



# **TEST REPORT**

**Report Number:** 13259315-E1V3

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

**Model :** A2341

**FCC ID :** BCG-E3545A

**IC :** 579C-E3545A

**EUT Description :** SMARTPHONE

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C  
ISED RSS-247 ISSUE 2  
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 Lab code: 200065-0

## REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions               | Revised By |
|------|------------|-------------------------|------------|
| V1   | 8/26/2020  | Initial Issue           | Chin Pang  |
| V2   | 9/18/2020  | Address TCB's Questions | Chin Pang  |
| V3   | 9/21/2020  | Address TCB's Questions | Chin Pang  |

## TABLE OF CONTENTS

|                                                                 |           |
|-----------------------------------------------------------------|-----------|
| <b>REPORT REVISION HISTORY .....</b>                            | <b>2</b>  |
| <b>TABLE OF CONTENTS .....</b>                                  | <b>3</b>  |
| <b>1. ATTESTATION OF TEST RESULTS .....</b>                     | <b>6</b>  |
| <b>2. TEST RESULTS SUMMARY .....</b>                            | <b>7</b>  |
| <b>3. TEST METHODOLOGY .....</b>                                | <b>7</b>  |
| <b>4. FACILITIES AND ACCREDITATION .....</b>                    | <b>7</b>  |
| <b>5. DECISION RULES AND MEASUREMENT UNCERTAINTY .....</b>      | <b>8</b>  |
| 5.1. METROLOGICAL TRACEABILITY .....                            | 8         |
| 5.2. DECISION RULES.....                                        | 8         |
| 5.3. MEASUREMENT UNCERTAINTY.....                               | 8         |
| <b>6. EQUIPMENT UNDER TEST .....</b>                            | <b>9</b>  |
| 6.1. EUT DESCRIPTION .....                                      | 9         |
| 6.2. MAXIMUM OUTPUT POWER.....                                  | 9         |
| 6.3. DESCRIPTION OF AVAILABLE ANTENNAS .....                    | 9         |
| 6.4. SOFTWARE AND FIRMWARE.....                                 | 10        |
| 6.5. WORST-CASE CONFIGURATION AND MODE .....                    | 10        |
| 6.6. DESCRIPTION OF TEST SETUP.....                             | 11        |
| <b>7. TEST AND MEASUREMENT EQUIPMENT .....</b>                  | <b>16</b> |
| <b>8. MEASUREMENT METHODS .....</b>                             | <b>17</b> |
| <b>9. ANTENNA PORT TEST RESULTS .....</b>                       | <b>18</b> |
| 9.1. ON TIME AND DUTY CYCLE.....                                | 18        |
| 9.2. 20 dB AND 99% BANDWIDTH .....                              | 19        |
| 9.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION .....         | 20        |
| 9.2.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....      | 21        |
| 9.2.3. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....     | 22        |
| 9.2.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION ..... | 23        |
| 9.3. HOPPING FREQUENCY SEPARATION .....                         | 24        |
| 9.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....          | 24        |
| 9.4. NUMBER OF HOPPING CHANNELS.....                            | 25        |
| 9.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION .....         | 26        |
| 9.5. AVERAGE TIME OF OCCUPANCY.....                             | 28        |
| 9.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION .....         | 29        |

|         |                                                          |     |
|---------|----------------------------------------------------------|-----|
| 9.6.    | OUTPUT POWER.....                                        | 33  |
| 9.6.1.  | HIGH POWER BASIC DATA RATE GFSK MODULATION.....          | 34  |
| 9.6.2.  | HIGH POWER ENHANCED DATA RATE QPSK MODULATION .....      | 34  |
| 9.6.3.  | HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....      | 35  |
| 9.6.4.  | LOW POWER BASIC DATA RATE GFSK MODULATION.....           | 35  |
| 9.6.5.  | LOW POWER ENHANCED DATA RATE QPSK MODULATION .....       | 36  |
| 9.6.6.  | LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....       | 36  |
| 9.6.7.  | HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....     | 37  |
| 9.6.8.  | HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION ..... | 37  |
| 9.6.9.  | HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION ..... | 37  |
| 9.6.10. | LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....     | 38  |
| 9.6.11. | LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION.....   | 38  |
| 9.6.12. | LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....  | 38  |
| 9.7.    | AVERAGE POWER.....                                       | 39  |
| 9.7.1.  | HIGH POWER BASIC DATA RATE GFSK MODULATION.....          | 40  |
| 9.7.2.  | HIGH POWER ENHANCED DATA RATE QPSK MODULATION .....      | 40  |
| 9.7.3.  | HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....      | 41  |
| 9.7.4.  | LOW POWER BASIC DATA RATE GFSK MODULATION.....           | 41  |
| 9.7.5.  | LOW POWER ENHANCED DATA RATE QPSK MODULATION .....       | 42  |
| 9.7.6.  | LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....       | 42  |
| 9.7.7.  | HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....     | 43  |
| 9.7.8.  | HIGH POWER ENHANCED RATE TXBF QPSK MODULATION.....       | 43  |
| 9.7.9.  | HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION ..... | 43  |
| 9.7.10. | LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....     | 44  |
| 9.7.11. | LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION.....   | 44  |
| 9.7.12. | LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....  | 44  |
| 9.8.    | CONDUCTED SPURIOUS EMISSIONS.....                        | 45  |
| 9.8.1.  | HIGH POWER BASIC DATA RATE GFSK MODULATION.....          | 46  |
| 9.8.2.  | HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....      | 50  |
| 9.8.3.  | LOW POWER BASIC DATA RATE GFSK MODULATION.....           | 54  |
| 9.8.4.  | LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....       | 58  |
| 9.8.5.  | HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....     | 62  |
| 9.8.6.  | HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION ..... | 66  |
| 9.8.7.  | LOW POWER BASIC DATA RATE TXBF GFSK MODULATION.....      | 70  |
| 9.8.8.  | LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....  | 74  |
| 10.     | RADIATED TEST RESULTS .....                              | 78  |
| 10.1.   | TRANSMITTER ABOVE 1 GHz.....                             | 80  |
| 10.1.1. | HIGH POWER BASIC DATA RATE GFSK MODULATION .....         | 80  |
| 10.1.2. | HIGH POWER ENHANCED DATA RATE 8PSK MODULATION.....       | 88  |
| 10.1.3. | LOW POWER BASIC DATA RATE GFSK MODULATION .....          | 96  |
| 10.1.4. | LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....       | 104 |
| 10.1.5. | HIGH POWER BASIC DATA RATE TX BF GFSK MODULATION .....   | 112 |
| 10.1.6. | HIGH POWER BASIC DATA RATE TXBF 8PSK MODULATION.....     | 116 |
| 10.1.7. | LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....     | 120 |
| 10.1.8. | LOW POWER BASIC DATA RATE TXBF 8PSK MODULATION.....      | 124 |
| 10.1.9. | HIGH POWER HARMONICS AND SPURIOUS TXBF GFSK MODULATION   |     |
|         | 128                                                      |     |
| 10.2.   | WORST CASE BELOW 1 GHZ.....                              | 134 |

|            |                                                |            |
|------------|------------------------------------------------|------------|
| 10.3.      | WORST CASE 18-26 GHZ.....                      | 136        |
| <b>11.</b> | <b>AC POWER LINE CONDUCTED EMISSIONS .....</b> | <b>138</b> |
| 11.1.      | AC Power Line With Laptop.....                 | 139        |
| 11.2.      | AC Power Line With AC/DC Adapter .....         | 141        |
| <b>12.</b> | <b>SETUP PHOTOS .....</b>                      | <b>143</b> |

## 1. ATTESTATION OF TEST RESULTS

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

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A2341

**SERIAL NUMBER:** G6TCP01UQ5R9, G6TCM020Q5T6

**DATE TESTED:** MARCH 02, 2020 – AUGUST 13, 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.

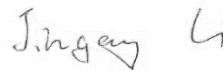
This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This 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:



Jingang Li  
Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST RESULTS SUMMARY

| FCC Clause         | ISED Clause       | Requirement                  | Result                  | Comment                              |
|--------------------|-------------------|------------------------------|-------------------------|--------------------------------------|
| See Comment        |                   | Duty Cycle                   | Reporting purposes only | Per ANSI C63.10, Section 11.6.       |
| See Comment        | RSS-GEN 6.7       | 20dB BW/99% OBW              | Reporting purposes only | ANSI C63.10 Sections 6.9.2 and 6.9.3 |
| 15.247 (a)(1)      | RSS-247 (5.1) (b) | Hopping Frequency Separation | Complies                | None.                                |
| 15.247 (a)(1)(iii) | RSS-247 (5.1) (d) | Number of Hopping Channels   | Complies                | None.                                |
| 15.247 (a)(1)(iii) | RSS-247 (5.1) (d) | Average Time of Occupancy    | Complies                | None.                                |
| 15.247 (b)(1)      | RSS-247 (5.4) (b) | Output Power                 | Complies                | None.                                |
| See Comment        |                   | Average Power                | Reporting purposes only | Per ANSI C63.10, Section 11.9.2.3.2. |
| 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.                                              |
|-------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------|
| <input type="checkbox"/> Chamber A (IC:2324B-1) | <input type="checkbox"/> Chamber D (IC:22541-1)            | <input checked="" type="checkbox"/> Chamber I (IC: 2324A-5) |
| <input type="checkbox"/> Chamber B (IC:2324B-2) | <input checked="" type="checkbox"/> Chamber E (IC:22541-2) | <input type="checkbox"/> Chamber J (IC: 2324A-6)            |
| <input type="checkbox"/> Chamber C (IC:2324B-3) | <input type="checkbox"/> Chamber F (IC:22541-3)            | <input type="checkbox"/> Chamber K (IC: 2324A-1)            |
|                                                 | <input checked="" type="checkbox"/> Chamber G (IC:22541-4) | <input type="checkbox"/> Chamber L (IC: 2324A-3)            |
|                                                 | <input type="checkbox"/> Chamber H (IC:22541-5)            | <input type="checkbox"/> 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

## 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 <sub>Lab</sub> |
|-----------------------------------------------------|------------------|
| 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%.

## 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           | Config     | Frequency Range (MHz) | Mode               | Output Power (dBm) | Output Power (mW) |
|-------------------|------------|-----------------------|--------------------|--------------------|-------------------|
| ANT 4             | High Power | 2402 - 2480           | Basic GFSK         | 20.20              | 104.71            |
|                   |            | 2402 - 2480           | QPSK               | 18.29              | 67.45             |
|                   |            | 2402 - 2480           | Enhanced 8PSK      | 18.40              | 69.18             |
|                   | Low Power  | 2402 - 2480           | Basic GFSK         | 12.99              | 19.91             |
|                   |            | 2402 - 2480           | QPSK               | 11.39              | 13.77             |
|                   |            | 2402 - 2480           | Enhanced 8PSK      | 11.59              | 14.42             |
| ANT 3             | High Power | 2402 - 2480           | Basic GFSK         | 20.16              | 103.75            |
|                   |            | 2402 - 2480           | QPSK               | 18.34              | 68.23             |
|                   |            | 2402 - 2480           | Enhanced 8PSK      | 18.42              | 69.50             |
|                   | Low Power  | 2402 - 2480           | Basic GFSK         | 12.93              | 19.63             |
|                   |            | 2402 - 2480           | QPSK               | 11.20              | 13.18             |
|                   |            | 2402 - 2480           | Enhanced 8PSK      | 11.32              | 13.55             |
| BF, ANT 4 + ANT 3 | High Power | 2402 - 2480           | Basic GFSK TxBF    | 20.72              | 118.03            |
|                   |            | 2402 - 2480           | QPSK TxBF          | 20.11              | 102.57            |
|                   |            | 2402 - 2480           | Enhanced 8PSK TxBF | 20.21              | 104.95            |
|                   | Low Power  | 2402 - 2480           | Basic GFSK TxBF    | 15.91              | 38.99             |
|                   |            | 2402 - 2480           | QPSK TxBF          | 14.28              | 26.79             |
|                   |            | 2402 - 2480           | Enhanced 8PSK TxBF | 14.40              | 27.54             |

Note: GFSK, DQPSK, 8PSK average Power are all investigated, The GFSK & 8PSK Power are the worst case. Testing is based on these modes to showing compliance

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Range (GHz) | ANT 4 (dBi) | ANT 3 (dBi) |
|-----------------------|-------------|-------------|
| 2.4                   | -1.9        | 0.4         |

## **6.4. SOFTWARE AND FIRMWARE**

The EUT firmware installed during testing was 18.1.148.558

## **6.5. WORST-CASE CONFIGURATION AND MODE**

The EUT was investigated in three orthogonal orientations X, Y and Z on ANT 4 (Core 0) and ANT 3 (Core 1). It was determined that X (Flatbed) orientation was the worst-case orientation for ANT 4 and 2TX BF, and Z (Portrait) was the worst case for ANT 3.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT 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 EUT was connected to AC power adapter as the worst case; and for above 1GHz, the worst-case configuration reported was tested with EUT only. There were no emissions found below 30MHz within 20dB of the limit. 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 BT and 5GHz bands, No noticeable emission was found.

Worst-case data rates as provided by the client were:

GFSK mode: DH5  
8PSK mode: 3-DH5  
Beamforming, GFSK, DH5  
Beamforming, 8PSK, 3-DH5

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.

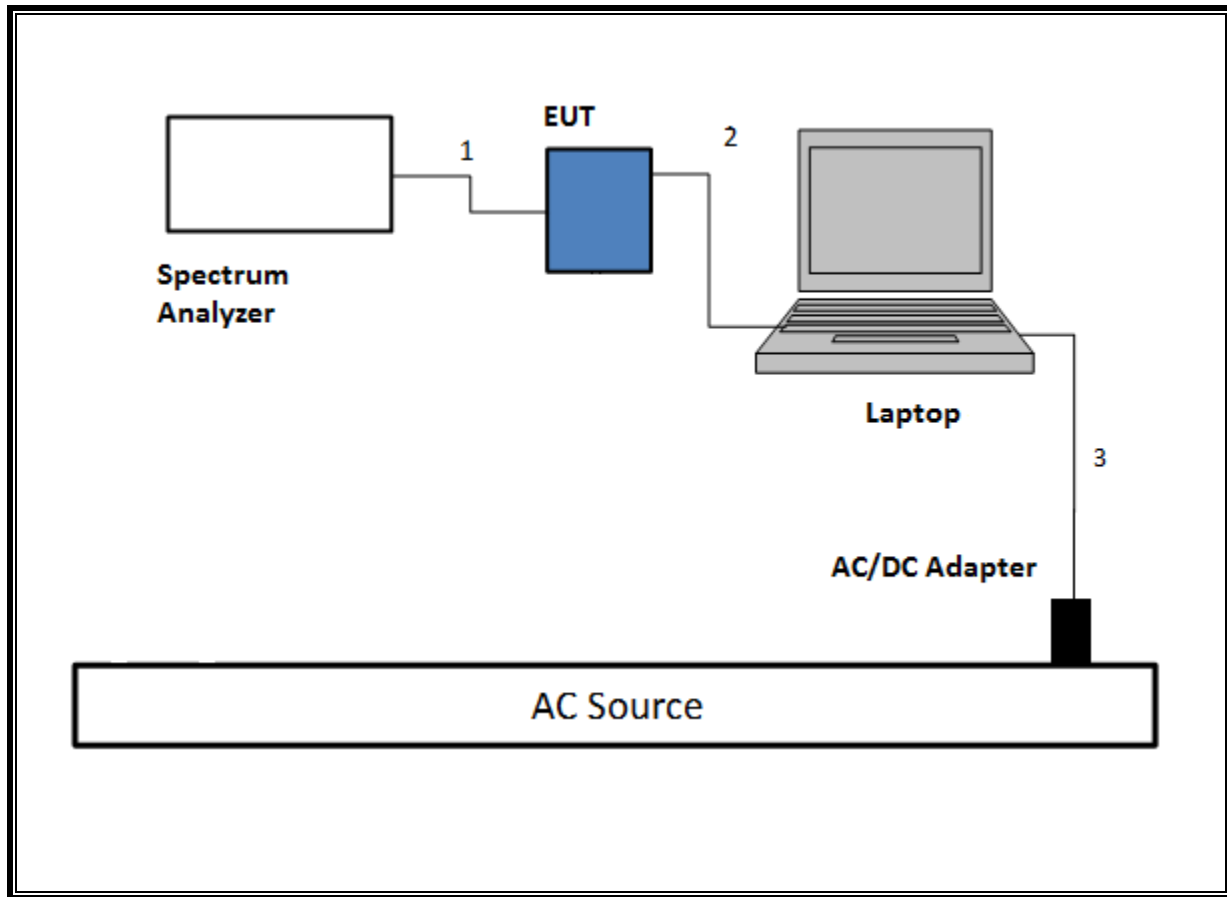
## 6.6. DESCRIPTION OF TEST SETUP

| SUPPORT TEST EQUIPMENT          |         |                      |                |                   |                  |                      |
|---------------------------------|---------|----------------------|----------------|-------------------|------------------|----------------------|
| Description                     |         | Manufacturer         | Model          | Serial Number     |                  | FCC ID/ DoC          |
| Laptop                          |         | Apple                | A1989          | C02YL3ZMJHC8      |                  | BCGA1989             |
| Laptop 61W USBC-C AC/DC adapter |         | Liteon Technology    | A1718          | C4N711404U3GN8RAW |                  | NA                   |
| EUT AC Adapter                  |         | Apple                | A2305          | D292365CDYADHLHC3 |                  | NA                   |
| 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                  |

