MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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March 15, 2017

TrackMan
Stubbeled 2
Vedbæk, DK-2950

Dear Claus Nilsson,

Enclosed is the EMC Wireless test report for compliance testing of the TrackMan, TMA4A as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

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 feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Joel Huna
Documentation Department

Reference: (\TrackMan\EMC88710-FCC247 Rev. 4)

Electromagnetic Compatibility Criteria
Test Report

for the

TrackMan
TMA4A

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

MET Report: EMC88710-FCC247 Rev. 4

March 15, 2017

Prepared For:

TrackMan
Stubbeled 2
Vedbæk, DK-2950

Prepared By:
MET Laboratories, Inc.
914 West Patapsco Avenue,
Baltimore MD 21230

Electromagnetic Compatibility Criteria
Test Report

for the

TrackMan
TMA4A

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

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 the FCC Rules Part 15.247 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	December 2, 2016	Initial Issue.
1	February 2, 2017	FCC ID
2	February 28, 2017	Customer corrections
3	March 2, 2017	Engineer corrections.
4	March 15, 2017	Engineer corrections.

Table of Contents

List of Tables

List of Plots

List of Figures

List of Photographs

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 TrackMan TMA4A, with the requirements of Part 15, §15.247. 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 TMA4A. TrackMan should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the TMA4A, 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 15, §15.247, in accordance with TrackMan, purchase order number KO4331. All tests were conducted using measurement procedure ANSI C63.4-2014.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RF Conducted Band Edge	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	Peak Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by TrackMan to perform testing on the TMA4A, under TrackMan's purchase order number KO4331.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the TrackMan, TMA4A.

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

Model(s) Tested:	TMA4A	
Model(s) Covered:	TMA4A	
EUT Specifications:	Primary Power: 19VDC	
	FCC ID: SFX-TMAN4	
	Type of Modulations:	WiFi, 2.4GHz 802.11 b/g/n
	Equipment Code:	DTS
	Peak RF Output Power:	22.668dBm
	EUT Frequency Ranges:	2412-2462MHz
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	
Report Date(s):	March 15, 2017	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
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
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, 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.

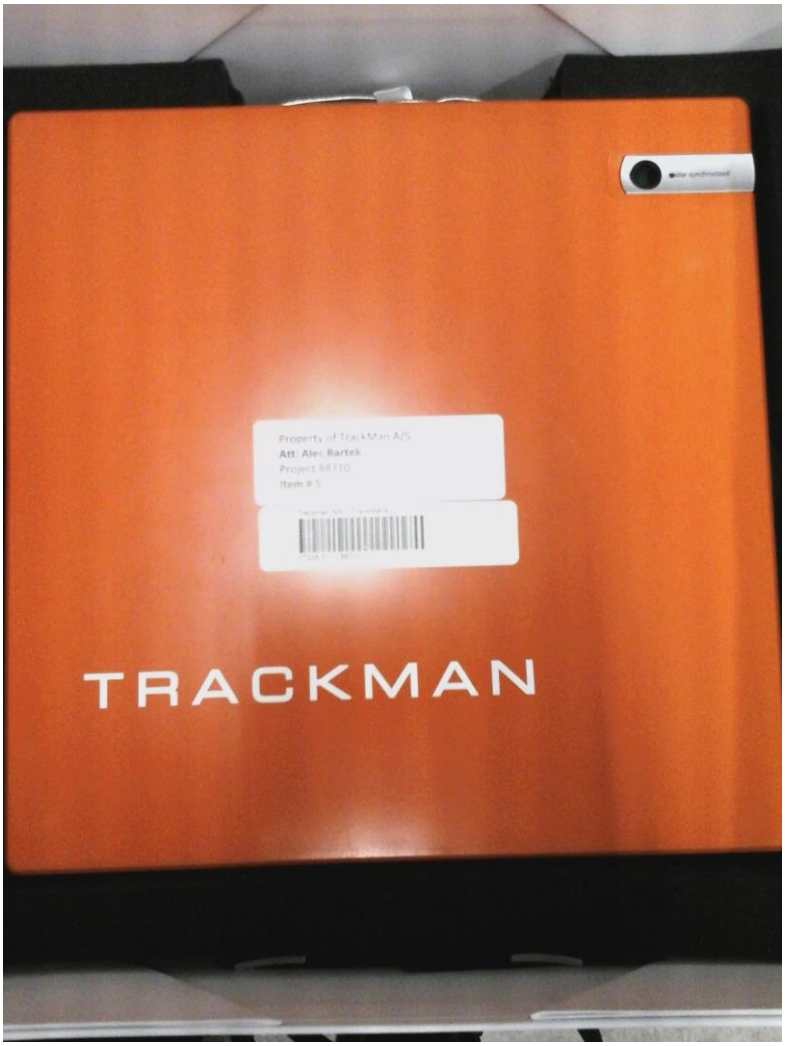
D. Description of Test Sample

The TrackMan TMA4A, Equipment Under Test (EUT), is an all-in-one complete dual radar system intended to measure the path and trajectory of golf clubs and balls.

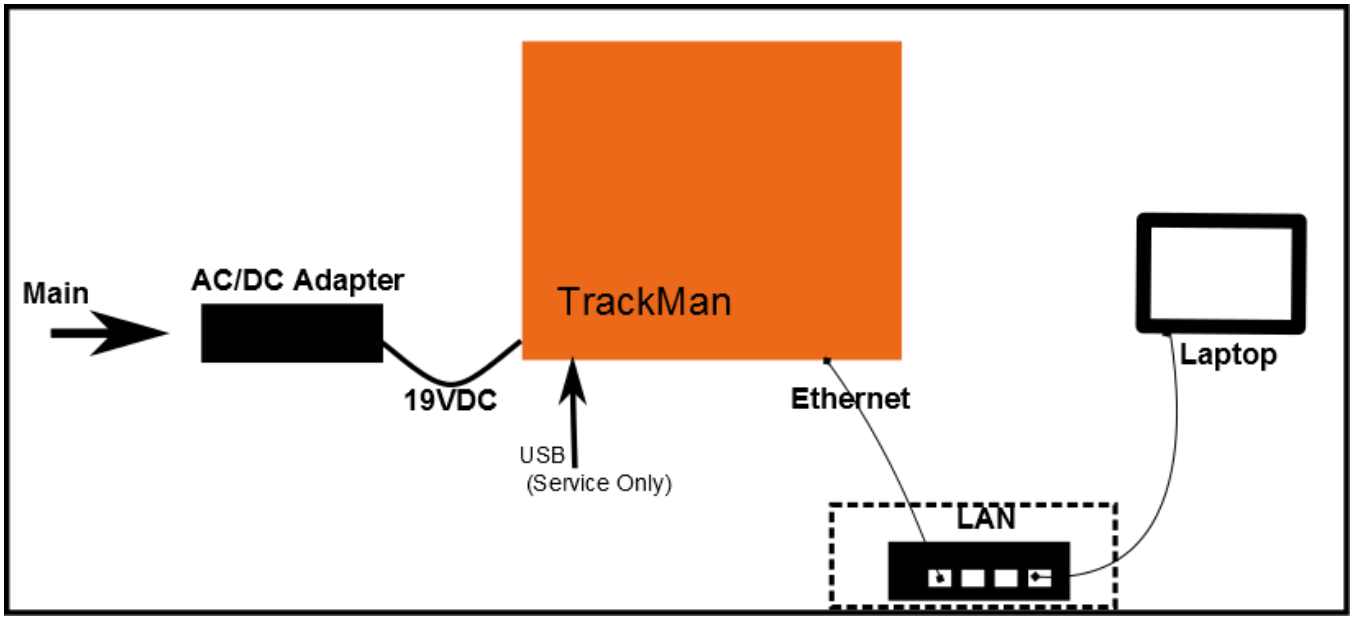
The only peripherals required in order to operate the TrackMan™, is a Smart Phone (iOS) with suitable app installed, a Tablet or a standard computer with wireless connectivity and a standard web-browser.

In order to provide auto alignment the radar is equipped with motorized legs. A 2-axis inclinometer provides angle data which are transmitted to an embedded microcontroller which in turn controls the motor driver circuit.

A software servo loop controls the motorized legs until perfect leveling is obtained. The servo loop is only active during TrackMan™ set-up and installation

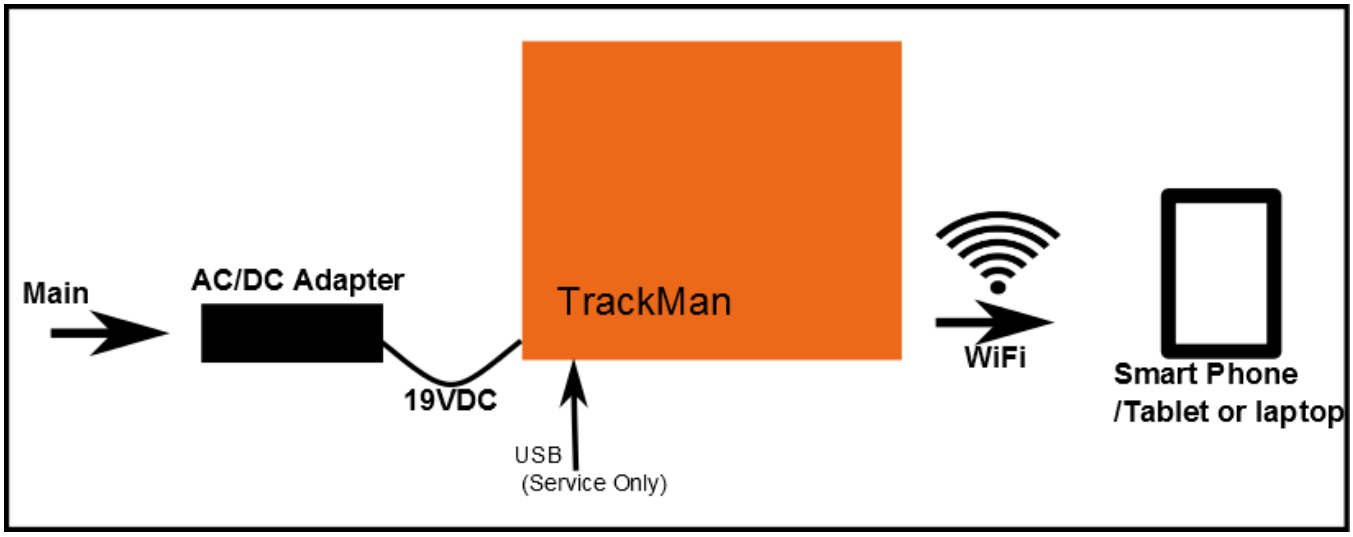


Photograph 1. TrackMan TMA4A



N.B. The LAN and Laptop is not part of the product. (LAN and Laptop is however supplied by TrackMan for the METlabs test.)

Figure 1. Block Diagram of Test Configuration, Ethernet Setup



N.B. The Laptop is not part of the product. (Laptop is however supplied by TrackMan for the METlabs test.)

Figure 2. Block Diagram of Test Configuration, Wifi Setup

E. Equipment Configuration

The EUT was set up as outlined in Figure 1 and Figure 2. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Part Number	Serial Number	Revision
1	TRACKMAN 4	TrackMan4	TMA4A		

Table 4. Equipment Configuration

F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
1	AC/DC ADAPTER	FSP GROUP INC.	FSP065-RECN2	100-240AC INPUT 19VDC, 3.42A OUTPUT
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 5. 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	USB	USB MICRO	1	1	3	YES	PC USB PORT
2	ETHERNET/LAN	CAT 5 LAN CABLE W. RJ45	1	5	100	YES	ROUTER
3	POWER PLUG IN	DC	1	1	N/A	YES	AC/DC ADAPTER

Table 6. Ports and Cabling Information

H. Mode of Operation

The TrackMan™ Radar Unit is an all-in-one complete dual radar system intended to measure the path and trajectory of golf clubs and balls.

The only peripherals required in order to operate the TrackMan™, is a Smart Phone (iOS) with suitable app installed, a Tablet or a standard computer with wireless connectivity and a standard web-browser.

In order to provide auto alignment the radar is equipped with motorized legs. A 2-axis inclinometer provides angle data which are transmitted to an embedded microcontroller which in turn controls the motor driver circuit.

A software servo loop controls the motorized legs until perfect leveling is obtained. The servo loop is only active during TrackMan™ set-up and installation.

I. Method of Monitoring EUT Operation

The TMA4A comprises both a single frequency X-band radar (10GHz) and a dual frequency K-band radar (24GHz). The X-band Radar comprises 3 Receiver channels and the K-Band Radar comprises 5 receiver channels. The Radar transmitters continuously illuminates the “target, and “target” reflects the signal which is received by the receiving antennas. The received signals are down converted to base band in a mixer utilizing a LO signals which are coherent with the transmitted signals (Zero-IF principle).

Frequency stabilization is provided by means of PLL controlled microwave oscillators. The reference for the PLL (and thus for the microwave oscillators) is a high performance crystal controlled oscillator providing better than ±25ppm overall frequency stability during normal operating conditions.

The base band signals are amplified and synchronously digitized in a 16channel, 24bit analog-to-digital converter. The digitized signals are routed to the embedded PC board (SMARC Module from ADLink) piggybacked on the EU33 4002 where data are processed in real-time.

The analyzed data are then routed to the GUI device (Smart phone, Tablet or PC with WLAN of similar) over the WiFi connection. The GUI shows the relevant data and results for the user.

For normal operation the TrackMan™ is powered by an internal SMART battery Li-ION battery. During normal operation, no external power supply is required, but charging of the battery is provided by means of an external +19VDC supply.

The antennas used for transmitting and receiving are identical. The antenna pattern is shaped to maximize the overall loop gain of the TrackMan™ system for golf ball trajectories, where the golf ball is launched a couple of meters in front of the radar.

An embedded digital camera (Global Digital Star) is used to point out the horizontal reference line from a picture. The camera is only used during setup of the TrackMan™ Radar Unit.

During operation, video is streamed to the user through the WiFi channel.

The build-in GPS receiver and integrated antenna provides location coordinates for data processing and location tracking purpose.

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 TrackMan upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of §15.203. The EUT has integral antennas.

Test Engineer(s): Djed Mouada

Test Date(s): October 10, 2016

Gain (dB)	Type	Model	Manufacturer	Comment
0	Chip Antenna	AH104N2450D1-T	Taiyo Yuden	2.4GHz antenna
0	Chip Antenna	AH104N2450D1-T	Taiyo Yuden	5GHz antenna
15	4x4 patch antenna array	Integrated on PC334002	Trackman	10GHz antenna
12	4x4 patch antenna array	Integrated on PC334002	Trackman	24GHz antenna

Table 7. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Σ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.45	66 - 56	56 - 46
0.45 - 0.5	56	46
0.5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT was compliant with this requirement. Measured emissions were within applicable limits.

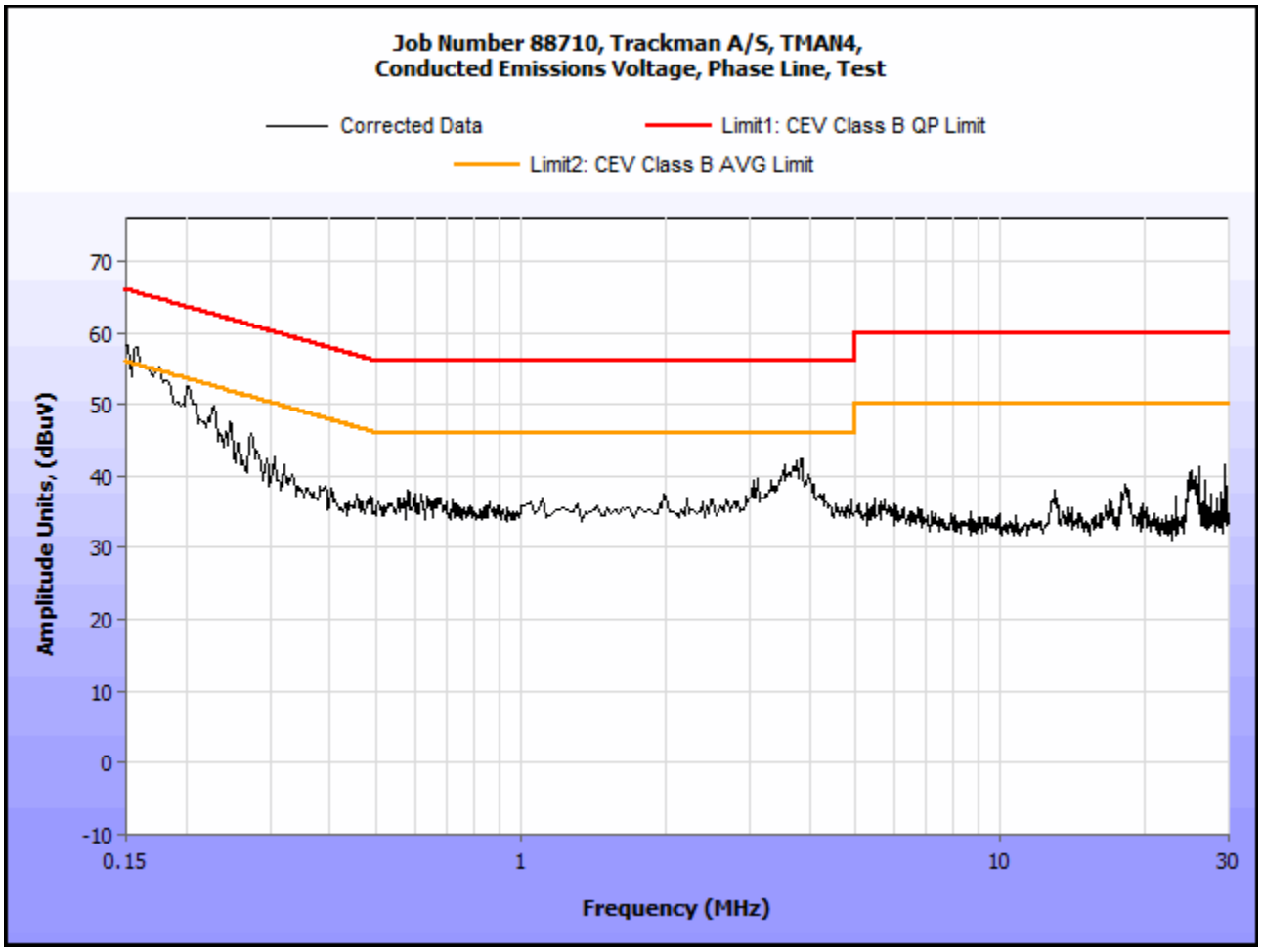
Test Engineer(s): Djed Mouada

Test Date(s): October 20, 2016

15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.157	37.96	0	37.96	79	-41.04	27.65	0	27.65	66	-38.35
0.365	35.15	0	35.15	79	-43.85	31.57	0	31.57	66	-34.43
7.324	34.16	0	34.16	73	-38.84	31.66	0	31.66	60	-28.34
2.668	22.82	0	22.82	73	-50.18	19.87	0	19.87	60	-40.13
14.39	36.35	0.12	36.47	73	-36.53	30.9	0.12	31.02	60	-28.98
20.2	32.75	0.16	32.91	73	-40.09	27.47	0.16	27.63	60	-32.37

Table 9. Conducted Emissions, 15.207(a), Phase Line, Test Results

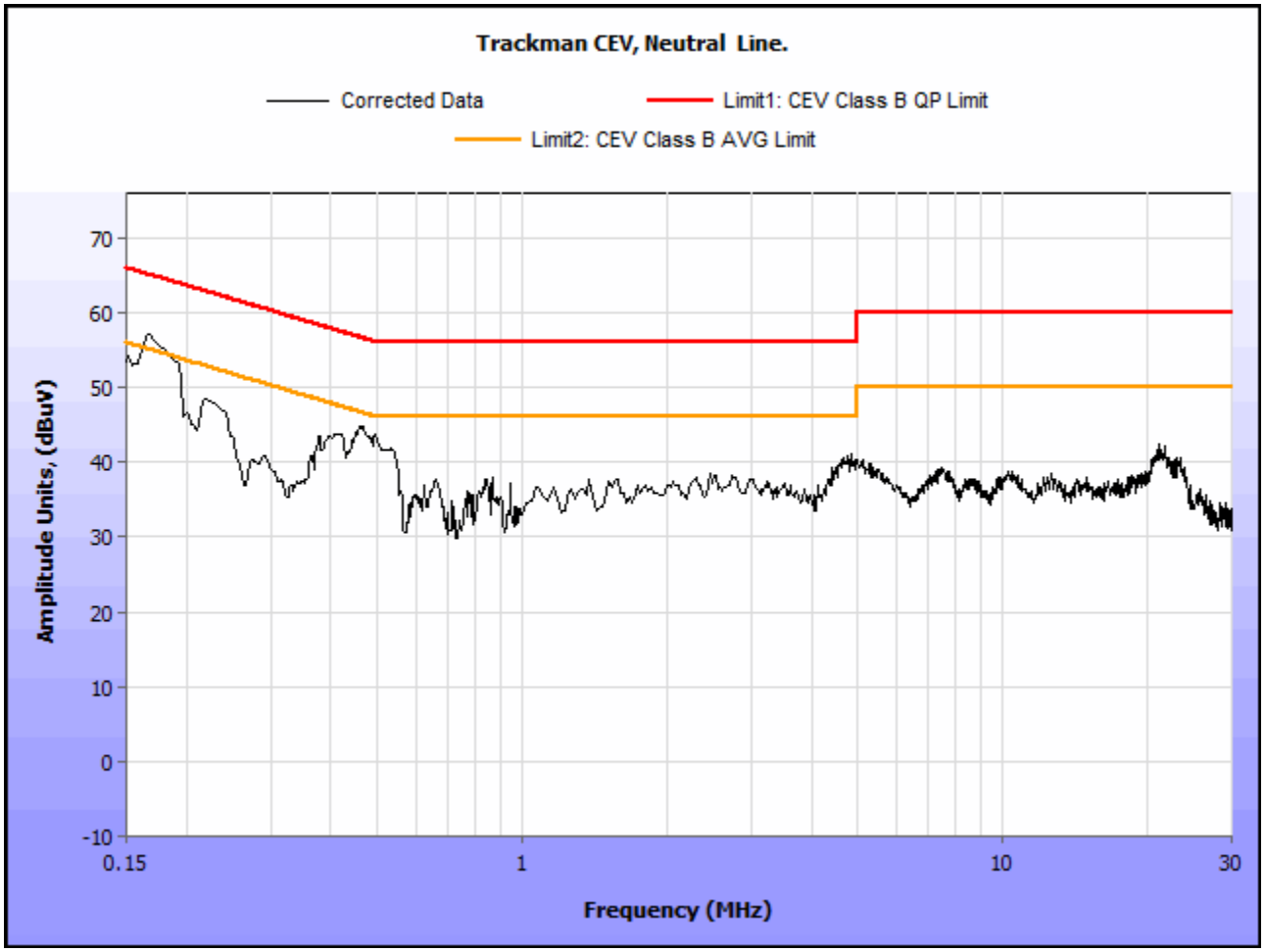


Plot 1. Conducted Emissions, 15.207(a), Phase Line

15.207(a) Conducted Emissions Test Results

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Margin (dB) AVG
0.26	43.22	0	43.22	61.43	-18.21	19.18	0	19.18	51.43	-32.25
0.574	42.17	0	42.17	56	-13.83	40.26	0	40.26	46	-5.74
1.287	29.4	0	29.4	56	-26.6	29.24	0	29.24	46	-16.76
13.2	29.17	0.11	29.28	60	-30.72	19.16	0.11	19.27	50	-30.73
15.97	32.15	0.12	32.27	60	-27.73	32.49	0.12	32.61	50	-17.39
20.322	32.95	0.17	33.12	60	-26.88	27.14	0.17	27.31	50	-22.69

Table 10. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 2. Conducted Emissions, 15.207(a), Neutral Line

15.207(a) Conducted Emissions Test Setup Photo

Photograph 2. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW 100KHz and, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was compliant with § 15.247 (a)(2). No anomalies detected.

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Djed Mouada

Test Date(s): October 11, 2016

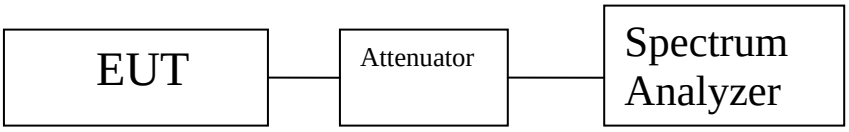


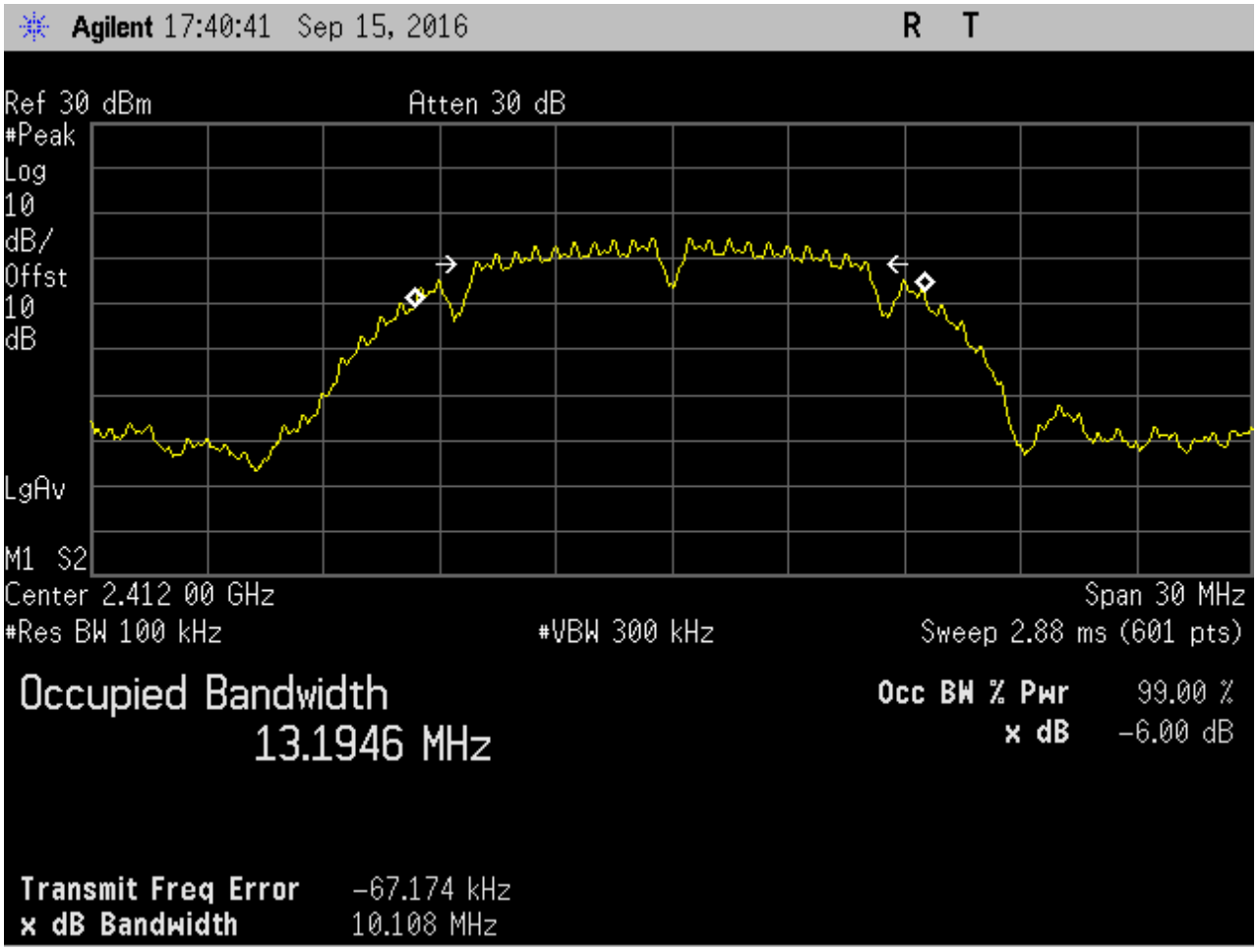
Figure 3. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

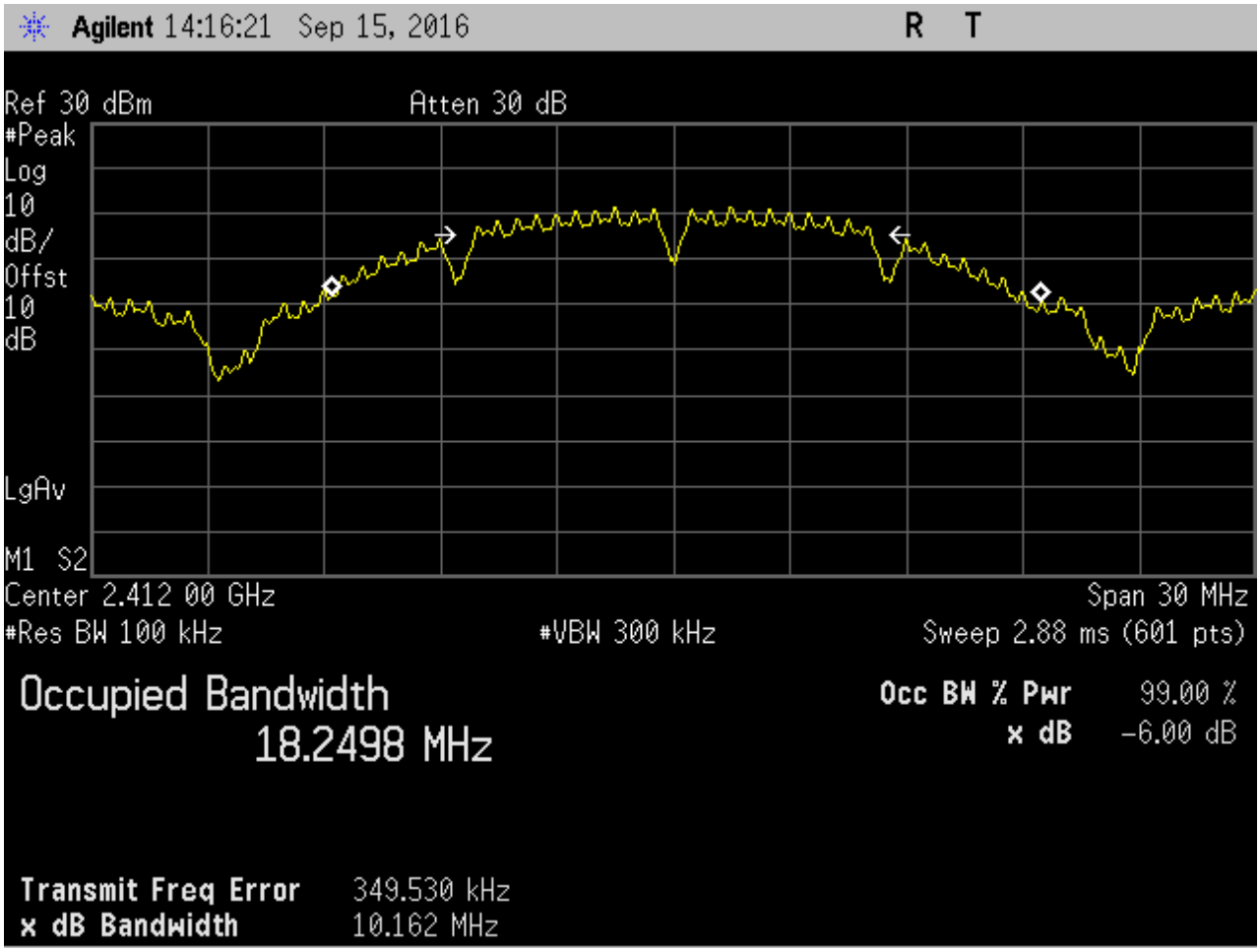
Occupied Bandwidth			
Carrier Channel	**Frequency (MHz)**	**Measured 6dB Bandwidth (MHz) Port1**	**Measured 6dB Bandwidth (MHz)Port2**
Low b_mode	2412	10.108	10.162
Mid b_mode	2437	10.087	10.17
High b_mode	2462	10.092	11.146
Low g_mode	2412	16.401	16.424
Mid g_mode	2437	16.399	16.546
High g_mode	2462	16.414	16.425
Low n_mode (20MHz)	2412	17.315	17.589
Mid n_mode (20MHz)	2437	17.288	17.655
Hig n_mode (20MHz)	2462	17.58	17.691
Low n_mode (40MHz)	2422	36.447	36.14
Mid n_mode (40MHz)	2437	35.433	34.897
Hig n_mode (40MHz)	***2452***	35.425	35.888

Table 11. 6 dB Occupied Bandwidth, Test Results

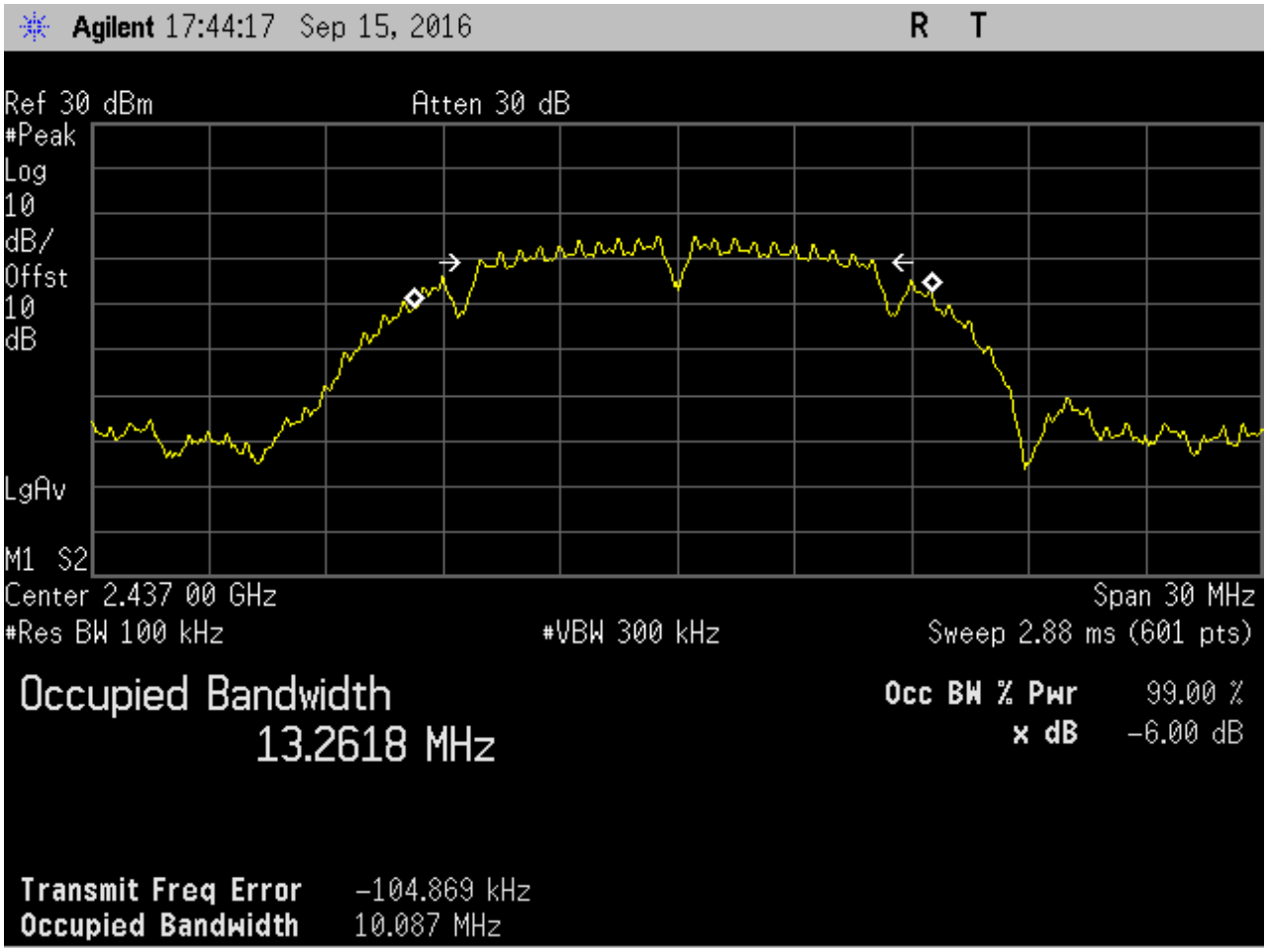
6 dB Occupied Bandwidth Test Results



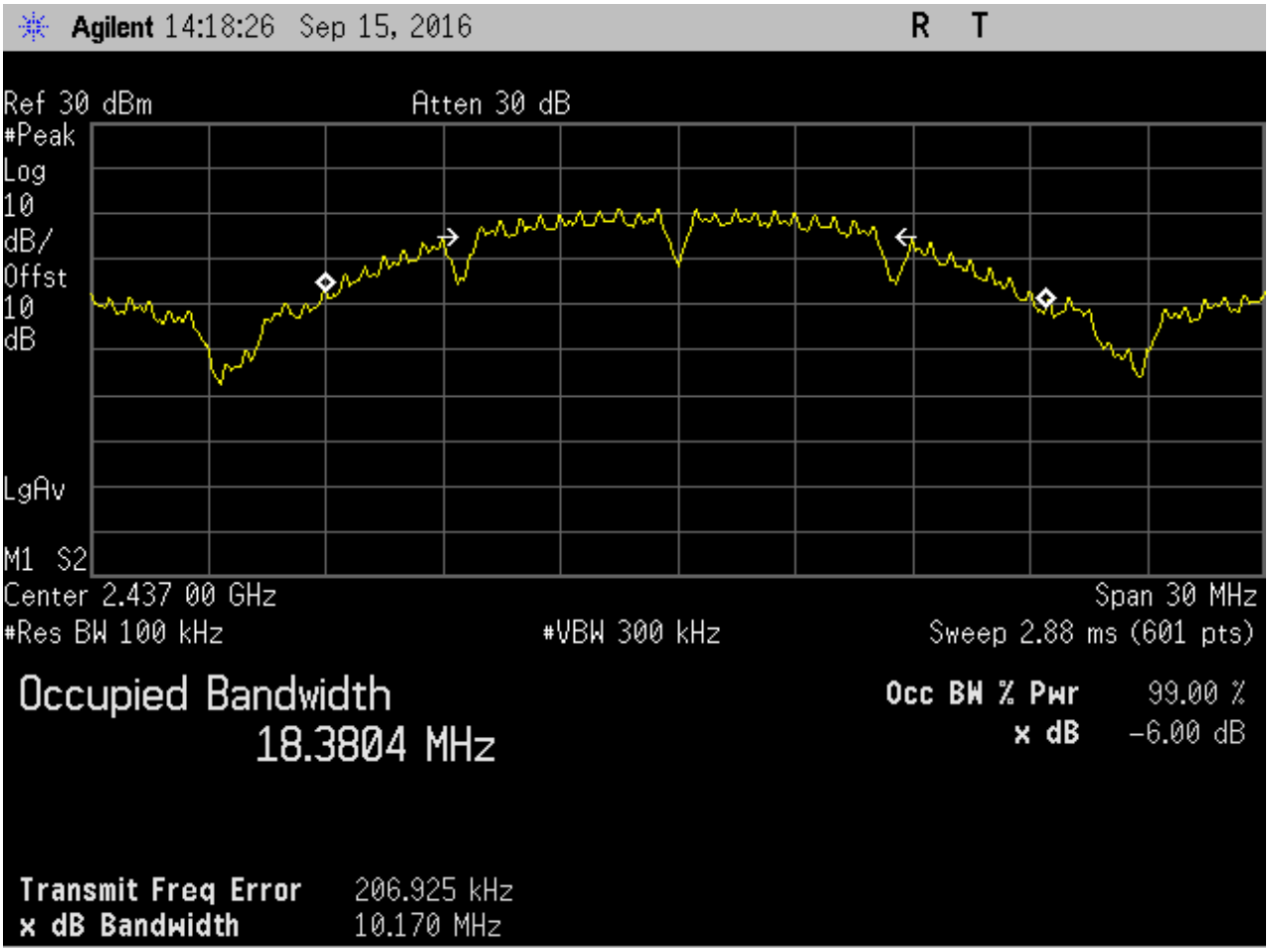
Plot 3. 6 dB Occupied Bandwidth, 20M, Ch.2412M, b mode, Port 2



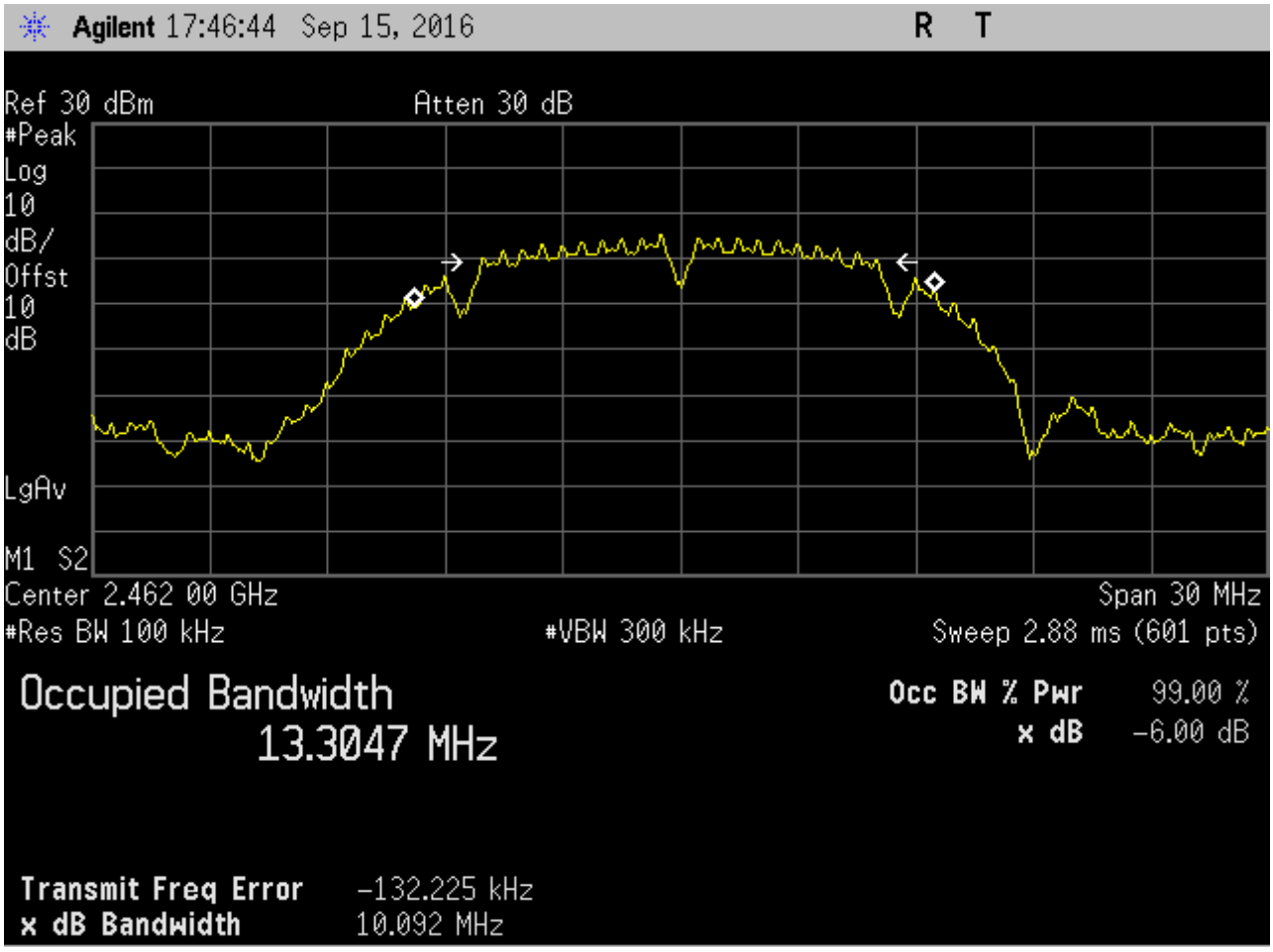
Plot 4. 6 dB Occupied Bandwidth, 20M, Ch. 2412M, b mode, Port 1



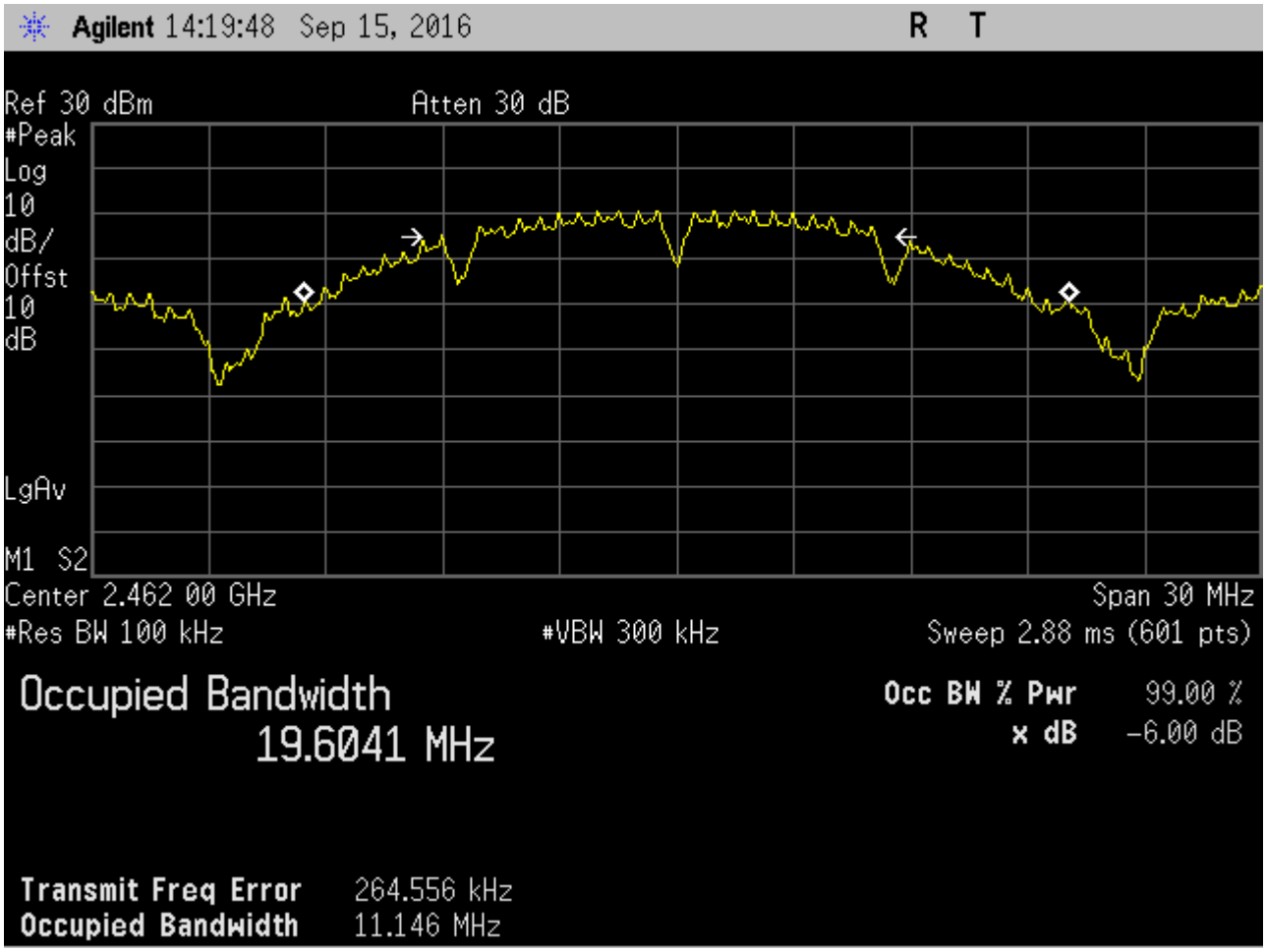
Plot 5. 6 dB Occupied Bandwidth, 20M, Ch. 2437M, b mode, Port 2



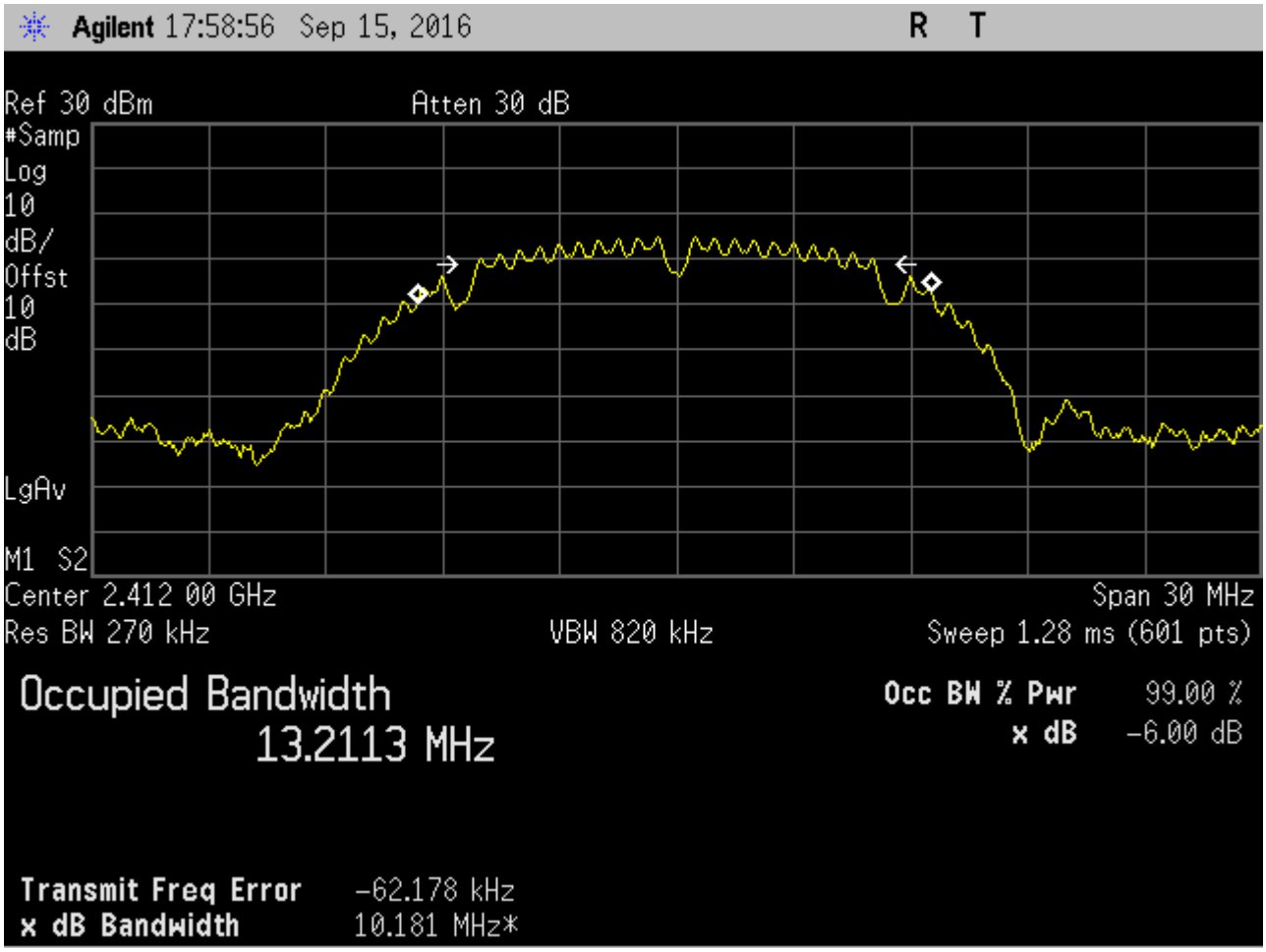
Plot 6. 6 dB Occupied Bandwidth, 20M, Ch. 2437M, b mode, Port 1



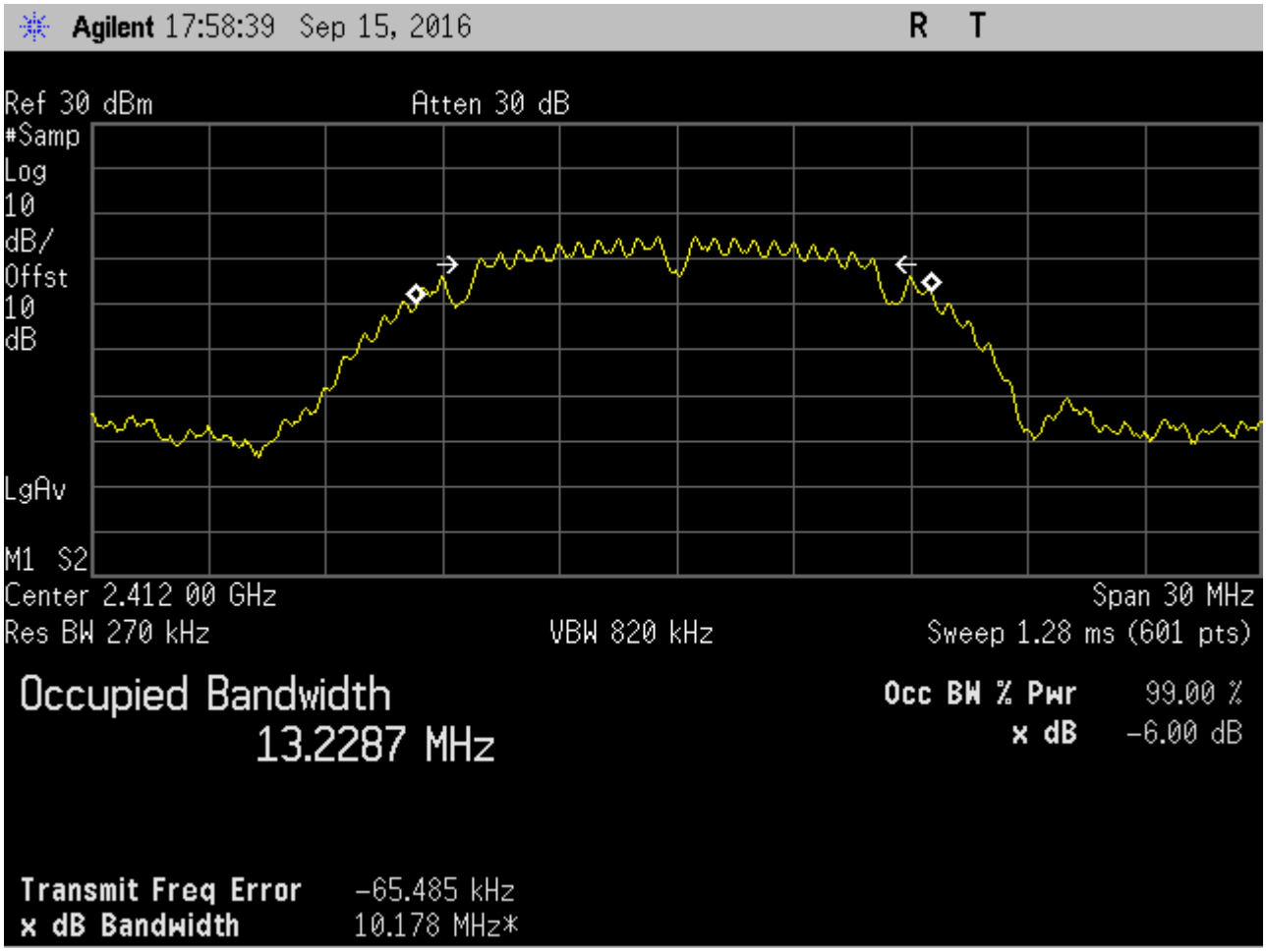
Plot 7. 6 dB Occupied Bandwidth, 20M, Ch. 2462M, b mode, Port 2



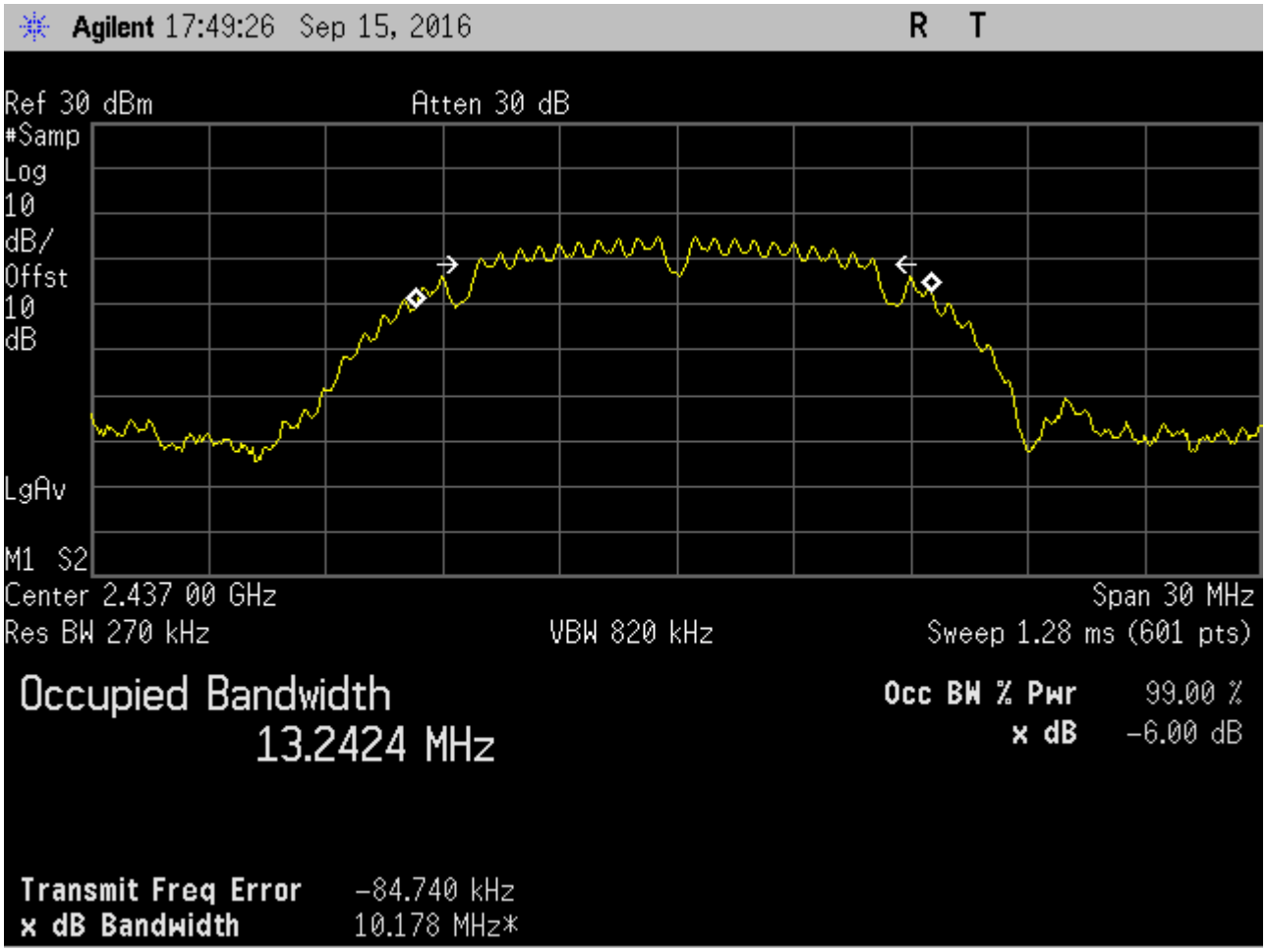
Plot 8. . 6 dB Occupied Bandwidth, 20M, Ch. 2462M, b mode, Port 1



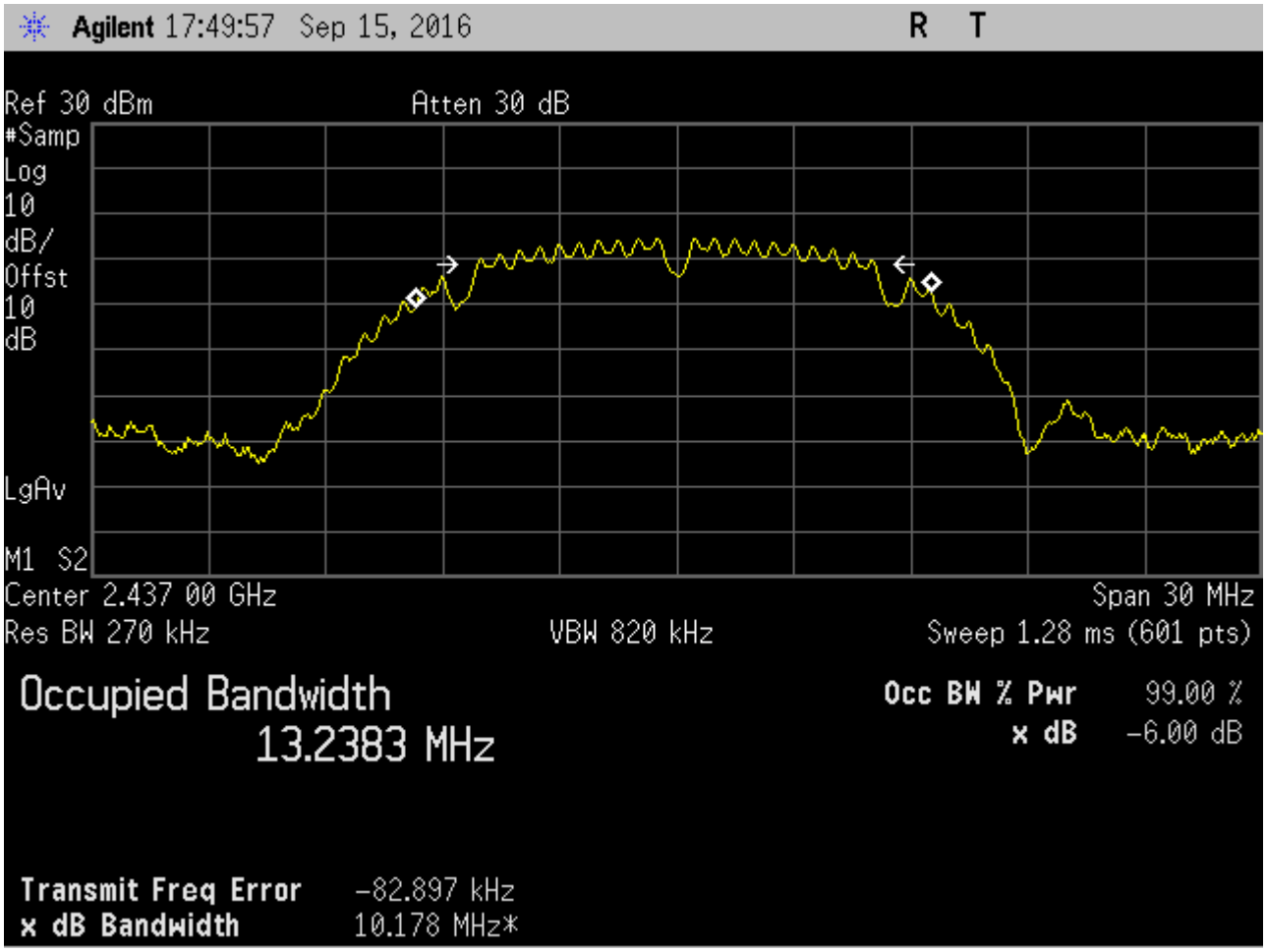
Plot 9. 99 Percent Occupied Bandwidth, 20M, Ch. 2412M, b mode, Port 1



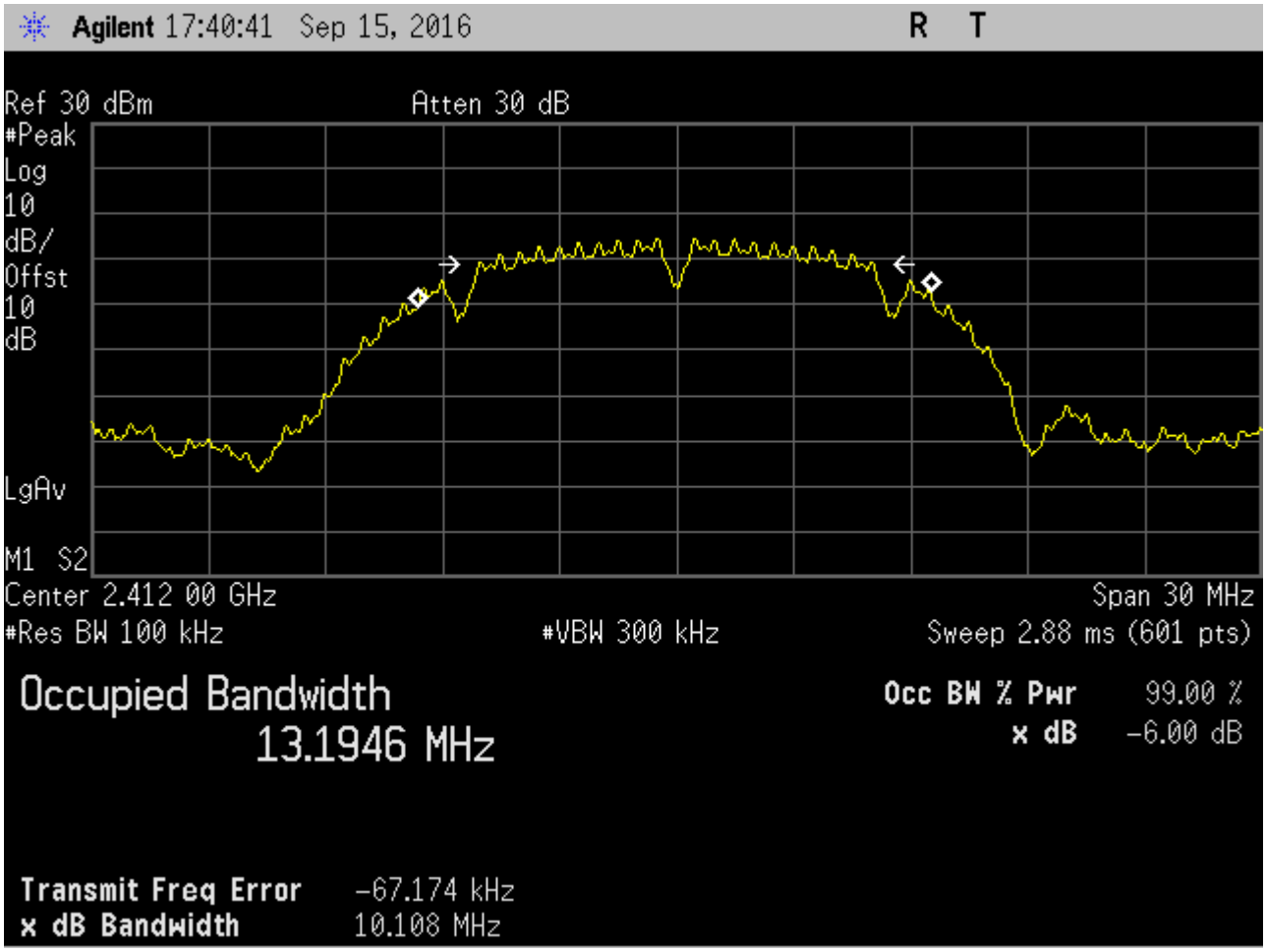
Plot 10. 99 Percent Occupied Bandwidth, 20M, Ch. 2142M, b mode, Port 2



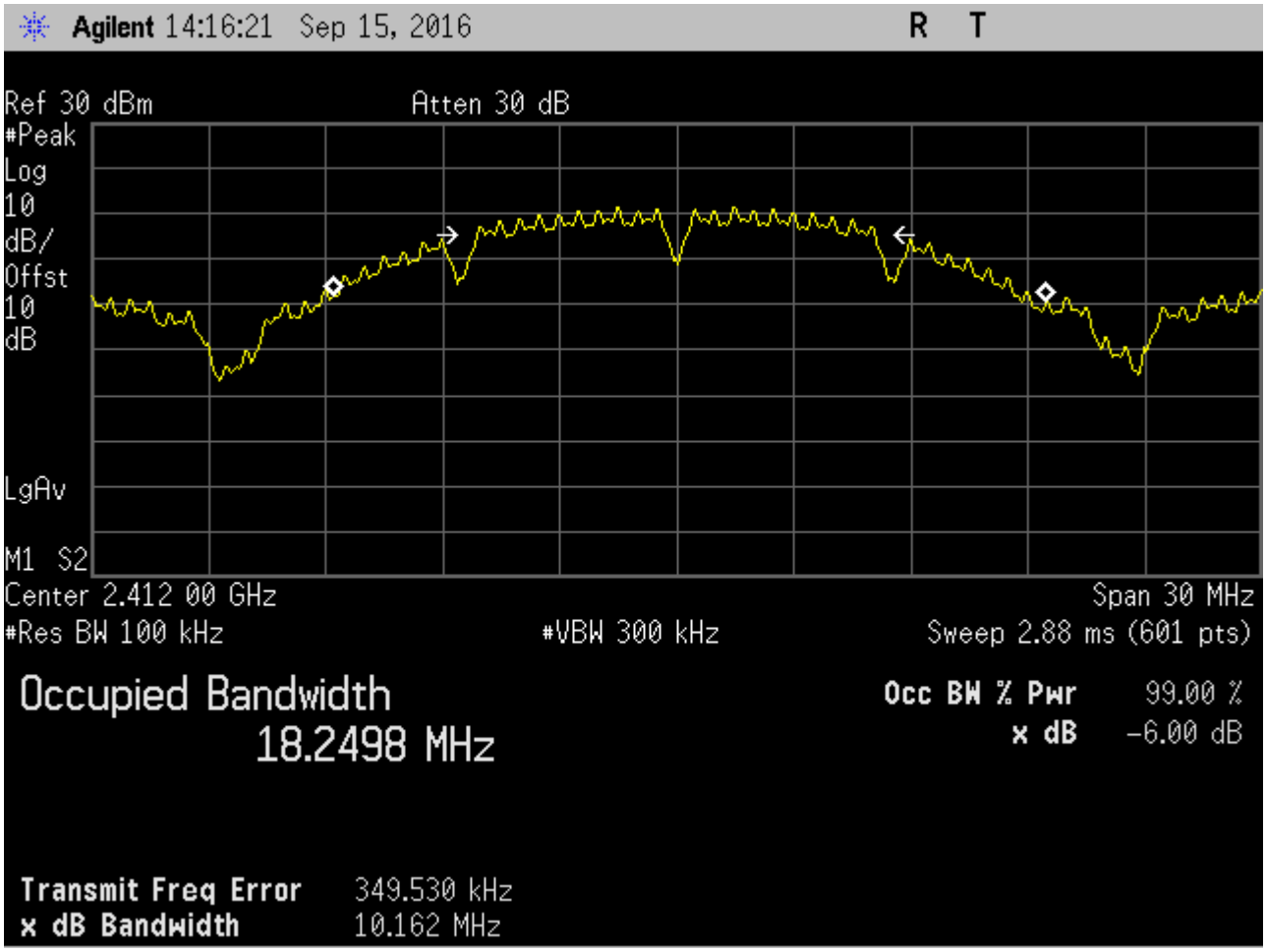
Plot 11. 99 Percent Occupied Bandwidth, 20M, Ch. 2437M, b mode, Port 1



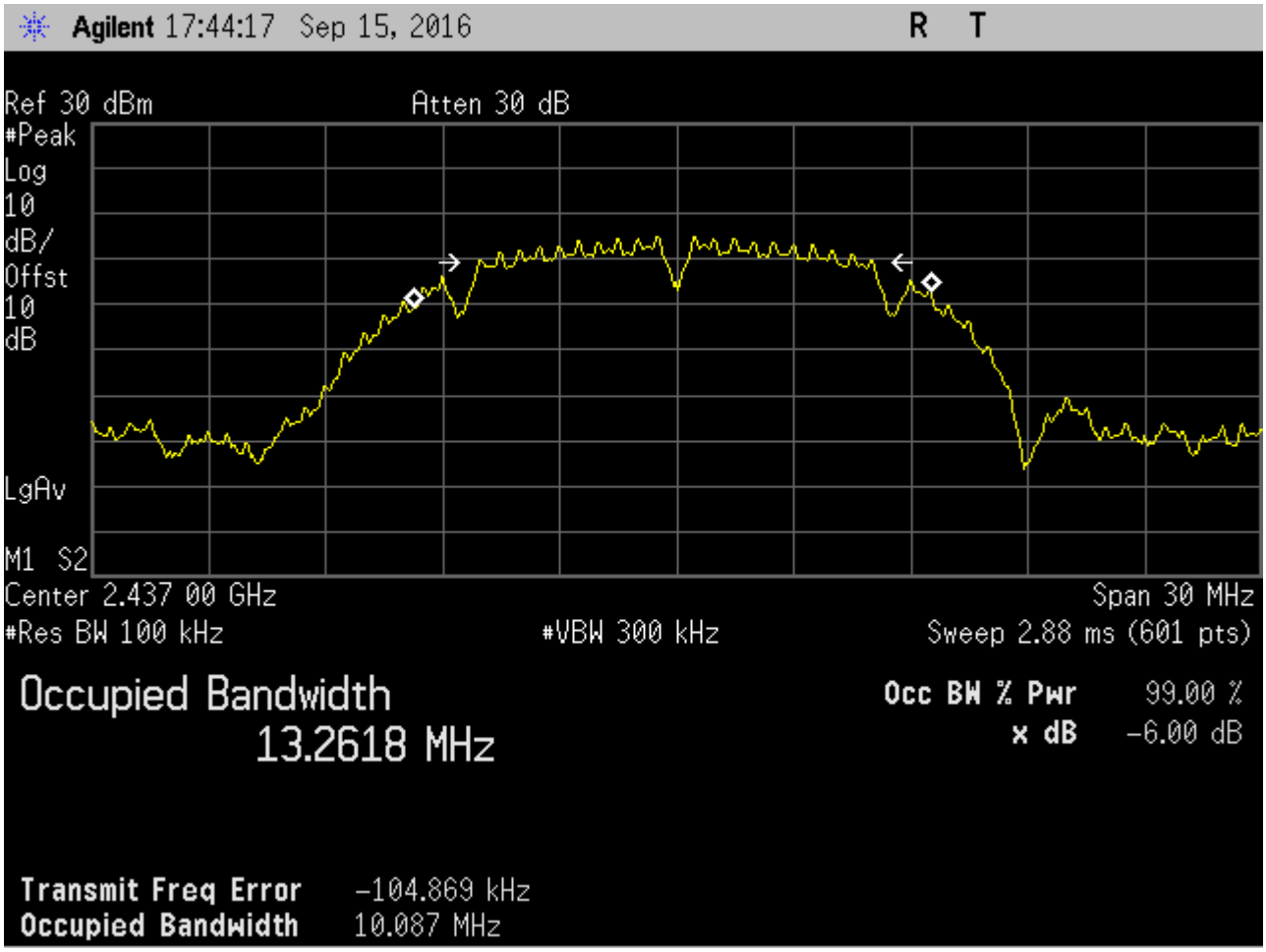
Plot 12. 99 Percent Occupied Bandwidth, 20M, Ch.2437M, b mode, Port 2



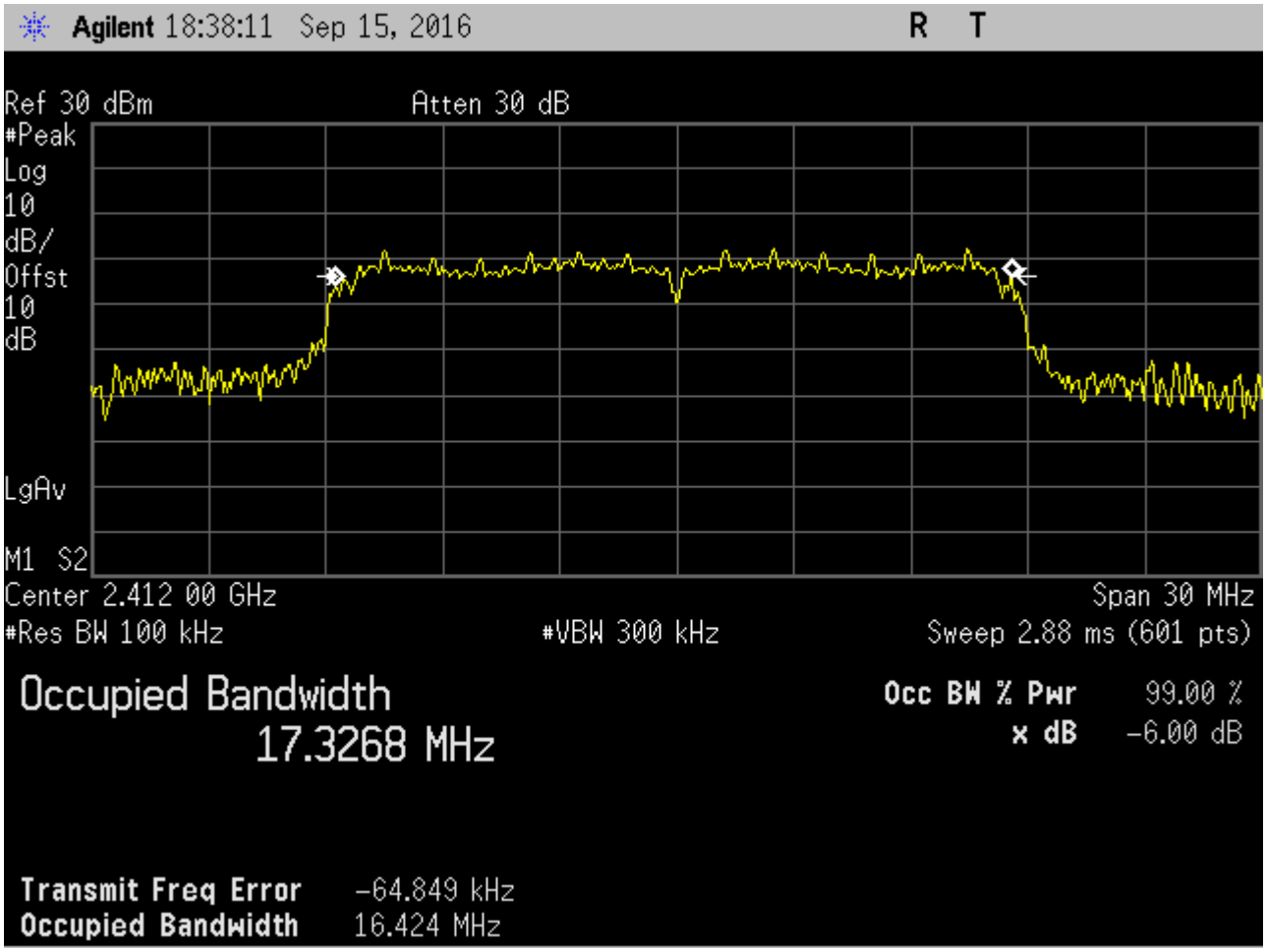
Plot 13. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, b mode, Port 1



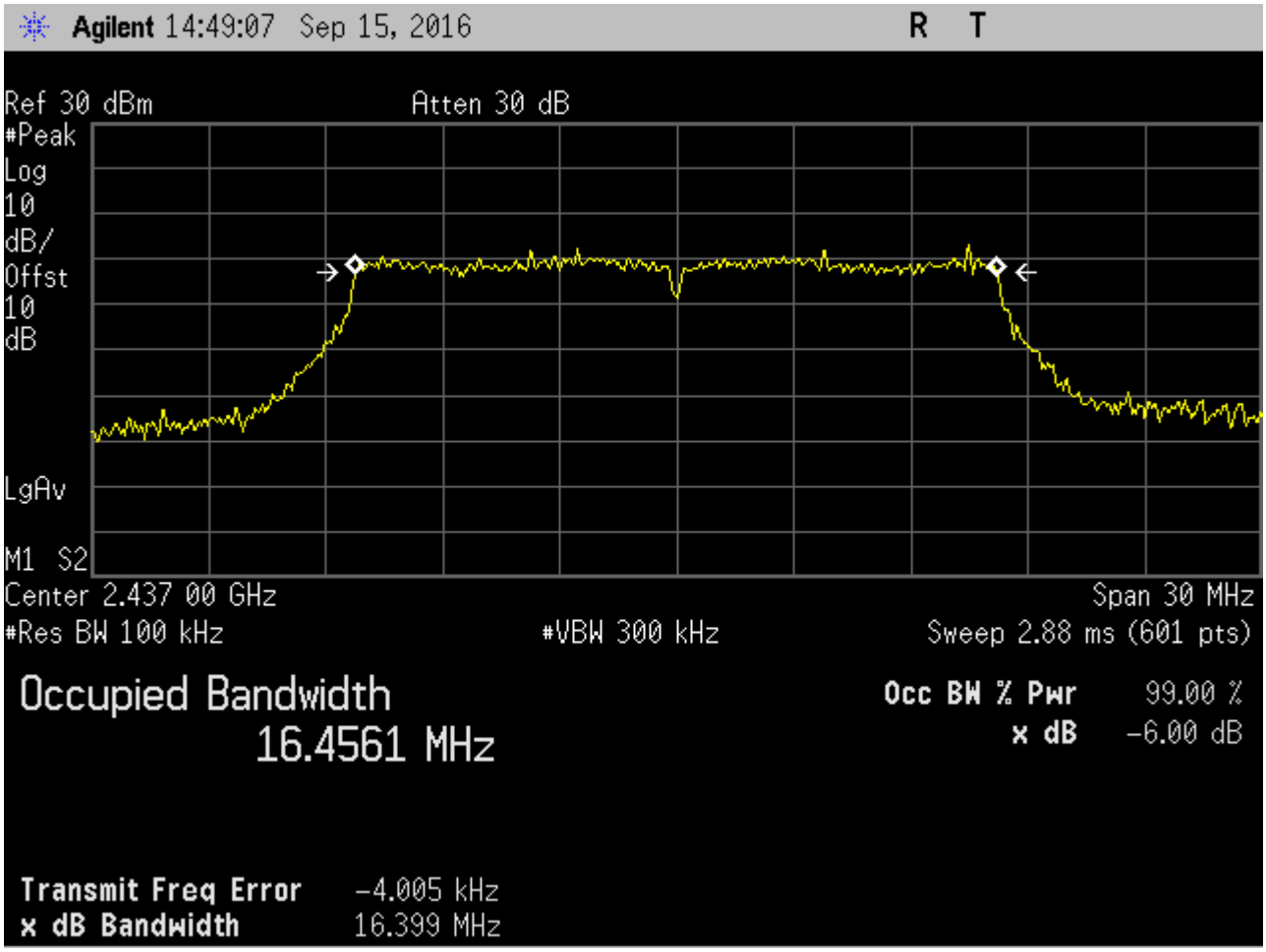
Plot 14. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, b mode, Port 2



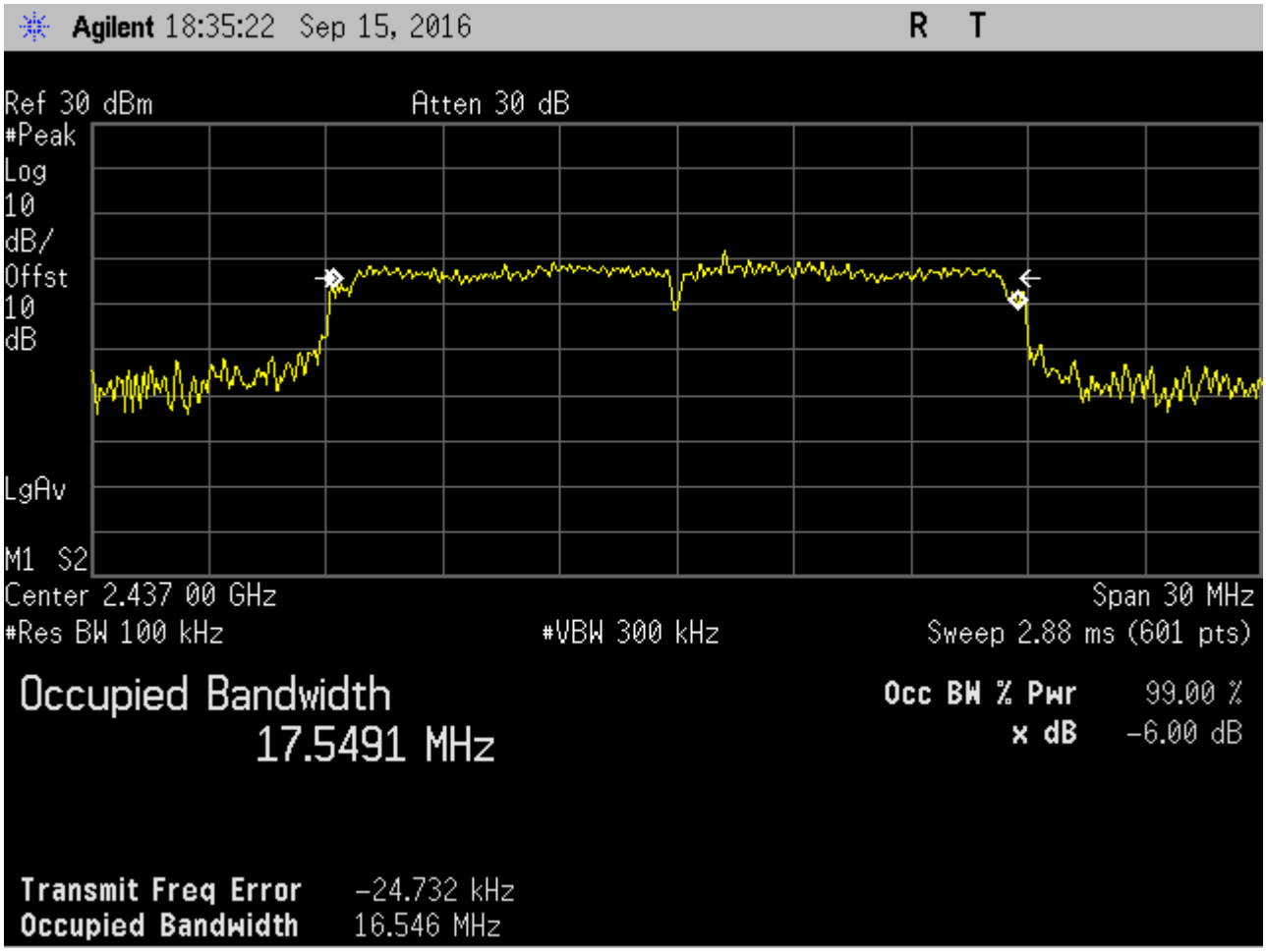
Plot 15. 6dB Occupied Bandwidth, 20M, Ch. 2412M, g mode, Port 1



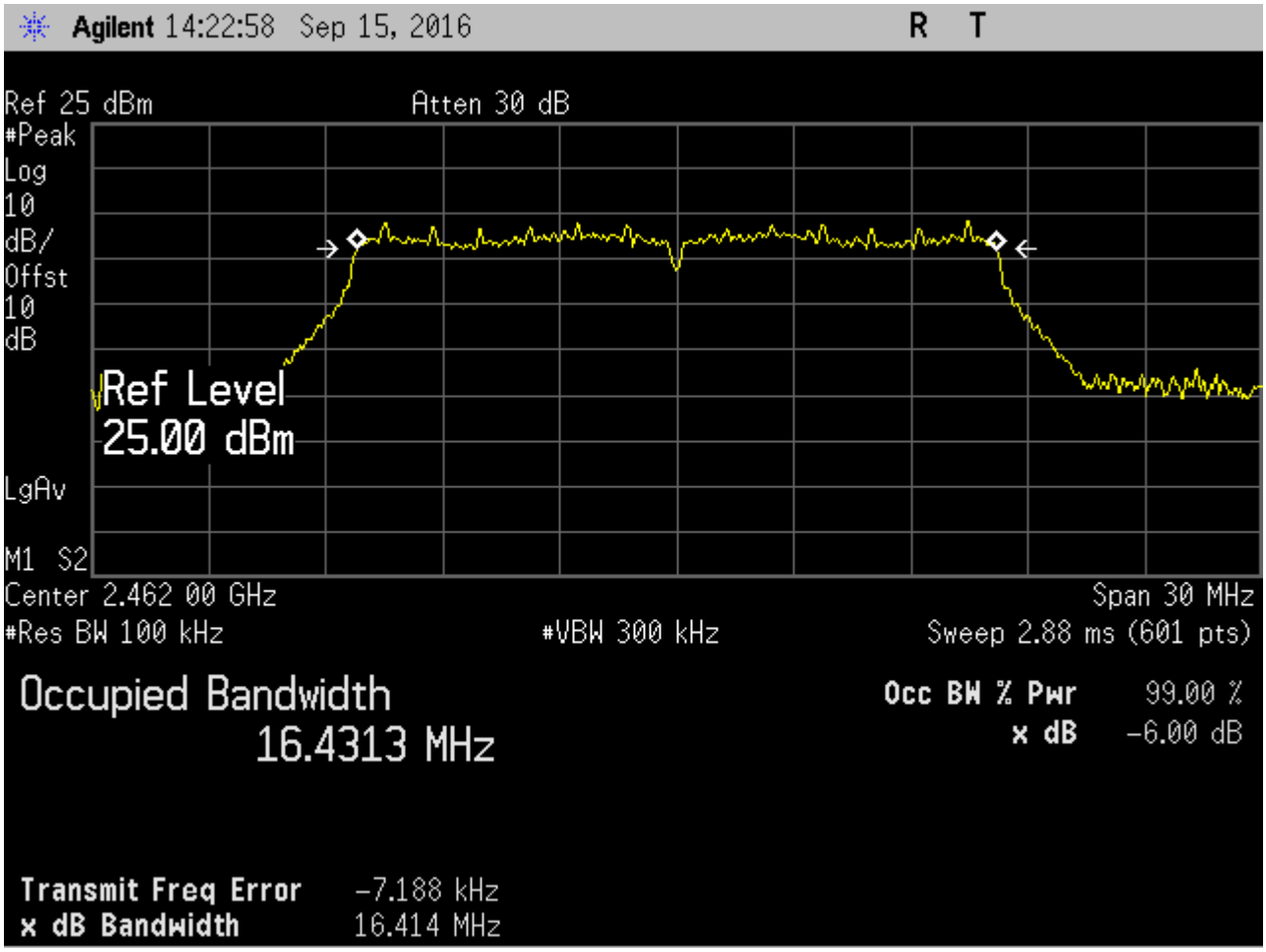
Plot 16. 6dB Occupied Bandwidth, 20M, Ch. 2412M, g mode, Port 2



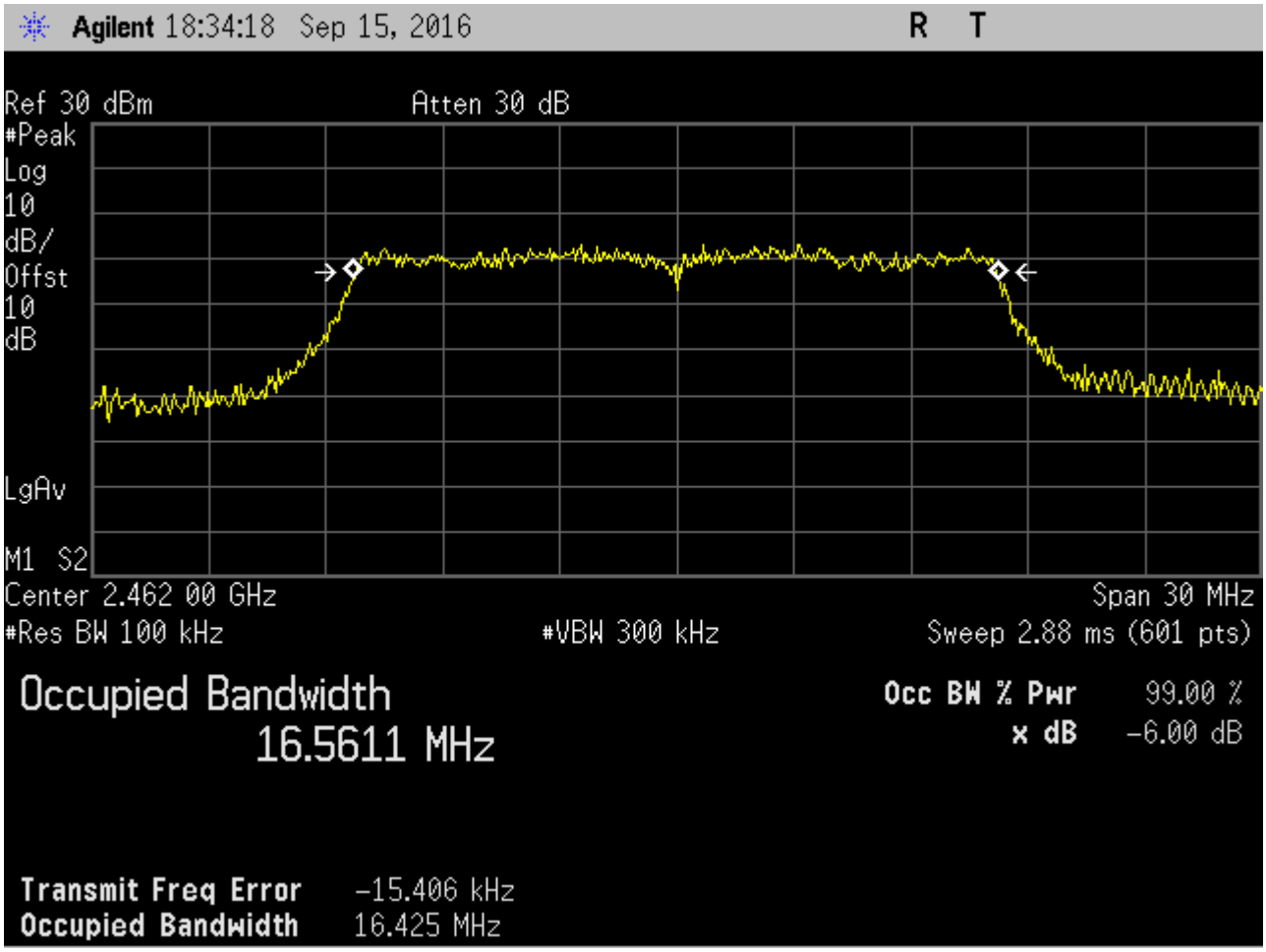
Plot 17. 6dB Occupied Bandwidth, 20M, Ch. 2437M, g mode, Port 1



