MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372
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13501 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

January 24, 2017

KEYW Corporation
7767 Old Telegraph Rd.
Severn, MD 21144

Dear Ken O'Brien,

Enclosed is the EMC Wireless test report for compliance testing of the KEYW Corporation, MPBTS as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 22 Subpart H and Industry Canada RSS-132 Issue 3 for Cellular Devices, and FCC Part 24 Subpart E and Industry Canada RSS-133 Issue 6 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.

Jennifer Warnell
Documentation Department

Reference: (\KEYW Corporation\EMC87554G-FCC22_24 Rev. 2)

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Electromagnetic Compatibility Criteria
Test Report

for the

KEYW Corporation
Model MPBTS

Tested under
FCC Certification Rules
Title 47 of the CFR,
Part 22 Subpart H for Cellular Devices and RSS-132 Issue 3
&
Part 24 Subpart E for Broadband PCS Devices and RSS-133 Issue 6

MET Report: EMC87554G-FCC22_24 Rev. 2

January 24, 2017

Prepared For:

KEYW Corporation
7767 Old Telegraph Rd.
Severn, MD 21144

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave
Baltimore, MD 21230

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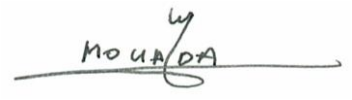

Djed Mouada
Project Engineer, Electromagnetic Compatibility Lab

Jennifer Warnell
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, and Industry Canada standards RSS-132 Issue 3 January 2013 and RSS-133 Issue 6 January 2013 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	July 27, 2016	Initial Issue
1	December 7, 2016	Engineer corrections.
2	January 24, 2017	Added MPE.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the KEYW Corporation MPBTS, 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 MPBTS. KEYW Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the MPBTS, 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 KEYW Corporation, purchase order number B003491.

FCC Reference	IC Reference	Description	Compliance
§2.1049; §22.917; §24.232(d)	RSS-GEN Issue 4	Occupied Bandwidth	Compliant
§2.1049, §24.238	RSS-132 Issue 3 (5.3) RSS-133 Issue 6 (6.3)	Frequency stability	Compliant
§24.323 (d)	N/A	Peak to Average Ration	Compliant
§2.1051; §22.917, §24.238	RSS-132 Issue 3 (5.5) RSS-133 Issue 6 (6.5)	Conducted Spurious Emissions at Antenna Terminals and Band Edge	Compliant
§2.1046; §22.913; §24.232	RSS-132 Issue 3 (5.4) RSS-133 Issue 6 (6.4)	RF Power Output (EIRP)	Compliant
§2.1053; §22.917, §24.238	RSS-132 Issue 3 (5.5) RSS-133 Issue 6 (6.5)	Radiated Spurious Emissions from the Cabinet	Compliant

Table 1. Executive Summary of EMC ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by KEYW Corporation to perform testing on the MPBTS, under KEYW Corporation's purchase order number B003491.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the KEYW Corporation, MPBTS.

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

Model(s) Tested:	MPBTS		
Model(s) Covered:	MPBTS		
Filing Status:	Original		
EUT Specifications:	Primary Power: 120 VAC, 60 Hz		
	FCC ID: 2AFYU26636		
	Type of Modulations:	GSM	
	Equipment Code:	AMP	
	RF Power Output	Part 22 ERP: 92.04(W)	Part 24 EIRP: 151 (W)
	EUT Frequency Ranges:	869-894 MHz	1930-1990 MHz
Analysis:	The results obtained relate only to the item(s) tested.		
Environmental Test Conditions:	Temperature: 15-35º C		
	Relative Humidity: 30-60%		
	Barometric Pressure: 860-1060 mbar		
Evaluated by:	Djed Mouada		
Date(s):	January 24, 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
RSS-132 Issue 3 January 2013	Cellular Telephone Systems Operating in the Bands 824-849 MHz and 869-894 MHz
RSS-133 Issue 6 January 2013	2 GHz Personal Communications Services
RSS-GEN Issue 4 November 2014	General Requirements for Compliance of Radio Apparatus
ANSI C63.4:20014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
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

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 Multi-Protocol Base Transceiver Station (MPBTS), Equipment Under Test (EUT), is a high-power, multi-protocol, multi-carrier capable base station that can be used for many cellular applications. The system is intended to be used in mobile environments installed in a vehicle with room mounted antenna, but can also function as a fixed base station.

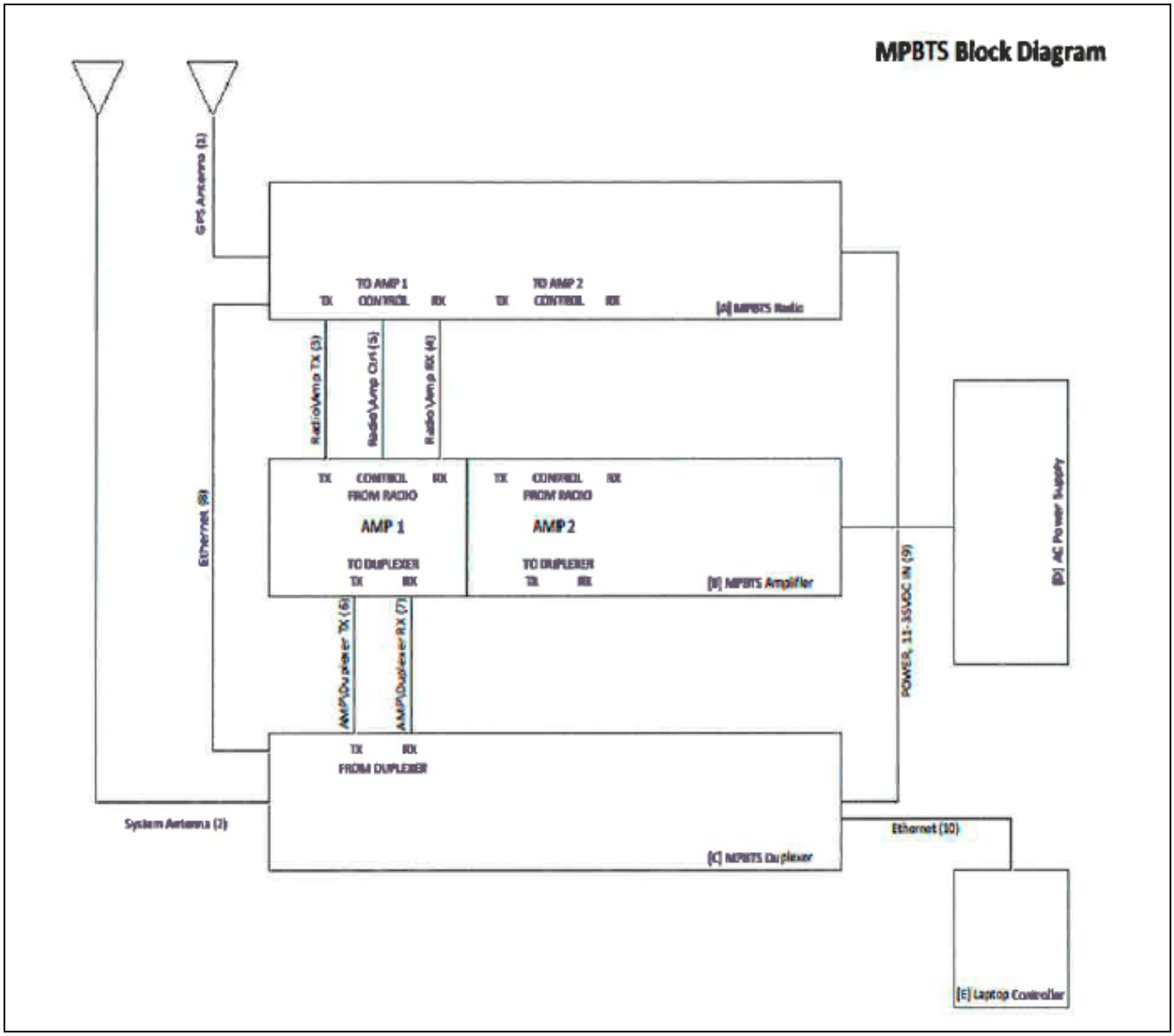


Figure 1. Block Diagram of Equipment Configuration

E. Equipment Configuration

Ref. ID	Name/Description	Model Number	Part Number	Serial Number
A	MPBTS Radio	TBD	--	TBD
B	MPBTS Amplifier	TBD	--	TBD
C	MPBTS Duplexer	TBD	--	TBD
D	Power Supply	TBD	--	TBD

Table 2. Equipment Configuration

F. Support Equipment

Ref. ID	Name / Description	Manufacturer	Model Number	Customer Supplied Calibration Data
--	System/GPS Dual Feed Antenna	Huber Suhner	1399.99.0120	--
E	Laptop Controller	Dell	ATG	--

Table 3. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description or Reason for No Cable	Qty.	Max Length	Shielded? (Y/N)	Termination Box ID & Port Name
1	[A] GPS Antenna	LMR200	1	15’	Yes	GSP Antenna
2	[C] System Antenna	LMR400	1	<10’	Yes	System Antenna
3	[A] To Amp 1 TX	LMR400	1	<18”	Yes	[B] From Radio TX
4	[A] To Amp 1 RX	LMR400	1	<18”	Yes	[B] From Radio RX
5	[A] To Amp 1 Control	24AWG, 12 Conductor	1	<18”	Yes	[B] From Radio Control
6	[B] To Duplexer TX	LMR400	1	<18”	Yes	[C] From Amp TX
7	[B] to Duplexer RX	LMR400	1	<18”	Yes	[C] From Amp RX
8	[A] Ethernet	8 Conductor, CAT5	1	--	No	[C] Ethernet (Port 2)
9	[A,B,C] Power, 11-35VDC In	14AWG, 4 Conductor SJ Cable	3	--	No	AC Power Supply
10	[C] Ethernet	8 Conductor, CAT5	1	--	No	Laptop Controller

Table 4. Ports and Cabling Information

H. Mode of Operation

The MPBTS continuously transmits a broadcast signal as part of its normal operation. There is no special operating mode required for testing.

I. Method of Monitoring EUT Operation

1. A blinking green heartbeat indicator in the GUI and green LEDs on the radio and amplifier front panels indicate normal operation of the system.
2. Any other LED status or lack of the green heartbeat indicator indicates a problem with the system.

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 KEYW Corporation 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 Power and antenna height limits.

§ 22.913(a): The Effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 watts.

§ 24.232 Power and antenna height limits.

§ 24.232 (a): **(**1**)** Base stations with an emission bandwidth of 1 MHz or less are limited to 1640 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.

Test Procedures: As required by 47 CFR 2.1046, RF power output measurements were made at the RF output terminals using an attenuator and spectrum analyzer or power meter. The spectrum analyzer was used in accordance with the licensed measurement guidance procedures. The "Channel Power" measurement feature of the spectrum analyzer was used. Measurements were taken in both high and low power modes, as permissible by compliance with Intermodulation requirements. Lower power mode must be used when operating in multi-channel mode.