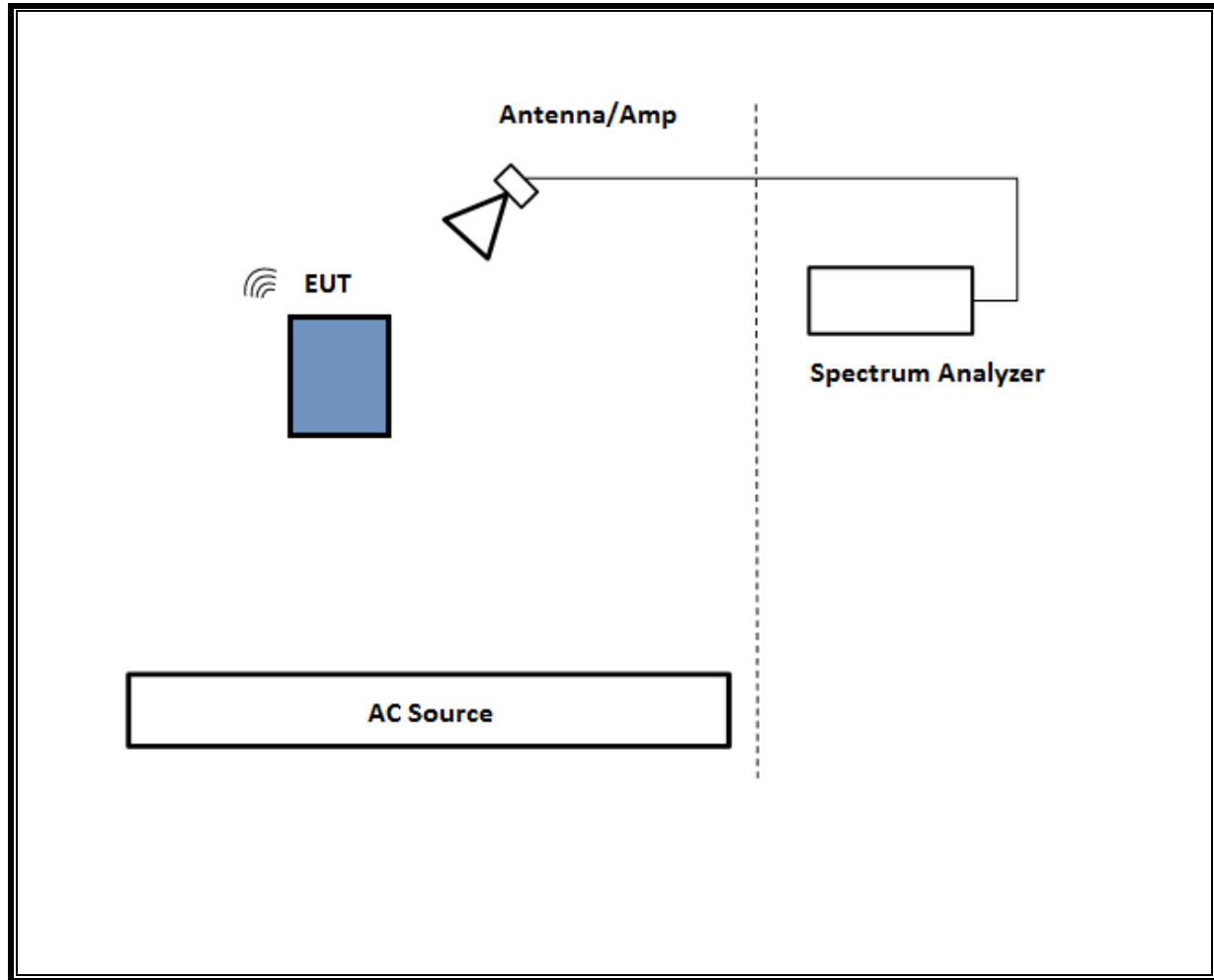
### TEST SETUP

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

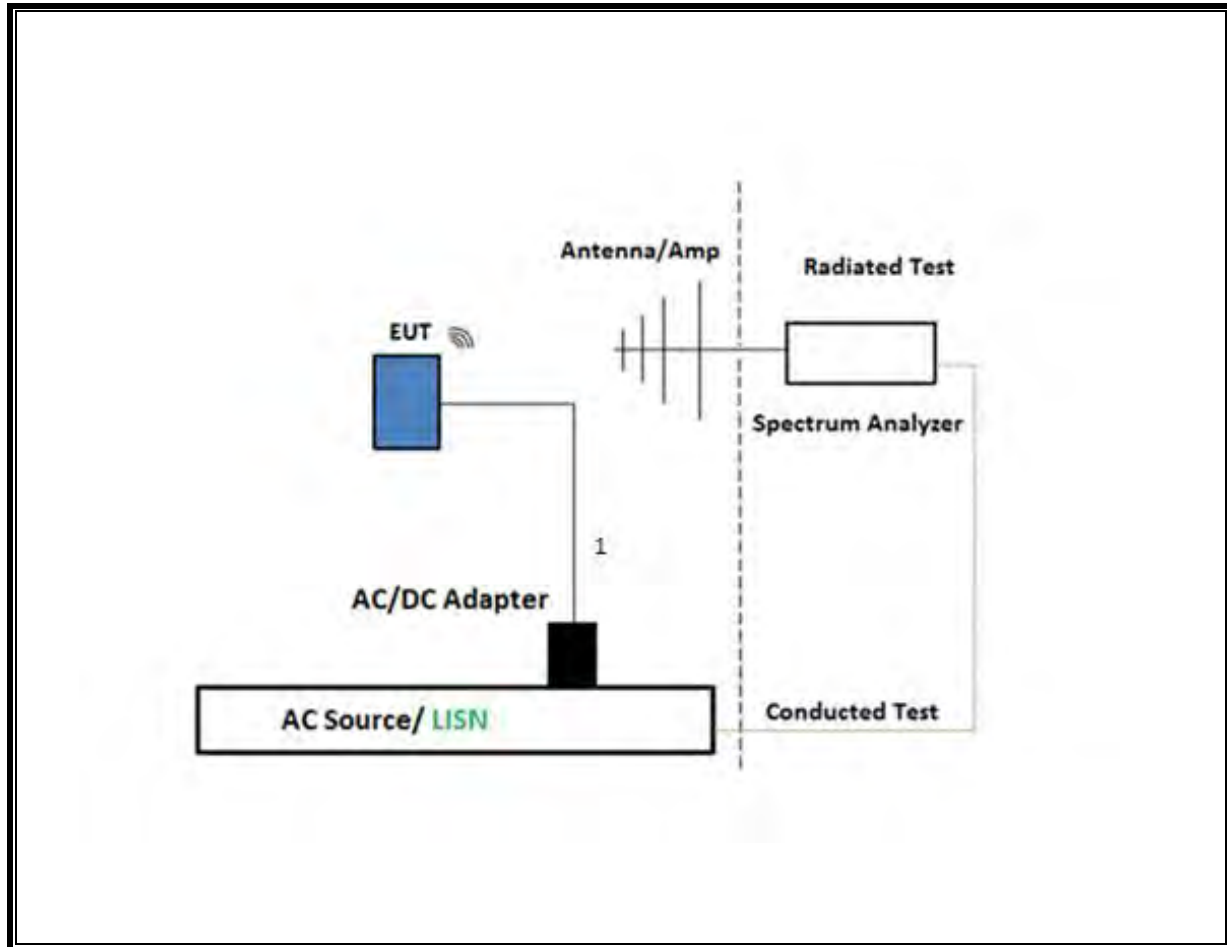
**SETUP DIAGRAM FOR CONDUCTED TESTS**



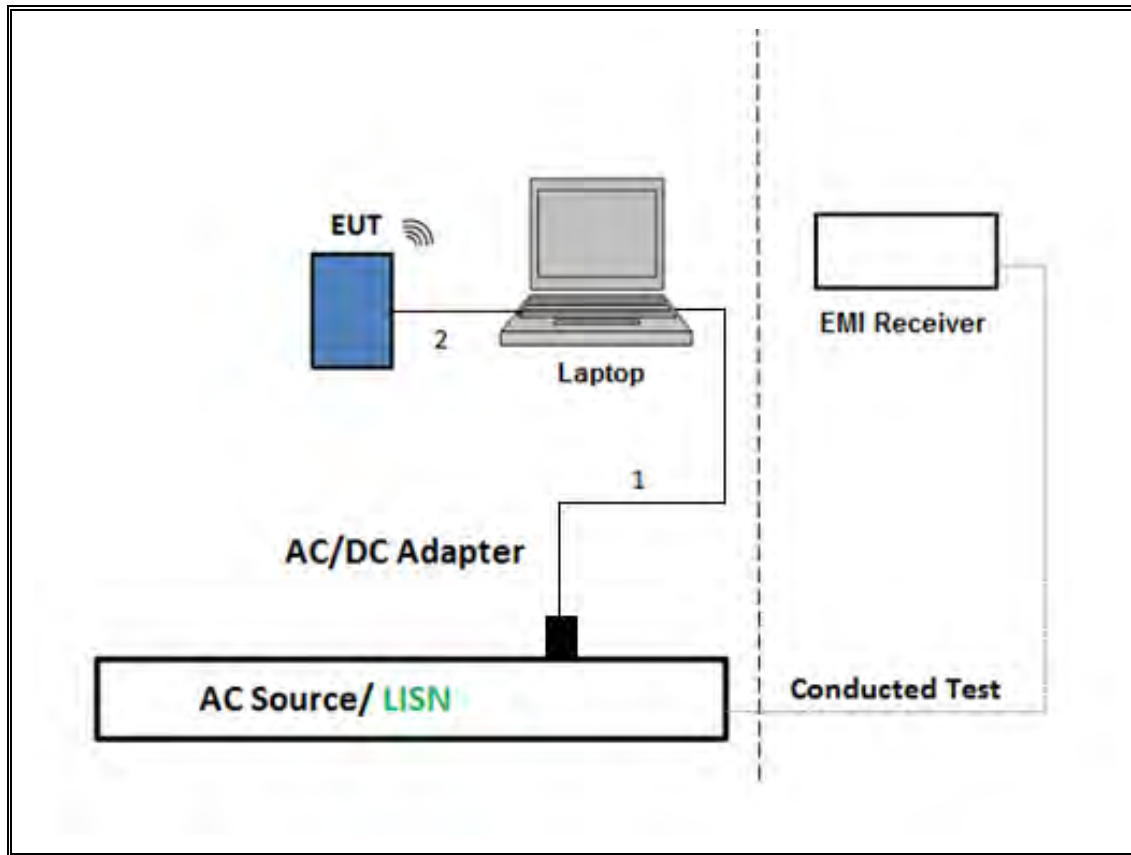
**SETUP DIAGRAM FOR RADIATED TESTS Above 1GHz**



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



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



## 7. TEST AND MEASUREMENT EQUIPMENT

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

| TEST EQUIPMENT LIST                    |                                 |                        |            |            |            |
|----------------------------------------|---------------------------------|------------------------|------------|------------|------------|
| Description                            | Manufacturer                    | Model                  | ID Num     | Cal Due    | Last Cal   |
| *Antenna, Horn 1-18GHz                 | ETS Lindgren                    | 3117                   | T862       | 08/20/2020 | 08/20/2019 |
| Amplifier, 1 to 18GHz, 35dB            | Ampical                         | AFS42-00101800-25-S-42 | T1567      | 01/24/2021 | 01/24/2020 |
| Antenna, Horn 1-18GHz                  | ETS Lindgren                    | 3117                   | T712       | 03/09/2021 | 03/09/2020 |
| RF Amplifier, 1-18GHz                  | MITEQ                           | AFS42-00101800-25-S-42 | 171460     | 08/24/2020 | 08/24/2019 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz   | Keysight Technologies Inc       | N9030A-544             | T1210      | 01/22/2021 | 01/22/2020 |
| Antenna, Horn 1-18GHz                  | ETS Lindgren                    | 3117                   | T120       | 04/19/2021 | 04/19/2020 |
| Amplifier, 1 to 18GHz                  | Miteq                           | AFS42-00101800-25-S-42 | T491       | 06/12/2021 | 06/12/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz   | Keysight Technologies Inc       | N9030A                 | T1466      | 01/23/2021 | 01/23/2020 |
| *Amplifier, 10KHz to 1GHz, 32dB        | Sonoma                          | 310N                   | T173       | 06/06/2020 | 6/06/2019  |
| EMI Test Receiver                      | Rohde & Schwarz                 | ESW44                  | Pre0179522 | 02/20/2021 | 02/20/2020 |
| *Antenna, Broadband Hybrid, 30-2000MHz | Sunol Sciences                  | JB1                    | T130       | 08/09/2020 | 08/09/2019 |
| Antenna Horn, 18 to 26GHz              | ARA                             | SWH-28                 | T125       | 04/17/2021 | 04/17/2020 |
| Pre-Amp 18-26GHz                       | Agilent Technology              | 8449B                  | T404       | 04/08/2021 | 04/08/2020 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz   | Agilent (Keysight) Technologies | N9030A                 | T1454      | 01/23/2021 | 01/23/2020 |
| Antenna, Active Loop 9KHz to 30MHz     | ETS-Lindgren                    | 6502                   | T757       | 10/01/2020 | 10/01/2019 |
| 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 is completed before equipment expiration date.

## 8. MEASUREMENT METHODS

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6

Occupied BW (20dB): ANSI C63.10-2013 Section 6.9.2

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

Carrier Frequency Separation: ANSI C63.10-2013 Section 7.8.2

Number of Hopping Frequencies: ANSI C63.10-2013 Section 7.8.3

Time of Occupancy (Dwell Time): ANSI C63.10-2013 Section 7.8.4

Peak Output Power: ANSI C63.10-2013 Section 7.8.5

Conducted Spurious Emissions: ANSI C63.10-2013 Section 7.8.8

Conducted Band-Edge: ANSI C63.10-2013 Section 6.10.4

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

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3, 6.5 & 13

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3, 6.6 & 13

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5 & section 13

AC Power-line conducted emissions: ANSI C63.10-2013, Section 6.2.

## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

#### PROCEDURE

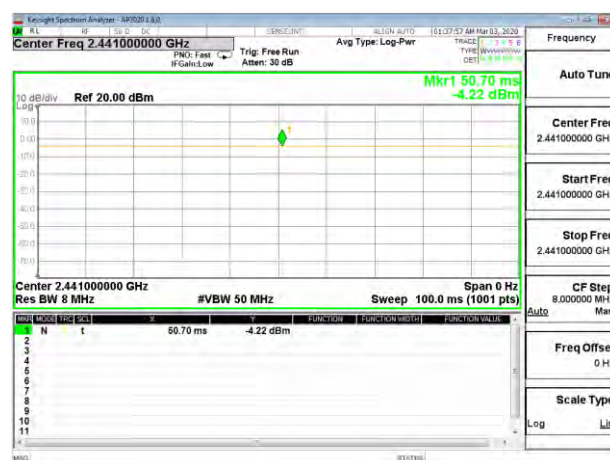
ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS

| Mode           | ON Time<br>B<br>(msec) | Period<br>(msec) | Duty Cycle<br>x<br>(linear) | Duty<br>Cycle<br>(%) | Duty Cycle<br>Correction Factor<br>(dB) | 1/T<br>Minimum VBW<br>(kHz) |
|----------------|------------------------|------------------|-----------------------------|----------------------|-----------------------------------------|-----------------------------|
| Bluetooth GFSK | 100.00                 | 100.00           | 1.000                       | 100.0                | 0.00                                    | 0.010                       |
| Bluetooth 8PSK | 100.00                 | 100.00           | 1.000                       | 100.0                | 0.00                                    | 0.010                       |

Note: Low power duty cycle is same as high power

#### DUTY CYCLE PLOTS



BLUETOOTH GFSK



BLUETOOTH 8PSK

## **9.2. 20 dB AND 99% BANDWIDTH**

### **LIMITS**

None; for reporting purposes only.

### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to  $\geq 1\%$  of the 20 dB bandwidth. The VBW is set to 3x RBW. The sweep time is coupled.

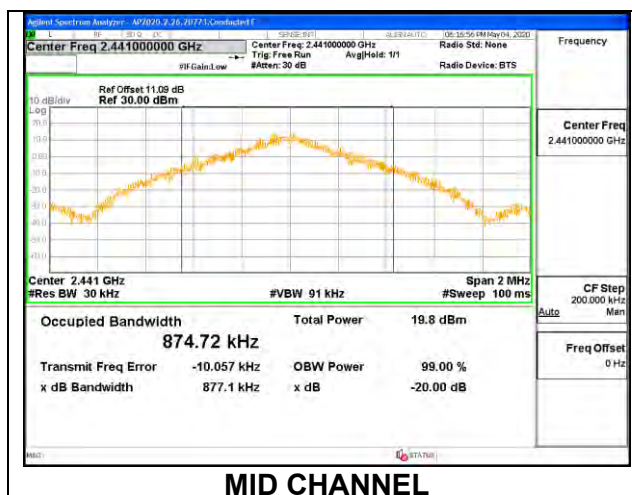
### **RESULTS**

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.