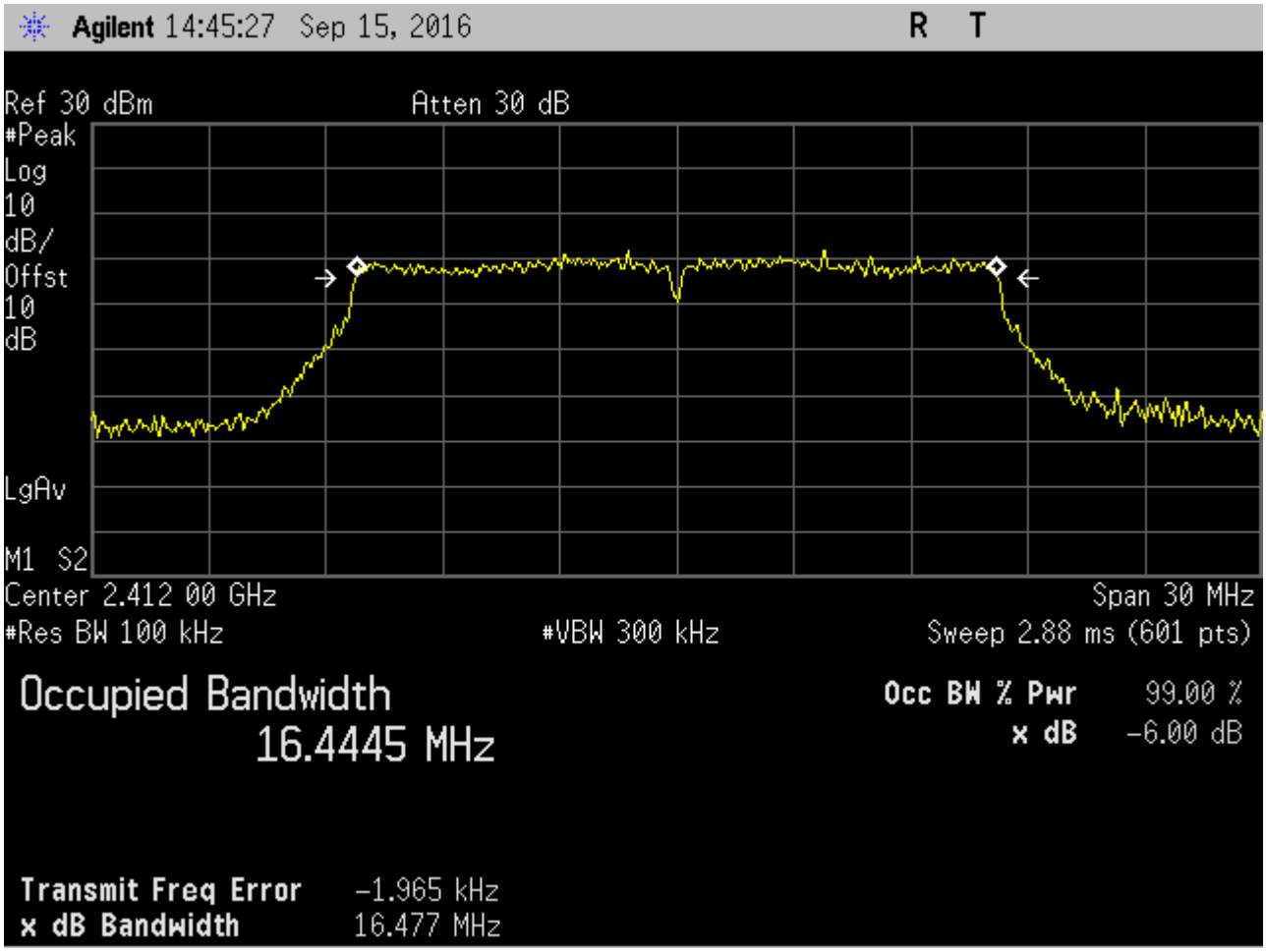
Plot 18. 6dB Occupied Bandwidth, 20M, Ch. 2437M, g mode, Port 2



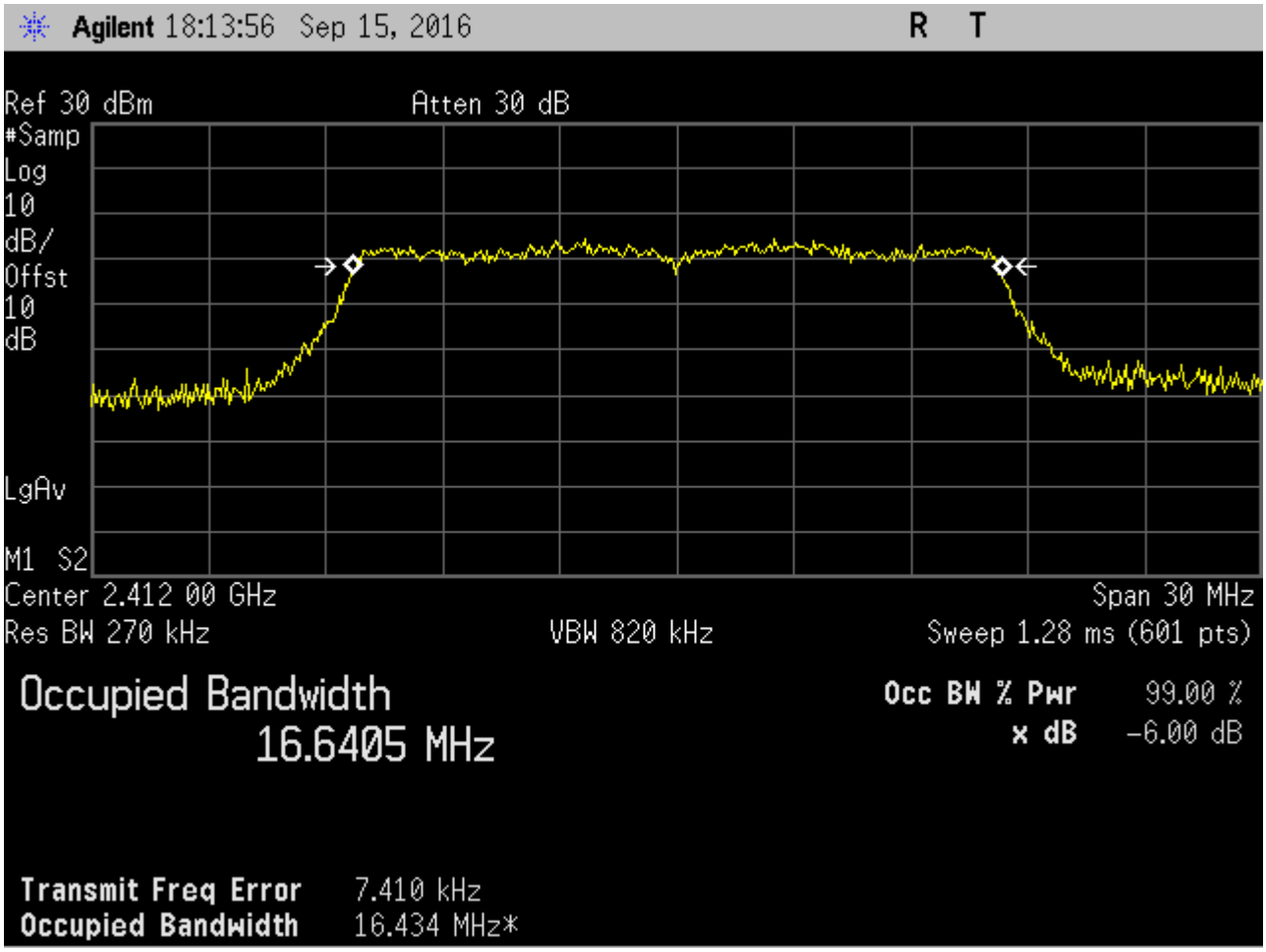
Plot 19. 6dB Occupied Bandwidth, 20M, Ch. 2462M, g mode, Port 1



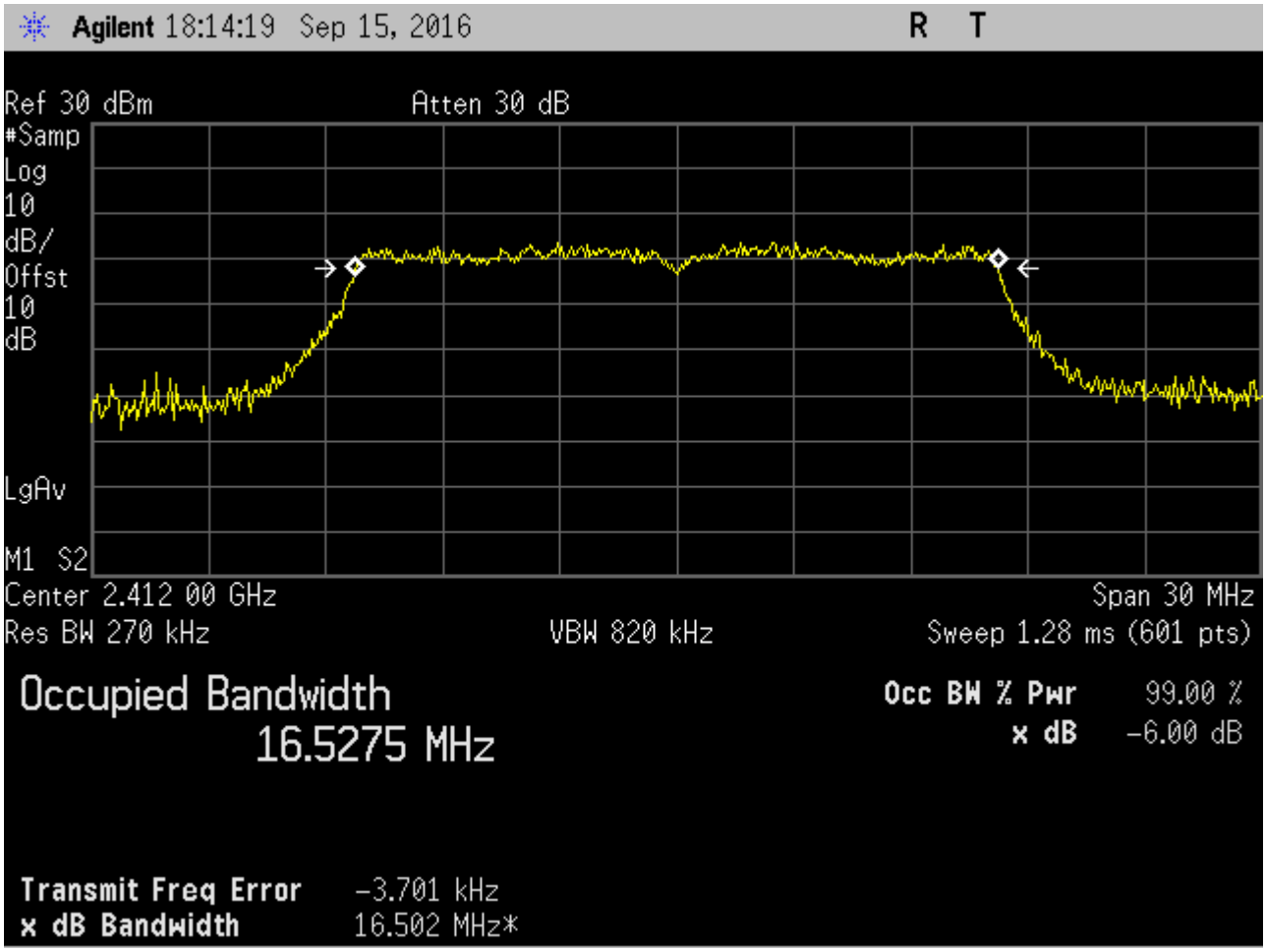
Plot 20. 6dB Occupied Bandwidth, 20M, Ch. 2462M, g mode, Port 2



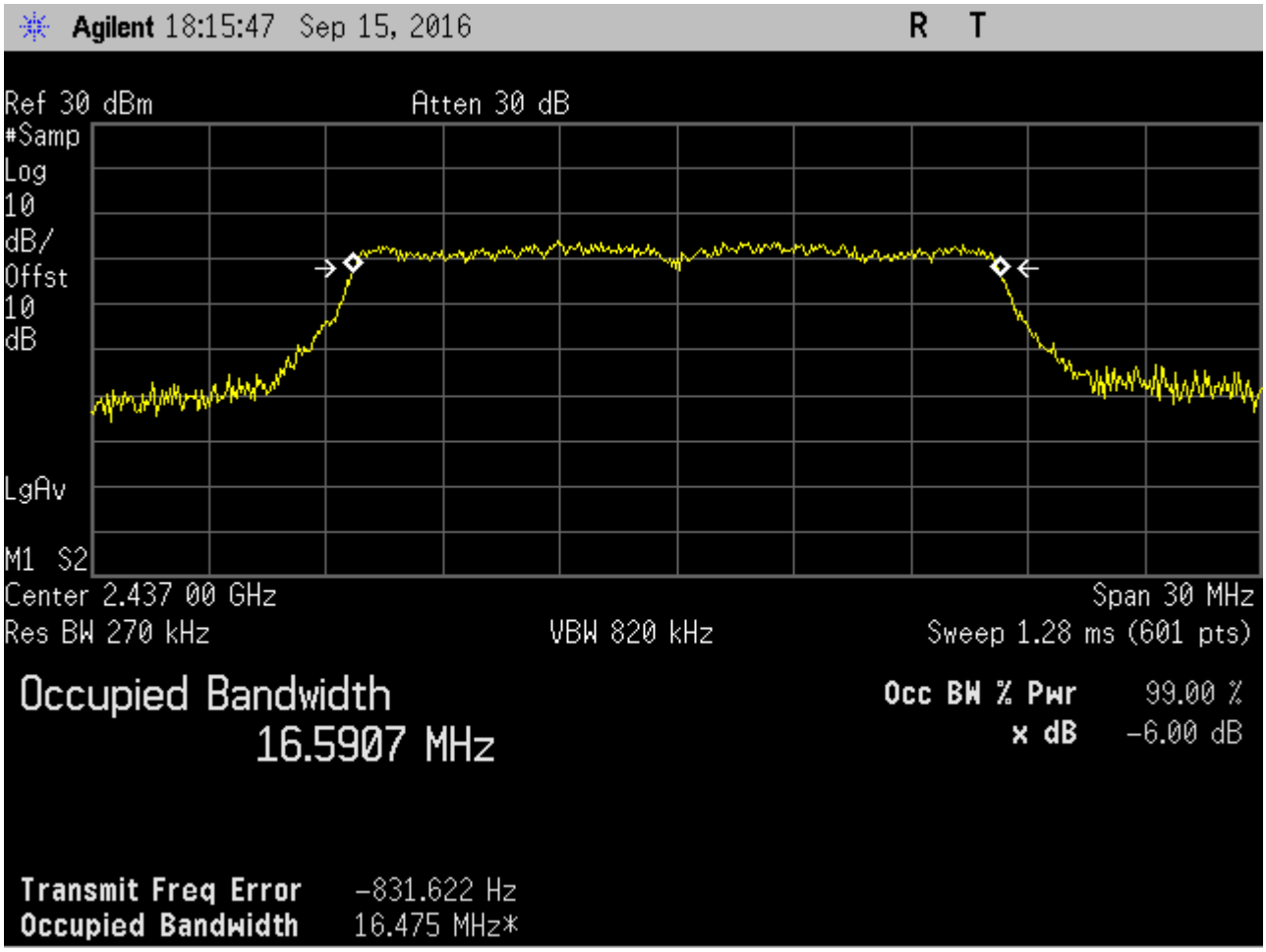
Plot 21. 6dB Occupied Bandwidth, 20M, Ch. 2412M, g mode, Port 1



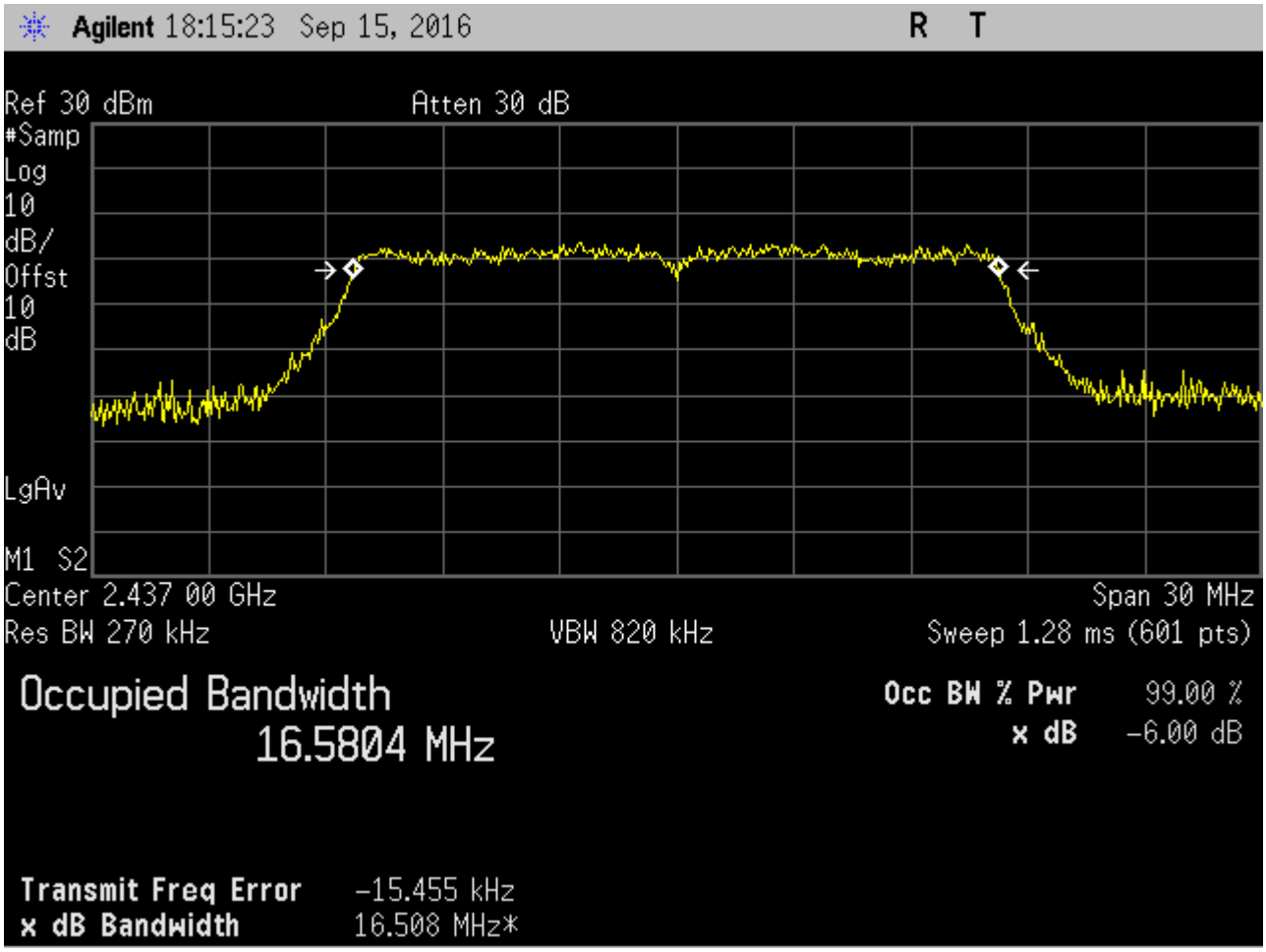
Plot 22. 99 Percent Occupied Bandwidth, 20M, Ch. 2412M, g mode, Port 1



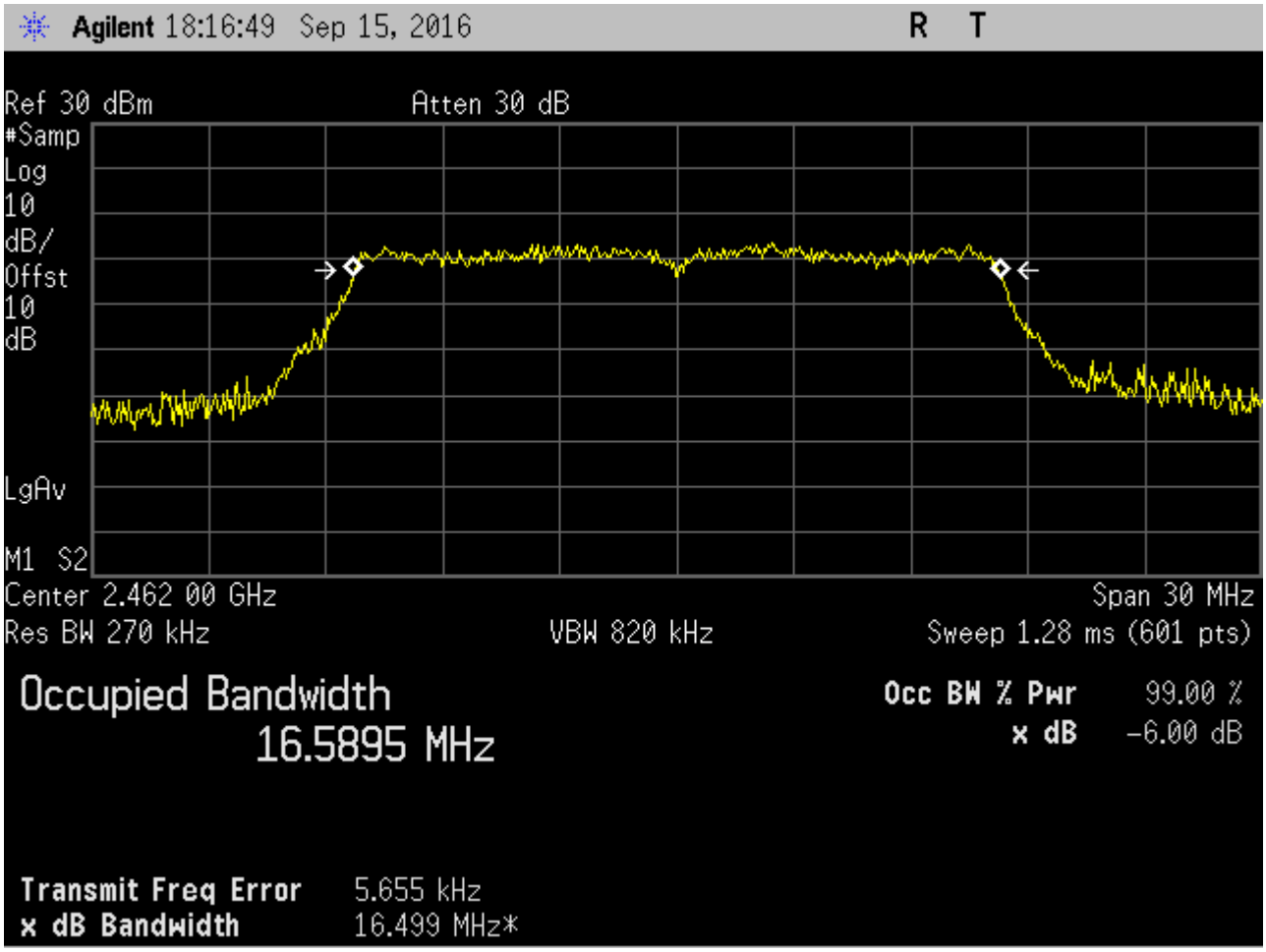
Plot 23. 99 Percent Occupied Bandwidth, 20M, Ch. 2412M, g mode, Port2



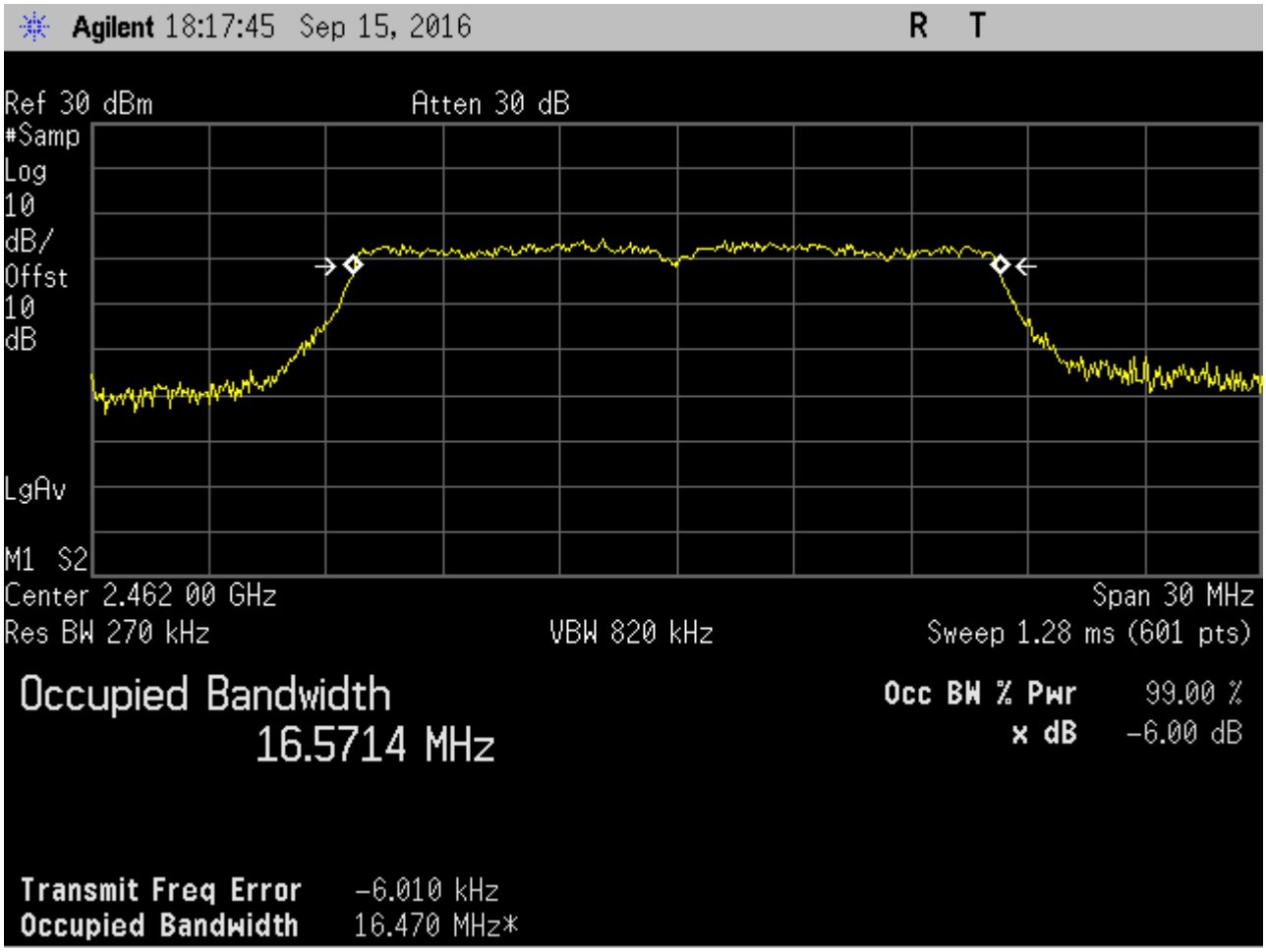
Plot 24. 99 Percent Occupied Bandwidth, 20M, Ch. 2437M, g mode Port 1



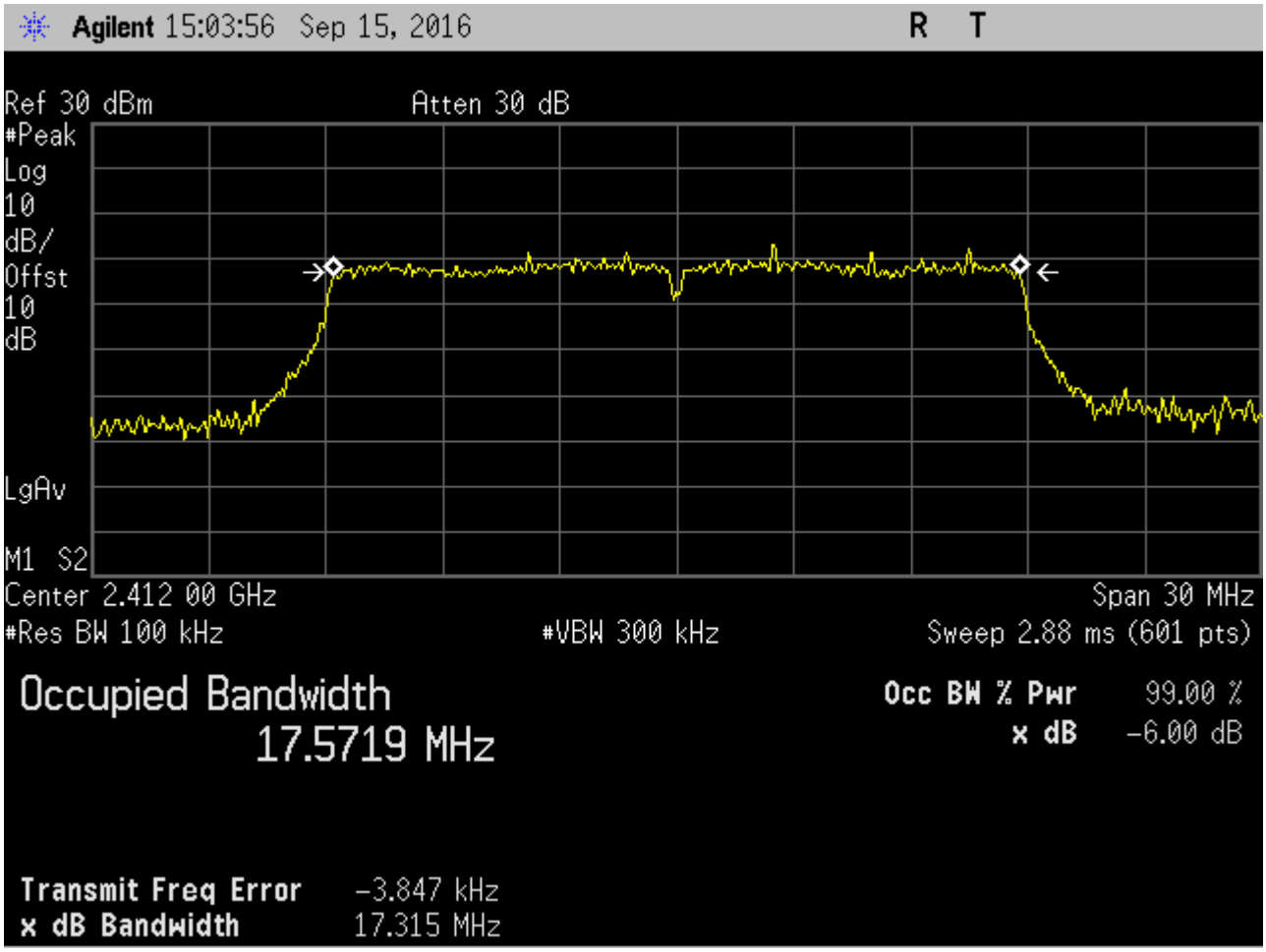
Plot 25. 99 Percent Occupied Bandwidth, 20M, Ch. 2437M, g mode, Port 2



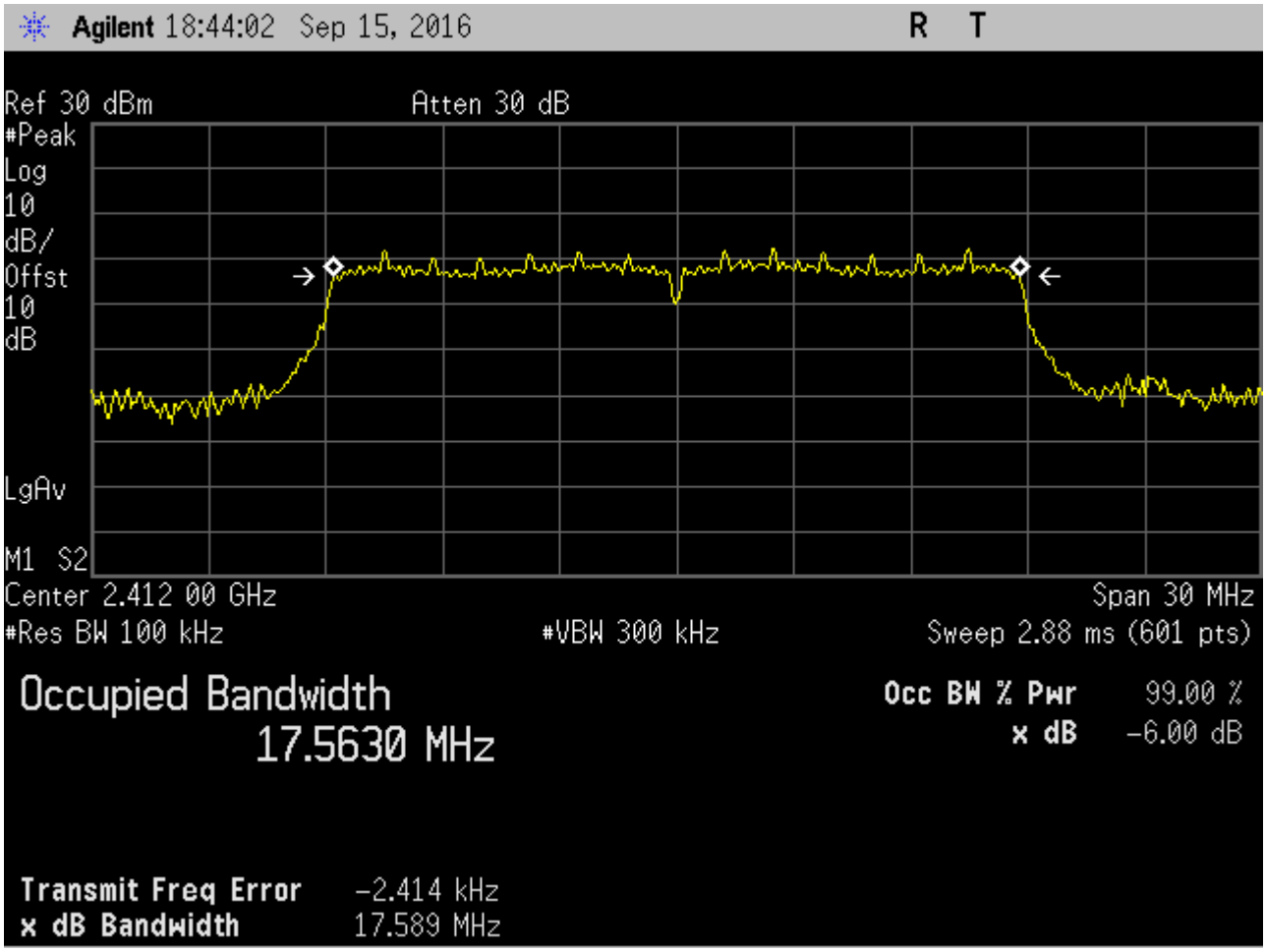
Plot 26. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, g mode, Port 1



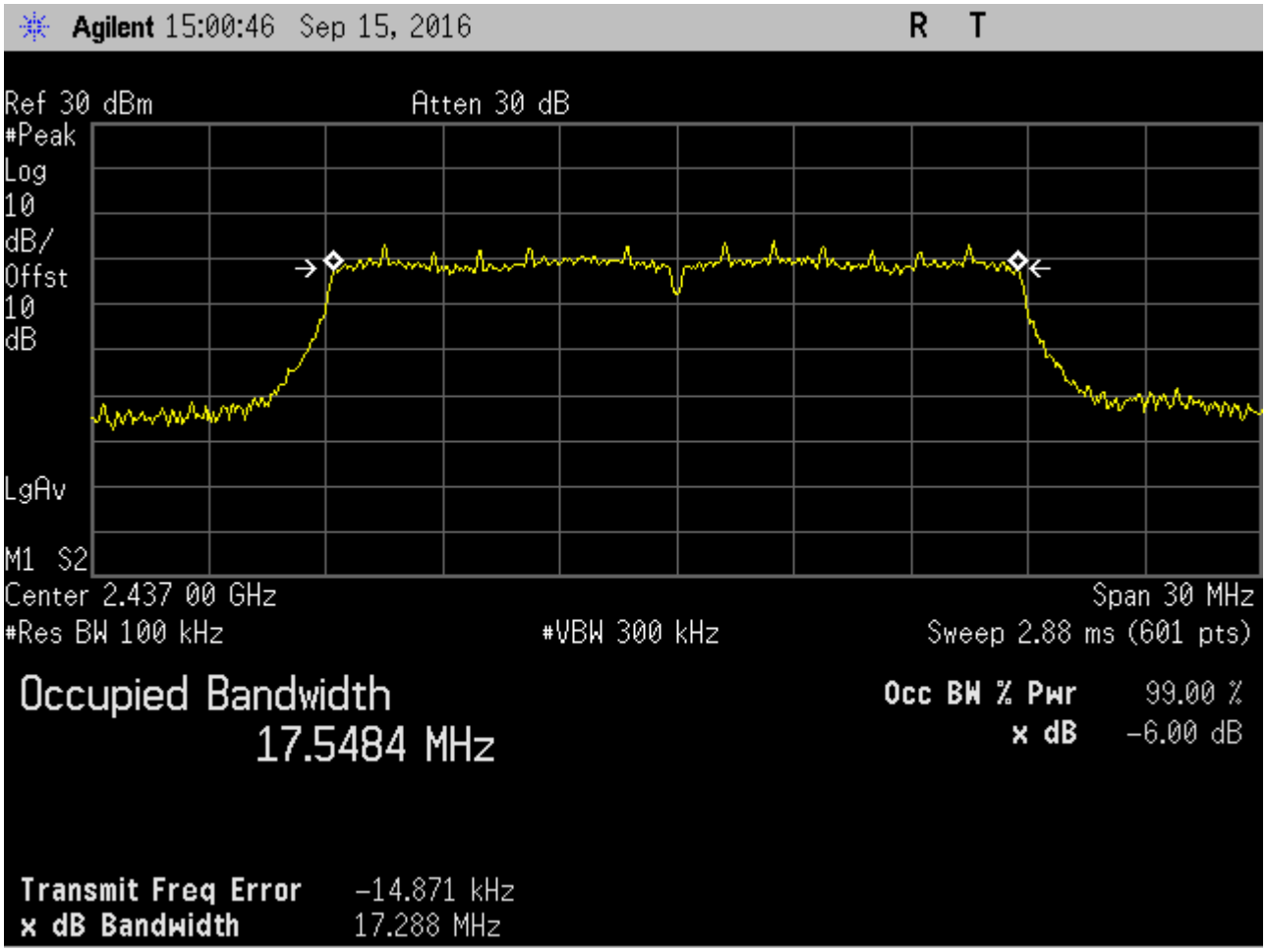
Plot 27. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, g mode, Port 2



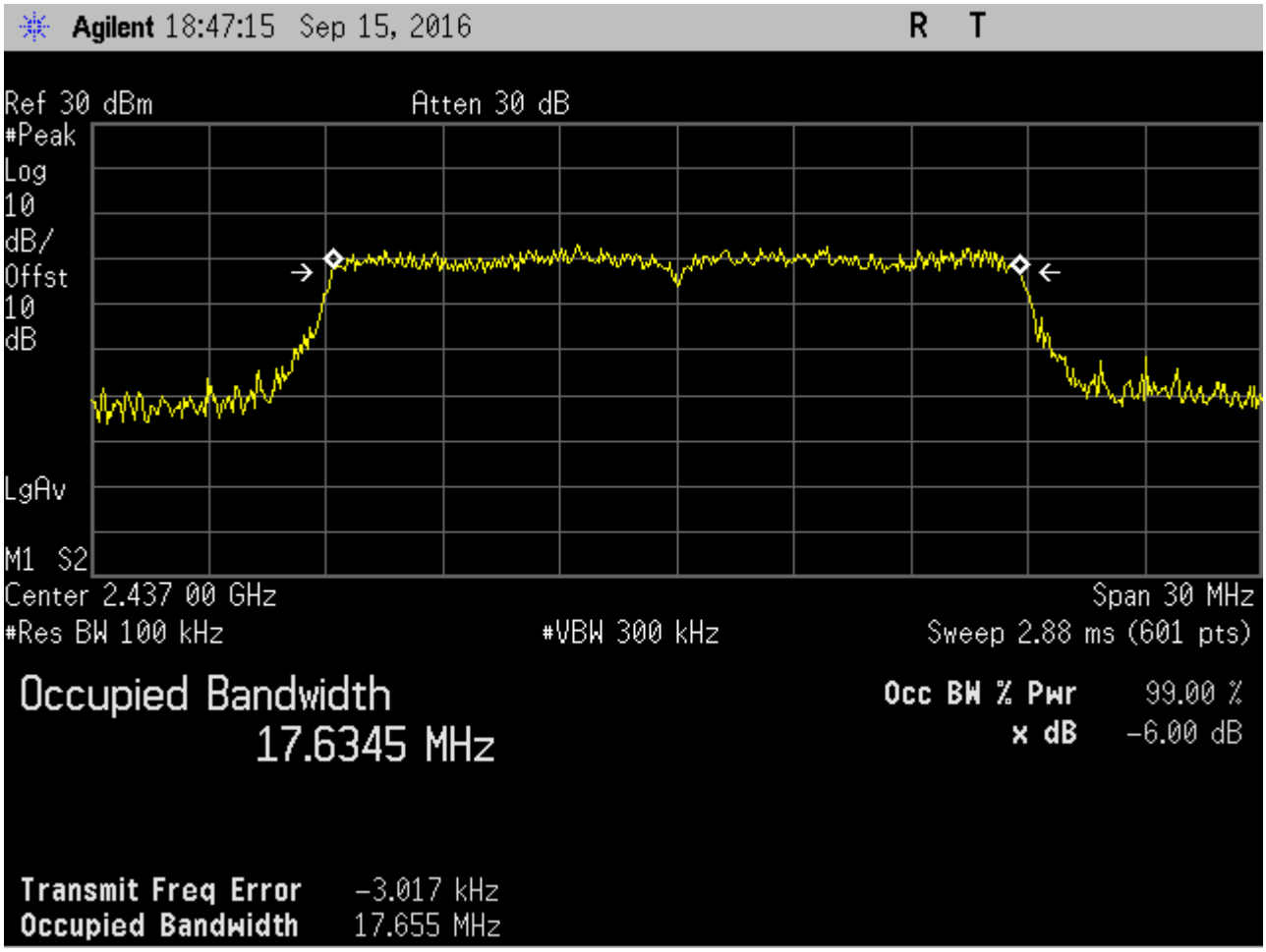
Plot 28. 6 dB Occupied Bandwidth, 20M, Ch. 2412M, n mode



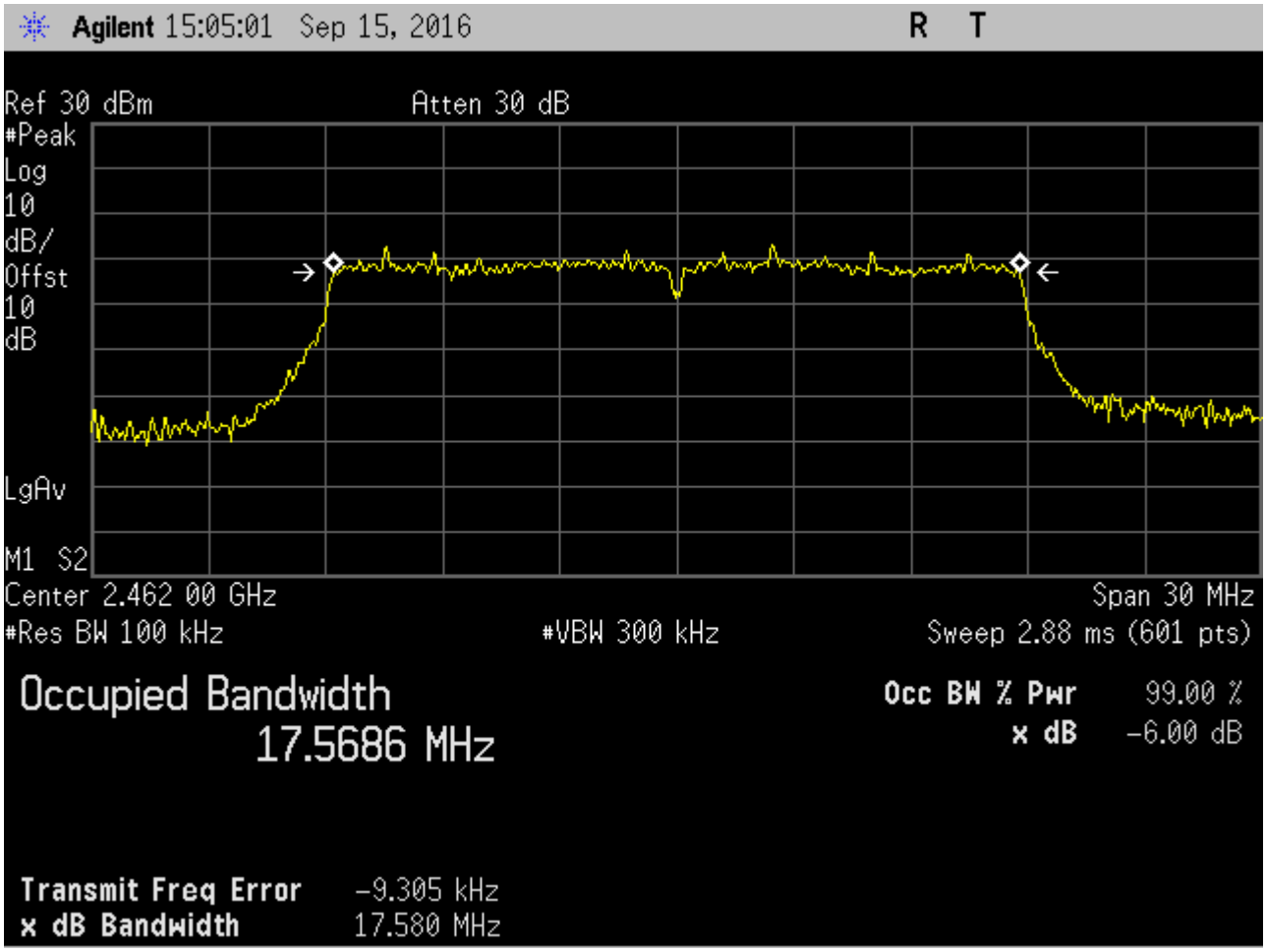
Plot 29. 6 dB Occupied Bandwidth, 20M, Ch. 2412M, n mode, Port 2



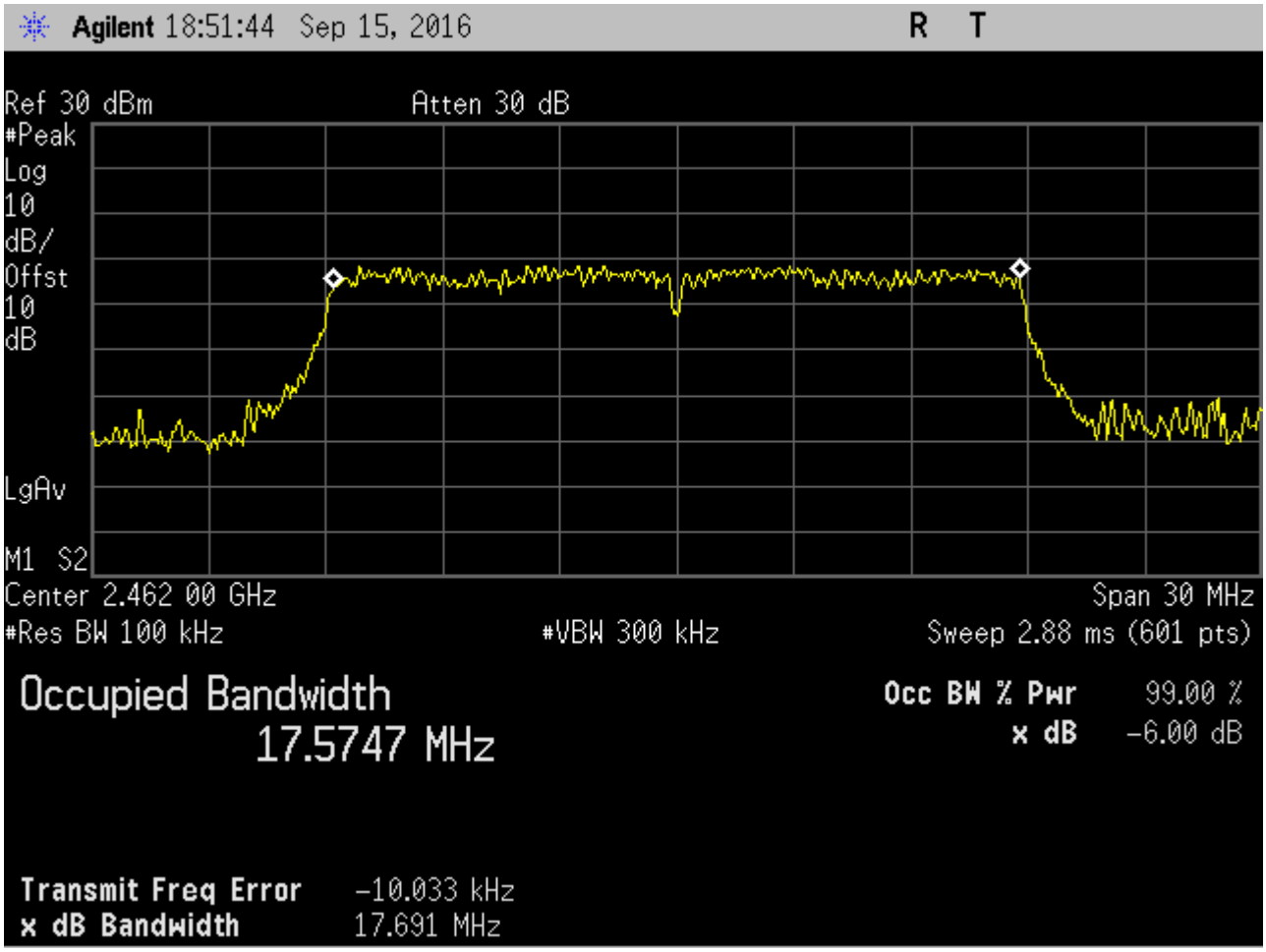
Plot 30. 6 dB Occupied Bandwidth, 20M, Ch. 2437M, n mode



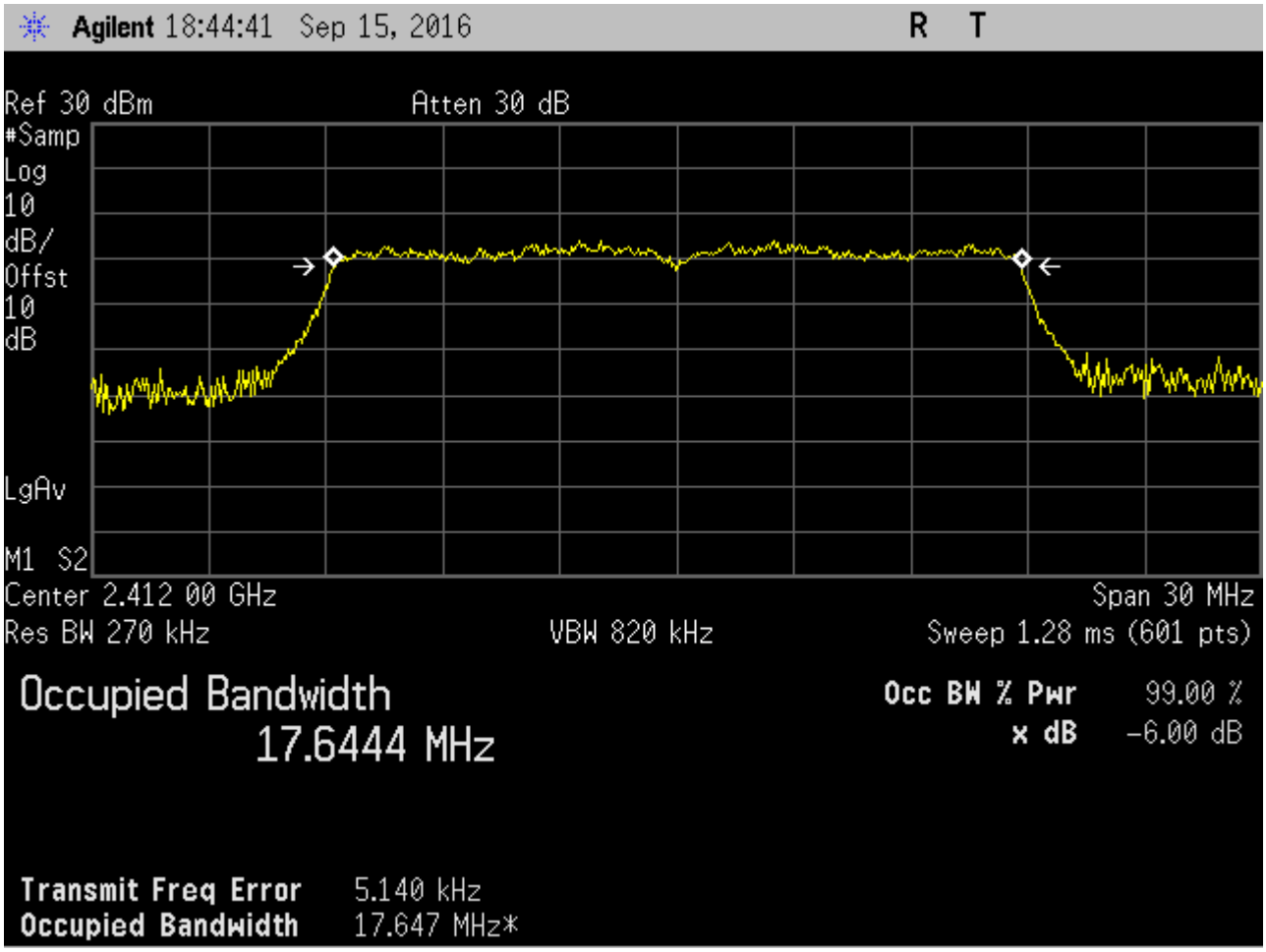
Plot 31. 6 dB Occupied Bandwidth, 20M, Ch. 2437M, n mode, Port 2



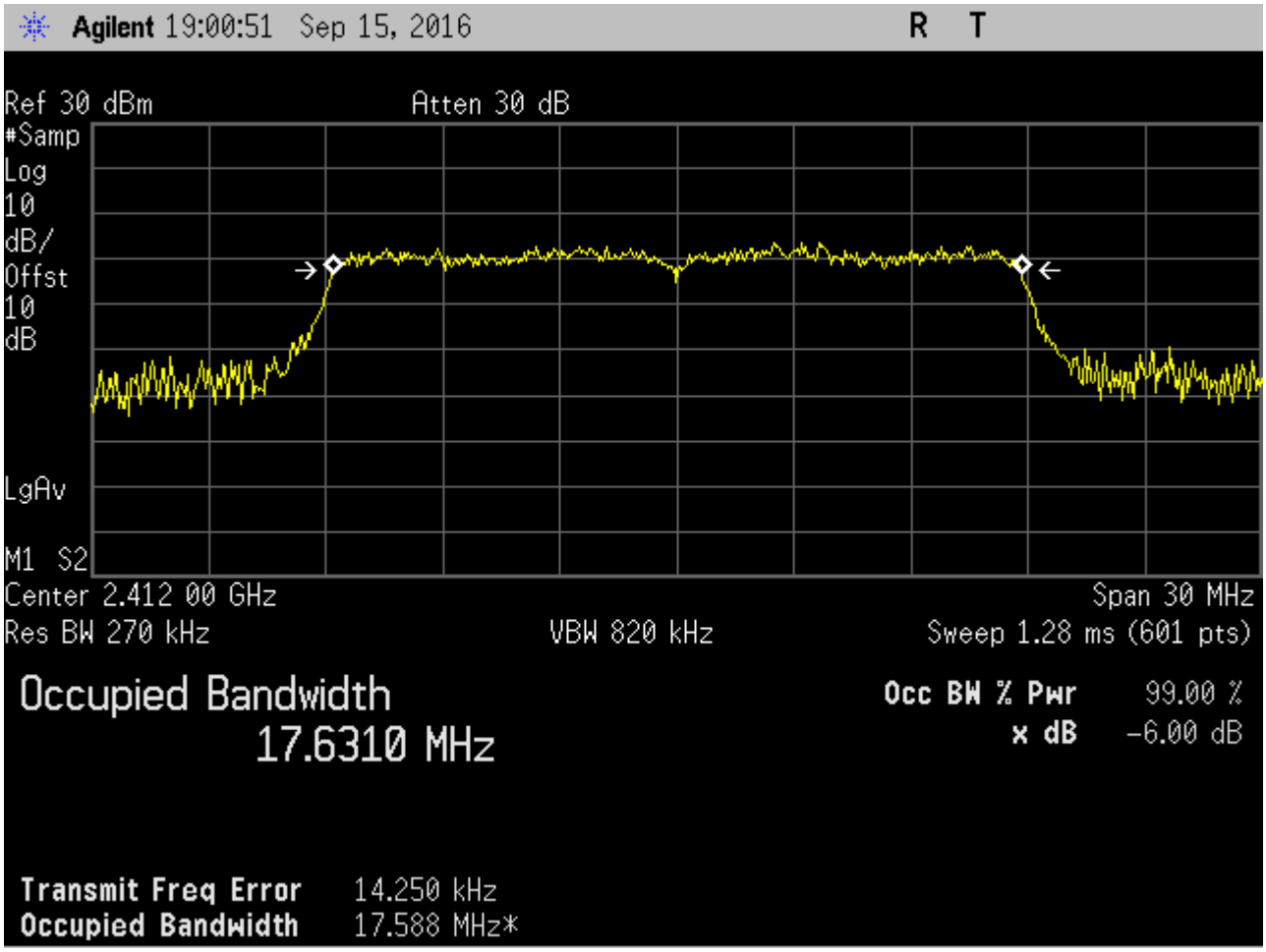
Plot 32. 6 dB Occupied Bandwidth, 20M, Ch. 2462M, n mode



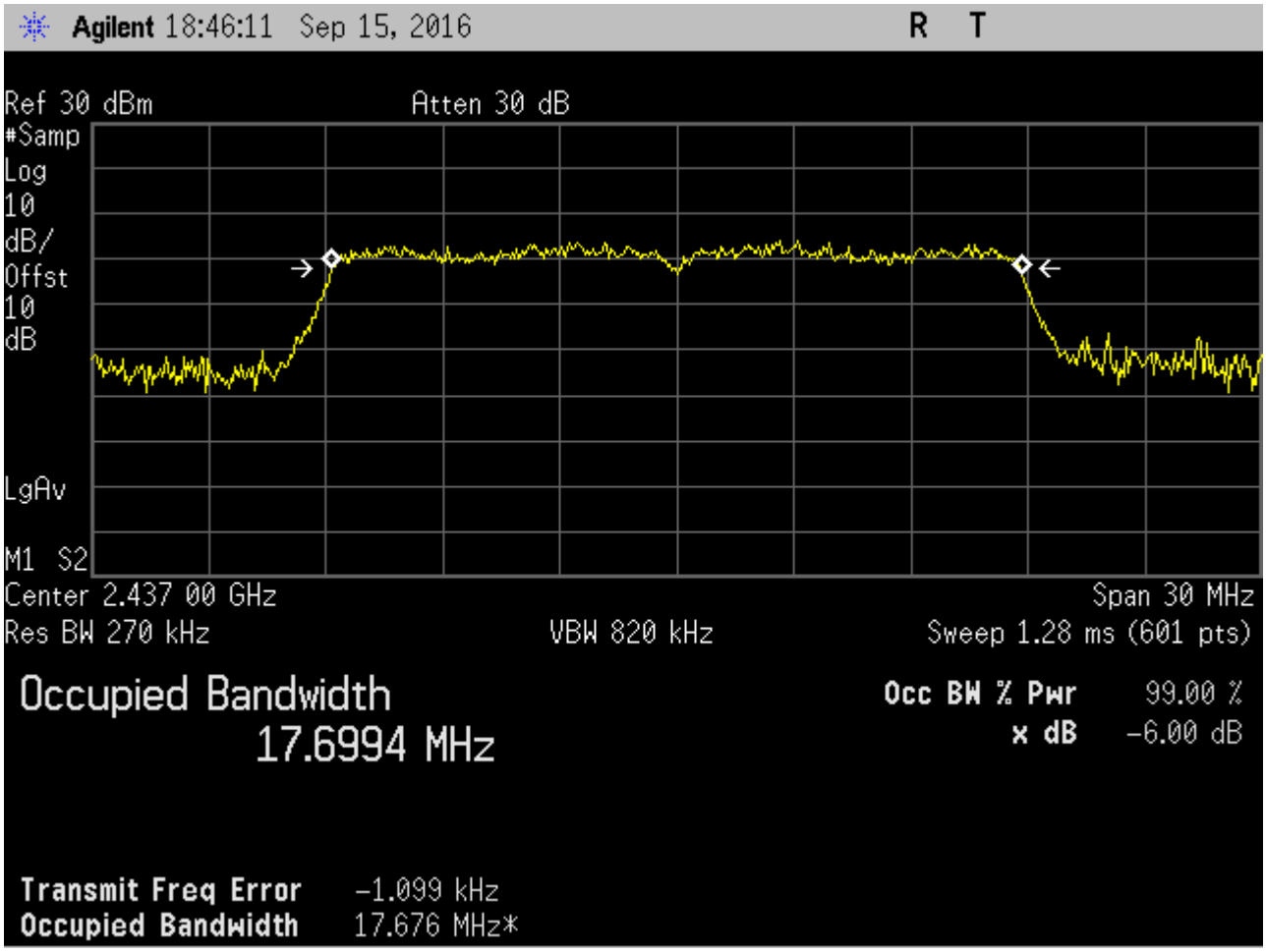
Plot 33. 6 dB Occupied Bandwidth, 20M, Ch. 2462M, n mode, Port 2



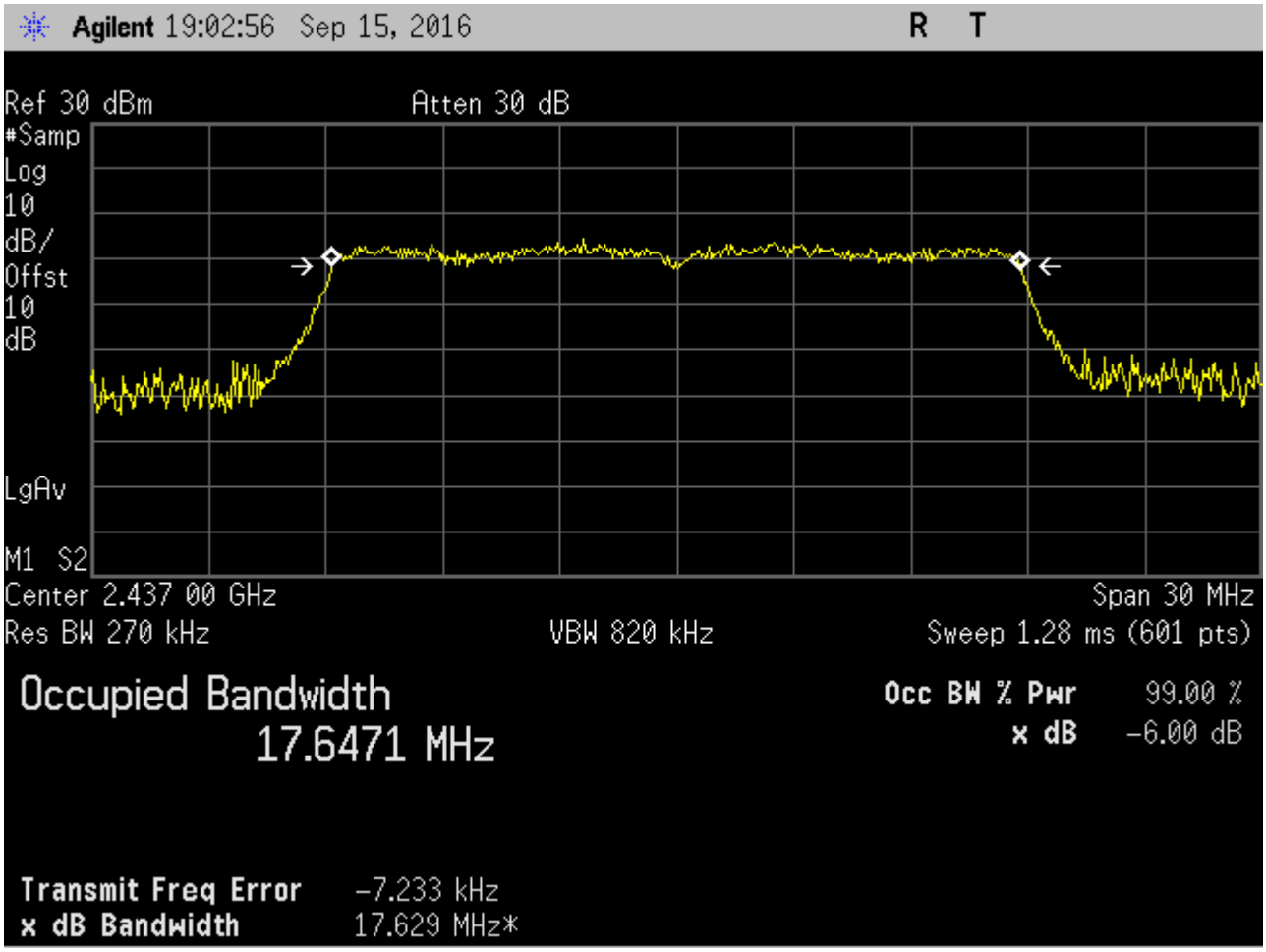
Plot 34. 99 Percent Occupied Bandwidth, 20M, Ch. 2412M, n mode, Port 2



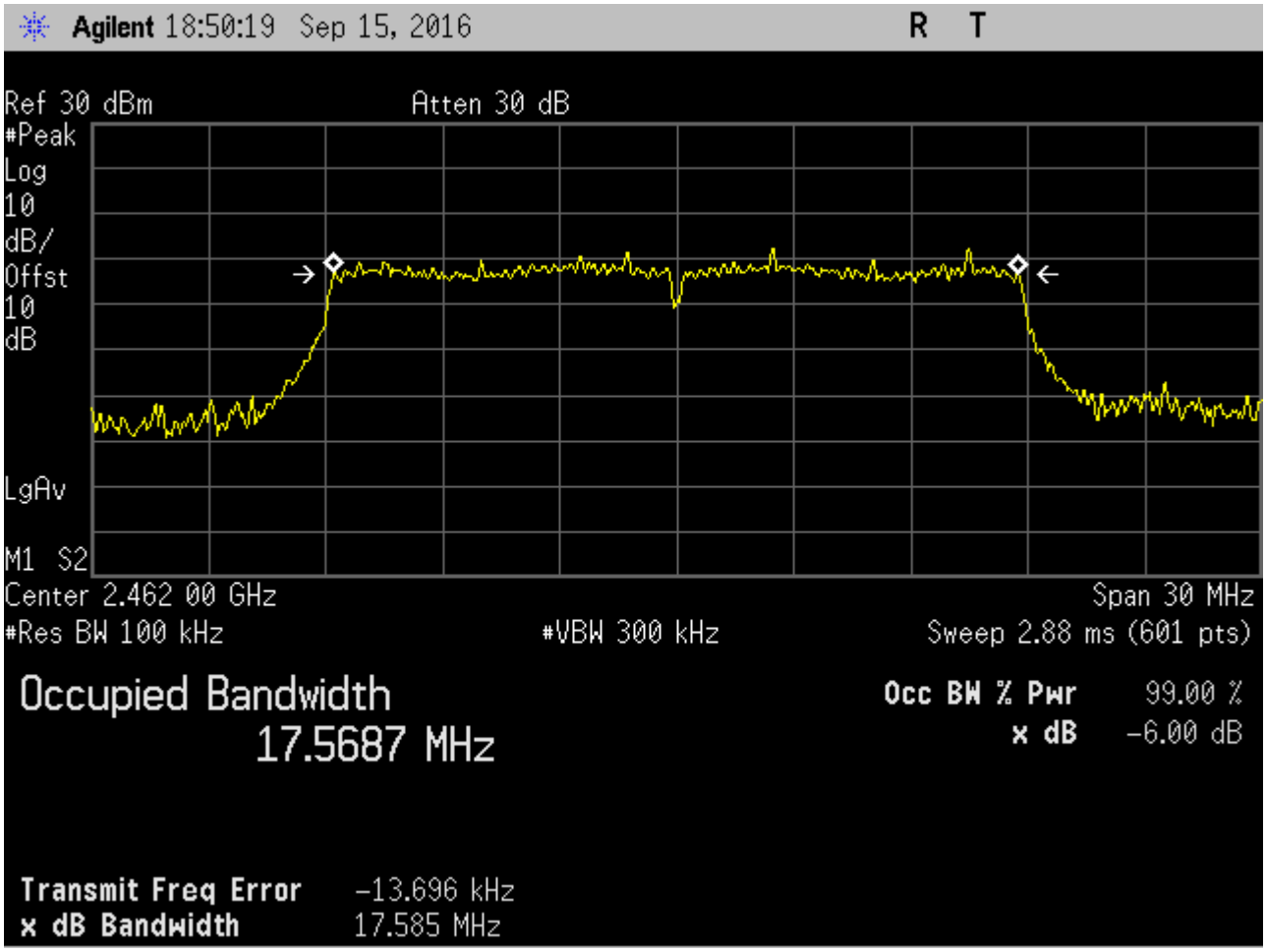
Plot 35. 99 Percent Occupied Bandwidth, 20M, Ch. 2412M, n mode, Port 1



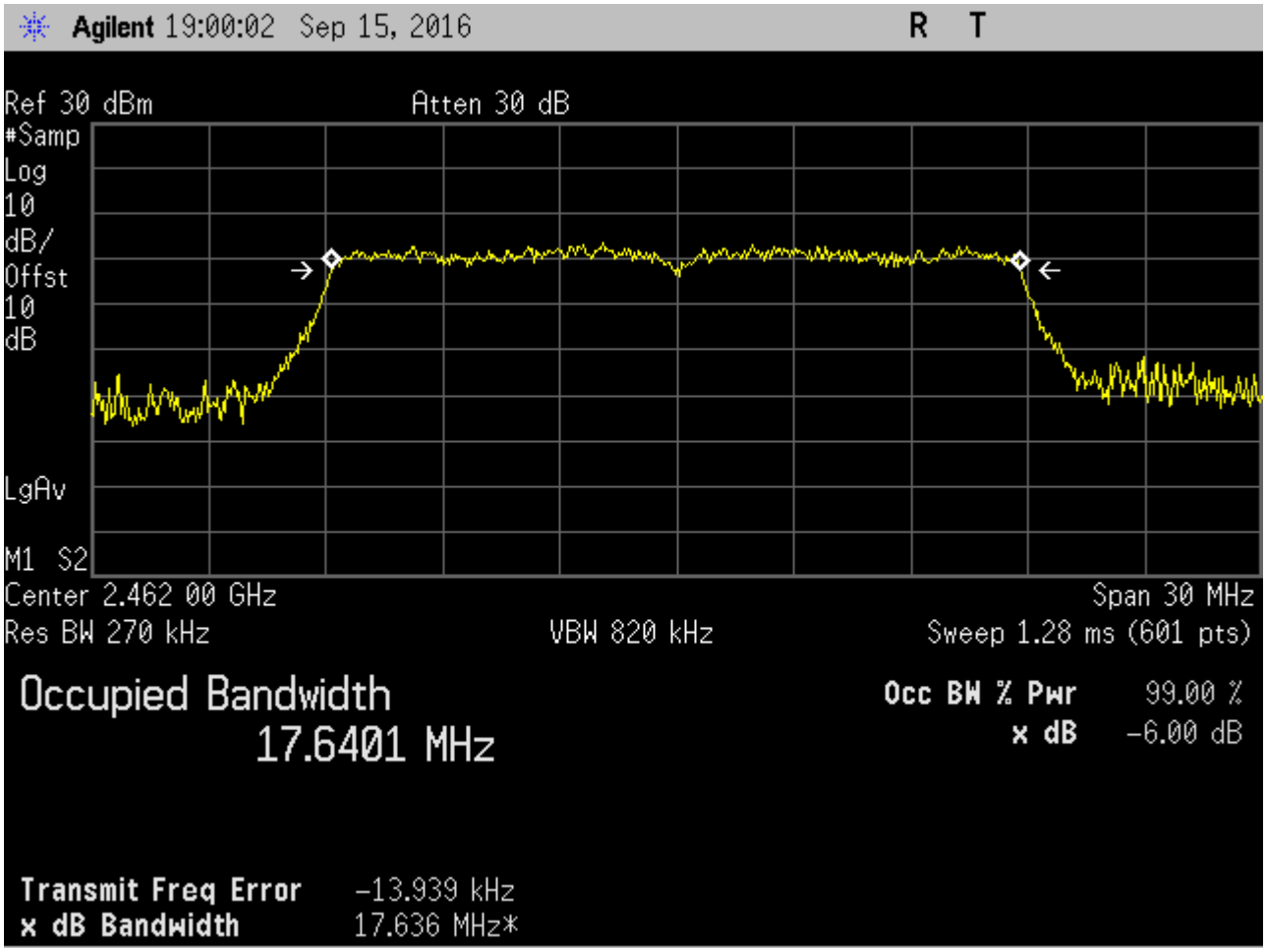
Plot 36. 99 Percent Occupied Bandwidth, 20M, Ch. 2437M, n mode, Port 2



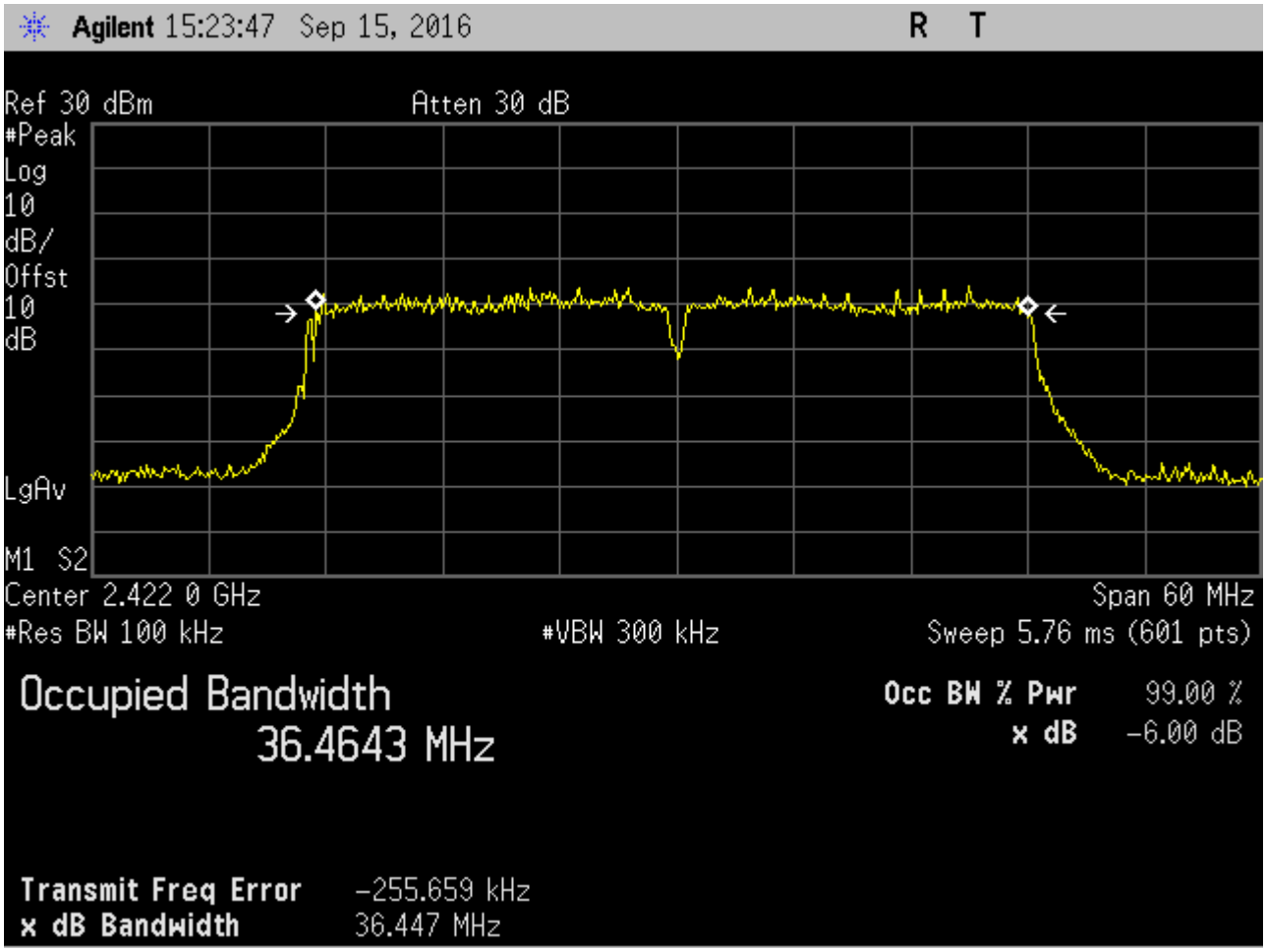
Plot 37. 99 Percent Occupied Bandwidth, 20M, Ch. 2437M, n mode, Port 1



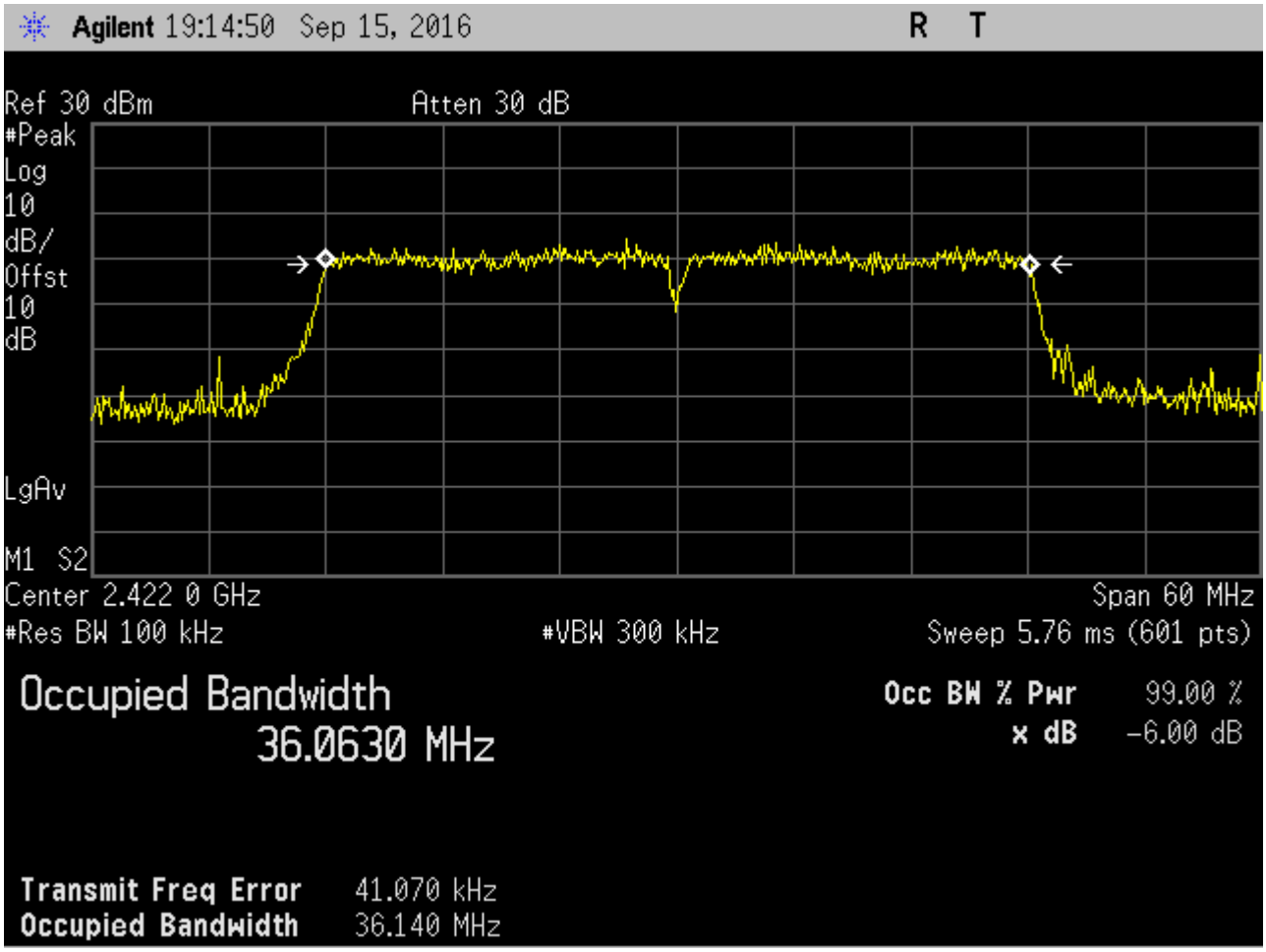
Plot 38. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, n mode, Port 2



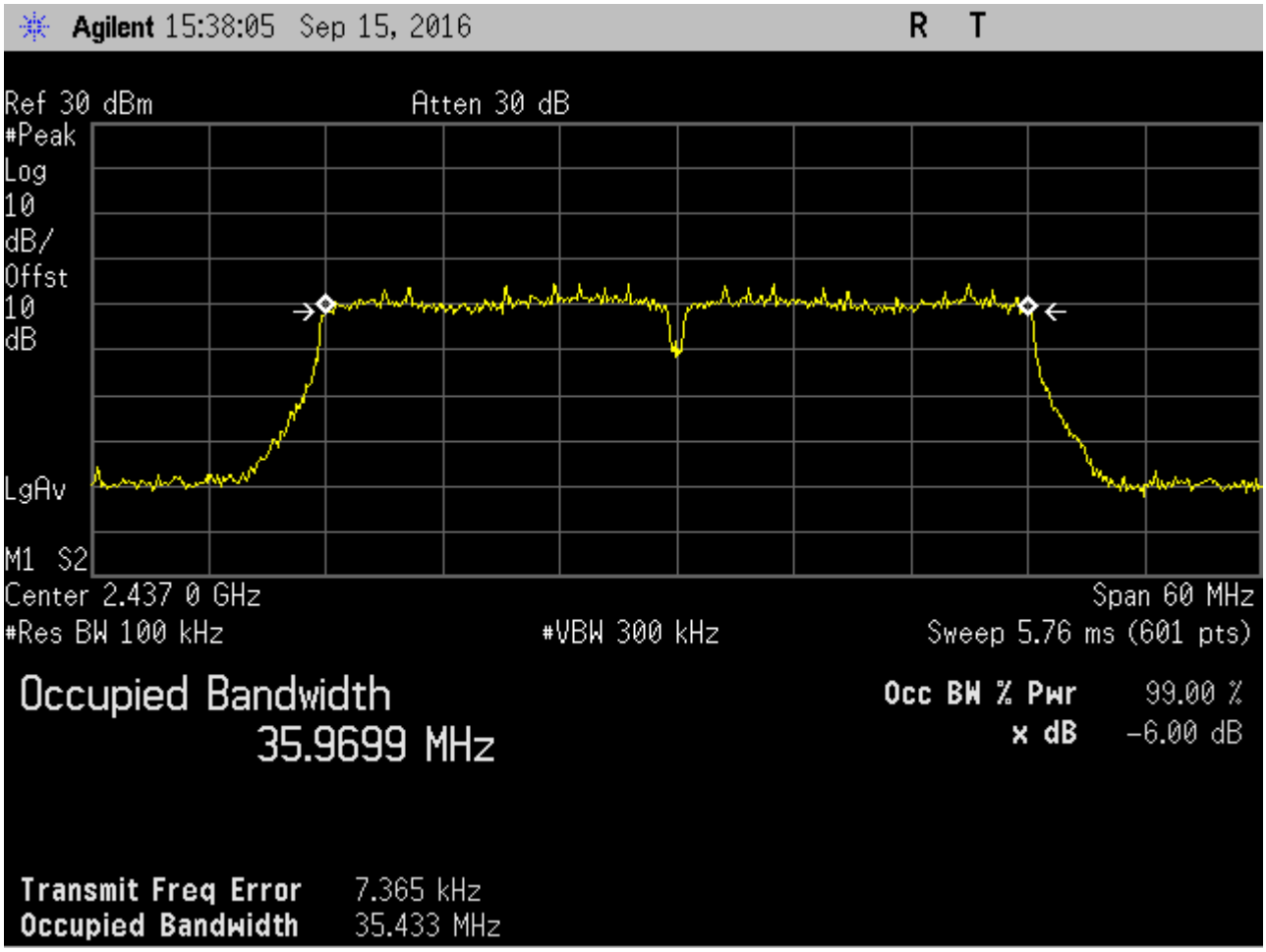
Plot 39. 99 Percent Occupied Bandwidth, 20M, Ch. 2462M, n mode, Port 1



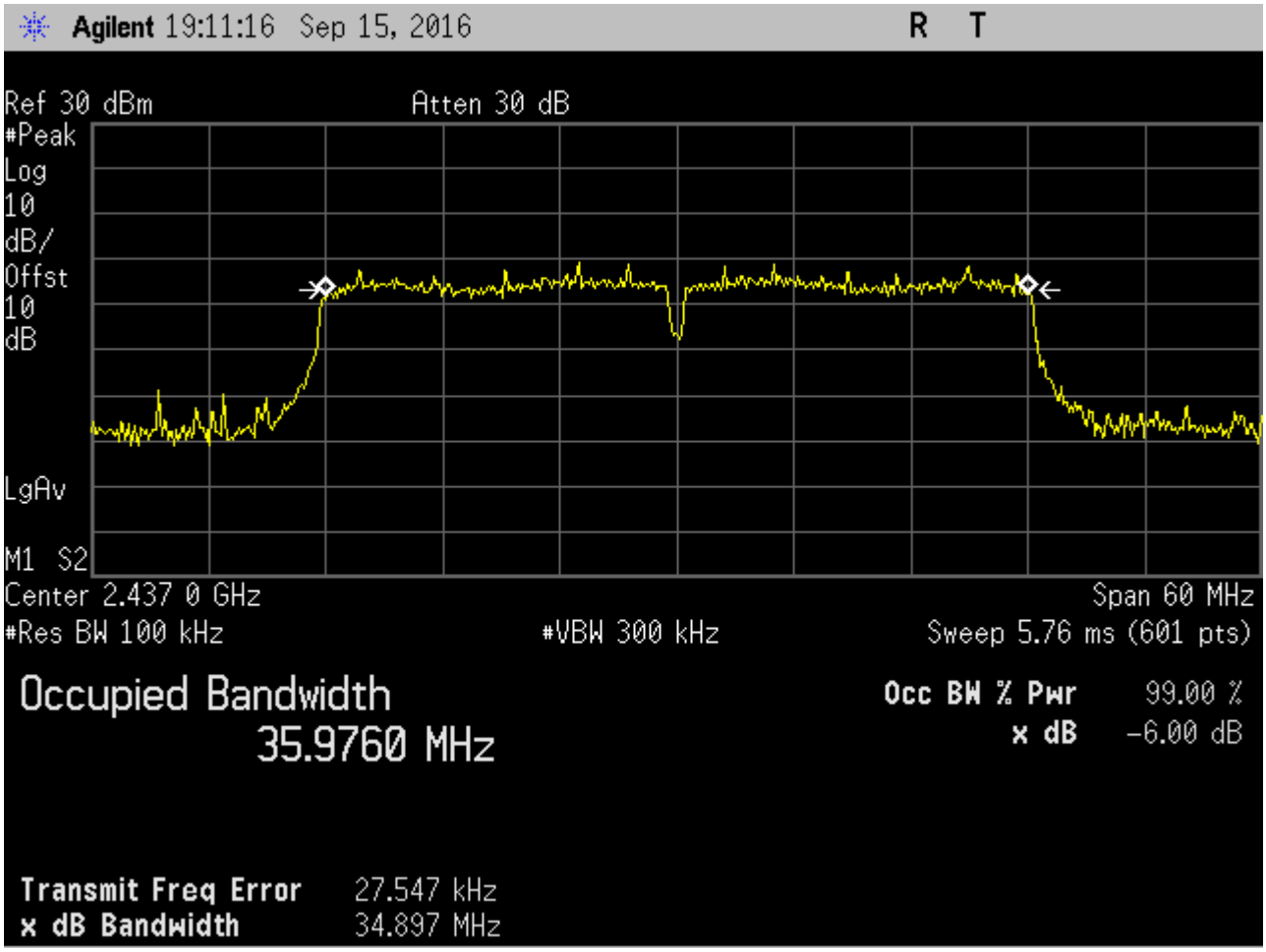
Plot 40. 6dB Occupied Bandwidth, 40M, Ch. 2422M, n mode, Port 1



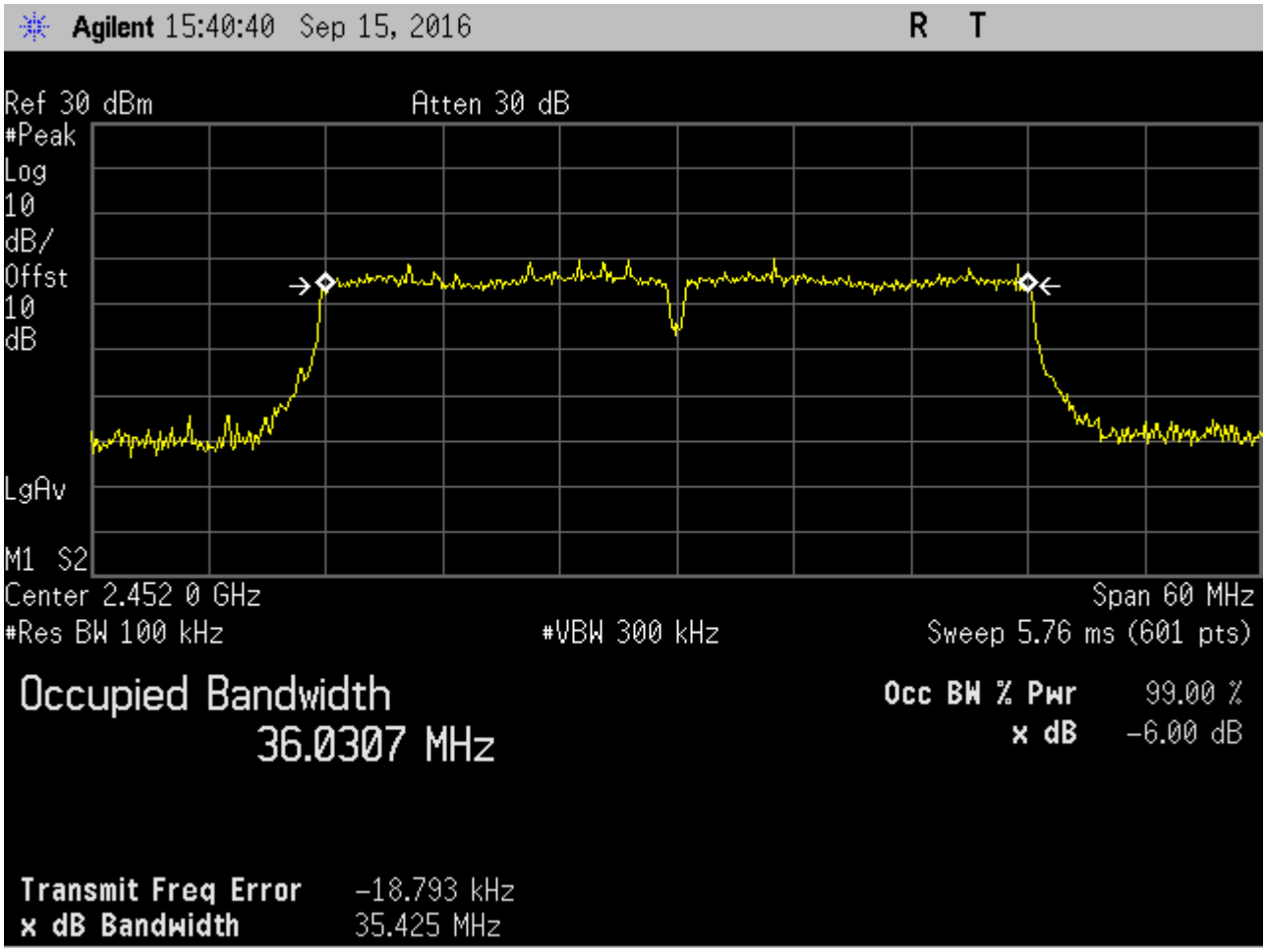
Plot 41. 6dB Occupied Bandwidth, 40M, Ch. 2422M, n mode, Port 2



