

FCC / ISED REPORT

Certification

Applicant Name:
SOLiD, Inc.**Address:**
10, 9th Floor, SOLiD Space, Pangyo-yeok-ro
220, Bundang-gu, Seongnam-si, Gyeonggi-do,
463-400, South Korea**Date of Issue:**
November 29, 2016**Location:****HCT CO., LTD.,**
74, Seoicheon-ro 578beon-gil, Majang-myeon,
Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA**Report No.:** HCT-R-1611-F014-1**HCT FRN:** 0005866421**IC Recognition No.:** 5944A-5

FCC ID:	W6UNH23WCS
IC:	9354A-NH23WCS
APPLICANT:	SOLiD, Inc

FCC/ IC Model(s):	N20-HRDU_2300_WCS
EUT Type:	ALLIANCE_20W
Frequency Ranges:	2350-2360 MHz (Downlink)
Conducted Output Power:	20 W (43 dBm)
Date of Test:	October 31, 2016 ~ November 15, 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 this equipment 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
: Yong Hyun Lee
Manager of RF Team

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Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1611-F014	November 16, 2016	- First Approval Report
HCT-R-1611-F014-1	November 28, 2016	- Remove the rule part RSS-199 on page 43.

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1. CLIENT INFORMATION

The EUT has been tested by request of

Company	SOLiD, Inc. 10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea
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FCC ID: W6UNH23WCS
IC: 9354A-NH23WCS
EUT Type: ALLIANCE_20W
FCC/ IC Model(s): N20-HRDU_2300_WCS
Power Supply: AC: 110 VAC / 220 VAC
DC: -48 VDC
Frequency Ranges: 2350-2360 MHz (Downlink)
Conducted Output Power: 20 W (43 dBm)
Antenna Gain(s): Manufacturer does not provide an antenna.
Measurement standard(s): ANSI/TIA-603-C-2004, KDB 971168 D01 v02r02
KDB 935210 D02 v03r02, KDB 935210 D05 v01r01,
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, Seocheon-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-131

Description	Reference (FCC)	Reference (IC)	Results
Conducted RF Output Power	§2.1046, §27.50	RSS-131, Section 4.3 RSS-131, Section 6.2 SRSP-516	Compliant
Occupied Bandwidth	§2.1049	RSS-GEN, Section 6.6	Compliant
Passband Gain and Bandwidth & Out of Band Rejection	KDB 935210 D05 v01r01	RSS-131, Section 4.2 RSS-131, Section 6.1	Compliant
Spurious Emissions at Antenna Terminals	§2.1051, §27.53	RSS-131, Section 4.4 RSS-131, Section 6.3 RSS-131, Section 6.4 SRSP-516	Compliant
Radiated Spurious Emissions	§2.1053, §27.53	-	Compliant
Frequency Stability	§2.1055, §27.54	RSS-131, Section 4.5 RSS-131, Section 6.5	Compliant

* Note: This EUT is supported power supply both of AC and DC. Test results are only attached worst cases.

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 MEASUREMENT UNCERTAINTY

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	$OBW \leq 20$ MHz	± 52 kHz
Passband Gain and Bandwidth & Out of Band Rejection	Gain 20 dB bandwidth	± 0.89 dB ± 0.58 MHz
Spurious Emissions at Antenna Terminals	-	± 1.08 dB
Radiated Spurious Emissions	$f \leq 1$ GHz $f > 1$ GHz	± 4.80 dB ± 6.07 dB
Frequency Stability	-	$\pm 1.22 \times 10^{-6}$

4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

Temperature :	+ 15 °C to + 35 °C
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	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	02/16/2016	Annual	BU5347
Weinschel	67-30-33 / Fixed Attenuator	02/16/2016	Annual	CC7264
ML Technology	JIG / Band Reject Filter(2350.5 MHz ~ 2359.5 MHz)	11/11/2016	Annual	1609R001
Mini-Circuits	ZGBDC20-33HP+ / Bi-Directional Coupler	08/24/2016	Annual	0518
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	10/21/2016	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	09/29/2016	Annual	836650/016
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/23/2016	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.

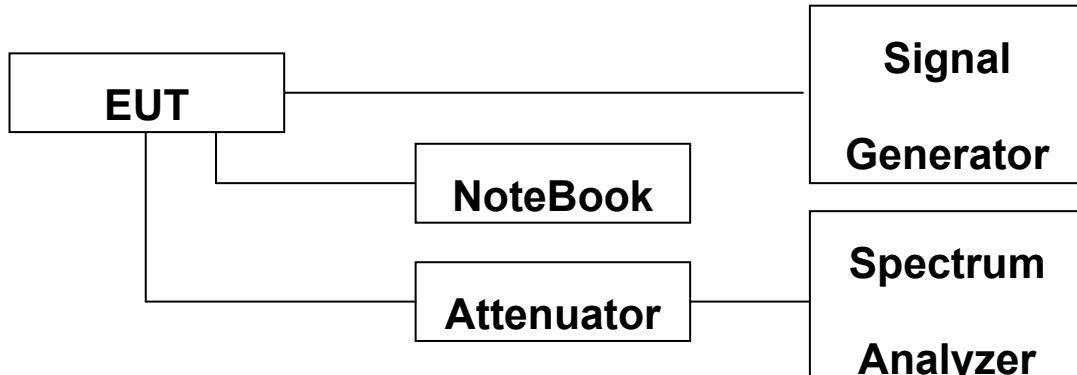
Test Procedures:

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 f_0 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 D01 v02r02.

**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 of enhancers.

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 the single 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. $P_{\text{permissible}} = P_{\text{rated}} - 3.5 \text{ dB}$).

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 power back-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	-16 dBm	59 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	43.16	20.718
	Middle	-	-	-
	High	2357.50	43.05	20.172
2300_WCS Band_ LTE 5 MHz +3dBm above the AGC threshold	Low	2352.50	43.07	20.297
	Middle	-	-	-
	High	2357.50	43.02	20.039
2300_WCS Band_ LTE 10 MHz AGC threshold	Low	-	-	-
	Middle	2355.00	43.13	20.564
	High	-	-	-
2300_WCS Band_ LTE 10 MHz +3dBm above the AGC threshold	Low	-	-	-
	Middle	2355.00	43.07	20.293
	High	-	-	-

[PAPR]

	Channel	Frequency (MHz)	PAPR
			(dB)
2300_WCS Band_ LTE 5 MHz The peak-to- average ratio (PAPR) AGC threshold	Low	2352.50	8.36
	Middle	-	-
	High	2357.50	8.32
2300_WCS Band_ LTE 5 MHz The peak-to- average ratio (PAPR) +3dBm above the AGC threshold	Low	2352.50	8.31
	Middle	-	-
	High	2357.50	8.32
2300_WCS Band_ LTE 10 MHz The peak-to- average ratio (PAPR) AGC threshold	Low	-	-
	Middle	2355.00	8.28
	High	-	-
2300_WCS Band_ LTE 10 MHz The peak-to- average ratio (PAPR) +3dBm above the AGC threshold	Low	-	-
	Middle	2355.00	8.31
	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	2350.20	40.181	43.181
	Middle	2355.00	40.186	43.186
	High	2359.80	40.119	43.119

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

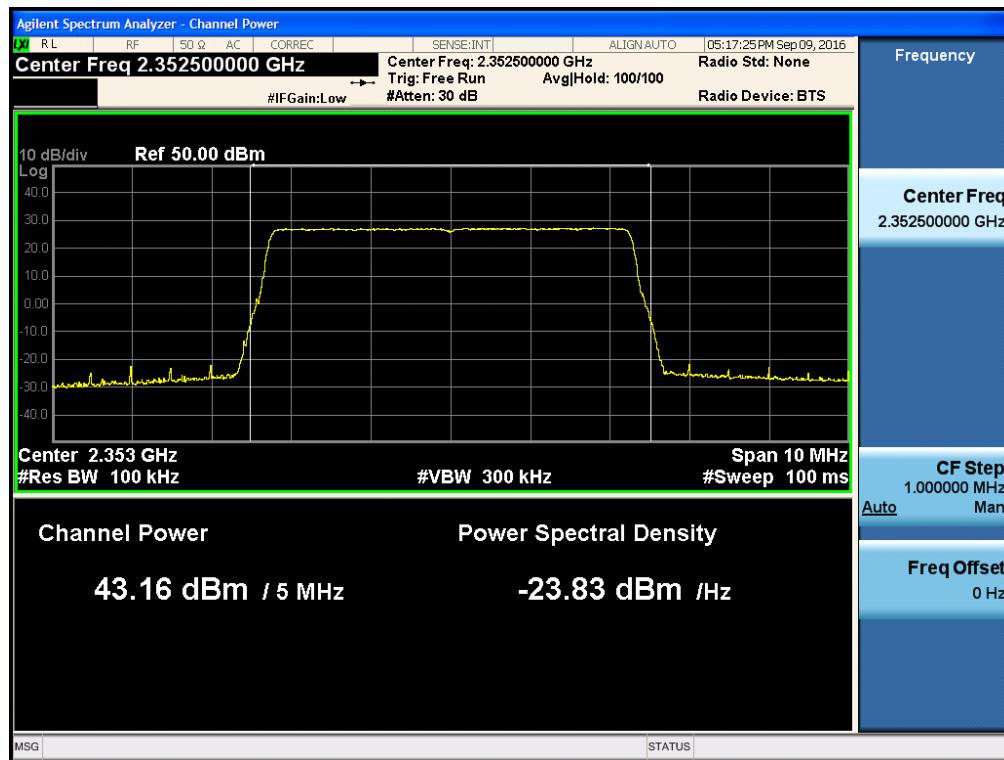
[Downlink]

	1 Carrier (dBm)	3 Carrier (dBm)	Power Back-off (dB)
2300_WCS Band	43.16	38.35	4.81

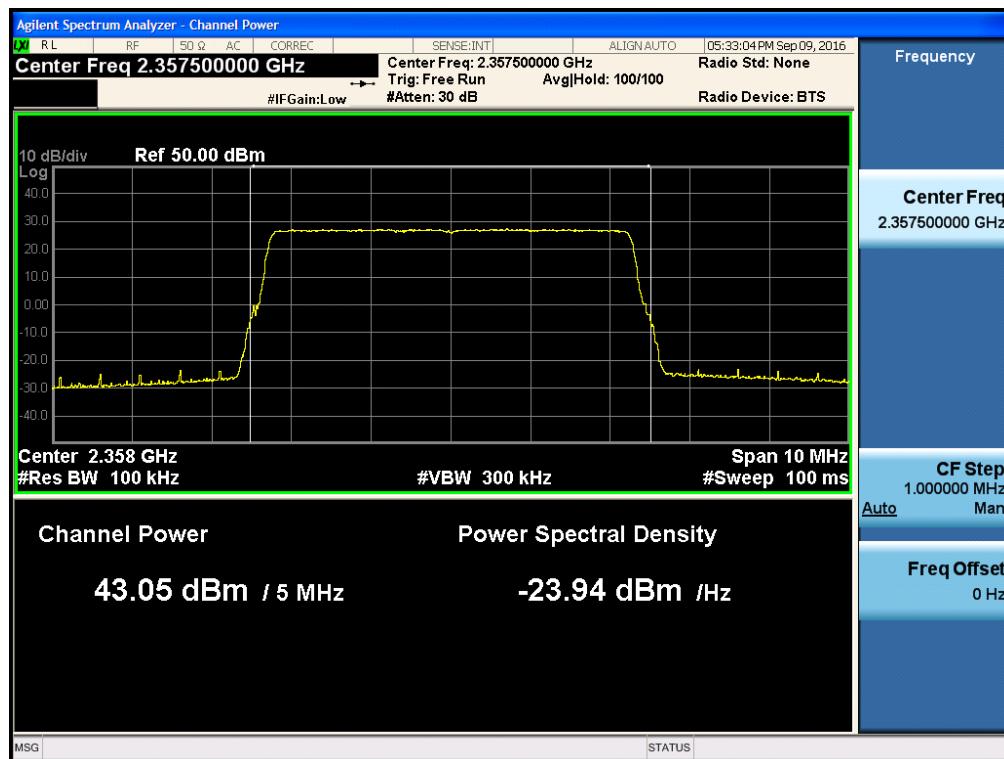
* The 1 carrier above value is maximum average output power of this device.

