HCT CO.,LTD

74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA
TEL: +82-31-645-6300 FAX: +82-31-645-6401

# FCC /ISED REPORT

**Class II Permissive Change**

**Applicant Name:**
SOLiD, Inc.

**Address:**
10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea

**Date of Issue:**
September 19, 2016

**Location:**
HCT CO., LTD.,
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

**Report No.:** HCT-R-1609-F014-1
**HCT FRN:** 0005866421
**IC Recognition No.:** 5944A-5

| | |
|---|---|
| **FCC ID:** | **W6UL23WCS** |
| **IC:** | **9354A-L23WCS** |
| **APPLICANT:** | **SOLiD, Inc** |

| | |
|---|---|
| **FCC/ IC Model(s):** | L2RDU_2300_WCS |
| **EUT Type:** | ALLIANCE_2W |
| **Frequency Ranges:** | 2350-2360 MHz (Downlink) |
| **Conducted Output Power:** | 2 W (33 dBm) |
| **Date of Test:** | September 1, 2016 ~ September 8, 2016 |
| **FCC Rule Part(s):** | CFR 47 Part 2, Part 27 |
| **IC Rules :** | RSS-Gen (Issue 4, November 2014), RSS-131 (Issue 2, July 2003) |

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from thisequipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC / IC Rules under normal use and maintenance.

**Report prepared by**
**: Kyung Soo Kang**
**Test Engineer of RF Team**

**Approved by**
**: Jong Seok Lee**
**Manager of RF Team**

# Version

| TEST REPORT NO. | DATE | DESCRIPTION |
|---|---|---|
| HCT-R-1609-F014 | September 13, 2016 | - First Approval Report |
| HCT-R-1609-F014-1 | September 19, 2016 | - Revise the PAPR data table on page 15.<br>- Add the spurious plot according to part 27.53. |
| | | |
| | | |

# Table of Contents

# 1. CLIENT INFORMATION

**The EUT has been tested by request of**

| | |
|---|---|
| **Company** | SOLiD, Inc.<br><br>10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea |

| | |
|---|---|
| **FCC ID:** | W6UL23WCS |
| **IC:** | 9354A-L23WCS |
| **EUT Type:** | ALLIANCE_2W |
| **FCC/ IC Model(s):** | L2RDU_2300_WCS |
| **Frequency Ranges:** | 2350-2360 MHz (Downlink) |
| **Conducted Output Power:** | 2 W (33 dBm) |
| **Antenna Gain(s):** | Manufacturer does not provide an antenna. |
| **Measurement standard(s):** | ANSI/TIA-603-C-2004, KDB 971168 D01 v02r02<br>KDB 935210 D02 v03r02, KDB 935210 D05 v01r01,<br>RSS-GEN, RSS-131 |
| **FCC Rule Part(s):** | CFR 47 Part 2, Part 27 |
| **IC Rules Part(s):** | RSS-Gen (Issue 4, November 2014), RSS-131 (Issue 2, July 2003), |
| **Place of Tests:** | 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA(IC Recognition No. : 5944A-5) |

# 2. FACILITIES AND ACCREDITATIONS

## 2.1. FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661).

## 2.2. EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.
Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

# 3. TEST SPECIFICATIONS

## 3.1. STANDARDS

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 2, Part 27, RSS-GEN, RSS-130, RSS-199.

| Description | Reference (FCC) | Reference (IC) | Results |
|---|---|---|---|
| Conducted RF Output Power | §2.1046, §27.50 | RSS-131, Section 4.3<br>RSS-131, Section 6.2<br>SRSP-516 | Compliant |
| Occupied Bandwidth | §2.1049 | RSS-GEN, Section 6.6 | Compliant |
| Passband Gain and Bandwidth & Out of Band Rejection | KDB 935210 D02 v03r02 | RSS-131, Section 4.2<br>RSS-131, Section 6.1 | Compliant |
| Spurious Emissions at Antenna Terminals | §2.1051, §27.53 | RSS-131, Section 4.4<br>RSS-131, Section 6.3<br>RSS-131, Section 6.4<br>SRSP-516 | Compliant |
| Radiated Spurious Emissions | §2.1053, §27.53 | - | Compliant |
| Frequency Stability | §2.1055, §27.54 | RSS-131, Section 4.5<br>RSS-131, Section 6.5 | Compliant |

## 3.2. MODE OF OPERATION DURING THE TEST

The EUT was operated in a manner representative of the typical usage of the equipment.

During all testing, system components were manipulated within the confines of typical usage to maximize each emission.

The device does not supply antenna(s) with the system, so the dummy loads were connected to the RF output ports for radiated spurious emission testing.

## 3.3. MAXIMUM MEASUREMENTUNCERTAINTY

The value of the measurement uncertainty for the measurement of each parameter.

Coverage factor *k* = 2, Confidence levels of 95 %

| Description | Condition | Uncertainty |
|---|---|---|
| Conducted RF Output Power | - | ± 0.72 dB |
| Occupied Bandwidth | OBW ≤ 20 MHz | ± 52 kHz |
| Passband Gain<br>and Bandwidth<br>& Out of Band Rejection | Gain<br>20 dB bandwidth | ± 0.89 dB<br>± 0.58 MHz |
| Spurious Emissions at Antenna Terminals | - | ± 1.08 dB |
| Radiated Spurious Emissions | f ≤ 1 GHz<br>f > 1 GHz | ± 4.80 dB<br>± 6.07 dB |
| Frequency Stability | - | ± 1.22 x $10^{-6}$ |

# 4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

| | |
|---|---|
| **Temperature :** | **+ 15 ℃ to + 35 ℃** |
| **Relative humidity:** | **30 % to 60 %** |
| **Air pressure** | **860 mbar to 1 060 mbar** |

# 5. TEST EQUIPMENT

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|---|---|---|---|---|
| Agilent | E4438C /Signal Generator | 09/02/2016 | Annual | MY42082646 |
| Agilent | N5182A /Signal Generator | 03/29/2016 | Annual | MY50141649 |
| Agilent | N5182A /Signal Generator | 05/13/2016 | Annual | MY47070230 |
| Agilent | N9030A / Signal Analyzer | 11/24/2015 | Annual | MY49431210 |
| Weinschel | 67-30-33 / Fixed Attenuator | 10/29/2015 | Annual | BR5347 |
| Weinschel | 1506A / Power Divider | 02/15/2016 | Annual | MD793 |
| DEAYOUNG ENT | DFSS60 / AC Power Supply | 04/06/2016 | Annual | 1003030-1 |
| AMETEK | XFR 60-20 / DC Power Supply | 02/27/2016 | Annual | 1045A01016 |
| NANGYEUL CO., LTD. | NY-THR18750 / Temperature and Humidity Chamber | 10/27/2015 | Annual | NY-2009012201A |
| Innco system | MA4000-EP / Antenna Position Tower | N/A | N/A | N/A |
| Innco system | CT0800 / Turn Table | N/A | N/A | N/A |
| Innco system | CO3000 / Controller(Antenna mast) | N/A | N/A | CO3000-4p |
| ETS | 2090 / Controller(Turn table) | N/A | N/A | 1646 |
| Rohde&Schwarz | Loop Antenna | 02/23/2016 | Biennial | 1513-175 |
| Schwarzbeck | VULB 9168 / Hybrid Antenna | 04/15/2015 | Biennial | 255 |
| Schwarzbeck | BBHA 9120D / Horn Antenna | 12/11/2015 | Biennial | 9120D-1191 |
| Schwarzbeck | BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz) | 09/03/2015 | Biennial | BBHA9170541 |
| Rohde & Schwarz | FSP / Spectrum Analyzer | 10/05/2015 | Annual | 836650/016 |
| Rohde & Schwarz | FSV40-N / Spectrum Analyzer | 09/23/2015 | Annual | 101068-SZ |
| Wainwright Instruments | WHK1.2/15G-10EF / Highpass Filter | 04/11/2016 | Annual | 4 |
| Wainwright Instruments | WHK3.0/18G-10EF / Highpass Filter | 06/24/2016 | Annual | 8 |
| CERNEX | CBLU1183540 / Power Amplifier | 02/01/2016 | Annual | 24614 |
| CERNEX | CBL06185030 / Power Amplifier | 02/01/2016 | Annual | 24615 |
| CERNEX | CBL18265035 / Power Amplifier | 07/11/2016 | Annual | 22966 |

# 6. RF OUTPUT POWER

**FCC Rules**

**Test Requirements:**

**§ 2.1046 Measurements required: RF power output:**

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8).The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radio telephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

**§ 27.50 Power limits and duty cycle.**

(a) The following power limits and related requirements apply to stations transmitting in the 2305-2320 MHz band or the 2345-2360 MHz band.(1) Base and fixed stations. (i) For base and fixed stations transmitting in the 2305-2315 MHz band or the 2350-2360 MHz band:

(A) The average equivalent isotropically radiated power (EIRP) must not exceed 2,000 watts within any 5 megahertz of authorized bandwidth and must not exceed 400 watts within any 1 megahertz of authorized bandwidth.

(B) The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB. The PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that PAPR will not exceed 13 dB for more than 0.1 percent of the time or other Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

**Test Procedures:**

Measurements were in accordance with the test methods section 3.5.2 of KDB 935210 D05 v01r01.

a) Connect a signal generator to the input of the EUT.

b) Configure to generate the AWGN (broadband) test signal.

c) The frequency of the signal generator shall be set to the frequency f0 as determined from 3.3.

d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.

e) Set the signal generator output power to a level that produces an EUT output level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.

f) Measure and record the output power of the EUT; use 3.5.3 or 3.5.4 for power measurement.

g) Remove the EUT from the measurement setup. Using the same signal generator settings, repeat the power measurement at the signal generator port, which was used as the input signal to the EUT, and record as the input power. EUT gain may be calculated as described in 3.5.5.

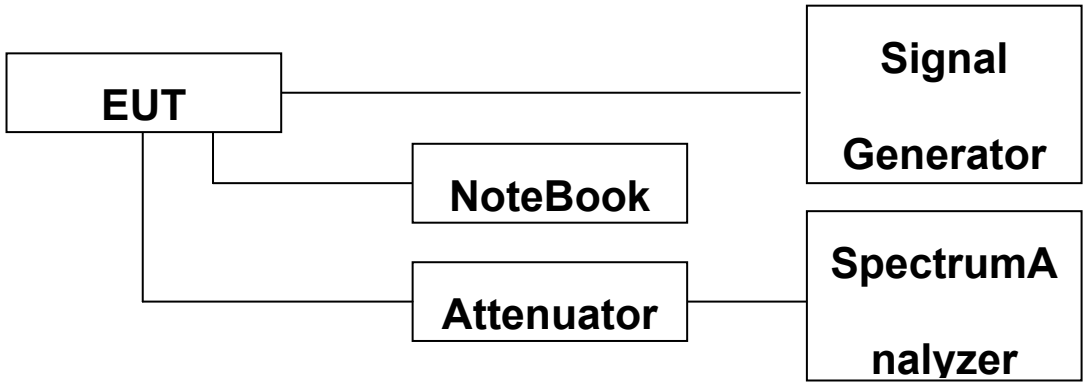
h) Repeat steps f) and g) with input signal amplitude set to 3 dB above the AGC threshold level.

i) Repeat steps e) to h) with the narrowband test signal.

j) Repeat steps e) to i) for all frequency bands authorized for use by the EUT.

**Power measurement Method:**

Guidance for performing input/output power measurements using a spectrum or signal analyzer is provided in 5.2 of KDB Publication 971168.




**Block Diagram 1. RF Power Output Test Setup**

**IC Rules**

**Test Requirements:**

**SRSP-516**

**5. Technical Criteria**

**5.1 Radiated Power Limits**

**5.1.1 Base and Fixed Stations**

5.1.1.1 The equivalent isotropically radiated power (e.i.r.p.) of the base and fixed stations (with the exception of fixed subscriber stations) operating in the band 2305-2315 MHz or in the band 2350-2360 MHz shall not exceed 400 watts within any 1 MHz band; and shall not exceed 2000 W within any 5 MHz of bandwidth. The peak to average power ratio (PAPR) of these transmissions shall comply with the limits specified in RSS-195.

5.1.1.2 The e.i.r.p. of the base and fixed stations (with the exception of fixed subscriber stations) operating in the band 2315-2320 MHz or in the band 2345-2350 MHz shall not exceed 2000 W within either 5 MHz band.

**RSS-131**

**6. Equipment Standard Specification**

**6.2 Output Power**

The manufacturer's output power rating Prated MUST NOT be greater than Pmean for all types ofenhancers.

**Additional Power Back-off Condition for Multiple Carrier Operations:**

An example of a single carrier operation is a band translator that incorporates an (IF) filter of a passband equal to one channel bandwidth. Another example of a single carrier operation is the use of an enhancer, before the connection to the antenna, to boost a low power transmitter (single carrier) to a higher power.

An example of a multiple carrier operation is the use of an enhancer to amplify off-air signals that contain the wanted carrier and two (or more) adjacent band carriers. If the enhancer passband is wide enough to pass more than the wanted channel bandwidth, the enhancer output stage will be loaded by the multiple carriers.

Examination: with 3 carrier signals (of assumed equal level), the peak voltage will be 3 times thesingle carrier voltage. The corresponding Peak Envelope Power (PEP) will be $3^2$times greater than a single carrier or 9/4 = 2.25 times greater than 2 tones PEP. Therefore the permissible wanted signal operating point has to be backed off by 3.5 dB (i.e. **$P_{permissible} = P_{rated}$ - 3.5 dB ).**

**Note 1:** All enhancers will be classified in the Radio Equipment List (REL) for a single carrier operation.

**Note 2:** For a multiple carrier operation, the rating must be reduced by 3.5 dB or more.

**Note 3:** If there are more than 3 carriers present at the amplifier input point, greater powerback-off may be required. This can be examined on a case-by-case basis.

**Test Procedures:**

**RSS-131**

**4. Measurement Methods**

**4.3 Mean Output Power**

**4.3.1 Multi-channel Enhancer**

The following subscript "o" denotes a parameter at the enhancer output point.

Connect two signal generators to the input of the Device Under Test (DUT), via a proper impedance matching network (and preferably via a variable attenuator) so that the two input signals are equal sinusoids (and can be raised equally).

Connect a dummy load of suitable load rating to the enhancer output point. Connect also a spectrum analyser to this output point via a coupling network and attenuator, so that only a portion of the output signal is coupled to the spectrum analyser. The coupling attenuation shall be stated in the test report.

Set the two generator frequencies $f_1$ and $f_2$ such that they and their third-order intermodulation product frequencies, $f_3 = 2f_1-f_2$ and $f_4 = 2f_2 - f_1$, are all within the passband of the DUT.

Raise the input level to the DUT while observing the output tone levels, $P_{o1}$ and $P_{o2}$, and the intermodulation product levels, $P_{o3}$ and $P_{o4}$.

**For enhancers rated 500 watts or less:** Raise the input level to the DUT until the greater level of the intermodulation products at the enhancer output terminals, $P_{o3}$ or $P_{o4}$, equals -43 dBW.

**For enhancers rated over 500 watts:** Raise the input level to the DUT until the greater level of the intermodulation products at the enhancer output terminals, $P_{o3}$ or $P_{o4}$, is 67 dB below the level of either output tone level, $P_{o1}$ or $P_{o2}$.

Record all signal levels and their frequencies. Calculate the mean output power ($P_{mean}$) under this testing condition using $P_{mean} = P_{o1} + 3$ dB.

**4.3.2 Single Channel Enhancer**

A suitably modulated signal, representative of the technology for which certification is sought, is applied to the input of the amplifier. The input power level is increased until the manufacturer's rated input power level is achieved or until a 2 dB increase in input level results in a 1 dB increase in output level (i.e. compression begins). Record the output power in the 99% emission bandwidth using any suitable means.

**Test Results:**

| Input Signal | Input Level (dBm) | Maximum Amp Gain |
|---|---|---|
| 2300_WCS | -14 dBm | 47 dB |

**Single channel Enhancer**

* Due to EUT's ALC function (Auto Level Control), even if input signal is increased, the same output power is transmit.

**[Downlink]**

| | Channel | Frequency (MHz) | Output Power | |
|---|---|---|---|---|
| | | | (dBm) | (W) |
| 2300_WCS Band_ LTE 5 MHz AGC threshold | Low | 2352.50 | 33.12 | 2.049 |
| | Middle | - | - | - |
| | High | 2357.50 | 33.07 | 2.029 |
| 2300_WCS Band_ LTE 5 MHz +3dBm above the AGC threshold | Low | 2352.50 | 33.08 | 2.034 |
| | Middle | - | - | - |
| | High | 2357.50 | 33.08 | 2.033 |
| 2300_WCS Band_ LTE 10 MHz AGC threshold | Low | - | - | - |
| | Middle | 2355.00 | 33.08 | 2.032 |
| | High | - | - | - |
| 2300_WCS Band_ LTE 10 MHz +3dBm above the AGC threshold | Low | - | - | - |
| | Middle | 2355.00 | 33.09 | 2.038 |
| | High | - | - | - |

**[PAPR]**

| | Channel | Frequency (MHz) | PAPR (dB) |
|---|---|---|---|
| 2300_WCS Band_ LTE 5 MHz The peak-to-average ratio (PAPR) AGC threshold | Low | 2352.50 | 8.39 |
| | Middle | - | - |
| | High | 2357.50 | 8.36 |
| 2300_WCS Band_ LTE 5 MHz The peak-to-average ratio (PAPR) +3dBm above the AGC threshold | Low | 2352.50 | 8.39 |
| | Middle | - | - |
| | High | 2357.50 | 8.41 |
| 2300_WCS Band_ LTE 10 MHz The peak-to-average ratio (PAPR) AGC threshold | Low | - | - |
| | Middle | 2355.00 | 8.40 |
| | High | - | - |
| 2300_WCS Band_ LTE 10 MHz The peak-to-average ratio (PAPR) +3dBm above the AGC threshold | Low | - | - |
| | Middle | 2355.00 | 8.38 |
| | High | - | - |

**Multi-channel Enhancer for IC**

* Due to EUT's ALC function (Auto Level Control), even if input signal is increased, the same output power is transmit.

