



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

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December 19, 2017

Weir Group Management Services
1 West Regent Street
Glasgow, Scotland G2 1RW

Dear Wayne Cooke,

Enclosed is the EMC Wireless test report for compliance testing of the Weir Group Management Services, Weir Industrial Gateway as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 22 Subpart H for Cellular Devices and FCC Part 24 Subpart E for Broadband PCS Devices.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
MET LABORATORIES, INC.

Joel Huna
Documentation Department

Reference: (\Weir Group Management Services\EMC92659B-FCC22_24 Rev. 1)

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Electromagnetic Compatibility Criteria Test Report

for the

**Weir Group Management Services
Weir Industrial Gateway**

Tested under
FCC Certification Rules
Title 47 of the CFR,
Part 22 Subpart H for Cellular Devices
&
Part 24 Subpart E for Broadband PCS Devices

MET Report: EMC92659B-FCC22_24 Rev. 1

December 19, 2017

Prepared For:

**Weir Group Management Services
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Prepared By:
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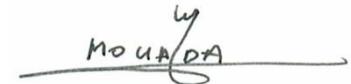


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FCC Certification Rules
Title 47 of the CFR,
Part 22 Subpart H for Cellular Devices
&
Part 24 Subpart E for Broadband PCS Devices**



Djed Mouada
Project Engineer, Electromagnetic Compatibility Lab



Joel Huna
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 22 Subpart H and Part 24 Subpart E of the FCC Rules under normal use and maintenance.



John Mason,
Director, Electromagnetic Compatibility Lab



Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	November 29, 2017	Initial Issue.
1	December 19, 2017	Customer Name/Address Change.



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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB_μA	Decibels above one microamp
dB_μV	Decibels above one microvolt
dB_μA/m	Decibels above one microamp per meter
dB_μV/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μH	microhenry
μ	microfarad
μs	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane



Weir Group Management Services
Weir Industrial Gateway

Executive Summary
CFR Title 47 Part 22 Subpart H & Part 24 Subpart E

I. Executive Summary



A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Weir Group Management Services Weir Industrial Gateway, with the requirements of Part 22 Subpart H and Part 24 Subpart E. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Weir Industrial Gateway. Weir Group Management Services should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Weir Industrial Gateway, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 22 Subpart H and Part 24 Subpart E, in accordance with Weir Group Management Services, purchase order number T10536863.

FCC Reference	Description	Compliance
§2.1049; §22.917; §24.232(d)	Occupied Bandwidth	Compliant
§2.1047	Modulation Characteristics	Not Applicable
§2.1049, §24.238	Frequency stability	Compliant
§24.323 (d)	Peak to Average Ratio	Compliant
§2.1051; §22.917, §24.238	Conducted Spurious Emissions at Antenna Terminals and Band Edge	Compliant
§2.1046; §22.913; §24.232	RF Power Output (EIRP)	Compliant
§2.1053; §22.917, §24.238	Radiated Spurious Emissions from the Cabinet	Compliant

Table 1. Executive Summary of EMC Compliance Testing



Weir Group Management Services
Weir Industrial Gateway

Equipment Configuration
CFR Title 47 Part 22 Subpart H & Part 24 Subpart E

II. Equipment Configuration



A. Overview

MET Laboratories, Inc. was contracted by Weir Group Management Services to perform testing on the Weir Industrial Gateway, under Weir Group Management Services's purchase order number T10536863.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Weir Group Management Services, Weir Industrial Gateway.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	Weir Industrial Gateway		
Model(s) Covered:	Weir Industrial Gateway		
Filing Status:	Original		
EUT Specifications:	Primary Power: 120/240 VAC 50/60 Hz		
	FCC ID: 2ANXR-STXMPM		
	Type of Modulations:	OFDM	
	Equipment Code:	PCB	
	RF Power Output	Part 22 ERP: (watts)	Part 24 EIRP: (watts)
	1.4MHz BW	.374	.912
	3MHz BW	.426	.908
	5MHz BW	.39	.998
	10MHz BW	.404	.984
	15MHz BW	n/a	.959
Analysis:	20MHz BW	n/a	.957
	EUT Frequency Ranges:	824.7 – 848.3 MHz	1850.7 – 1909.3 MHz
Environmental Test Conditions:	The results obtained relate only to the item(s) tested.		
Evaluated by:	Temperature: 15-35° C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Date(s):	Djed Mouada		
	December 19, 2017		



B. References

CFR 47, Part 22, Subpart H	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 22: Rules and Regulations for Cellular Devices.
CFR 47, Part 24, Subpart E	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 24: Rules and Regulations for Personal Communications Services
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26: 2015	Compliance Testing of Transmitters Used in Licensed Radio Services
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
EIA/TIA-603-D-2010	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards
KDB 971168 v02r02	Measurement Guidance For Certification of Licensed Digital Transmitters

C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Description of Test Sample

The Weir Industrial Gateway, Equipment Under Test (EUT), is used to monitor the operation of the components of a drilling rig, in particular the sound and vibration from the bearings in the system. This is monitored through digital signal processing to determine if the bearing is nearing the end of its life and needs to be replaced

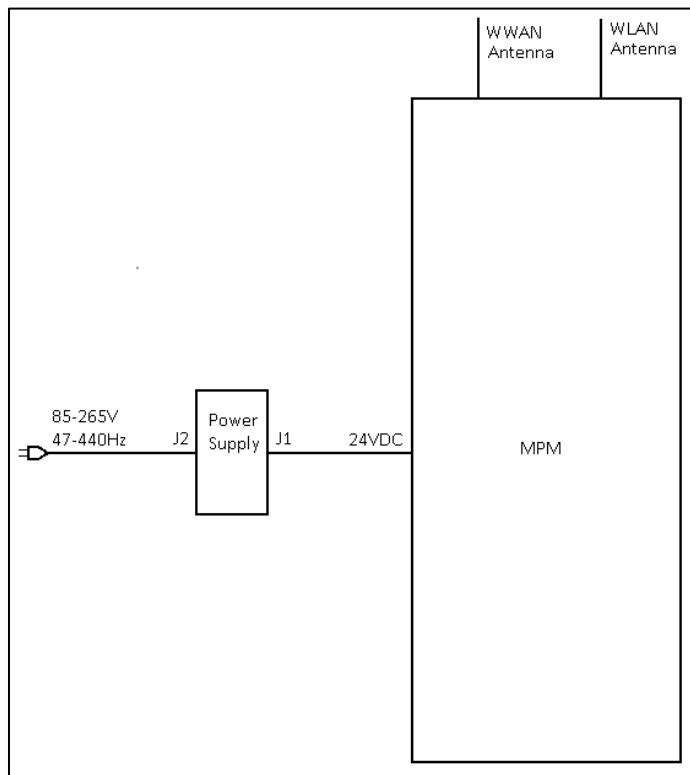


Figure 1. Block Diagram of Equipment Configuration

E. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number	Rev. #
A	Power Supply	CH-SAN500AC-24	161103	01
B	MPM	North America: STX-000004	006	01
P	Antenna	MY-0W4VW8-74431- 5CM-0668-A00	N/A	N/A

Table 2. Equipment Configuration



F. Support Equipment

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
E	Ethernet Switch	Netgear	N300	N/A
F	External Laptop	Dell	Latitude E5570	N/A

The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer.

Table 3. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	AC Input	3 conductor, bare wires at AC Mains end, 14 AWG	1	10	50	No	Power Box.J2
2	24VDC	4 conductor, 14 AWG	1	2	50	No	Power Box.J1
9	LAN	8 conductor, 20 AWG	1	5	50	Yes	Ethernet switch
33	MPM	Antenna cable, 1 conductor, coax, CA120/195-XC	1	10	10	Yes	Antenna

Table 4. Ports and Cabling Information

H. Mode of Operation

Custom software (WinEMI) will exercise all ports and send the system performance to a WiFi link to be monitored by an external laptop.

I. Method of Monitoring EUT Operation

An external laptop with a WiFi link will monitor the system and display the system performance.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Weir Group Management Services upon completion of testing.



III. Electromagnetic Compatibility Criteria for Intentional Radiators



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.1046 RF Power Output

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

§ 2.1046 (a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

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

§ 2.1046 (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

§ 22.913(5): The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts

§ 24.232 (c): Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications

Test Procedures: The EUT was tested according to the average power integration procedures of ANSI C63.26 5.2.4.4.1. The power measurement function of spectrum analyzer was used and configured in the following manner.

- (a) Frequency = channel cf
- (b) Span = 2-3 x the OBW
- (c) RBW = 1-5 % of the OBW
- (d) VBW 1-3 x the RBW
- (e) Sweep Time = Auto
- (f) Detector = Average

Test Results: The EUT complies with the requirements of this section.

Test Engineer(s): Djed Mouada

Test Date(s): May 1, 2017



Band	Channel Bandwidth (MHz)	Channel #	Frequency (MHz)	Average Power (dBm)	Antenna Gain (dBi)	Antenna Gain (dBi)3	EIRP / ERP 1 (W)	EIRP / ERP 3 (W)	Limit (W)	Rule Part	Band Edges
2	1.4	18607	1850.7	19.6	4	10	0.229	0.912	2	24E	
		18900	1880	19.02	4	10	0.2	0.798	2		
		19193	1909.3	19.93	4	10	0.247	0.984	2		1850
	3	18615	1851.5	19.51	4	10	0.224	0.893	2		
		18900	1880	19.02	4	10	0.2	0.798	2		
		19185	1908.5	19.58	4	10	0.228	0.908	2		1910
	5	18625	1852.5	19.25	4	10	0.211	0.841	2		
		18900	1880	19.99	4	10	0.251	0.998	2		
		19175	1907.5	19.36	4	10	0.217	0.863	2		
	10	18650	1855	19.82	4	10	0.241	0.959	2		
		18900	1880	19.93	4	10	0.247	0.984	2		
		19150	1905	19.85	4	10	0.243	0.966	2		
	15	18675	1857.5	19.6	4	10	0.229	0.912	2		
		18900	1880	19.54	4	10	0.226	0.899	2		
		19125	1902.5	19.82	4	10	0.241	0.959	2		
	20	18700	1860	19.59	4	10	0.229	0.91	2		
		18900	1880	19.81	4	10	0.24	0.957	2		
		19100	1900	19.81	4	10	0.24	0.957	2		

Table 5. RF Output Power, LTE Band 2, 24E, Test Results



Band	Channel Bandwidth (MHz)	Channel #	Frequency (MHz)	Average Power (dBm)	Antenna Gain (dBi)	Antenna Gain(dBi) 2	EIRP / ERP 1 (W)	EIRP / ERP 2 (W)	Limit (W)	Rule Part	Band Edges
5	1.4	20407	824.7	19.81	4	8	0.147	0.368	7	22H	
		20525	836.5	19.88	4	8	0.149	0.374	7		
		20643	848.3	19.87	4	8	0.149	0.373	7		
	3	20415	825.5	20.44	4	8	0.169	0.426	7		
		20525	836.5	20.13	4	8	0.158	0.396	7		824
		20635	847.5	19.75	4	8	0.145	0.363	7		849
	5	20425	826.5	19.84	4	8	0.148	0.371	7		
		20525	836.5	20.02	4	8	0.154	0.386	7		
		20625	846.5	20.06	4	8	0.155	0.39	7		
	10	20450	829	20.21	4	8	0.161	0.404	7		
		20525	836.5	20.06	4	8	0.155	0.39	7		
		20600	844	20.13	4	8	0.158	0.396	7		

Table 6. RF Output Power, LTE Band 5, 22H, Test Result

§ 2.1049 Occupied Bandwidth

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

§22.917 (1) 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.

§24.238 (b) 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.

Test Procedures: The EUT was tested according to relative measurement procedure of ANSI C63.26 5.4.3 The OBW measurement function of the spectrum analyzer was used and configured in the following manner.

- (a) Frequency = channel cf
- (b) Span = 2-5 x the OBW
- (c) RBW = 1-5 % of the OBW
- (d) VBW 1-3 x the RBW
- (e) Sweep Time = Auto
- (f) Detector = peak
- (g) -X dB = 26

Test Results: Equipment complies with FCC requirements.

Test Engineer(s): Djed Mouada

Test Date(s): May 1, 2017

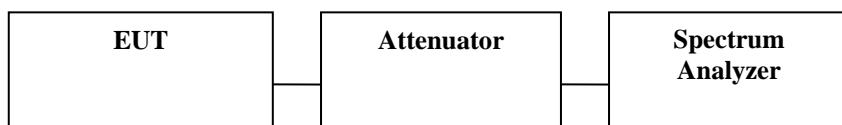
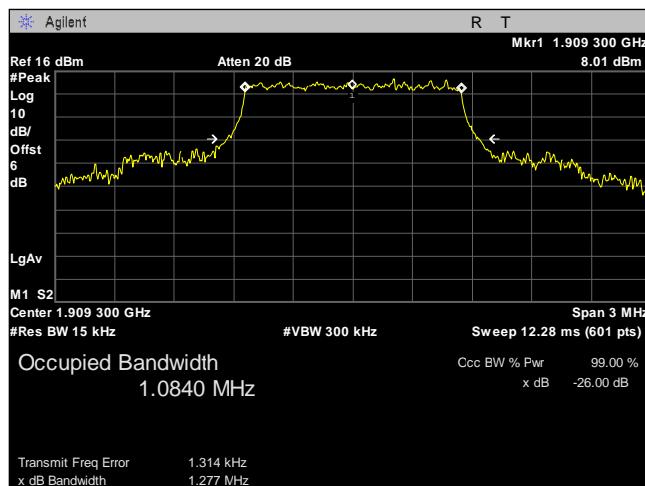
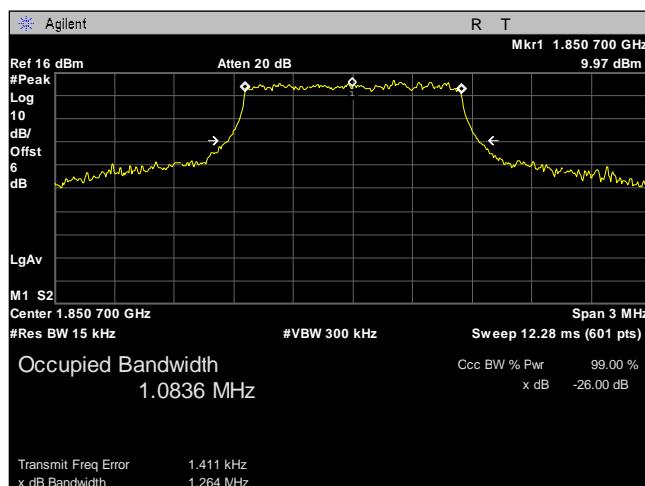