## 9.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

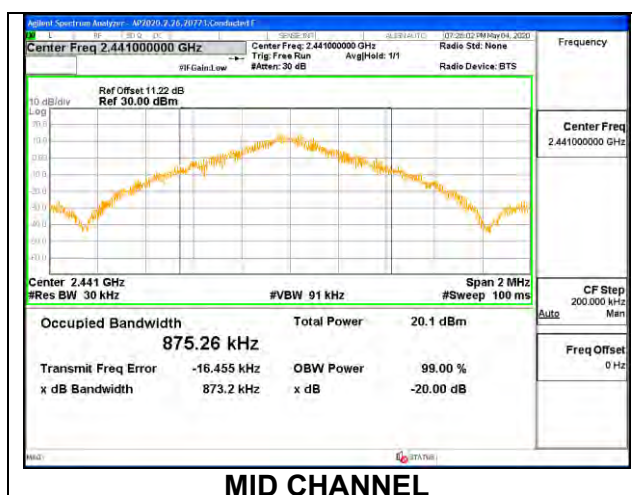
### ANT 4

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.875                | 0.872               |
| Mid     | 2441            | 0.877                | 0.875               |
| High    | 2480            | 0.925                | 0.875               |



### ANT 3

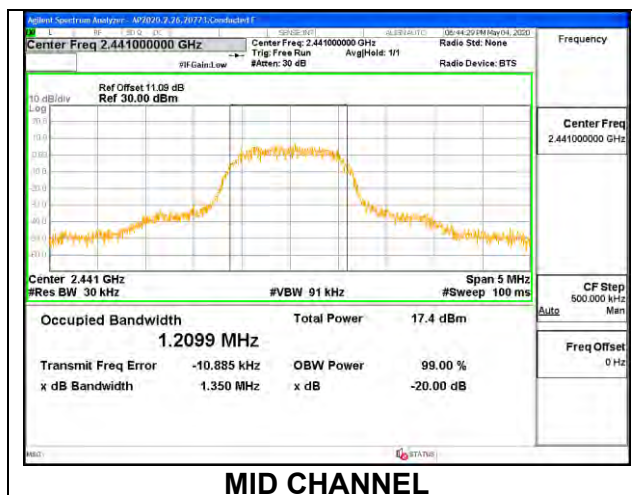
| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.926                | 0.875               |
| Mid     | 2441            | 0.873                | 0.875               |
| High    | 2480            | 0.873                | 0.873               |



## 9.2.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

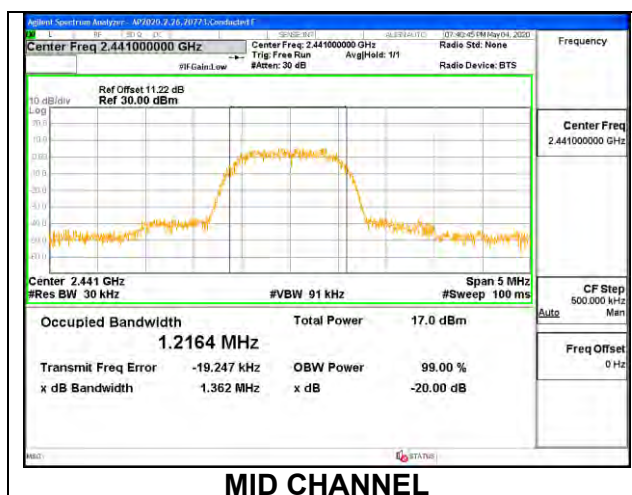
### ANT 4

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.353                | 1.212               |
| Mid     | 2441            | 1.350                | 1.210               |
| High    | 2480            | 1.382                | 1.228               |



### ANT 3

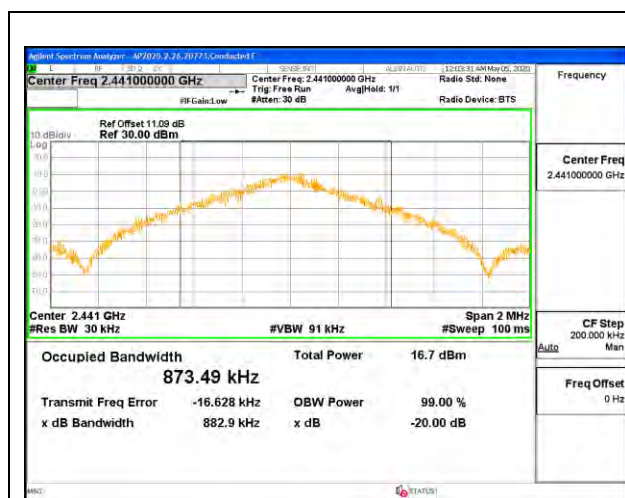
| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.377                | 1.218               |
| Mid     | 2441            | 1.362                | 1.216               |
| High    | 2480            | 1.376                | 1.223               |



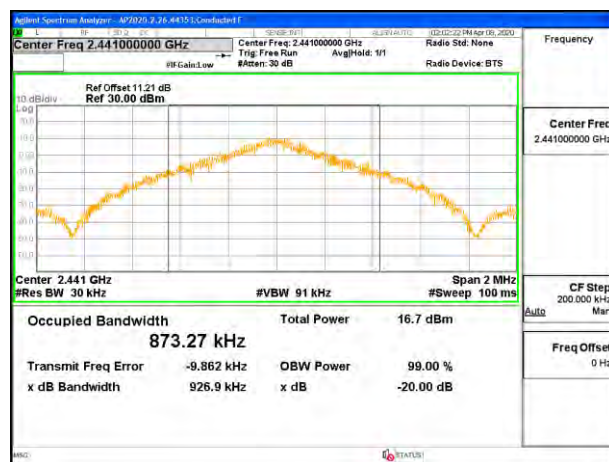
### 9.2.3. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF MODE

| Channel | Frequency<br>(MHz) | 20dB Bandwidth<br>Antenna 4<br>(MHz) | 99% Bandwidth<br>Antenna 4<br>(MHz) | 20dB Bandwidth<br>Antenna 3<br>(MHz) | 99% Bandwidth<br>Antenna 3<br>(MHz) |
|---------|--------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|
| Low     | 2402               | 0.883                                | 0.873                               | 0.927                                | 0.874                               |
| Mid     | 2441               | 0.883                                | 0.873                               | 0.927                                | 0.873                               |
| High    | 2480               | 0.873                                | 0.874                               | 0.874                                | 0.872                               |



MID CHANNEL ANT 4

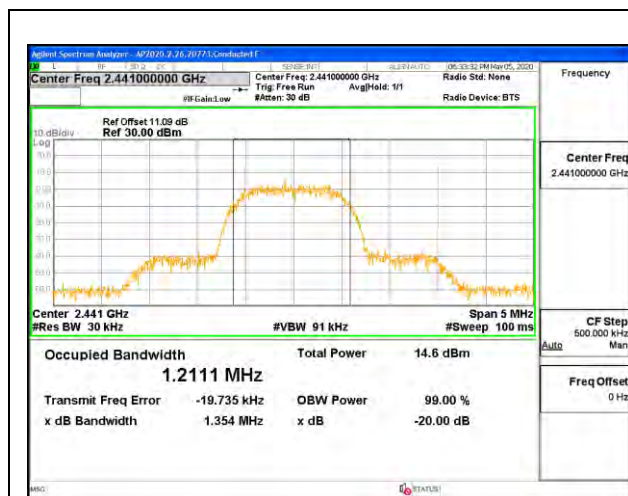


MID CHANNEL ANT 3

## 9.2.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX ANT 4 + ANT 3 TxBF MODE

| Channel | Frequency<br>(MHz) | 20dB Bandwidth<br>Antenna 4<br>(MHz) | 99% Bandwidth<br>Antenna 4<br>(MHz) | 20dB Bandwidth<br>Antenna 3<br>(MHz) | 99% Bandwidth<br>Antenna 3<br>(MHz) |
|---------|--------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|
| Low     | 2402               | 1.368                                | 1.210                               | 1.356                                | 1.212                               |
| Mid     | 2441               | 1.354                                | 1.211                               | 1.369                                | 1.212                               |
| High    | 2480               | 1.350                                | 1.215                               | 1.369                                | 1.214                               |



MID CHANNEL ANT 4



MID CHANNEL ANT 3

### 9.3. HOPPING FREQUENCY SEPARATION

#### LIMITS

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

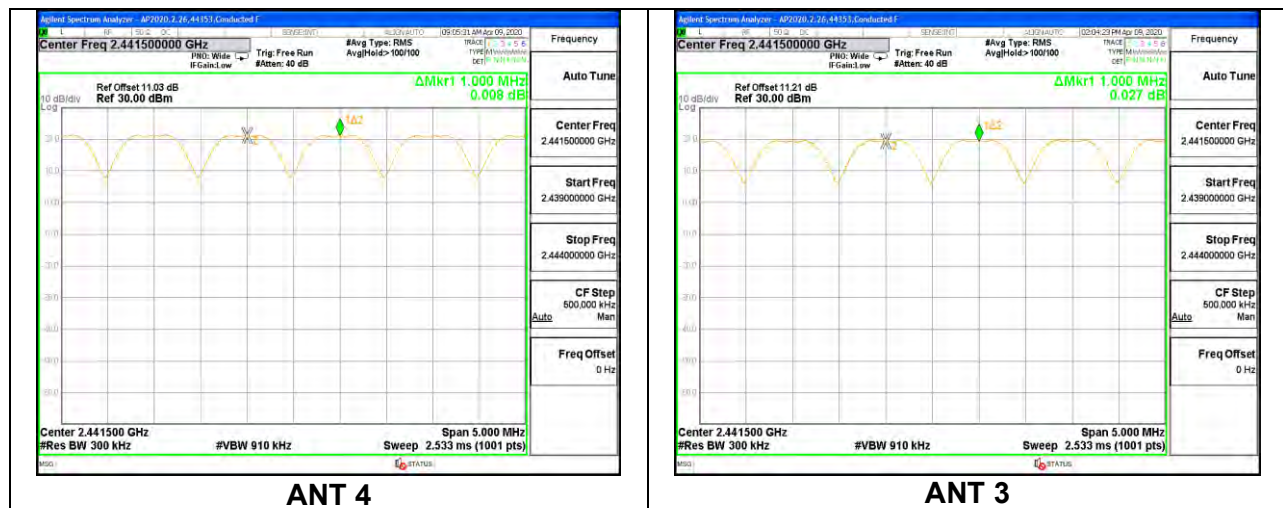
#### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to VBW = 3x RBW. The sweep time is coupled.

#### RESULTS

Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same channel plan.

#### 9.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION



## **9.4. NUMBER OF HOPPING CHANNELS**

### **LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

### **TEST PROCEDURE**

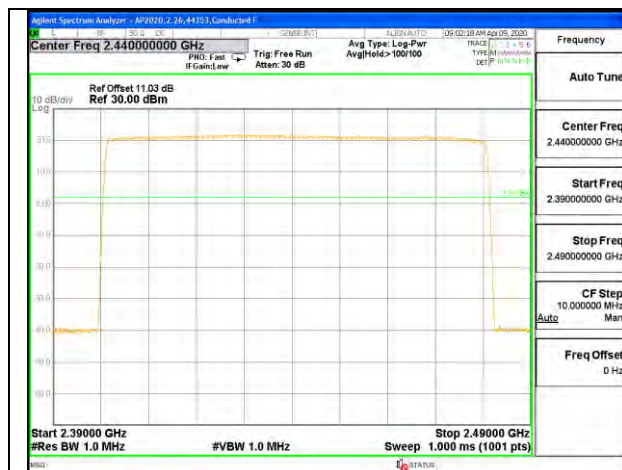
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

### **RESULTS**

Normal Mode: 79 Channels Observed. Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same channel plan.

## 9.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

### ANT 4



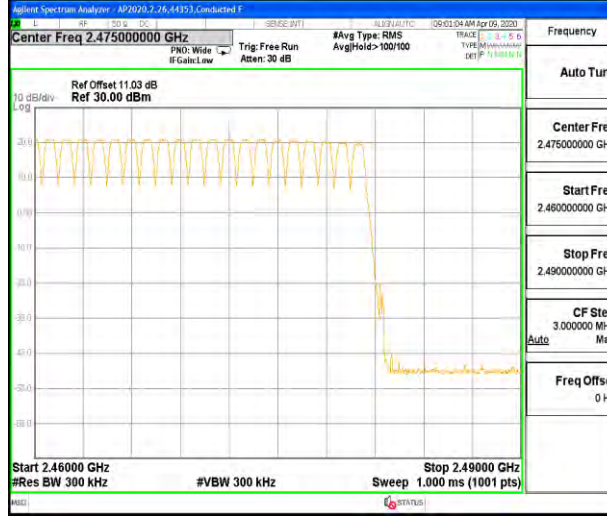
100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3

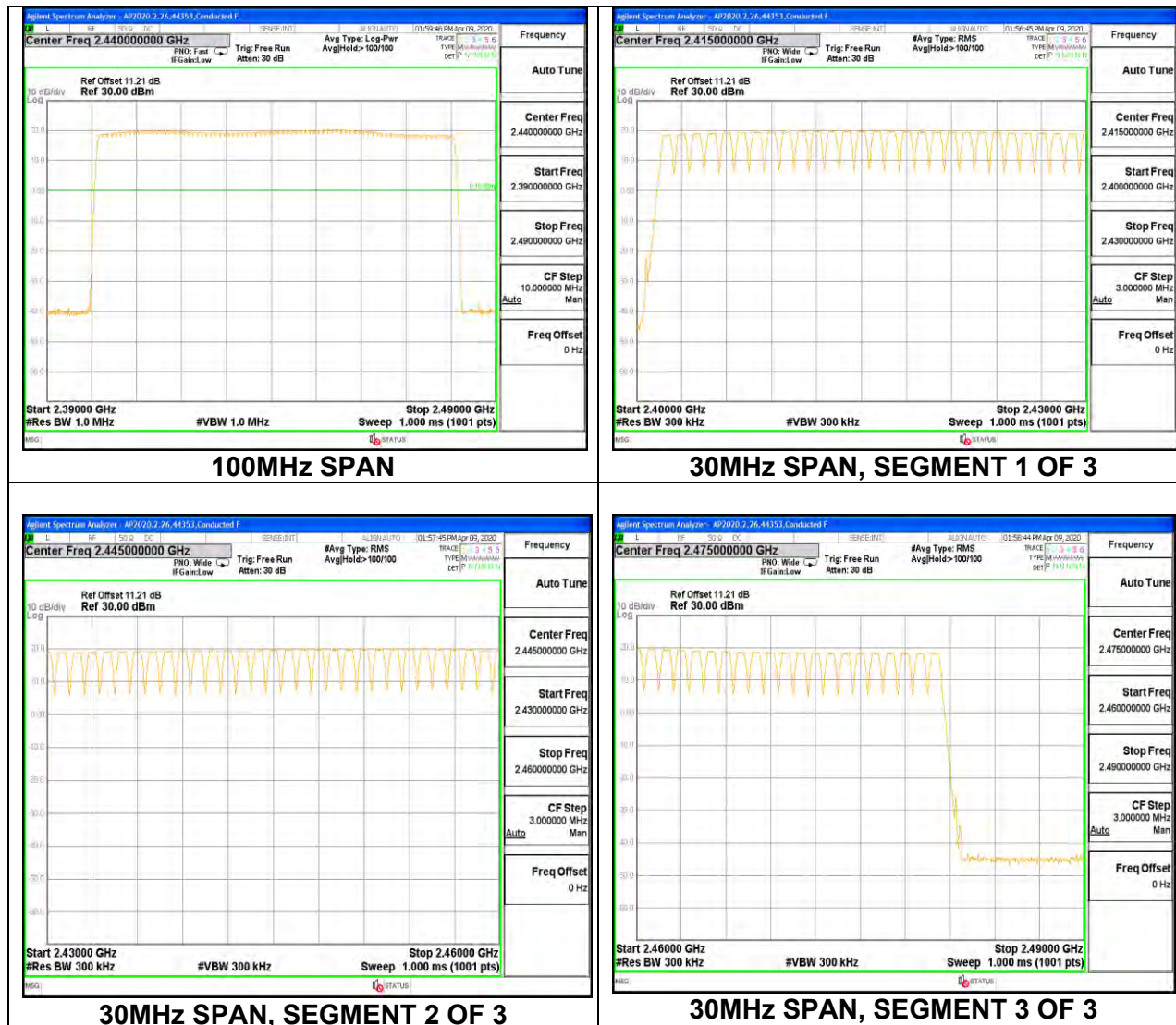


30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

# ANT 3



## **9.5. AVERAGE TIME OF OCCUPANCY**

### **LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 3.16 second period (79 channels \* 0.4 s) is equal to  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$ .

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels \* 0.4 seconds) is equal to  $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{pulse width}$ .

### **RESULTS**

Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same timing.

