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MEASUREMENT REPORT
FCC PART 15.247 / ISED RSS-247 Bluetooth

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

Date of Testing:
04/01 - 6/10/2022
Test Report Issue Date:
6/10/2022
Test Site/Location:
Element Lab., Columbia, MD, USA
Test Report Serial No.:
1M2204010046-09.A3L

FCC ID:	**A3LSMF936U**
IC:	**649E-SMF936W**
APPLICANT:	**Samsung Electronics Co., Ltd.**

Application Type:	Certification
Model:	SM-F936U
Additional Model(s):	SM-F936U1
HVIN:	SM-F936W
EUT Type:	Portable Handset
Max. RF Output Power:	79.634 mW (19.01 dBm) Peak Conducted
Frequency Range:	2402 – 2480MHz
Type of Modulation:	GFSK, π/4-DQPSK, 8DPSK
FCC Classification:	FCC Part 15 Spread Spectrum Transmitter (DSS)
Test Procedure(s):	ANSI C63.10-2013, KDB 558074 D01 v05r02, KDB 648474 D03 v01r04

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. 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 #2041.01

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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 Test Location

These measurement tests were conducted at the Element laboratory located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 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 (2451B) 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).

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Portable Handset FCC ID: A3LSMF936U**. The test data contained in this report pertains only to the emissions due to the EUT's Bluetooth transmitter.

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  - A) The hopping sequence is pseudorandom
  - B) All channels are used equally on average
  - C) The receiver input bandwidth equals the transmit bandwidth
  - D) The receiver hops in sequence with the transmit signal
- 15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.
- 15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
- 15.247(h): The EUT employs Adaptive Frequency Hopping (AFH) which identifies sources of interference namely devices operating in 802.11 WLAN and excludes them from the list of available channels. The process of re-mapping reduces the number of test channels from 79 channels to a minimum number of 20 channels.

Test Device Serial No.: 0109M, 0070M, 3059R, 0303M, 0374M, 0417M

2.2 Device Capabilities

This device contains the following capabilities:

850/1900 GSM/GPRS/EDGE, 850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1 and FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII (5,6GHz), Bluetooth (1x, EDR, LE), NFC, UWB, Wireless Power Transfer

Ch.	Frequency (MHz)
00	2402
:	:
39	2441
:	:
78	2480

Table 2-1. Frequency/ Channel Operations

Note: This device is capable of operating in hopping and non-hopping mode. The EUT can hop between 79 different channels in the 2400 – 2483.5MHz band.

2.3 Antenna Description

The following antenna was used for the testing.

Antenna	Frequency [GHz]	Antenna Gain (dBi)
1	2.4	-2.05
2	2.4	-5.15

Table 2-2. Antenna Peak Gain

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Note: This device is capable of operating in hopping and non-hopping mode. The EUT can hop between 79 different channels in the 2400 – 2483.5MHz band.

2.4 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was also 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, 7.6, 7.7, and 7.8 for antenna port conducted emissions test setups.

This device supports wireless charging capability and, thus, is subject to the test requirements of KDB 648474 D03 v01r04. Additional radiated spurious emission measurements were performed with the EUT lying flat on an authorized wireless charging pad (WCP) EP-N5100 while operating under normal conditions in a simulated call or data transmission configuration. The worst case radiated emissions data is shown in this report.

This device supports two configurations: one is with screen open and one is with screen closed. Open, half opened and closed configurations are tested, and the worst case radiated emissions data is shown in this report.

2.5 Software and Firmware

The test was conducted with software/firmware version F936USQU0AVEC installed on the EUT.

2.6 EMI Suppression Device(s)/Modifications

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

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) was 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 10'x16'x9' shielded enclosure. The shielded enclosure is manufactured by ETS Lindgren RF Enclosures The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. 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 an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are ETS Lindgren Model LRW-2030-S1 (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 7.12. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

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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.

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.

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 414788 D01 v01r01.

3.4 Environmental Conditions

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

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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 antennas 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.

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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. 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	1.13
Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurement 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
-	ETS-001	EMC Cable and Switch System	12/9/2021	Annual	12/9/2022	ETS-001
-	ETS-002	EMC Cable and Switch System	12/9/2021	Annual	12/9/2022	ETS-002
-	AP2-001	EMC Cable and Switch System	1/4/2022	Annual	1/4/2023	AP2-001
-	AP2-002	EMC Cable and Switch System	1/4/2022	Annual	1/4/2023	AP2-002
-	BT1	Bluetooth Cable Set	12/19/2021	Annual	12/19/2022	BT1
Agilent	N4010A	Wireless Connectivity Test Set	N/A			GB46170464
Agilent	N4010A	Wireless Connectivity Test Set	N/A			GB44450273
Agilent	N9038A	MXE EMI Receiver	1/21/2022	Annual	1/21/2023	MY51210133
Agilent	N9020A	MXA Signal Analyzer	3/4/2022	Annual	3/4/2023	US46470561
Emco	3115	Horn Antenna (1-18GHz)	6/18/2020	Biennial	6/18/2022	9704-5182
ETS-Lindgren	3816/2NM	Line Impedance Stabilization Network	7/9/2020	Biennial	7/9/2022	114451
Pasternack	NMLC-2	Line Conducted Emissions Cable (NM)	12/19/2021	Annual	12/19/202	NMLC-2
Rohde & Schwarz	CMU200	Base Station Simulator	N/A			836371/0079
Rohde & Schwarz	CMU200	Base Station Simulator	N/A			833855/0010
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	8/10/2021	Annual	8/10/2022	100342
Solar Electronics	8012-50-R-24-BNC	Line Impedance Stabilization Network	9/21/2021	Biennial	9/21/2022	310233
Sunol	DRH-118	Horn Antenna (1-18GHz)	2/14/2022	Biennial	2/14/2024	A050307
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	7/27/2020	Biennial	7/27/2022	A051107

Table 6-1. Annual Test Equipment Calibration Schedule

Notes:

1. 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.

2. Equipment with a calibration date of "N/A" shown in this list was not used to make direct calibrated measurements.

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7.0 TEST RESULTS

7.1 Summary

Company Name: Samsung Electronics Co., Ltd.

FCC ID: A3LSMF936U

Method/System: Frequency Hopping Spread Spectrum (FHSS)

Number of Channels: 79

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(1)(iii)	RSS-247 [5.1(1)]	20dB Bandwidth	N/A	CONDUCTED	PASS	Section 7.2
15.247(b)(1)	RSS-247 [5.4(2)]	Peak Transmitter Output Power	< 1 Watt if ≥ 75 non-overlapping channels used		PASS	Section 7.3
15.247(a)(1)	RSS-247 [5.1(2)]	Channel Separation	> 2/3 of 20 dB BW for systems with Output Power < 125mW		PASS	Section 7.5
15.247(a)(1)(iii)	RSS-247 [5.1(4)]	Number of Channels	> 15 Channels		PASS	Section 7.7
15.247(a)(1)(iii)	RSS-247 [5.1(4)]	Time of Occupancy	< 0.4 sec in 31.6 sec period		PASS	Section 7.6
15.247(d)	RSS-247 [5.5]	Band Edge / Out-of-Band Emissions	Conducted > 20dBc		PASS	Section 7.4, Section 7.8
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-247 limits)	RADIATED	PASS	Section 7.9, Section 7.10, Section 7.11
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits (RSS-Gen [8.8] limits)	LINE CONDUCTED	PASS	Section 7.12

Table 7-1. Summary of Test Results

Notes:

1) All modes of operation and data rates 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, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT 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, attenuators, and couplers.
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 PCTEST "BT Auto," Version 3.5.
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 PCTEST "Chamber Automation," Version 1.3.1.

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7.2 20dB Bandwidth Measurement

§15.247 (a.1.iii); RSS-247 [5.1(1)]

Test Overview and Limit

The bandwidth at 20dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

Test Procedure Used

ANSI C63.10-2013 – Section 6.9.2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 20dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 20. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.

2. RBW = 1 – 5% OBW

3. VBW ≥ 3 x RBW

4. Reference level set to keep signal from exceeding maximum input mixer level for linear operation.

5. Detector = Peak

6. Trace mode = max hold

7. Sweep = auto couple

8. The trace was allowed to stabilize

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

None

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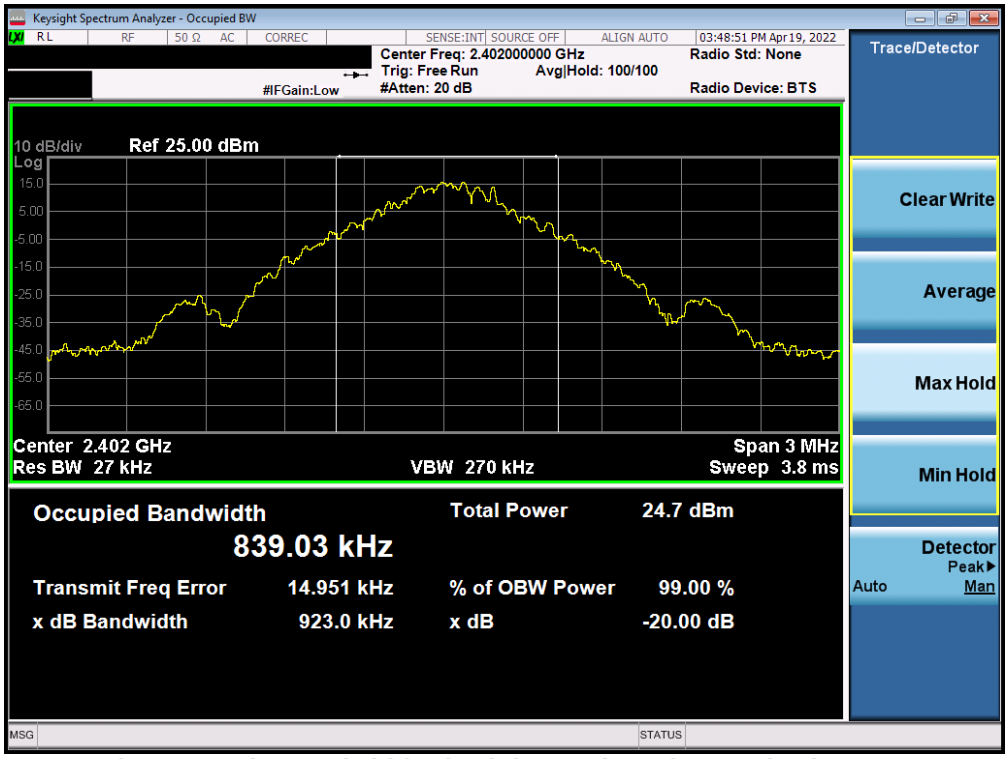
Frequency [MHz]	Data Rate [Mbps]	Channel No.	20dB Bandwidth Test Results [kHz]
2402	1.0	0	923.00
2441	1.0	39	856.10
2480	1.0	78	867.60
2402	2.0	0	1336.00
2441	2.0	39	1331.00
2480	2.0	78	1308.00
2402	3.0	0	1299.00
2441	3.0	39	1360.00
2480	3.0	78	1345.00

Table 7-2. Conducted 20dB Bandwidth Measurements – Ant1



Plot 7-1. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 0) – Ant1

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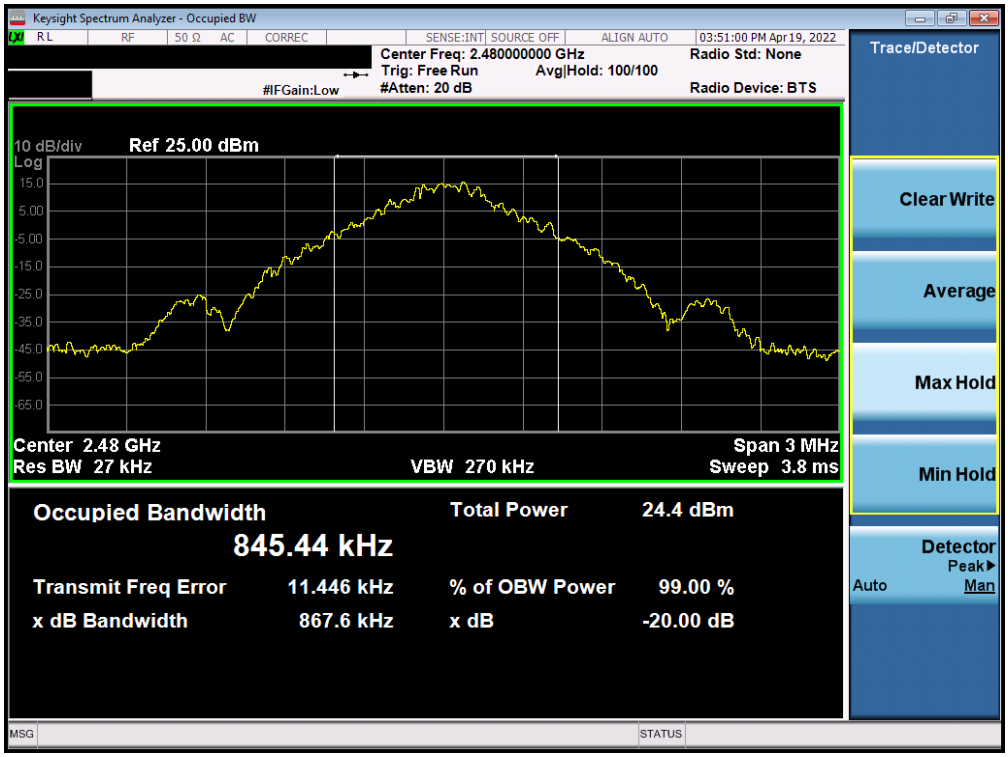
Plot 7-2. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 39) – Ant1



Plot 7-3. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 78) – Ant1

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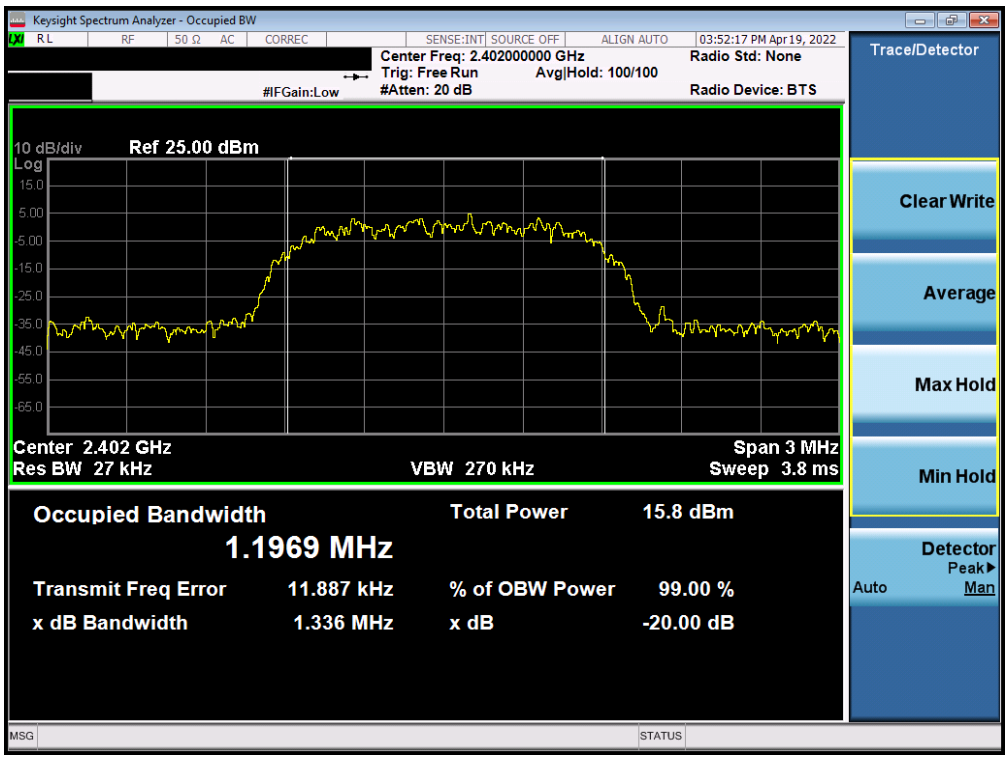
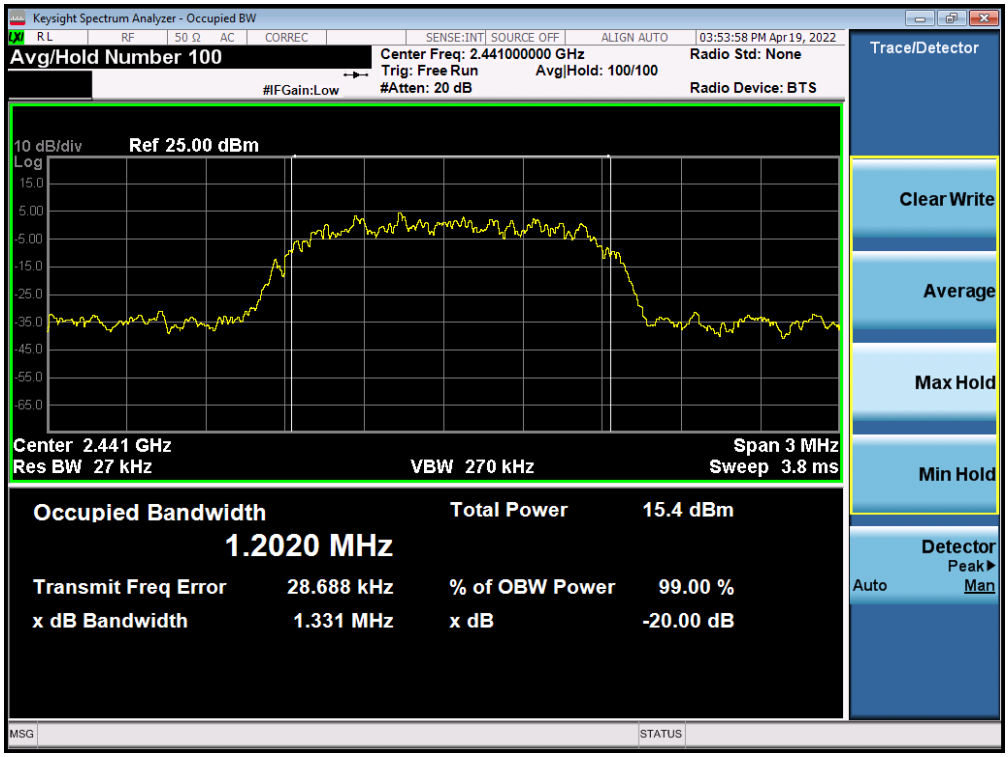


Plot 7-4. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 0) – Ant1



Plot 7-5. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 39) – Ant1

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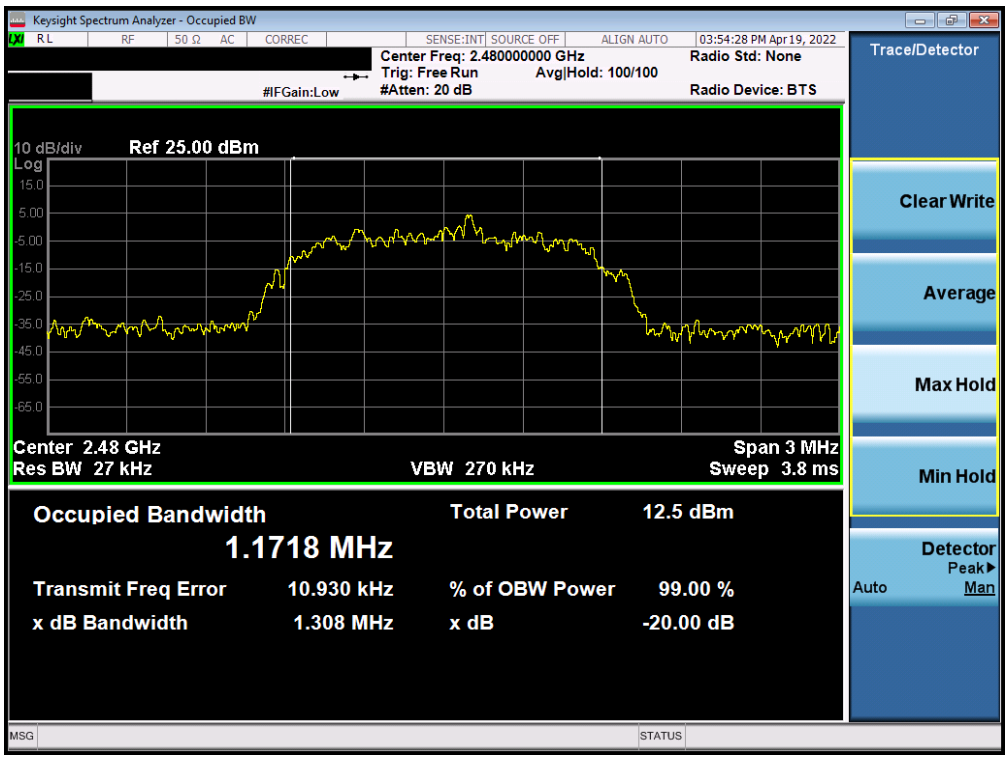
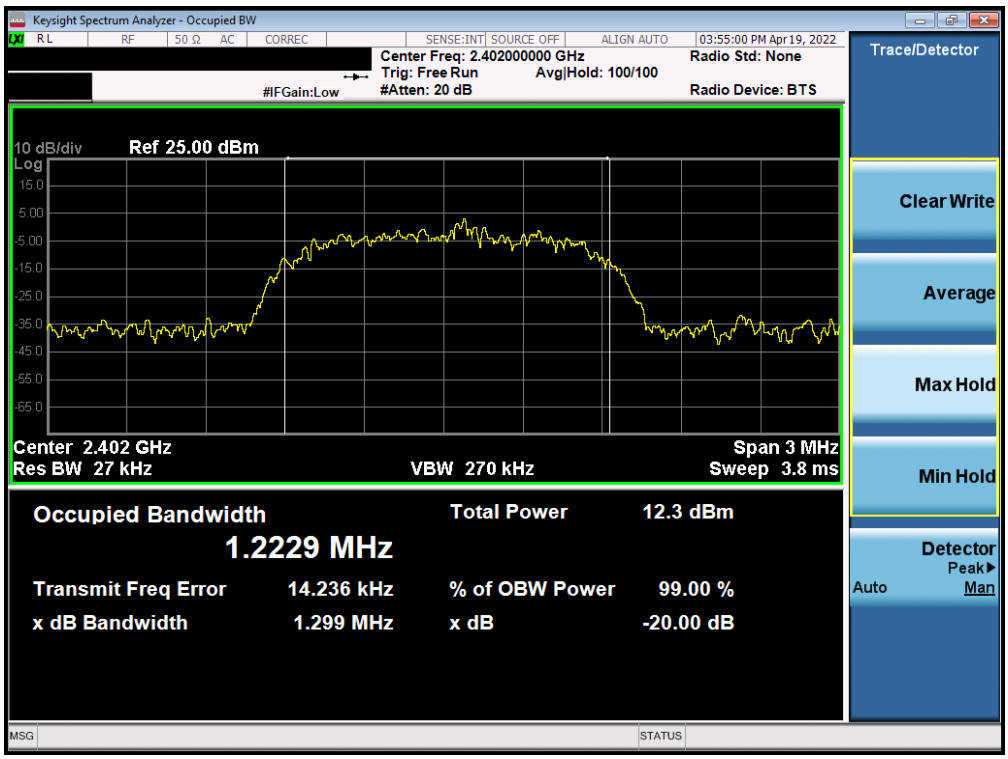


Plot 7-6. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 78) – Ant1



Plot 7-7. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 0) – Ant1

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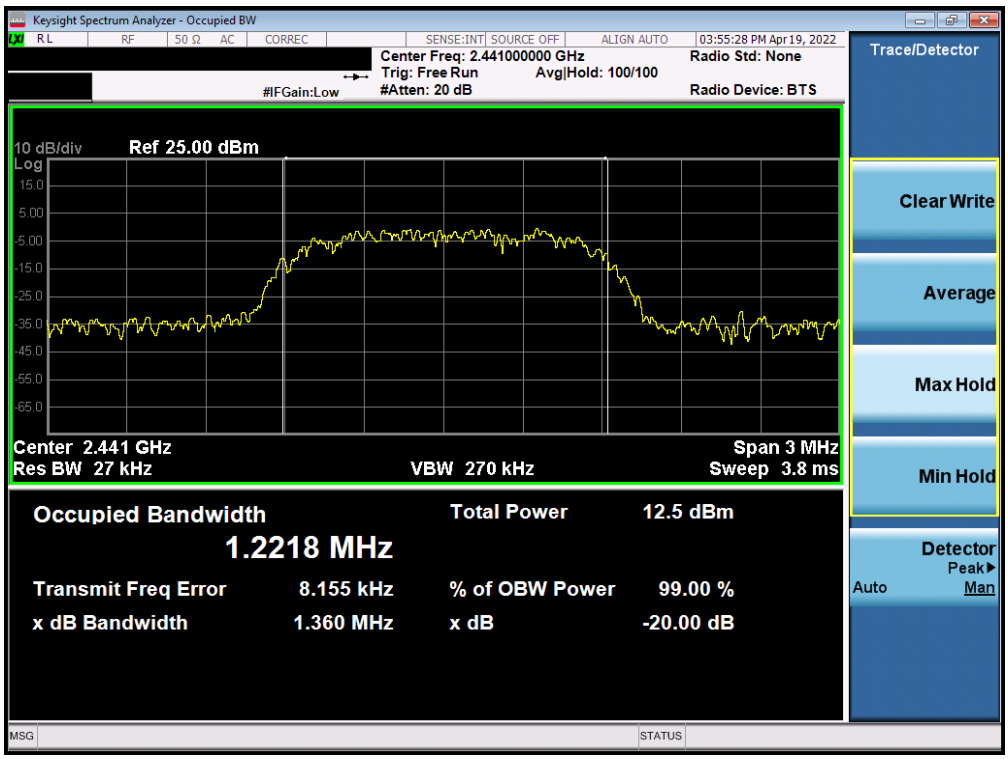
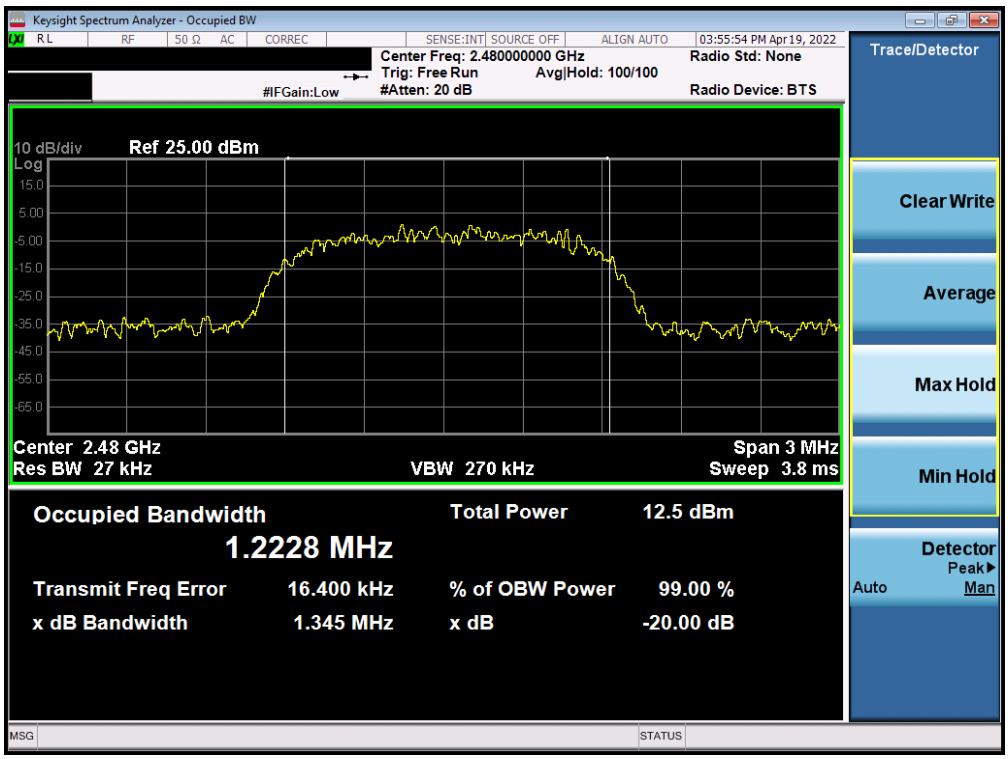


Plot 7-8. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 39) – Ant1



Plot 7-9. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 78) – Ant1

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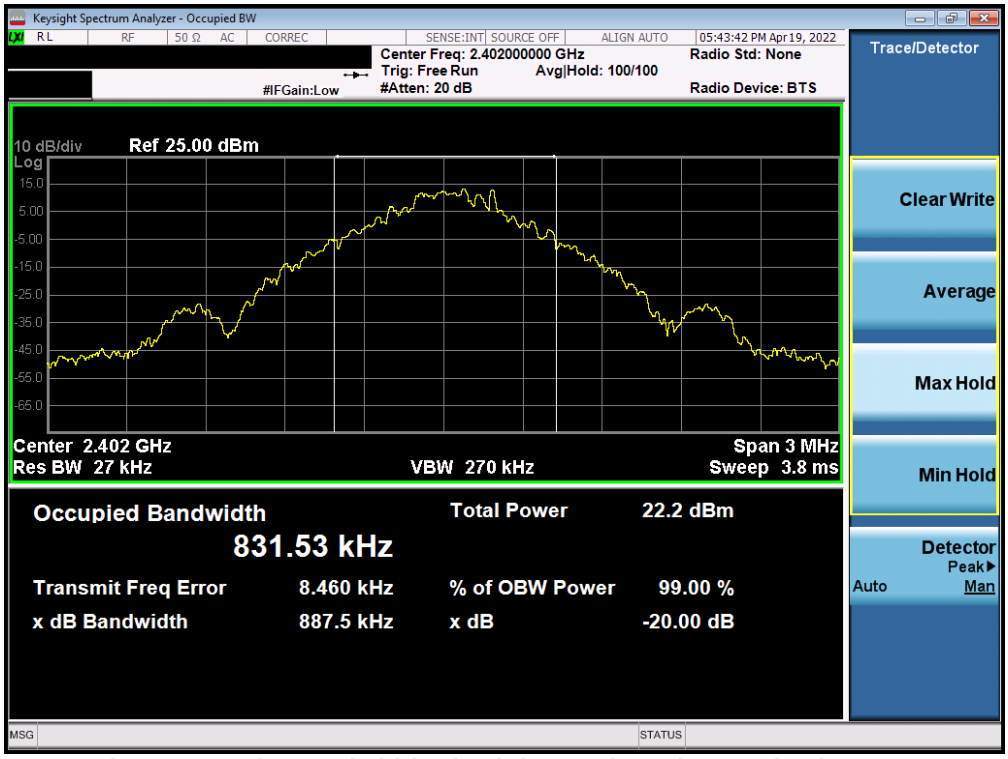
Frequency [MHz]	Data Rate [Mbps]	Channel No.	20dB Bandwidth Test Results [kHz]
2402	1.0	0	887.50
2441	1.0	39	928.60
2480	1.0	78	917.60
2402	2.0	0	1314.00
2441	2.0	39	1318.00
2480	2.0	78	1220.00
2402	3.0	0	1296.00
2441	3.0	39	1218.00
2480	3.0	78	1295.00

Table 7-3. Conducted 20dB Bandwidth Measurements – Ant2



Plot 7-10. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 0) – Ant2

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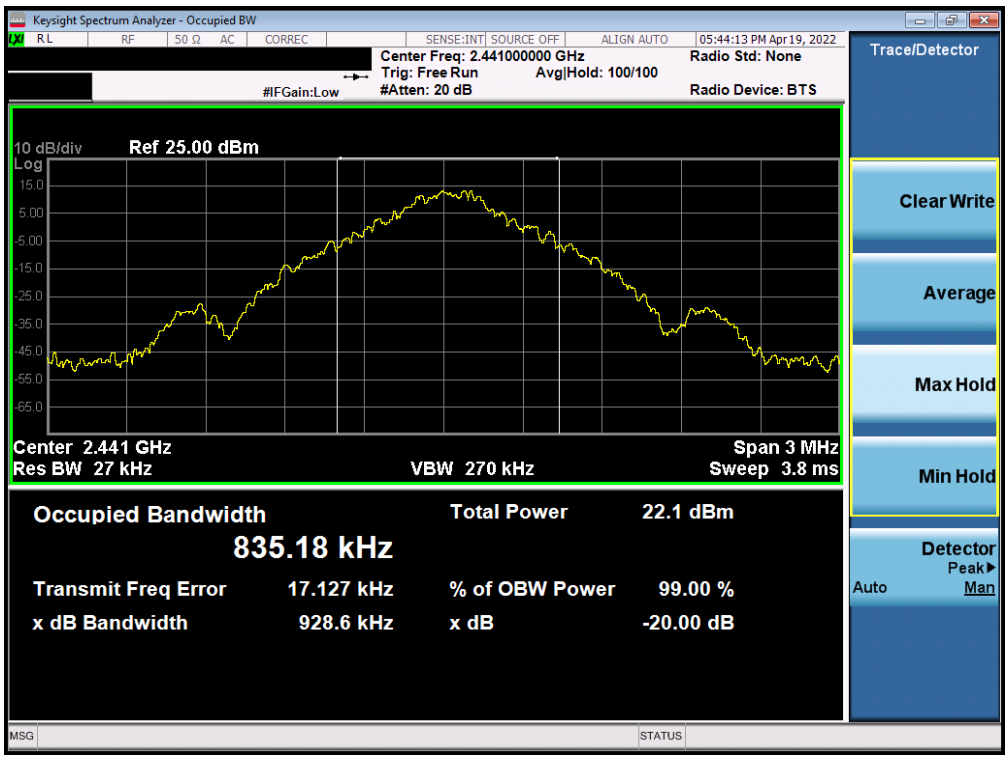
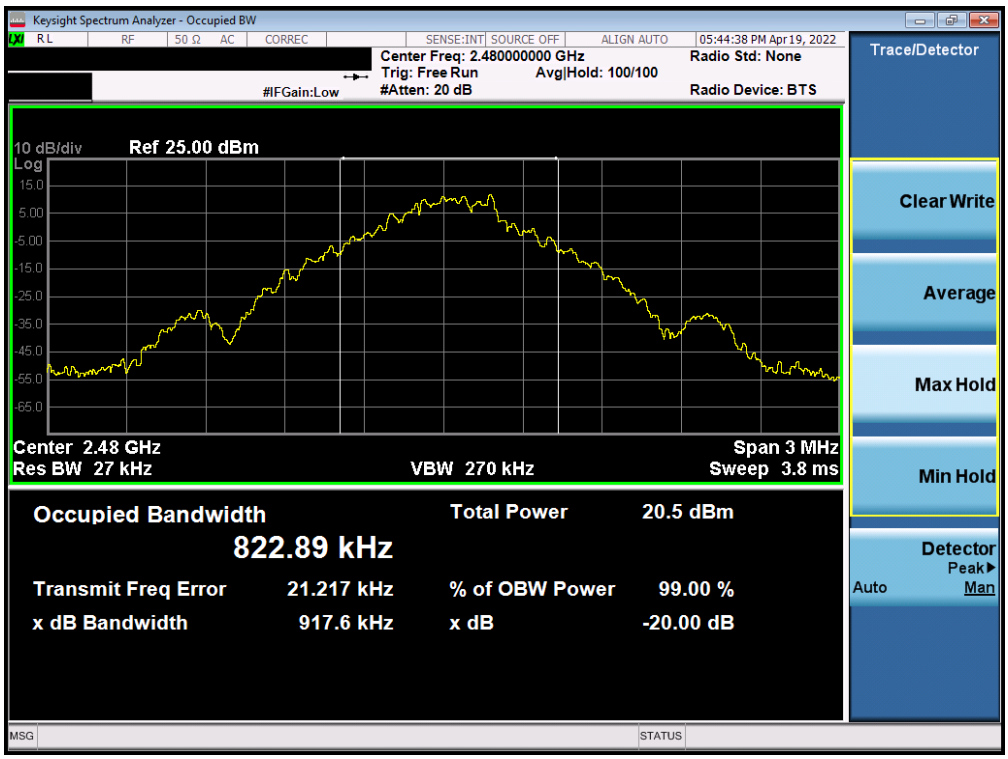


