# TEST REPORT

**Report Number:** 13389132-E2V1

| | | |
|---|---|---|
| **Applicant** | : | APPLE, INC.<br>1 APPLE PARK WAY<br>CUPERTINO, CA 95014, U.S.A |
| **Model** | : | A2411, A2412, A2413 |
| **FCC ID** | : | BCG-E3550A |
| **IC** | : | 579C-E3550A |
| **EUT Description** | : | SMARTPHONE |
| **Test Standard(s)** | : | FCC 47 CFR PART 15 SUBPART C<br>ISED RSS-247 ISSUE 2<br>ISED RSS-GEN ISSUE 5 |

**Date of Issue:**
September 21, 2020

**Prepared by:**
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

NVLAP TESTING

NVLAP Lab code: 200065-0

## REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| V1 | 9/21/2020 | Initial Issue | Chin Pang |



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UL VERIFICATION SERVICES INC.
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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A2411, A2412, A2413

**SERIAL NUMBER:** (Original): G6TCQ01TQ897, G6TCQ02KQ897
(Spot Check): G6TD401R06R1, G6TD401N06R1

**DATE TESTED:** AUGUST 26, 2020 – SEPTEMBER 01, 2020

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| CFR 47 Part 15 Subpart C | Complies |
| ISED RSS-247 Issue 2 | Complies |
| ISED RSS-GEN Issue 5 | Complies |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

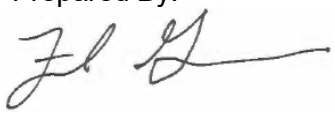
The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:

Chin Pang
Senior Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:



Francisco Guarnero
Test Engineer
Consumer Technology Division
UL Verification Services Inc.

# 2. TEST SUMMARY

| FCC Clause | ISED Clause | Requirement | Result | Comment |
|---|---|---|---|---|
| 15.209, 15.205 | RSS-GEN 8.9, 8.10 | Radiated Emissions | Complies | None. |

# 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 662911, RSS-GEN Issue 5, and RSS-247 Issue 2.

# 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 47173 Benicia Street | 47266 Benicia Street | 47658 Kato Road |
|---|---|---|
| ☐ Chamber A | ☐ Chamber D | ☐ Chamber I |
| ☐ Chamber B | ☐ Chamber E | ☒ Chamber J |
| ☐ Chamber C | ☐ Chamber F | ☐ Chamber K |
| | ☐ Chamber G | ☒ Chamber L |
| | ☐ Chamber G | ☐ Chamber M |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.
UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0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# 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

## 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

## 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

## 5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | $U_{LAB}$ |
|---|---|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz | 3.39 dB |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz | 3.07 dB |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz | 2.52 dB |
| Worst Case Radiated Disturbance, 30 to 1000 MHz | 4.88 dB |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz | 4.24 dB |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.37 dB |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.17 dB |

Uncertainty figures are valid to a confidence level of 95%.



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# 6. INTRODUCTION OF TEST DATA REUSE

## 6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, 5G, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wideband, GPS, NFC and WPT. All models support at least one UICC based SIM. The second SIM is either an UICC based p-SIM (physical SIM) or e-SIM (electronic SIM). The device supports a built-in inductive charging transmitter and receiver. The rechargeable battery is not user accessible.

## 6.2. INTRODUCTION

This application for certification is leveraging the data reuse procedures from KDB 484596 D01 based on reference FCC ID BCG-E3548A, IC: 579C-E3548A to cover variant model BCG-E3550A, 579C-E3550A. The major difference between the parent/reference model and the variant model is the depopulation in the variant model of the mmWave transmitter. All other circuitry and features are identical. The data reuse test plan was approved via manufacturer KDB inquiry.

## 6.3. DIFFERENCE IN MODEL NUMBER

Models A2411, A2412, and A2413 are electrically identical and the model numbers are allocated for marketing and logistic purposes only. Model A2411 was used for the spot check testing described in this report.

## 6.4. SPOT CHECK VERIFICATION RESULTS SUMMARY

Spot check verification has been done on device model A2411, FCC ID: BCG-E3550A, IC: 579C-E3550A for radiated spurious and radiated band-edge in accordance with the Test Plan that was approved via KDB inquiry.

| BCG-E3550A SPOT CHECK RESULTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Technology | Mode | Test Item | Channel | Measured | Original model | | Spot check model | | Delta (dB) | |
| | | | | | A2342 | | A2411, A2412, A2413 | | | |
| | | | | | BCG-E3548A 579C-E3548A | | BCG-E3550A 579C-E3550A | | | |
| | | | | Frequency (MHz) | Peak | Ave | Peak | Ave | Peak | Ave |
| BLE | TXBF 1Mbps | RBE | Low | 2390 | 49.09 | 38.45 | 54.33 | 43.4 | -5.24 | -4.95 |
| | | RBE | High | 2483.5 | 51.24 | 39.60 | 55.83 | 44.57 | -4.59 | -4.97 |
| | TXBF 1Mbps | RSE | Mid | N/A | NF | NF | NF | NF | -- | -- |

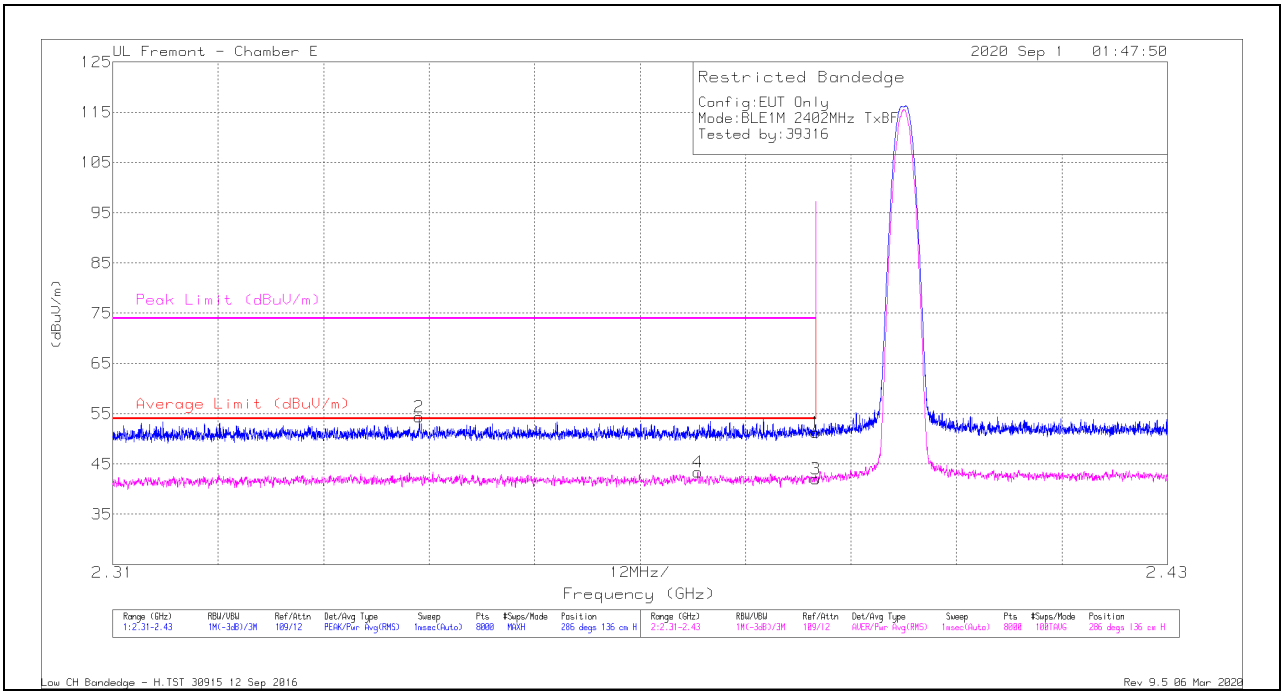
Comparison of the models, upper deviation is within 3dB range and all tests are under FCC Technical Limits. The test report for FCC ID BCG-E3548A, IC: 579C-E3548A is therefore being used to support the application for certification for FCC ID: BCG-E3550A, IC: 579C-E3550A.

Note: The output powers were verified on model A2411 to match with model A2342 before radiated emissions spot check was performed.

## SPOT CHECK DATA

## BANDEDGE (LOW CHANNEL)

### HORIZONTAL RESULT




| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T712 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | * 2.34488 | 40.53 | Pk | 32.1 | -18.3 | 54.33 | - | - | 74 | -19.67 | 286 | 136 | H |
| 4 | * 2.37656 | 29.6 | RMS | 32.2 | -18.4 | 43.4 | 54 | -10.6 | - | - | 286 | 136 | H |
| 1 | * 2.38999 | 37.47 | Pk | 32.2 | -18.4 | 51.27 | - | - | 74 | -22.73 | 286 | 136 | H |
| 3 | * 2.38999 | 28.18 | RMS | 32.2 | -18.4 | 41.98 | 54 | -12.02 | - | - | 286 | 136 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection



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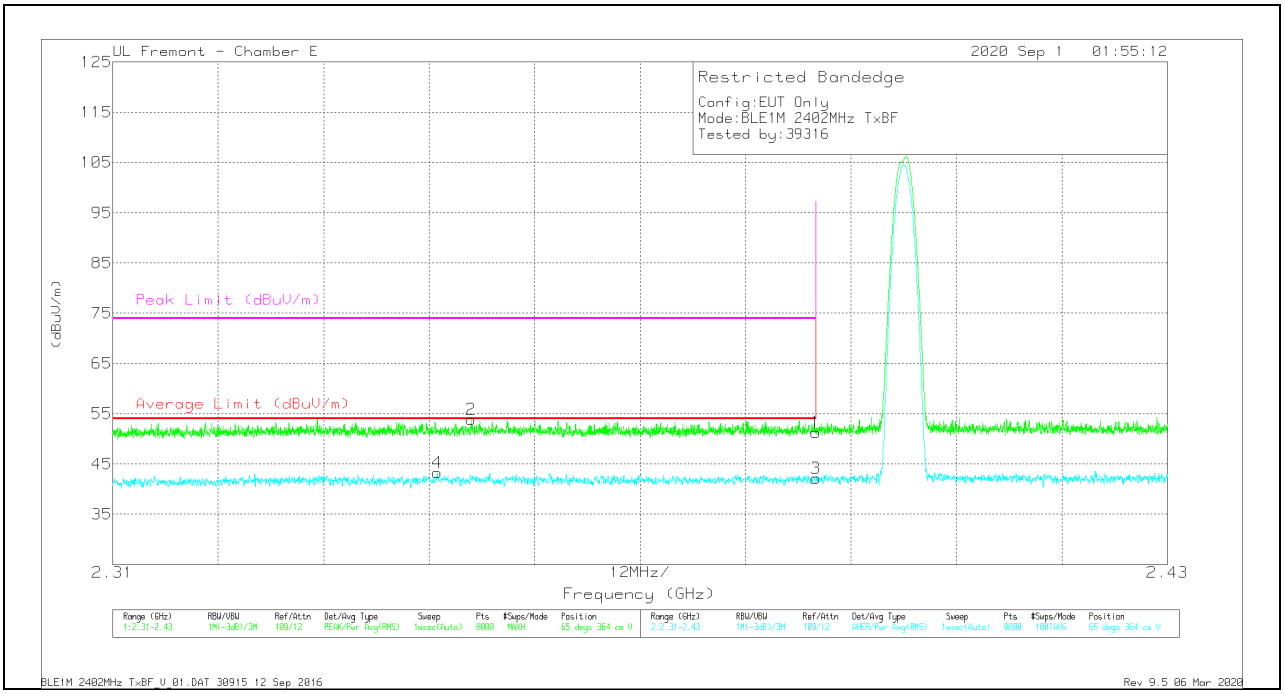
# VERTICAL RESULT




| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T712 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | * 2.38999 | 37.49 | Pk | 32.2 | -18.4 | 51.29 | - | - | 74 | -22.71 | 65 | 364 | V |
| 2 | * 2.35079 | 40.06 | Pk | 32.1 | -18.3 | 53.86 | - | - | 74 | -20.14 | 65 | 364 | V |
| 3 | * 2.38999 | 28.36 | RMS | 32.2 | -18.4 | 42.16 | 54 | -11.84 | - | - | 65 | 364 | V |
| 4 | * 2.34695 | 29.45 | RMS | 32.1 | -18.3 | 43.25 | 54 | -10.75 | - | - | 65 | 364 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection



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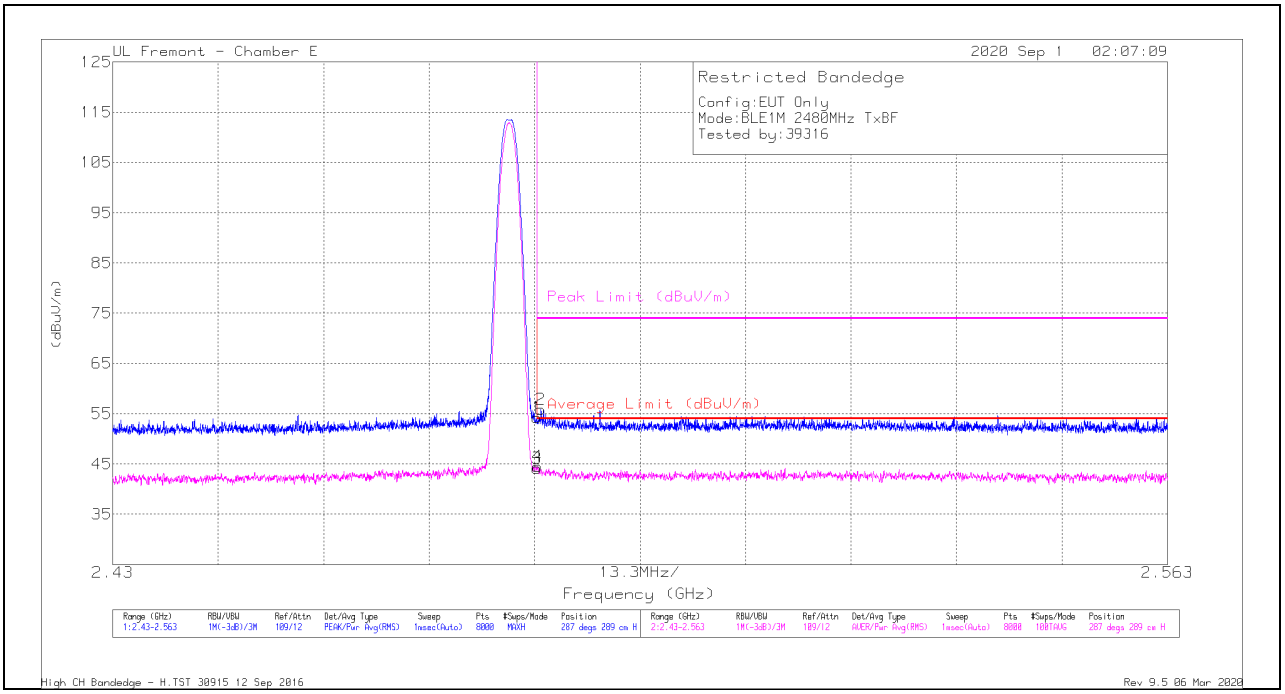
## BANDEDGE (HIGH CHANNEL)

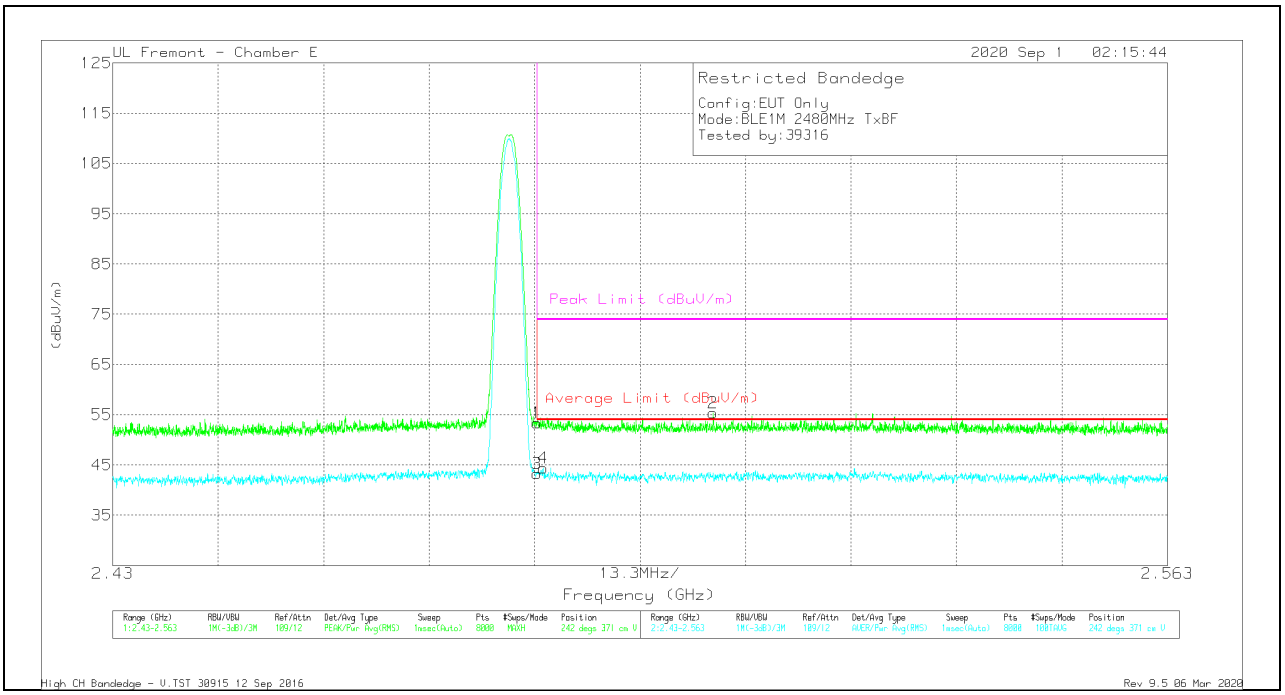
### HORIZONTAL RESULT




| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T712 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | * 2.48351 | 39.8 | Pk | 32.8 | -18.4 | 54.2 | - | - | 74 | -19.8 | 287 | 289 | H |
| 2 | * 2.484 | 41.43 | Pk | 32.8 | -18.4 | 55.83 | - | - | 74 | -18.17 | 287 | 289 | H |
| 3 | * 2.48351 | 29.76 | RMS | 32.8 | -18.4 | 44.16 | 54 | -9.84 | - | - | 287 | 289 | H |
| 4 | * 2.48361 | 30.17 | RMS | 32.8 | -18.4 | 44.57 | 54 | -9.43 | - | - | 287 | 289 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

## VERTICAL RESULT

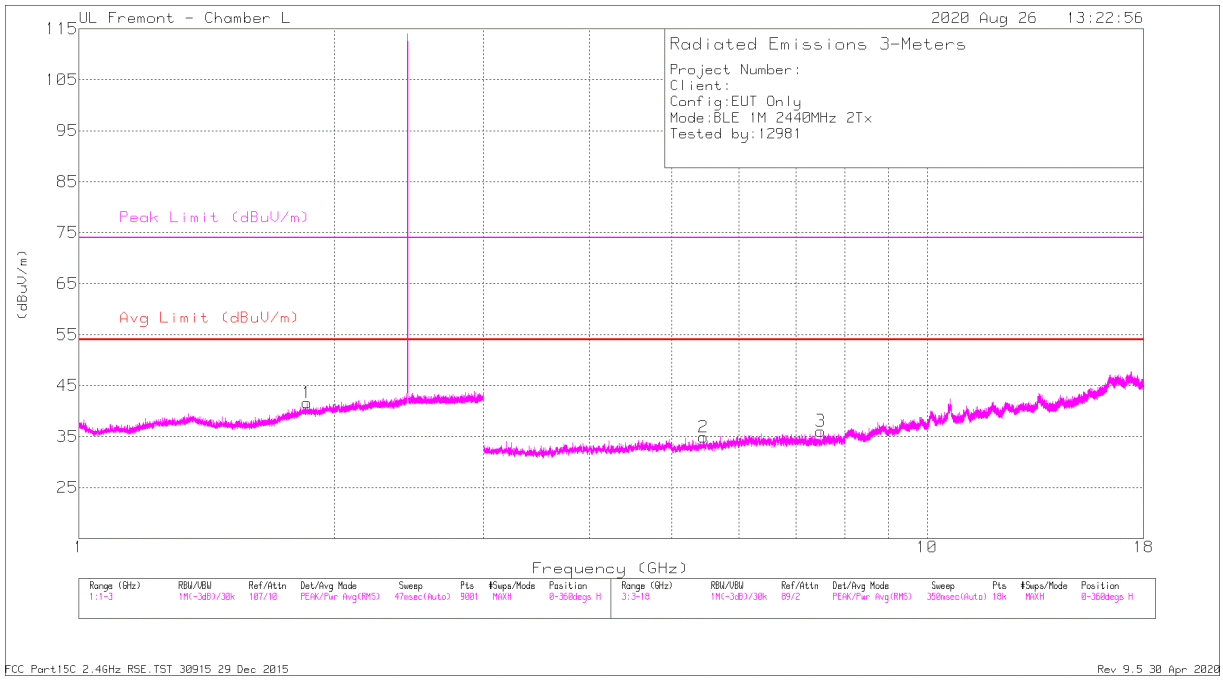



| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T712 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | * 2.48351 | 38.96 | Pk | 32.8 | -18.4 | 53.36 | - | - | 74 | -20.64 | 242 | 371 | V |
| 3 | * 2.48351 | 28.91 | RMS | 32.8 | -18.4 | 43.31 | 54 | -10.69 | - | - | 242 | 371 | V |
| 4 | * 2.48427 | 29.97 | RMS | 32.8 | -18.4 | 44.37 | 54 | -9.63 | - | - | 242 | 371 | V |
| 2 | 2.50572 | 40.97 | Pk | 32.9 | -18.5 | 55.37 | - | - | 74 | -18.63 | 242 | 371 | V |

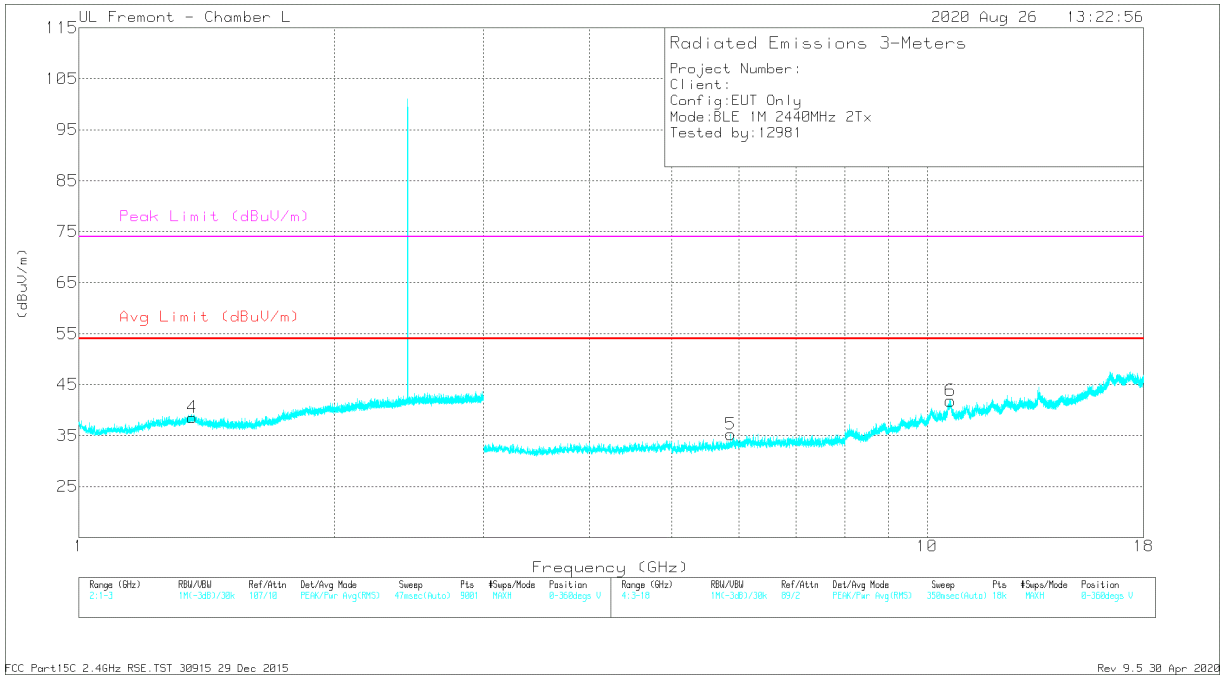
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

## HARMONICS AND SPURIOUS EMISSIONS

### MID CHANNEL RESULTS




**HORIZONTAL**




**VERTICAL**

## RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF 344 (dB/m) | Amp/Cbl/Fltr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.86036 | 40.05 | PK2 | 30.5 | -22.2 | 48.35 | - | - | - | - | 56 | 367 | H |
| 4 | * 1.36092 | 41.75 | PK2 | 29.3 | -23.5 | 47.55 | - | - | 74 | -26.45 | 288 | 138 | V |
| | * 1.36125 | 28.17 | MAv1 | 29.3 | -23.5 | 33.97 | 54 | -20.03 | - | - | 288 | 138 | V |
| 2 | * 5.44552 | 33.38 | PK2 | 34.6 | -25.5 | 42.48 | - | - | 74 | -31.52 | 243 | 113 | H |
| | * 5.44617 | 20.28 | MAv1 | 34.6 | -25.5 | 29.38 | 54 | -24.62 | - | - | 243 | 113 | H |
| 3 | * 7.48899 | 32.92 | PK2 | 35.6 | -23.6 | 44.92 | - | - | 74 | -29.08 | 194 | 133 | H |
| | * 7.48962 | 19.83 | MAv1 | 35.7 | -23.6 | 31.93 | 54 | -22.07 | - | - | 194 | 133 | H |
| 6 | * 10.65614 | 30.37 | PK2 | 37.9 | -17.2 | 51.07 | - | - | 74 | -22.93 | 292 | 110 | V |
| | * 10.65698 | 16.46 | MAv1 | 38 | -17.2 | 37.26 | 54 | -16.74 | - | - | 292 | 110 | V |
| 5 | 5.86316 | 35.94 | PK2 | 35 | -25.9 | 45.04 | - | - | - | - | 119 | 344 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average



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## 6.5. REFERENCE DETAIL

Reference application that contains the reference data which is attached to this report in Appendix A.

| Equipment Class | Reference FCC ID & IC | Reference Report Number | Report Title/Section |
|---|---|---|---|
| DTS | BCG-E3548A<br>579C-E3548A | 13335182-E2 | FCC IC_BLE Report / All sections |

## 6.6. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Range (GHz) | ANT 4 (dBi) | ANT 3 (dBi) |
|---|---|---|
| 2.4 | 0.3 | -1.7 |

## 6.7. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 18.1.148.558

## 6.8. WORST-CASE CONFIGURATION AND MODE

Radiated band edge and spurious emissions from 1GHz to 18GHz were performed based on the Model A2342 worst case with the EUT set at highest power at Low/Middle/High channels.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.



