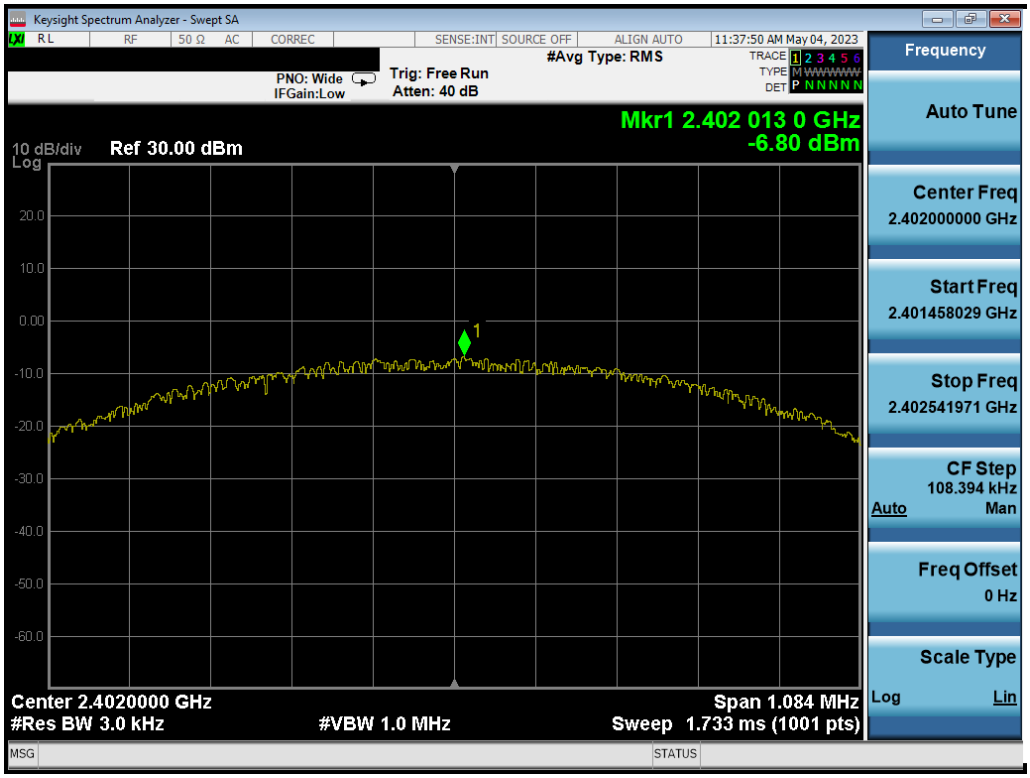
Plot 7-31. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



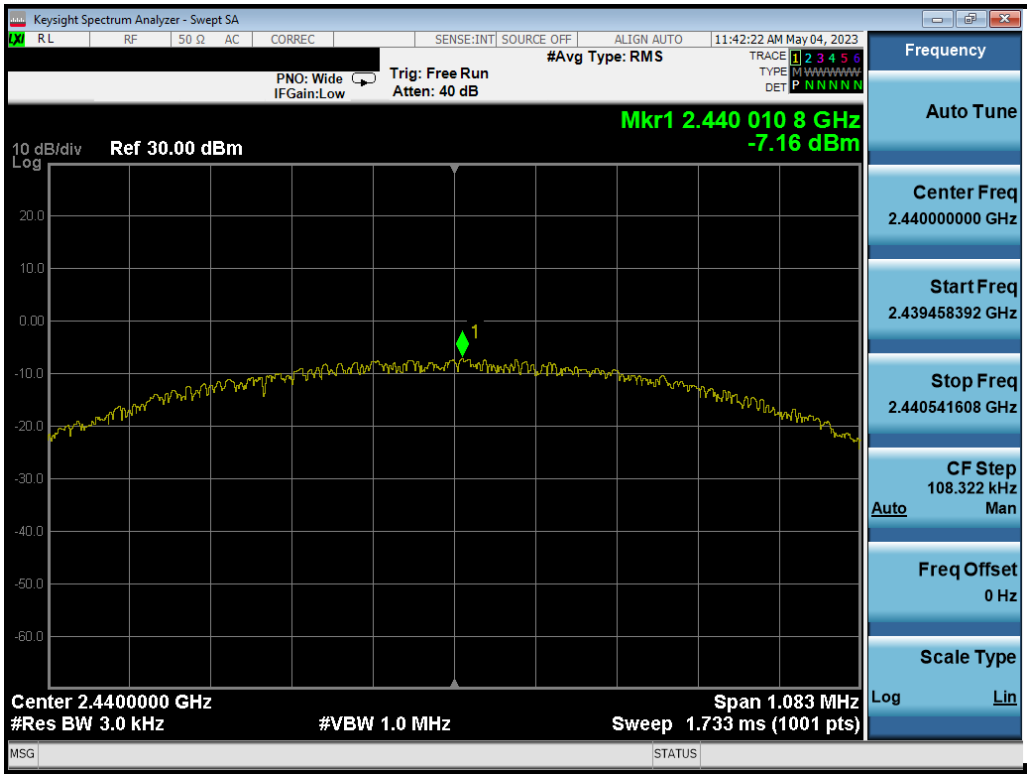
Plot 7-32. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



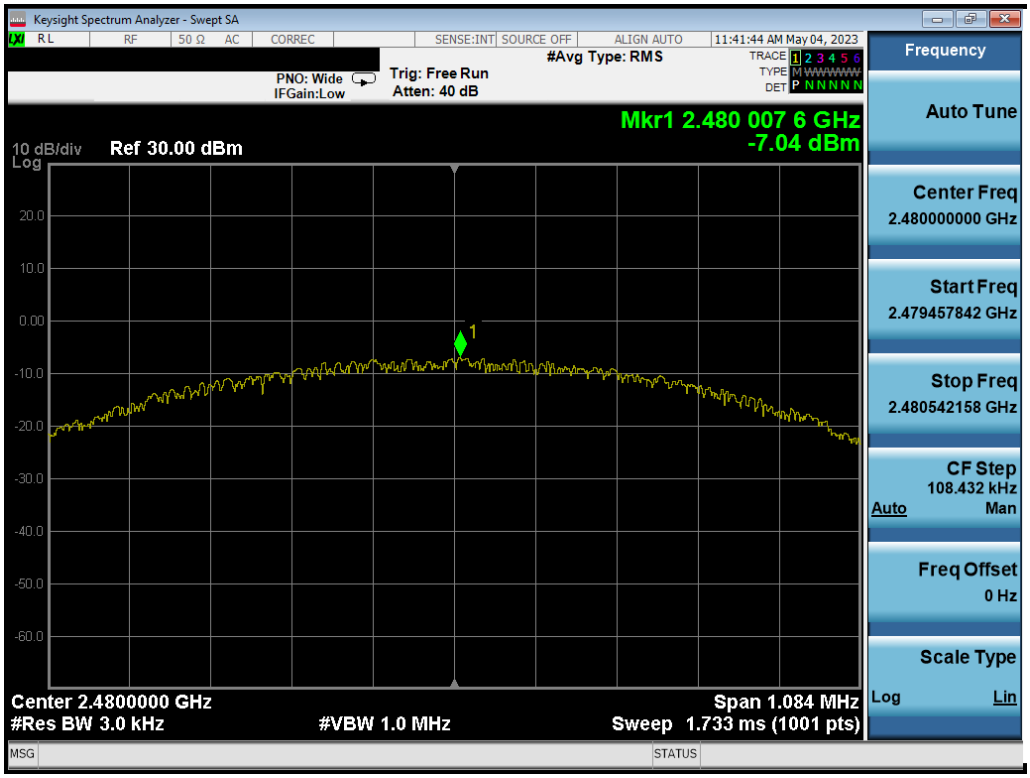
Plot 7-33. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



