



# **CERTIFICATION TEST REPORT**

**Report Number. :** 12124121-E2V5

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

**Model :** A1920, A2099 AND A2100

**FCC ID :** BCG-E3218A

**ISED ID :** 579C-E3218A

**EUT Description :** SMARTPHONE

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

**Date Of Issue:**  
August 10, 2018

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NVLAP LAB CODE 200065-0

## REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions               | Revised By |
|------|------------|-------------------------|------------|
| V1   | 7/2/2018   | Initial Issue           | Chin Pang  |
| V2   | 7/05/2018  | Address TCB's Questions | Chin Pang  |
| V3   | 7/9/2018   | Address TCB's Questions | Chin Pang  |
| V4   | 7/13/2018  | Address TCB's Questions | Chin Pang  |
| V5   | 8/10/2018  | Address TCB's Questions | Jingang Li |

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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:** A1920, A2099 AND A2100

**SERIAL NUMBER:** C39WF004JVX8

**DATE TESTED:** JANUARY 30, 2018 – JUNE 22, 2018

| 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. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. 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  
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## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, KDB 558074 D01 v04, ANSI C63.10-2013, RSS-GEN Issue 5, and RSS-247 Issue 2.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, 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                                         |
|---------------------------------------------------|--------------------------------------------------------------|
| <input type="checkbox"/> Chamber A (ISED:2324B-1) | <input checked="" type="checkbox"/> Chamber D (ISED:22541-1) |
| <input type="checkbox"/> Chamber B (ISED:2324B-2) | <input type="checkbox"/> Chamber E (ISED:22541-2)            |
| <input type="checkbox"/> Chamber C (ISED:2324B-3) | <input checked="" type="checkbox"/> Chamber F (ISED:22541-3) |
|                                                   | <input type="checkbox"/> Chamber G (ISED:22541-4)            |
|                                                   | <input checked="" type="checkbox"/> Chamber H (ISED:22541-5) |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through C is covered under ISED company address code 2324B with site numbers 2324B -1 through 2324B-3, respectively. Chambers D through H are covered under ISED Canada company address code 22541 with site numbers 22541 -1 through 22541-5, respectively.

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at [NVLAP Lab Search](#).

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

### 4.3. MEASUREMENT UNCERTAINTY

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

| PARAMETER                                           | UNCERTAINTY |
|-----------------------------------------------------|-------------|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz  | 3.84 dB     |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz    | 3.65 dB     |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz     | 3.15 dB     |
| Worst Case Radiated Disturbance, 30 to 1000 MHz     | 5.36 dB     |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz  | 4.32 dB     |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.45 dB     |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.24 dB     |

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

## 5. EQUIPMENT UNDER TEST

### 5.1. EUT DESCRIPTION

The Apple iPhone, is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM is either UICC based, electronic SIM (e-SIM), or second SIM is not present. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is not user accessible.

### 5.2. DIFFERENCE IN MODEL NUMBER

Model A2099, A2100 is electrically identical to Model A1920. Three model numbers are allocated for marketing and logistic purposes only. A1920 was used to perform all final tests.

### 5.3. 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   | Pstandalone   | 2402 - 2480           | BLE 1M | 16.98              | 49.89             |
|         | Plow          |                       |        | 10.56              | 11.38             |
|         | Pstandalone   |                       | BLE 2M | 17.03              | 50.47             |
|         | Plow          |                       |        | 10.58              | 11.43             |
| Ant 3   | Pstandalone   | 2402 - 2480           | BLE 1M | 20.36              | 108.64            |
|         | Plow          |                       |        | 10.54              | 11.32             |
|         | Pstandalone   |                       | BLE 2M | 20.40              | 109.65            |
|         | Plow          |                       |        | 10.56              | 11.38             |

### 5.4. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Range (GHz) | Ant. 4 (dBi) | Ant. 3 (dBi) |
|-----------------------|--------------|--------------|
| 2.4                   | -2.8         | -4.1         |

### 5.5. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v16.30.67.7



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

The EUT was investigated in three orthogonal orientations X, Y and Z on Ant 4 (Antenna 4) and Ant 3 (Antenna 3), it was determined that X(Flatbed) orientation was the worst-case orientation for both Ant 4 and Ant 3.

Pstandalone is high power and Plow is low power.

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 30MHz, 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.

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. 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 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.

## 5.7. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

| Support Equipment List |                   |             |                   |         |
|------------------------|-------------------|-------------|-------------------|---------|
| Description            | Manufacturer      | Model       | Serial Number     | FCC ID  |
| laptop                 | Apple             | Macbook Pro | C02P41RZG086      | FCC DoC |
| Laptop AC/DC adapter   | Liteon Technology | PA-1450-BA1 | B123              | NA      |
| EUT AC Adapter         | Apple             | A1385       | D292365CDYADHLHC3 | NA      |

### I/O CABLES (CONDUCTED TEST)

| I/O Cable List |         |                      |                |             |                  |                      |
|----------------|---------|----------------------|----------------|-------------|------------------|----------------------|
| 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                | N/A                  |
| 3              | AC      | 1                    | AC             | Un-shielded | 2                | N/A                  |

### I/O CABLES (RADIATED ABOVE 1 GHZ)

| I/O Cable List |      |                      |                |            |                  |         |
|----------------|------|----------------------|----------------|------------|------------------|---------|
| Cable No       | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| NA             |      |                      |                |            |                  |         |

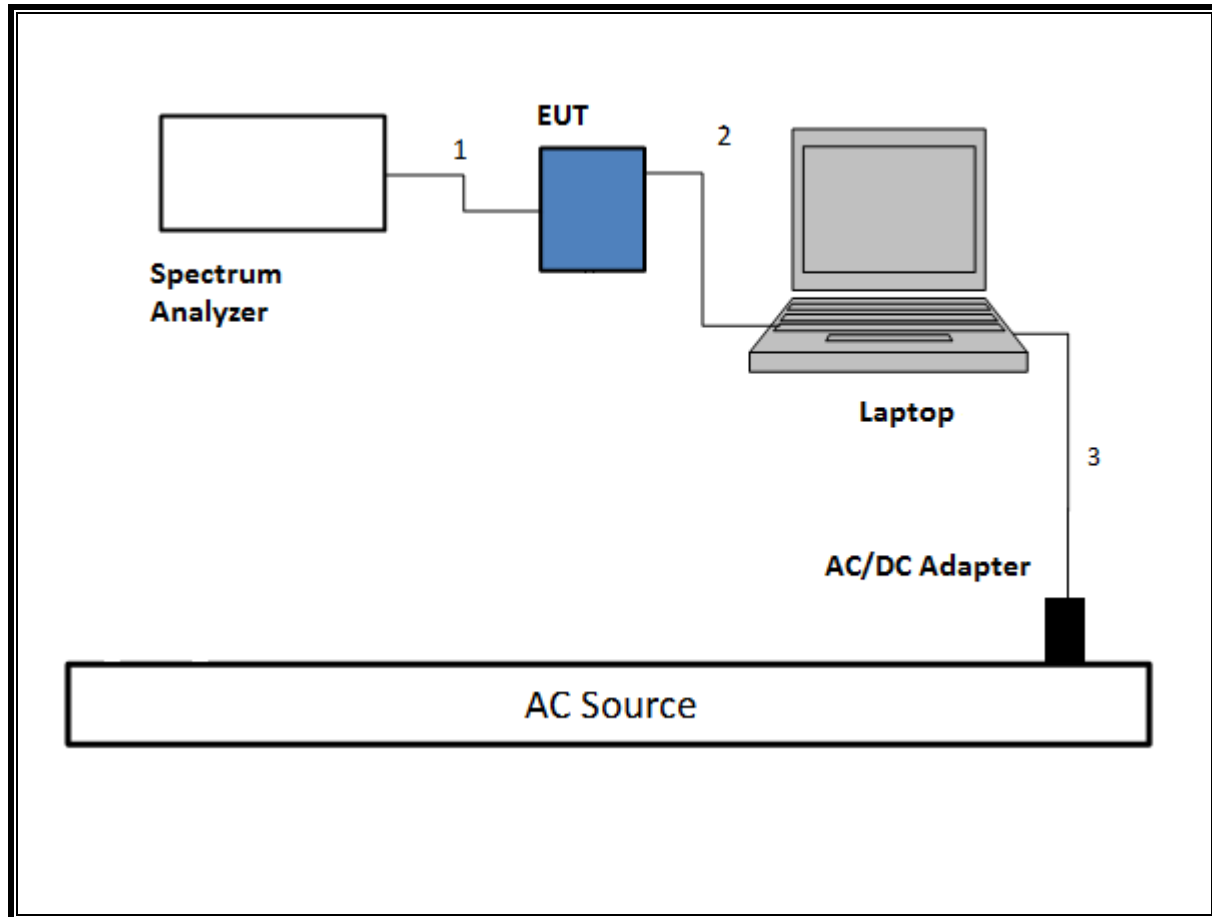
### I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

| I/O Cable List |      |                |                |             |                  |         |
|----------------|------|----------------|----------------|-------------|------------------|---------|
| Cable No       | Port | # of identical | 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     |

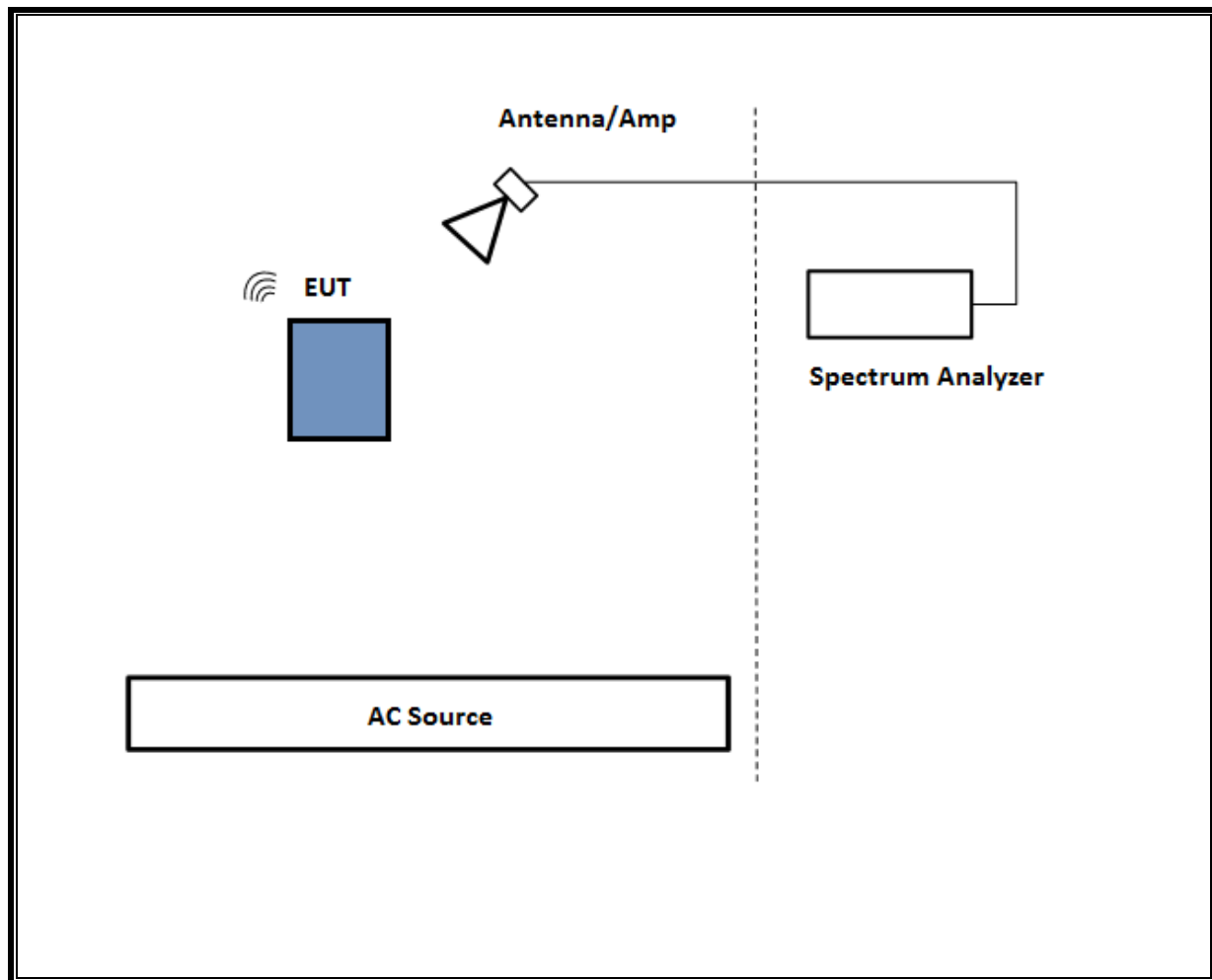
### TEST SETUP

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

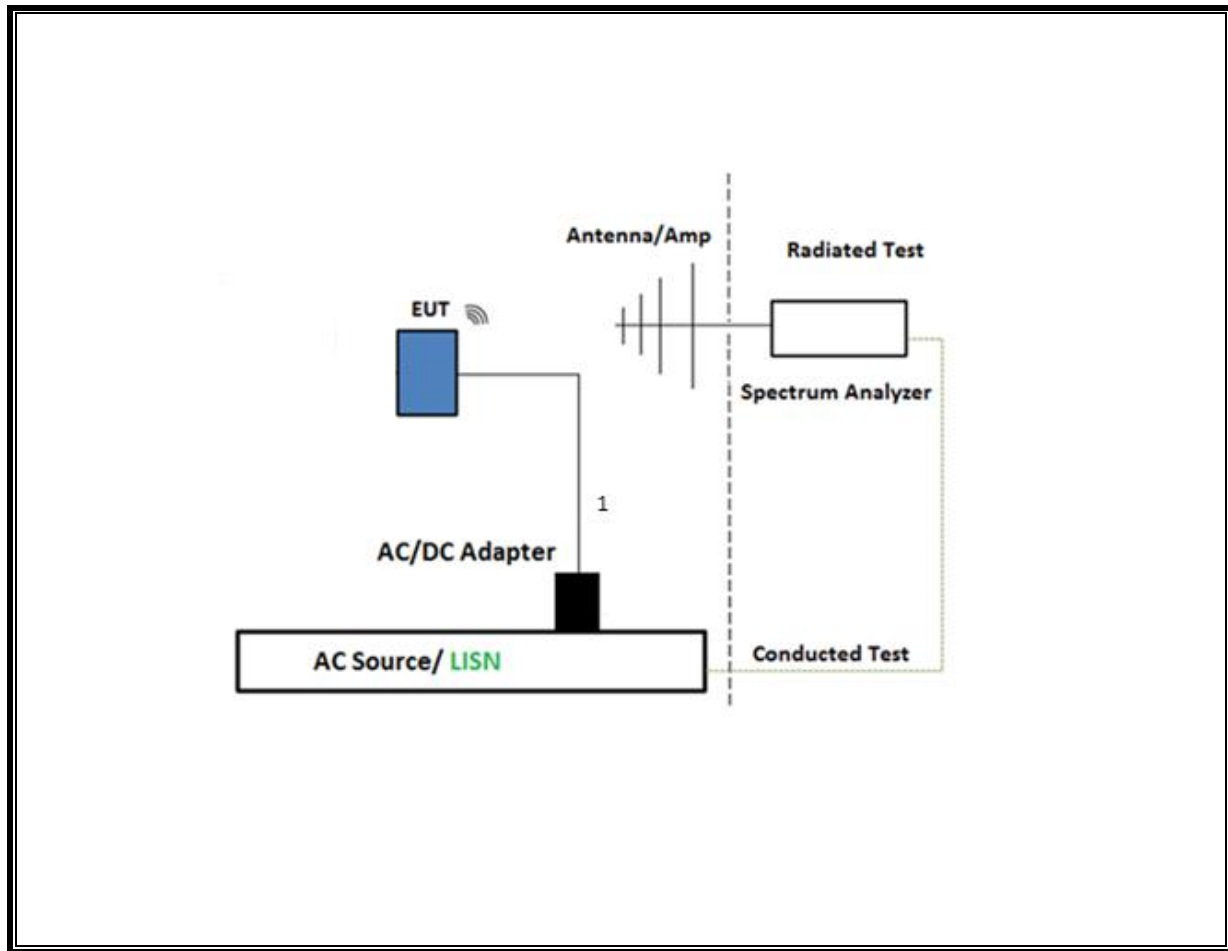
**SETUP DIAGRAM FOR CONDUCTED TESTS**



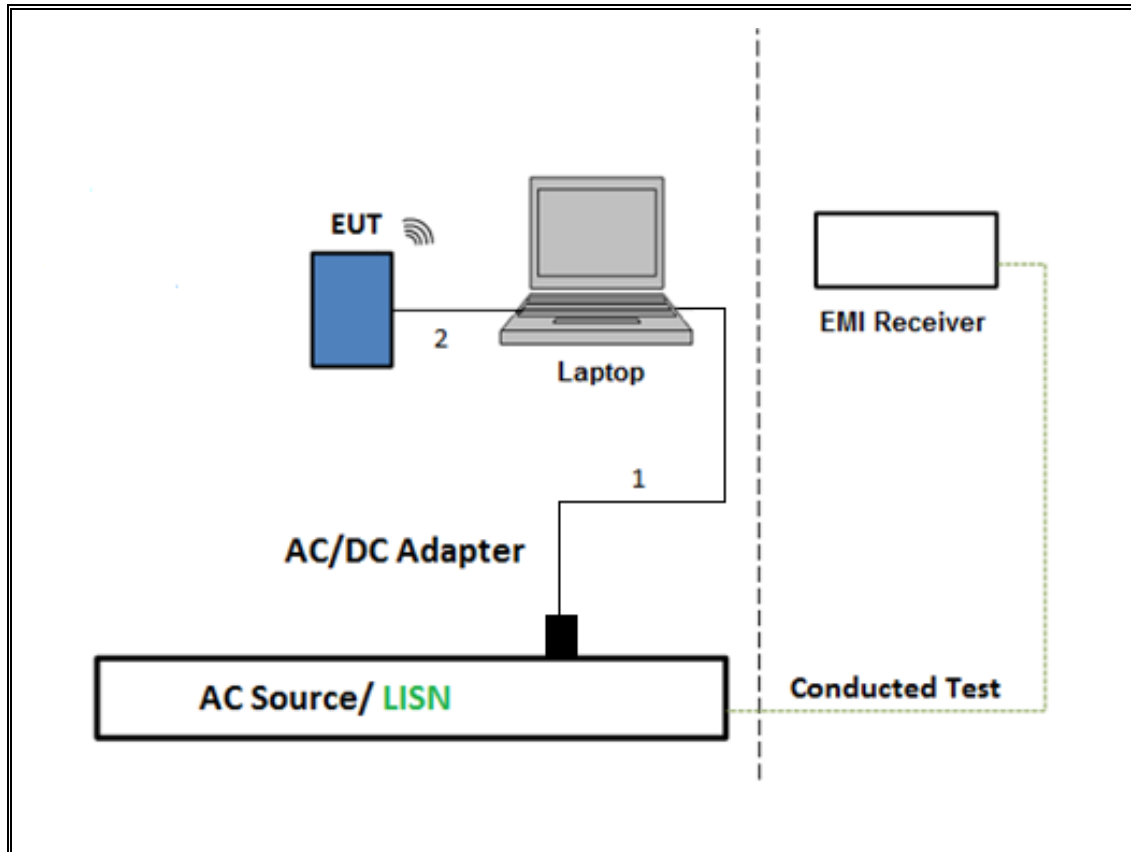
**SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz**



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



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



## 6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 558074 D01 v04, Section 6.

6 dB BW: KDB 558074 D01 v04, Section 8.1.

Output Power: KDB 558074 D01 v04, Section 9.1.3.

Power Spectral Density: KDB 558074 D01 v04, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v04, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v04, Section 12.1.

Band-edge: KDB 558074 D01 v04, Section 12.1.

