NOKIA Bell Labs

TESTING
NVLAP LAB CODE: 100275-0

FCC Certification Test Report

Product Evaluated

Alcatel-Lucent AWS LTE B66a RRH 4x45W
(FCC ID: AS5BBTRX-28)

Customer

Alcatel-Lucent USA, Inc

600-700 Mountain Avenue
Murray Hill, New Jersey 07974-0636 USA

Test Laboratory

Nokia
Global Product Compliance Laboratory
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Date: January 12, 2017

Revisions

Date	Revision	Section	Change
01/12/17	0		Initial Release

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Technical Manager

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1. ATTESTATION OF TEST RESULTS

Company Name	**Alcatel-Lucent USA, Inc.**
FCC ID	**AS5BBTRX-28**
Product Name	**B66a RRH 4x45W**
Model Name	**AWS LTE B66a RRH 4x45W**
Part No	**3JR59011AAAC 01 M**
Serial Number(s)	**LBALLU-YD1615057QK**
Test Standard(s)	47 CFR FCC Part 27
Reference(s)	• 47 CFR FCC Part 2 and Part 27 • FCC KDB 971168 D01 (October 17, 2014) • ANSI C63.4 (2009) • 3GPP TS 36.104 v12.6.0 (2015-02)
Operating Frequency Band	AWS (Tx: 2110 - 2180 MHz and Rx: 1710 – 1780 MHz), E-UTRAN Band 66a (AWS-1 + AWS-3)
Technology	LTE
Test Frequency Range	10 MHz – 22 GHz
Operation Mode(s)	2x90W MIMO and 4x45W MIMO
Submission Type	Class II Permissive Change
FCC Part 15 Subpart B Compliance	Compliance with Class B
Test Date	December 7, 2016 – January 10, 2017
Test Laboratory	Global Product Compliance Laboratory 600-700 Mountain Avenue, Rm 5B-108 Murray Hill, New Jersey 07974-0636 USA

This is to certify that the above product has been evaluated and found to be in compliance with the Rules and Regulations set forth in the above standard(s). The data and the descriptions about the test setup, procedures and configuration presented in this report are accurate. The results of testing in this report apply only to the product/system which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Per the requirement of Section 2.911(d) Certification of Technical Test Data, I hereby certify that the technical test data are the results of tests either performed or supervised by me.

Michael P. Farina
Member of Technical Staff
Global Product Compliance Laboratory
Nokia Bell Labs

2. SUMMARY OF THE TEST RESULTS

47 CFR FCC Sections	Description of Tests	Compliance Results	Notes
2.1046	**RF Power Output**	**Yes**	
2.1047	**Modulation Characteristics**	**Yes**	
2.1049, 27.53(h)	**(a) Occupied Bandwidth** **(b) Out-of-Band Emissions**	**Yes**	
2.1051, 27.53(h)	**Spurious Emissions at Antenna Terminals**	**Yes**	
2.1053, 27.53(h)	**Field Strength of Spurious Radiation**	**Yes**	
2.1055, 27.54	**Measurement of Frequency Stability**	**NR**	

NR: Not Required
NA: Not Applicable

2.1 Measurement Uncertainty

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. Classical Emissions, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, using ESHS 30,	Conducted Emissions	0.009 - 30	±3.5 dB
	Radiated Emissions (AR-9 Semi-Anechoic Chamber)	30 MHz – 200MHz 200 MHz – 1000 MHz	±5.1 dB ±4.7 dB

2.2 Measurement uncertainty for Antenna Port Testing:

- 9 kHz to 20 MHz: Frequency = 10 Hz, Amplitude = 0.5 dB
- 20 MHz to 1 GHz: Frequency = 100Hz, Amplitude = 0.5 dB
- 1 GHz to 10 GHz: Frequency = 10 kHz, Amplitude = 0.5 dB

3. GENERAL INFORMATION

3.1 Product Descriptions

The equipment under test (EUT) has the following specifications.

Table 3.1.1 Product Specifications

Specification Items	Description
Product Type	Remote Radio Head (RRH) (4Tx, 4Rx): 2x90W MIMO (2T4R) and 4x45W MIMO (4T4R)
Radio Type	Intentional Transceiver
Power Type	- 48 Vdc , 14 Adc nominal
Modulation	QPSK, 16QAM, 64QAM
Operating Frequency Range	Tx 2110 - 2180 MHz/Rx 1710-1780 MHz
Channel Bandwidth	5, 10, 15 and 20 MHz
Max Conducted Power (Rated)	46.53 dBm per port for 4T4R and 49.54dBm per port for 2T4R
Min Conducted Power (Rated)	30.53 dBm per port for 4T4R and 33.54dBm per port for 2T4R
Max EIRP Power (Rated)	82.23 dBµV/m at 3 m and 71.77 dBµV/m at 10 m
Min EIRP Power (Rated)	
Software Version	LR 16.2
Hardware Version	B66a RRH 4x45
Antenna(s)	Refer to Section 3.2

The EUT supports the following carrier configurations:

Table 3.1.2 EUT Supported Configurations

Carrier Bandwidth (MHz)	Maximum No of Carriers per Path	Technology	Supported?
5	3	LTE	√
10	3	LTE	√
15	1	LTE	√
20	1	LTE	√

The operating band consists of the following blocks and spectrum:

Table 3.1.3 EUTRAN 66a, AWS Band

AWS-1 (45 MHz)

Blocks	Tx Frequency (MHz)	Rx Frequency (MHz)	Bandwidth (MHz)
A	2110 - 2120	1710 - 1720	10
B	2120 - 2130	1720 - 1730	10
C	2130 - 2135	1730 - 1735	5
D	2135 - 2140	1735 - 1740	5
E	2140 - 2145	1740 - 1745	5
F	2145 - 2155	1745 - 1755	10

AWS-3 (25 MHz)

Blocks	Tx Frequency (MHz)	Rx Frequency (MHz)	Bandwidth (MHz)
G	2155 - 2160	1755 - 1760	5
H	2160 - 2165	1760 - 1765	5
I	2165 - 2170	1765 - 1770	5
J	2170 - 2180	1770 - 1780	10

3.2 Antenna Information

The product does not incorporate integrated antennas.

4. REQUIRED MEASUREMENTS AND RESULTS

The EUT software has been upgraded to enable it to transmit and receive three carriers (contiguous and non-contiguous), which is the subject of this Class II Permissive Change authorization request. Per 47CFR FCC Section 2.1033(c)(14), the following certification tests are required by Section 2.1046 through Section 2.1057. The measurements were conducted in accordance with the procedures set out in Section 2.1041.

47 CFR FCC Sections	Description of Tests	Required	Notes
2.1046	**RF Power Output**	**Yes**	
2.1047	**Modulation Characteristics**	**Yes**	
2.1049, 27.53(h)	**(a) Occupied Bandwidth** **(b) Out-of-Band Emissions**	**Yes**	
2.1051, 27.53(h)	**Spurious Emissions at Antenna Terminals**	**Yes**	
2.1053, 27.53(h)	**Field Strength of Spurious Radiation**	**Yes**	
2.1055, 27.54	**Measurement of Frequency Stability**	**No**	Same As Original Equipment Filing

Three carrier operation can incorporte any combination of carrier bandwidths (5, 10, 15 MHz) and modulation, in any sequence, for both 4x45W MIMO and 2x90W MIMO. The combinations tested and evaluated are tabulated below. All demonstrated emission mask compliance. Test numbers 9, 15 and 17 will be displayed as representative of all, since 4x45W MIMO has the more stringent emission limitation, and in order to keep this report to a manageable size and complexity.

Test Number	BW Combination MHz	Power	Frequencies MHz	Modulation
8a	5 + 5 + 15	4x45W MIMO	2112.5 + 2152.5 + 2172.5	Q + 16Q + 64Q
9	**5 + 10 + 15**	**4x45W MIMO**	**2112.5 + 2150 + 2172.5**	**Q + 16Q + 64Q**
10	5 + 5 + 5	2x90W MIMO	2112.5 + 2152.5 + 2177.5	Q + (Q + 16Q) + 64Q
11	5 + 5 + 5	4x45W MIMO	2112.5 + 2152.5 + 2177.5	Q + (Q + 16Q) + 64Q
12	10 +5 + 5	2x90W MIMO	2115 + 2152.5 + 2177.5	Q + (Q + 16Q) + 64Q
13	10 +5 + 5	4x45W MIMO	2115 + 2152.5 + 2177.5	Q + (Q + 16Q) + 64Q
14	10 + 10 + 5	2x90W MIMO	2115 + 2150 + 2177.5	Q + (Q + 16Q) + 64Q
15	**10 + 10 + 5**	**4x45W MIMO**	**2115 + 2150 + 2177.5**	**Q + (Q + 16Q) + 64Q**
16	10 + 10 + 10	2x90W MIMO	2115 + 2150 + 2175	Q + (Q + 16Q) + 64Q
17	**10 + 10 + 10**	**4x45W MIMO**	**2115 + 2150 + 2175**	**Q + (Q + 16Q) + 64Q**

Where: Q = Quadrature Phase-Shift Keying
16Q = 16 Quadrature Amplitude Modulation
64Q = 64 Quadrature Amplitude Modulation
(Q + 16Q) = combination of both modulations

4.1 Section 2.1046 MEASUREMENT REQUIRED: RF POWER OUTPUT

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal, as shown in the accompanying test set-up diagram. The radio was tuned to a channel which is transmitting continuously in its operating frequency band. The power level of the base station was calibrated to allow the base station to operate at the manufacturer's maximum rated mean power level, i.e., ±1dBm (1.25 mW) per LTE carrier at the antenna-transmitting terminal.

4.1.1 RF Power Output Measurement

Power measurements were conducted with a broadband Power Meter in the average mode per KDB 971168 D01. Before the testing was started, the Base Station was given a sufficient "warm-up" period as required.

The maximum rated mean power per three carrier combination was measured at the antenna transmitting terminal for the carrier bandwidths (5, 10, 15 & 20 MHz) with QPSK, 16QAM and 64QAM modulation. The maximum rated mean RF power outputs of the EUT measured are given in Table 4.1.1. The RF power output measured for each configuration was also shown as "Ref Lvl" in the plots provided in Sections 4.3 and 4.4.

Table 4.1.1 The Maximum Average RF Output Power of the EUT- Measured

Single Carrier and Three Carrier Combination per Antenna Port

Transmit Configuration	Measurement Configuration	Maximum Average RF Output Power		Maximum Derivation
		Watts	dBm	dB
2xMIMO	BW 5 MHz	40	46.02	⩽±1
2xMIMO	BW 10, 15, 20 MHz	90	49.54	
4xMIMO	BW 5 MHz	20	43.01	
4xMIMO	BW 10, 15, 20 MHz	45	46.53	⩽±1
2xMIMO	3 Carrier Combo	90	49.54	⩽±1
4xMIMO	3 Carrier Combo	45	46.53	⩽±1

4.1.1.1 RF Power Output Results:

The maximum mean RF power outputs of the EUT measured at its antenna transmitting terminals were measured in full compliance with the Rules of the Commission and are listed above.

4.1.2 Peak-to-Average Power Ratio Measurement:

The Peak-to-Average Power Ratio (PAPR) of the EUT was measured per KDB 971168 D01 procedures for each carrier in the 3-carrier combinations tabulated above. Measurements were made at Tx1 for 2T4R operation and at Tx3 for 4T4R operation. The PAPR values (0.1% probability) of the EUT measured are all below 13dB. The maximum PAPR value measured is given in Table 4.1.2 and the plot below. Test numbers 9, 15 and 17 will be displayed as representative of all, since 4x45W MIMO has the more stringent emission limitation, and in order to keep this report to a manageable size and complexity.

Table 4.1.2 The Maximum PAPR Value at 0.1% probability of the EUT

4T4R MIMO Operation

Test Number	BW MHz	Ant. Term.	Freq MHz	Power 4T	Configuration Modulation	Maximum PAPR Value at 0.1% probability (dB)
9	5	Tx1	2112.5	15W	QPSK	< 10dB
	10	Tx1	2150	15W	16QAM	< 13 dB
	15	Tx1	2172.5	15W	64QAM	< 13 dB
15	10	Tx3	2115	15W	QPSK	< 13 dB
	10	Tx3	2150	15W	QPSK + 16QAM	< 13 dB
	5	Tx3	2177.5	15W	64QAM	< 13 dB
17	10	Tx3	2115	15W	QPSK	< 13 dB
	10	Tx3	2150	15W	QPSK + 16QAM	< 13 dB
	10	Tx3	2175	15W	64QAM	< 8 dB

4.1.2.1 Peak-to-Average Power Ratio Results:

The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals were measured to be in full compliance with the ≤ 13 dB Rules of the Commission and are listed above.

As stated in KDB 971168 D01 *Power Meas License Digital Systems v02r02*, the peak power of a digitally-modulated signal is predictable only on a statistical basis. Thus, for these types of signals, a statistical measurement of the peak power is necessary. The power complementary cumulative distribution function (CCDF) curves provide a means for characterizing the power peaks of a digitally modulated signal on a statistical basis. A CCDF curve depicts the probability of the peak signal amplitude exceeding the average power level. Most contemporary measurement instrumentation include the capability to produce CCDF curves for an input signal provided that the instrument's resolution bandwidth can be set wide enough to accommodate the entire input signal bandwidth.

Plots of the CCDF curves are shown in the following **Fig. 4.1.2**

Figure 4.1.1 Test Set-Up for Measurement of

Radio Frequency Power Output

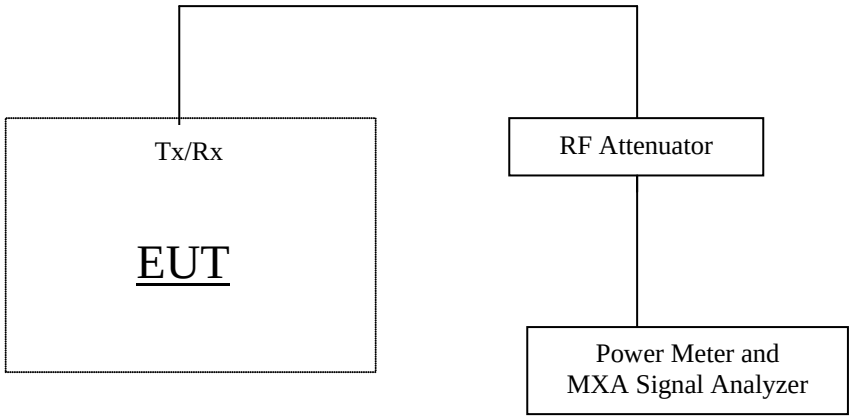
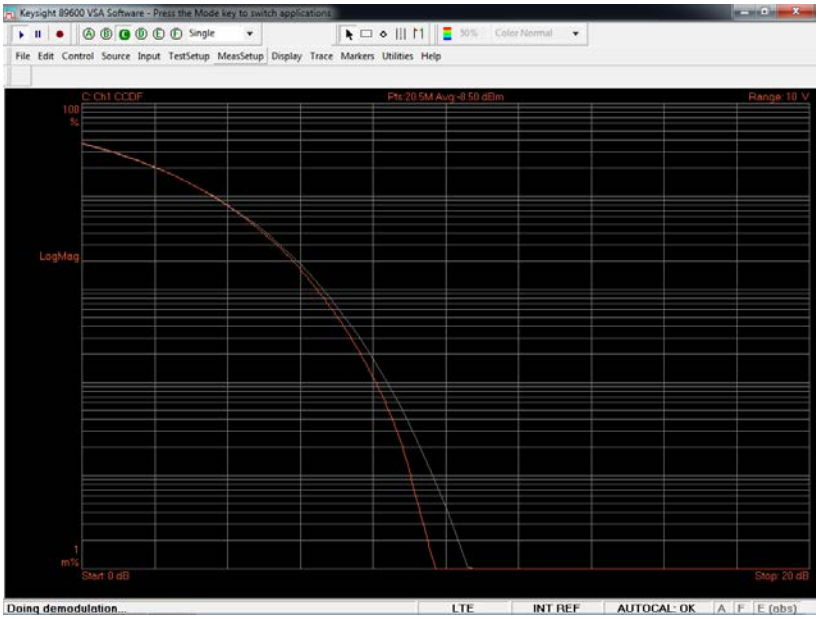
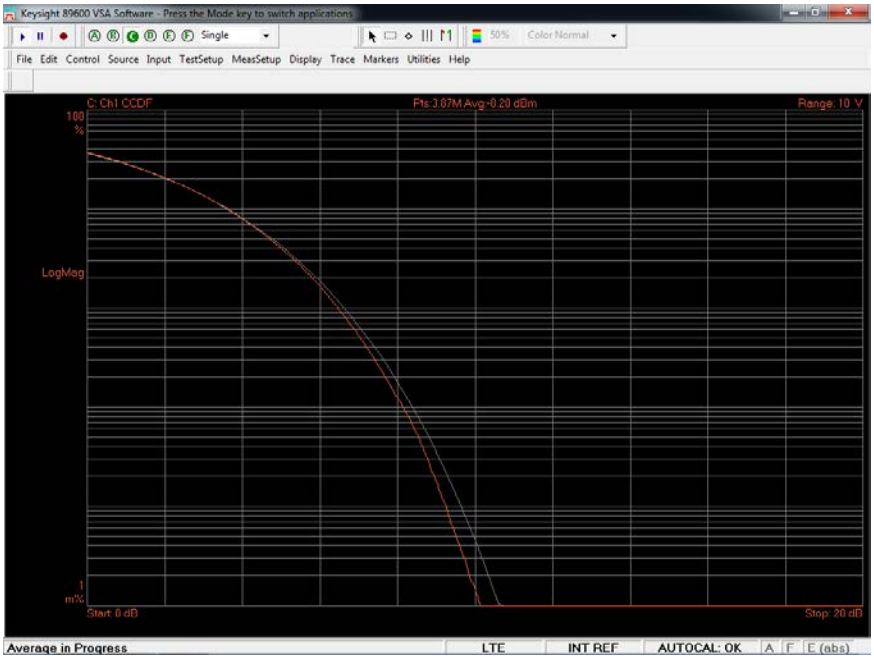