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## 6.9. DESCRIPTION OF TEST SETUP

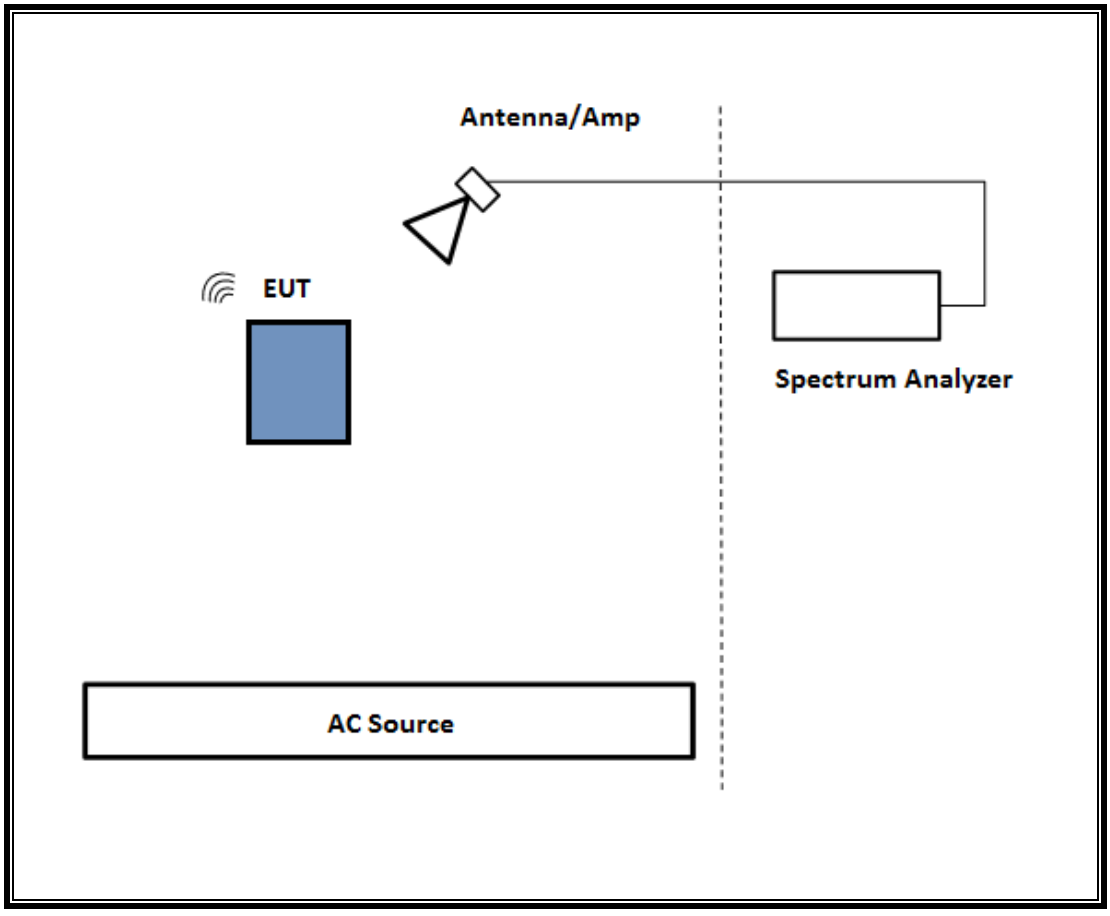
| SUPPORT TEST EQUIPMENT | | | | |
|---|---|---|---|---|
| Description | Manufacturer | Model | Serial Number | FCC ID/ DoC |
| Laptop | Apple | A1398 | C02PM012G3QD | QDS-BRCM1069 |
| Laptop AC/DC adapter | Liteon Technology | PA-1450-BA1 | B123 | N/A |
| EUT AC/DC adapter | Apple | A1385 | D29325SM03XDHLHC9 | N/A |

| I/O CABLES (RF RADIATED TEST) | | | | | | |
|---|---|---|---|---|---|---|
| Cable No. | Port | # of Identical Ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| 1 | AC | 1 | AC | Un-shielded | 2 | N/A |
| 2 | USB | 1 | USB | Un-shielded | 1 | N/A |

**TEST SETUP**

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz**



# 7. MEASUREMENT METHOD

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Measurement using gated average power meter.

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 & Clause 13

Band-edge: ANSI C63.10 Subclause -11.13.3.3 & Clause 13: Integration method -Trace averaging with continuous transmission at full power

Radiated emissions non-restricted frequency bands ANSI C63.10 Subclause -11.11 & Clause 13

**NOTE**: All conducted antenna port tests for Beamforming applied the same test procedures as BLE 1Mbps and BLE 2Mbps normal modes.

# 8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment were utilized for the tests documented in this report:

| Description | Manufacturer | Model | ID Num | Cal Due | Last Cal |
|---|---|---|---|---|---|
| Antenna, Double Ridge Guide Horn Antenna | A.H. Systems, Inc. | SAS-571 | T963 | 01/25/2021 | 01/25/2021 |
| Amplifier, 1 to 18GHz, 35dB | AMPLICAL | AMP1G18-35 | T1571 | 08/20/2021 | 08/20/2021 |
| EMI Test Receiver | Rohde & Schwarz | ESW44 | Pre0179372 | 02/25/2021 | 02/25/2021 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T344 | 5/26/2021 | 5/26/2020 |
| Amplifier, 1 - 18GHz | MITEQ | AFS42-00101800-25-S-42 | T1568 | 04/14/2021 | 04/14/2020 |
| EMI TEST RECEIVER | Rohde & Schwarz | ESW44 | PRE0180917 | 02/26/2021 | 02/26/2020 |
| Power Meter, P-series single channel | Keysight | N1911A | PRE0177682 | 01/21/2021 | 01/21/2020 |
| Power Sensor | Keysight | N1921A | T1226 | 02/13/2021 | 02/13/2020 |

# 9. SETUP PHOTOS

Please refer to 13335182-EP1 for setup photos



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# Appendix A – Reference Test Report

Attached is the test report (13335182-E2) containing the reference data from the parent model as detailed in section 6.5.



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# TEST REPORT

**Report Number:** 13335182-E2V3

| | | |
|---|---|---|
| **Applicant** | : | APPLE, INC.<br>1 APPLE PARK WAY<br>CUPERTINO, CA 95014, U.S.A |
| **Model** | : | A2342 |
| **FCC ID** | : | BCG-E3548A |
| **IC** | : | 579C-E3548A |
| **EUT Description** | : | SMARTPHONE |
| **Test Standard(s)** | : | FCC 47 CFR PART 15 SUBPART C<br>ISED RSS-247 ISSUE 2<br>ISED RSS-GEN ISSUE 5 |

**Date of Issue:**
September 30, 2020

**Prepared by:**
UL Verification Services Inc.
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Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
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NVLAP Lab code: 200065-0

## REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| V1 | 9/21/2020 | Initial Issue | Chin Pang |
| V2 | 9/25/2020 | Address TCB's Questions | Chin Pang |
| V3 | 9/30/2020 | Address TCB's Questions | Vien Tran |



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UL VERIFICATION SERVICES INC.
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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A2342

**SERIAL NUMBER:** G6TCQ01TQ897, G6TCQ02KQ897

**DATE TESTED:** MAY 06, 2020 to SEPTEMBER 05, 2020

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| CFR 47 Part 15 Subpart C | Complies |
| ISED RSS-247 Issue 2 | Complies |
| ISED RSS-GEN Issue 5 | Complies |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:

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UL Verification Services Inc.

Prepared By:

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# 2. TEST SUMMARY

| FCC Clause | ISED Clause | Requirement | Result | Comment |
|---|---|---|---|---|
| See Comment | | Duty Cycle | Reporting purposes only | ANSI C63.10 Section 11.6. |
| - | RSS-GEN 6.7 | 99% OBW | Reporting purposes only | ANSI C63.10 Section 6.9.3. |
| 15.247 (a) (2) | RSS-247 5.2 (a) | 6dB BW | Complies | None. |
| 15.247 (b) (3) | RSS-247 5.4 (d) | Output Power | Complies | None. |
| See Comment | | Average power | Reporting purposes only | Per ANSI C63.10, Section 11.9.2.3.2. |
| 15.247 (e) | RSS-247 5.2 (b) | PSD | Complies | None. |
| 15.247 (d) | RSS-247 5.5 | Conducted Spurious Emissions | Complies | None. |
| 15.209, 15.205 | RSS-GEN 8.9, 8.10 | Radiated Emissions | Complies | None. |
| 15.207 | RSS-Gen 8.8 | AC Mains Conducted Emissions | Complies | None. |

# 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 662911, RSS-GEN Issue 5, and RSS-247 Issue 2.

# 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 47173 Benicia Street | 47266 Benicia Street | 47658 Kato Rd. |
|---|---|---|
| ☐ Chamber A (IC:2324B-1) | ☐ Chamber D (IC:22541-1) | ☐ Chamber I (IC: 2324A-5) |
| ☐ Chamber B (IC:2324B-2) | ☒ Chamber E (IC:22541-2) | ☐ Chamber J (IC: 2324A-6) |
| ☐ Chamber C (IC:2324B-3) | ☐ Chamber F (IC:22541-3) | ☐ Chamber K (IC: 2324A-1) |
| | ☐ Chamber G (IC:22541-4) | ☐ Chamber L (IC: 2324A-3) |
| | ☒ Chamber H (IC:22541-5) | ☐ Chamber M (IC: 2324A-2) |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.
UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0


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# 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

## 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

## 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

## 5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | $U_{LAB}$ |
|---|---|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz | 3.39 dB |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz | 3.07 dB |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz | 2.52 dB |
| Worst Case Radiated Disturbance, 30 to 1000 MHz | 4.88 dB |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz | 4.24 dB |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.37 dB |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.17 dB |

Uncertainty figures are valid to a confidence level of 95%.



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# 6. EQUIPMENT UNDER TEST

## 6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, 5G, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wideband, GPS, NFC and WPT. All models support at least one UICC based SIM. The second SIM is either an UICC based p-SIM (physical SIM) or e-SIM (electronic SIM). The device supports a built-in inductive charging transmitter and receiver. The rechargeable battery is not user accessible.

## 6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

| Antenna | Configuration | Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|---|---|---|---|---|---|
| ANT 4 | High Power | 2402 - 2480 | BLE 1M | 20.22 | 105.20 |
| | Low Power | | | 12.71 | 18.66 |
| | High Power | 2404 - 2478 | BLE 2M | 20.15 | 103.51 |
| | Low Power | | | 12.70 | 18.62 |
| ANT 3 | High Power | 2402 - 2480 | BLE 1M | 20.21 | 104.95 |
| | Low Power | | | 12.80 | 19.05 |
| | High Power | 2404 - 2478 | BLE 2M | 20.23 | 105.44 |
| | Low Power | | | 12.79 | 19.01 |
| BF, ANT 4 + ANT 3 | High Power | 2402 - 2480 | BLE 1M | 20.41 | 109.90 |
| | Low Power | | | 15.76 | 37.67 |
| | High Power | 2404 - 2478 | BLE 2M | 20.27 | 106.41 |
| | Low Power | | | 15.77 | 37.76 |

## 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Range (GHz) | ANT 4 (dBi) | NT 3 (dBi) |
|---|---|---|
| 2.4 | 0.3 | -1.7 |

## 6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was18.1.148.558.



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## 6.5. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on ANT 3 and ANT 4. It was determined that Y (Landscape) orientation was the worst-case orientation for ANT 3 and X (Flatbed) for ANT 4 and beamforming 2TX.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario. There were no emissions found below 30MHz within 20dB of the limit.

For below 1GHz tests were performed with EUT connected to AC power adapter as the worst case; and for above 1GHz, the worst-case configuration reported was tested with EUT only. For AC line conducted emission, test was investigated with AC power adapter and with laptop.

For simultaneous transmission of multiple channels in the 2.4GHz BLE and 5GHz bands. No noticeable emission was found.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.



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## 6.6. DESCRIPTION OF TEST SETUP

| SUPPORT TEST EQUIPMENT | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID/ DoC** |
| Laptop | Apple | A1398 | C02PM012G3QD | QDS-BRCM1069 |
| Laptop AC/DC adapter | Liteon Technology | PA-1450-BA1 | B123 | N/A |
| EUT AC/DC adapter | Apple | A1385 | D29325SM03XDHLHC9 | N/A |

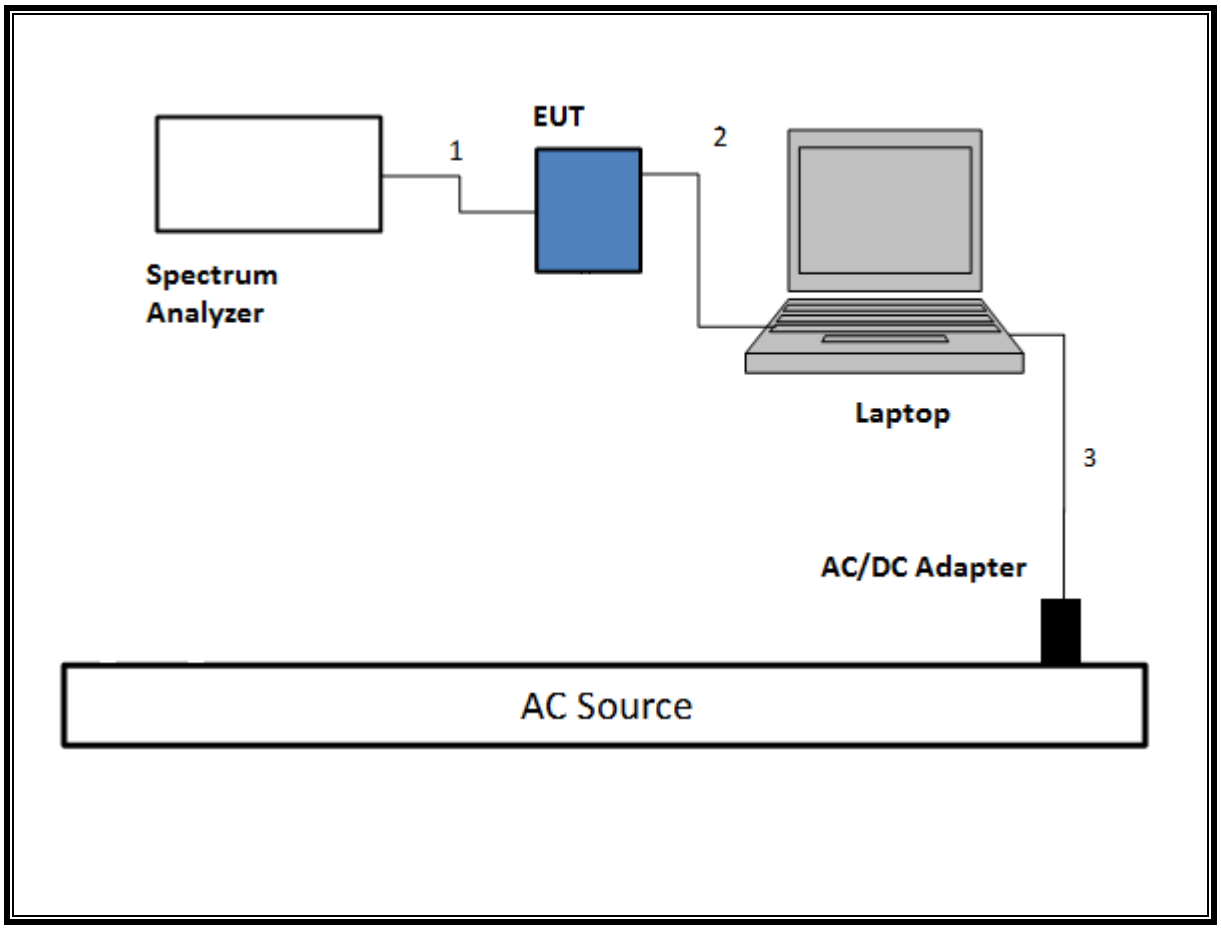
| I/O CABLES (RF CONDUCTED TEST) | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length (m)** | **Remarks** |
| 1 | Antenna | 1 | SMA | Un-shielded | 0.2 | To spectrum Analyzer |
| 2 | USB | 1 | USB | Shielded | 1.0 | N/A |
| 3 | AC | 1 | AC | Un-shielded | 2 | N/A |

| I/O CABLES (RF RADIATED TEST) | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No.** | **Port** | **# of Identical Ports** | **Connector Type** | **Cable Type** | **Cable Length (m)** | **Remarks** |
| 1 | AC | 1 | AC | Un-shielded | 2 | N/A |
| 2 | USB | 1 | USB | Un-shielded | 1 | N/A |

**TEST SETUP**

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR CONDUCTED TESTS**





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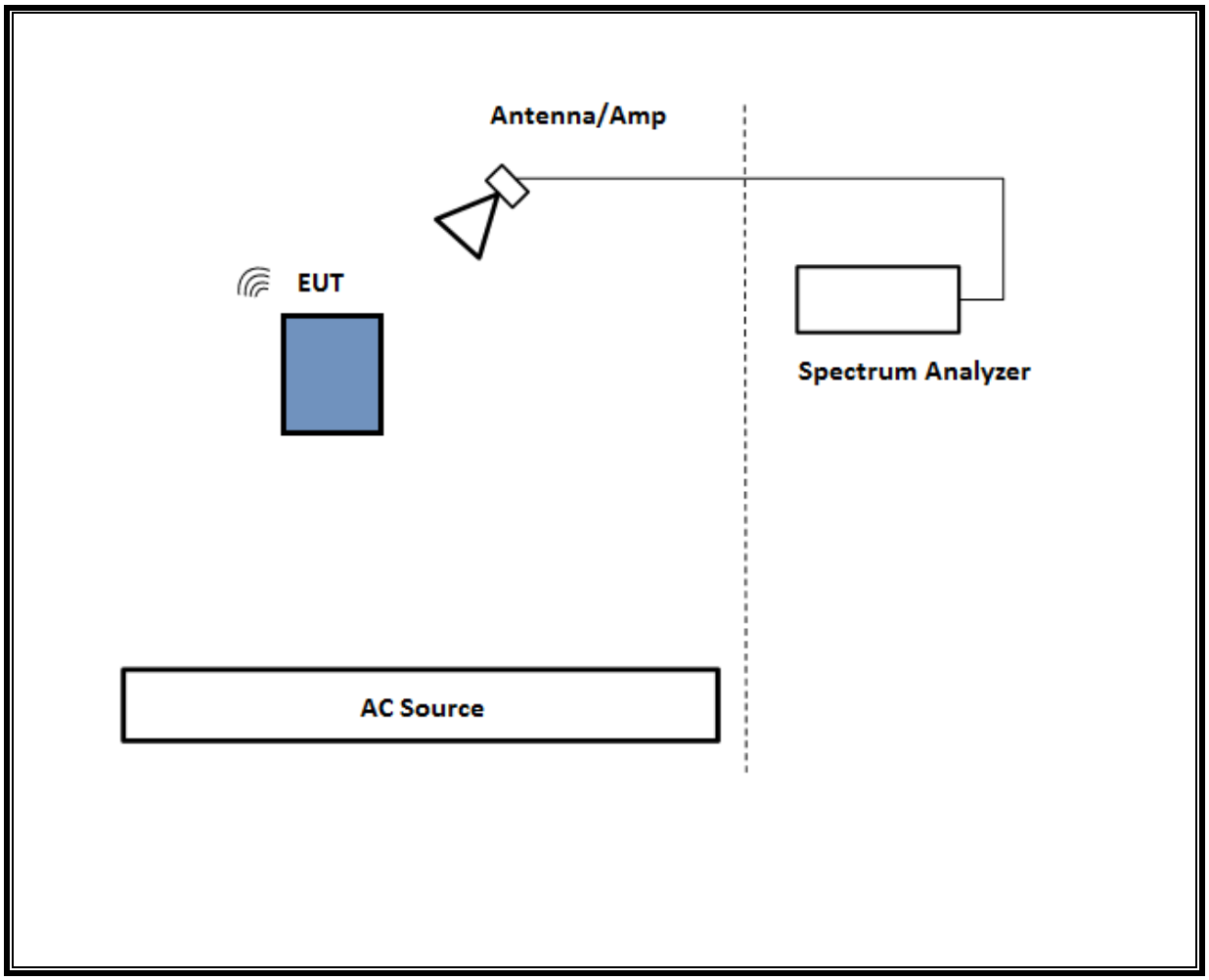
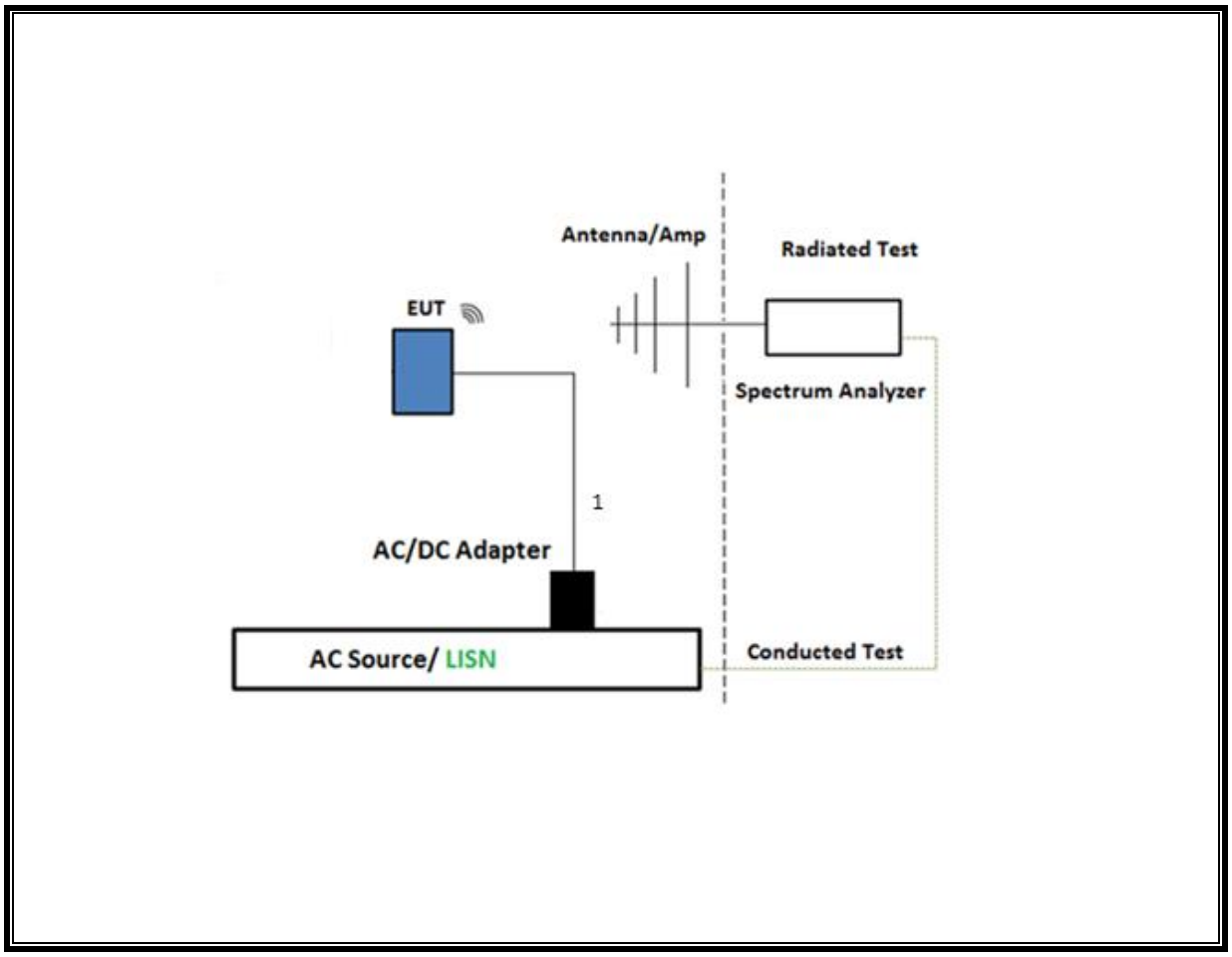
**SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz**



**SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST**



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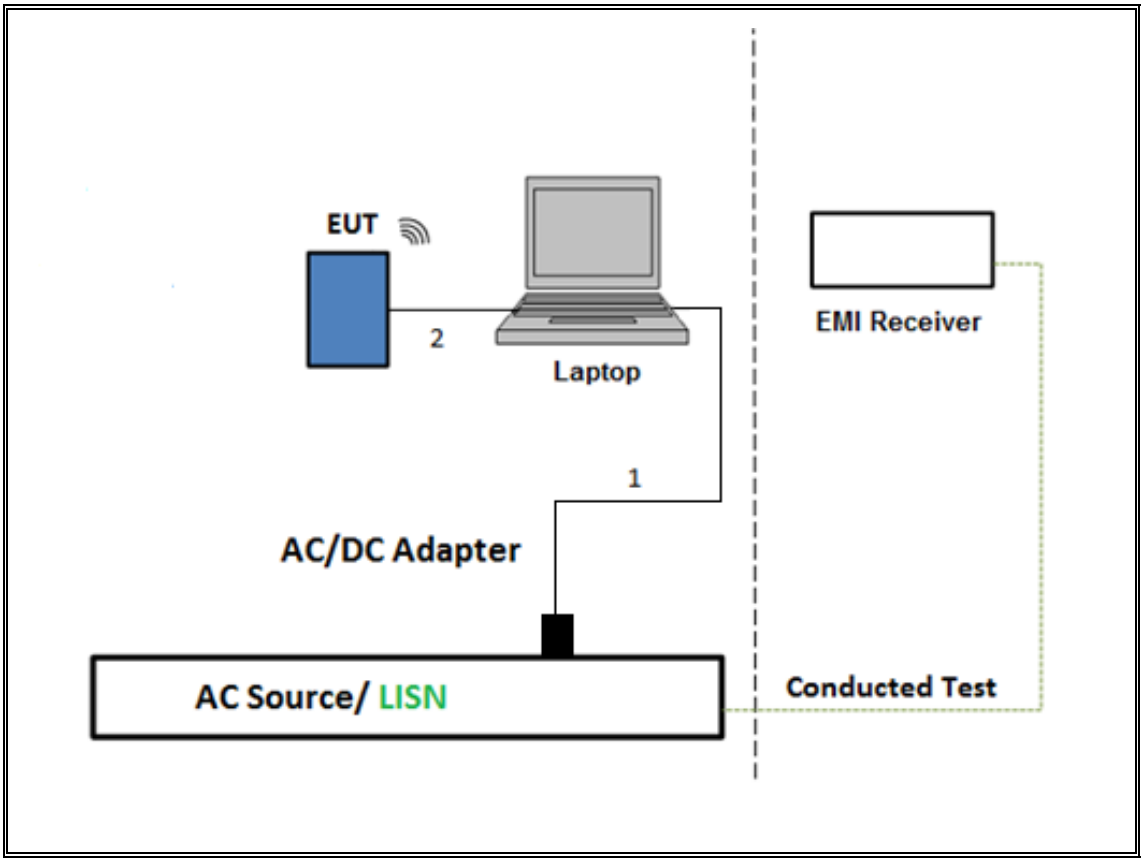
**TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION**



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# 7. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 558074 D01 v05r02, Section 6.

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW ≥ DTS BW

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Measurement using gated average power meter.

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 & Clause 13

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

Band-edge: ANSI C63.10 Subclause -11.13.3.2 & Clause 13: Integration method -Peak detection

Band-edge: ANSI C63.10 Subclause -11.13.3.3 & Clause 13: Integration method -Trace averaging with continuous transmission at full power

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Radiated emissions non-restricted frequency bands ANSI C63.10 Subclause -11.11 & Clause 13

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4 & 13

**NOTE**: All conducted antenna port tests for Beamforming applied the same test procedures as BLE 1Mbps and BLE 2Mbps normal modes.



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# 8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment were utilized for the tests documented in this report:

| Description | Manufacturer | Model | ID Num | Cal Due | Last Cal |
|---|---|---|---|---|---|
| Spectrum Analyzer, PXA 3Hz to 44GHz | Keysight | N9030A | T907 | 01/22/2021 | 01/22/2020 |
| Antenna, Broadband Hybrid, 30-2000MHz | Sunol Sciences | JB1 | T130 | 08/09/2020 | 08/09/2019 |
| Amplifier, 10KHz to 1GHz, 32dB | Sonoma | 310N | T285 | 06/06/2020 | 06/06/2019 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T863 | 11/01/2020 | 11/01/2019 |
| Amplifier, 1 to 18GHz, 35dB | Amplical | AFS42-00101800-25-S-42 | T1567 | 01/24/2021 | 01/24/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1210 | 01/21/2021 | 01/21/2020 |
| Antenna, Double Ridge Guide Horn Antenna | A.H. Systems, Inc. | SAS-571 | T963 | 01/25/2021 | 01/25/2020 |
| Amplifier, 1 to 18GHz, 35dB | Amplical | AFS42-00101800-25-S-42 | T1568 | 04/14/2021 | 04/14/2020 |
| Pre-Amp 18-26GHz | Agilent Technology | 8449B | T404 | 04/08/2021 | 04/08/2020 |
| Antenna, Horn 18-26GHz | ARA | SWH-28 | T125 | 04/17/2021 | 04/17/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1454 | 01/23/2021 | 01/23/2020 |
| Power Meter, P-series single channel | Keysight | N1911A | PRE0177682 | 01/21/2021 | 01/21/2020 |
| Power Sensor | Keysight | N1921A | T1226 | 02/13/2021 | 02/13/2020 |

| AC Line Conducted | | | | | |
|---|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **ID Num** | **Cal Due** | **Last Cal** |
| *EMI Test Receiver 9kHz-7GHz | Rohde & Schwarz | ESR | T1436 | 02/20/2021 | 02/20/2020 |
| Power Cable, Line Conducted Emissions | UL | PR1 | T861 | 10/27/2020 | 10/27/2019 |
| LISN for Conducted Emissions CISPR-16 | FISCHER CUSTOM COMMUNICATIONS | FCC-LISN-50/250-25-2-01 | PRE0186446 | 01/23/2021 | 01/23/2020 |
| **UL AUTOMATION SOFTWARE** | | | | | |
| Radiated Software | UL | UL EMC | Ver 9.5, Mar 6, 2020 | | |
| Conducted Software | UL | UL EMC | 2020.2.26 | | |
| AC Line Conducted Software | UL | UL EMC | Ver 9.5, February 21, 2020 | | |

*Testing was completed before equipment calibration date

# 9. ANTENNA PORT TEST RESULTS

## 9.1. ON TIME AND DUTY CYCLE

**LIMITS**

None; for reporting purposes only.

**PROCEDURE**

KDB 558074 Zero-Span Spectrum Analyzer Method.

**ON TIME AND DUTY CYCLE RESULTS**

| Mode | ON Time B (msec) | Period (msec) | Duty Cycle x (linear) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) | 1/B Minimum VBW (kHz) |
|---|---|---|---|---|---|---|
| **2.4GHz Band** | | | | | | |
| BLE, 1Mbps | 17.1 | 17.1 | 1.00 | 100.0 | 0.00 | 0.010 |
| BLE, 2Mbps | 28.5 | 28.5 | 1.00 | 100.0 | 0.00 | 0.010 |
| BLE, TXBF, 1Mbps | 26.1 | 26.1 | 1.00 | 100.0 | 0.00 | 0.010 |
| BLE, TXBF, 2Mbps | 24.0 | 24.0 | 1.00 | 100.0 | 0.00 | 0.010 |

Note: Low power duty cycle is same as higher power



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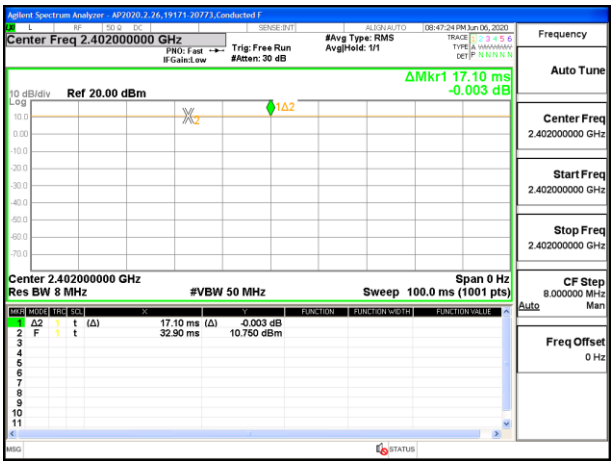
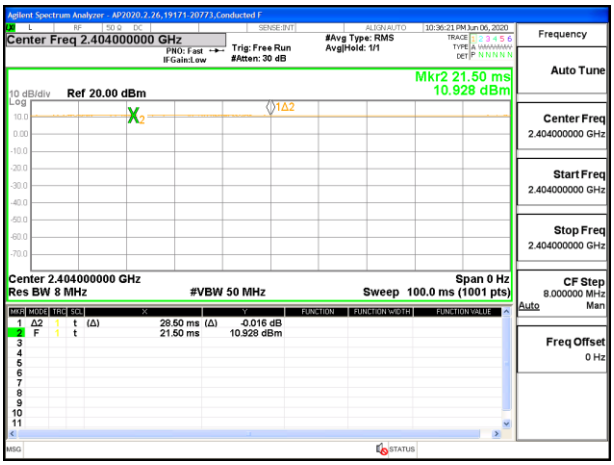
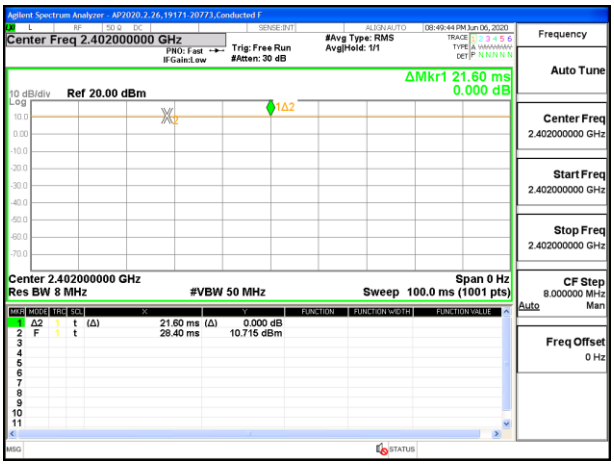
## DUTY CYCLE PLOTS



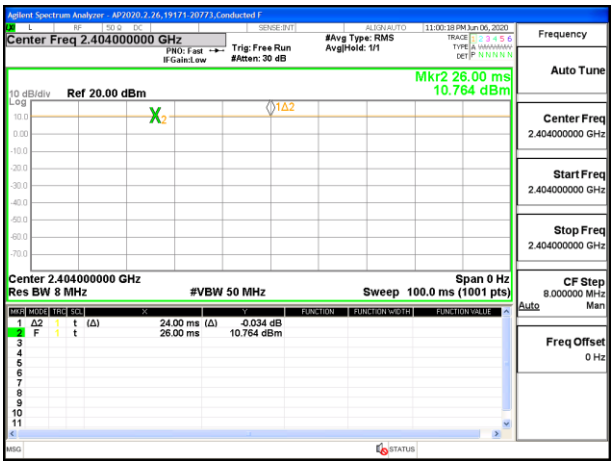

**BLE 1Mbps**




**BLE 2Mbps**




**BLE TXBF 1Mbps**




**BLE TXBF 2Mbps**

## 9.2. 99% BANDWIDTH

**LIMITS**

None; for reporting purposes only.

**RESULTS**

Only High Power modes result is reported, it covers all Low Power modes. Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.



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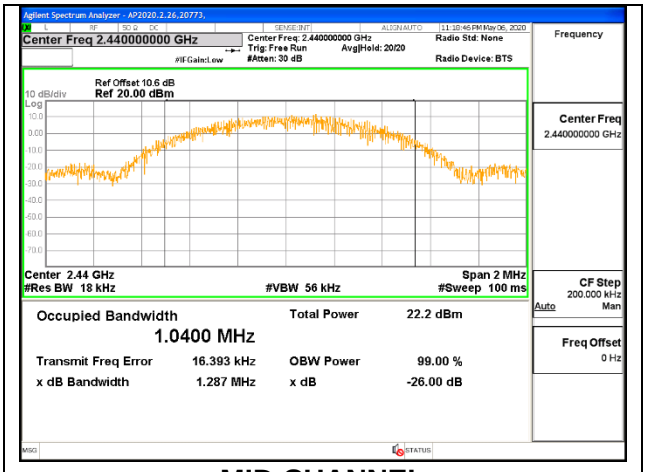
### 9.2.1. HIGH POWER BLE (1Mbps)

**ANT 4**

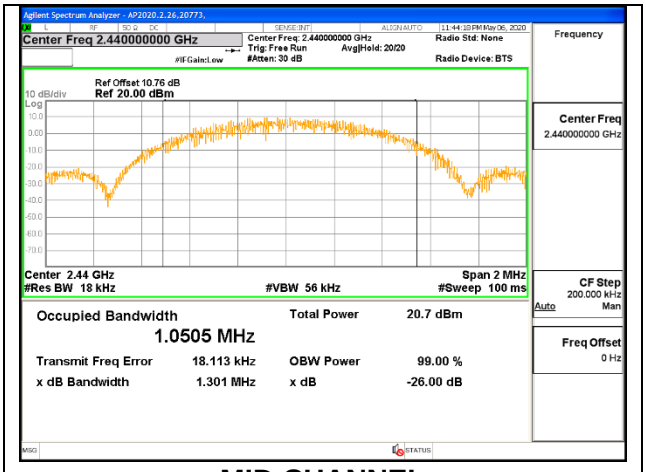
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2402 | 1.056 |
| Middle | 2440 | 1.040 |
| High | 2480 | 1.051 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2402 | 1.051 |
| Middle | 2440 | 1.051 |
| High | 2480 | 1.043 |

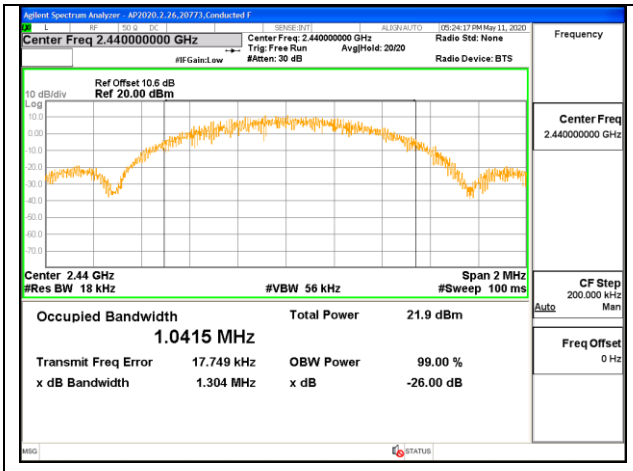



**MID CHANNEL**

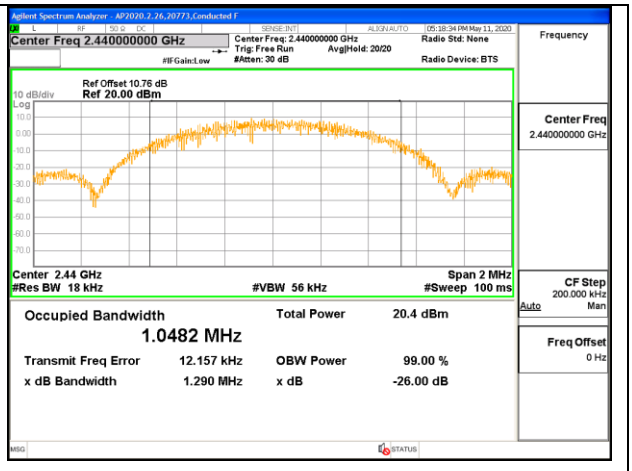
### 9.2.2. HIGH POWER BLE TXBF (1Mbps)

| Channel | Frequency (MHz) | 99% Bandwidth ANT 4 (MHz) | 99% Bandwidth ANT 3 (MHz) |
|---|---|---|---|
| Low | 2402 | 1.036 | 1.038 |
| Mid | 2440 | 1.042 | 1.048 |
| High | 2480 | 1.041 | 1.041 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**

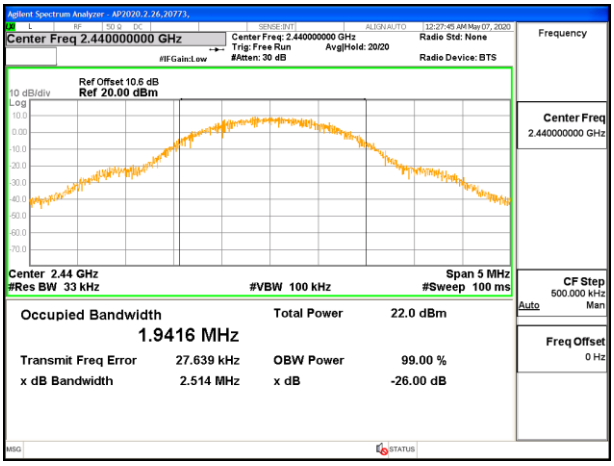



**MID CHANNEL ANT 3**

### 9.2.3. HIGH POWER BLE (2Mbps)

**ANT 4**

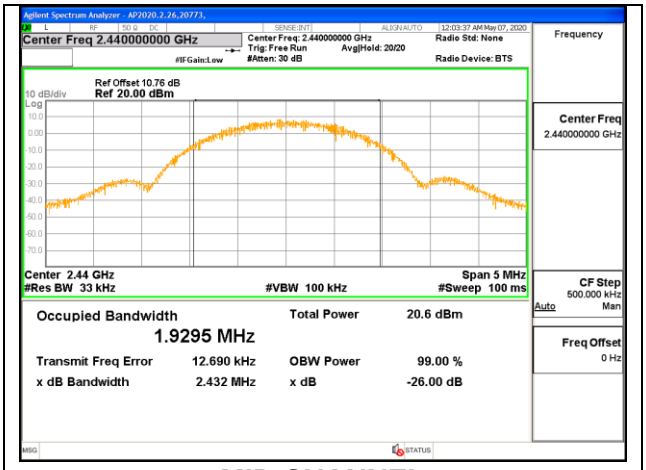
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2404 | 1.921 |
| Middle | 2440 | 1.942 |
| High | 2478 | 1.937 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---|---|---|
| Low | 2402 | 1.921 |
| Middle | 2440 | 1.930 |
| High | 2480 | 1.928 |

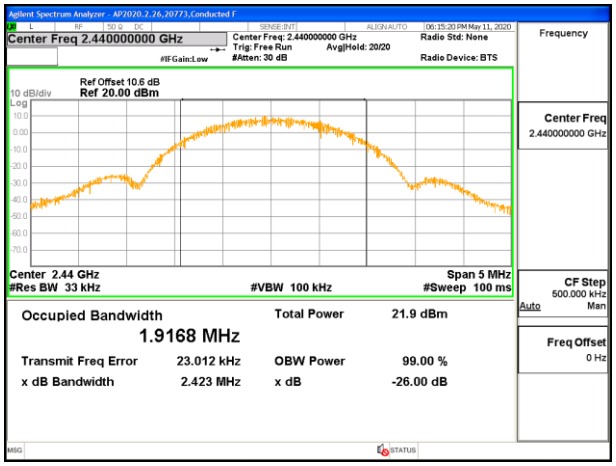



**MID CHANNEL**

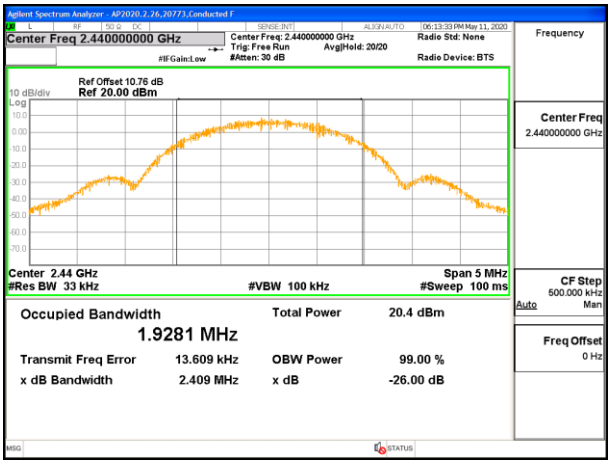
### 9.2.4. HIGH POWER BLE TXBF (2Mbps)

| Channel | Frequency (MHz) | 99% Bandwidth ANT 4 (MHz) | 99% Bandwidth ANT 3 (MHz) |
|---|---|---|---|
| Low | 2404 | 1.909 | 1.918 |
| Mid | 2440 | 1.917 | 1.928 |
| High | 2478 | 1.914 | 1.925 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**




**MID CHANNEL ANT 3**



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## 9.3. 6 dB BANDWIDTH

**LIMITS**

FCC §15.407 (e)

RSS-247 5.2 (a)

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

**RESULTS**

The 6dB bandwidth was measured for the 1Mbps mode, high power, to demonstrate compliance with the minimum required bandwidth of 500 kHz. Other modes were not tested as their bandwidth is greater than the 1Mbps mode, as demonstrated by the 99% bandwidth measurements performed on all modes.

Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.



