



# **CERTIFICATION TEST REPORT**

**Report Number. :** 11724033-E3V5

**Applicant :** APPLE, INC.  
1 INFINITE LOOP  
CUPERTINO, CA 95014, U.S.A.

**Model :** A1898

**FCC ID :** BCG-E3173A

**IC :** 579C-E3173A

**EUT Description :** SMARTPHONE

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

**Date Of Issue:**

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NVLAP LAB CODE 200065-0

Revision History

| Rev. | Issue Date | Revisions                                                                             | Revised By         |
|------|------------|---------------------------------------------------------------------------------------|--------------------|
| V1   | 7/14/2017  | Initial Issue                                                                         | Mengistu Mekuria   |
| V2   | 7/18/2017  | Address TCB's Questions                                                               | Chin Pang          |
| V3   | 7/19/2017  | Address TCB's Questions                                                               | Chin Pang          |
| V4   | 7/19/2017  | Added additional worst case config info &<br>Updated output power method in section 7 | Francisco Guarnero |
| V5   | 7/28/2017  | Updated Section 5.5                                                                   | Tina Chu           |

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.  
1 INFINITE LOOP  
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A1898

**SERIAL NUMBER:** C39TQ005J6LP

**DATE TESTED:** MARCH 08, 2017- JULY 11, 2017

| APPLICABLE STANDARDS            |              |
|---------------------------------|--------------|
| STANDARD                        | TEST RESULTS |
| CFR 47 Part 15 Subpart C        | Pass         |
| INDUSTRY CANADA RSS-247 Issue 2 | Pass         |
| INDUSTRY CANADA RSS-GEN Issue 4 | Pass         |

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 any government.

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Prepared By:



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SENIOR ENGINEER  
UL VERIFICATION SERVICES INC.

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LAB ENGINEER  
UL VERIFICATION SERVICES INC.

## 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, MIMO KDB 662911, RSS-GEN Issue 4, 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 (IC:2324B-1) | <input type="checkbox"/> Chamber D (IC: 22541-1)            |
| <input type="checkbox"/> Chamber B (IC:2324B-2) | <input checked="" type="checkbox"/> Chamber E (IC: 22541-2) |
| <input type="checkbox"/> Chamber C (IC:2324B-3) | <input checked="" type="checkbox"/> Chamber F (IC: 22541-3) |
|                                                 | <input checked="" type="checkbox"/> Chamber G (IC: 22541-4) |
|                                                 | <input checked="" type="checkbox"/> Chamber H (IC: 22541-5) |

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 <http://ts.nist.gov/standards/scopes/2000650.htm>.

## 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     |
| Occupied Channel Bandwidth                          | ±0.39 %     |

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

## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

The equipment under test is a mobile phone with GSM, GPRS, EGPRS, UMTS, LTE and TD-SCDMA technologies. It also supports IEEE 802.11a/b/g/n/ac, Bluetooth, GPS and NFC. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is not user accessible.

### 5.2. MAXIMUM OUTPUT POWER

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

| Frequency Range (MHz) | Mode                 | Output Power (dBm)      | Output Power (mW) |
|-----------------------|----------------------|-------------------------|-------------------|
| 2412 - 2472           | 802.11b 1TX          | 24.18                   | 261.82            |
| 2412 - 2472           | 802.11g 1TX          | Covered by HT20 1TX     |                   |
| 2412 - 2472           | 802.11g 2TX          | Covered by HT20 2TX CDD |                   |
| 2412 - 2472           | 802.11n HT20 1TX     | 27.49                   | 561.05            |
| 2412 - 2472           | 802.11n HT20 2TX CDD | 28.85                   | 767.36            |

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

| Frequency Band (GHz) | Antenna Gain (dBi) |       |
|----------------------|--------------------|-------|
|                      | UAT 1              | LAT 3 |
| 2.4                  | 1.01               | -2.24 |

### 5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was version 13.10.452.12

## 5.5. WORST-CASE CONFIGURATION AND MODE

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 30MHz, below 1GHz, above 18GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario.

For g and HT20 modes, radiated harmonics spurious and power line conducted emissions were performed with the EUT set at the CDD mode among the CDD/STBC/SDM modes with power setting equal or higher than SISO modes as worst-case scenario

The fundamental of the EUT was investigated in three orthogonal orientations, X (Flatbed), Y (Landscape), and Z (Portrait), on both UAT 1 and LAT 3 antennas. In addition, the EUT was also investigated with and without AC/DC charger, headphones & laptop. It was determined that Y (Landscape) orientation was worst-case orientation for both antennas without AC/DC charger, headphones, or laptop; therefore, all final radiated testing was performed with EUT only in Y orientation for 1 - 18GHz and 18 – 26GHz. EUT was tested with AC/DC charger for 30MHz – 1000MHz testing.

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

802.11b mode: 1 Mbps  
802.11g mode: 6 Mbps  
802.11n HT20mode: MCS0

The following modes have the same target power and use the same modulation (OFDM). Therefore, 802.11g 1TX and 802.11g 2TX are covered by 802.11n HT20 1TX and 802.11n HT20 2TX CDD respectively.

- 802.11g and 802.11n HT20 1TX
- 802.11g 2TX and 802.11n HT20 2TX CDD

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.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

| Support Equipment List |              |            |               |        |
|------------------------|--------------|------------|---------------|--------|
| Description            | Manufacturer | Model      | Serial Number | FCC ID |
| Laptop AC/DC adapter   | HP           | HSTNN-DA40 | 744481-003    | NA     |
| Laptop                 | HP           | 3160HMMW   | CND5340FPD    | NA     |
| Dongle                 | N/A          | N/A        | HDG1409226823 | 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 | 3                | 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 |
| None Used      |      |                      |                |            |                  |         |

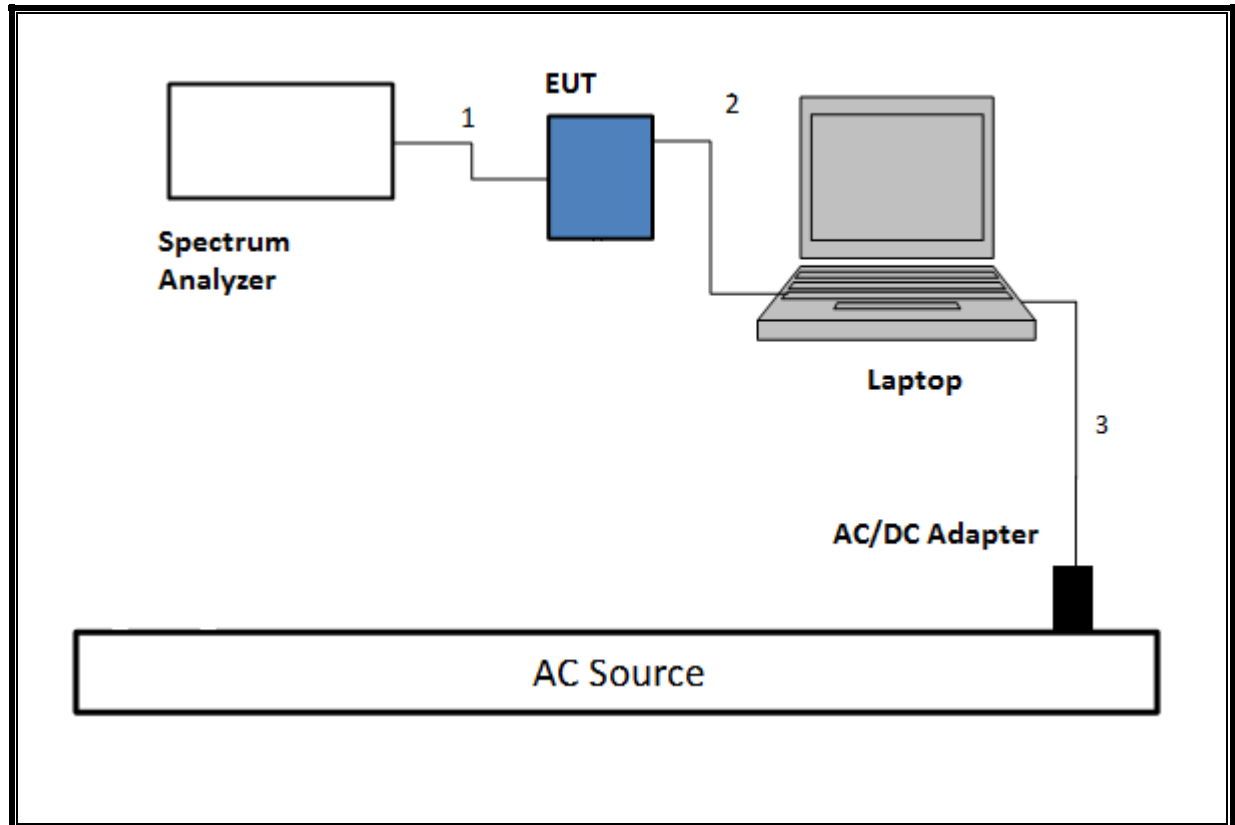
### I/O CABLES (AC POWER CONDUCTED TEST AND BELOW 1 GHZ)

| I/O Cable List |      |                      |                |             |                  |         |
|----------------|------|----------------------|----------------|-------------|------------------|---------|
| Cable No       | Port | # of identical ports | Connector Type | Cable Type  | Cable Length (m) | Remarks |
| 1              | AC   | 1                    | AC             | Un-shielded | 3                | N/A     |

## TEST SETUP

The EUT was tested connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

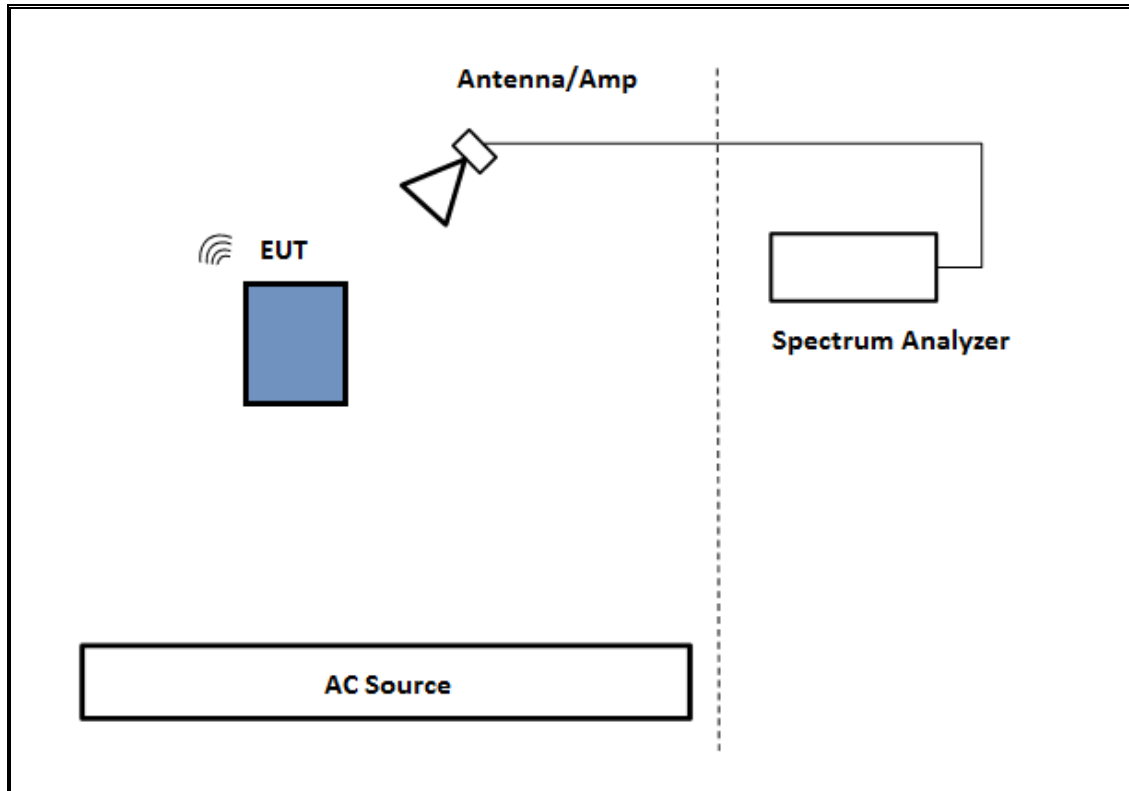
## SETUP DIAGRAM



### **TEST SETUP- RADIATED-ABOVE 1 GHZ**

The EUT was tested by battery powered. Test software exercised the EUT.

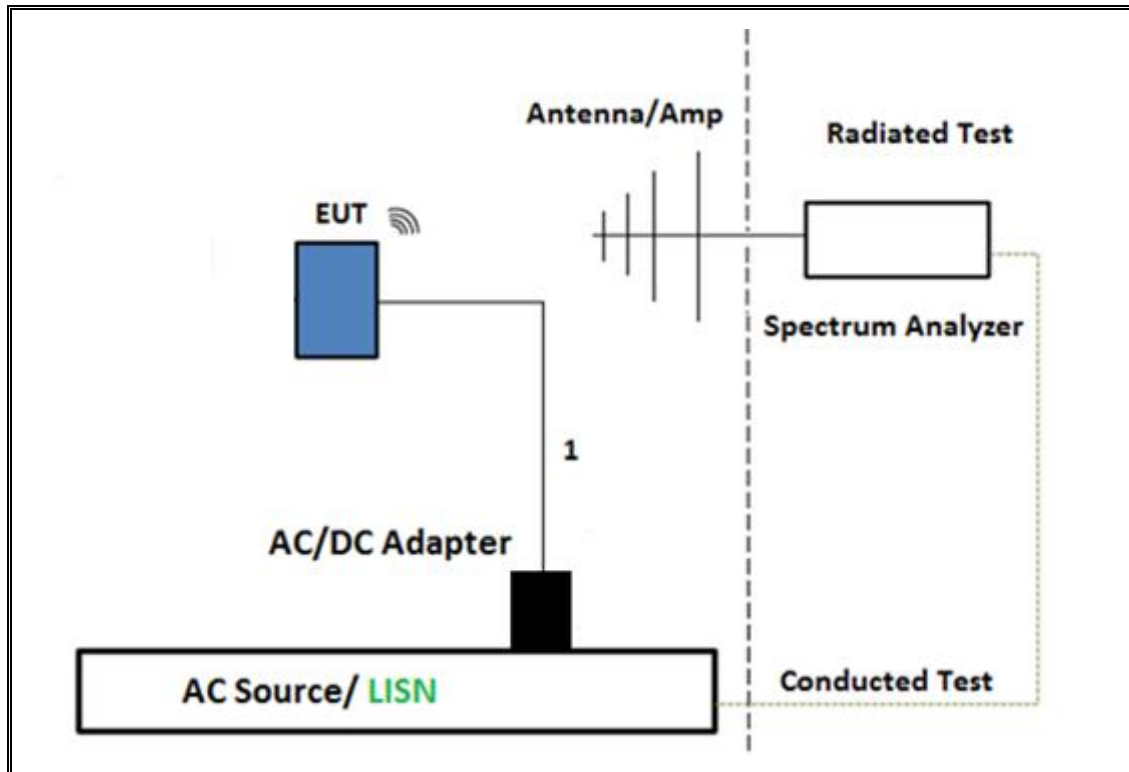
### **SETUP DIAGRAM**



### TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS

The EUT was tested with earphone connected and powered by AC adapter. Test software exercised the EUT.

### SETUP DIAGRAM



## 6. 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                  | Asset                     | Cal Due    |
| *Antenna, Horn 1-18GHz                      | ETS Lindgren       | 3117                   | T863                      | 4/26/2017  |
| Antenna, Horn 1-18GHz                       | ETS Lindgren       | 3117                   | T863                      | 6/9/2018   |
| Amplifier, 1 to 18GHz                       | Miteq              | AFS42-00101800-25-S-42 | T740                      | 11/29/17   |
| Spectrum Analyzer, PXA 3Hz to 44GHz         | Keysight           | N9030A                 | T340                      | 12/14/2017 |
| Antenna, Horn 1-18GHz                       | ETS Lindgren       | 3117                   | T119                      | 3/28/2018  |
| Antenna, Horn 1-18GHz                       | ETS Lindgren       | 3117                   | T120                      | 4/5/2017   |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz | Sunol Sciences     | JB1                    | T122                      | 1/31/2018  |
| Amplifier, 1 to 18GHz                       | Miteq              | AFS42-00101800-25-S-42 | T742                      | 11/29/2017 |
| *Amplifier, 10KHz to 1GHz, 32dB             | Sonoma             | 310N                   | T173                      | 6/17/2017  |
| Spectrum Analyzer, PXA 3Hz to 44GHz         | Keysight           | N9030A                 | T1113                     | 12/20/2017 |
| Antenna, Horn 1-18GHz                       | ETS Lindgren       | 3117                   | T344                      | 4/20/2018  |
| *Amplifier, 1 to 18GHz                      | Miteq              | AFS42-00101800-25-S-42 | T491                      | 5/31/2017  |
| Spectrum Analyzer, PXA 3Hz to 44GHz         | Keysight           | N9030A-544             | T341                      | 10/25/2017 |
| Antenna, Horn 1-18GHz                       | ETS Lindgren       | 3117                   | T345                      | 4/14/2018  |
| Amplifier, 1 to 18GHz, 35dB                 | Amplical           | AMP1G18-35             | T1569                     | 9/15/2017  |
| Spectrum Analyzer, PXA 3Hz to 44GHz         | Keysight           | N9030A                 | T1613                     | 12/2/2017  |
| Spectrum Analyzer, 40GHz                    | Agilent            | 8564E                  | T106                      | 9/7/2017   |
| *Antenna Horn, 18 to 26GHz                  | ARA                | MWH-1826               | T447                      | 6/16/2017  |
| Pre-Amp 18-26GHz                            | Agilent Technology | 8449B                  | T404                      | 7/5/2017   |
| Power Meter, P-series single channel        | Keysight           | N1912A                 | T1245                     | 1/05/2018  |
| Power Sensor                                | Keysight           | N1921A                 | T1224                     | 1/31/2018  |
| AC Line Conducted                           |                    |                        |                           |            |
| EMI Test Receiver 9KHz-7GHz                 | Rohde & Schwarz    | ESCI7                  | T1436                     | 01/06/2018 |
| *LISN for Conducted Emissions CISPR-16      | Fischer            | 50/250-25-2-01         | T1310                     | 06/08/2017 |
| Power Cable, Line Conducted Emissions       | UL                 | PG1                    | T861                      | 9/1/2017   |
| UL AUTOMATION SOFTWARE                      |                    |                        |                           |            |
| 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 calibration expiration date.

## 7. MEASUREMENT METHODS

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.

Conducted line emissions: C63.10, Clause 6.2

## 8. ANTENNA PORT TEST RESULTS

### 8.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

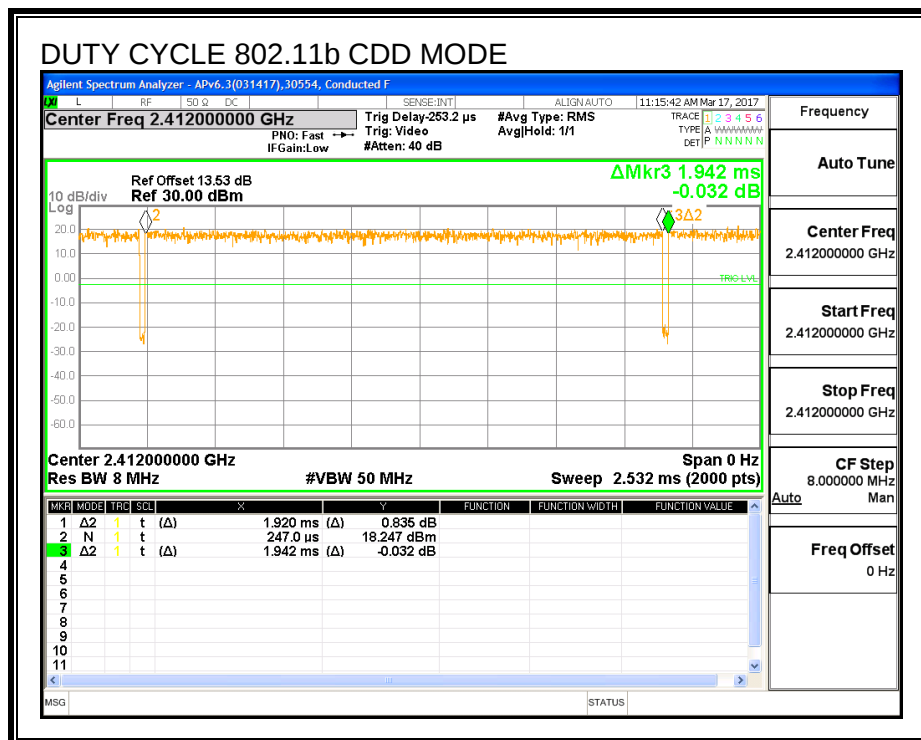
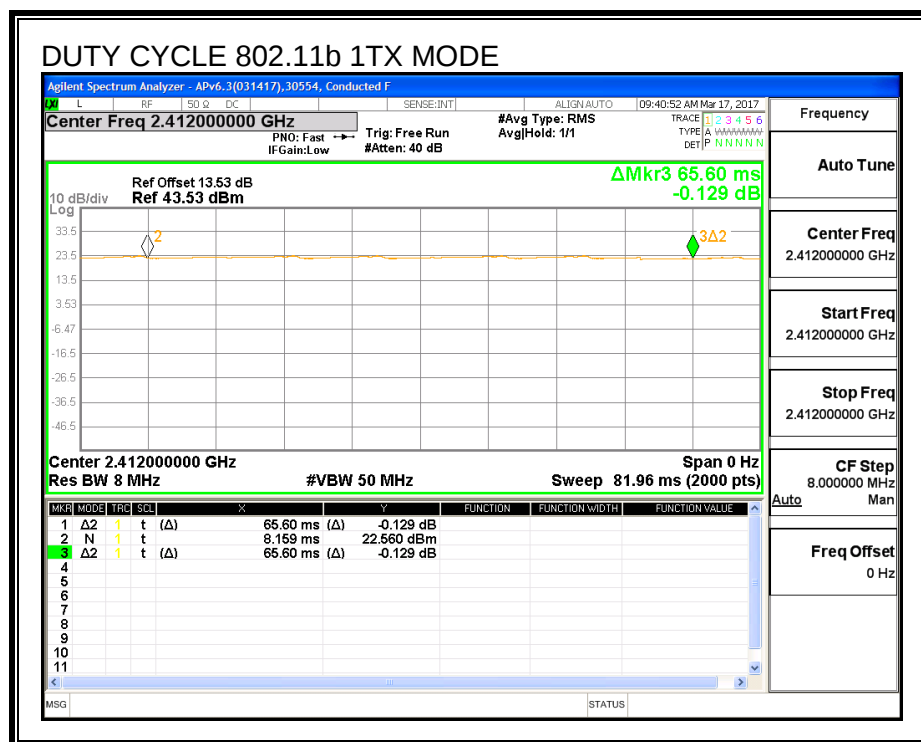
#### PROCEDURE

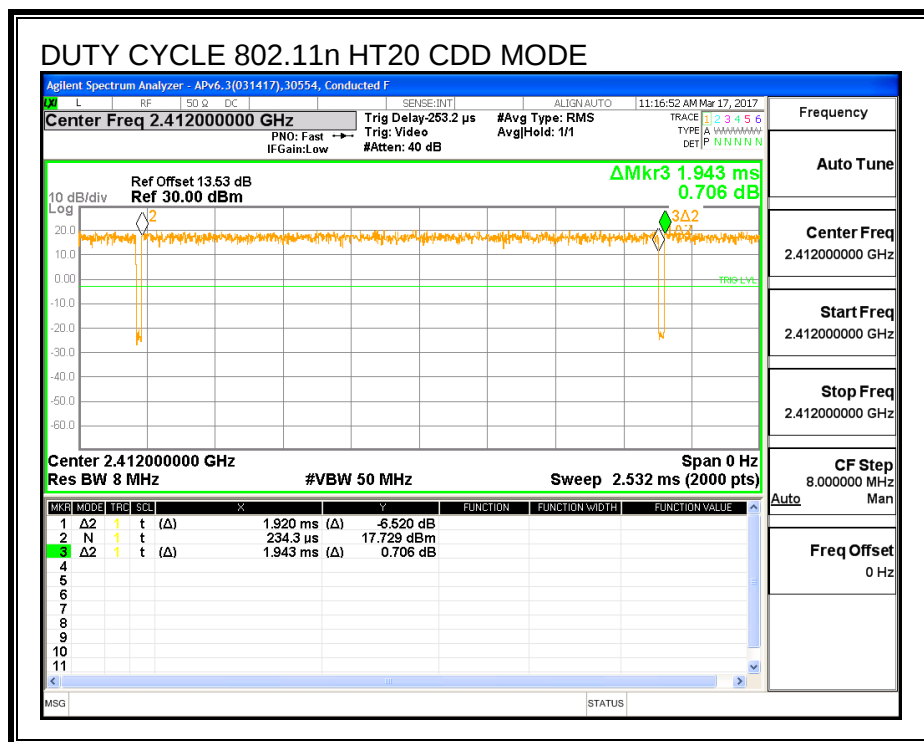
KDB 558074 Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS

| Mode                | ON Time<br>B (msec) | Period<br>(msec) | Duty<br>Cycle x<br>(linear) | Duty Cycle<br>(%) | Duty Cycle<br>Correction<br>Factor (dB) | 1/B Minimum<br>VBW (khz) |
|---------------------|---------------------|------------------|-----------------------------|-------------------|-----------------------------------------|--------------------------|
| 11b 1TX             | 65.6                | 65.6             | 1.00                        | 100%              | 0.00                                    | 0.010                    |
| 11n HT20 1TX<br>CDD | 1.920               | 1.942            | 0.989                       | 98.87%            | 0.00                                    | 0.010                    |
| 11n HT20 2TX<br>CDD | 1.920               | 1.943            | 0.988                       | 98.82%            | 0.00                                    | 0.010                    |

## DUTY CYCLE PLOTS





## 8.2. 11b UAT 1 SISO MODE IN THE 2.4GHz BAND

### 8.2.1. 6 dB BANDWIDTH

#### LIMITS

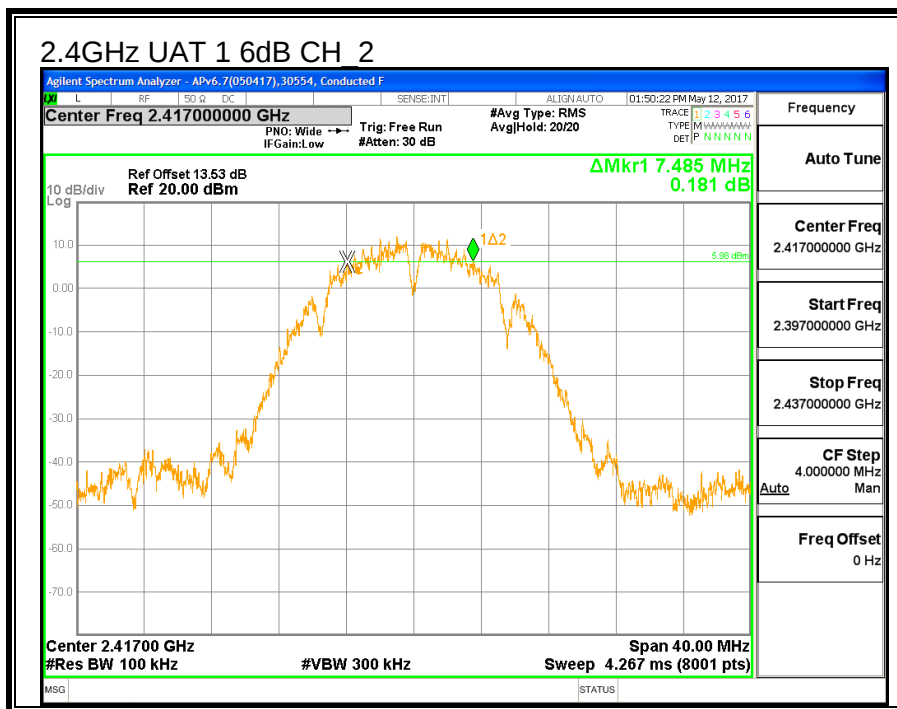
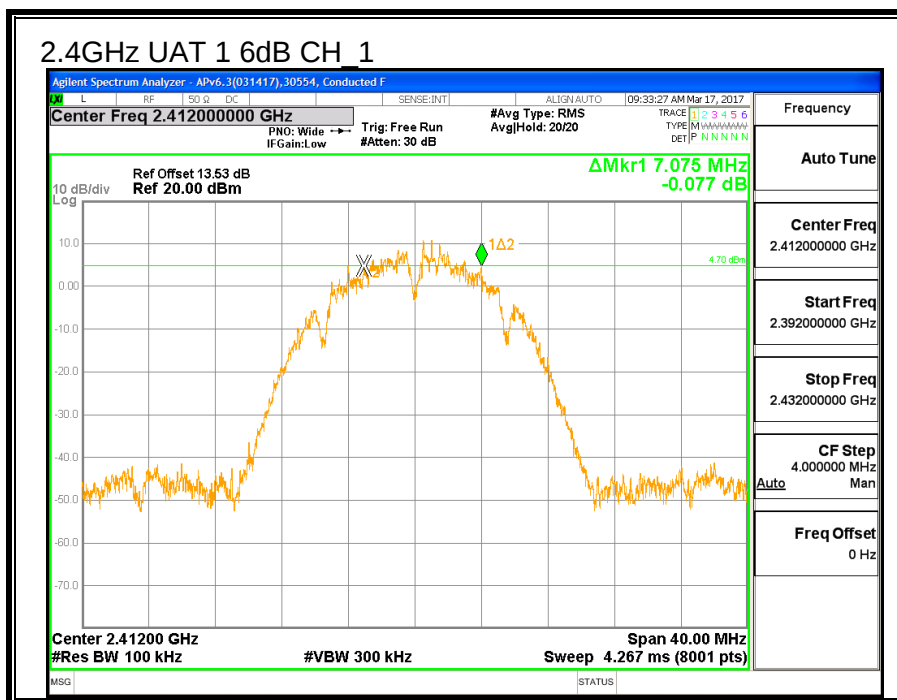
FCC §15.247 (a) (2)