Figure 4.1.2 PAPR Plot Measured with the Maximum Value

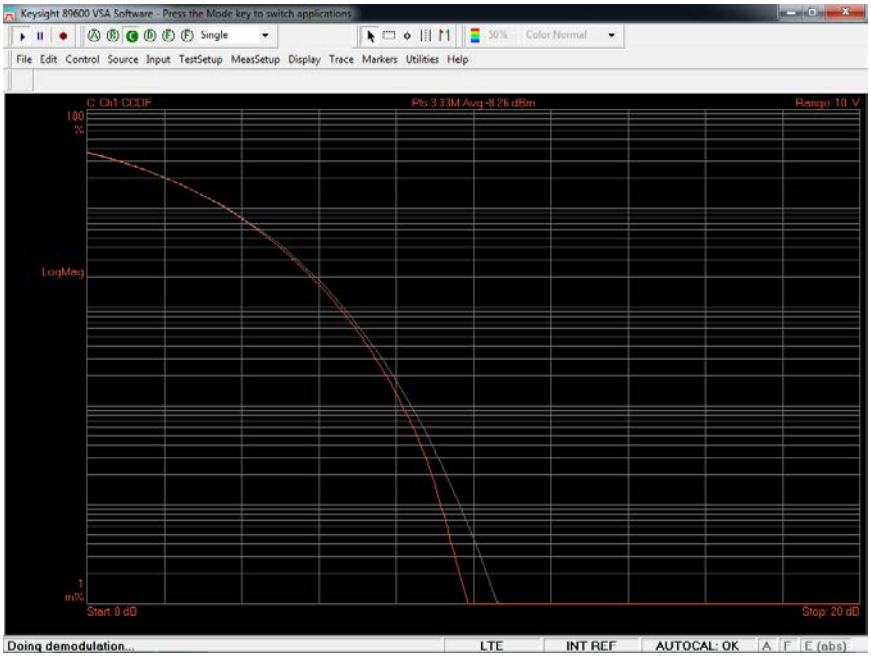
Test 9	BW 5 MHz	Tx1	2112.5 MHz	15W	QPSK



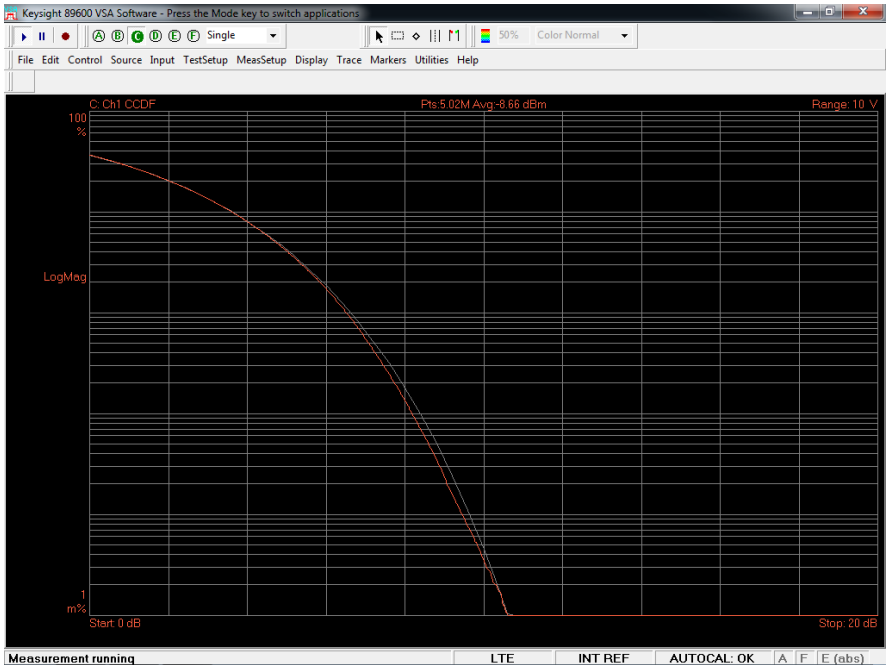
Test 9	BW 10 MHz	Tx1	2150 MHz	15W	16QAM



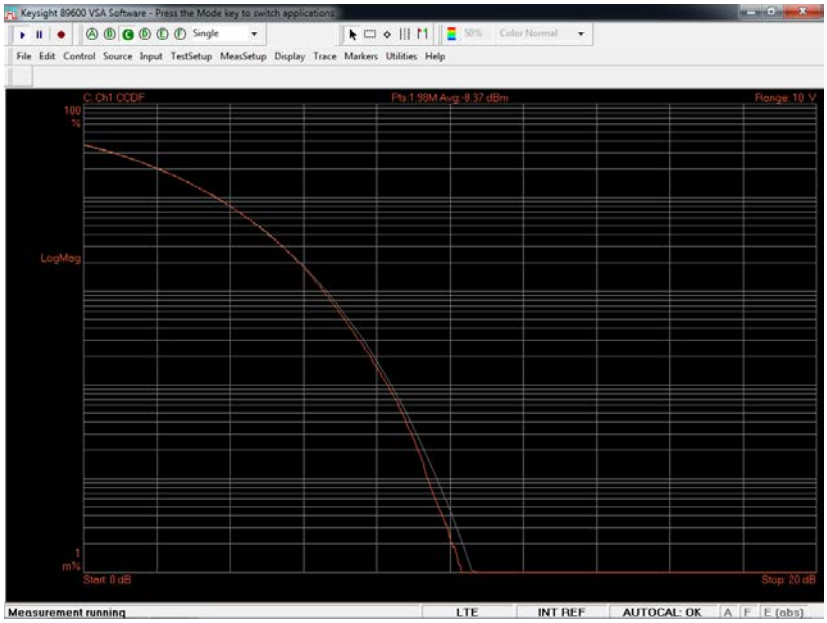
Test 9	BW 15 MHz	Tx1	2172.5 MHz	15W	64QAM



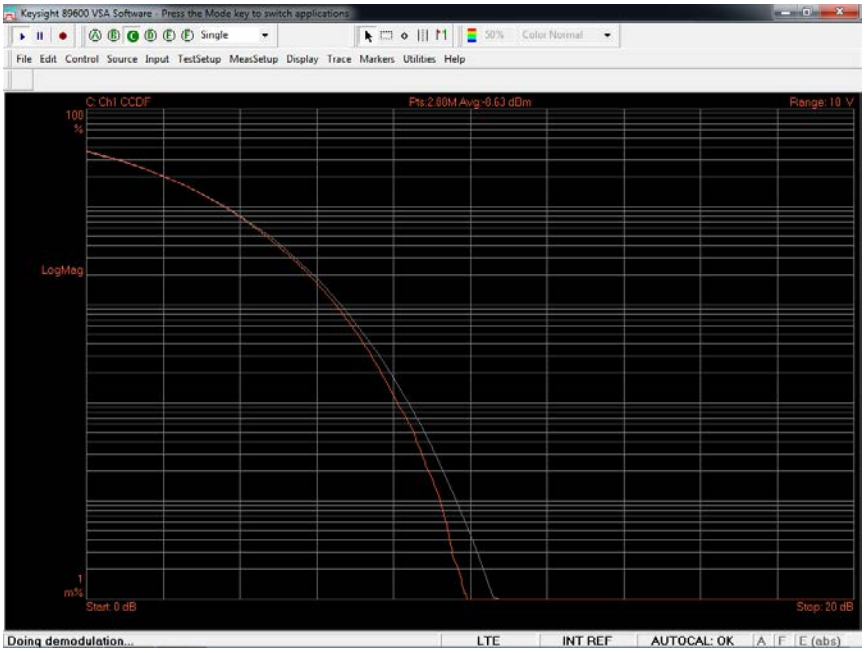
Test 15	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



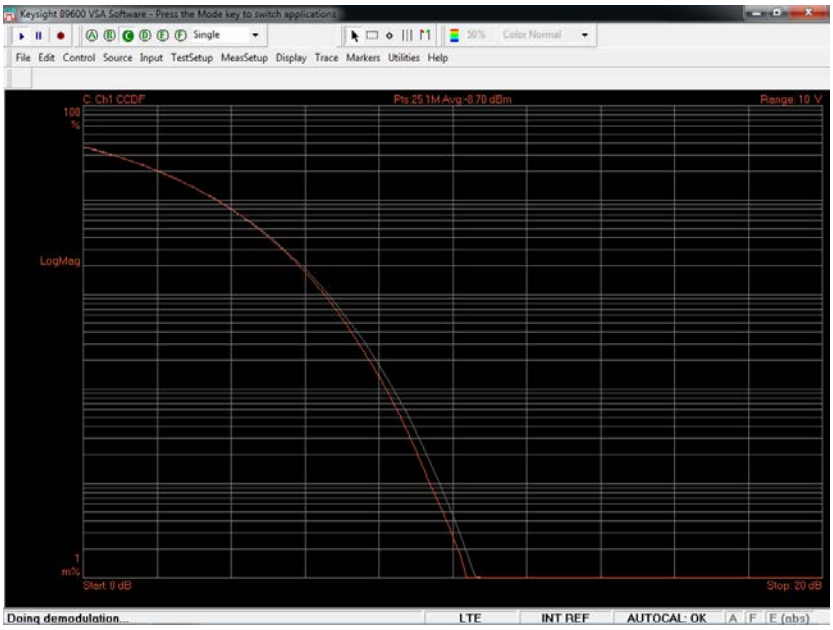
Test 15	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



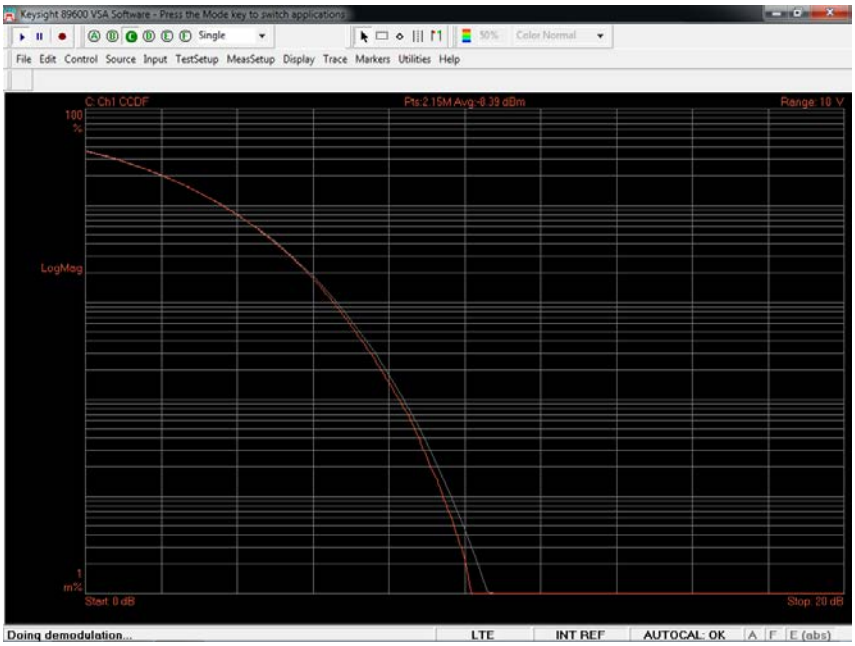
Test 15	BW 5 MHz	Tx3	2177.5 MHz	15W	64QAM



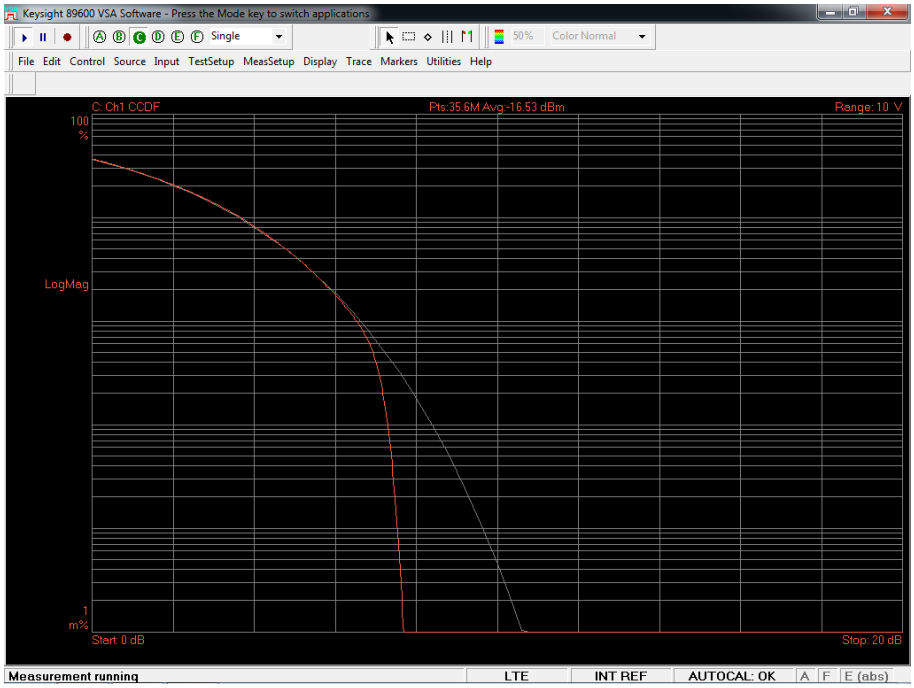
Test 17	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



Test 17	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



Test 17	BW 10 MHz	Tx3	2175 MHz	15W	64QAM



4.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERIST

The EUT supports LTE technology only. The LTE utilizes Orthogonal Frequency Division Multiplexing (OFDM) which splits the carrier frequency bandwidth into many small subcarriers. Each individual subcarrier is modulated with QPSK, 16QAM and 64QAM digital modulation formats.

In QPSK, there are 4 possible symbol states and each symbol carries 2 bits of information. In 16QAM, there are 16 possible symbol states and each 16-QAM symbol carries 4 bits of information. While in 64QAM, there are 64 possible symbol states and each 64-QAM symbol carries 6 bits of information. Higher-order modulation, where the constellations become more dense, is more sensitive to poor channel conditions than the lower-order modulation.

The modulation characteristics measurement of LTE carriers measures the difference between the ideal symbols and the measured symbols after the equalization. The measurement was performed for QPSK, 16QAM and 64QAM, respectively, where the carrier power level was adjusted to the maximum rated mean power at the antenna terminal.

4.2.1 Modulation Characteristics Measurement

The measurements were performed at the antenna transmitting terminal of the base station system with a signal analyzer, which was calibrated in accordance with ISO 9001 process. The test set-up diagram is given in the Figure 4.2.1, where the signal analyzer used the external signals from the base station as its trigger source and time reference. Figures 4.2.2, 4.2.3 and 4.2.4 show representative screen plots of the modulation measurement for 5 MHz,10 MHz and 15 MHz LTE carriers, respectively, in QPSK, QPSK+16QAM combined and 64QAM modulations.

4.2.1.1 Modulation Measurements Results:

The modulation characteristics of the EUT measured are in full compliance with the Rules of the Commission. Since these measurements are repetitive, it is sufficient to display only the 4T4R measurements (Tests 9, 15, 17), which have the more stringent emission limitations, as previously cited for the PAPR measurements.

Figure 4.2.1 Test Set-Up for Measurement of Modulation Characteristics, Occupied Bandwidth and Out-of-Band Emissions

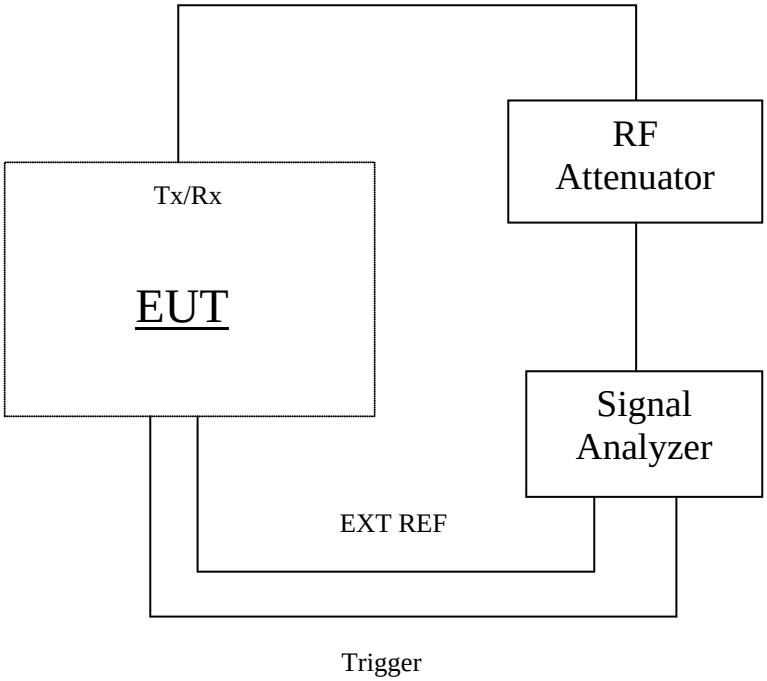
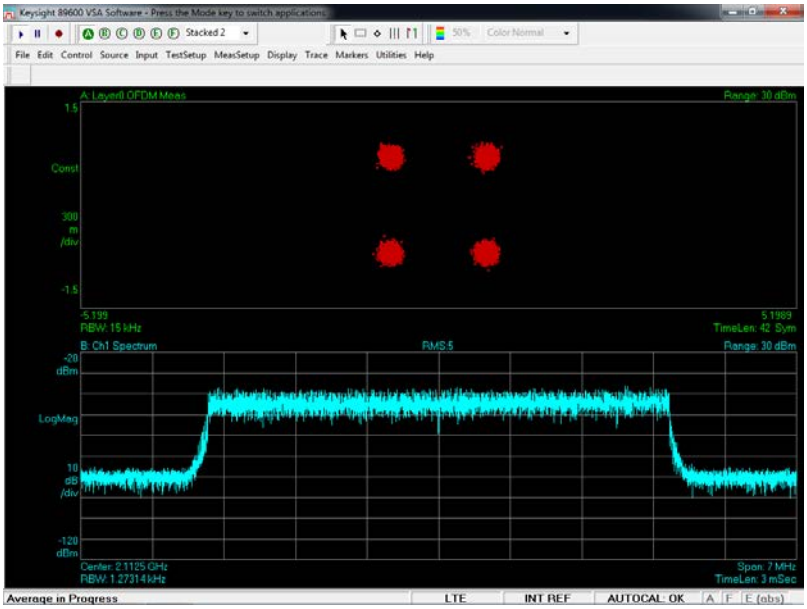
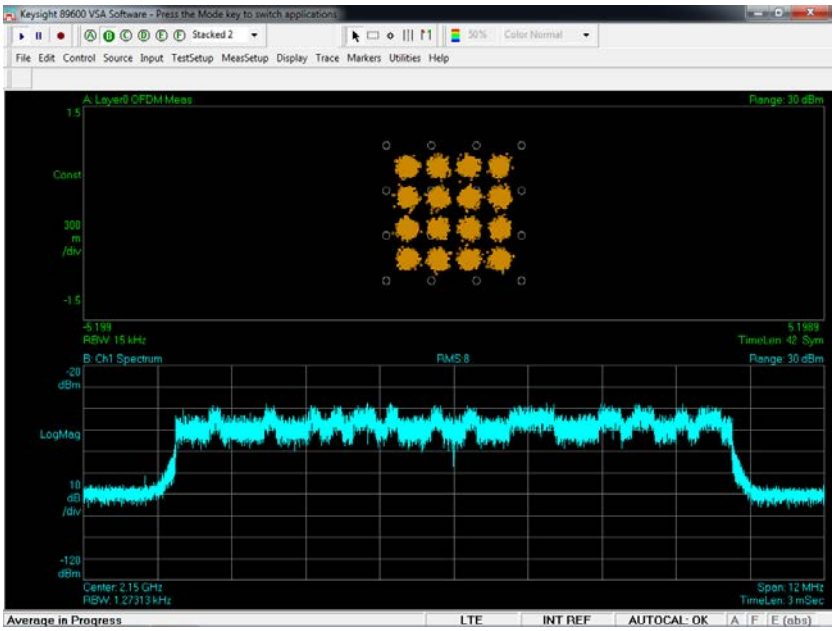