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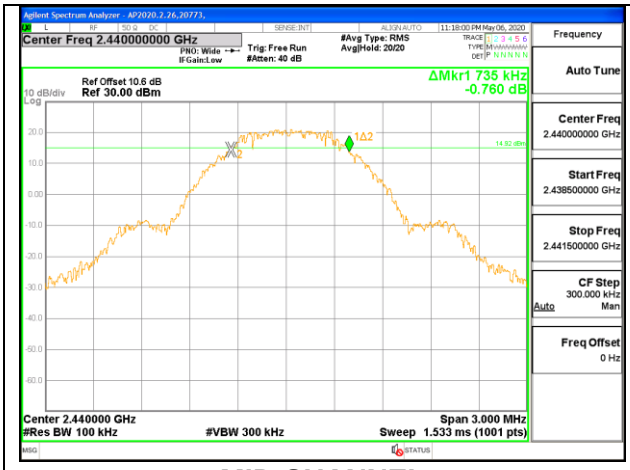
### 9.3.1. HIGH POWER BLE (1Mbps)

**ANT 4**

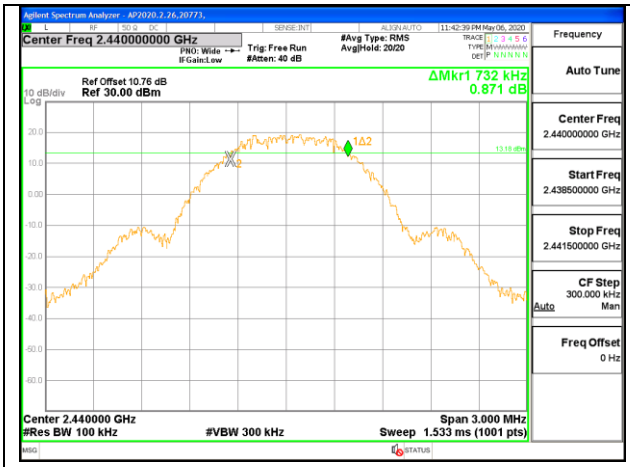
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---|---|---|---|
| Low | 2402 | 0.696 | 0.5 |
| Middle | 2440 | 0.735 | 0.5 |
| High | 2480 | 0.654 | 0.5 |




**MID CHANNEL**

**ANT 3**

| Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---|---|---|
| 2402 | 0.717 | 0.5 |
| 2440 | 0.732 | 0.5 |
| 2480 | 0.699 | 0.5 |




**MID CHANNEL**

## 9.4. OUTPUT POWER

**LIMITS**

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

**TEST PROCEDURE**

Measurement was performed using a power meter with wideband power sensor.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband peak power sensor. Peak output power was read directly from power meter

**DIRECTIONAL ANTENNA GAIN**

For 1 TX:
There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2TX:

Tx chains are correlated for power and PSD due to the device supporting Beamforming mode.The directional gains are as follows:

| Band (GHz) | ANT 4 Antenna Gain (dBi) | ANT 3 Antenna Gain (dBi) | Uncorrelated Chains Directional Gain (dBi) | Correlated Chains Directional Gain (dBi) |
|---|---|---|---|---|
| 2.4 | 0.30 | -1.70 | -0.59 | 2.37 |

**RESULTS**

### 9.4.1. HIGH POWER BLE (1Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 20.18 | 30 | -9.82 |
| Middle | 2440 | 20.22 | 30 | -9.78 |
| High | 2480 | 20.19 | 30 | -9.81 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 20.14 | 30 | -9.86 |
| Middle | 2440 | 20.21 | 30 | -9.79 |
| High | 2480 | 20.20 | 30 | -9.80 |

### 9.4.2. HIGH POWER BLE TXBF (1Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Output Power ANT 4 (dBm) | Output Power ANT 3 (dBm) | Total Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | 17.39 | 17.40 | 20.41 | 30 | -9.59 |
| Middle | 2440 | 17.36 | 17.32 | 20.35 | 30 | -9.65 |
| High | 2480 | 17.32 | 17.31 | 20.33 | 30 | -9.67 |



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### 9.4.3. HIGH POWER BLE (2Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 20.13 | 30 | -9.87 |
| Middle | 2440 | 20.09 | 30 | -9.91 |
| High | 2480 | 20.15 | 30 | -9.85 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 20.09 | 30 | -9.91 |
| Middle | 2440 | 20.12 | 30 | -9.88 |
| High | 2480 | 20.23 | 30 | -9.77 |

### 9.4.4. HIGH POWER BLE TXBF (2Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Output Power Ant 4 (dBm) | Output Power Ant 3 (dBm) | Total Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | 17.10 | 17.18 | 20.15 | 30 | -9.85 |
| Middle | 2440 | 17.21 | 17.11 | 20.17 | 30 | -9.83 |
| High | 2480 | 17.31 | 17.21 | 20.27 | 30 | -9.73 |

## 9.4.5. LOW POWER BLE (1Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 12.69 | 30 | -17.31 |
| Middle | 2440 | 12.59 | 30 | -17.41 |
| High | 2480 | 12.71 | 30 | -17.29 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 12.66 | 30 | -17.34 |
| Middle | 2440 | 12.74 | 30 | -17.26 |
| High | 2480 | 12.80 | 30 | -17.20 |

## 9.4.6. LOW POWER BLE TXBF (1Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Output Power ANT 4 (dBm) | Output Power ANT 3 (dBm) | Total Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | 12.71 | 12.52 | 15.63 | 30 | -14.37 |
| Middle | 2440 | 12.76 | 12.74 | 15.76 | 30 | -14.24 |
| High | 2480 | 12.66 | 12.77 | 15.73 | 30 | -14.27 |

## 9.4.7. LOW POWER BLE (2Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 12.59 | 30 | -17.41 |
| Middle | 2440 | 12.66 | 30 | -17.34 |
| High | 2480 | 12.70 | 30 | -17.30 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Peak Power Reading (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 12.68 | 30 | -17.32 |
| Middle | 2440 | 12.79 | 30 | -17.21 |
| High | 2480 | 12.77 | 30 | -17.23 |

## 9.4.8. LOW POWER BLE TXBF (2Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Output Power ANT 4 (dBm) | Output Power ANT 3 (dBm) | Total Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | 12.62 | 12.71 | 15.68 | 30 | -14.32 |
| Middle | 2440 | 12.75 | 12.76 | 15.77 | 30 | -14.23 |
| High | 2480 | 12.79 | 12.66 | 15.74 | 30 | -14.26 |

## 9.5. AVERAGE POWER

**LIMITS**

None; for reporting purposes only.

**TEST PROCEDURE**

Measurement was performed using a power meter with gated wideband power sensor.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband average power sensor. Gated average output power was read directly from power meter.

**RESULTS**



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### 9.5.1. HIGH POWER BLE (1Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 19.68 |
| Middle | 2440 | 19.81 |
| High | 2480 | 19.72 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 19.74 |
| Middle | 2440 | 19.88 |
| High | 2480 | 19.76 |

### 9.5.2. HIGH POWER BLE TXBF (1Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Average Power ANT 4 (dBm) | Average Power ANT 3 (dBm) | Total Power (dBm) |
|---|---|---|---|---|
| Low | 2402 | 16.83 | 16.92 | 19.89 |
| Middle | 2440 | 16.91 | 16.86 | 19.90 |
| High | 2480 | 16.89 | 16.85 | 19.88 |



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### 9.5.3. HIGH POWER BLE (2Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 19.66 |
| Middle | 2440 | 19.79 |
| High | 2480 | 19.77 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 19.68 |
| Middle | 2440 | 19.79 |
| High | 2480 | 19.80 |

### 9.5.4. HIGH POWER BLE TXBF (2Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Average Power ANT 4 (dBm) | Average Power ANT 3 (dBm) | Total Power (dBm) |
|---|---|---|---|---|
| Low | 2402 | 16.71 | 16.69 | 19.71 |
| Middle | 2440 | 16.83 | 16.78 | 19.82 |
| High | 2480 | 16.89 | 16.80 | 19.86 |

### 9.5.5. LOW POWER BLE (1Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 12.20 |
| Middle | 2440 | 12.19 |
| High | 2480 | 12.29 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 12.17 |
| Middle | 2440 | 12.29 |
| High | 2480 | 12.31 |

### 9.5.6. LOW POWER BLE TXBF (1Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Average Power ANT 4 (dBm) | Average Power ANT 3 (dBm) | Total Power (dBm) |
|---|---|---|---|---|
| Low | 2402 | 12.22 | 12.16 | 15.20 |
| Middle | 2440 | 12.32 | 12.34 | 15.34 |
| High | 2480 | 12.19 | 12.31 | 15.26 |


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### 9.5.7. LOW POWER BLE (2Mbps)

**ANT 4**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 12.19 |
| Middle | 2440 | 12.29 |
| High | 2480 | 12.28 |

**ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | AV power (dBm) |
|---|---|---|
| Low | 2402 | 12.29 |
| Middle | 2440 | 12.33 |
| High | 2480 | 12.39 |

### 9.5.8. LOW POWER BLE TXBF (2Mbps)

**ANT 4 + ANT 3**

| | |
|---|---|
| **Tested By:** | 39472 |
| **Date:** | 9/2/2020 |

| Channel | Frequency (MHz) | Average Power Ant 4 (dBm) | Average Power Ant 3 (dBm) | Total Power (dBm) |
|---|---|---|---|---|
| Low | 2402 | 12.22 | 12.29 | 15.27 |
| Middle | 2440 | 12.31 | 12.34 | 15.34 |
| High | 2480 | 12.39 | 12.20 | 15.31 |



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## 9.6. POWER SPECTRAL DENSITY

**LIMITS**

FCC §15.247 (e)

RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

**RESULTS**

Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.



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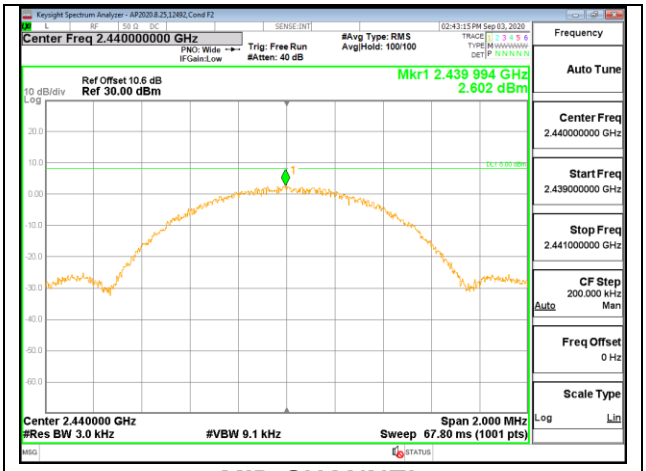
### 9.6.1. HIGH POWER BLE (1Mbps)

**ANT 4**

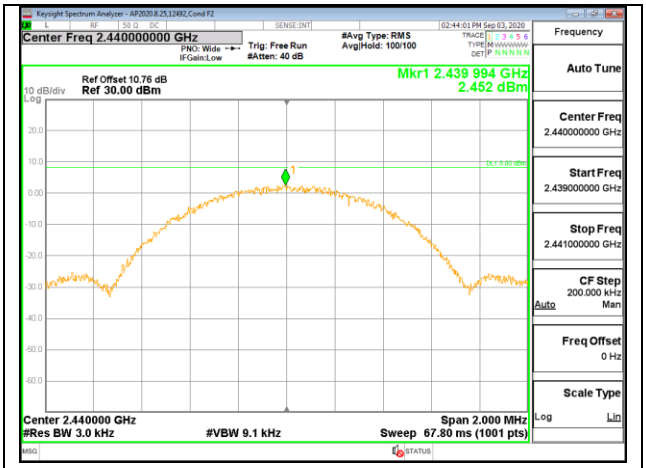
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 2.576 | 8 | -5.42 |
| Middle | 2440 | 2.602 | 8 | -5.40 |
| High | 2480 | 1.513 | 8 | -6.49 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | 2.584 | 8 | -5.42 |
| Middle | 2440 | 2.452 | 8 | -5.55 |
| High | 2480 | 1.666 | 8 | -6.33 |



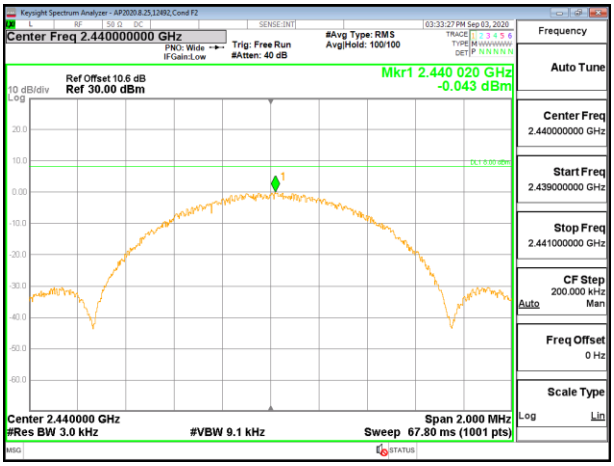

**MID CHANNEL**

### 9.6.2. HIGH POWER BLE TXBF (1Mbps)

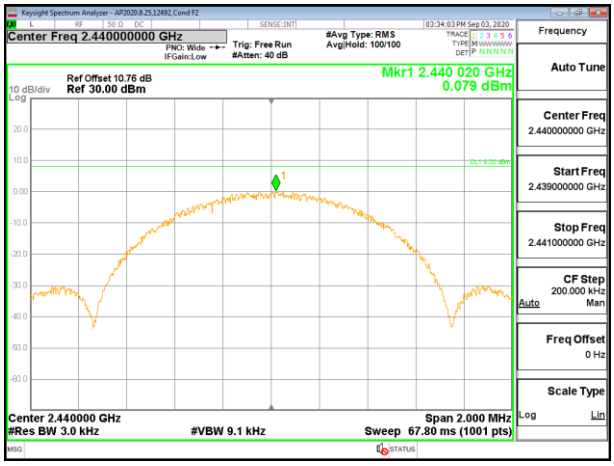
**PSD Results**

| Channel | Frequency (MHz) | ANT 4 Meas (dBm/ 3kHz) | ANT 3 Meas (dBm/ 3kHz) | Total Corr'd PSD (dBm/ 3kHz) | Limit (dBm/ 3kHz) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | -0.608 | -0.108 | 2.66 | 8.0 | -5.3 |
| Mid | 2440 | -0.043 | 0.079 | 3.03 | 8.0 | -5.0 |
| Hjigh | 2480 | 0.162 | -0.196 | 3.00 | 8.0 | -5.0 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**

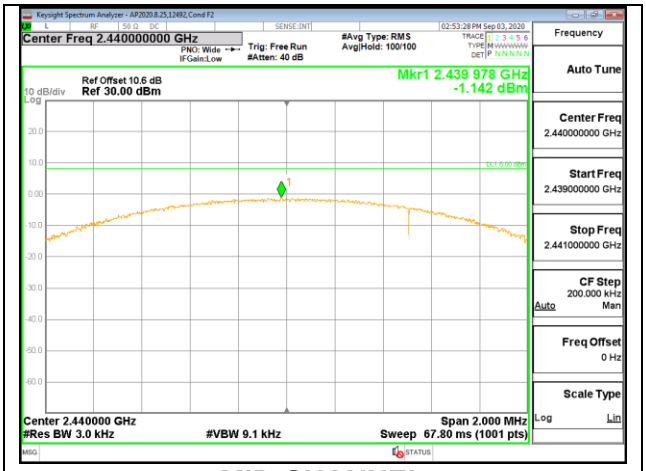



**MID CHANNEL ANT 3**

### 9.6.3. HIGH POWER BLE (2Mbps)

**ANT 4**

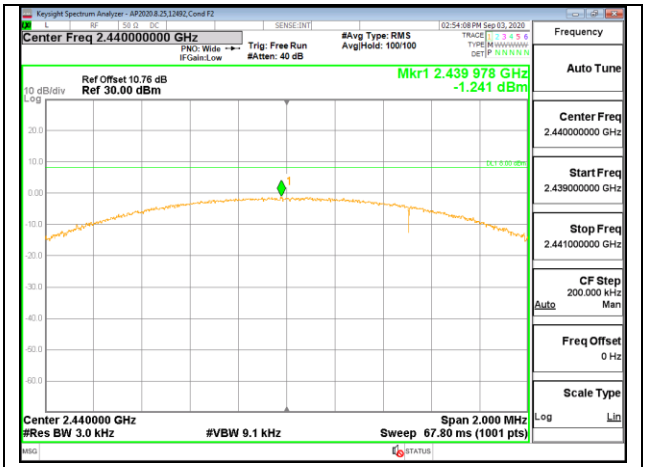
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2404 | -1.843 | 8 | -9.84 |
| Middle | 2440 | -1.142 | 8 | -9.14 |
| High | 2478 | -2.558 | 8 | -10.56 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2404 | -1.730 | 8 | -9.73 |
| Middle | 2440 | -1.241 | 8 | -9.24 |
| High | 2478 | -2.452 | 8 | -10.45 |



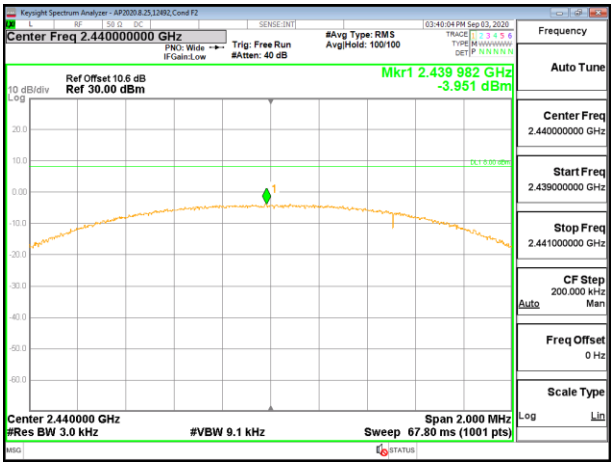

**MID CHANNEL**

### 9.6.4. HIGH POWER BLE TXBF (2Mbps)

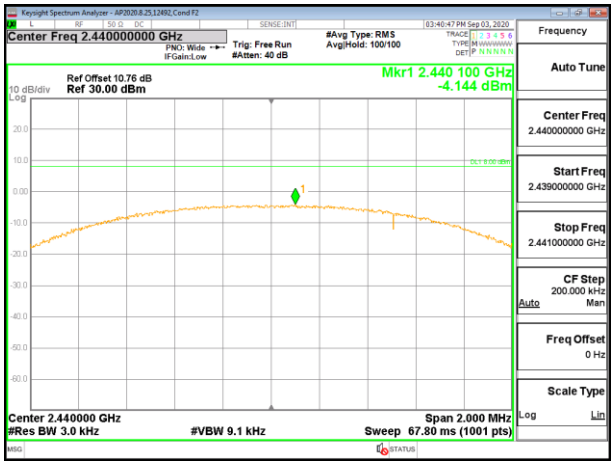
**PSD Results**

| Channel | Frequency (MHz) | ANT 4 Meas (dBm/ 3kHz) | ANT 3 Meas (dBm/ 3kHz) | Total Corr'd PSD (dBm/ 3kHz) | Limit (dBm/ 3kHz) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2404 | -4.403 | -4.221 | -1.30 | 8.0 | -9.3 |
| Mid | 2440 | -3.951 | -4.144 | -1.04 | 8.0 | -9.0 |
| Hjigh | 2478 | -3.890 | -3.696 | -0.78 | 8.0 | -8.8 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**

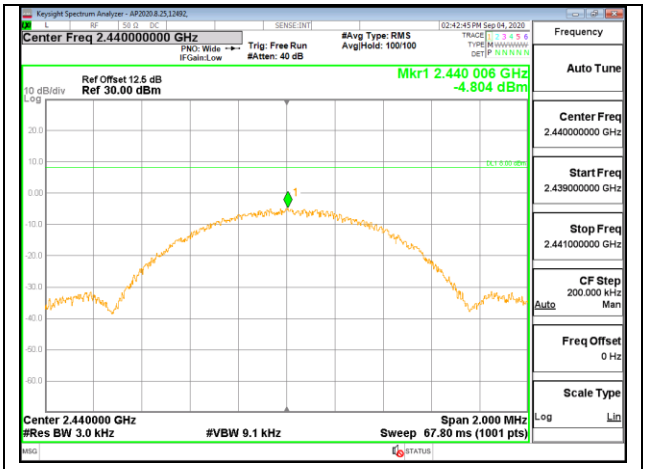



**MID CHANNEL ANT 3**

### 9.6.5. LOW POWER BLE (1Mbps)

**ANT 4**

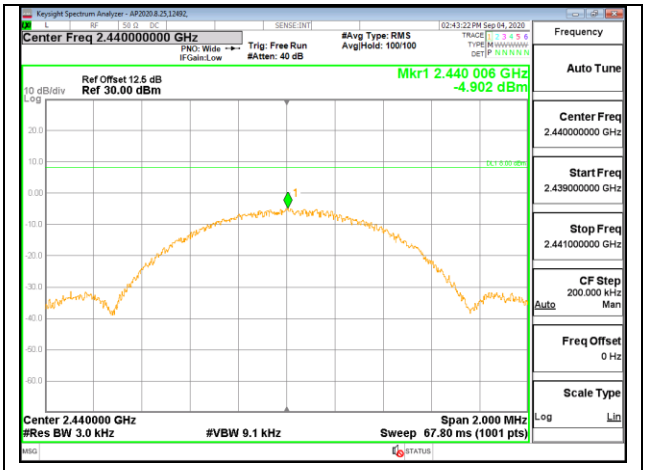
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | -5.425 | 8 | -13.43 |
| Middle | 2440 | -4.804 | 8 | -12.80 |
| High | 2480 | -6.300 | 8 | -14.30 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2402 | -5.077 | 8 | -13.08 |
| Middle | 2440 | -4.902 | 8 | -12.90 |
| High | 2480 | -6.418 | 8 | -14.42 |



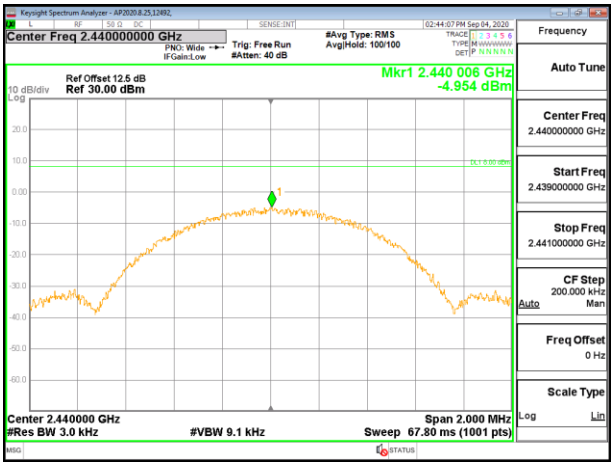

**MID CHANNEL**

## 9.6.6. LOW POWER BLE TXBF (1Mbps)

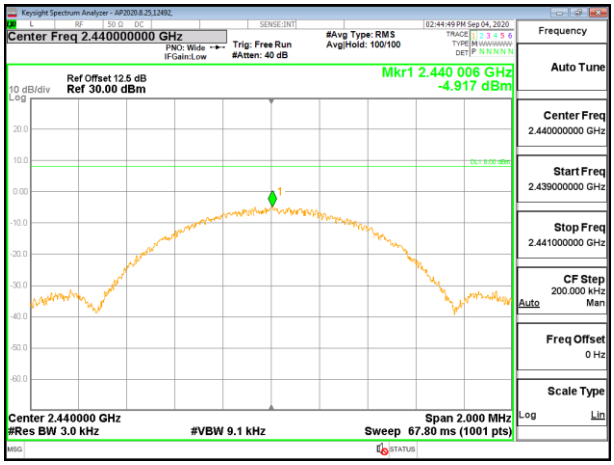
**PSD Results**

| Channel | Frequency (MHz) | ANT 4 Meas (dBm/ 3kHz) | ANT 3 Meas (dBm/ 3kHz) | Total Corr'd PSD (dBm/ 3kHz) | Limit (dBm/ 3kHz) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2402 | -5.147 | -5.215 | -2.17 | 8.0 | -10.2 |
| Mid | 2440 | -4.954 | -4.917 | -1.93 | 8.0 | -9.9 |
| Hjigh | 2480 | -6.348 | -6.400 | -3.36 | 8.0 | -11.4 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**