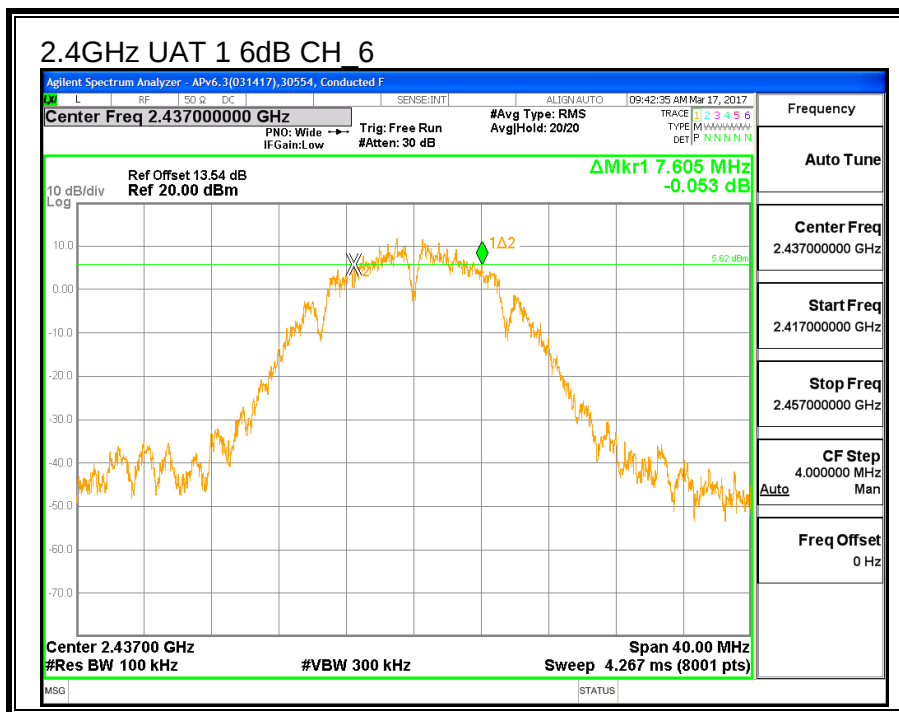
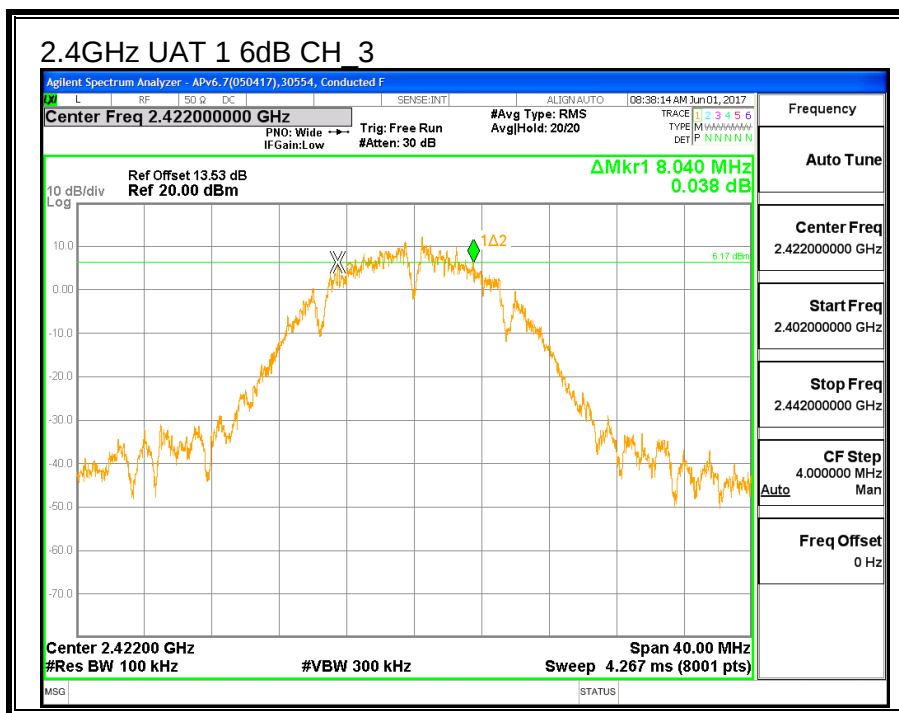
IC RSS-247 (5.2) (a)

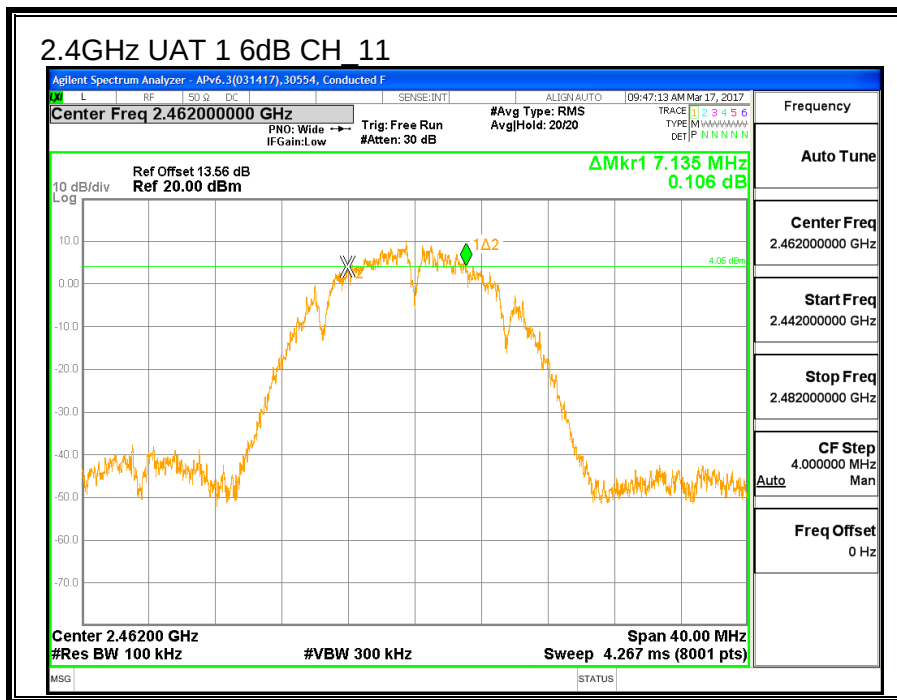
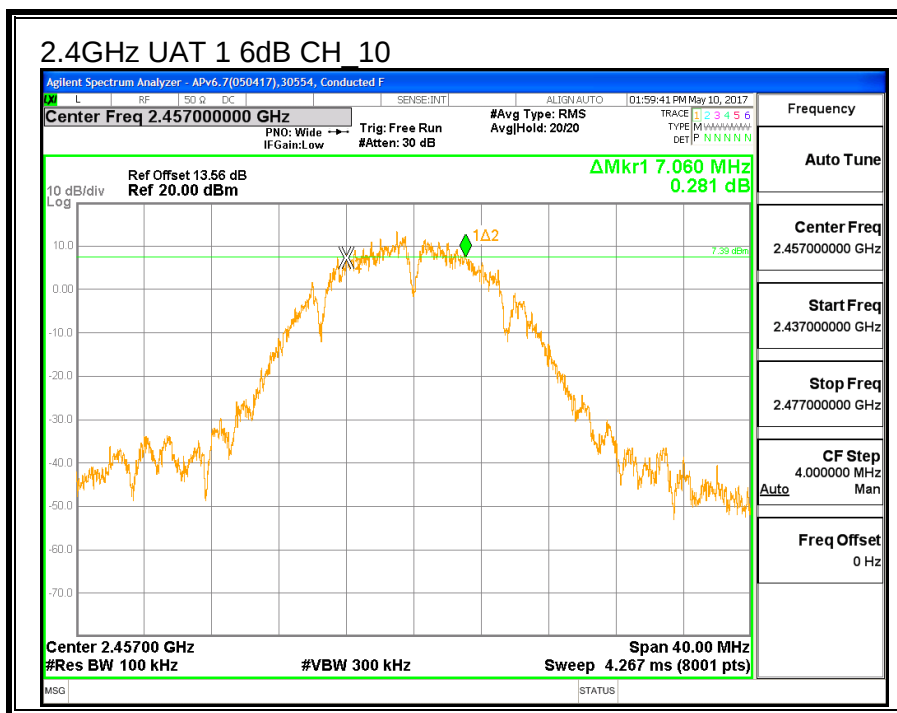
The minimum 6 dB bandwidth shall be at least 500 kHz.

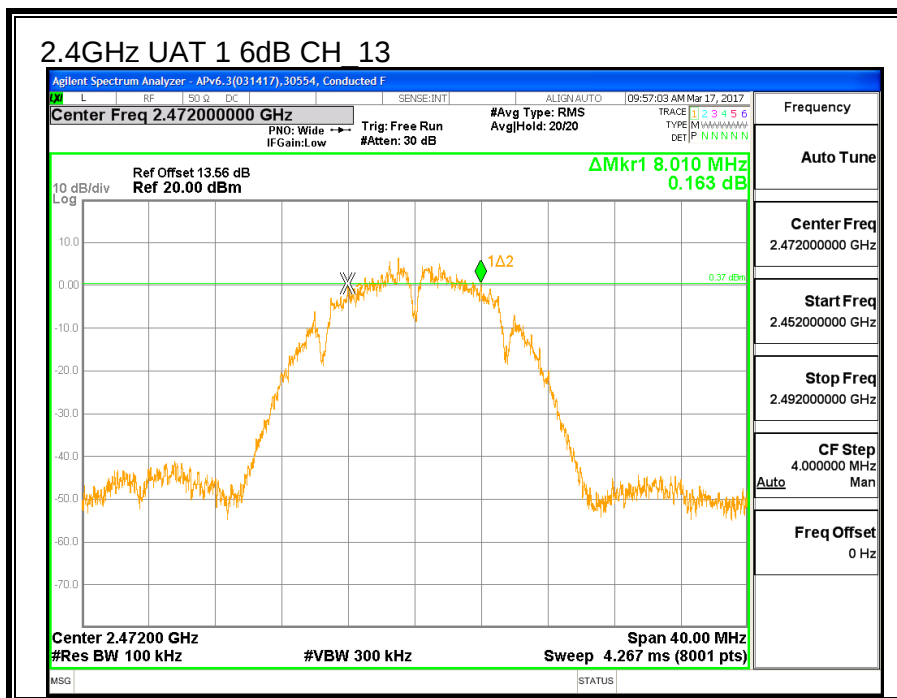
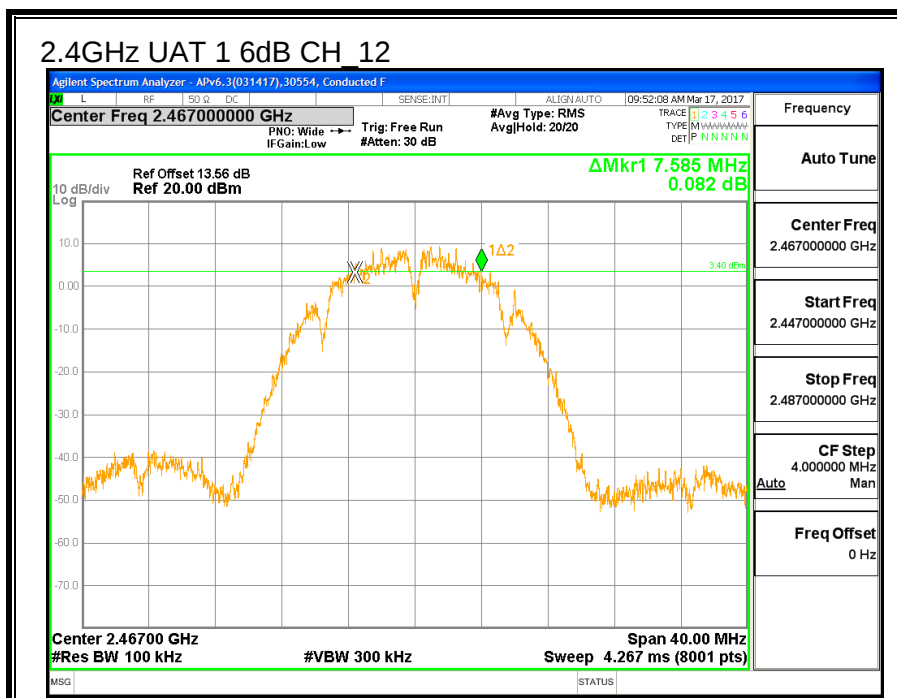
#### RESULTS

| Channel | Frequency | 6 dB BW<br>UAT 1<br>(MHz) | Minimum Limit<br>(MHz) |
|---------|-----------|---------------------------|------------------------|
| Low_1   | 2412      | 7.075                     | 0.5                    |
| Low_2   | 2417      | 7.485                     | 0.5                    |
| Low_3   | 2422      | 8.040                     | 0.5                    |
| Mid_6   | 2437      | 7.605                     | 0.5                    |
| High_10 | 2457      | 7.060                     | 0.5                    |
| High_11 | 2462      | 7.135                     | 0.5                    |
| High_12 | 2467      | 7.585                     | 0.5                    |
| High_13 | 2472      | 8.010                     | 0.5                    |









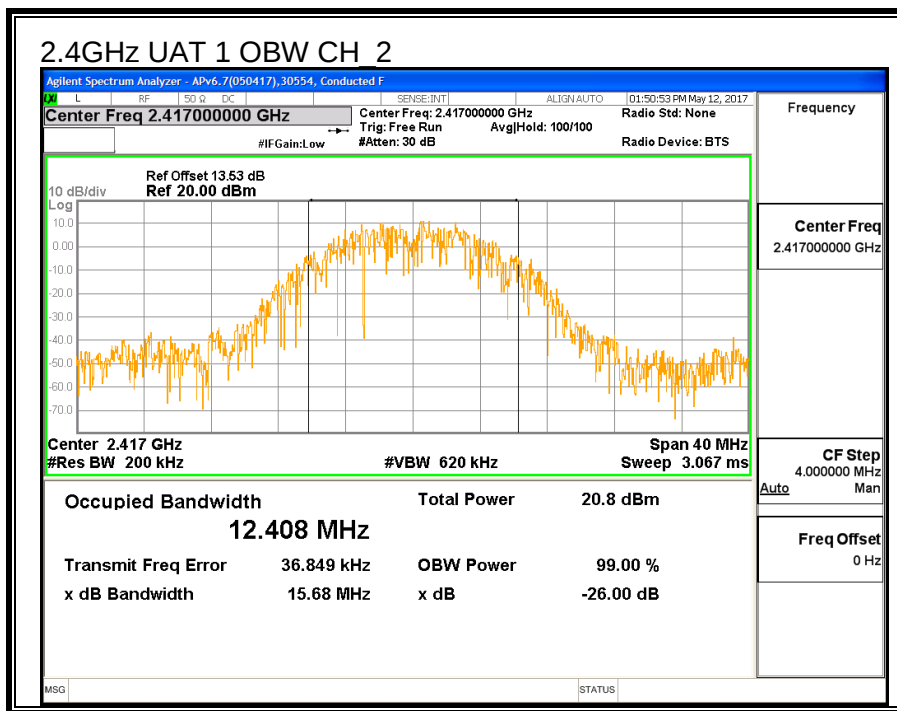
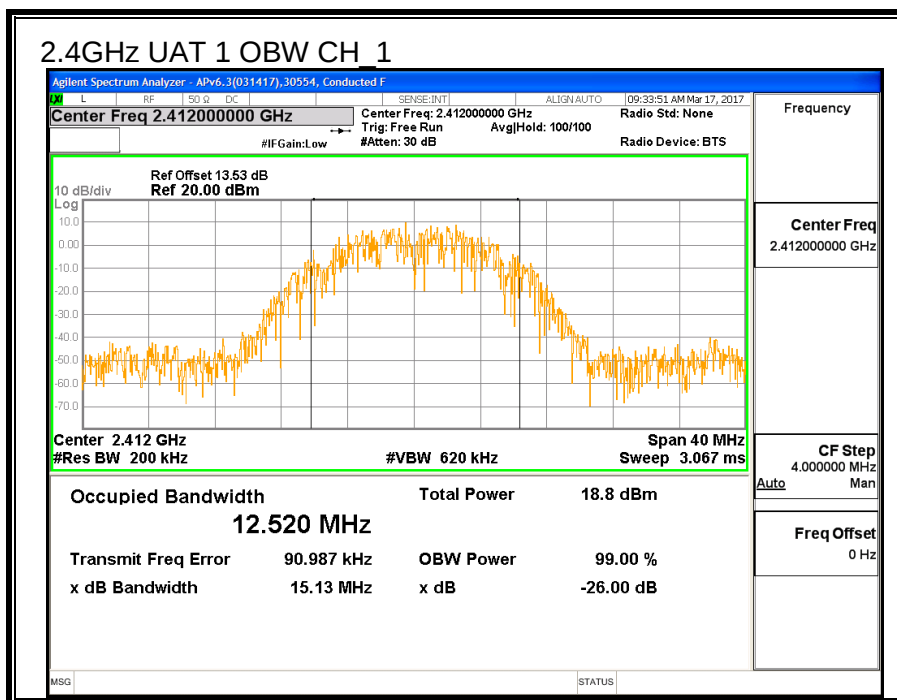
### 8.2.2. 99% BANDWIDTH

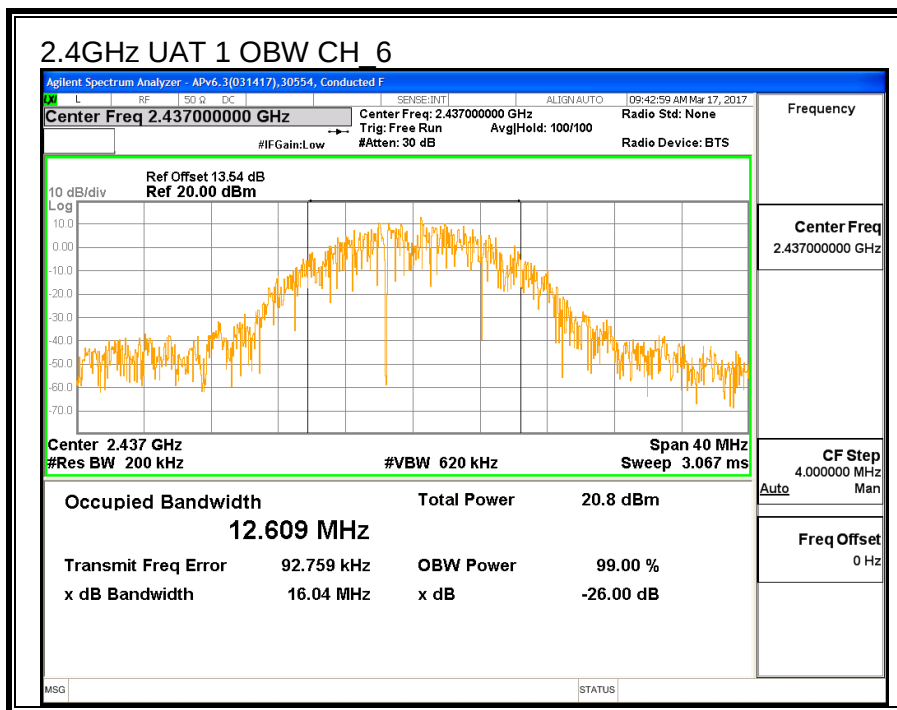
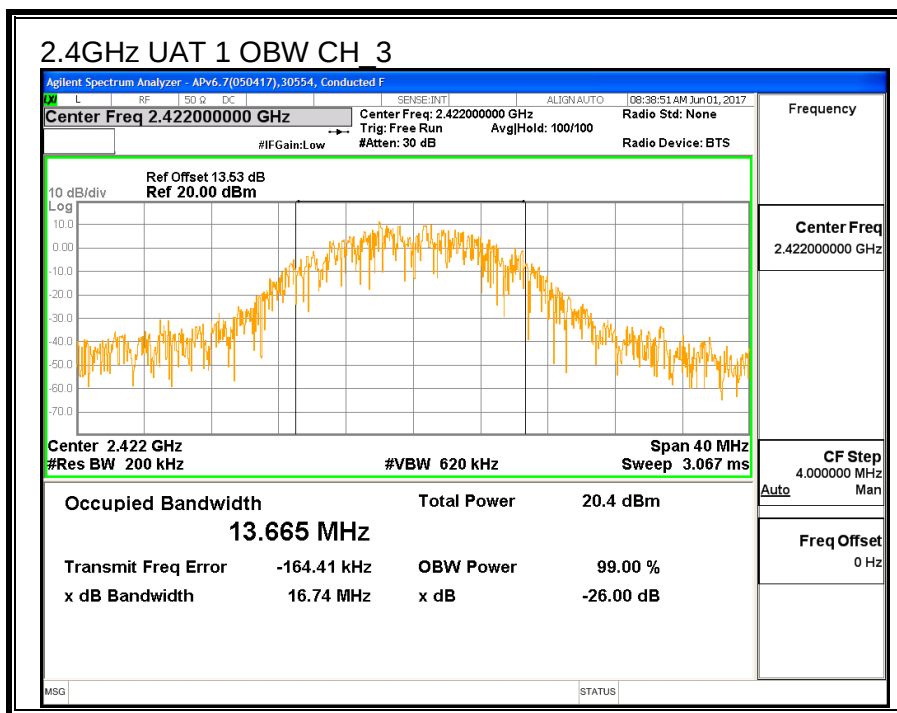
#### LIMITS

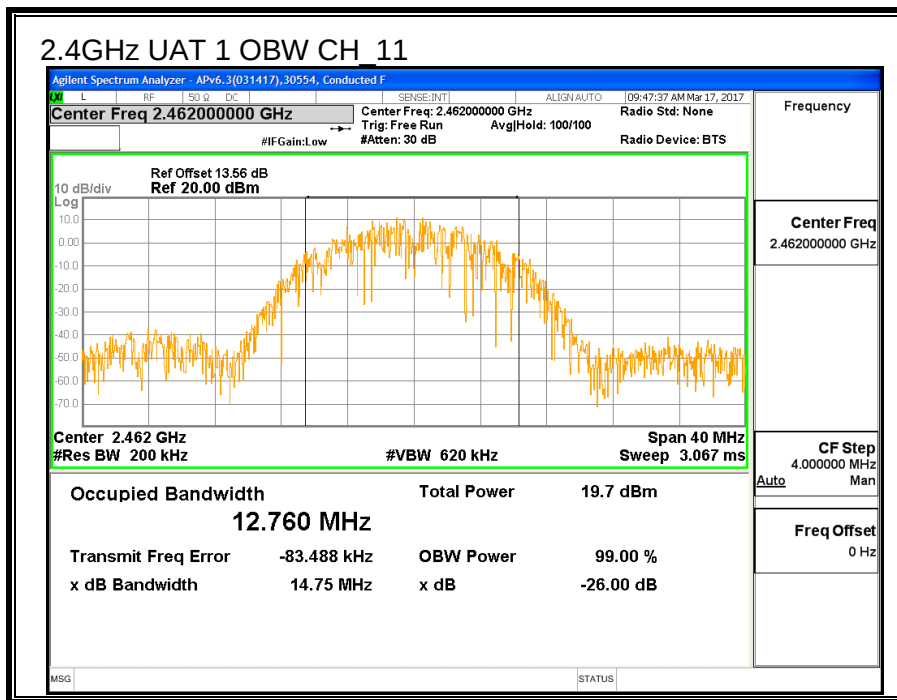
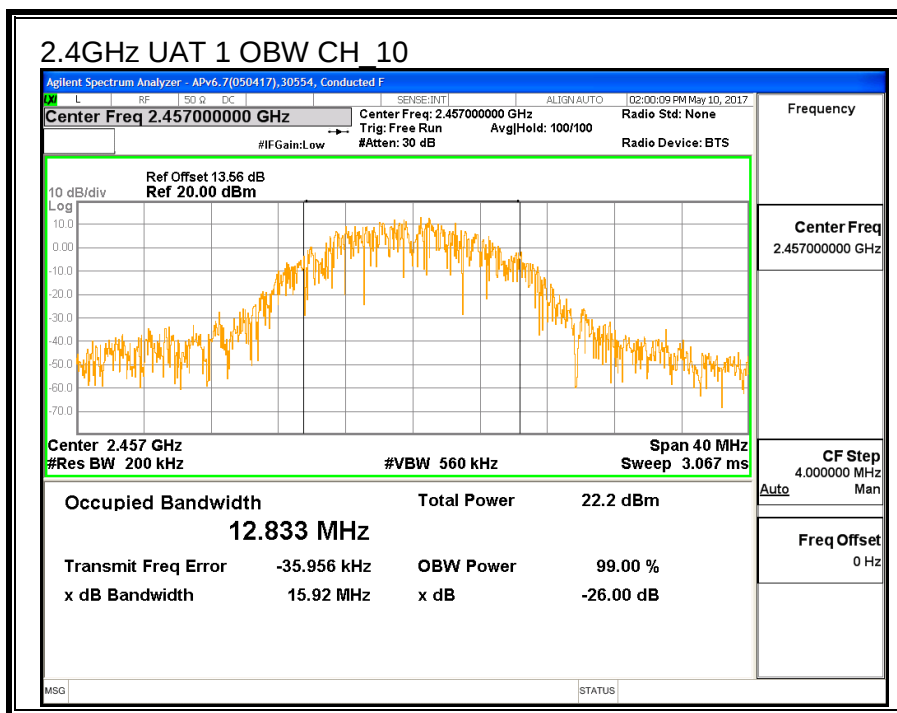
None; for reporting purposes only.

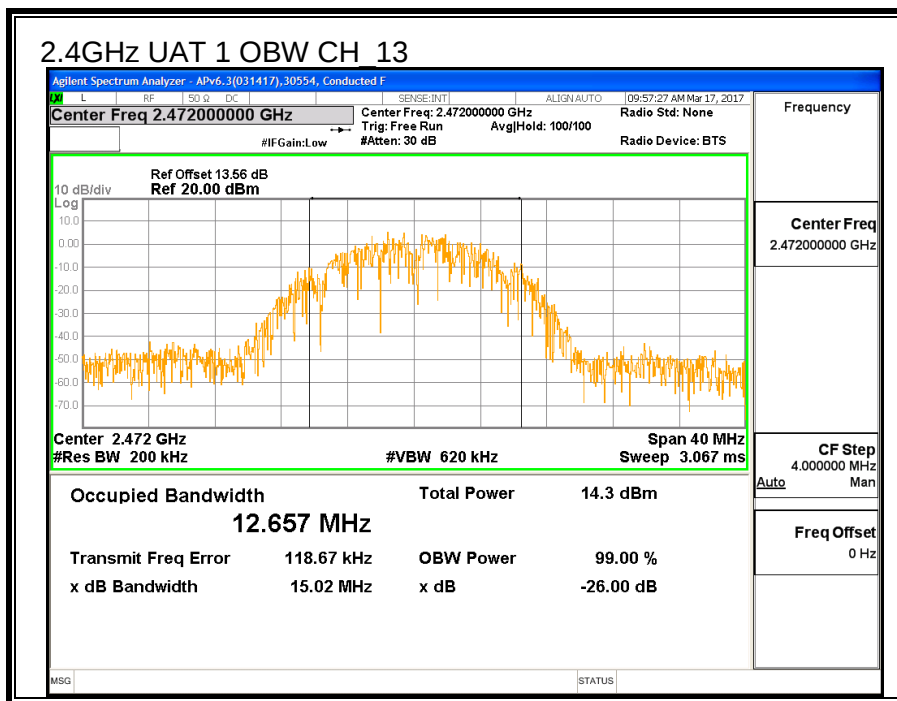
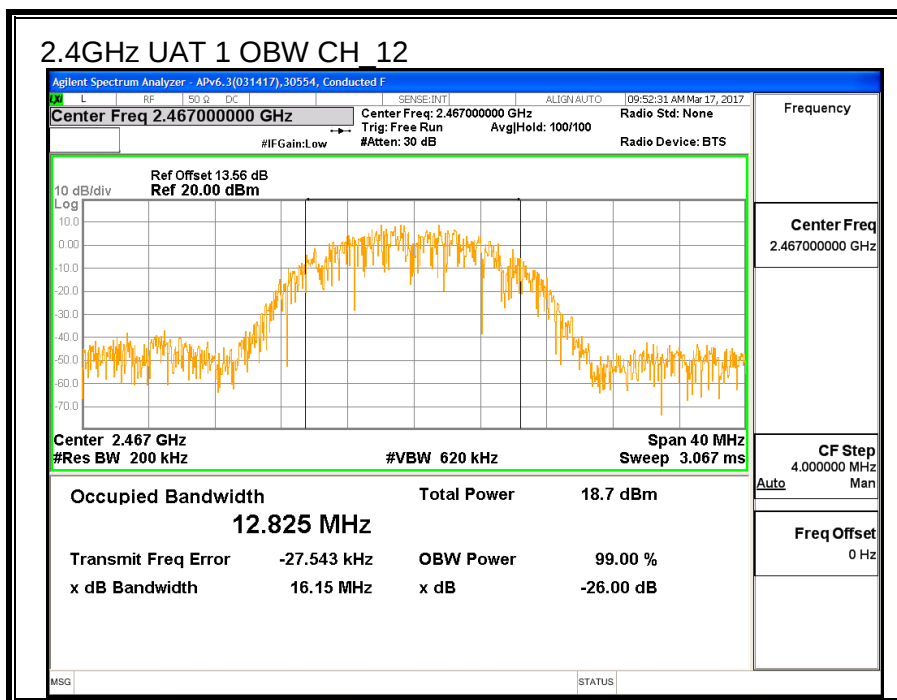
#### RESULTS

| Channel | Frequency (MHz) | 99% Bandwidth UAT 1 (MHz) |
|---------|-----------------|---------------------------|
| Low_1   | 2412            | 12.520                    |
| Low_2   | 2417            | 12.408                    |
| Low_3   | 2422            | 13.665                    |
| Mid_6   | 2437            | 12.609                    |
| High_10 | 2457            | 12.833                    |
| High_11 | 2462            | 12.760                    |
| High_12 | 2467            | 12.825                    |
| High_13 | 2472            | 12.657                    |









### 8.2.3. AVERAGE POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

#### LIMITS

None; for reporting purposes only.