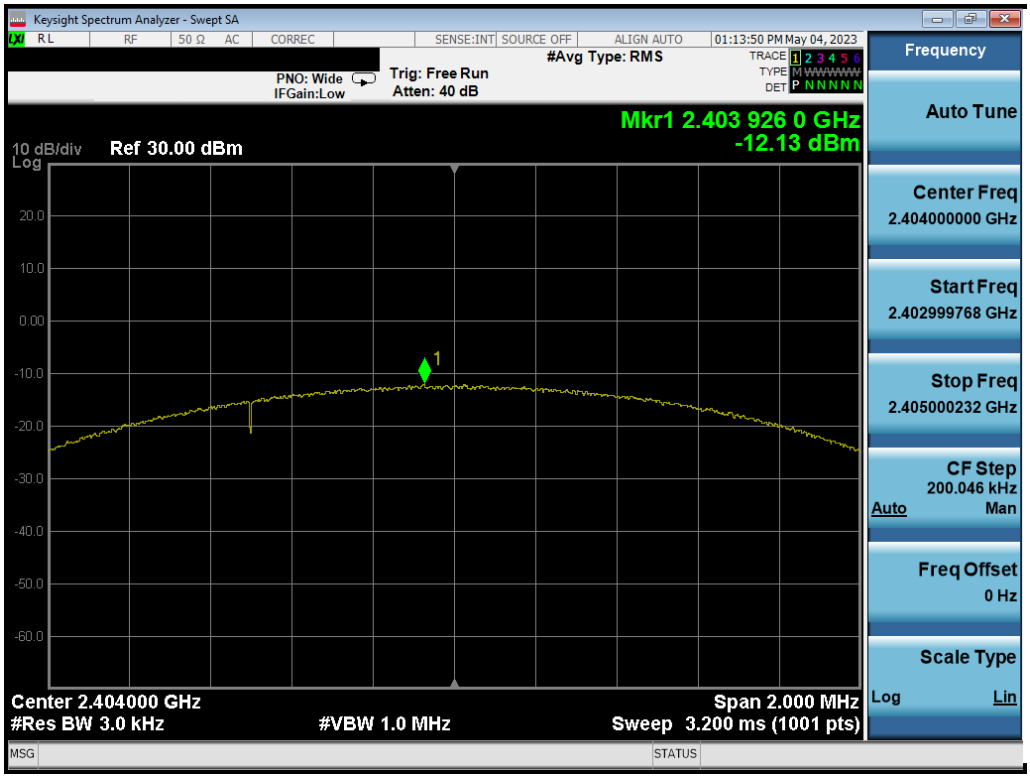
Plot 7-34. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



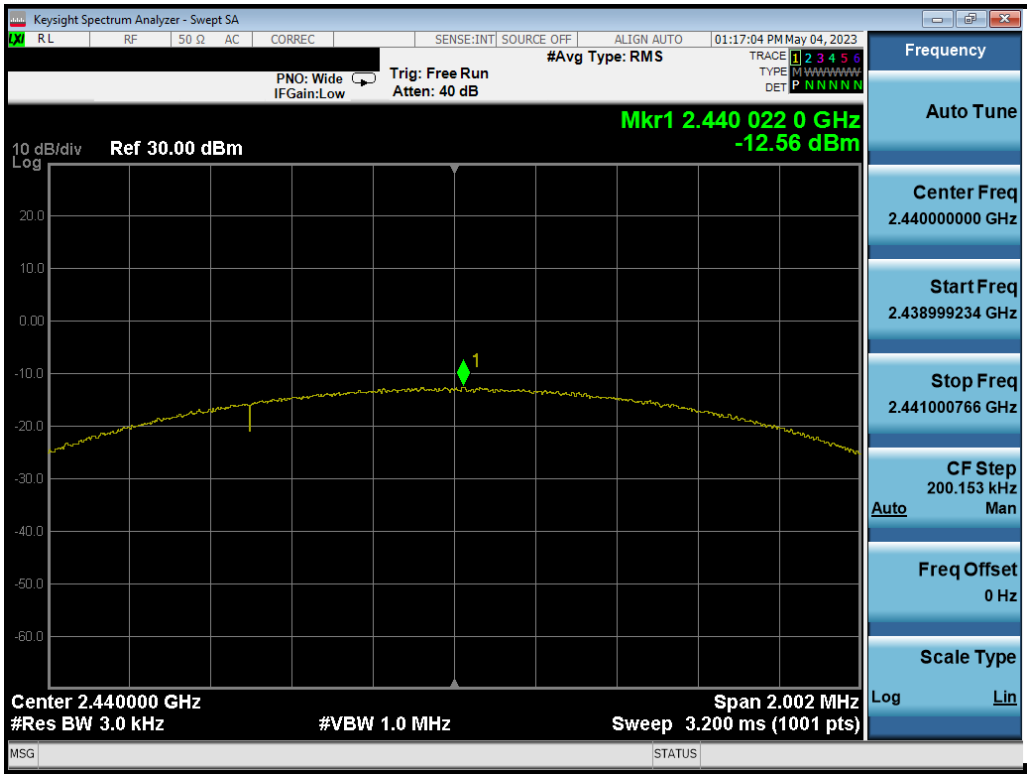
Plot 7-35. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



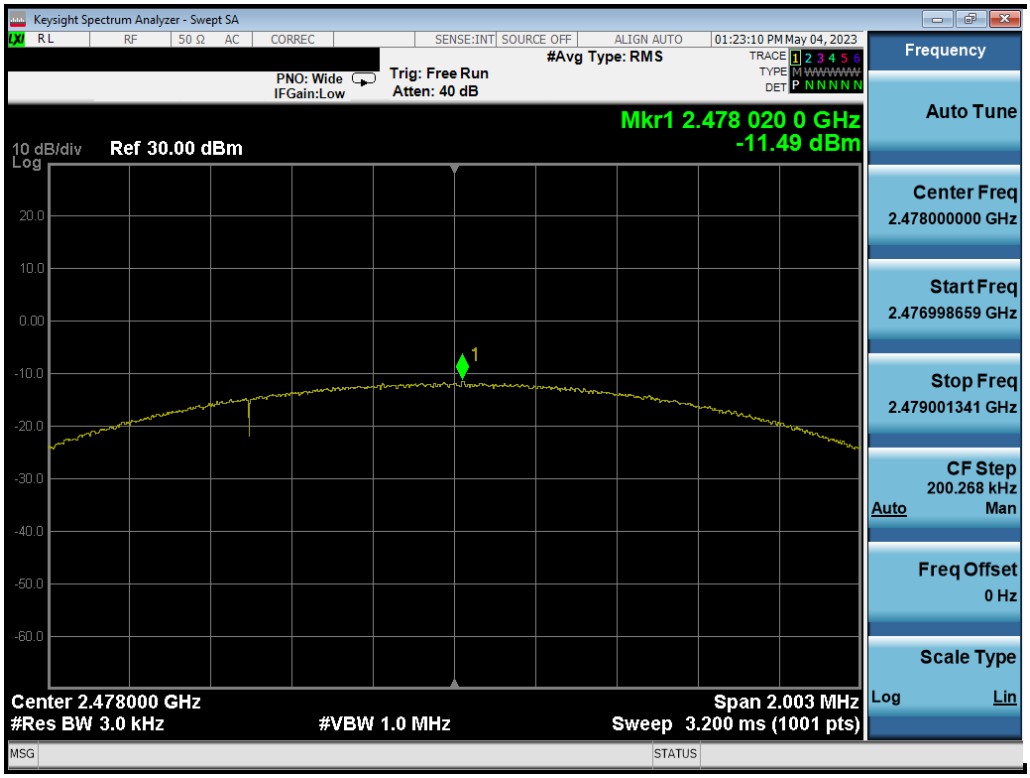
Plot 7-36. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



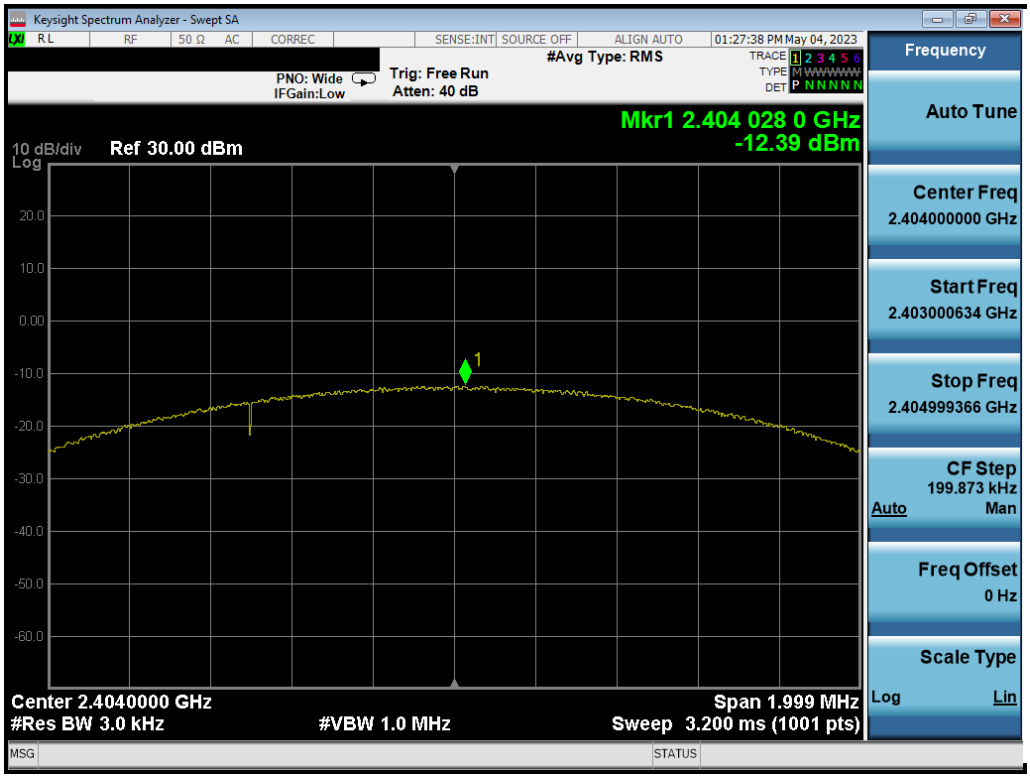
Plot 7-37. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)