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

Test Engineer(s): Djed Mouada

Test Date(s): 11/10/15

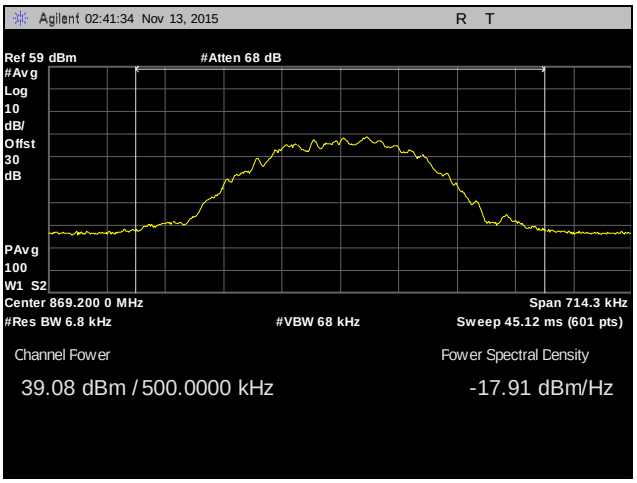
Channel	Conducted Power (dBm)	Antenna Gain (dBi)	ERP (W)	Limit(W)
Low (869.2MHz)	39.08	9	39.17	500
Mid (881.6MHz)	42.79	9	92.04	500
High (893.8MHz)	34.56	9	13.84	500

Table 5. ERP, Test Results, Part 22

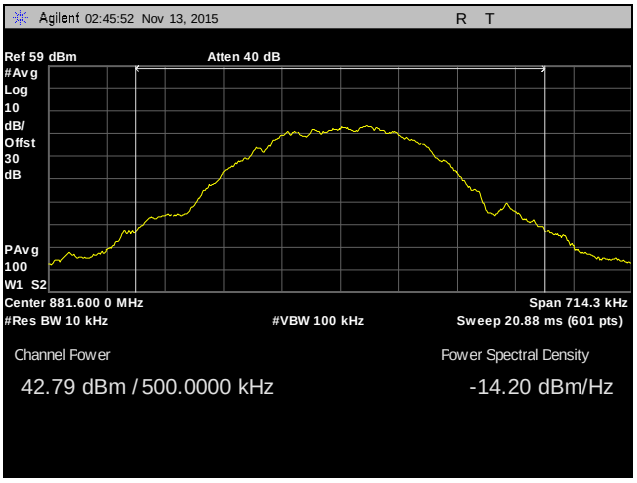
Channel	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (W)	Limit (W)
Low (1930.2 MHz)	39.08	9	64.27	1640
Mid (1960 MHz)	42.79	9	151	1640
High (1989.8MHz)	34.56	9	22.70	1640

Table 6. EIRP, Test Results, Part 24

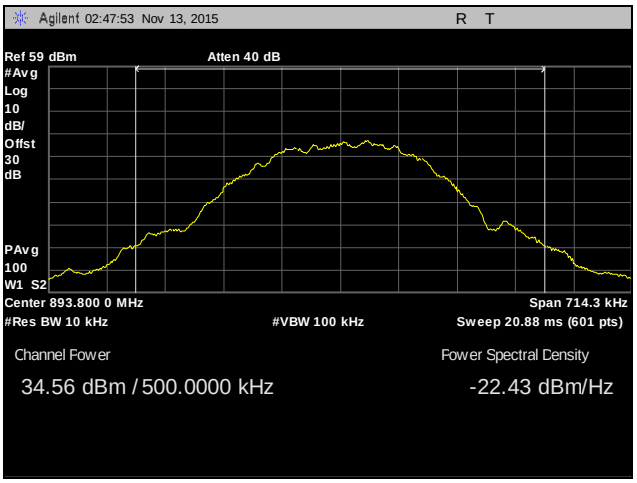
Part 22, Conducted Power



Plot 1, Channel 128, Conducted Power, Part 22

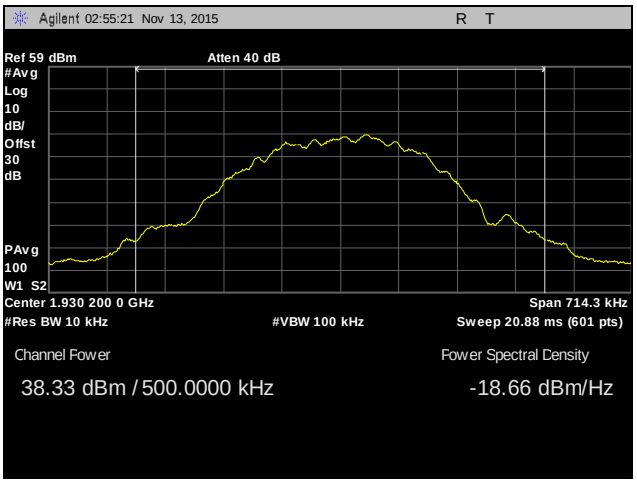


Plot 2, Channel 190, Conducted Power, Part 22

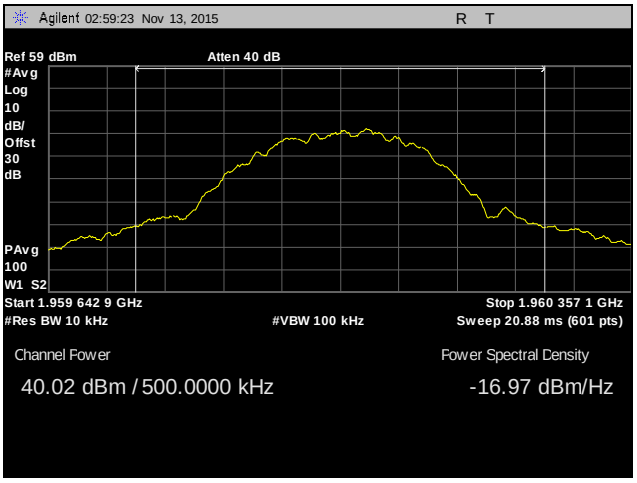


Plot 3, Channel 251, Conducted Power, Part 22

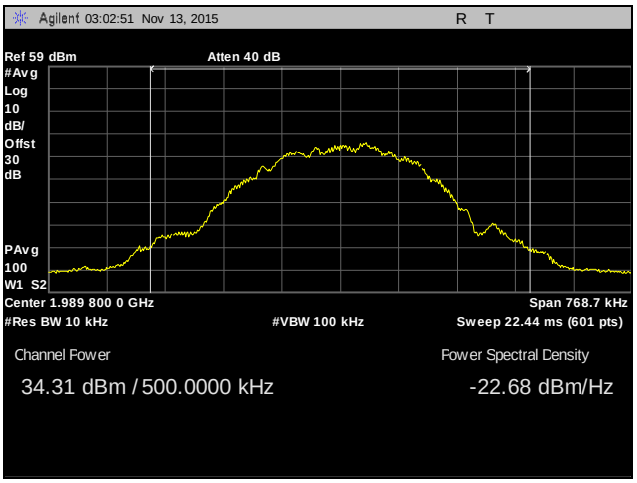
Part 24, Conducted Power



Plot 4, Channel 512, Conducted Power, Part 24



Plot 5, Channel 661, Conducted Power, Part 24



Plot 6, Channel 810, Conducted Power, Part 24

§ 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.

Test Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF frequency channel. The EUT was connected to a Spectrum Analyzer via attenuator. The RBW of the Spectrum Analyzer was set in accordance with the licensed measurement guidance procedures. Measurements were carried out at the low, mid, and high channels of the TX band.

Test Results: Equipment complies with FCC requirements.

Test Engineer(s): Djed Mouada

Test Date(s): 11/10/15

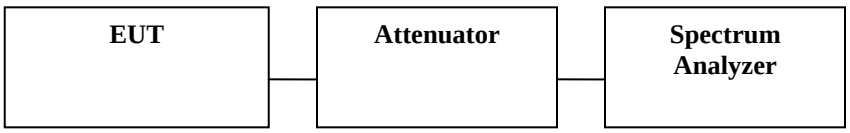
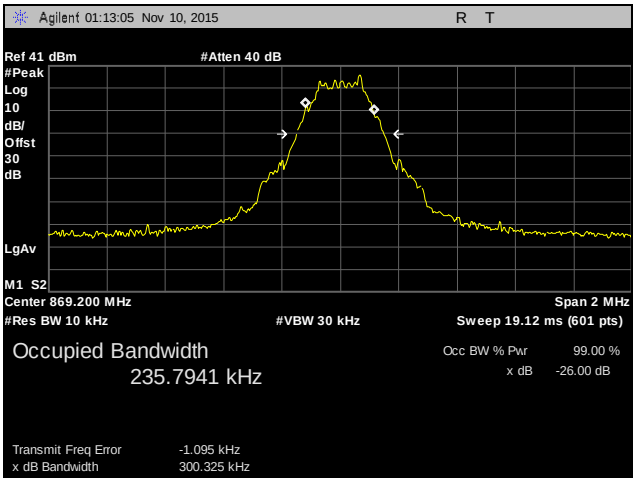
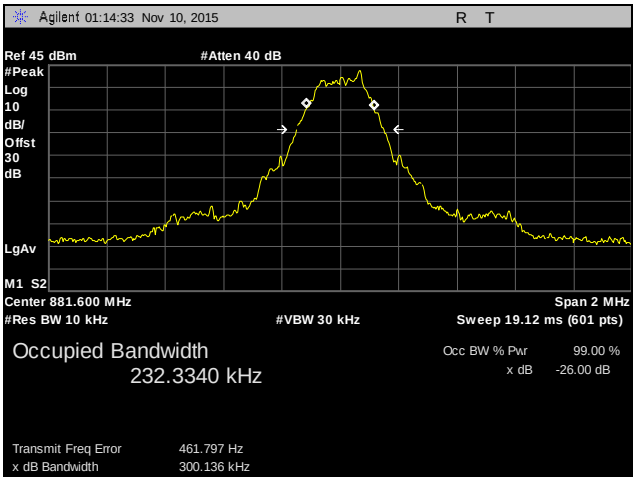


