NOKIA Bell Labs

Global Product Compliance Laboratory
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TESTING
NVLAP LAB CODE: 100275-0

FCC Certification Part 96 Test Report

Product Evaluated

Flexi Zone Multiband Outdoor (MBO) Micro BTS
CBRS FW2QMBOM1,
FCC ID: 2AD8UFW2QMBOM1

Customer

Nokia Solutions and Networks, OY
2000 W. Lucent Lane
Naperville, IL 60563 USA

Test Laboratory

Nokia Bell Labs
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Date: September 12, 2018

Revisions

Date	Revision	Section	Change
6/1/2018	0		Multicarrier Initial Release
7/9/2018	1		Typo corrections.
7/24/2018	2		Change to an Original Authorization Report.
9/12/2018	3		FCC Requested Change Page 13-14 EIRP PSD

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9/12/2018

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9/12/2018

Technical Manager
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1. ATTESTATION OF TEST RESULTS

Company Name	**Nokia Solutions and Networks, OY** 2000 W. Lucent Lane Naperville, IL 60563 USA
FCC ID	**2AD8UFW2QMBOM1**
Product Name	**Flexi Zone Multiband Micro BTS CBRS Band 48 Module**
Model Name	**FW2QMBOM1**
Part No	474444AX31
Serial Number(s)	s/n's: EB173411601, EB173410348; EB173410409 & EB173410134
Test Standard(s)	• 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v02 June 4, 2013 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • KDB 940660 D01 Part 96 CBRS Equipment v01
Reference(s)	• 47 CFR FCC Part 2 and Part 99 • ANSI C63.26 (2015) • ANSI C63.4 (2014) • KDB 552295 D01 CBP Guidance for 3650 3700 Band v02r02
Frequency Band	CBRS (Tx: 3550-3700 MHz), E-UTRAN Band 48
Technology	LTE-TDD: 10M0F9W, 15M0F9W, 20M0F9W
Test Frequency Range	10MHz – 37GHz
Operation Mode(s)	2x2W MIMO
Submission Type	Initial Filing
FCC Part 15 Subpart B	Compliance with Class B
Test Date	September 1, 2017 - January 31, 2018
Test Laboratory	Nokia Global Product Compliance Laboratory 600-700 Mountain Avenue, Rm 5B-108 Murray Hill, New Jersey 07974-0636 USA **NVLAP** Lab Code: 100275-0 **FCC Registration Number: 395774**

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.

W. Steve Majkowski NCE
Member of Technical Staff
Nokia, Global Product Compliance Laboratory

2. SUMMARY OF THE TEST RESULTS

47 CFR FCC Sections	Description of Tests	Compliance Results
2.1046, 96.41 (b)	RF Power Output	Pass
2.1047, 96.41	Modulation Characteristics	Pass
2.1049, 96.41	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Pass
2.1051, 96.41	Spurious Emissions at Antenna Terminals	Pass
2.1053, 96.41	Field Strength of Spurious Radiation	Pass
2.1055, 96.41	Measurement of Frequency Stability	Pass
96.53, WINNF-TS-0122	Citizens Broadband Radio Service Device (CBSD) - Spectrum Access System (SAS) functionality per CBRS CBSD Test Specification WINNF-TS-0122 Tested in accordance with KDB 552295 D01 CBP Guidance for 3650 3700 Band.	Pass

2.1 Measurement Uncertainty

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Tables 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-5 Semi-Anechoic Chamber)	30 MHz – 200MHz H 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz- 18 GHz	±5.1 dB ±5.1 dB ±4.7 dB ±4.7 dB ±3.3 dB

Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	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	Compact Base Station LTE Module (2Tx, 2Rx), 2x2 MIMO
Radio Type	Intentional Transceiver
CBSD Category	Category B CBSD Device
Power Type	115 VAC
Modulation	LTE-TDD with QPSK, 16QAM, 64QAM and 256QAM
Operating Frequency Range	CBRS (Tx/Rx: 3550-3700 MHz),
Channel Bandwidth	10, 15, & 20 MHz, Multi carrier enabled
Max Conducted Power (Rated)	33.01 dBm (2 W) per port, 36.02 dBm (4W) Total for 2 ports
Operating Mode	2x2 MIMO (2 duplex Tx/Rx Ports)
Software Version	FLF17SP
Hardware Version	FW2QMBOM1
Antenna(s)	Refer to Section 3.2

The EUT supports the following carrier configurations:

Table 3.1.2 EUT Supported Configurations

Carrier Bandwidth (MHz)	Carriers per Path	MIMO Modes	Signal Type	Modulation
10	1 & 2	2x	LTE-TDD	QPSK, 16QAM, 64QAM & 256QAM
15	1 & 2	2x	LTE-TDD	QPSK, 16QAM, 64QAM & 256QAM
20	1 & 2	2x	LTE-TDD	QPSK, 16QAM, 64QAM & 256QAM

The operating band consists of the following channels and spectrum:

Table 3.1.3 EUTRAN 43, CBRS Band

CBRS Band 48 Center Frequency	TDD Frequency Range (MHz)	Width of Channel (MHz)
3555	3550 – 3560	10
3565	3560 – 3570	10
3575	3580 – 3590	10
3585	3590 – 3600	10
3595	3600 – 3610	10
3605	3600 – 3610	10
3615	3610 – 3620	10
3625	3620 – 3630	10
3635	3630 – 3640	10
3645	3640 – 3650	10
3655	3650 - 3660	10
3665	3660 - 3670	10
3675	3670 – 3680	10
3685	3680 – 3690	10
3695	3690 - 3700	10

3.2 EIRP/ PSD Compliance and Antenna Information.

The product does not incorporate integrated antennas. Externally mounted antennas can be attached to the unit or mounted remotely. The unit is supplied with unit mounted Omni antennas for use on the B48 transmit ports. This antenna has a nominal gain of 6 dBi.

4. REQUIRED MEASUREMENTS AND RESULTS

The EUT previously demonstrated compliance to the Part 90Z limits for the 3650-3700 MHz spectrum. This FCC Original Filing Report shall demonstrate compliance to the Part 96 limits and operation over the 3550-3700 MHz frequency range.

Per 47CFR FCC Section 2.1033(c)(14), the following certification tests are required by Section 2.1046 through Section 2.1057. These tests are identified in Table 4.0a below.

Table 4.0a Required Certification Measurements

47 CFR FCC Sections	Description of Tests	Test Required for Original Authorization
2.1046, 96.41(b), 96.41(g)	**RF Power Output** **(b) Power Limits, EIRP, PSD** **(g) Peak-to-Average Power Ratio**	**Yes**
2.1047, 96.41(a)	**Modulation Characteristics**	**Yes**
2.1049, 96.41(e)(2)(3)	**(a) Occupied Bandwidth** **(b) Out-of-Band Emissions**	**Yes**
2.1051, 96.41(e)	**Spurious Emissions at Antenna Terminals**	**Yes**
2.1053, 96.41(e)(2)(3)	**Field Strength of Spurious Radiation**	**Yes**
2.1055, 96.41(e)(2)(3)	**Measurement of Frequency Stability**	**Yes**
96.53, WINNF-TS-0122	**CBSD SAS functionality per CBRS CBSD Test Specification WINNF-TS-0122** **Tested in accordance with KDB 552295 D01 CBP Guidance for 3650 3700 Band.**	**Yes**

Note (1). Frequency Stability compliance was previously reported in the initial authorization. There were no changes to the frequency generating/ stabilizing portions of this product.

The measurements were conducted in accordance with the procedures set out in Section 2.1041. The CBSD-SAS Protocol test was performed in accordance with a PAG Request as detailed in the Operational Description Exhibit 5. The comprehensive list of tests performed included measurements at Left, Center and Right side of the Part 96 Band for each LTE Test Modulation and Signal Bandwidths. The list of tests performed are listed in Table 4.0b below. A subset of these tests are presented to demonstrate compliance with FCC requirements.

Table 4.0b Table of Performed Tests

					MXA						ESIB	
Test #	CBRS Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = QPSK + 16QAM	RF Power/ EIRP/ PSD	MOD	PAR	Sig. BW	OBW	CSE 10M-26G	OBW Peak	CSE 10M-37G
1	3555	Left	10	Q16	X	X	X	X	X	X	X	X
2	3555	Left	10	64QAM	X	X	X	X	X	X	X	X
3	3555	Left	10	256QAM	X	X	X	X	X	X	X	X
4	3557.5	Left	15	Q16	X	X	X	X	X	X	X	X
5	3557.5	Left	15	64QAM	X	X	X	X	X	X	X	X
6	3557.5	Left	15	256QAM	X	X	X	X	X	X	X	X
7	3560	Left	20	Q16	X	X	X	X	X	X	X	X
8	3560	Left	20	64QAM	X	X	X	X	X	X	X	X
9	3560	Left	20	256QAM	X	X	X	X	X	X	X	X
10	3615	Center	10	Q16	X	X	X	X	X	X	X	X
11	3615	Center	10	64QAM	X	X	X	X	X	X	X	X
12	3615	Center	10	256QAM	X	X	X	X	X	X	X	X
13	3617.5	Center	15	Q16	X	X	X	X	X	X	X	X
14	3617.5	Center	15	64QAM	X	X	X	X	X	X	X	X
15	3617.5	Center	15	256QAM	X	X	X	X	X	X	X	X
16	3620	Center	20	Q16	X	X	X	X	X	X	X	X
17	3620	Center	20	64QAM	X	X	X	X	X	X	X	X
18	3620	Center	20	256QAM	X	X	X	X	X	X	X	X
19	3695	Right	10	Q16	X	X	X	X	X	X	X	X
20	3695	Right	10	64QAM	X	X	X	X	X	X	X	X
21	3695	Right	10	256QAM	X	X	X	X	X	X	X	X
22	3692.5	Right	15	Q16	X	X	X	X	X	X	X	X
23	3692.5	Right	15	64QAM	X	X	X	X	X	X	X	X
24	3692.5	Right	15	256QAM	X	X	X	X	X	X	X	X
25	3690	Right	20	Q16	X	X	X	X	X	X	X	X
26	3690	Right	20	64QAM	X	X	X	X	X	X	X	X
27	3690	Right	20	256QAM	X	X	X	X	X	X	X	X
Multicarrier Tests: 10+10 MHz, 15+15 MHz and 20+20 MH												
28	3560	Left	10+10	256QAM	X	X	X	X	X	X	X	X
29	3620	Center	10+10	256QAM	X	X	X	X	X	X	X	X
30	3690	Right	10+10	256QAM	X	X	X	X	X	X	X	X
31	3565	Left	15+15	256QAM	X	X	X	X	X	X	X	X
32	3625	Center	15+15	256QAM	X	X	X	X	X	X	X	X
33	3685	Right	15+15	256QAM	X	X	X	X	X	X	X	X
34	3685	Right	15+15	Q16	X	X	X	X	X	X	X	X
35	3685	Right	15+15	64QAM	X	X	X	X	X	X	X	X
36	3570	Left	20+20	256QAM	X	X	X	X	X	X	X	X
37	3630	Center	20+20	256QAM	X	X	X	X	X	X	X	X
38	3680	Right	20+20	256QAM	X	X	X	X	X	X	X	X

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. The product was configured for test as shown in Figure 4.1.1 below and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

For LTE TDD transmit carrier operation, the **Flexi Zone Micro BTS CBRS FW2QMBOM1, FCC ID: 2AD8UFW2QMBOM1,** is specified to provide a maximum power output of 2W/33.01 dBm per transmit port for a sum total of 4 Watts /36.02 dBm per transmit module.

The power is under digital control. The product is designed to operate under Part 96 rules for Band 48. (The product was previously authorized under Part 90Z for Band 48.)

Under Part 96 the product is limited to the Category B CBSD maximum EIRP of 47 dBm/10 MHz with a PSD of 37 dBm/MHz.

The unit is supplied with externally mounted Omni antennas for use on the B48 transmit ports. This antenna has a nominal gain of 6 dBi.

In the event the customer wants to use a different antenna, the maximum gain + cable loss cannot exceed 10.98 dBi when operating at full power in order to stay within the EIRP limits for the band.

If the product is installed with other antenna(s), then per FCC Rules the RF exposure compliance shall be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co- location requirements of Part 1.1307(b)(3).

4.1.1 RF Power Output Measurement

Power measurements of the TDD transmit signal were conducted with an MXA Signal analyzer per KDB 971168 D01 and a gated broadband RF Power Meter. The applied signal from an **Flexi Zone Micro BTS CBRS FW2QMBOM1 / 2AD8UFW2QMBOM1**, met the recommended characteristics as defined in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** The maximum rated mean power at the antenna transmitting terminal was measured at the Left, Center and Right side of the 3550-3700 CBRS frequency range for in three different Modulations modes. These were 3GPP standard base station test models for QPSK+16QAM, 64QAM and 256QAM modulation. This power level was documented on each data sheet for Occupied bandwidth.

4.1.1.1 RF Power Output Results

Power output measurements were performed for every modulation and bandwidth combination identified in Table 4.0b , Table of Performed Tests Measurements.

A table of measured RF power outputs of the EUT documenting Power measurements for each modulation, bandwidth and at left, center and right side of the band is given in Table 4.1.1.1 The RF power output was measured for the 2x2W MIMO configuration. The measured performance was in full compliance with the Rules of the Commission. The level is detailed on each of the Peak to Average Ratio (PAR) plots and in comments in Sections 4.3 and 4.4.

Figure 4.1.1 Test Set-Up for Measurement of Radio Frequency Power Output

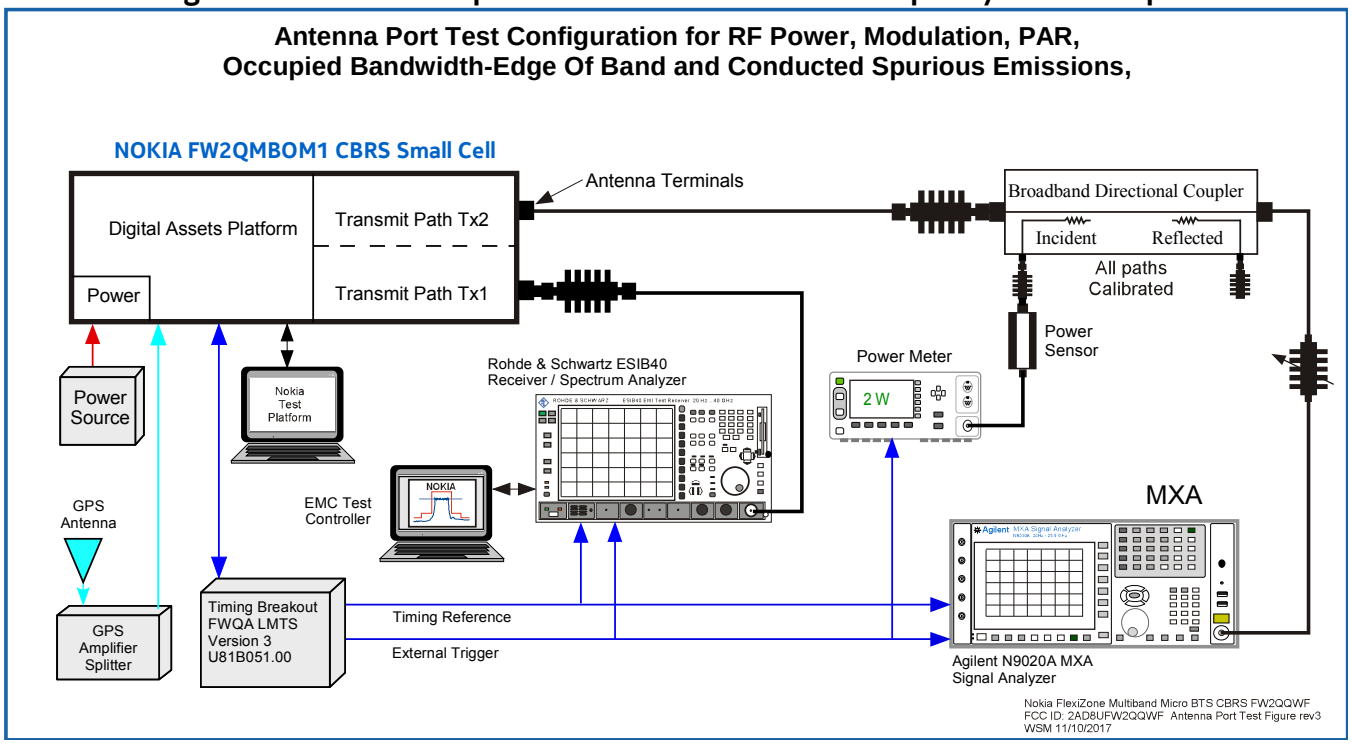


Table 4.1.1.1 Measured Maximum Average RF Output Power and Peak to Average Ratio of the EUT

Test #	CBRS Channel Center Frequency MHz	Tx Port	MIMO Mode	Signal Bandwidth, MHz	Modulation Q16=qpsk+16qam 64=64QAM 256=256QAM	Total per Port Transmit Power, Watts	Total per Port Transmit Power, dBm	RF Power Pass / Fail
1	3555	Tx1	2x2W	10	QPSK + 16 QAM	2	33.06	Pass
2	3555	Tx2	2x2W	10	64QAM	2	32.90	Pass
3	3555	Tx1	2x2W	10	256QAM	2	33.27	Pass
4	3615	Tx1	2x2W	10	256QAM	2	32.76	Pass
5	3695	Tx1	2x2W	10	QPSK + 16 QAM	2	32.85	Pass
6	3657.5	Tx1	2x2W	15	256QAM	2	33.16	Pass
7	3617.5	Tx1	2x2W	15	256QAM	2	32.74	Pass
8	3692.5	Tx1	2x2W	15	QPSK + 16 QAM	2	32.82	Pass
9	3560	Tx2	2x2W	20	64QAM	2	33.29	Pass
10	3620	Tx1	2x2W	20	64QAM	2	32.69	Pass
11	3690	Tx1	2x2W	20	256QAM	2	33.12	Pass
12	3560	Tx1	2x2W	10+10	256QAM	2	32.95	Pass
13	3685	Tx2	2x2W	15+15	QPSK + 16 QAM	2	32.5	Pass
14	3680	Tx1	2x2W	20+20	256QAM	2	32.5	Pass

4.1.2 EIRP Compliance

The product does not incorporate integrated antennas. Externally mounted antennas can be attached to the unit or mounted remotely. The unit is supplied with unit mounted Omni antennas for use on the B48 transmit ports. This antenna has a nominal gain of 6 dBi. Compliance with the supplied antennas is documented in Table 4.1.2 for EIRP.

Under Part 96.41 the product is limited to a maximum Effective Isotropically Radiated Power (EIRP) of 47 dBm/10 MHz. Compliance with the EIRP requirements of Part 96.41 is tabulated in Table 4.1.2 below.

When set to the maximum total output power of 36.02 dBm the maximum allowable antenna gain is 10.98 dBi.

In the event the customer wants to use a different antenna, the maximum gain + cable loss cannot exceed 10.98 dBi when operating at full power in order to stay within the EIRP limits for the band.

If the product is installed with other antenna(s), then per FCC Rules the RF exposure compliance shall be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co- location requirements of Part 1.1307(b)(3).

Table 4.1.2 Effective Isotropically Radiated Power (EIRP) Compliance

Transmit Signal Bandwidth	Total 2x MIMO Transmit Power	Antenna Gain	EIRP Bandwidth Correction	EIRP	Part 96.41 EIRP Limit	Margin to Part 96 EIRP Limit.	EIRP Compliance
MHz	dBm	dBi	dB	dBm/10 MHz	dBm/ 10 MHz	dB	Pass/Fail
10	36.02	6	0.00	42.02	47.00	4.98	Pass
15	36.02	6	-1.76	40.26	47.00	6.74	Pass
20	36.02	6	-3.01	39.01	47.00	7.98	Pass
Maximum Antenna Gain Configuration							
MHz	dBm	dBi	dB	Total dBm/BW	dBm/ 10 MHz	Total EIRP W	Pass/Fail
10	36.02	10.98	0	47.0	47.00	50.12	Pass
15	36.02	10.98	0	47.0	47.00	50.12	Pass
20	36.02	10.98	0	47.0	47.00	50.12	Pass

4.1.3 Power Spectral Density

The Power Spectral Density (PSD) of the EUT was measured per KDB 971168 D01 using the setup in Figure 4.1.1 above and the Channel Power Measurement feature of the MXA Analyzer. The signal bandwidths, modulations and transmit channels identified in Table 4.1.3 were evaluated.

The FCC Part 96 requirement for PSD is that the Power Spectral Density (PSD) of the EUT shall not exceed 37 dBm/MHz.

4.1.3.1 Power Spectral Density Results:

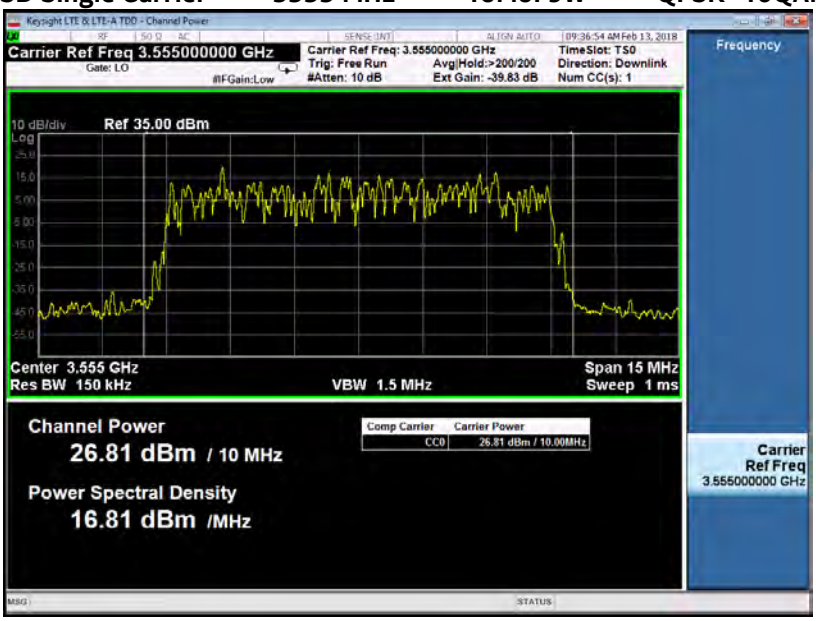
The maximum conducted Power Spectral Density (PSD) of the EUT measured at its antenna transmitting terminals was18.02 dBM/MHz. when added to the maximum antenna gain results in a radiated PSD of 29.0 which is 8 dB below the 37 dBm/MHz limit. This is in full compliance with the requirement. The measured values are in Table 4.1.3 below

Table 4.1.3 Power Spectral Density Results

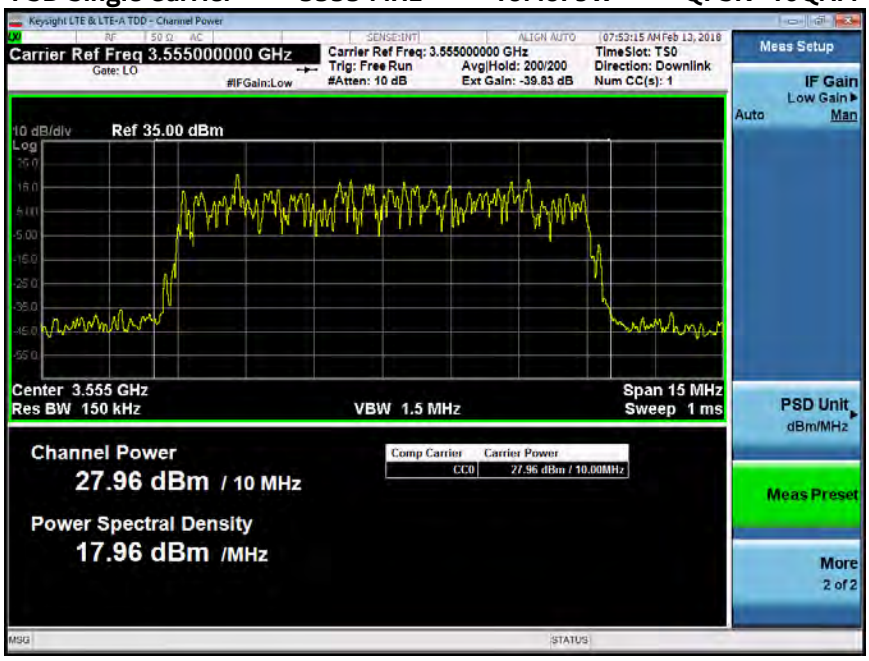
Test #	CBRS Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = qpsk + 16qam	Measured Conducted PSD dBm/MHz	Maximum Antenna Gain, dBi	Maximum Radiated PSD, dBm/MHz	Part 96 PSD Limit dBm/MHz	Compliant Y/N
1	3555	Left	10	Q16	17.44	10.98	28.42	37	Yes
2	3555	Left	10	64QAM	16.81	10.98	27.79	37	Yes
3	3555	Left	10	256QAM	17.96	10.98	28.94	37	Yes
4	3657.5	Left	15	64QAM	15.68	10.98	26.66	37	Yes
5	3660	Left	20	Q16	14.59	10.98	25.57	37	Yes
6	3615	Center	10	Q16	16.06	10.98	27.04	37	Yes
7	3615	Center	10	64QAM	16.46	10.98	27.44	37	Yes
8	3615	Center	10	256QAM	16.29	10.98	27.27	37	Yes
9	3617.5	Center	15	64QAM	14.65	10.98	25.63	37	Yes
10	3620	Center	20	Q16	13.63	10.98	24.61	37	Yes
11	3695	Right	10	Q16	16.44	10.98	27.42	37	Yes
12	3695	Right	10	64QAM	17.1	10.98	28.08	37	Yes
13	3695	Right	10	256QAM	16.76	10.98	27.74	37	Yes
14	3692.5	Right	15	64QAM	14.84	10.98	25.82	37	Yes
15	3690	Right	20	Q16	13.67	10.98	24.65	37	Yes
16	3560	LL	20+20	256QAM	16.40	10.98	27.38	37	Yes
17	3580	LR	20+20	256QAM	16.26	10.98	27.24	37	Yes
18	3572.5	LR	15+15	256QAM	18.02	10.98	29.00	37	yes

Figure 4.1.3 Power Spectral Density (PSD) Sample Data Compliance

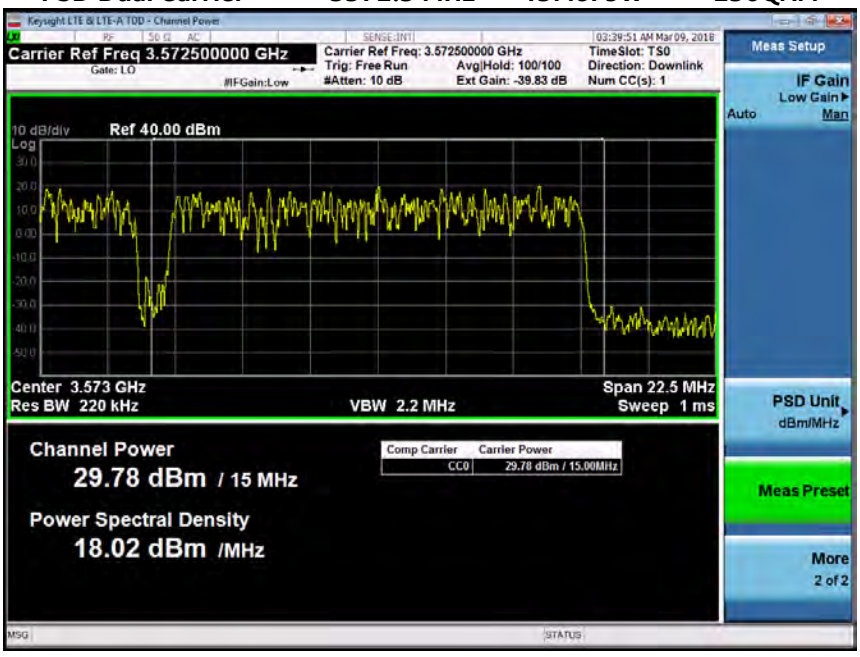
PSD Single Carrier 3555 MHz 10M0F9W QPSK+16QAM



PSD Single Carrier 3555 MHz 10M0F9W QPSK+16QAM



PSD Dual Carrier 3572.5 MHz 15M0F9W 256QAM



4.1.4 Peak-to-Average Power Ratio Measurement

The Peak-to-Average Power Ratio (PAPR) of the EUT was measured per KDB 971168 D01 using the setup in Figure 4.1.1 above and the Power Complementary Cumulative Distribution Function (CCDF) feature of the MXA Analyzer. All modulations and all transmit ports were evaluated. The PAPR measurements were made for every carrier in the test table for nominal 2W carriers as tabulated in Table 4.1.4.

The FCC requirement for PAPR is that the transmitter's peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission. The maximum PAPR value for each measured configuration is given in Table 4.1.4. Sample measurements are shown in the plots in Figure 4.1.4 below.

4.1.4.1 Peak-to-Average Power Ratio Results:

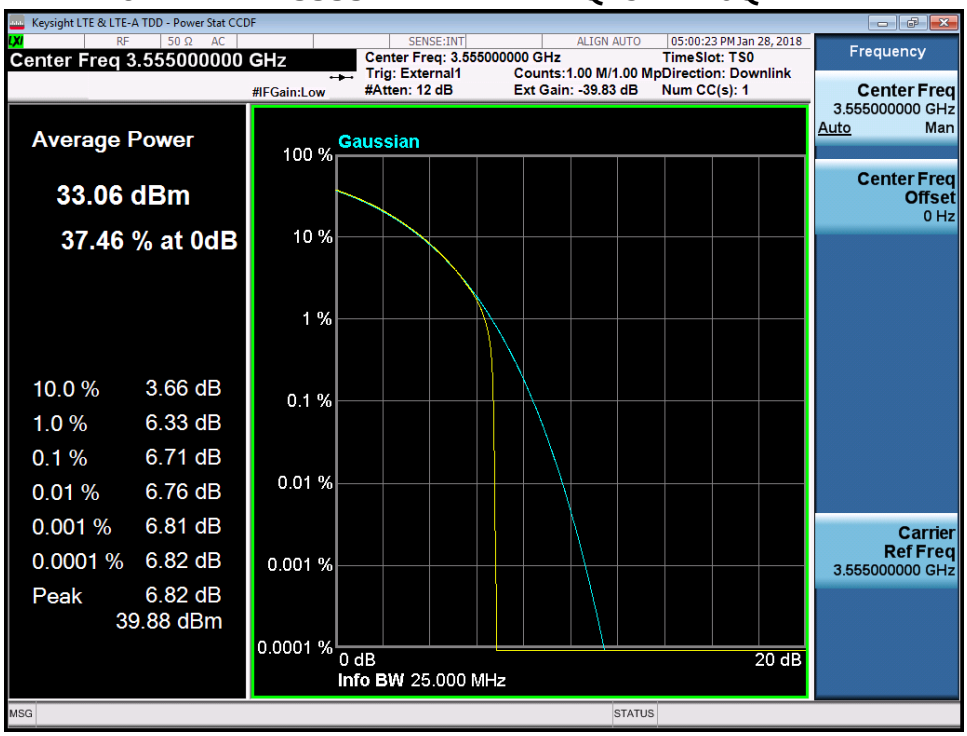
The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals were measured to be 8.20 dB maximum, which is in full compliance with the requirement to not exceed 13 dB as specified by the FCC. The representative data sets exact values are listed in Table 4.1.4 below.