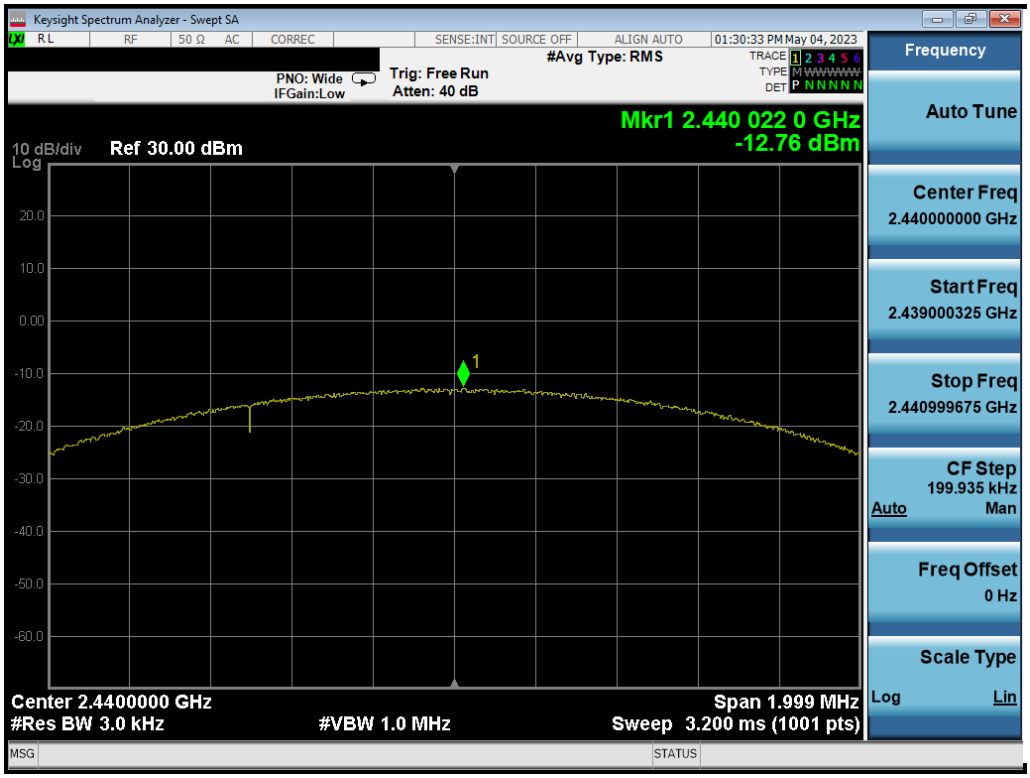
Plot 7-38. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)



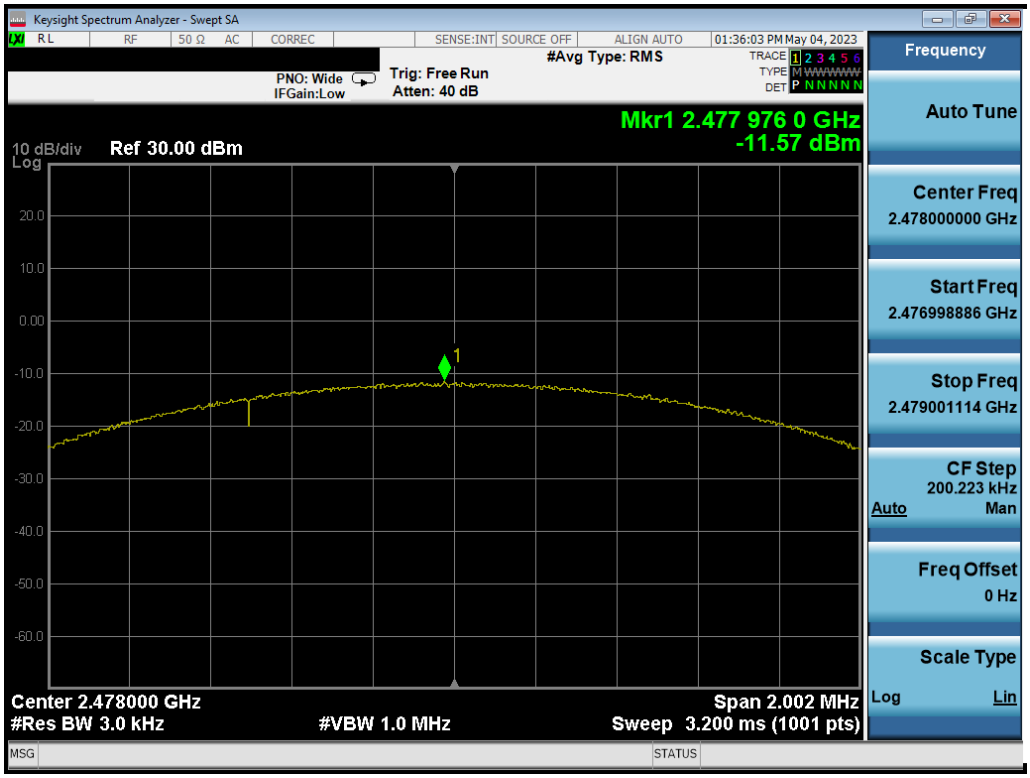
Plot 7-39. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)



Plot 7-40. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, iPA – Ch. 1)