Figure 2. Occupied Bandwidth Test Setup

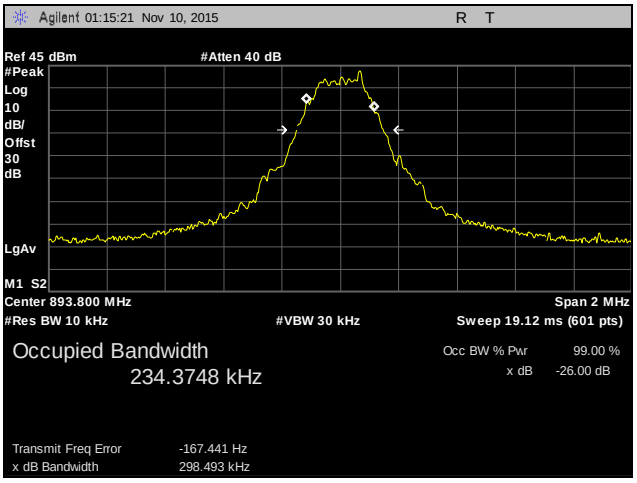
Part 22



Plot 7. Occupied Bandwidth, Channel 128, Part 22

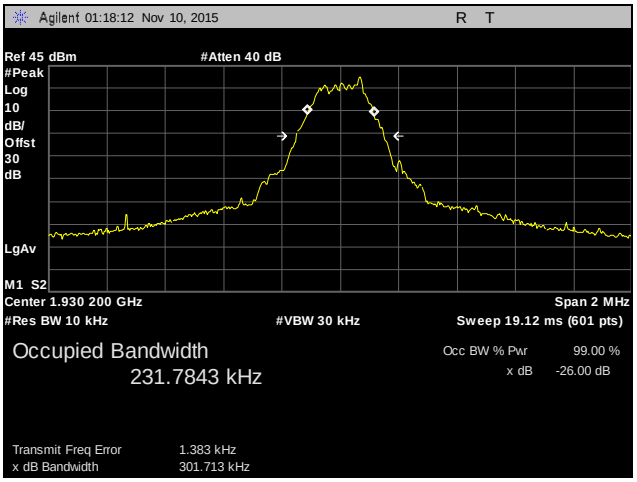


Plot 8. Occupied Bandwidth, Channel 190, Part 22

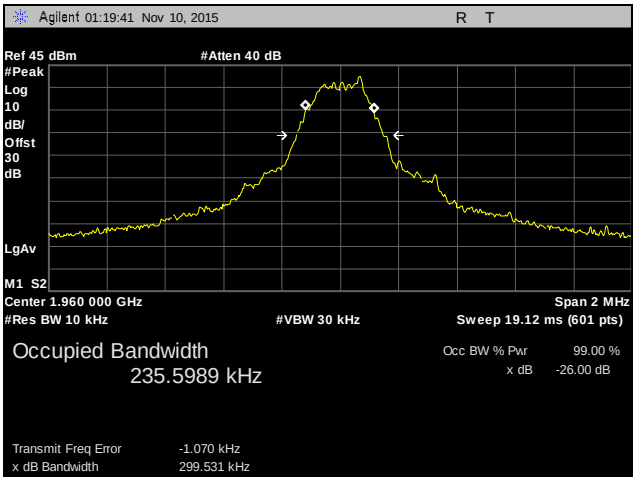


Plot 9. Occupied Bandwidth, Channel 251, Part 22

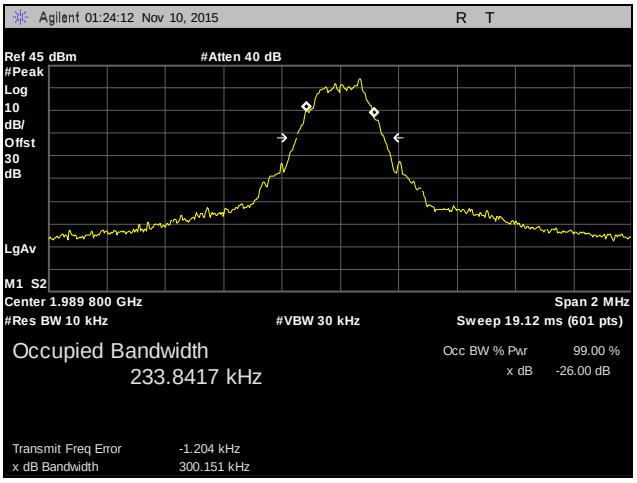
Part 24



Plot 10. Occupied Bandwidth, Channel 512, Part 24



Plot 11. Occupied Bandwidth, Channel 661, Part 24



Plot 12. Occupied Bandwidth, Channel 810, Part 24

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 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).

Test Procedures: As required by 47 CFR 2.1053, *field strength of radiated spurious measurements* was made in accordance with the procedures of EIA/TIA-603-D-2010 "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards".

Radiated emission measurements were performed inside a 3 meter semi-anechoic chamber. The EUT's RF ports were terminated to 50ohm load. The EUT was tested using both modulations and at the low, mid, and high channels. The EUT was rotated about 360^0 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. Harmonic emissions up to the 10^{th} or 40GHz, which ever was the lesser, were investigated.

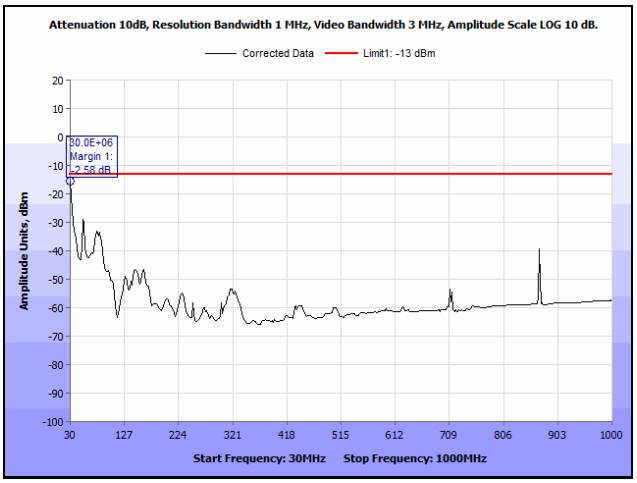
The spectrum analyzer was set to 1MHz RBW and 3MHz VBW. The spectrum was investigated from 30MHz to the 10^{th} harmonic of the carrier.

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

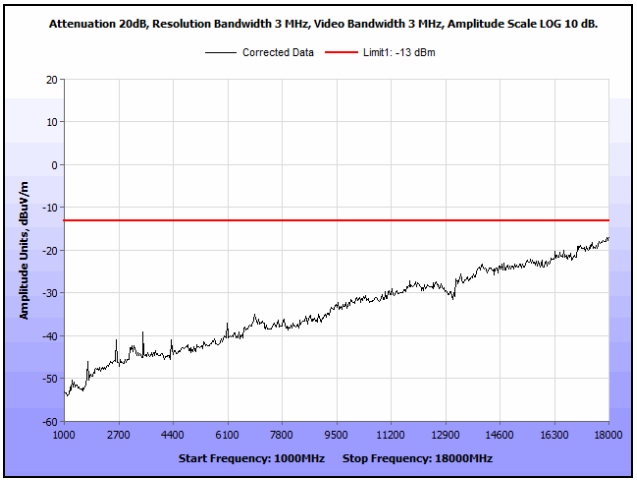
Test Engineer: Djed Mouada

Test Date(s): 12/18/15

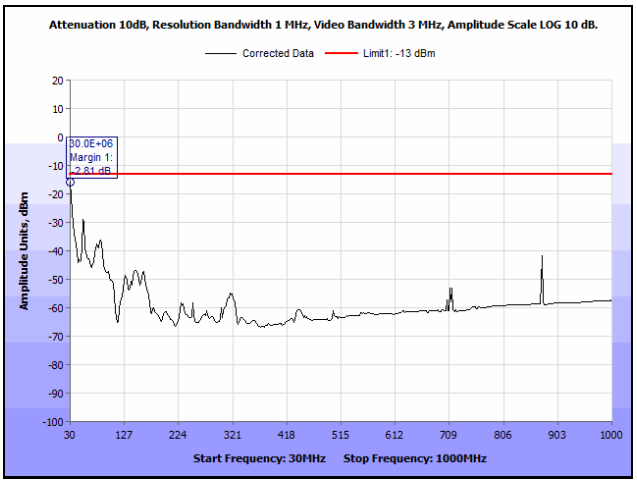
Radiated Spurious Emissions, Part 22



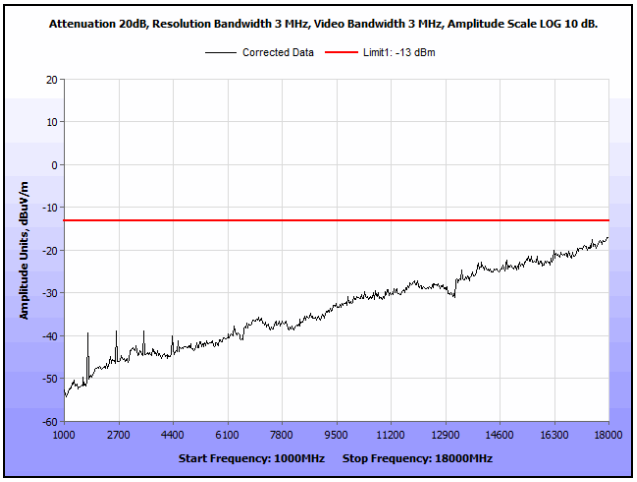
Plot 13. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Part 22



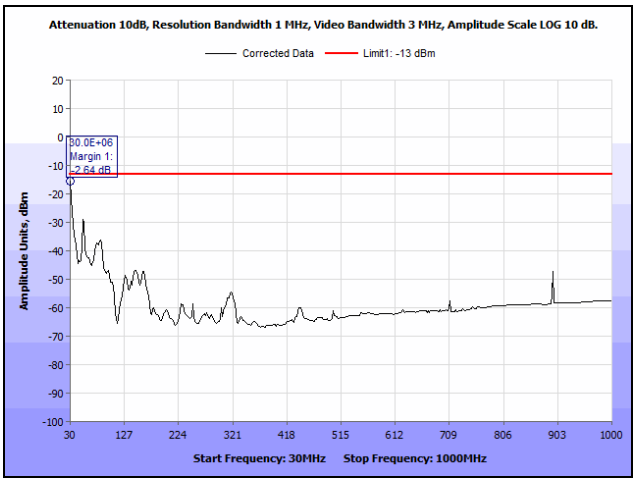
Plot 14. Radiated Spurious Emissions, Low Channel, 1 GHz – 18 GHz, Part 22



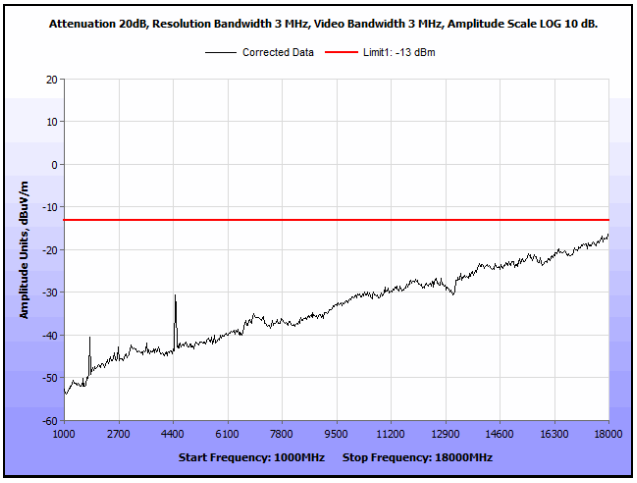
Plot 15. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Part 22