Table 4.1.4 The Maximum PAPR Value at 0.1% probability of the EUT

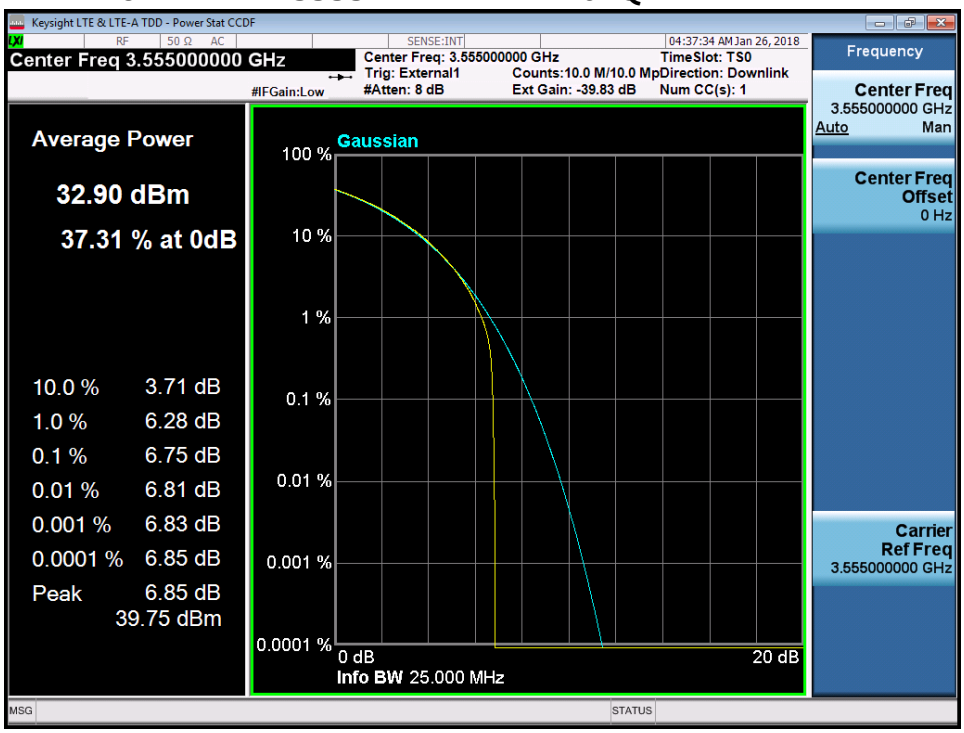
Test #	CBRS Channel Center Frequency MHz	Band Location	Tx Port	Signal Bandwidth, MHz	Modulation Q16=qpsk+16qam 64=64QAM 256=256QAM	Peak To Average Ratio at 0.1% dB	Peak To Average Ratio Limit dB	PAR Pass / Fail
1	3555	Left	Tx1	10	QPSK + 16 QAM	6.71	13	Pass
2	3555	Left	Tx2	10	64QAM	6.75	13	Pass
3	3555	Left	Tx1	10	256QAM	8.20	13	Pass
4	3615	Center	Tx1	10	256QAM	6.70	13	Pass
5	3695	Right	Tx1	10	QPSK + 16 QAM	6.68	13	Pass
6	3657.5	Left	Tx1	15	256QAM	7.99	13	Pass
7	3617.5	Center	Tx1	15	256QAM	6.76	13	Pass
8	3692.5	Right	Tx1	15	QPSK + 16 QAM	6.68	13	Pass
9	3560	Left	Tx2	20	64QAM	6.78	13	Pass
10	3620	Center	Tx1	20	64QAM	6.75	13	Pass
11	3690	Right	Tx1	20	256QAM	6.78	13	Pass
12	3555/3565	Left	Tx1	10+10	256QAM	8.49/8.04	13/13	Pass
13	3717.5/3672.5	Center	Tx1	15+15	256QAM	9.28/10.73	13/13	Pass
14	3670/3690	Right	Tx1	20+20	256QAM	9.29/9.14	13/13	Pass

Figure 4.1.4 Peak to Average Power Ratio Measurements Plots

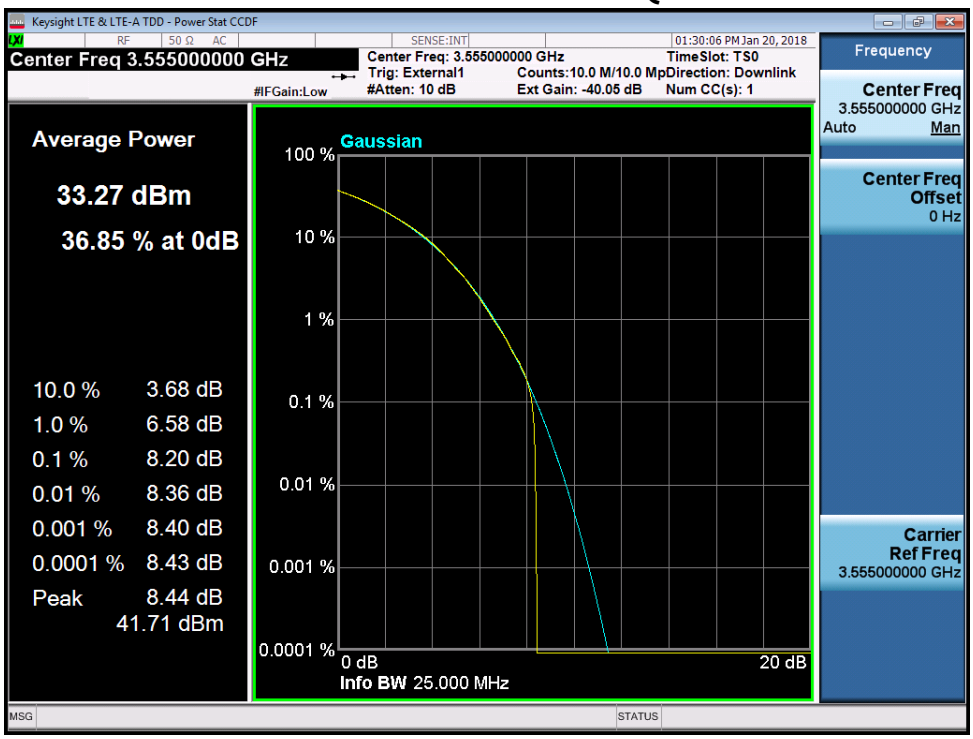
PAR 10 MHz 3555MHz Tx1 QPSK + 16QAM



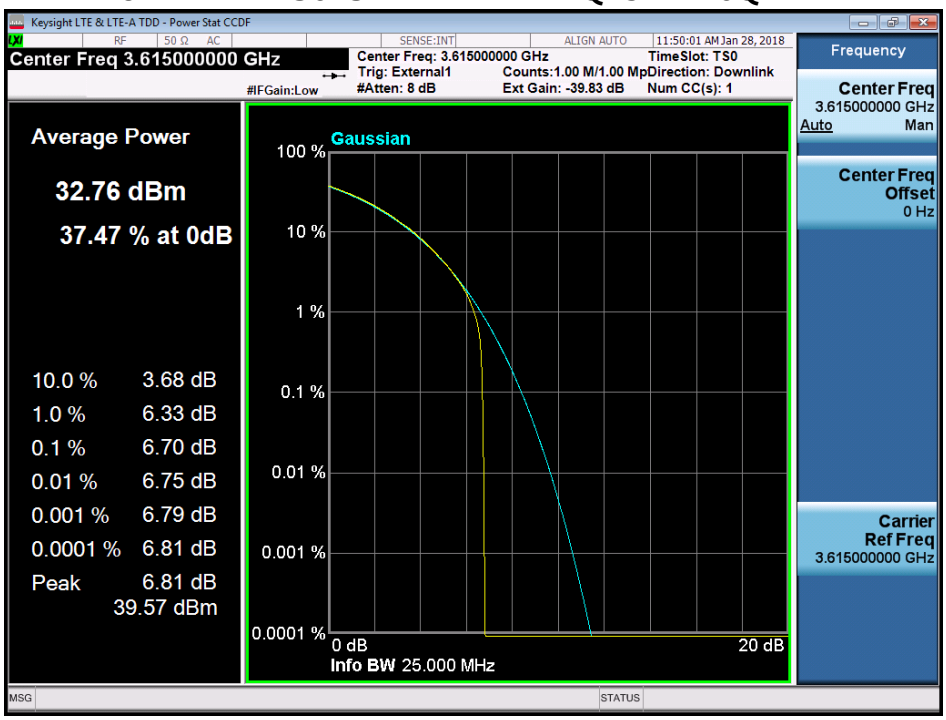
PAR 10 MHz 3555MHz Tx2 64QAM



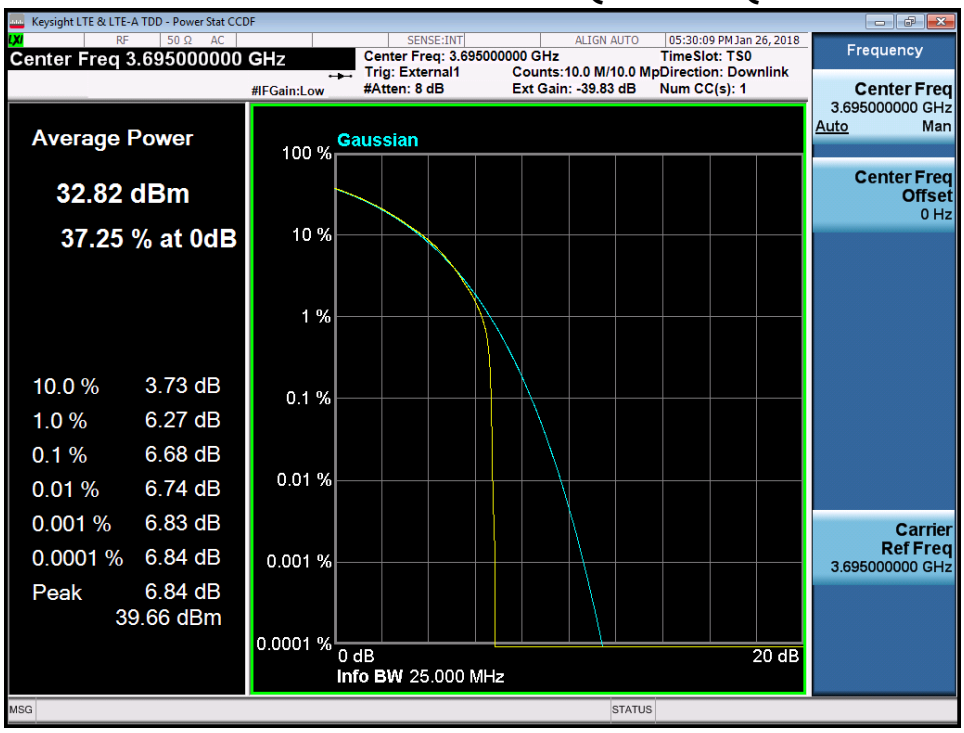
PAR 10 MHz 3555MHz Tx1 256QAM



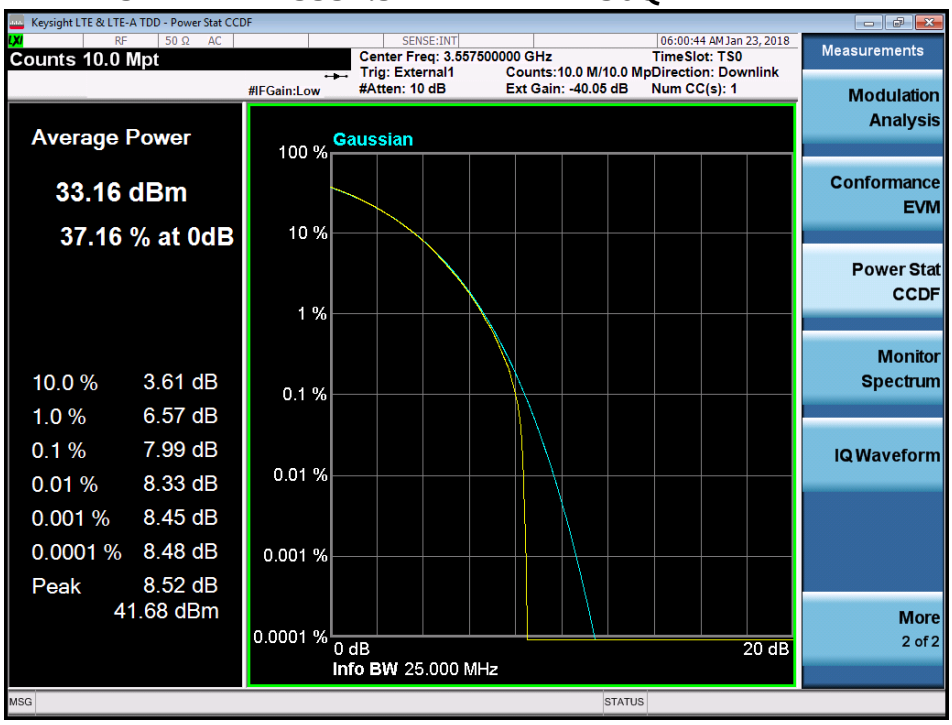
PAR 10 MHz 3615 MHz Tx1 QPSK + 16QAM



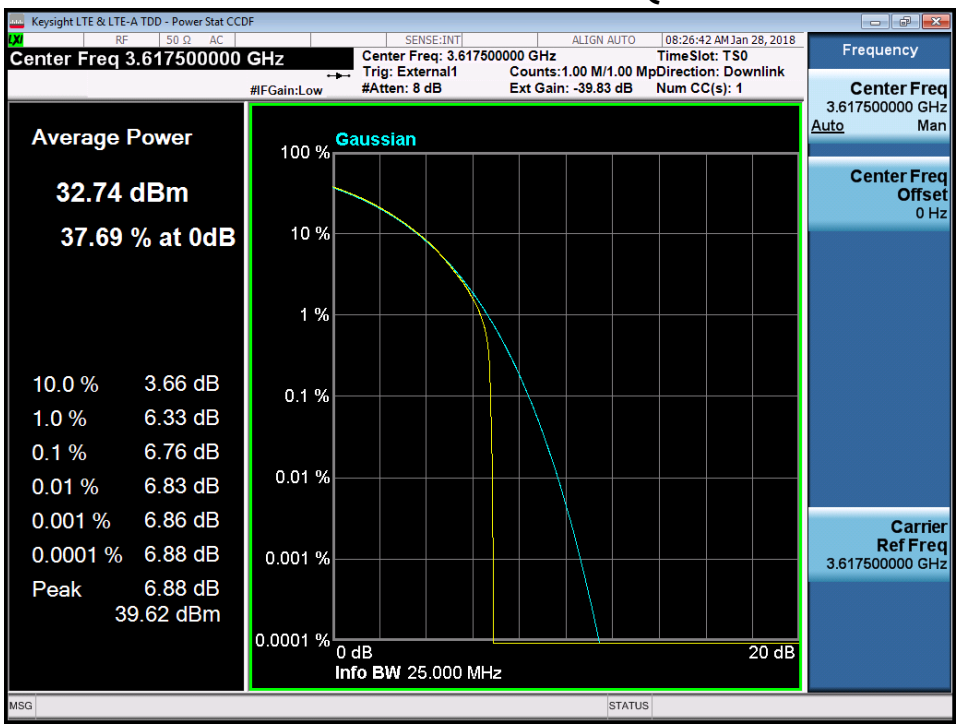
PAR 10 MHz 3695 MHz Tx1 QPSK + 16QAM



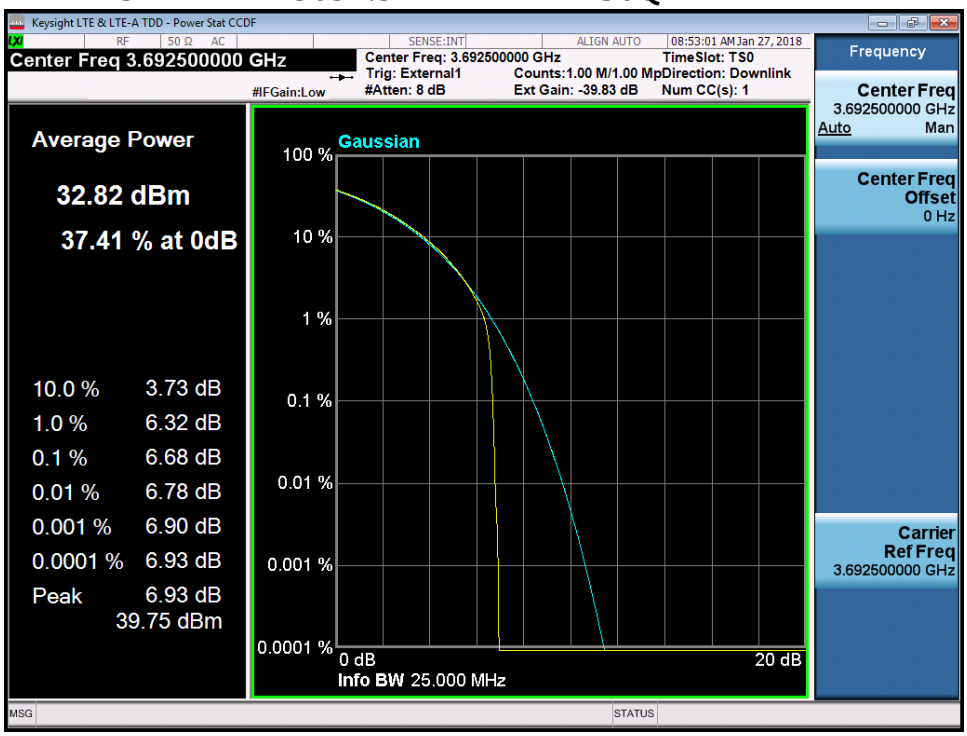
PAR 15 MHz 3557.5 MHz Tx1 256QAM



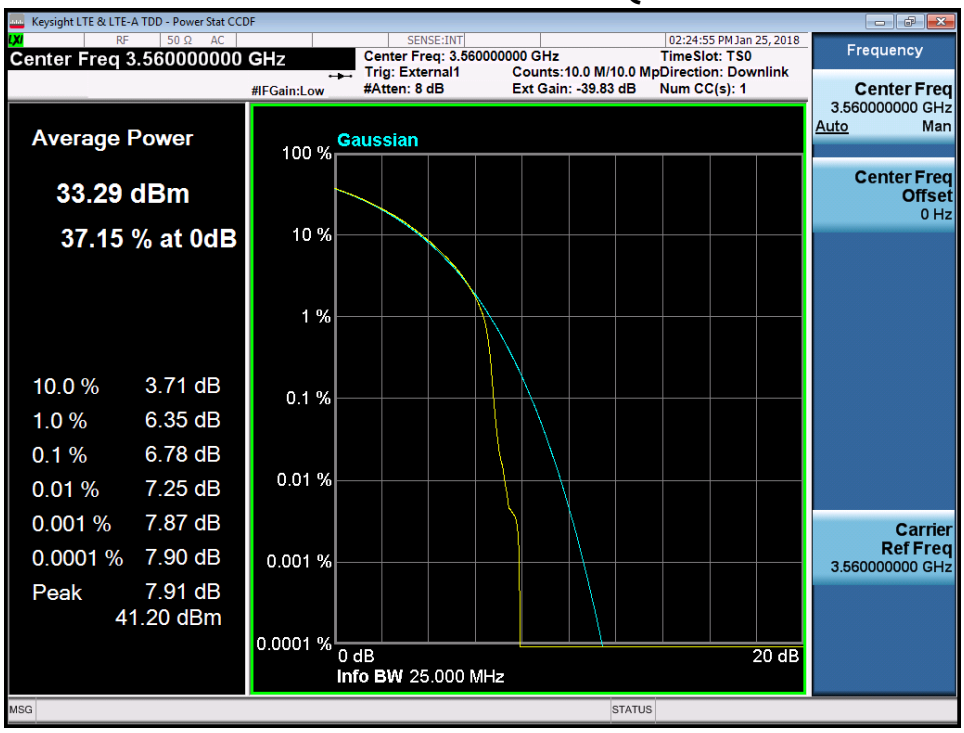
PAR 15 MHz 3617.5 MHz Tx1 256QAM



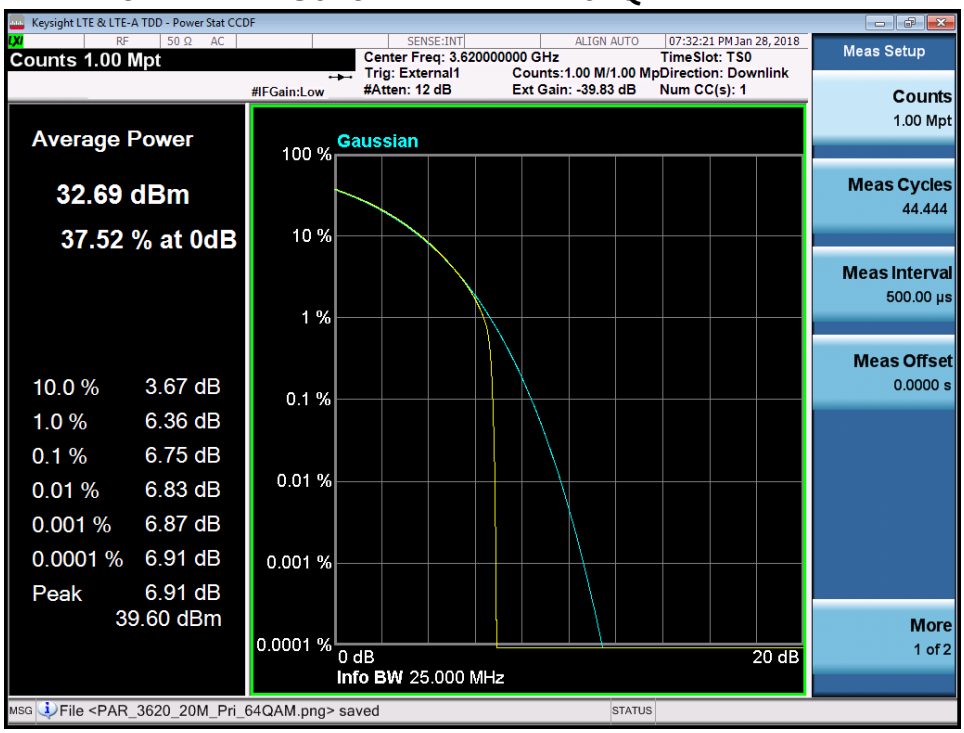
PAR 15 MHz 3692.5 MHz Tx1 256QAM



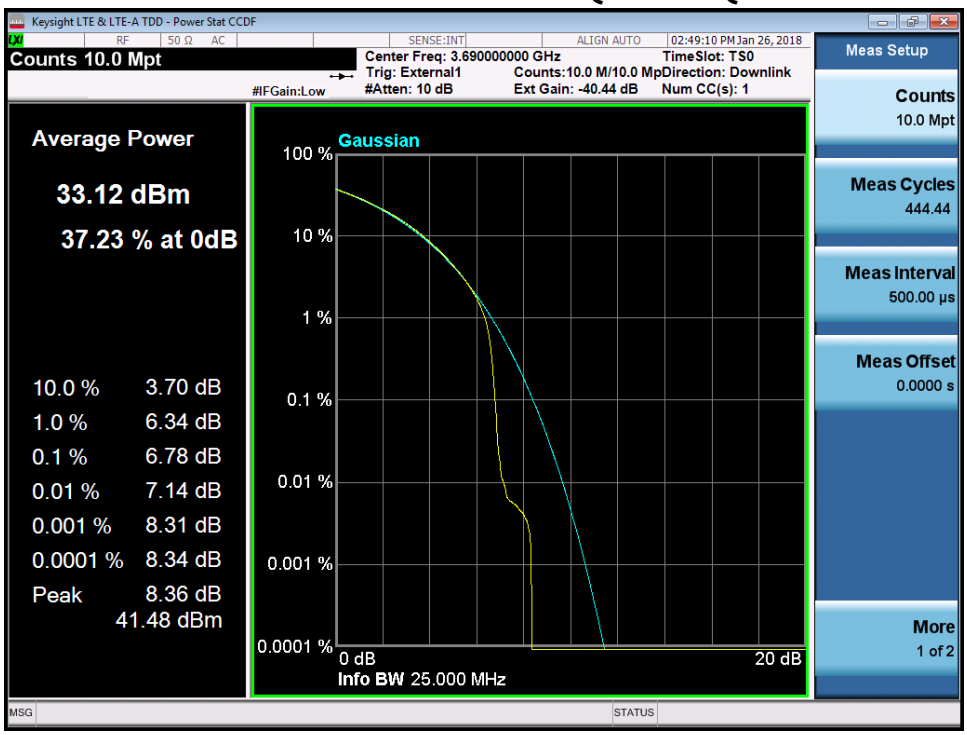
PAR 20 MHz 3560 MHz Tx1 64QAM



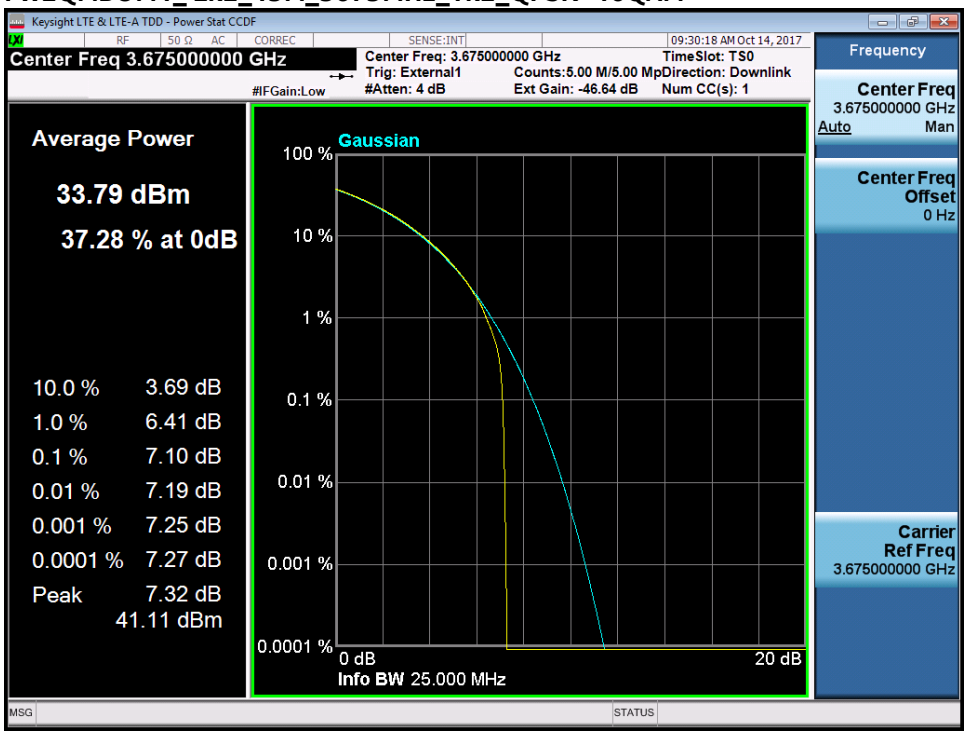
PAR 20 MHz 3620 MHz Tx1 64QAM



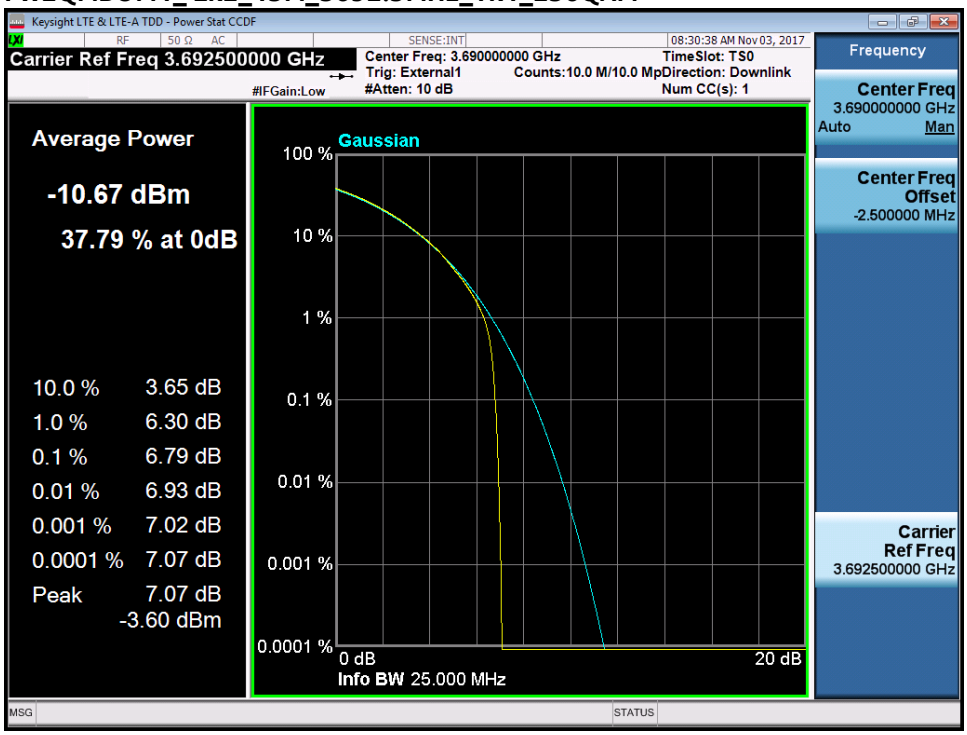
PAR 20 MHz 3590 MHz Tx1 QPSK-16QAM



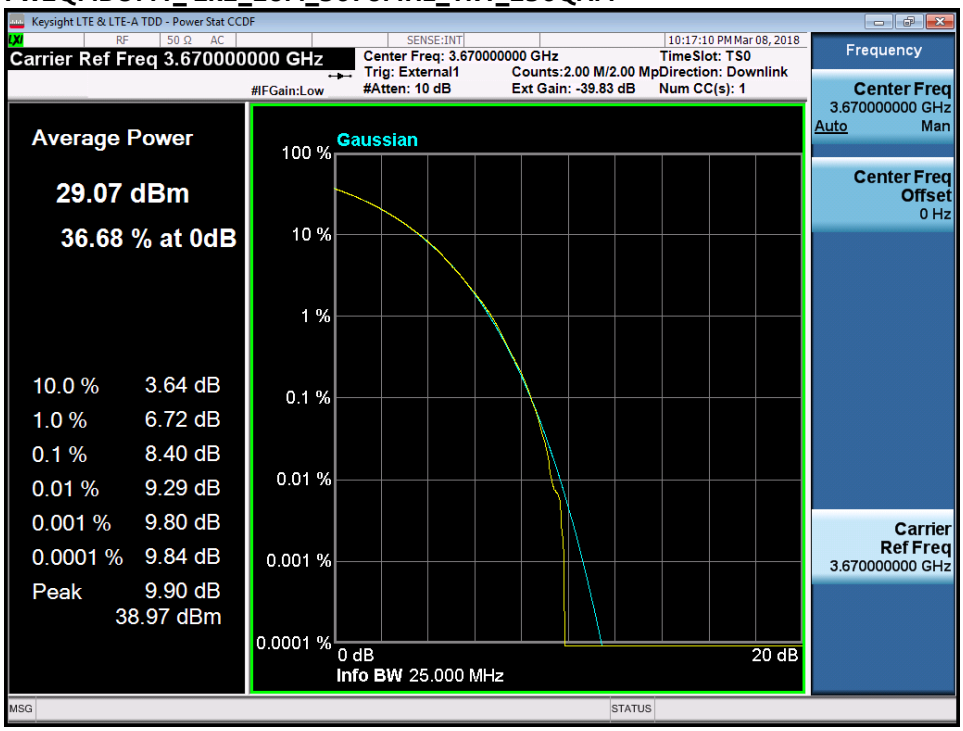
FW2QMBOM1_ 2x2_15M_3675MHz_Tx2_QPSK+16QAM



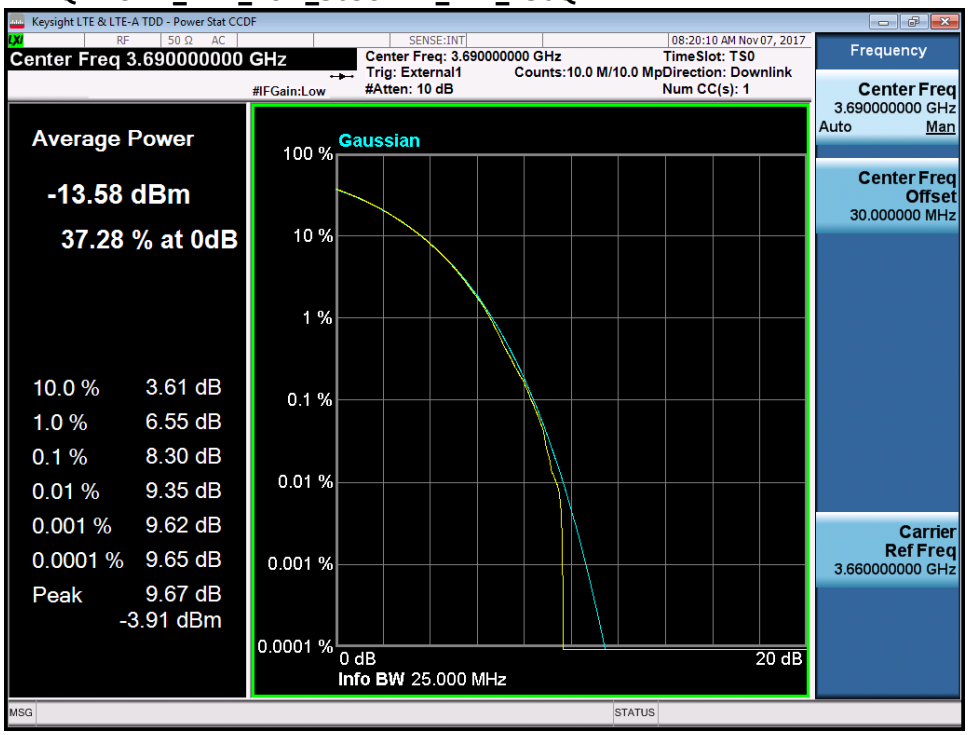
FW2QMBOM1_ 2x2_15M_3692.5MHz_Tx1_256QAM



FW2QMBOM1_ 2x2_20M_3670MHz_Tx1_256QAM



FW2QMBOM1_ 2x2_20M_3690MHz_Tx2_256QAM



4.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERISTICS

The **FW2QMBOM1** supports LTE TDD technologies. LTE utilizes Orthogonal Frequency Division Multiplexing (OFDM) which splits the carrier frequency bandwidth into many small subcarriers. Each individual subcarrier can be modulated with a combined QPSK + 16QAM, 64QAM or with a 256QAM 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. In 64QAM, there are 64 possible symbol states and each 64-QAM symbol carries 6 bits of information. While in 256QAM, there are 256 possible symbol states and each 256-QAM symbol carries 8 bits of information. The higher-order modulations, where the constellations become more dense, are 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 all of the channels as documented in table 4.2 below.

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 Figure 4.2.1, where the signal analyzer used the external signals from the base station as its trigger source and time reference. Figure 4.2.2 below shows representative screen plots of the modulation measurement for an LTE carrier in the various modulations.

4.2.2 Modulation Measurements Results:

The measured modulation characteristics of the EUT are tabulated in Table 4.2 and are in full compliance with the FCC. Sample plots are in Figure 4.2.2 below.