Plot 7-41. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

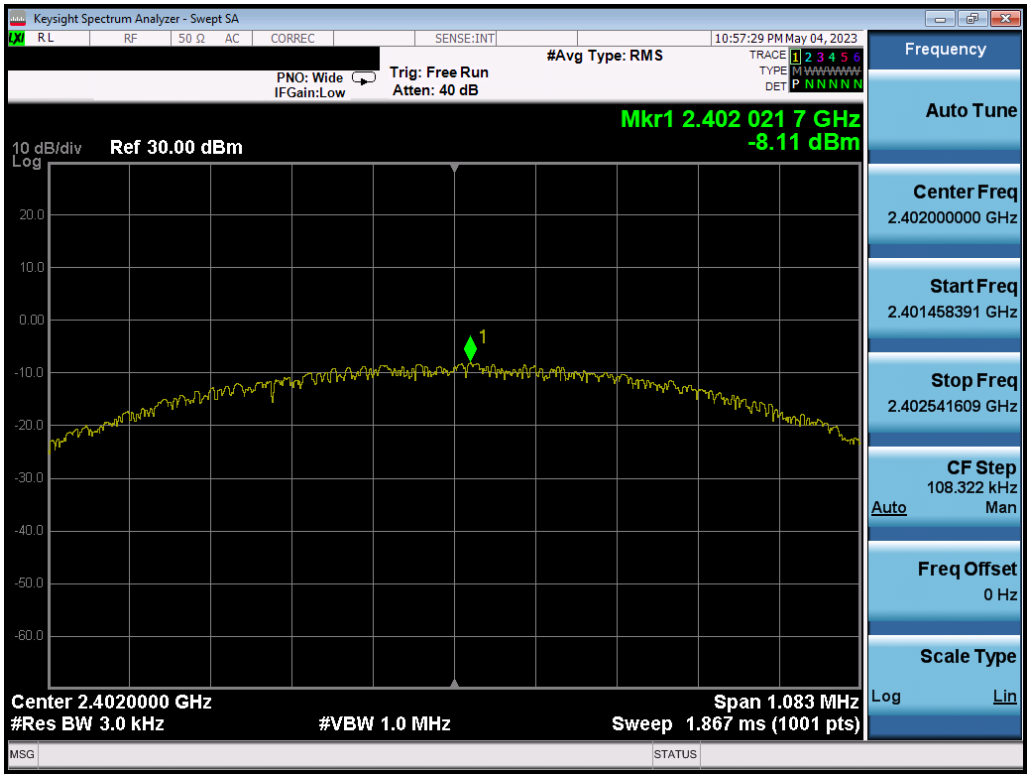


Plot 7-42. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

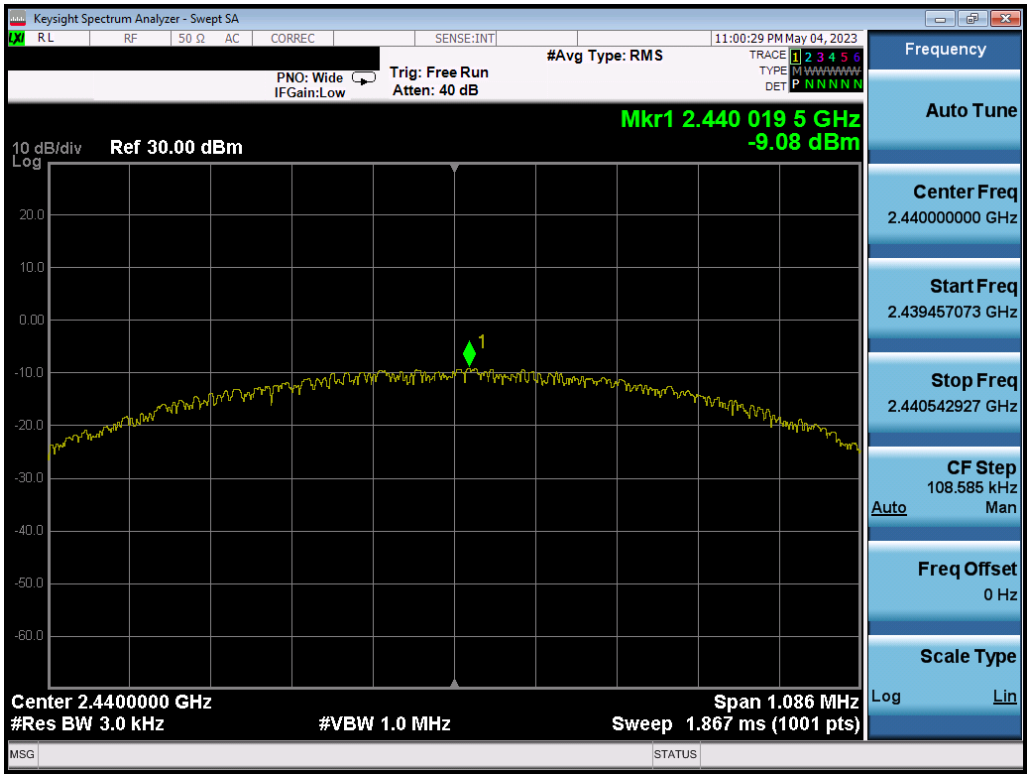
NB UNII_L

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	iPA	0	-8.11	8.0	-16.11
2440	1.0	iPA	19	-9.08	8.0	-17.08
2480	1.0	iPA	39	-8.67	8.0	-16.67
2404	2.0	iPA	1	-13.80	8.0	-21.80
2440	2.0	iPA	19	-14.39	8.0	-22.39
2478	2.0	iPA	38	-13.91	8.0	-21.91

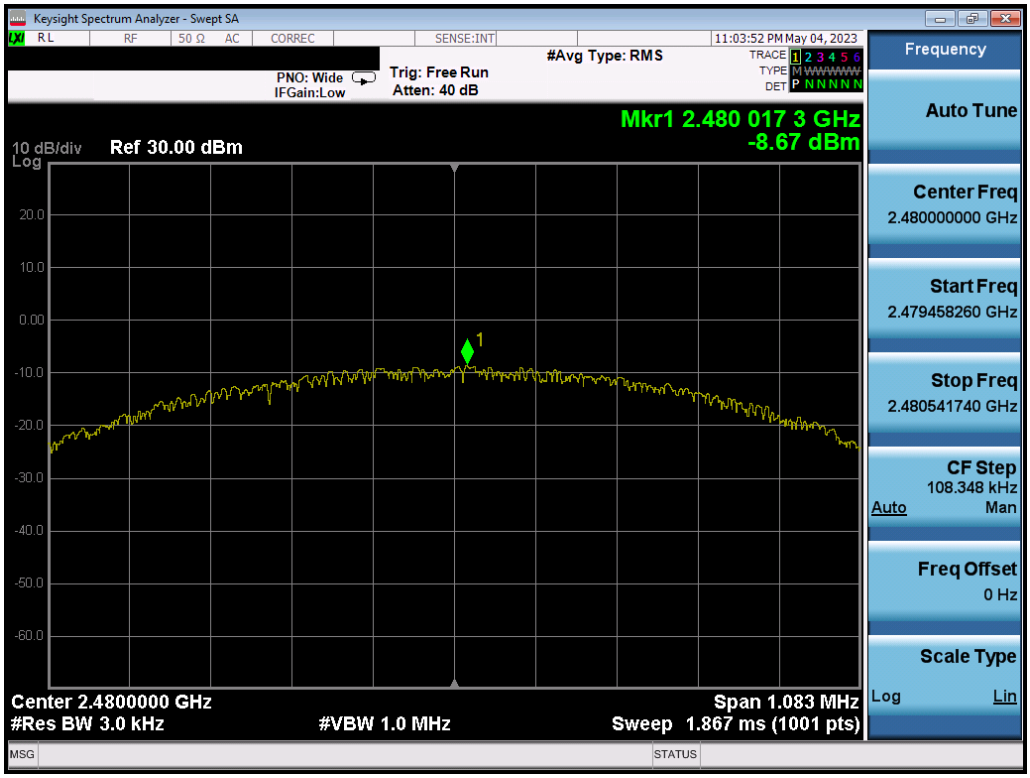
Table 7-15. Conducted Power Density Measurements NB UNII_L



Plot 7-43. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



Plot 7-44. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



Plot 7-45. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 1Mbps, iPA – Ch. 39)

Plot 7-46. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 2Mbps, iPA – Ch. 1)

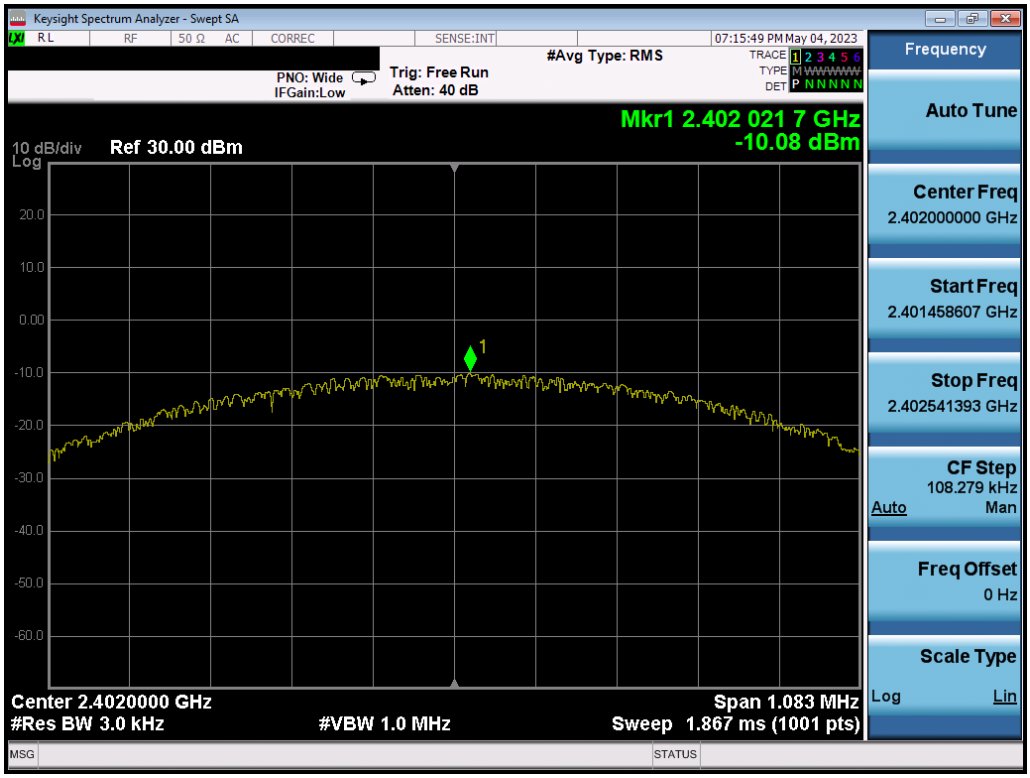
Plot 7-47. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-48. Power Spectral Density Plot NB UNII_L (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