Figure 2. Occupied Bandwidth Test Setup

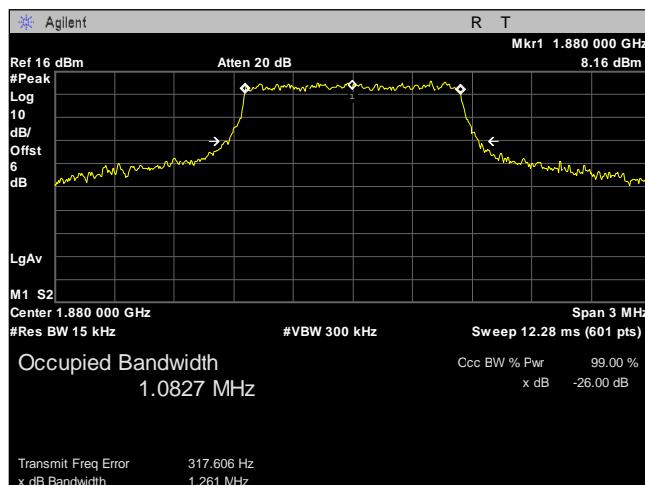
Occupied Bandwidth, Part 24, 1.4MHz BW



Plot 1. Part 24, Occupied Bandwidth, High Channel, 1.4MHz

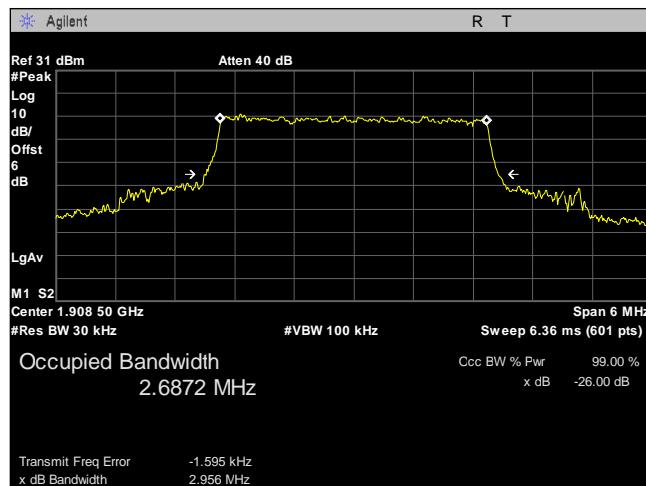


Plot 2. Part 24, Occupied Bandwidth, Low Channel, 1.4MHz

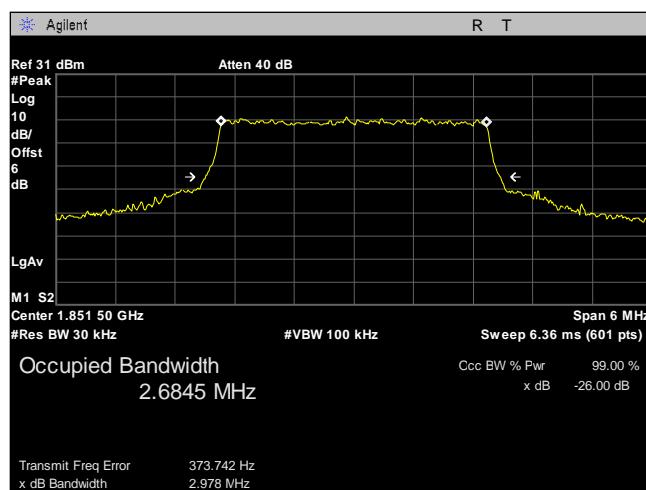


Plot 3. Part 24, Occupied Bandwidth, Mid Channel, 1.4MHz

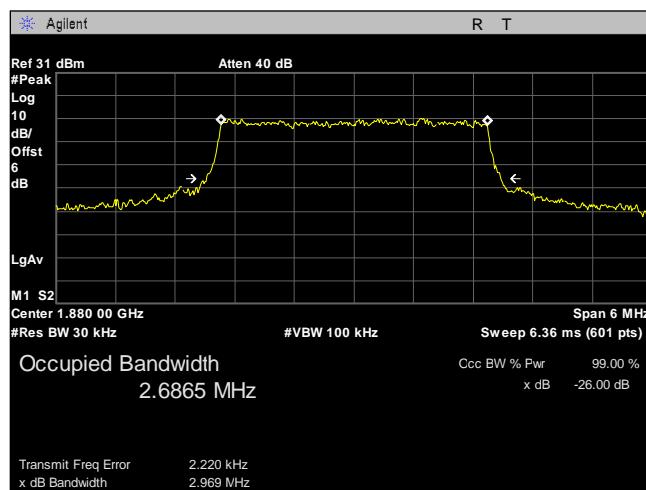
Occupied Bandwidth, Part 24, 3MHz BW



Plot 4. Part 24, Occupied Bandwidth, High Channel, 3MHz

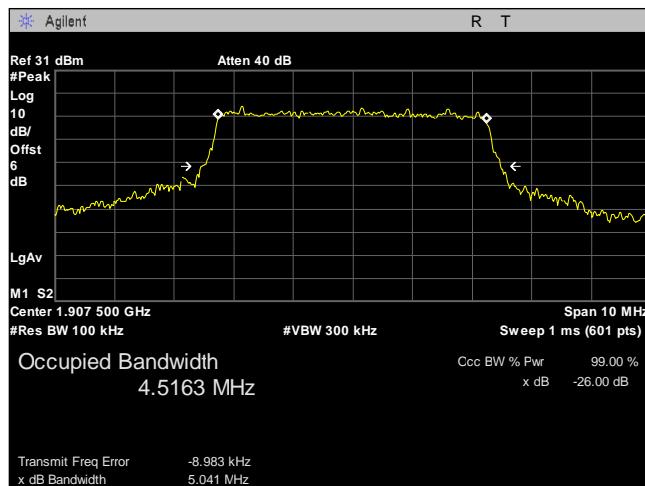


Plot 5. Part 24, Occupied Bandwidth, Low Channel, 3MHz

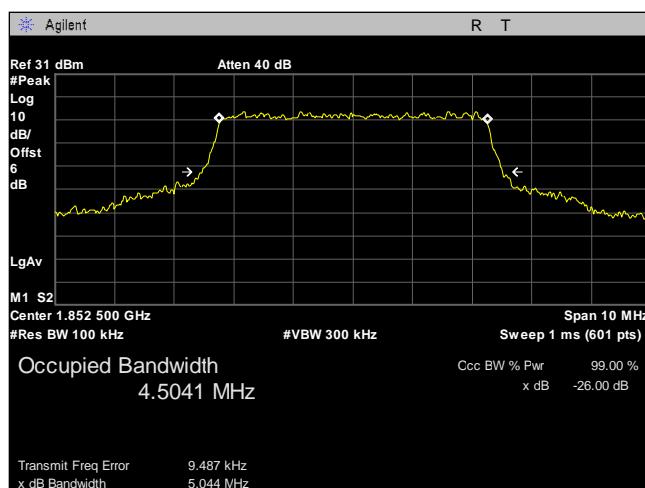


Plot 6. Part 24, Occupied Bandwidth, Mid Channel, 3MHz

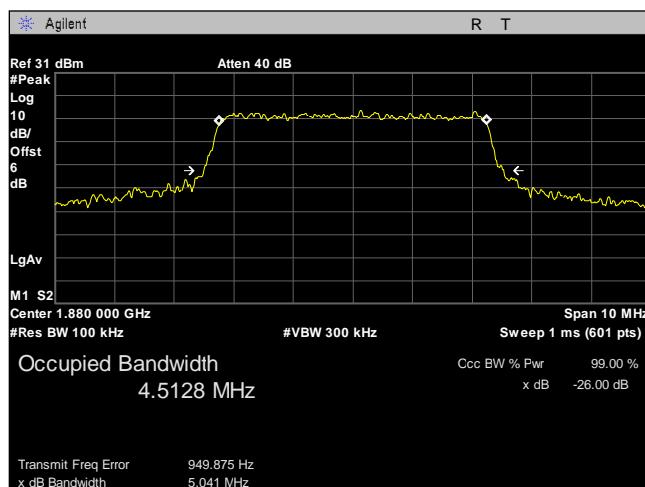
Occupied Bandwidth, Part 24, 5MHz BW



Plot 7. Part 24, Occupied Bandwidth, High Channel, 5MHz

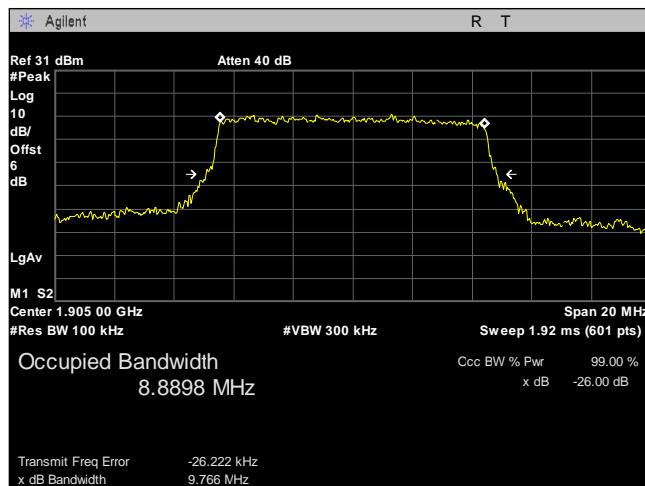


Plot 8. Part 24, Occupied Bandwidth, Low Channel, 5MHz

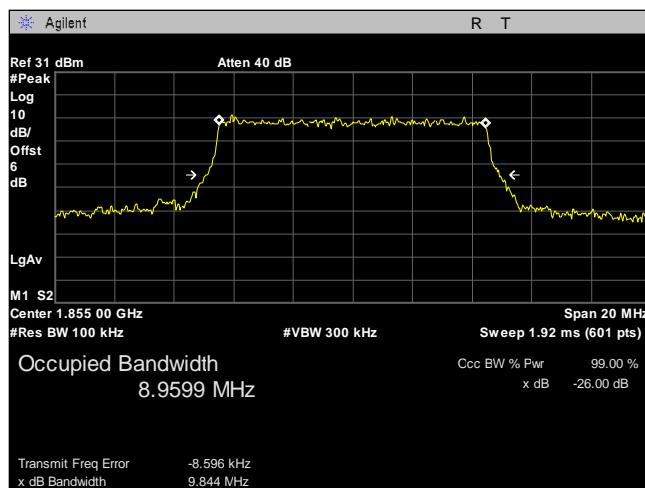


Plot 9. Part 24, Occupied Bandwidth, Mid Channel, 5MHz

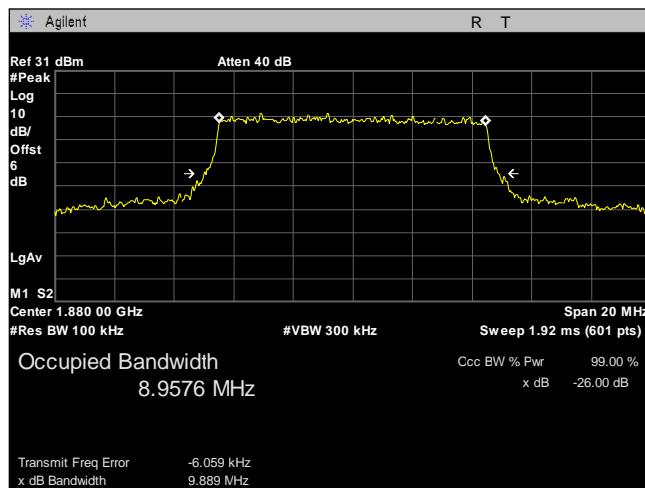
Occupied Bandwidth, Part 24, 10MHz BW



Plot 10. Part 24, Occupied Bandwidth, High Channel, 10MHz

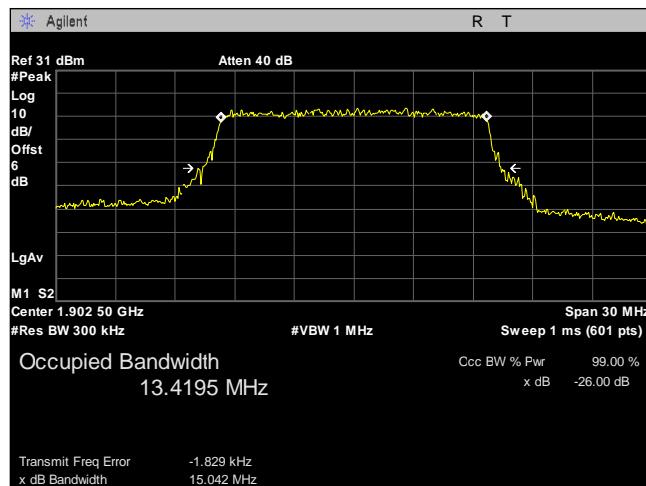


Plot 11. Part 24, Occupied Bandwidth, Low Channel, 10MHz

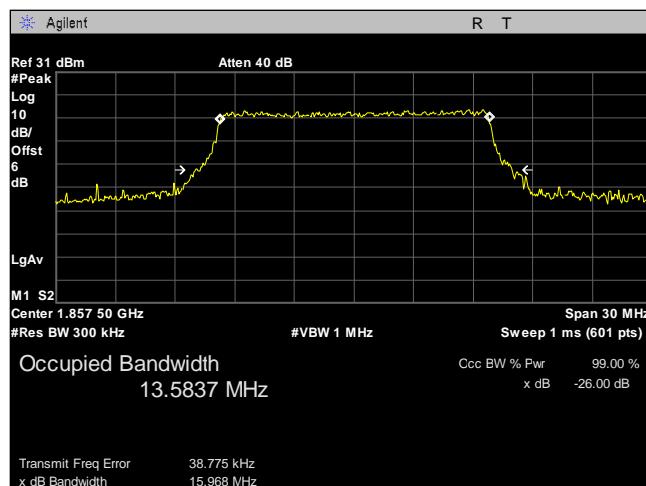


Plot 12. Part 24, Occupied Bandwidth, Mid Channel, 10MHz

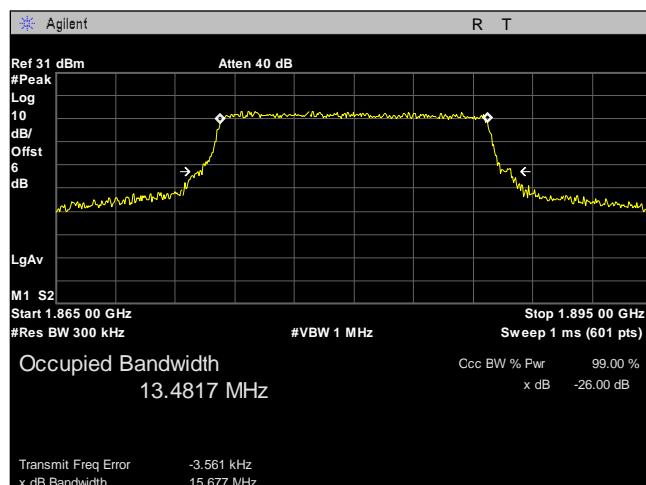
Occupied Bandwidth, Part 24, 15MHz BW



Plot 13. Part 24, Occupied Bandwidth, High Channel, 15MHz

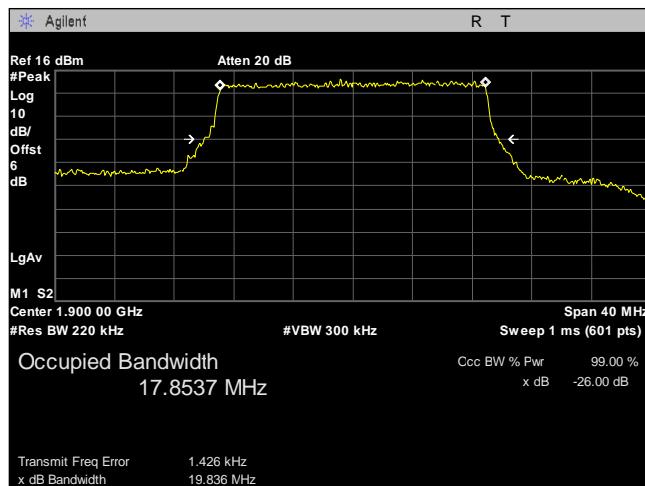


Plot 14. Part 24, Occupied Bandwidth, Low Channel, 15MHz

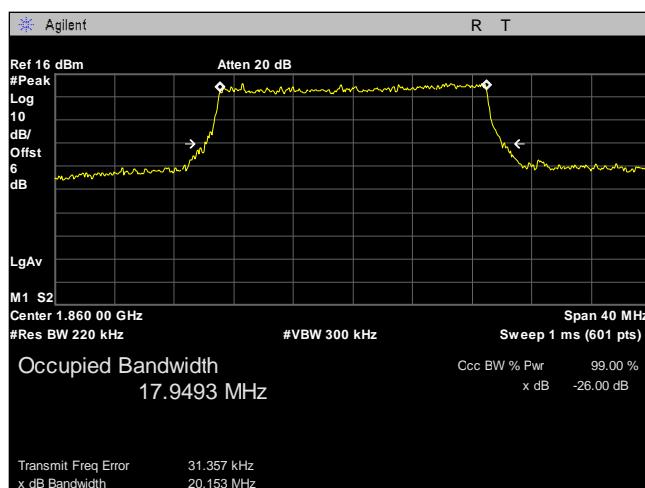


Plot 15. Part 24, Occupied Bandwidth, Mid Channel, 15MHz

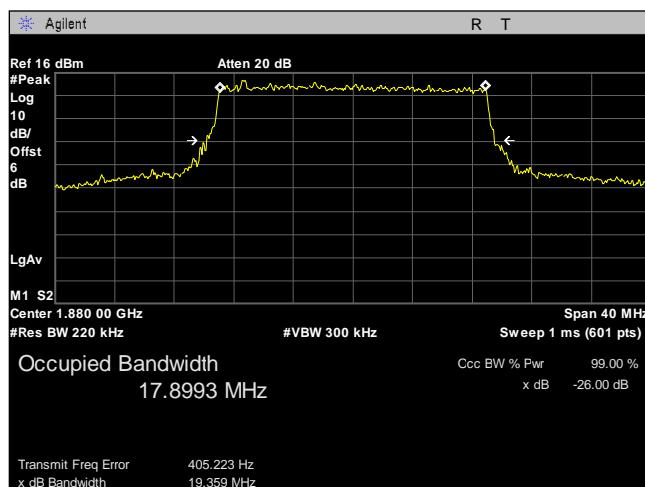
Occupied Bandwidth, Part 24, 20MHz BW



Plot 16. Part 24, Occupied Bandwidth, High Channel, 20MHz

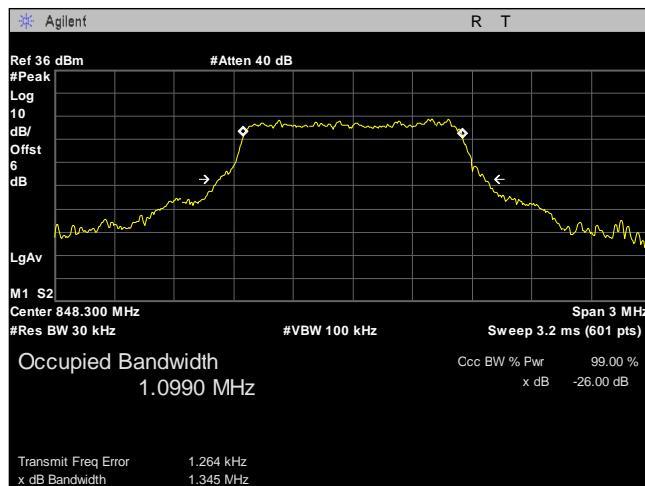


Plot 17. Part 24, Occupied Bandwidth, Low Channel, 20MHz

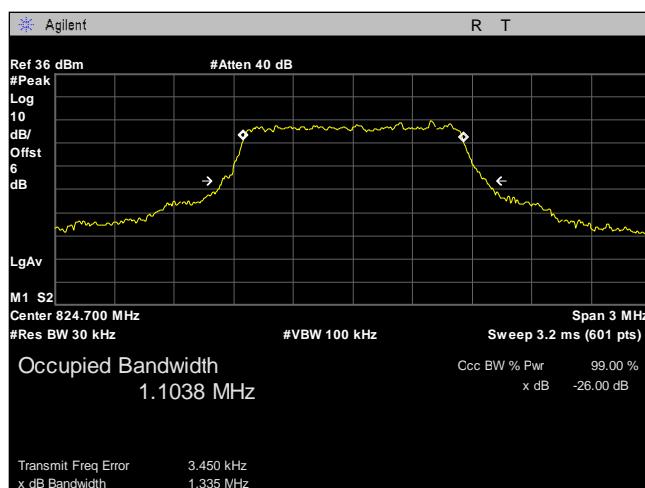


Plot 18. Part 24, Occupied Bandwidth, Mid Channel, 20MHz

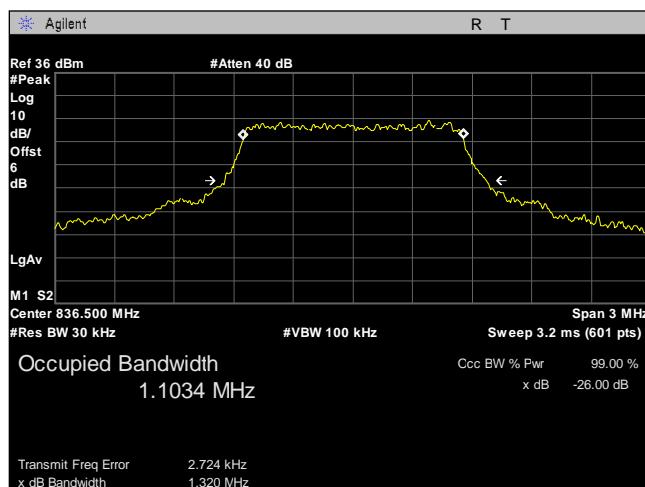
Occupied Bandwidth, Part 22, 1.4MHz BW



Plot 19. Part 22, Occupied Bandwidth, High Channel 1.4 MHz

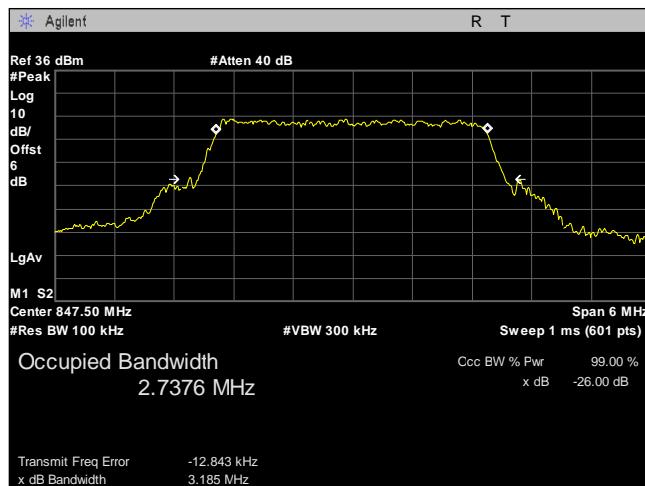


Plot 20. Part 22, Occupied Bandwidth, Low Channel 1.4 MHz

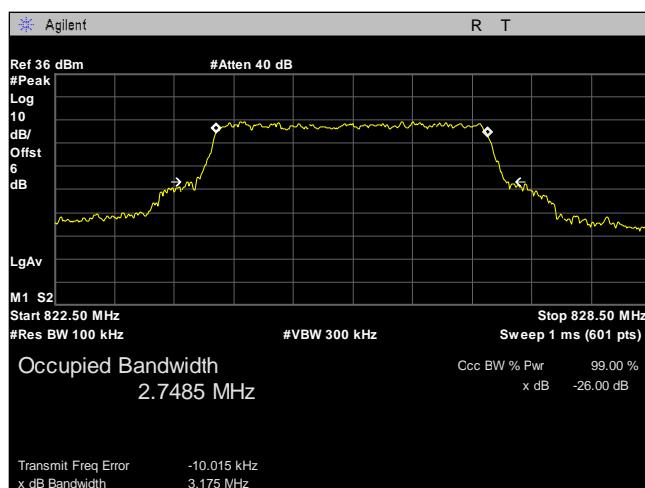


Plot 21. Part 22, Occupied Bandwidth, Mid Channel 1.4 MHz