Plot 7-11. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 39) – Ant2



Plot 7-12. 20dB Bandwidth Plot (Bluetooth, 1Mbps – Ch. 78) – Ant2

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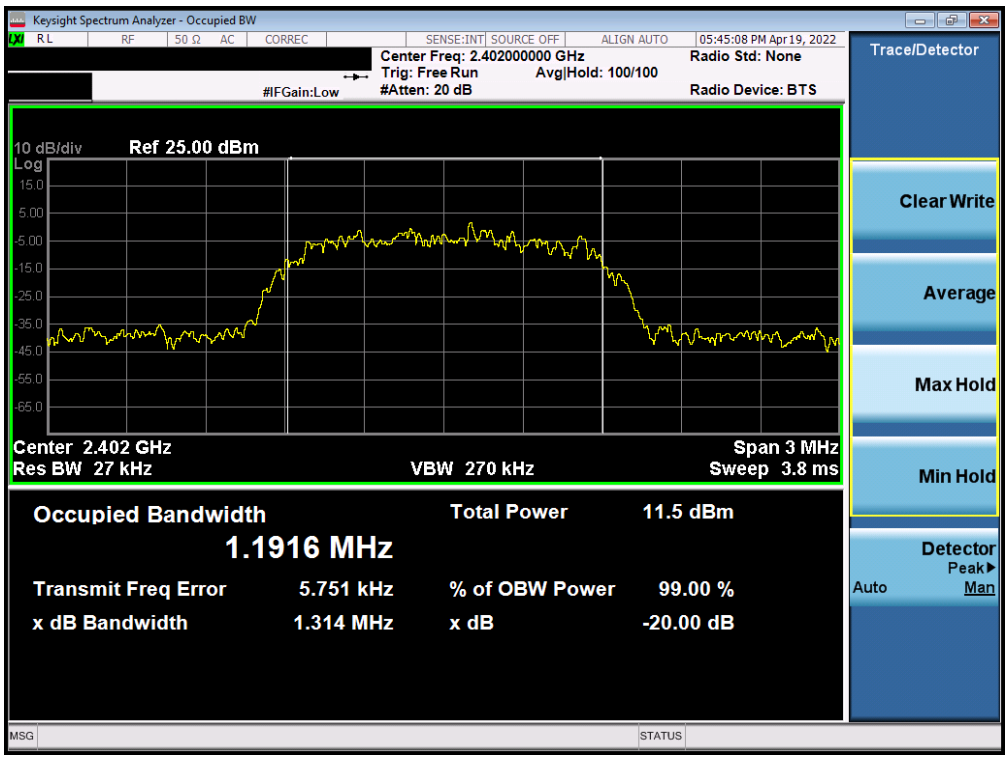
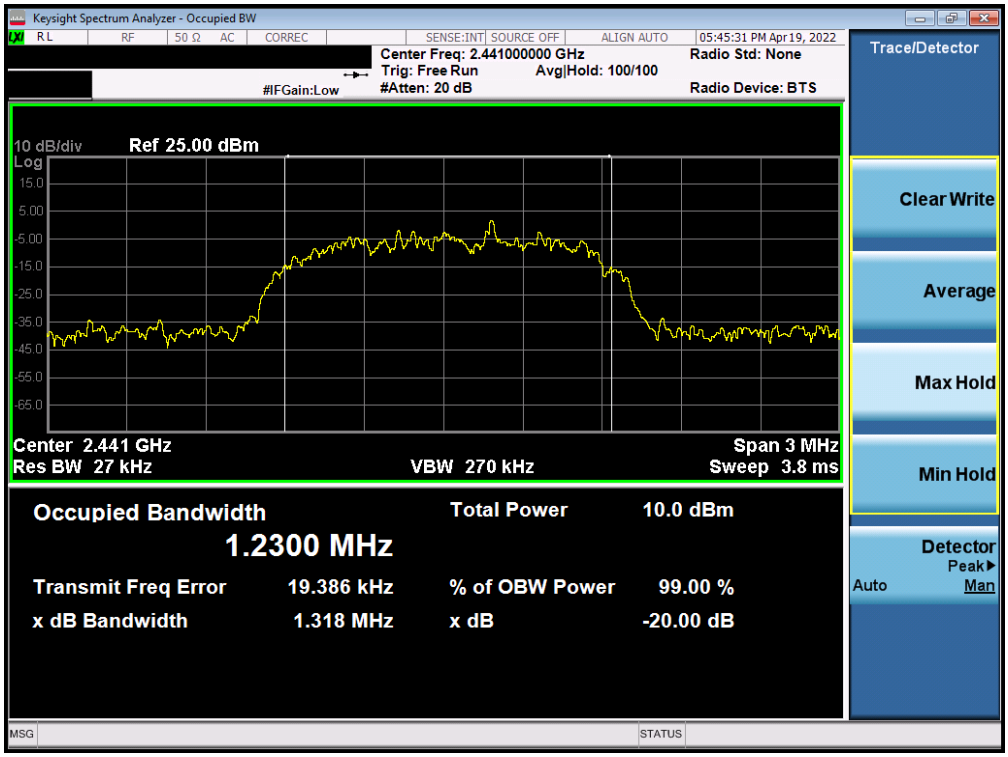


Plot 7-13. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 0) – Ant2



Plot 7-14. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 39) – Ant2

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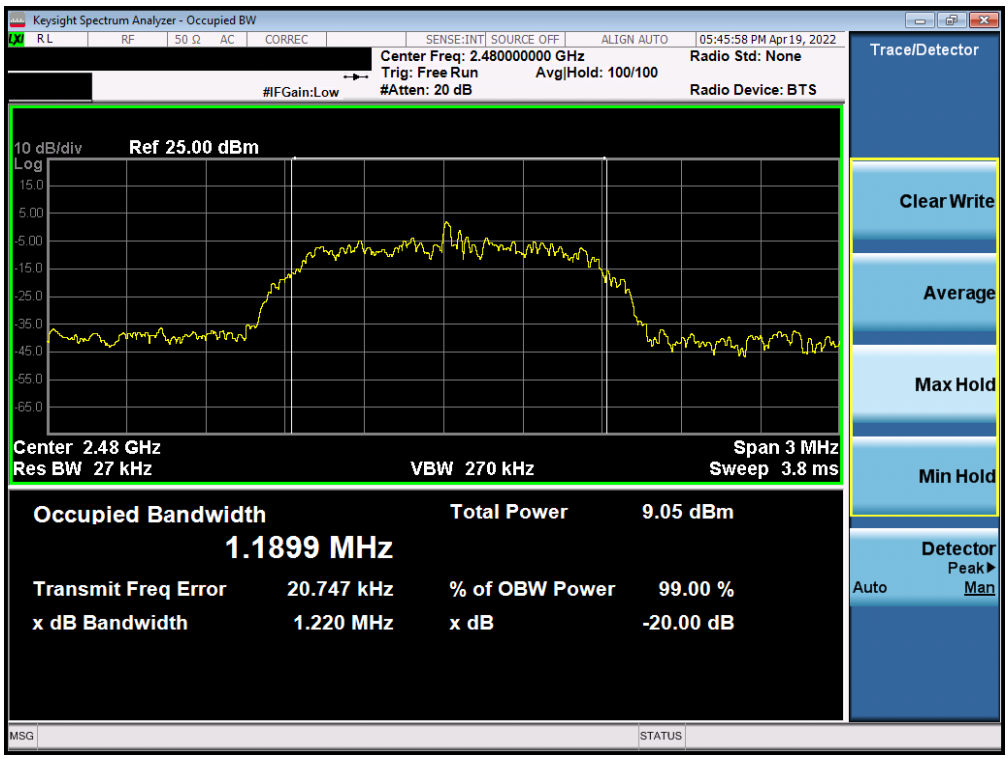
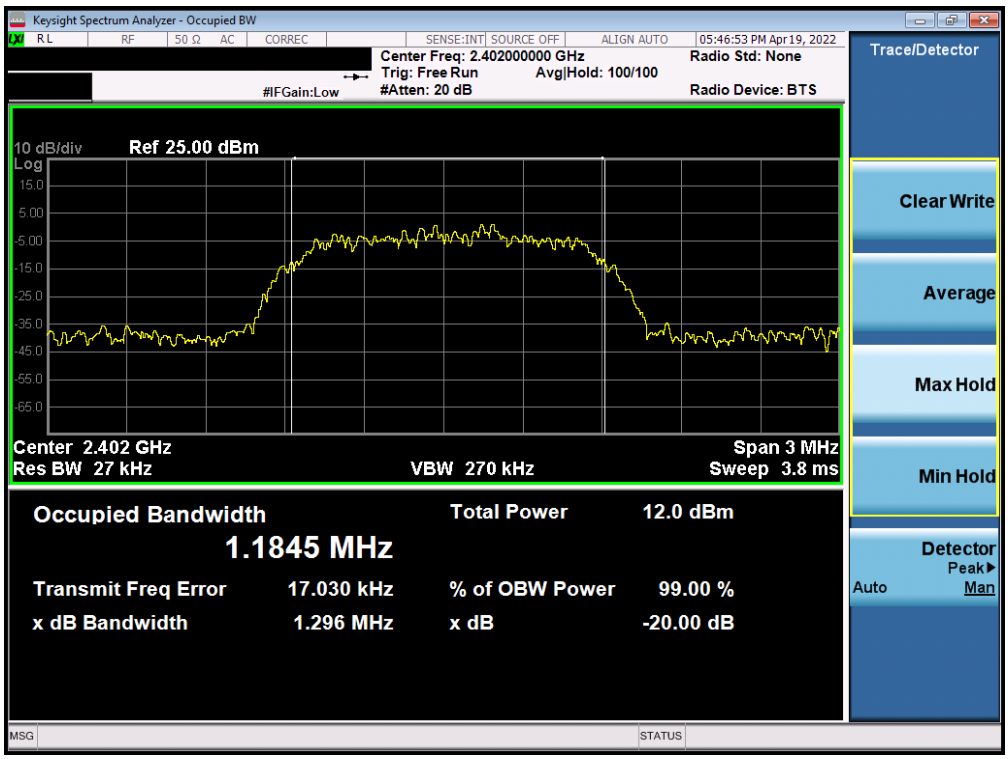


Plot 7-15. 20dB Bandwidth Plot (Bluetooth, 2Mbps – Ch. 78) – Ant2



Plot 7-16. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 0) – Ant2

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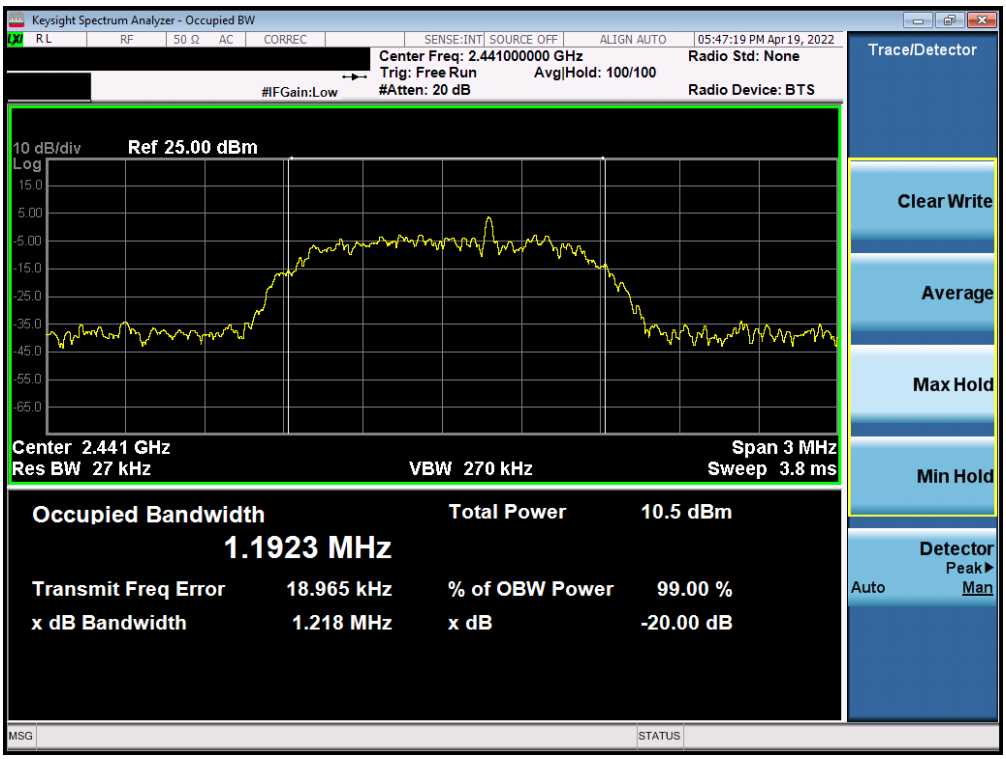
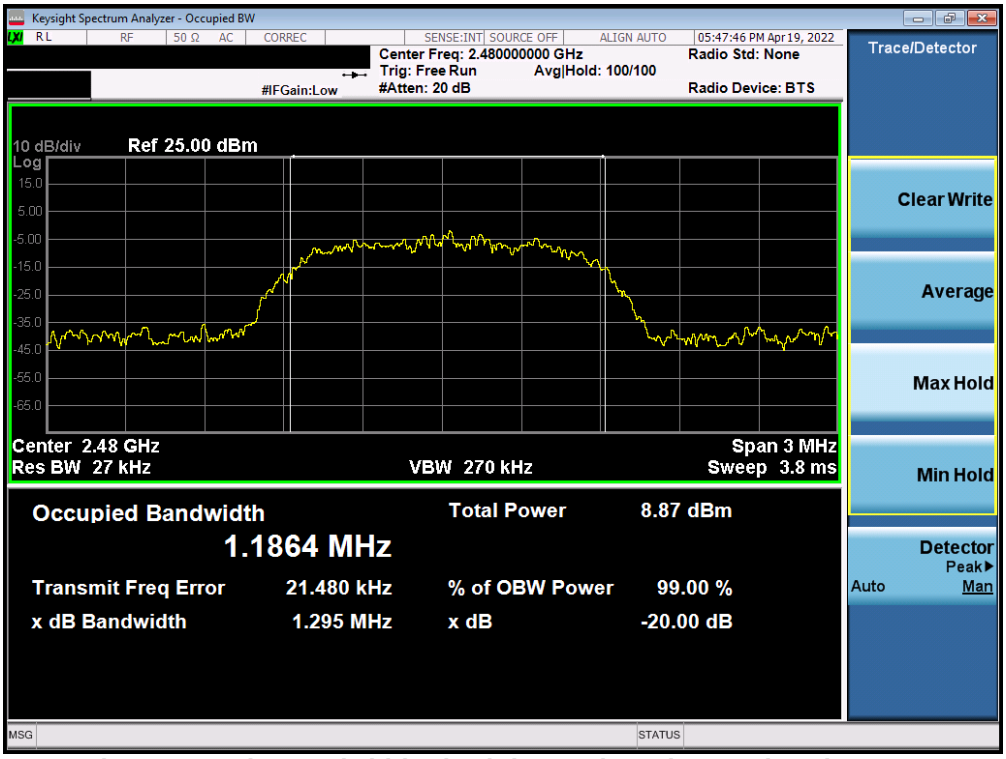


Plot 7-17. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 39) – Ant2



Plot 7-18. 20dB Bandwidth Plot (Bluetooth, 3Mbps – Ch. 78) – Ant2

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7.3 Output Power Measurement

§15.247 (b.1); RSS-247 [5.4(2)]

Test Overview and Limits

Measurement is made while the EUT is operating in non-hopping transmission mode. The powers shown below were measured using a spectrum analyzer with a Bluetooth signaling test set (Agilent Model: N4010A) used only to maintain a Bluetooth link with the EUT. Average power measurements are performed using the analyzer's "burst power" function with RBW = 3MHz. The burst power function triggers on a single set burst set to maximum power and measures the maximum average power on the on-time.

The maximum permissible output power is 1 Watt.

The maximum e.i.r.p. shall not exceed 4 Watts.

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.5
ANSI C63.10-2013 – Section 11.9.2.3.2 method AVGPM-G

Test Settings

Peak Power Measurement

1. Span = approximately 5x 20dB bandwidth, centered on hopping channel
2. RBW > 20dB bandwidth of emission being measured
3. VBW ≥ RBW
4. Sweep = auto
5. Detector = peak
6. Trace mode = max hold
7. The trace was allowed to stabilize

Test Setup

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

Figure 7-2. Test Instrument & Measurement Setup

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Note

This unit was tested with all possible data rates and the highest peak power is reported with the unit transmitting at 1 Mbps. Final results were obtained using calibrated couplers, attenuators and cables. The following formula was used:

Output Power (dBm) = Raw Analyzer Level (dBm) + Cable Loss (dB) + Loss in Directional Coupler/Insertion Loss (dB)

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Peak Conducted Power		Avg Conducted Power		Ant. Gain [dBi]	EIRP [dBm]	Limit [dBm]	Margin [dB]
			[dBm]	[mW]	[dBm]	[mW]				
2402	1.0	0	18.80	75.910	18.57	71.928	-2.05	16.75	36.02	-19.27
2441	1.0	39	19.01	79.634	18.77	75.266	-2.05	16.96	36.02	-19.06
2480	1.0	78	18.85	76.807	18.58	72.078	-2.05	16.80	36.02	-19.22
2402	2.0	0	18.09	64.372	15.55	35.892	-2.05	16.04	36.02	-19.98
2441	2.0	39	18.32	67.842	15.16	32.817	-2.05	16.27	36.02	-19.76
2480	2.0	78	18.28	67.360	14.85	30.514	-2.05	16.23	36.02	-19.79
2402	3.0	0	18.53	71.285	15.56	35.975	-2.05	16.48	36.02	-19.54
2441	3.0	39	18.69	74.012	15.18	32.984	-2.05	16.64	36.02	-19.38
2480	3.0	78	18.72	74.508	15.14	32.651	-2.05	16.67	36.02	-19.35

Table 7-4. Conducted Output Power Measurements – Ant 1

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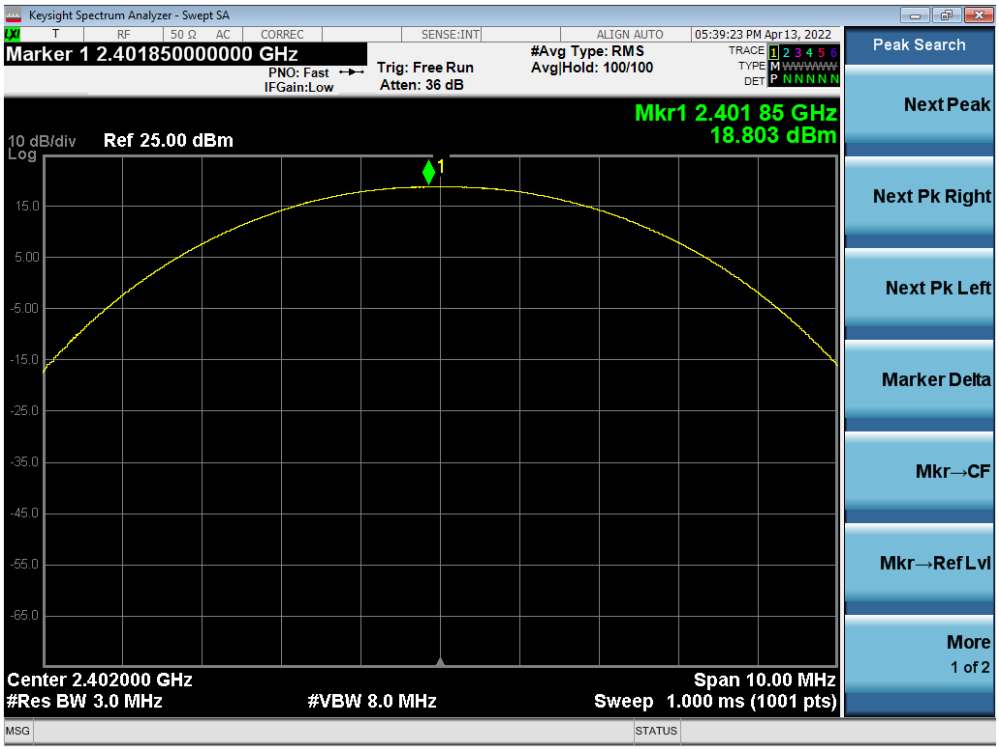
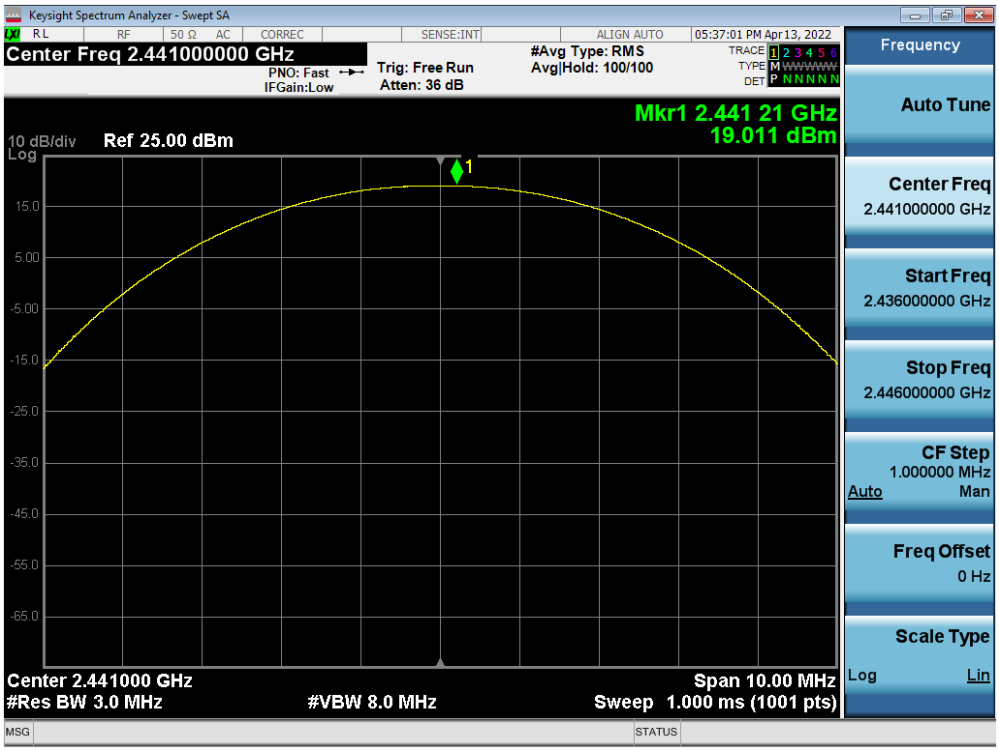


Plot 7-19. Peak Conducted Power (1Mbps – Ch. 0) – Ant 1



Plot 7-20. Peak Conducted Power (1Mbps – Ch. 39) – Ant 1

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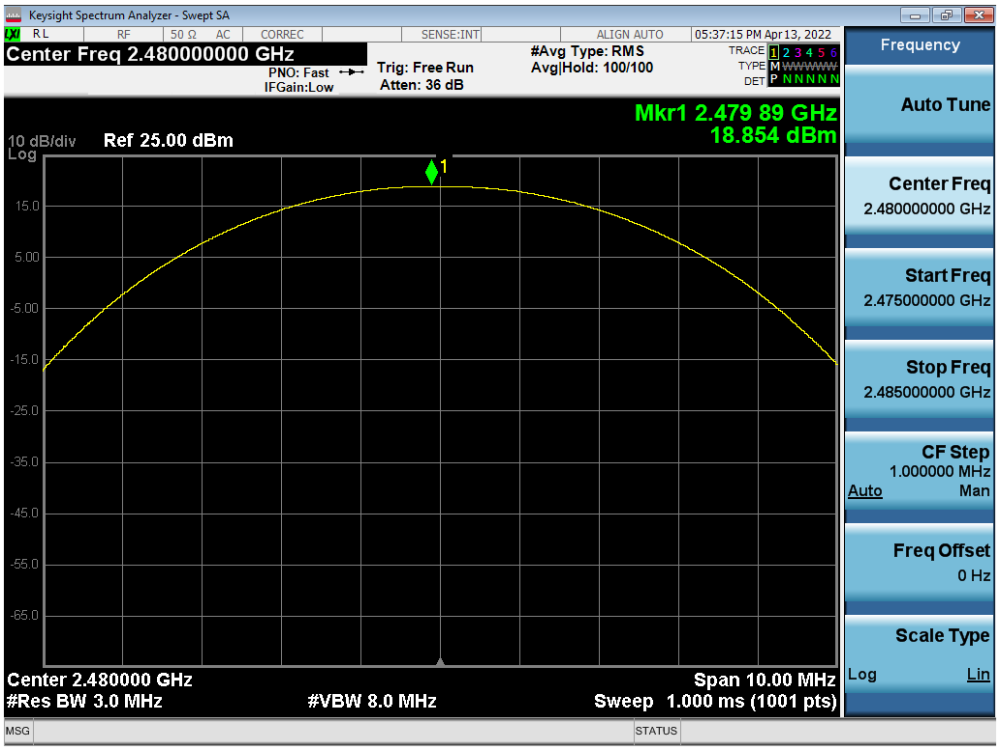
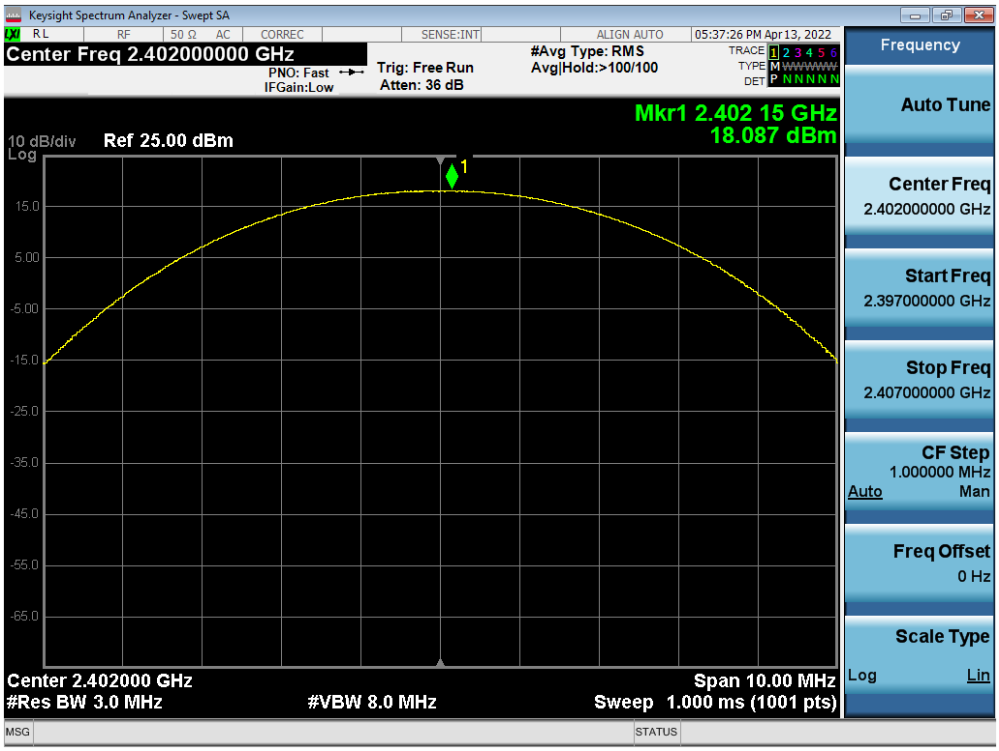


Plot 7-21. Peak Conducted Power (1Mbps – Ch. 78) – Ant 1



Plot 7-22. Peak Conducted Power (2Mbps – Ch. 0) – Ant 1

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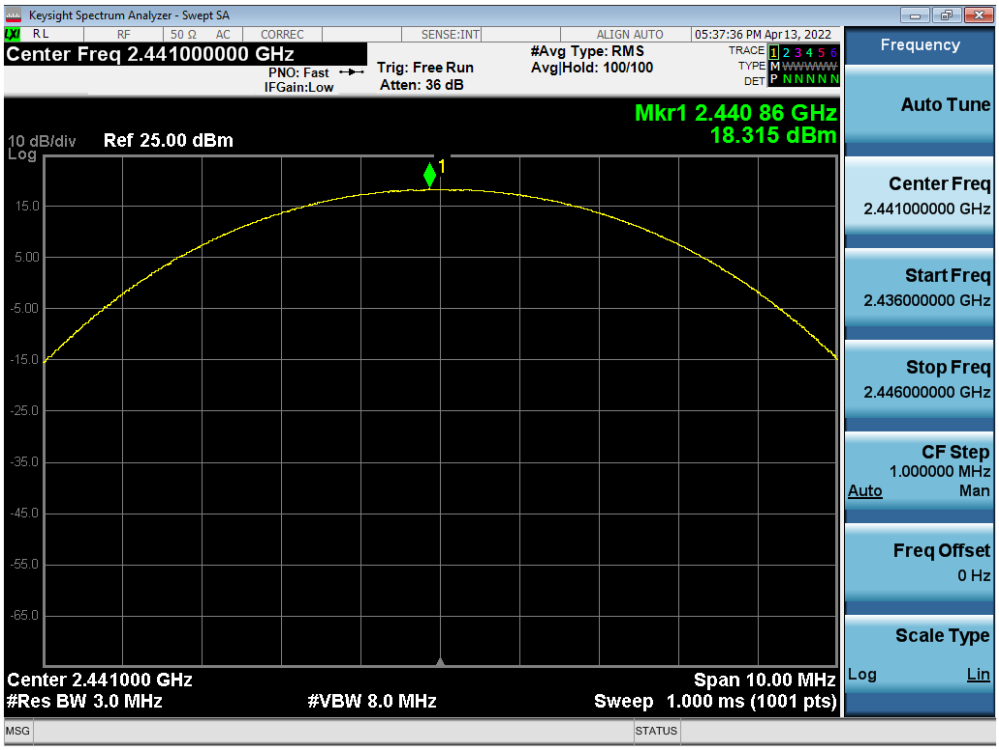
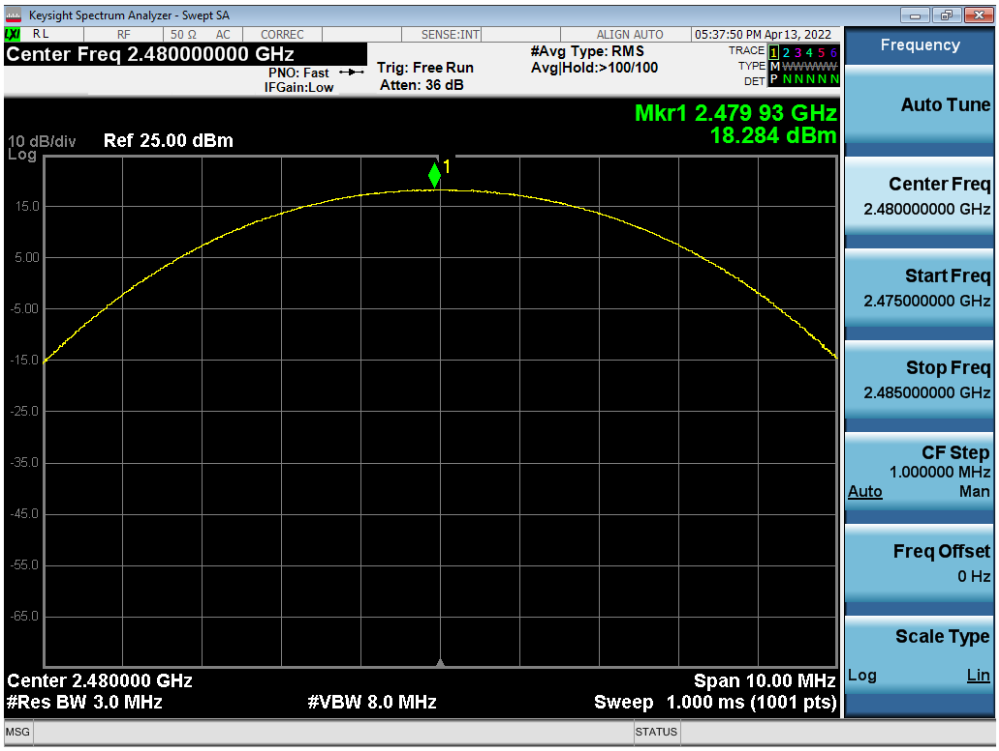