## 9.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

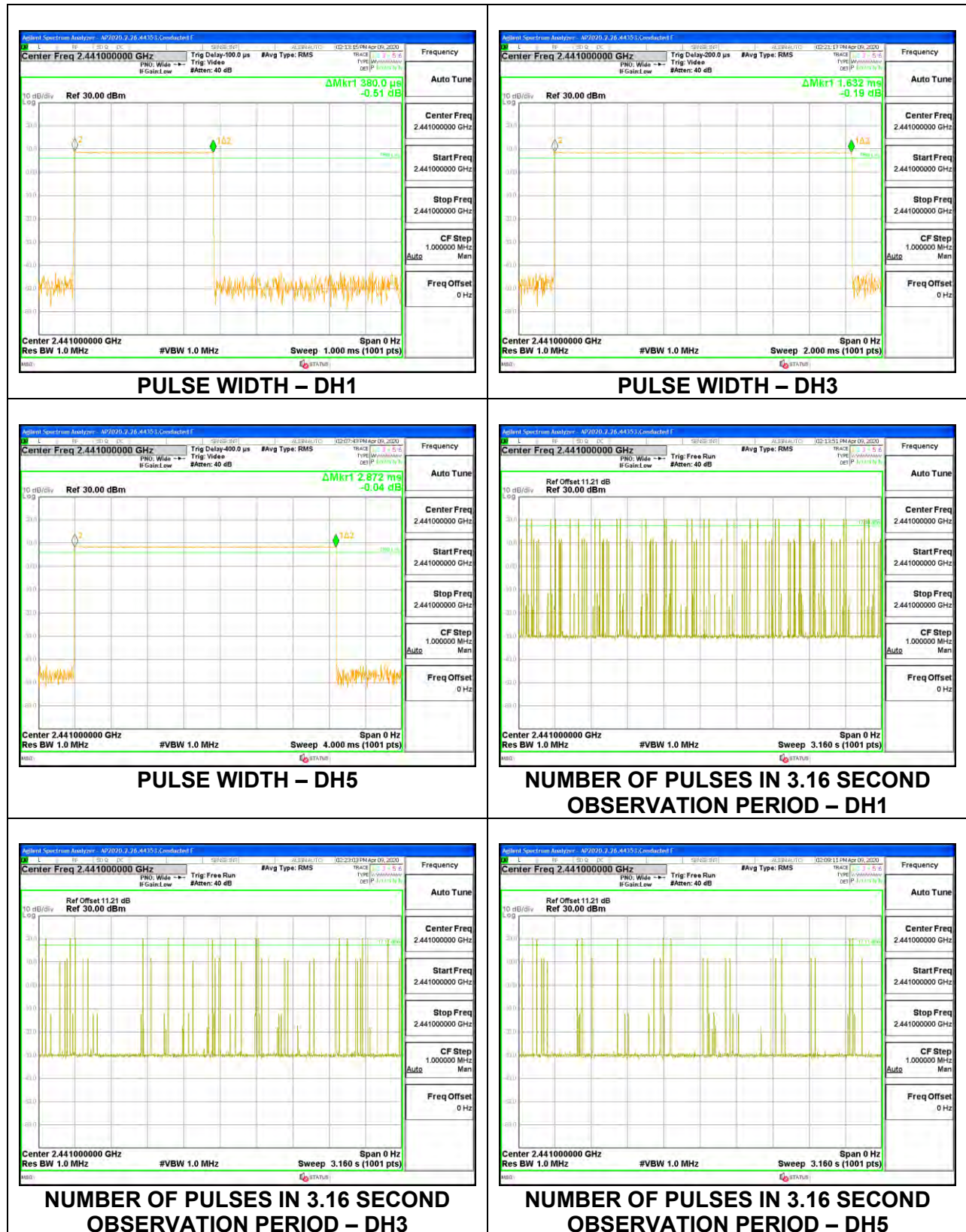
### ANT 4

| DH Packet        | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| GFSK Normal Mode |                    |                                  |                                 |             |              |
| DH1              | 0.379              | 32                               | 0.1213                          | 0.4         | -0.2787      |
| DH3              | 1.632              | 15                               | 0.2448                          | 0.4         | -0.1552      |
| DH5              | 2.876              | 9                                | 0.2588                          | 0.4         | -0.1412      |
|                  |                    |                                  |                                 |             |              |
| DH Packet        | Pulse Width (sec)  | Number of Pulses in 0.8 seconds  | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
| GFSK AFH Mode    |                    |                                  |                                 |             |              |
| DH1              | 0.379              | 8                                | 0.03032                         | 0.4         | -0.3697      |
| DH3              | 1.632              | 3.75                             | 0.06120                         | 0.4         | -0.3388      |
| DH5              | 2.876              | 2.25                             | 0.06471                         | 0.4         | -0.3353      |



**ANT 3**

| DH Packet        | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| GFSK Normal Mode |                    |                                  |                                 |             |              |
| DH1              | 0.38               | 32                               | 0.1216                          | 0.4         | -0.2784      |
| DH3              | 1.632              | 16                               | 0.2611                          | 0.4         | -0.1389      |
| DH5              | 2.872              | 10                               | 0.2872                          | 0.4         | -0.1128      |
|                  |                    |                                  |                                 |             |              |
| DH Packet        | Pulse Width (sec)  | Number of Pulses in 0.8 seconds  | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
| GFSK AFH Mode    |                    |                                  |                                 |             |              |
| DH1              | 0.38               | 8                                | 0.03040                         | 0.4         | -0.3696      |
| DH3              | 1.632              | 4                                | 0.06528                         | 0.4         | -0.3347      |
| DH5              | 2.872              | 2.5                              | 0.07180                         | 0.4         | -0.3282      |



## 9.6. OUTPUT POWER

### LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

### TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

### DIRECTIONAL ANTENNA GAIN

For 1 TX:

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2 TX:

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

| Band<br>(GHz) | ANT 4<br>Antenna<br>Gain<br>(dBi) | ANT 3<br>Antenna<br>Gain<br>(dBi) | Uncorrelated Chains<br>Directional<br>Gain<br>(dBi) | Correlated Chains<br>Directional<br>Gain<br>(dBi) |
|---------------|-----------------------------------|-----------------------------------|-----------------------------------------------------|---------------------------------------------------|
| 2.4           | -1.90                             | 0.40                              | -0.60                                               | 2.34                                              |

### RESULTS

## 9.6.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 20.05                 | 21             | -0.95          |
| Middle  | 2441               | 20.20                 | 21             | -0.8           |
| High    | 2480               | 20.16                 | 21             | -0.84          |

### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 20.02                 | 21             | -0.98          |
| Middle  | 2441               | 20.16                 | 21             | -0.84          |
| High    | 2480               | 20.12                 | 21             | -0.88          |

## 9.6.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 18.22                 | 21             | -2.78          |
| Middle  | 2441               | 18.29                 | 21             | -2.71          |
| High    | 2480               | 18.19                 | 21             | -2.81          |

### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 18.34                 | 21             | -2.66          |
| Middle  | 2441               | 18.32                 | 21             | -2.68          |
| High    | 2480               | 18.21                 | 21             | -2.79          |

### 9.6.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 18.29                 | 21             | -2.71          |
| Middle  | 2441               | 18.40                 | 21             | -2.6           |
| High    | 2480               | 18.26                 | 21             | -2.74          |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 18.37                 | 21             | -2.63          |
| Middle  | 2441               | 18.42                 | 21             | -2.58          |
| High    | 2480               | 19.39                 | 21             | -1.61          |

### 9.6.4. LOW POWER BASIC DATA RATE GFSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 12.92                 | 21             | -8.08          |
| Middle  | 2441               | 12.99                 | 21             | -8.01          |
| High    | 2480               | 12.95                 | 21             | -8.05          |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 12.86                 | 21             | -8.14          |
| Middle  | 2441               | 12.93                 | 21             | -8.07          |
| High    | 2480               | 12.82                 | 21             | -8.18          |

## 9.6.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION

### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 11.13                 | 21             | -9.87          |
| Middle  | 2441               | 11.39                 | 21             | -9.61          |
| High    | 2480               | 11.26                 | 21             | -9.74          |

### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 11.12                 | 21             | -9.88          |
| Middle  | 2441               | 11.20                 | 21             | -9.8           |
| High    | 2480               | 11.13                 | 21             | -9.87          |

## 9.6.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 11.32                 | 21             | -9.68          |
| Middle  | 2441               | 11.59                 | 21             | -9.41          |
| High    | 2480               | 11.23                 | 21             | -9.77          |

### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low     | 2402               | 11.29                 | 21             | -9.71          |
| Middle  | 2441               | 11.32                 | 21             | -9.68          |
| High    | 2480               | 11.20                 | 21             | -9.8           |

### 9.6.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 17.66                          | 17.58                          | 20.63                | 21             | -0.37          |
| Middle  | 2441               | 17.74                          | 17.68                          | 20.72                | 21             | -0.28          |
| High    | 2480               | 17.69                          | 17.56                          | 20.64                | 21             | -0.36          |

### 9.6.8. HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 17.02                          | 17.04                          | 20.04                | 21             | -0.96          |
| Middle  | 2441               | 17.07                          | 17.12                          | 20.11                | 21             | -0.89          |
| High    | 2480               | 17.05                          | 17.08                          | 20.08                | 21             | -0.92          |

### 9.6.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 17.12                          | 17.20                          | 20.17                | 21             | -0.83          |
| Middle  | 2441               | 17.15                          | 17.25                          | 20.21                | 21             | -0.79          |
| High    | 2480               | 17.19                          | 17.18                          | 20.20                | 21             | -0.80          |

## 9.6.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 12.71                          | 12.89                          | 15.81                | 21             | -5.19          |
| Middle  | 2441               | 12.87                          | 12.92                          | 15.91                | 21             | -5.09          |
| High    | 2480               | 12.96                          | 12.91                          | 15.95                | 21             | -5.05          |

## 9.6.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 11.22                          | 11.18                          | 14.21                | 21             | -6.79          |
| Middle  | 2441               | 11.24                          | 11.28                          | 14.27                | 21             | -6.73          |
| High    | 2480               | 11.32                          | 11.21                          | 14.28                | 21             | -6.72          |

## 9.6.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date:      | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Output Power<br>ANT 4<br>(dBm) | Output Power<br>ANT 3<br>(dBm) | Total Power<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|--------------------------------|----------------------|----------------|----------------|
| Low     | 2402               | 11.43                          | 11.31                          | 14.38                | 21             | -6.62          |
| Middle  | 2441               | 11.37                          | 11.41                          | 14.40                | 21             | -6.60          |
| High    | 2480               | 11.26                          | 11.35                          | 14.32                | 21             | -6.68          |

## **9.7. AVERAGE POWER**

### **LIMITS**

None; for reporting purposes only

### **TEST PROCEDURE**

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

### **RESULTS**

### 9.7.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 19.75                  |
| Middle  | 2441               | 19.91                  |
| High    | 2480               | 19.86                  |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 19.72                  |
| Middle  | 2441               | 19.86                  |
| High    | 2480               | 19.82                  |

### 9.7.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 15.72                  |
| Middle  | 2441               | 15.78                  |
| High    | 2480               | 15.69                  |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 15.75                  |
| Middle  | 2441               | 15.82                  |
| High    | 2480               | 15.72                  |

### 9.7.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 15.76                  |
| Middle  | 2441               | 15.88                  |
| High    | 2480               | 15.73                  |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 15.85                  |
| Middle  | 2441               | 15.89                  |
| High    | 2480               | 15.86                  |

### 9.7.4. LOW POWER BASIC DATA RATE GFSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 12.18                  |
| Middle  | 2441               | 12.44                  |
| High    | 2480               | 12.31                  |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 12.24                  |
| Middle  | 2441               | 12.46                  |
| High    | 2480               | 12.38                  |

### 9.7.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 8.56                   |
| Middle  | 2441               | 8.60                   |
| High    | 2480               | 8.58                   |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 8.55                   |
| Middle  | 2441               | 8.59                   |
| High    | 2480               | 8.57                   |

### 9.7.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

#### ANT 4

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 8.89                   |
| Middle  | 2441               | 8.92                   |
| High    | 2480               | 8.79                   |

#### ANT 3

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>(dBm) |
|---------|--------------------|------------------------|
| Low     | 2402               | 8.82                   |
| Middle  | 2441               | 8.86                   |
| High    | 2480               | 8.77                   |

### 9.7.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 17.36                           | 17.28                           | 20.33                           |
| Middle  | 2441               | 17.44                           | 17.38                           | 20.42                           |
| High    | 2480               | 17.39                           | 17.26                           | 20.34                           |

### 9.7.8. HIGH POWER ENHANCED RATE TXBF QPSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 14.41                           | 14.45                           | 17.44                           |
| Middle  | 2441               | 14.44                           | 14.51                           | 17.49                           |
| High    | 2480               | 14.43                           | 14.46                           | 17.46                           |

### 9.7.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 14.60                           | 14.69                           | 17.66                           |
| Middle  | 2441               | 14.63                           | 14.72                           | 17.69                           |
| High    | 2480               | 14.66                           | 14.66                           | 17.67                           |

### 9.7.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 12.24                           | 12.30                           | 15.28                           |
| Middle  | 2441               | 12.30                           | 12.44                           | 15.38                           |
| High    | 2480               | 12.29                           | 12.28                           | 15.30                           |

### 9.7.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 8.49                            | 8.41                            | 11.46                           |
| Middle  | 2441               | 8.41                            | 8.52                            | 11.48                           |
| High    | 2480               | 8.46                            | 8.42                            | 11.45                           |

### 9.7.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

#### 2TX ANT 4 + ANT 3 TxBF Mode

|            |           |
|------------|-----------|
| Tested By: | 20773     |
| Date       | 7/27/2020 |

| Channel | Frequency<br>(MHz) | Average Power<br>ANT 4<br>(dBm) | Average Power<br>ANT 3<br>(dBm) | Total<br>Average Power<br>(dBm) |
|---------|--------------------|---------------------------------|---------------------------------|---------------------------------|
| Low     | 2402               | 8.69                            | 8.72                            | 11.72                           |
| Middle  | 2441               | 8.78                            | 8.79                            | 11.80                           |
| High    | 2480               | 8.77                            | 8.71                            | 11.75                           |

## **9.8. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

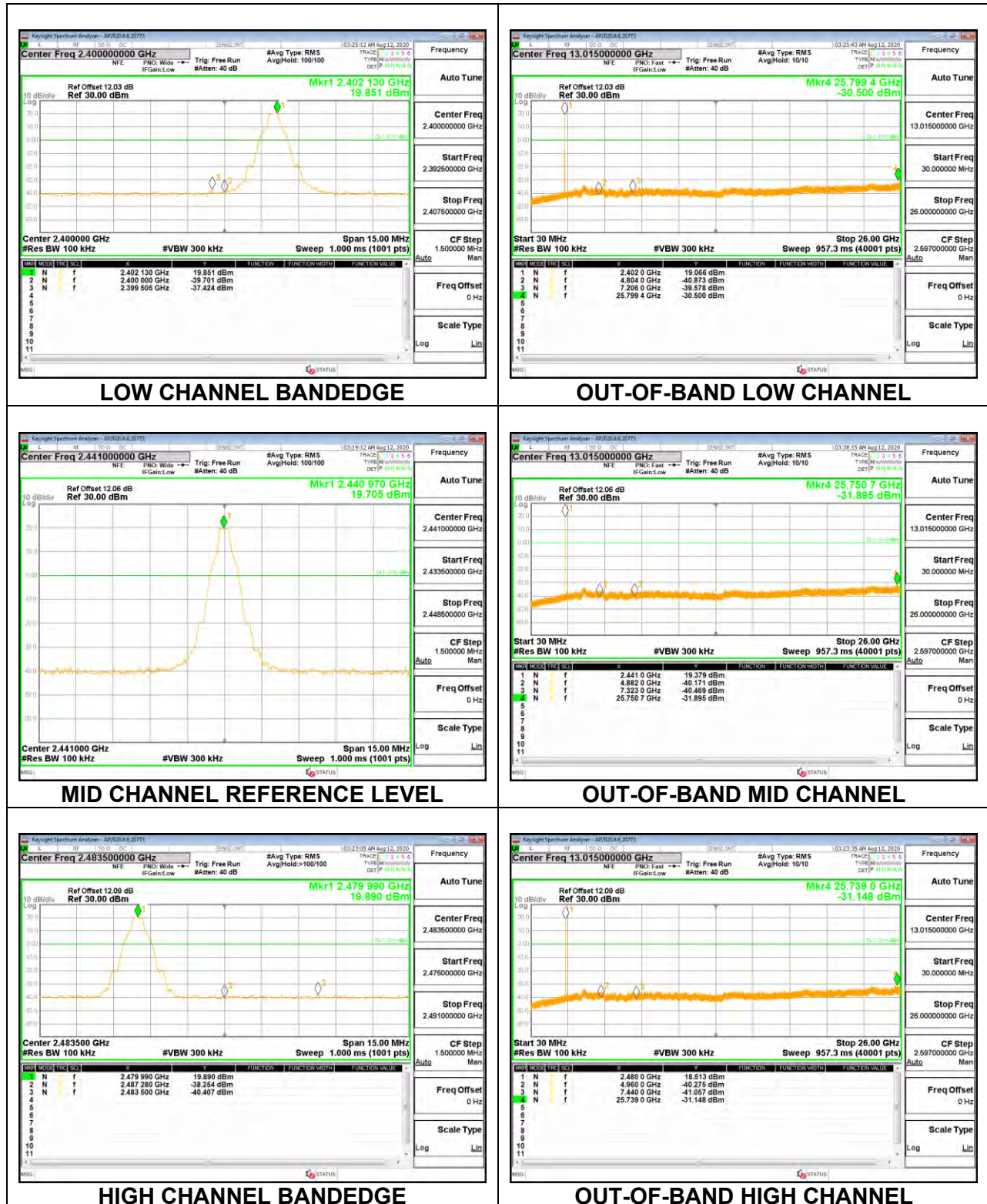
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