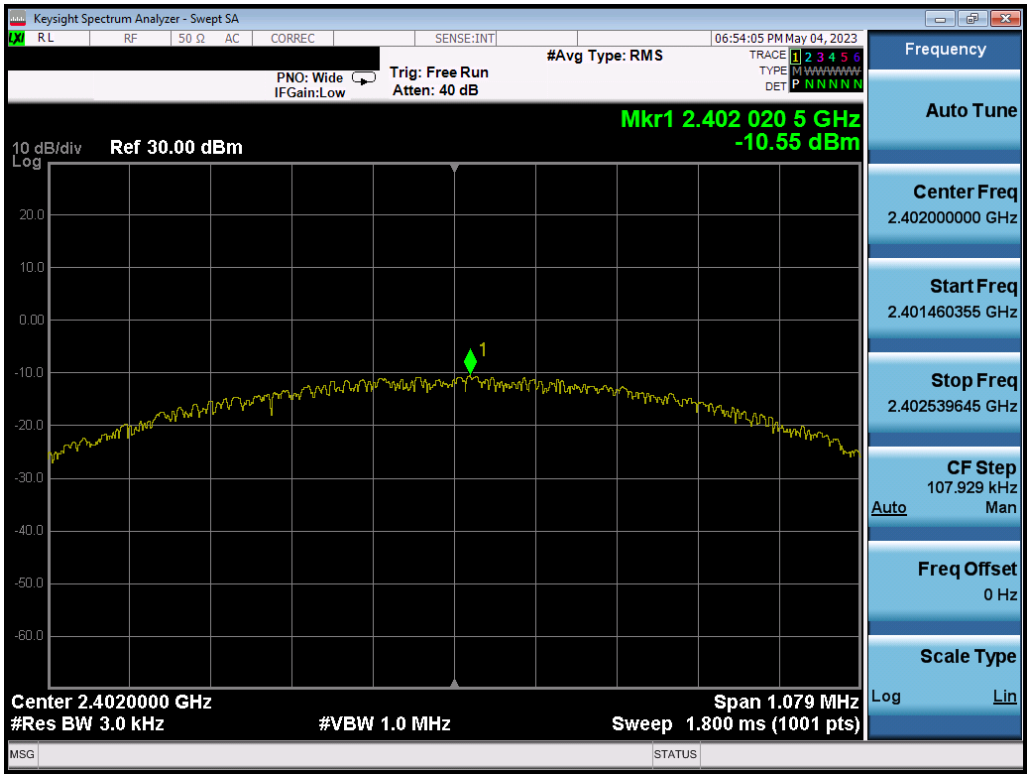
TxBF

Frequency [MHz]	Data Rate [Mbps]	Power Scheme	Channel No.	Measured Power Spectral Density [dBm / 3kHz]			Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
				Ant1	Ant2	Summed		
2402	1.0	ePA	0	-10.08	-10.55	-7.30	8.0	-15.30
2440	1.0	ePA	19	-9.96	-10.40	-7.16	8.0	-15.16
2480	1.0	ePA	39	-10.42	-10.36	-7.38	8.0	-15.38
2402	1.0	iPA	0	-10.04	-9.70	-6.86	8.0	-14.86
2440	1.0	iPA	19	-11.87	-10.39	-8.06	8.0	-16.06
2480	1.0	iPA	39	-10.44	-10.37	-7.39	8.0	-15.39
2404	2.0	ePA	1	-14.21	-15.83	-11.93	8.0	-19.93
2440	2.0	ePA	19	-15.82	-16.24	-13.02	8.0	-21.02
2478	2.0	ePA	38	-16.19	-16.10	-13.14	8.0	-21.14
2404	2.0	iPA	1	-15.37	-15.11	-12.23	8.0	-20.23
2440	2.0	iPA	19	-15.94	-16.20	-13.06	8.0	-21.06
2478	2.0	iPA	38	-16.19	-16.29	-13.23	8.0	-21.23

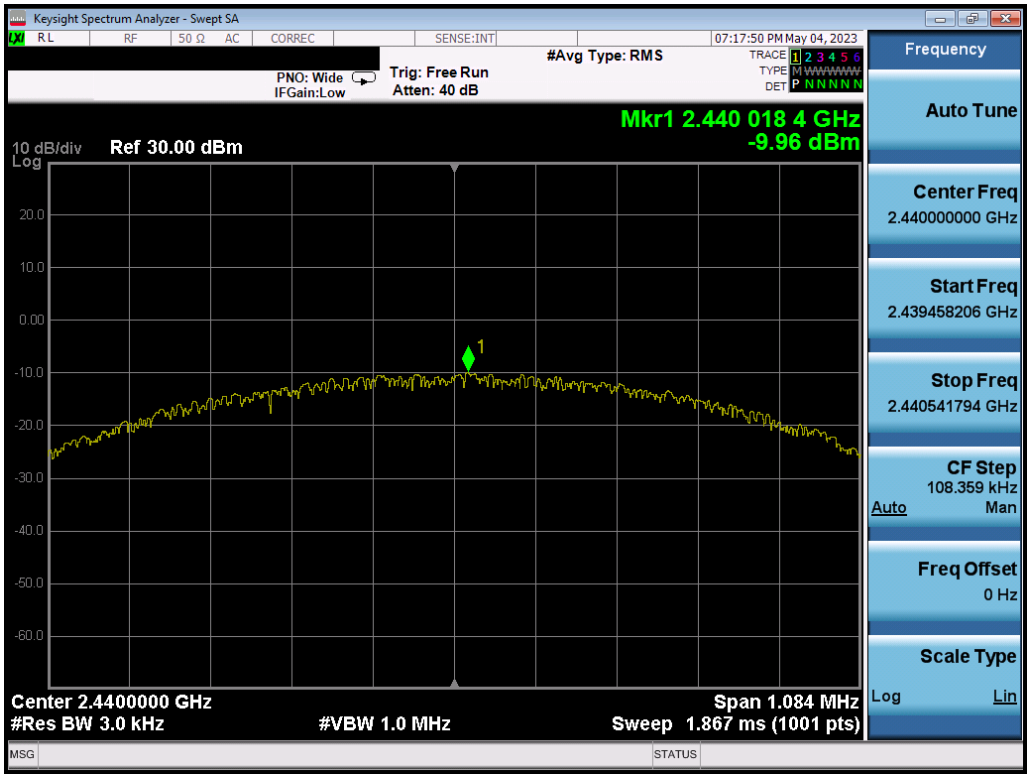
Table 7-16. Conducted Power Density Measurements TxBF



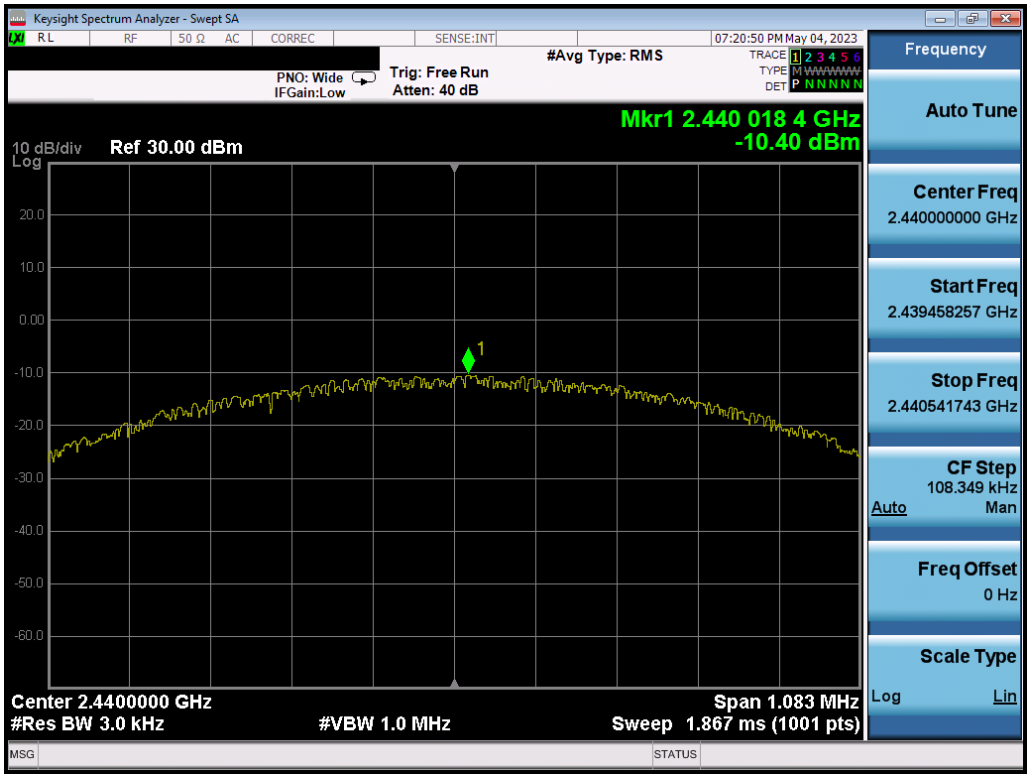
Plot 7-49. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