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

## 7. TEST AND MEASUREMENT EQUIPMENT

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

| Description                                 | Manufacturer                    | Model                  | ID Num                    | Cal Due    |
|---------------------------------------------|---------------------------------|------------------------|---------------------------|------------|
| *Antenna, Horn 1-18GHz                      | ETS Lindgren                    | 3117                   | T344                      | 04/20/2018 |
| *Amplifier, 1 to 18GHz, 35dB                | Amplical                        | AMP1G18-35             | T1569                     | 05/31/2018 |
| Antenna, Horn 1-18GHz                       | ETS Lindgren                    | 3117                   | T119                      | 04/03/2019 |
| Amplifier, 1 to 18GHz                       | Miteq                           | AFS42-00101800-25-S-42 | T742                      | 12/04/2018 |
| *Spectrum Analyzer, PSA, 3Hz to 44GHz       | Agilent (Keysight) Technologies | E4446A                 | T177                      | 03/20/2018 |
| *Antenna, Horn 1-18GHz                      | ETS Lindgren                    | 3117                   | T136                      | 06/26/2018 |
| Amplifier, 1 to 18GHz                       | Miteq                           | AFS42-00101800-25-S-42 | T740                      | 12/30/2018 |
| Antenna, Horn 1-18GHz                       | ETS-Lindgren                    | 3117                   | T862                      | 05/24/2019 |
| Amplifier, 1 to 18GHz                       | Miteq                           | AFS42-00101800-25-S-42 | T1165                     | 06/12/2019 |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz | Sunol Sciences                  | JB3                    | T477                      | 07/07/2018 |
| *Amplifier, 10KHz to 1GHz, 32dB             | Sonoma                          | 310N                   | T286                      | 06/02/2018 |
| Spectrum Analyzer, PXA 3Hz to 44GHz         | Keysight                        | N9030A                 | T340                      | 12/15/2018 |
| *Spectrum Analyzer, PSA, 3Hz to 44GHz       | Agilent (Keysight) Technologies | E4446A                 | T177                      | 03/20/2018 |
| Antenna Horn, 18 to 26GHz                   | ARA                             | MWH-1826               | T89                       | 01/18/2019 |
| Pre-Amp 18-26GHz                            | Agilent Technology              | 8449B                  | T404                      | 07/23/2018 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz        | Agilent (Keysight) Technologies | N9030A                 | T1454                     | 01/08/2019 |
| Antenna, Active Loop 9KHz to 30MHz          | ETS-Lindgren                    | 6502                   | T757                      | 09/14/2018 |
| Power Meter, P-series single channel        | Keysight                        | N1912A                 | T1273                     | 07/17/2018 |
| Power Sensor                                | Keysight                        | N1921A                 | T1226                     | 08/30/2018 |
| <b>AC Line Conducted</b>                    |                                 |                        |                           |            |
| EMI Test Receiver 9KHz-7GHz                 | Rohde & Schwarz                 | ESC17                  | T1436                     | 01/25/2019 |
| *LISN for Conducted Emissions CISPR-16      | Fischer                         | 50/250-25-2-01         | T1310                     | 06/15/2018 |
| Power Cable, Line Conducted Emissions       | UL                              | PG1                    | T861                      | 08/31/2018 |
| *LISN for Conducted Emissions CISPR-16      | Fischer                         | 50/250-25-2-01         | T1310                     | 06/15/2018 |
| <b>UL AUTOMATION SOFTWARE</b>               |                                 |                        |                           |            |
| Radiated Software                           | UL                              | UL EMC                 | Ver 9.5, April 26, 2016   |            |
| Conducted Software                          | UL                              | UL EMC                 | Ver 5.4, October 13, 2016 |            |
| AC Line Conducted Software                  | UL                              | UL EMC                 | Ver 9.5, May 26, 2015     |            |

Note: \*Testing is completed before equipment expiration date.



## 8. ANTENNA PORT TEST RESULTS

### 8.1. ON TIME AND DUTY CYCLE

#### LIMITS

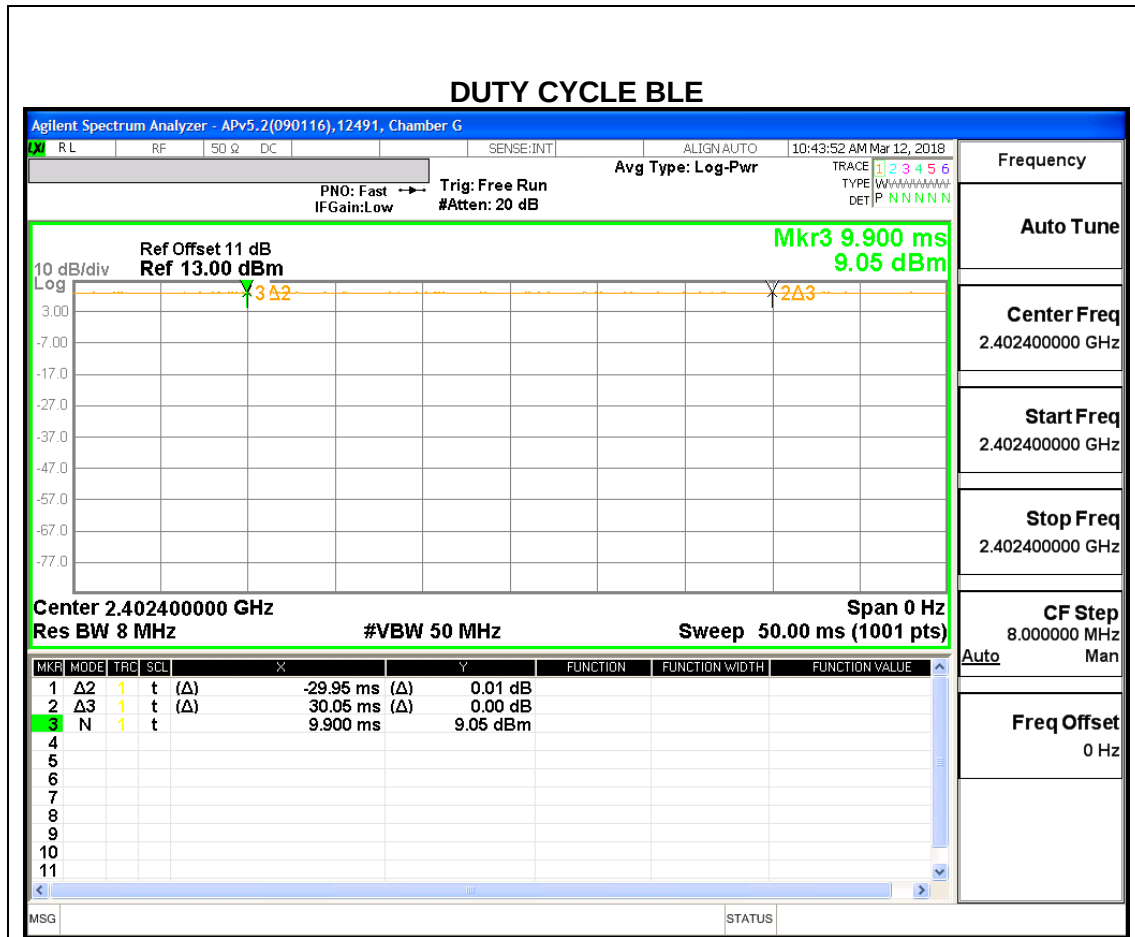
None; for reporting purposes only.

#### PROCEDURE

#### 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/B<br>Minimum VBW<br>(kHz) |
|-------------|------------------------|------------------|-----------------------------|----------------------|-----------------------------------------|-----------------------------|
| 2.4GHz Band |                        |                  |                             |                      |                                         |                             |
| BLE         | 100.0                  | 100.0            | 1.000                       | 100.00%              | 0.00                                    | 0.010                       |

## DUTY CYCLE PLOTS



## **8.2. 99% BANDWIDTH**

### **LIMITS**

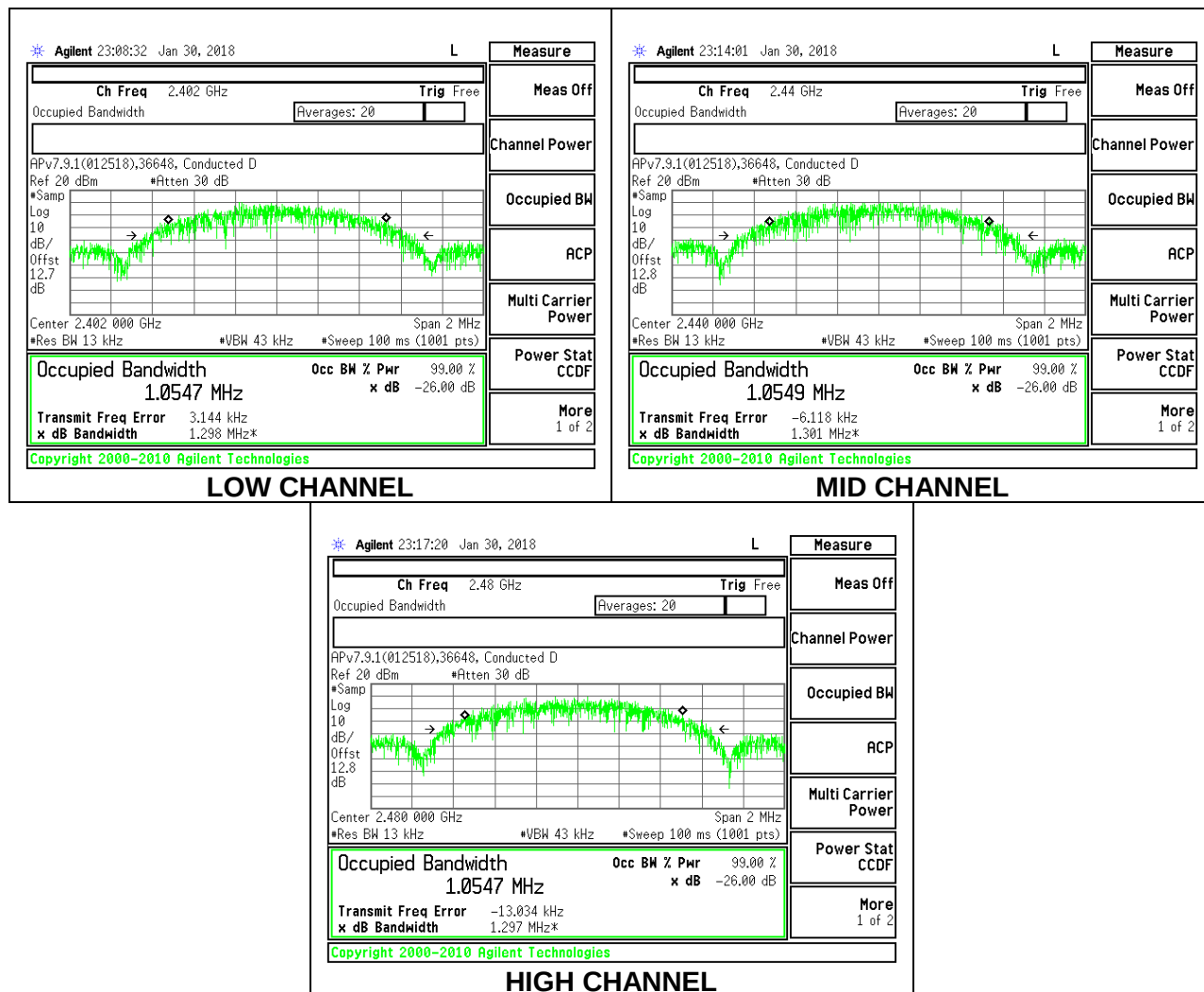
None; for reporting purposes only.

### **RESULTS**

## 8.2.1. HIGH POWER BLE (1Mbps)

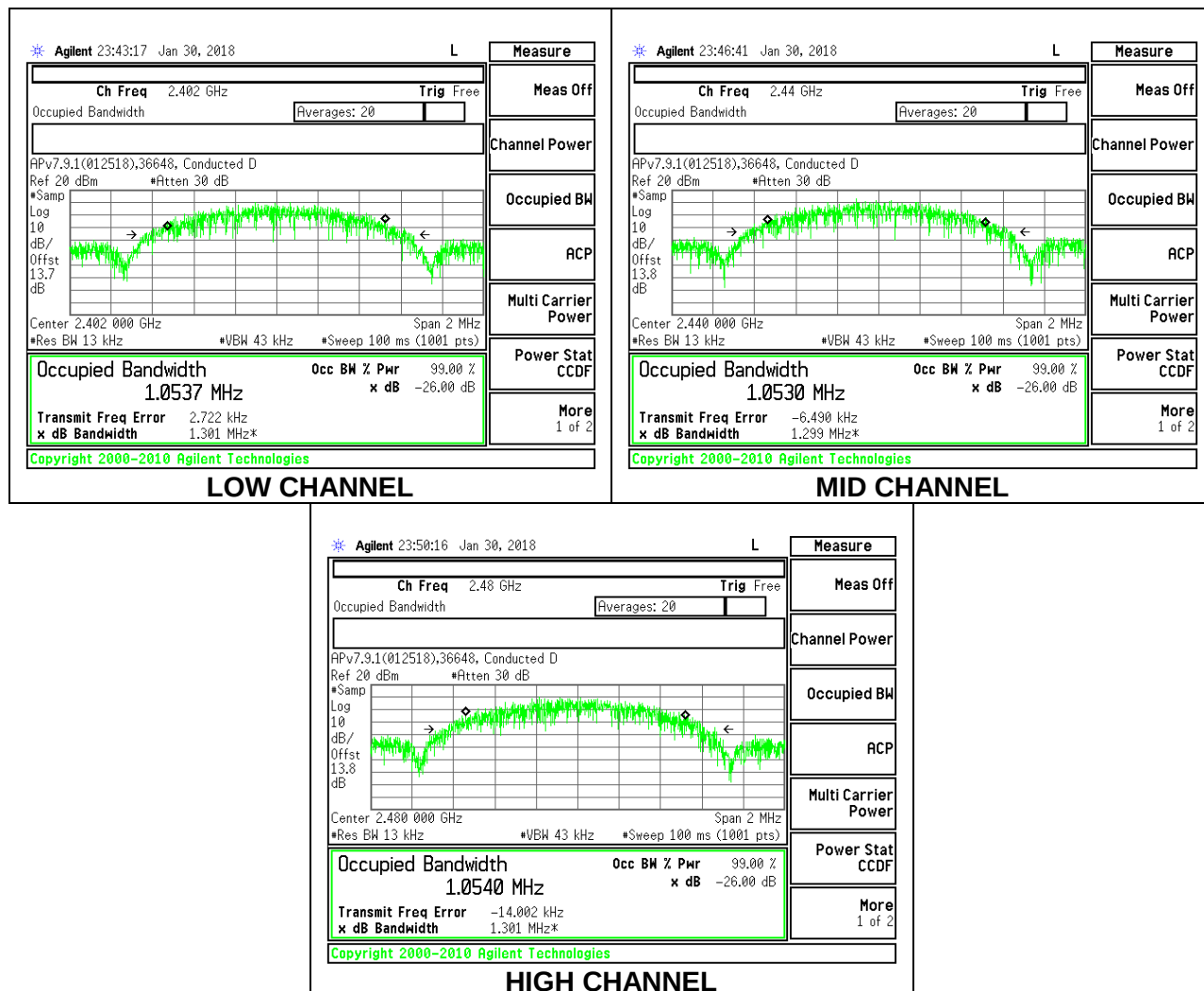
### Antenna 4

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.0550              |
| Middle  | 2440            | 1.0550              |
| High    | 2480            | 1.0550              |



### Antenna 3

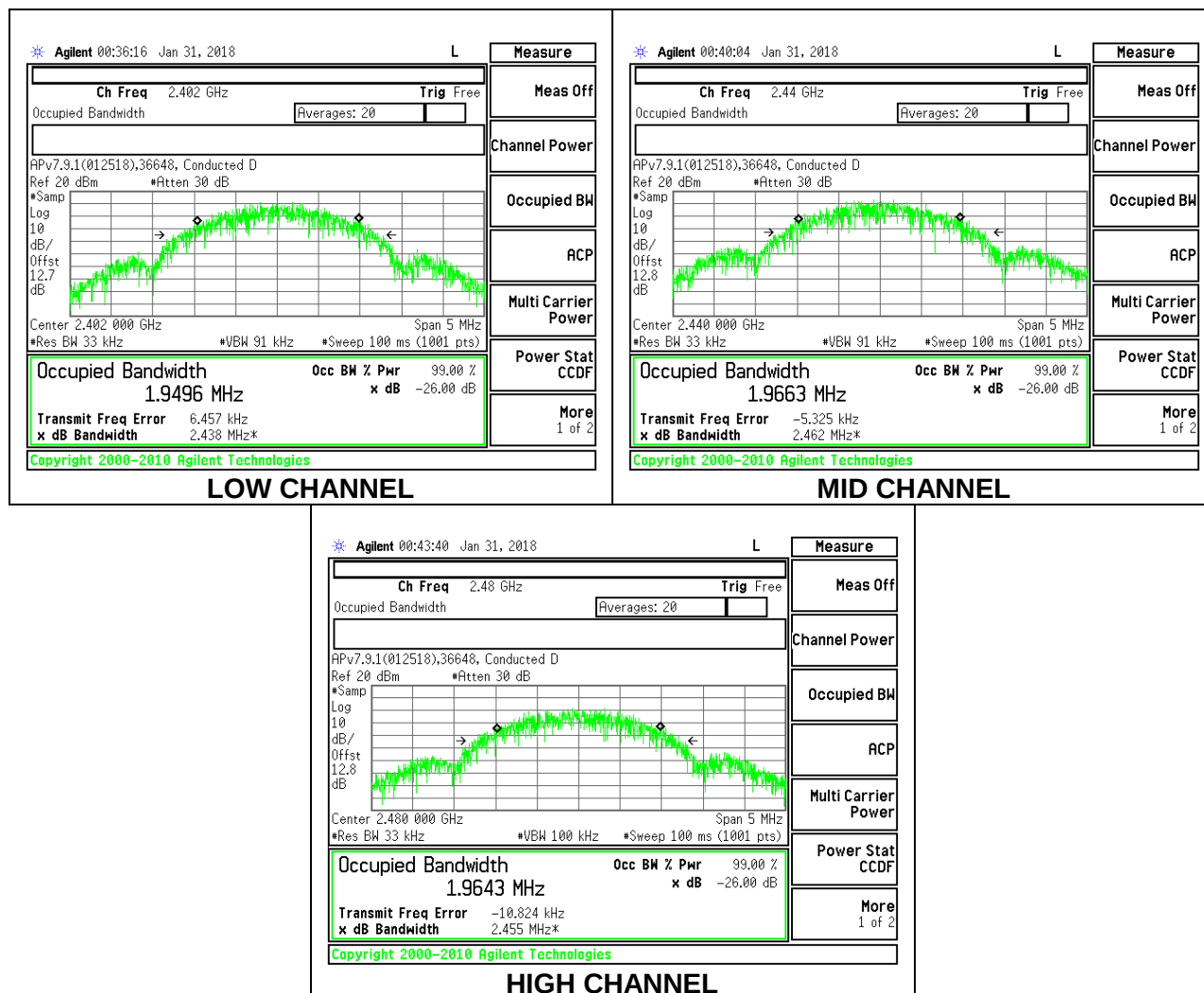
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.0540              |
| Middle  | 2440            | 1.0530              |
| High    | 2480            | 1.0540              |