#### RESULTS

| Channel  | Frequency (MHz) | Power UAT 1 (MHz) |
|----------|-----------------|-------------------|
| Low_1    | 2412            | 19.96             |
| Low_2    | 2417            | 21.44             |
| Low_3    | 2422            | 21.50             |
| Middle_6 | 2437            | 21.37             |
| High_10  | 2457            | 21.47             |
| High_11  | 2462            | 20.94             |
| High_12  | 2467            | 18.42             |
| High_13  | 2472            | 14.99             |

#### 8.2.4. OUTPUT POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

##### LIMITS

FCC §15.247

IC RSS-247 (5.4) (d)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

##### DIRECTIONAL ANTENNA GAIN

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

## RESULTS

### Limits

| Channel | Frequency<br>(MHz) | Directional<br>Gain<br>(dBi) | FCC<br>Power<br>Limit<br>(dBm) | IC<br>Power<br>Limit<br>(dBm) | IC<br>EIRP<br>Limit<br>(dBm) | Max<br>Power<br>(dBm) |
|---------|--------------------|------------------------------|--------------------------------|-------------------------------|------------------------------|-----------------------|
| Low_1   | 2412               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| Low_2   | 2417               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| Low_3   | 2422               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| Mid     | 2437               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| High_10 | 2457               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| High_11 | 2462               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| High_12 | 2467               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |
| High_13 | 2472               | 1.01                         | 30.00                          | 30                            | 36                           | 30.00                 |

|                    |      |                                          |
|--------------------|------|------------------------------------------|
| Duty Cycle CF (dB) | 0.00 | Included in Calculations of Corr'd Power |
|--------------------|------|------------------------------------------|

### Results

| Channel | Frequency<br>(MHz) | Meas<br>Power<br>(dBm) | Total<br>Corr'd<br>Power<br>(dBm) | Power<br>Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|------------------------|-----------------------------------|-------------------------|----------------|
| Low_1   | 2412               | 22.56                  | 22.56                             | 30.00                   | -7.44          |
| Low_2   | 2417               | 24.02                  | 24.02                             | 30.00                   | -5.98          |
| Low_3   | 2422               | 24.12                  | 24.12                             | 30.00                   | -5.88          |
| Mid     | 2437               | 24.09                  | 24.09                             | 30.00                   | -5.91          |
| High_10 | 2457               | 24.10                  | 24.10                             | 30.00                   | -5.90          |
| High_11 | 2462               | 23.68                  | 23.68                             | 30.00                   | -6.32          |
| High_12 | 2467               | 21.04                  | 21.04                             | 30.00                   | -8.96          |
| High_13 | 2472               | 17.71                  | 17.71                             | 30.00                   | -12.29         |

## 8.2.5. POWER SPECTRAL DENSITY

### LIMITS

FCC §15.247

IC RSS-247 (5.2) (b)

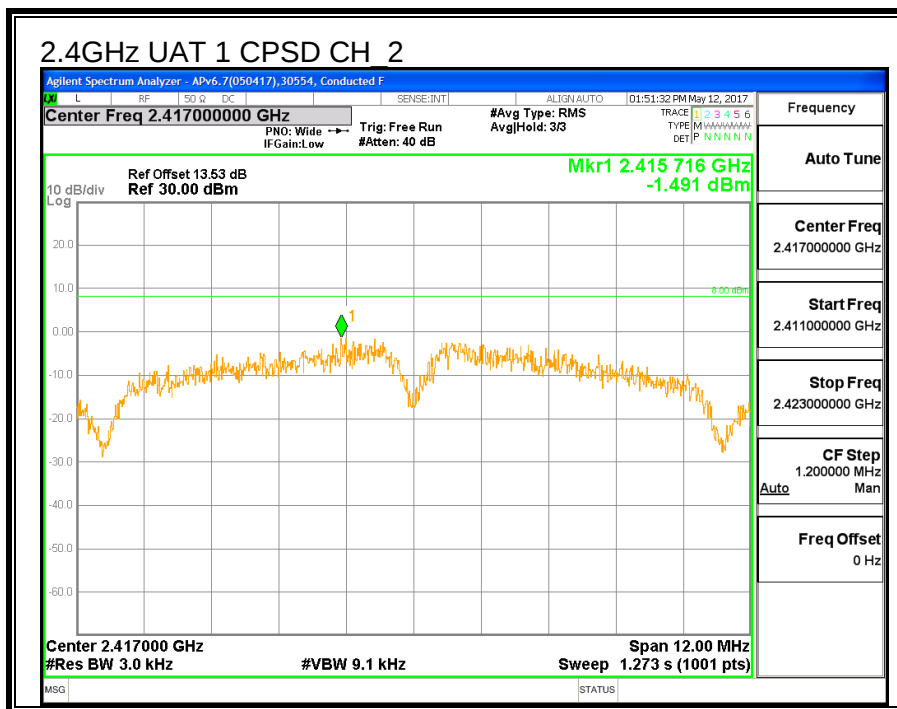
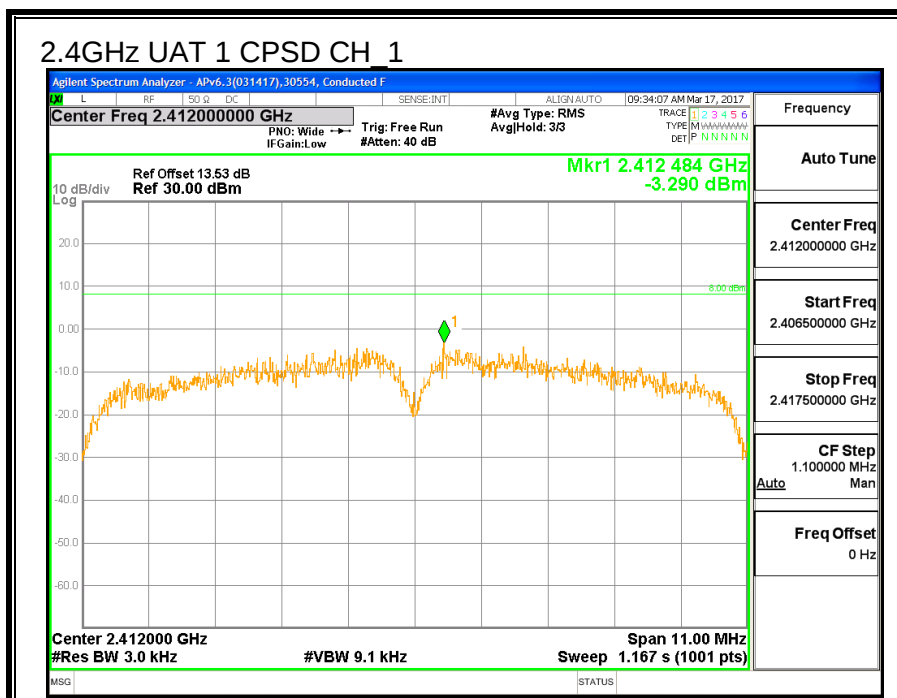
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

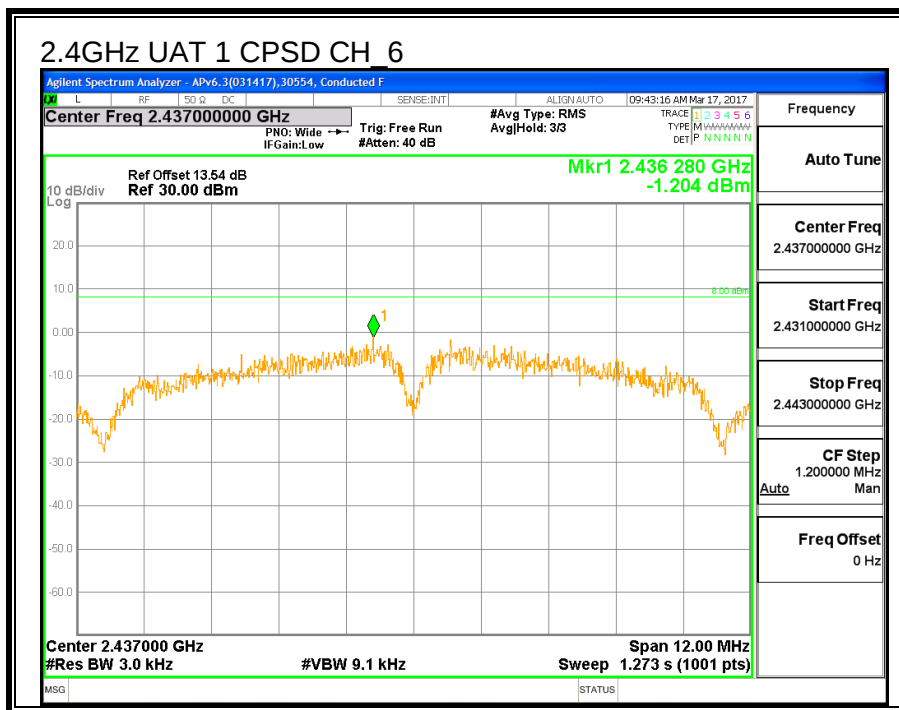
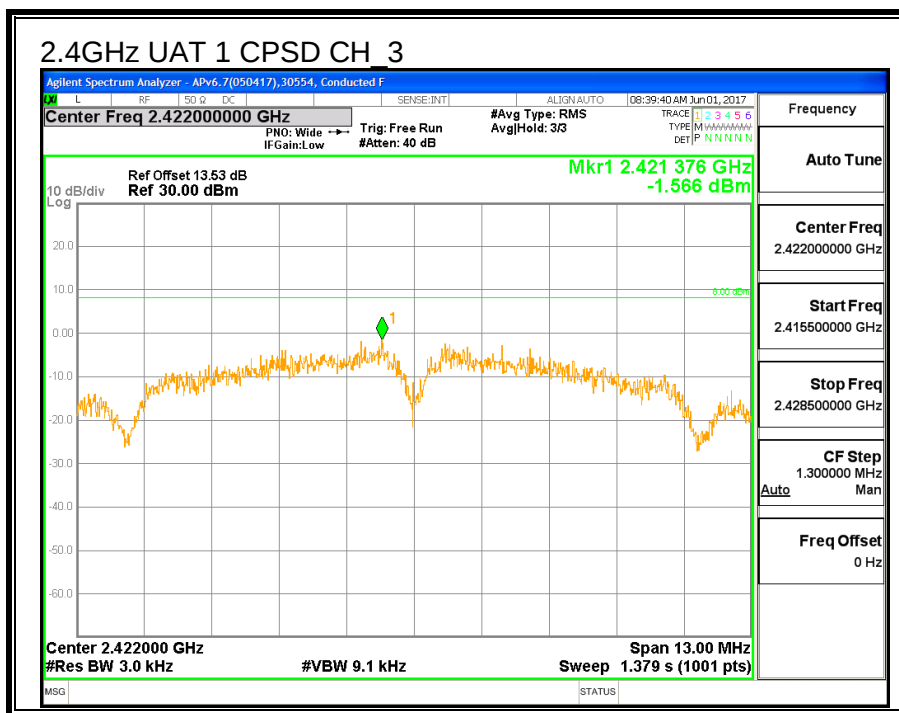
### RESULTS

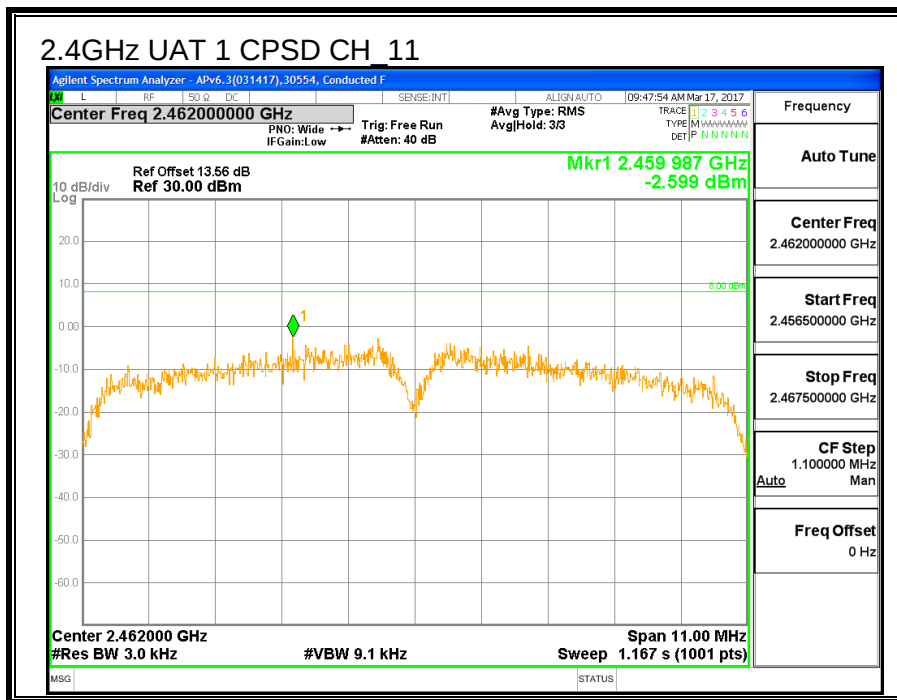
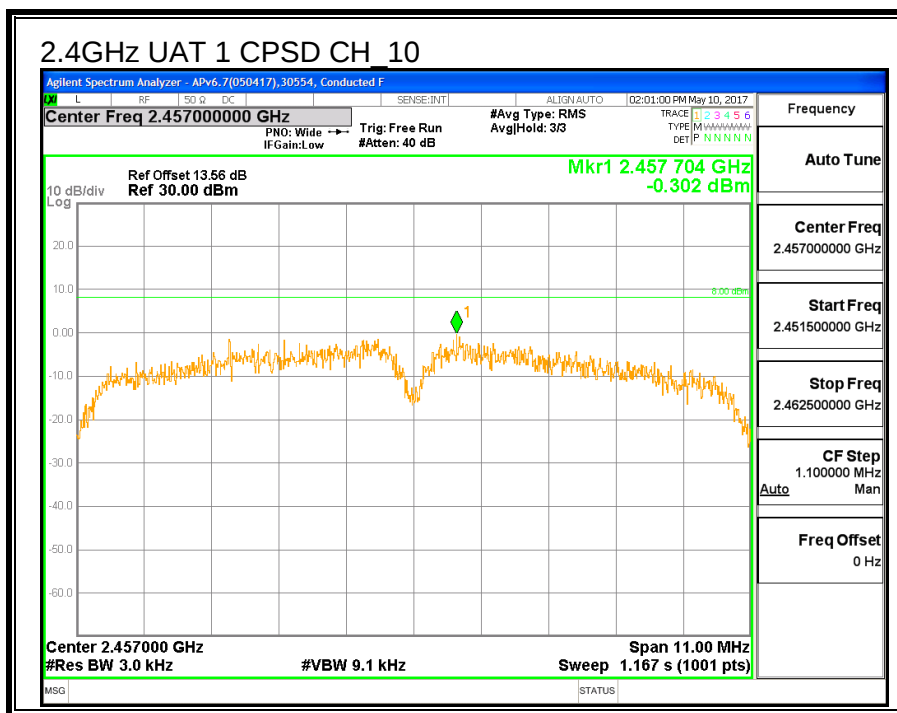
|                           |      |                                               |
|---------------------------|------|-----------------------------------------------|
| <b>Duty Cycle CF (dB)</b> | 0.00 | <b>Included in Calculations of Corr'd PSD</b> |
|---------------------------|------|-----------------------------------------------|

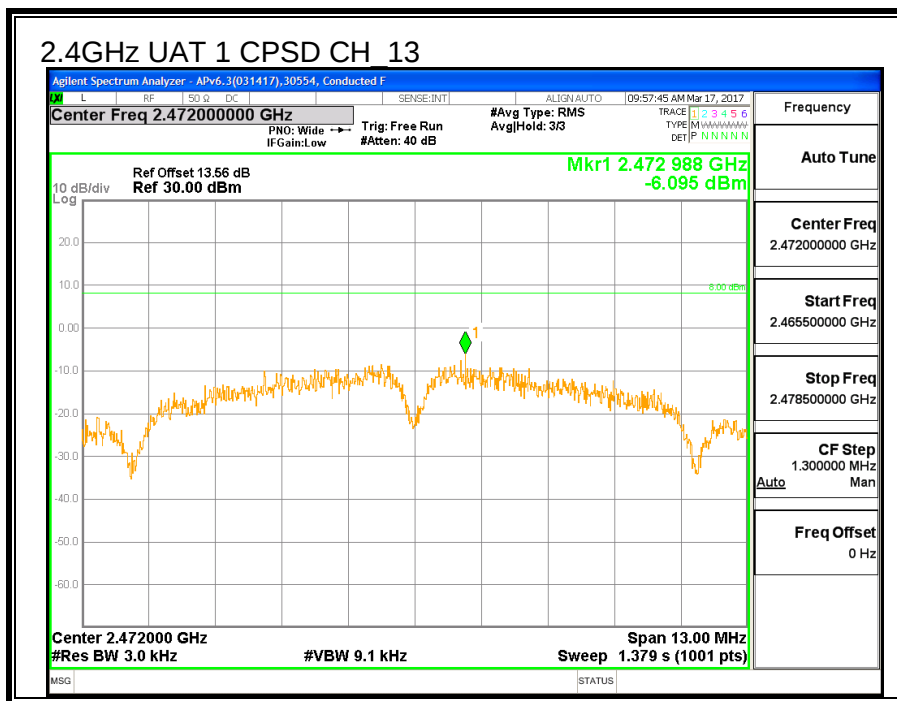
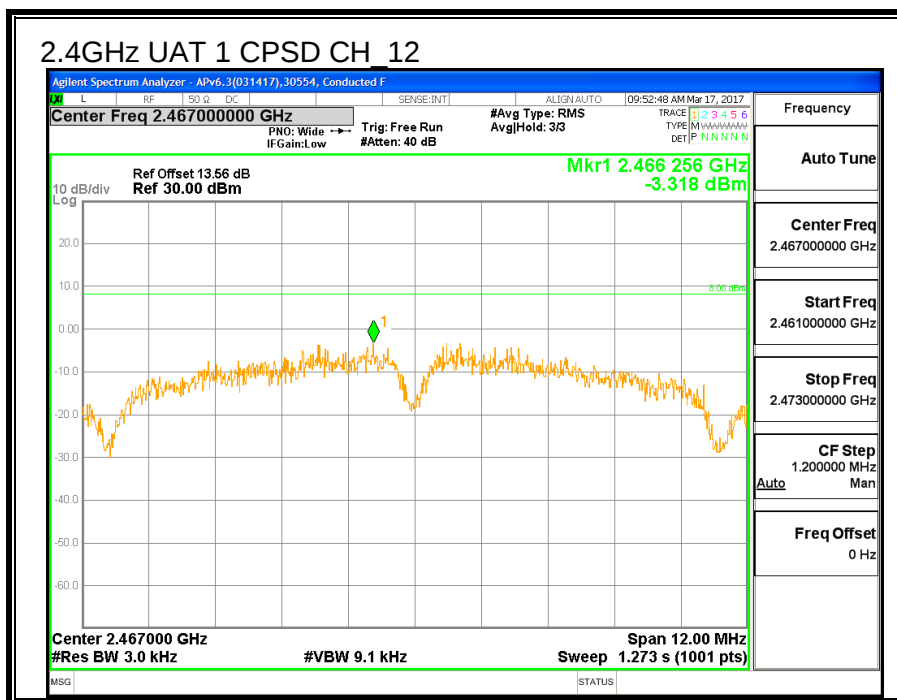
#### **PSD Results**

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Meas<br/>(dBm)</b> | <b>Total<br/>Corr'd<br/>PSD<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------|-------------------------------------------|------------------------|------------------------|
| Low_1          | 2412                       | -3.290                | -3.29                                     | 8.0                    | -11.3                  |
| Low_2          | 2417                       | -1.491                | -1.49                                     | 8.0                    | -9.5                   |
| Low_3          | 2422                       | -1.566                | -1.57                                     | 8.0                    | -9.6                   |
| Mid            | 2437                       | -1.204                | -1.20                                     | 8.0                    | -9.2                   |
| High_10        | 2457                       | -0.302                | -0.30                                     | 8.0                    | -8.3                   |
| High_11        | 2462                       | -2.599                | -2.60                                     | 8.0                    | -10.6                  |
| High_12        | 2467                       | -3.318                | -3.32                                     | 8.0                    | -11.3                  |
| High_13        | 2472                       | -6.095                | -6.10                                     | 8.0                    | -14.1                  |









## 8.2.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

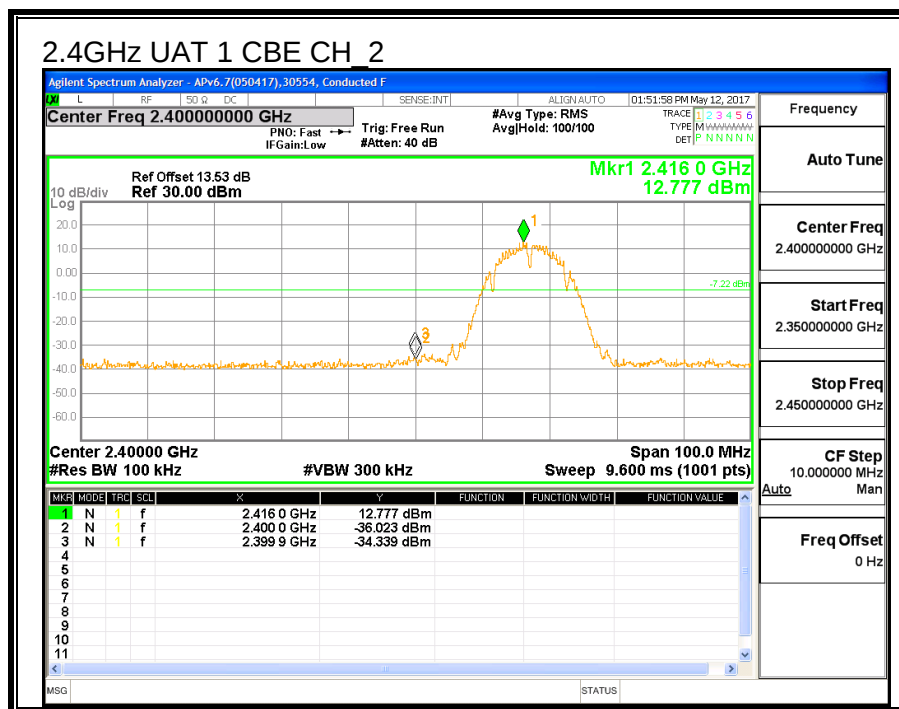
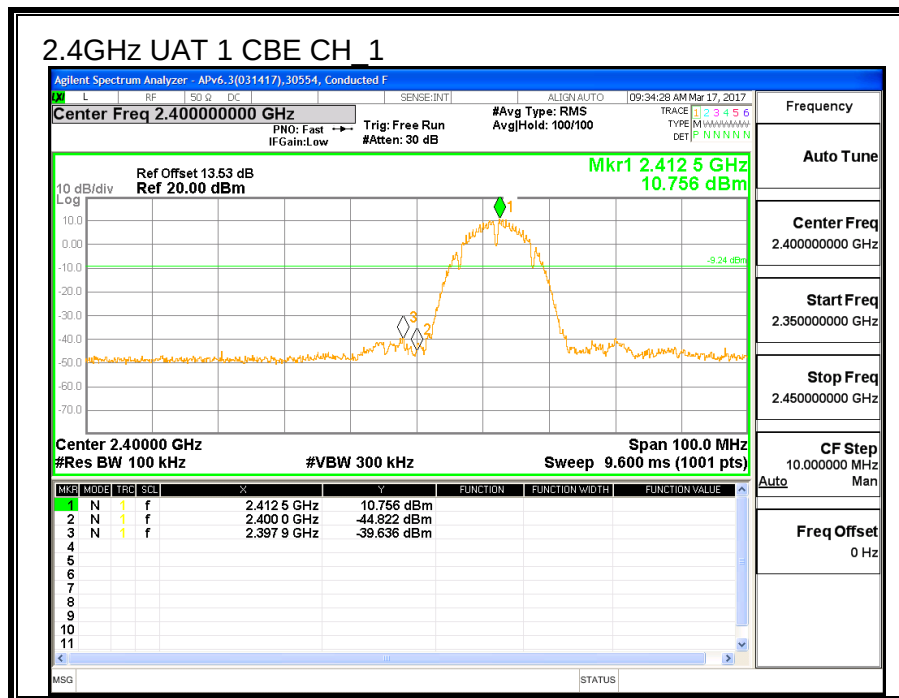
### LIMITS

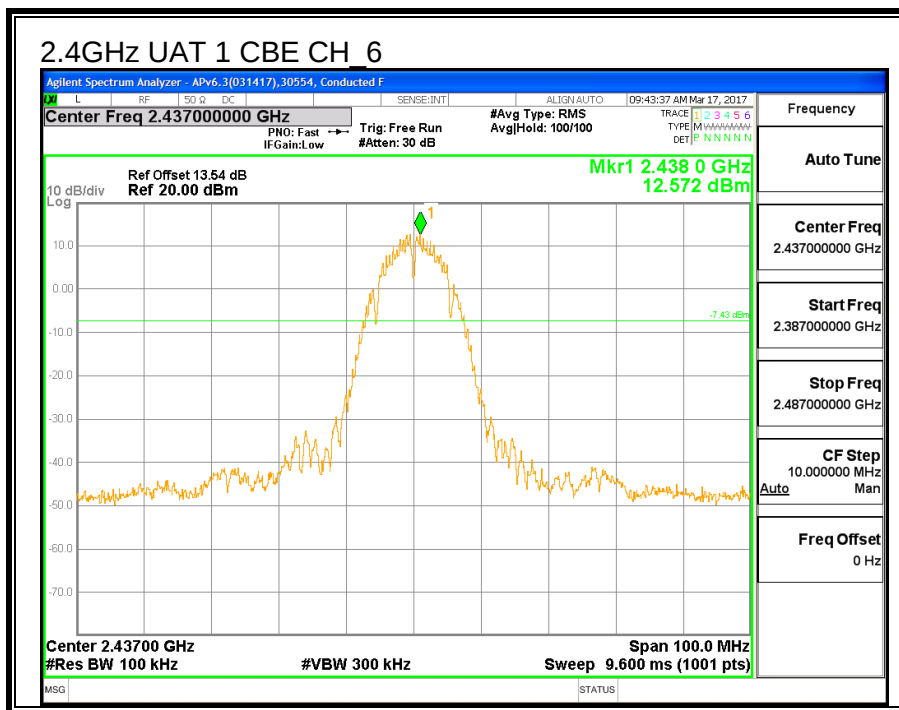
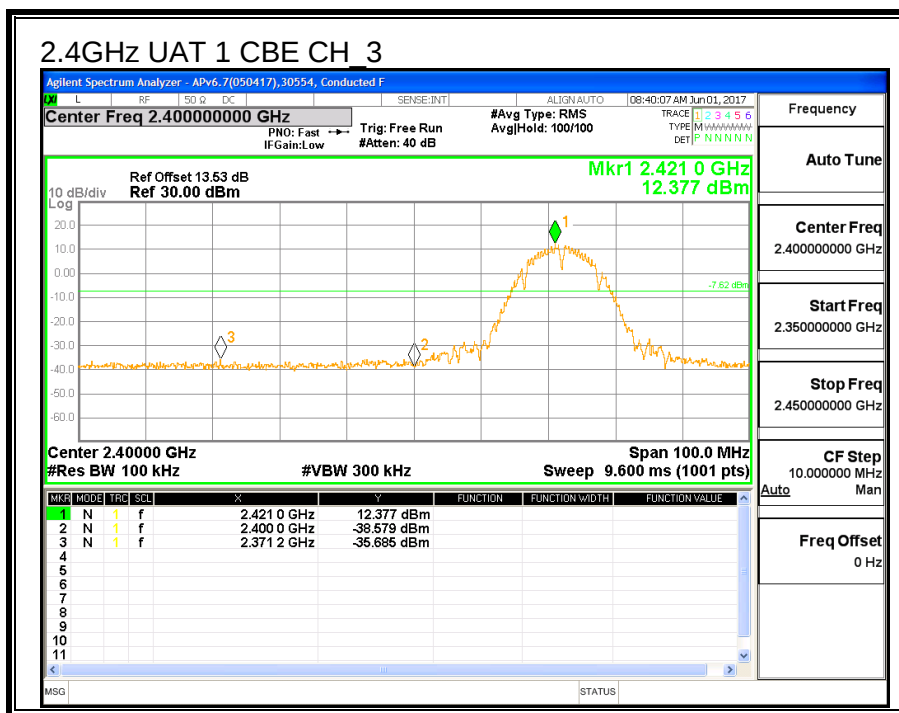
FCC §15.247 (d)