**[Downlink]**

| | Channel | Frequency (MHz) | Output Power | |
|---|---|---|---|---|
| | | | Po1(dBm) | Pmean(dBm) |
| 2300_WCS Band | Low | 2350.40 | 30.106 | 33.106 |
| | Middle | 2355.00 | 30.115 | 33.115 |
| | High | 2359.60 | 30.078 | 33.078 |

**Additional Power Back-off Condition for Multiple Carrier Operations for IC**

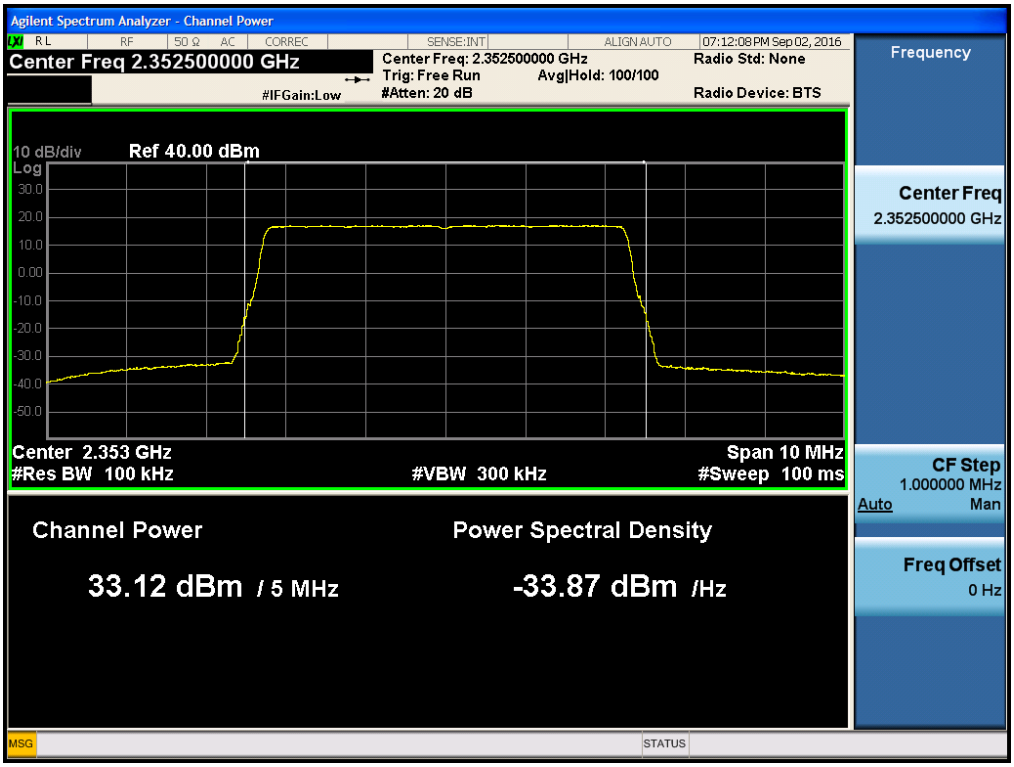
**[Downlink]**

| | 1 Carrier (dBm) | 3 Carrier (dBm) | Power Back-off (dB) |
|---|---|---|---|
| 2300_WCS Band | 33.00 | 28.50 | 4.50 |

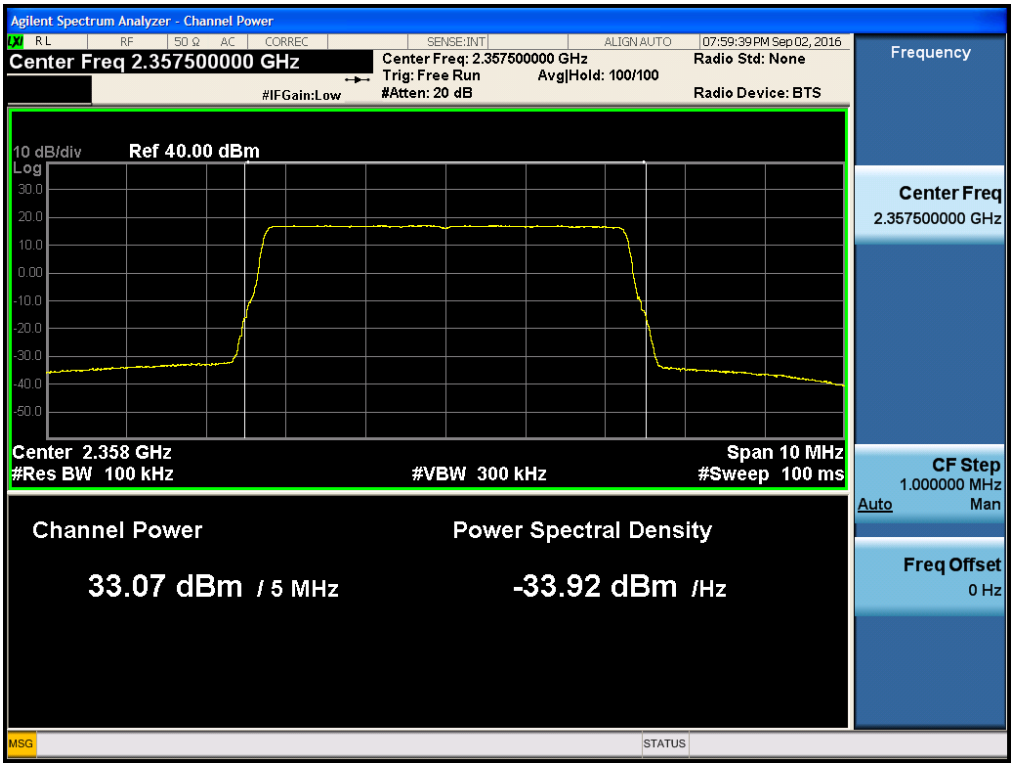
*** The 1 carrier above value is rated power of this device.**

## Plots of RF Output Power for 2300_WCS Band LTE 5 MHz

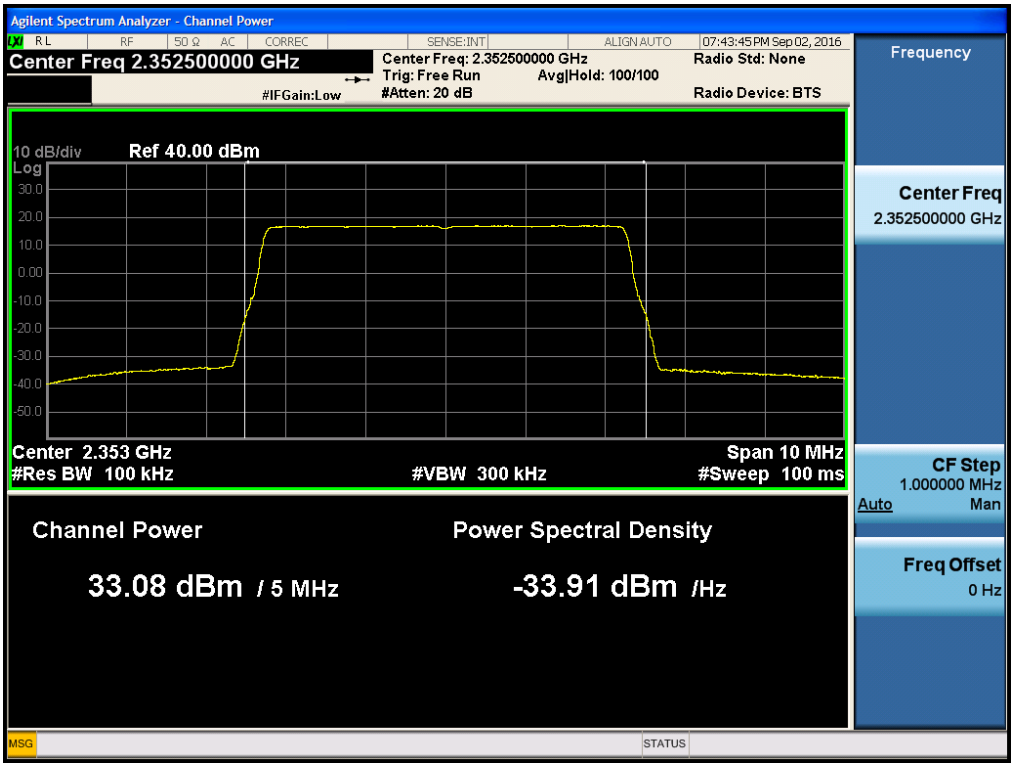
### [AGC threshold Downlink Low]