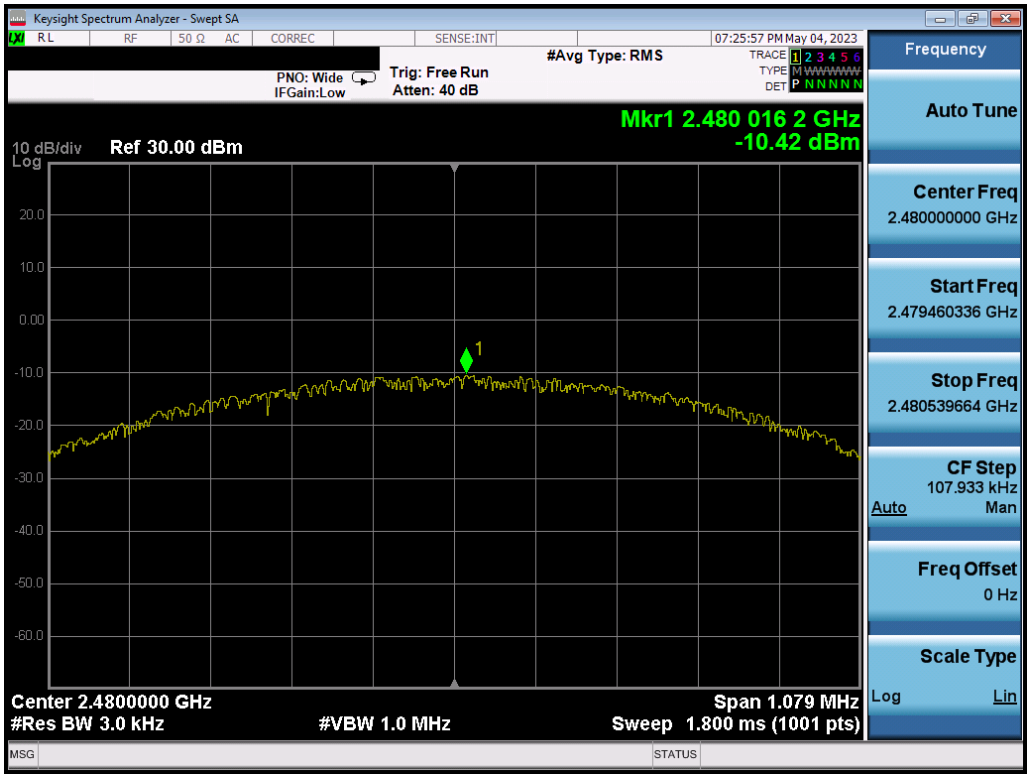
Plot 7-50. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



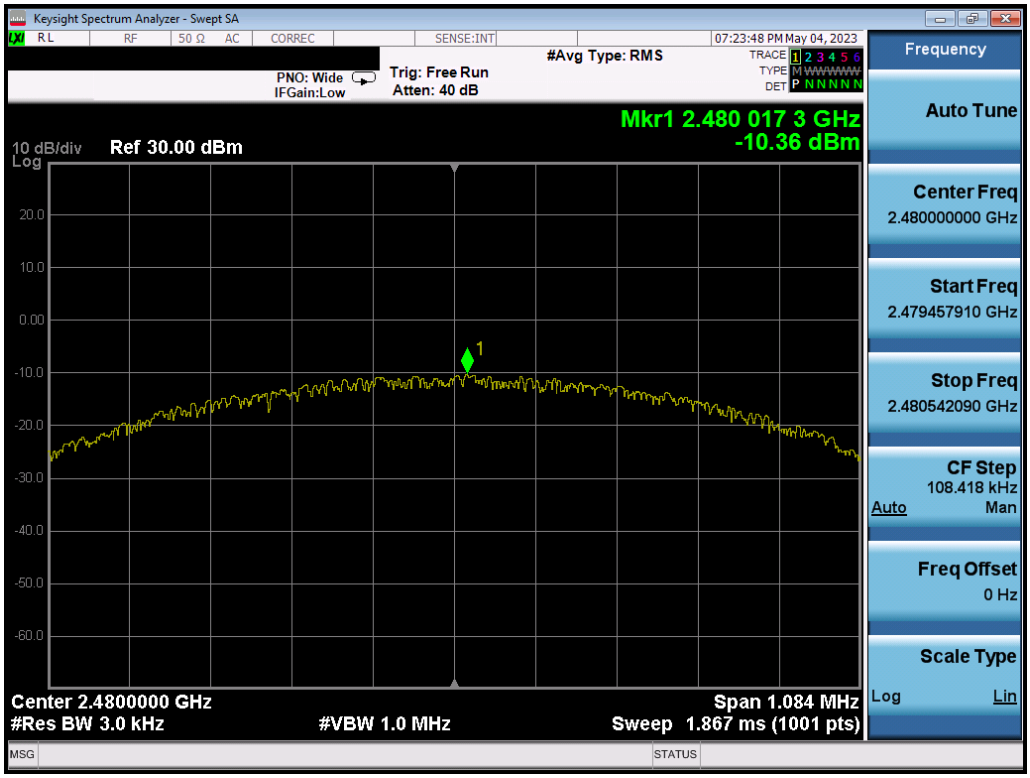
Plot 7-51. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



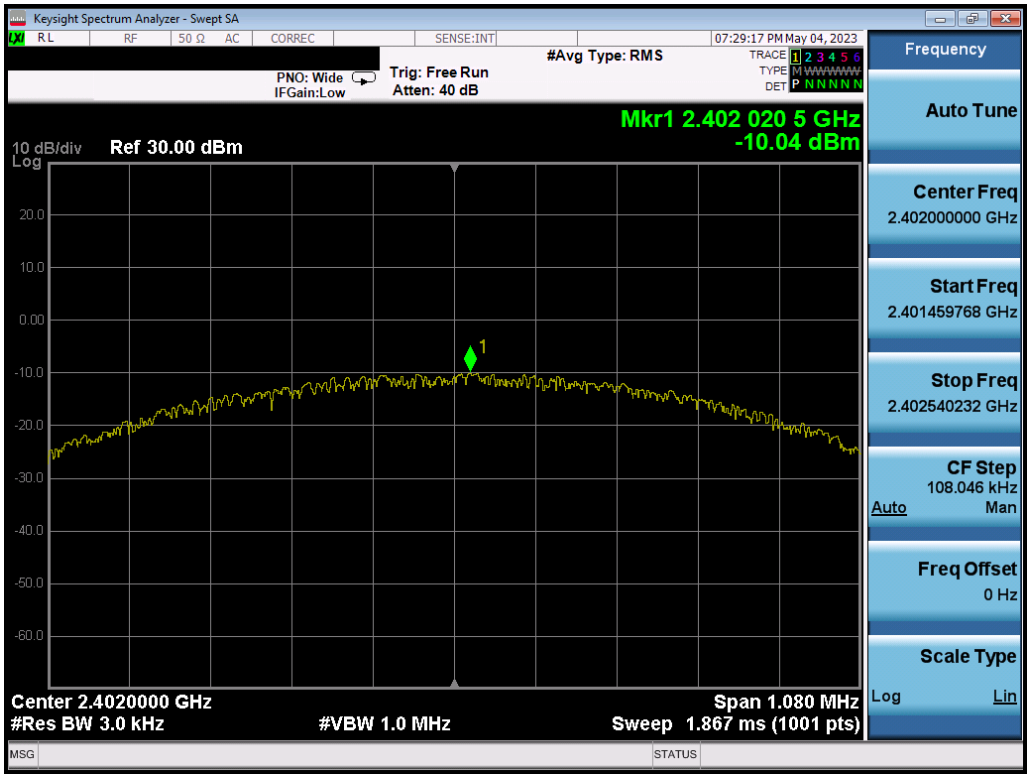
Plot 7-52. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 19)



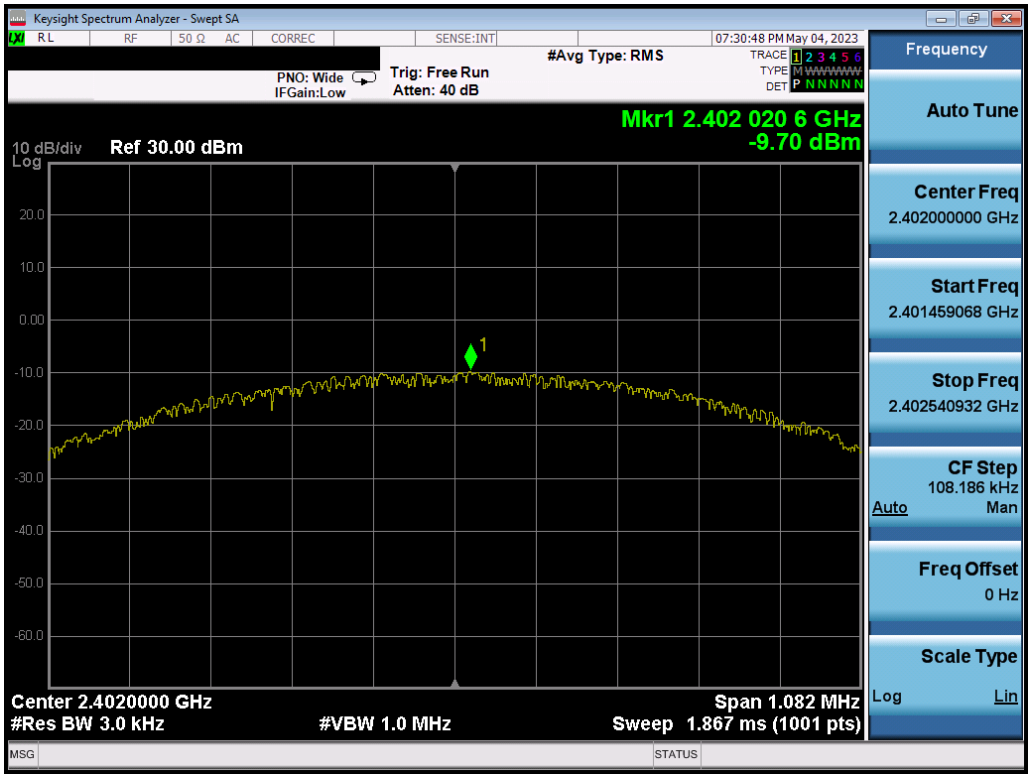
Plot 7-53. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