Plot 7-23. Peak Conducted Power (2Mbps – Ch. 39) – Ant 1



Plot 7-24. Peak Conducted Power (2Mbps – Ch. 78) – Ant 1

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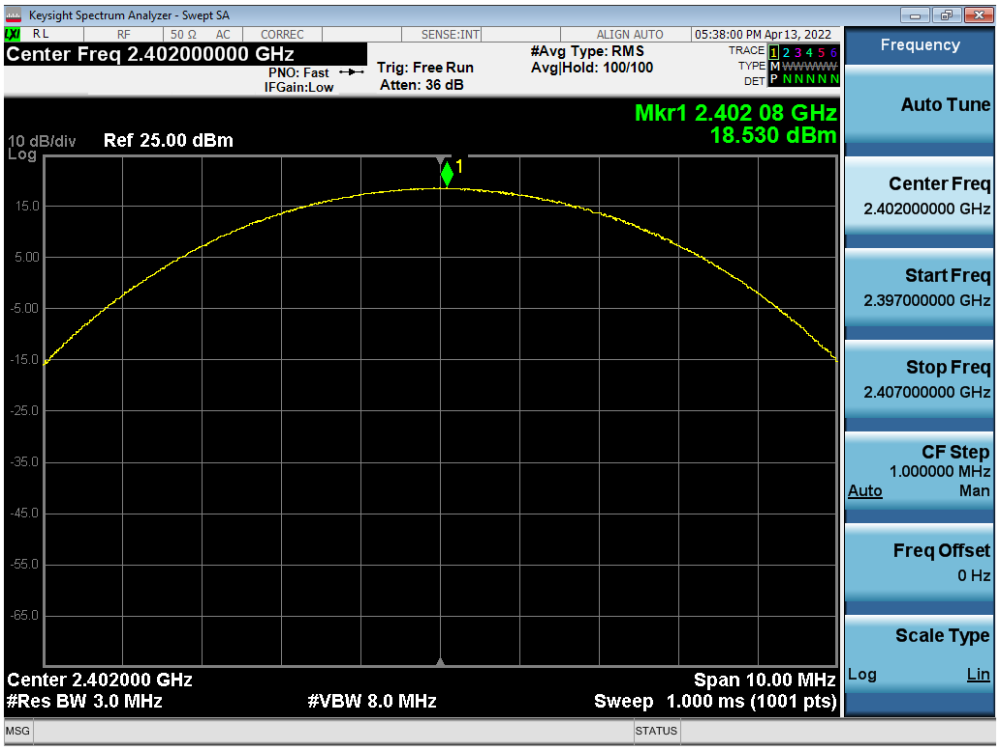
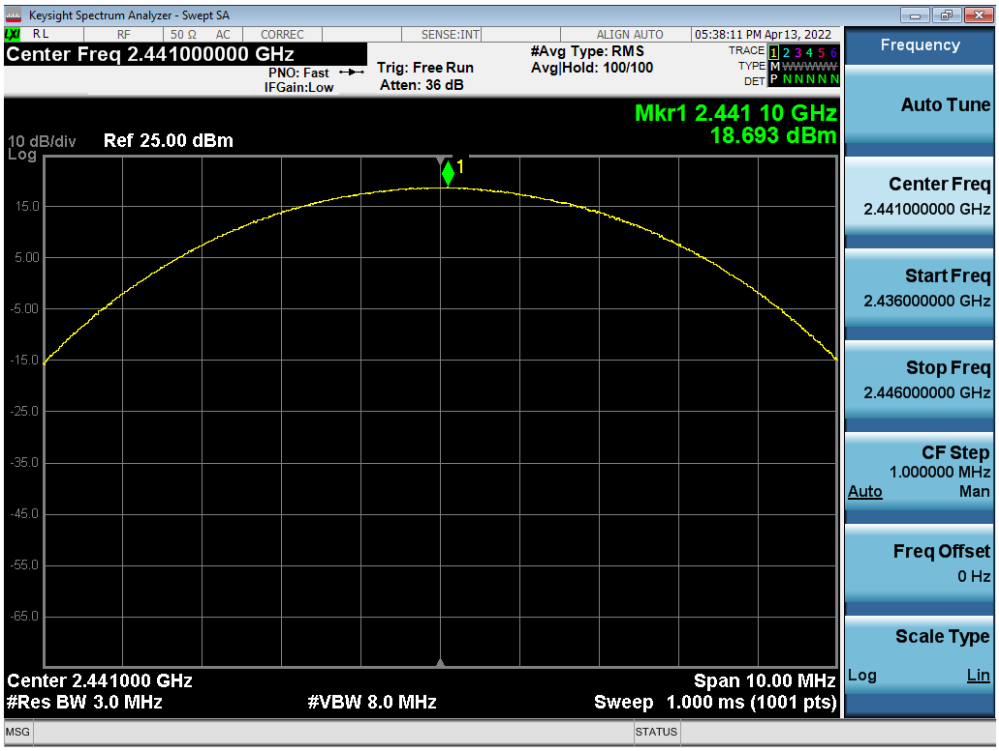


Plot 7-25. Peak Conducted Power (3Mbps – Ch. 0) – Ant 1



Plot 7-26. Peak Conducted Power (3Mbps – Ch. 39) – Ant 1

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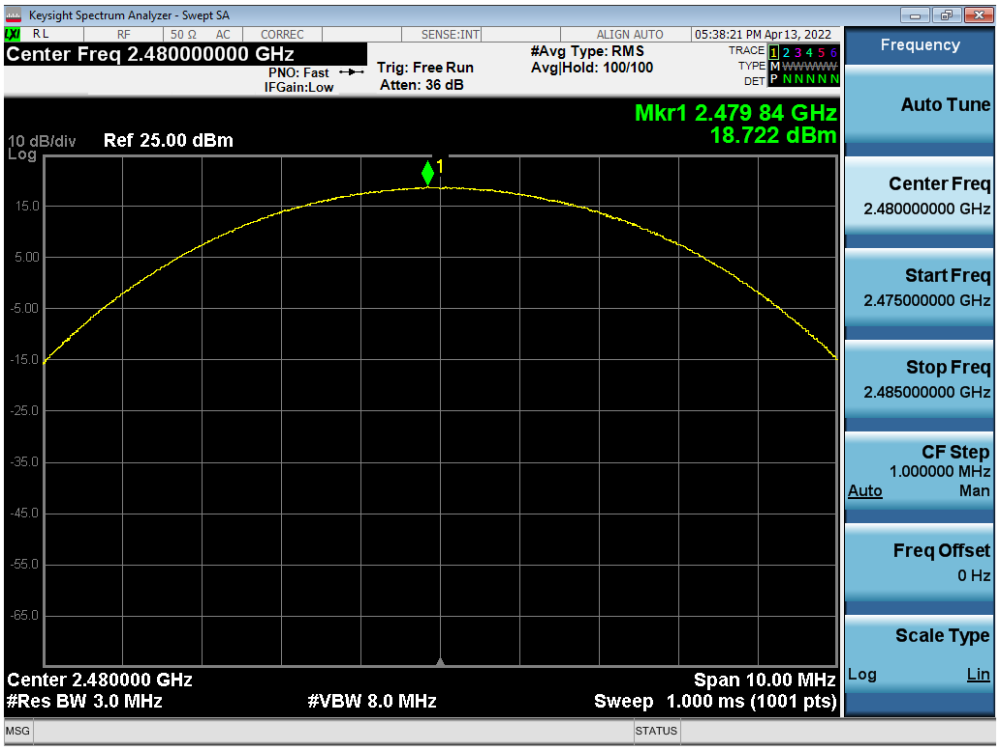
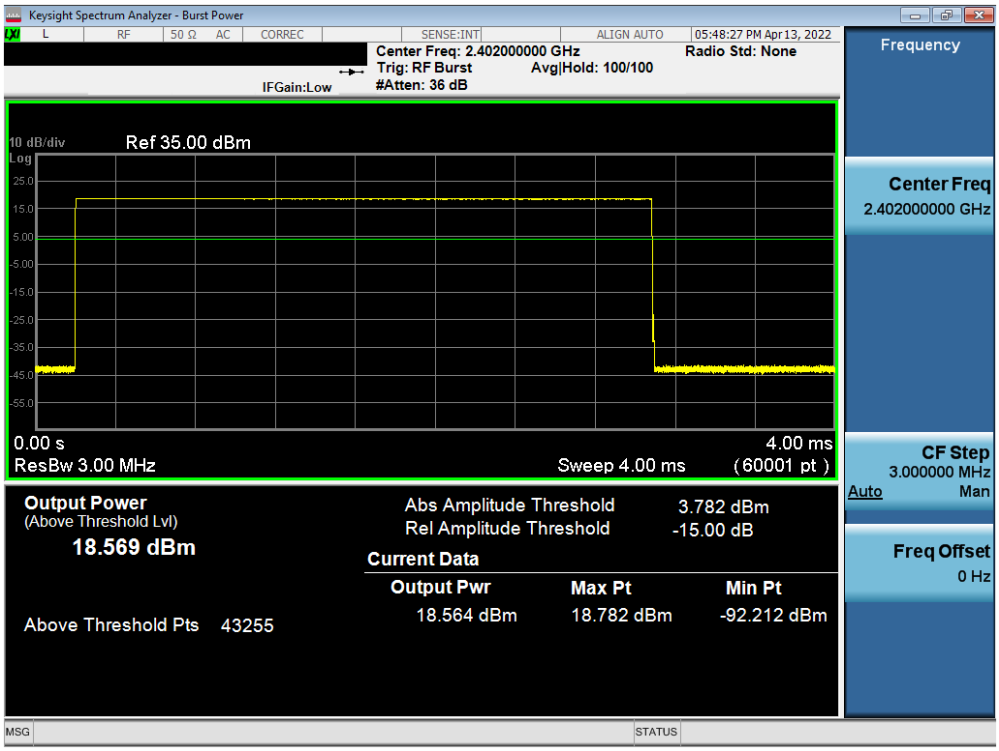


Plot 7-27. Peak Conducted Power (3Mbps – Ch. 78) – Ant 1



Plot 7-28. Average Conducted Power (1Mbps – Ch. 0) – Ant 1

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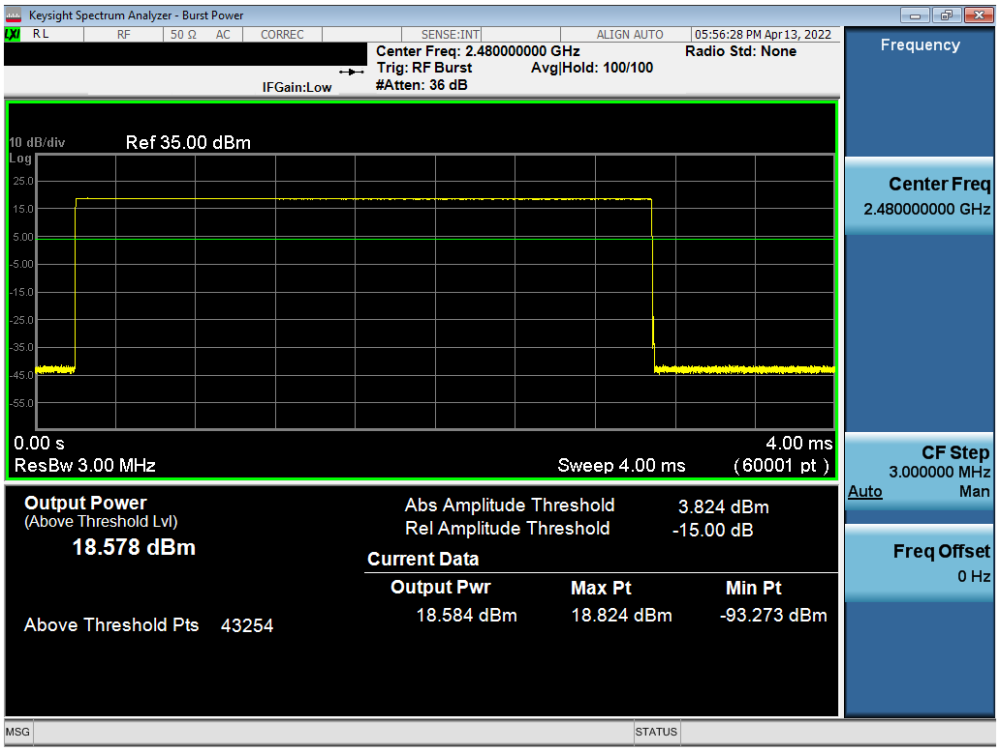
Plot 7-29. Average Conducted Power (1Mbps – Ch. 39) – Ant 1



Plot 7-30. Average Conducted Power (1Mbps – Ch. 78) – Ant 1

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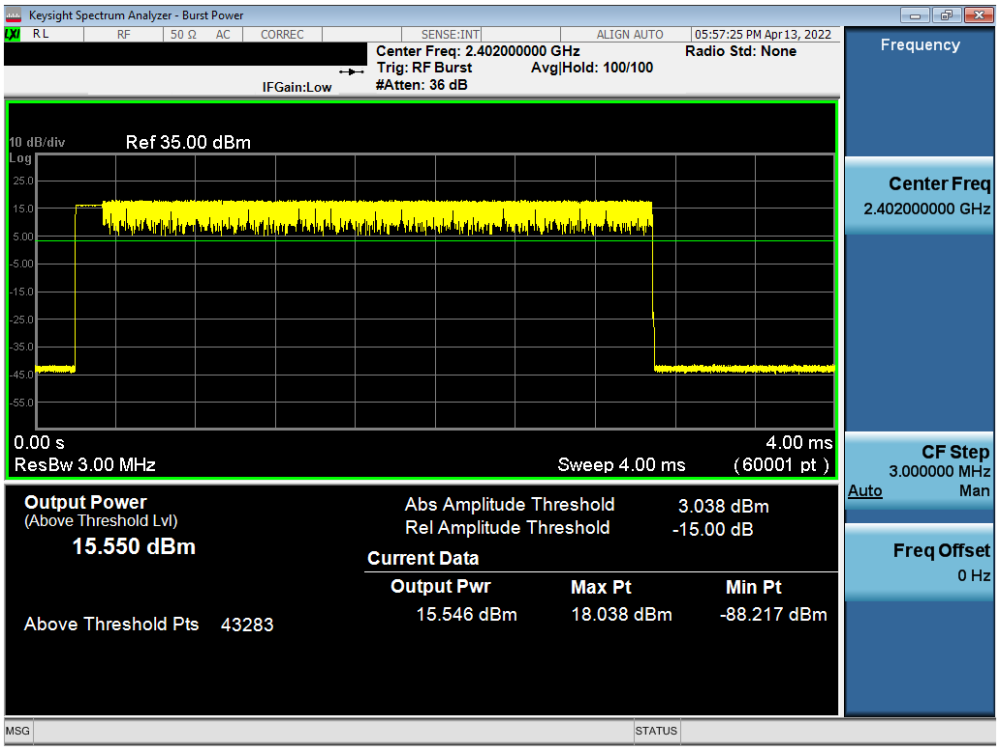
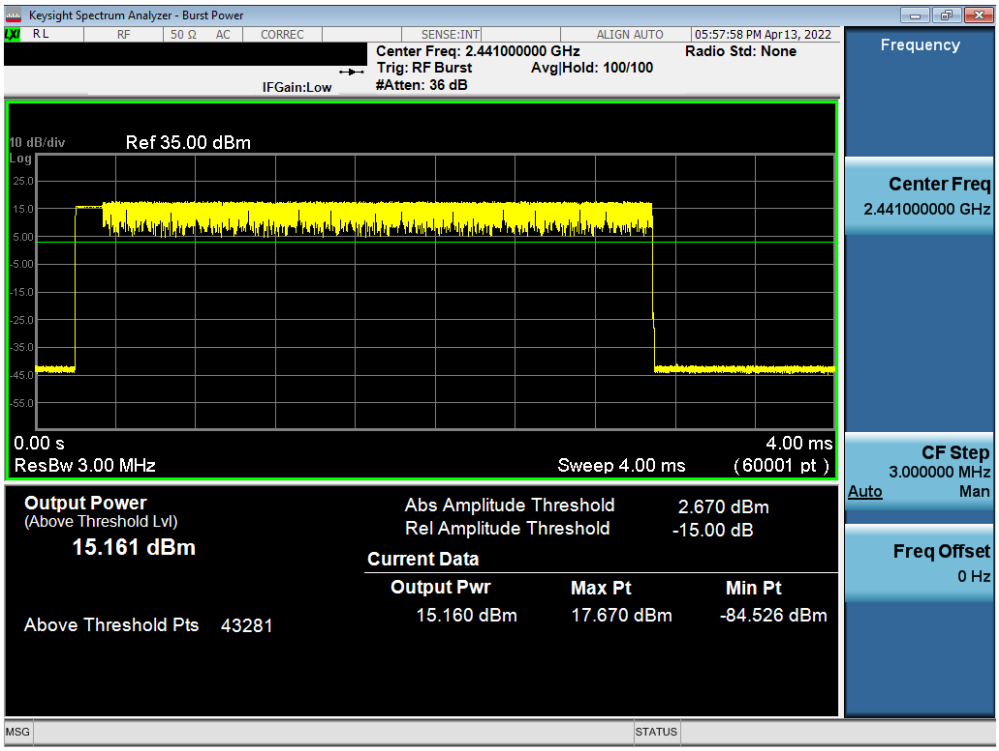


Plot 7-31. Average Conducted Power (2Mbps – Ch. 0) – Ant 1



Plot 7-32. Average Conducted Power (2Mbps – Ch. 39) – Ant 1

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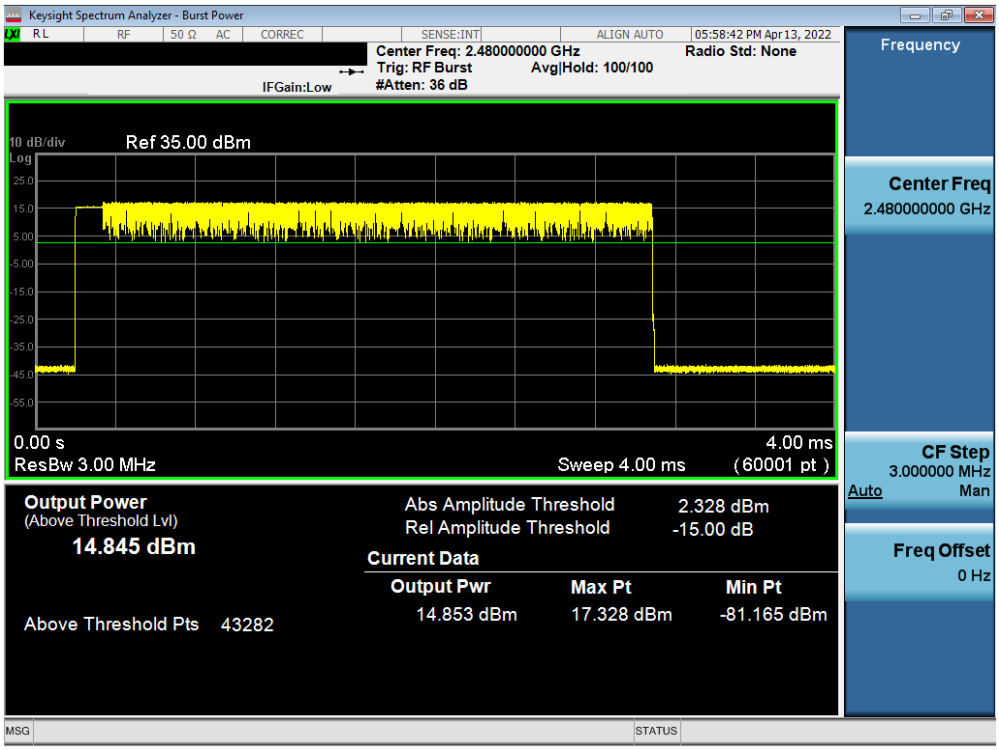
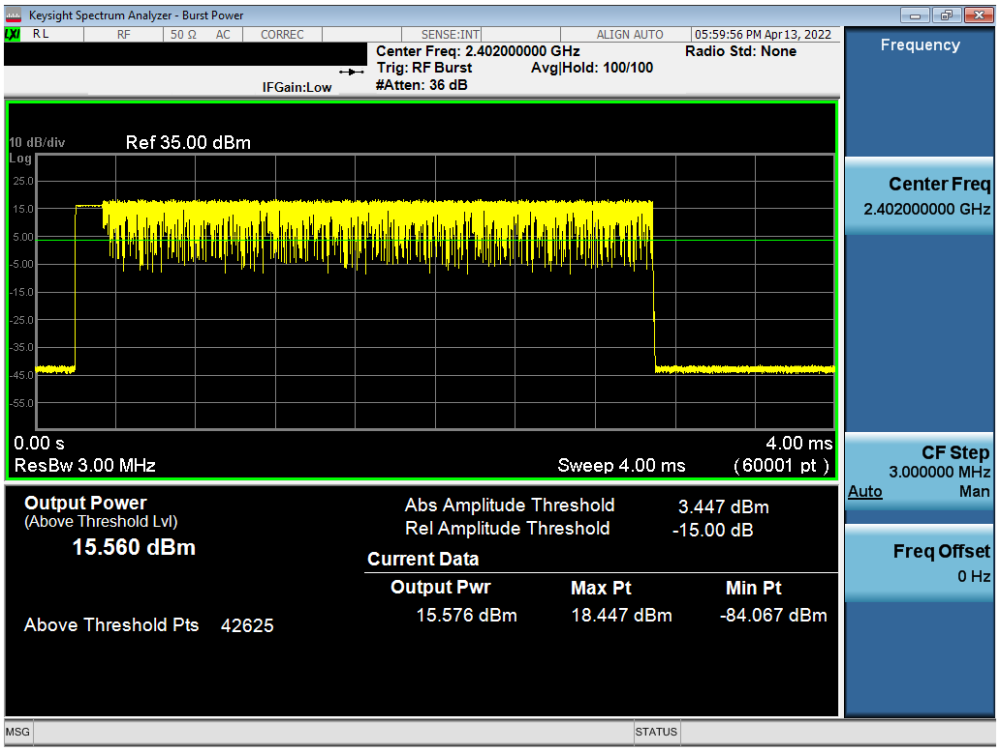


Plot 7-33. Average Conducted Power (2Mbps – Ch. 78) – Ant 1



Plot 7-34. Average Conducted Power (3Mbps – Ch. 0) – Ant 1

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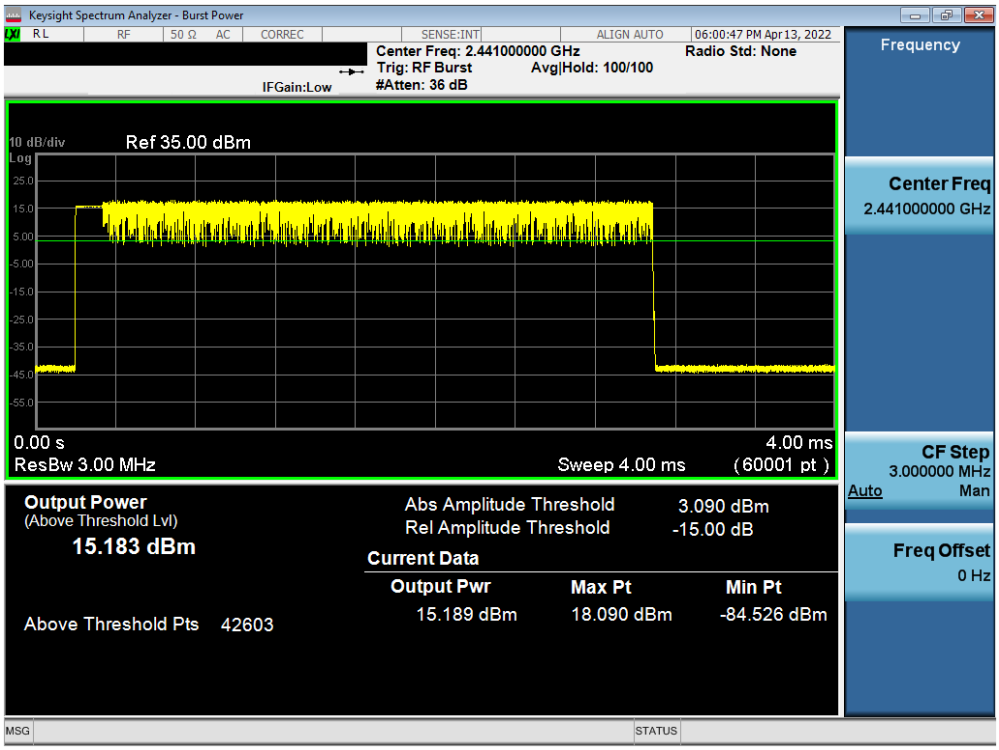
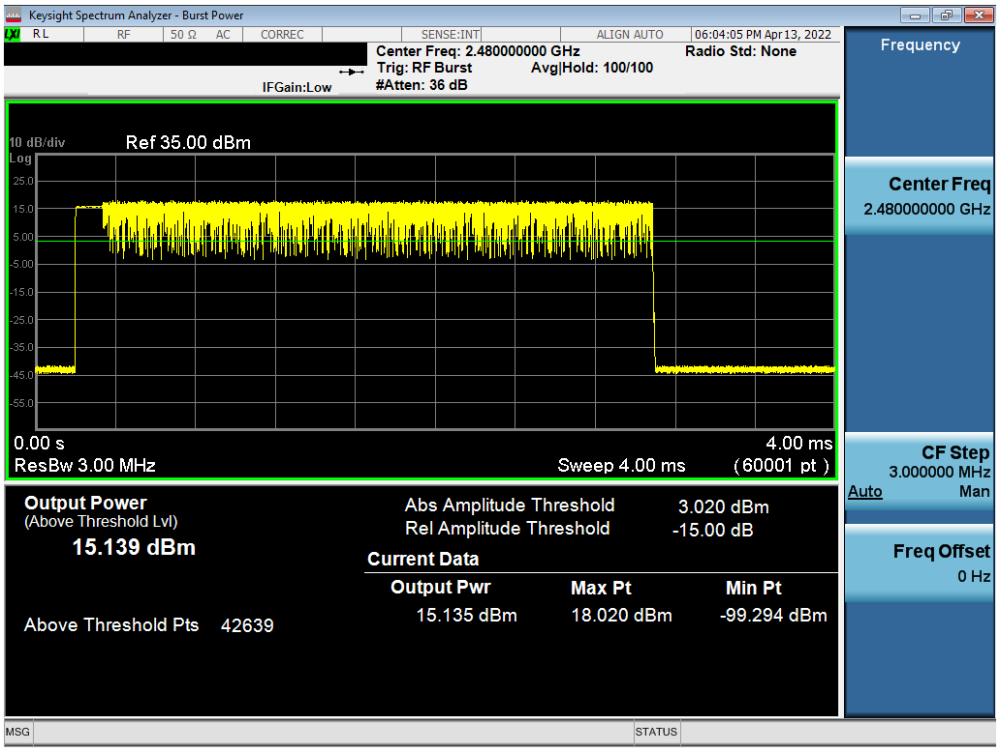


Plot 7-35. Average Conducted Power (3Mbps – Ch. 39) – Ant 1



Plot 7-36. Average Conducted Power (3Mbps – Ch. 78) – Ant 1

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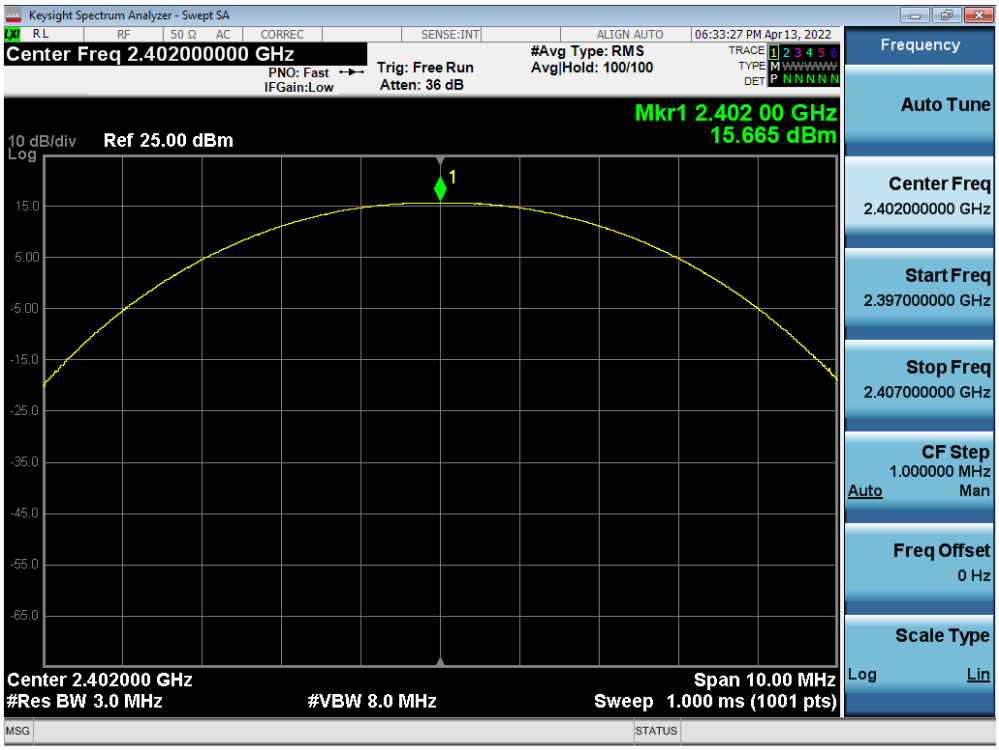
Frequency [MHz]	Data Rate [Mbps]	Channel No.	Peak Conducted Power		Avg Conducted Power		Ant. Gain [dBi]	EIRP [dBm]	Limit [dBm]	Margin [dB]
			[dBm]	[mW]	[dBm]	[mW]				
2402	1.0	0	15.67	36.855	15.30	33.908	-5.15	10.52	36.02	-25.51
2441	1.0	39	16.13	41.020	15.82	38.186	-5.15	10.98	36.02	-25.04
2480	1.0	78	14.32	27.040	14.01	25.188	-5.15	9.17	36.02	-26.85
2402	2.0	0	14.89	30.803	12.25	16.784	-5.15	9.74	36.02	-26.28
2441	2.0	39	15.46	35.116	12.89	19.440	-5.15	10.31	36.02	-25.72
2480	2.0	78	13.69	23.372	11.07	12.800	-5.15	8.54	36.02	-27.48
2402	3.0	0	15.42	34.850	12.29	16.959	-5.15	10.27	36.02	-25.75
2441	3.0	39	15.91	38.967	12.97	19.792	-5.15	10.76	36.02	-25.26
2480	3.0	78	14.18	26.188	11.15	13.032	-5.15	9.03	36.02	-26.99

Table 7-5. Conducted Output Power Measurements – Ant 2



Plot 7-37. Peak Conducted Power (1Mbps – Ch. 0) – Ant 2

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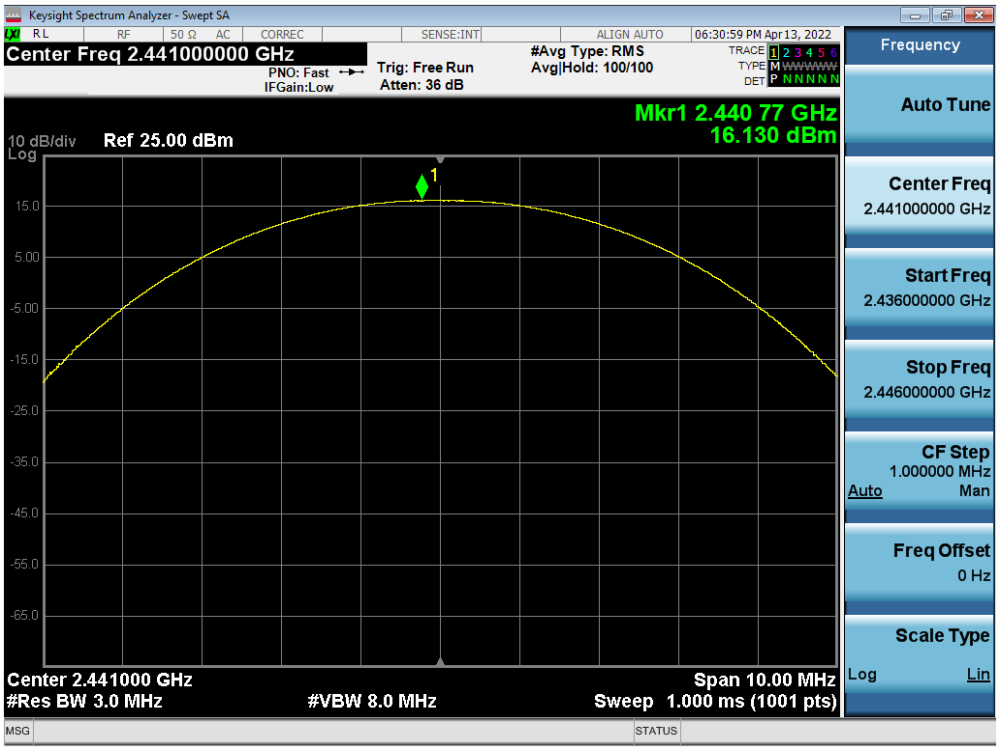
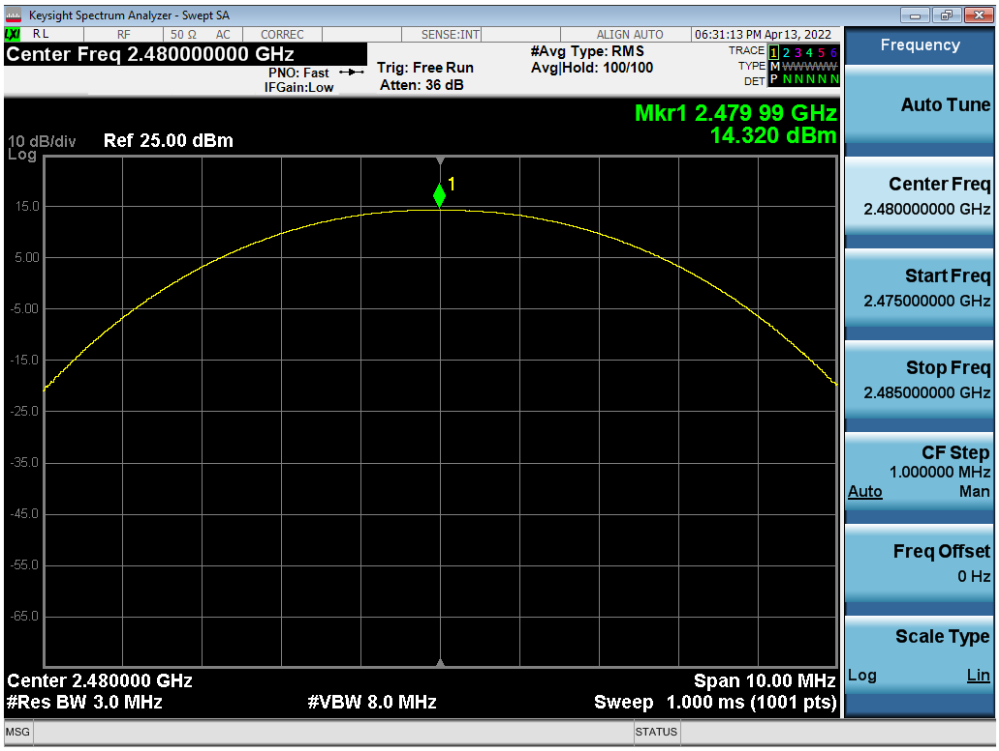