Table 4.2 Modulation Results

Test #	CBRS Channel Center Frequency MHz	Band Location	Tx Port	Signal Bandwidth, MHz	Modulation Q16=qpsk+16qam 64=64QAM 256=256QAM	Modulation Pass / Fail
1	3555	Left	Tx1	10	QPSK + 16 QAM	Pass
2	3555	Left	Tx2	10	64QAM	Pass
3	3555	Left	Tx1	10	256QAM	Pass
4	3615	Center	Tx1	10	256QAM	Pass
5	3695	Right	Tx1	10	QPSK + 16 QAM	Pass
6	3657.5	Left	Tx1	15	256QAM	Pass
7	3617.5	Center	Tx1	15	256QAM	Pass
8	3692.5	Right	Tx1	15	QPSK + 16 QAM	Pass
9	3560	Left	Tx2	20	64QAM	Pass
10	3620	Center	Tx1	20	64QAM	Pass
11	3690	Right	Tx1	20	256QAM	Pass

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

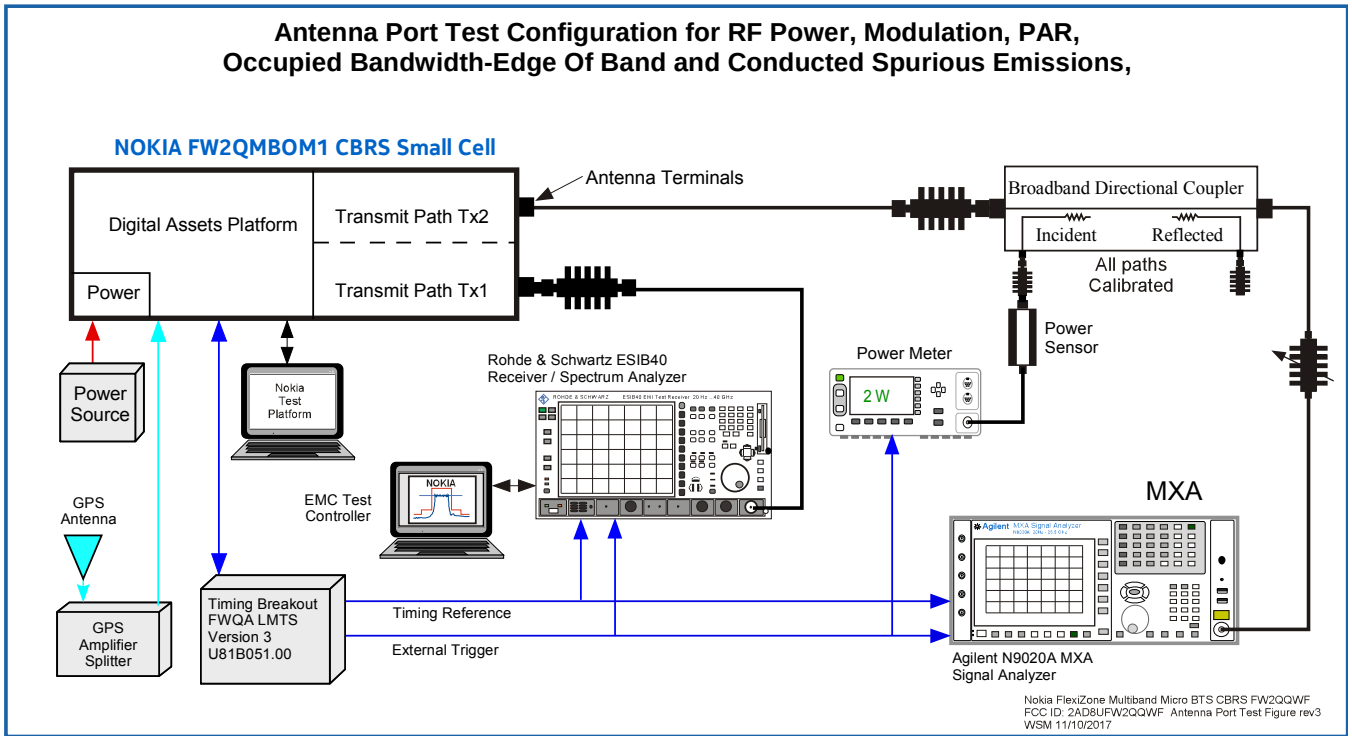
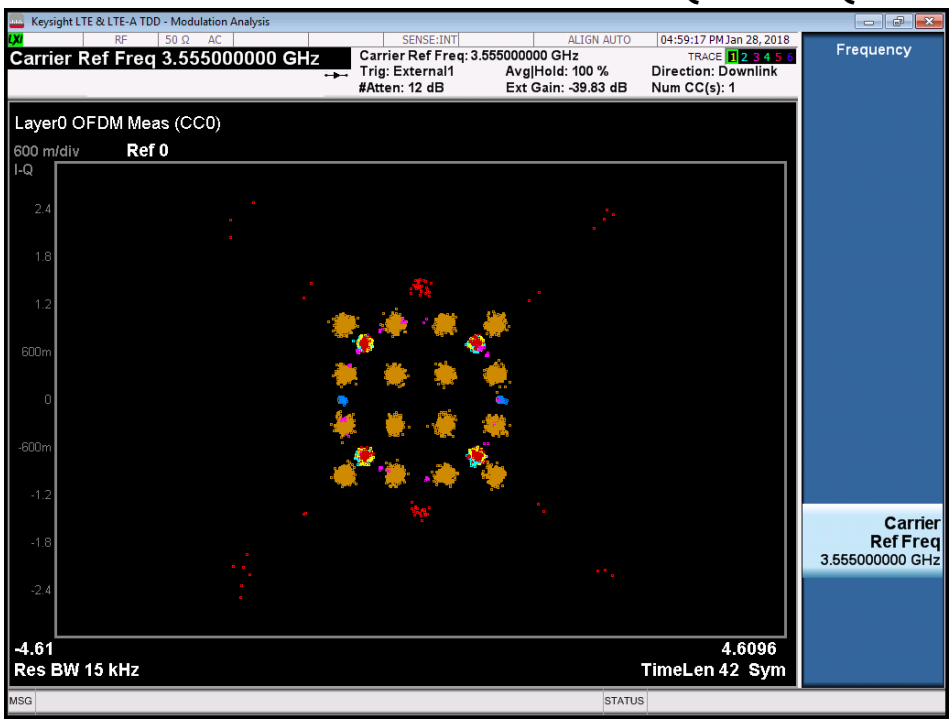
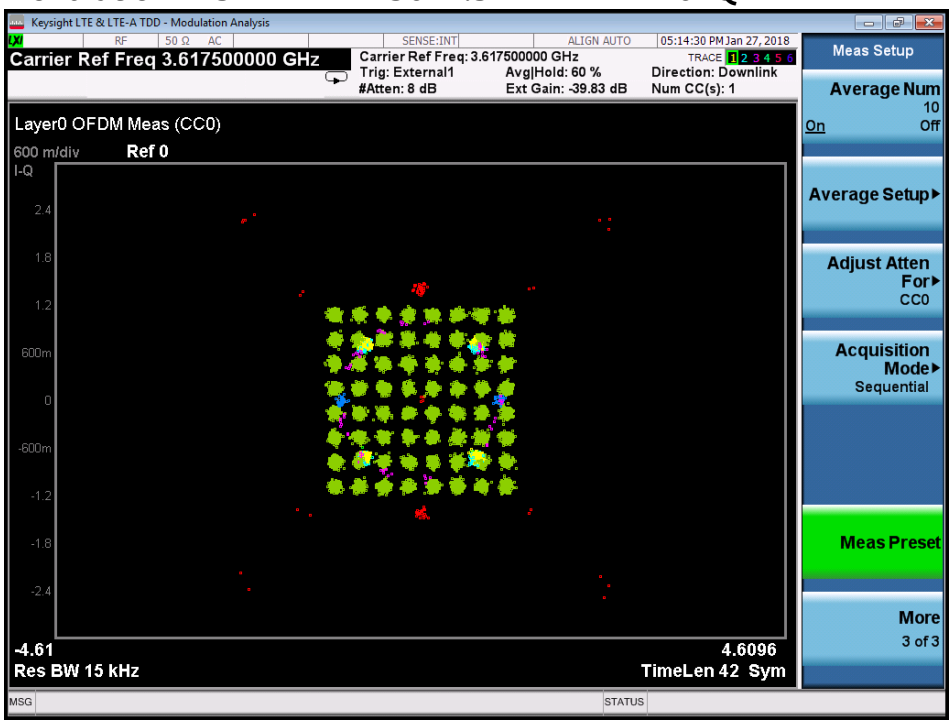


Figure 4.2.2 Typical Modulation Measurements

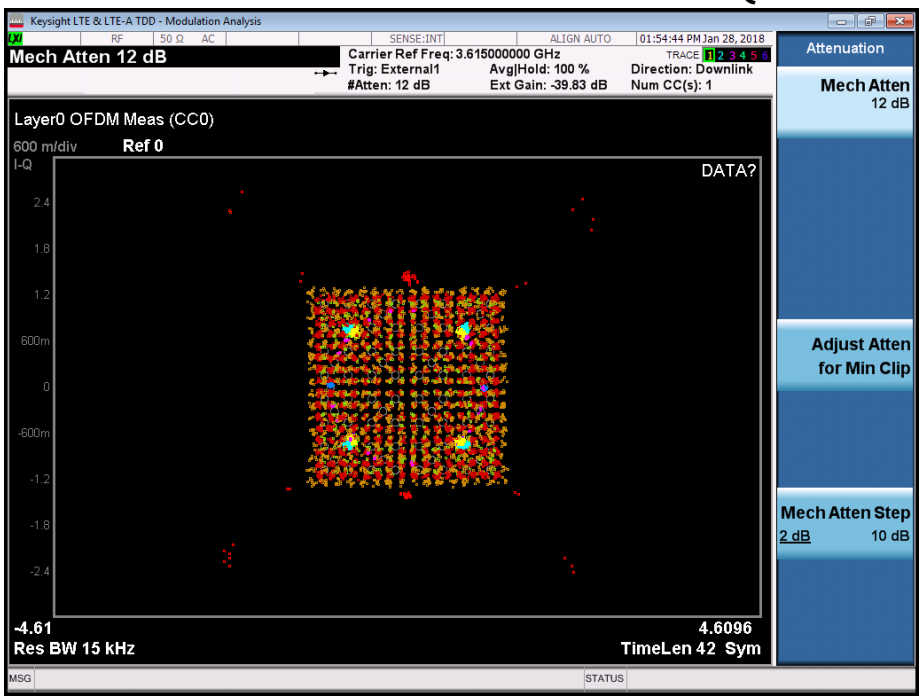
Modulation 10 MHz 3555MHz Tx1 QPSK + 16QAM



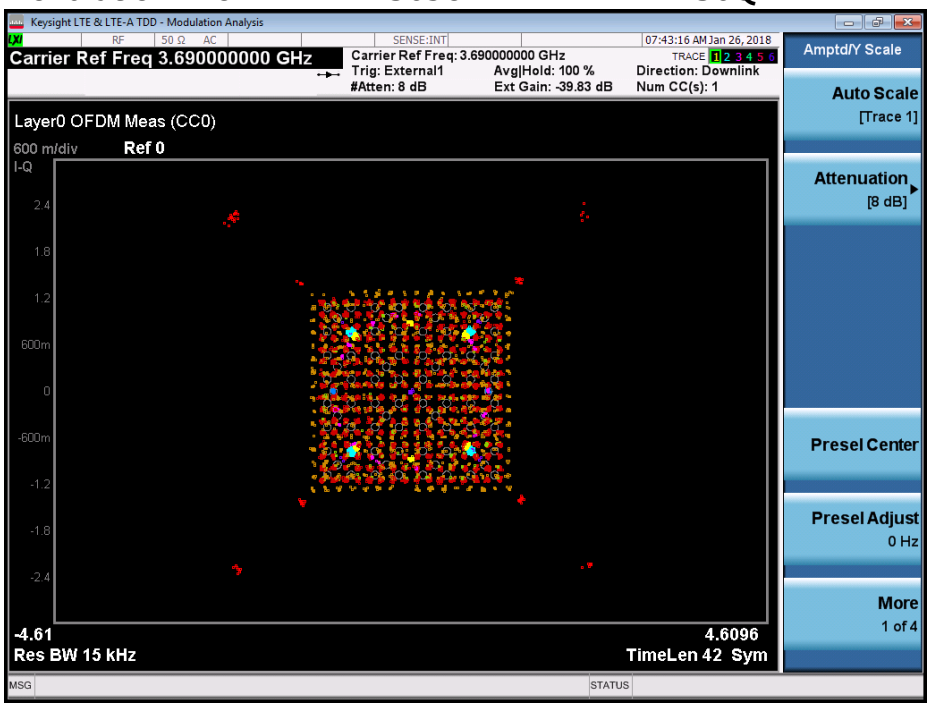
Modulation 15 MHz 3617.5MHz Tx1 64QAM



Modulation 10 MHz 3615MHz Tx1 256QAM



Modulation 20 MHz 3690 MHz Tx1 256QAM



4.3 Section 2.1049 MEASUREMENT REQUIRED: OCCUPIED BANDWIDTH and EDGE of BLOCK EMISSIONS

This test measures the Occupied Bandwidth of the transmitting carrier and the Edge of-Block 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 signal bandwidth such that, below its lower and above its upper frequency limits, the mean power 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 v02, 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 Results Occupied Bandwidth (Signal Bandwidth)

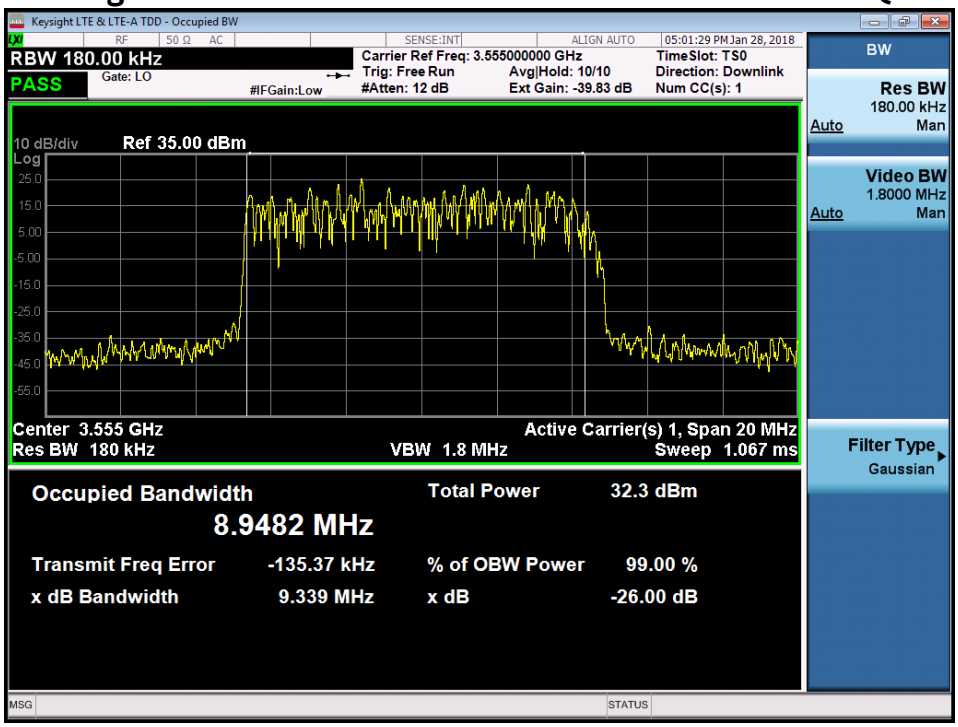
The measured 99% occupied bandwidth and -26 dB relative bandwidth was measured with a Agilent/Keysight MXA signal analyzer for the 10M0F9W, 15M0F9W and 20M0F9W emission designators. The results are tabulated in Table 4.3.1 and examples are in Figure 4.3.1 below and shows that the measured signals are within the parameters of the emissions designator for the FCC.

Table 4.3.1 Signal Bandwidth Results

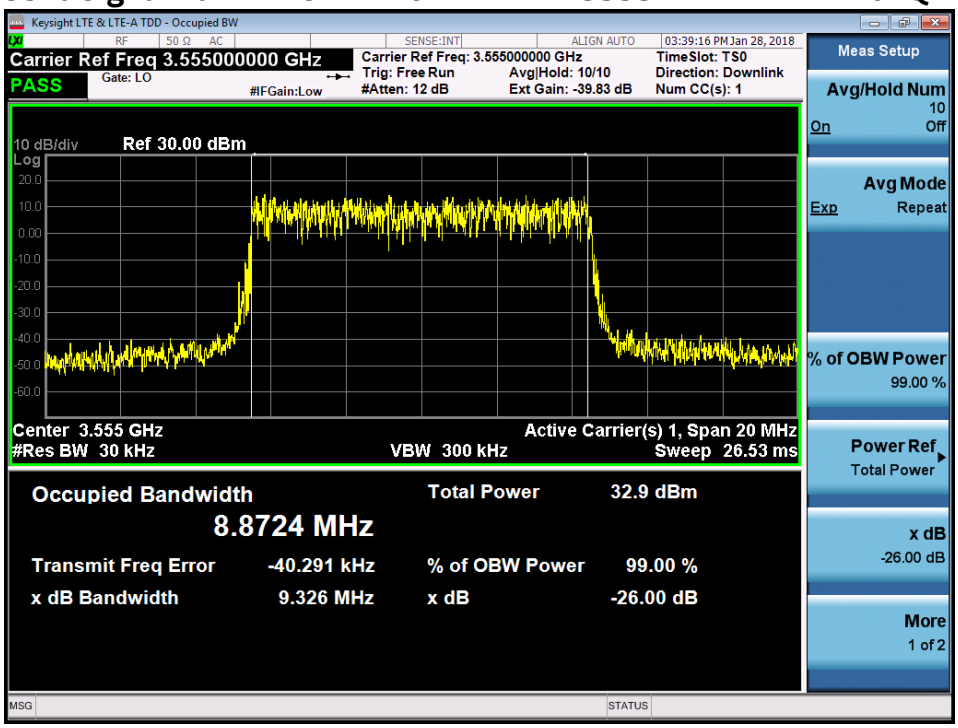
Test #	CBRS Channel Center Frequency MHz	Band Location	Tx Port	Modulation Q16=qpsk+16qam 64=64QAM 256=256QAM	Nominal Signal Bandwidth, MHz	Measured 99% Signal Bandwidth, MHz	Signal Bandwidth Pass / Fail
1	3555	Left	Tx1	QPSK + 16 QAM	10	8.948	Pass
2	3555	Left	Tx2	64QAM	10	8.872	Pass
3	3555	Left	Tx1	256QAM	10	8.896	Pass
4	3615	Center	Tx1	256QAM	10	8.961	Pass
5	3695	Right	Tx1	QPSK + 16 QAM	10	8.925	Pass
6	3557.5	Left	Tx1	256QAM	15	13.402	Pass
7	3617.5	Center	Tx1	256QAM	15	13.292	Pass
8	3692.5	Right	Tx1	64QAM	15	13.420	Pass
9	3560	Left	Tx2	QPSK + 16 QAM	20	17.680	Pass
10	3620	Center	Tx1	64QAM	20	17.756	Pass
11	3690	Right	Tx1	256QAM	20	17.857	Pass

Figure 4.3.1- Occupied Bandwidth - Typical Signal Bandwidth

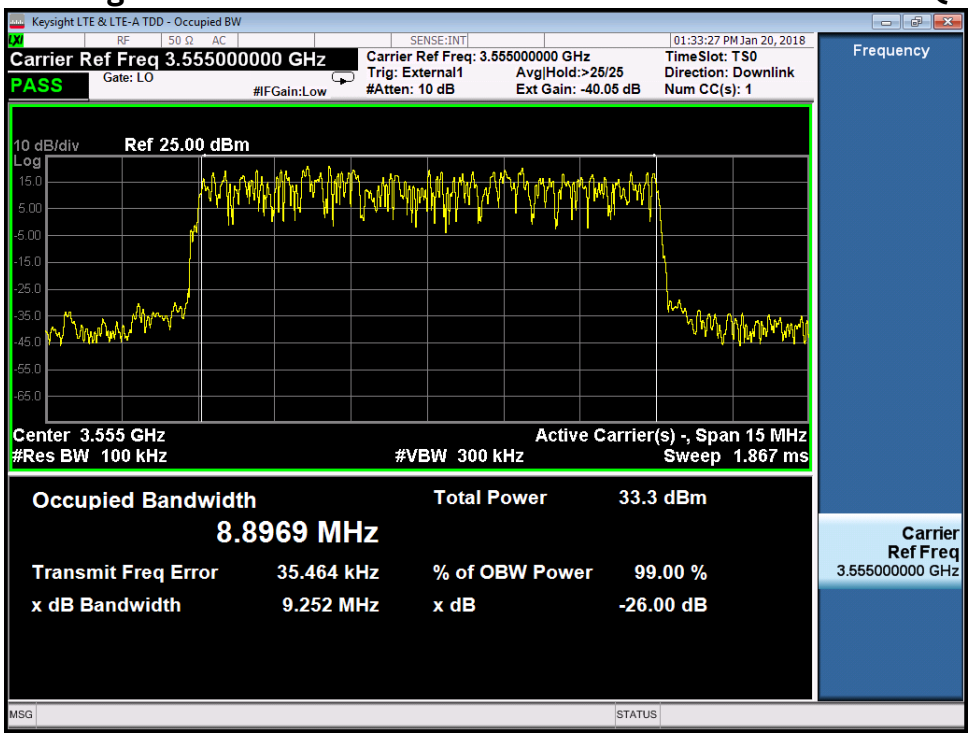
99% Signal Bandwidth 10 MHz 3555MHz Tx1 QPSK + 16QAM



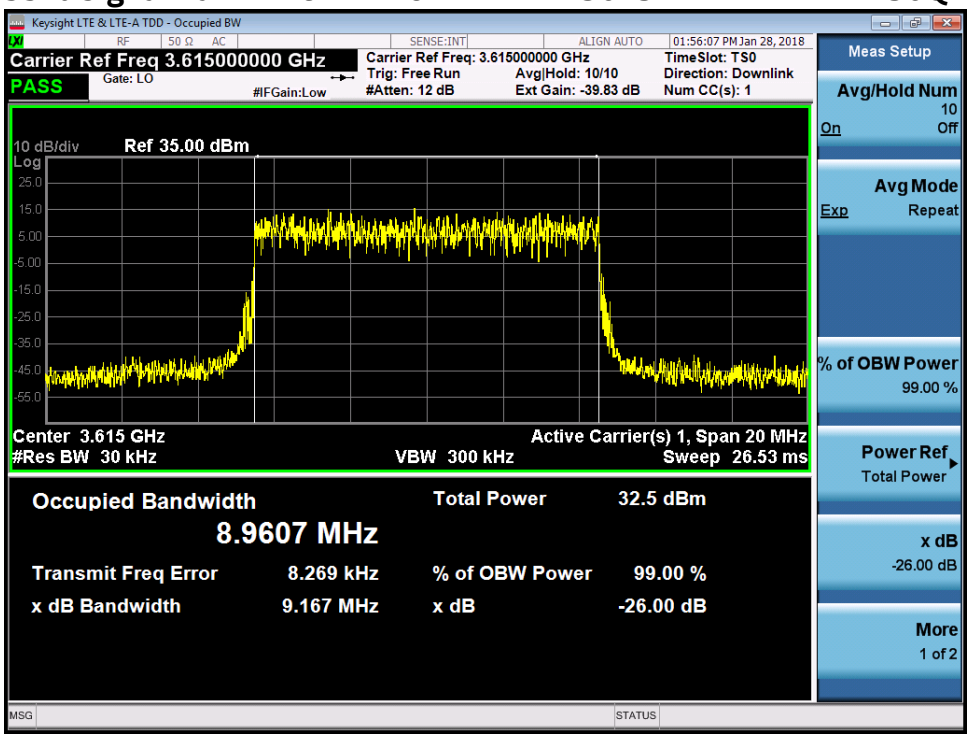
99% Signal Bandwidth 10 MHz 3555 MHz Tx1 64QAM



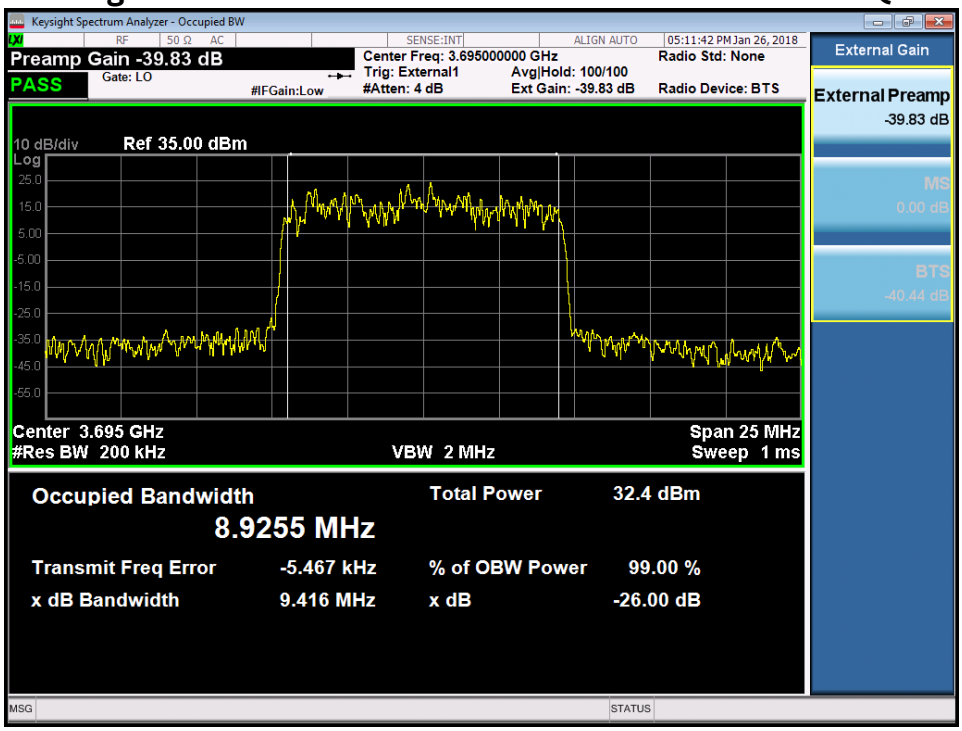
99% Signal Bandwidth 10 MHz 3555 MHz Tx1 256QAM



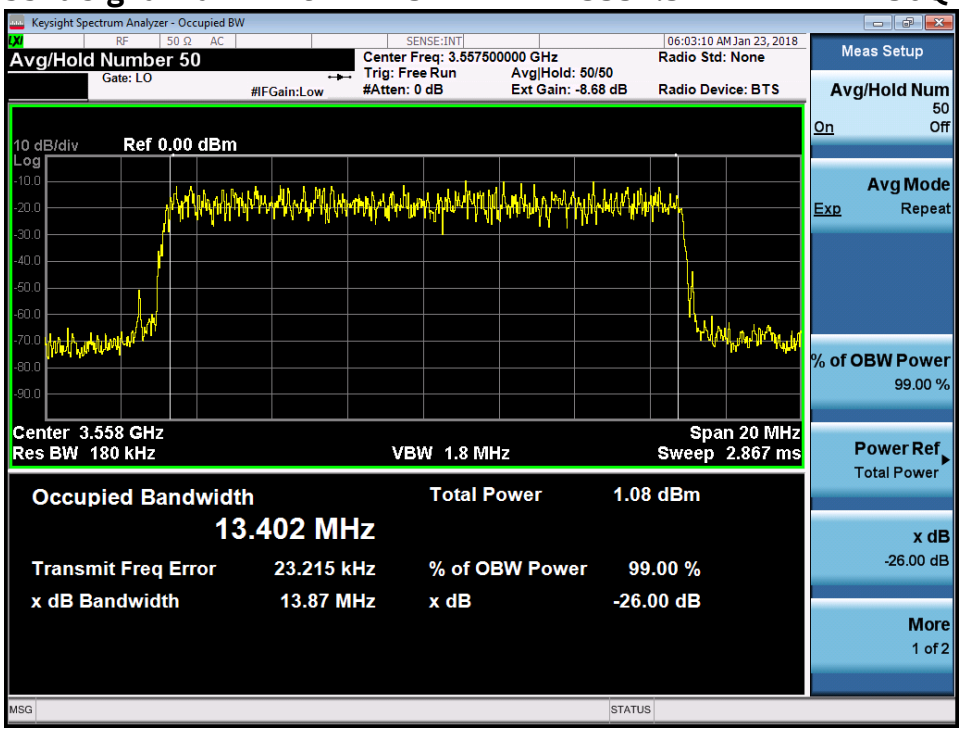
99% Signal Bandwidth 10 MHz 3615 MHz Tx1 256QAM



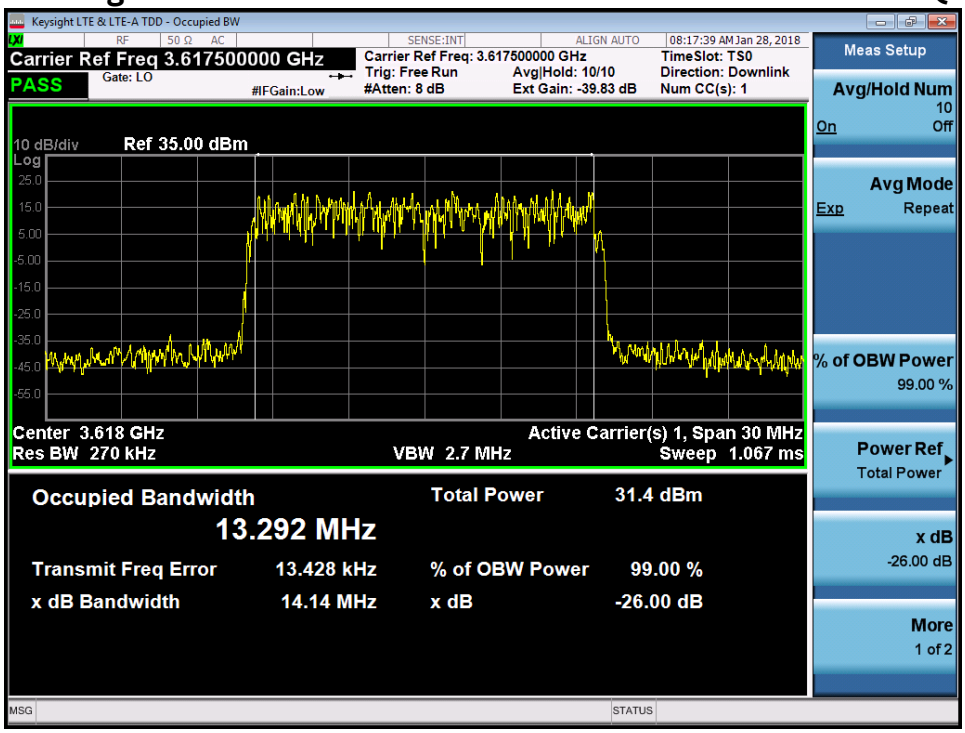
99% Signal Bandwidth 10 MHz 3695 MHz Tx1 QPSK + 16QAM



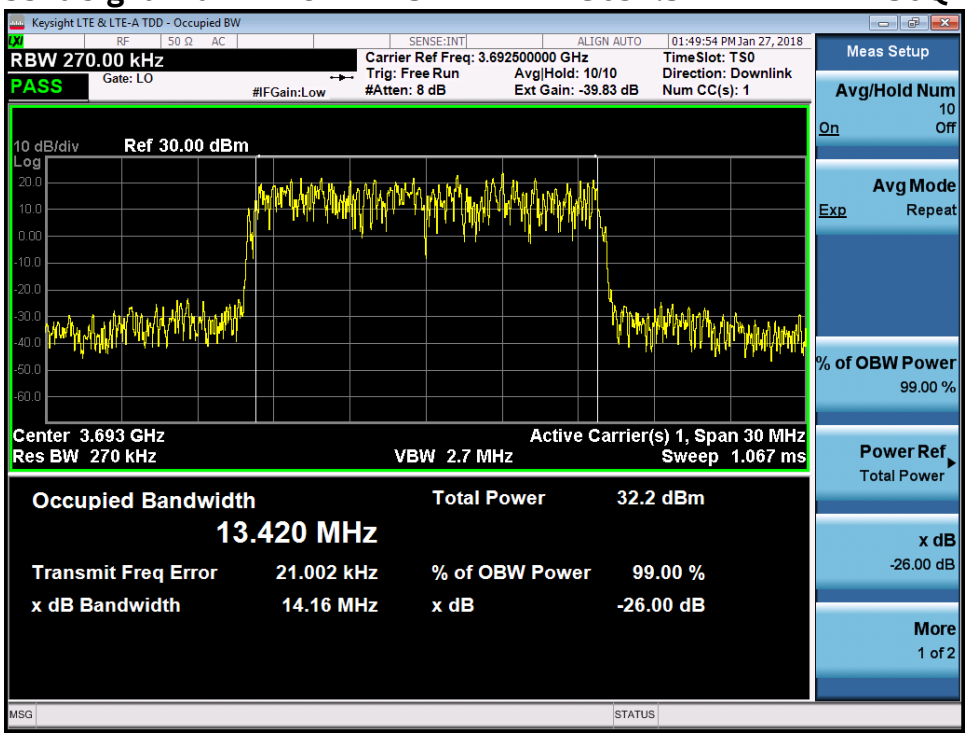
99% Signal Bandwidth 15 MHz 3557.5MHz Tx1 256QAM