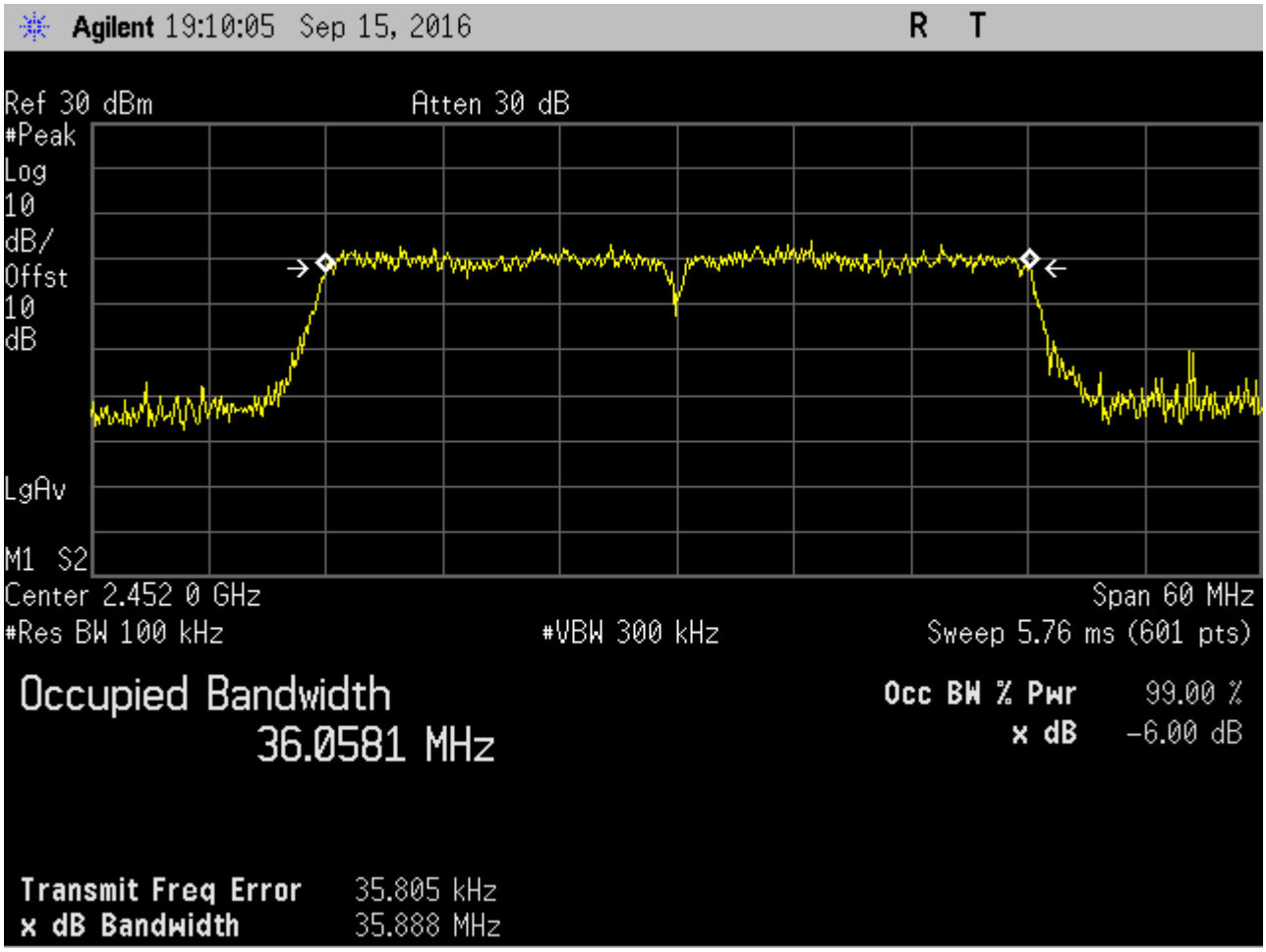
Plot 42. 6dB Occupied Bandwidth, 40M, Ch. 2437M, n mode, Port 1



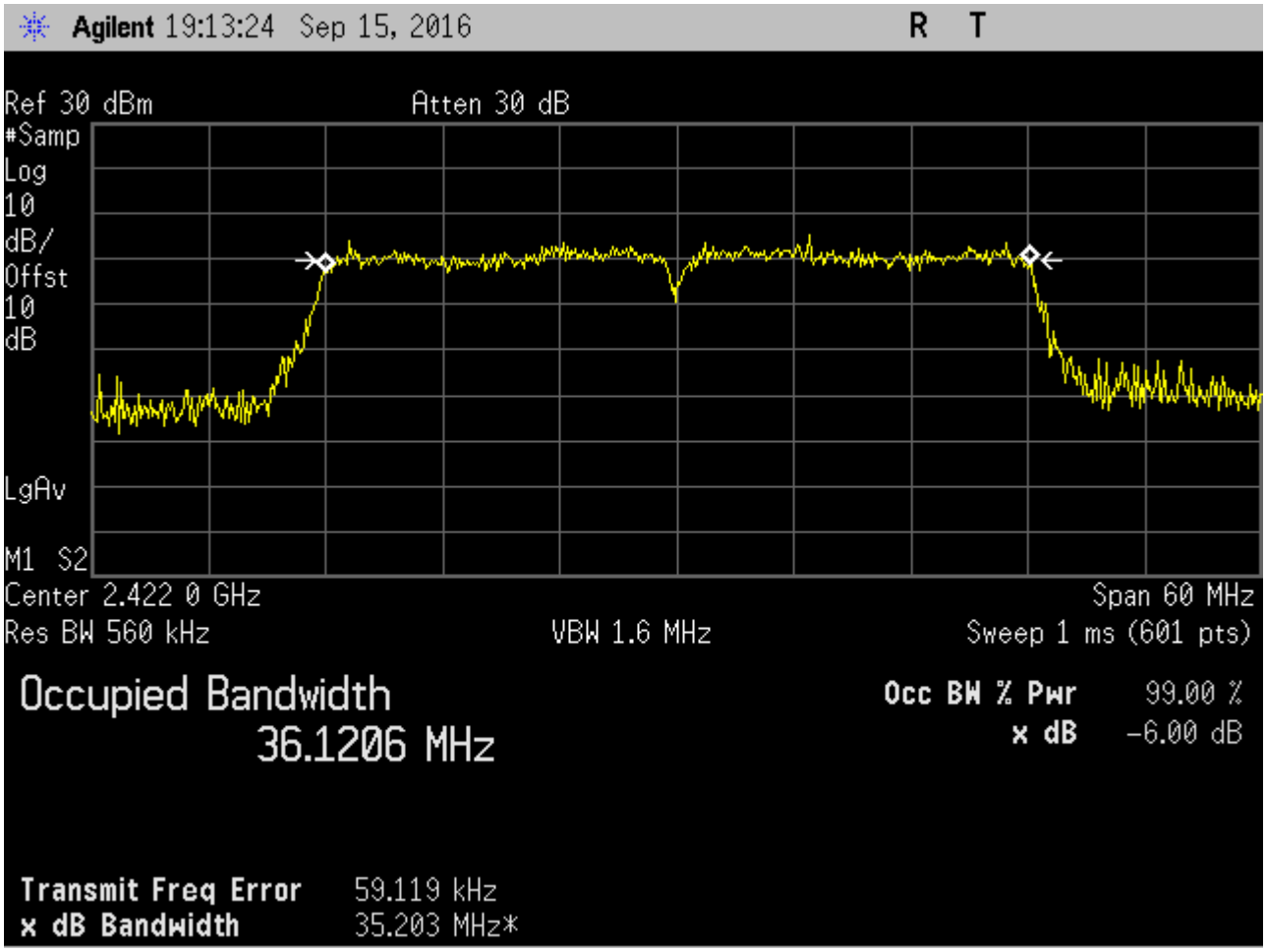
Plot 43. 6dB Occupied Bandwidth, 40M, Ch. 2437M, n mode, Port 2



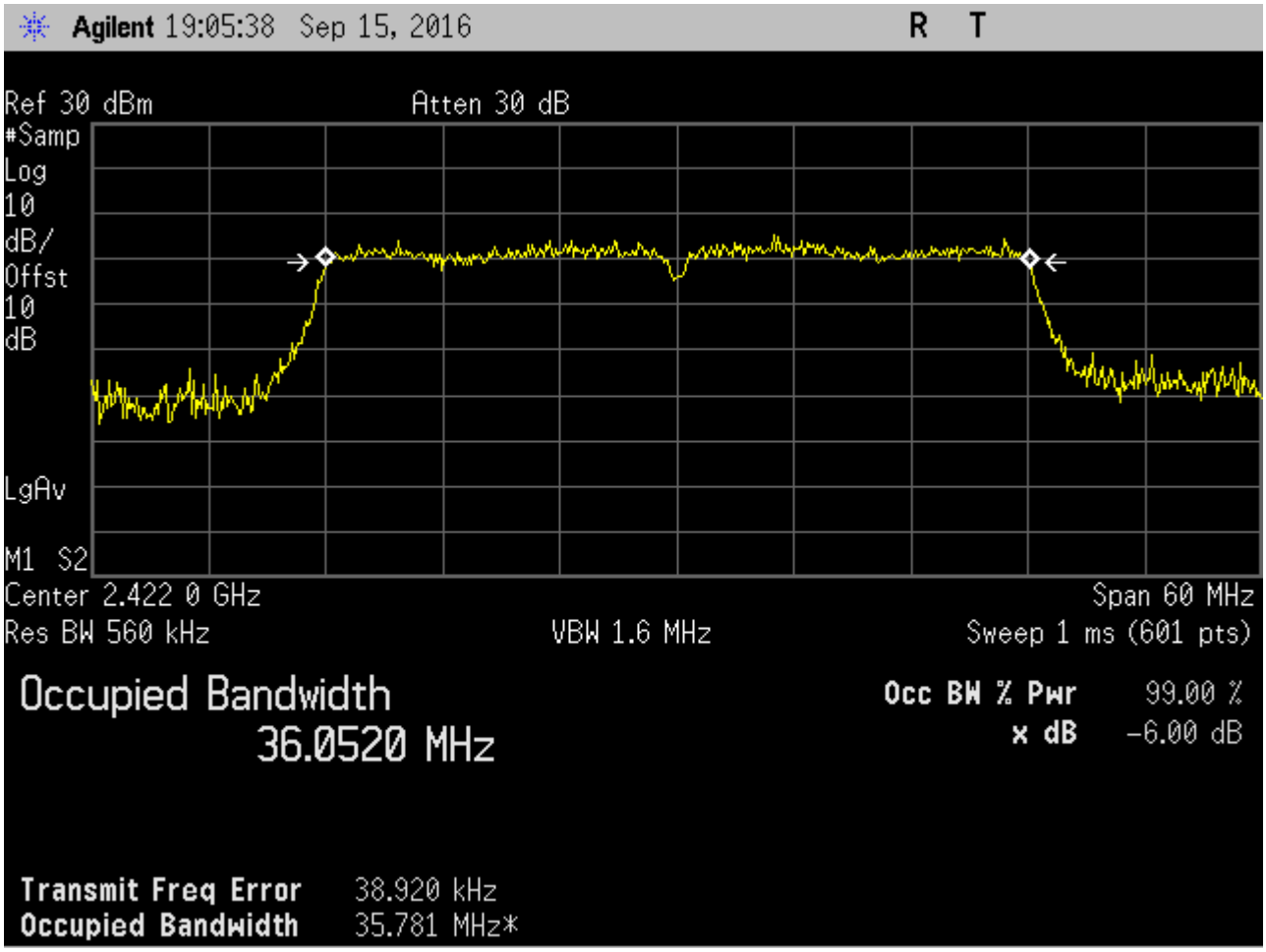
Plot 44. 6dB Occupied Bandwidth, 40M, Ch. 2452M, n mode, Port 1



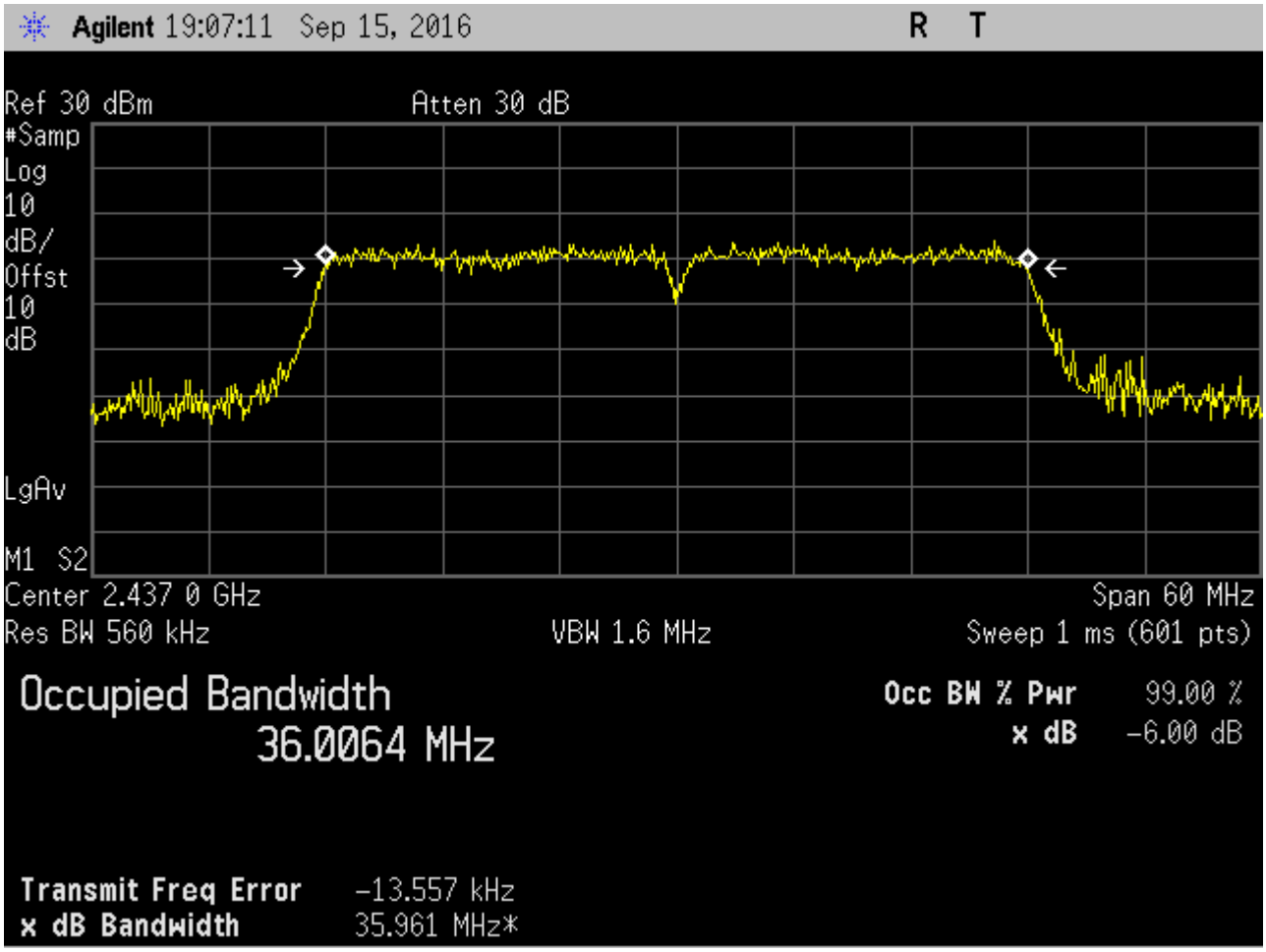
Plot 45. 6dB Occupied Bandwidth, 40M, Ch. 2452M, n mode, Port 2



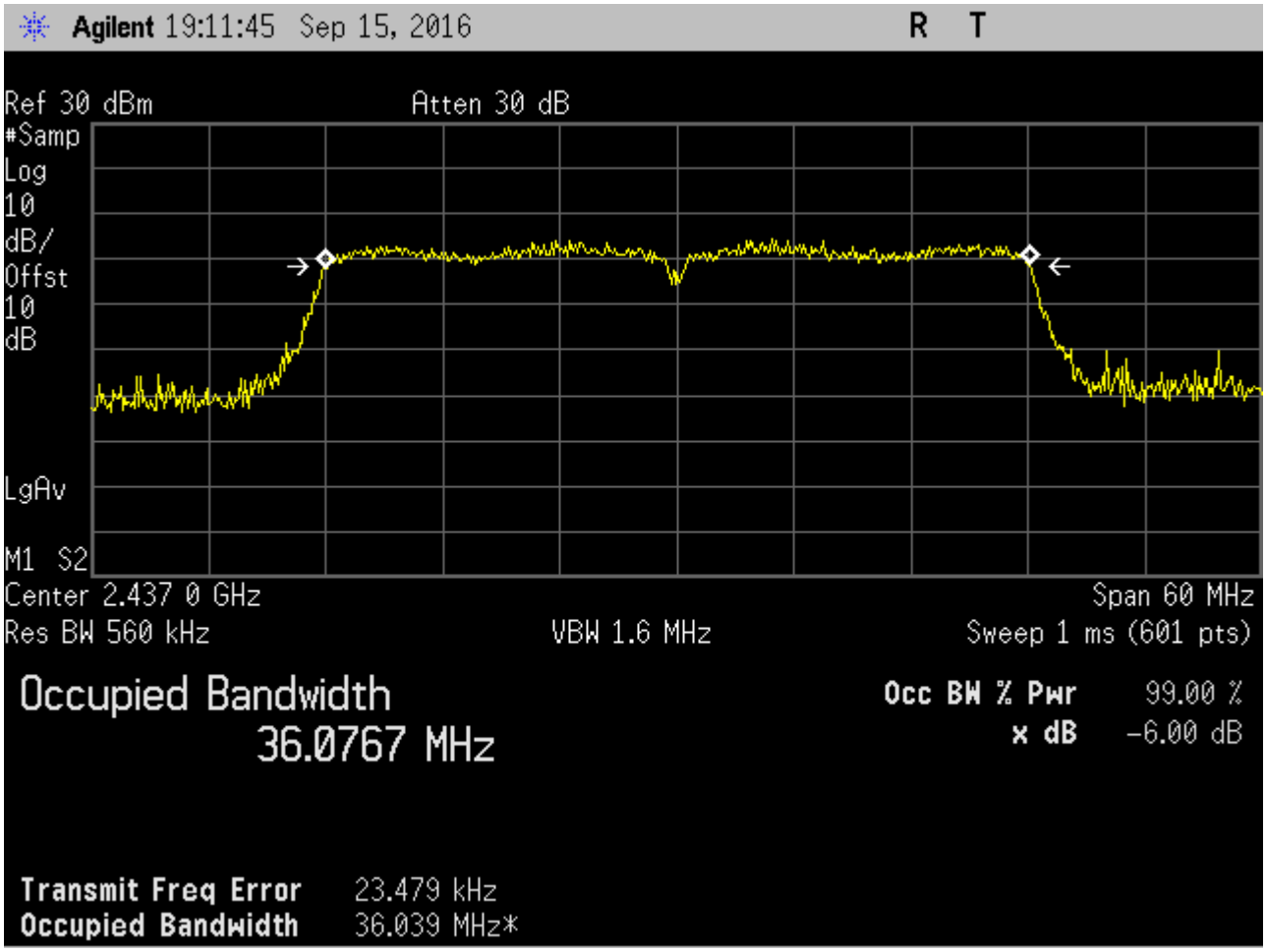
Plot 46. 99 percent Occupied Bandwidth, 40M, Ch. 2422M, n mode, Port 2



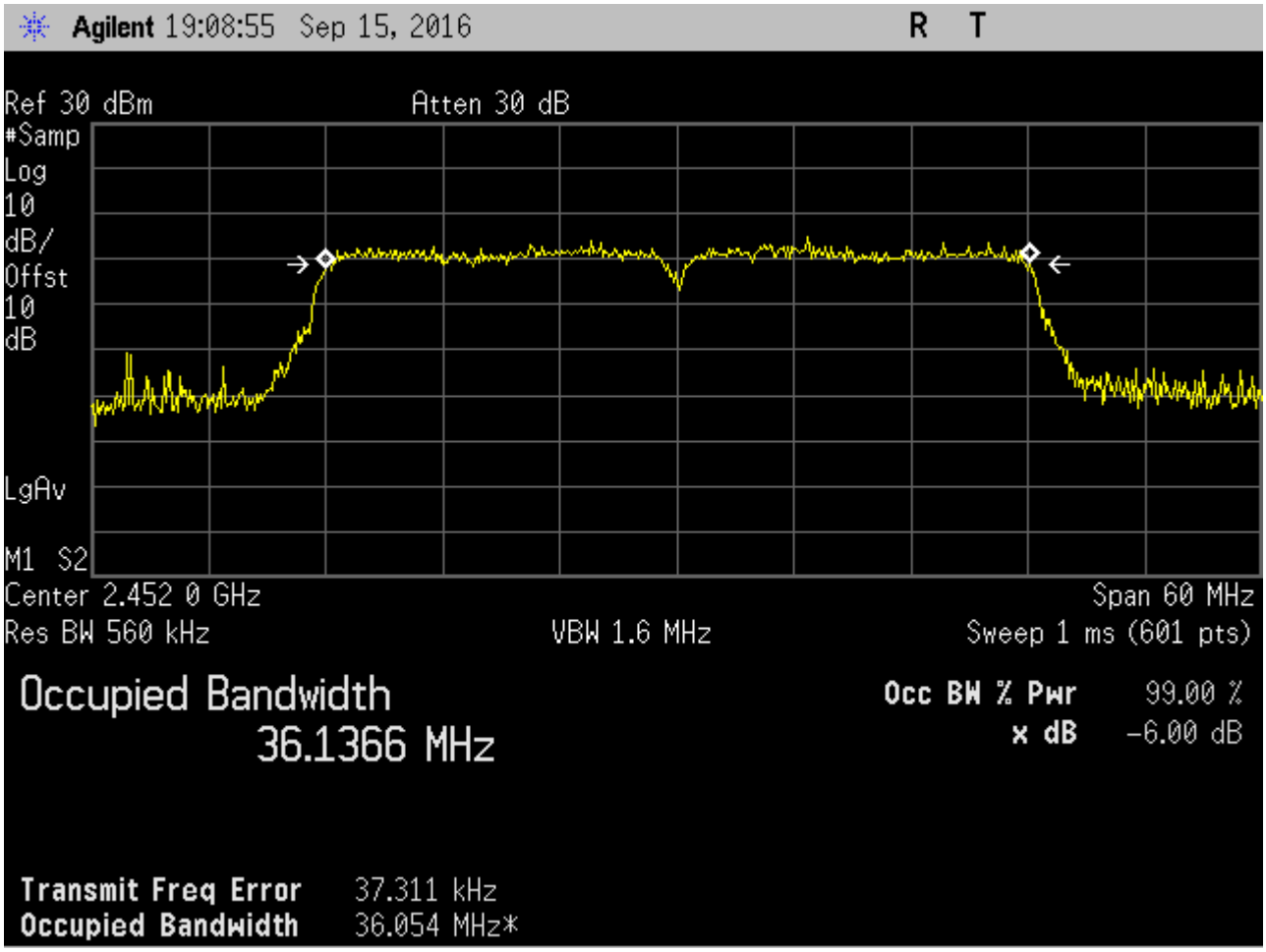
Plot 47. 99 percent Occupied Bandwidth, 40M, Ch. 2422M, n mode, Port 1



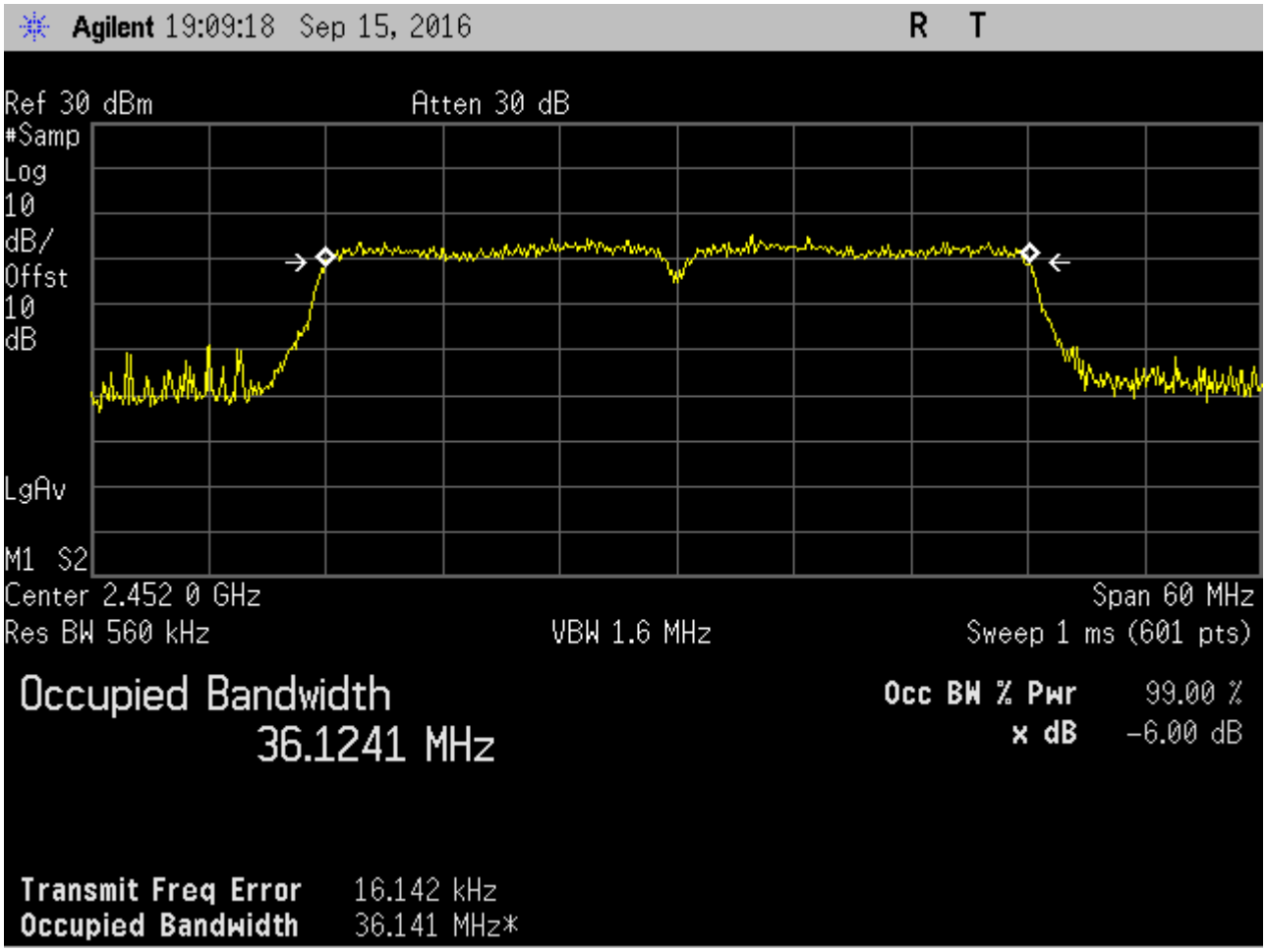
Plot 48. 99 percent Occupied Bandwidth, 40M Ch. 2437M, n mode, Port 1



Plot 49. 99 percent Occupied Bandwidth, 40M, Ch. 2437M, n mode, Port 2



Plot 50. 99 percent Occupied Bandwidth, 40M, Ch. 2452M, n mode, Port 1



Plot 51. 99 percent Occupied Bandwidth, 40M, Ch. 2452M, n mode, Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (Watts)
902-928	1.000
2400–2483.5	1.000
5725– 5850	1.000

Table 12. Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 12, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

Test Results: The EUT was compliant with the Peak Power Output limits of **§15.247(b)**. Note that the antenna gain is 0 dBi.
Directional Gain = G_{ANT} + 10log(N_{ANT}) dBi
0 + 10log(2) dBi
0 + 3 = 3 dBi

Test Engineer(s): Djed Mouada

Test Date(s): October 11, 2016

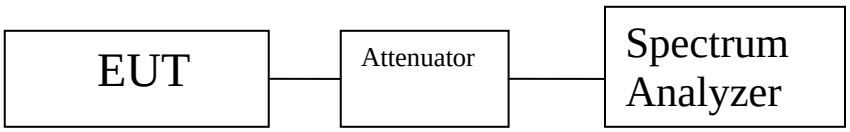
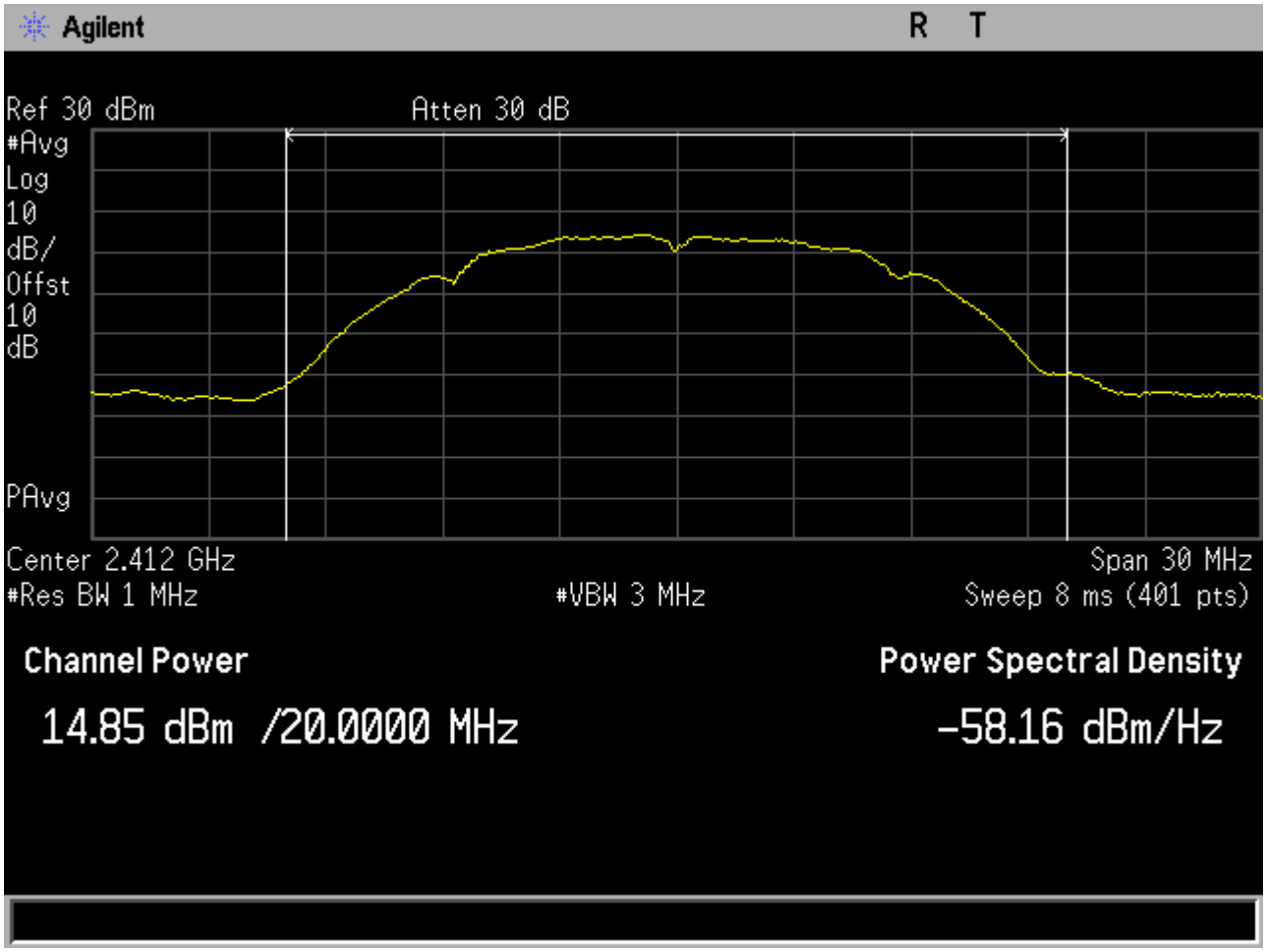


Figure 4. Peak Power Output Test Setup

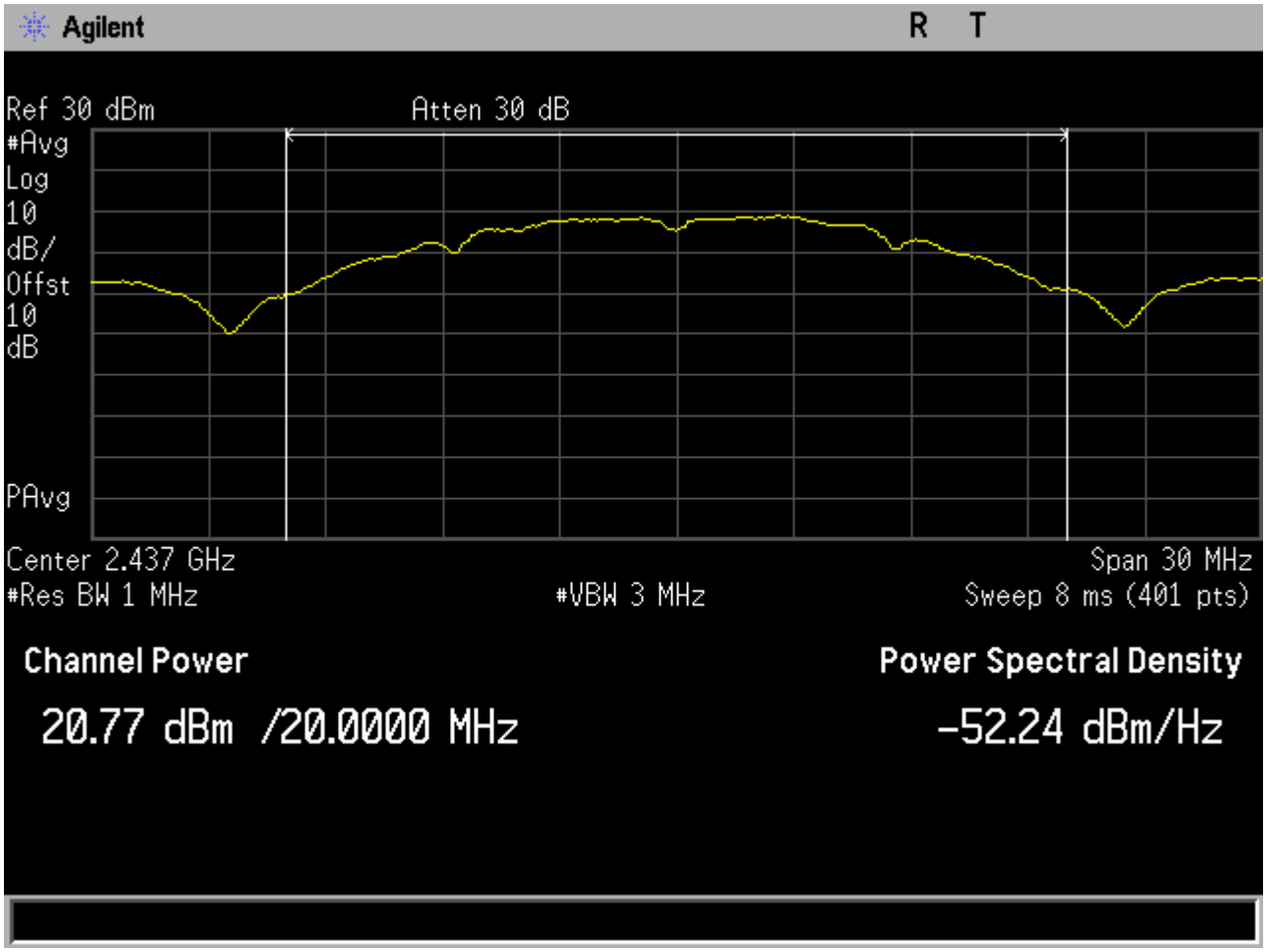
Channel	Port 1 (dBm)	Port 2 (dBm)	Antenna Gain (dBi)	Sum (dBm)	Limit (dBm)	Margin (dBm)
Low b_mode	14.85	14.13	3	17.515	30	12.485
Mid b_mode	20.77	18.16	3	22.668	30	7.332
High b_mode	14.98	14.59	3	17.8	30	12.2
Low g_mode	12.22	12.29	3	15.265	30	14.735
Mid g_mode	15.32	14.93	3	18.14	30	11.86
High g_mode	12.59	10.04	3	14.51	30	15.49
Low n_mode (20MHz)	11.7	11.11	3	14.425	30	15.575
Mid n_mode (20MHz)	14.9	14.46	3	17.696	30	12.304
High n_mode (20MHz)	12.39	11.58	3	15.014	30	14.986
Low n_mode (40MHz)	8.25	9.12	3	11.717	30	18.283
Mid n_mode (40MHz)	12.16	12.07	3	15.126	30	14.874
High n_mode (40MHz)	8.62	8.01	3	11.336	30	18.664

Table 13. Peak Power Output, Test Results

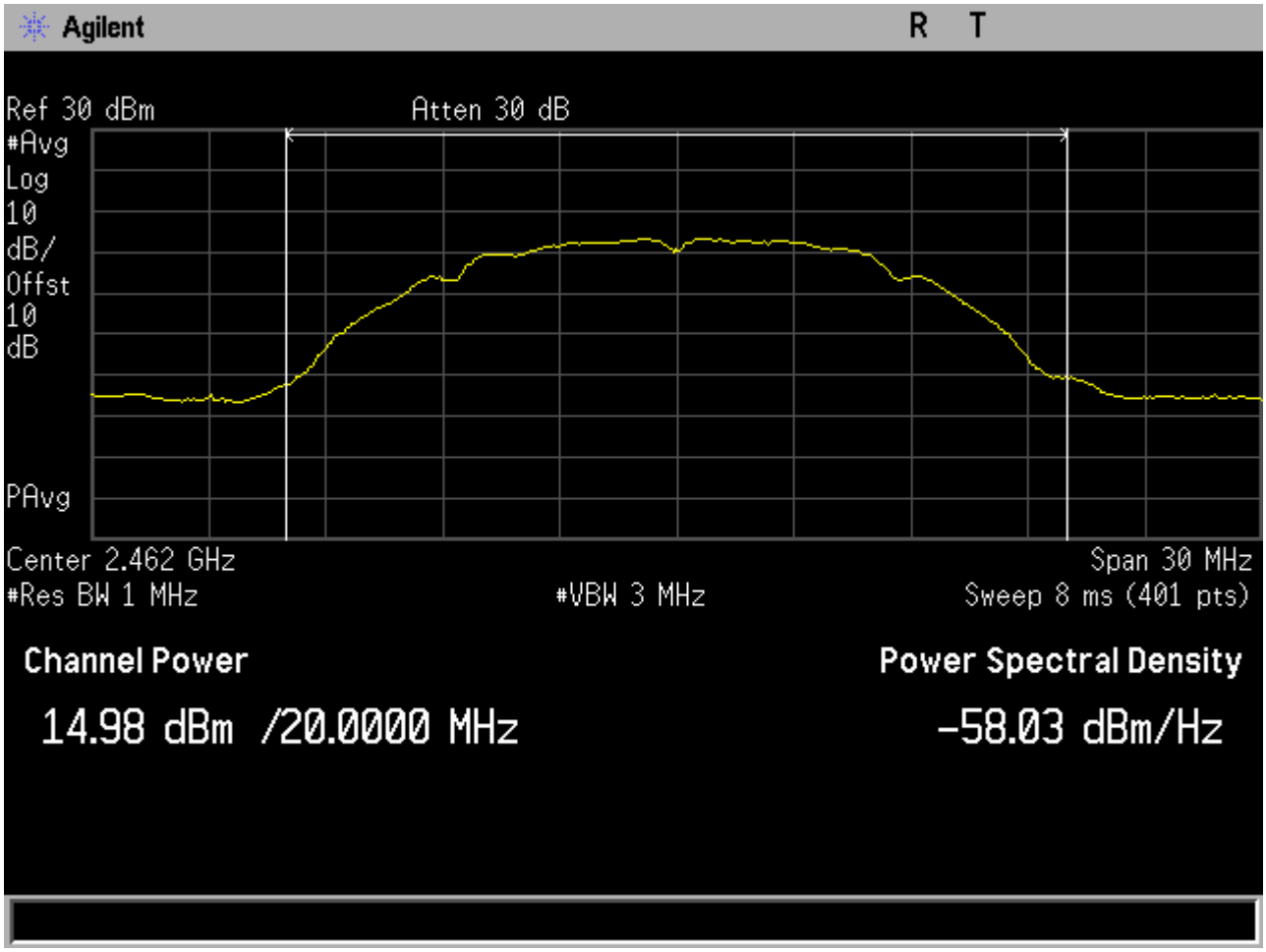
Peak Power Output Test Results



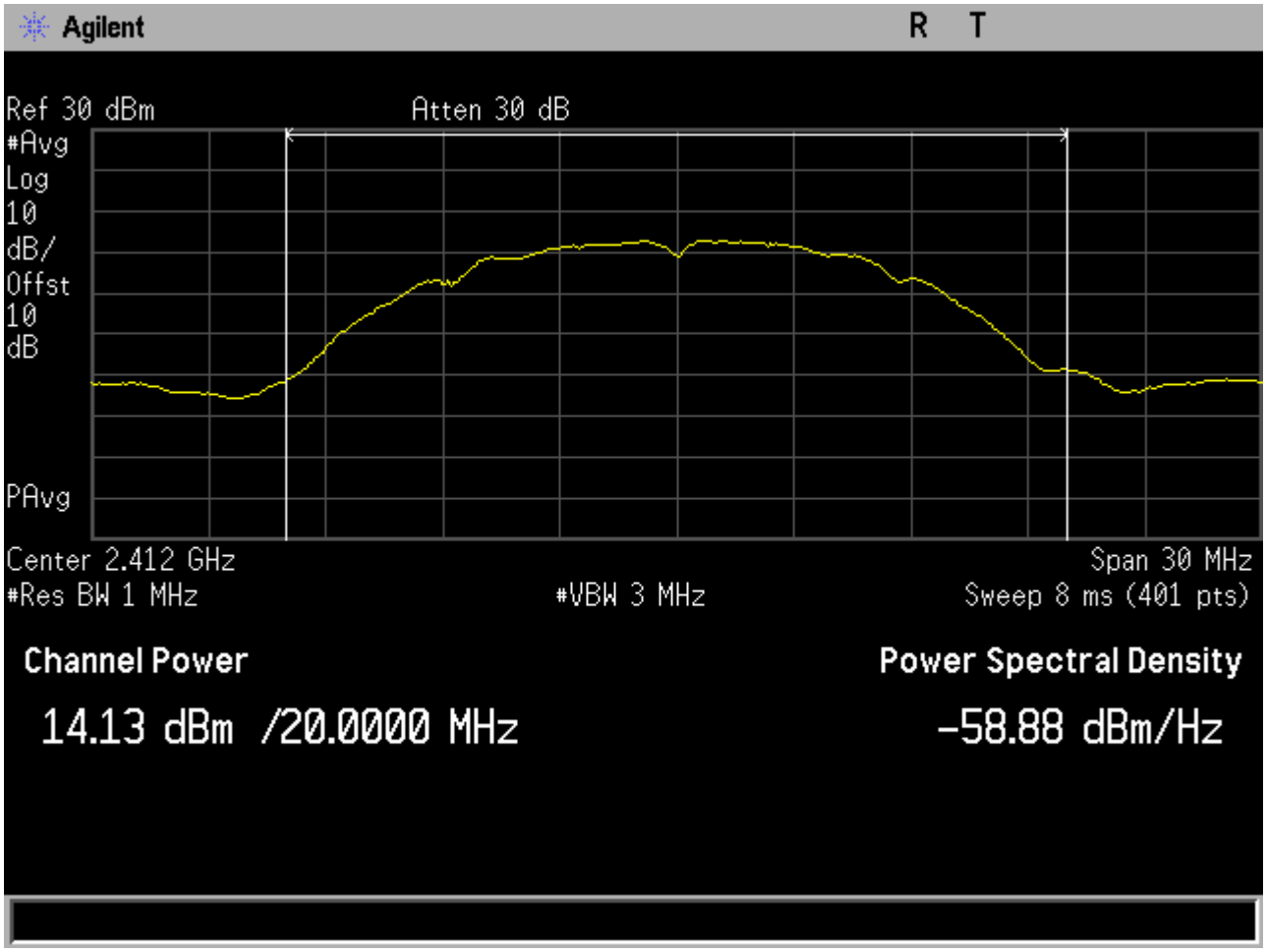
Plot 52. Peak Power Output, Bandwidth 20M, Ch. 2412M, Port 1



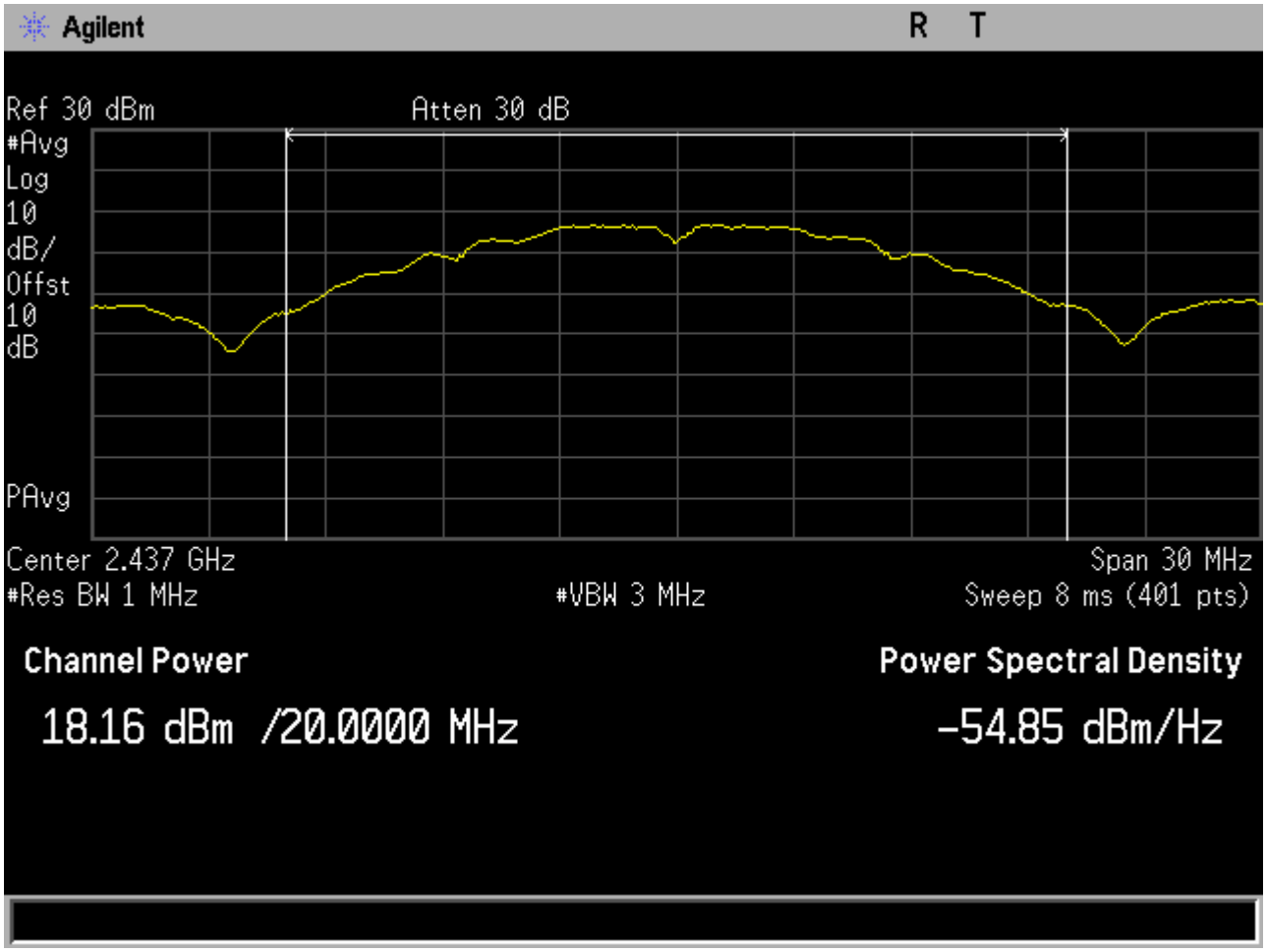
Plot 53. Peak Power Output, Bandwidth 20M, Ch. 2437M, Port 1



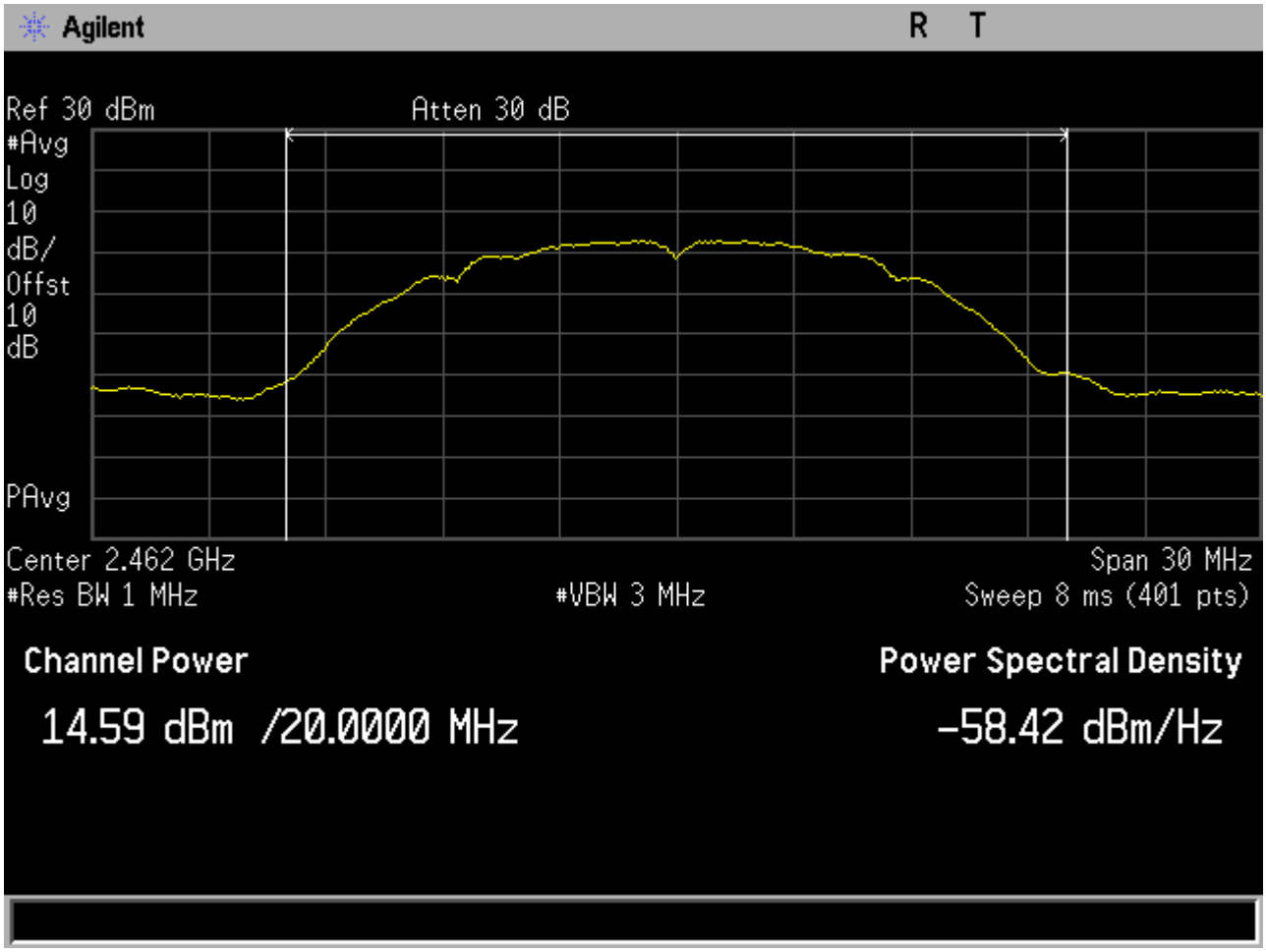
Plot 54. Peak Power Output, Bandwidth 20M, Ch. 2462M, Port 1



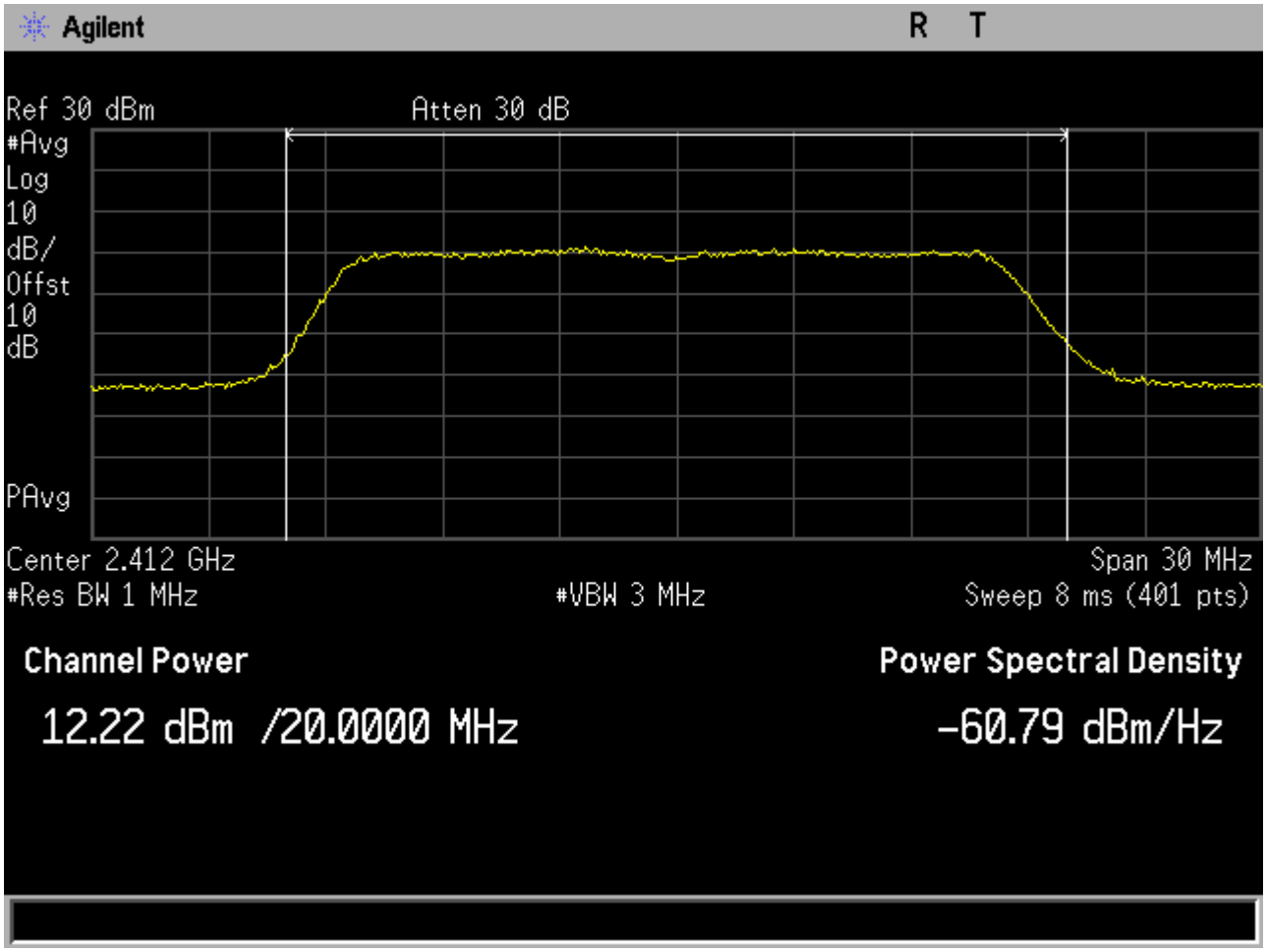
Plot 55. Peak Power Output, Bandwidth 20M, Ch. 2412M, Port 2



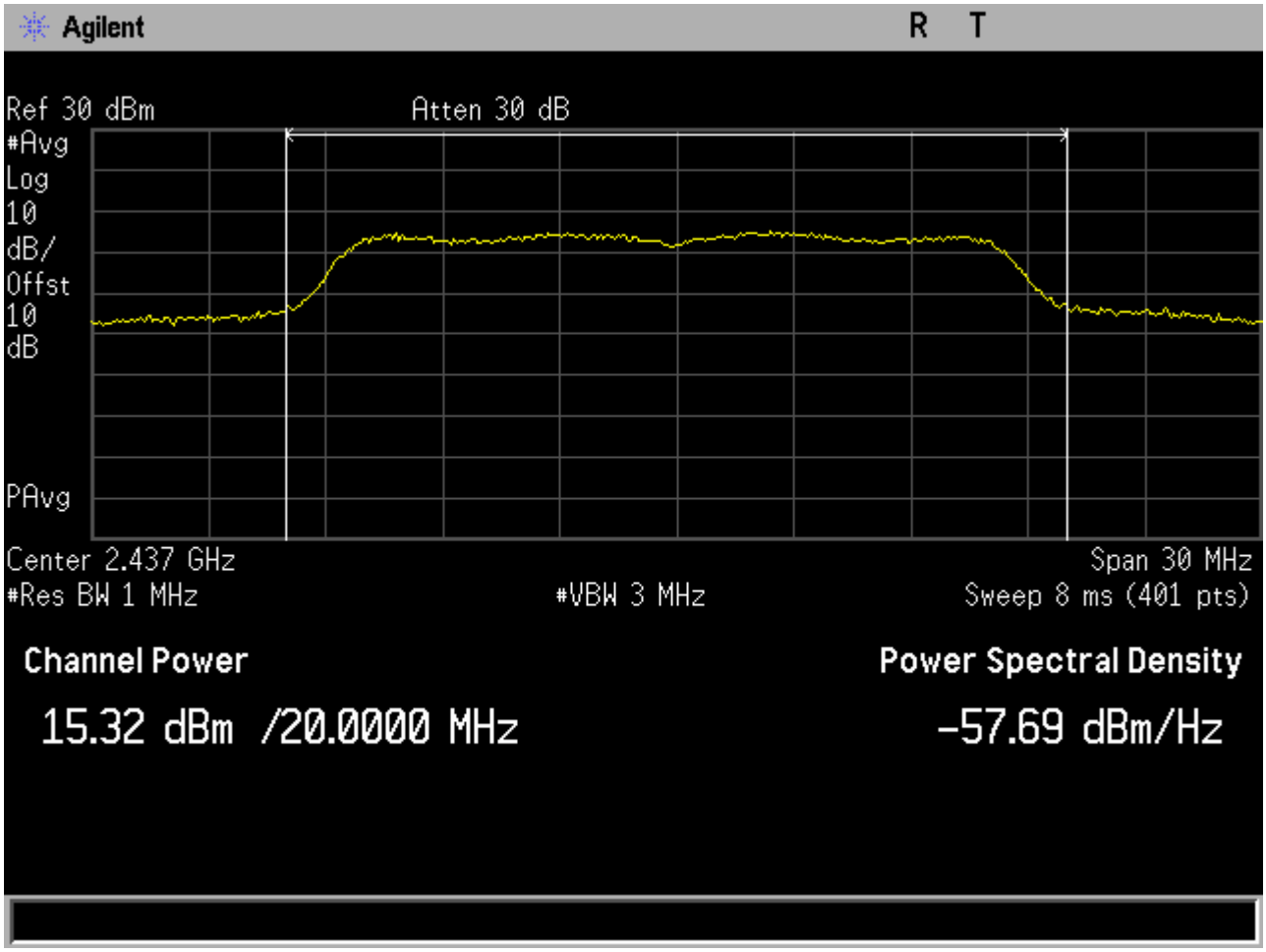
Plot 56. Peak Power Output, Bandwidth 20M, Ch. 2437M, Port 2



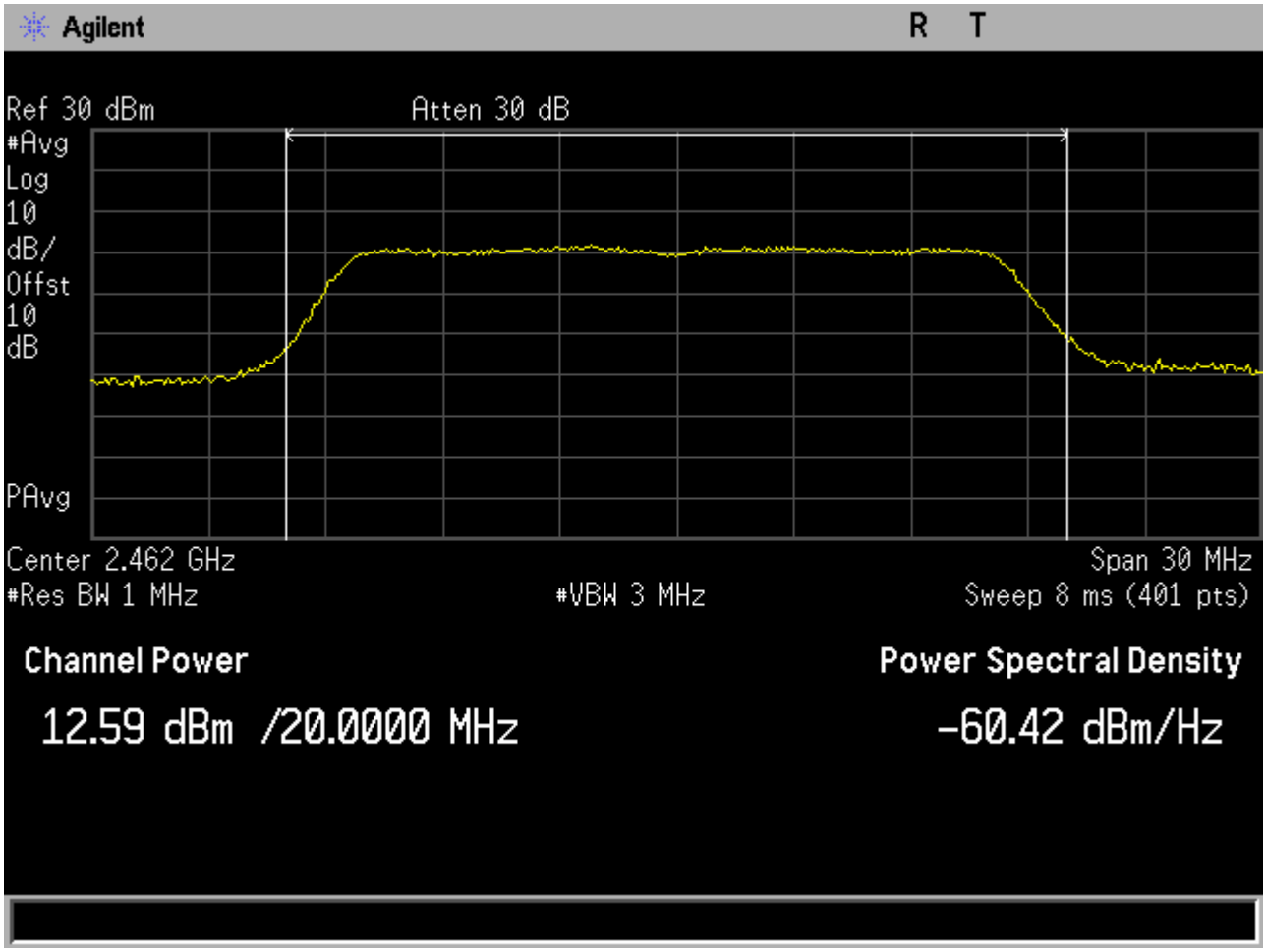
Plot 57. Peak Power Output, Bandwidth 20M, Ch. 2462M, Port 2



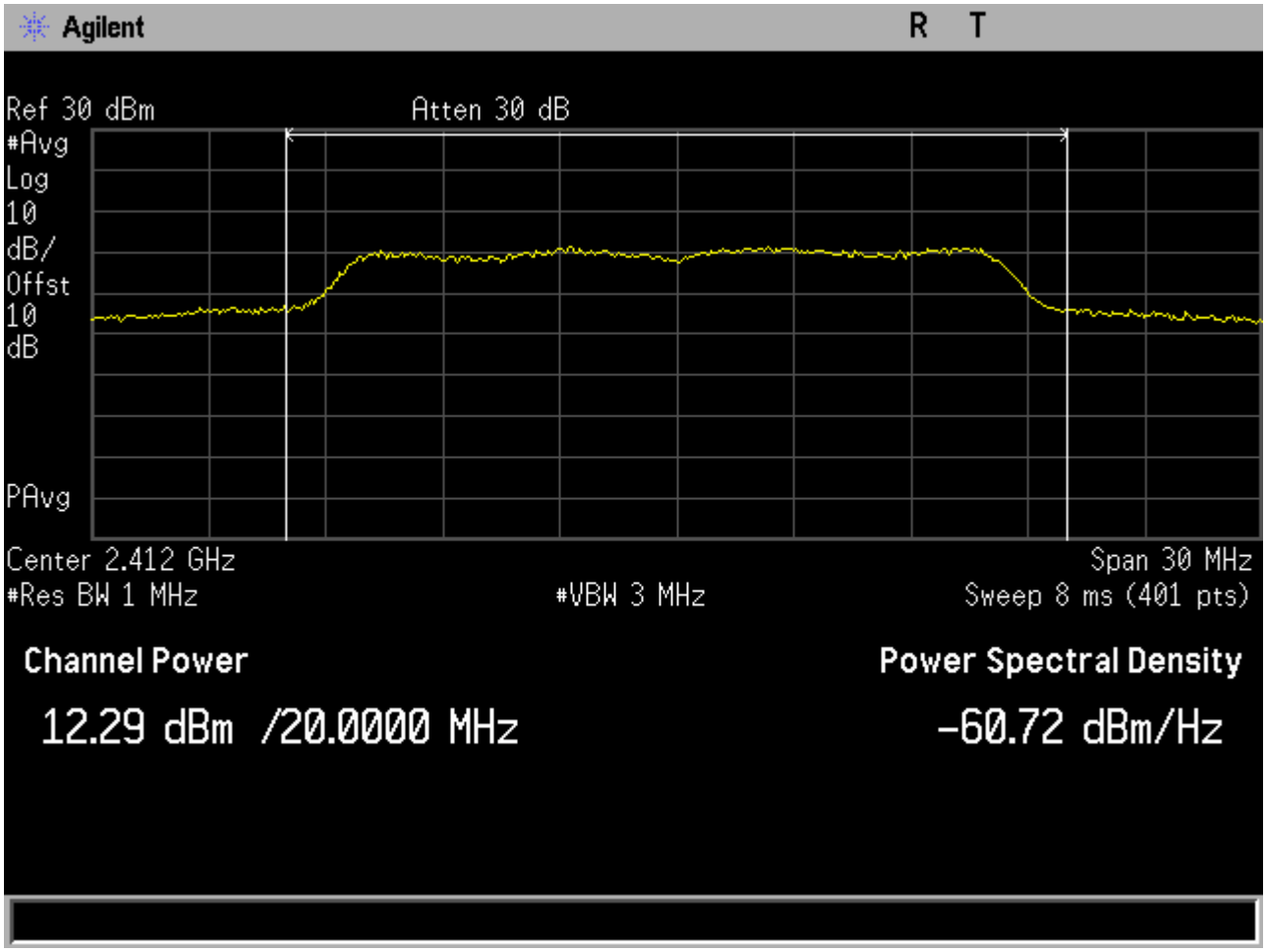
Plot 58. Peak Power Output, Bandwidth 20M, Ch. 2412M, G mode, Port 1



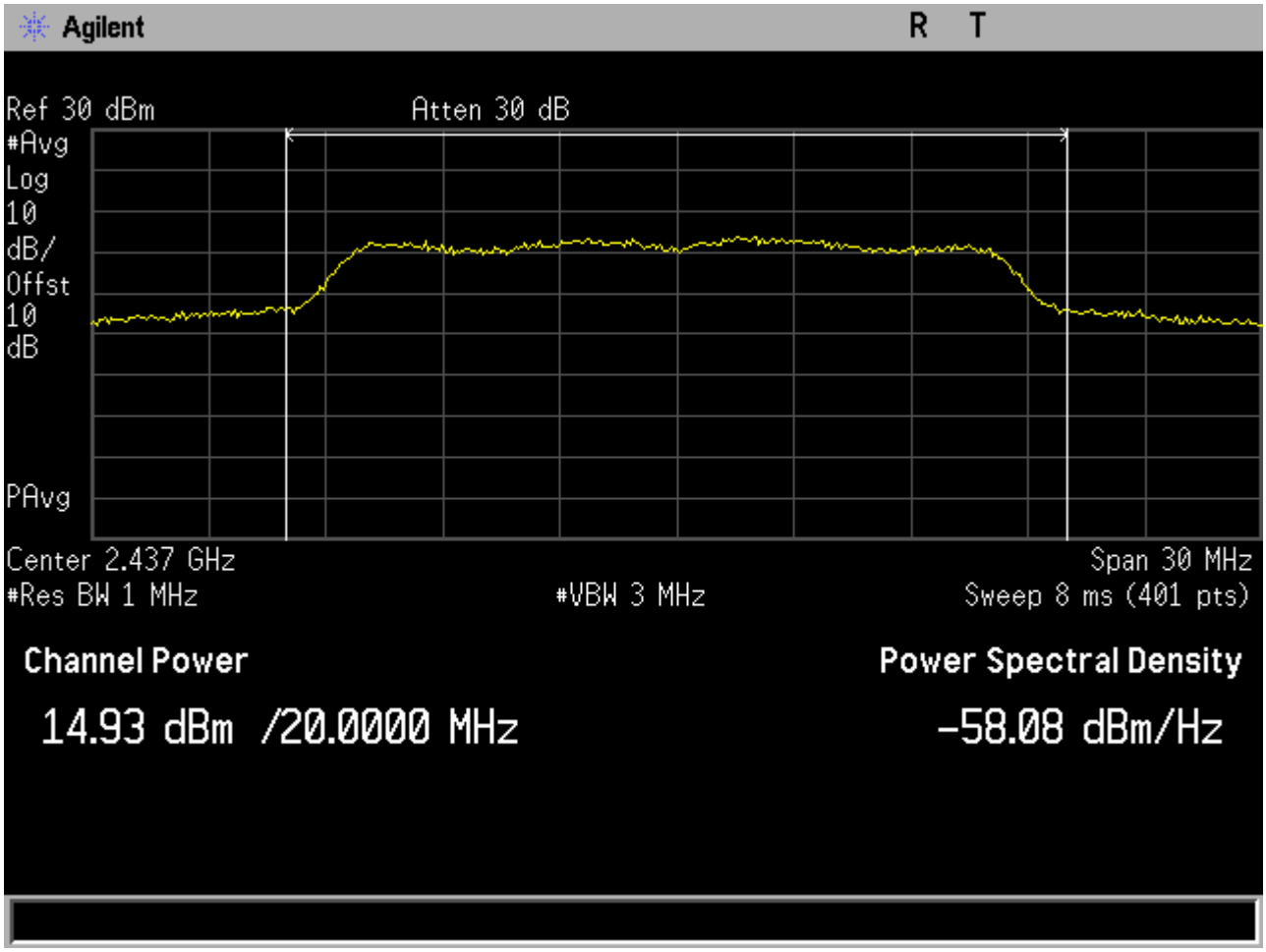
Plot 59. Peak Power Output, Bandwidth 20M, Ch. 2437, g mode, Port 1



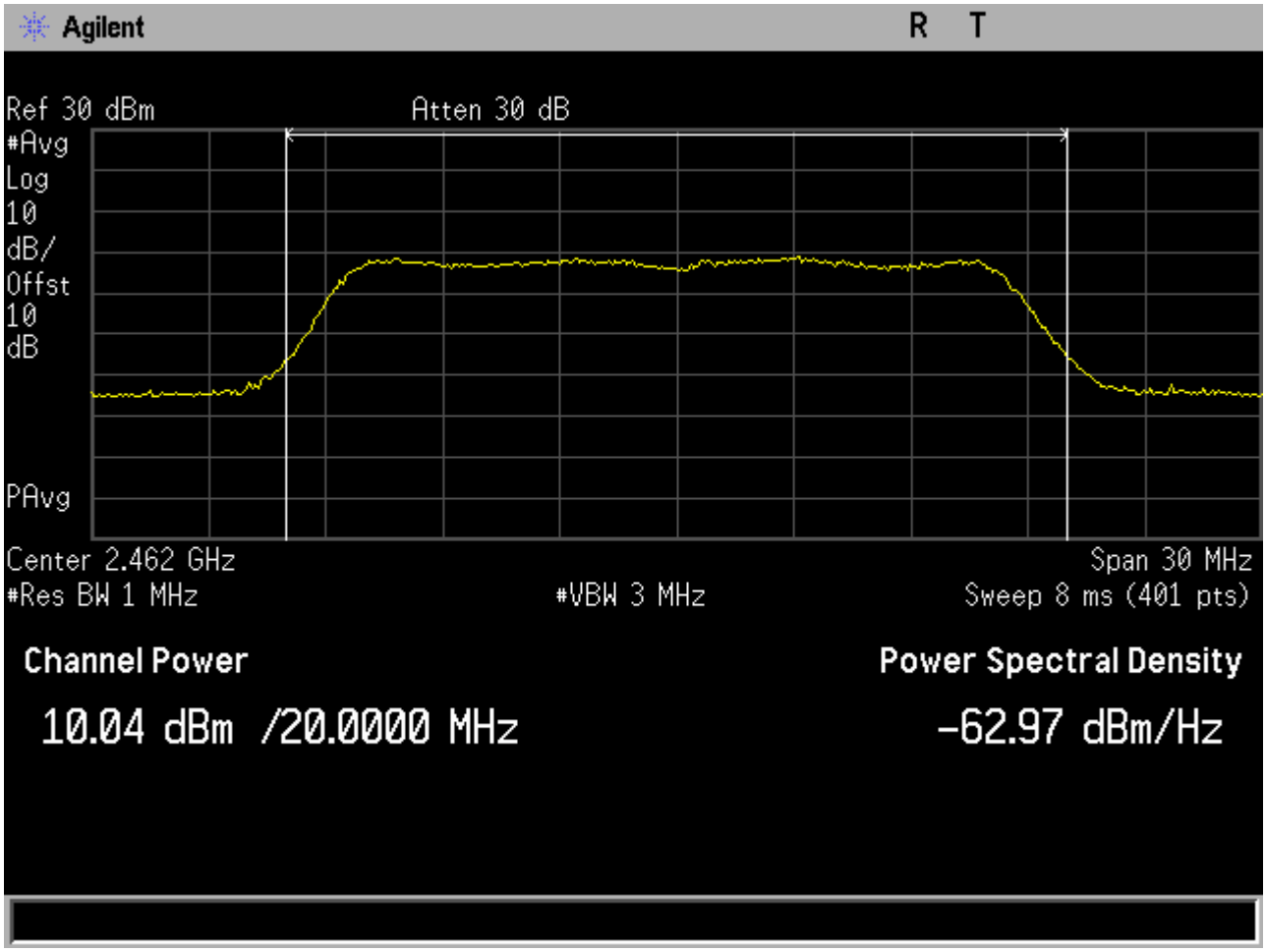
Plot 60. Peak Power Output, Bandwidth 20M, Ch. 2462M, g mode, Port 1



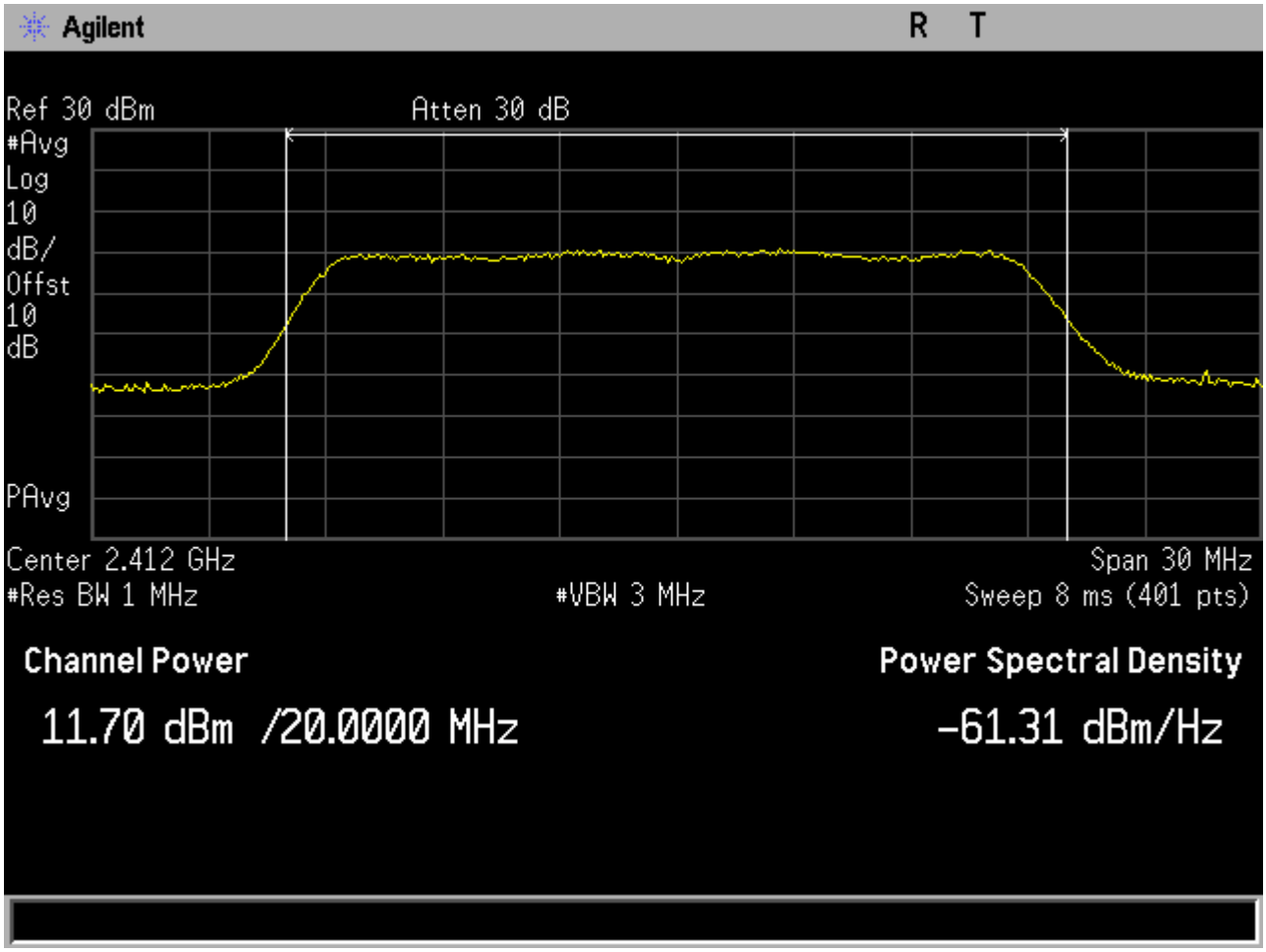
Plot 61. Peak Power Output, Bandwidth 20M, Ch. 2412M, g mode, Port 2



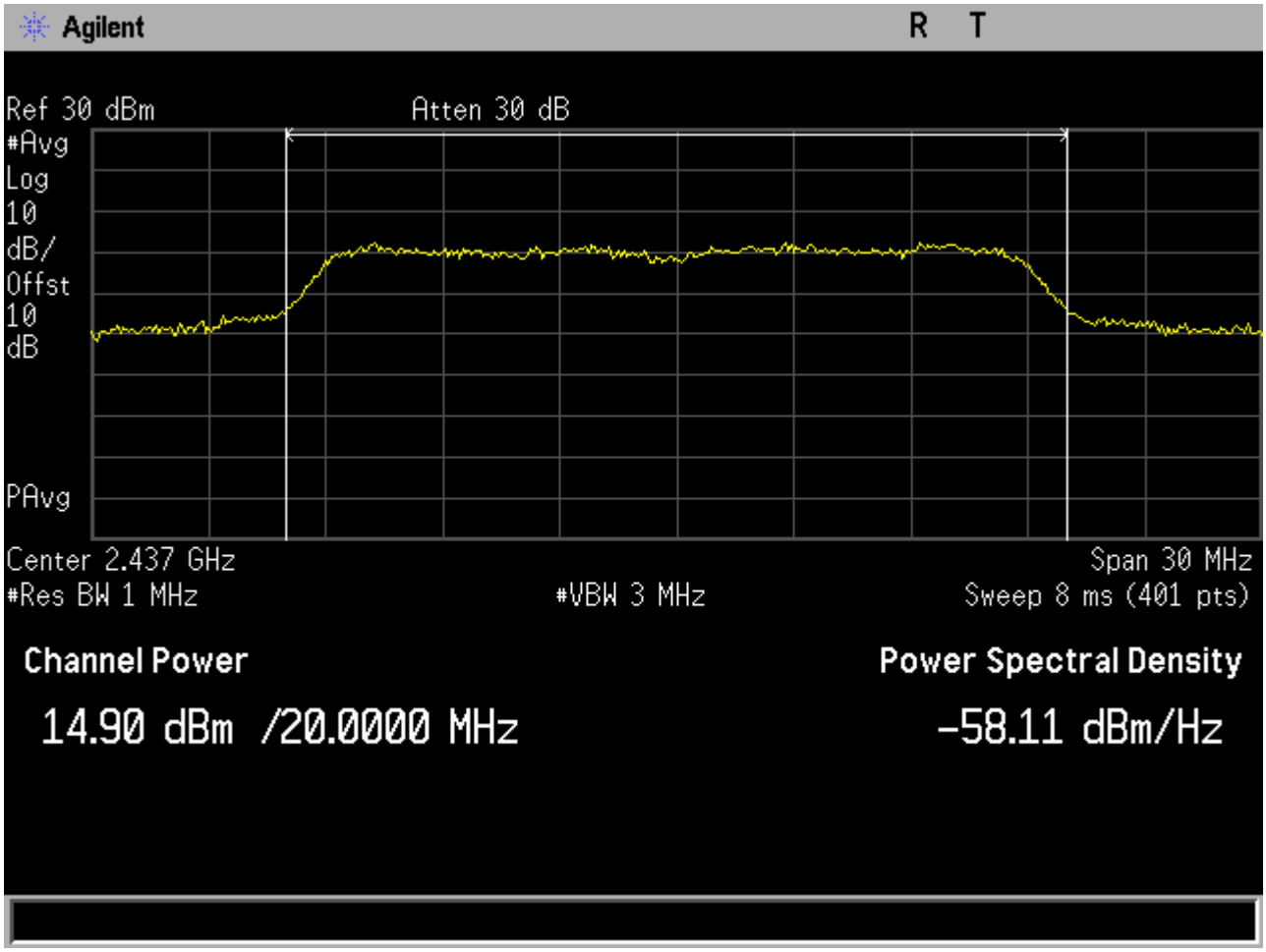
Plot 62. Peak Power Output, Bandwidth 20M, Ch. 2437M, g mode, Port 2



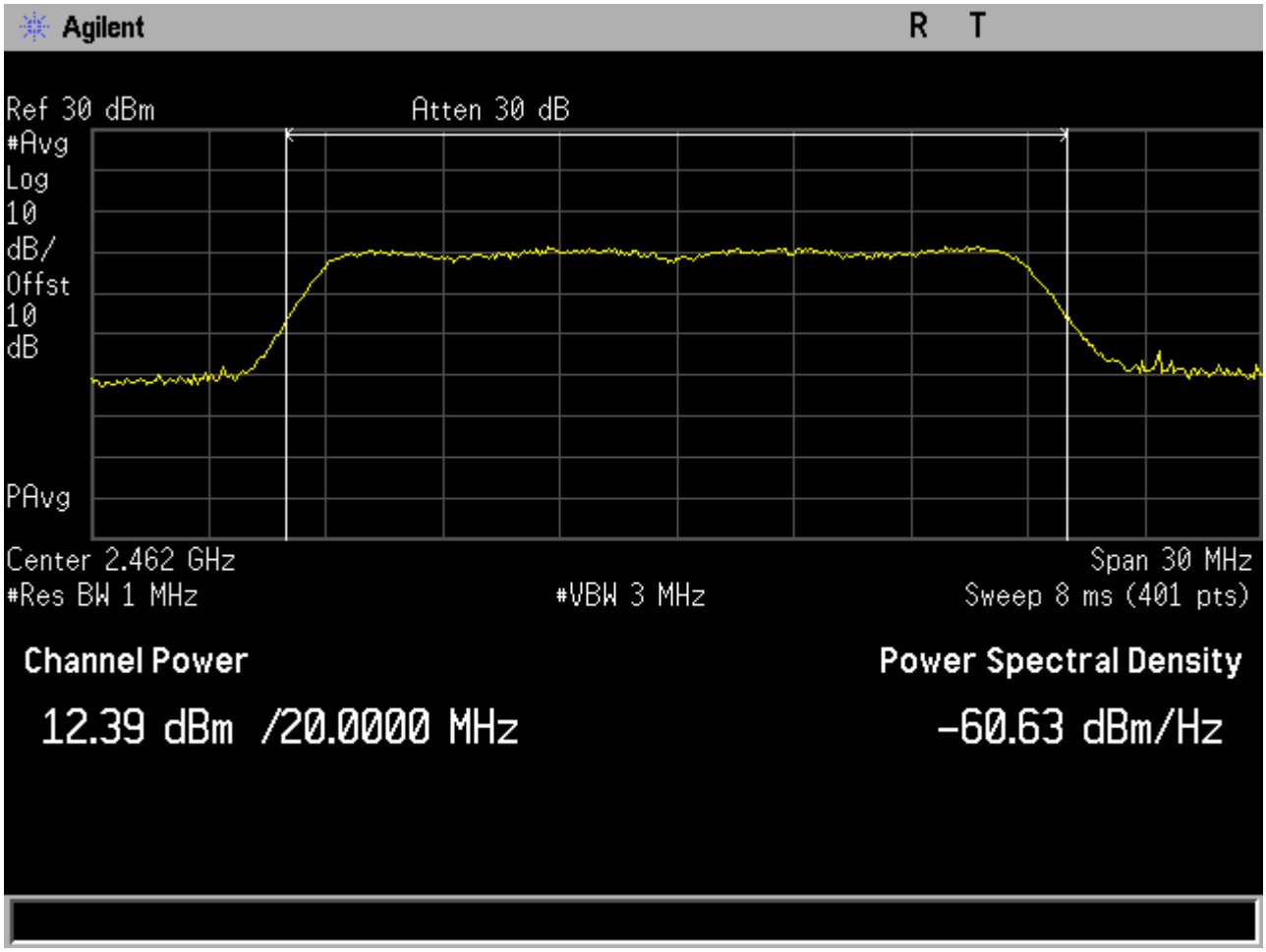
Plot 63. Peak Power Output, Bandwidth 20M, Ch. 2462M, g mode, Port 2



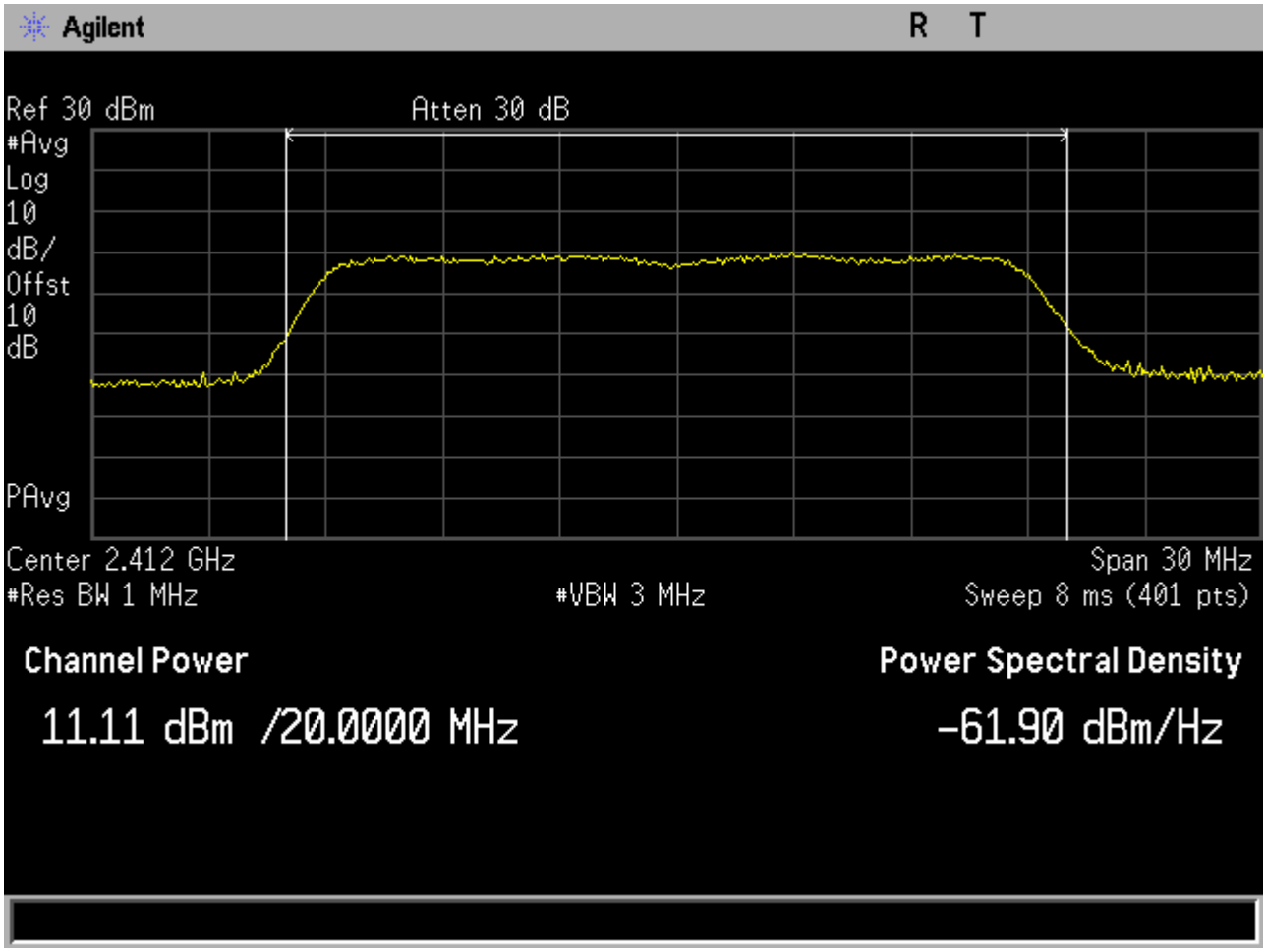
Plot 64. Peak Power Output, Bandwidth 20M, Ch. 2412M, n mode, Port 1



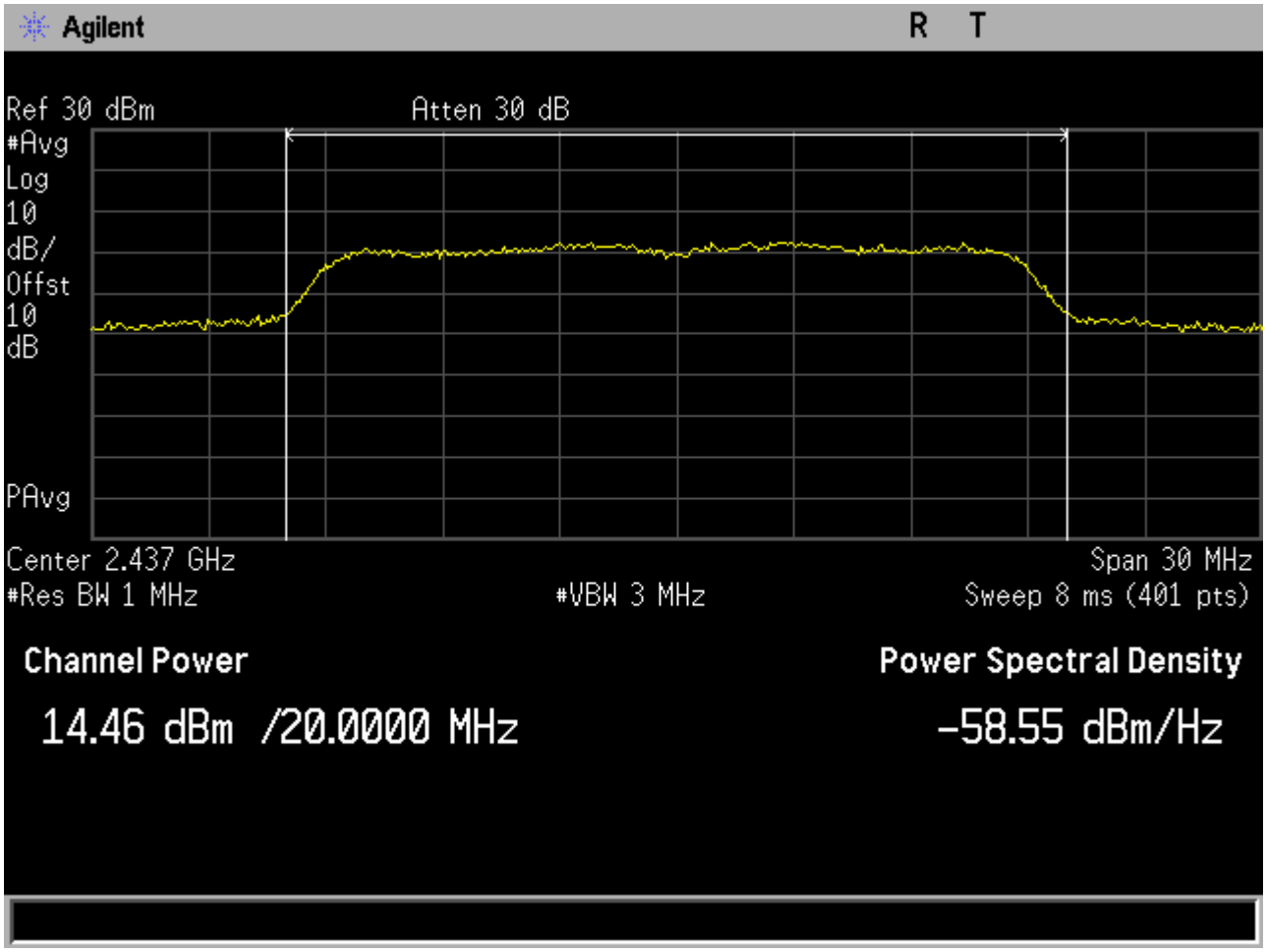
Plot 65. Peak Power Output, Bandwidth 20M, Ch. 2437M, n mode, Port 1