FIGURE 4.2.2 Modulation Measurement for Test 9 LTE (5+10+15) Carriers with QPSK +16QAM and 64QAM Modulations

Test 9	BW 5 MHz	Tx1	2112.5 MHz	15W	QPSK



Test 9	BW 10 MHz	Tx1	2150 MHz	15W	16QAM



Test 9	BW 15 MHz	Tx1	2172.5 MHz	15W	64QAM

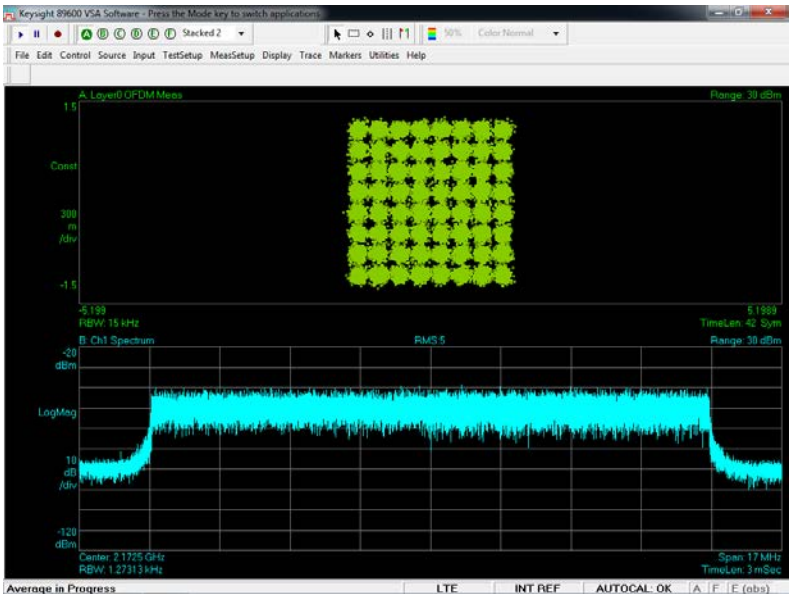
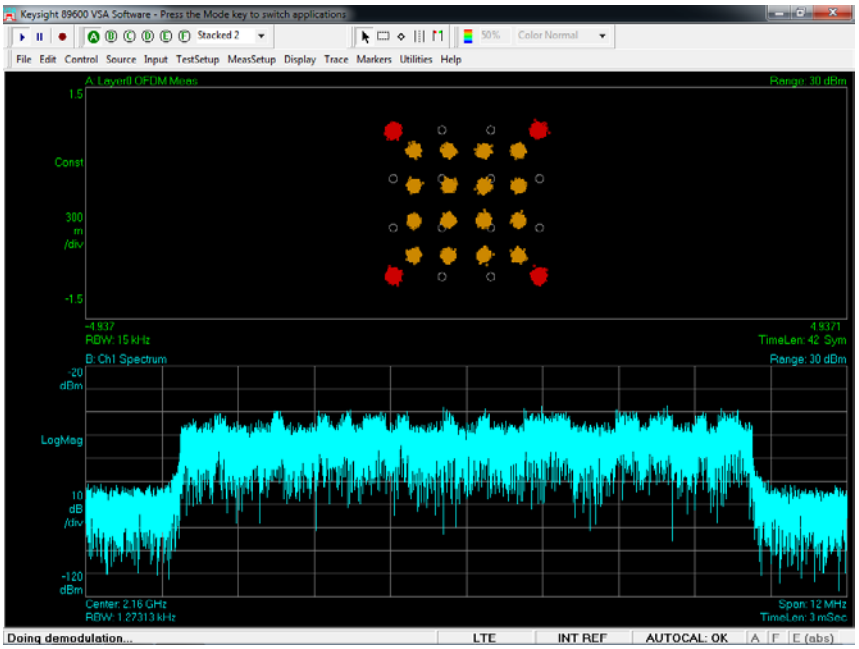
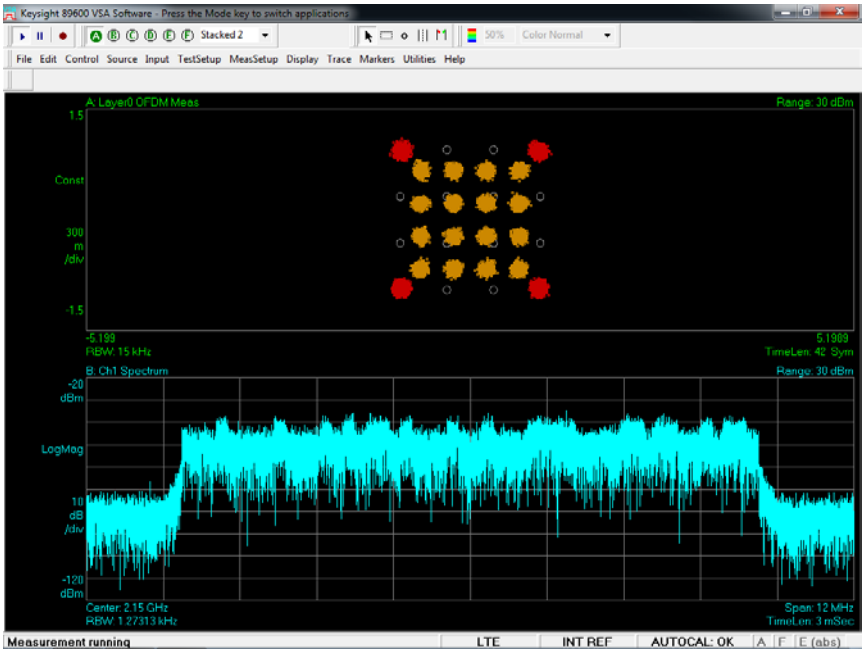


FIGURE 4.2.3 Modulation Measurement for Test 15 (10+10+5) LTE Carriesr with QPSK + 16QAM and 64QAM Modulations

Test 15	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



Test 15	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



Test 15	BW 5 MHz	Tx3	2177.5 MHz	15W	64QAM

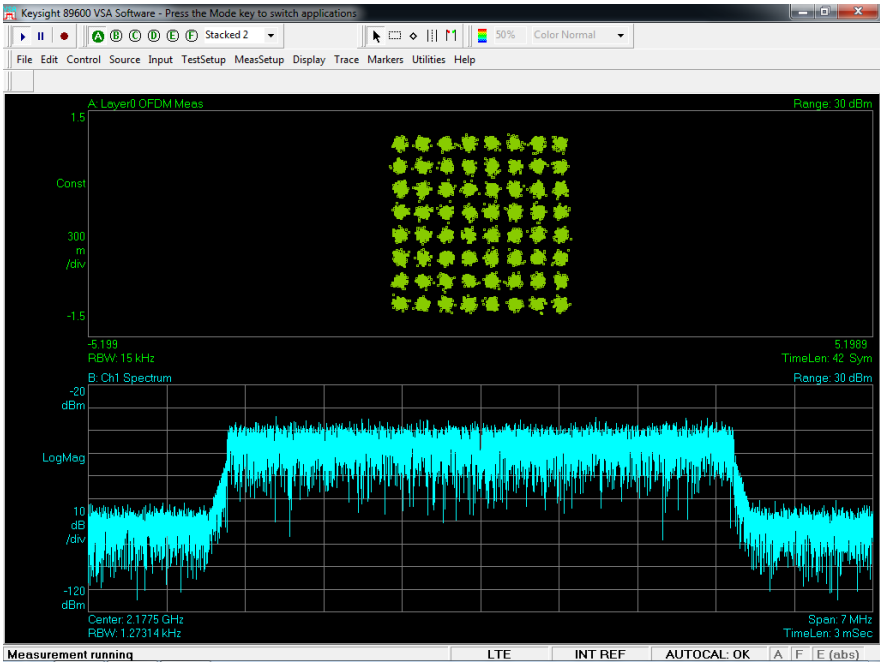
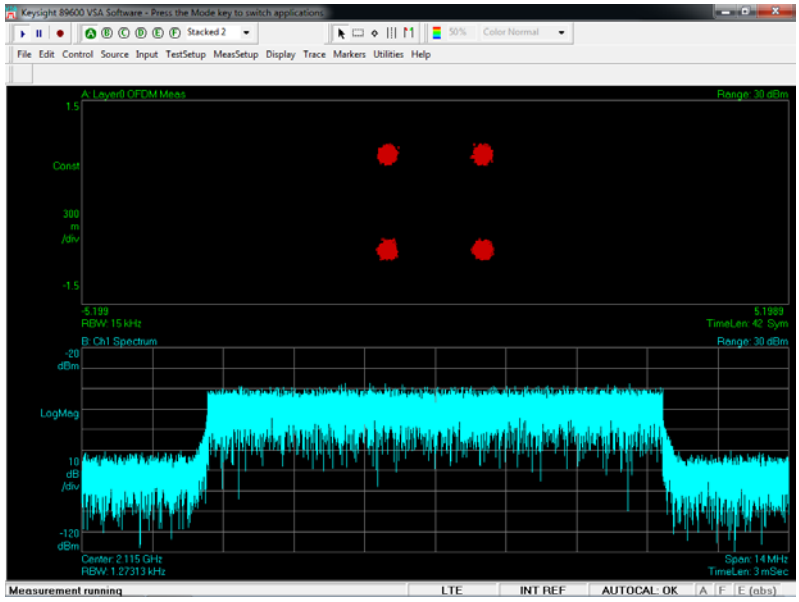
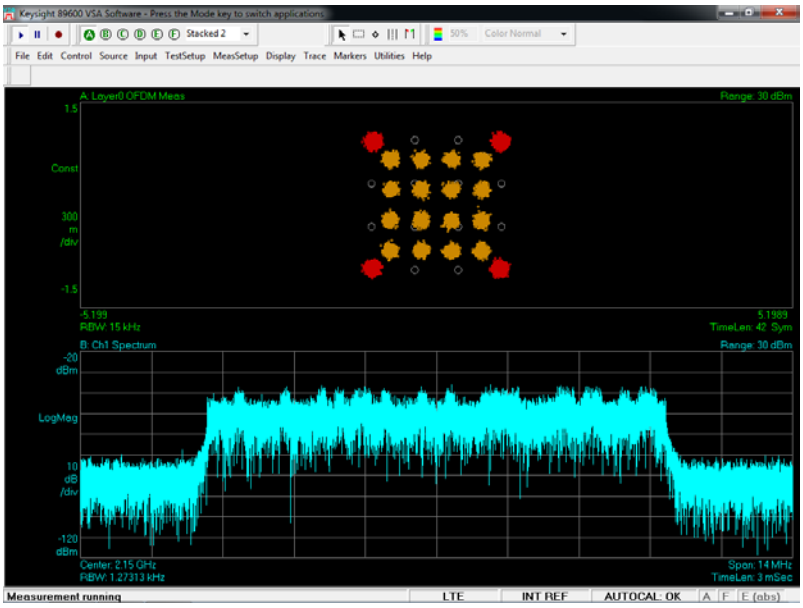


FIGURE 4.2.4 Modulation Measurement for Test 17 (10+10+10) LTE Carriers with QPSK, QPSK + 16QAM and 64QAM Modulations

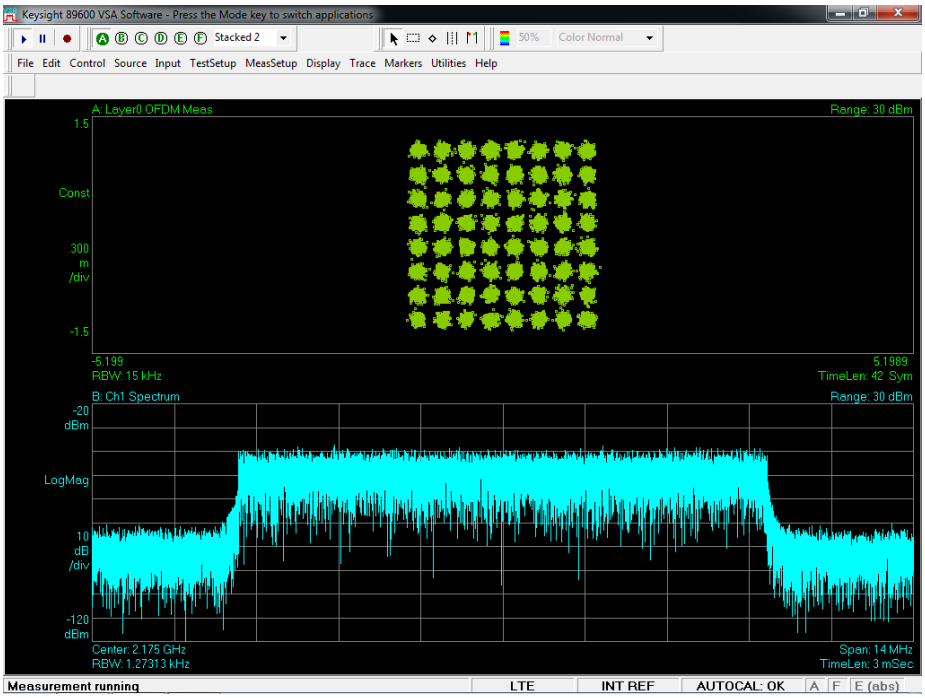
Test 17	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



Test 17	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



Test 17	BW 10 MHz	Tx3	2175 MHz	15W	64QAM



4.3 Section 2.1049 MEASUREMENT REQUIRED: OCCUPIED BANDWIDTH AND OUT-OF-BAND EMISSIONS

This test measures the Occupied Bandwidth of the transmitting carrier and the Out-of-Band Emissions in the frequency spectrum immediately outside and adjacent to the transmitting carrier(s).

The occupied bandwidth (OBW) is usually defined either as the 99% power OBW or a relative OBW. The 99% OBW is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated or conducted are each equal to 0.5 percent of the total mean power radiated or conducted by a given emission. The relative OBW is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated by at least X dB below the transmitter power, where the value of X is typically specified as 26.

Per KDB 971168 D01 v02r02, the relative OBW must be measured and reported when it is specified in the applicable rule part; otherwise, the 99% OBW shall be measured and reported. The OBW shall be measured when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment is operated.

4.3.1 Measurement of Occupied Bandwidth

The operating blocks and carrier configurations supported are provided in Section 3.1 Product Descriptions. The EUT transmitting band for wireless communication is governed by the FCC rules in CFR 47, Part 27, Subpart C. The minimum emission requirements and the setting of measurement equipment for the out-of-band emissions measurement of carriers were specified in FCC Part 27.53(h). The FCC's requirements are tabulated in the following table:

Table 4.3.1 FCC Part 27.53(h) Transmitter Unwanted Emission Limits

Frequency	Required Minimum Attenuation below the Mean Carrier Power *P*	Measurement Resolution Bandwidth (RBW)** of Spectrum Analyzer
1MHz Bands Immediately Outside the Transmitting Frequency Band	(43 + 10 log P watts) dBc = -13dBm*	30 kHz for BW 5 MHz 100kHz for BW 10MHz 100kHz for BW 15MHz 100kHz for BW 20MHz
Outside the above Frequency Range	(43 + 10 log P watts) dBc = -13dBm*	1MHz

***For Nx MIMO, the limit is reduced by 10·*log*(N) dB.**

**** 3GPP TS 36.104, Table 6.6.3.3-2: Additional operating band unwanted emission limits for E-UTRA bands>1GHz**

The above requirement was used as the required emission limit mask in the out-of-band emissions measurement. The occupied bandwidth and out-of-band emissions measurements were made at the antenna transmitting terminal for QPSK+16QAM and 64QAM modulations, respectively. The appropriate E-UTRA test model specified in 3GPP TS 36.141 and TS 36.104 was used for LTE carriers.

The measurements were performed with a spectrum analyzer, consistent with ANSI C63.26. The test set-up diagram is same as the one shown in the Figure 4.3.1.

The 99% occupied bandwidth measurement of an LTE carrier was measured per FCC KDB 971168, using an Agilent Technologies N9020A MXA Signal Analyzer. For the out-of-band emissions measurement, the spectrum analyzer is normally set with a resolution bandwidth which is equal to at least 1% of carrier bandwidth [Part 27.53 (h) (1), (3)] and a video bandwidth which is equal to at least 3xRBW as shown in the plots of the occupied bandwidth measurement attached in the following pages. The emissions outside the above spans were evaluated in Measurement Required: Out-of-Block Spurious Conducted Emissions. The top of the carrier measured with a resolution bandwidth which is equal to 1% of carrier bandwidth was 20 dB below the LTE carrier power measured with a resolution bandwidth greater than the carrier bandwidth (if available) or a wideband power meter. This 20dB offset was due to the fact that 10 log (BW/1% *BW) = 20 dB. The RMS average detector was used in all above measurements. The measurement met the requirements of ANSI C63.26 paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW.