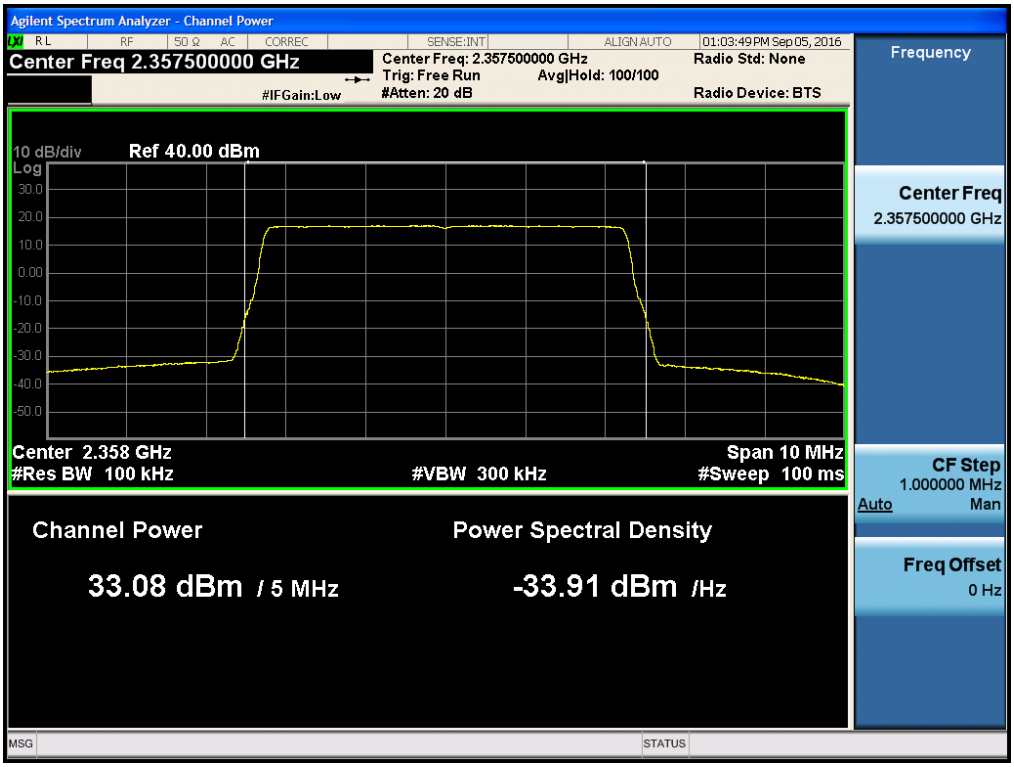

### [AGC threshold Downlink High]



**[+3dBm above AGC threshold Downlink Low]**

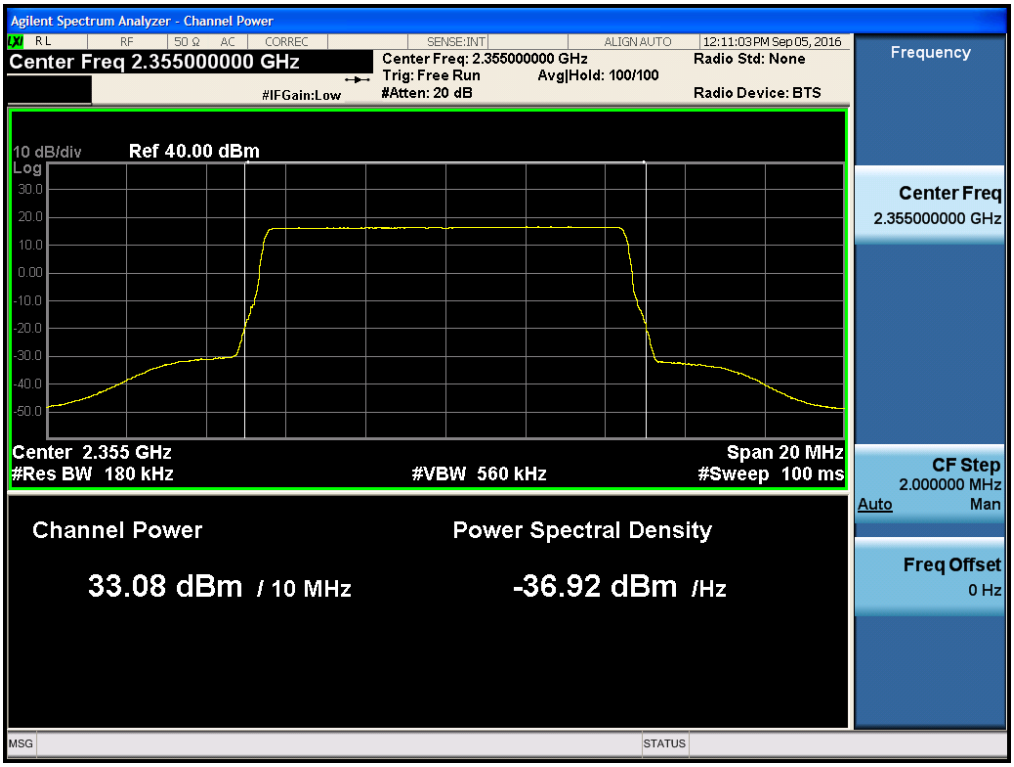



**[+3dBm above AGC threshold Downlink High]**

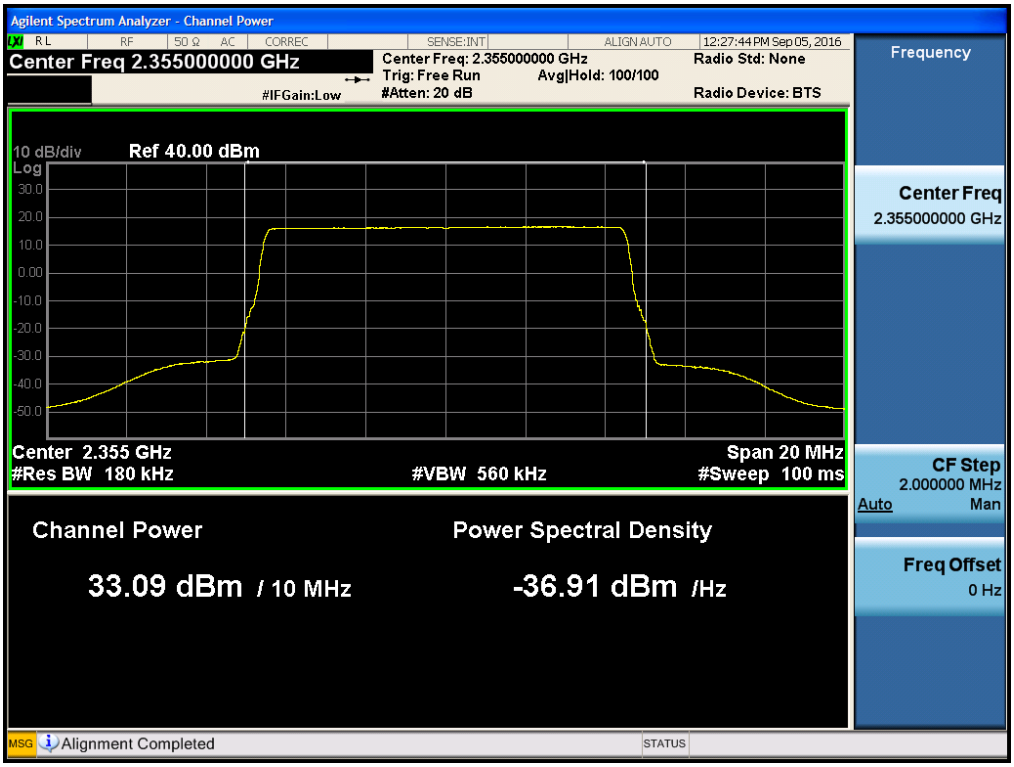


## Plots of RF Output Power for 2300_WCS Band LTE 10 MHz

### [AGC threshold Downlink Middle]

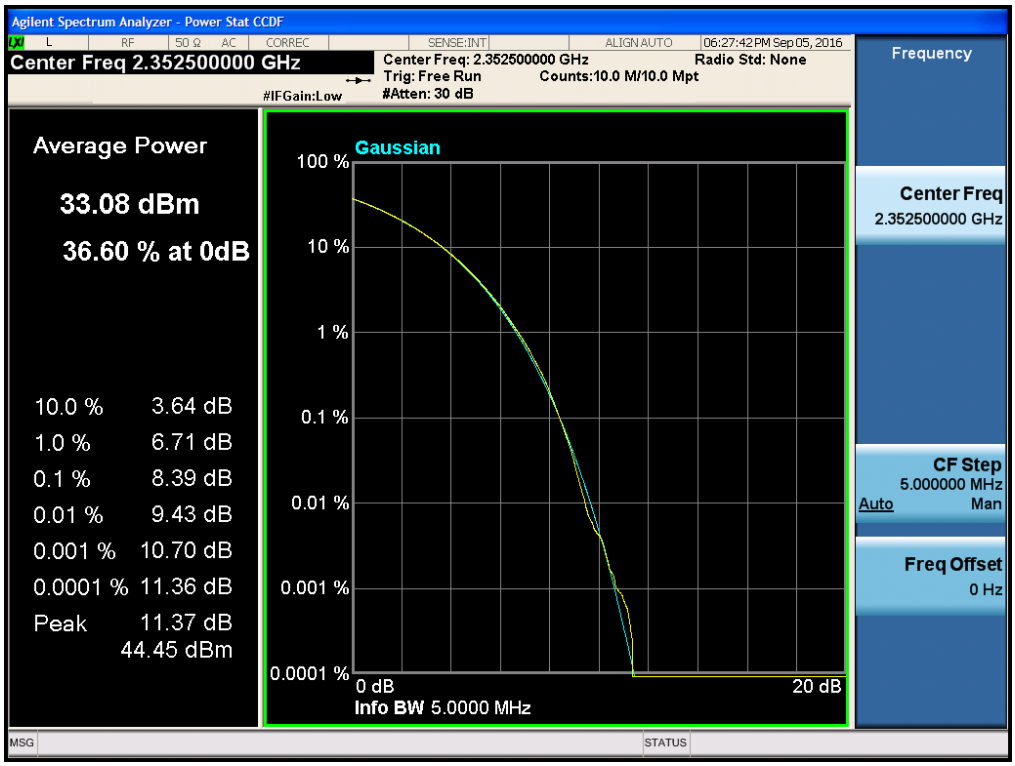



### [+3dBm above AGC threshold Downlink Middle]

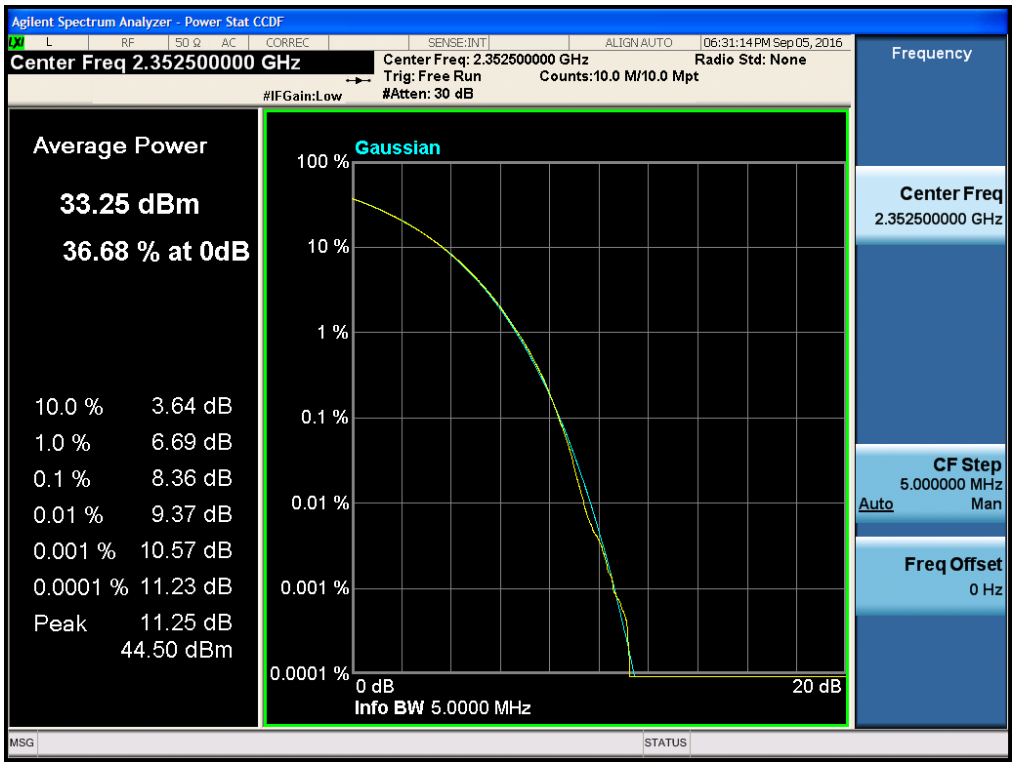


## Plots of PAPR for 2300_WCS Band LTE 5 MHz

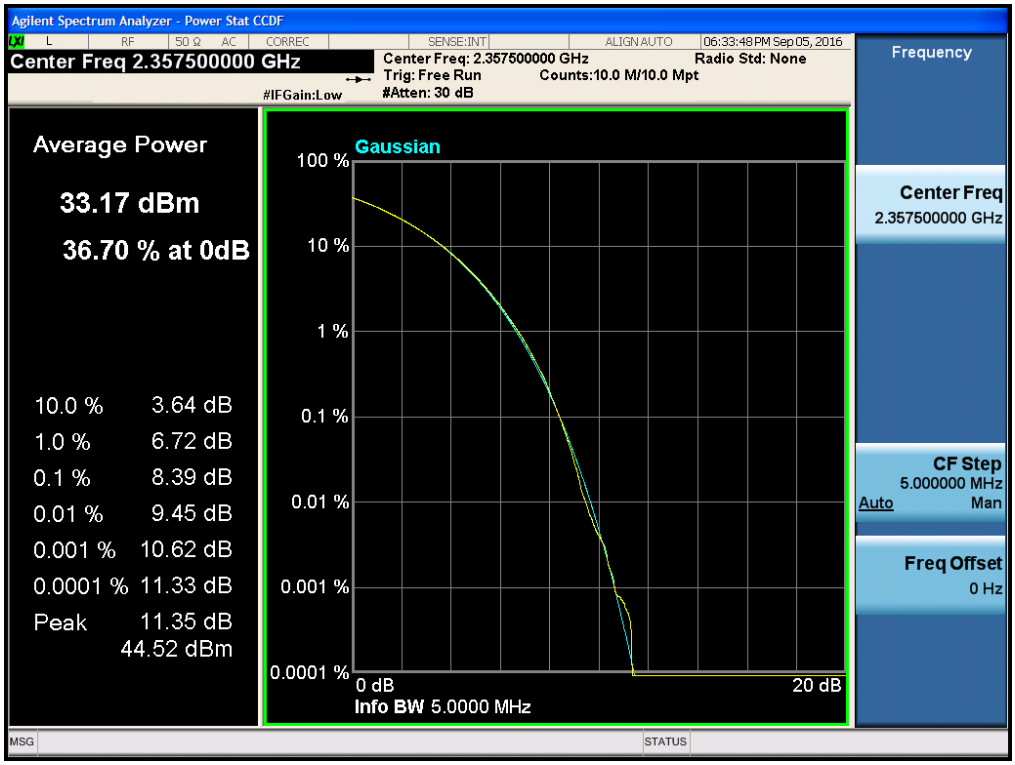
### [AGC threshold Downlink Low]