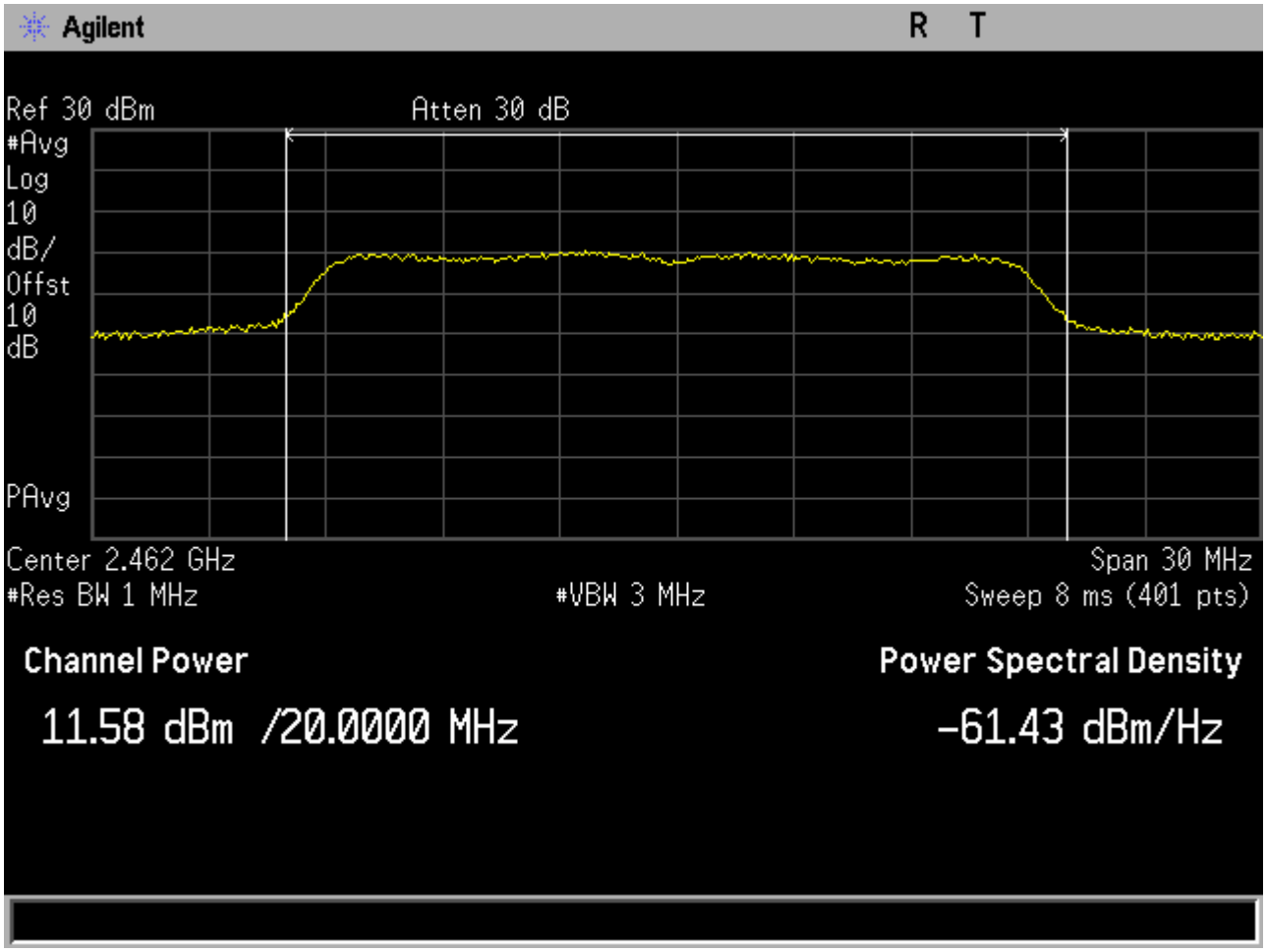
Plot 66. Peak Power Output, Bandwidth 20M, Ch. 2462M, n mode, Port 1



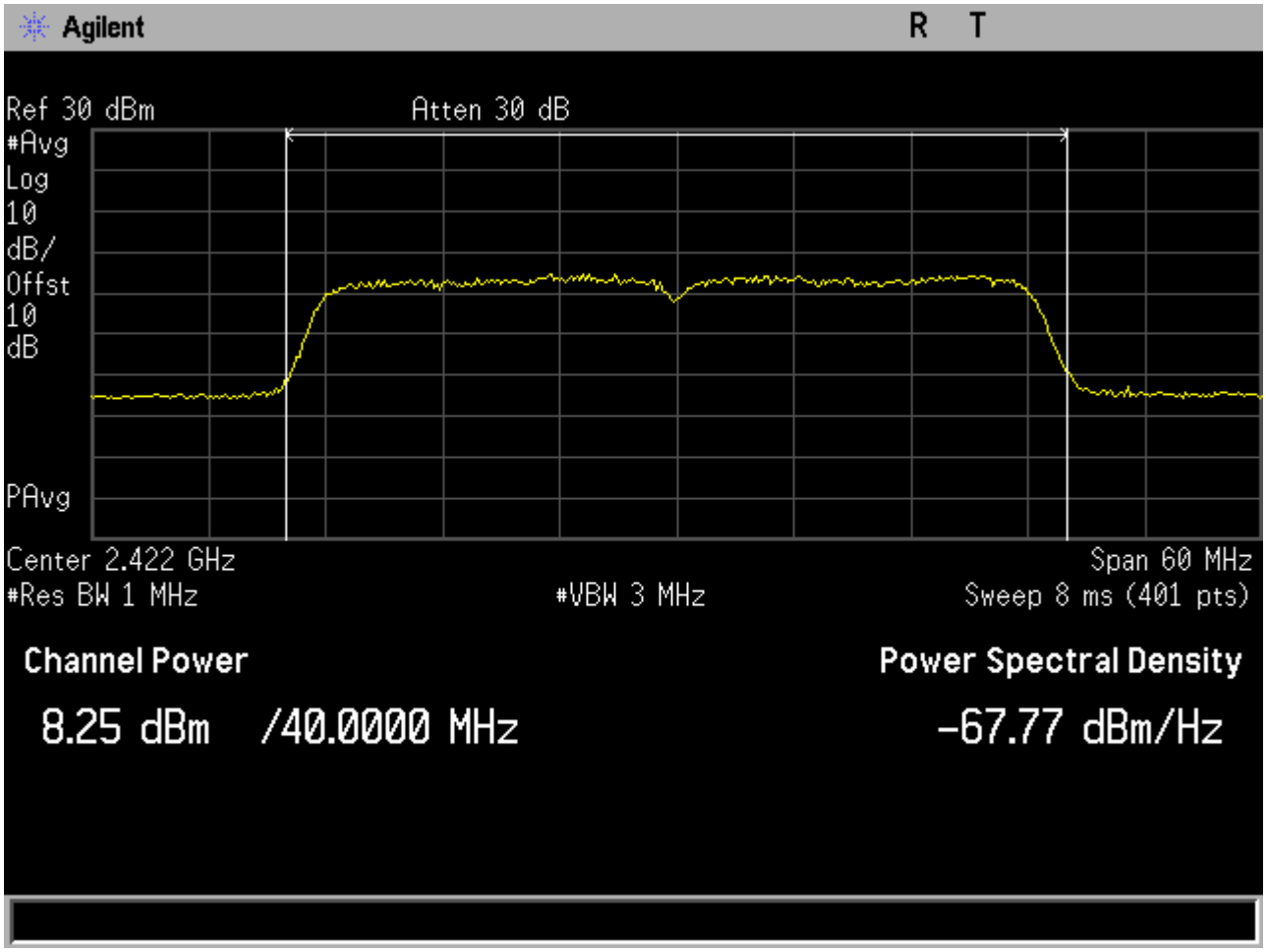
Plot 67. Peak Power Output, Bandwidth 20M, Ch. 2412M, n mode, Port 2



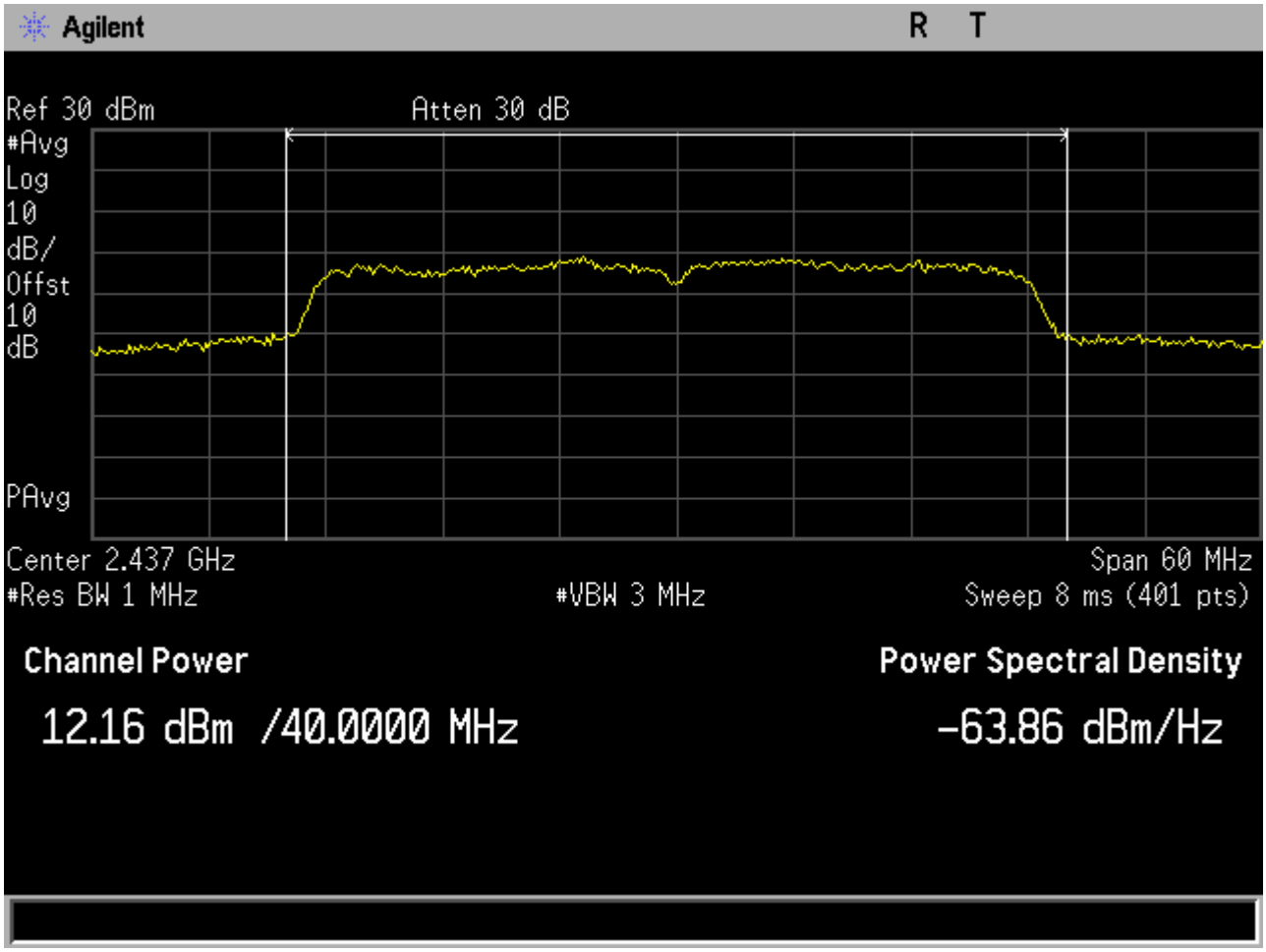
Plot 68. Peak Power Output, Bandwidth 20M, Ch. 2437M, n mode, Port 2



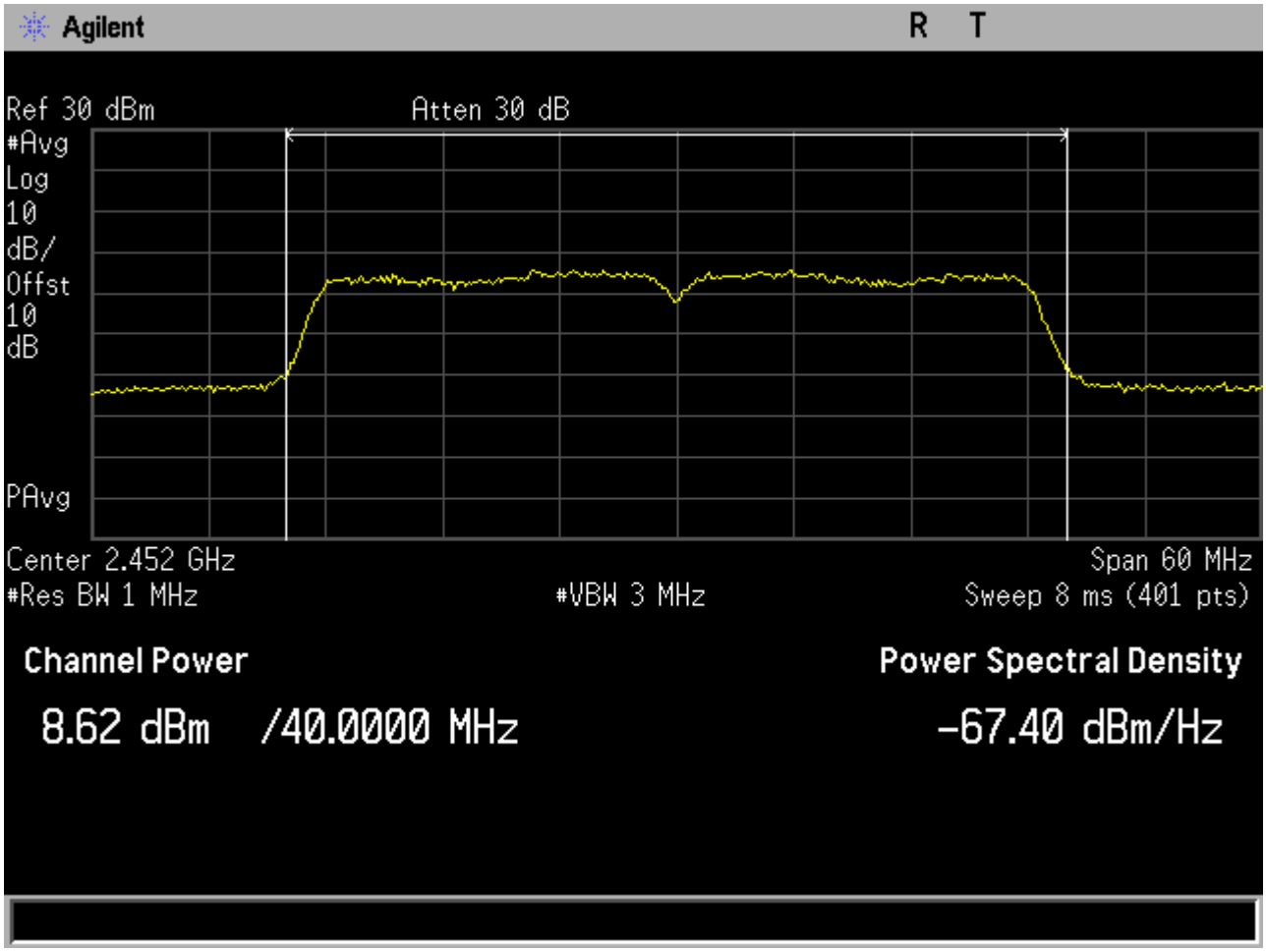
Plot 69. Peak Power Output, Bandwidth 20M, Ch. 2462M, n mode, Port 2



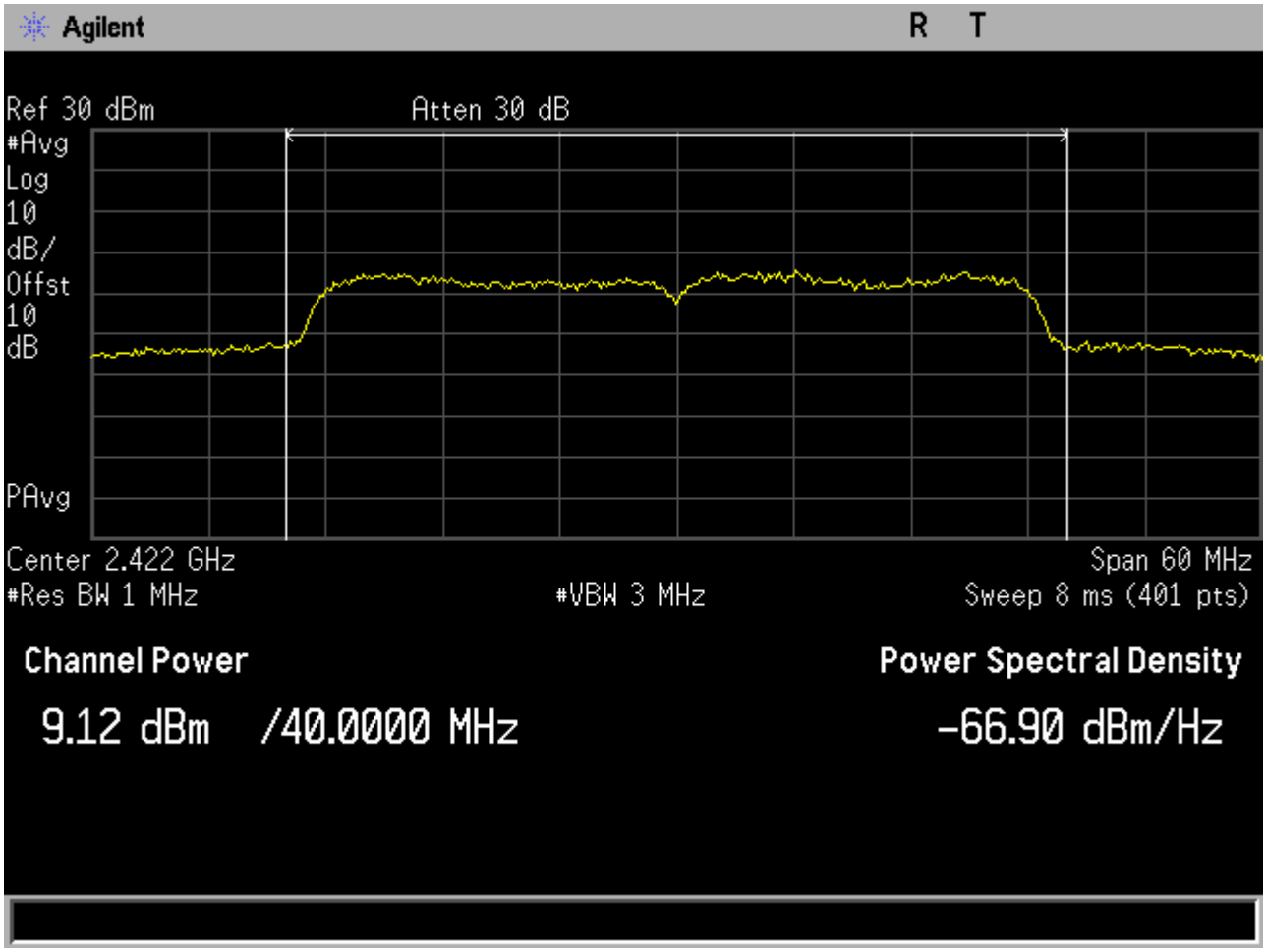
Plot 70. Peak Power Output, Bandwidth 40M, Ch. 2422M, n mode, Port 1



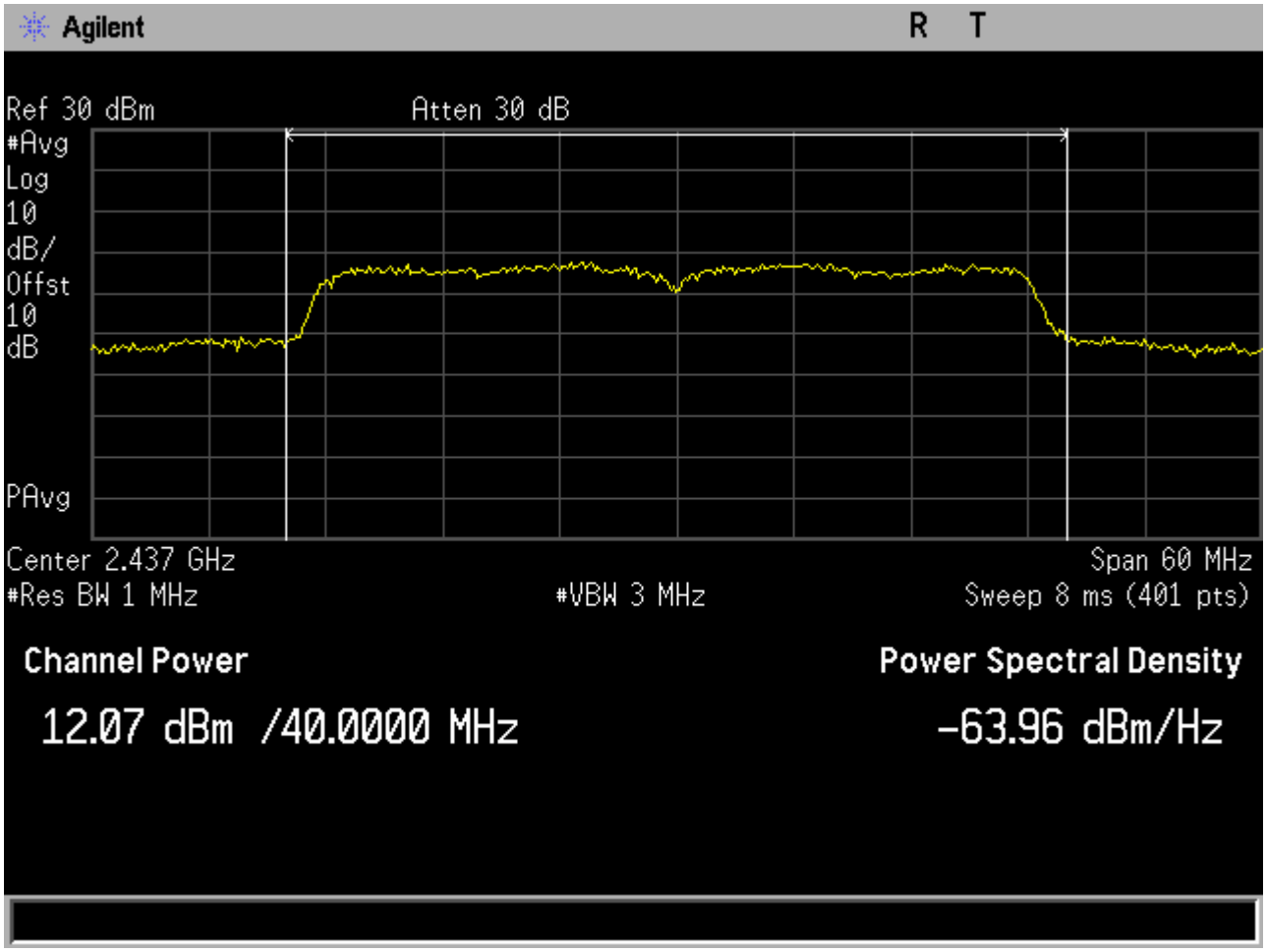
Plot 71. Peak Power Output, Bandwidth 40M, Ch. 2437M, n mode, Port 1



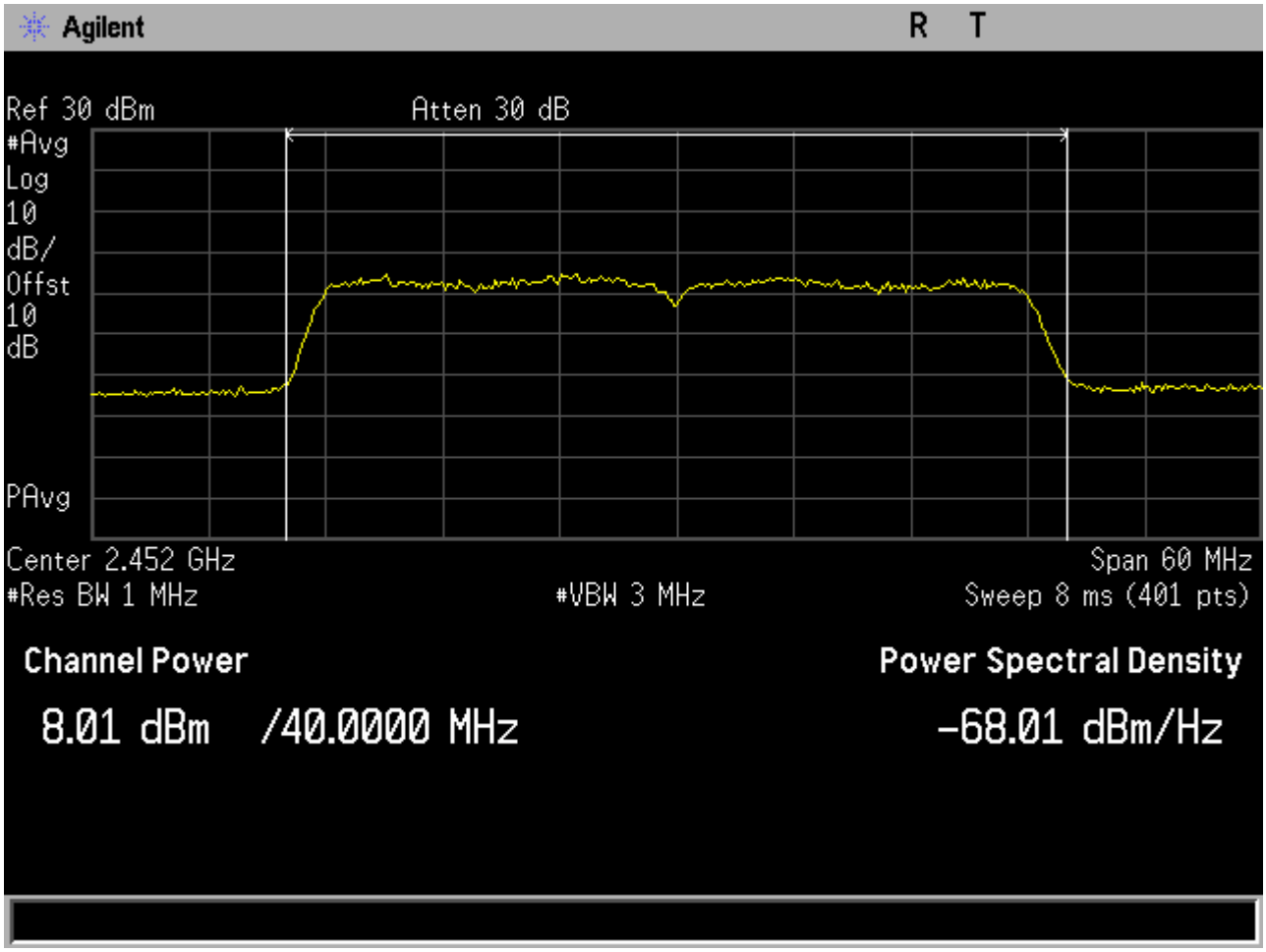
Plot 72. Peak Power Output, Bandwidth 40M, Ch. 2452M, n mode, Port 1



Plot 73. Peak Power Output, Bandwidth 40M, Ch. 2422M, n mode, Port 2



Plot 74. Peak Power Output, Bandwidth 40M, Ch. 2437M, n mode, Port 2



Plot 75. Peak Power Output, Bandwidth 40M, Ch. 2452M, n mode, Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Table 14. Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 15.

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV/m) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 15. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

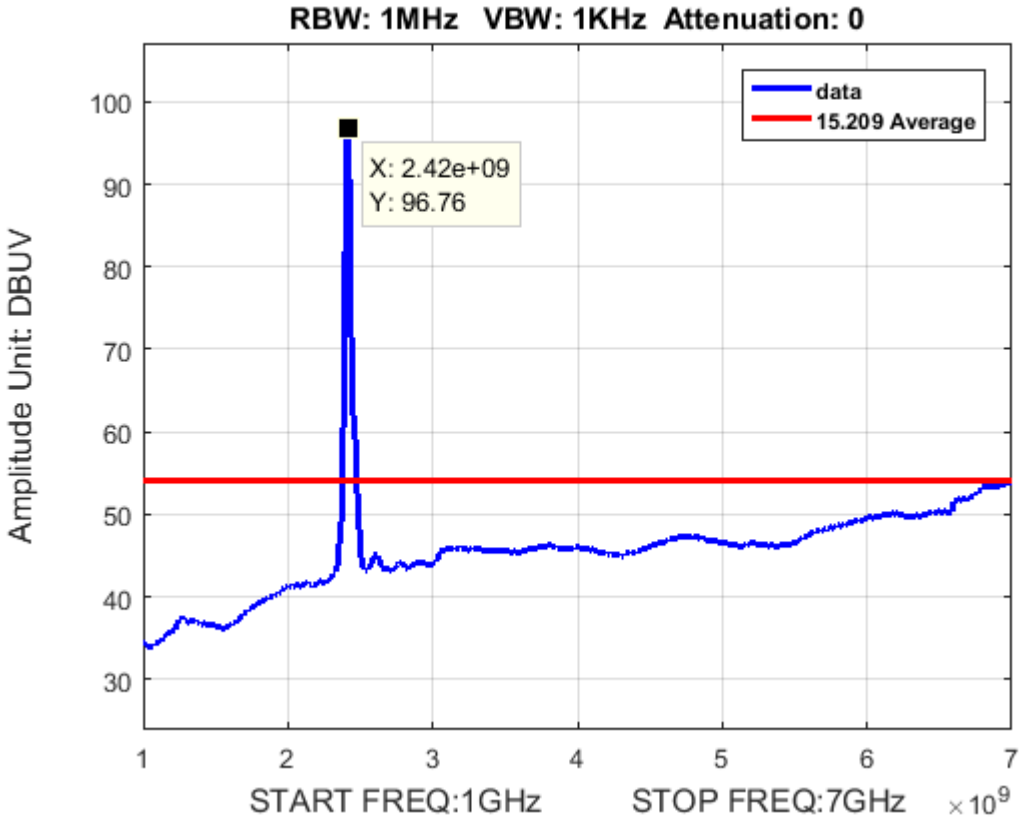
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured above 18 GHz.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of **§ 15.247(d)**. Measured emissions were within applicable limits. The following plots used to demonstrate compliance are corrected field strength in dBµV/m.

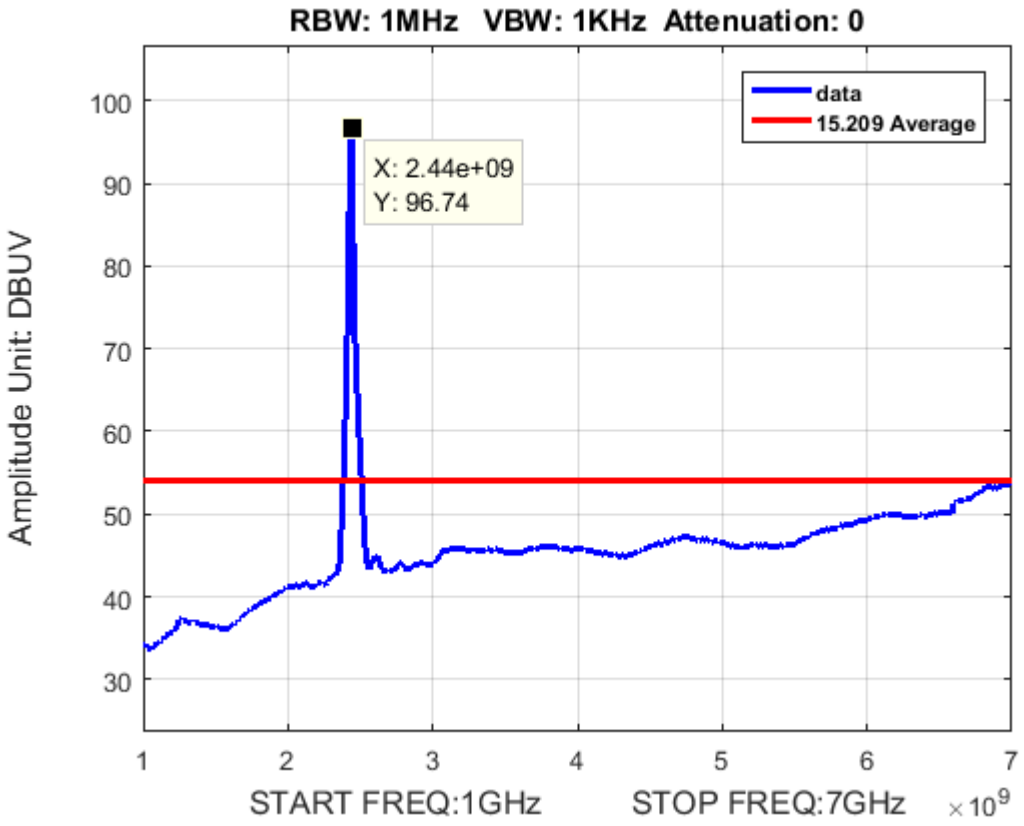
Test Engineer(s): Djed Mouada

Test Date(s): October 11, 2016

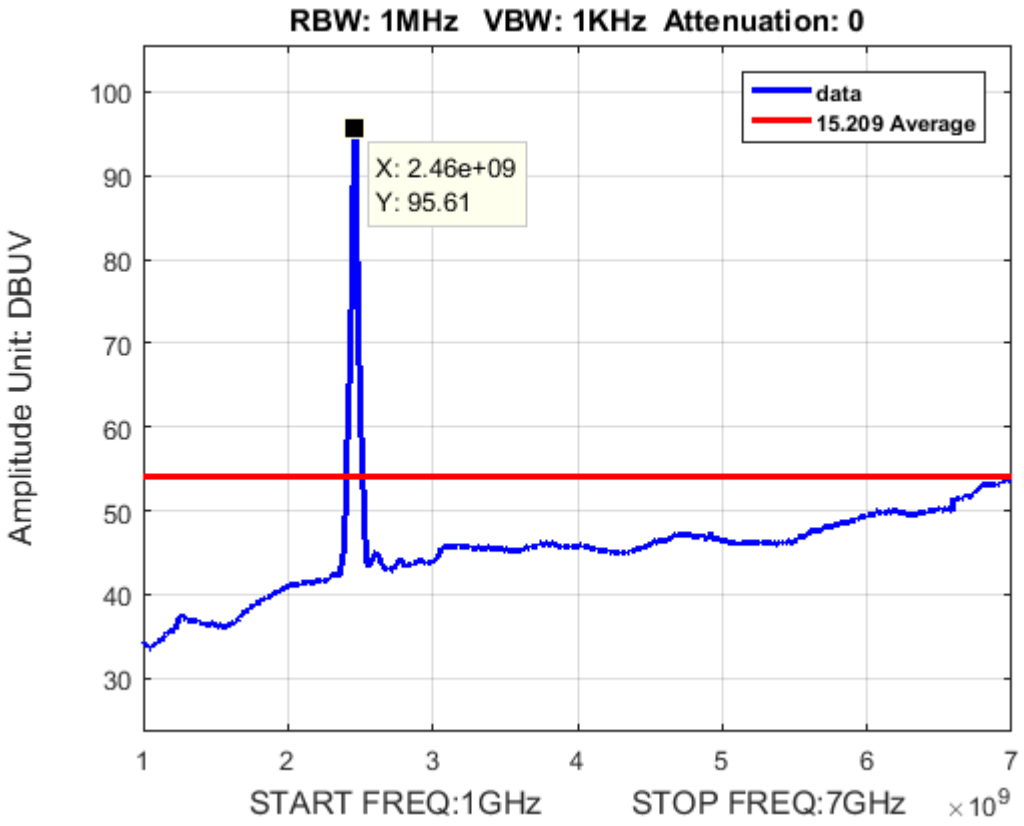
Radiated Spurious Emissions Test Results



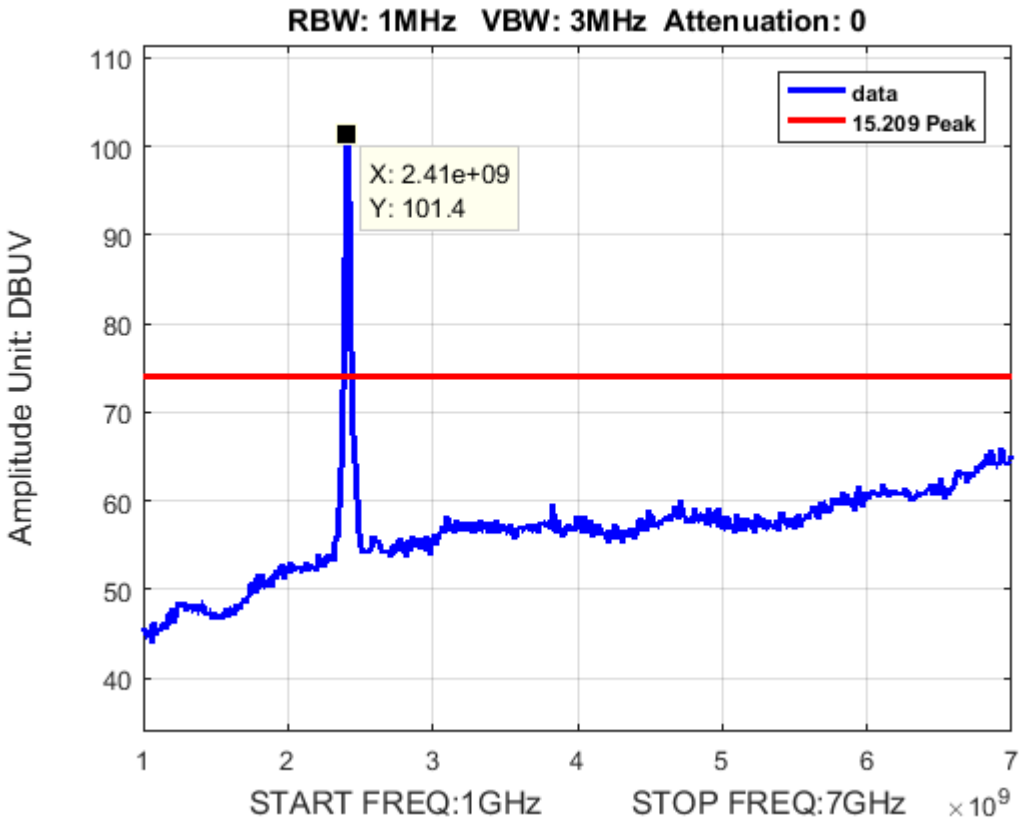
Plot 76. Average Spurious Emission 1-7GHz, Bandwidth 20Mb, Ch. 2412M, b mode



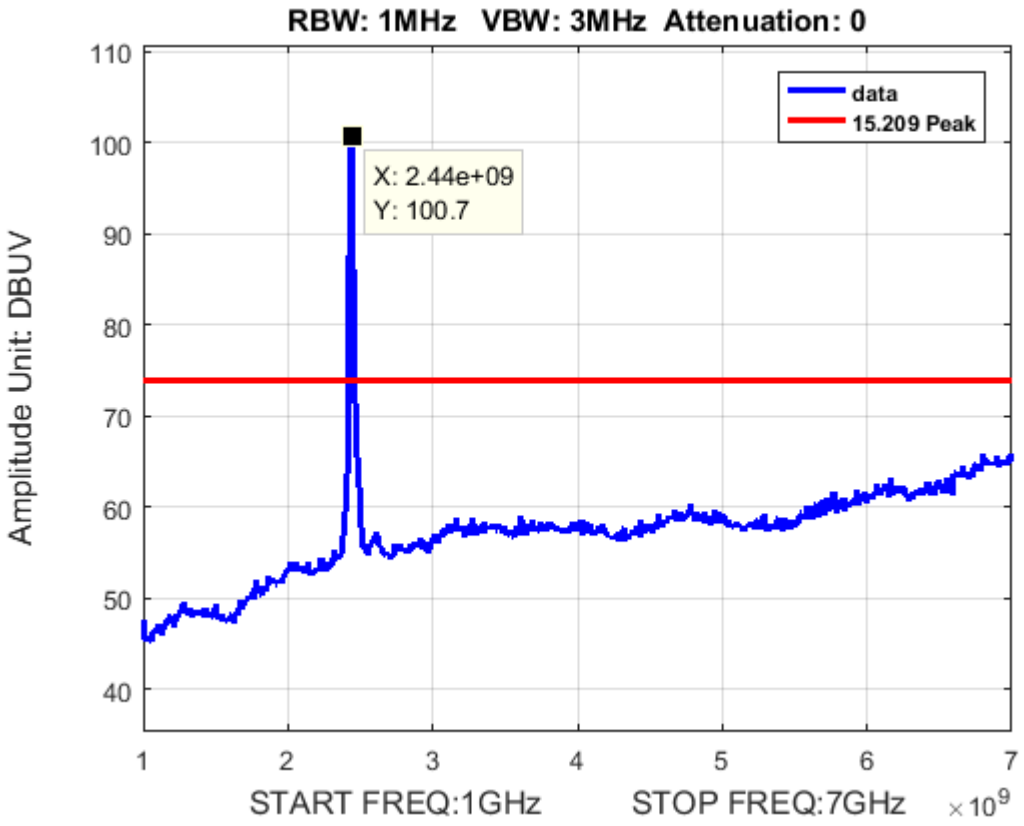
Plot 77. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2437M, b mode



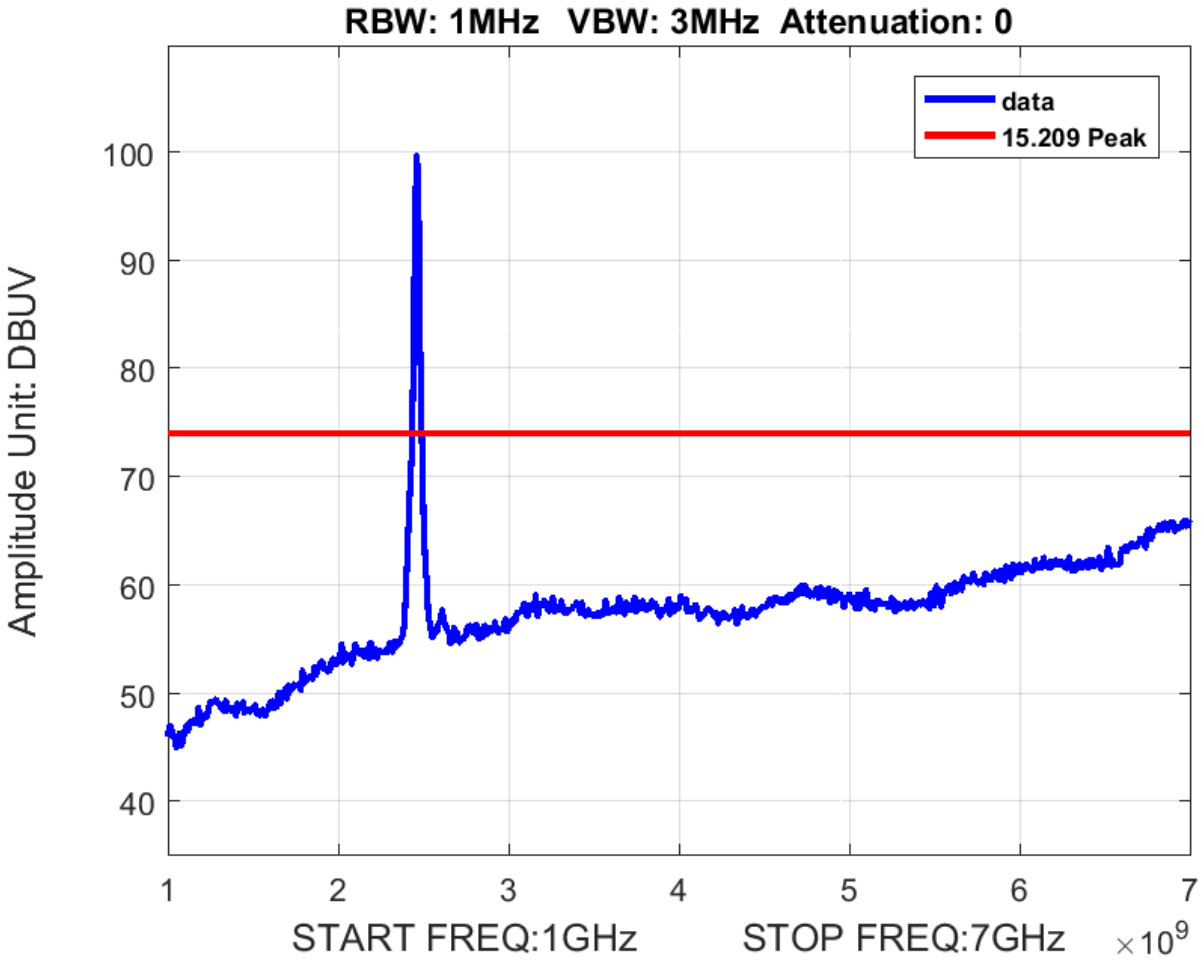
Plot 78. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2462M, b mode



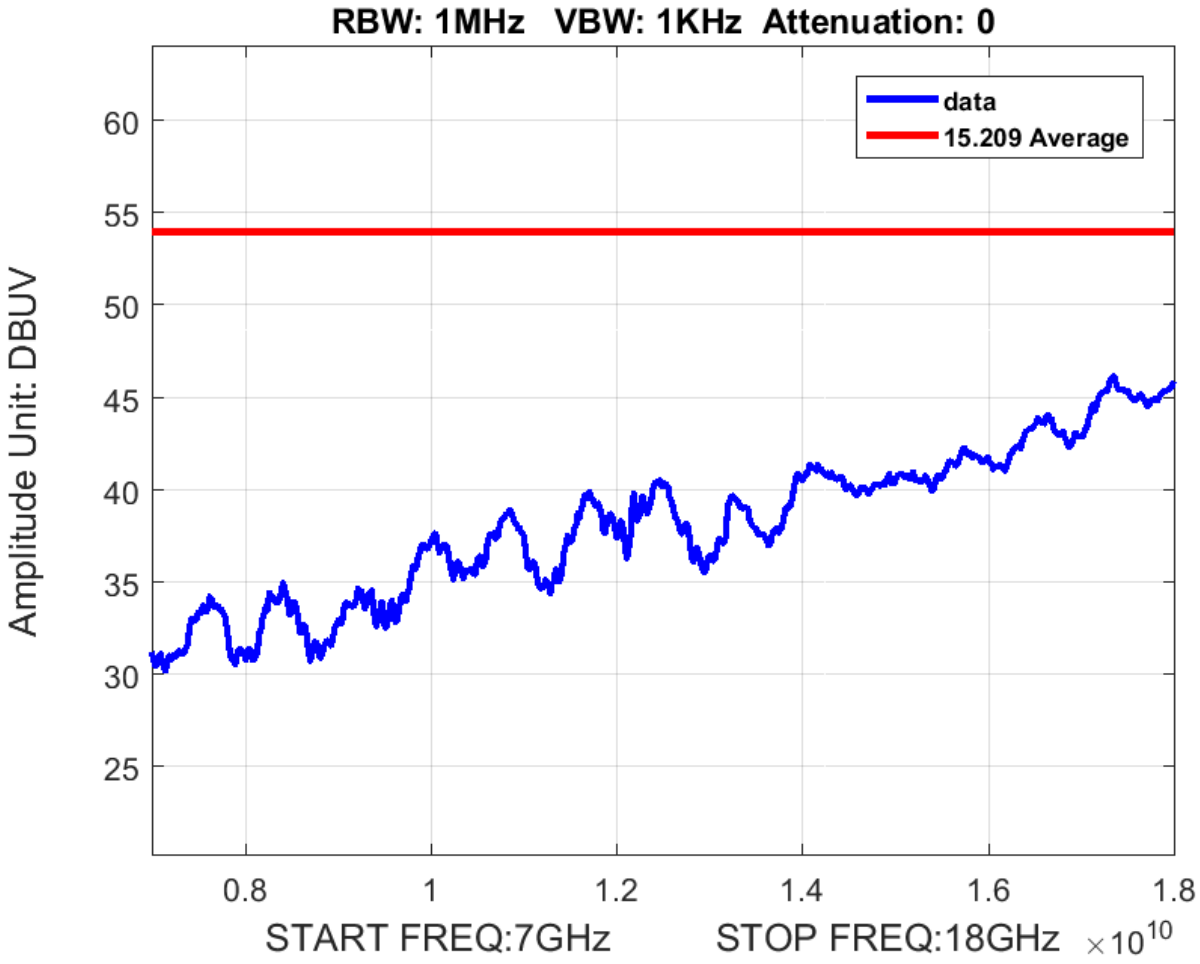
Plot 79. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2412M, b mode



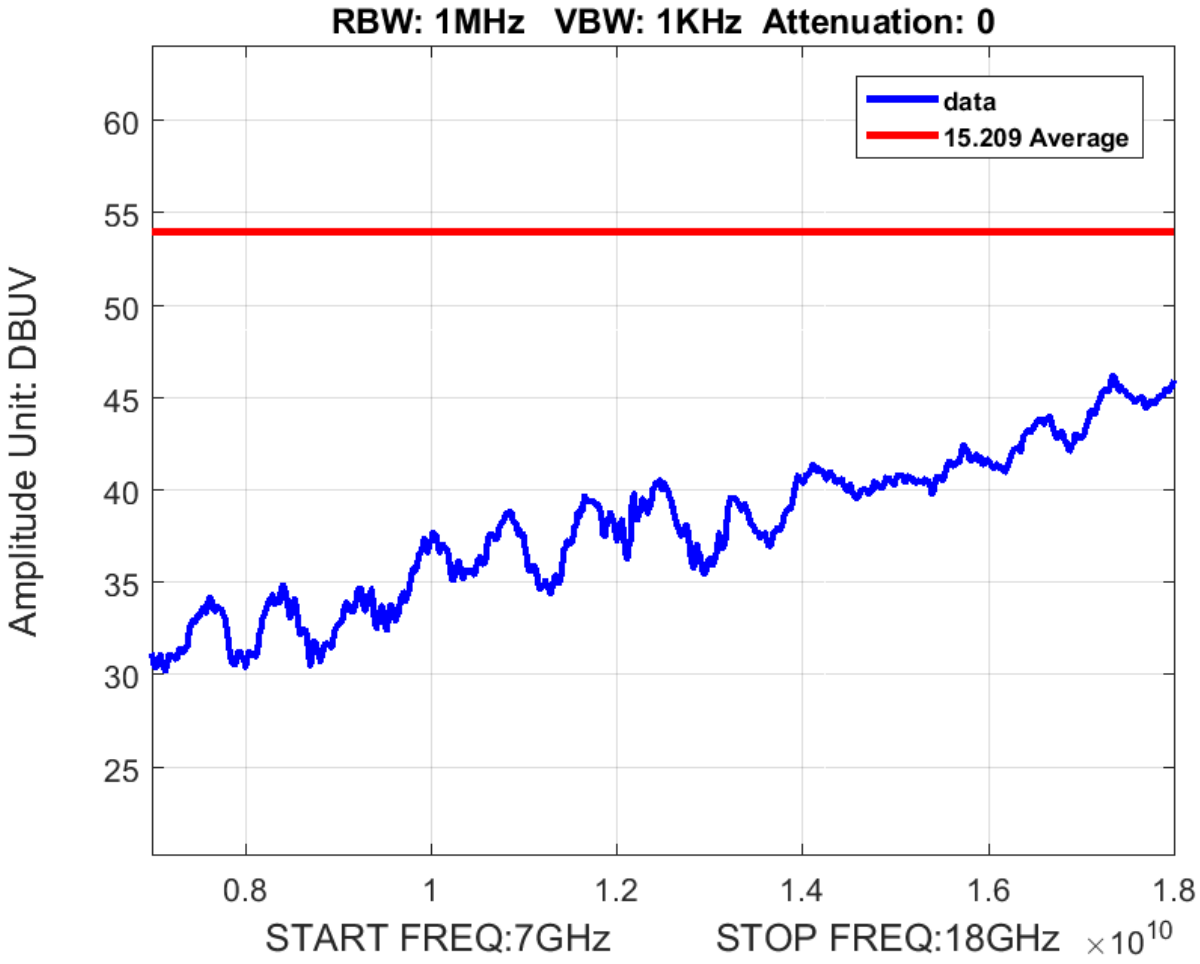
Plot 80. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2437M, b mode



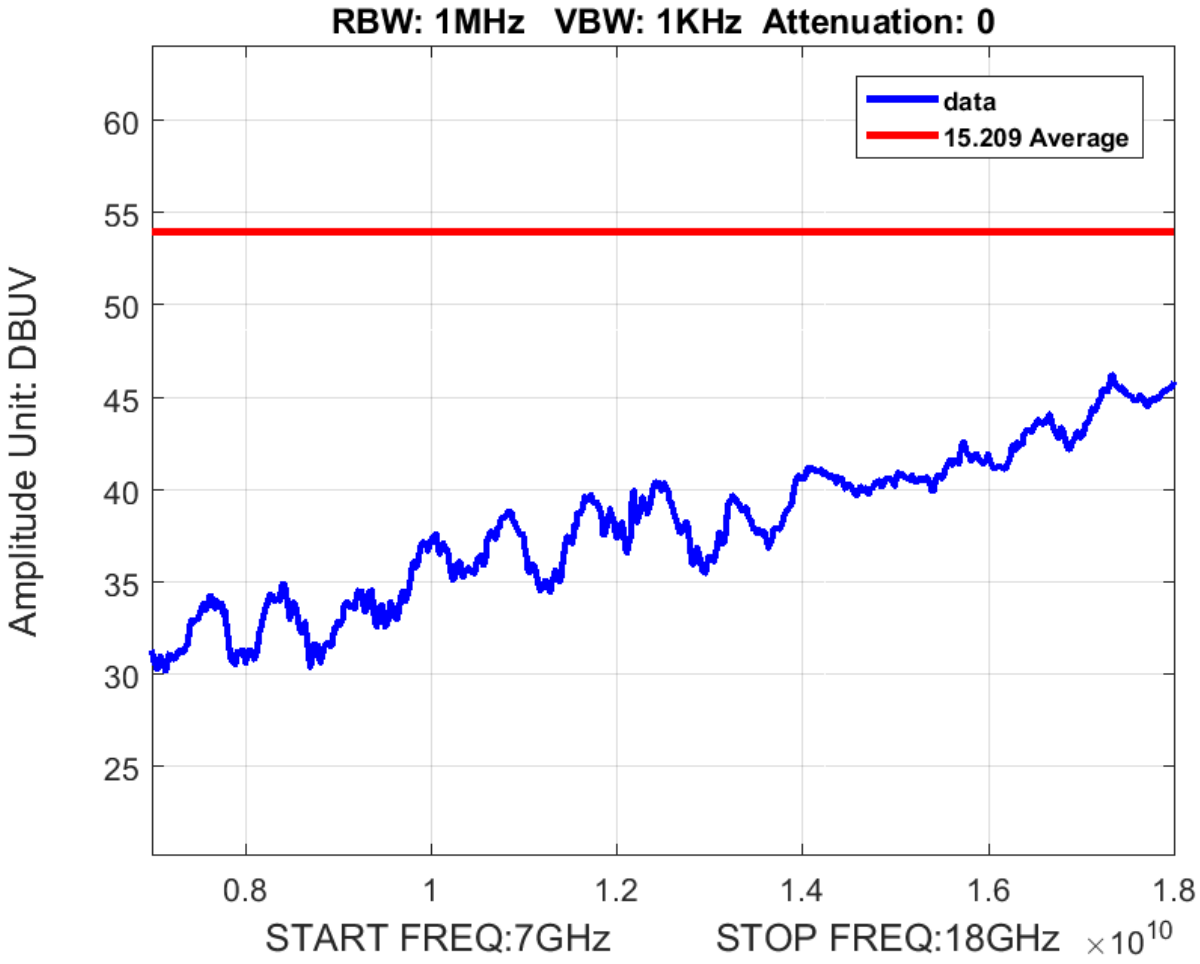
Plot 81. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2462M, b mode



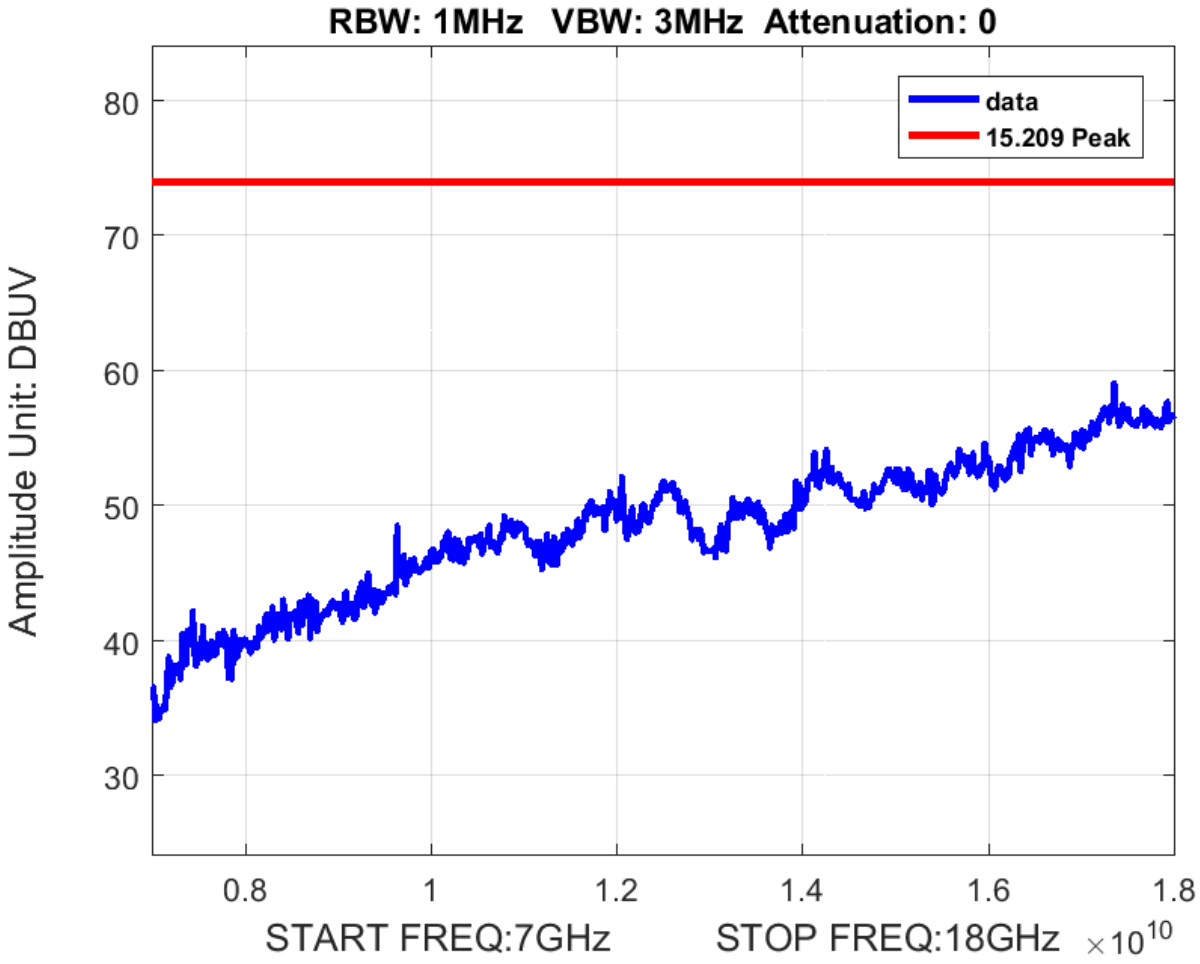
Plot 82. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2412M, b mode



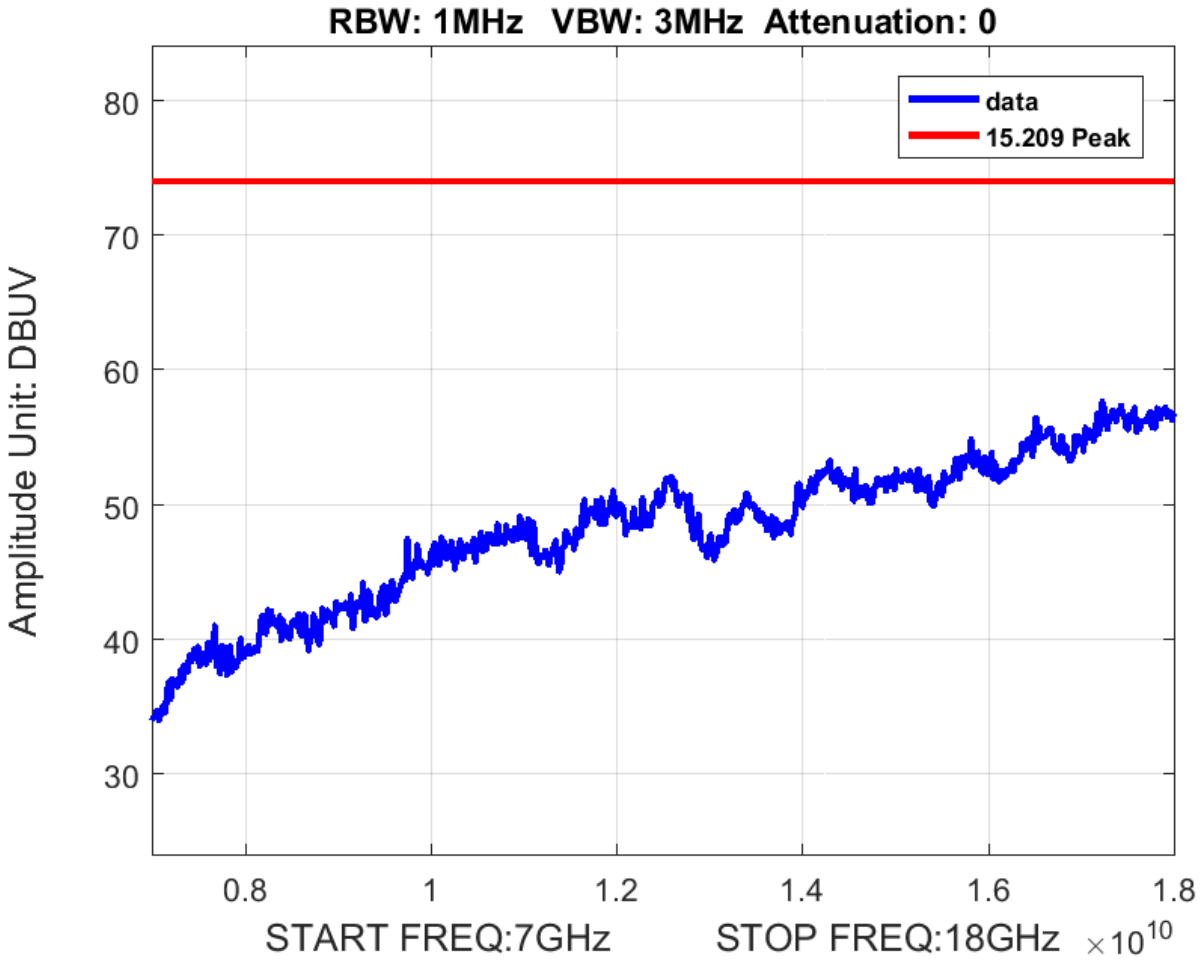
Plot 83. Average Spurious Emission 7- 18GHz, Bandwidth 20M, Ch. 2437M, b mode



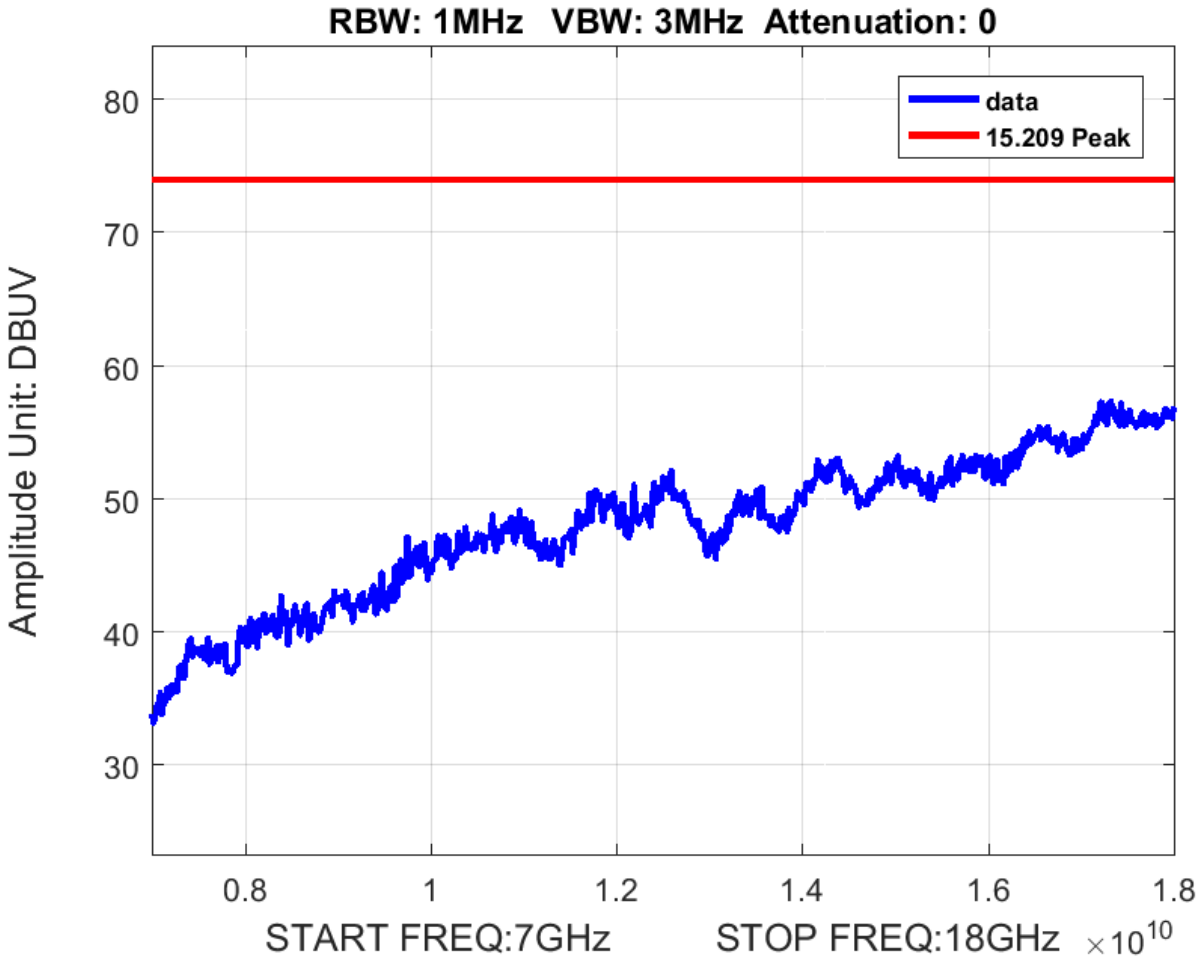
Plot 84. Average Spurious Emission 7- 18GHz, Bandwidth 20M, Ch. 2462M, b mode



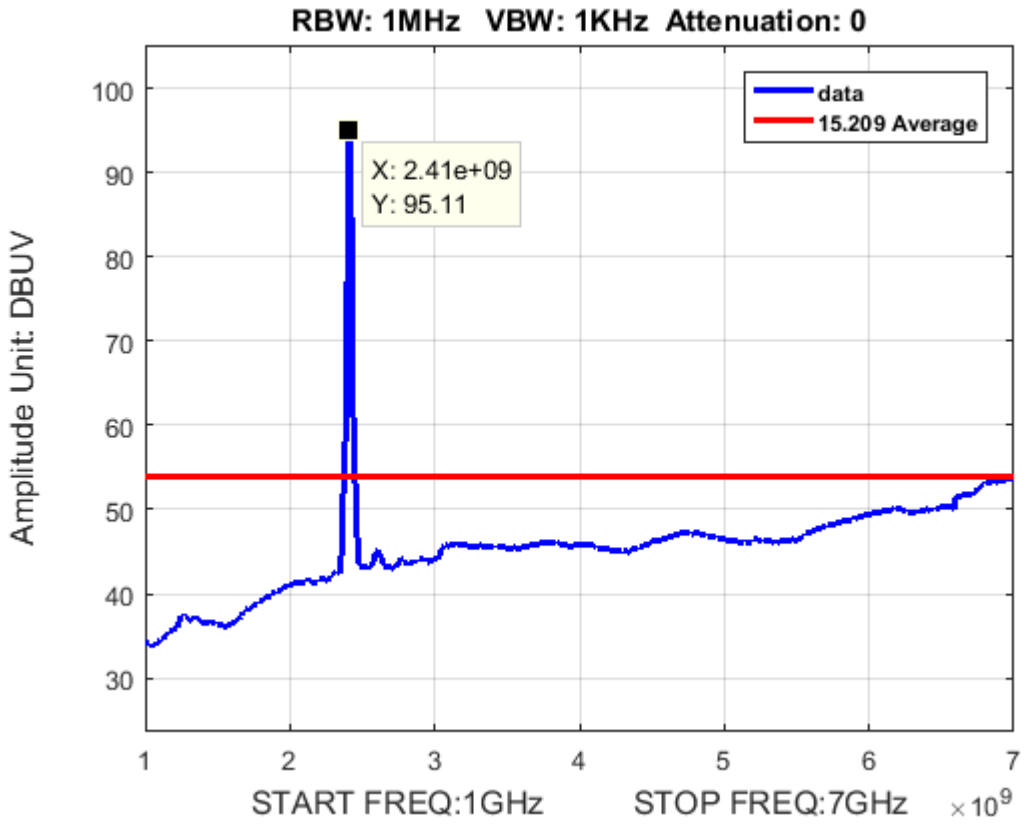
Plot 85. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2412M, b mode



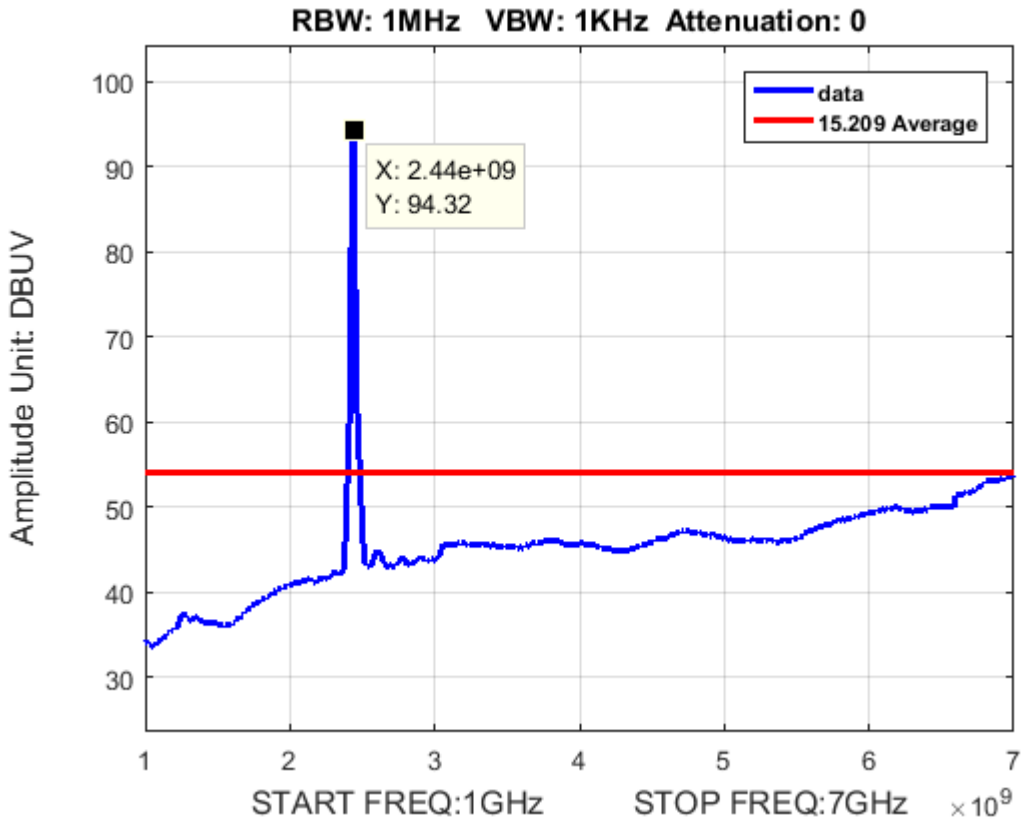
Plot 86. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2437M, b mode



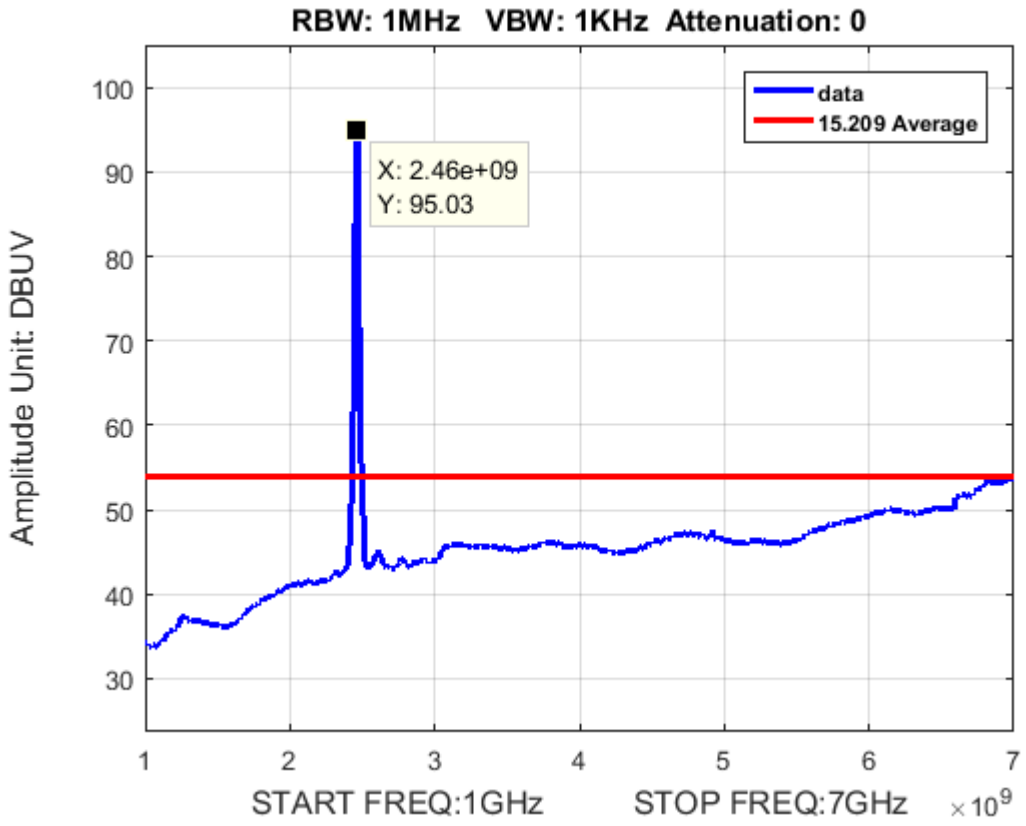
Plot 87. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2462M, b mode



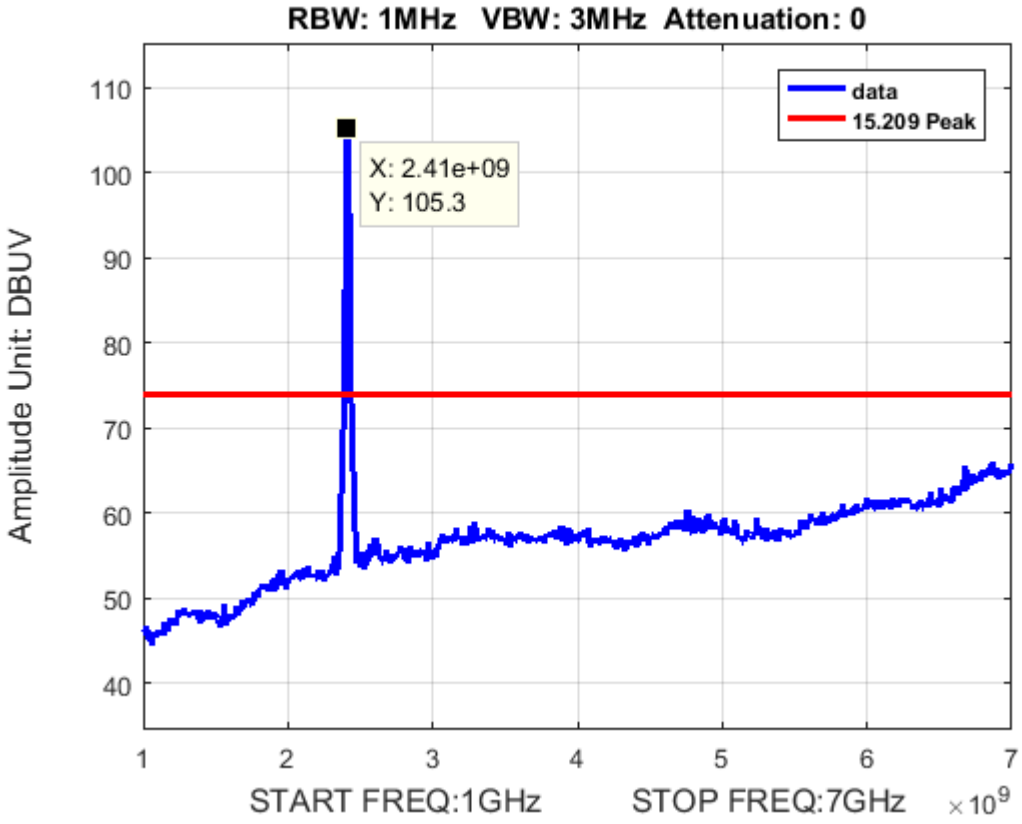
Plot 88. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2412M, g mode



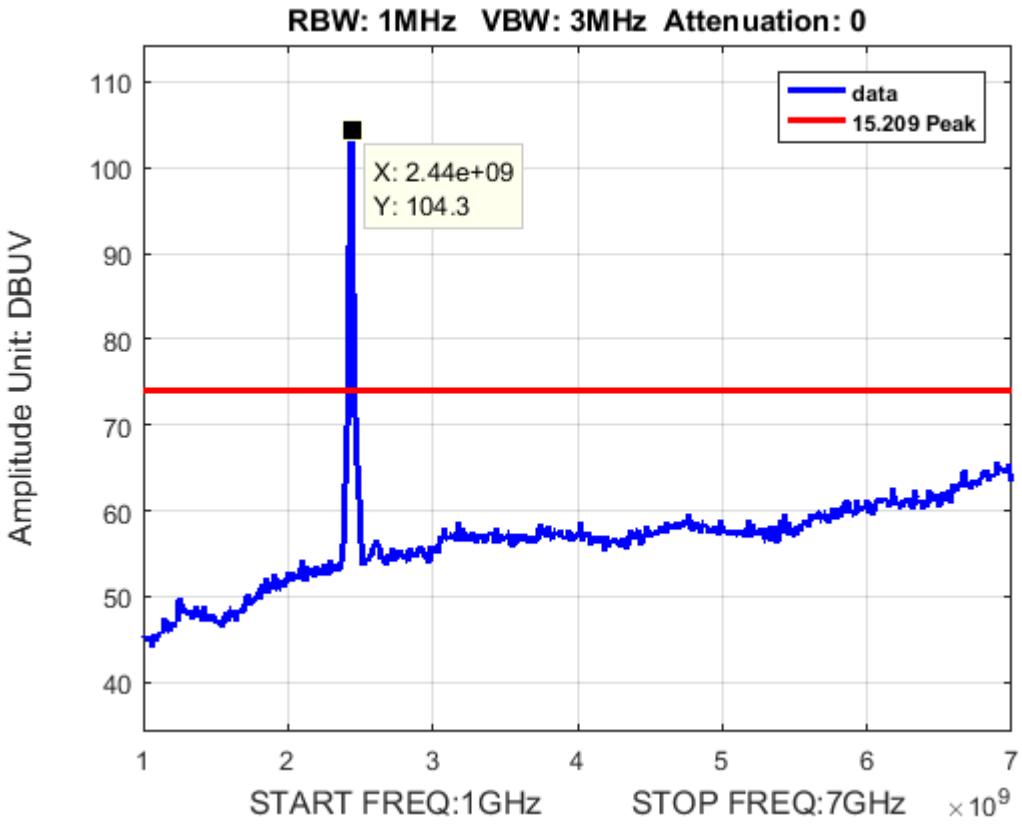
Plot 89. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2437M, g mode



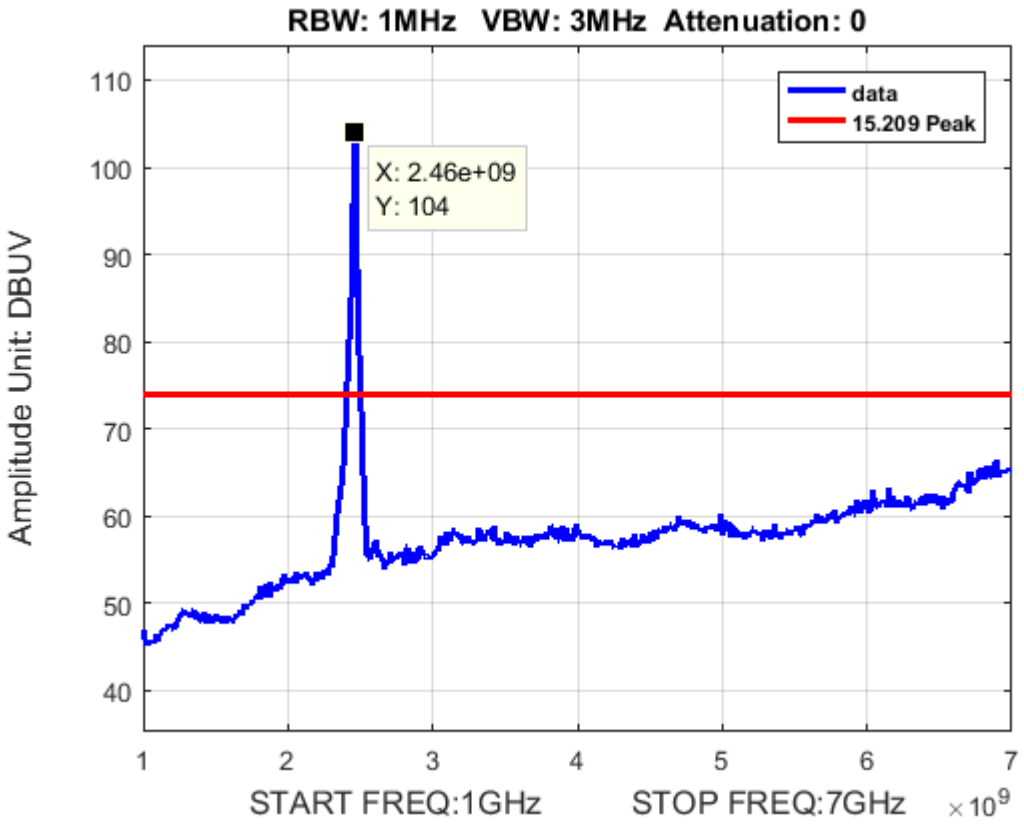
Plot 90. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2437M, g mode



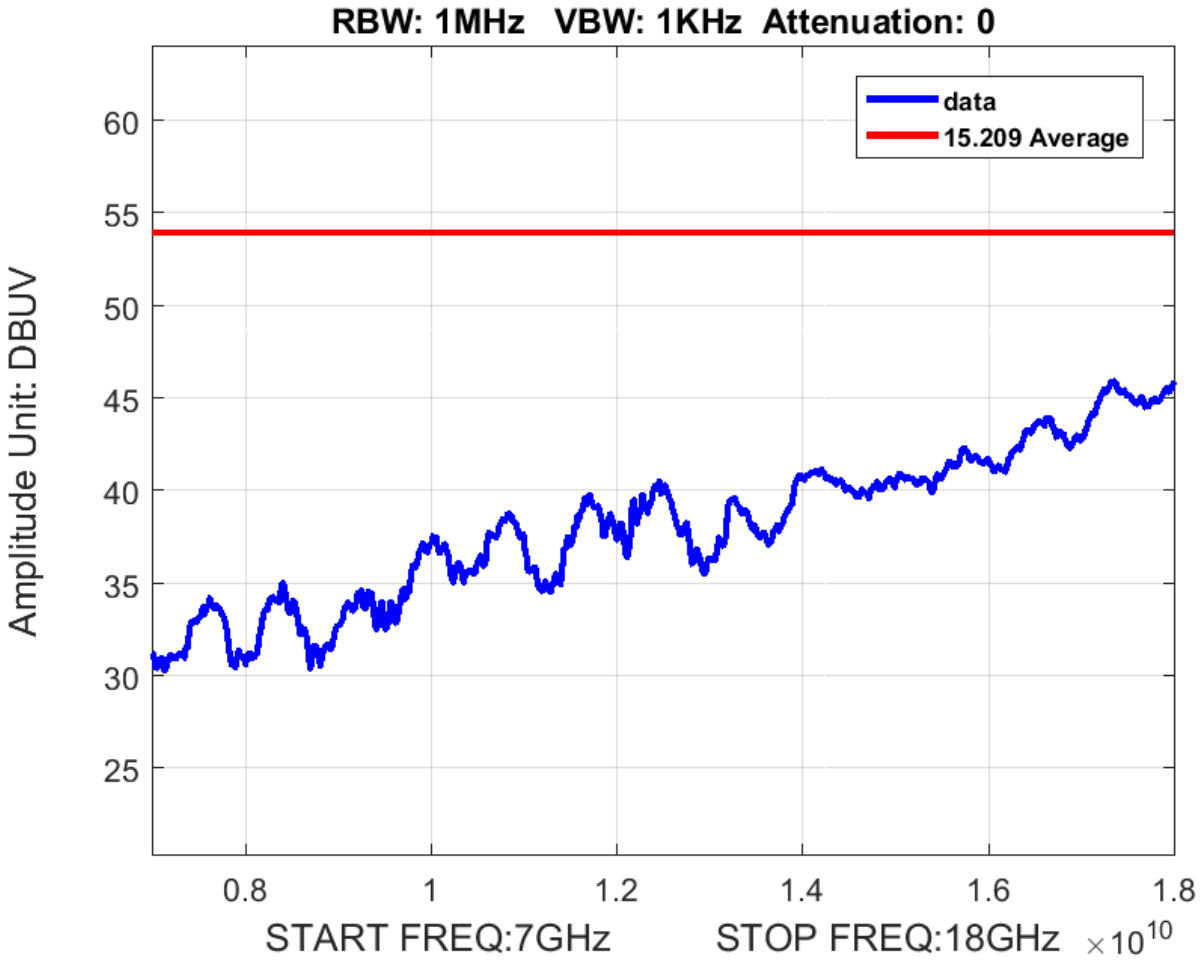
Plot 91. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2412M, g mode



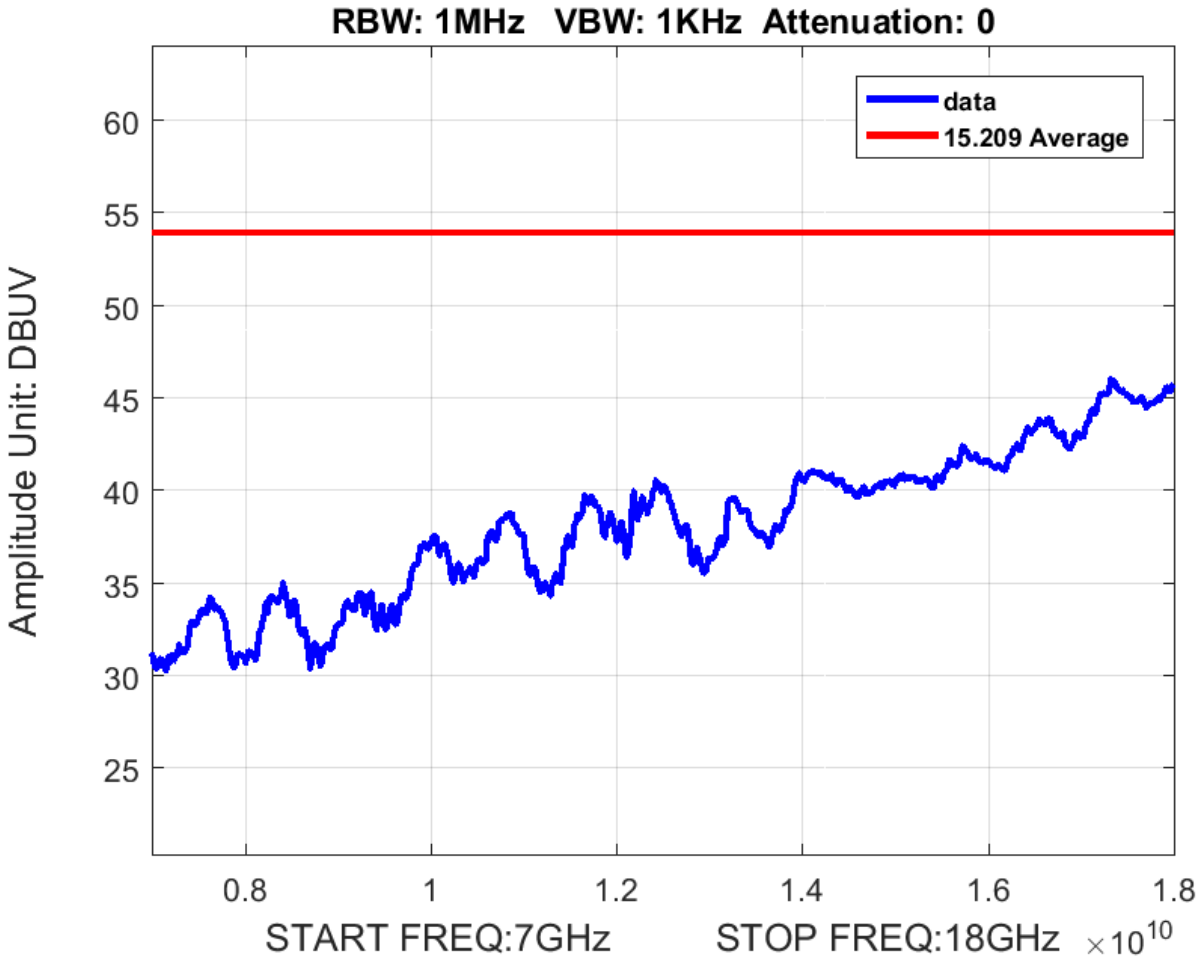
Plot 92. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2437M, g mode



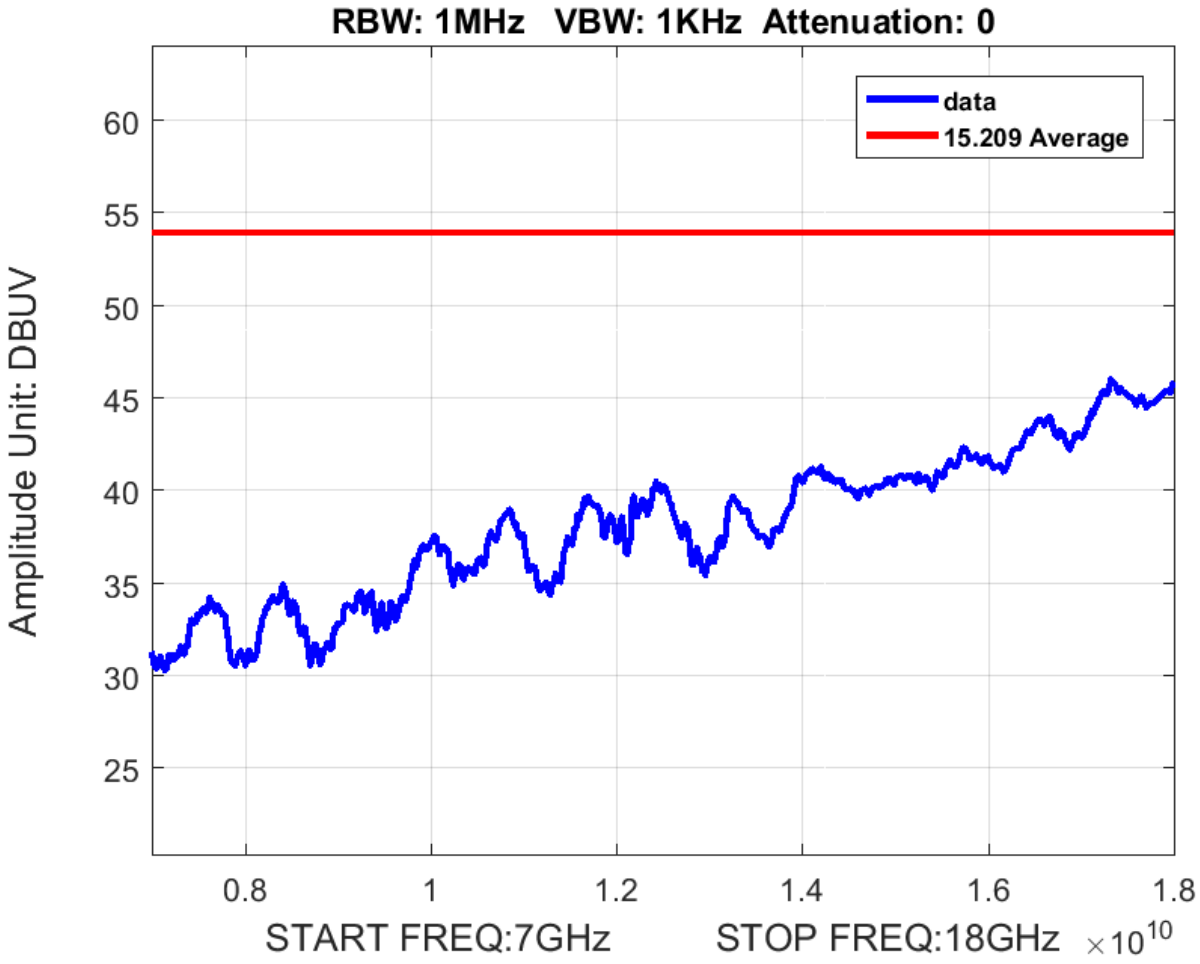
Plot 93. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2462M, g mode