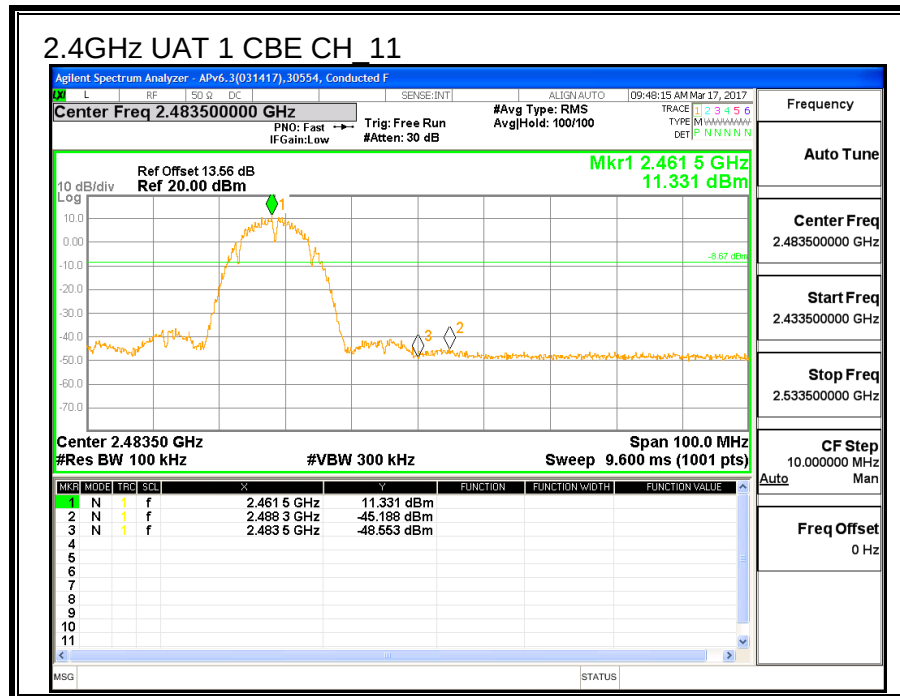
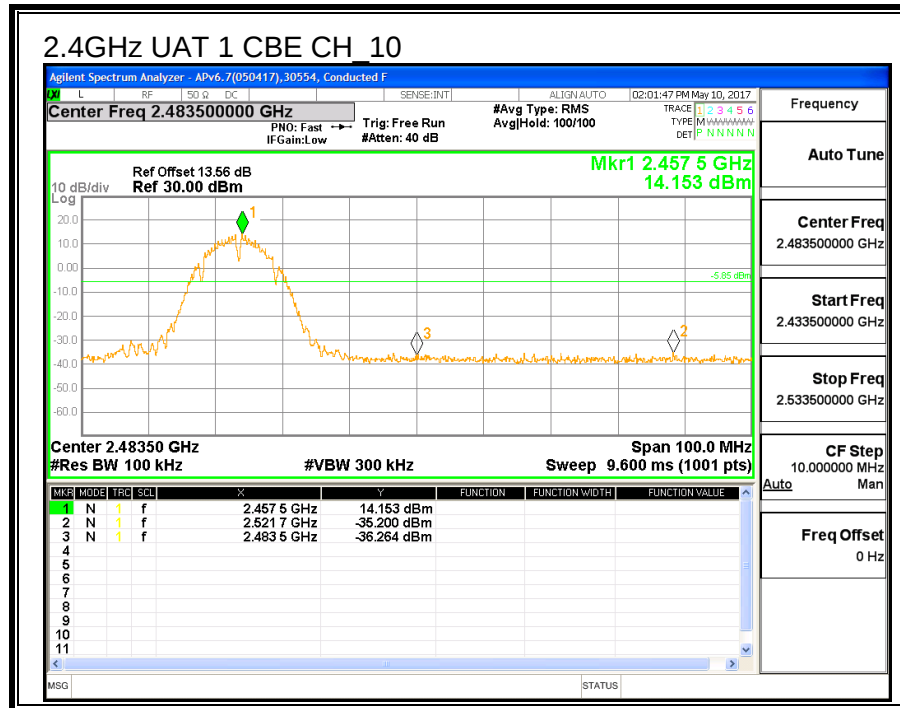
IC RSS-247 (5.5)

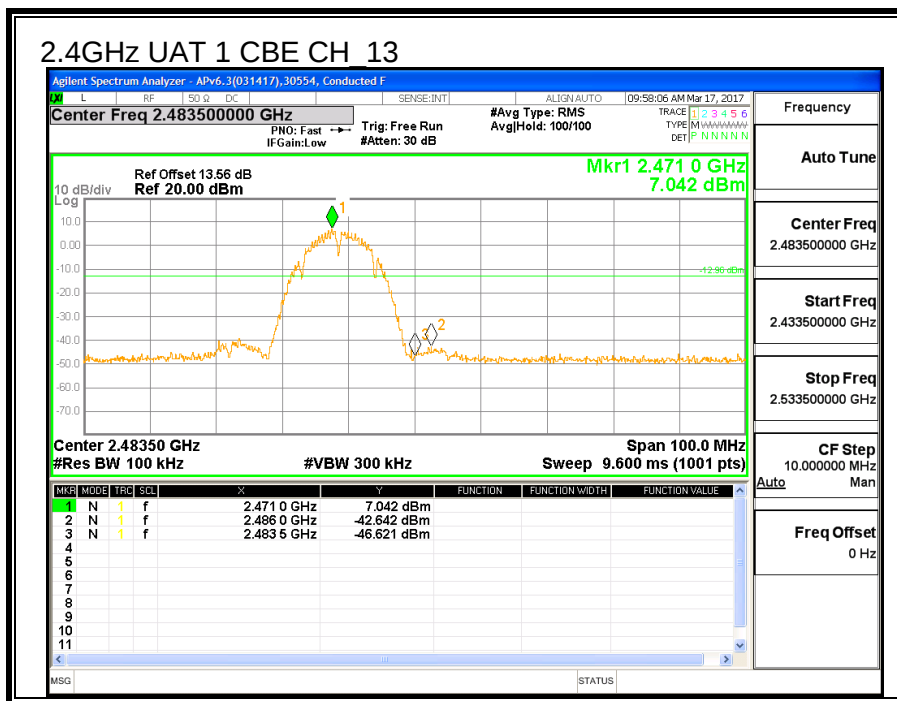
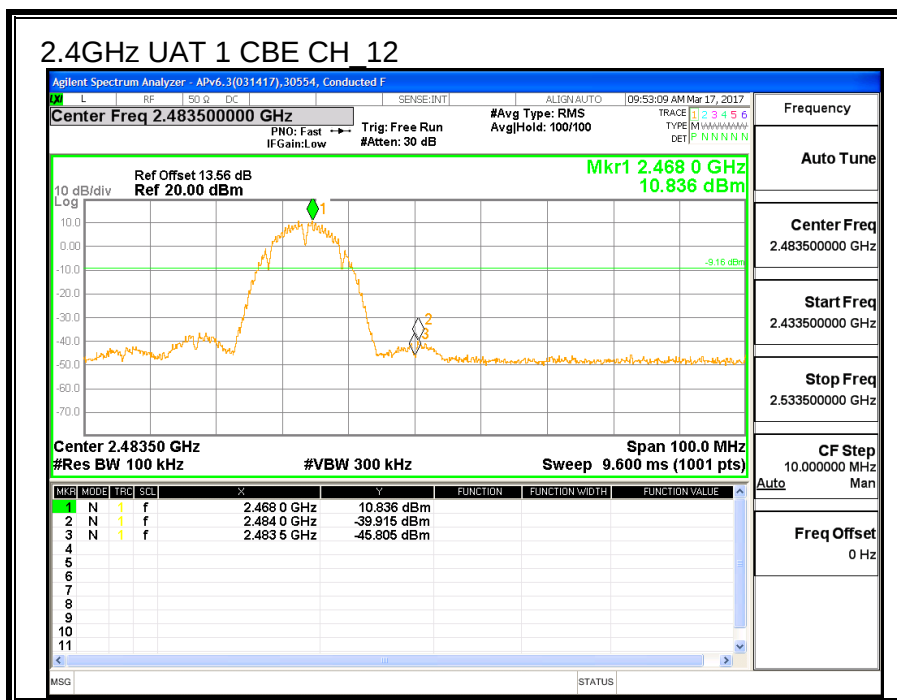
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

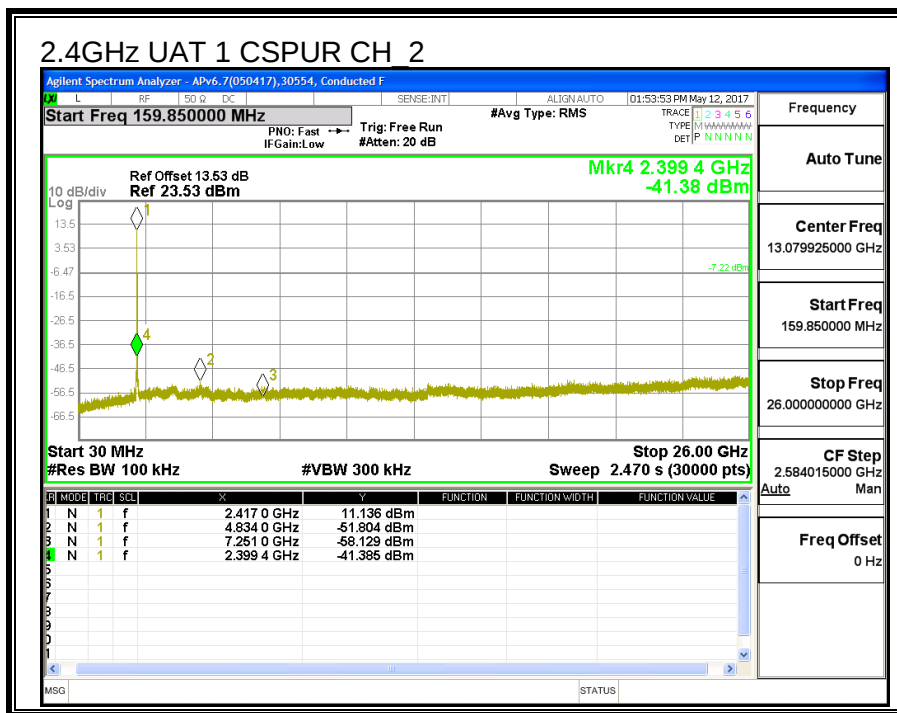
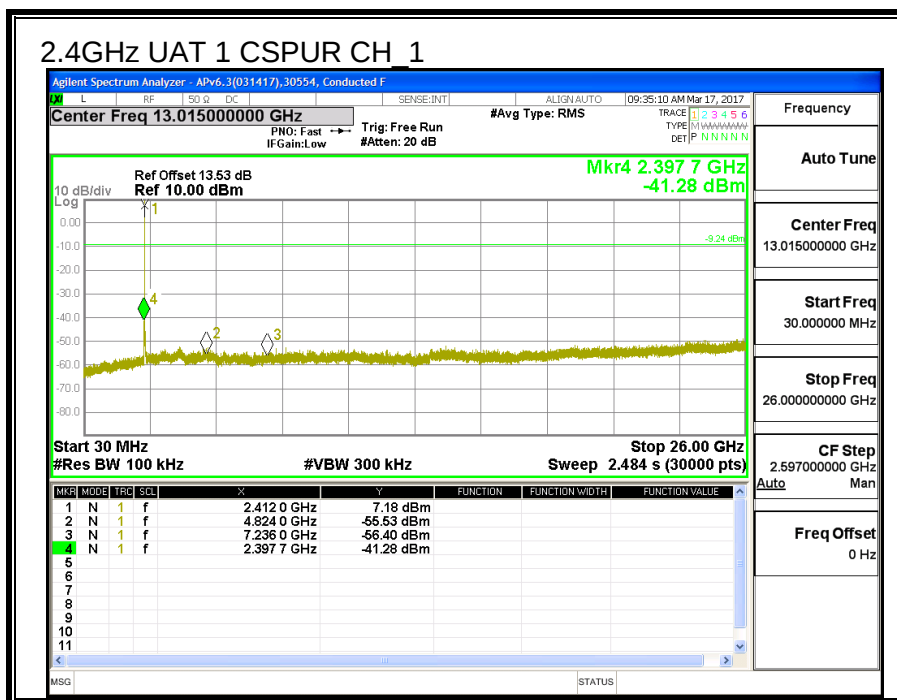
# CONDUCTED BANDEGE AND SPURIOUS EMISSIONS

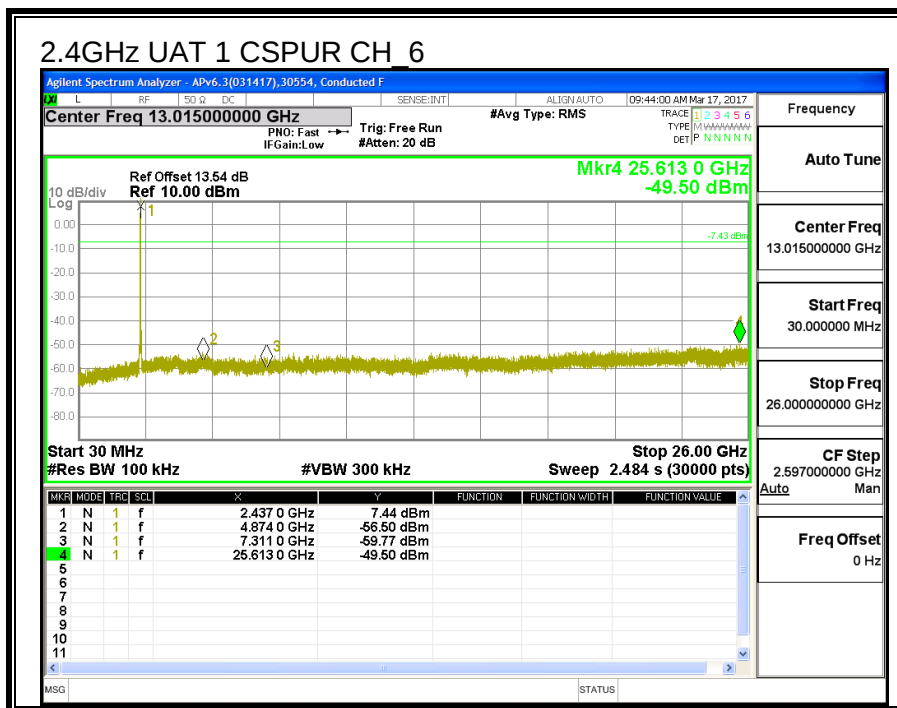
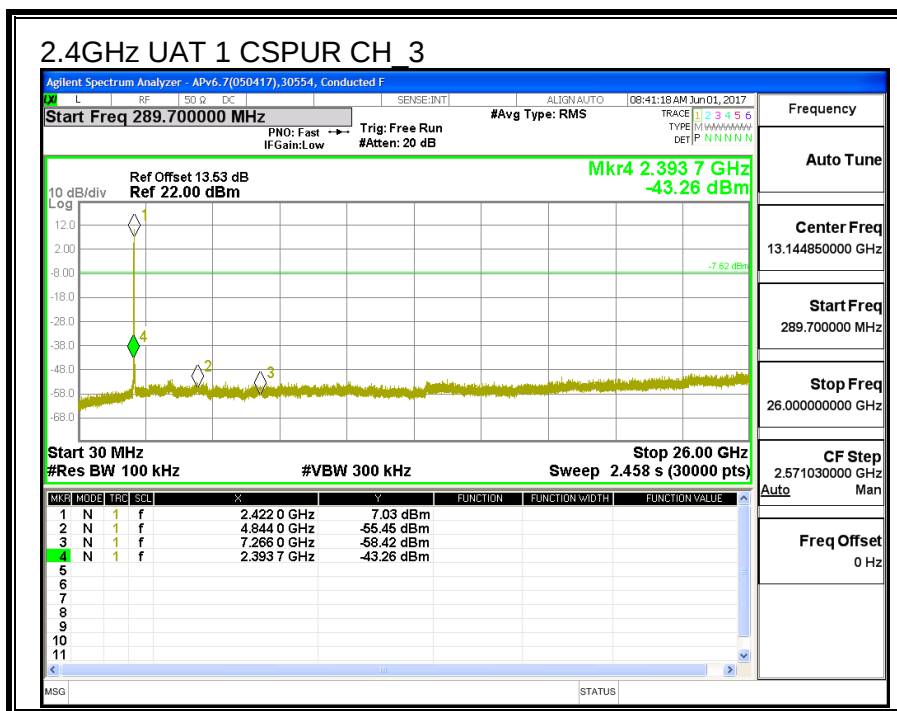


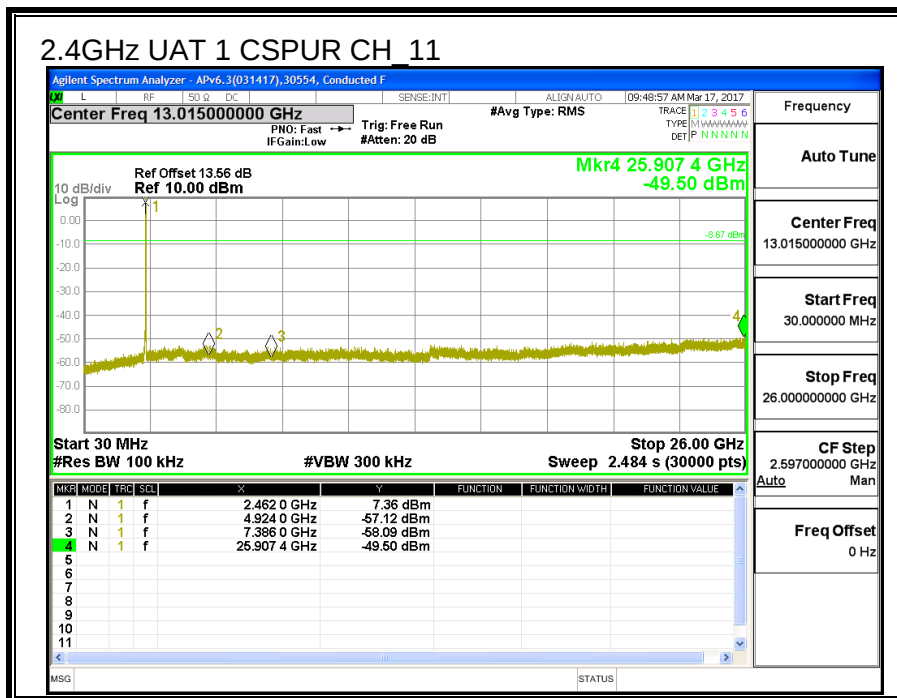
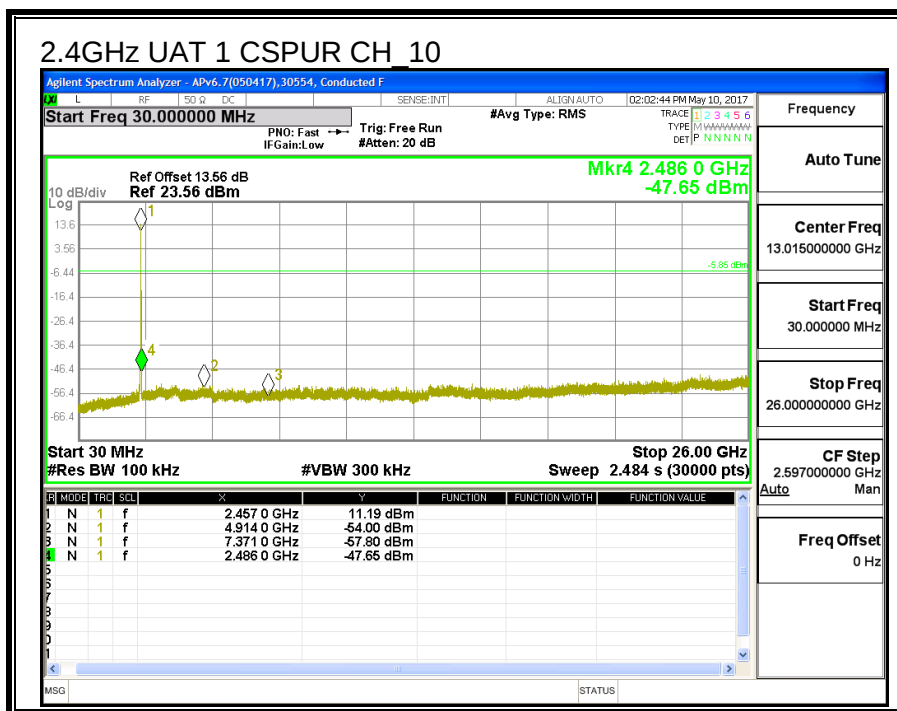


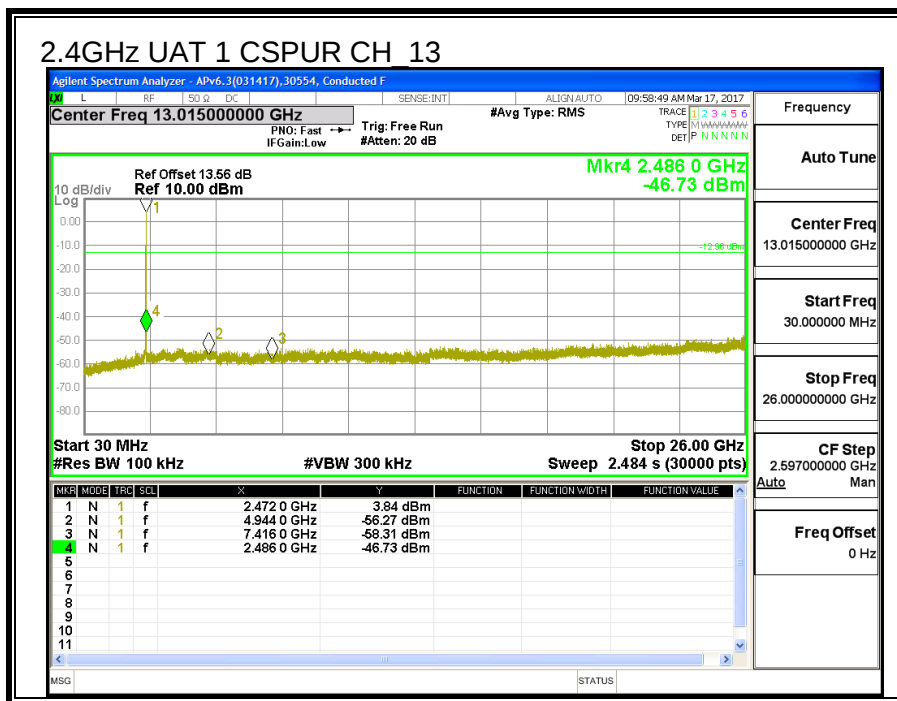
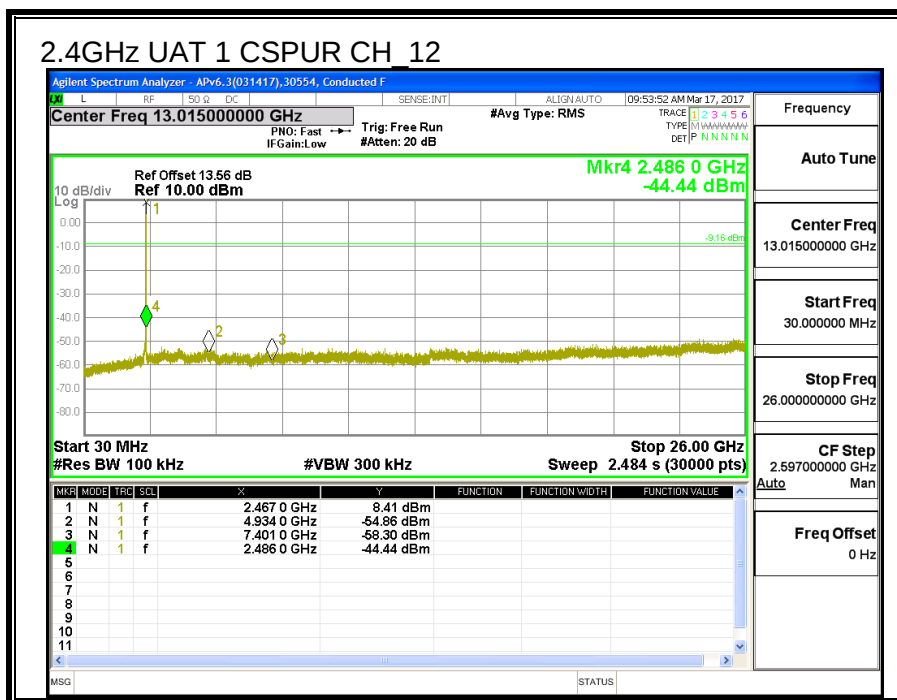












### 8.3. 11b LAT 3 SISO MODE IN THE 2.4GHz BAND

#### 8.3.1. 6 dB BANDWIDTH

##### LIMITS

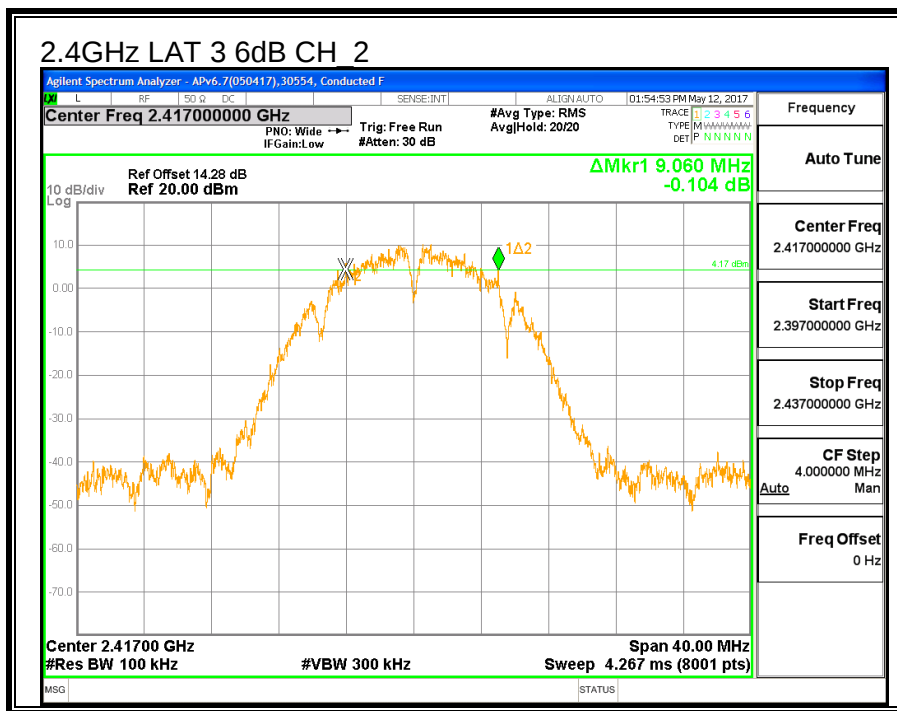
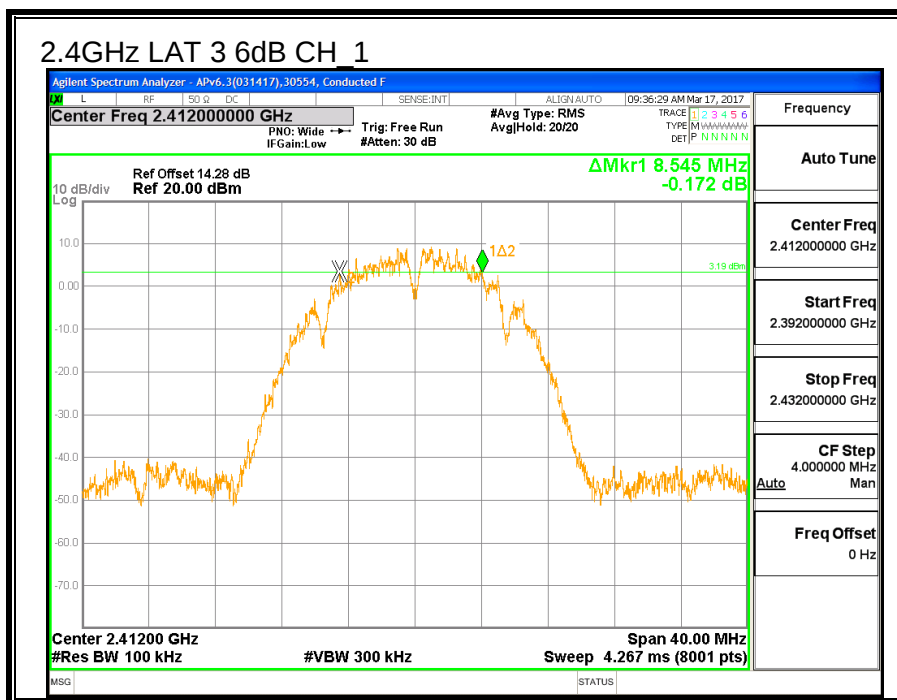
FCC §15.247 (a) (2)

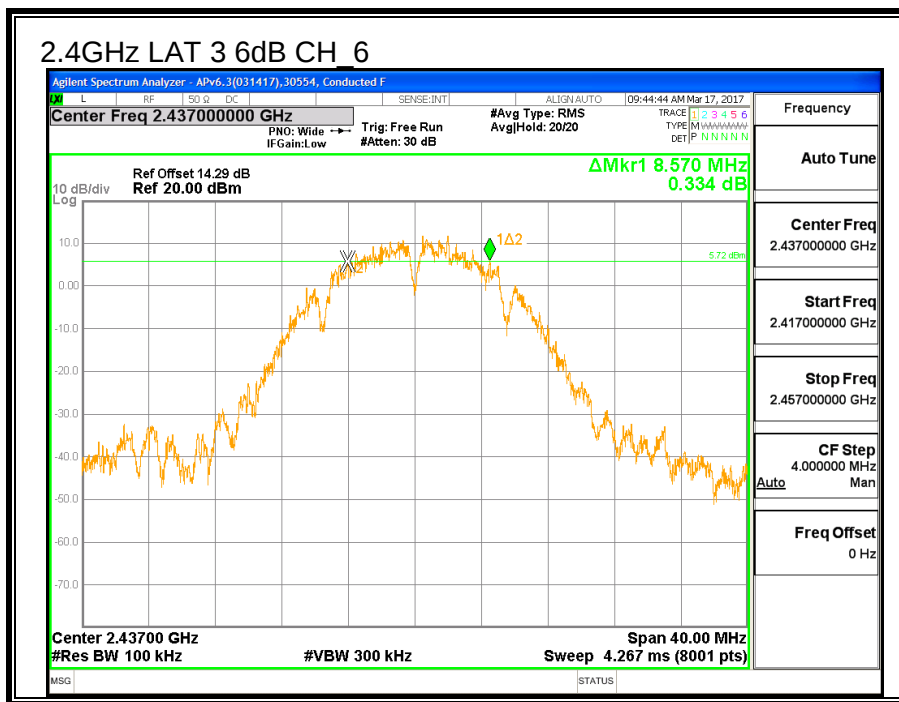
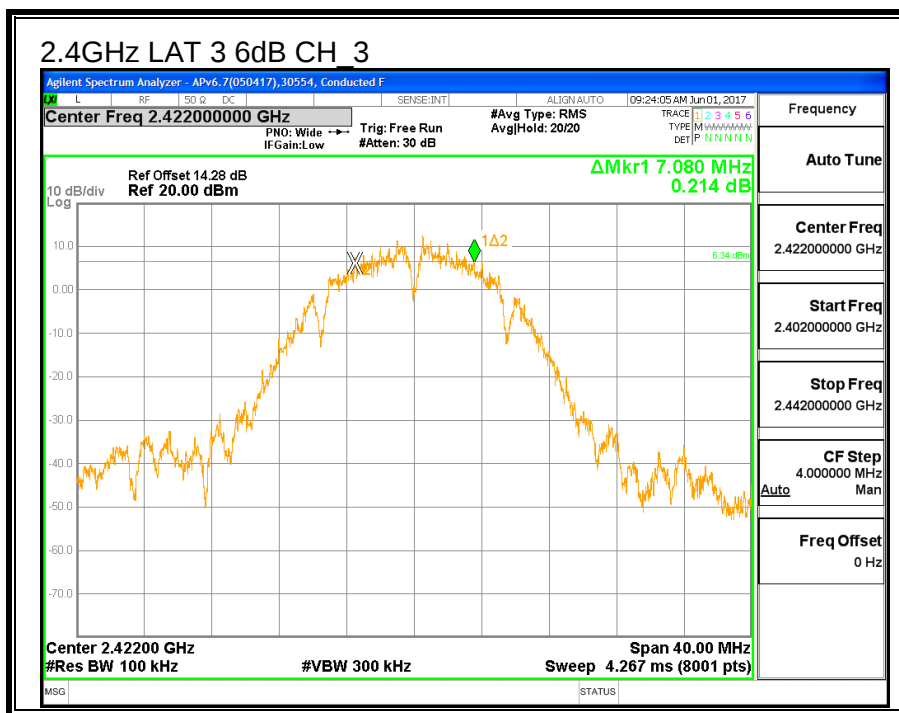
IC RSS-247 (5.2) (a)