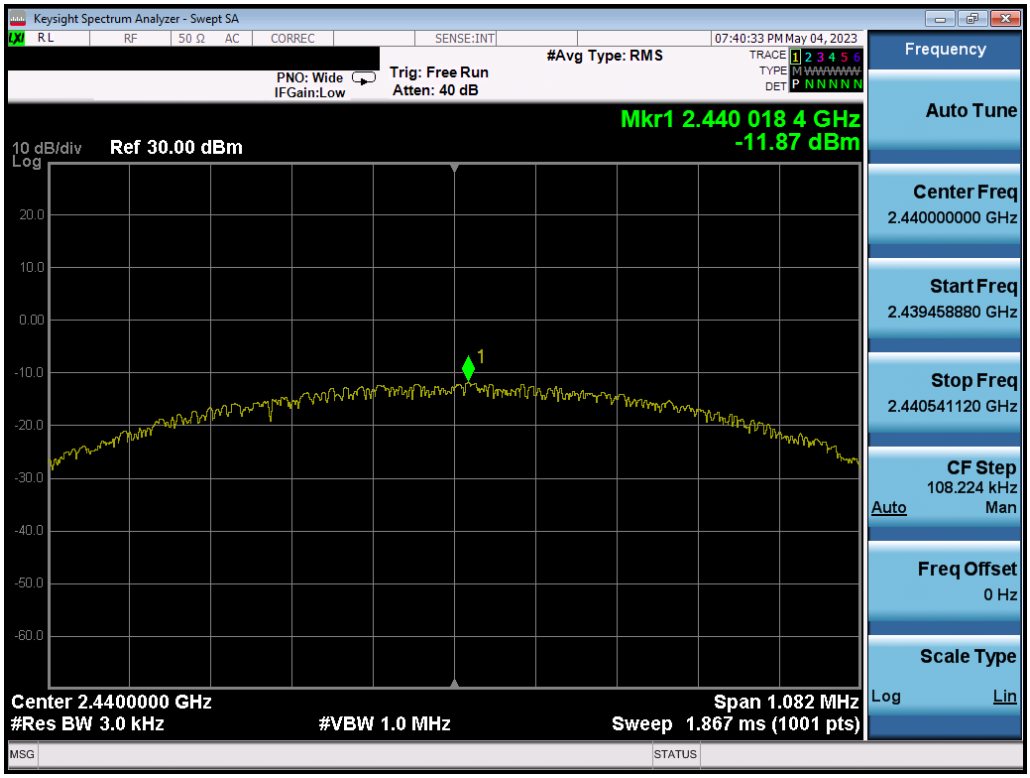
Plot 7-54. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)



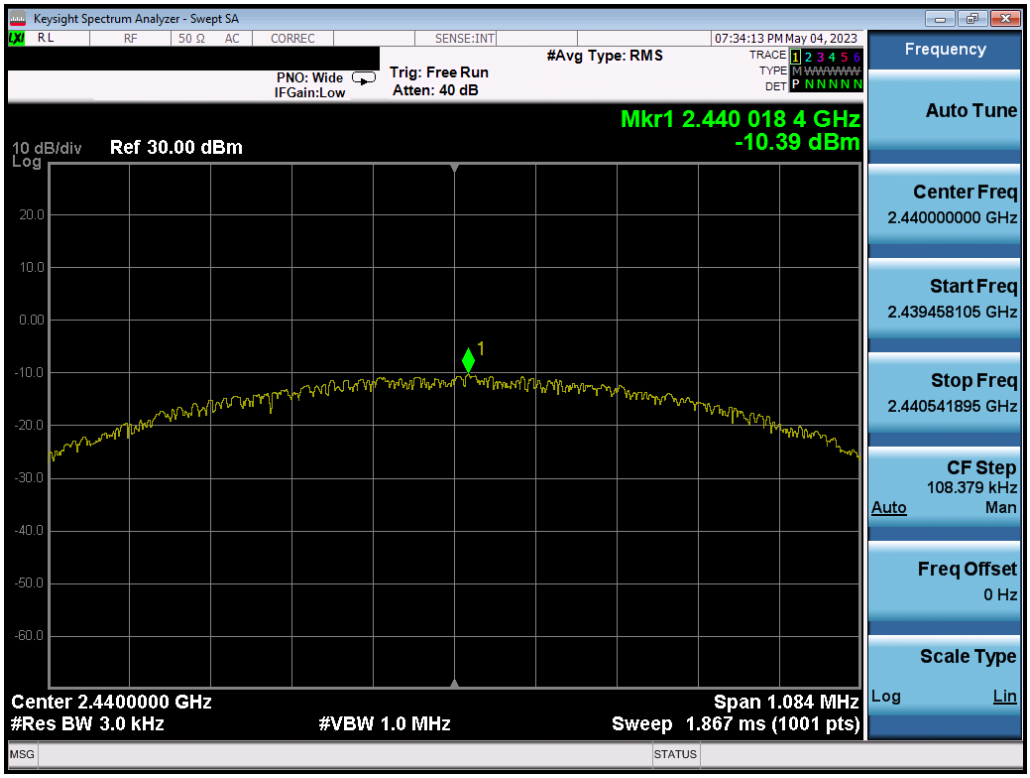
Plot 7-55. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



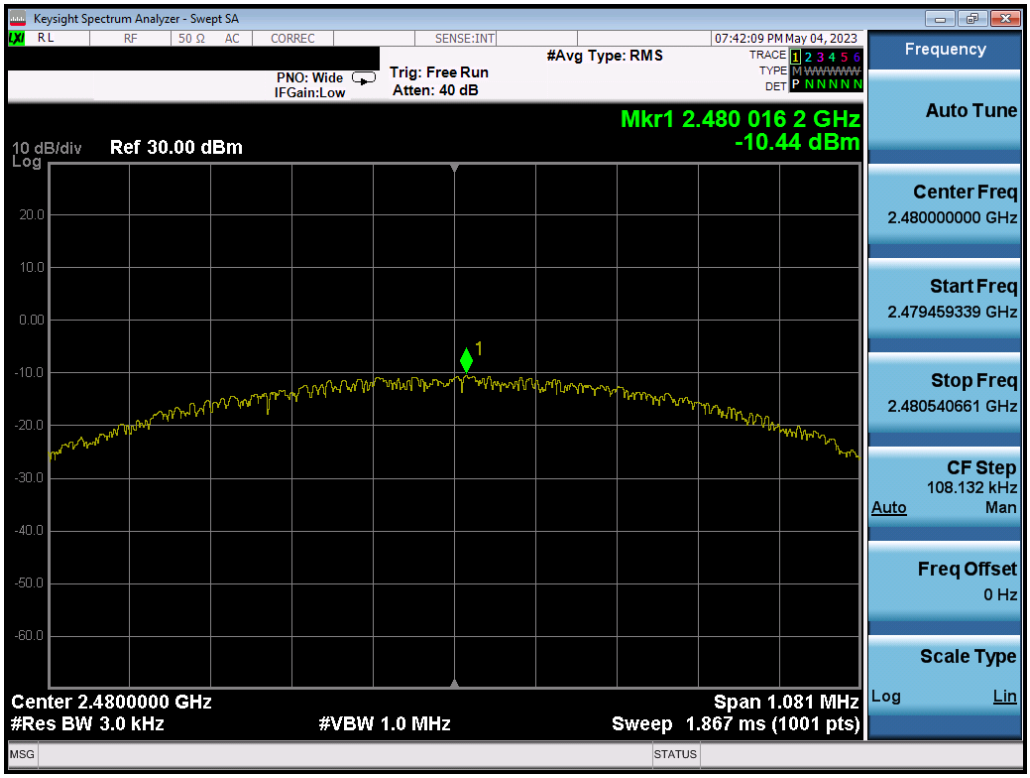
Plot 7-56. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 0)