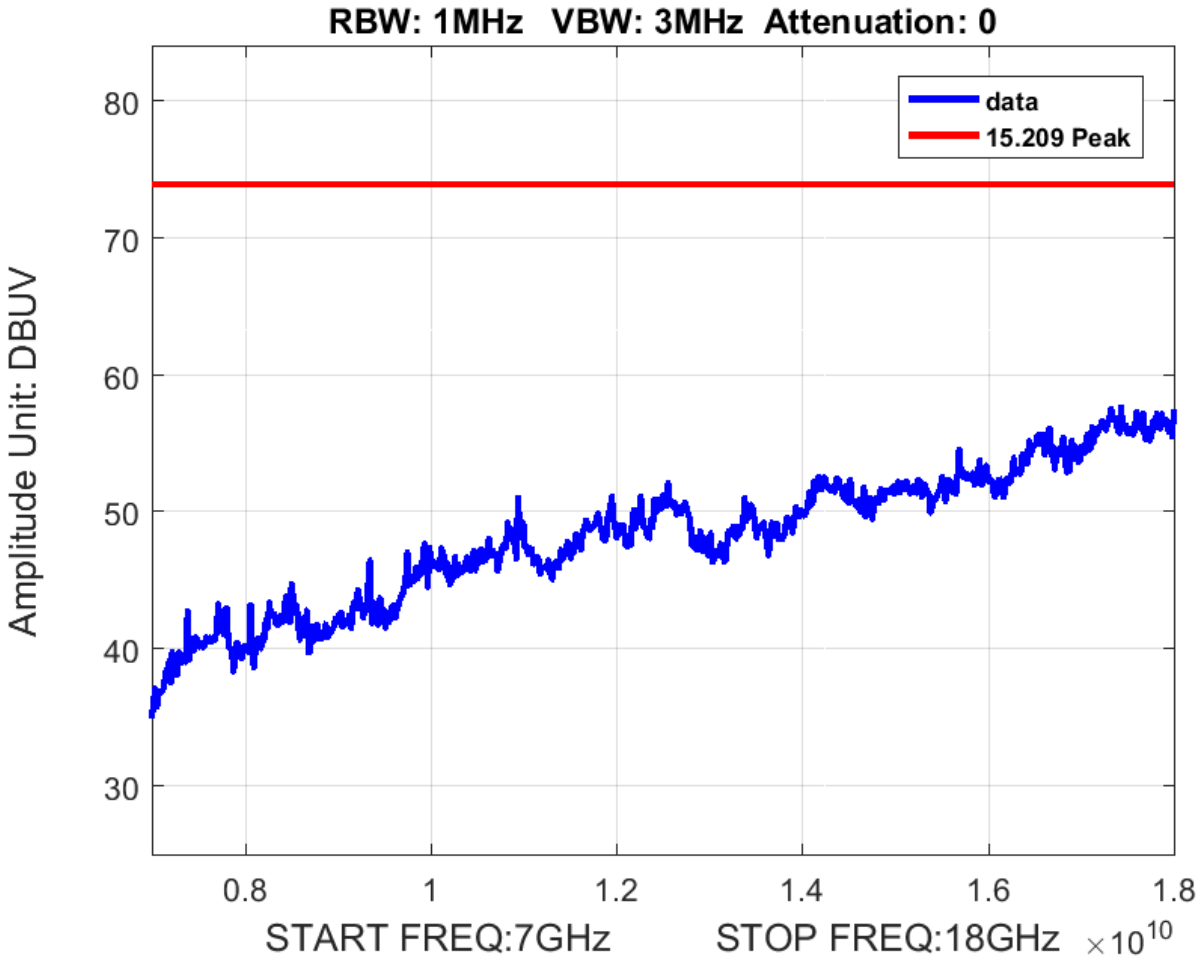
Plot 94. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2412M, g mode



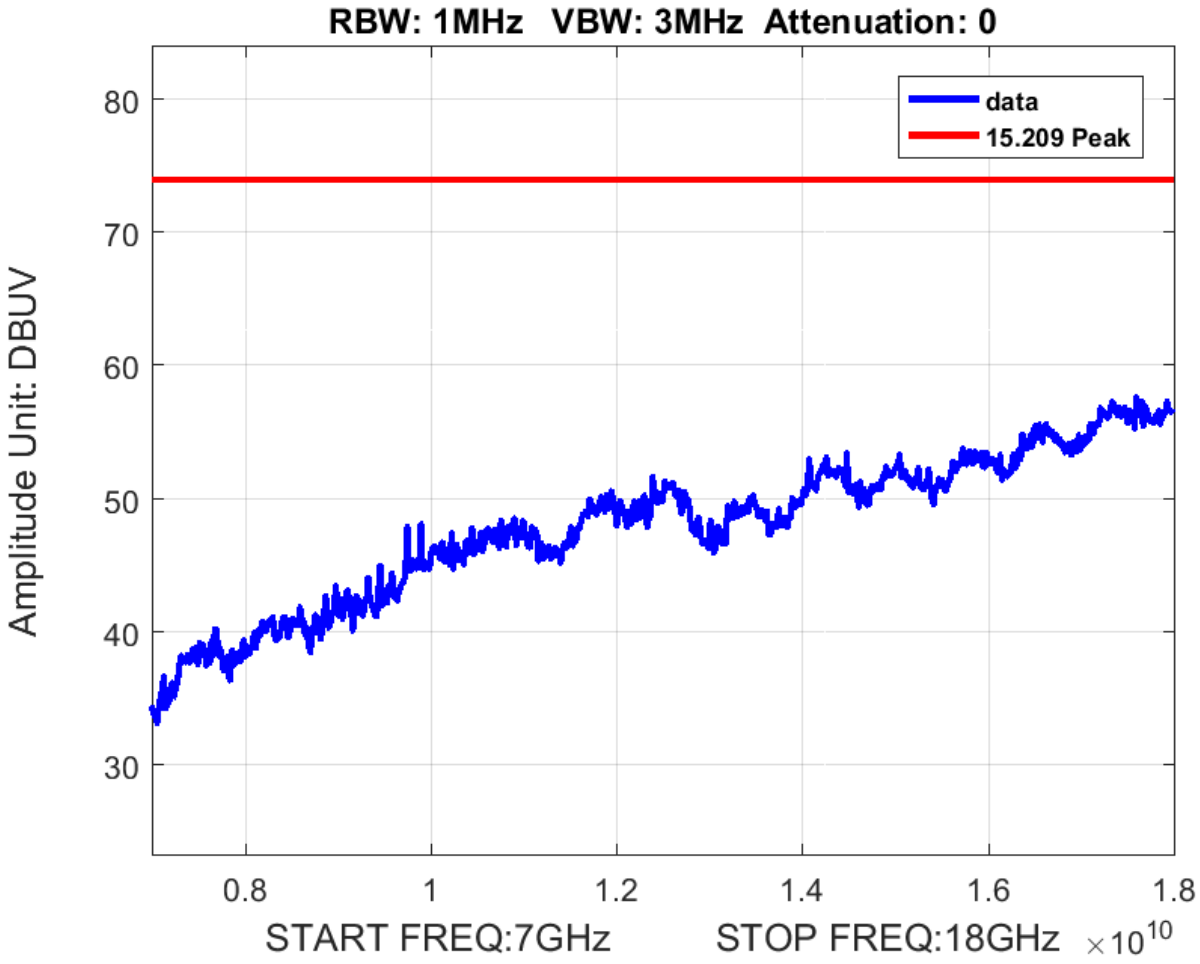
Plot 95. Average Spurious Emissions 7-18GHz, Bandwidth 20M, Ch. 2437M, g mode



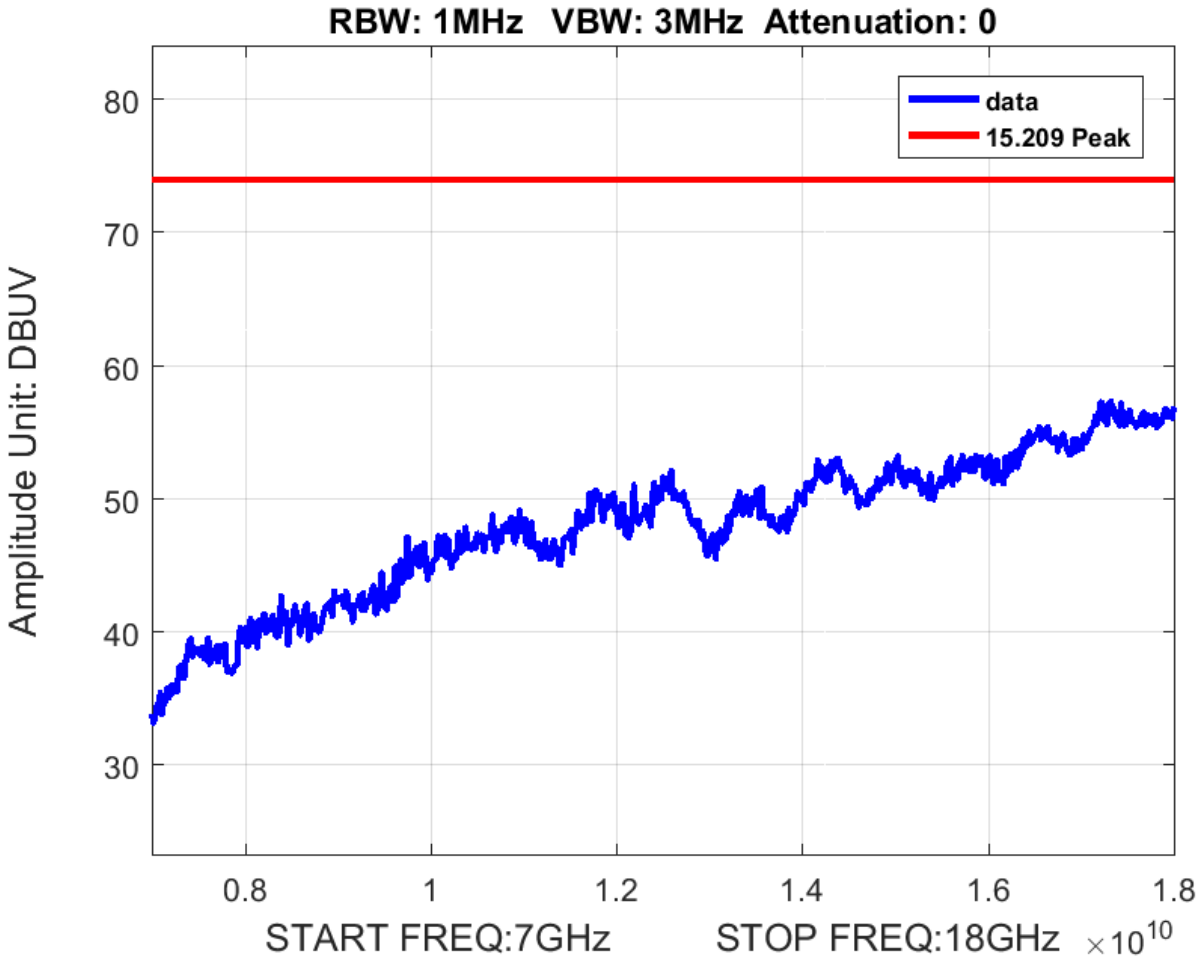
Plot 96. Average Spurious Emissions 7-18GHz, Bandwidth 20M, Ch. 2462M, g mode



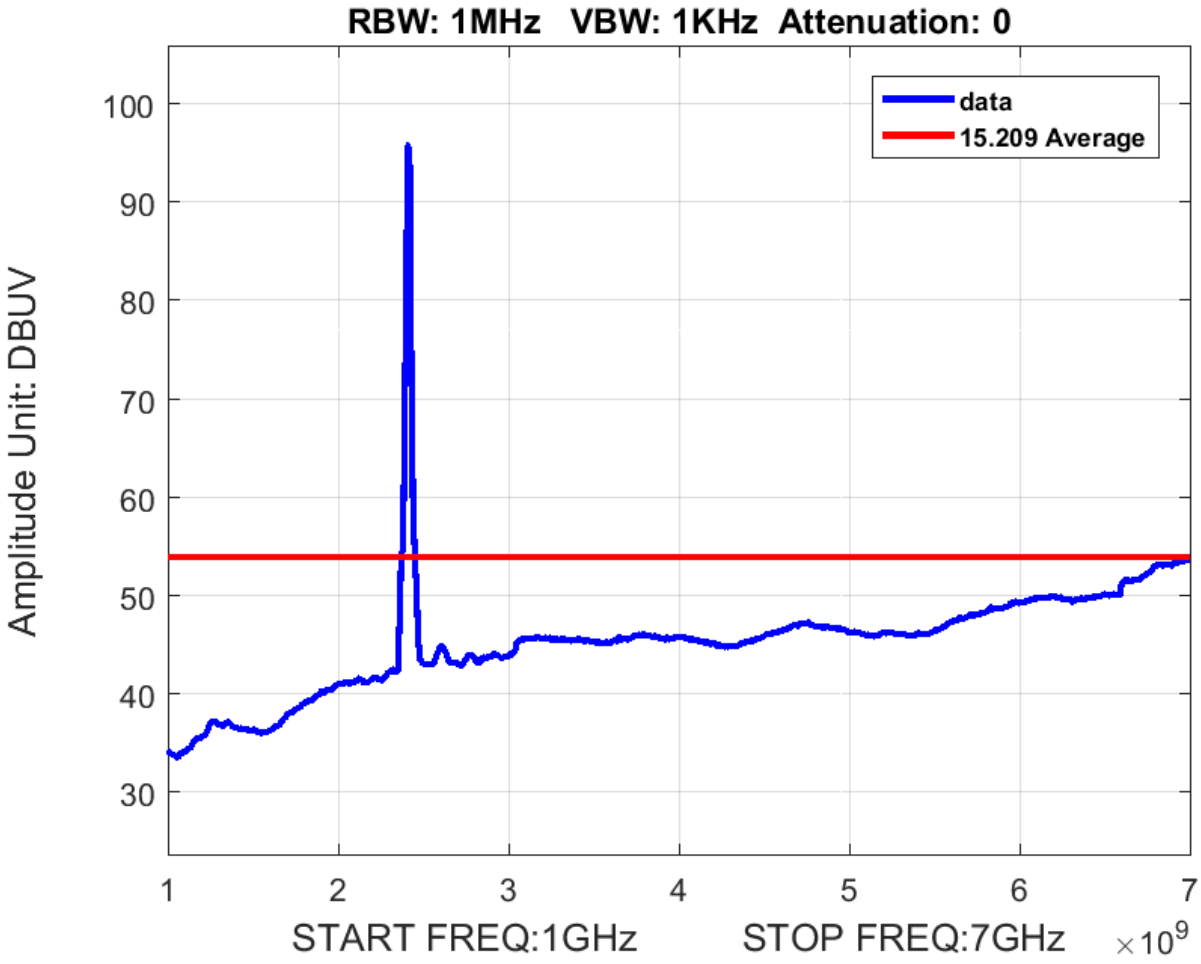
Plot 97. Peak Spurious Emissions 7-18GHz, Bandwidth 20M, Ch. 2412M, g mode



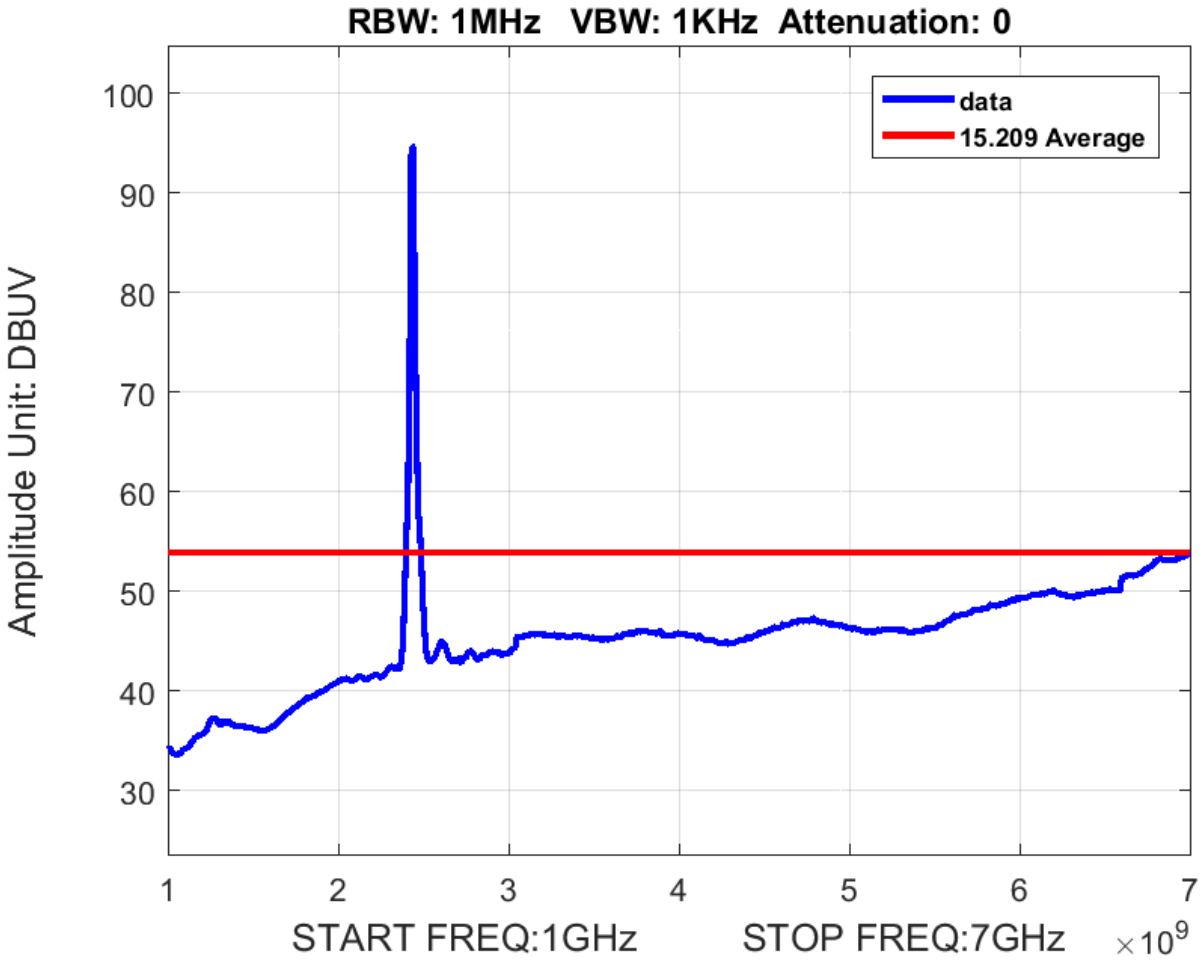
Plot 98. Peak Spurious Emissions 7-18GHz, Bandwidth 20M, Ch. 2437M, g mode



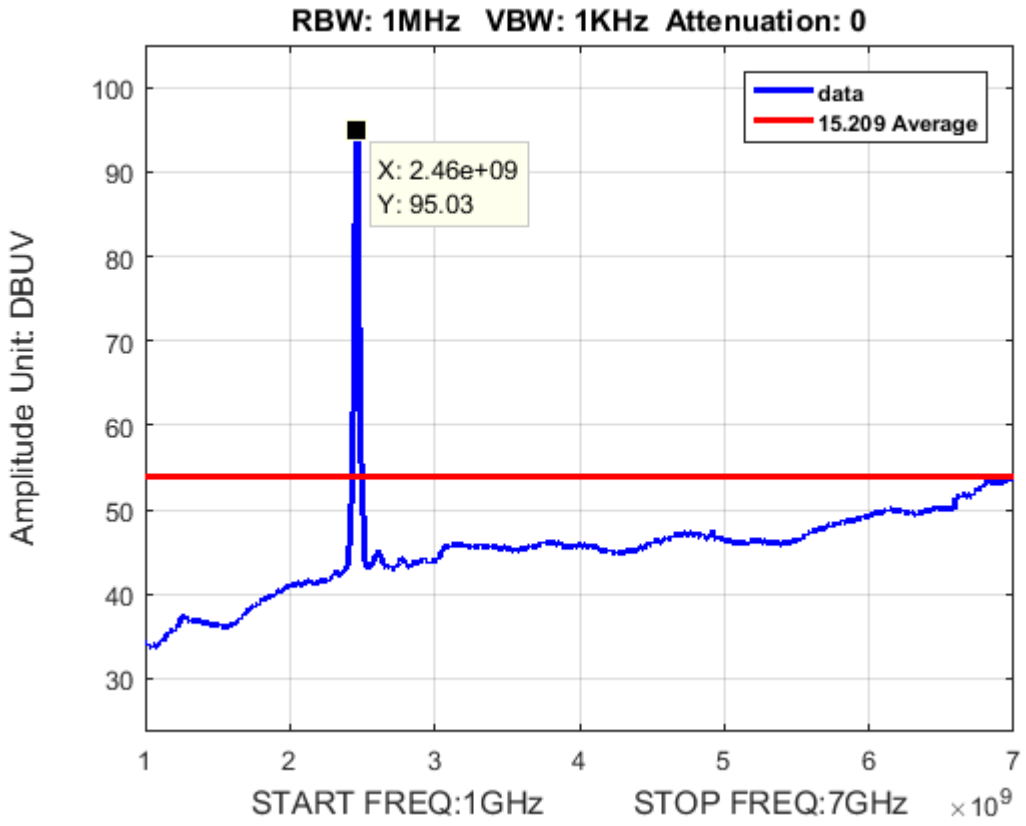
Plot 99. Peak Spurious Emissions 7-18GHz, Bandwidth 20M, Ch. 2462M, g mode



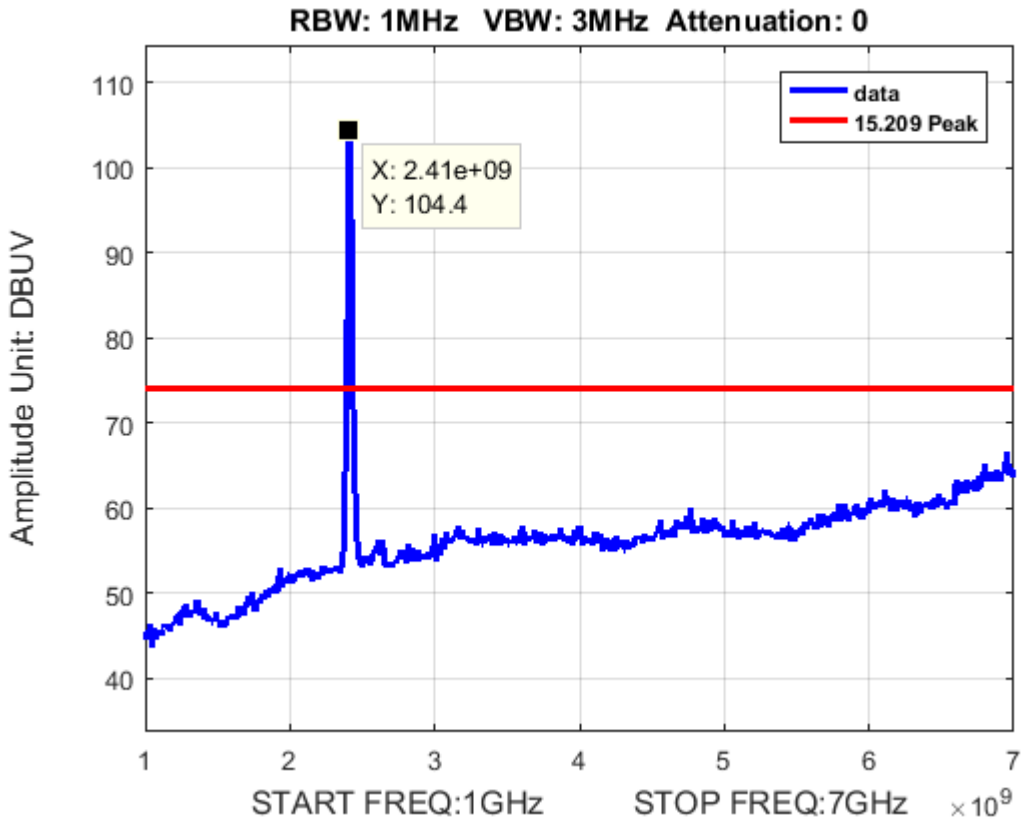
Plot 100. Average Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2412M, n mode, *AVG*



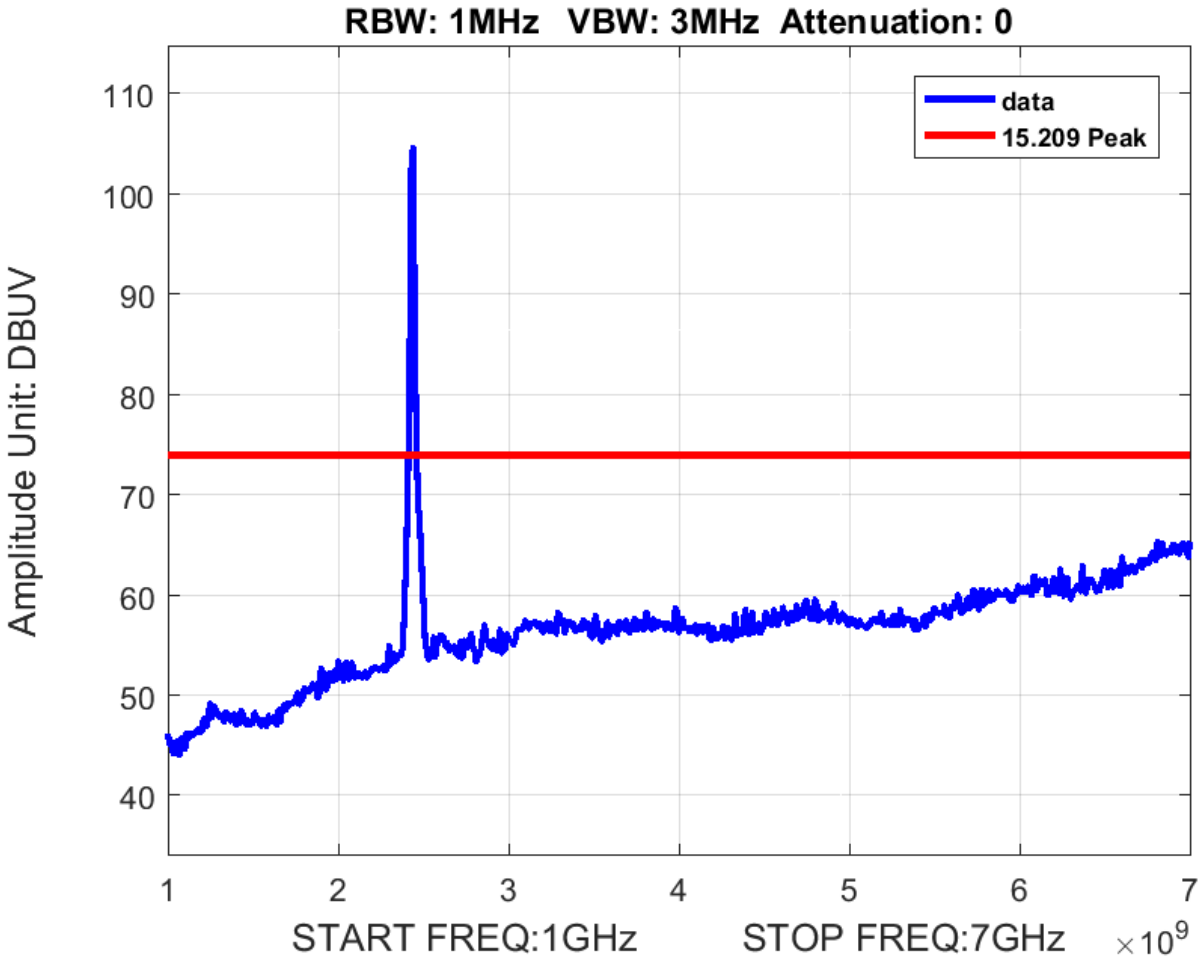
Plot 101. Average Spurious Emission 1-7Ghz, Bandwidth 20M Ch. 2422M, n mode, *AVG*



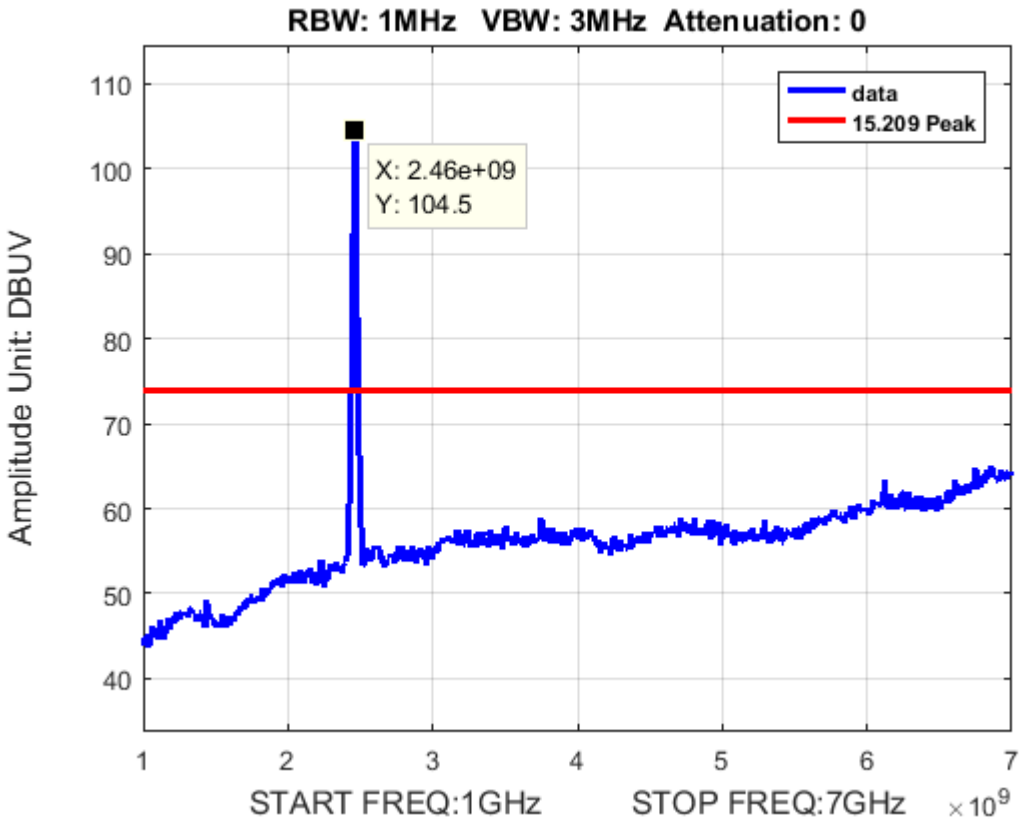
Plot 102. Average Spurious Emission 1-7Ghz, Bandwidth 20M, Ch. 2462M, n mode



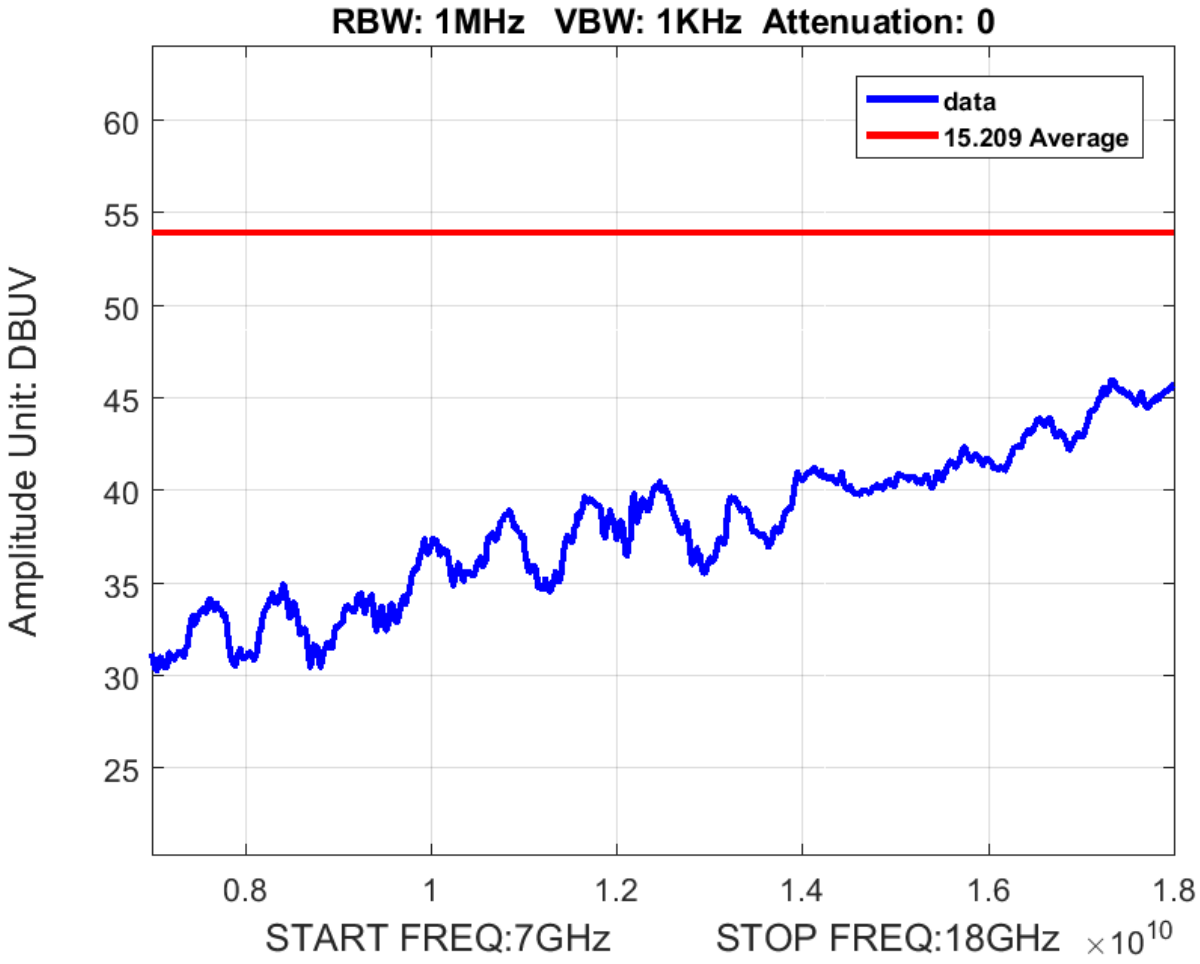
Plot 103. Peak Spurious Emission 1-7Ghz, Bandwidth 20M, Ch. 2412M, n mode, Peak



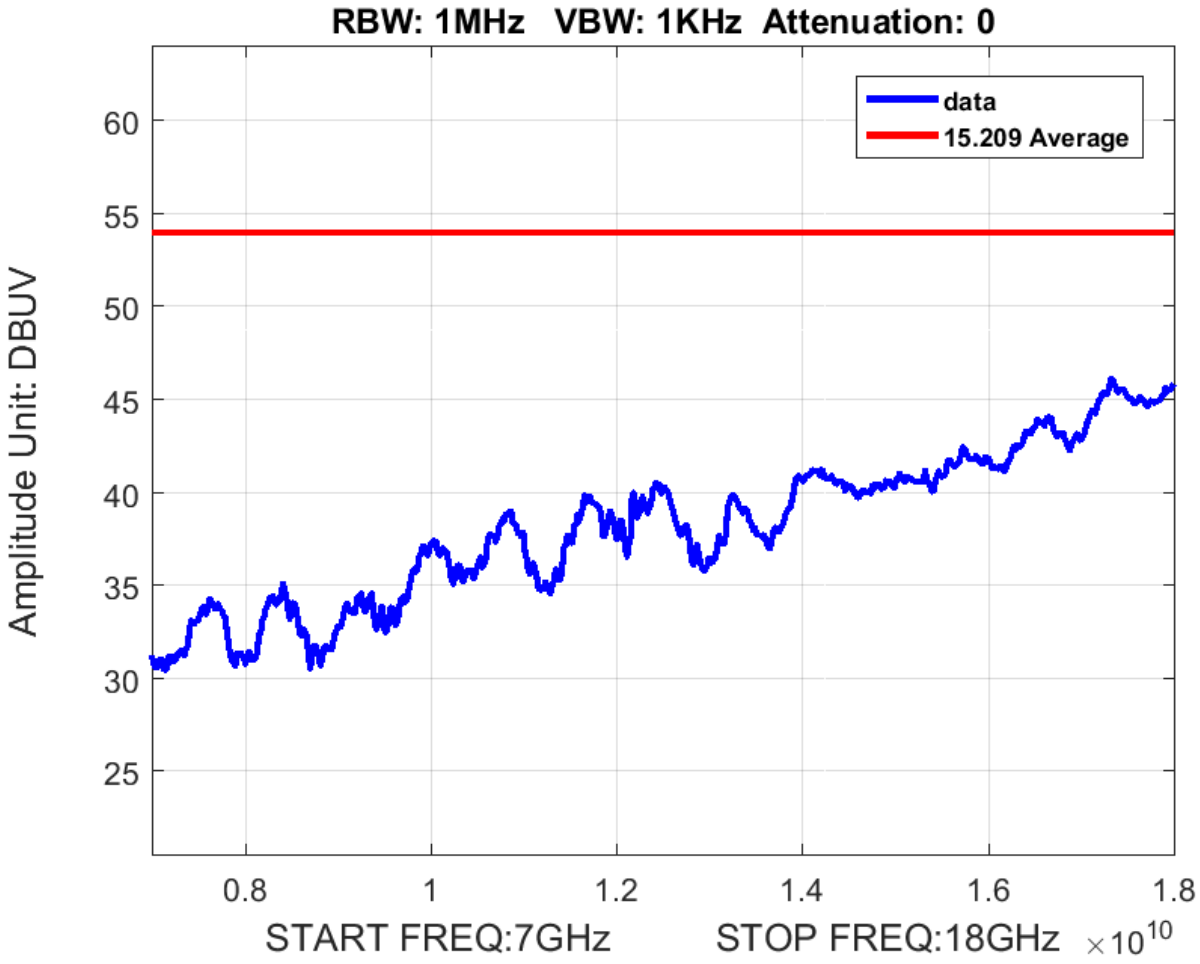
Plot 104. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2422M, n mode, Peak



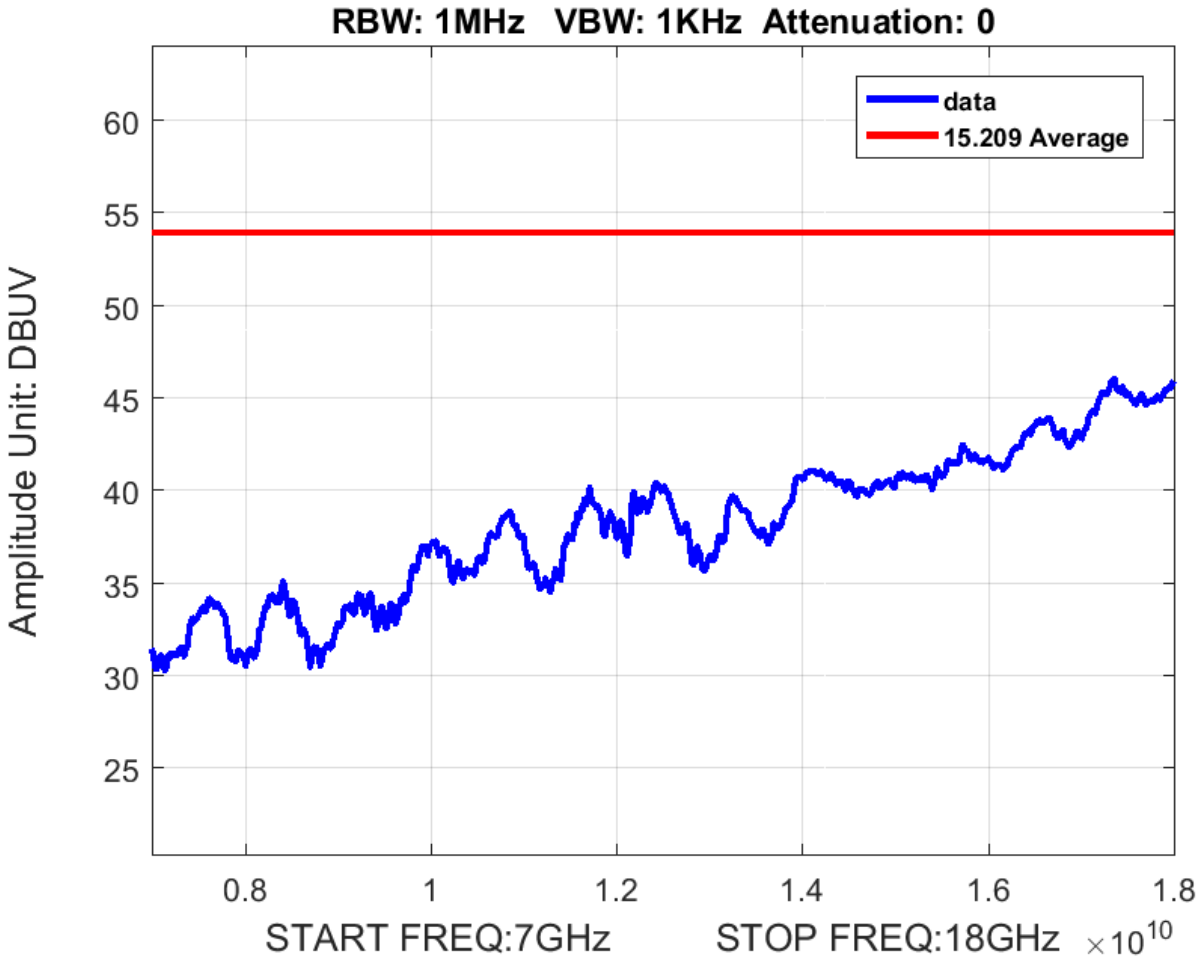
Plot 105. Peak Spurious Emission 1-7GHz, Bandwidth 20M, Ch. 2462M, n mode



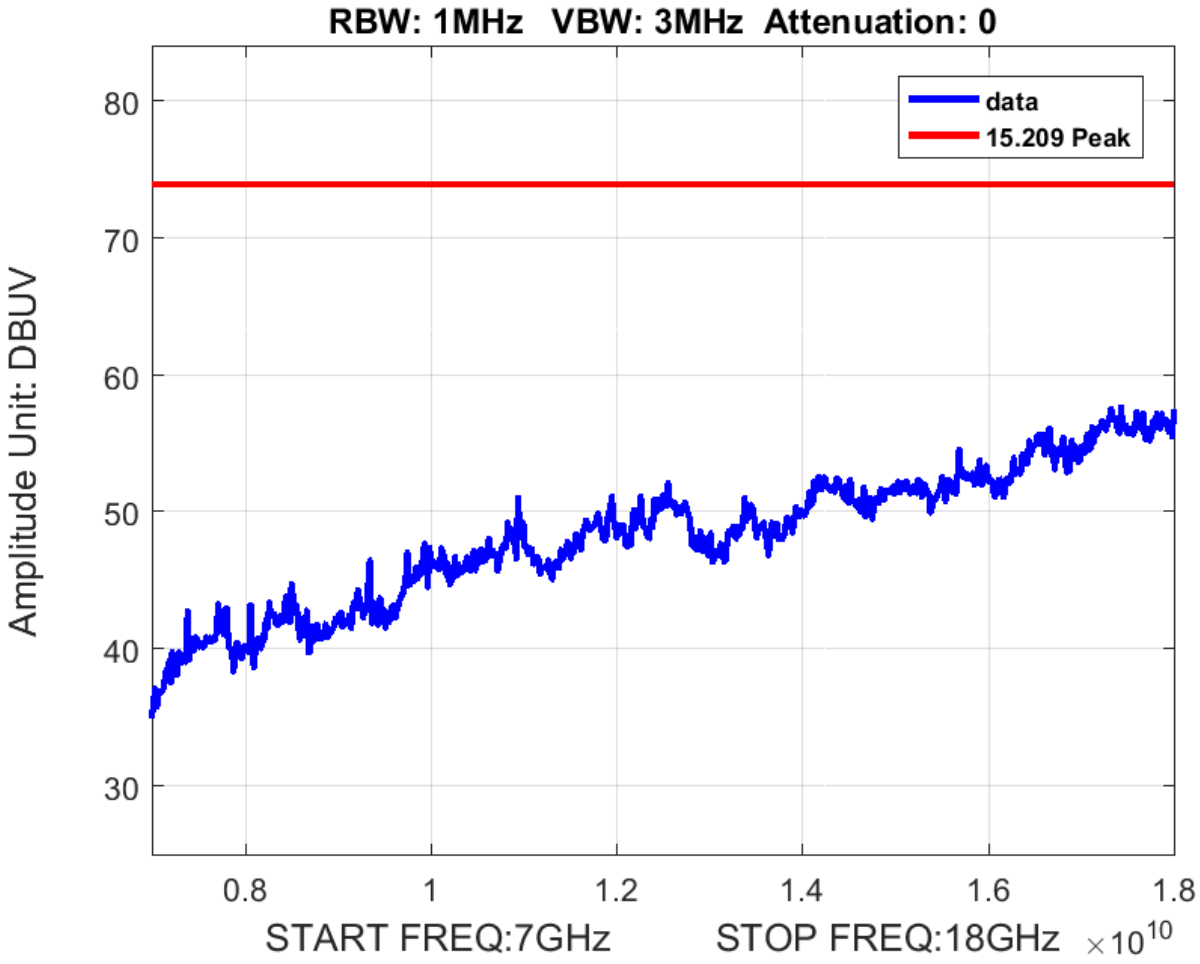
Plot 106. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2412M, n mode



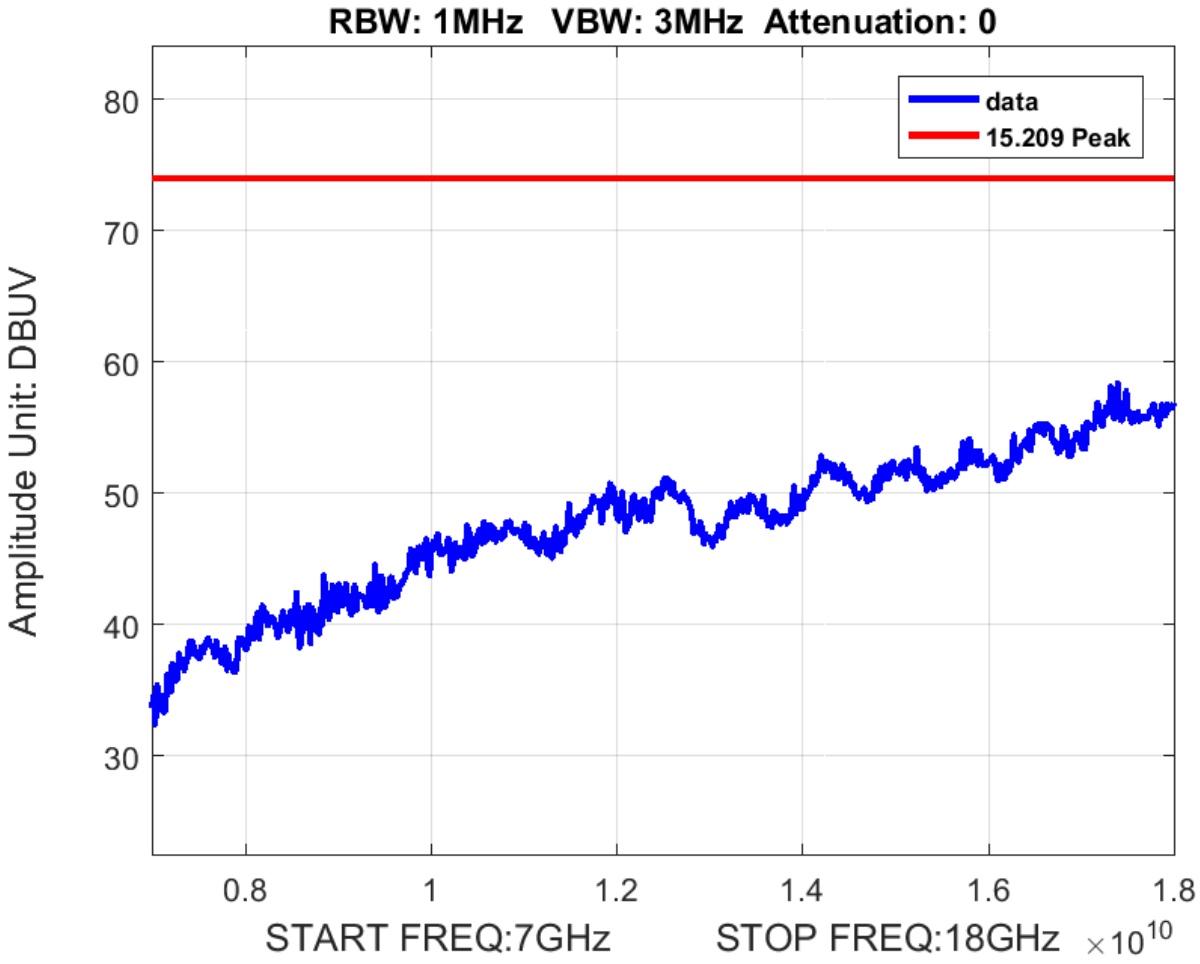
Plot 107. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2437M, n mode



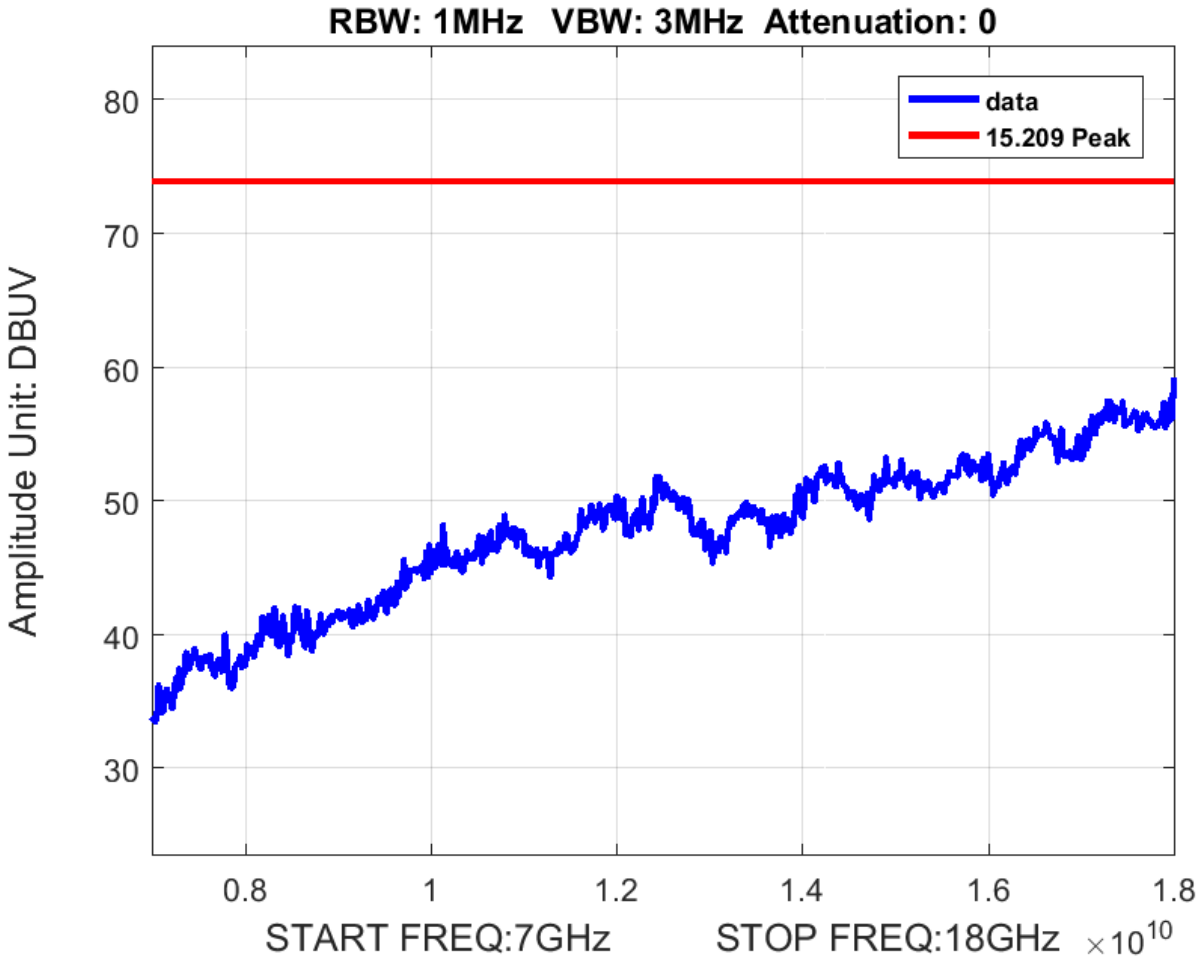
Plot 108. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2462M, n mode



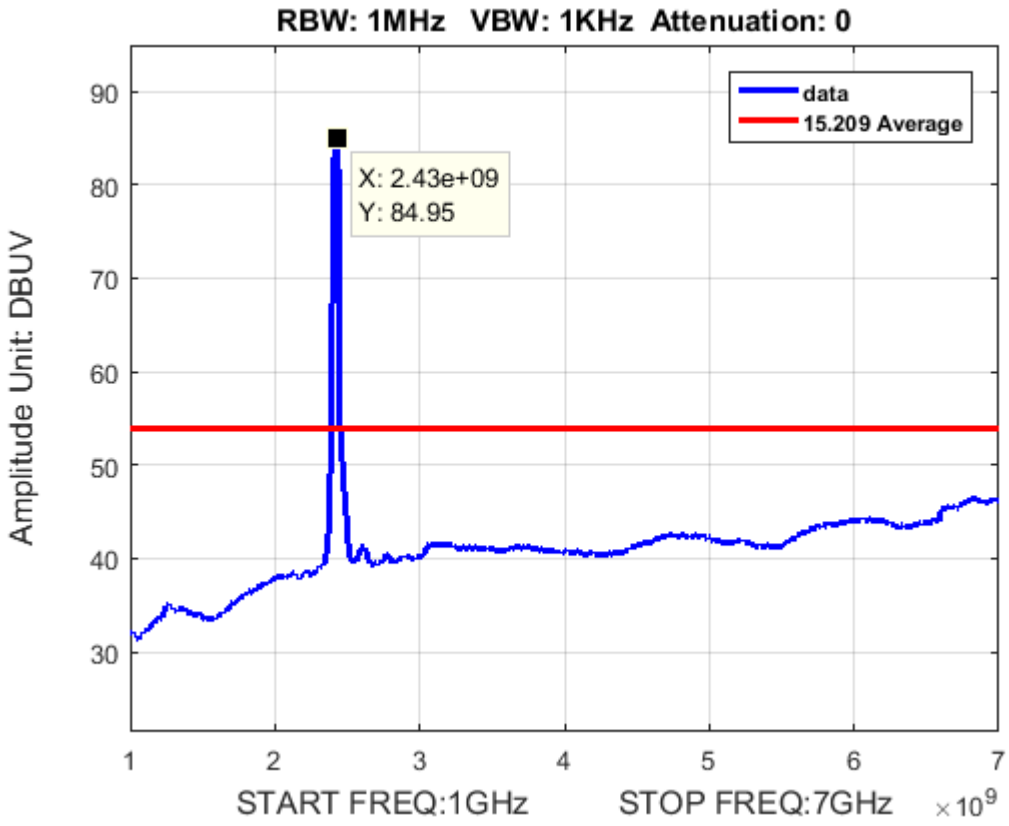
Plot 109. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2412M, n mode



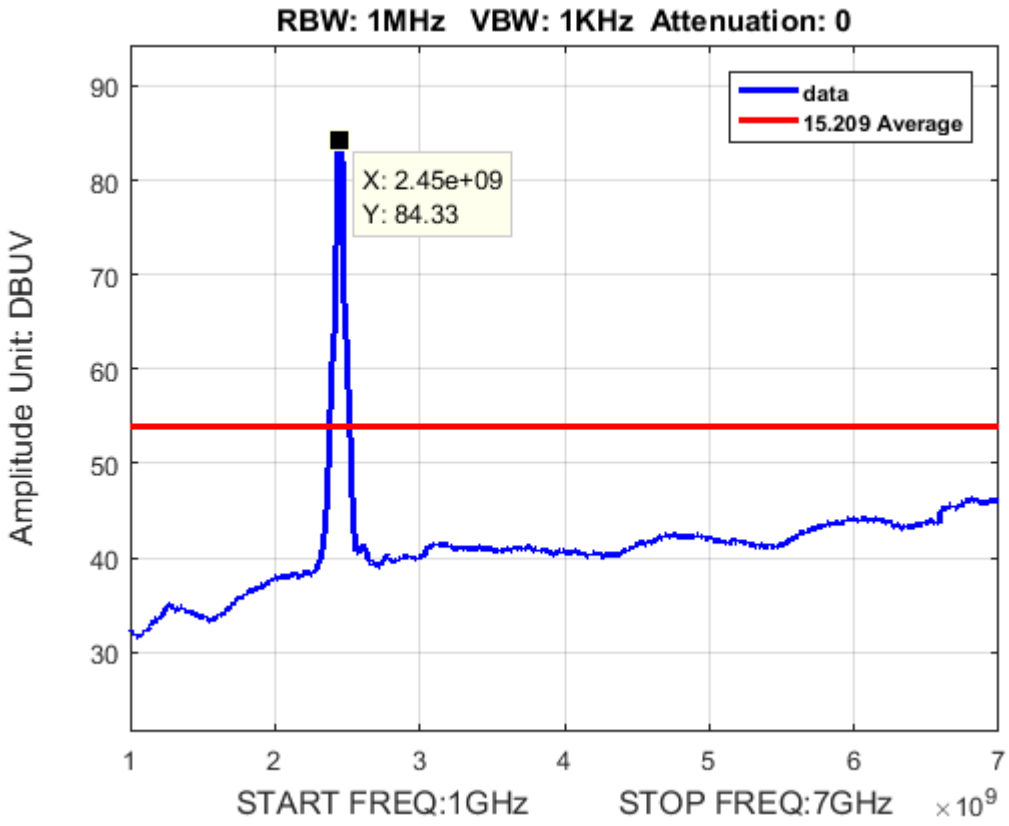
Plot 110. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2437M, n mode



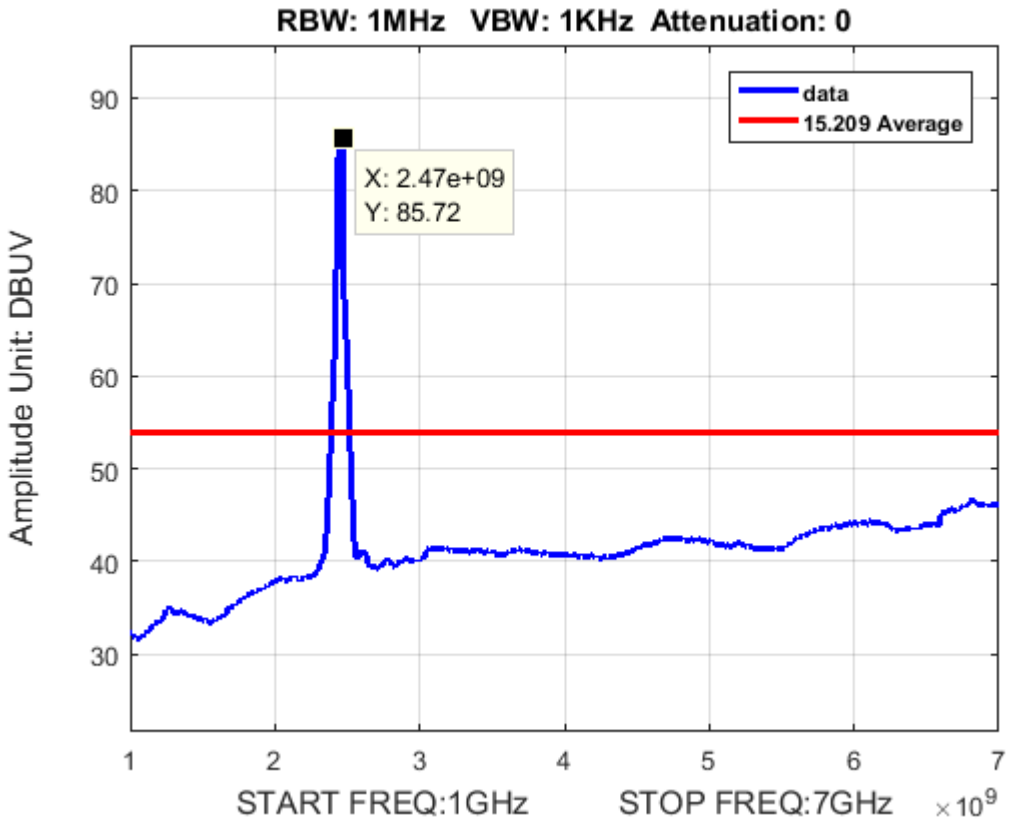
Plot 111. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2462M, n mode



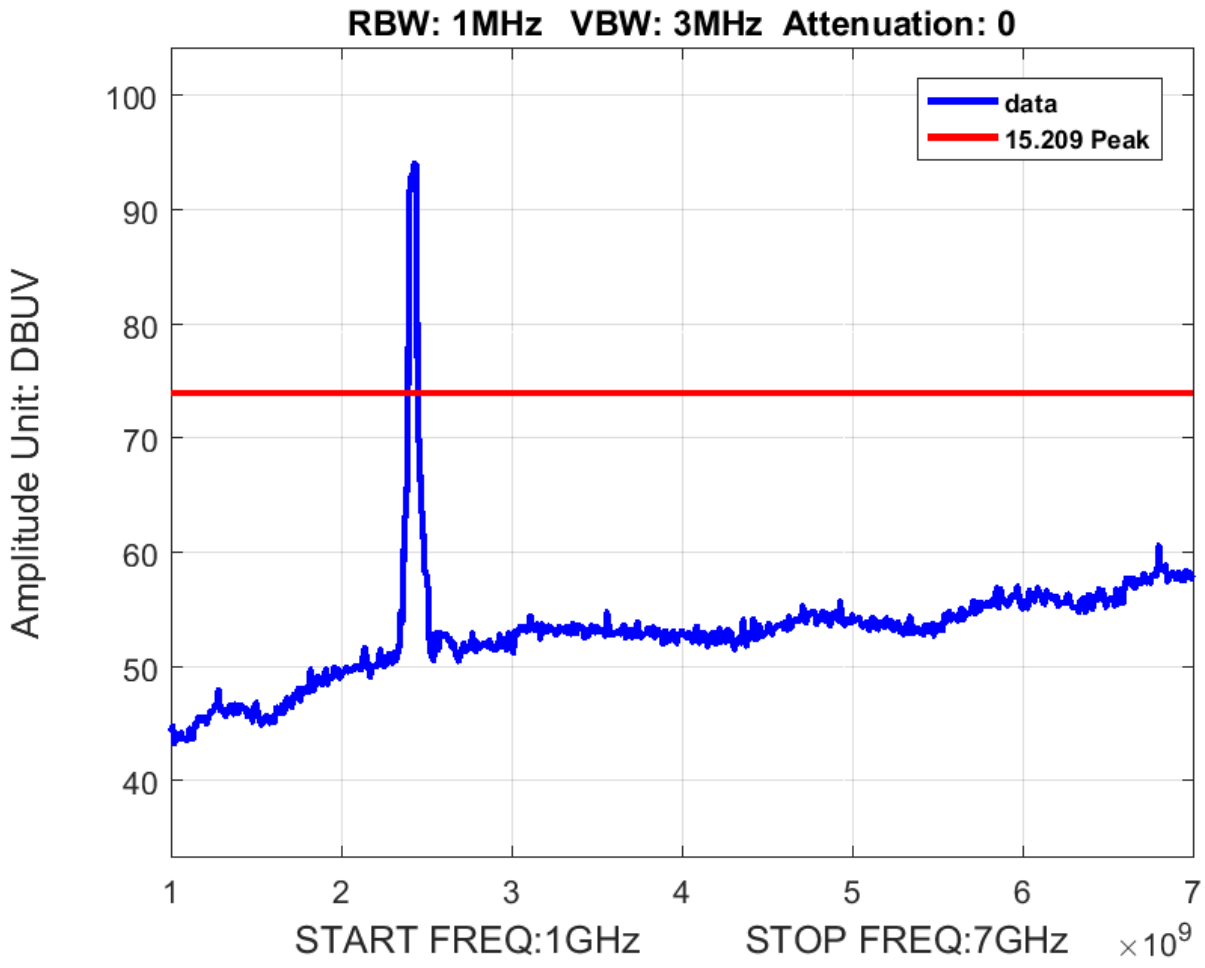
Plot 112. Average Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2422M, n mode



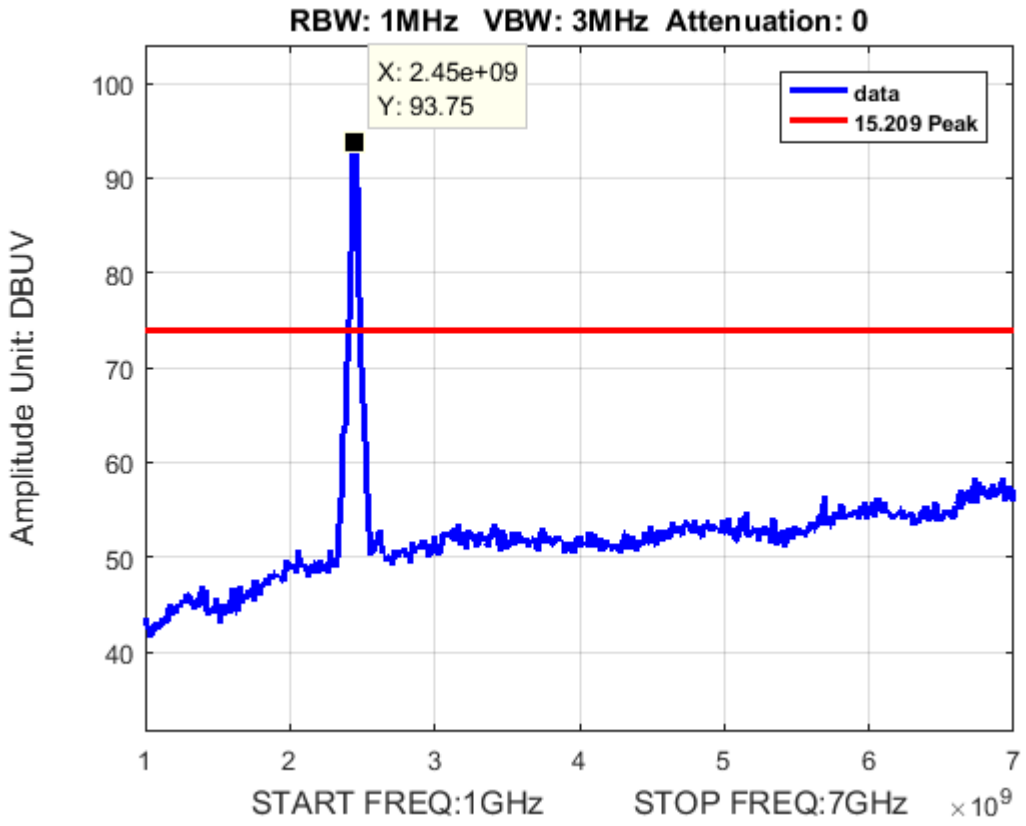
Plot 113. Average Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2437M, n mode



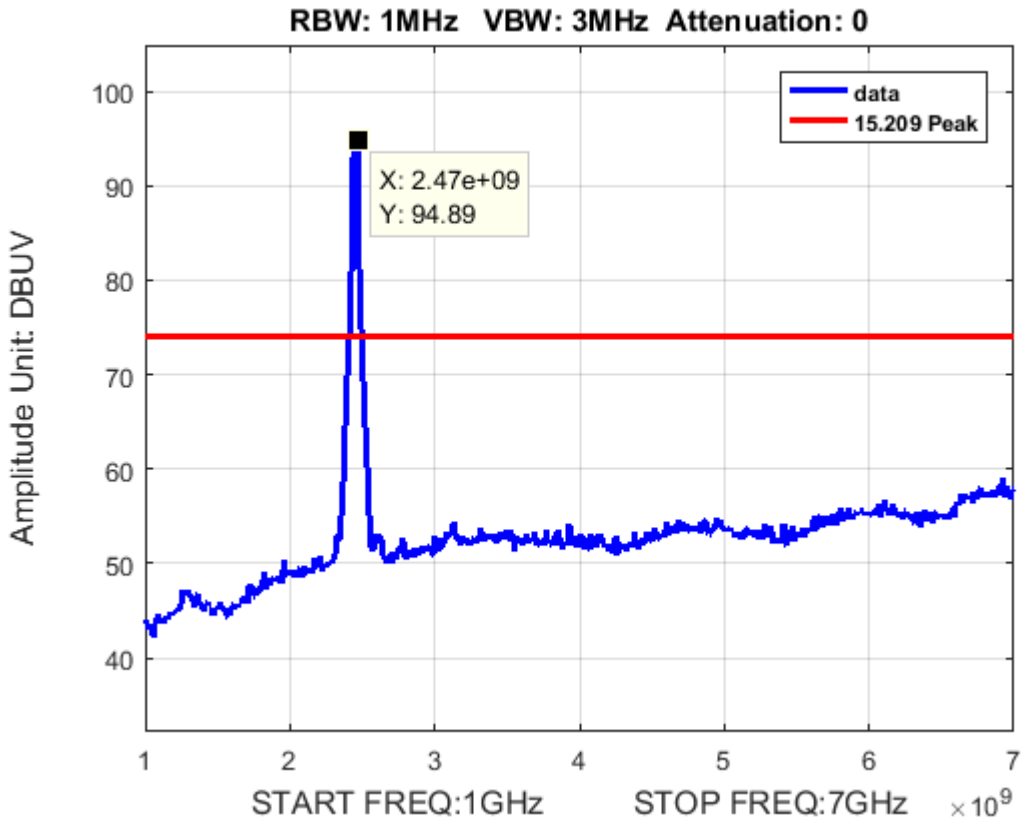
Plot 114. Average Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2452M, n mode



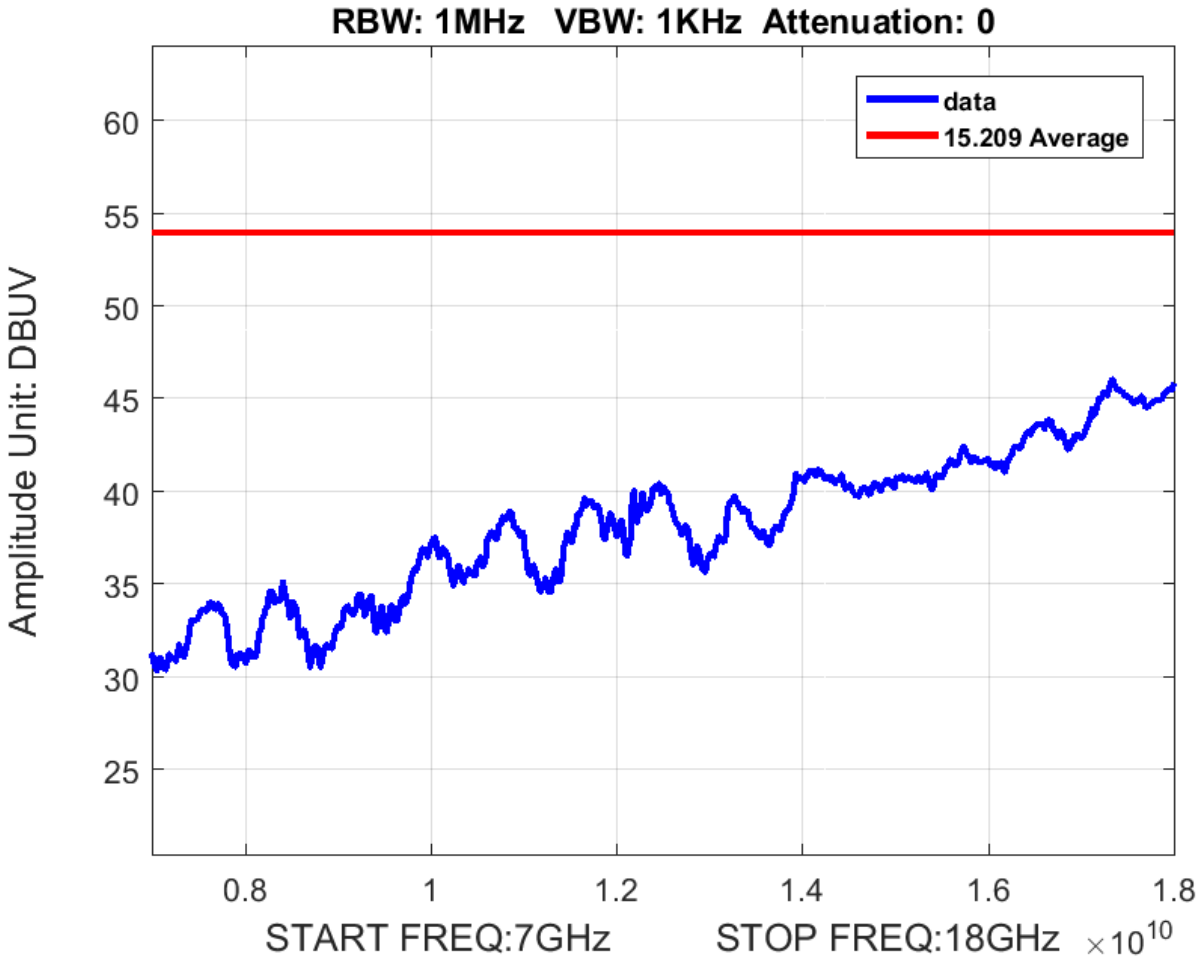
Plot 115. Peak Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2422M, n mode



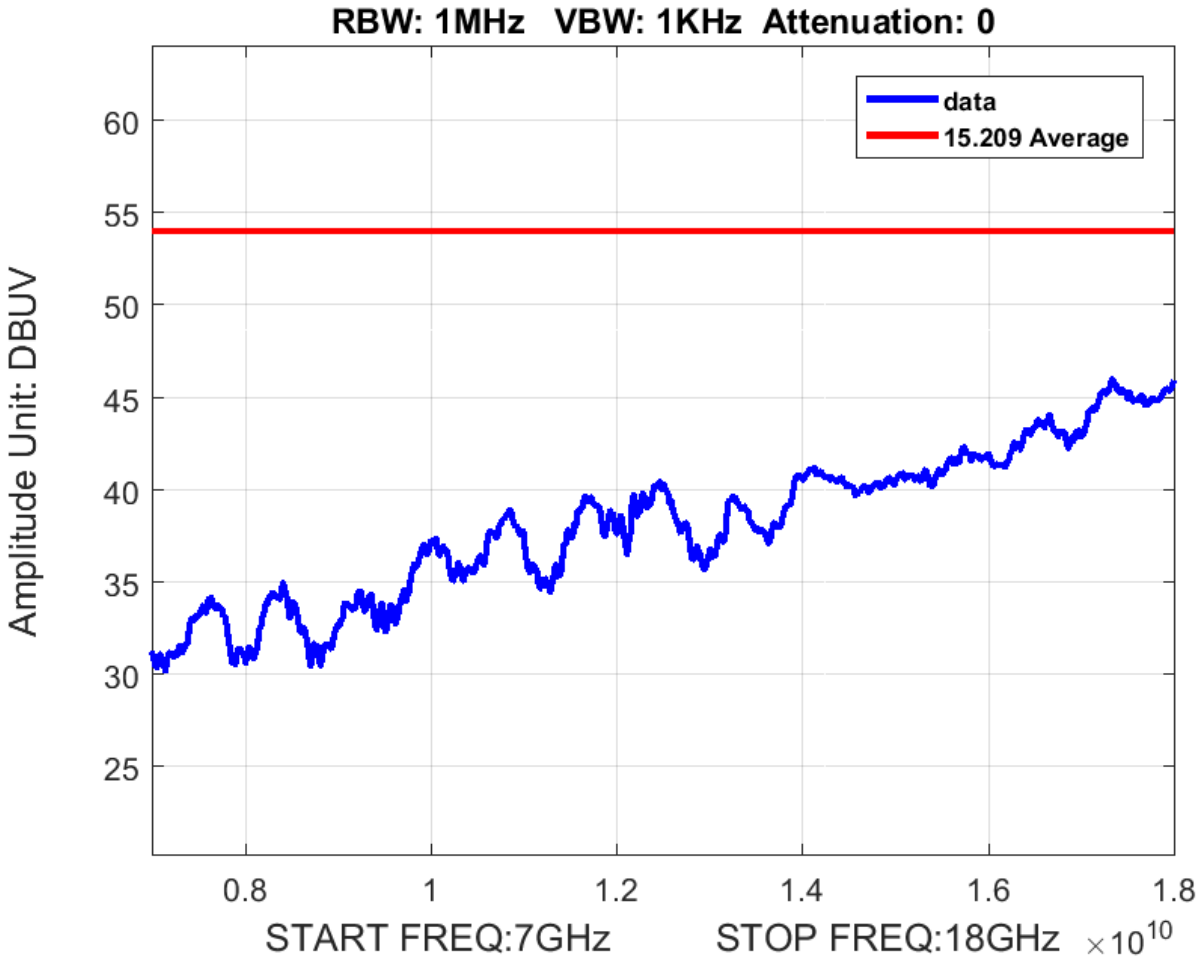
Plot 116. Peak Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2437M, n mode



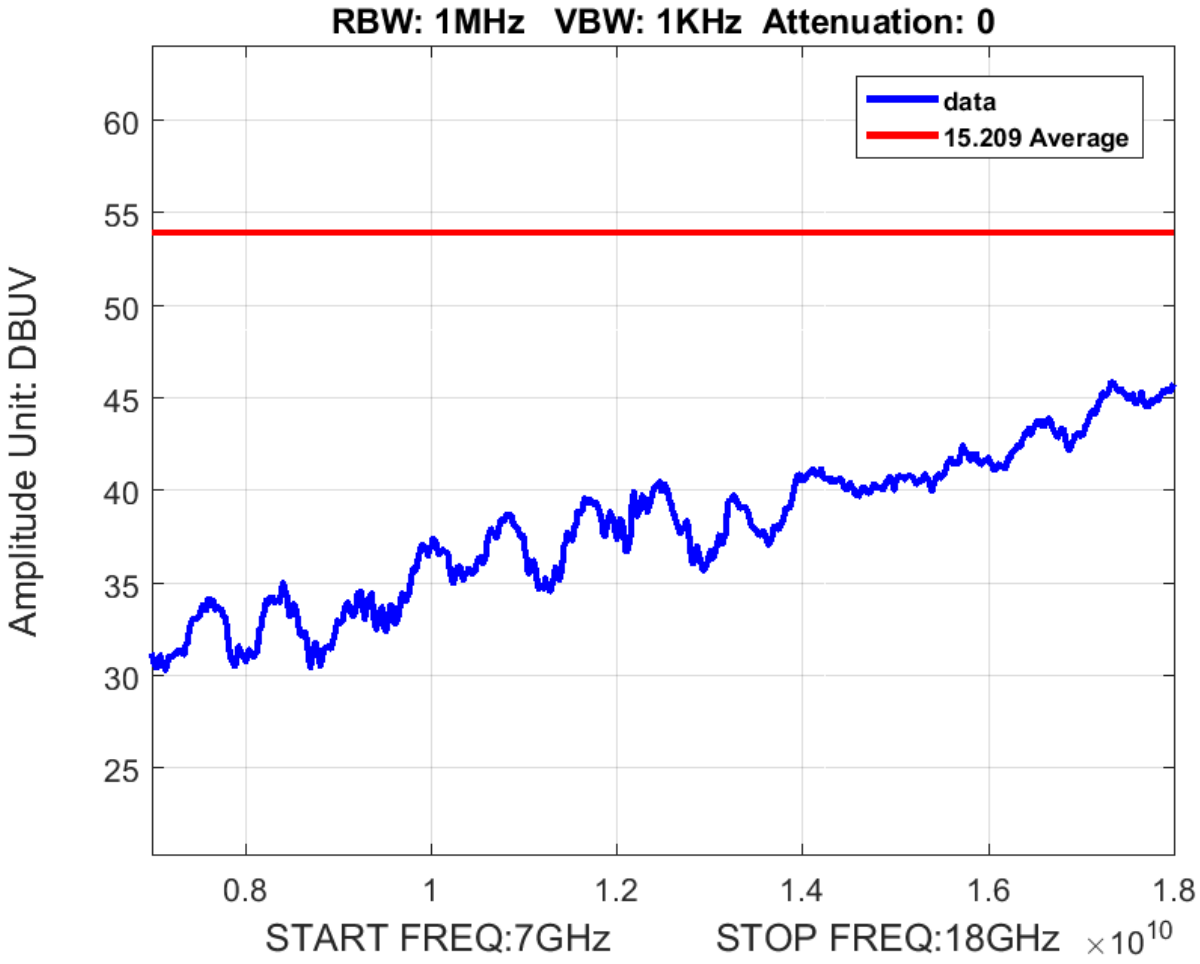
Plot 117. Peak Spurious Emission 1-7GHz, Bandwidth 40M, Ch. 2452M, n mode



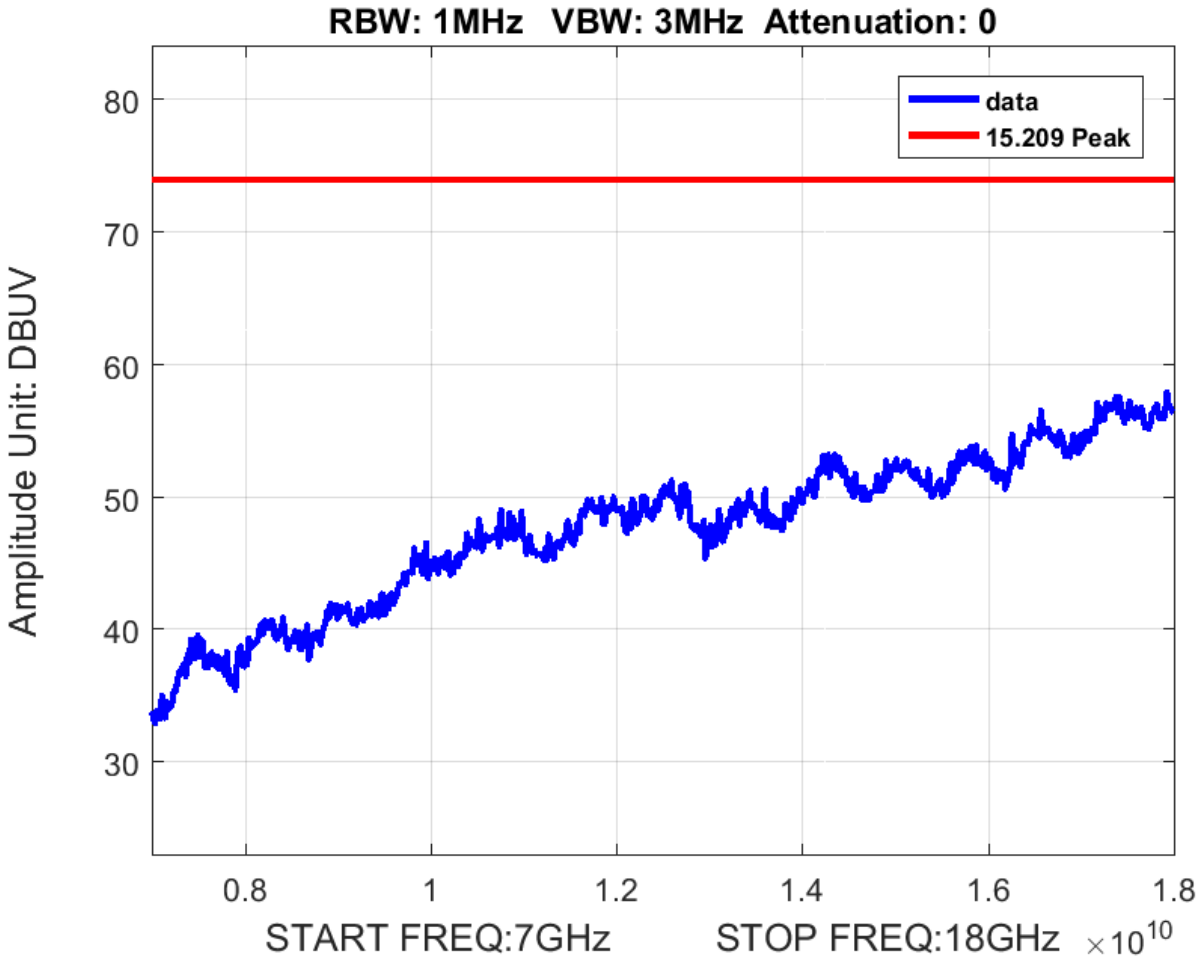
Plot 118. Average Spurious Emssion 7-18GHz, Bandwidth 20M, Ch. 2422M, n mode



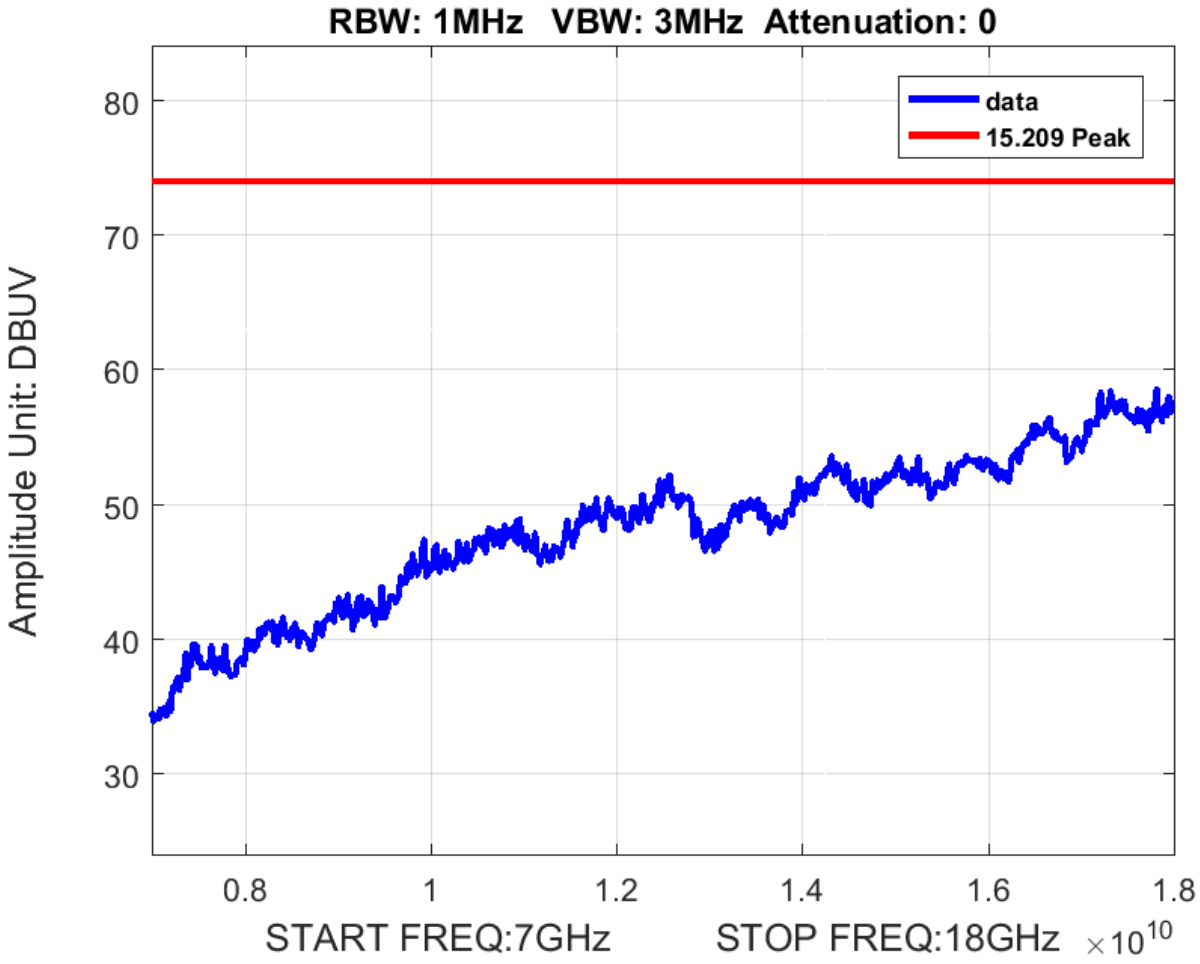
Plot 119. Average Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2437M, n mode



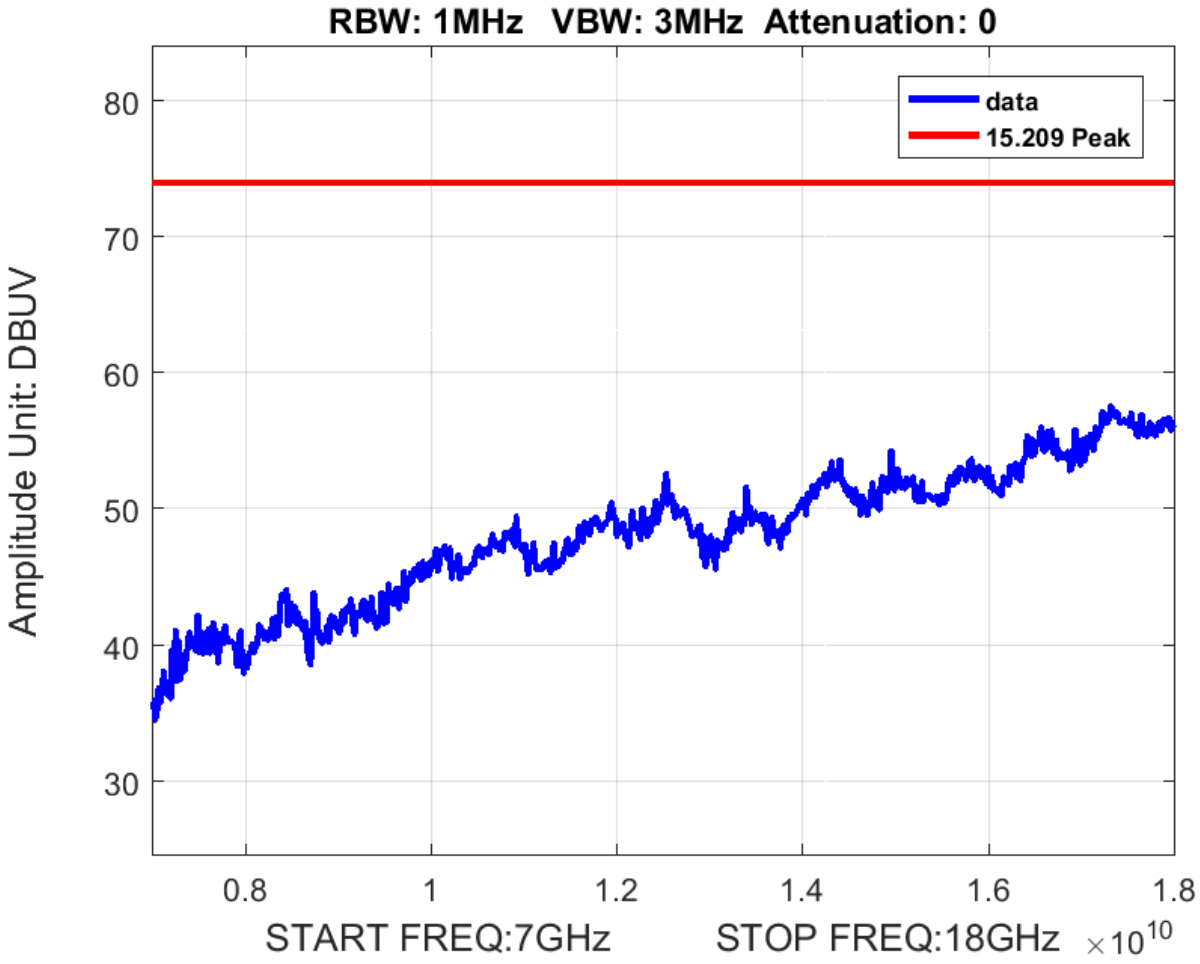
Plot 120. Peak Spurious Emission 7-18GHz, Bandwidth 20M Ch. 2452M, n mode