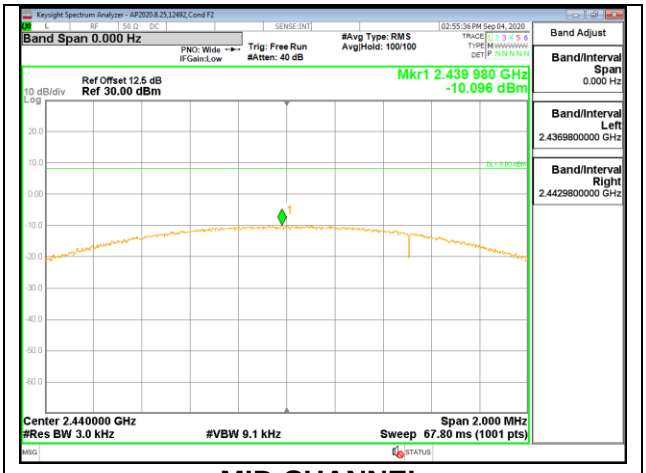



**MID CHANNEL ANT 3**

### 9.6.7. LOW POWER BLE (2Mbps)

**ANT 4**

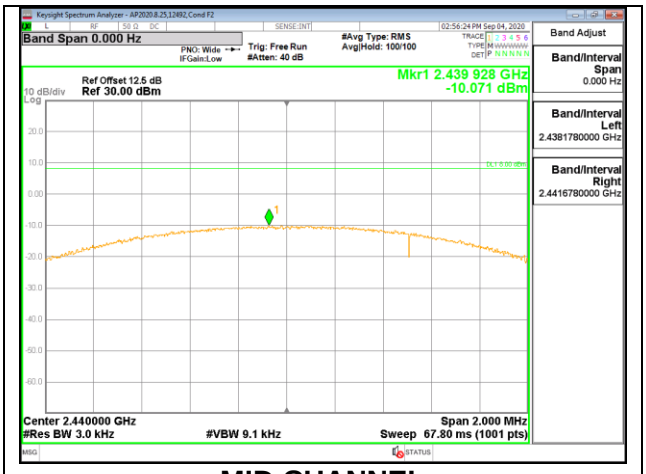
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2404 | -10.368 | 8 | -18.37 |
| Middle | 2440 | -10.096 | 8 | -18.10 |
| High | 2478 | -10.979 | 8 | -18.98 |




**MID CHANNEL**

**ANT 3**

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---|---|---|---|---|
| Low | 2404 | -10.525 | 8 | -18.53 |
| Middle | 2440 | -10.071 | 8 | -18.07 |
| High | 2478 | -11.309 | 8 | -19.31 |



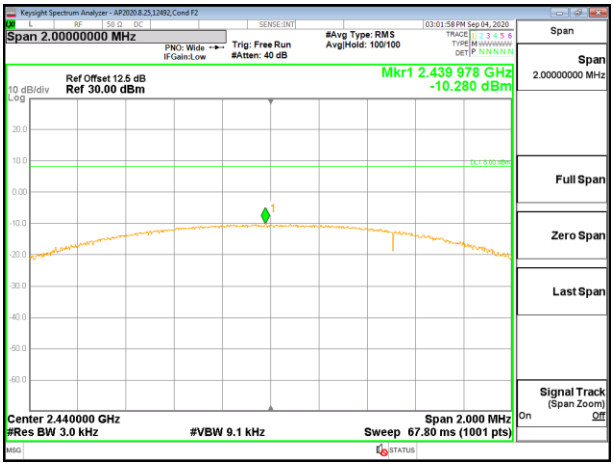

**MID CHANNEL**

## 9.6.8. LOW POWER BLE TXBF (2Mbps)

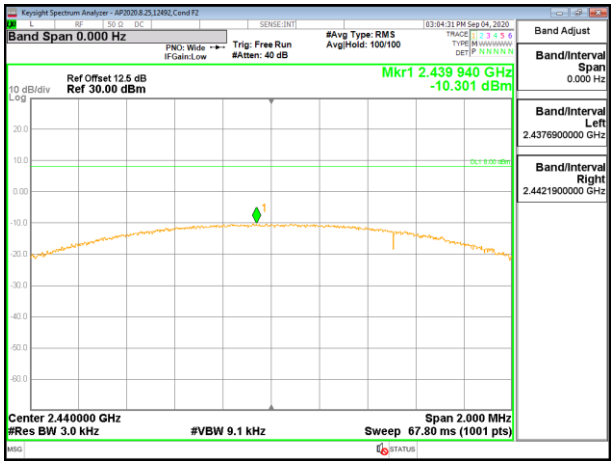
**PSD Results**

| Channel | Frequency (MHz) | ANT 4 Meas (dBm/ 3kHz) | ANT 3 Meas (dBm/ 3kHz) | Total Corr'd PSD (dBm/ 3kHz) | Limit (dBm/ 3kHz) | Margin (dB) |
|---|---|---|---|---|---|---|
| Low | 2404 | -10.548 | -10.535 | -7.53 | 8.0 | -15.5 |
| Mid | 2440 | -10.280 | -10.301 | -7.28 | 8.0 | -15.3 |
| Hjigh | 2478 | -11.061 | -11.080 | -8.06 | 8.0 | -16.1 |

Note: Test procedures and setting are same as BLE normal mode.




**MID CHANNEL ANT 4**




**MID CHANNEL ANT 3**

## 9.7. CONDUCTED SPURIOUS EMISSIONS

**LIMITS**

FCC §15.247 (d)

RSS-247 5.5

Output power was measured based on the use of a peak measurement; the required attenuation is 20 dB; therefore, spurious emissions are required to be 20dBc.

Note: Test procedures and setting are same as BLE normal mode.

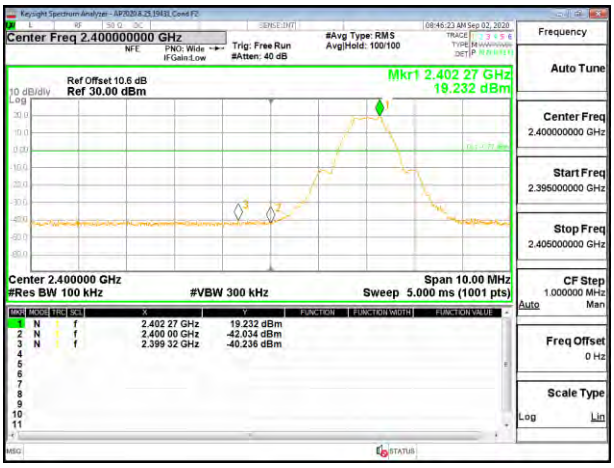
**RESULTS**



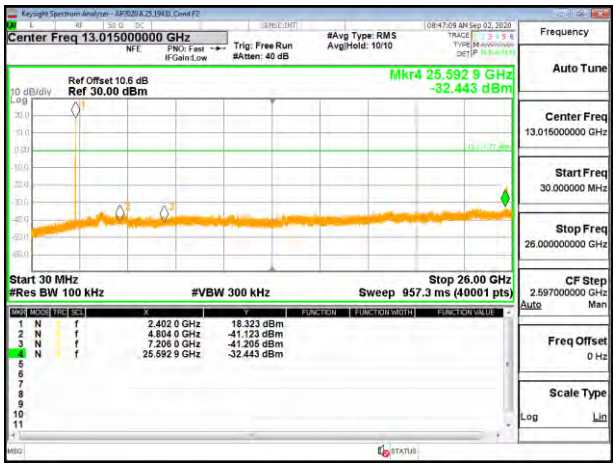
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

## 9.7.1. HIGH POWER BLE (1Mbps)

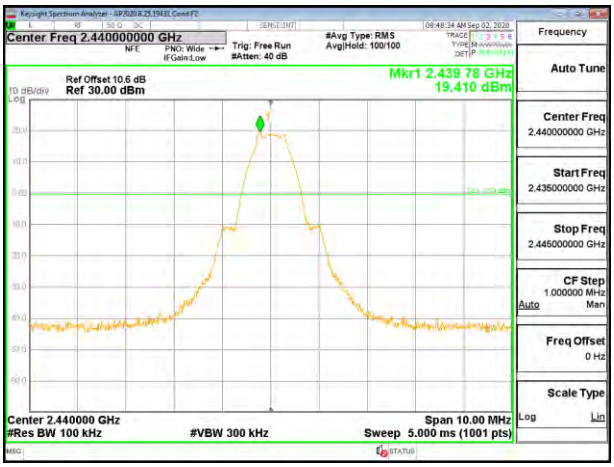
**ANT 4**



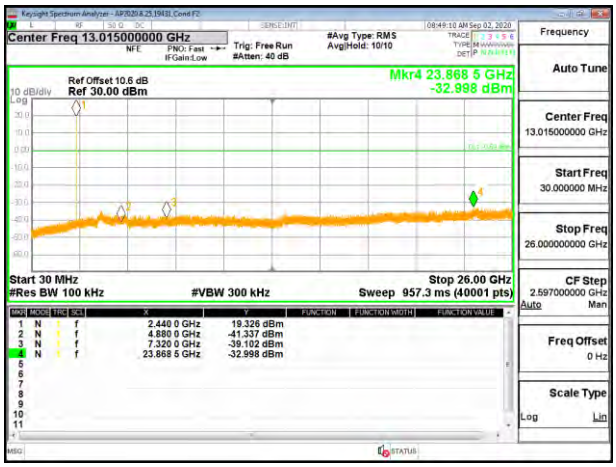

**LOW CHANNEL BANDEDGE**



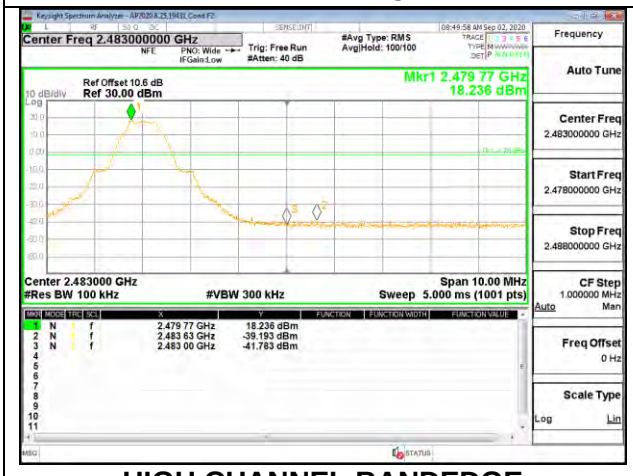

**OUT-OF-BAND LOW CHANNEL**



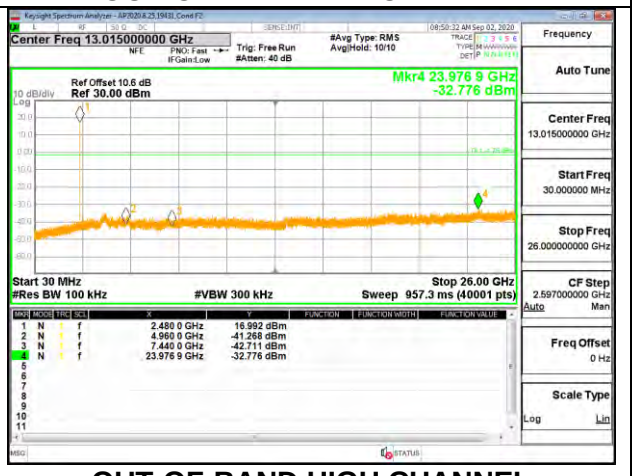

**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**

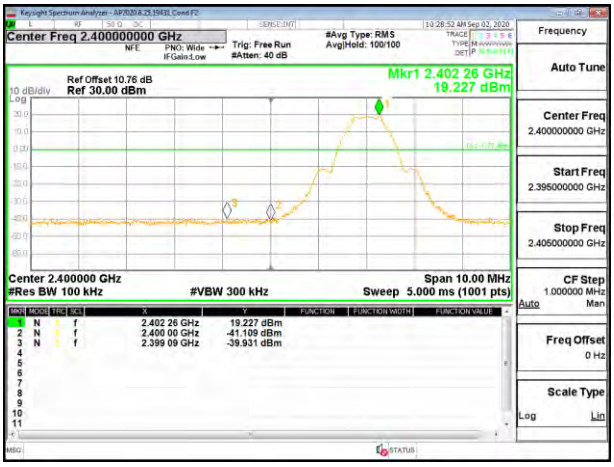



**HIGH CHANNEL BANDEDGE**

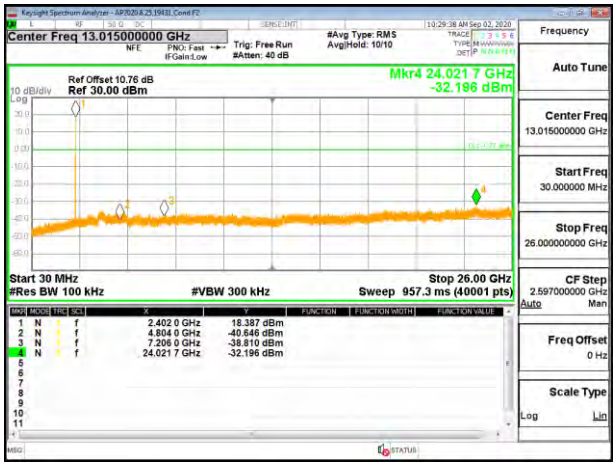



**OUT-OF-BAND HIGH CHANNEL**

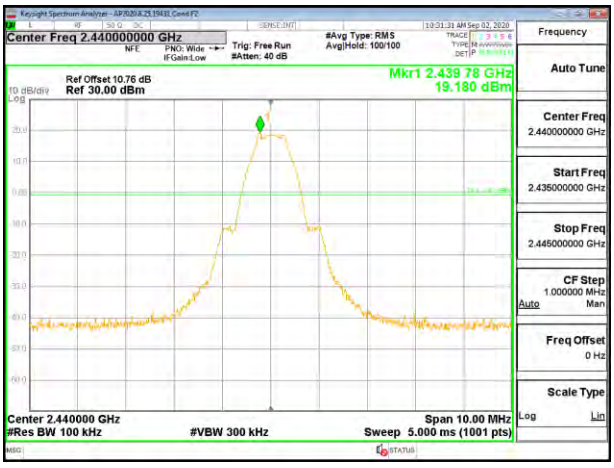
**ANT 3**



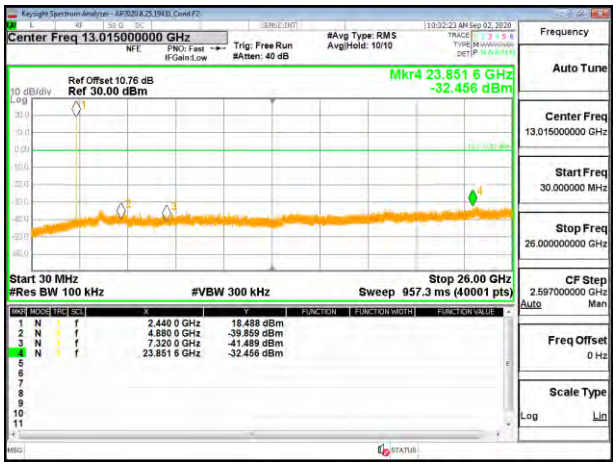

**LOW CHANNEL BANDEDGE**



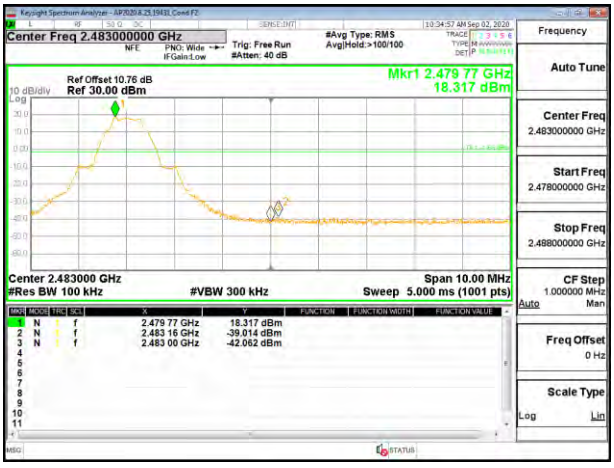

**OUT-OF-BAND LOW CHANNEL**



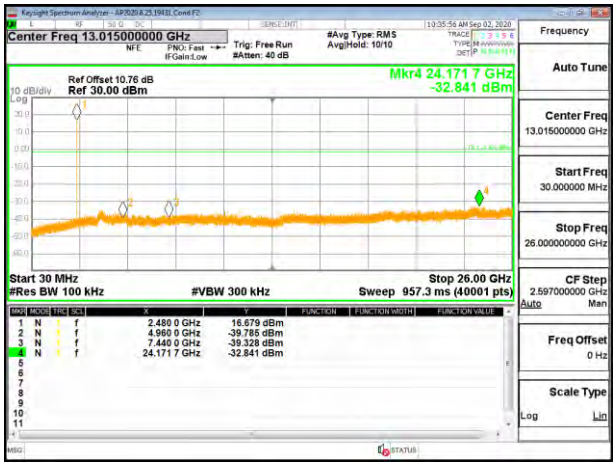

**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**



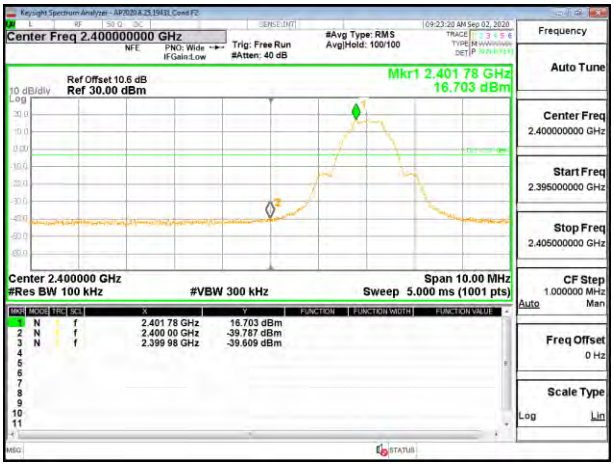

**HIGH CHANNEL BANDEDGE**




**OUT-OF-BAND HIGH CHANNEL**

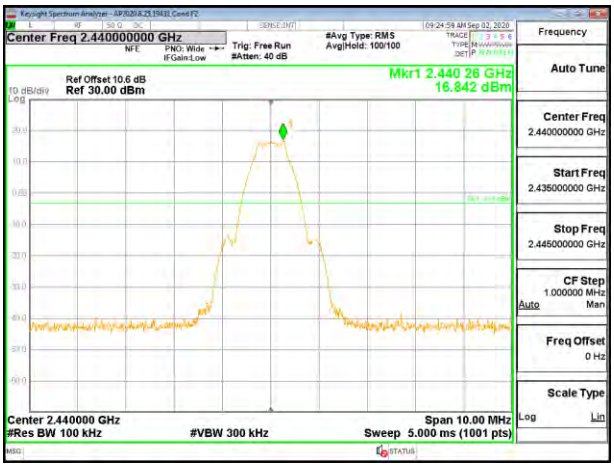
## 9.7.2. HIGH POWER BLE TXBF (1Mbps)

Note: Test procedures and setting are same as BLE normal mode.