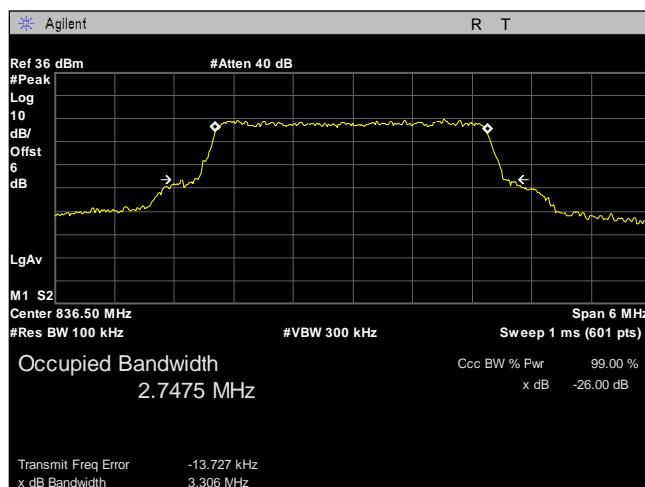
Occupied Bandwidth, Part 22, 3MHz BW



Plot 22. Part 22, Occupied Bandwidth, High Channel 3 MHz

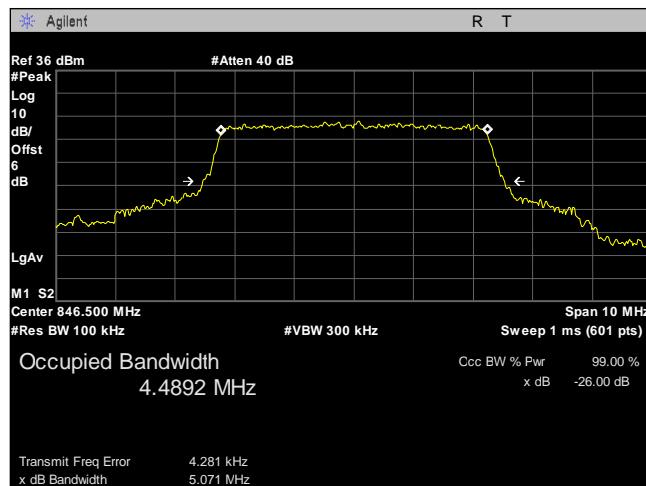


Plot 23. Part 22, Occupied Bandwidth, Low Channel 3 MHz

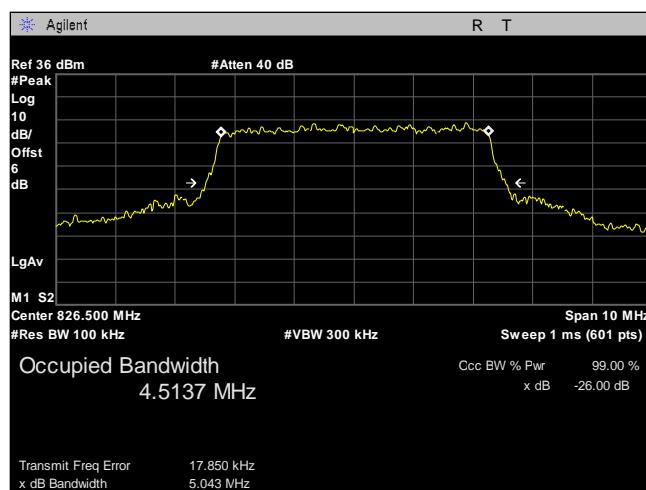


Plot 24. Part 22, Occupied Bandwidth, Mid Channel 3 MHz

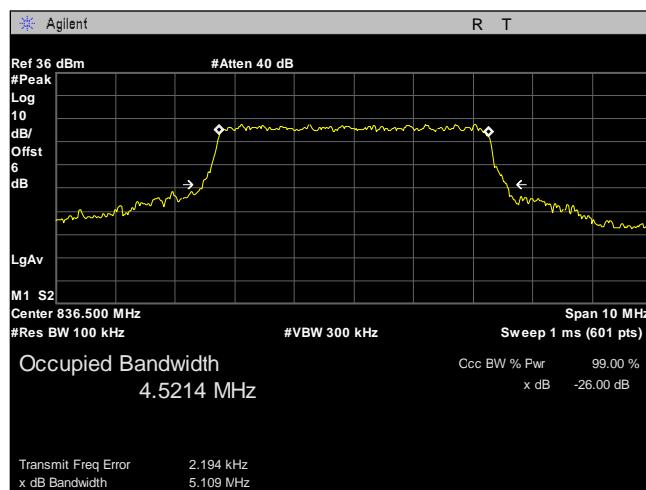
Occupied Bandwidth, Part 22, 5MHz BW



Plot 25. Part 22, Occupied Bandwidth, High Channel 5 MHz

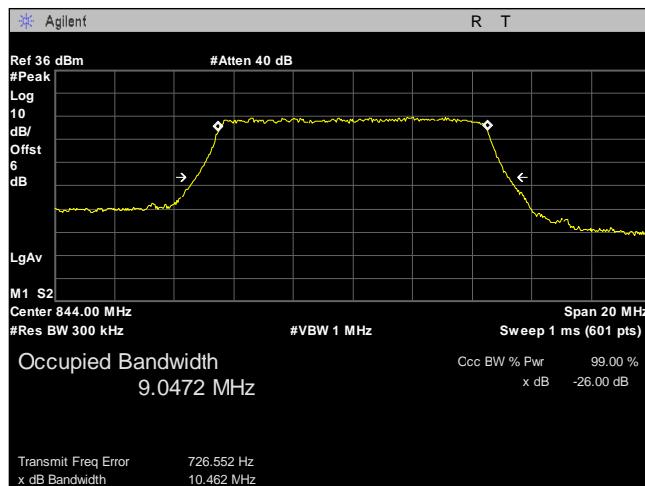


Plot 26. Part 22, Occupied Bandwidth, Low Channel 5 MHz

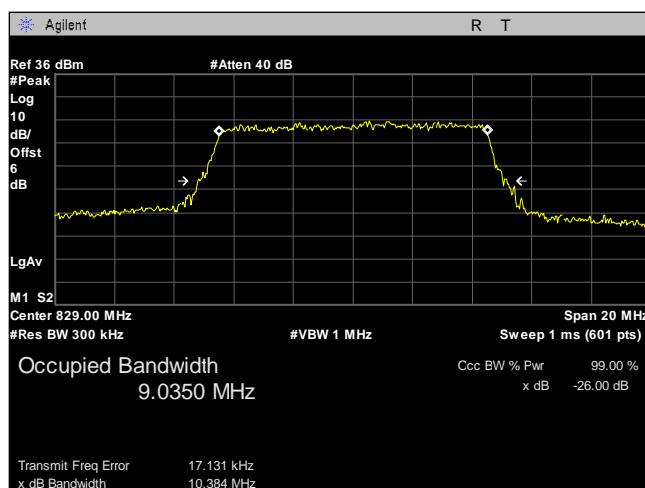


Plot 27. Part 22, Occupied Bandwidth, Mid Channel 5 MHz

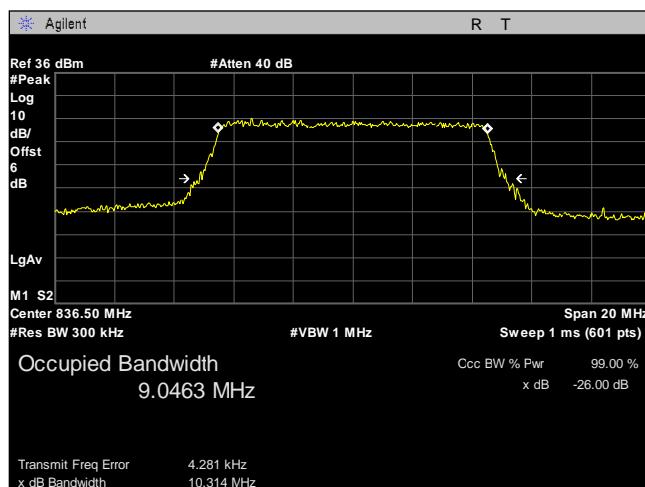
Occupied Bandwidth, Part 22, 10MHz BW



Plot 28. Part 22, Occupied Bandwidth, High Channel 10 MHz



Plot 29. Part 22, Occupied Bandwidth, Low Channel 10 MHz



Plot 30. Part 22, Occupied Bandwidth, Mid Channel 10 MHz



§ 2.1053 Radiated Spurious Emissions

Test Requirement(s): § 2.1053 Measurements required: Field strength of spurious radiation.

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

§ 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

§ 22.917 Emission limitations Cellular equipment: The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

§ 22.917 (a): Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$.

§ 24.238 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB



Test Procedures: The EUT was tested according to field strength method of ANSI C63.26 5.5.4. The spectrum analyzer was used and configured in the following manner:

- (a) Frequency Range = Lowest Generated – 10th Harmonic
- (b) RBW = 1MHz
- (c) VBW 1-3 x the RBW
- (d) Detector = Average

Radiated emission measurements were performed inside a 3 meter chamber that satisfies the site requirements of ANSI C63.4-2014. The EUT was place on an rf transparent 80 cm table for measurements below 1GHz and an rf transparent 1.5 meter table for measurements above 1GHz. The EUT's RF ports were terminated to 50ohm load. The EUT was tested using all modulations and at the low, mid, and high channels. The EUT was rotated about 360⁰ and the receiving antenna scanned from 1-4m in order to capture the maximum emission. The plots are corrected for cable loss, antenna correction factor, and distance correction. The field strength was mathematically corrected to an E.I.R.P.