Plot 121. Peak Spurious Emission, 7-18GHz, Bandwidth 20M, Ch. 2422M, n mode



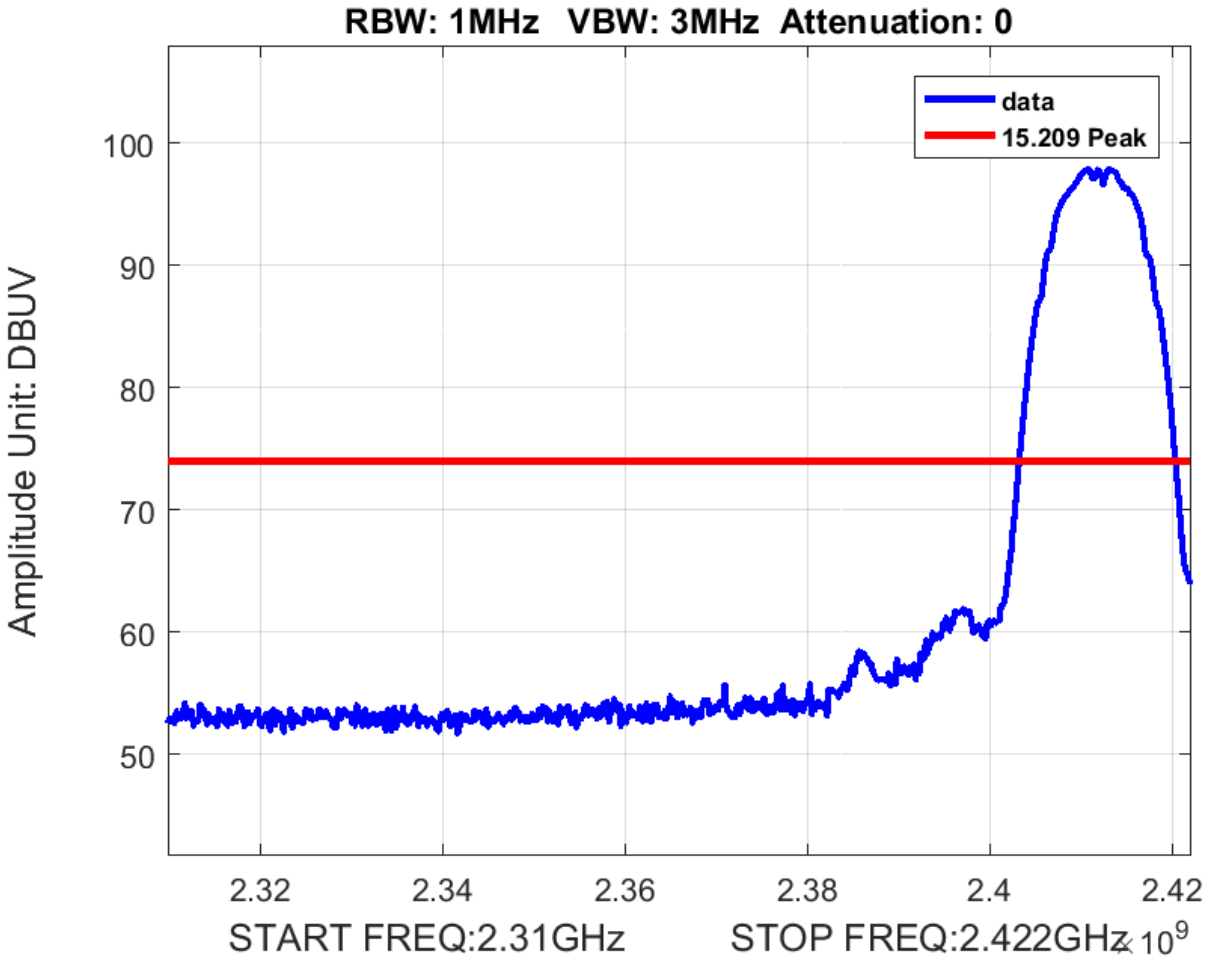
Plot 122. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2437M, n mode



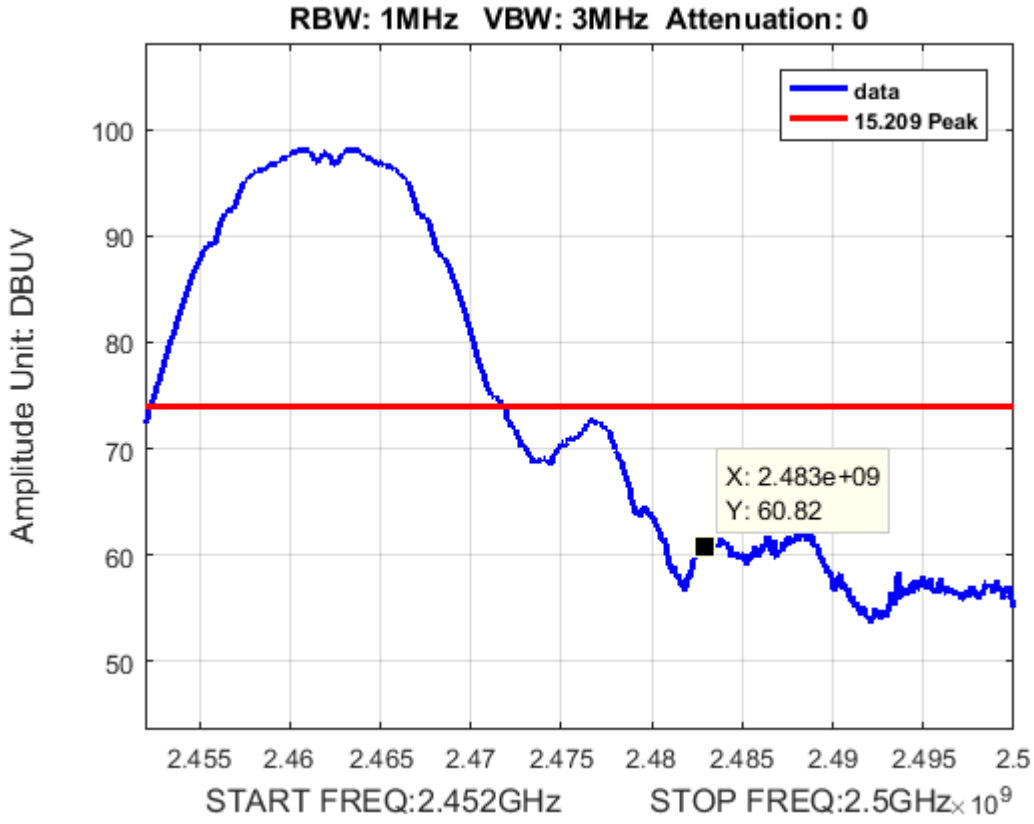
Plot 123. Peak Spurious Emission 7-18GHz, Bandwidth 20M, Ch. 2452M, n mode

Radiated Band Edge Measurements

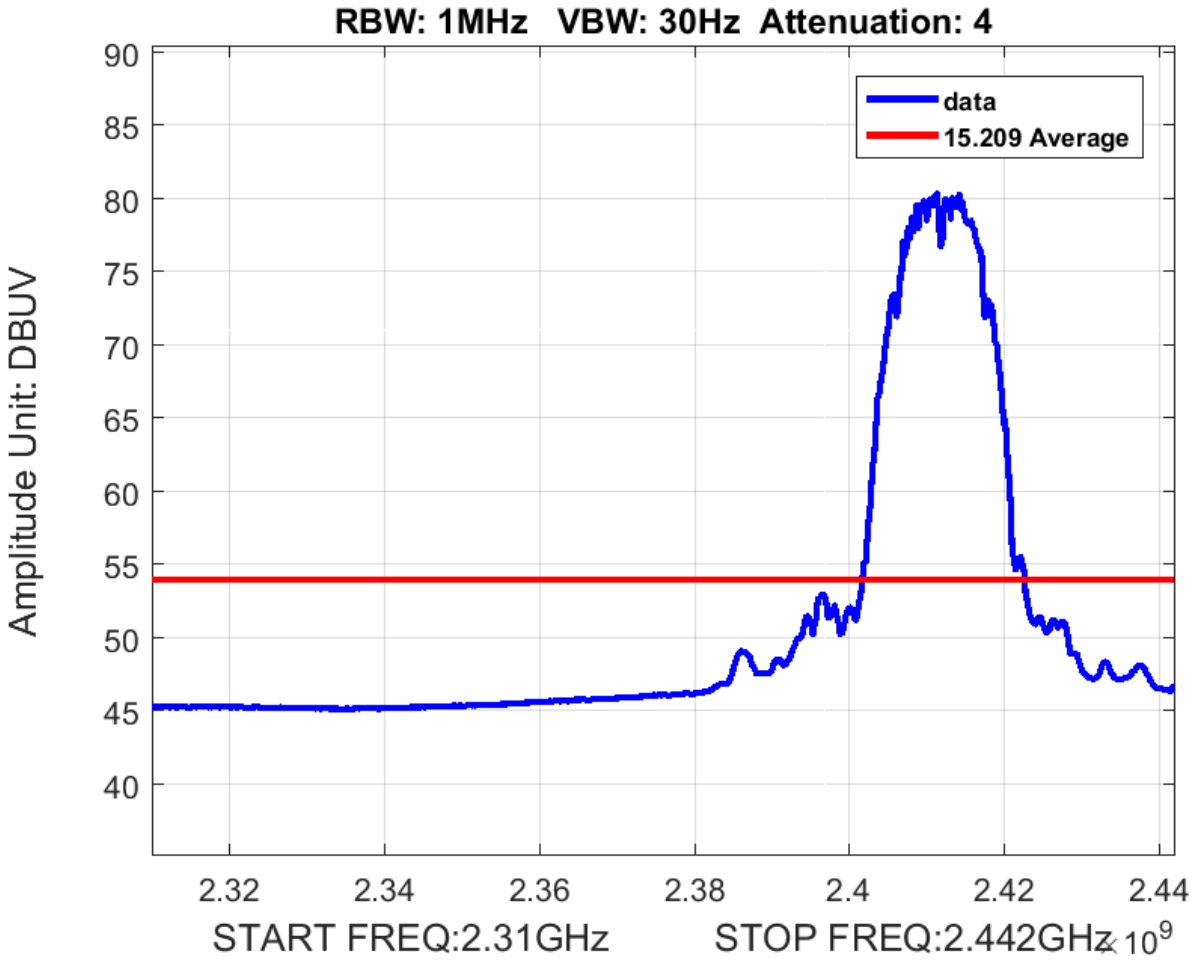
Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



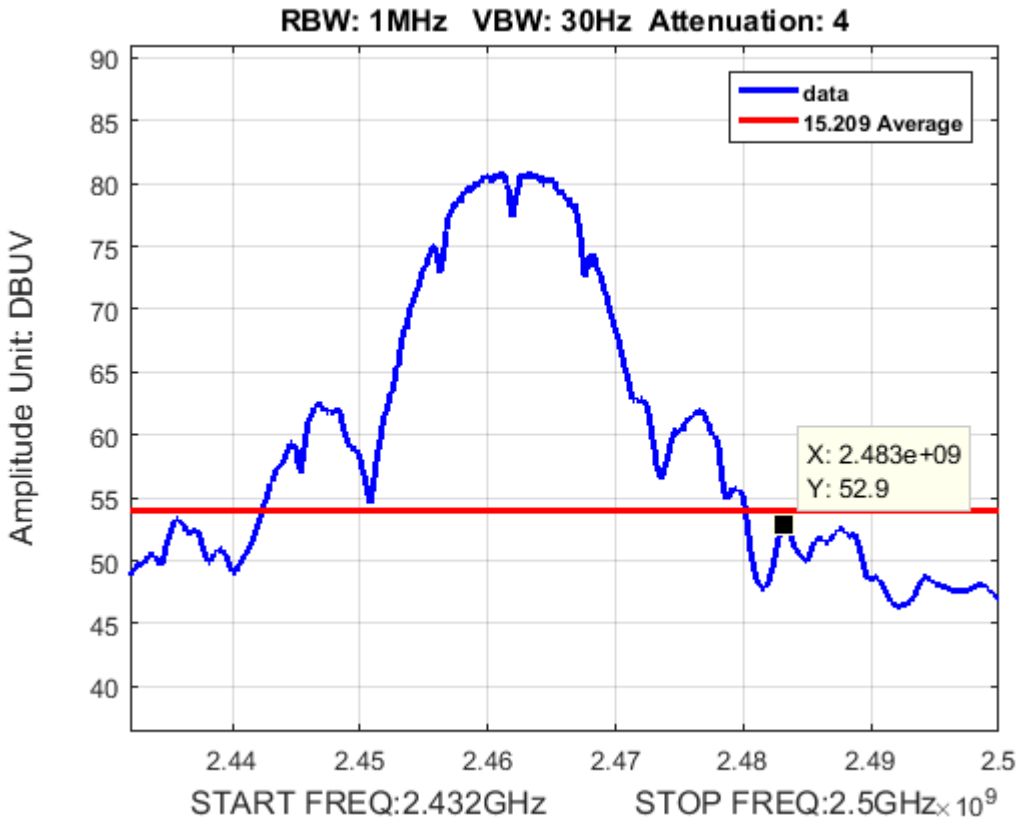
Plot 124. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2412M, b mode



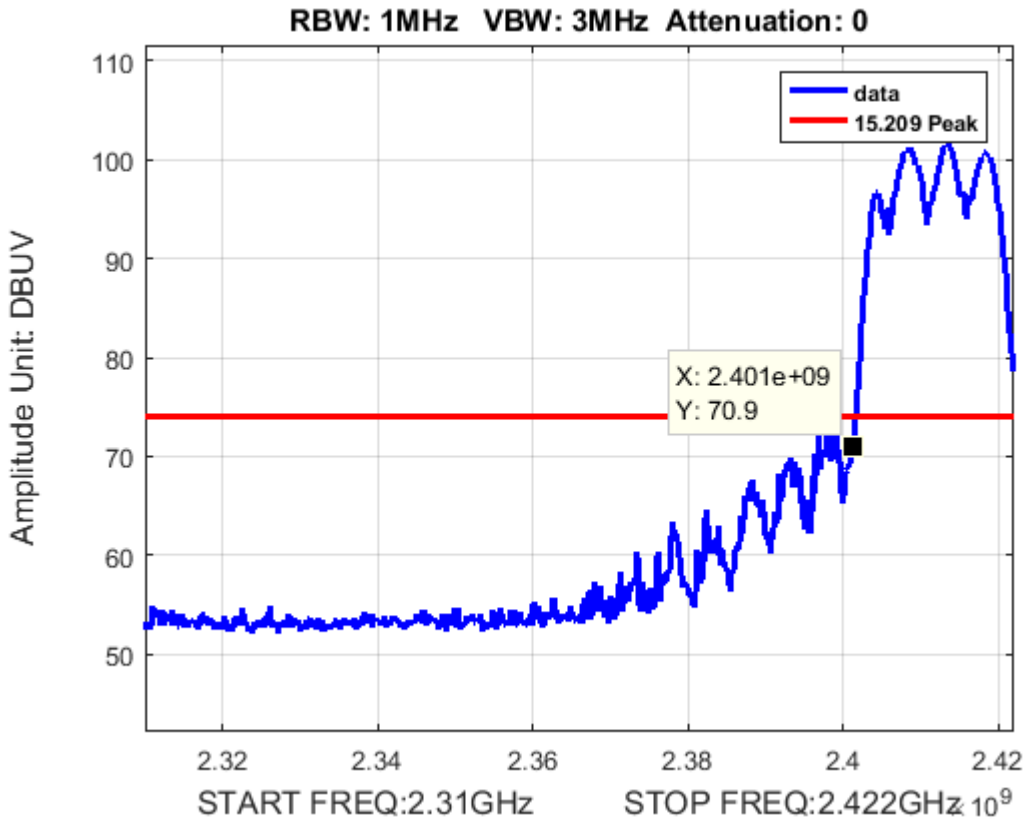
Plot 125. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2462M, b mode



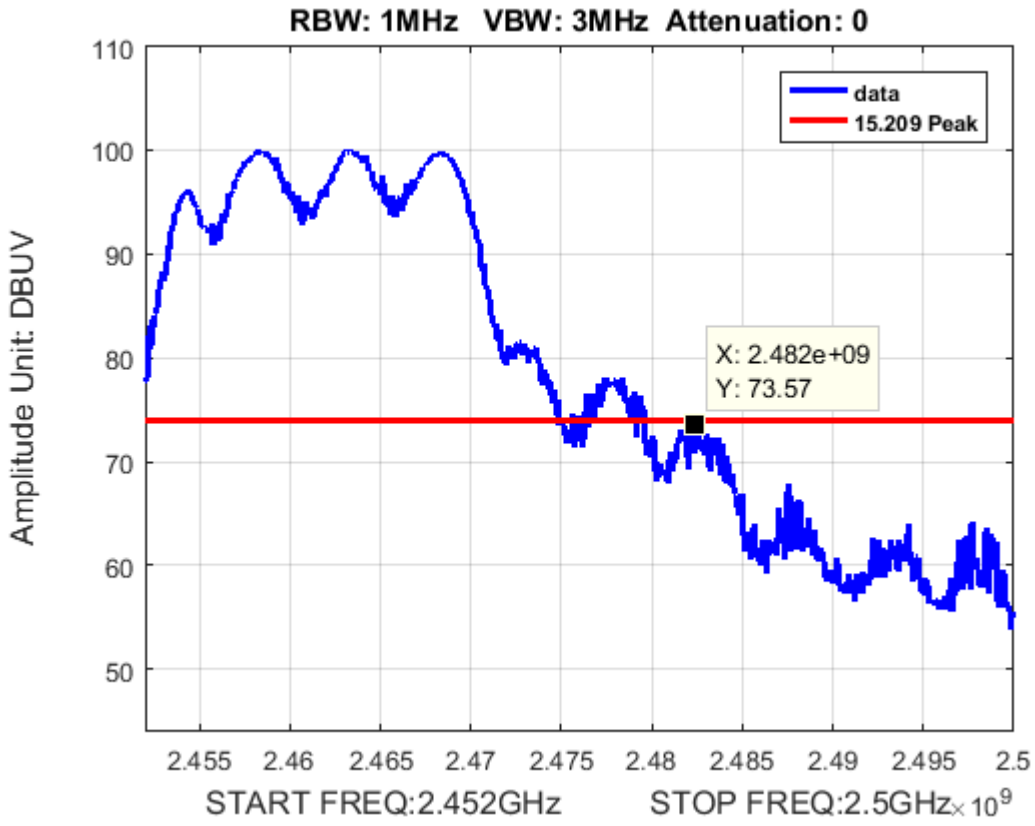
Plot 126. Average Band Edge Spurious, Bandwidth 20M, Ch. 2412M, b mode



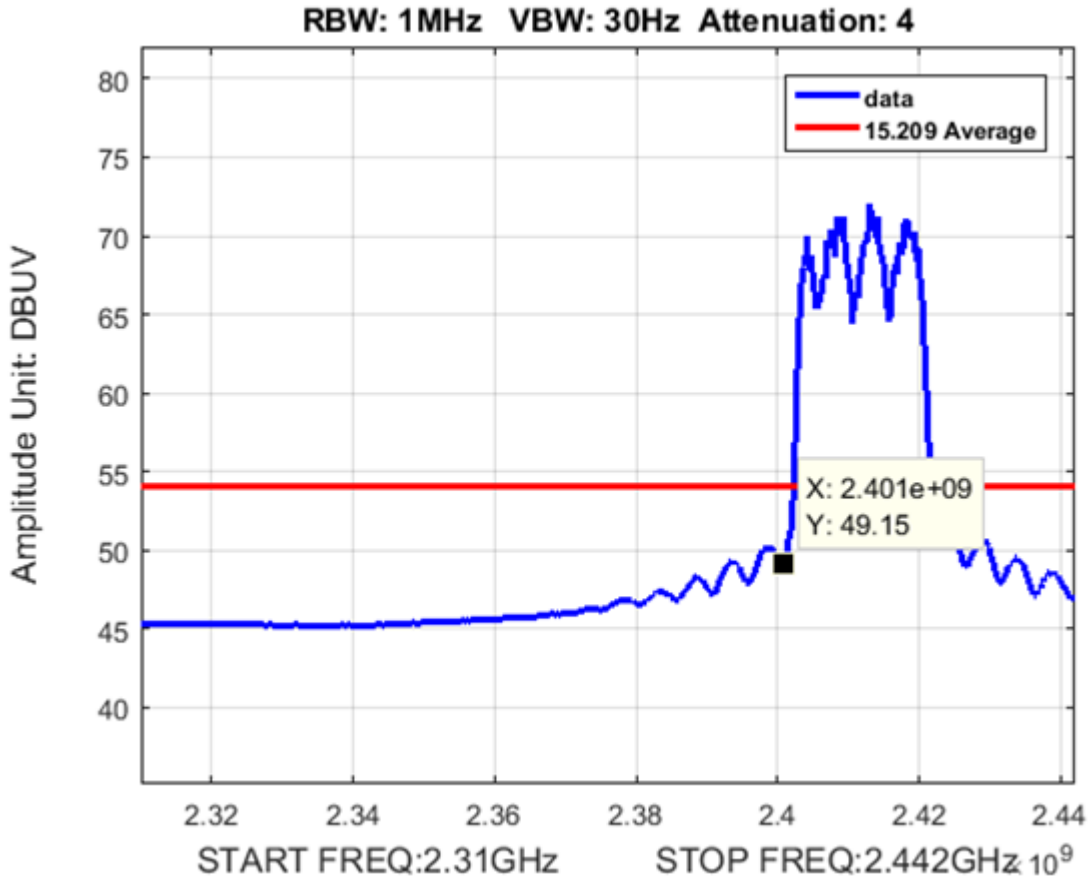
Plot 127. Average Band Edge Spurious, Bandwidth 20M, Ch. 2462M, b mode



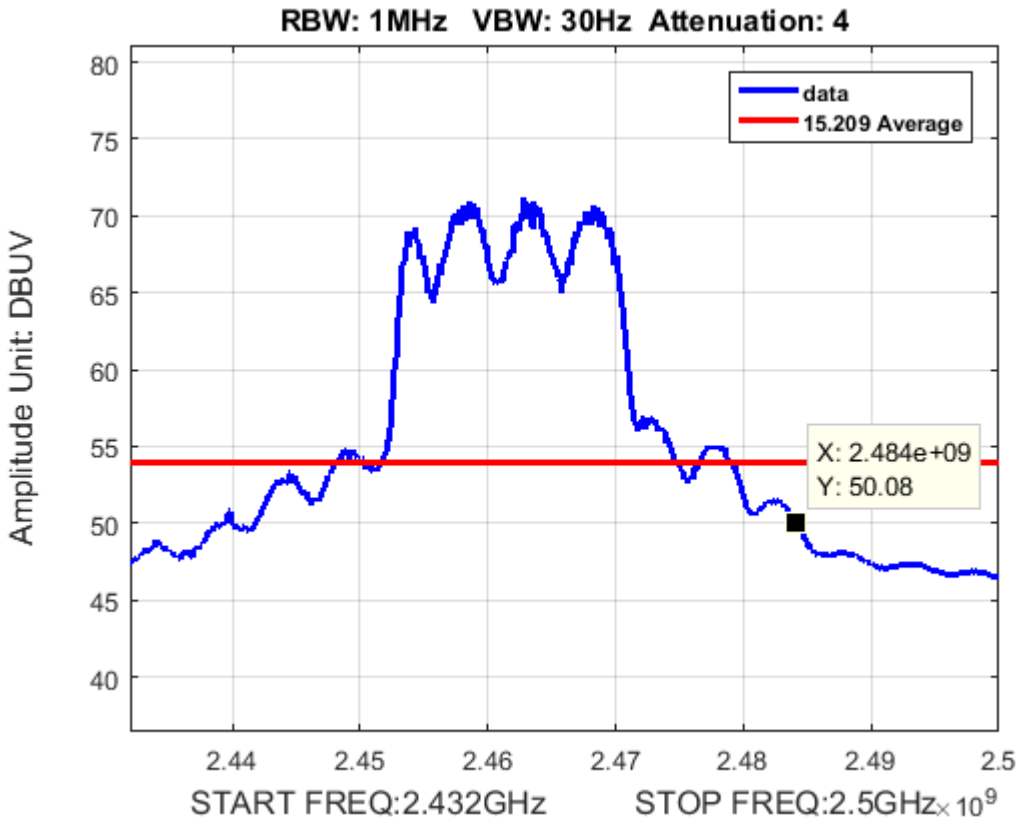
Plot 128. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2412M, g mode



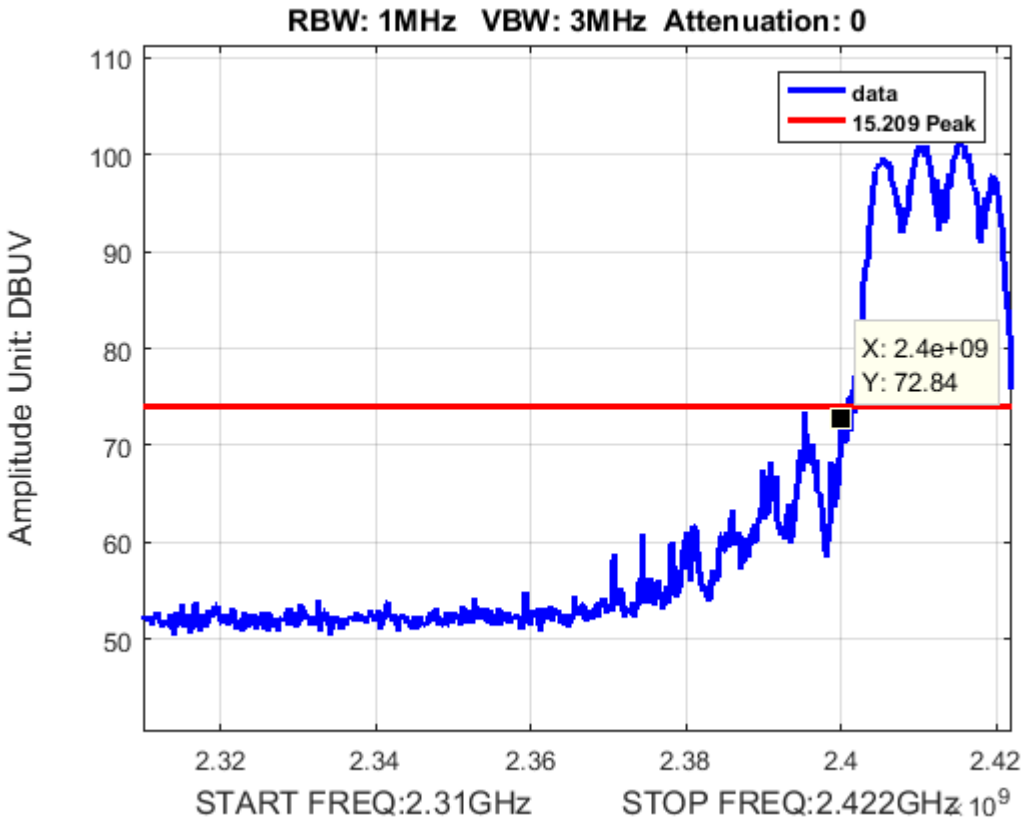
Plot 129. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2462M, g mode



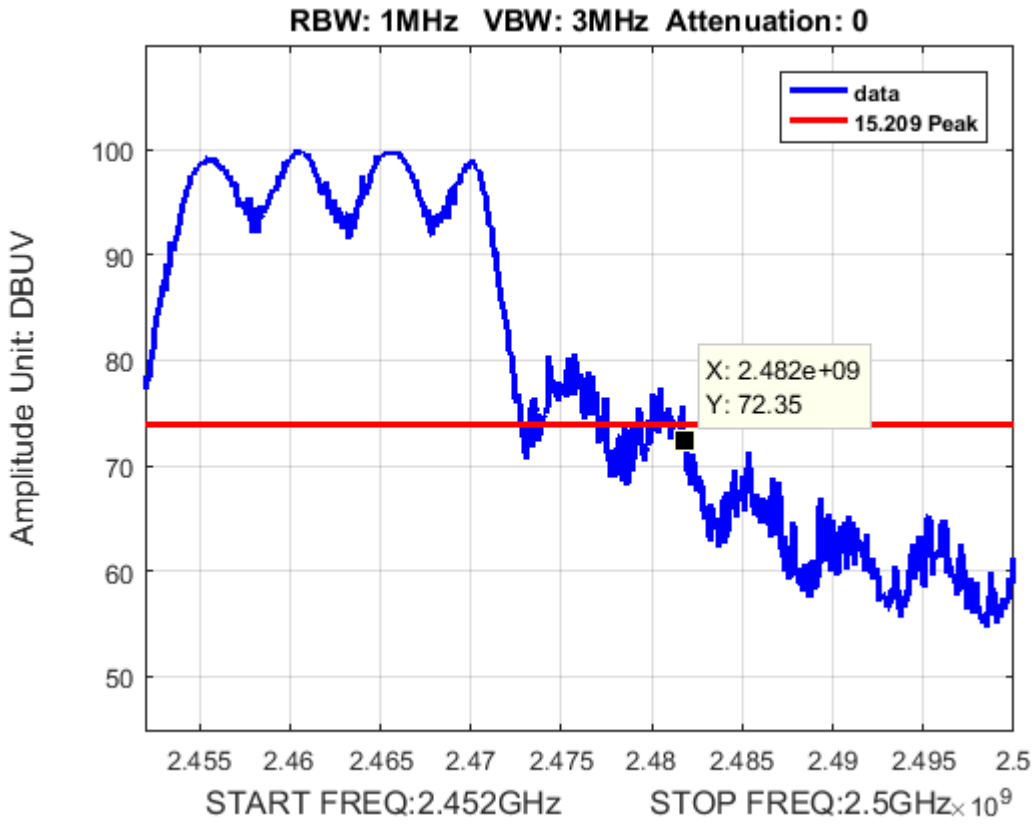
Plot 130. Average Edge Spurious, Bandwidth 20M, Ch. 2412M, g mode



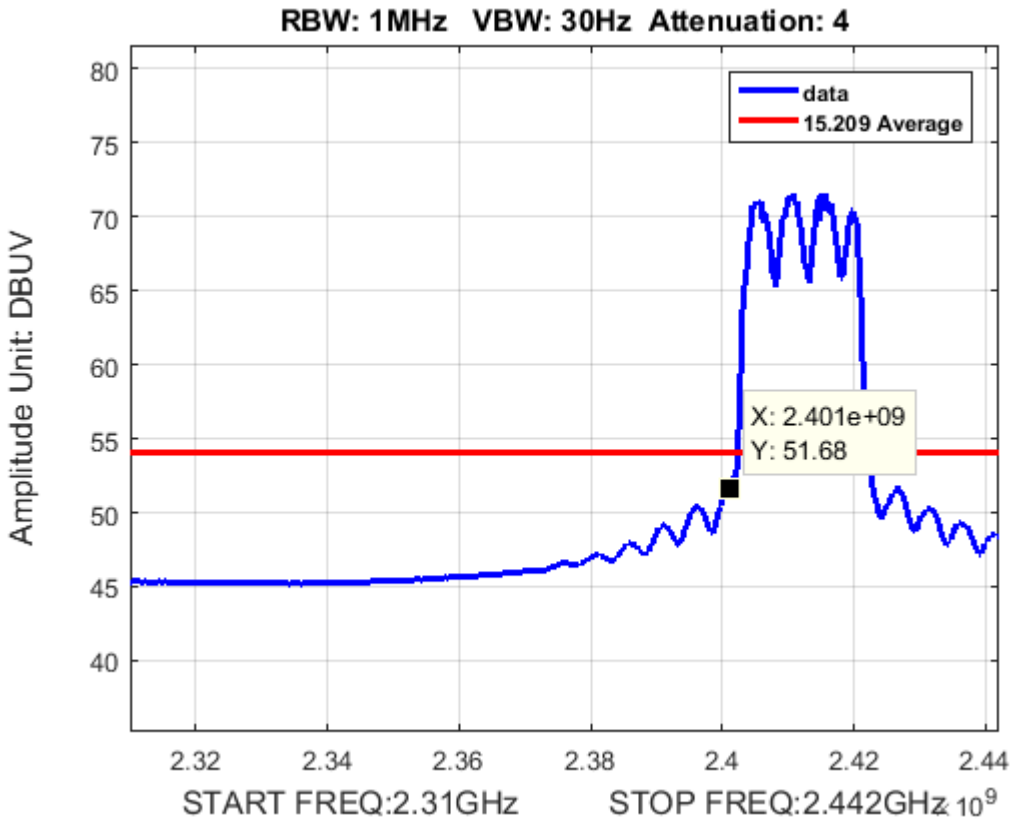
Plot 131. Average Band Edge Spurious, Bandwidth 20M, Ch. 2462M, g mode



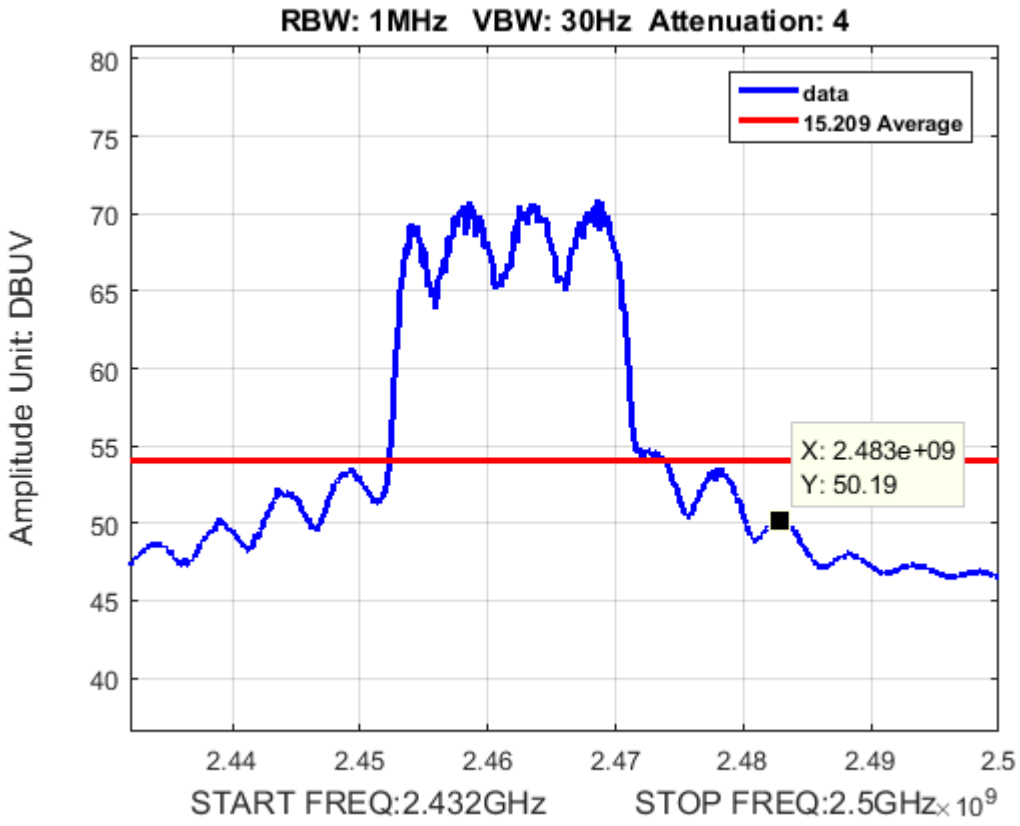
Plot 132. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2412M, n mode



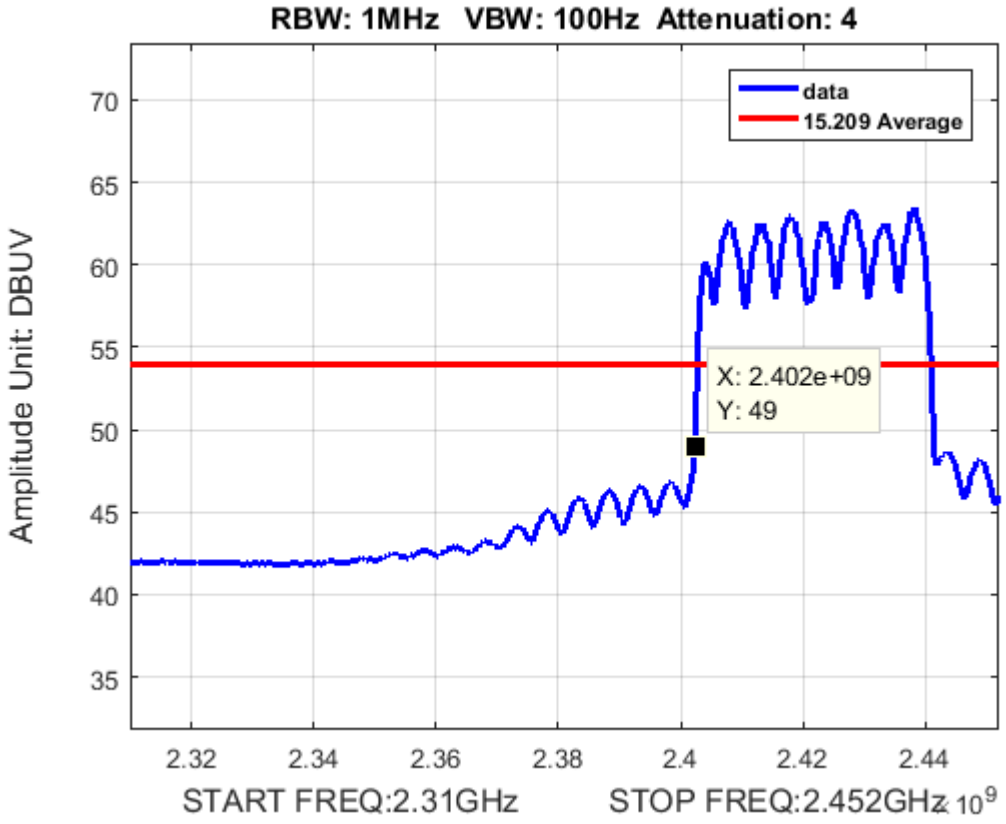
Plot 133. Peak Band Edge Spurious, Bandwidth 20M, Ch. 2462M, n mode



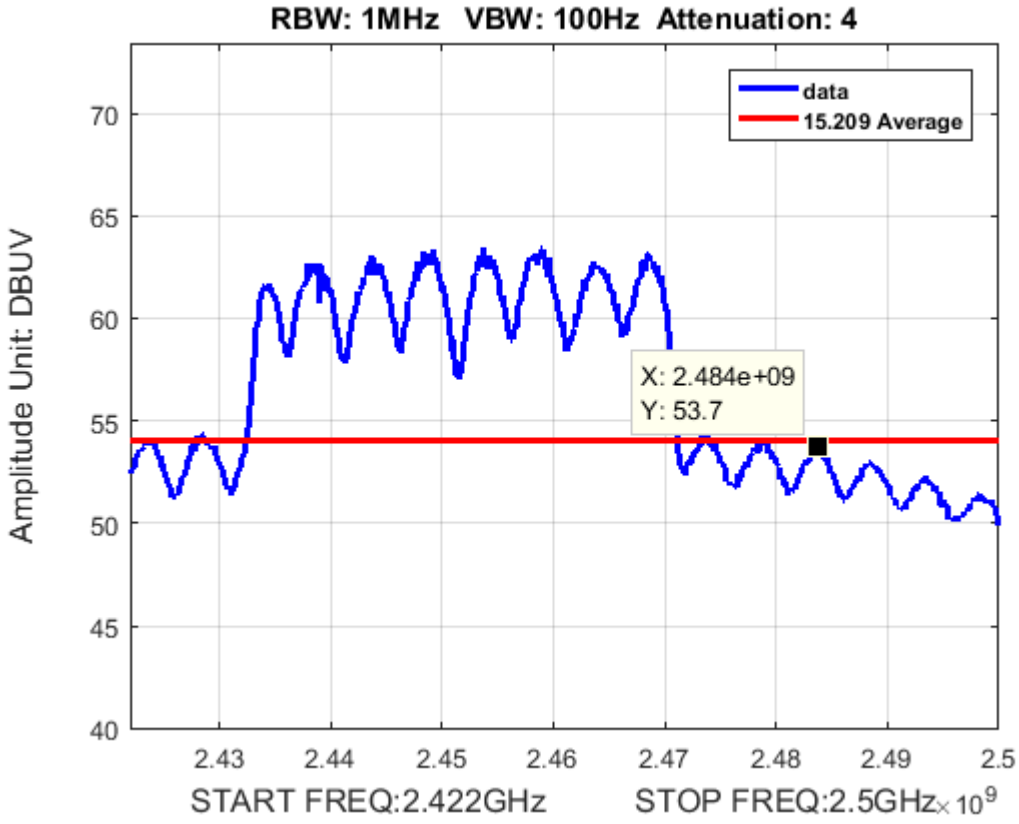
Plot 134. Average Band Edge Spurious, Bandwidth 20M, Ch. 2412M, n mode



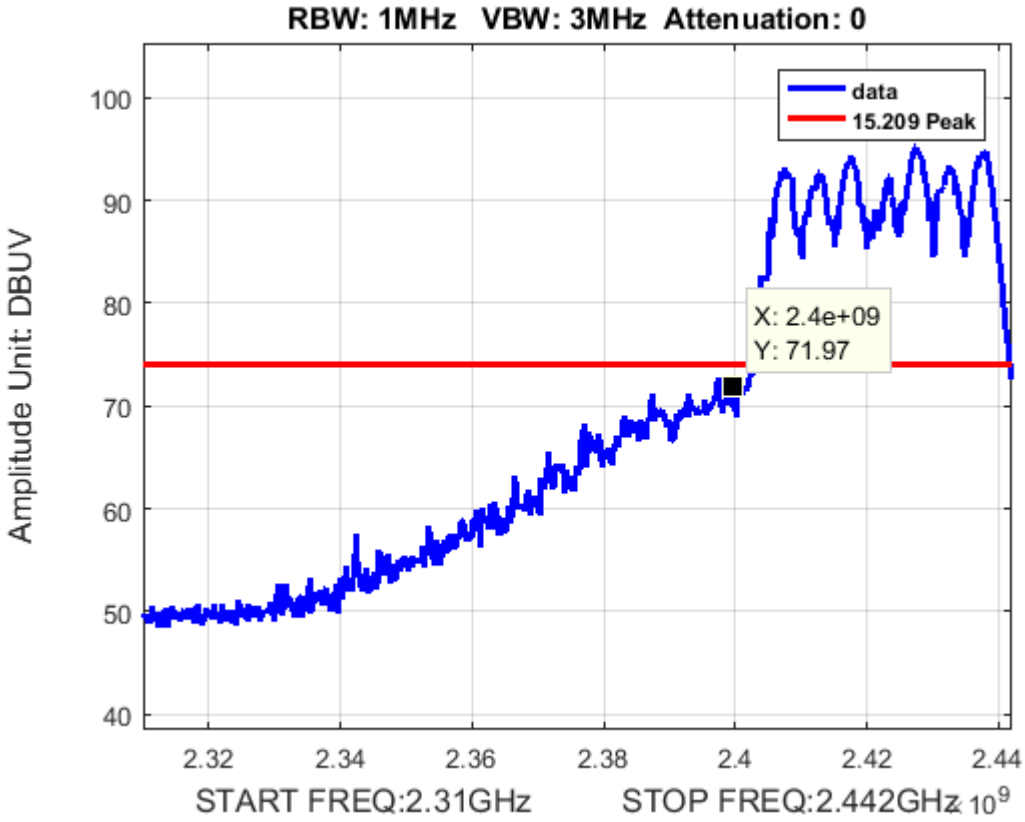
Plot 135. Average Band Edge Spurious, Bandwidth 20M, Ch. 2462M, n mode



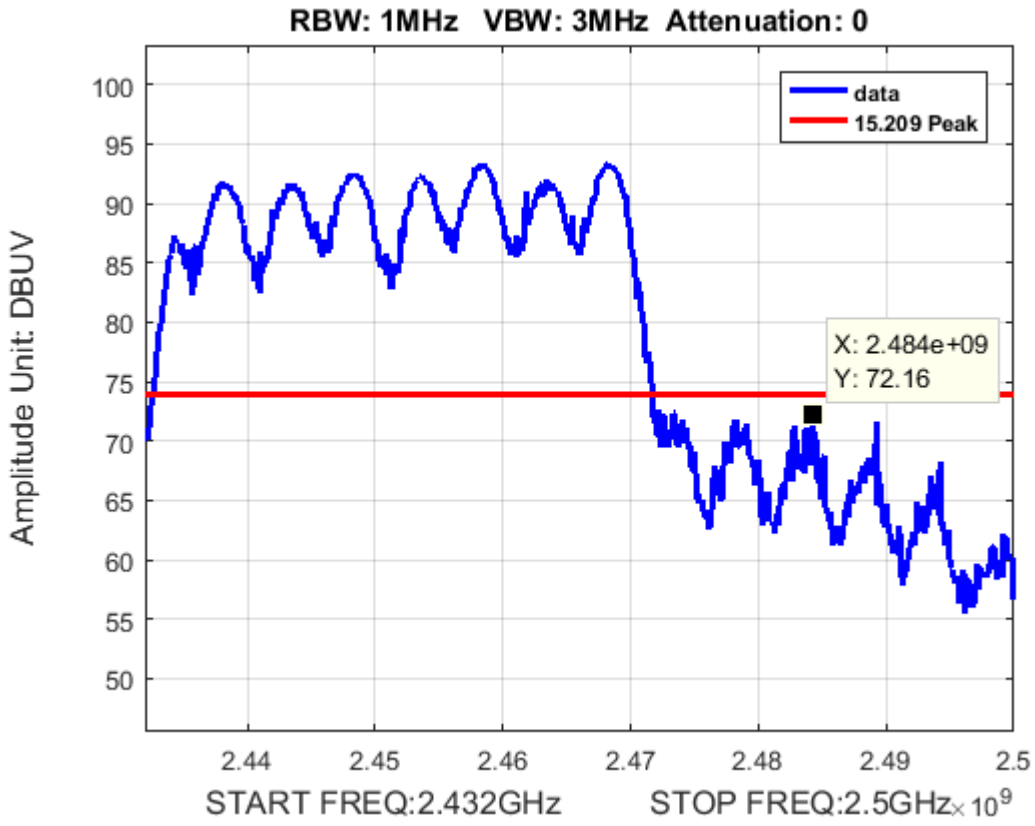
Plot 136. Average Band Edge Spurious, Bandwidth 40M, Ch. 2422M, n mode



Plot 137. Average Band Edge Spurious, Bandwidth 40M, Ch. 2452M, n mode



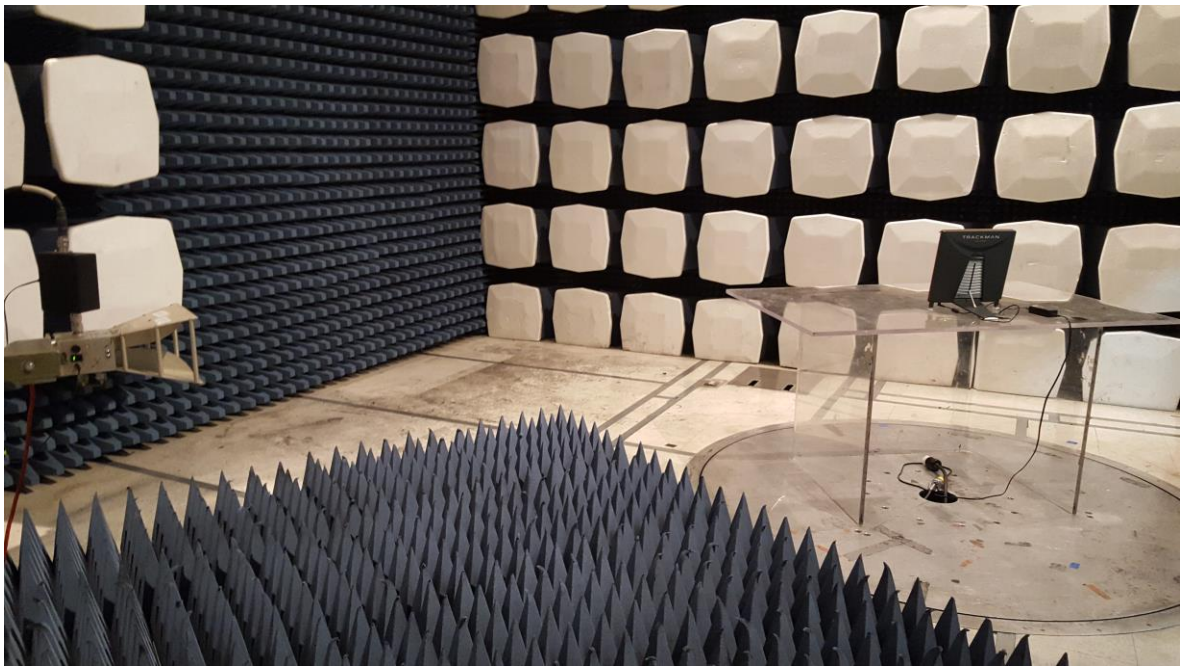
Plot 138. Peak Band Edge Spurious, Bandwidth 40M, Ch. 2422M, n mode



Plot 139. Peak Band Edge Spurious, Bandwidth 40M, Ch. 2452M, n mode

Radiated Spurious Emissions Test Setup

Photograph 3. Radiated Spurious Emissions, Test Setup, Below 1GHz



Photograph 4. Radiated Spurious Emissions, Test Setup, Above 1GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Since the EUT had an integral antenna, conducted measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable lost.

See following pages for detailed test results with RF Conducted Spurious Emissions.

Test Results: The EUT was compliant with the Conducted Spurious Emission limits of **§15.247(d)**. Measured emissions were withing applicable limits.

Test Engineer(s): Djed Mouada

Test Date(s): October 11, 2016

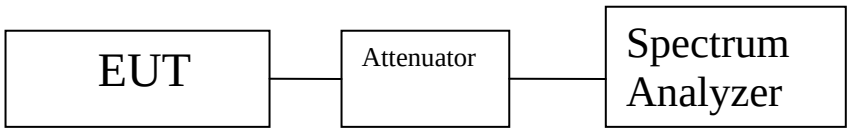
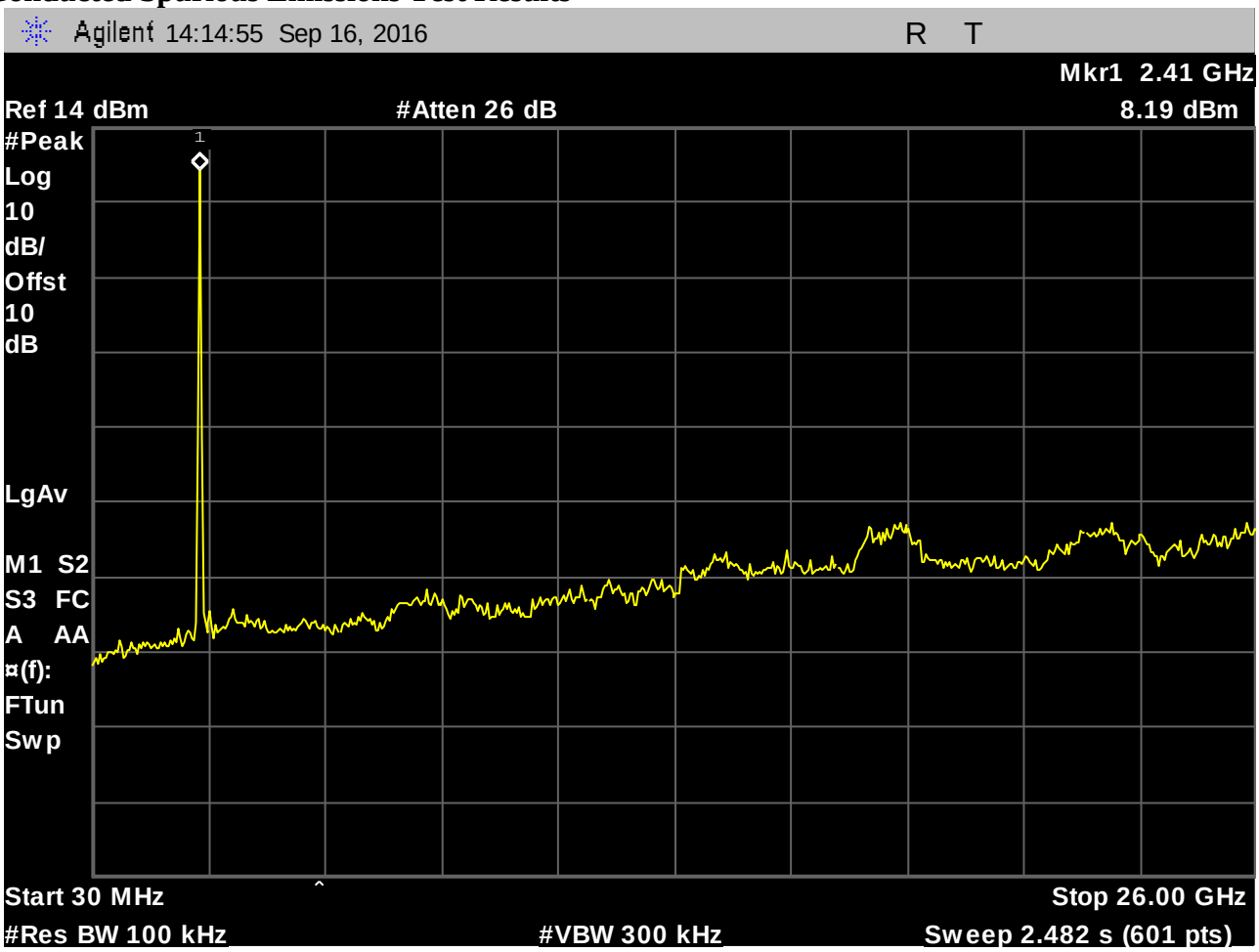
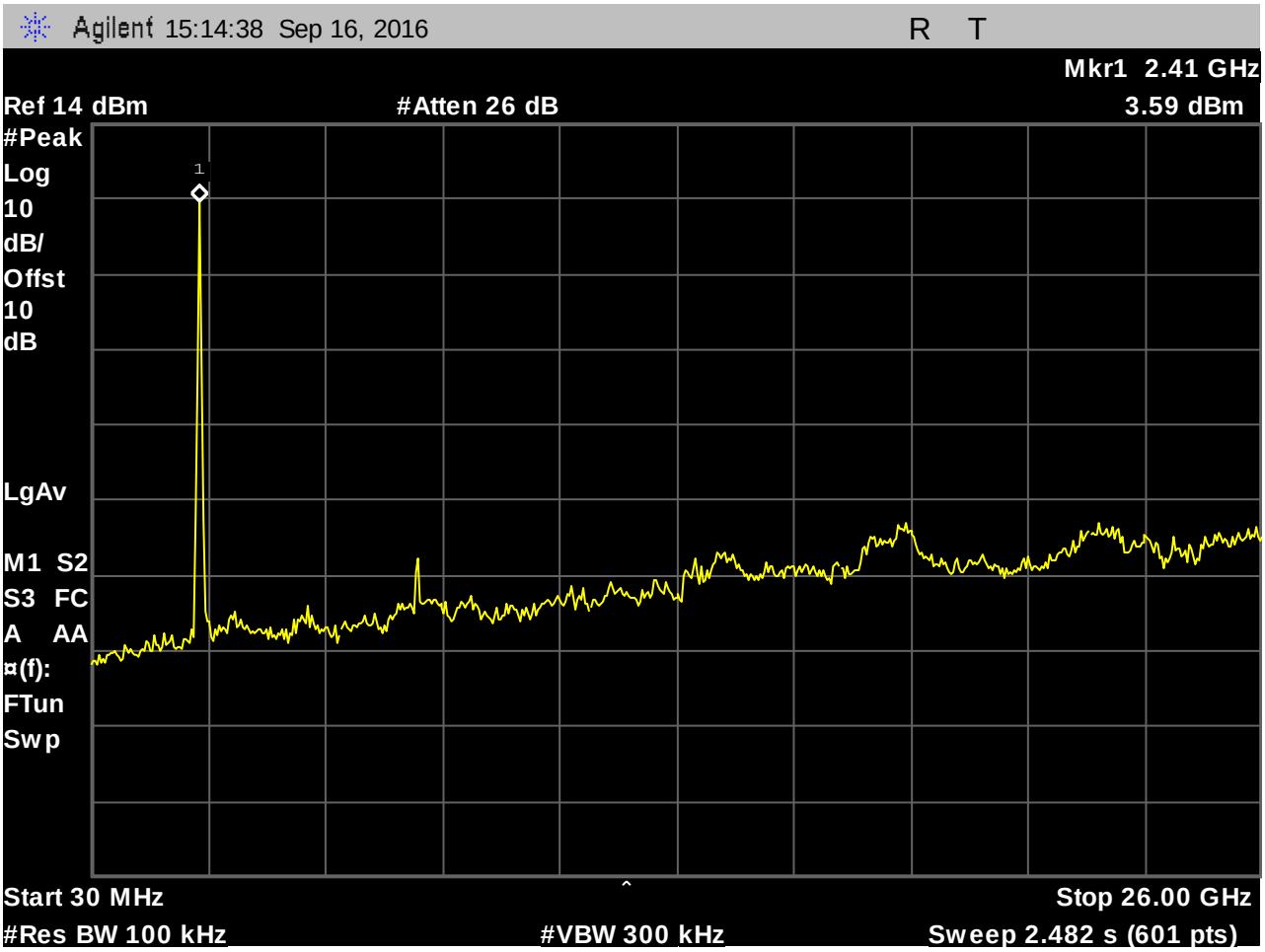


Figure 5. Block Diagram, Conducted Spurious Emissions Test Setup

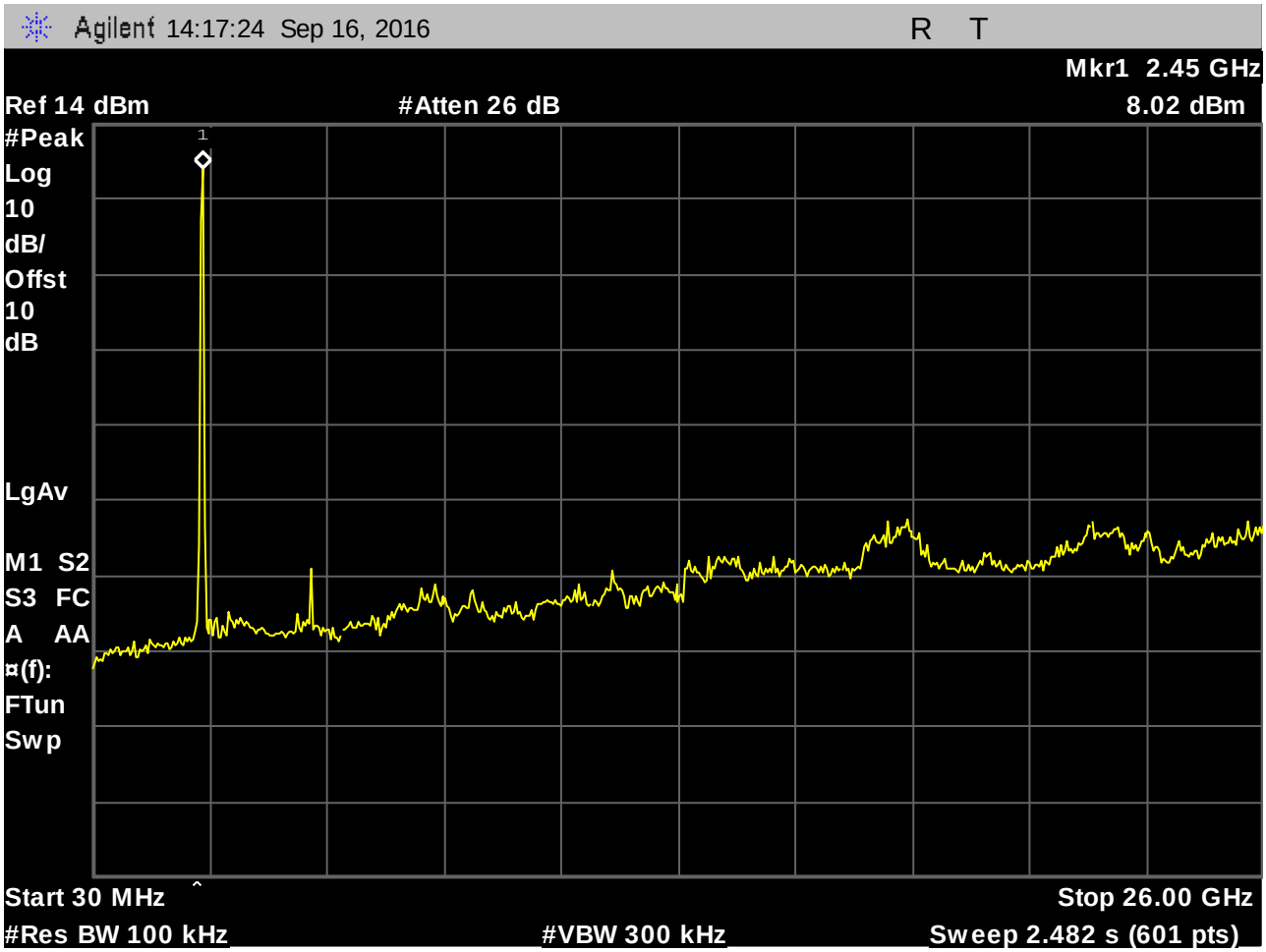
Conducted Spurious Emissions Test Results



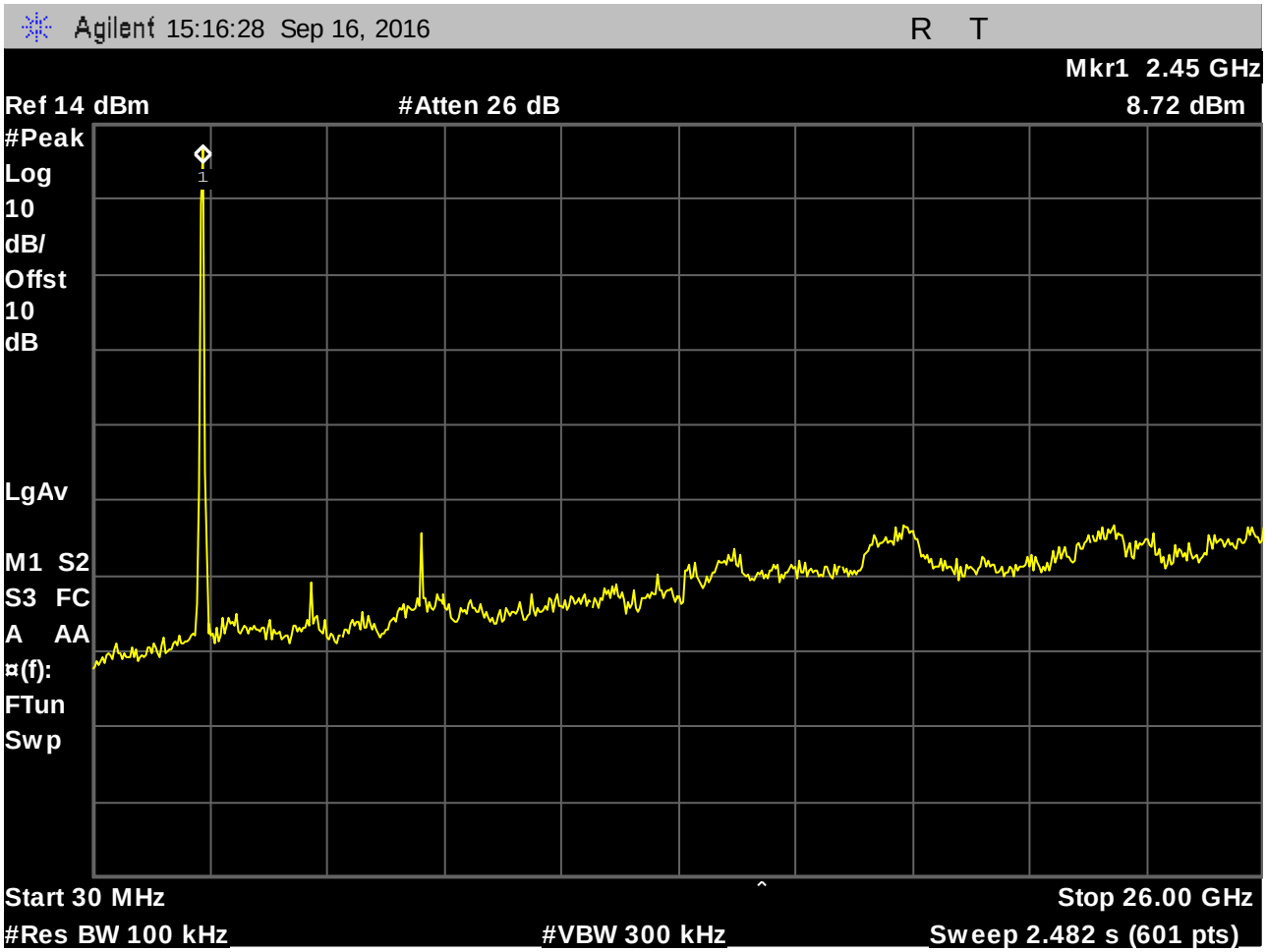
Plot 140. Conducted Spurious Emissions, Ch. 2412, b mode, 30 dBc, Port 1



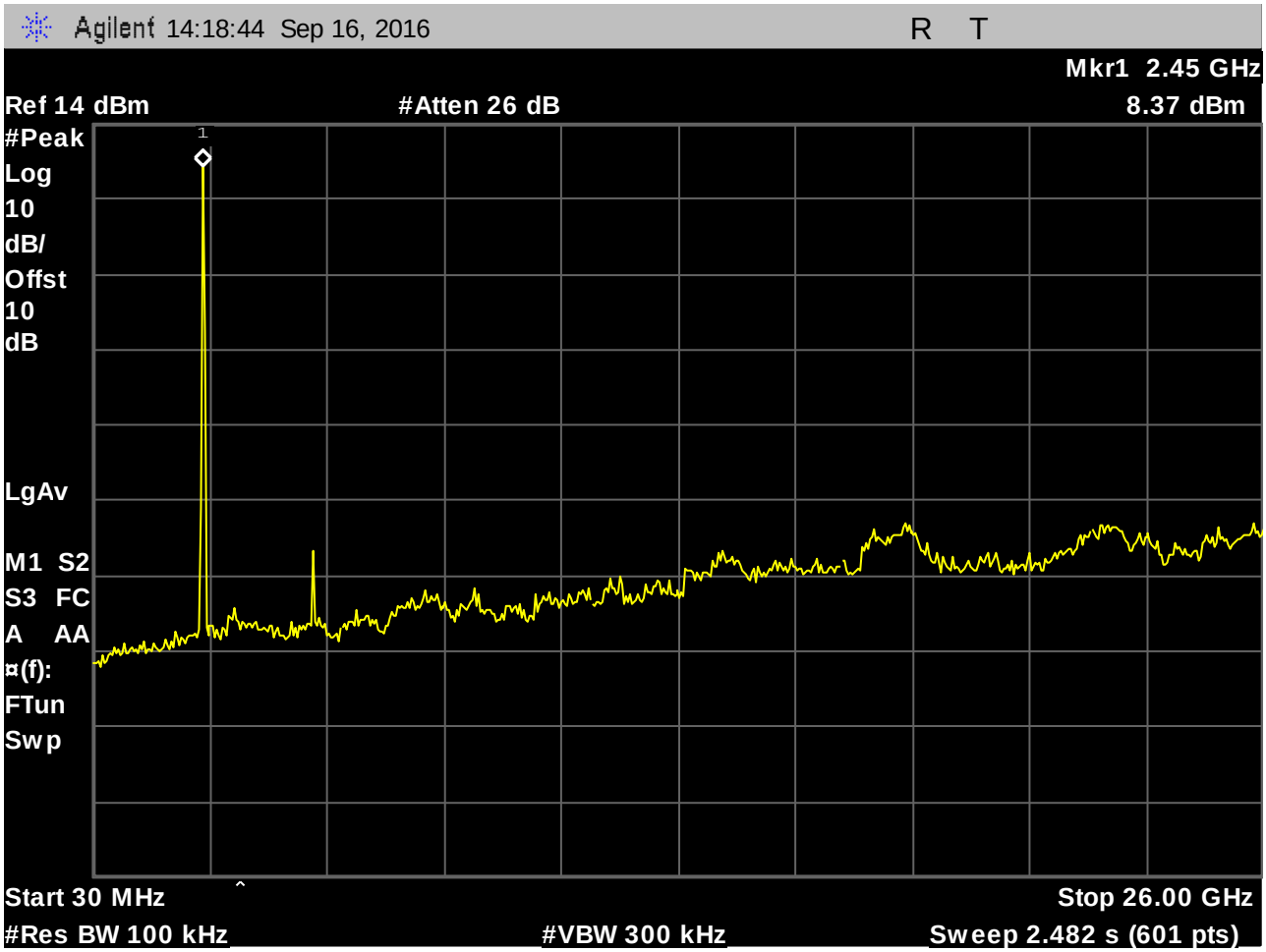
Plot 141. Conducted Spurious Emissions, Ch. 2412, b mode, 30 dBc, Port 2



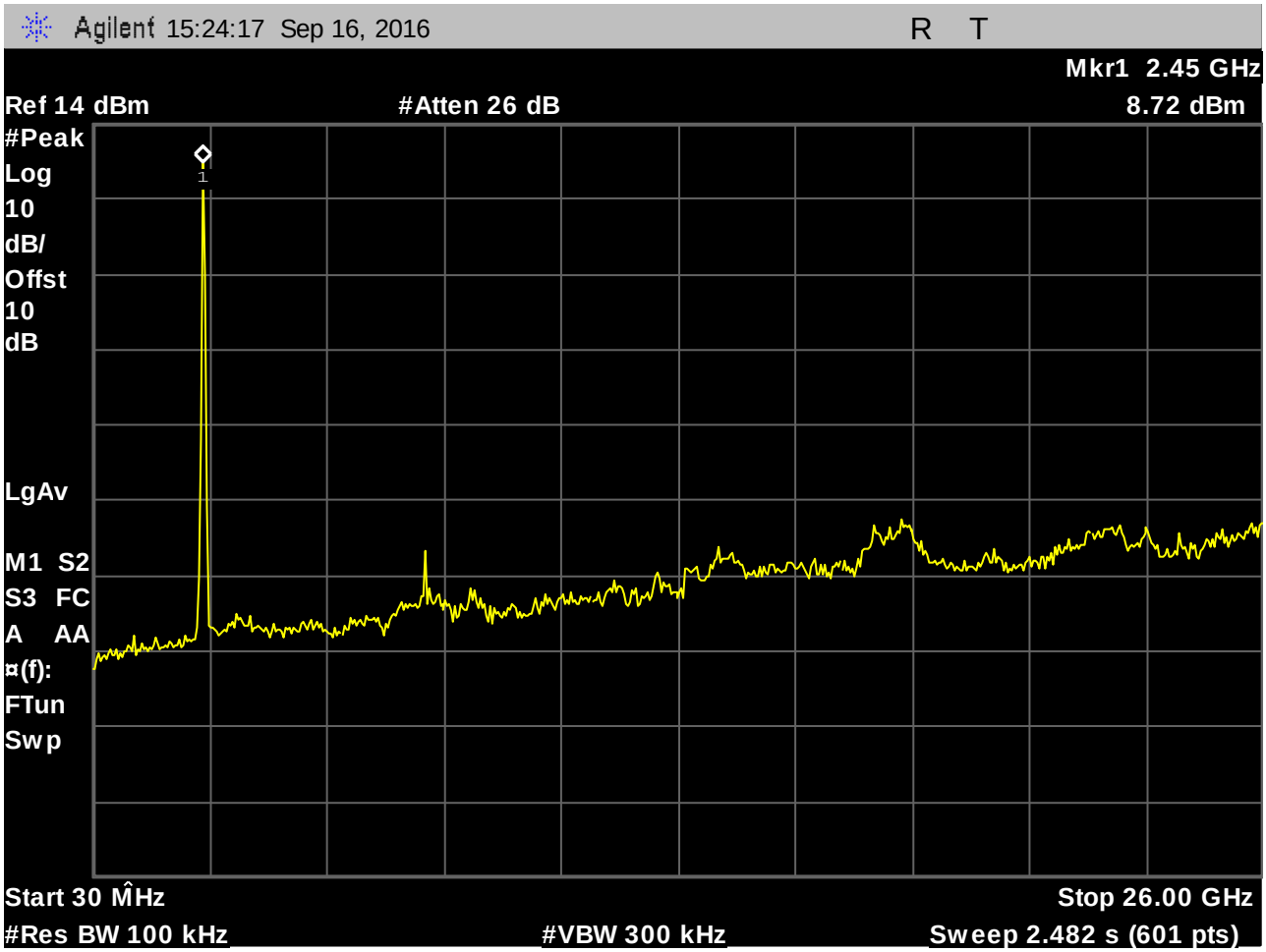
Plot 142. Conducted Spurious Emissions, Ch. 2437, b mode, 30 dBc, Port 1



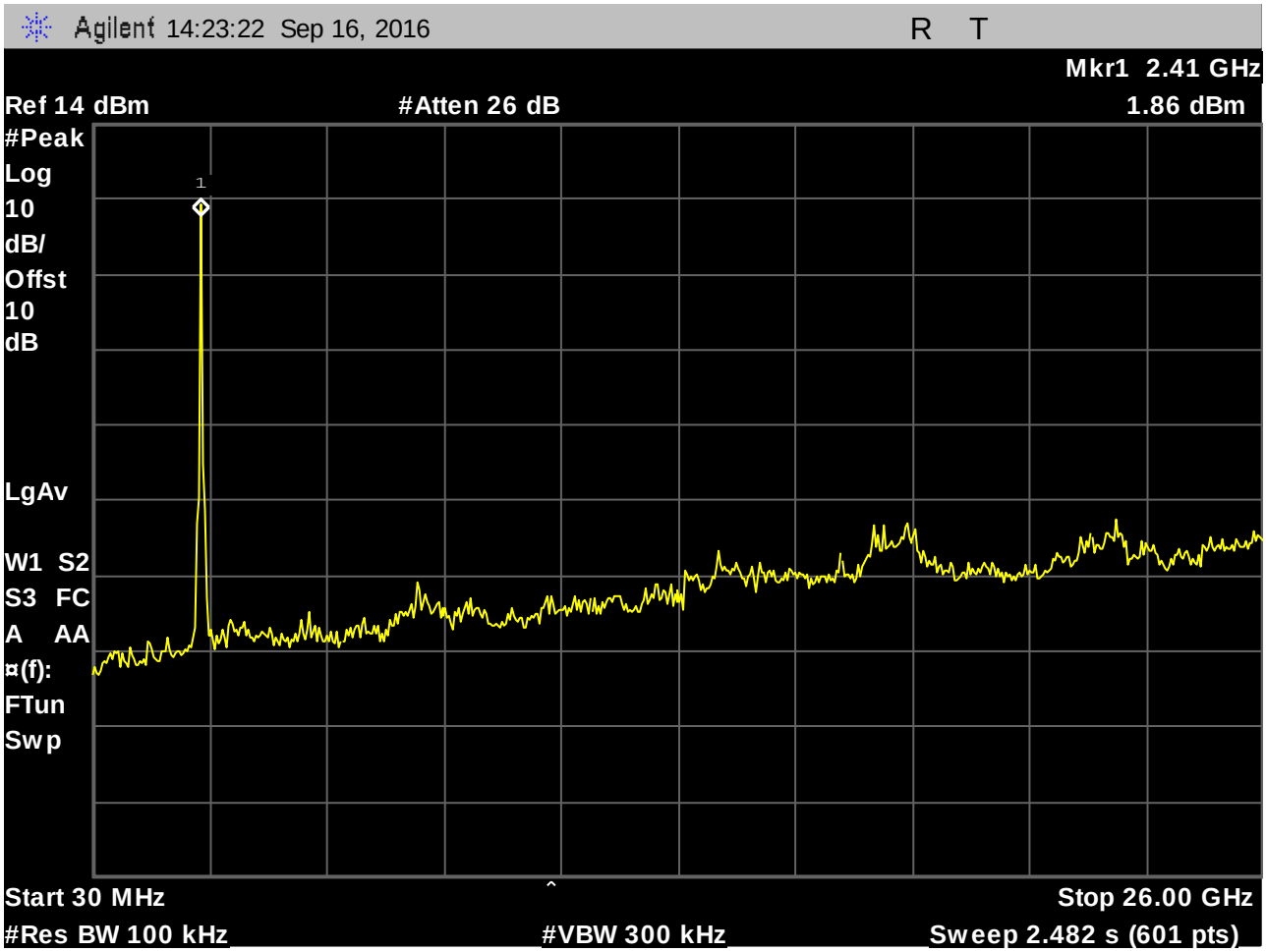
Plot 143. Conducted Spurious Emissions, Ch. 2437, b mode, 30 dBc, Port 2



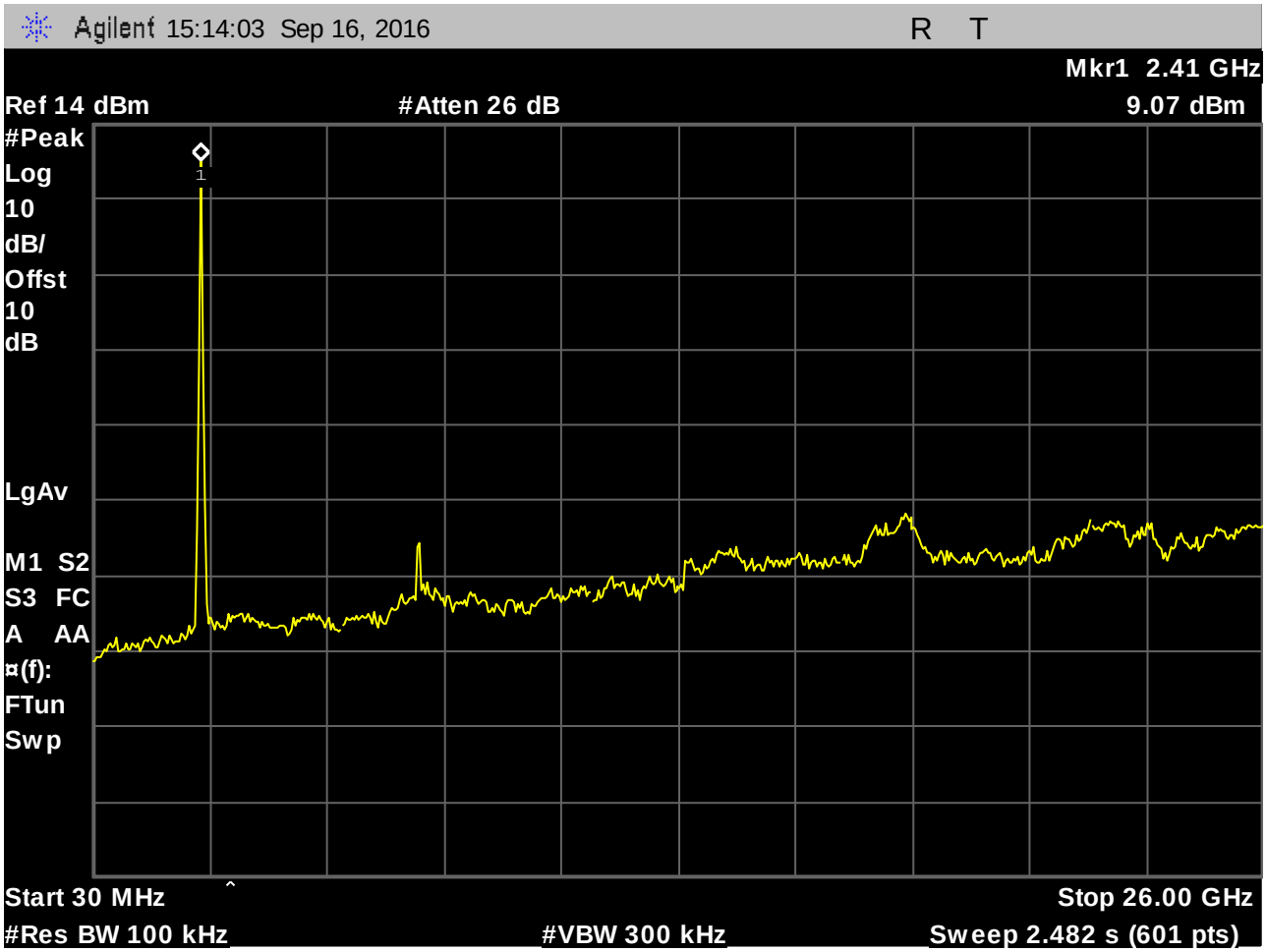
Plot 144. Conducted Spurious Emissions, Ch. 2462, b mode, 30 dBc, Port 1



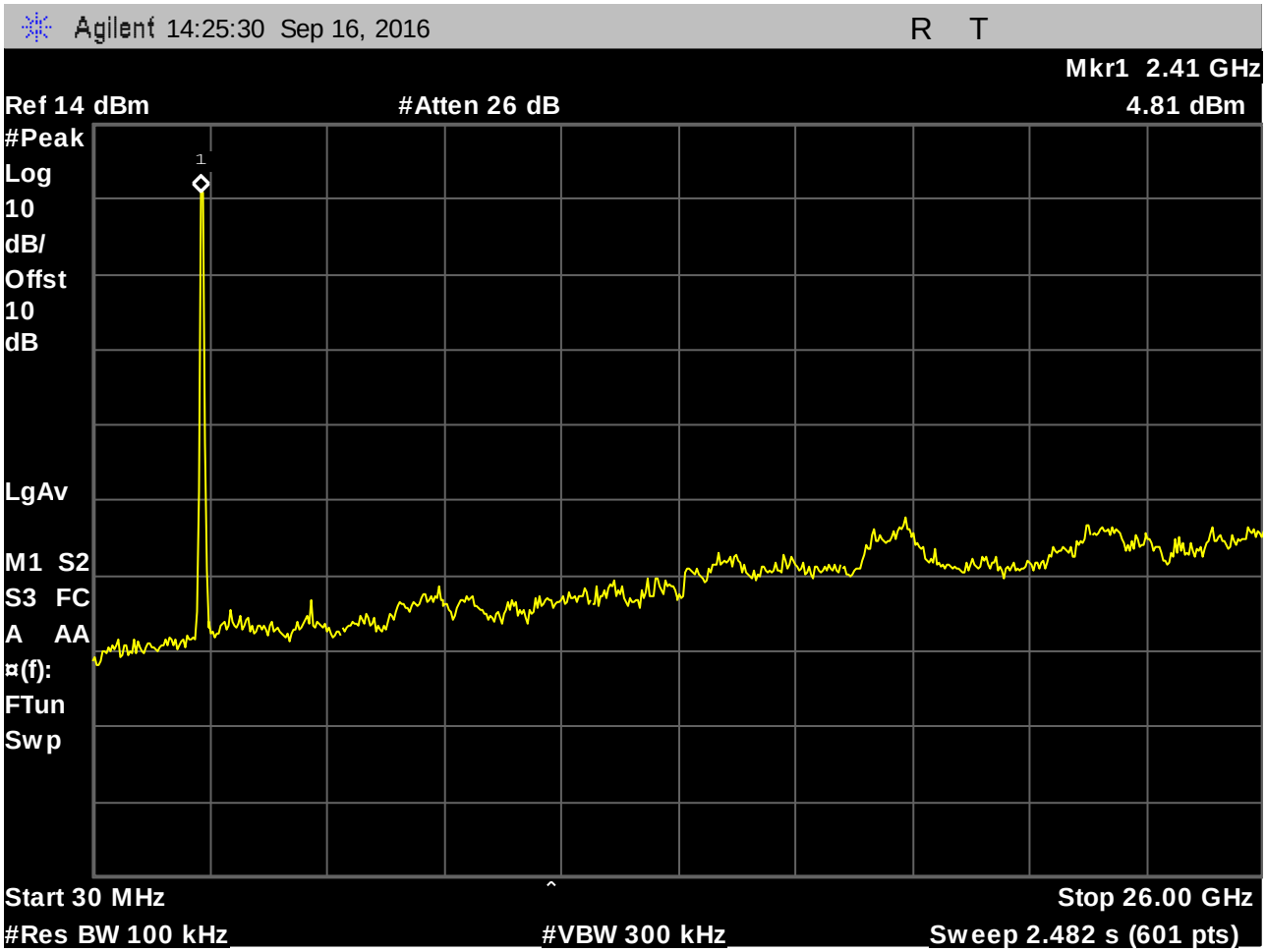
Plot 145. Conducted Spurious Emissions, Ch. 2462, b mode, 30 dBc, Port 2



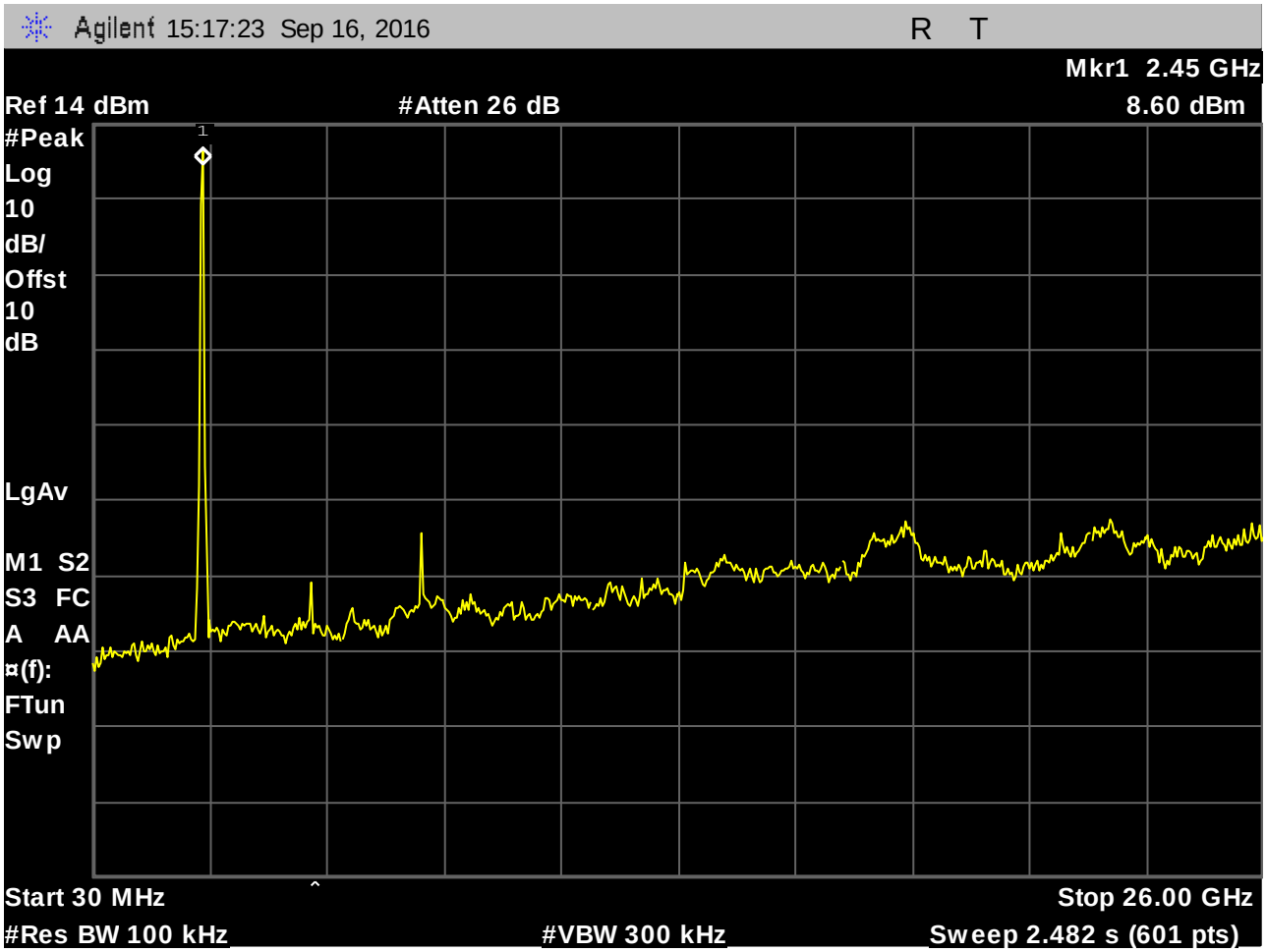
Plot 146. Conducted Spurious Emissions, Ch. 2412, g mode, 30 dBc, Port 1



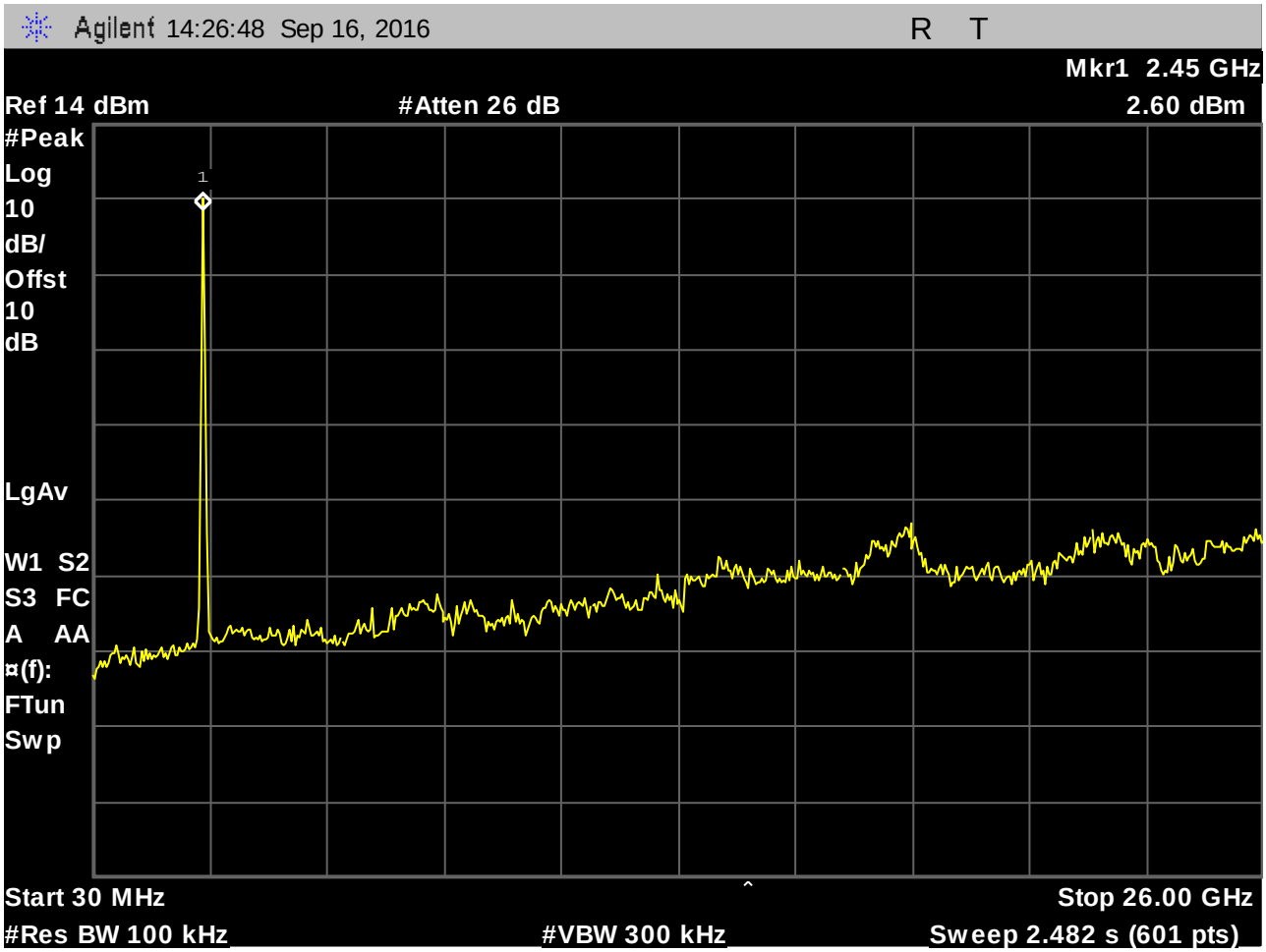
Plot 147. Conducted Spurious Emissions, Ch. 2412, g mode, 30 dBc, Port 2