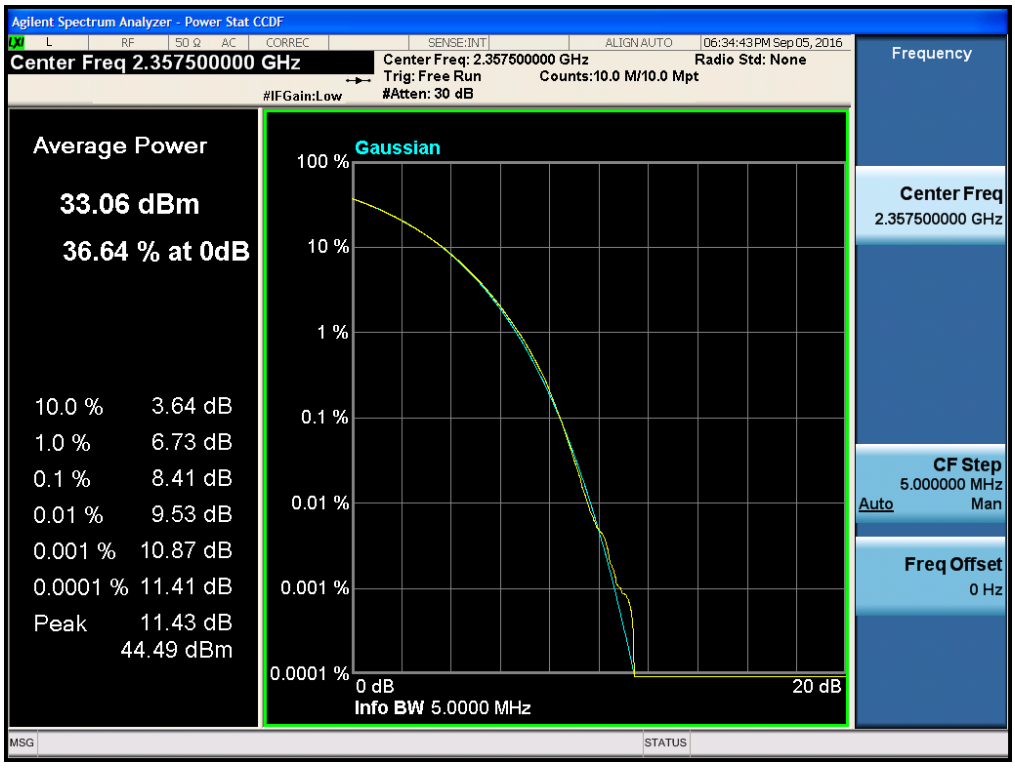

### [+3dBm above AGC threshold Downlink Low]



**[AGC threshold Downlink High]**

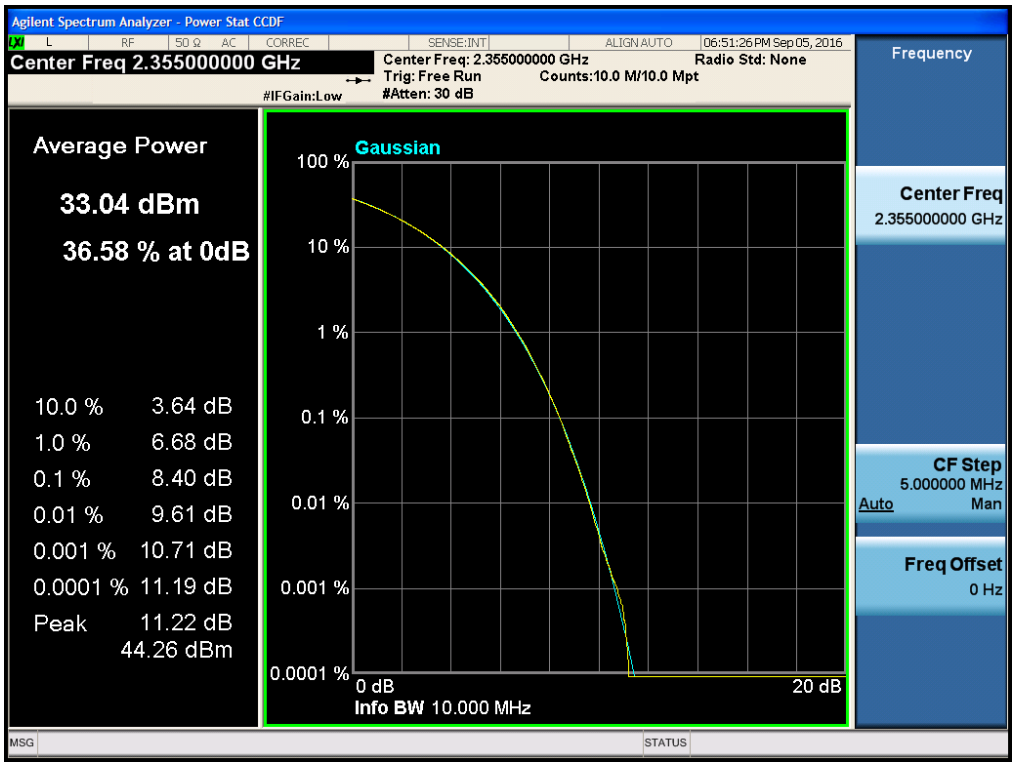



**[+3dBm above AGC threshold Downlink High]**

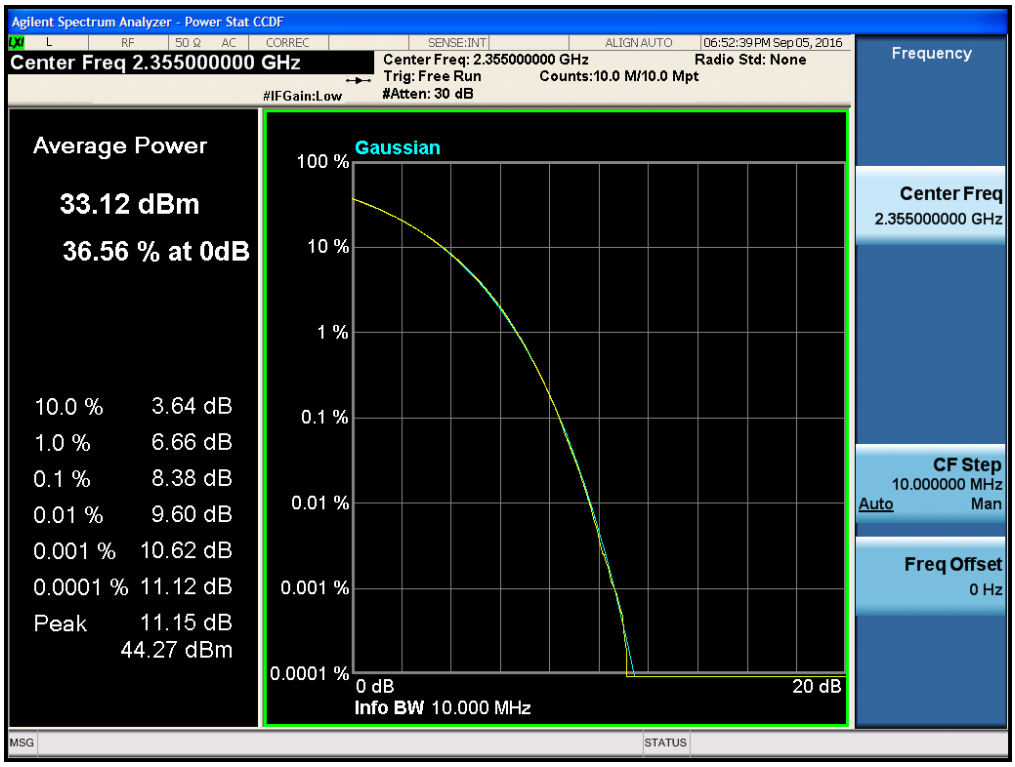


## Plots of PAPR for 2300_WCS Band LTE 10 MHz

### [AGC threshold Downlink Middle]

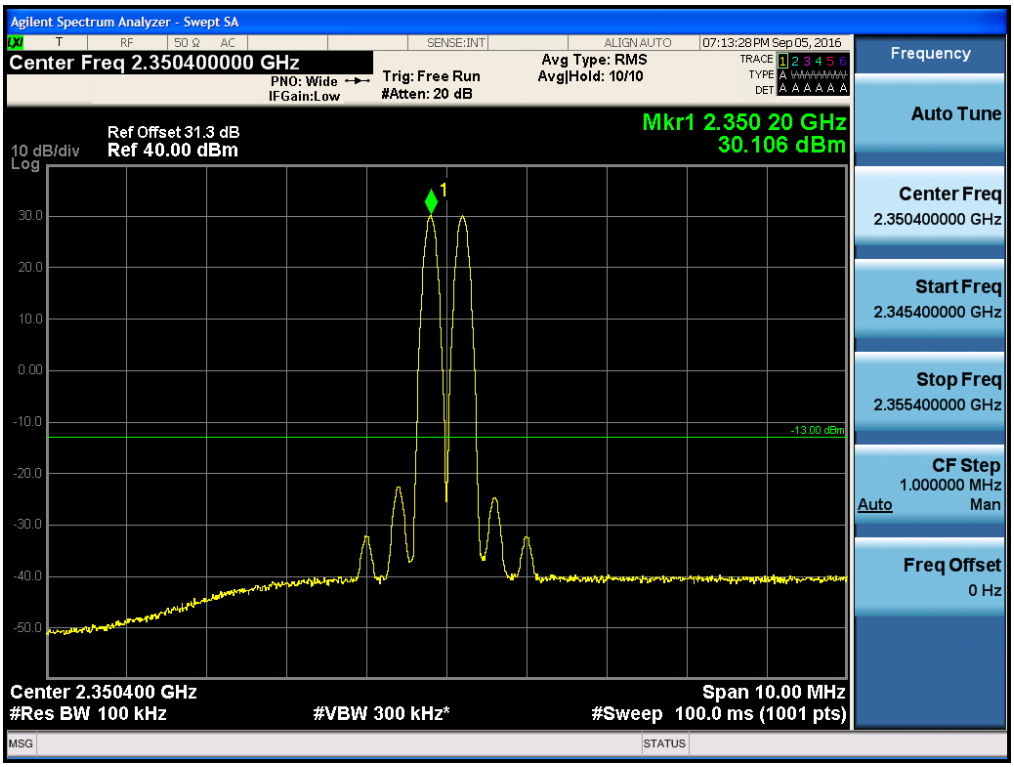



### [+3dBm above AGC threshold Downlink Middle]

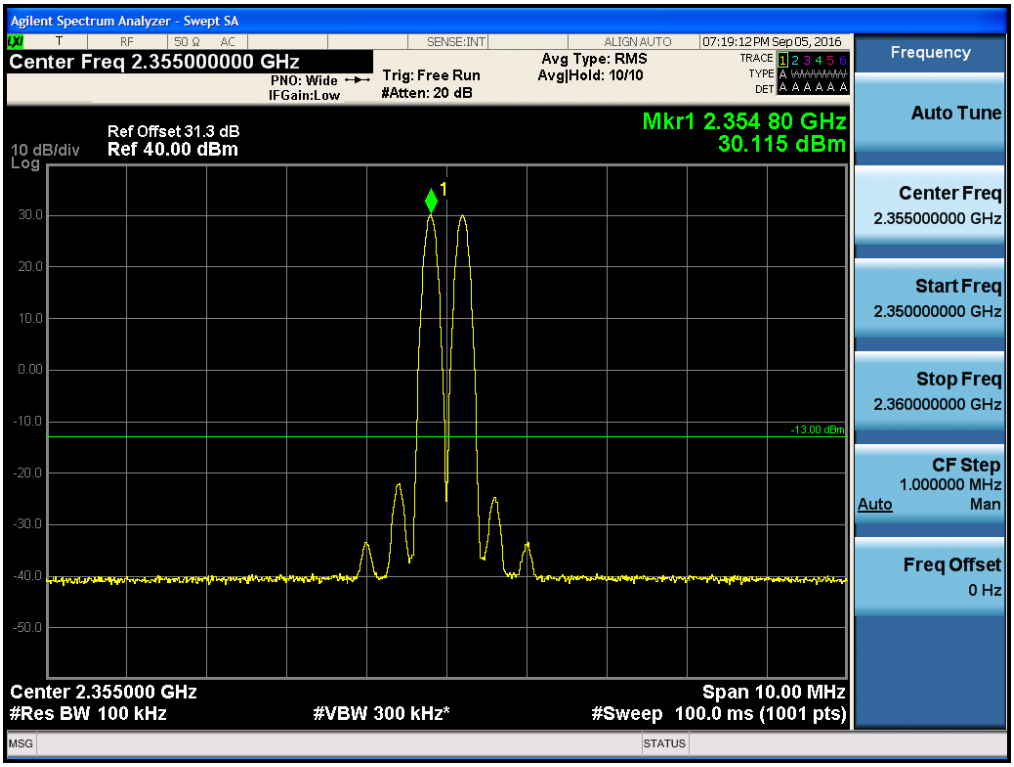


**Multi-channel Enhancer for IC_ 2300_WCS BAND**

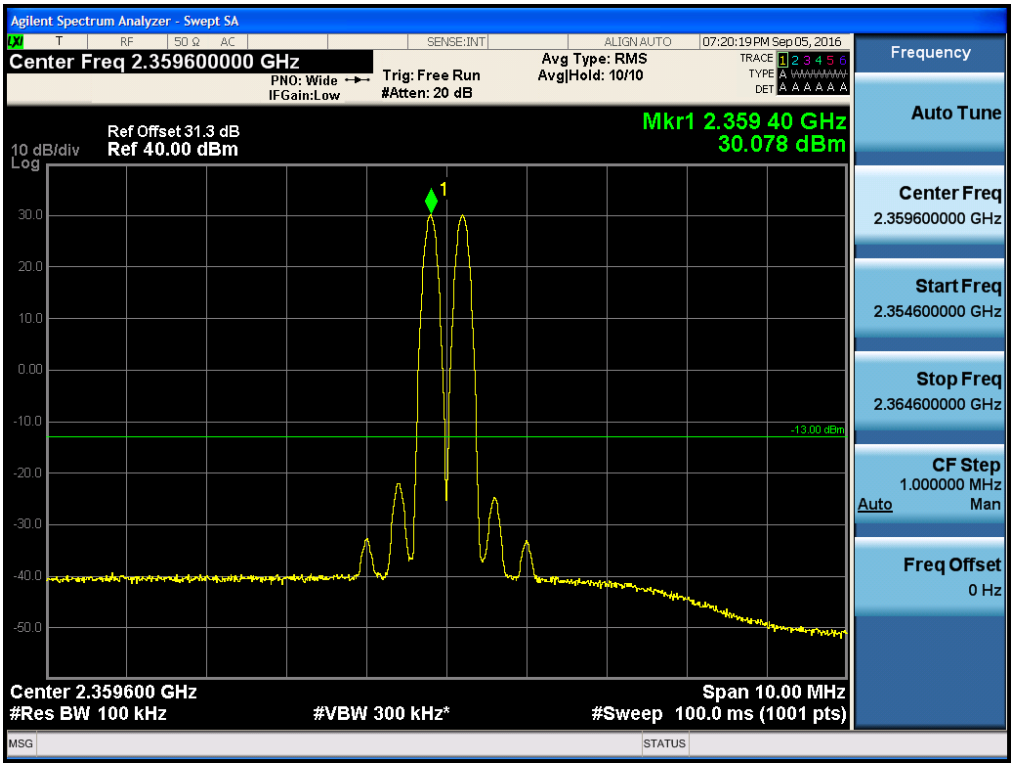
**[Downlink Low]**




**[Downlink Middle]**

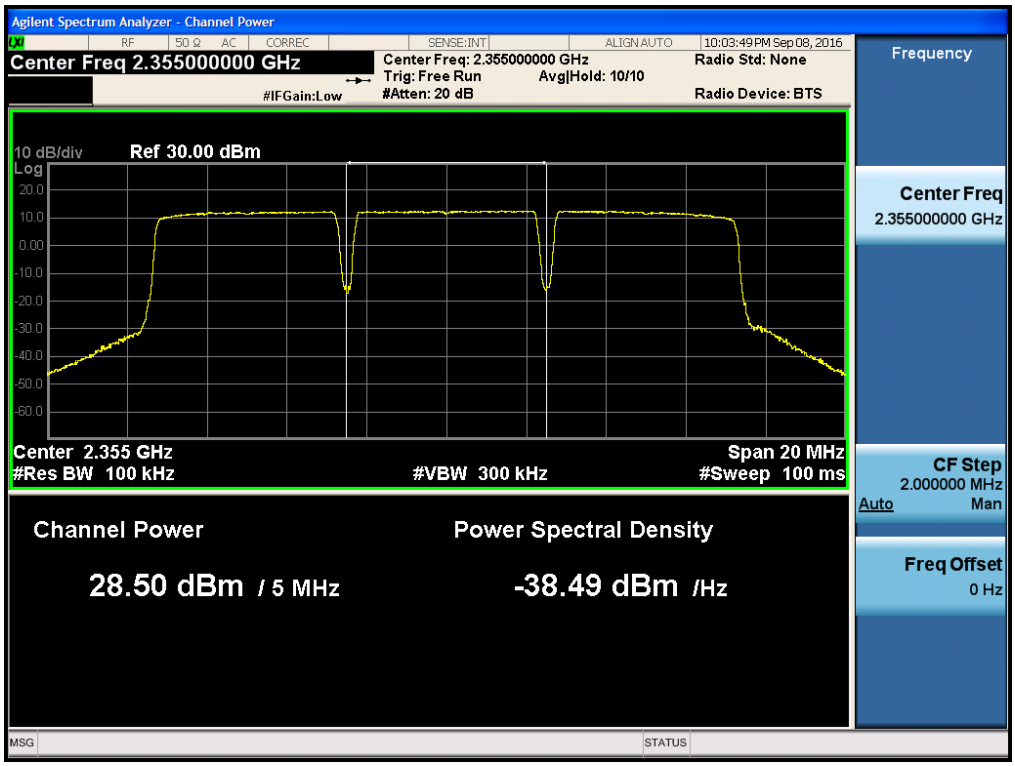


**[Downlink High]**



*** Power Back-off for IC_ 2300_WCS BAND**

**[Downlink 3 Carrier Middle]**



# 7. OCCUPIED BANDWIDTH

**FCC Rules**

**Test Requirement(s):**

**§ 2.1049 Measurements required: Occupied bandwidth:**

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

**Test Procedures:**

Measurements were in accordance with the test methods section 3.4 of KDB 935210 D05 v01r01 and section 4.2 of KDB 971168 D01 v02r02.

Test is 99% OBW measured and used.

a) Connect a signal generator to the input of the EUT.

b) Configure the signal generator to transmit the AWGN signal.

c) Configure the signal amplitude to be just below the AGC threshold level (see 3.2), but not more than 0.5 dB below.

d) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.

e) Set the spectrum analyzer center frequency to the center frequency of the operational band under test. The span range of the spectrum analyzer shall be between 2 times to 5 times the OBW.

f) The nominal resolution bandwidth (RBW) shall be in the range of 1% to 5 % of the anticipated OBW, and the VBW shall be ≥ 3 × RBW.

g) Set the reference level of the instrument as required to preclude the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope must be more than [10 log (OBW / RBW)] below the reference level.

NOTE—Steps f) and g) may require iteration to enable adjustments within the specified tolerances.

h) The noise floor of the spectrum analyzer at the selected RBW shall be at least 36 dB below the reference level.

i) Set spectrum analyzer detection function to positive peak.

j) Set the trace mode to max hold.

k) Use the 99 % power bandwidth function of the spectrum analyzer (if available) and report the measured bandwidth.

l) Repeat steps e) to k) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).

m) Compare the spectral plot of the input signal (determined from step l) to the output signal (determined from step k) to affirm that they are similar (in pass band and roll off characteristic features and relative spectral locations), and include plot(s) and descriptions in test report.

n) Repeat for all frequency bands authorized for use by the EUT.

**IC Rules**

**Test Requirements:**

**RSS-GEN**

**6 Technical Requirements**

**6.6 Occupied Bandwidth**

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99 % emission bandwidth, as calculated or measured.

**Test Procedures:**

**RSS-GEN**

**6 Technical Requirements**

**6.6 Occupied Bandwidth**

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3×RBW.

**Note:** Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

**Test Results:**

The EUT complies with the requirements of this section.

| Input Signal | Input Level (dBm) | Maximum Amp Gain |
|---|---|---|
| 2300_WCS | -14 dBm | 47 dB |

**[Downlink Output_2300_WCS BAND ]**

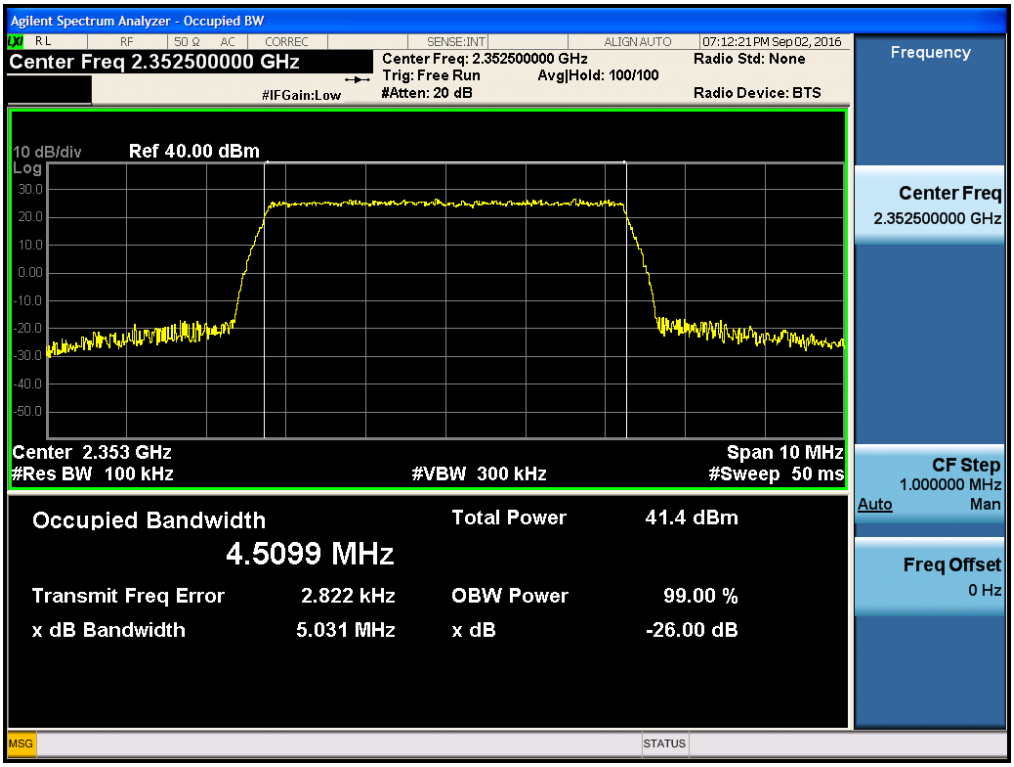
| | Channel | Frequency (MHz) | OBW (MHz) |
|---|---|---|---|
| 2300_WCS Band_ LTE 5 MHz AGC threshold | Low | 2352.50 | 4.510 |
| | Middle | - | - |
| | High | 2357.50 | 4.507 |
| 2300_WCS Band_ LTE 5 MHz +3dBm above the AGC threshold | Low | 2352.50 | 4.514 |
| | Middle | - | - |
| | High | 2357.50 | 4.507 |
| 2300_WCS Band_ LTE 10 MHz AGC threshold | Low | - | - |
| | Middle | 2355.00 | 8.994 |
| | High | - | - |
| 2300_WCS Band_ LTE 10 MHz +3dBm above the AGC threshold | Low | - | - |
| | Middle | 2355.00 | 8.997 |
| | High | - | - |

**[Downlink Input_2300_WCS BAND ]**

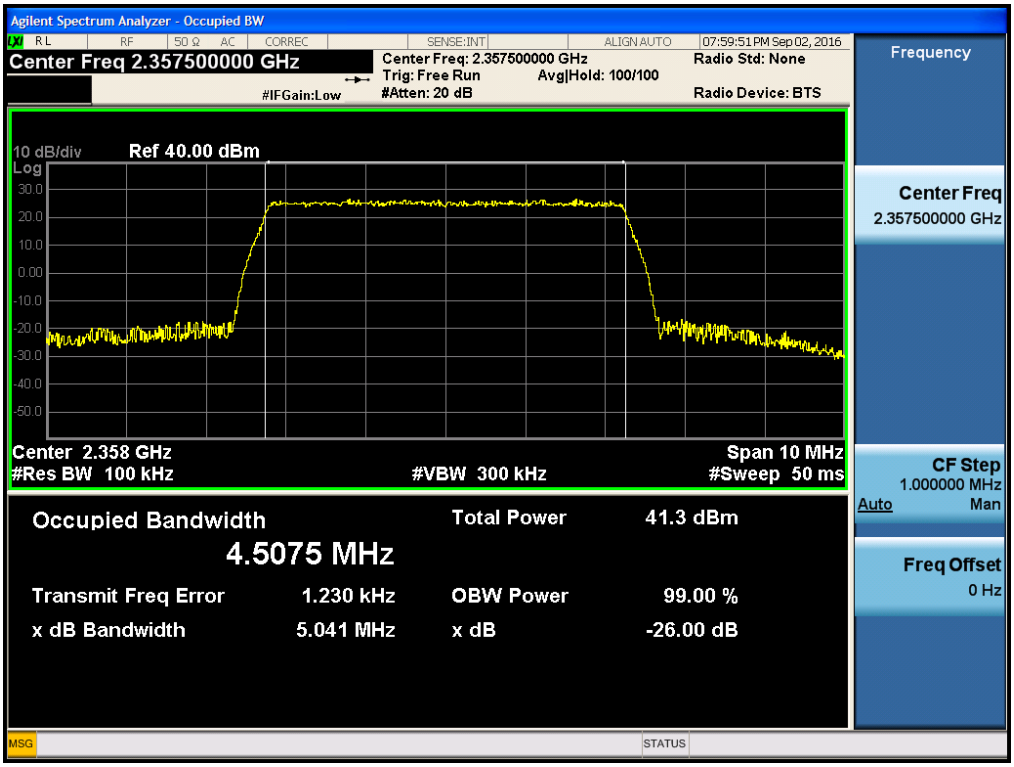
| | Channel | Frequency (MHz) | OBW (MHz) |
|---|---|---|---|
| 2300_WCS Band_ LTE 5 MHz AGC threshold | Low | 2352.50 | 4.512 |
| | Middle | - | - |
| | High | 2357.50 | 4.514 |
| 2300_WCS Band_ LTE 10 MHz AGC threshold | Low | - | - |
| | Middle | 2355.00 | 8.992 |
| | High | - | - |

## Plots of Occupied Bandwidth_2300_WCS BAND LTE 5 MHz_Output

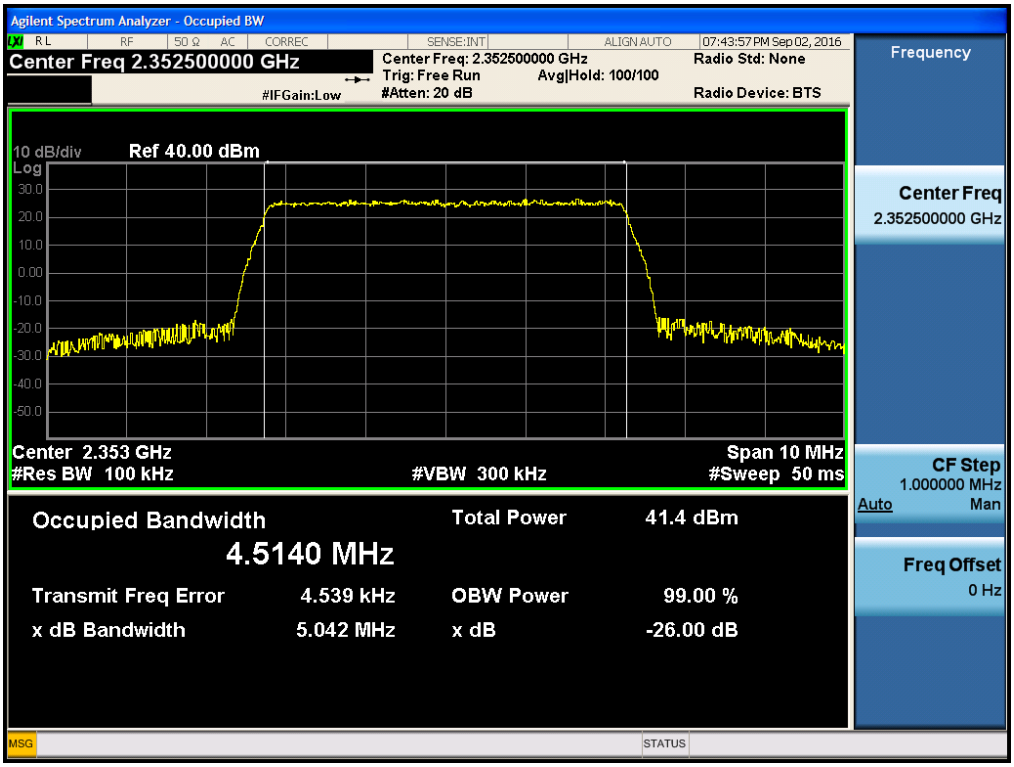
### [AGC threshold Output Downlink Low]