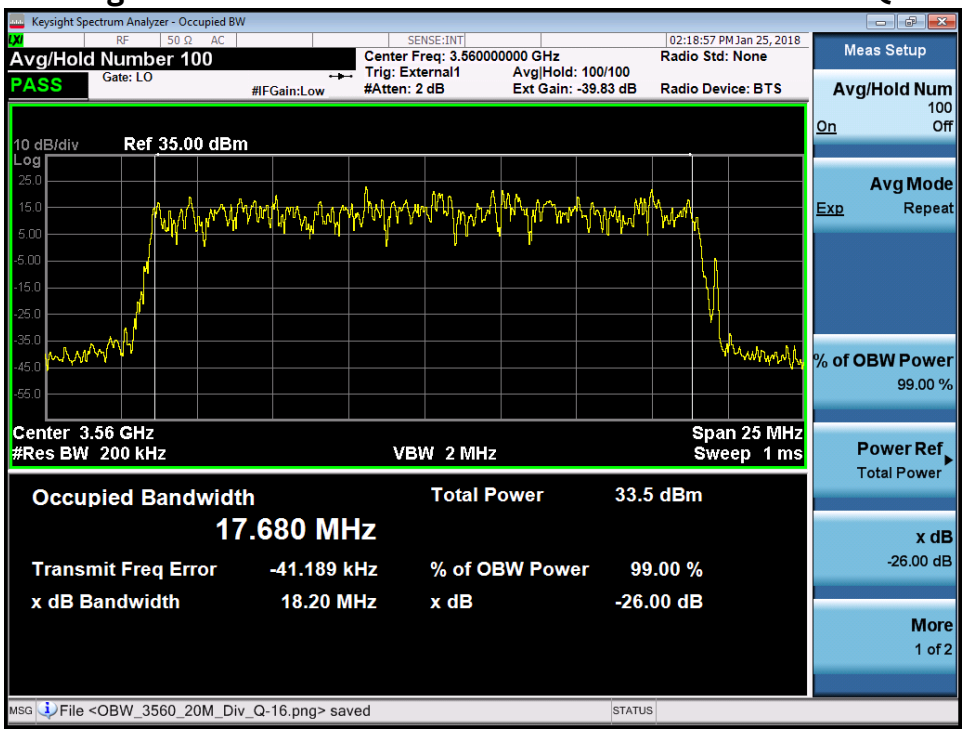
99% Signal Bandwidth 15 MHz 3617.5 MHz Tx1 256QAM



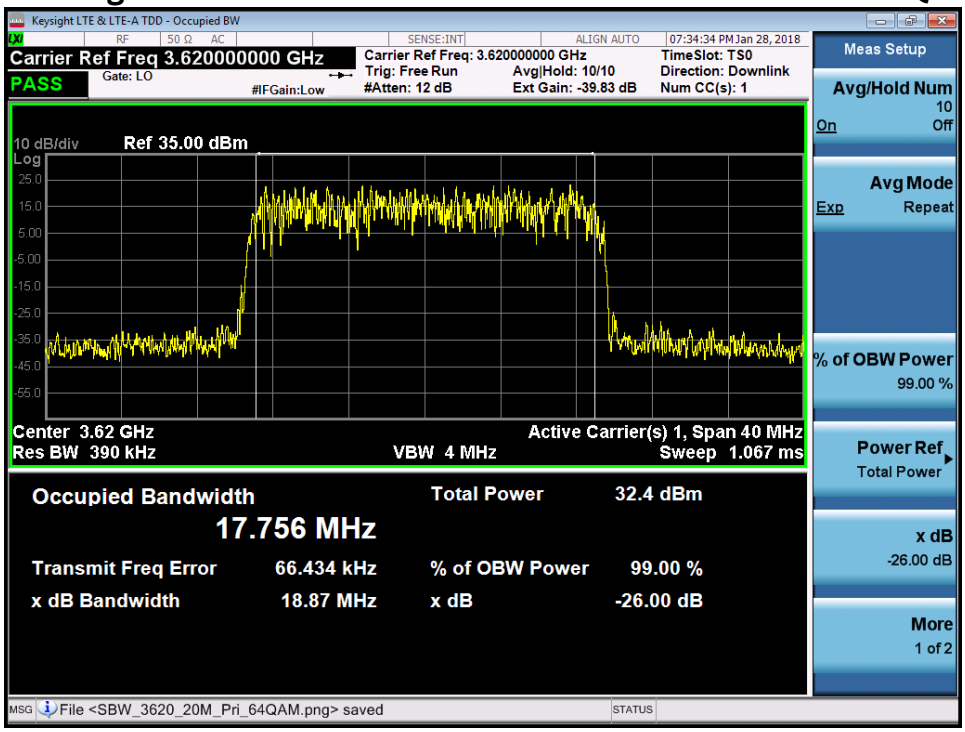
99% Signal Bandwidth 15 MHz 3692.5 MHz Tx1 256QAM



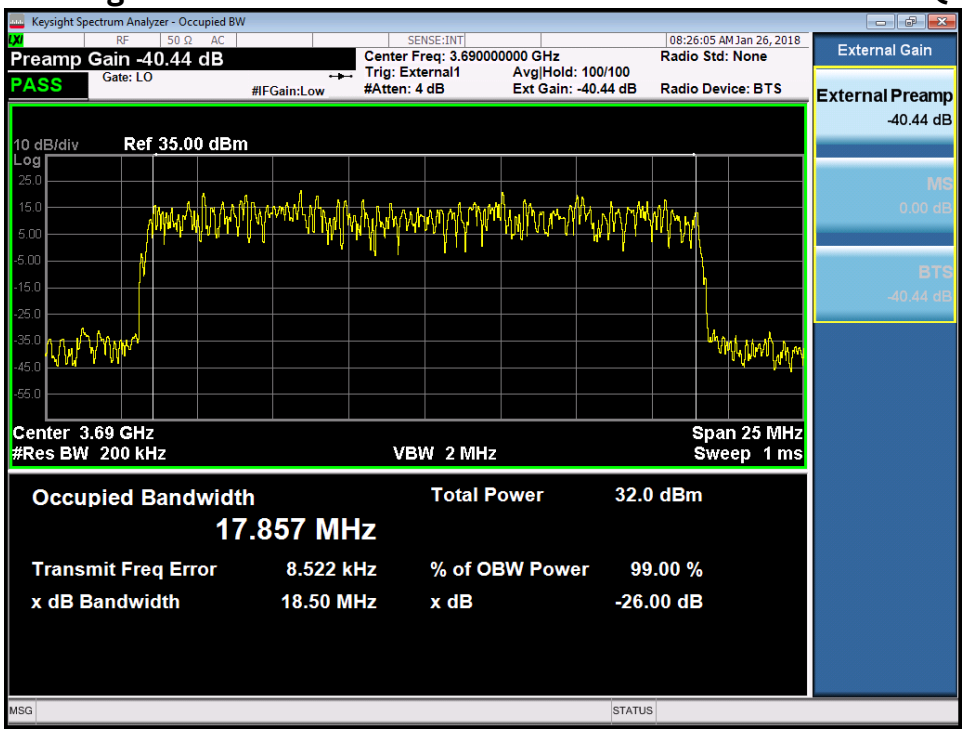
99% Signal Bandwidth 20 MHz 3560 MHz Tx1 QPSK + 16QAM



99% Signal Bandwidth 20 MHz 3620 MHz Tx1 64QAM



99% Signal Bandwidth 20 MHz 3690 MHz Tx1 256QAM



4.3.2 Occupied Bandwidth-Edge of Block Emissions

Classical Occupied Bandwidth – Edge of Block Emissions is an evaluation of the transmit carrier compliance with edge of block/edge of band requirements. This measurement documents the product's ability to maintain compliance with FCC Parts 2 and Part 96.41 limitations on emissions outside the block of operation.

The **FW2QMBOM1** LTE RF Module system supports single and multi-carrier LTE TDD technologies. This evaluation addresses 2x2W MIMO operation with 10, 15 or 20 MHz carriers with various LTE modulations. In each test configuration the carriers were configured at the left side, center and right side of the Part 96 band as appropriate. All power adjustments were performed prior to other measurements. Power was set to the total per port maximum for the specific configuration with equal levels of power per carrier. The measurements are described below.

The occupied bandwidth of each of the signals identified in Table 4.3.6.1 was measured using a MXA signal analyzer and a Rohde & Schwarz ESIB-40 EMI Receiver/ Spectrum Analyzer, a PC based instrumentation controller using TILE™ software and calibrated RF attenuation and coupled signal path. The measurement process meets the requirements of ANSI C63.26 and ISO17025. The RF power level was measured and adjusted via the test setup in Figure 4.3. The set RF output from the transmitter was reduced by calibrated broadband attenuators to amplitudes usable by the spectrum analyzer and power meter. The attenuation factors are reflected in the displayed values of the charts. The typical occupied bandwidth measurement displays the signal adjusted to the reference level corresponding to the corrected RF power level for the signal bandwidth and given resolution bandwidth (RBW). This set-point was performed as follows:

For each test the power calibration was individually verified at the transmitter antenna connection (J4) with a power meter by using the test setup depicted in Figure 4.3. The power calibration was performed to calibrate the spectrum analyzers power measurement against the more accurate power meter measurement. This provides a specific reference for measurements performed with either a 100 kHz, and/or 200 kHz Resolution Bandwidth signal.

Plots are provided using the triggered LTE-TDD functionality of the MXA and peak detected plots using the EMC Test Receiver. The plots complement each other and demonstrate compliance with edge of band limits.

The duality of the measurements are necessary as conducted spurious measurements are required to be performed with the same detector functions as the RF Power/Occupied Bandwidth/Edge of Band Emissions. Conducted spurious measurements were therefore performed over the frequency range of 10 MHz-26.5 GHz with the N9020A MXA Signal analyzer (average detector) and 10 MHz to 37 GHz with the ESIB40 EMC Test receiver (peak detector). Since CBRS Band 48 (3550-3700MHz) requires Conducted spurious testing to 37 GHz the second measurement using peak detector was performed to 37 GHz

The test procedure above as applied to Figure 4.3.5, calibrates the carrier power against the Mask and accurately places the measured occupied bandwidth carrier at the appropriate reference line. All of the plots are presented with a sufficiently wide frequency span for the specific signals or Block of interest. This allows for ease of comparison of the multi-carrier performance. This data was electronically recorded using the TILE™ software and electronically placed in the Occupied Bandwidth Data Sheets. These sheets contain data for multiple mixed carrier configurations for "Left Edge of Block", and "Right Edge of Block" across CBRS Band 48.

4.3.3 Requirements 3.5 GHz Emissions and Interference Limits

The Limit in 47 CFR 96.41 (e) for 3.5 GHz Emissions and Interference Limits is as follows:

(1) Except as otherwise specified in paragraph (e)(2) of this section, for channel and frequency assignments made by the SAS to CBSDs, the conducted power of any emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed −13 dBm/MHz within 0-10 megahertz above the upper SAS-assigned channel edge and within 0-10 megahertz below the lower SAS-assigned channel edge.

At all frequencies greater than 10 megahertz above the upper SAS assigned channel edge and less than 10 MHz below the lower SAS assigned channel edge, the conducted power of any emission shall not exceed −25 dBm/MHz. The upper and lower SAS assigned channel edges are the upper and lower limits of any channel assigned to a CBSD by an SAS, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

(2) *Additional protection levels.* Notwithstanding paragraph (d)(1) of this section, the conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed −40dBm/MHz.

(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 authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.,* 1 MHz or 1 percent of emission bandwidth, as specified). 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.

(ii) When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits.

(iii) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

In order to address the limit as imposed for the requirement in 47CFR 96.41 we evaluated emissions per the requirements in ANSI C63.26 and per KDB 940660 D01 Part 96 CBRS Equipment.
The average detector function was used for all MXA measurements and the Peak detector function were used for EMC receiver measurements.

4.3.4 Measurement Offset and MIMO

The spectrum analysis output plots show the peak of the LTE channel signal at the reference line that is an appropriate number of dB below the top of Mask reference of the spectrum analyzer. For the LTE system there is no carrier without modulation. Since the LTE signal is broadband and is 10, 15 or 20 MHz wide, all of the measurements performed at narrower resolution bandwidths need to be evaluated with limits adjusted for the reduction in signal energy. The following relationship was used to provide the correct level for an unmodulated carrier vs. the modulated signal.

10*log (Resolution Bandwidth/ Transmit Bandwidth) = Signal Offset (1)

For the peak of the 10, 15 or 20 MHz LTE signal measured with a RBW of 100, 150 or 200 kHz the signal offset is:

For a 10 MHz carrier the Signal Offset = 10*log (100 kHz /10 MHz) = -20.00 dB
For a 15 MHz carrier the Signal Offset = 10*log (100 kHz /15 MHz) = -21.76 dB
For a 15 MHz carrier the Signal Offset = 10*log (150 kHz /15 MHz) = -21.76 dB
For a 20 MHz carrier the Signal Offset = 10*log (100 kHz /20 MHz) = -23.01 dB
For a 20 MHz carrier the Signal Offset = 10*log (200 kHz /20 MHz) = -23.01 dB

For MIMO operation in accordance with KDB 662911 D01 the limits must be adjusted per the equation:

MIMO Offset = 10LOG(n) where n= MIMO Value

For 2x MIMO = 10LOG(2)= 3.01 dB

4.3.5 Mask Parameters

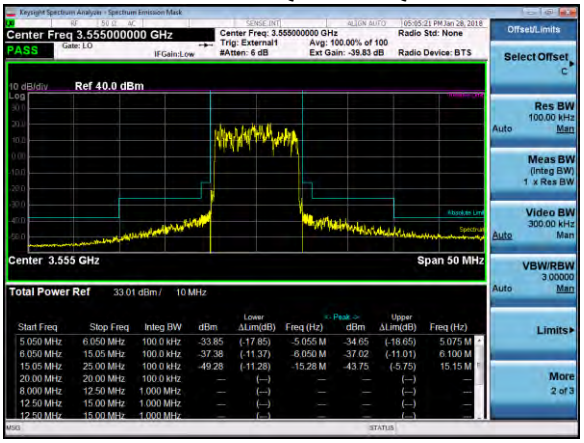
The parameters for all of the limits used for these tests are detailed in Table 4.3.5, below.
Per Part 2 limits which are specified as appropriate at a given RBW can be measured and evaluated at other RBW's if the limit is adjusted per equation (1). Table 4.3.5, below, identifies all of the limits and calibrations line levels used on the Occupied Bandwidth Masks to evaluate Out of Band Emissions. The line designations are as identified on the sample Occupied Bandwidth Chart Figure 4.3.5.

Table 4.3.5 - Mask Parameters Occupied Bandwidth-Edge of Band

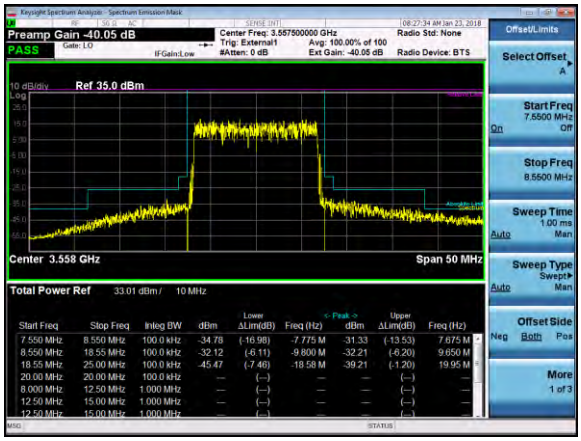
Carrier Power		Signal Band-width	Measurement RBW		Power Calibration			Signal Offset Reference level		"n" x MIMO	M Bandwidth an Factor	Edge of Band Emission Limits			
			OBW-Edge of Band	RF Power	Offset Level	Power Levels						1st MHz Limit c-b & bb-cc	>1 MHz to 10 MHz Limit e-d & dd-ee	3530 to -10 MHz & +10 to 3720 MHz g-f & ff-gg	Below 3530 MHz and Above 3720 MHz Limit
W	dBm	MHz	MHz	MHz	dB	dBc	dBm	dBc	dBm	integer	dB	dBm	dBm	dBm	dBm
2	33.01	10	0.1	3	-5.23	-5.23	27.78	-20.00	13.01	2	3.01	-16.01	-26.01	-38.01	-53.01
2	33.01	15	0.1	3	-6.99	-6.99	26.02	-21.76	11.25	2	3.01	-17.77	-26.01	-38.01	-53.01
2	33.01	15	0.15	3	-6.99	-6.99	26.02	-20.00	13.01	2	3.01	-16.01	-24.25	-36.25	-51.25
2	33.01	20	0.1	3	-8.24	-8.24	24.77	-23.01	10.00	2	3.01	-19.02	-26.01	-38.01	-53.01
2	33.01	20	0.2	3	-8.24	-8.24	24.77	-20.00	13.01	2	3.01	-16.01	-23.00	-35.00	-50.00
Conducted Spurious Limits at 1 MHz Resolution Bandwidth															
2	33.01	10	1	3						2	3.01		-16.01	-28.01	-43.01
2	33.01	15	1	3						2	3.01		-16.01	-28.01	-43.01
2	33.01	20	1	3						2	3.01		-16.01	-28.01	-43.01

Figure 4.3.5 - Sample Occupied Bandwidth Charts

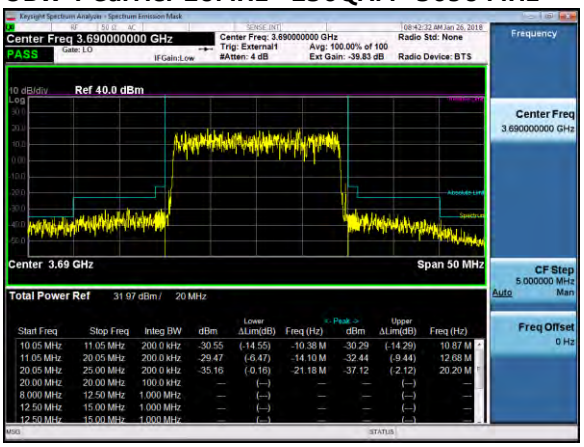
OBW 1 Carrier 10MHz QPSK-16QAM 3550 MHz.



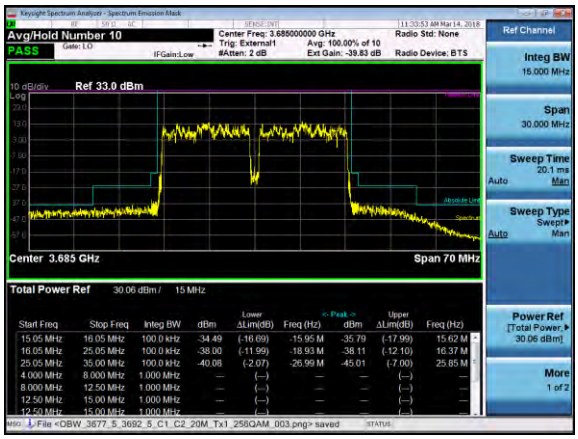
OBW 1 Carrier 15MHz 256QAM 3557.5 MHz



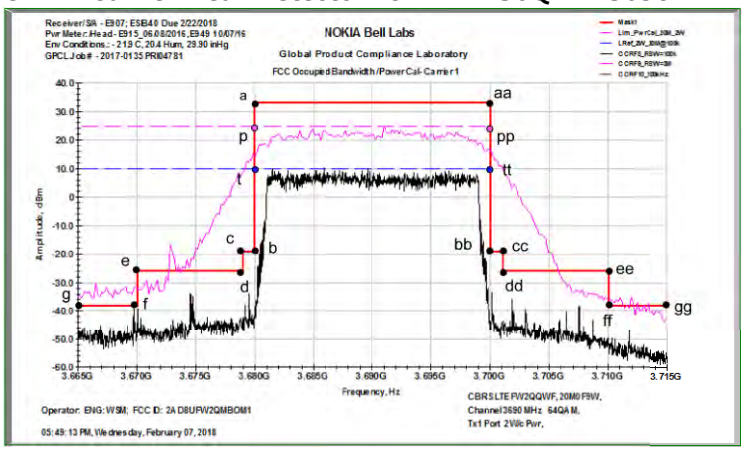
OBW 1 Carrier 20MHz 256QAM 3690 MHz



OBW 2 Carrier 15+15 256QAM 3685 MHz



OBW 1 Carrier Peak Detector 20MHz 256QAM 3690 MHz



4.3.6 Occupied Bandwidth-Edge of Block Emissions Measurement

The occupied bandwidth and out-of-band emissions measurements were made at the antenna transmitting terminal for single 10, 15 and 20 MHz carriers and 10+10, 15+15 and 20+20 MHz dual carriers. These included measurements with QPSK+16QAM, 64QAM and 256QAM modulation. The appropriate E-UTRA test model specified in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** was used for these LTE carriers.
The measurements were performed with both a spectrum analyzer and with an MXA signal analyzer in compliance with the procedure and requirements of ANSI C63.26. The test set-up diagram in Figure 4.3 is used for RF Power, Modulation, Peak to Average Ratio, occupied bandwidth, out-of-band emissions and Antenna Port Conducted Spurious Emissions.

Testing was performed for the 10, 15 and 20 MHz carrier configurations at the left side, center and right side of the Part 96 Band. The total overall carrier power level at each antenna terminal was adjusted to the maximum rated mean power 33.01 dBm (2W) for 2xMIMO configurations. This is 4W total for the two ports.

Mask parameters were as stated in Table 4.3.5. For proper evaluation of the carrier the measurement parameters for Resolution Bandwidth and Mask Edge Offsets were followed as shown in Table 4.3.6. All of the Mask Edge Offsets are equal to ½ of the Resolution Bandwidths used for the measurements.

Table 4.3.6. Measurement Parameters and Mask Edge Offsets

Signal Bandwidth	Measurement Resolution Band Width (RBW)	Resolution Bandwidth Offsets
MHz	MHz	MHz
10	0.1	0.05
15	0.1	0.05
20	0.1	0.05
20	0.2	0.1

4.3.6.1 Results Occupied Bandwidth-Edge of Block Emissions

The occupied bandwidth plots for operation at the left side and the right side of the band for all of the signal bandwidths are below. The mask accurately depicts the limits for the specific blocks to determine compliance with FCC Part 96. The mask limits include the appropriate considerations for 2x2W MIMO operation.

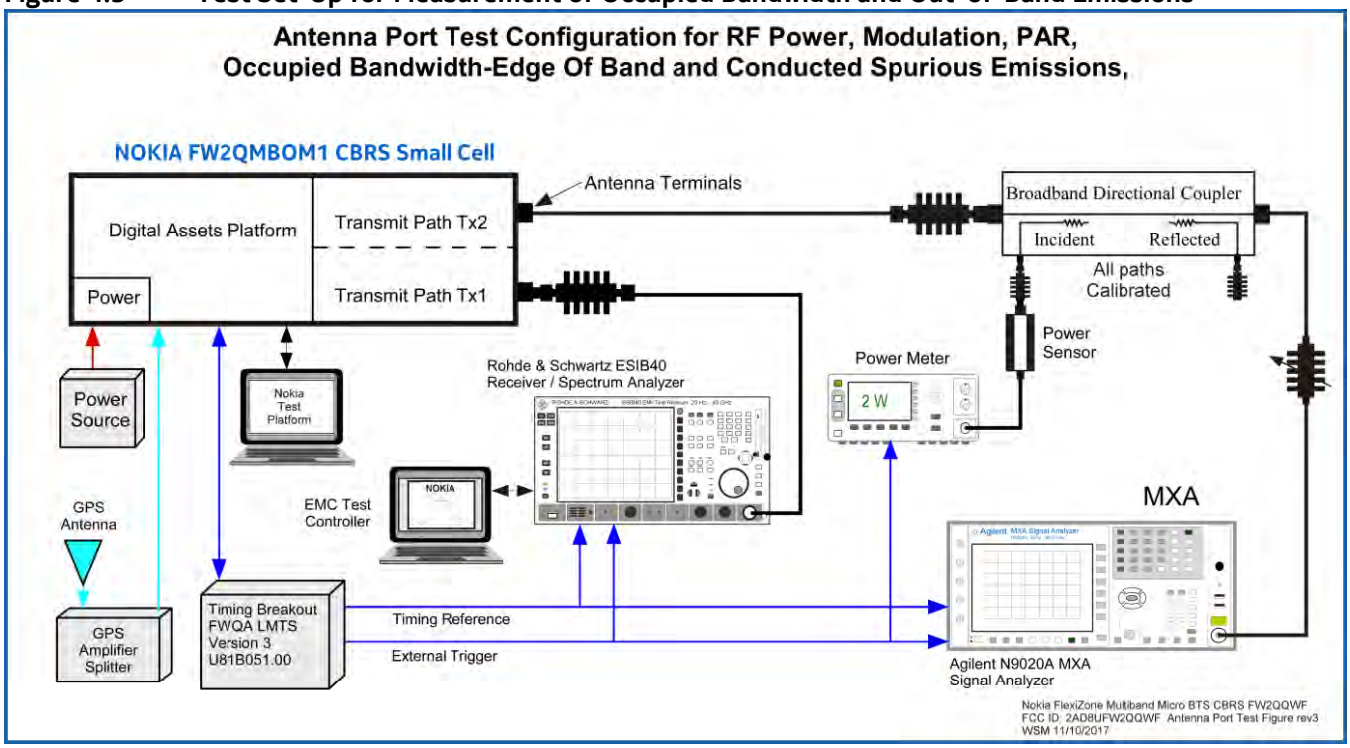
From the out-of-band emissions plots attached below, it can be seen that all the emissions are under the required emission masks for MIMO operation.

The measurement results of the occupied bandwidth and the out-of-band emissions as documented in the plots and Table 4.3.6.1 demonstrate the full compliance with the Rules of the Commission for the operating band.

Table 4.3.6.1 Compliance Tabulation of Occupied Bandwidth-Edge of Block Measurements

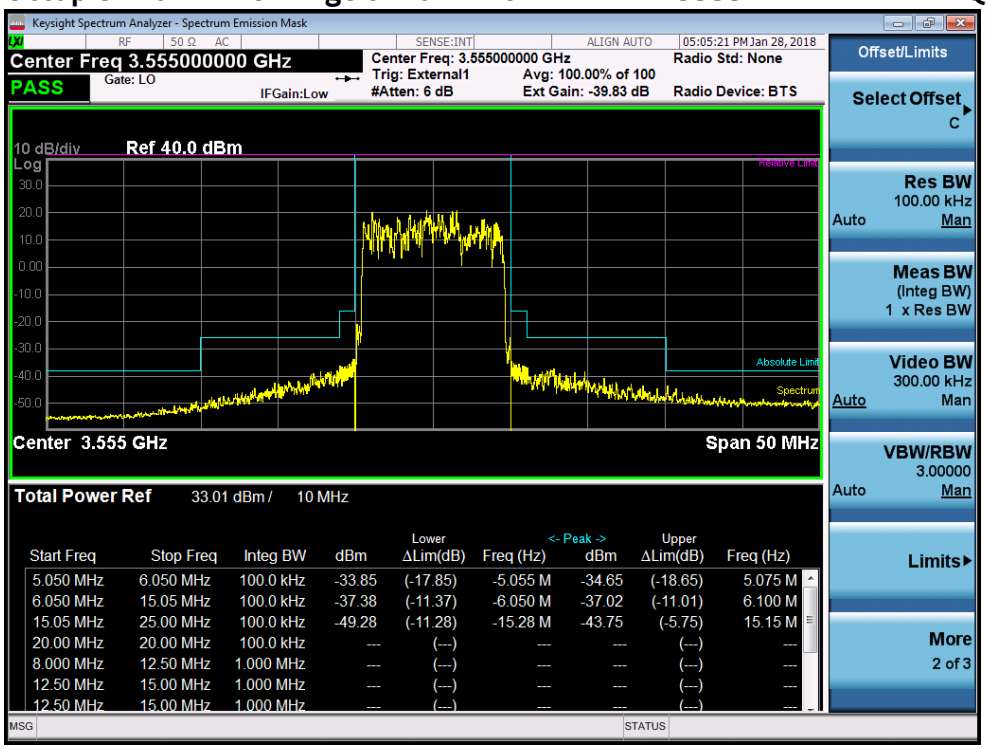
Test #	Transmit Frequency	Tx Port	Signal Bandwidth, MHz	Modulation	Occupied Bandwidth / Edge of Block Results Pass / Fail
1	3555	Tx1	10	QPSK+16QAM	Pass
2	3565	Tx1	10	64QAM	Pass
3	3555	Tx2	10	256QAM	Pass
4	3615	Tx1	10	256QAM	Pass
5	3695	Tx1	10	256QAM	Pass
6	3657.5	Tx1	15	256QAM	Pass
7	3617.5	Tx1	15	256QAM	Pass
8	3692.5	Tx1	15	QPSK+16QAM	Pass
9	3560	Tx1	20	QPSK+16QAM	Pass
10	3620	Tx1	20	64QAM	Pass
11	3690	Tx1	20	256QAM	Pass
12	3555	Tx1	10	256QAM	Pass
13	3690	Tx1	20	64QAM	Pass
14	3555+3565	Left	10+10	256QAM	Pass
15	3615+3625	Center	10+10	256QAM	Pass
16	3685+3695	Right	10+10	256QAM	Pass
17	3557.5+3572.5	Left	15+15	256QAM	Pass
18	3617.5+3632.5	Center	15+15	256QAM	Pass
19	3677.5+3692.5	Right	15+15	256QAM	Pass
20	3677.5+3692.5	Right	15+15	Q16	Pass
21	3677.5+3692.5	Right	15+15	64QAM	Pass
22	3560+3580	Left	20+20	256QAM	Pass
23	3620+3640	Center	20+20	256QAM	Pass
24	3670+3690	Right	20+20	256QAM	Pass

Figure 4.3 - Test Set-Up for Measurement of Occupied Bandwidth and Out-of-Band Emissions



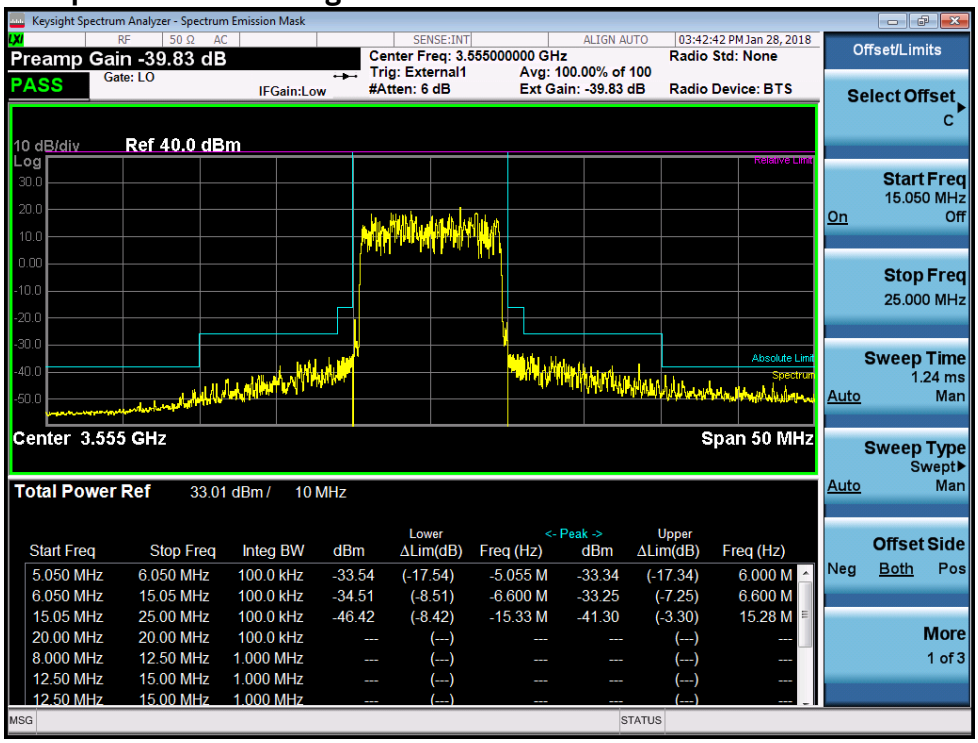
4.3.7 Transmitter Measurements of Occupied Bandwidth and Edge of Band Emissions