## 8.2.2. HIGH POWER BLE (2Mbps)

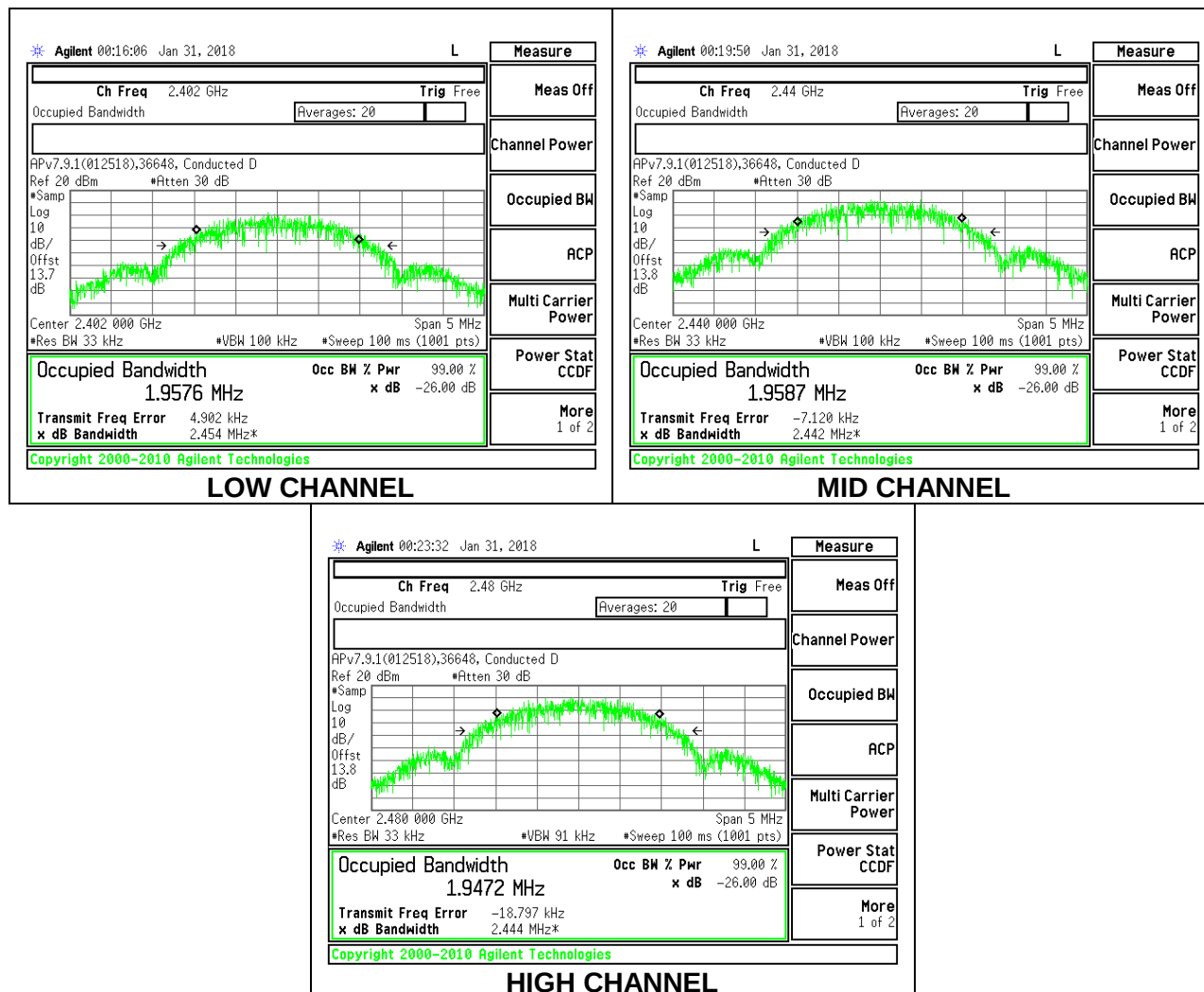
### Antenna 4

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.9500              |
| Middle  | 2440            | 1.9660              |
| High    | 2480            | 1.9640              |



### Antenna 3

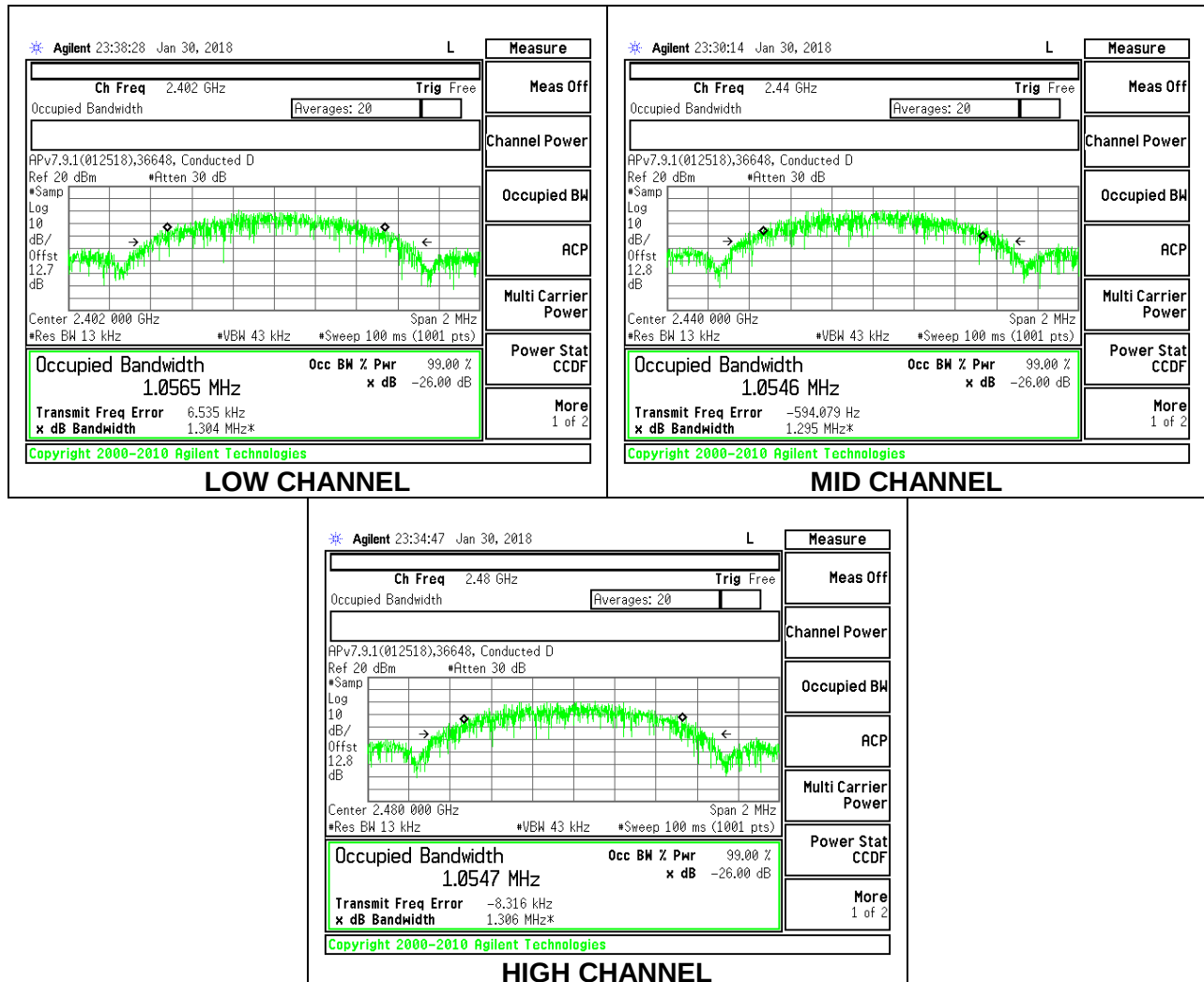
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.9580              |
| Middle  | 2440            | 1.9590              |
| High    | 2480            | 1.9470              |



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

#### Antenna 4

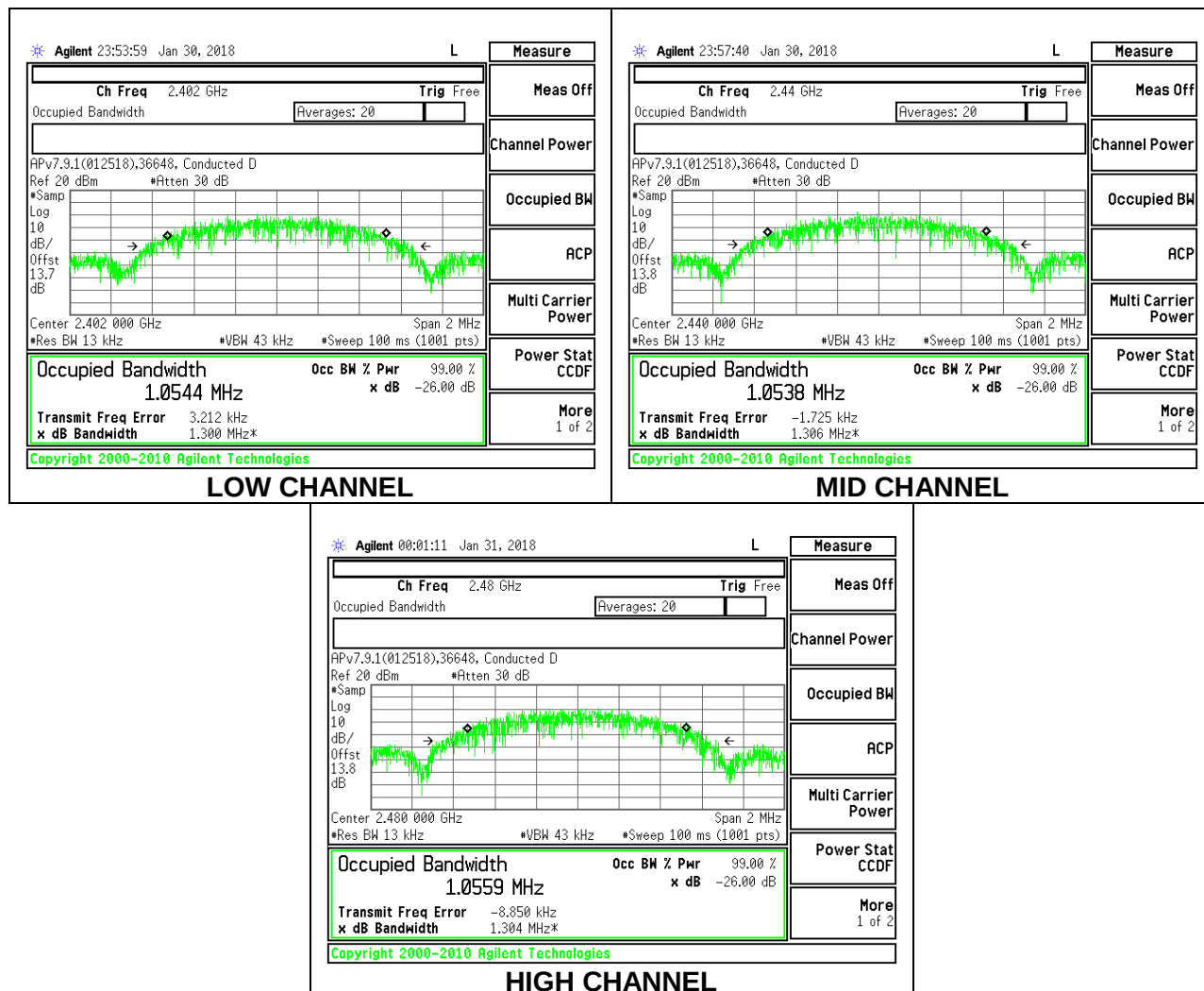
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.0565              |
| Middle  | 2440            | 1.0550              |
| High    | 2480            | 1.0550              |





### Antenna 3

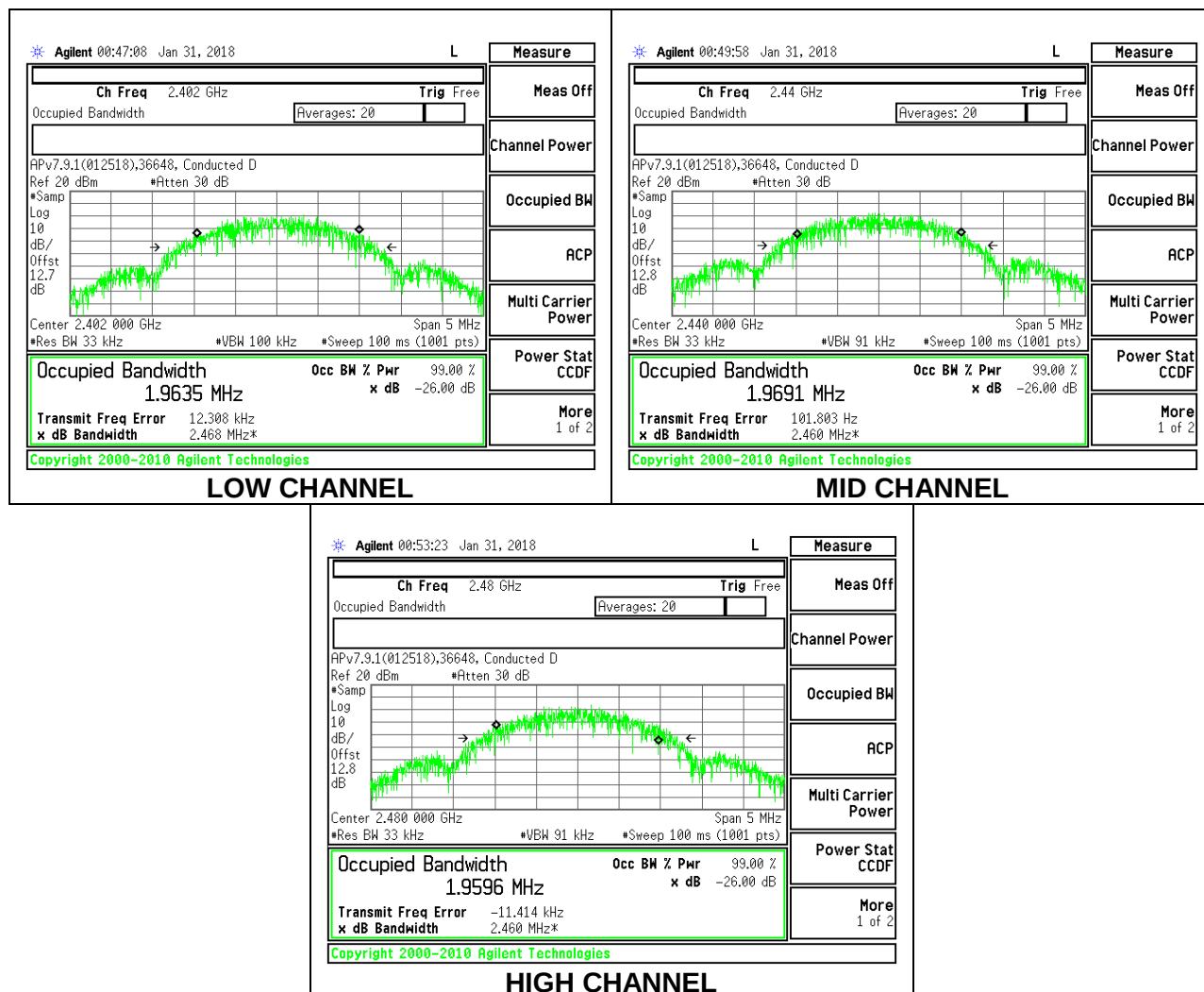
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.0540              |
| Middle  | 2440            | 1.0540              |
| High    | 2480            | 1.0560              |



## 8.2.4. LOW POWER BLE (2Mbps)

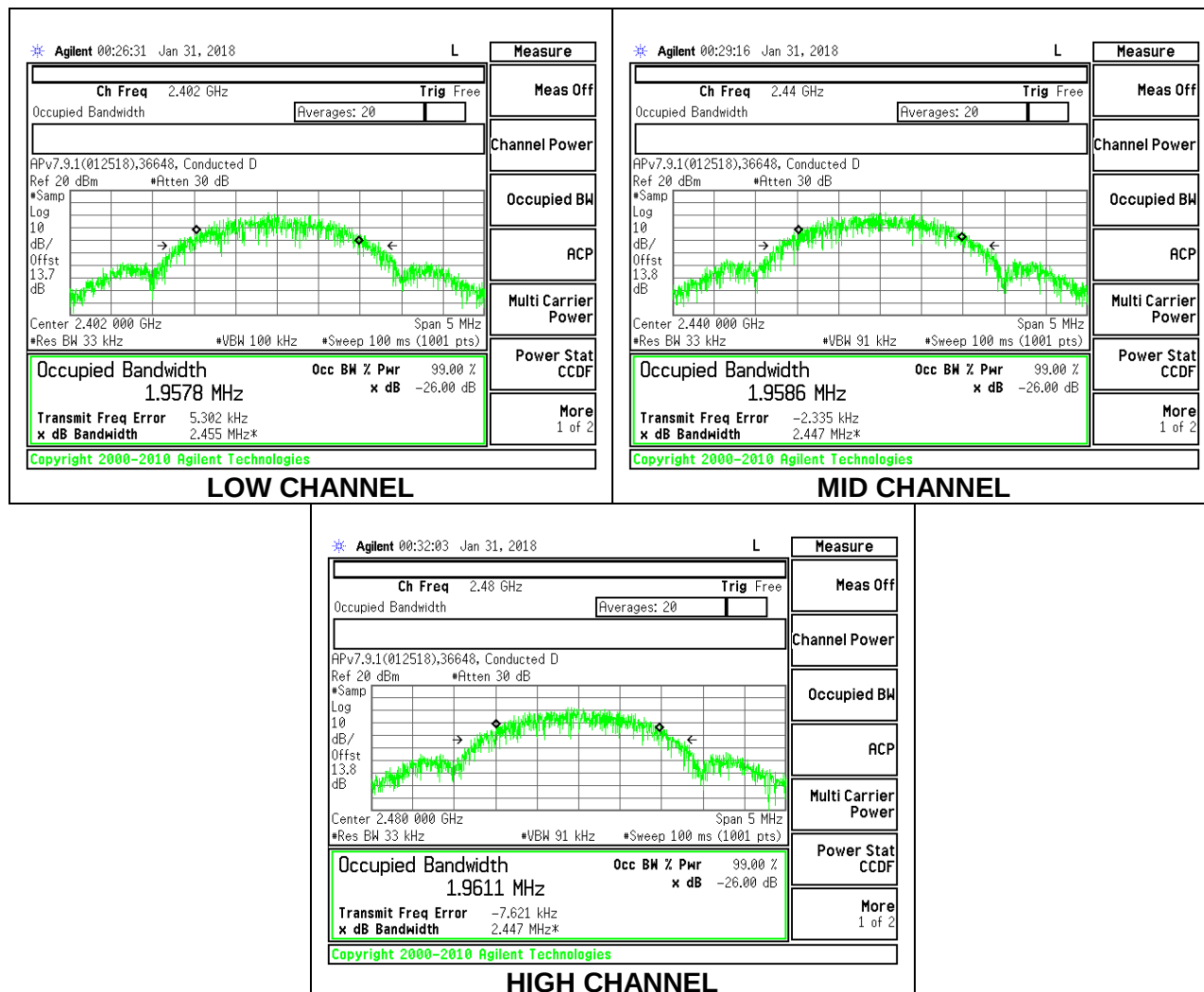
### Antenna 4

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.9640              |
| Middle  | 2440            | 1.9690              |
| High    | 2480            | 1.9600              |



### Antenna 3

| Channel | Frequency (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|---------------------|
| Low     | 2402            | 1.9580              |
| Middle  | 2440            | 1.9590              |
| High    | 2480            | 1.9610              |



### **8.3. 6 dB BANDWIDTH**

#### **LIMITS**

FCC §15.407 (e)

RSS-247 5.2 (a)