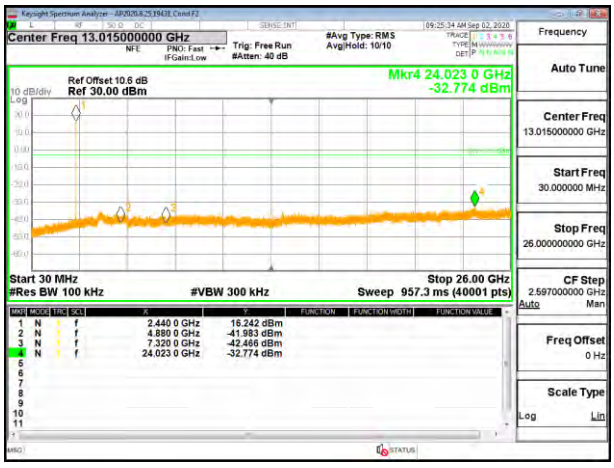



**LOW CHANNEL, BANDEDGE ANT 4**

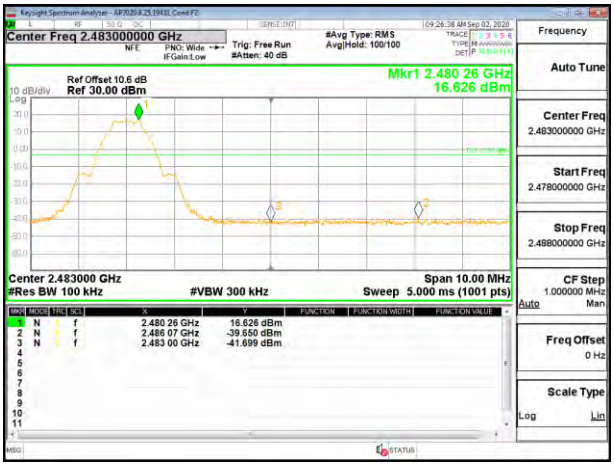

**LOW CHANNEL OUT-OF-BAND ANT 4**



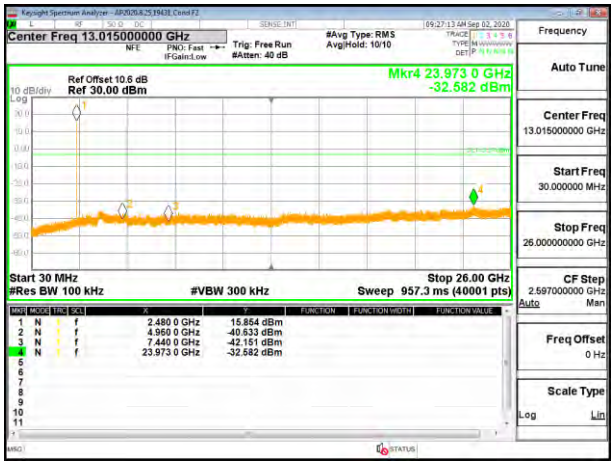

**MID CHANNEL REFERENCE ANT 4**




**MID CHANNEL OUT-OF-BAND ANT 4**

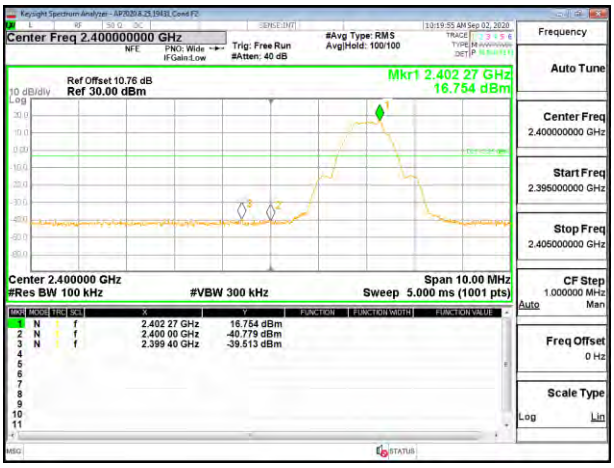



**HIGH CHANNEL BANDEDGE ANT 4**

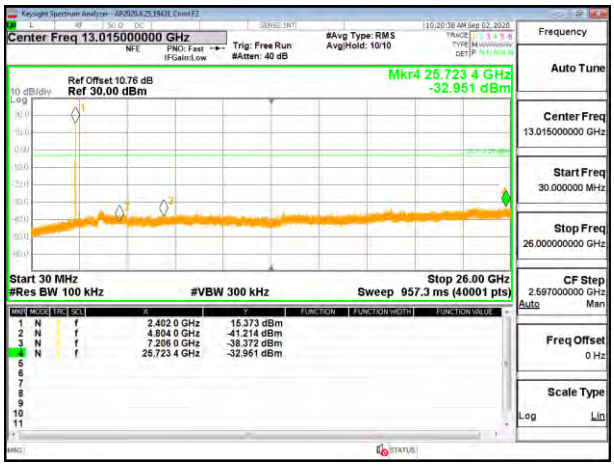



**HIGH CHANNEL OUT-OF-BAND ANT 4**

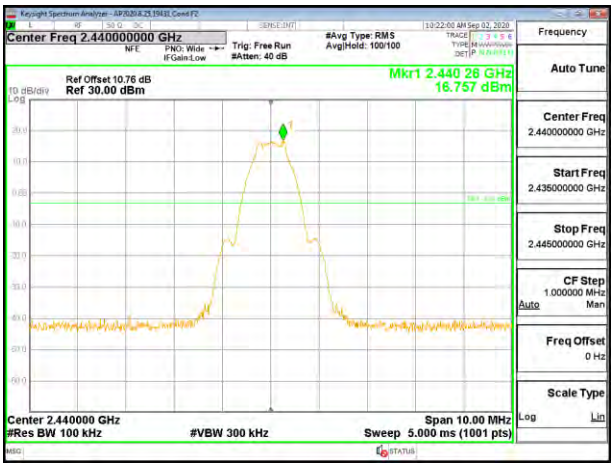
**HIGH POWER (1Mbps)**



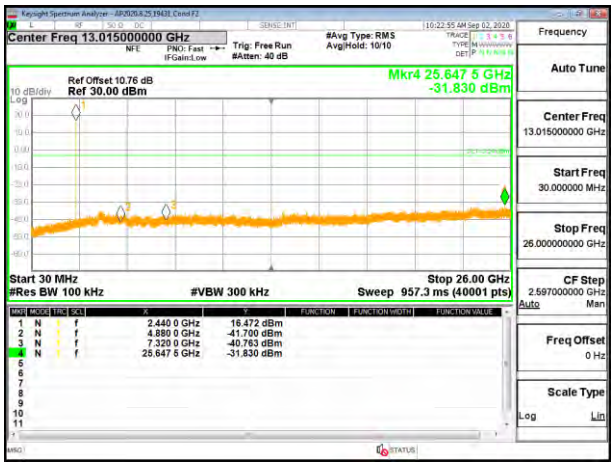

**LOW CHANNEL , BANDEDGE ANT 3**



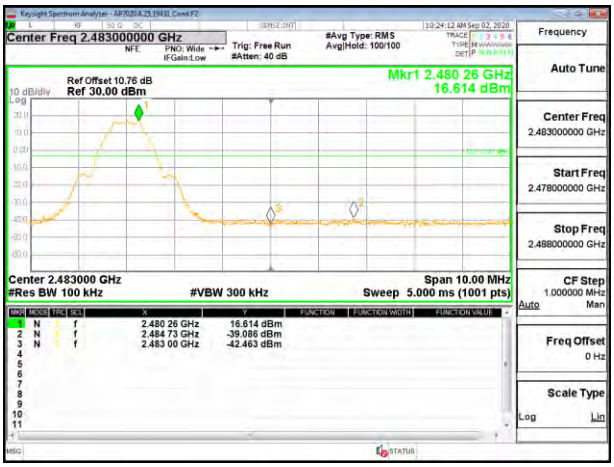

**LOW CHANNEL OUT-OF-BAND ANT 3**



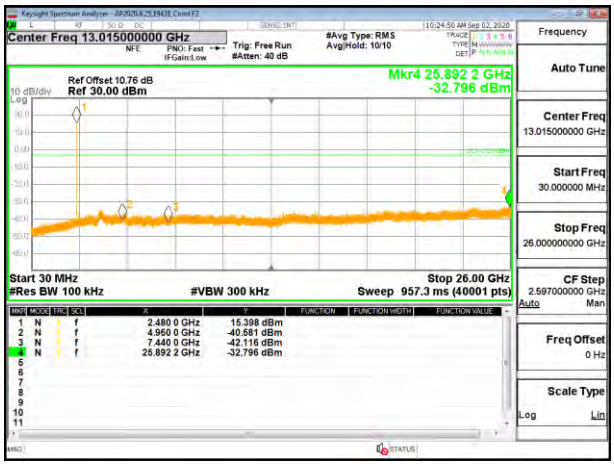

**MID CHANNEL REFERENCE ANT 3**




**MID CHANNEL OUT-OF-BAND ANT 3**



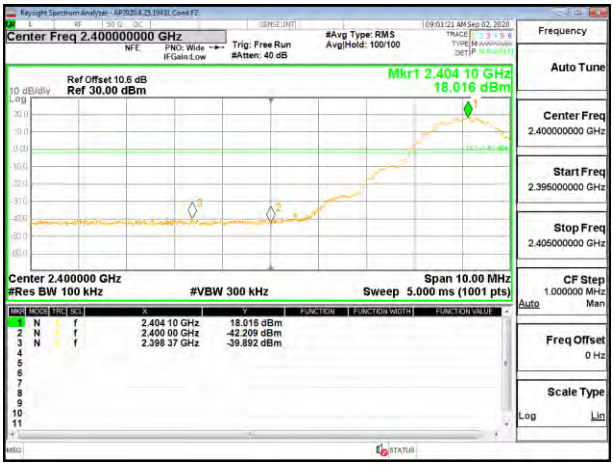

**HIGH CHANNEL BANDEDGE ANT 3**



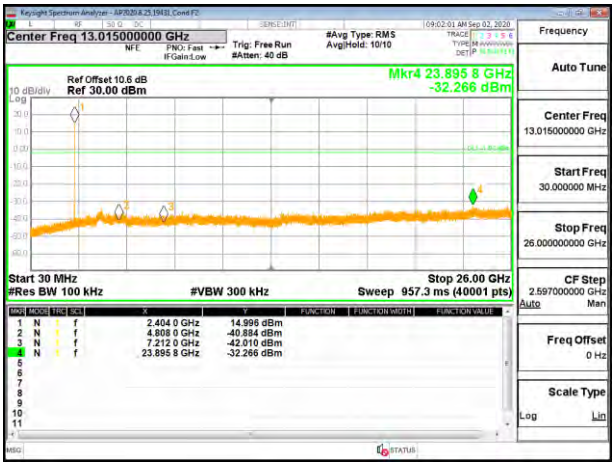

**HIGH CHANNEL OUT-OF-BAND ANT 3**

## 9.7.3. HIGH POWER BLE (2Mbps)

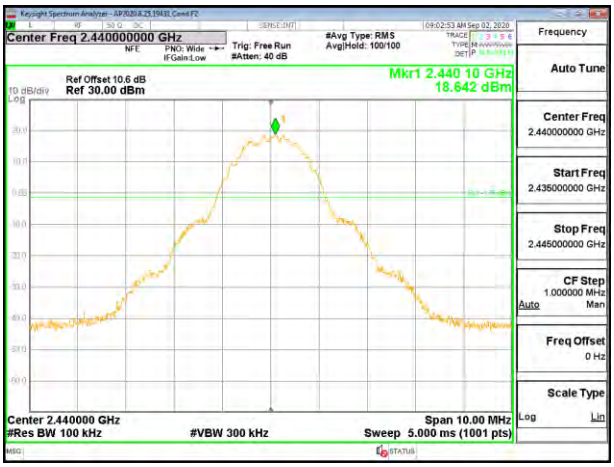
**ANT 4**



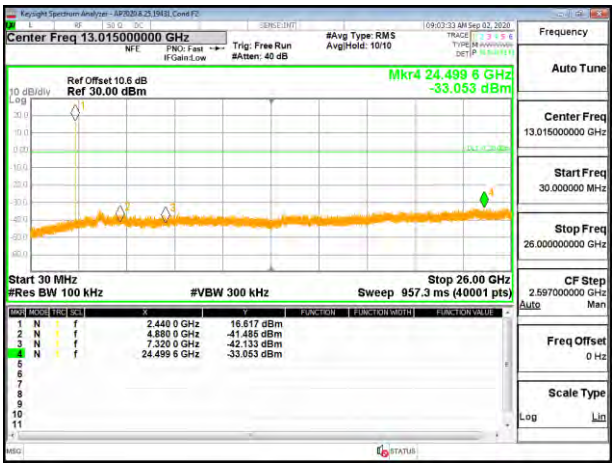

**LOW CHANNEL BANDEDGE**



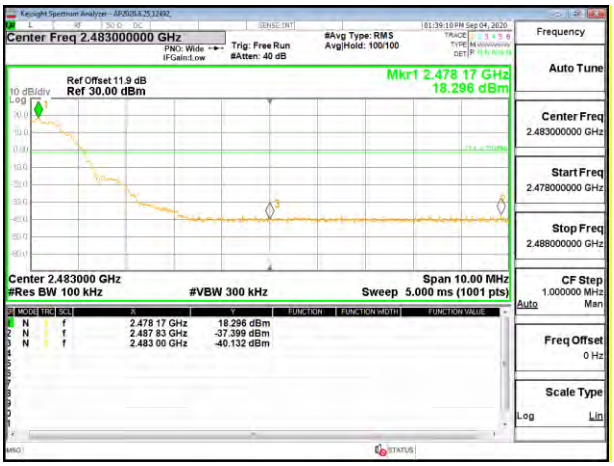

**OUT-OF-BAND LOW CHANNEL**



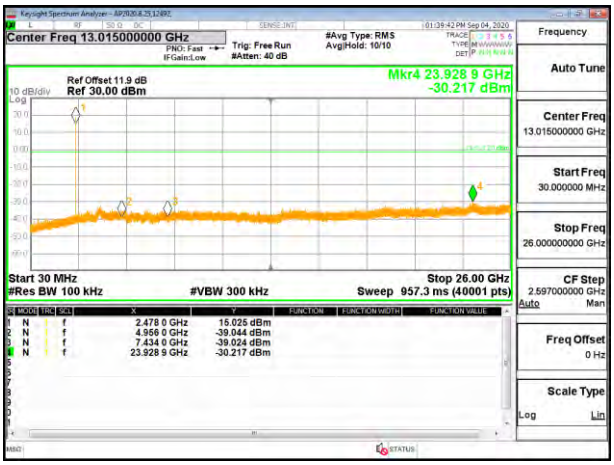

**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**

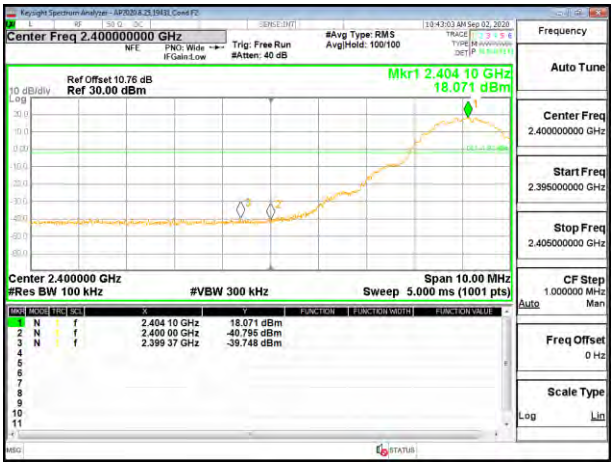



**HIGH CHANNEL BANDEDGE**

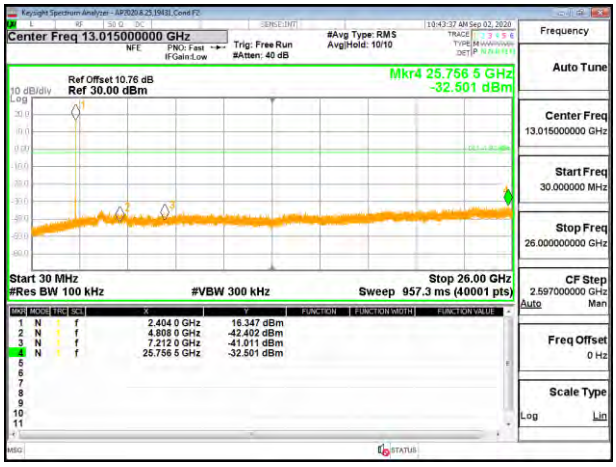



**OUT-OF-BAND HIGH CHANNEL**

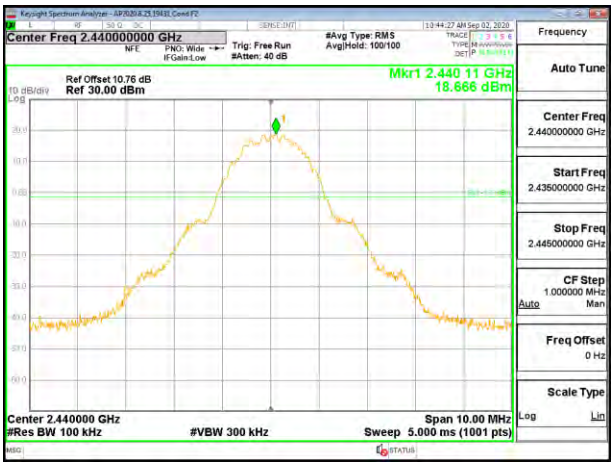
**ANT 3**



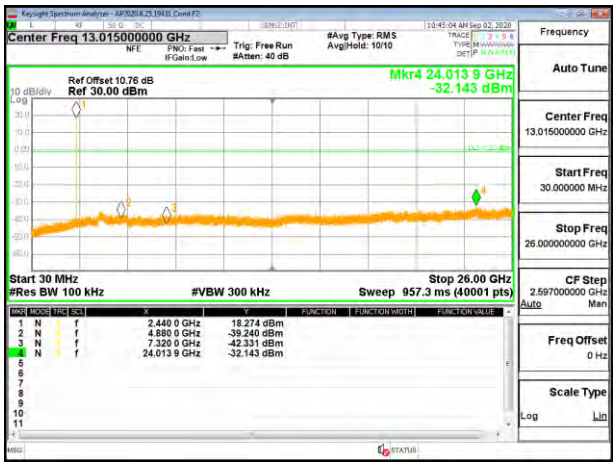

**LOW CHANNEL BANDEDGE**



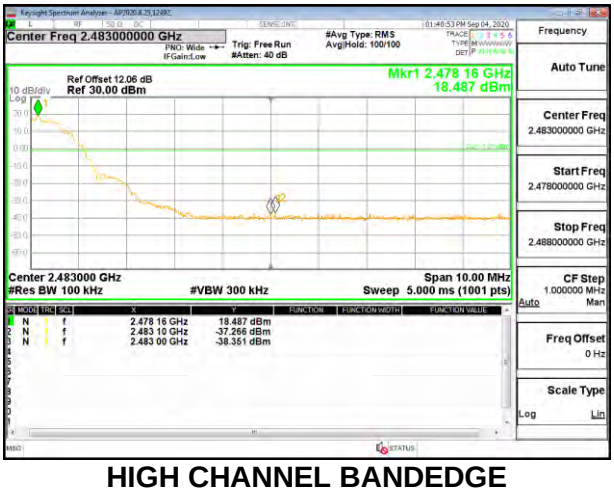

**OUT-OF-BAND LOW CHANNEL**



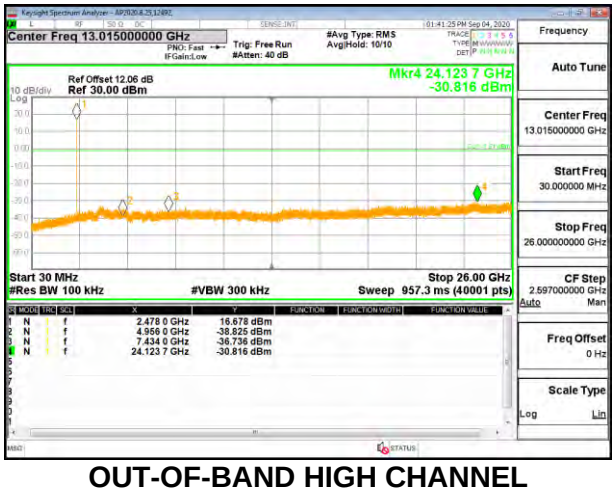

**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**



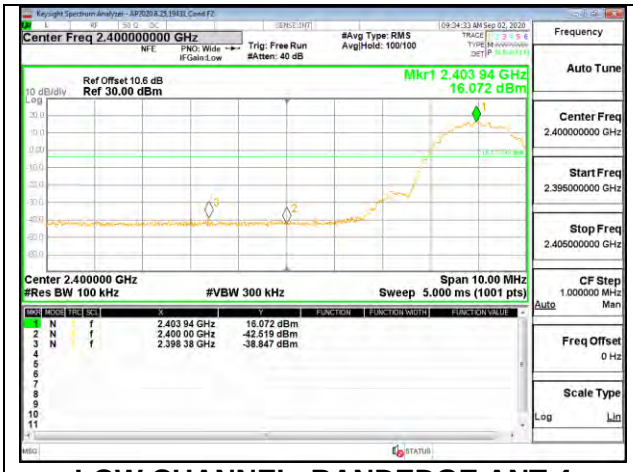

**HIGH CHANNEL BANDEDGE**



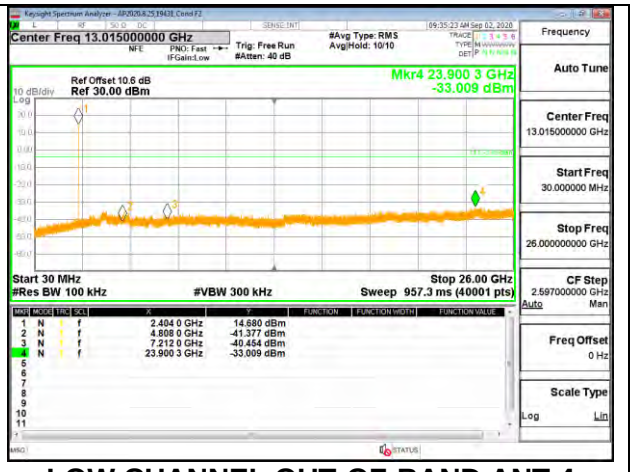

**OUT-OF-BAND HIGH CHANNEL**

### 9.7.4. HIGH POWER BLE TXBF (2Mbps)

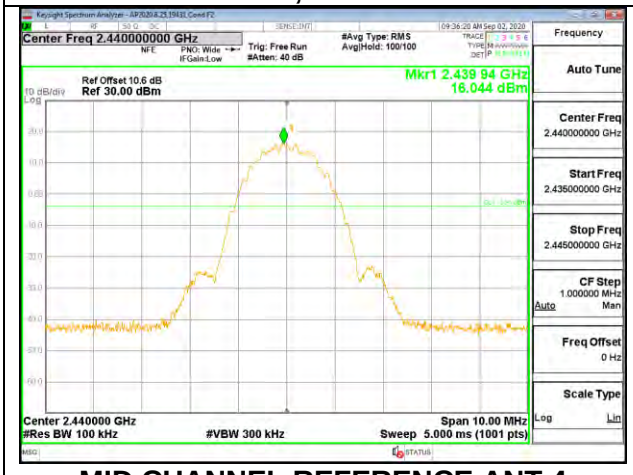
Note: Test procedures and setting are same as BLE normal mode.