The B66a RRH 4x45W operates either with a single carrier set to bandwidths (BW) of 5 MHz, 10 MHz, 15 MHz or 20 MHz, with dual carriers of BW 5, 10, 15 and 20 MHz (contiguous or non-contiguous) in any combination or sequence, and with three carriers of BW 5, 10 and 15 MHz (contiguous or non-contiguous) in any combination or sequence over the AWS spectrum 2110 – 2180 MHz. **Three carrier operation is the focus of this Class II Permissive Change application. Test numbers 9, 15 and 17 will be displayed as representative of all, since 4x45W MIMO has the more stringent emission limitation, and in order to keep this report to a manageable size and complexity.**

The emission masks and measurement resolution bandwidths (RBW) were consistent with 3GPP TS 36.104 Table 6.6.3.3-2. The out-of-band emissions were measured using Total Integrated Laboratory Environment (TILE) EMI test software, by ETS-Lindgren. The carrier configurations displayed are tabulated below.

Table 4.3.2 Channels Tested and Displayed for Occupied Bandwidth and Out-of-Band

4T4R MIMO Operation

Test Number	BW MHz	Ant. Term.	Freq MHz	Power 4T	Configuration Modulation	99 % OBW MHz
9	5	Tx1	2112.5	15W	QPSK	4.4833
	10	Tx1	2150	15W	16QAM	8.9615
	15	Tx1	2172.5	15W	64QAM	13.432
15	10	Tx3	2115	15W	QPSK	8.9470
	10	Tx3	2150	15W	QPSK + 16QAM	8.9809
	5	Tx3	2177.5	15W	64QAM	4.4841
17	10	Tx3	2115	15W	QPSK	8.9607
	10	Tx3	2150	15W	QPSK + 16QAM	8.9596
	10	Tx3	2175	15W	64QAM	8.9591

4.3.1.1 Mask Parameters

§27.53 (h) AWS Emission Limits

(1) *General protection levels.* Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}$ (P) dB.

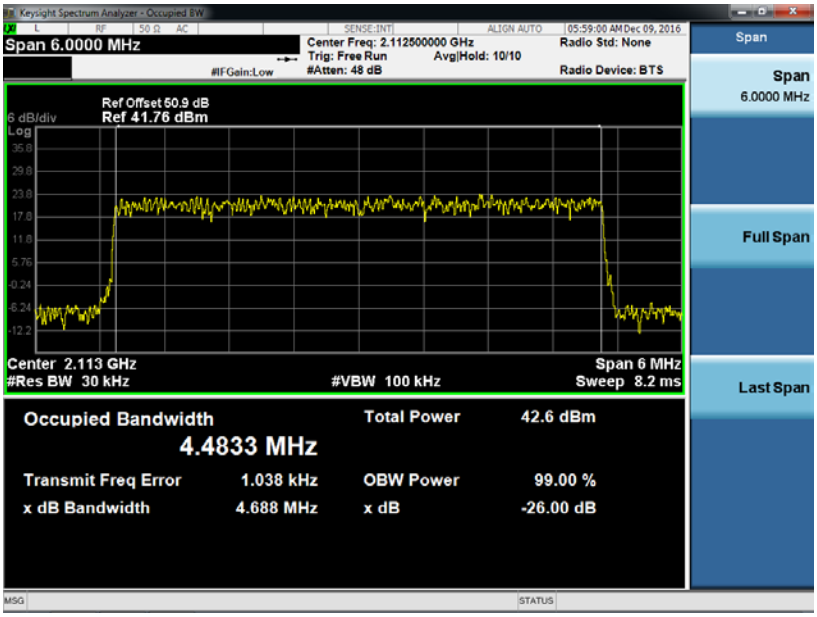
(3) *Measurement procedure.* (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

Results:

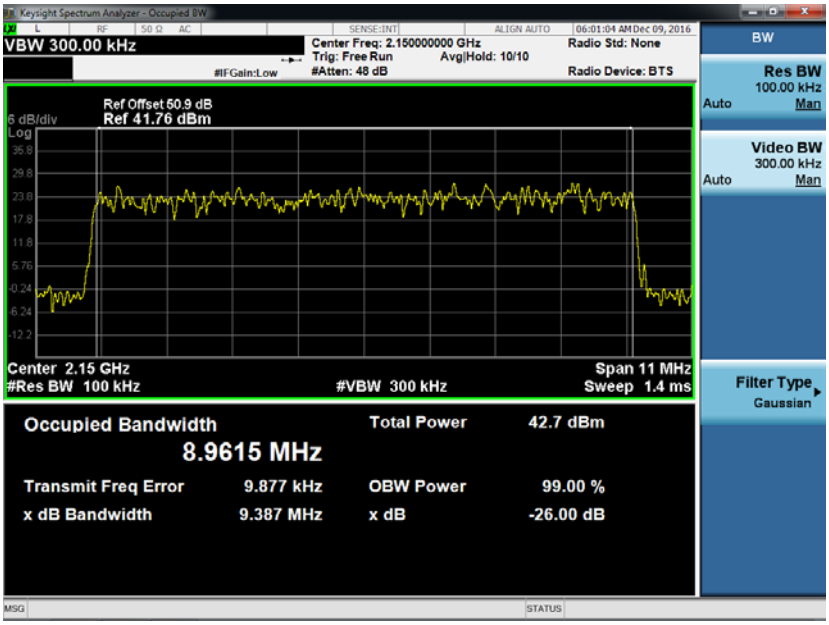
The widest occupied bandwidth plots for each single carrier configuration, with QPSK+16QAM and 64 QAM test modulations, are displayed below. The results are tabulated above.

FIGURE 4.3.1 99% Power OCCUPIED BANDWIDTH PLOTS

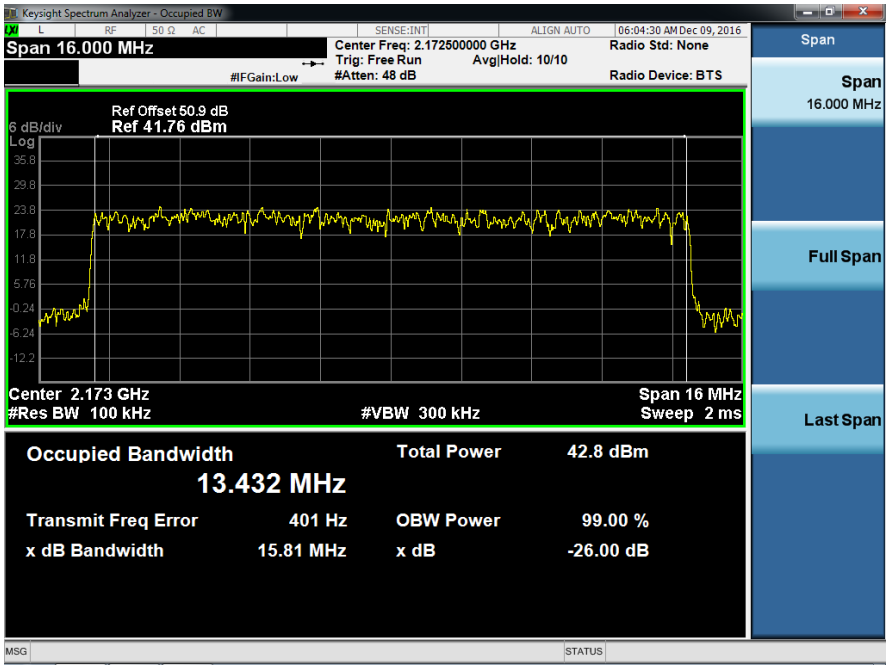
Test 9	BW 5 MHz	Tx1	2112.5 MHz	15W	QPSK



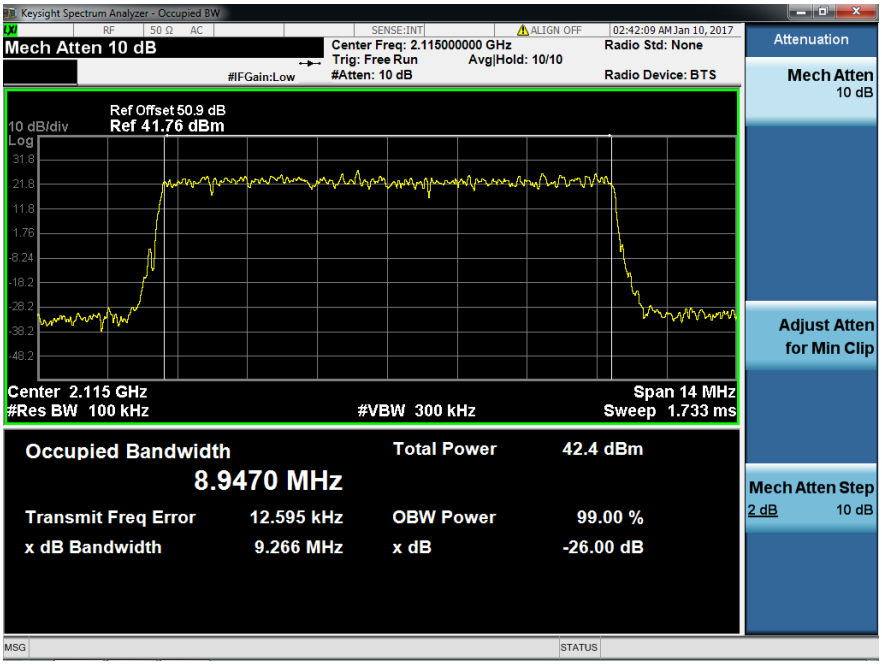
Test 9	BW 10MHz	Tx1	2150 MHz	15W	16QAM



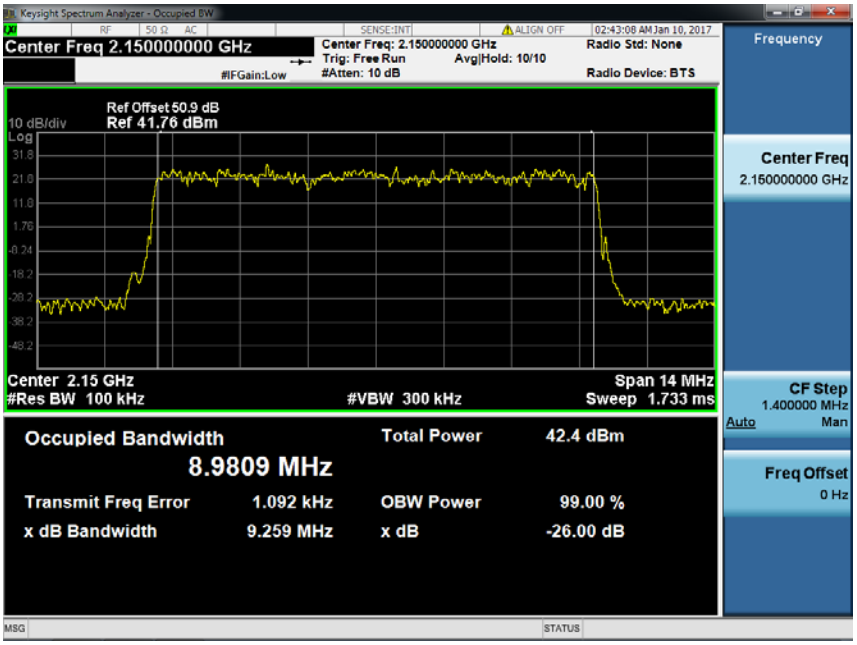
Test 9	BW 15 MHz	Tx1	2172.5 MHz	15W	64QAM



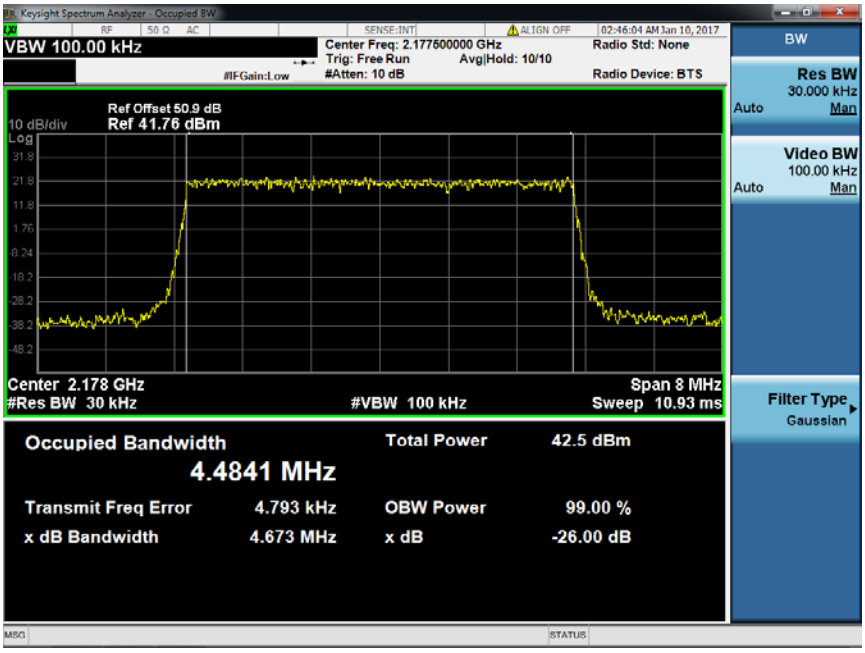
Test 15	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



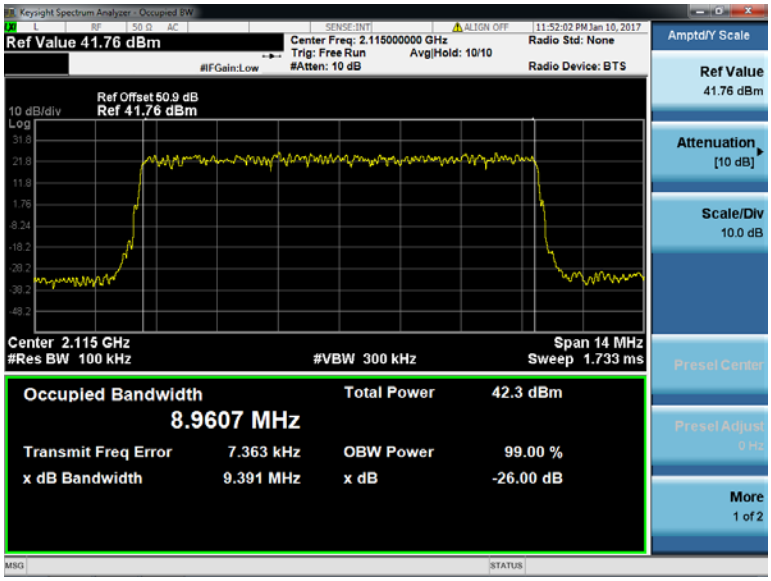
Test 15	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



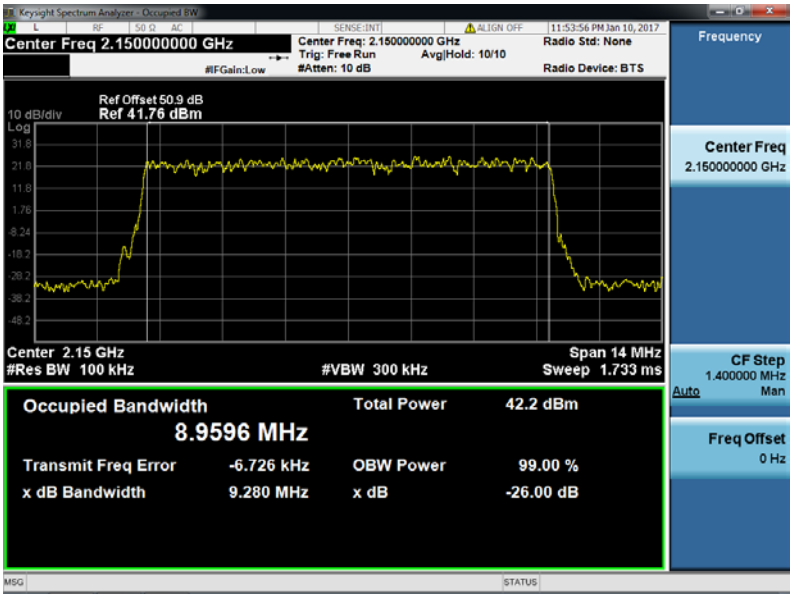
Test 15	BW 5 MHz	Tx3	2177.5 MHz	15W	64QAM



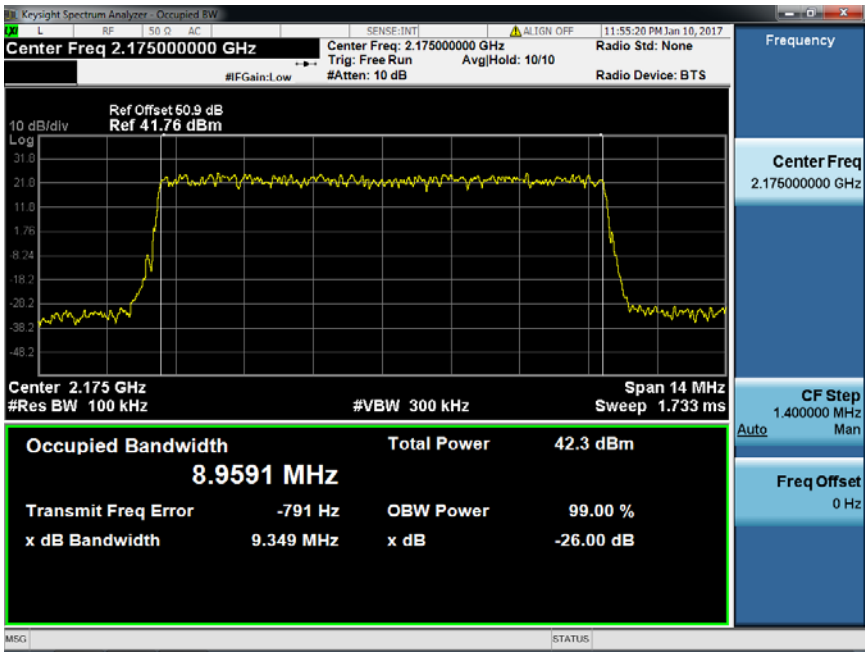
Test 17	BW 10 MHz	Tx3	2115 MHz	15W	QPSK



Test 17	BW 10 MHz	Tx3	2150 MHz	15W	QPSK + 16QAM



Test 17	BW 10 MHz	Tx3	2175 MHz	15W	64QAM



Out-of-Band Emission Mask Compliance

The emission mask limits are defined by:

For the 1 MHz spectrum immediately adjacent to the upper and lower edge of the measurement block/band:

$$P\ dBm - [43 + 10 \log P\ W] - 10 \log (Meas\ RBW/1\%\ BW) - 10 \log N$$

For greater than 1 MHz from the upper and lower edge of the measurement block/band:

$$P\ dBm - [43 + 10 \log P\ W] - 10 \log (Meas\ RBW/1\ MHz) - 10 \log N$$

Where N = the number of transmit antenna terminals/ports.