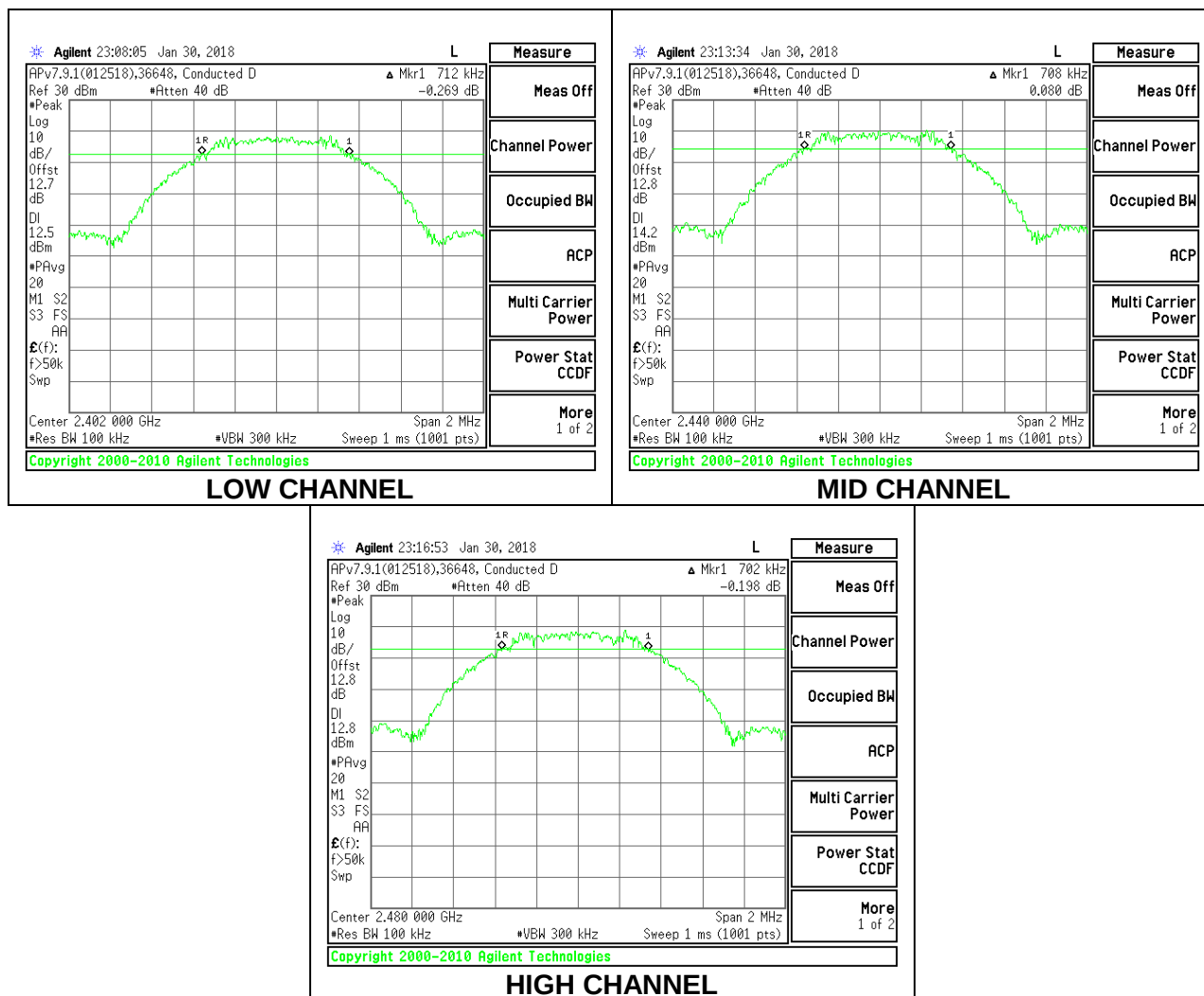
The minimum 6 dB bandwidth shall be at least 500 kHz.

#### **RESULTS**

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

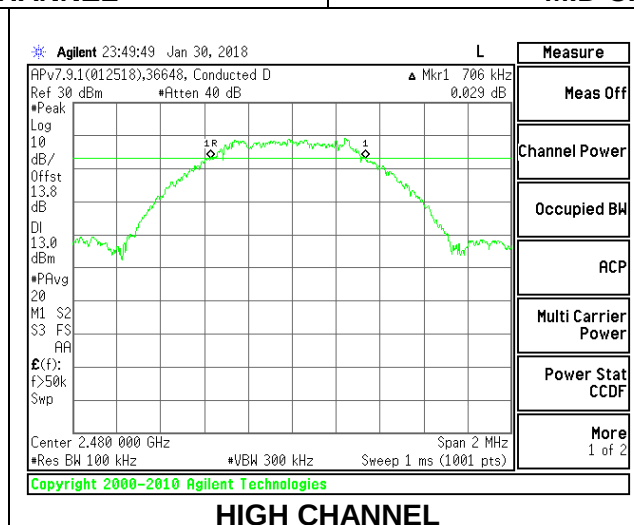
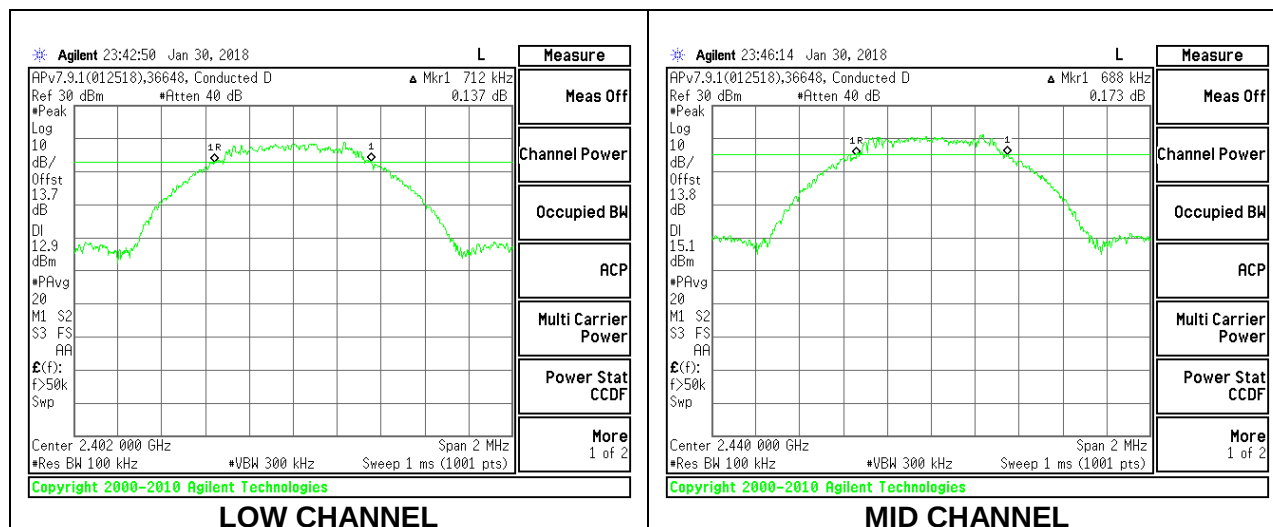
#### Antenna 4

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.712                | 0.5                 |
| Middle  | 2440            | 0.708                | 0.5                 |
| High    | 2480            | 0.702                | 0.5                 |



### Antenna 3

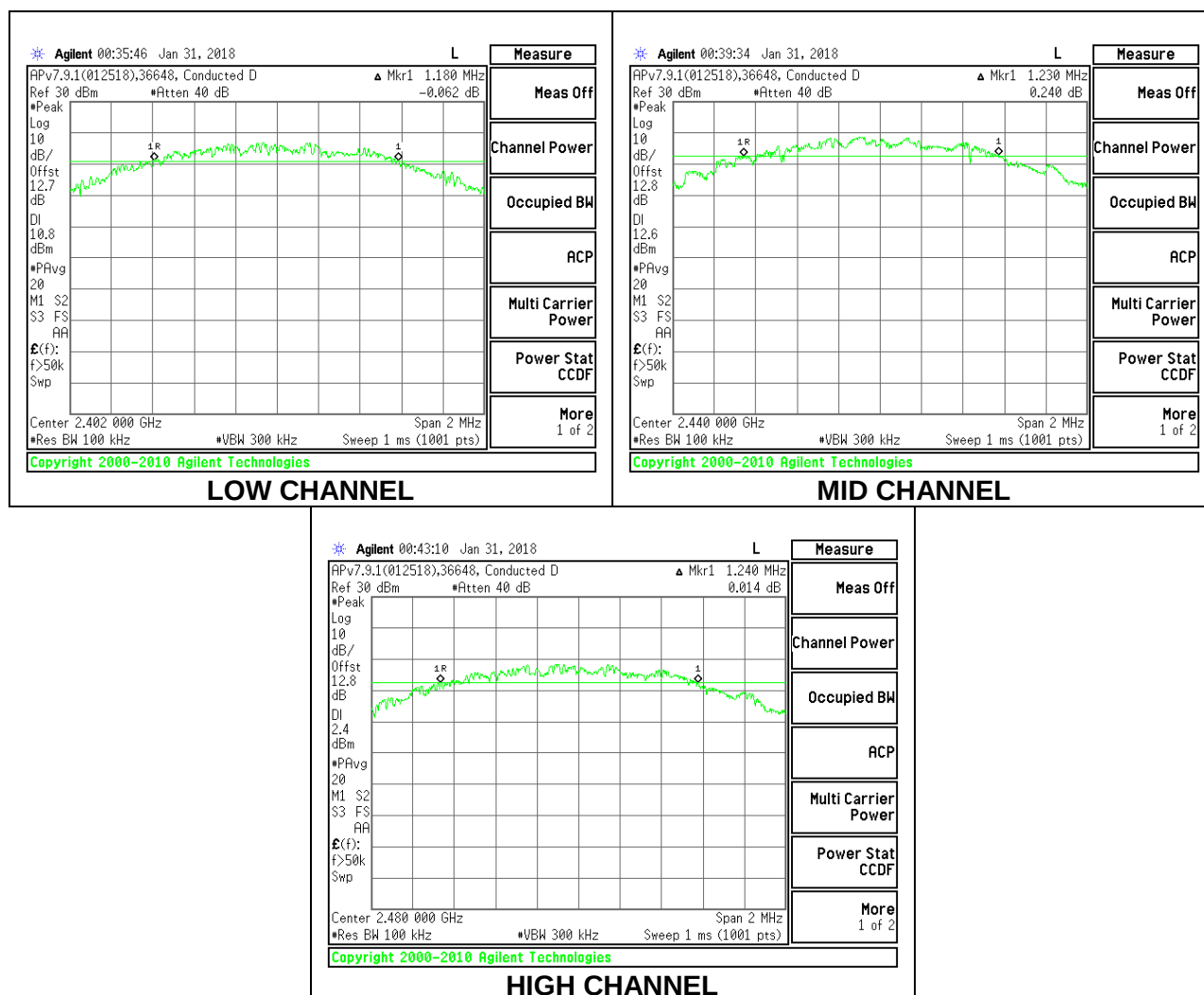
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.712                | 0.5                 |
| Middle  | 2440            | 0.688                | 0.5                 |
| High    | 2480            | 0.706                | 0.5                 |



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

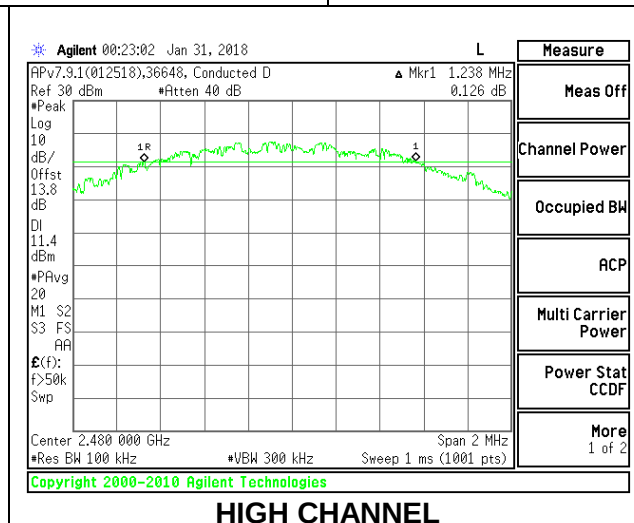
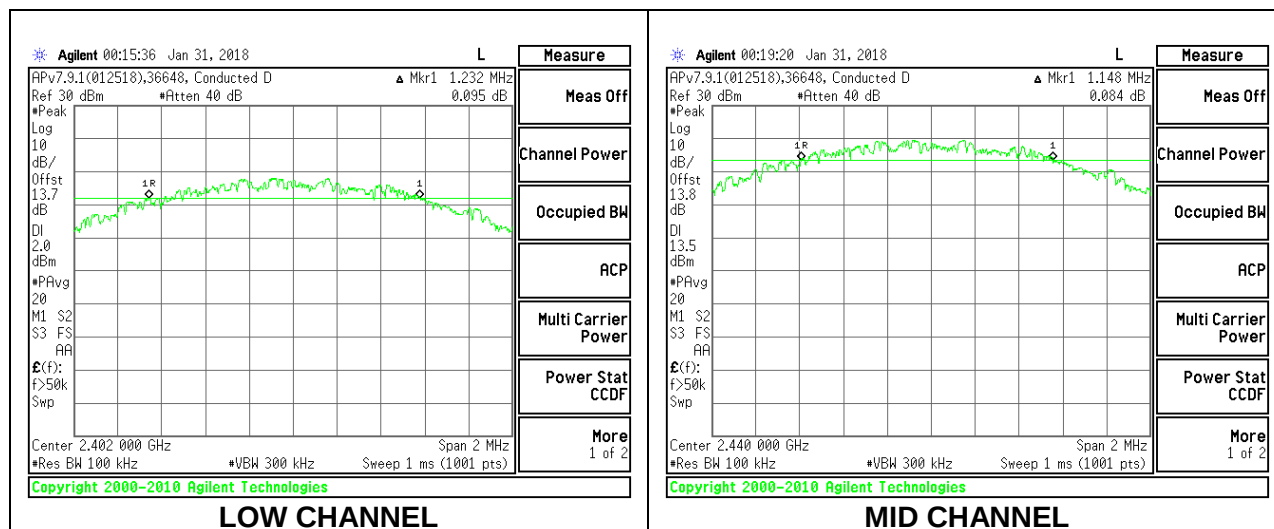
#### Antenna 4

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.180                | 0.5                 |
| Middle  | 2440            | 1.230                | 0.5                 |
| High    | 2480            | 1.240                | 0.5                 |



### Antenna 3

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.232                | 0.5                 |
| Middle  | 2440            | 1.148                | 0.5                 |
| High    | 2480            | 1.238                | 0.5                 |

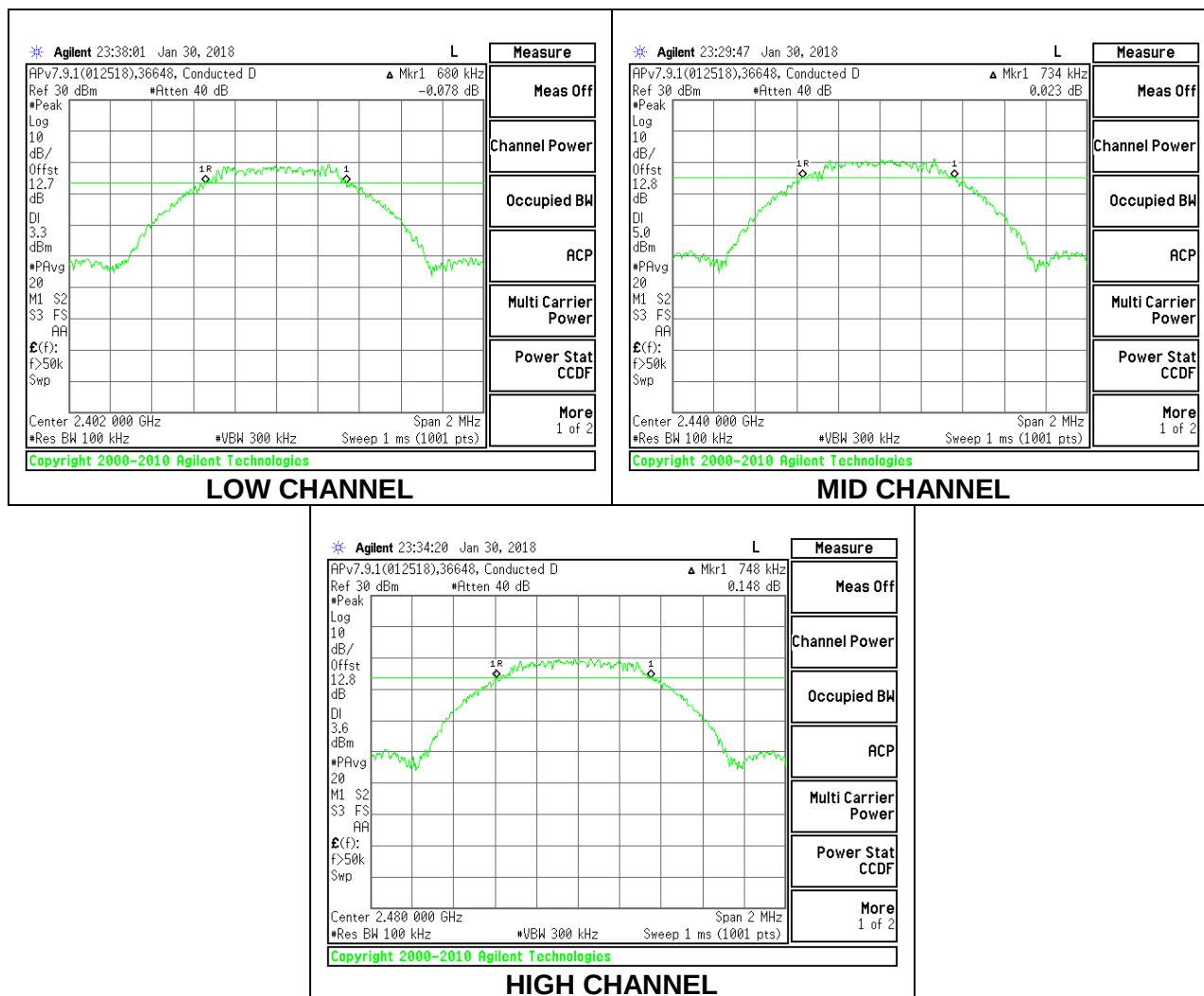




### 8.3.3. LOW POWER BLE (1Mbps)

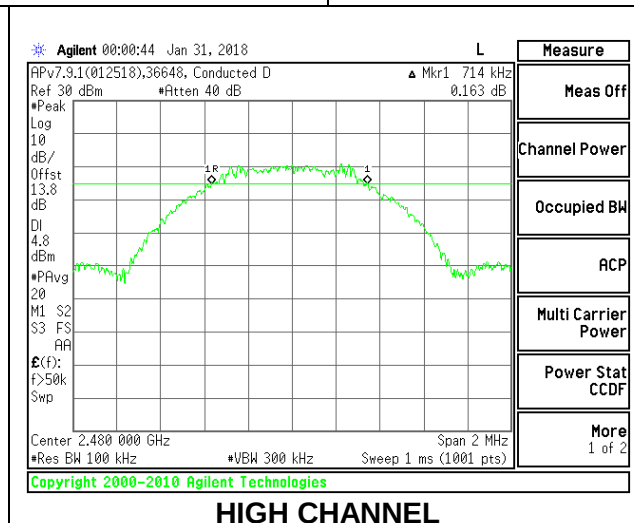
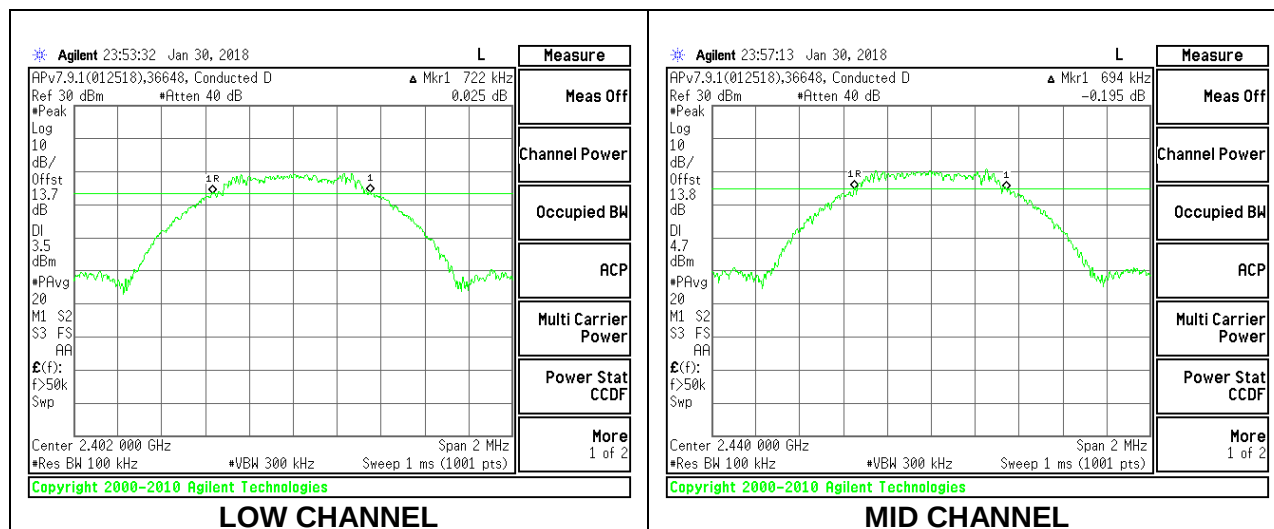
#### Antenna 4