RF Output Power for 2300_WCS Band LTE 5 MHz

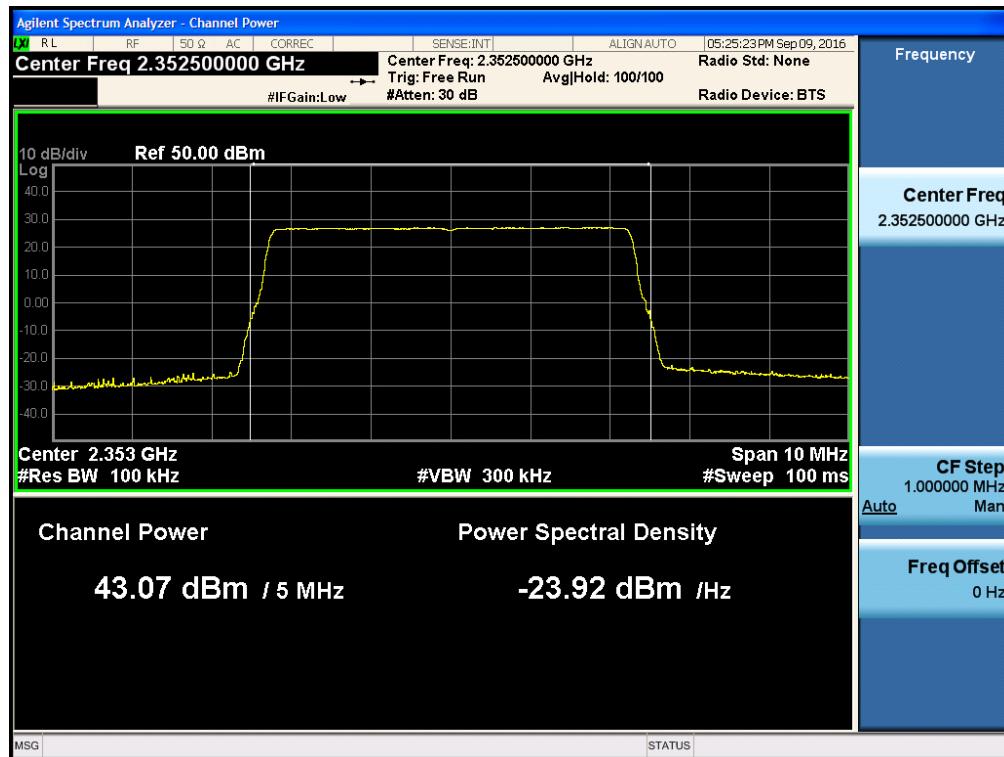
[AGC threshold Downlink Low]



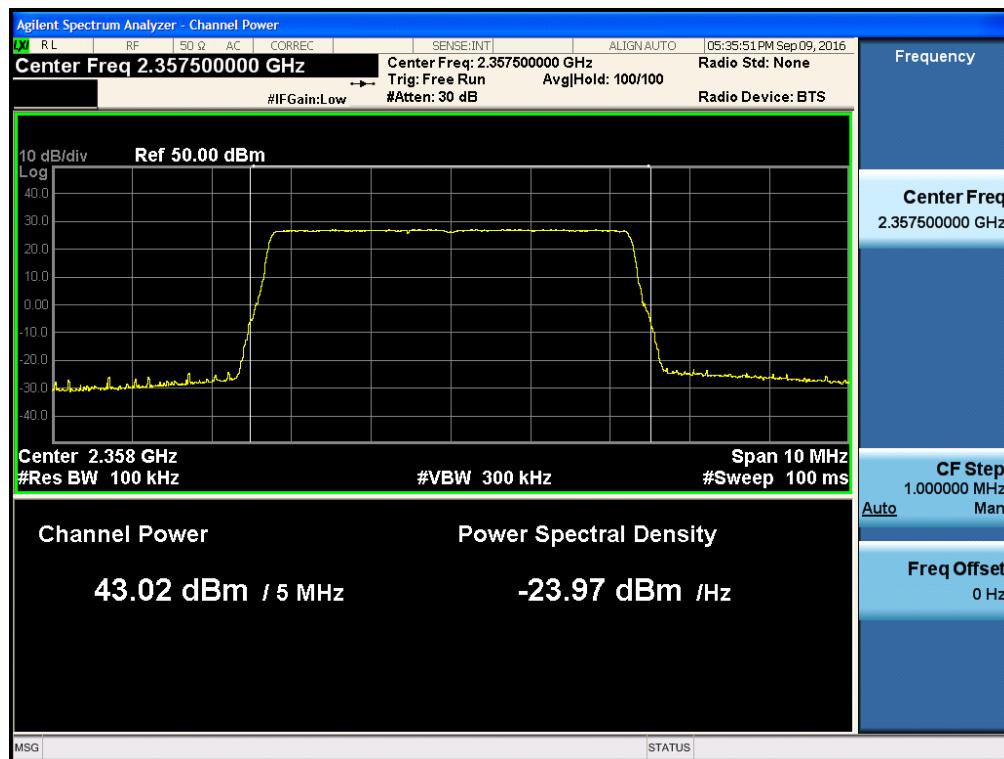
[AGC threshold Downlink High]



[+3dBm above AGC threshold Downlink Low]

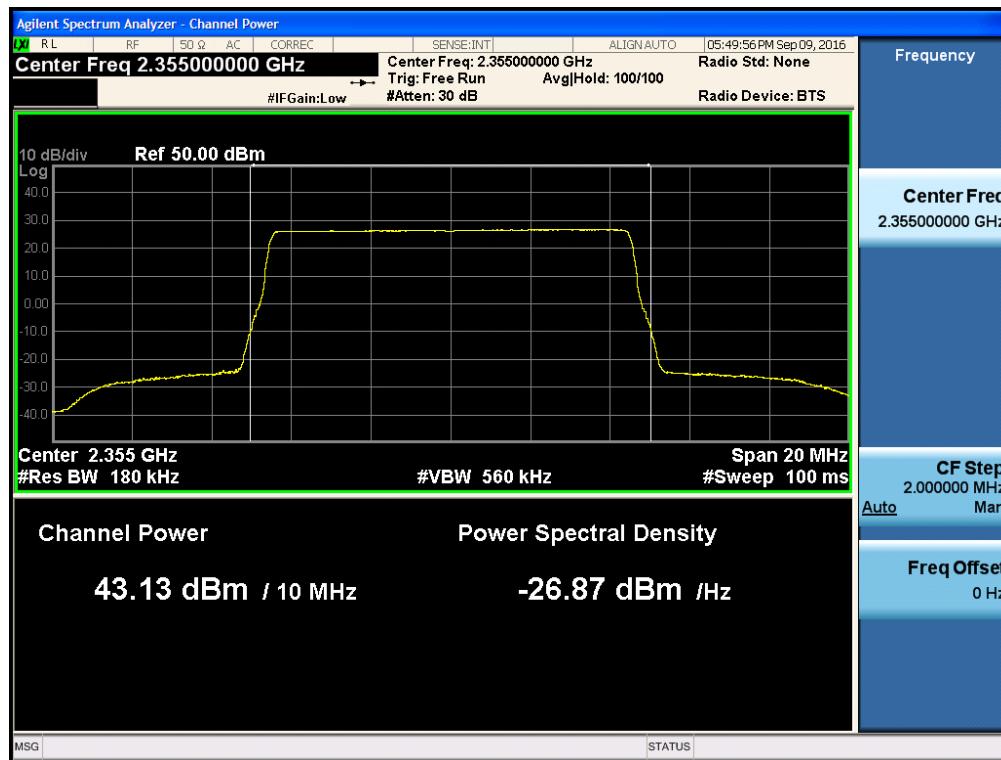


[+3dBm above AGC threshold Downlink High]

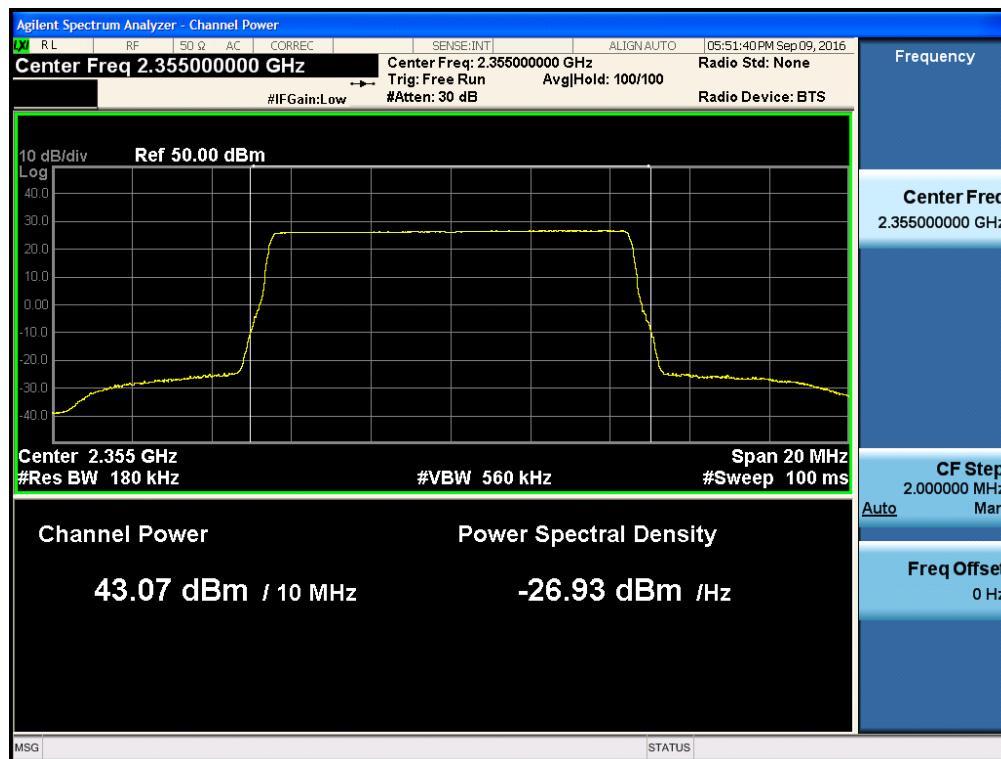


RF Output Power for 2300_WCS Band LTE 10 MHz

[AGC threshold Downlink Middle]

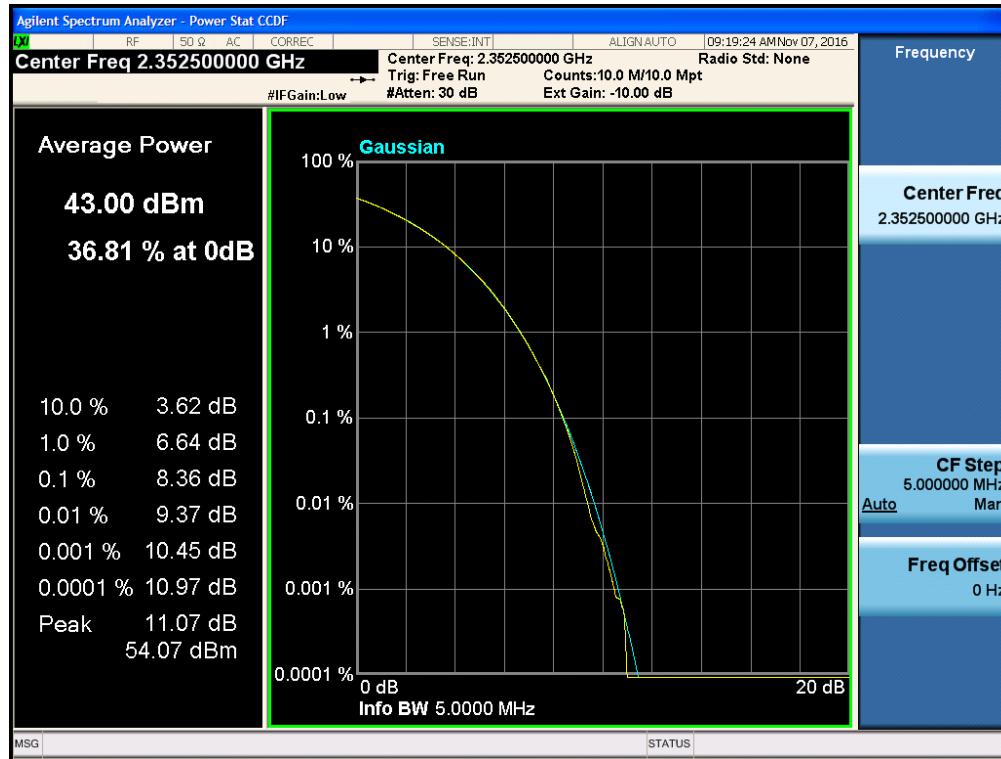


[+3dBm above AGC threshold Downlink Middle]



PAPR for 2300_WCS Band LTE 5 MHz

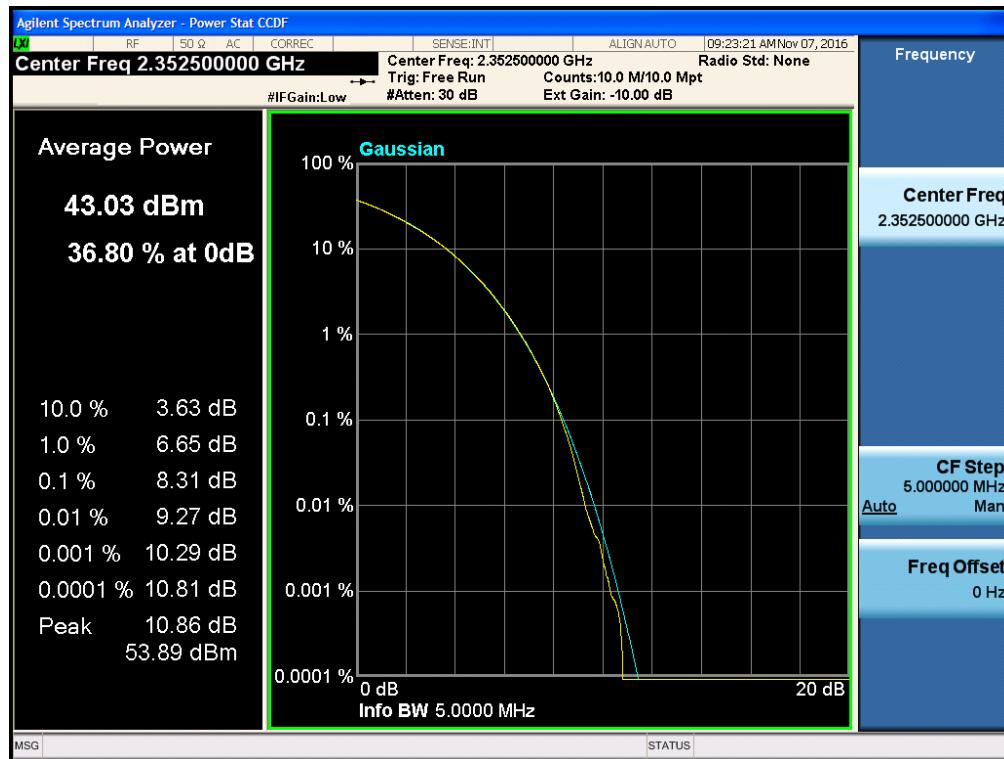
[AGC threshold Downlink Low]