Emissions below 30MHz and above 18GHz were more than 20dB below the limit. The worse-case configurations are reported.

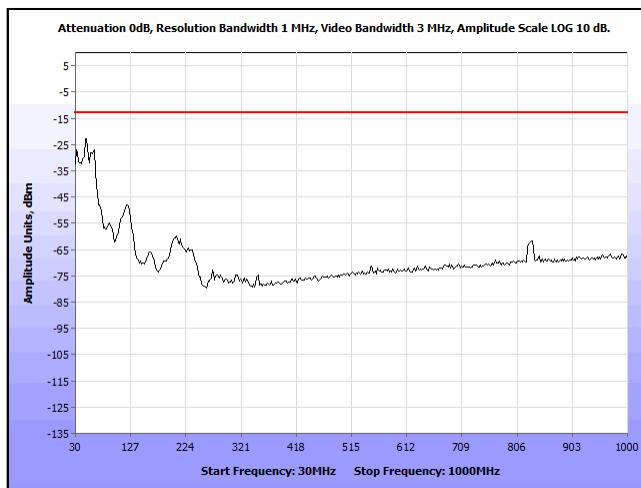
Test Results: The EUT complies with the requirements of this section.

Measurements were made in each configuration. Data is presented for the worse case configuration.

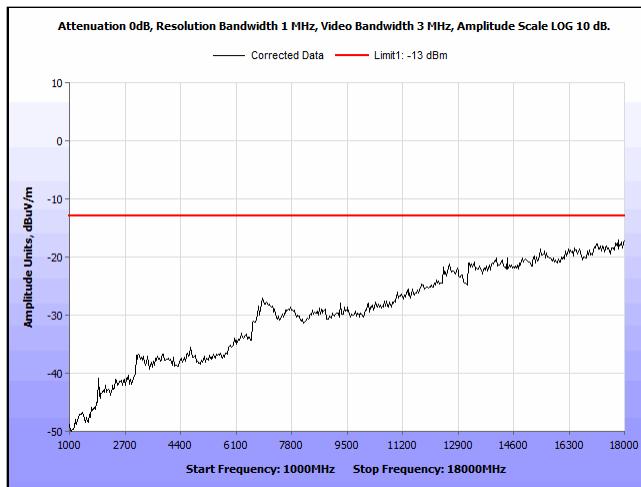
Test Engineer: Djed Mouada

Test Date(s): May 1, 2017

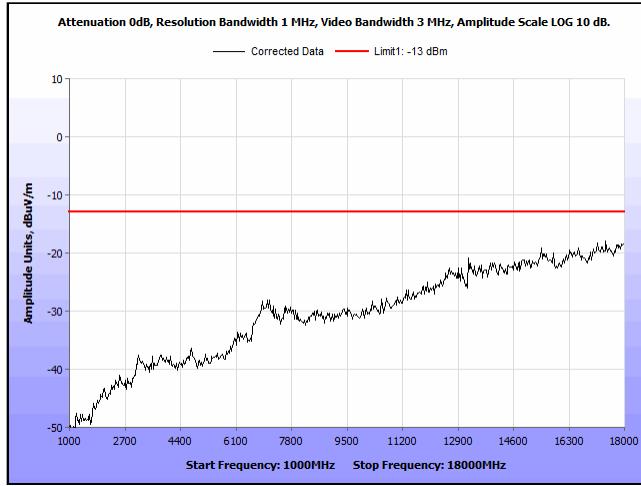
Radiated Spurious Emissions



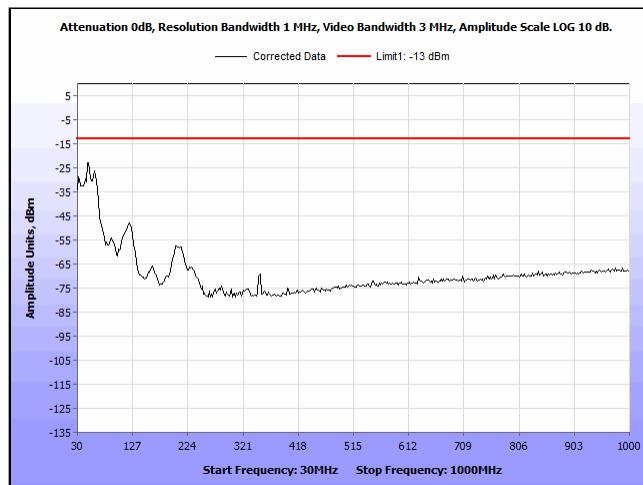
Plot 31. Radiated Spurious Emissions, band 5, 30MHz-1GHz



Plot 32. Radiated Spurious Emissions, band 5, 10MHzBW, 1GHz-18GHz



Plot 33. Radiated Spurious Emissions, band 2, 20MHzBW, 1GHz-18GHz



Plot 34. Radiated Spurious Emissions, band 2, 20MHzBW, -30MHz-1GHz



Photograph 1. Radiated Spurious Emissions, Test Setup (1)



Photograph 2. Radiated Spurious Emissions, Test Setup (2)

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.1051 Spurious Emissions at Antenna Terminals

Test Requirement(s):

§ 2.1051 Measurements required: Spurious emissions at antenna terminals: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 22.917 The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

§ 22.917 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

§24.238 Emission limitations for Broadband PCS equipment: The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

§ 24.238 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Test Procedures:

The EUT was tested according to the unwanted emissions procedures of ANSI C63.26 5.7.3. The spectrum analyzer was used and configured in the following manner:

- (a) Frequency Range = 30MHz – 10th Harmonic
- (b) RBW = 1% of the OBW, or greater
- (c) VBW 1-3 x the RBW
- (d) Detector = Peak
- (e) Sweet Time = Auto

Test Results:

The equipment complies with the requirements of this section.

For out of band emissions, the low, mid, and high channels for each test mode were evaluated. Data is presented for the worse case/ highest output channel for the widest and narrowest bandwidth modes.

For band edge emissions, each bandwidth mode was evaluated. Data is presented for the worse case configuration.

Test Engineer(s):

Djed Mouada

Test Date(s):

May 1, 2017

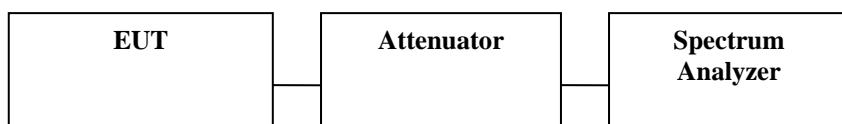
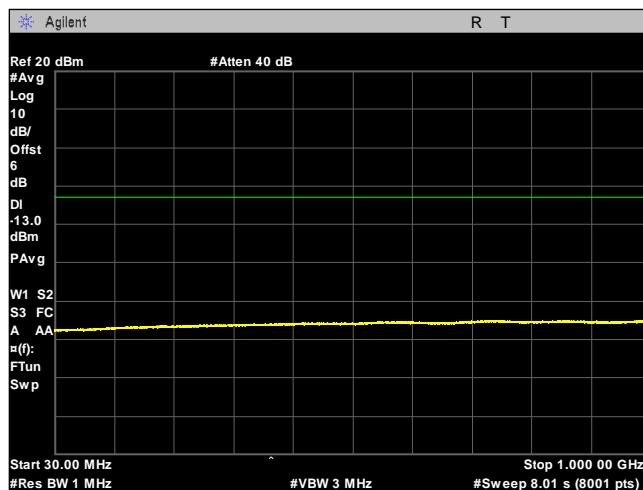
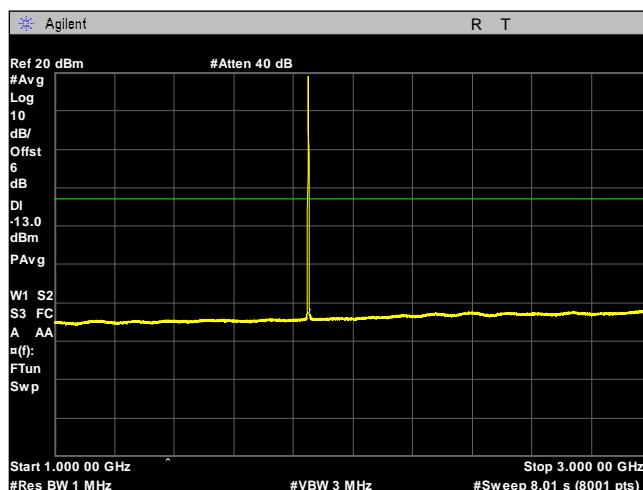