Plot 16. Radiated Spurious Emissions, Mid Channel, 1 GHz – 18 GHz, Part 22

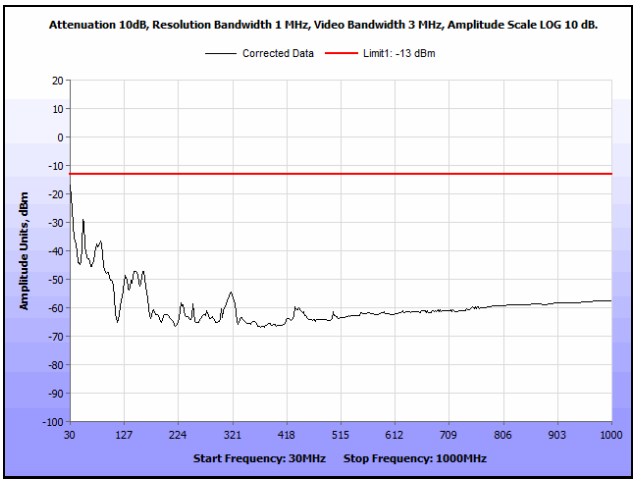


Plot 17. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Part 22

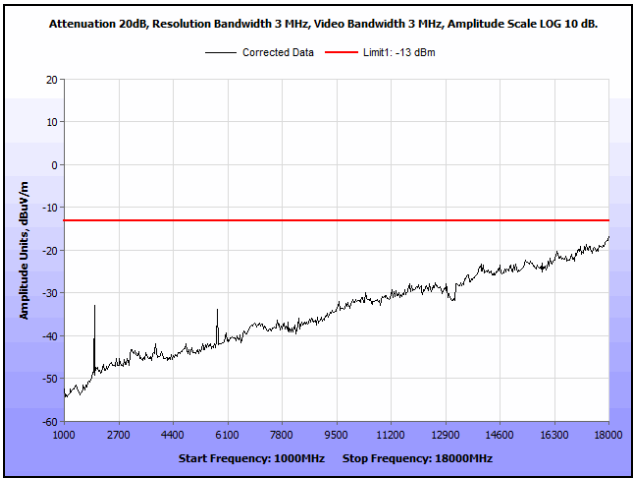


Plot 18. Radiated Spurious Emissions, High Channel, 1 GHz – 18 GHz, Part 22

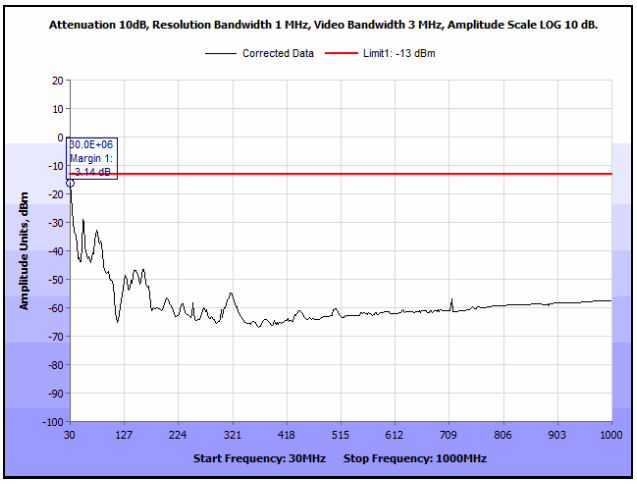
Radiated Spurious Emissions, Part 24



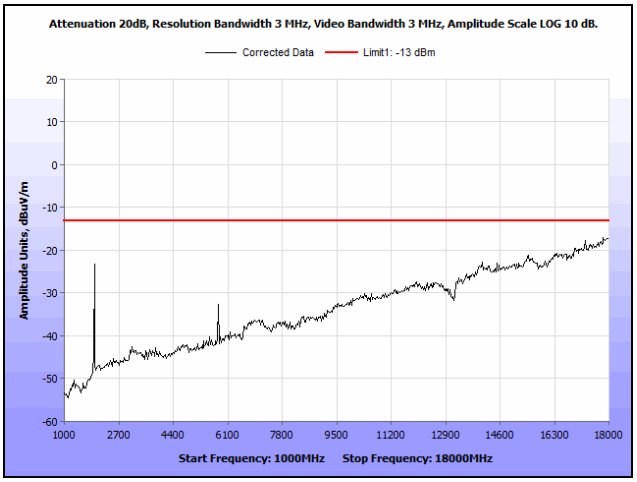
Plot 19. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Part 24



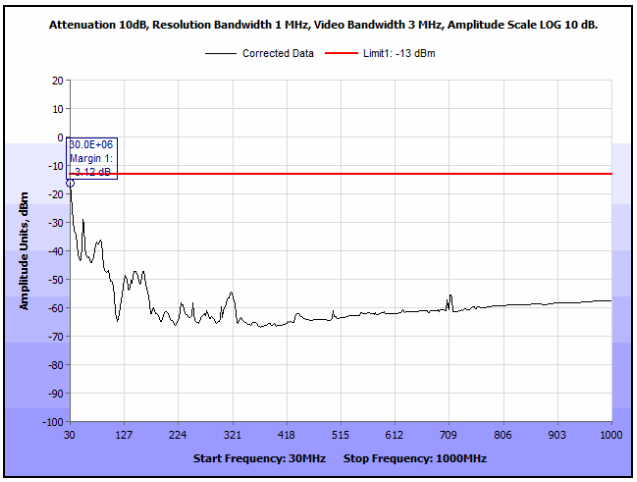
Plot 20. Radiated Spurious Emissions, Low Channel, 1 GHz – 18 GHz, Part 24



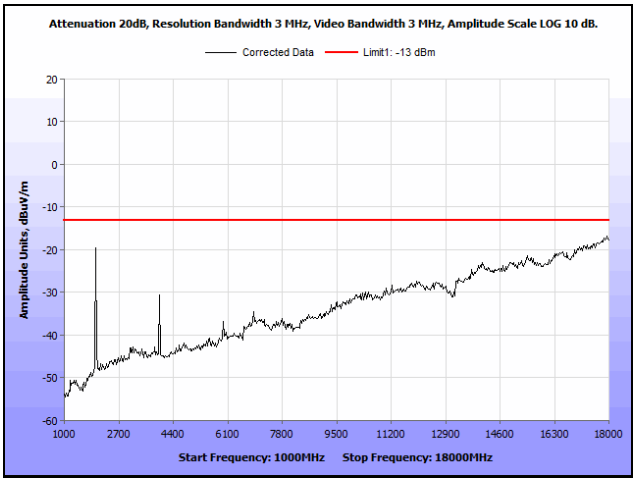
Plot 21. Radiated Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Part 24



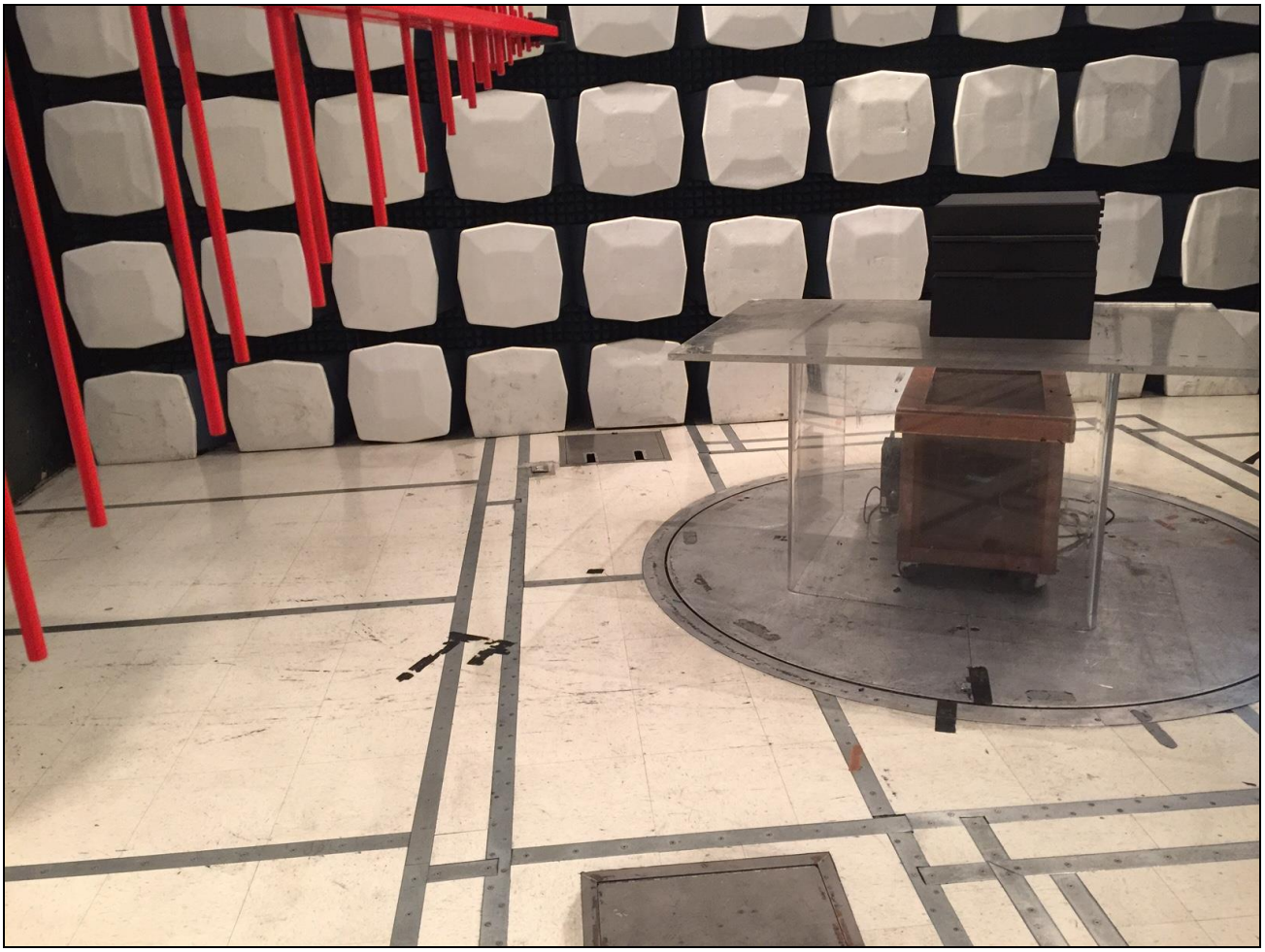
Plot 22. Radiated Spurious Emissions, Mid Channel, 1 GHz – 18 GHz, Part 24



Plot 23. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Part 24



Plot 24. Radiated Spurious Emissions, High Channel, 1 GHz – 18 GHz, Part 24



Photograph 1. Radiated Spurious Emissions, Test Setup

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.

§ 22.917 (b) *Measurement procedure*. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy approved the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz 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.

§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.

§ 24.238 (b) *Measurement procedure*. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter 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 required measurement 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.

Test Procedures: As required by 47 CFR §2.1051, *spurious emissions at antenna terminal measurements* were made at the RF output terminals using a Spectrum Analyzer.

A laptop was connected to EUT to control the RF power output and frequency channel. The EUT was connected to a Spectrum Analyzer through an attenuator. The Spectrum Analyzer was set to sweep 30 MHz and up to 10th harmonic of the fundamental or 40 GHz whichever is the lesser. Measurements were made in all applicable frequency bands.

Band Edge Plots: If a reduction of power was necessary for compliance at band edges, a second band edge plot was taken at the outermost channel that was compliant at the highest power. The channel number is noted in the caption of those plots.

Test Results: Equipment complies with these requirements.