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.680                | 0.5                 |
| Middle  | 2440            | 0.734                | 0.5                 |
| High    | 2480            | 0.748                | 0.5                 |



### Antenna 3

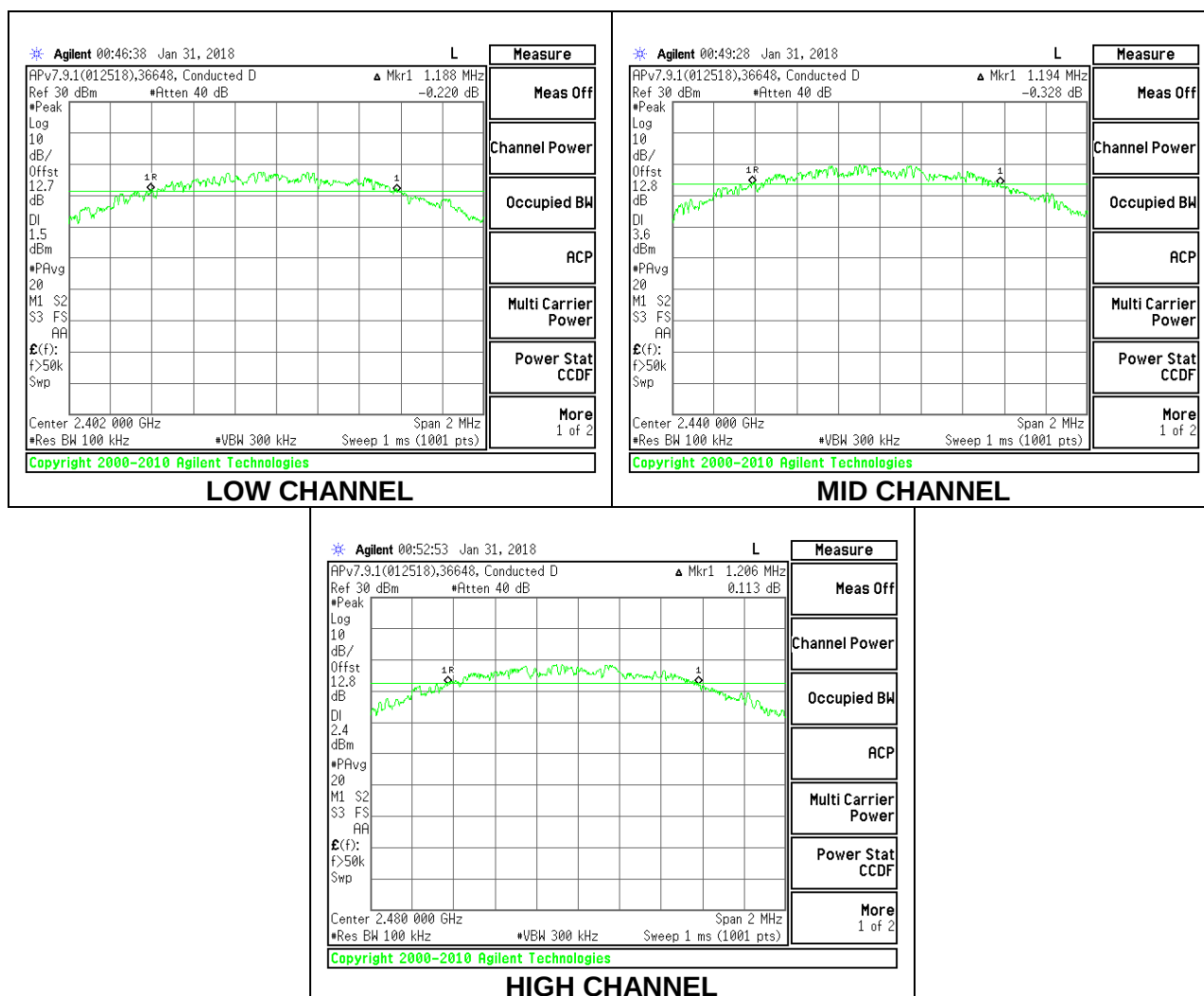
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 0.722                | 0.5                 |
| Middle  | 2440            | 0.694                | 0.5                 |
| High    | 2480            | 0.714                | 0.5                 |



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

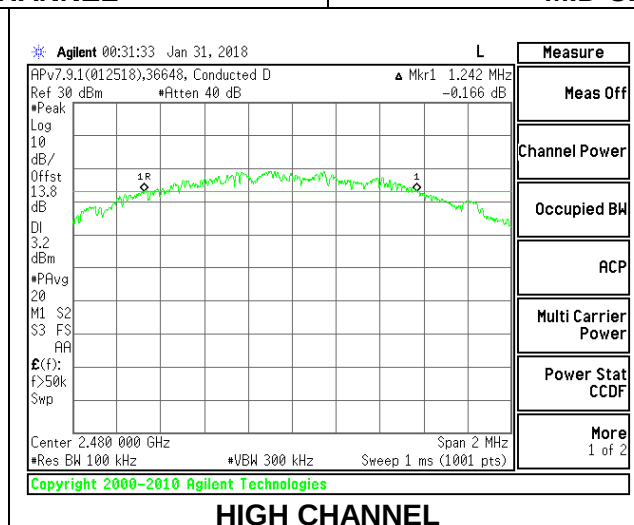
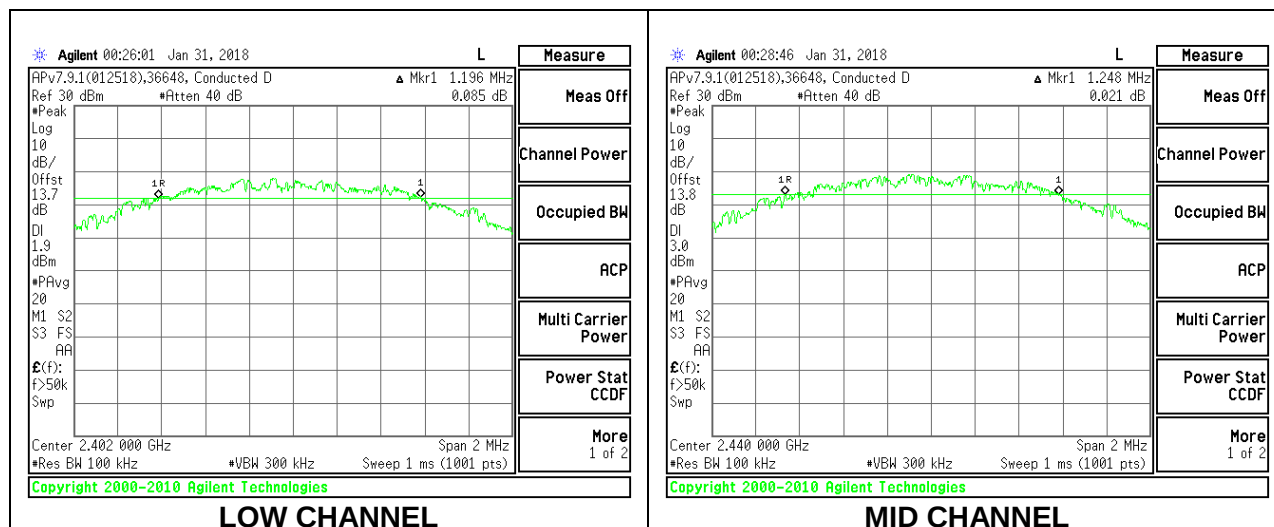
#### Antenna 4

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.188                | 0.5                 |
| Middle  | 2440            | 1.194                | 0.5                 |
| High    | 2480            | 1.206                | 0.5                 |



### Antenna 3

| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low     | 2402            | 1.196                | 0.5                 |
| Middle  | 2440            | 1.248                | 0.5                 |
| High    | 2480            | 1.242                | 0.5                 |



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## **8.4. 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**

The transmitter output is connected to a broadband gated Peak/average 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 peak reading of power.

### **RESULTS**

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 16.93                                   | 30                     | -13.07                 |
| Middle         | 2440                       | 16.88                                   | 30                     | -13.12                 |
| High           | 2480                       | 16.98                                   | 30                     | -13.02                 |

#### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 20.18                                   | 30                     | -9.82                  |
| Middle         | 2440                       | 20.36                                   | 30                     | -9.64                  |
| High           | 2480                       | 20.28                                   | 30                     | -9.72                  |

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

##### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| Channel | Frequency<br>(MHz) | Peak Power<br>Reading<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|----------------|----------------|
| Low     | 2402               | 16.97                          | 30             | -13.03         |
| Middle  | 2440               | 17.03                          | 30             | -12.97         |
| High    | 2480               | 16.91                          | 30             | -13.09         |

##### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| Channel | Frequency<br>(MHz) | Peak Power<br>Reading<br>(dBm) | Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|--------------------------------|----------------|----------------|
| Low     | 2402               | 19.86                          | 30             | -10.14         |
| Middle  | 2440               | 20.40                          | 30             | -9.60          |
| High    | 2480               | 20.31                          | 30             | -9.69          |

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 10.42                                   | 30                     | -19.58                 |
| Middle         | 2440                       | 10.37                                   | 30                     | -19.63                 |
| High           | 2480                       | 10.56                                   | 30                     | -19.440                |

#### Antenna 3

|                   |            |
|-------------------|------------|
| <b>Tested By:</b> | Jingang Li |
| <b>Date:</b>      | 3/2/2018   |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 10.54                                   | 30                     | -19.46                 |
| Middle         | 2440                       | 10.49                                   | 30                     | -19.51                 |
| High           | 2480                       | 10.41                                   | 30                     | -19.59                 |



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

##### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 10.54                                   | 30                     | -19.46                 |
| Middle         | 2440                       | 10.43                                   | 30                     | -19.57                 |
| High           | 2480                       | 10.58                                   | 30                     | -19.42                 |

##### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Peak Power<br/>Reading<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------------------|------------------------|------------------------|
| Low            | 2402                       | 10.38                                   | 30                     | -19.62                 |
| Middle         | 2440                       | 10.56                                   | 30                     | -19.44                 |
| High           | 2480                       | 10.34                                   | 30                     | -19.66                 |

## **8.5. AVERAGE POWER**

### **LIMITS**

None; for reporting purposes only.

### **TEST PROCEDURE**

The transmitter output is connected to a broadband gated Peak/average 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 peak reading of power.

### **RESULTS**

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 16.48                     |
| Middle         | 2440                       | 16.41                     |
| High           | 2480                       | 16.47                     |

#### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 19.72                     |
| Middle         | 2440                       | 19.83                     |
| High           | 2480                       | 19.74                     |

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 16.42                     |
| Middle         | 2440                       | 16.48                     |
| High           | 2480                       | 16.39                     |

#### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 19.46                     |
| Middle         | 2440                       | 19.87                     |
| High           | 2480                       | 19.77                     |

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 9.89                      |
| Middle         | 2440                       | 9.95                      |
| High           | 2480                       | 9.92                      |

#### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 9.88                      |
| Middle         | 2440                       | 9.86                      |
| High           | 2480                       | 9.92                      |

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

#### Antenna 4

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 9.98                      |
| Middle         | 2440                       | 9.90                      |
| High           | 2480                       | 9.99                      |

#### Antenna 3

|                   |          |
|-------------------|----------|
| <b>Tested By:</b> | 30554    |
| <b>Date:</b>      | 5/2/2018 |

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>AV power<br/>(dBm)</b> |
|----------------|----------------------------|---------------------------|
| Low            | 2402                       | 9.89                      |
| Middle         | 2440                       | 9.95                      |
| High           | 2480                       | 9.93                      |

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## **8.6. POWER SPECTRAL DENSITY**

### **LIMITS**

FCC §15.247 (e)

RSS-247 (5.2) (b)

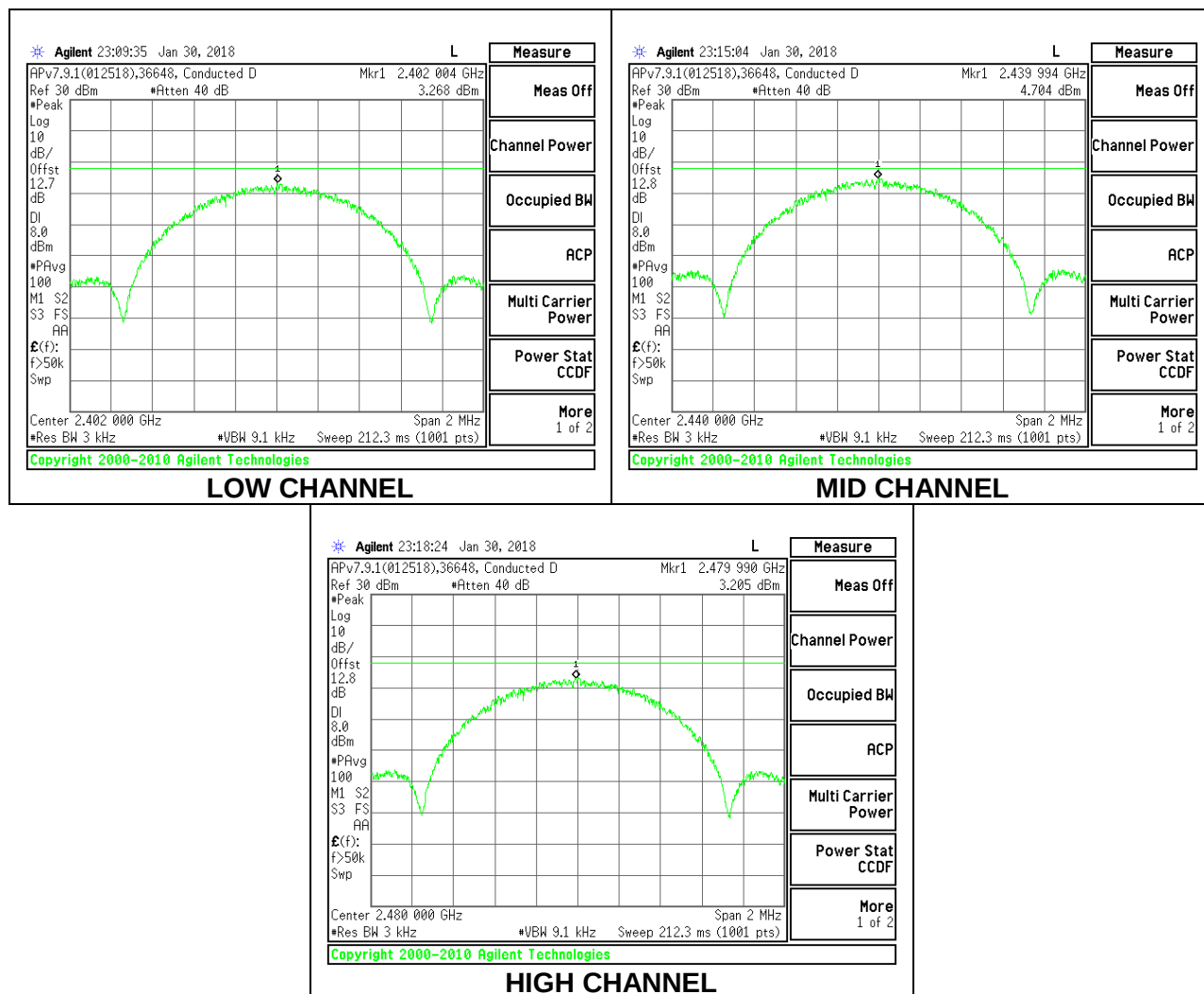
The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### **RESULTS**

## 8.6.1. HIGH POWER BLE (1Mbps)

### Antenna 4

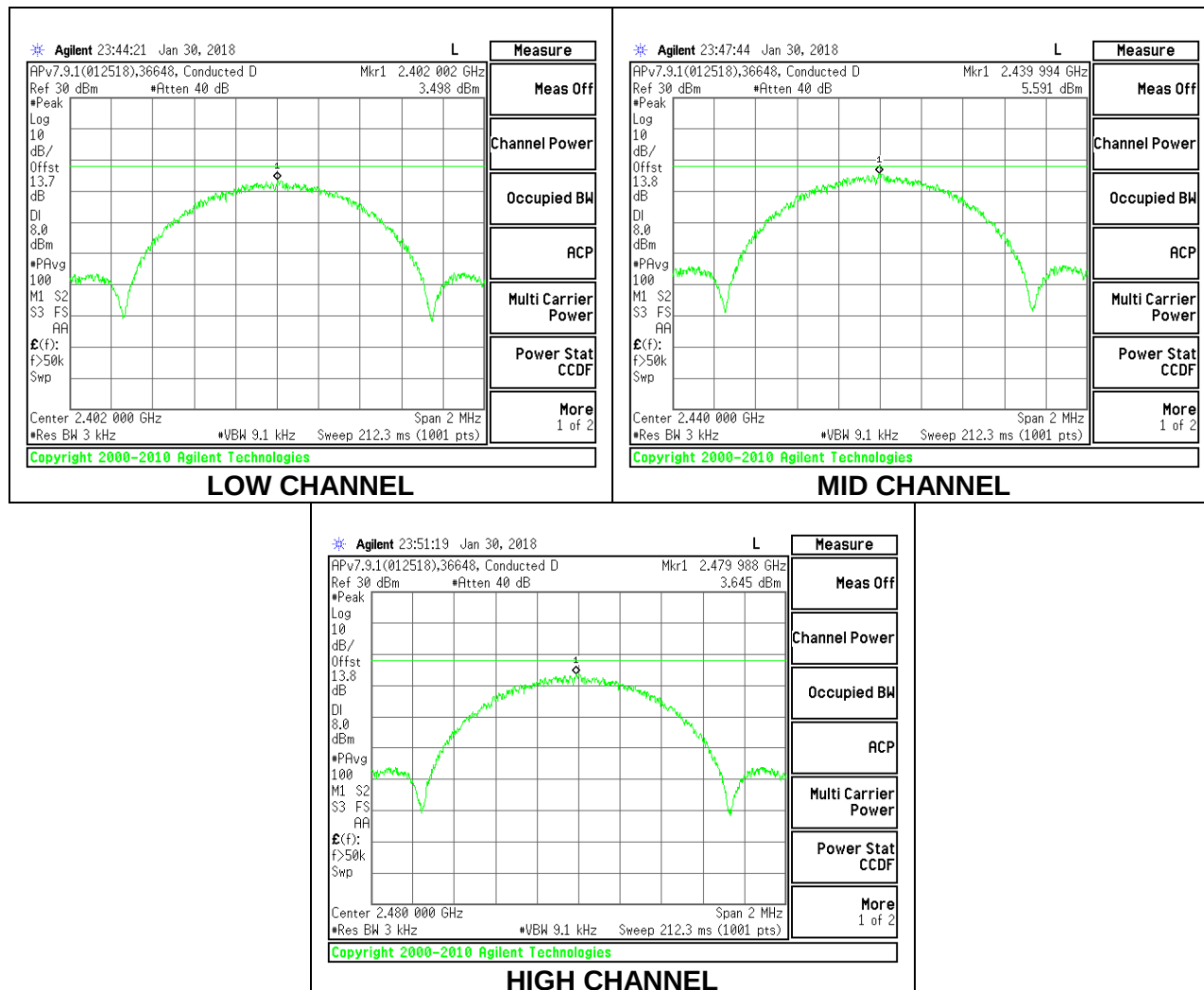
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | 3.27           | 8                | -4.73       |
| Middle  | 2440            | 4.70           | 8                | -3.30       |
| High    | 2480            | 3.21           | 8                | -4.79       |