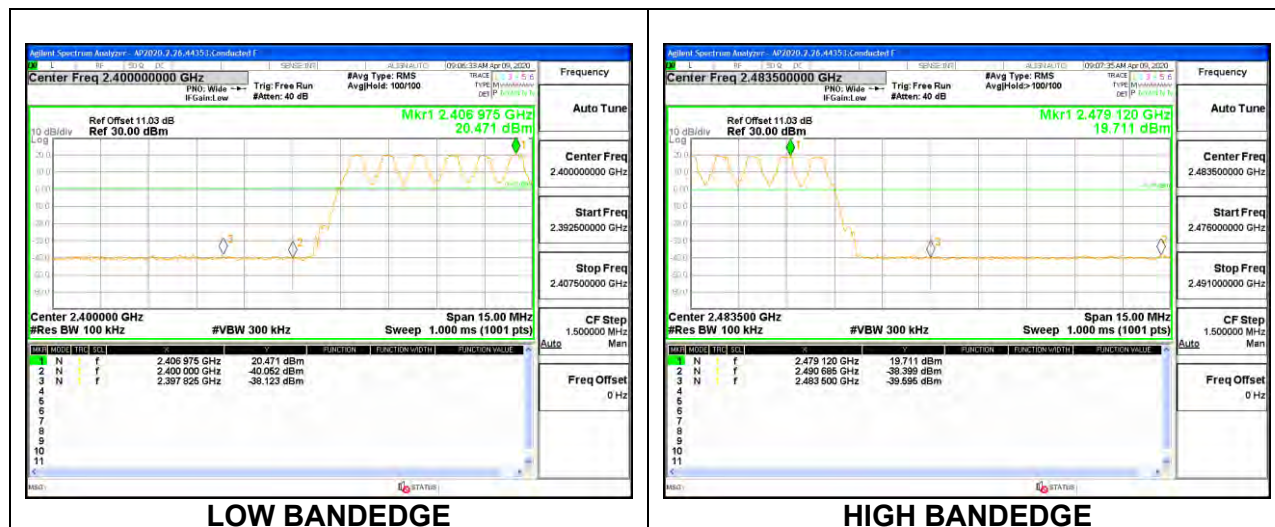
### **RESULTS**

## 9.8.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

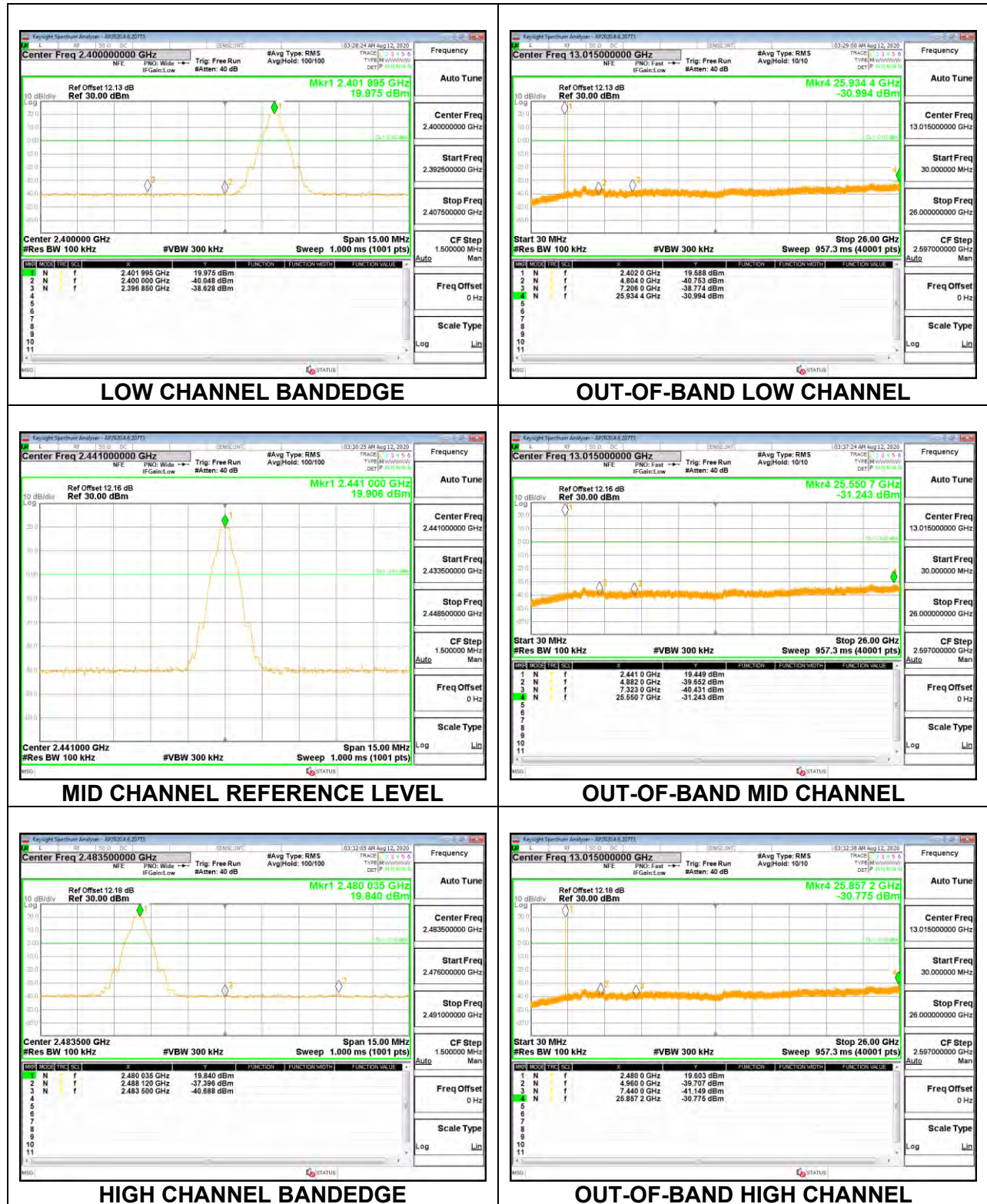
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



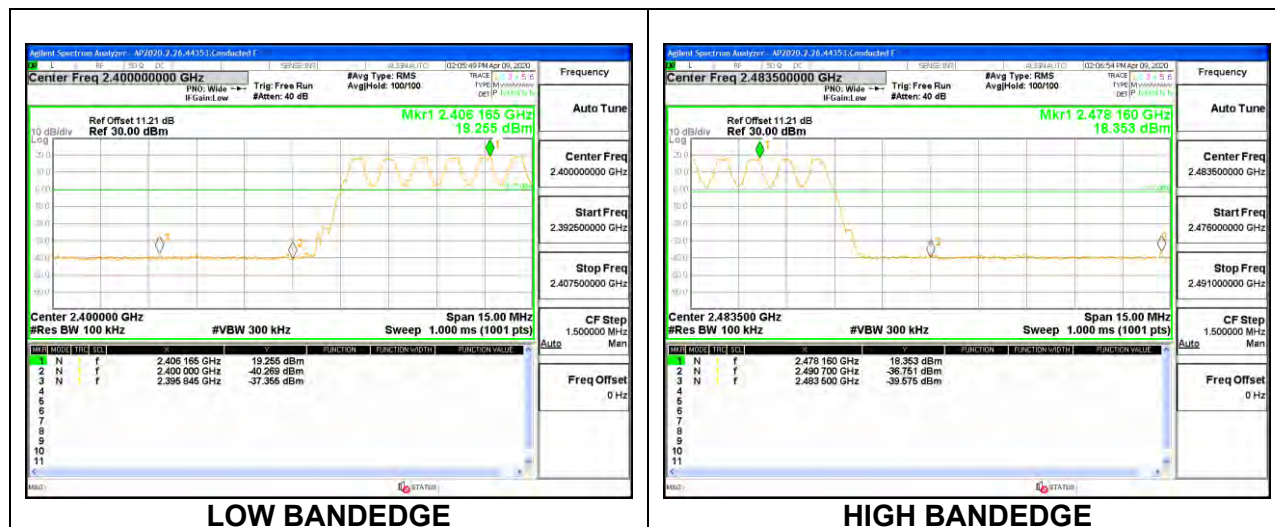
# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# **ANT 3 SPURIOUS EMISSIONS, NON-HOPPING**

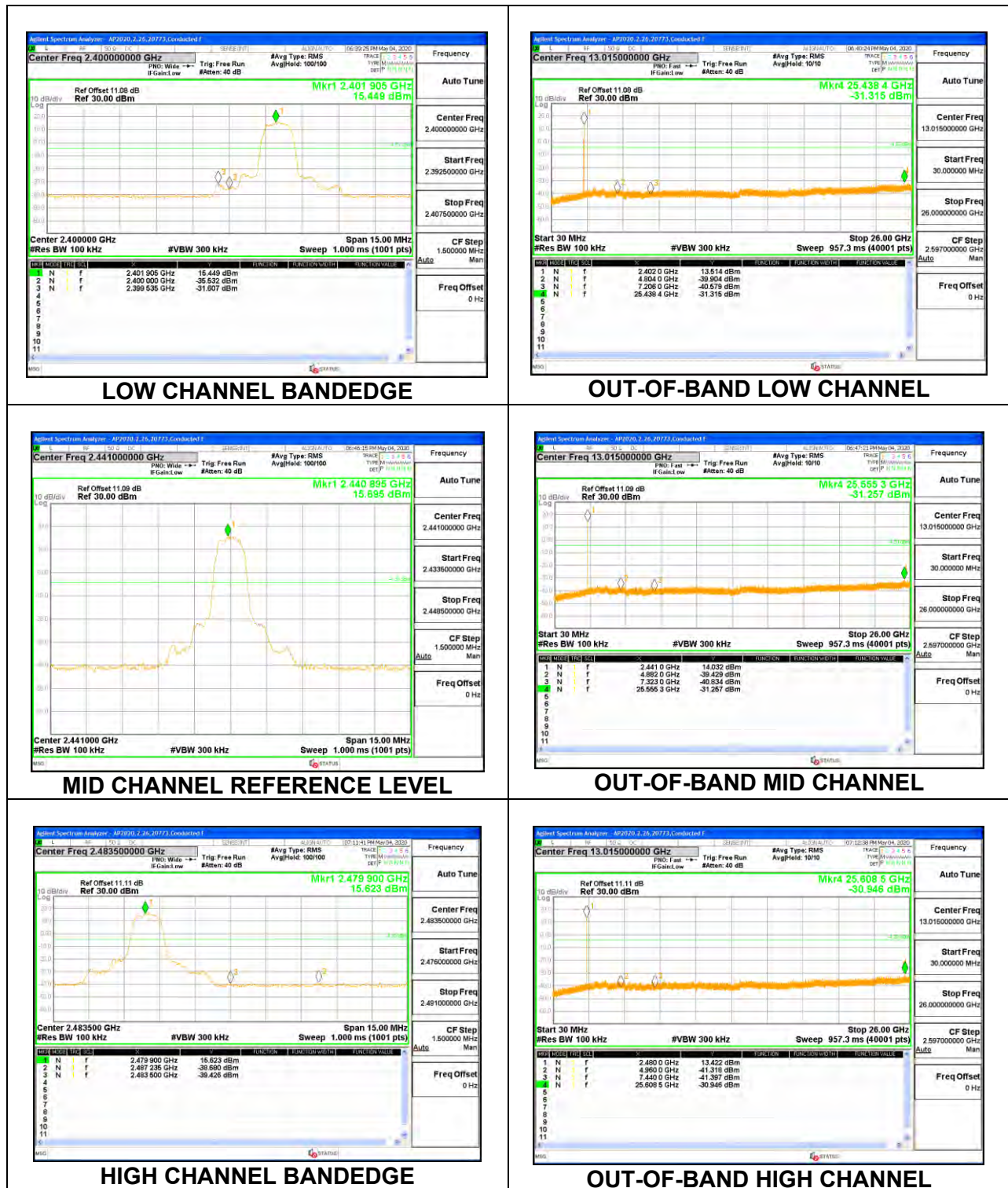


# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



## 9.8.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

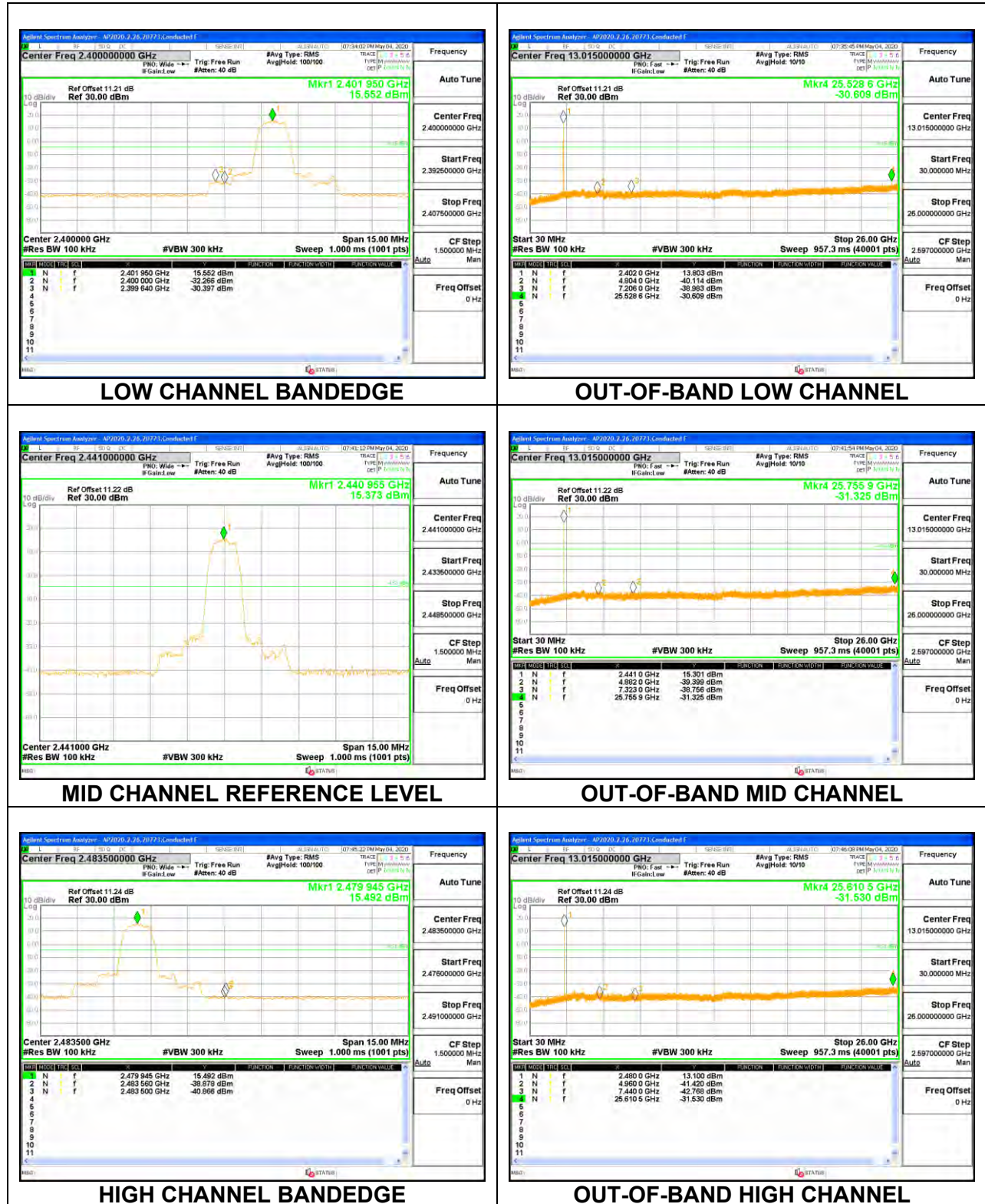
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# **ANT 3 SPURIOUS EMISSIONS, NON-HOPPING**