Test Engineer(s): Djed Mouada

Test Date(s): 11/10/15

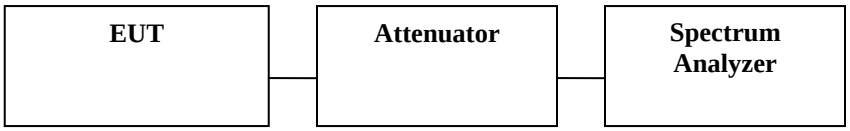
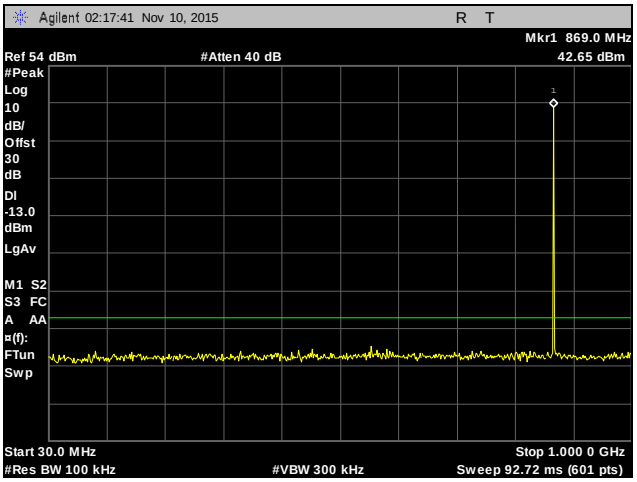
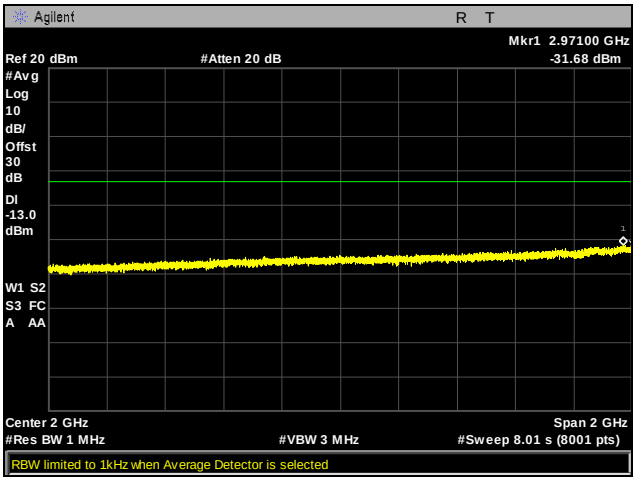


Figure 3. Spurious Emissions at Antenna Terminals Test Setup

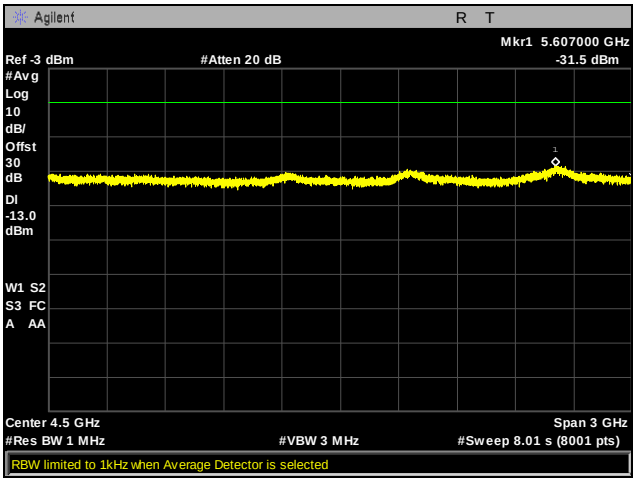
Part 22



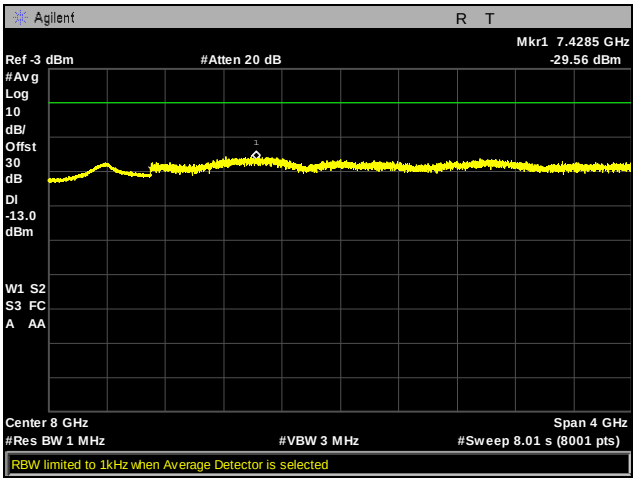
Plot 25. Conducted Spurious Emissions, Channel 128, 30 MHz – 1 GHz, Part 22



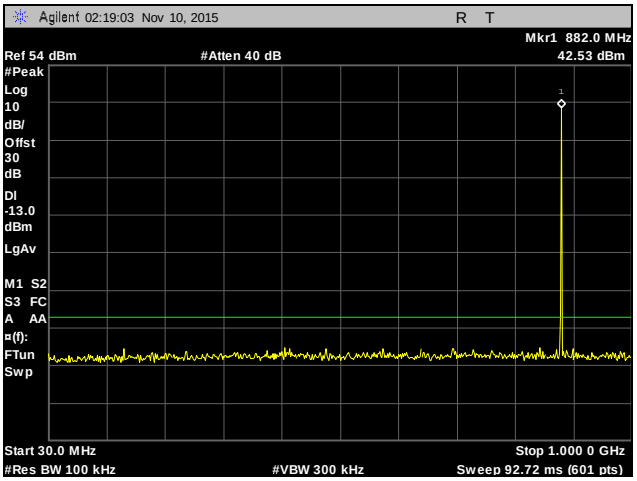
Plot 26. Conducted Spurious Emissions, Channel 128, 1 GHz – 3 GHz, Part 22



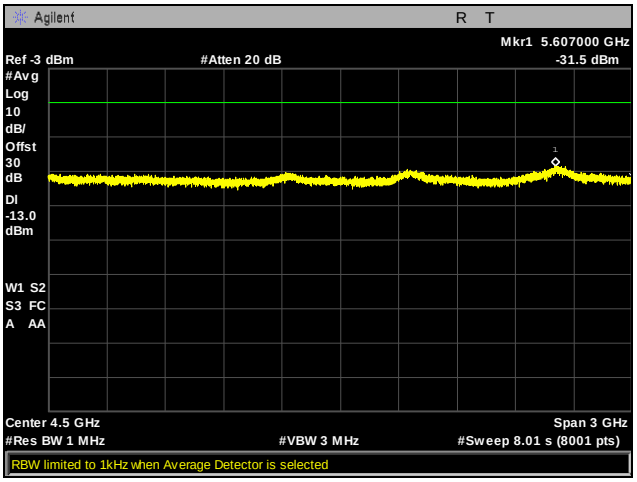
Plot 27. Conducted Spurious Emissions, Channel 128, 3 GHz – 6 GHz, Part 22



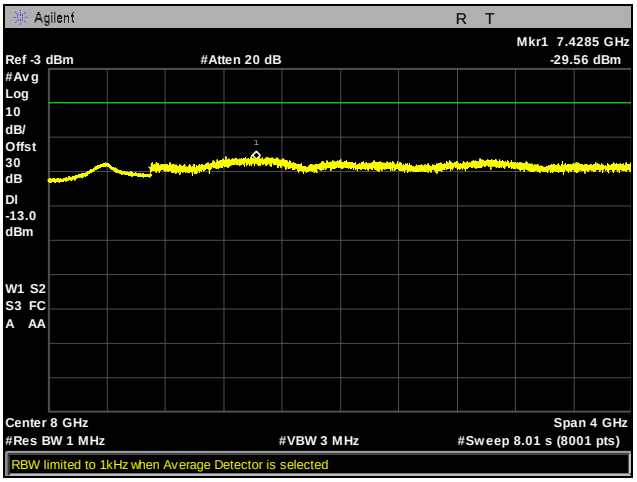
Plot 28. Conducted Spurious Emissions, Channel 128, 6 GHz – 10 GHz, Part 22



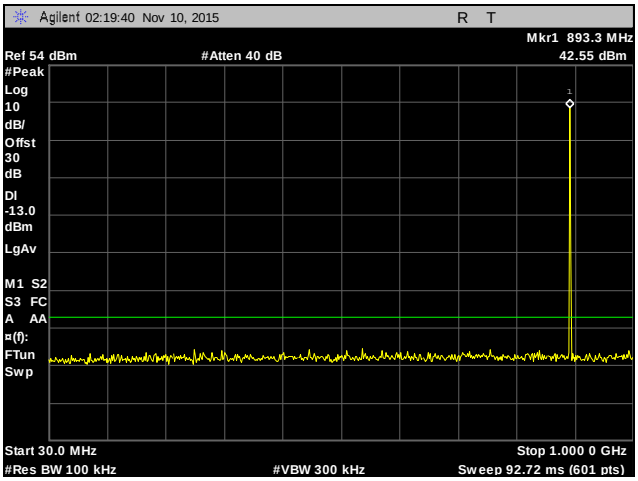
Plot 29. Conducted Spurious Emissions, Channel 190, 30 MHz – 1 GHz, Part 22



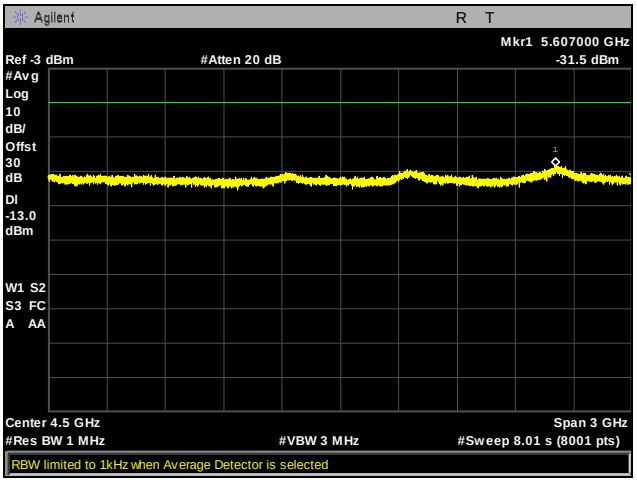
Plot 30. Conducted Spurious Emissions, Channel 190, 3 GHz – 6 GHz, Part 22



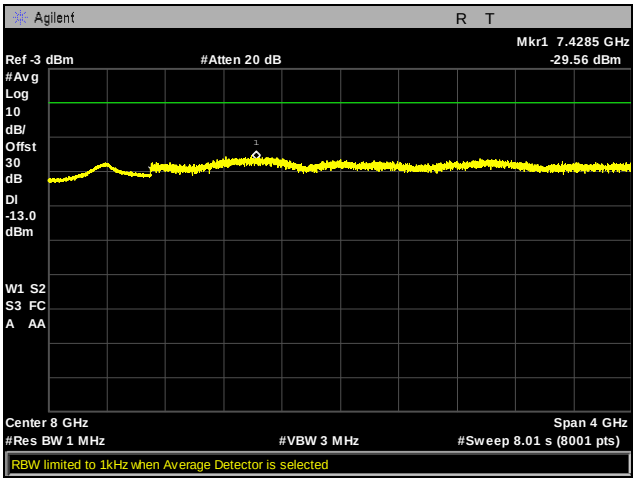
Plot 31. Conducted Spurious Emissions, Channel 190, 6 GHz – 10 GHz, Part 22