Occupied Bandwidth-Edge of Band 10 MHz 3555MHz Tx1 QPSK + 16QAM



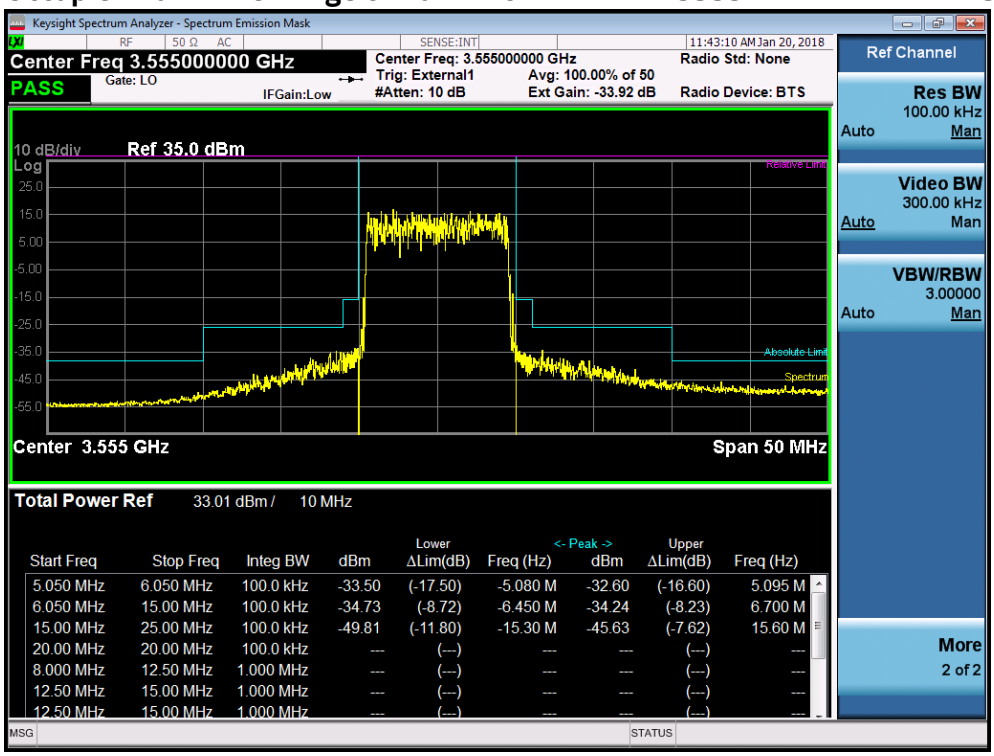
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
5.050 MHz	6.050 MHz	100.0 kHz	-33.85	(-17.85)	-5.055 M	-34.65	(-18.65)	5.075 M
6.050 MHz	15.05 MHz	100.0 kHz	-37.38	(-11.37)	-6.050 M	-37.02	(-11.01)	6.100 M
15.05 MHz	25.00 MHz	100.0 kHz	-49.28	(-11.28)	-15.28 M	-43.75	(-5.75)	15.15 M
20.00 MHz	20.00 MHz	100.0 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Occupied Bandwidth-Edge of Band 10 MHz 3555 MHz Tx1 64QAM

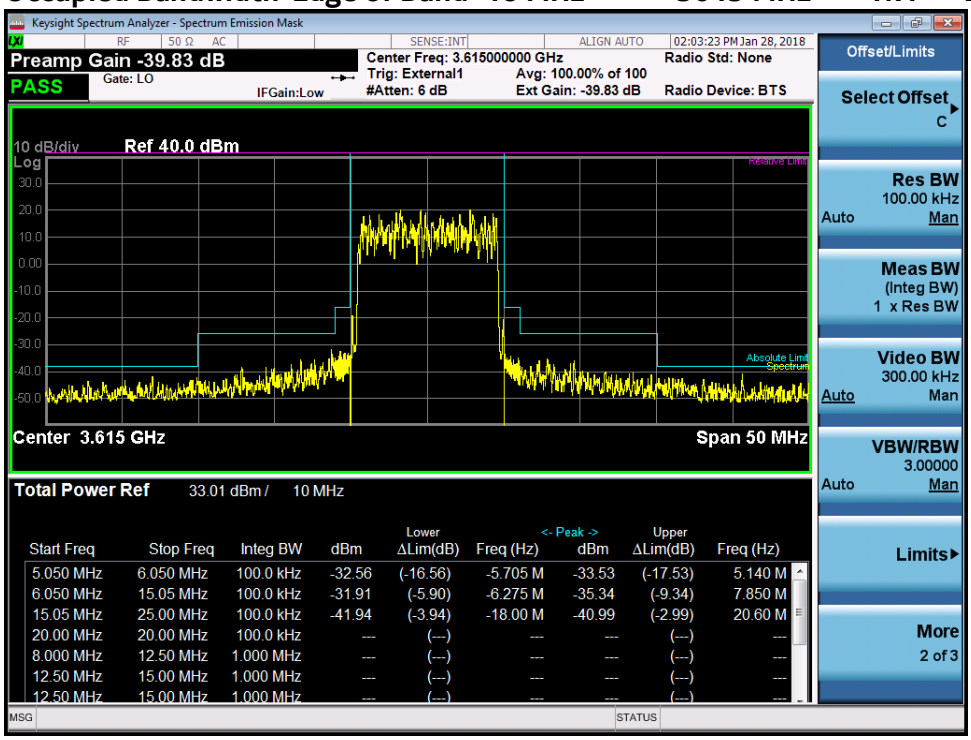


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
5.050 MHz	6.050 MHz	100.0 kHz	-33.54	(-17.54)	-5.055 M	-33.34	(-17.34)	6.000 M
6.050 MHz	15.05 MHz	100.0 kHz	-34.51	(-8.51)	-6.600 M	-33.25	(-7.25)	6.600 M
15.05 MHz	25.00 MHz	100.0 kHz	-46.42	(-8.42)	-15.33 M	-41.30	(-3.30)	15.28 M
20.00 MHz	20.00 MHz	100.0 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

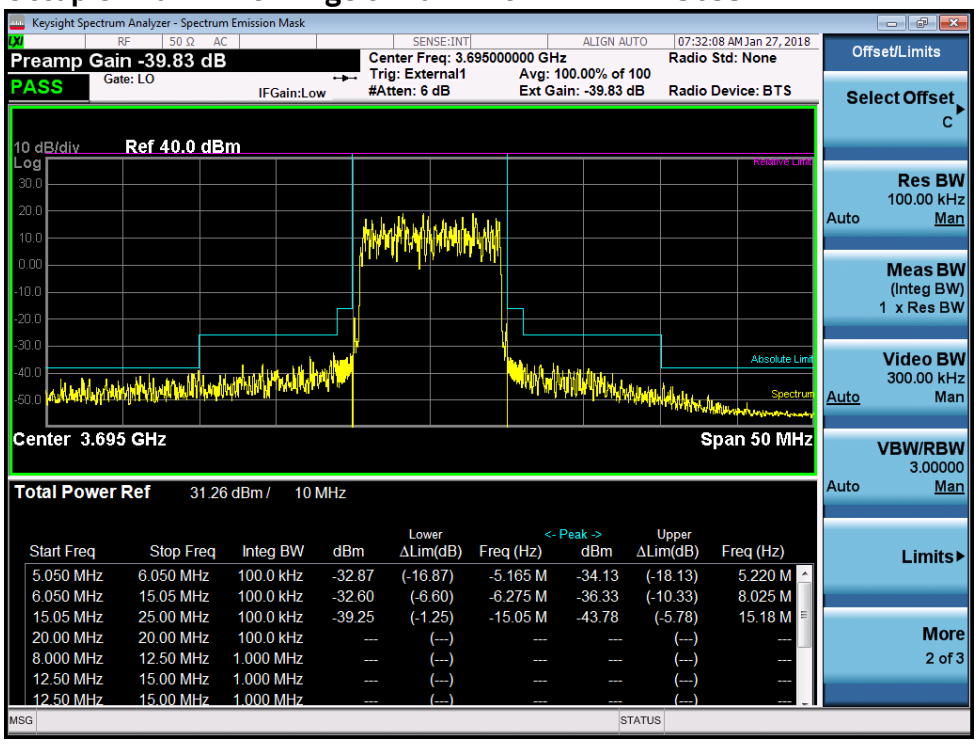
Occupied Bandwidth-Edge of Band 10 MHz 3555 MHz Tx2 256QAM



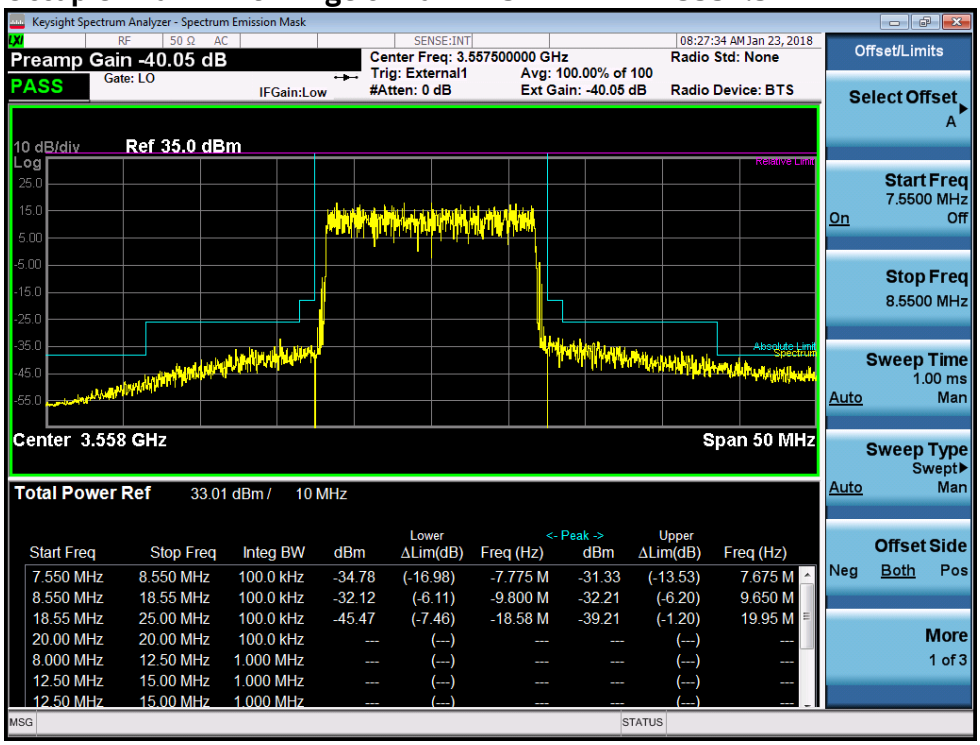
Occupied Bandwidth-Edge of Band 10 MHz 3615 MHz Tx1 256QAM



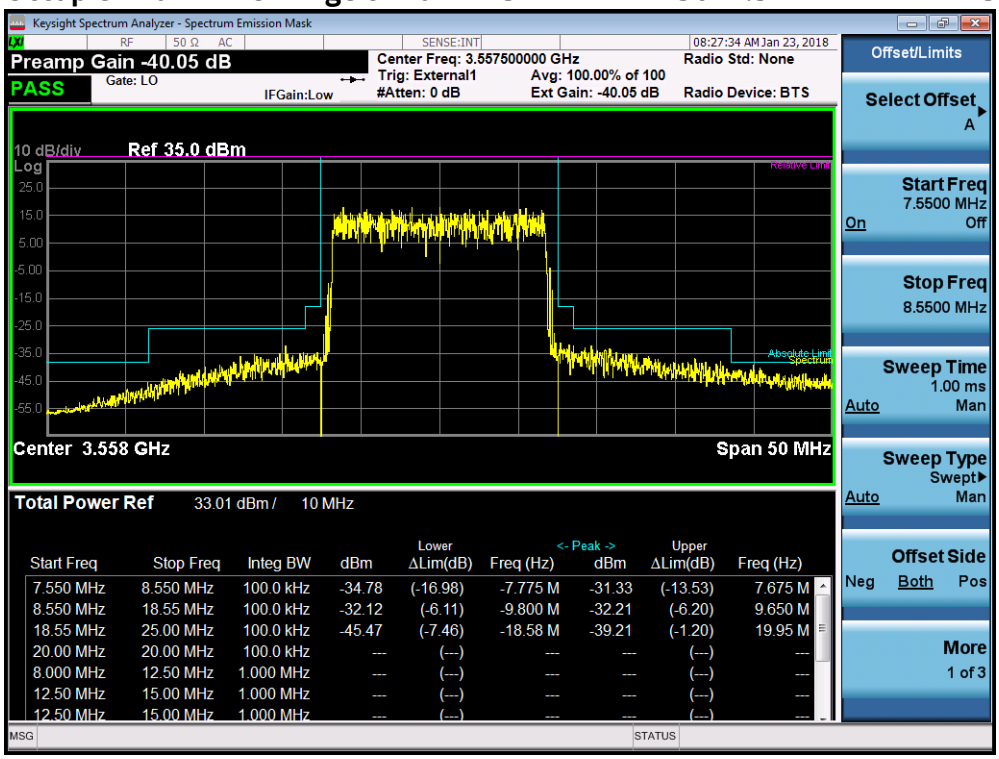
Occupied Bandwidth-Edge of Band 10 MHz 3695 MHz Tx1 256QAM



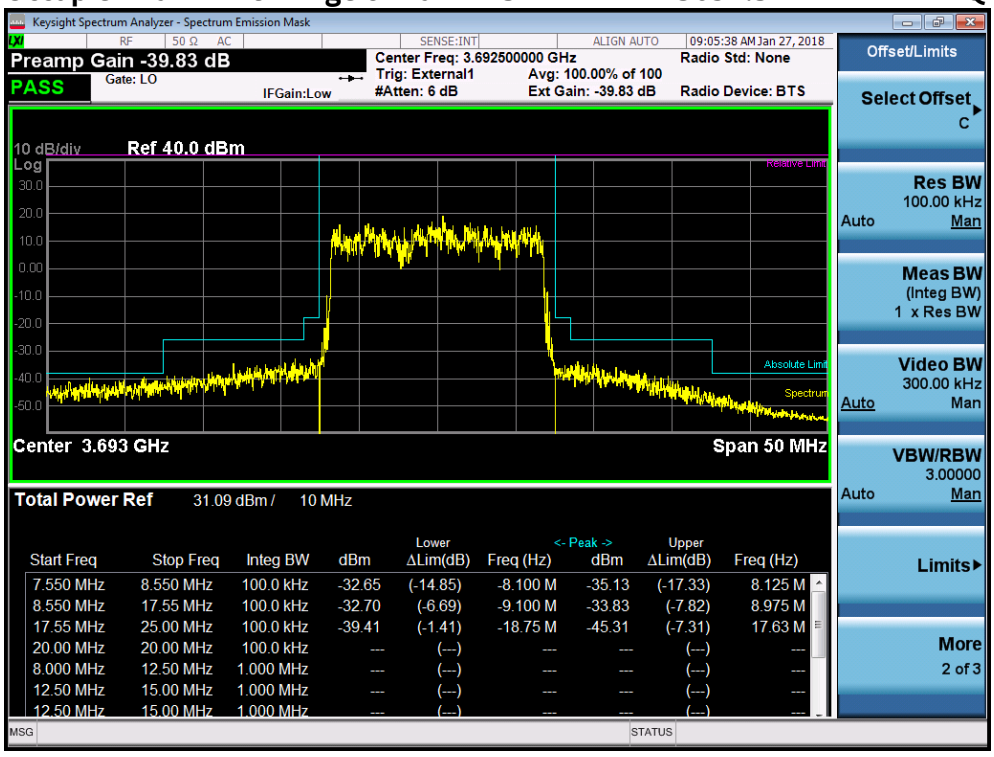
Occupied Bandwidth-Edge of Band 15 MHz 3557.5MHz Tx1 256QAM



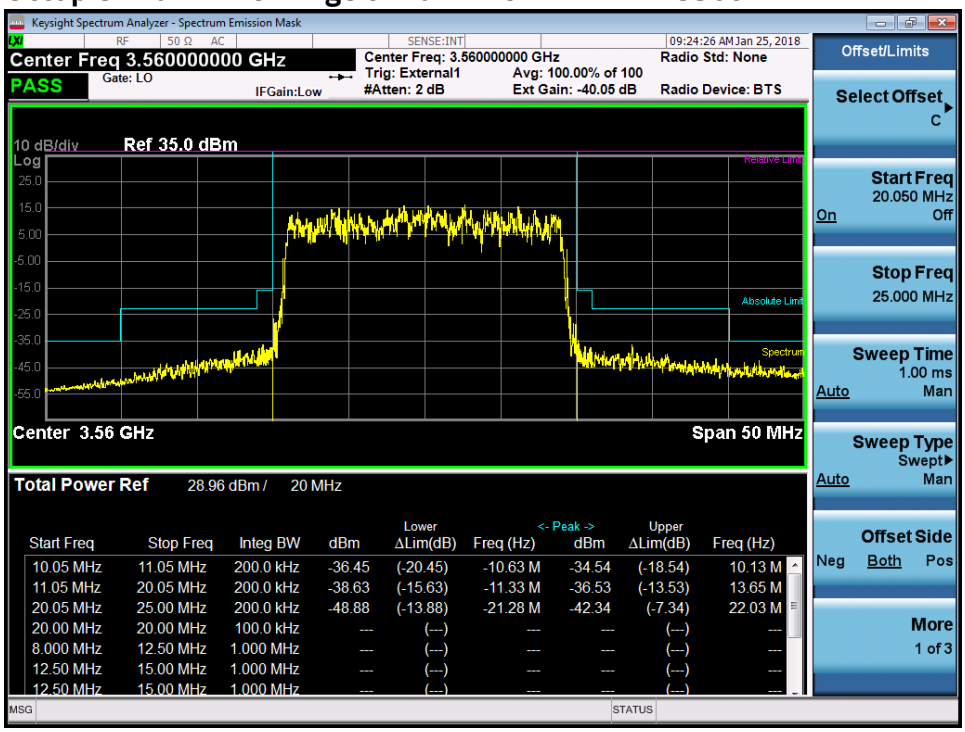
Occupied Bandwidth-Edge of Band 15 MHz 3617.5 MHz Tx1 256QAM



Occupied Bandwidth-Edge of Band 15 MHz 3692.5 MHz Tx1 QPSK + 16QAM

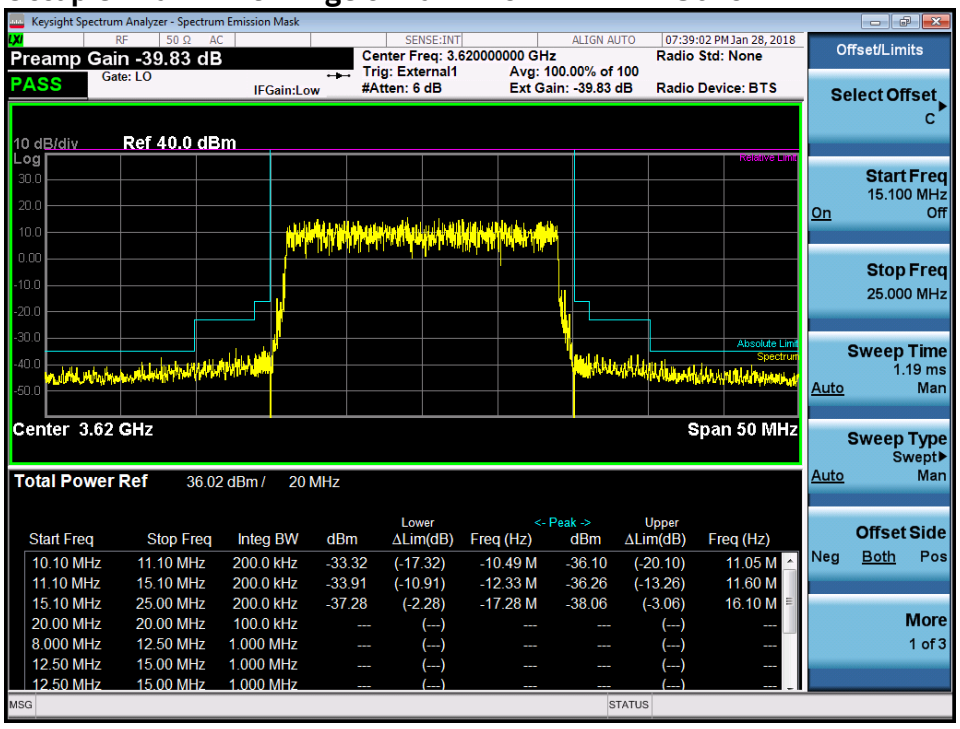


Occupied Bandwidth-Edge of Band 20 MHz 3560 MHz Tx1 QPSK + 16QAM



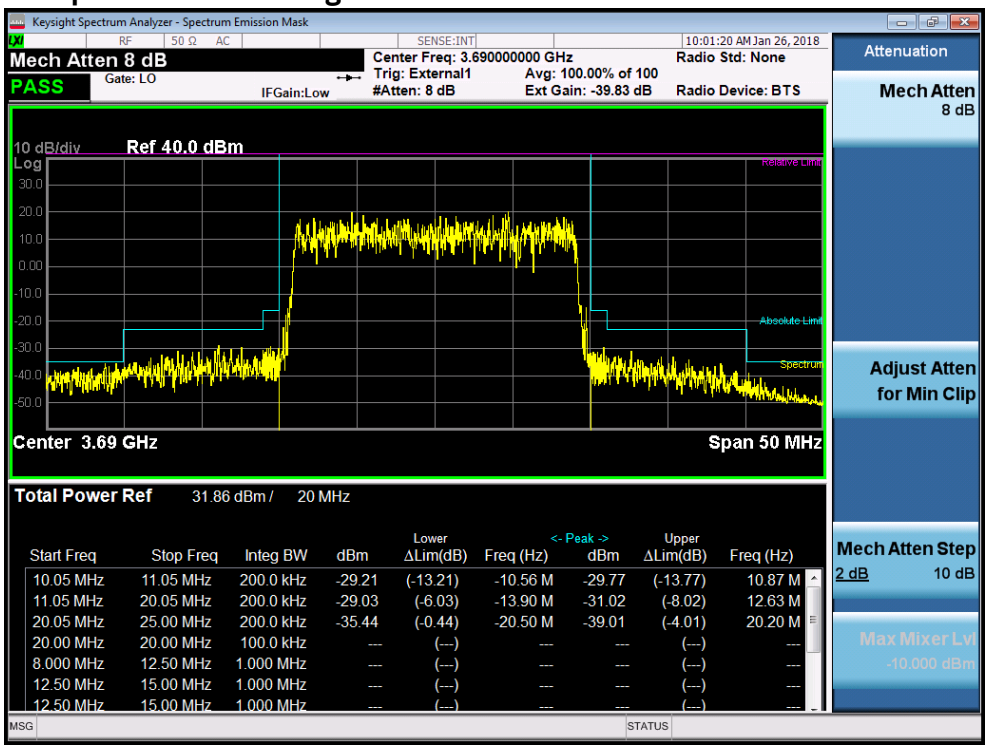
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.05 MHz	11.05 MHz	200.0 kHz	-36.45	(-20.45)	-10.63 M	-34.54	(-18.54)	10.13 M
11.05 MHz	20.05 MHz	200.0 kHz	-38.63	(-15.63)	-11.33 M	-36.53	(-13.53)	13.65 M
20.05 MHz	25.00 MHz	200.0 kHz	-48.88	(-13.88)	-21.28 M	-42.34	(-7.34)	22.03 M
20.00 MHz	20.00 MHz	100.0 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Occupied Bandwidth-Edge of Band 20 MHz 3620 MHz Tx1 64QAM



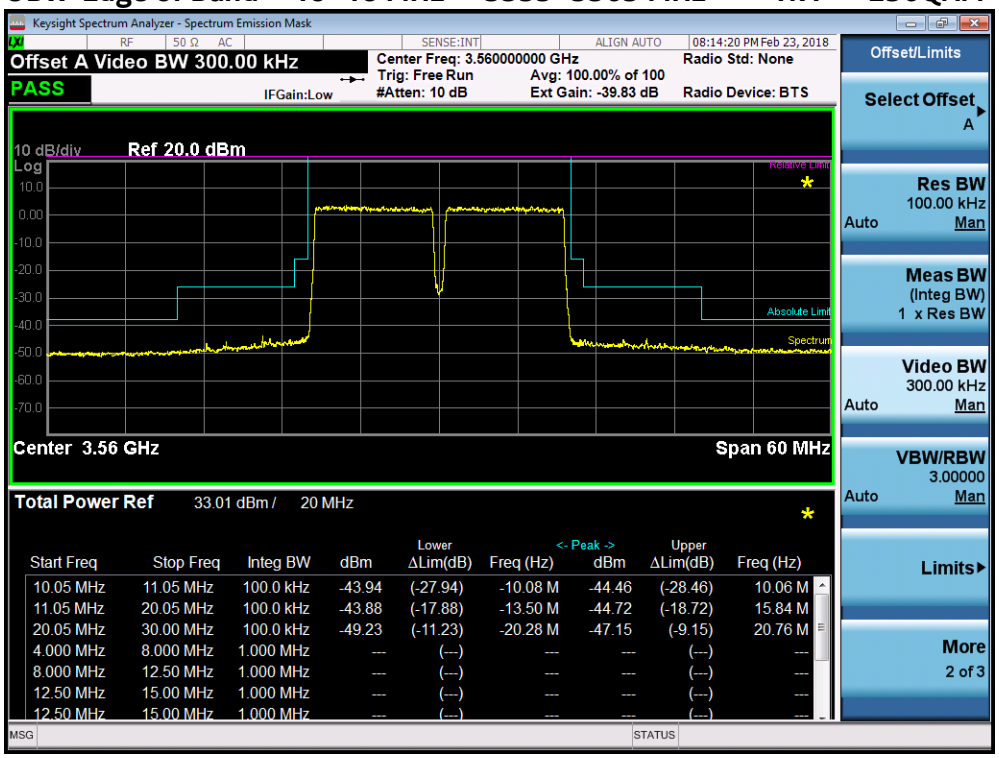
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.10 MHz	11.10 MHz	200.0 kHz	-33.32	(-17.32)	-10.49 M	-36.10	(-20.10)	11.05 M
11.10 MHz	15.10 MHz	200.0 kHz	-33.91	(-10.91)	-12.33 M	-36.26	(-13.26)	11.60 M
15.10 MHz	25.00 MHz	200.0 kHz	-37.28	(-2.28)	-17.28 M	-38.06	(-3.06)	16.10 M
20.00 MHz	20.00 MHz	100.0 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Occupied Bandwidth-Edge of Band 20 MHz 3690 MHz Tx1 256QAM



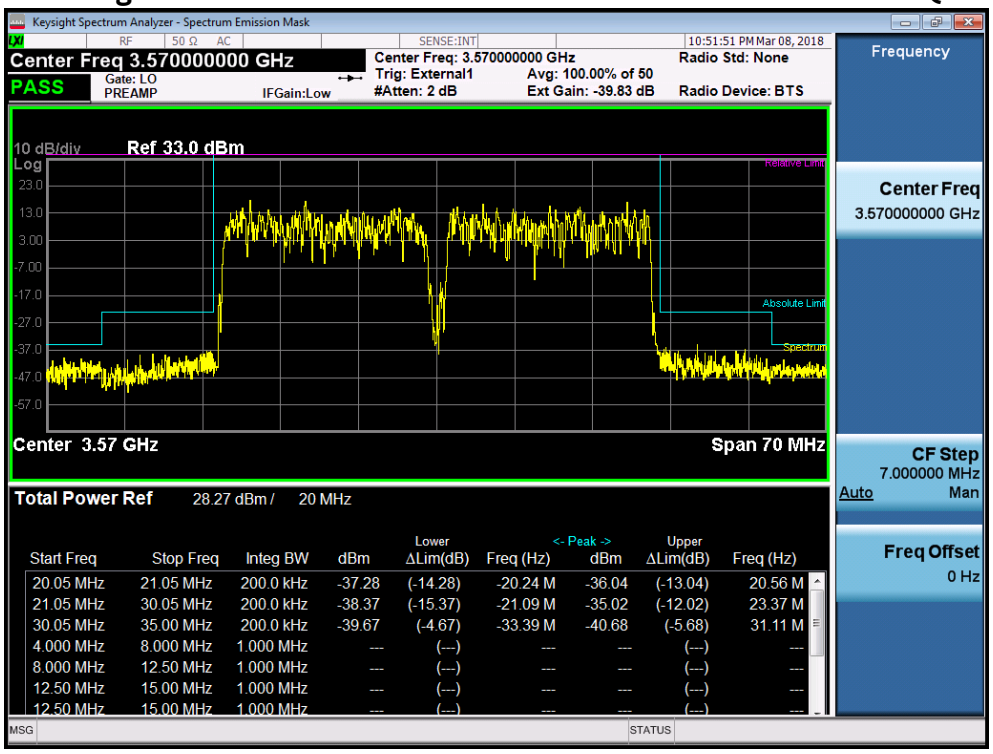
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.05 MHz	11.05 MHz	200.0 kHz	-29.21	(-13.21)	-10.56 M	-29.77	(-13.77)	10.87 M
11.05 MHz	20.05 MHz	200.0 kHz	-29.03	(-6.03)	-13.90 M	-31.02	(-8.02)	12.63 M
20.05 MHz	25.00 MHz	200.0 kHz	-35.44	(-0.44)	-20.50 M	-39.01	(-4.01)	20.20 M
20.00 MHz	20.00 MHz	100.0 kHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

OBW-Edge of Band 10+10 MHz 3555+3565 MHz Tx1 256QAM

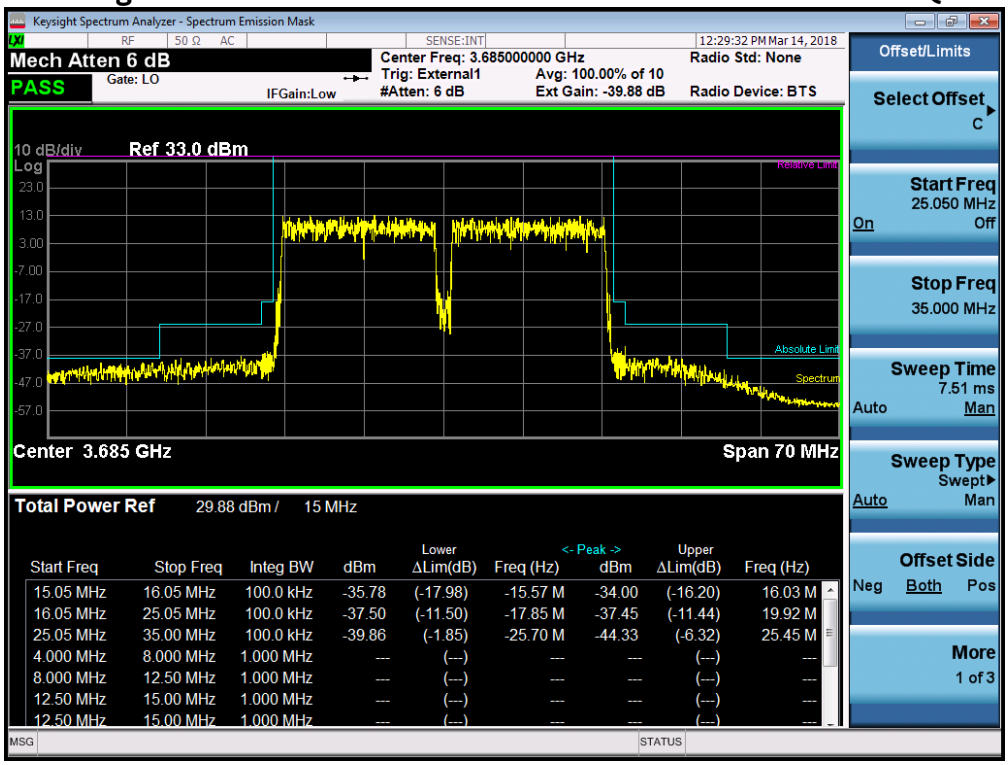


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
10.05 MHz	11.05 MHz	100.0 kHz	-43.94	(-27.94)	-10.08 M	-44.46	(-28.46)	10.06 M
11.05 MHz	20.05 MHz	100.0 kHz	-43.88	(-17.88)	-13.50 M	-44.72	(-18.72)	15.84 M
20.05 MHz	30.00 MHz	100.0 kHz	-49.23	(-11.23)	-20.28 M	-47.15	(-9.15)	20.76 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