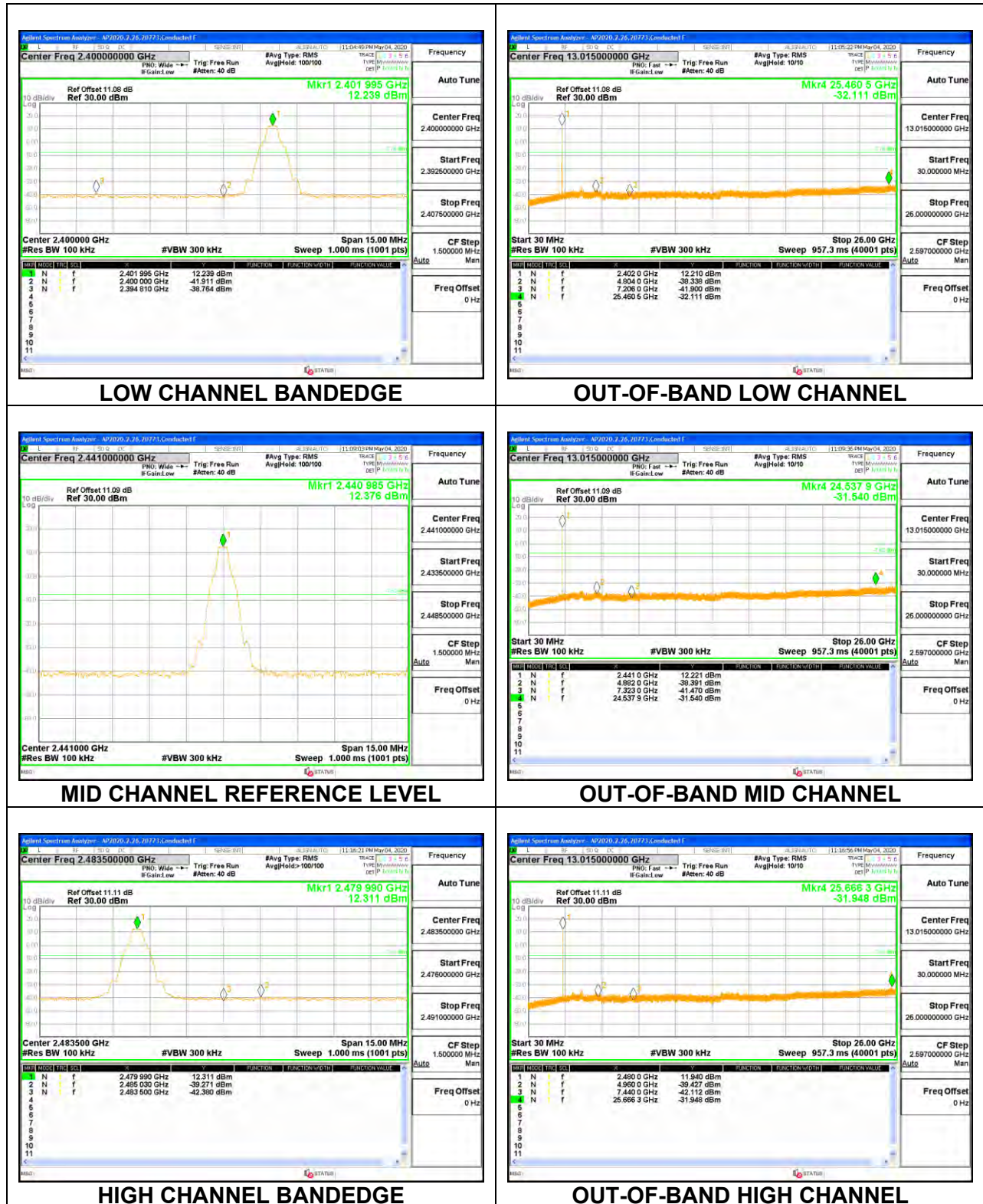


# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

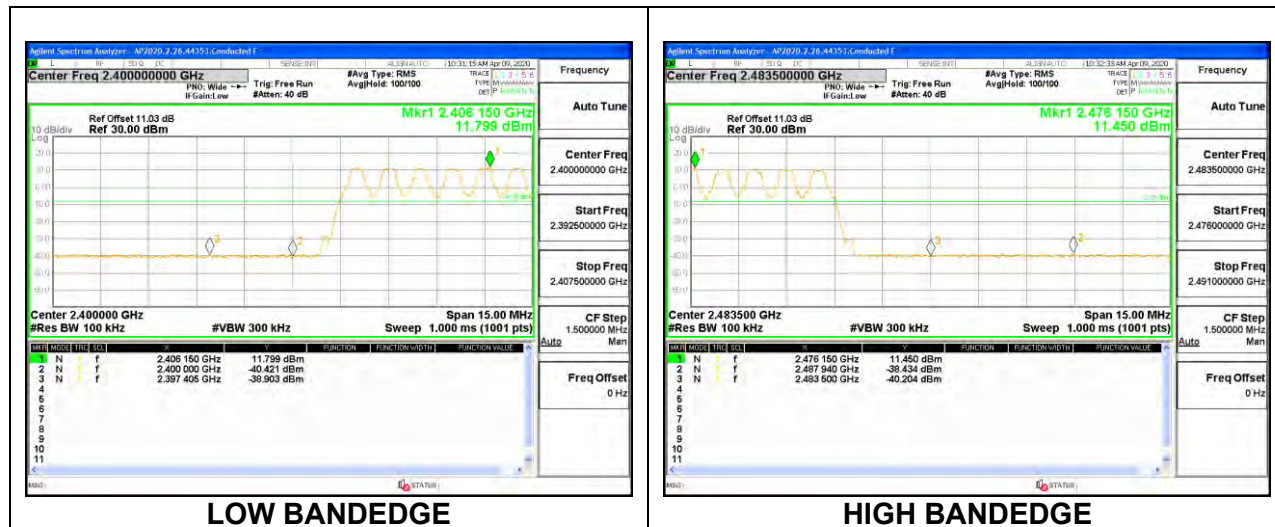


## 9.8.3. LOW POWER BASIC DATA RATE GFSK MODULATION

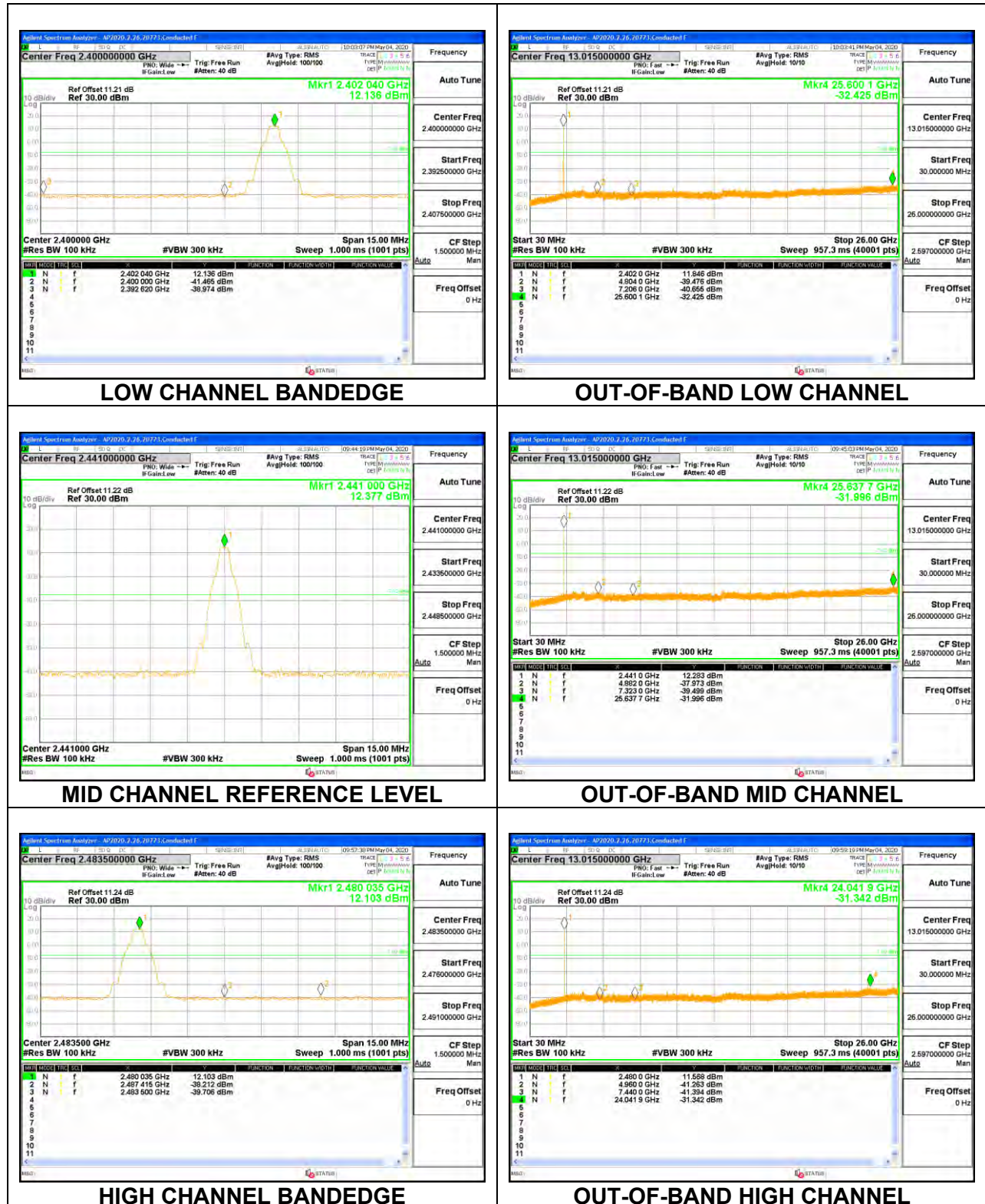
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



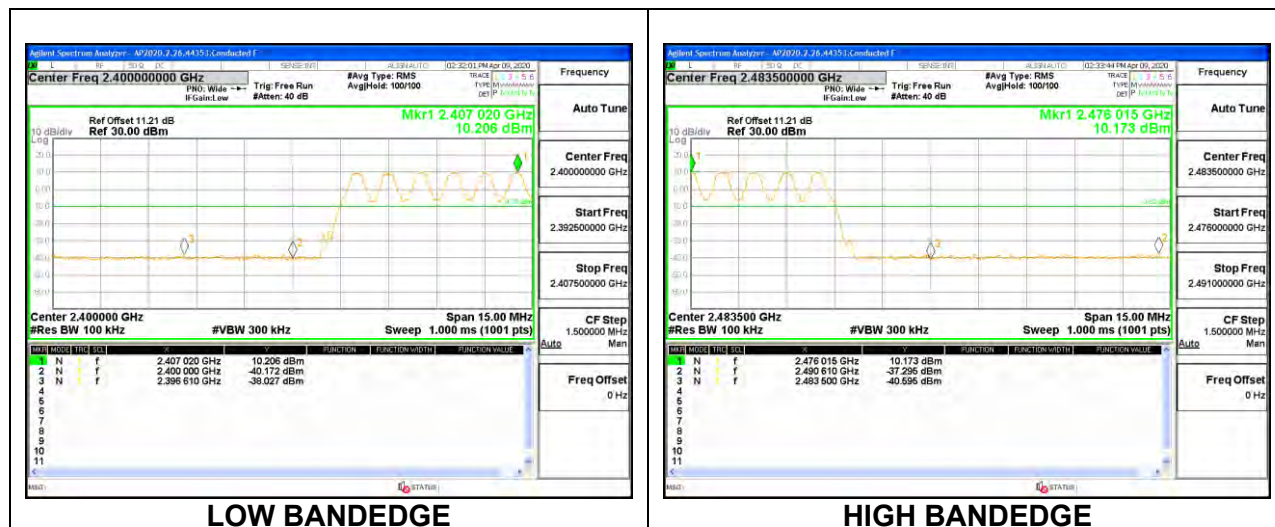
# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# ANT 3 SPURIOUS EMISSIONS, NON-HOPPING

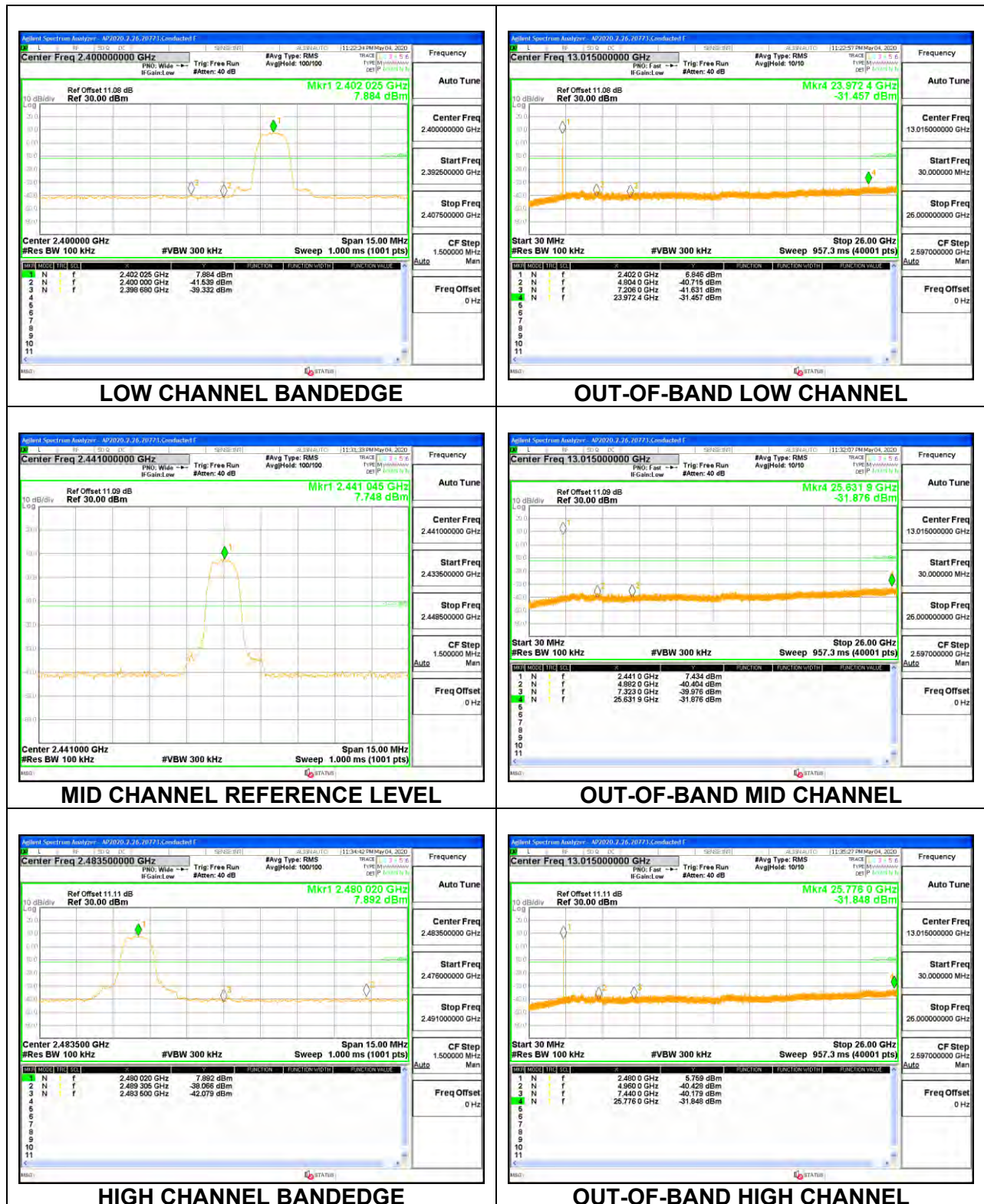


# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

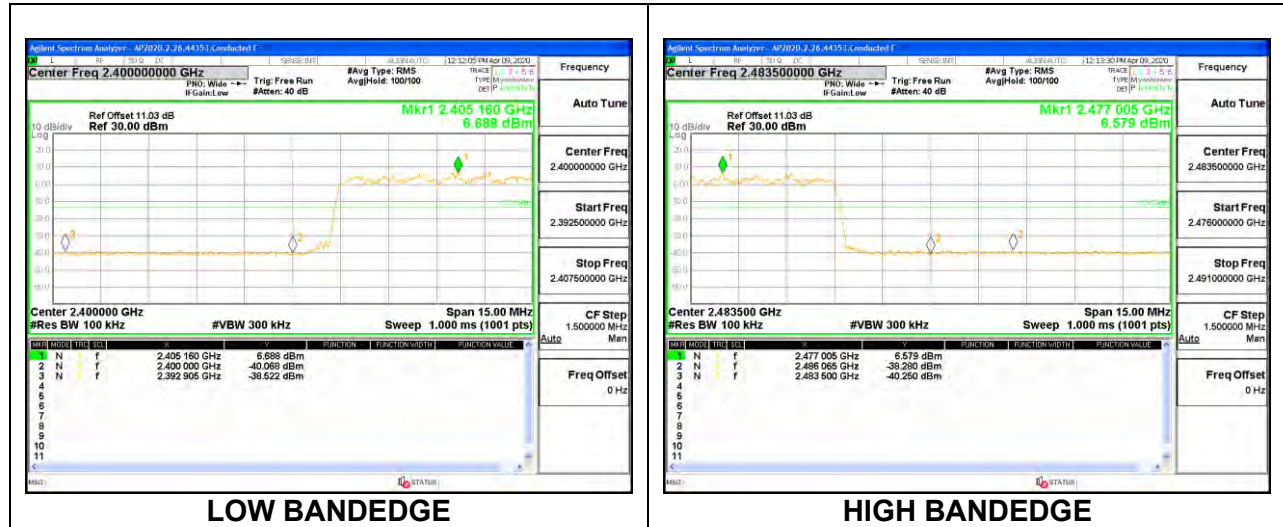


## 9.8.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

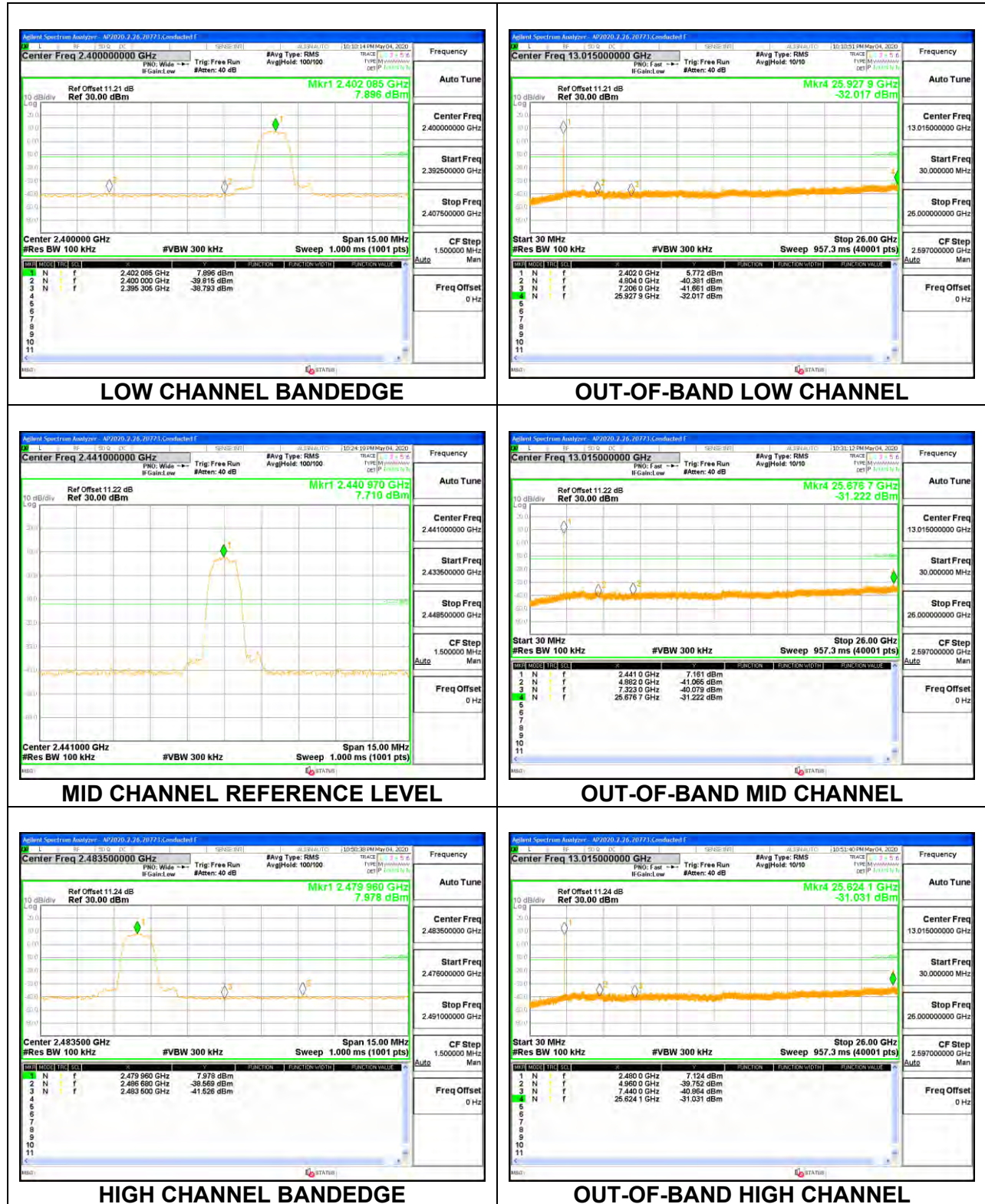
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