Plot 32. Conducted Spurious Emissions, Channel 251, 30 MHz – 1 GHz, Part 22

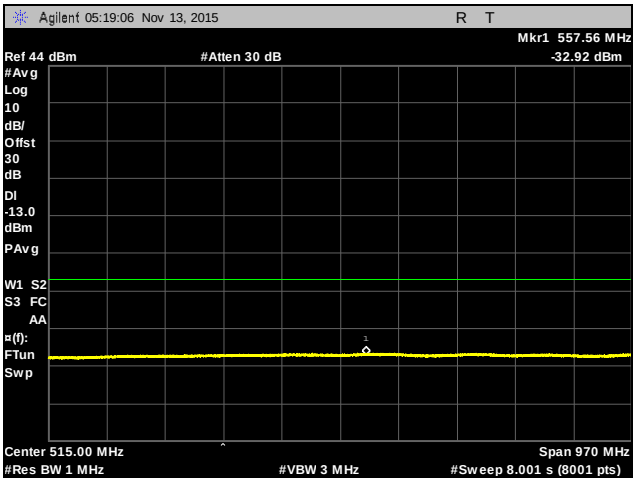


Plot 33. Conducted Spurious Emissions, Channel 251, 3 GHz – 6 GHz, Part 22

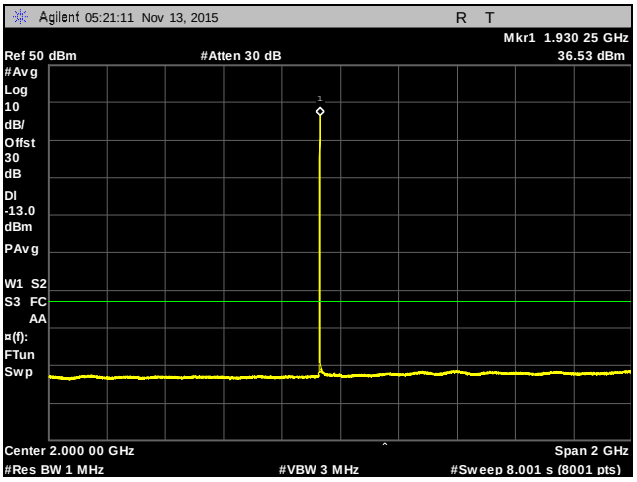


Plot 34. Conducted Spurious Emissions, Channel 251, 6 GHz – 10 GHz, Part 22

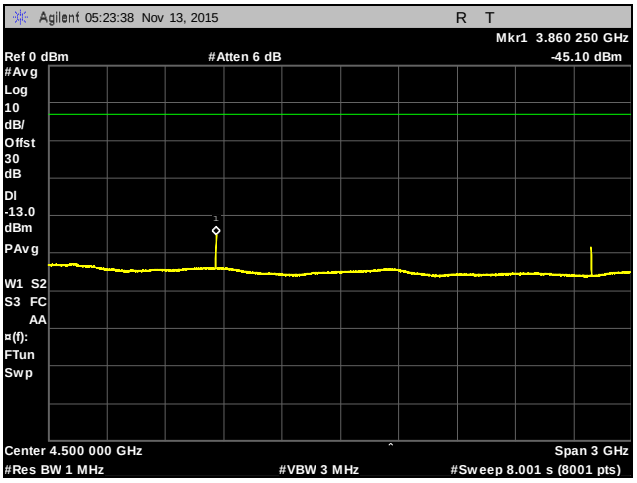
Part 24



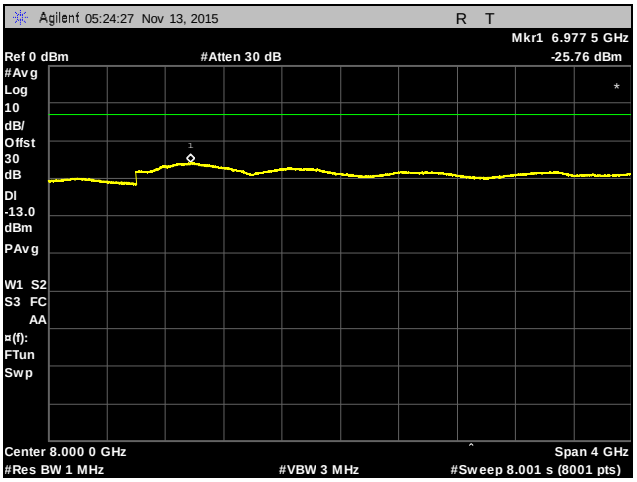
Plot 35. Conducted Spurious Emissions, Channel 512, 30 MHz – 1 GHz, Part 24



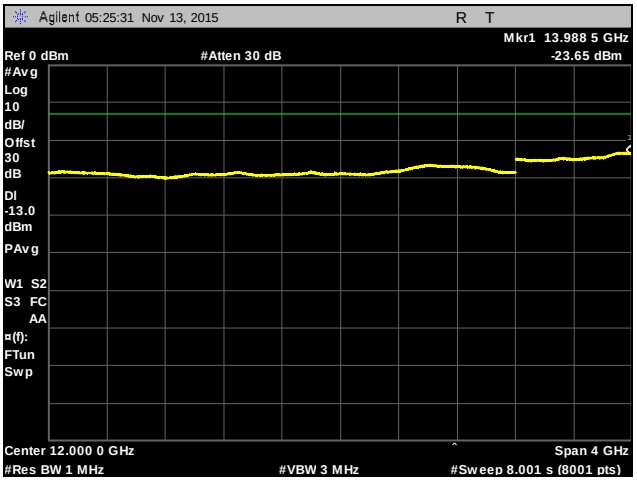
Plot 36. Conducted Spurious Emissions, Channel 512, 1 GHz – 3 GHz, Part 24



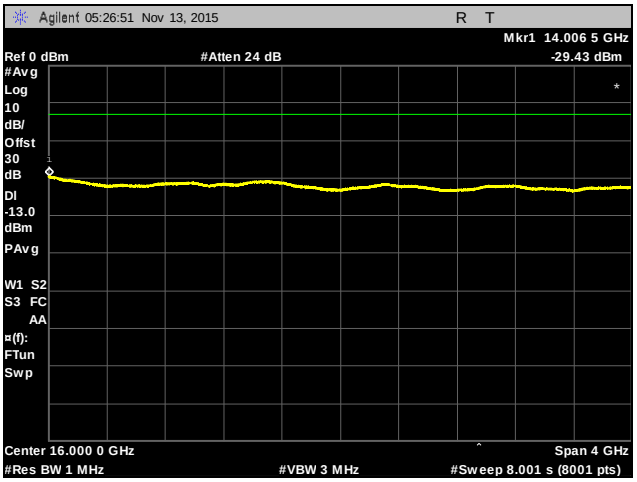
Plot 37. Conducted Spurious Emissions, Channel 512, 3 GHz – 6 GHz, Part 24



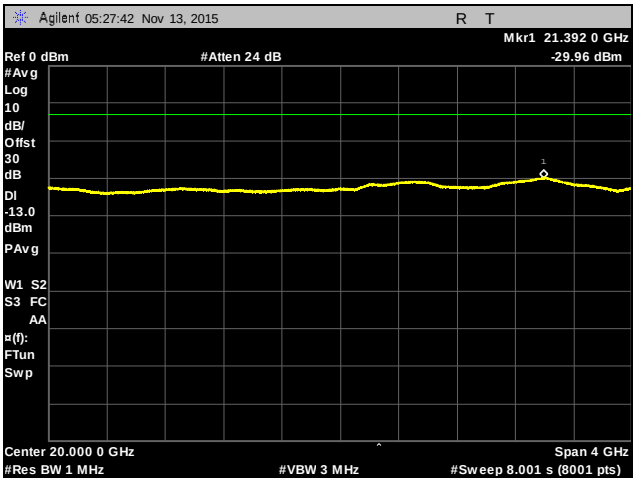
Plot 38. Conducted Spurious Emissions, Channel 512, 6 GHz – 10 GHz, Part 24



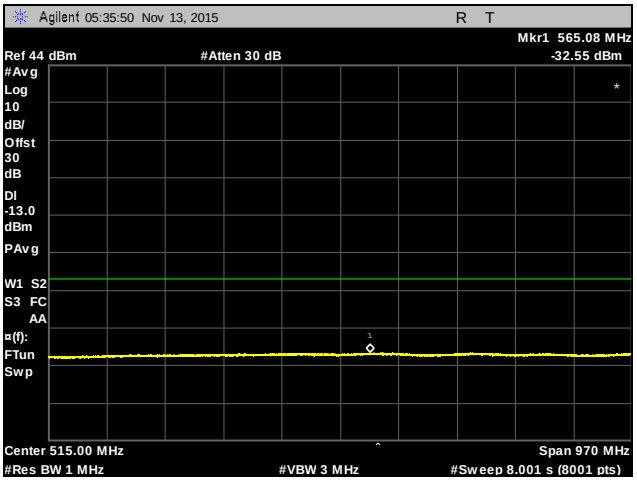
Plot 39. Conducted Spurious Emissions, Channel 512, 10 GHz – 14 GHz, Part 24



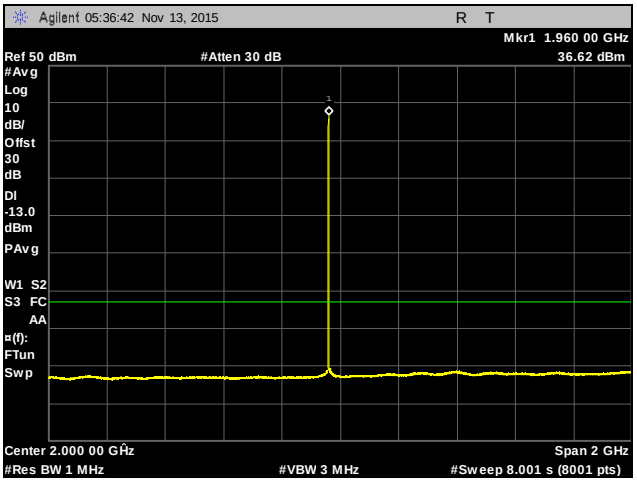
Plot 40. Conducted Spurious Emissions, Channel 512, 14 GHz – 18 GHz, Part 24



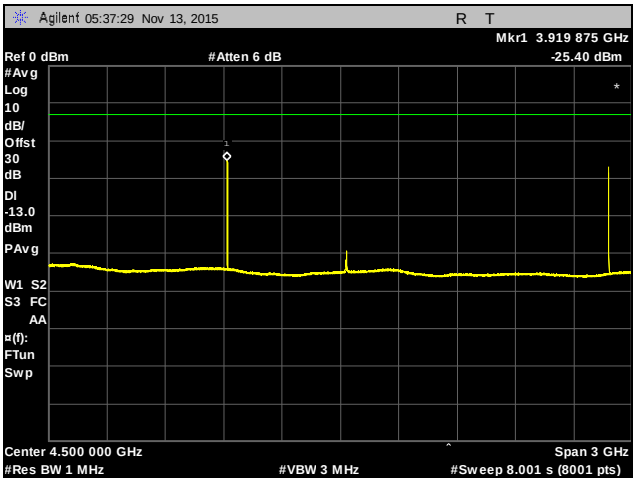
Plot 41. Conducted Spurious Emissions, Channel 512, 18 GHz – 22 GHz, Part 24