[AGC threshold Downlink High]



[+3dBm above AGC threshold Downlink Low]

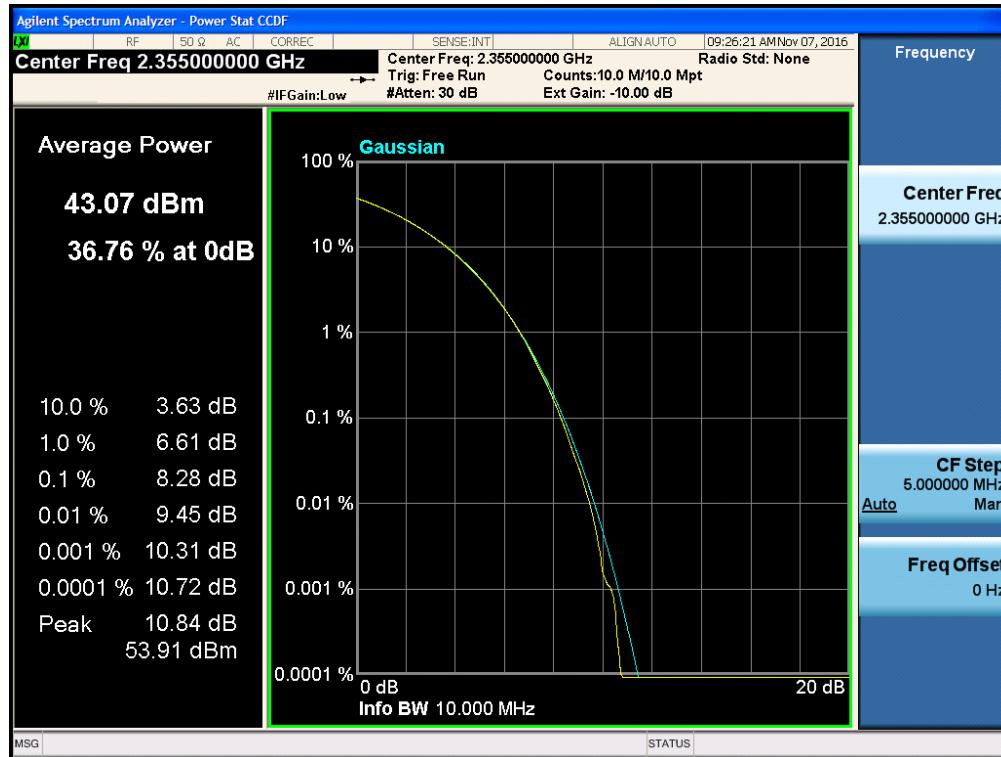


[+3dBm above AGC threshold Downlink High]

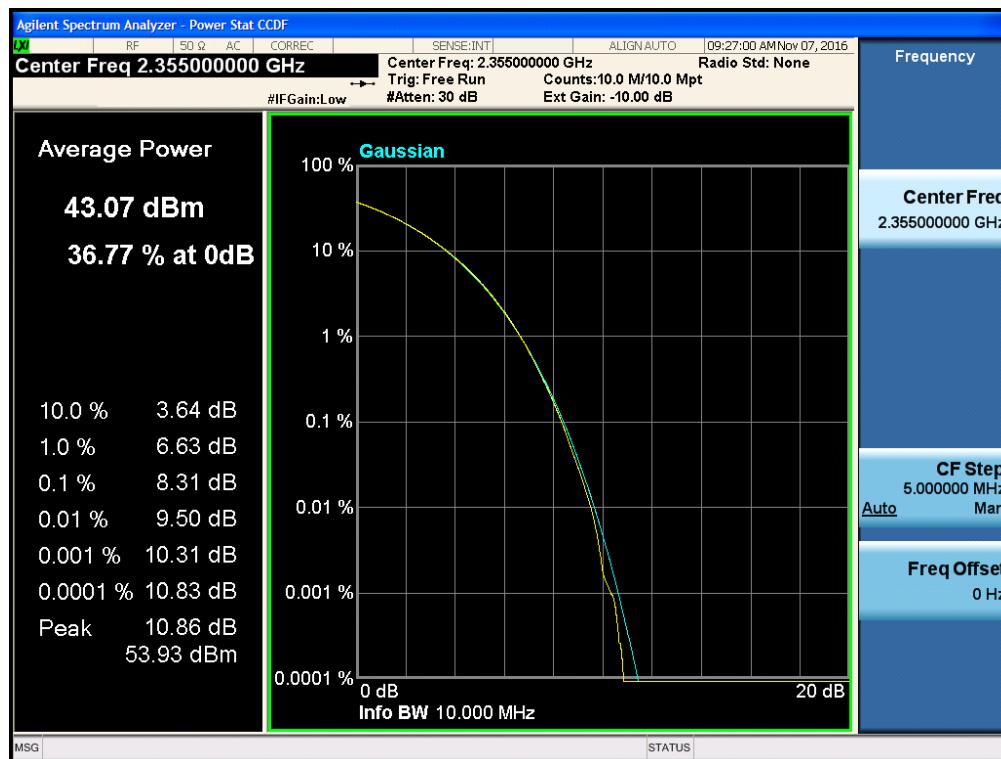


PAPR for 2300_WCS Band LTE 10 MHz

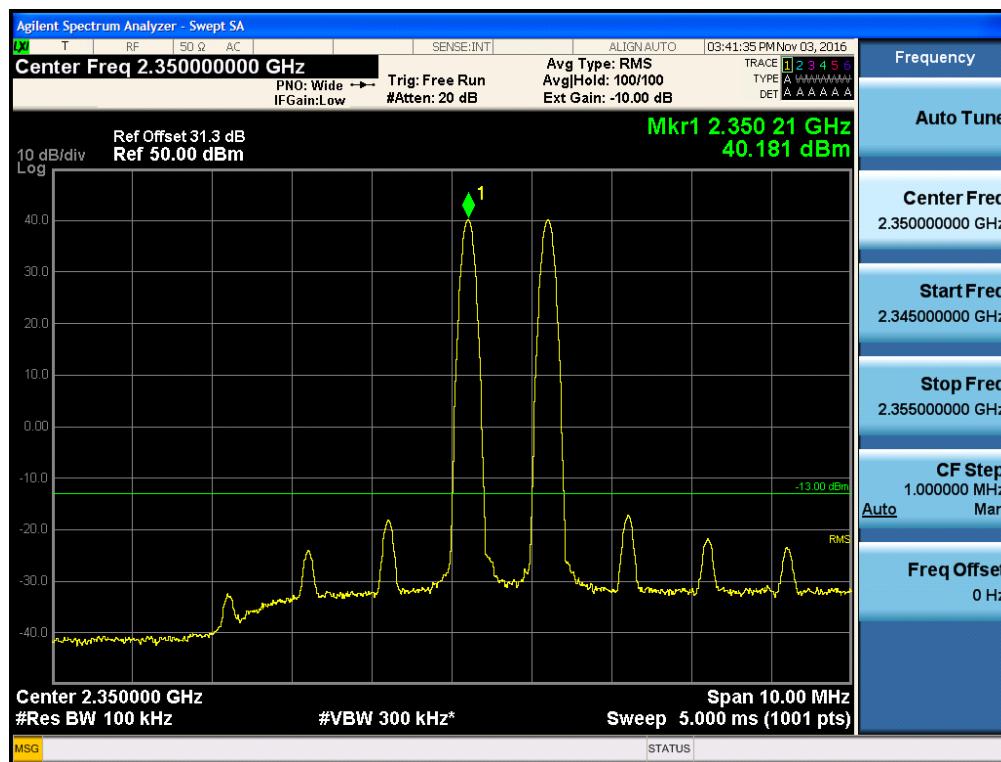
[AGC threshold Downlink Middle]



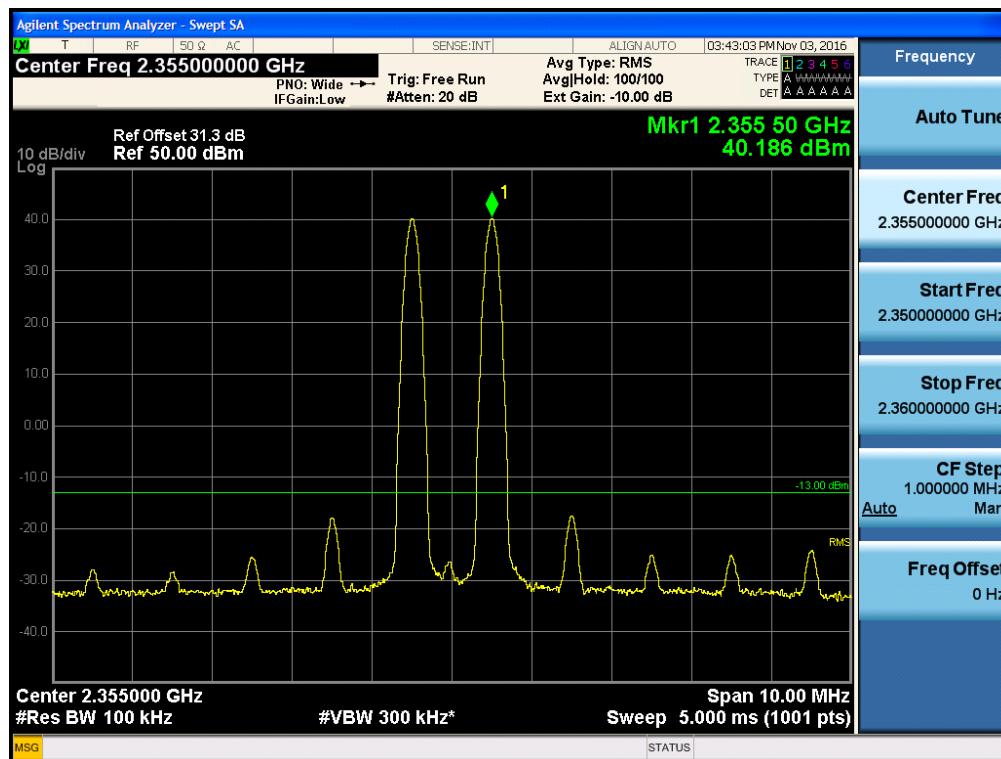
[+3dBm above AGC threshold Downlink Middle]



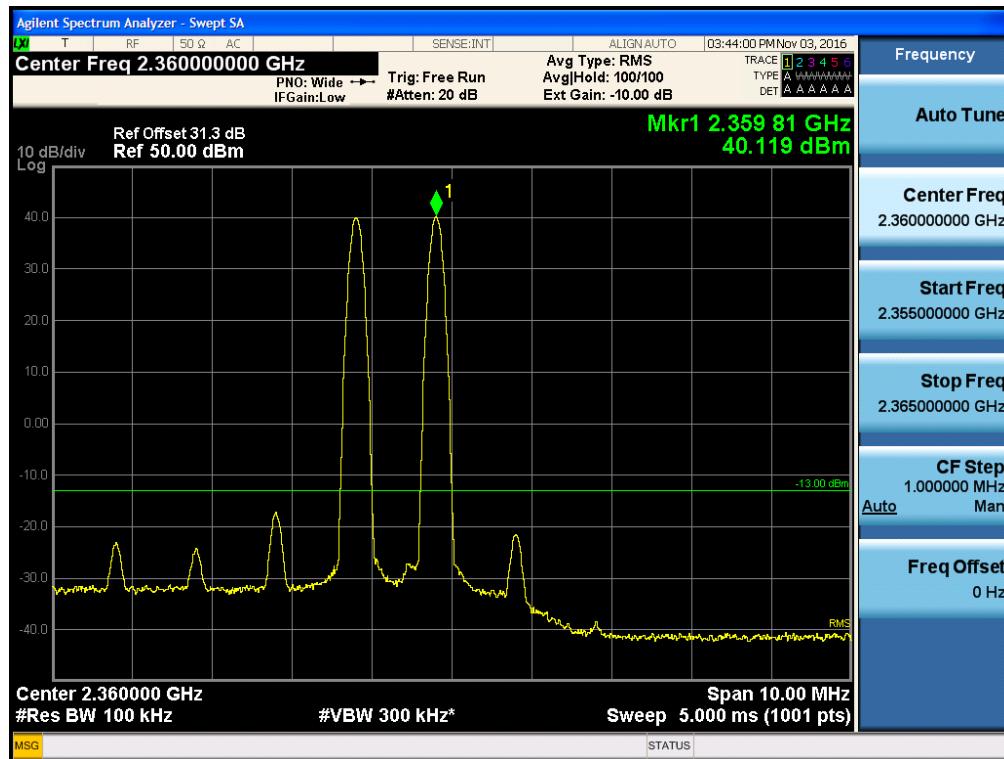
Multi-channel Enhancer for IC_ 2300_WCS BAND
[Downlink Low]