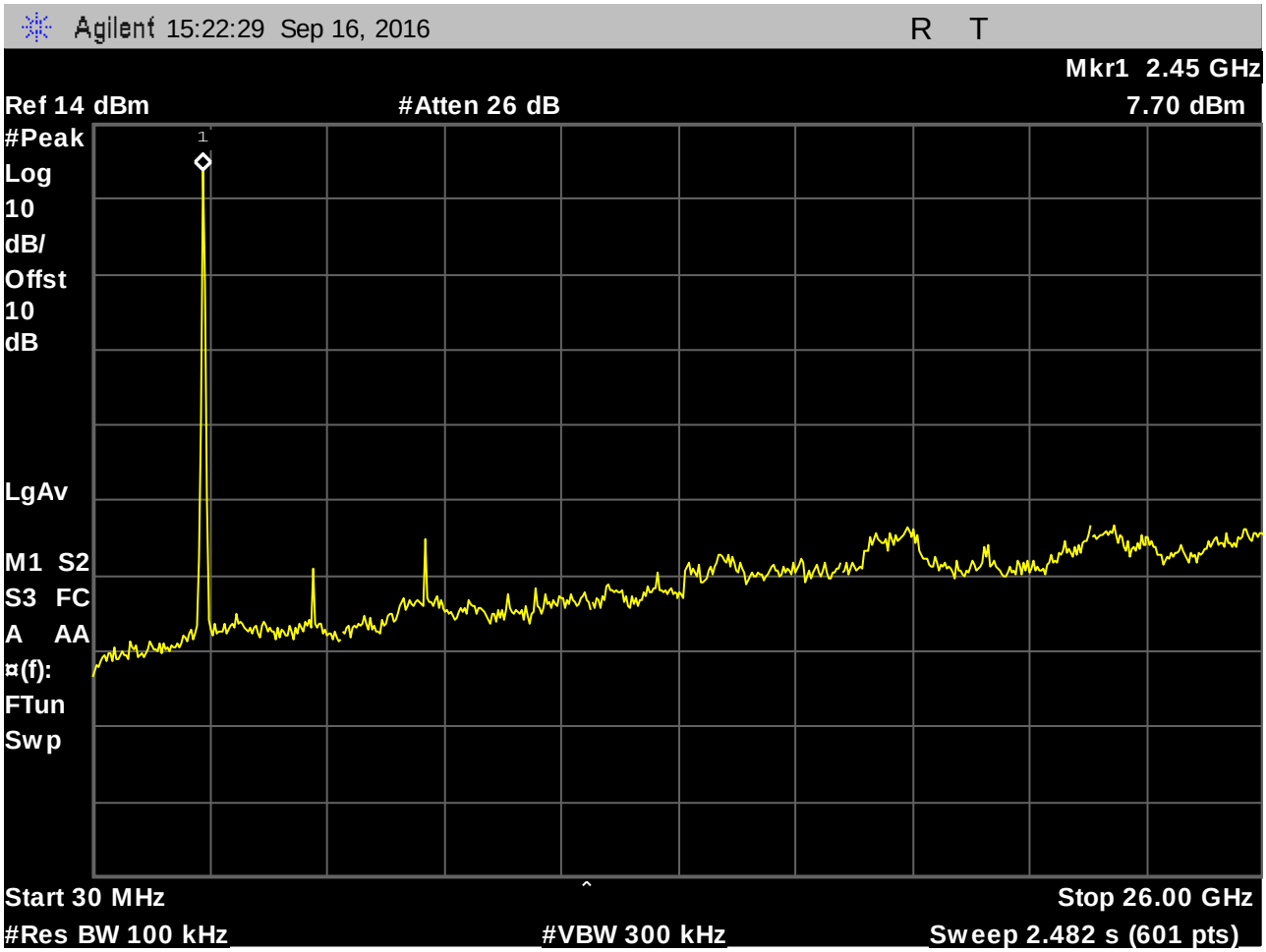
Plot 148. Conducted Spurious Emissions, Ch. 2437, g mode, 30 dBc, Port 1



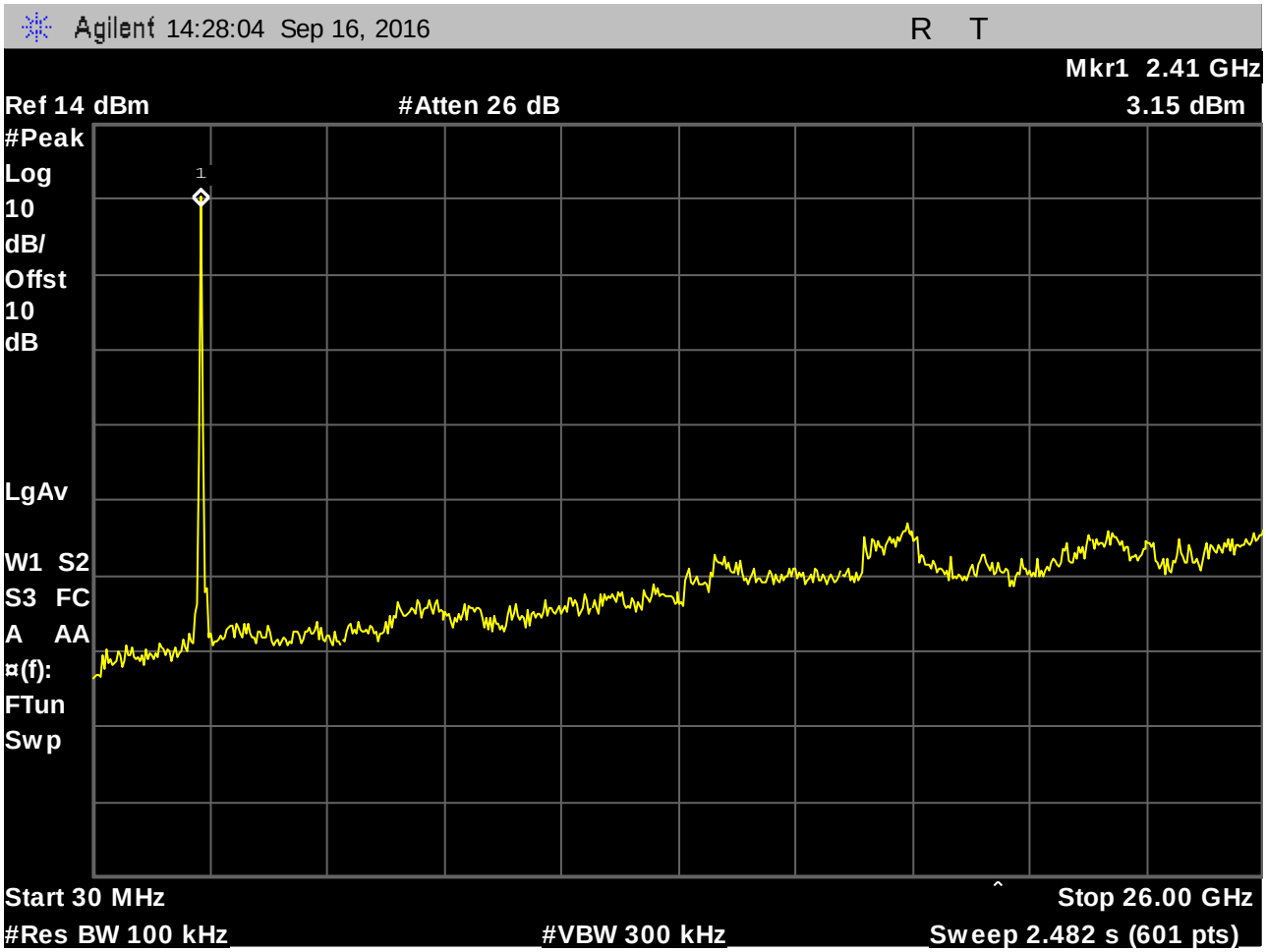
Plot 149. Conducted Spurious Emissions, Ch. 2437, g mode, 30 dBc, Port 2



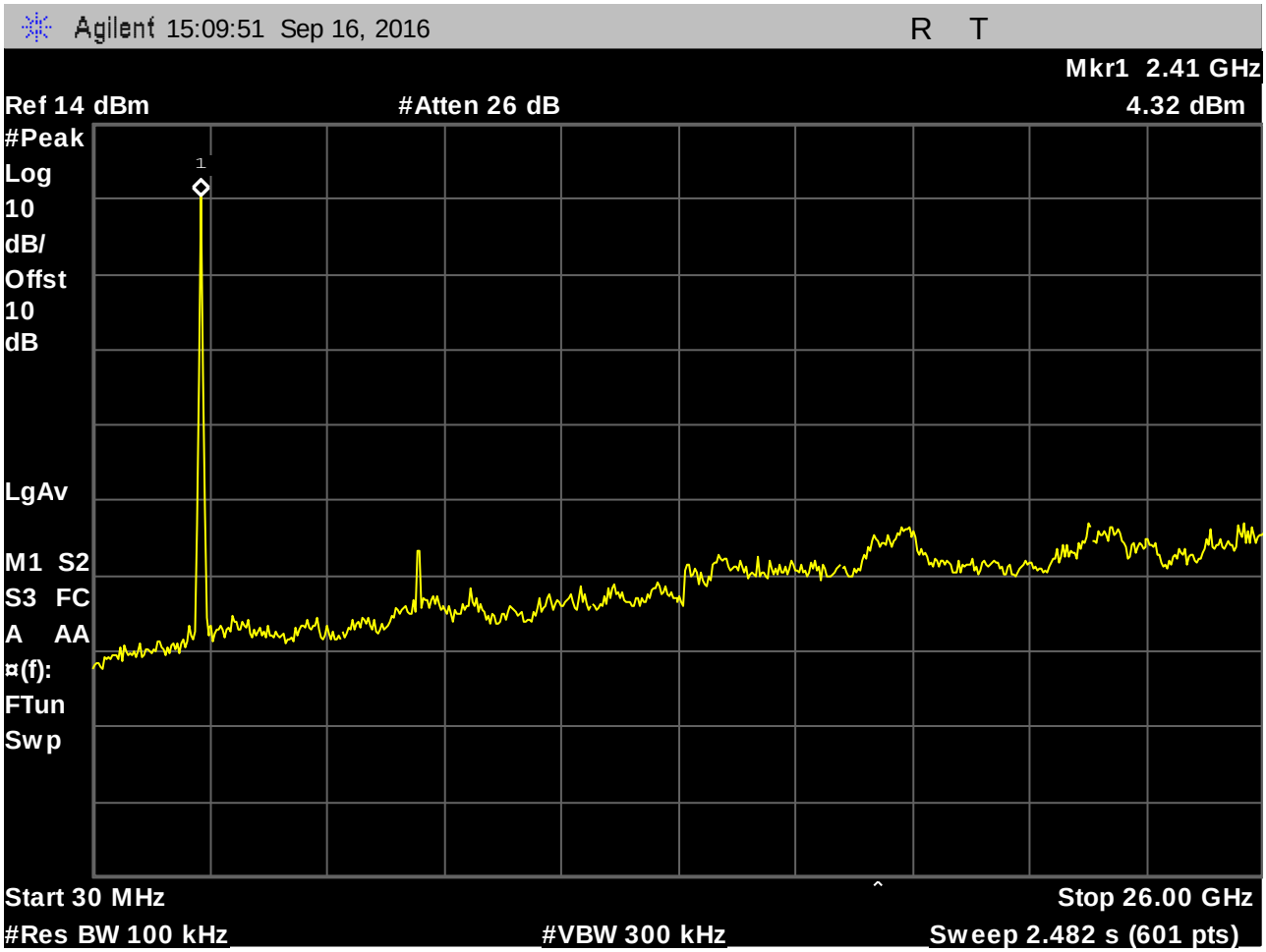
Plot 150. Conducted Spurious Emissions, Ch. 2462, g mode, 30 dBc, Port 1



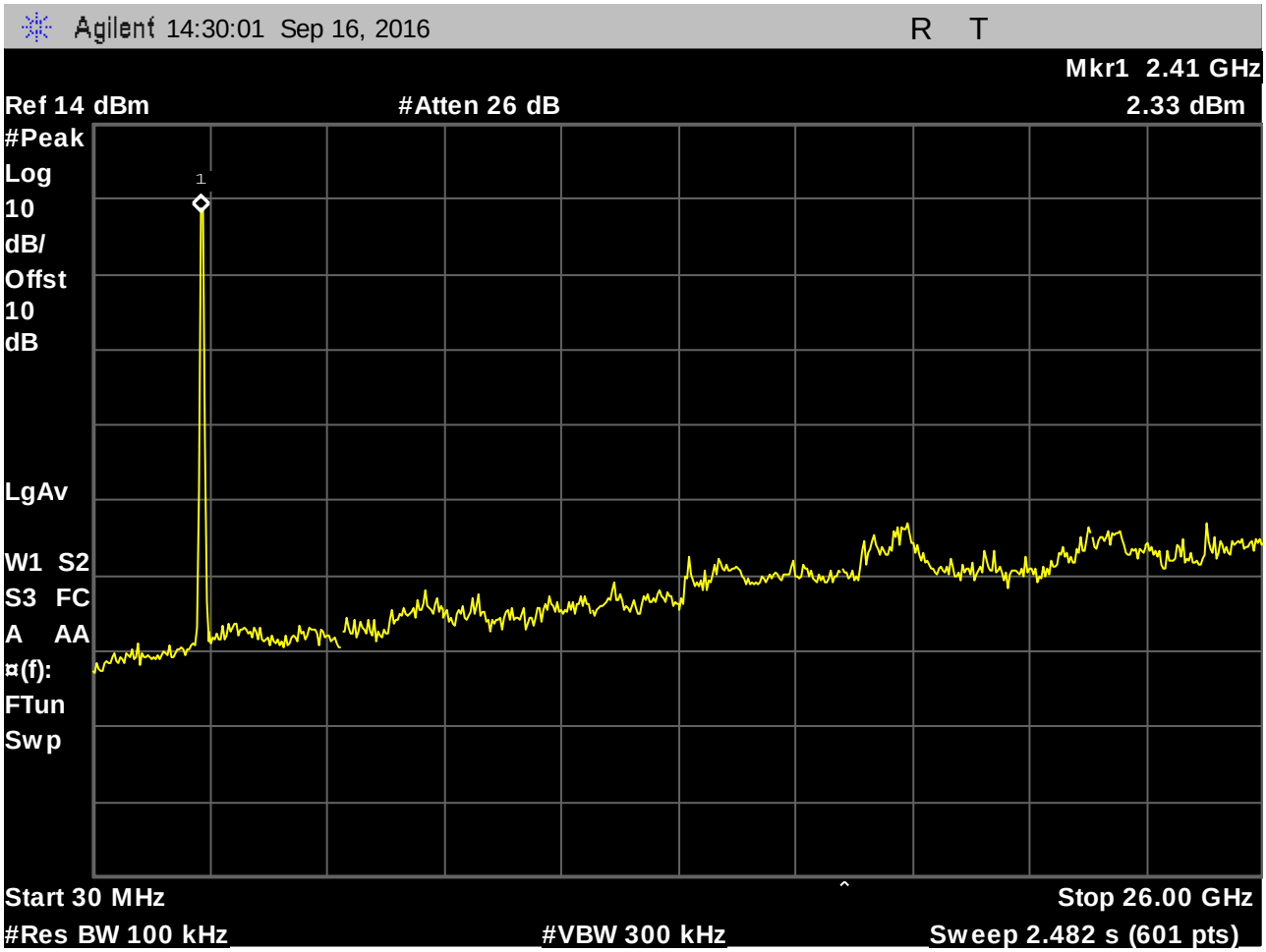
Plot 151. Conducted Spurious Emissions, Ch. 2462, g mode, 30 dBc, Port 2



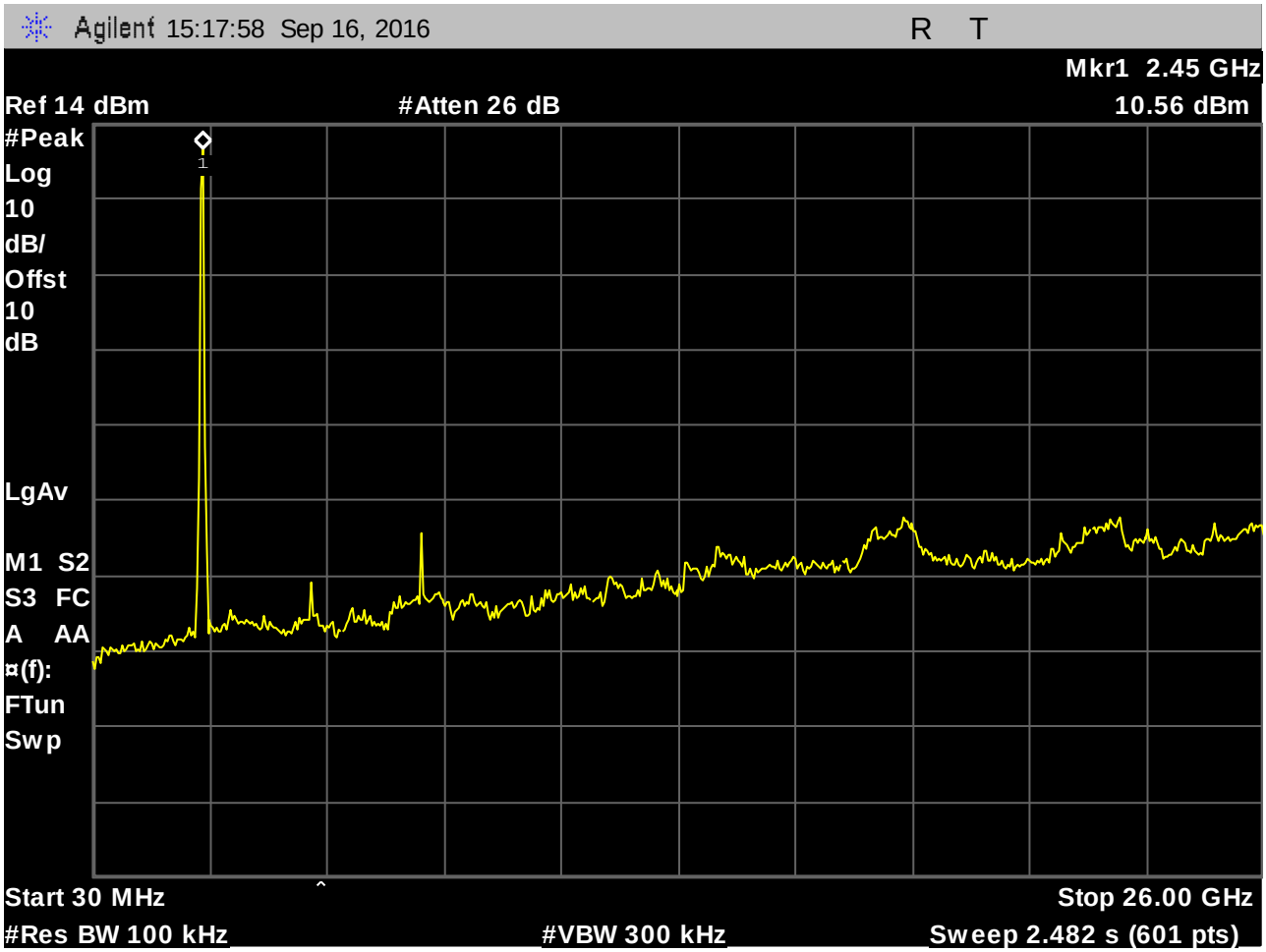
Plot 152. Conducted Spurious Emissions, Ch. 2412, n mode, 20MHz, 30 dBc, Port 1



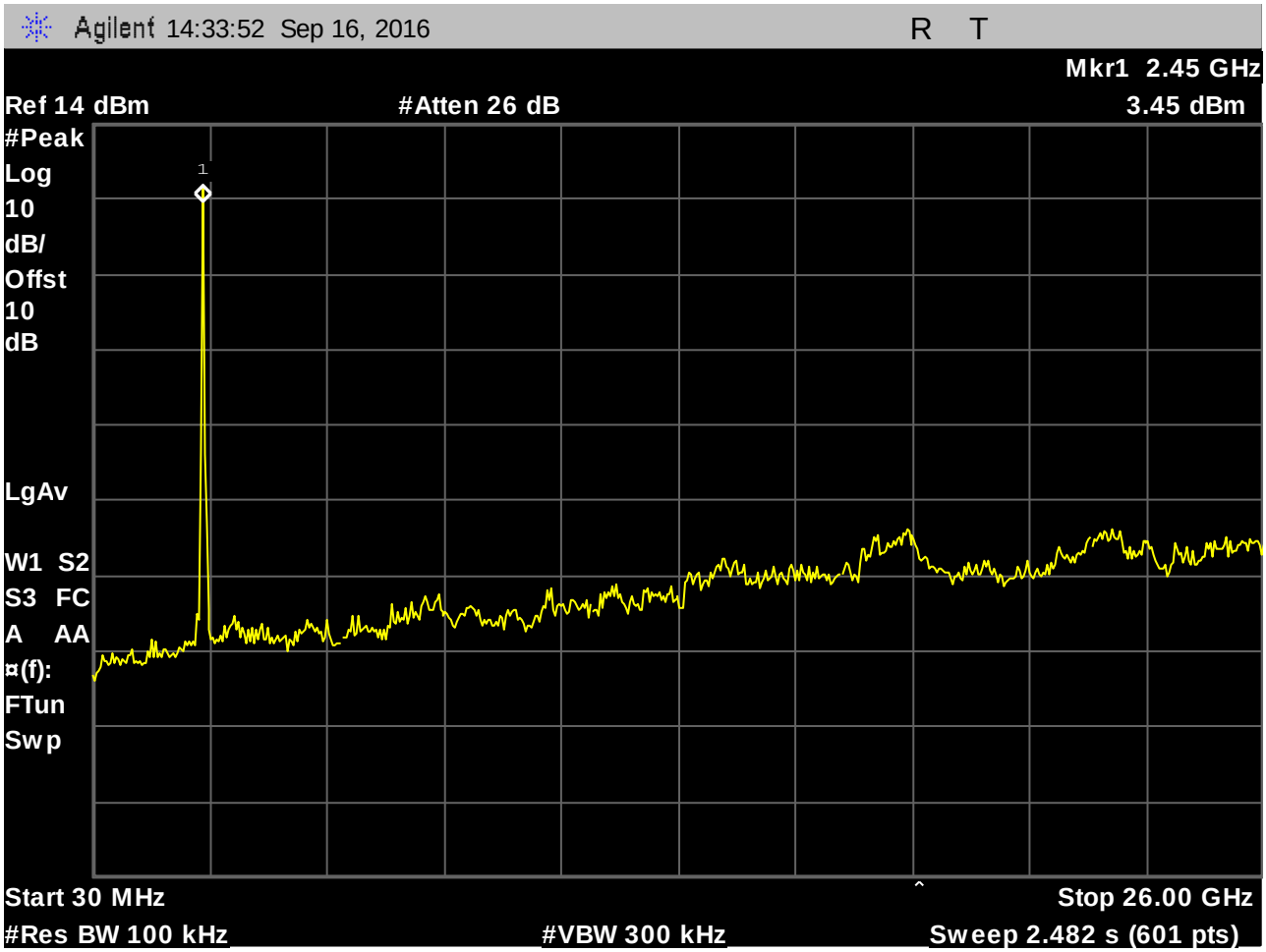
Plot 153. Conducted Spurious Emissions, Ch. 2412, n mode, 20MHz, 30 dBc, Port 2



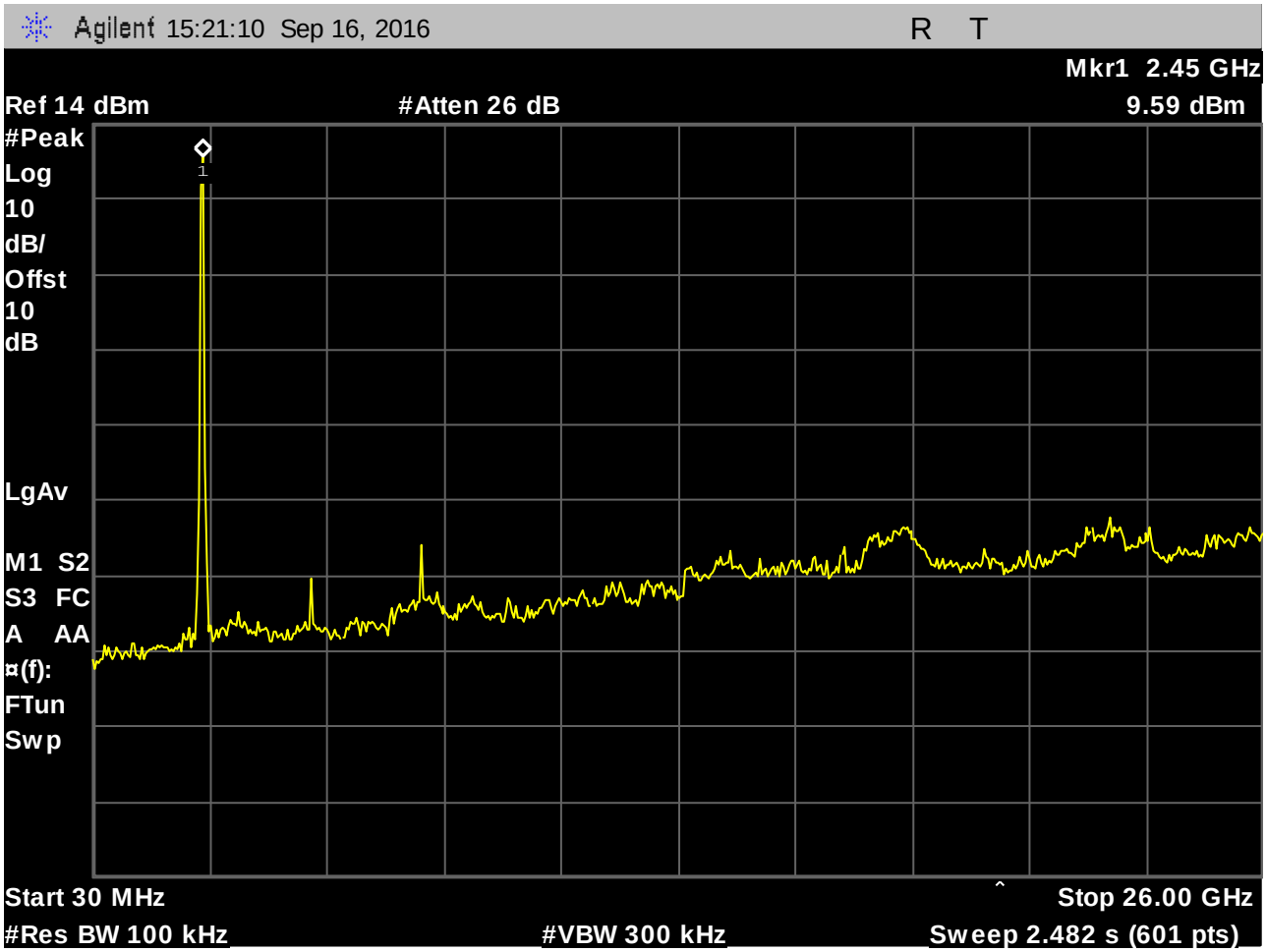
Plot 154. Conducted Spurious Emissions, Ch. 2437, n mode, 20MHz, 30 dBc, Port 1



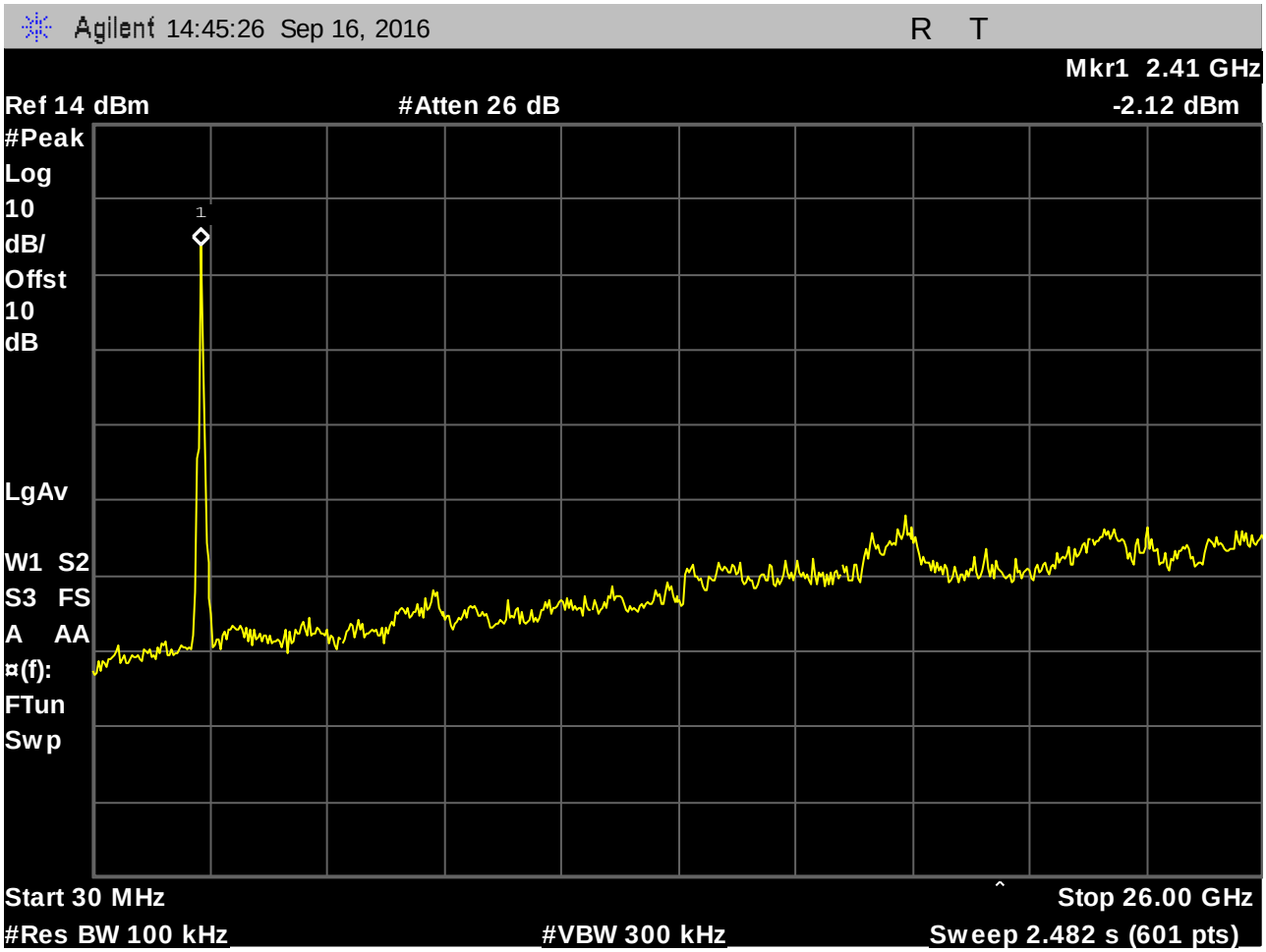
Plot 155. Conducted Spurious Emissions, Ch. 2437, n mode, 20 MHz, 30 dBc, Port 2



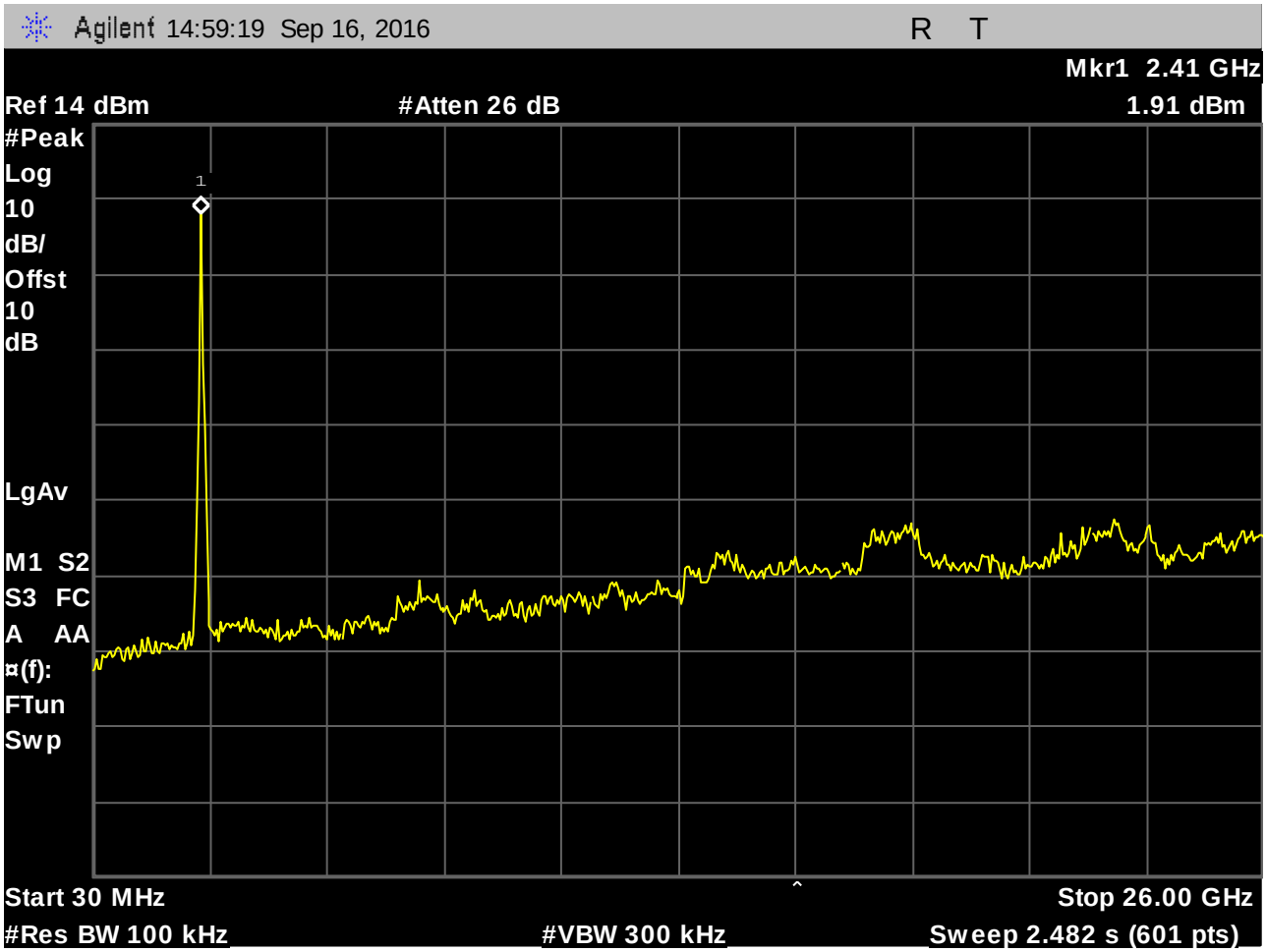
Plot 156. Conducted Spurious Emissions, Ch. 2462, n mode, 20MHz, 30 dBc, Port 1



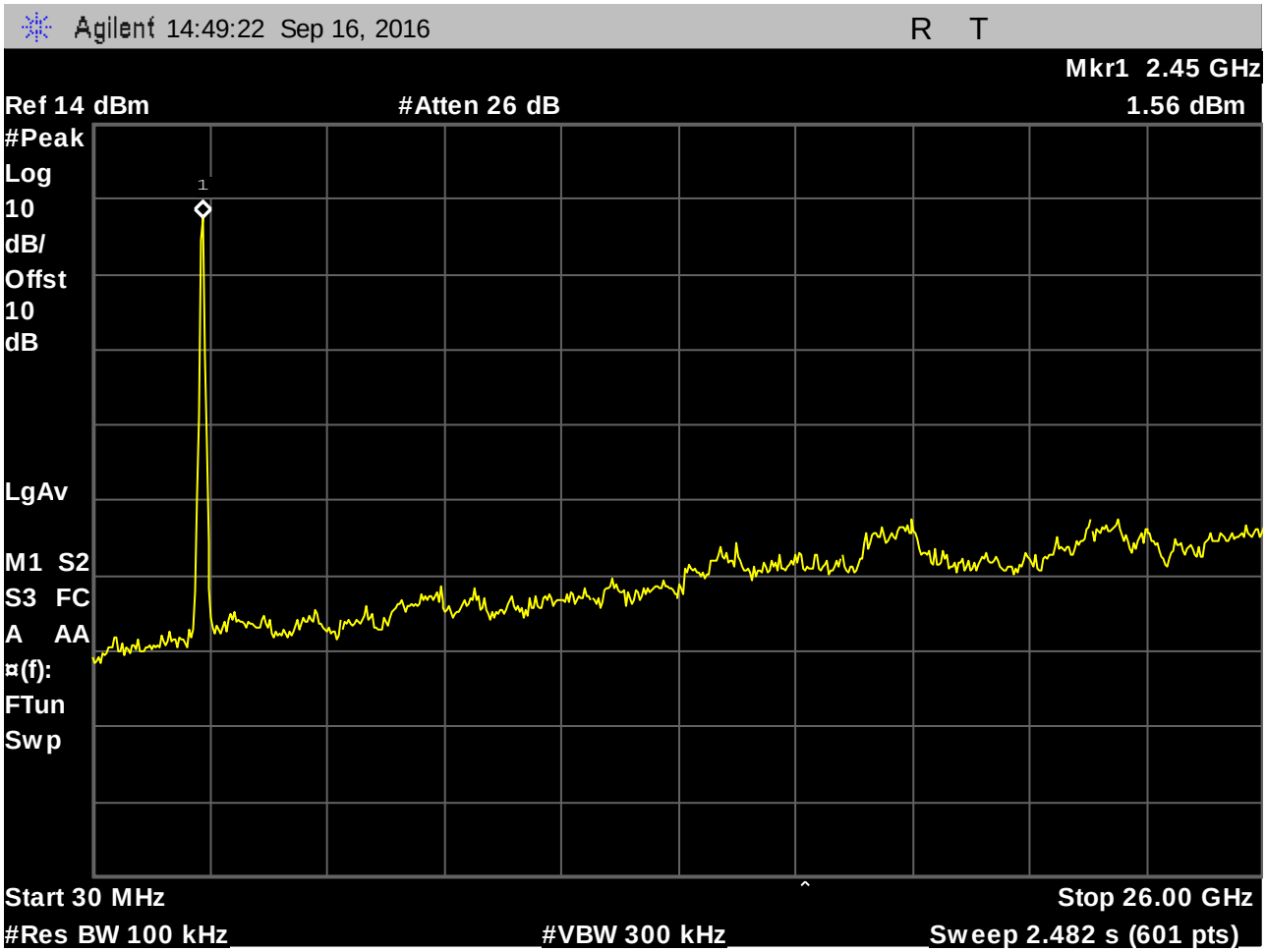
Plot 157.Conducted Spurious Emissions, Ch. 2462, n mode, 20MHz, 30 dBc, Port 2



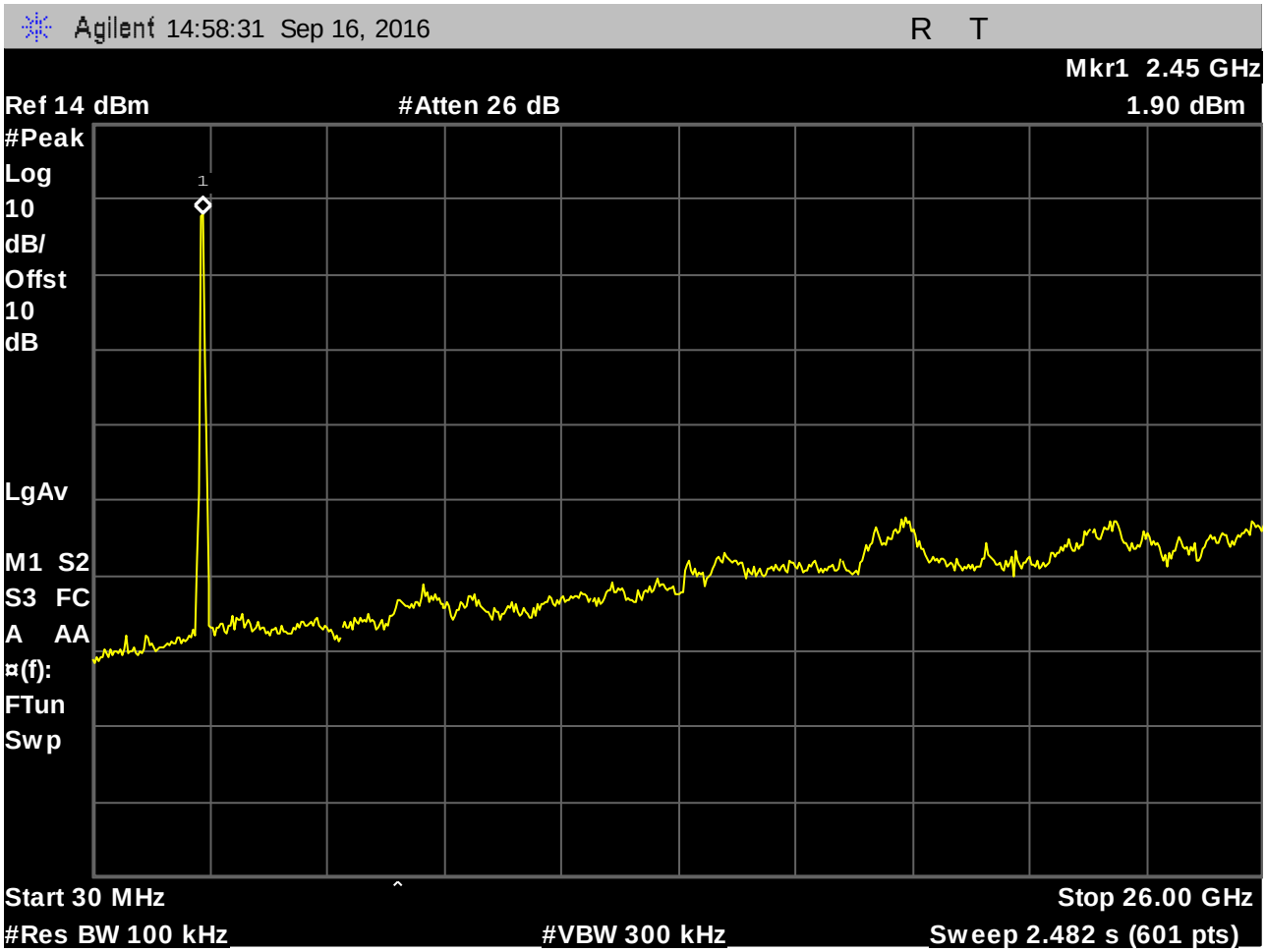
Plot 158. Conducted Spurious Emissions, 40MHz, Ch. 2422MHz, 100KHz, n mode, 30dBc, Port 1



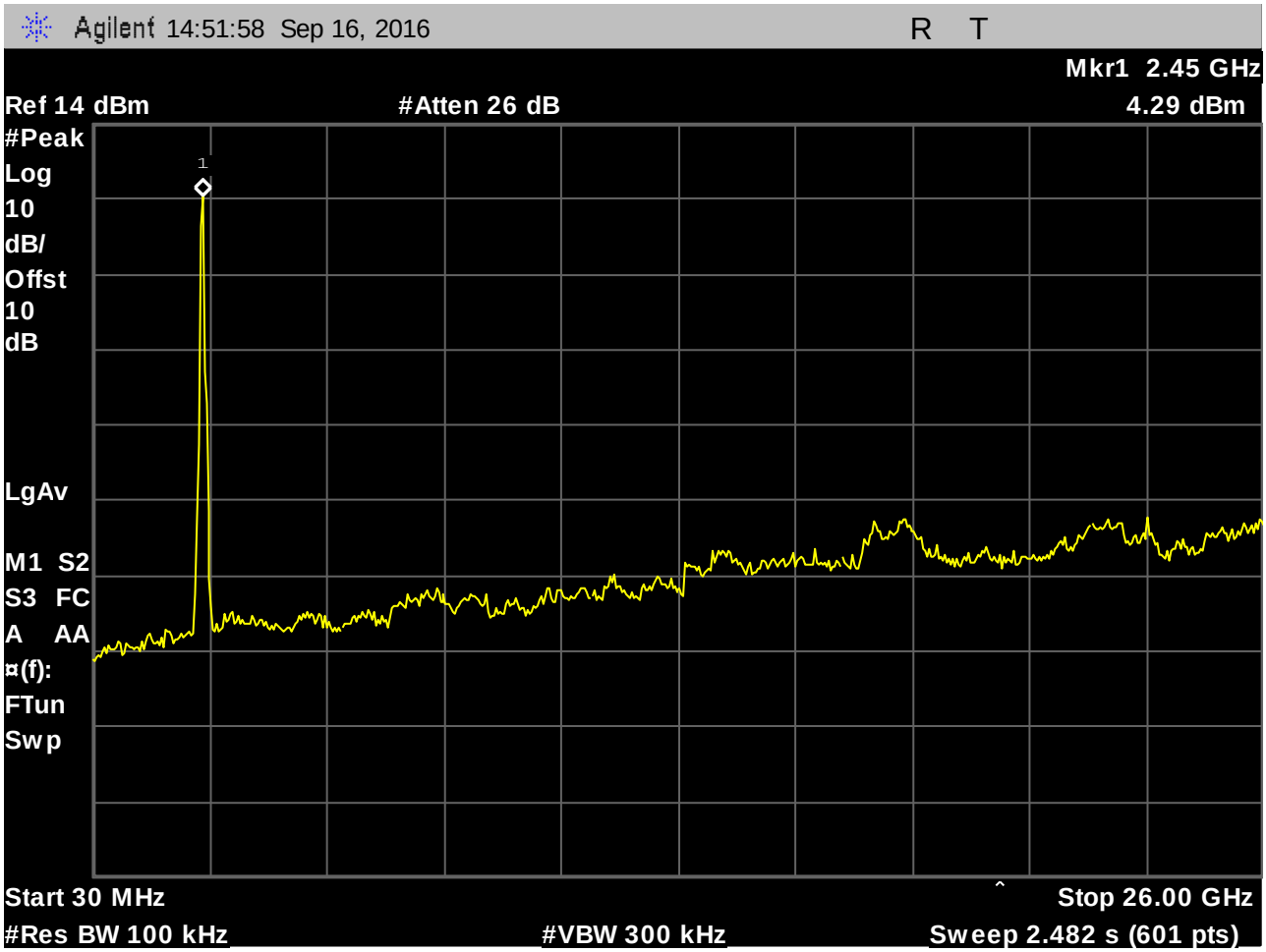
Plot 159. Conducted Spurious Emissions, 40MHz, Ch. 2422MHz, 100KHz, n mode, 30 dBc, Port 2



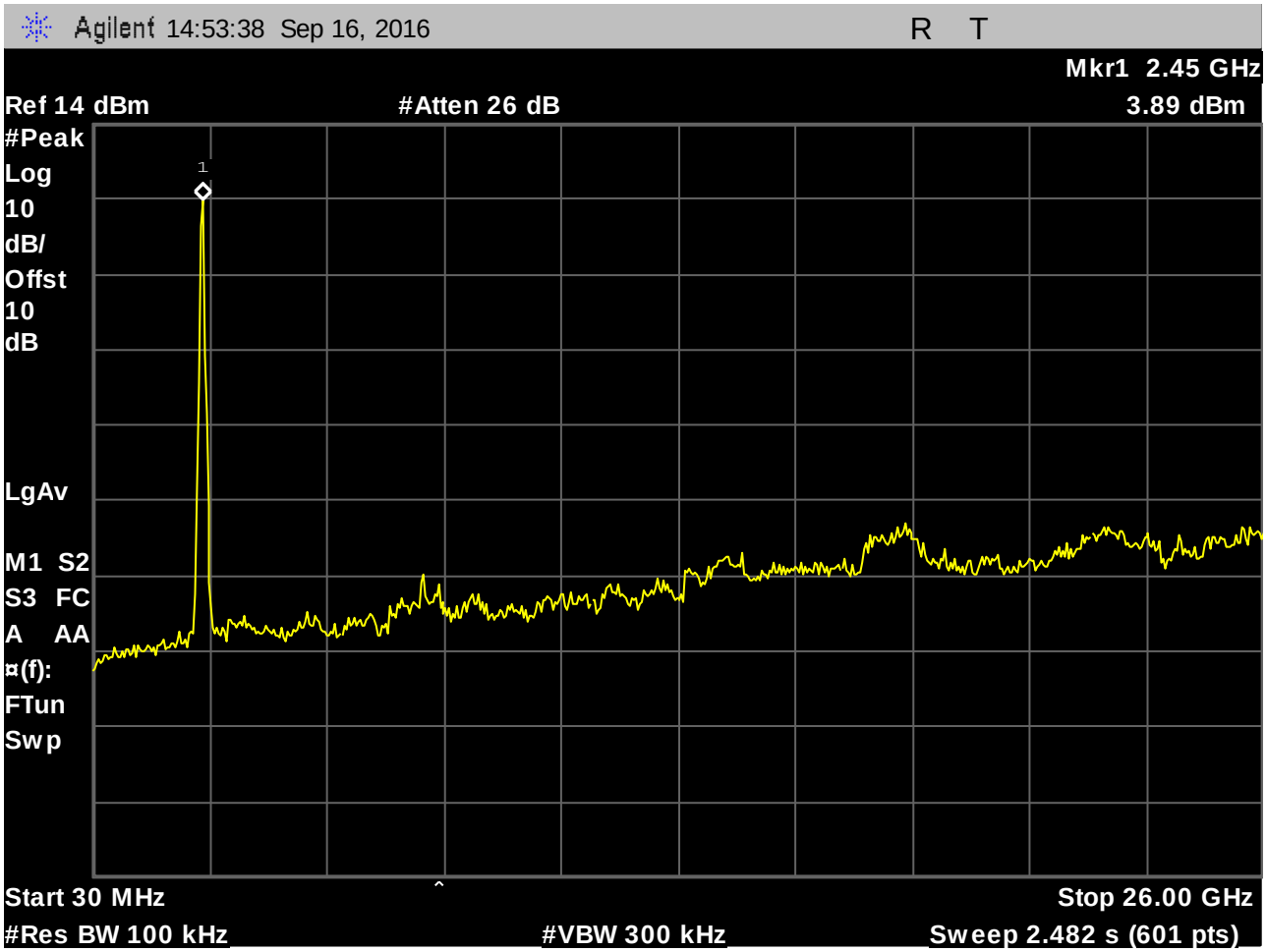
Plot 160. Conducted Spurious Emissions, 40MHz, Ch. 2437MHz, 100KHz, n mode, 30 dBc, Port 1



Plot 161. Conducted Spurious Emissions, 40MHz, Ch. 2437MHz, 100MHz, n mode, 30 dBc, Port 2

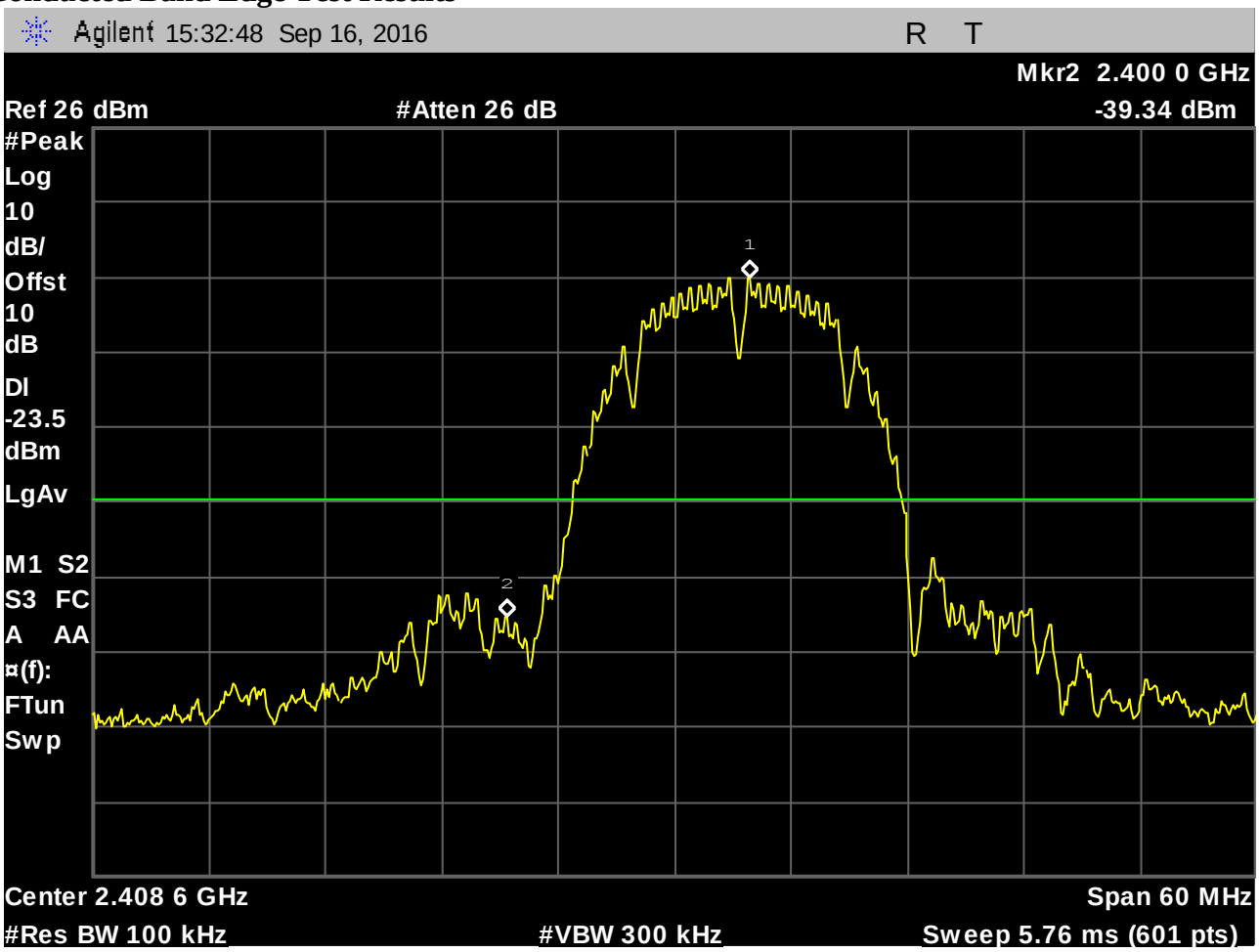


Plot 162. Conducted Spurious Emissions, 40MHz, Ch. 2452MHz, 100MHz, n mode, 30 dBc, Port 1

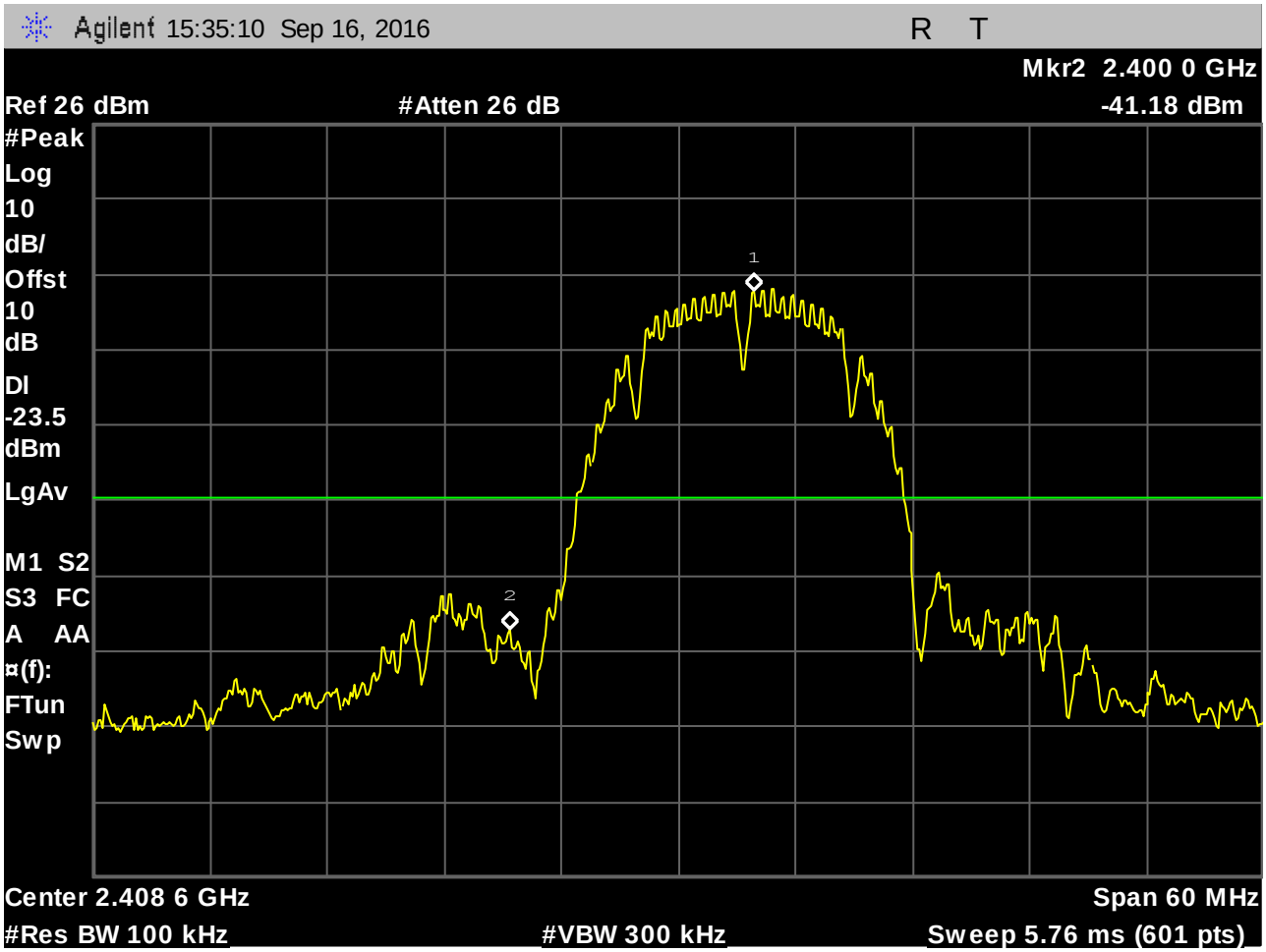


Plot 163. Conducted Spurious Emissions, 40MHz, Ch. 2452MHz, 100KHz, n mode, 30 dBc, Port 2

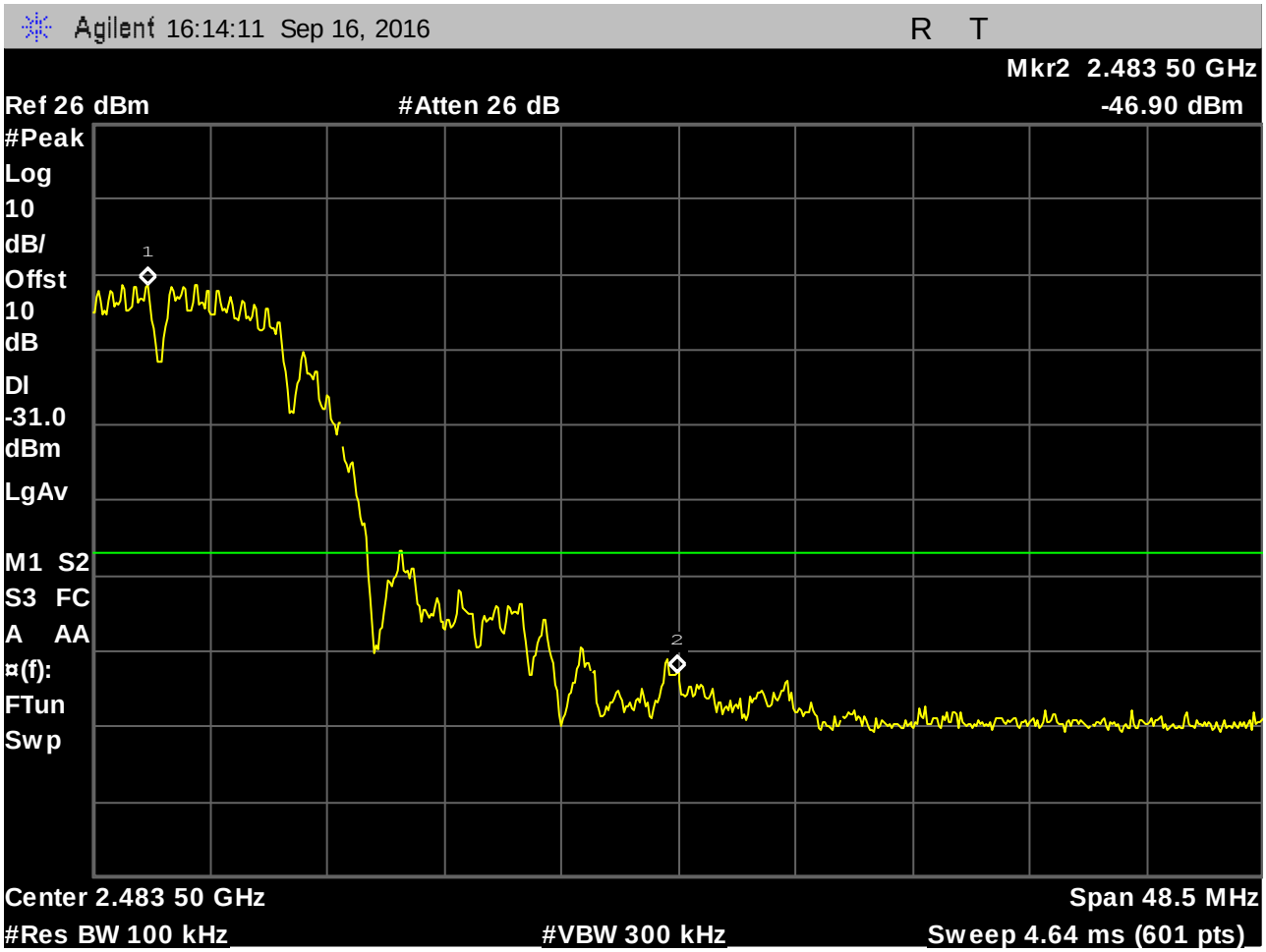
Conducted Band Edge Test Results



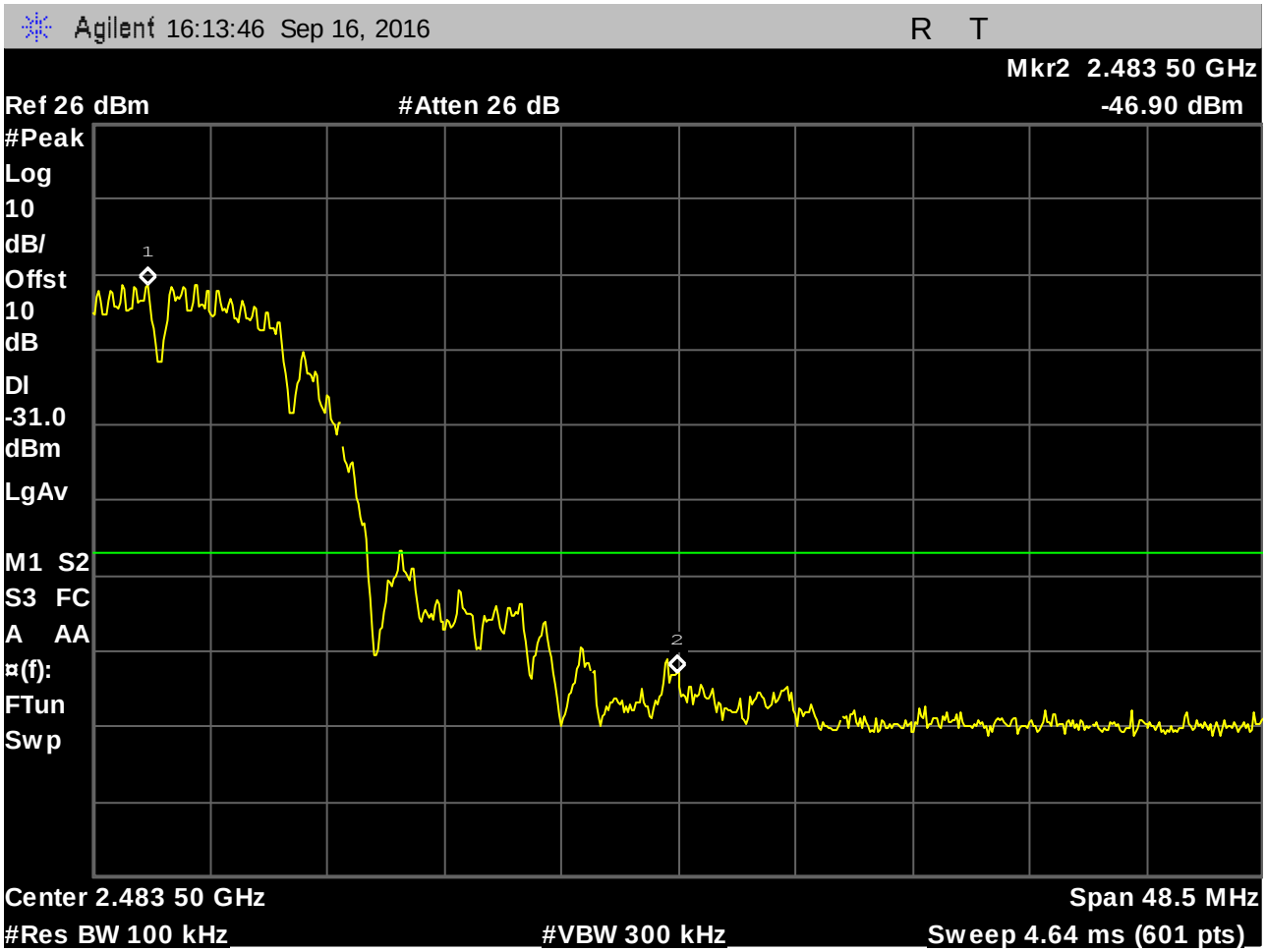
Plot 164. Conducted Band Edge, Ch. 2412, b mode, 30 dBc, Port 1



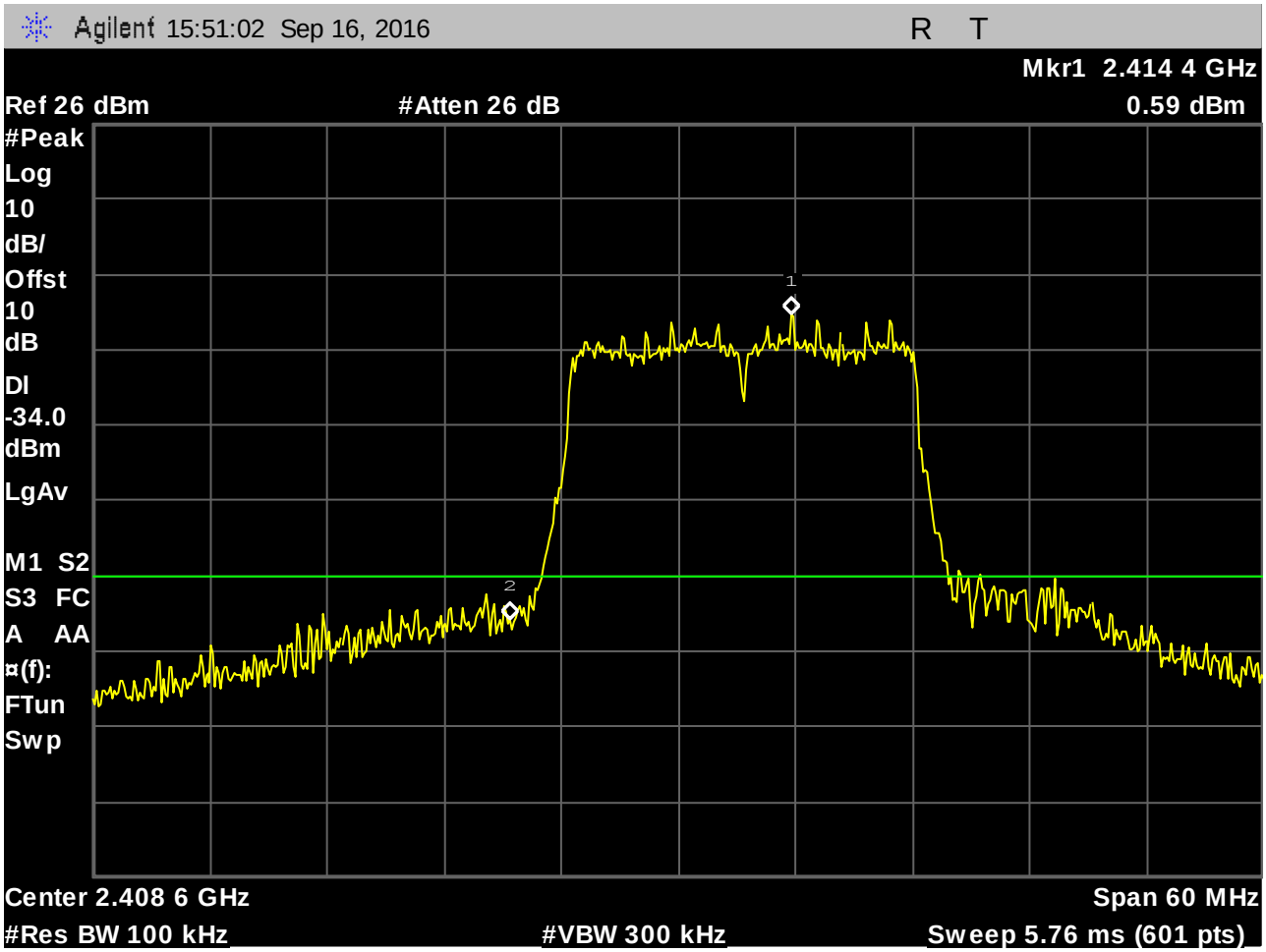
Plot 165. Conducted Band Edge, Ch. 2412, b mode, 30 dBc, Port 2



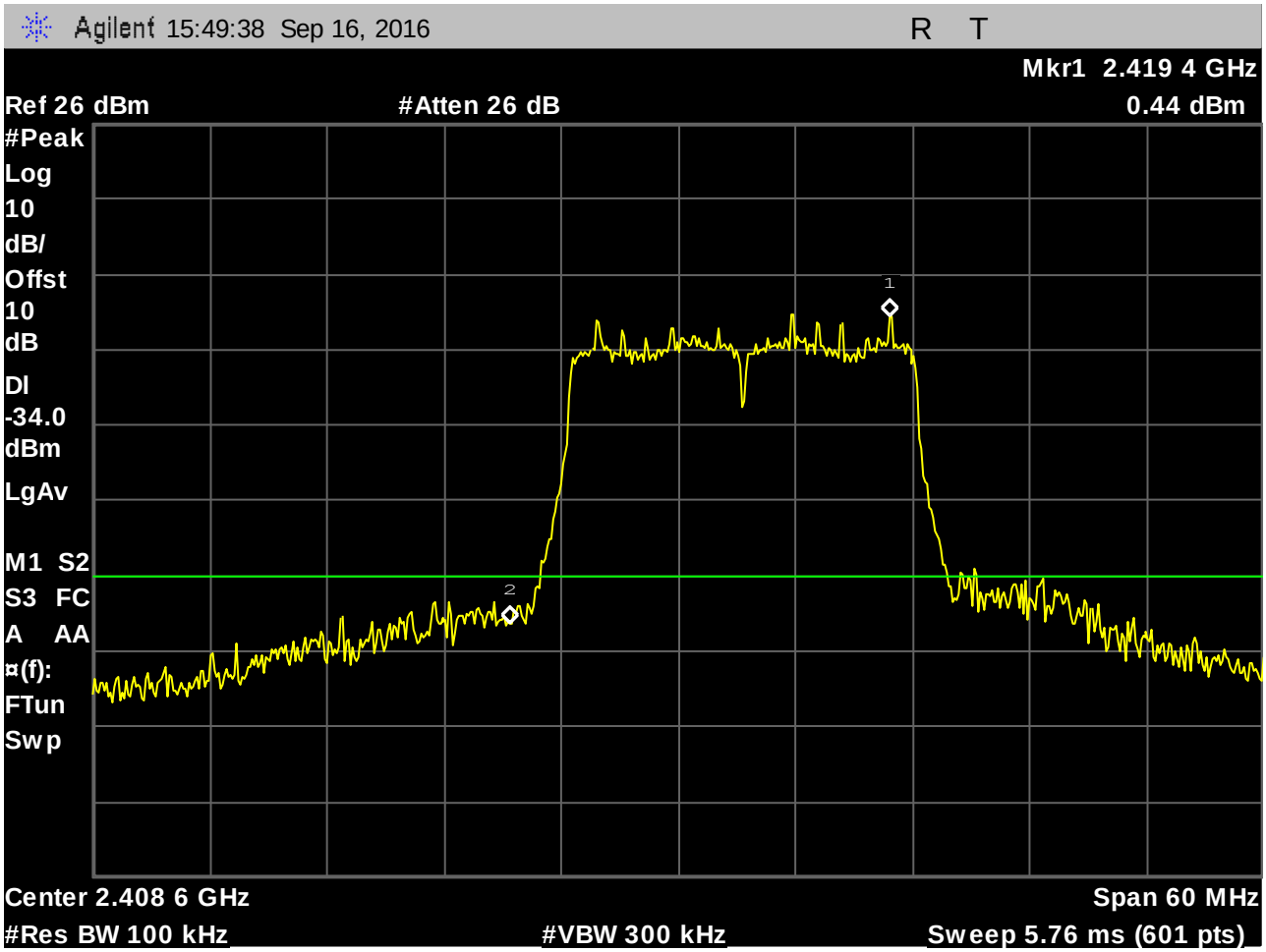
Plot 166. Conducted Band Edge, Ch. 2462, b mode, 30 dBc, Port 1



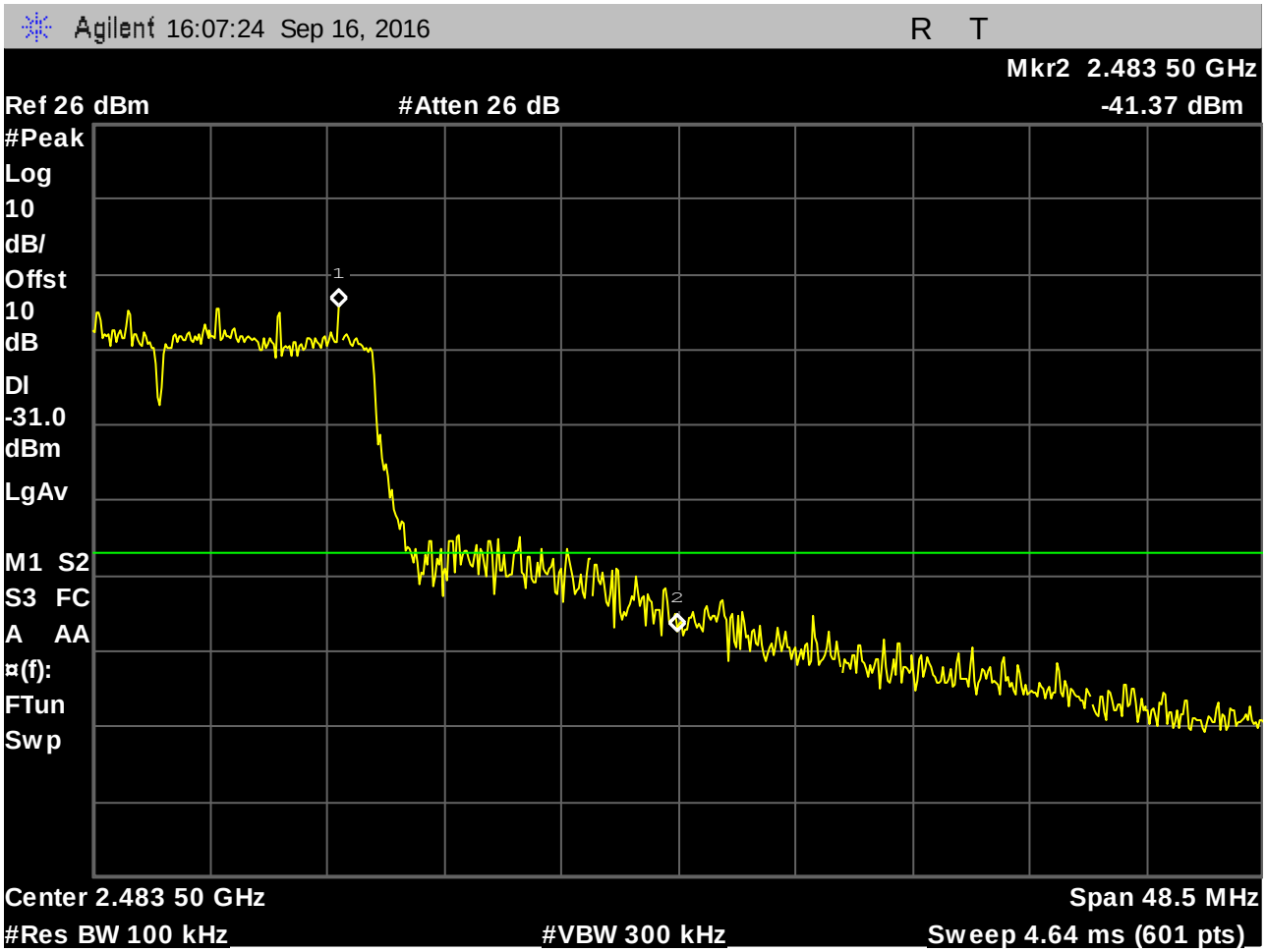
Plot 167. Conducted Band Edge, Ch. 2462, b mode, 30 dBc, Port 2



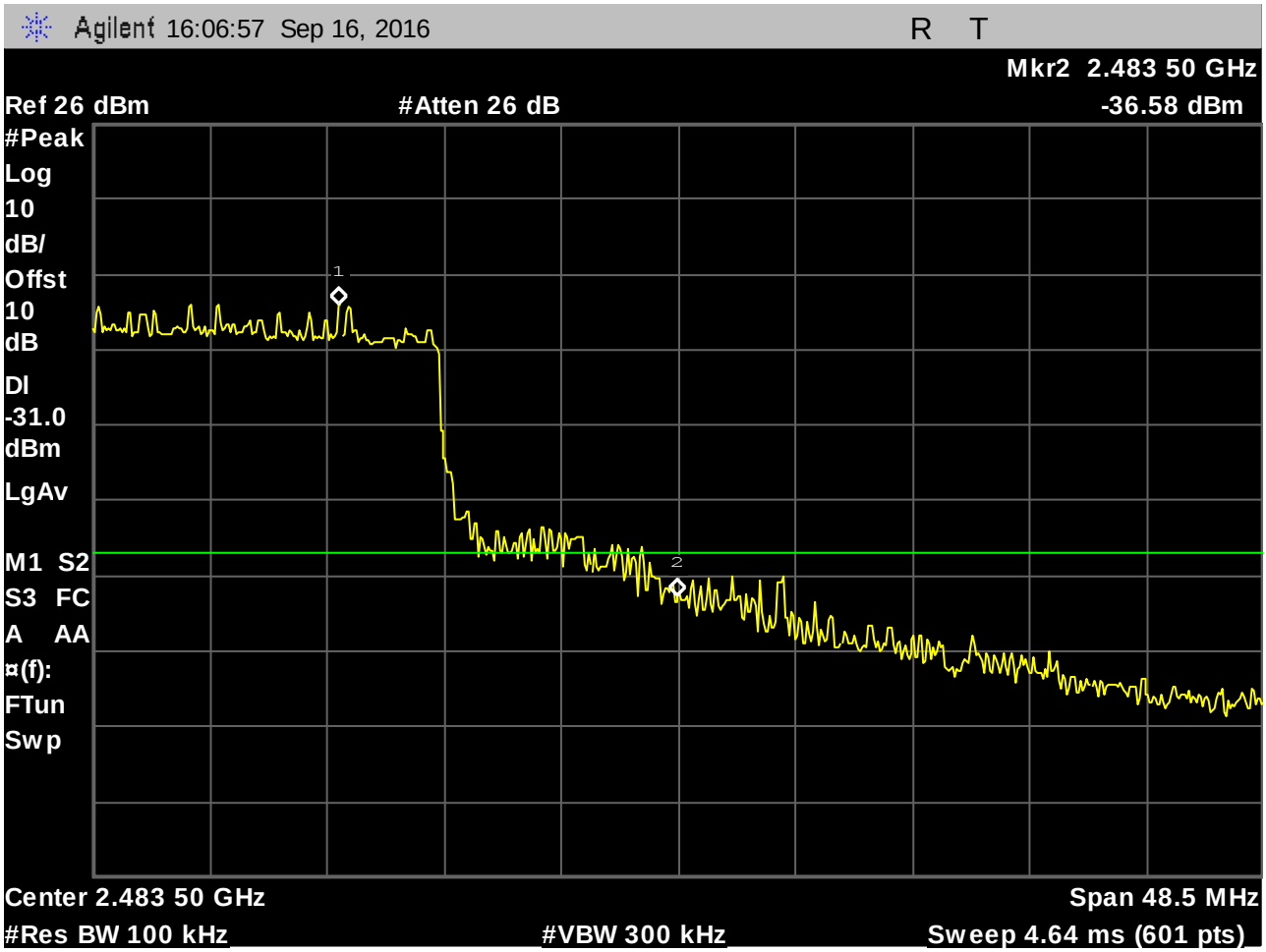
Plot 168. Conducted Band Edge, Ch. 2412, n mode, 30 dBc, Port 1



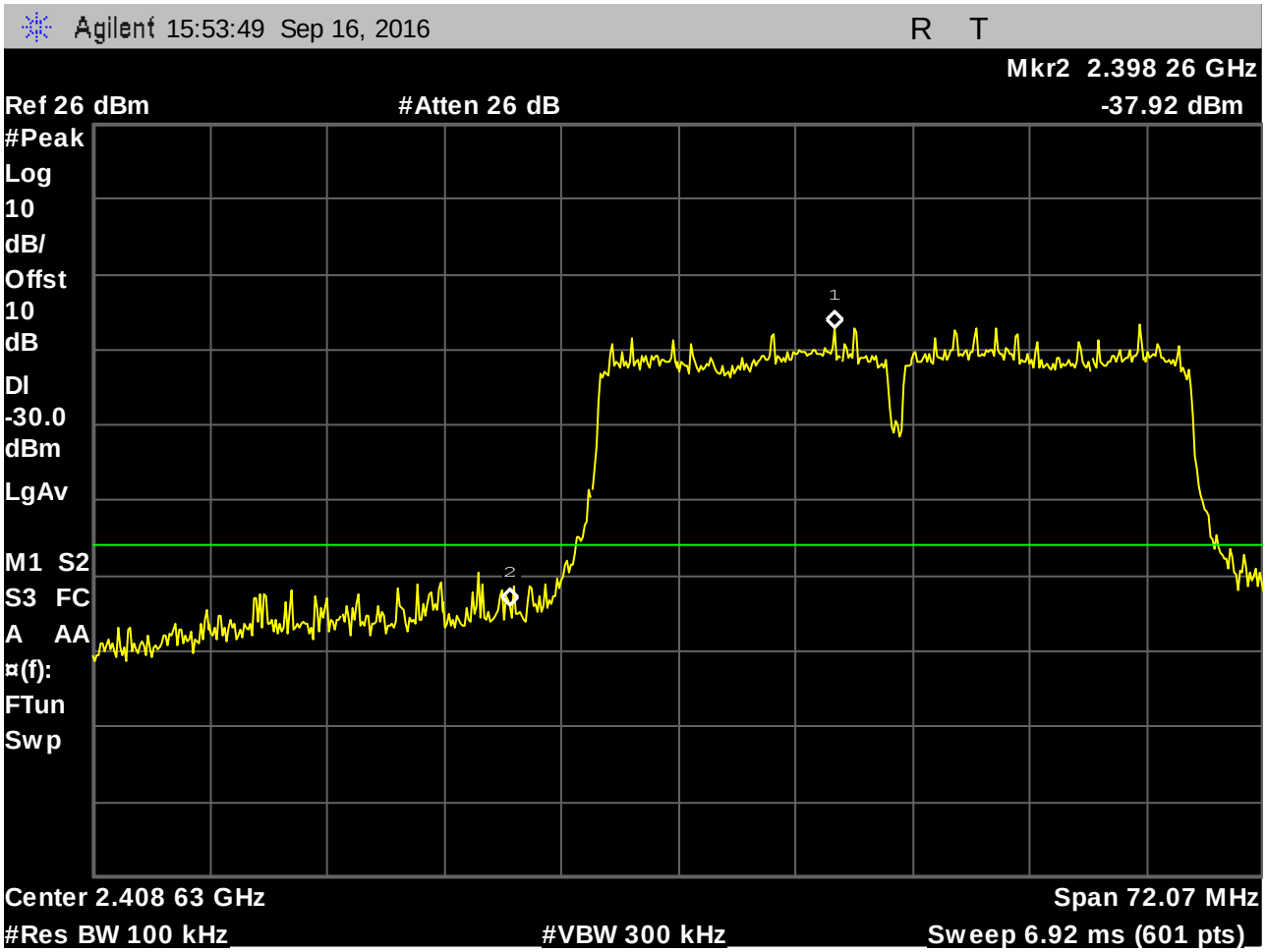
Plot 169. Conducted Band Edge, Ch. 2412, n mode, 30 dBc, Port 2



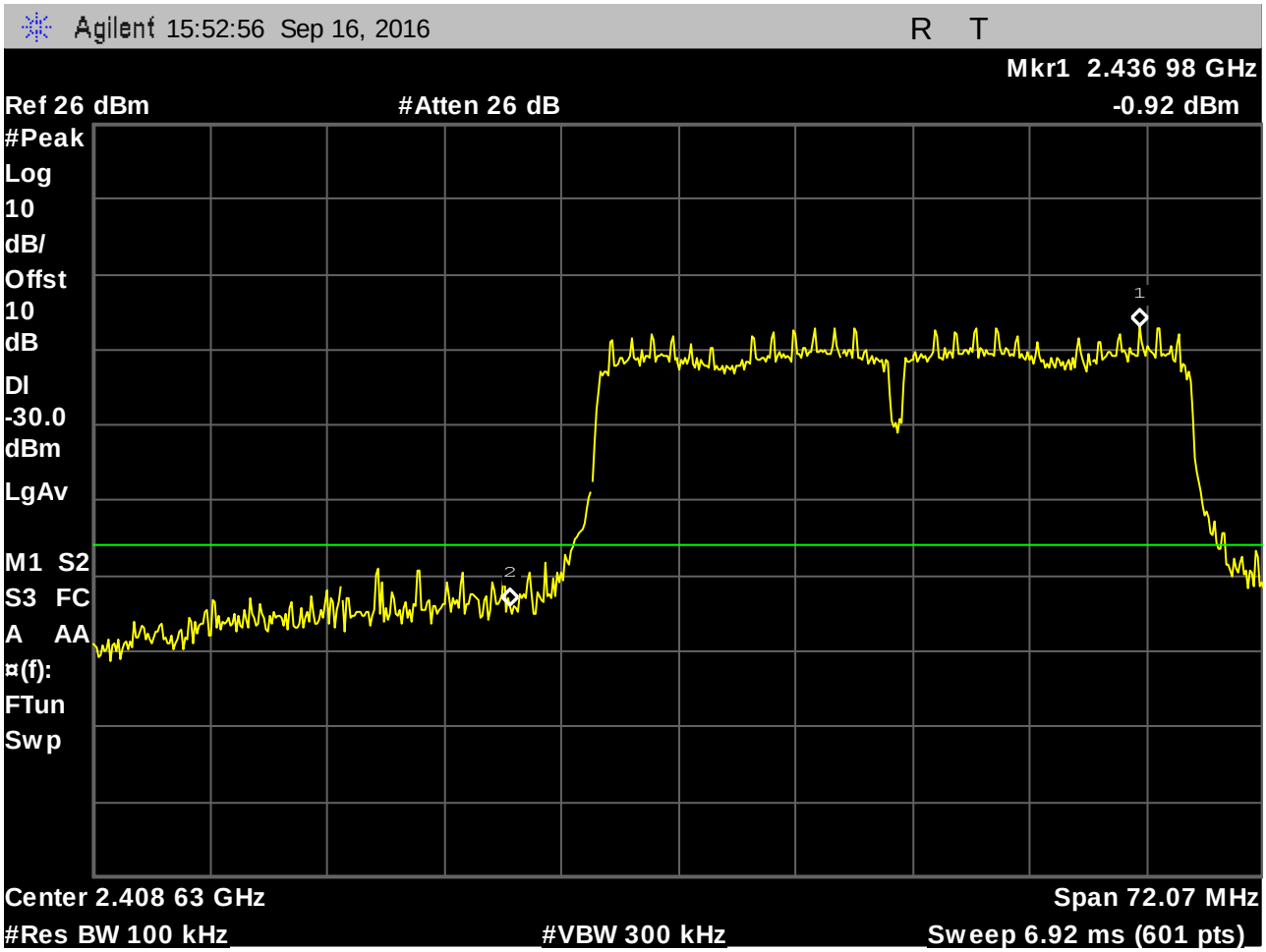
Plot 170. Conducted Band Edge, Ch. 2462, 20MHz, n mode, 30 dBc, Port 1



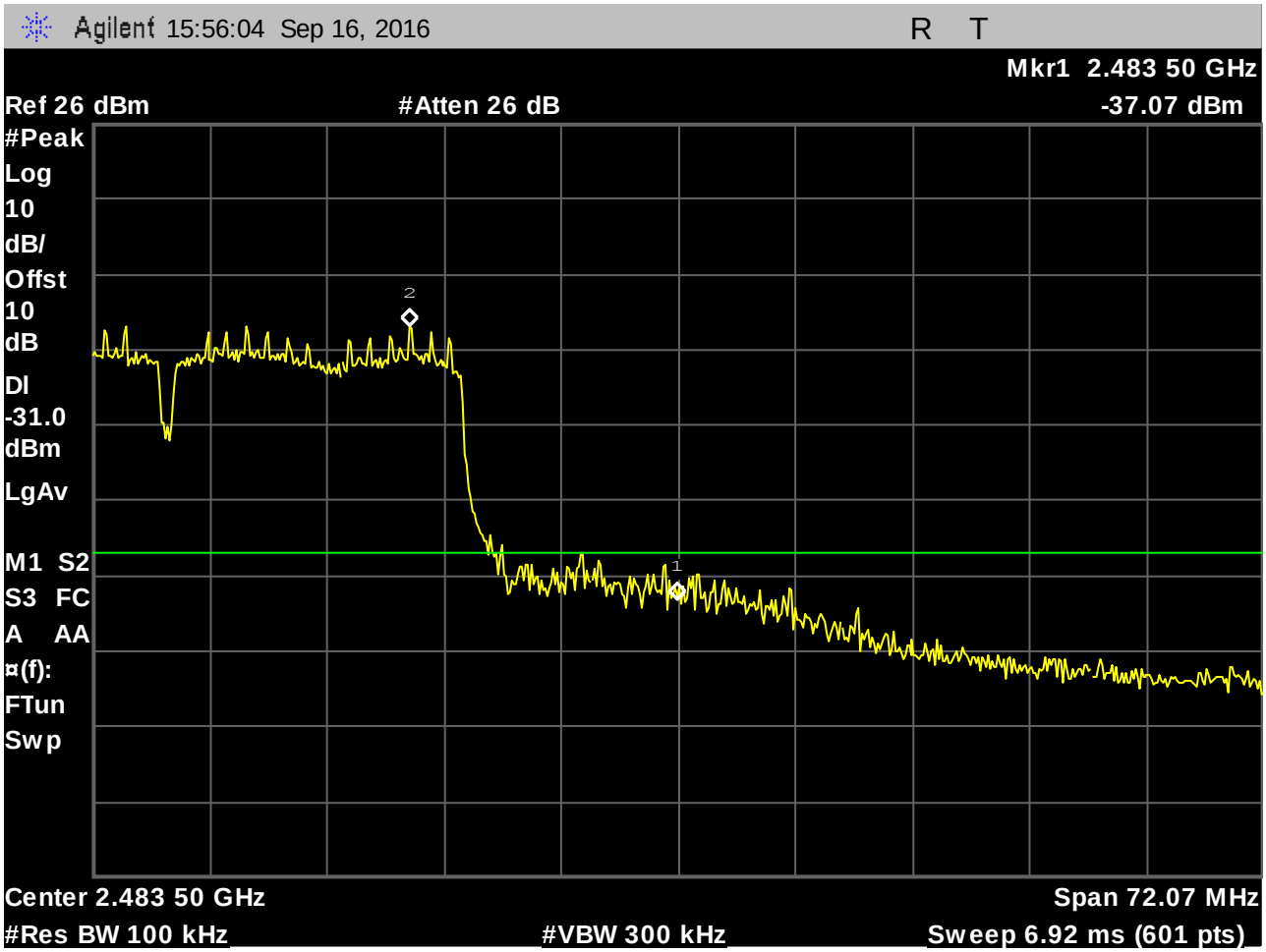
Plot 171. Conducted Band Edge, Ch. 2462, 20MHz, n mode, 30 dBc, Port 2



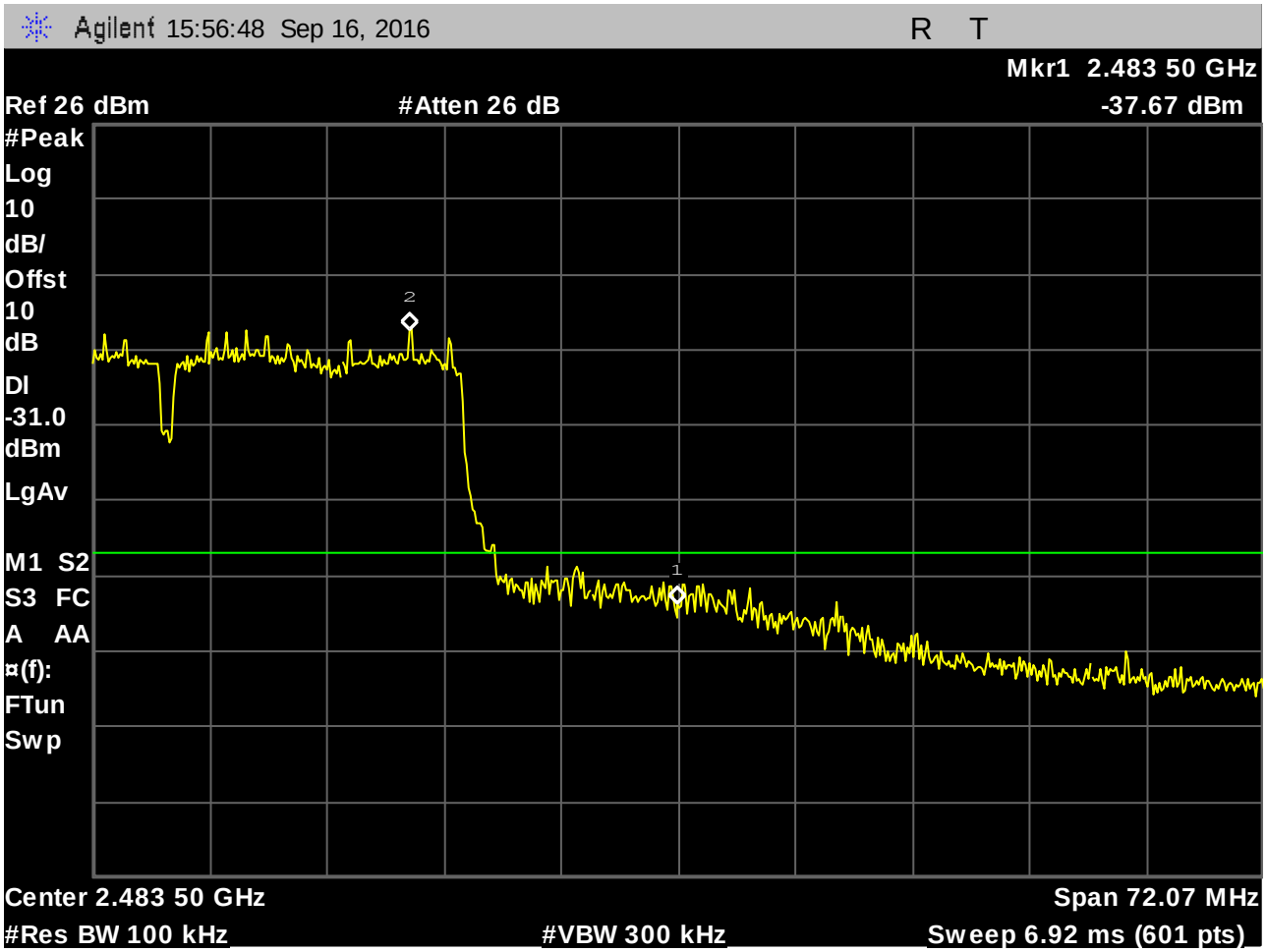
Plot 172. Conducted Band Edge, Ch. 2412, 40MHz, n mode, 30 dBc, Port 1