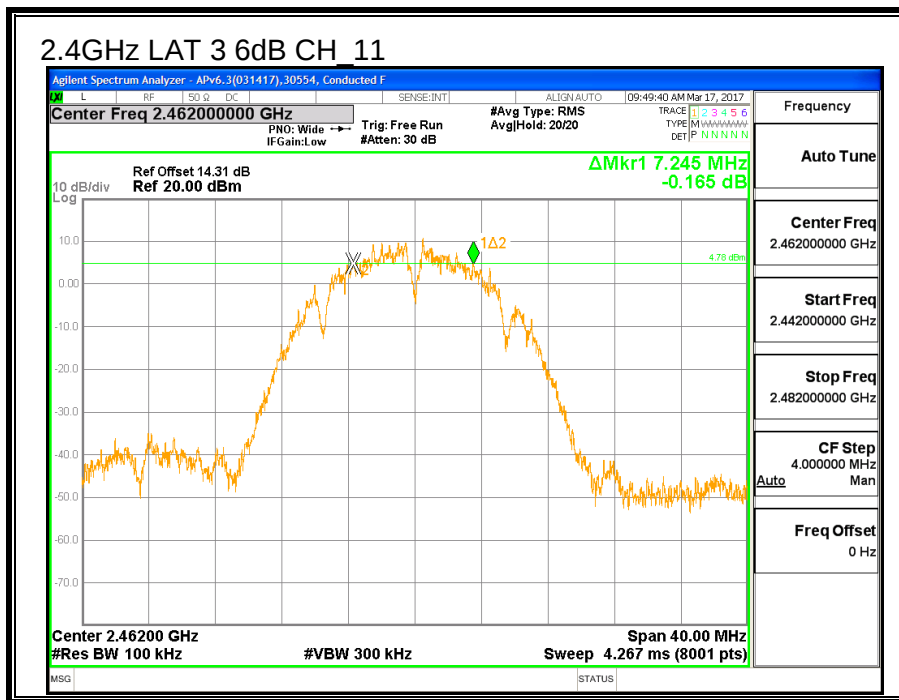
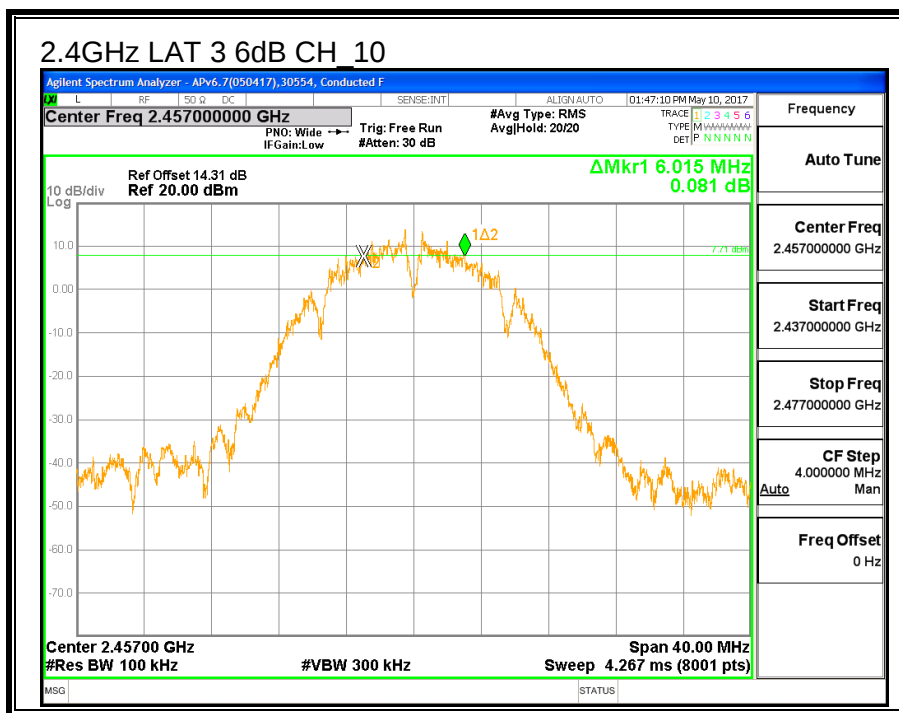
The minimum 6 dB bandwidth shall be at least 500 kHz.

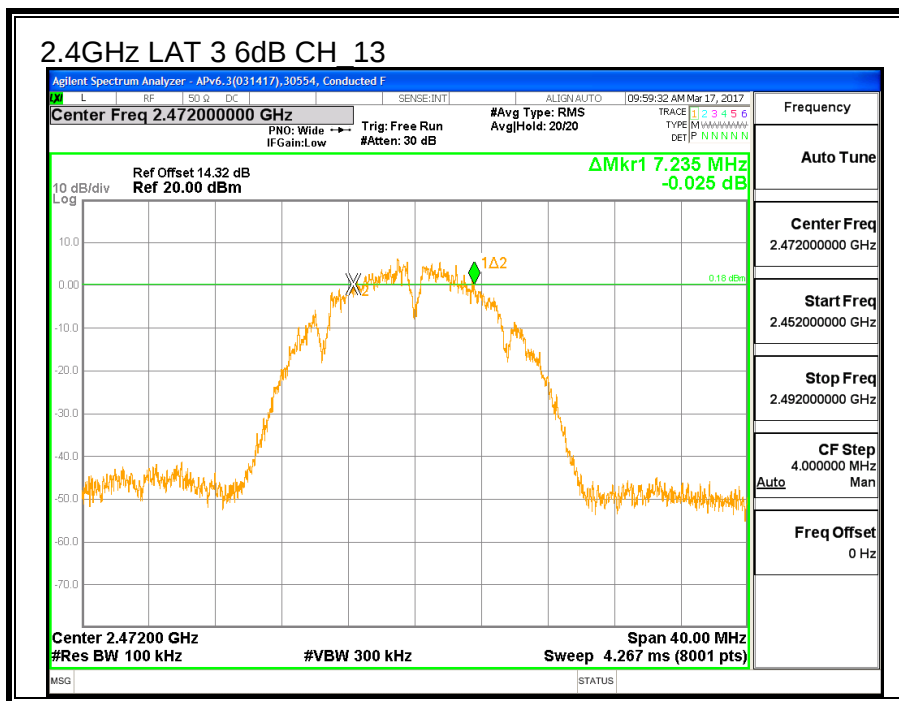
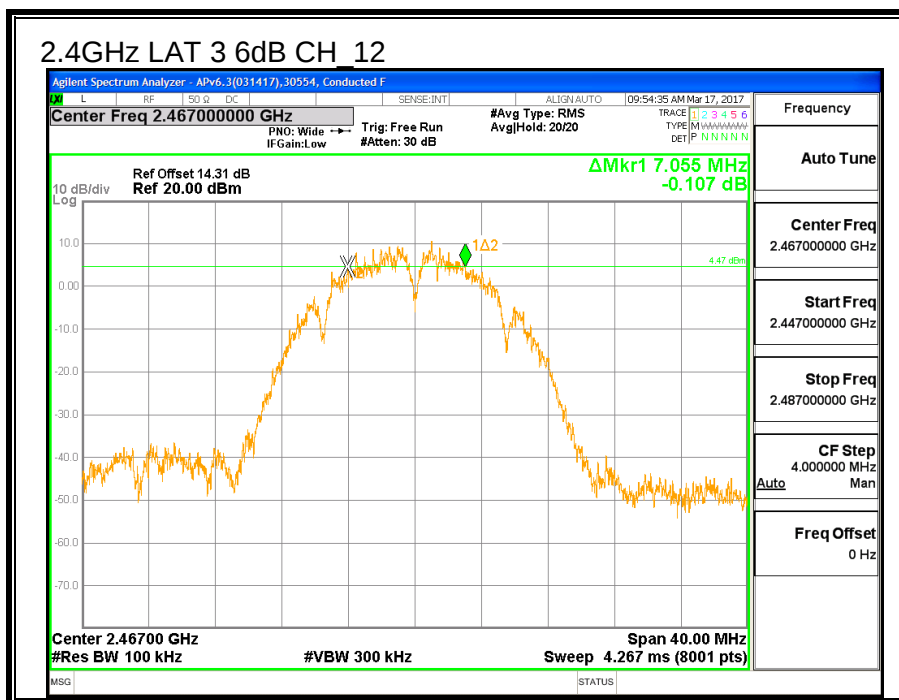
##### RESULTS

| Channel  | Frequency | 6 dB BW<br>LAT 3<br>(MHz) | Minimum Limit<br>(MHz) |
|----------|-----------|---------------------------|------------------------|
| Low_1    | 2412      | 8.545                     | 0.5                    |
| Low_2    | 2417      | 9.060                     | 0.5                    |
| Low_3    | 2422      | 7.08                      | 0.5                    |
| Middle_6 | 2437      | 8.570                     | 0.5                    |
| High_10  | 2457      | 6.015                     | 0.5                    |
| High_11  | 2462      | 7.245                     | 0.5                    |
| High_12  | 2467      | 7.055                     | 0.5                    |
| High_13  | 2472      | 7.235                     | 0.5                    |









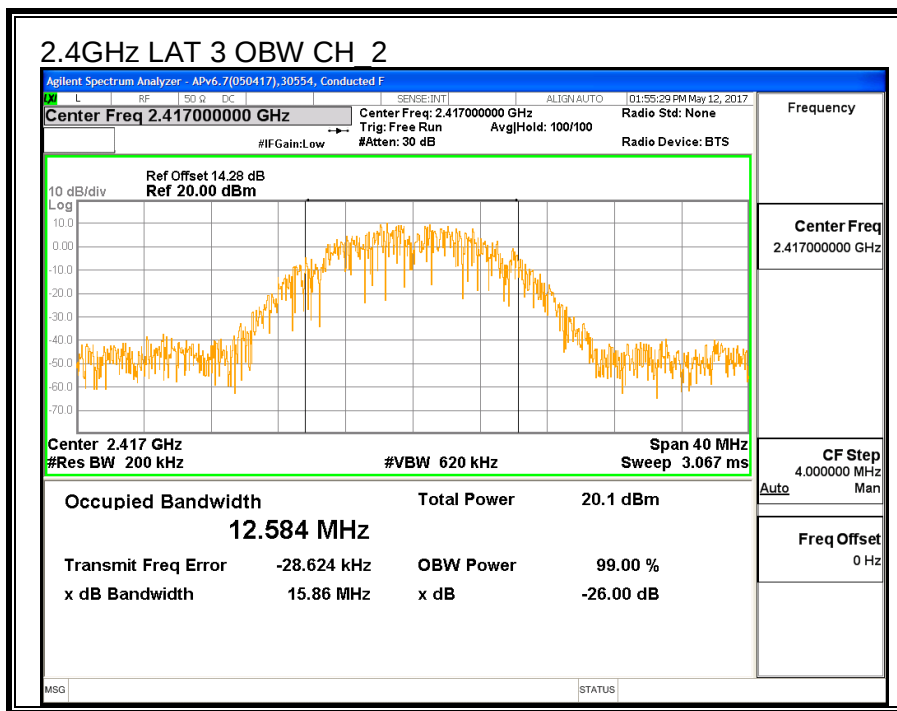
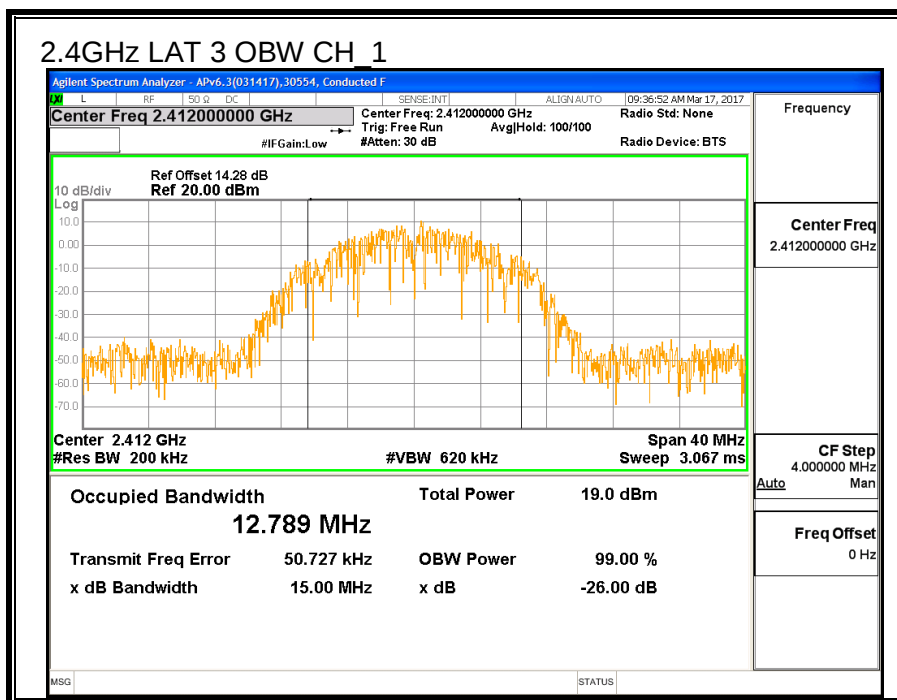
### 8.3.2. 99% BANDWIDTH

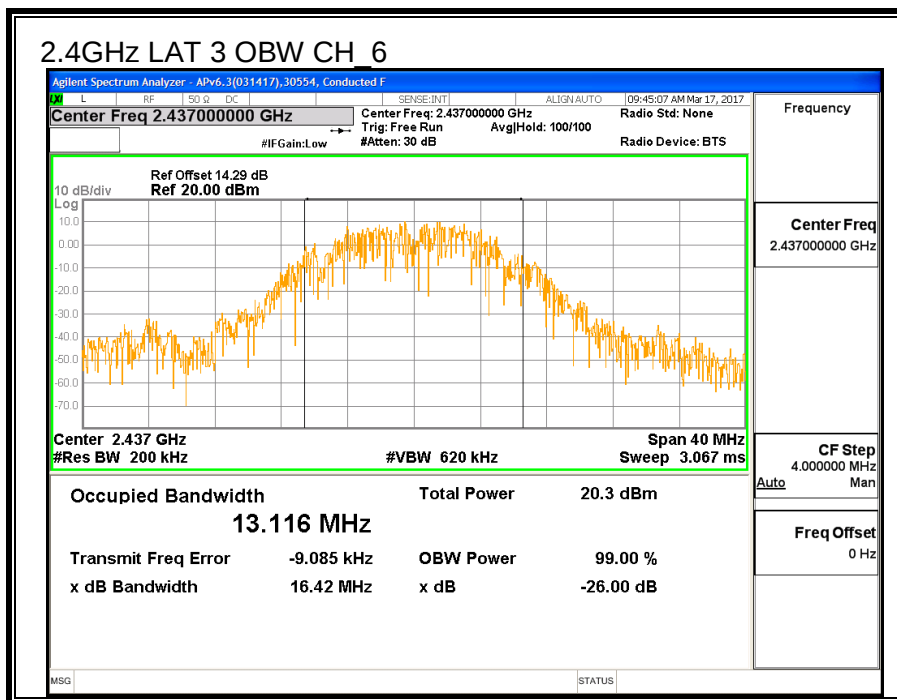
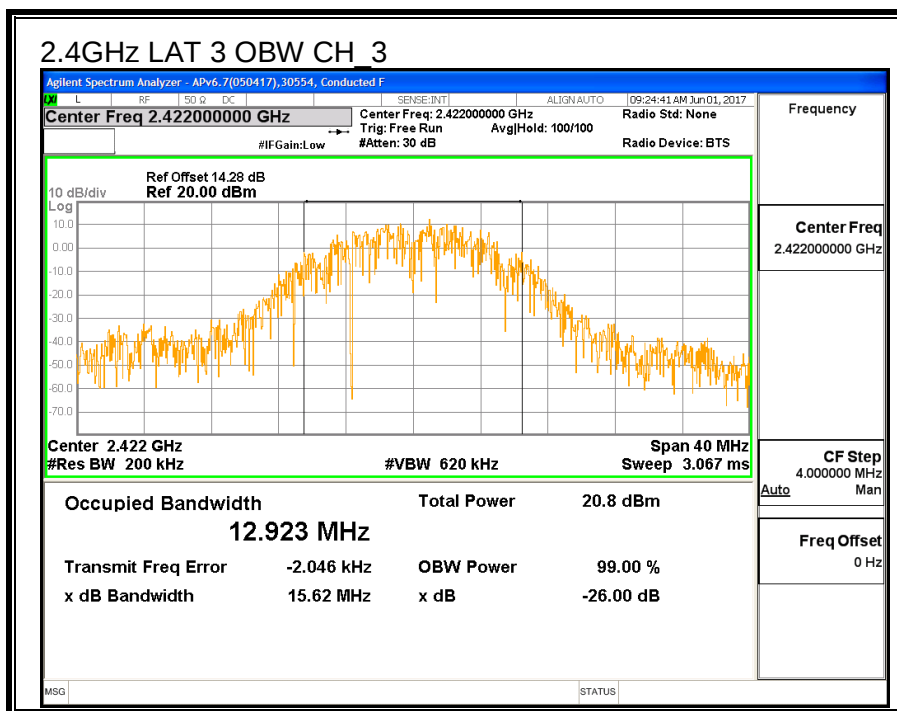
#### LIMITS

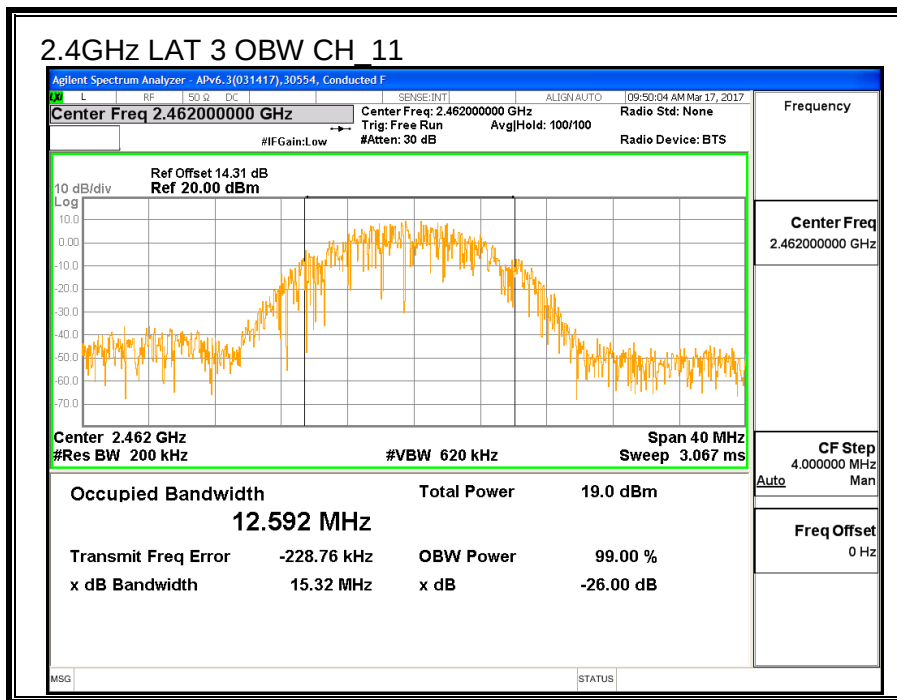
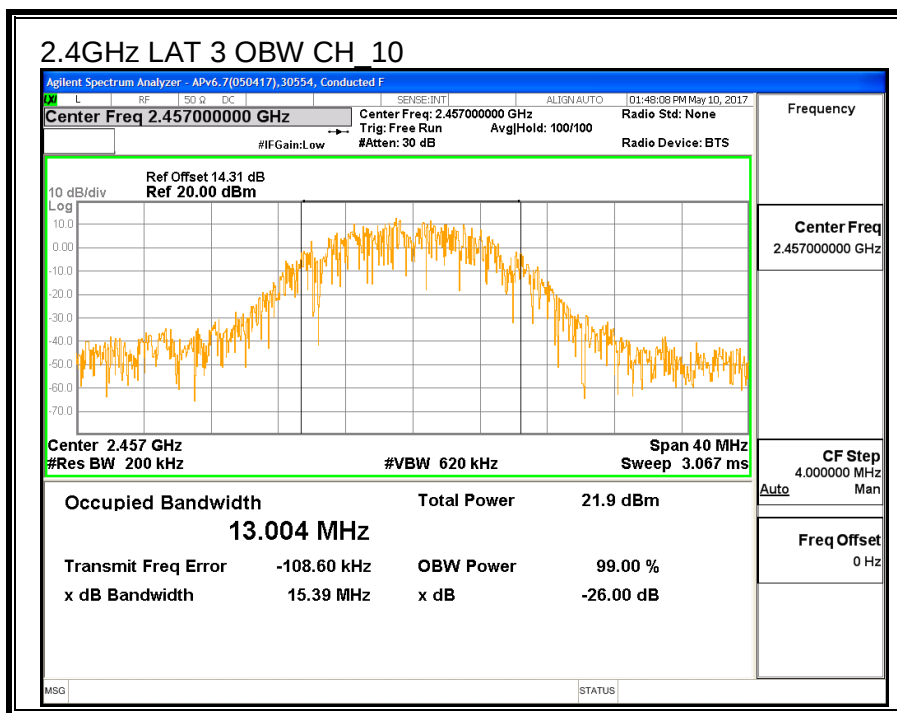
None; for reporting purposes only.

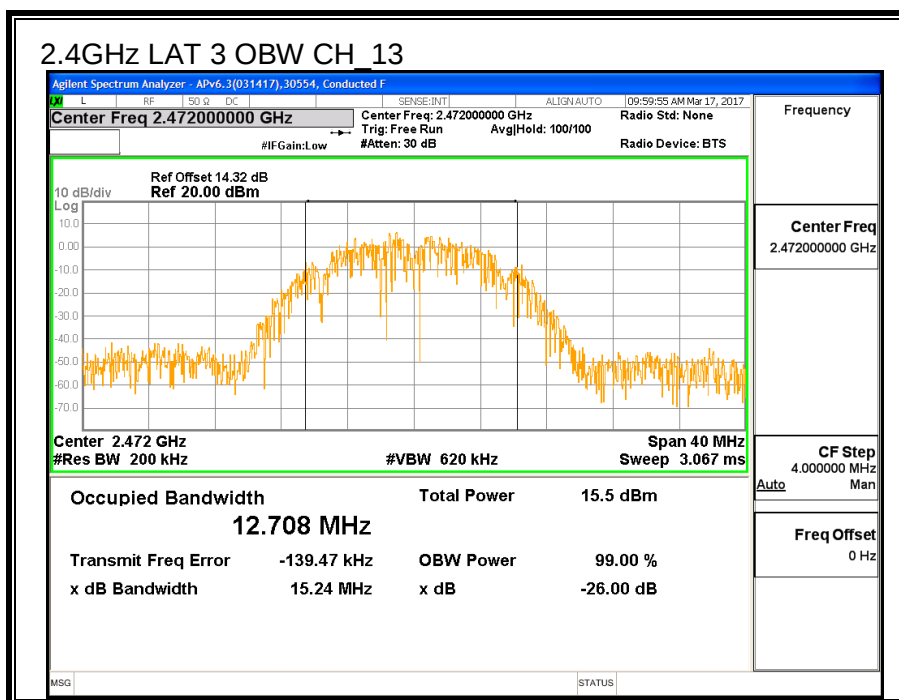
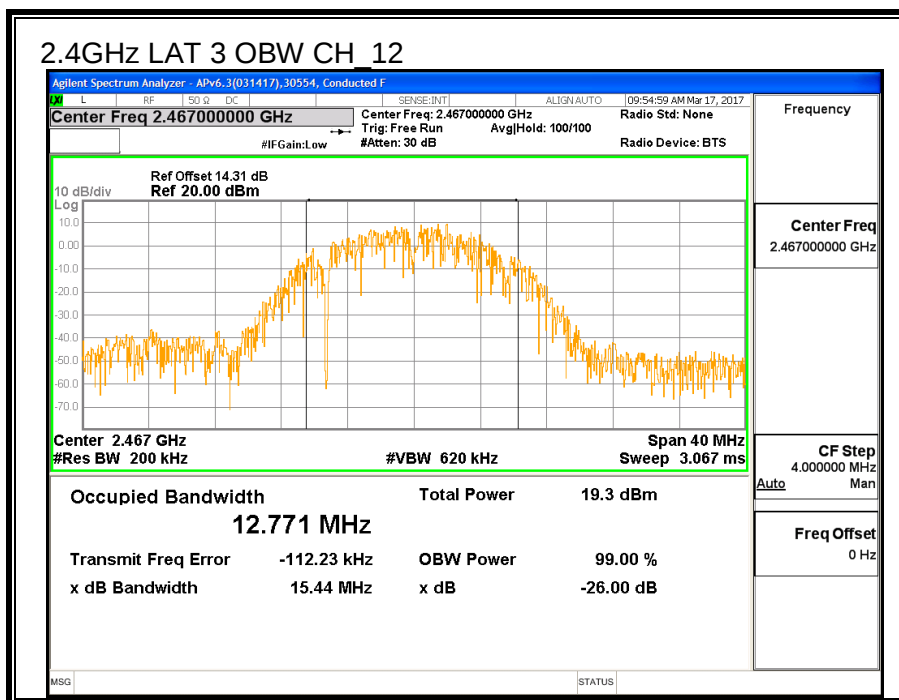
#### RESULTS

| Channel  | Frequency (MHz) | 99% Bandwidth LAT 3 (MHz) |
|----------|-----------------|---------------------------|
| Low_1    | 2412            | 12.789                    |
| Low_2    | 2417            | 12.584                    |
| Low_3    | 2422            | 12.923                    |
| Middle_6 | 2437            | 13.116                    |
| High_10  | 2457            | 13.004                    |
| High_11  | 2462            | 12.592                    |
| High_12  | 2467            | 12.771                    |
| High_13  | 2472            | 12.708                    |









### 8.3.3. AVERAGE POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

#### LIMITS

None; for reporting purposes only.