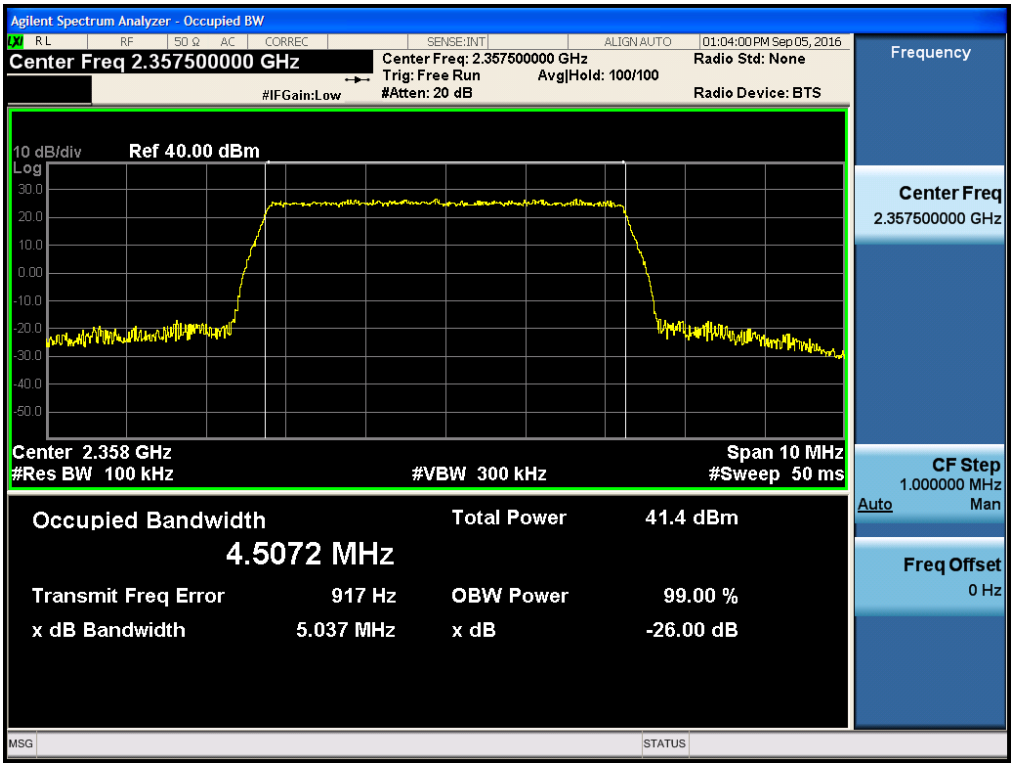

### [AGC threshold Output Downlink High]



**[+3dBmabove AGC threshold Output Downlink Low]**

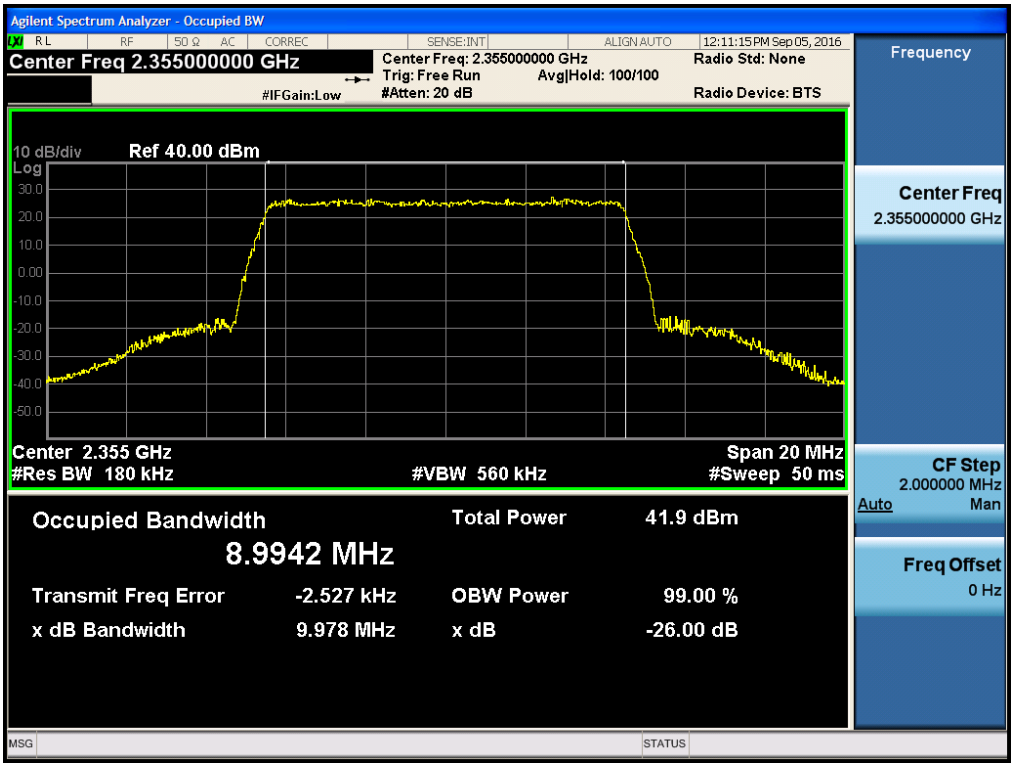



**[+3dBm above AGC threshold Output Downlink High]**

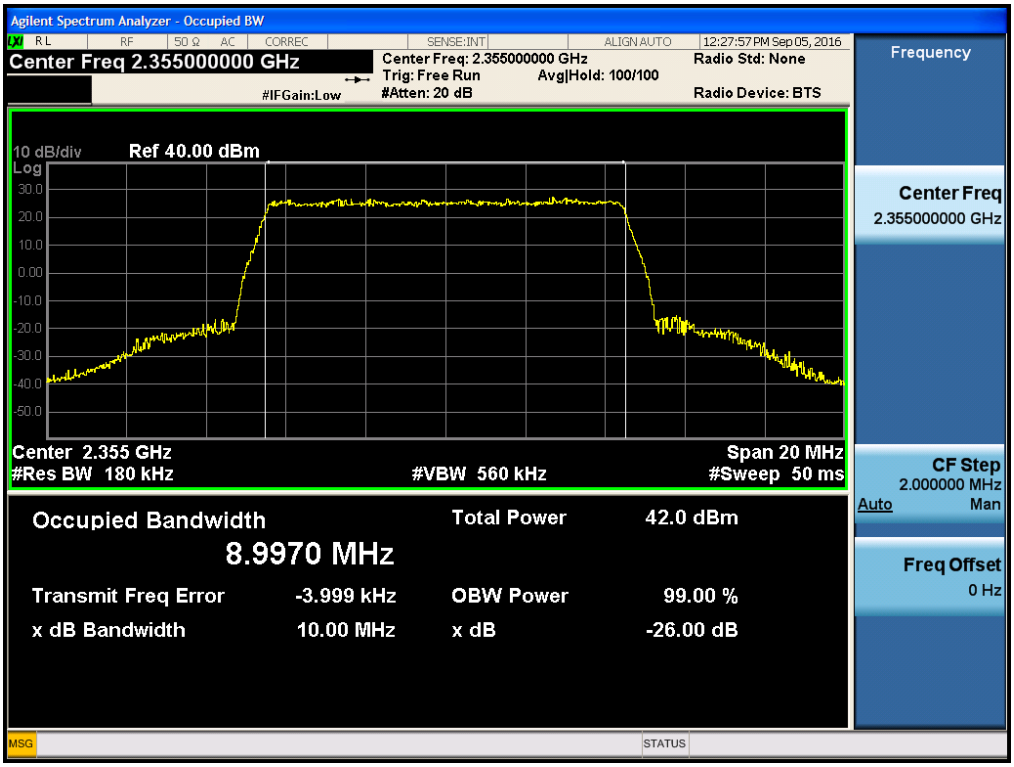


## Plots of Occupied Bandwidth_ 2300_WCS BAND LTE 10 MHz_Output

### [AGC threshold Output Downlink Middle]

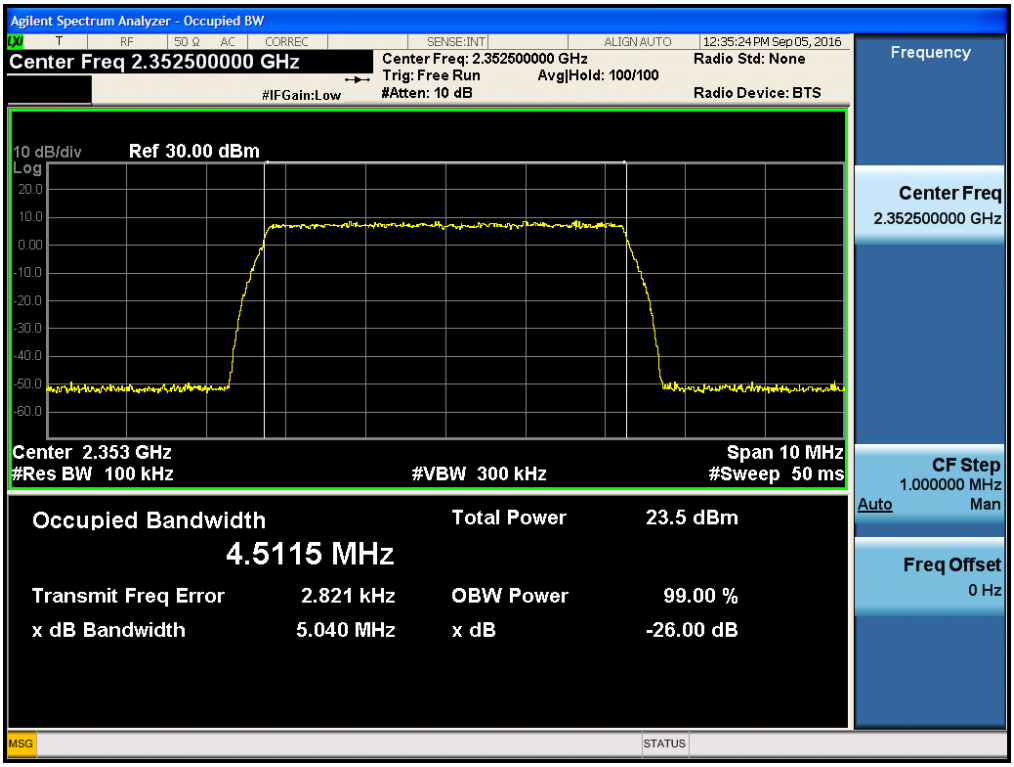



### [+3dBm above AGC threshold Output Downlink Middle]

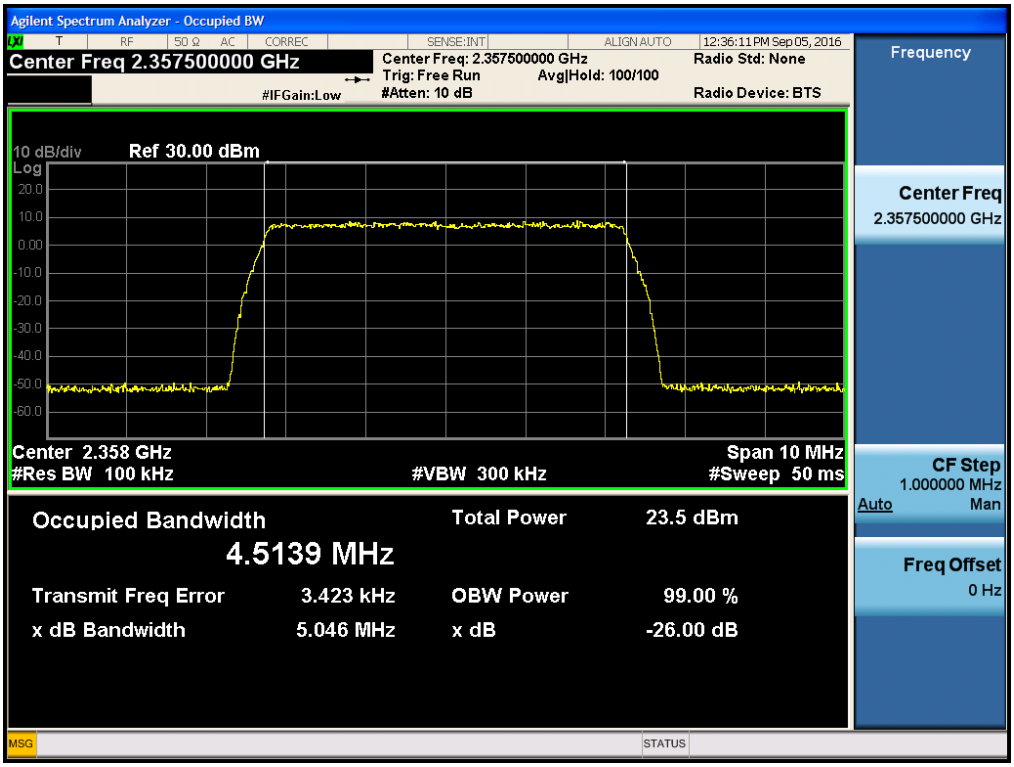


## Plots of Occupied Bandwidth_2300_WCS BAND LTE 5 MHz_Input

### [AGC threshold Input Downlink Low]

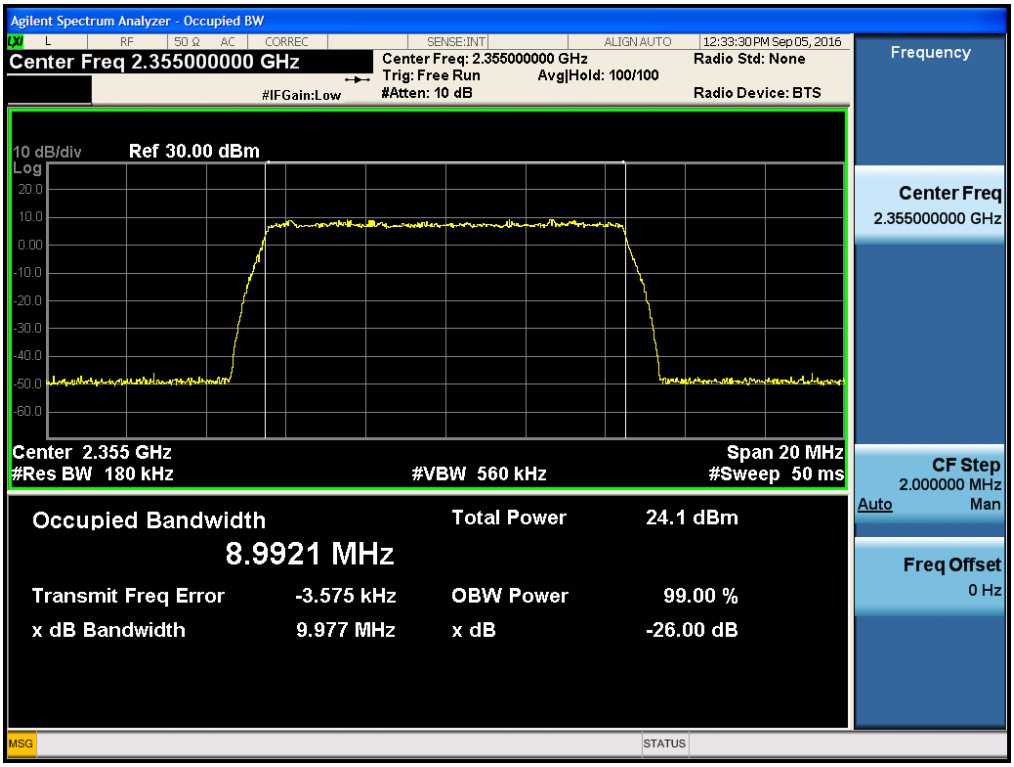



### [AGC threshold Input Downlink High]



## Plots of Occupied Bandwidth_ 2300_WCS BAND LTE 10 MHz_Input

### [AGC threshold Input Downlink Middle]



# 8. PASSBAND GAIN AND BANDWIDTH & OUT OF BAND REJECTION

**FCC Rules**

**Test Requirement(s):**

**KDB 935210 D02 v03r02**

Out of Band Rejection – Test for rejection of out of band signals. Filter freq. response plots are acceptable.

**Test Procedures:**

Measurements were in accordance with the test methods section 3.3 of KDB 935210 D05 v01r01.

a) Connect a signal generator to the input of the EUT.

b) Configure a swept CW signal with the following parameters:

1) Frequency range = ± 250 % of the passband, for each applicable CMRS band (see also KDB Publication 935210 D02 [R7] and KDB Publication 634817 [R5] about selection of frequencies for testing and for grant listings).

2) Level = a sufficient level to affirm that the out-of-band rejection is > 20 dB above the noise floor and will not engage the AGC during the entire sweep.

3) Dwell time = approximately 10 ms.

4) Number of points = SPAN/(RBW/2).

c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.

d) Set the span of the spectrum analyzer to the same as the frequency range of the signal generator.

e) Set the resolution bandwidth (RBW) of the spectrum analyzer to be 1 % to 5 % of the EUT passband, and the video bandwidth (VBW) shall be set to ≥ 3 × RBW.

f) Set the detector to Peak Max-Hold and wait for the spectrum analyzer's spectral display to fill.

g) Place a marker to the peak of the frequency response and record this frequency as f0.

h) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the −20 dB down amplitude, to determine the 20 dB bandwidth.

i) Capture the frequency response of the EUT.

j) Repeat for all frequency bands applicable for use by the EUT.

**IC Rules**

**Test Requirements:**

**RSS-131**

**6 Equipment Standard Specifications**

**6.1 Amplifier Gain and Bandwidth**

The passband gain shall not exceed the nominal gain by more than 1.0 dB. The 20 dB bandwidth shall not exceed the nominal bandwidth that is stated by the manufacturer. Outside of the 20 dB bandwidth, the gain shall not exceed the gain at the 20 dB point.

**Test Procedures:**

**RSS-131**

**4 Measurement Methods**

**4.2 Passband Gain and Bandwidth**

Adjust the internal gain control of the equipment under test to the nominal gain for which equipment certification is sought.

With the aid of a signal generator and spectrum analyzer, measure the 20 dB bandwidth of the amplifier (i.e. at the point where the gain has fallen by 20 dB). Measure the gain-versus-frequency response of the amplifier from the midband frequency f0 of the passband up to at least f0 + 250% of the 20 dB bandwidth.

**Test Results:**

The EUT complies with the requirements of this section.

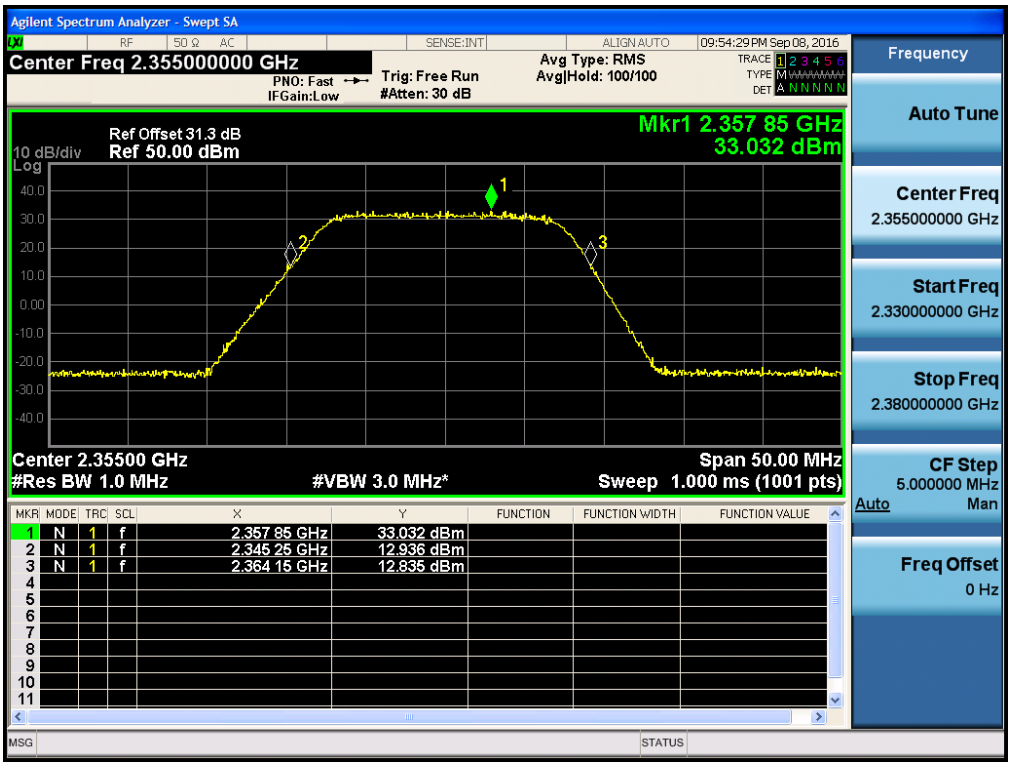
| Input Signal | Input Level (dBm)<br>Input Signal : Sinusoidal | Maximum Amp Gain |
|---|---|---|
| 2300_WCS Band | -14 dBm | 47 dB |

**[Downlink_2300_WCS BAND]**

| | 20 dB point frequency (MHz) | Output power (dBm) | Gain (dB) |
|---|---|---|---|
| 2300_WCS Band | 2345.250 MHz ~ 2364.150 MHz | 33.032 | 47.032 |

## Plots of Passband Gain and Bandwidth & Out of Band Rejection

**[2300_WCS BAND]**



# 9. SPURIOUS AND HARMONIC EMISSION AT ANTENNA TERMINAL

**FCC Rules**

**Test Requirement(s):**

**§ 2.1051 Measurements required: Spurious emissions at antenna terminals:**

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

**§ 27.53 Emission limits.**

(a) For operations in the 2305-2320 MHz band and the 2345-2360 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power P (with averaging performed only during periods of transmission) within the licensed band(s) of operation, in watts, by the following amounts:

(1) For base and fixed stations' operations in the 2305-2320 MHz band and the 2345-2360 MHz band:

(i) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, and not less than 75 + 10 log (P) dB on all frequencies between 2320 and 2345 MHz;

(ii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305 MHz, 70 + 10 log (P) dB on all frequencies between 2287.5 and 2300 MHz, 72 + 10 log (P) dB on all frequencies between 2285 and 2287.5 MHz, and 75 + 10 log (P) dB below 2285 MHz;

(iii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2362.5 MHz, 55 + 10 log (P) dB on all frequencies between 2362.5 and 2365 MHz, 70 + 10 log (P) dB on all frequencies between 2365 and 2367.5 MHz, 72 + 10 log (P) dB on all frequencies between 2367.5 and 2370 MHz, and 75 + 10 log (P) dB above 2370 MHz.

**Test Procedures:**

Measurements were in accordance with the test methods section 3.6 and 4.7 of KDB 935210 D05 v01r01.

3.6.1. General

Spurious emissions shall be measured using a single test signal sequentially tuned to the low, middle and high channels or frequencies within each authorized frequency band of operation. Out-of-band/block emissions (including intermodulation products) shall be measured under each of the following two stimulus conditions:

a) two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;

b) a single test signal, sequentially tuned to the lowest and highest frequencies or channels within the frequency band/block under examination.

NOTE—Single channel boosters that cannot accommodate two simultaneous signals within the passband, can be excluded from the test stipulated in step a).

3.6.2. EUT out-of-band/block emissions conducted measurement

a) Connect a signal generator to the input of the EUT.