[Downlink Middle]

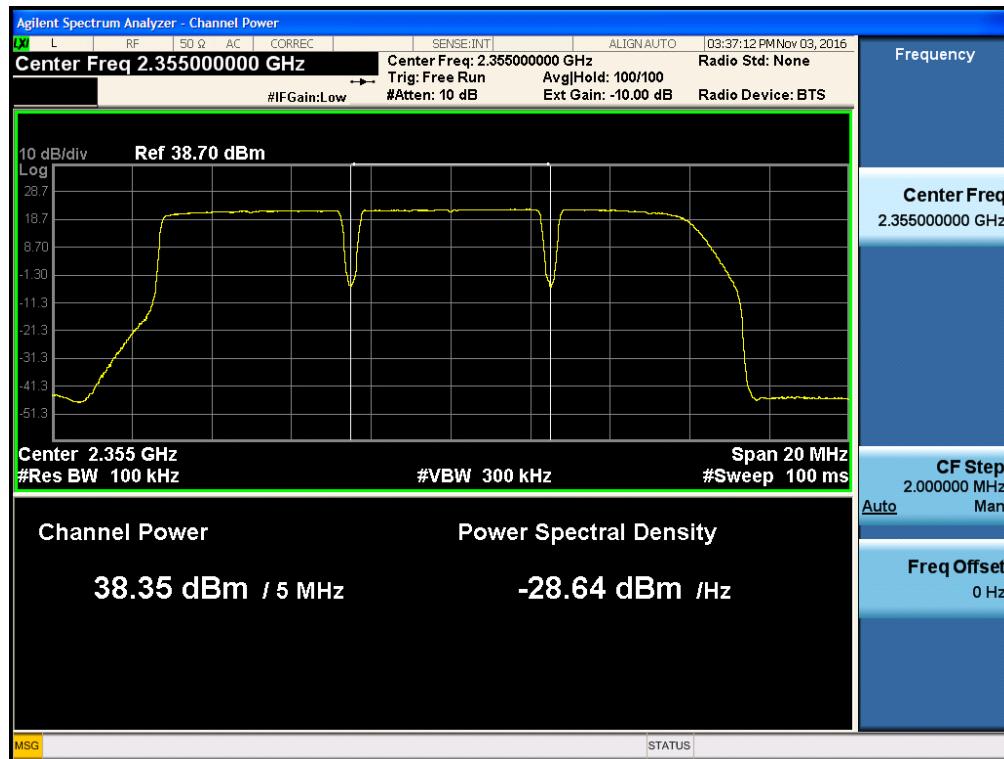


[Downlink High]



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 emission bandwidth (EBW) or alternatively, the OBW.
- f) The nominal RBW shall be in the range of 1 % to 5 % of the anticipated OBW, and the VBW shall be $\geq 3 \times \text{RBW}$.
- 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 $[10 \log (\text{OBW} / \text{RBW})]$ below the reference level.
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) Determine the reference value: Allow the trace to stabilize. Set the spectrum analyzer marker to the highest amplitude level of the displayed trace (this is the reference value) and record the associated frequency as f_0 .
- l) 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 -26 dB down amplitude.

The 26 dB EBW (alternatively OBW) is the positive frequency difference between the two markers. If the spectral envelope crosses the -26 dB down amplitude at multiple points, the lowest or highest frequency shall be selected as the frequencies that are the furthest removed from the center frequency at which the spectral envelope crosses the -26 dB down amplitude point.

- m) Repeat steps e) to l) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).
- n) Compare the spectral plot of the input signal (determined from step m) to the output signal (determined from step l) to affirm that they are similar (in passband and rolloff characteristic features and relative spectral locations), and include plot(s) and descriptions in test report.
- o) Repeat the procedure [steps e) to n)] with the input signal amplitude set to 3 dB above the AGC threshold.
- p) Repeat steps e) to o) with the signal generator set to the narrowband signal.
- q) Repeat steps e) to p) 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	-16 dBm	59 dB

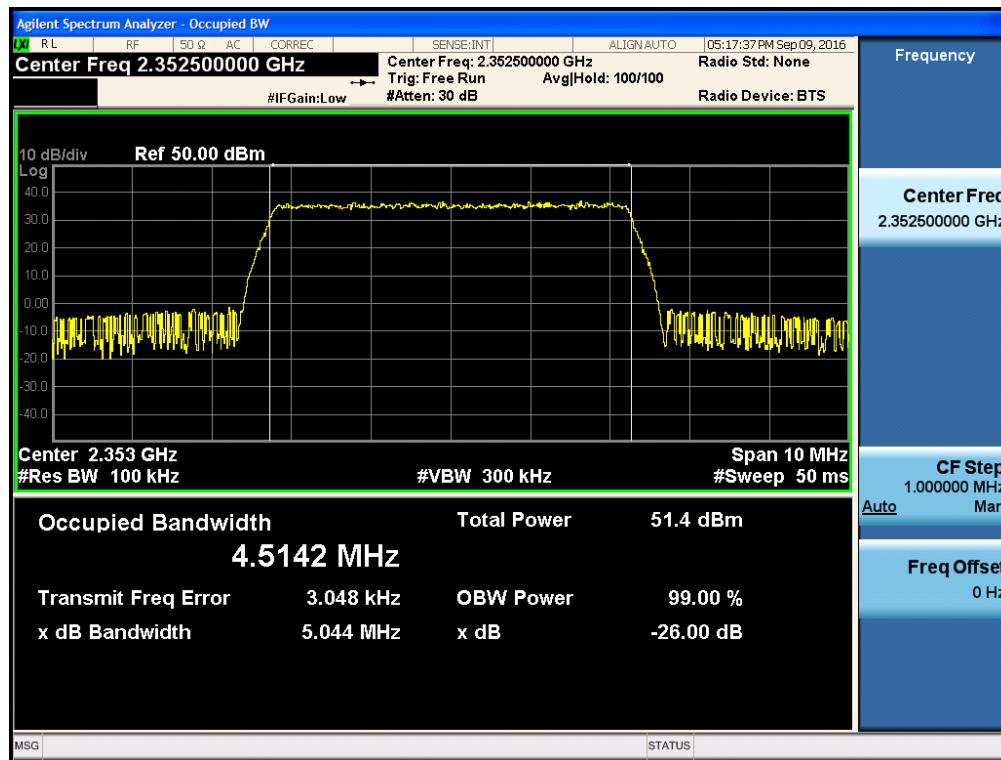
[Downlink Output_2300_WCS BAND]

	Channel	Frequency (MHz)	OBW (MHz)
2300_WCS Band_ LTE 5 MHz AGC threshold	Low	2352.50	4.5142
	Middle	-	-
	High	2357.50	4.5090
2300_WCS Band_ LTE 5 MHz +3dBm above the AGC threshold	Low	2352.50	4.5093
	Middle	-	-
	High	2357.50	4.5094
2300_WCS Band_ LTE 10 MHz AGC threshold	Low	-	-
	Middle	2355.00	8.9928
	High	-	-
2300_WCS Band_ LTE 10 MHz +3dBm above the AGC threshold	Low	-	-
	Middle	2355.00	8.9993
	High	-	-

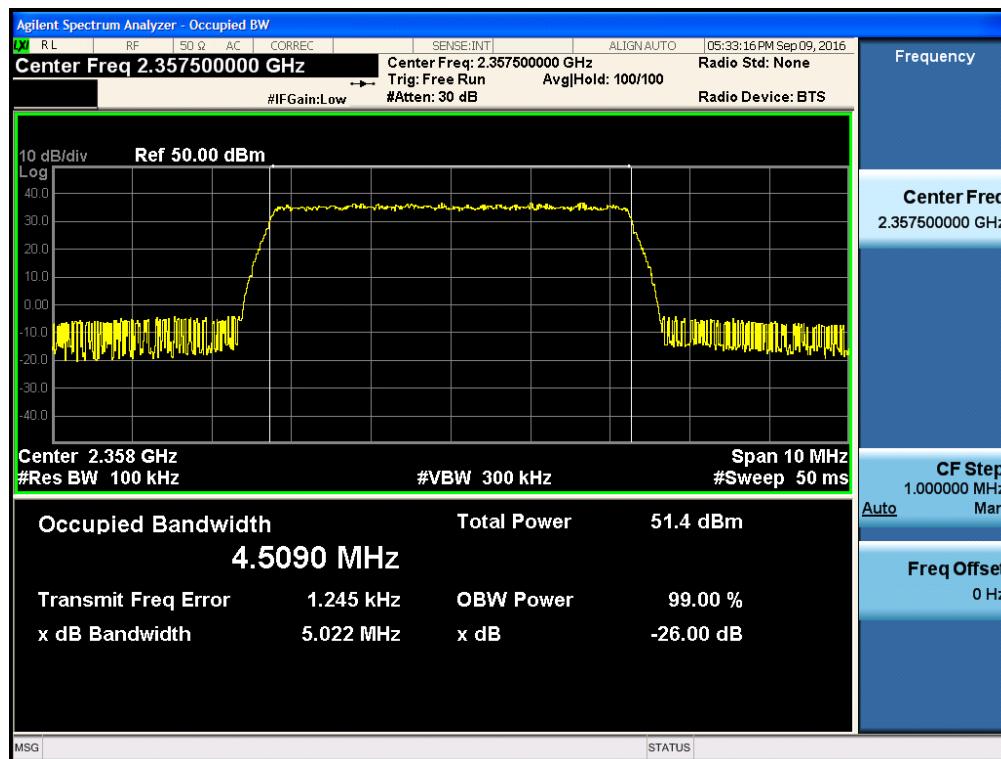
[Downlink Input_2300_WCS BAND]

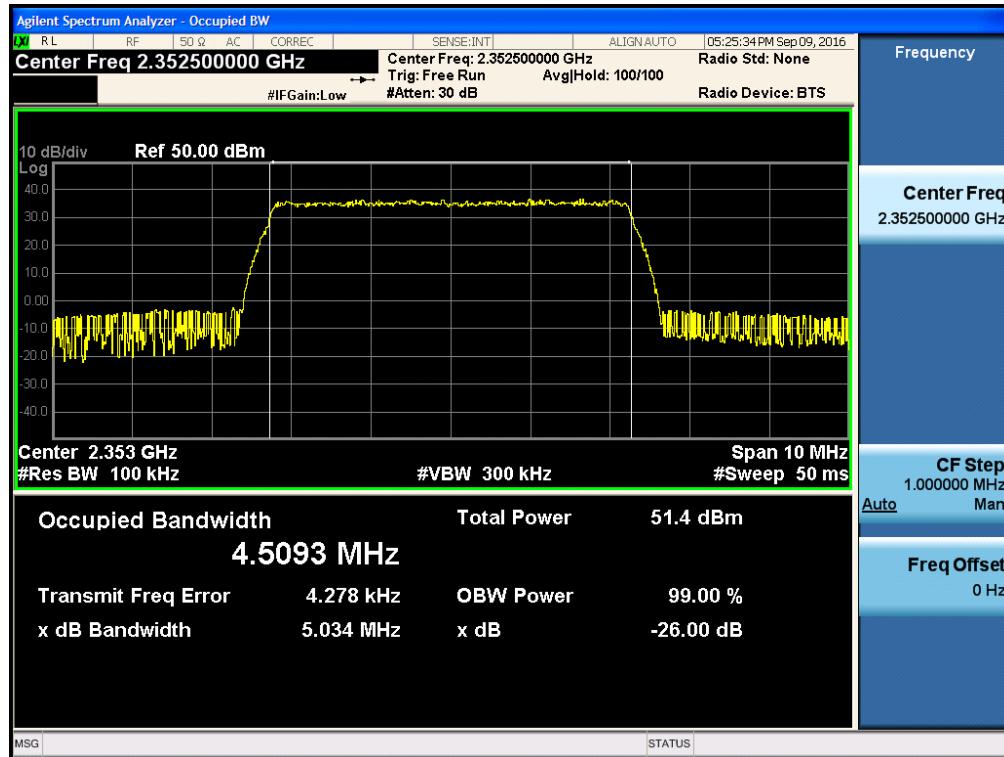
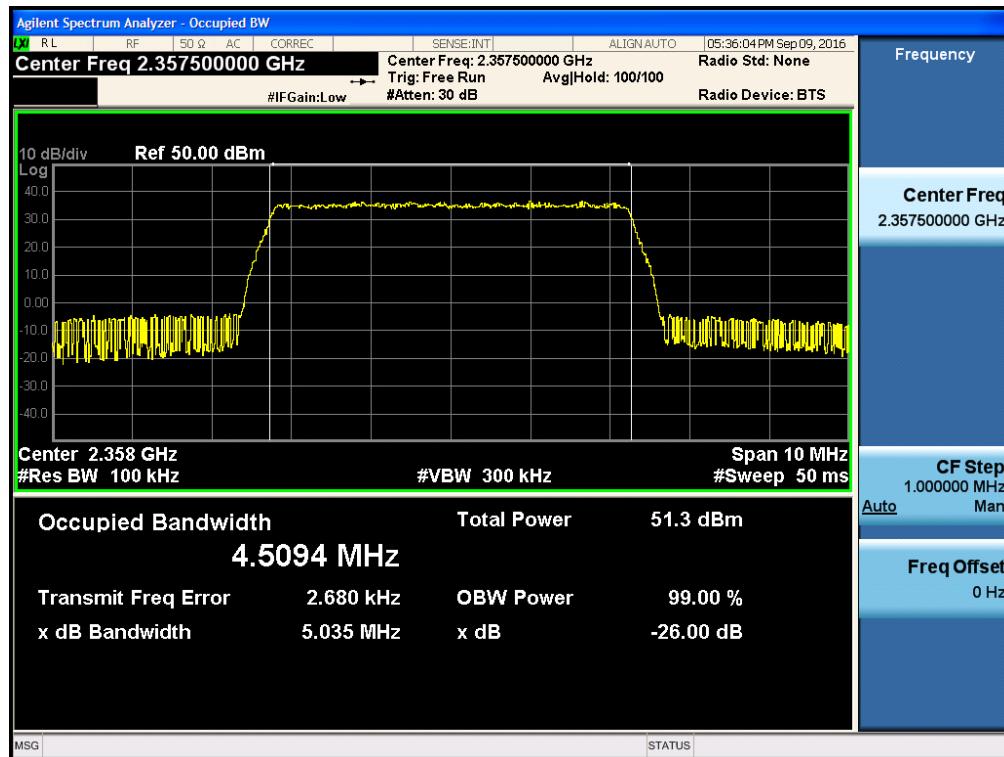
	Channel	Frequency (MHz)	OBW (MHz)
2300_WCS Band_ LTE 5 MHz AGC threshold	Low	2352.50	4.5140
	Middle	-	-
	High	2357.50	4.5104
2300_WCS Band_ LTE 10 MHz AGC threshold	Low	-	-
	Middle	2355.00	8.9998
	High	-	-