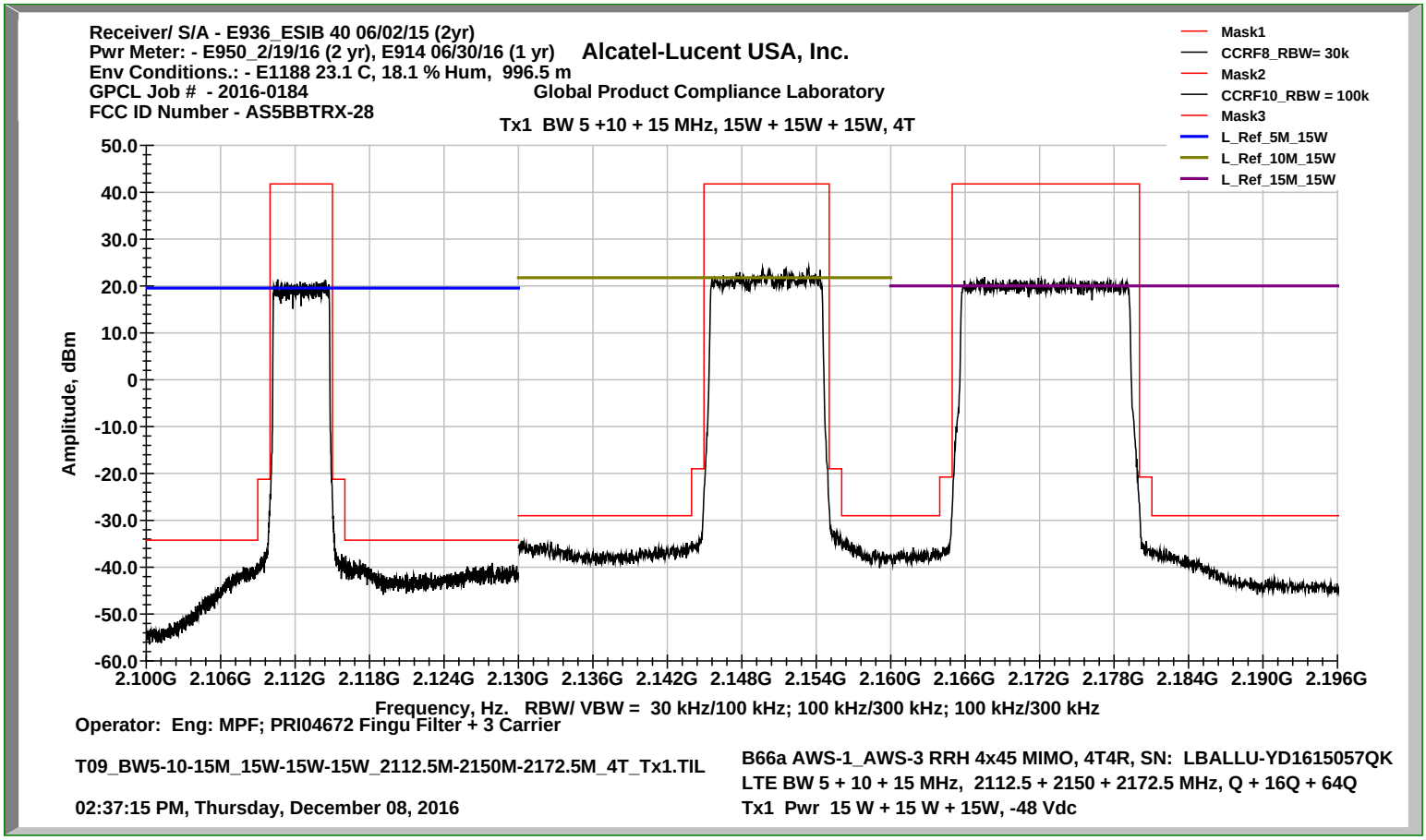
The carriers are offset from the top of the emission mask by:

$$P\ dBm - 10 \log (Meas\ RBW/\ BW)$$

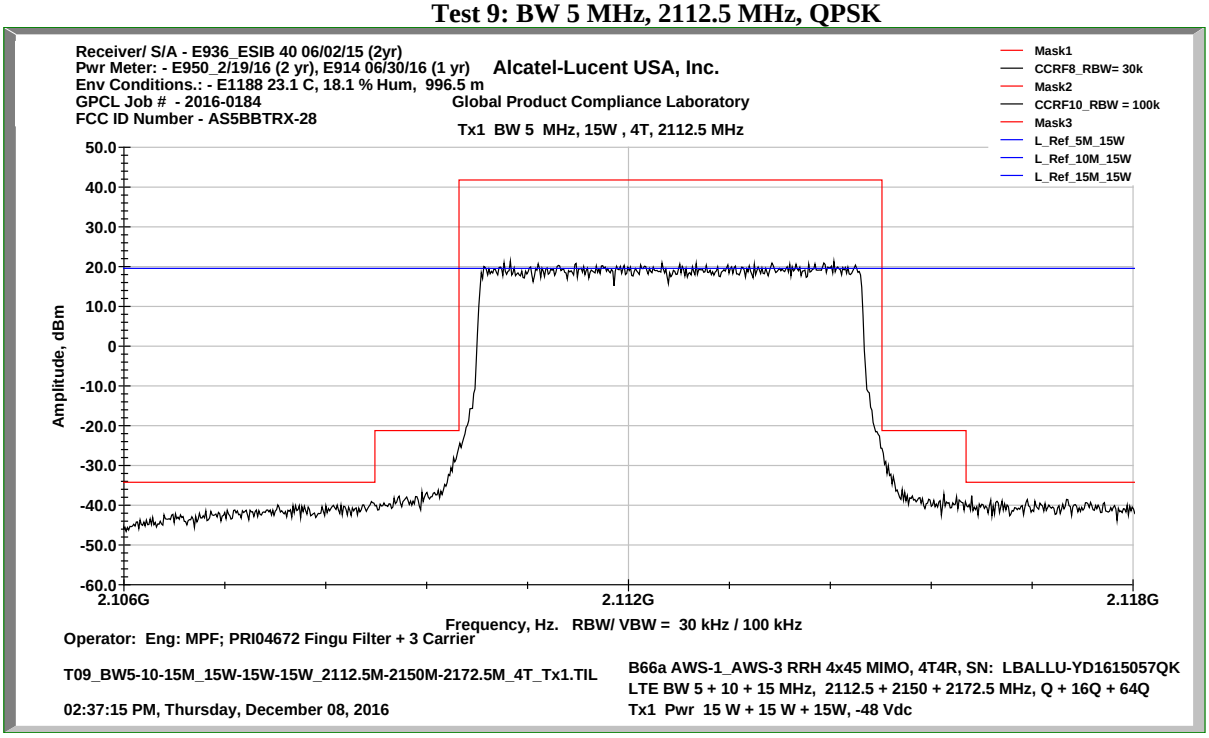
The data plots that follow show compliance for all three-carrier configurations, represented by the previous Test Numbers 9, 15 and 17. From the out-of-band emissions plots attached below, it can be seen that all the emissions are under the required FCC emission masks (i.e., the mask is not cut) for 4x45W MIMO (4T4R) operation, which has the more stringent emission limitations.

FIGURE 4.3.2 OUT-OF-BAND EMISSIONS PLOTS – THREE CARRIER

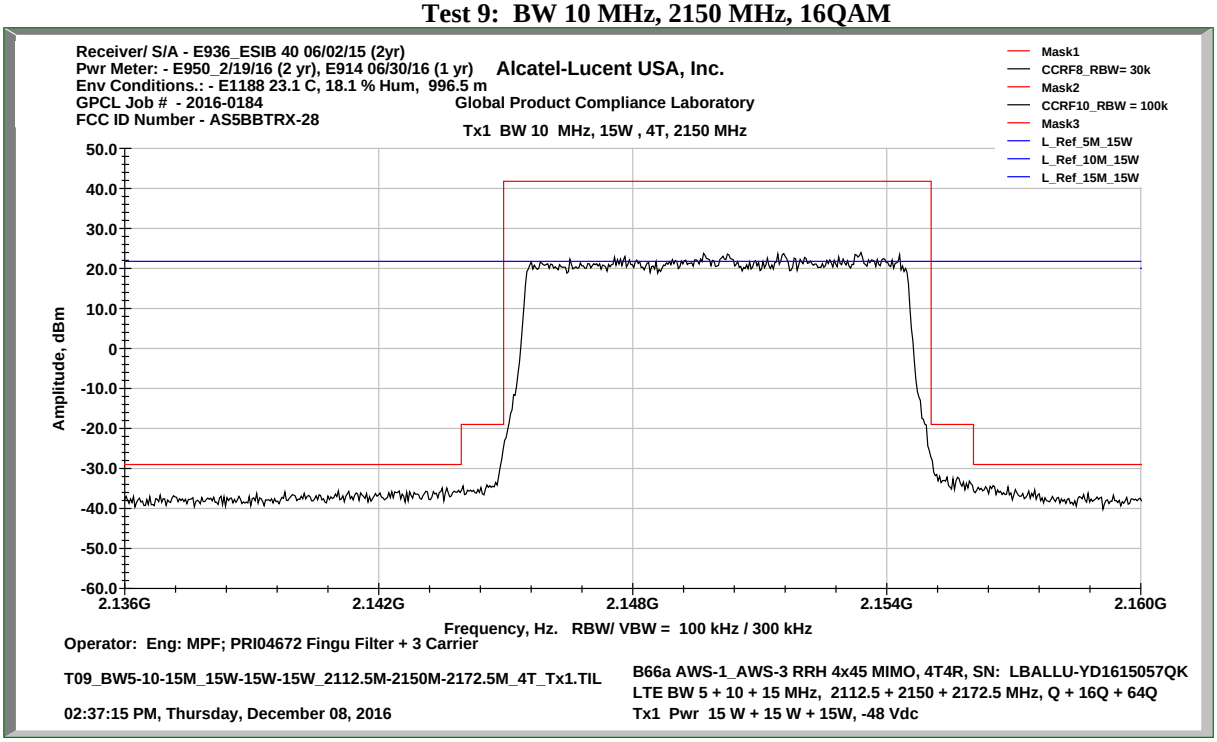
Test 9: BW 5 + 10 + 15 MHz, 4x45W MIMO at 15 W/C