NOTE—If the signal generator is not capable of generating two modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support the two-tone test.

b) Set the signal generator to produce two AWGN signals as previously described (e.g., 4.1 MHz OBW).

c) Set the center frequencies such that the AWGN signals occupy adjacent channels, as defined by industry standards such as 3GPP or 3GPP2, at the upper edge of the frequency band or block of interest.

d) Set the composite power levels such that the input signal is just below the AGC threshold (see 3.2), but not more than 0.5 dB below. The composite power can be measured using the procedures provided in KDB Publication 971168, but it will be necessary to expand the power integration bandwidth so as to include both of the transmit channels. Alternatively, the composite power can be measured using an average power meter as described in KDB Publication 971168.

e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.

f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band (typically 1 % of the emission bandwidth, 100 kHz, or 1 MHz)

g) Set the VBW = 3 × RBW.

h) Set the detector to power averaging (rms) detector.

i) Set the Sweep time = auto-couple.

j) Set the analyzer start frequency to the upper block edge frequency and the stop frequency to the upper block edge frequency plus 300 kHz or 3 MHz for frequencies below and above 1 GHz, respectively.

k) Trace average at least 100 traces in power averaging (i.e., rms) mode.

l) Use the marker function to find the maximum power level.

m) Capture the spectrum analyzer trace of the power level for inclusion in the test report.

n) Repeat the procedure with the composite input power level set to 3 dB above the AGC threshold.

o) Reset the input signals frequencies to the lower edge of the frequency block or band under

examination.

p) Reset the spectrum analyzer start frequency to the lower block edge frequency minus 300 kHz, or 3 MHz (for frequencies below and above 1 GHz, respectively), and the stop frequency to the lower band or block edge frequency.

q) Repeat steps k) to n).

r) Repeat steps a) to q) with the signal generator configured for a single test signal tuned as close as possible to the block edges.

s) Repeat steps a) to r) with the narrowband test signal.

t) Repeat steps a) to s) for all authorized frequency bands or blocks used by the EUT.

3.6.3. EUT spurious emissions conducted measurement

a) Connect a signal generator to the input of the EUT.

b) Set the signal generator to produce the broadband test signal as previously described (e.g., 4.1 MHz OBW AWGN).

c) Set the center frequency of the test signal to the lowest available channel within the frequency band or block.

d) Set the EUT input power to a level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.

e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.

f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band of operation (e.g., reference bandwidth is typically 100 kHz or 1 MHz).

g) Set the VBW ≥ 3 × RBW.

h) Set the Sweep time = auto-couple.

i) Set the analyzer start frequency to the lowest radio frequency signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.

NOTE—The number of measurement points in each sweep must be ≥ (2 × span/RBW) which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

j) Select the power averaging (rms) detector function.

k) Trace average at least 10 traces in power averaging (i.e., rms) mode.

l) Use the peak marker function to identify the highest amplitude level over each measured frequency range. Record the frequency and amplitude and capture a plot for inclusion in the test report.

m) Reset the analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the analyzer stop frequency to 10 times the highest frequency of the fundamental emission (see §2.1057). Note that the number of

measurement points in each sweep must be ≥ (2 × span/RBW) which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

n) Trace average at least 10 traces in power averaging (i.e., rms) mode.

o) Use the peak marker function to identify the highest amplitude level over each of the measured frequency ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report and provide tabular data, if required.

p) Repeat the procedure with the input test signals tuned to a middle band/block frequency/channel and then a high band/block frequency/channel.

q) Repeat entire procedure with the narrowband test signal.

r) Repeat for all authorized frequency bands/blocks used by the EUT.

**IC Rules**

**Test Requirement(s):**

**RSS-131**

**6. Equipment Standard Specifications**

**6.3 Non-Linearity**

Transmitter signals amplified by a non-linear device (enhancer or translator) will alter the occupied bandwidth of the transmitted signals; therefore, the extent of non-linearity shall be tested.

**6.3.1 Multi-channel Enhancer**

For a multi-channel enhancer, any intermodulation product level must be attenuated, relative to P, by at least:

43 + 10 $Log_{10}$P, or 70 dB, whichever is less stringent,

where P is the total RF output power of the test tones in watts.

**6.3.2 Single Channel Enhancer**

For a single channel amplifier, the 99% emission bandwidth shall be measured under the conditions described in section 4.3.2 and the spectrum analyser plots submitted in the test report. Set the resolution bandwidth of the spectrum analyser from 1% to 3% of the 99% emission bandwidth and set the video bandwidth to 3 times the resolution bandwidth. Record both the amplifier input and output signals.

All emissions in the amplifier's output signal that falls outside a licensed frequency block or allocated bandwidth for the technology under test must be attenuated, relative to P, by at least:

43 + 10 $Log_{10}$P, or 70 dB, whichever is less stringent

where P is the manufacturer's rated output power in watts.

**6.4 Spurious Emissions**

Spurious emissions of zone enhancers and translators shall be suppressed as much as possible. Spurious emissions shall be attenuated below the rated power of the enhancer by at least:

43 + 10 $Log_{10}$($P_{rated}$ in watts), or 70 dB, whichever is less stringent.

**Note:** If the minimum standard is not met, check to see if the input signal generators have a high harmonic content.

**RSS-199**

**4. Transmitter and Receiver Standard Specifications**

**4.6 Transmitter Unwanted Emissions**

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth is allowed to be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz or 1%/2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emissions limits:

a. For base station and fixed subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p

**Test Procedures:**

**RSS-131**

**4 Measurement Methods**

**4.4 Spurious Emission**

**4.4.1 Multi-channel Enhancer**

The spurious emissions of the equipment under test shall be measured using the two-tone method in section 4.3.1, with the two tones $P_{o1}$ and $P_{o2}$ set to the required levels.

Using a spectrum analyser with a resolution bandwidth set at 100 kHz, search for spurious emissions from 30 MHz to at least 5 times the highest RF passband frequency. The search may omit the band that contains the test tones and intermodulation products.

**4.4.2 Single channel Enhancer**

The enhancer shall be operated as described in section 4.3.2 during the search for spurious emissions.

Using a spectrum analyser with a resolution bandwidth set at 100 kHz, search for spurious emissions from 30 MHz to at least 5 times the highest RF passband frequency. The search may omit the band that contains the input signal.

**Test Results:**

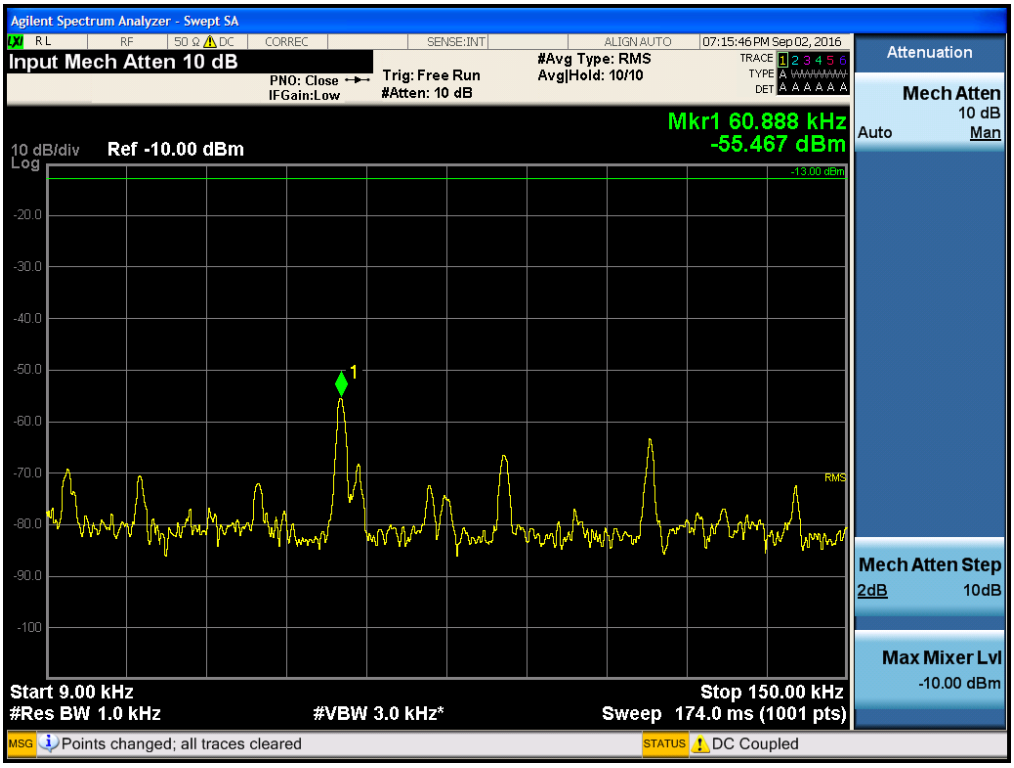
The EUT complies with the requirements of this section. There were no Detectable Spurious emissions for this EUT.

**Notes:** In 9 KHz-150 KHz and 150 KHz-30 MHz bands, RBW was reduced to 1% and 10% of the reference bandwidth for measuring unwanted emission level(typically, 100KHz if the authorized frequency band is below 1GHz) and power was integrated.(1% = +20 dB, 10% = +10 dB )

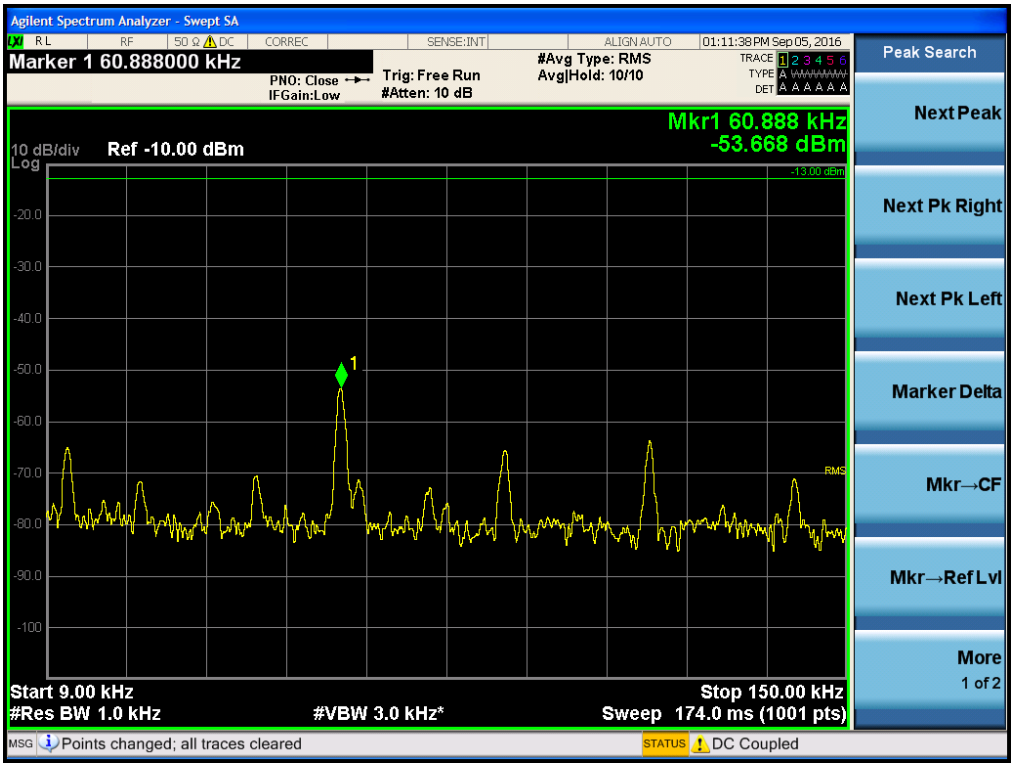
## Single channel Enhancer Plots of Spurious Emission for 2300_WCS BAND LTE 5 MHz