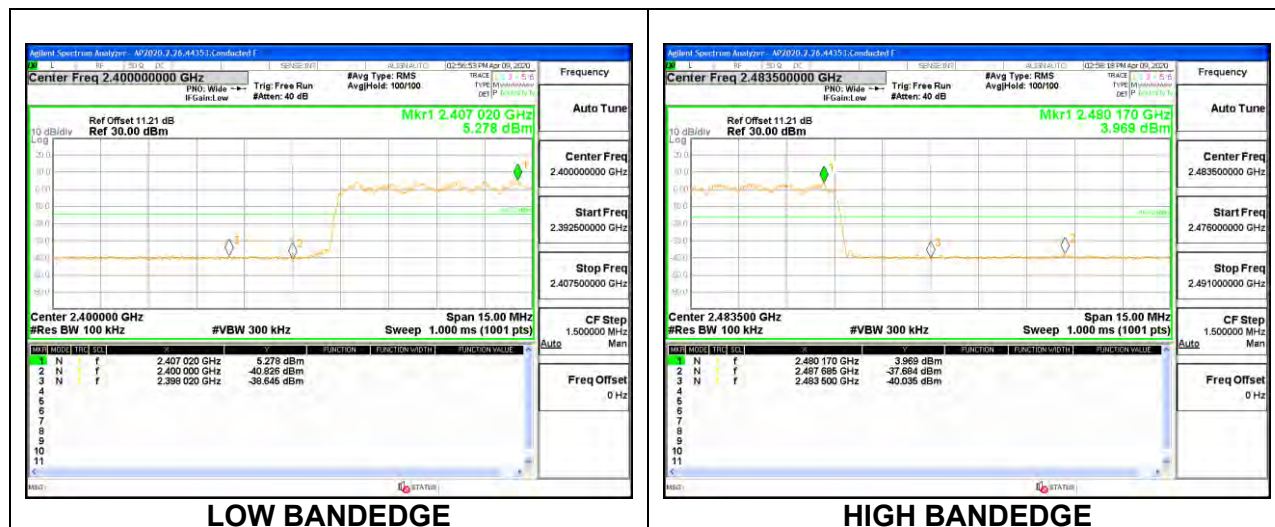
# **LAT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# **ANT 3 SPURIOUS EMISSIONS, NON-HOPPING**

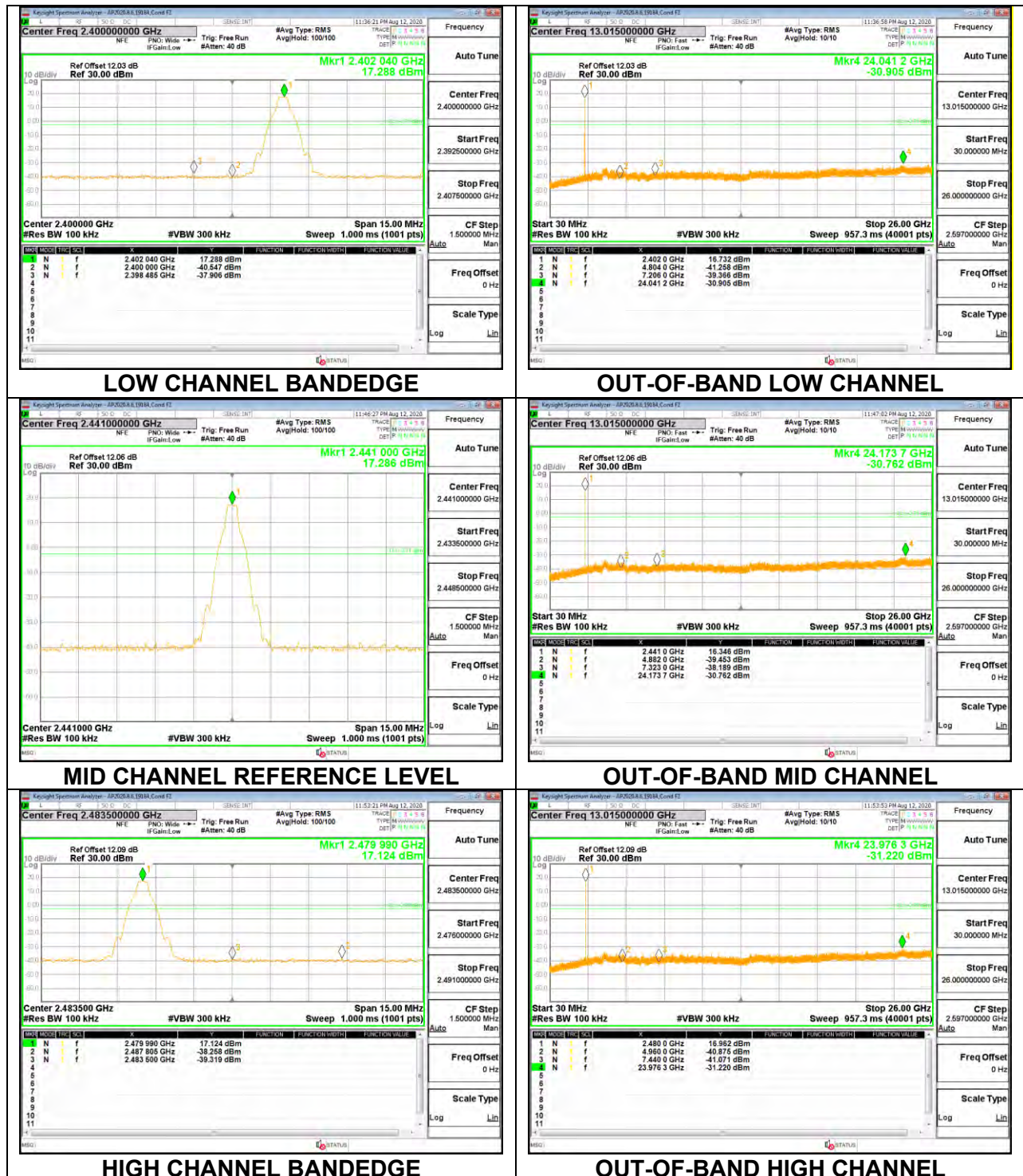


# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

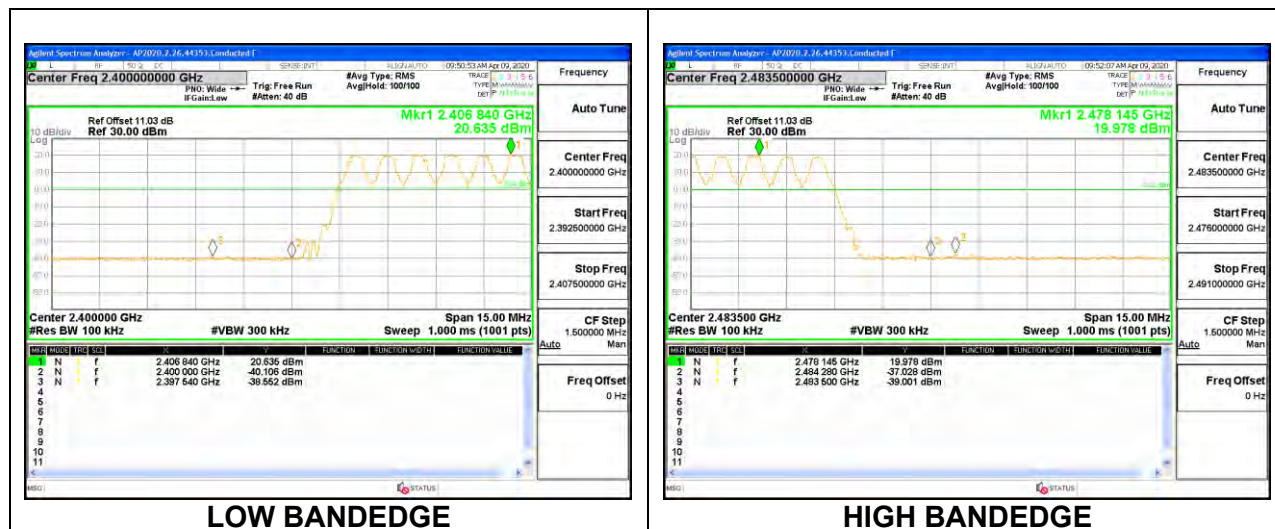


## 9.8.5. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



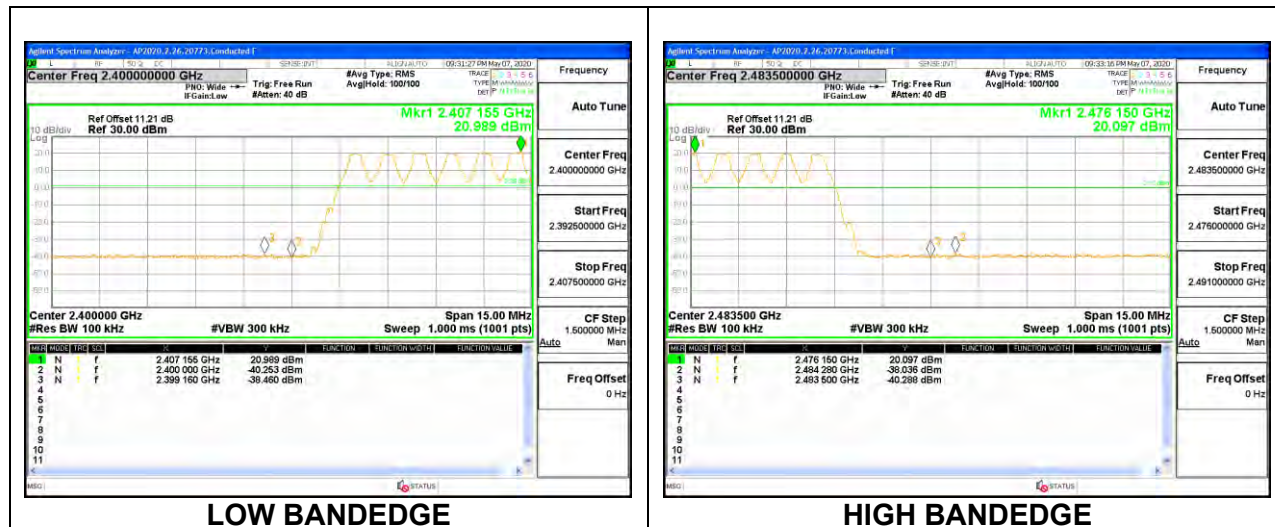
# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# **ANT 3 SPURIOUS EMISSIONS, NON-HOPPING**



**ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

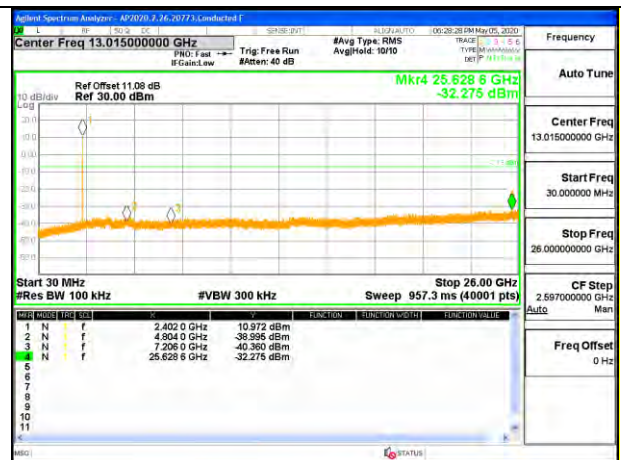


## 9.8.6. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

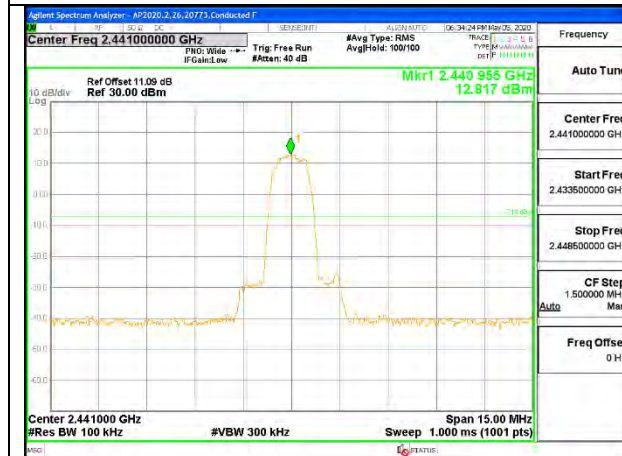
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



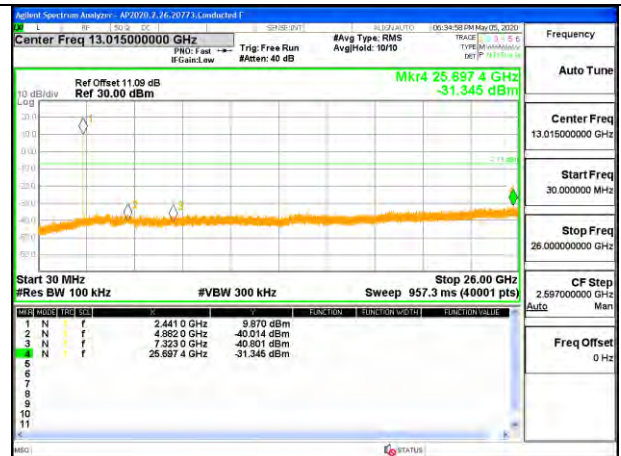
LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

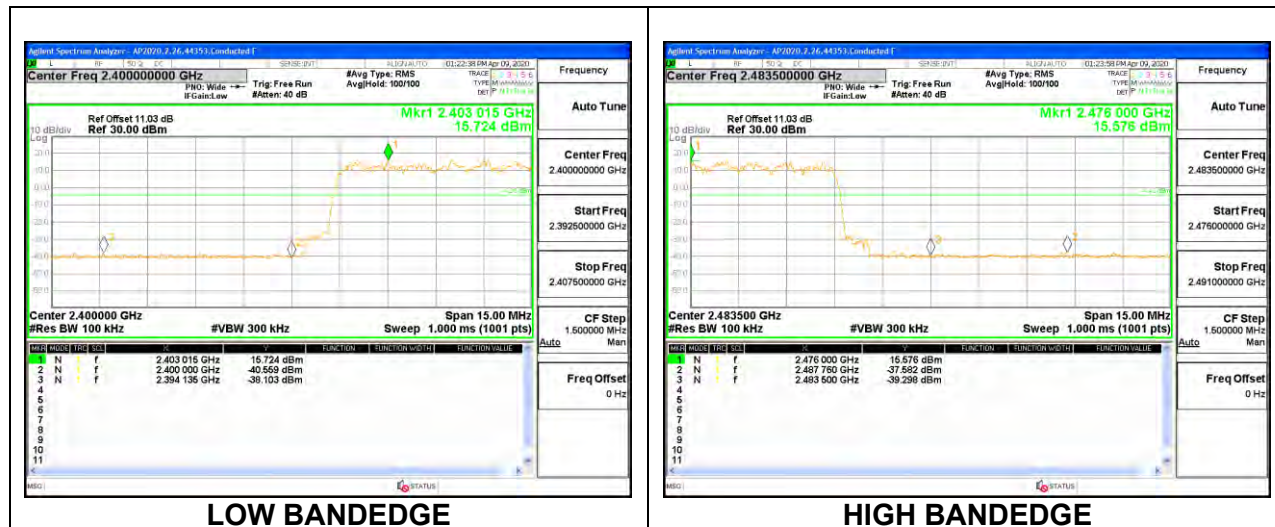


HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

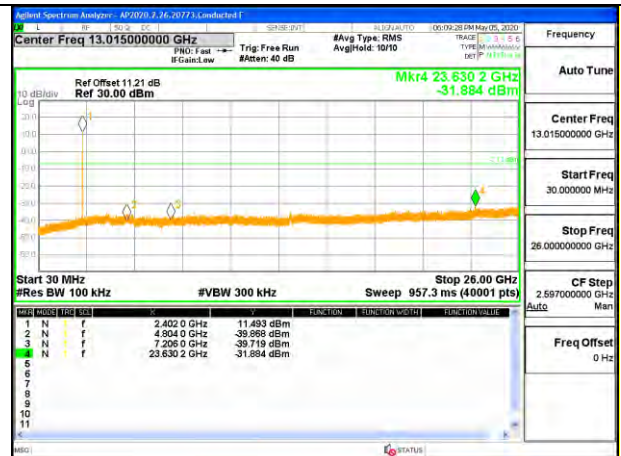
**ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



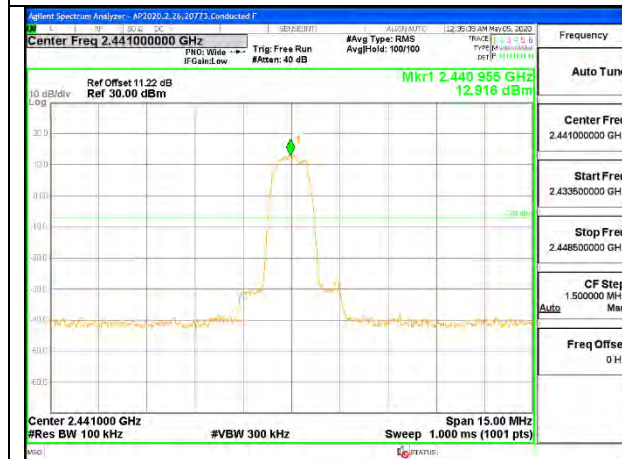
# ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

The image displays two side-by-side screenshots of a Rohde & Schwarz Spectrum Analyzer interface, showing test results for 'LOW BANDEDGE' and 'HIGH BANDEDGE'.