#### RESULTS

| Channel  | Frequency (MHz) | Power LAT 3 (MHz) |
|----------|-----------------|-------------------|
| Low_1    | 2412            | 19.77             |
| Low_2    | 2417            | 21.45             |
| Low_3    | 2422            | 21.37             |
| Middle_6 | 2437            | 21.42             |
| High_10  | 2457            | 21.39             |
| High_11  | 2462            | 20.91             |
| High_12  | 2467            | 18.44             |
| High_13  | 2472            | 14.88             |

#### 8.3.4. OUTPUT POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

#### LIMITS

FCC §15.247

IC RSS-247 (5.4) (d)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### DIRECTIONAL ANTENNA GAIN

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

## RESULTS

### Limits

| Channel | Frequency<br>(MHz) | Directional<br>Gain<br>(dBi) | FCC<br>Power<br>Limit<br>(dBm) | IC<br>Power<br>Limit<br>(dBm) | IC<br>EIRP<br>Limit<br>(dBm) | Max<br>Power<br>(dBm) |
|---------|--------------------|------------------------------|--------------------------------|-------------------------------|------------------------------|-----------------------|
| Low_1   | 2412               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| Low_2   | 2417               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| Low_3   | 2422               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| Mid     | 2437               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| High_10 | 2457               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| High_11 | 2462               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| High_12 | 2467               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |
| High_13 | 2472               | -2.24                        | 30.00                          | 30                            | 36                           | 30.00                 |

|                    |      |                                          |
|--------------------|------|------------------------------------------|
| Duty Cycle CF (dB) | 0.00 | Included in Calculations of Corr'd Power |
|--------------------|------|------------------------------------------|

### Results

| Channel | Frequency<br>(MHz) | Meas<br>Power<br>(dBm) | Total<br>Corr'd<br>Power<br>(dBm) | Power<br>Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|------------------------|-----------------------------------|-------------------------|----------------|
| Low_1   | 2412               | 22.45                  | 22.45                             | 30.00                   | -7.55          |
| Low_2   | 2417               | 24.17                  | 24.17                             | 30.00                   | -5.83          |
| Low_3   | 2422               | 24.01                  | 24.01                             | 30.00                   | -5.99          |
| Mid     | 2437               | 24.18                  | 24.18                             | 30.00                   | -5.82          |
| High_10 | 2457               | 23.72                  | 23.72                             | 30.00                   | -6.28          |
| High_11 | 2462               | 20.80                  | 20.80                             | 30.00                   | -9.20          |
| High_12 | 2467               | 18.69                  | 18.69                             | 30.00                   | -11.31         |
| High_13 | 2472               | 17.49                  | 17.49                             | 30.00                   | -12.51         |

### 8.3.5. POWER SPECTRAL DENSITY

#### LIMITS

FCC §15.247

IC RSS-247 (5.2) (b)

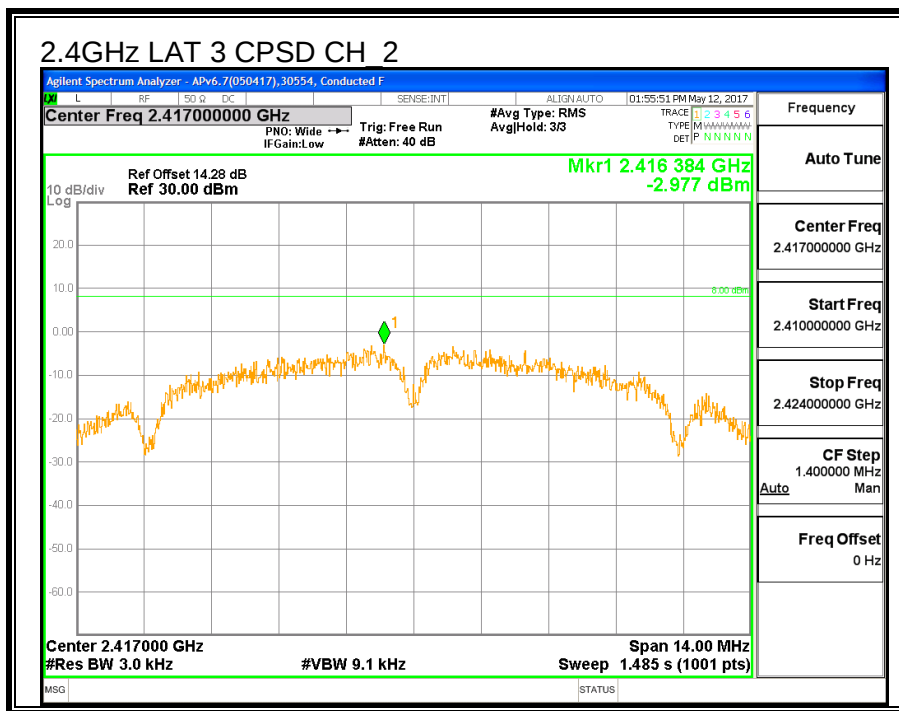
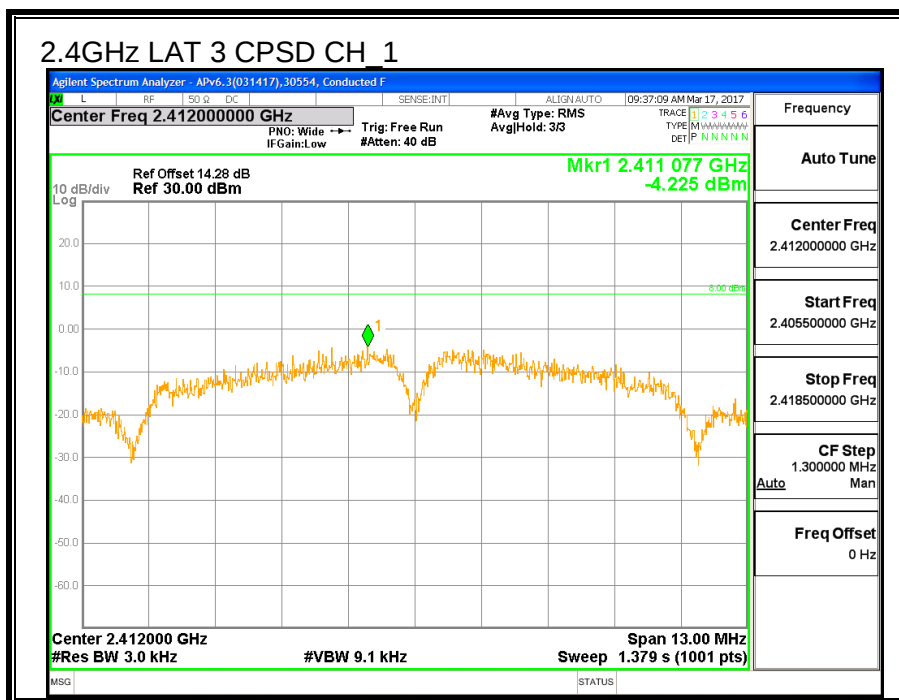
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

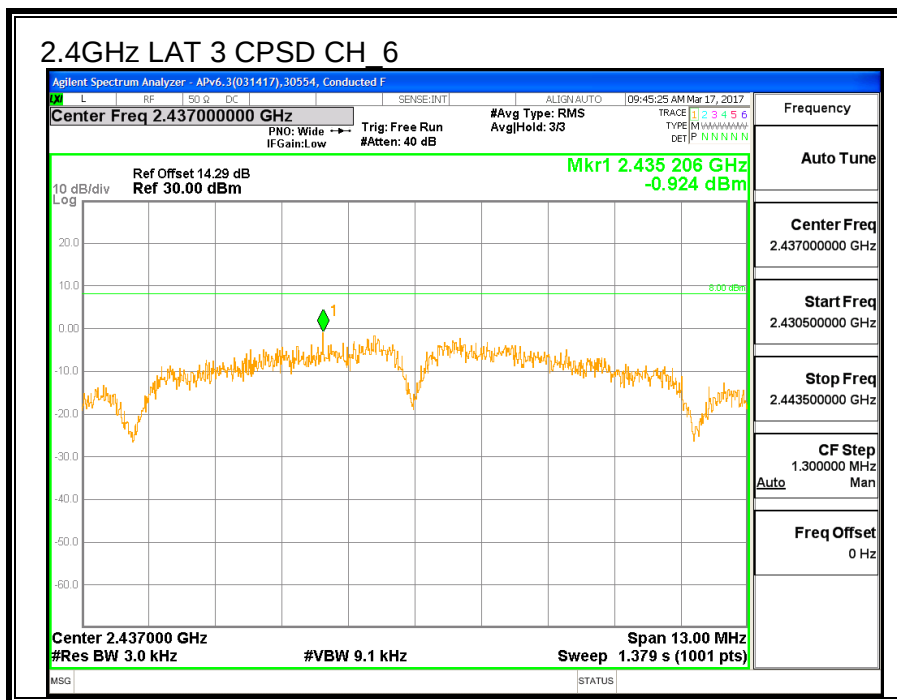
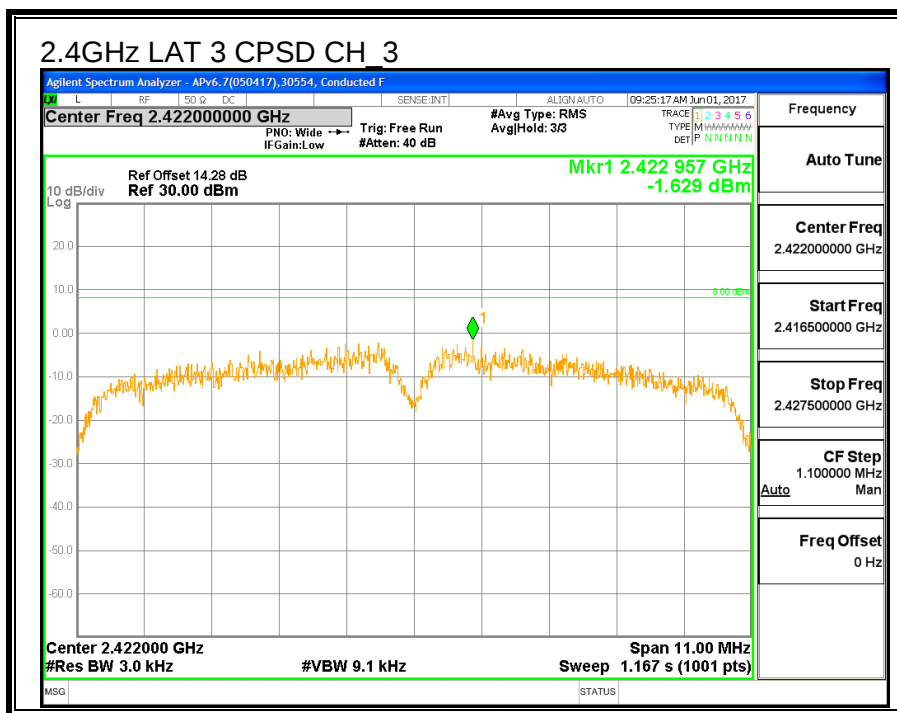
#### RESULTS

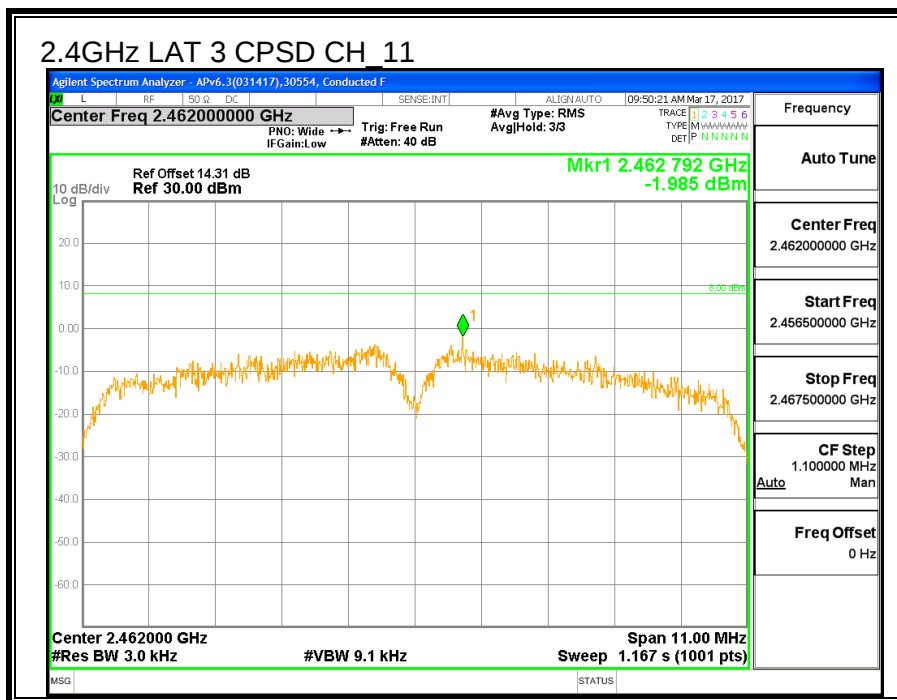
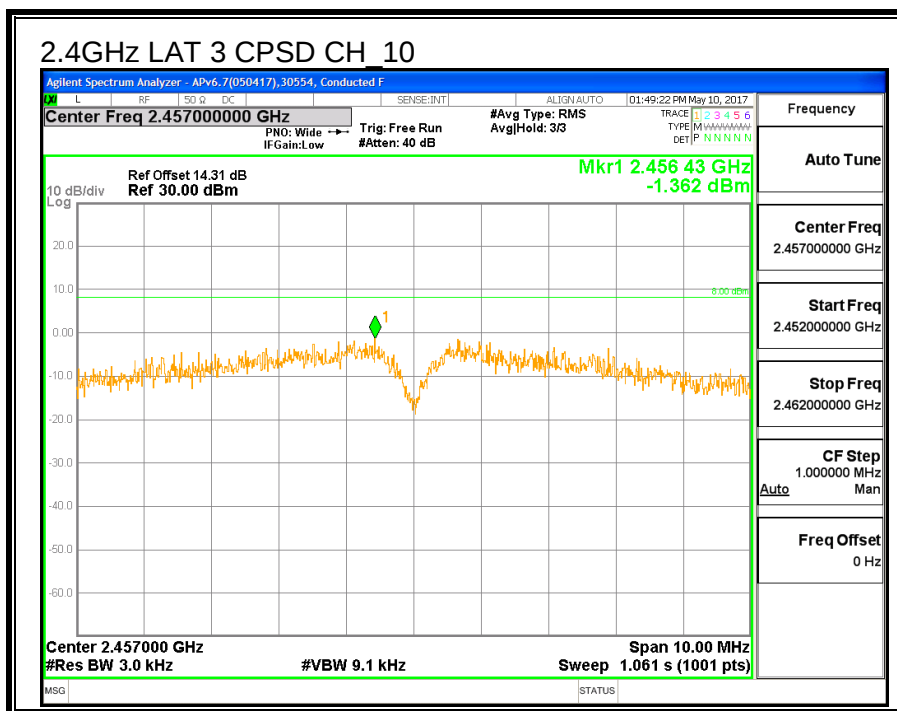
|                           |      |                                               |
|---------------------------|------|-----------------------------------------------|
| <b>Duty Cycle CF (dB)</b> | 0.00 | <b>Included in Calculations of Corr'd PSD</b> |
|---------------------------|------|-----------------------------------------------|

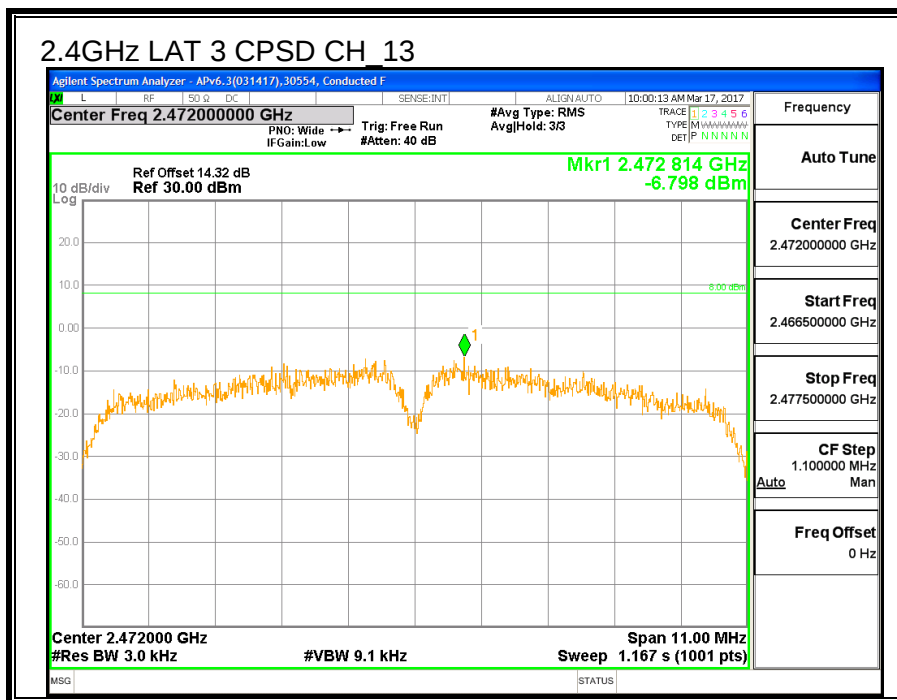
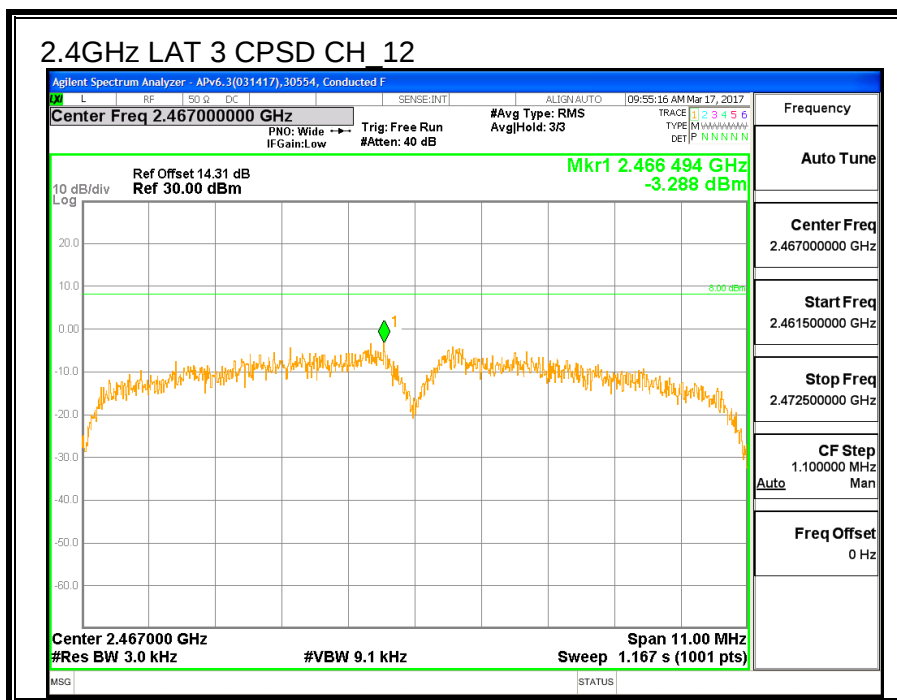
#### **PSD Results**

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Meas<br/>(dBm)</b> | <b>Total<br/>Corr'd<br/>PSD<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------|-------------------------------------------|------------------------|------------------------|
| Low_1          | 2412                       | -4.225                | -4.23                                     | 8.0                    | -12.2                  |
| Low_2          | 2417                       | -2.977                | -2.98                                     | 8.0                    | -11.0                  |
| Low_3          | 2422                       | -1.629                | -1.63                                     | 8.0                    | -9.6                   |
| Mid            | 2437                       | -0.924                | -0.92                                     | 8.0                    | -8.9                   |
| High_10        | 2457                       | -1.362                | -1.36                                     | 8.0                    | -9.4                   |
| High_11        | 2462                       | -1.985                | -1.99                                     | 8.0                    | -10.0                  |
| High_12        | 2467                       | -3.288                | -3.29                                     | 8.0                    | -11.3                  |
| High_13        | 2472                       | -6.798                | -6.80                                     | 8.0                    | -14.8                  |









### 8.3.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

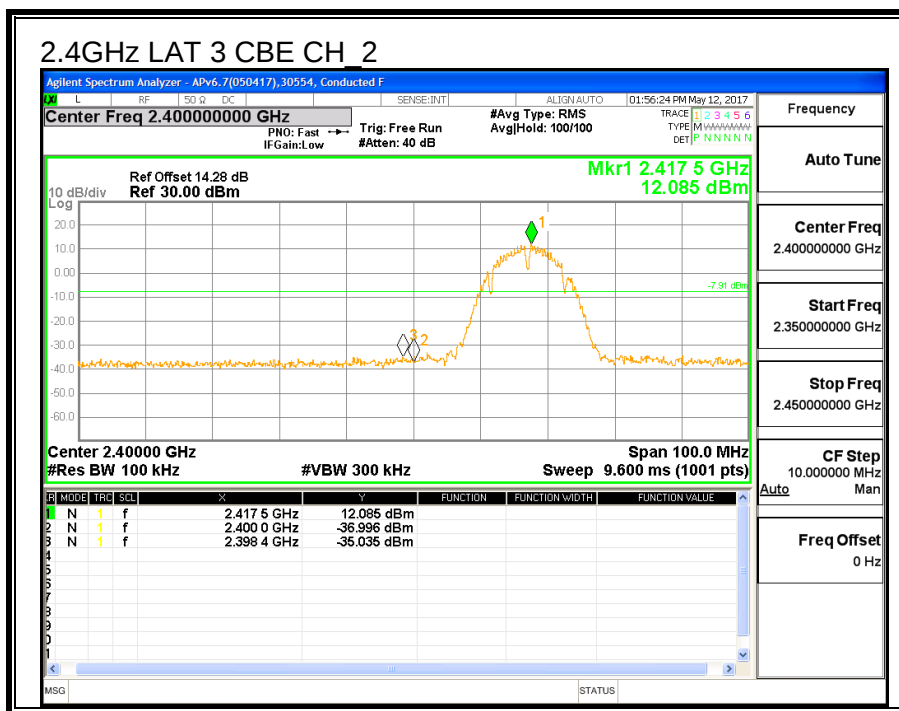
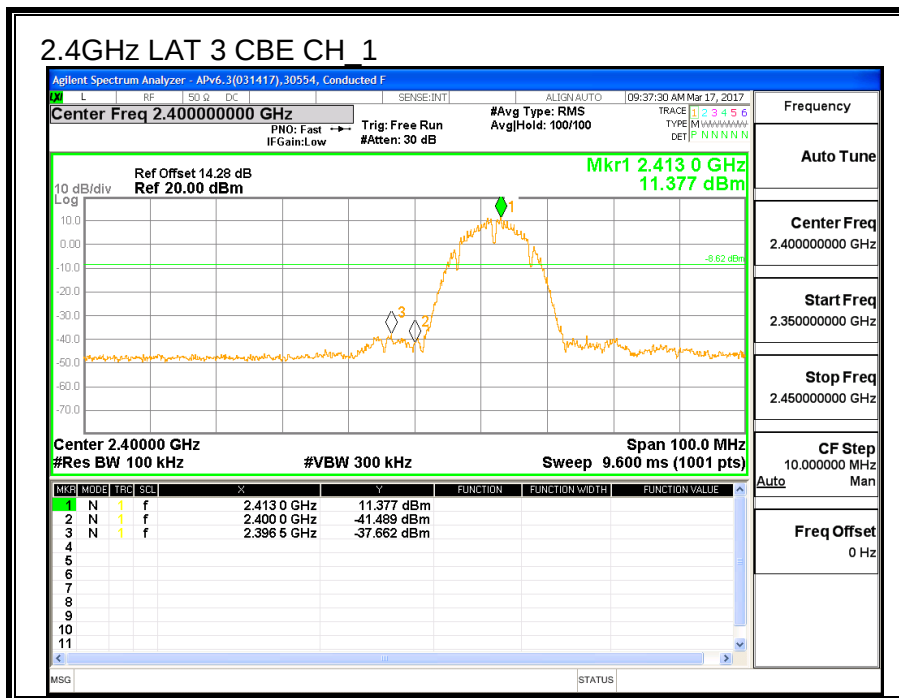
#### LIMITS

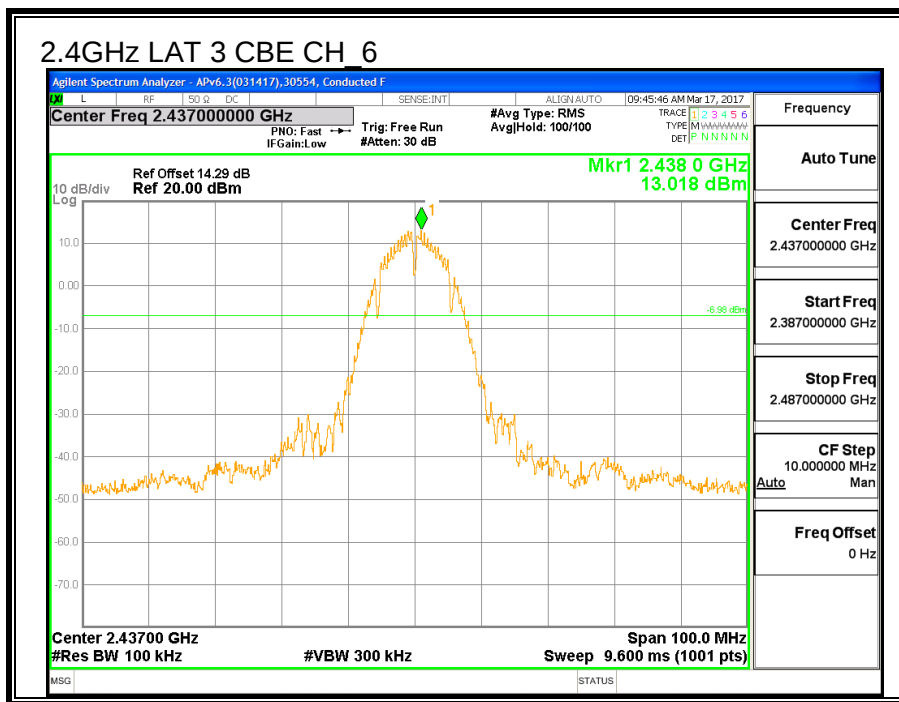
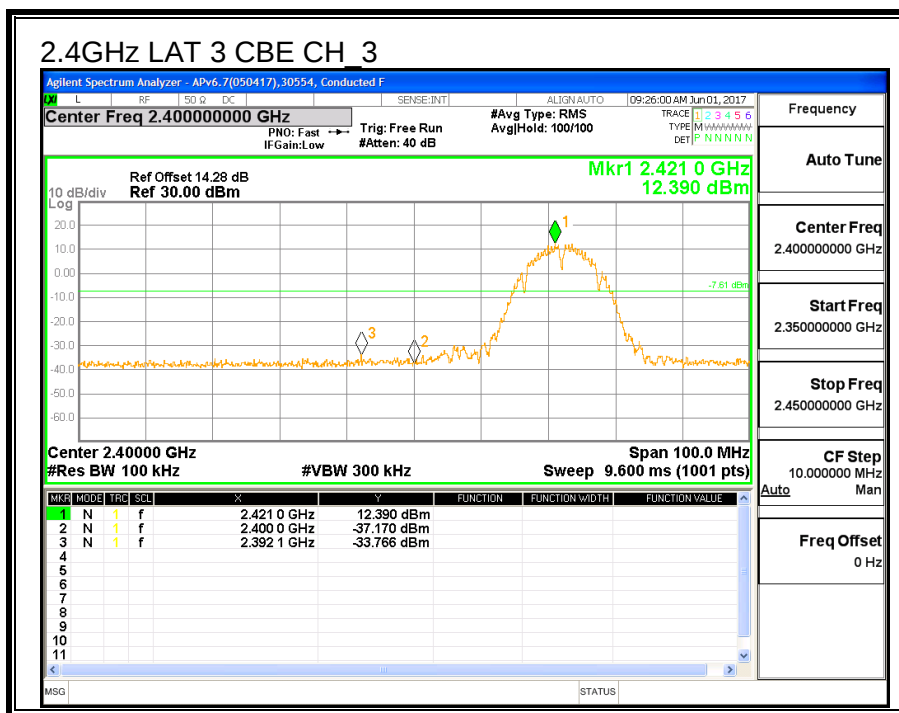
FCC §15.247 (d)

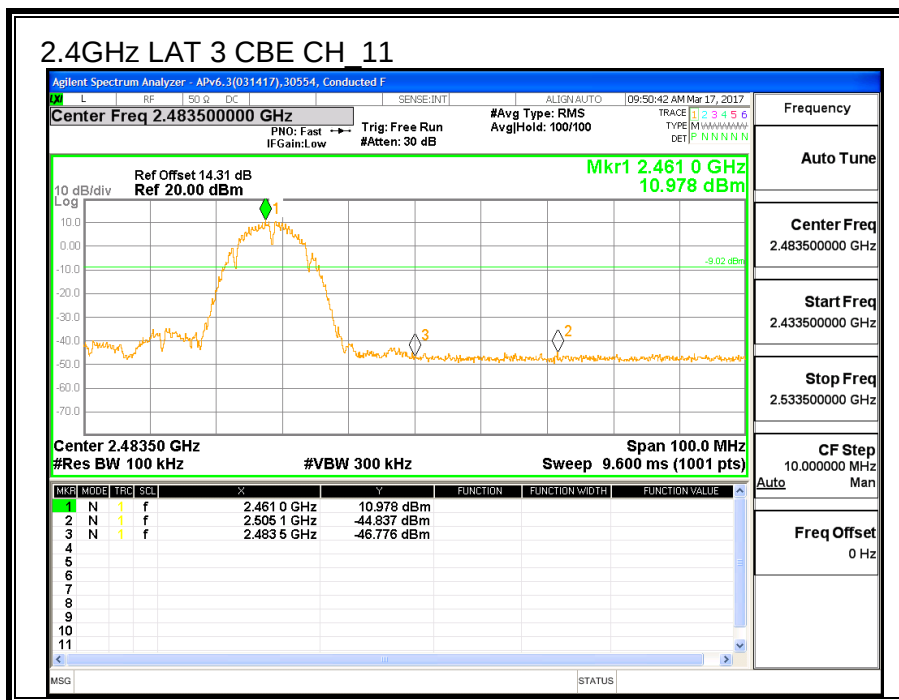
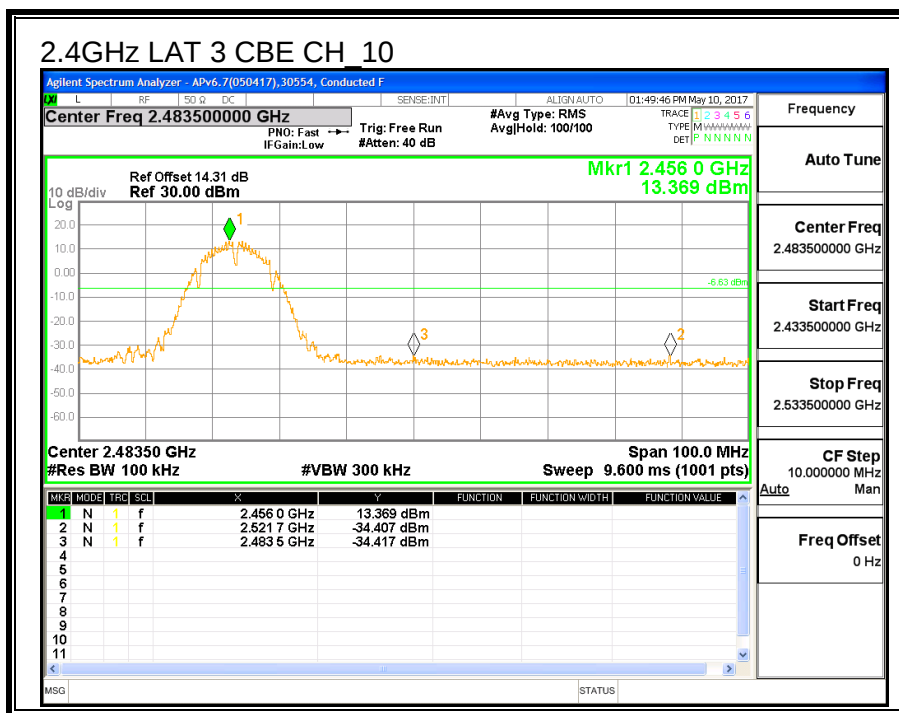
IC RSS-247 (5.5)