### Conducted Spurious Emissions (9 kHz – 150 kHz)

**[Downlink Low]**

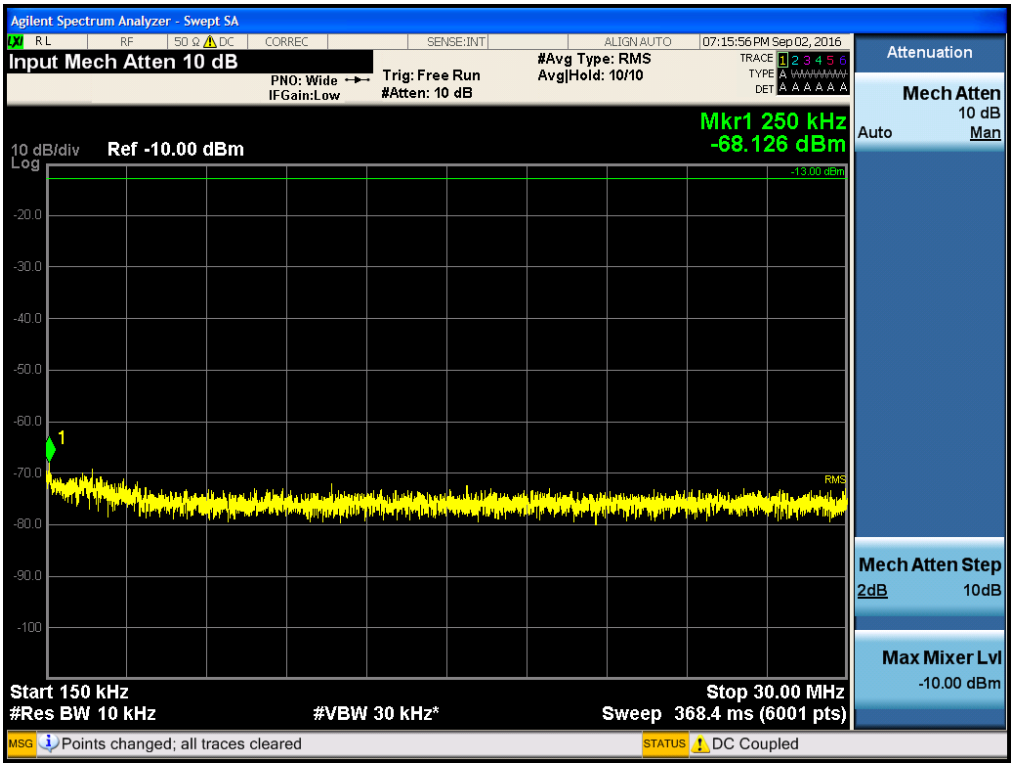



**[Downlink High]**

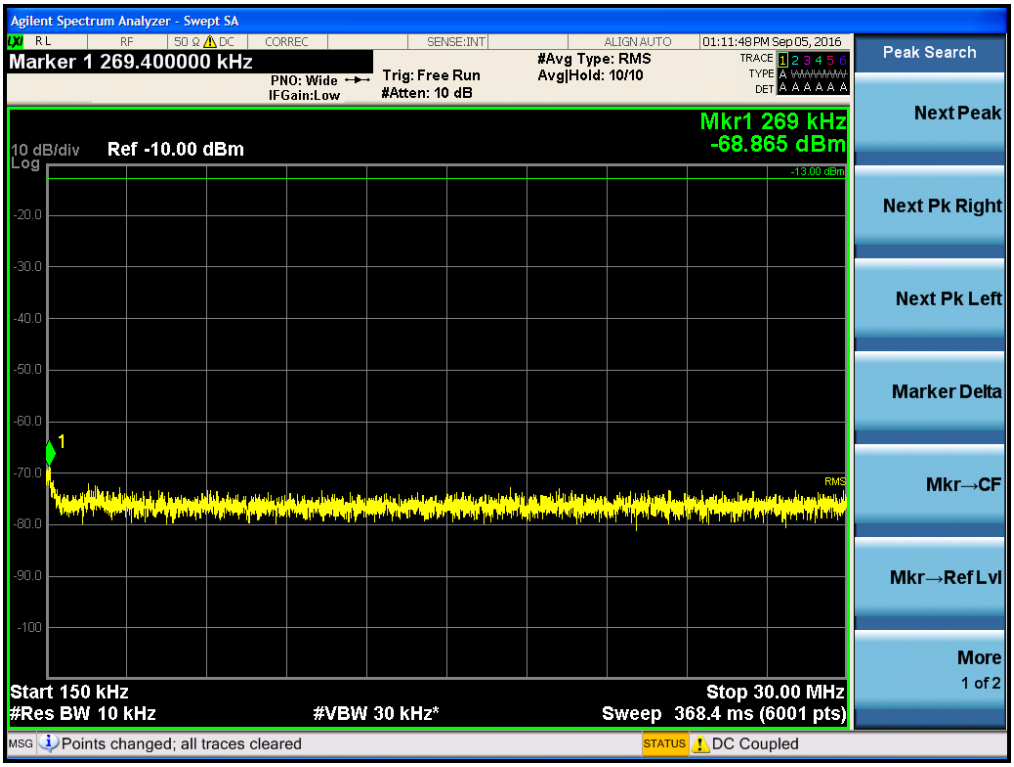


**Conducted Spurious Emissions (150 kHz – 30 MHz)**

**[Downlink Low]**

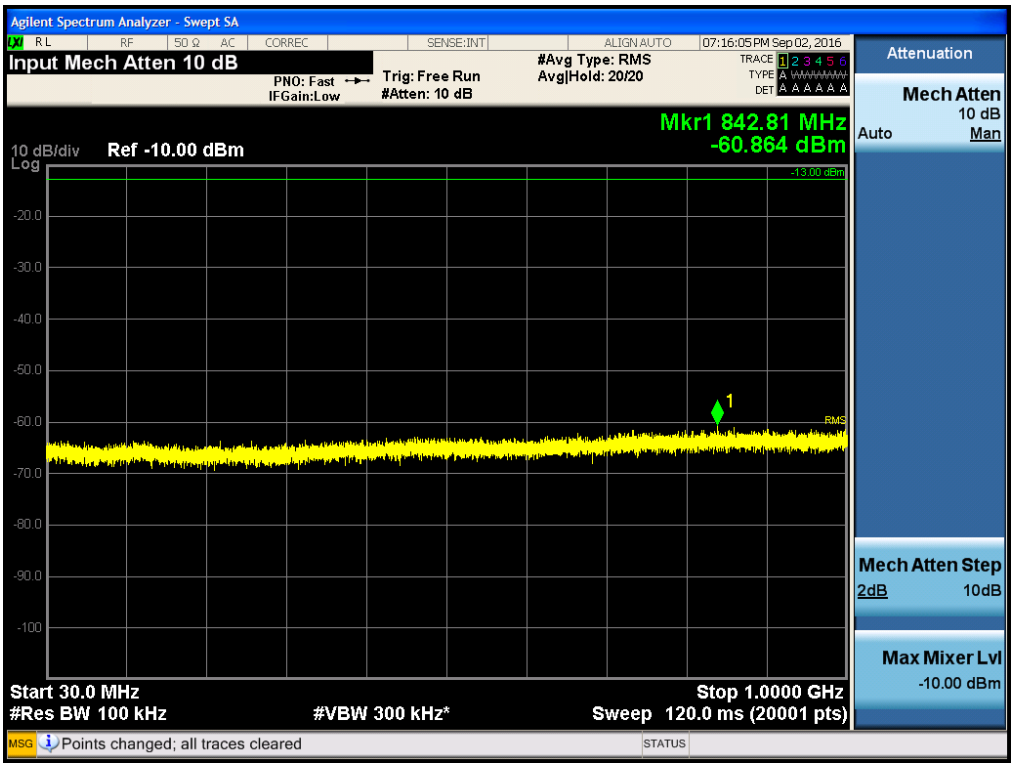



**[Downlink High]**

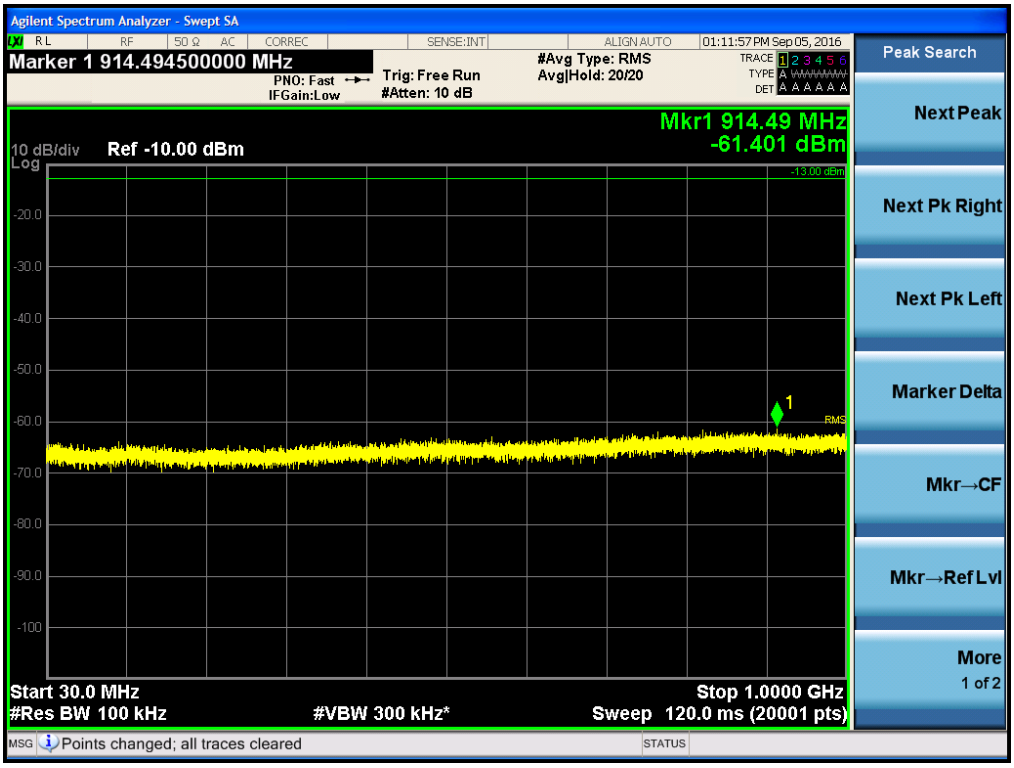


**Conducted Spurious Emissions (30 MHz – 1 GHz)**

**[Downlink Low ]**

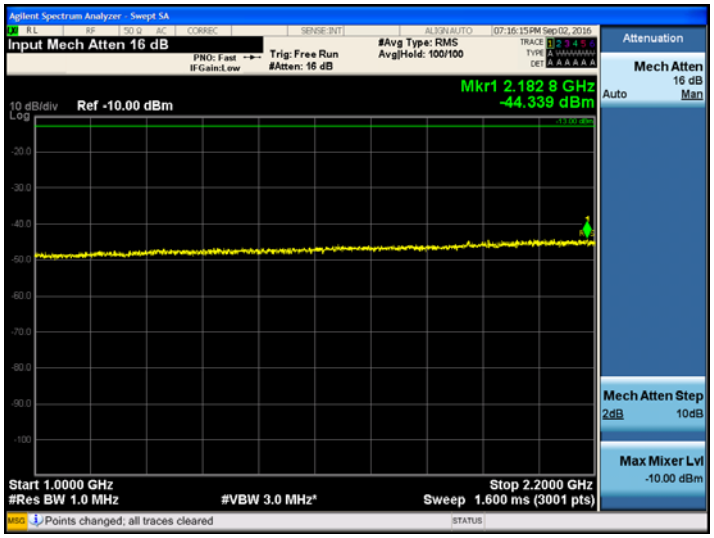
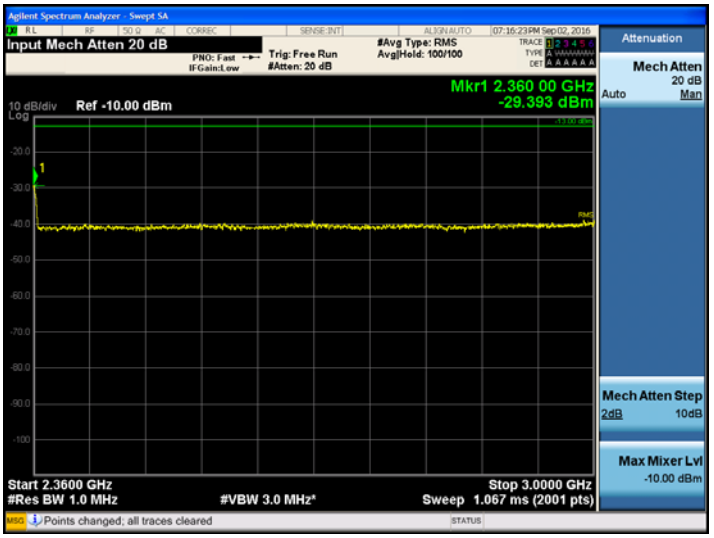
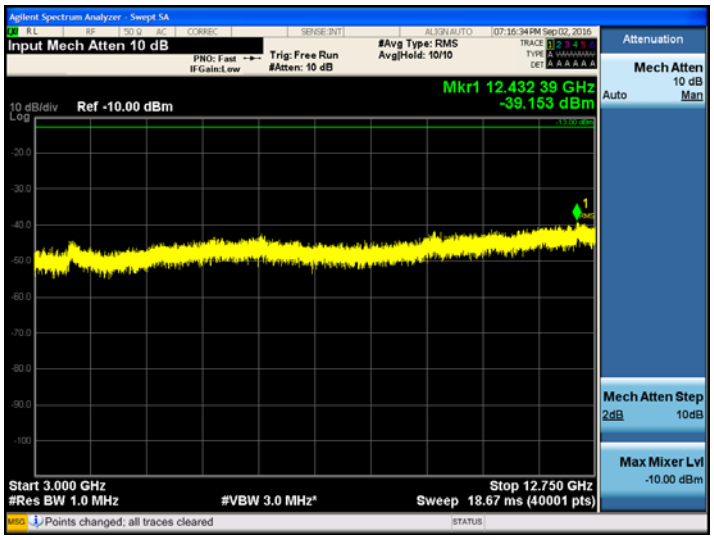
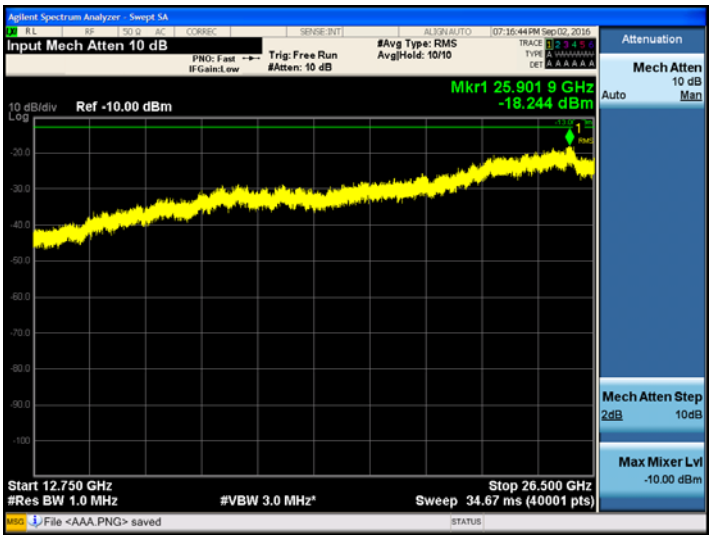


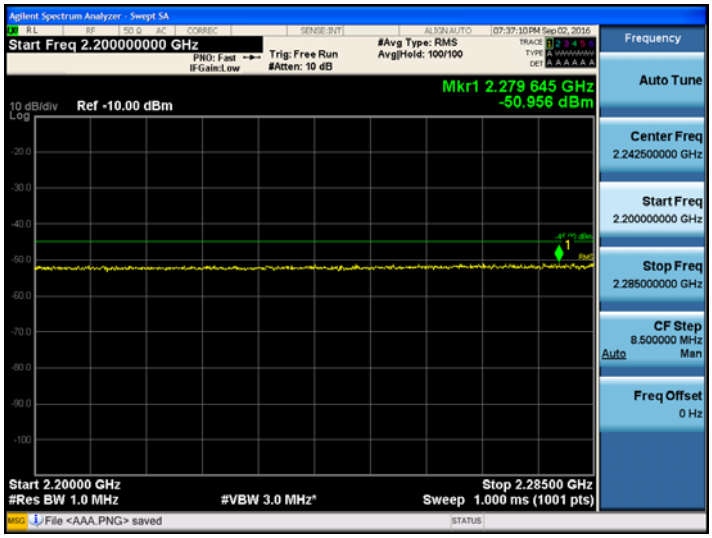
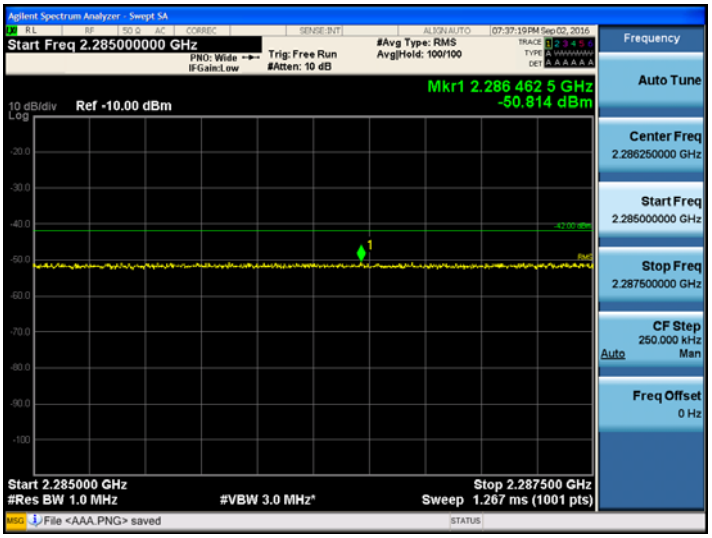
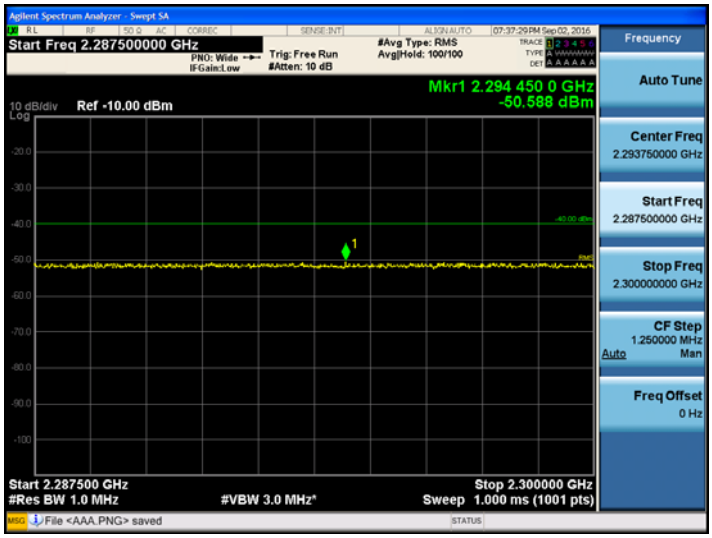
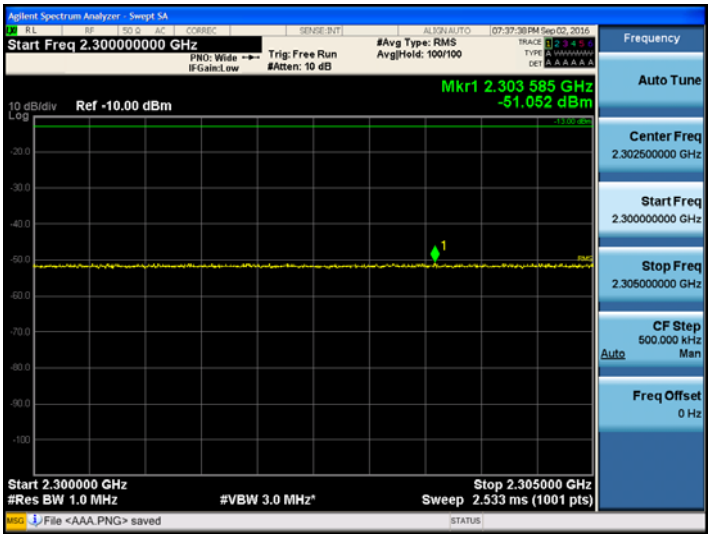

**[Downlink High]**

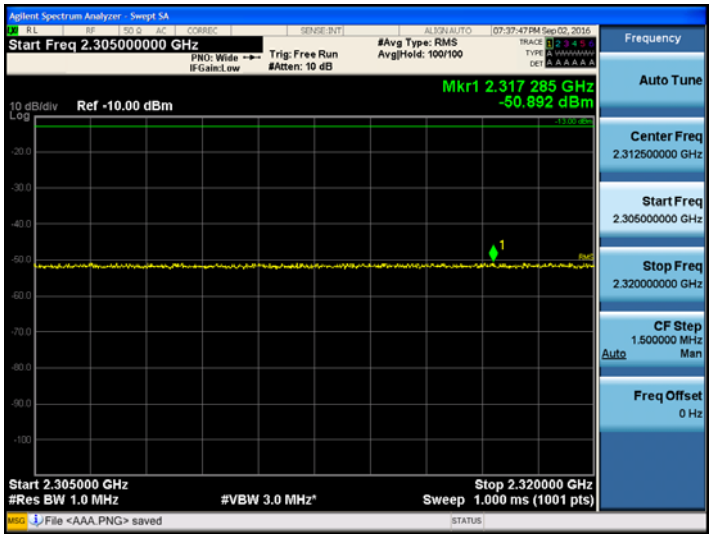
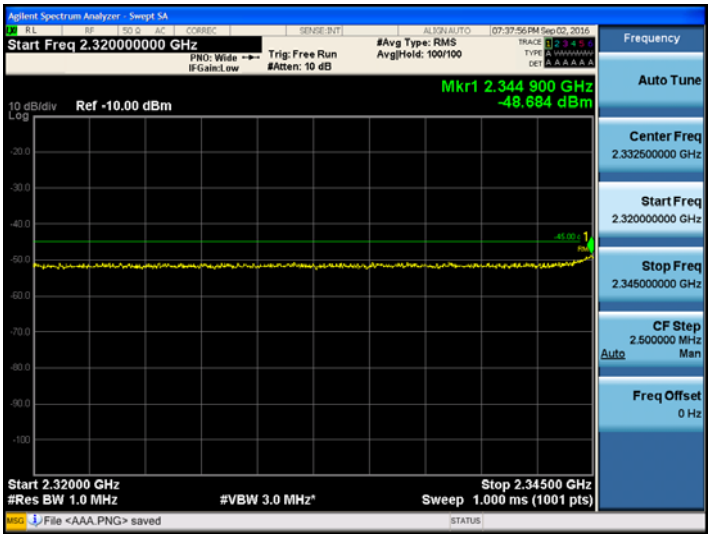
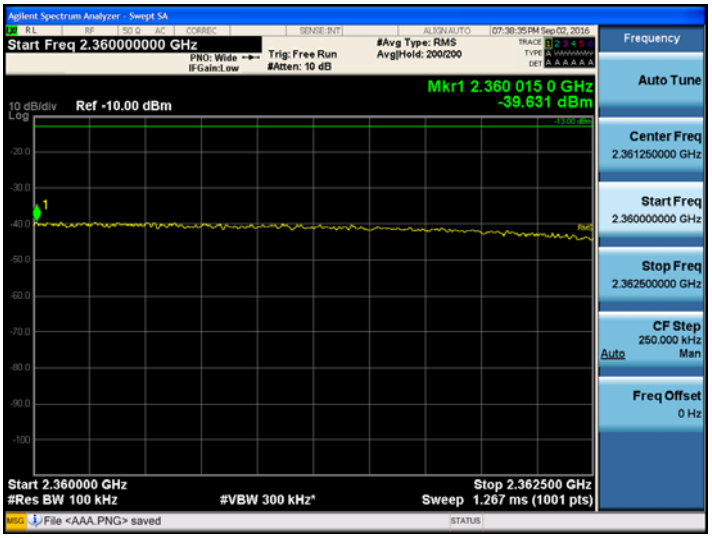