### Antenna 3

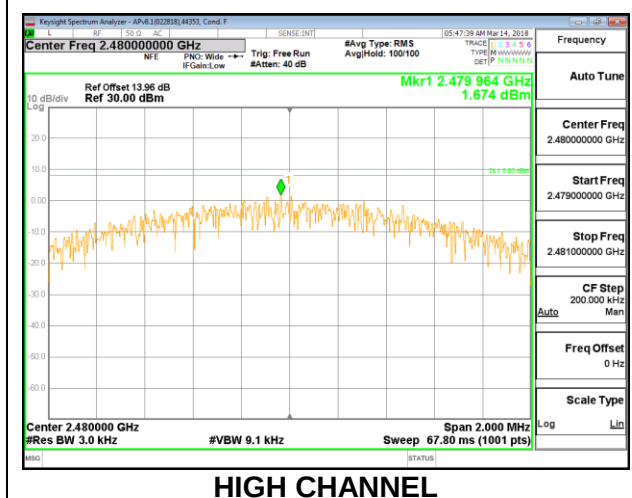
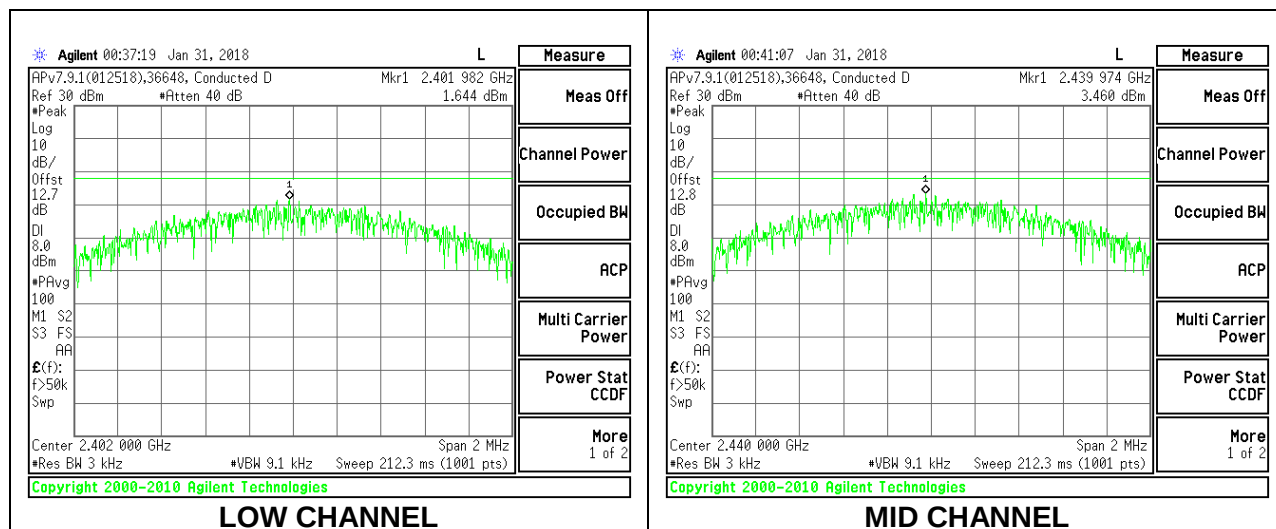
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | 3.50           | 8                | -4.50       |
| Middle  | 2440            | 5.59           | 8                | -2.41       |
| High    | 2480            | 3.65           | 8                | -4.35       |



## 8.6.2. HIGH POWER BLE (2Mbps)

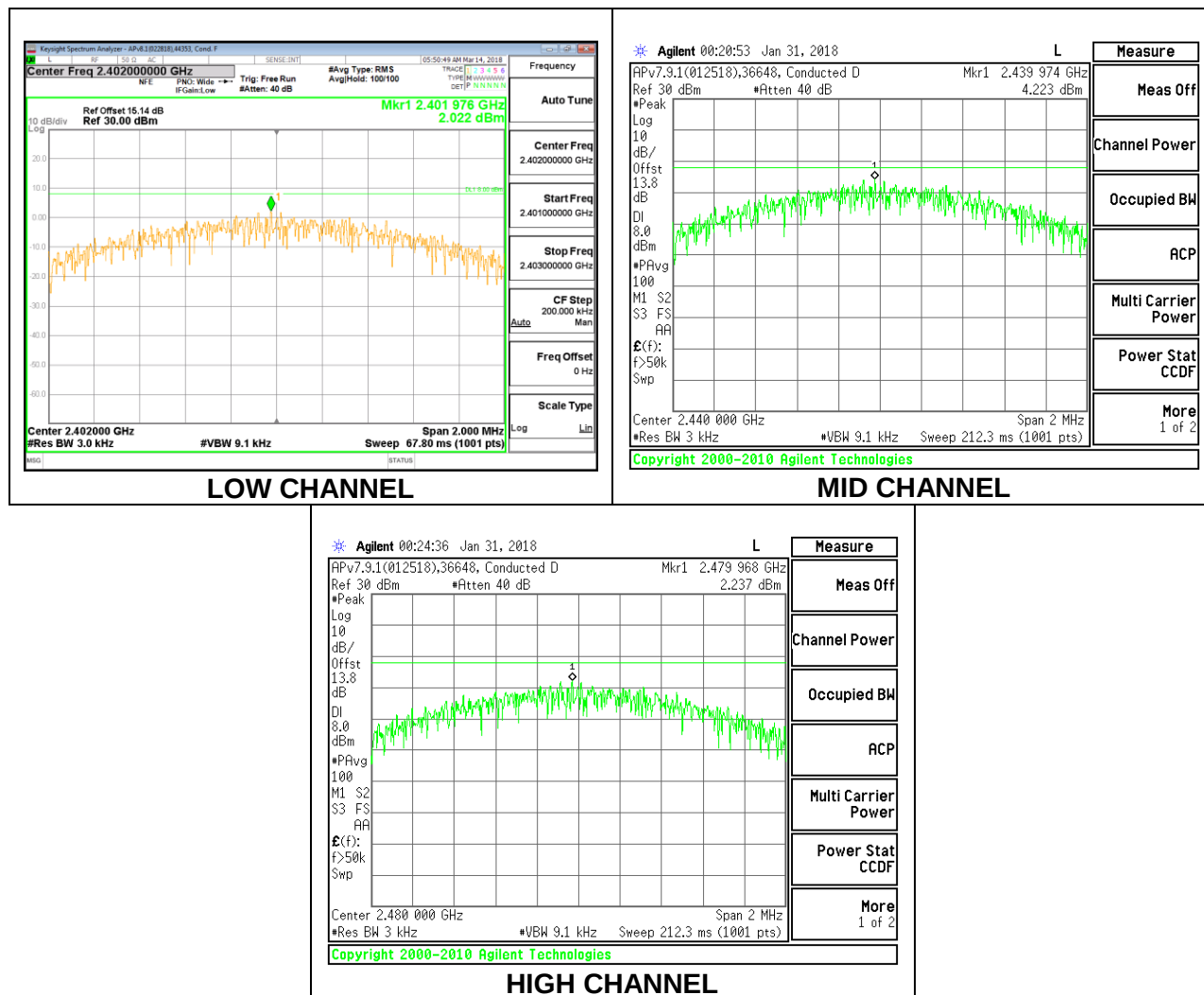
### Antenna 4

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | 1.64           | 8                | -6.36       |
| Middle  | 2440            | 3.46           | 8                | -4.54       |
| High    | 2480            | 1.67           | 8                | -6.33       |



### Antenna 3

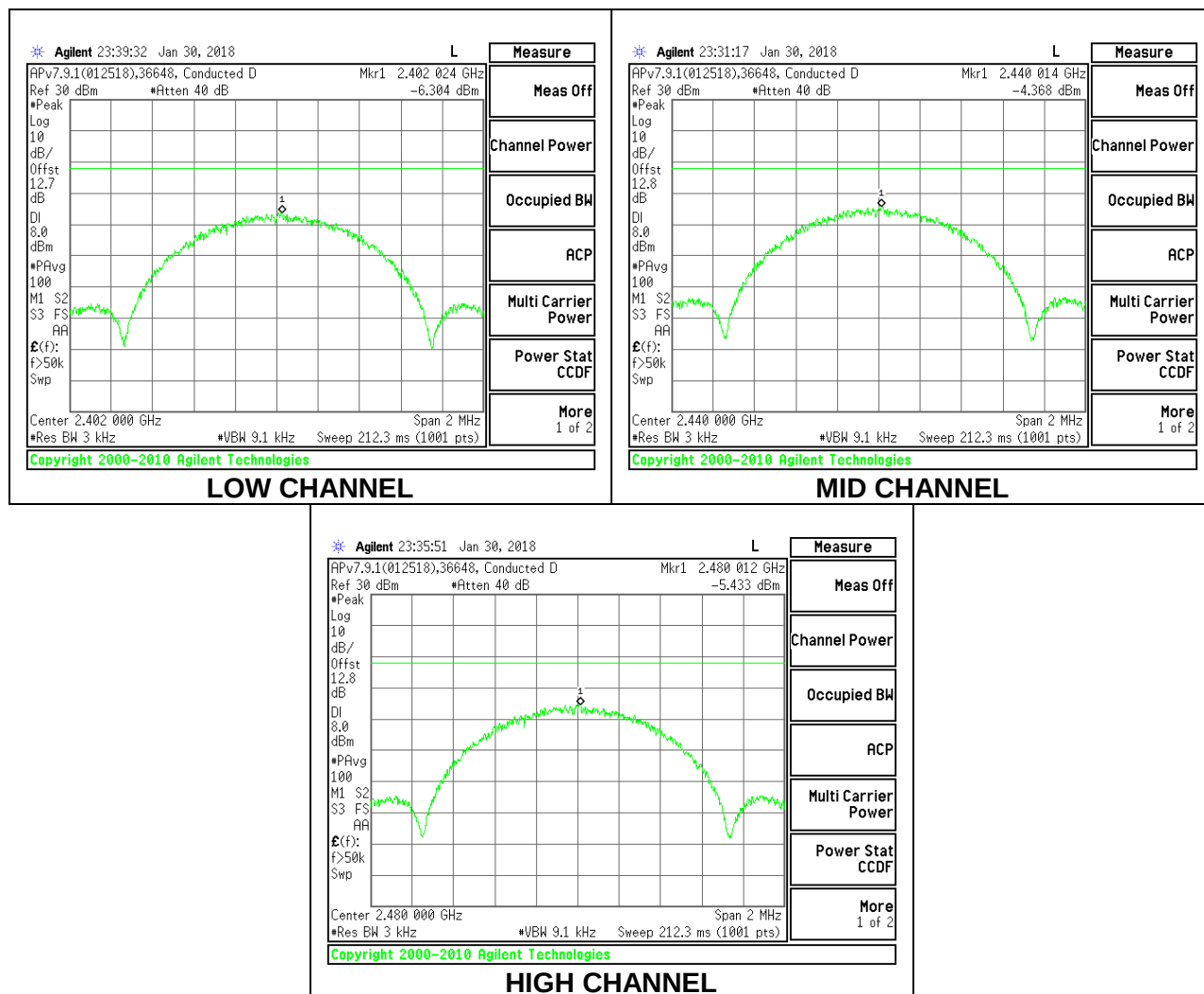
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | 2.02           | 8                | -5.98       |
| Middle  | 2440            | 4.22           | 8                | -3.78       |
| High    | 2480            | 2.24           | 8                | -5.76       |



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

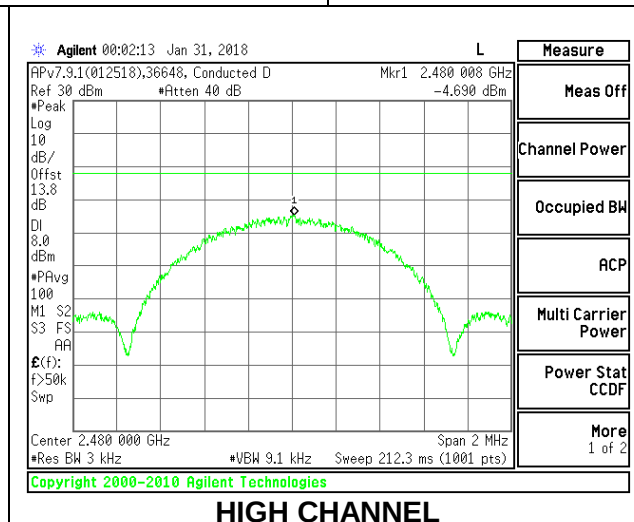
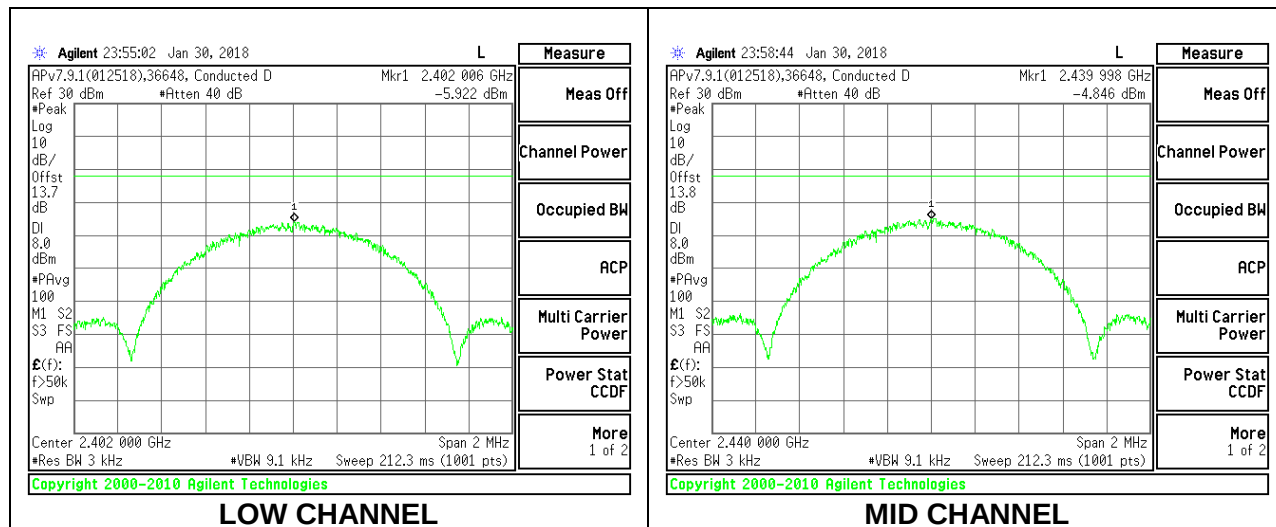
#### Antenna 4

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | -6.30          | 8                | -14.30      |
| Middle  | 2440            | -4.37          | 8                | -12.37      |
| High    | 2480            | -5.43          | 8                | -13.43      |



### Antenna 3

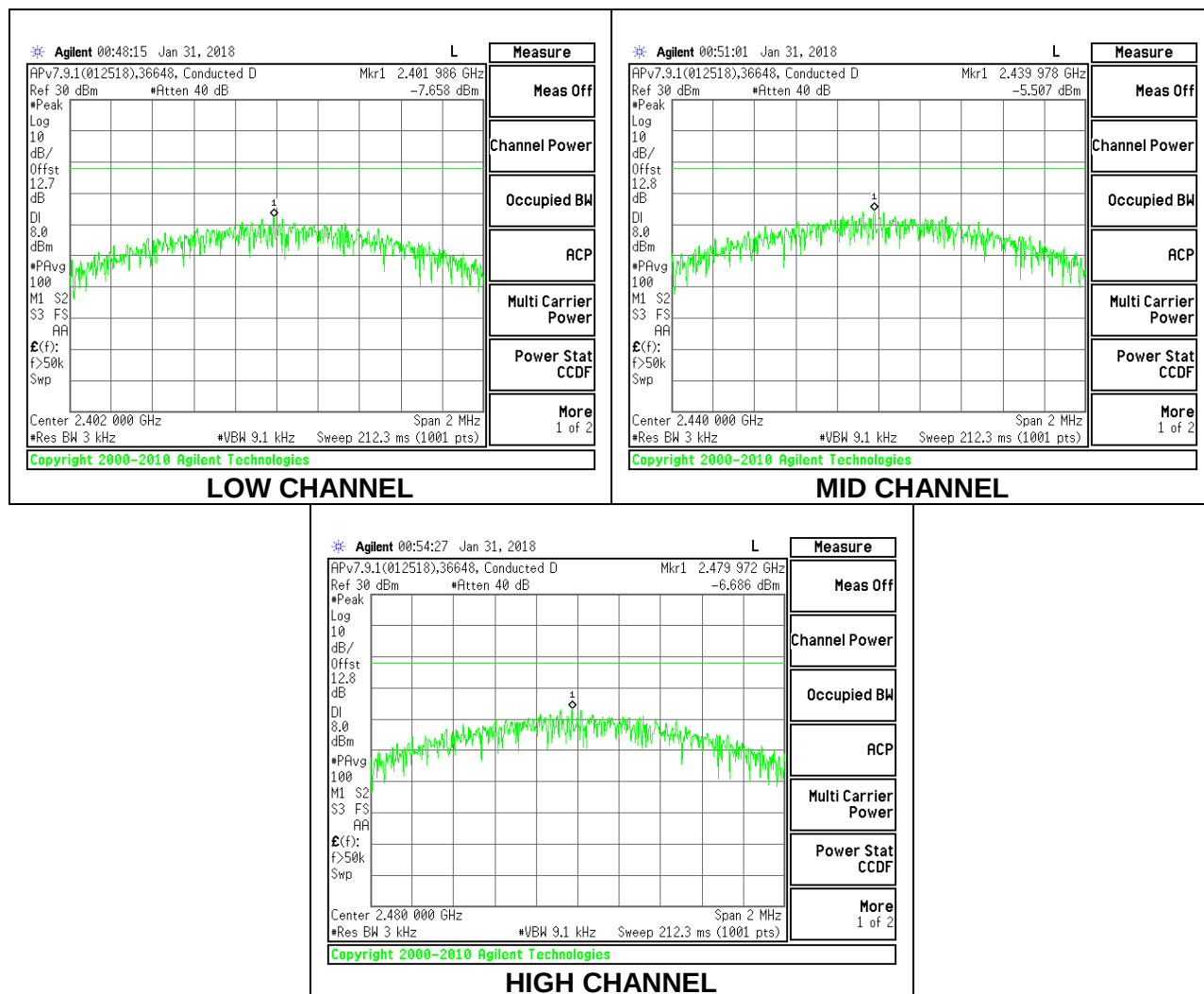
| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | -5.92          | 8                | -13.92      |
| Middle  | 2440            | -4.85          | 8                | -12.85      |
| High    | 2480            | -4.69          | 8                | -12.69      |