Plot 7-38. Peak Conducted Power (1Mbps – Ch. 39) – Ant 2



Plot 7-39. Peak Conducted Power (1Mbps – Ch. 78) – Ant 2

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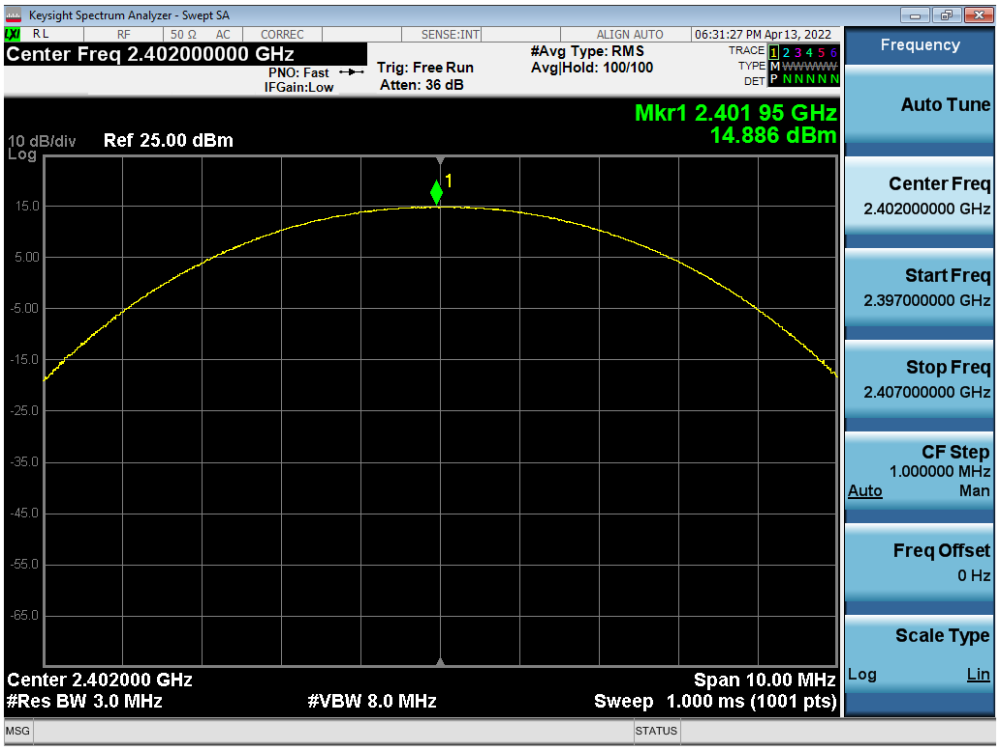
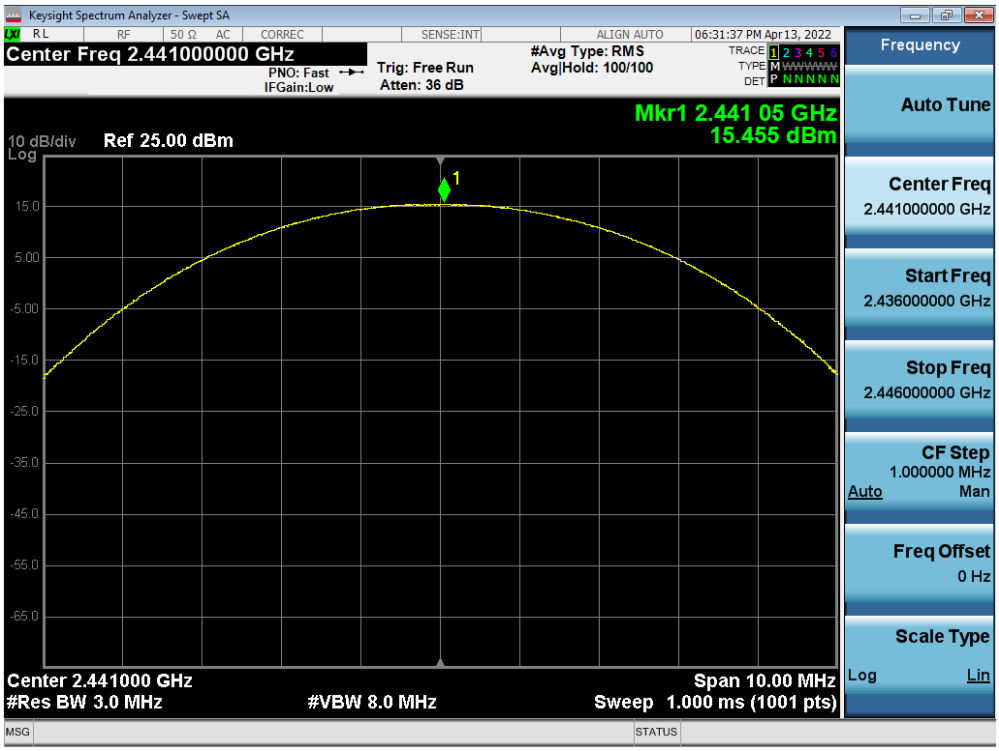


Plot 7-40. Peak Conducted Power (2Mbps – Ch. 0) – Ant 2



Plot 7-41. Peak Conducted Power (2Mbps – Ch. 39) – Ant 2

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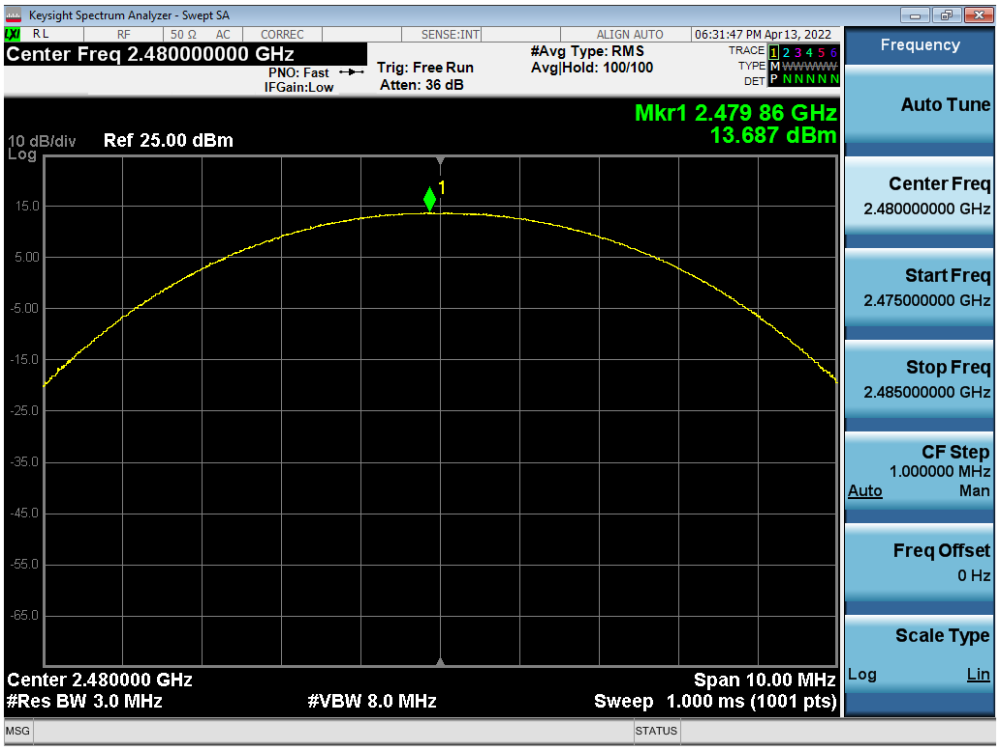
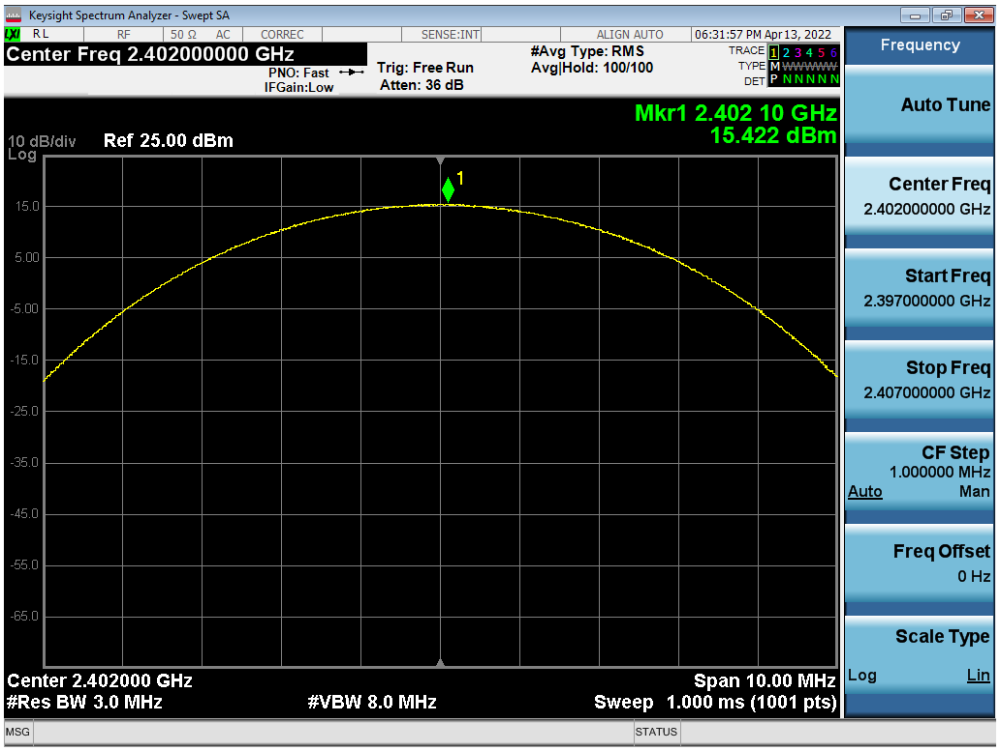


Plot 7-42. Peak Conducted Power (2Mbps – Ch. 78) – Ant 2



Plot 7-43. Peak Conducted Power (3Mbps – Ch. 0) – Ant 2

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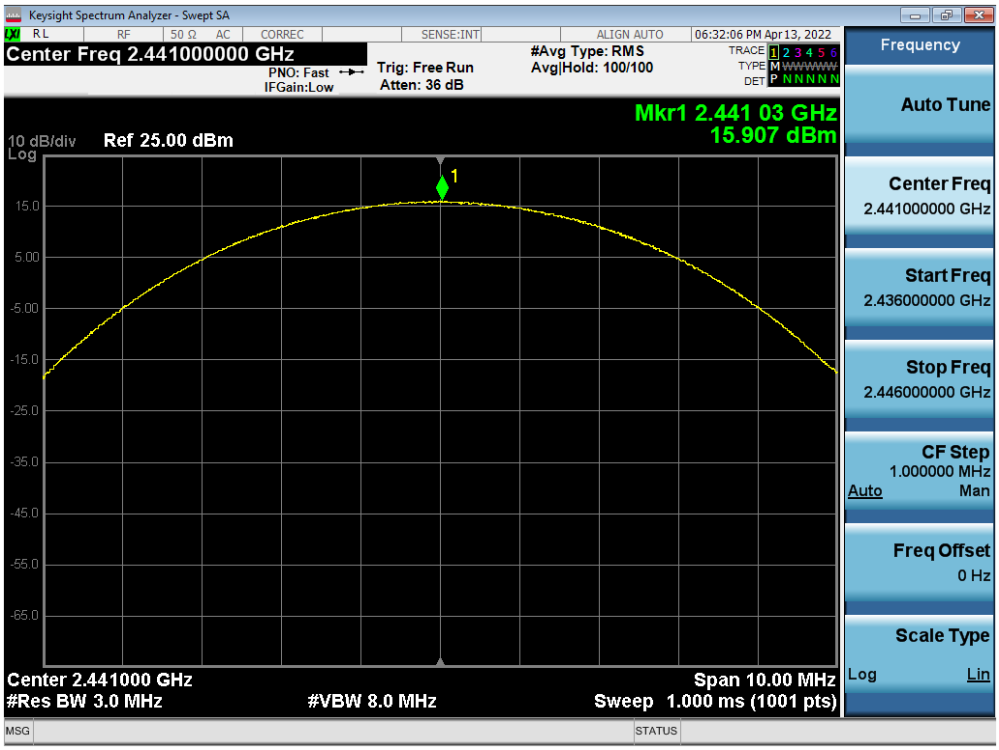
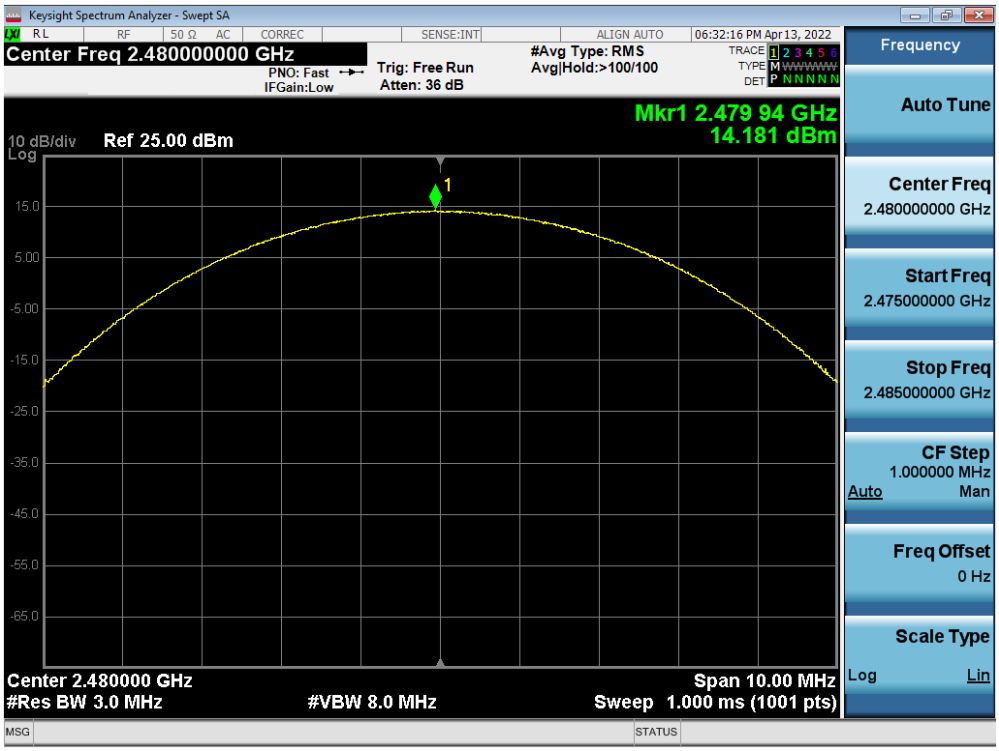


Plot 7-44. Peak Conducted Power (3Mbps – Ch. 39) – Ant 2



Plot 7-45. Peak Conducted Power (3Mbps – Ch. 78) – Ant 2

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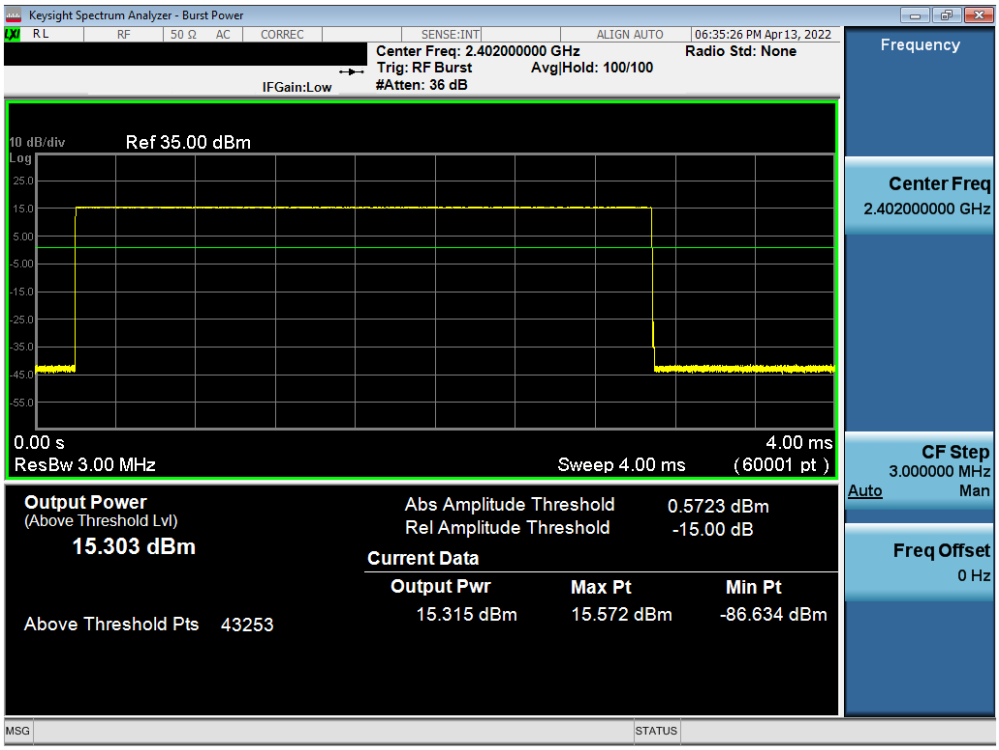

Plot 7-46. Average Conducted Power (1Mbps – Ch. 0) – Ant 2

Plot 7-47. Average Conducted Power (1Mbps – Ch. 39) – Ant 2

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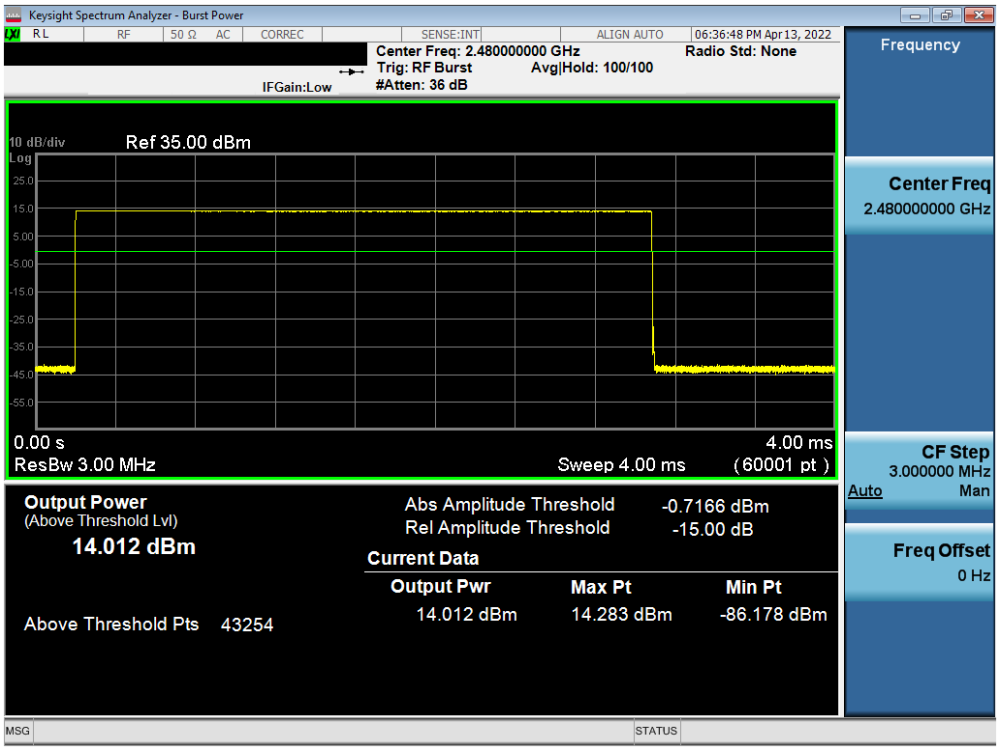
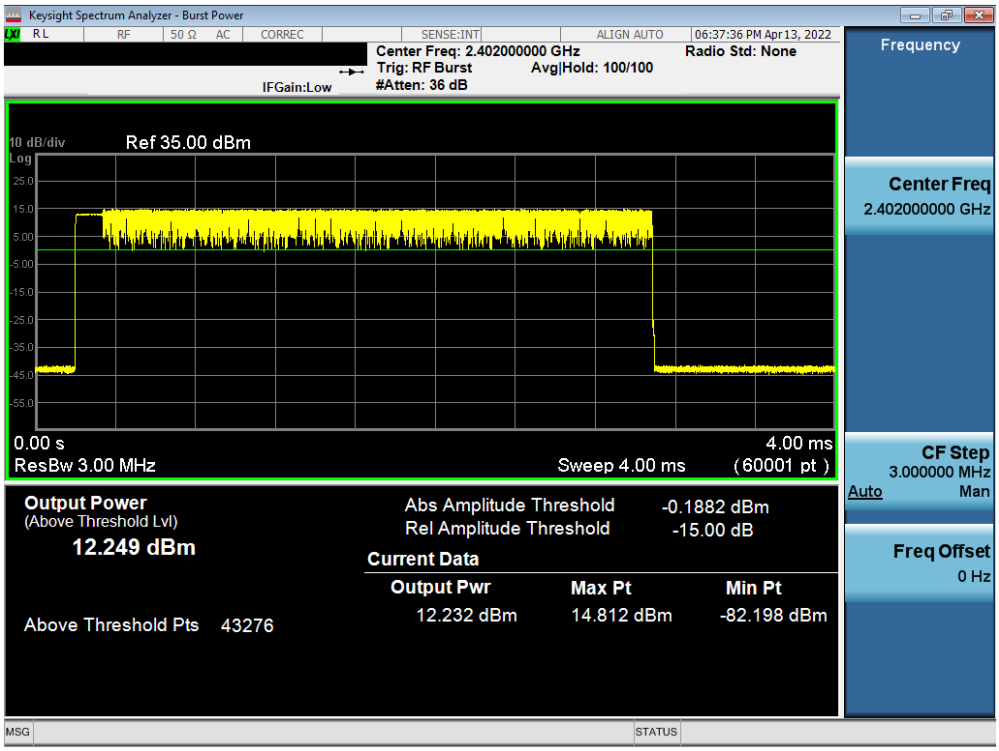


Plot 7-48. Average Conducted Power (1Mbps – Ch. 78) – Ant 2



Plot 7-49. Average Conducted Power (2Mbps – Ch. 0) – Ant 2

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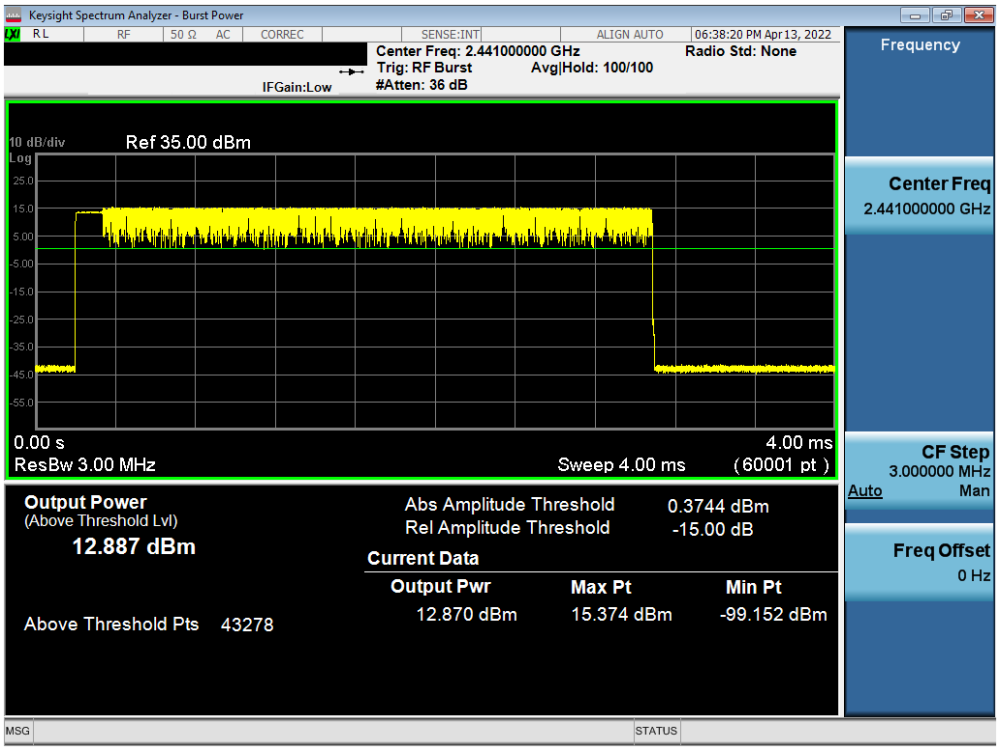
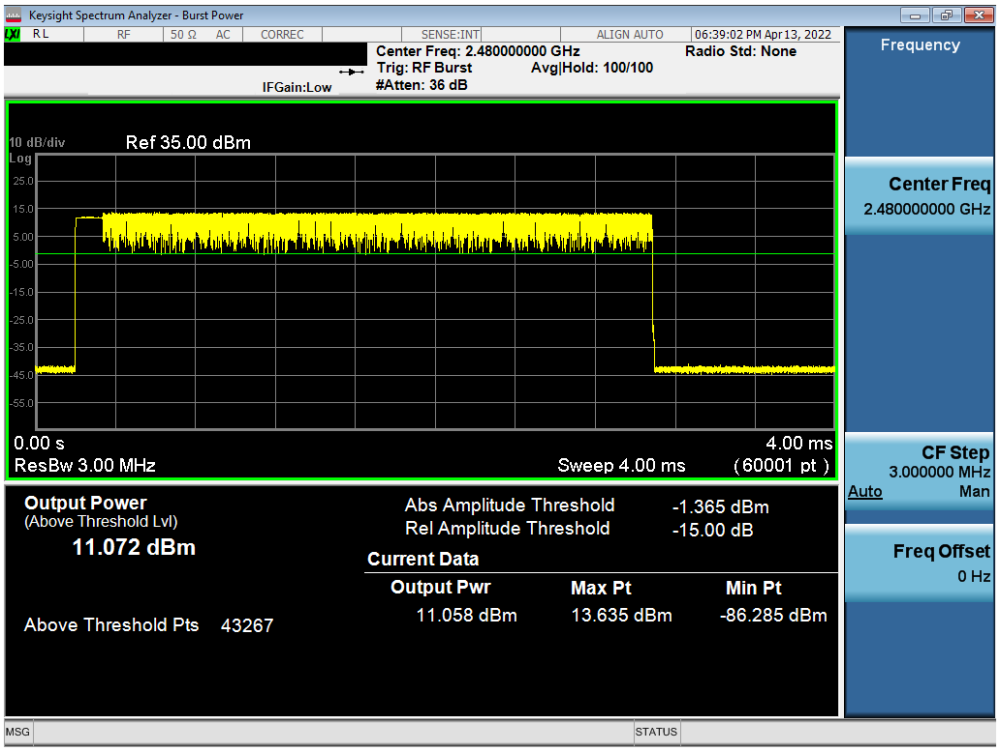


Plot 7-50. Average Conducted Power (2Mbps – Ch. 39) – Ant 2



Plot 7-51. Average Conducted Power (2Mbps – Ch. 78) – Ant 2

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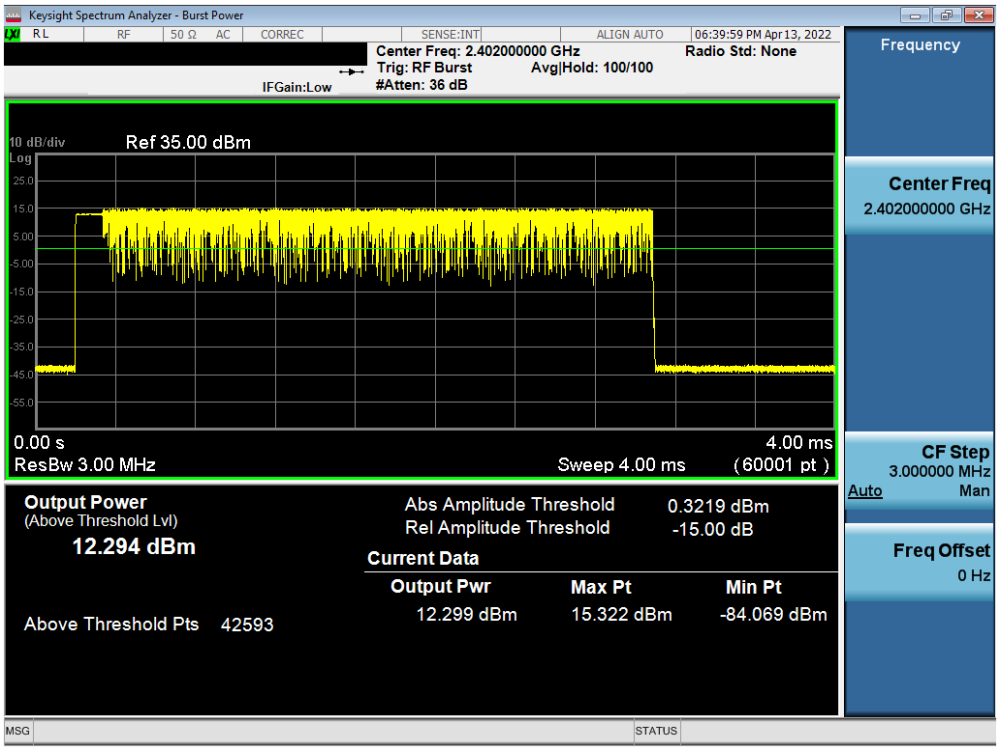
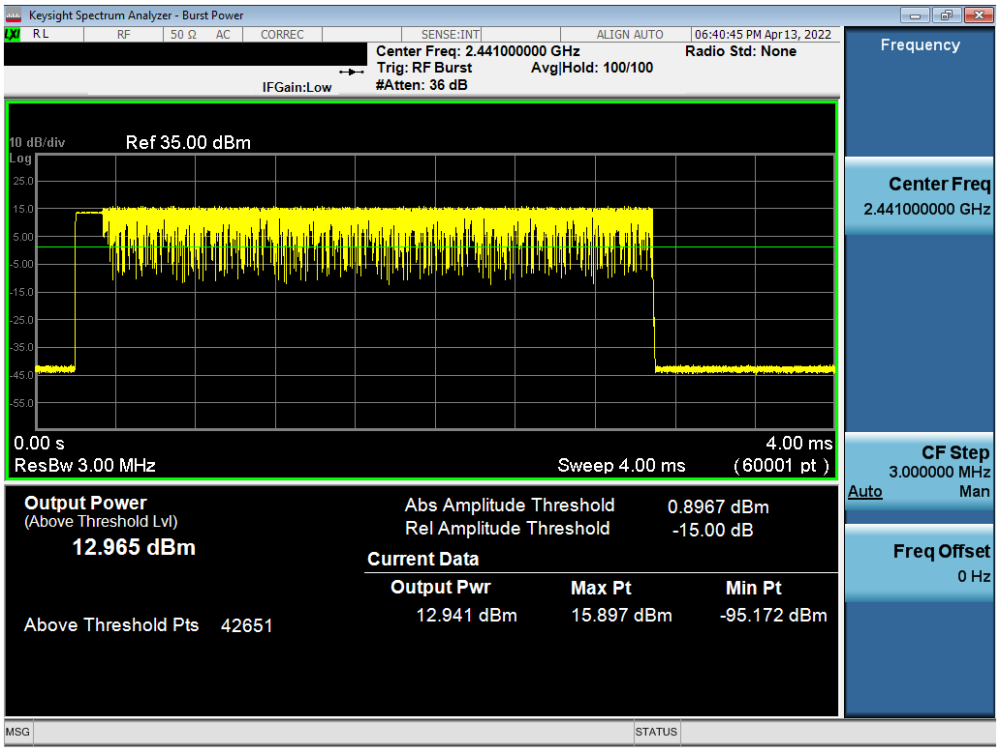


Plot 7-52. Average Conducted Power (3Mbps – Ch. 0) – Ant 2



Plot 7-53. Average Conducted Power (3Mbps – Ch. 39) – Ant 2

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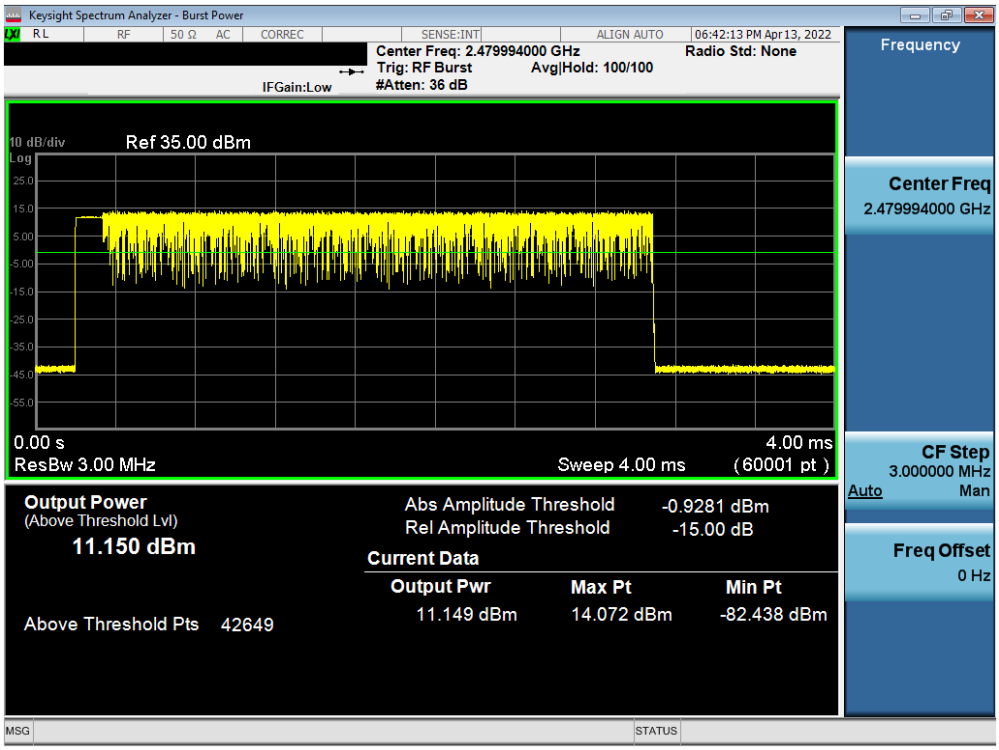

Plot 7-54. Average Conducted Power (3Mbps – Ch. 78) – Ant 2

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7.4 Band Edge Compliance

§15.247 (d); RSS-247 [5.5]

Test Overview and Limits

EUT operates in hopping and non-hopping transmission mode. Measurement is taken at the highest point located outside of the emission bandwidth. ***The maximum permissible out-of-band emission level is 20 dBc.***

Test Procedure Used

ANSI C63.10-2013 – Section 6.10.4

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 7-3. Test Instrument & Measurement Setup

Test Notes

Out of band conducted spurious emissions at the band edge were investigated for all data rates in hopping and non-hopping modes. The worst case emissions were found with the EUT transmitting at 3 Mbps. Band edge emissions were also investigated with the EUT transmitting in all data rates. Plots of the worst case emissions are shown below.