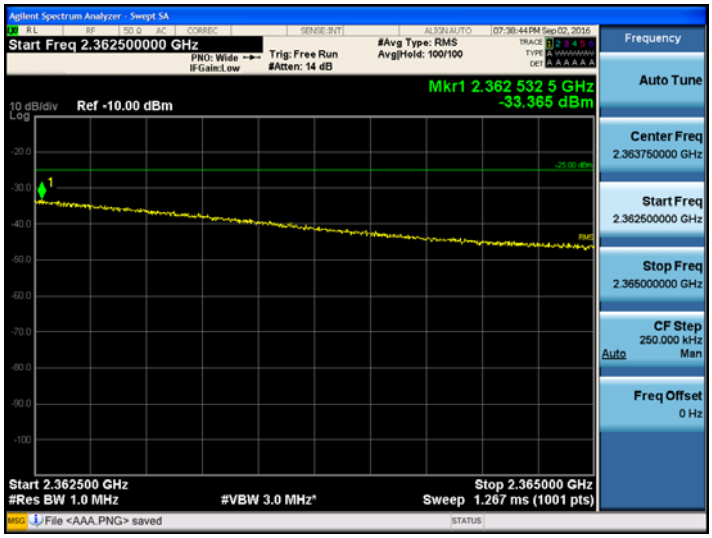
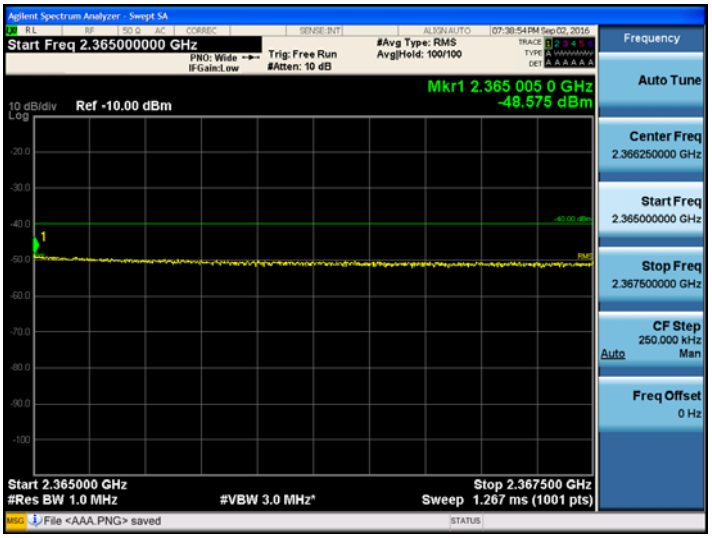
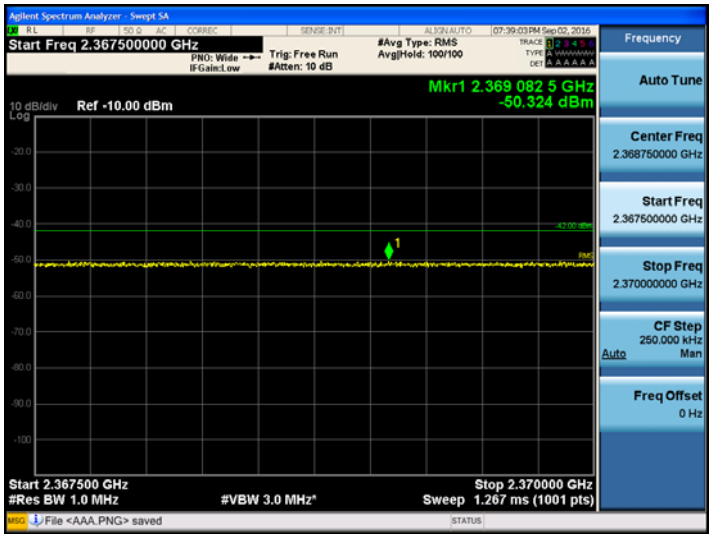
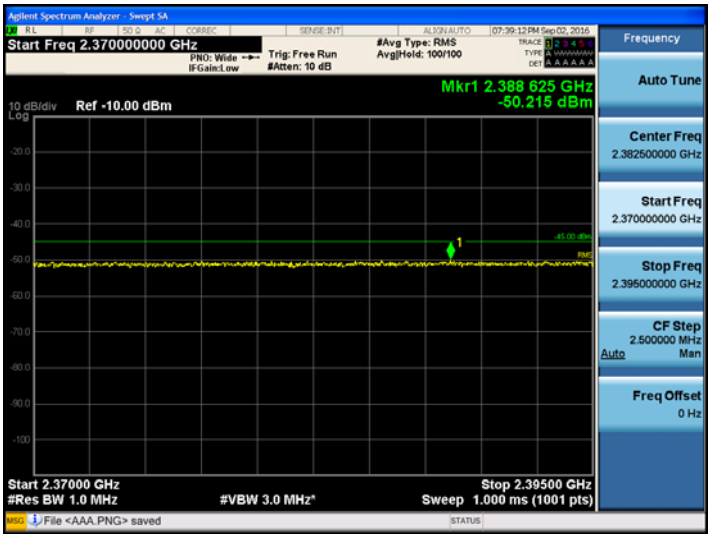
**Conducted Spurious Emissions (1 GHz – 26.5 GHz)**

**[Downlink Low]**

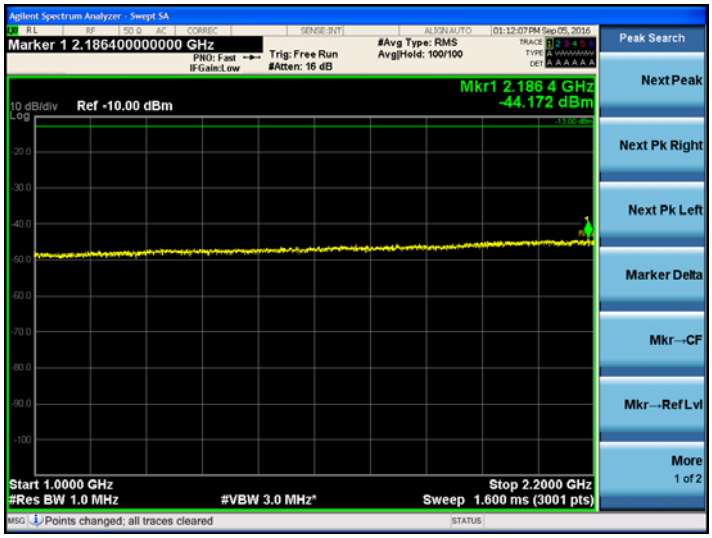
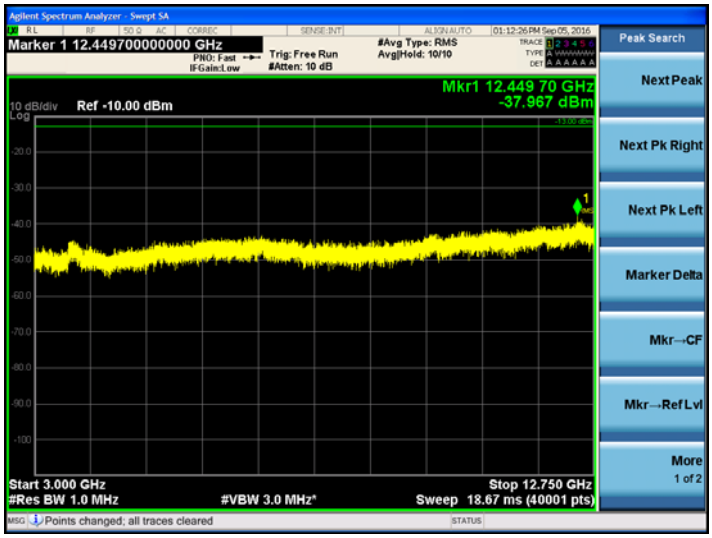
| 1000 ㎒ ~ 2200 ㎒ | 2360 ㎒ ~ 3000 ㎒ |
|---|---|
|  |  |
| **3000 ㎒ ~ 12750 ㎒** | **12750 ㎒ ~ 26500 ㎒** |
|  |  |

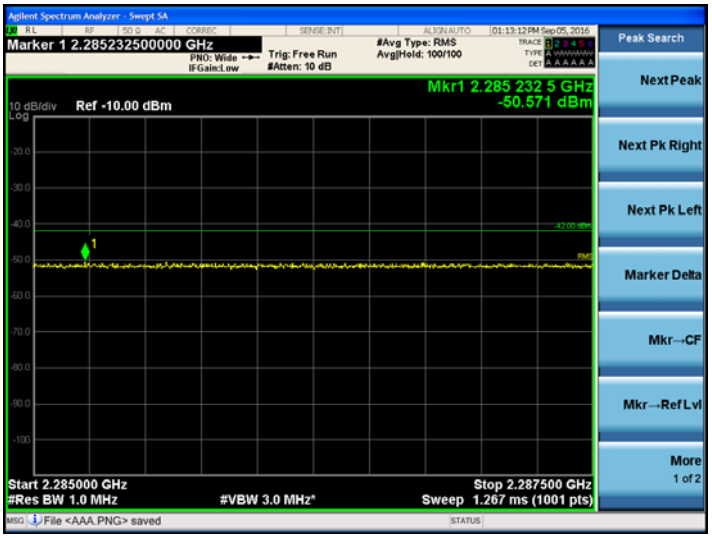
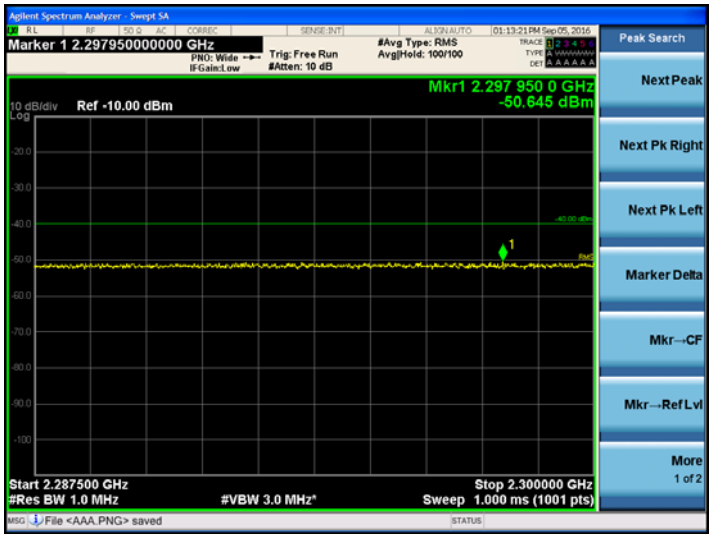
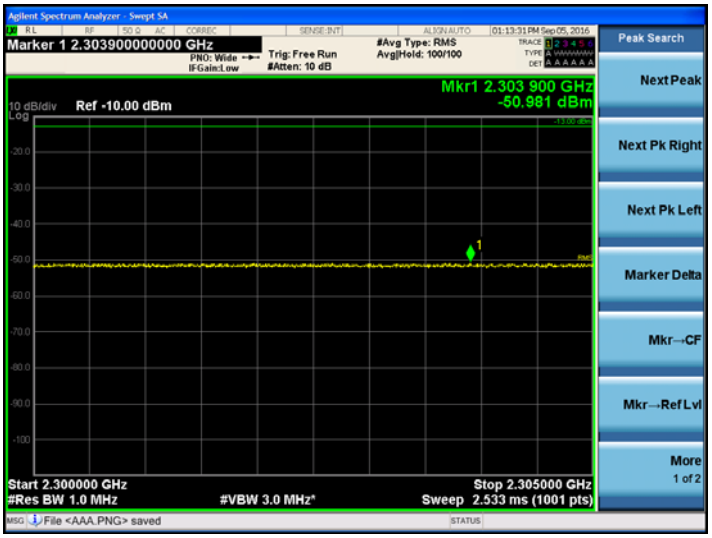
| 2200 ㎒ ~ 2285 ㎒ | 2285 ㎒ ~ 2287.5 ㎒ |
|---|---|
|  |  |
| **2287.5 ㎒ ~ 2300 ㎒** | **2300 ㎒ ~ 2305 ㎒** |
|  |  |

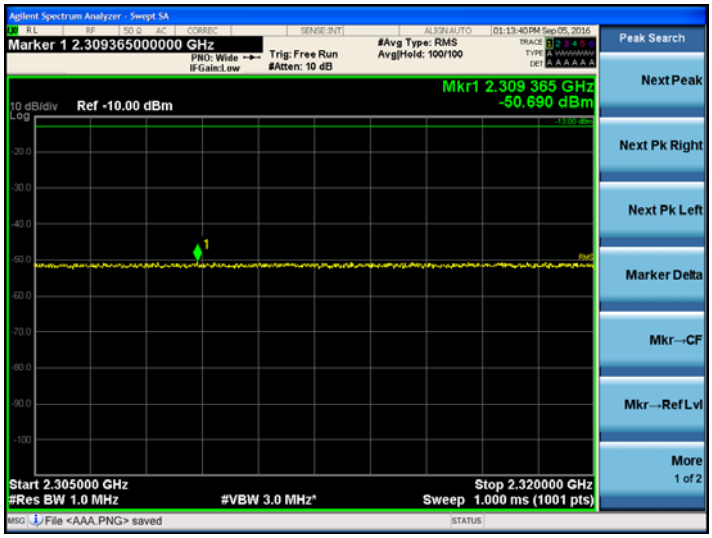
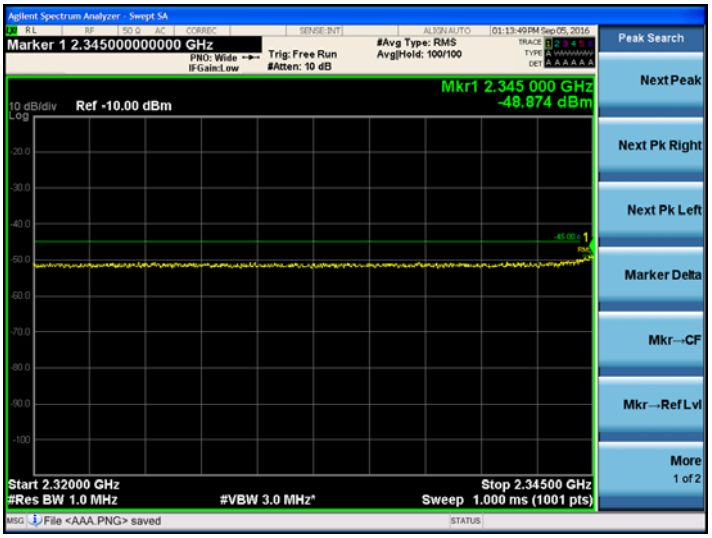
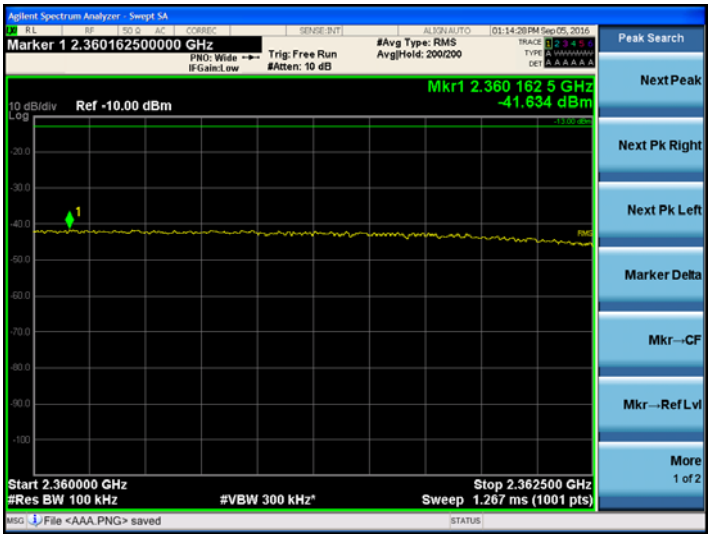
| 2305 ㎒ ~ 2320 ㎒ | 2320 ㎒ ~ 2345 ㎒ |
|---|---|
|  |  |
| **2345 ㎒ ~ 2350 ㎒** | **2360 ㎒ ~ 2362.5 ㎒** |
|  |  |

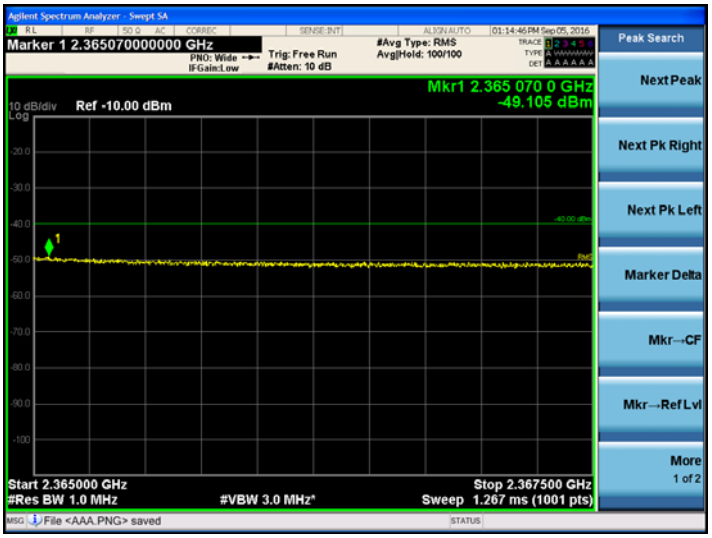
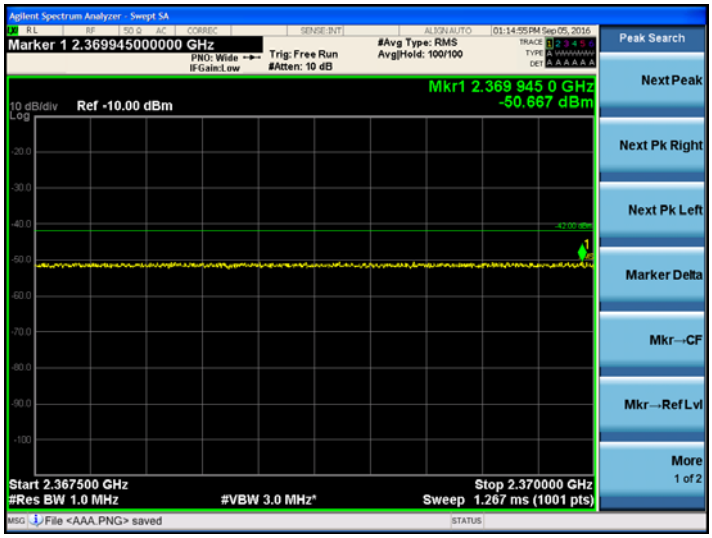
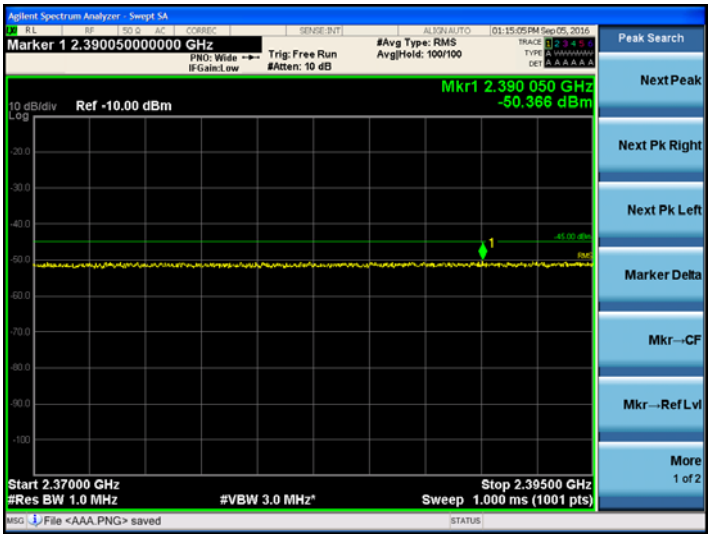
| 2362.5 ㎒ ~ 2365 ㎒ | 2365 ㎒ ~ 2367.5 ㎒ |
|---|---|
|  |  |
| **2367.5 ㎒ ~ 2370 ㎒** | **2370 ㎒ ~ 2395 ㎒** |
|  |  |

**[Downlink High]**

| 1000 ㎒ ~ 2200 ㎒ | 2360 ㎒ ~ 3000 ㎒ |
|---|---|
|  |  |
| **3000 ㎒ ~ 12750 ㎒** | **12750 ㎒ ~ 26500 ㎒** |
|  |  |

| 2200 ㎒ ~ 2285 ㎒ | 2285 ㎒ ~ 2287.5 ㎒ |
|---|---|
|  |  |
| **2287.5 ㎒ ~ 2300 ㎒** | **2300 ㎒ ~ 2305 ㎒** |
|  |  |

| 2305 ㎒ ~ 2320 ㎒ | 2320 ㎒ ~ 2345 ㎒ |
|---|---|
|  |  |
| **2345 ㎒ ~ 2350 ㎒** | **2360 ㎒ ~ 2362.5 ㎒** |
|  |  |

| 2362.5 ㎒ ~ 2365 ㎒ | 2365 ㎒ ~ 2367.5 ㎒ |
|---|---|
|  |  |
| **2367.5 ㎒ ~ 2370 ㎒** | **2370 ㎒ ~ 2395 ㎒** |
|  |  |