**Left Screenshot (LOW BANDEDGE):**

- Center Freq:** 2.400000000 GHz
- Ref Offset:** 11.21 dB
- Ref:** 30.00 dBm
- Mkr1:** 2.406 015 GHz, 17.599 dBm
- Center Freq:** 2.400000000 GHz
- Start Freq:** 2.392500000 GHz
- Stop Freq:** 2.407500000 GHz
- CF Step:** 1.500000 MHz
- Auto:** Man
- Frequency Offset:** 0 Hz
- Table:**

| MN | MODE | TRIG | ESL | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |
|----|------|------|-----|----------|----------------|----------------|
| 1  | N    | f    |     |          | 2.406 015 GHz  | 17.599 dBm     |
| 2  | N    | f    |     |          | 2.400 000 GHz  | -33.146 dBm    |
| 3  | N    | f    |     |          | 2.399 775 GHz  | -30.959 dBm    |

**Right Screenshot (HIGH BANDEDGE):**

- Center Freq:** 2.483500000 GHz
- Ref Offset:** 11.21 dB
- Ref:** 30.00 dBm
- Mkr1:** 2.478 160 GHz, 16.623 dBm
- Center Freq:** 2.483500000 GHz
- Start Freq:** 2.476500000 GHz
- Stop Freq:** 2.481000000 GHz
- CF Step:** 1.500000 MHz
- Auto:** Man
- Frequency Offset:** 0 Hz
- Table:**

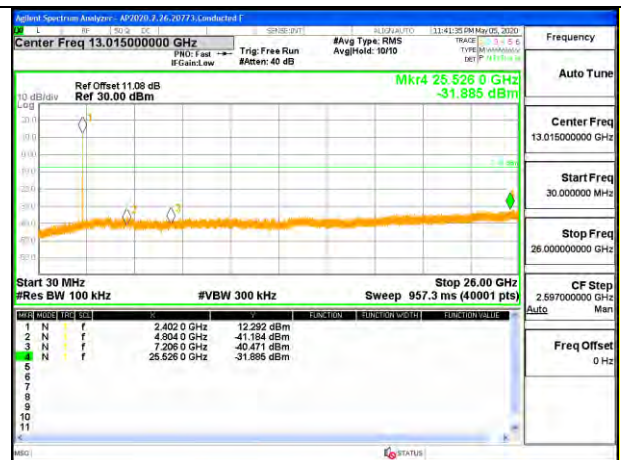
| MN | MODE | TRIG | ESL | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |
|----|------|------|-----|----------|----------------|----------------|
| 1  | N    | f    |     |          | 2.478 160 GHz  | 16.623 dBm     |
| 2  | N    | f    |     |          | 2.489 265 GHz  | -37.426 dBm    |
| 3  | N    | f    |     |          | 2.493 500 GHz  | -39.633 dBm    |

## 9.8.7. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

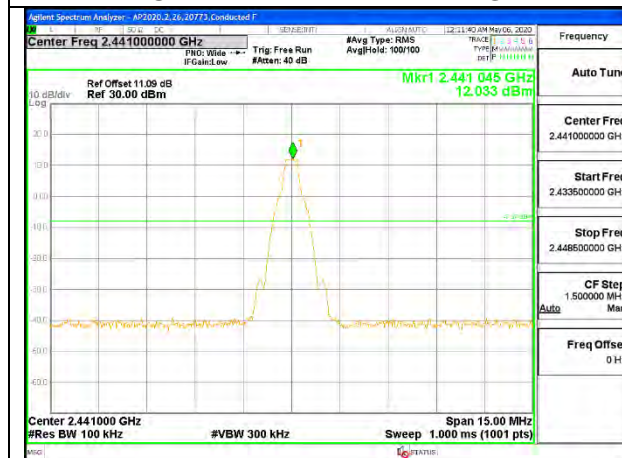
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



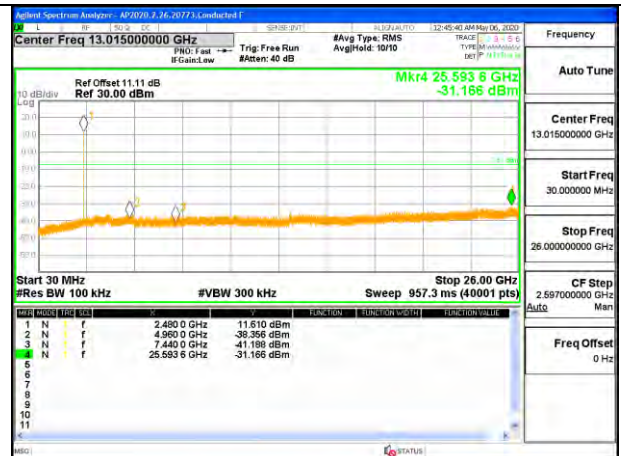
MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

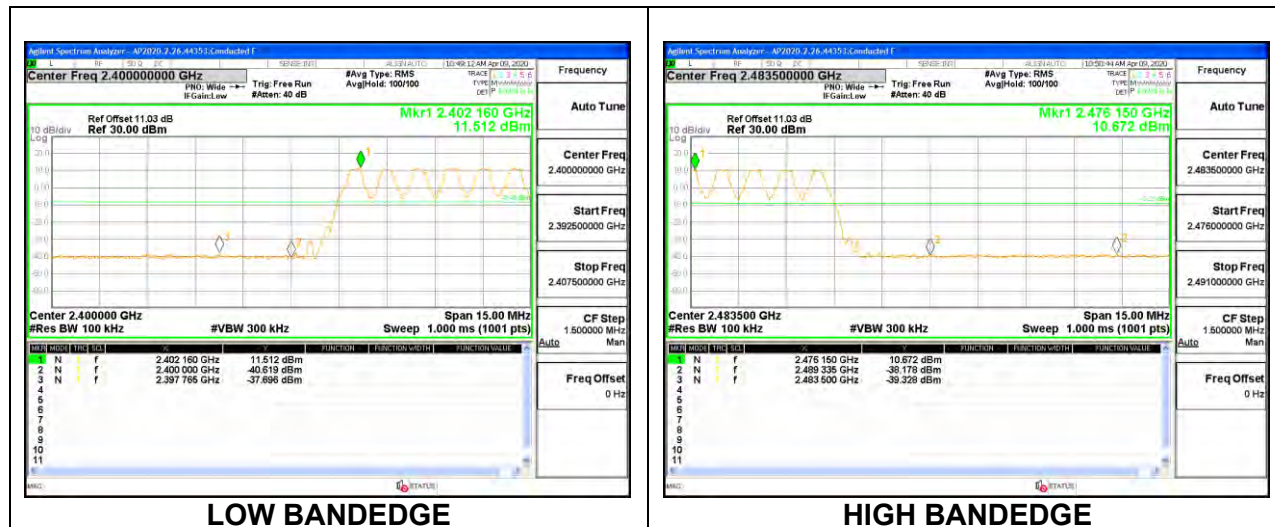


HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

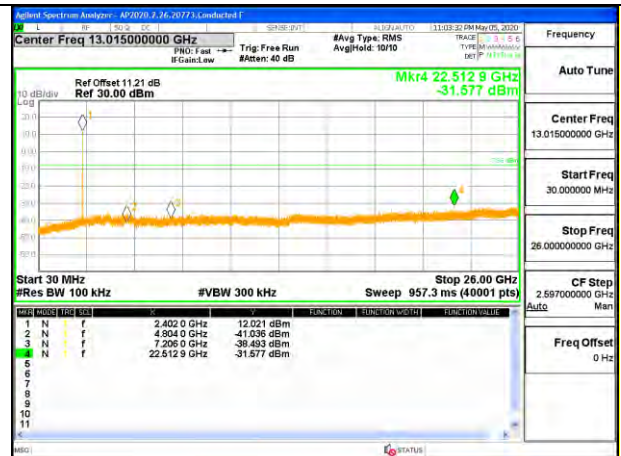
# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



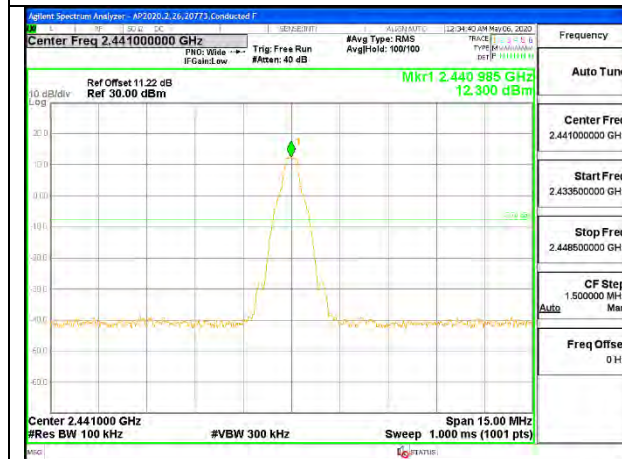
# ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

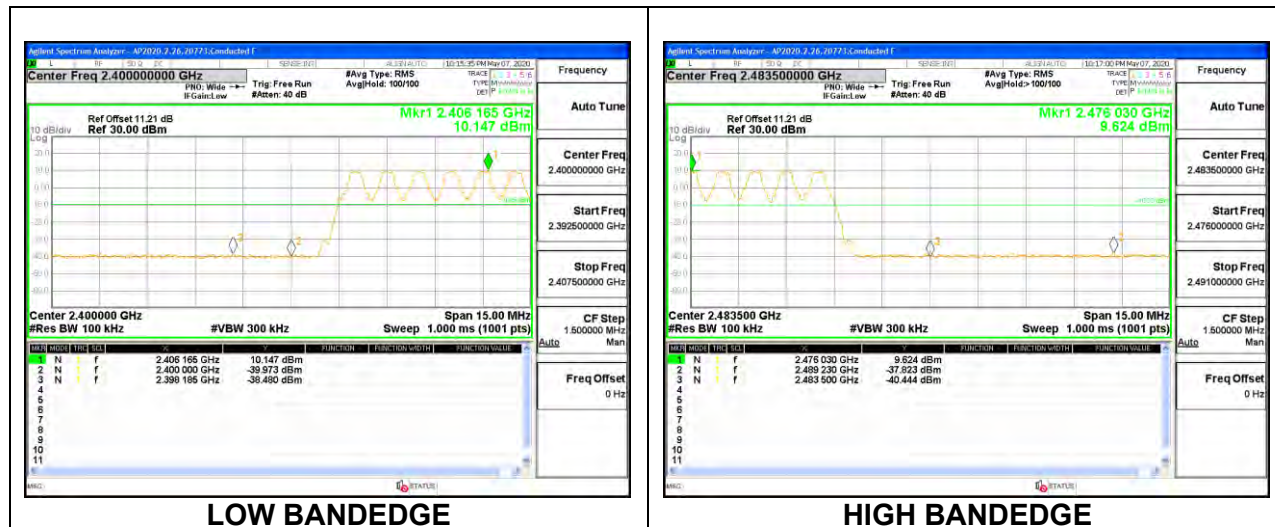


HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



## 9.8.8. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

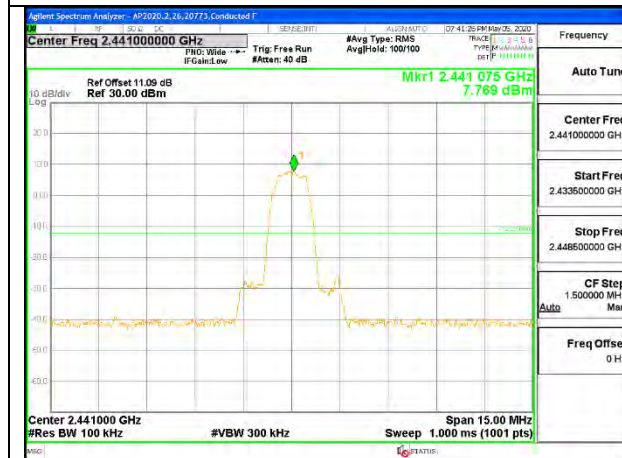
### ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



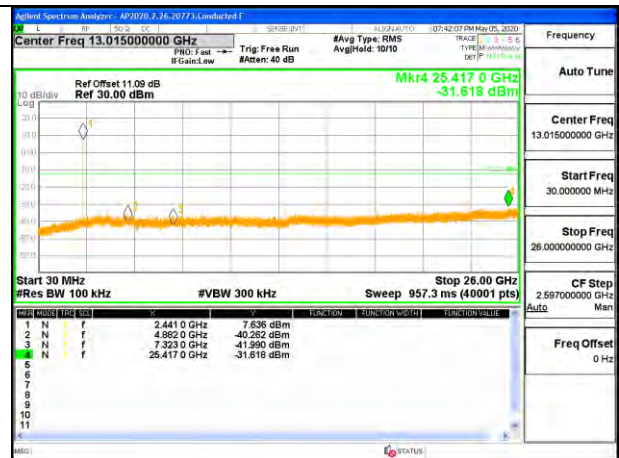
LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



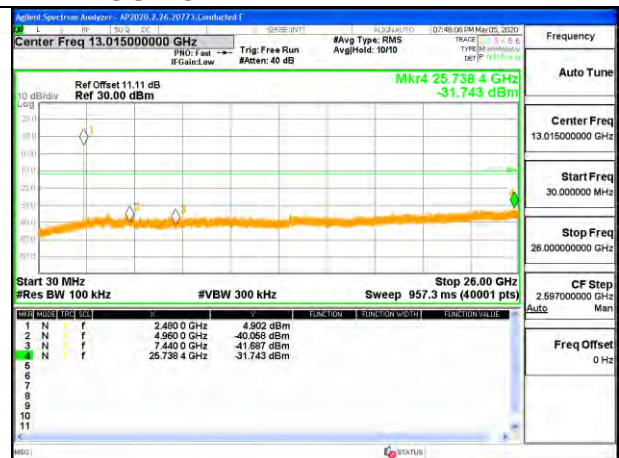
MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE

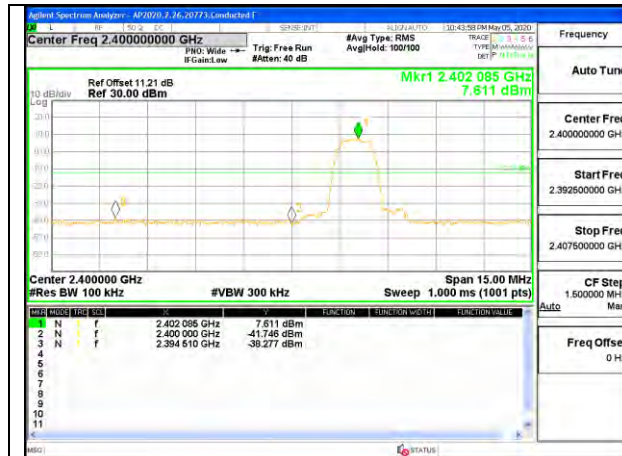


OUT-OF-BAND HIGH CHANNEL

# **ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



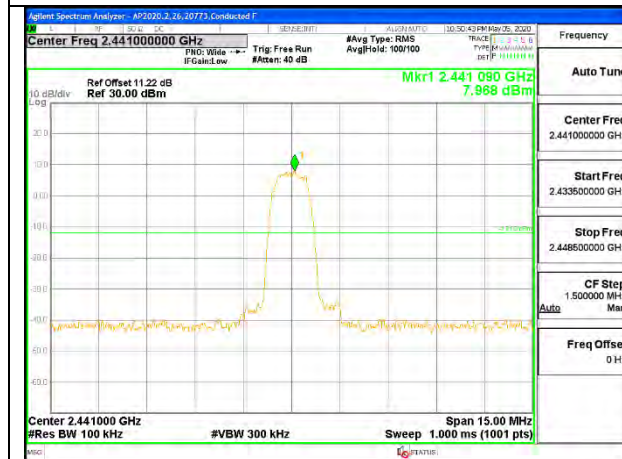
# ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

# **ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