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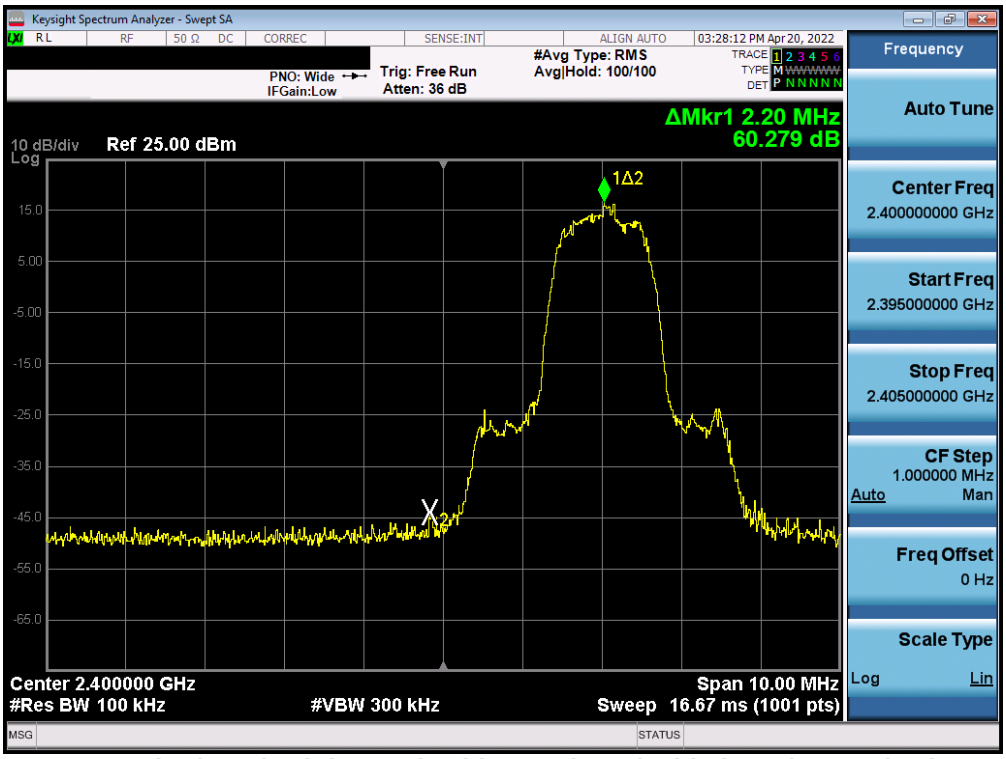
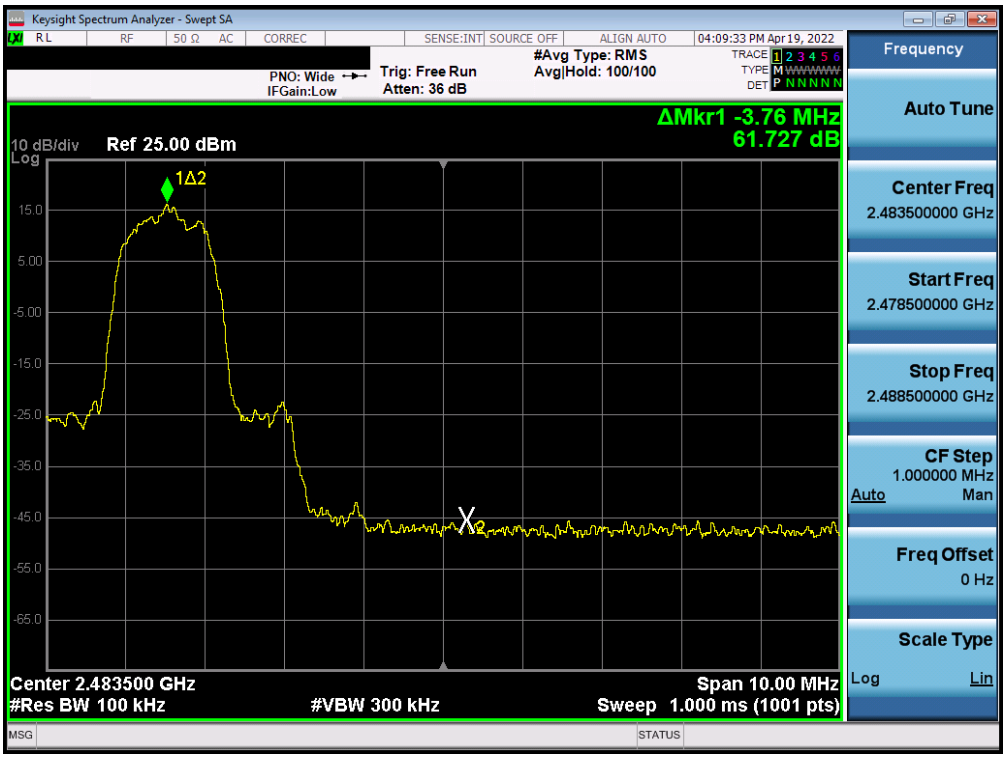


Plot 7-55. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 0) – Ant 1



Plot 7-56. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 78) – Ant 1

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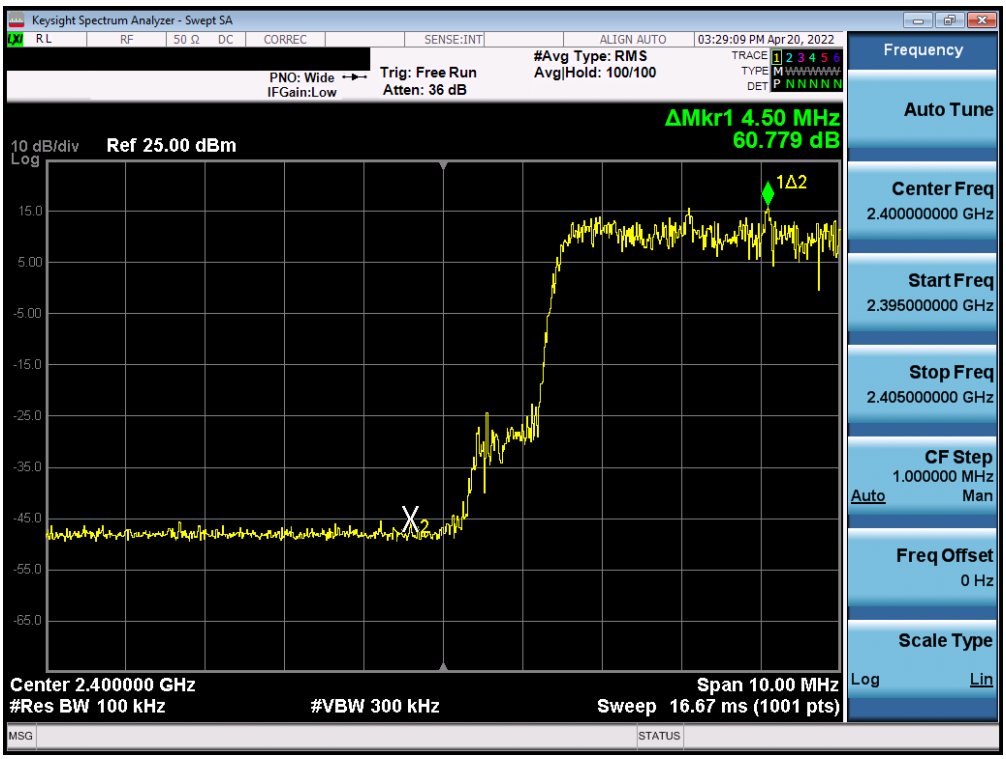
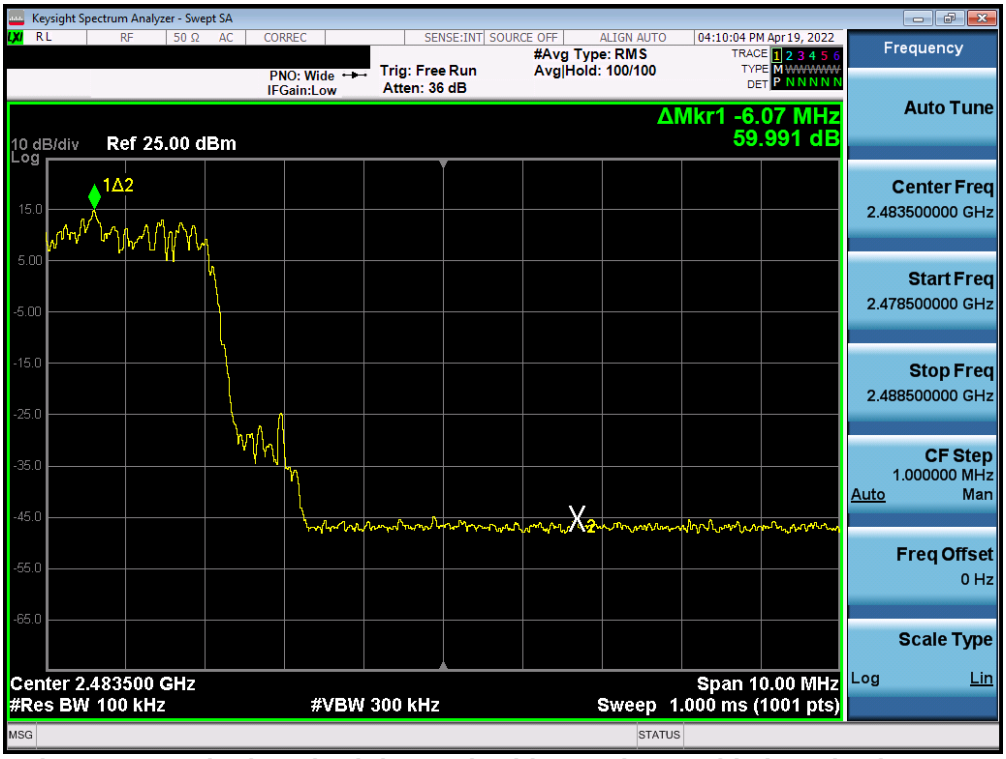


Plot 7-57. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps) – Ant 1



Plot 7-58. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps) – Ant 1

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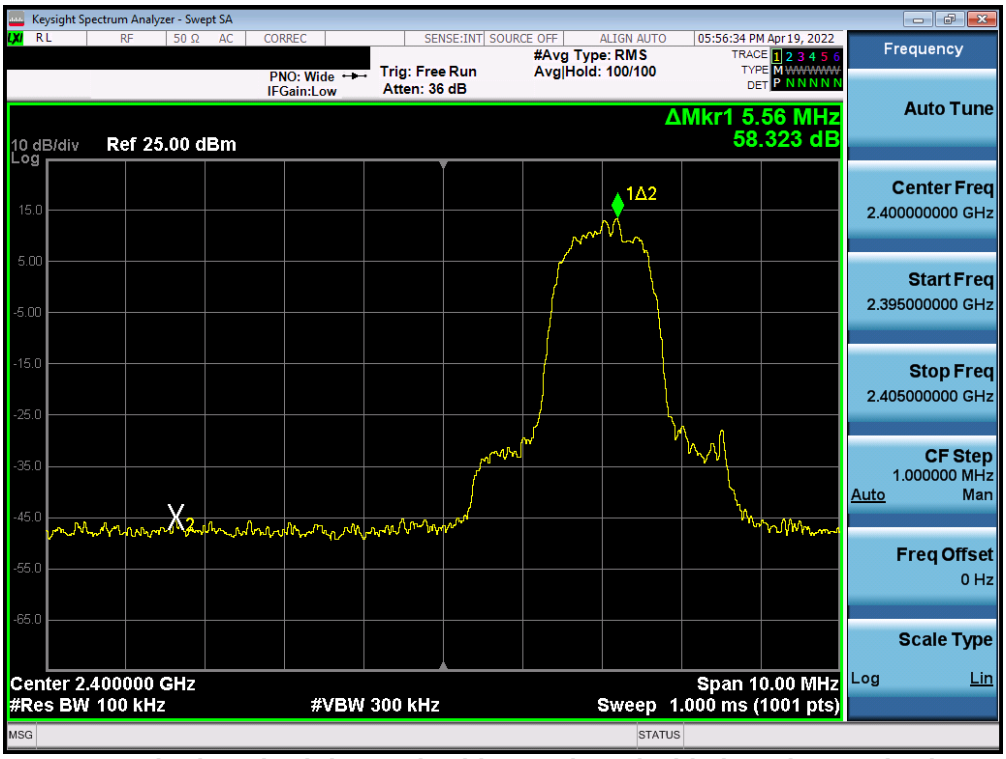
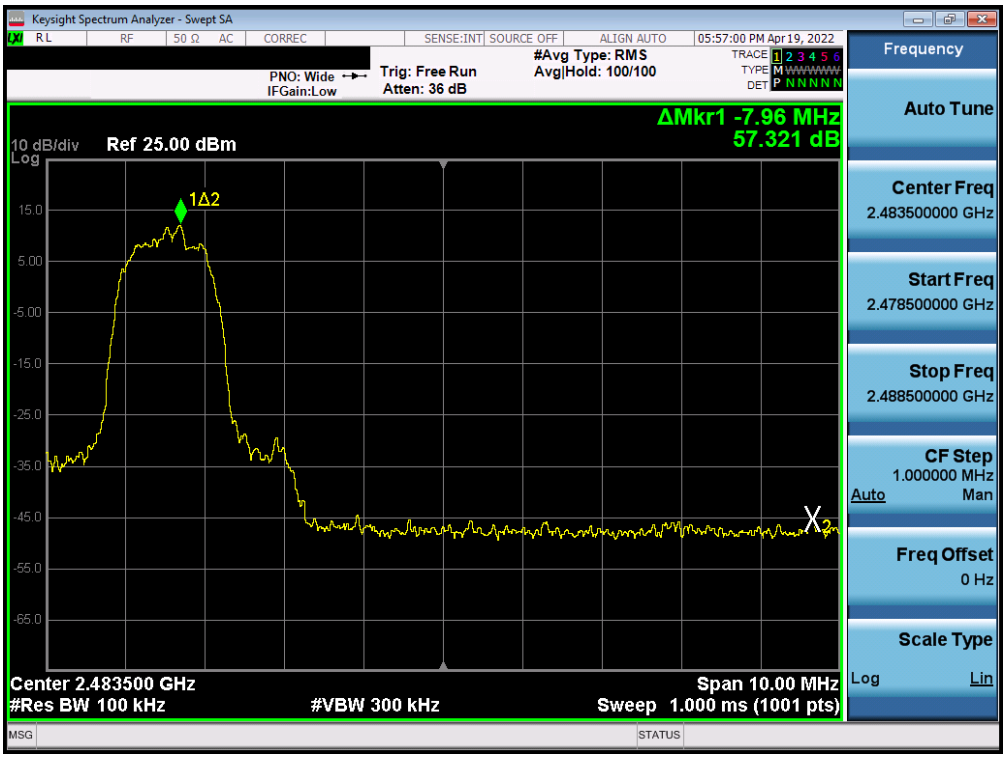


Plot 7-59. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 0) – Ant 2



Plot 7-60. Band Edge Plot (Bluetooth with Hopping Disabled, 3 Mbps – Ch. 78) – Ant 2

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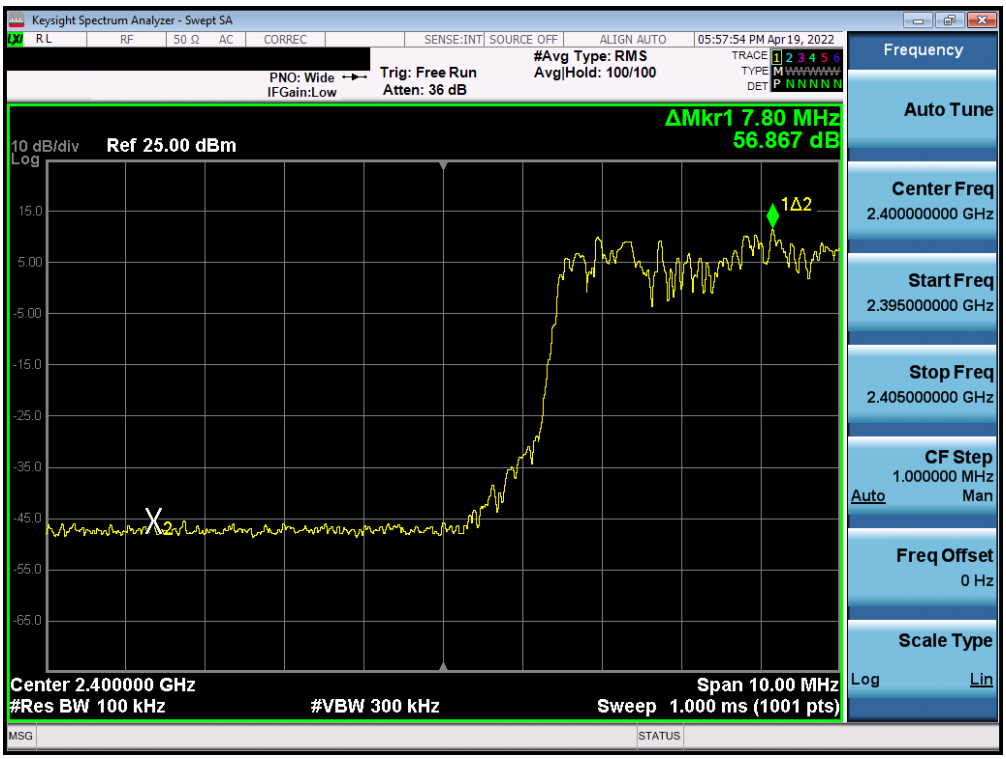
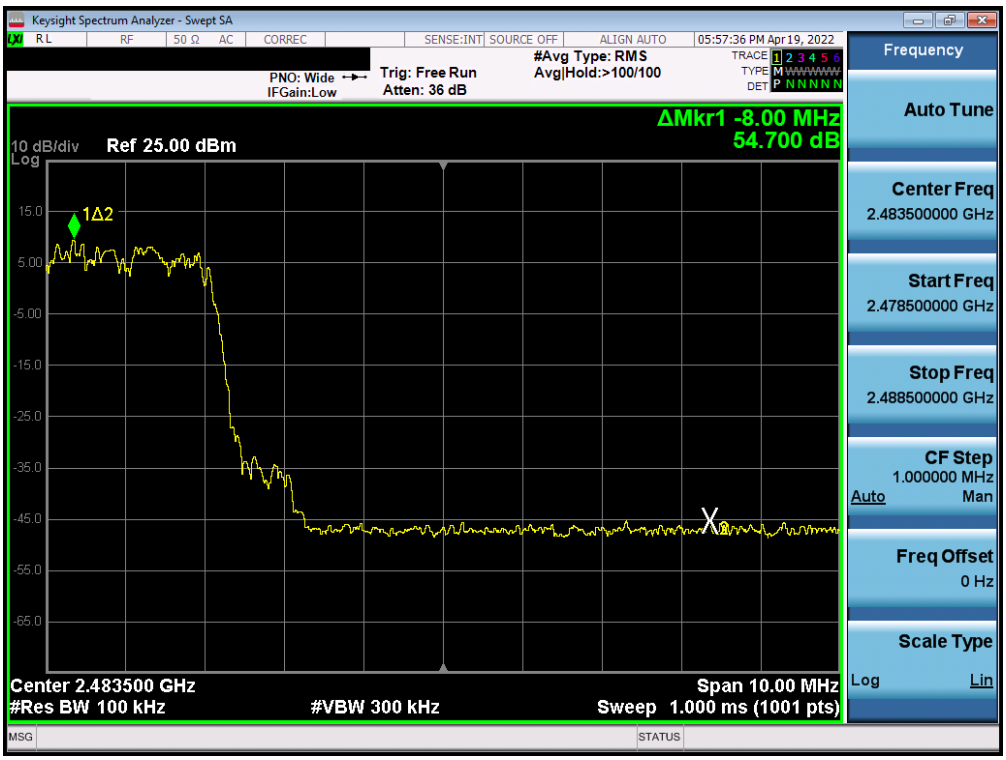


Plot 7-61. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps) – Ant 2



Plot 7-62. Band Edge Plot (Bluetooth with Hopping Enabled, 3 Mbps) – Ant 2

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7.5 Carrier Frequency Separation

§15.247 (a.1); RSS-247 [5.1(2)]

Test Overview and Limit

Measurement is made with EUT operating in hopping mode. ***The minimum permissible channel separation for this system is 2/3 the value of the 20dB BW.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.2

Test Settings

1. Span = Wide enough to capture peaks of two adjacent channels
2. RBW = 30% of channel spacing. Adjust as necessary to best identify center of each individual channel
3. VBW ≥ RBW
4. Sweep = Auto
5. Detector = Peak
6. Trace mode = max hold
7. The trace was allowed to stabilize.
8. Marker-delta function used to determine separation between peaks of the adjacent channels

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

The EUT complies with the minimum channel separation requirement when it is operating in 1x/EDR mode using 79 channels and when operating in AFH mode using 20 channels.

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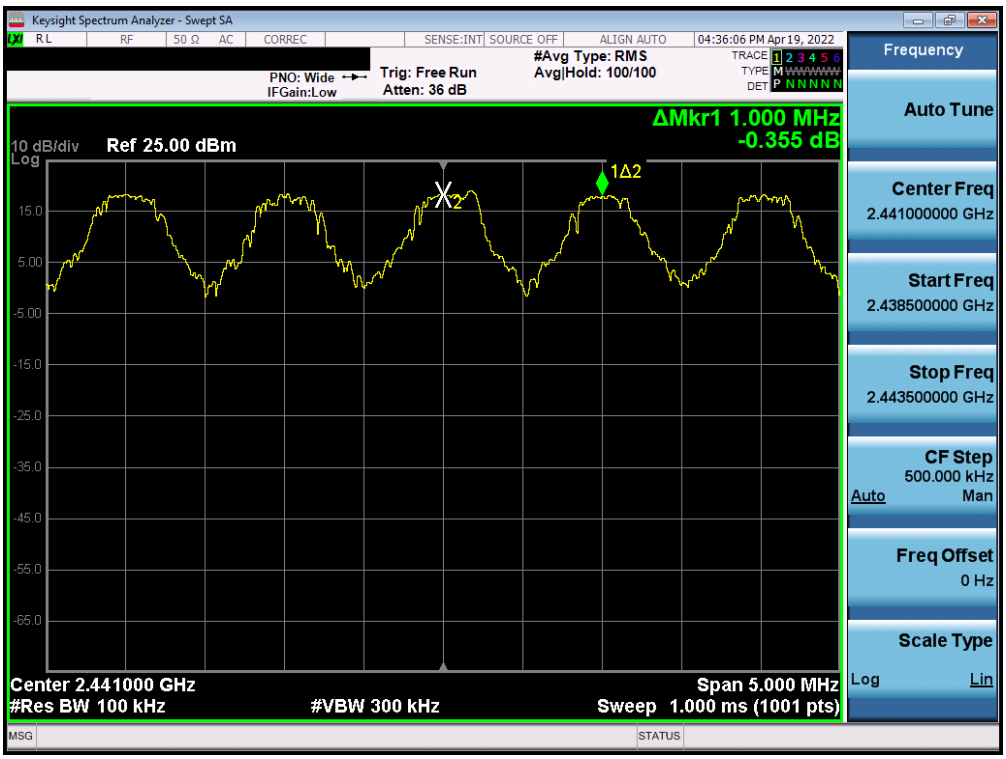
Frequency [MHz]	Data Rate [Mbps]	Mod.	Channel No.	Min. Channel Separation [MHz]
2402	1.0	GFSK	0	0.592
2441	1.0	GFSK	39	0.619
2480	1.0	GFSK	78	0.612
2402	2.0	π/4-DQPSK	0	0.876
2441	2.0	π/4-DQPSK	39	0.879
2480	2.0	π/4-DQPSK	78	0.813
2402	3.0	8DPSK	0	0.864
2441	3.0	8DPSK	39	0.812
2480	3.0	8DPSK	78	0.863

Table 7-6. Minimum Channel Separation – Ant 1



Plot 7-63. Channel Spacing Plot (Bluetooth) – Ant 1

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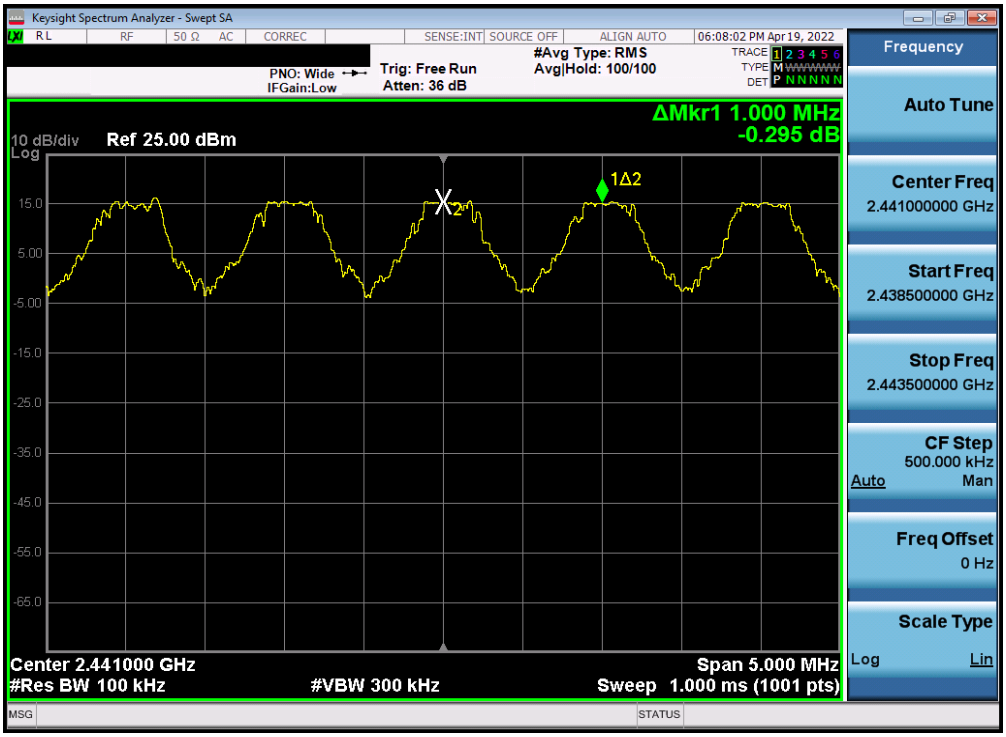
Frequency [MHz]	Data Rate [Mbps]	Mod.	Channel No.	Min. Channel Separation [MHz]
2402	1.0	GFSK	0	0.615
2441	1.0	GFSK	39	0.571
2480	1.0	GFSK	78	0.578
2402	2.0	π/4-DQPSK	0	0.891
2441	2.0	π/4-DQPSK	39	0.887
2480	2.0	π/4-DQPSK	78	0.872
2402	3.0	8DPSK	0	0.866
2441	3.0	8DPSK	39	0.907
2480	3.0	8DPSK	78	0.897

Table 7-7. Minimum Channel Separation – Ant 2



Plot 7-64. Channel Spacing Plot (Bluetooth) – Ant 2

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7.6 Time of Occupancy

§15.247 (a.1.iii); RSS-247 [5.1(4)]

Test Overview and Limit

Measurement is made while EUT is operating in hopping mode with the spectrum analyzer set to zero span. ***The maximum permissible time of occupancy is 400 ms within a period of 400ms multiplied by the number of hopping channels employed.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.4

Test Settings

1. Span = zero span, centered on a hopping channel
2. RBW ≤ channel spacing and >> 1/T, where T is expected dwell time per channel
3. Sweep = as necessary to capture entire dwell time. Second plot may be required to demonstrate two successive hops on a channel
4. Trigger is set with appropriate trigger delay to place pulse near the center of the plot
5. Detector = peak
6. Trace mode = max hold
7. Marker-delta function used to determine transmit time per hop

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

None

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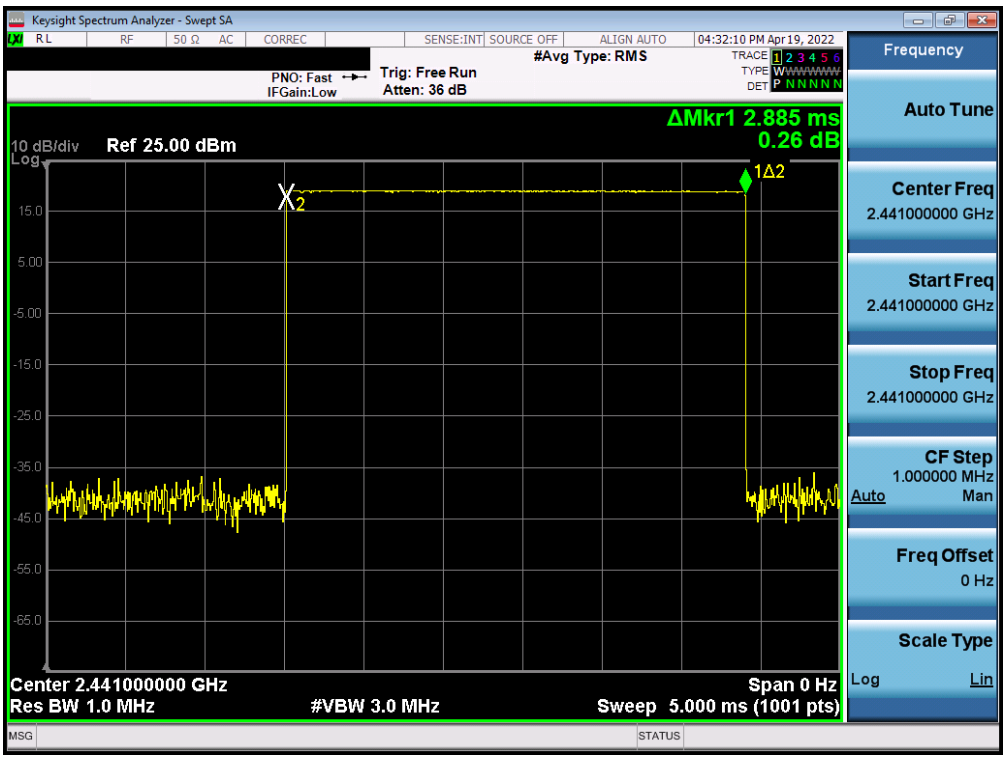

Plot 7-65. Time of Occupancy Plot (Bluetooth) – Ant 1

Bluetooth Time of Occupancy Calculation

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s. Since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of 1600 / 6 = 266.67 hops/s/slot

- 400ms x 79 hopping channels = 31.6 sec (Time of Occupancy Limit)
- Worst case BT has 266.67 hops/second (for 1x/EDR modes with DH5 operation)
- 266.67 hops/second / 79 channels = 3.38 hops/second (# of hops/second on one channel)
- 3.38 hops/second/channel x 31.6 seconds = 106.67 hops (# hops over a 31.6 second period)
- 106.67 hops x 2.885 ms/channel = 307.74 ms (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800 hops/s. AFH mode also uses 6 total slots so the Bluetooth transmitter hops at a rate of 800 / 6 = 133.3 hops/s/slot

- 400ms x 20 hopping channels = 8 sec (Time of Occupancy Limit)
- Worst case BT has 133.3 hops/second/slot (for AFH mode with DH5 operation)
- 133.3 hops/s / 20 channels = 6.67 hops/second (# of hops/second on one channel)
- 6.67 hops/s / channel x 8 seconds = 53.34 hops (# hops over a 8 second period)
- 53.34 hops x 2.885 ms/channel = 153.89 ms (worst case dwell time for one channel in AFH mode)

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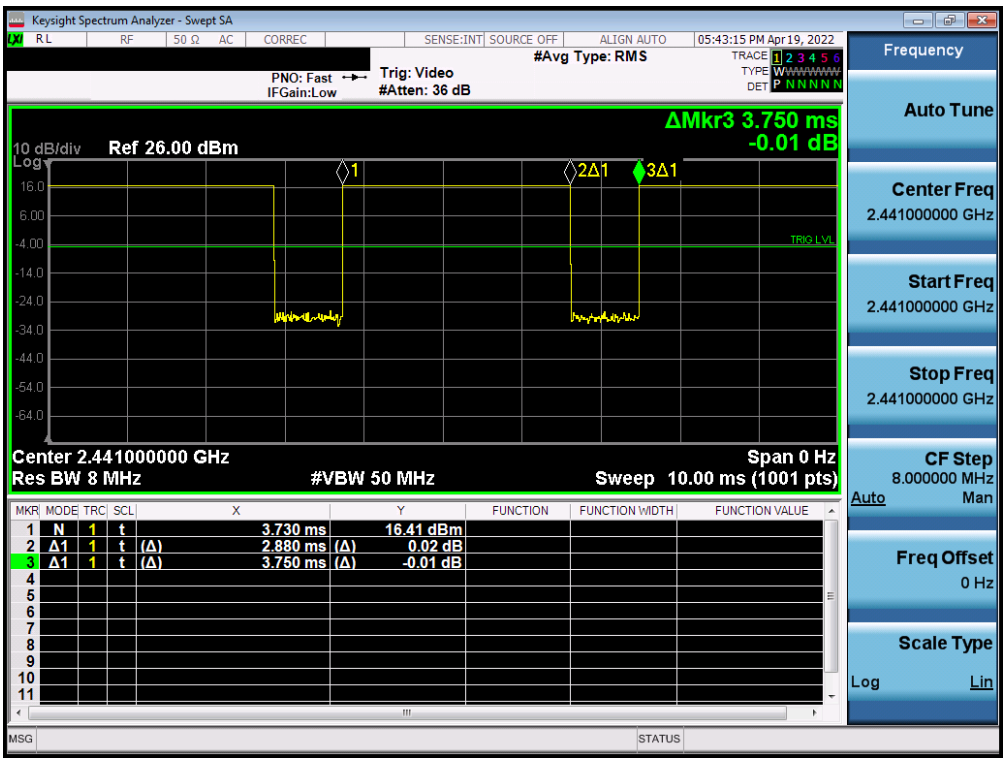

Plot 7-66. Time of Occupancy Plot (Bluetooth) – Ant 2

Bluetooth Time of Occupancy Calculation

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s. Since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of 1600 / 6 = 266.67 hops/s/slot

- 400ms x 79 hopping channels = 31.6 sec (Time of Occupancy Limit)
- Worst case BT has 266.67 hops/second (for 1x/EDR modes with DH5 operation)
- 266.67 hops/second / 79 channels = 3.38 hops/second (# of hops/second on one channel)
- 3.38 hops/second/channel x 31.6 seconds = 106.67 hops (# hops over a 31.6 second period)
- 106.67 hops x 3.750 ms/channel = 400.01 ms (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800 hops/s. AFH mode also uses 6 total slots so the Bluetooth transmitter hops at a rate of 800 / 6 = 133.3 hops/s/slot

- 400ms x 20 hopping channels = 8 sec (Time of Occupancy Limit)
- Worst case BT has 133.3 hops/second/slot (for AFH mode with DH5 operation)
- 133.3 hops/s / 20 channels = 6.67 hops/second (# of hops/second on one channel)
- 6.67 hops/s / channel x 8 seconds = 53.34 hops (# hops over a 8 second period)
- 53.34 hops x 3.750 ms/channel = 200.025 ms (worst case dwell time for one channel in AFH mode)

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7.7 Number of Hopping Channels

§15.247 (a.1.iii); RSS-247 [5.1(4)]

Test Overview and Limit

Measurement is made while EUT is operating in hopping mode. ***This frequency hopping system must employ a minimum of 15 hopping channels.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.3

Test Settings

1. Span = frequency of band of operation (divided into two plots)
2. RBW < 30% of channel spacing or 20dB bandwidth, whichever is smaller
3. VBW ≥ RBW
4. Sweep = auto
5. Detector = peak
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

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

Figure 7-6. Test Instrument & Measurement Setup

Test Notes

The frequency spectrum was broken up into two sub-ranges to clearly show all the hopping frequencies. In AFH mode, this device operates using 20 channels so the requirement for minimum number of hopping channels is satisfied.