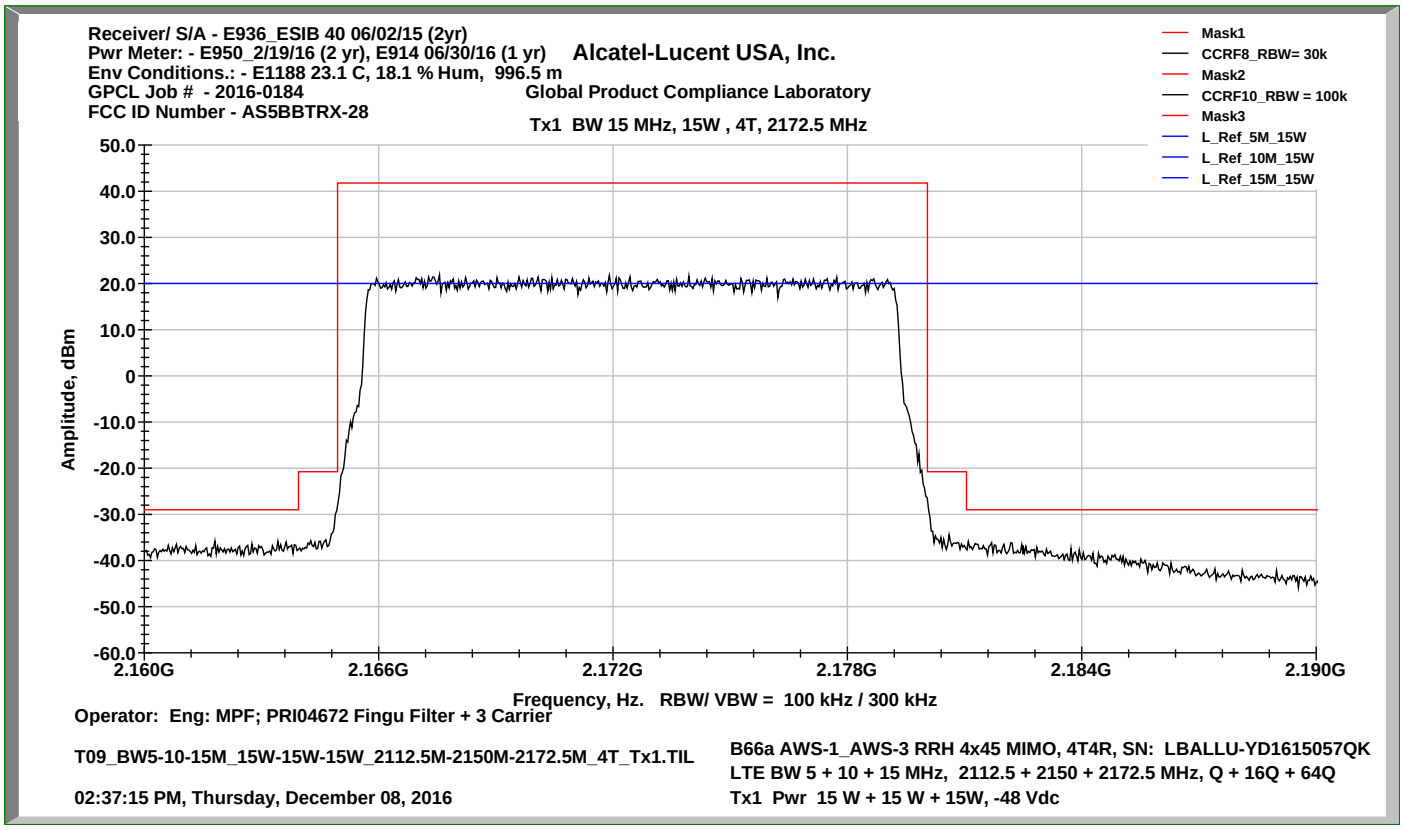
Test 9: BW 5 MHz, 2112.5 MHz, QPSK



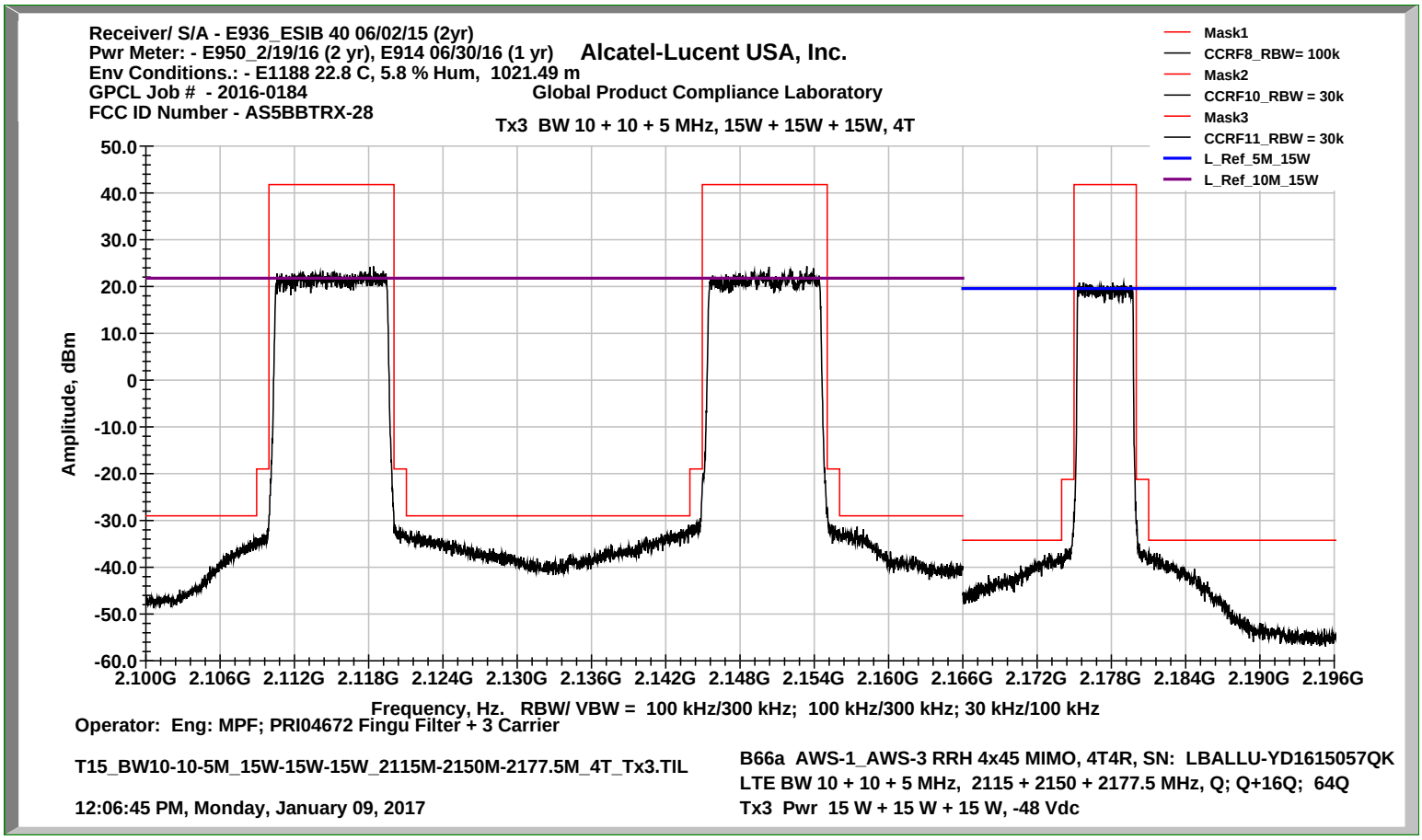
Test 9: BW 10 MHz, 2150 MHz, 16QAM



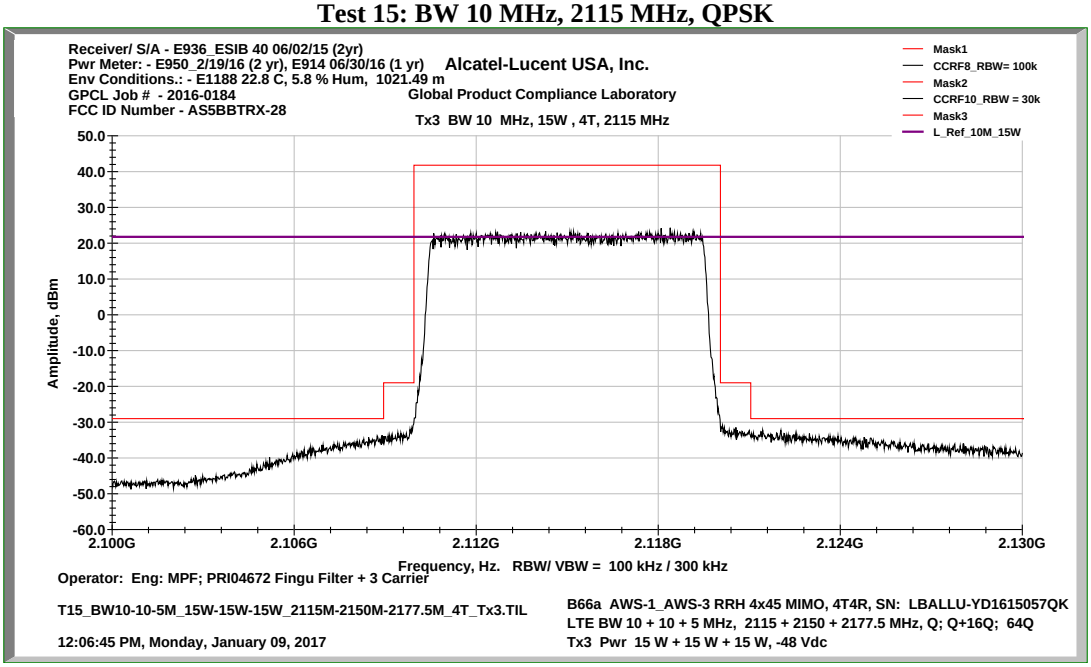
Test 9: BW 15 MHz, 2172.5 MHz, 64QAM



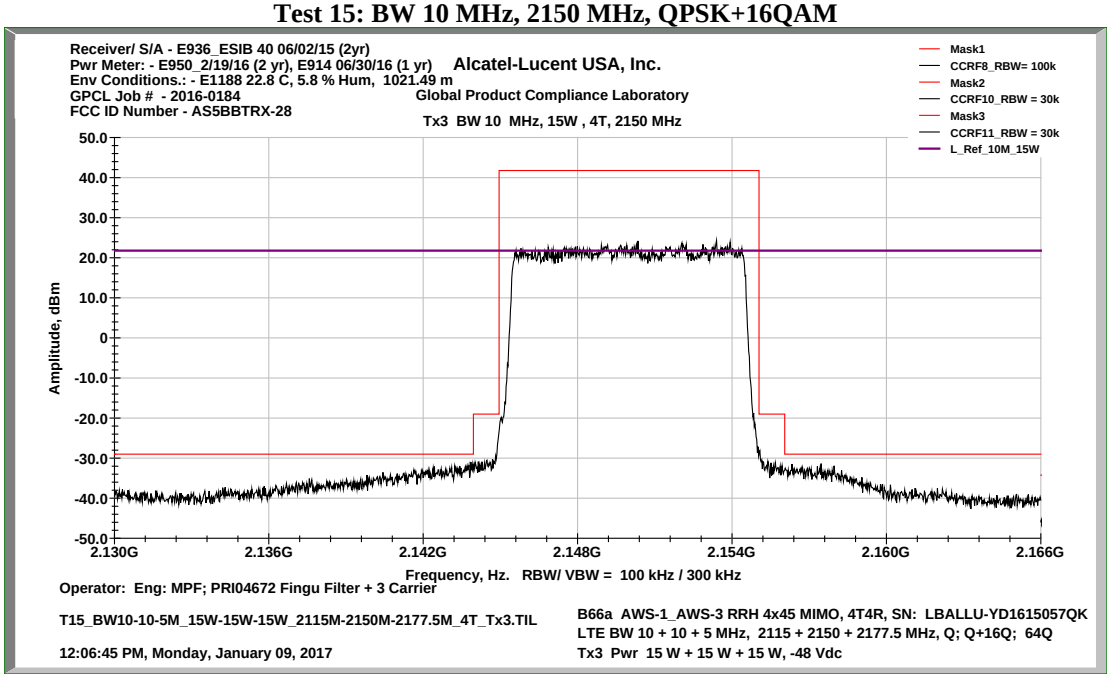
Test 15: BW 10 + 10 + 5 MHz, 4x45W MIMO at 15 W/C



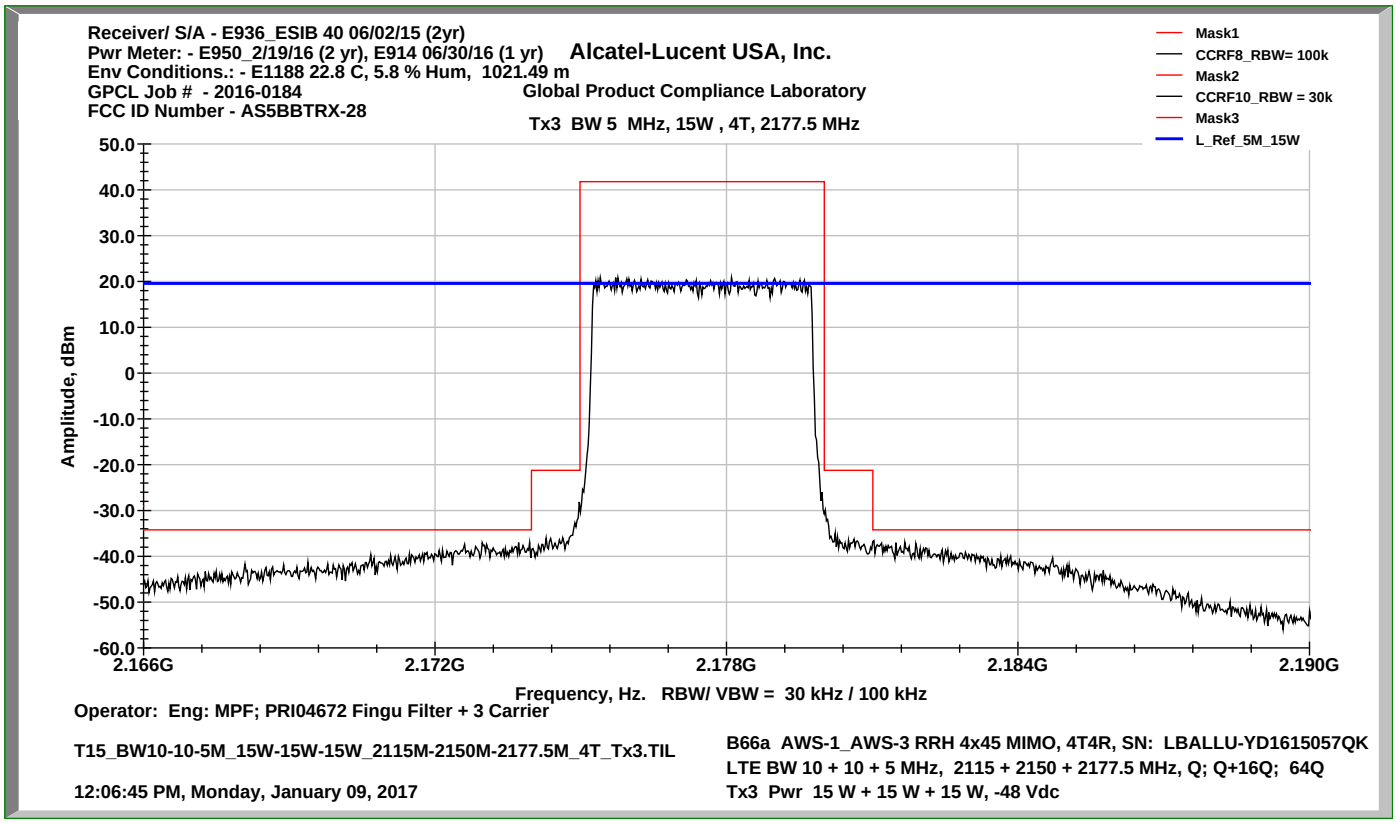
Test 15: BW 10 MHz, 2115 MHz, QPSK



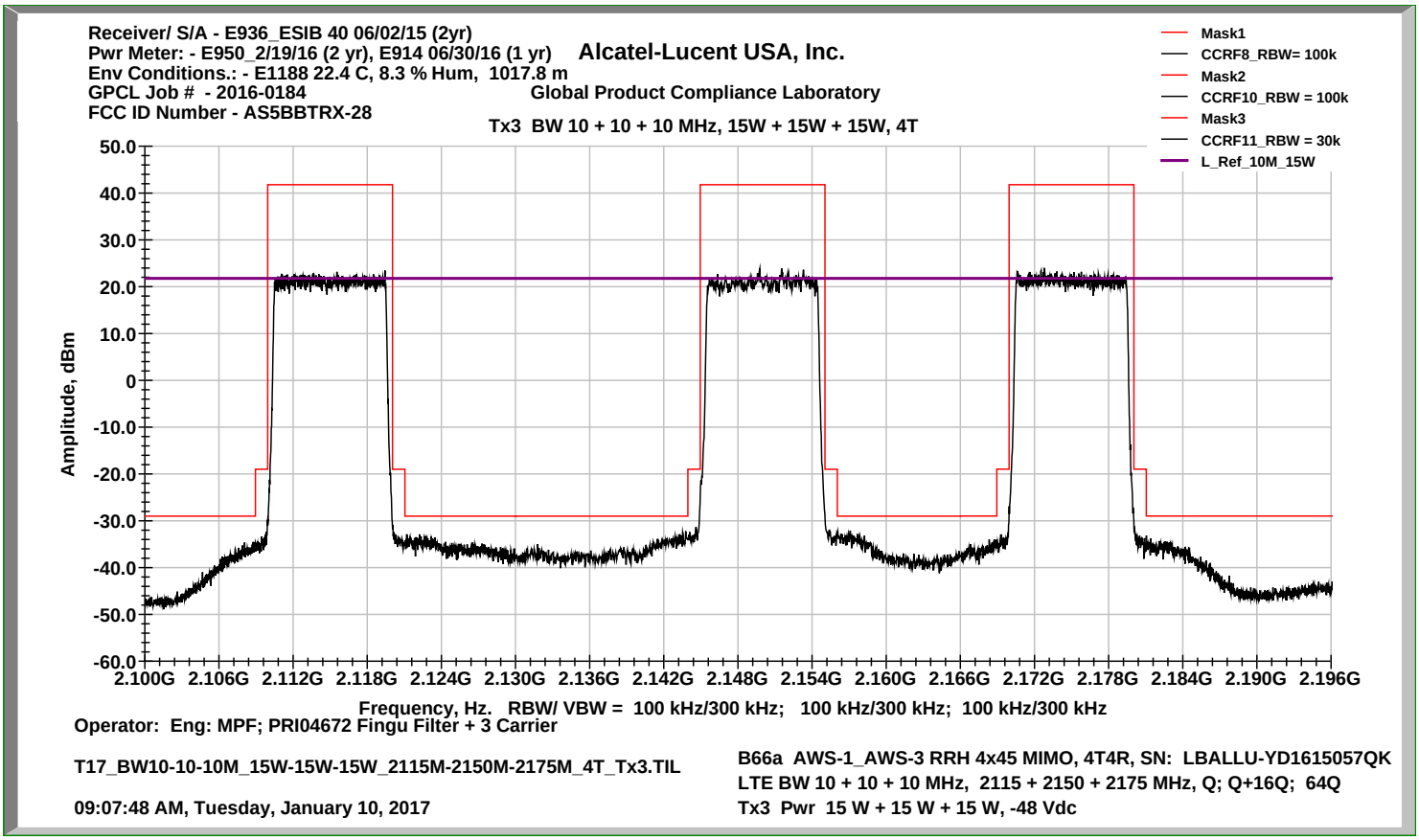
Test 15: BW 10 MHz, 2150 MHz, QPSK+16QAM



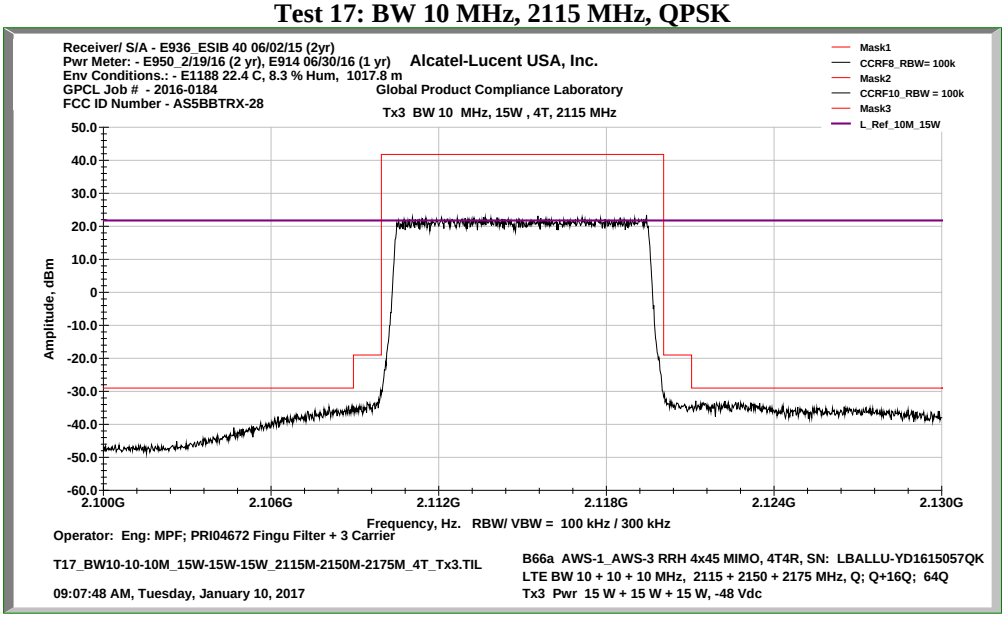
Test 15: BW 5 MHz, 2177.5 MHz, 64QAM



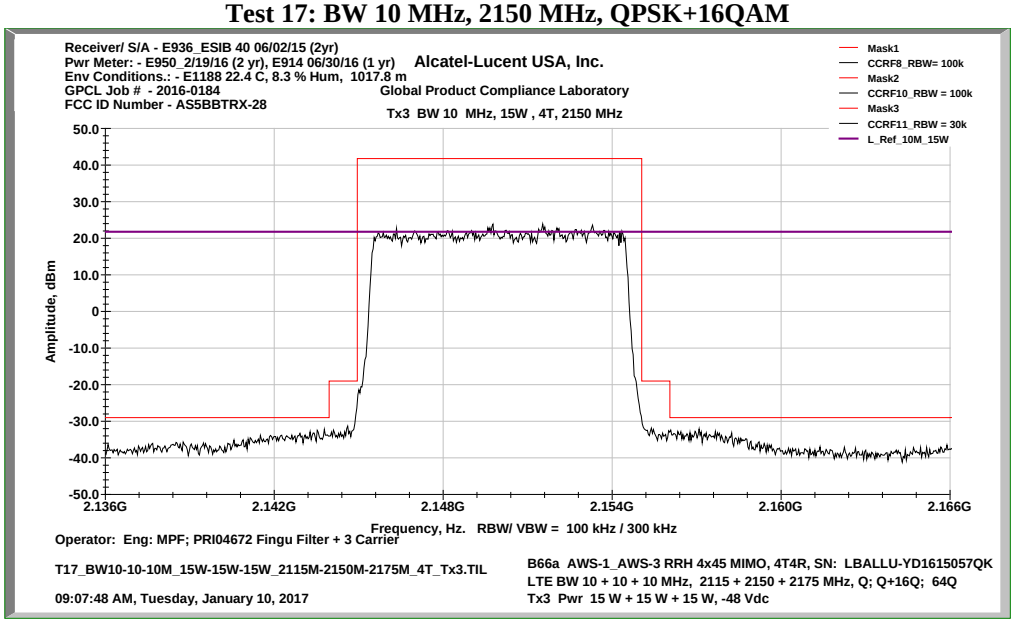
Test 17: BW 10 + 10 + 10 MHz, 4x45W MIMO at 15 W/C