Occupied Bandwidth_2300_WCS BAND LTE 5 MHz_Output [AGC threshold Output Downlink Low]

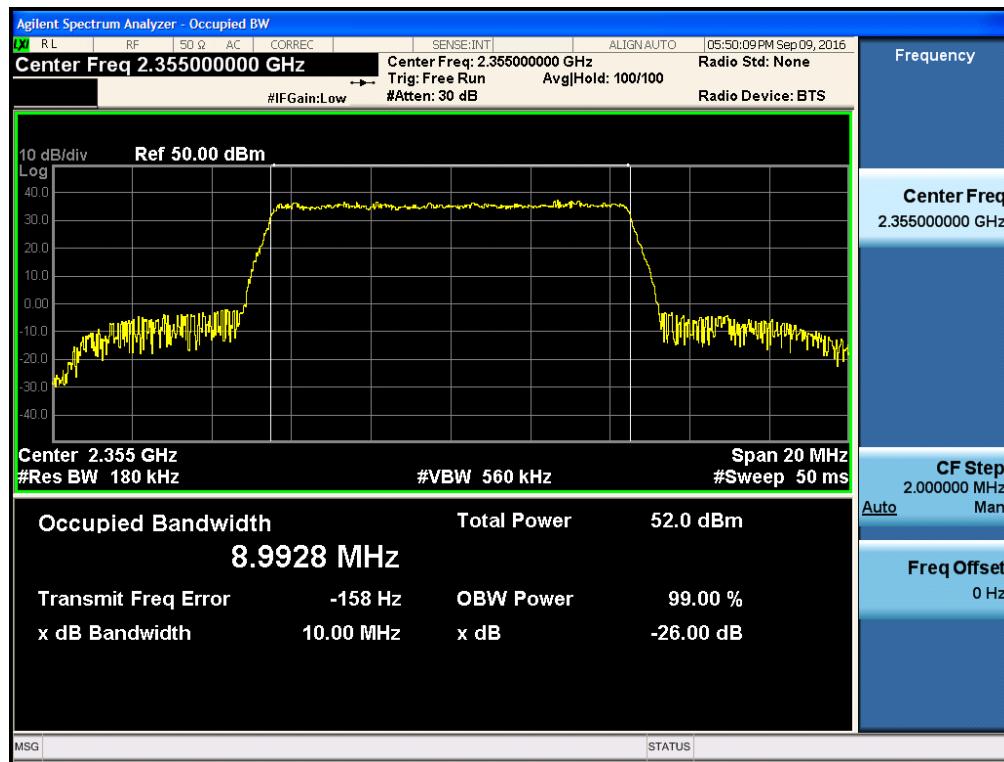


[AGC threshold Output Downlink High]

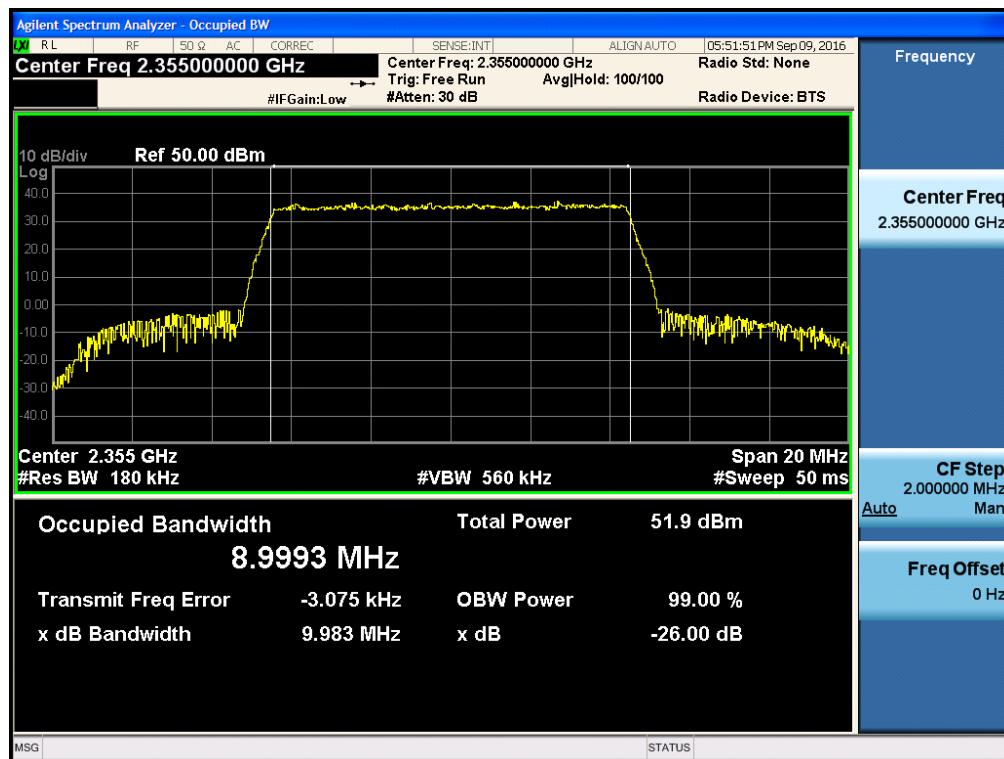


[+3dBm above AGC threshold Output Downlink Low]

[+3dBm above AGC threshold Output Downlink High]


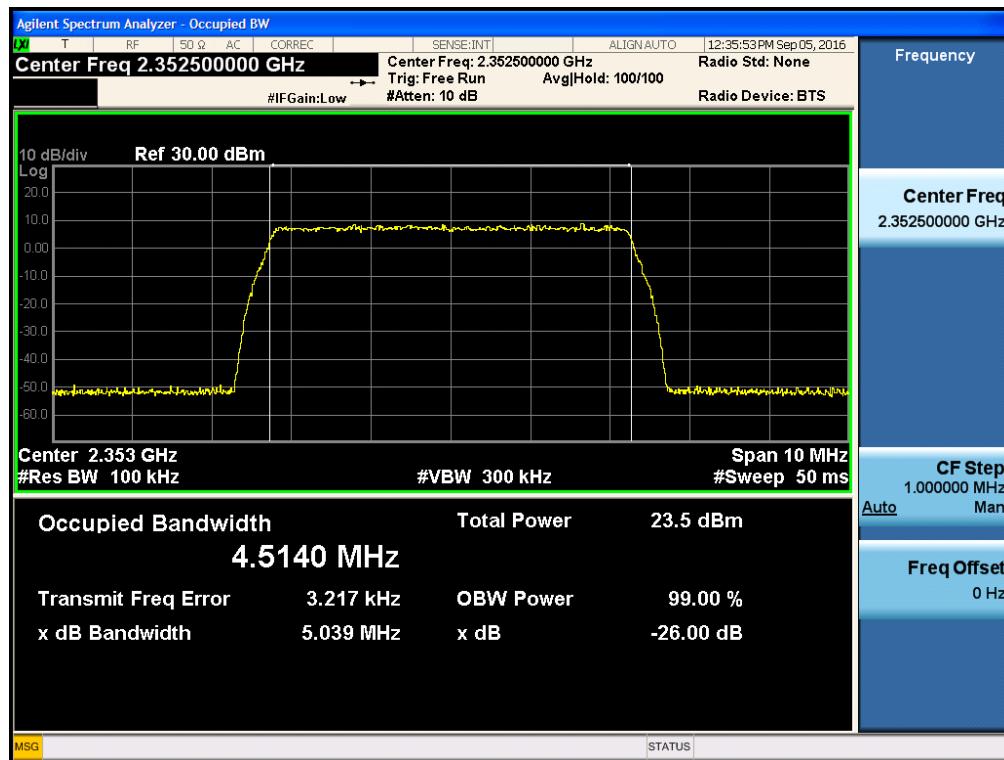
Occupied Bandwidth_ 2300_WCS BAND LTE 10 MHz_Output [AGC threshold Output Downlink Middle]



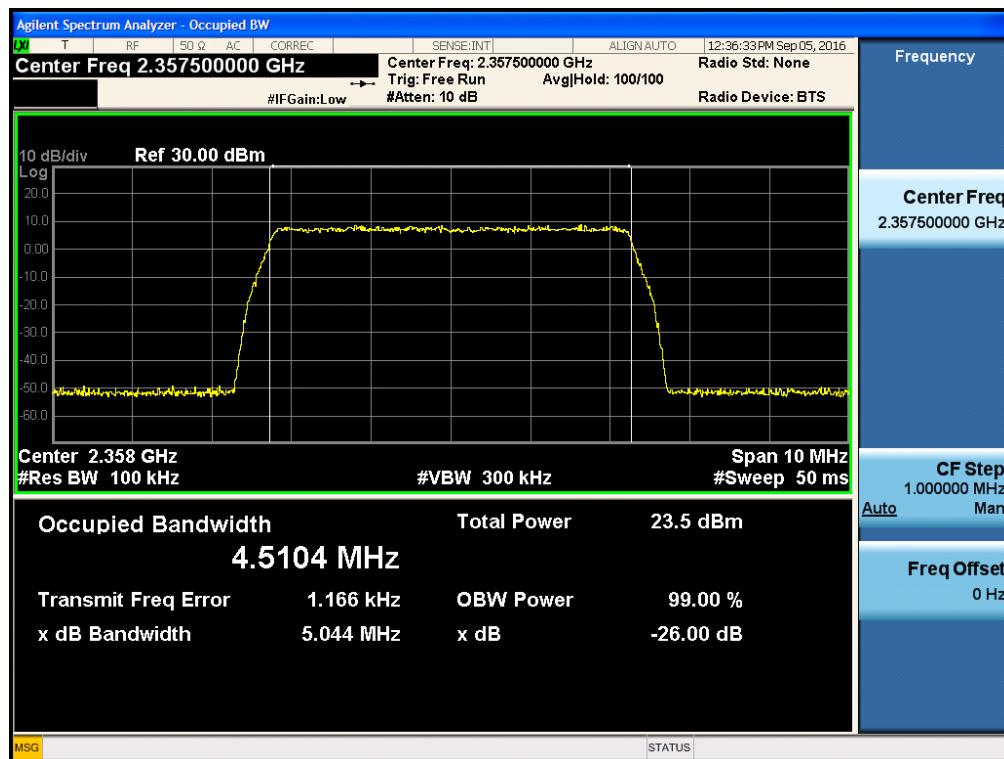
[+3dBm above AGC threshold Output Downlink Middle]



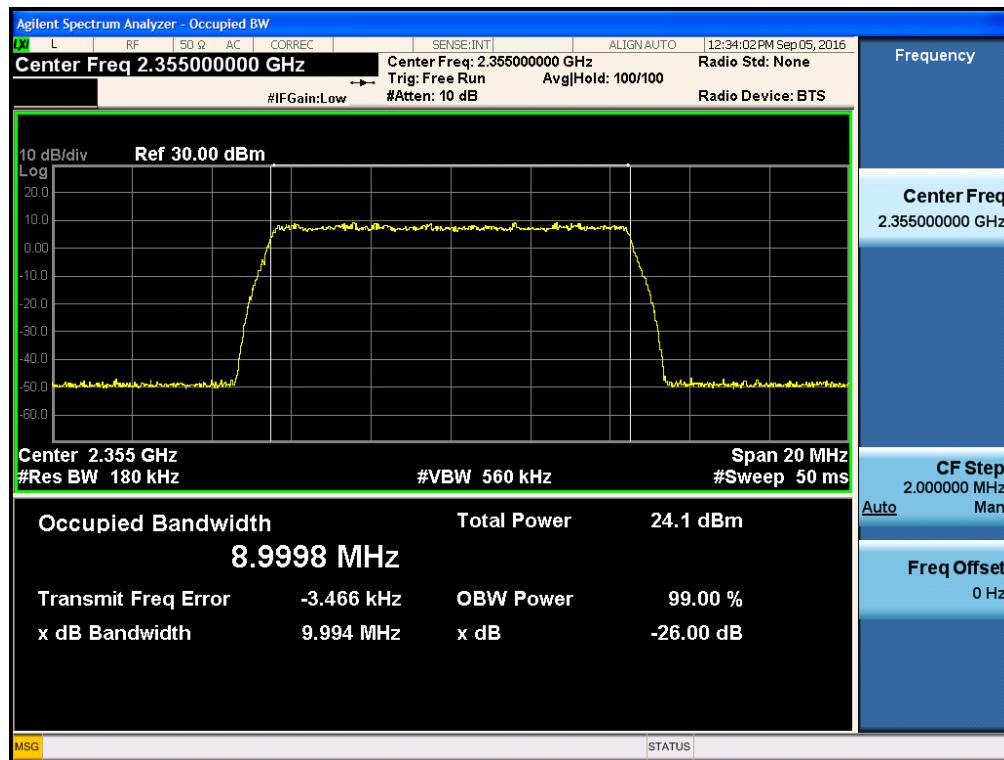
Occupied Bandwidth_2300_WCS BAND LTE 5 MHz Input [AGC threshold Input Downlink Low]



[AGC threshold Input Downlink High]



**Occupied Bandwidth_ 2300_WCS BAND LTE 10 MHz_Input
[AGC threshold Input Downlink Middle]**



8. OUT OF BAND REJECTION

FCC Rules

Test Requirement(s):

KDB 935210 D05 v01r01

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, 4.3 of KDB 935210 D05 v01r01.