Plot 173. Conducted Band Edge, Ch. 2412, 40MHz, n mode, 30 dBc, Port 2



Plot 174. Conducted Band Edge, Ch. 2452, 40 MHz, n mode, 30 dBc, Port 1



Plot 175. Conducted Band Edge, Ch. 2452, 40MHz, n mode, 30 dBc, Port 2

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. The RBW was set to 3 kHz and a VBW set to 9 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was compliant with the peak power spectral density limits of **§ 15.247 (e)**.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Djed Mouada

Test Date: October 11, 2016

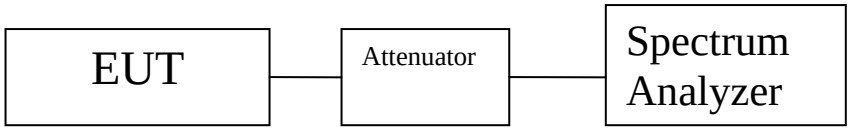


Figure 6. Block Diagram, Peak Power Spectral Density Test Setup

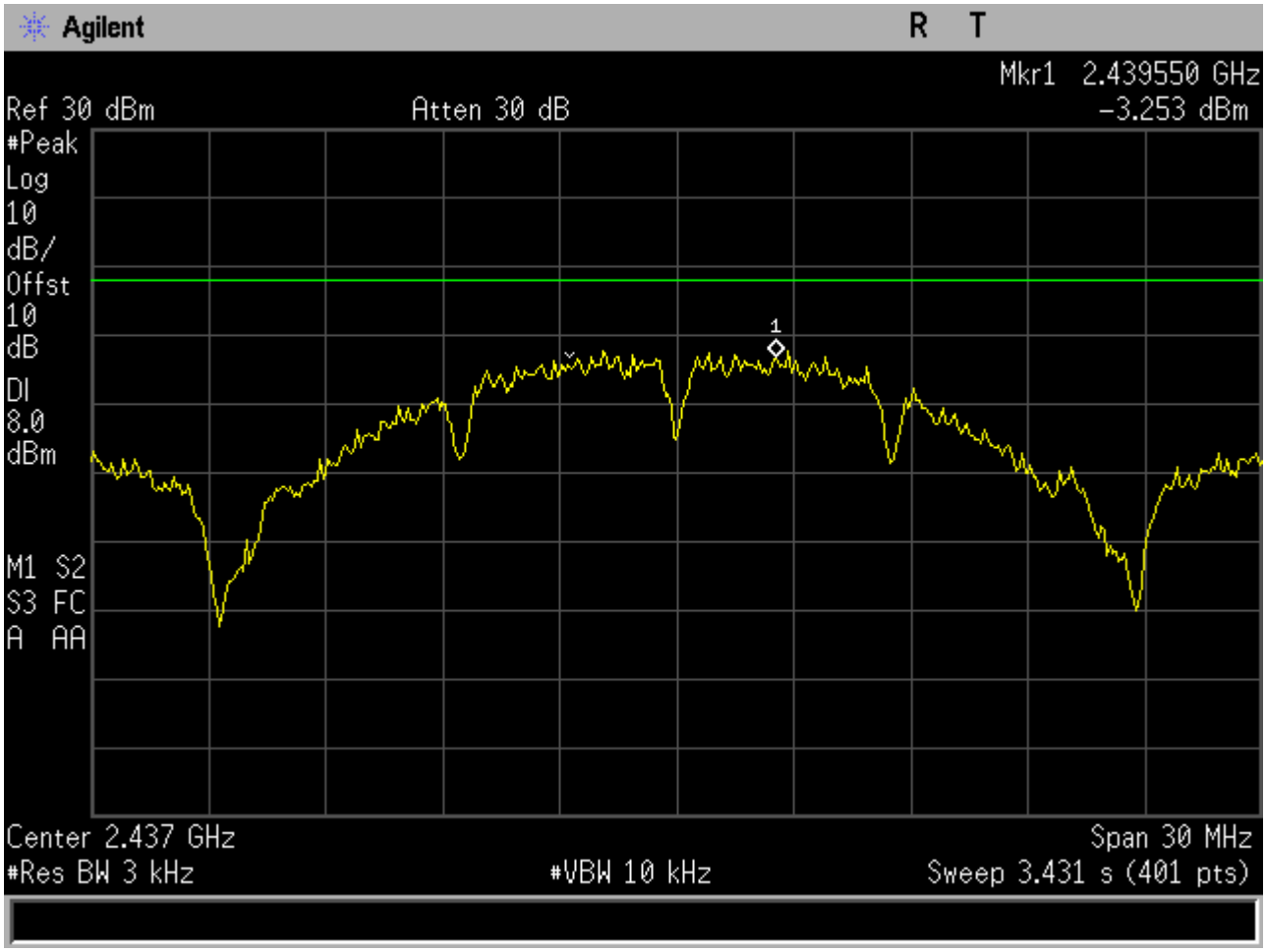
Peak Power Spectral Density Test Results

Power Spectral Density					
Channel	**Port 1 (dBm)**	**Port 2 (dBm)**	**Sum (dBm)**	**Limit (dBm)**	**Margin**
Low b_mode	-7.613	-8.416	-4.986	8	12.986
Mid b_mode	-3.253	-5.043	-1.046	8	9.046
High b_mode	-5.766	-6.607	-3.156	8	11.156
Low g_mode	-12.15	-10.88	-8.458	8	16.458
Mid g_mode	-6.925	-9.141	-4.883	8	12.883
High g_mode	-11.72	-11.05	-8.362	8	16.362
Low n_mode (20MHz)	-9.99	-11.18	-7.534	8	15.534
Mid n_mode (20MHz)	-5.938	-8.329	-3.961	8	11.961
Hig n_mode (20MHz)	-10.93	-10.94	-7.925	8	15.925
Low n_mode (40MHz)	-11.11	-12.7	-8.822	8	16.822
Mid n_mode (40MHz)	-9.667	-10.85	-7.208	8	15.208
Hig n_mode (40MHz)	-10.35	-10.35	-7.34	8	15.34

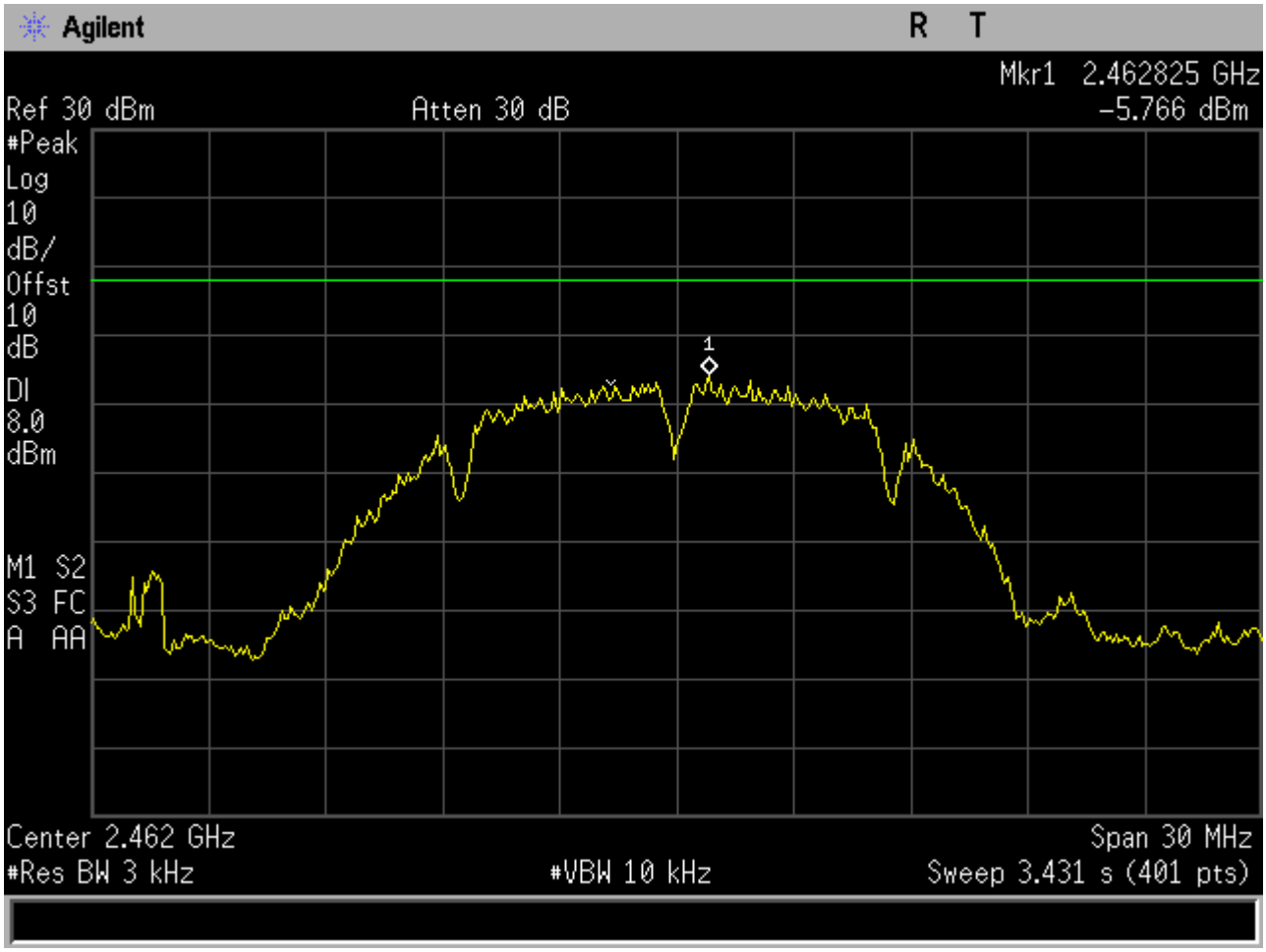
Table 16. Peak Power Spectral Density, Test Results

Peak Power Spectral Density

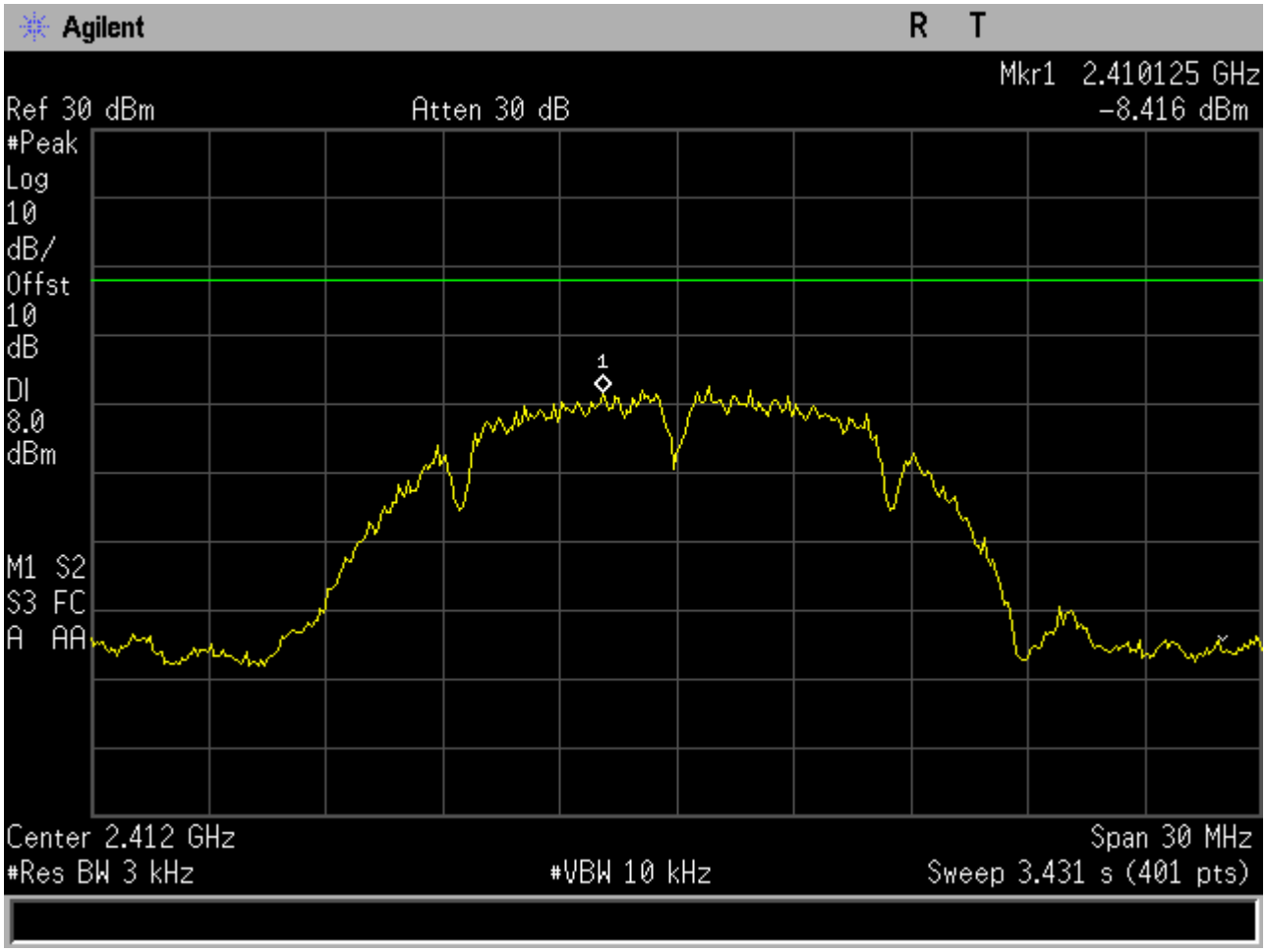
Plot 176. Power Spectral Density, Bandwidth 20M, Ch. 2412M, b mode, Port 1



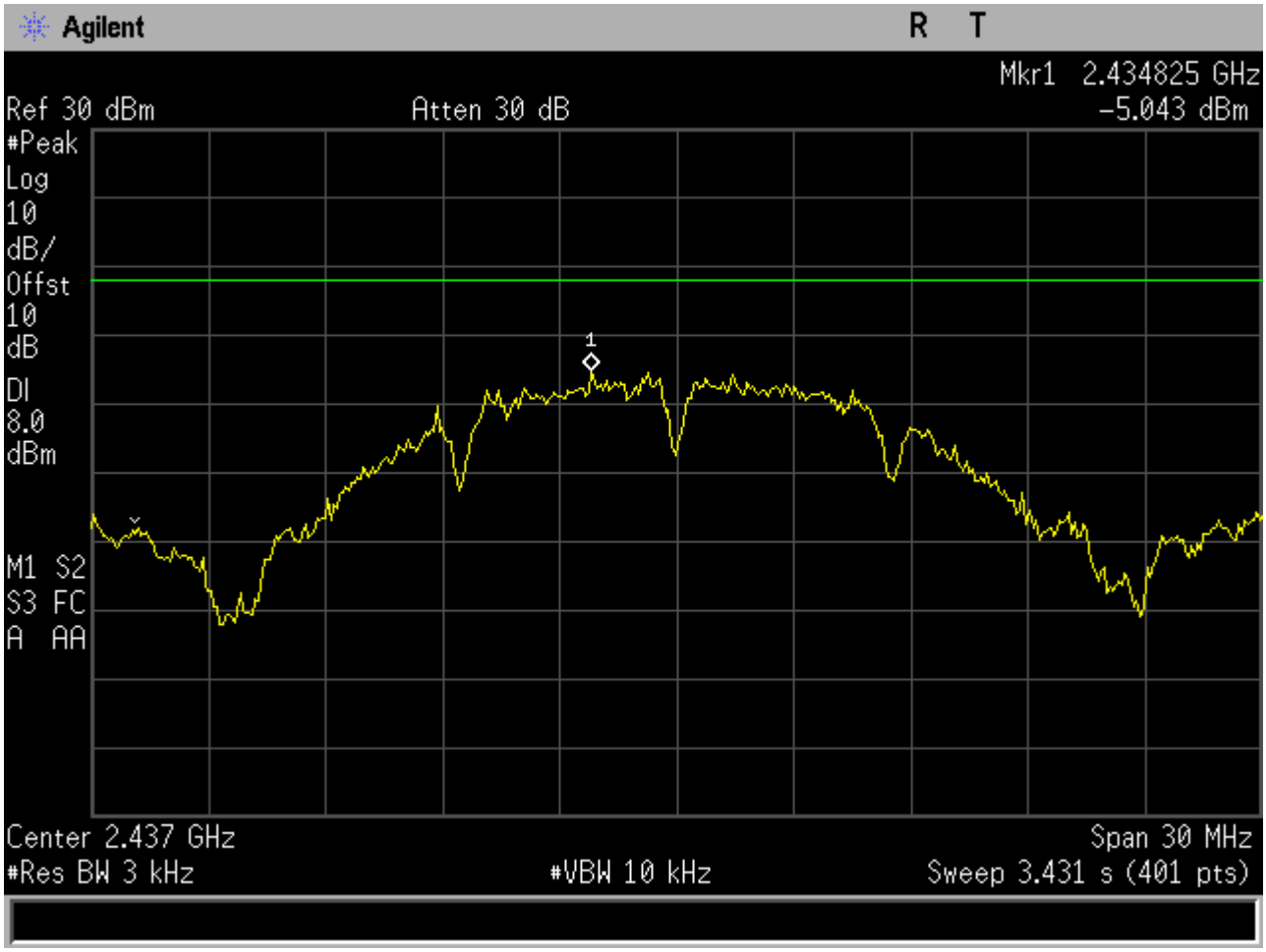
Plot 177. Power Spectral Density, Bandwidth 20M, Ch. 2437M, b mode, Port 1



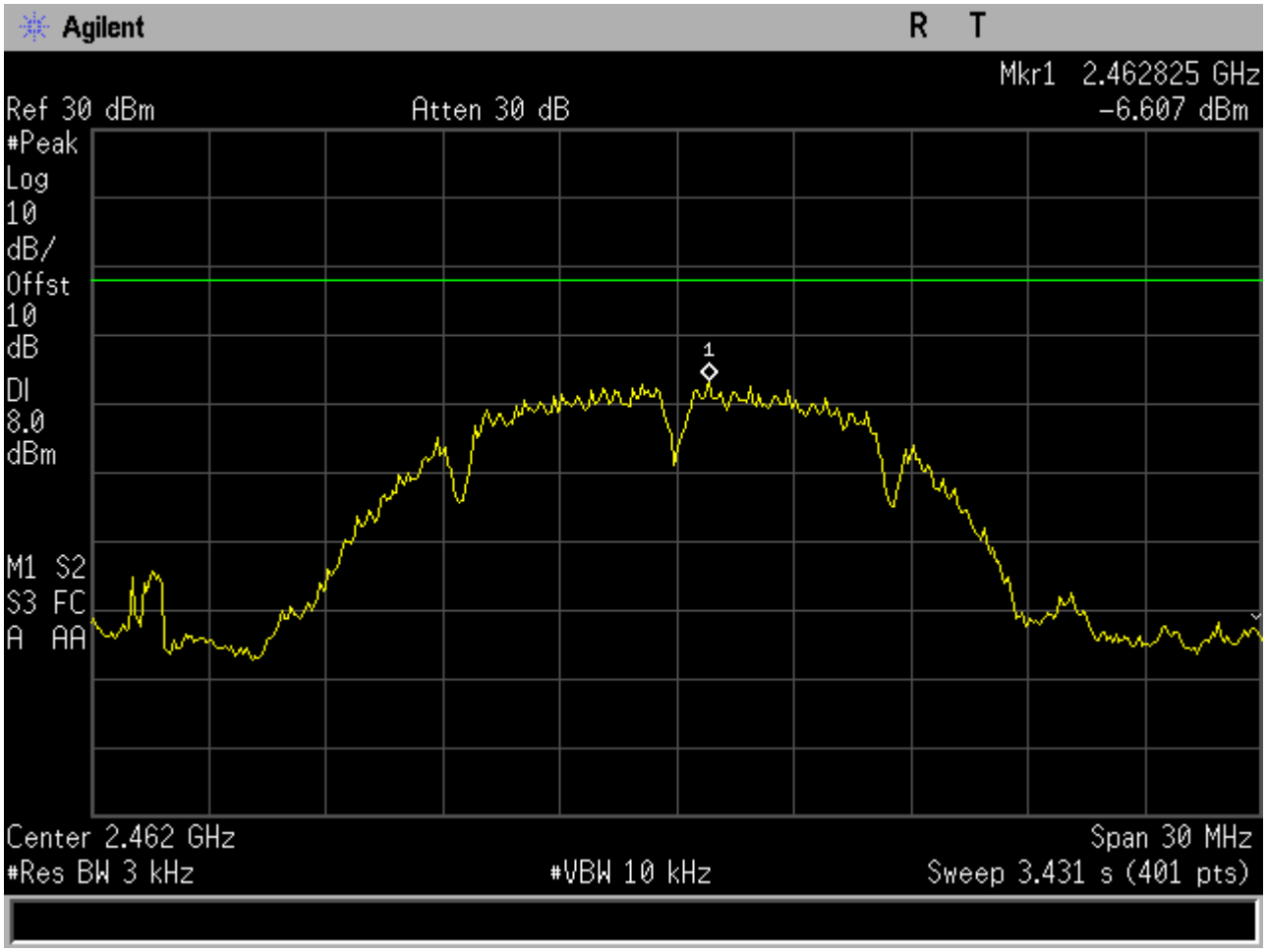
Plot 178. Power Spectral Density, Bandwidth 20M, Ch. 2437M, b mode, Port 1



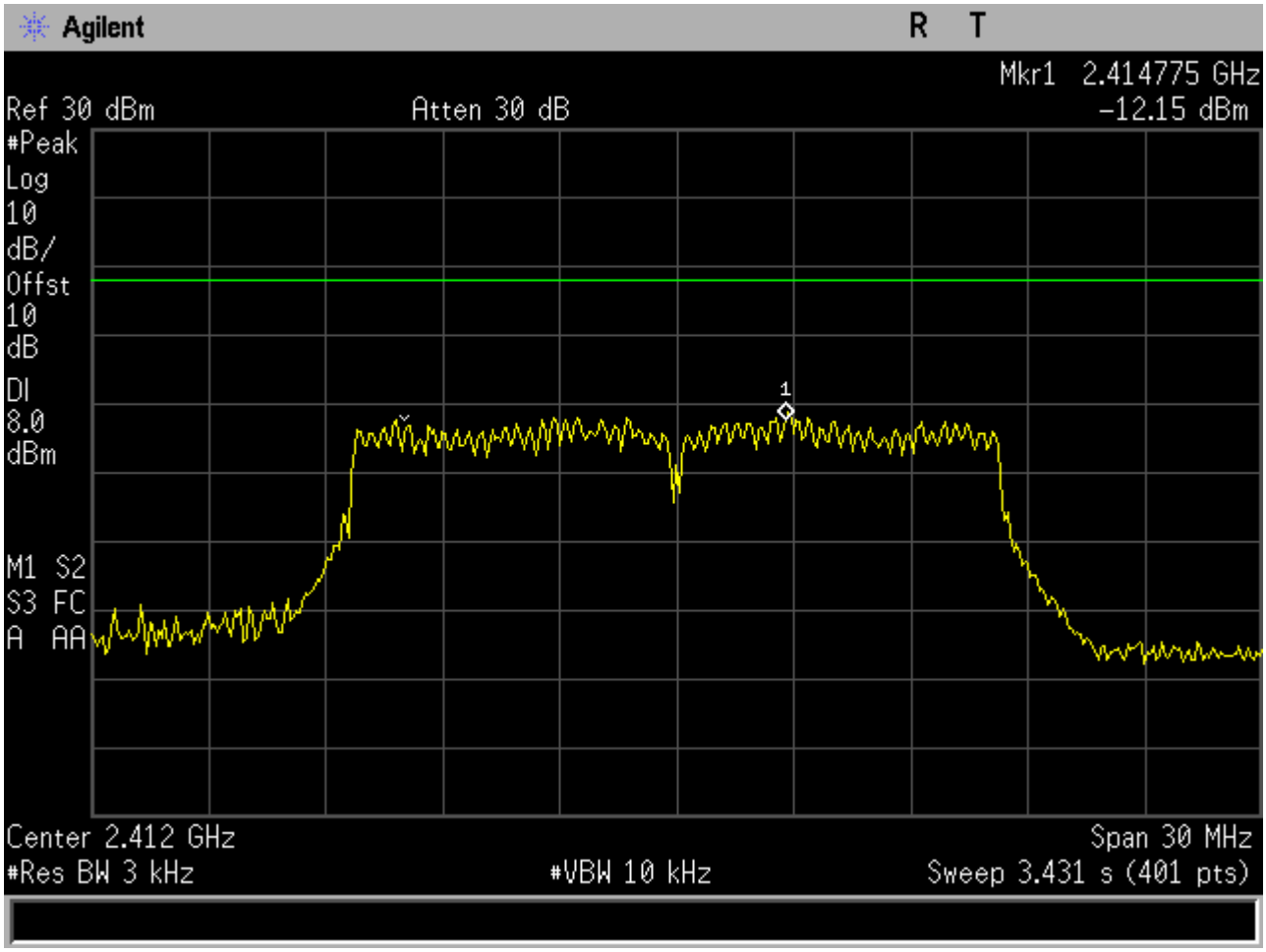
Plot 179. Power Spectral Density, Bandwidth 20M, Ch. 2412M, b mode, Port 2



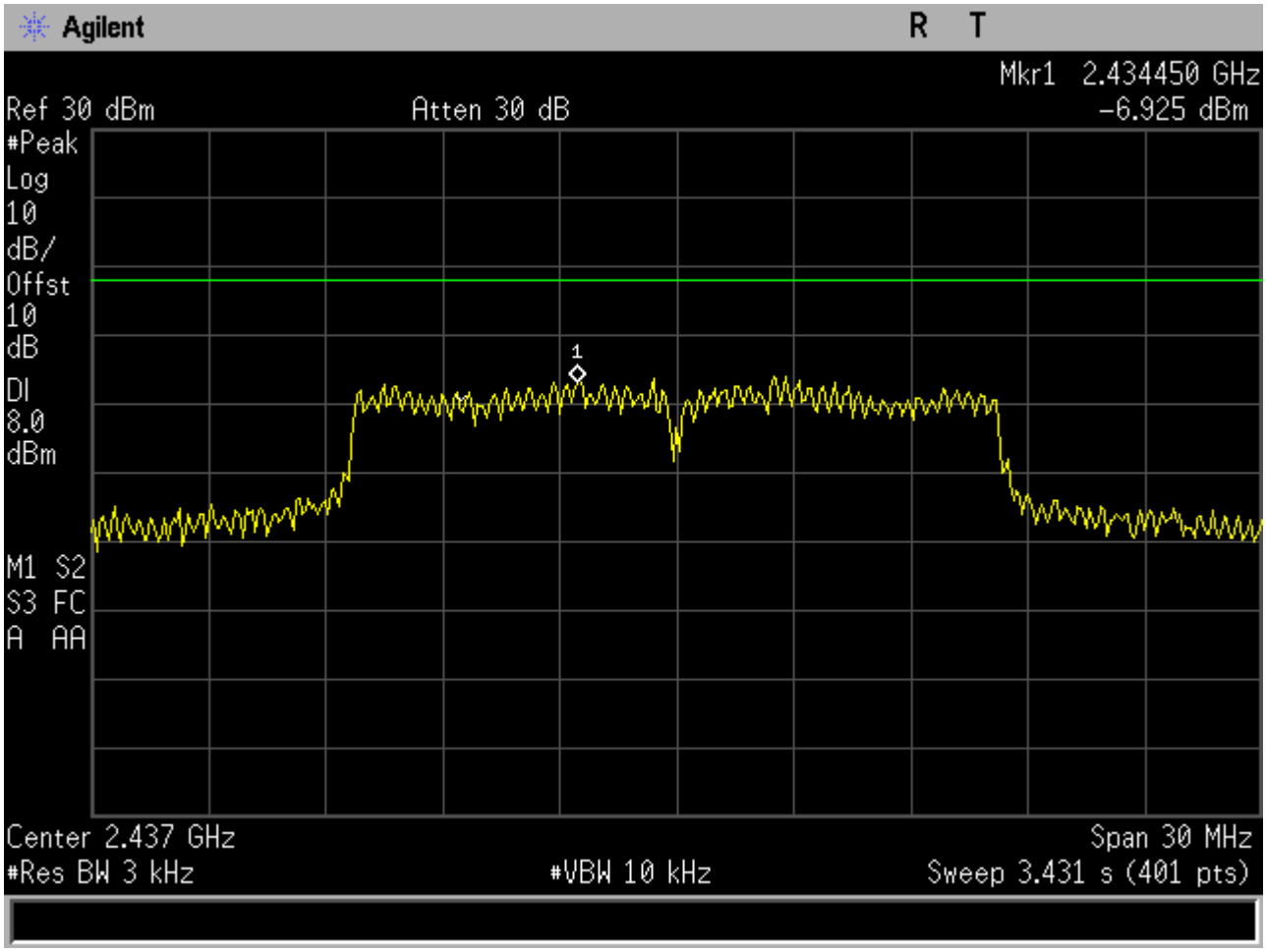
Plot 180. Power Spectral Density, Bandwidth 20M, Ch. 2437M, b mode, Port 2



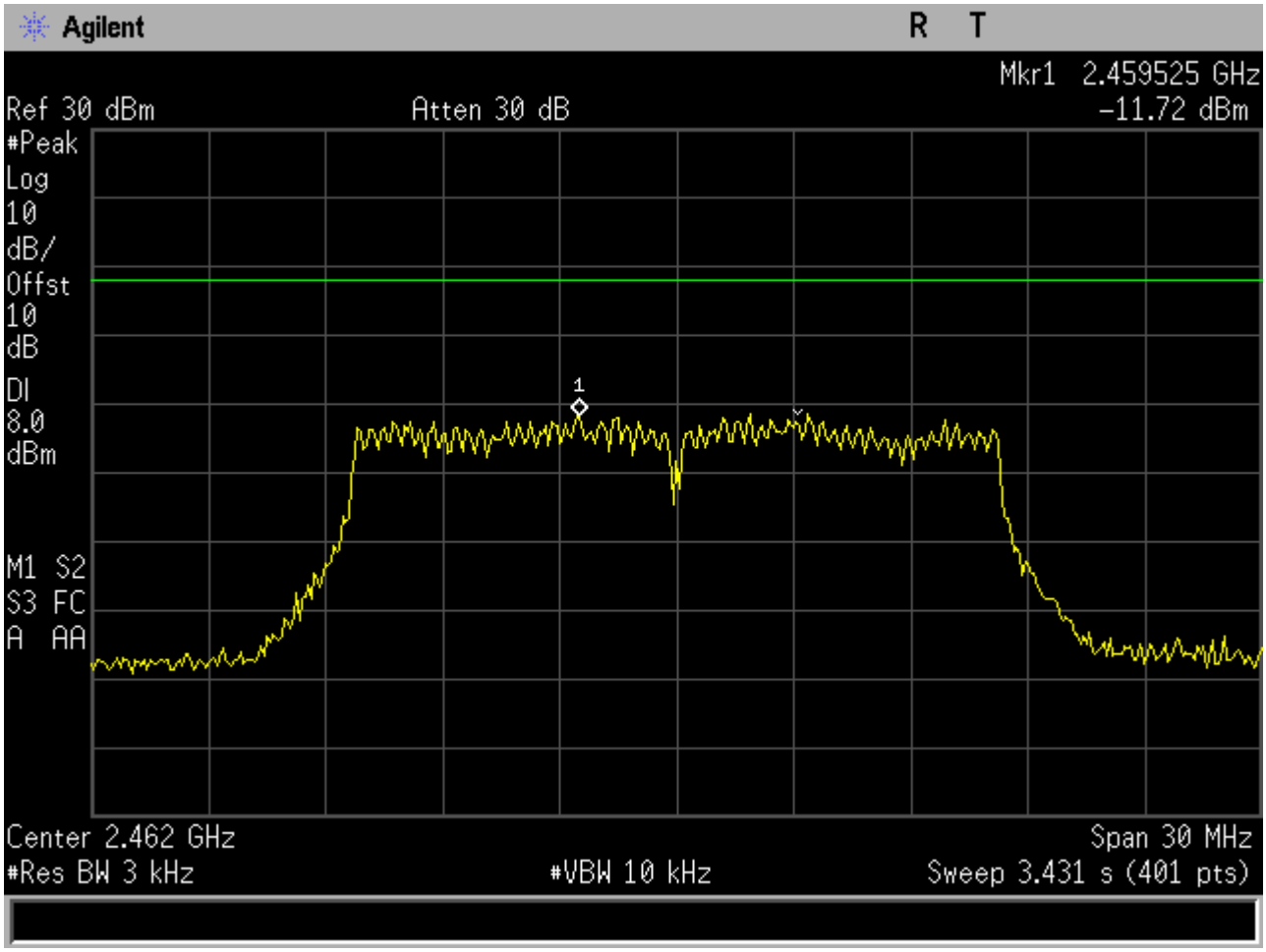
Plot 181. Power Spectral Density, Bandwidth 20M, Ch. 2462M, b mode, Port 2



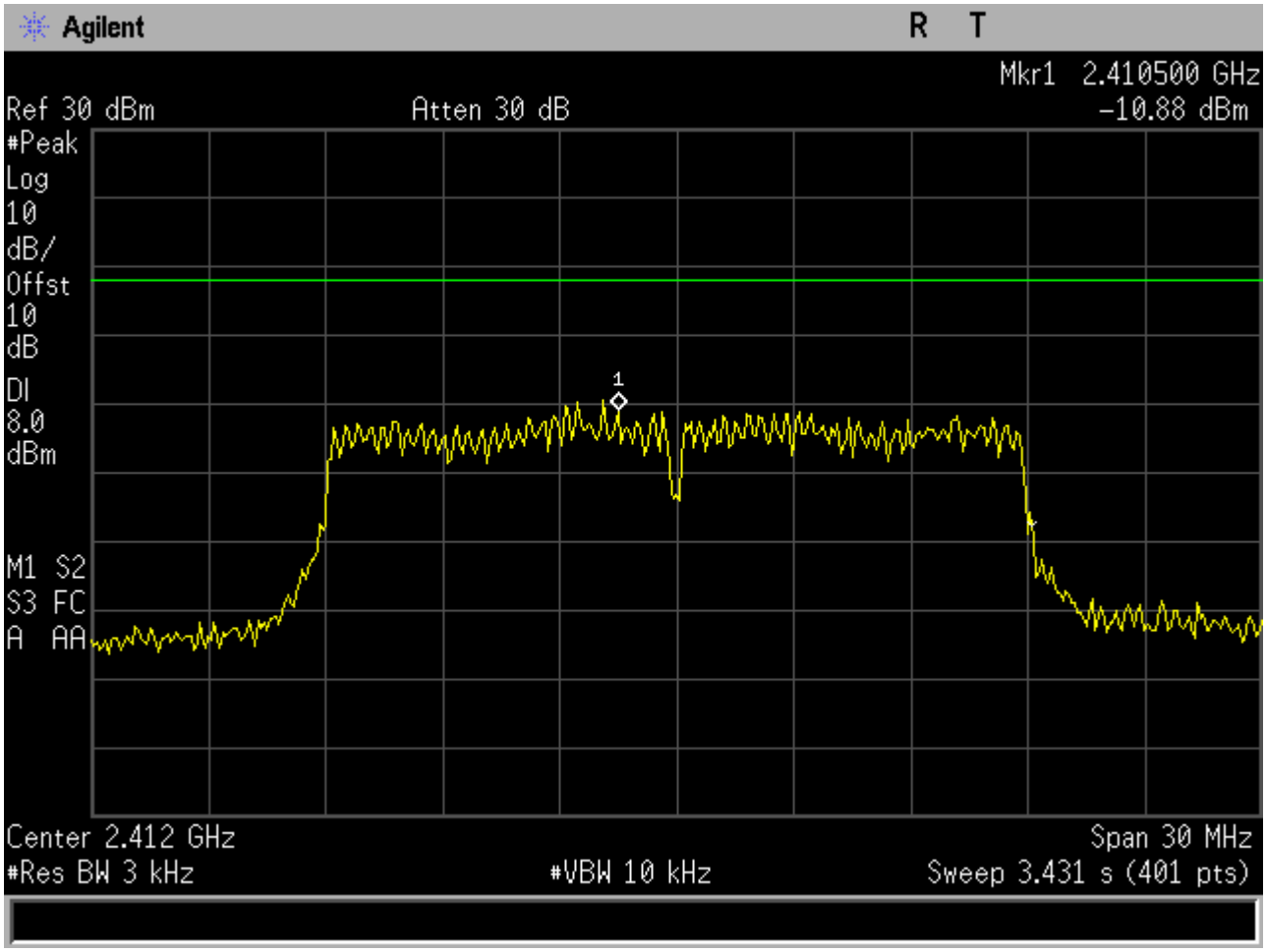
Plot 182. Power Spectral Density, Bandwidth 20M, Ch. 2412M, g mode, Port 1



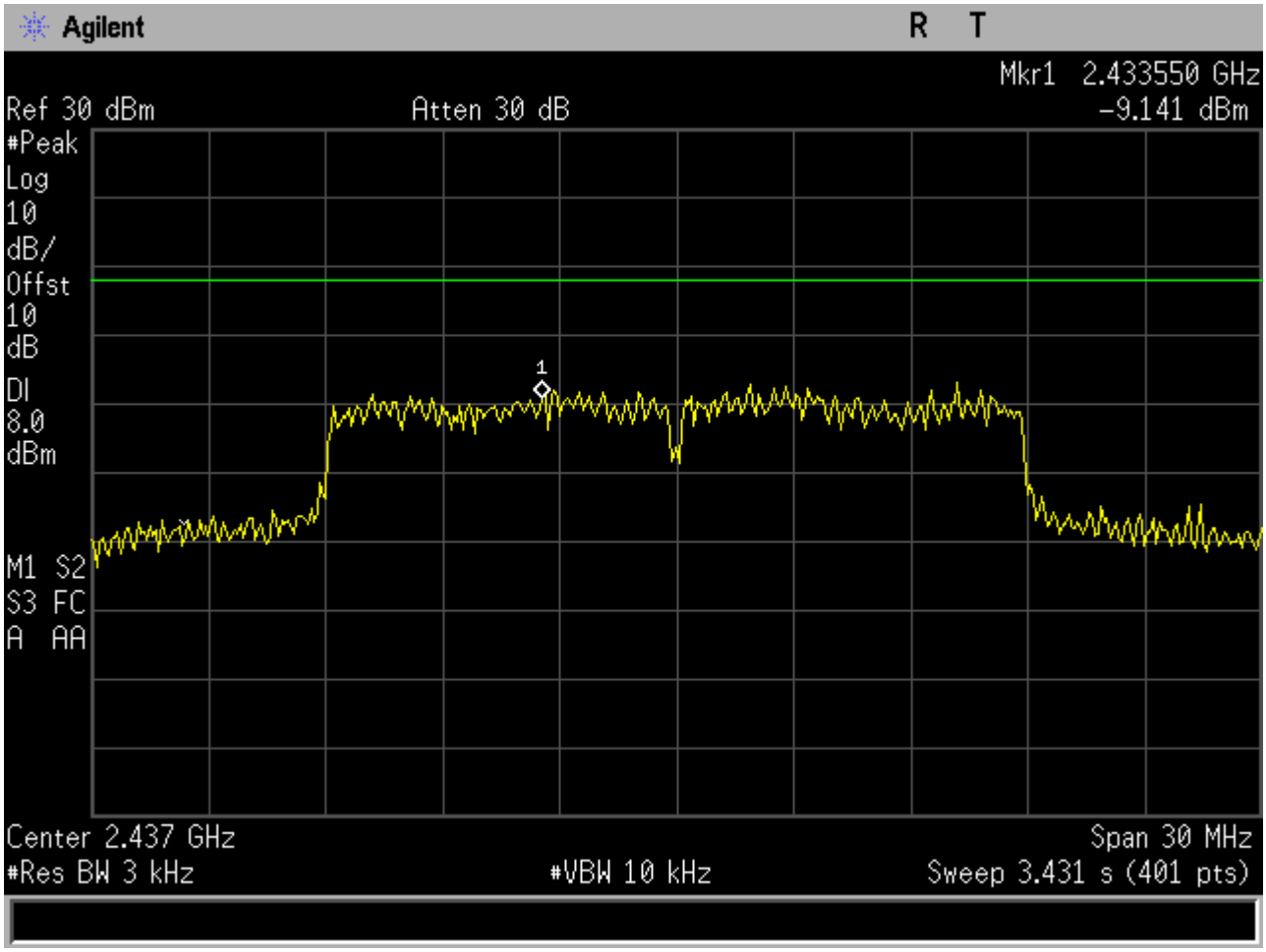
Plot 183. Power Spectral Density, Bandwidth 20M, Ch. 2437M, g mode, Port 1



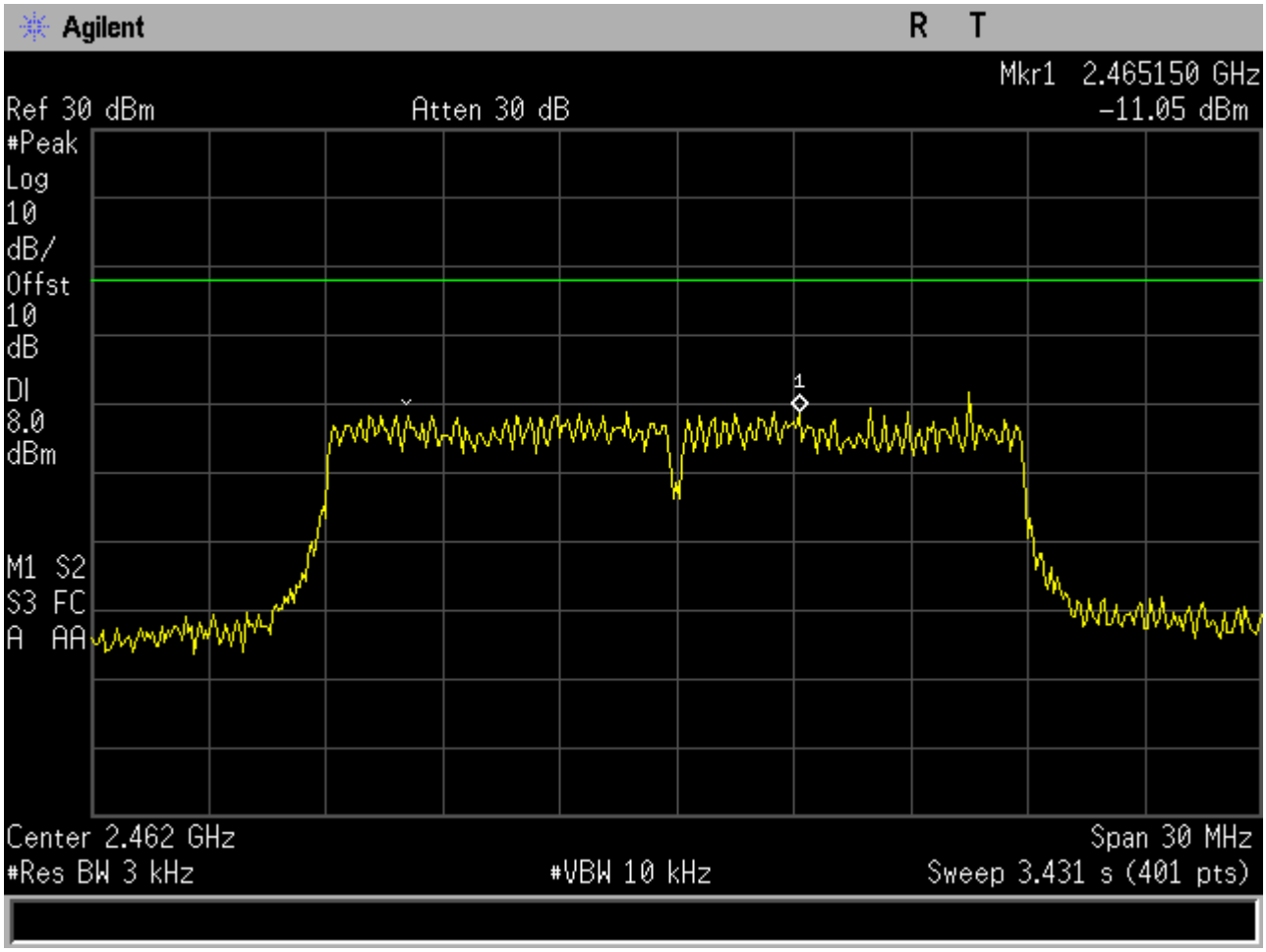
Plot 184. Power Spectral Density, Bandwidth 20M, Ch. 2462M, g mode, Port 1



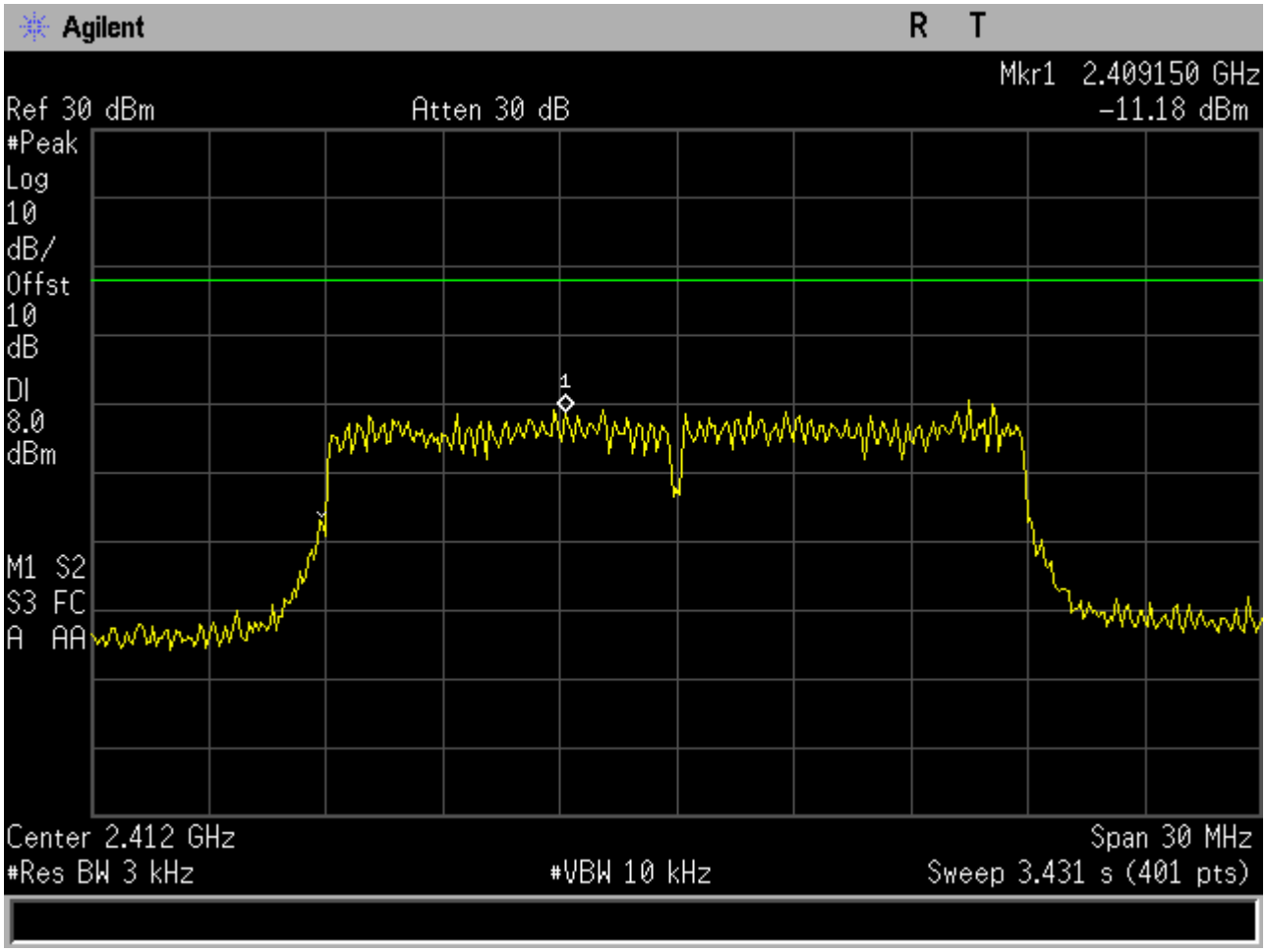
Plot 185. Power Spectral Density, Bandwidth 20M, Ch. 2412M, g mode, Port 2



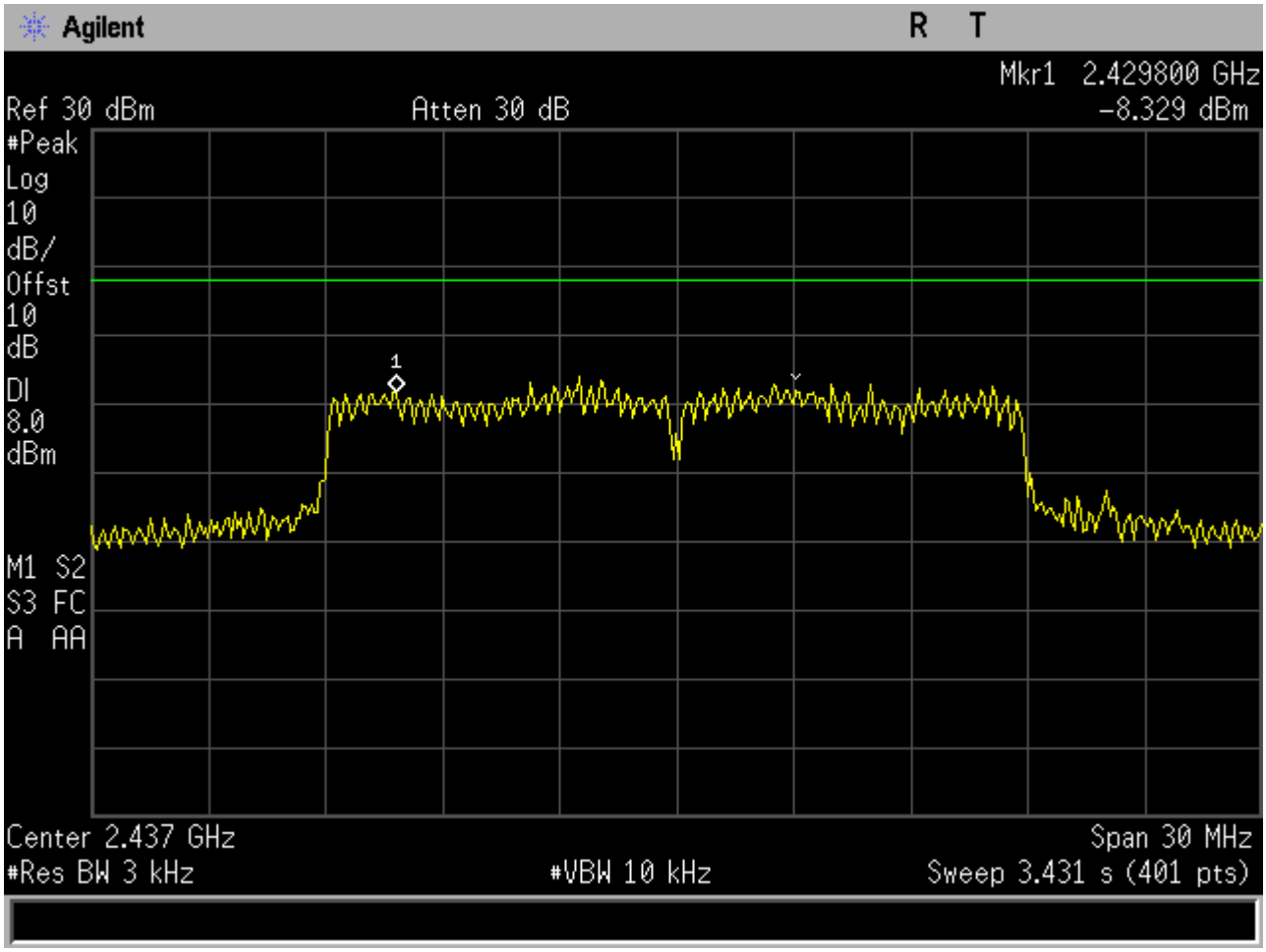
Plot 186. Power Spectral Density, Bandwidth 20M, Ch. 2437M, g mode, Port 2



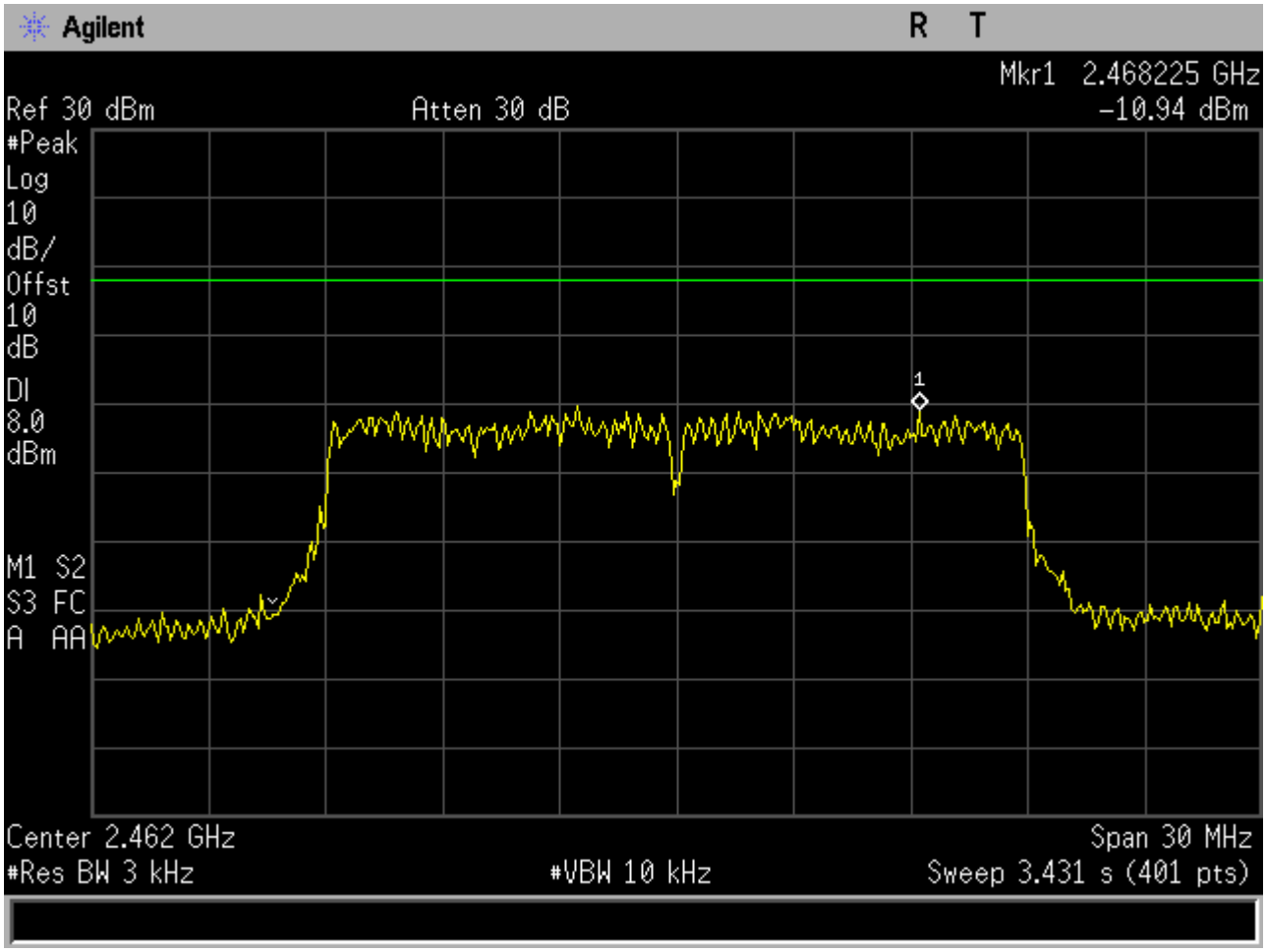
Plot 187. Power Spectral Density, Bandwidth 20M, Ch. 2462M, g mode, Port 2



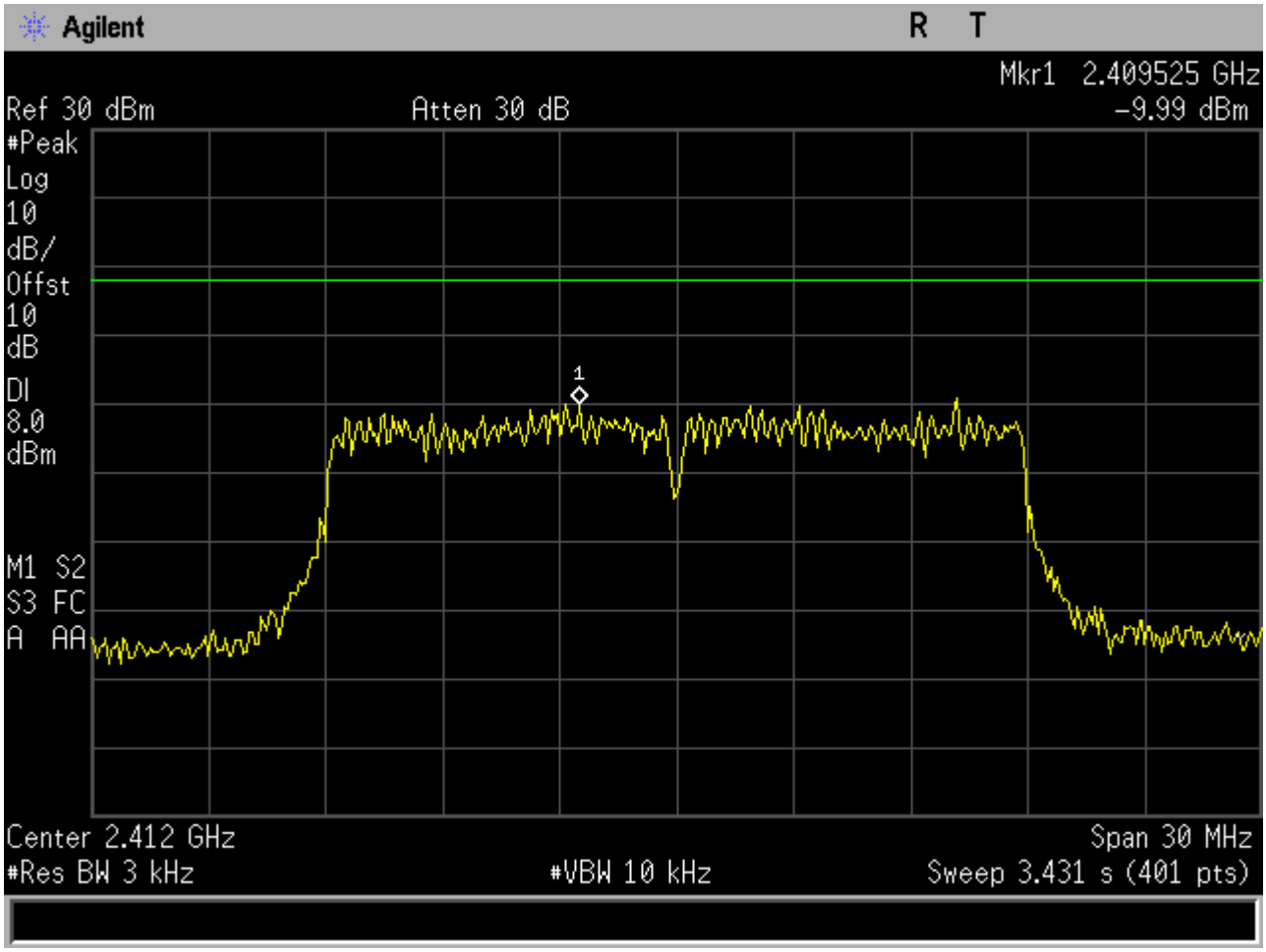
Plot 188. Power Spectral Density, Bandwidth 20M, Ch. 2412M, n mode, Port 2



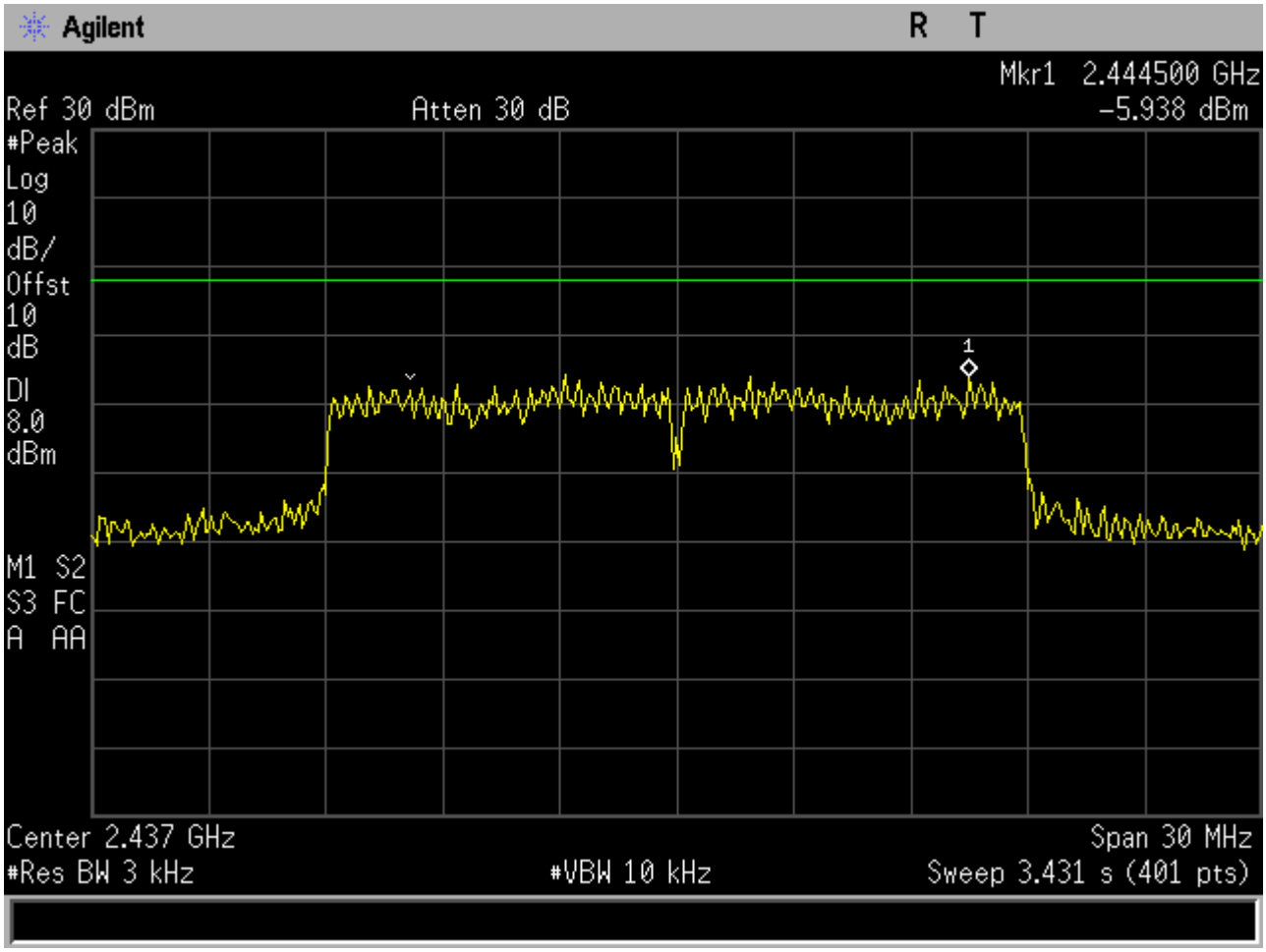
Plot 189. Power Spectral Density, Bandwidth 20M, Ch. 2437M, n Mode, Port 2



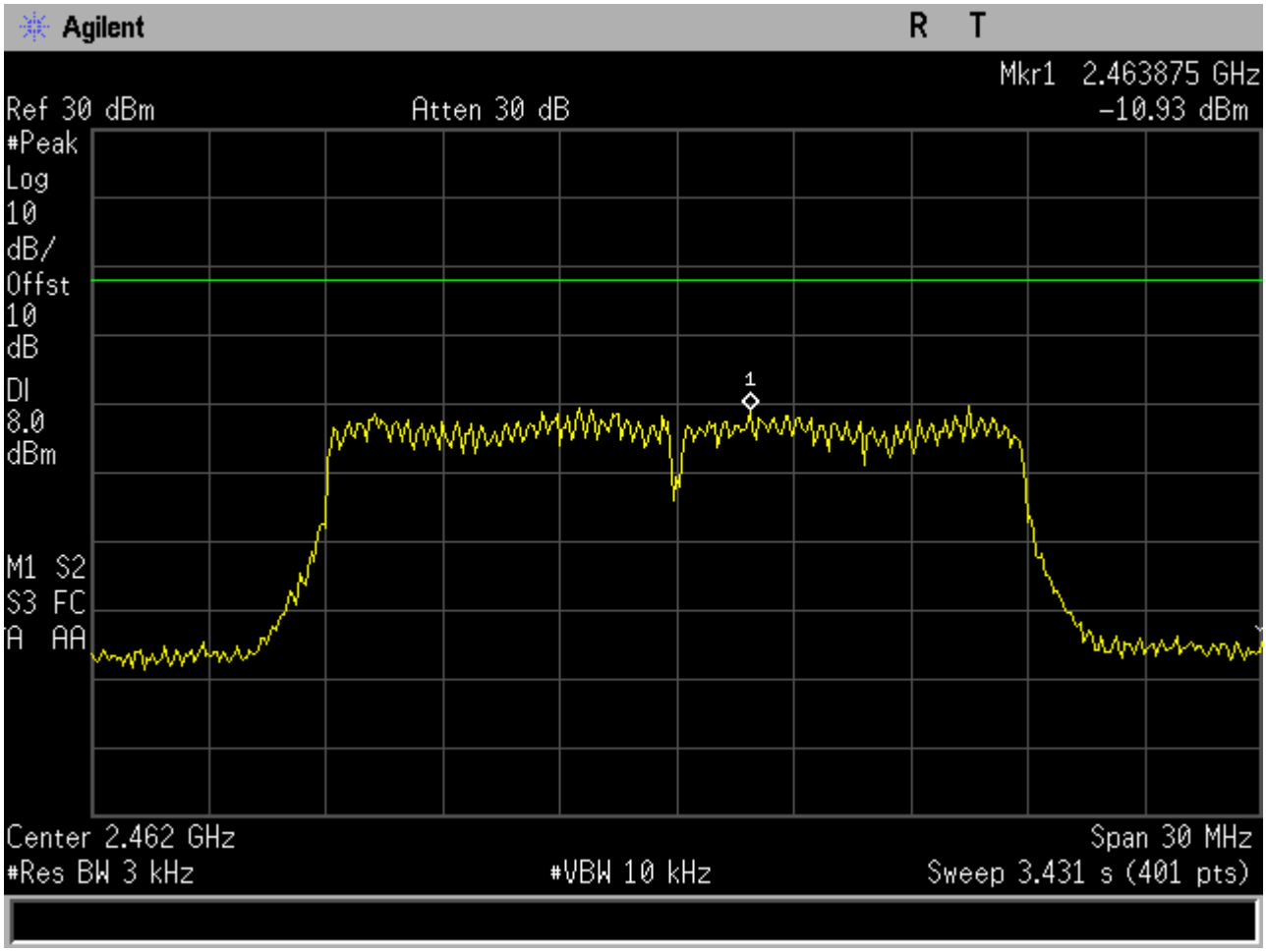
Plot 190. Power Spectral Density, Bandwidth 20M, Ch. 2462M, n mode, Port 2



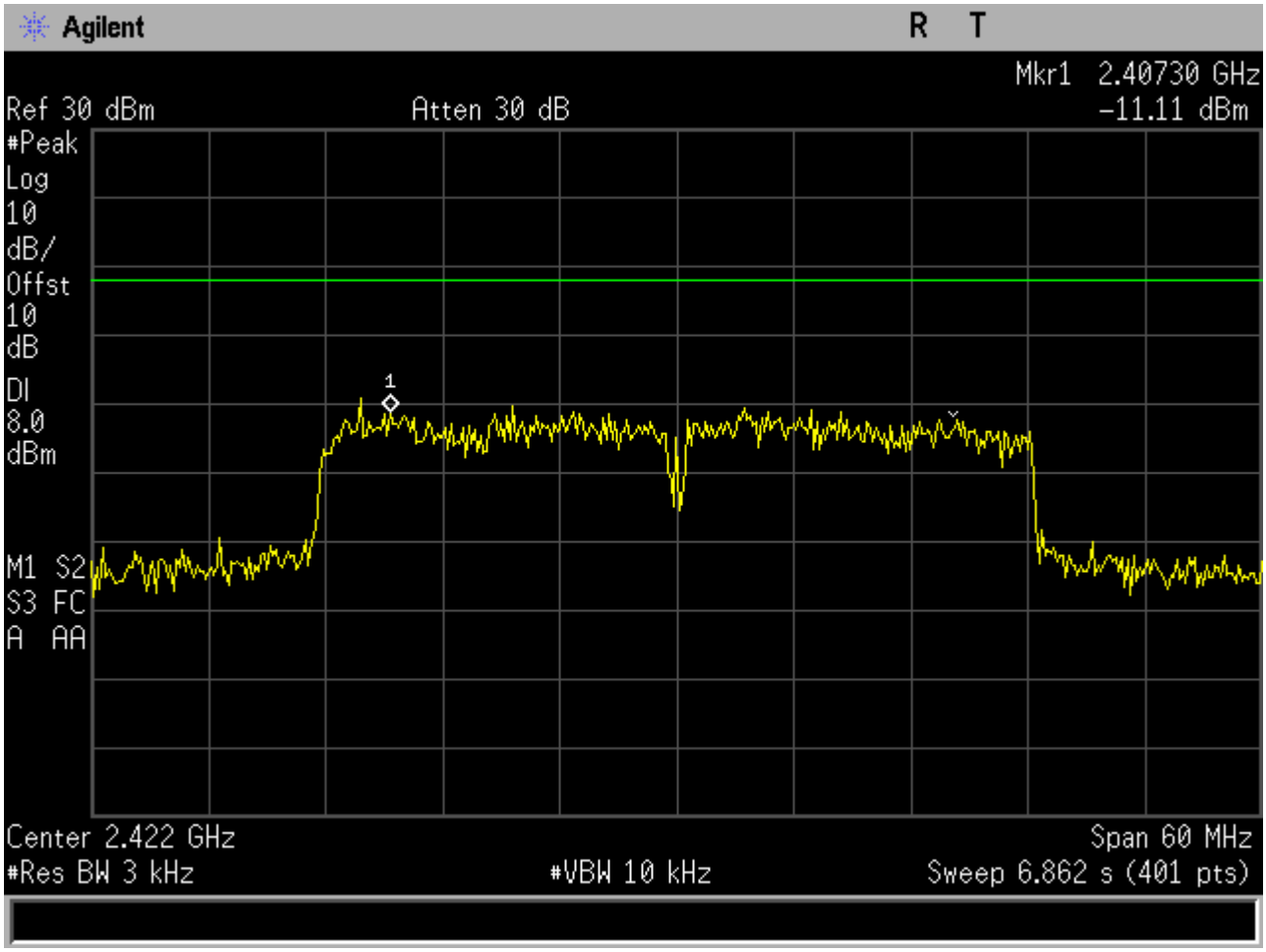
Plot 191. Power Spectral Density, Bandwidth 20M, Ch. 2412M, n mode, Port 1



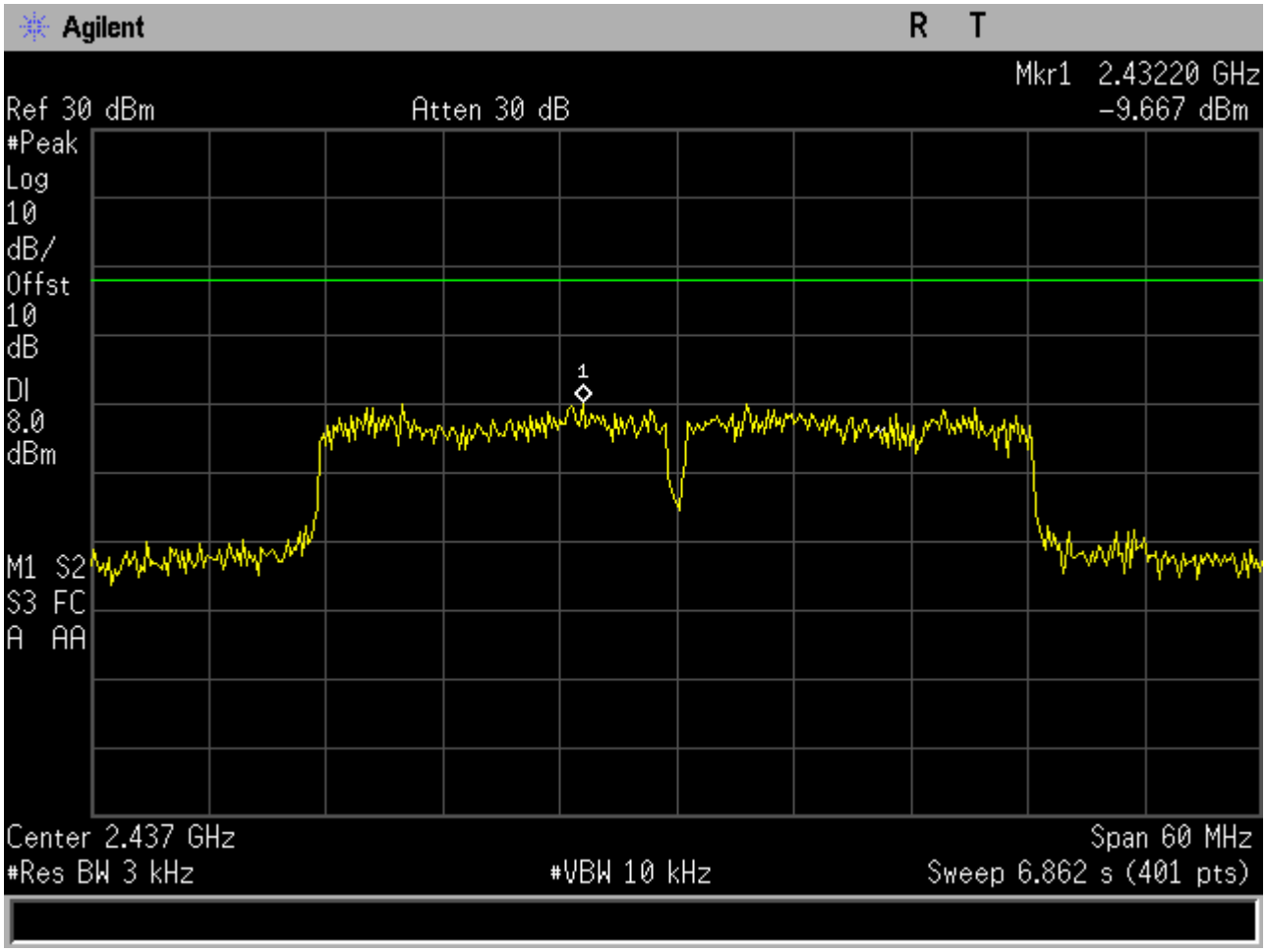
Plot 192. Power Spectral Density, Bandwidth 20M, Ch. 2437M, n mode, Port 1



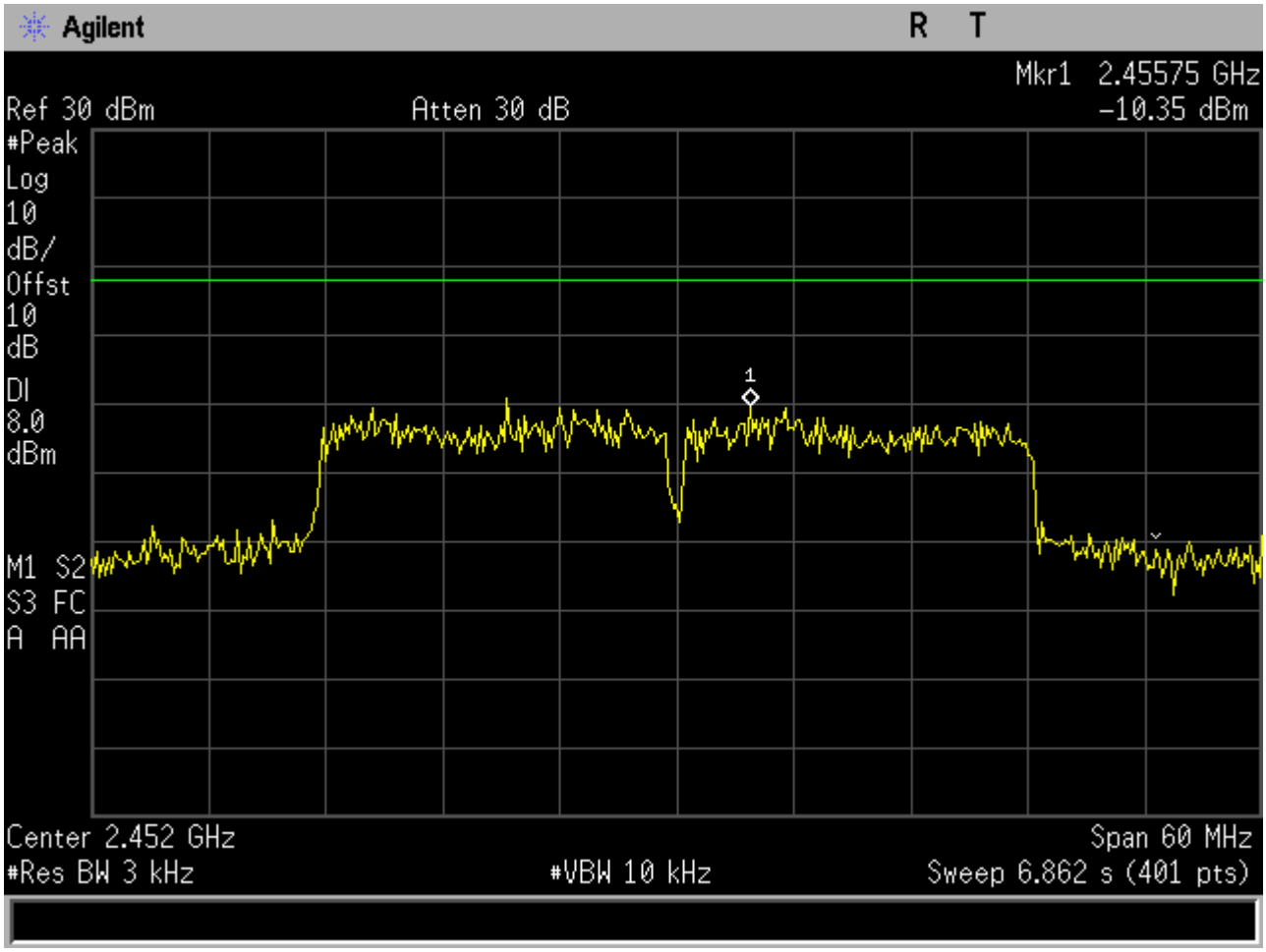
Plot 193. Power Spectral Density, Bandwidth 20M, Ch. 2462M, n mode, Port 1



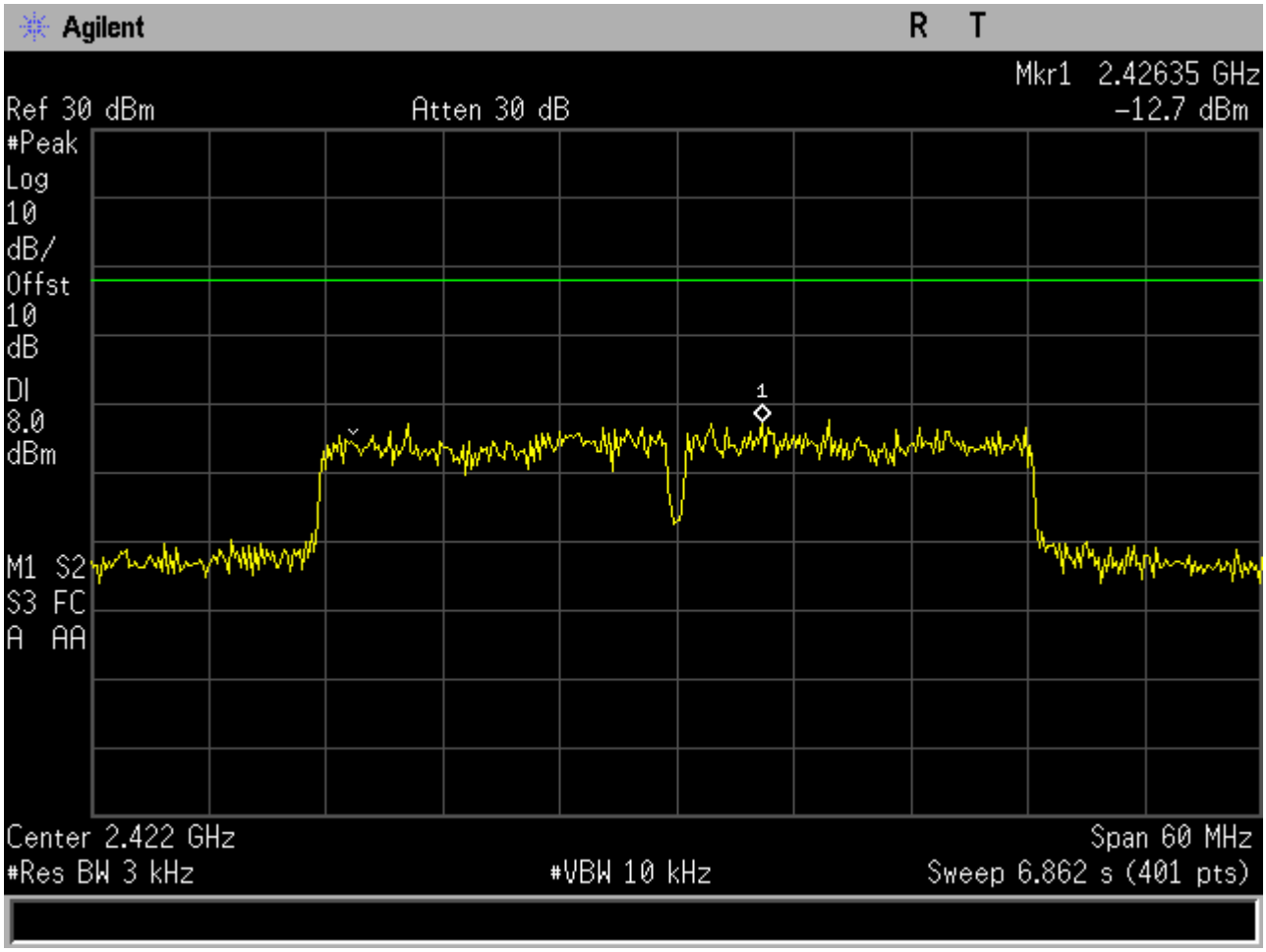
Plot 194. Power Spectral Density, Bandwidth 40M, Ch. 2422M, n mode, Port 1



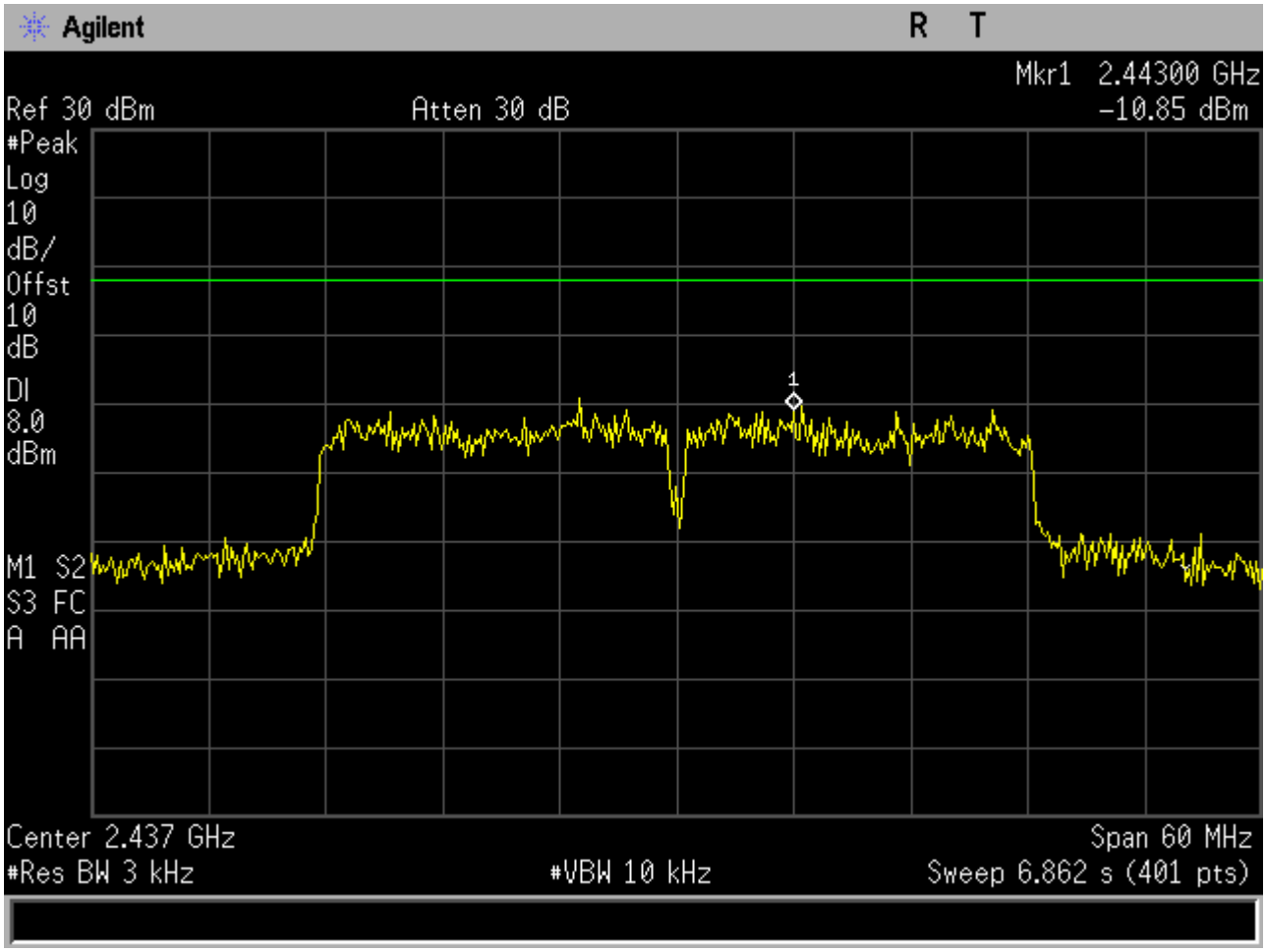
Plot 195. Power Spectral Density, Bandwidth 40M, Ch. 2437M, n mode, Port 1



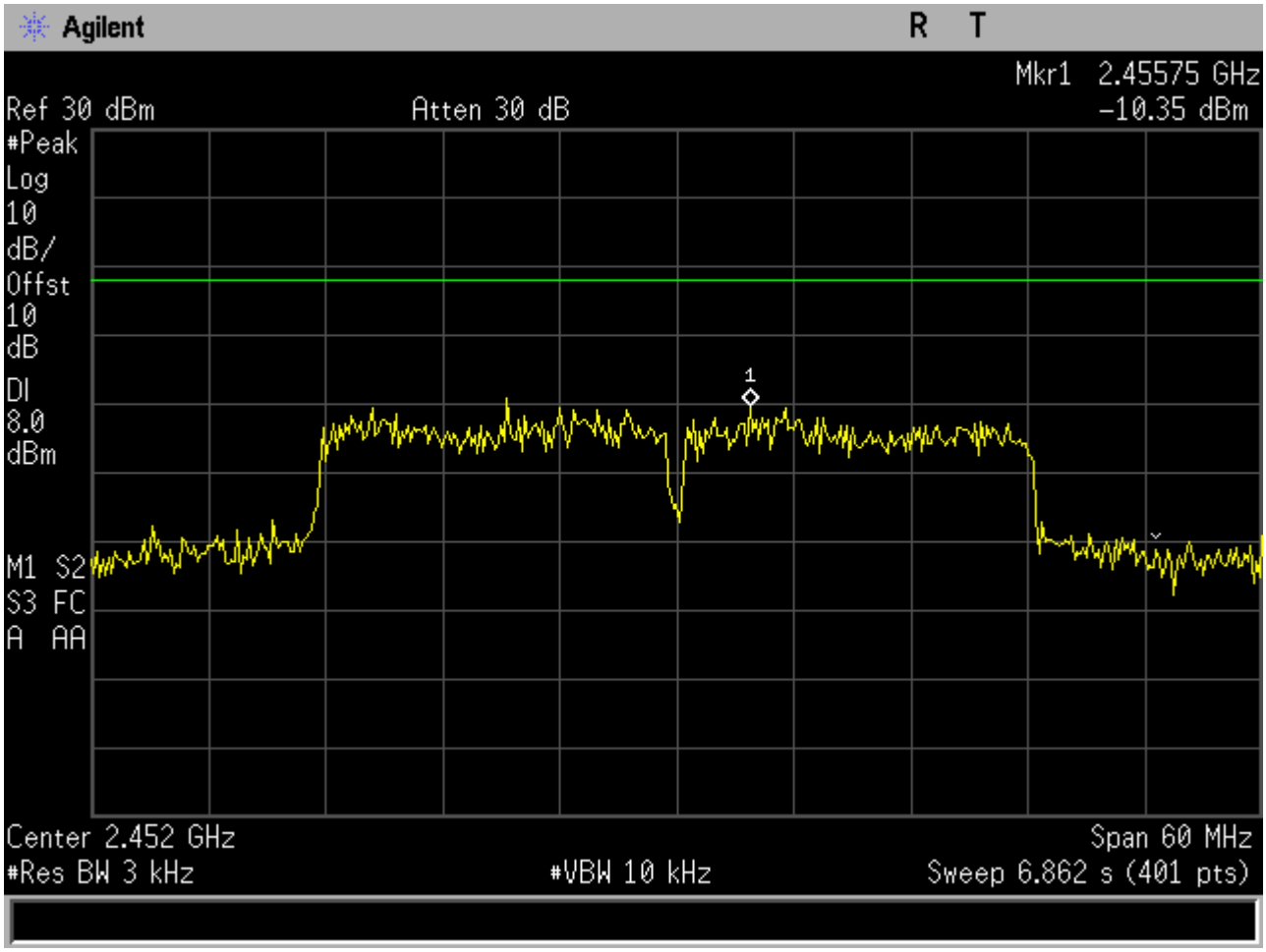
Plot 196. Power Spectral Density, Bandwidth 40M, Ch. 2452M, n mode, Port 1



Plot 197. Power Spectral Density, Bandwidth 40M, Ch. 2422M, n mode, Port 2



Plot 198. Power Spectral Density, Bandwidth 40M, Ch. 2437M, n mode, Port 2



Plot 199. Power Spectral Density, Bandwidth 40M, Ch. 2452M, n mode, Port 2

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	10/22/2017
1T4497	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4432B	10/06/2014	2/10/2018
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	2/26/2016	8/26/2017
1T4666	HARMONIC MIXER	HP	11970Q	11/3/2016	5/3/2018
1T4855	WR-06 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M06HWD	SEE NOTE	
1T4853	WR-15 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M15HWA	SEE NOTE	
1T4854	WR-10 HARMONIC MIXER WITH HORN ANTENNA	OML, INC.	M10HWA	SEE NOTE	
1T4857	DIPLEXER	OML, INC.	DPL26 DIPLEXER	SEE NOTE	
1T4666	HARMONIC MIXER	HP	11970Q	11/3/2016	5/3/2018
331T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	

Table 17. Test Equipment List

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

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report