OBW-Edge of Band 20+20 MHz 3560+3680 MHz Tx1 256QAM

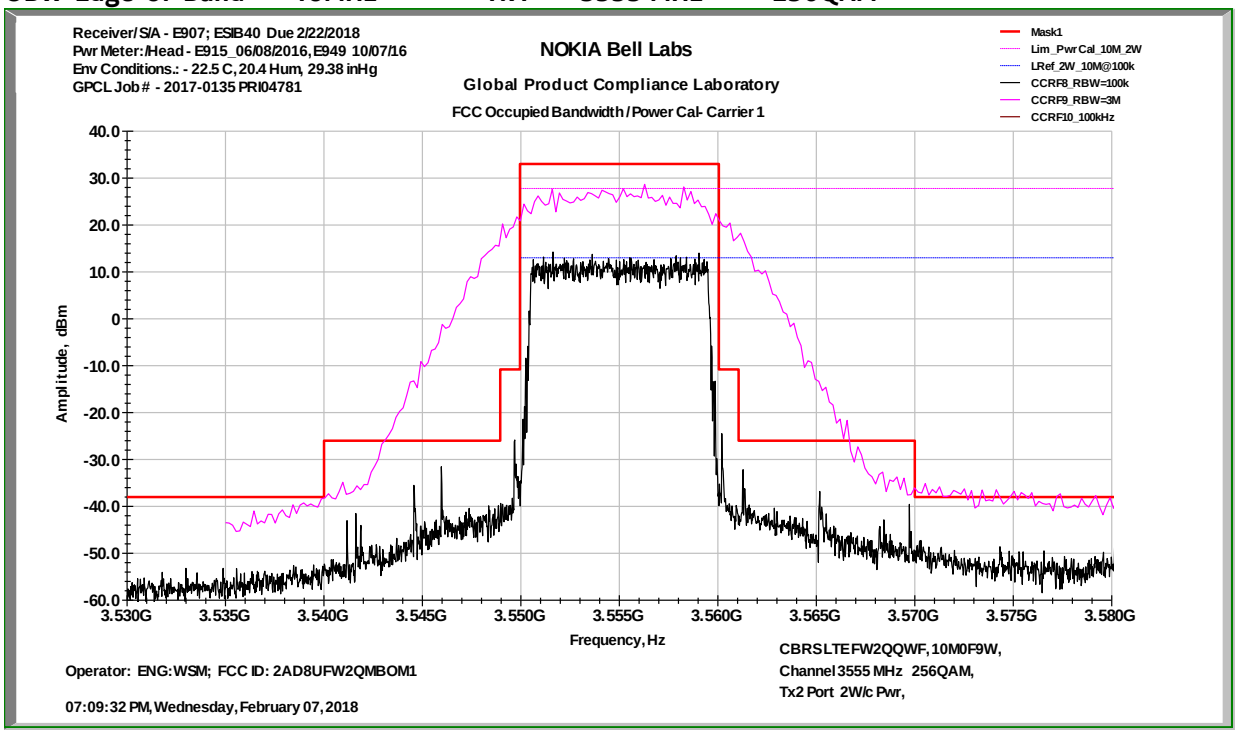


OBW-Edge of Band 15+15 MHz 3677.5+3692.5 MHz Tx1 256QAM

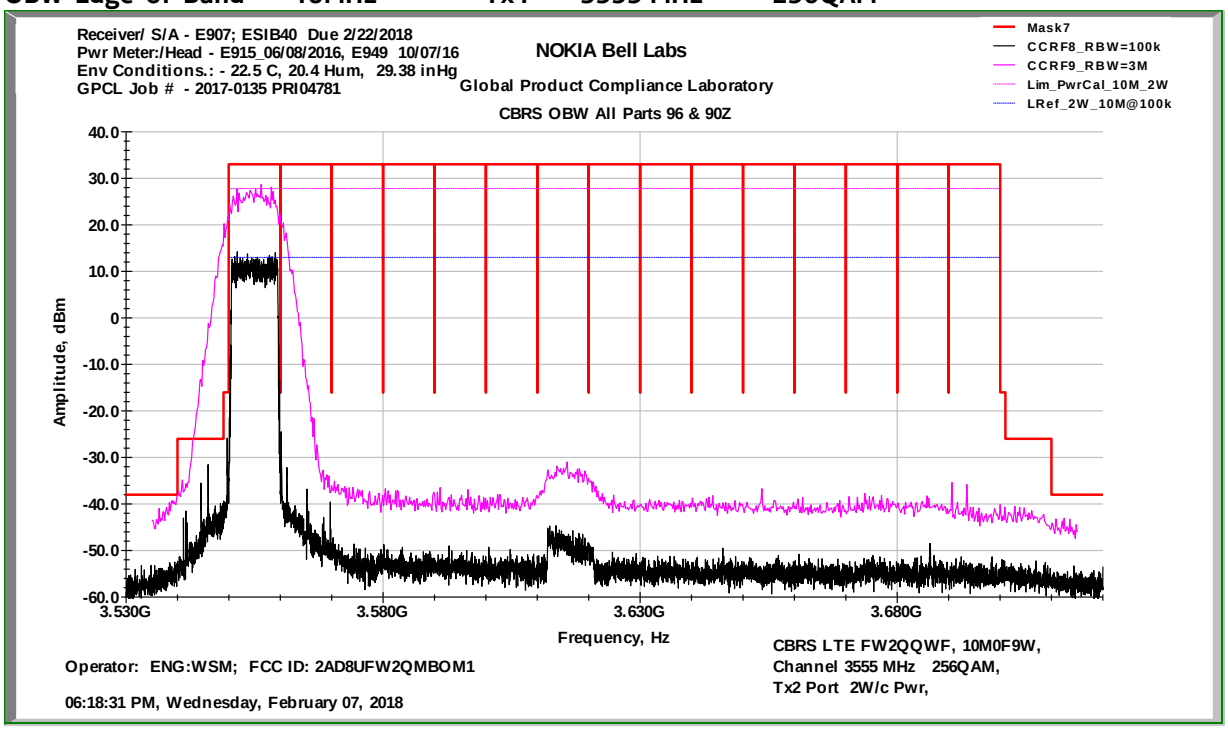


Peak Detector Measurements

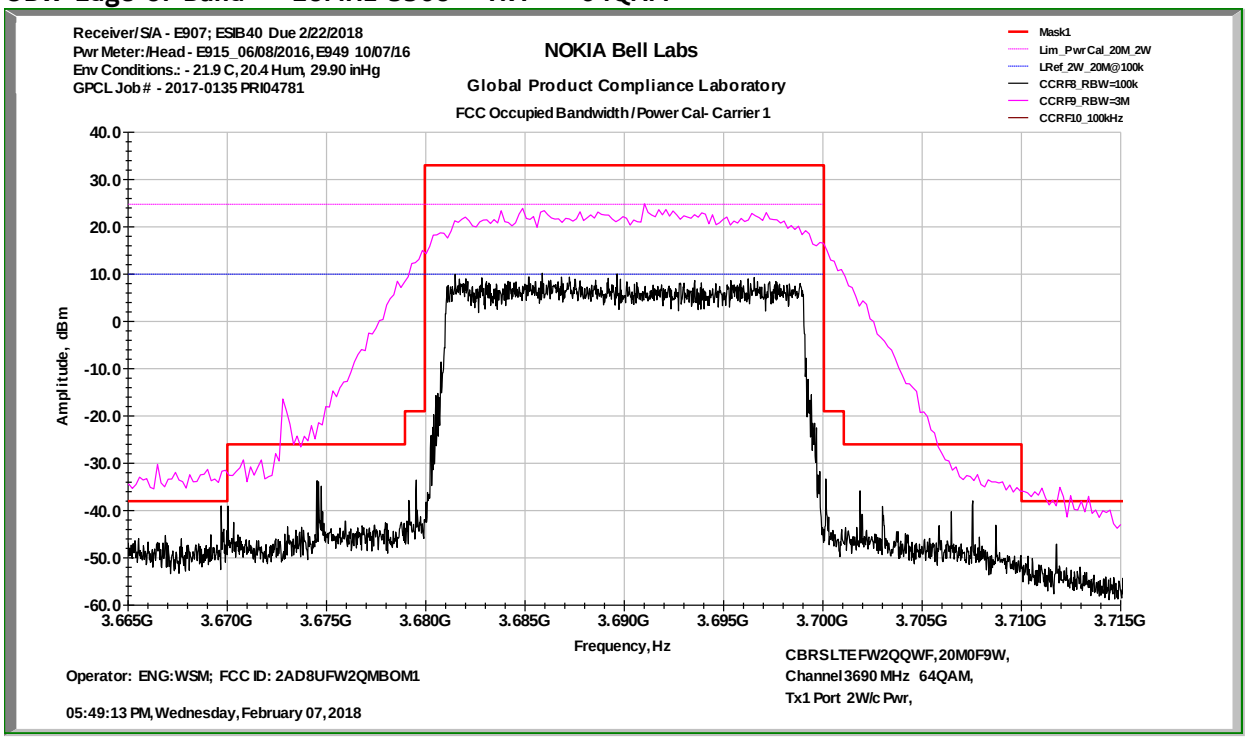
OBW-Edge-of-Band 10MHz Tx1 3555 MHz 256QAM



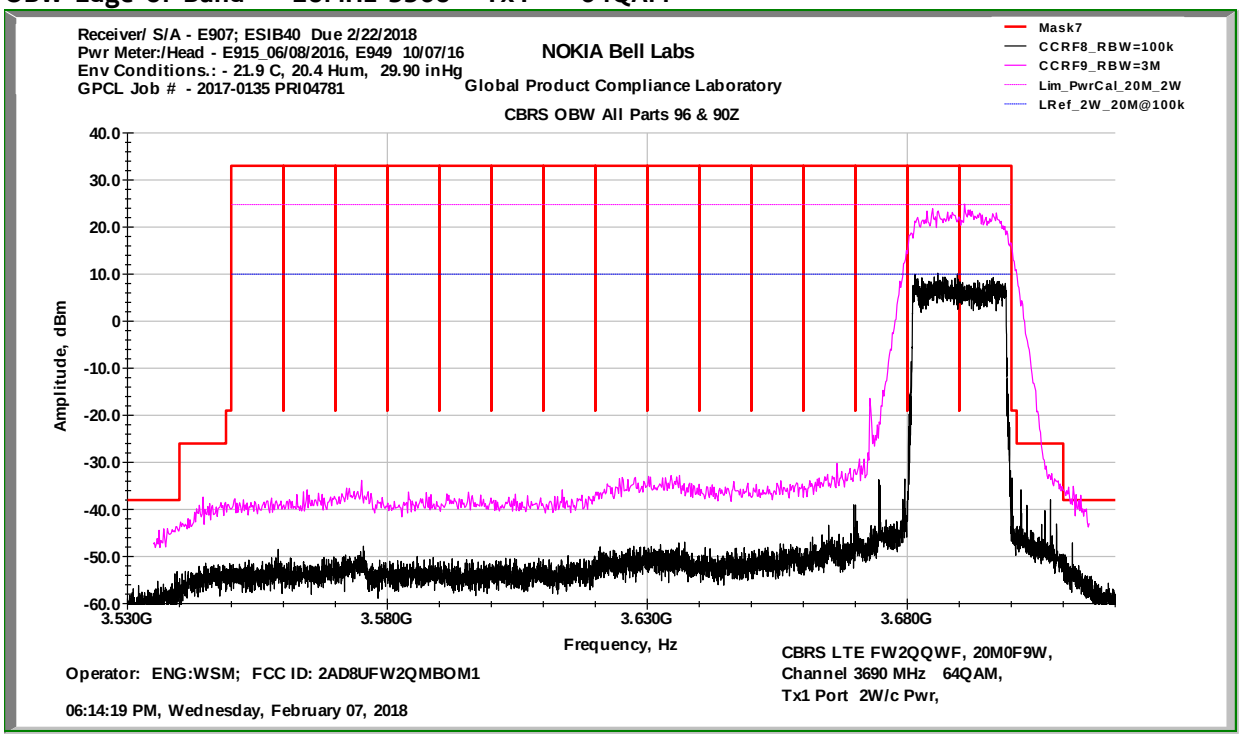
OBW-Edge-of-Band 10MHz Tx1 3555 MHz 256QAM



OBW-Edge-of-Band 20MHz 3560 Tx1 64QAM



OBW-Edge-of-Band 20MHz 3560 Tx1 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 excludes Edge-of-Band emissions.

4.4.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions at the antenna terminals were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 10 MHz to 37 GHz which is beyond the 10th harmonic of the carrier frequency. A test coupler which incorporates a low intermod broadband RF attenuator was used to reduce the transceiver's amplitude to a level usable by the spectrum analyzer. The test configuration is shown in Figure 4.4.1 which documents the test set up used for the measurements. In this set up the complete RF test path was calibrated over the 10 MHz-37 GHz range.

The spurious measurements were made using an automated test system and an MXA Signal Analyzer. The automated test system consists of a Rohde & Schwarz ESIB-40 Test Receiver/ Spectrum Analyzer, a PC based computer test controller, calibrated test hardware and a TILE ™ software program to acquire the test data. These measurements are performed in compliance with ANSI C63.26 and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW. The MXA signal analyzer measurements examine the 10 MHz to 26.5 GHz range while the automated test system overlaps and extends the frequency range to examine the 10 MHz to 37 GHz range.
Measurements were performed for all of the test configurations in Table 4.5.4 and these match the test configurations used for Occupied Bandwidth / Edge of Band Emissions, RF Power and modulation.

4.4.2 Required Limit

The required emission limitation specified in **47CFR 96.41 (e)** was applied to these tests. Based upon the criterion given in Section 96 of the Code and as developed in 4.3.3, the required emission limit for emissions outside a licensee's frequency block is:

47CFR 96.41 (e)(2) *Additional protection levels.* Notwithstanding paragraph (d)(1) of this section, the conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed −40dBm/MHz.

In order to account for the spectral adding of identical signals from the primary and diversity ports, per KDB 662911 D01 Multiple Transmitter Output v01r01, the level needs be adjusted by 10LOG(n) where n= number of outputs.

The adjustment for n=2 is: 3.01 dB = 10LOG(2)

Therefore the limit for emissions >1 MHz outside a licensees frequency block when measured with a RBW of 1 MHz is:

-40 dBm - 3.01 dB = -43.01 dBm for 2x MIMO

4.4.3 Operational Configuration

The modulation used in this evaluation are described in the pertinent standards documents which include **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14)**. The modulation is Orthogonal Frequency Division Multiple Access (OFDMA) which is processed into an uplink IF signal. The input data stream is divided into several parallel sub-streams of reduced data rate and each sub-stream is transmitted on a separate orthogonal sub-carrier. For this test the sub-carriers were modulated using 256QAM.

4.4.4 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 and are tabulated in Table 4.4.4 below. Two sets of data which represent the two extremes of MIMO configurations tested are attached below. The measurement results demonstrate that the subject of the application is in full compliance with the Rules of the Commission and Industry Canada.

Table 4.4.4 Compliance Tabulation of Conducted Spurious Emissions Measurements

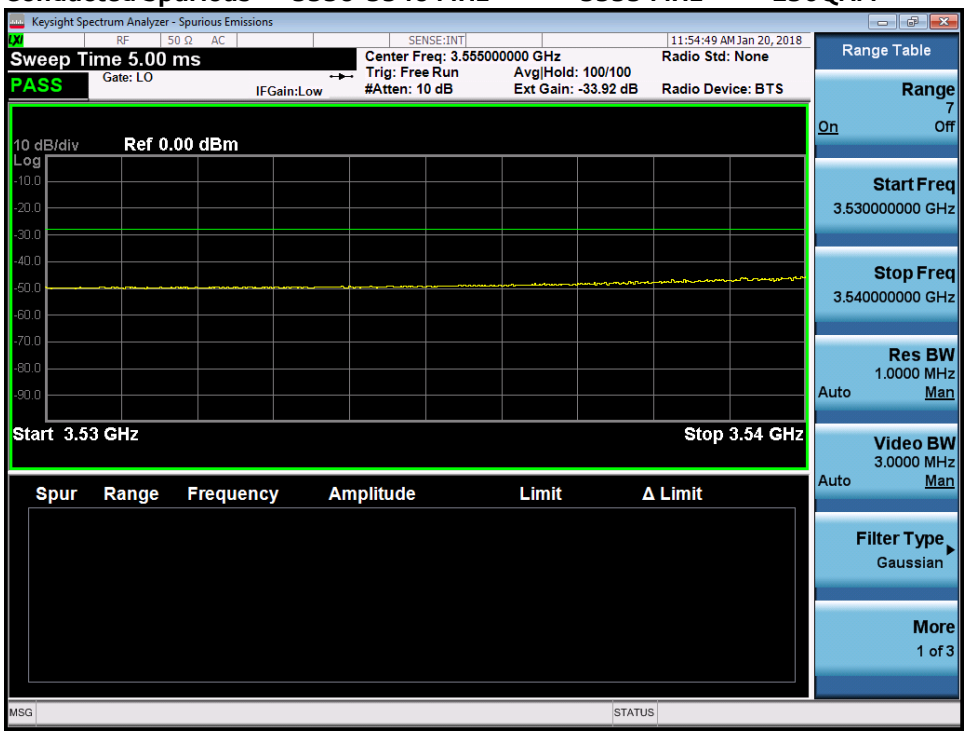
Test #	Transmit Frequency	Tx Port	Signal Bandwidth, MHz	Modulation	Conducted Spurious Emissions Results Pass / Fail
1	3655	Tx2	10	QPSK+16QAM	Pass
2	3665	Tx1	10	64QAM	Pass
3	3655	Tx1	10	256QAM	Pass
4	3675	Tx2	10	QPSK+16QAM	Pass
5	3675	Tx1	10	256QAM	Pass
6	3695	Tx2	10	QPSK+16QAM	Pass
7	3695	Tx1	10	256QAM	Pass
8	3657.5	Tx1	15	256QAM	Pass
9	3675	Tx1	15	256QAM	Pass
10	3657.5	Tx1	15	256QAM	Pass
11	3660	Tx1	20	256QAM	Pass
12	3690	Tx1	20	256QAM	Pass
13	3660+3690	Tx1	20+20	256QAM	Pass
14	3660+3690	Tx2	20+20	256QAM	Pass
15	3555+3565	Tx1	10+10	256QAM	Pass
16	3615+3625	Tx1	10+10	256QAM	Pass
14	3685+3695	Tx1	10+10	256QAM	Pass
15	3557.5+3572.5	Tx2	15+15	256QAM	Pass
16	3617.5+3632.5	Tx2	15+15	256QAM	Pass
17	3677.5+3692.5	Tx2	15+15	256QAM	Pass
18	3677.5+3692.5	Tx2	15+15	Q16	Pass
19	3677.5+3692.5	Tx2	15+15	64QAM	Pass
20	3560+3580	Tx1	20+20	256QAM	Pass
21	3620+3640	Tx1	20+20	256QAM	Pass
22	3670+3690	Tx1	20+20	256QAM	Pass

4.4.5 Transmitter Measurements of Conducted Spurious Emissions

10M0F9W Left Side of Band

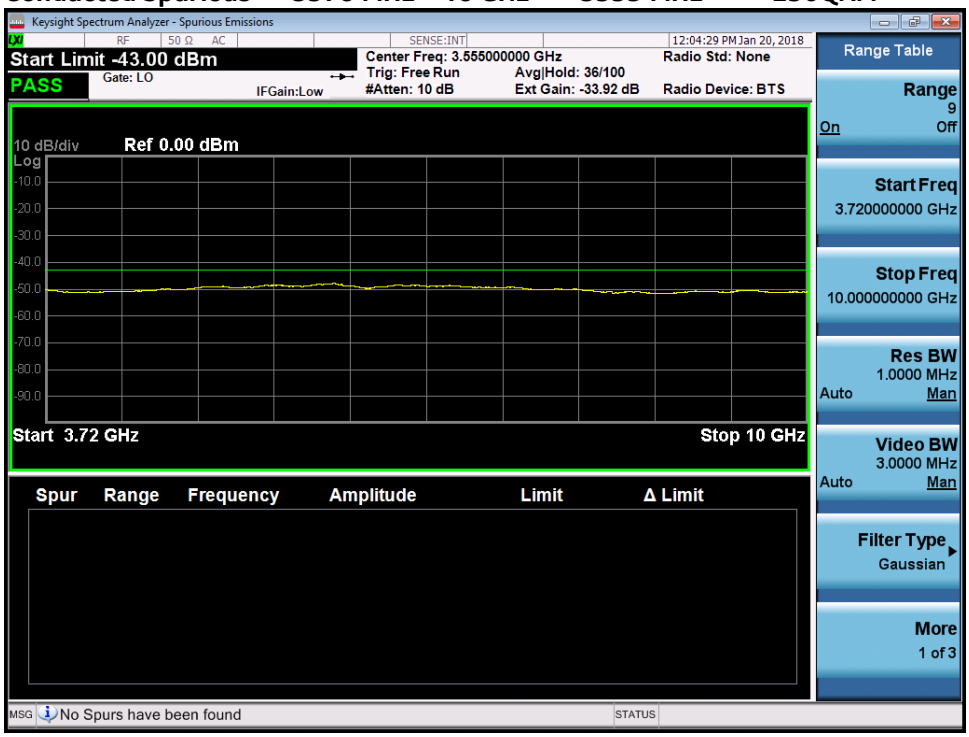
Conducted Spurious 10-3530 MHz 3555 MHz 256QAM 10M0F9W Tx2

Conducted Spurious 3530-3540 MHz 3555 MHz 256QAM 10M0F9W Tx2



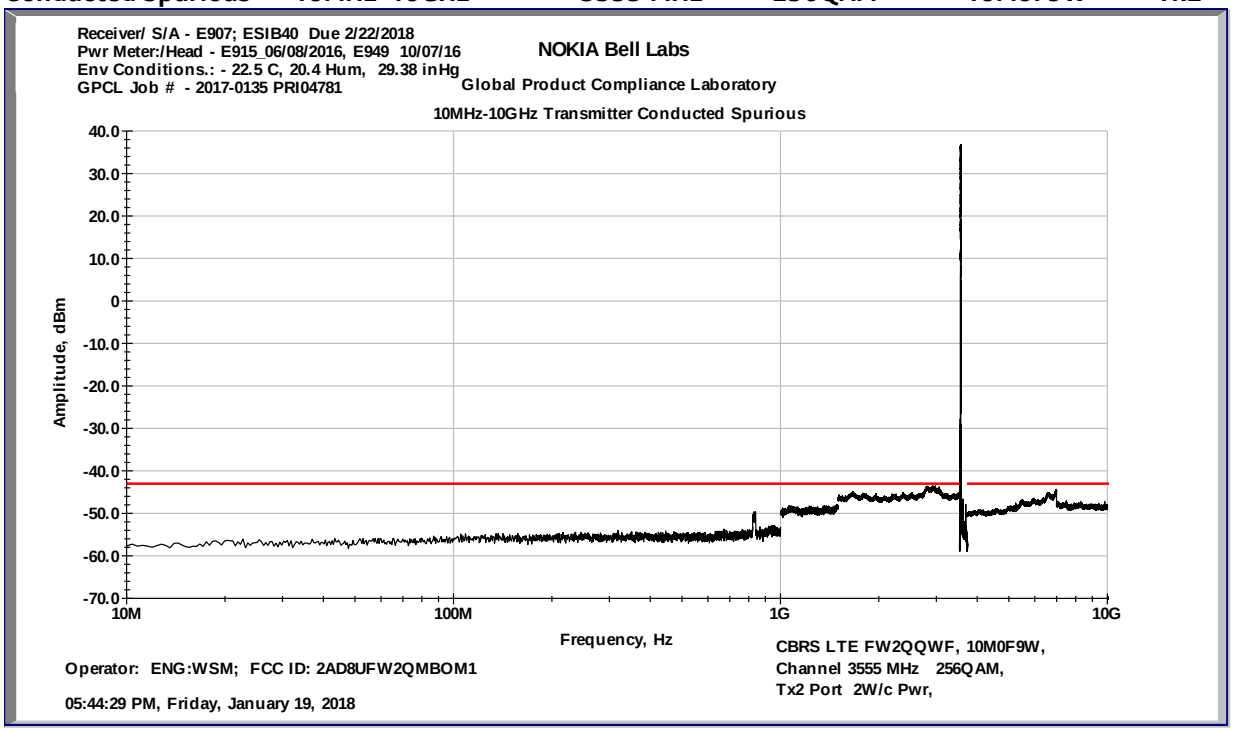
Conducted Spurious 3570–3720 MHz 3555 MHz 256QAM 10M0F9W Tx2