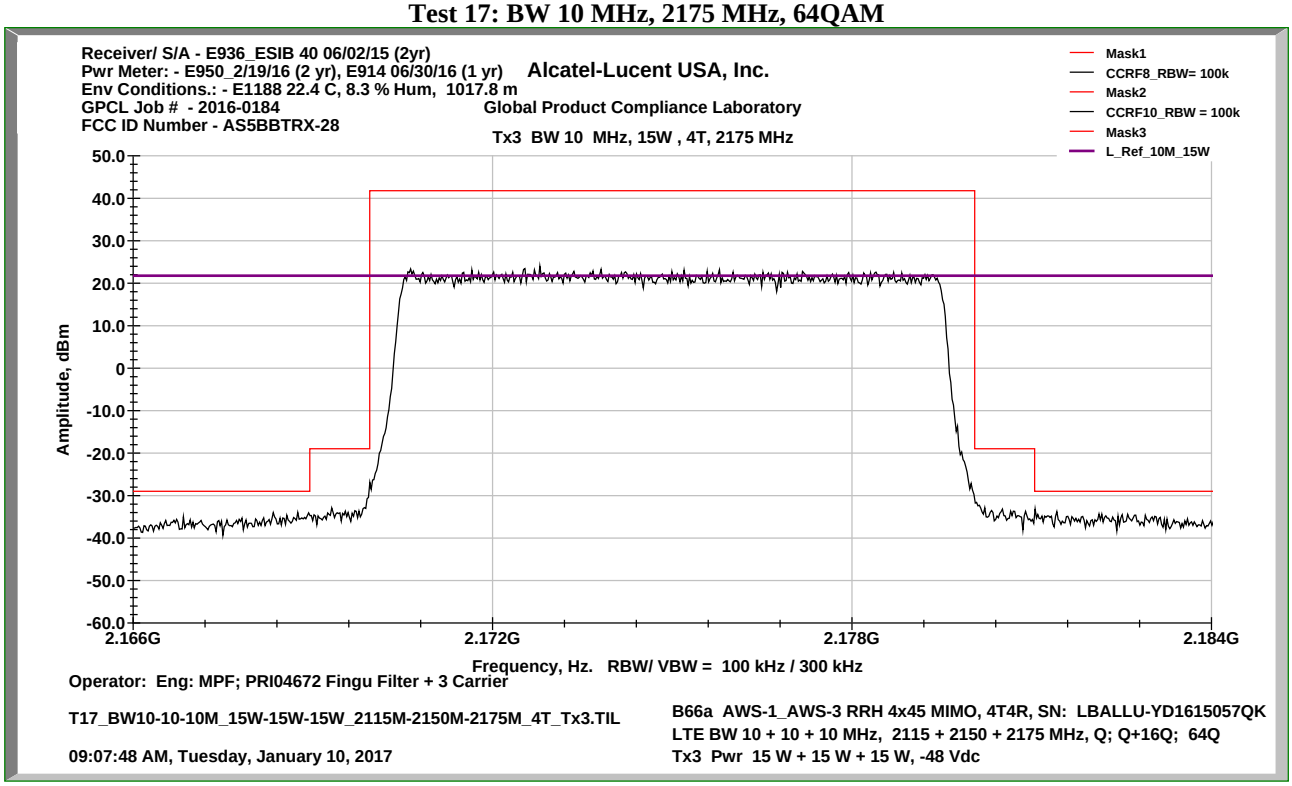
Test 17: BW 10 MHz, 2115 MHz, QPSK



Test 17: BW 10 MHz, 2150 MHz, QPSK+16QAM



Test 17: BW 10 MHz, 2175 MHz, 64QAM



4.4 Section 2.1051 MEASUREMENT REQUIRED: SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS

This test measures the emissions of spurious signals which may come from harmonic, parasitic, intermodulation and frequency conversion products and are outside the necessary bandwidth but exclude out-of-band emissions. The out-of-block spurious emissions at the antenna transmitting terminal were investigated from 10 MHz to the 10th harmonic of the carrier, per Section 2.1057(a)(1). The emission limit is as previously stated in Part 27.53(h), as :

For greater than 1 MHz from the upper and lower edge of the measurement block/band:

P dBm - [43 + 10 log P W] – 10 log (Meas RBW/1 MHz) – 10 log N
Where, Meas RBW = 1 MHz and N = 2 for 2T4R and 4 for 4T4R

The measurement configurations and carrier setup were same as in Section 4.3. The out-of-band emissions were measured using Total Integrated Laboratory Environment (TILE) EMI test software, by ETS-Lindgren.

The emission limits and the setting of measurement equipment for the unwanted emissions measurement were given in Table 4.3.3 and provided in Table 4.4.1, where per FCC CFR 47, Sections 2.1051 and 2.1057(c), **the spurious emissions attenuated more than 20 dB below the permissible value need not be reported.**

Table 4.4.1 Conducted Spurious Emissions Limit

Frequency of Emission (MHz)	MIMO Configuration	Required Limit (dBm)	Reportable Limit (dBm)	Detector/RBW
10-22,000	2x90 MIMO	-16	-36	Average/1MHz
10-22,000	4x45 MIMO	-19		Average/1MHz

The measurements were performed with a spectrum analyzer, which was calibrated in accordance with the ISO 9001 process. The carrier power level at the antenna transmitting terminal was calibrated before the conducted spurious emissions testing for each test. The spectrum analyzer was set to a 1MHz resolution bandwidth. The RMS average detector was used. The measurement met the requirements in ANSI C63.26 which requires in 5.2.4.4.1 and 5.7 that the number of points in the sweep be > 2 × Span/RBW.

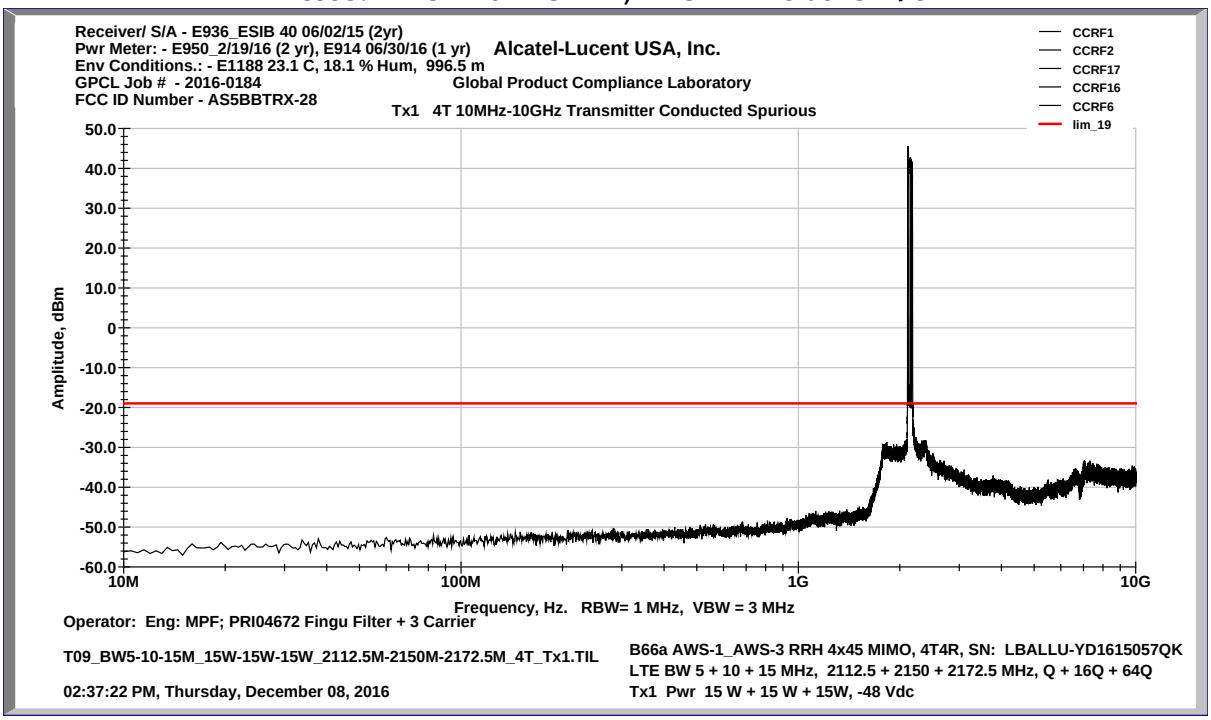
The spurious emissions in the frequency range measured are well under the required reportable emission limit for all carrier bandwidths with QPSK, QPSK+16QAM and 64QAM modulations evaluated. **Therefore, there are no reportable emissions.**

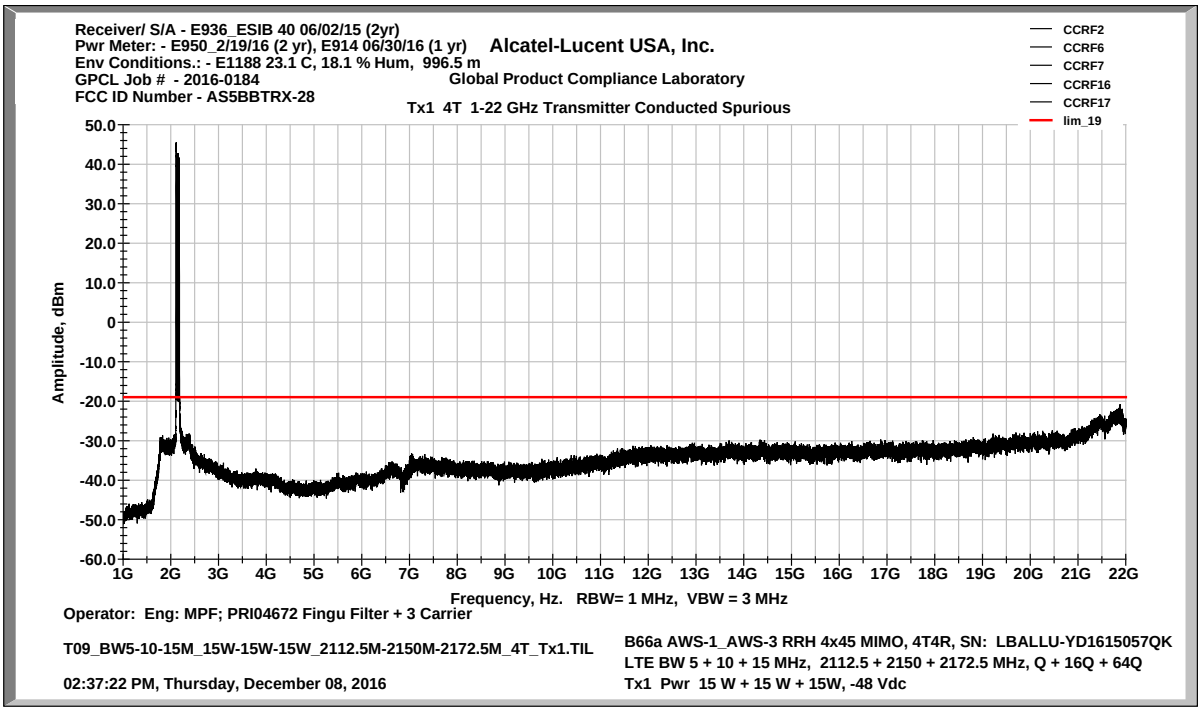
4.4.1 Results:

Over the required frequency spectrum investigated for the EUT, no reportable out-of-block spurious emissions were detected. The out-of-block spurious emissions in the entire spectrum investigated are under the required reportable emission limit. The measurement results demonstrate that the subject of the application is in full compliance with the Rules of the Commission. **There are no reportable emissions.**

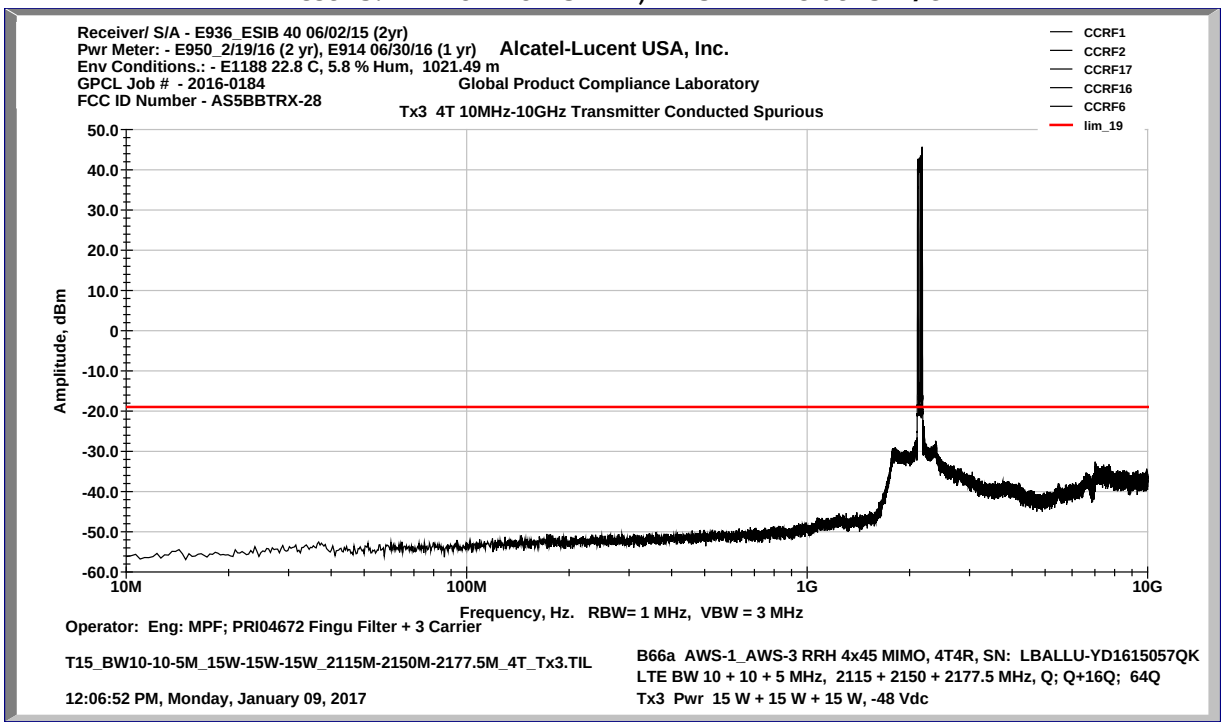
However, Test 9, 15 and 17 results are displayed for consistency with the preceding measuremenbts.

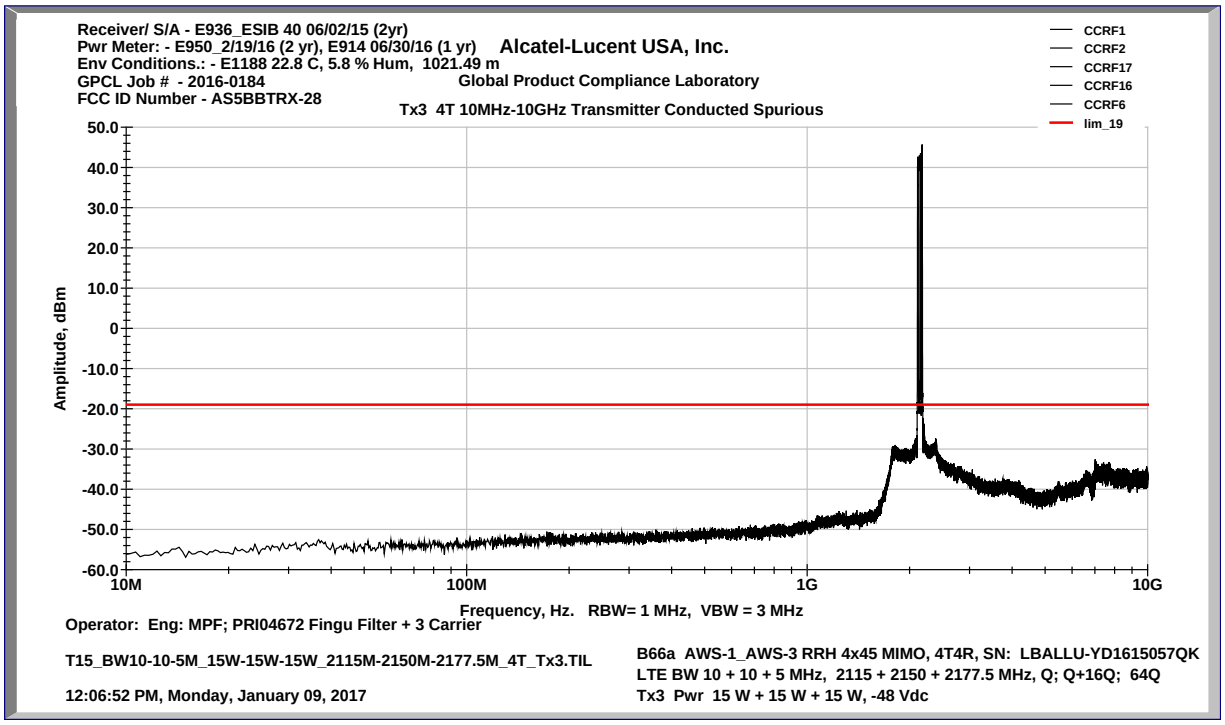
Test 9: BW 5 + 10 + 15 MHz, 4x45W MIMO at 15 W/C