Figure 3. Spurious Emissions at Antenna Terminals Test Setup

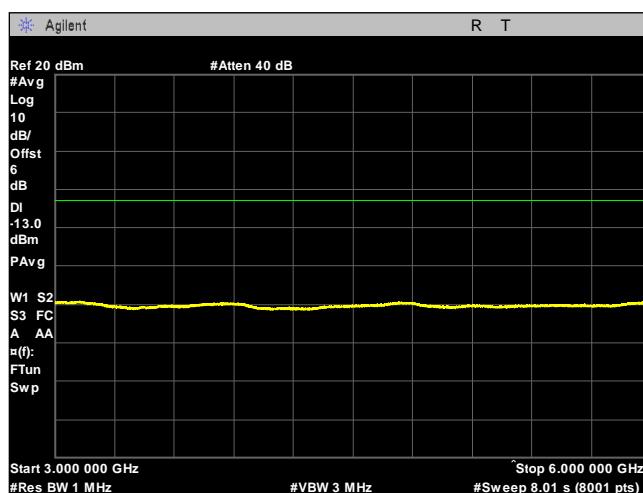
Conducted Spurious Emissions, Part 24, LTE Band 2, 1.4MHz BW, Low Channel



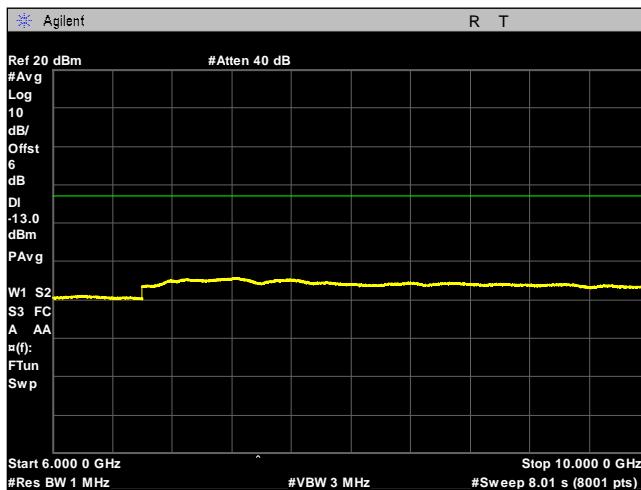
Plot 35. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 30MHz – 1 GHz



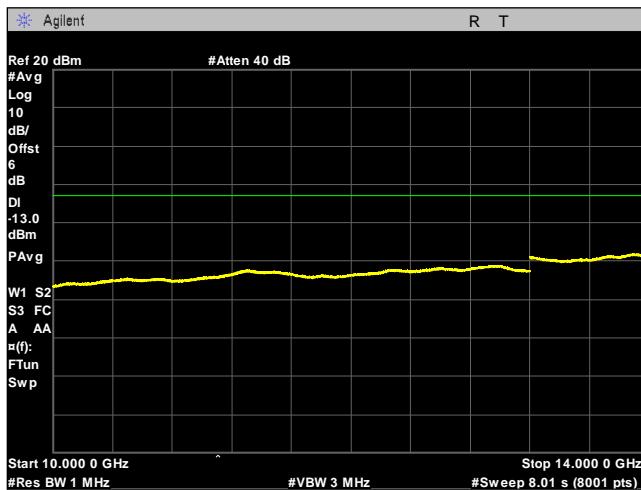
Plot 36. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 1 GHz – 3 GHz



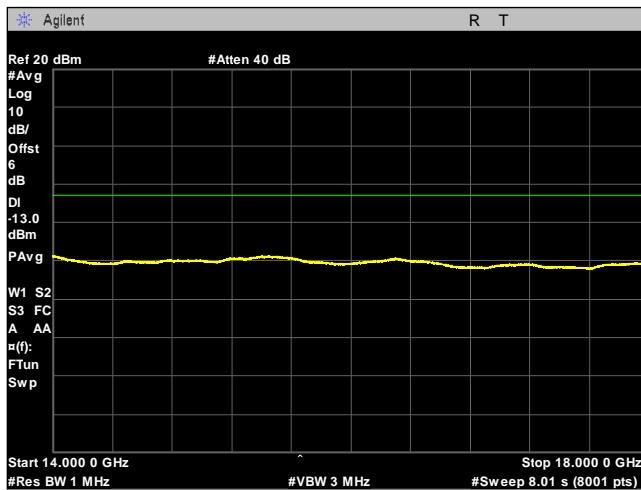
Plot 37. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 3 GHz – 6 GHz



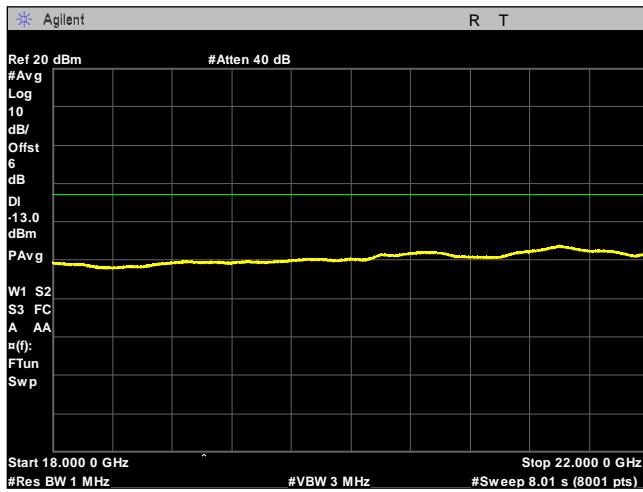
Plot 38. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 6 GHz – 10 GHz



Plot 39. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 10 GHz – 14 GHz

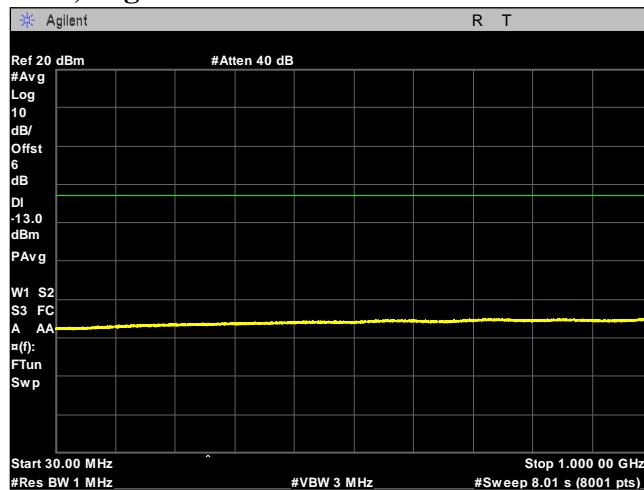


Plot 40. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 14 GHz – 18 GHz

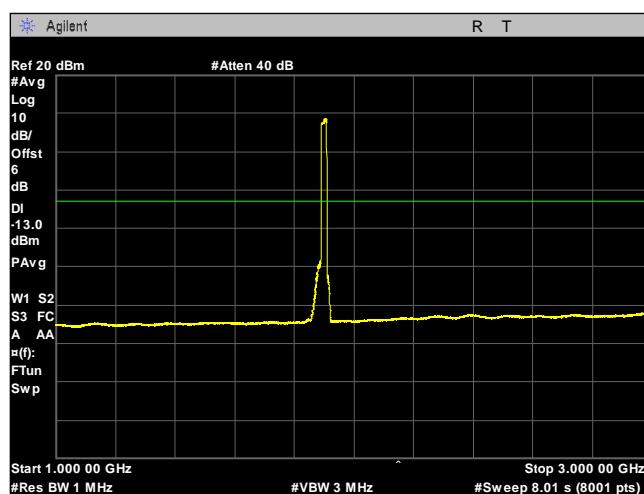


Plot 41. Spurious Emissions at Antenna Terminals, Low Channel, 1.4MHz BW, 18 GHz – 22 GHz

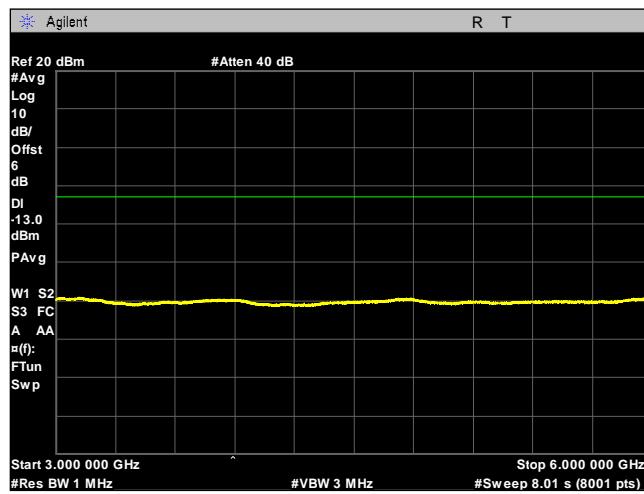
**Conducted Spurious Emissions,
Part 24, LTE Band 2, 20MHz, High Channel**



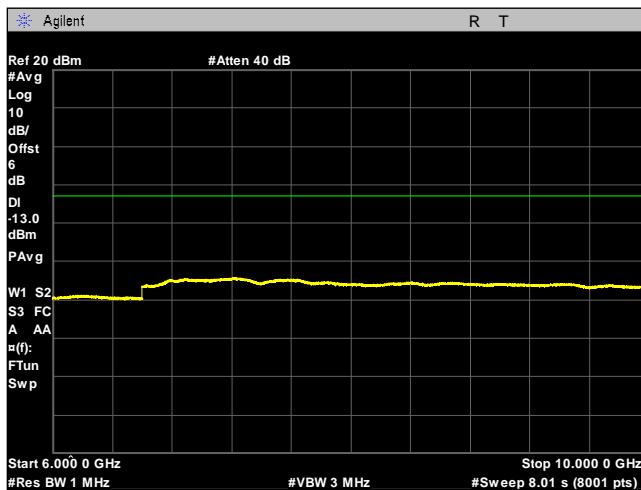
Plot 42. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 30 MHz - 1 GHz



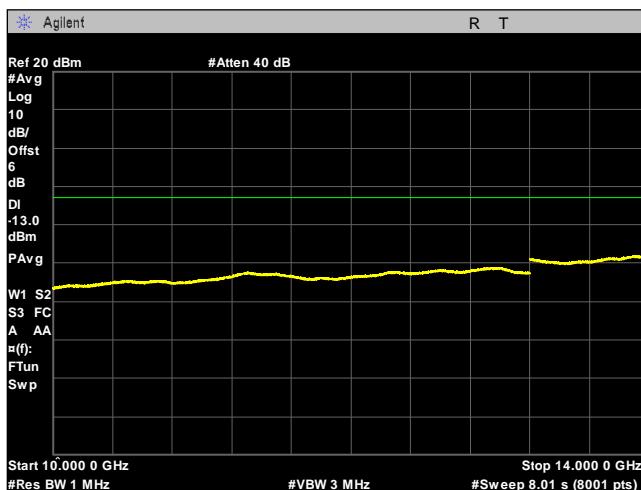
Plot 43. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 1 GHz -3 GHz



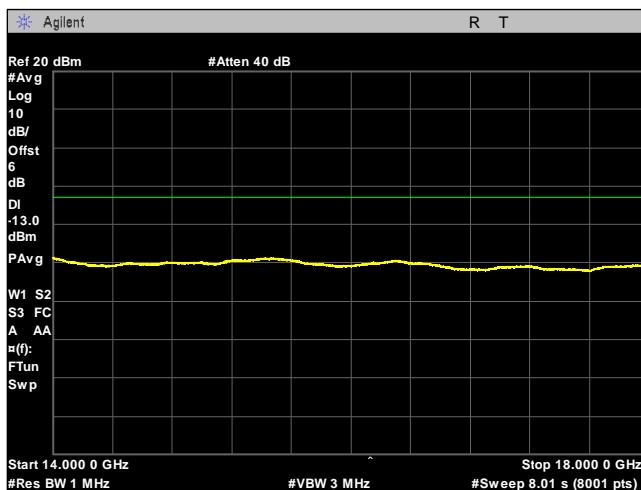
Plot 44. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 3 GHz- 6 GHz



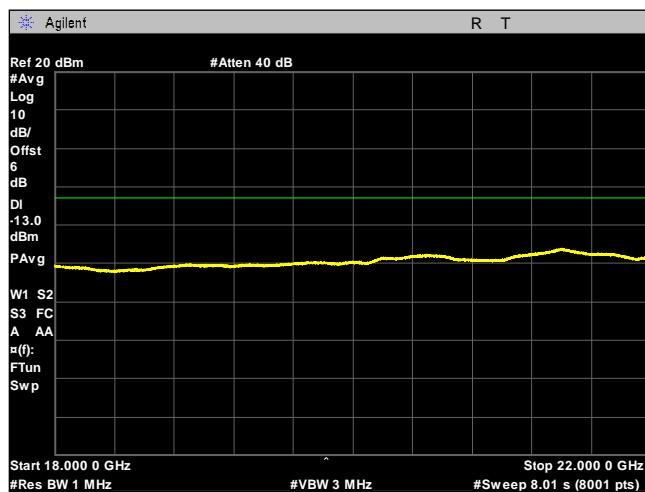
Plot 45. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 6 GHz - 10 GHz