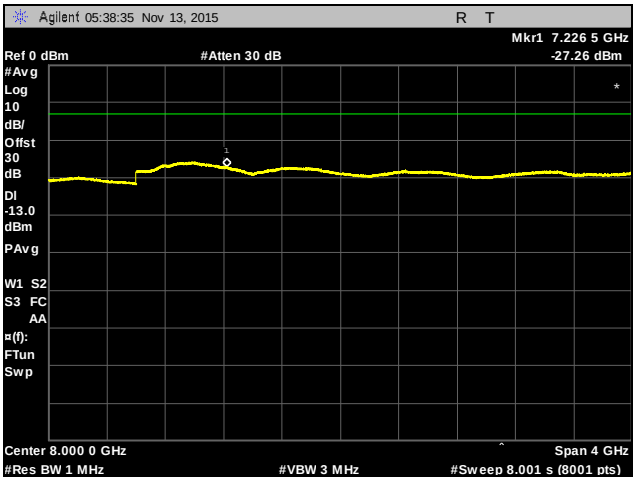
Plot 42. Conducted Spurious Emissions, Channel 661, 30 MHz – 1 GHz, Part 24



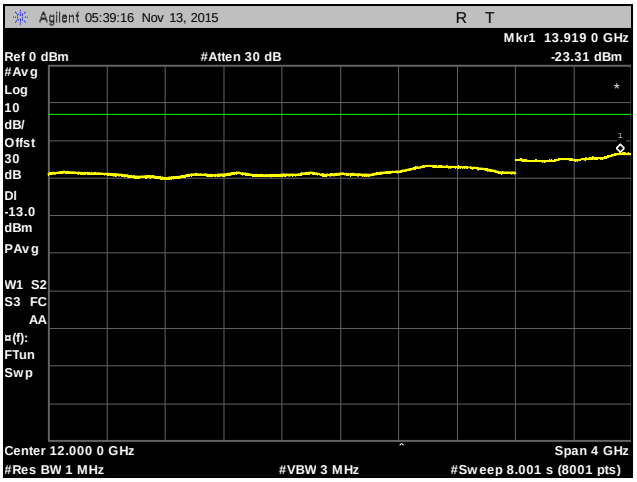
Plot 43. Conducted Spurious Emissions, Channel 661, 1 GHz – 3 GHz, Part 24



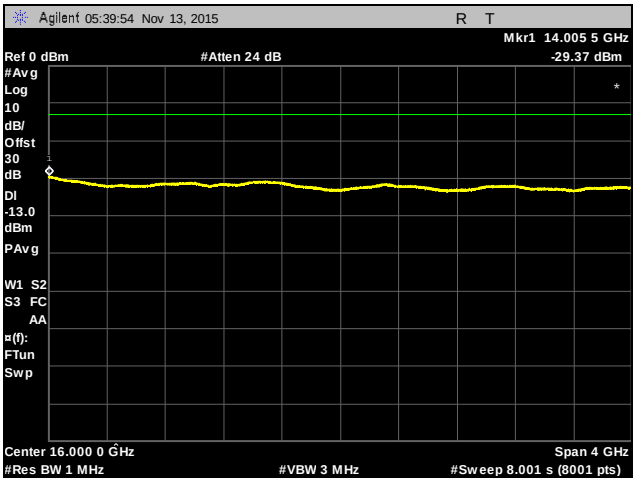
Plot 44. Conducted Spurious Emissions, Channel 661, 3 GHz – 6 GHz, Part 24



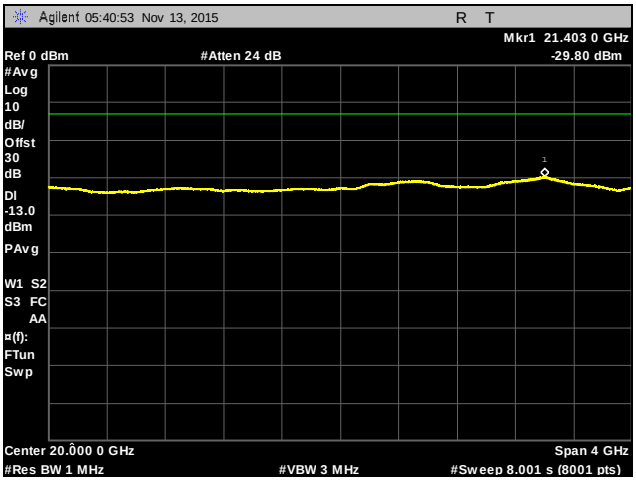
Plot 45. Conducted Spurious Emissions, Channel 661, 6 GHz – 10 GHz, Part 24



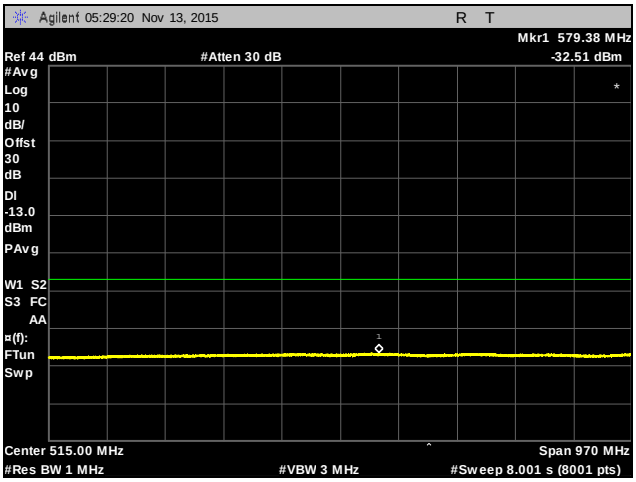
Plot 46. Conducted Spurious Emissions, Channel 661, 10 GHz – 14 GHz, Part 24



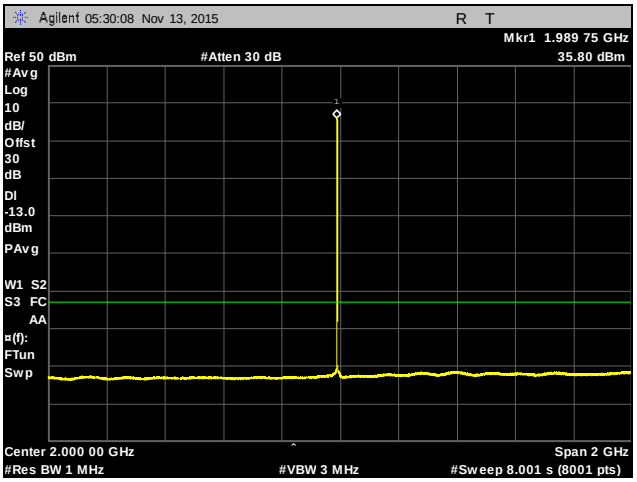
Plot 47. Conducted Spurious Emissions, Channel 661, 14 GHz – 18 GHz, Part 24



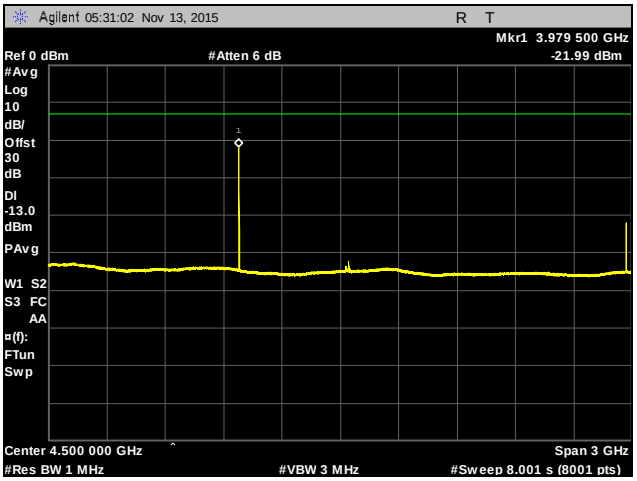
Plot 48. Conducted Spurious Emissions, Channel 661, 18 GHz – 22 GHz, Part 24



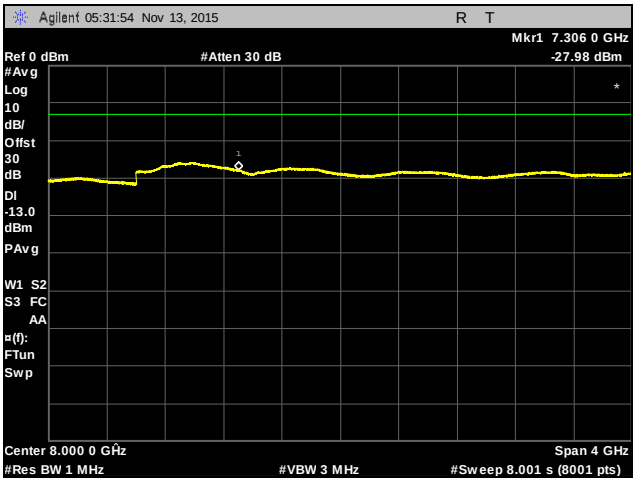
Plot 49. Conducted Spurious Emissions, Channel 810, 30 MHz – 1 GHz, Part 24



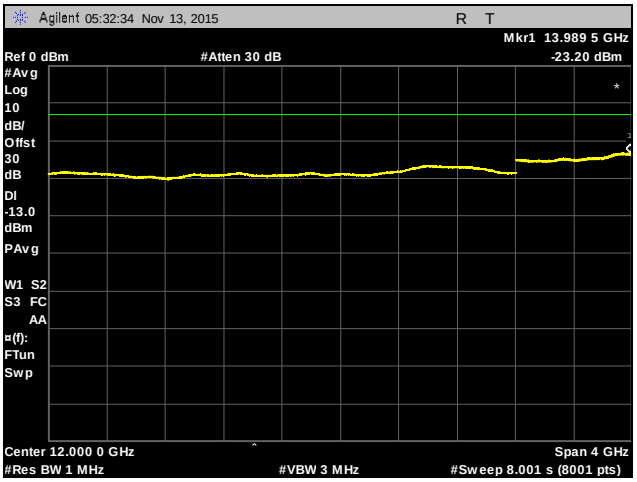
Plot 50. Conducted Spurious Emissions, Channel 810, 1 GHz – 3 GHz, Part 24



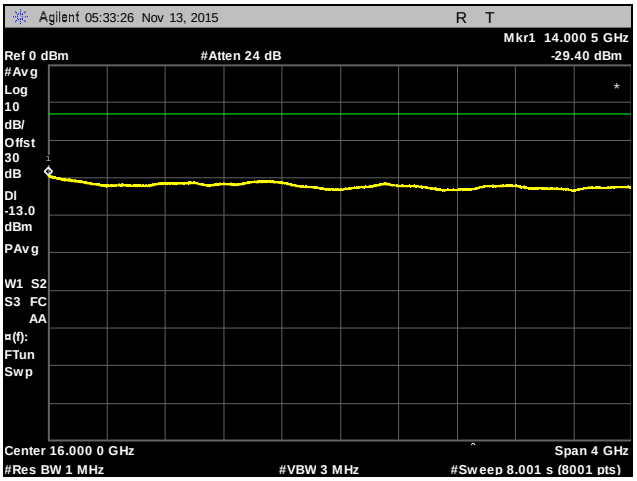
Plot 51. Conducted Spurious Emissions, Channel 810, 3 GHz – 6 GHz, Part 24



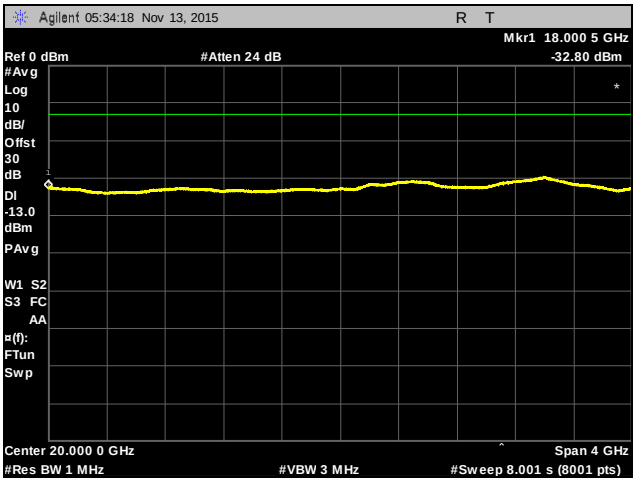
Plot 52. Conducted Spurious Emissions, Channel 810, 6 GHz – 10 GHz, Part 24



Plot 53. Conducted Spurious Emissions, Channel 810, 10 GHz – 14 GHz, Part 24



Plot 54. Conducted Spurious Emissions, Channel 810, 14 GHz – 18 GHz, Part 24



Plot 55. Conducted Spurious Emissions, Channel 810, 18 GHz – 22 GHz, Part 24

Band Edge, Part 22

Plot 56. Conducted Band Edge, Channel 128, Part 22

Plot 57. Conducted Band Edge, Channel 251, Part 22

Band Edge, Part 24

Plot 58. Conducted Band Edge, Channel 512, Part 24

Plot 59. Conducted Band Edge, Channel 810, Part 24

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 ration (PAR) of the transmission may not exceed 13 dB.