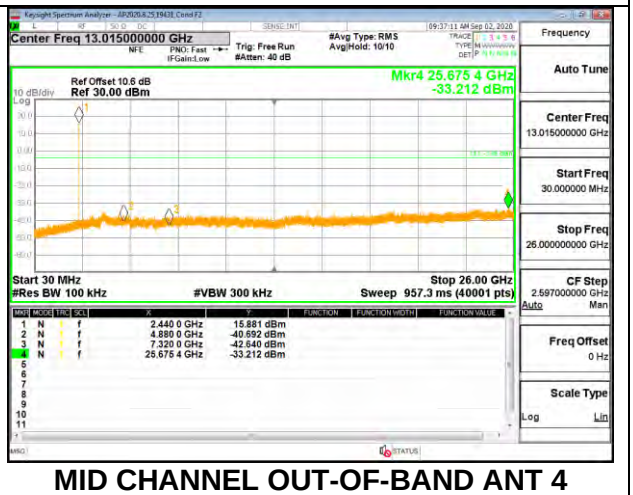

**LOW CHANNEL, BANDEDGE ANT 4**



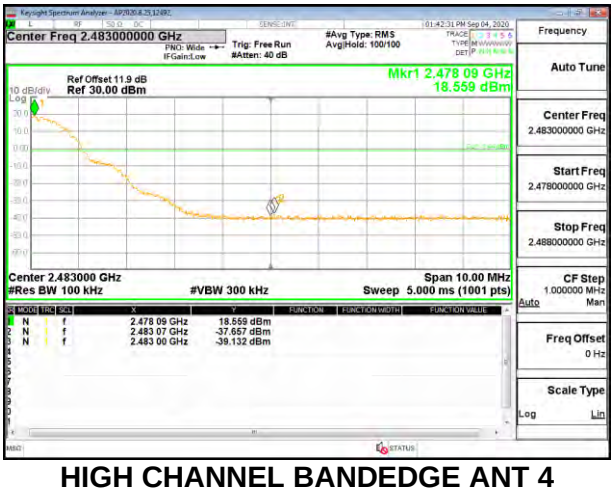

**LOW CHANNEL OUT-OF-BAND ANT 4**



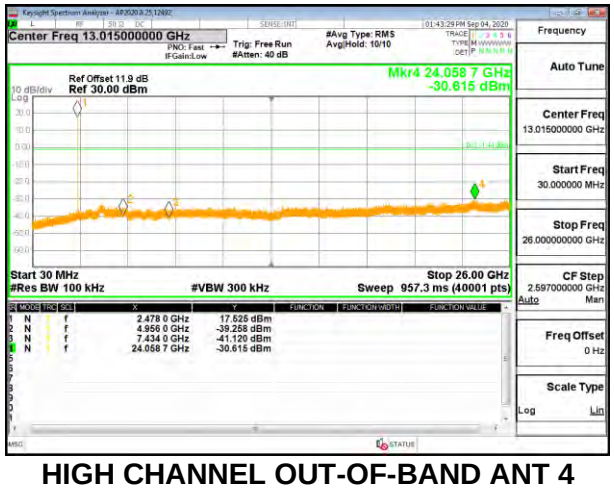

**MID CHANNEL REFERENCE ANT 4**




**MID CHANNEL OUT-OF-BAND ANT 4**

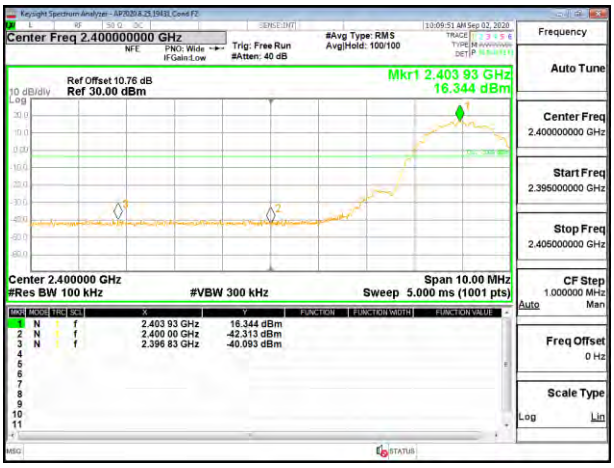



**HIGH CHANNEL BANDEDGE ANT 4**

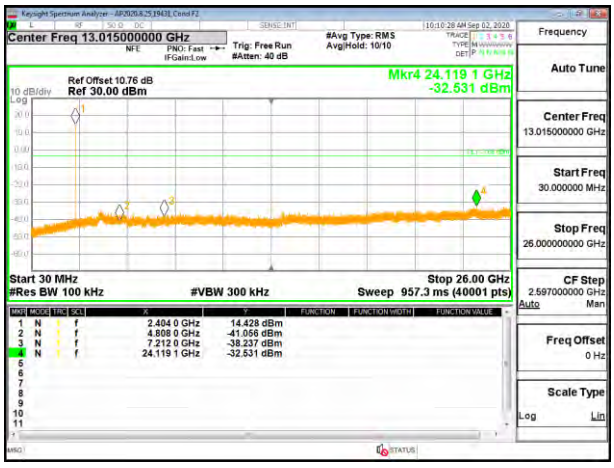



**HIGH CHANNEL OUT-OF-BAND ANT 4**

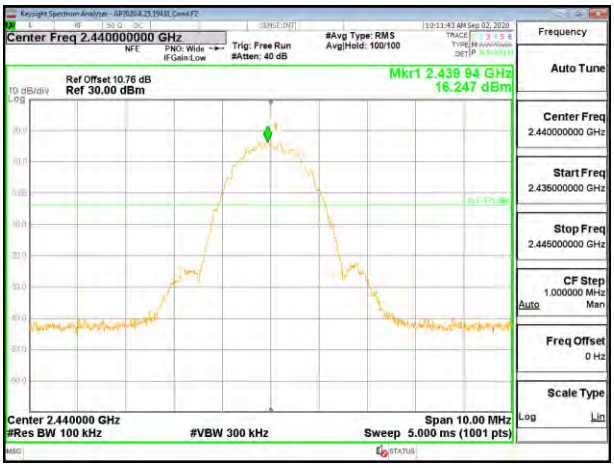
**HIGH POWER (2Mbps)**



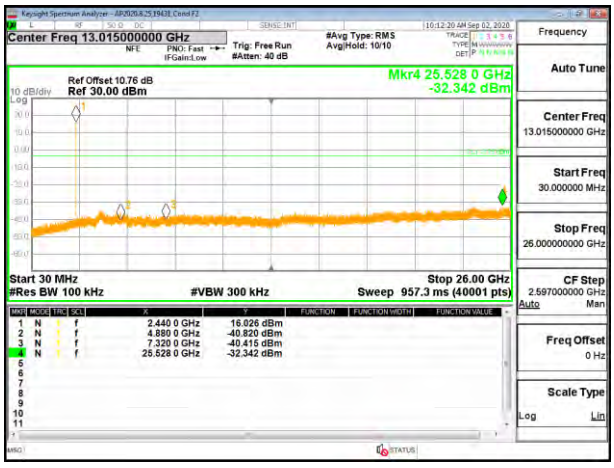

**LOW CHANNEL , BANDEDGE ANT 3**



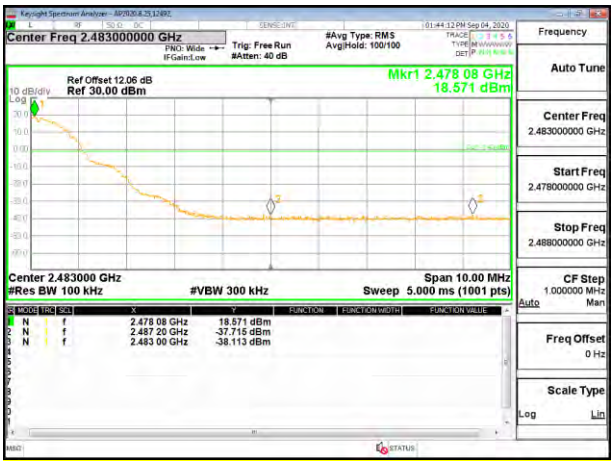

**LOW CHANNEL OUT-OF-BAND ANT 3**



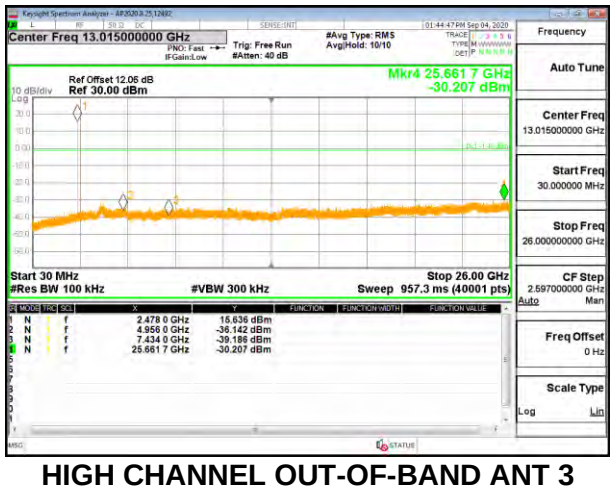

**MID CHANNEL REFERENCE ANT 3**




**MID CHANNEL OUT-OF-BAND ANT 3**



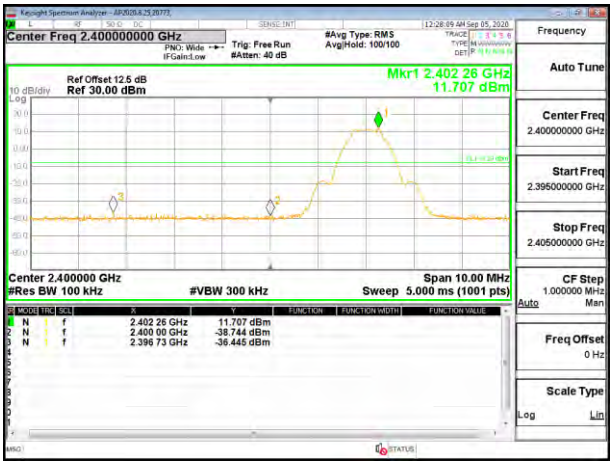

**HIGH CHANNEL BANDEDGE ANT 3**



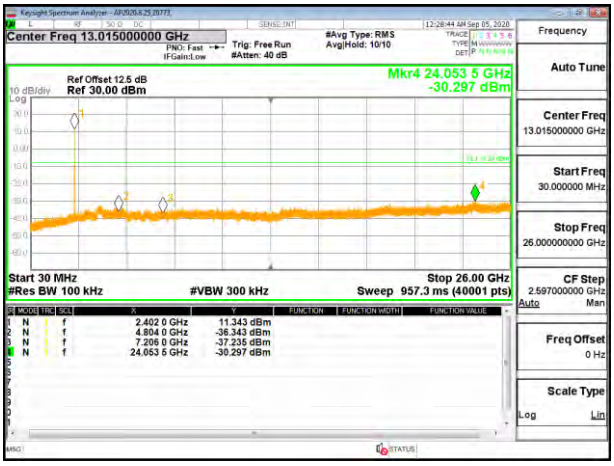

**HIGH CHANNEL OUT-OF-BAND ANT 3**

## 9.7.5. LOW POWER BLE (1Mbps)

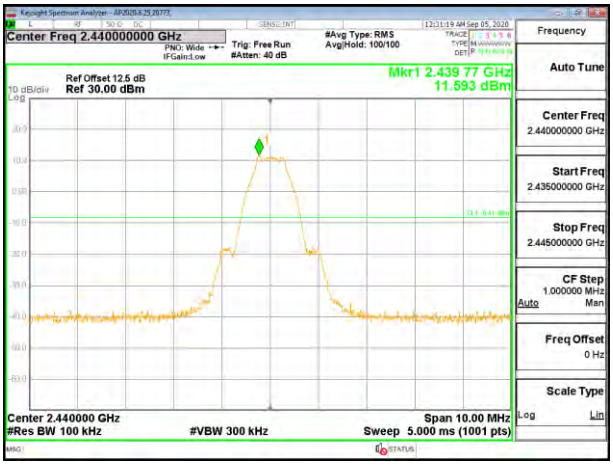
**ANT 4**




**LOW CHANNEL BANDEDGE**

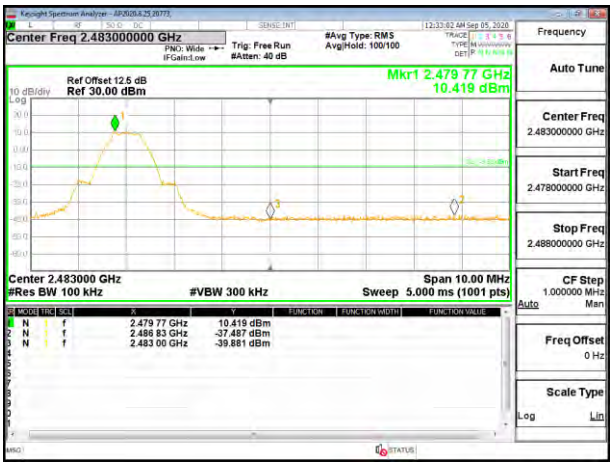



**OUT-OF-BAND LOW CHANNEL**

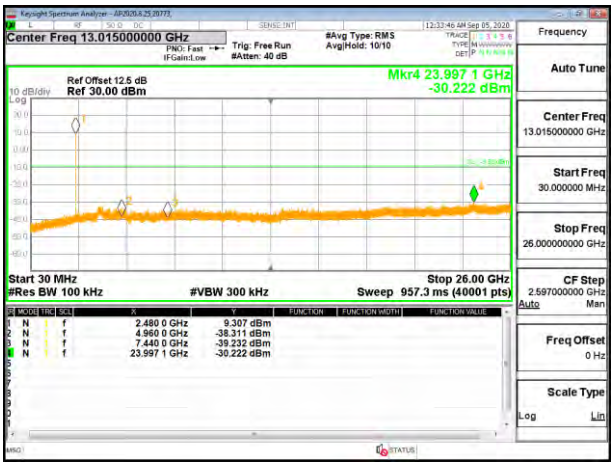



**IN-BAND REFERENCE LEVEL**


**OUT-OF-BAND MID CHANNEL**

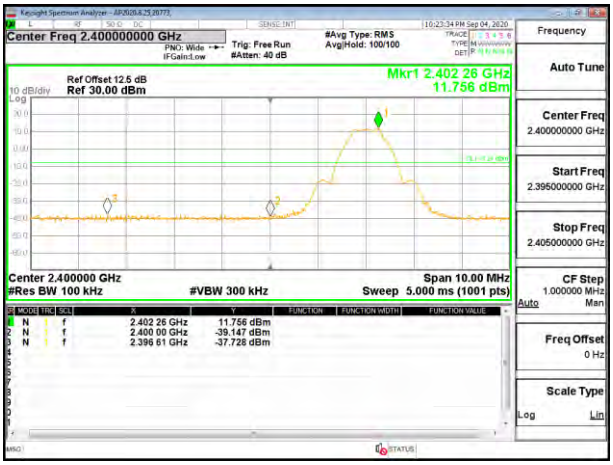



**HIGH CHANNEL BANDEDGE**

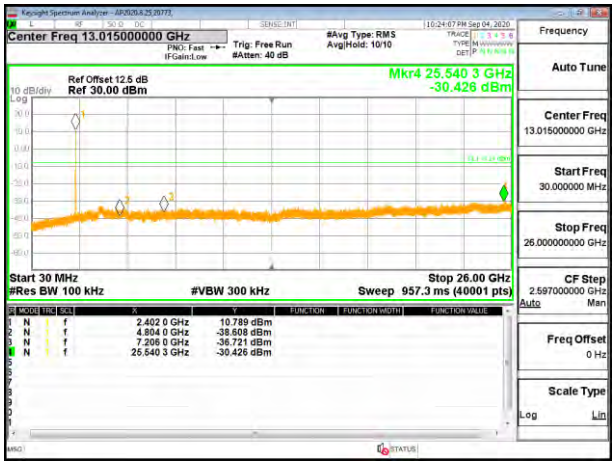



**OUT-OF-BAND HIGH CHANNEL**

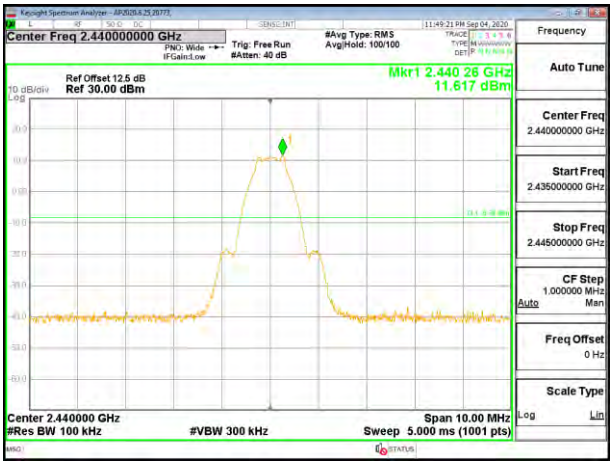
**ANT 3**



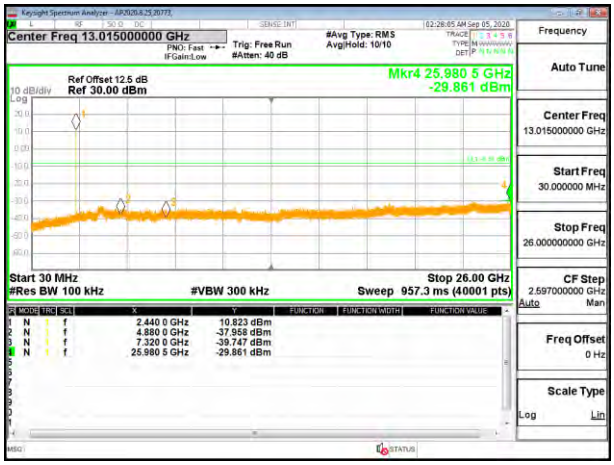

**LOW CHANNEL BANDEDGE**



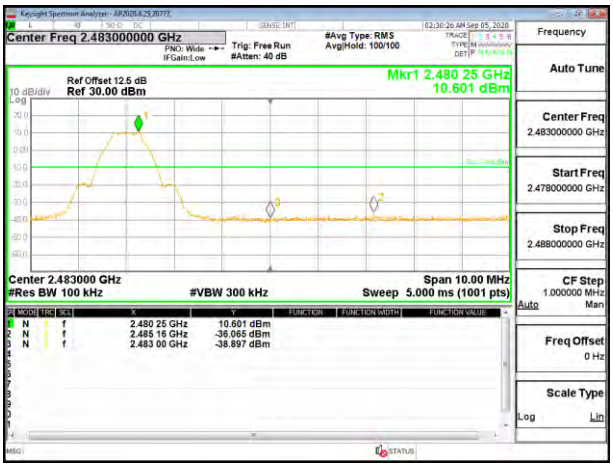

**OUT-OF-BAND LOW CHANNEL**



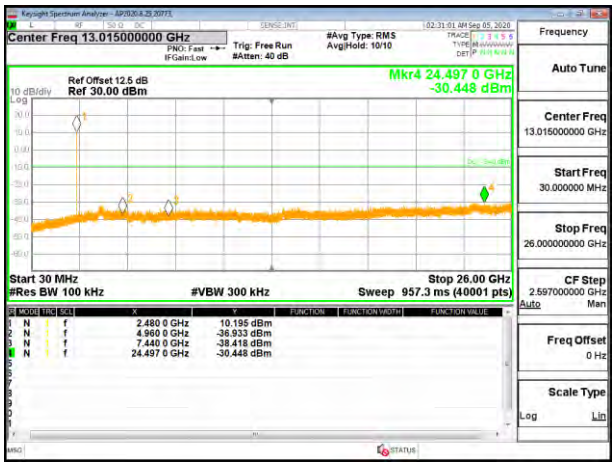

**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**



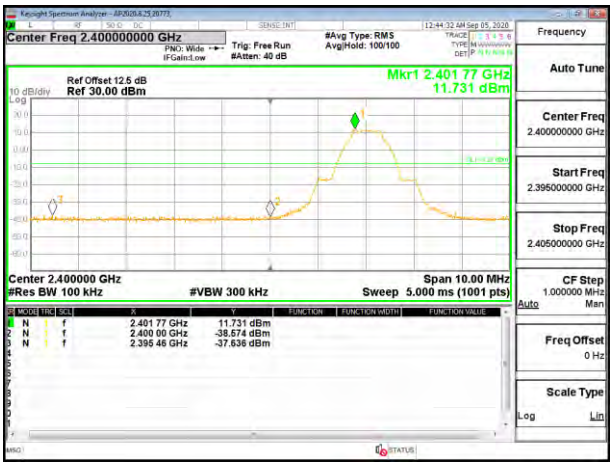

**HIGH CHANNEL BANDEDGE**



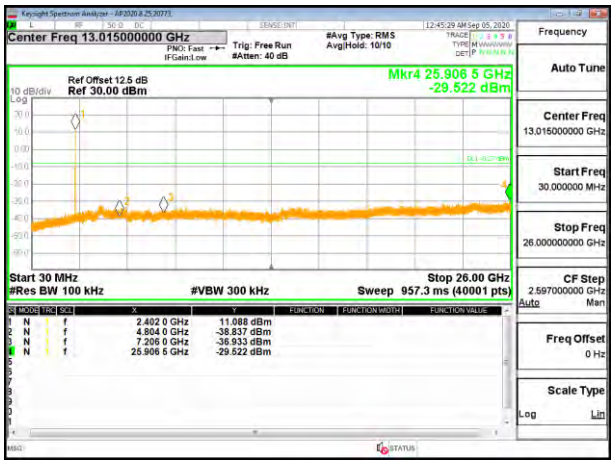

**OUT-OF-BAND HIGH CHANNEL**

## 9.7.6. LOW POWER BLE TXBF (1Mbps)

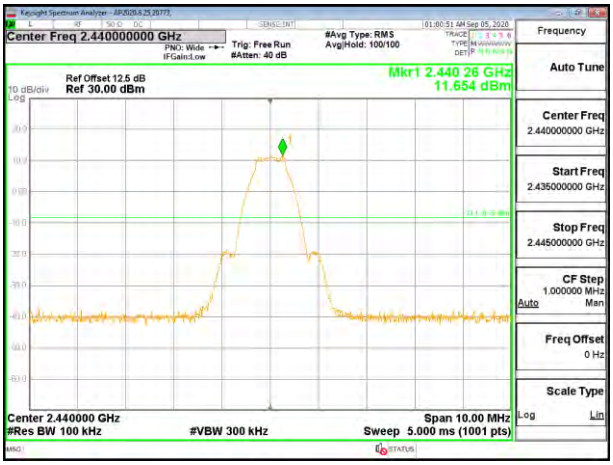
Note: Test procedures and setting are same as BLE normal mode.