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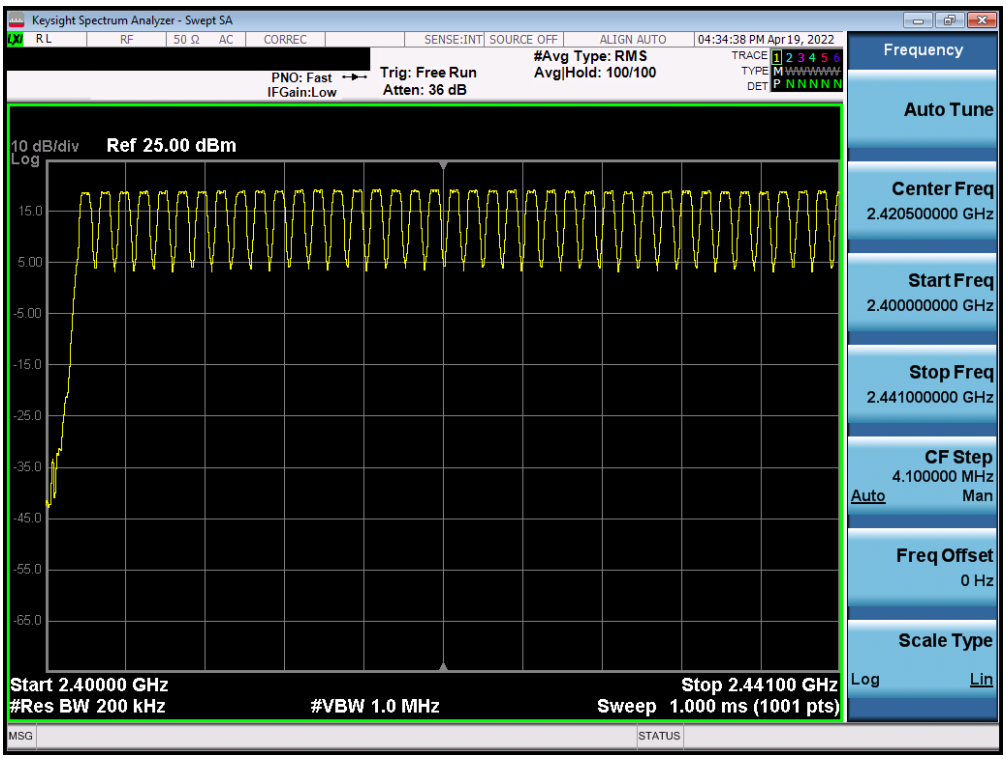
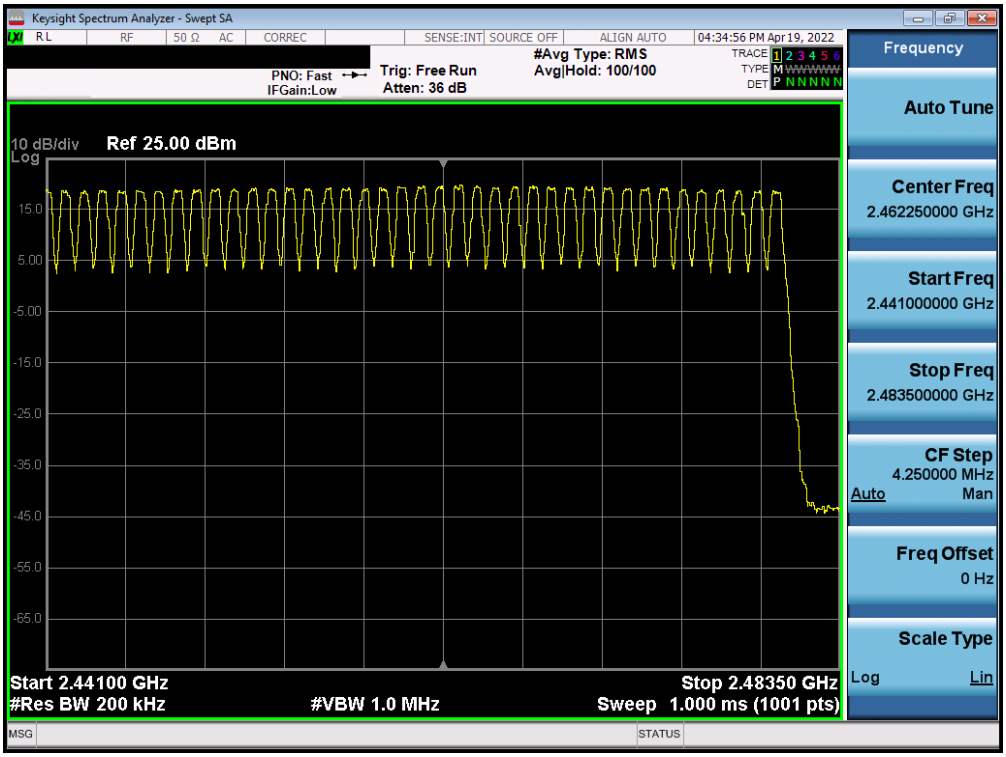


Plot 7-67. Low End Spectrum Channel Hopping Plot (Bluetooth) – Ant 1



Plot 7-68. High End Spectrum Channel Hopping Plot (Bluetooth) – Ant 1

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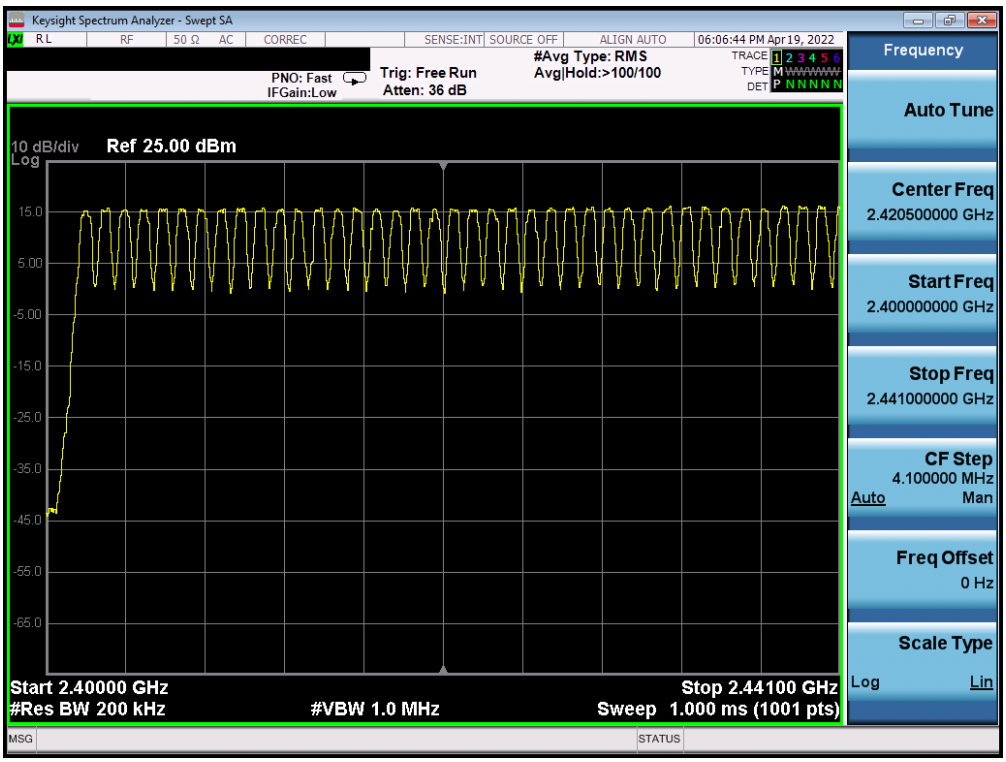
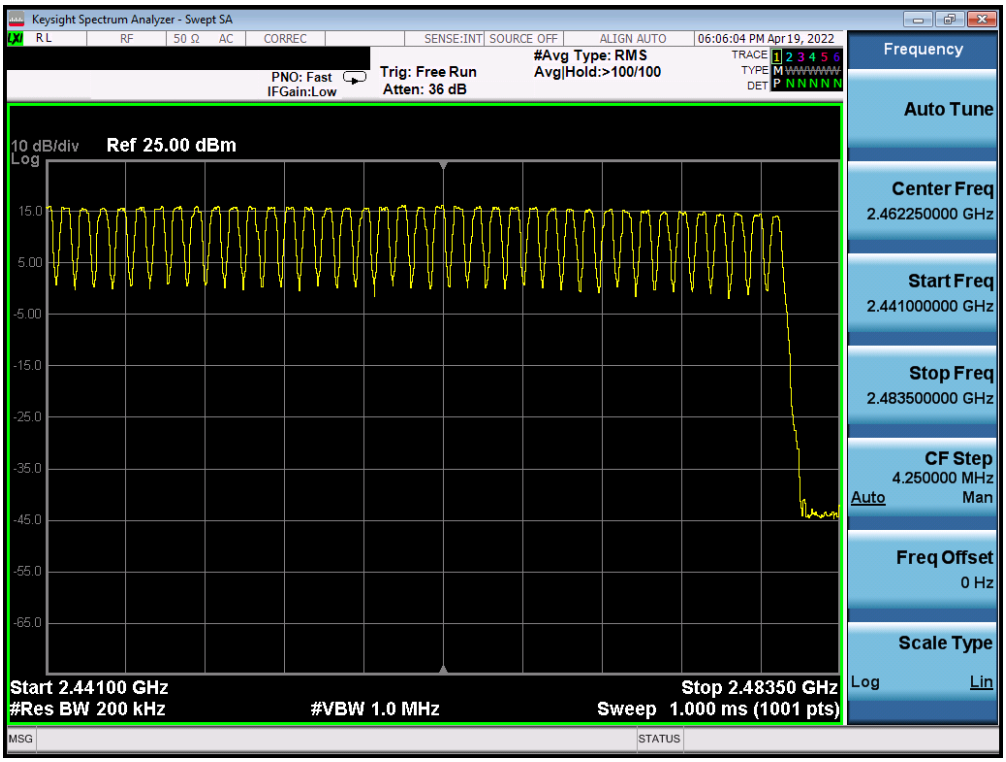


Plot 7-69. Low End Spectrum Channel Hopping Plot (Bluetooth) – Ant 2



Plot 7-70. High End Spectrum Channel Hopping Plot (Bluetooth) – Ant 2

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7.8 Conducted Spurious Emissions

§15.247 (d); RSS-247 [5.5]

Test Overview and Limit

Conducted out-of-band spurious emissions were investigated from 30MHz up to 25GHz to include the 10th harmonic of the fundamental transmit frequency. ***The maximum permissible out-of-band emission level is 20 dBc.***

Test Procedure Used

ANSI C63.10-2013 – Section 7.8.8

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* (See note below)
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 7-7. Test Instrument & Measurement Setup

Test Notes

Out-of-band conducted spurious emissions were investigated for all data rates and the worst-case emissions were found with the EUT transmitting at 1 Mbps. The display line shown in the following plots is the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, the traces in the following plots are measured with a 1MHz RBW to reduce test time, so the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

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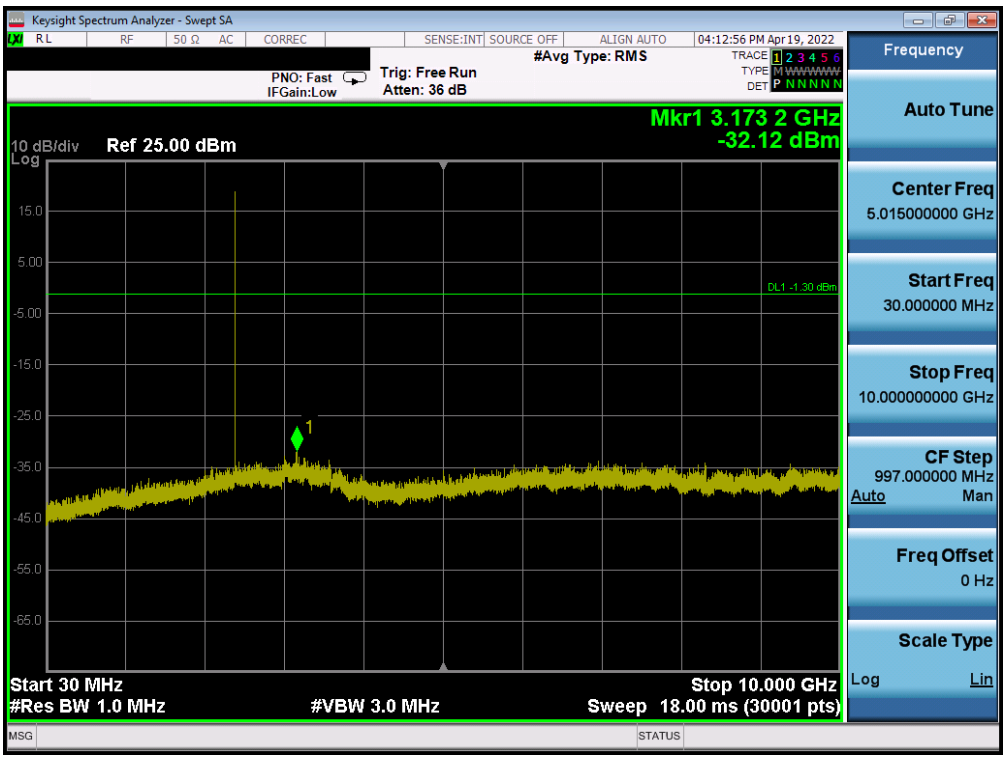
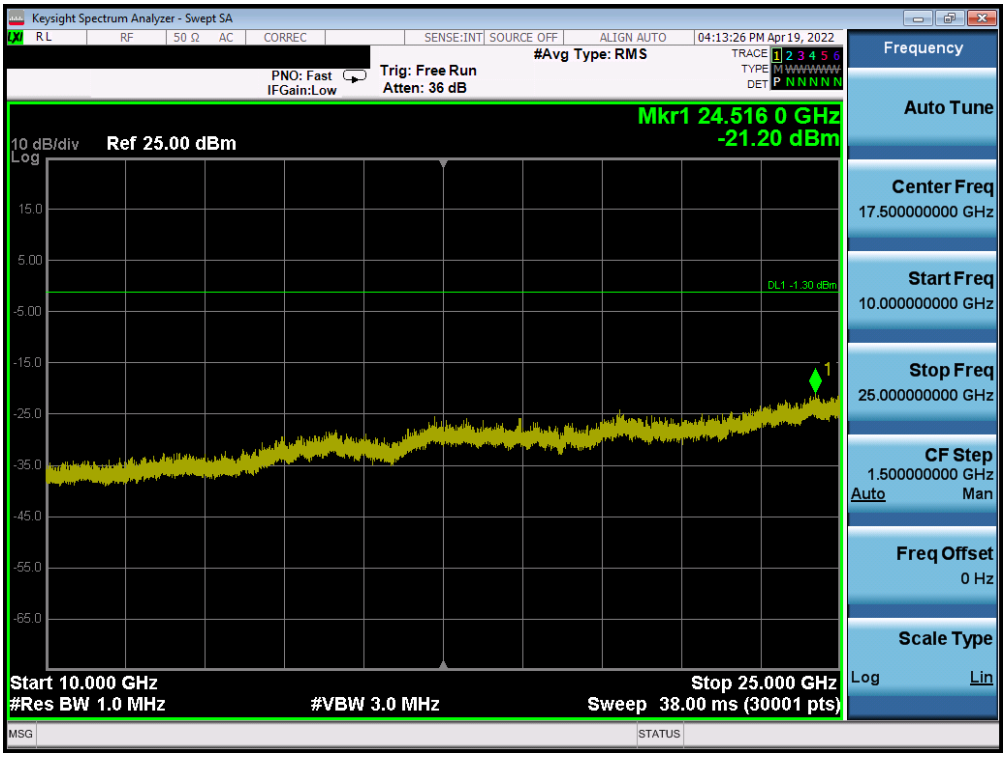


Plot 7-71. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0) – Ant 1



Plot 7-72. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0) – Ant 1

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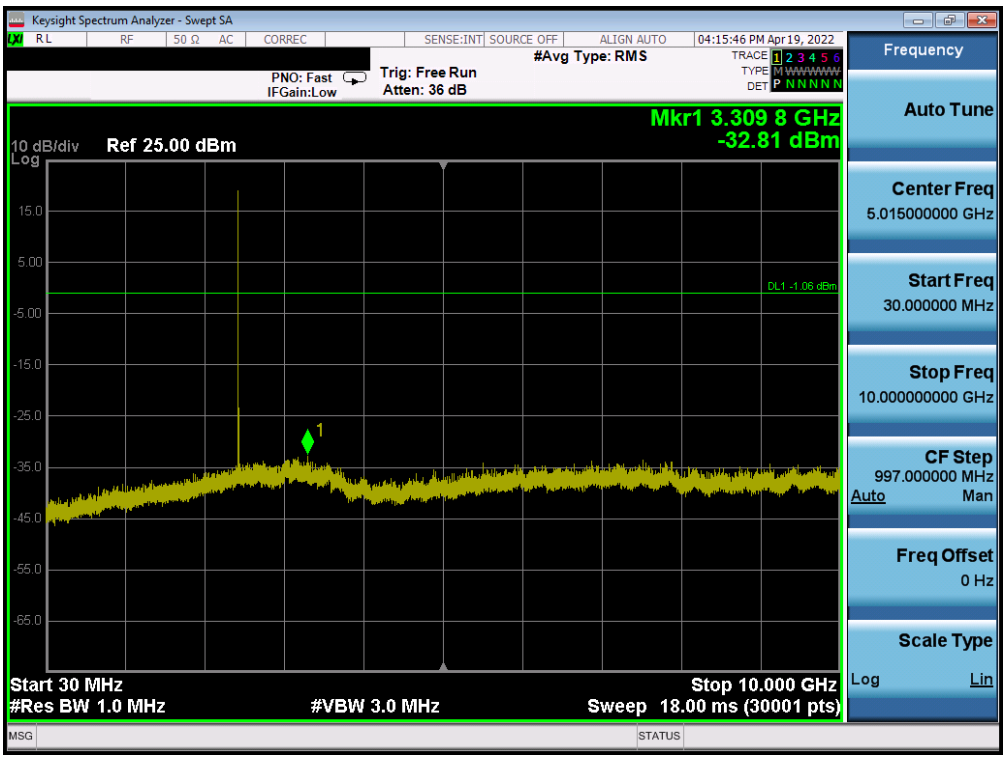
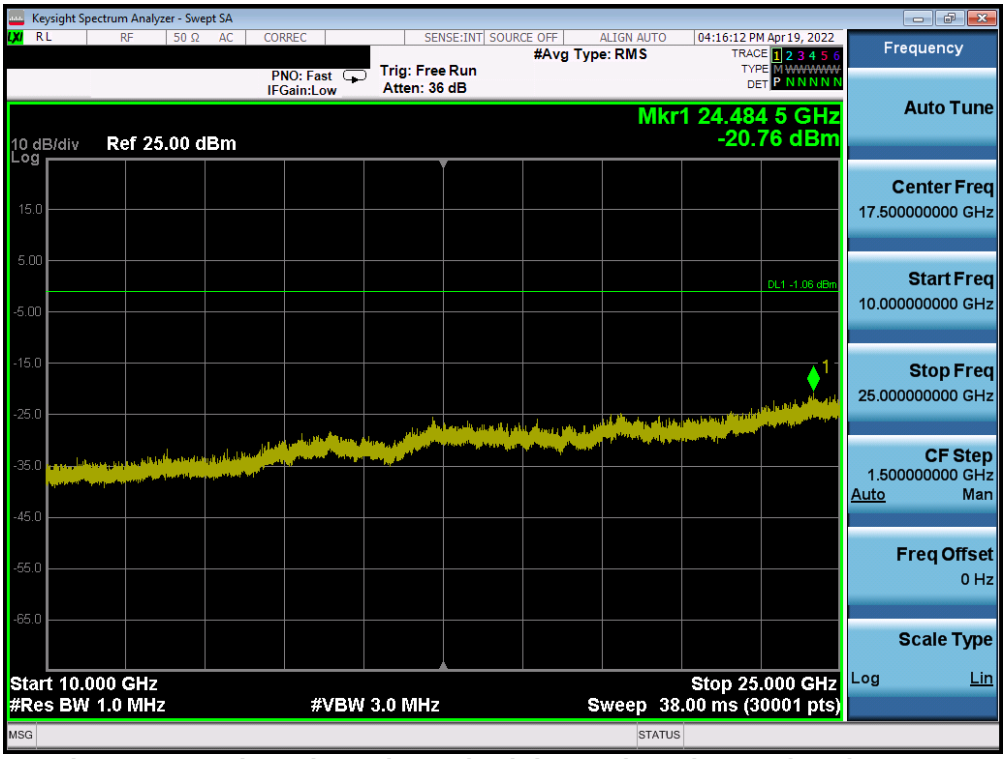


Plot 7-73. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39) – Ant 1



Plot 7-74. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39) – Ant 1

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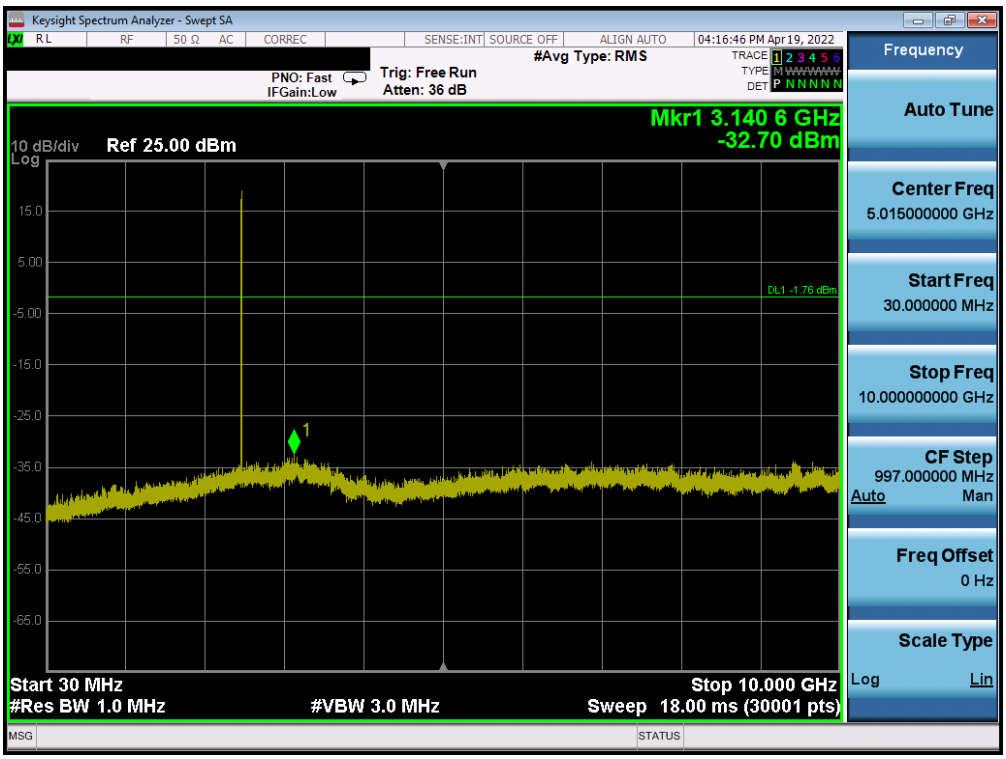

Plot 7-75. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78) – Ant 1

Plot 7-76. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78) – Ant 1

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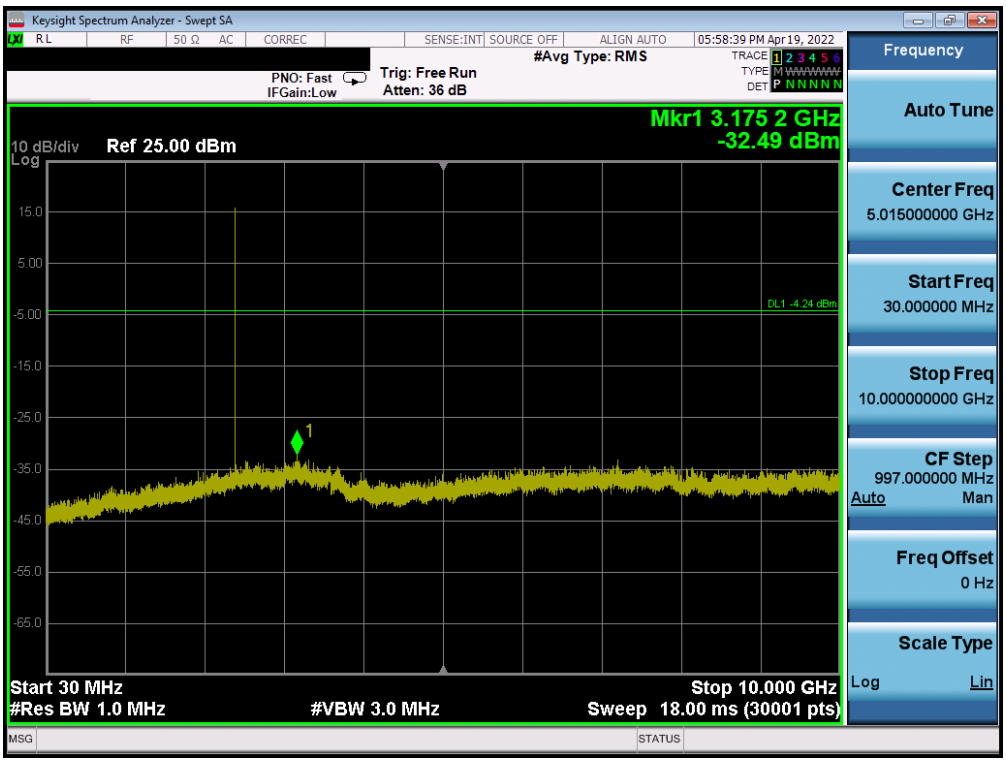
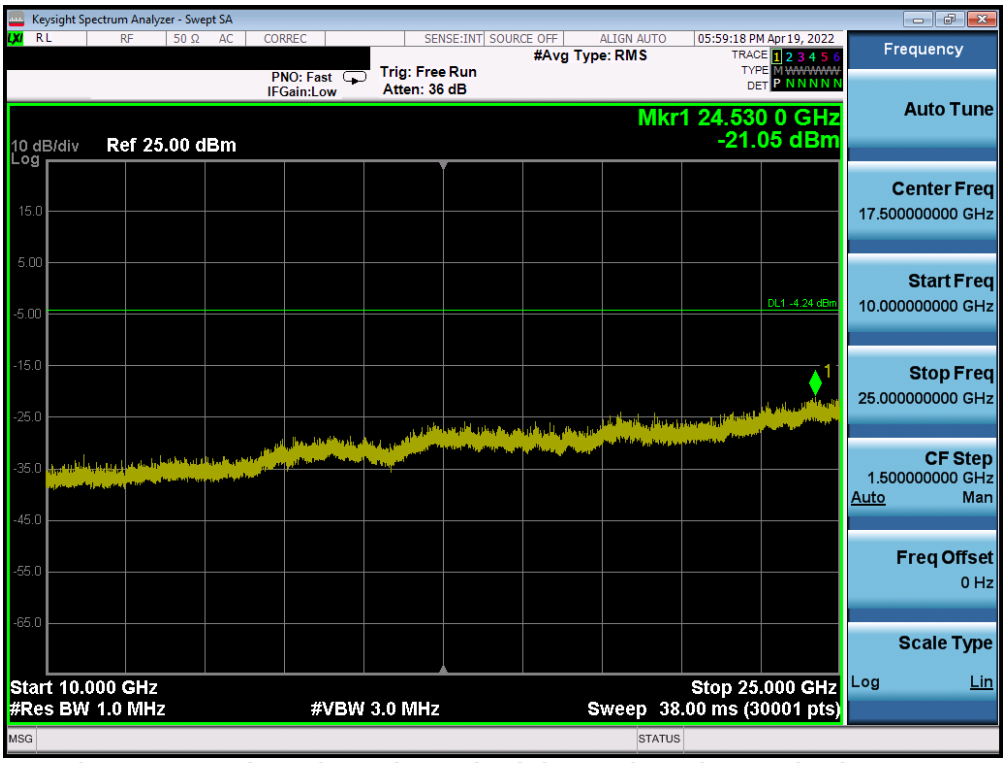


Plot 7-77. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0) – Ant 2



Plot 7-78. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 0) – Ant 2

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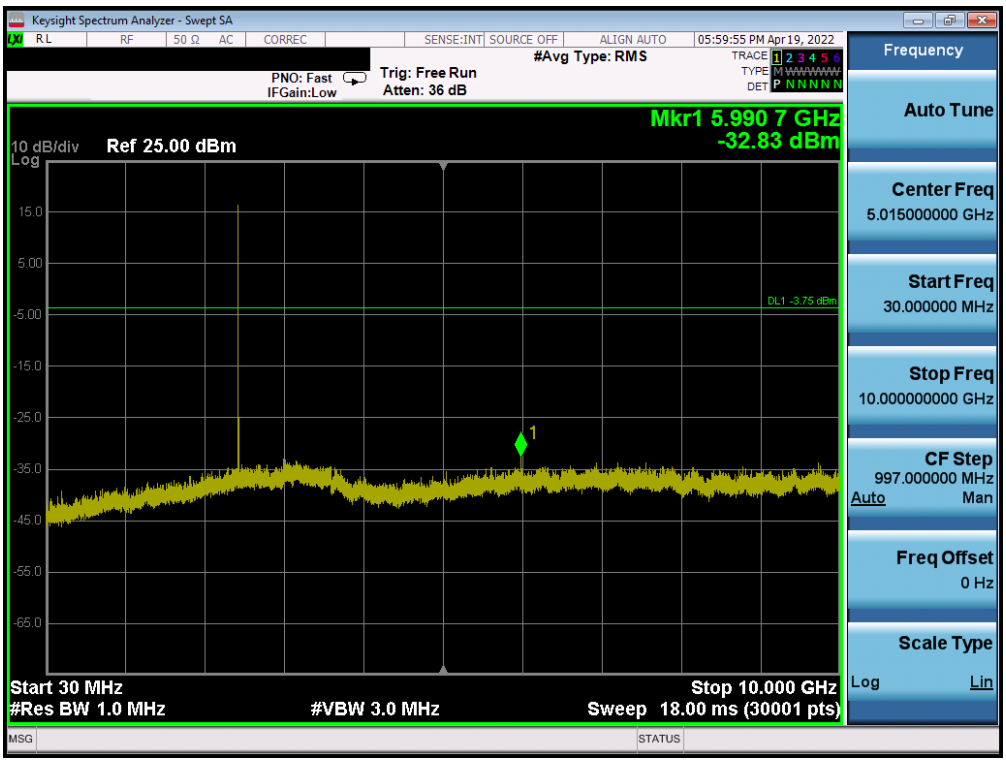