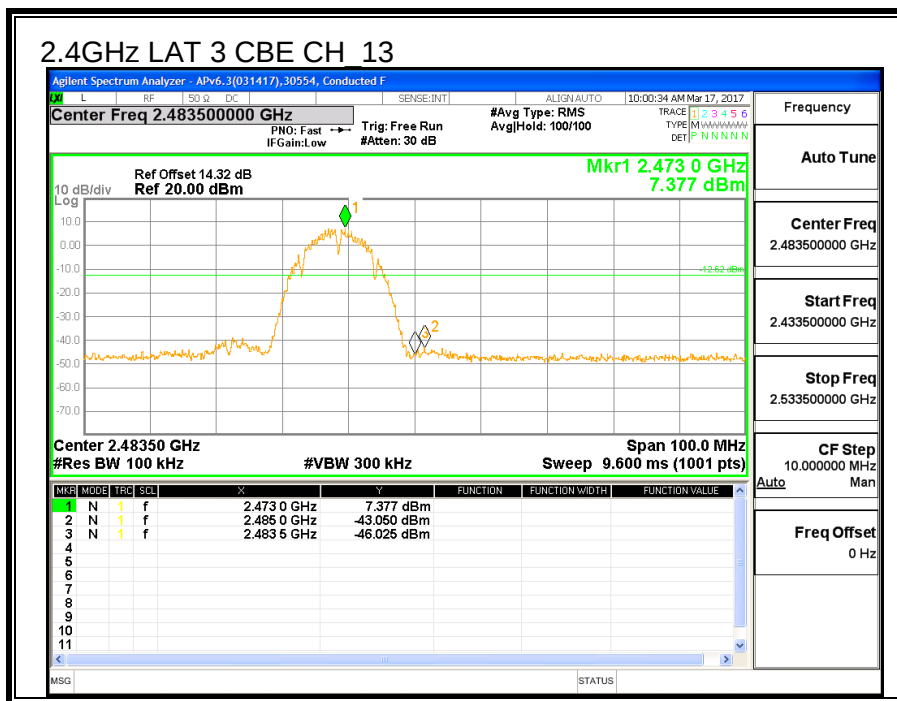
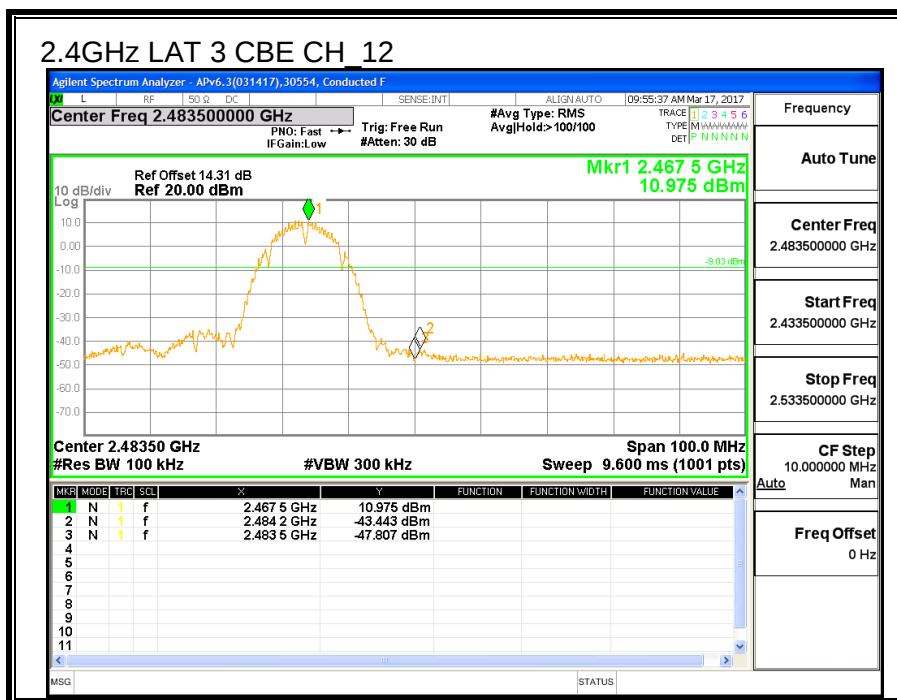
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

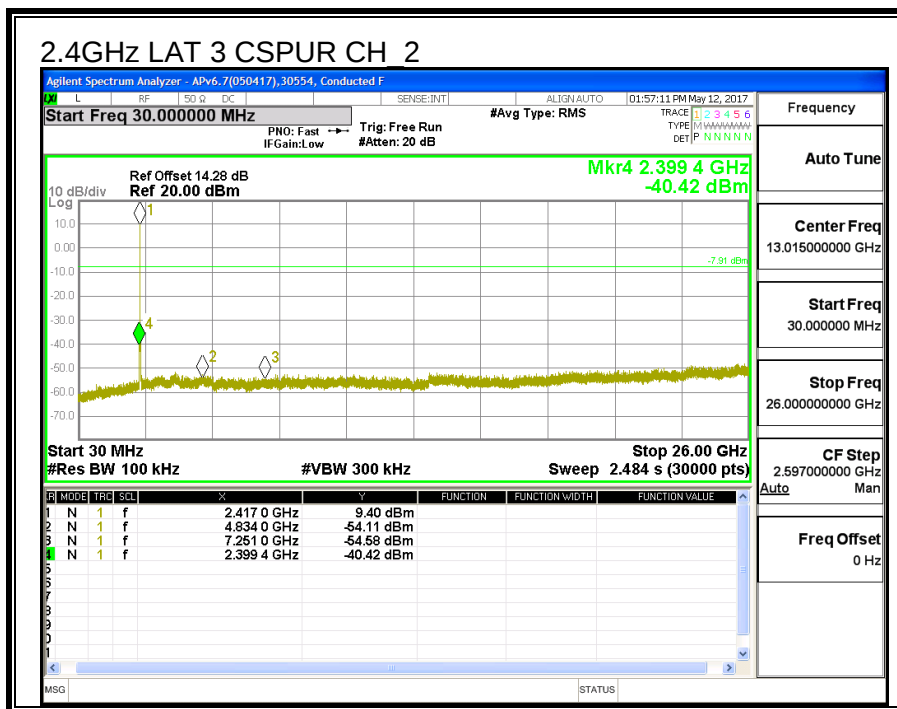
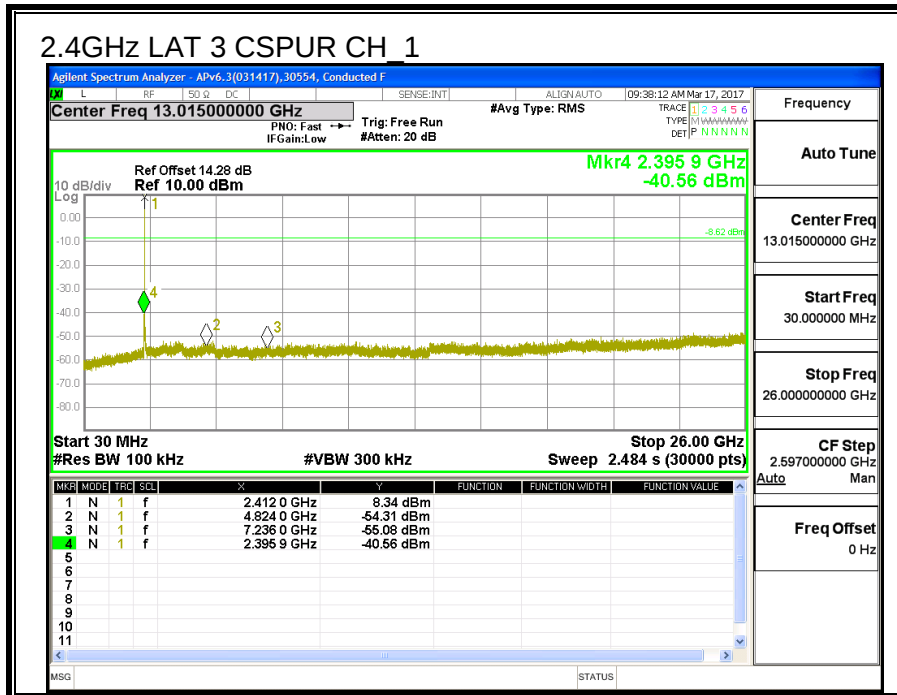
# **CONDUCTED BANDEGE AND SPURIOUS EMISSIONS**

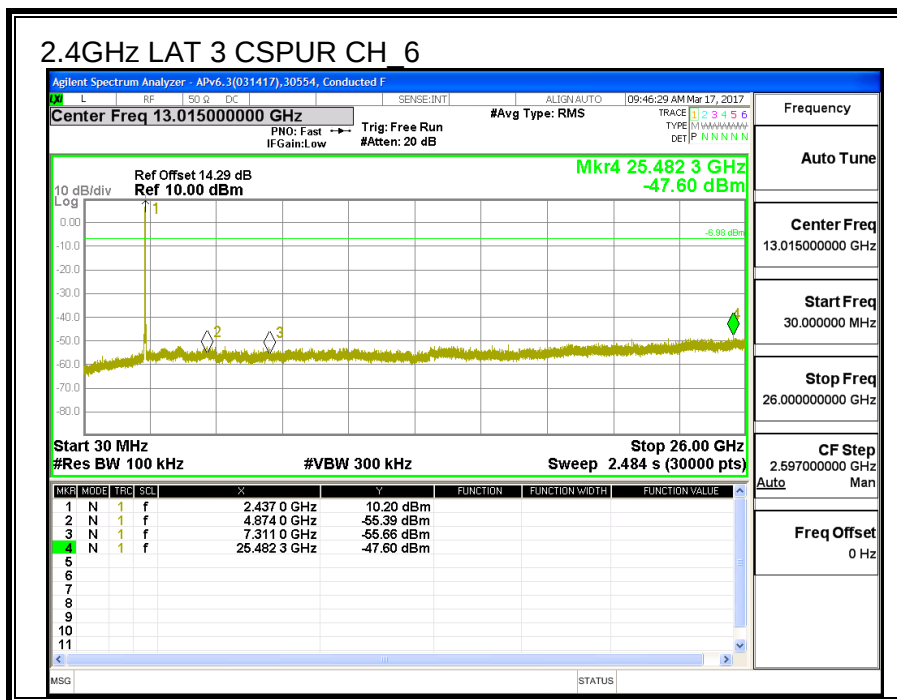
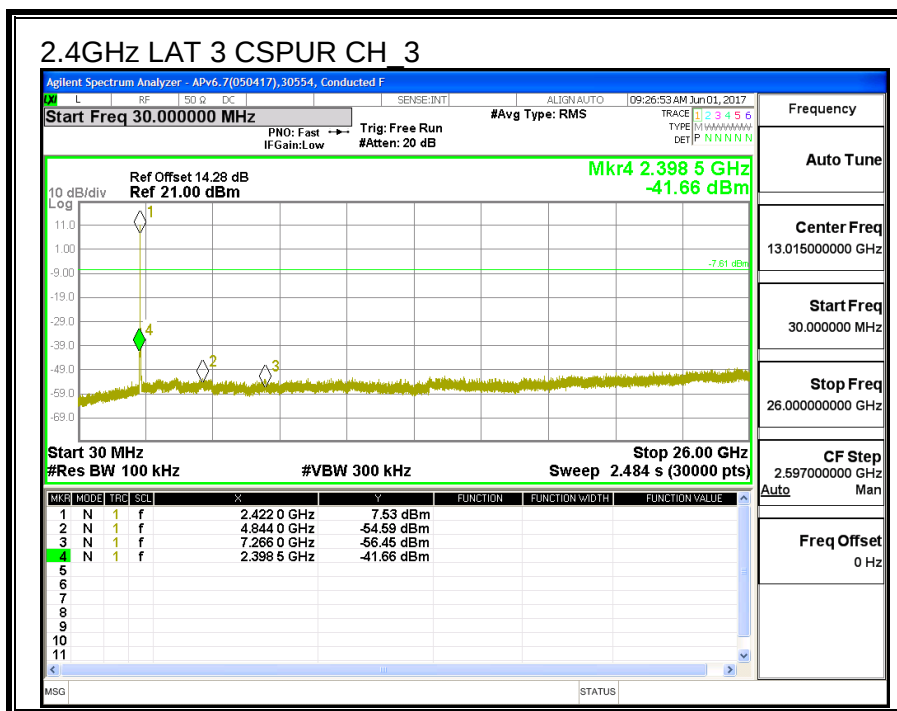


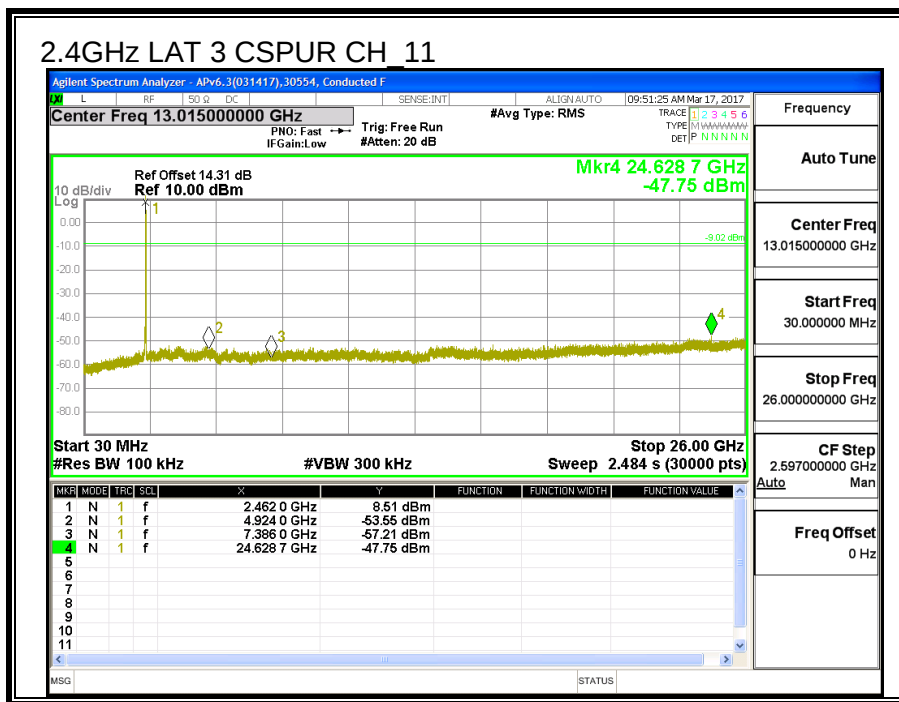
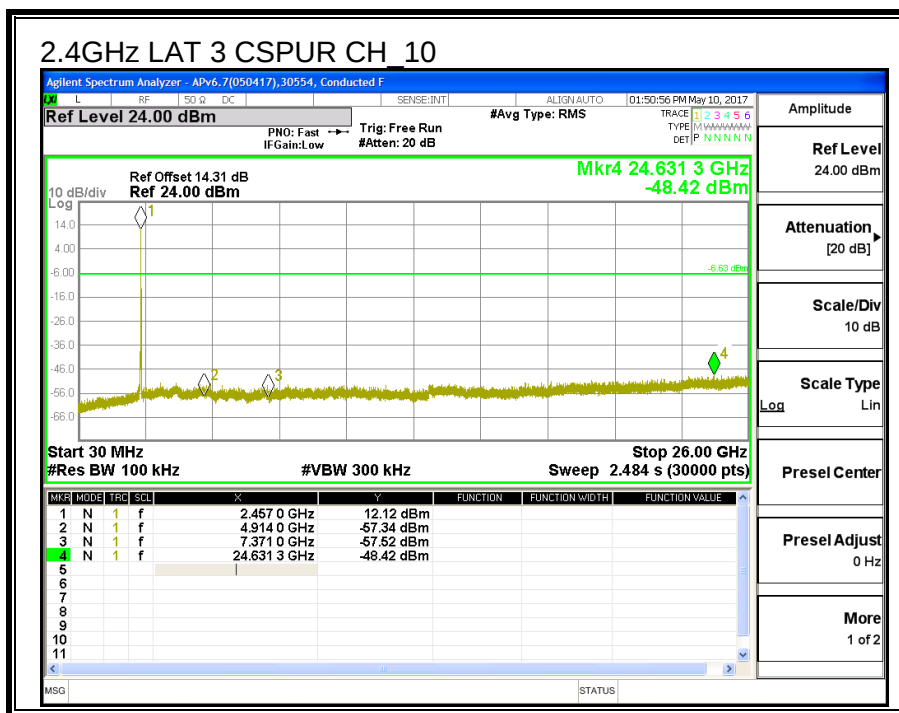


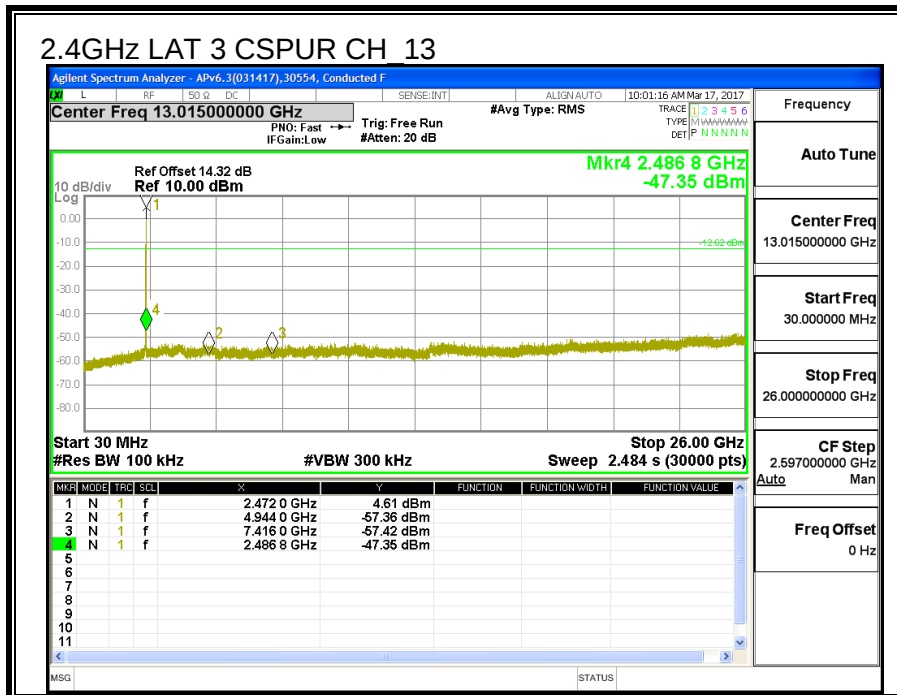
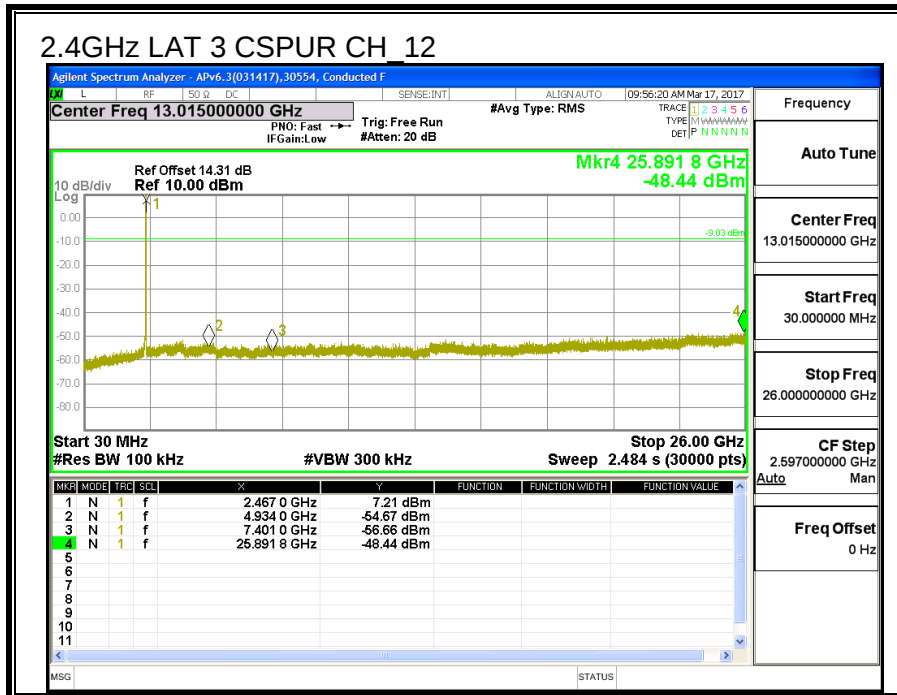












## 8.4. 11n HT20 UAT 1 SISO MODE IN THE 2.4GHz BAND

### 8.4.1. 6 dB BANDWIDTH

#### LIMITS

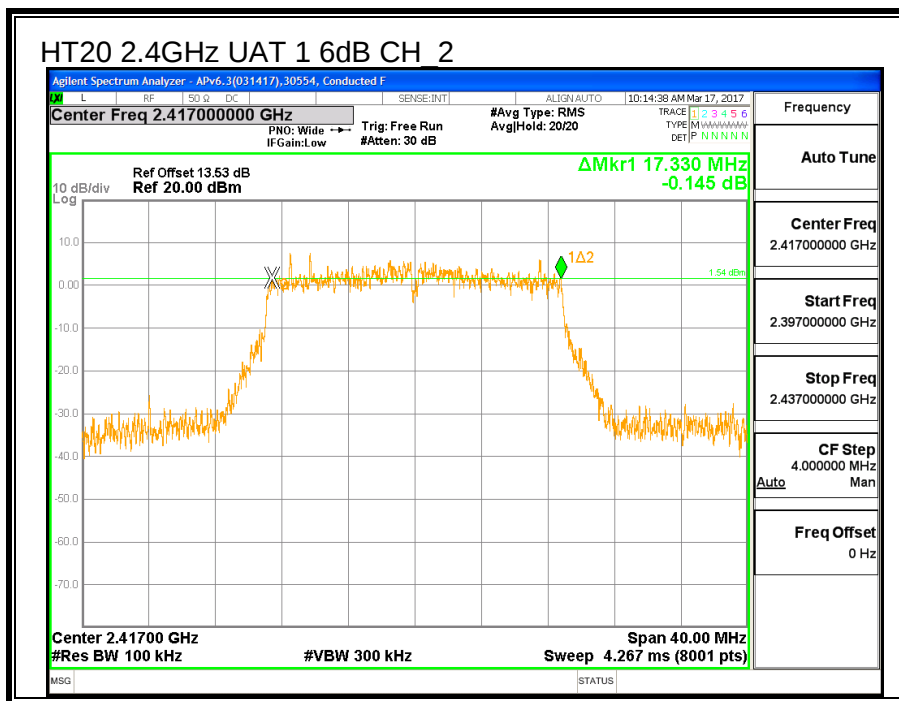
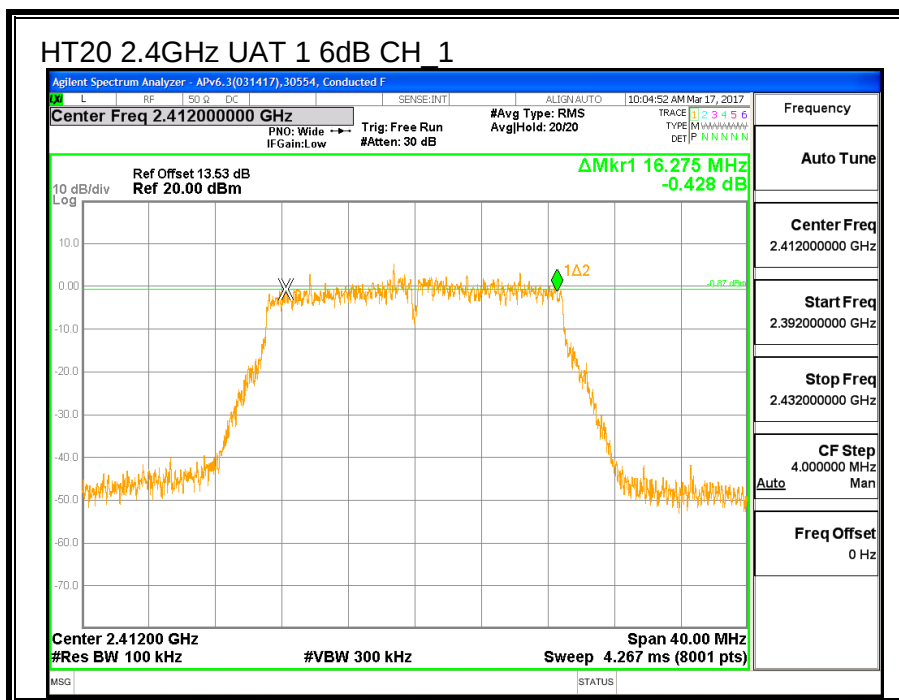
FCC §15.247 (a) (2)

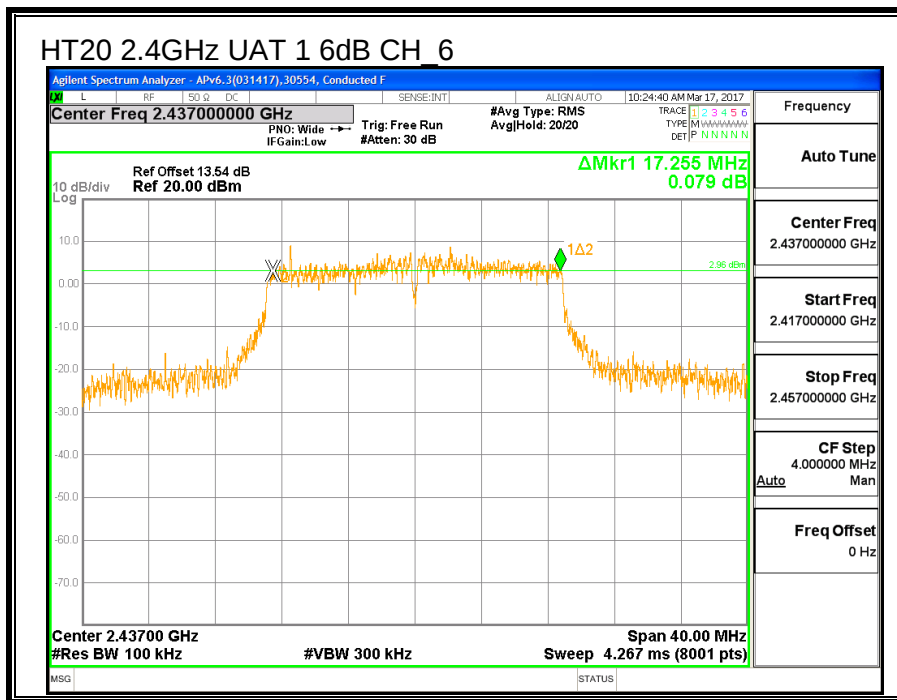
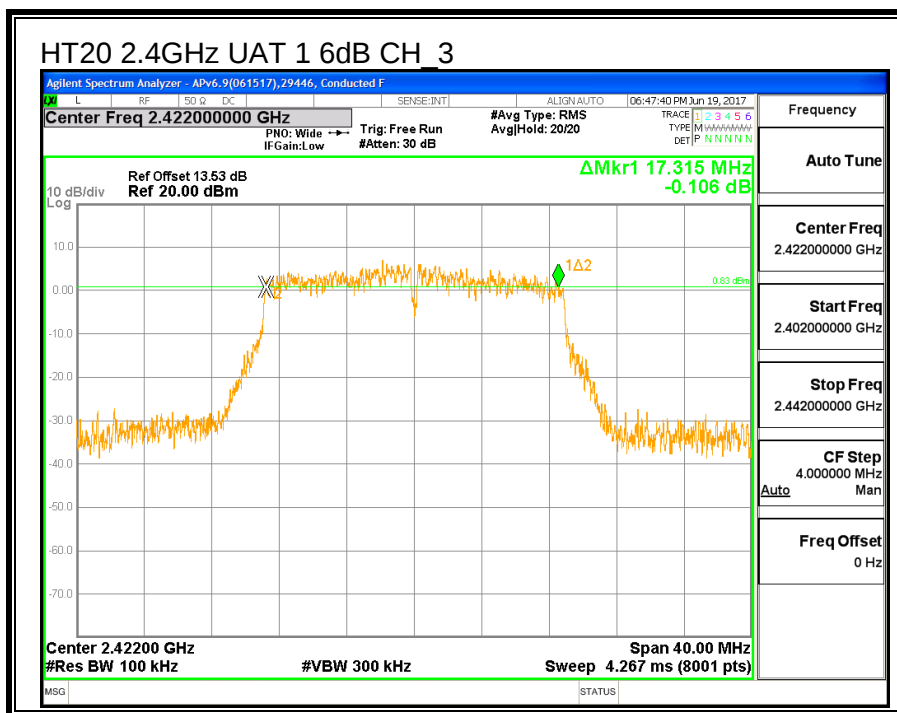
IC RSS-247 (5.2) (a)

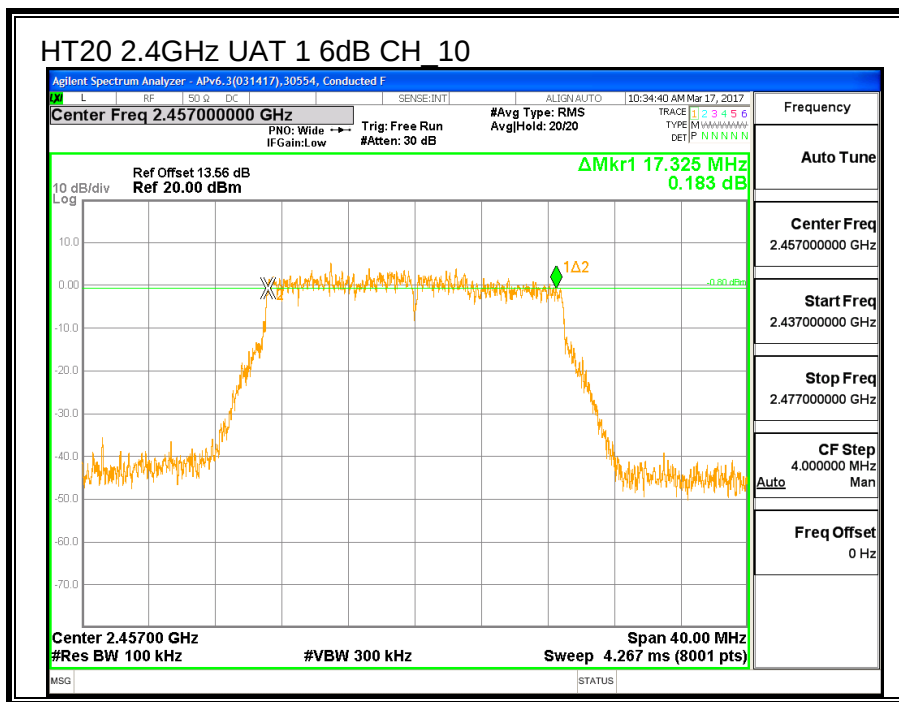
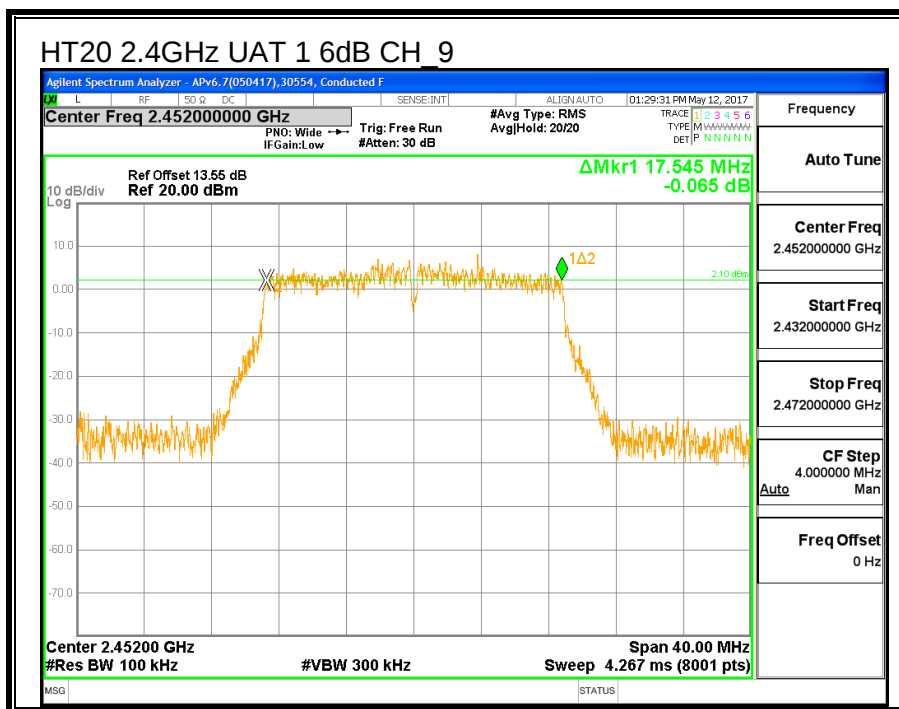
The minimum 6 dB bandwidth shall be at least 500 kHz.