## 8.6.4. LOW POWER BLE (2Mbps)

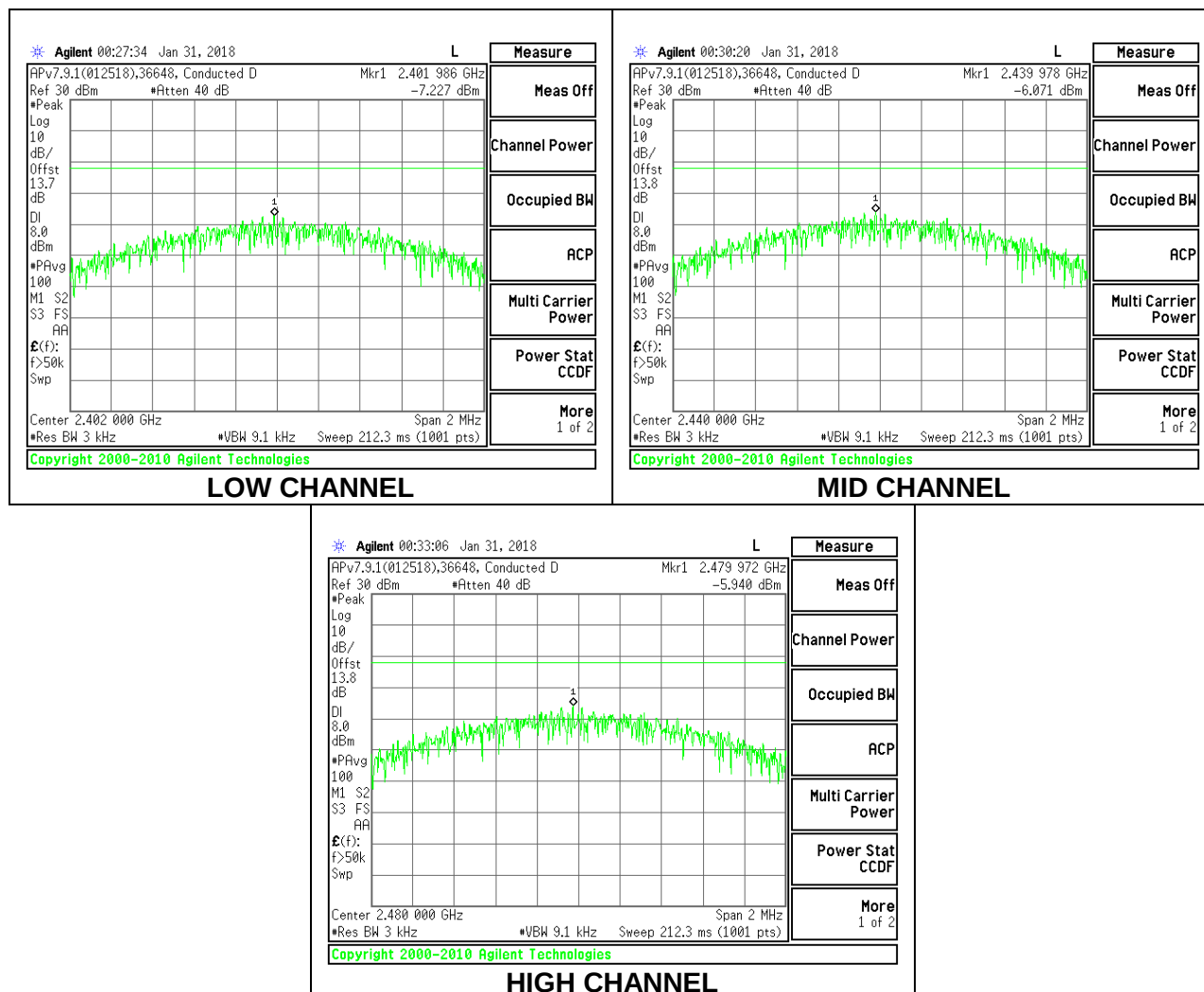
### Antenna 4

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | -7.66          | 8                | -15.66      |
| Middle  | 2440            | -5.51          | 8                | -13.51      |
| High    | 2480            | -6.69          | 8                | -14.69      |



### Antenna 3

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Margin (dB) |
|---------|-----------------|----------------|------------------|-------------|
| Low     | 2402            | -7.23          | 8                | -15.23      |
| Middle  | 2440            | -6.07          | 8                | -14.07      |
| High    | 2480            | -5.94          | 8                | -13.94      |



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## **8.7. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

RSS-247 5.5

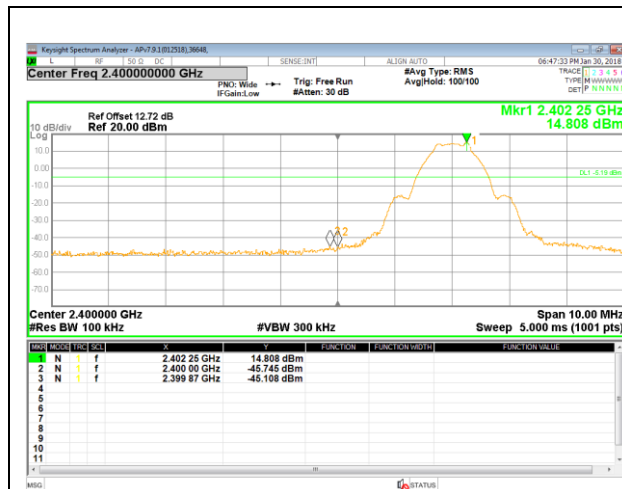
Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

### **8.7.1. RESULTS**

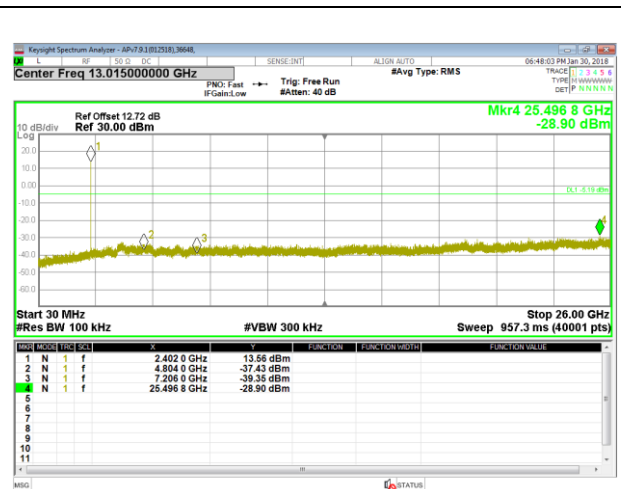


# HIGH POWER BLE (1Mbps)

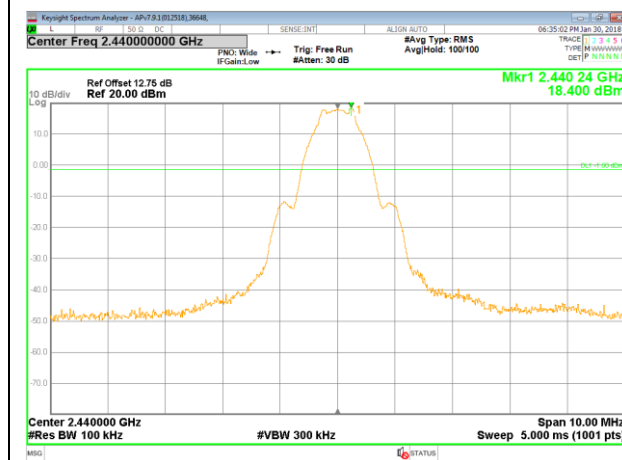
## Antenna 4



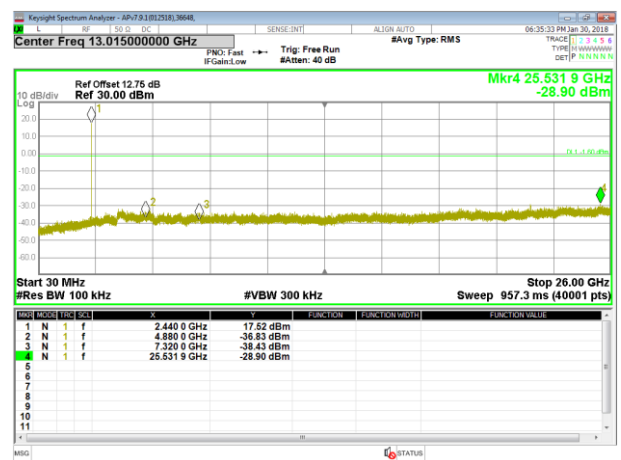
LOW CHANNEL BANDEDGE



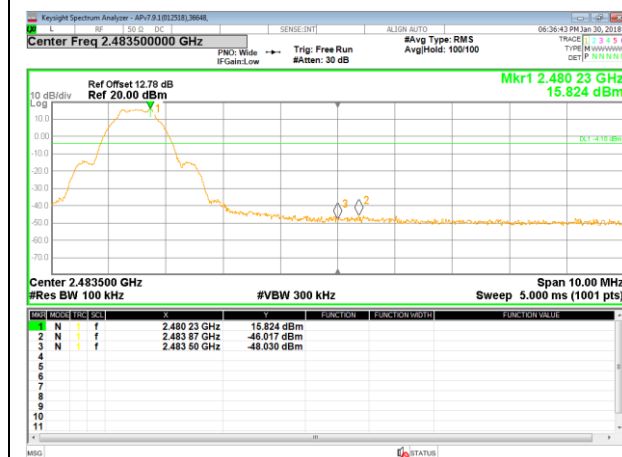
OUT-OF-BAND LOW CHANNEL



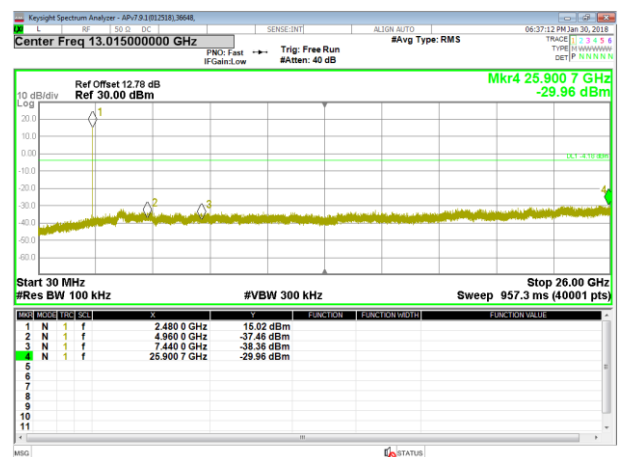
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