3.3 Out-of-band rejection

- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
 - 1) Frequency range = $\pm 250\%$ of the passband, for each applicable CMRS band.
 - 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 $\geq 3 \times$ 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 f_0 .
- 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.

4.3 Out-of-band rejection

Adjust the internal gain control of the EUT to the maximum gain for which equipment certification is sought.

- 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 manufacturer's specified pass band.
- 2) The CW amplitude shall be 3 dB below the AGC threshold (see 4.2), and shall not activate the AGC threshold throughout the test.
- 3) Dwell time = approximately 10 ms.
- 4) Frequency step = 50 kHz.
- c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- d) Set the RBW of the spectrum analyzer to between 1 % and 5 % of the manufacturer's rated passband, and $VBW = 3 \times RBW$.
- e) Set the detector to Peak and the trace to Max-Hold.
- f) After the trace is completely filled, place a marker at the peak amplitude, which is designated as f_0 , and with two additional markers (use the marker-delta method) at the 20 dB bandwidth (i.e., at the points where the level has fallen by 20 dB).
- g) Capture the frequency response plot for inclusion in the test report.

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 f_0 of the passband up to at least $f_0 + 250\%$ of the 20 dB bandwidth.

Test Results:

The EUT complies with the requirements of this section.

Input Signal	Input Level (dBm) Input Signal : Sinusoidal	Maximum Amp Gain
2300_WCS Band	-16 dBm	59 dB

[Downlink_2300_WCS BAND]

	20 dB point frequency (MHz)	Output power (dBm)	Gain (dB)
2300_WCS Band	2346.350 MHz ~ 2362.400 MHz	43.141	59.141

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. Out-of-band/out-of-block emissions conducted measurements

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

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 this two-signal test.

- b) Set the signal generator to produce two AWGN signals as previously described.
- 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 under test.
- 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 [R8], 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 [R8].
- 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 EBW or 100 kHz or 1 MHz)
- g) Set the VBW = $3 \times$ RBW.
- h) Set the detector to power averaging (rms) detector.
- i) Set the Sweep time = auto-couple.
- j) Set the spectrum 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 (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 steps k) to m) with the composite input power level set to 3 dB above the AGC

threshold.

- o) Reset the frequencies of the input signals to the lower edge of the frequency block or band under test.
- 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. Spurious emissions conducted measurements

- 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.
- 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).
- 935210 D05 Indus Booster Basic Meas v01r01 Page 8
- g) Set the VBW $\geq 3 \times$ RBW.
- h) Set the Sweep time = auto-couple.
- i) Set the spectrum analyzer start frequency to the lowest RF 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.
- The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, 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.²
- j) Select the power averaging (rms) detector function.
- k) Trace average at least 10 traces in power averaging (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 spectrum 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 spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission (see § 2.1057). The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, 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 (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; also provide tabular data, if required.

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:

$43 + 10 \log_{10}(P_{\text{rated}}$ 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.

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.

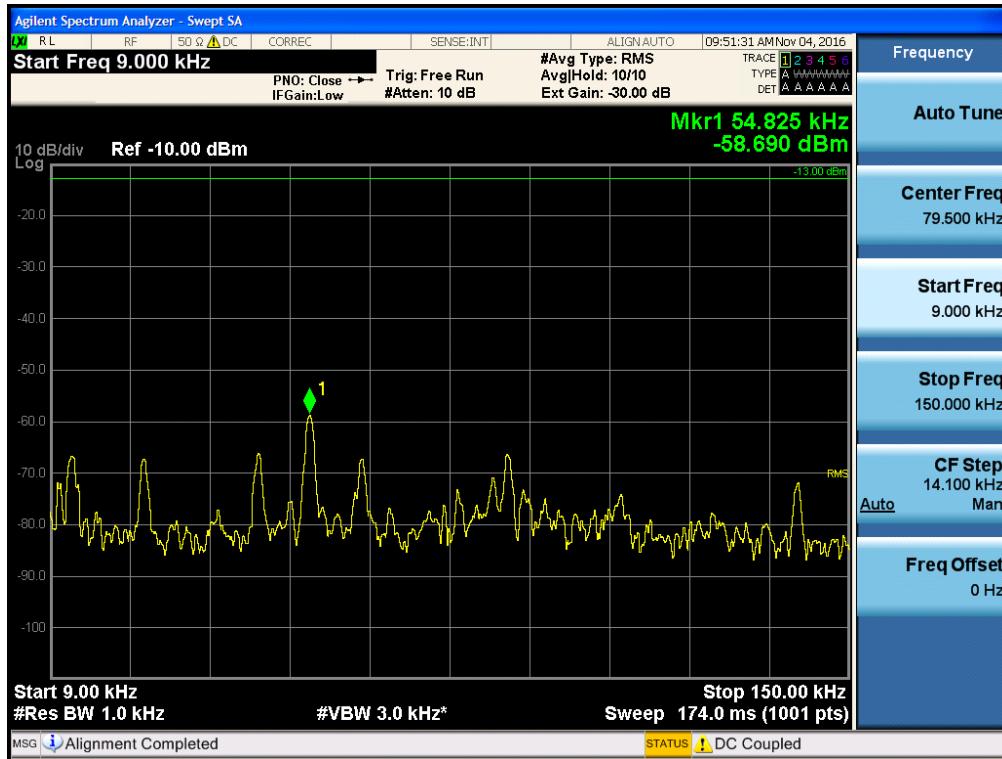
Test Results:

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

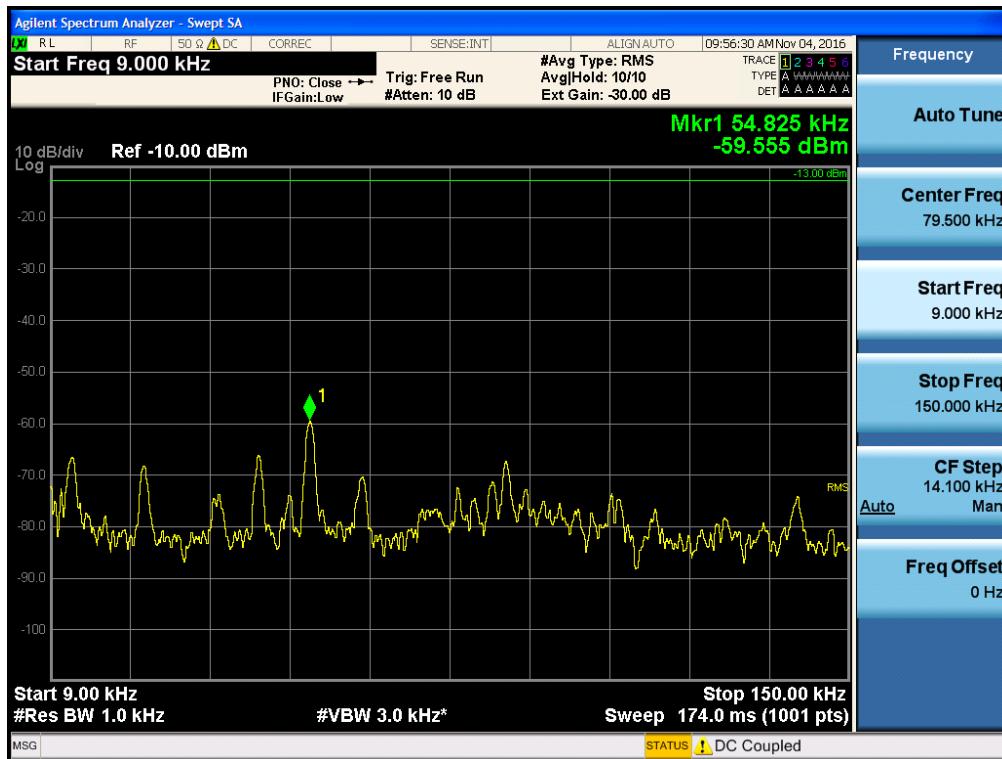
Notes: In 9 KHz-150 KHz and 150 KHz-30 MHz bands, RBW was reduced to 1% and 10% of the reference bandwidth for measuring unwanted emission level(typically, 100KHz if the authorized frequency band is below 1GHz) and power was integrated.(1% = +20 dB, 10% = +10 dB)

**Single channel Enhancer Plots of Spurious Emission for 2300_WCS BAND LTE 5 MHz
Conducted Spurious Emissions (9 kHz – 150 kHz)**

[Downlink Low]

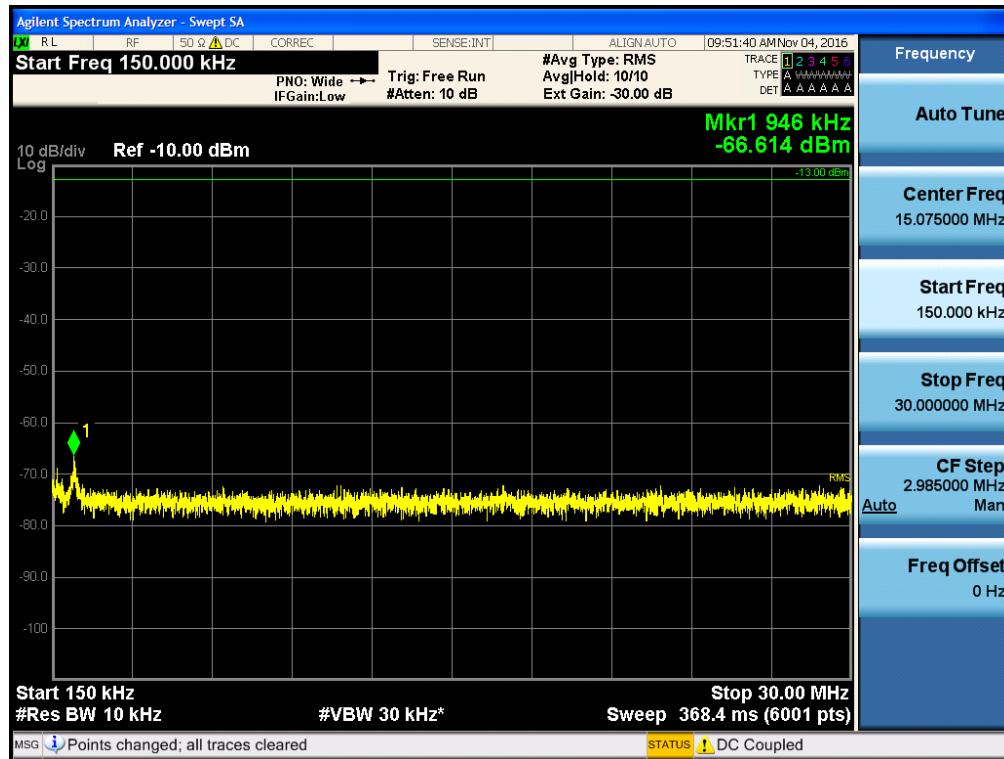


[Downlink High]