Conducted Spurious 3570 MHz – 10 GHz 3555 MHz 256QAM 10M0F9W Tx2

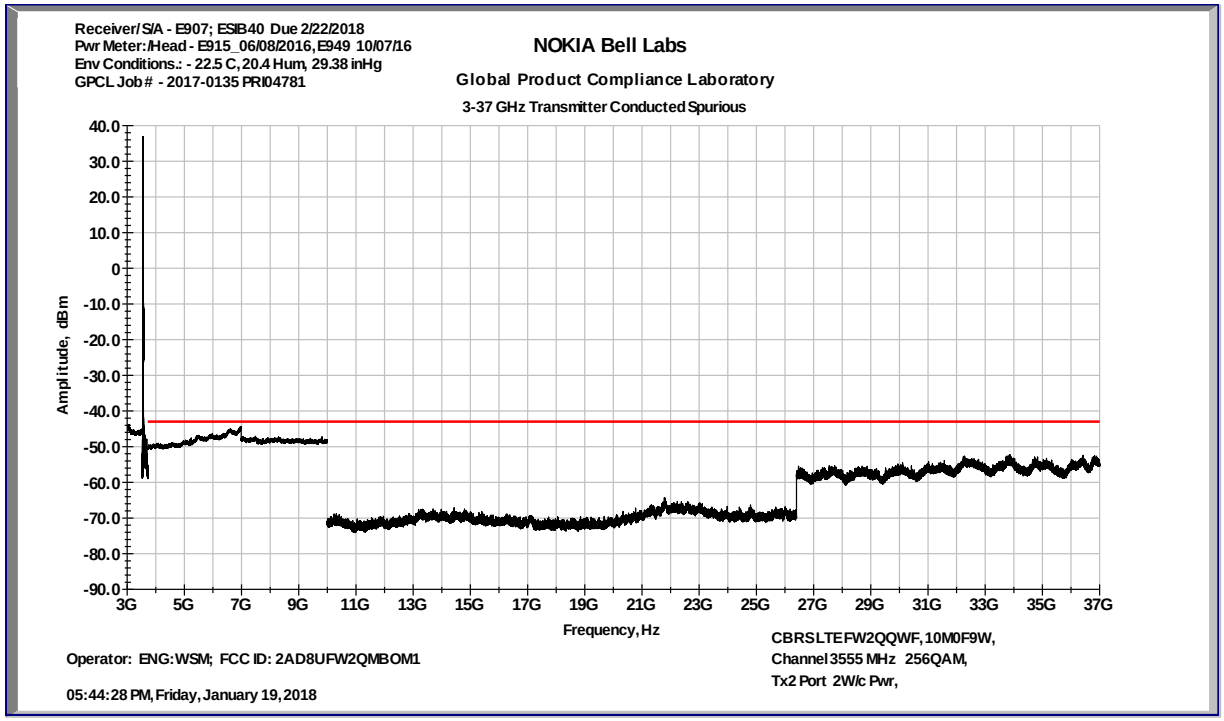


Conducted Spurious 10-26.5 GHz 3555 MHz 256QAM 10M0F9W Tx2

Conducted Spurious 10MHz-10GHz 3555 MHz 256QAM 10M0F9W Tx2

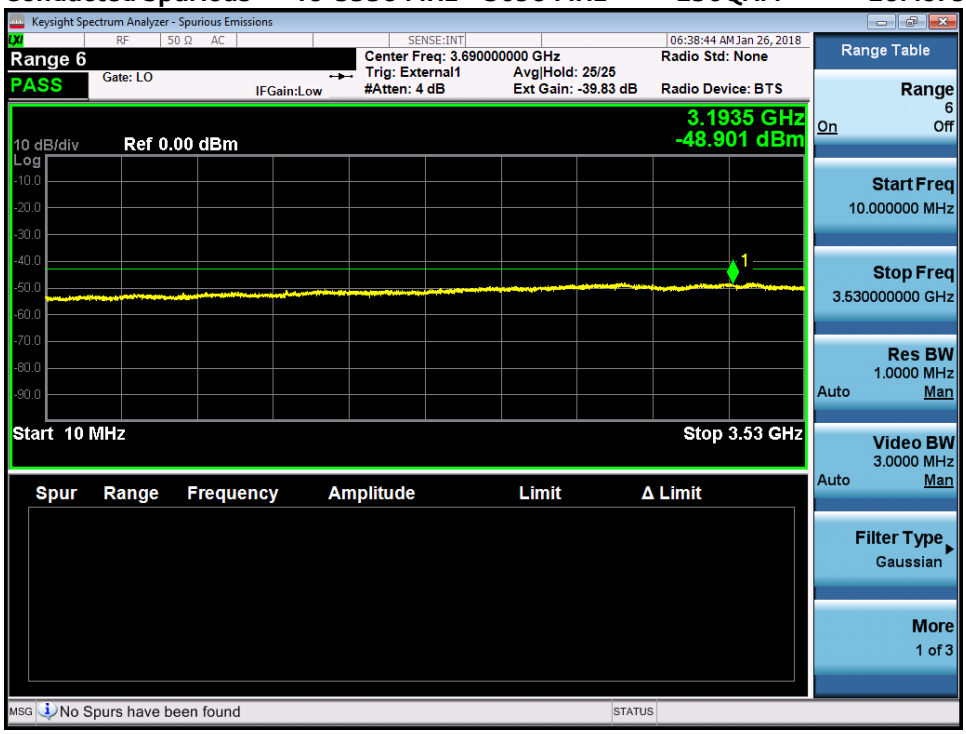


Conducted Spurious 1-37GHz 3555 MHz 256QAM 10M0F9W Tx2



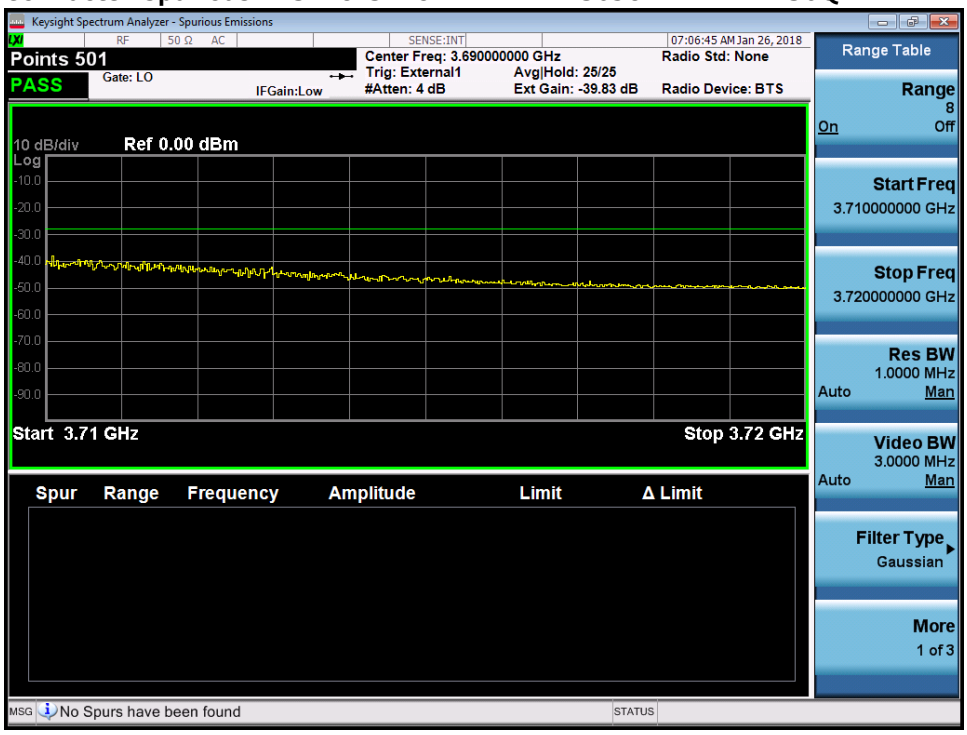
20M0F9W Right Side of Band

Conducted Spurious 10-3530 MHz 3690 MHz 256QAM 20M0F9W Tx1

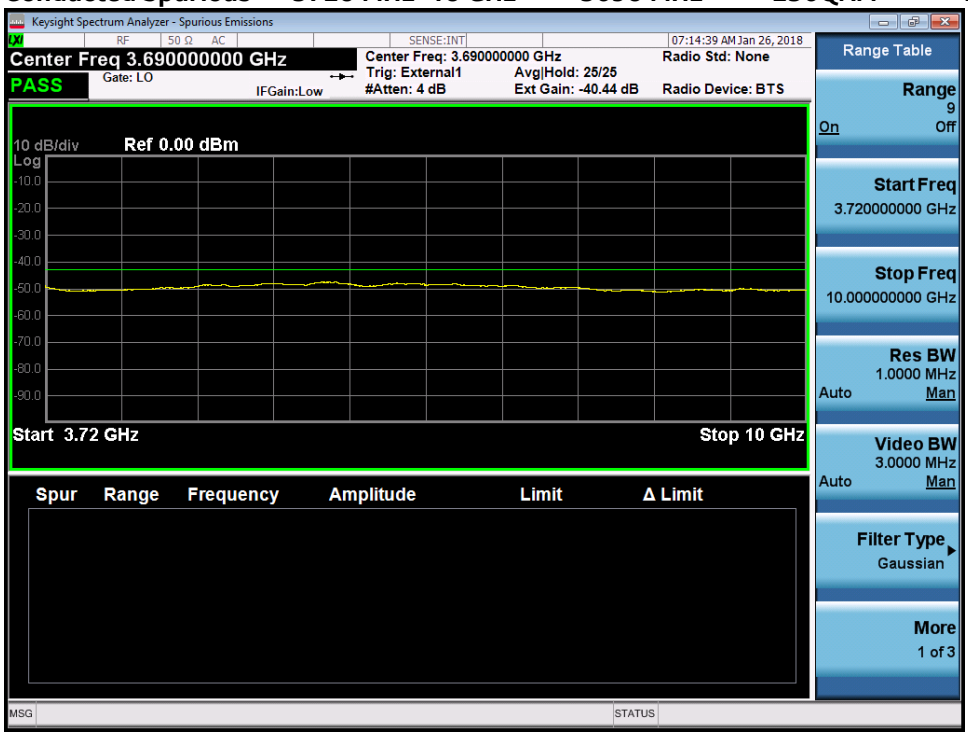


Conducted Spurious 3530-3670 MHz 3690 MHz 256QAM 20M0F9W Tx1

Conducted Spurious 3710–3720 MHz 3690 MHz 256QAM 20M0F9W Tx1

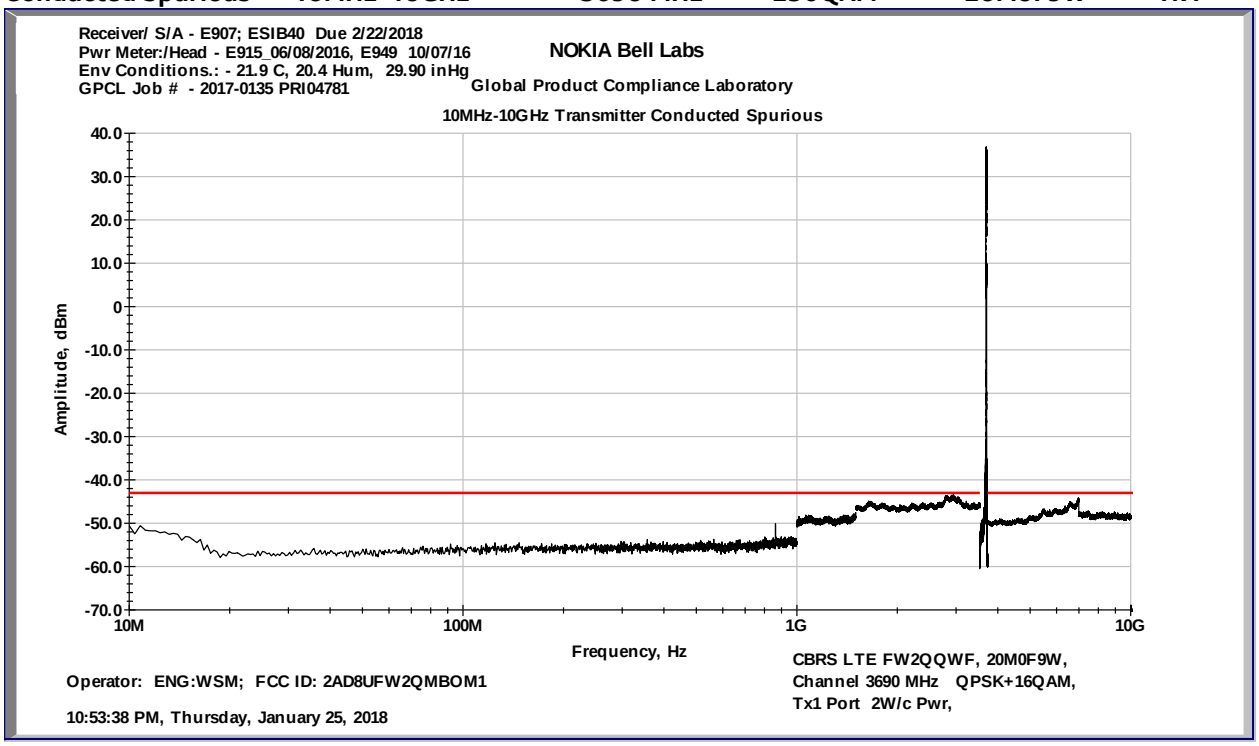


Conducted Spurious 3720 MHz–10 GHz 3690 MHz 256QAM 20M0F9W Tx1

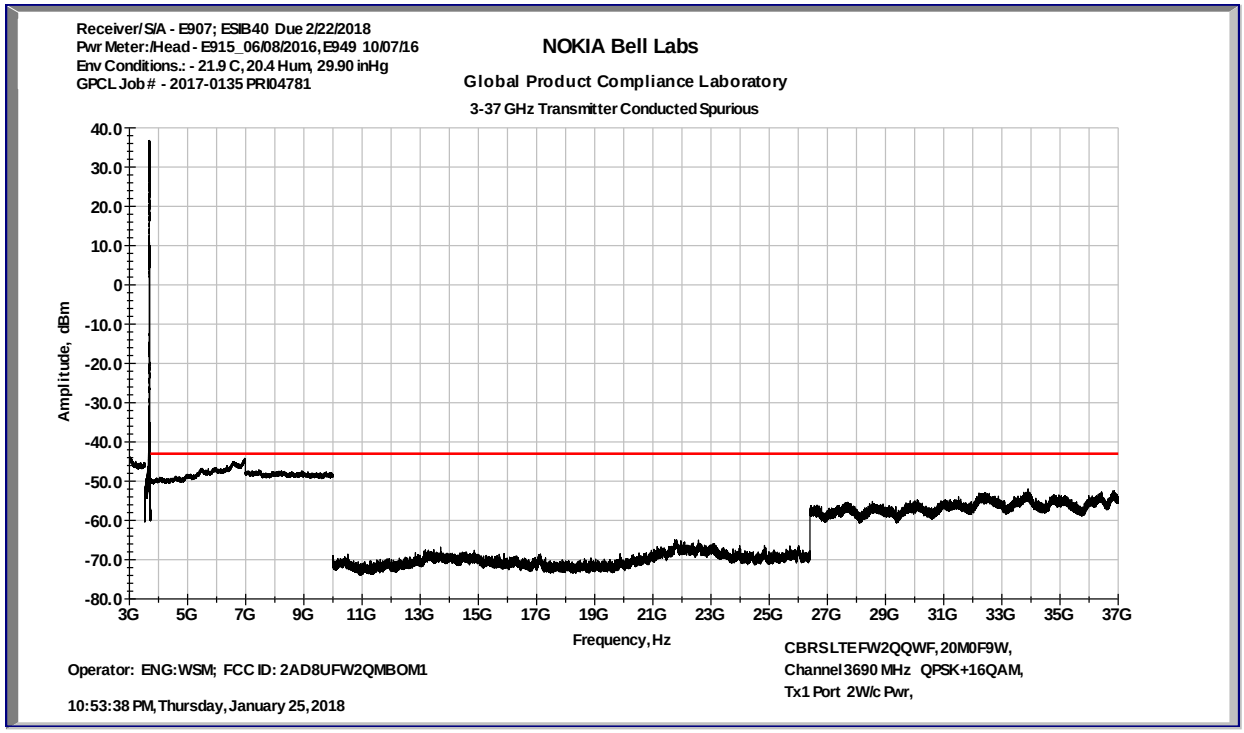


Conducted Spurious 10-26.5 GHz 3690 MHz 256QAM 20M0F9W Tx1

Conducted Spurious 10MHz-10GHz 3690 MHz 256QAM 20M0F9W Tx1



Conducted Spurious 1-37GHz 3690 MHz 256QAM 20M0F9W Tx1



4.5 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

The field strength measurements of radiated spurious emissions were made in a FCC registered three meter semi-anechoic chamber AR-5, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey.
The **CBRS FW2QMBOM1 2x2W** (EUT) was configured with two transmit modules in semi-anechoic chamber AR-5 in the normal field installation. The recommendations of ANSI C63.4–2014 and C63.26-2015 were followed for EUT testing setup and cabling. The EUT was configured to operate per the E-UTRA test model specified in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** A depiction of the setup is in Figure 4.5
The base station was configured into the worst case transmit configuration to transmit two 2x MIMO 10 MHz LTE carrier with the total transmit power of 8W (2x2x2W per port/39.03 dBm). This configuration provides the highest Power Spectral Density transmit signal for the product. All transmit ports were terminated into non-radiating 50 Ω resistive loads. The product in the below configurations was evaluated over the 30 MHz to 37 GHz frequency range.

Table 4.5.1 EUT Configurations

Test Configuration	CBRS Frequency MHz	Active Ports	Signal Bandwidth, MHz	Modulation	Total Power, Watts	Radiated Emissions Pass / Fail
8	3675	Tx1, Tx2 Tx1, Tx2	10	64QAM	8	Pass

4.5.1 Spurious Radiation and Radiated Emissions Requirements.

This product meets Part 15, Part 90Z and Part 96 requirements. . FCC Part 15 Class B require emissions to be below 54.5 dBuV/m at 3m. Part 96 does not contain any additional radiated requirements.
Title 47CFR section 90.1323 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.

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

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

Where: E = Field Intensity in Volts/ meter R = Distance in meters = 3 m
P = Transmitted Power, Watts = 8 W

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 the 3m semi-anechoic chamber, AR-5 as detailed above. 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 4.5. The minimum margin to the Part 90.1323 limit as measured in accordance with 2.1053 is more than 20dB. Sample data plots are per Table 4.6.2

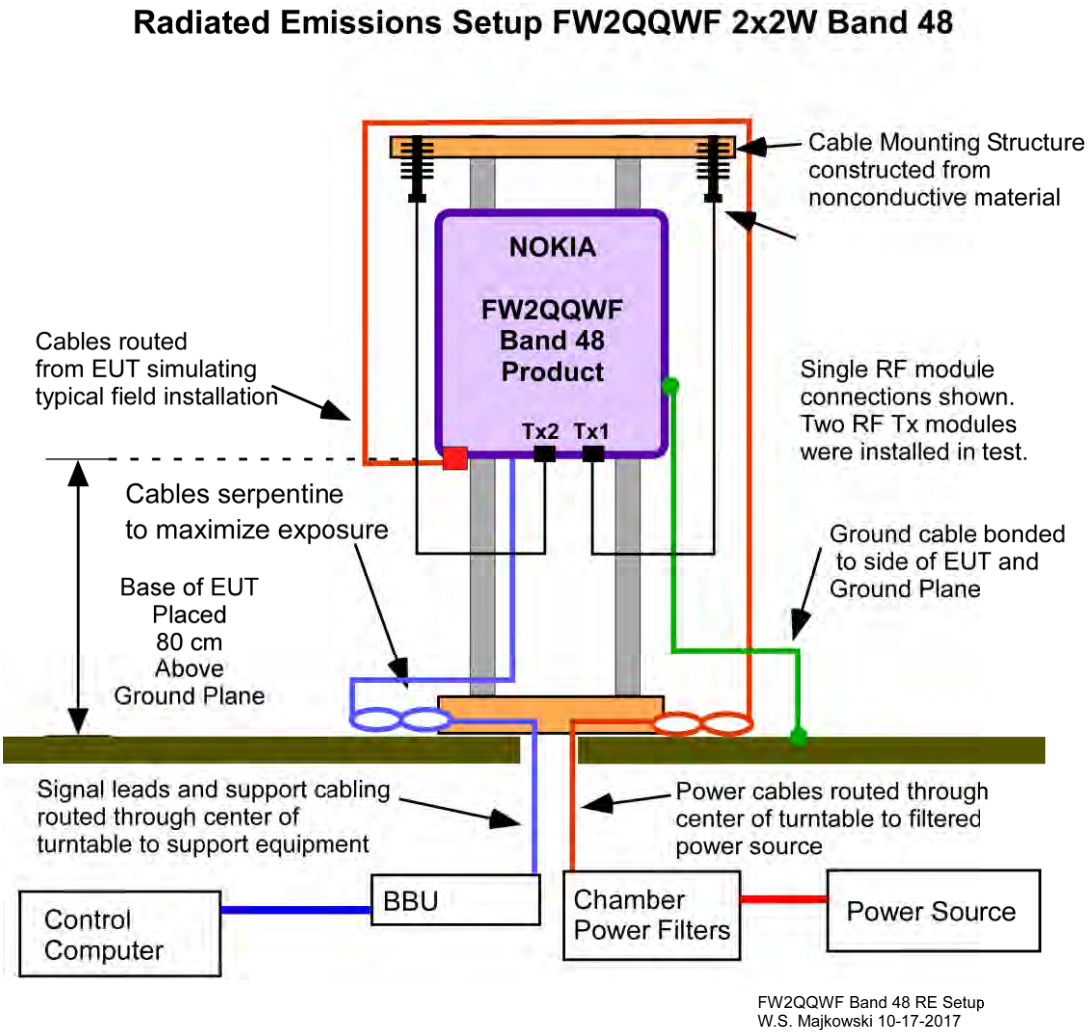
4.5.2 Field Strength of Spurious Radiation Results:

This product meets both Part 90Z and Part 96 Requirements. Part 96 does not have additional radiated Emissions limits beyond those of Part 90Z. For the Title 47CFR section 90.1323 and 2.1053 test, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBμV/meter. Emissions equal to or less than 62.23 dBμV/meter are not reportable and may be verified using field strength measurements with broadband antennas.

Over the out of band spectrum investigated from 10 MHz to beyond the tenth harmonic of the carrier (37GHz), no reportable spurious emissions were detected. Additionally, from 10 MHz to beyond the tenth harmonic of the carrier (37GHz), all non-transmit carrier emissions were below 54.5 dBμV/m. This demonstrates that the **FW2QMBOM1 Flexi Zone Micro BTS CBRS / FCC ID: 2AD8UFW2QMBOM1**, the subject of this application, complies with FCC Part 15 Class B, and FCC Sections 2.1053, 90.1323 and 2.1057 of the Rules.

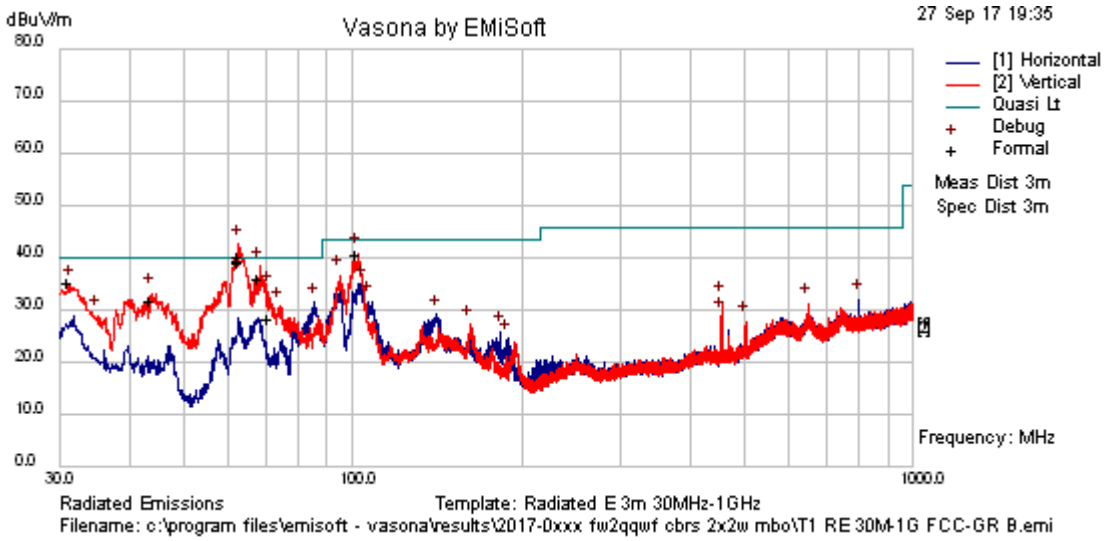
Photographs of the measurement setup are in the filing exhibits.

Figure 4.5 Radiated Emissions Product Setup



4.5.3 Transmitter Measurements of Radiated Spurious Emissions

T1 Radiated Emissions 30M-1GHz FCC Class B Final



Results Title:	Radiated E 3m 30MHz-1GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0135 FW2QMBOM1 cbrs 2x2w mbo\T1 RE 30M-1G FCC-GR B.emi
Test Laboratory:	GPCL AR5-MH 23C, 52%RH, 993mB
Test Engineer:	MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QMBOM1 CBRS 2X2 Watts, 10MBW 64QAM, 3675MHz, x 4, MBO. Hatch closed. AC power cable over the top in cable manager.
Configuration:	Powered by 120VAC - 60Hz, Antenna E602. 6dB pad E889, Sonoma preamp E814, RS-ESI E1190. Tested to FCC Class B RE 30M-1GHz. BW's Default.
Date:	2017-09-27 19:35:22

Formal Data

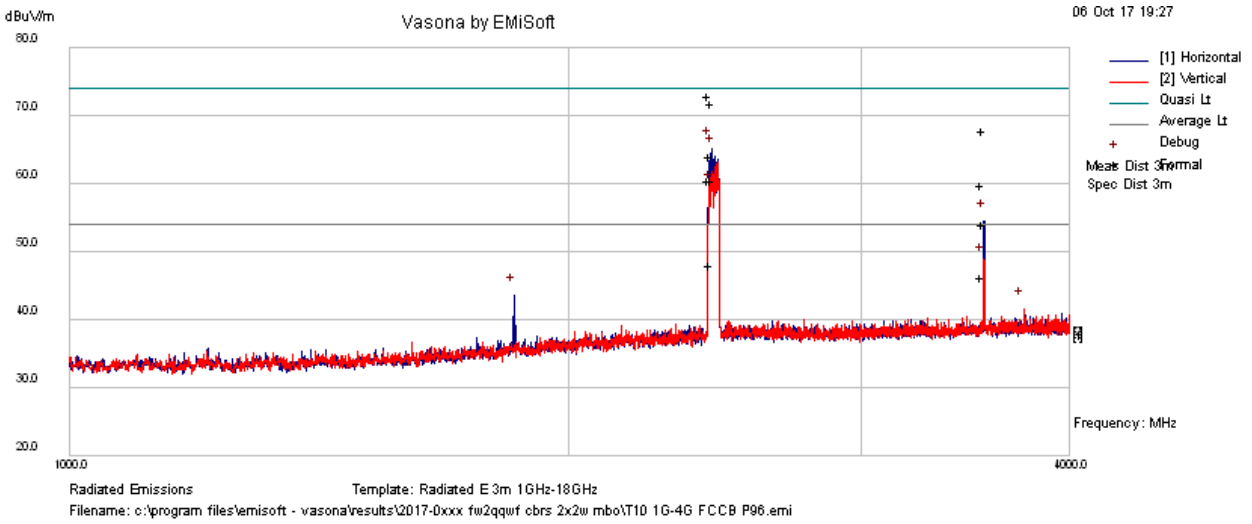
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass /Fail	Comment
62.922	55.96	6.36	-25.4	36.97	Quasi Max	V	205	0	40	-3.03	Pass	
62.922	55.28	6.36	-25.4	36.29	Quasi Max	V	182	84	40	-3.71	Pass	
62.922	54.85	6.36	-25.4	35.86	Quasi Max	V	122	164	40	-4.14	Pass	
101.872	48.38	6.61	-17.6	37.35	Quasi Max	V	110	60	43.5	-6.15	Pass	
67.924	51.58	6.39	-25.1	32.92	Quasi Max	V	108	6	40	-7.08	Pass	
31.308	39.04	6.23	-13.2	32.09	Quasi Max	V	112	169	40	-7.91	Pass	
43.883	41.48	6.25	-19.2	28.54	Quasi Max	V	118	112	40	-11.46	Pass	
70.8818	43.22	6.41	-24.5	25.1	Quasi Max	V	106	209	40	-14.9	Pass	

All non Tx carrier emissions are below 37 dBµV/m/MHz which is 45 dB margin to the Part 90.1323 Limit and more than 35 dB margin to the non report limit

Preview Data

Frequency MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass / Fail	Comment
62.6092	61.55	6.35	-25.3	42.57	Preview	V	202	270	40	2.57	Fail	
68.0922	57.11	6.39	-25	38.47	Preview	V	202	45	40	-1.53	Pass	
102.048	51.89	6.61	-17.6	40.89	Preview	V	202	45	43.5	-2.61	Pass	
31.3467	41.63	6.23	-13.2	34.66	Preview	V	102	90	40	-5.34	Pass	
70.8818	51.78	6.41	-24.5	33.66	Preview	V	202	45	40	-6.34	Pass	
43.8517	46.23	6.25	-19.2	33.31	Preview	V	102	90	40	-6.69	Pass	
94.7375	49.1	6.57	-19	36.65	Preview	V	302	315	43.5	-6.85	Pass	
85.503	45.99	6.51	-21.1	31.44	Preview	H	290	180	40	-8.56	Pass	
104.549	45.35	6.62	-17.2	34.78	Preview	V	102	225	43.5	-8.72	Pass	
74.1523	47.96	6.43	-23.7	30.71	Preview	V	102	45	40	-9.29	Pass	
35.002	37.77	6.24	-15	29.02	Preview	V	102	135	40	-10.98	Pass	
106.858	42	6.64	-16.8	31.81	Preview	H	190	0	43.5	-11.69	Pass	
800.02	33.16	8.25	-9.42	31.99	Preview	H	190	45	46	-14.01	Pass	
455.844	38.93	7.47	-14.6	31.8	Preview	V	102	270	46	-14.2	Pass	
141.487	35.64	6.78	-13.2	29.23	Preview	H	190	135	43.5	-14.27	Pass	
649.671	31.69	7.93	-8.38	31.23	Preview	V	302	90	46	-14.77	Pass	
162.168	35.32	6.86	-15	27.21	Preview	V	102	315	43.5	-16.29	Pass	
454.016	35.93	7.47	-14.6	28.77	Preview	V	102	270	46	-17.23	Pass	
184.004	37.25	6.92	-18.3	25.91	Preview	H	102	180	43.5	-17.59	Pass	
502.016	33.74	7.55	-13.5	27.77	Preview	V	102	0	46	-18.23	Pass	
189.295	36.61	6.94	-18.9	24.65	Preview	H	102	225	43.5	-18.85	Pass	

T10 Radiated Emissions 1GHz—4GHz FCC B_ Part 90Z & Part 96



Results Title:	Radiated E 3m 1GHz-4 GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0135 FW2QMBOM1 2x cbrs 2x2w mbo\T10 1G-4G FCCB P96.emi
Test Laboratory:	GPCL AR5-MH 21C, 47%RH, 1011mB
Test Engineer:	MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QMBOM1 CBRS 2X2 Watts, 10MBW 64QAM, 3555MHz, x 4, MBO. SW: Drop 37. Wi-Fi (2432 MHz [40MHz BW] TX Output= 19 dBm. Wi-Fi [5540 MHz [40 MHz MW] Tx Output = 19 dBm [S/N: EB173411601] Unit #2 LMT Cable: Cat 6e. Gigabit Ethernet Switch Installed between EUT and Laptop
Configuration:	Powered by 120VAC - 60Hz, RS-ESI-1G E704, HP preamp E1166, 3117 E1073, 6dB pad E889. Tested to FCC Class B RE 1G-4GHz. Debug RBW 100KHz, VBW 3MHz Formals 1M and 3M BW's.
Date:	2017-10-06 19:27:39

Formal Data

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2437.1	55.22	8.2	-5.72	57.69	AvgMax	H	299	74	54	3.69	N/A	Authorized Wi Fi Carrier
2445.94	55.16	8.21	-5.7	57.67	AvgMax	H	286	139	54	3.67	N/A	
3558.33	46.71	9.29	-4.87	51.13	AvgMax	H	135	330	54	-2.87	Pass	Authorized
2437.1	67.49	8.2	-5.72	69.96	Quasi Max	H	299	74	74	-4.04	Pass	Authorized
2445.94	66.51	8.21	-5.7	69.02	Quasi Max	H	286	139	74	-4.98	Pass	Authorized
2442.3	42.71	8.21	-5.71	45.21	AvgMax	V	371	209	54	-8.79	Pass	Authorized
3558.33	60.45	9.29	-4.87	64.87	Quasi Max	H	135	330	74	-9.13	Pass	Authorized
3555.1	39.02	9.29	-4.88	43.43	AvgMax	V	184	328	54	-10.57	Pass	Authorized
2442.3	58.63	8.21	-5.71	61.13	Quasi Max	V	371	209	74	-12.87	Pass	Authorized
3555.1	52.51	9.29	-4.88	56.92	Quasi Max	V	184	328	74	-17.08	Pass	Authorized

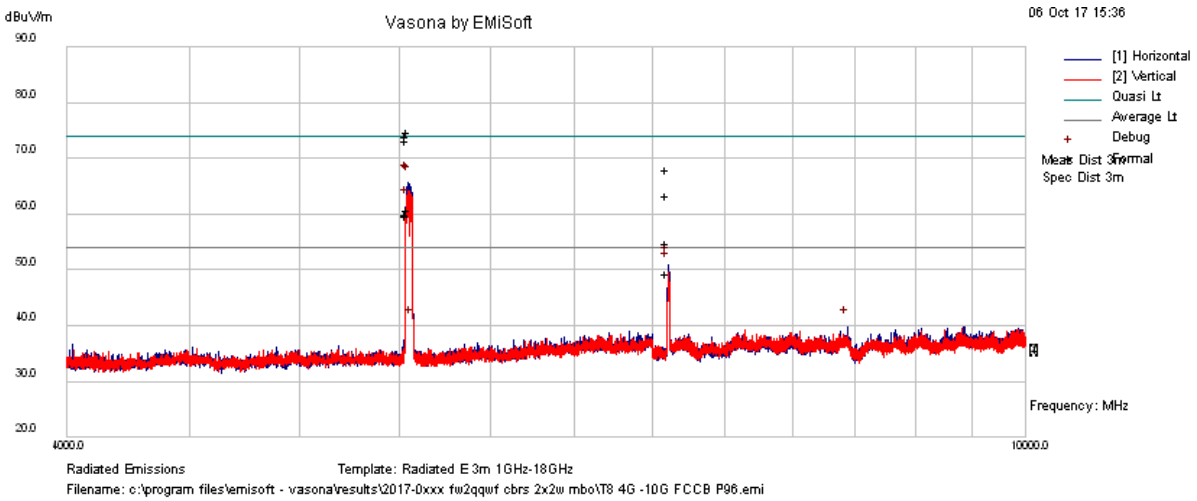
Note: All emissions identified above are authorized carriers for Part 90Z or WiFi .
All non Tx carrier emissions are below 43.53 dBmV/m/MHz which is 38.7 dB margin to the Part 90.1323 Limit and 18.7 dB margin to the non report limit

Preview Data

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2437.1	62.72	8.2	-5.72	65.2	Preview	H	290	135	54	11.2	N/A	Authorized Wi Fi Carrier
2445.94	61.43	8.21	-5.7	63.94	Preview	H	290	135	54	9.94	N/A	
3558.33	50	9.29	-4.87	54.42	Preview	H	190	352	54	0.42	N/A	Authorized Carrier
1854.38	43.76	7.69	-7.92	43.53	Preview	H	290	352	54	-10.47	Pass	-21dB to Pt90
3752.84	36.66	9.47	-4.57	41.56	Preview	V	390	352	54	-12.44	Pass	Authorized
2442.3	56.14	8.21	-5.71	58.64	Debug	V	100	355	54	4.64	Fail	Authorized
3555.1	43.58	9.29	-4.88	47.99	Debug	V	100	355	54	-6.01	Pass	Authorized

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T8 Radiated Emissions 4GHz-10GHz FCC B Part 96



Results Title:	Radiated E 3m 4 GHz-10 GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0135 FW2QMBOM1 cbrs 2x2w mbo\T8 4G -10G FCCB P96.emi
Test Laboratory:	GPCL AR5-MH 21C, 47%RH, 1011mB
Test Engineer:	EEM /MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QMBOM1 CBRS 2X2 Watts, 10MBW 64QAM, 3555MHz, x 4, MBO. SW: Drop 37. Wi-Fi (2432 MHz [40MHz BW] TX Output= 19 dBm. Wi-Fi [5540 MHz [40 MHz MW] Tx Output = 19 dBm [S/N: EB173411601] Unit #2 LMT Cable: Cat 6e. Gigabit Ethernet Switch Installed between EUT and Laptop
Configuration:	Powered by 120VAC - 60Hz, RS-ESI-1G E704, HP preamp E1166, 3117 E1073, HPF (2.5GHz) E1210. Tested to FCC Class B RE 4G-10GHz. Debug RBW 100KHz, VBW 3MHz Formals 1M and 3M BW's.
Date:	2017-10-06 15:36:11

Formal Data

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin- dB	Pass /Fail	Comments
5554.03	55.36	5.16	-3.04	57.49	AvgMax	H	142	231	54	3.49	N/A	Wi-Fi
5545.19	54.43	5.16	-3.04	56.54	AvgMax	H	216	230	54	2.54	N/A	Wi-Fi
5549.16	54.27	5.16	-3.04	56.39	AvgMax	V	182	223	54	2.39	N/A	Wi-Fi
7110.69	46.85	6.66	-2.08	51.43	AvgMax	H	147	337	54	-2.57	Pass	Harmonic
5554.03	69.28	5.16	-3.04	71.4	Quasi Max	H	142	231	74	-2.6	Pass	Wi-Fi
5545.19	68.36	5.16	-3.04	70.48	Quasi Max	H	216	230	74	-3.52	Pass	Wi-Fi
5549.16	67.76	5.16	-3.04	69.88	Quasi Max	V	182	223	74	-4.12	Pass	Wi-Fi
7110.74	41.47	6.66	-2.08	46.05	AvgMax	V	131	14	54	-7.95	Pass	Harmonic
7110.69	60.06	6.66	-2.08	64.64	Quasi Max	H	147	337	74	-9.36	Pass	Harmonic
7110.74	55.5	6.66	-2.08	60.08	Quasi Max	V	131	14	74	-13.92	Pass	Harmonic

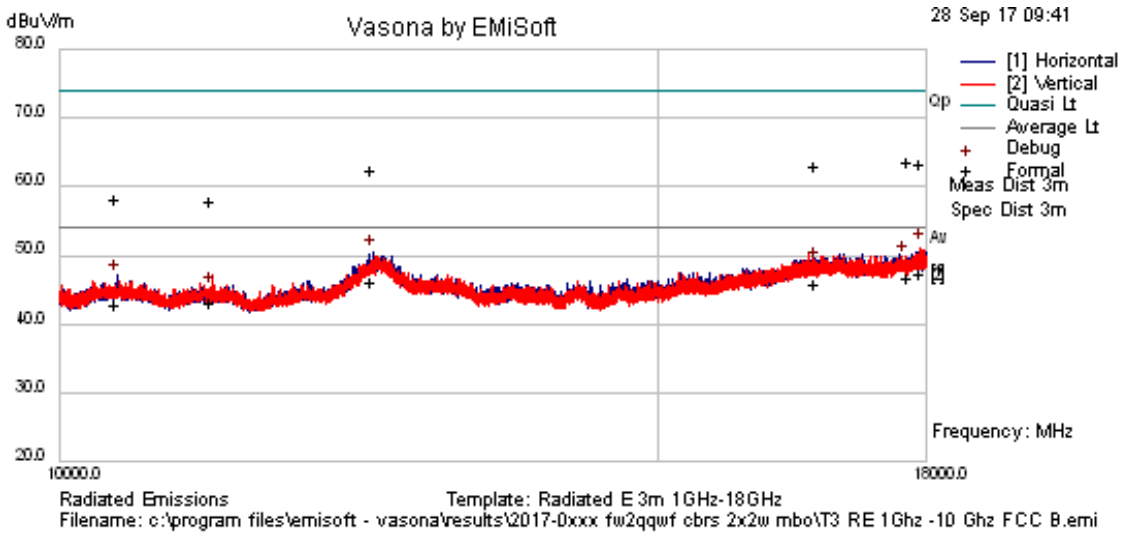
Note: All non Tx carrier emissions are below 51.5 dBmV/m/MHz which is 30.7 dB margin to the Part 90.1323 Limit and 10.7 dB margin to the non report limit

Preview Data

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
5545.19	63.45	5.16	-3.04	65.56	Preview	H	152	225	54	11.56	Fail	
5554.03	63.19	5.16	-3.04	65.31	Preview	H	152	225	54	11.31	Fail	
5549.16	59.29	5.16	-3.04	61.41	Debug	V	156	360	54	7.41	Fail	
7110.09	46.45	6.66	-2.08	51.03	Preview	H	152	360	54	-2.97	Pass	
7110.74	45.28	6.66	-2.08	49.86	Debug	V	156	360	54	-4.14	Pass	
5571.72	37.64	5.17	-3.02	39.79	Preview	H	152	225	54	-14.21	Pass	
8441.09	34.01	8.05	-2.28	39.77	Preview	H	152	225	54	-14.23	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T4 Radiated Emissions 10 GHz – 18 GHz FCC Class B Final



Results Title:	Radiated E 3m 10GHz-18GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0xxx fw2qqwf cbrs 2x2w mbo\T4A RE 10Ghz -18 GHz FCC B.emi
Test Laboratory:	GPCL AR5-MH 21C, 61%RH, 993mB
Test Engineer:	EEM
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QQWF CBRS 2X2 Watts, 10MBW 64QAM, 3675MHz, x 4, MBO. Hatch closed. AC power cable over the top in cable manager. SW: Drop 37. Wi-Fi (2432 MHz [40MHz BW] TX Output= 19 dBm. Wi-Fi[5540 MHz [40 MHz MW] Tx Output = 19 dBm
Configuration:	Powered by 120VAC - 60Hz, Antenna E1073. 6dB pad - E889, Preamp E1166, RS-ESI-1g E1190. Tested to FCC Class B RE 10G-18GHz. Debug BW's 100k-3M // Formals 1M-3M.
Date:	2017-09-28 14:19:19