Plot 7-79. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39) – Ant 2

Plot 7-80. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 39) – Ant 2

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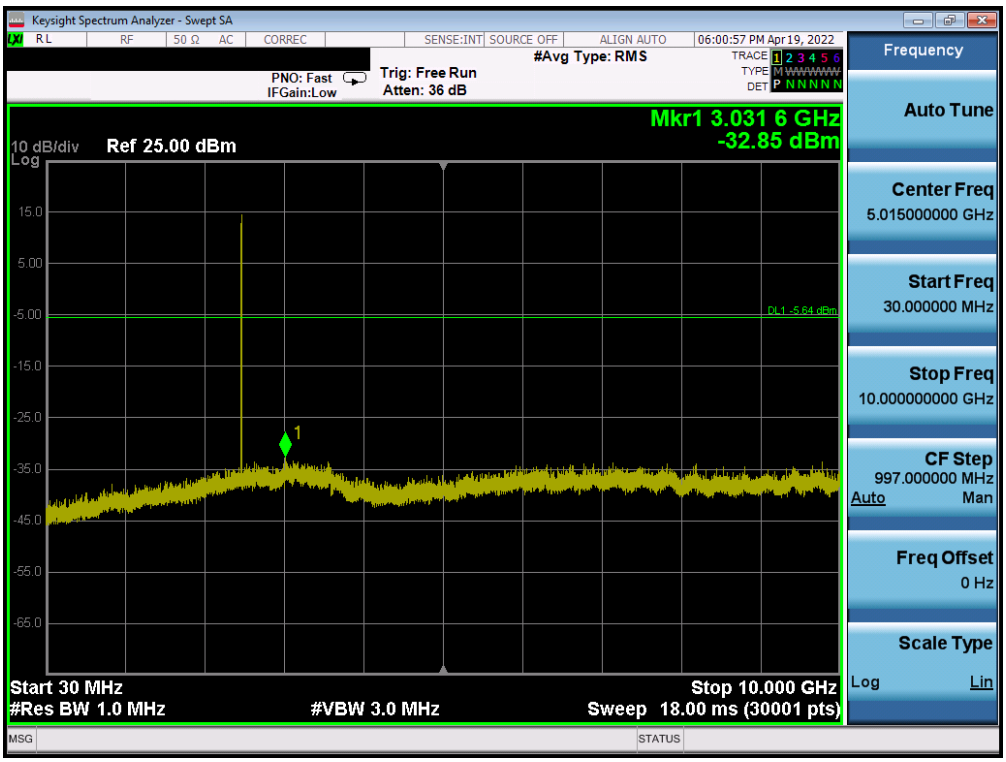
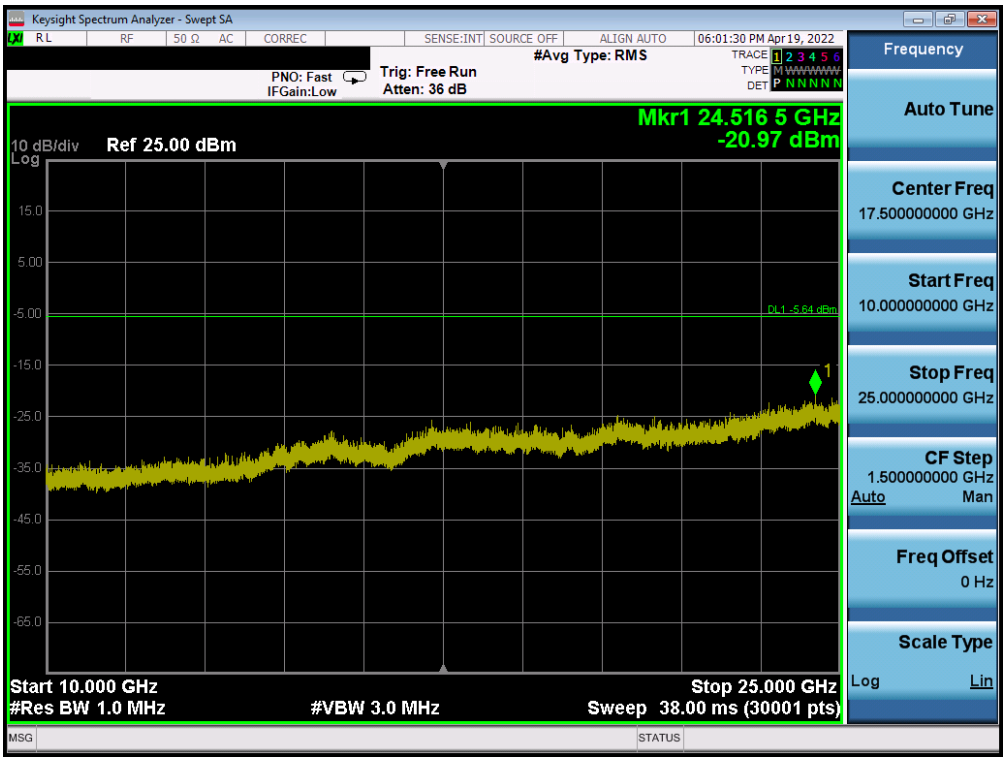


Plot 7-81. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78) – Ant 2



Plot 7-82. Conducted Spurious Plot (Bluetooth, 1Mbps – Ch. 78) – Ant 2

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7.9 Radiated Spurious Emission Measurements – Above 1GHz

§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst-case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown below per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [μV/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-8. Radiated Limits

Test Procedure Used

ANSI C63.10-2013 – Section 6.6.4.3

Test Settings

Average Field Strength Measurements per Section 4.1.4.2.3 of ANSI C63.10-2013

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 1kHz $\geq 1/\tau$ Hz, where τ = pulse width in seconds
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to stabilize

Peak Field Strength Measurements per Section 4.1.4.2.2 of ANSI C63.10-2013

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in Table 7-9 below
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

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Frequency	RBW
9 – 150kHz	200 – 300Hz
0.15 – 30MHz	9 – 10kHz
30 – 1000MHz	100 – 120kHz
> 1000MHz	1MHz

Table 7-9. RBW as a Function of Frequency

Test Setup

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

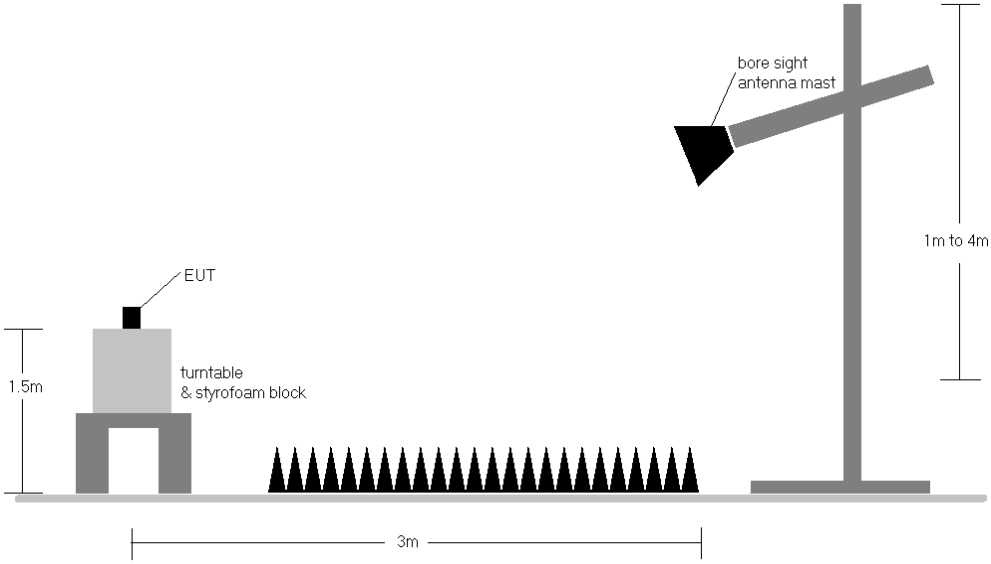

Figure 7-8. Radiated Test Setup >1GHz

Test Notes

2. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in §15.209.
3. No significant radiated emissions were found in the 2310 - 2390MHz restricted band.
4. The antenna is manipulated through typical positions, polarity, and length during the tests. The EUT is manipulated through three orthogonal planes.
5. This unit was tested with its standard battery.
6. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
7. The duty cycle correction factor was not applied to noise floor measurements.
8. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
9. The "-" shown in the following RSE tables is used to denote a noise floor measurement.

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Sample Calculation

- Field Strength Level [dBμV/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m] + Duty Cycle Correction [dB]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
- Margin [dB] = Field Strength Level [dBμV/m] – Limit [dBμV/m]

Duty Cycle Correction Factor Calculation

- Channel hop rate = 800 hops/second (AFH Mode)
- Adjusted channel hop rate for DH5 mode **=** 133.33 hops/second
- Time per channel hop **=** 1 / 133.33 hops/second = 7.50 ms
- Time to cycle through all channels = 7.50 x 20 channels = 150 ms
- Number of times transmitter hits on one channel = 100 ms / 150 ms = 1 time(s)
- Worst case dwell time = 7.5 ms
- Duty cycle correction factor = $20\log_{10}(7.5ms/100ms)$ = -22.5 dB

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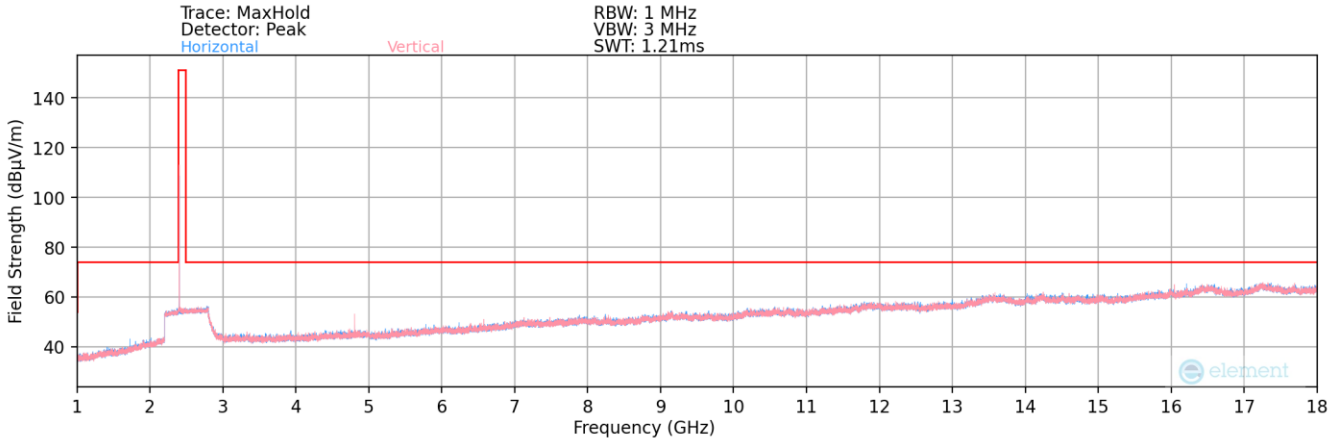
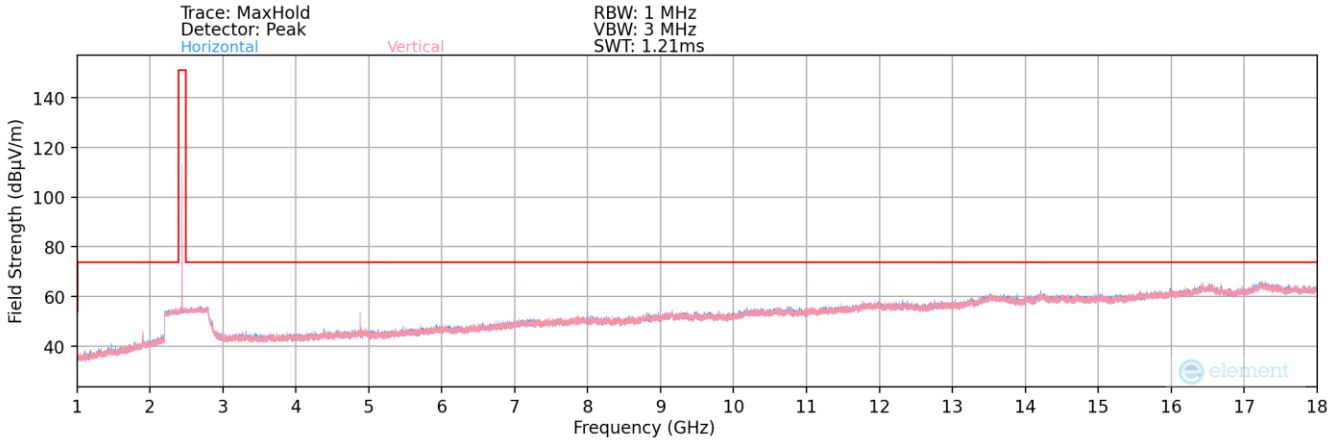
Radiated Spurious Emission Measurements – Ant 1

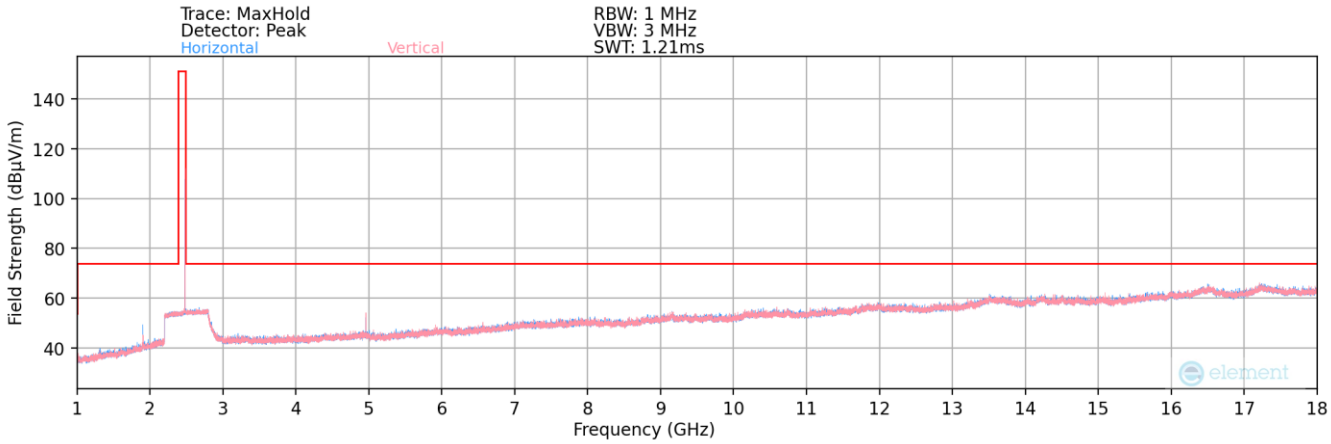
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]



Plot 7-83. Radiated Spurious Plot above 1GHz (BT– Ch. 0) – Ant 1 – HALF Open



Plot 7-84. Radiated Spurious Plot above 1GHz (BT– Ch. 39) – Ant 1 – HALF Open



Plot 7-85. Radiated Spurious Plot above 1GHz (BT– Ch. 78) – Ant 1 – HALF Open

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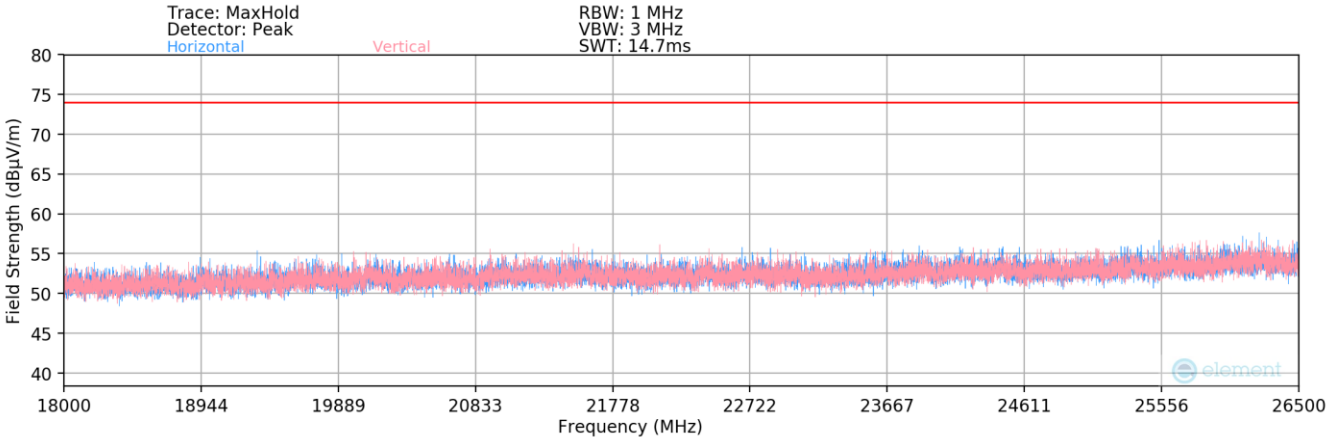
Radiated Spurious Emissions Measurements (Above 18GHz)

§15.209; RSS-Gen [8.9]



Plot 7-86. Radiated Spurious Plot above 18GHz – Ant 1 – HALF Open

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Radiated Spurious Emission Measurements – Ant 1

§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	V	169	275	-76.00	9.56	-22.50	18.06	53.98	-35.92
4804.00	Peak	V	169	275	-61.85	9.56	0.00	54.71	73.98	-19.27
12010.00	Avg	V	-	-	-78.86	23.60	0.00	51.74	53.98	-2.24
12010.00	Peak	V	-	-	-66.65	23.60	0.00	63.95	73.98	-10.03

Table 7-10. Radiated Measurements – Ant 1– HALF Open

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2441MHz
Channel:	39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	V	143	336	-63.66	9.52	-22.50	30.36	53.98	-23.62
4882.00	Peak	V	143	336	-57.51	9.52	0.00	59.01	73.98	-14.97
7323.00	Avg	V	-	-	-79.68	15.82	0.00	43.14	53.98	-10.84
7323.00	Peak	V	-	-	-67.68	15.82	0.00	55.14	73.98	-18.84
12205.00	Avg	V	-	-	-79.88	23.29	0.00	50.41	53.98	-3.57
12205.00	Peak	V	-	-	-68.01	23.29	0.00	62.28	73.98	-11.70

Table 7-11. Radiated Measurements – Ant 1 – HALF Open

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Radiated Spurious Emission Measurements
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2480MHz
Channel: 78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	V	153	333	-63.76	9.82	-22.50	30.57	53.98	-23.41
4960.00	Peak	V	153	333	-58.00	9.82	0.00	58.82	73.98	-15.16
7440.00	Avg	V	-	-	-78.66	16.09	0.00	44.43	53.98	-9.55
7440.00	Peak	V	-	-	-68.01	16.09	0.00	55.08	73.98	-18.90
12400.00	Avg	V	-	-	-80.21	23.60	0.00	50.39	53.98	-3.59
12400.00	Peak	V	-	-	-69.00	23.60	0.00	61.60	73.98	-12.38

Table 7-12. Radiated Measurements – Ant 1 – HALF Open

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2441MHz
Channel: 39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	V	-	-	-77.59	9.52	-22.50	16.43	53.98	-37.55
4882.00	Peak	V	-	-	-68.25	9.52	0.00	48.27	73.98	-25.71
7323.00	Avg	V	-	-	-76.21	15.82	0.00	46.61	53.98	-7.37
7323.00	Peak	V	-	-	-68.66	15.82	0.00	54.16	73.98	-19.82
12205.00	Avg	V	-	-	-79.00	23.29	0.00	51.29	53.98	-2.69
12205.00	Peak	V	-	-	-69.35	23.29	0.00	60.94	73.98	-13.04

Table 7-13. Radiated Measurements with WCP – Ant 1– HALF Open

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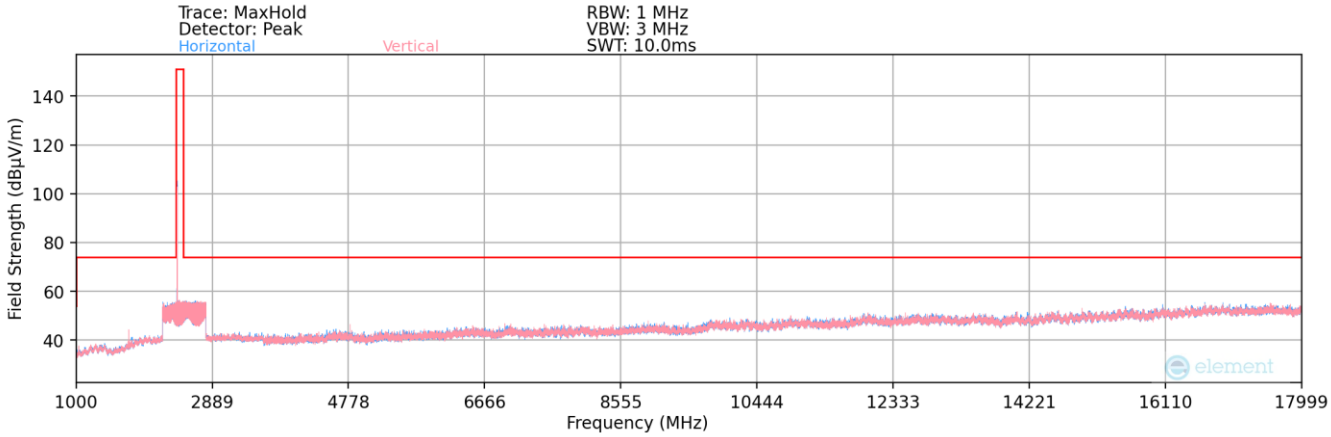
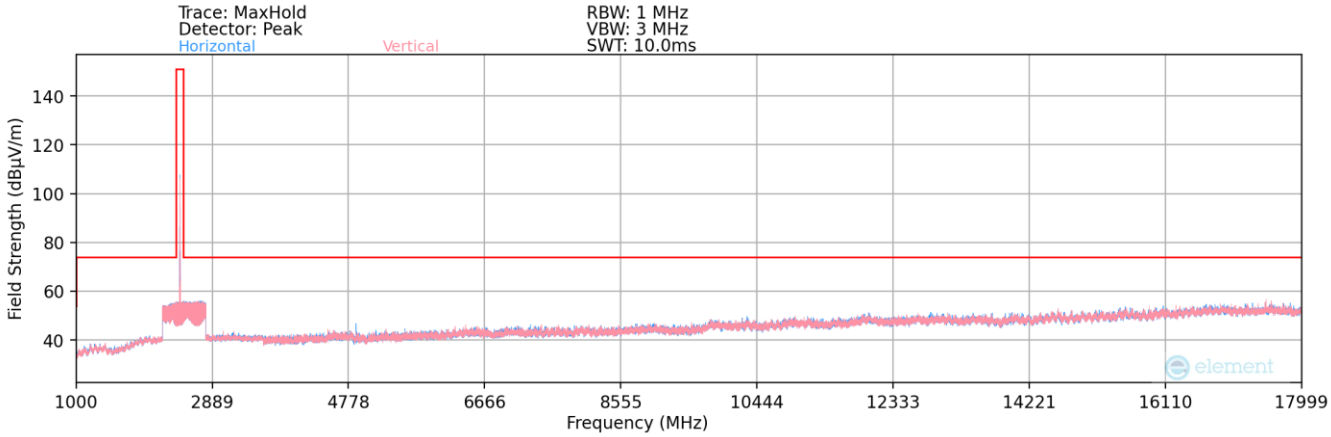
Radiated Spurious Emission Measurements – Ant 2

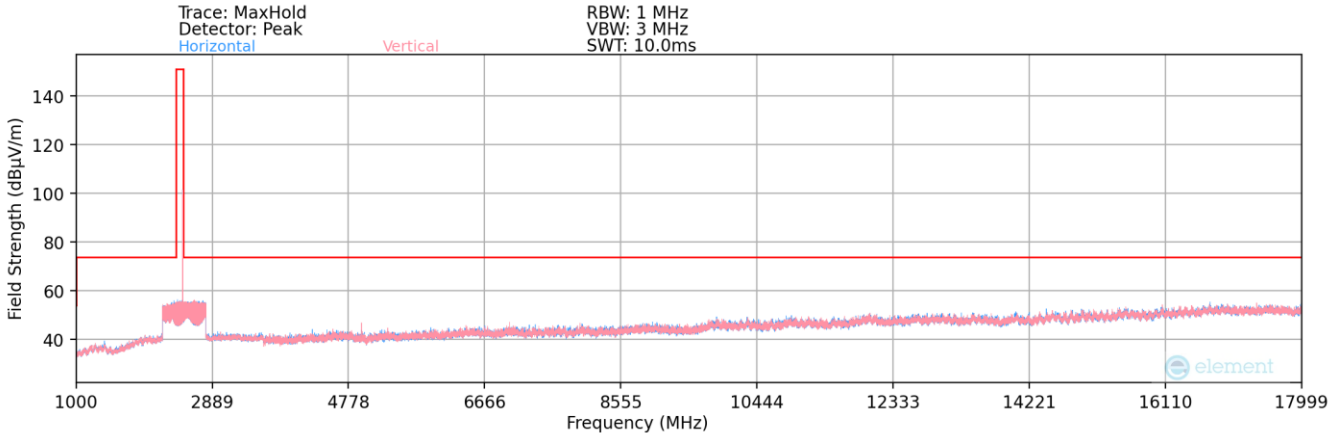
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]



Plot 7-87. Radiated Spurious Plot above 1GHz (BT– Ch. 0) – Ant 2 – HALF Open



Plot 7-88. Radiated Spurious Plot above 1GHz (BT– Ch. 39) – Ant 2 – HALF Open



Plot 7-89. Radiated Spurious Plot above 1GHz (BT– Ch. 78) – Ant 2 – HALF Open

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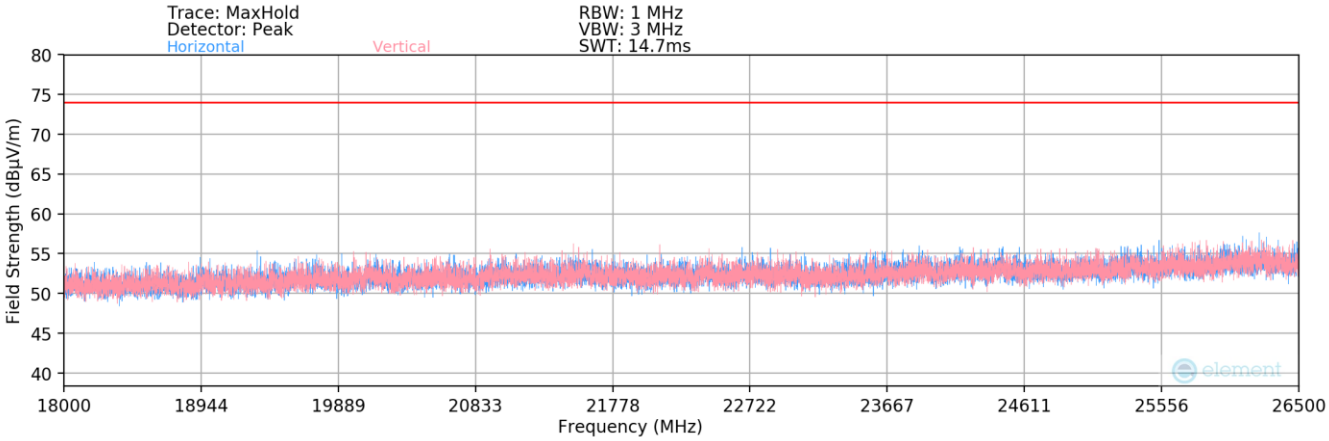
Radiated Spurious Emissions Measurements (Above 18GHz)

§15.209; RSS-Gen [8.9]



Plot 7-90. Radiated Spurious Plot above 18GHz – Ant 2 – HALF Open

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Radiated Spurious Emission Measurements – Ant 2

§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	V	311	141	-76.21	9.56	-22.50	17.85	53.98	-36.13
4804.00	Peak	V	316	139	-64.01	9.56	0.00	52.55	73.98	-21.43
12010.00	Avg	V	-	-	-89.33	23.60	0.00	41.27	53.98	-12.71
12010.00	Peak	V	-	-	-69.00	23.60	0.00	61.60	73.98	-12.38

Table 7-14. Radiated Measurements – Ant 2 – HALF Open

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2441MHz
Channel:	39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	V	316	139	-75.96	9.52	-22.50	18.06	53.98	-35.92
4882.00	Peak	V	316	139	-63.79	9.52	0.00	52.73	73.98	-21.25
7323.00	Avg	V	-	-	-79.68	15.82	0.00	43.14	53.98	-10.84
7323.00	Peak	V	-	-	-67.68	15.82	0.00	55.14	73.98	-18.84
12205.00	Avg	V	-	-	-79.88	23.29	0.00	50.41	53.98	-3.57
12205.00	Peak	V	-	-	-68.01	23.29	0.00	62.28	73.98	-11.70

Table 7-15. Radiated Measurements – Ant 2 – HALF Open

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Radiated Spurious Emission Measurements
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2480MHz
Channel: 78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	V	298	141	-76.01	9.82	-22.50	18.32	53.98	-35.66
4960.00	Peak	V	298	141	-64.11	9.82	0.00	52.71	73.98	-21.27
7440.00	Avg	V	-	-	-80.21	16.09	0.00	42.88	53.98	-11.10
7440.00	Peak	V	-	-	-68.01	16.09	0.00	55.08	73.98	-18.90
12400.00	Avg	V	-	-	-79.77	23.60	0.00	50.83	53.98	-3.15
12400.00	Peak	V	-	-	-67.88	23.60	0.00	62.72	73.98	-11.26

Table 7-16. Radiated Measurements – Ant 2– HALF Open

Worst Case Mode: Bluetooth
Worst Case Data Rate: 1 Mbps
Measurement Distance: 3 Meters
Operating Frequency: 2441MHz
Channel: 39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Dist. Corr. Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	V	-	-	-78.96	9.52	-22.50	0.00	15.06	53.98	-38.92
4882.00	Peak	V	-	-	-66.57	9.52	0.00	0.00	49.95	73.98	-24.03
7323.00	Avg	V	-	-	-78.99	15.82	0.00	0.00	43.83	53.98	-10.15
7323.00	Peak	V	-	-	-69.11	15.82	0.00	0.00	53.71	73.98	-20.27
12205.00	Avg	V	-	-	-80.04	23.29	0.00	0.00	50.25	53.98	-3.73
12205.00	Peak	V	-	-	-68.96	23.29	0.00	0.00	61.33	73.98	-12.65

Table 7-17. Radiated Measurements with WCP – Ant 2 – HALF Open

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7.10 Radiated Restricted Band Edge Measurements

§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated emissions at the band edge are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power, at the appropriate frequencies, and with hopping disabled. Only the radiated emissions of the configuration that produced the worst-case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown below per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-18. Radiated Limits

Test Procedure Used

ANSI C63.10-2013 – Section 6.10.5.2

Test Settings

1. Span is set large enough to capture the peak level of the emission operating on the channel closest to the band edge
2. Reference level offset is set with the appropriate corrections for the frequencies shown in the plots
3. Reference level is set to provide the appropriate amount of “head room” above the signal as specified in ANSI C63.10-2013 Section 4.1.5.2
4. Attenuation is set to a low enough level to maintain enough dynamic range between the noise floor and the radiated limit
5. Sweep time = Auto coupled
6. RBW = 1MHz
7. VBW = 3 x RBW for peak measurements and 1kHz for RMS measurements
8. Detector = RMS and peak
9. Trace = Max Hold
10. Trace was allowed to stabilize

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Test Setup

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

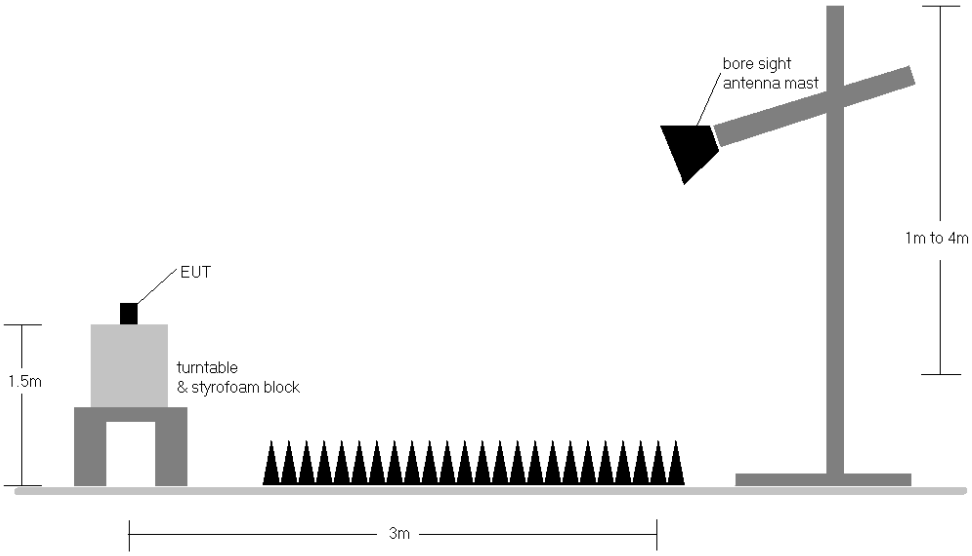

Figure 7-9. Radiated Test Setup >1GHz

Test Notes

1. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limits shown in §15.209.
2. No significant radiated emissions were found in the 2310 - 2390MHz restricted band.
3. The antenna is manipulated through typical positions, polarity, and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
6. Two different amplitude offsets were used depending on whether peak or average measurements were measured. The average measurements use a duty cycle correction factor (DCCF).