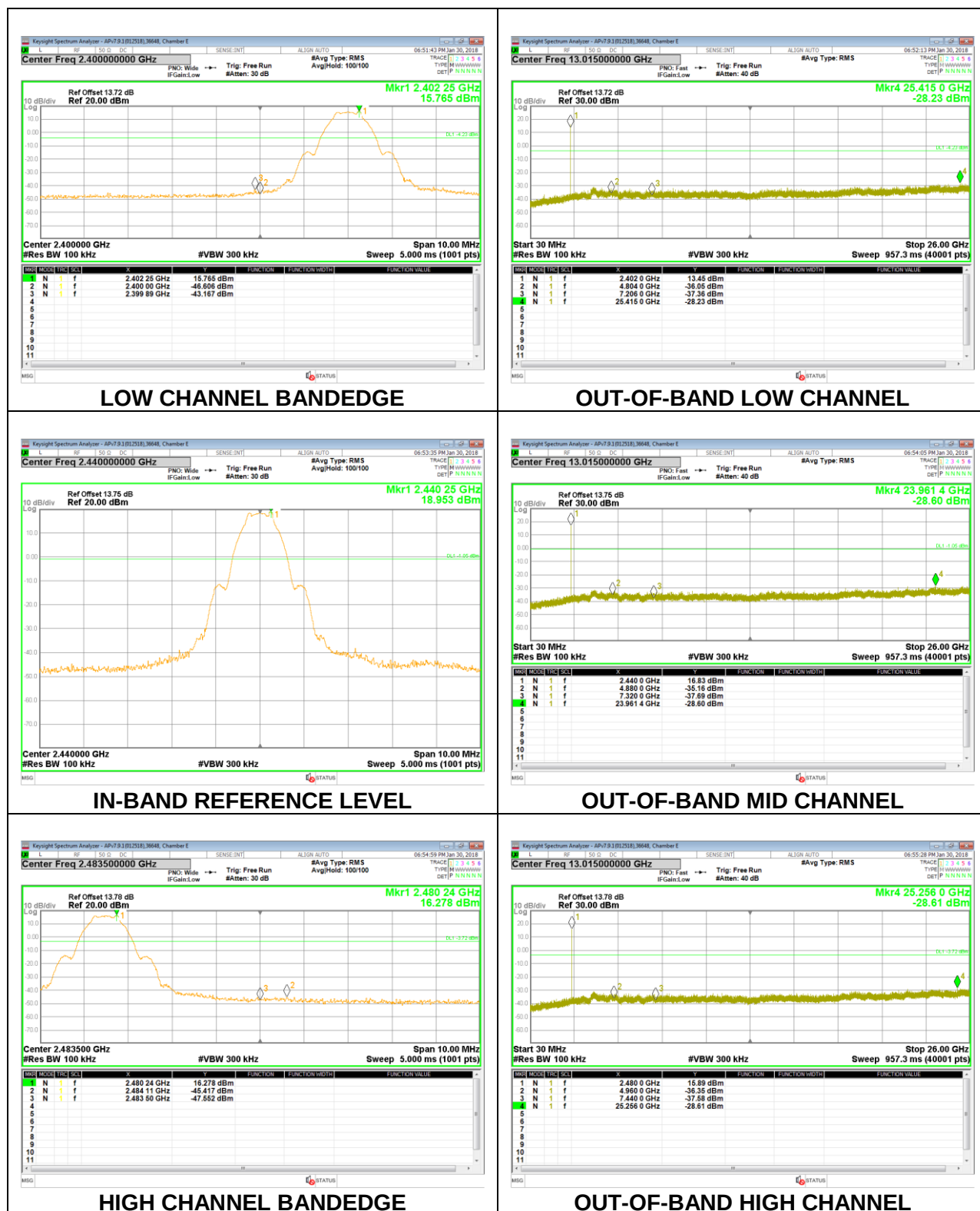


HIGH CHANNEL BANDEDGE



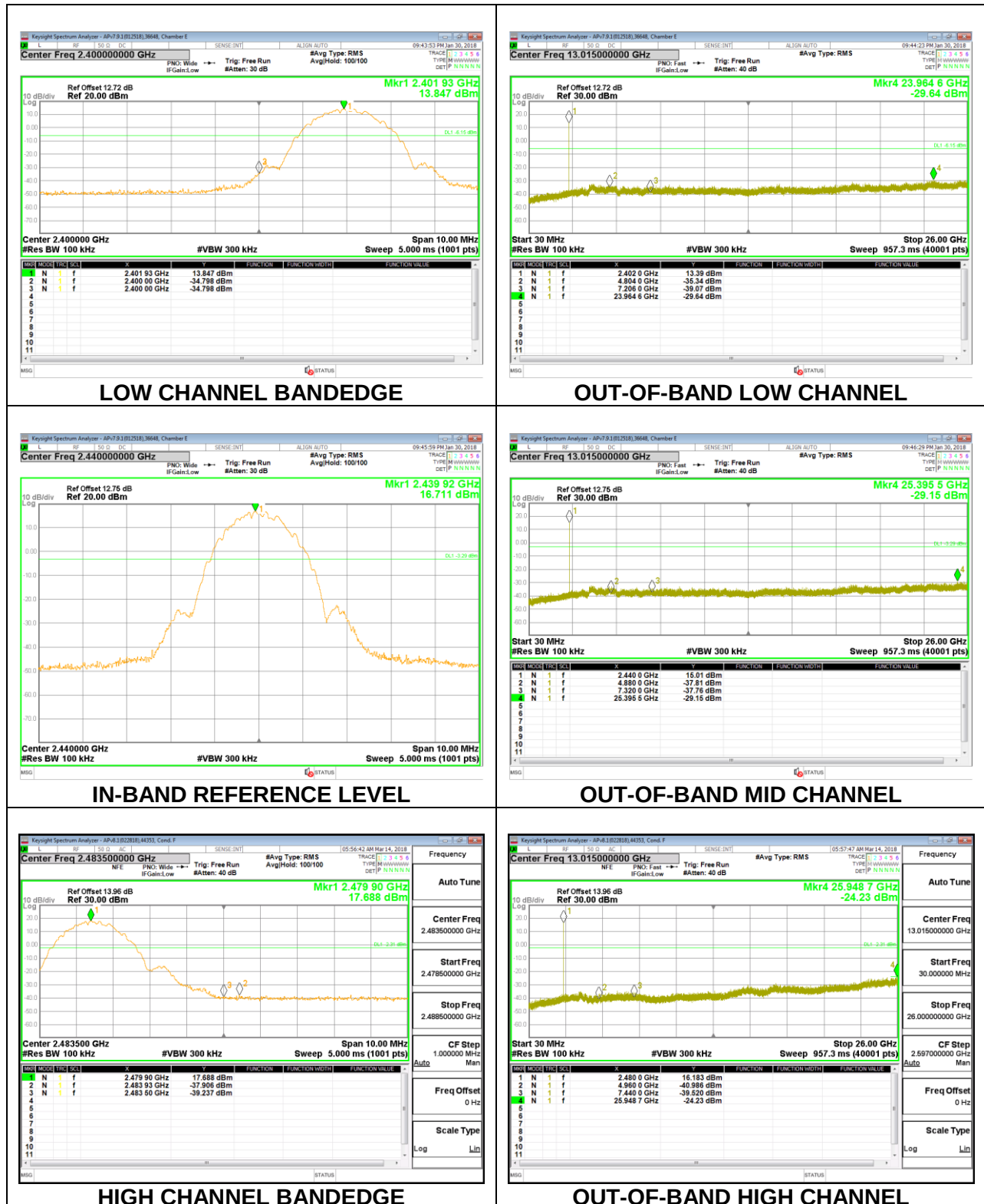
OUT-OF-BAND HIGH CHANNEL

# Antenna 3

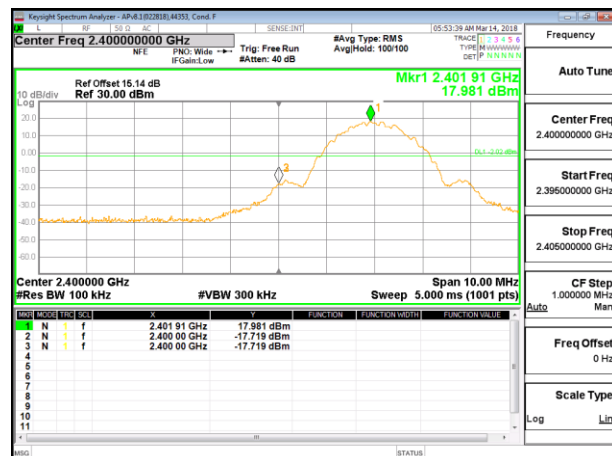


## 8.7.2. HIGH POWER BLE (2Mbps)

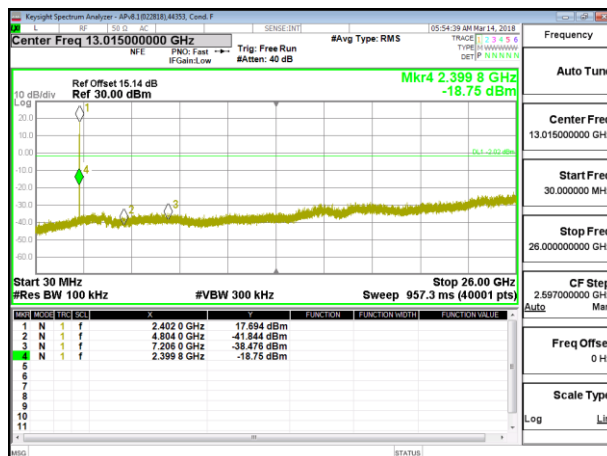
### Antenna 4



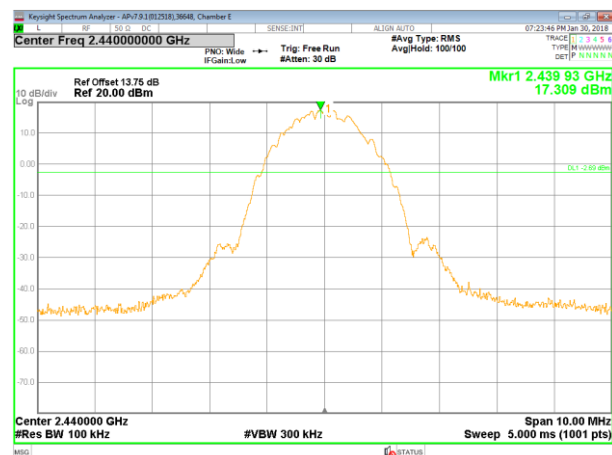
### Antenna 3



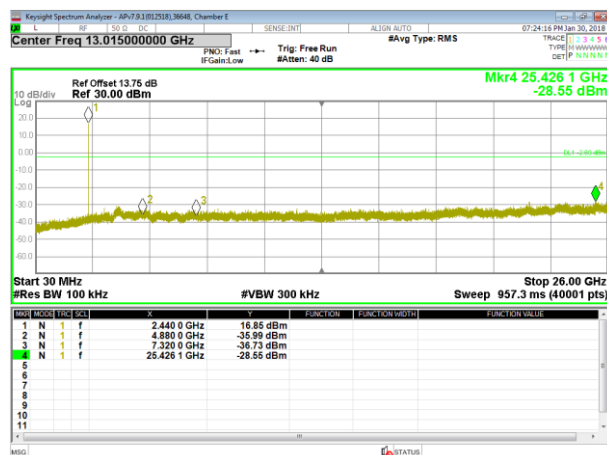
LOW CHANNEL BANDEDGE



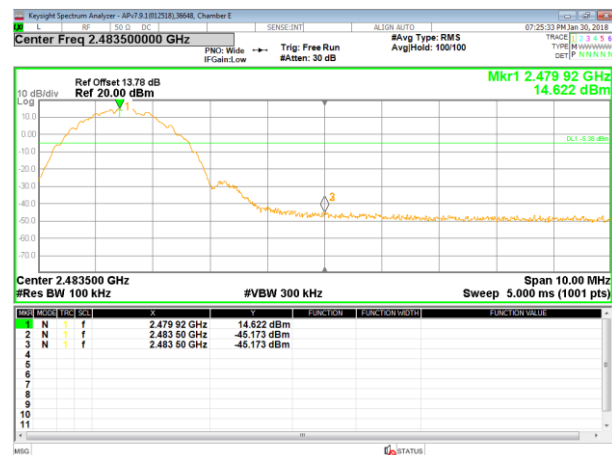
OUT-OF-BAND LOW CHANNEL



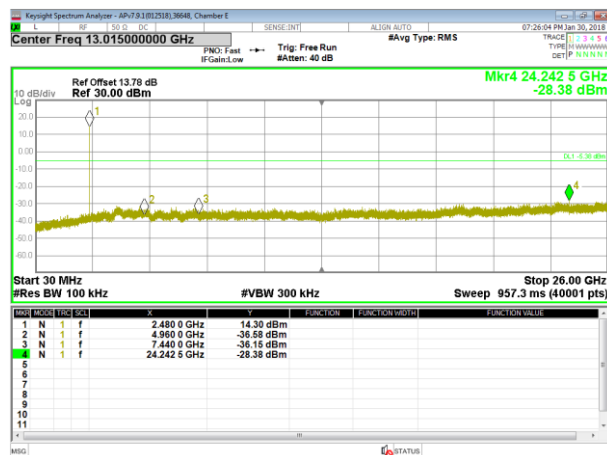
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



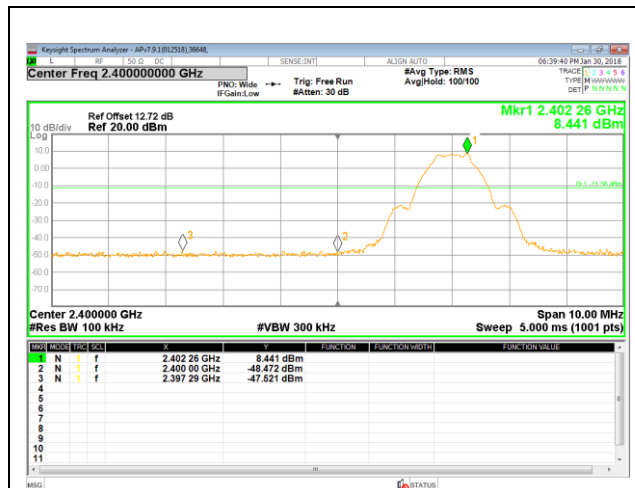
HIGH CHANNEL BANDEDGE



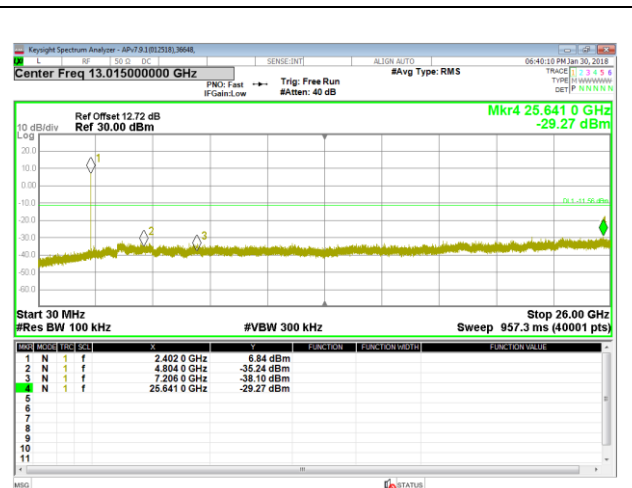
OUT-OF-BAND HIGH CHANNEL

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

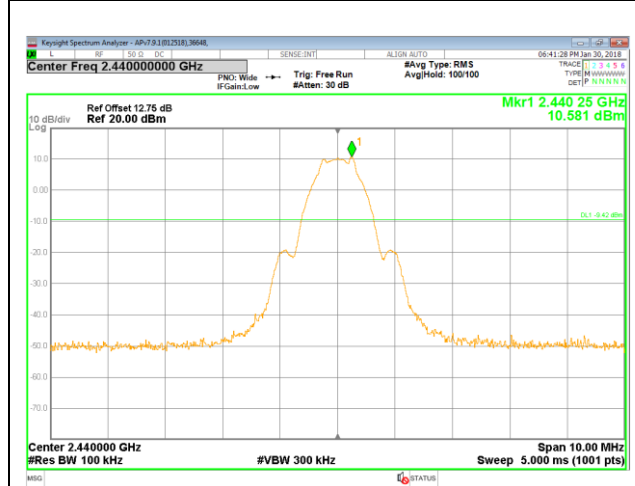
#### Antenna 4



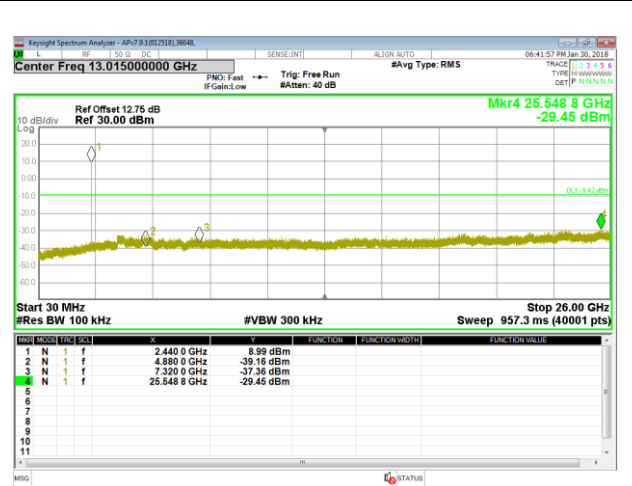
LOW CHANNEL BANDEDGE



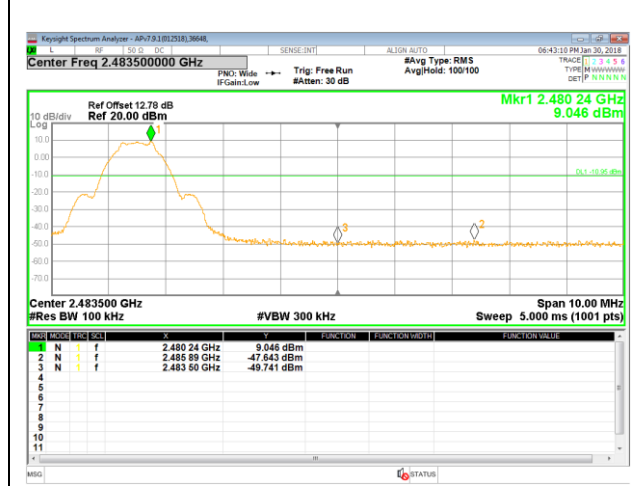
OUT-OF-BAND LOW CHANNEL



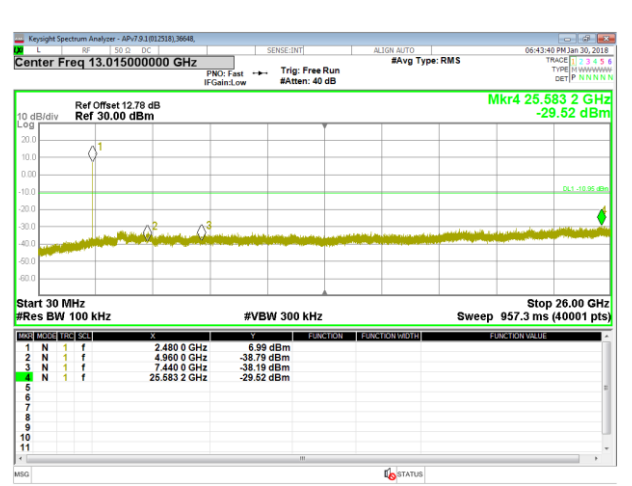
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

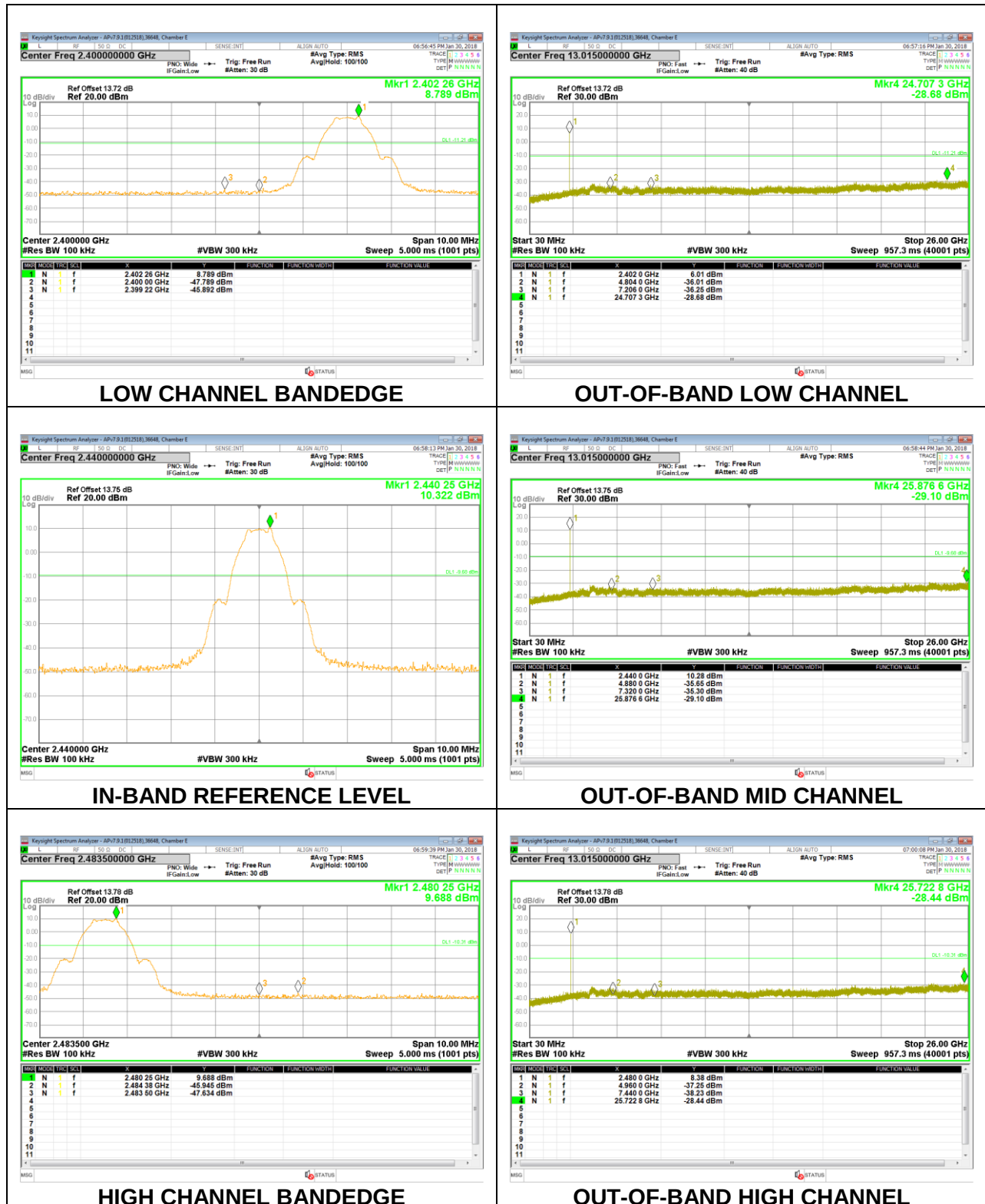


HIGH CHANNEL BANDEDGE



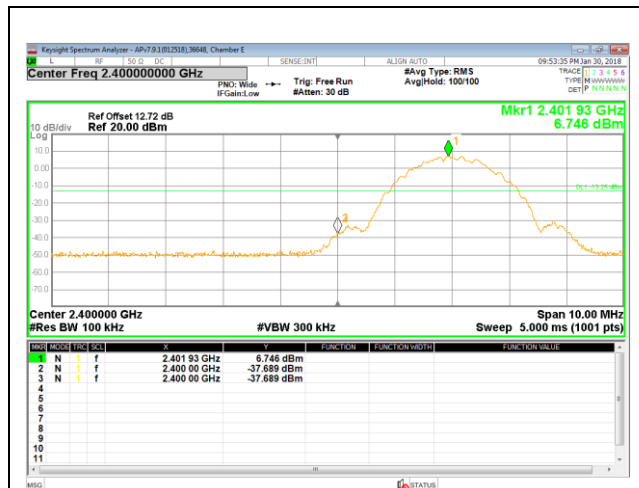
OUT-OF-BAND HIGH CHANNEL

### Antenna 3

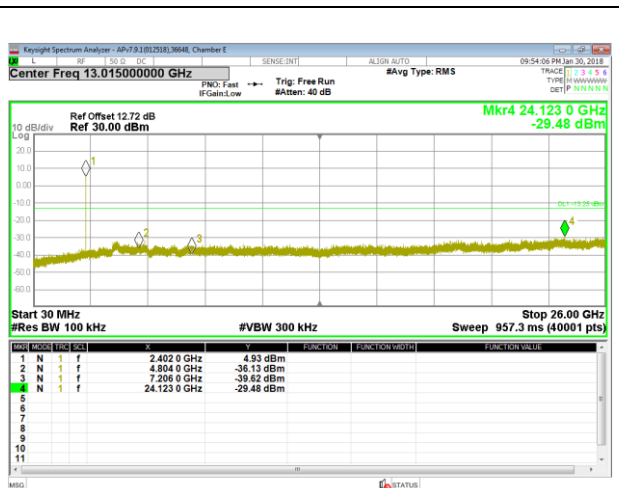


## 8.7.4. LOW POWER BLE (2Mbps)

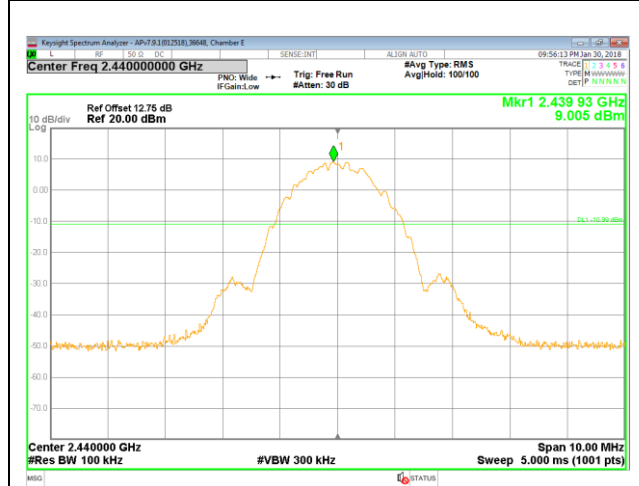
### Antenna 4



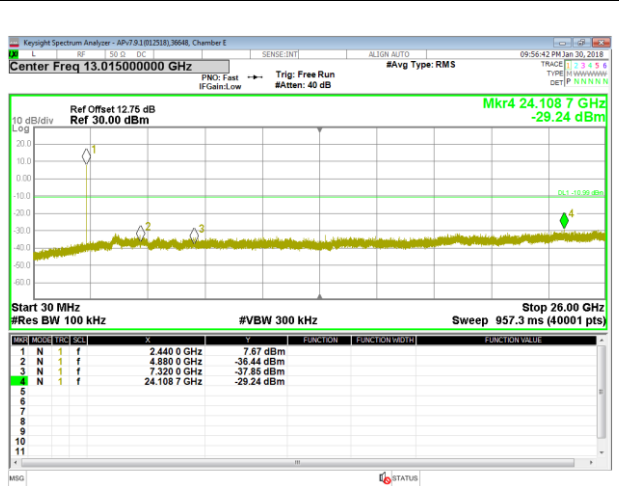
LOW CHANNEL BANDEDGE



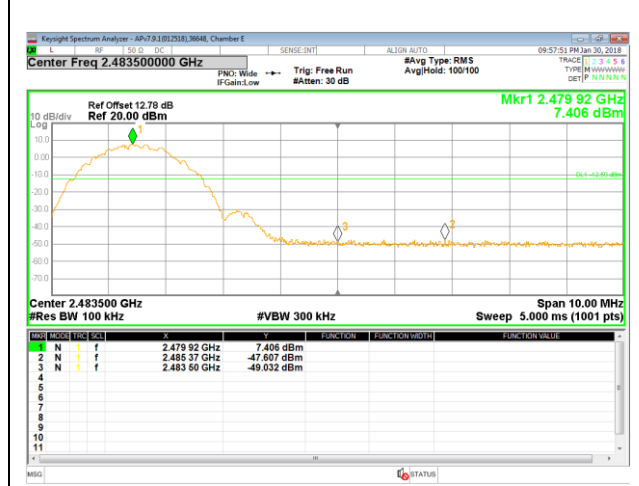
OUT-OF-BAND LOW CHANNEL



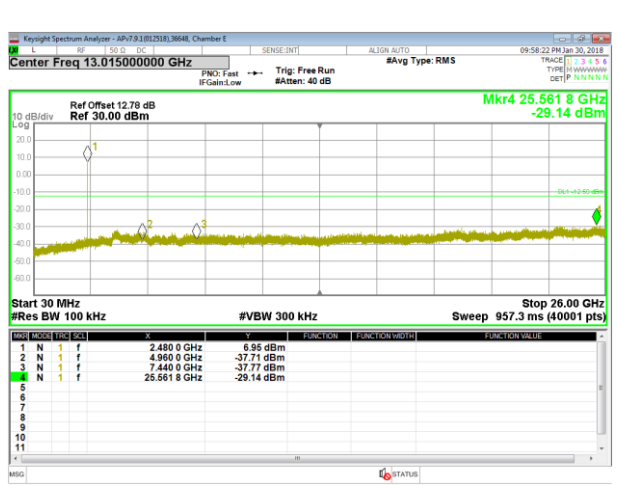
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL



# Antenna 3