FORMAL DATA

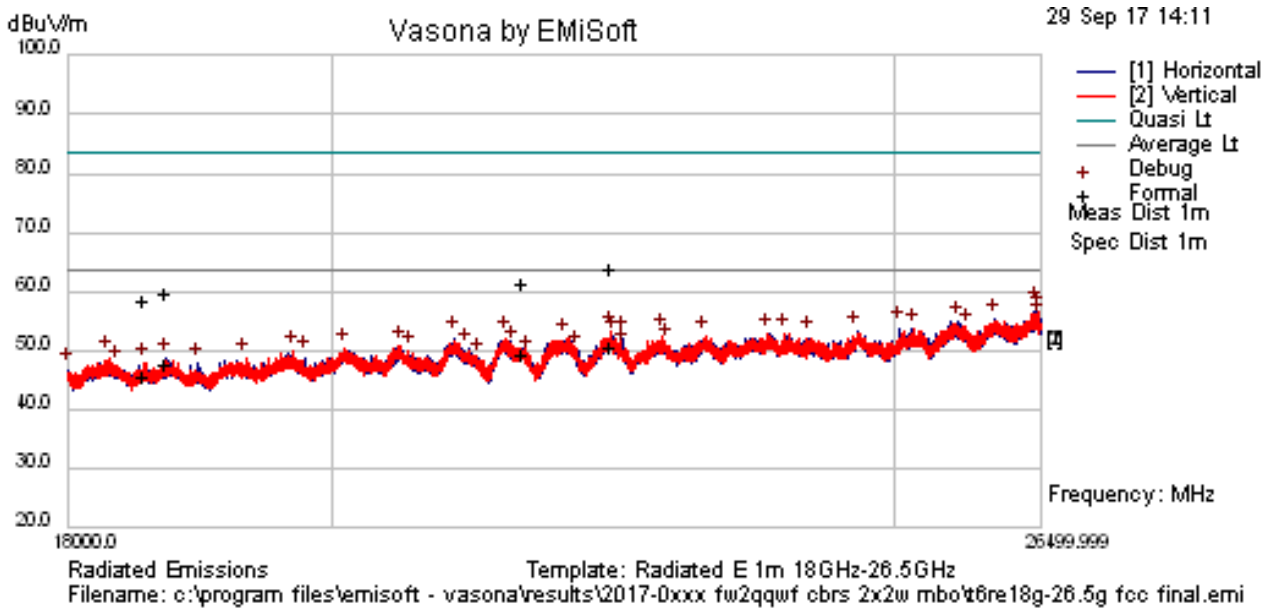
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin-dB	Pass /Fail	Comments
17926.4	24.17	16.41	4.49	45.07	AvgMax	V	227	335	54	-8.93	Pass	
17778.3	23.62	16.29	4.47	44.37	AvgMax	H	111	284	54	-9.63	Pass	
12361	28.13	14.4	1.33	43.86	AvgMax	H	323	229	54	-10.14	Pass	
16692	23.8	15.38	4.46	43.65	AvgMax	H	355	349	54	-10.35	Pass	
17778.3	40.69	16.29	4.47	61.45	Max Peak	H	111	284	74	-12.55	Pass	
17926.4	40.02	16.41	4.49	60.92	Max Peak	V	227	335	74	-13.08	Pass	
11084.1	27.04	13.66	0.14	40.84	AvgMax	H	270	283	54	-13.16	Pass	
16692	40.83	15.38	4.46	60.67	Max Peak	H	355	349	74	-13.33	Pass	
10393.6	27.48	13.4	-0.48	40.4	AvgMax	H	144	252	54	-13.6	Pass	
12361	44.47	14.4	1.33	60.2	Max Peak	H	323	229	74	-13.8	Pass	
10393.6	42.83	13.4	-0.48	55.75	Max Peak	H	144	252	74	-18.25	Pass	
11084.1	41.76	13.66	0.14	55.56	Max Peak	H	270	283	74	-18.44	Pass	

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin- dB	Pass /Fail	Comments
17926.4	30.03	16.41	4.49	50.93	Debug	V	102	154	54	-3.07	Pass	
12351.7	34.62	14.39	1.31	50.32	Debug	H	102	330	54	-3.68	Pass	
10393.6	33.52	13.4	-0.48	46.44	Debug	H	100	355	54	-7.56	Pass	
11084.1	30.97	13.66	0.14	44.77	Debug	H	100	355	54	-9.23	Pass	
16692	28.56	15.38	4.46	48.4	Debug	H	100	355	54	-5.6	Pass	
17733.7	28.68	16.25	4.46	49.39	Debug	H	100	355	54	-4.61	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T6 Radiated Emissions 18G-26.5GHz FCC Class B Final



Results Title:	Radiated E 1m 18GHz-26.5GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0135 FW2QMBOM1 cbrs 2x2w mbo\t6re18g-26.5g fcc final.emi
Test Laboratory:	GPCL AR5-MH 21C, 54%RH, 999mB
Test Engineer:	EEM
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QMBOM1 CBRS 2X2 Watts, 10MBW 64QAM, 3675MHz, x 4, MBO. Hatch closed. AC power cable over the top in cable manager. SW: Drop 37. Wi-Fi (2432 MHz [40MHz BW] TX Output= 19 dBm. Wi-Fi [5540 MHz [40 MHz MW] Tx Output = 19 dBm
Configuration:	Powered by 120VAC - 60Hz, Antenna E513, RS-ESI-1G E704. HP preamp -E1166, Tested to FCC Class B RE 18G-26.5GHz. Debug BW's 100k-3M Formals 1M / 3M. BW's.
Date:	2017-09-29 14:11:58

FORMAL DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin-dB	Pass /Fail	Comments
22355.4	31.4	7.91	8.18	47.49	AvgMax	V	204	121	63.5	-16.01	Pass	
21588.3	30.37	7.85	8.17	46.39	AvgMax	V	184	238	63.5	-17.11	Pass	
18721	30.71	7.04	6.95	44.7	AvgMax	H	117	81	63.5	-18.8	Pass	
18557	28.78	6.99	6.98	42.76	AvgMax	V	122	259	63.5	-20.74	Pass	
22355.4	44.76	7.91	8.18	60.85	Quasi Max	V	204	121	83.5	-22.65	Pass	
21588.3	42.39	7.85	8.17	58.41	Quasi Max	V	184	238	83.5	-25.09	Pass	
18721	42.82	7.04	6.95	56.8	Quasi Max	H	117	81	83.5	-26.7	Pass	
18557	41.68	6.99	6.98	55.65	Quasi Max	V	122	259	83.5	-27.85	Pass	

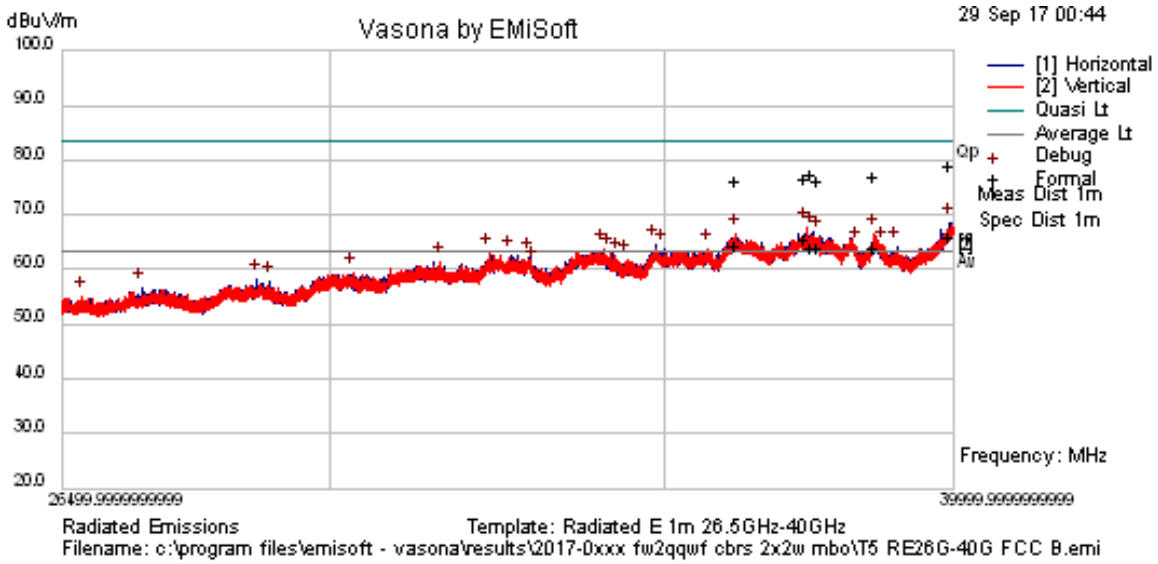
Note: All non Tx carrier emissions are below 47.5 dBmV/m/MHz which is 34.7 dB margin to the Part 90.1323 Limit and 14.7 dB margin to the non report limit

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin- dB	Pass /Fail	Comments
26459.1	36.69	9.27	11.04	57.01	Preview	H	102	264	63.5	-6.49	Pass	
26487.4	36.02	9.31	11.12	56.45	Preview	V	102	0	63.5	-7.05	Pass	
26037.5	36.74	8.74	9.84	55.32	Preview	H	102	286	63.5	-8.18	Pass	
26495.8	34.81	9.32	11.15	55.27	Preview	V	152	22	63.5	-8.23	Pass	
25650.1	36.83	8.57	9.39	54.79	Preview	H	150	132	63.5	-8.71	Pass	
25063.3	36.58	8.48	8.75	53.81	Preview	H	200	242	63.5	-9.69	Pass	
25203.2	36.25	8.5	8.91	53.66	Preview	V	152	44	63.5	-9.84	Pass	
25752.9	35.35	8.59	9.49	53.42	Preview	V	200	154	63.5	-10.08	Pass	
22345.9	37.11	7.9	8.18	53.19	Preview	V	152	44	63.5	-10.31	Pass	
24639	36.45	8.48	8.24	53.16	Preview	H	200	176	63.5	-10.34	Pass	
23777.3	36.57	8.35	7.85	52.77	Preview	V	200	242	63.5	-10.73	Pass	
23948.5	36.57	8.43	7.75	52.74	Preview	V	200	242	63.5	-10.76	Pass	
22811.2	36.51	8	8.13	52.64	Preview	V	152	264	63.5	-10.86	Pass	
23199.4	36.15	8.11	8.04	52.3	Preview	V	102	66	63.5	-11.2	Pass	
22375.6	36.08	7.91	8.19	52.18	Preview	V	152	286	63.5	-11.32	Pass	
21428	36.05	7.85	8.24	52.14	Preview	V	152	264	63.5	-11.36	Pass	
24187.2	35.74	8.47	7.85	52.06	Preview	H	102	0	63.5	-11.44	Pass	
20997.2	35.75	7.85	8.45	52.06	Preview	H	150	0	63.5	-11.44	Pass	
22447.9	35.89	7.92	8.22	52.04	Preview	H	102	110	63.5	-11.46	Pass	
21946.4	36.02	7.84	8.05	51.91	Preview	V	152	154	63.5	-11.59	Pass	
22859.5	34.85	8.01	8.12	50.97	Preview	V	152	66	63.5	-12.53	Pass	
20549.5	35.03	7.64	8.11	50.77	Preview	V	152	22	63.5	-12.73	Pass	
21489.9	34.6	7.85	8.21	50.66	Preview	V	152	352	63.5	-12.84	Pass	
21108.1	34.1	7.86	8.4	50.35	Preview	H	200	154	63.5	-13.15	Pass	
20097	34.85	7.41	8.02	50.28	Preview	V	200	88	63.5	-13.22	Pass	
22461.6	34.1	7.93	8.22	50.26	Preview	H	150	352	63.5	-13.24	Pass	
22050.9	33.98	7.85	8.05	49.88	Preview	H	200	110	63.5	-13.62	Pass	
19691.1	34.67	7.29	7.8	49.75	Preview	V	152	44	63.5	-13.75	Pass	
20643.5	33.84	7.68	8.18	49.7	Preview	V	200	110	63.5	-13.8	Pass	
21627.3	33.12	7.85	8.16	49.12	Preview	V	102	220	63.5	-14.38	Pass	
18295	34.9	6.92	7.06	48.88	Preview	V	200	220	63.5	-14.62	Pass	
19786.7	33.65	7.31	7.86	48.82	Preview	H	150	286	63.5	-14.68	Pass	
21195.7	32.5	7.86	8.35	48.71	Preview	H	150	286	63.5	-14.79	Pass	
19323	34.07	7.2	7.39	48.66	Preview	V	102	132	63.5	-14.84	Pass	
18721	34.6	7.04	6.95	48.59	Preview	H	102	308	63.5	-14.91	Pass	
18557	33.89	6.99	6.98	47.86	Preview	V	200	220	63.5	-15.64	Pass	
18963.7	33.71	7.11	6.9	47.71	Preview	H	102	286	63.5	-15.79	Pass	
18360.9	33.34	6.94	7.04	47.32	Preview	V	102	264	63.5	-16.18	Pass	
18004	32.77	6.83	7.16	46.76	Preview	H	150	154	63.5	-16.74	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T5 Radiated Emissions 26.5 GHz-40 GHz FCC B



Results Title:	Radiated E 1m 26.5GHz-40GHz
File Name:	c:\program files\EMISoft - vasona\results\2017-0135 FW2QMBOM1 cbrs 2x2w mbo\T5 RE26G-40G FCC B.emi
Test Laboratory:	GPCL AR5-MH 21C, 61%RH, 993mB
Test Engineer:	MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	FW2QMBOM1 CBRS 2X2 Watts, 10MBW 64QAM, 3675MHz, x 4, MBO. Hatch closed. AC power cable over the top in cable manager. SW: Drop 37. Wi-Fi (2432 MHz [40MHz BW] TX Output= 19 dBm. Wi-Fi [5540 MHz [40 MHz MW] Tx Output = 19 dBm
Configuration:	Powered by 120VAC - 60Hz, Antenna E526, RS-ESI-40G E704. Tested to FCC Class B RE 26.5G-40GHz. Debug BW's 100k-3M Formals 1M / 3M. BW's.
Date:	2017-09-29 00:44:44

FORMAL DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin- dB	Pass /Fail	Comments
36188.3	33.47	0	27.63	61.1	AvgMax	V	109	132	63.5	-2.4	Pass	
37489.6	32.9	0	28.07	60.97	AvgMax	H	99	314	63.5	-2.53	Pass	
38571.4	33.71	0	27.13	60.84	AvgMax	V	139	259	63.5	-2.66	Pass	
37600.5	32.73	0	27.98	60.71	AvgMax	H	179	265	63.5	-2.79	Pass	
39943.2	47.82	0	27.94	75.75	Quasi Max	H	171	231	83.5	-7.75	Pass	
37489.6	46.38	0	28.07	74.45	Quasi Max	H	99	314	83.5	-9.05	Pass	
38571.4	46.78	0	27.13	73.9	Quasi Max	V	139	259	83.5	-9.6	Pass	
37377	45.59	0	28.14	73.73	Quasi Max	V	125	0	83.5	-9.77	Pass	
37600.5	45.32	0	27.98	73.3	Quasi Max	H	179	265	83.5	-10.2	Pass	
36188.3	45.46	0	27.63	73.09	Quasi Max	V	109	132	83.5	-10.41	Pass	

Note: No discernable emissions. Noise floor was 61.1 dBmV/m/MHz which is 21.13 dB margin to the Part 90.1323 Limit and 1.13 dB margin to the non report limit

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin-dB	Pass /Fail	Comments
36188.3	38.84	0	27.63	66.47	Preview	V	180	44	63.5	2.97	Fail	
37600.5	38.21	0	27.98	66.19	Preview	H	142	286	63.5	2.69	Fail	
34858.1	39.09	0	25.28	64.37	Preview	H	182	308	63.5	0.87	Fail	
38270.8	36.82	0	27.39	64.21	Preview	H	162	198	63.5	0.71	Fail	
38982.1	37.24	0	26.81	64.05	Preview	H	182	308	63.5	0.55	Fail	
38737	36.99	0	27	63.99	Preview	V	140	154	63.5	0.49	Fail	
34989.9	38.43	0	25.37	63.81	Preview	H	142	330	63.5	0.31	Fail	
34031.8	38.97	0	24.79	63.76	Preview	V	102	0	63.5	0.26	Fail	
35711.7	36.98	0	26.71	63.68	Preview	V	200	286	63.5	0.18	Fail	
34130.7	38.16	0	24.84	63	Preview	V	160	22	63.5	-0.5	Pass	
32280.5	38.89	0	23.97	62.86	Preview	V	140	220	63.5	-0.64	Pass	
32606.8	38.37	0	24.17	62.54	Preview	H	142	110	63.5	-0.96	Pass	
32894.5	37.77	0	24.25	62.02	Preview	H	122	242	63.5	-1.48	Pass	
34257.7	37.03	0	24.9	61.93	Preview	V	160	220	63.5	-1.57	Pass	
34406.4	36.78	0	24.97	61.75	Preview	V	140	132	63.5	-1.75	Pass	
31564.3	37.97	0	23.33	61.3	Preview	V	160	330	63.5	-2.2	Pass	
32957.2	36.23	0	24.27	60.5	Preview	H	122	132	63.5	-3	Pass	
30309.7	36.21	0	22.99	59.2	Preview	V	180	176	63.5	-4.3	Pass	
28994.8	36.3	0	21.77	58.07	Preview	H	122	176	63.5	-5.43	Pass	
29175.6	35.97	0	21.9	57.86	Preview	H	182	286	63.5	-5.64	Pass	
27490.1	36.35	0	20.07	56.43	Preview	H	162	286	63.5	-7.07	Pass	
26754.3	35.62	0	19.28	54.91	Preview	V	140	110	63.5	-8.59	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

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4.6 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 and RSS-133. The unit which provides baseband signals, such as BBU (baseband unit), can be located outside the chamber if it is a separated unit.

4.6.1 Frequency Stability Test Article and Configuration

The unit under test is identified as follows:
Nokia Flexi Zone Micro BTS CBRS FW2QQWF MBO B48+B48+WiFi, SN: EB173411599, PN: 474444A.X31.
CBRS B48 RF Module, FW2QMBOM1, PN: 090043A.X31, SN: EB173410348;
CBRS B48 RF Module, FW2QMBOM1, PN: 090043A.X31, SN: EB173410409;
WIFI Module FZCW2OM, PN: 088775A.X22, SN: EB170612507.

4.6.2 Frequency Stability Test

Frequency Stability Testing was performed on– Flexi Zone Multi-Band Outdoor (MBO) CBRS B48+WiFi with B48 CF 3675MHz. The testing was performed on the B48 CBRS MBO from 10/16-18/2017. The product was configured per Figure 4.6.2 and tested in the T-17 Thermal chamber of the GPCL test facility located in Bldg 4, Room 4-278, Murray Hill, NJ. Testing was witnessed by Joe Bordonaro from GPCL. The UUT was subjected to a range of temperature from ambient to +50ºC to -30ºC and back to ambient. Frequency Stability performance was verified by measuring Frequency Tolerance at EAC using an MXA Signal Analyzer. Frequency Tolerance is a measurement of the difference between the actual transmit frequency and the assigned frequency (3675MHz). The system level Frequency Stability testing of the UUT yielded results in compliance with established design criteria.

4.6.3 Frequency Stability Test Equipment

Instrument Type	Serial Number	Vendor	Cal Due Date
MXA Signal Analyzer	MY49060086	AGILENT N9020A	12/07/2018
Power Meter	GB37170415	HP EPM-442 Power Meter	01/05/2018
Power Sensor	US37291096	HP 8482A	03/02/2018
Power Sensor	3318A90689	HP 8481A	02/07/2018
Multi-meter	71520011	FLUKE 16 MULTIMETER	03/07/2019
Digital Power Meter	91HA24429	YOKOGAWA WT210 Power Meter	02/24/2018
Thermal Logger	S5H103437	YOKOGAWA MV200S	03/07/2019
GPS Receiver	KR93200773	SYMMETRICOM 58503B	No Cal Req.
Power supply	04243	BEHLMAN AC Source Model BL1350	No Cal Req.

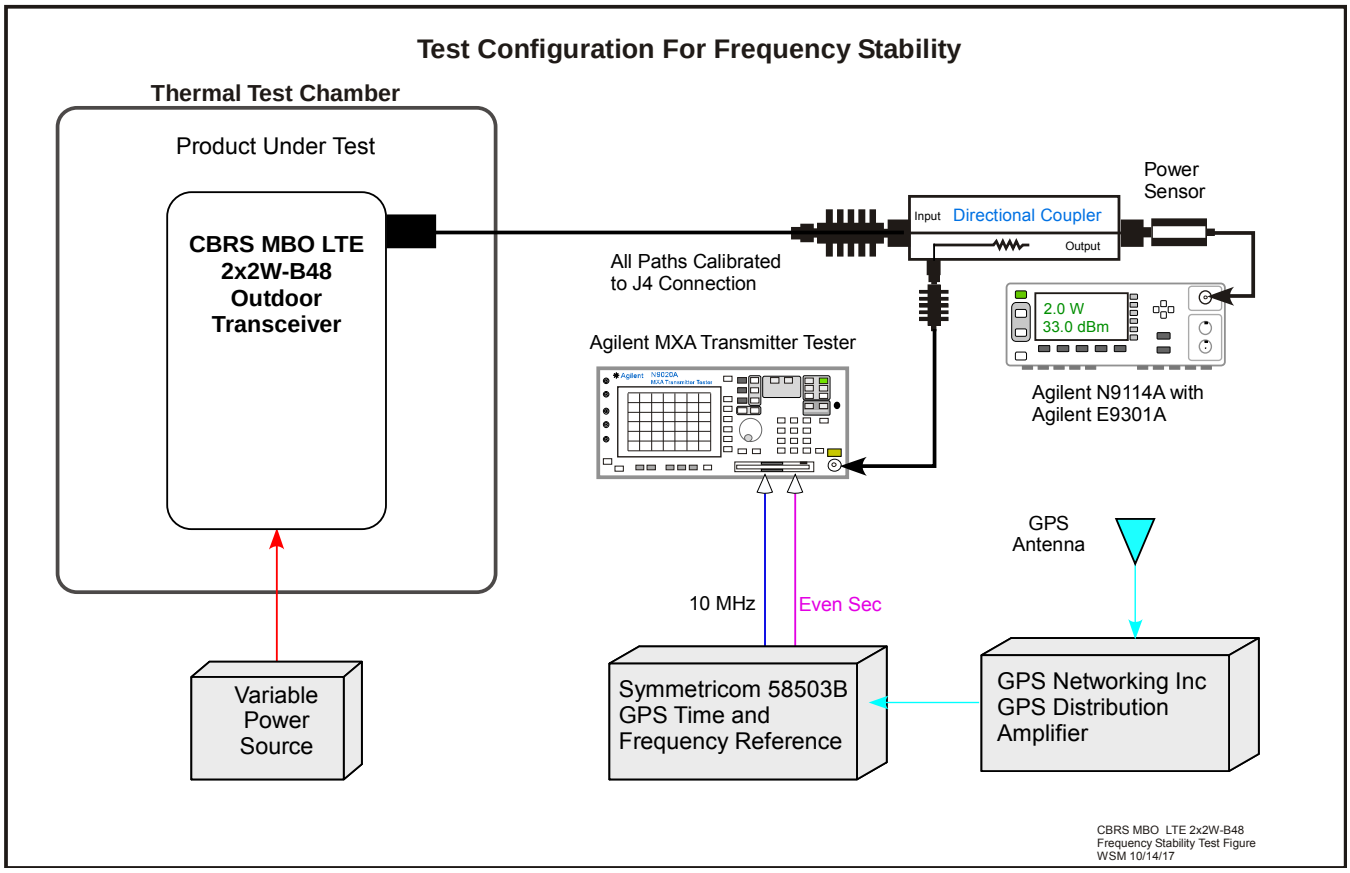
4.6.4 Frequency Stability Test process

Set the power supply to nominal Voltage. (b) Record the frequency at ~25°C. (c)Raise EUT operating temperature to 50°C. (d)Record the frequency difference. (e) Repeat step (d) at each 10°C step down to -30°C. Result will be 10 readings and take temperature readings to establish thermal stability at each point.

4.6.5 Frequency Stability Results:

The worst case Frequency Stability over temperature and voltage was **-55.231 Hz which is -0.015 ppm.** This is within the +/- 0.05ppm desired performance required for LTE operation.

FIGURE 4.6.2: Frequency Stability Test Set-Up



4.6.6 Frequency Stability Test Photos

Photographs of the Frequency Stability test setups are in the filing exhibits.

4.6.7 Frequency Stability Data:

Baseline Measurement at +25°C

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-36.478
0.5	-55.231
1.0	-25.299
1.5	-29.614
2.0	-44.824
2.5	-32.041
3.0	-26.702
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-32.702
0.5	-16.516
1.0	-28.810
1.5	-37.816
2.0	-55.177
2.5	-52.841
3.0	-23.886
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-23.185
0.5	-34.655
1.0	-46.395
1.5	-33.557
2.0	-40.943
2.5	-22.156
3.0	-45.844
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-38.796**
0.5	**-17.984**
1.0	**-34.813**
1.5	**-27.267**
2.0	**-44.850**
2.5	**-30.447**
3.0	**-31.248**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-25.732**
0.5	**-34.508**
1.0	**-41.209**
1.5	**-32.778**
2.0	**-48.960**
2.5	**-51.285**
3.0	**-35.025**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	**-31.350**
0.5	**-43.513**
1.0	**-24.947**
1.5	**-33.516**
2.0	**-31.818**
2.5	**-30.375**
3.0	**-23.769**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-27.997**
0.5	**-14.032**
1.0	**-24.338**
1.5	**-35.115**
2.0	**-46.111**
2.5	**-23.590**
3.0	**-30.401**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-40.217**
0.5	**-19.335**
1.0	**-24.788**
1.5	**-39.880**
2.0	**-46.103**
2.5	**-34.784**
3.0	**-28.565**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-23.726**
0.5	**-38.680**
1.0	**-41.442**
1.5	**-23.890**
2.0	**-29.945**
2.5	**-42.512**
3.0	**-30.761**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-21.197**
0.5	**-40.711**
1.0	**-37.284**
1.5	**-29.627**
2.0	**-36.089**
2.5	**-26.676**
3.0	**-35.821**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Upon return to +25°C. vary voltage to +15% and -15% of nominal VAC and record frequency difference.

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-32.966**
0.5	**-26.678**
1.0	**-51.813**
1.5	**-29.916**
2.0	**-20.554**
2.5	**-43.203**
3.0	**-27.597**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +15% of Nominal Voltage, 138VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-28.695**
0.5	**-33.193**
1.0	**-27.317**
1.5	**-39.724**
2.0	**-26.821**
2.5	**-42.937**
3.0	**-27.310**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +12% of Nominal Voltage, 134.40VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-47.951**
0.5	**-28.603**
1.0	**-32.118**
1.5	**-33.271**
2.0	**-23.917**
2.5	**-43.605**
3.0	**-35.420**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +9% of Nominal Voltage, 130.80VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-34.183**
0.5	**-43.662**
1.0	**-34.987**
1.5	**-22.425**
2.0	**-40.592**
2.5	**-29.867**
3.0	**-24.560**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +6% of Nominal Voltage, 127.20VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-31.825**
0.5	**-37.046**
1.0	**-33.114**
1.5	**-30.696**
2.0	**-32.876**
2.5	**-28.322**
3.0	**-30.725**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +3% of Nominal Voltage, 123.60VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-25.970**
0.5	**-32.433**
1.0	**-53.518**
1.5	**-30.749**
2.0	**-25.827**
2.5	**-30.832**
3.0	**-29.635**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, 116.40VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-40.020**
0.5	**-32.856**
1.0	**-34.518**
1.5	**-33.775**
2.0	**-42.605**
2.5	**-33.128**
3.0	**-27.277**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, 112.80VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-21.036**
0.5	**-33.596**
1.0	**-29.039**
1.5	**-32.341**
2.0	**-36.711**
2.5	**-31.684**
3.0	**-28.871**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, 109.20VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	-32.097
0.5	-44.428
1.0	-32.624
1.5	-42.051
2.0	-38.275
2.5	-28.415
3.0	-33.354
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, 105.60VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	-46.011
0.5	-28.185
1.0	-41.045
1.5	-32.218
2.0	-39.682
2.5	-32.884
3.0	-29.638
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, 102VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	-30.694
0.5	-35.690
1.0	-32.391
1.5	-42.446
2.0	-29.622
2.5	-34.206
3.0	-41.540
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

4.7 List of Test Equipment

4.7.1 List of Radiated Emissions Test Equipment

The following equipment was used for the measurement of Radiated Emissions.

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E602	A.H. Systems Inc.	Bilogical Antenna	25 - 2000 MHz	SAS-521-2	410	12/08/16	12/08/18
E1166	Agilent Technologies	Amplifier	Pre-Amplifier 1-26.5GHz	8449B	3008A01740	2/25/16	2/25/18
E555	EMC Test Systems	Multi-Device Controller		2090	1577		
E1073	ETS Lindgren	Horn Antenna	Double-Ridged Waveguide Horn 1-18 GHz	3117	00135198	6/09/17	6/09/19
E1190	Rohde & Schwarz	Test Receiver	EMI Test Receiver 20Hz-26.5GHz	ESI	832692/005	6/29/16	6/29/18
E814	Sonoma Instrument Co.	Amplifier	9kHz-1GHz	310N	186747	8/10/16	8/10/18
E889	Weinschel	Attenuator	6 dB DC-18GHz 5 Watt	2-6	BX3438	2/25/16	2/25/18

4.7.2 List of Antenna Port Test Equipment

The following equipment was used for conducted measurement performed at the products antenna ports.

Asset ID▼	Manufacturer	Type	Details	Model	Serial	Calibration Date	Calibration. Due Date
E907	Rohde & Schwarz	Test Receiver	EMI (20Hz to 40 GHz) -150 +30dBM	ESIB40	100101	9/22/15	2/22/18
E704	Rohde & Schwarz	Test Receiver	EMI (20Hz to 40 GHz) -150 +30dBM	ESIB40	100121	4/28/17	4/28/19
E915	Agilent Technologies	Power Meter	P-Series Dual Channel	N1912A	GB44440226	6/8/16	6/8/18
E949	Agilent Technologies	Power Sensor	-35 - +20 dBm 50 MHz -18 GHz	N1921A	MY45242502	10/7/16	1/7/18
E914	Agilent Technologies	Power Sensor	-35 - +20 dBm 50 MHz -18 GHz	N1921A	US44510270	6/30/16	6/30/18
E1152	Keysight	MXA Signal Analyzer	20 Hz-3.6 GHz	N9020A	MY48011791	3/13/17	3/13/19
E831	Keysight	MXA Signal Analyzer	20 Hz-26.5 GHz	N9020A	MY40011791	2/23/17	2/23/18
E1017	Weinschel	Attenuator	DC-18GHz 10dB 25W	46-10-34-	BH9326	7/28/17	7/28/18
E1022	Weinschel	Attenuator	DC-18GHz 10dB 25W	46-10-34-LIM	BN3121	7/28/17	7/28/18

4.7.2.1 Antenna Port Coupling Networks

Two coupling networks were used to perform testing and monitor product operation.

Antenna Port Test Coupler-White Mule LP Antenna Port Test Coupler-White Mule LP (Verified as a unit)

Asset ID▼	Manufacturer	Type	Details	Model	Serial	Calibration Date	Calibration. Due Date
E1220	Hewlett Packard	Attenuator	70dB Digital Attenuator	8495B	157170	7/28/17	7/28/18
E1221	Hewlett Packard	Attenuator	11 dB Digital Attenuator	8494B	157171	7/28/17	7/28/18
E1222	Hewlett Packard	Directional Coupler	Dual coupler 2-18GHz	772D	02839A0073	7/28/17	7/28/18
E1223	Weinschel	Attenuator	DC-18GHz 30dB 150W	6528-30-34-LIM	BN4170	7/28/17	7/28/18
E1229	Weinschel	Attenuator	6dB 25W	46-6-34	BH9330	7/28/17	7/28/18
E1258	Weinschel	Directional Coupler	1-6 GHz	1540R-10	1027	7/28/17	7/28/18

10 MHz - 40 GHz Antenna Port Test Coupler

The components below formed the 40GHz coupling networks and were verified as a unit.

Asset ID▼	Manufacturer	Type	Details	Model	Serial	Calibration Date	Calibration. Due Date
E1300	Meca Electronics	Attenuator	3dB DC-40GHz 2.92mm	668-03-1H	37078	11/30/17	11/30/18
E1302	Pasternack	Attenuator	10 dB DC-40GHz 2.92mm	PE7088-10	1515	11/30/17	11/30/18
E1303	Pasternack	Attenuator	30 dB DC-40GHz 2.92mm	PE7088-30	1515	11/30/17	11/30/18
E1301	Meca Electronics	Attenuator	6dB DC-40GHz 2.92mm	668-06-1H	37081	11/30/17	11/30/18
E1211	RLC Electronics Inc	High Pass Filter	5-40GHz High Pass Filter 2.92mm	PE7088-30	1444003	11/30/17	11/30/18
	Micro-Coax	Test Cable	10 MHz-40GHz Cable-2.92mm	UFB142A-0-0400-2002G0	228872-002	11/30/17	11/30/18

4.8 PHOTOGRAPHS OF THE TEST SETUPS

Response:

The photographs of the test setups for the **FW2QMBOM1 Band 25 , FCC ID: 2AD8UFW2QMBOM1** are provided in the Filing exhibits.

4.9 FACILITIES AND ACCREDITATION

Measurement facilities at Nokia, Global Product Compliance Laboratory (GPCL) a member of the Nokia family of companies, was used to collect the measurement data in the test report. The laboratory, which is part of Nokia Bell Labs, is located at 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636 USA.

The field strength measurements of radiated spurious emissions were made in a FCC registered three meter semi-anechoic chamber AR-5, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs 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 FCC OET Accredited Test Firm Scope List is accessible at:

https://apps.fcc.gov/oetcf/eas/reports/ViewTestFirmAccredScopes.cfm?calledFromFrame=N&RequestTimeout=500&regnum_specified=N&test_firm_id=7007

and is as listed in the Table below.

OET Accredited Test Firm Scope List

Test Firm: Nokia, Global Product Compliance Lab

Scope	FCC Rule Parts	Maximum Assessed Frequency, MHz	Status	Expiration Date	Recognition Date
Unintentional Radiators	FCC Part15, Subpart B	40000	Approved	9/30/2018	7/6/2017
Intentional Radiators	FCC Part 15 Subpart C	40000	Approved	9/30/2018	6/5/2018
U-NII without DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
U-NII with DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
Commercial Mobile Services	Part 22 (cellular), Part 24, Part 25 (below 3 GHz), Part 27	40000	Approved	9/30/2018	6/5/2018
General Mobile Radio Services	Part 22 (non-cellular), Part 90 (below 3 GHz), Part 95 (below 3 GHz), Part 97 (below 3 GHz), Part 101 (below 3 GHz)	40000	Approved	9/30/2018	6/5/2018
Citizens Broadband Radio Services	Part 96	40000	Approved	9/30/2018	7/6/2017
Microwave and Millimeter Bands Radio Services	Part 25, Part30, Part 74, Part 90 (90M DSRC, Y, Z), Part 95 (M & L), Part 101	200000	Approved	9/30/2018	7/6/2017

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