   The amplitude offset shown in the following plots for average measurements was calculated using the formula:

   Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain + DCCF

7. The "-" shown in the following RSE tables is used to denote a noise floor measurement.

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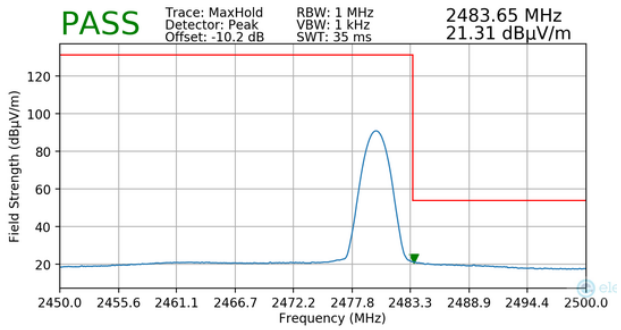
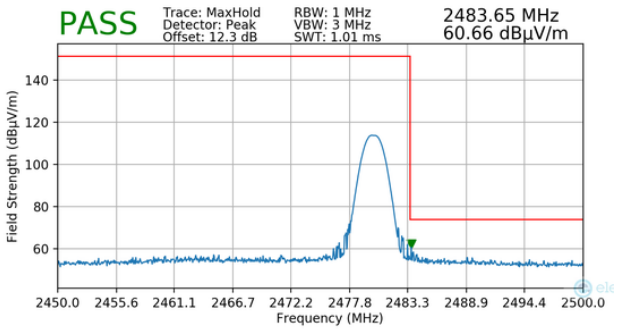
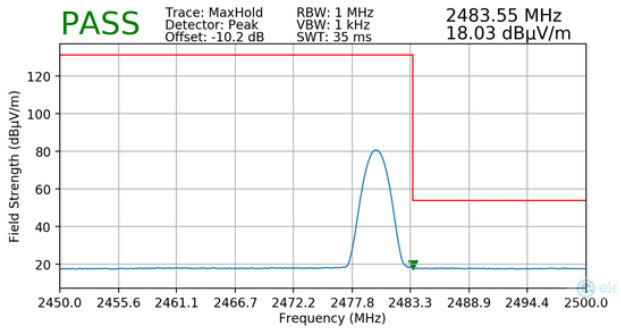
Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78



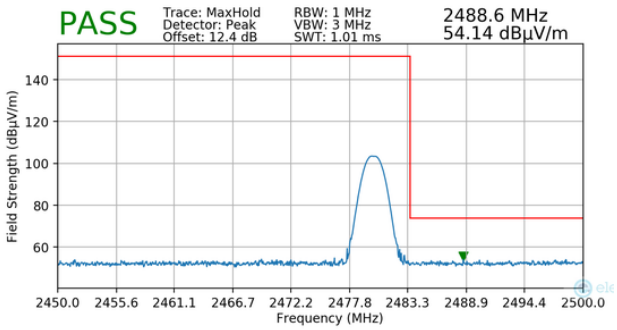
Plot 7-91. Radiated Restricted Upper Band Edge Measurement (Average) – Ant 1



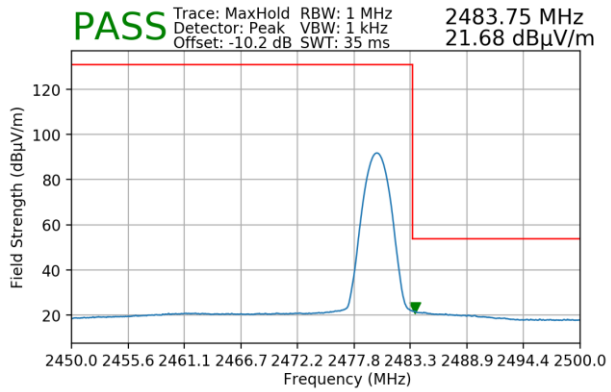
Plot 7-92. Radiated Restricted Upper Band Edge Measurement (Peak) – Ant 1



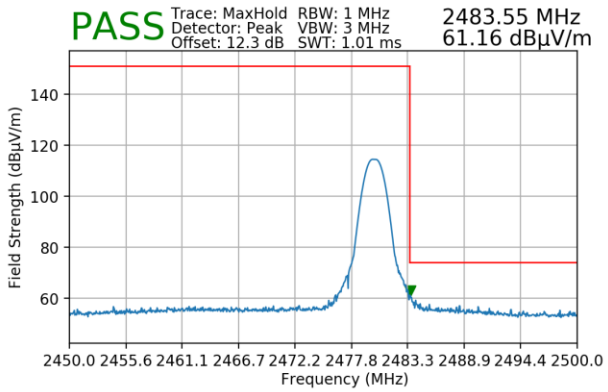
Plot 7-93. Radiated Restricted Upper Band Edge Measurement (Average) – Ant 2



Plot 7-94. Radiated Restricted Upper Band Edge Measurement (Peak) – Ant 2



Plot 7-95. Radiated Restricted Upper Band Edge Measurement (Average) with WCP – Ant 1



Plot 7-96. Radiated Restricted Upper Band Edge Measurement (Peak) with WCP – Ant 1

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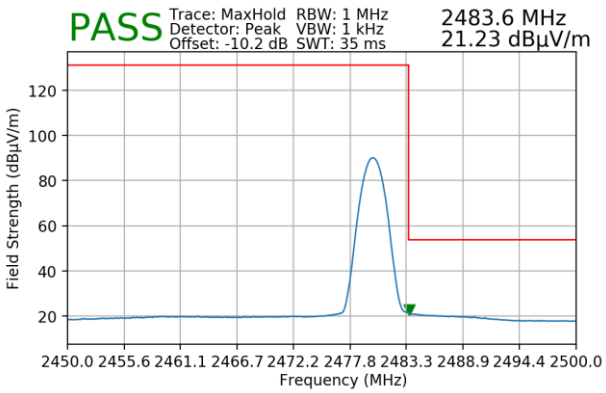
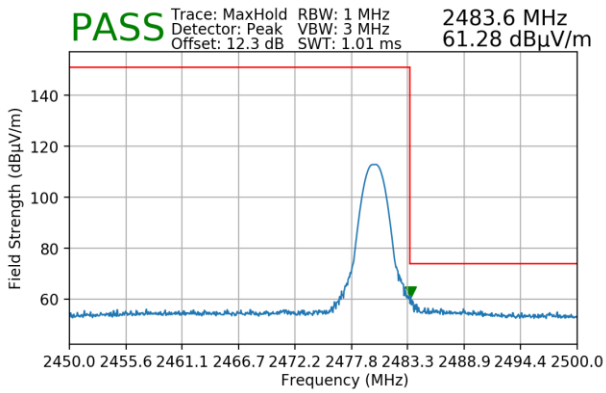


Plot 7-97. Radiated Restricted Upper Band Edge Measurement (Average) with WCP – Ant 2



Plot 7-98. Radiated Restricted Upper Band Edge Measurement (Peak) with WCP – Ant 2

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7.11 Radiated Spurious Emissions Measurements – Below 1GHz

§15.209; RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions must not exceed the limits shown below per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-19. Radiated Limits

Test Procedures Used

ANSI C63.10-2013

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

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Test Setup

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

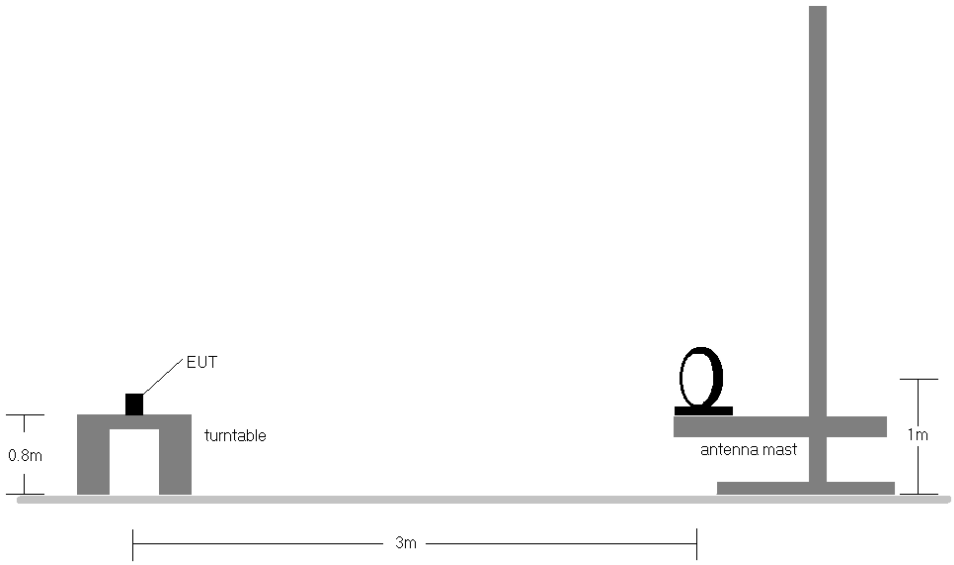

Figure 7-10. Radiated Test Setup < 30Mhz

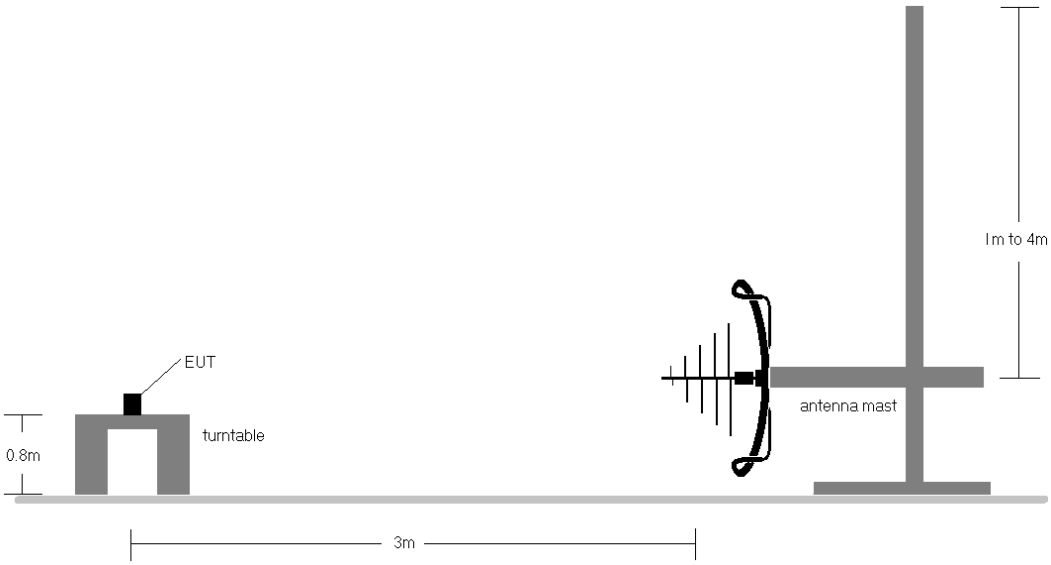

Figure 7-11. Radiated Test Setup < 1GHz

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Test Notes

1. All emissions lying in restricted bands specified in §15.205 and RSS-Gen (8.10) are below the limits shown in §15.209.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested with its standard battery.
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
9. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

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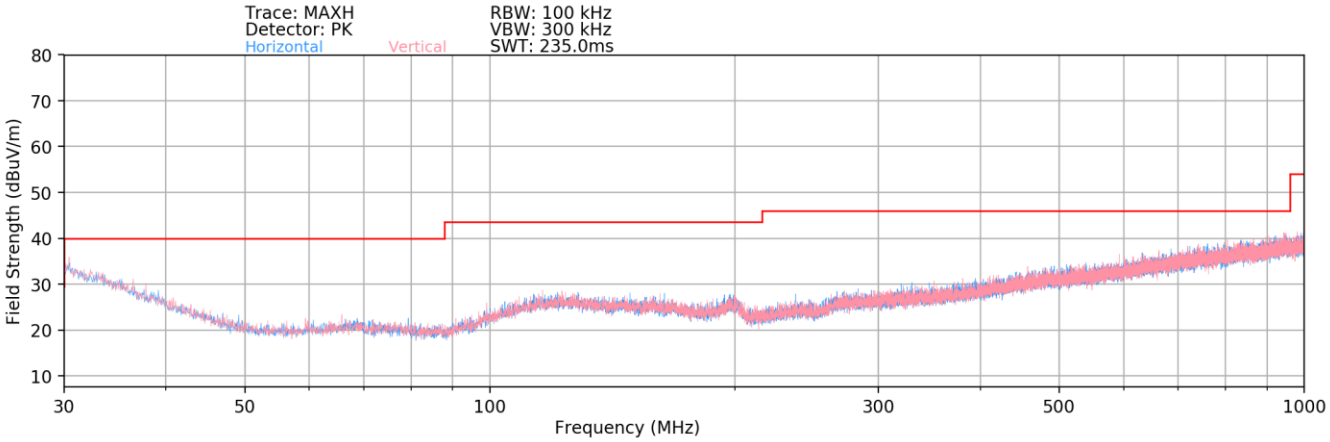
Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209; RSS-Gen [8.9]



Plot 7-99. Radiated Spurious Plot below 1GHz – Ant 1

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
59.00	Quasi-Peak	V	-	-	-97.14	14.18	24.04	40.00	-15.96
113.00	Quasi-Peak	V	-	-	-97.51	19.84	29.33	43.52	-14.19
186.00	Quasi-Peak	V	-	-	-96.64	18.51	28.87	43.52	-14.65
455.00	Quasi-Peak	V	-	-	-98.02	24.99	33.97	46.02	-12.05
586.00	Quasi-Peak	V	-	-	-96.48	27.29	37.81	46.02	-8.21
701.00	Quasi-Peak	V	-	-	-96.54	29.01	39.47	46.02	-6.55

Table 7-20. Radiated Spurious Emissions Below 1GHz – Ant 1

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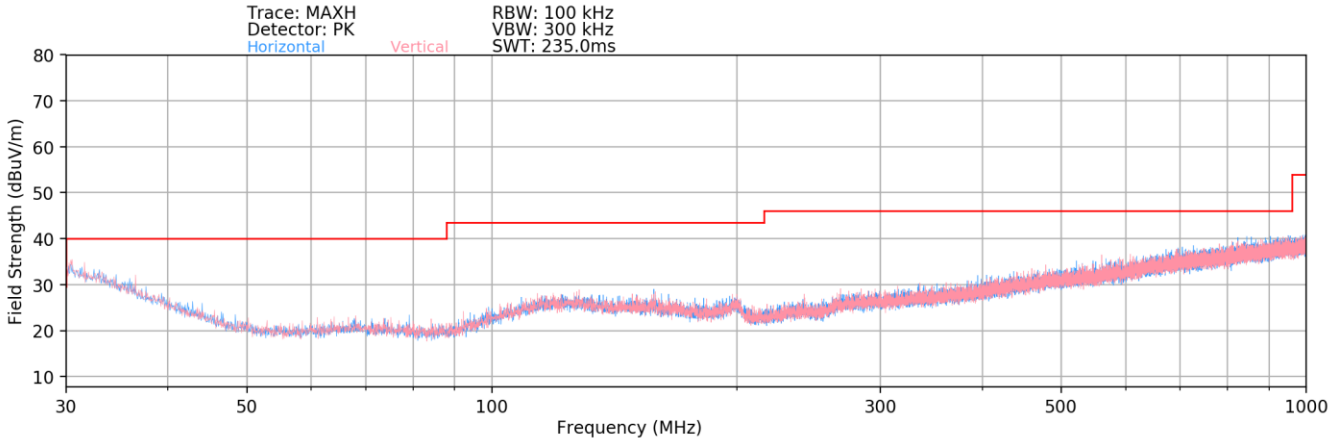

Plot 7-100. Radiated Spurious Plot below 1GHz – Ant 2

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
32.00	Quasi-Peak	V	-	-	-97.47	25.89	35.42	40.00	-4.58
53.00	Quasi-Peak	V	-	-	-98.02	14.27	23.25	40.00	-16.75
144.00	Quasi-Peak	V	-	-	-97.92	19.87	28.95	43.52	-14.57
200.00	Quasi-Peak	V	-	-	-98.20	20.24	29.04	43.52	-14.49
355.00	Quasi-Peak	V	-	-	-97.70	22.49	31.79	46.02	-14.23
556.00	Quasi-Peak	V	-	-	-96.85	26.25	36.40	46.02	-9.63

Table 7-21. Radiated Spurious Emissions Below 1GHz – Ant 2

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7.12 Line Conducted Measurement Data

§15.207; RSS-Gen [8.8]

Test Overview and Limit

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

All conducted emissions must not exceed the limits shown in the table below per Section 15.207 and RSS-Gen (8.8).

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

Table 7-22. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

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Test Setup

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

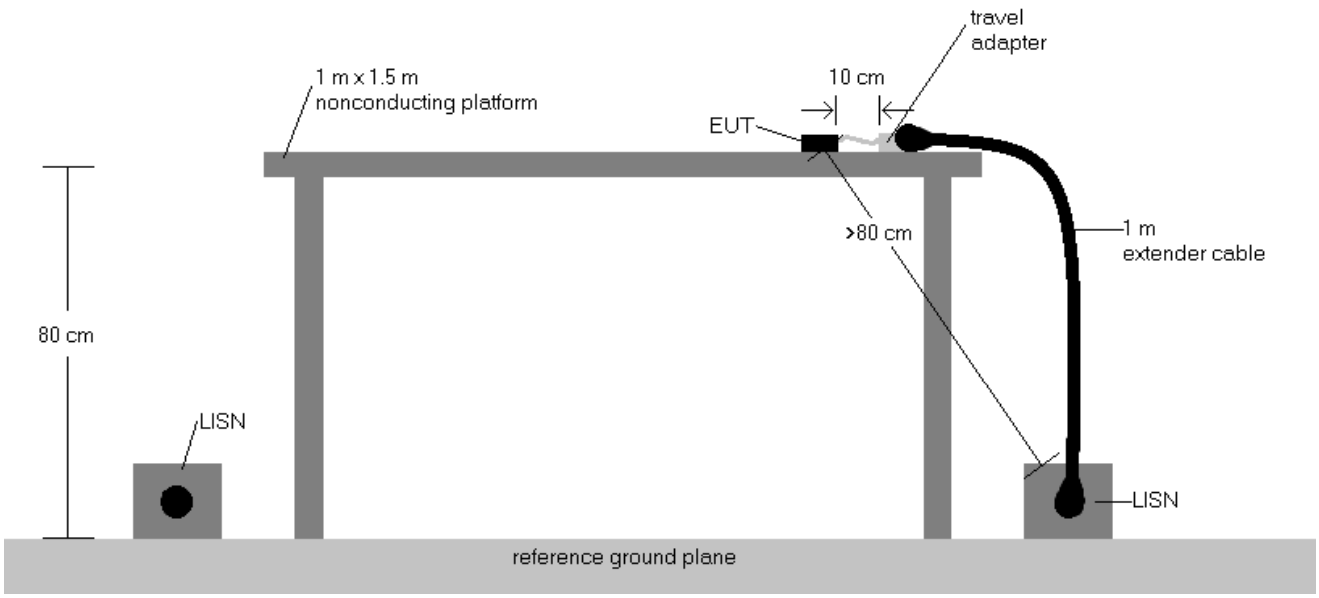

Figure 7-12. Test Instrument & Measurement Setup

Test Notes

1. All modes of operation were investigated, and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207 and RSS-Gen (8.8).
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dBμV) = QP/AV Analyzer/Receiver Level (dBμV) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dBμV) - QP/AV Level (dBμV)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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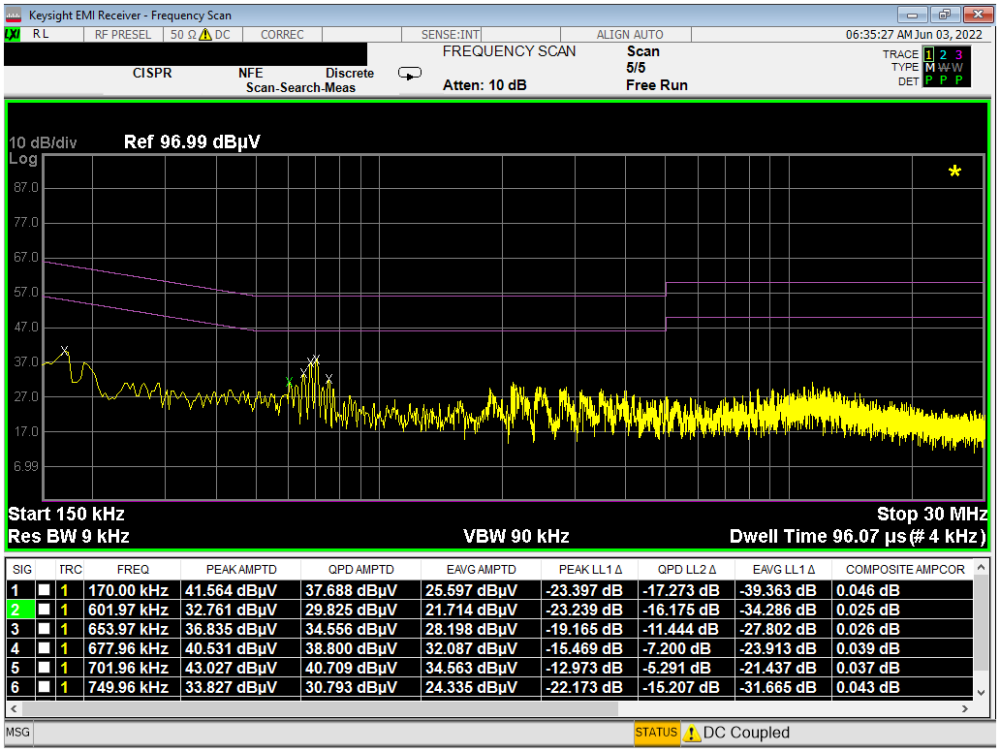
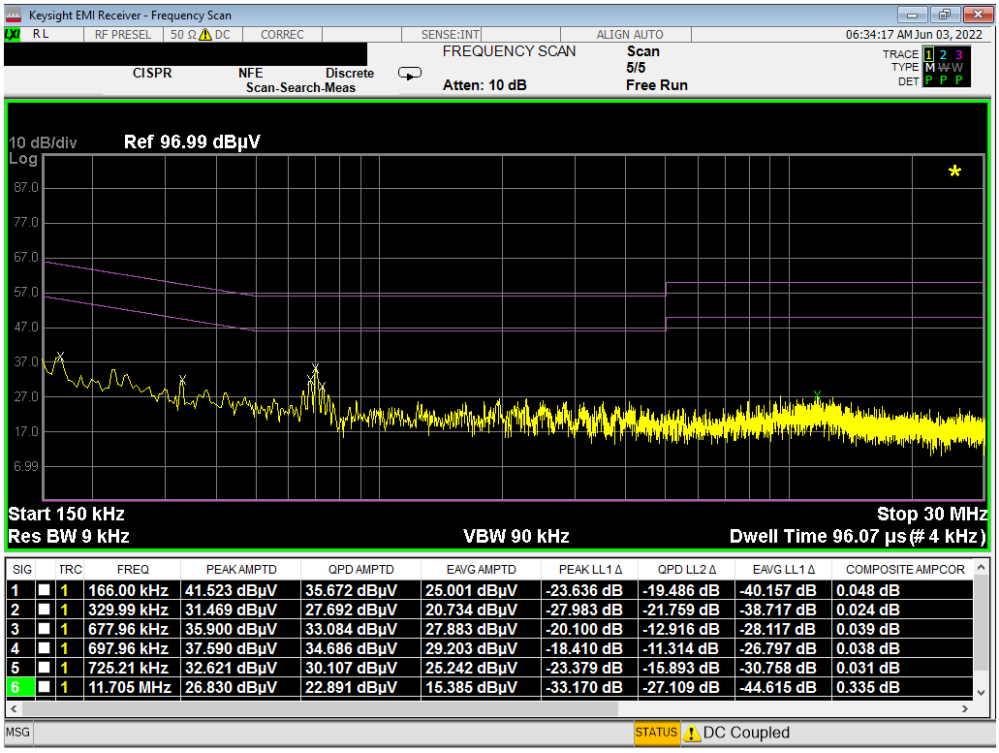


SIG	TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL2 Δ	EAVG LL1 Δ	COMPOSITE AMPCOR
1	1	170.00 kHz	41.564 dBµV	37.688 dBµV	25.597 dBµV	-23.397 dB	-17.273 dB	-39.363 dB	0.046 dB
2	1	601.97 kHz	32.761 dBµV	29.825 dBµV	21.714 dBµV	-23.239 dB	-16.175 dB	-34.286 dB	0.025 dB
3	1	653.97 kHz	36.835 dBµV	34.556 dBµV	28.198 dBµV	-19.165 dB	-11.444 dB	-27.802 dB	0.026 dB
4	1	677.96 kHz	40.531 dBµV	38.800 dBµV	32.087 dBµV	-15.469 dB	-7.200 dB	-23.913 dB	0.039 dB
5	1	701.96 kHz	43.027 dBµV	40.709 dBµV	34.563 dBµV	-12.973 dB	-5.291 dB	-21.437 dB	0.037 dB
6	1	749.96 kHz	33.827 dBµV	30.793 dBµV	24.335 dBµV	-22.173 dB	-15.207 dB	-31.665 dB	0.043 dB

Plot 7-101. Line-Conducted Test Plot (L1) - OPEN



SIG	TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL2 Δ	EAVG LL1 Δ	COMPOSITE AMPCOR
1	1	166.00 kHz	41.523 dBµV	35.672 dBµV	25.001 dBµV	-23.636 dB	-19.486 dB	-40.157 dB	0.048 dB
2	1	329.99 kHz	31.469 dBµV	27.692 dBµV	20.734 dBµV	-27.983 dB	-21.759 dB	-38.717 dB	0.024 dB
3	1	677.96 kHz	35.900 dBµV	33.084 dBµV	27.883 dBµV	-20.100 dB	-12.916 dB	-28.117 dB	0.039 dB
4	1	697.96 kHz	37.590 dBµV	34.686 dBµV	29.203 dBµV	-18.410 dB	-11.314 dB	-26.797 dB	0.038 dB
5	1	725.21 kHz	32.621 dBµV	30.107 dBµV	25.242 dBµV	-23.379 dB	-15.893 dB	-30.758 dB	0.031 dB
6	1	11.705 MHz	26.830 dBµV	22.891 dBµV	15.385 dBµV	-33.170 dB	-27.109 dB	-44.615 dB	0.335 dB

Plot 7-102. Line-Conducted Test Plot (N) – OPEN

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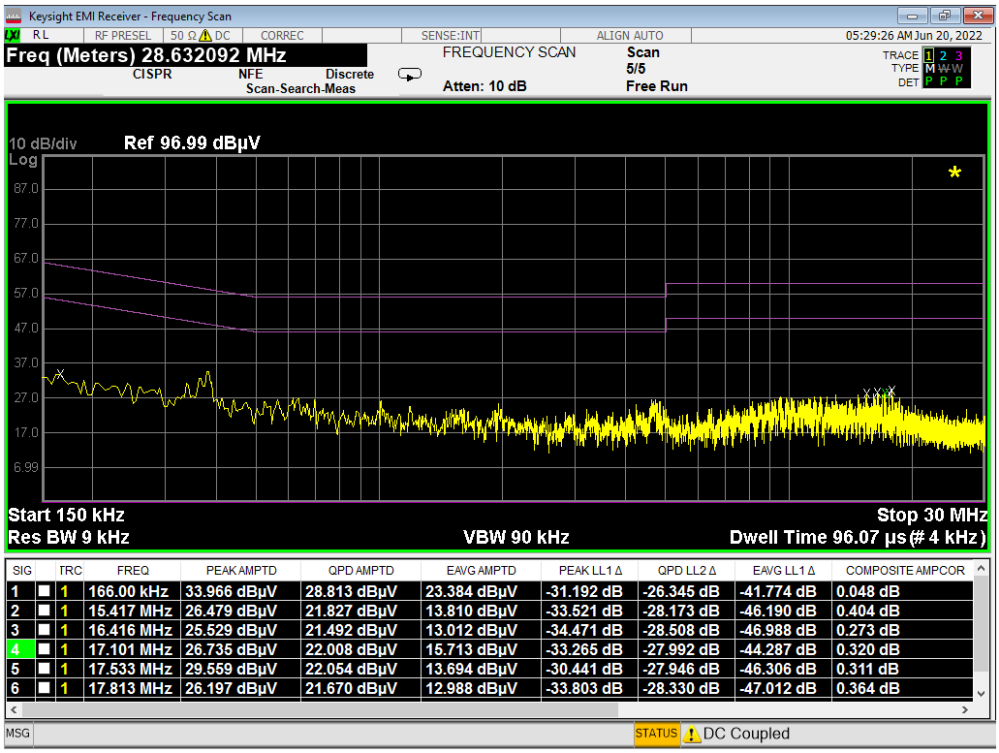
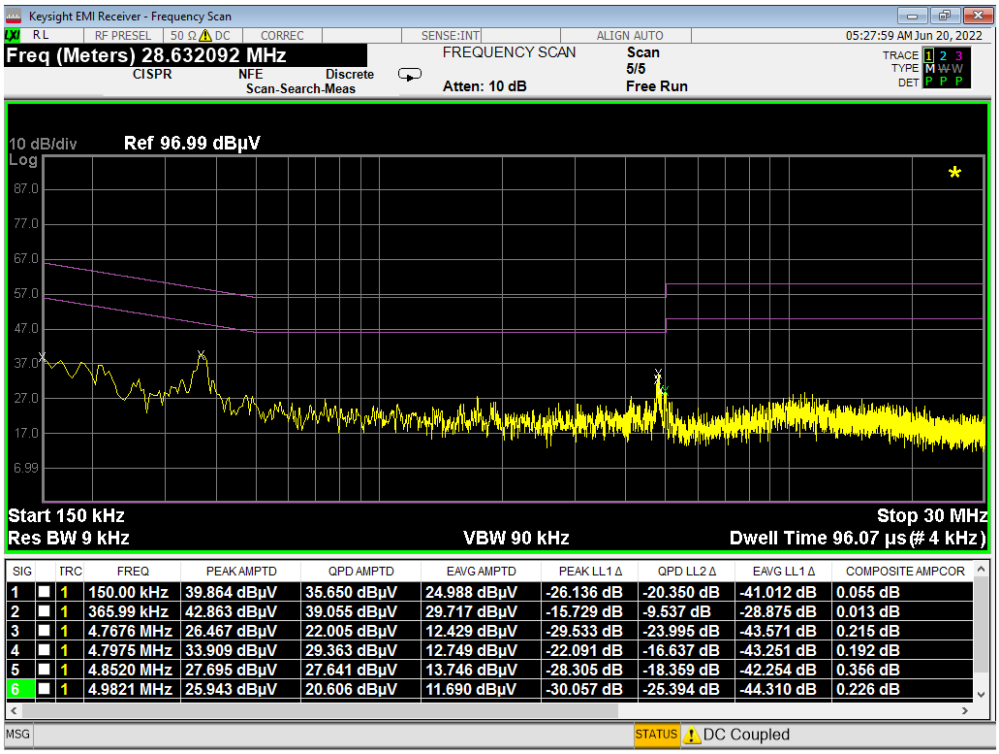


SIG	TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL2 Δ	EAVG LL1 Δ	COMPOSITE AMPCOR
1	1	166.00 kHz	33.966 dBµV	28.813 dBµV	23.384 dBµV	-31.192 dB	-26.345 dB	-41.774 dB	0.048 dB
2	1	15.417 MHz	26.479 dBµV	21.827 dBµV	13.810 dBµV	-33.521 dB	-28.173 dB	-46.190 dB	0.404 dB
3	1	16.416 MHz	25.529 dBµV	21.492 dBµV	13.012 dBµV	-34.471 dB	-28.508 dB	-46.988 dB	0.273 dB
4	1	17.101 MHz	26.735 dBµV	22.008 dBµV	15.713 dBµV	-33.265 dB	-27.992 dB	-44.287 dB	0.320 dB
5	1	17.533 MHz	29.559 dBµV	22.054 dBµV	13.694 dBµV	-30.441 dB	-27.946 dB	-46.306 dB	0.311 dB
6	1	17.813 MHz	26.197 dBµV	21.670 dBµV	12.988 dBµV	-33.803 dB	-28.330 dB	-47.012 dB	0.364 dB

Plot 7-103. Line-Conducted Test Plot (L1) – CLOSED



SIG	TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL2 Δ	EAVG LL1 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	39.864 dBµV	35.650 dBµV	24.988 dBµV	-26.136 dB	-20.350 dB	-41.012 dB	0.055 dB
2	1	365.99 kHz	42.863 dBµV	39.055 dBµV	29.717 dBµV	-15.729 dB	-9.537 dB	-28.875 dB	0.013 dB
3	1	4.7676 MHz	26.467 dBµV	22.005 dBµV	12.429 dBµV	-29.533 dB	-23.995 dB	-43.571 dB	0.215 dB
4	1	4.7975 MHz	33.909 dBµV	29.363 dBµV	12.749 dBµV	-22.091 dB	-16.637 dB	-43.251 dB	0.192 dB
5	1	4.8520 MHz	27.695 dBµV	27.641 dBµV	13.746 dBµV	-28.305 dB	-18.359 dB	-42.254 dB	0.356 dB
6	1	4.9821 MHz	25.943 dBµV	20.606 dBµV	11.690 dBµV	-30.057 dB	-25.394 dB	-44.310 dB	0.226 dB

Plot 7-104. Line-Conducted Test Plot (N) – CLOSED

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8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMF936U** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules and RSS-247 of the Innovation, Science and Economic Development Canada rules.

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