Plot 46. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 10 GHz- 14 GHz

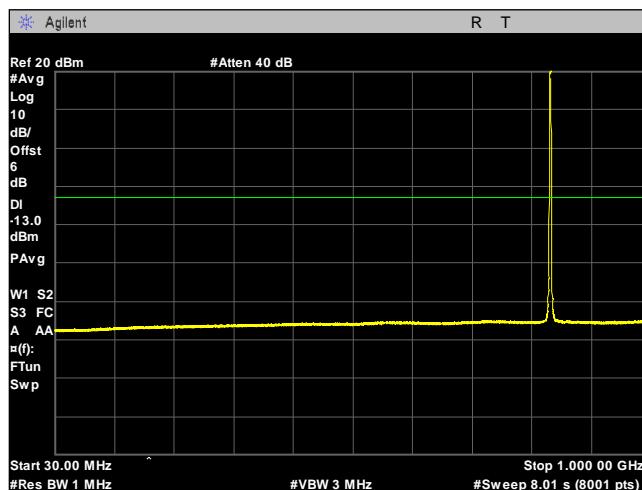


Plot 47. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 14 GHz – 18 GHz

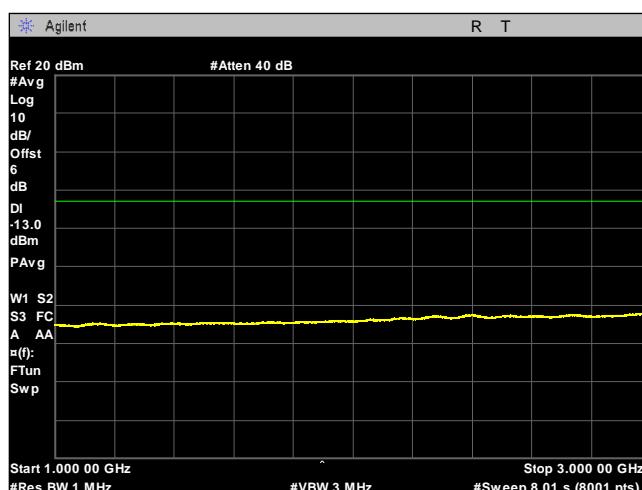


Plot 48. Spurious Emissions at Antenna Terminals, High Channel, 20MHz BW, 18 GHz – 22 GHz

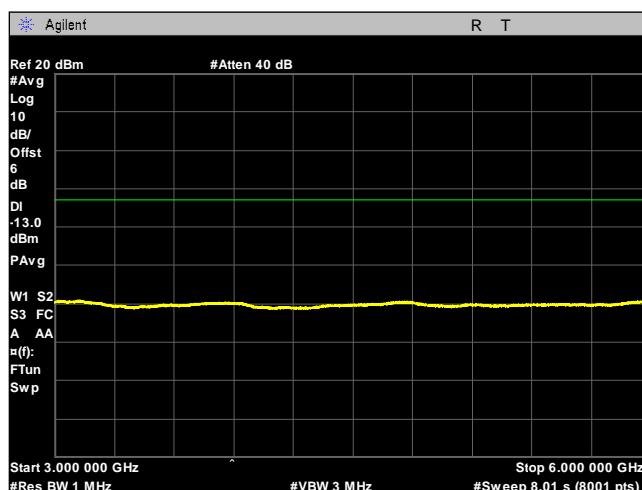
Conducted Spurious Emissions, Part 22, LTE Band 5, 1.4 MHz, Mid Channel



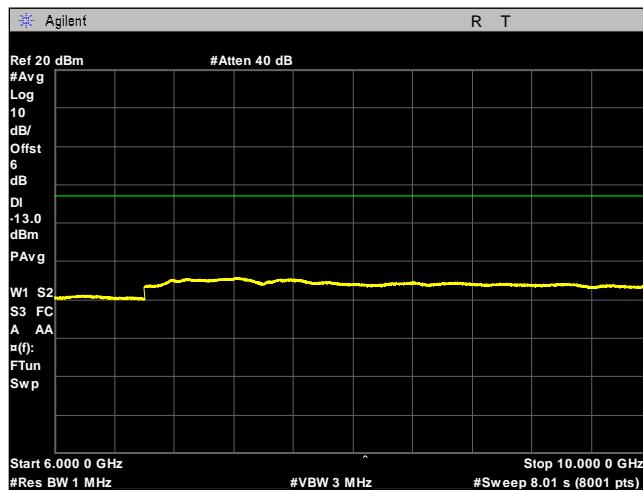
Plot 49. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 30 MHz – 1 GHz



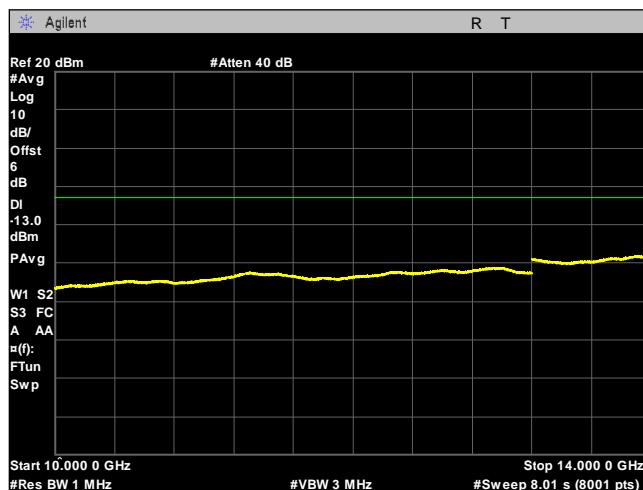
Plot 50. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 1 GHz – 3 GHz



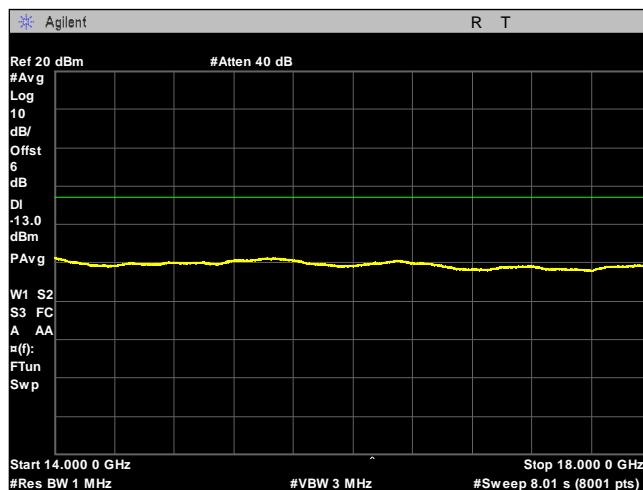
Plot 51. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 3 GHz – 6 GHz



Plot 52. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 6 GHz – 10 GHz

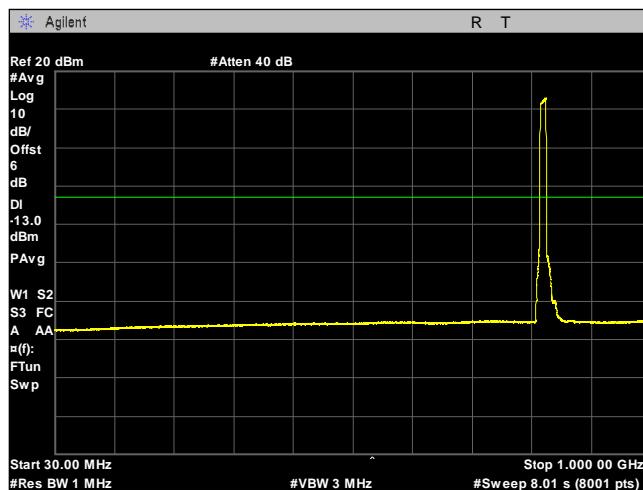


Plot 53. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 10 GHz – 14 GHz

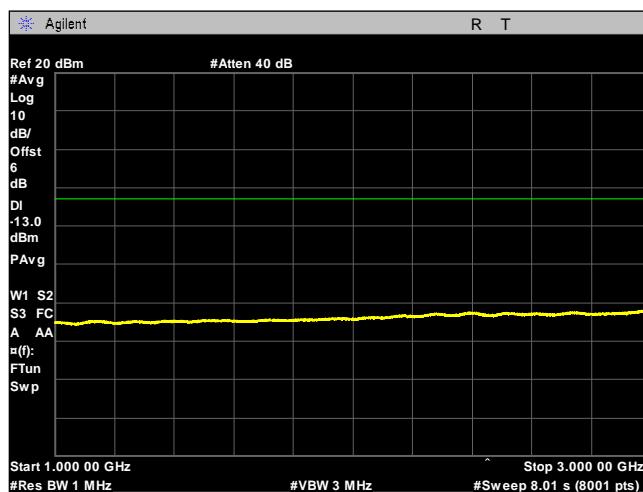


Plot 54. Spurious Emissions at Antenna Terminals, Mid Channel, 1.4MHz, 14 GHz – 18 GHz

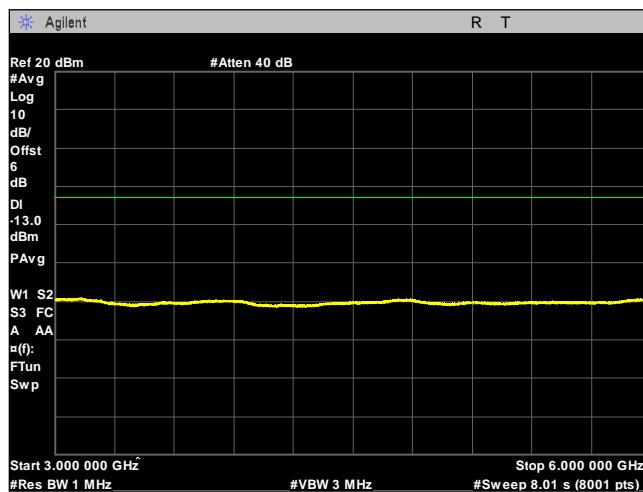
Conducted Spurious Emissions, Part 22, LTE Band 5, 10 MHz, Low Channel



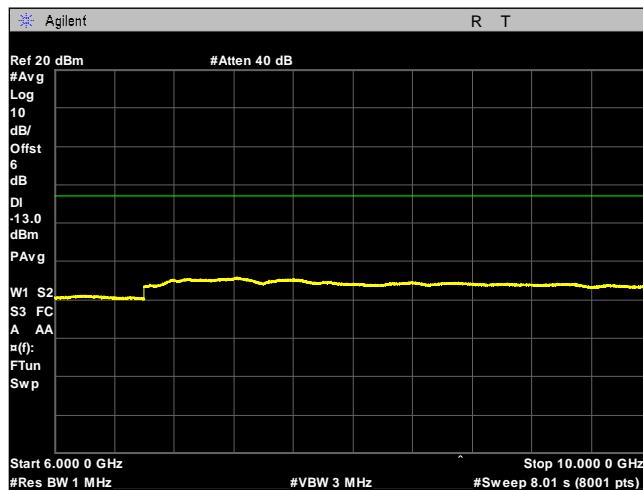
Plot 55. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 30 MHz – 1 GHz



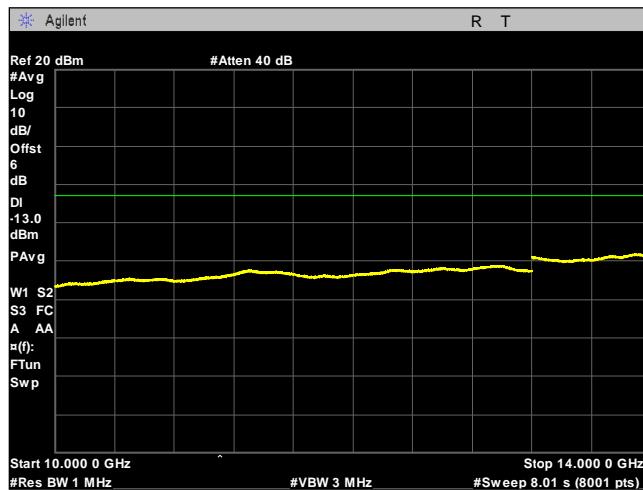
Plot 56. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 1 GHz – 3 GHz



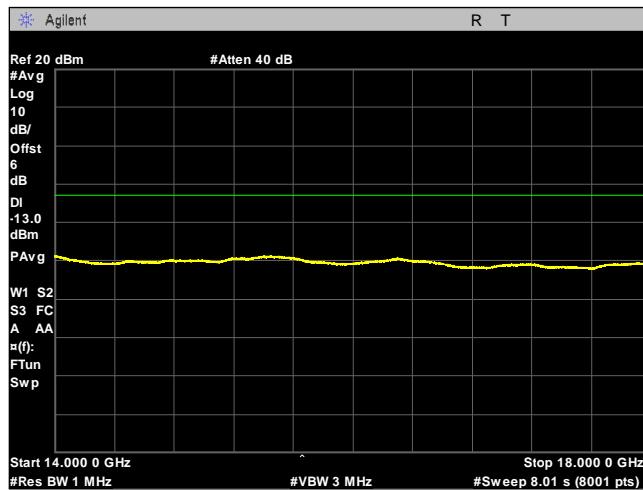
Plot 57. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 3 GHz - 6GHz