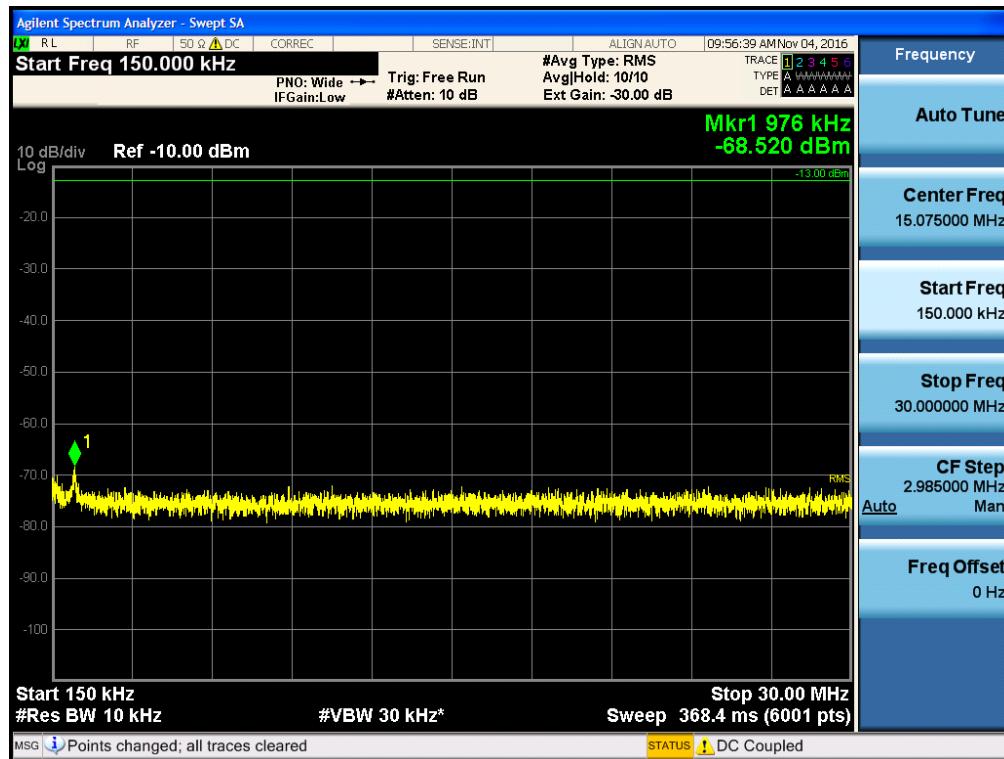


Conducted Spurious Emissions (150 kHz – 30 MHz)

[Downlink Low]

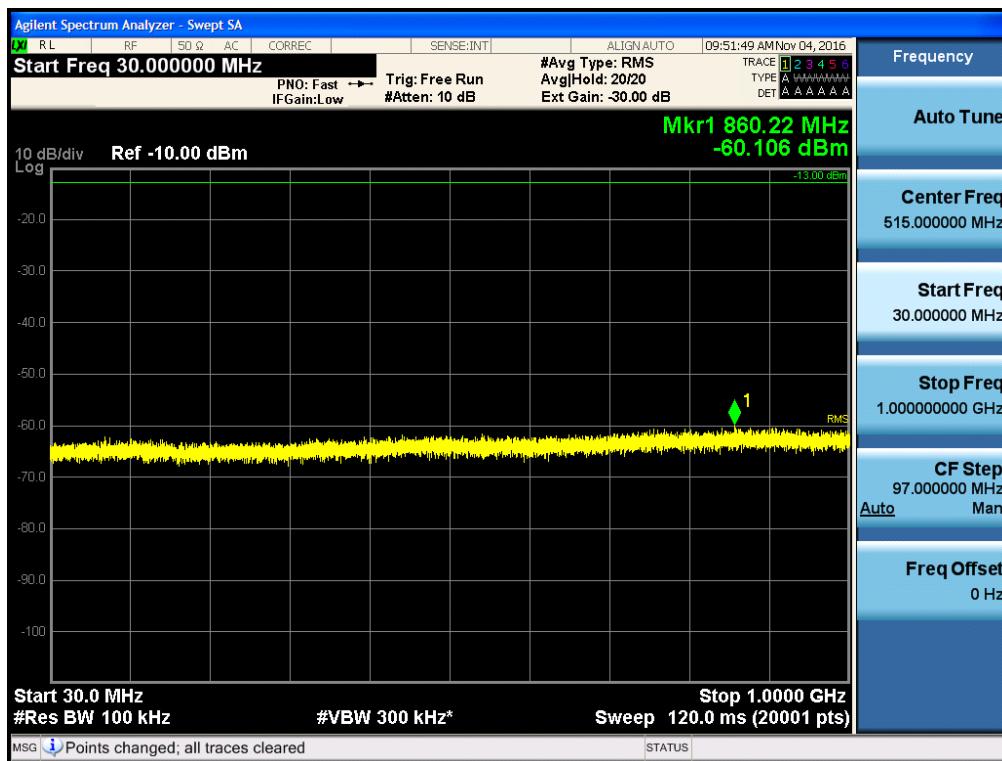


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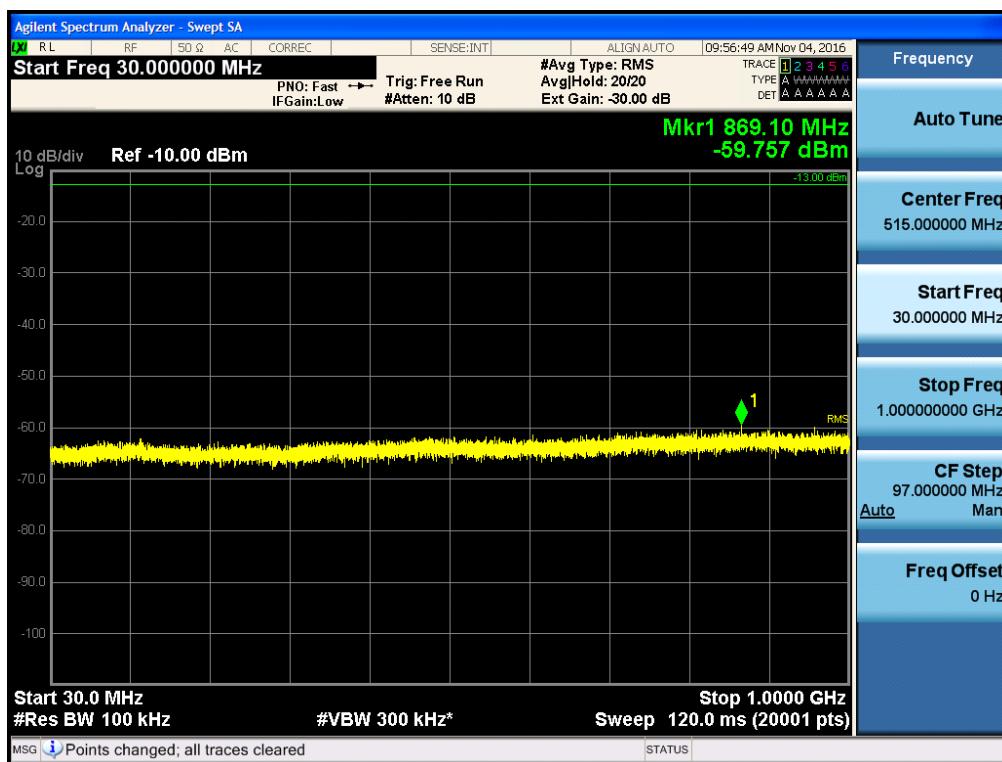


Conducted Spurious Emissions (30 MHz – 1 GHz)

[Downlink Low]



[Downlink High]



Conducted Spurious Emissions (1 GHz – 26.5 GHz)

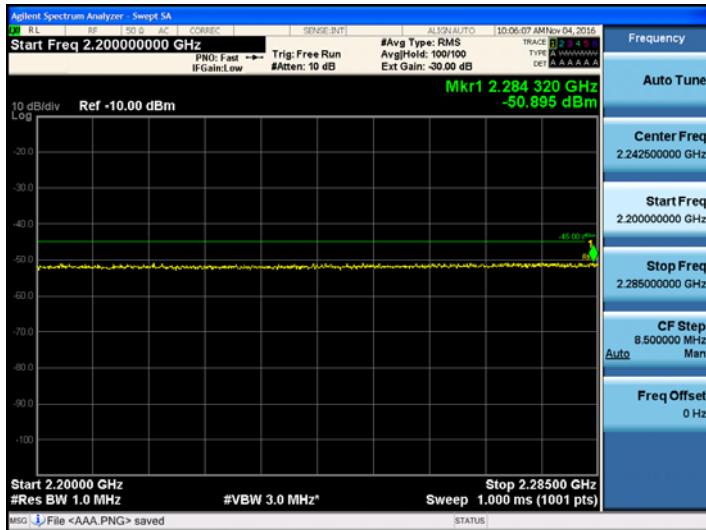
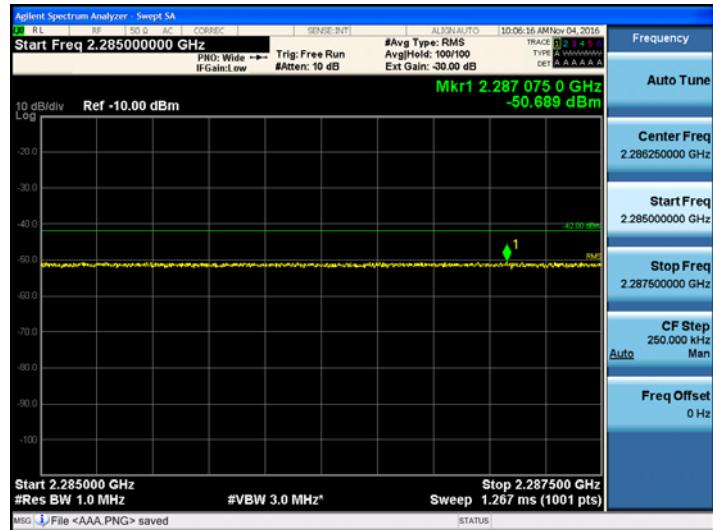
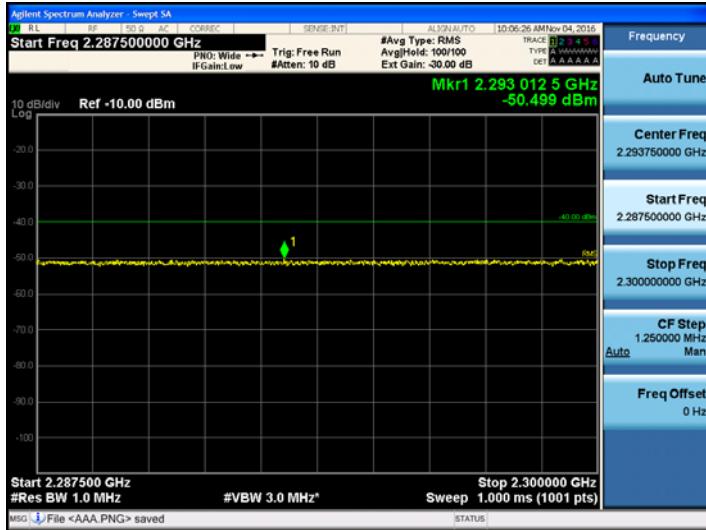
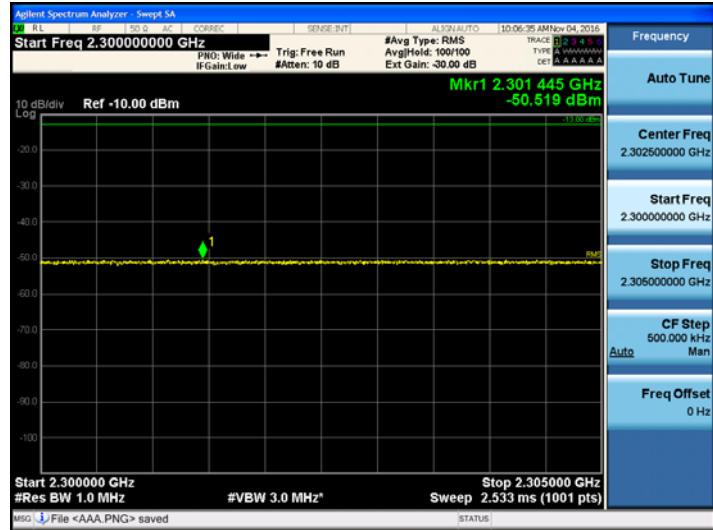
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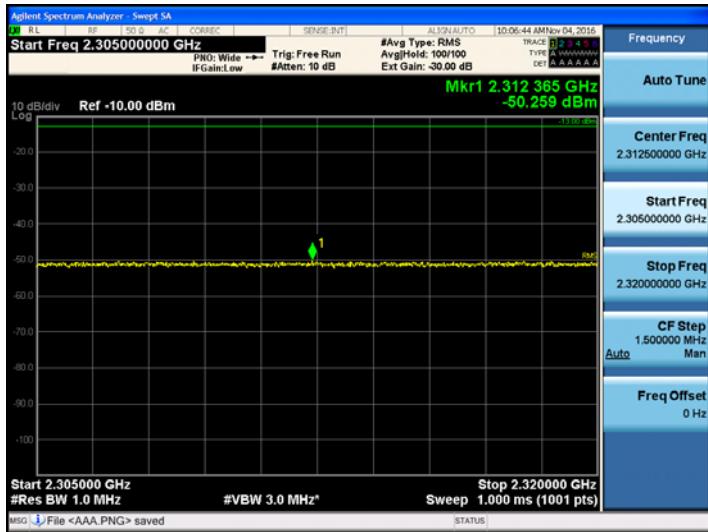
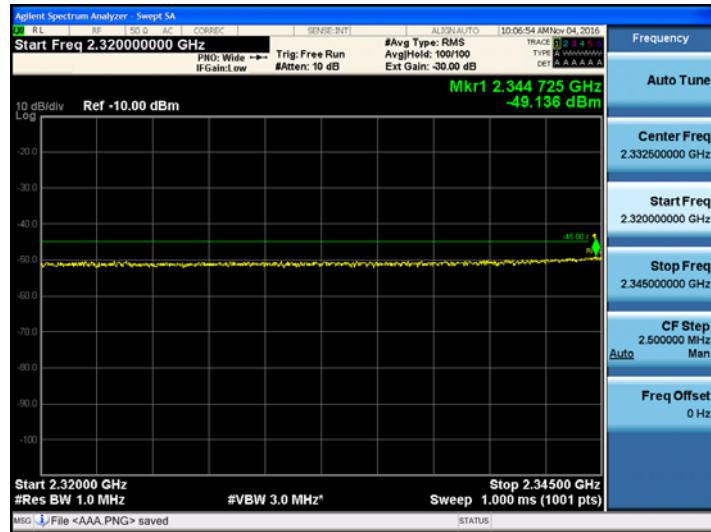
1000 MHz ~ 12750 MHz