**LOW CHANNEL , BANDEDGE ANT 4**

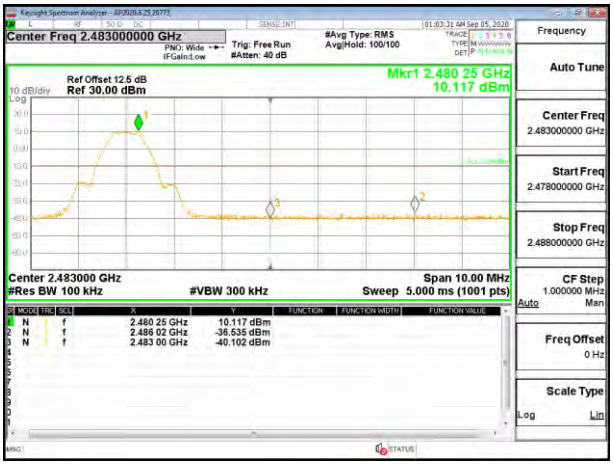



**LOW CHANNEL OUT-OF-BAND ANT 4**

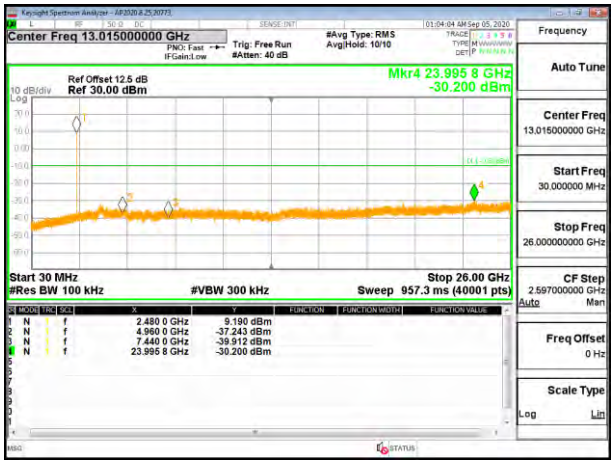



**MID CHANNEL REFERENCE ANT 4**


**MID CHANNEL OUT-OF-BAND ANT 4**

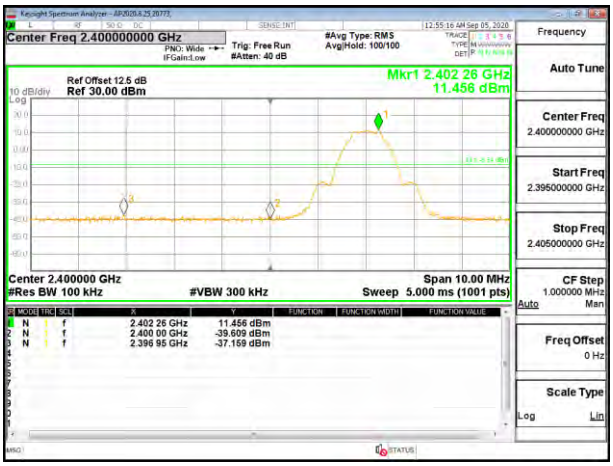



**HIGH CHANNEL BANDEDGE ANT 4**

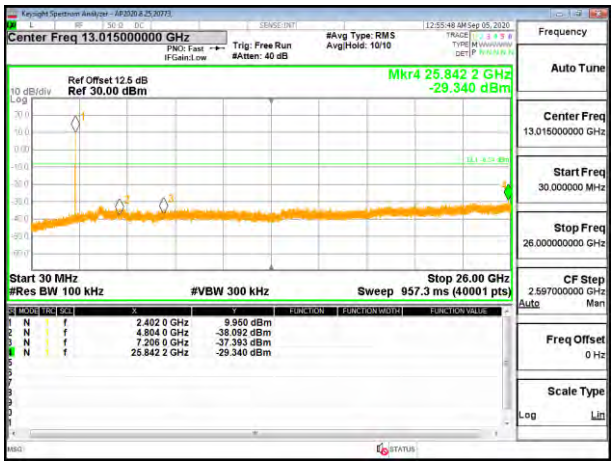



**HIGH CHANNEL OUT-OF-BAND ANT 4**

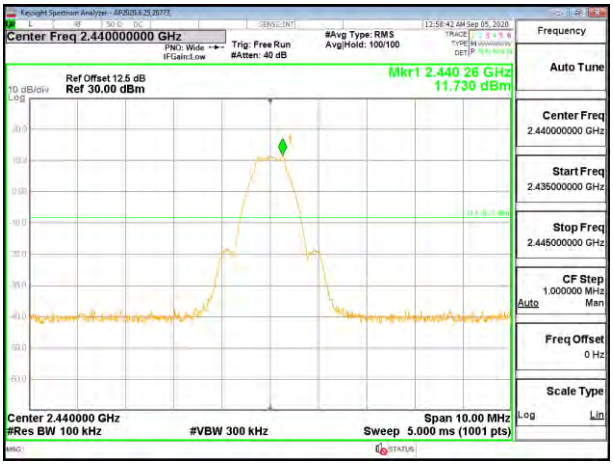
**LOW POWER (1Mbps)**



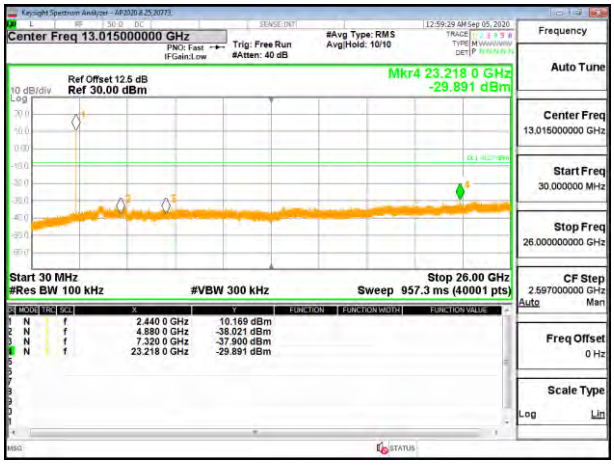

**LOW CHANNEL , BANDEDGE ANT 3**



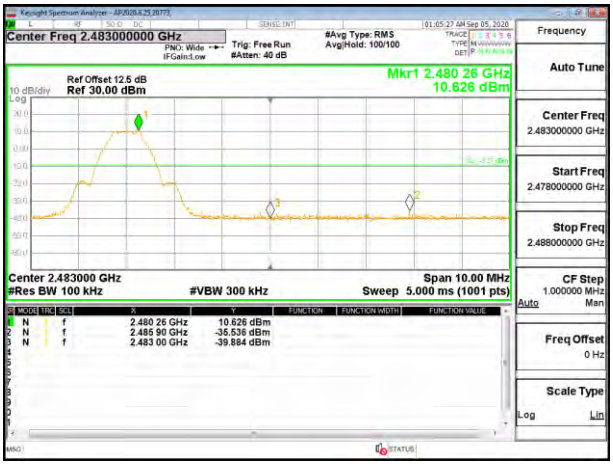

**LOW CHANNEL OUT-OF-BAND ANT 3**




**MID CHANNEL REFERENCE ANT 3**




**MID CHANNEL OUT-OF-BAND ANT 3**

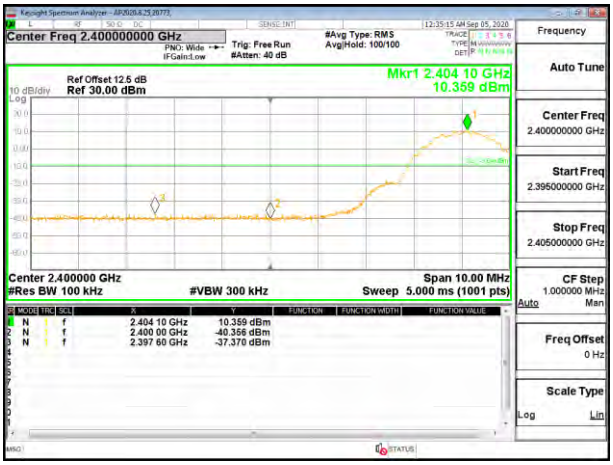



**HIGH CHANNEL BANDEDGE ANT 3**

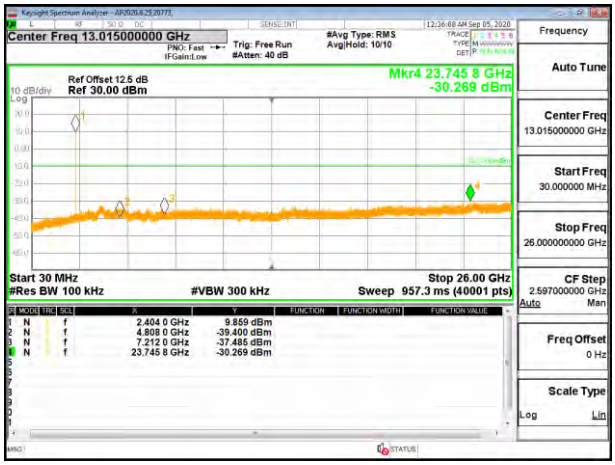

**HIGH CHANNEL OUT-OF-BAND ANT 3**

## 9.7.7. LOW POWER BLE (2Mbps)

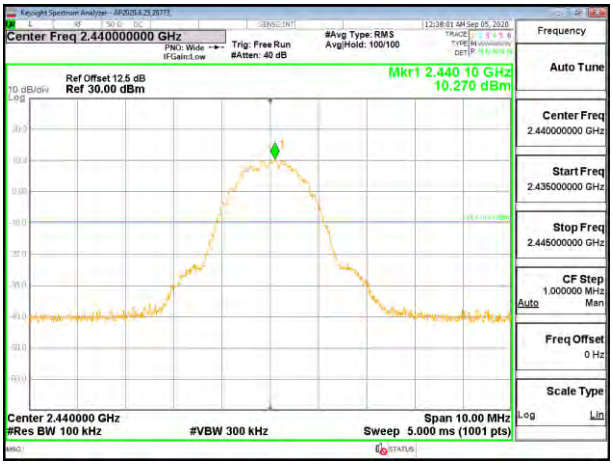
**ANT 4**




**LOW CHANNEL BANDEDGE**

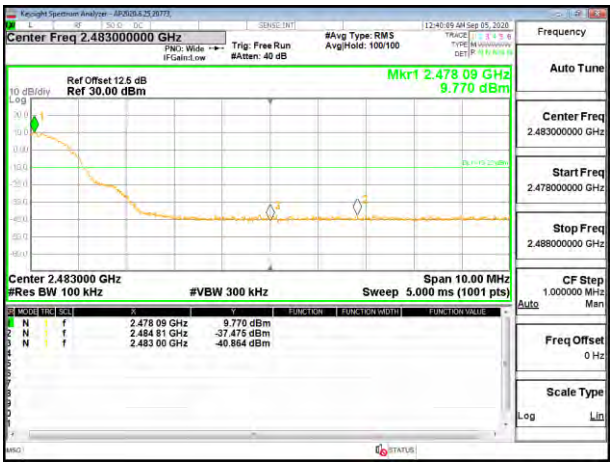



**OUT-OF-BAND LOW CHANNEL**

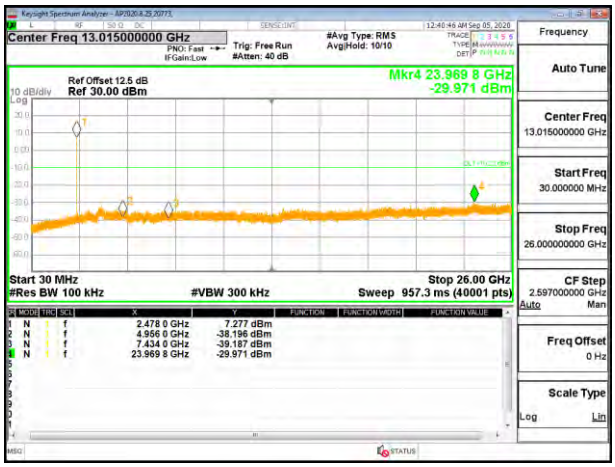



**IN-BAND REFERENCE LEVEL**


**OUT-OF-BAND MID CHANNEL**

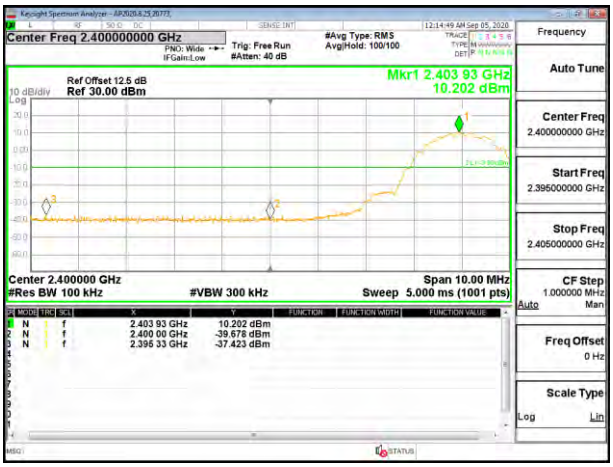



**HIGH CHANNEL BANDEDGE**

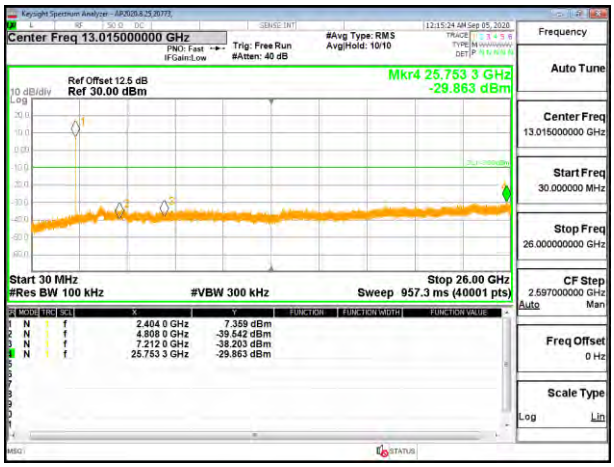



**OUT-OF-BAND HIGH CHANNEL**

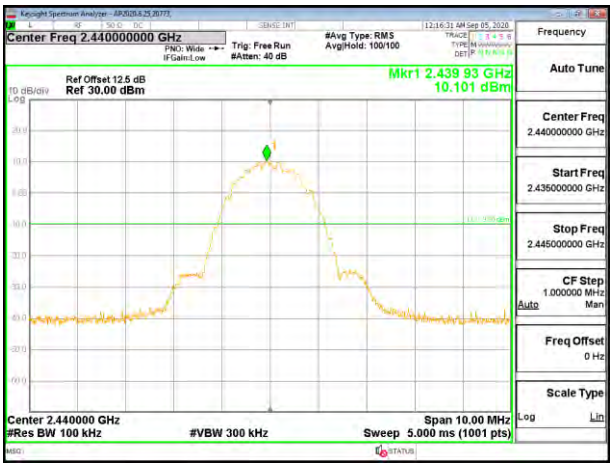
**ANT 3**



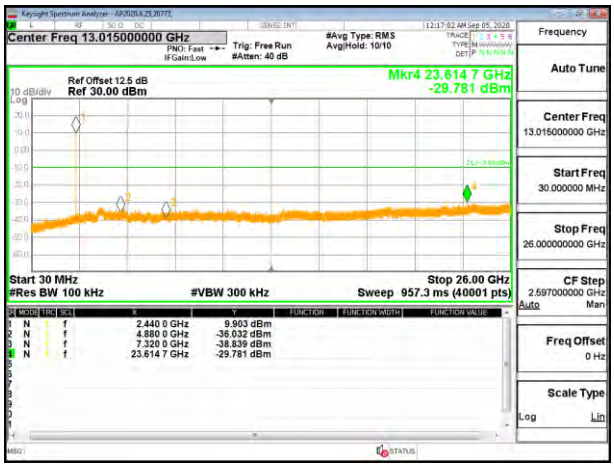

**LOW CHANNEL BANDEDGE**



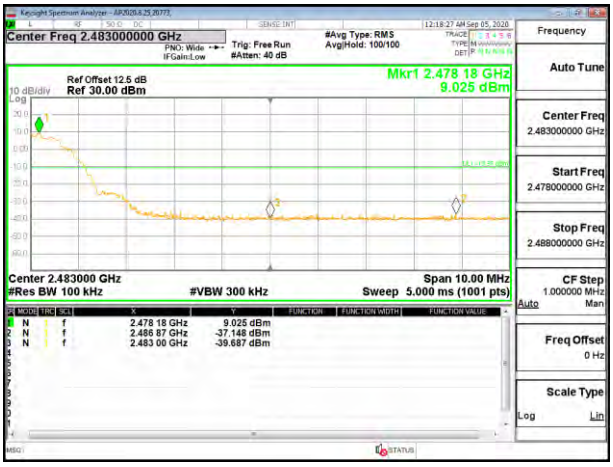

**OUT-OF-BAND LOW CHANNEL**




**IN-BAND REFERENCE LEVEL**




**OUT-OF-BAND MID CHANNEL**

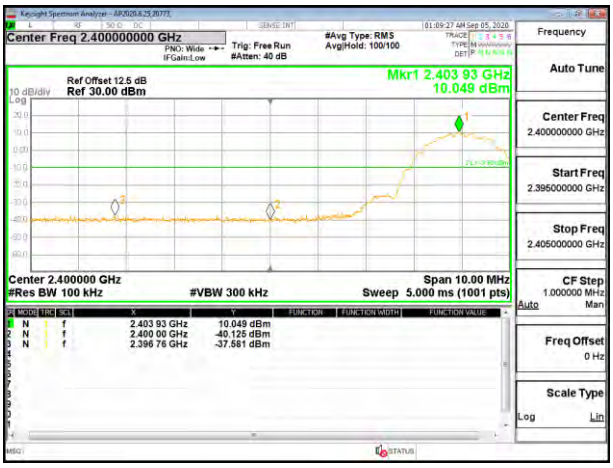



**HIGH CHANNEL BANDEDGE**

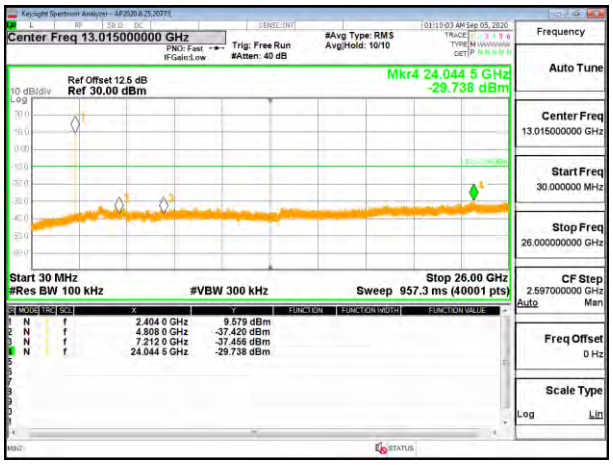

**OUT-OF-BAND HIGH CHANNEL**

### 9.7.8. LOW POWER BLE TXBF (2Mbps)

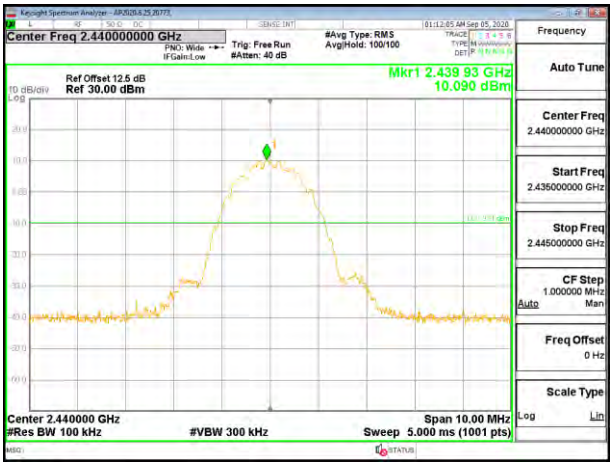
Note: Test procedures and setting are same as BLE normal mode.



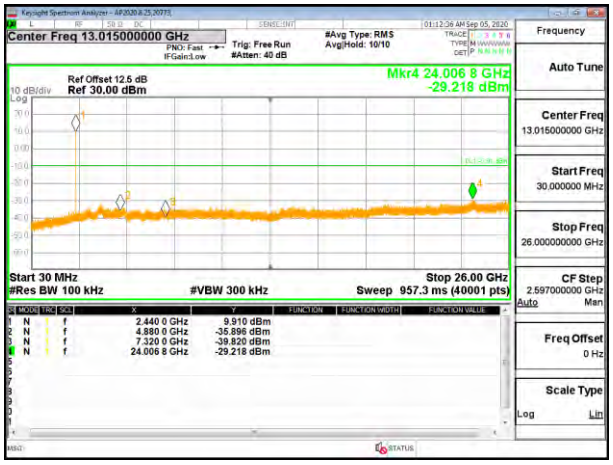

**LOW CHANNEL , BANDEDGE ANT 4**



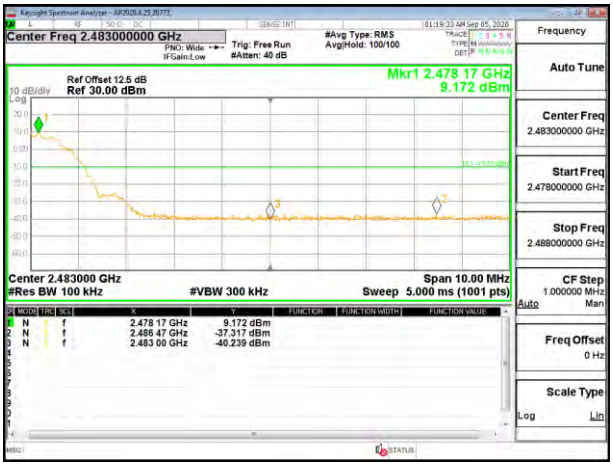

**LOW CHANNEL OUT-OF-BAND ANT 4**



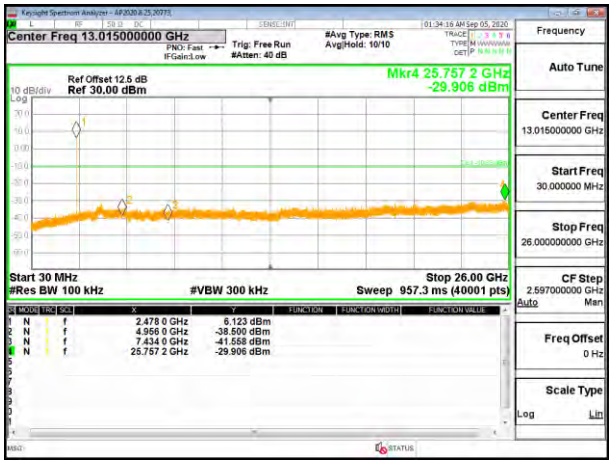

**MID CHANNEL REFERENCE ANT 4**




**MID CHANNEL OUT-OF-BAND ANT 4**

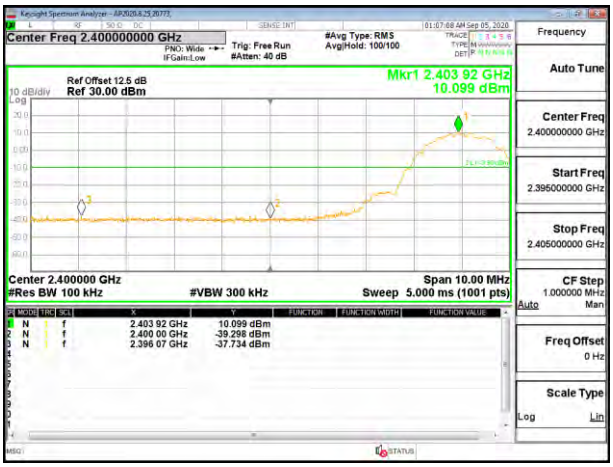



**HIGH CHANNEL BANDEDGE ANT 4**

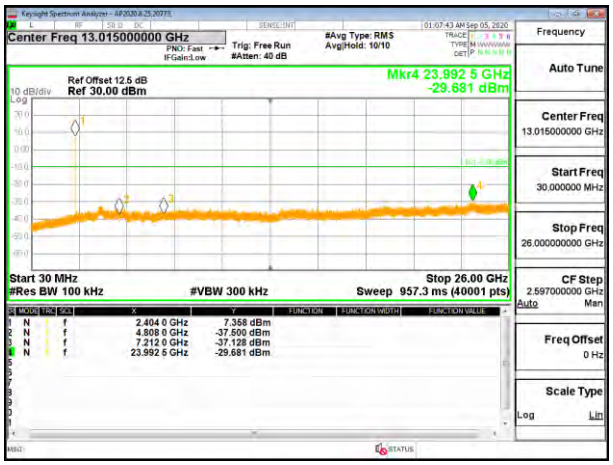



**HIGH CHANNEL OUT-OF-BAND ANT 4**

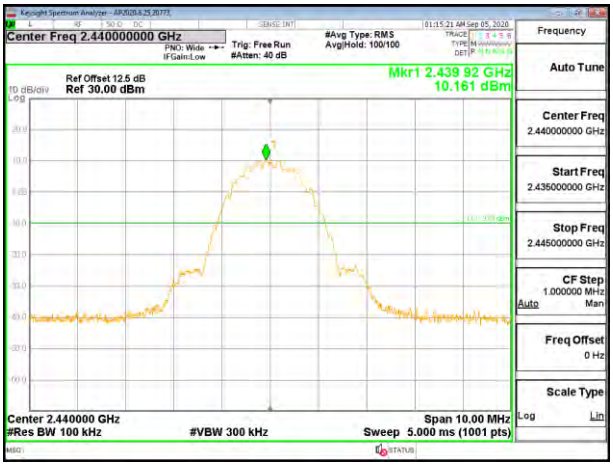
**LOW POWER (2Mbps)**



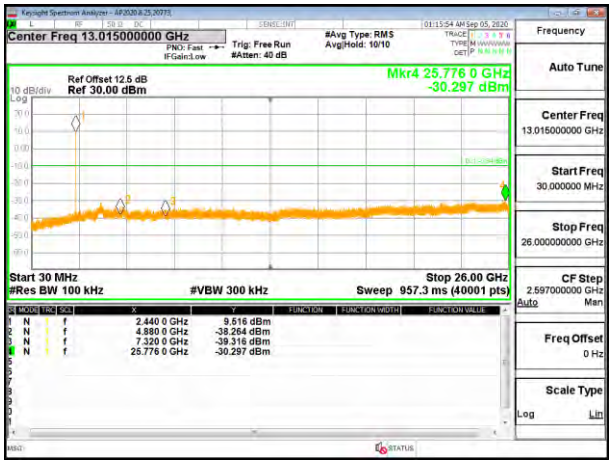

**LOW CHANNEL, BANDEDGE ANT 3**



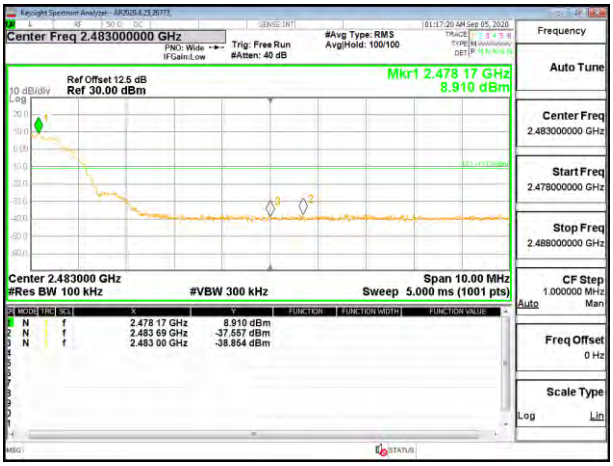

**LOW CHANNEL OUT-OF-BAND ANT 3**



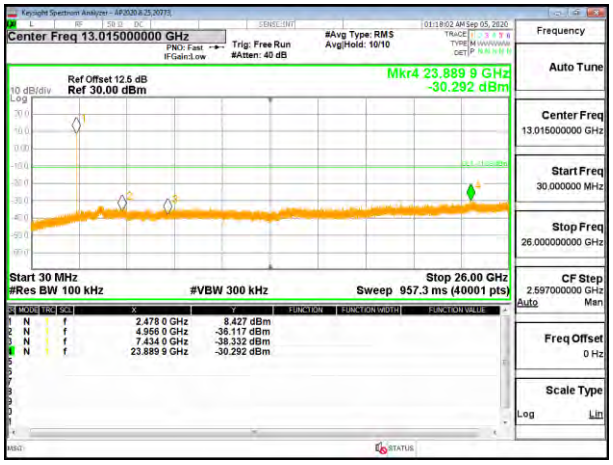

**MID CHANNEL REFERENCE ANT 3**




**MID CHANNEL OUT-OF-BAND ANT 3**




**HIGH CHANNEL BANDEDGE ANT 3**




**HIGH CHANNEL OUT-OF-BAND ANT 3**

# 10. RADIATED TEST RESULTS

## 10.1. LIMITS AND PROCEDURE

**LIMITS**

FCC §15.205 and §15.209

RSS-GEN, Section 8.9 and 8.10.

| Frequency Range (MHz) | Field Strength Limit (uV/m) at 3 m | Field Strength Limit (dBuV/m) at 3 m |
|---|---|---|
| 0.009-0.490 | 2400/F(kHz) @ 300 m | - |
| 0.490-1.705 | 24000/F(kHz) @ 30 m | - |
| 1.705 - 30 | 30 @ 30m | - |
| 30 - 88 | 100 | 40 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46 |
| Above 960 | 500 | 54 |

**TEST PROCEDURE**

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.



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**KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification**

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst-case test result.

Compliance with radiated spurious emissions limits in the restricted bands closest to the allocated 2402 – 2480 MHz band were performed on all modes for the low and high channels. Additional measurements on adjacent channels to the low and/or high channels were limited to cases where the edge channels have a significantly lower rated power than the adjacent channels.

Compliance with radiated spurious emissions limits in the restricted bands between 1GHz and 18GHz (except as explained for the band edge) the operating band were performed on the low, middle and high channel for 2Mbps mode. As this mode has the highest output power and highest power spectral density it is considered worst case for spurious emissions across all modes. For these tests both transmit chains were operating simultaneously and set to the maximum power per chain to cover both TXBF mode. The spurious emissions for frequencies below 1Ghz and above 18GHz were limited to the center channel as preliminary testing indicated that changing the operating frequency had no significant impact on the emissions in those frequency bands.

**RESULTS**

High Power Beamforming BLE 1Mbps mode is set to maximum power per chain to cover both SISO and MIMO modes to complies with radiated spurious emissions limits in the restricted bands between 1GHz and 18GHz low/mid/high channels (except the band edge).

Spurious emissions for frequencies below 1GHz and above 18GHz were limited to the middle channel as preliminary testing indicated that changing the operating frequency had no significant impact on the emissions in those frequency bands.



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