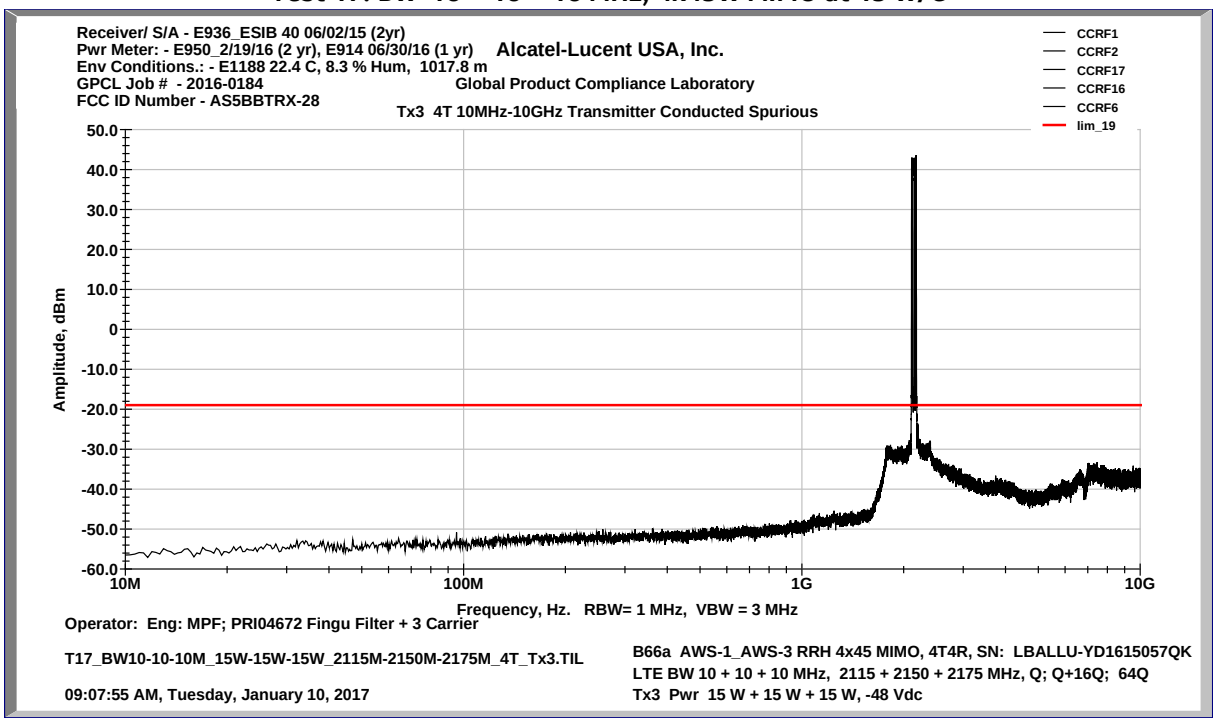


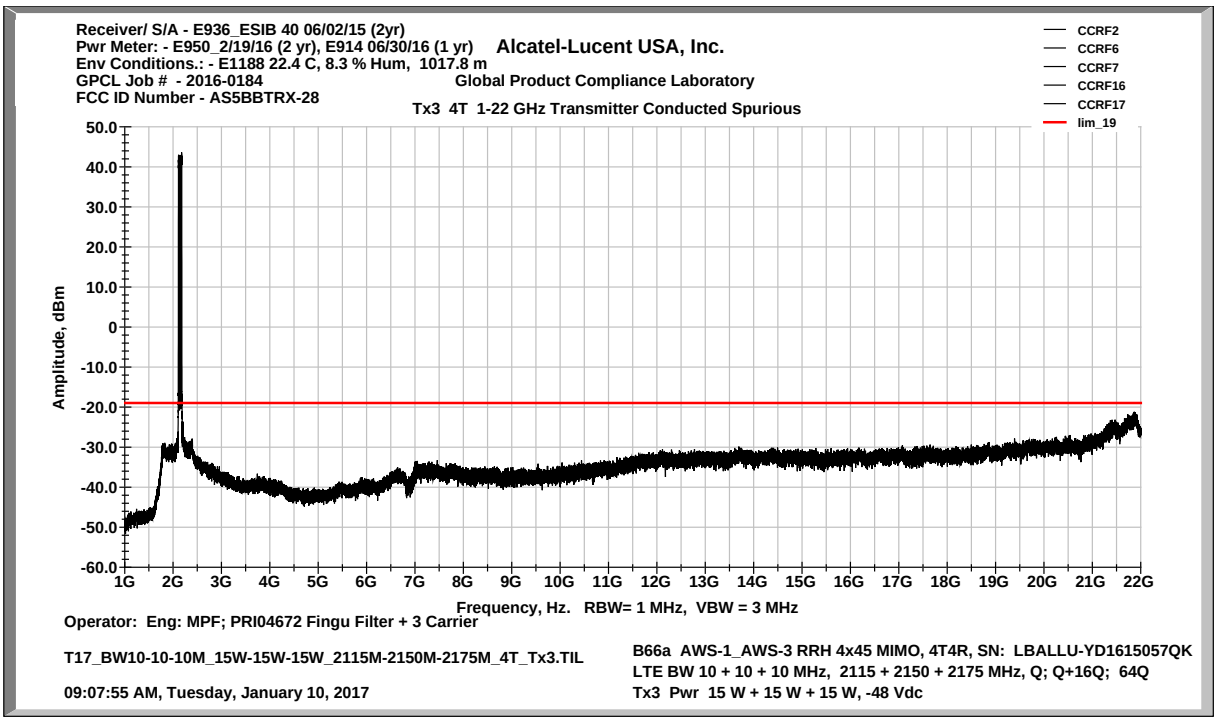
Test 15: BW 10 + 10 + 5 MHz, 4x45W MIMO at 15 W/C





Test 17: BW 10 + 10 + 10 MHz, 4x45W MIMO at 15 W/C





4.5 Section 2.1055 MEASUREMENT REQUIRED: FREQUENCY STABILITY

This measurement evaluates the frequency difference between the actual transmit carrier frequency and the specified transmit frequency assignment. Only the portion of the transmitter system containing the frequency determining and stabilizing circuitry need be put in an environmental chamber and subjected to the temperature variation test per FCC Section 2.1055. The unit which provides baseband signals, such as BBU (baseband unit), can be located outside the chamber if it is a separated unit.

This Class II Permissive Change was software only. No changes were made to the frequency determining and stabilization circuitry. There is no change from the Original Equipment Authorization. **Therefore, it was not necessary to repeat this test.**

4.6 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

This measurement evaluates the spurious emissions that may be radiated directly from the EUT cabinet, circuits or power leads under normal conditions of installation and operation. The EUT shall be investigated from 30 MHz to the 10th harmonic of the carrier, per Section 2.1057(a)(1).

The EUT was set to transmit in the 2110 - 2180 MHz frequency band with LTE technology and 2x45W MIMO. It was configured as in the normal mode of the installation and operation with the maximum power output per Table 4.6.1. The test model used for configuring the LTE carrier was described in Section 4.3. All carriers were transmitting to non-radiating 50 Ω resistive loads.

Table 4.6.1 EUT Configuration – Three Carrier – 4x45W MIMO

Config No	No of Carriers/Port	BW MHz	Carrier MJHz	Power/C (dBm)	Modulations
9	3	5 + 10 + 15	2112.5 + 2150 + 2172.5	41.76	QPSK+ 16QAM + 64QAM

The emission limits and the setting of measurement equipment for the spurious emissions measurement were given in Section 4.3. FCC sections 2.1051 and 2.1057(c) specify that the spurious emissions attenuated more than 20 dB below the permissible value need not be reported. By using the relation between the electric field strength of an ideal dipole and its excitation power given in Reference Data for Radio Engineers, page 676, 4th edition, ITT Corp., the emission limit calculated for electric field strength and its reportable limit equal.

The equipment under test (EUT) was configured as recommended for *floor standing equipment,* following the guidelines of ANSI C63.4-2009. The EUT was installed and operated as in the *normal mode of operation.* Field strength measurements of radiated spurious emissions were evaluated in a 3m semi-anechoic chamber, using an EUT-to-Antenna separation of 3-meters. Test software was Vasona by EMiSoft.

Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, *when the emissions are more than 20 dB below the specification limit*, the use of field strength measurements for compliance determination is acceptable and those emissions are considered *not reportable* (Section 2.1057 and the FCC Interpretive database for 2.1053).

For this case the evaluation of acceptable radiated field strength is as follows. The calculated emission levels were found by:

Pmeas (dBm) + Cable Loss(dB) + Antenna Factor(dB) + 107 (dBμV/dBm) -Amplifier Gain (dB)
= Field Strength (dBμV/m)

Section 27.53 and 2.1053 contains the requirements for the levels of spurious radiation as a function of the EIRP of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an isotropic radiator excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 27-7, 6th edition, IT&T Corp.

$$E = (120\pi P)^{1/2} = [(30*P)^{1/2}] / R$$

$$20 \log (E*10^{6}) - (43 + 10 \log P) = 82.23 \text{ dB } \mu V/\text{meter}$$

Where: E = Field Intensity in Volts/ meter R = Distance in meters = 3 m
P = Transmitted Power in watts = 180 W (2x90w MIMO)

Table 4.6.2 Calculated Radiated Spurious Emission Limit in Electrical Field Strength

Frequency Range (MHz)	Measurement Distance (m)	Required E Limit (2x2 MIMO) (dBμV/m)	Reportable E Limit (dBμV/m)	Detector/RBW
10-22,000	3	82.23	62.23	Average/1MHz

The field strength of radiated spurious emissions measured was determined by

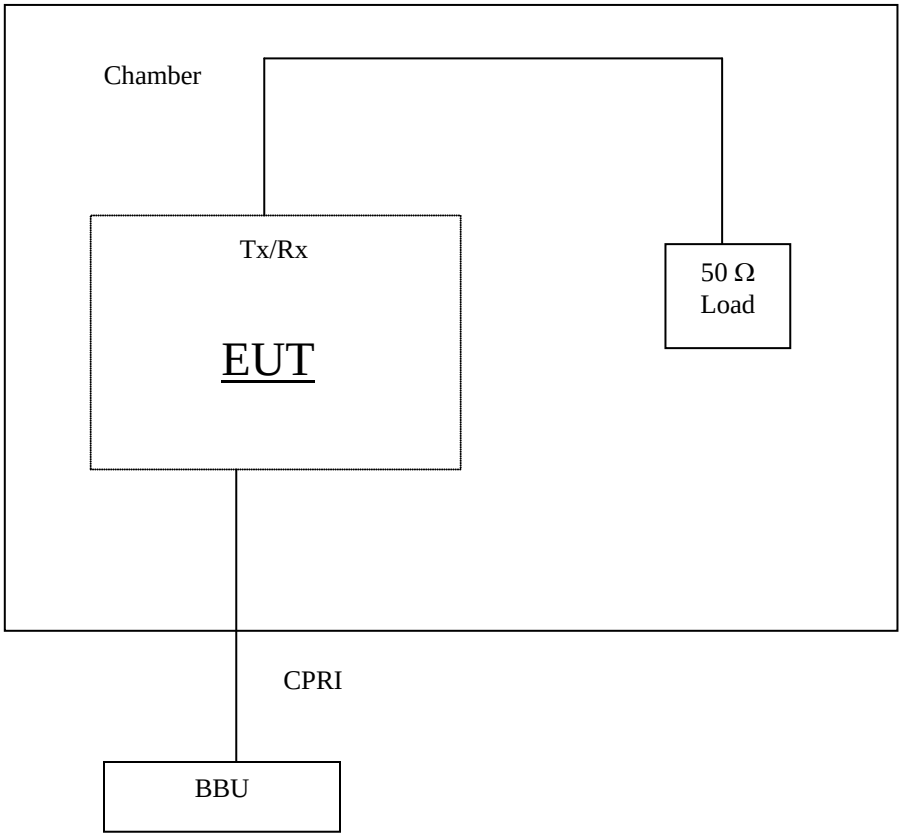
$$E(\text{dB}\mu\text{V/m}) = V_{meas}(\text{dB}\mu\text{V}) + \text{Cable Loss (dB)} + \text{Antenna Factor (dBi/m)}$$

Field strength measurements of radiated spurious emissions were made in a semi-anechoic chamber of Global Product Compliance Laboratories of Nokia, Murray Hill, which was detailed in Section 6. The recommendations of ANSI C63.4 and ANSI C63.26 were followed for EUT testing setup, cabling, and measurement approach and procedures. All the measurement equipment used, including antennas, was calibrated in accordance with ISO 9001 process. The EUT setup diagram is given in the Figure 4.6.1. **The minimum margin measured per Table 4.6.2 is more than 20dB below the required limit.**

4.6.1 Field Strength of Radiated Emissions Results:

Over the frequency spectrum investigated no reportable radiated spurious emissions were detected. The smallest passing margin was 124.383 MHz at 29.08 dB μV/meter, which is 53.15 dB below the limit, **and is not reportable.** The measurement results of the EUT, subject of this application, demonstrate the full compliance with the Rules of the Commission.

Figure 4.6.1 Test Set-Up for Measurement of Radiated Spurious Emissions



4.7 LIST OF TEST EQUIPMENT

Table 5.1 List of Test Equipment Used

Test Equipment and Attenuator List; Antenna Port Measurements, Project 2016-0184

Manufacturer	Model	Serial Number	Type	Description	GPCL ID	Last Cal	Interval	Status
Agilent Technologies	N1921A	MY45101984	Power Meter	P-Series	E950	2/19/2016	24	Active
Agilent Technologies	N1921A	US44510270	Power Sensor	-35 - +20 dBm 50 MHz -18 GHz	E914	6/30/2016	24	Active
TDK	GEN-60-25	14H9764AA	Power Supply	DC Power Supply 60 Volts 25 Amps	E1203	NCR	NCR	Active
Agilent Technologies	N9020A	MY48011791	MXA Signal Analyzer	20Hz-26.5GHz	E831	2/23/2016	24	Active
Rohde & Schwarz	ESIB 40	100119	EMI Test Receiver	20 Hz - 40 GHz	E936	6/2/15	24	Active
Trilithic	10LC1790-3-AA	PCS-LPF-10	Low Pass Filter	PCS	E979	NCR		Active
Trilithic	5HC2850/18050-1.8-KK	PCS-HPF-10	High Pass Filter	PCS	e1132	NCR		Active
Agilent	8495B	MY42140029	Attenuator	Step Attenuator 70 dB DC-18GHz	---	NCR	NCR	Active
Agilent	8494B	MY41111301	Attenuator	Step Attenuator 11 dB DC-18GHz	---	NCR	NCR	Active
Hewlett Packard	772D	Not Readable	Directional Coupler	Dual 2-18 GHz	---	NCR	NCR	Active
MCE/Weinschel	6530-6-34-LIM	BN3221	Attenuator (Incident)	6 dB, 25W DC-18GHz	---	NCR	12	Active
Weinschel	7003	CC0647	DC Block	9kHz - 18.6 GHz	E1101	NCR	24	Active
Weinschel Corp.	48-20-43	BC5417	Input Attenuator	20dB, 100W, DC-18GHz	---	NCR	NCR	Active
Weinschel Corp.	46-20-34	BJ4772	Test Port	20dB, 25W, DC-18GHz	E1023	NCR	NCR	Active
Agilent Technologies	N5230C	MY49000897	PNA-L Network Analyzer	10 MHz – 40 GHz	E896	8/15/14	24 + 3 Extension	Active
TxRx2 – 1/3 Aeroflex/Weinschel	49-30-43	QZ222	Attenuator	30dB, 150W	---	NCR	NCR	Active
TxRx2– 2/3 MCE/Weinschel	46-20-34-LIM	BN3134	Attenuator	20dB, 25W, DC-18GHz	---	NCR	NCR	Active
TxRx2a – 3/3 MCA	401-1F3	---	Termination	---	---	NCR	NCR	Active
TxRx1 – 1/3 Weinschel Corp	49-20-33	LY101	Attenuator	20dB, 150W	---	NCR	NCR	Active
TxRx1 – 2/3 Weinschel Corp	24-30-43	BC8948	Attenuator	30dB, 50W, DC-8.5GHz	---	NCR	NCR	Active
TxRx1– 3/3 MECA	400-1	---	Termination		---	NCR	NCR	Active
TxRx4 – 1/3 Weinschel Corp	49-30-53	LV821	Attenuator	30dB, 150W	---	NCR	NCR	Active
TxRx4 – 2/3 Weinschel Corp	46-20-34	BJ2719	Attenuator	20dB, 25W, DC-18GHz	---	NCR	NCR	Active
TxRx4 – 3/3 TFE	20-3-NJ-Z	11091962	Termination	20W, DC-3GHz	---	NCR	NCR	Active
TxRx3 – 1/2 Weinschel Corp	49-40-43	LC235	Attenuator	40dB, 150W	---	NCR	NCR	Active
TxRx3 – 2/2 Weinschel Corp	M1426	BB8528	Termination	50W, DC-8GHz	---	NCR	NCR	Active

List of Cables

Function	Manufacturer	Model	SN	Comcode
TxRx3	Lucent	KS-25467L7110	G00580	848610259
TxRx1	Lucent	KS-25467L7140	01AIPC30000166	848610358
TxRx4	Lucent	KS-25467L7160	03TK22161153	848610416
TxRx2	Lucent	KS-25467L7110	G00009	848610259
BBU GPS	---	---	15AGEC11A47342	849184023
BBU Optic 1	Optical Fiber	---	---	849122238
BBU Port 1	Type CM 20AWG/4PRS	E188601	---	CC84201 Cat 6 Cable
BBU Alarms	CCM	3JR22028ACAA	---	RUC/ALARM

Customer Supplied Support Equipment
Baseband Unit (BBU)

Module	Serial Number	Part Number
9926 BBU V2	ZJ1242000WD	3JR37526AAAC
bCEM2	YP15300782C	3JR50506AF01
bCEM-U	ZJ132500A89	3BK28961CAAE03
eCCM2	ZJ14370047H	3JR20120ABAJ01
CCM (ALARMS) / eAM(INT)	YP130405334	3JR37517AE01
Chasis SANMINA (SUZHOU)	HDZZA ED 01	3BK28764AAAA

Test Equipment List for Radiated Emissions Testing

RE Test Equipment List 2016-0184

Manufacturer	Model	Serial Number	Type	Description	GPCL ID	Last Cal	Interval	Status
ETS Lindgren	3117	00135194	Horn Antenna	Double-Ridged Waveguide Horn 1-18 GHz	E1074	12/25/2014	24	Active
Hewlett Packard	8449B	3008A01384	Pre-Amplifier	Preamplifier 1-26.5 GHz	E447	12/17/2015	24	Active
Weinschel	2-6	BC0255	Attenuator	6 dB , 2 Watt DC-12.5 GHz	E176	10/28/2015	24	Active
Rohde & Schwarz	ESIB40	100101	Test Receiver	EMI (20Hz to 40 GHz)-150 +30dBM	E907	9/22/2015	24	Active
A.H. Systems Inc.	SAS-521-2	458	Bilogical Antenna	25 - 2000 MHz	E758	4/13/2015	24	Active
Sonoma Instrument Co.	310N	186744	Amplifier	9kHz-1GHz	E812	8/10/2016	24	Active
EMC Test Systems	3116	2539	Horn Antenna	Double Ridged Horn 18-40 GHz	E513	3/19/2015	24	Active
EMC Test Systems	2090	0004-1507	Multi-Device Controller		E489	NA	0	Active

4.8 FACILITIES AND ACCREDITATION

All measurement facilities at Nokia Global Product Compliance Laboratory (GPCL) used to collect the measurement data in the test report are located at 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636 USA.

The field strength measurements of radiated spurious emissions are made in a FCC and IC registered three meter semi-anechoic chamber AR9 (FCC Site Registration Number: 896745, IC Filing Number: 6933F-7) which is maintained by Alcatel-Lucent in Murray Hill, New Jersey. The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

Nokia Global Product Compliance Laboratory is accredited with the US Department of Commerce National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations for offering test services for selected test methods in Electromagnetic Compatibility; Voluntary Control Council for Interference (VCCI), Japan; Australian Communications and Media Authority (ACMA). The laboratory is ISO 9001:2008 Certified.

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2016-09-09 through 2017-09-30
Effective Dates

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA •

For the National Voluntary Laboratory Accreditation Program