12750 MHz ~ 26500 MHz



2200 MHz ~ 2285 MHz

2285 MHz ~ 2287.5 MHz

2287.5 MHz ~ 2300 MHz

2300 MHz ~ 2305 MHz


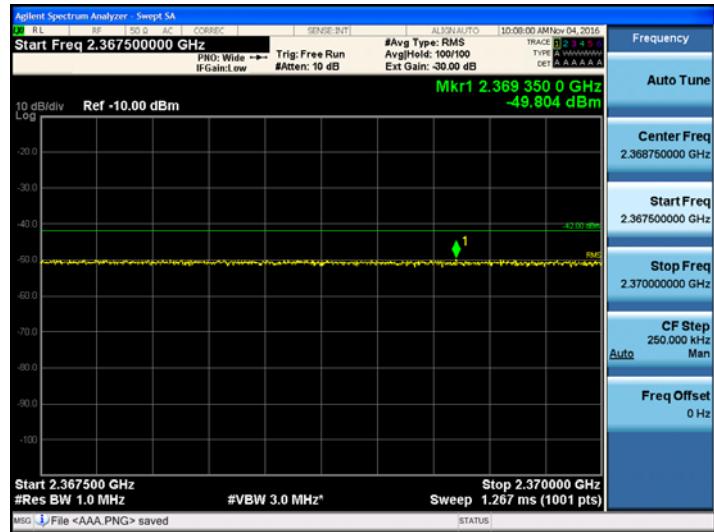
2305 MHz ~ 2320 MHz

2320 MHz ~ 2345 MHz

2360 MHz ~ 2362.5 MHz

2362.5 MHz ~ 2365 MHz

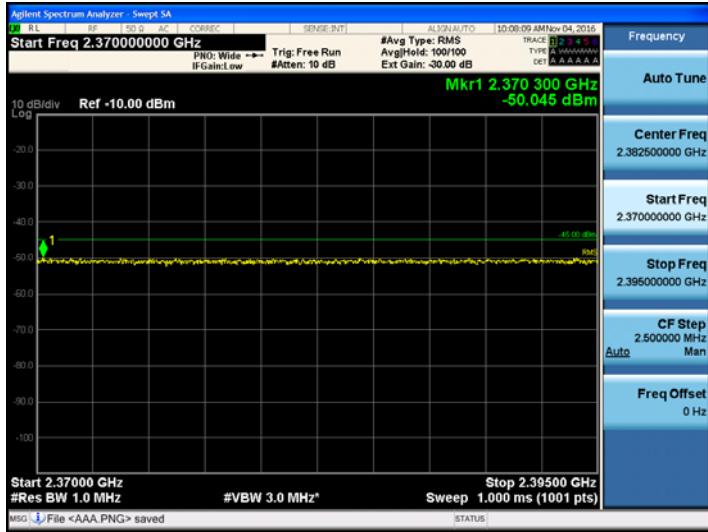

2365 MHz ~ 2367.5 MHz



2367.5 MHz ~ 2370 MHz



2370 MHz ~ 2395 MHz



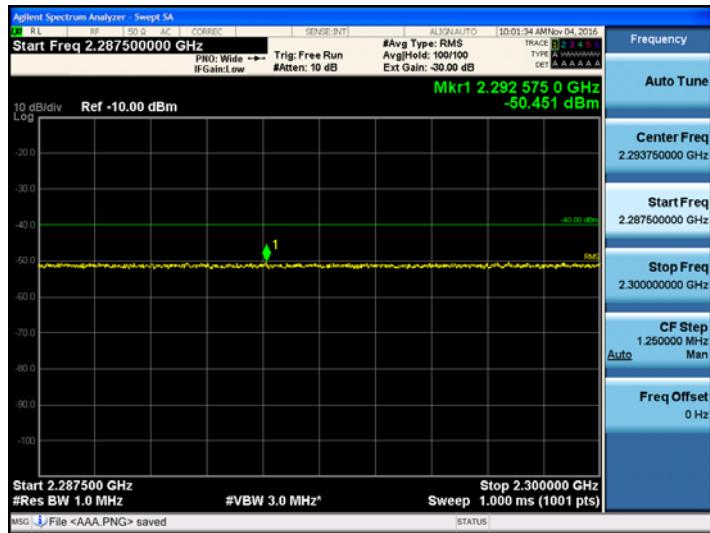
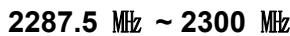
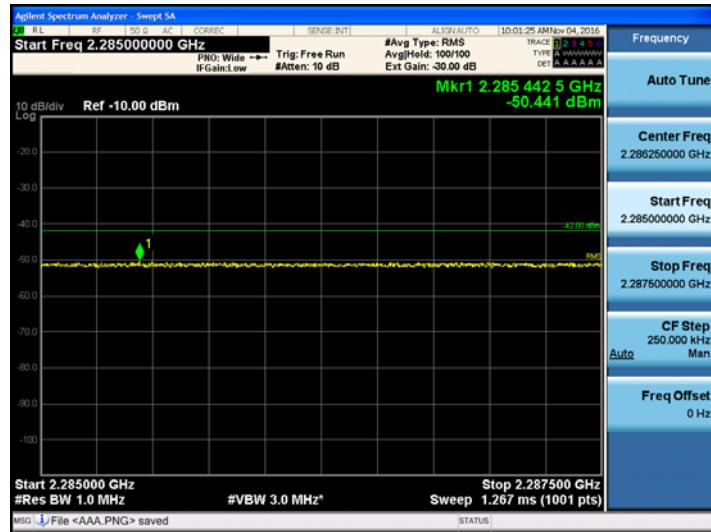
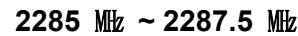
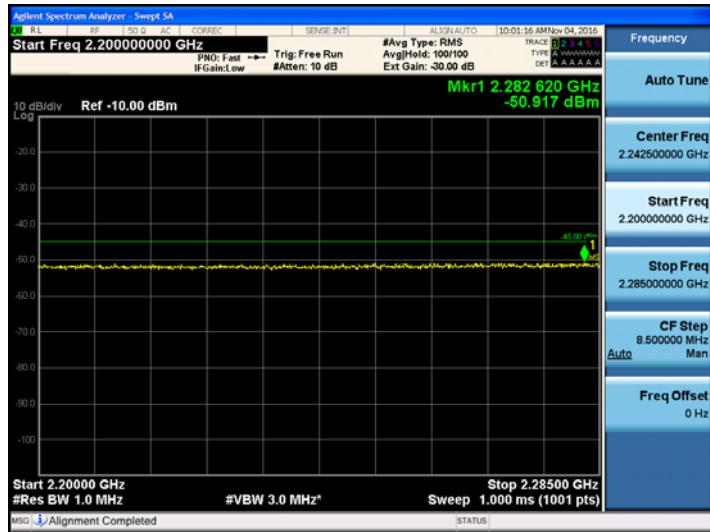
[Downlink High]

1000 MHz ~ 12750 MHz

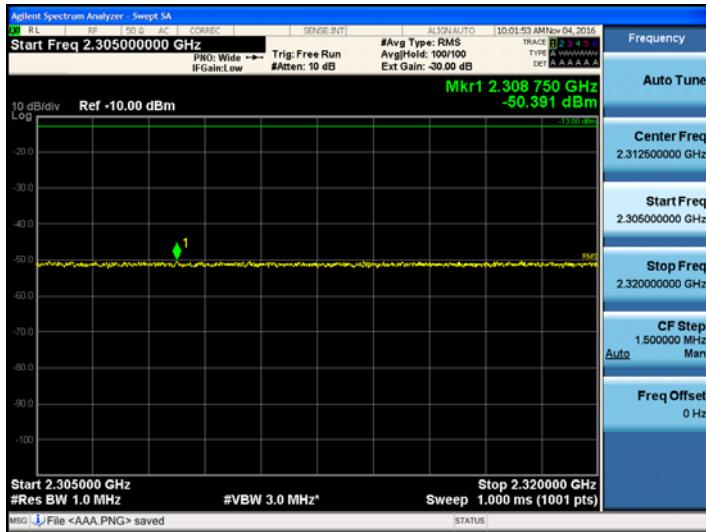


12750 MHz ~ 26500 MHz

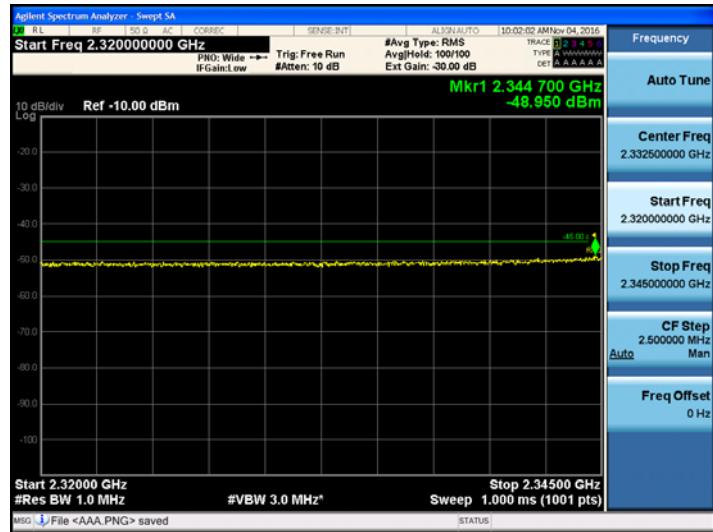




2305 MHz ~ 2320 MHz



2320 MHz ~ 2345 MHz



2360 MHz ~ 2362.5 MHz



2362.5 MHz ~ 2365 MHz



2365 MHz ~ 2367.5 MHz



2367.5 MHz ~ 2370 MHz

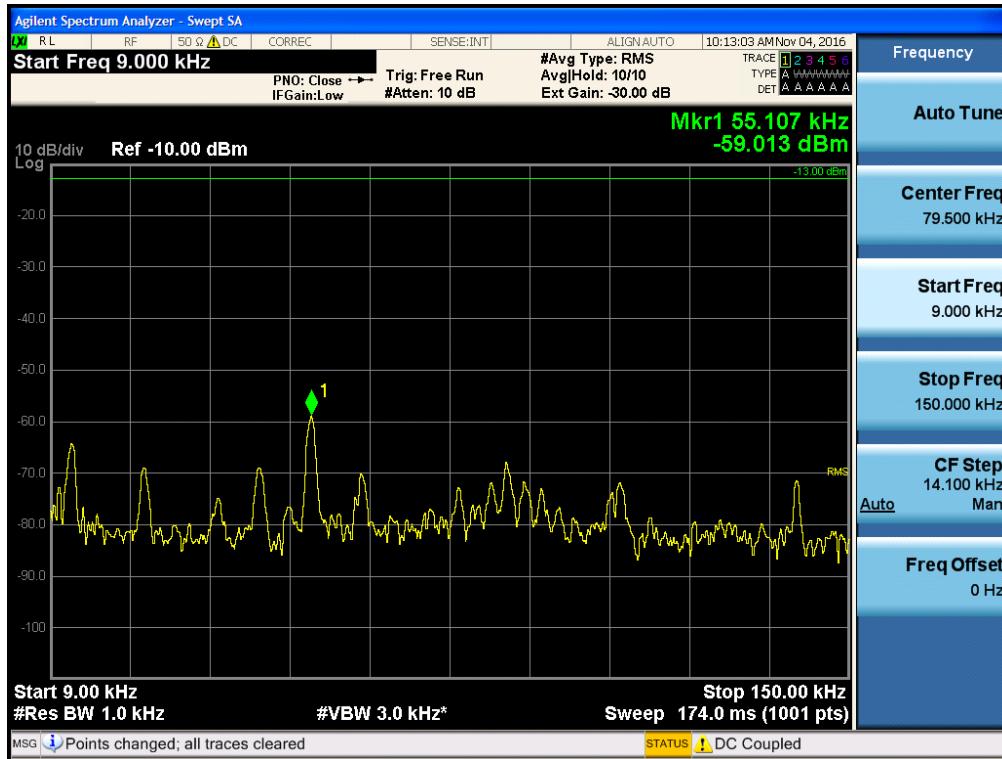


2370 MHz ~ 2395 MHz



**Single channel Enhancer Plots of Spurious Emission for 2300_WCS BAND LTE 10 MHz
Conducted Spurious Emissions (9 kHz – 150 kHz)**

[Downlink Middle]



Conducted Spurious Emissions (150 kHz – 30 MHz)

[Downlink Middle]