Plot 58. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 6 GHz – 10 GHz

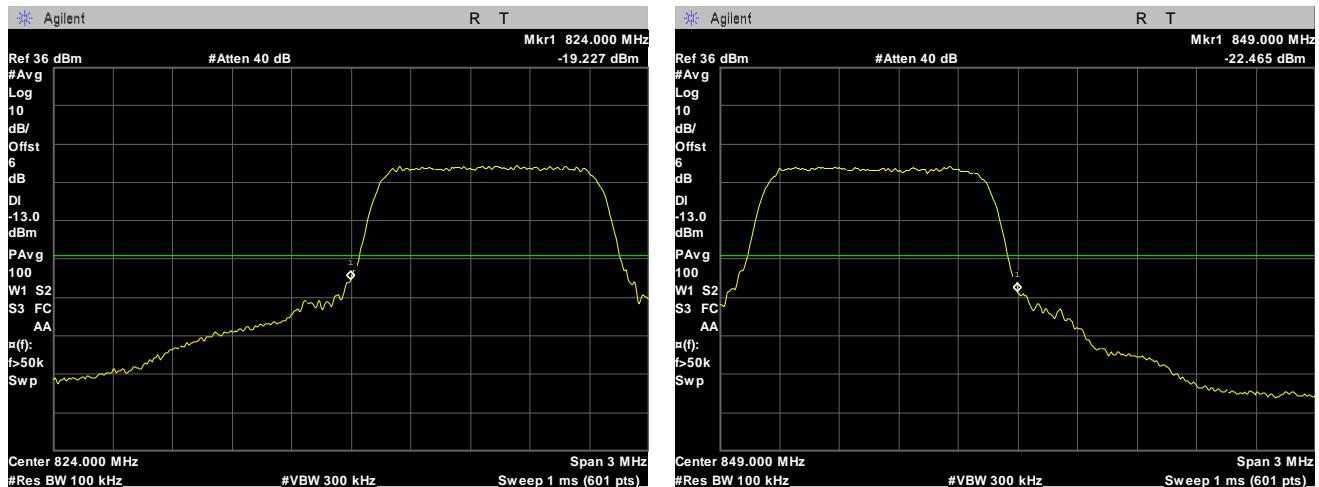


Plot 59. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 10 GHz – 14 GHz

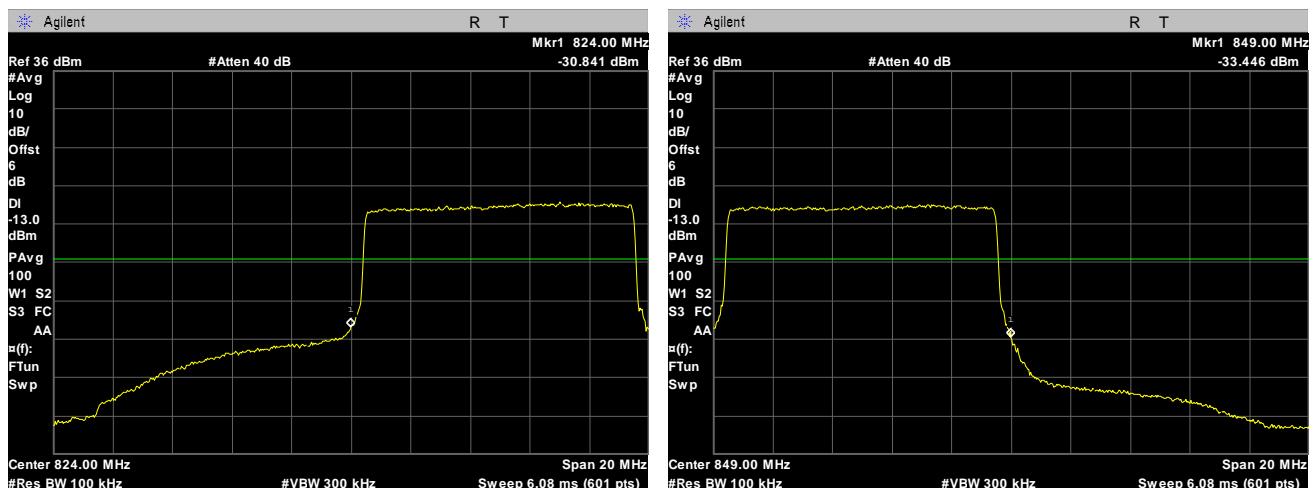


Plot 60. Spurious Emissions at Antenna Terminals, Low Channel, 10MHz, 14 GHz – 18 GHz

Conducted Bandedge, Part 22, LTE Band 5

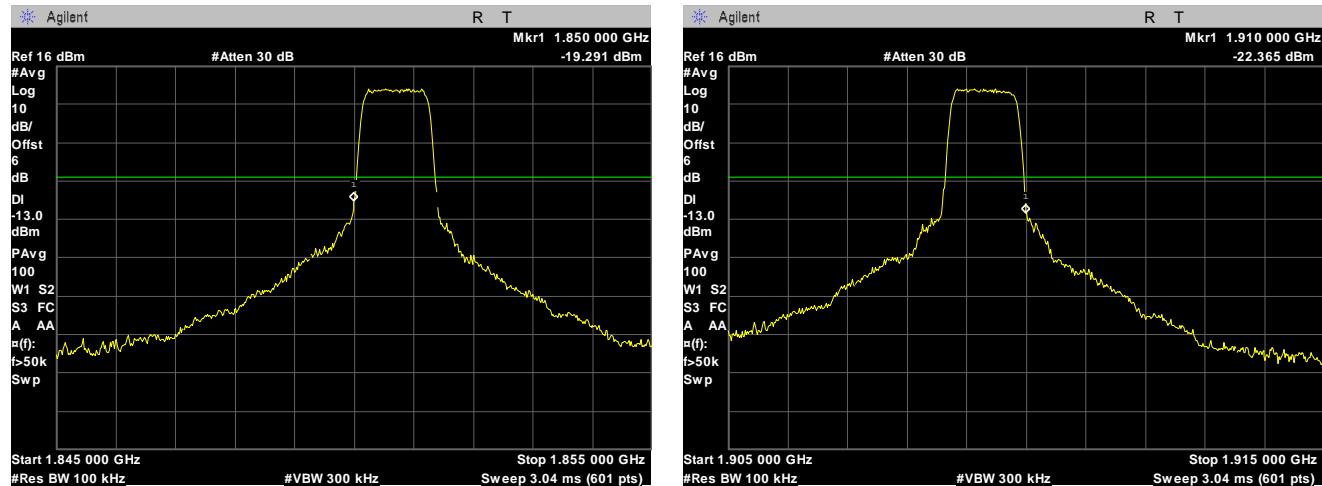


Plot 61. Conducted Bandedge, LTE Band 5, 1.4MHz BW

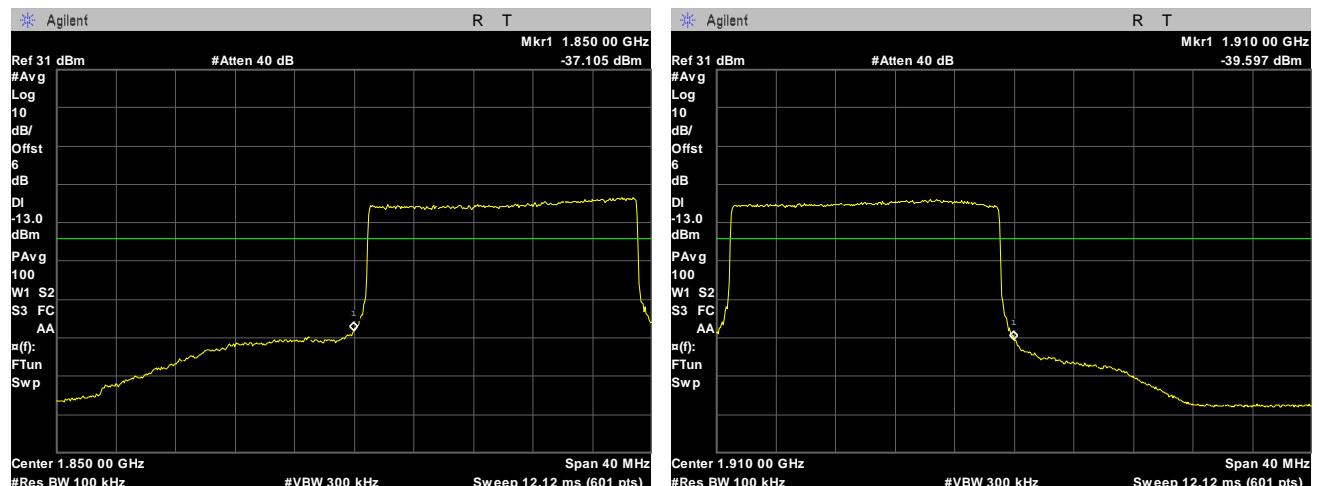


Plot 62. Conducted Bandedge, LTE Band 5, 10MHz BW

Conducted Bandedge, Part 24, LTE Band 2



Plot 63. Conducted Bandedge, LTE Band 2, 1.4MHz BW



Plot 64. Conducted Bandedge, LTE Band 2, 20MHz BW

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 24.232(d) Peak to Average Ratio

Test Requirement(s): **§ 24.232(d)** Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

Test Procedures: The EUT was tested using the spectrum analyzers peak to average power measurement function.

Test Results: Equipment complies with these requirements.

Test Engineer(s): Djed Mouada

Test Date(s): May 1, 2017

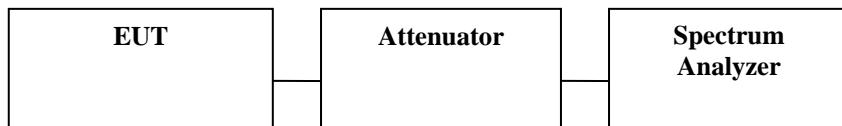
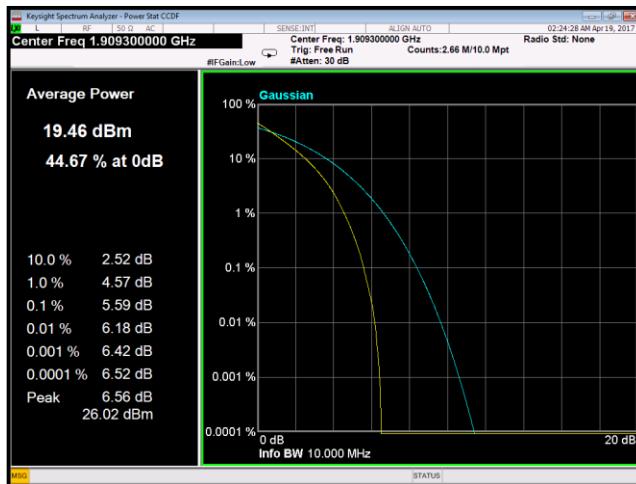
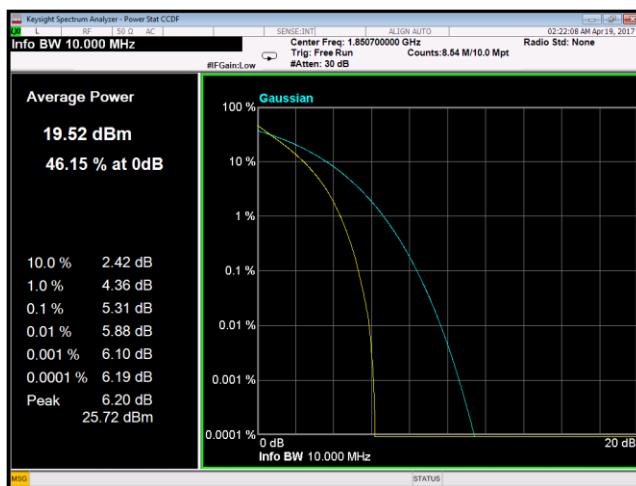


Figure 4. Spurious Emissions at Antenna Terminals Test Setup

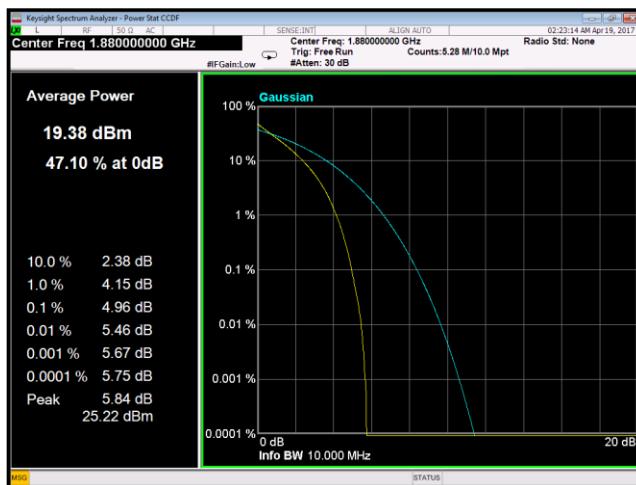
Conducted Spurious Emissions, Part 24, LTE Band 2, 1.4 MHz BW



Plot 65. Peak to Average Ratio, Band 2, 1.4MHz, High channel

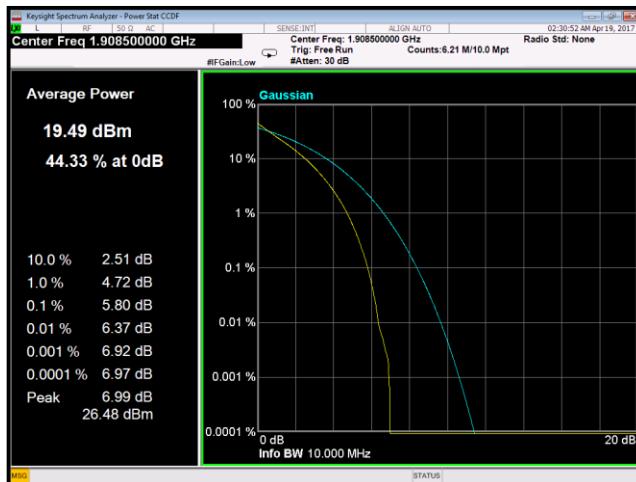


Plot 66. Peak to Average Ratio, Band 2, 1.4MHz, Low Channel



Plot 67. Peak to Average Ratio, Band 2, 1.4MHz, Mid channel

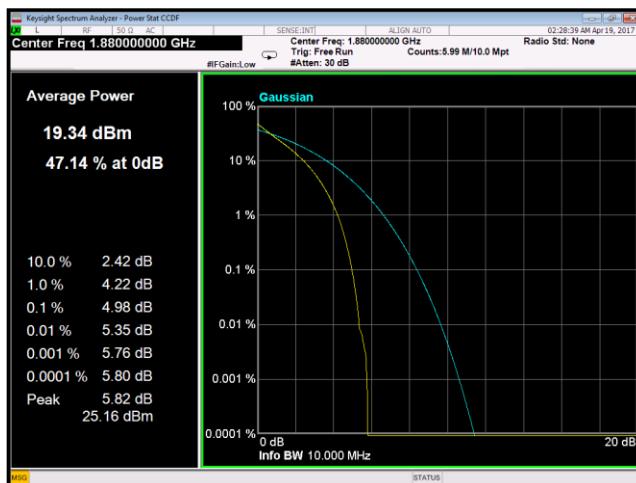
Conducted Spurious Emissions, Part 24, LTE Band 2, 3 MHz BW