Test Procedures:

Test Results: Equipment complies with these requirements.

Test Engineer(s): Djed Mouada

Test Date(s): 11/10/15

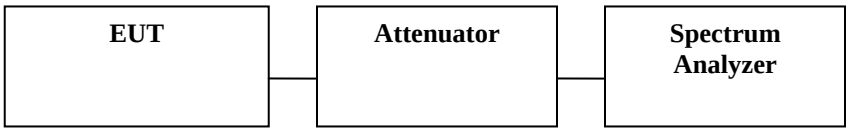
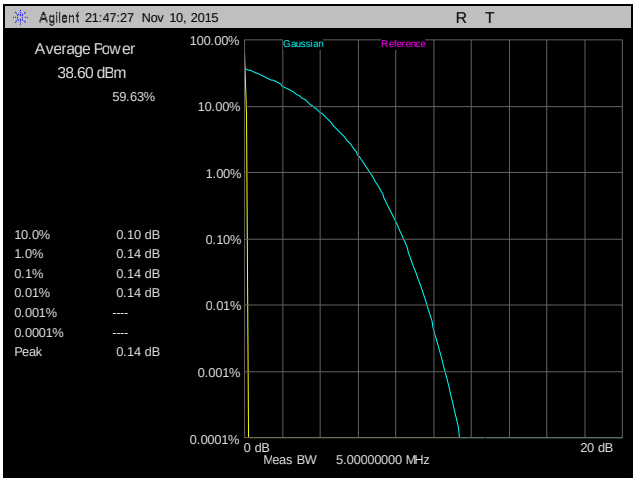
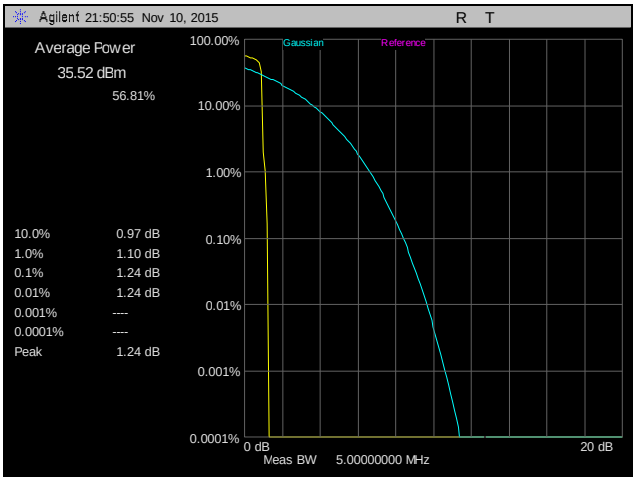


Figure 4. Spurious Emissions at Antenna Terminals Test Setup

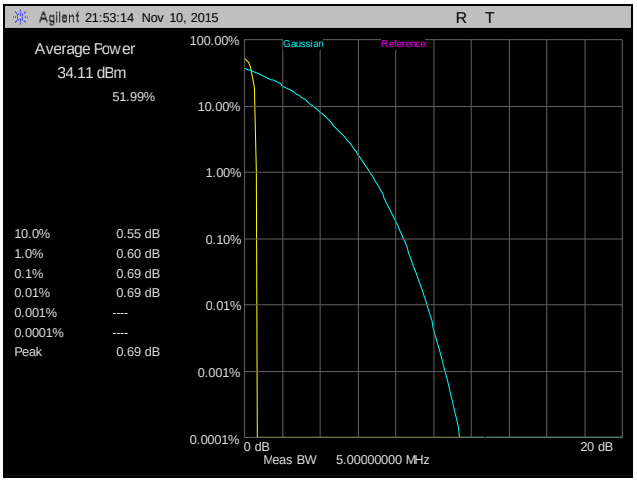
Part 22



Plot 60. Peak to Average Ratio, Channel 128, Part 22

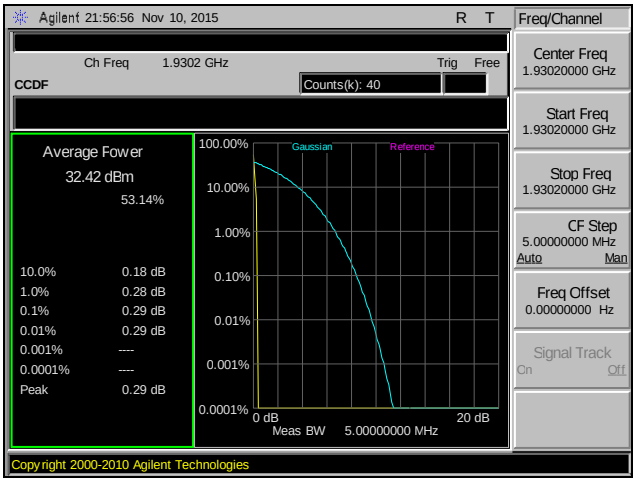


Plot 61. Peak to Average Ratio, Channel 190, Part 22

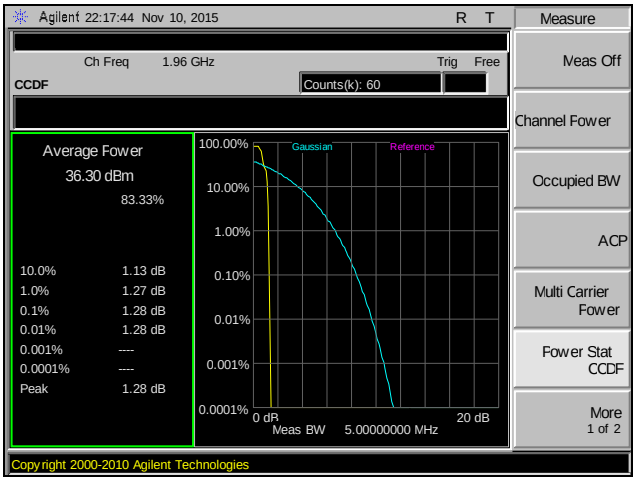


Plot 62. Peak to Average Ratio, Channel 251, Part 22

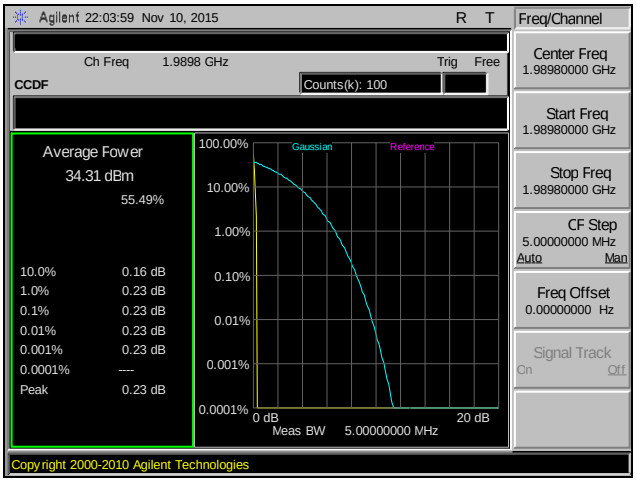
Part 24



Plot 63. Peak to Average Ratio, Channel 512, Part 24



Plot 64. Peak to Average Ratio, Channel 661, Part 24



Plot 65. Peak to Average Ratio, Channel 810, Part 24

Channel	PAR	Limit
Low (869.2MHz)	0.14	13
Mid (881.6MHz)	1.24	13
High (893.8MHz)	0.69	13
Low (1930.2 MHz)	0.29	13
Mid (1960 MHz)	1.28	13
High (1989.8MHz)	0.23	13

Table 7. PAR Table

Electromagnetic Compatibility Criteria for Intentional Radiators

§2.1049 Frequency Stability 2.1049

Test Requirement(s): §2.1049 §24.238

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. The frequency deviations are then compared to frequency of normal operation and shall not exceed 1ppm.

Test Results: Equipment complies with this section.

Test Engineer(s): Djed Mouada

Test Date(s): 12/18/15

GSM 1900	512	Calculated Frequency	Δ Hz	Δ ppm	Limit
Voltage (DC)	Temperature				
12	-30	1930.193	-1160.48	0.60	1
12	-20	1930.193	-1000	0.51	1
12	-10	1930.194	0	0	1
12	0	1930.195	999.99	0.51	1
12	10	1930.195	500	0.26	1
12	20	1930.1945	----	0	1
12	30	1930.196	1500	0.77	1
12	40	1930.195	500	0.25	1
12	50	1930.196	1500	0.77	1
10.2	20	1930.196	1500	0.77	1
13.8	20	1930.196	1500	0.77	1

Table 8. Frequency Stability, Test Results

Photograph 2. 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 frequency @ 881.6 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

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/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

Test Results:

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
881.6	42.79	19010.783	9.5	8.913	1	1	0	116.117	Pass

The safe distance where Power Density is less than the MPE Limit listed above was found to be 144.509 cm.

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
1T6658	SPECTRUM ANALYZER	AGILENT	E4407B	12/09/2015	12/09/2016
1T4497	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4432B	10/06/2014	04/06/2016
1T4483	ANTENNA; HORN	ETS-LINDGREN	3117	10/08/2015	04/08/2017
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	11/25/2014	05/25/2016
1T4300B	SEMI-ANECHOIC 3M CHAMBER # 1 D (2043A-1) (IC)	EMC TEST SYSTEMS	NONE	01/11/2015	01/11/2018
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	10/29/2014	10/29/2016
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	07/29/2014	01/29/2016
331T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T4859	DIGITAL BAROMETER, HYGROMETER, THERMOMETER	CONTROL COMPANY	15-078-198, FB70423, 245CD	12/19/2013	12/19/2015
2T5280	TEMPERATURE CHAMBER	THERMOTRON	F270-CH(V) 30-30/EVA	1/8/2015	1/8/2016

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

End of Report