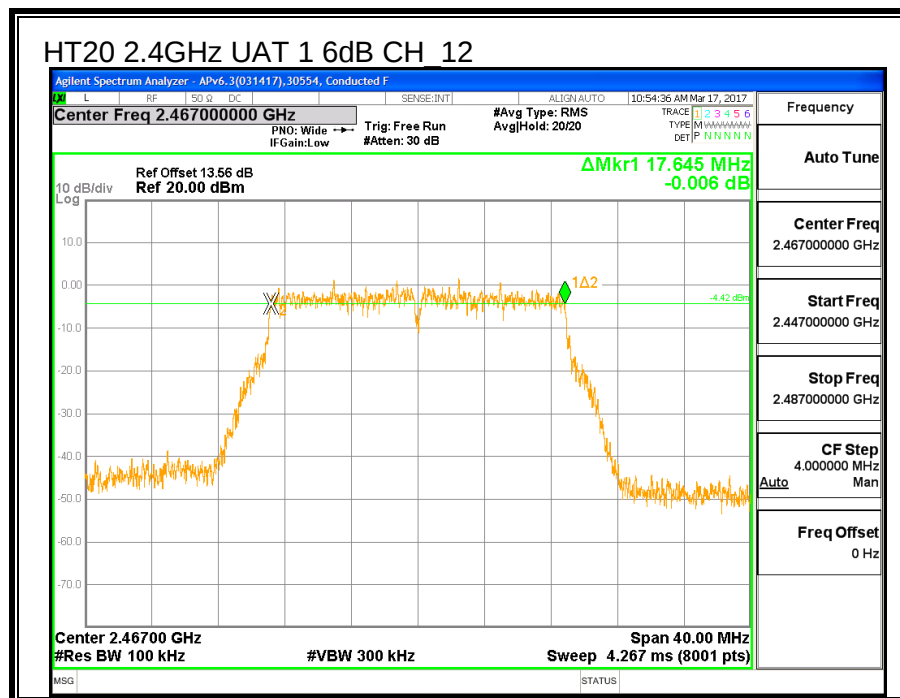
#### RESULTS

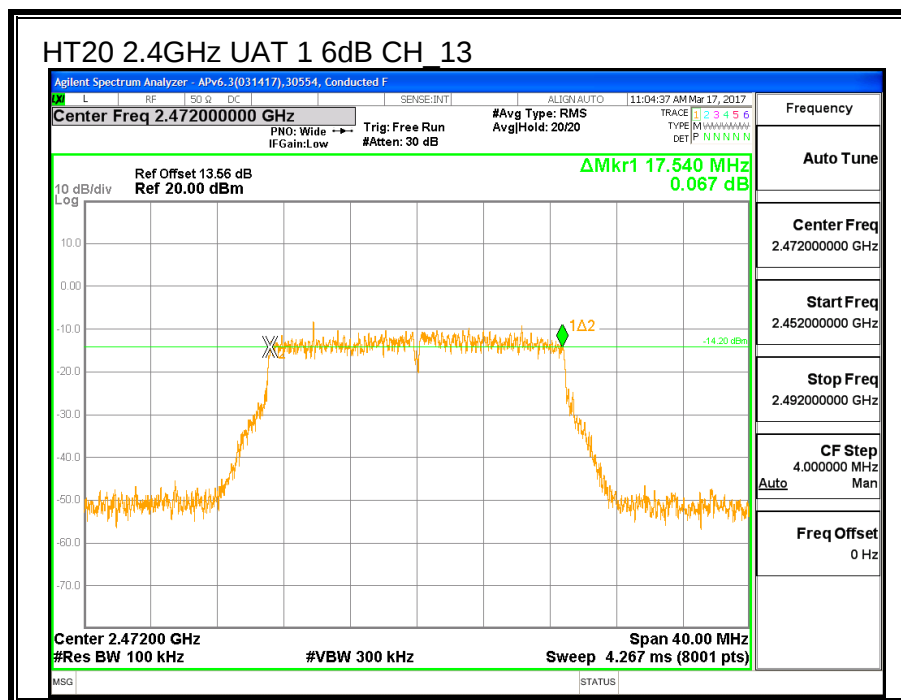
| Channel  | Frequen<br>cy | 6 dB BW<br>UAT 1<br>(MHz) | Minimum Limit<br>(MHz) |
|----------|---------------|---------------------------|------------------------|
| Low_1    | 2412          | 16.275                    | 0.5                    |
| Low_2    | 2417          | 17.330                    | 0.5                    |
| Low_3    | 2422          | 17.315                    | 0.5                    |
| Middle_6 | 2437          | 17.255                    | 0.5                    |
| High_9   | 2452          | 17.545                    | 0.5                    |
| High_10  | 2457          | 17.325                    | 0.5                    |
| High_11  | 2462          | 16.520                    | 0.5                    |
| High_12  | 2467          | 17.645                    | 0.5                    |
| High_13  | 2472          | 17.540                    | 0.5                    |











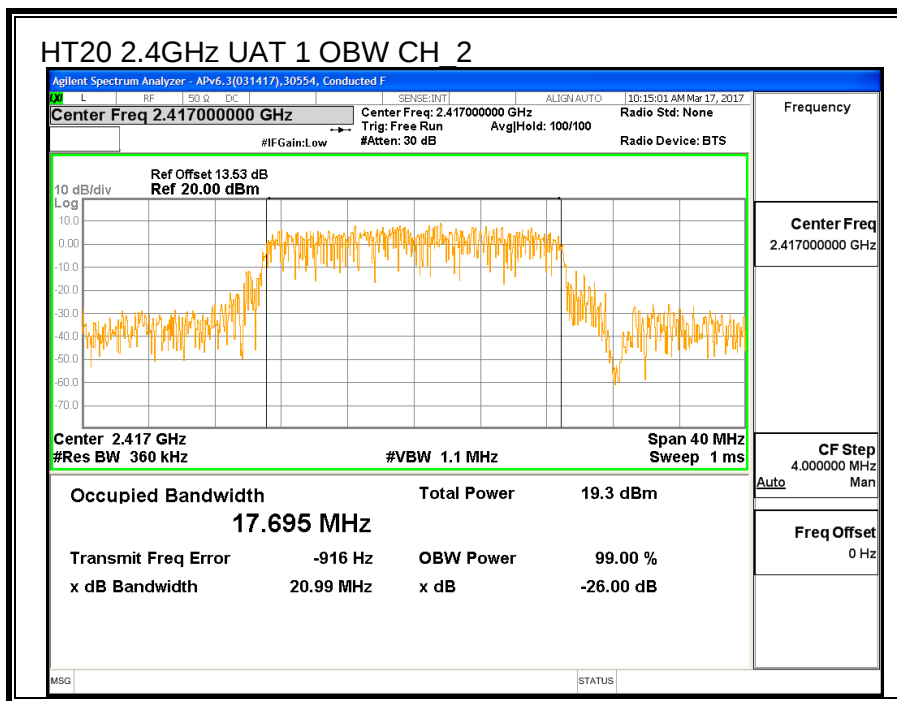
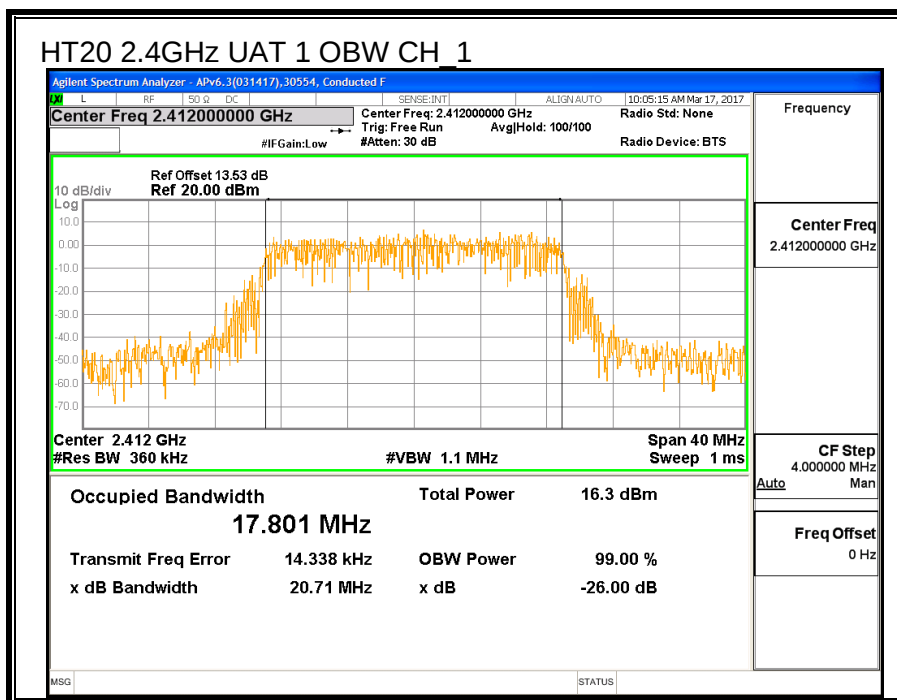
#### 8.4.2. 99% BANDWIDTH

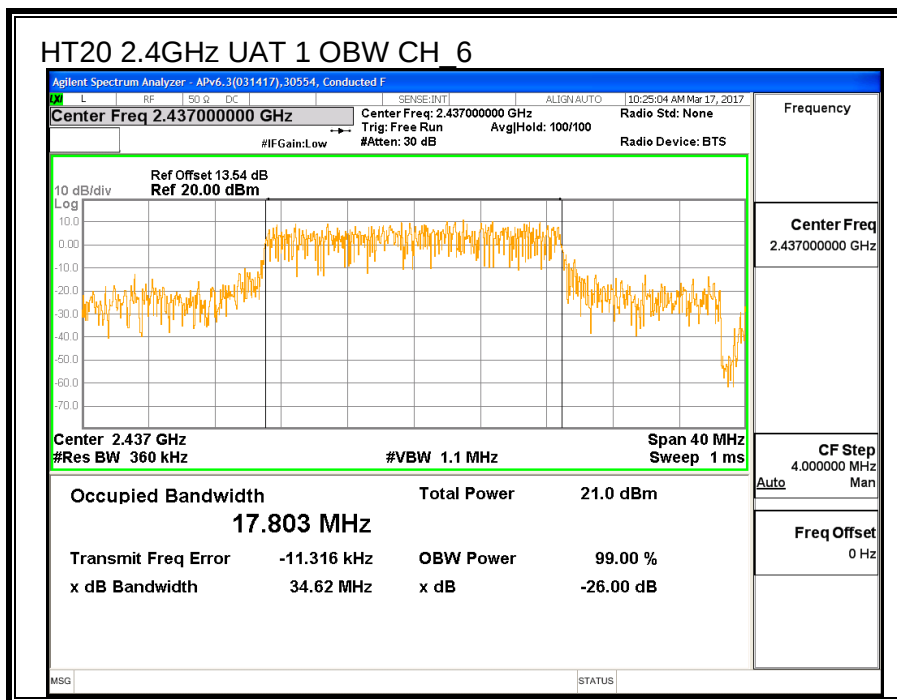
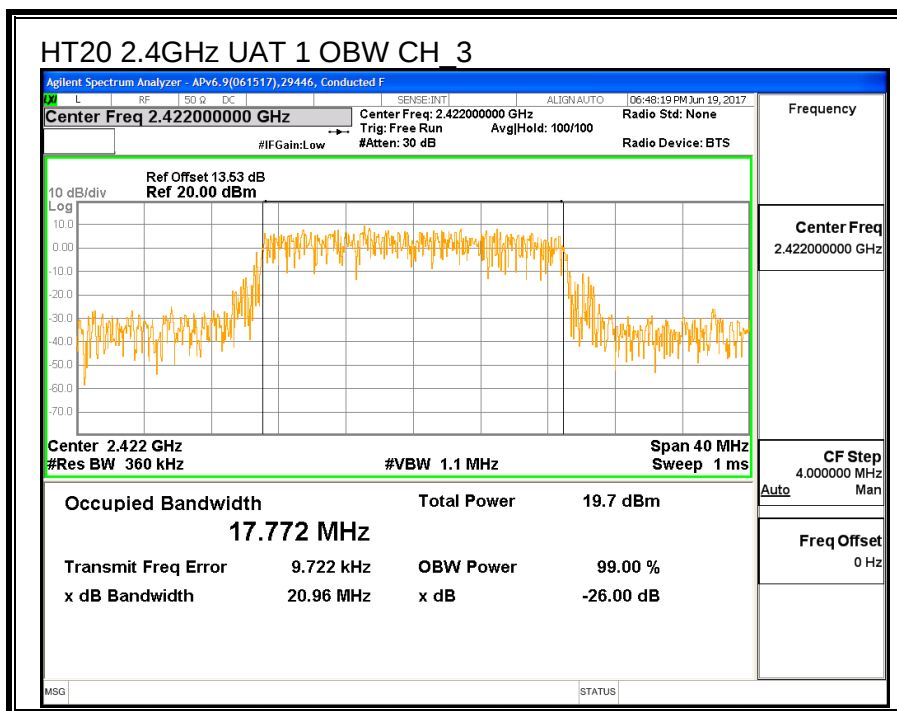
##### LIMITS

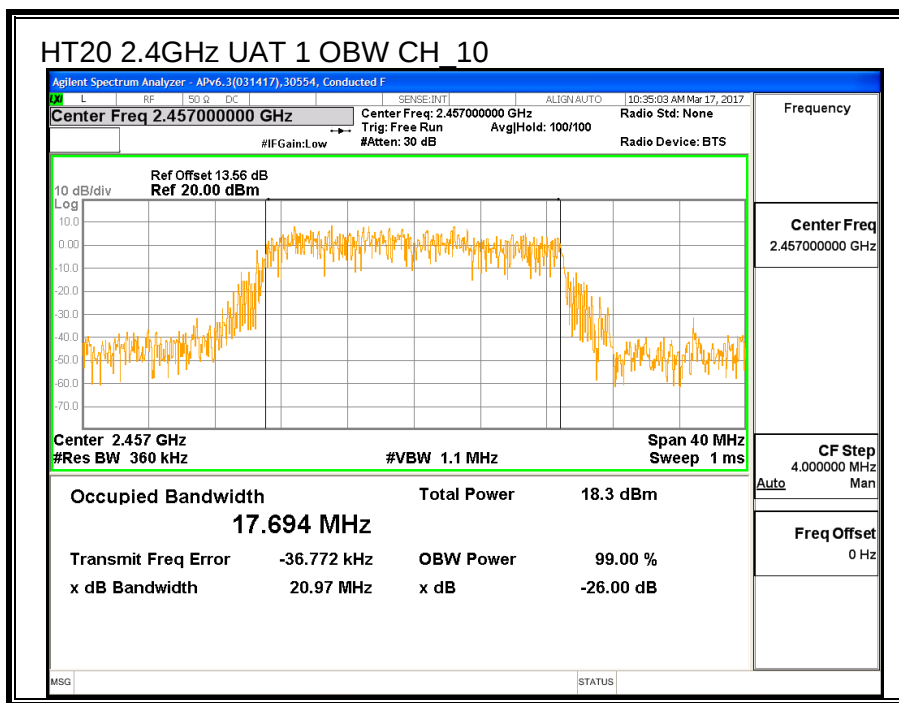
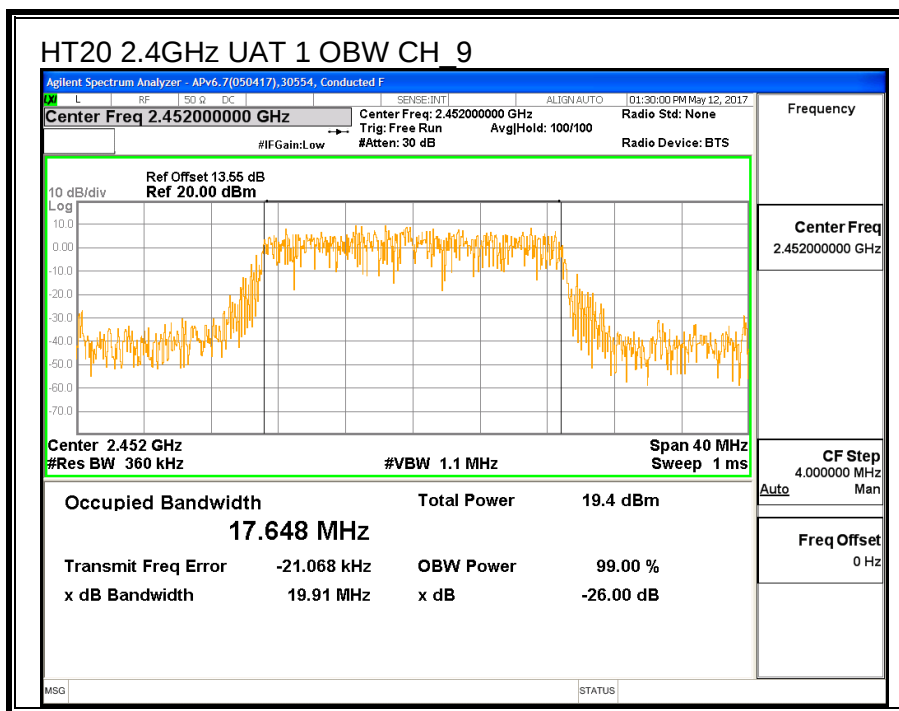
None; for reporting purposes only.

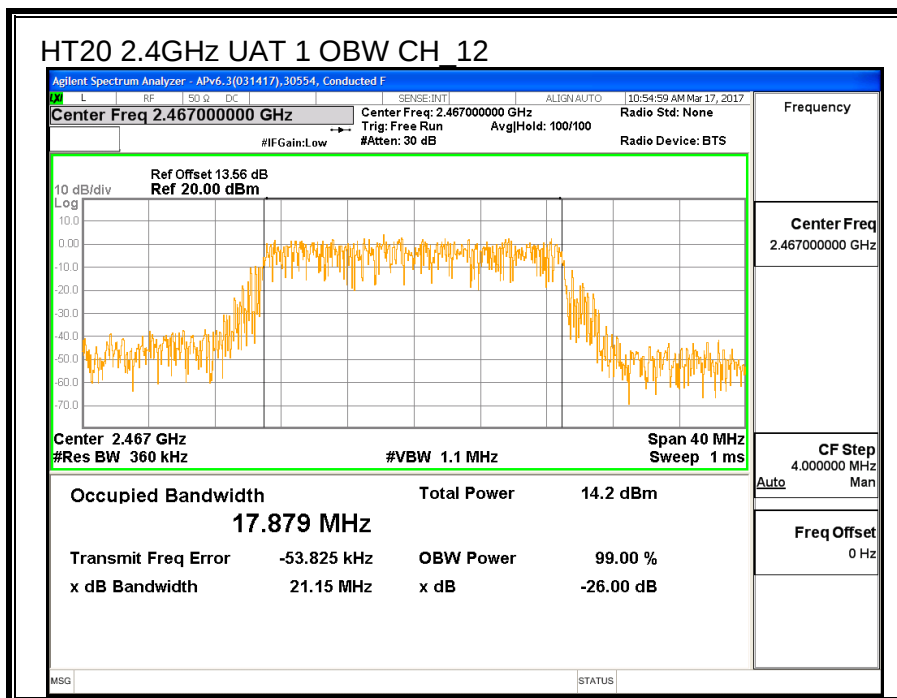
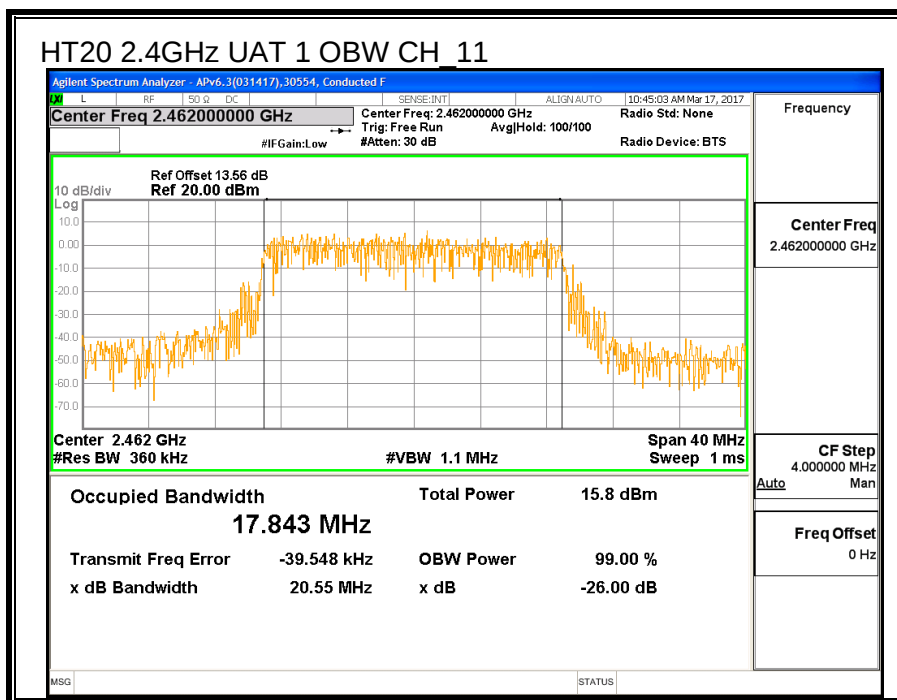
##### RESULTS

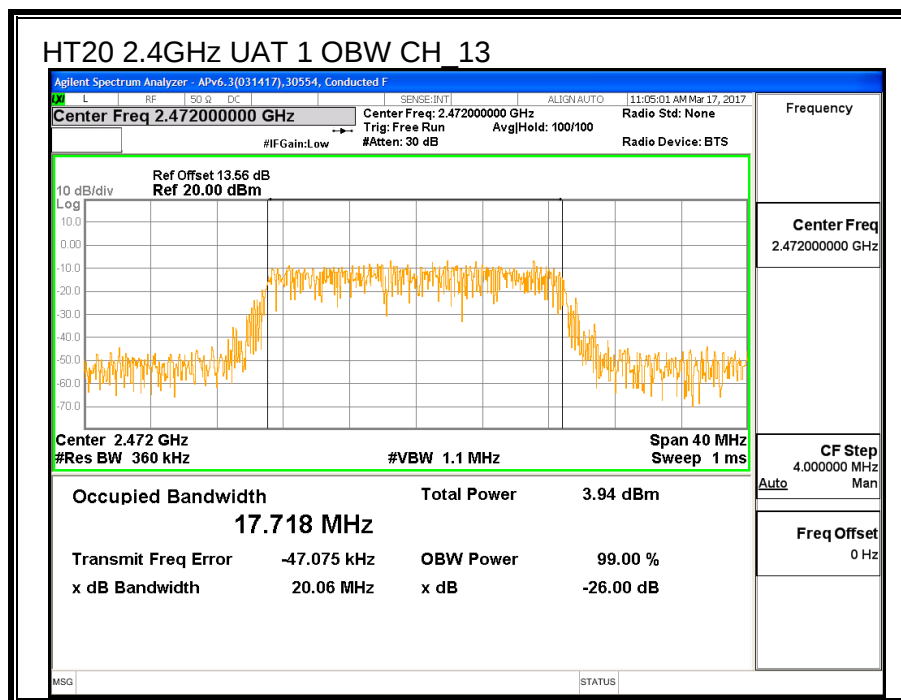
| Channel  | Frequency (MHz) | 99% Bandwidth UAT 1 (MHz) |
|----------|-----------------|---------------------------|
| Low_1    | 2412            | 17.801                    |
| Low_2    | 2417            | 17.695                    |
| Low_3    | 2422            | 17.772                    |
| Middle_6 | 2437            | 17.803                    |
| High_9   | 2452            | 17.648                    |
| High_10  | 2457            | 17.694                    |
| High_11  | 2462            | 17.843                    |
| High_12  | 2467            | 17.879                    |
| High_13  | 2472            | 17.718                    |











### 8.4.3. AVERAGE POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

#### LIMITS

None; for reporting purposes only.

#### RESULTS

| Channel  | Frequency (MHz) | Power UAT 1 (MHz) |
|----------|-----------------|-------------------|
| Low_1    | 2412            | 15.99             |
| Low_2    | 2417            | 18.32             |
| Low_3    | 2422            | 19.86             |
| Middle_6 | 2437            | 20.79             |
| High_9   | 2452            | 19.94             |
| High_10  | 2457            | 17.39             |
| High_11  | 2462            | 15.82             |
| High_12  | 2467            | 13.47             |
| High_13  | 2472            | 3.98              |

#### 8.4.4. OUTPUT POWER

|            |       |              |         |
|------------|-------|--------------|---------|
| <b>ID:</b> | 39472 | <b>Date:</b> | 6/11/17 |
|------------|-------|--------------|---------|

#### LIMITS

FCC §15.247

IC RSS-247 (5.4) (d)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### DIRECTIONAL ANTENNA GAIN

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

## RESULTS

|         | (MHz) | Gain<br>(dBi) | Power<br>Limit<br>(dBm) | Power<br>Limit<br>(dBm) | EIRP<br>Limit<br>(dBm) | Power<br>(dBm) |
|---------|-------|---------------|-------------------------|-------------------------|------------------------|----------------|
| Low_1   | 2412  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| Low_2   | 2417  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| Low_3   | 2422  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| Mid     | 2437  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| High_9  | 2452  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| High_10 | 2457  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| High_11 | 2462  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| High_12 | 2467  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |
| High_13 | 2472  | 1.01          | 30.00                   | 30                      | 36                     | 30.00          |

|                    |      |                                          |
|--------------------|------|------------------------------------------|
| Duty Cycle CF (dB) | 0.00 | Included in Calculations of Corr'd Power |
|--------------------|------|------------------------------------------|

## Results

| Channel | Frequency<br>(MHz) | Meas<br>Power<br>(dBm) | Total<br>Corr'd<br>Power<br>(dBm) | Power<br>Limit<br>(dBm) | Margin<br>(dB) |
|---------|--------------------|------------------------|-----------------------------------|-------------------------|----------------|
| Low_1   | 2412               | 23.05                  | 23.05                             | 30.00                   | -6.95          |
| Low_2   | 2417               | 25.01                  | 25.01                             | 30.00                   | -4.99          |
| Low_3   | 2422               | 25.74                  | 25.74                             | 30.00                   | -4.26          |
| Mid     | 2437               | 27.44                  | 27.44                             | 30.00                   | -2.56          |
| High_9  | 2452               | 26.51                  | 26.51                             | 30.00                   | -3.49          |
| High_10 | 2457               | 24.22                  | 24.22                             | 30.00                   | -5.78          |
| High_11 | 2462               | 22.63                  | 22.63                             | 30.00                   | -7.37          |
| High_12 | 2467               | 20.11                  | 20.11                             | 30.00                   | -9.89          |
| High_13 | 2472               | 10.77                  | 10.77                             | 30.00                   | -19.23         |

## 8.4.5. POWER SPECTRAL DENSITY

### LIMITS

FCC §15.247

IC RSS-247 (5.2) (b)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

### RESULTS

|                               |   |                                                                    |
|-------------------------------|---|--------------------------------------------------------------------|
| <b>Duty Cycle<br/>CF (dB)</b> | 0 | <b>Included<br/>in<br/>Calculatio<br/>ns of<br/>Corr'd<br/>PSD</b> |
|-------------------------------|---|--------------------------------------------------------------------|

Results

| <b>Channel</b> | <b>Frequency<br/>(MHz)</b> | <b>Meas UAT<br/>1 (MHz)</b> | <b>Total<br/>Corr'd<br/>Power<br/>(dBm)</b> | <b>Limit<br/>(dBm)</b> | <b>Margin<br/>(dB)</b> |
|----------------|----------------------------|-----------------------------|---------------------------------------------|------------------------|------------------------|
| Low_1          | 2412                       | -9.937                      | -9.937                                      | 8                      | -17.937                |
| Low_2          | 2417                       | -5.966                      | -5.966                                      | 8                      | -13.966                |
| Low_3          | 2422                       | -5.233                      | -5.233                                      | 8                      | -13.233                |
| Middle_6       | 2437                       | -3.610                      | -3.610                                      | 8                      | -11.610                |
| High_9         | 2452                       | -4.264                      | -4.264                                      | 8                      | -12.264                |
| High_10        | 2457                       | -7.359                      | -7.359                                      | 8                      | -15.359                |
| High_11        | 2462                       | -9.802                      | -9.802                                      | 8                      | -17.802                |
| High_12        | 2467                       | -11.014                     | -11.014                                     | 8                      | -19.014                |
| High_13        | 2472                       | -21.191                     | -21.191                                     | 8                      | -29.191                |