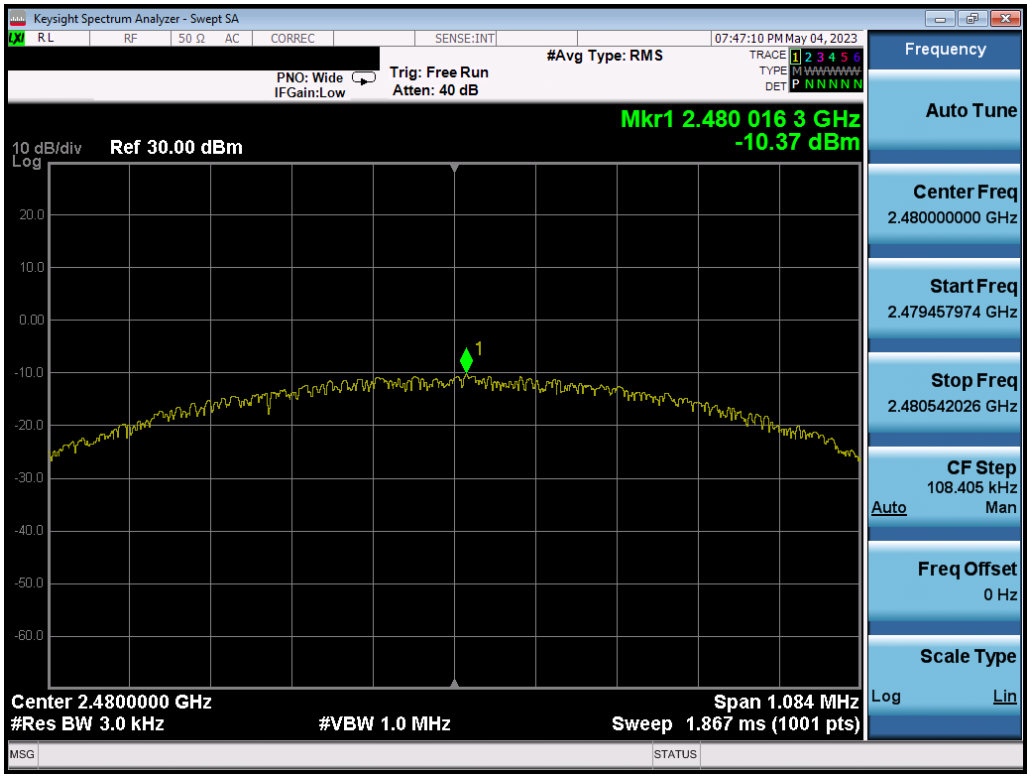
Plot 7-57. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



Plot 7-58. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 19)



Plot 7-59. Power Spectral Density Plot Ant1 (Bluetooth (LE), 1Mbps, iPA – Ch. 39)



Plot 7-60. Power Spectral Density Plot Ant2 (Bluetooth (LE), 1Mbps, iPA – Ch. 39)

Plot 7-61. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)

Plot 7-62. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 1)

Plot 7-63. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)

Plot 7-64. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 19)

Plot 7-65. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

Plot 7-66. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, ePA – Ch. 38)

Plot 7-67. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 1)

Plot 7-68. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, iPA – Ch. 1)

Plot 7-69. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-70. Power Spectral Density Plot Ant2 (Bluetooth (LE), 2Mbps, iPA – Ch. 19)

Plot 7-71. Power Spectral Density Plot Ant1 (Bluetooth (LE), 2Mbps, iPA – Ch. 38)

Plot 7-72. Power Spectral Density Plot Ant2 (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 Ant1 and Ant2 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 -10.08 dBm for Ant1 and -10.55 dBm for Ant2.

Ant1 + Ant2 = TxBF

(-10.08dBm + -10.55dBm) = (0.098 mW + 0.088 mW) = 0.186 mW = -7.30 dBm

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

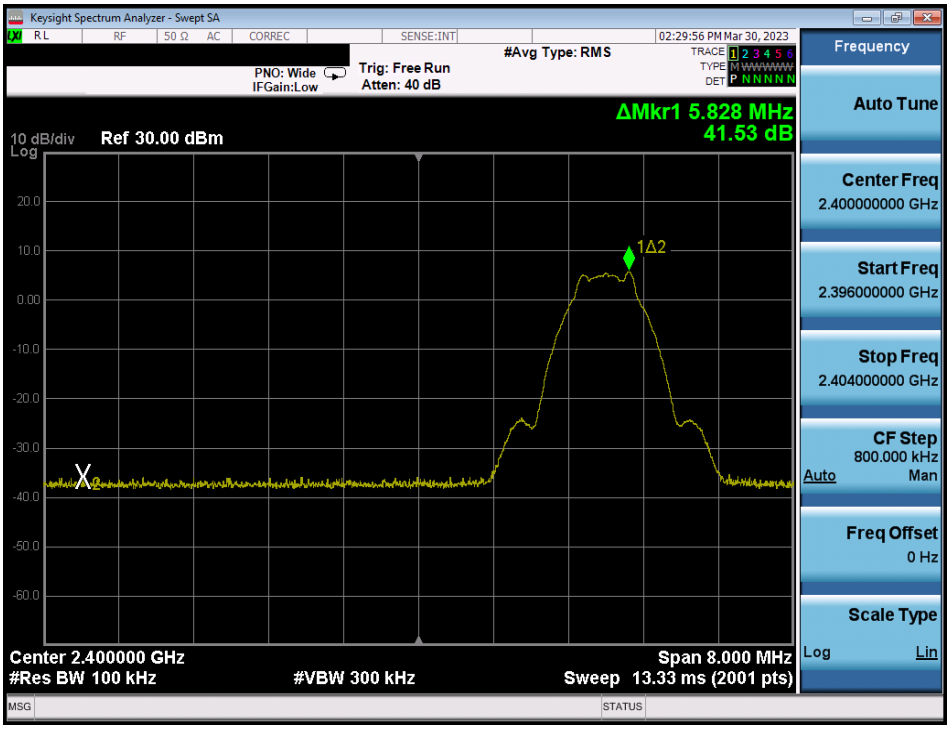
The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-4. Test Instrument & Measurement Setup

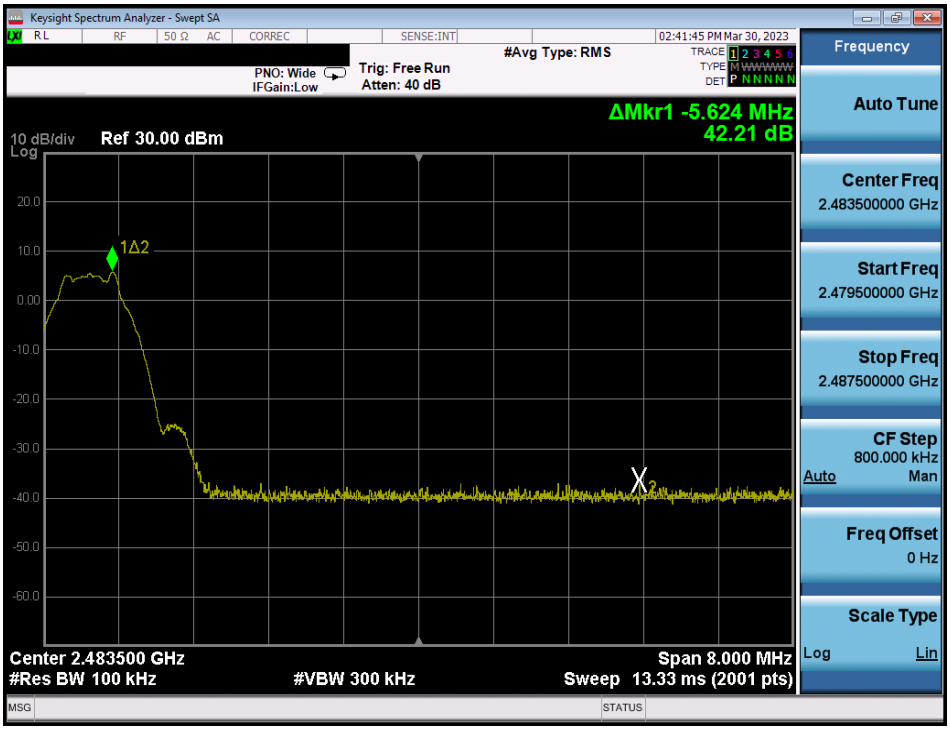
Test Notes

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

Ant1



Plot 7-73. Band Edge Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 0)



Plot 7-74. Band Edge Plot Ant1 (Bluetooth (LE), 1Mbps, ePA – Ch. 39)