Plot 68. Peak to Average Ratio, Band 2, 3MHz, High channel

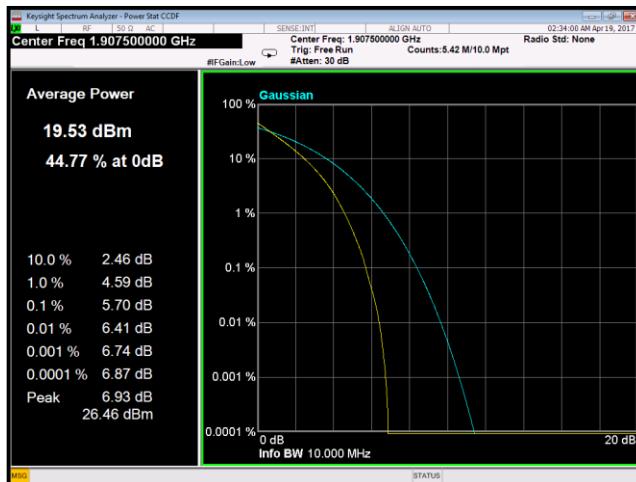


Plot 69. Peak to Average Ratio, Band 2, 3MHz, Low channel

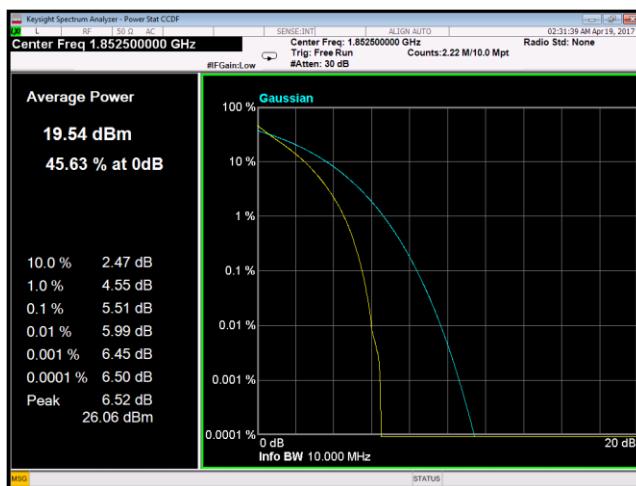


Plot 70. Peak to Average Ratio, Band 2, 3MHz, Mid channel

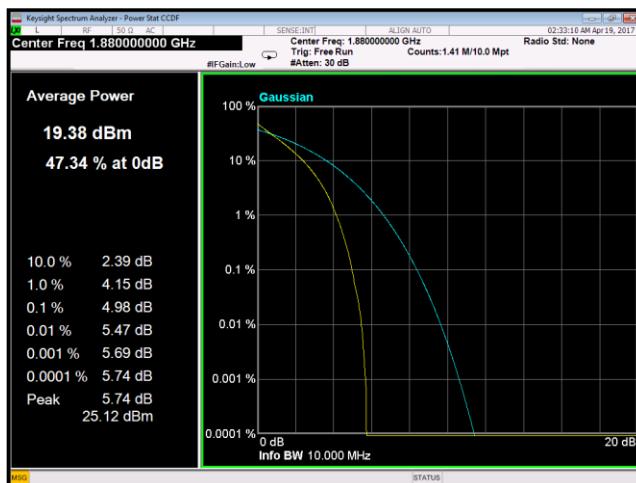
Conducted Spurious Emissions, Part 24, LTE Band 2, 5 MHz BW



Plot 71. Peak to Average Ratio, Band 2, 5MHz, High channel

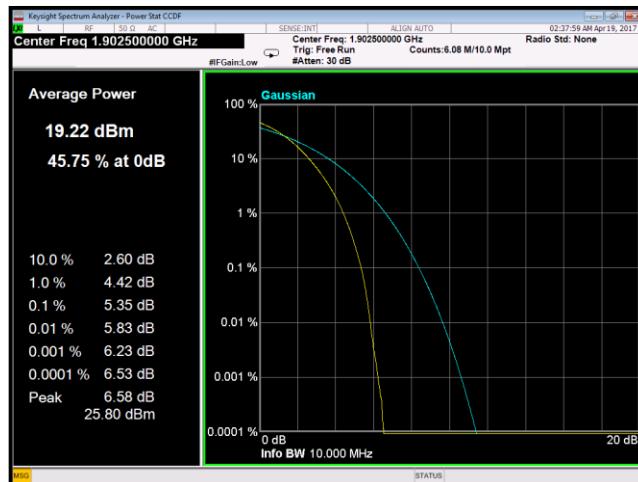


Plot 72. Peak to Average Ratio, Band 2, 5MHz, Low channel

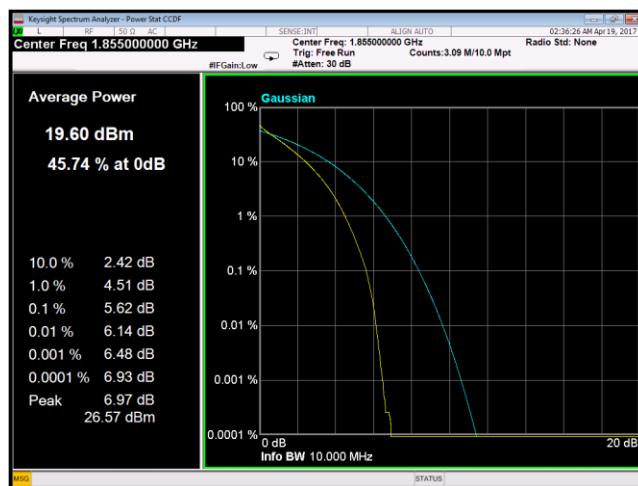


Plot 73. Peak to Average Ratio, Band 2, 5MHz, Mid channel

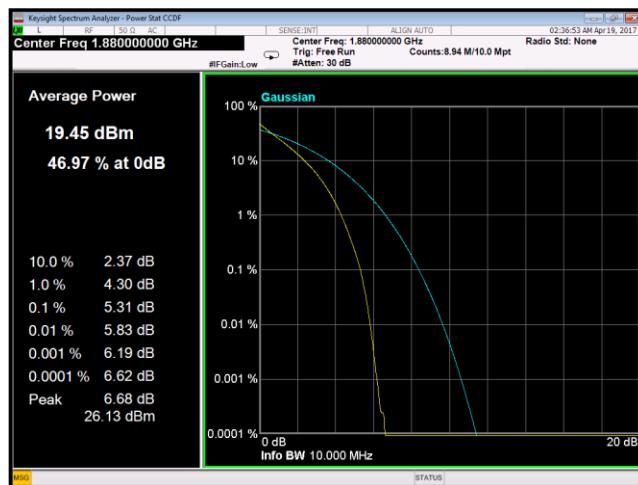
Conducted Spurious Emissions, Part 24, LTE Band 2, 10 MHz BW



Plot 74. Peak to Average Ratio, Band 2, 10MHz, High channel



Plot 75. Peak to Average Ratio, Band 2, 10MHz, Low channel



Plot 76. Peak to Average Ratio, Band 2, 10MHz, Mid channel



Electromagnetic Compatibility Criteria for Intentional Radiators

§2.1049 Frequency Stability

Test Requirement(s): §2.1055 (a) The frequency stability shall be measured with variation of ambient temperature.
(d) The frequency stability shall be measured with variation of primary supply voltage.

§24.235 The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

Test Procedures: The EUT was placed inside a temperature chamber and Frequency measurements were made at the extremes of the specified temperature range and at intervals of than 10° centigrade through the range. The operating voltage is varied to +/- 15 % of the nominal voltage at normal temperature.

Test Results: Equipment complies with the requirements of this section.

Test Engineer(s): Djed Mouada

Test Date(s): May 1, 2017



LTE Band 5 10MHz					
Voltage (DC)	Temperature	low 26dB point	Band Edge	High 26dB point	Band Edge
110	-20	824.0025522	824	848.9982367	849
110	-10	824.0012307	824	848.998236	849
110	0	824.003551	824	848.99242	849
110	10	824.0075587	824	848.9920014	849
110	20	824.0013559	824	848.980016	849
110	30	824.0010654	824	848.9980149	849
110	40	824.0009251	824	848.90021	849
110	50	824.0009891	824	848.990003	849
110	55	824.00145	824	848.995004	849
93.5	20	824.012	824	848.98554	849
108	20	824.012	824	898.98553	849

Table 7. Module Frequency Stability, LTE Band II, Test Results

LTE Band 2 20MHz					
Voltage (DC)	Temperature	low 26dB point	Band Edge	High 26dB point	Band Edge
110	-20	1850.111696	1850	1909.998126	1910
110	-10	1850.001917	1850	1909.9991	1910
110	0	1850.001848	1850	1909.889221	1910
110	10	1850.445608	1850	1909.980746	1910
110	20	1850.0263	1850	1909.840037	1910
110	30	1850.001208	1850	1909.998127	1910
110	40	1850.001133	1850	1909.99891	1910
110	50	1850.00556	1850	1909.998892	1910
110	55	1850.00781	1850	1909.998897	1910
93.5	20	1850.00154	1850	1909.89919	1910
108	20	1850.0163	1850	1909.899983	1910

Table 8. Module Frequency Stability, LTE Band V, Test Results

Frequency Stability Test Setup



Photograph 3. Frequency Stability, Test Setup



Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit: EUT's operating frequencies @ 869-894 MHz and 1930-1990 MHz; **Limit for Uncontrolled exposure: 1 mW/cm² or 10 W/m²**

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where,
S = Power Density (mW/cm²)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

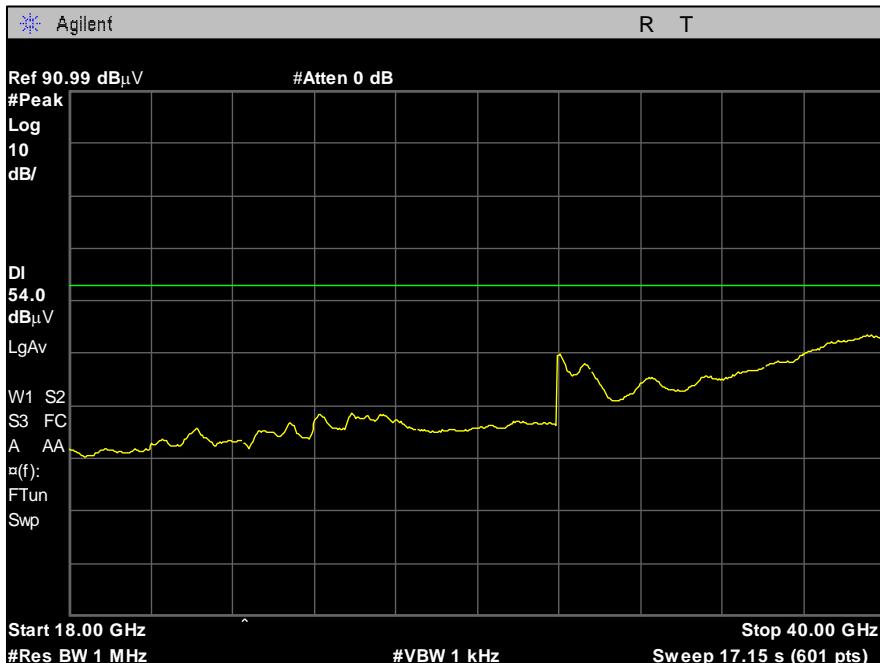
Test Results:

FCC									
Frequency (MHz)	Con. Pwr. (dBm)	Con. Pwr. (mW)	Ant. Gain (dBi)	Ant. Gain numeric	Pwr. Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
1880	19.99	99.77	10	10	0.19849	1	0.80151	20	Pass

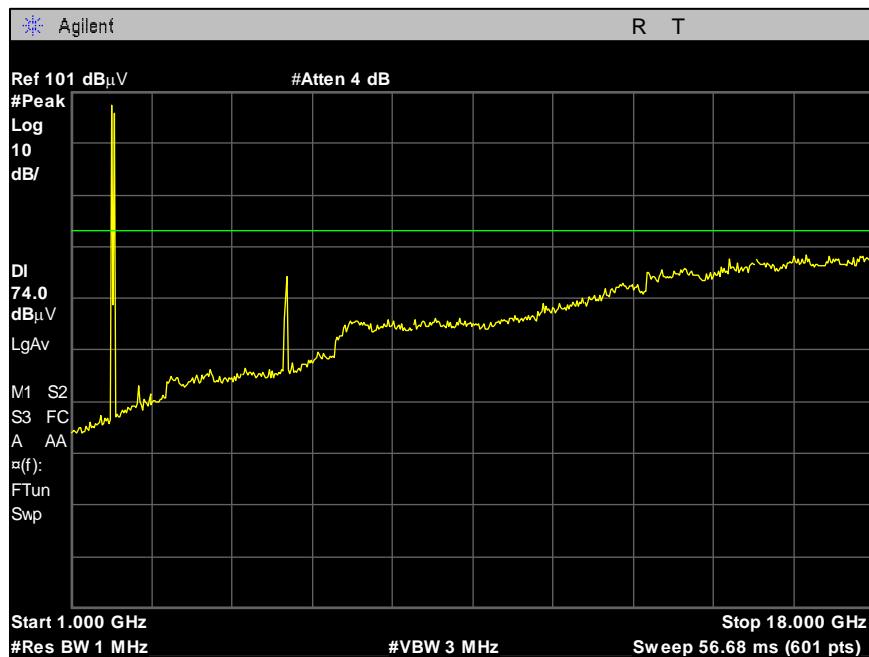
The safe distance where Power Density is less than the MPE Limit listed above was found to be 20 cm.



Plot 77. Simultaneous Transmission LTE WiFi 1-18 GHz Average



Plot 78. Simultaneous Transmission LTE WiFi 18-40 GHz Average



Plot 79. Simultaneous Transmission LTE WiFi 1-18 GHz Peak



Plot 80. Simultaneous Transmission LTE WiFi 18-40 GHz Peak



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Test Equipment
CFR Title 47 Part 22 Subpart H & Part 24 Subpart E

IV. Test Equipment



Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T8818	Spectrum Analyzer	Agilent Technologies	E4407B	2/24/2017	2/24/2018
1T4753	Antenna - Bilog	Sunol Sciences	JB6	10/24/2016	4/24/2018
1T4563	LISN (10 AMP)	Solar Electronics Company	9322-50-R-10-BNC	3/13/2017	9/13/2018
1T4300	SEMI-ANECHOIC CHAMBER #1 (NSA)	EMC TEST SYSTEMS	NONE	2/6/2015	2/6/2018
1T4409	EMI Receiver	Rohde & Schwarz	ESIB7	12/7/2016	12/7/2018
1T4269	Antenna: Loop	EMCO	10/28/1917	1/11/2016	7/11/2017
1T4483	Antenna; Horn	ETS-Lindgren	7/13/1908	4/19/2017	10/19/2018
1T4771	PSA Spectrum Analyzer	Agilent Technologies	E4446A	8/10/2016	2/10/2018

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.



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Electromagnetic Compatibility
End of Report
CFR Title 47 Part 22 Subpart H & Part 24 Subpart E

End of Report